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FCC LISTED, REGISTRATION NUMBER: 720267

Informe de ensayo nº:
Test report No:

NIE: 49652RRF.001

Test report

USA FCC Part 15.247, 15.209

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.
General Requirements and Information for the Certification of Radio Apparatus.

Identificación del objeto ensayado.....: Identification of item tested	Multimedia System
Marca .....: Trademark	Continental
Modelo y/o referencia tipo .....: Model and /or type reference	NAC EUR wave 2
Other identification of the product .....:	FCC ID:ZFW-NACEUR2
Final HW version .....:	C2
Final SW version .....:	5.15.29.42
Características .....: Features	Radio (FM, AM, DAB band III & L), Navigation (GPS + GLONASS), BT 3.0 EDR, WiFi b, g, n 2.4GHz, External GMSL colour display, CAN interface car, Internal Audio Amplifier, USB plug
Fabricante .....: Manufacturer	Continental Automotive Czech Republic, s.r.o. Prumyslová 1851 – 250 01 Brandýs nad Labem. Czech Republic.
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.247 10-1-15 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-15 Edition: Radiated emission limits; general requirements. Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r05 dated 04/08/2016. 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 RODRIGUEZ Fecha: 2016.10.11 14:42:29 +02'00'
Fecha de realización .....: Date of issue	2016-10-11
Formato de informe No. .....: Report template No	FDT08_18

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Competences and guarantees

AT4 wireless is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

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.

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General conditions

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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
49648/014	Multimedia System	NAC EUR wave 2	P2577	2016-08-22
49648/019	Config board	---	---	2016-08-22
49648/020	Harness	---	---	2016-08-22
49648/021	TTL cable	---	---	2016-08-22

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

   All radiated tests indicated in appendixes A and B.

Auxiliary elements used with the sample S/01:

Control Nº	Description	Manufacture	Model	Serial Nº	Date of reception
48946/005	CAN-Traffic Simulator	Continental	---	---	2016-03-22
49648/022	Micro-USB cable	---	---	---	2016-08-22
CTC-2052-I	Laptop	Dell latitude	E6530	---	2013-12-02

Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
49648/015	Multimedia System	NAC EUR wave 2	---	2016-08-22
49648/019	Config board	---	---	2016-08-22
49648/020	Harness	---	---	2016-08-22
49648/021	TTL cable	---	---	2016-08-22

1. Sample S/02 has undergone following test(s).

   All conducted tests indicated in appendixes A and B.

Auxiliary elements used with the sample S/02:

Control Nº	Description	Manufacture	Model	Serial Nº	Date of reception
48946/005	CAN-Traffic Simulator	Continental	---	---	2016-03-22
49648/022	Micro-USB cable	---	---	---	2016-08-22
CTC-2052-I	Laptop	Dell latitude	E6530	---	2013-12-02

Test sample description

The NAC EUR wave 2 consists of a Multimedia System. NAC EUR wave 2 is an OEM product for PSA. The NAC is connected to the BSI (Boitier de Servitude Intelligent) via CAN Low Speed BUS. Two displays can be connected to the NAC.

Identification of the client

Continental Automotive Rambouillet France SAS

1, rue de Clairefontaine - 78120 Rambouillet France

Testing period

The performed test started on 2016-08-22 and finished on 2016-09-15.

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. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

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

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 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. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

Remarks and comments

1: Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Agilent E4440A	2015/10	2017/10
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.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2014/03	2017/03
6.	EMI Test Receiver R&S ESU 40	2016/03	2018/03
7.	Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
8.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2015/09	2016/09
9.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2016/02	2018/02
10.	RF pre-amplifier 18-40 GHz BONN ELEKTRONIK BLMA 1840-1M	2015/12	2017/12

Testing verdicts

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

1. BT EDR

FCC PART 15 PARAGRAPH		VERDICT			
		NA	P	F	NM
FCC 15.247 Subclause (a) (1)	20 dB Bandwidth and Carrier frequency separation		P		
FCC 15.247 Subclause (a)(1)(iii)	Number of hopping channels		P		
FCC 15.247 Subclause (a)(1)(iii)	Time of occupancy (Dwell Time)		P		
FCC 15.247 Subclause (b)	Maximum peak output power and antenna gain		P		
FCC 15.247 Subclause (d)	Emission limitations conducted (Transmitter)		P		
FCC 15.247 Subclause (d)	Emission limitations radiated (Transmitter)		P		

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

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

Appendix A – Test result (Bluetooth EDR)

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TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 12.0 Vdc

Type of power supply = DC voltage from battery.

Type of antenna = Integral antenna.

Declared Gain for antenna (maximum) = -0.99 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 directly connected to the spectrum analyzer.

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

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna 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).

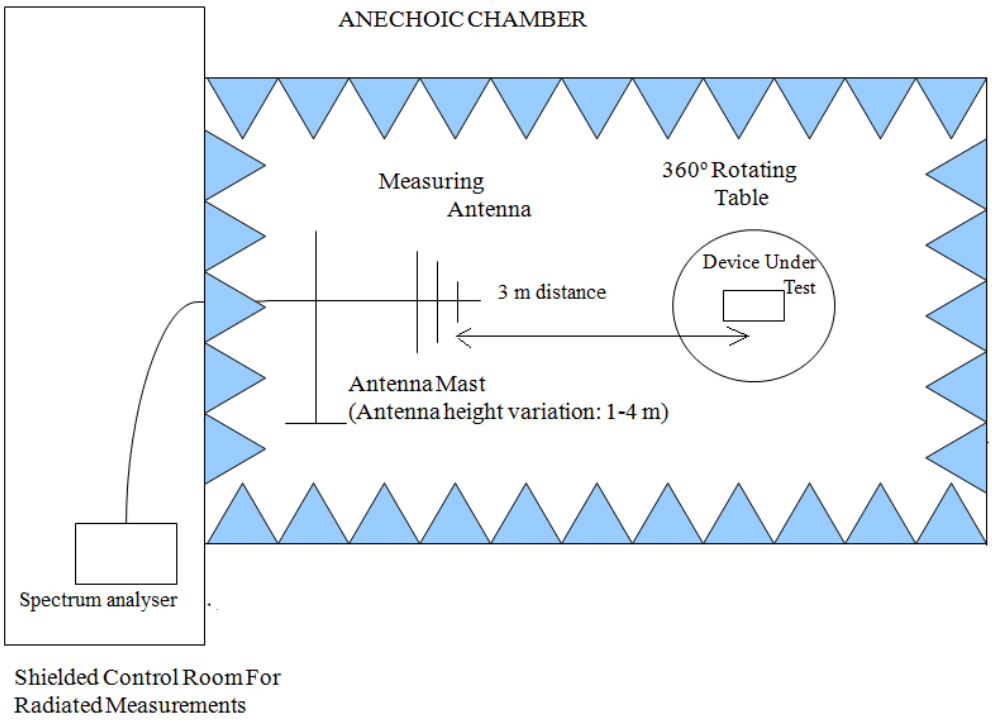
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission.

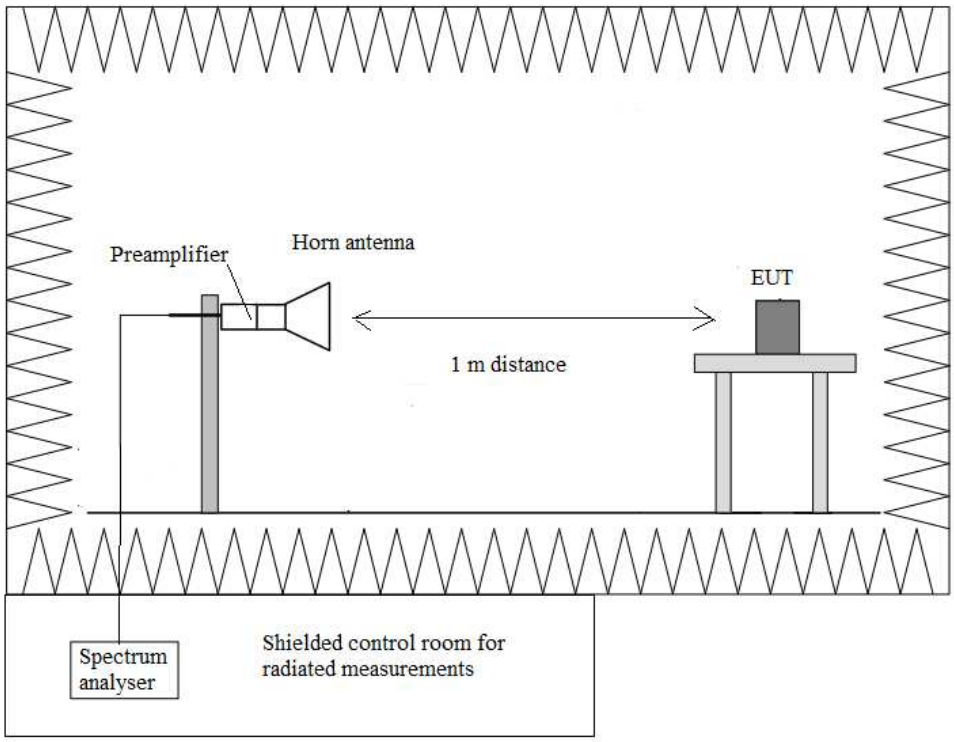
It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



FCC Section 15.247 Subclause (a) (1). 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)	948.463	945.421	947.463
Measurement uncertainty (kHz)	<±5.00		

Modulation: Π/4-DQPSK (2Mbps)

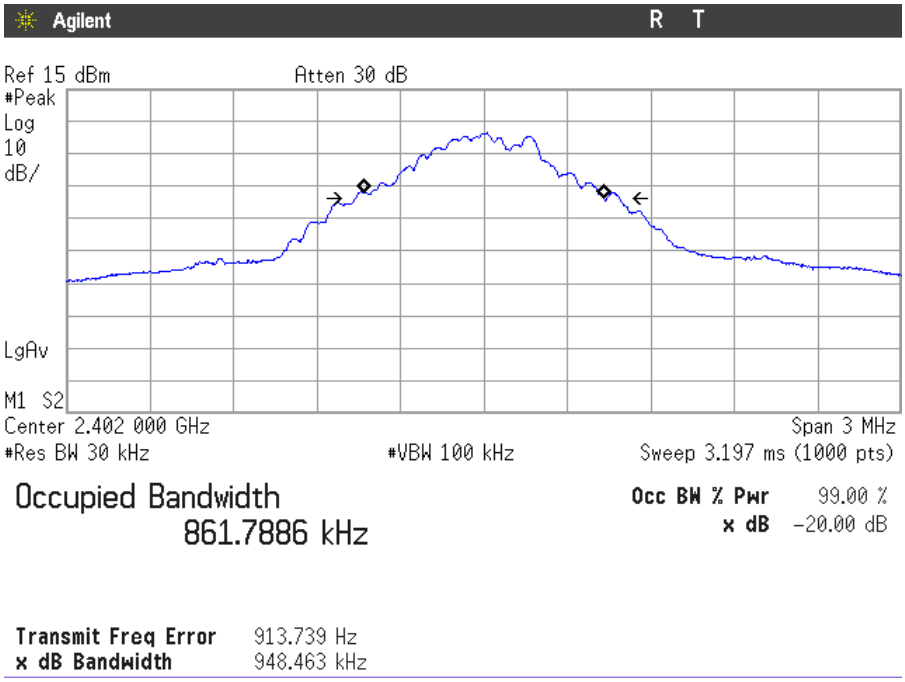
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1318	1318	1319
Measurement uncertainty (kHz)	<±5.00		

Modulation: 8-DPSK (3Mbps)

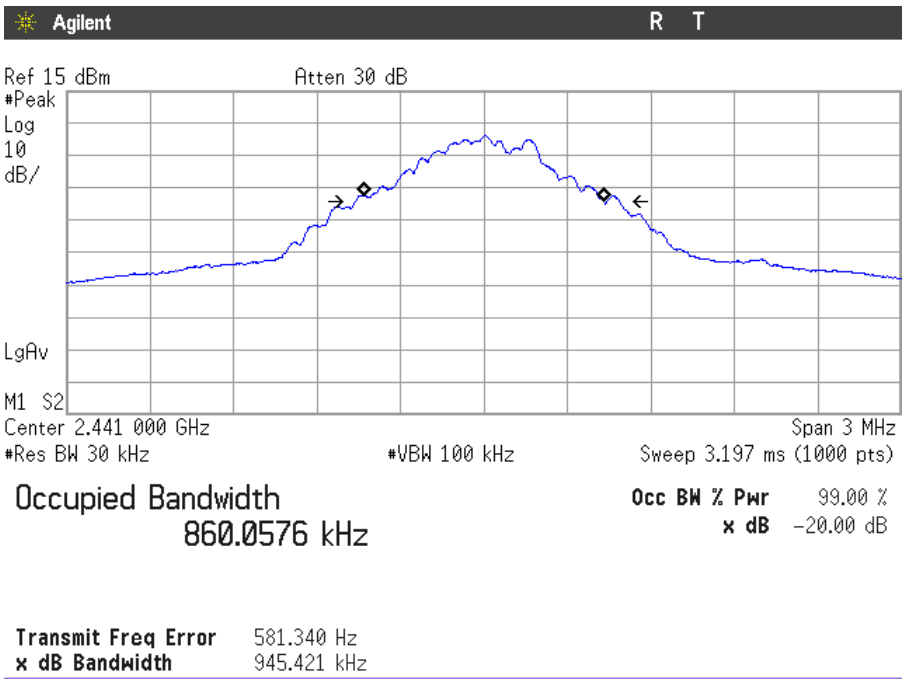
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1304	1304	1305
Measurement uncertainty (kHz)	<±5.00		

Modulation: GFSK

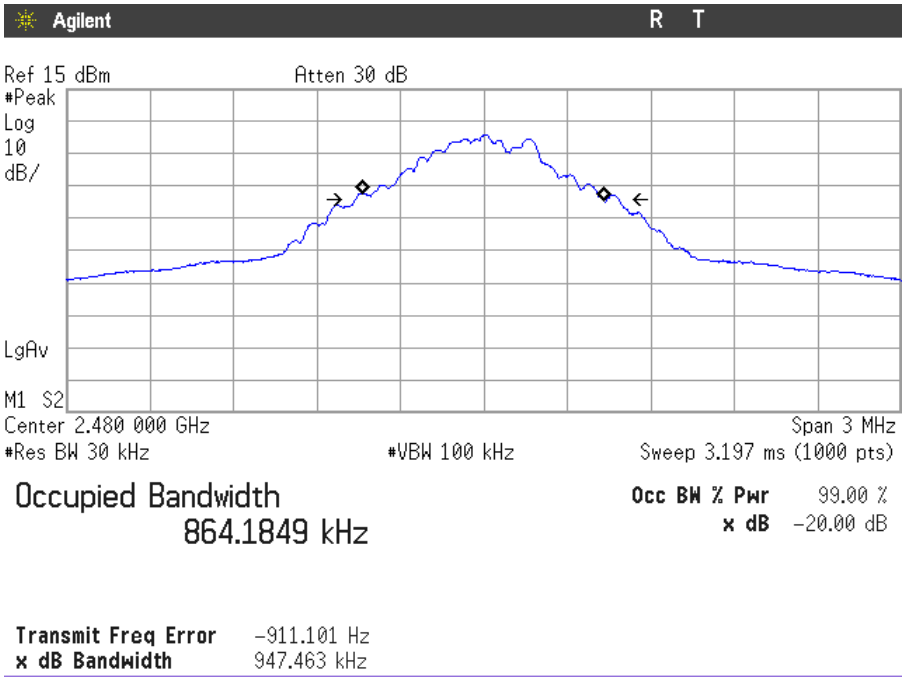
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



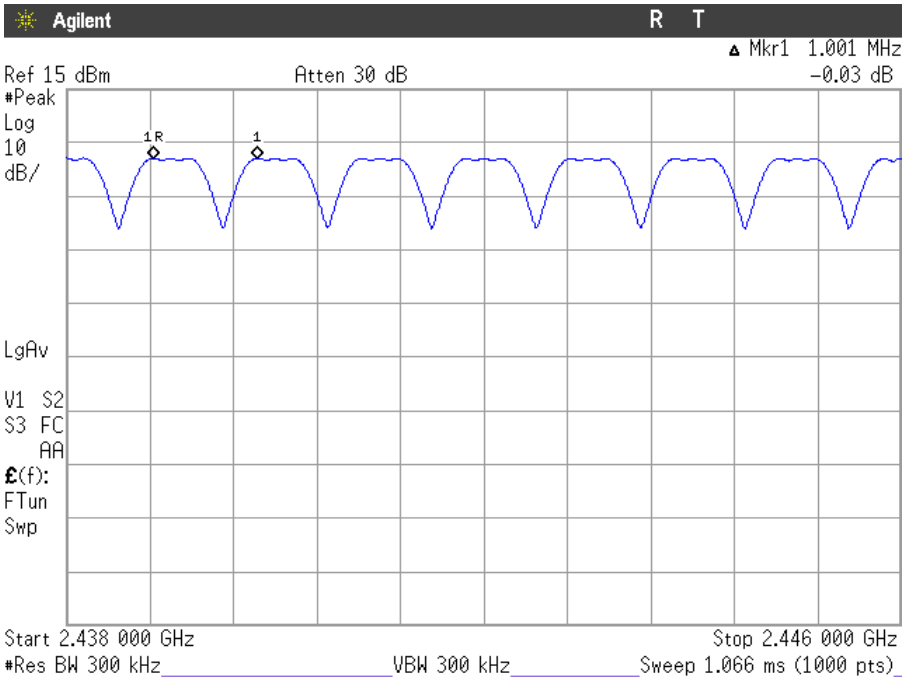
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation

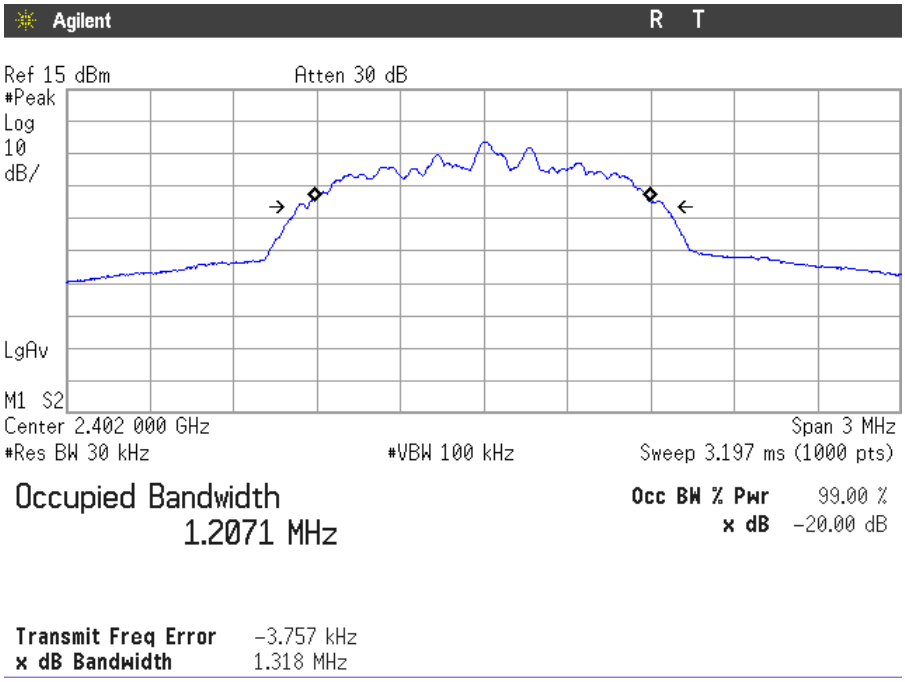


The hopping channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

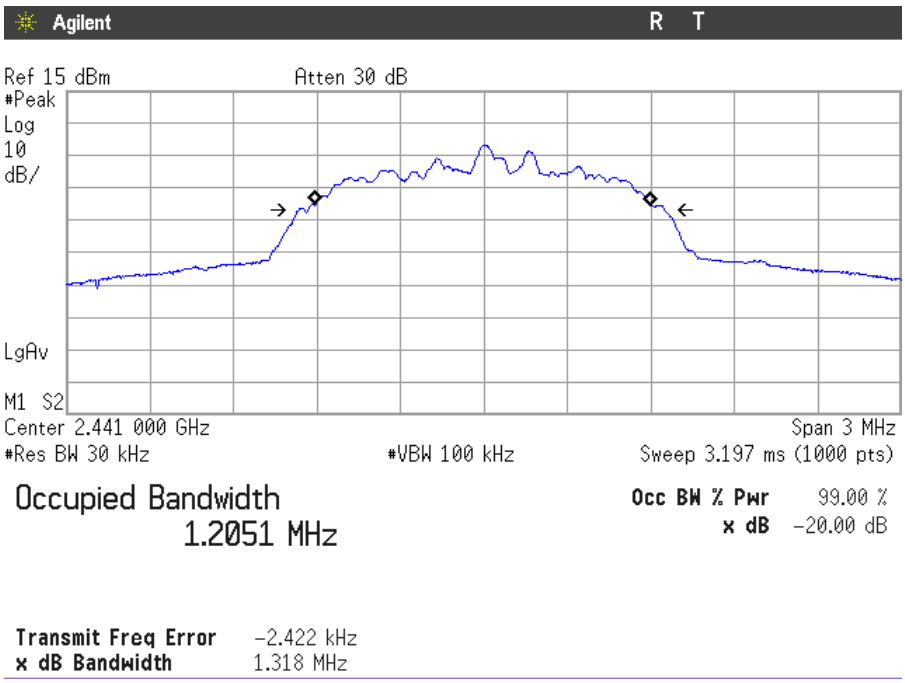
Verdict: PASS

Modulation: Π/4-DQPSK

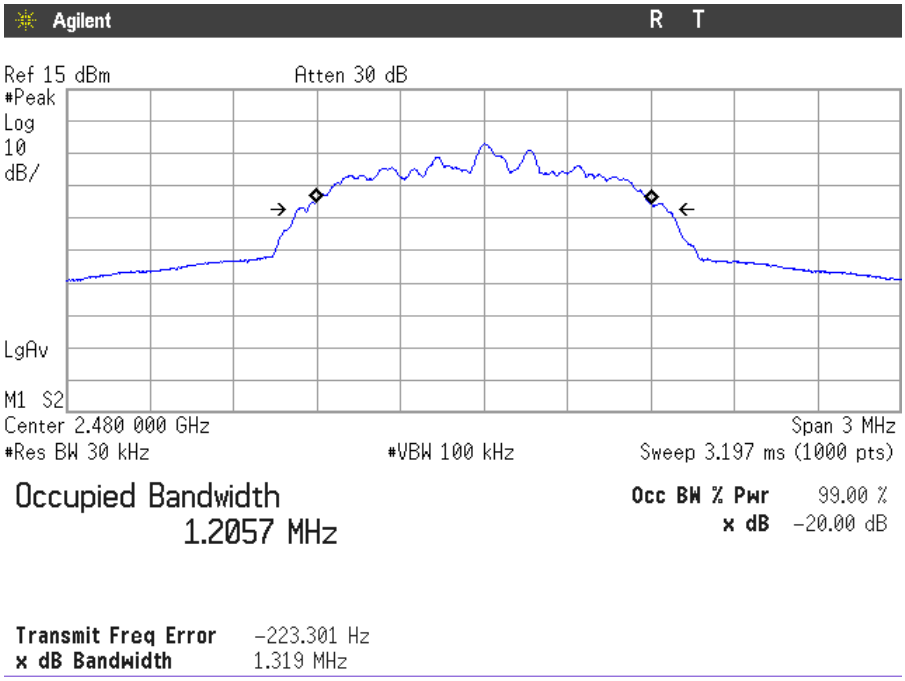
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



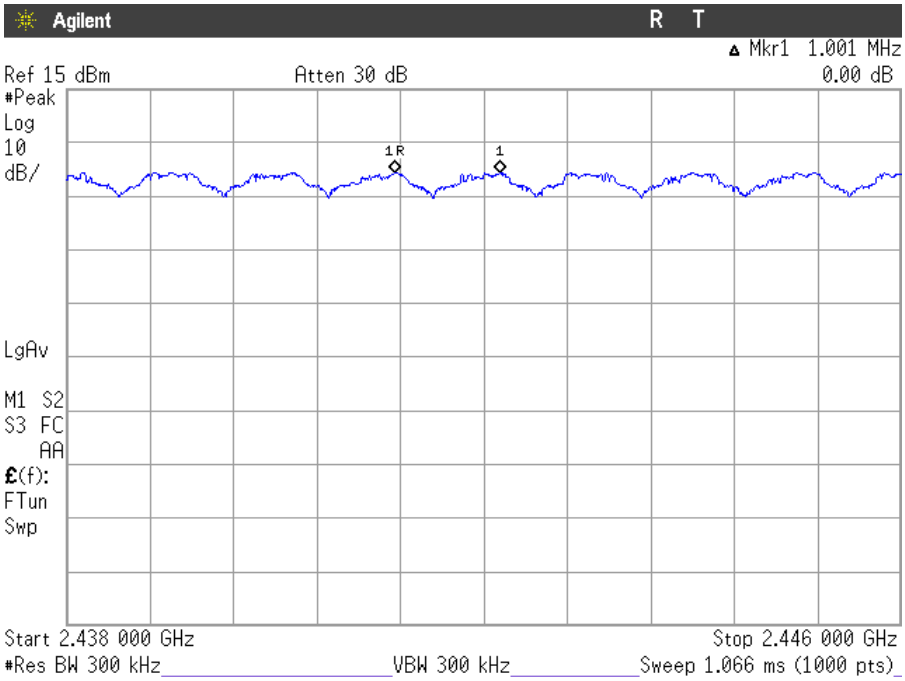
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation

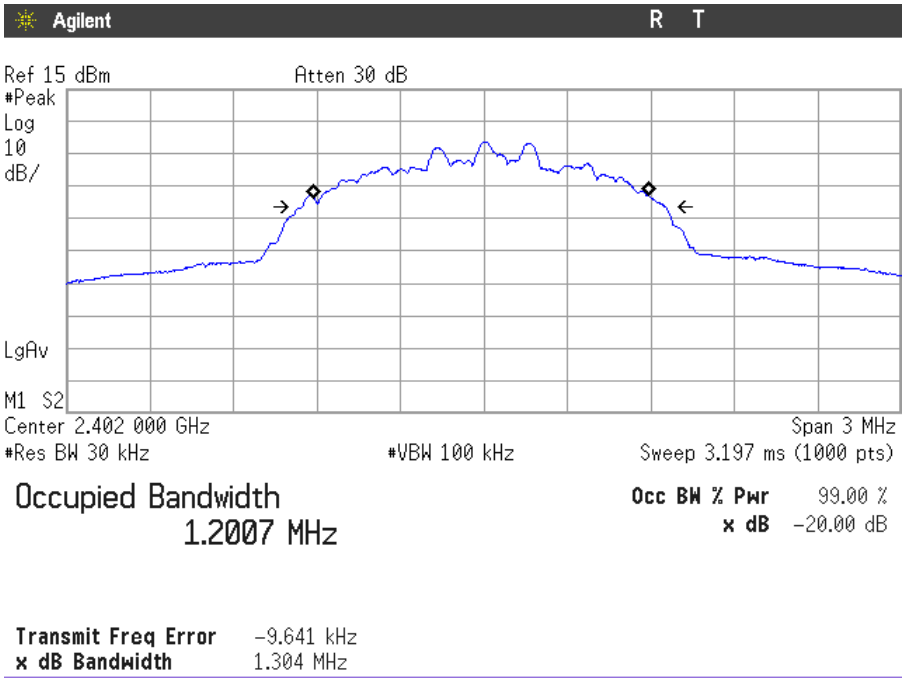


The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel

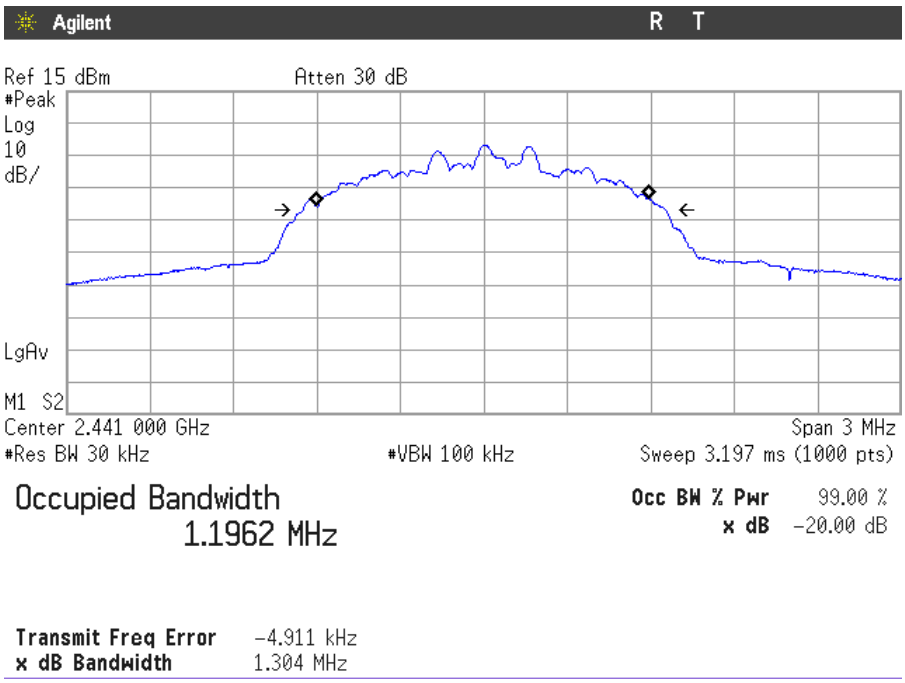
Verdict: PASS

Modulation: 8-DPSK

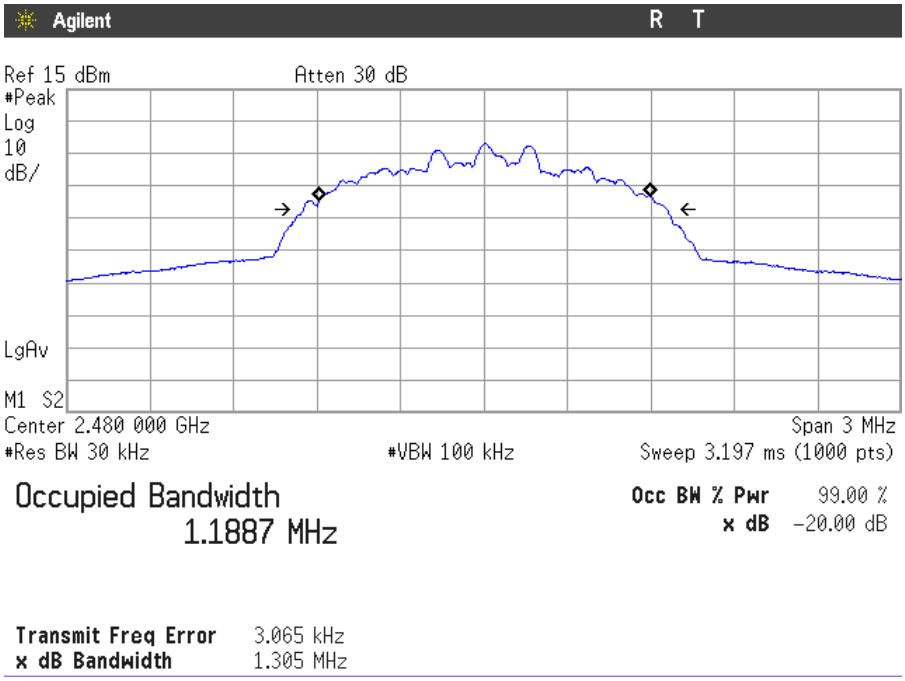
20 dB BANDWIDTH Lowest Channel: 2402 MHz.



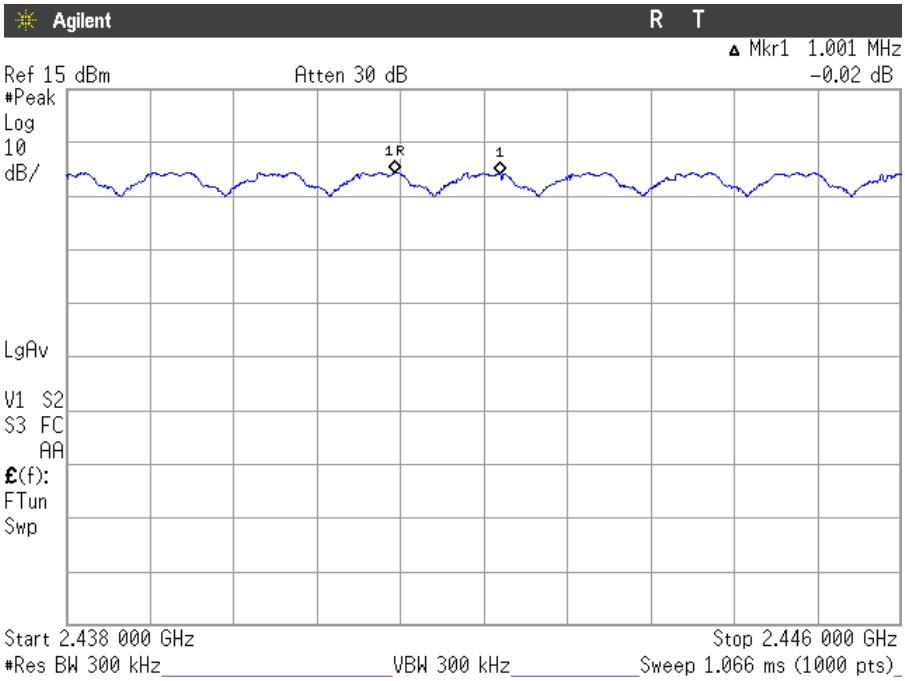
20 dB BANDWIDTH Middle Channel: 2441 MHz.



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). Number of hopping channels

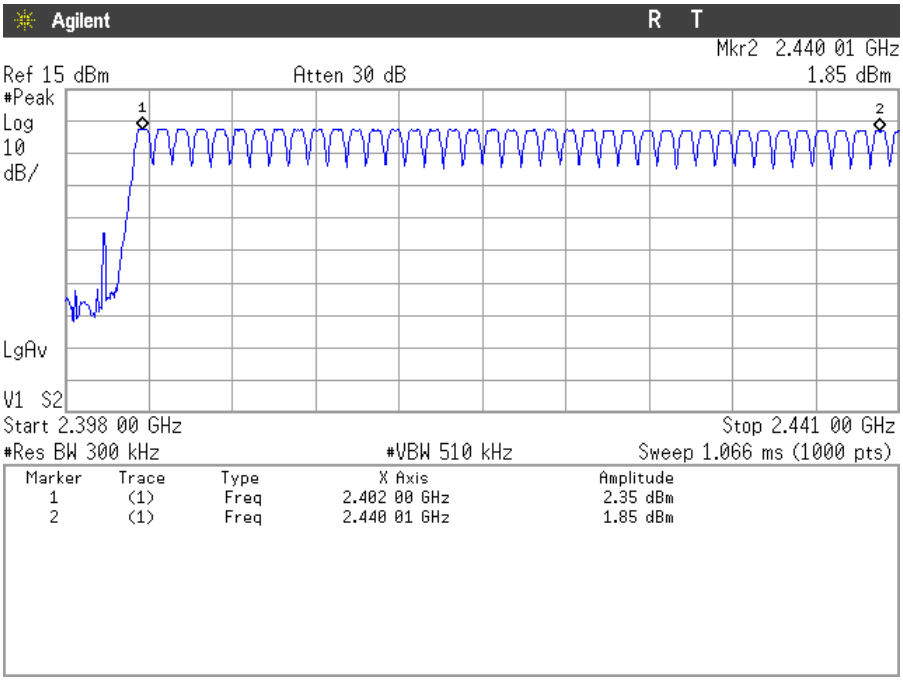
SPECIFICATION

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

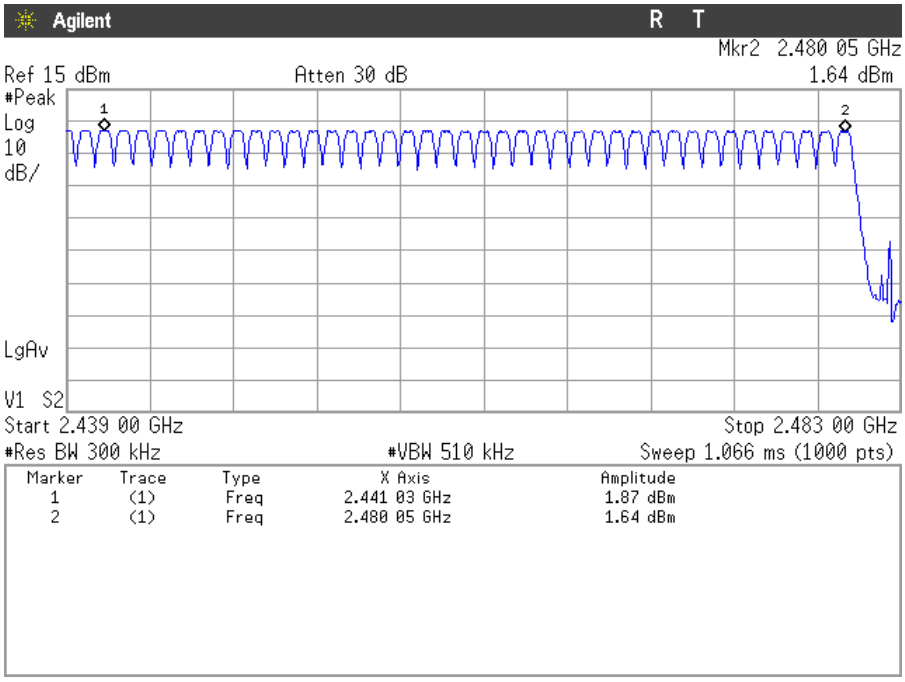
RESULTS

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

Modulation: GFSK



Number of hopping frequencies: 39

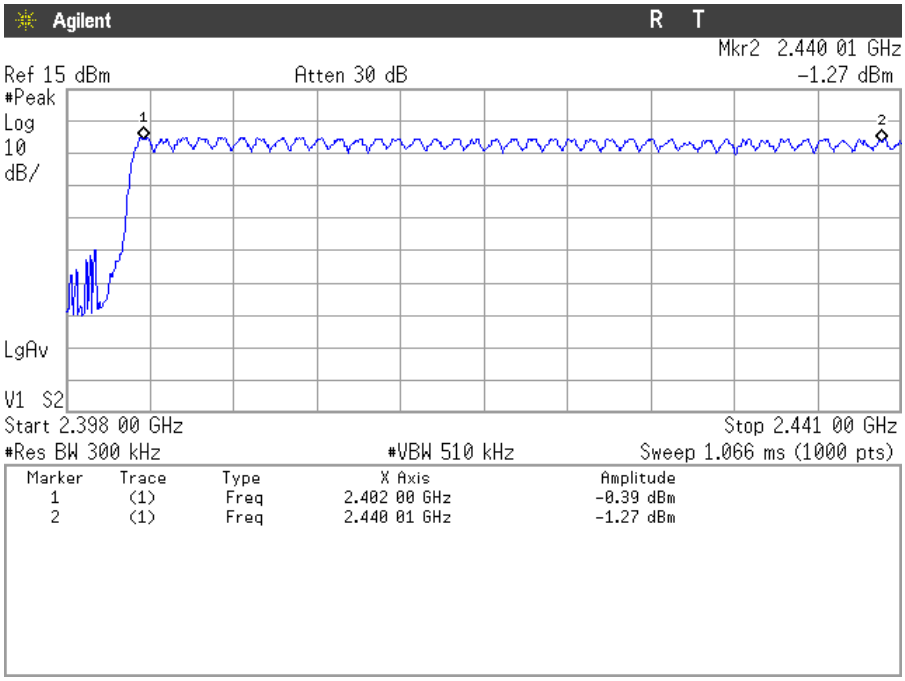


Number of hopping frequencies: 40

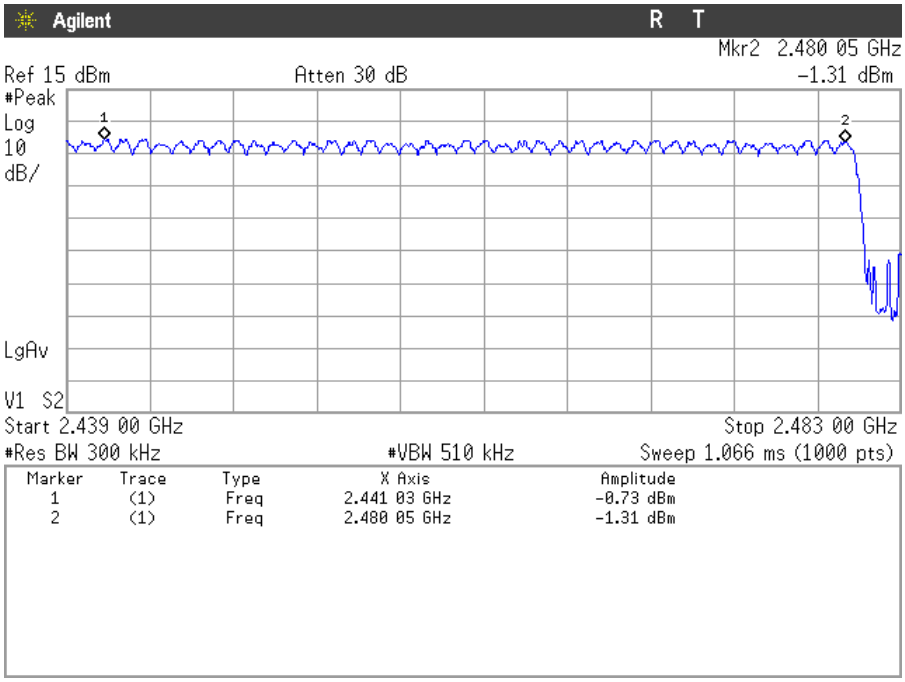
Total number of hopping frequencies: 79

Verdict: PASS

Modulation: Π/4-DQPSK



Number of hopping frequencies: 39

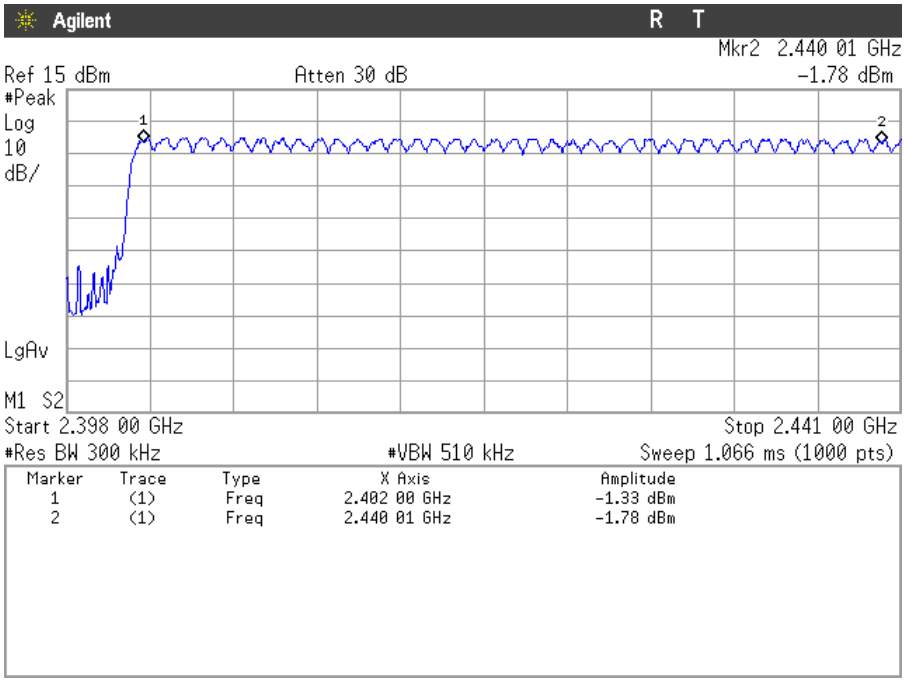


Number of hopping frequencies: 40

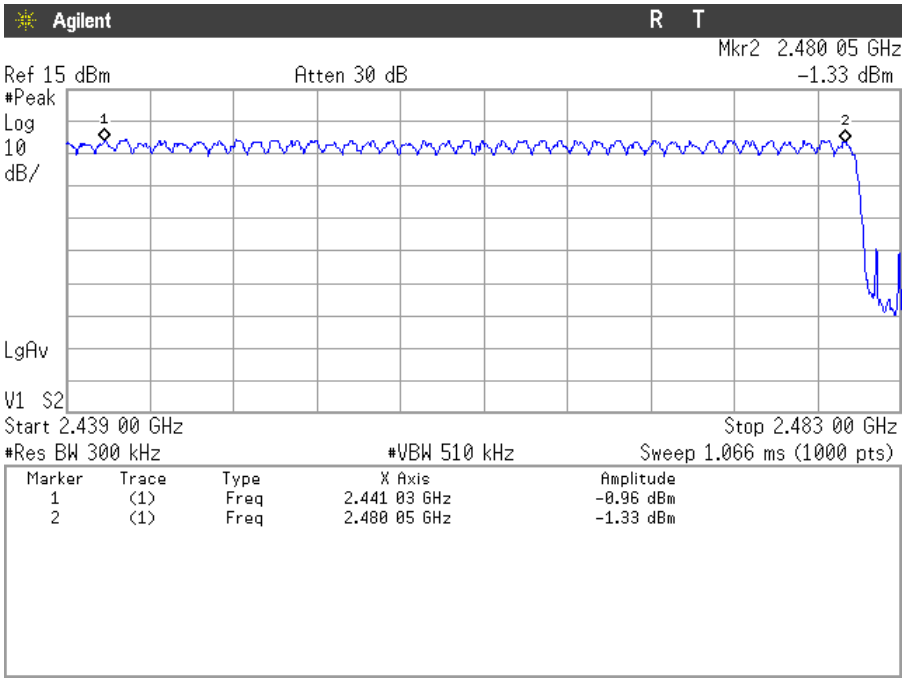
Total number of hopping frequencies: 79

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). Time of occupancy (Dwell Time)

SPECIFICATION

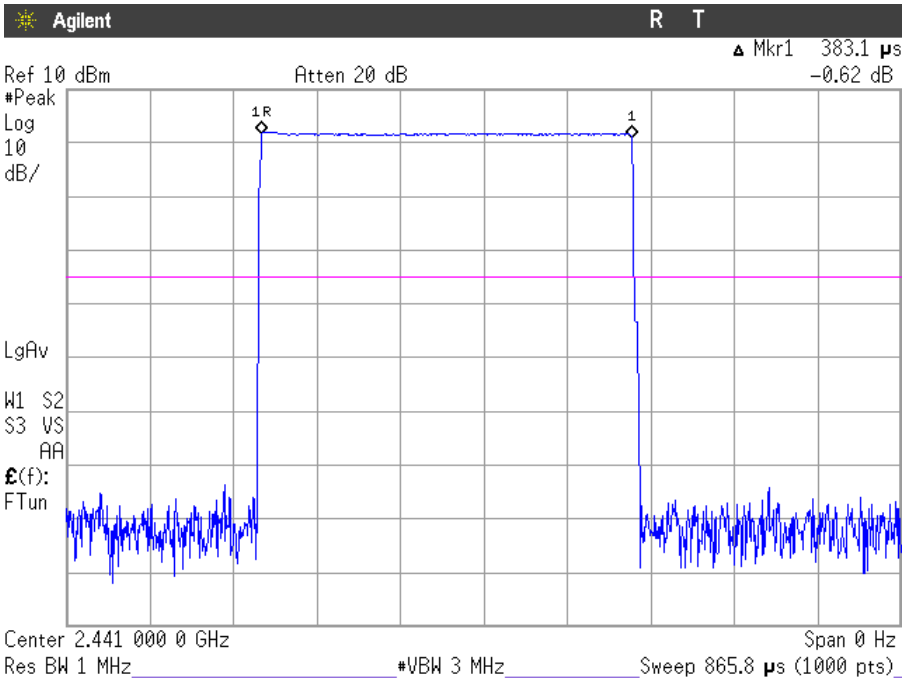
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = 0.4 x 79= 31.6 seconds.

RESULTS

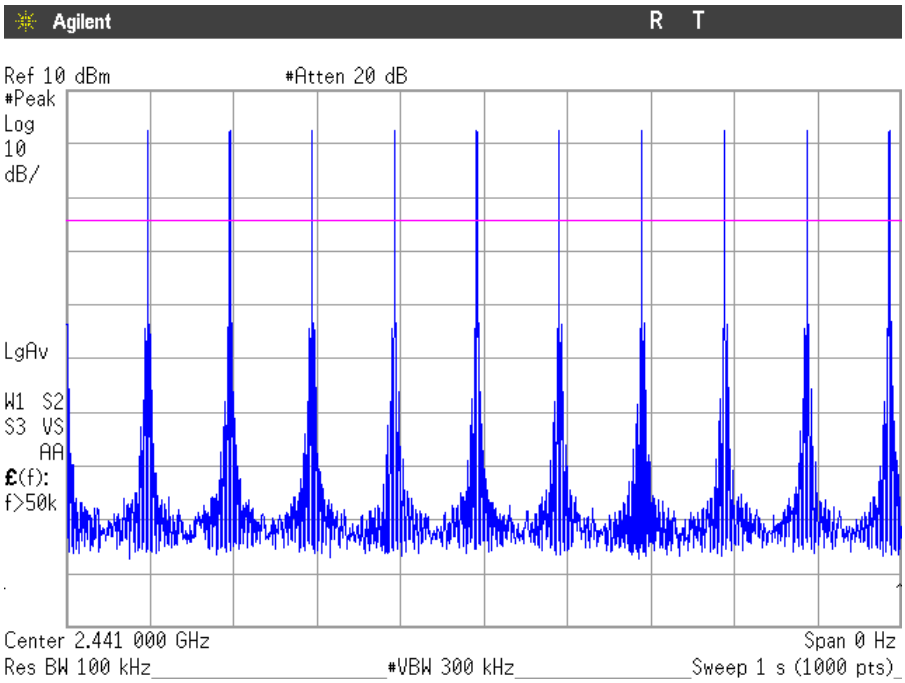
Modulation: GFSK

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

- Tx- time per hop = 383.1µs (see next plot).



- Number of hops over a period of 1 second = 10 (see next plot).



Number of hops in the period specified in the requirements = (10 hops) x (31.6 s / 1 s) = 316 hops.

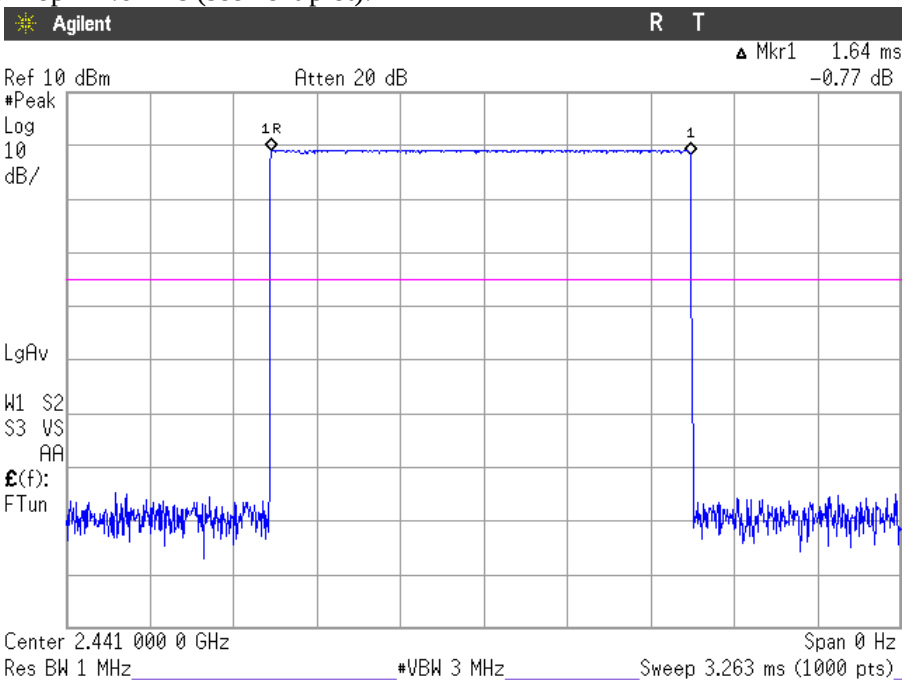
Averaging time of occupancy = 383.1 µs x 316 hops = 121.06 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

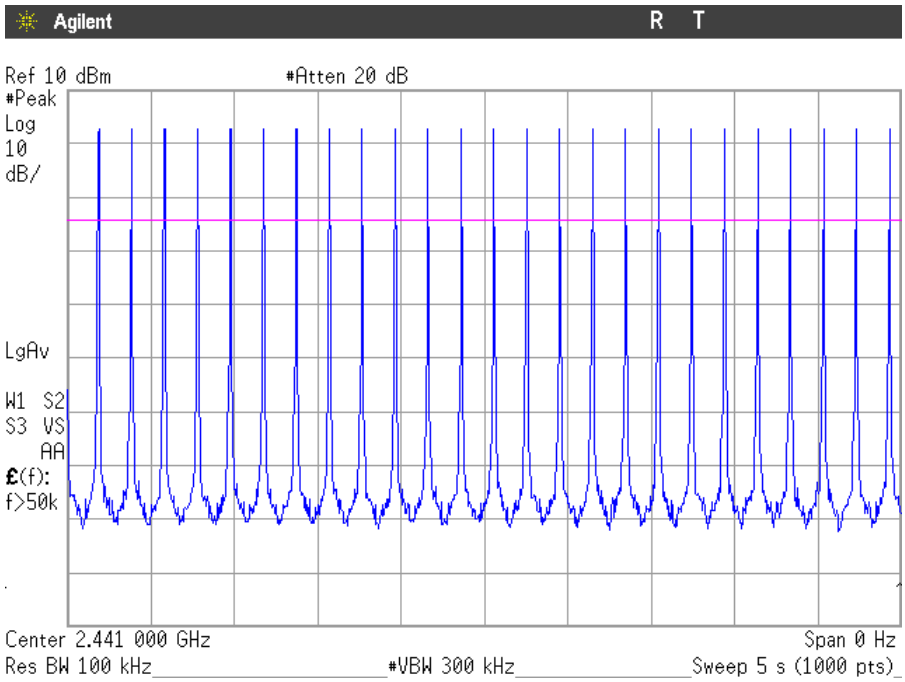
Verdict: PASS

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

- Tx- time per hop = 1.64 ms (see next plot).



- Number of hops over a period of 5 seconds = 25 (see next plot).



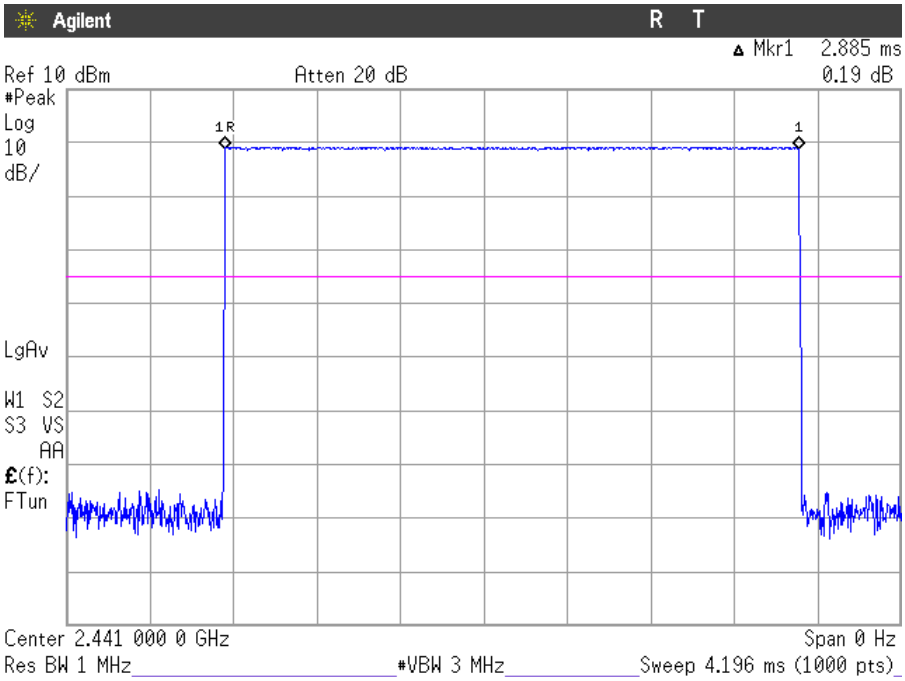
Number of hops in the period specified in the requirements = (25 hops) x (31.6 s / 5 s) = 158 hops.
Averaging time of occupancy = 1.64 ms x 158 hops = 259.12 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

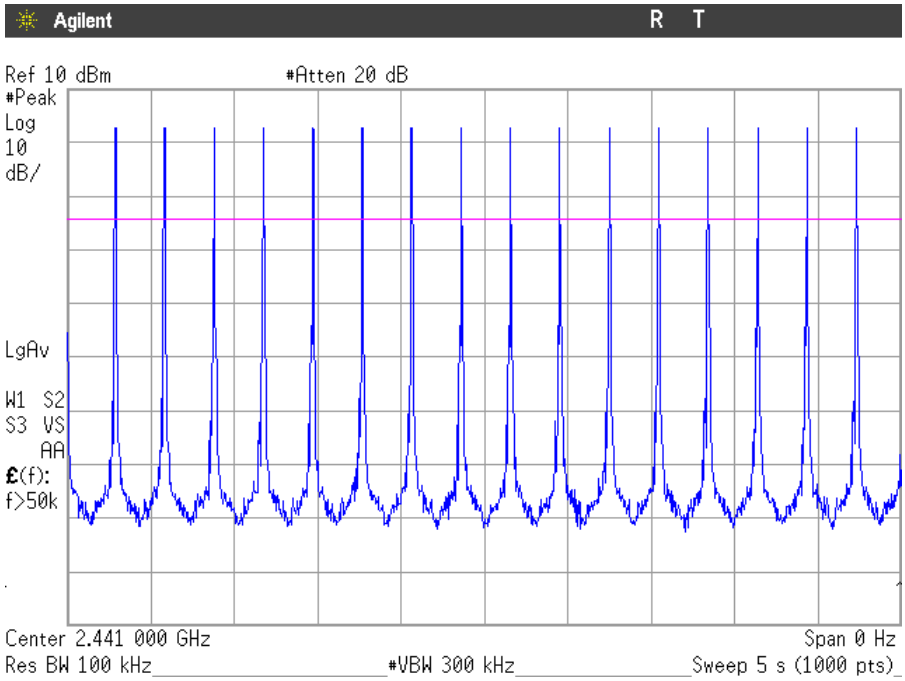
Verdict: PASS

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

- Tx- time per hop = 2.885 ms (see next plot).



- Number of hops over a period of 5 seconds = 16 (see next plot).



Number of hops in the period specified in the requirements = (16 hops) x (31.6 s / 5 s) = 101.12 hops.
Averaging time of occupancy = 2.885 ms x 101.12 hops = 291.732 ms per 31.6 seconds.

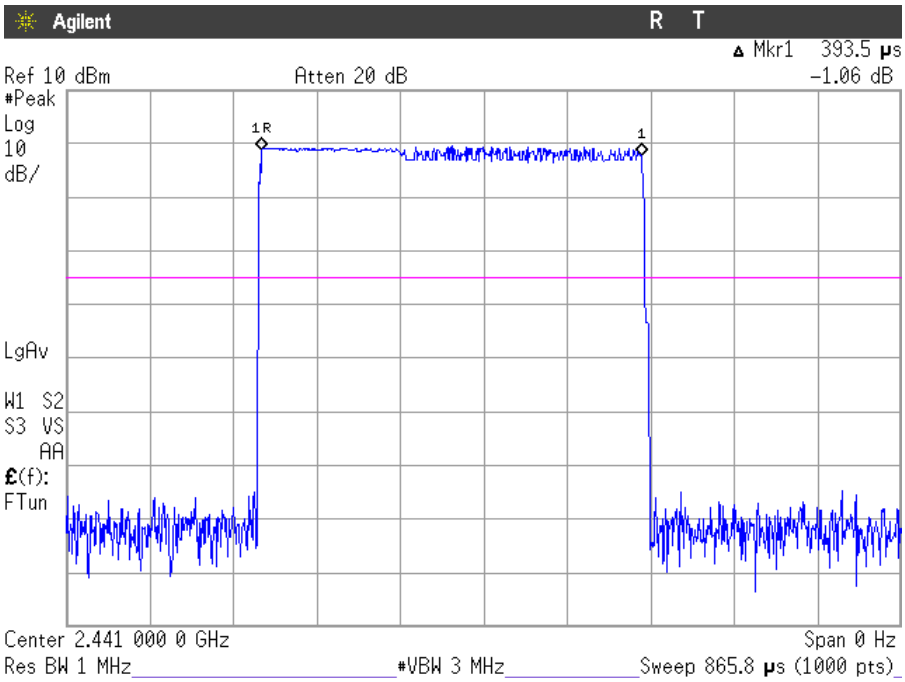
Measurement uncertainty (%)	<±0.01

Verdict: PASS

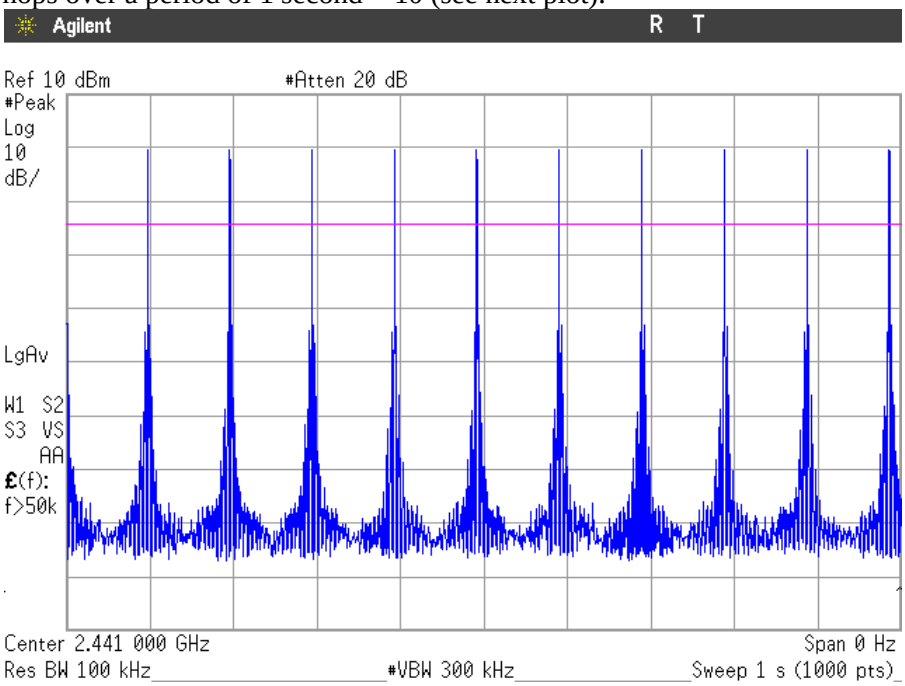
Modulation: Π/4-DQPSK

1. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 2-DH1.

- Tx- time per hop = 393.5 µs (see next plot).



- Number of hops over a period of 1 second = 10 (see next plot).



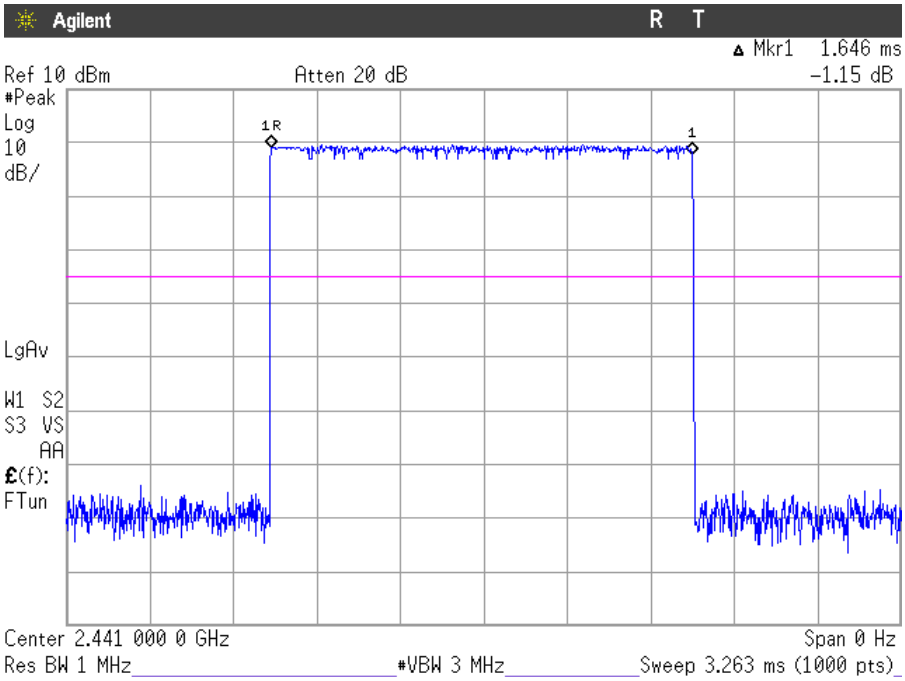
Number of hops in the period specified in the requirements = (10 hops) x (31.6 s / 1 s) = 316 hops.
Averaging time of occupancy = 393.5 µs x 316 hops = 124.35 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

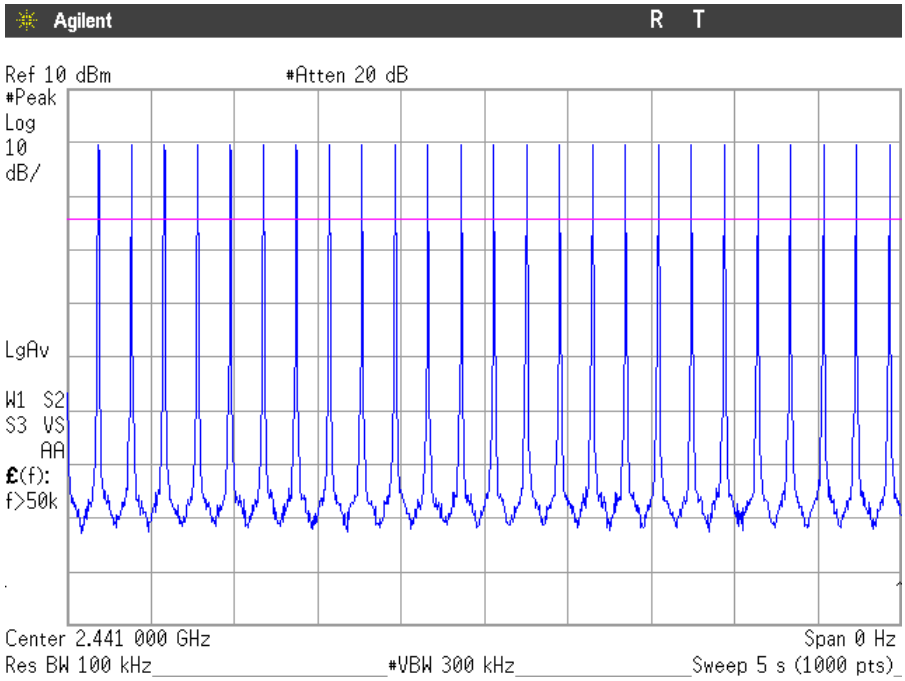
Verdict: PASS

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

- Tx- time per hop = 1.646 ms (see next plot).



- Number of hops over a period of 5 seconds = 25(see next plot).



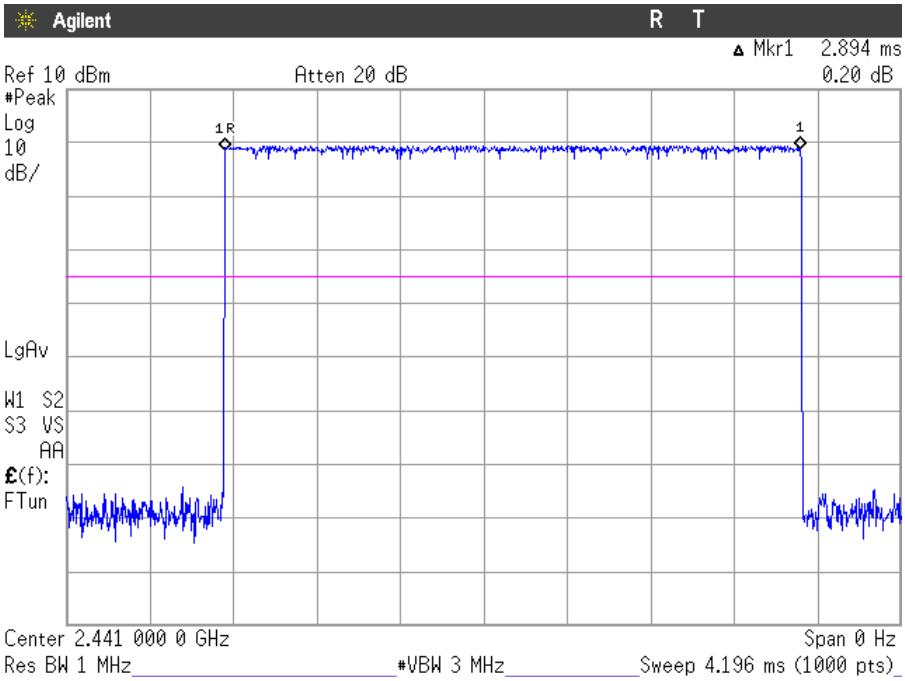
Number of hops in the period specified in the requirements = (25 hops) x (31.6 s / 5 s) = 158 hops.
Averaging time of occupancy = 1.646 ms x 158 hops = 260.07 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

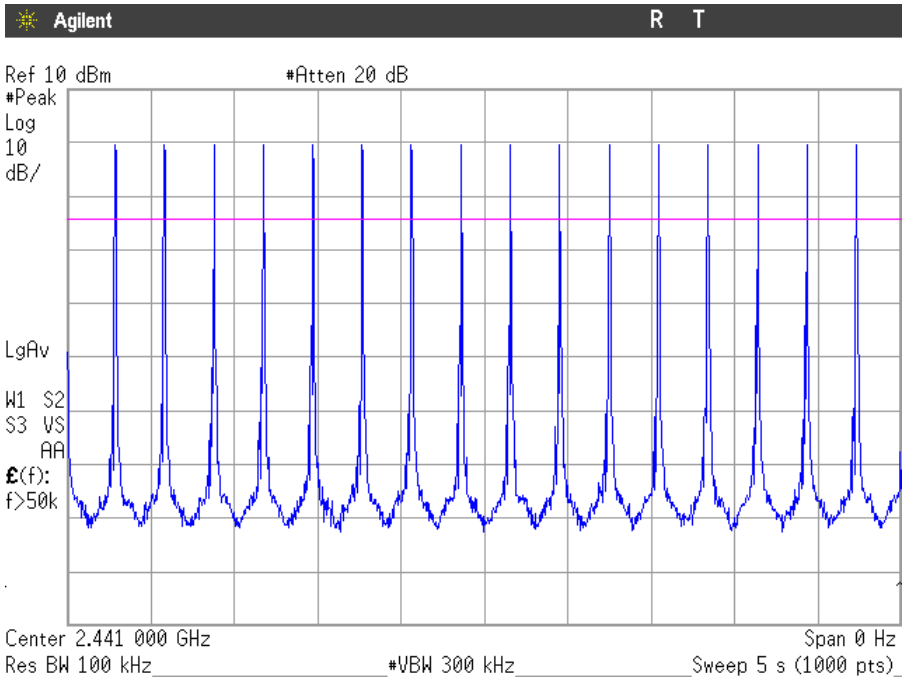
Verdict: PASS

3. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 2-DH5.

- Tx- time per hop = 2.894 ms (see next plot).



- Number of hops over a period of 5 seconds = 16 (see next plot).



Number of hops in the period specified in the requirements = (16 hops) x (31.6 s / 5 s) = 101.12 hops.
Averaging time of occupancy = 2.894 ms x 101.12 hops = 292.64 ms per 31.6 seconds.

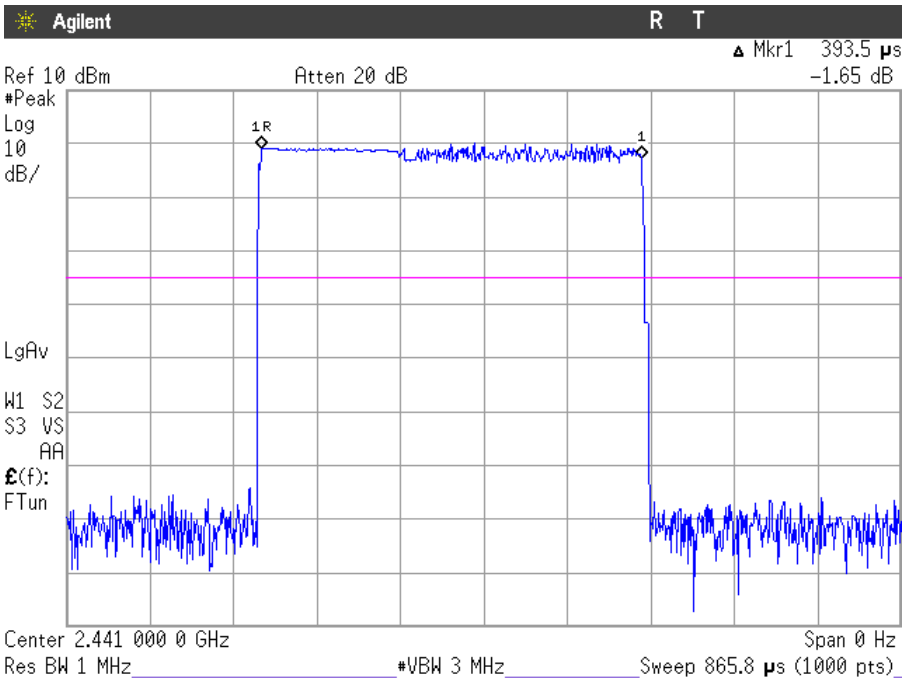
Measurement uncertainty (%)	<±0.01

Verdict: PASS

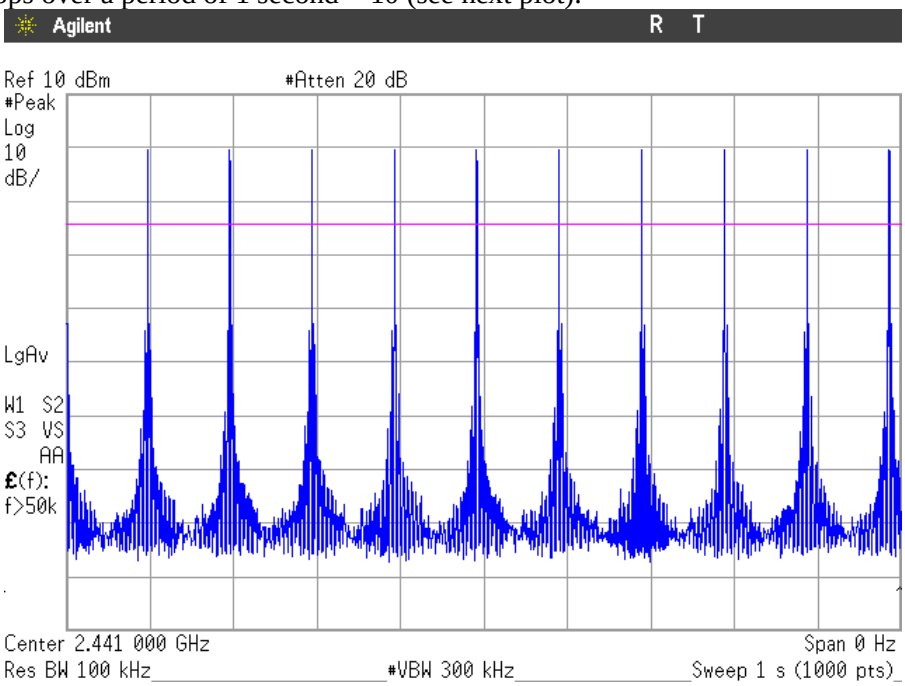
Modulation: 8-DPSK

1. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 3-DH1.

- Tx- time per hop = 393.5 µs (see next plot).



- Number of hops over a period of 1 second = 10 (see next plot).



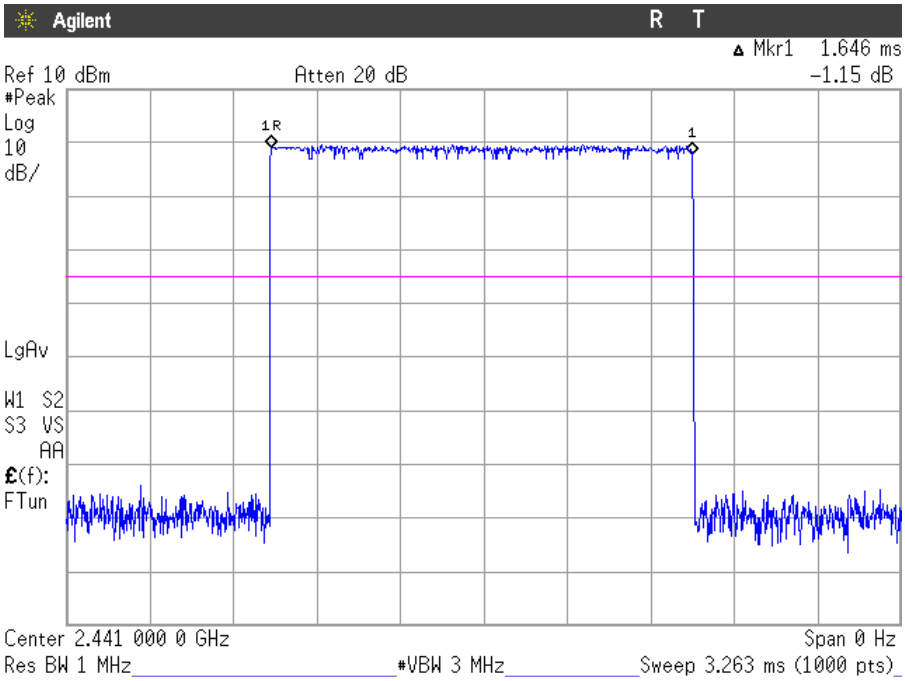
Number of hops in the period specified in the requirements = (10 hops) x (31.6 s / 1 s) = 316 hops.
Averaging time of occupancy = 393.5 µs x 316 hops = 124.35 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

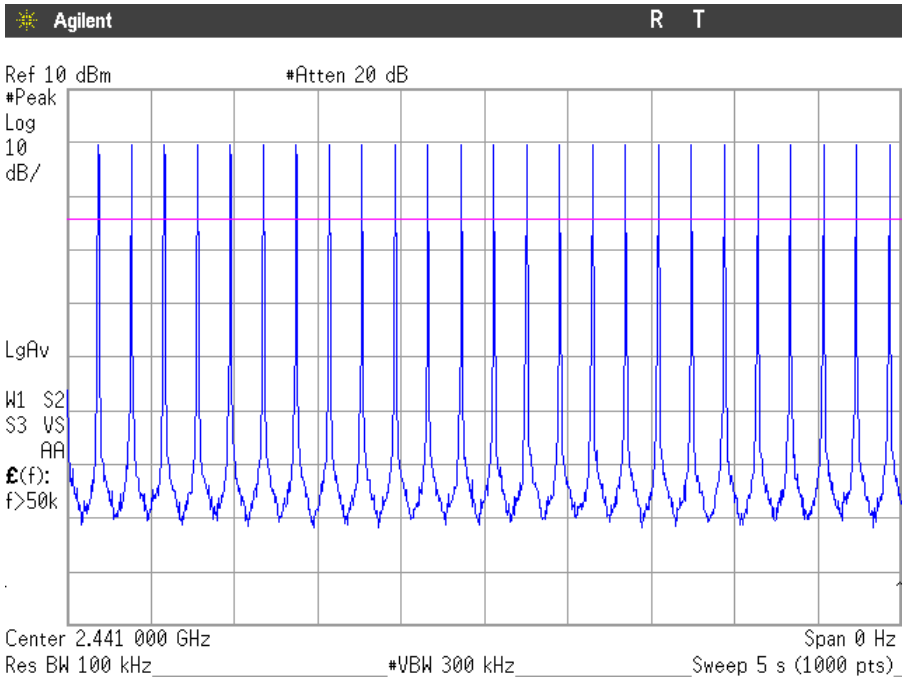
Verdict: PASS

2. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 3-DH3.

- Tx- time per hop = 1.646 ms (see next plot).



- Number of hops over a period of 5 seconds = 25 (see next plot).



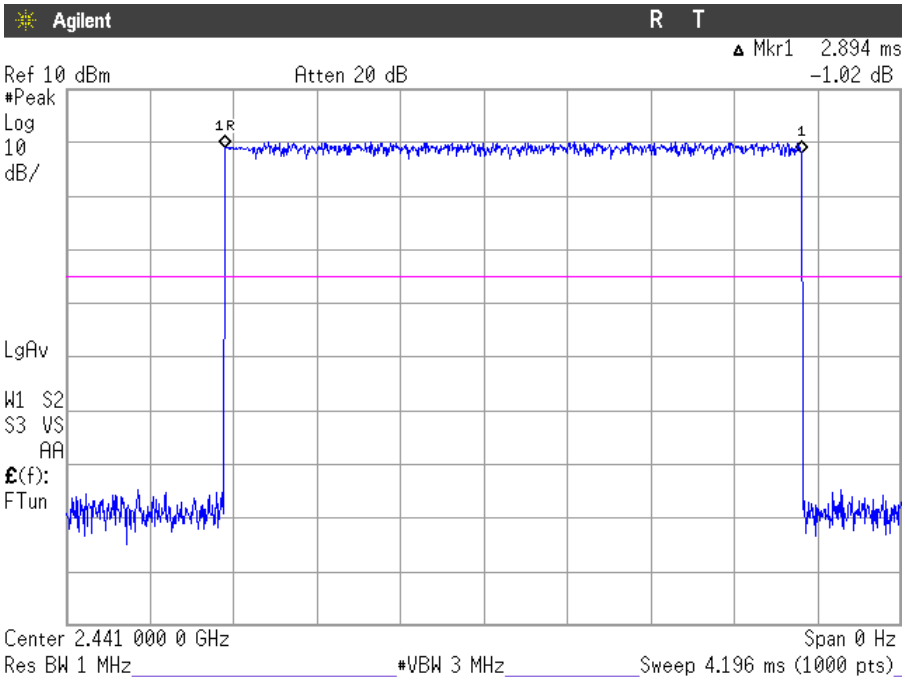
Number of hops in the period specified in the requirements = (25 hops) x (31.6 s / 5 s) = 158 hops.
Averaging time of occupancy = 1.646 ms x 158 hops = 260.07 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

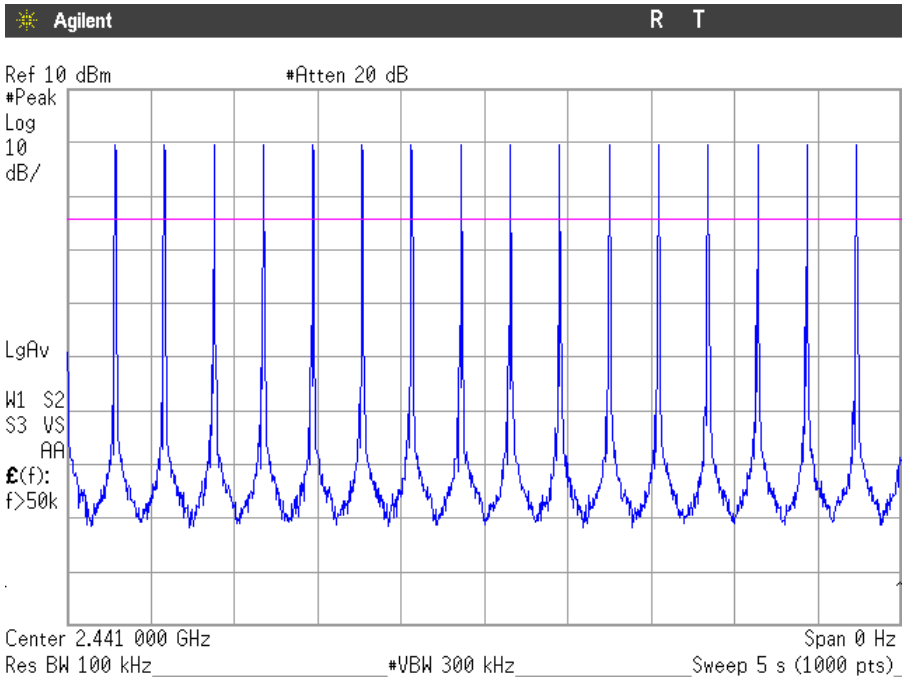
Verdict: PASS

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

- Tx- time per hop = 2.894 ms (see next plot).



- Number of hops over a period of 5 seconds = 16 (see next plot).



Number of hops in the period specified in the requirements = (16 hops) x (31.6 s / 5 s) = 101.12 hops.
Averaging time of occupancy = 2.894 ms x 101.12 hops = 292.64 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

Verdict: PASS

FCC Section 15.247 Subclause (b). Maximum peak output power and antenna gain

SPECIFICATION

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt (30 dBm).

MAXIMUM OUTPUT POWER. See next plots.

Declared maximum antenna gain: -0.99 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)	2.68	2.15	1.92
Maximum EIRP power (dBm)	1.69	1.16	0.93
Measurement uncertainty (dB)	<±0.78		

Modulation: Π/4-DQPSK (2Mbps)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	0.72	0.18	-0.05
Maximum EIRP power (dBm)	-0.27	-0.81	-1.04
Measurement uncertainty (dB)	<±0.78		

Modulation: 8-DPSK (3Mbps)

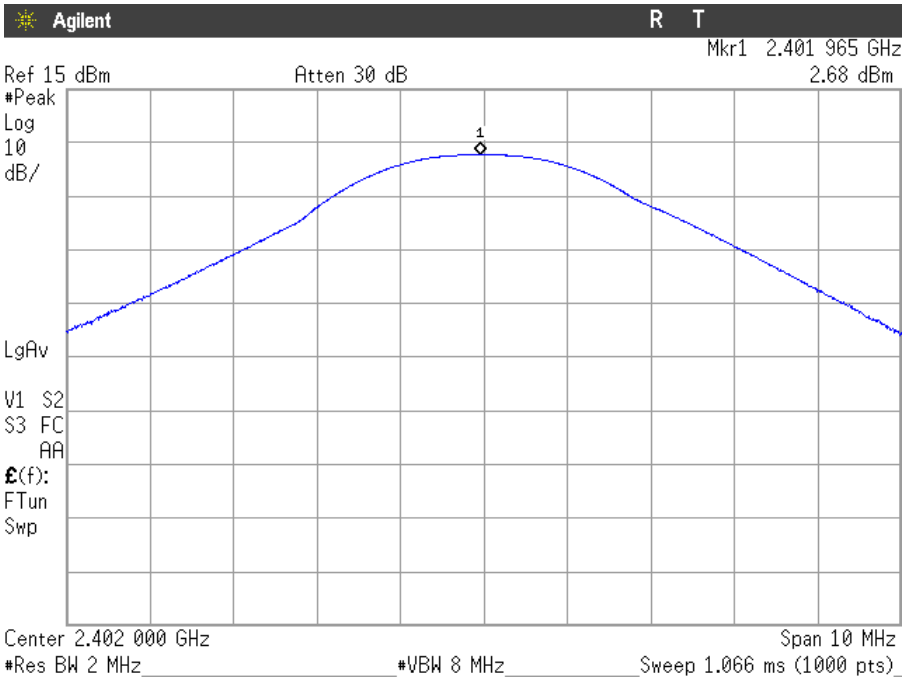
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	1.37	0.79	0.57
Maximum EIRP power (dBm)	0.38	-0.20	-0.42
Measurement uncertainty (dB)	<±0.78		

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.

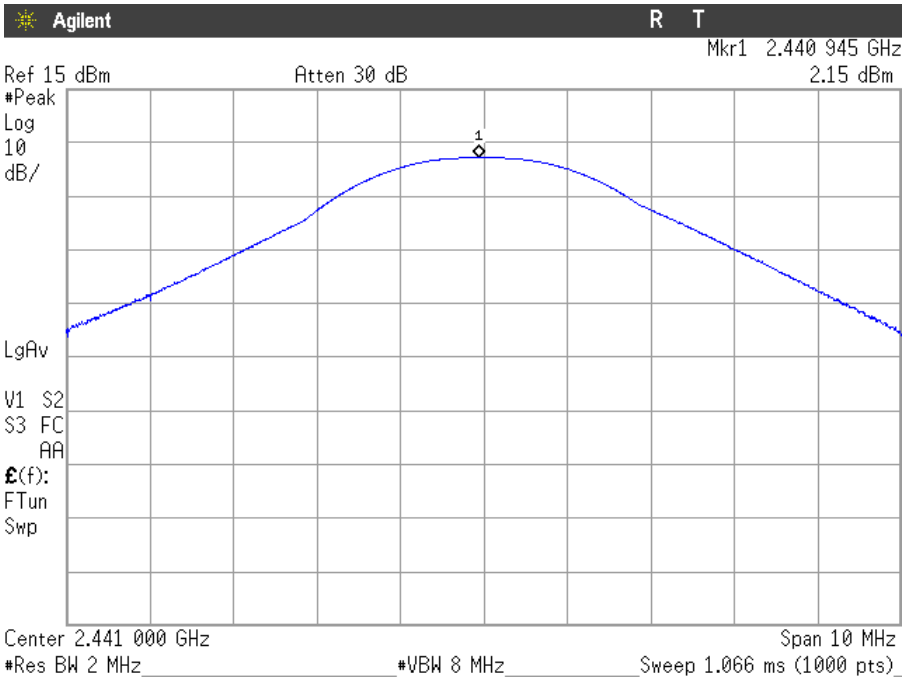
Verdict: PASS

PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK Lowest Channel: 2402 MHz.

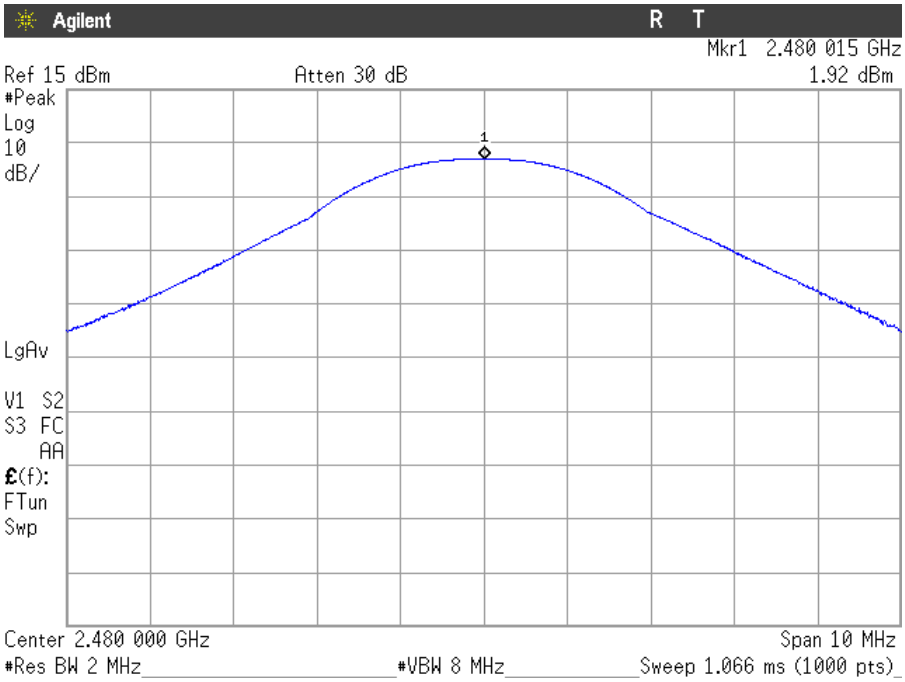


Modulation: GFSK Middle Channel: 2441 MHz.

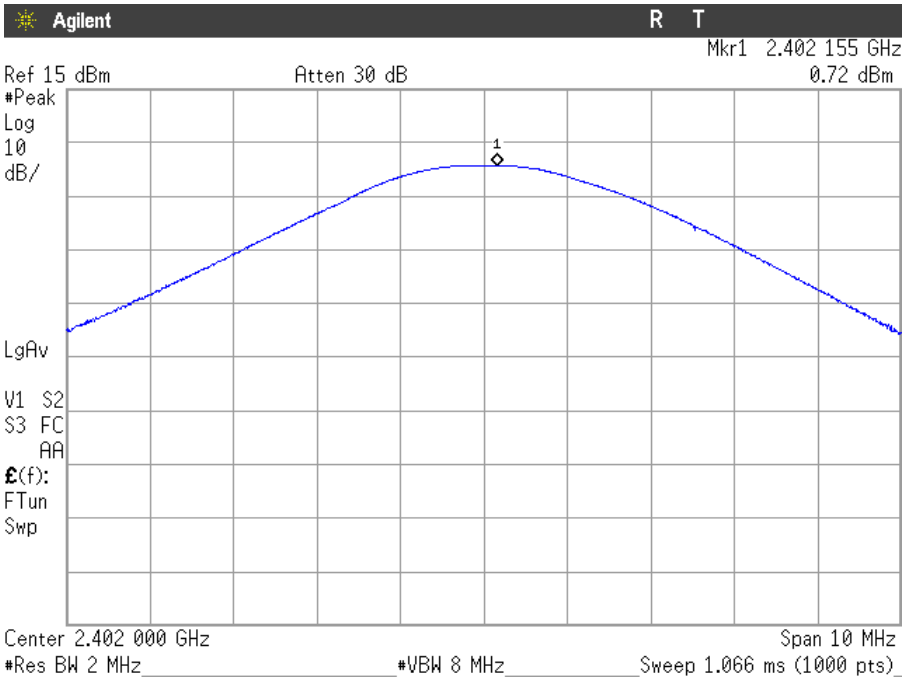


PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK Highest Channel: 2480 MHz.

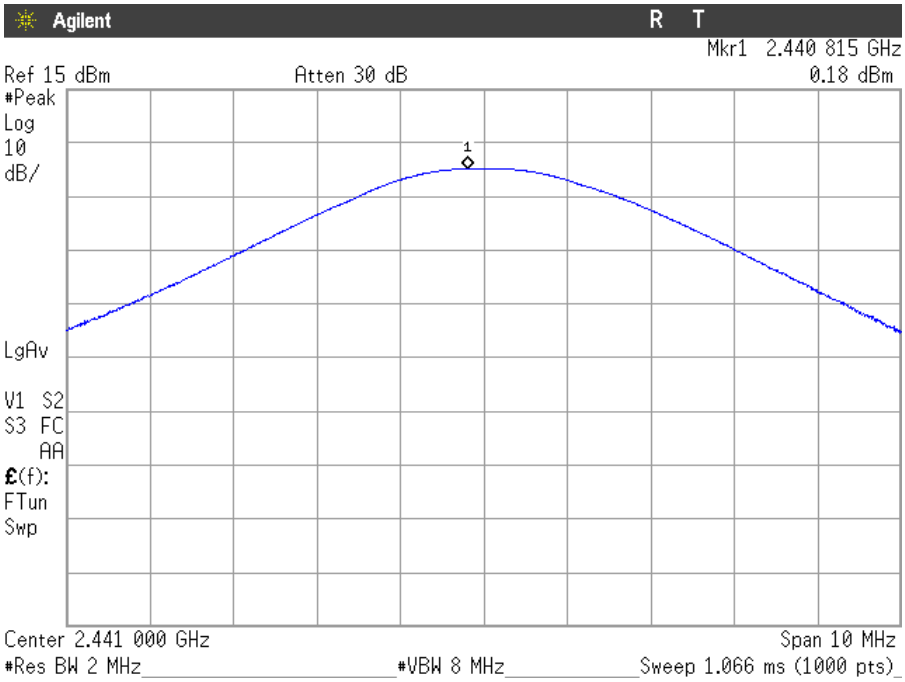


Modulation: Π/4-DQPSK Lowest Channel: 2402 MHz

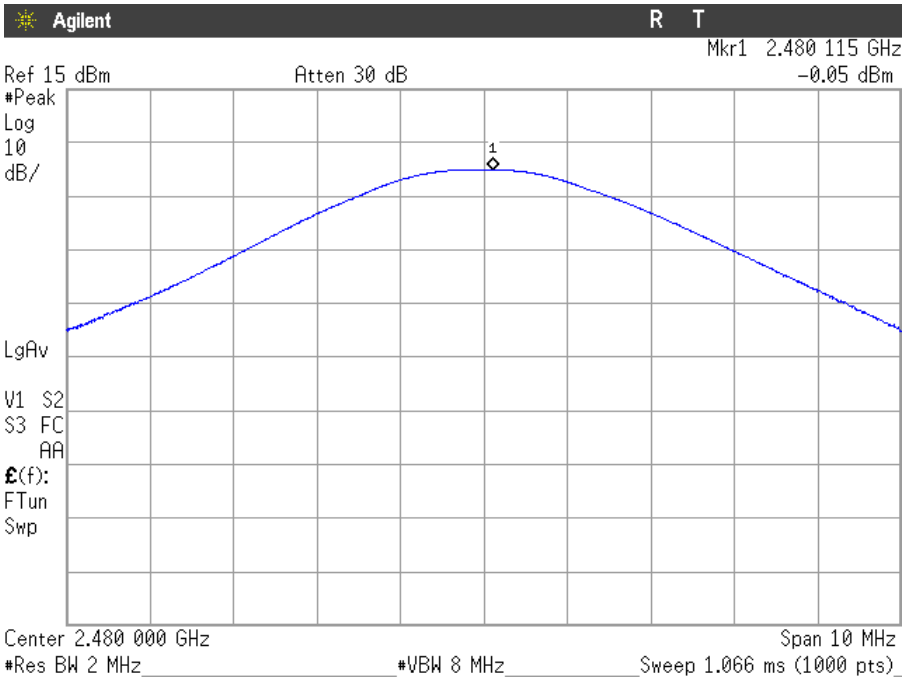


PEAK OUTPUT POWER (CONDUCTED)

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

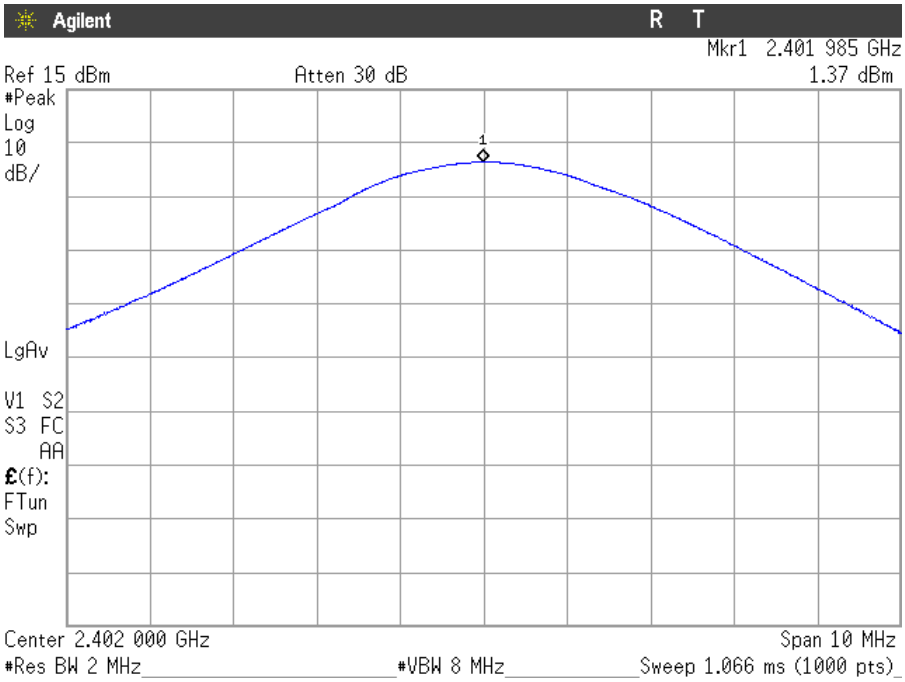


Modulation: Π/4-DQPSK Highest Channel: 2480 MHz.

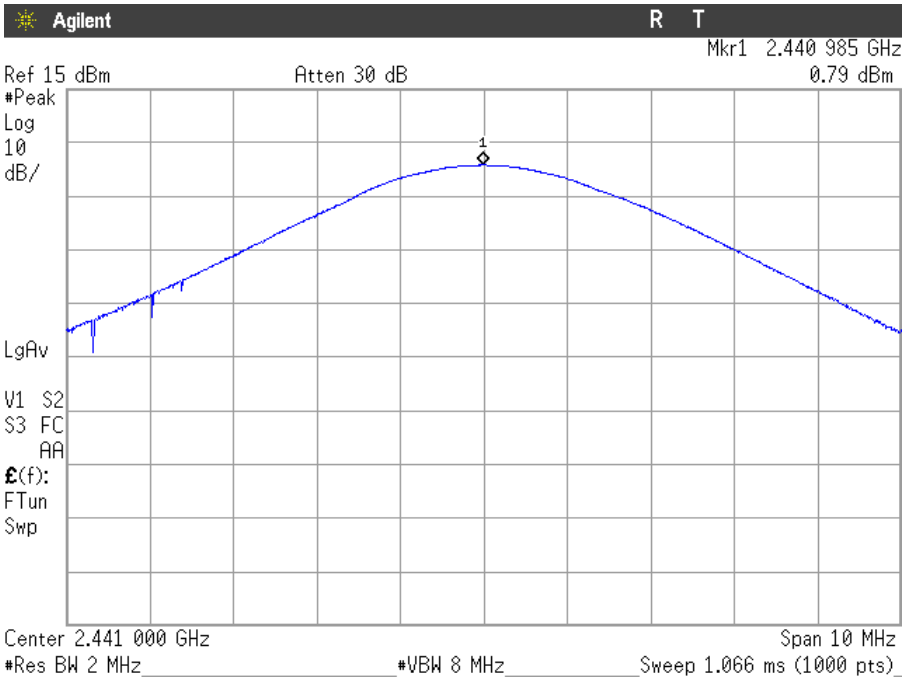


PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK Lowest Channel: 2402 MHz

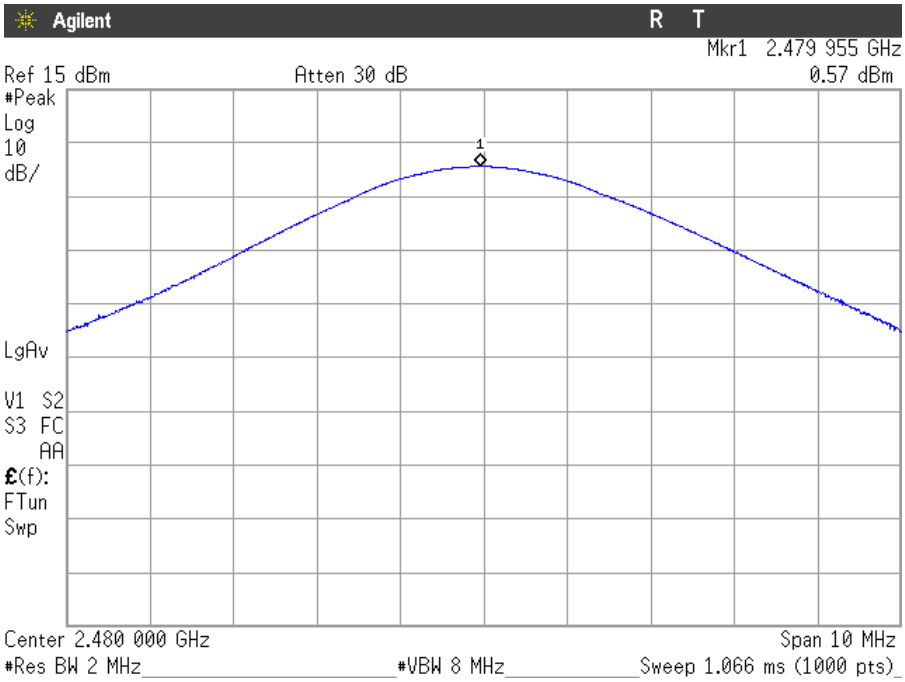


Modulation: 8-DPSK Middle Channel: 2441 MHz.



PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK Highest Channel: 2480 MHz.



FCC Section 15.247 Subclause (d). Band-edge compliance of conducted emissions (Transmitter)

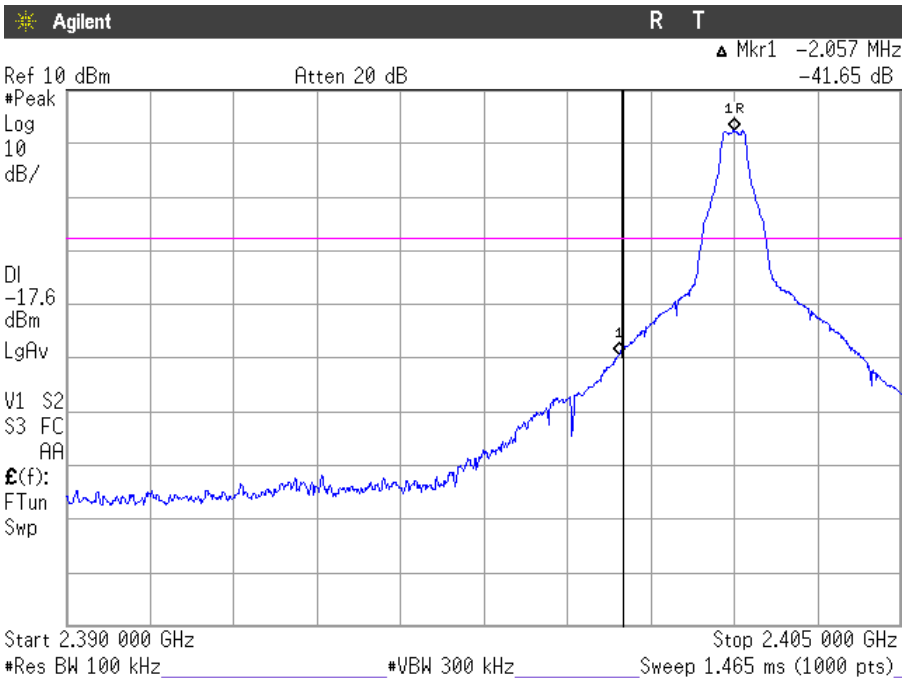
SPECIFICATION

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:

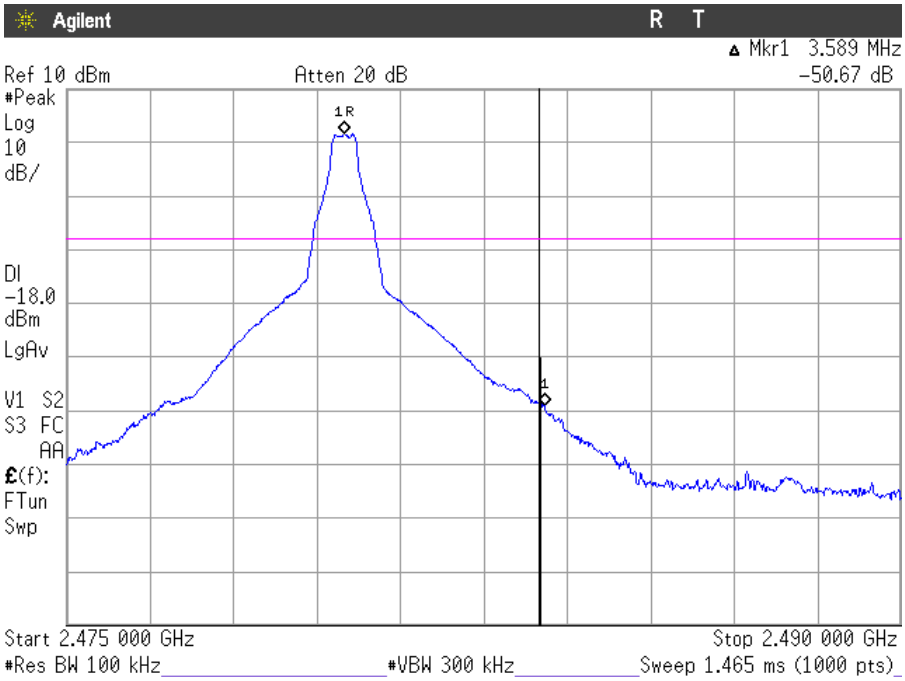
Modulation: GFSK

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



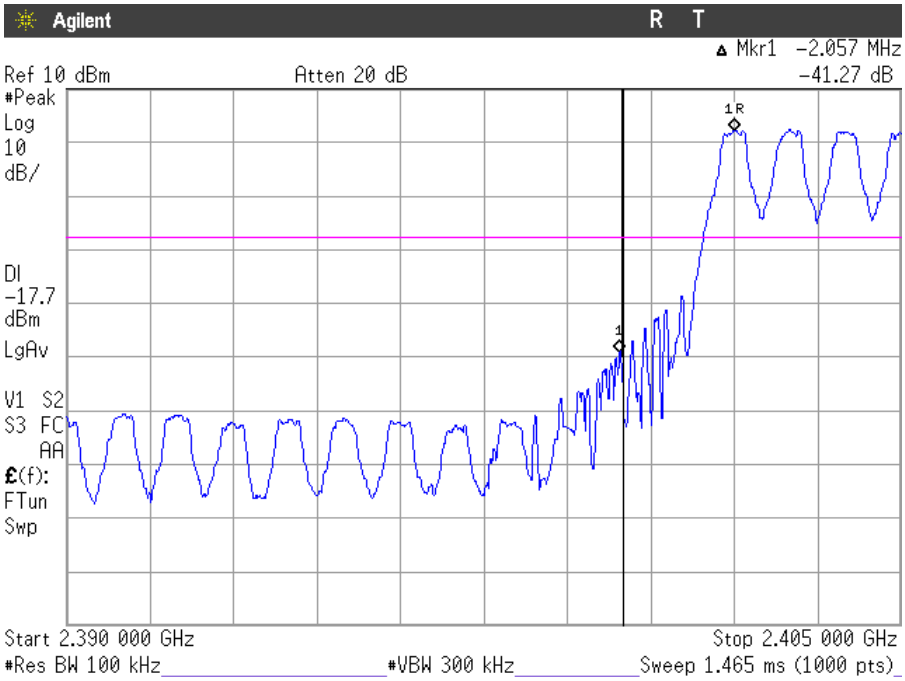
Verdict: PASS

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



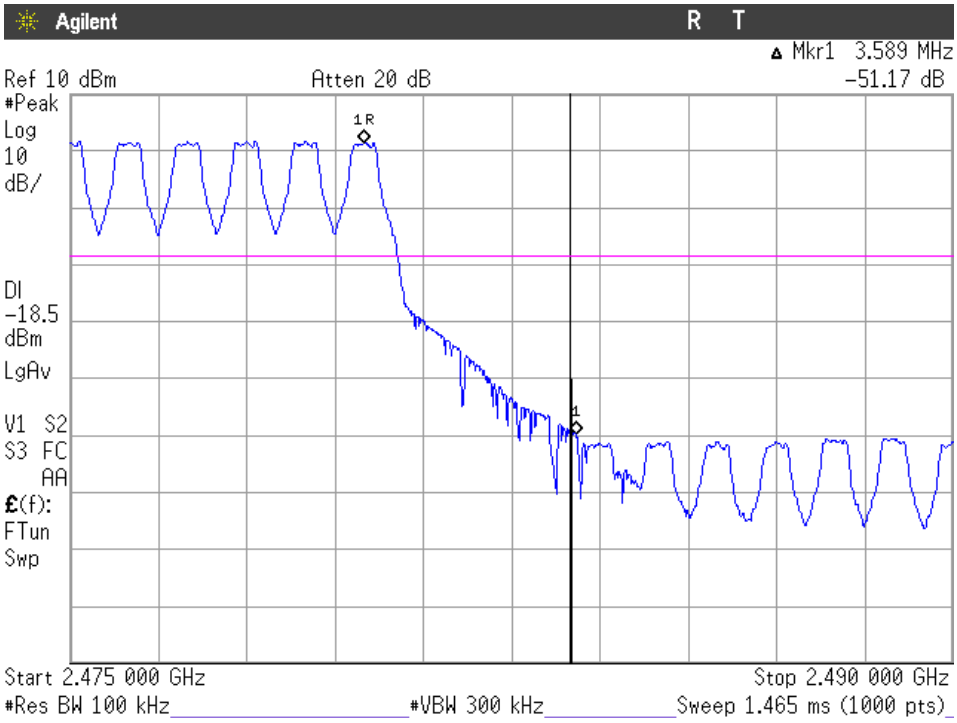
Verdict: PASS

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



Verdict: PASS

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

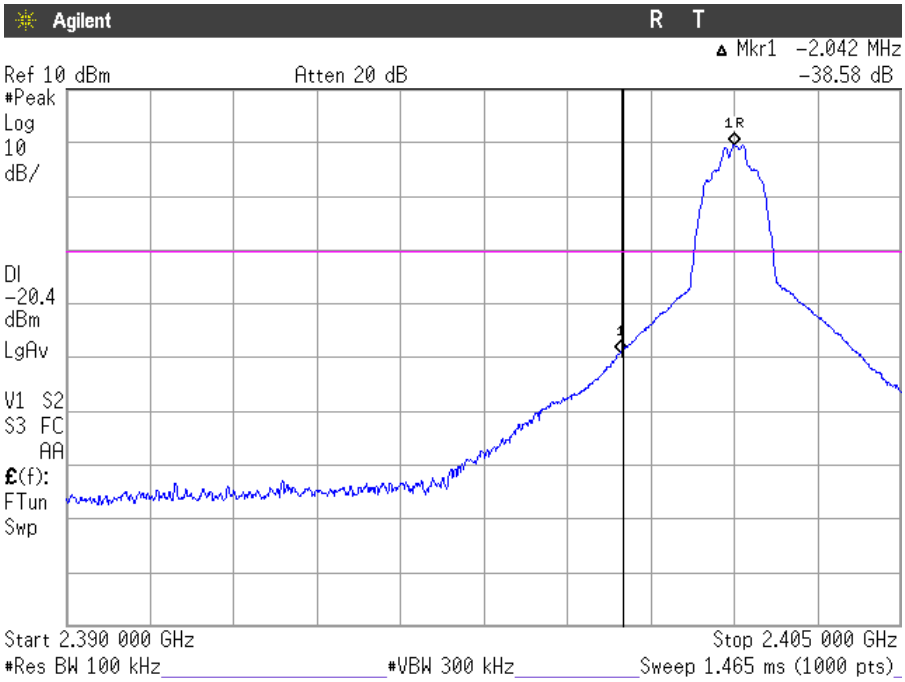


Verdict: PASS

Measurement uncertainty (dB)	<±2.03

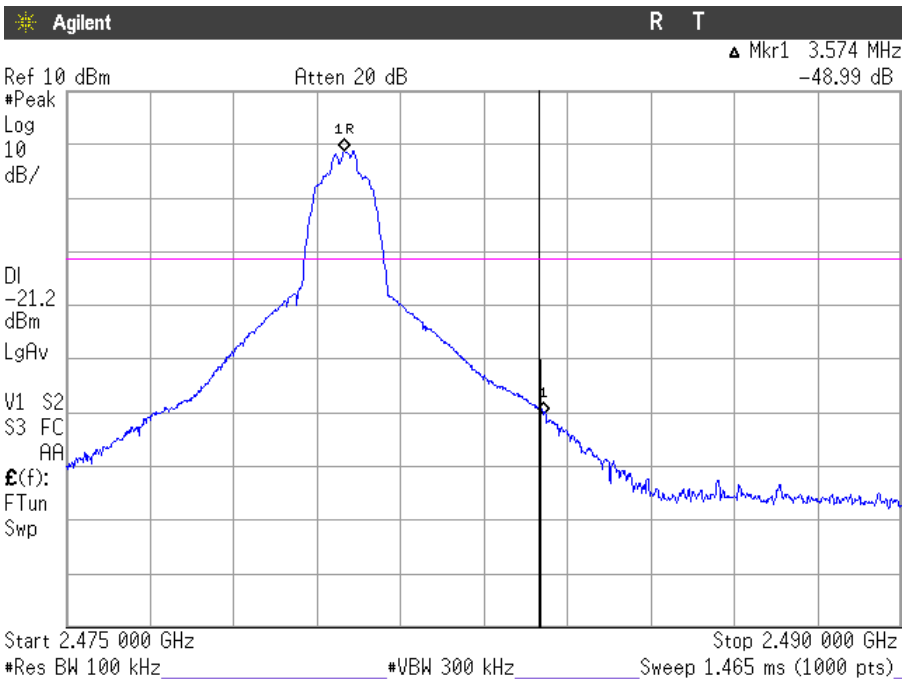
Modulation: II/4-DQPSK

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



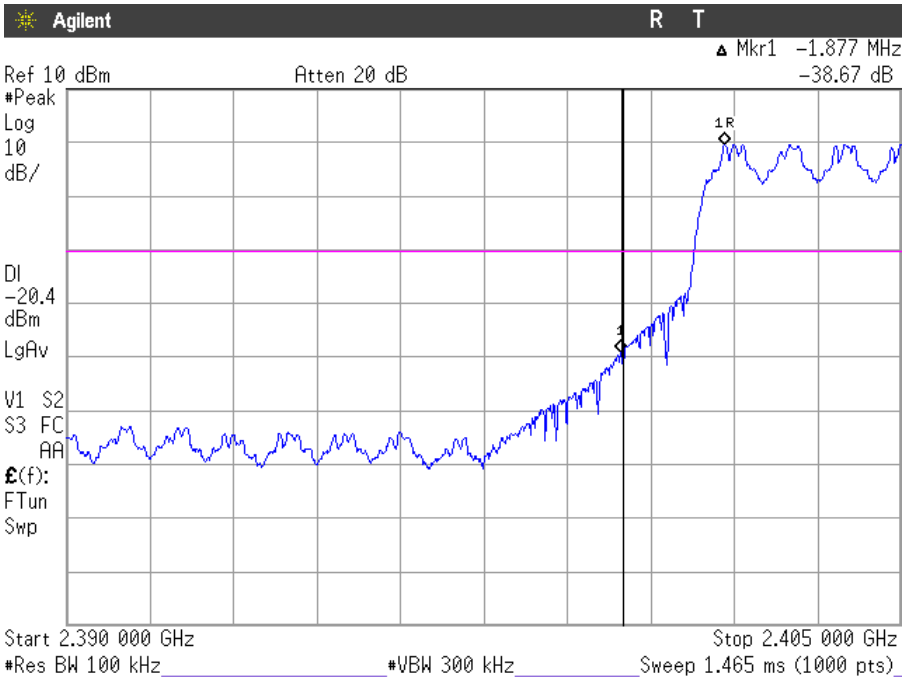
Verdict: PASS

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



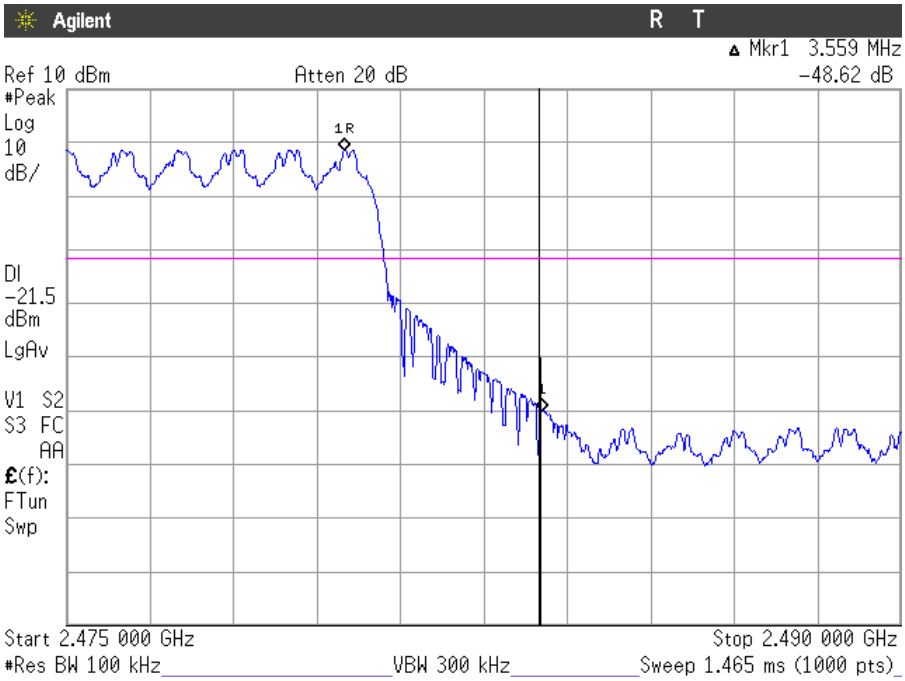
Verdict: PASS

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



Verdict: PASS

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

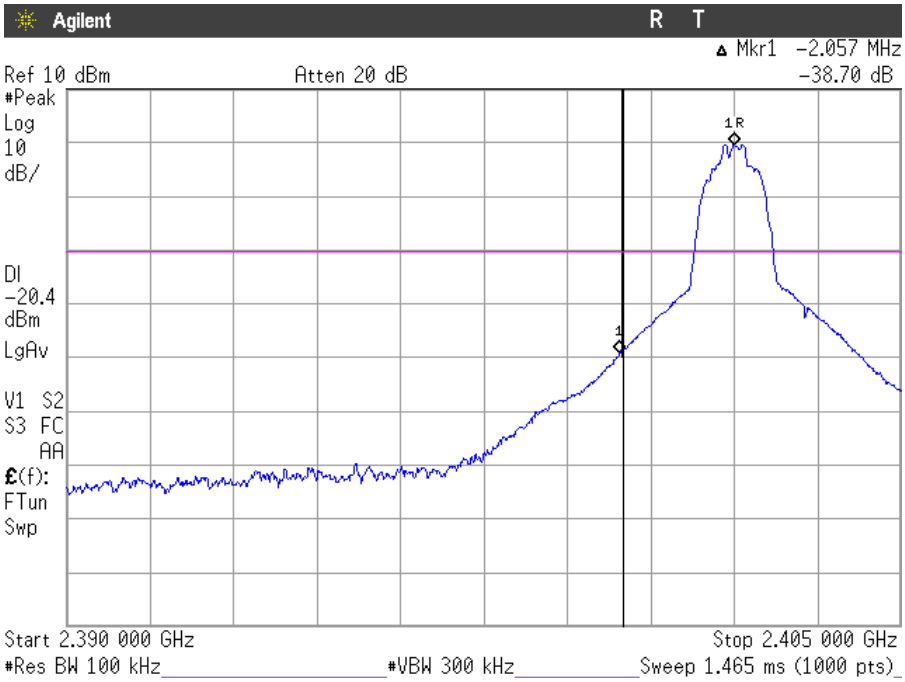


Verdict: PASS

Measurement uncertainty (dB)	<±2.03

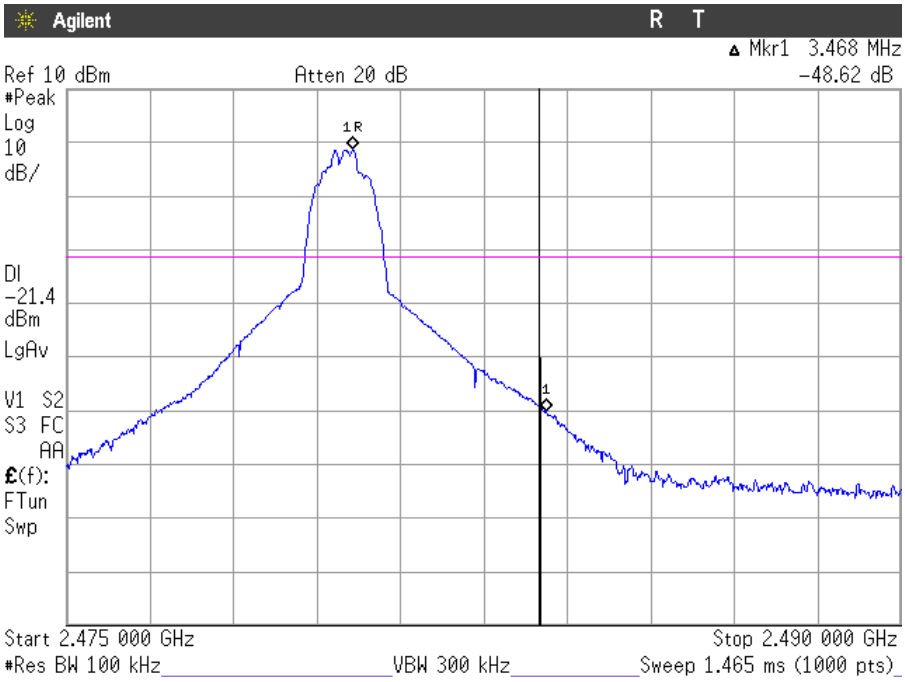
Modulation: 8-DPSK

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



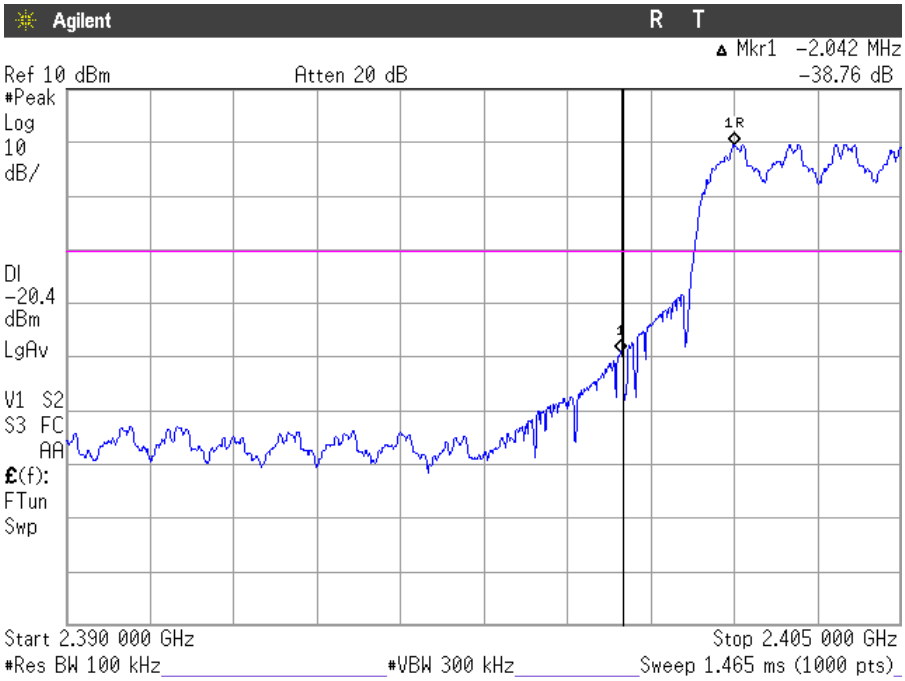
Verdict: PASS

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



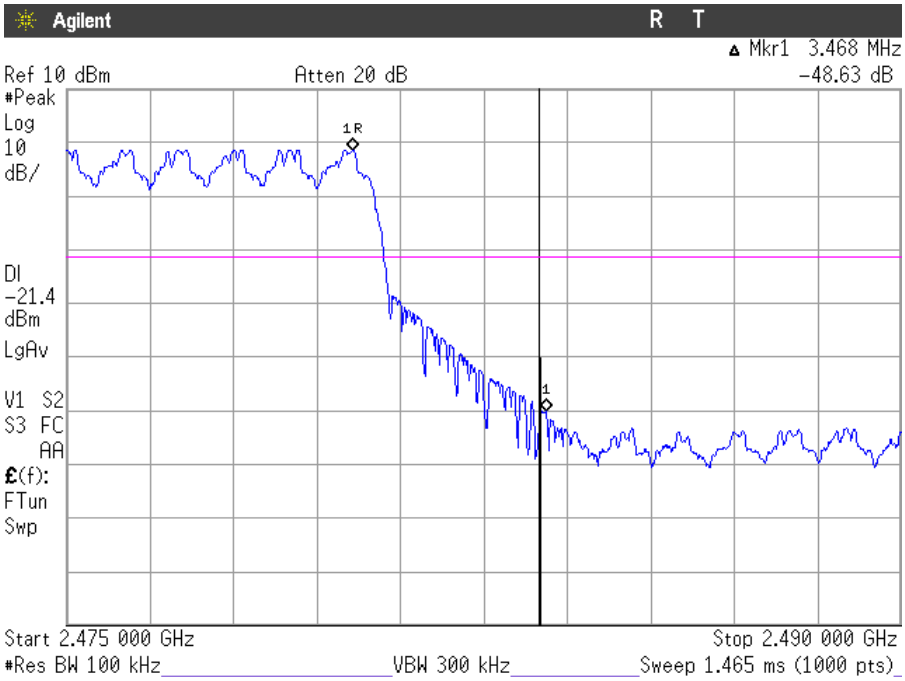
Verdict: PASS

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



Verdict: PASS

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



Verdict: PASS

Measurement uncertainty (dB)	<±2.03

FCC Section 15.247 Subclause (d). Emission limitations conducted (Transmitter)

SPECIFICATION

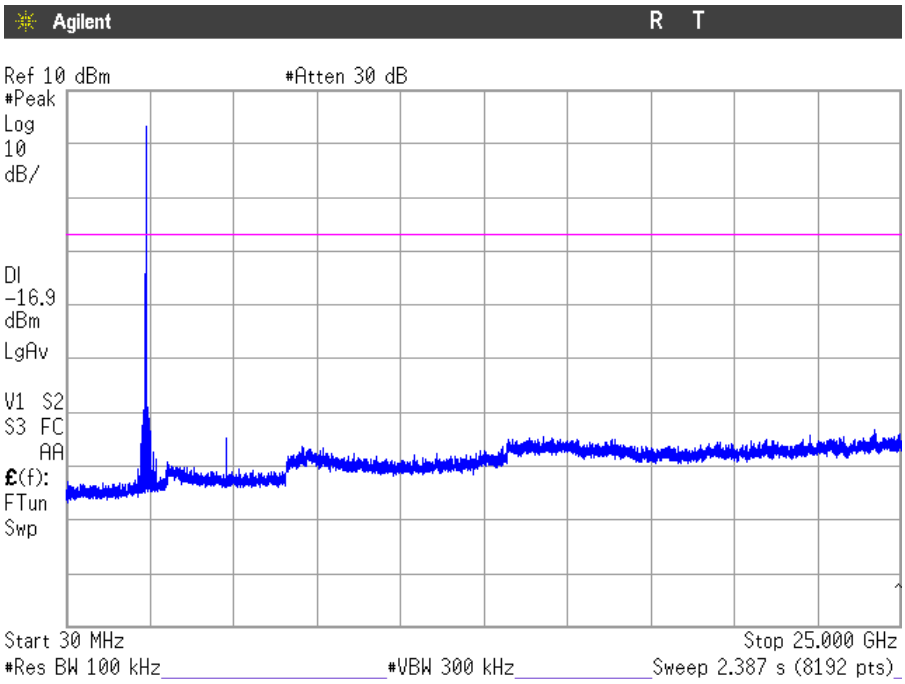
In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

RESULTS:

All peaks are more than 20 dB below the limit.

Modulation: GFSK

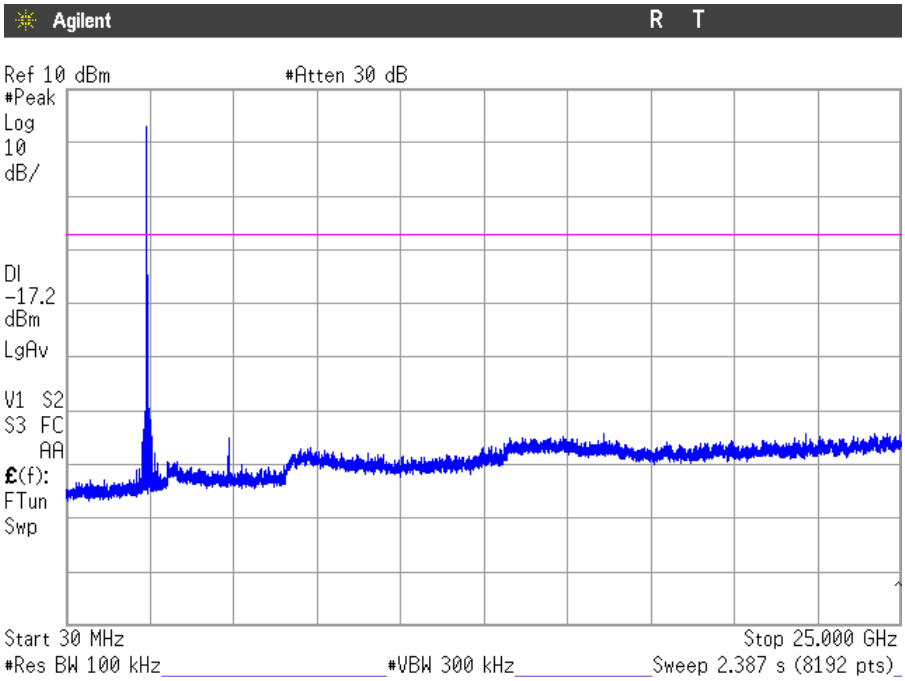
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

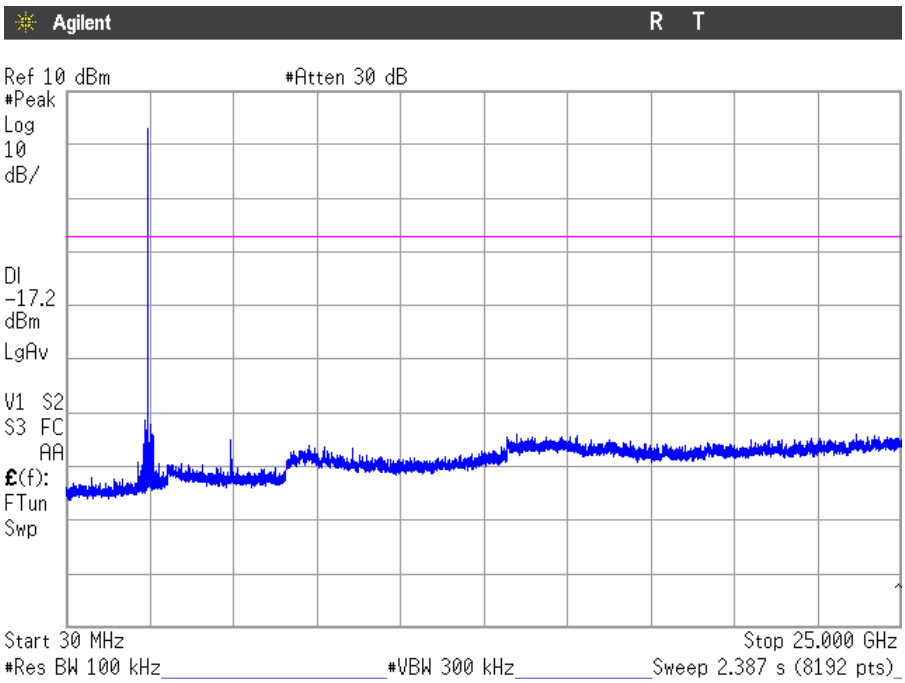
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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



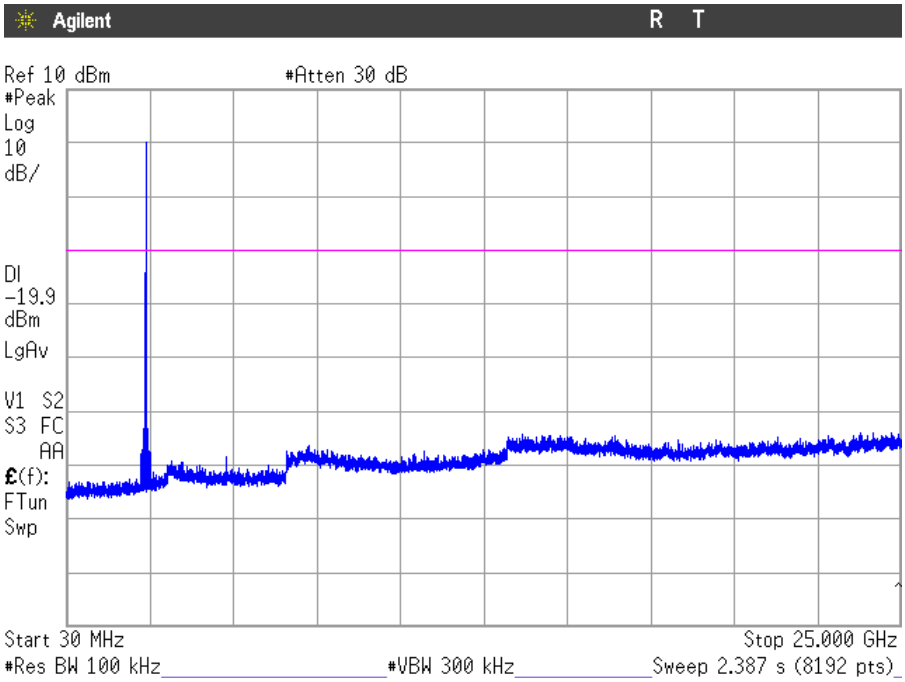
Note: The peak above the limits is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±2.03

Modulation: II/4-DQPSK

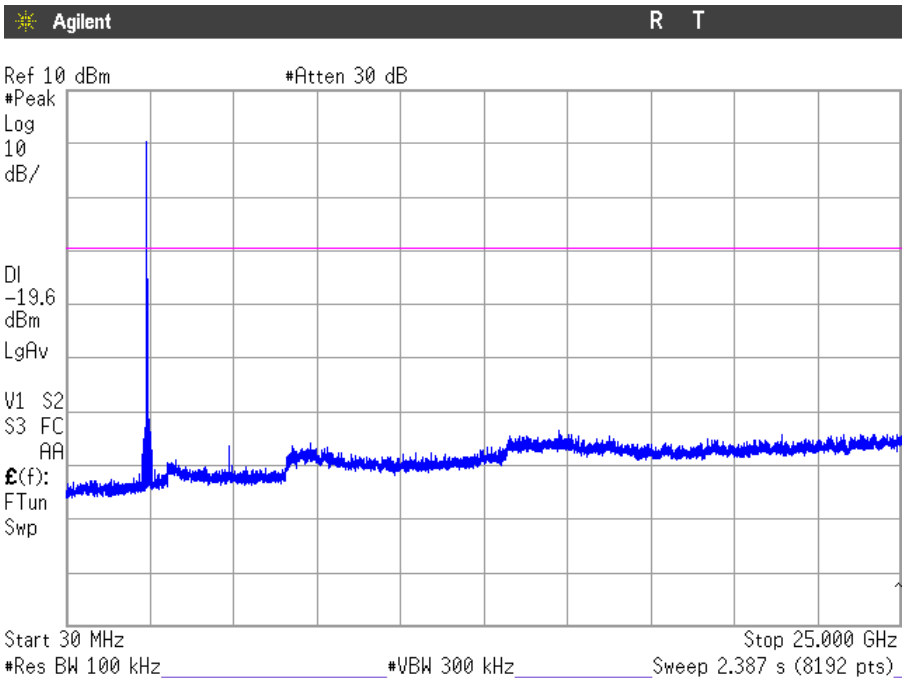
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

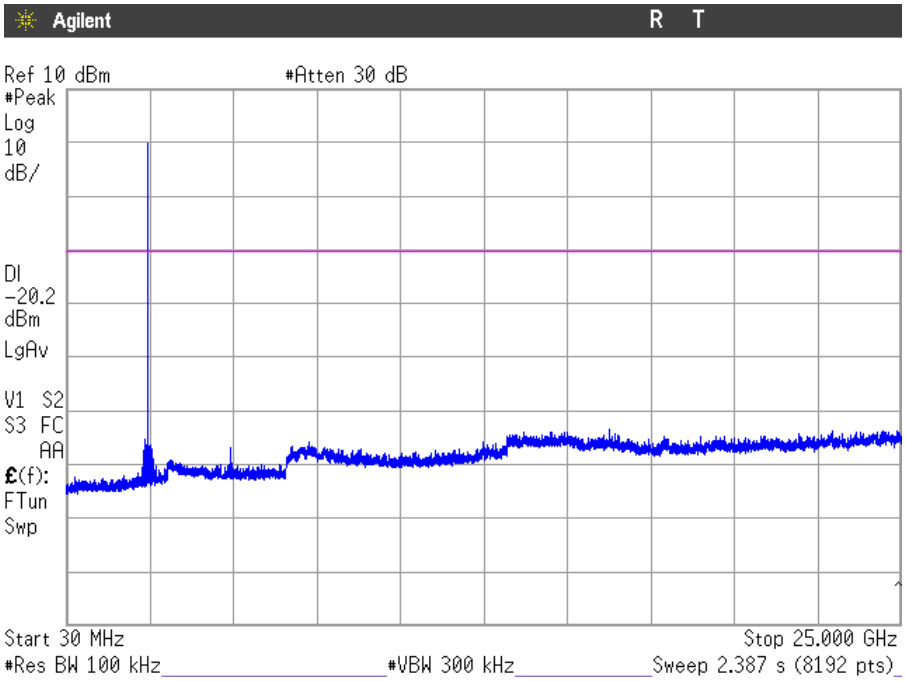
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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



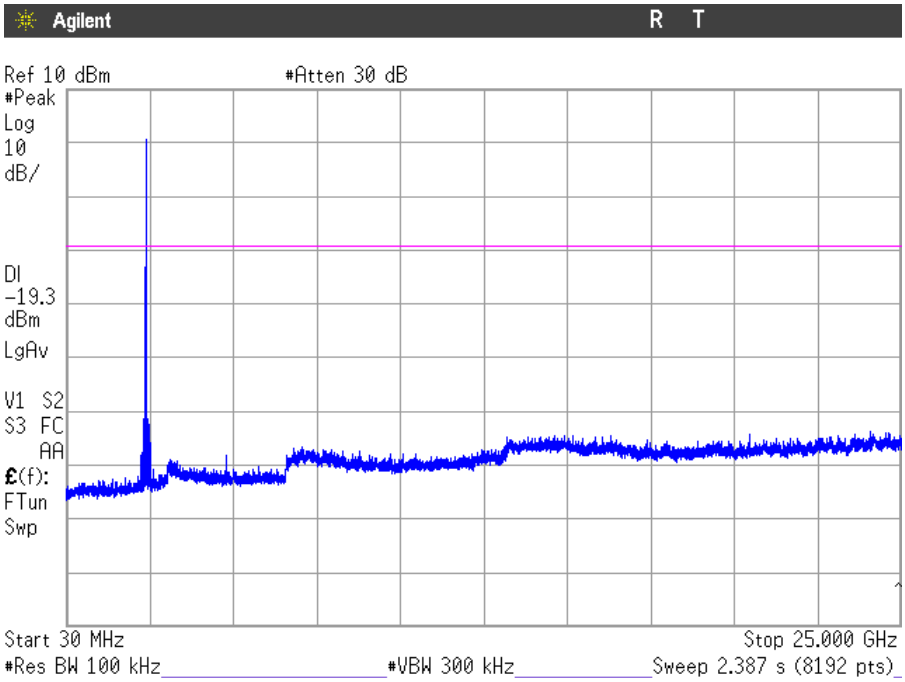
Note: The peak above the limit is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±2.03

Modulation: 8-DPSK

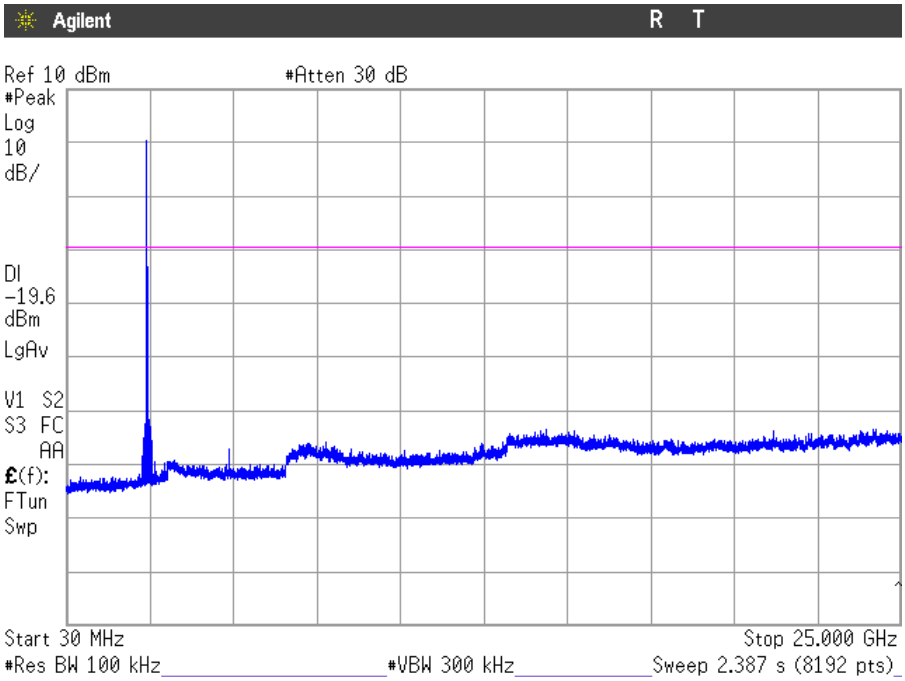
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

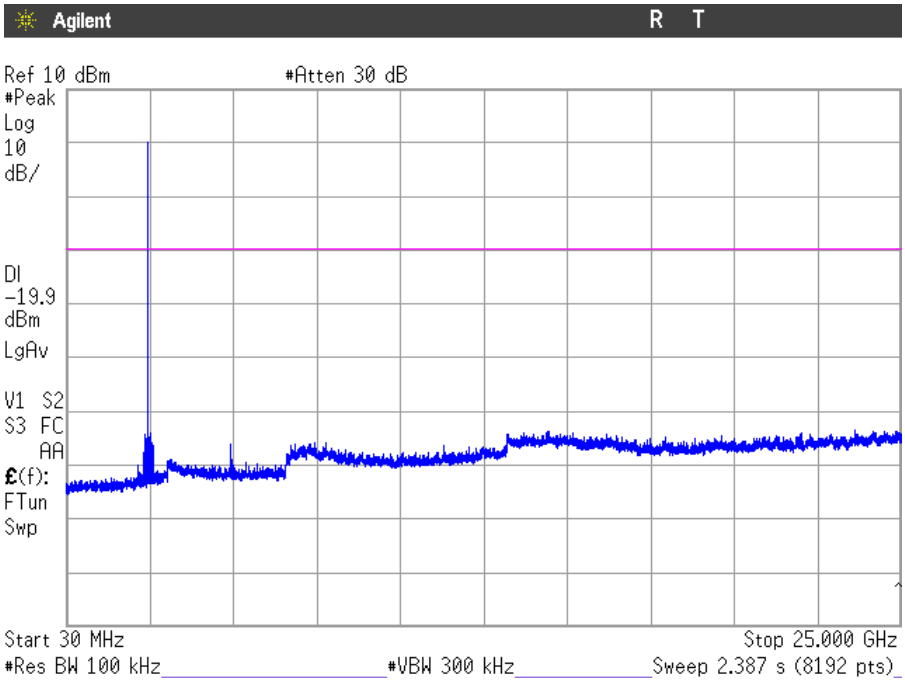
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Measurement uncertainty (dB)	<±2.03

FCC Section 15.247 Subclause (d). 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)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

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

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

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 frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
295.974	H	Quasi-Peak	38.51	± 3.88
320.030	H	Quasi-Peak	40.93	± 3.88
327.984	H	Quasi-Peak	42.21	± 3.88
383.953	H	Quasi-Peak	39.03	± 3.88
392.004	H	Quasi-Peak	39.69	± 3.88
431.968	H	Quasi-Peak	39.96	± 3.88
440.019	H	Quasi-Peak	41.78	± 3.88
447.973	H	Quasi-Peak	42.38	± 3.88
456.024	H	Quasi-Peak	41.35	± 3.88
463.978	H	Quasi-Peak	40.02	± 3.88

All peaks are more than 20 dB below the limit.

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).

Modulation: GFSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.03204	H	Peak	43.12	± 4.87
		Average	37.33	
2.28203	V	Peak	46.50	± 4.87
		Average	41.74	
2.32196	V	Peak	50.50	± 4.87
		Average	44.46	
2.36189	V	Peak	46.06	± 4.87
		Average	39.35	
2.49805	V	Peak	46.63	± 4.87
		Average	38.51	
2.52203	V	Peak	48.36	± 4.87
		Average	44.67	
2.56203	V	Peak	48.92	± 4.87
		Average	42.86	
3.46375	H	Peak	42.99	± 4.87
		Average	41.45	
4.80375	H	Peak	43.94	± 4.87
		Average	40.23	
7.20625	V	Peak	56.11	± 4.87
		Average	53.28	
9.60825	V	Peak	46.92	± 4.87
		Average	39.54	
12.00925	V	Peak	48.77	± 4.87
		Average	42.15	
14.74325	V	Peak	54.75	± 4.87
		Average	42.71	

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.03190	H	Peak	43.78	± 4.87
		Average	37.61	
2.321009	V	Peak	47.59	± 4.87
		Average	42.58	
2.36093	V	Peak	49.85	± 4.87
		Average	43.47	
2.52103	V	Peak	50.09	± 4.87
		Average	43.50	
2.56090	V	Peak	48.59	± 4.87
		Average	44.56	
3.41575	H	Peak	43.75	± 4.87
		Average	41.98	
4.88175	V	Peak	45.04	± 4.87
		Average	42.65	
7.32325	H	Peak	54.36	± 4.87
		Average	50.55	
9.76425	V	Peak	47.15	± 4.87
		Average	40.72	
12.20475	H	Peak	49.05	± 4.87
		Average	41.05	

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.03203	H	Peak	43.45	± 4.87
		Average	37.46	
2.31993	V	Peak	46.88	± 4.87
		Average	40.04	
2.32501	V	Peak	45.26	± 4.87
		Average	38.30	
2.36029	V	Peak	45.65	± 4.87
		Average	37.92	
2.48352	V	Peak	66.69	± 4.87
		Average	39.61	
2.56003	V	Peak	46.97	± 4.87
		Average	42.08	
2.63997	V	Peak	47.13	± 4.87
		Average	39.87	
3.31675	H	Peak	41.52	± 4.87
		Average	39.86	
3.46425	V	Peak	42.27	± 4.87
		Average	39.22	
4.95975	V	Peak	45.75	± 4.87
		Average	44.03	
7.44025	V	Peak	56.12	± 4.87
		Average	52.55	
9.91975	V	Peak	48.19	± 4.87
		Average	39.62	
12.39925	H	Peak	47.42	± 4.87
		Average	39.97	

Verdict: PASS

Modulation: Π/4-DQPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.03203	H	Peak	44.37	± 4.87
		Average	37.14	
2.32190	V	Peak	47.88	± 4.87
		Average	42.03	
2.56223	V	Peak	46.61	± 4.87
		Average	39.23	
3.33275	V	Peak	42.84	± 4.87
		Average	41.30	
4.80425	H	Peak	40.76	± 4.87
		Average	34.33	
7.20575	H	Peak	54.17	± 4.87
		Average	49.34	

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.03190	H	Peak	46.02	± 4.87
		Average	36.98	
2.32115	V	Peak	45.02	± 4.87
		Average	39.14	
2.36092	V	Peak	47.51	± 4.87
		Average	41.47	
2.56077	V	Peak	49.41	± 4.87
		Average	41.49	
3.44175	H	Peak	43.05	± 4.87
		Average	41.36	
7.32325	H	Peak	51.63	± 4.87
		Average	47.79	
22.27267	V	Peak	38.28	± 4.87
		Average	34.15	

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.03203	H	Peak	43.02	± 4.87
		Average	37.65	
2.32014	V	Peak	46.10	± 4.87
		Average	37.60	
3.32504	V	Peak	45.46	± 4.87
		Average	37.85	
2.48350	V	Peak	66.64	± 4.87
		Average	40.89	
3.32750	V	Peak	42.94	± 4.87
		Average	41.75	
3.41925	H	Peak	42.26	± 4.87
		Average	40.75	
4.96025	V	Peak	43.64	± 4.87
		Average	38.84	
7.44025	V	Peak	53.89	± 4.87
		Average	51.02	

Verdict: PASS

Modulation: 8-DPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.10467	H	Peak	42.89	± 4.87
		Average	37.62	
2.32200	V	Peak	48.42	± 4.87
		Average	41.93	
2.38930	V	Peak	50.45	± 4.87
		Average	36.43	
3.39375	H	Peak	43.58	± 4.87
		Average	41.37	
3.41925	V	Peak	42.67	± 4.87
		Average	40.58	
4.80375	H	Peak	40.98	± 4.87
		Average	34.25	
7.20575	H	Peak	53.79	± 4.87
		Average	47.83	

2. CHANNEL: MIDDLE (2441 MHz).

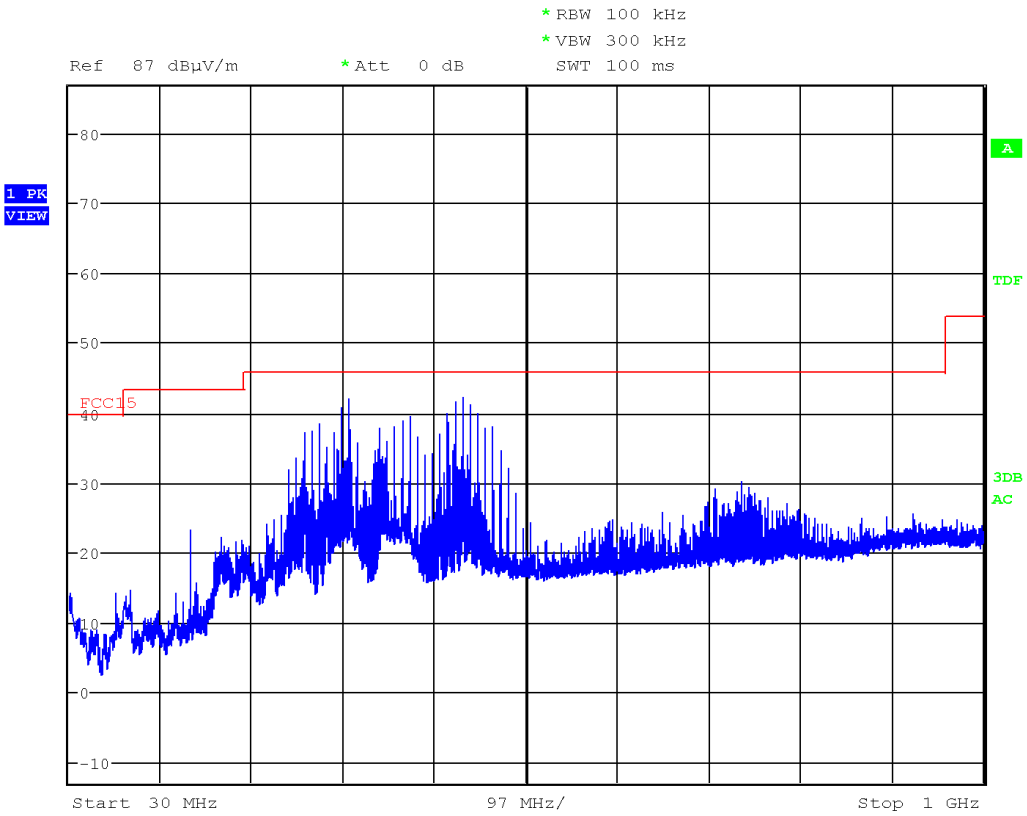
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.10410	H	Peak	45.99	± 4.87
		Average	36.79	
2.32118	V	Peak	45.73	± 4.87
		Average	38.04	
2.36092	V	Peak	47.94	± 4.87
		Average	41.54	
2.52117	V	Peak	49.05	± 4.87
		Average	41.71	
3.40325	V	Peak	42.41	± 4.87
		Average	40.12	
3.46375	H	Peak	43.02	± 4.87
		Average	41.49	
4.88175	V	Peak	42.24	± 4.87
		Average	37.51	
7.32325	V	Peak	52.70	± 4.87
		Average	47.79	

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.10403	H	Peak	43.48	± 4.87
		Average	36.99	
2.31999	V	Peak	48.01	± 4.87
		Average	37.71	
2.35991	V	Peak	46.26	± 4.87
		Average	37.25	
2.48355	V	Peak	66.82	± 4.87
		Average	40.34	
2.56003	V	Peak	47.86	± 4.87
		Average	39.66	
3.42525	V	Peak	42.10	± 4.87
		Average	40.13	
4.96025	V	Peak	43.65	± 4.87
		Average	41.42	
7.43975	H	Peak	53.00	± 4.87
		Average	47.97	

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

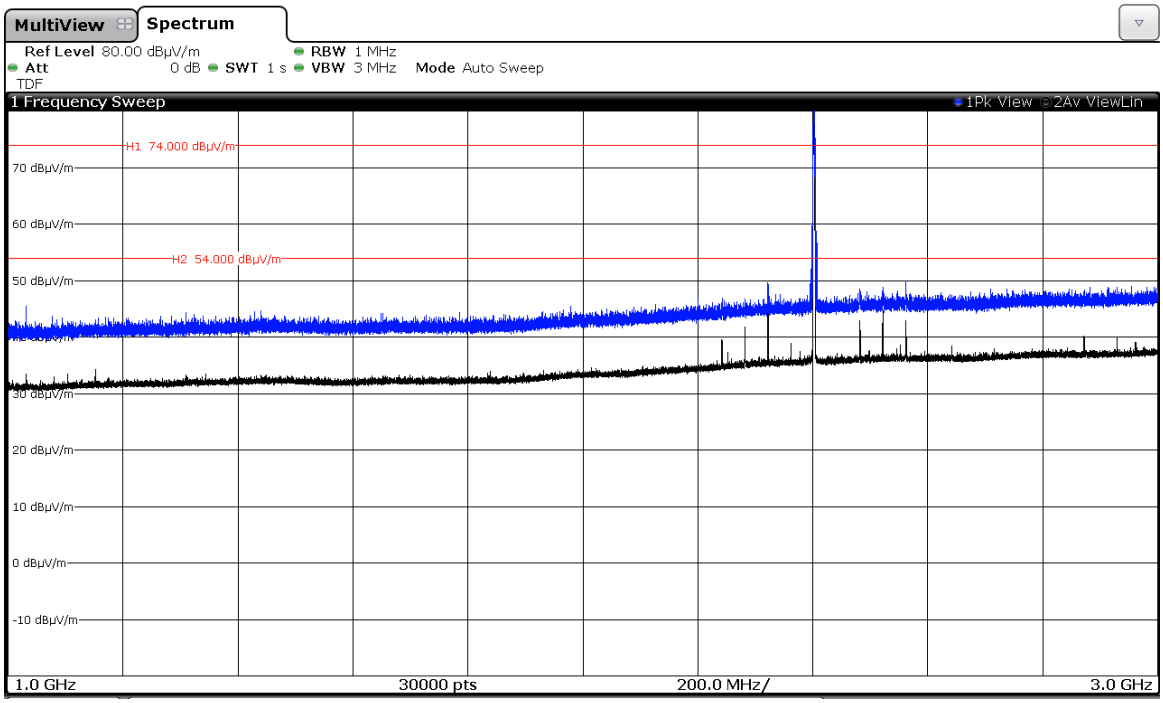


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

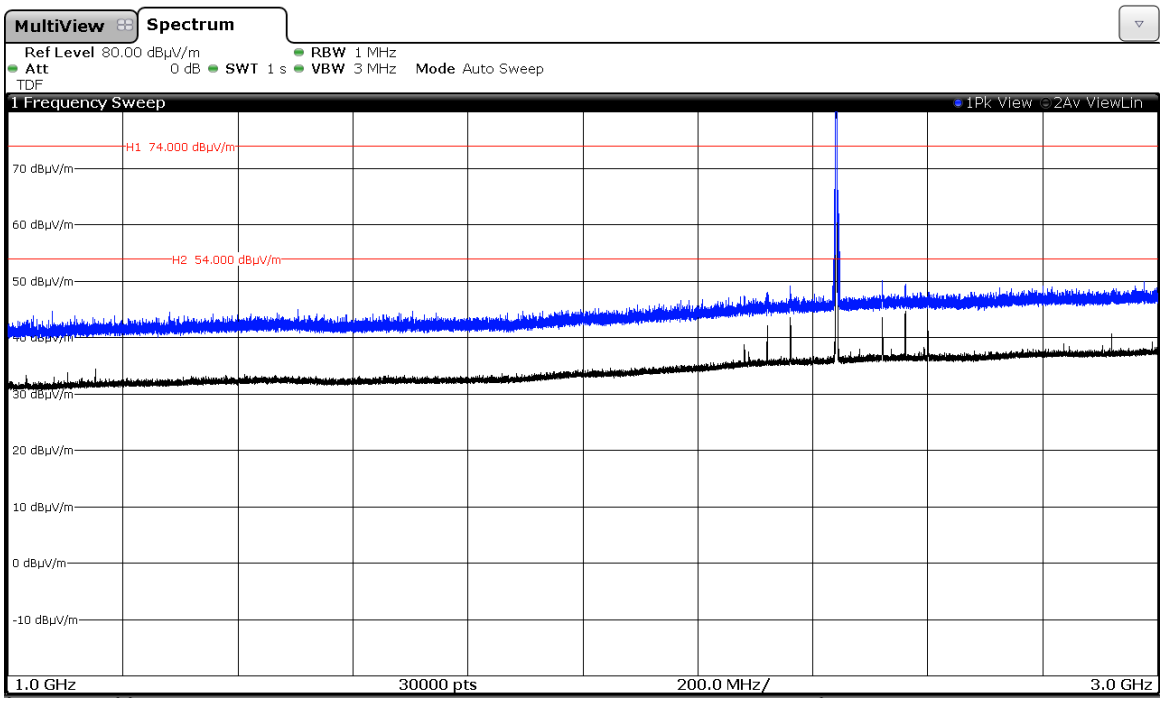
Modulation: GFSK

CHANNEL: Lowest (2402 MHz).



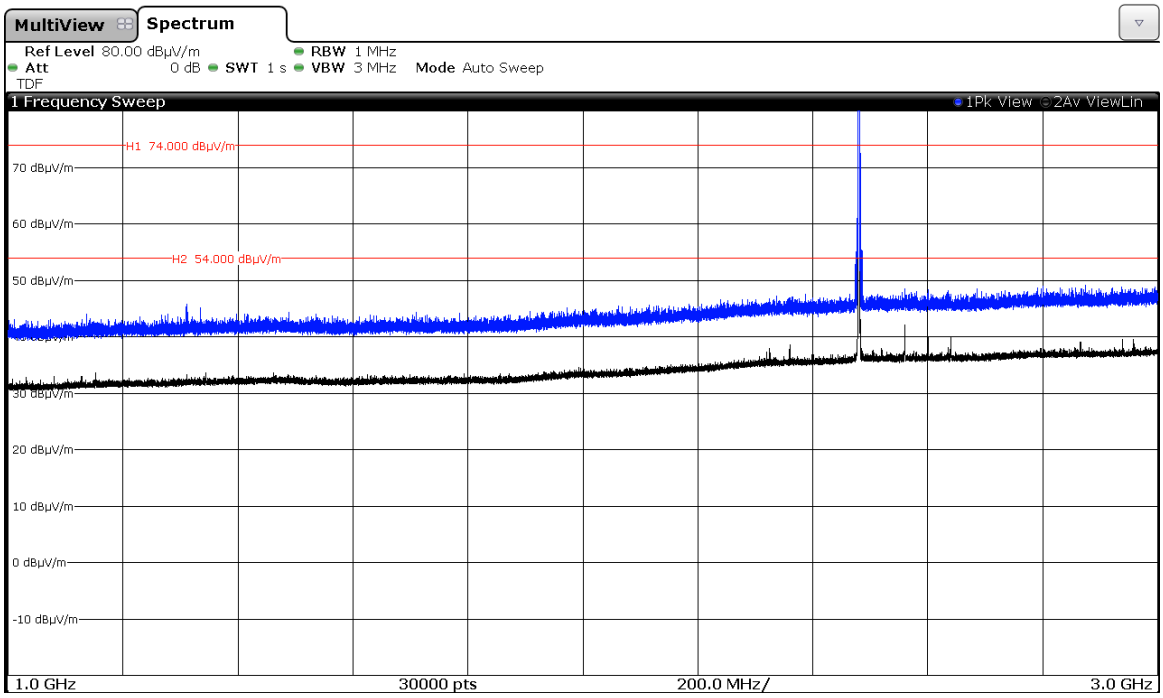
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

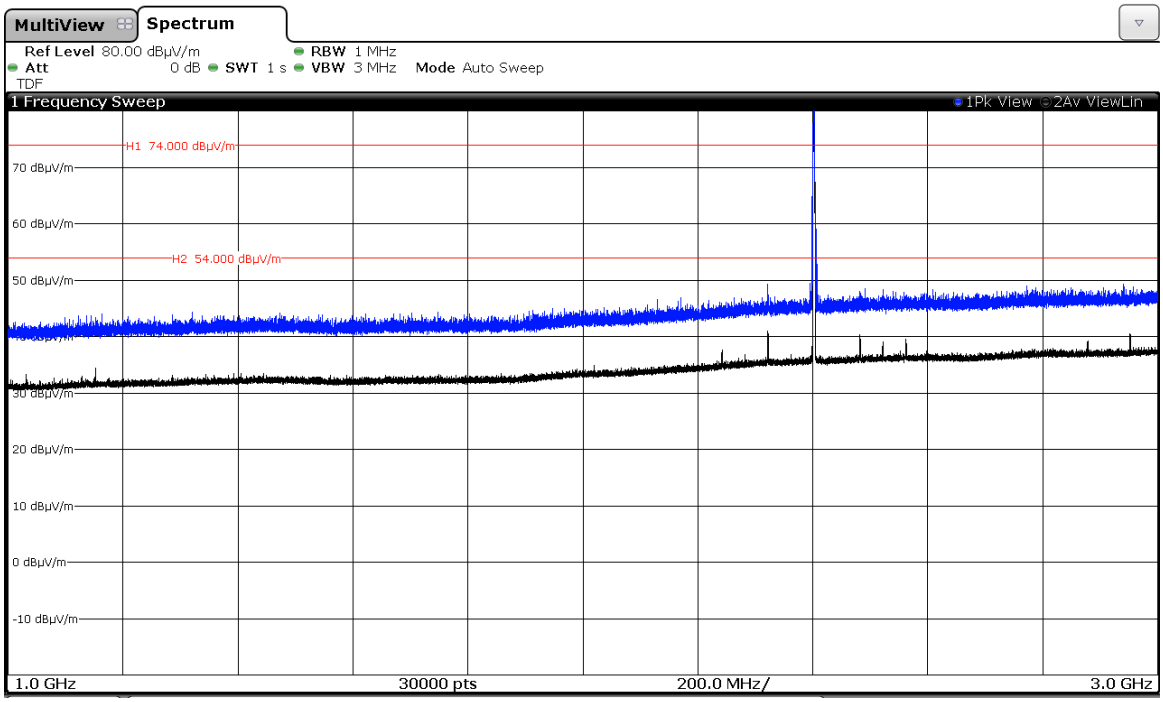
CHANNEL: Highest (2480 MHz).



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

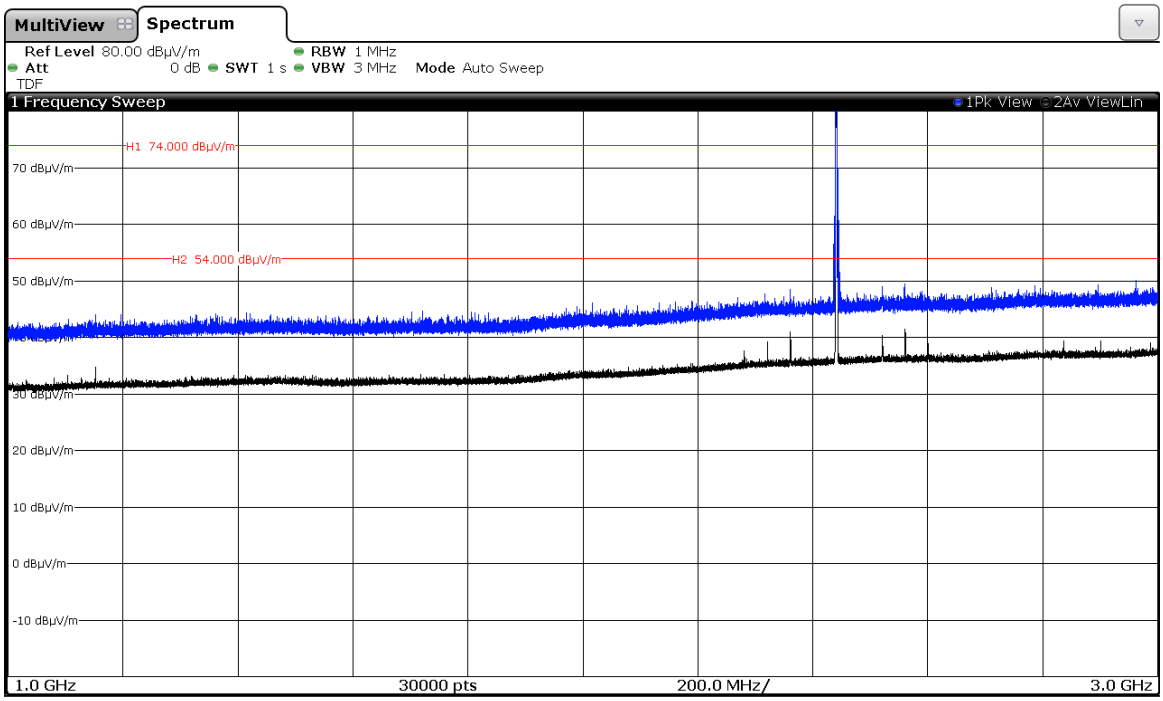
Modulation: Π/4-DQPSK

CHANNEL: Lowest (2402 MHz).



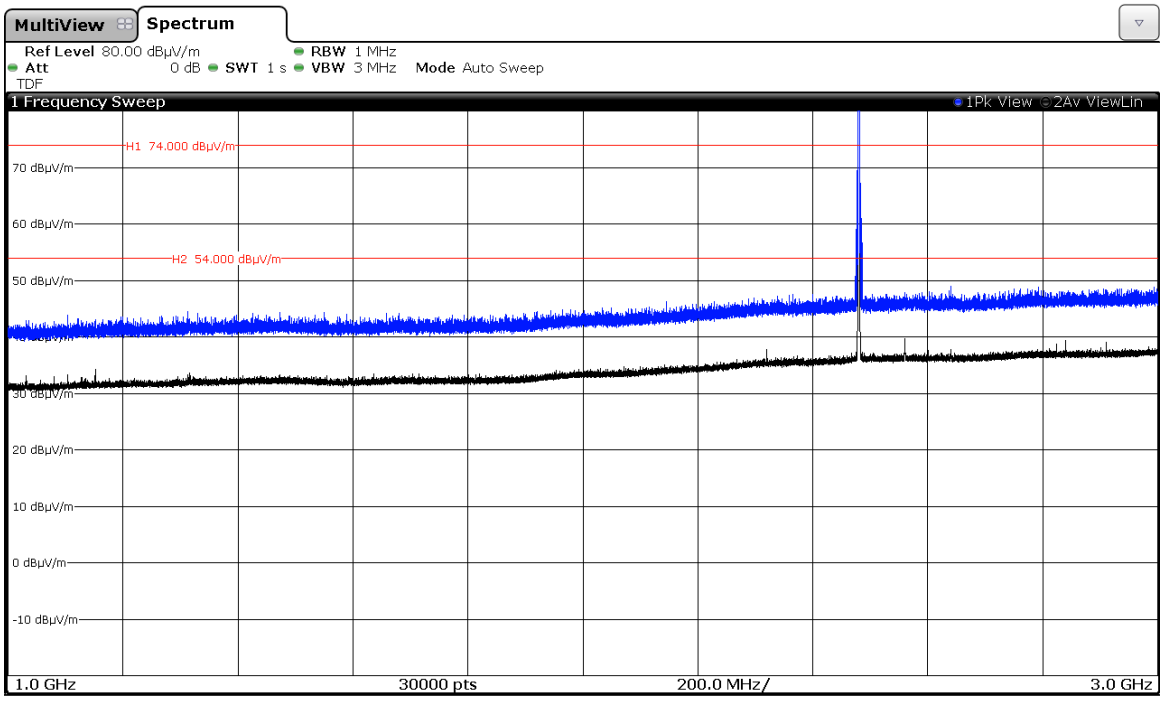
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

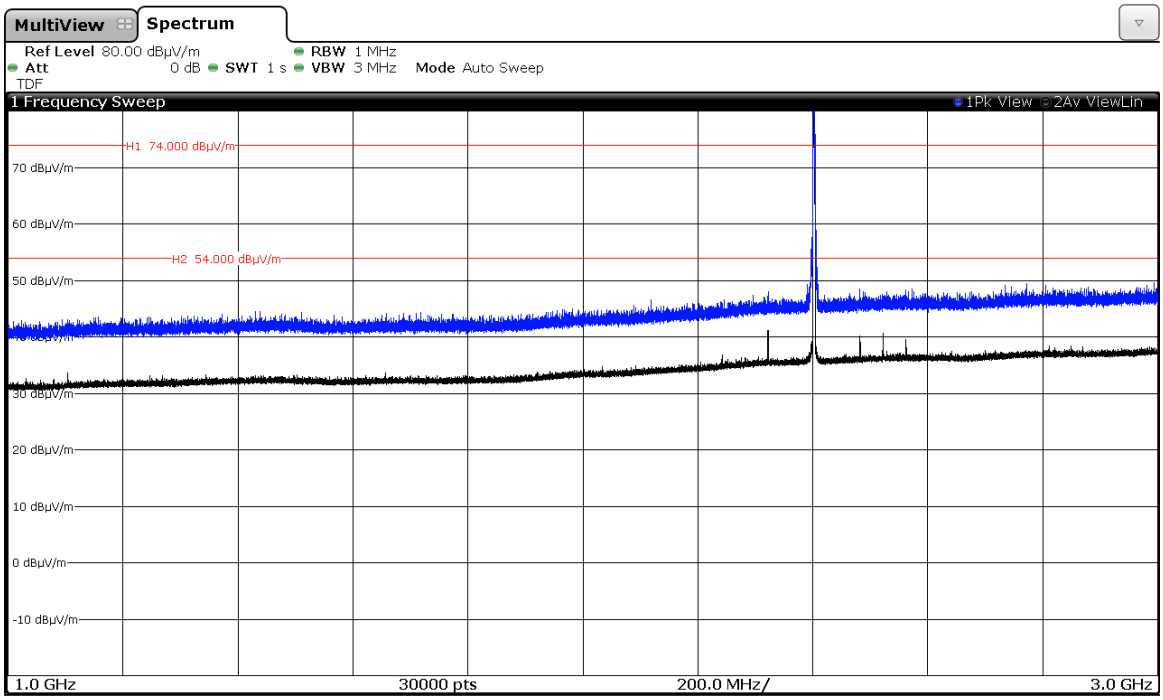
CHANNEL: Highest (2480 MHz).



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

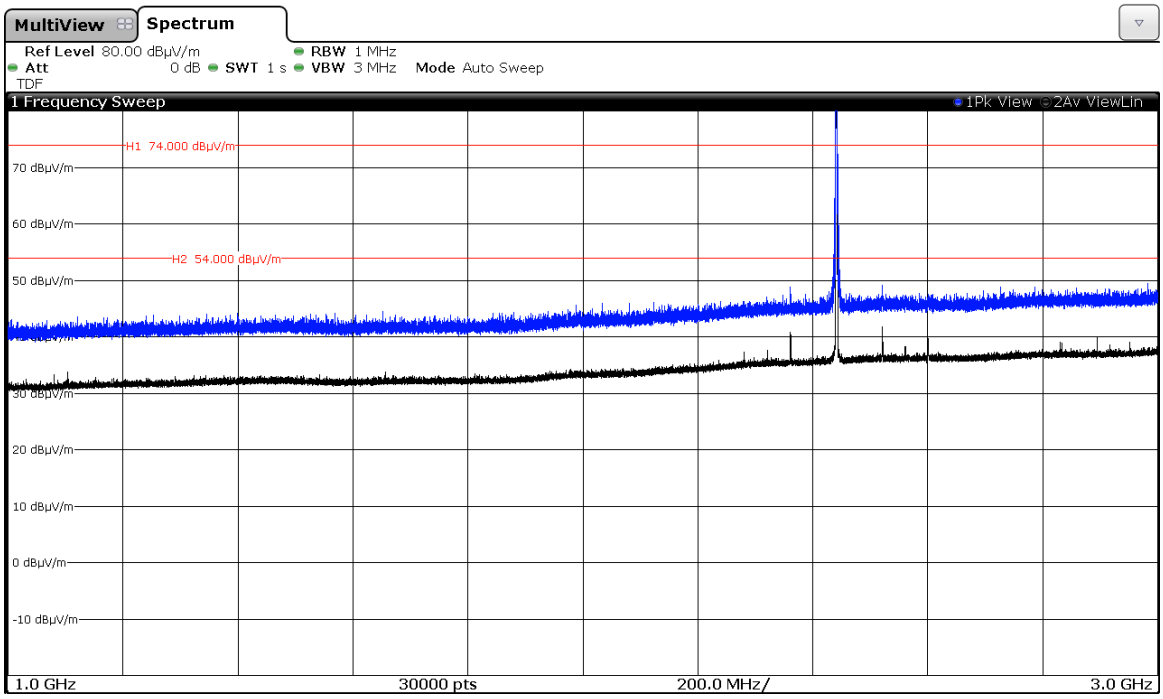
Modulation: 8-DPSK

CHANNEL: Lowest (2402 MHz).



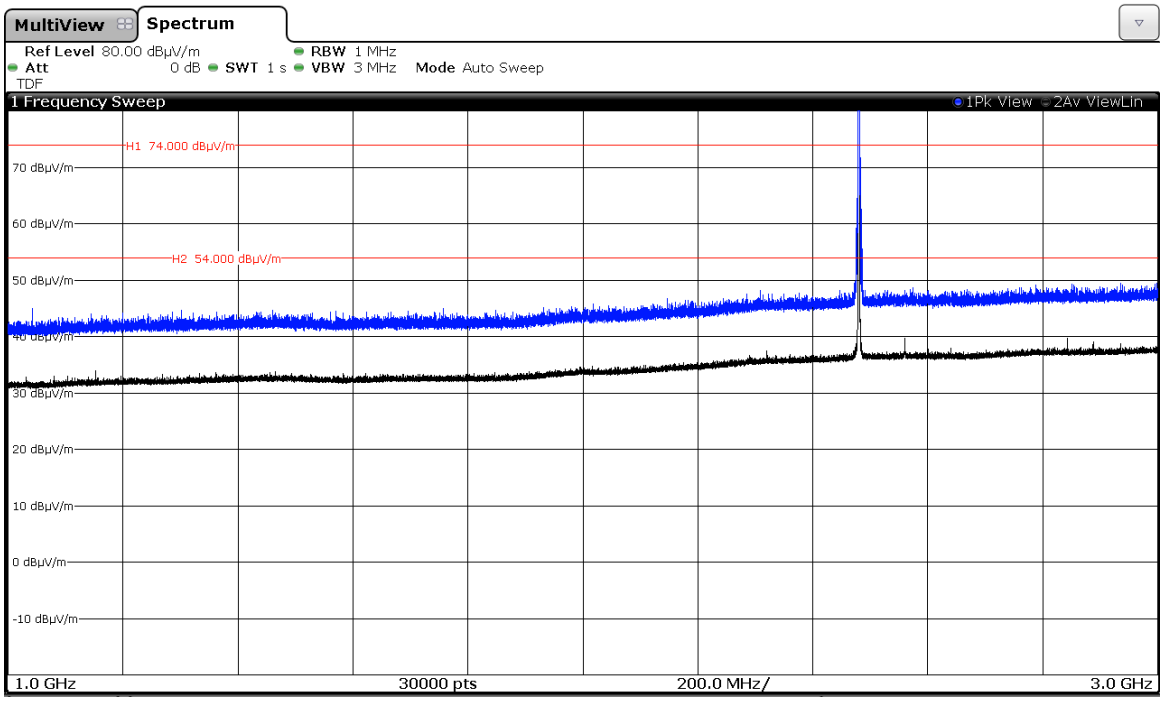
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

CHANNEL: Highest (2480 MHz).

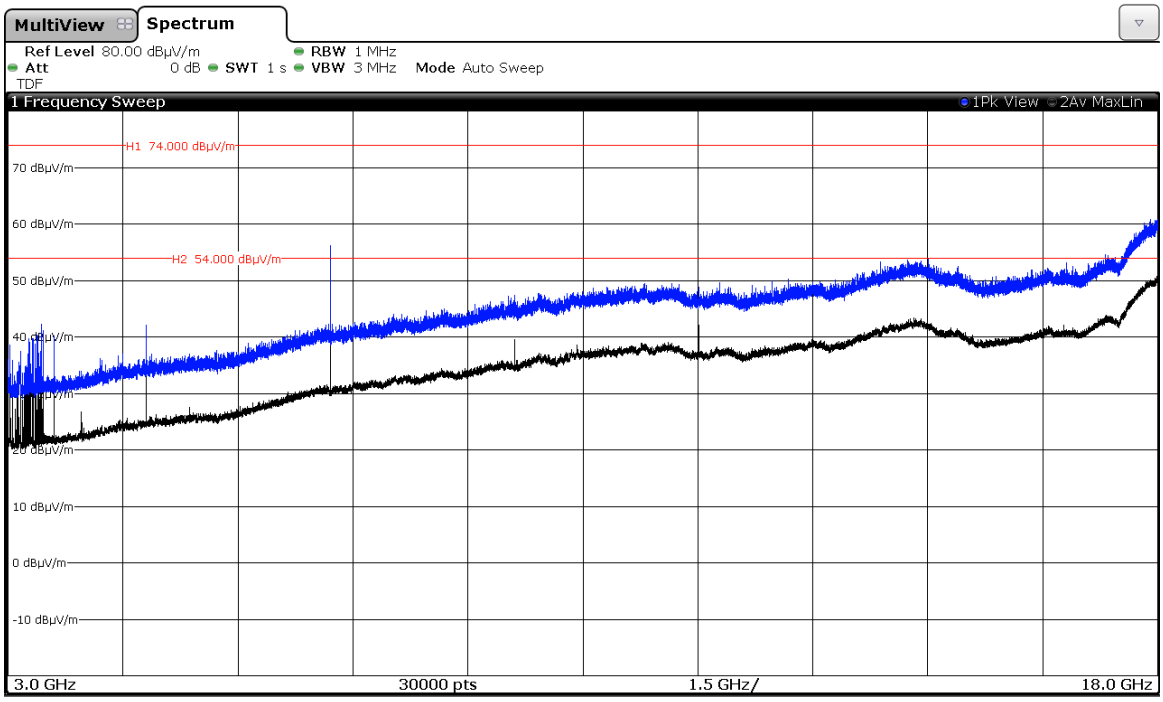


Note: The peak shown in the plot above the limits is the carrier frequency.

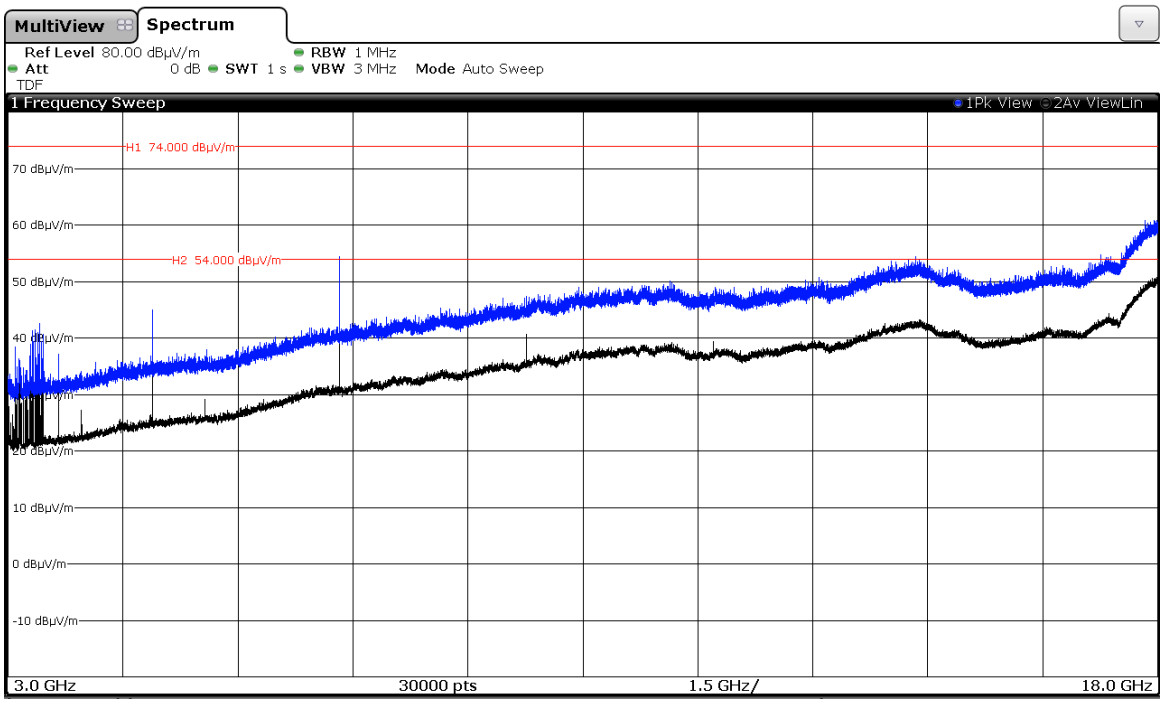
FREQUENCY RANGE 3 GHz to 18 GHz.

Modulation: GFSK

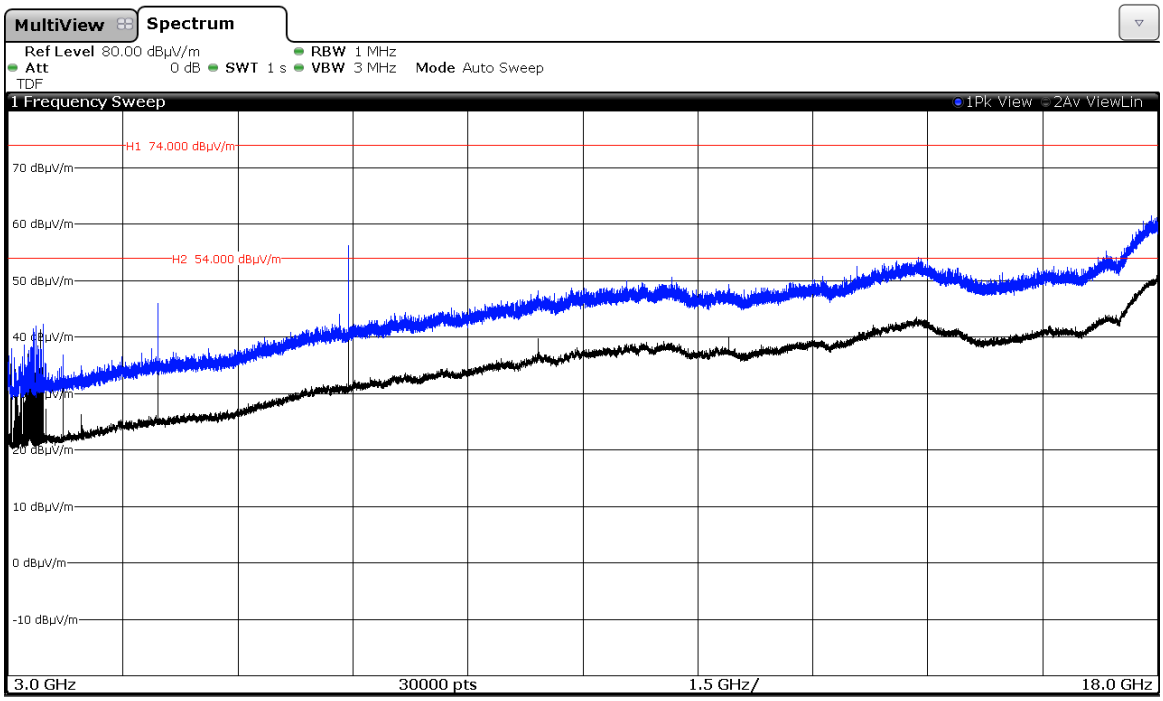
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

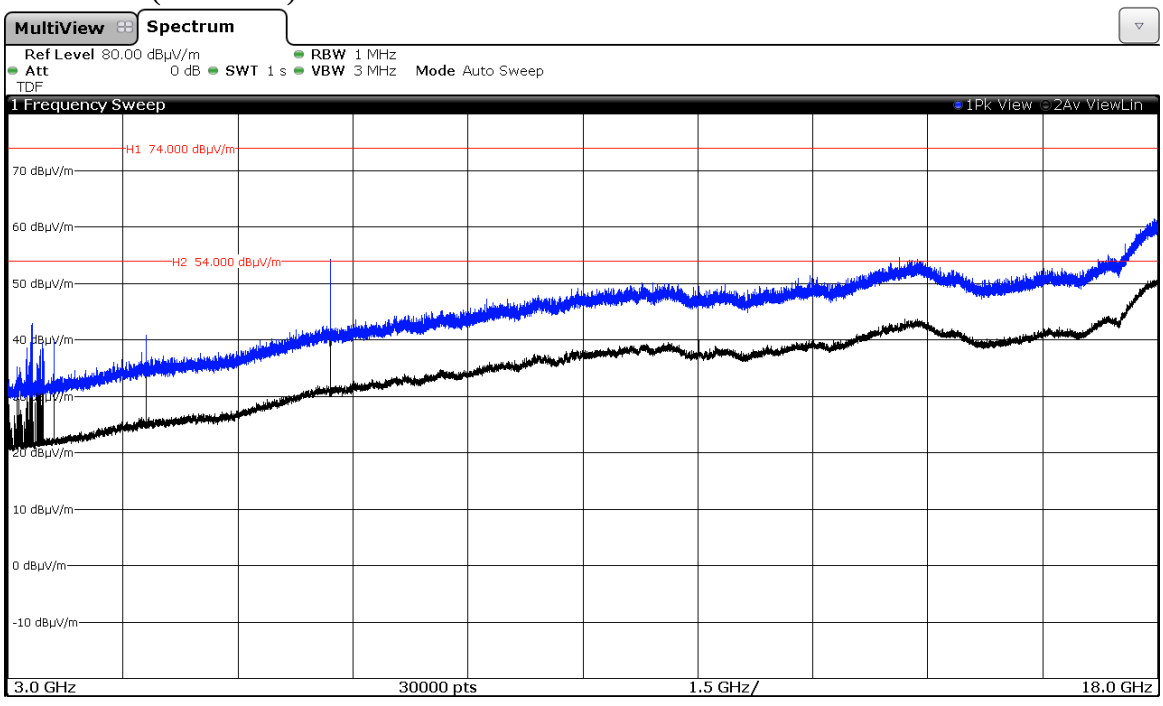


CHANNEL: Highest (2480 MHz).

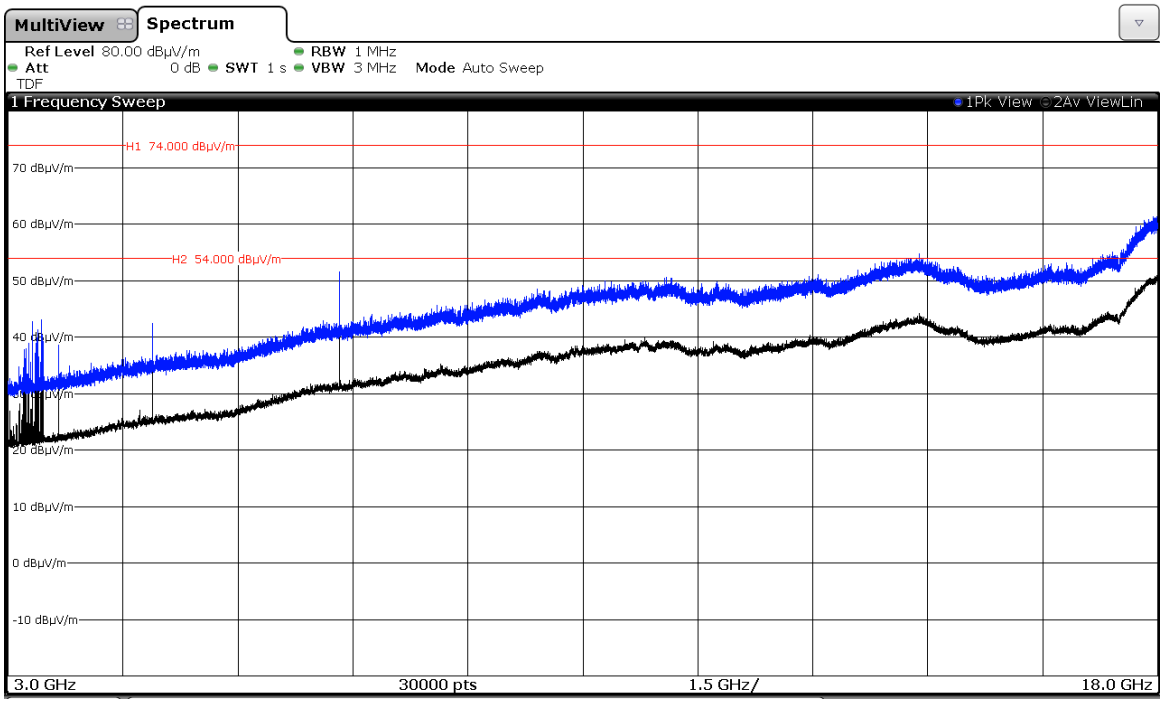


Modulation: Π/4-DQPSK

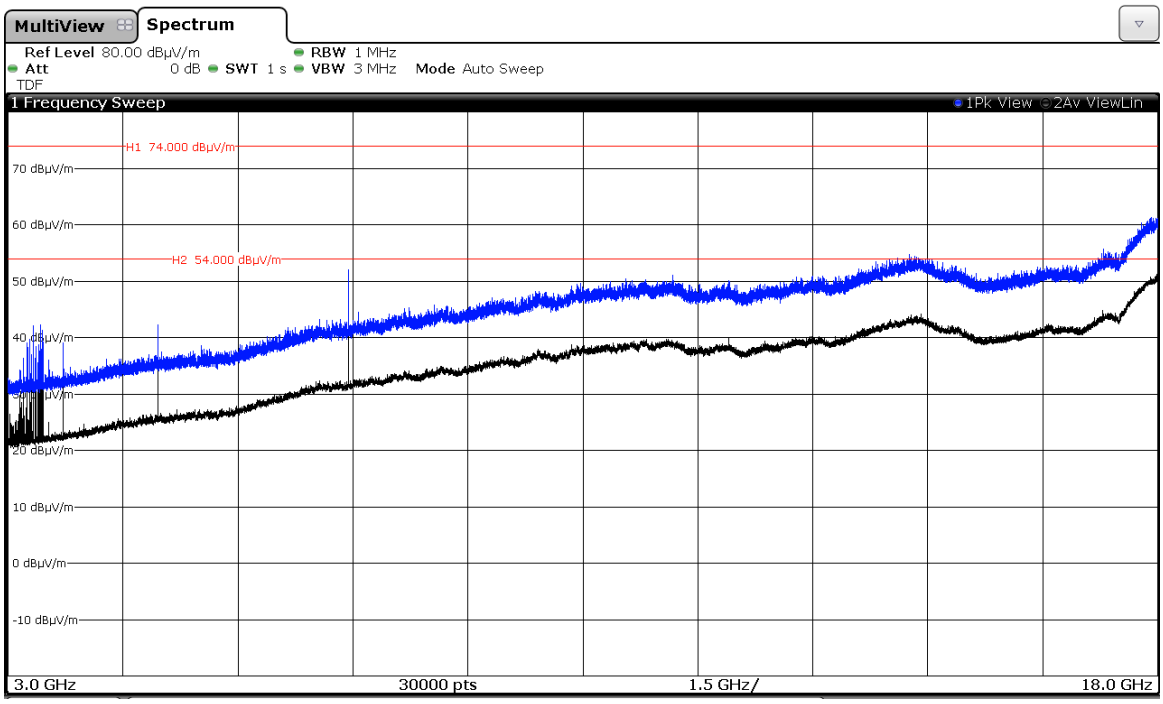
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

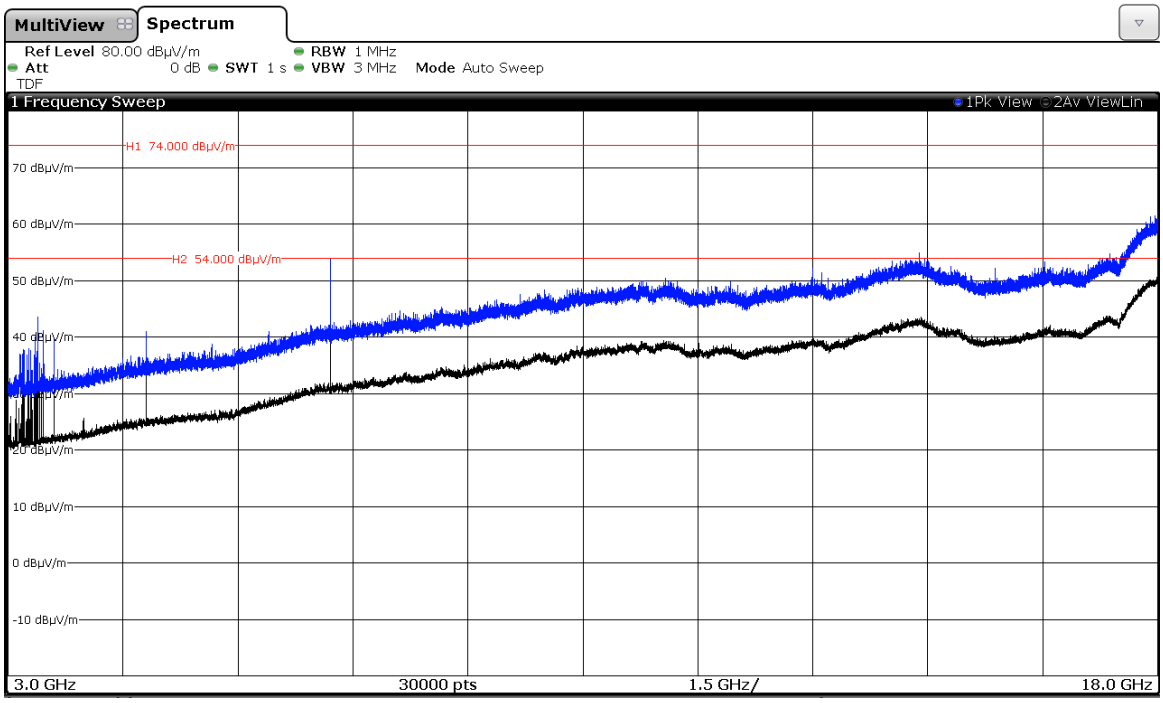


CHANNEL: Highest (2480 MHz).

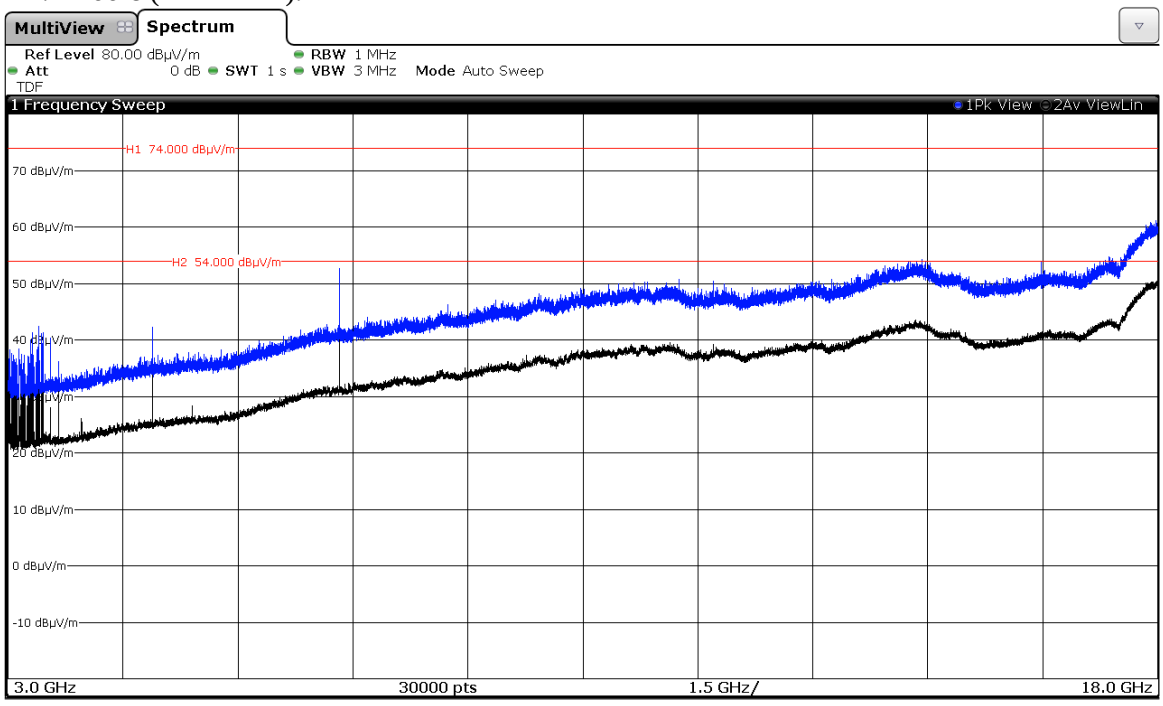


Modulation: 8-DPSK

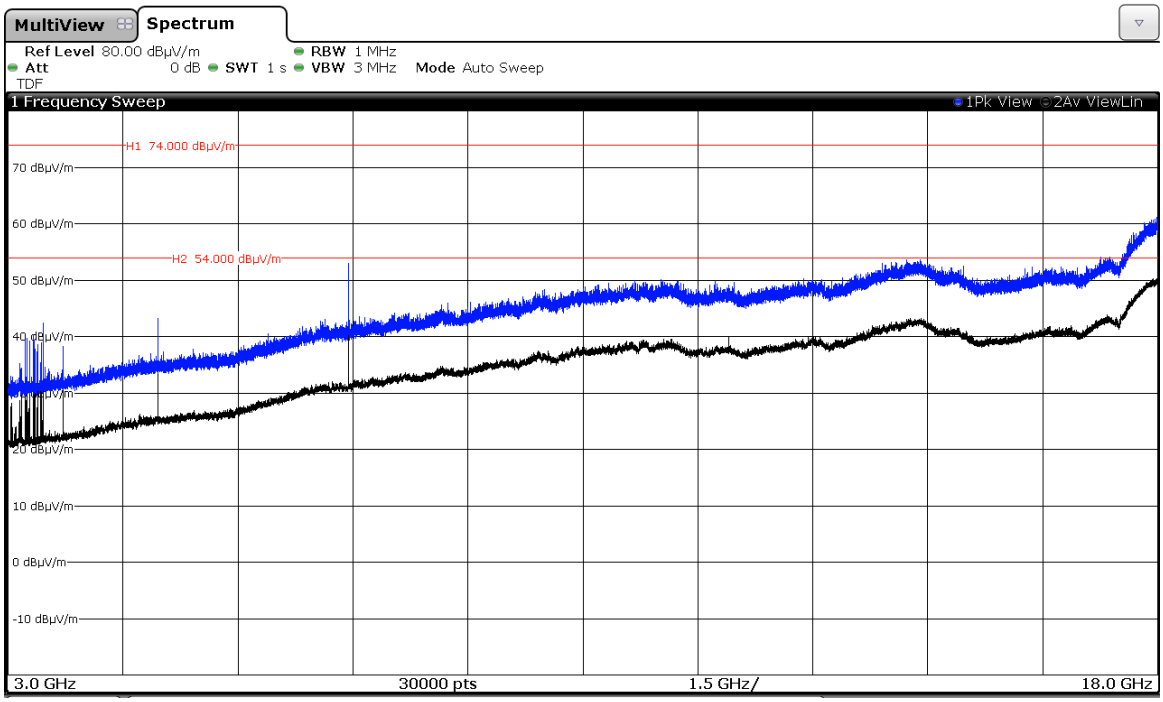
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).



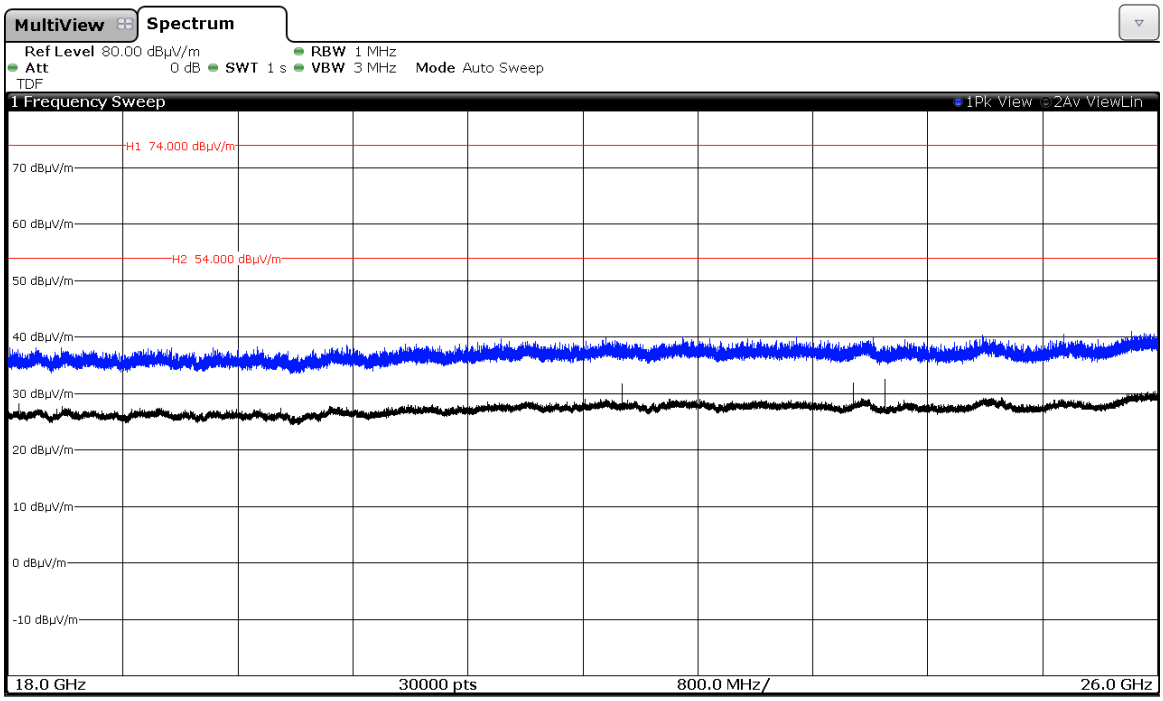
CHANNEL: Highest (2480 MHz).



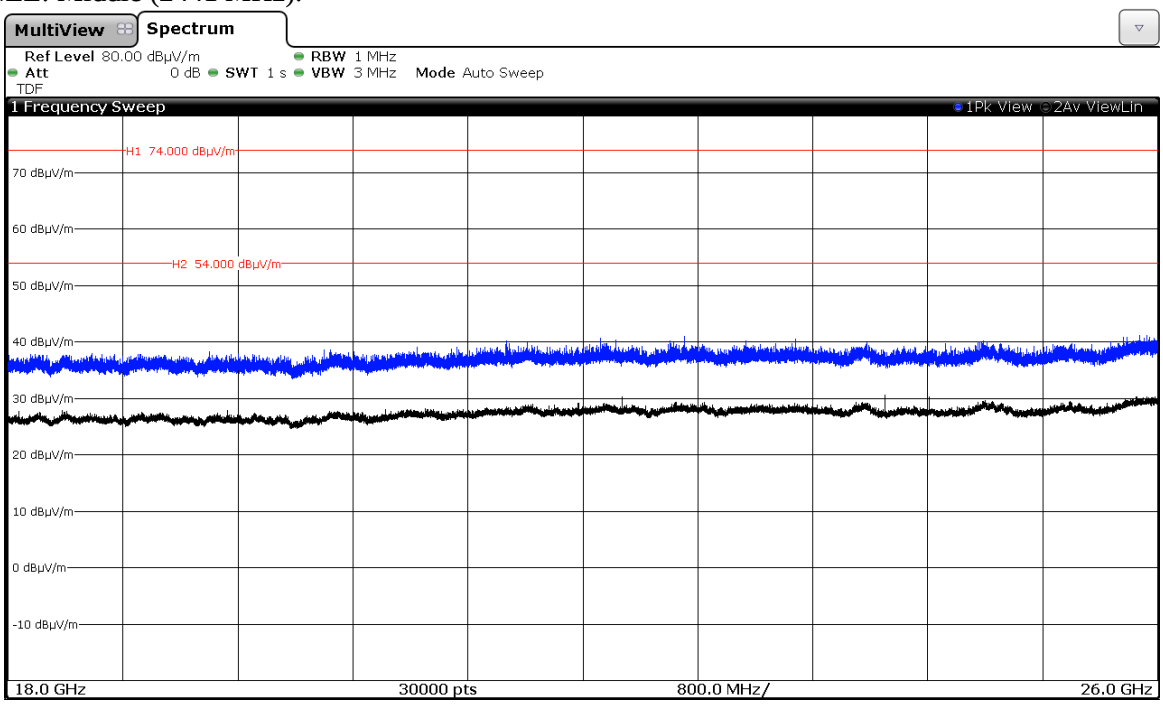
FREQUENCY RANGE 18 GHz to 26 GHz.

Modulation: GFSK

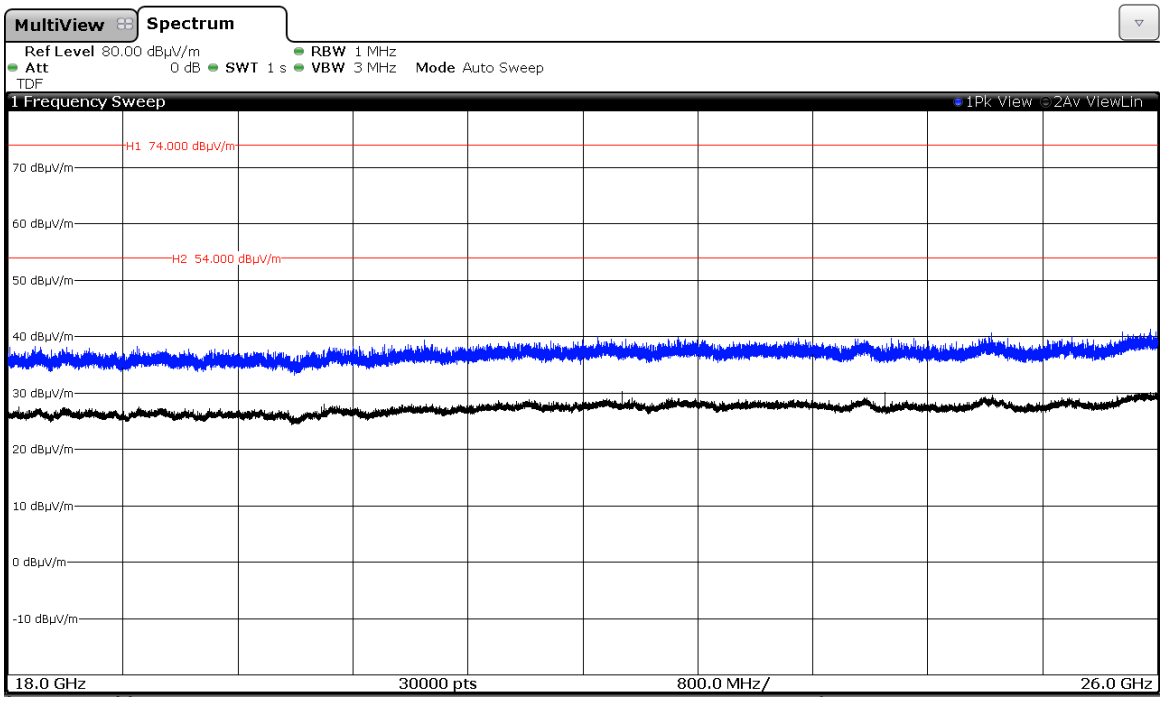
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

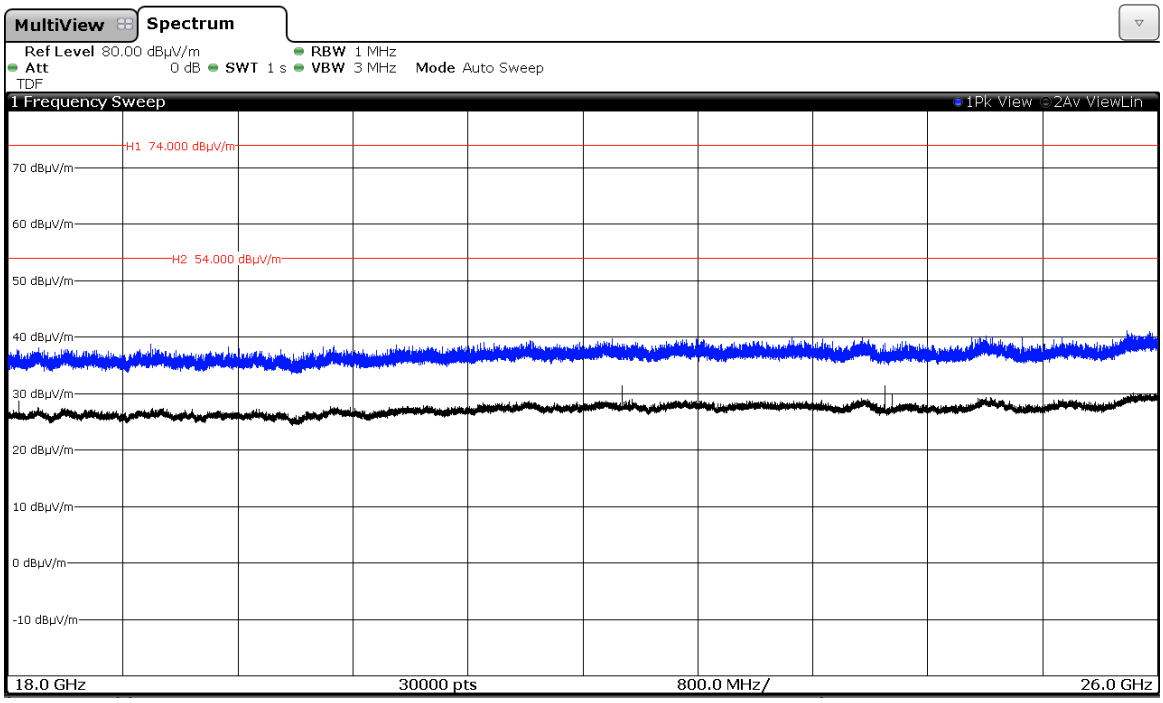


CHANNEL: Highest (2480 MHz).

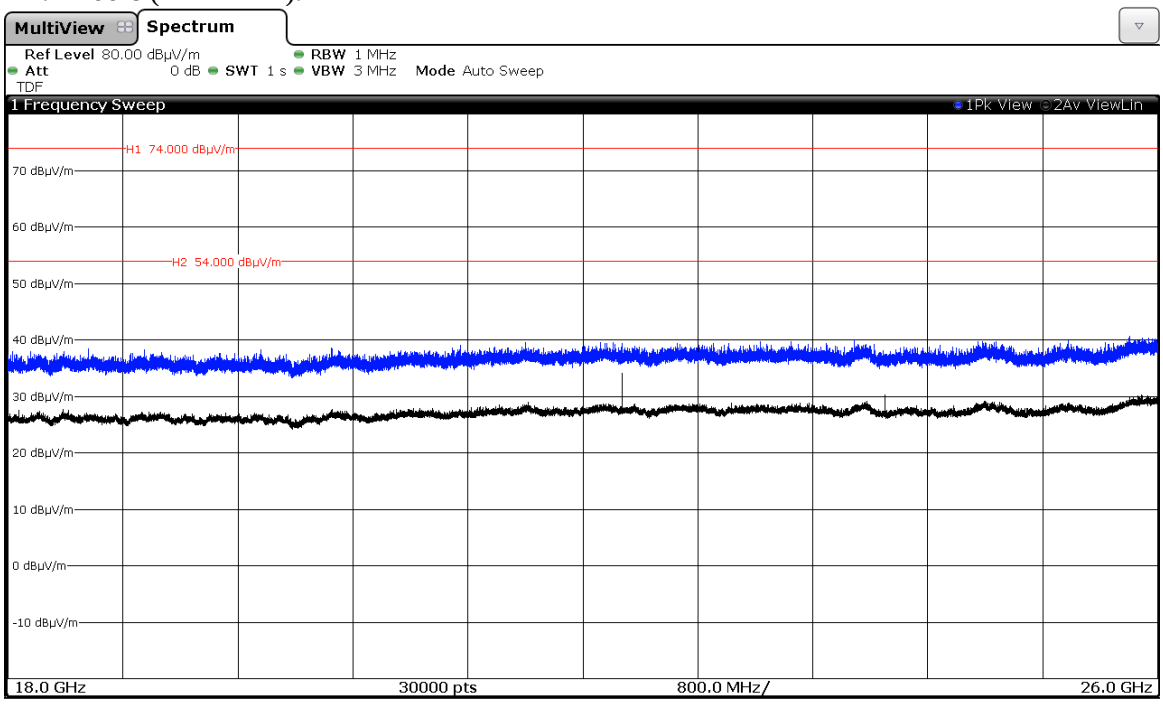


Modulation Π/4-DQPSK

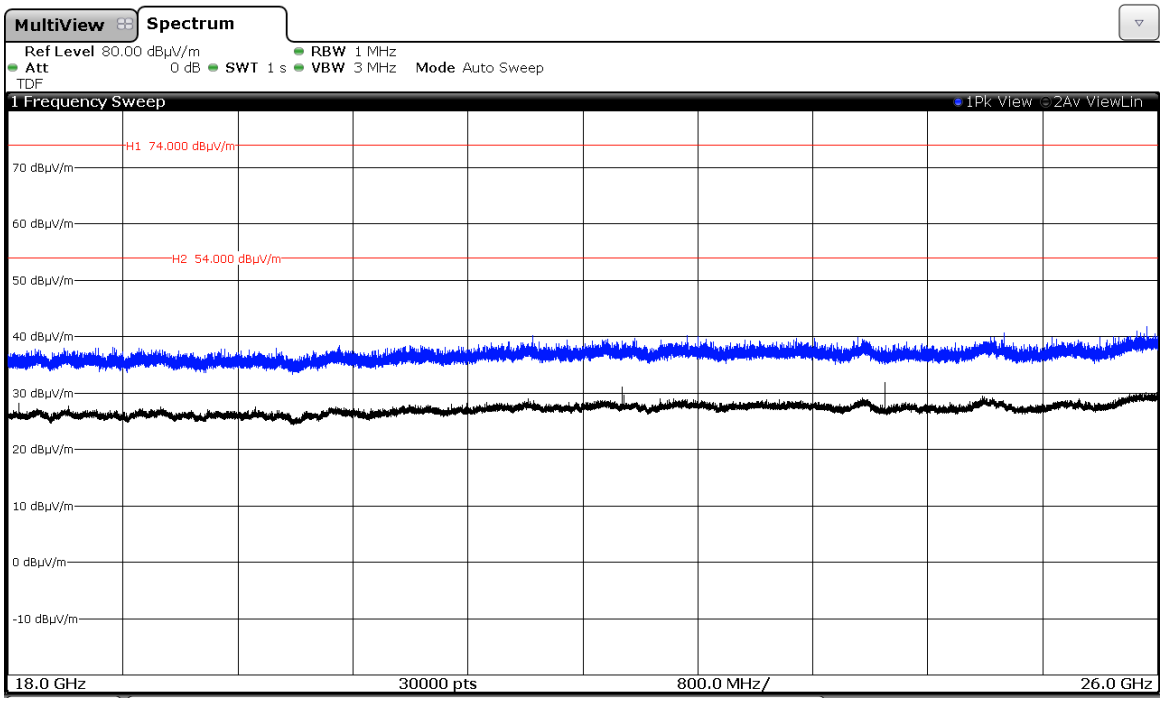
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

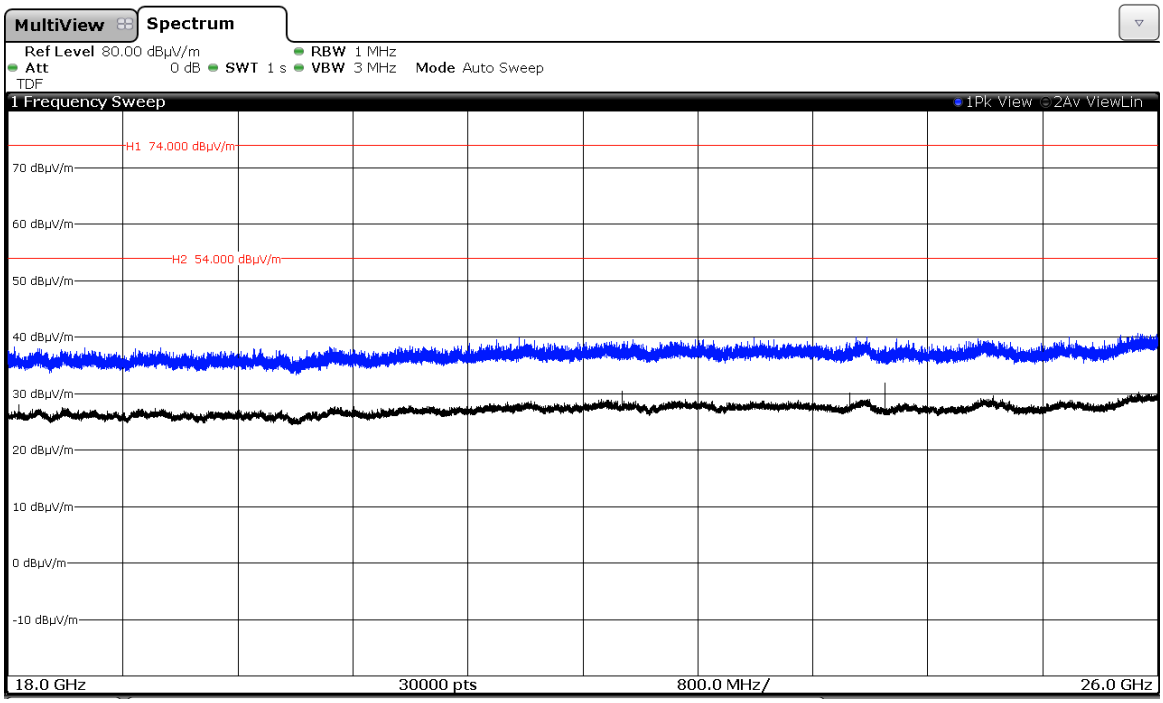


CHANNEL: Highest (2480 MHz).

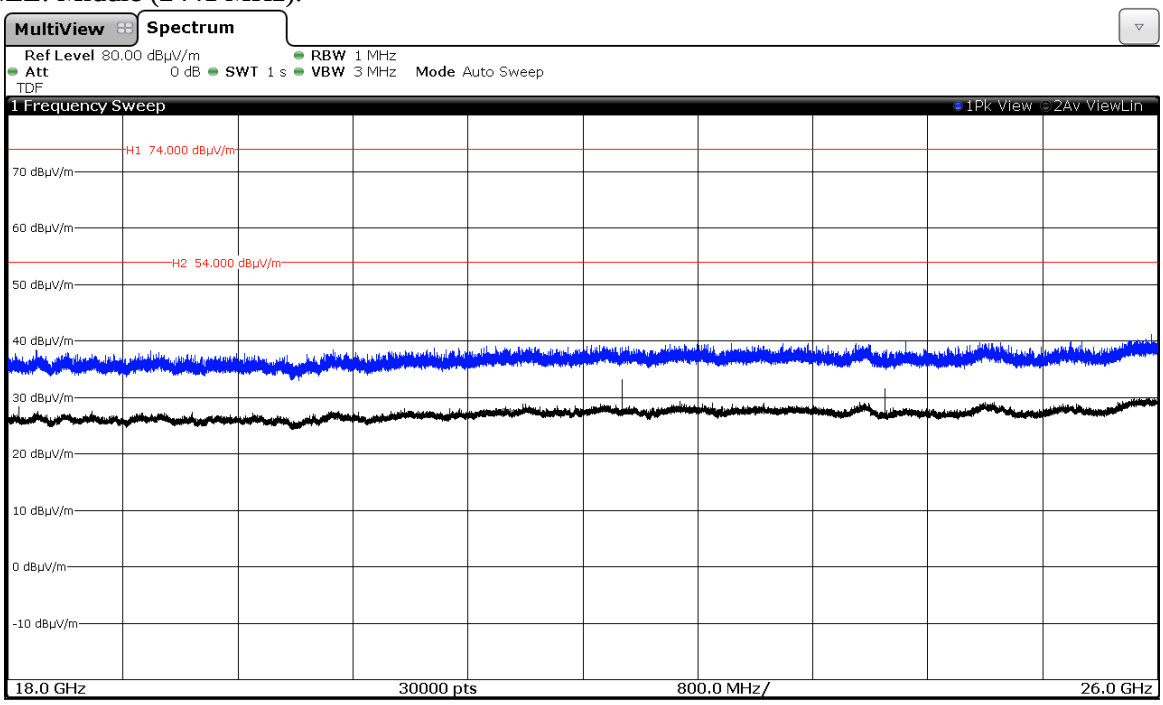


Modulation: 8-DPSK

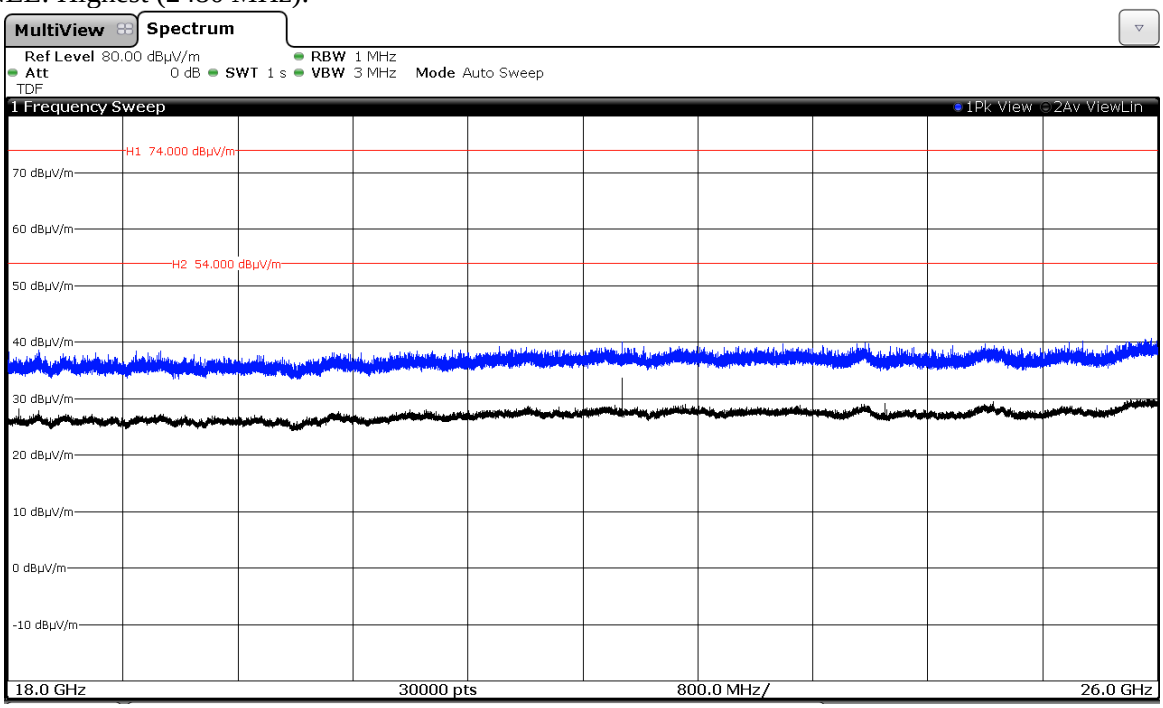
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).



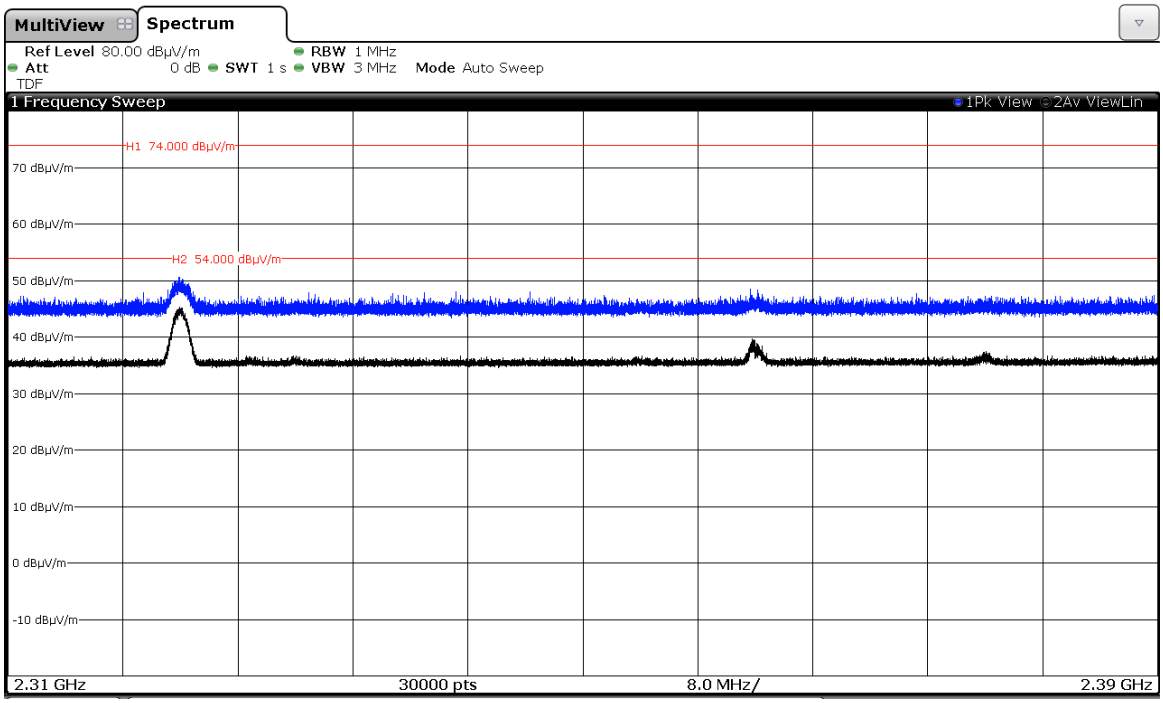
CHANNEL: Highest (2480 MHz).



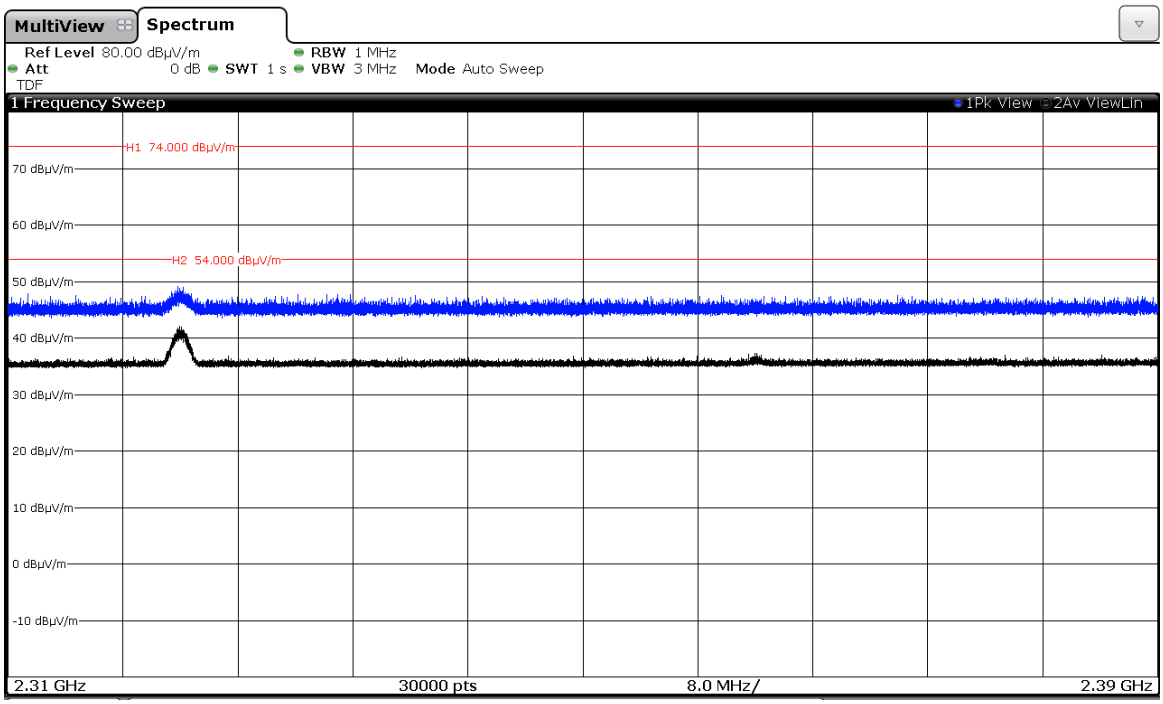
FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

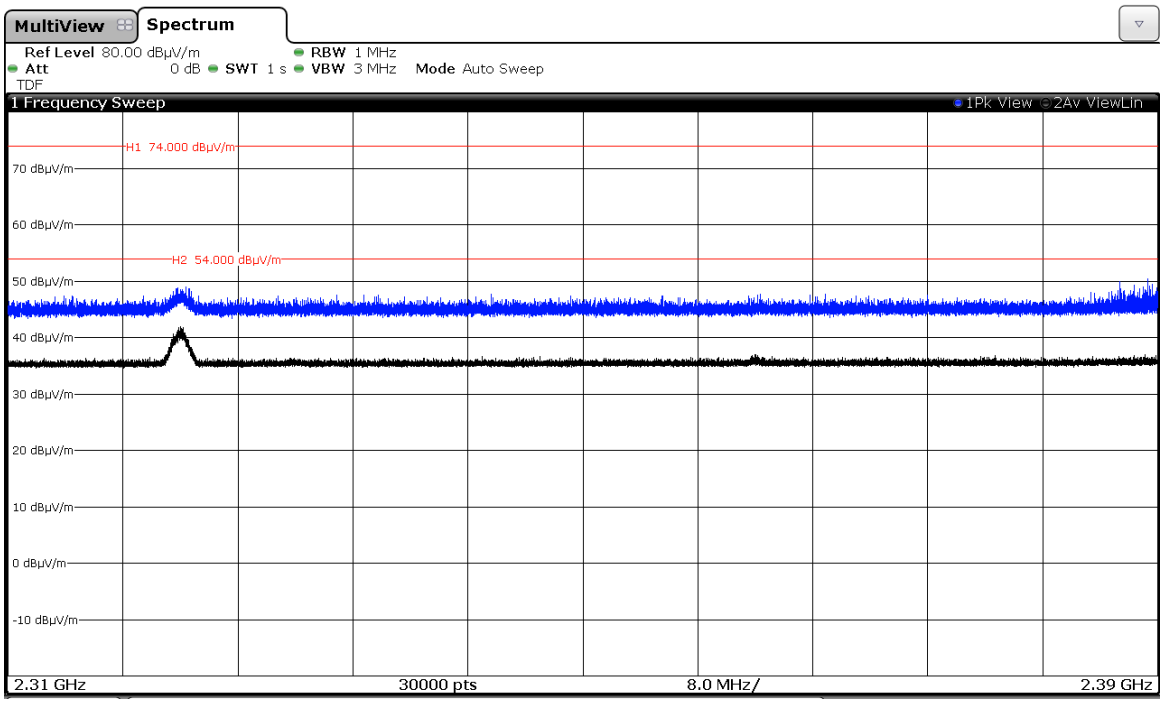
Modulation: GFSK



Modulation: Π/4-DQPSK

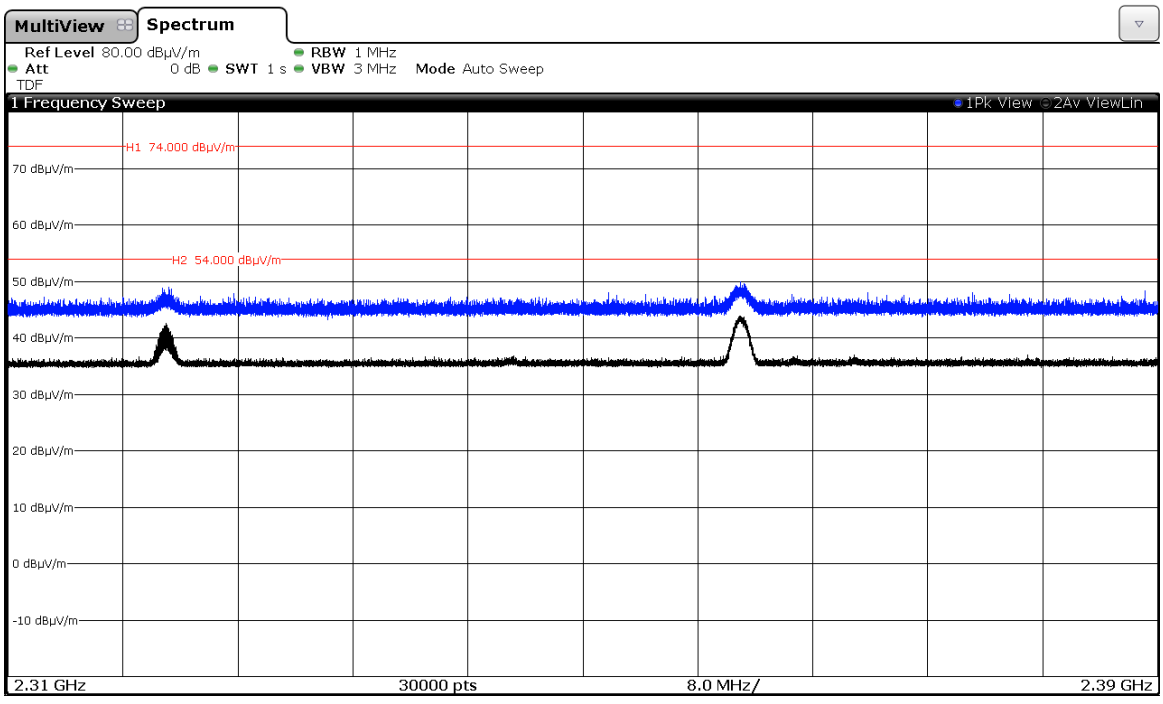


Modulation: 8-DPSK

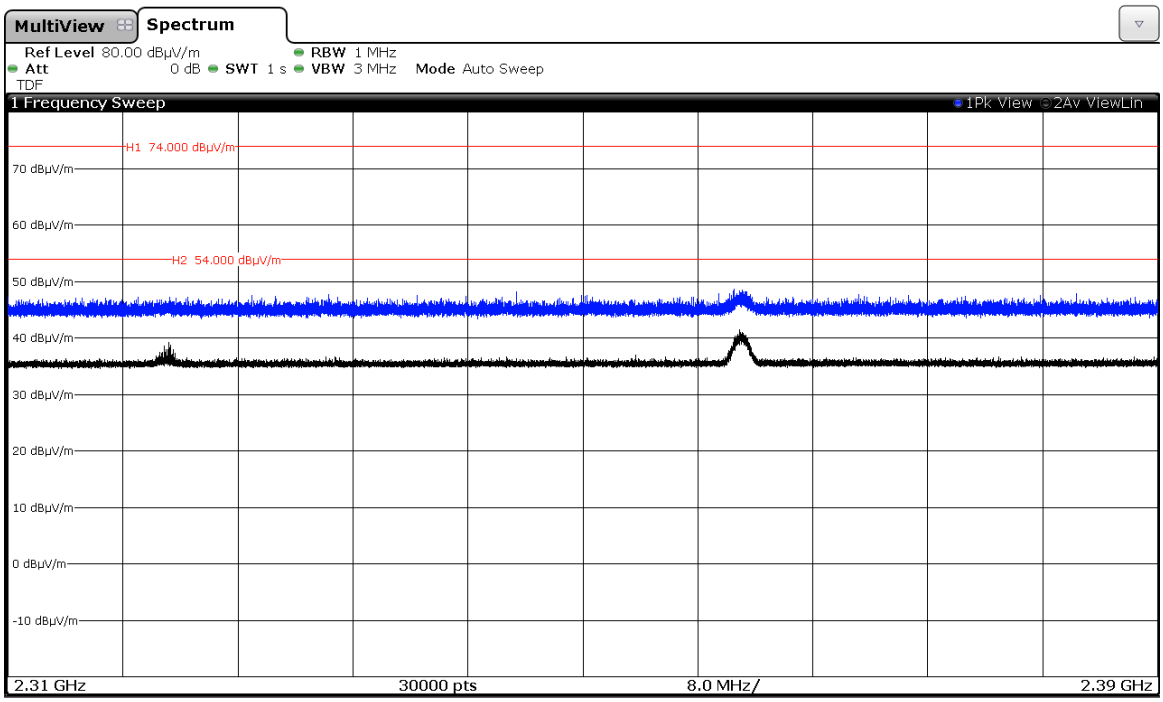


CHANNEL: Middle

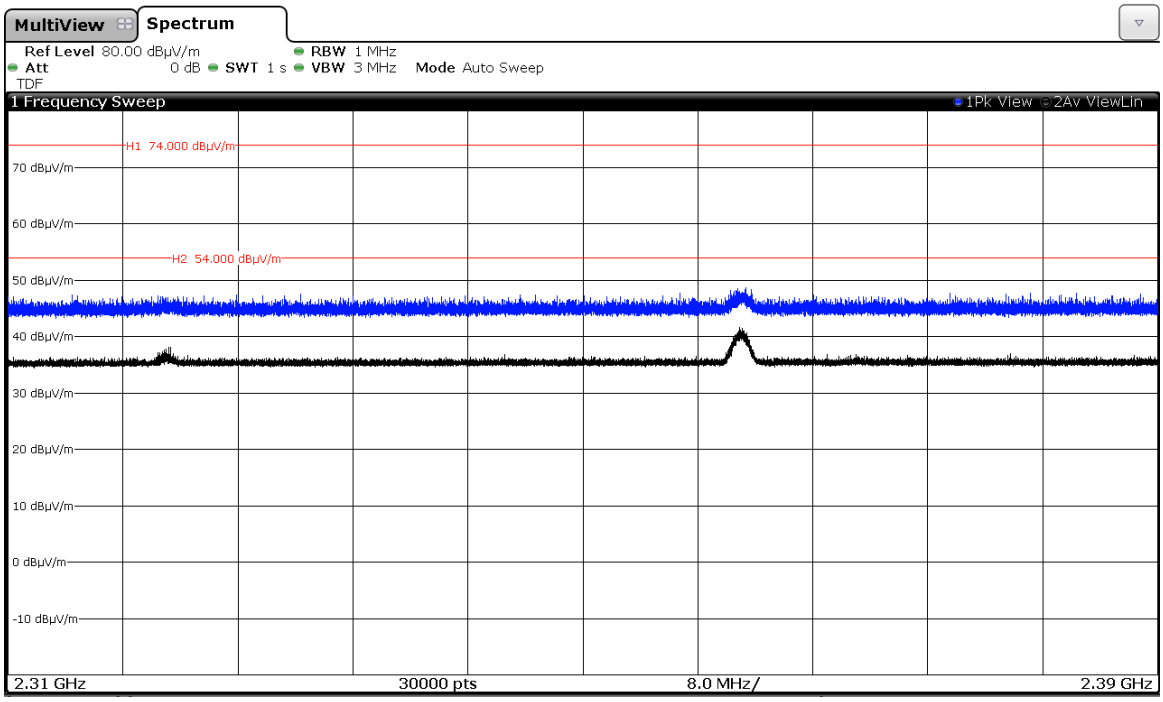
Modulation: GFSK



Modulation: Π/4-DQPSK

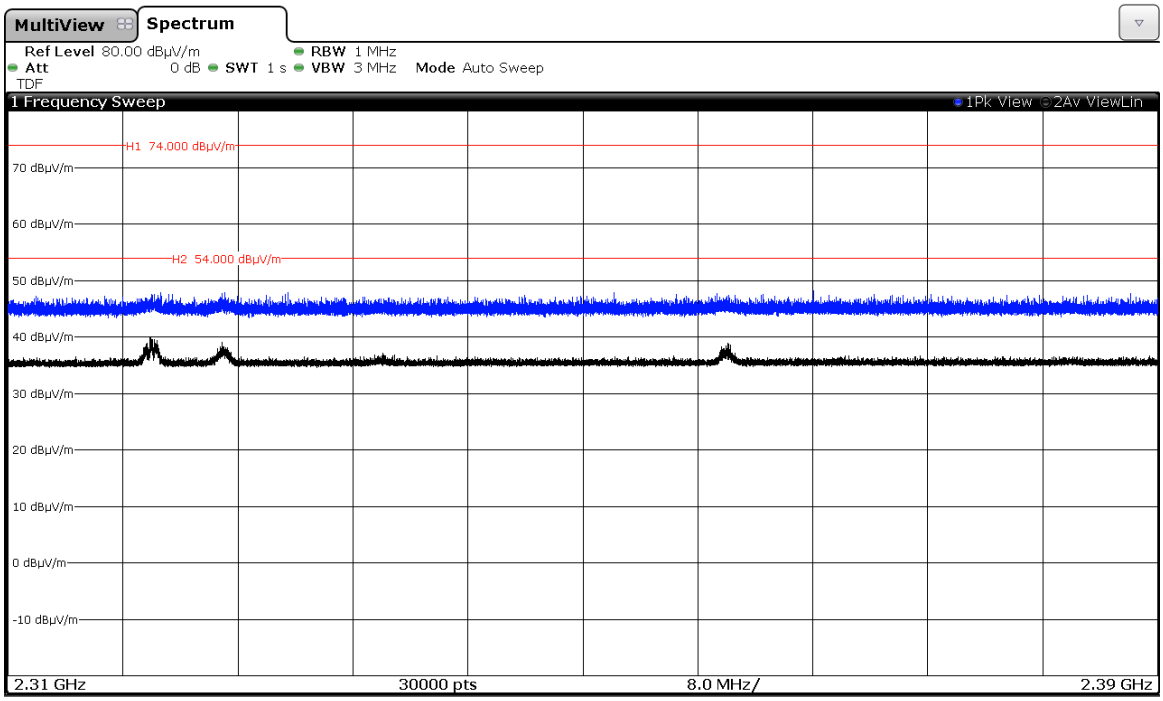


Modulation: 8-DPSK

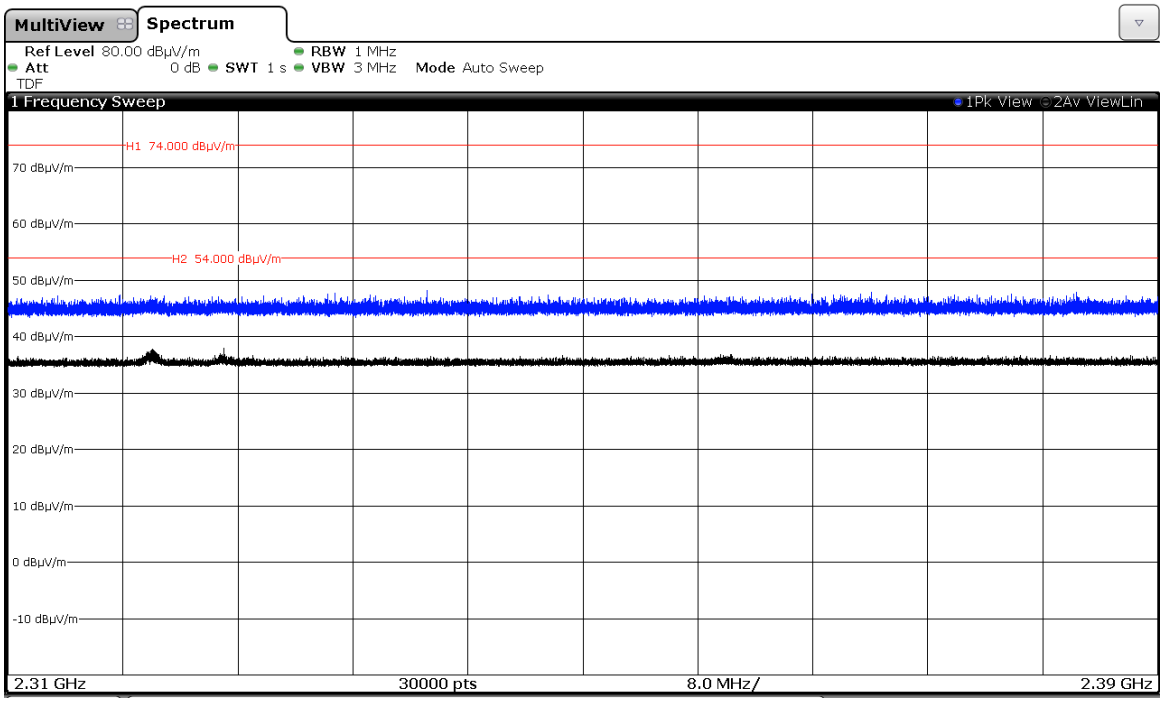


CHANNEL: Highest

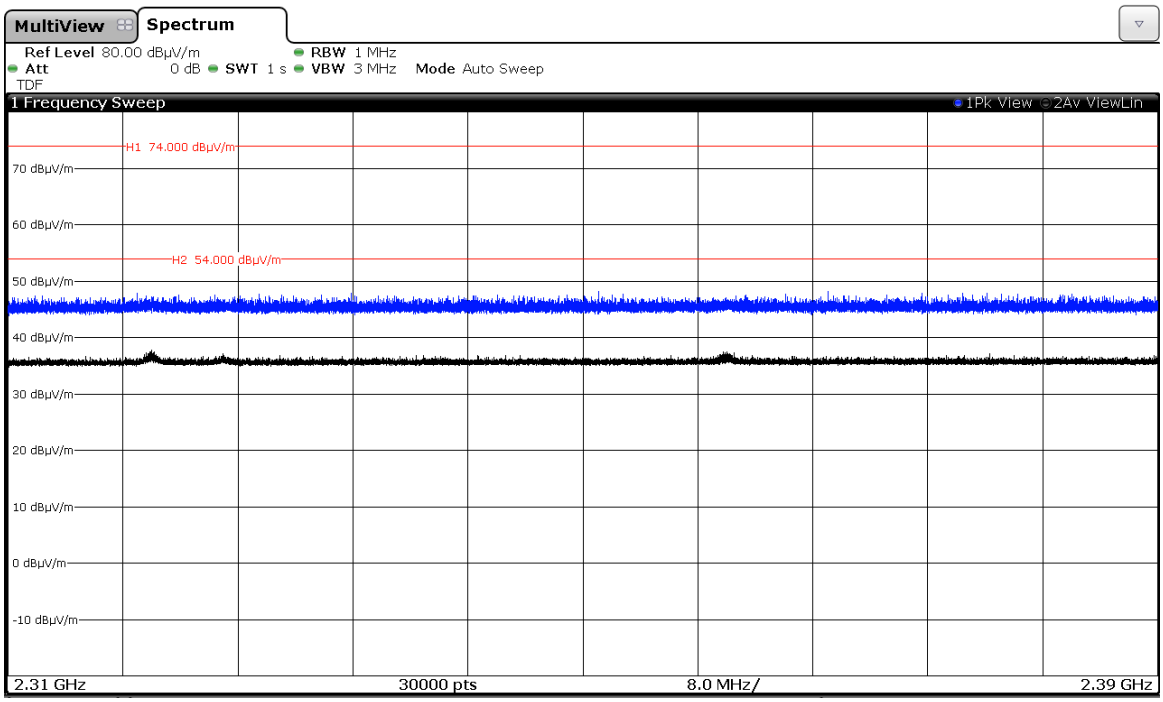
Modulation: GFSK



Modulation: Π/4-DQPSK



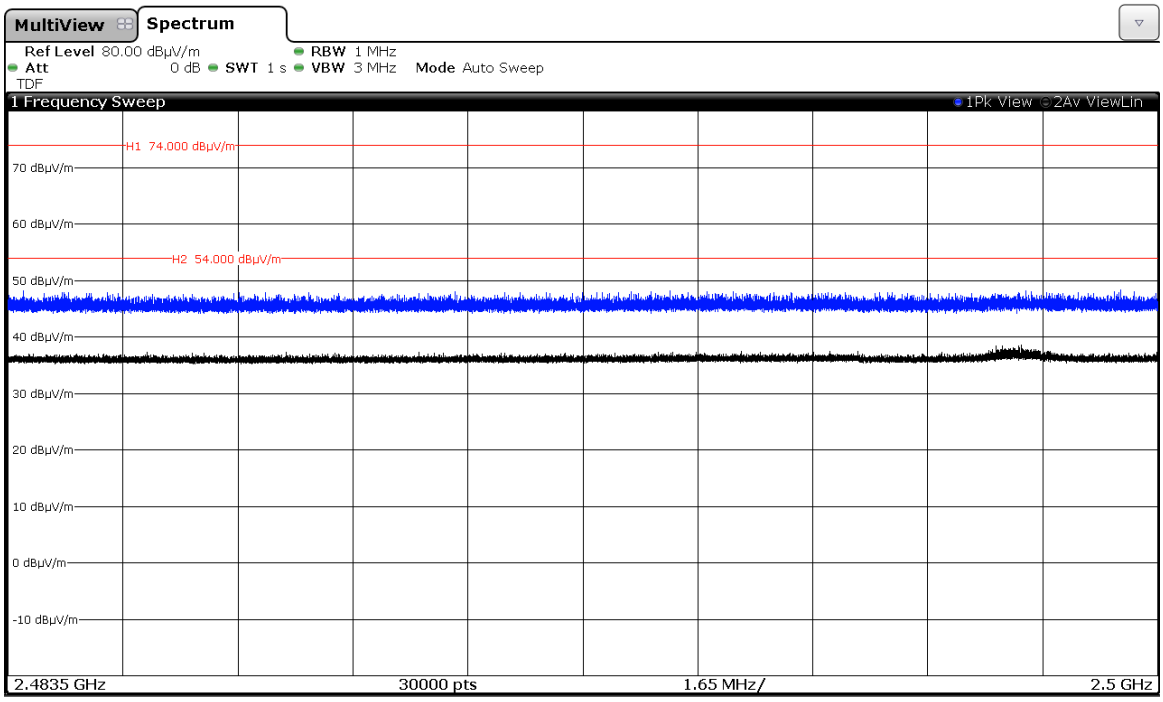
Modulation: 8-DPSK



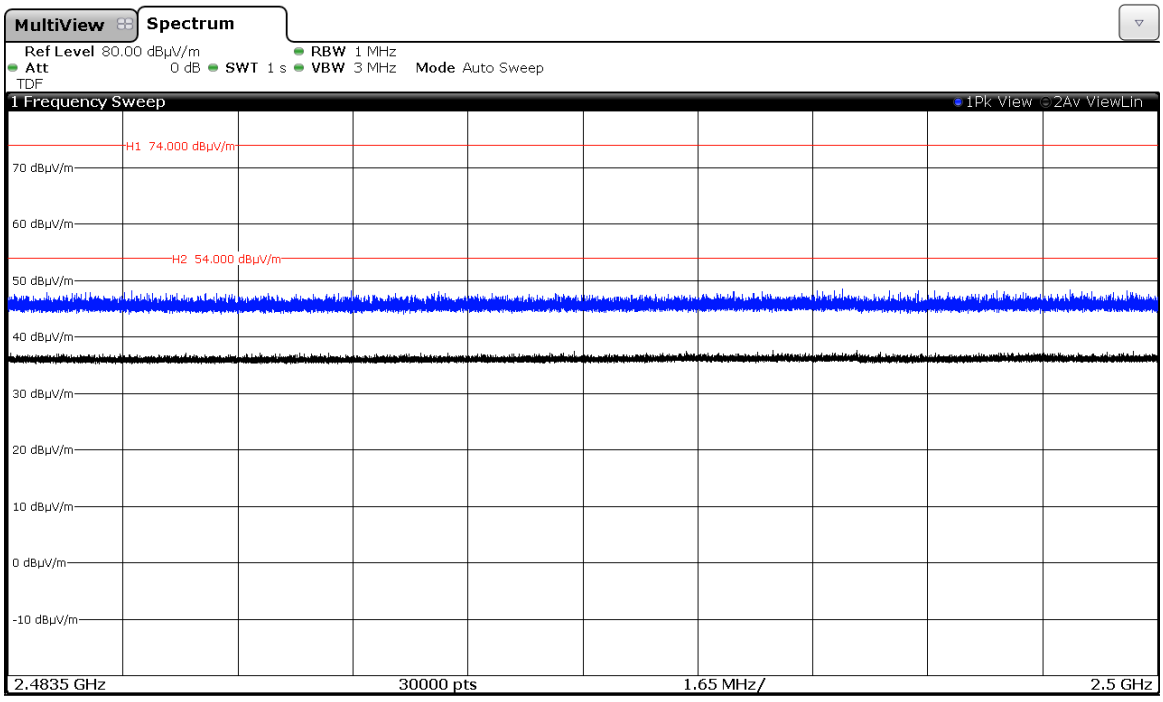
FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

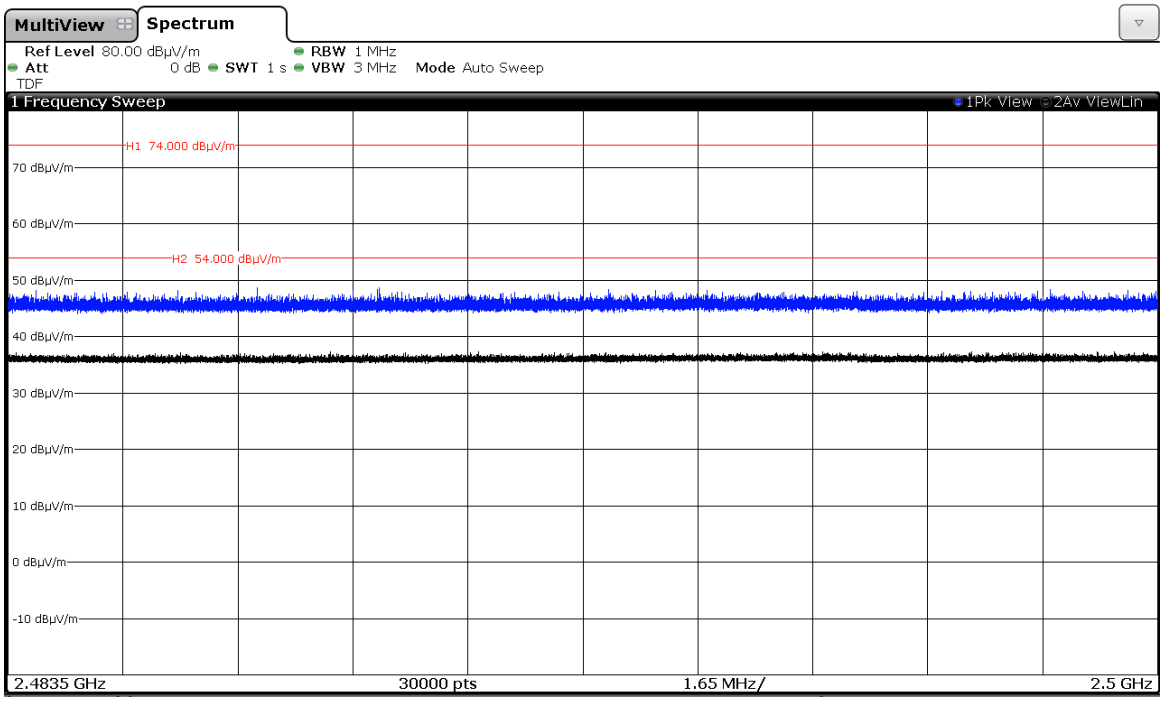
Modulation: GFSK



Modulation: Π/4-DQPSK

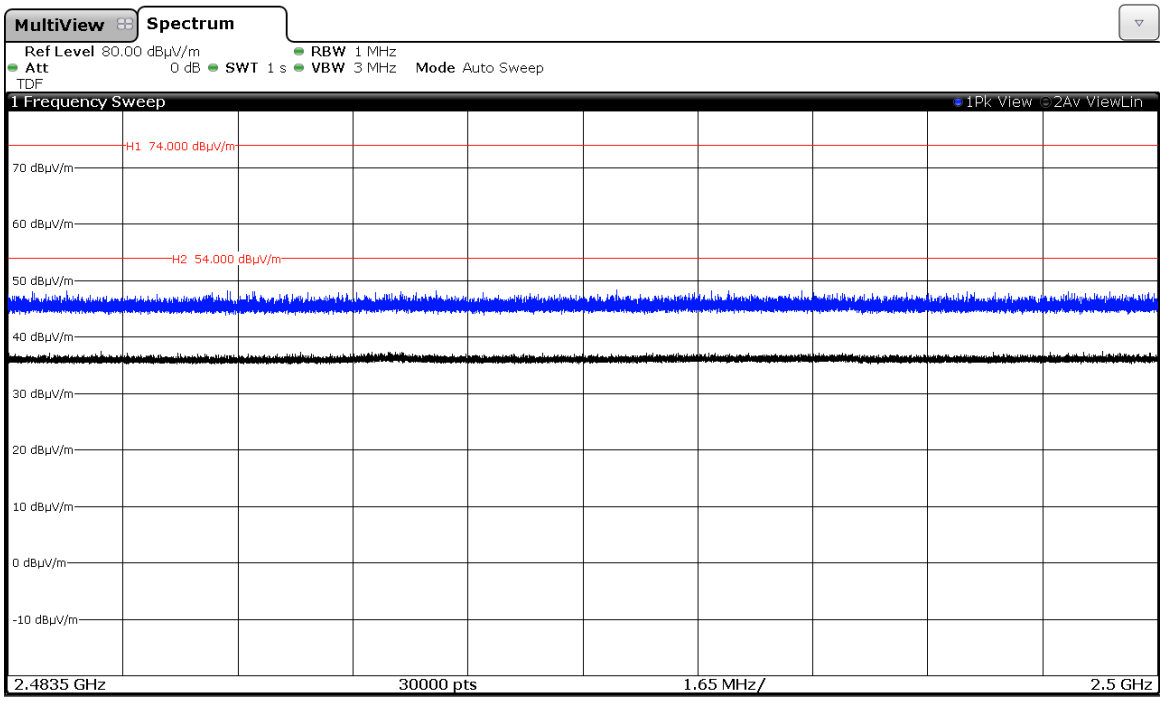


Modulation: 8-DPSK

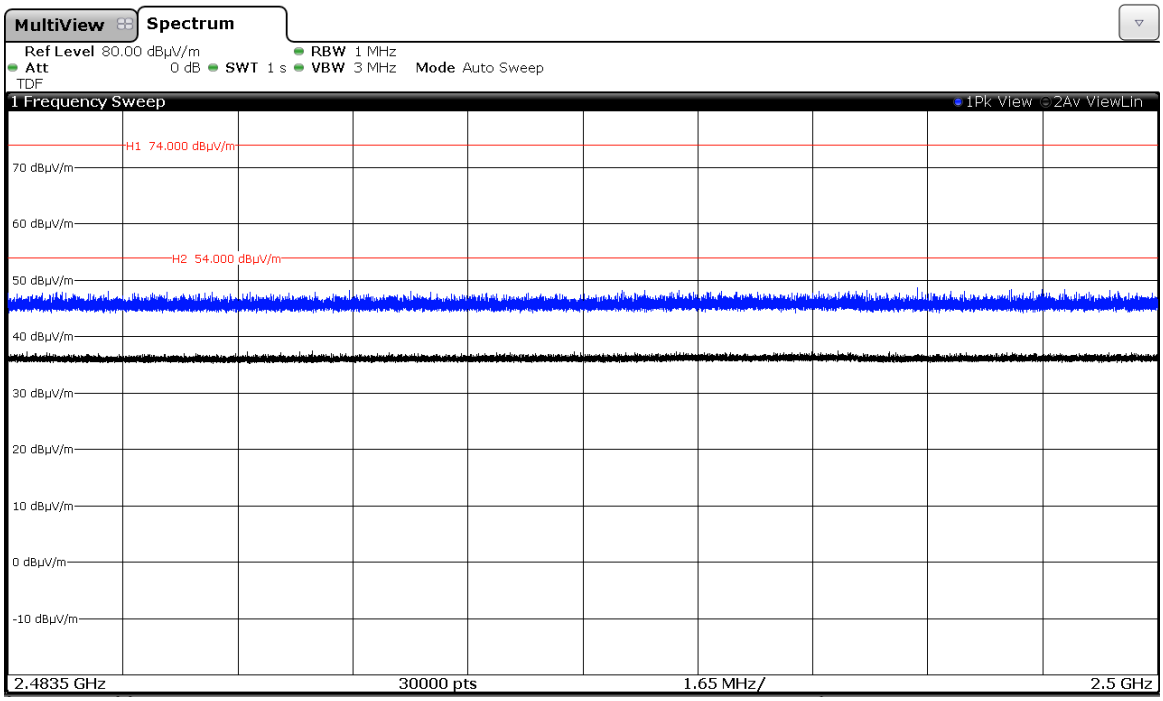


CHANNEL: Middle

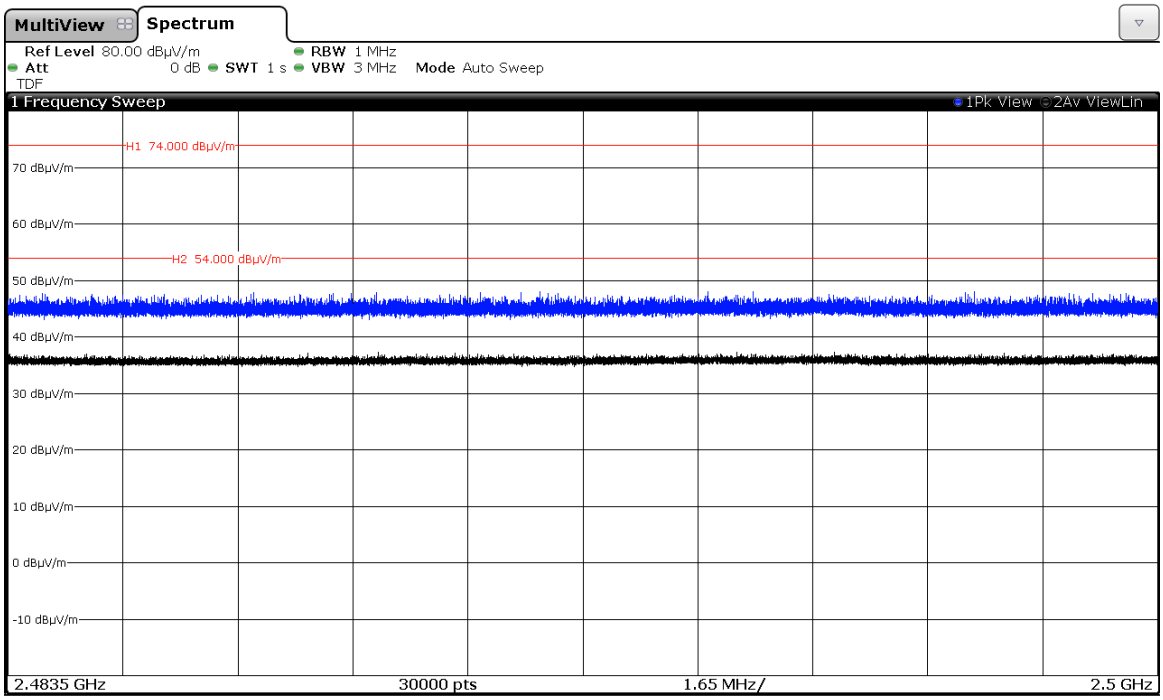
Modulation: GFSK



Modulation: Π/4-DQPSK

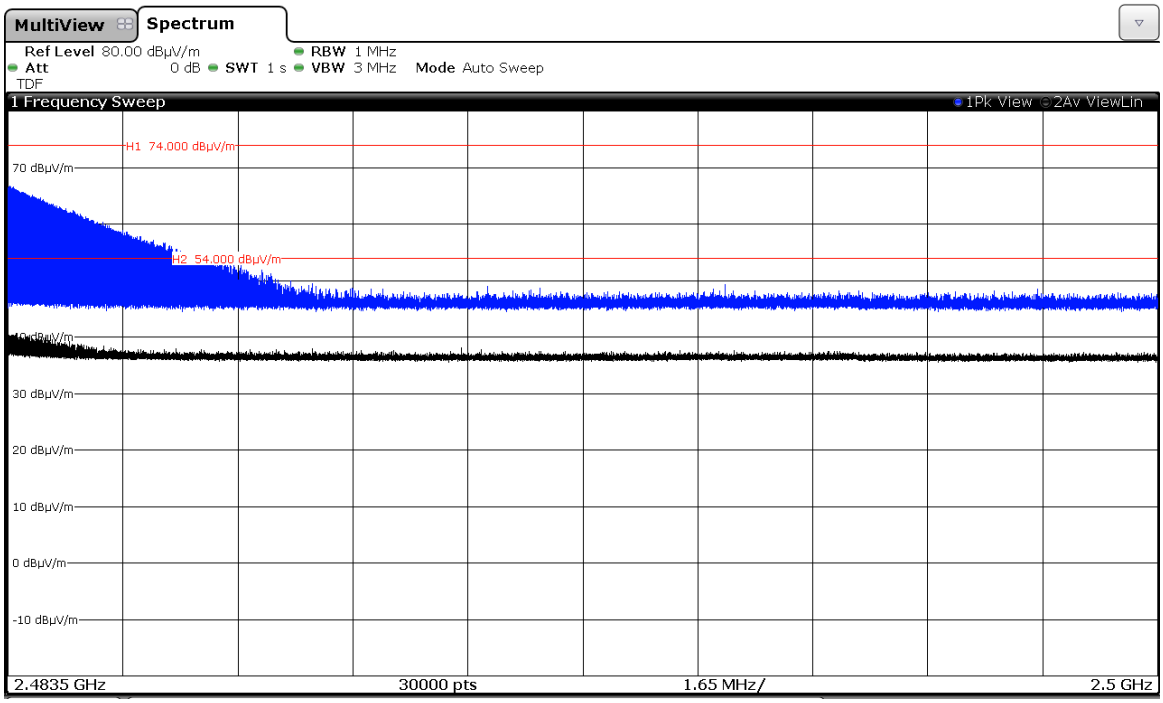


Modulation: 8-DPSK

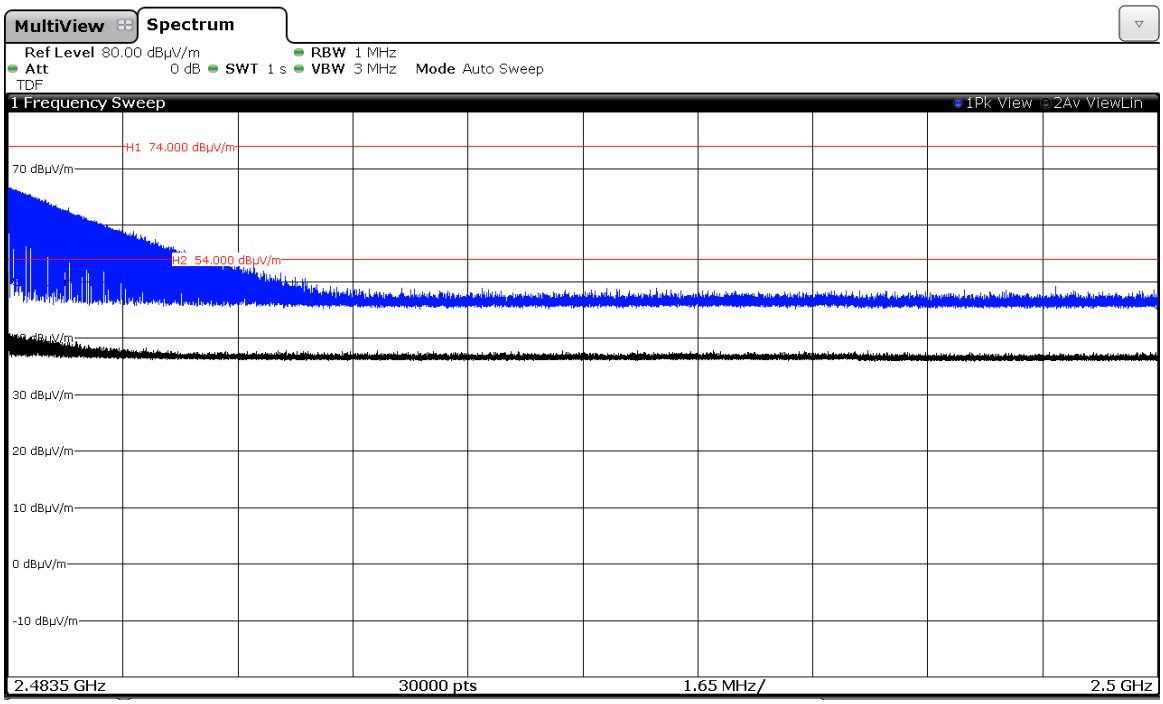


CHANNEL: Highest

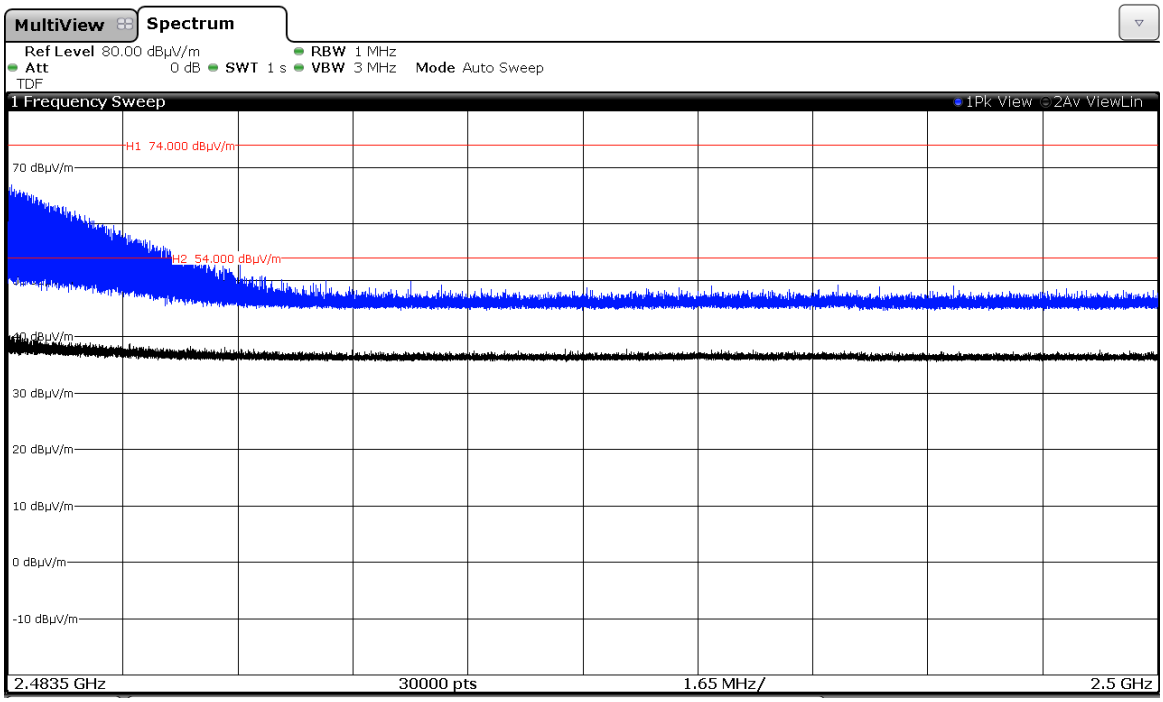
Modulation: GFSK



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):

$V_{nominal}$ = 12 Vdc

Type of power supply = DC voltage from battery.

Type of antenna = Integral antenna.

Declared Gain for antenna (maximum) = -0.99 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 558074 D01 DTS Meas Guidance v03r05 dated 04/08/2016.

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

WiFi 2.4 GHz	WIFI Tool: TX Power (dBm)
802.11b	18
802.11g	16
802.11n20	16

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

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

The data rates of 1Mb/s for 802.11b, 6Mb/s for 802.11g, MSC0 for 802.11n20 and MSC0 for 802.11n40 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and band edge levels at restricted bands.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is directly connected to the spectrum analyzer.

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).

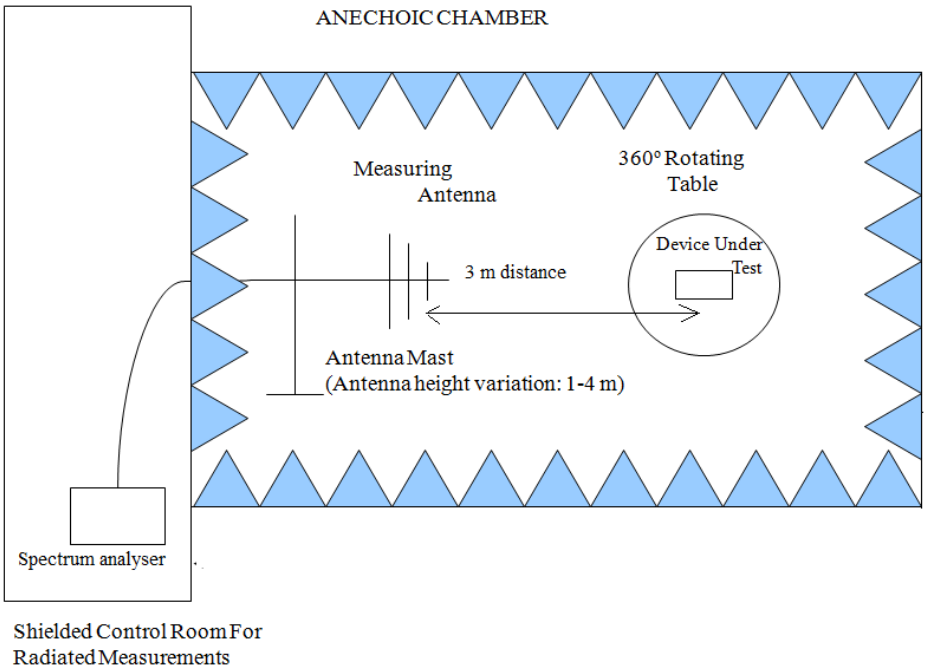
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission.

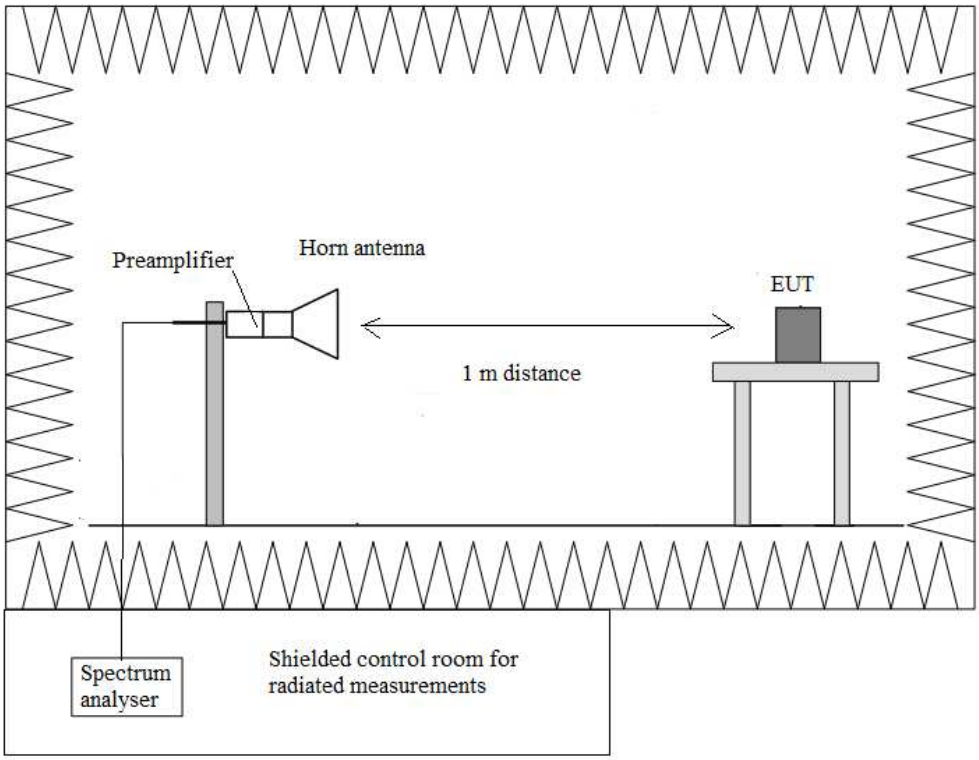
It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



Occupied Bandwidth

RESULTS

(see next plots)

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	13.392	13.429	13.454
-26 dBc bandwidth (MHz)	17.249	17.262	17.255
Measurement uncertainty (kHz)	<±50		

Mode G

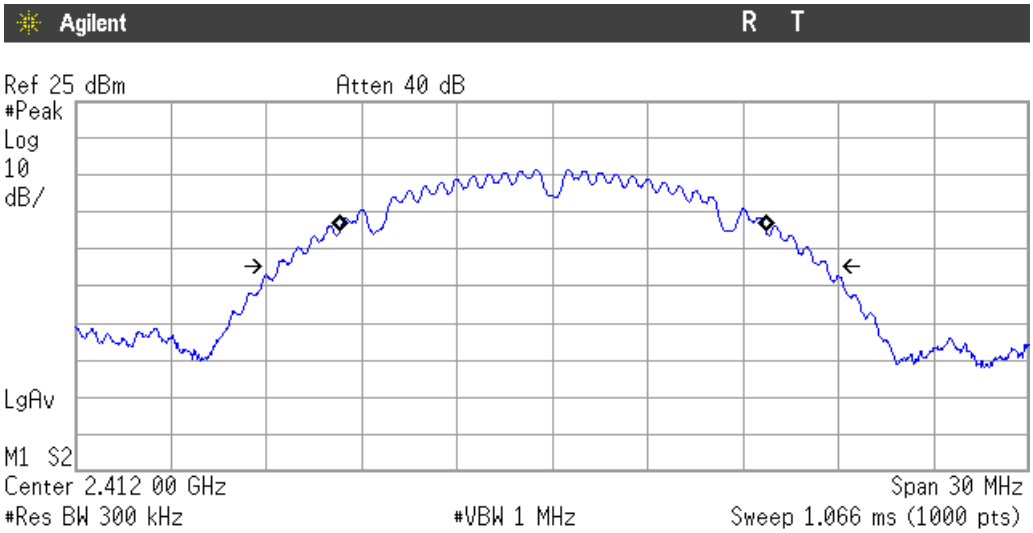
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	18.827	18.788	18.742
-26 dBc bandwidth (MHz)	24.107	22.729	21.855
Measurement uncertainty (kHz)	<±50		

Mode N20

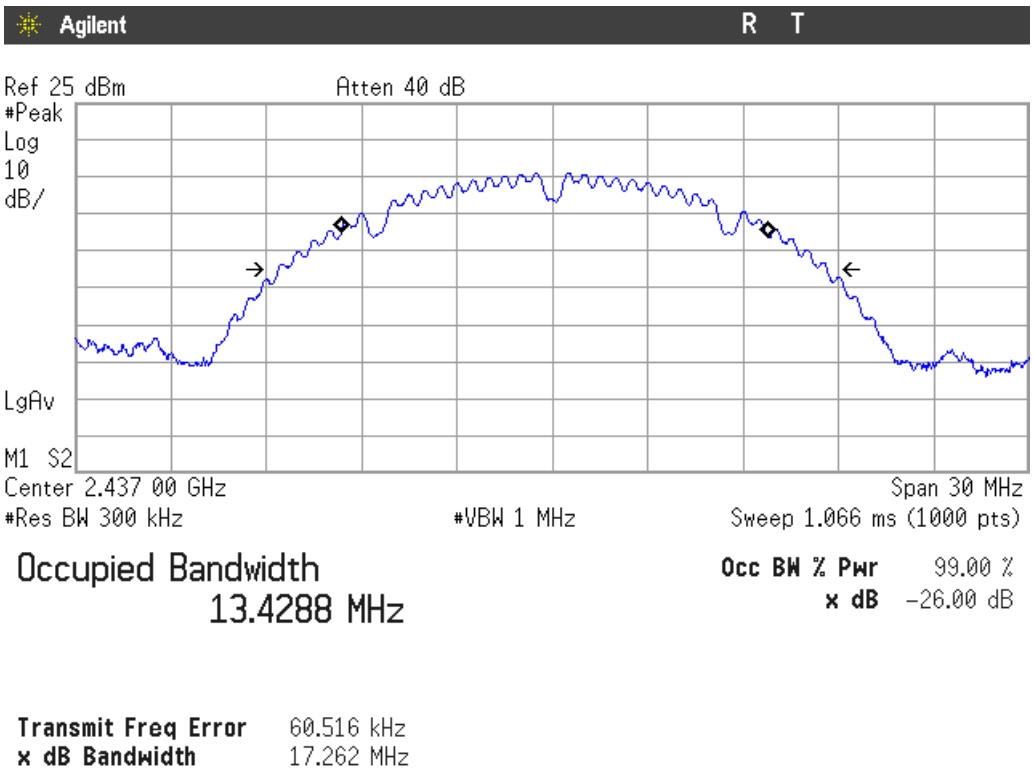
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	19.377	19.282	19.159
-26 dBc bandwidth (MHz)	25.501	23.526	23.304
Measurement uncertainty (kHz)	<±50		

Mode B

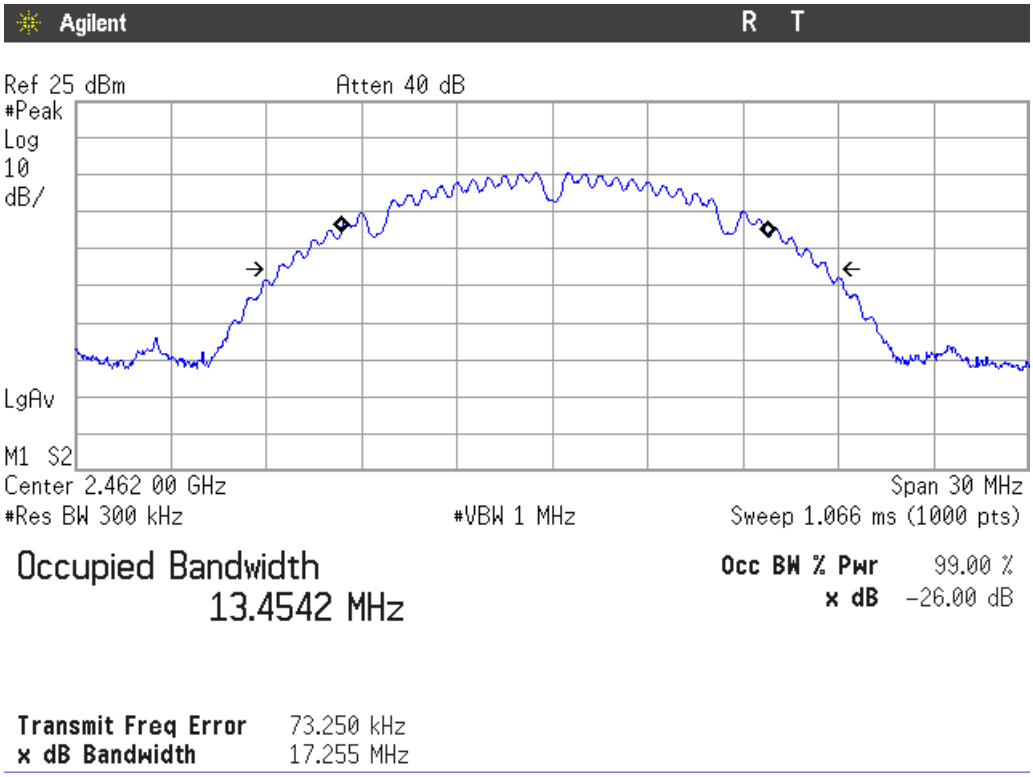
Lowest Channel



Middle Channel

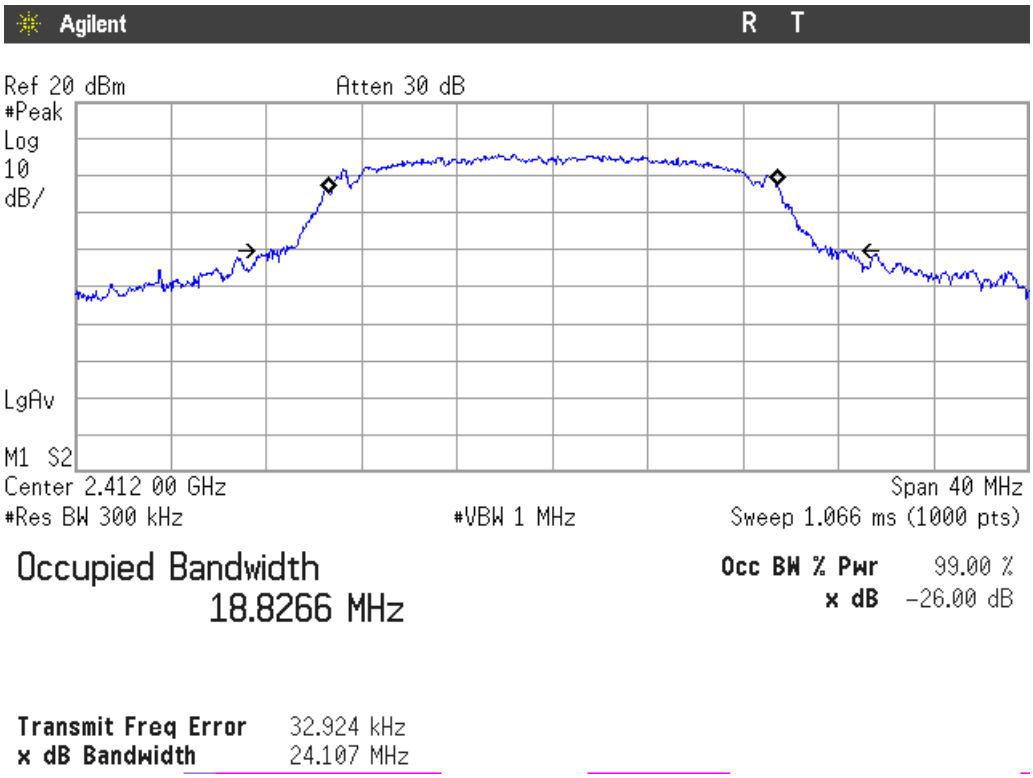


Highest channel

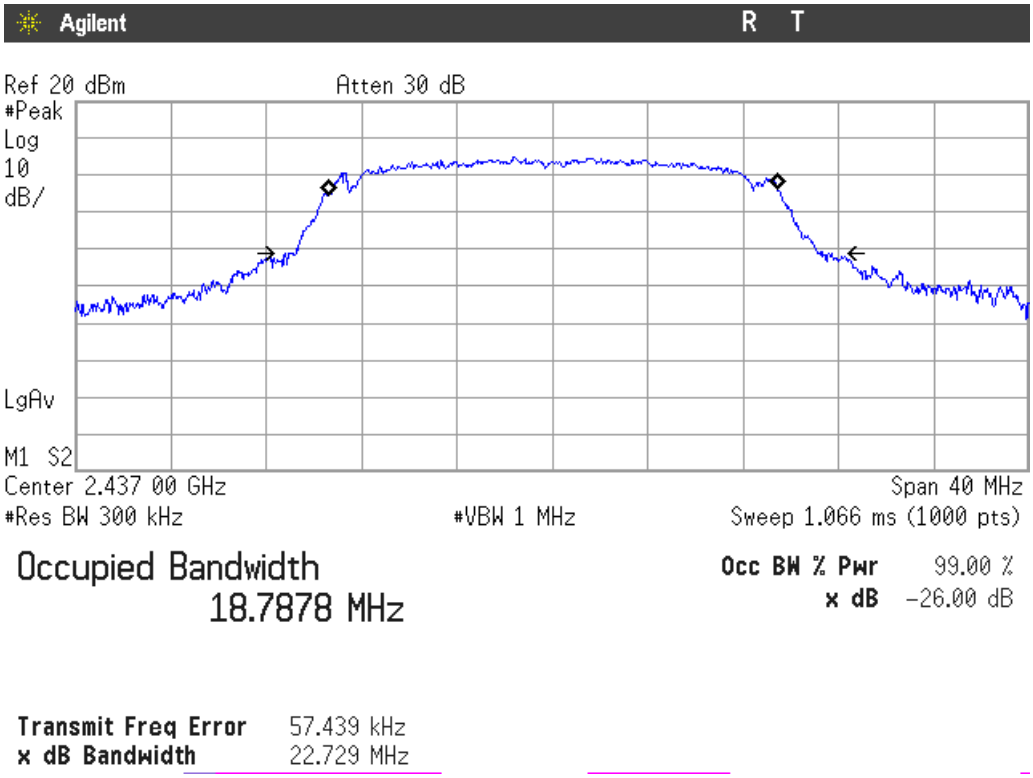


Mode G

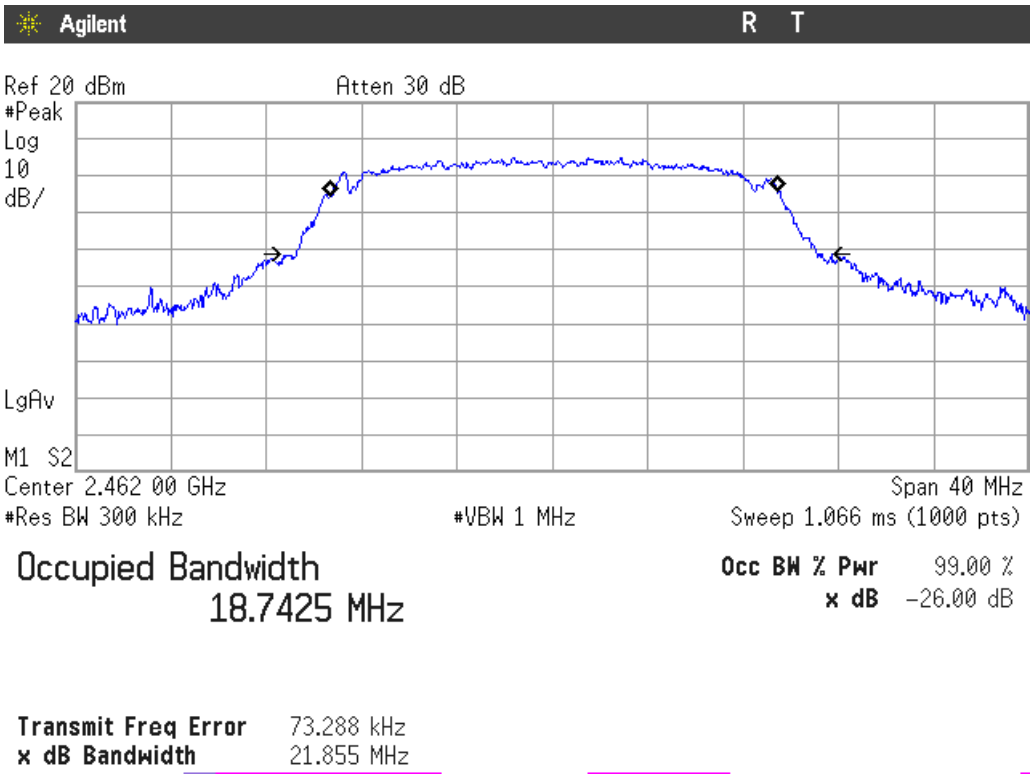
Lowest Channel



Middle Channel

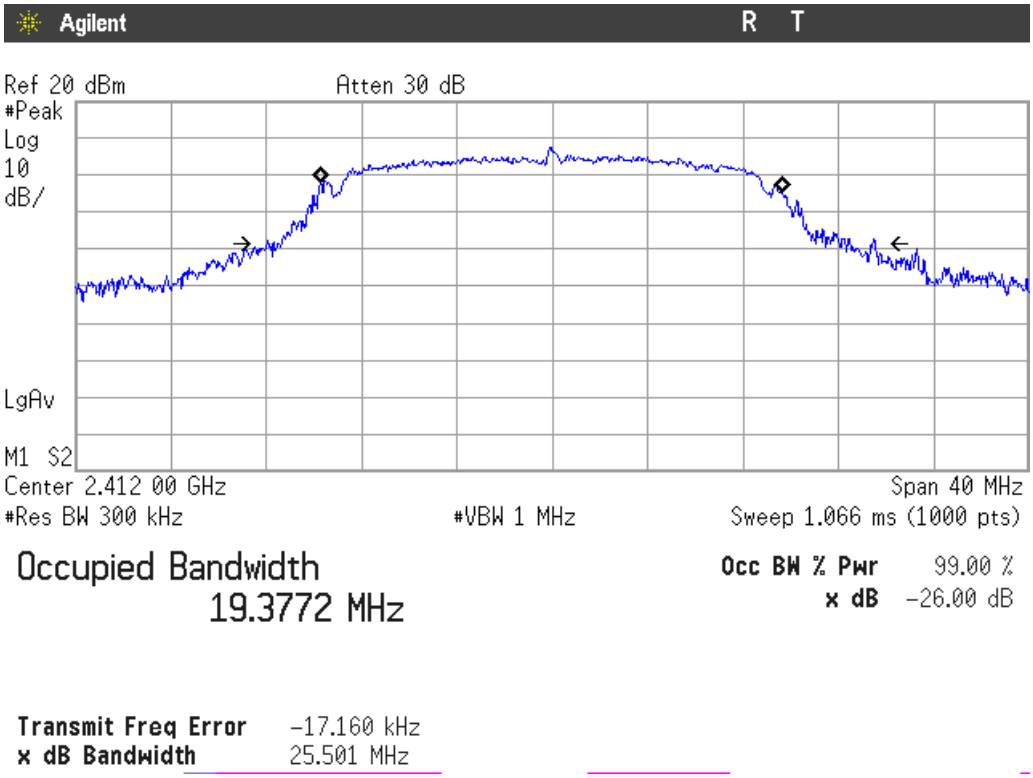


Highest channel

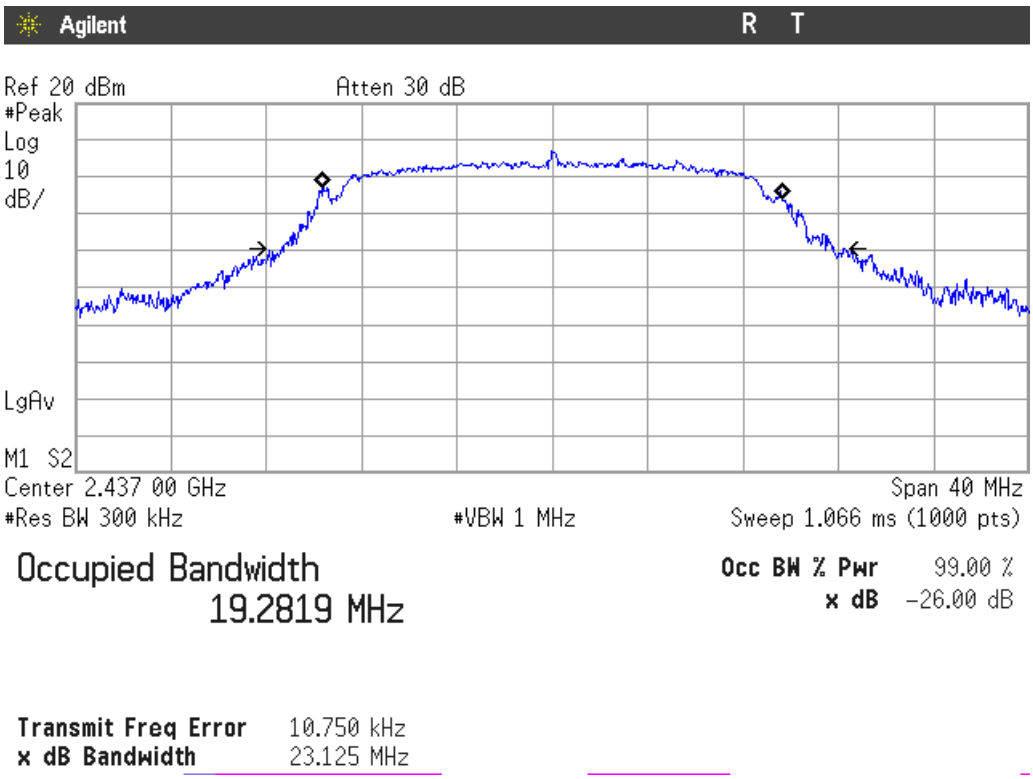


Mode N20

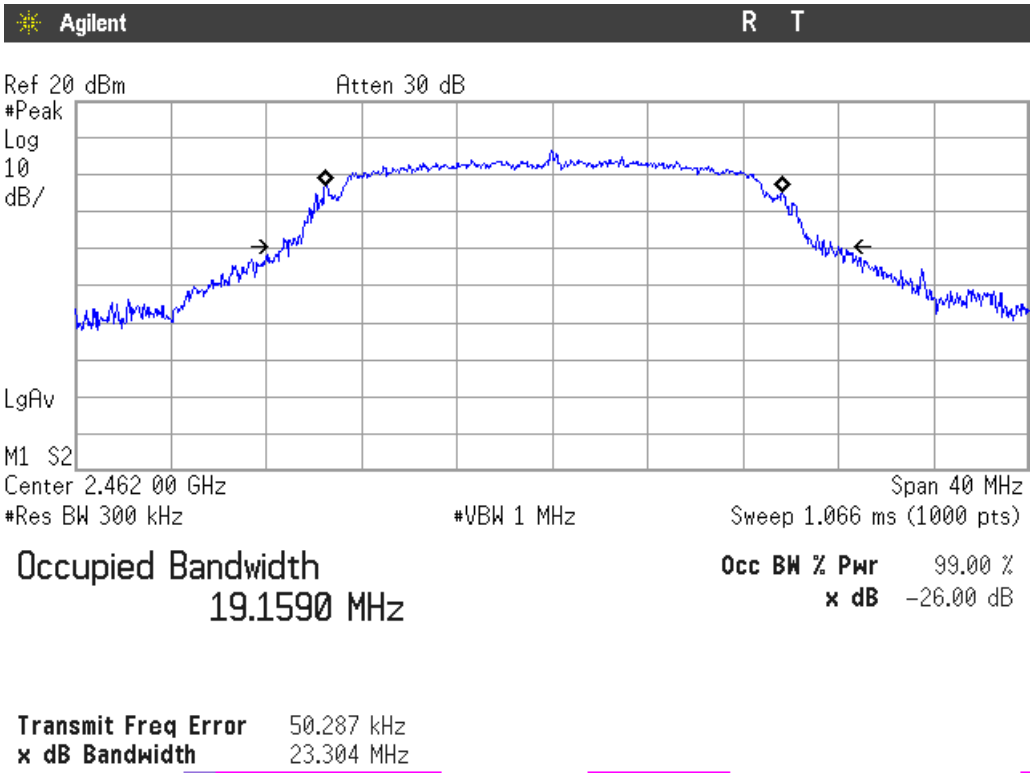
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (a) (2). 6 dB Bandwidth

SPECIFICATION

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

RESULTS

6 dB Bandwidth (see next plots).

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	9.029	8.609	8.649
Measurement uncertainty (kHz)	<±65.0		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	15.29	15.20	15.20
Measurement uncertainty (kHz)	<±65.0		

Mode N20

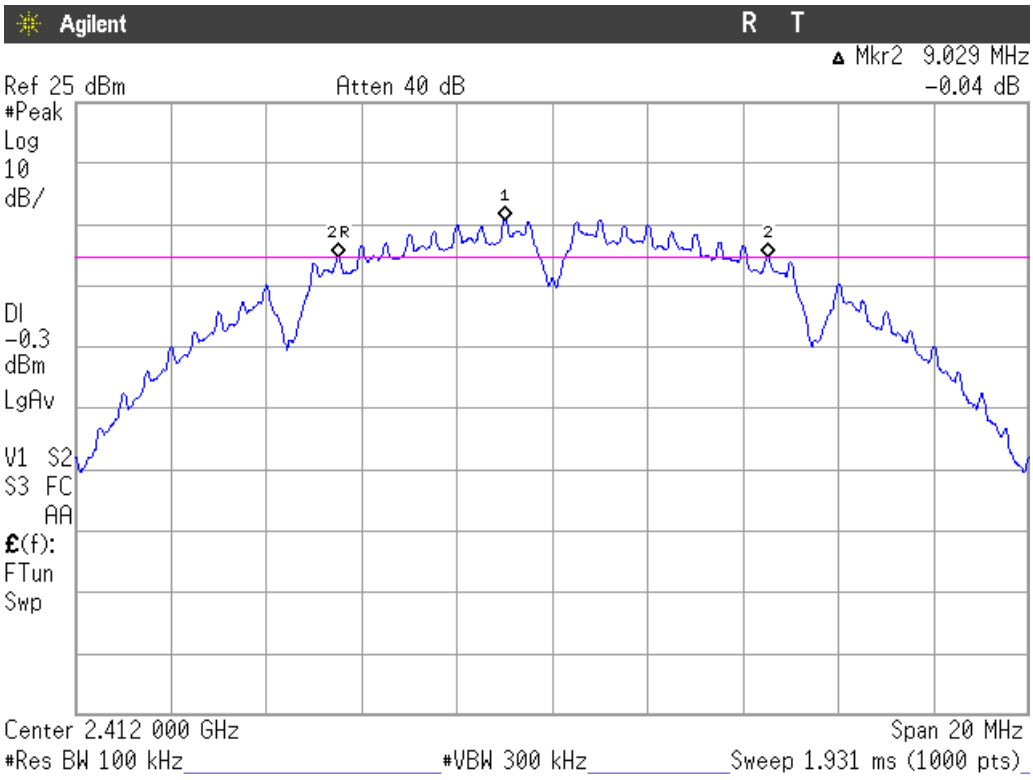
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	15.20	15.20	15.20
Measurement uncertainty (kHz)	<±65.0		

Verdict: PASS

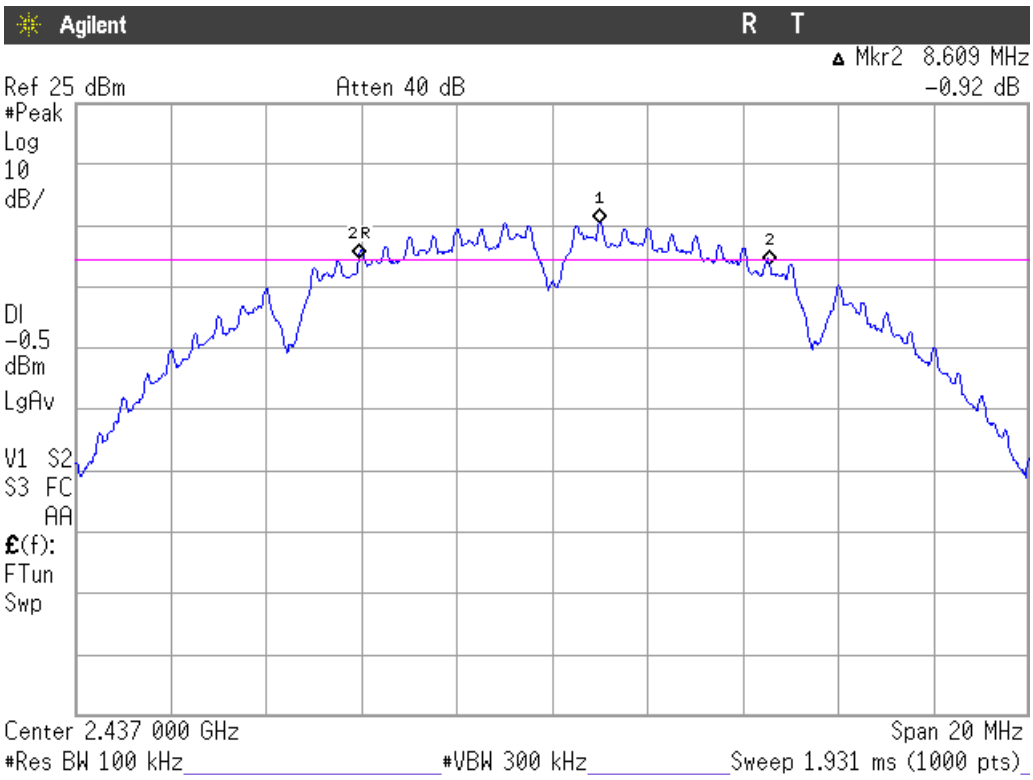
6 dB BANDWIDTH.

Mode B

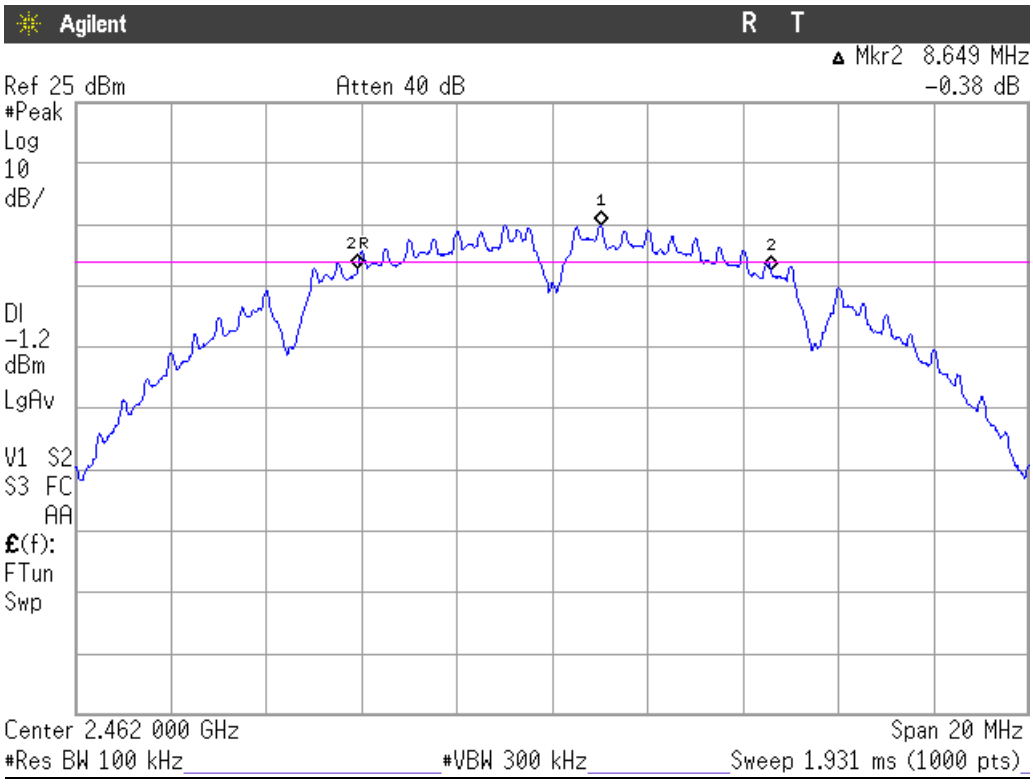
Lowest Channel



Middle Channel

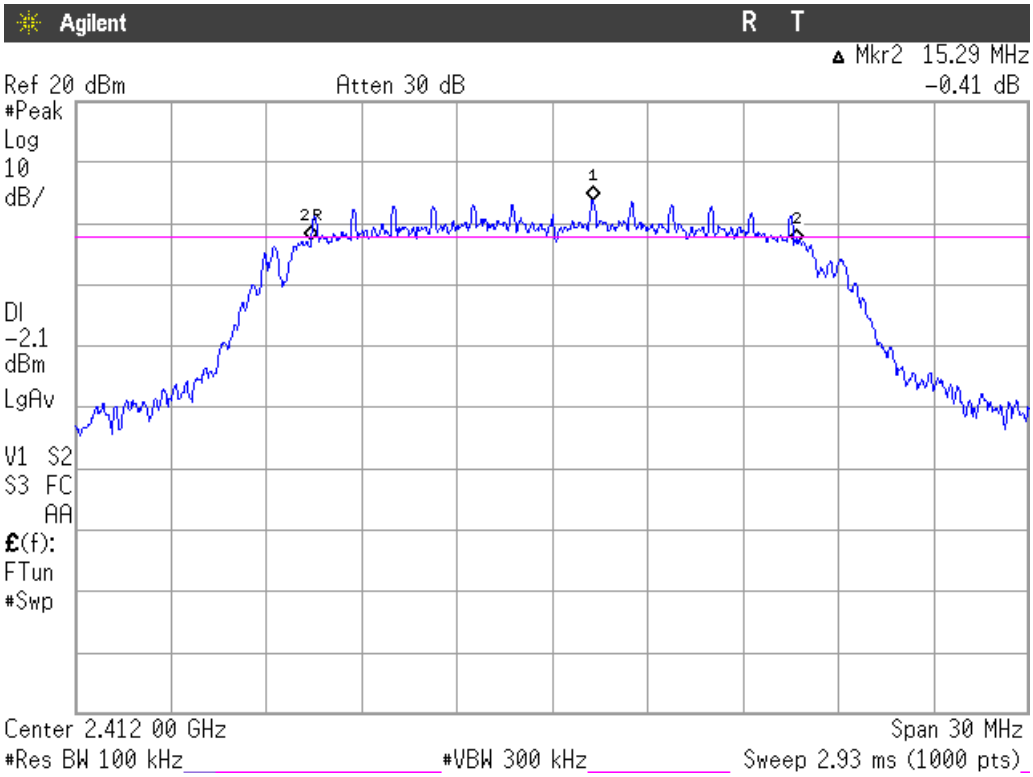


Highest channel

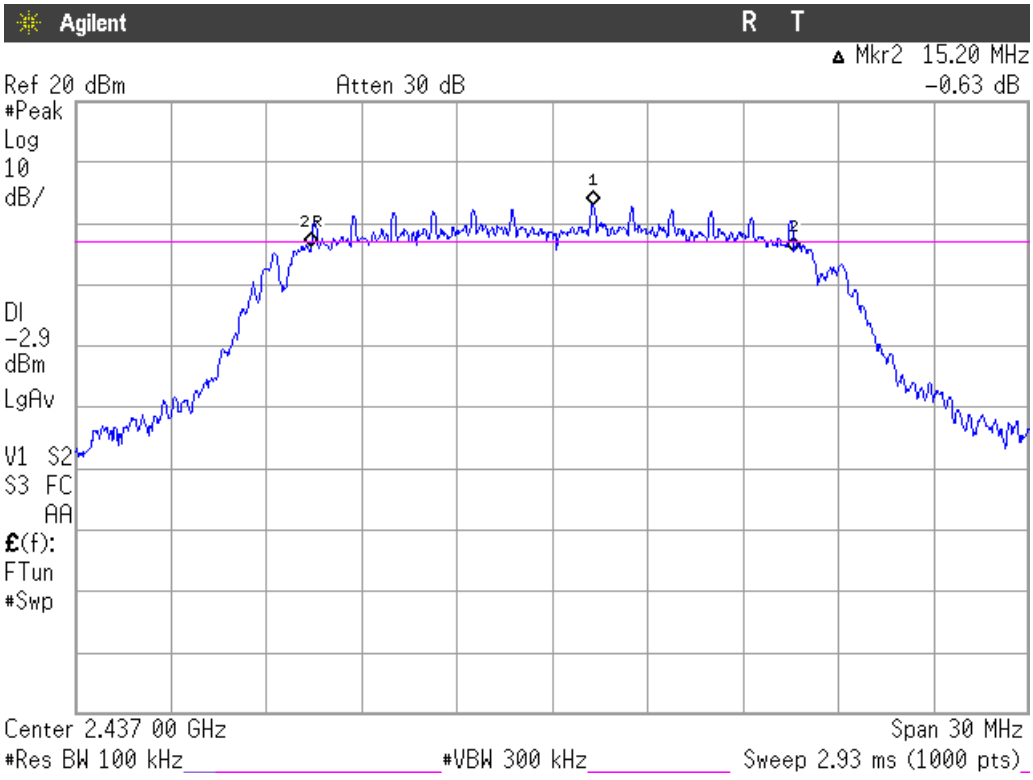


Mode G

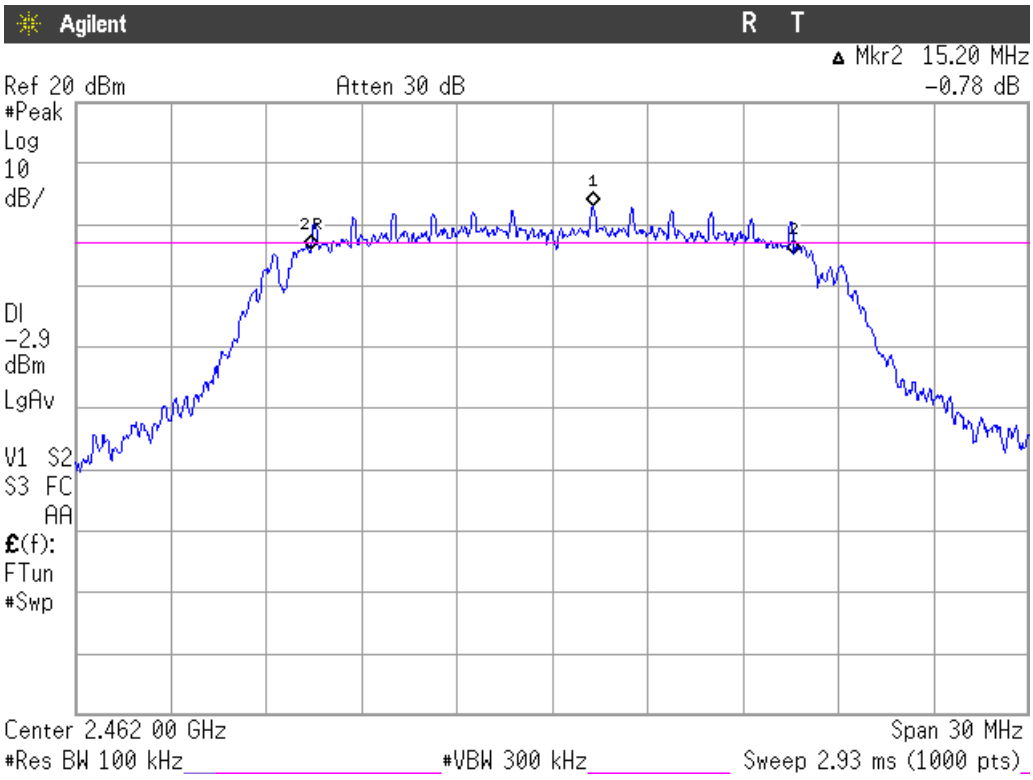
Lowest Channel



Middle Channel

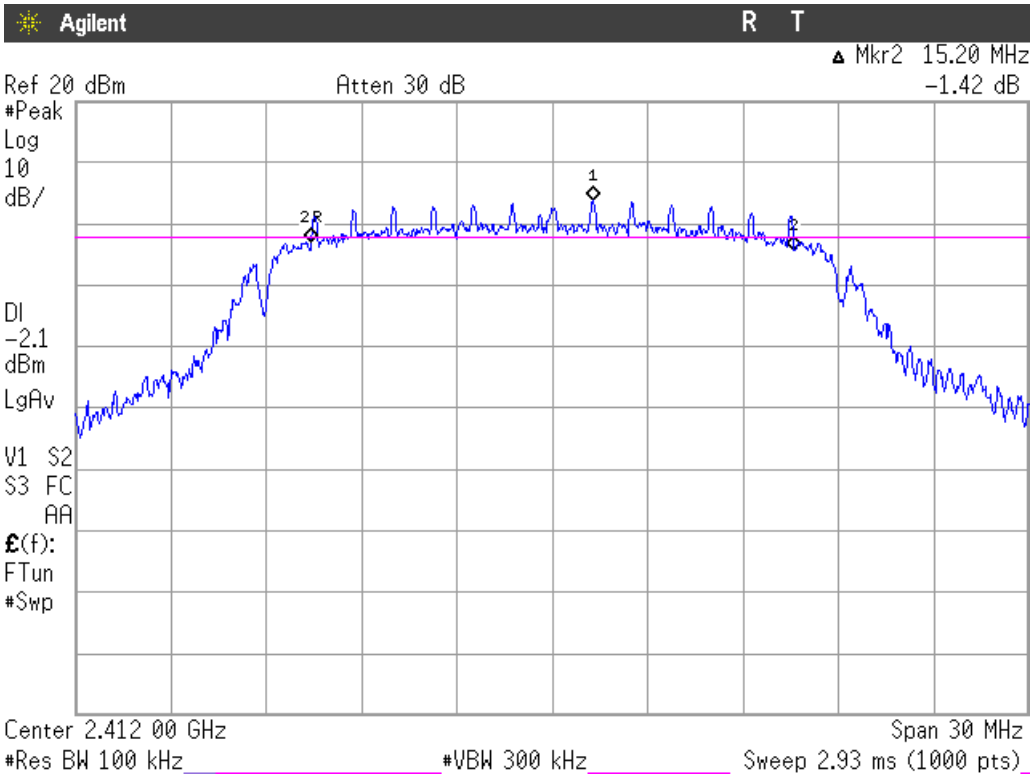


Highest channel

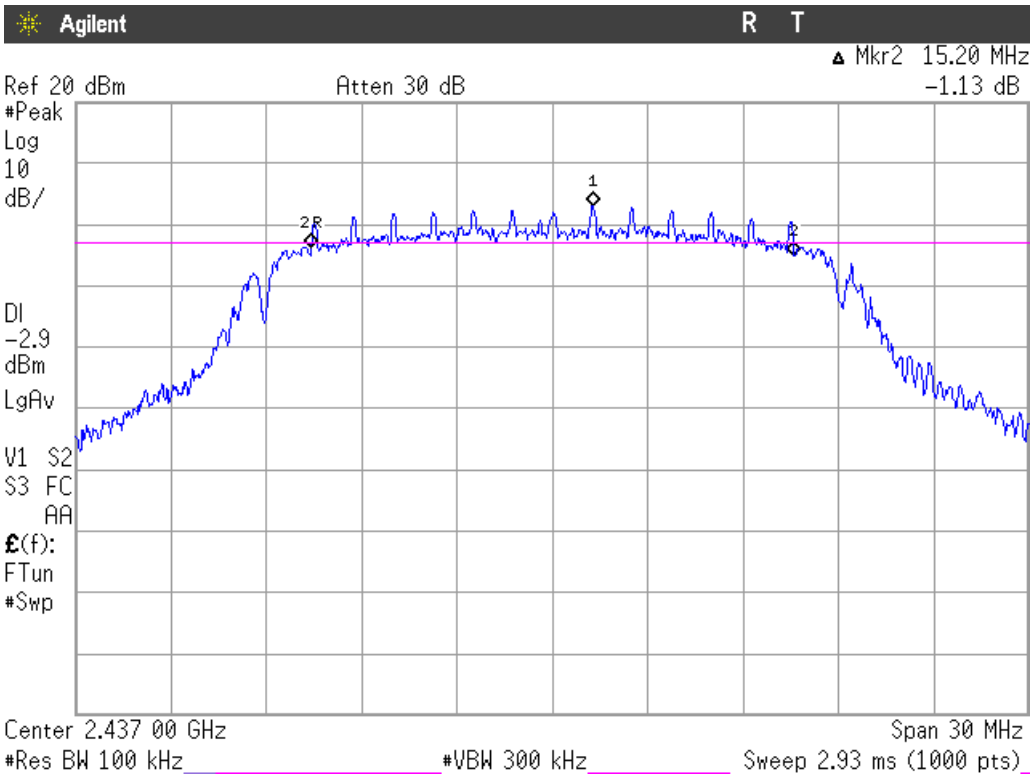


Mode N20

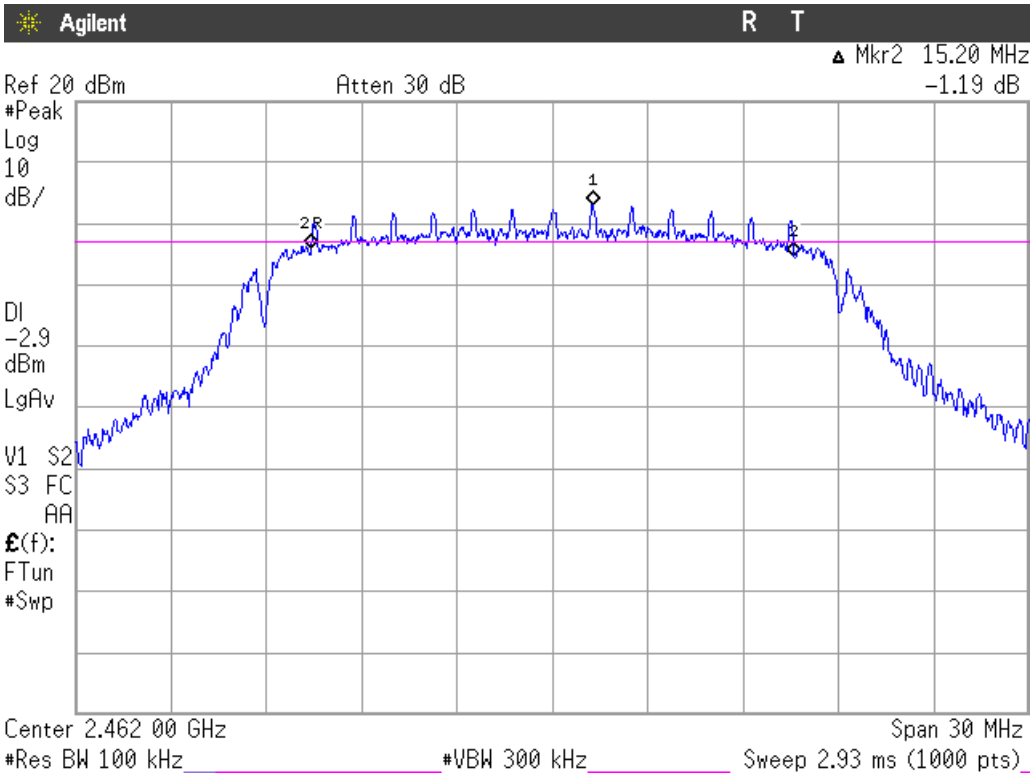
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (b). Maximum output power and antenna gain

SPECIFICATION

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).

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 Unde§15.247 558074 D01 DTS Meas Guidance v03r05 dated 04/08/2016.
The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

MAXIMUM OUTPUT POWER. See next plots.

Maximum declared antenna gain: -0.99 dBi.

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	14.04	13.73	13.26
Maximum EIRP power (dBm)	13.05	12.74	12.27
Measurement uncertainty (dB)	<±0.79		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	13.90	13.16	13.07
Maximum EIRP power (dBm)	12.91	12.17	12.08
Measurement uncertainty (dB)	<±0.79		

Mode N20

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	13.60	12.95	12.93
Maximum EIRP power (dBm)	12.61	11.96	11.94
Measurement uncertainty (dB)	<±0.79		

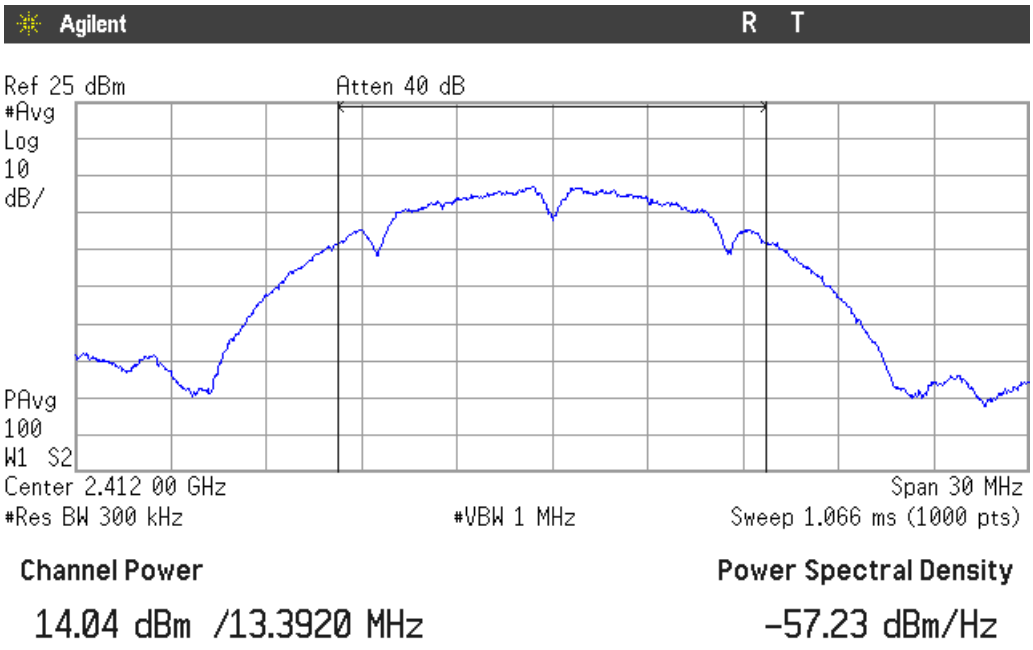
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

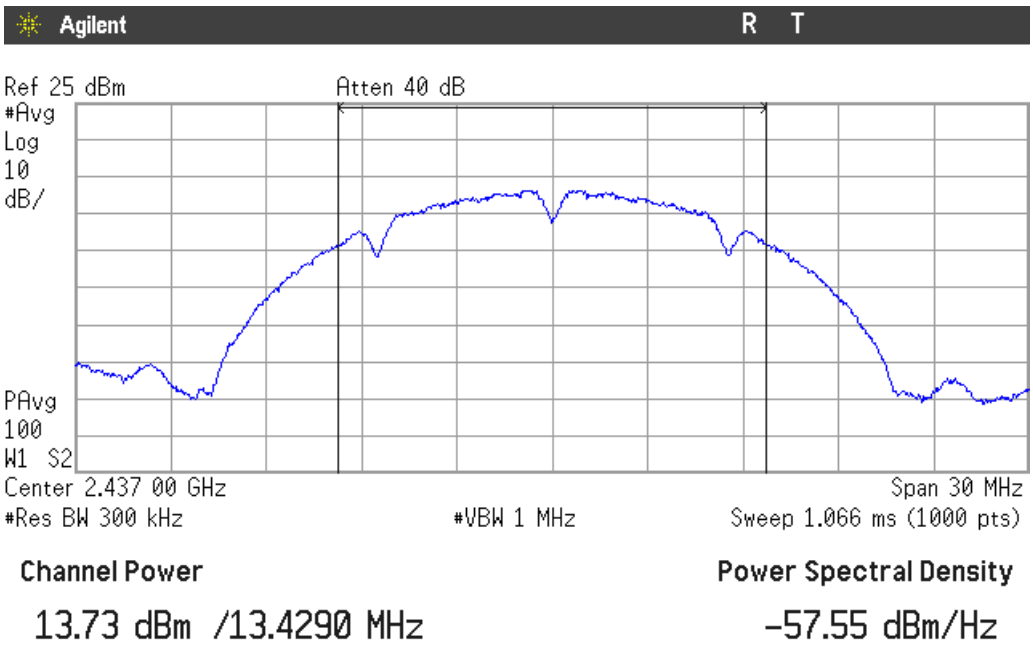
CONDUCTED AVERAGE POWER.

Mode B

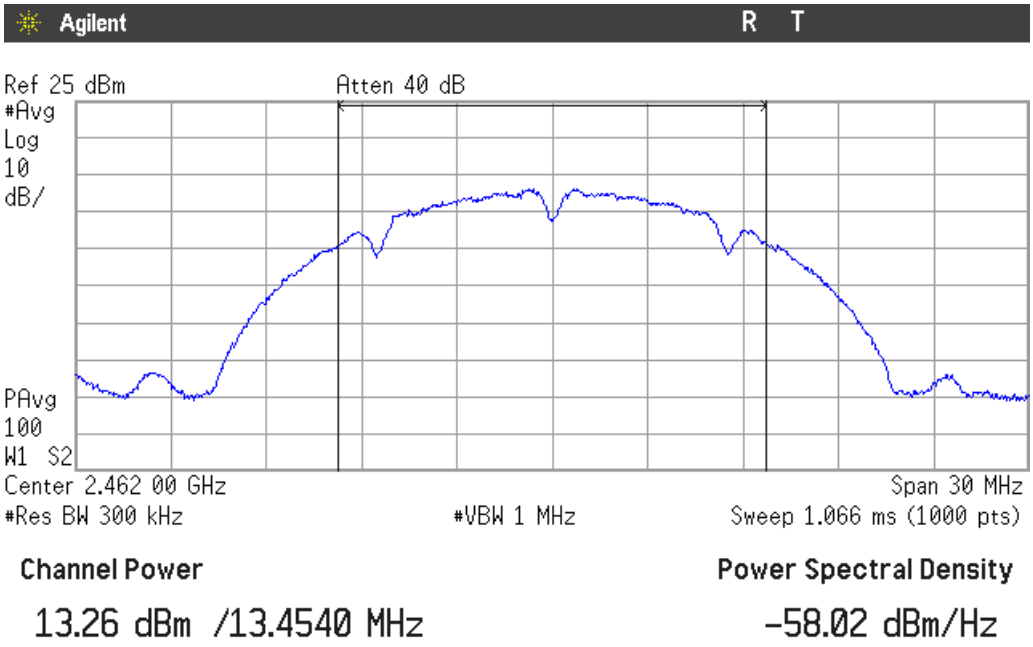
Lowest Channel



Middle Channel

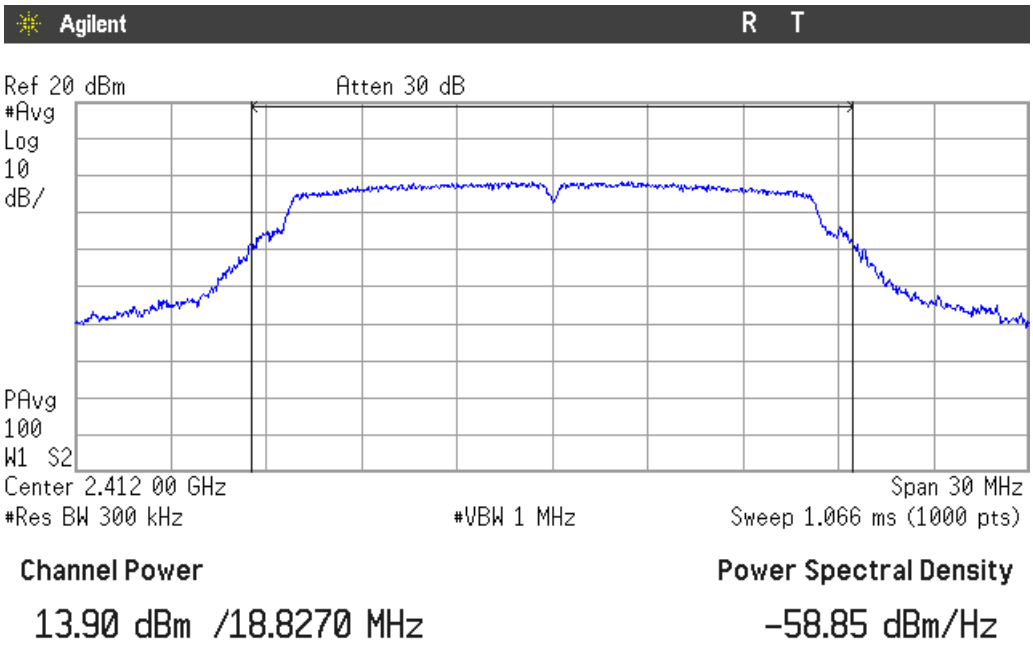


Highest channel

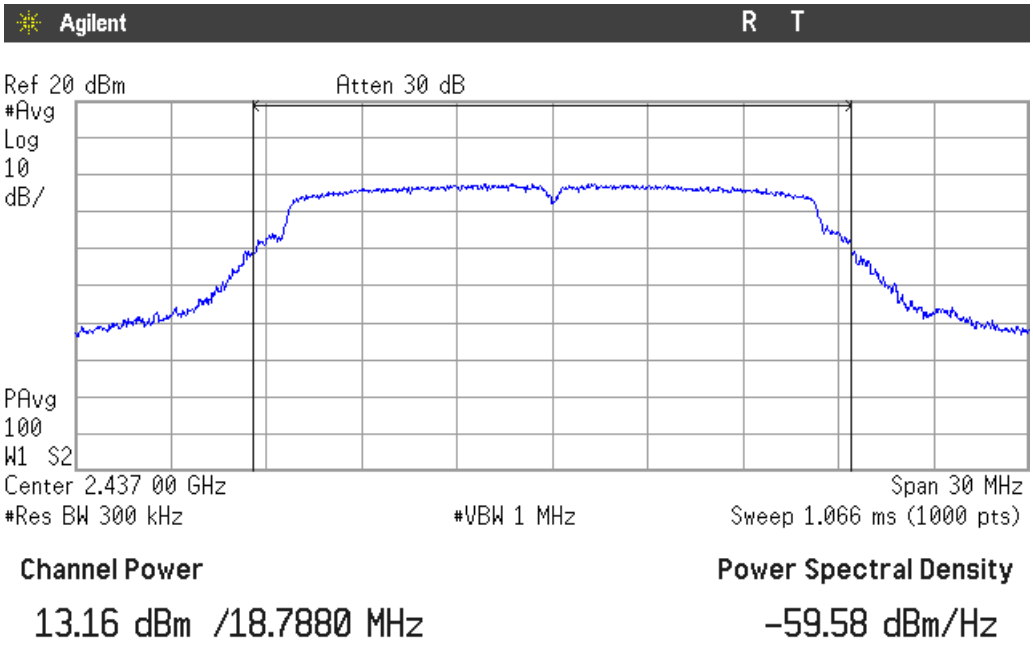


Mode G

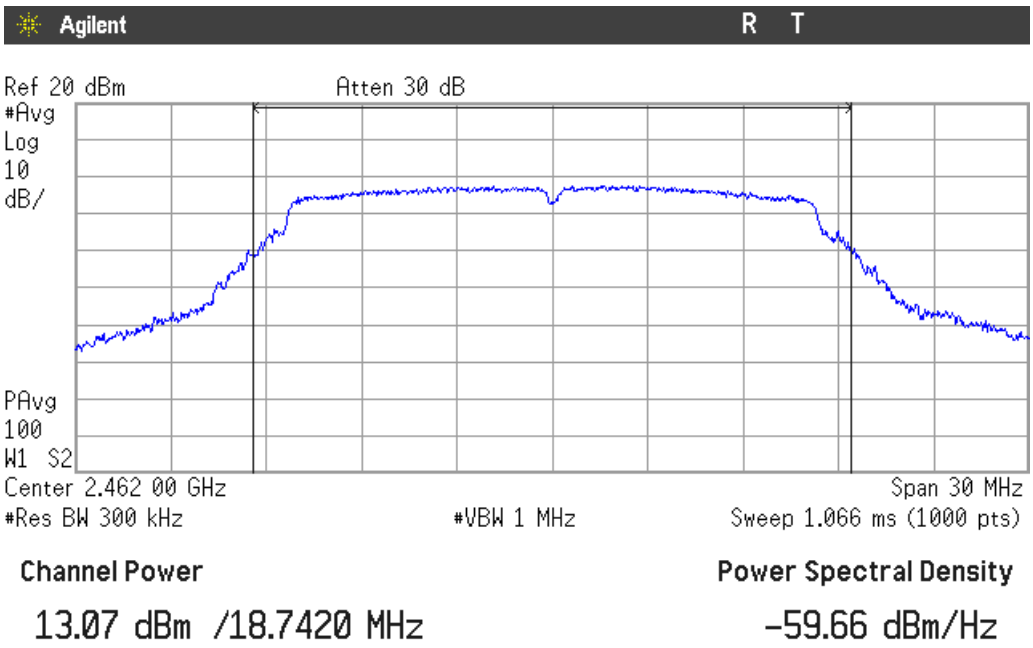
Lowest Channel



Middle Channel

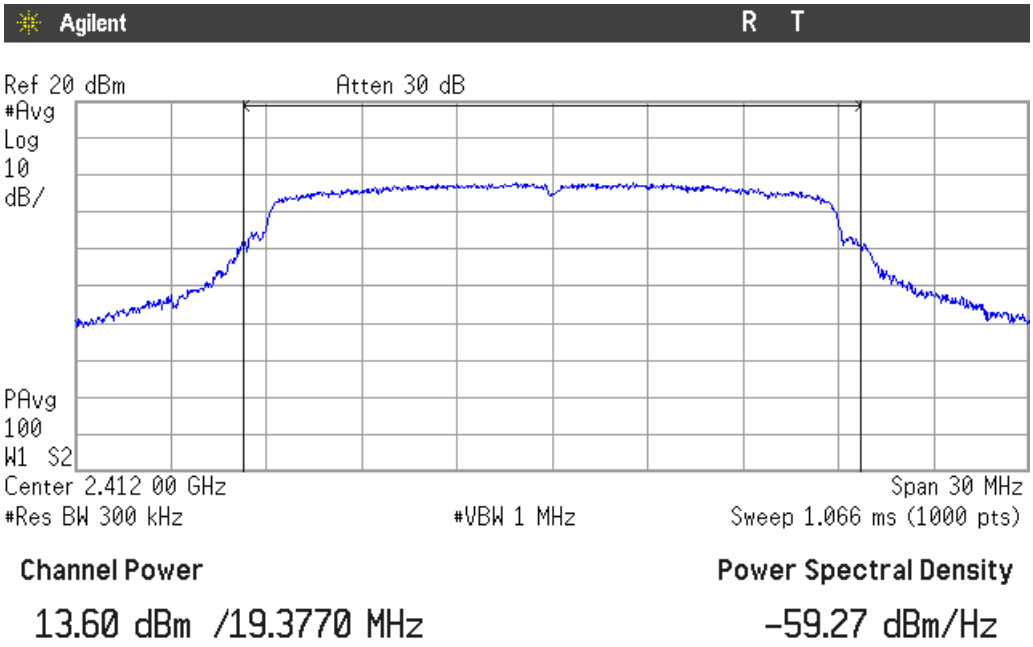


Highest channel

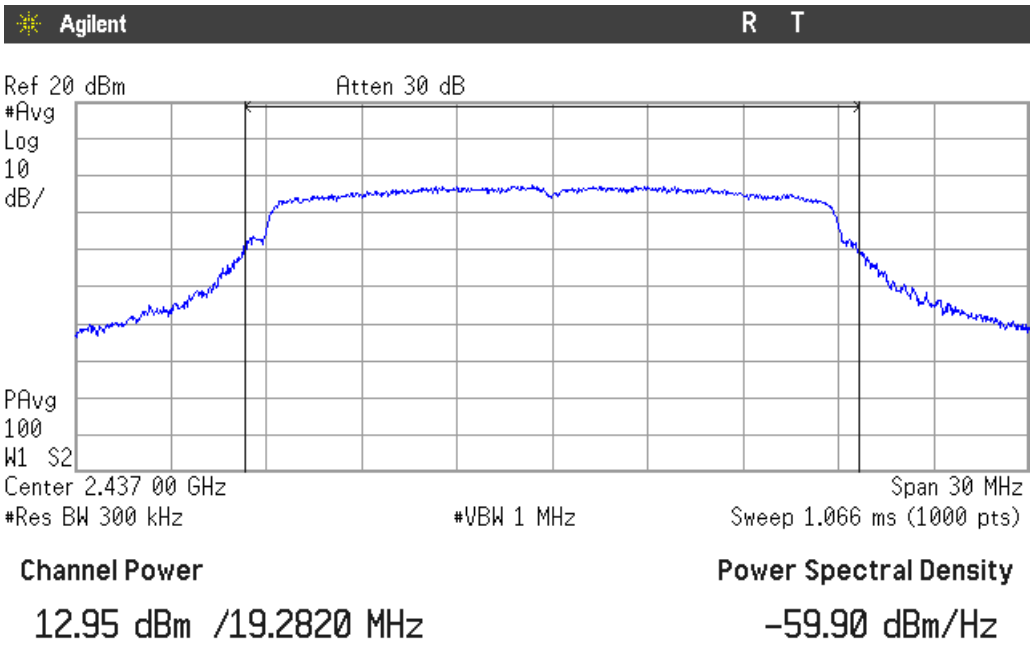


Mode N20

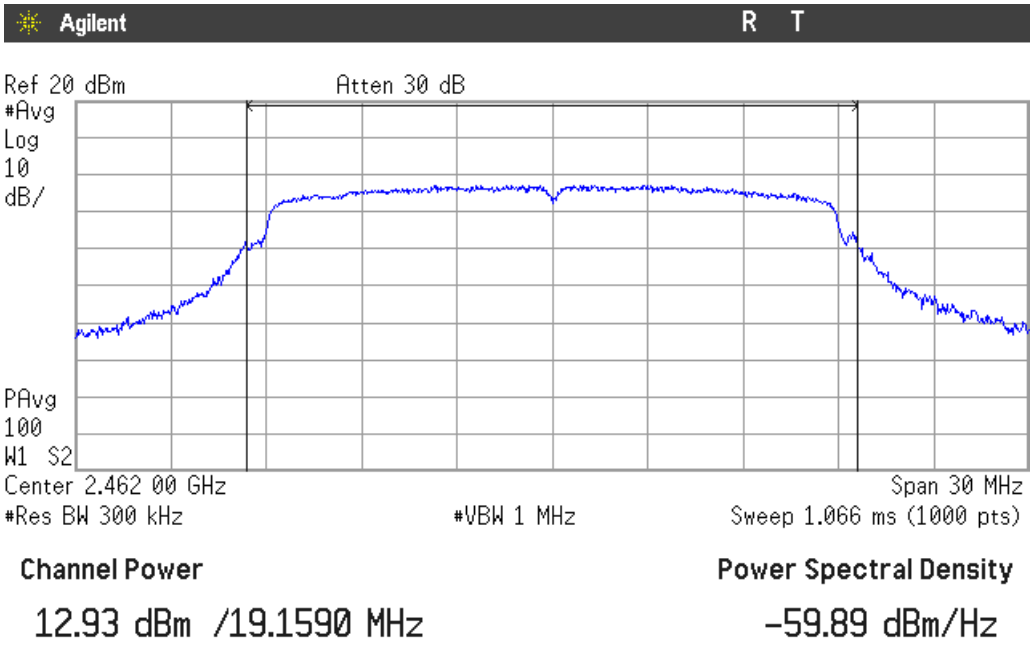
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (d). 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:

Reference Level Measurement

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	5.74	5.44	4.67
Measurement uncertainty (dB)	<±0.78		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	3.88	3.06	3.06
Measurement uncertainty (dB)	<±0.78		

Mode N20

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	3.90	3.10	3.06
Measurement uncertainty (dB)	<±0.78		

Mode B

Lowest frequency 2412 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.26

Middle frequency 2437 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.56

Highest frequency 2462 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.33

Mode G

Lowest frequency 2412 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.12

Middle frequency 2437 MHz

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.94

Highest frequency 2462 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.94

Mode N20

Lowest frequency 2412 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.10

Middle frequency 2437 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.90

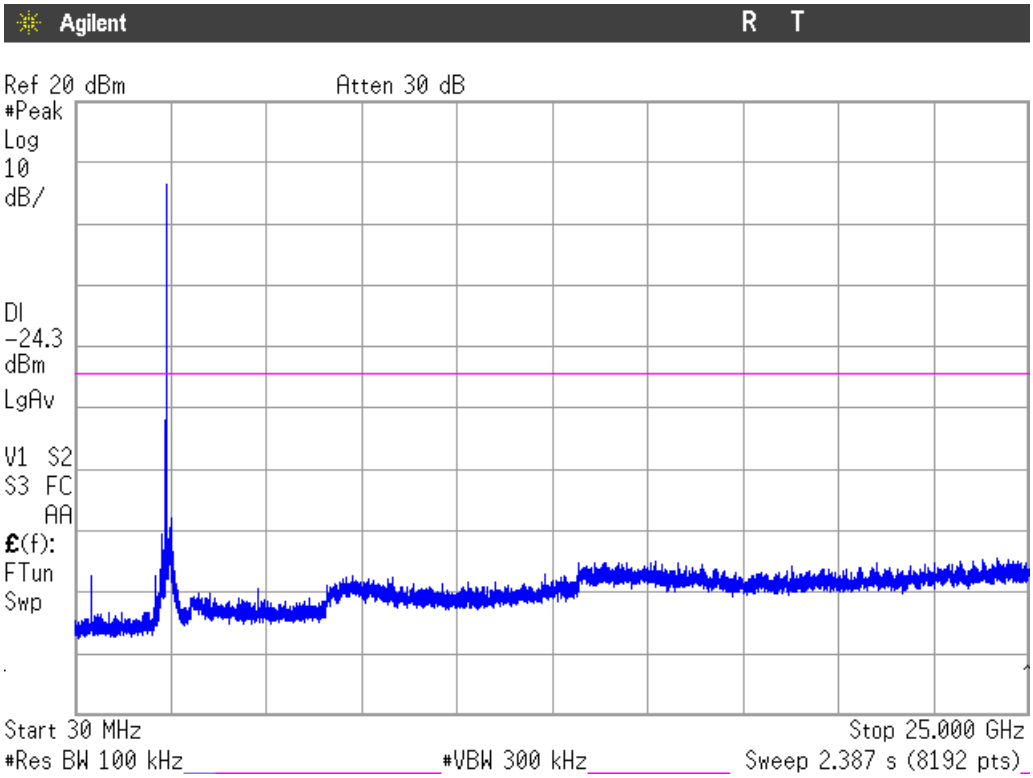
Highest frequency 2462 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.94

Verdict: PASS

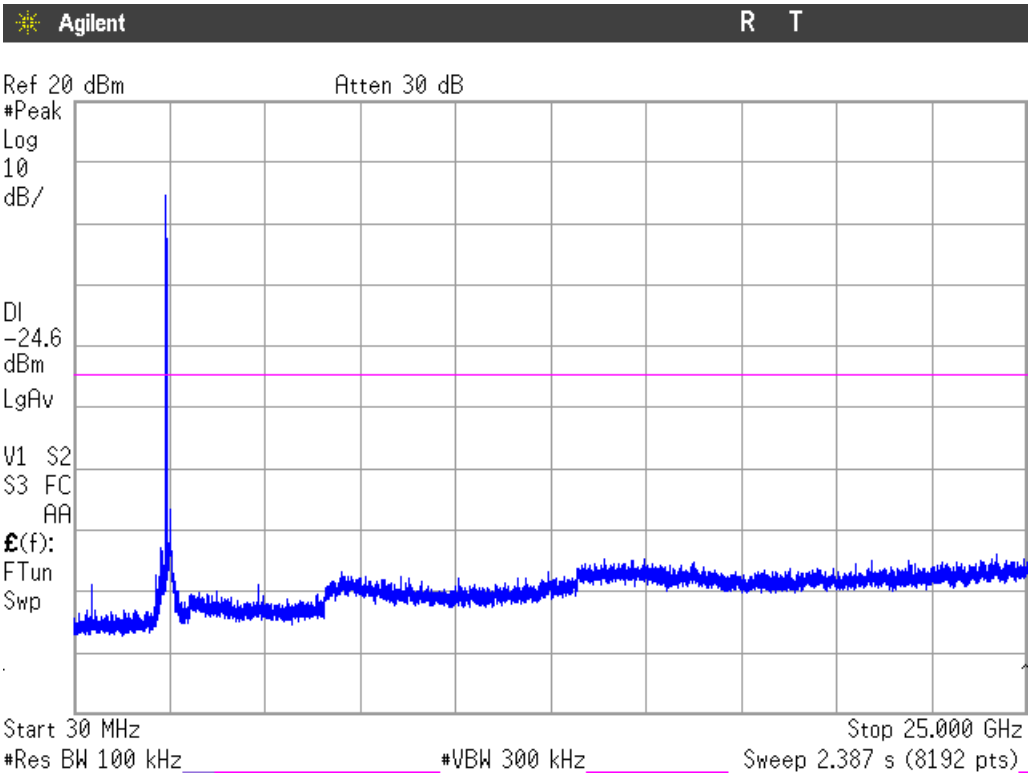
Mode B

Lowest Channel



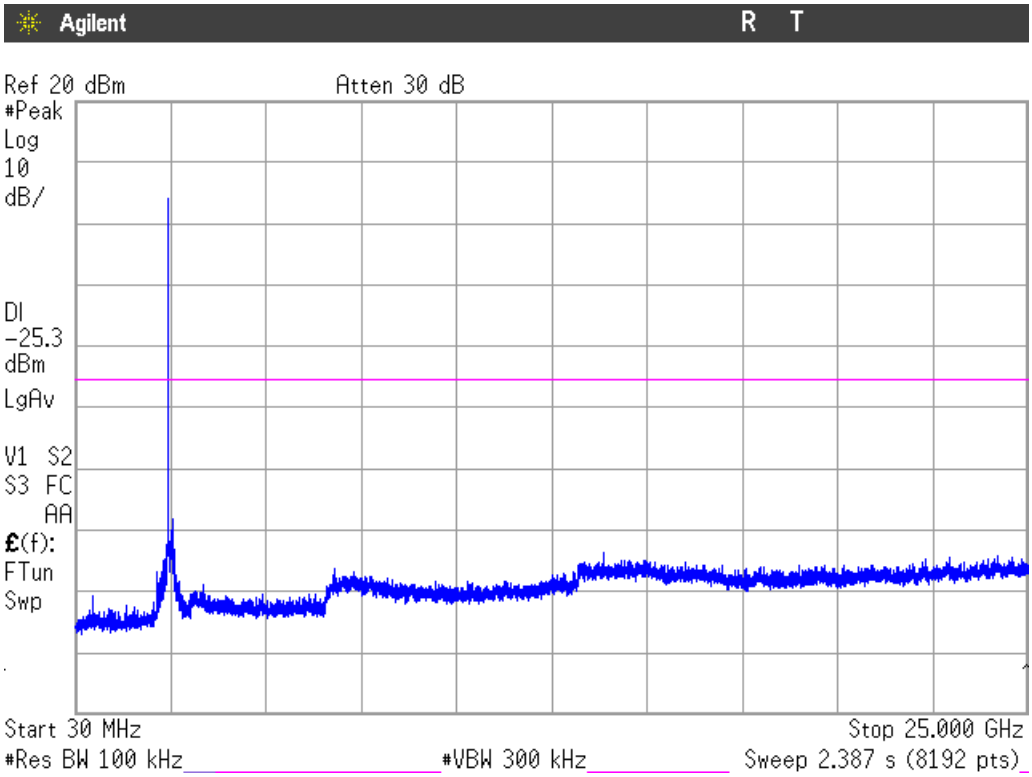
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

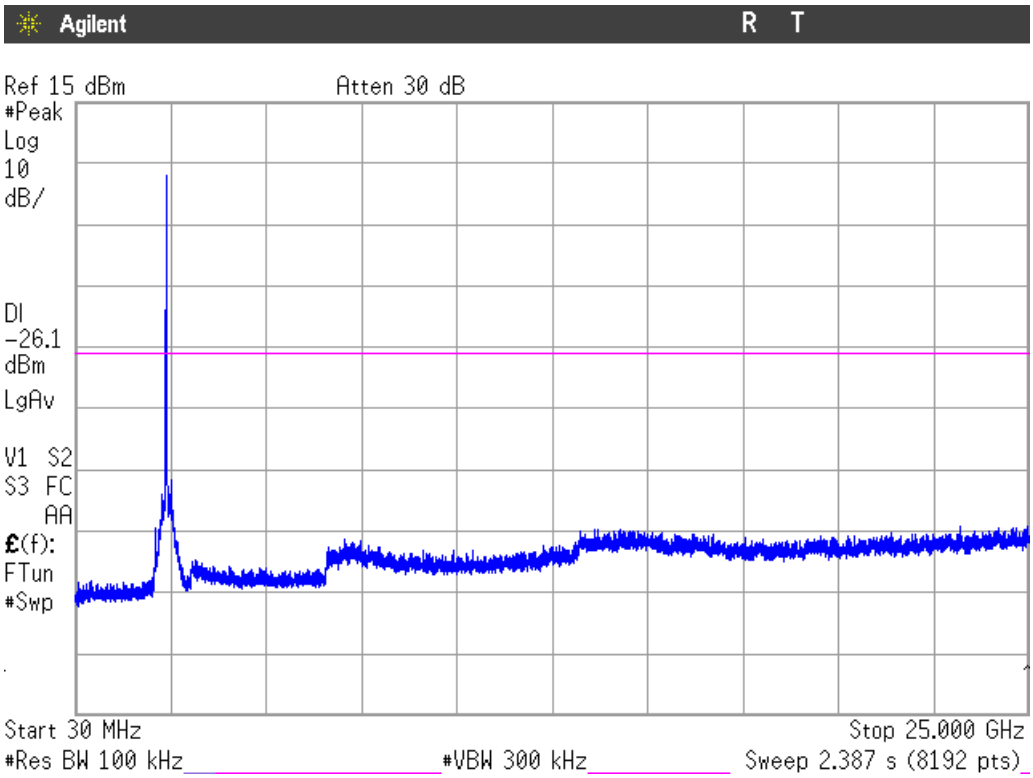
Highest channel



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

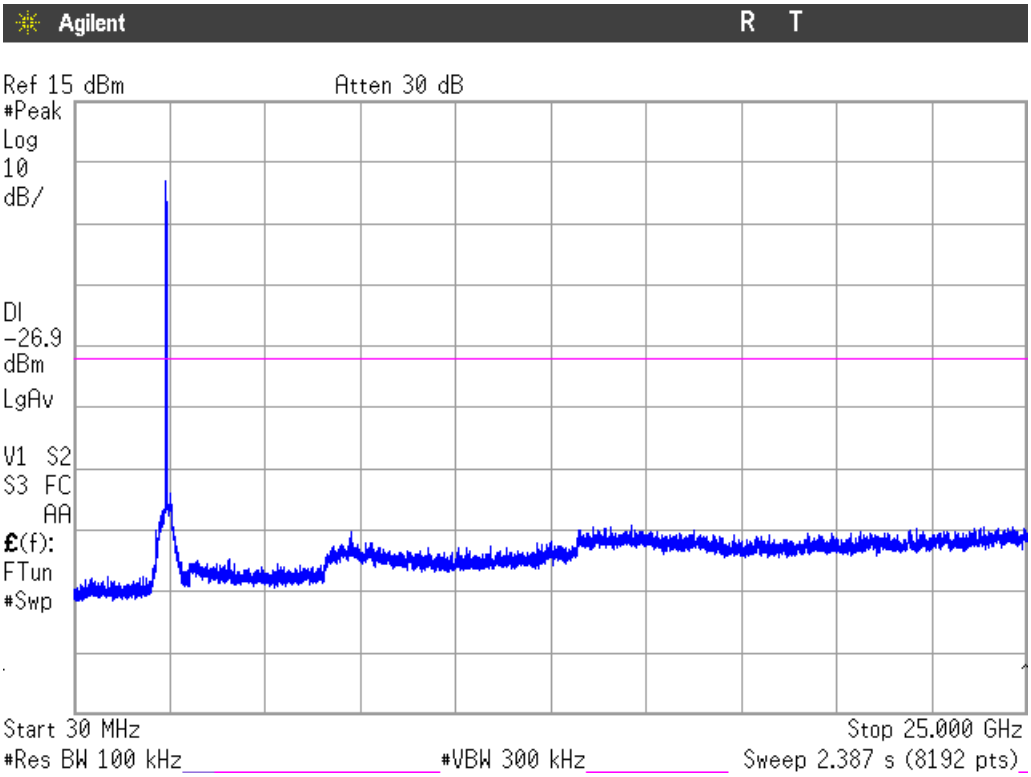
Mode G

Lowest Channel



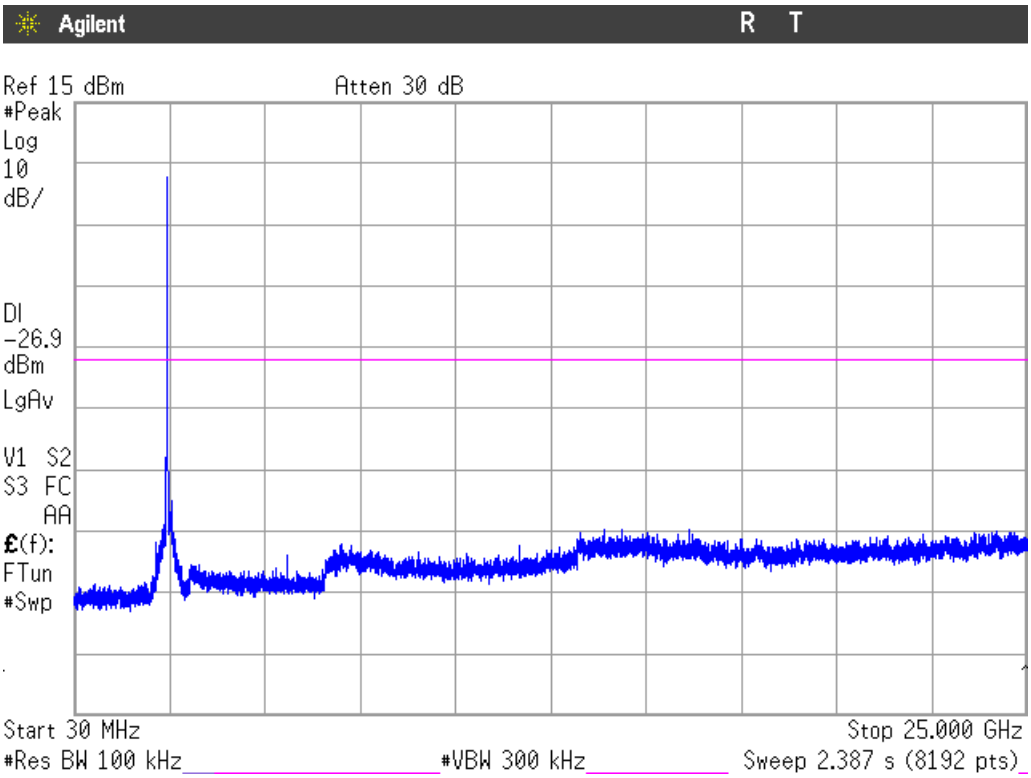
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

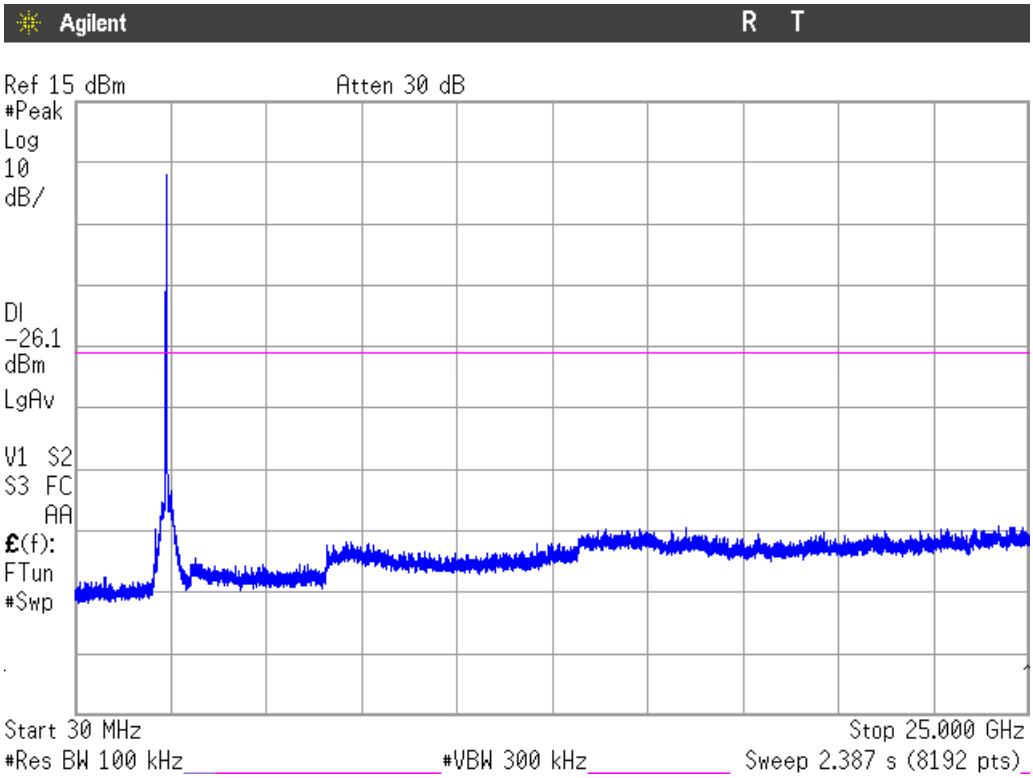
Highest channel



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

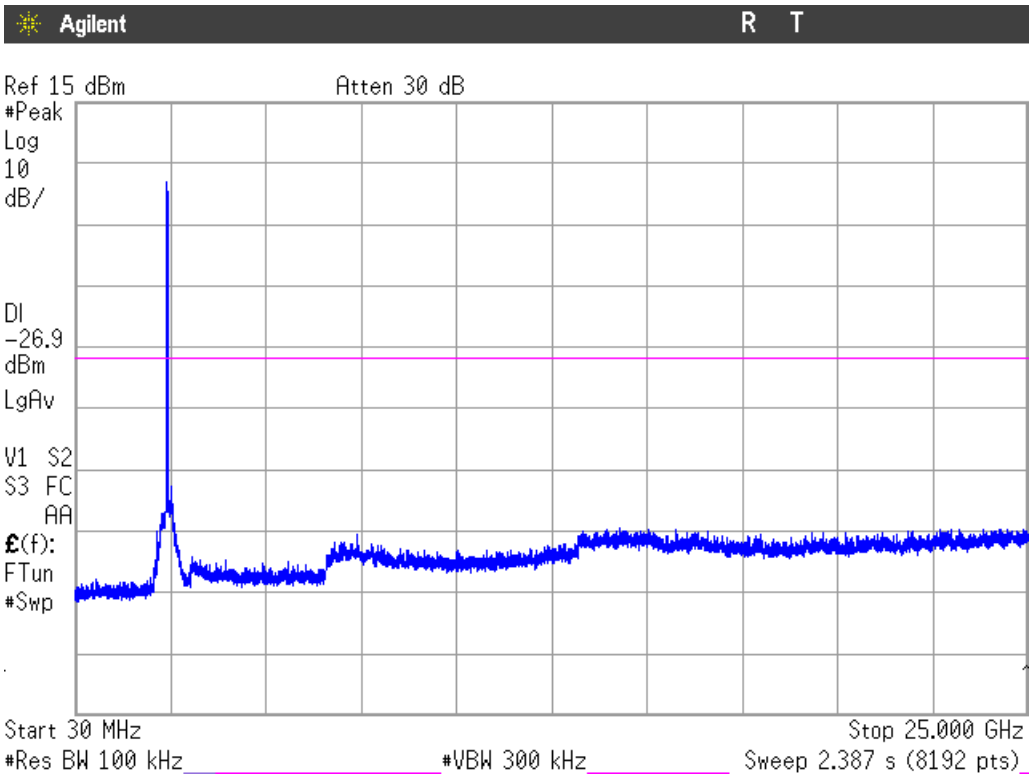
Mode N20

Lowest Channel



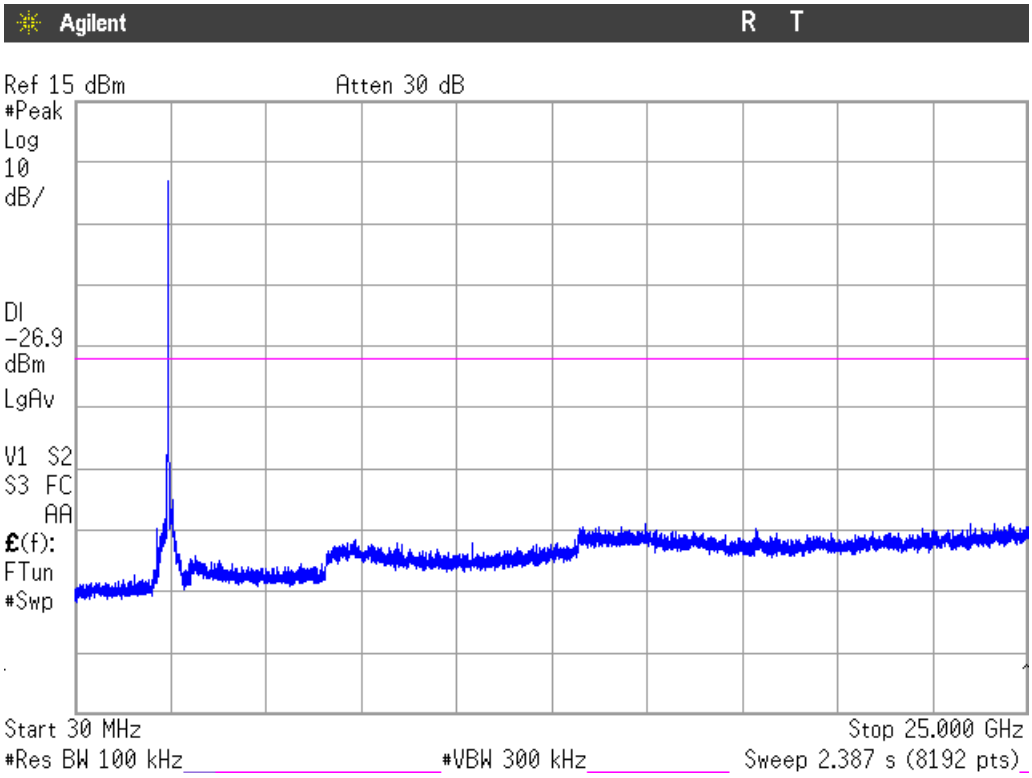
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

Highest channel



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

Section 15.247 Subclause (d). Band-edge emissions compliance (Transmitter)

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

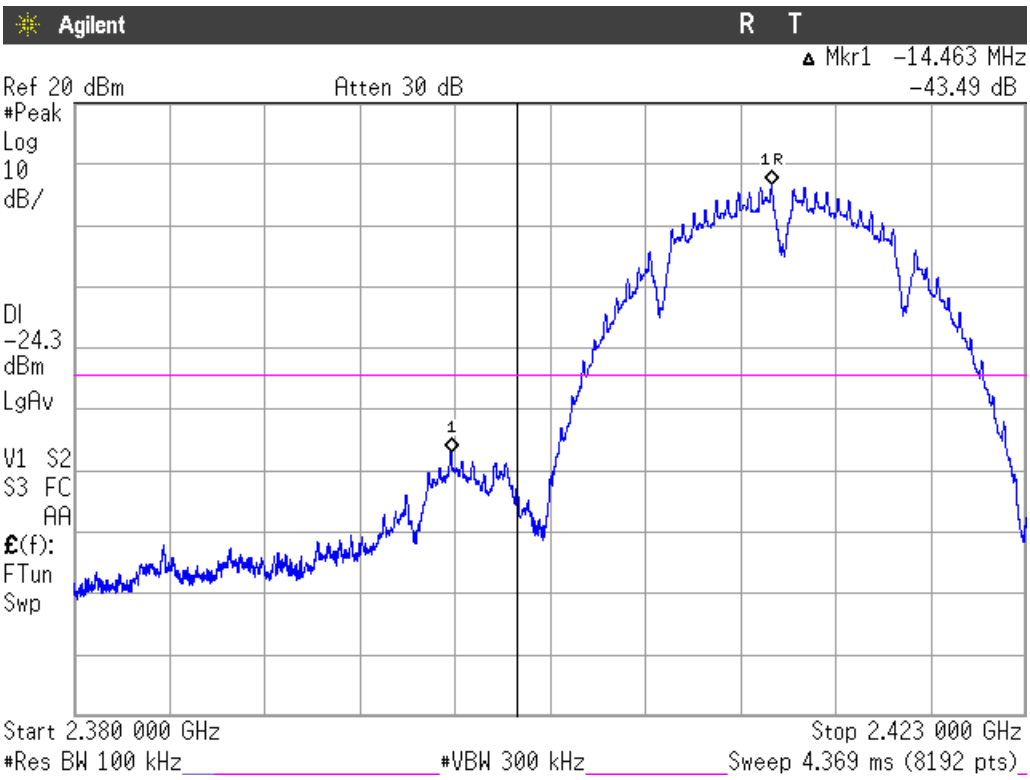
RESULTS:

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.

LOW FREQUENCY SECTION 2412 MHz (b/g/n20). CONDUCTED.

Mode B

See next plots.

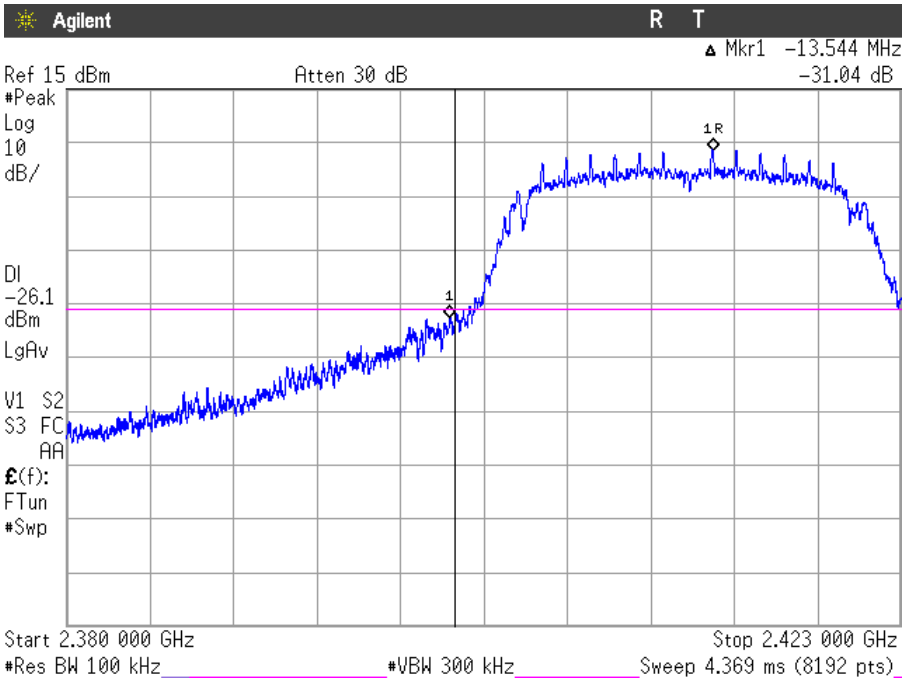


Measurement uncertainty (dB)	< ±2.03

Verdict: PASS

Mode G

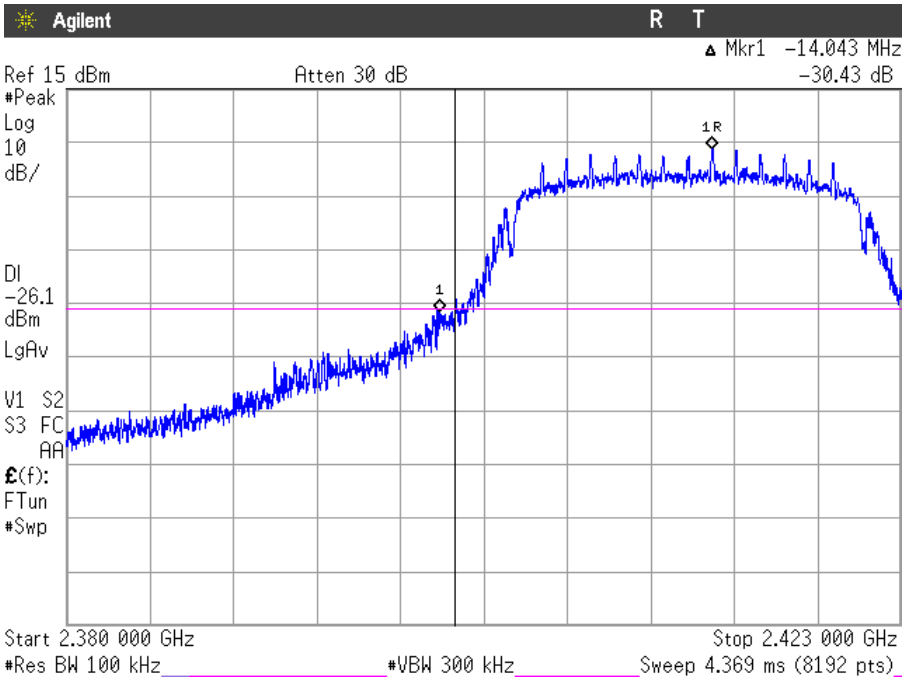
See next plot.



Measurement uncertainty (dB)	< ±2.03

Mode N20

See next plot.



Measurement uncertainty (dB)	< ±2.03

Verdict: PASS

Section 15.247 Subclause (e). 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 AVGPSD-1 (AVG PSD) 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 v03r05 dated 04/08/2016.

Power spectral density (see next plots).

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-1.774	-2.007	-3.410
Measurement uncertainty (dB)	<±0.78		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-5.643	-6.196	-6.373
Measurement uncertainty (dB)	<±0.78		

Mode N20

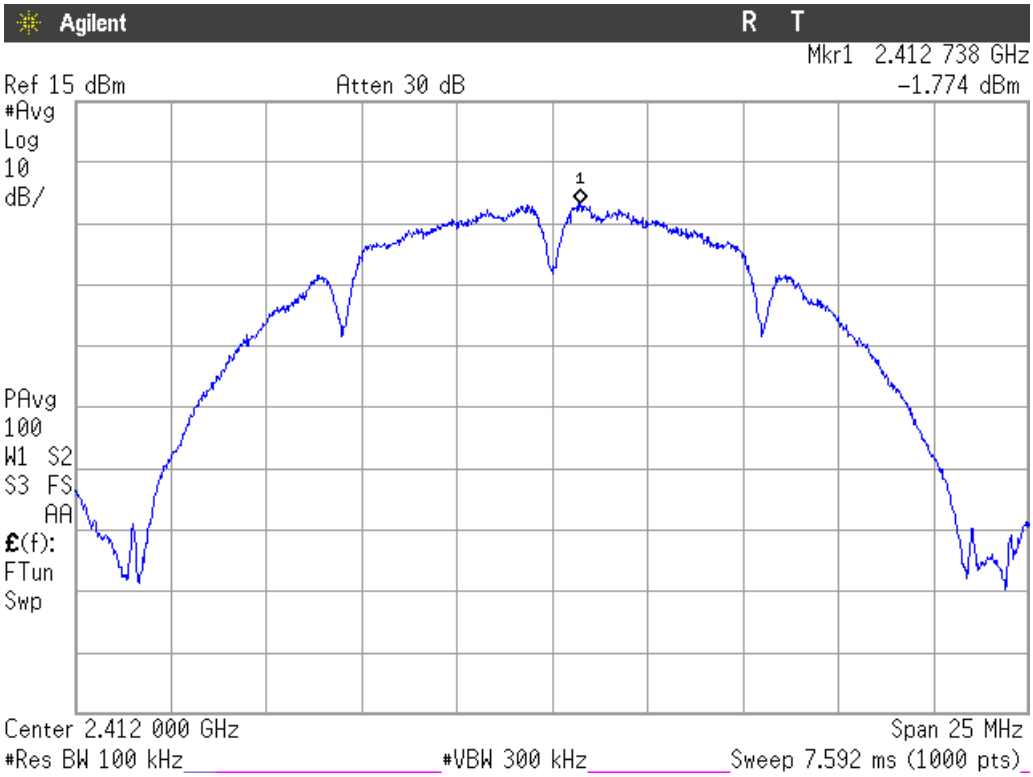
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-6.145	-6.663	-6.454
Measurement uncertainty (dB)	<±0.78		

Verdict: PASS

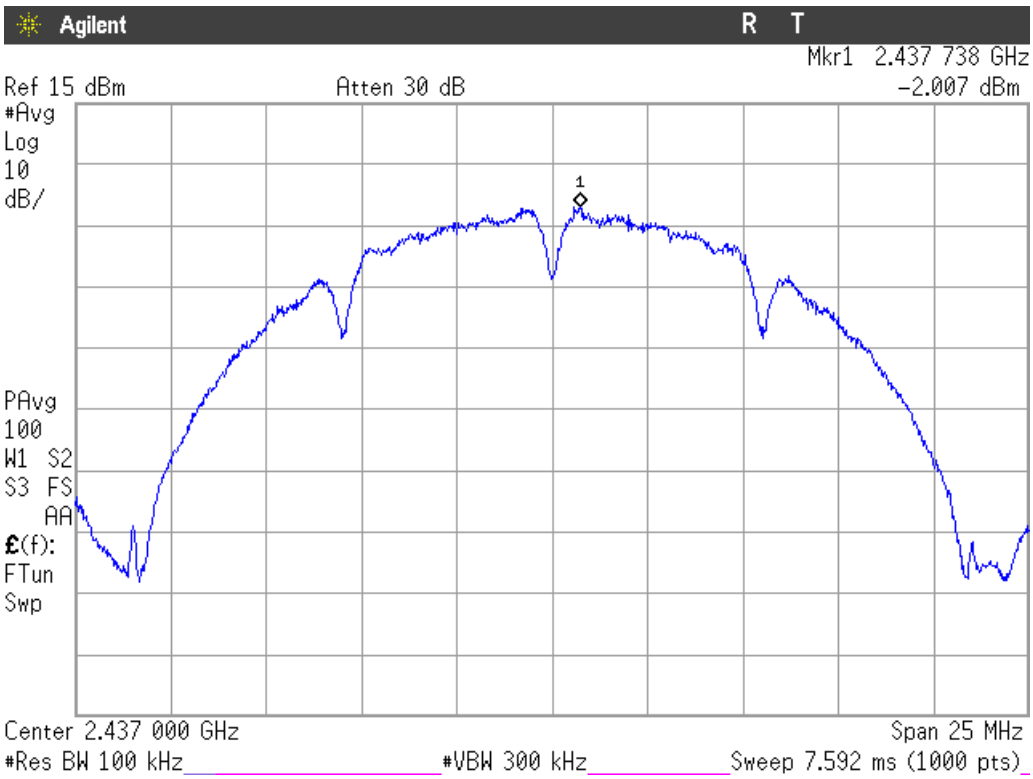
Power spectral density.

Mode B

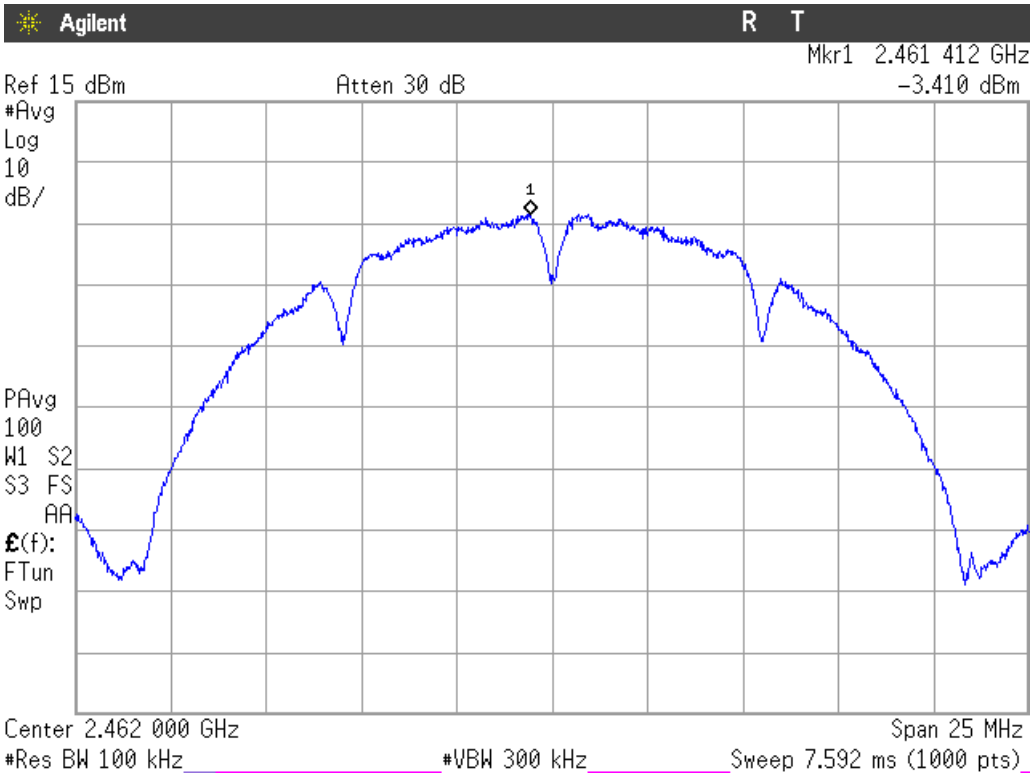
Lowest Channel



Middle Channel

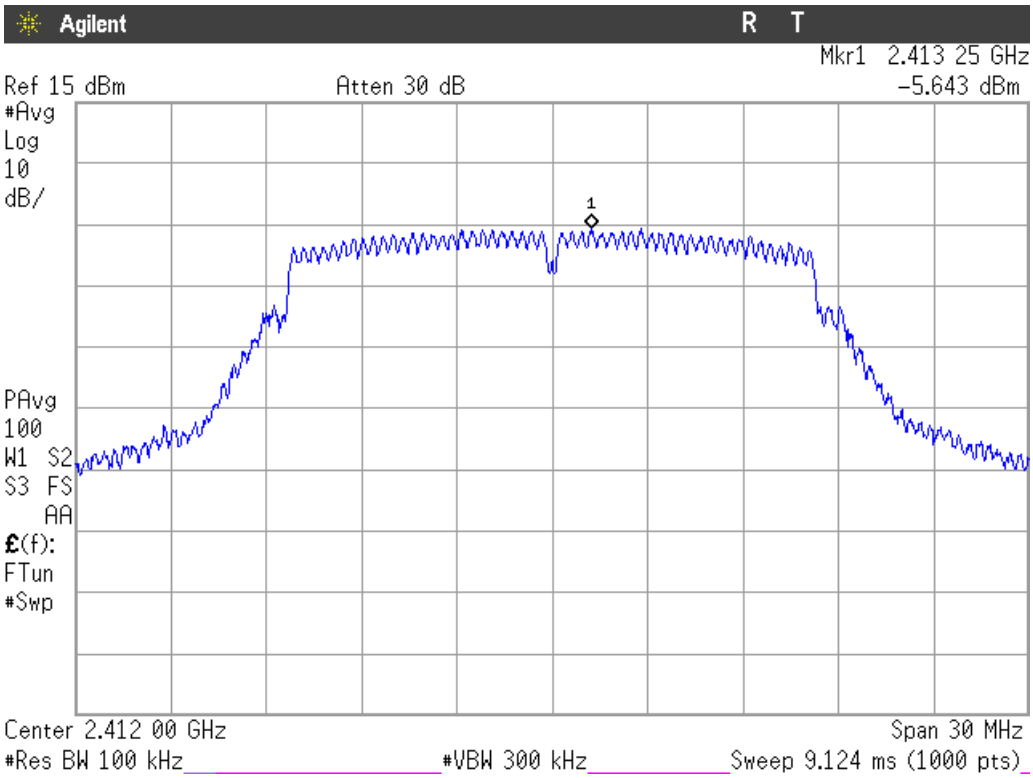


Highest channel

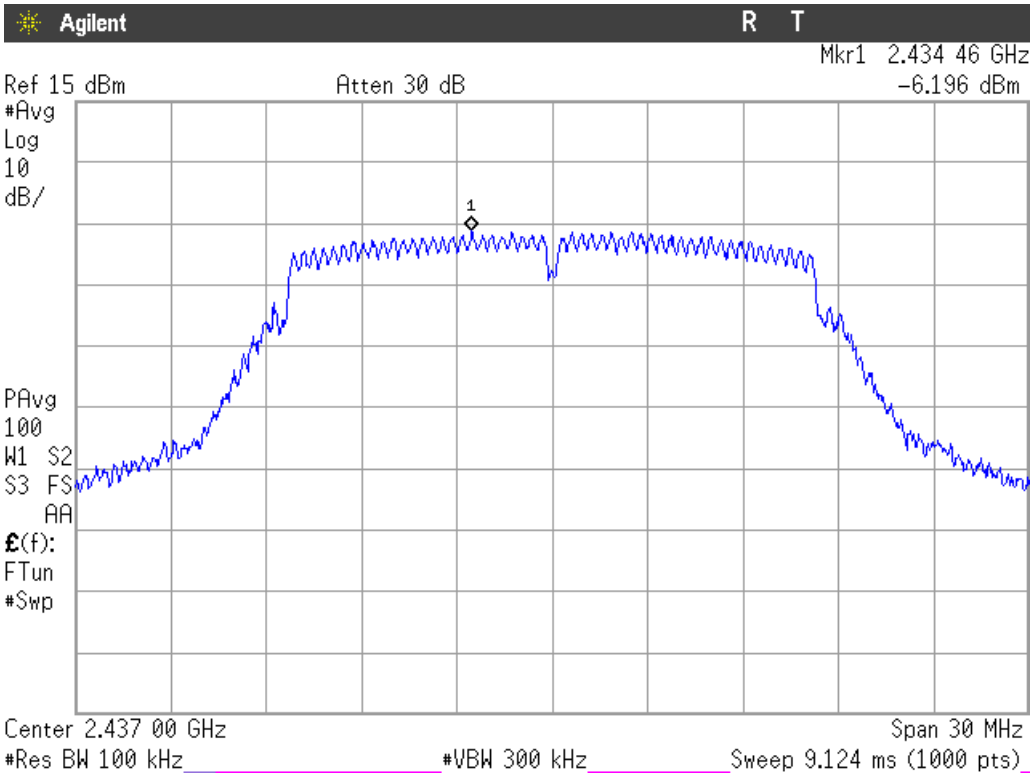


Mode G

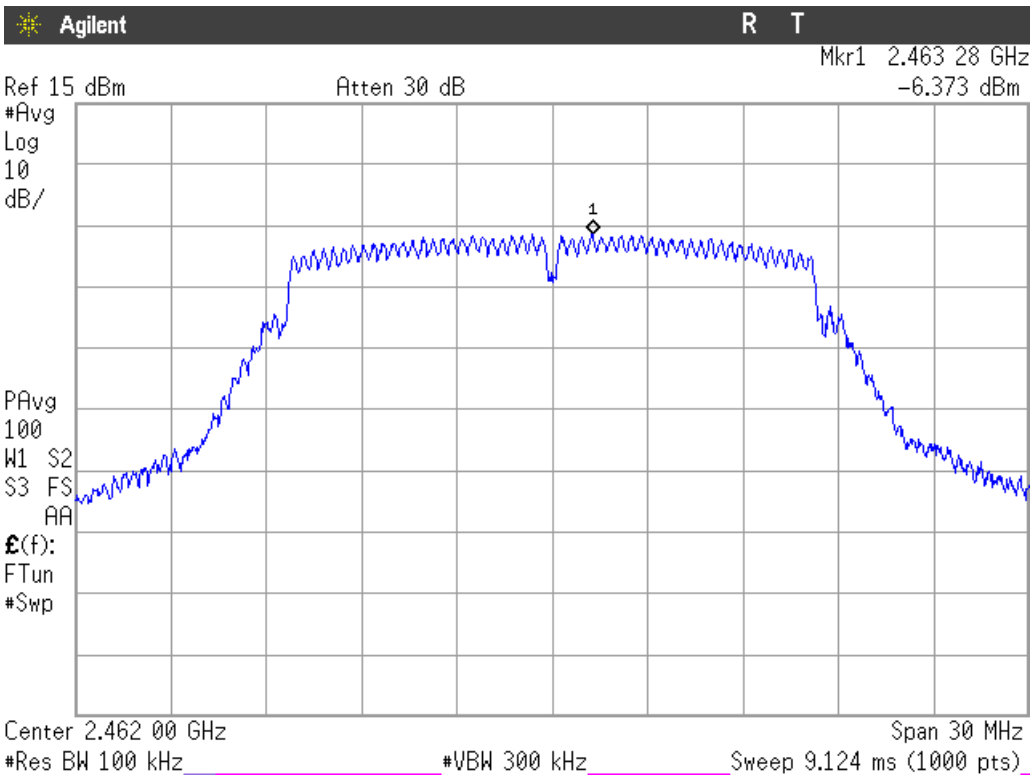
Lowest Channel



Middle Channel

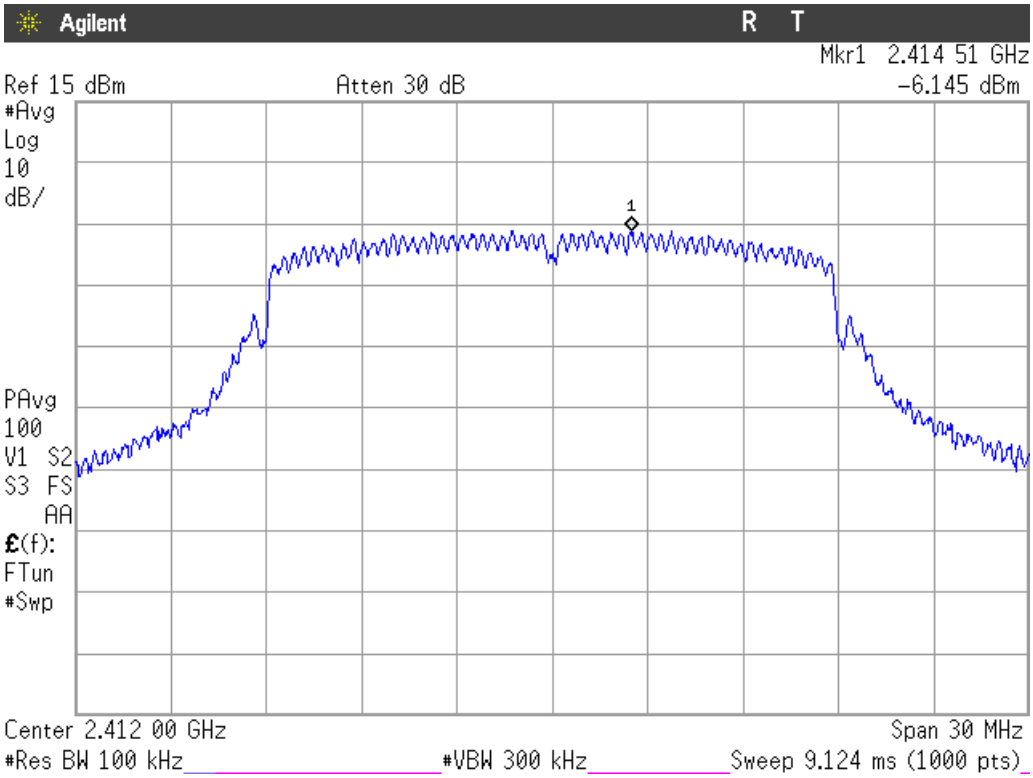


Highest channel

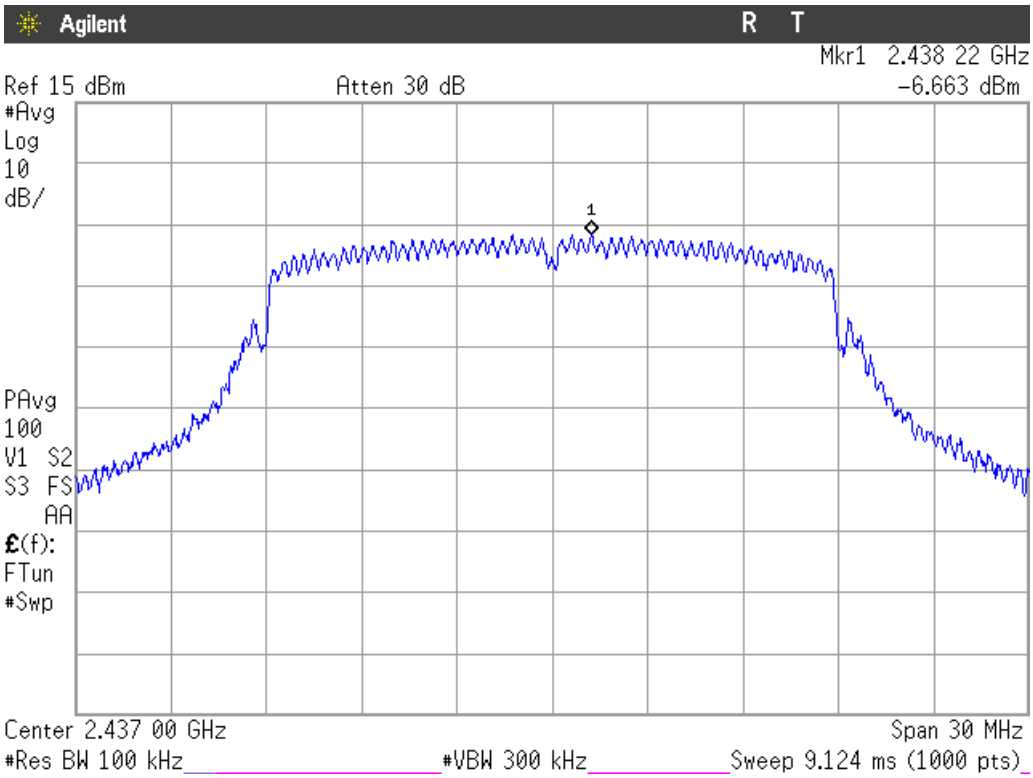


Mode N20

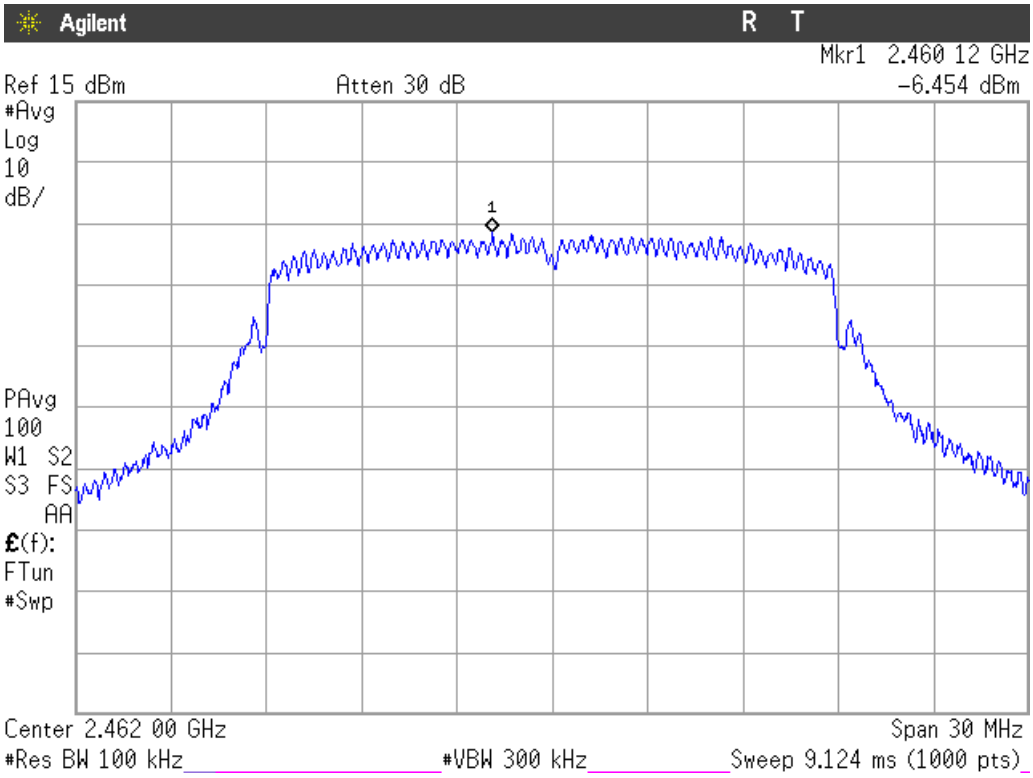
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (d). Emission limitations radiated (Transmitter)

SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)) / RSS-Gen 8.9.:

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

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

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

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.

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

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
287.923	H	Quasi-Peak	33.00	± 3.88
295.974	H	Quasi-Peak	40.72	± 3.88
304.025	H	Quasi-Peak	39.97	± 3.88
311.979	H	Quasi-Peak	40.45	± 3.88
320.030	V	Quasi-Peak	31.24	± 3.88
327.984	H	Quasi-Peak	33.83	± 3.88
351.943	H	Quasi-Peak	40.04	± 3.88
359.994	H	Quasi-Peak	43.44	± 3.88
367.948	H	Quasi-Peak	30.90	± 3.88
375.999	H	Quasi-Peak	40.75	± 3.88
399.958	H	Quasi-Peak	36.00	± 3.88
408.009	V	Quasi-Peak	32.09	± 3.88
415.963	H	Quasi-Peak	38.93	± 3.88
424.014	V	Quasi-Peak	31.47	± 3.88
431.968	H	Quasi-Peak	39.69	± 3.88
447.973	V	Quasi-Peak	32.28	± 3.88

All peaks are more than 20 dB below the limit.

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 for the channel under test.

Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with AVG 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)
2.33111	PH	Peak	46.48	± 4.87
2.33254	PV	Peak	53.17	± 4.87
2.48830	PV	Peak	53.40	± 4.87
3.21575	PH	Peak	44.74	± 4.87
3.39025	PV	Peak	42.39	± 4.87
4.82375	PH	Peak	46.16	± 4.87
7.23675	PH	Peak	49.66	± 4.87
19.29587	PV	Peak	46.36	± 4.87

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

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.51737	PV	Peak	50.88	± 4.87
2.57084	PV	Peak	53.07	± 4.87
3.36475	PV	Peak	42.26	± 4.87
3.44475	PH	Peak	43.62	± 4.87
4.87425	PV	Peak	46.11	± 4.87
7.30975	PH	Peak	46.29	± 4.87
19.49587	PV	Peak	47.62	± 4.87

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)
2.38304	PV	Peak	49.67	± 4.87
2.48354	PV	Peak	49.85	± 4.87
2.5385	PH	Peak	54.11	± 4.87
		Average	47.14	± 4.87
2.5753	PV	Peak	53.34	± 4.87
3.42875	PH	Peak	43.52	± 4.87
4.92375	PV	Peak	45.60	± 4.87
7.38525	PV	Peak	44.30	± 4.87
19.69587	PV	Peak	50.61	± 4.87

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)
2.33357	PV	Peak	52.75	± 4.87
2.38958	PV	Peak	57.03	± 4.87
		Average	44.25	± 4.87
2.38997	PV	Peak	67.32	± 4.87
		Average	51.94	± 4.87
2.57270	PV	Peak	52.45	± 4.87
3.33925	PV	Peak	41.53	± 4.87
3.46375	PH	Peak	41.60	± 4.87
4.82575	PV	Peak	44.40	± 4.87
7.23875	PV	Peak	51.54	± 4.87
9.64775	PV	Peak	47.87	± 4.87
19.29587	PV	Peak	47.27	± 4.87

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

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.36270	PV	Peak	52.40	± 4.87
2.55863	PV	Peak	55.89	± 4.87
		Average	47.15	± 4.87
3.37375	PH	Peak	44.39	± 4.87
3.46375	PV	Peak	41.40	± 4.87
4.87575	PV	Peak	44.43	± 4.87
7.30825	PV	Peak	50.15	± 4.87
9.74775	PH	Peak	48.59	± 4.87
19.49587	PV	Peak	48.16	± 4.87

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)
2.34843	PV	Peak	50.70	± 4.87
2.48450	PH	Peak	56.73	± 4.87
		Average	40.35	± 4.87
2.48458	PV	Peak	65.92	± 4.87
		Average	47.19	± 4.87
2.58330	PV	Peak	56.50	± 4.87
		Average	45.68	± 4.87
3.43175	PV	Peak	45.63	± 4.87
3.46375	PH	Peak	40.98	± 4.87
4.92425	PH	Peak	44.14	± 4.87
7.38325	PH	Peak	52.19	± 4.87
9.84775	PV	Peak	48.61	± 4.87
19.69587	PV	Peak	50.82	± 4.87

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)
2.33290	PV	Peak	56.32	± 4.87
		Average	45.04	± 4.87
2.38981	PV	Peak	68.68	± 4.87
		Average	52.91	± 4.87
2.38987	PH	Peak	60.31	± 4.87
		Average	44.97	± 4.87
2.56810	PV	Peak	56.44	± 4.87
		Average	46.57	± 4.87
3.39325	PV	Peak	43.45	± 4.87
3.46375	PH	Peak	44.88	± 4.87
4.82725	PV	Peak	44.43	± 4.87
7.24025	PH	Peak	52.62	± 4.87
9.64775	PH	Peak	49.72	± 4.87
19.29560	PV	Peak	47.20	± 4.87

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

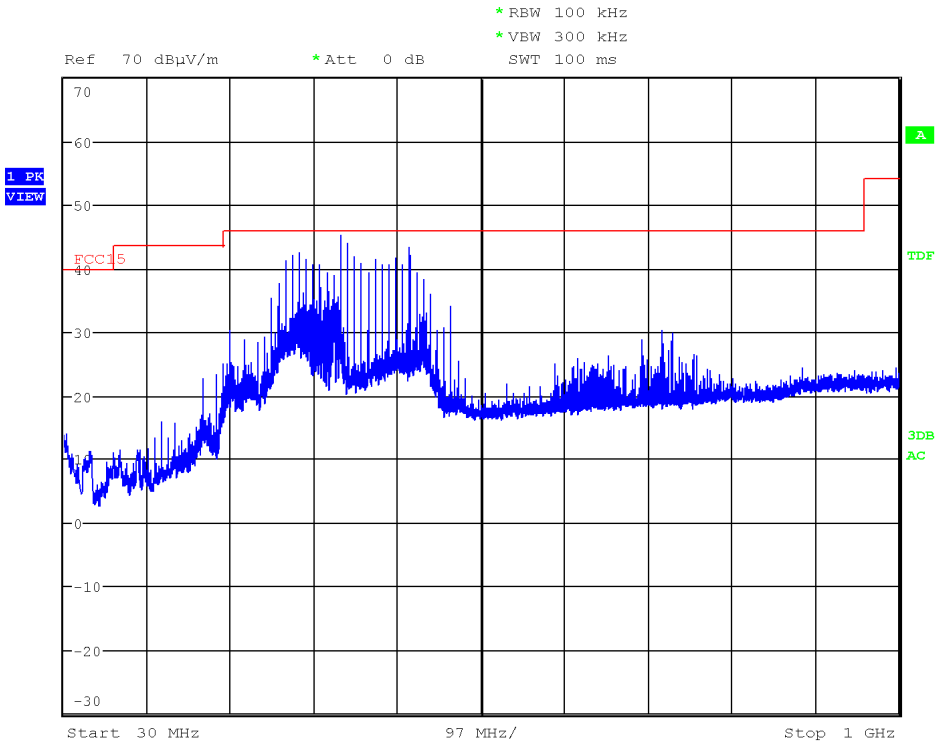
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.51557	PV	Peak	54.87	± 4.87
		Average	42.35	± 4.87
2.55810	PV	Peak	56.26	± 4.87
		Average	45.87	± 4.87
3.38375	PV	Peak	40.39	± 4.87
3.46375	PH	Peak	44.32	± 4.87
4.87425	PV	Peak	45.66	± 4.87
7.30125	PV	Peak	52.11	± 4.87
9.74775	PV	Peak	47.72	± 4.87
19.49587	PV	Peak	47.98	± 4.87

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)
2.48065	PH	Peak	55.30	± 4.87
		Average	40.16	± 4.87
2.48483	PV	Peak	67.23	± 4.87
		Average	48.23	± 4.87
2.54350	PV	Peak	55.02	± 4.87
		Average	45.17	± 4.87
2.57901	PV	Peak	57.10	± 4.87
		Average	47.01	± 4.87
3.36775	PV	Peak	42.69	± 4.87
3.46375	PH	Peak	44.06	± 4.87
4.92175	PV	Peak	46.28	± 4.87
7.38925	PV	Peak	51.63	± 4.87
9.84775	PV	Peak	48.61	± 4.87
19.69587	PV	Peak	50.59	± 4.87

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

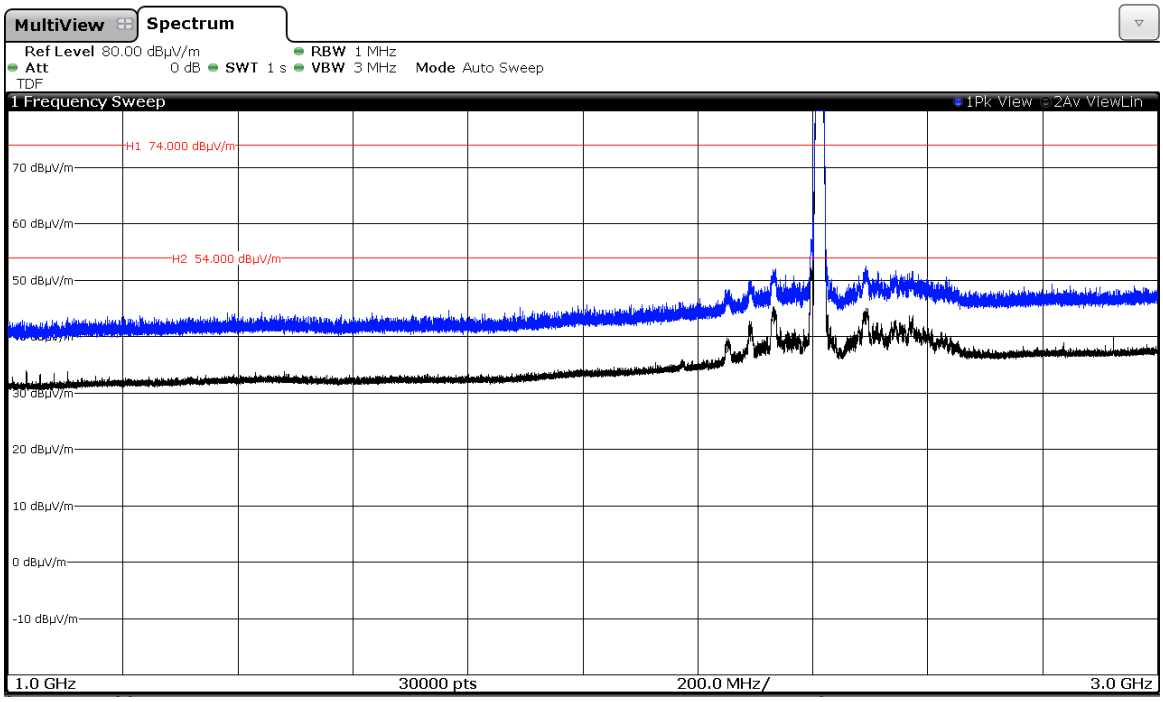


(This plot is valid for all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

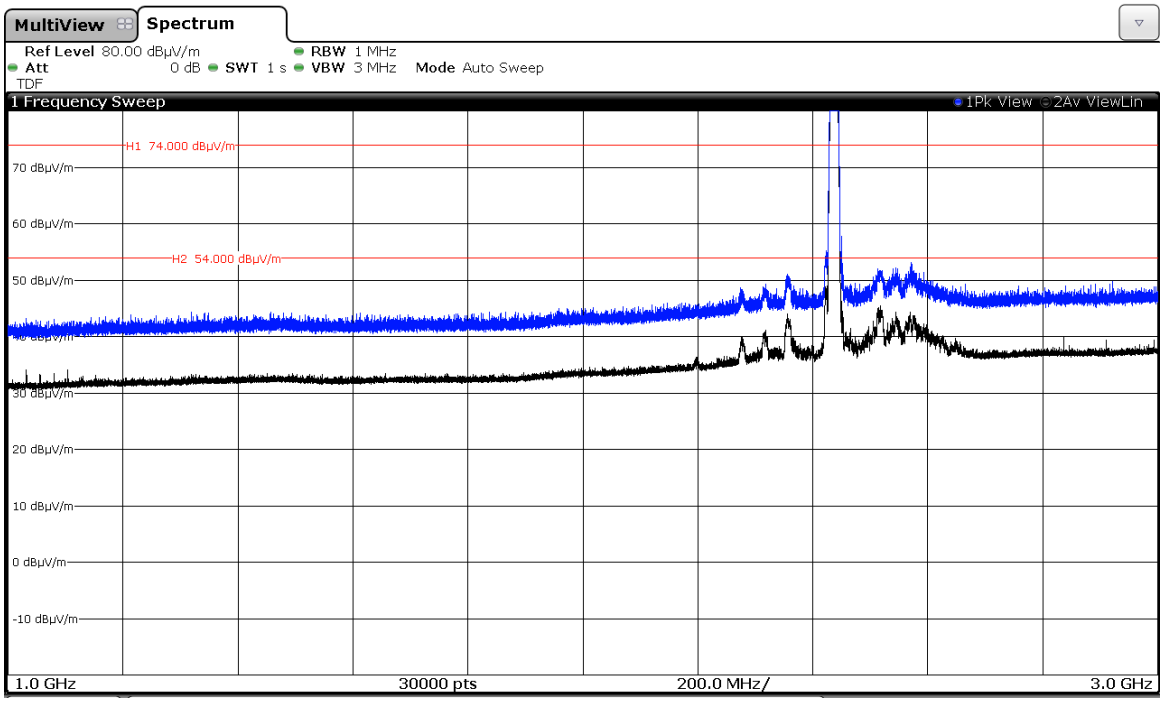
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



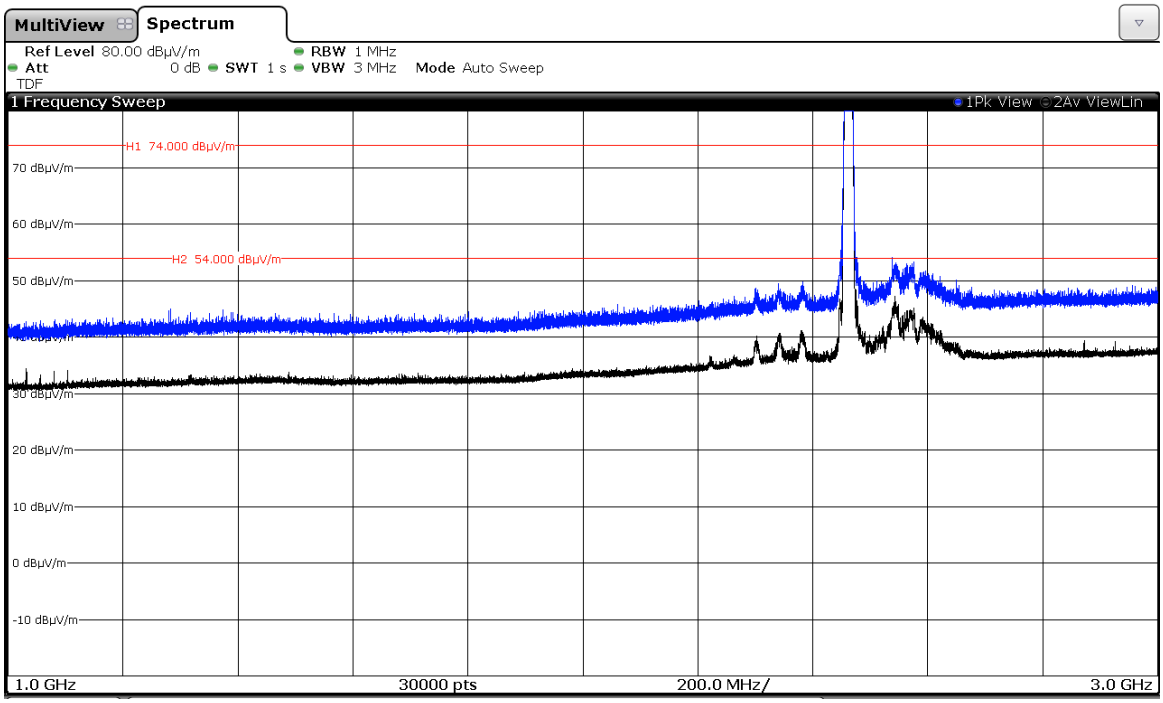
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

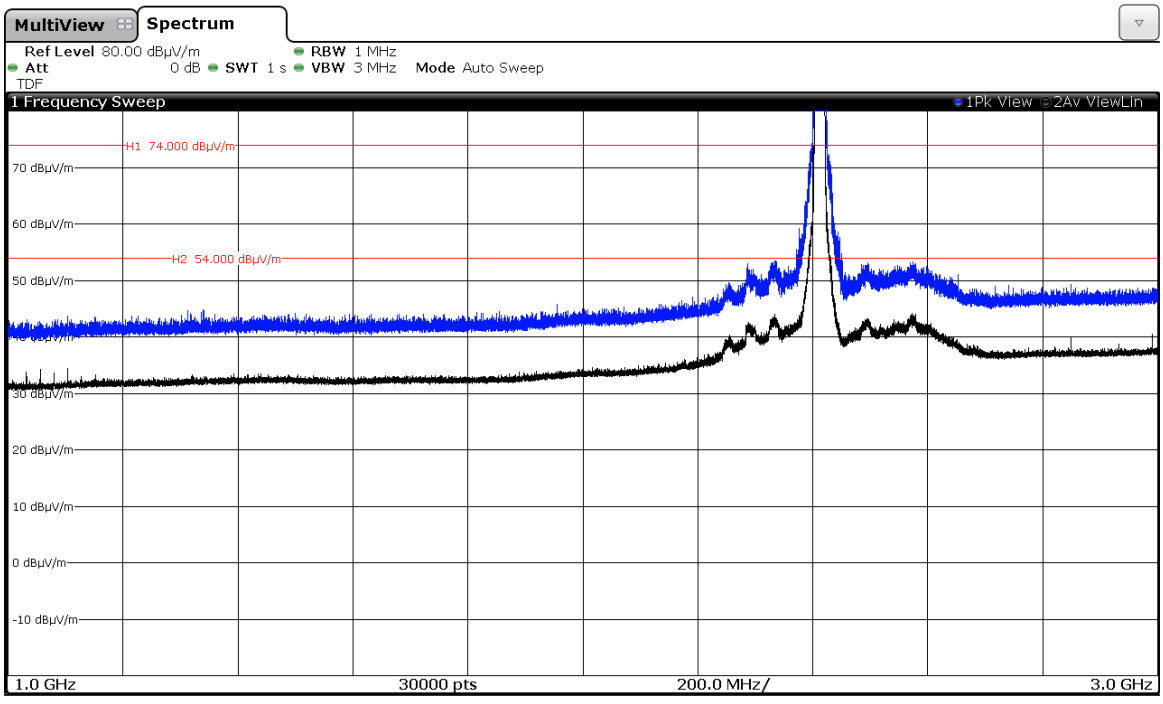
CHANNEL 11 (2462 MHz).



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

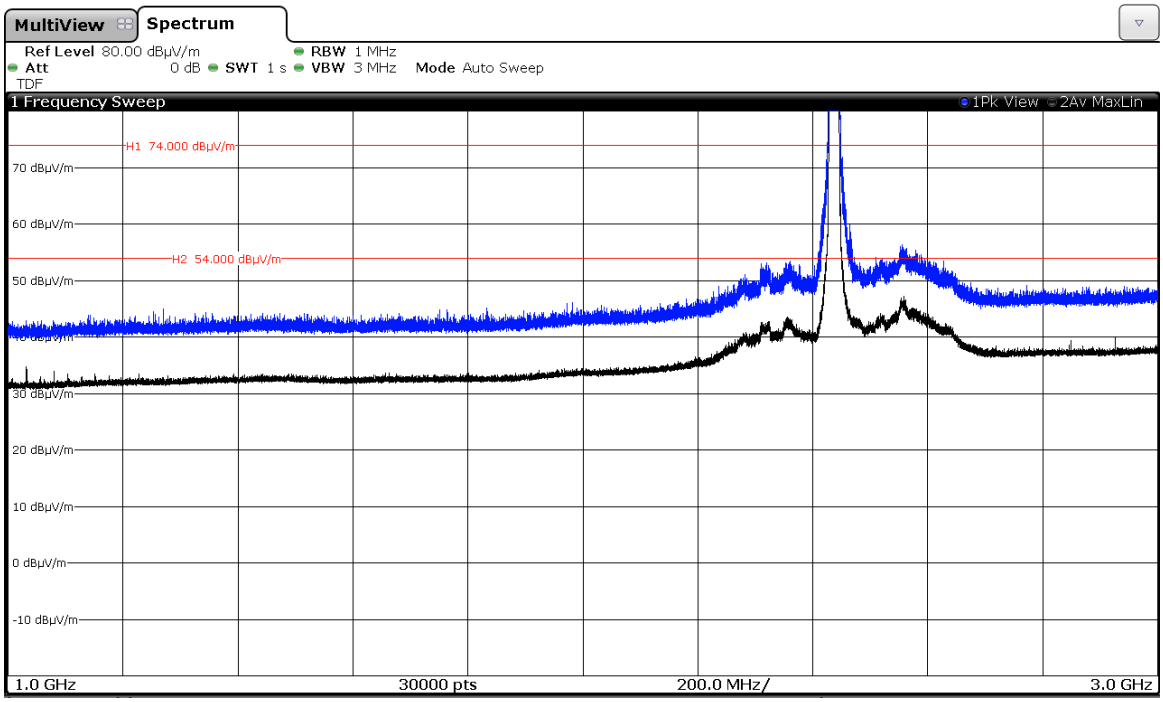
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



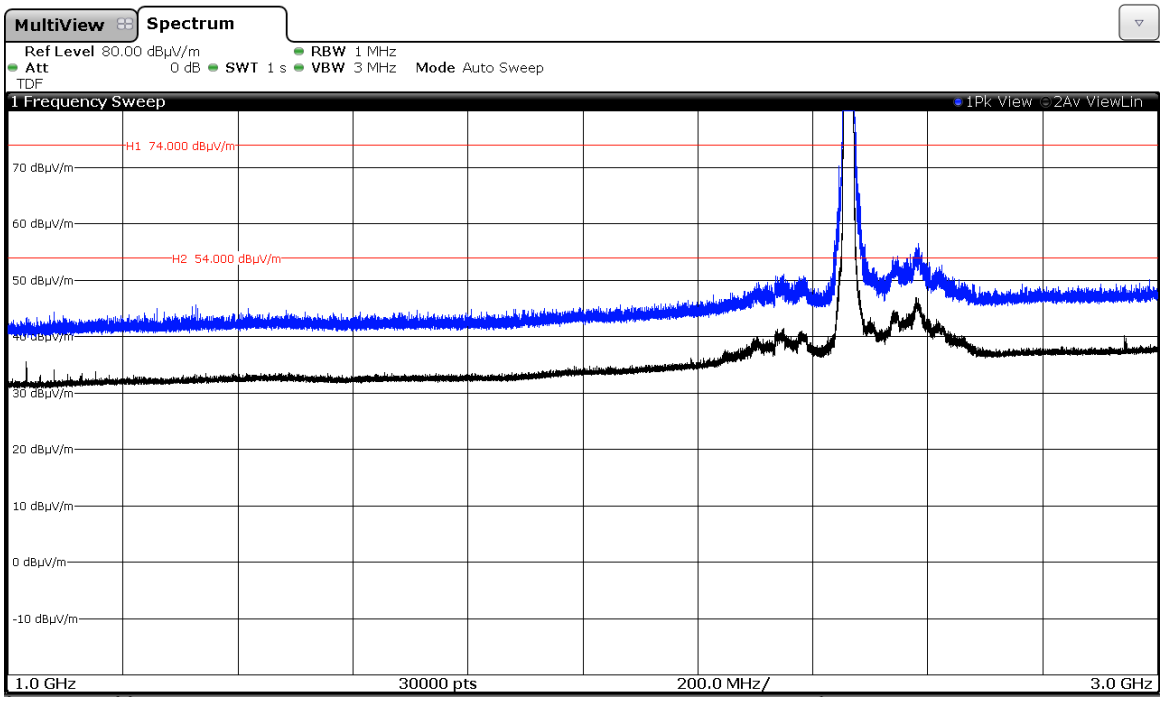
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

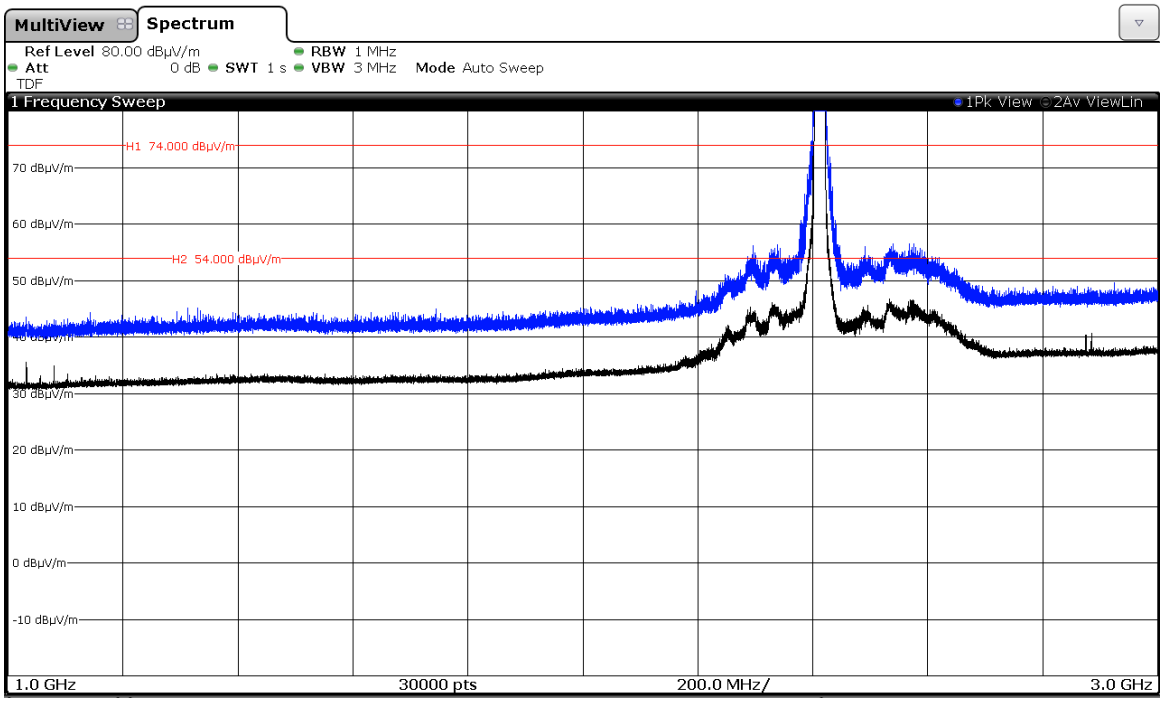
CHANNEL 11 (2462 MHz).



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

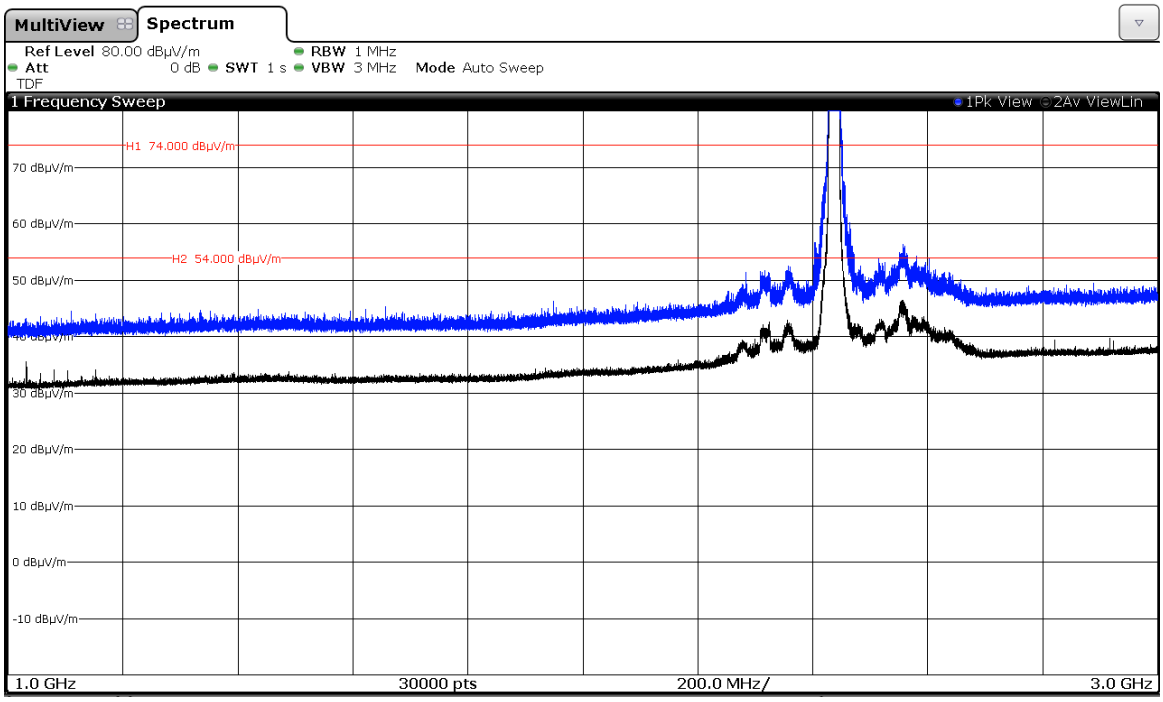
3. WiFi 2.4GHz 802.11 n20 mode

CHANNEL 1 (2412 MHz).



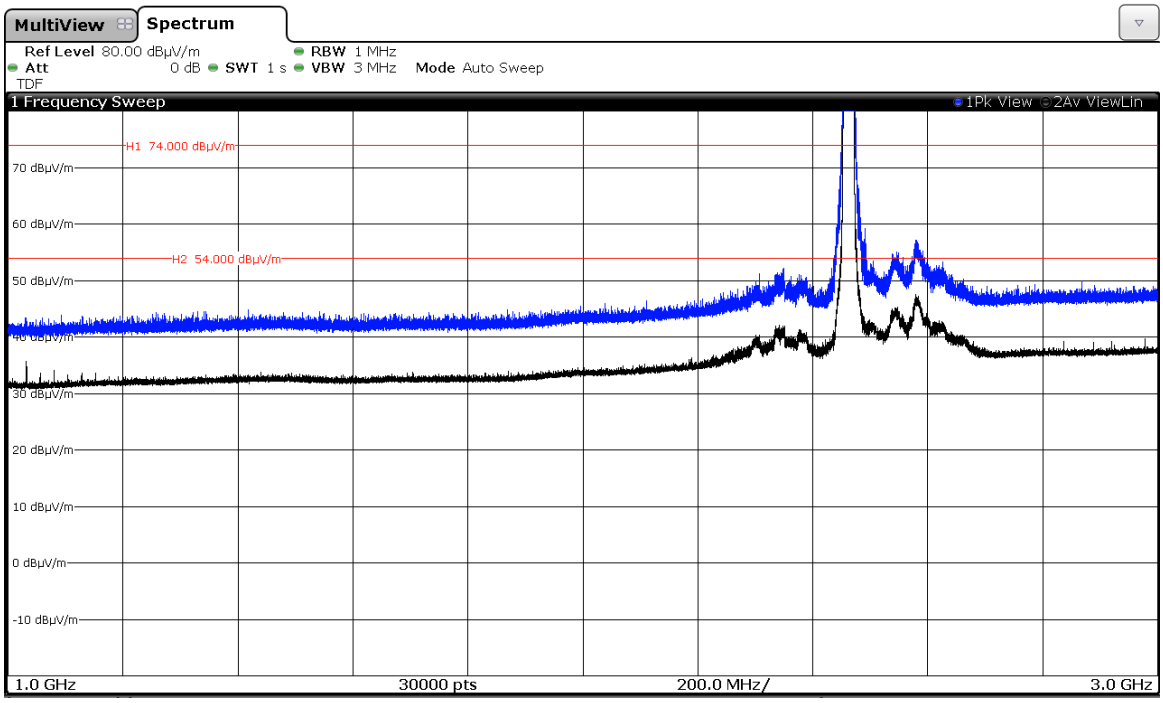
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

CHANNEL 11 (2462 MHz).

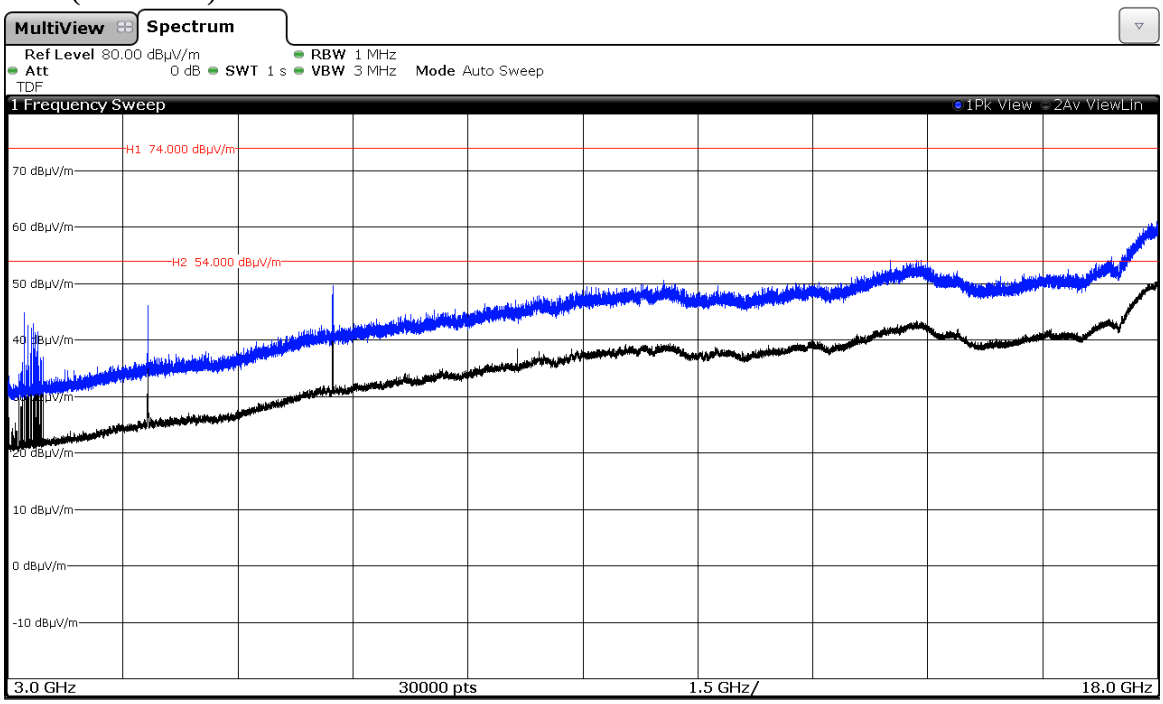


Note: The peak above the limit is the carrier frequency.

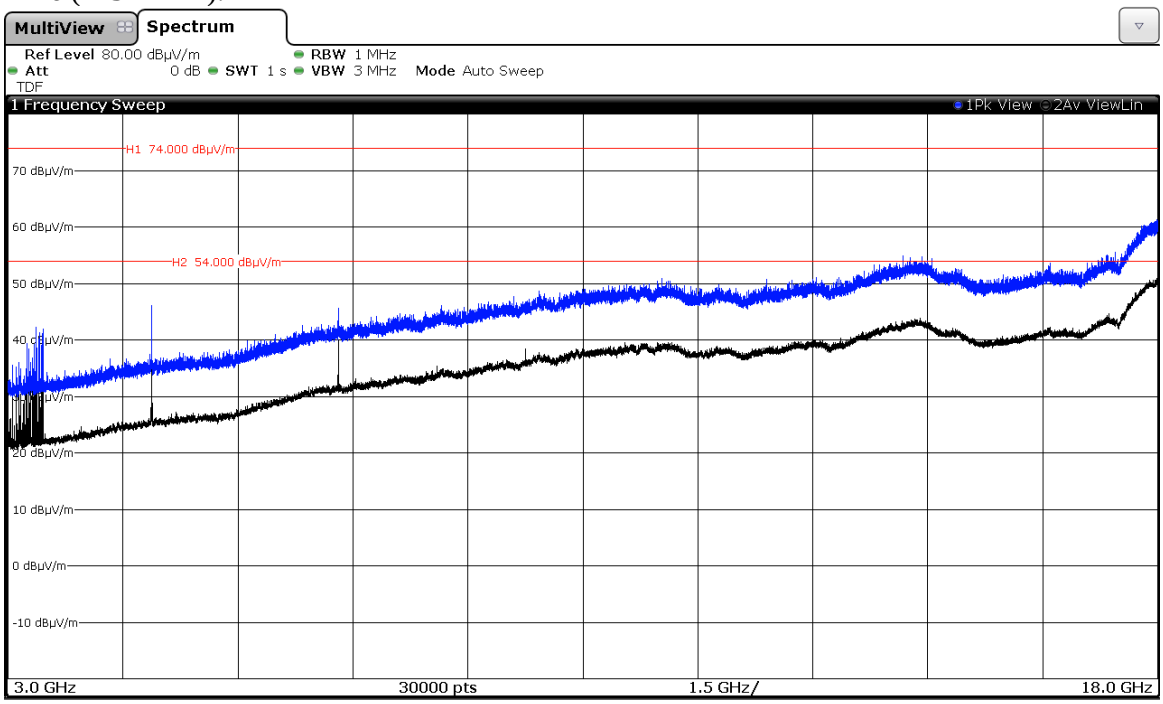
FREQUENCY RANGE 3 GHz to 18 GHz.

1. WiFi 2.4GHz 802.11 b mode

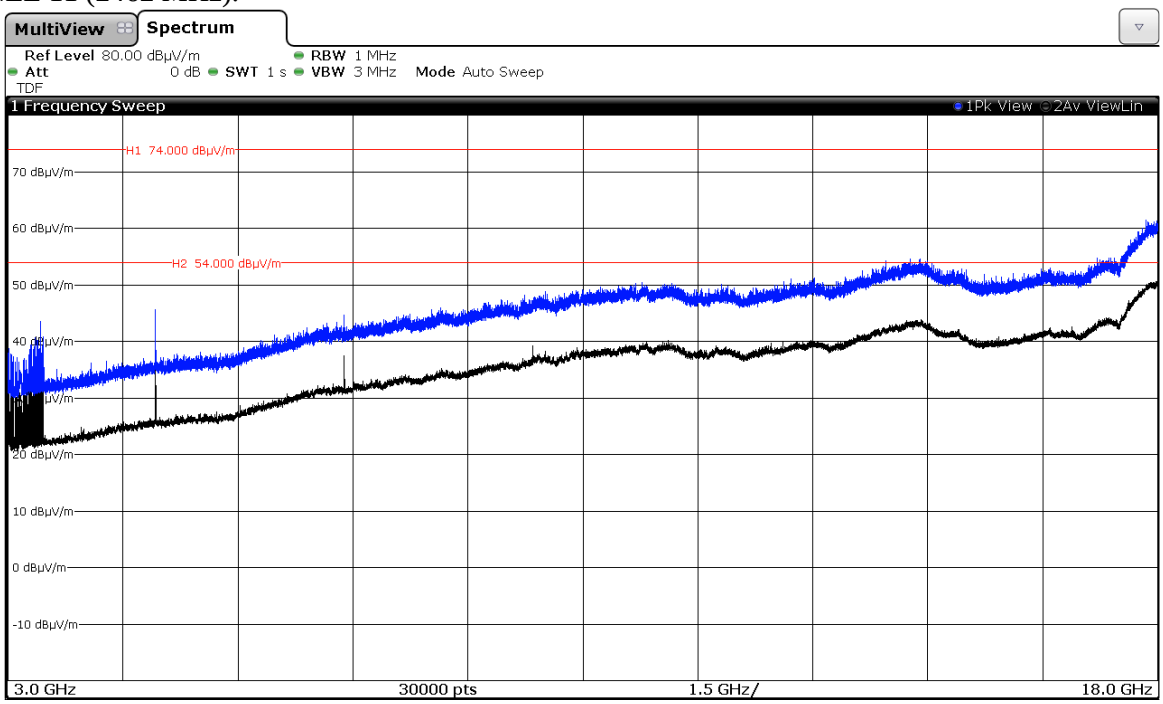
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

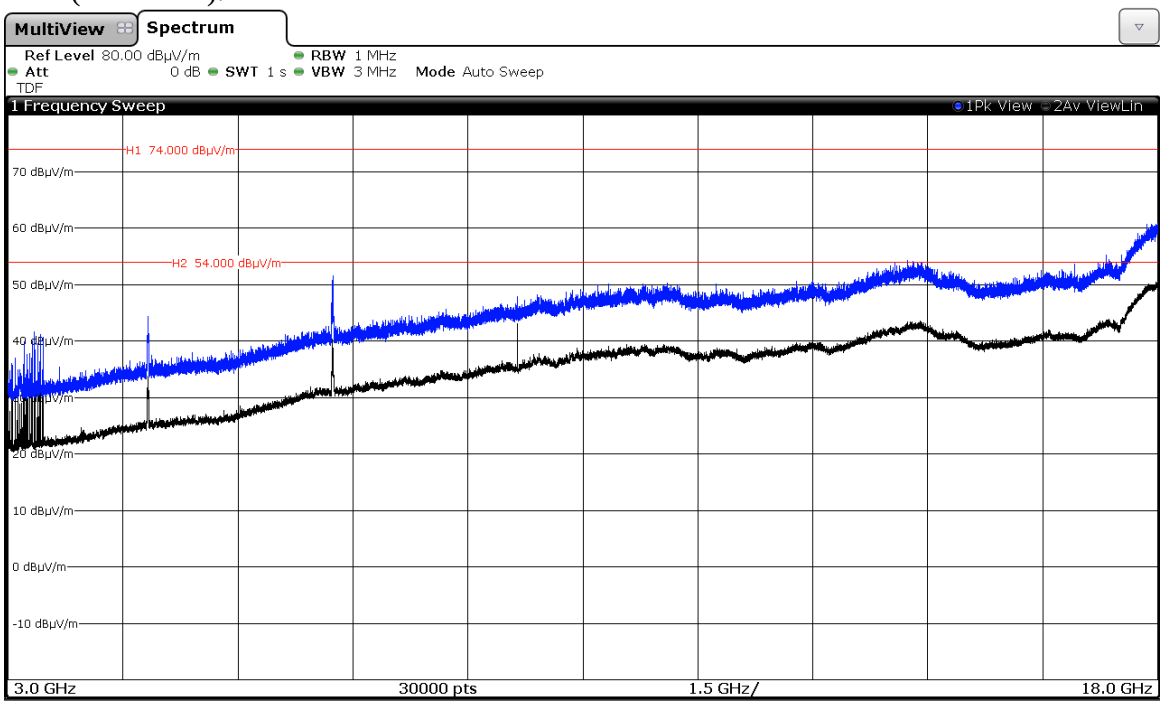


CHANNEL 11 (2462 MHz).

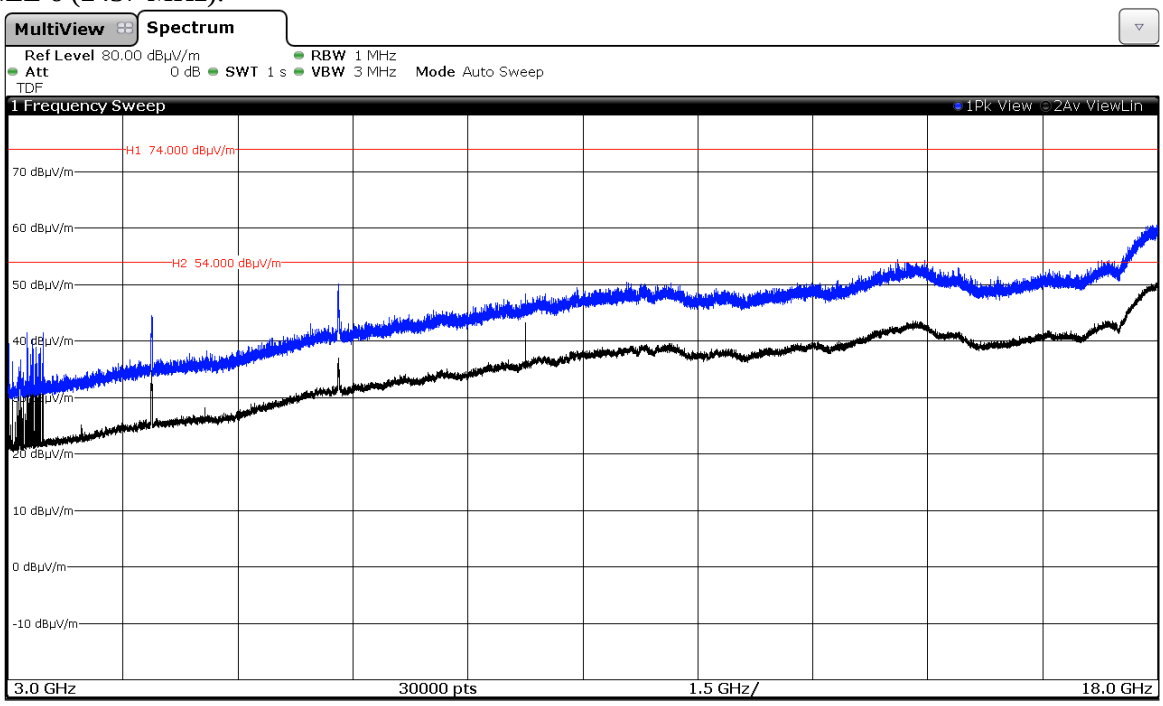


2. WiFi 2.4GHz 802.11 g mode

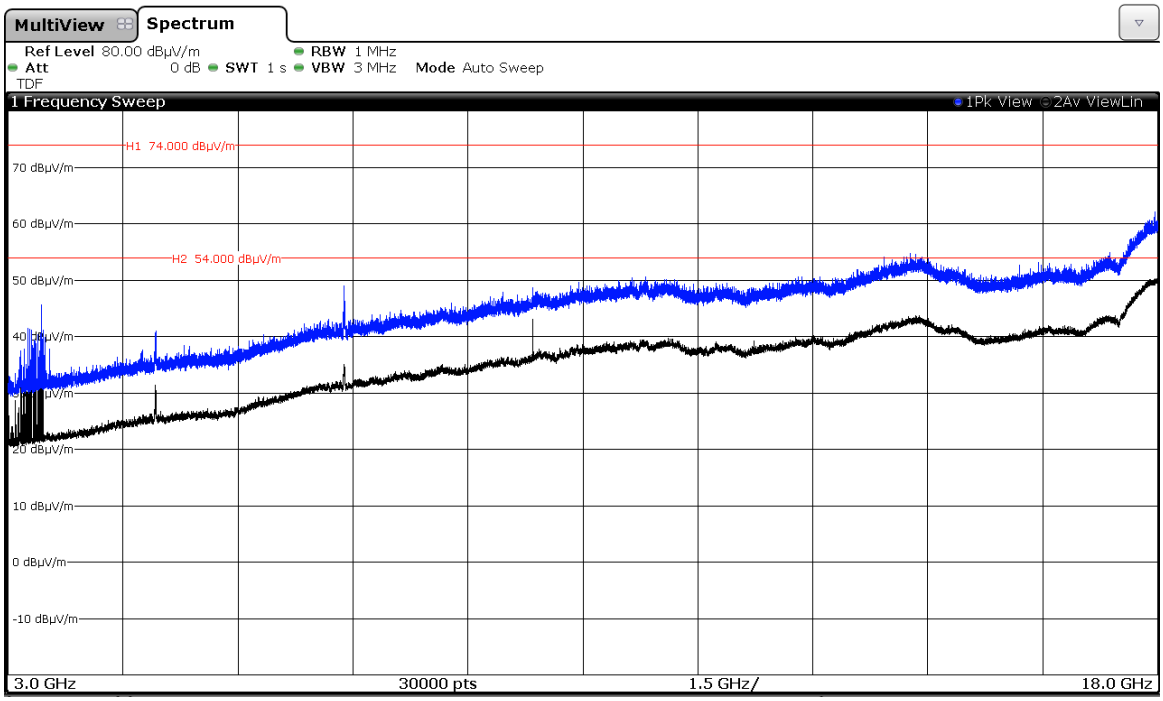
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

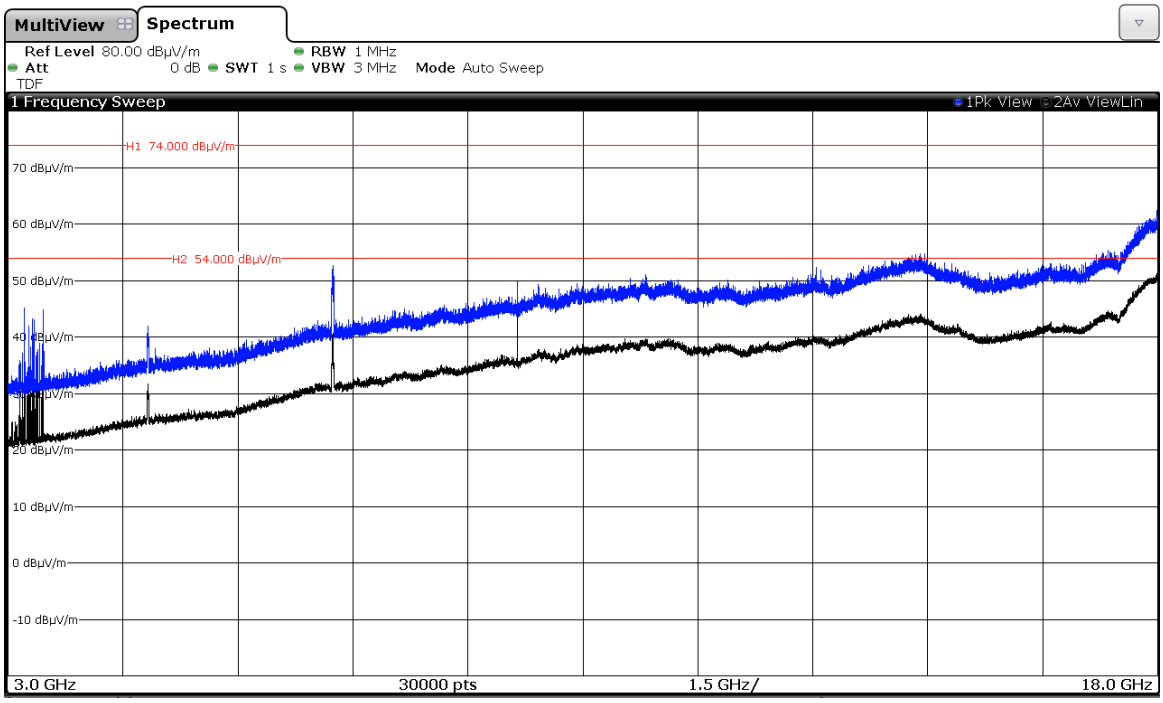


CHANNEL 11 (2462 MHz).

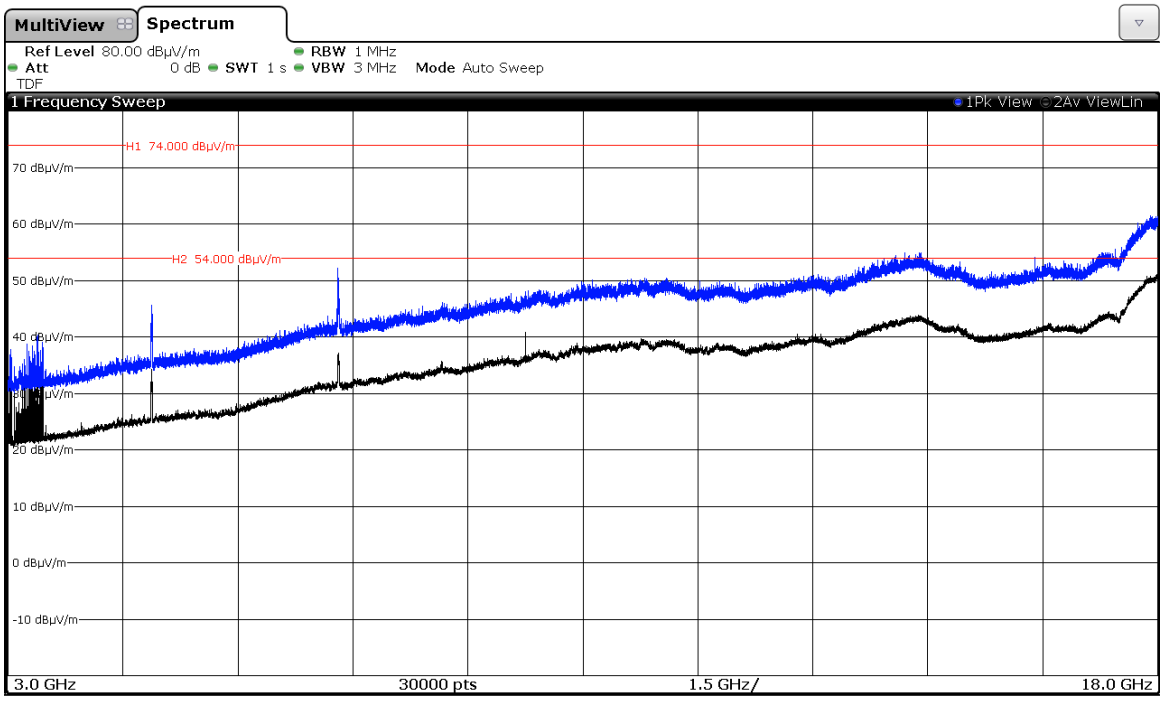


3. WiFi 2.4GHz 802.11 n20 mode

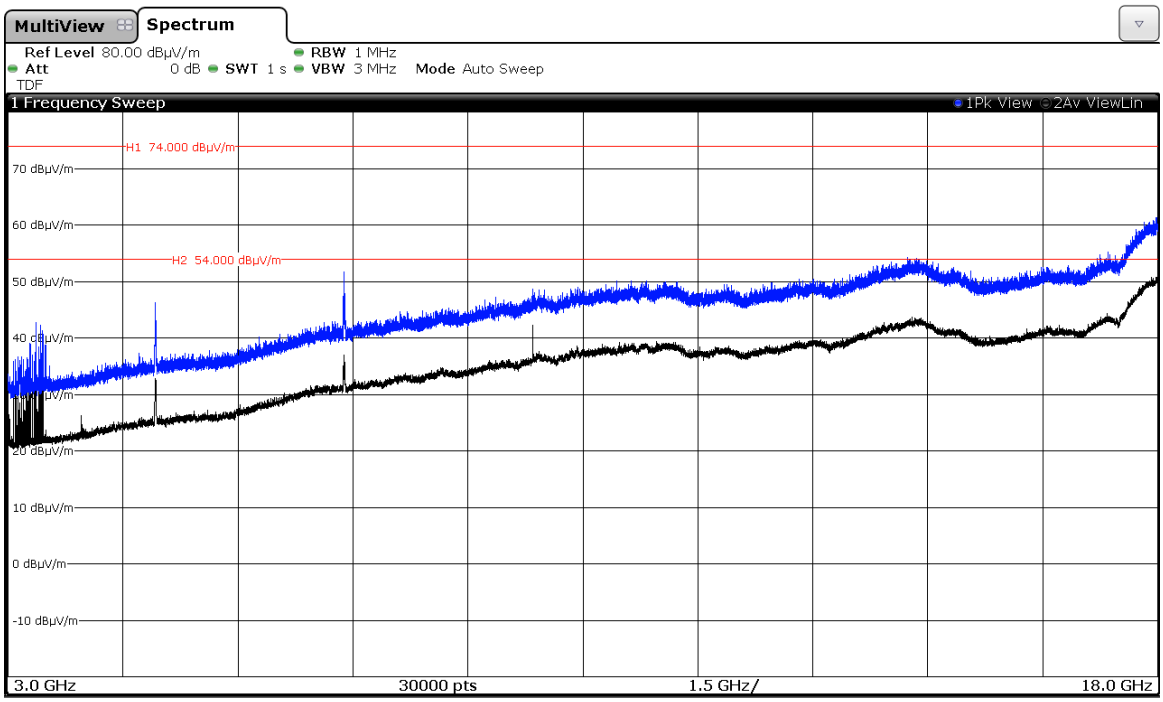
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).



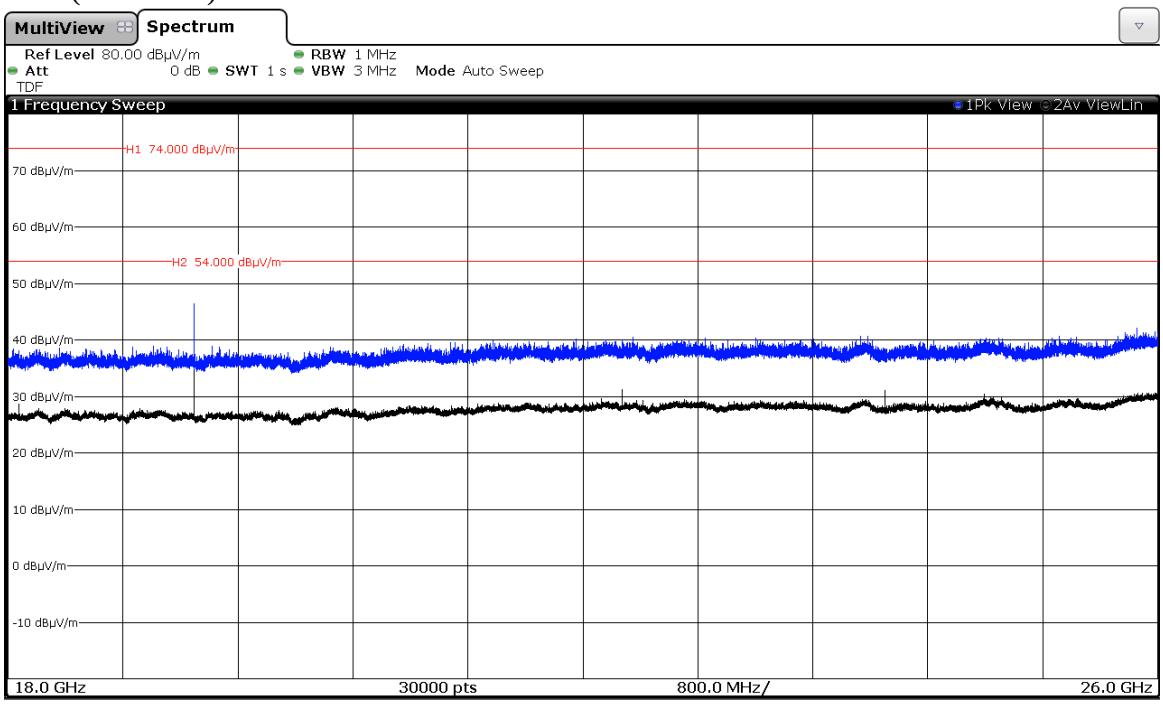
CHANNEL 11 (2462 MHz).



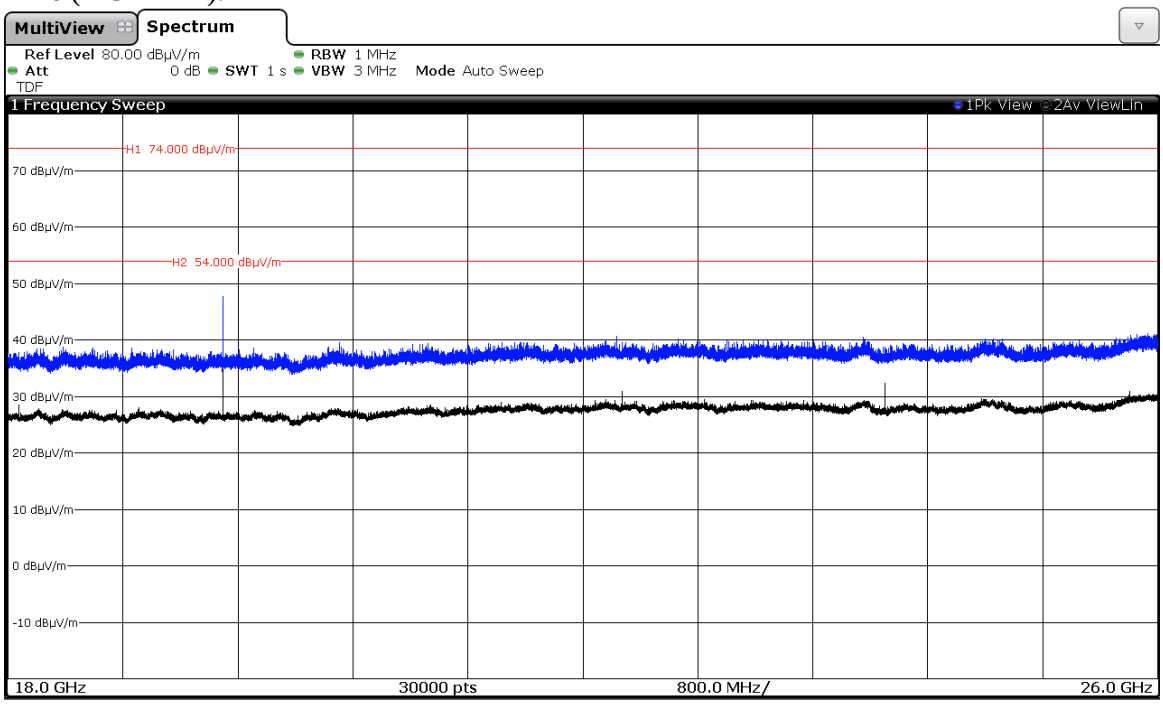
FREQUENCY RANGE 18 GHz to 26 GHz.

1. WiFi 2.4GHz 802.11 b mode

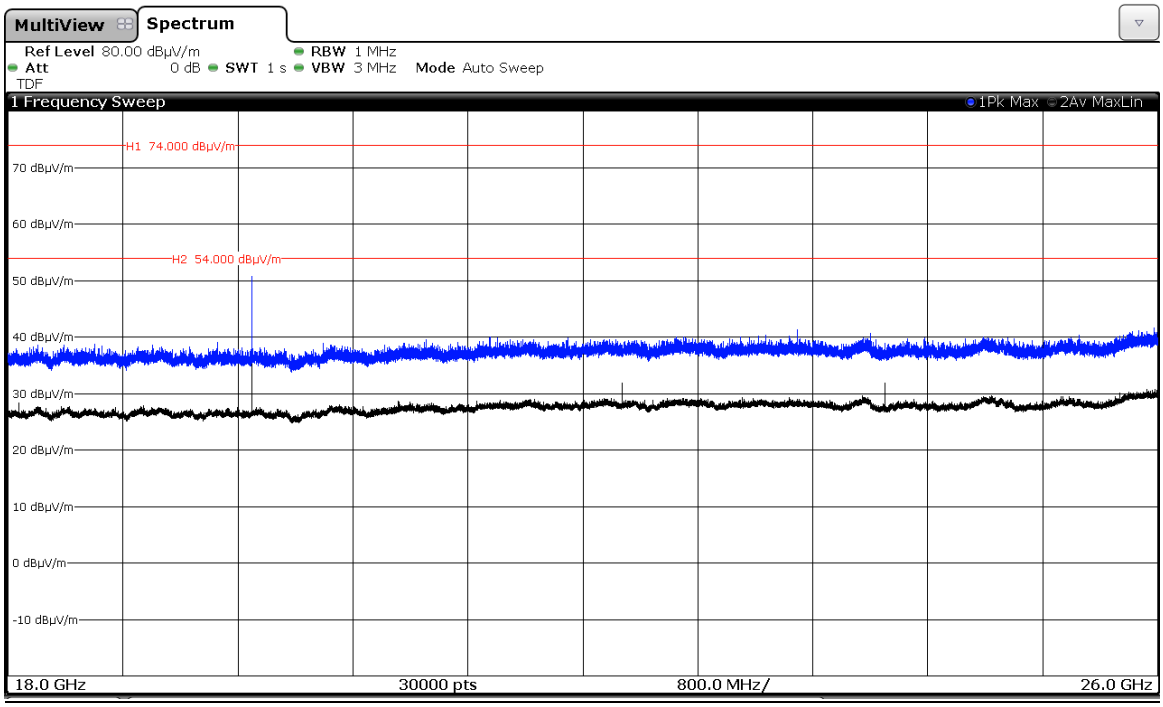
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

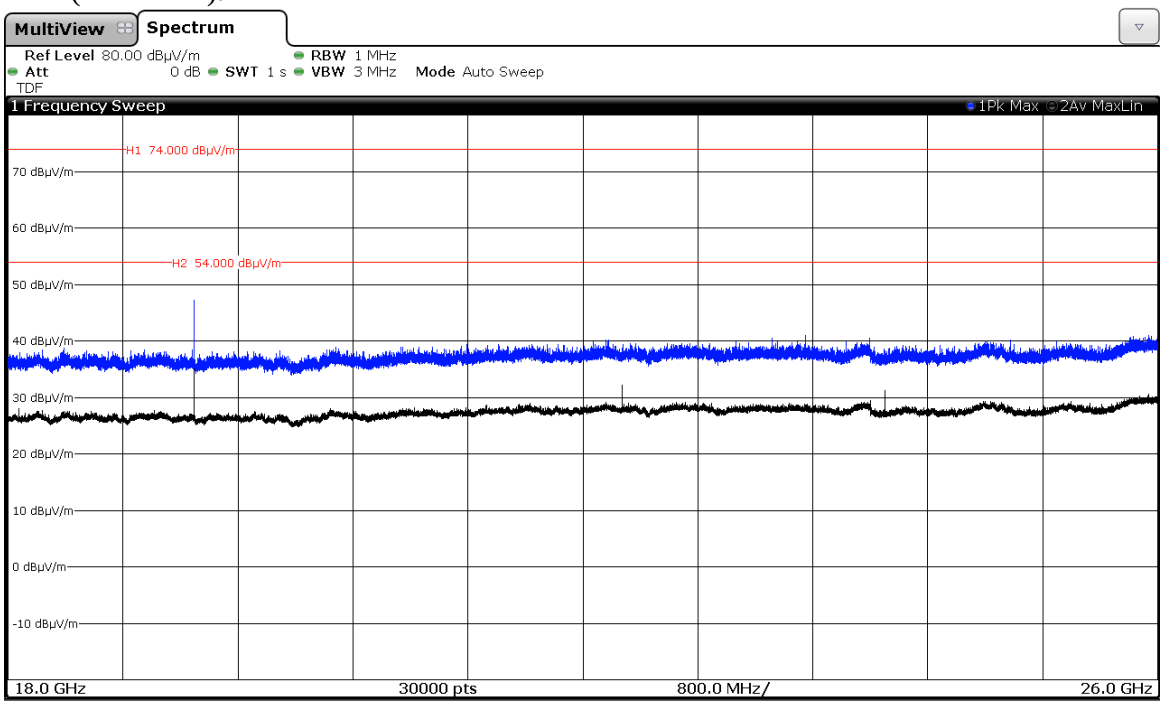


CHANNEL 11 (2462 MHz).

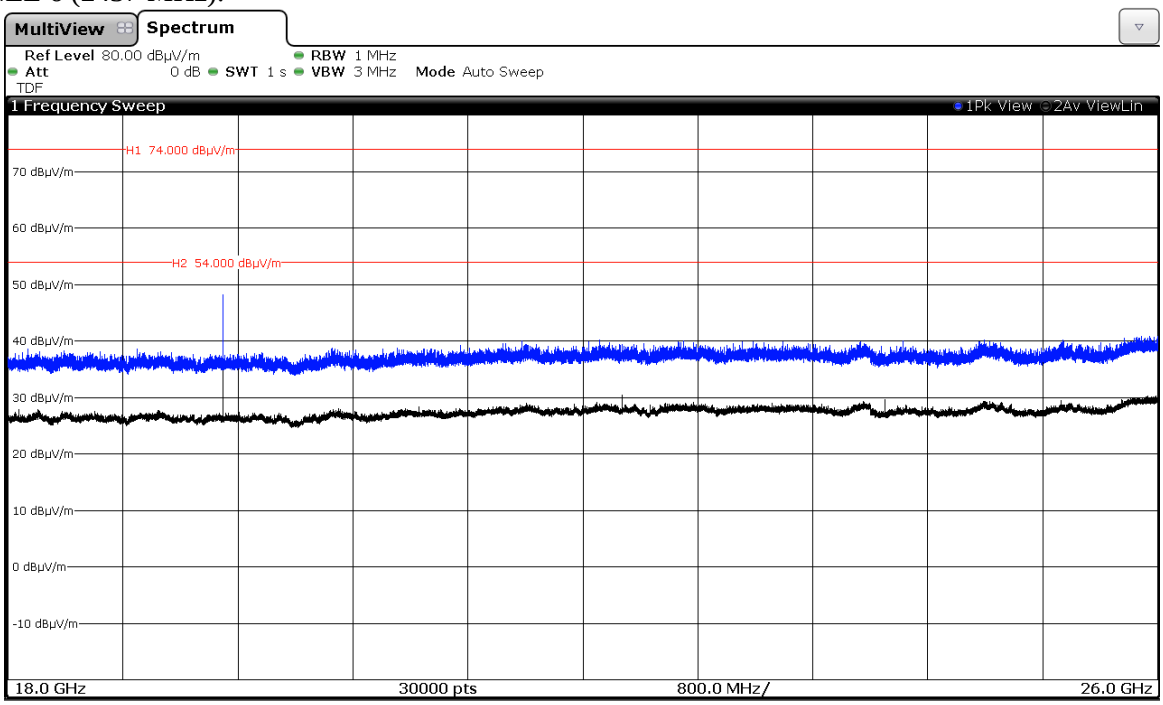


2. WiFi 2.4GHz 802.11 g mode

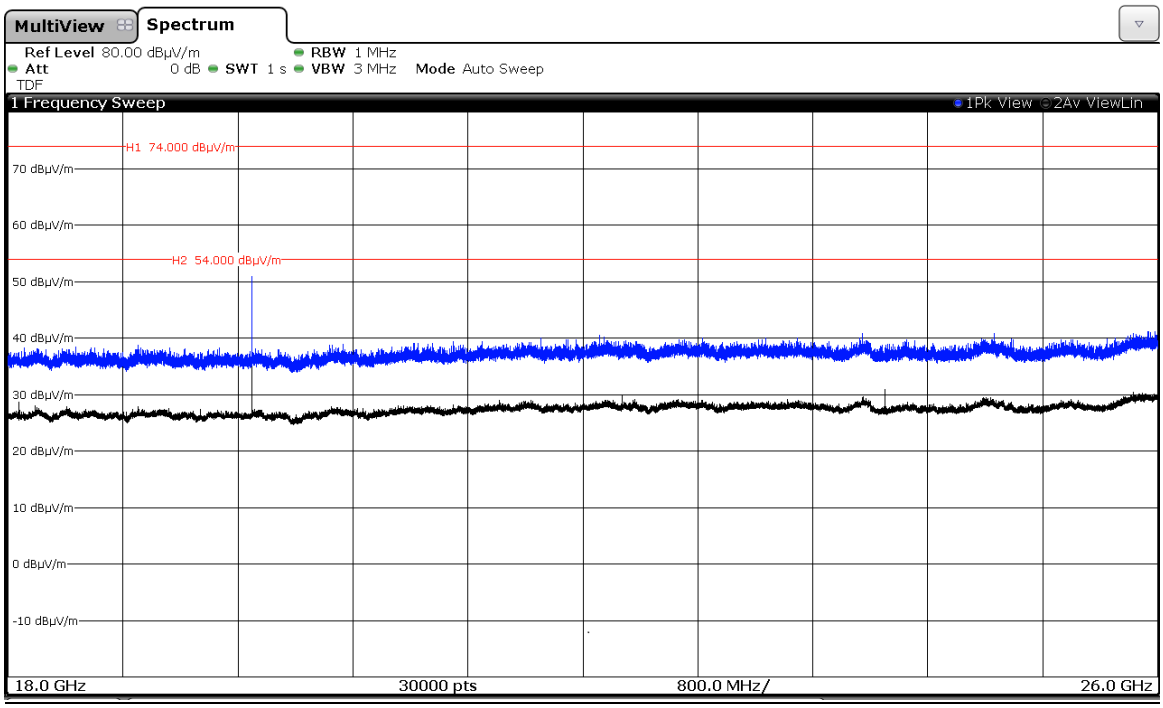
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

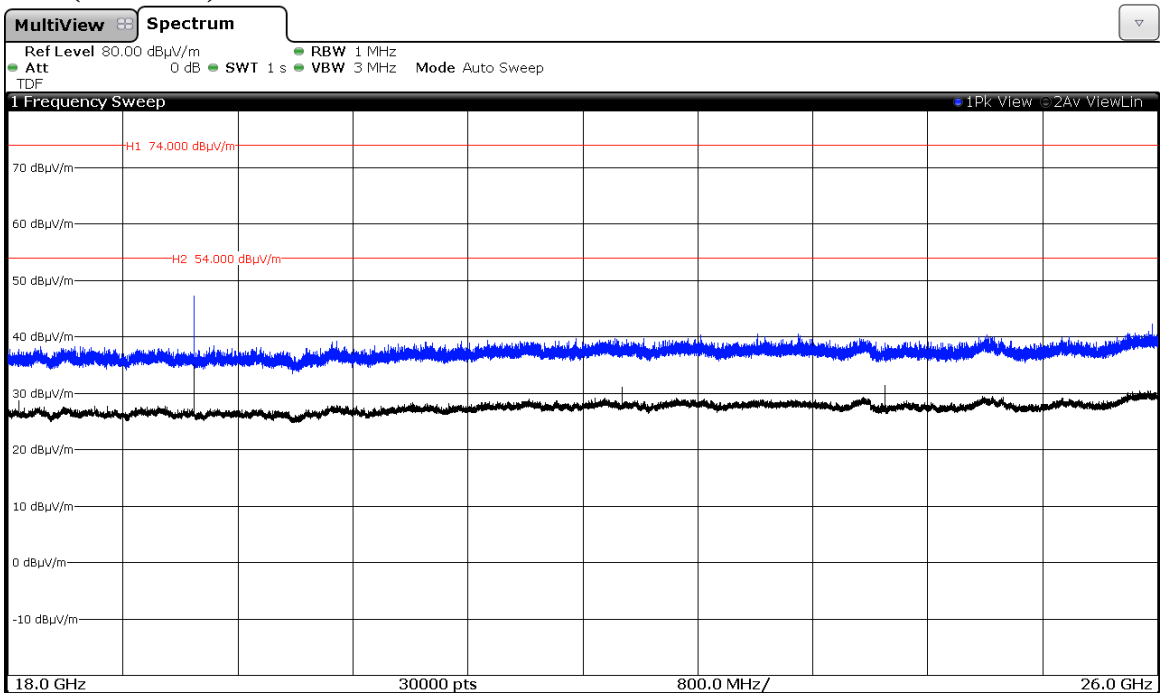


CHANNEL 11 (2462 MHz).

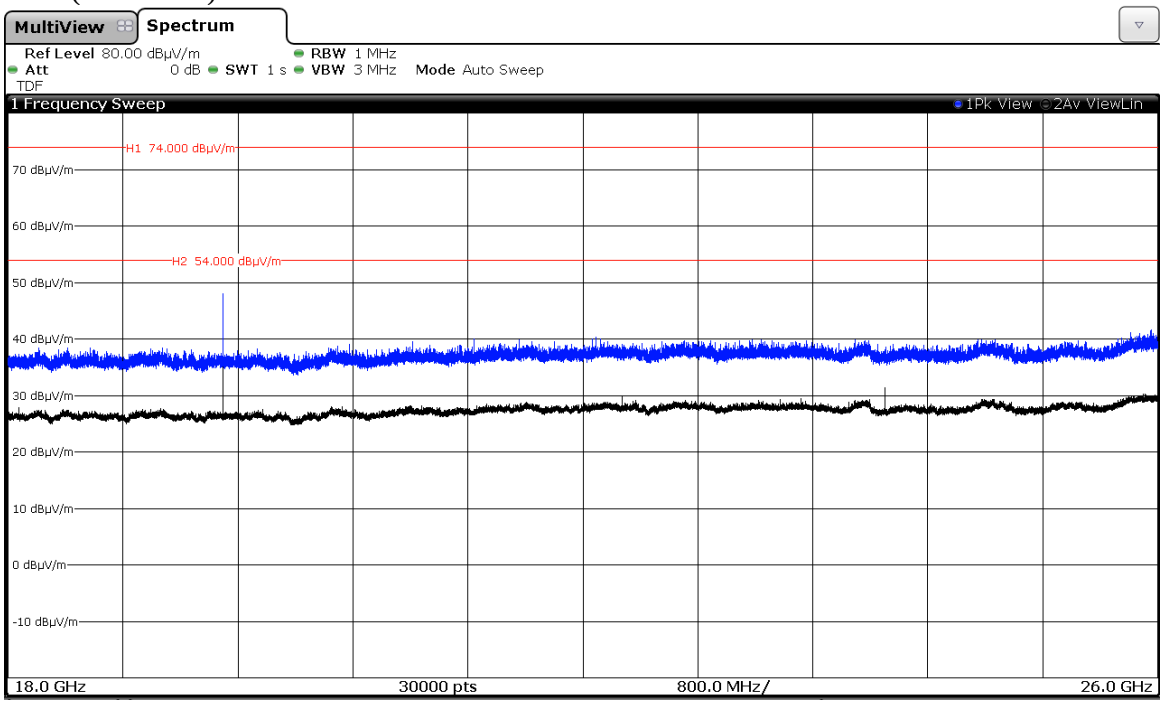


3. WiFi 2.4GHz 802.11 n20 mode

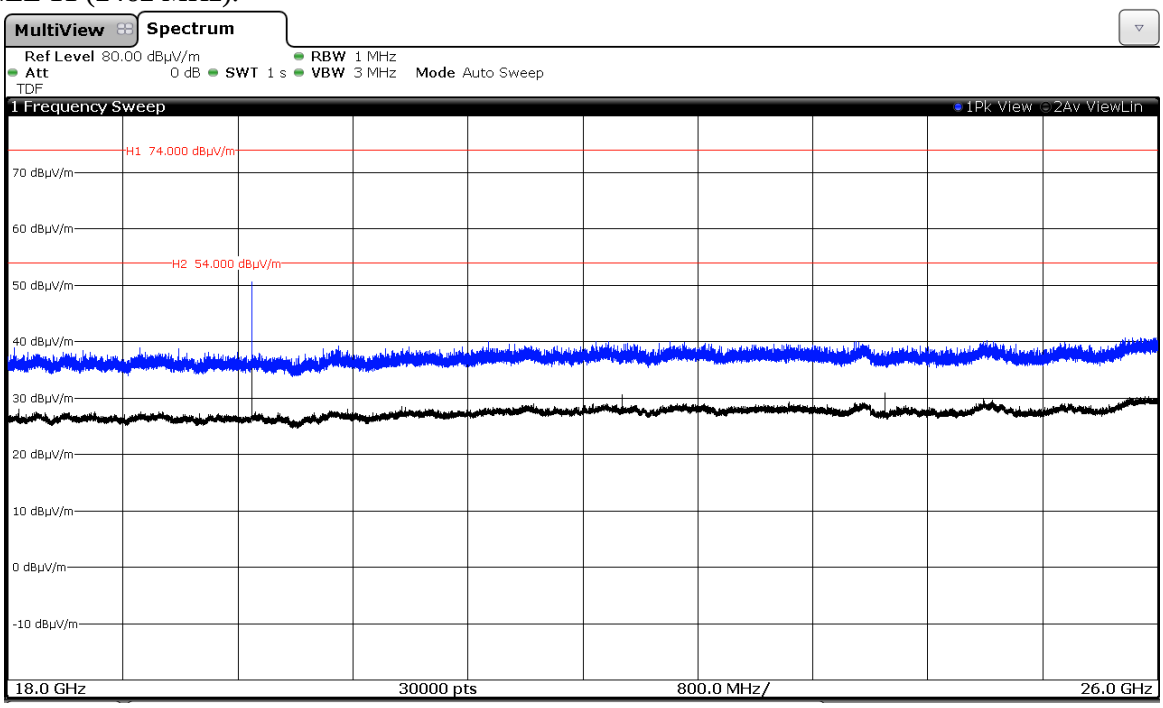
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).



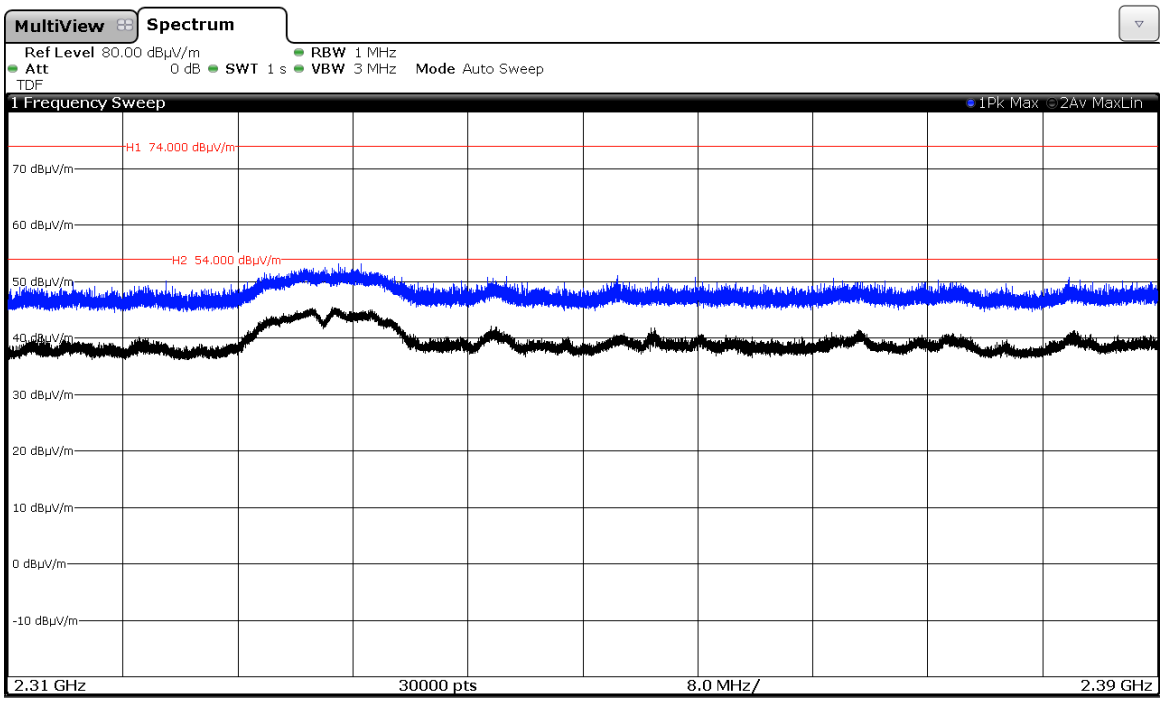
CHANNEL 11 (2462 MHz).



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

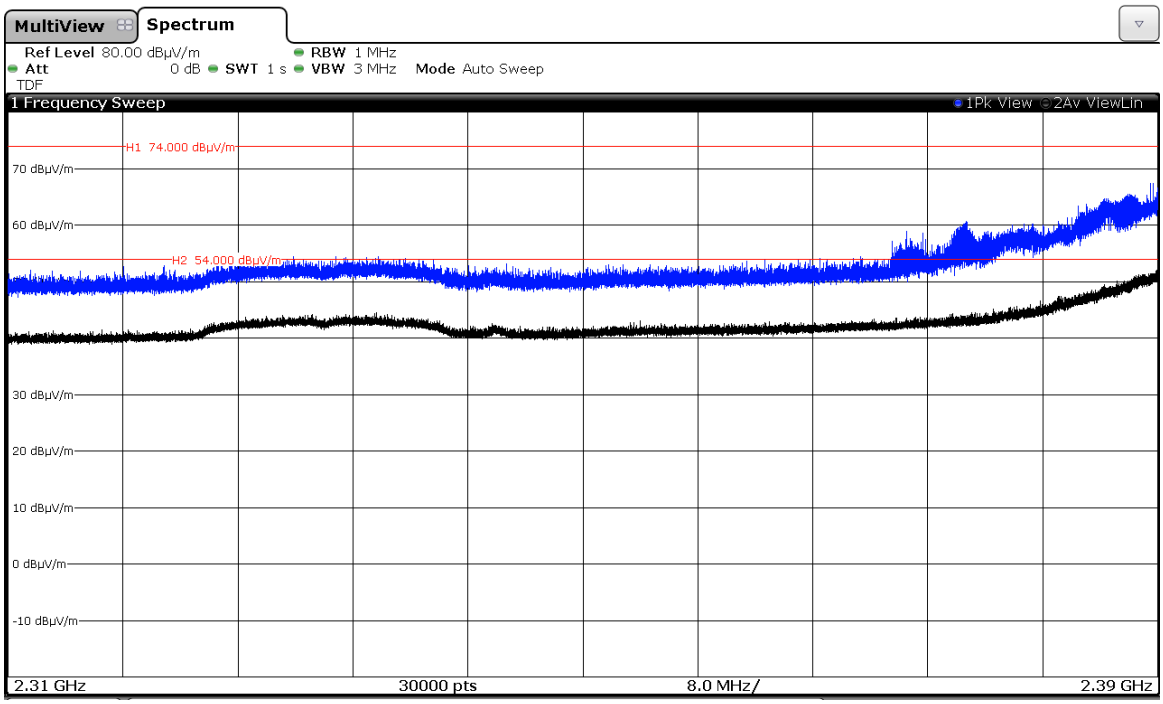
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



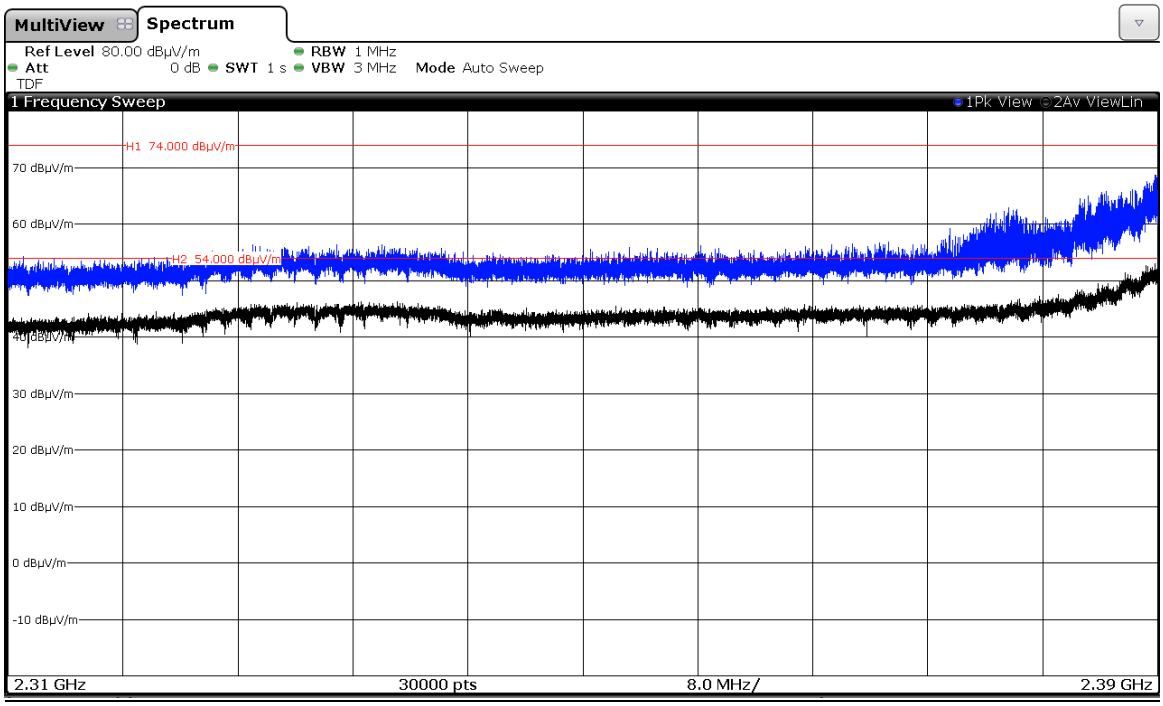
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



3. WiFi 2.4GHz 802.11 n20 mode

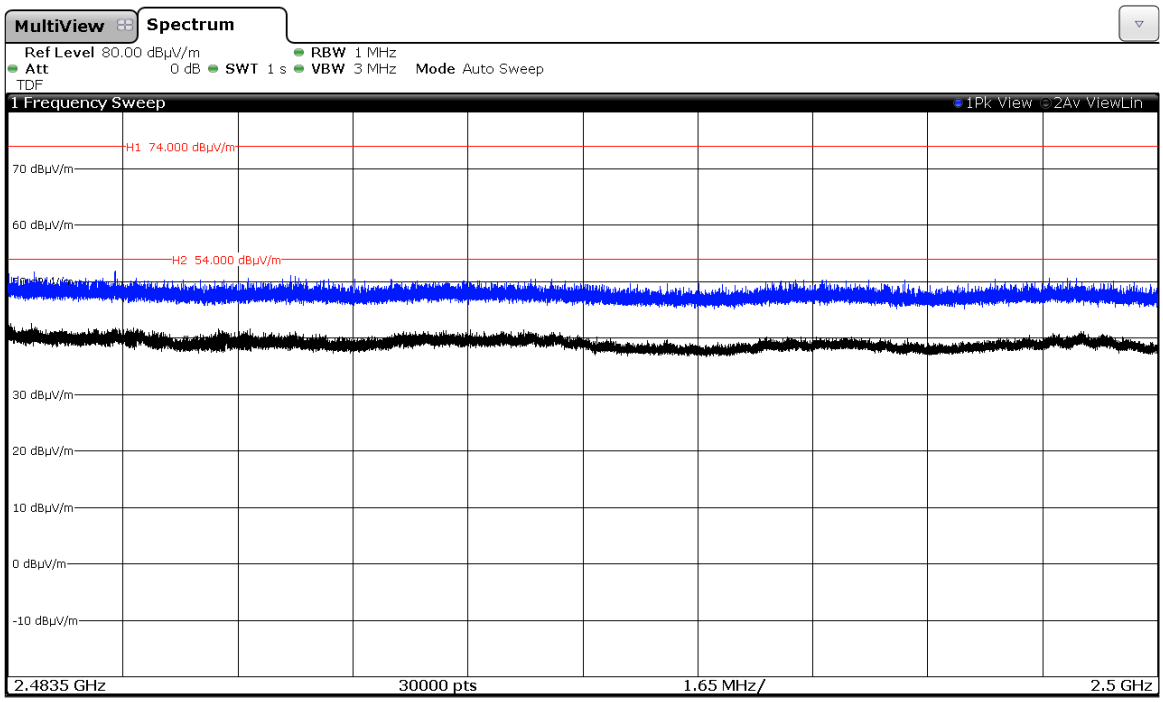
CHANNEL 1 (2412 MHz).



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

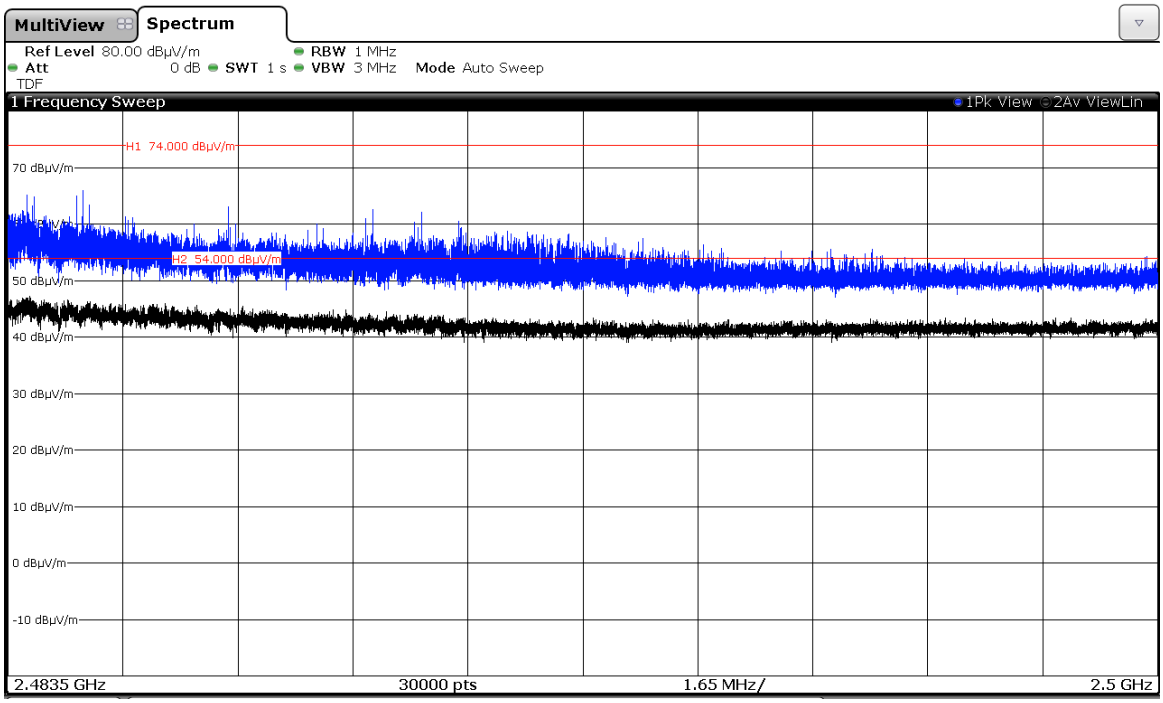
1. WiFi 2.4GHz 802.11 b mode

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).