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

FCC LISTED,
REGISTRATION NUMBER:
720267

Informe de ensayo nº:
Test report No:

NIE: 51746RRF.007

Test report

USA FCC Part 15.247, 15.209

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz. Radiated emission limits; general requirements.

Identificación del objeto ensayado.....: Identification of item tested	Satellite Smartphone
Marca .....: Trade	Bittium
Modelo y/o referencia tipo .....: Model and /or type reference	Mx Rugged B
Other identification of the product .....:	FCC ID: V27SSD-52
HW version .....:	2201
SW version .....:	1.8.31
Características .....: Features	SATELLITE • L-band 1525 – 1660.5 MHz • GMR-1 3G 45.005; Radio Transmission and Reception DL 186kbps, UL 30kbps • GMR-1 3G with internal antenna DL 21kbps, UL 2.6kbps • GMR-1 3G AMBE2+ voice call Other Radios Bluetooth 4.0
Fabricante .....: Manufacturer	BITTIUM WIRELESS LTD. Tutkijantie 8 90590 Oulu, Finland
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. 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: 2017.03.02 17:43:37 +01'00'
Fecha de realización .....: Date of issue	2017-02-23
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 conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

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.

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

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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
51746/027	Satellite Smartphone	Mx Rugged B (SSD-52)	---	2017-01-16
51746/028	Battery	9304576A01	---	2017-01-16
51746/038	Antenna	---	---	2017-01-16

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

   All radiated tests indicated in appendixes A and B.

Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
51746/027	Satellite Smartphone	Mx Rugged E (SSD-53)	---	2017-01-16
51746/020	Dummy battery	DB-6BM proto 0.1	162510006	2017-01-16

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

   All conducted tests indicated in appendixes A and B.

Test sample description

The Rugged B is a satellite phone targeted for professional Public Safety use.

Identification of the client

Bittium Wireless Ltd.

Tutkijantie 8 90590 Oulu, Finland

Testing period

The performed test started on 2017-01-19 and finished on 2017-02-03.

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: Conducted RF measurements were performed with model Mx Rugged E which has the same BT radio module as model Mx Rugged B.

2: 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
3.	Bluetooth Signalling unit ANRITSU MT8852B	N.A.	N.A.

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	2016/11	2019/11
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	2016/04	2017/04
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
11.	Bluetooth Signalling unit ANRITSU MT8852B	N.A.	N.A.

Testing verdicts

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

1.- BTEDR

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.- BTLE

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 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_{nom} = 4.2 Vdc

V_{max} = N/A

V_{min} = N/A

The subscripts nom, min and max indicate voltage test conditions (nominal, minimum and maximum respectively, as declared by the applicant).

Type of power supply = DC Voltage from rechargeable battery

Type of antenna = PIFA antenna 2400-2500MHz (-0.3dBi).

TEST FREQUENCIES:

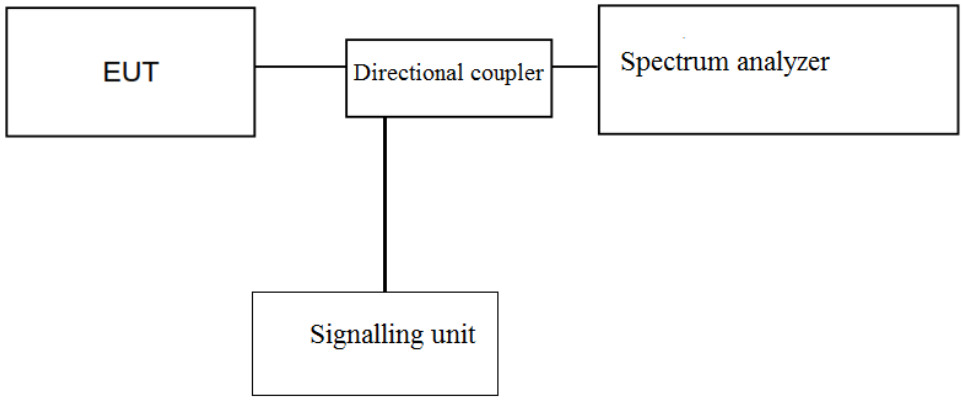
Lowest channel: 2402 MHz

Middle channel: 2441 MHz

Highest channel: 2480 MHz

CONDUCTED MEASUREMENTS

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



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

RADIATED MEASUREMENTS

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

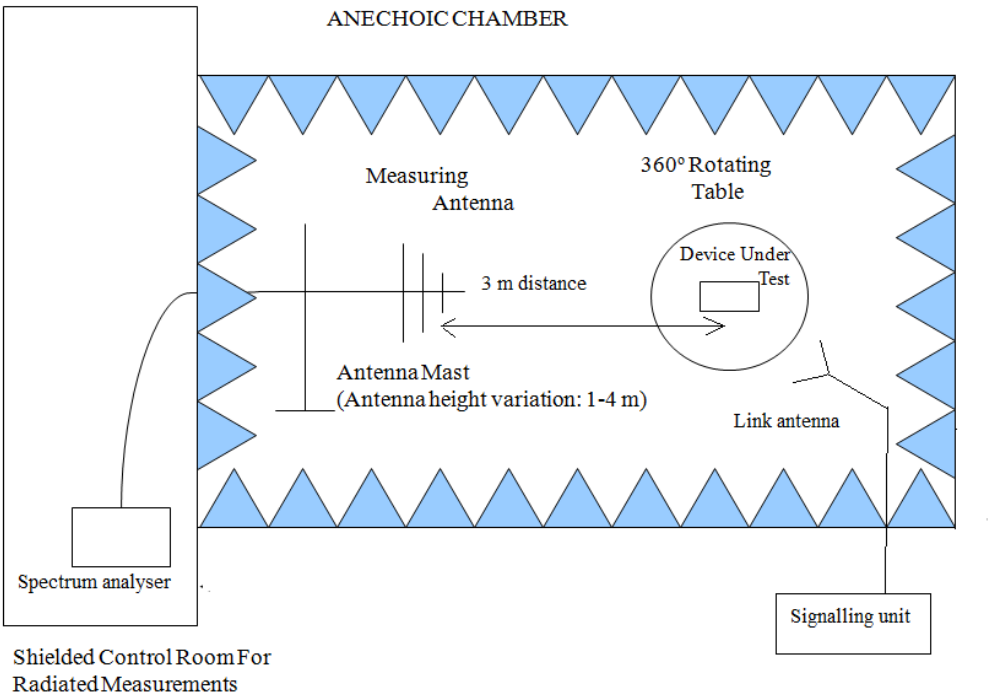
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform 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.

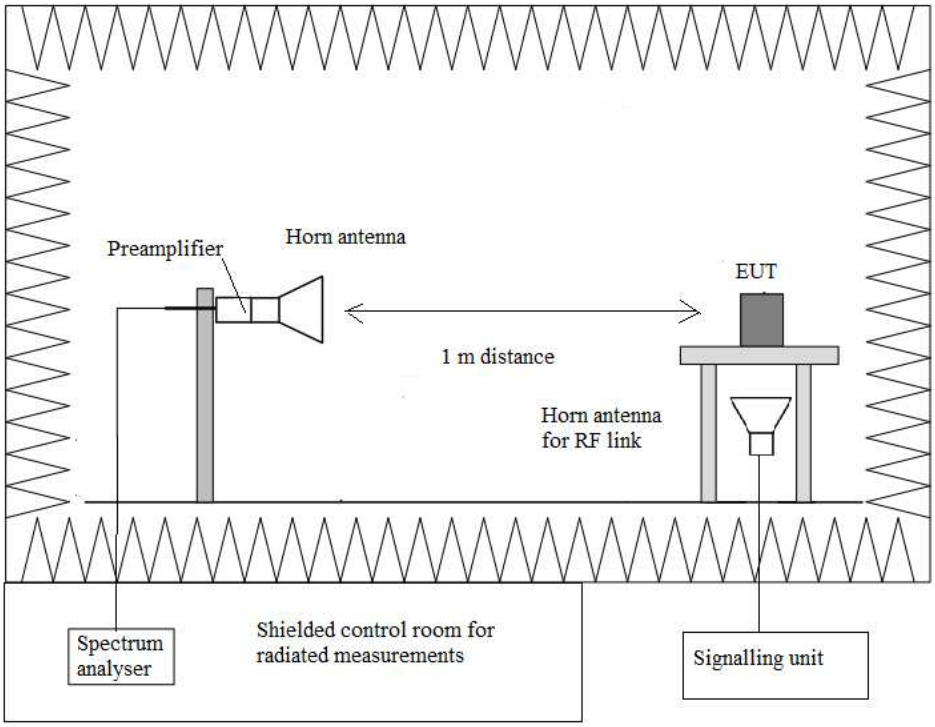
Measurements were made in both horizontal and vertical planes of polarization.

An additional horn antenna is used to control the equipment under test with the Bluetooth signalling unit (Bluetooth test set).

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)	1016	1012	942.6
Measurement uncertainty (kHz)	<±5.00		

Modulation: Π/4-DQPSK (2Mbps)

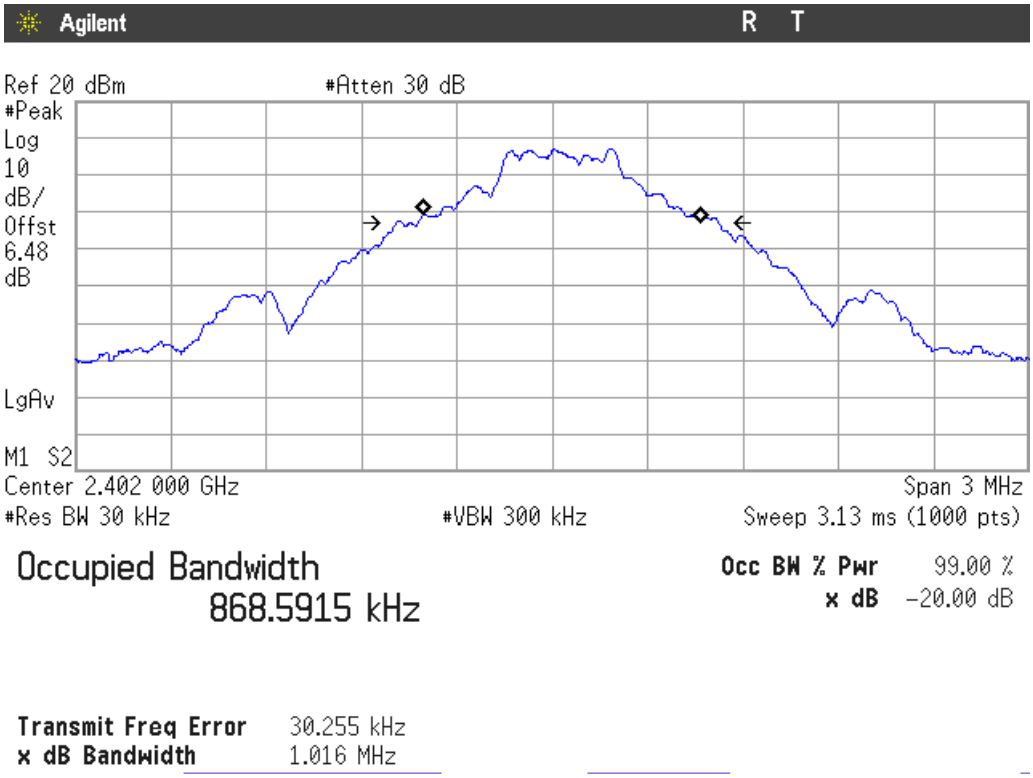
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1313	1315	1313
Measurement uncertainty (kHz)	<±5.00		

Modulation: 8-DPSK (3Mbps)

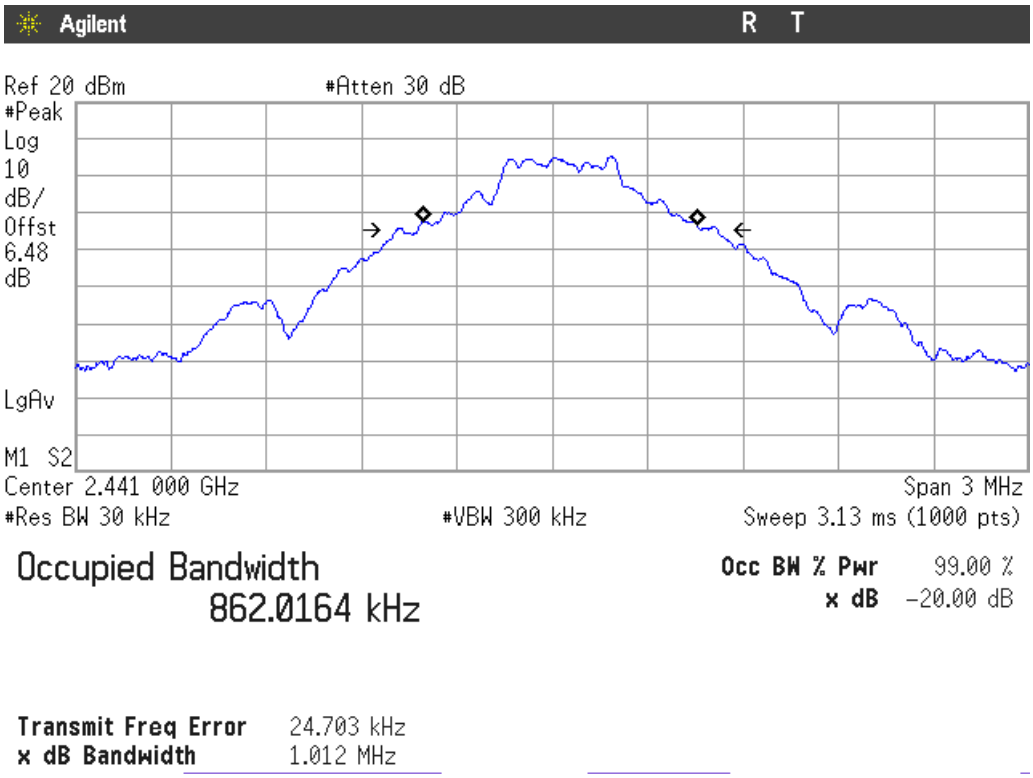
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1295	1296	1299
Measurement uncertainty (kHz)	<±5.00		

Modulation: GFSK

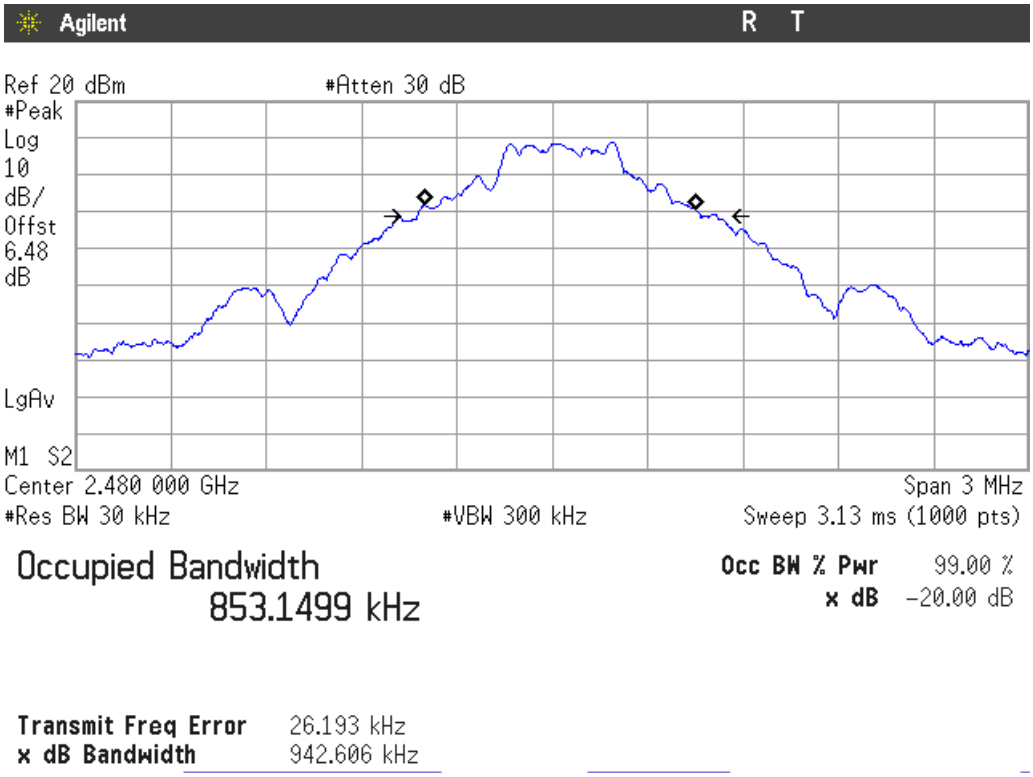
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



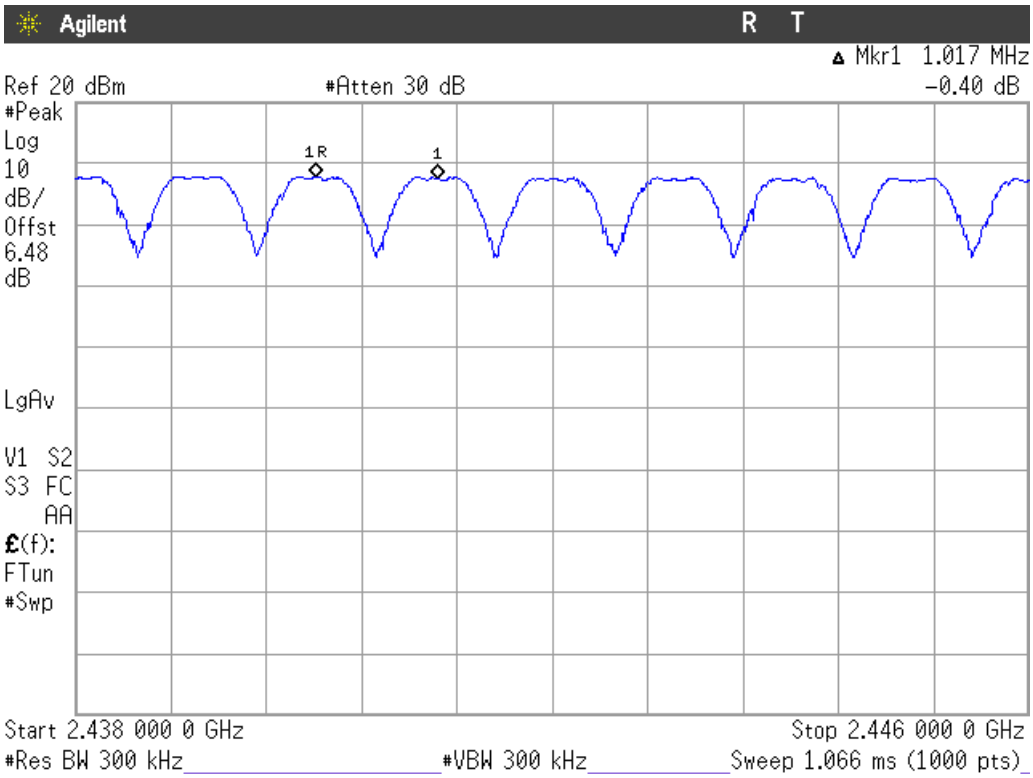
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation

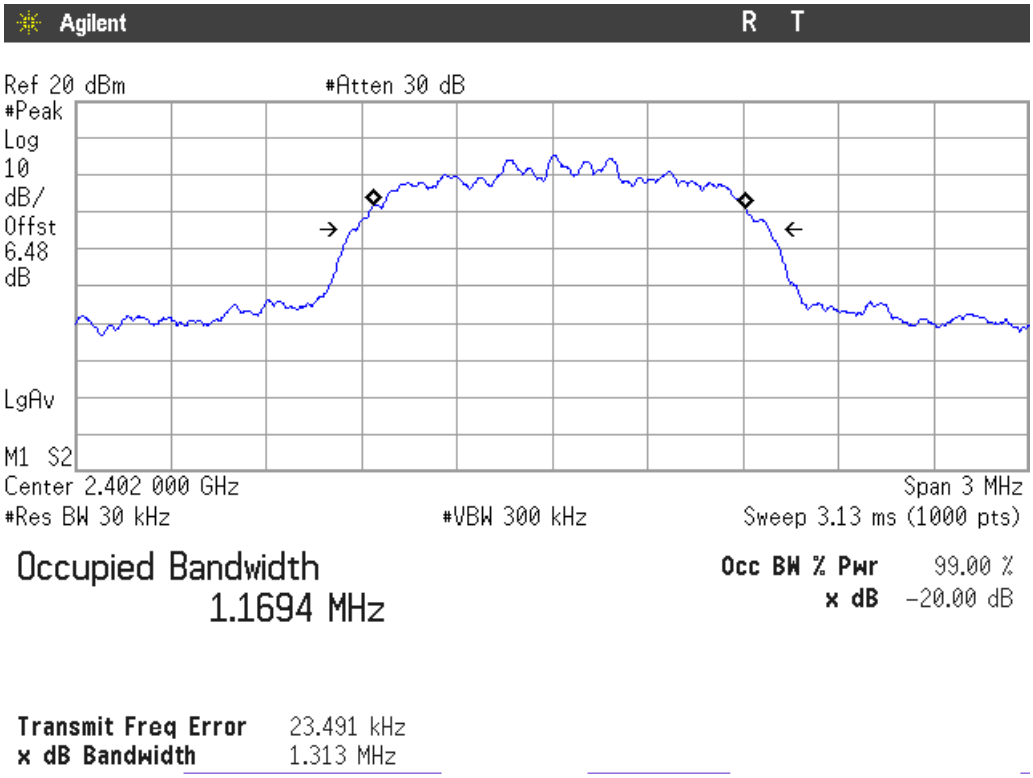


The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel.

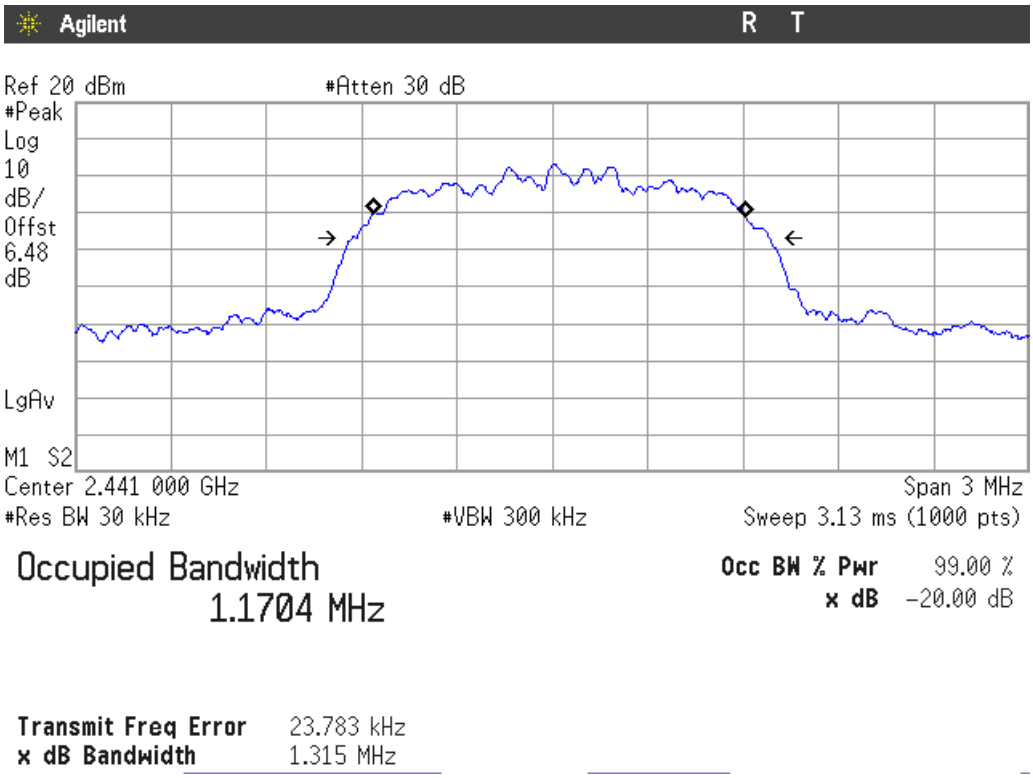
Verdict: PASS

Modulation: II/4-DQPSK

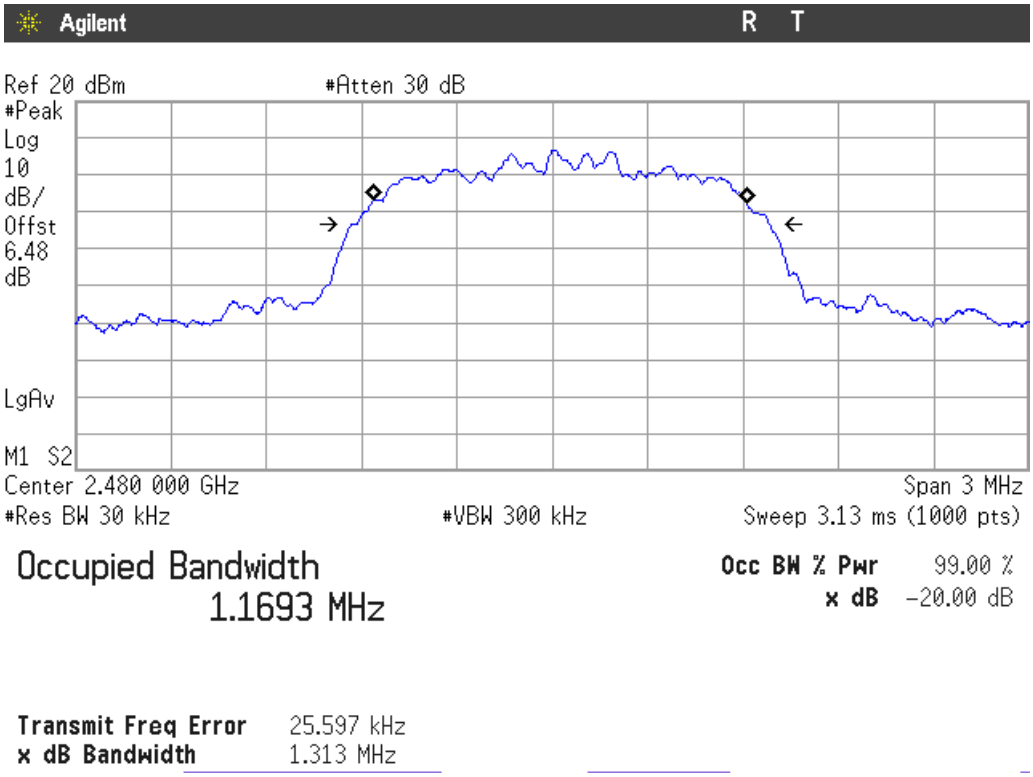
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



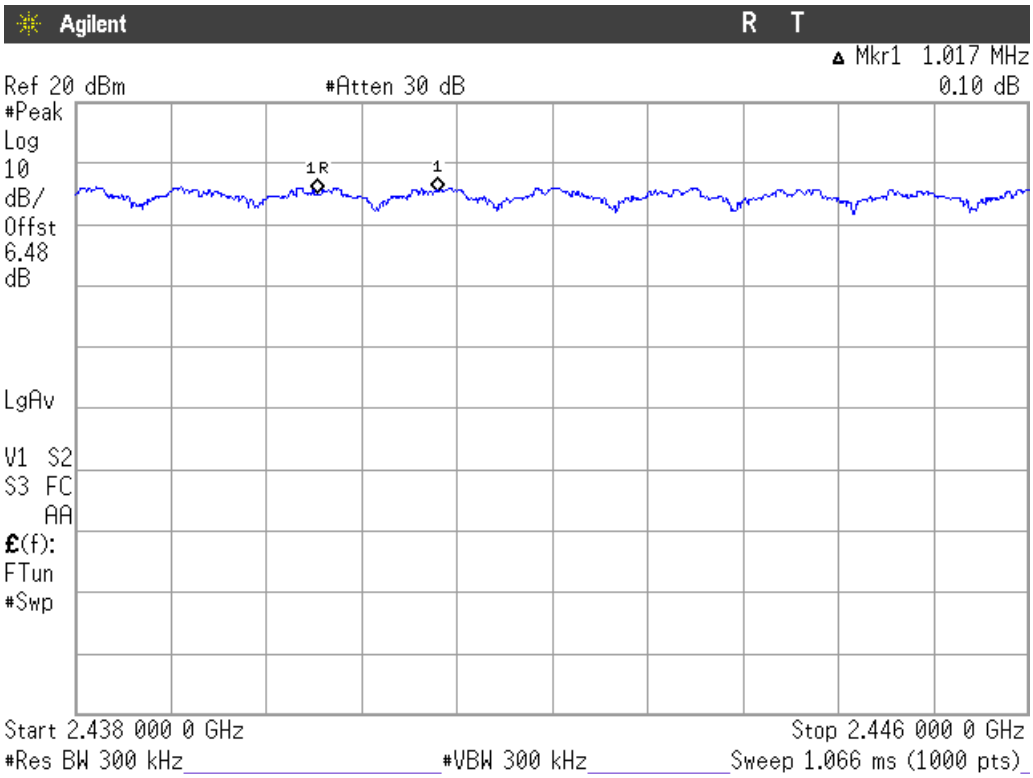
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation

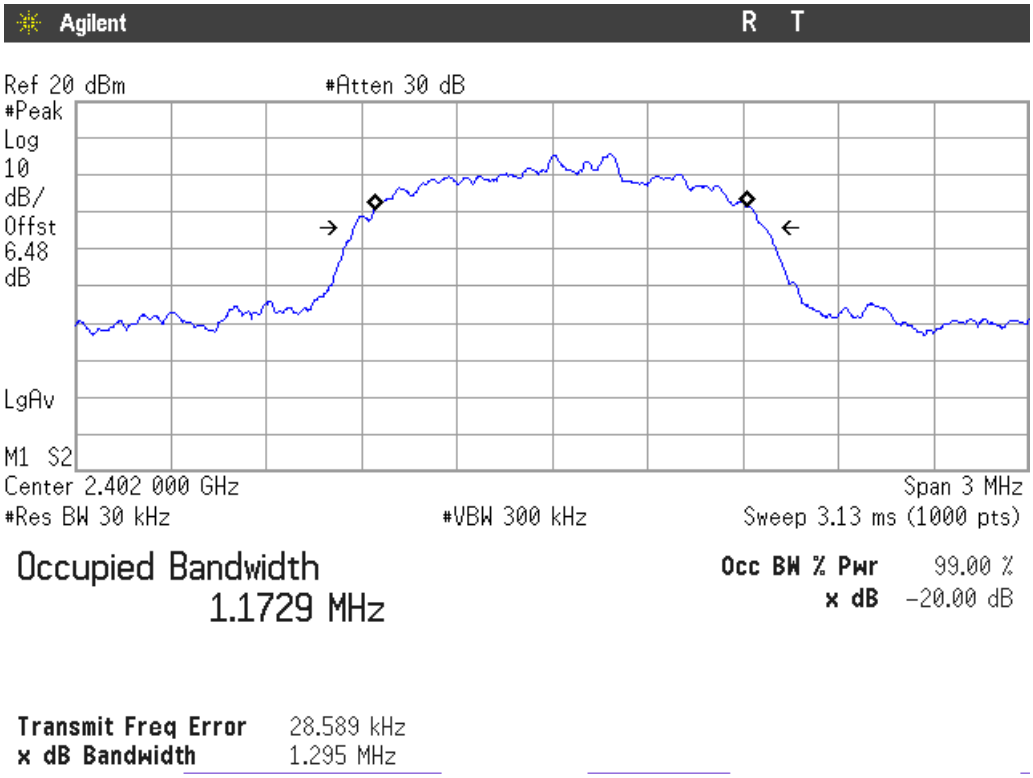


The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel

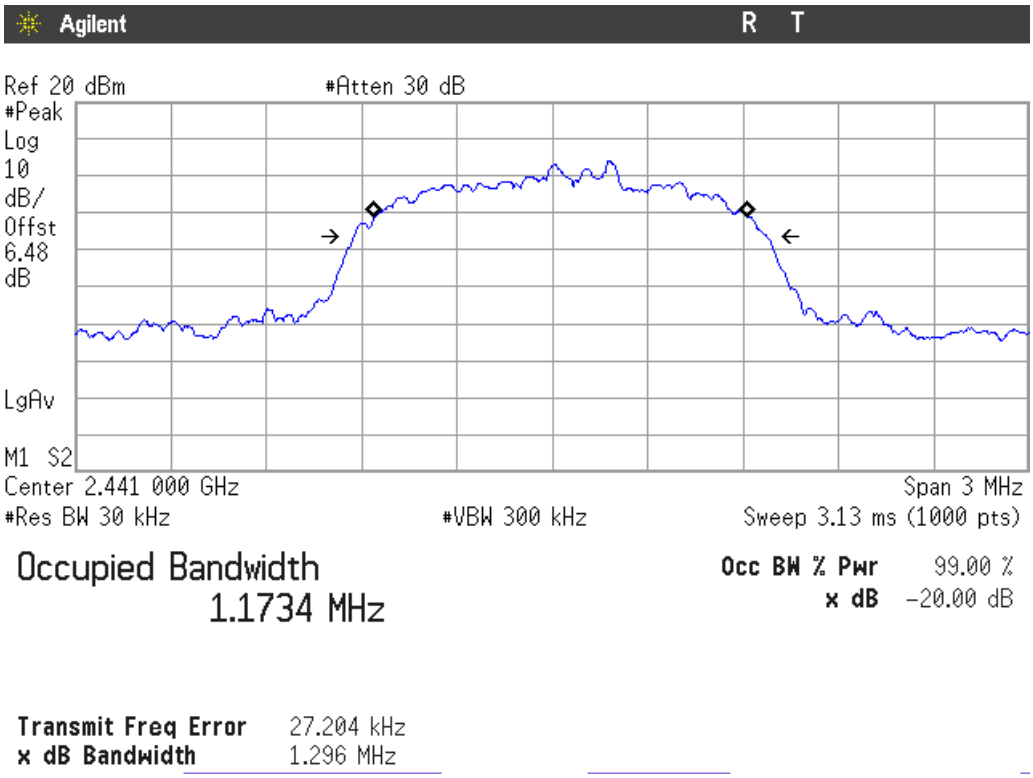
Verdict: PASS

Modulation: 8-DPSK

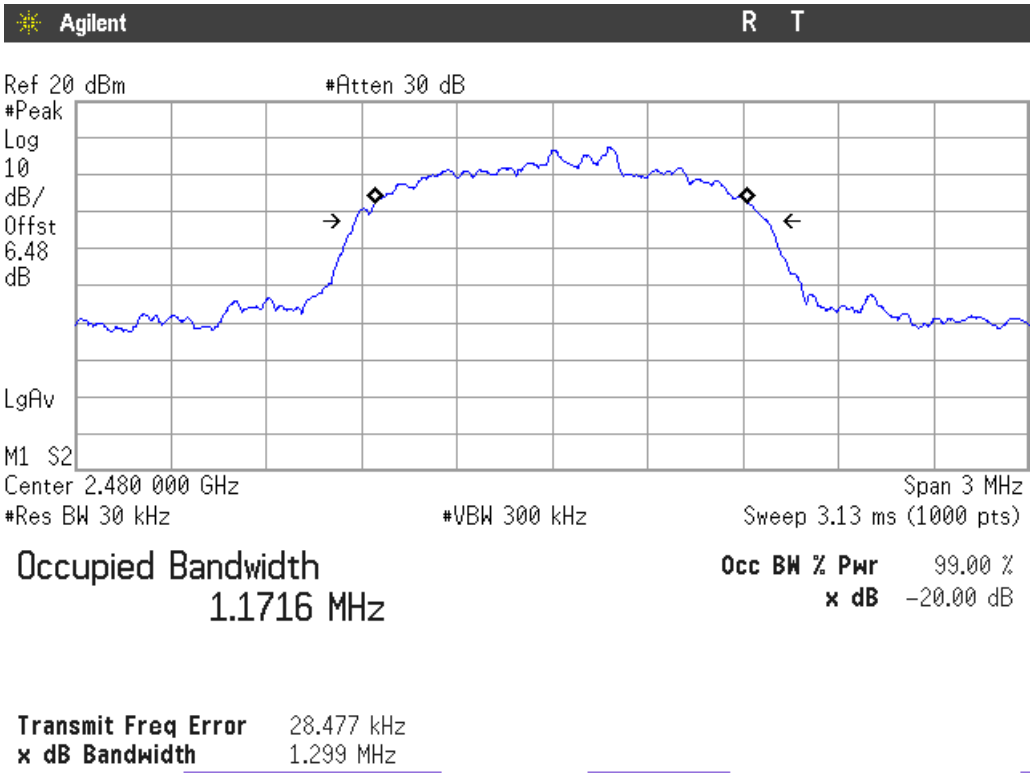
20 dB BANDWIDTH Lowest Channel: 2402 MHz.



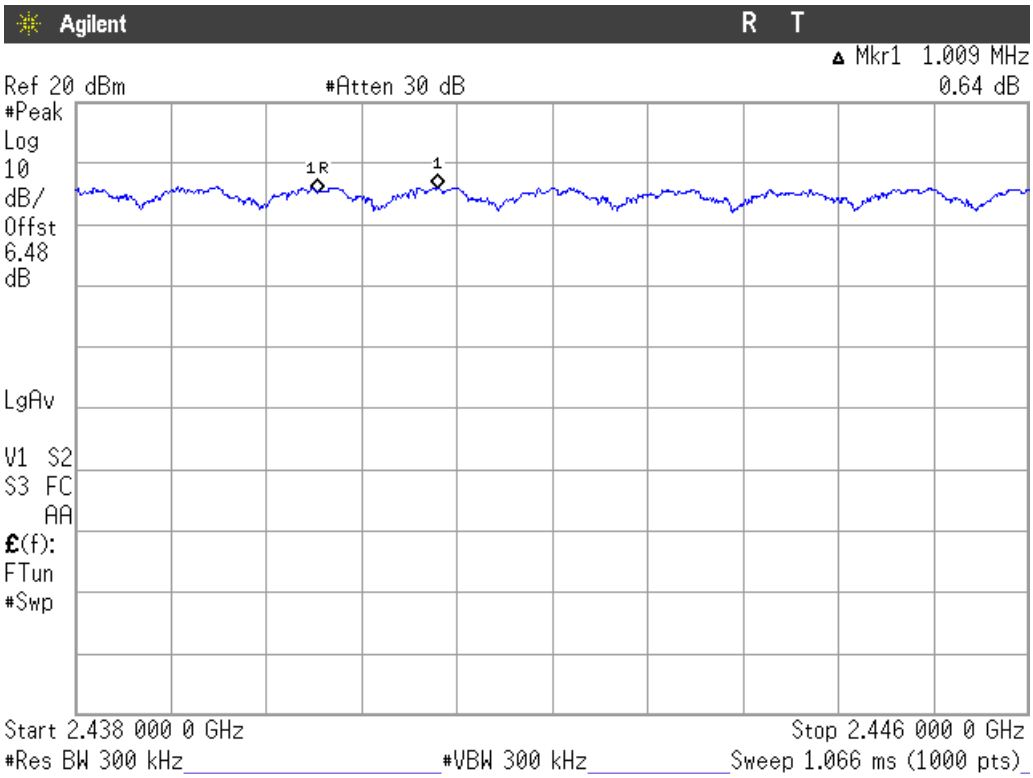
20 dB BANDWIDTH Middle Channel: 2441 MHz.



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

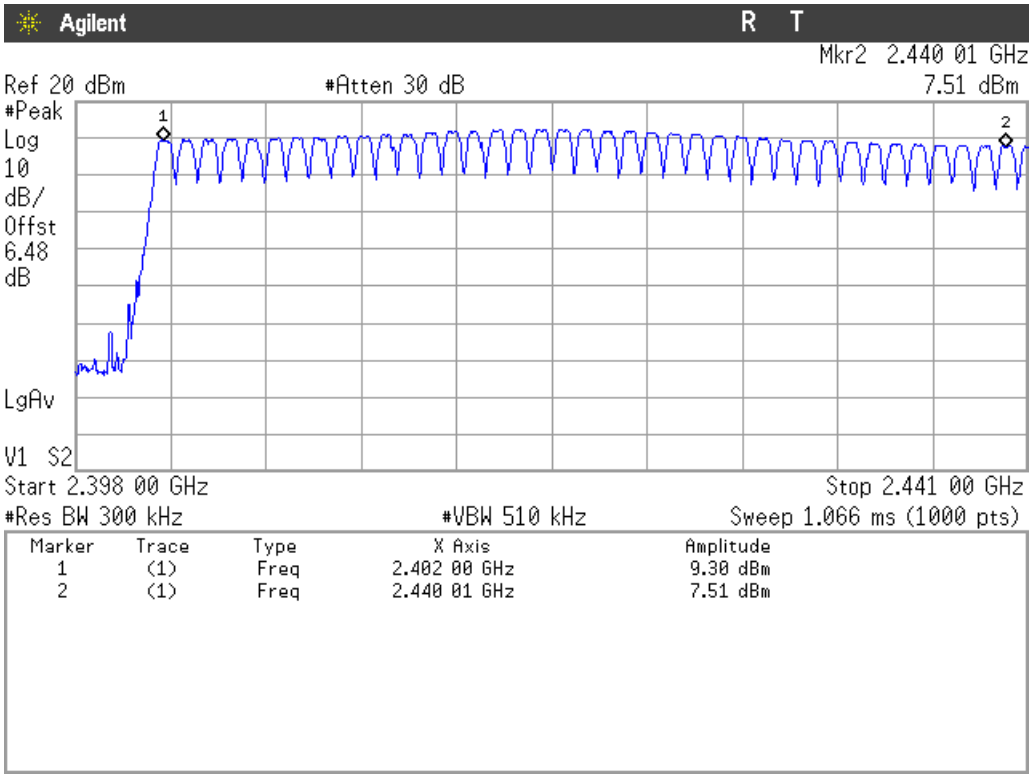
SPECIFICATION

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

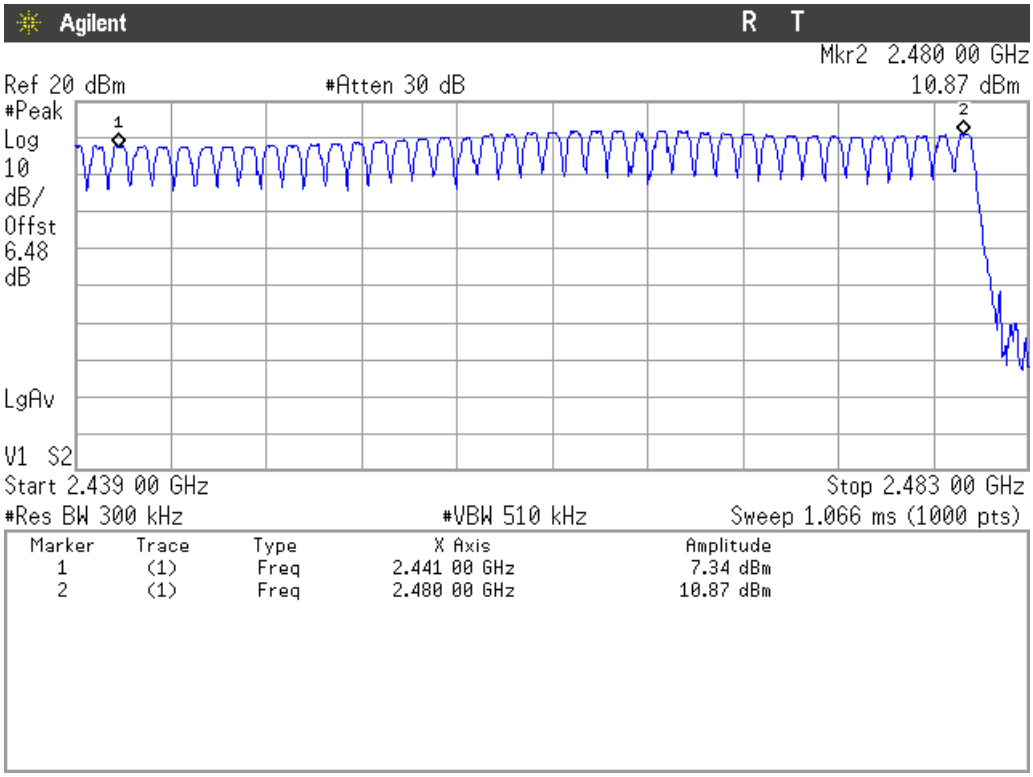
RESULTS

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

Modulation: GFSK



Number of hopping frequencies: 39

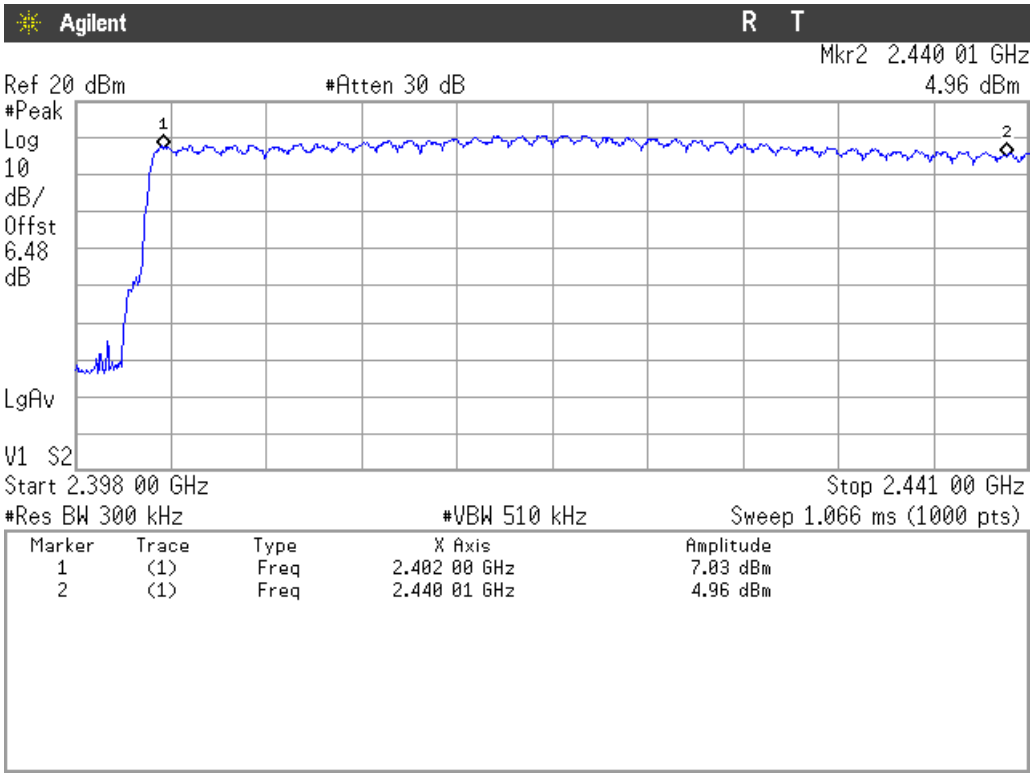


Number of hopping frequencies: 40

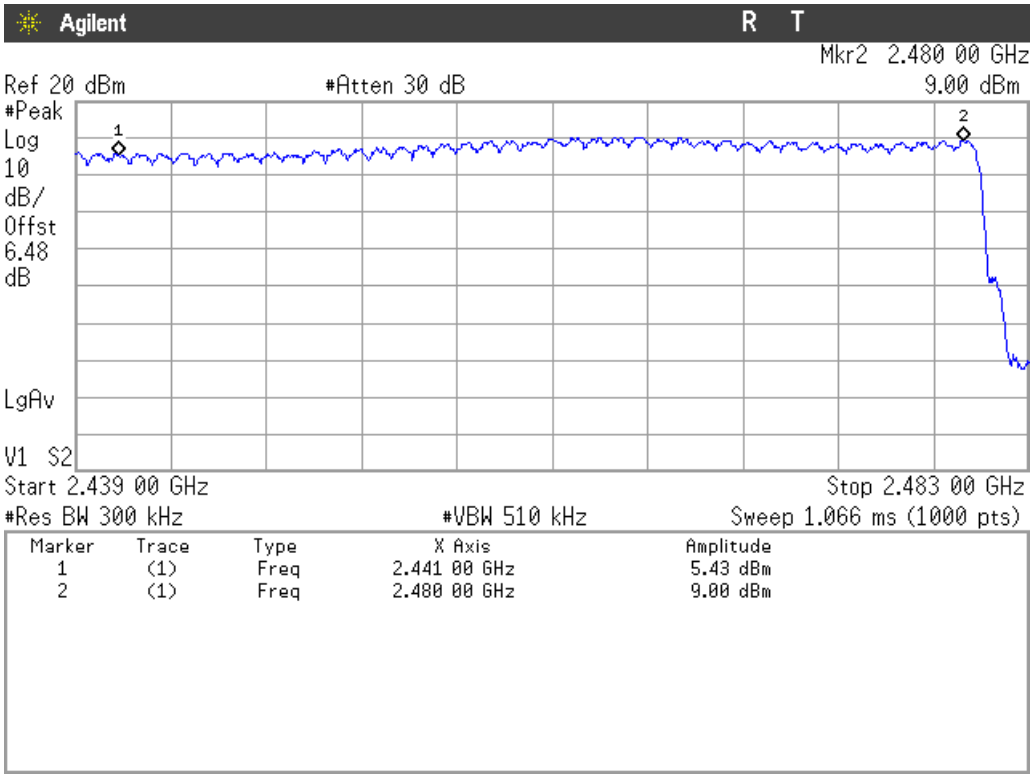
Total number of hopping frequencies: 79

Verdict: PASS

Modulation: Π/4-DQPSK



Number of hopping frequencies: 39

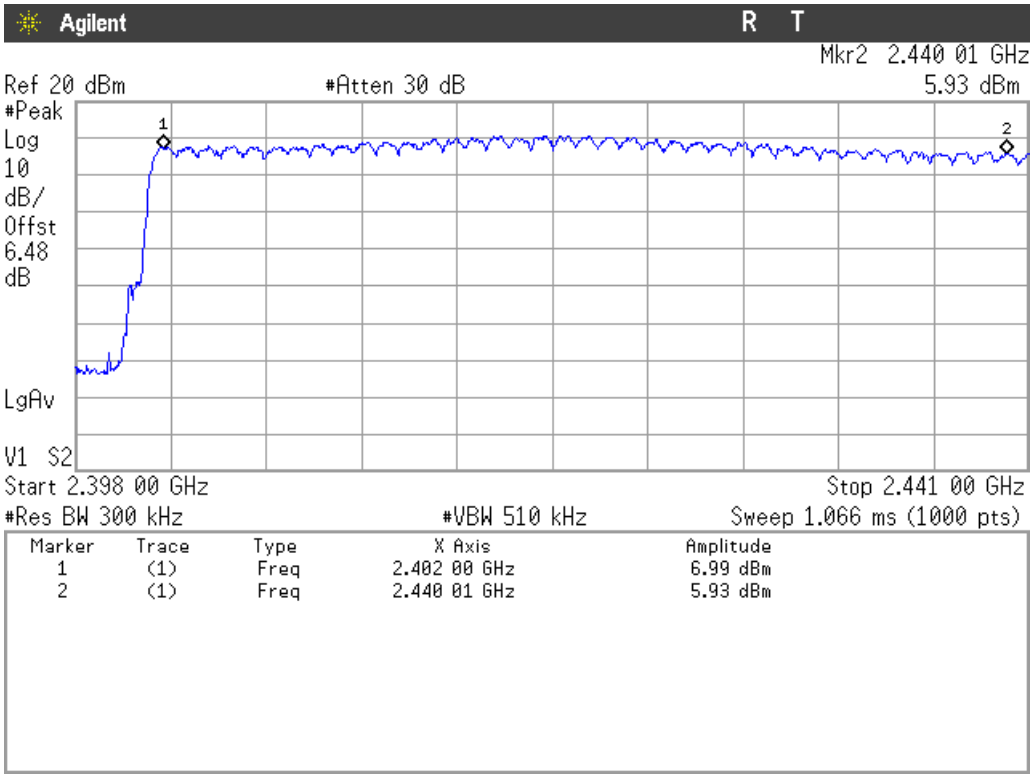


Number of hopping frequencies: 40

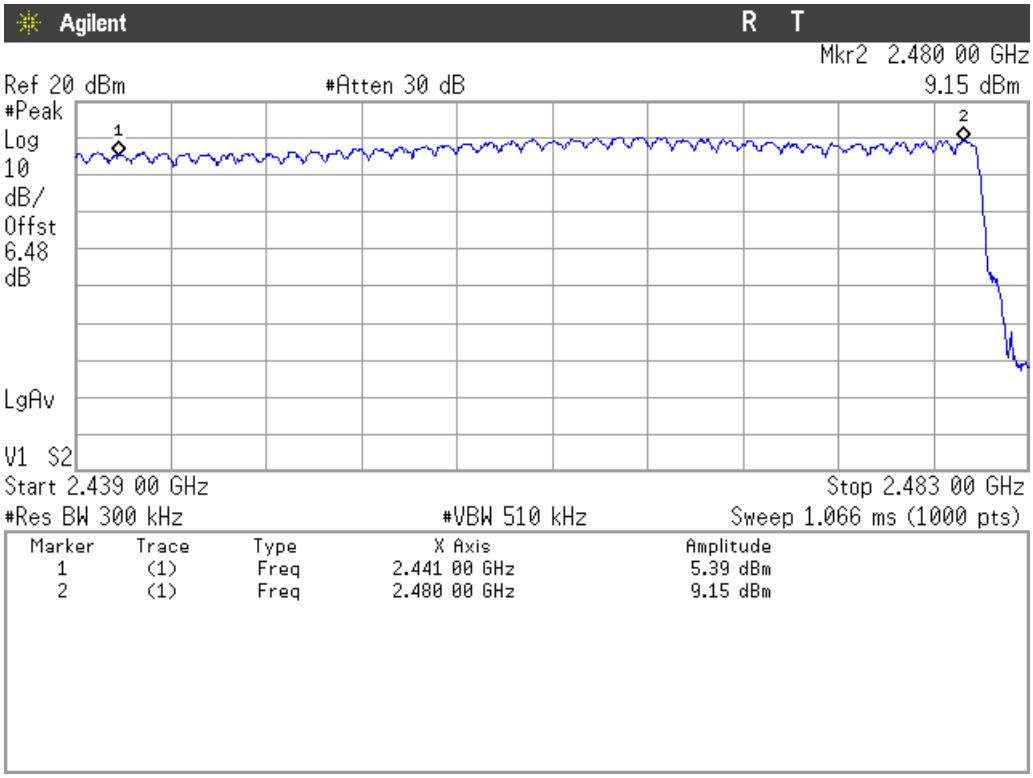
Total number of hopping frequencies: 79

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

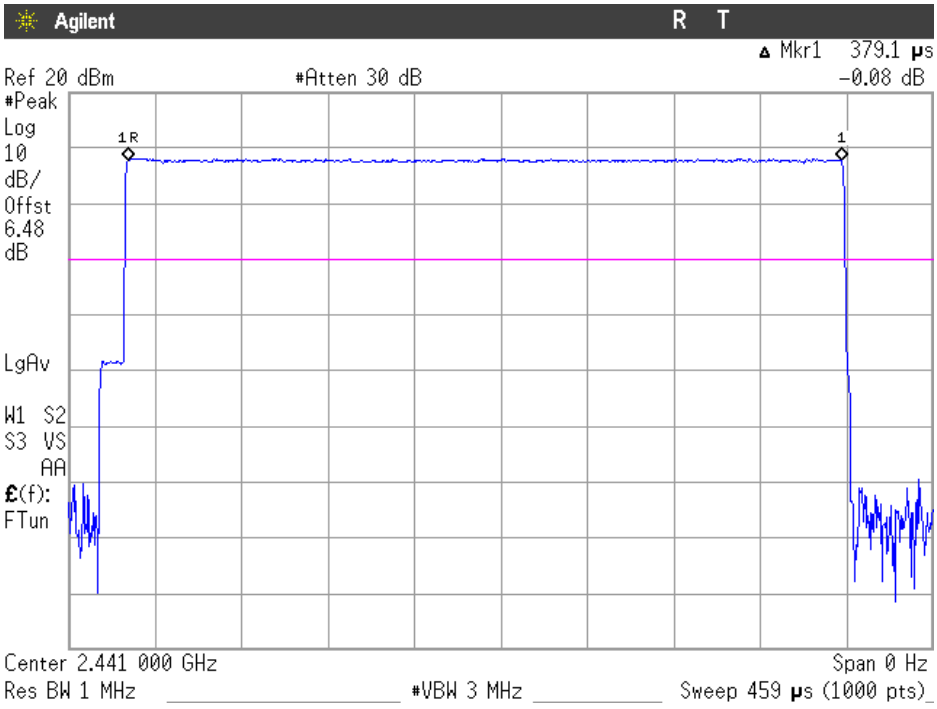
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = 0.4 x 79= 31.6 seconds.

RESULTS

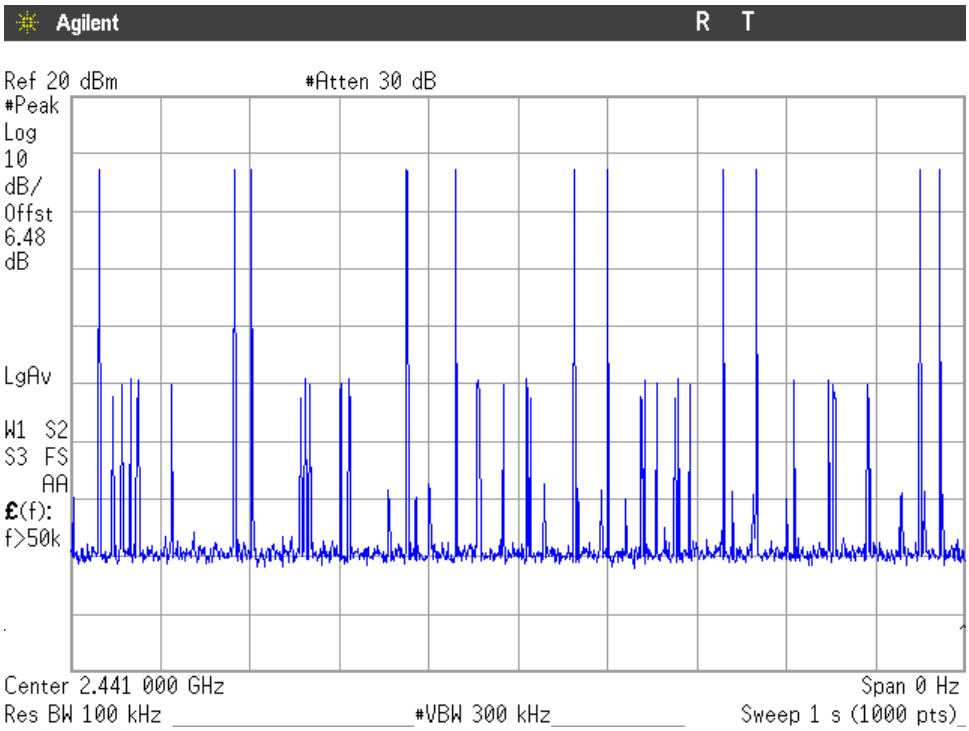
Modulation: GFSK

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

- Tx- time per hop = 379.1 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 = (11 hops) x (31.6 s / 1 s) = 347.6 hops.

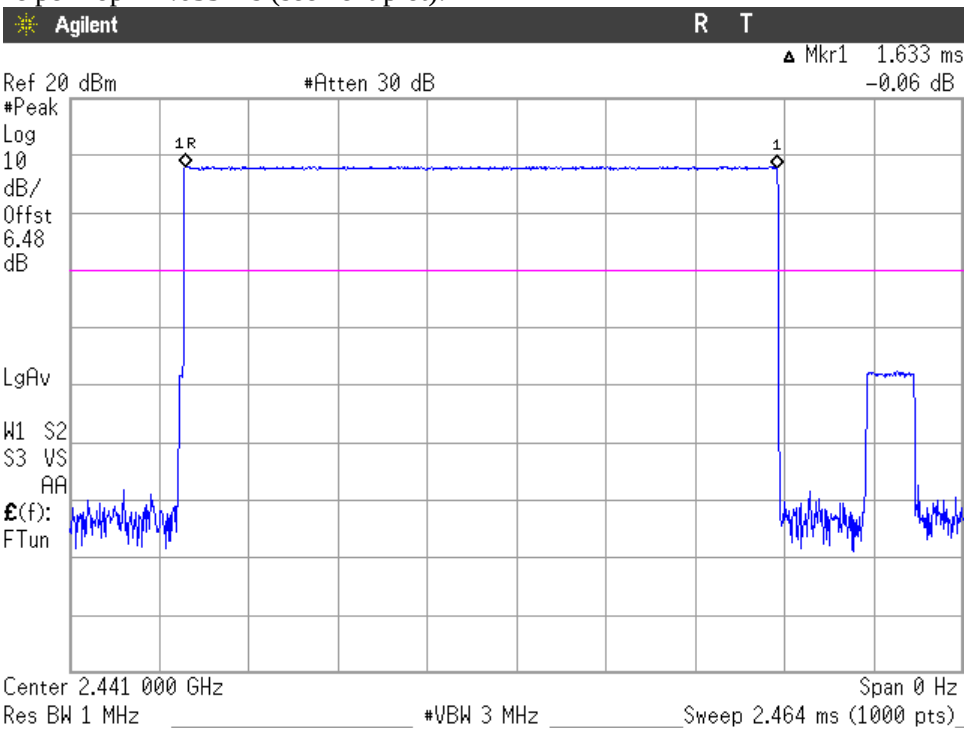
Averaging time of occupancy = 379.1 µs x 347.6 hops = 131.77 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

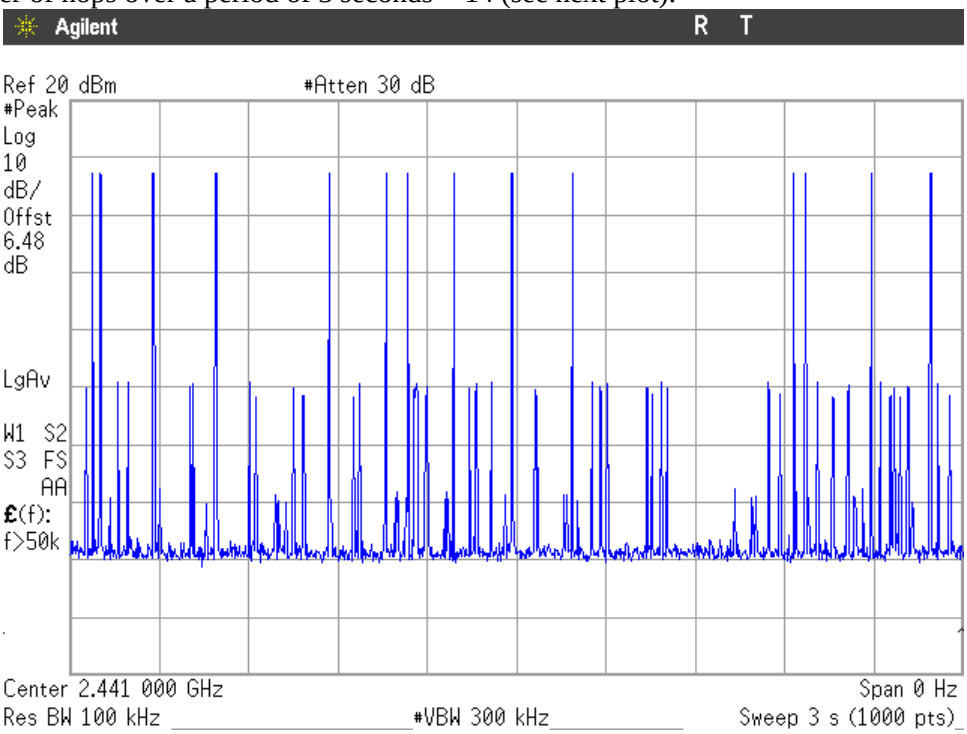
Verdict: PASS

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

- Tx- time per hop = 1.633 ms (see next plot).



- Number of hops over a period of 3 seconds = 14 (see next plot).



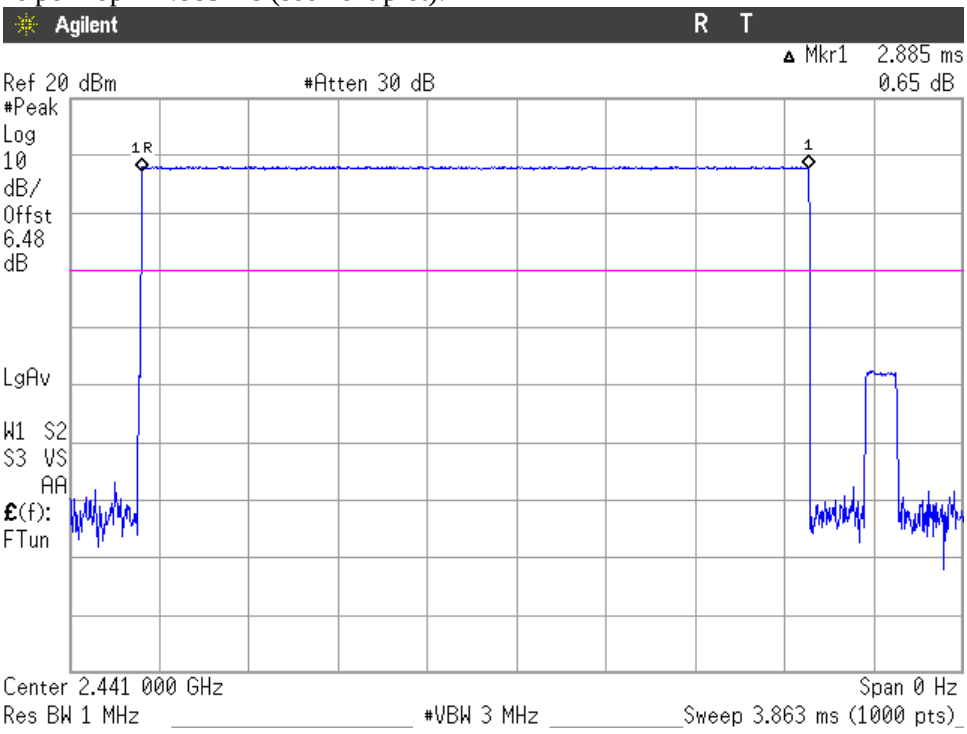
Number of hops in the period specified in the requirements = (14 hops) x (31.6 s / 3 s) = 147.46 hops.
Averaging time of occupancy = 1.633 ms x 147.46 hops = 240.81 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

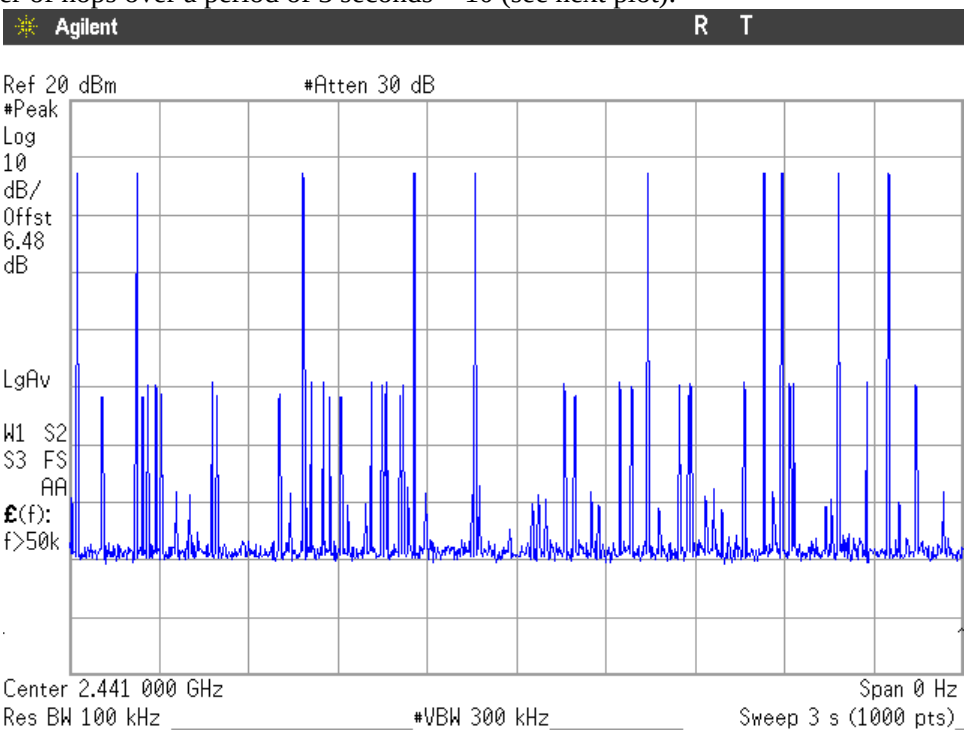
Verdict: PASS

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 3 seconds = 10 (see next plot).



Number of hops in the period specified in the requirements = (10 hops) x (31.6 s / 3 s) = 105.33 hops.
Averaging time of occupancy = 2.885 ms x 105.33 hops = 308.88 ms per 31.6 seconds.

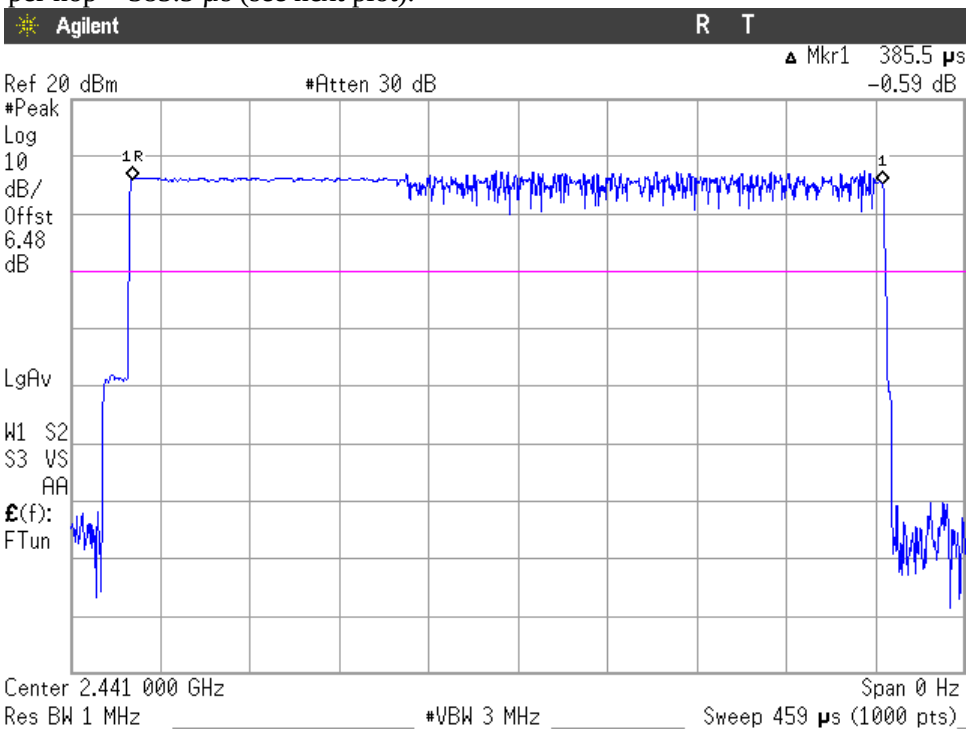
Measurement uncertainty (%)	<±0.01

Verdict: PASS

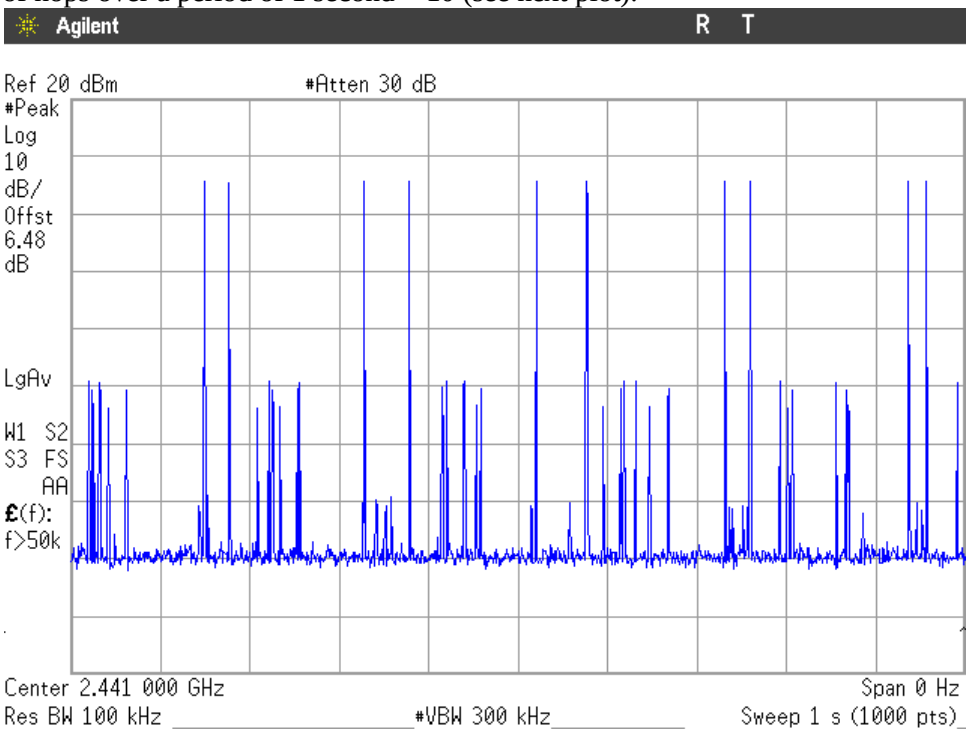
Modulation: Π/4-DQPSK

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

- Tx- time per hop = 385.5 µs (see next plot).



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



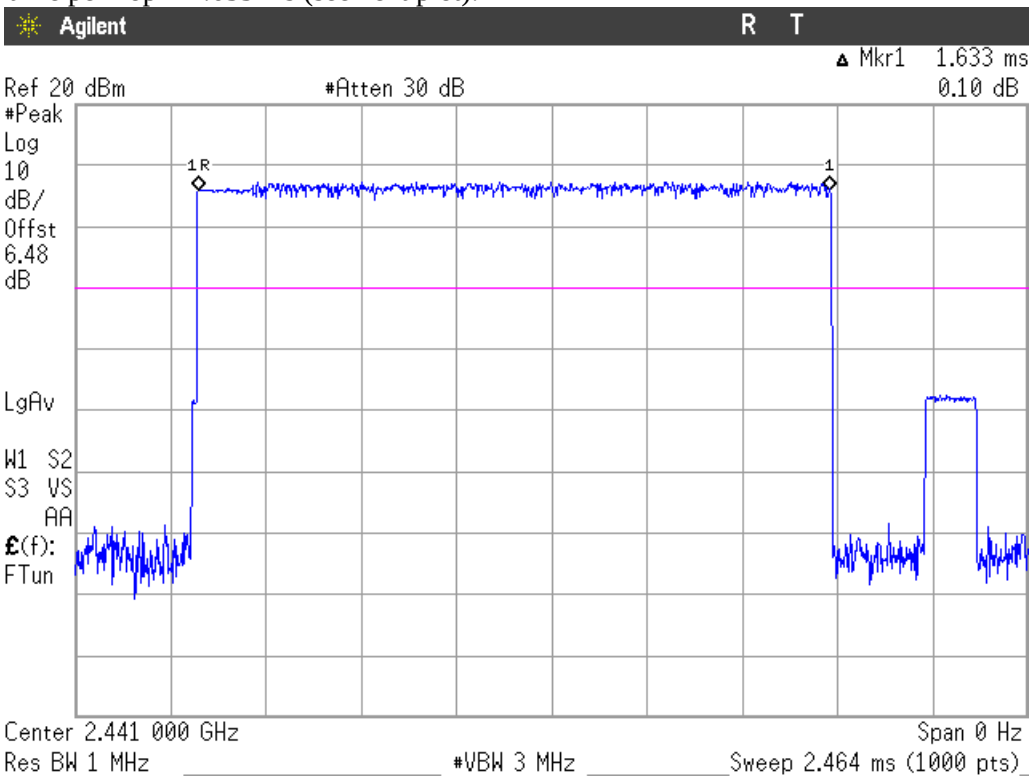
Number of hops in the period specified in the requirements = (10 hops) x (31.6 s / 1 s) = 316 hops.
Averaging time of occupancy = 385.5 µs x 316 hops = 121.82 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

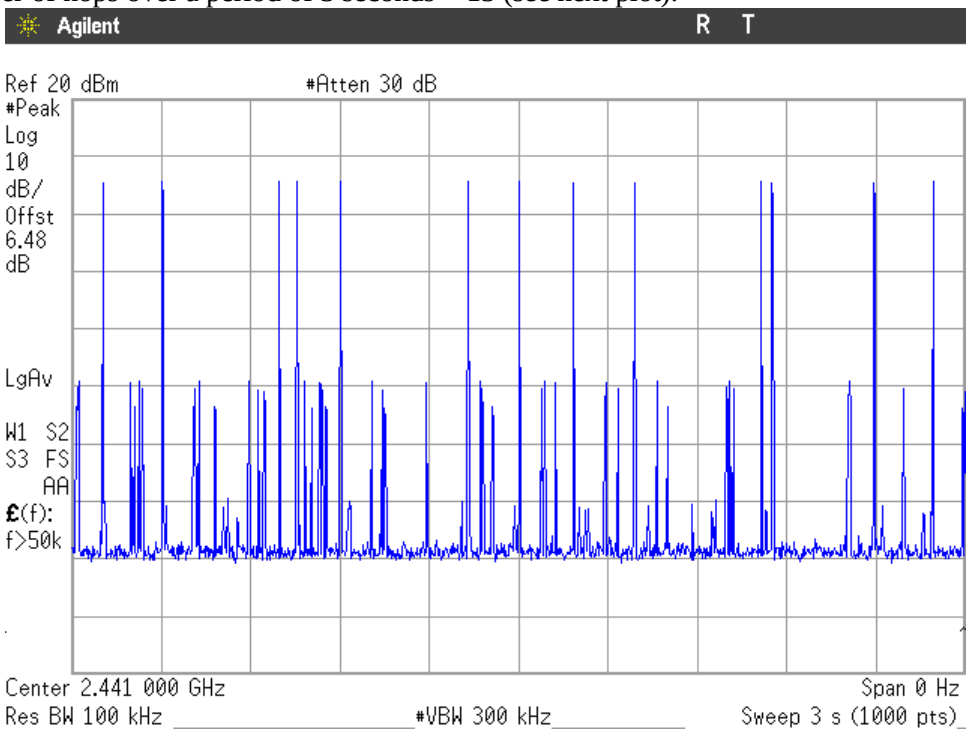
Verdict: PASS

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

- Tx- time per hop = 1.633 ms (see next plot).



- Number of hops over a period of 3 seconds = 13 (see next plot).



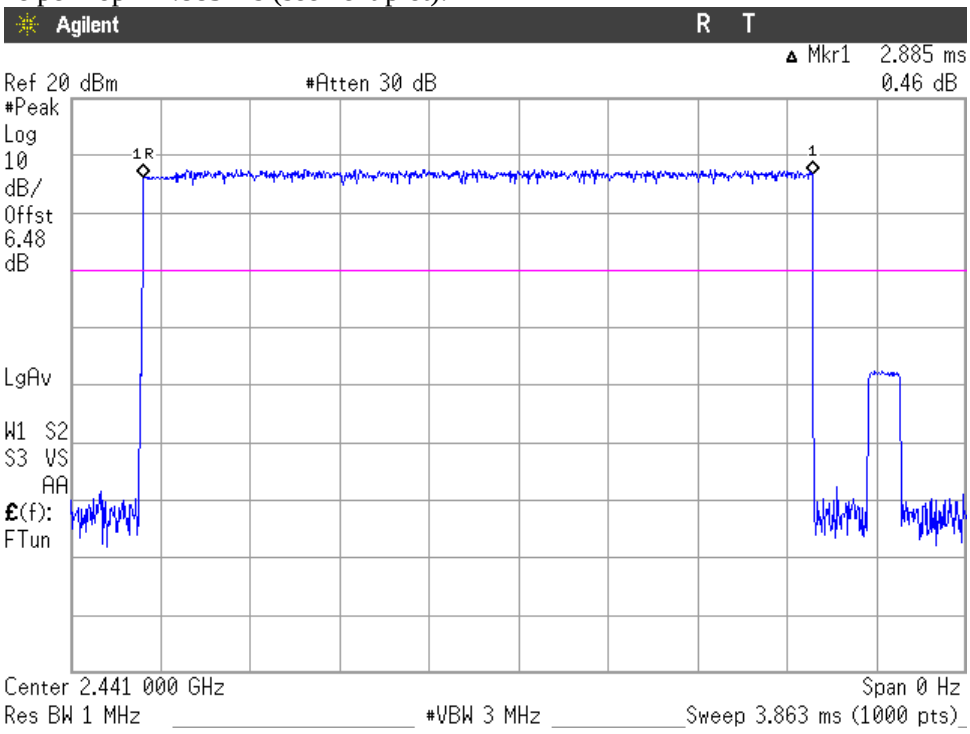
Number of hops in the period specified in the requirements = (13 hops) x (31.6 s / 3 s) = 136.93 hops.
Averaging time of occupancy = 1.633 ms x 136.93 hops = 223.61 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

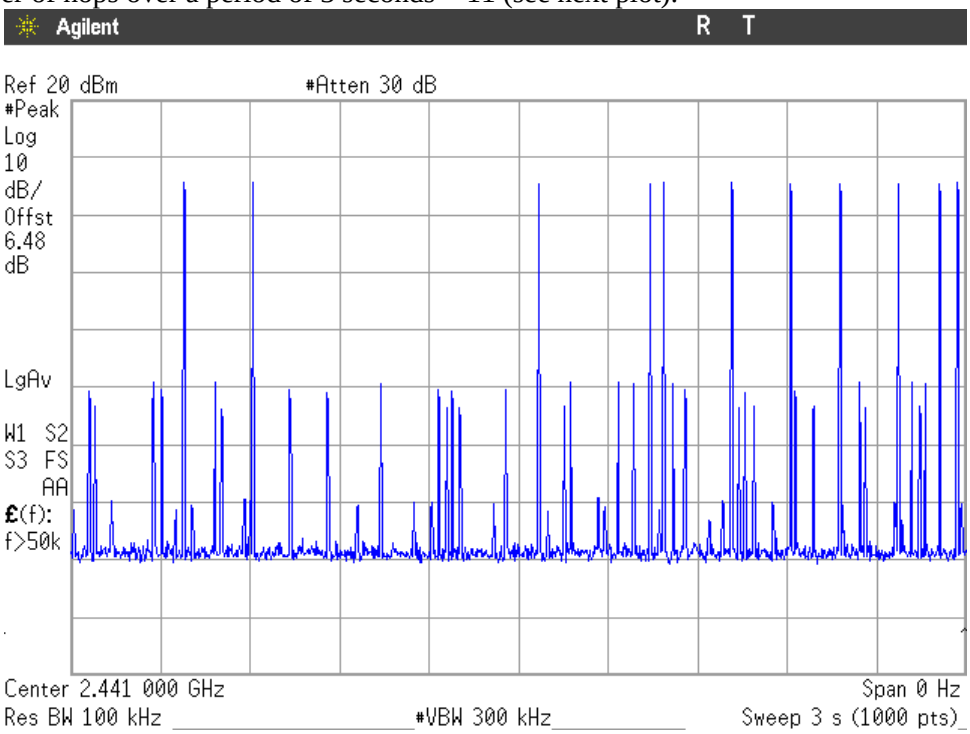
Verdict: PASS

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

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



- Number of hops over a period of 3 seconds = 11 (see next plot).



Number of hops in the period specified in the requirements = (11 hops) x (31.6 s / 3 s) = 115.86 hops.
Averaging time of occupancy = 2.885 ms x 115.86 hops = 334.28 ms per 31.6 seconds.

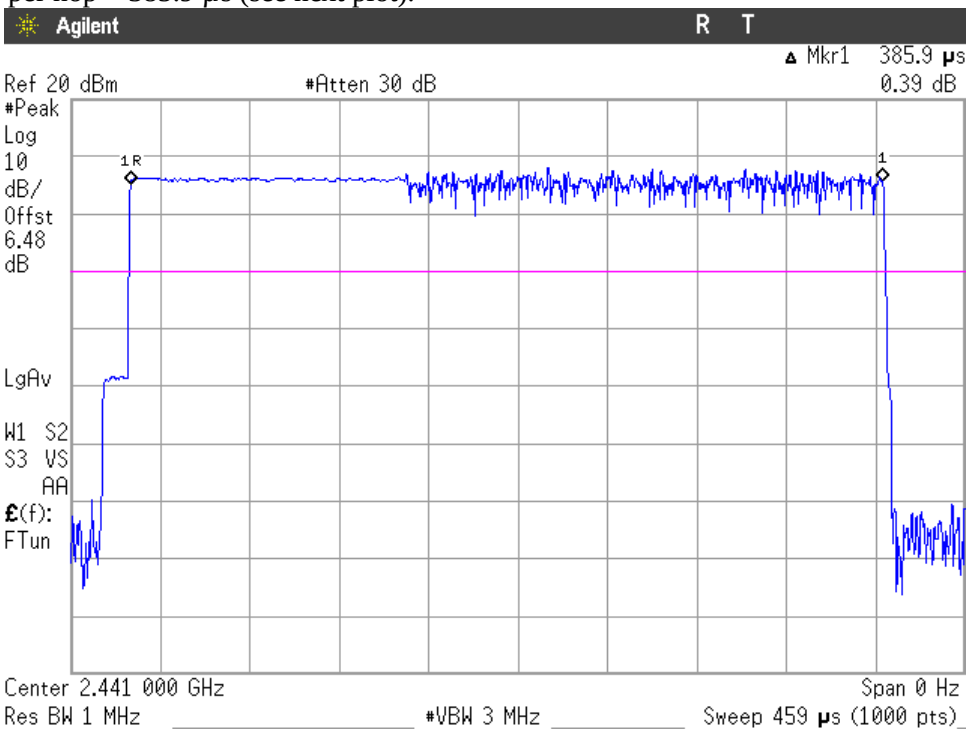
Measurement uncertainty (%)	<±0.01

Verdict: PASS

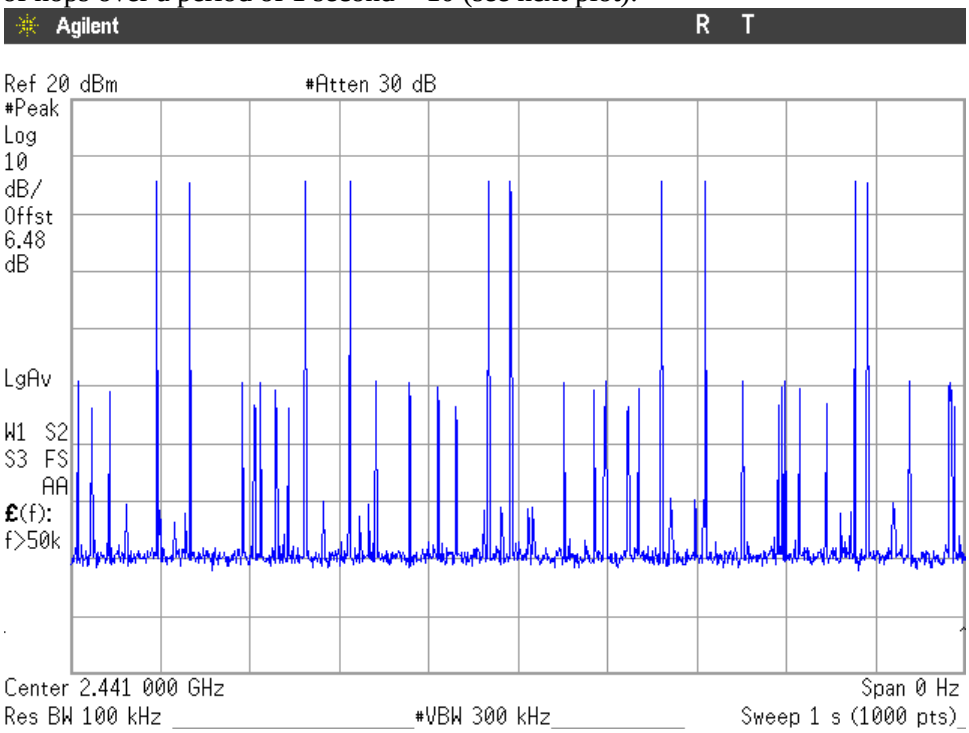
Modulation: 8-DPSK

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

- Tx- time per hop = 385.9 µs (see next plot).



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



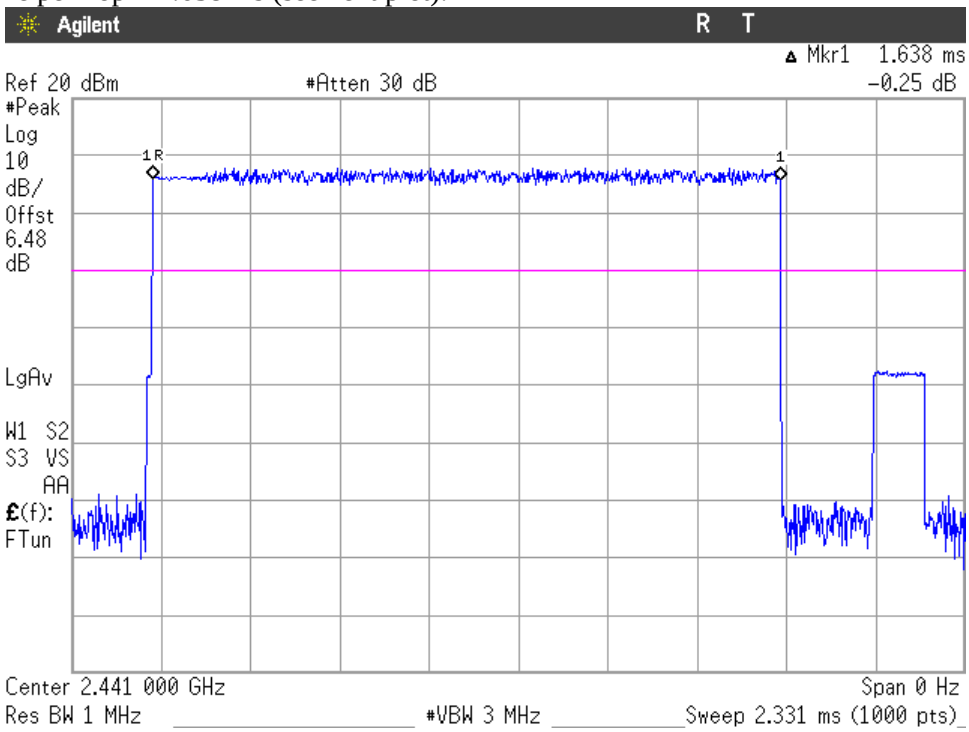
Number of hops in the period specified in the requirements = (10 hops) x (31.6 s / 1 s) =316 hops.
Averaging time of occupancy = 385.9 µs x 316 hops = 121.94 ms per seconds.

Measurement uncertainty (%)	<±0.01

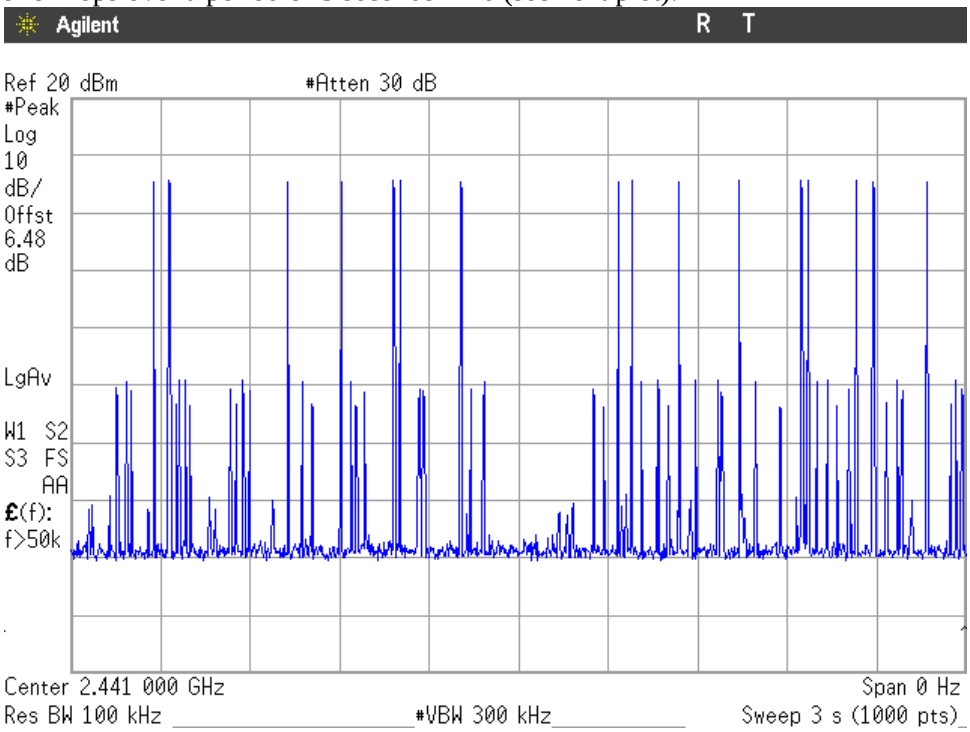
Verdict: PASS

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

- Tx- time per hop = 1.638 ms (see next plot).



- Number of hops over a period of 3 seconds = 16 (see next plot).



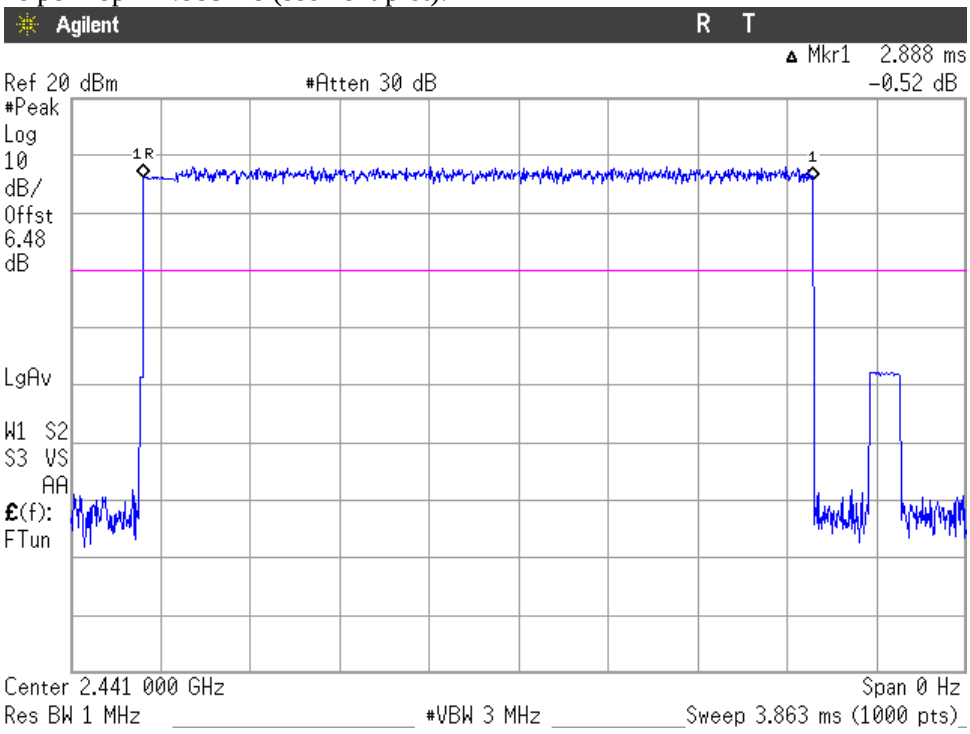
Number of hops in the period specified in the requirements = (16 hops) x (31.6 s / 3 s) = 168.53 hops.
Averaging time of occupancy = 1.638 ms x 168.53 hops = 276.06 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

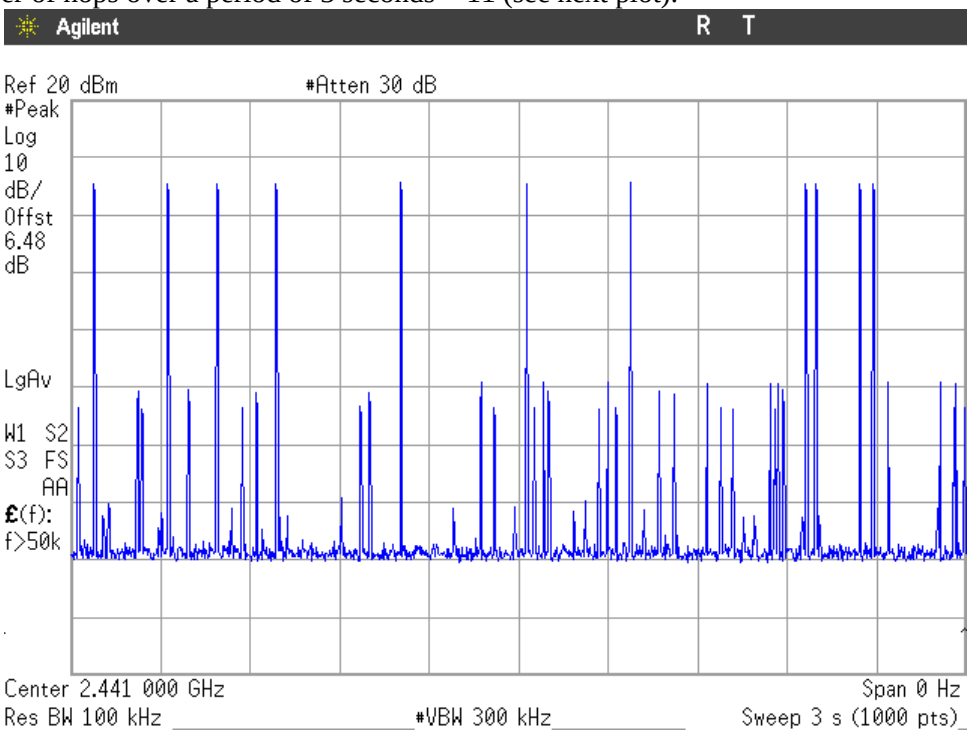
Verdict: PASS

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

- Tx- time per hop = 2.888 ms (see next plot).



- Number of hops over a period of 3 seconds = 11 (see next plot).



Number of hops in the period specified in the requirements = (11 hops) x (31.6 s / 3 s) = 115.87 hops.
Averaging time of occupancy = 2.888 ms x 115.87 hops = 334.63 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: -0.3 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)	9.54	7.65	11.16
Maximum EIRP power (dBm)	9.24	7.35	10.86
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)	9.54	7.64	11.17
Maximum EIRP power (dBm)	9.24	7.34	10.87
Measurement uncertainty (dB)	<±0.78		

Modulation: 8-DPSK (3Mbps)

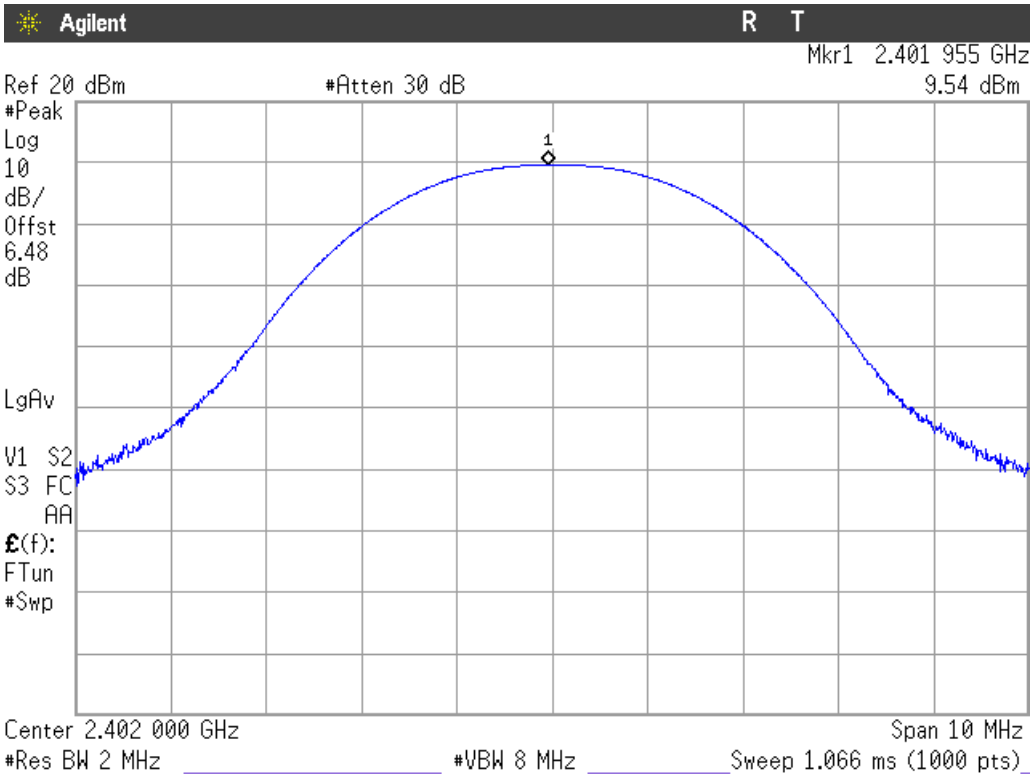
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	10.28	8.01	11.52
Maximum EIRP power (dBm)	9.98	7.71	11.20
Measurement uncertainty (dB)	<±0.78		

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.

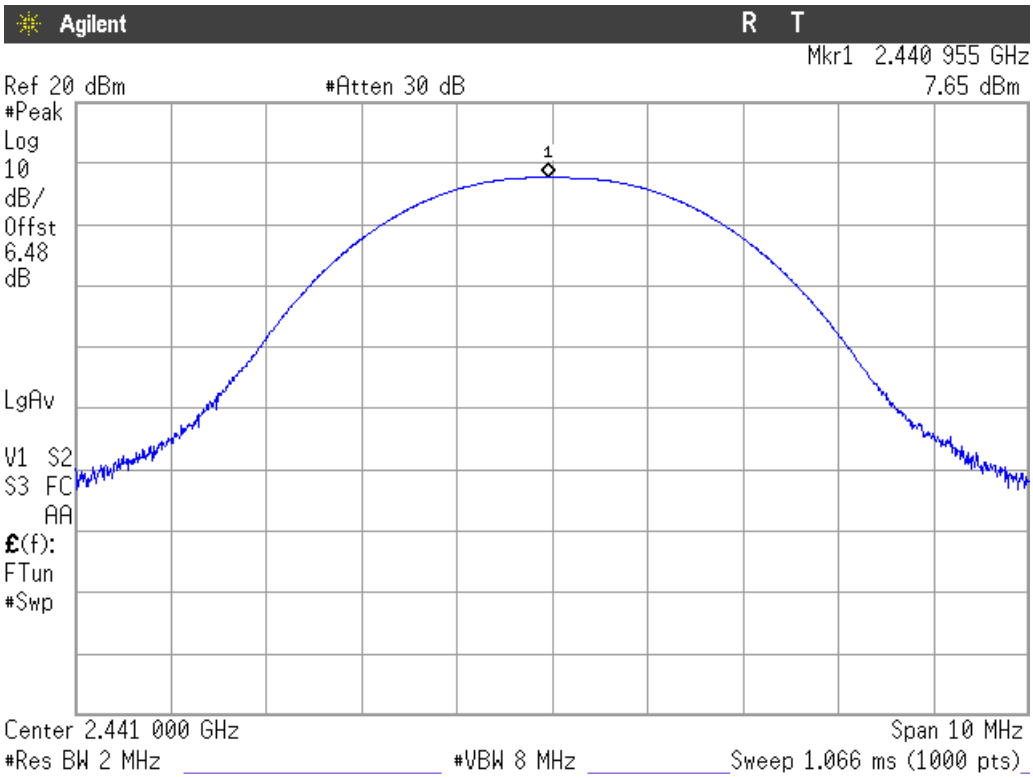
Verdict: PASS

PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK Lowest Channel: 2402 MHz.

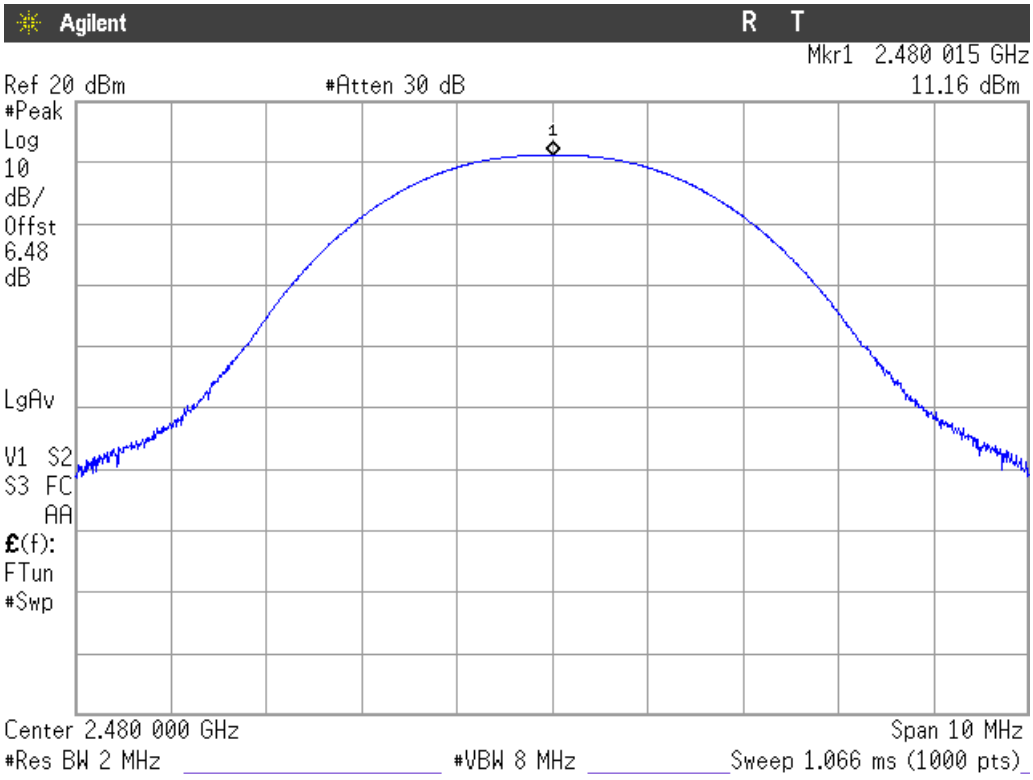


Modulation: GFSK Middle Channel: 2441 MHz.

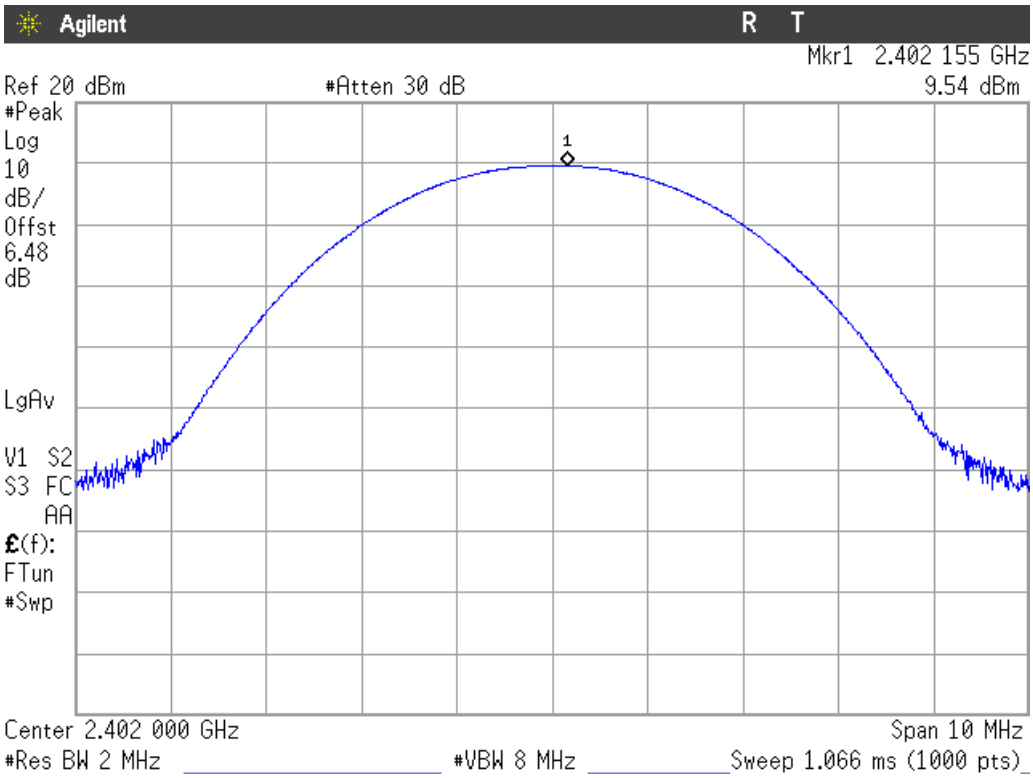


PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK Highest Channel: 2480 MHz.

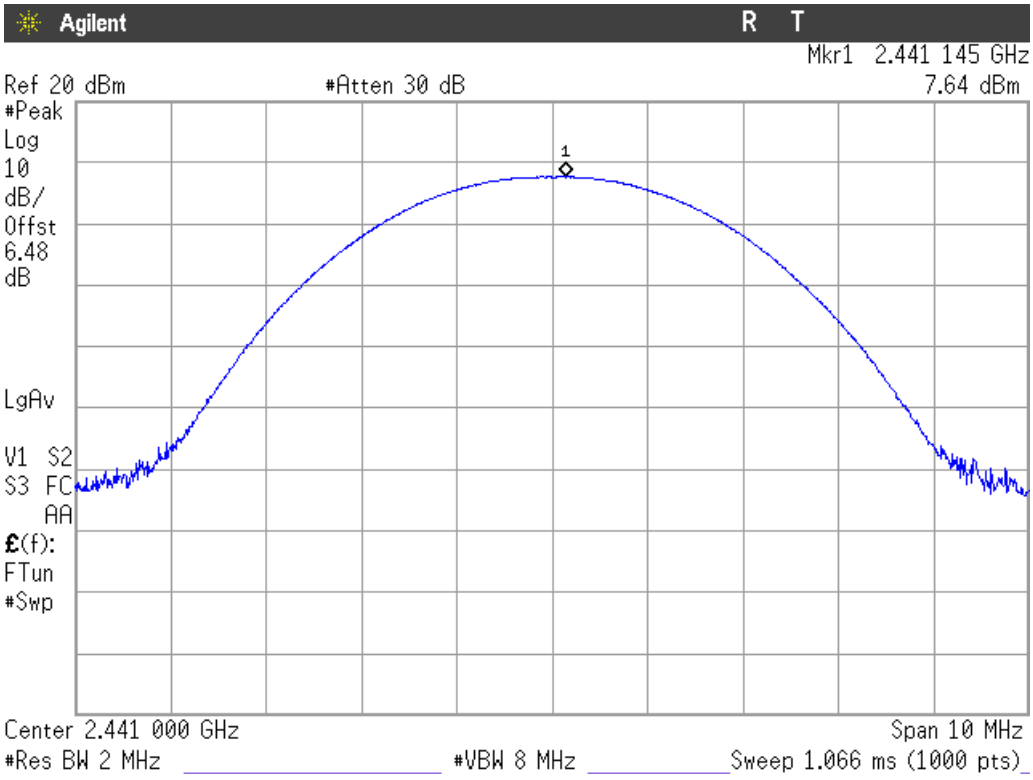


Modulation: Π/4-DQPSK Lowest Channel: 2402 MHz

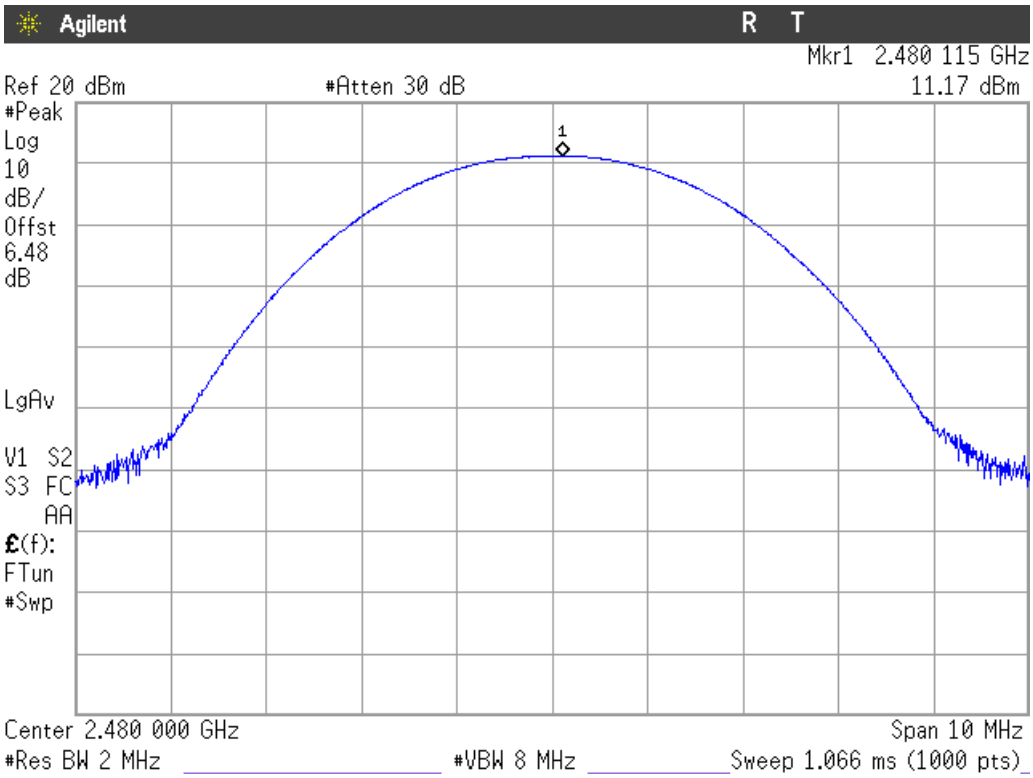


PEAK OUTPUT POWER (CONDUCTED)

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

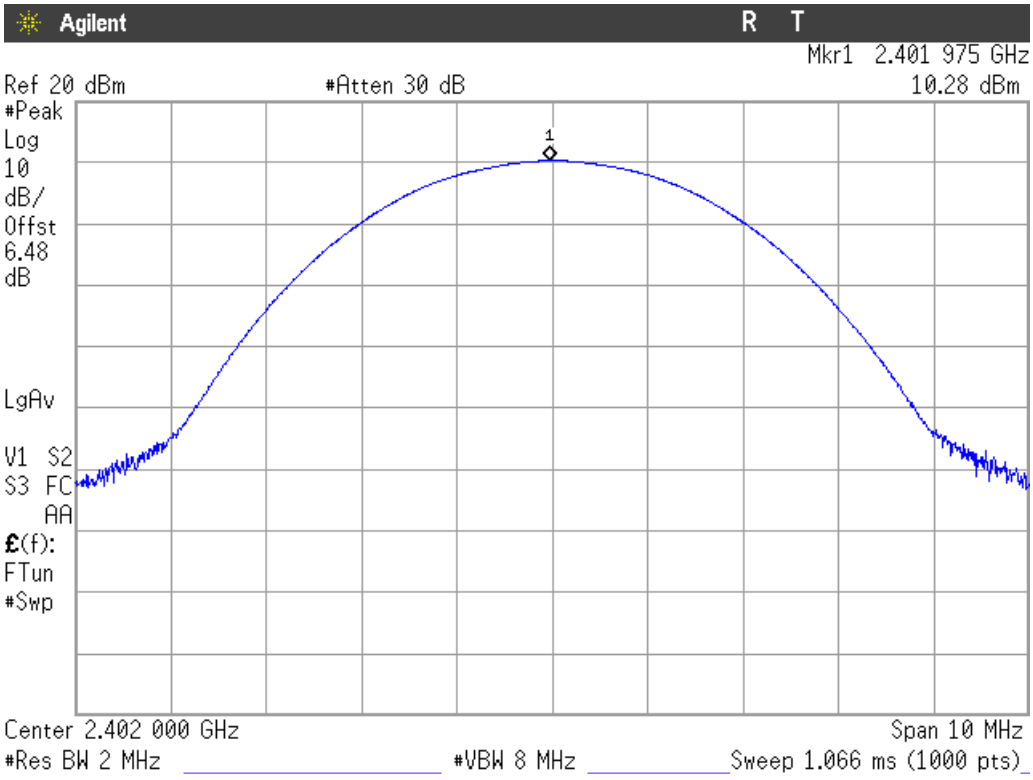


Modulation: Π/4-DQPSK Highest Channel: 2480 MHz.

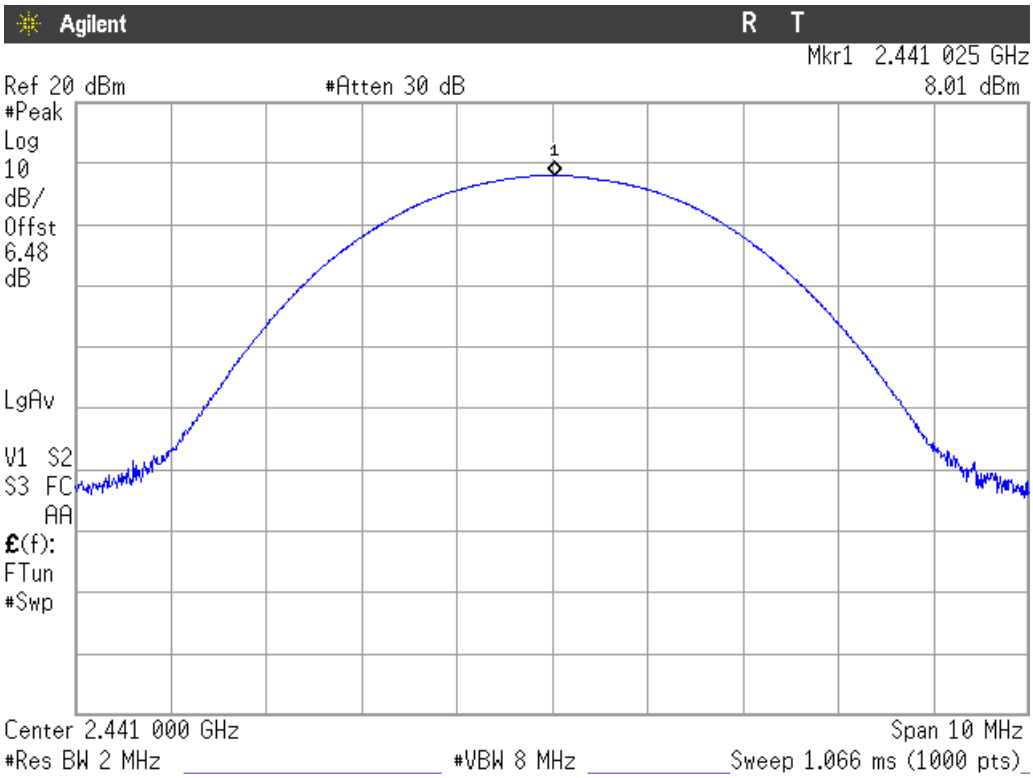


PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK Lowest Channel: 2402 MHz

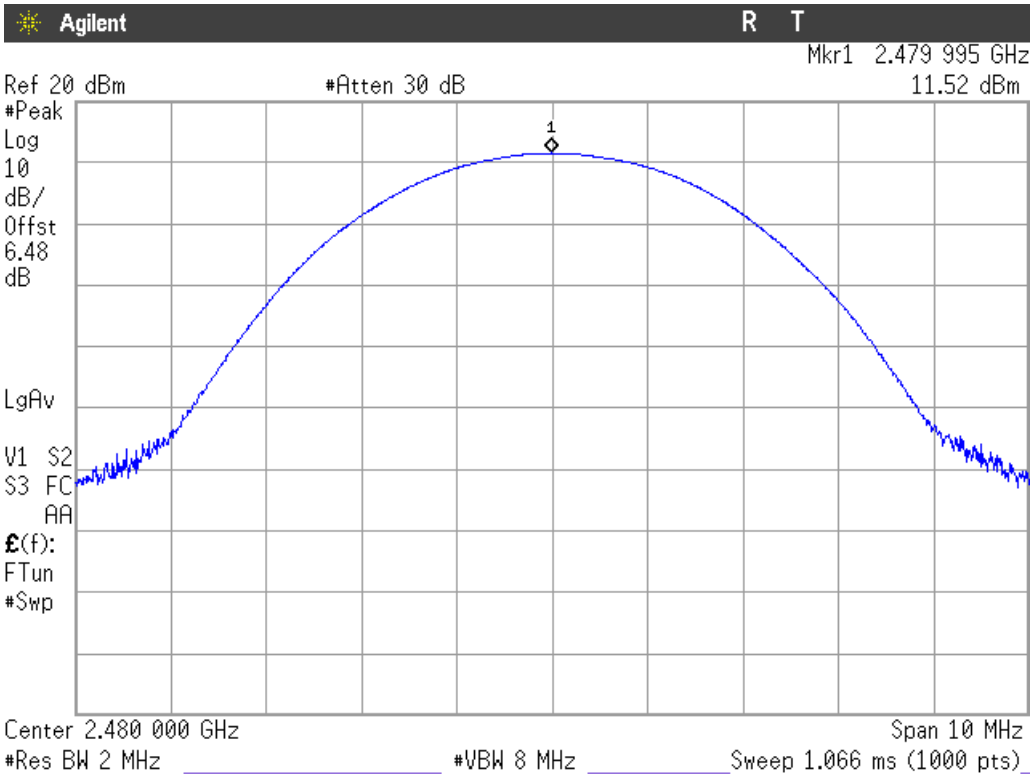


Modulation: 8-DPSK Middle Channel: 2441 MHz.



PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK Highest Channel: 2480 MHz.



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

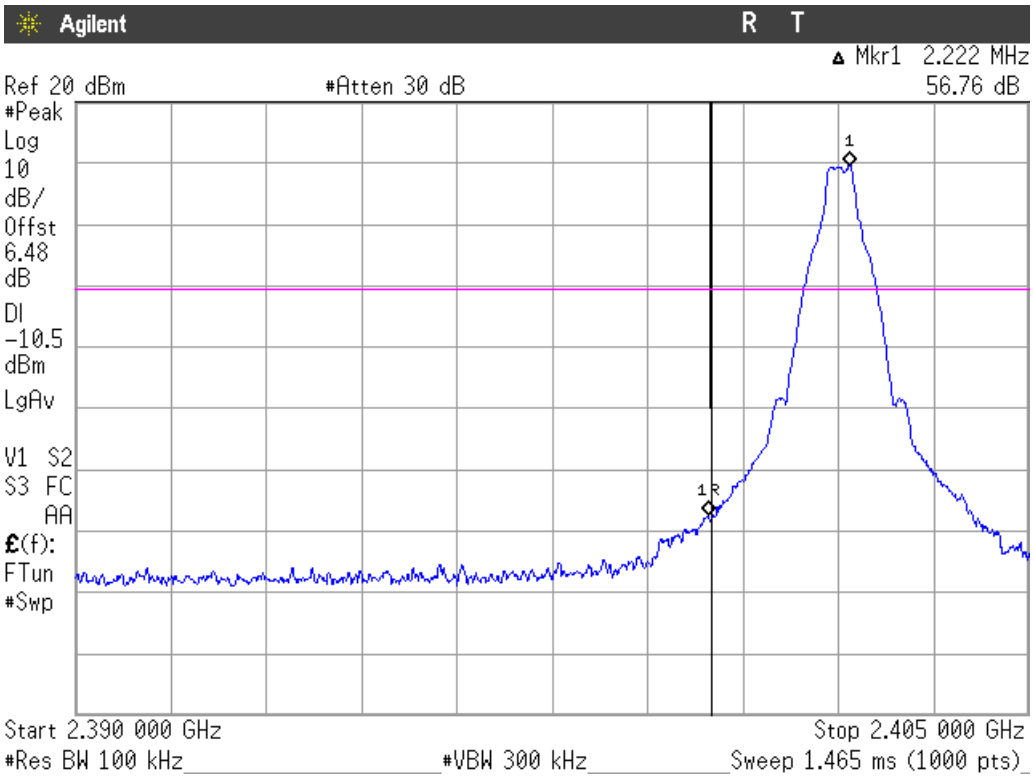
SPECIFICATION

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:

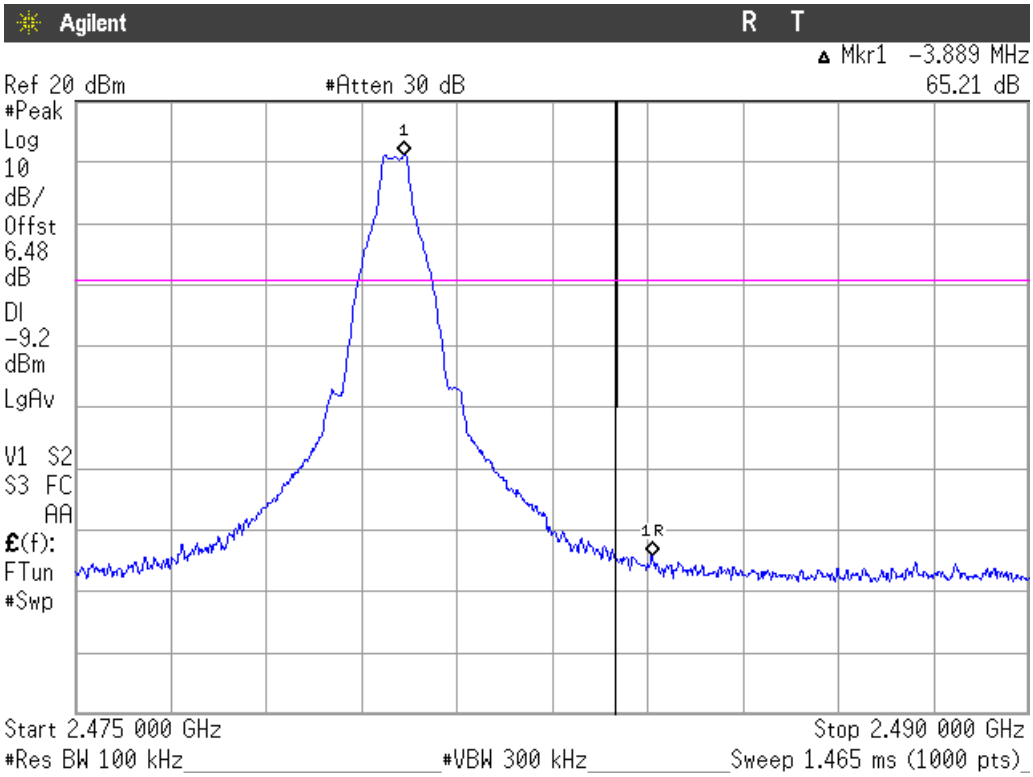
Modulation: GFSK

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



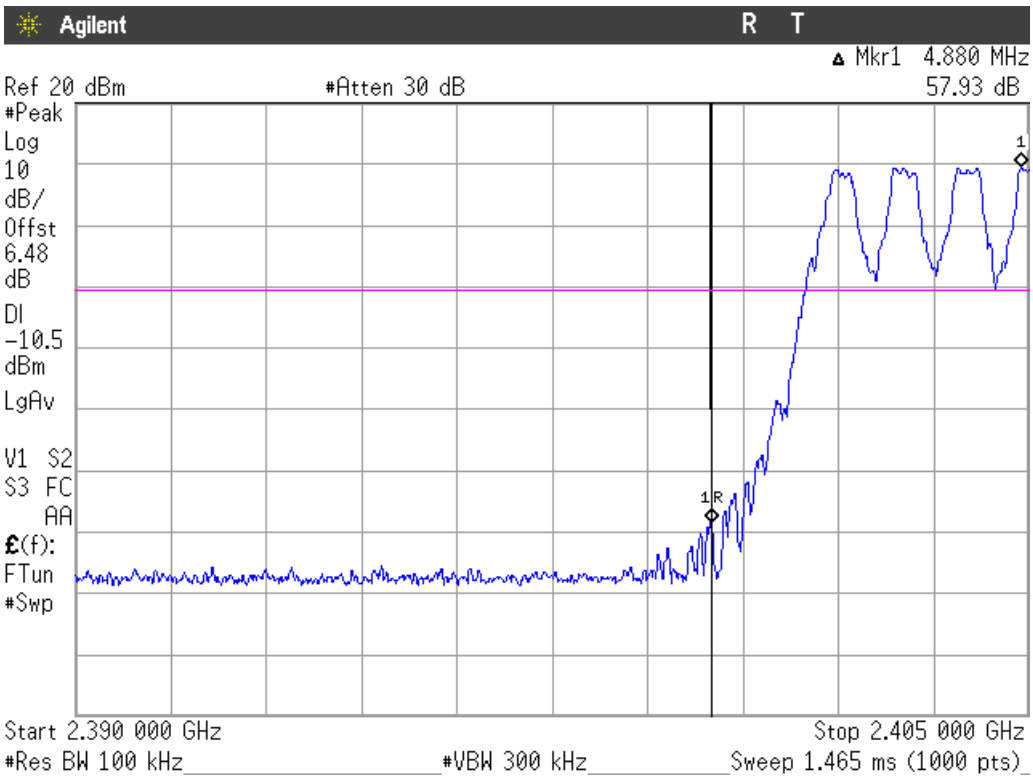
Verdict: PASS

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



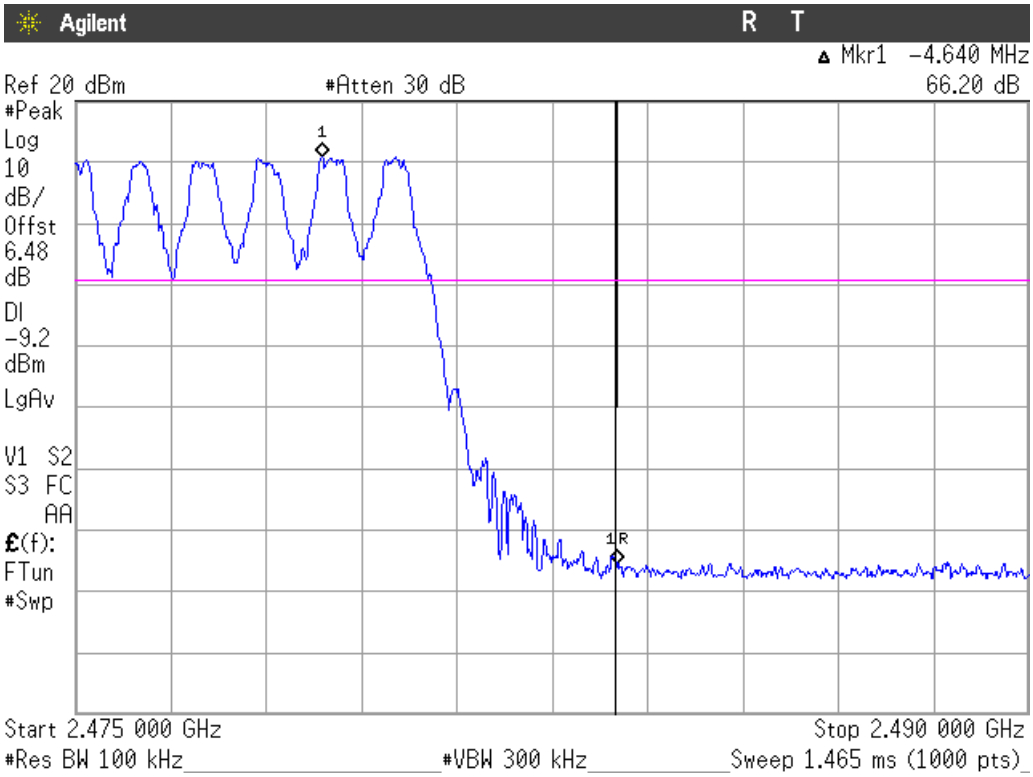
Verdict: PASS

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



Verdict: PASS

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

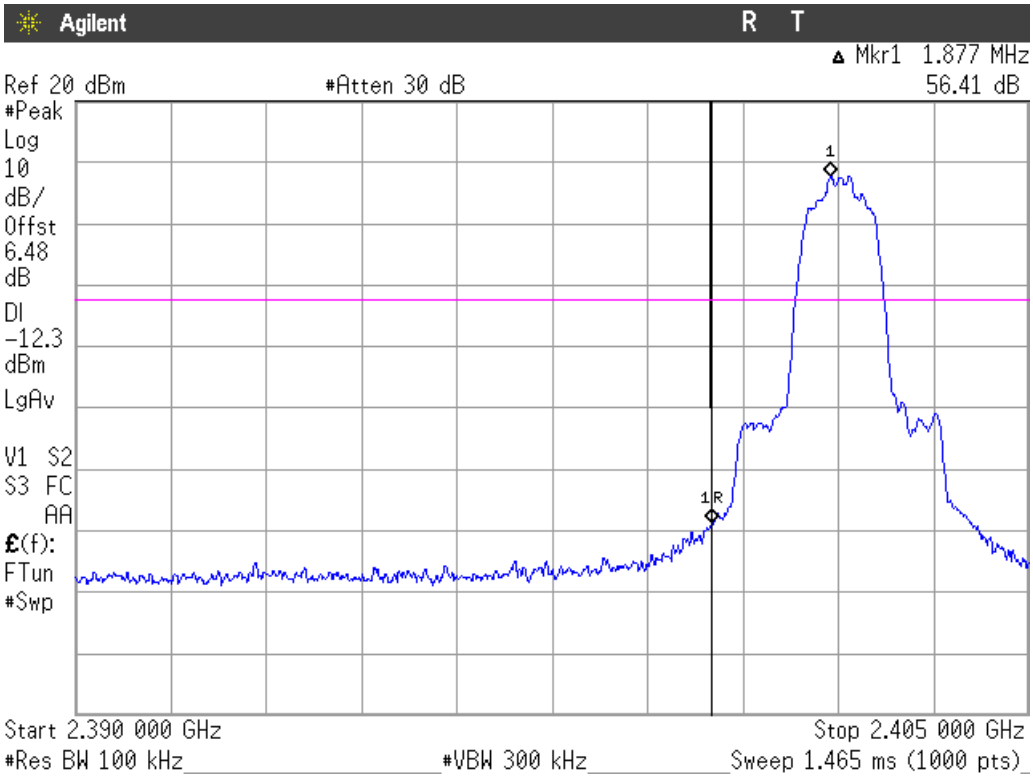


Verdict: PASS

Measurement uncertainty (dB)	<±0.78

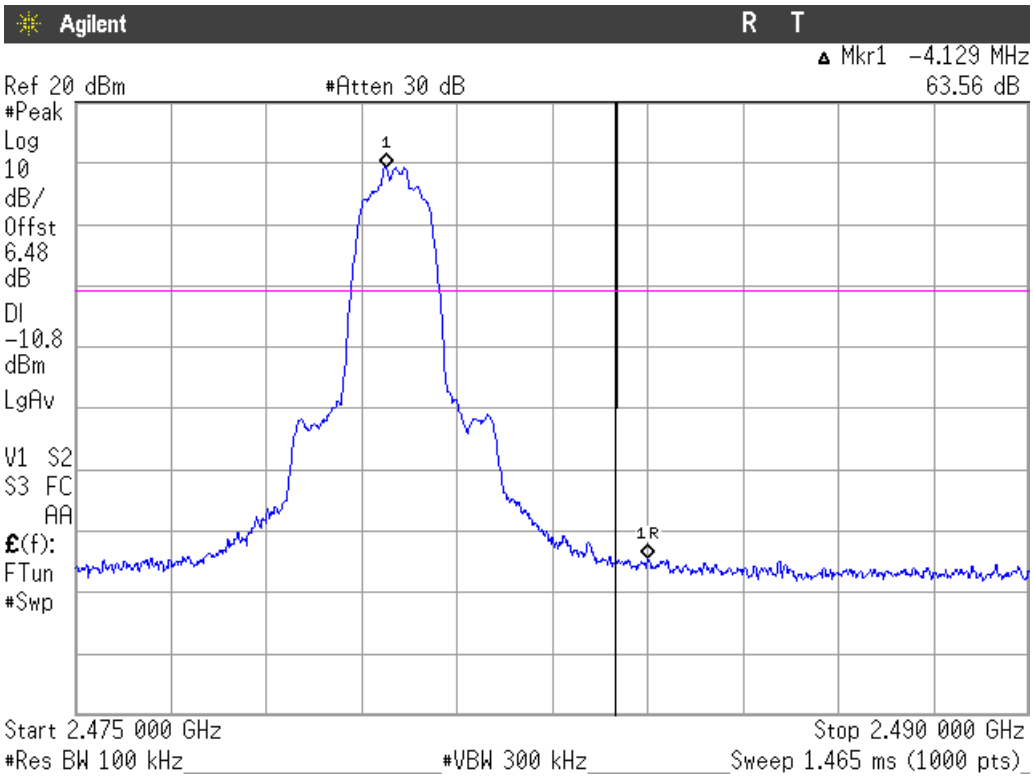
Modulation: Π/4-DQPSK

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



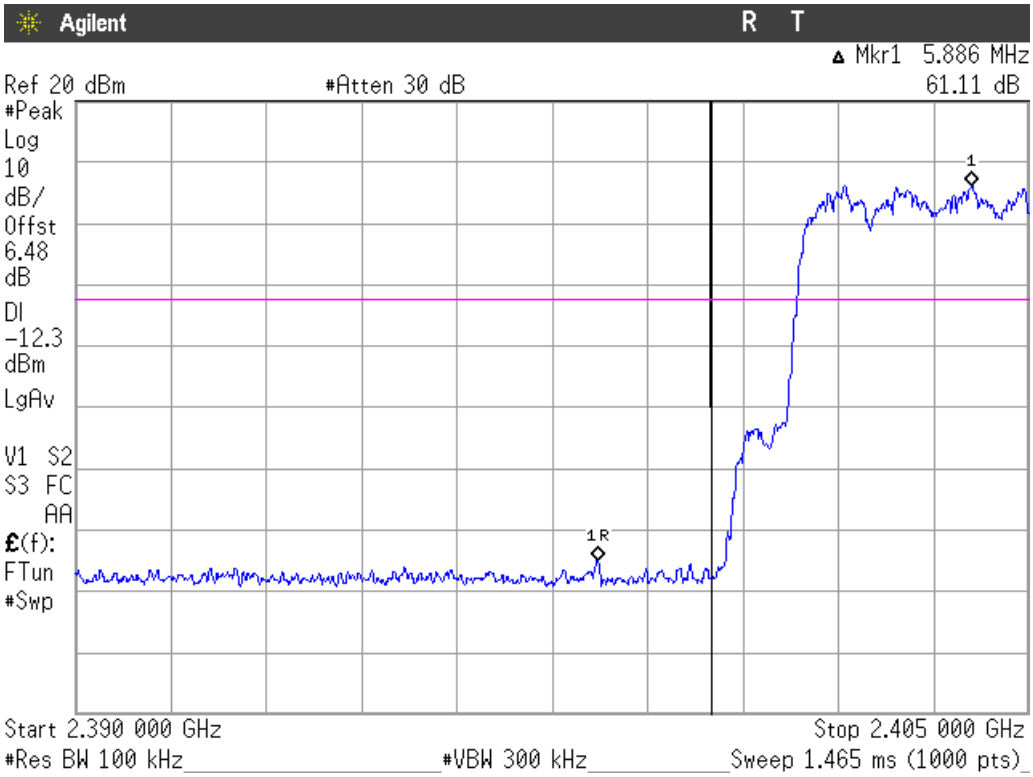
Verdict: PASS

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



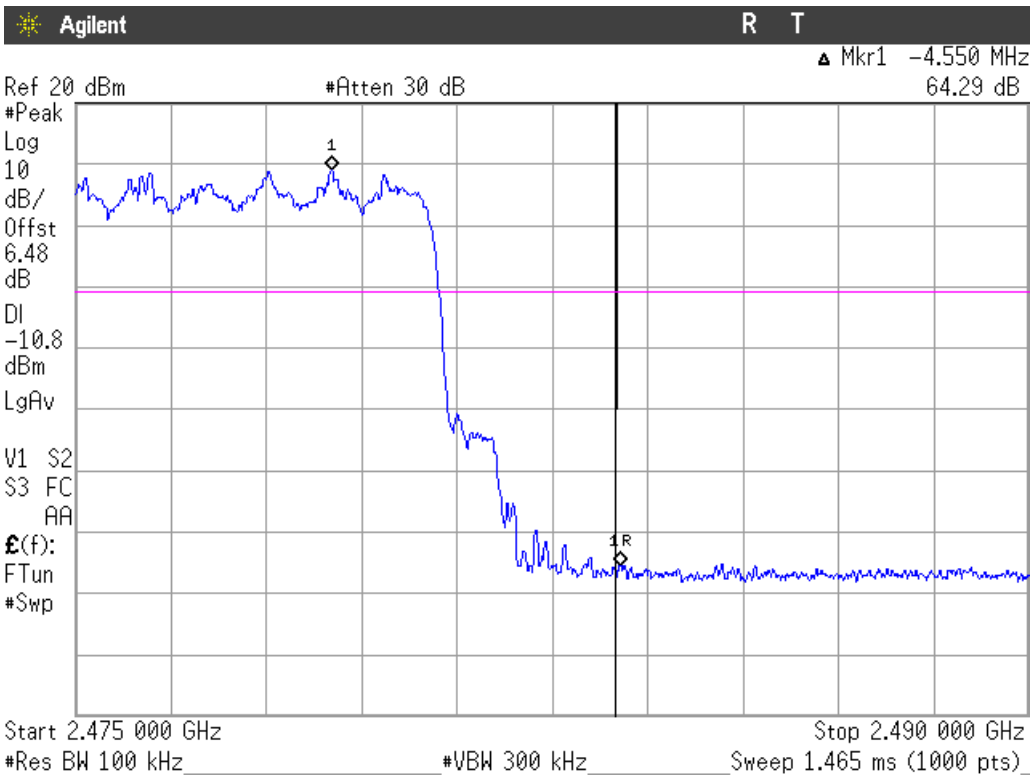
Verdict: PASS

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



Verdict: PASS

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

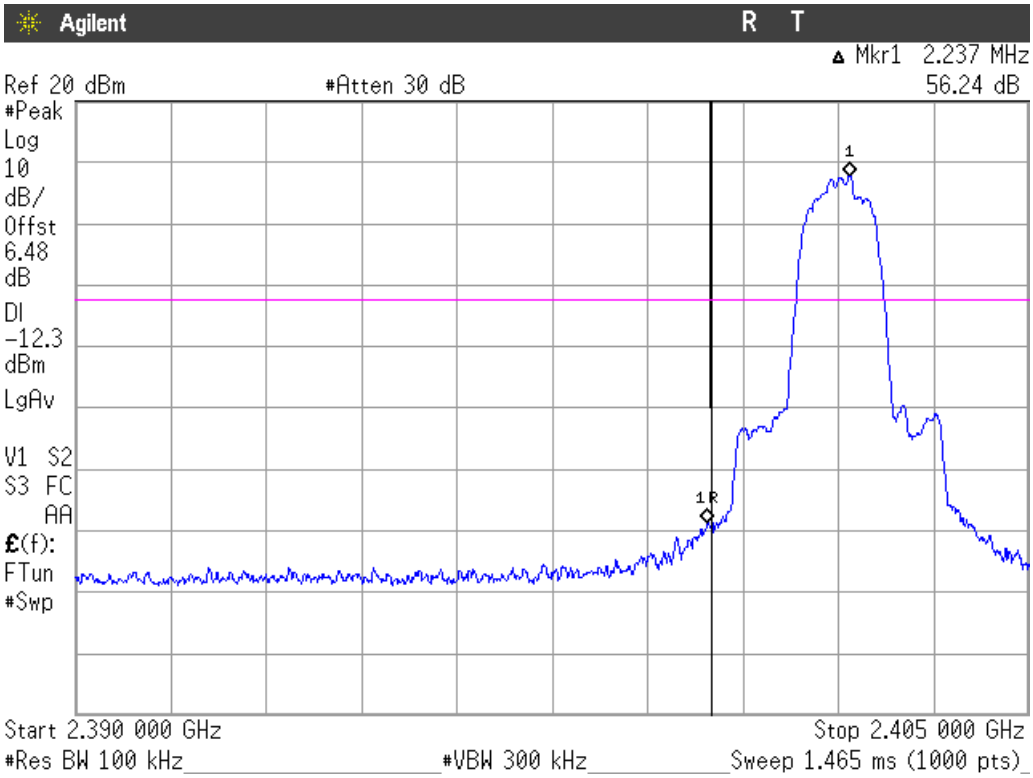


Verdict: PASS

Measurement uncertainty (dB)	<±0.78

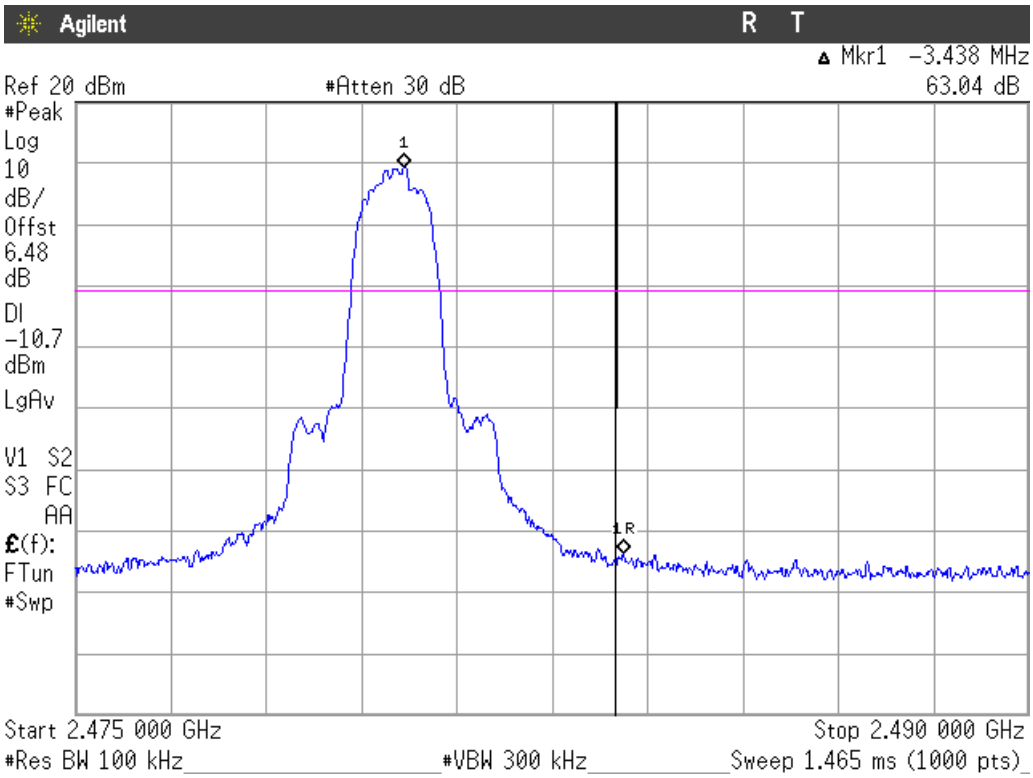
Modulation: 8-DPSK

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



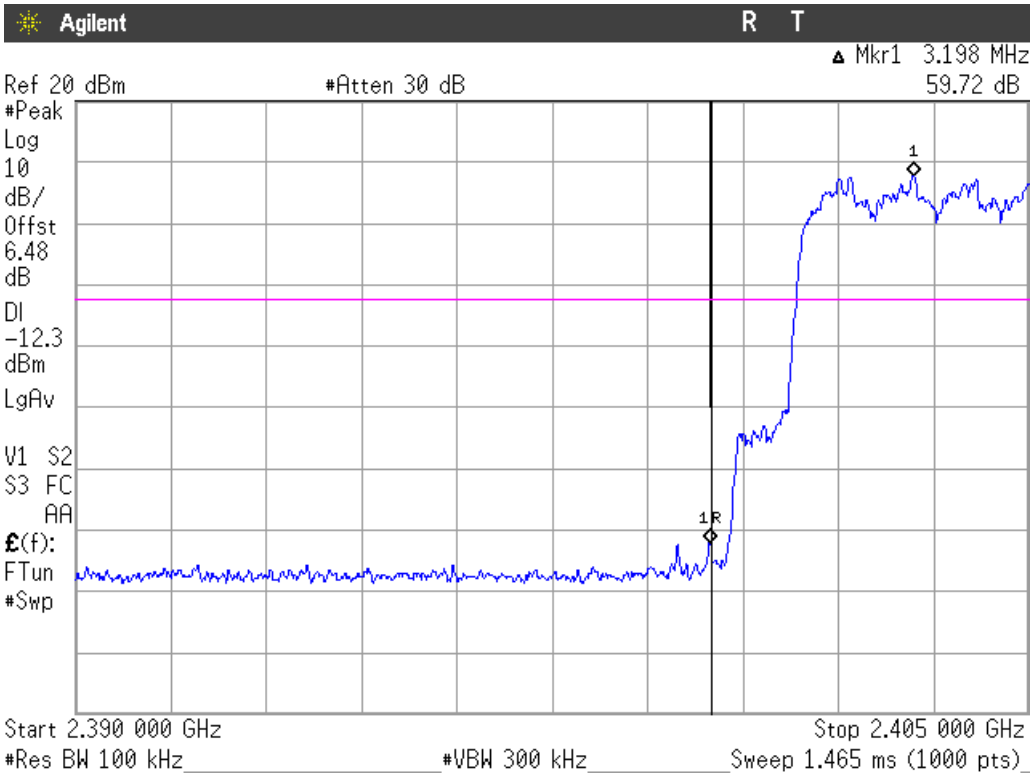
Verdict: PASS

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



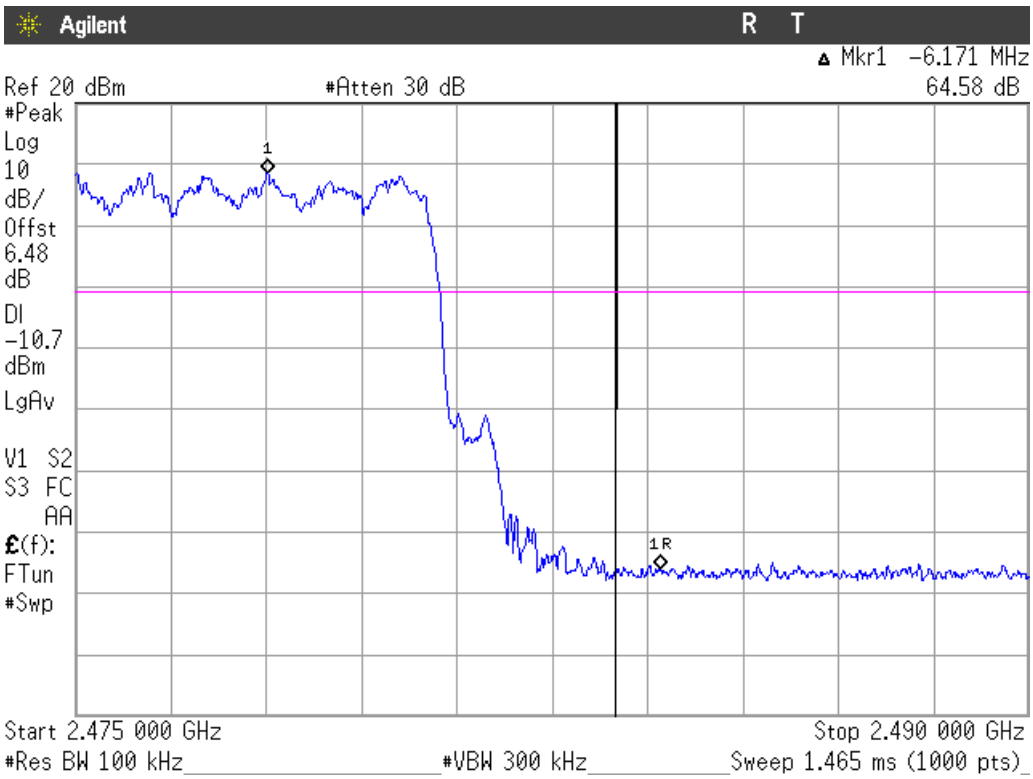
Verdict: PASS

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)	<±0.78

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

SPECIFICATION

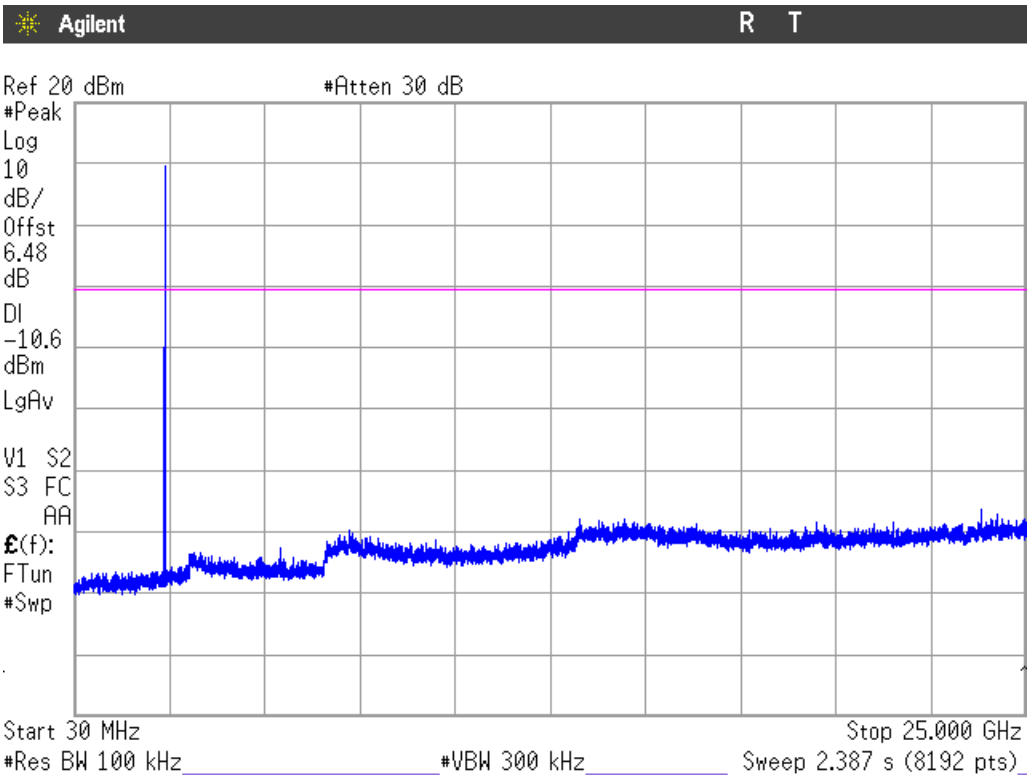
In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

RESULTS:

All peaks are more than 20 dB below the limit.

Modulation: GFSK

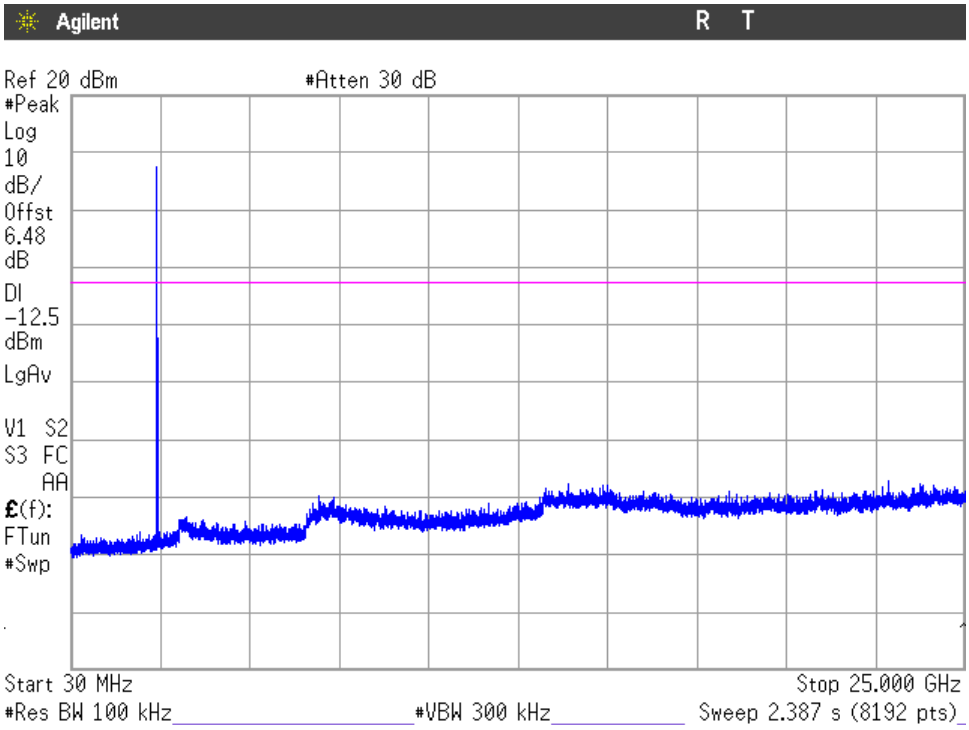
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

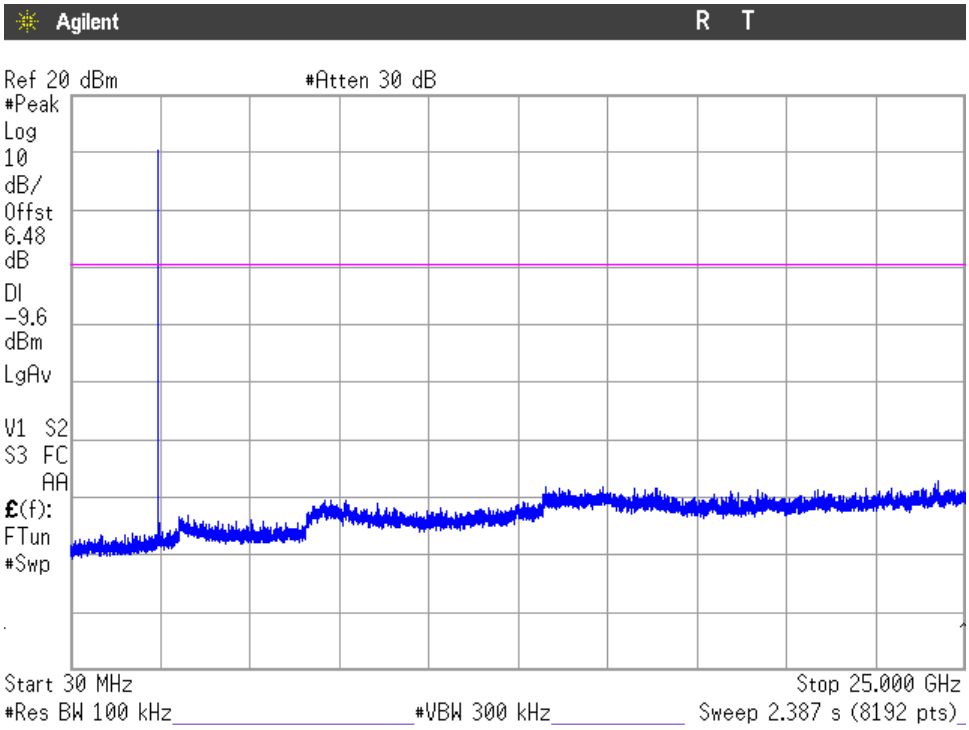
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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



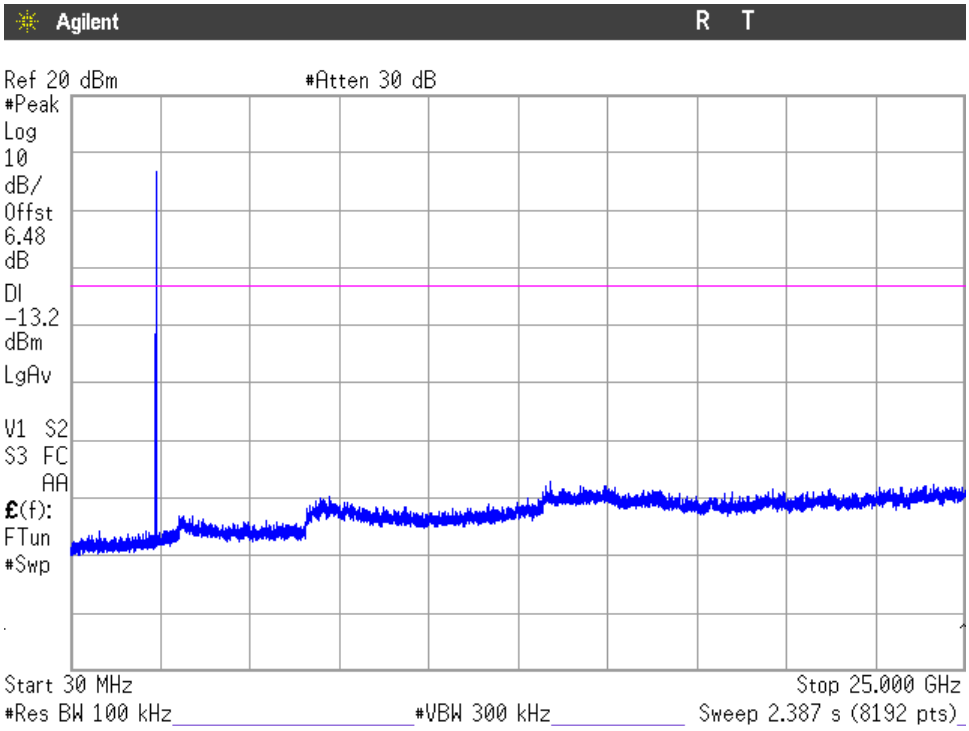
Note: The peak above the limit is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±2.03

Modulation: II/4-DQPSK

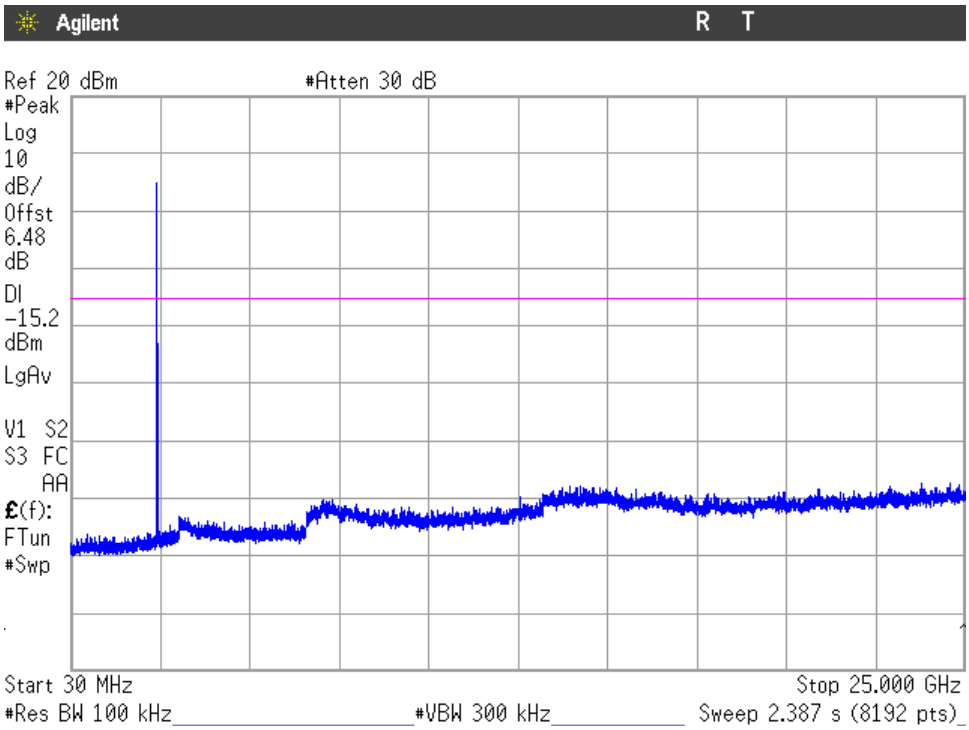
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

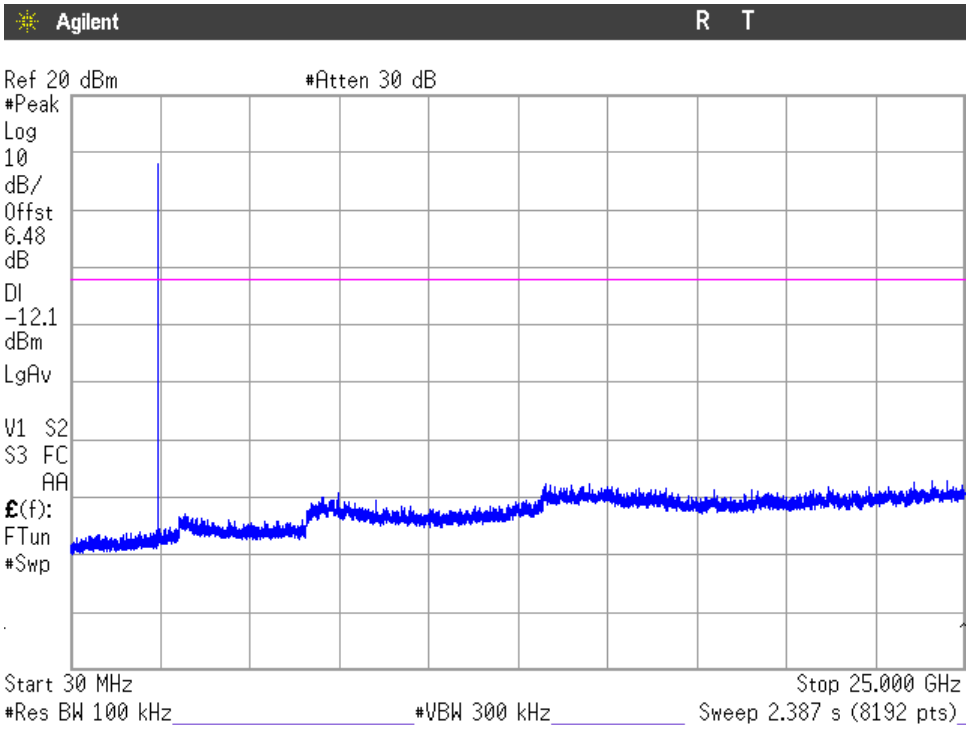
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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



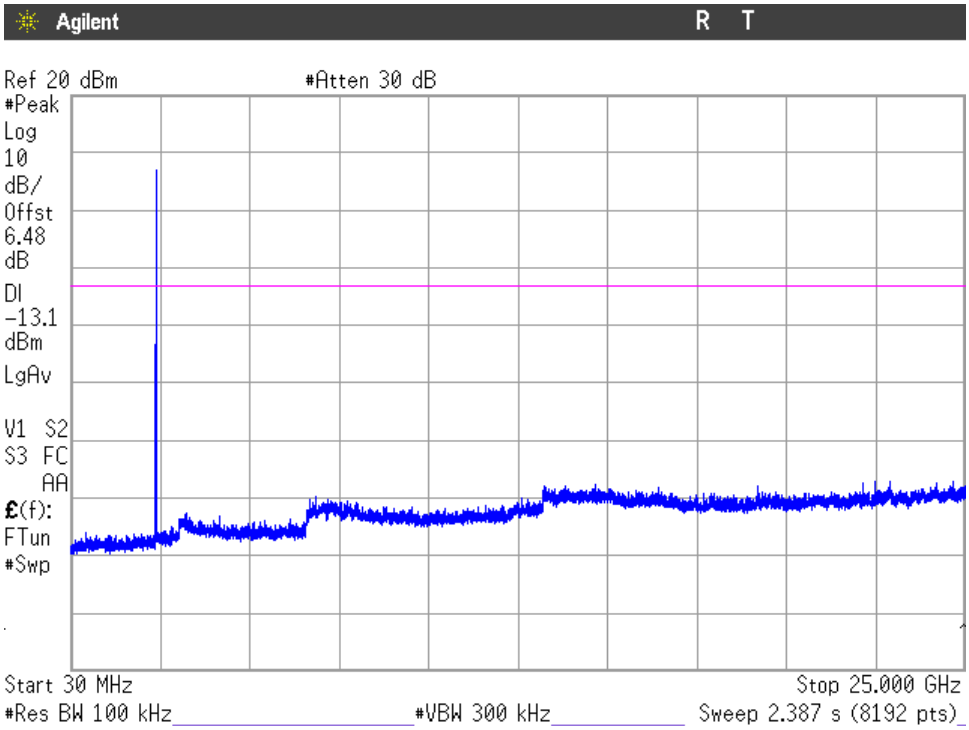
Note: The peak above the limit is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±2.03

Modulation: 8-DPSK

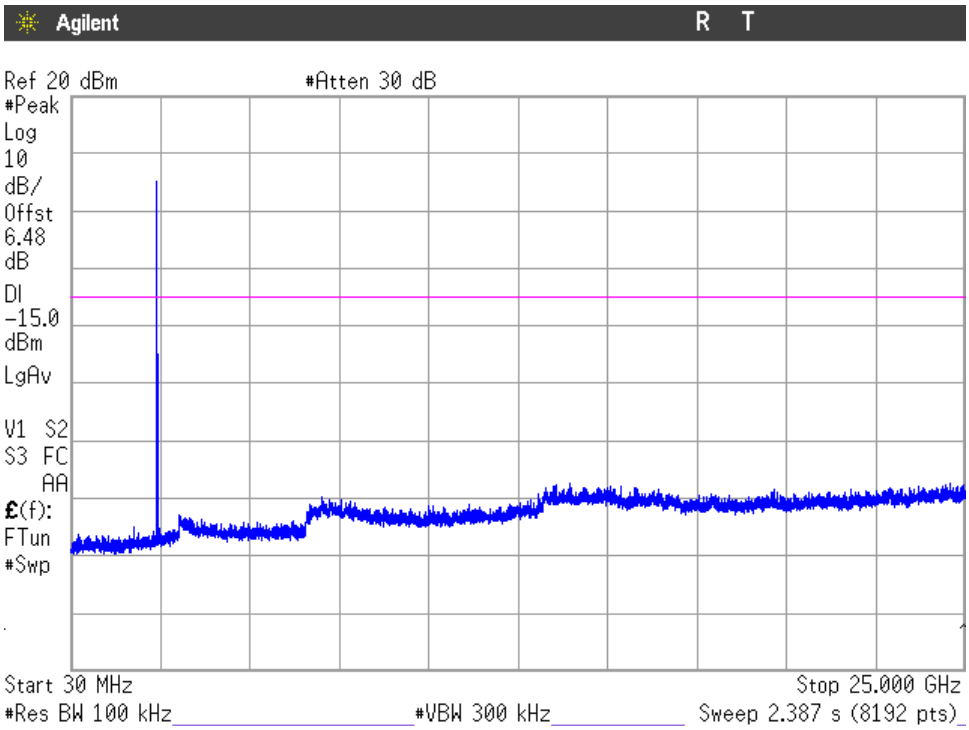
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

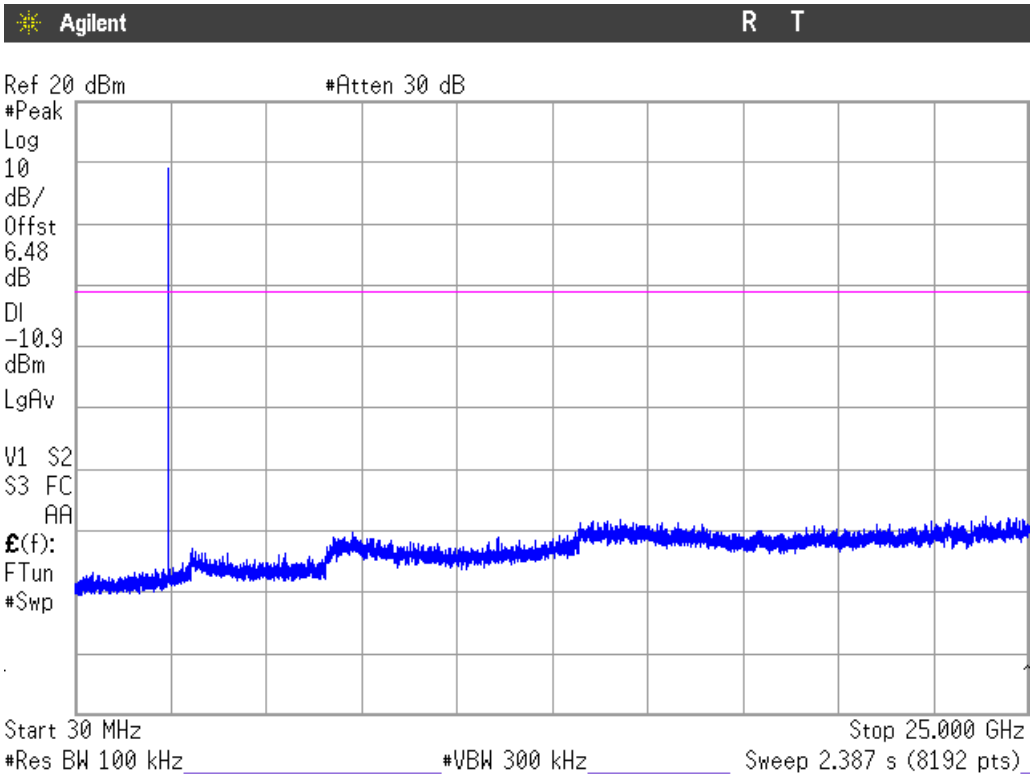
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

3. HIGHEST 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 (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
37.243.	H	Quasi-Peak	24.92	± 3.88
44.130	V	Quasi-Peak	22.42	± 3.88
57.580	V	Quasi-Peak	22.65	± 3.88

Frequency range 1 GHz-25 GHz

Modulation: GFSK

1. CHANNEL: LOWEST (2402 MHz).

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE (2441 MHz).

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.48351	H	Peak	50.86	± 4.87

Verdict: PASS

Modulation: Π/4-DQPSK

1. CHANNEL: LOWEST (2402 MHz).

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE (2441 MHz).

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.48353	V	Peak	50.17	± 4.87

Verdict: PASS

Modulation: 8-DPSK

1. CHANNEL: LOWEST (2402 MHz).

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE (2441 MHz).

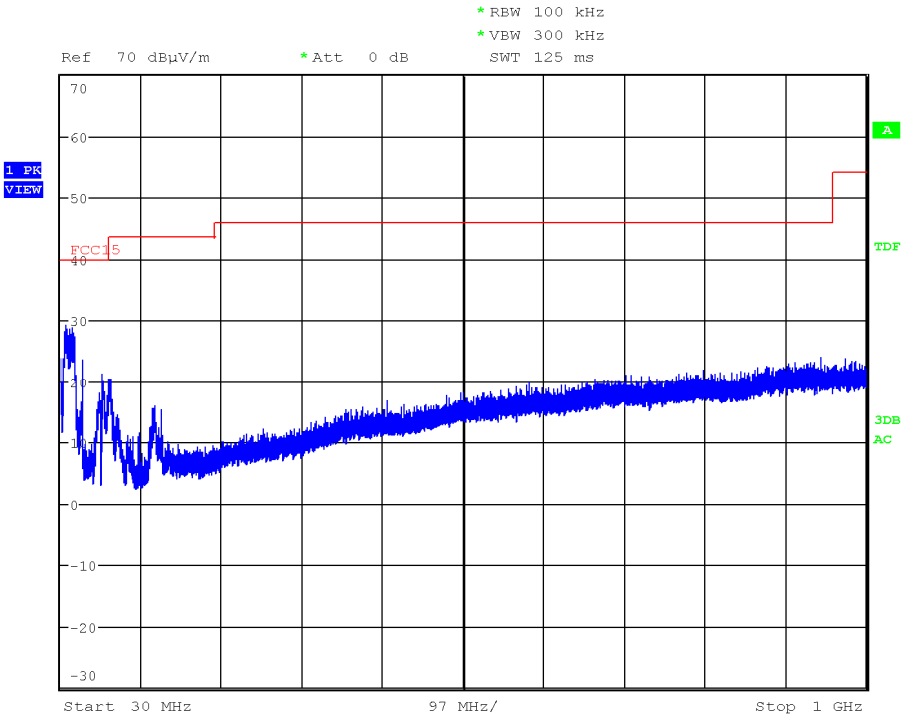
No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.48355	H	Peak	49.99	± 4.87

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

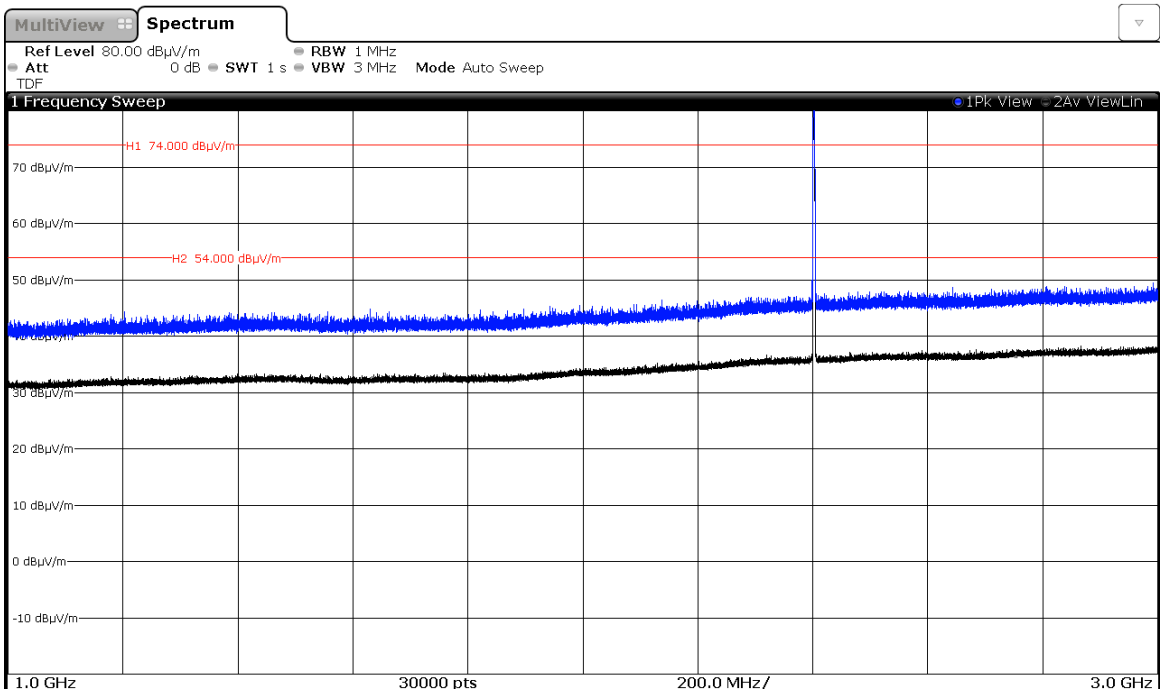


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

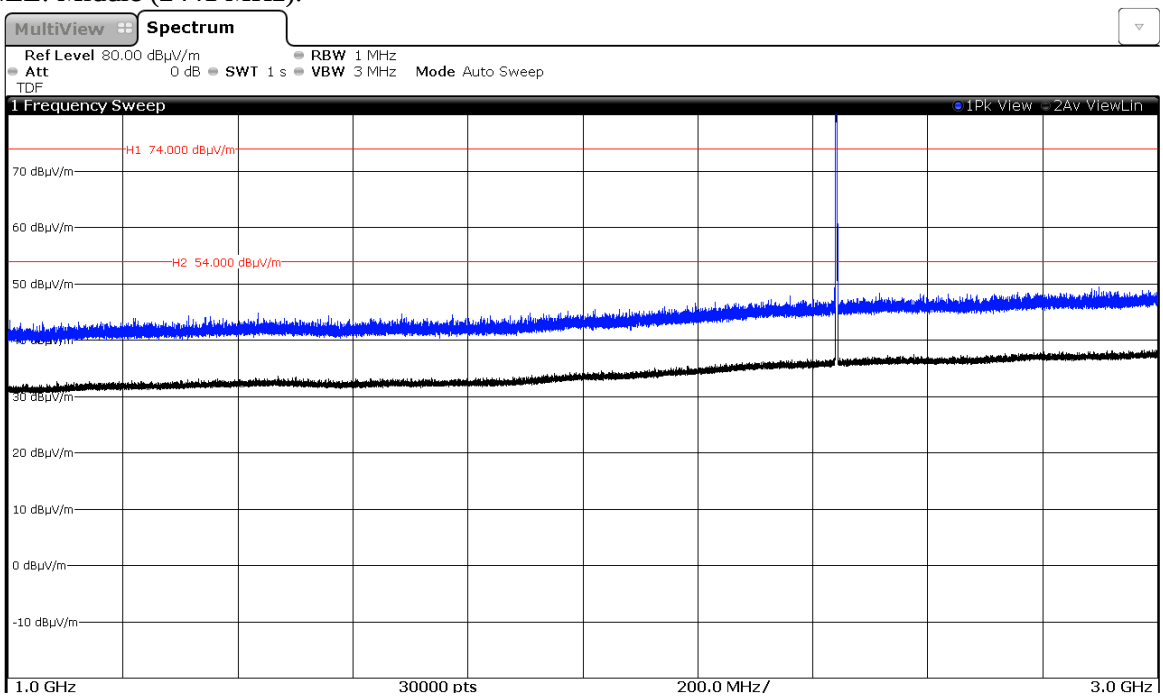
Modulation: GFSK

CHANNEL: Lowest (2402 MHz).



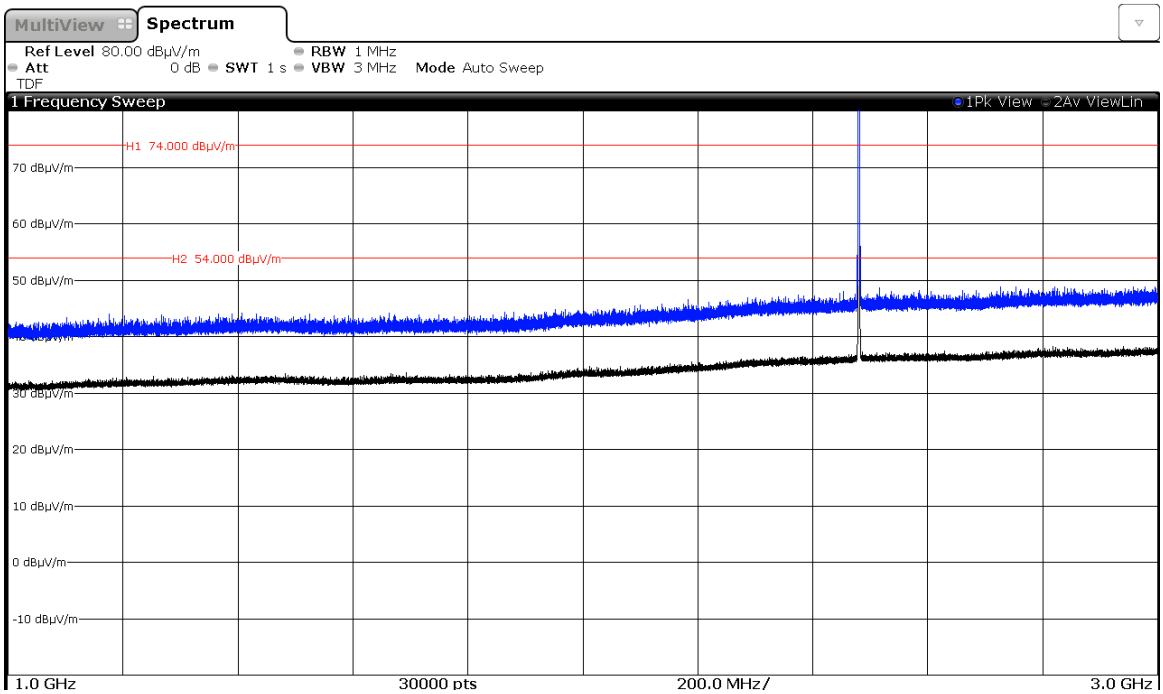
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

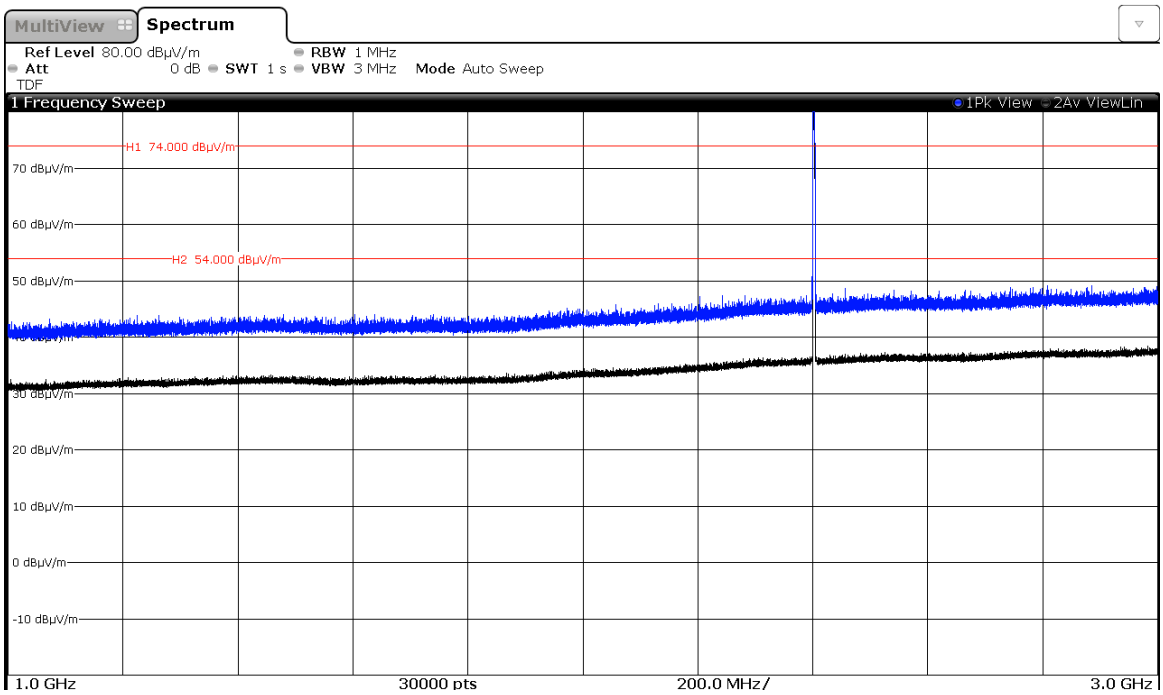
CHANNEL: Highest (2480 MHz).



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

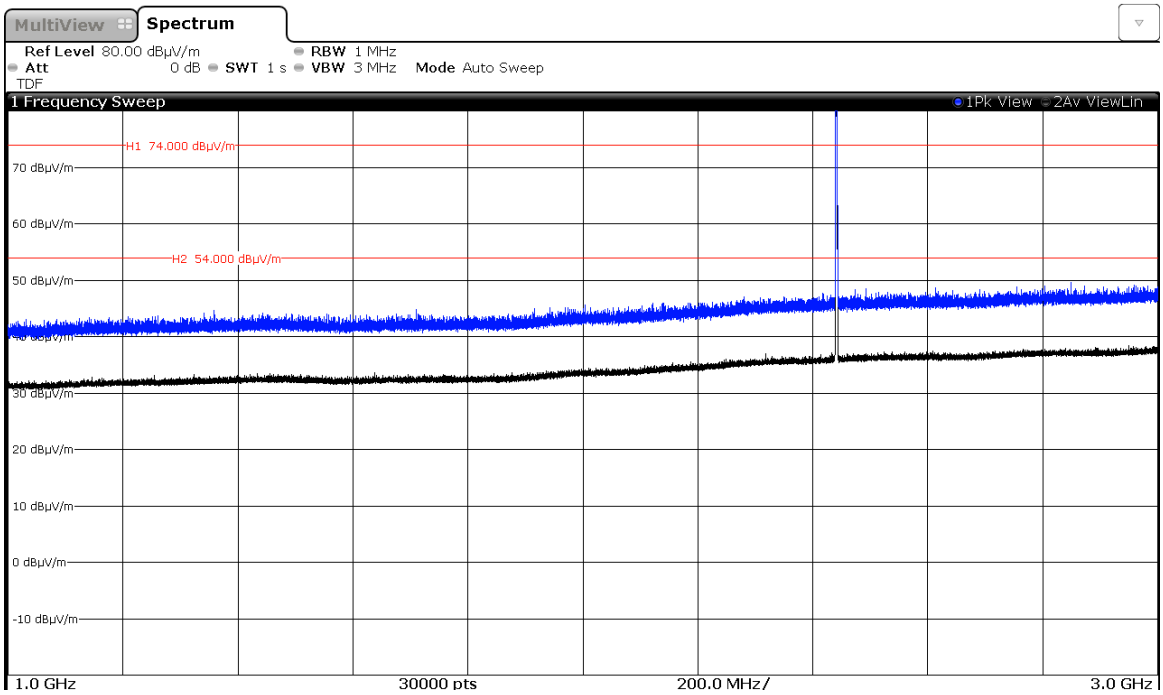
Modulation: Π/4-DQPSK

CHANNEL: Lowest (2402 MHz).



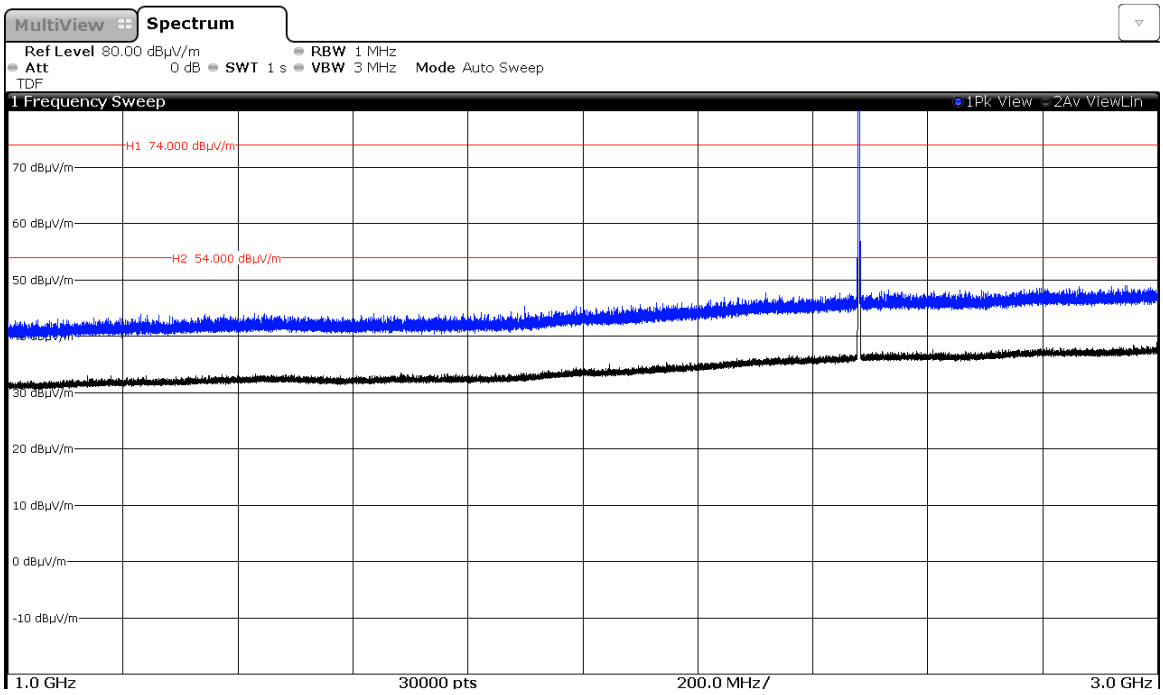
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

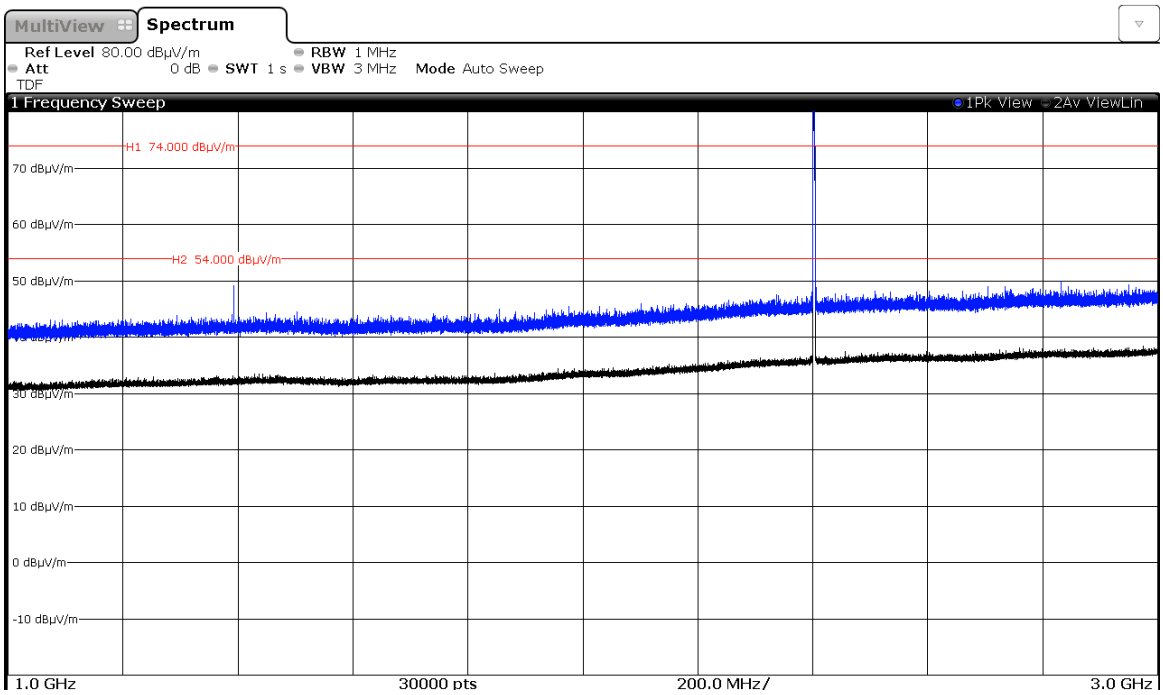
CHANNEL: Highest (2480 MHz).



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

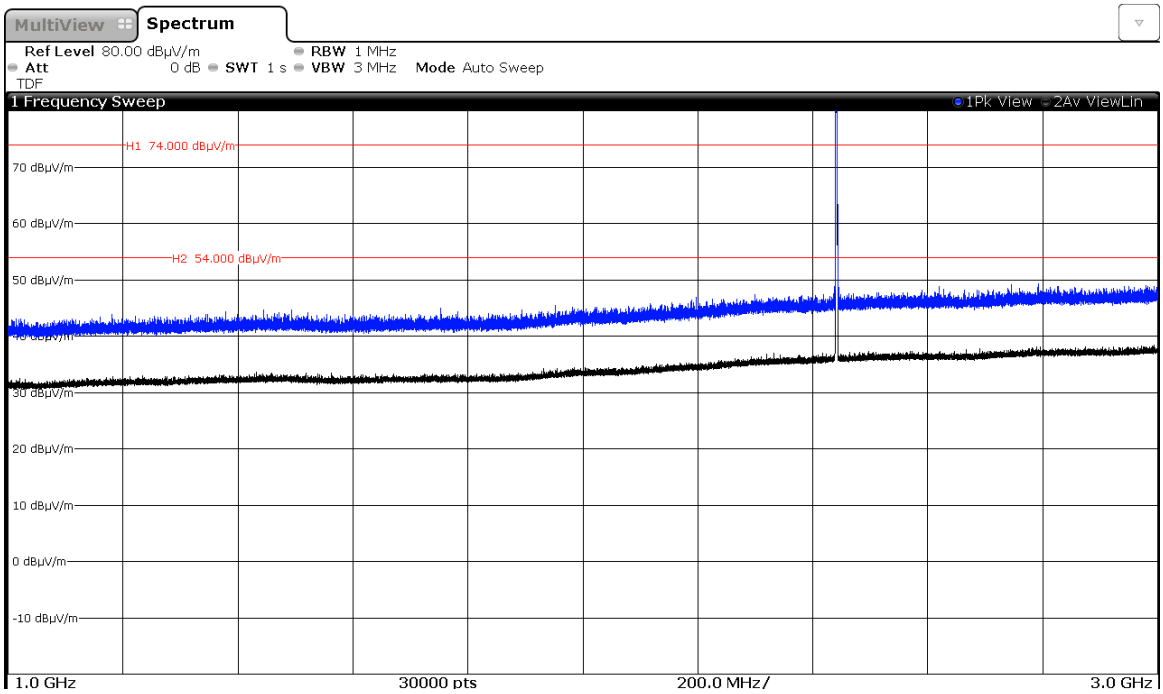
Modulation: 8-DPSK

CHANNEL: Lowest (2402 MHz).



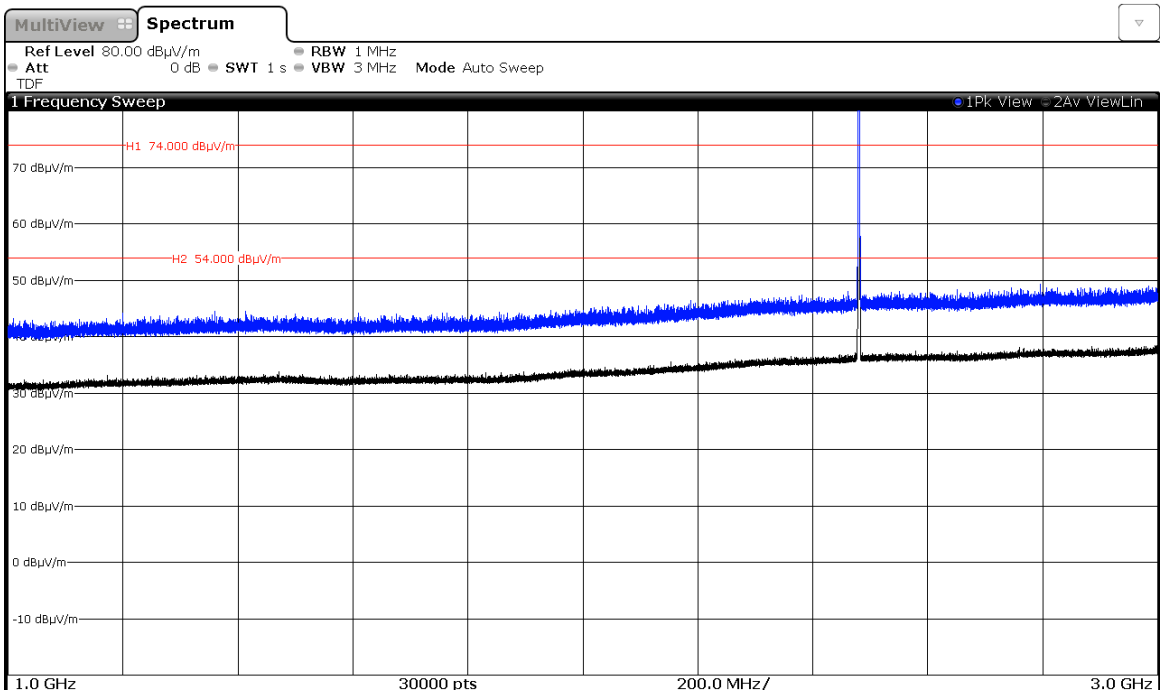
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

CHANNEL: Highest (2480 MHz).

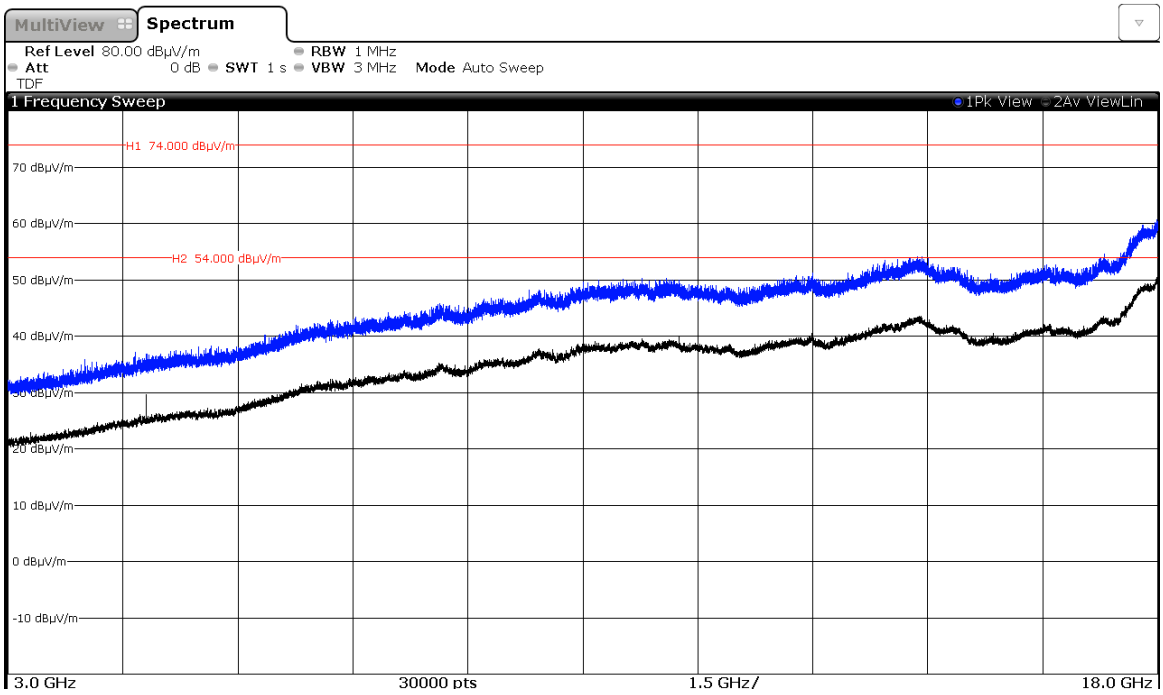


Note: The peak shown in the plot above the limit is the carrier frequency.

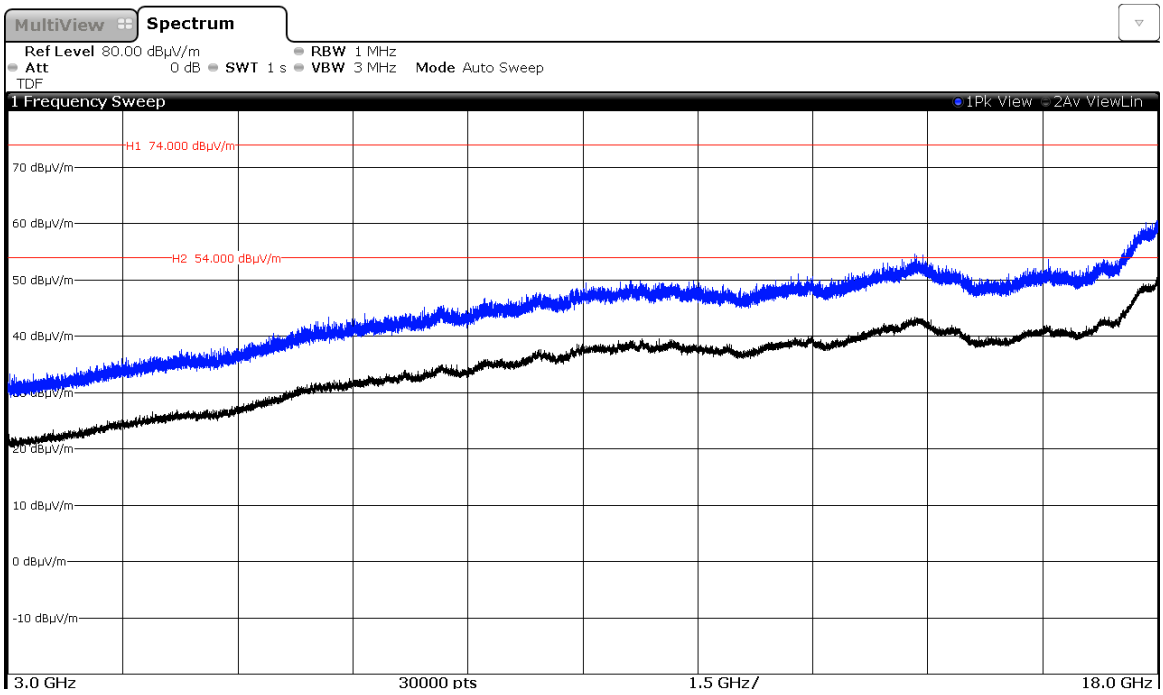
FREQUENCY RANGE 3 GHz to 18 GHz.

Modulation: GFSK

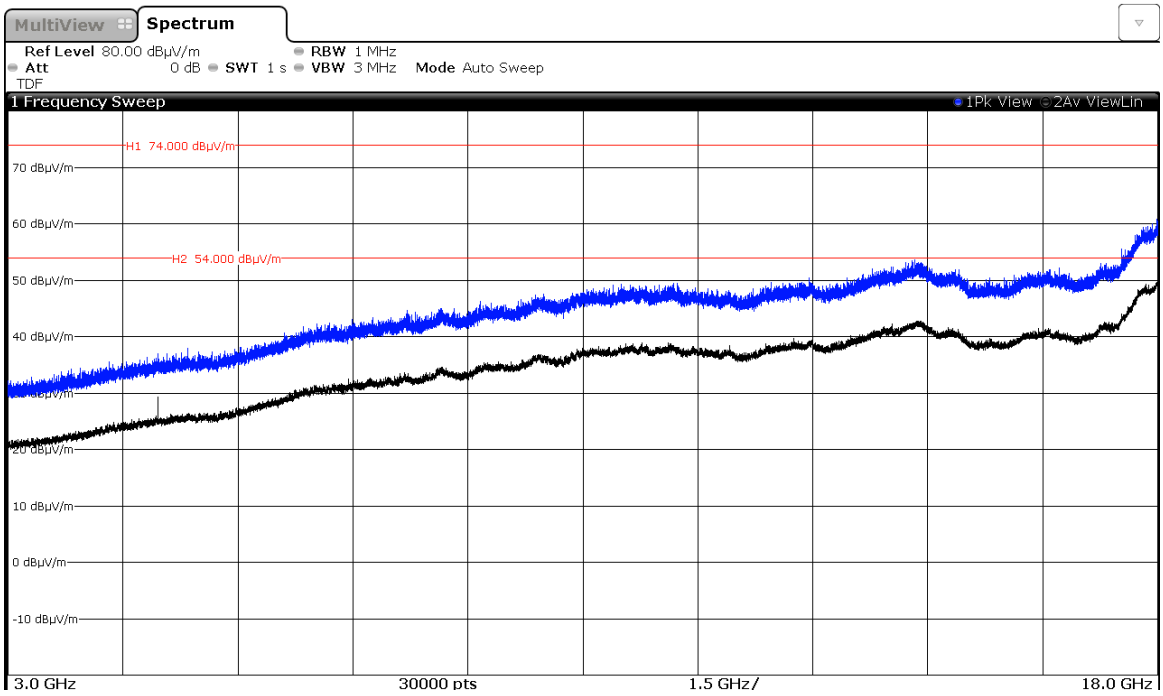
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

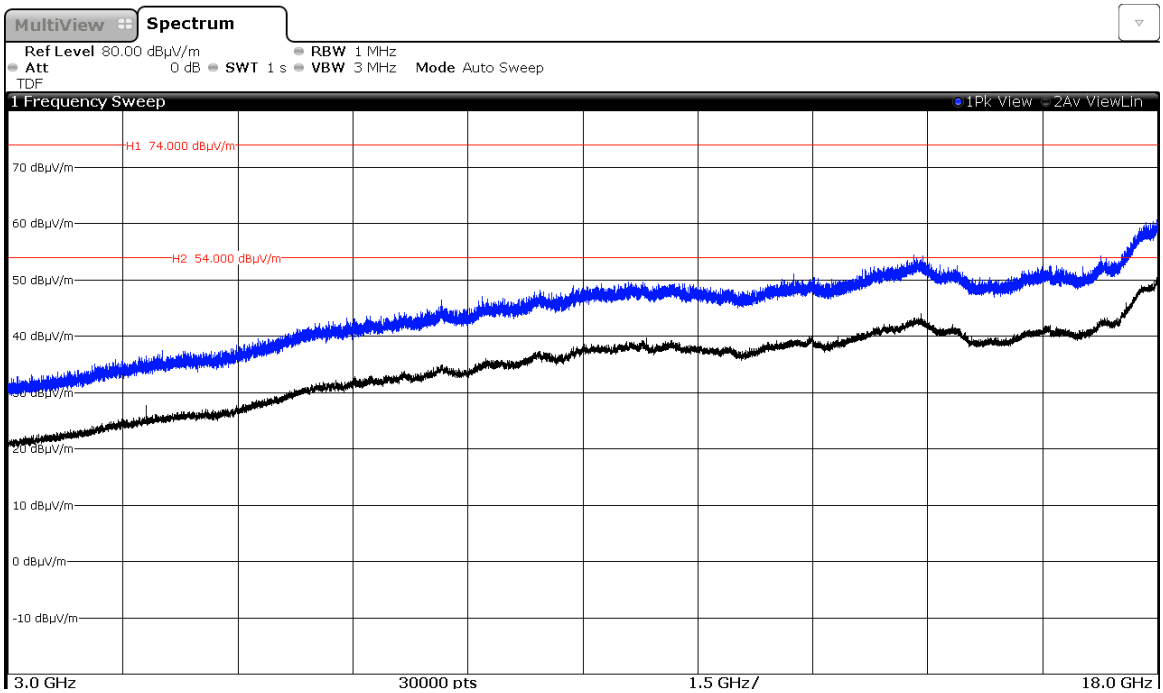


CHANNEL: Highest (2480 MHz).

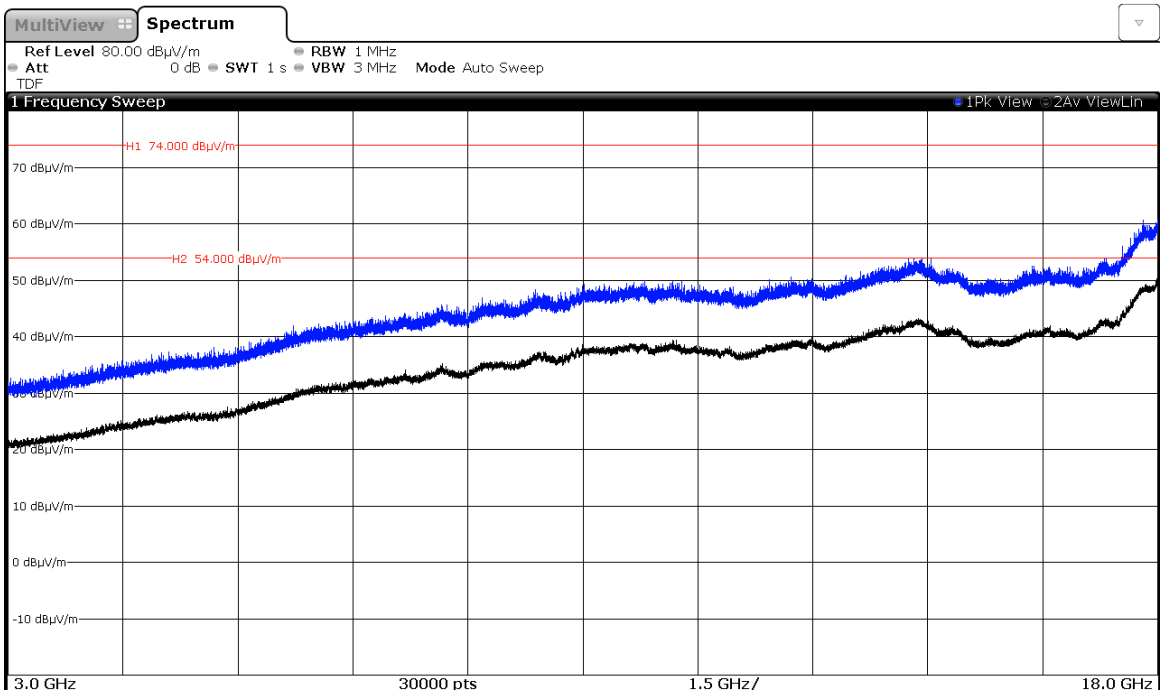


Modulation: Π/4-DQPSK

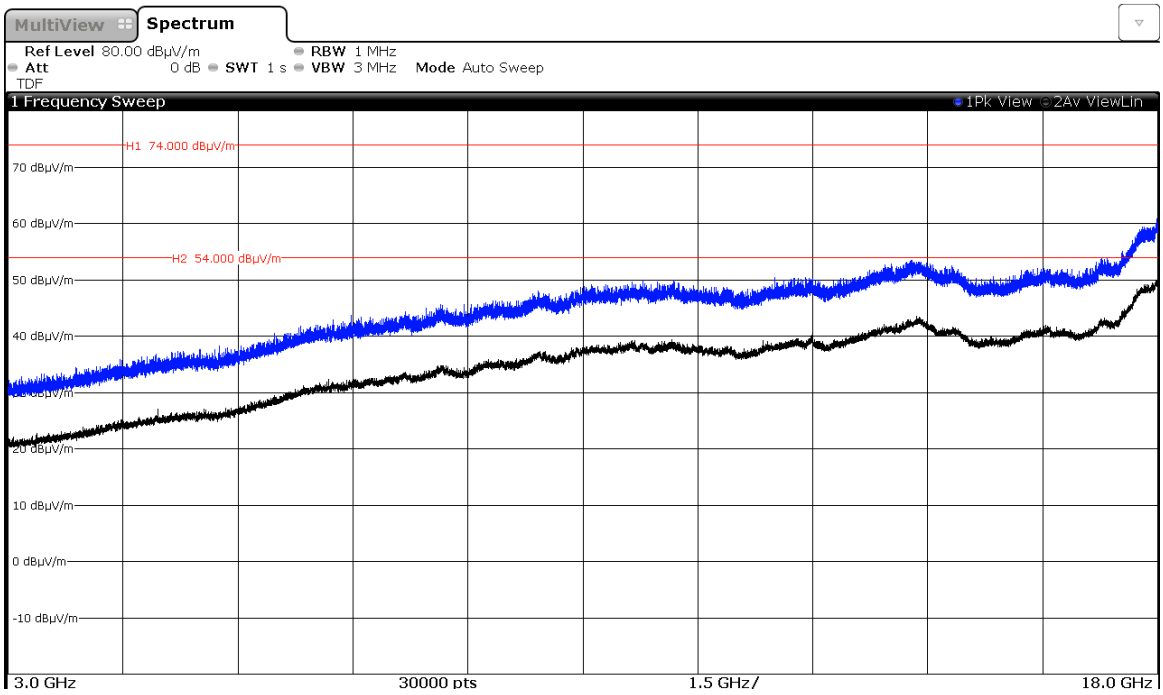
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

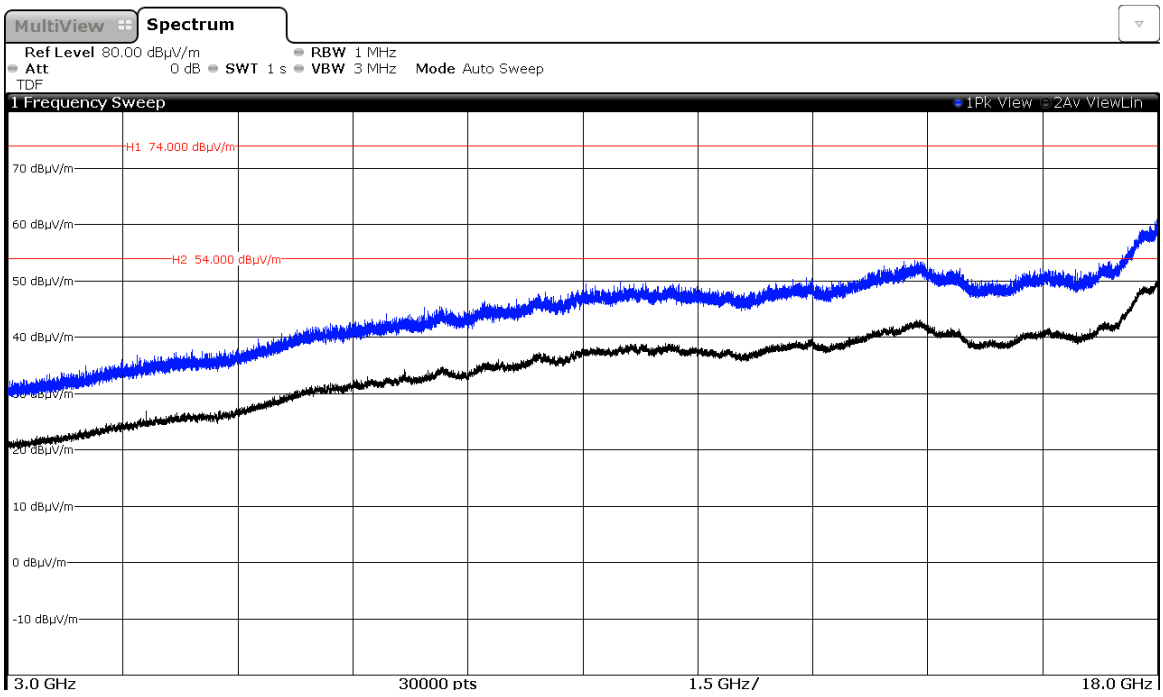


CHANNEL: Highest (2480 MHz).

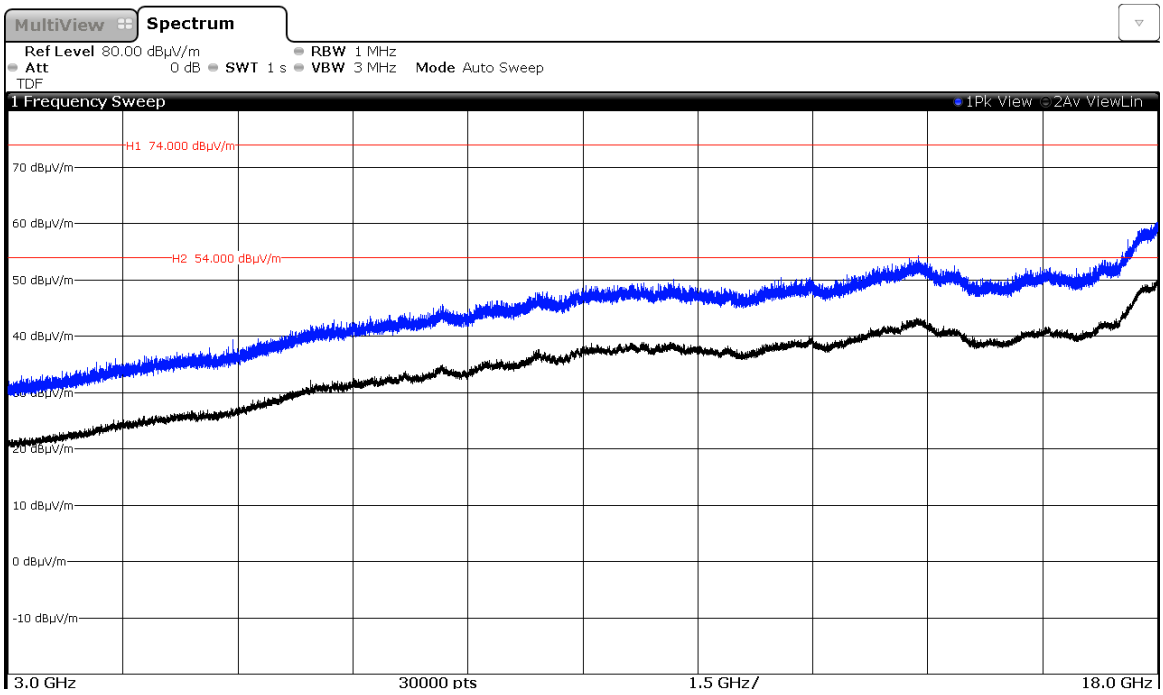


Modulation: 8-DPSK

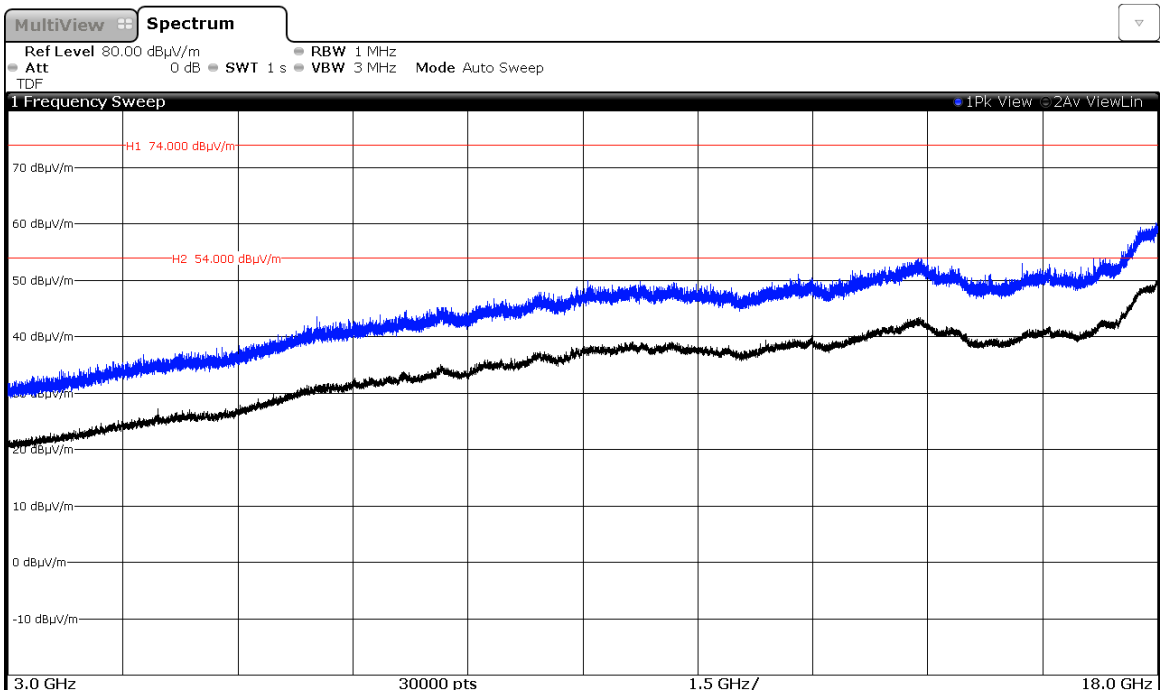
CHANNEL: Lowest (2402 MHz).



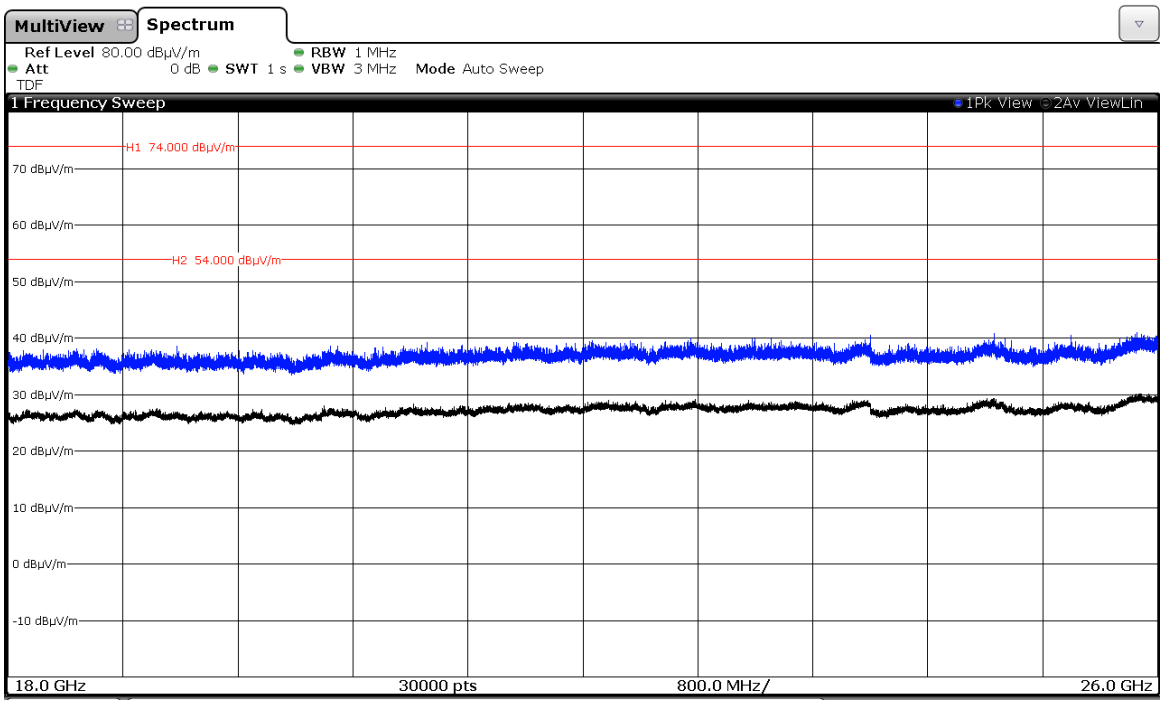
CHANNEL: Middle (2441 MHz).



CHANNEL: Highest (2480 MHz).



FREQUENCY RANGE 18 GHz to 25 GHz.

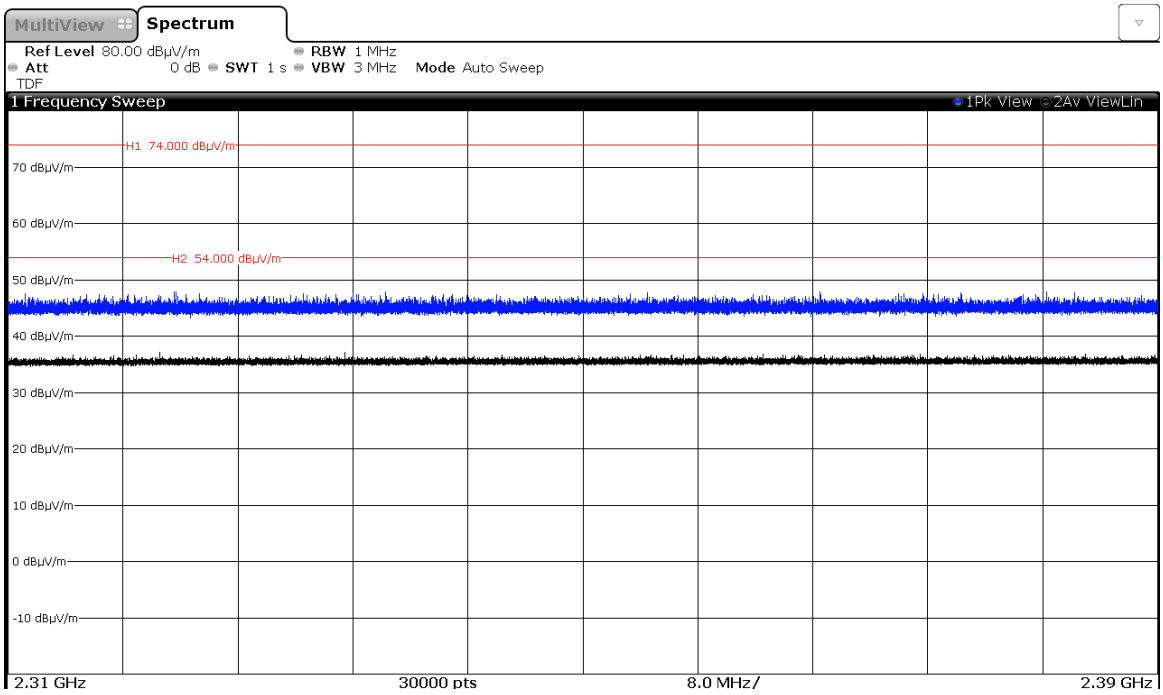


(This plot is valid for all three channels and all modulation modes).

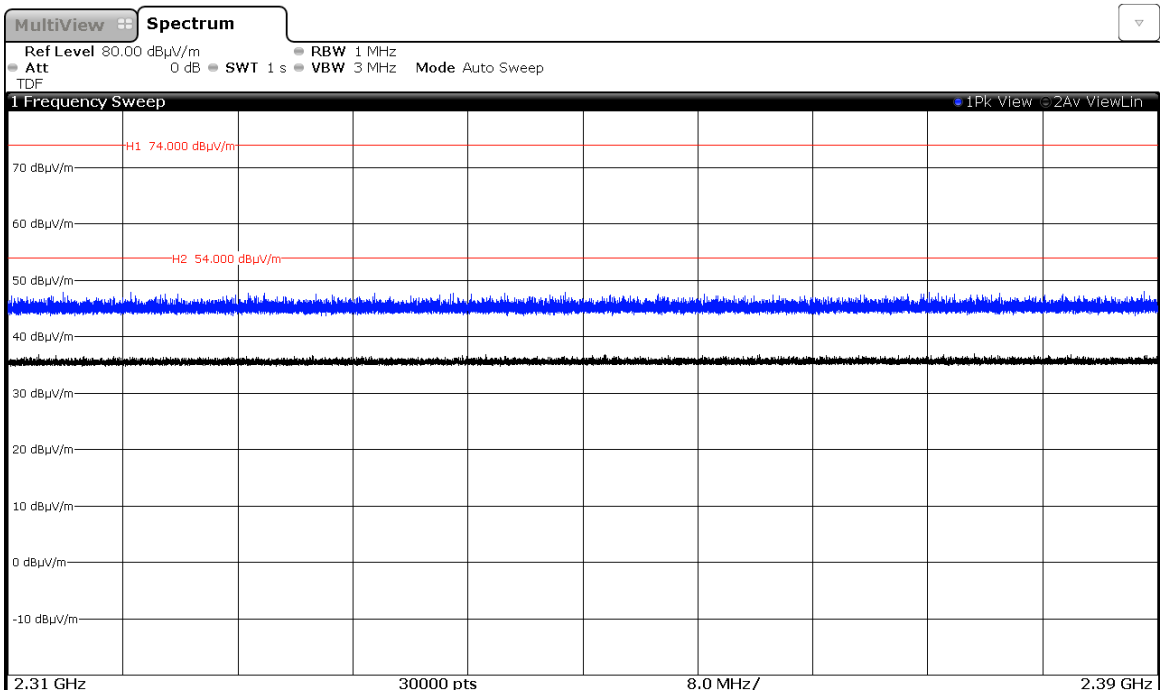
FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

CHANNEL: Lowest (2402 MHz).

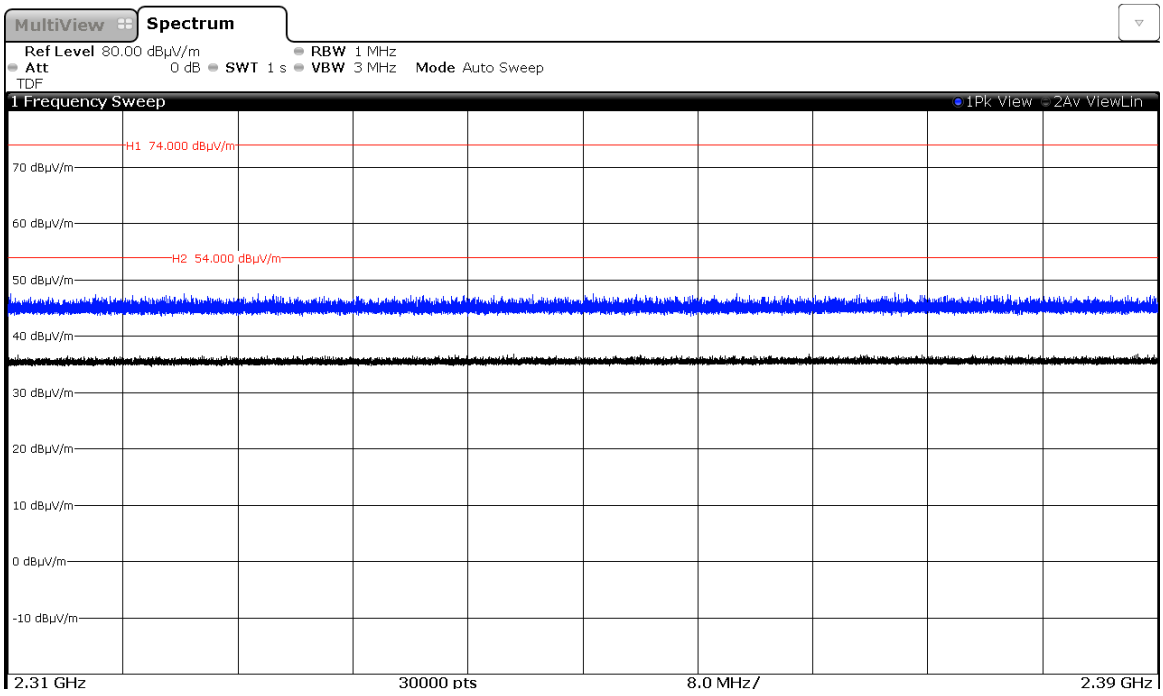
Modulation: GFSK



Modulation: Π/4-DQPSK

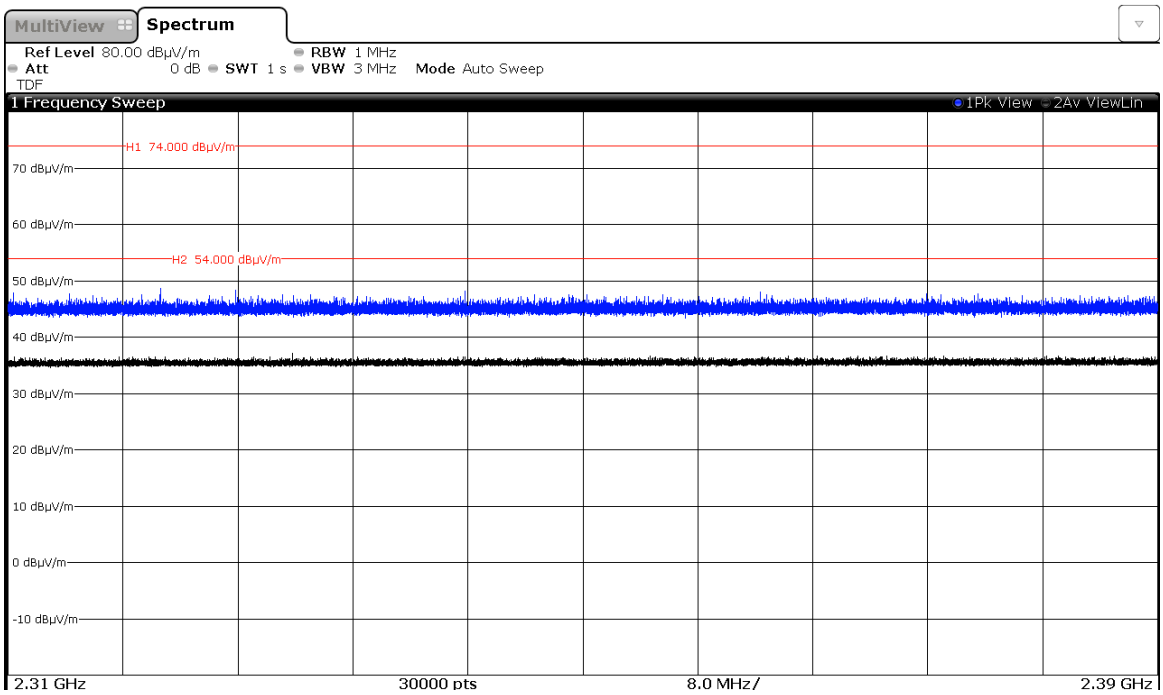


Modulation: 8-DPSK

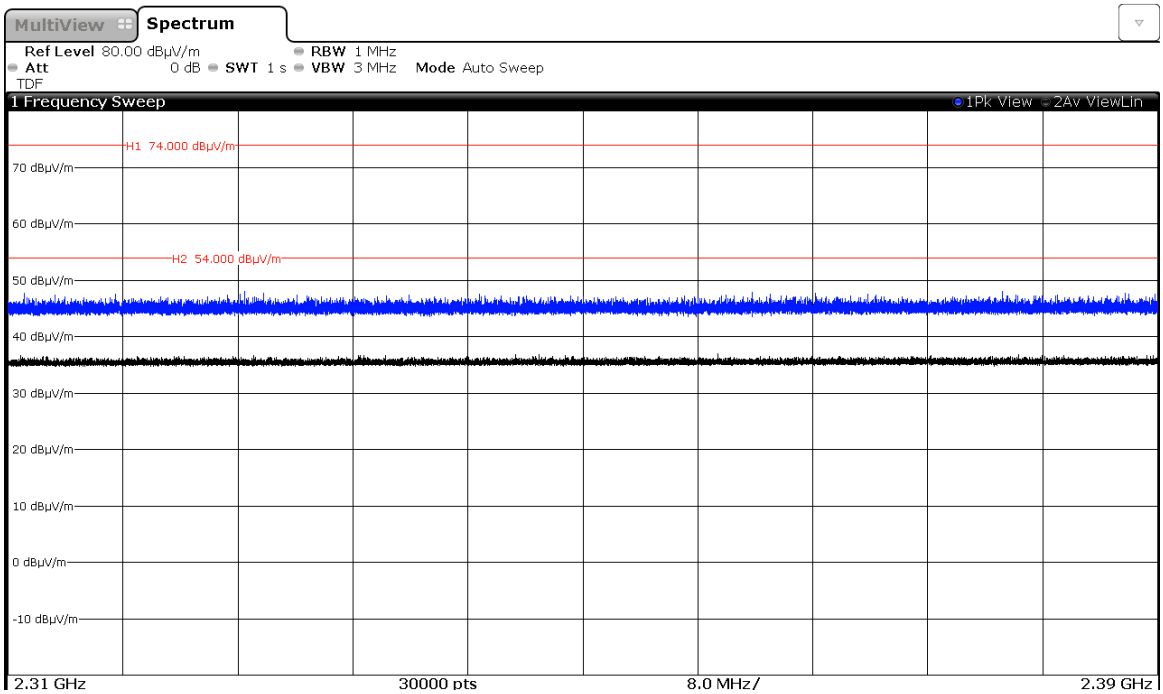


CHANNEL: Middle (2441 MHz).

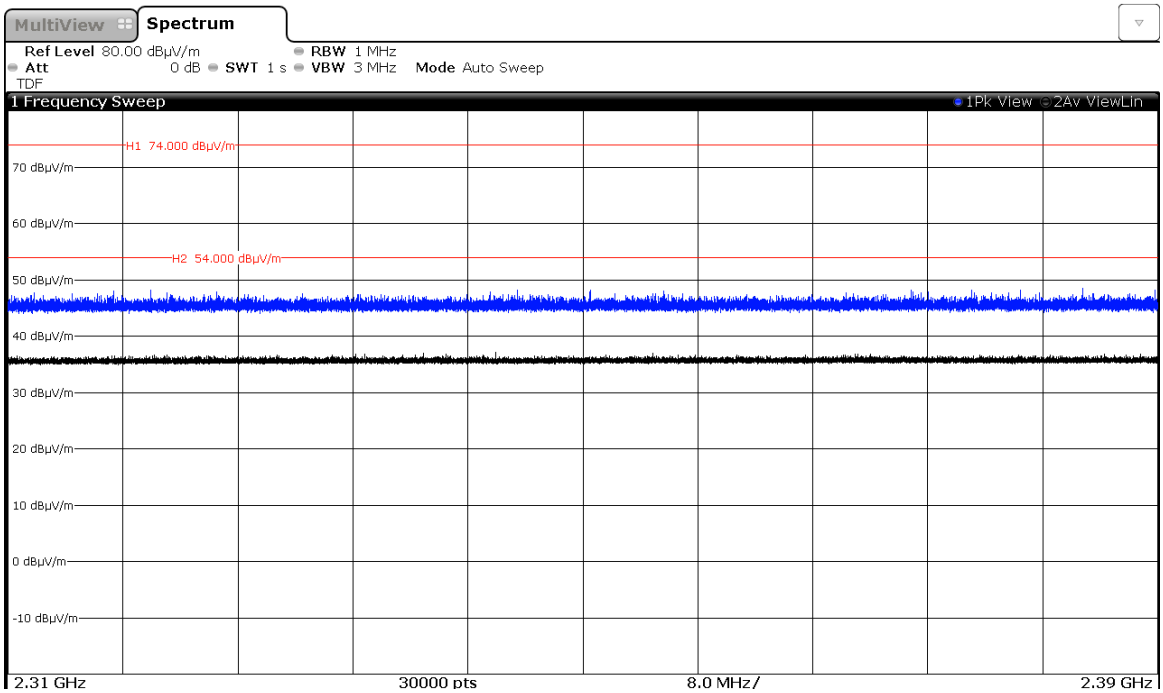
Modulation: GFSK



Modulation: Π/4-DQPSK

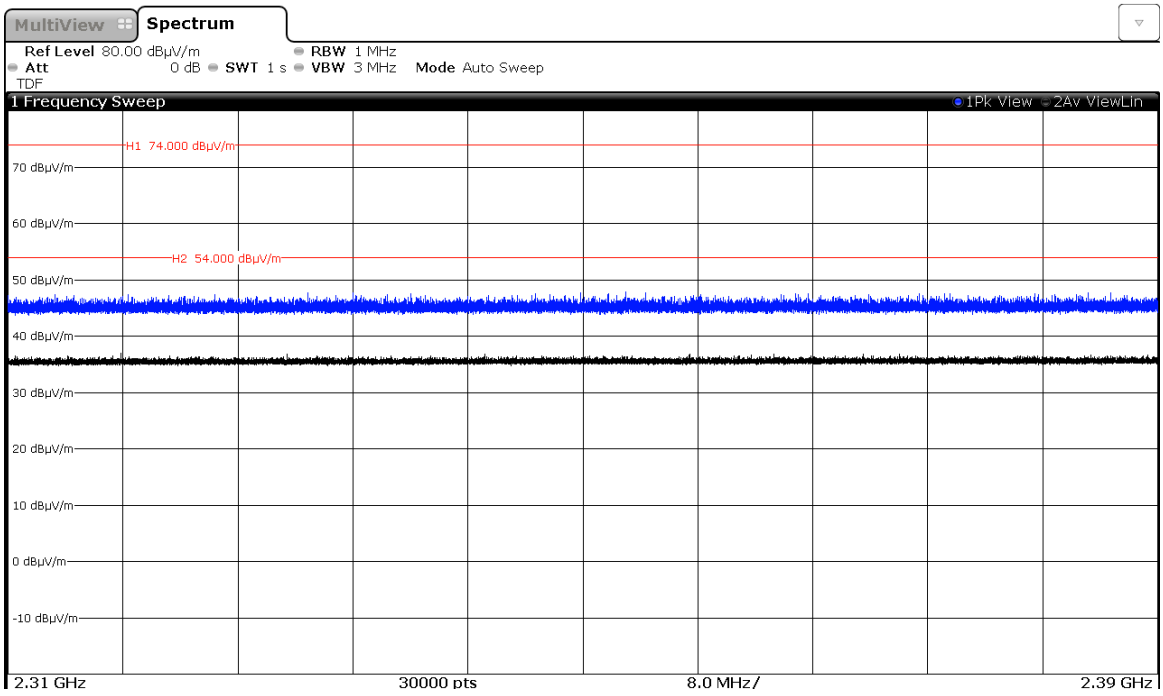


Modulation: 8-DPSK

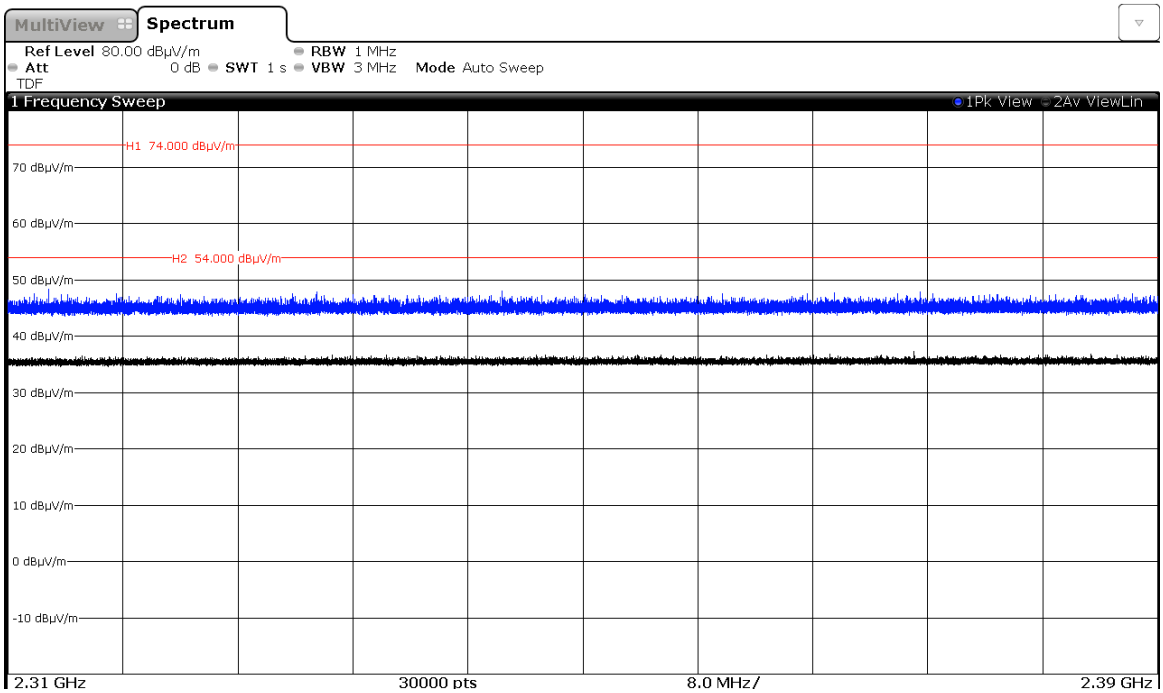


CHANNEL: Highest (2480 MHz).

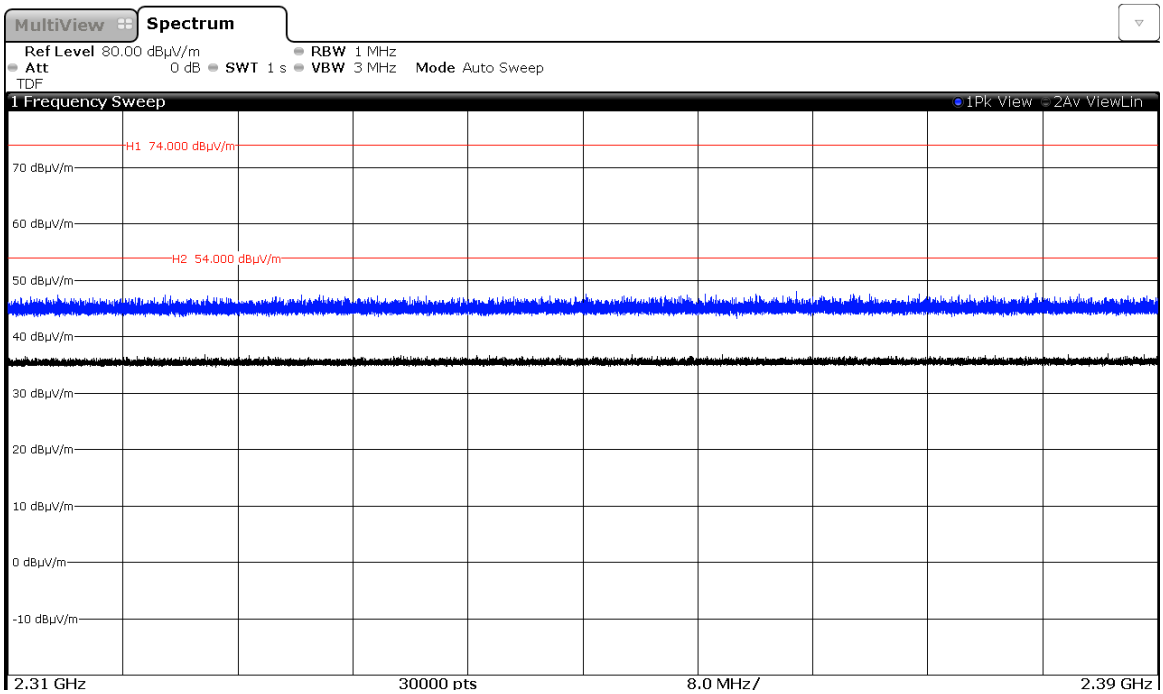
Modulation: GFSK



Modulation: Π/4-DQPSK



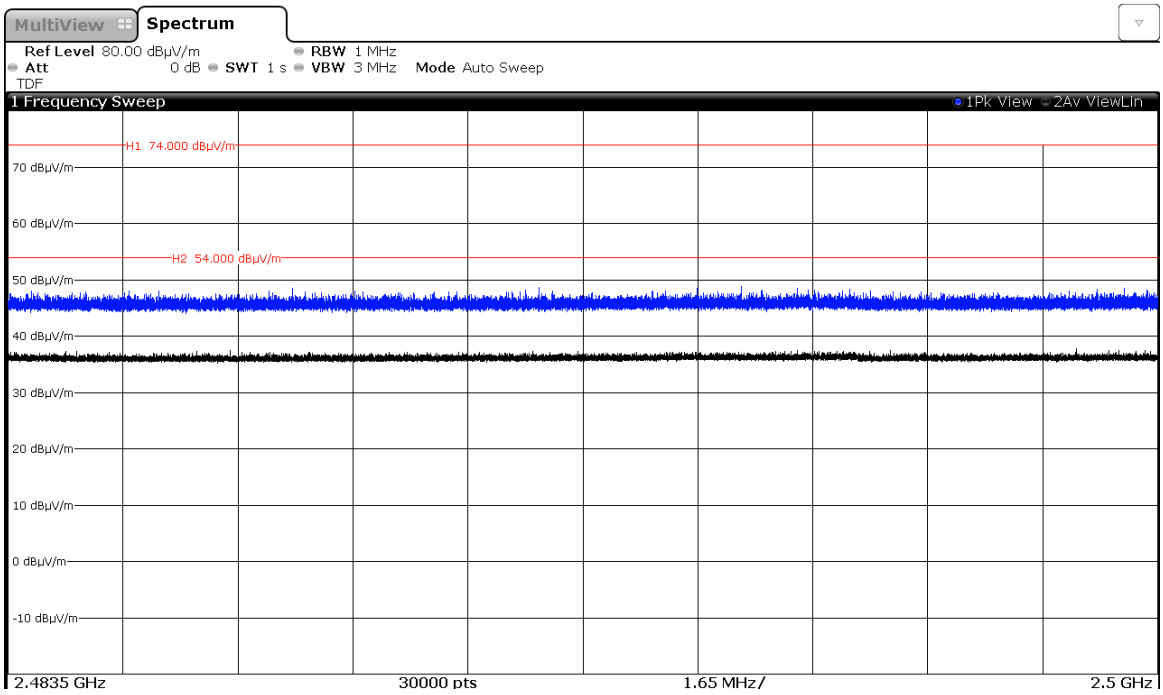
Modulation: 8-DPSK



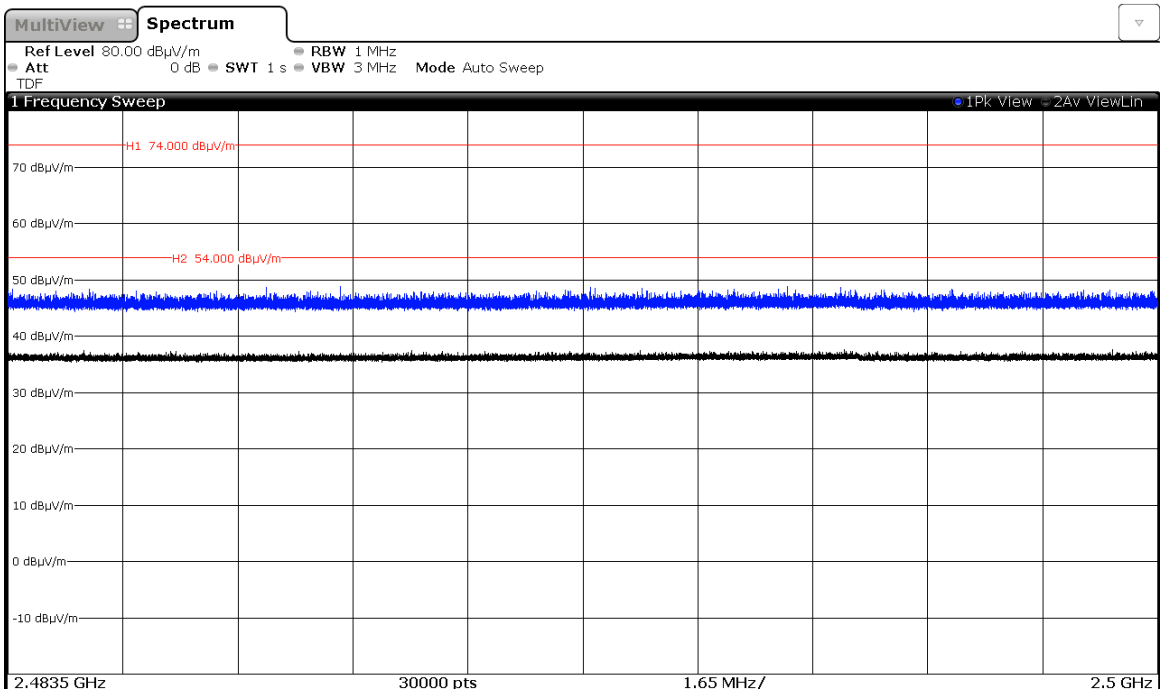
FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest (2402 MHz).

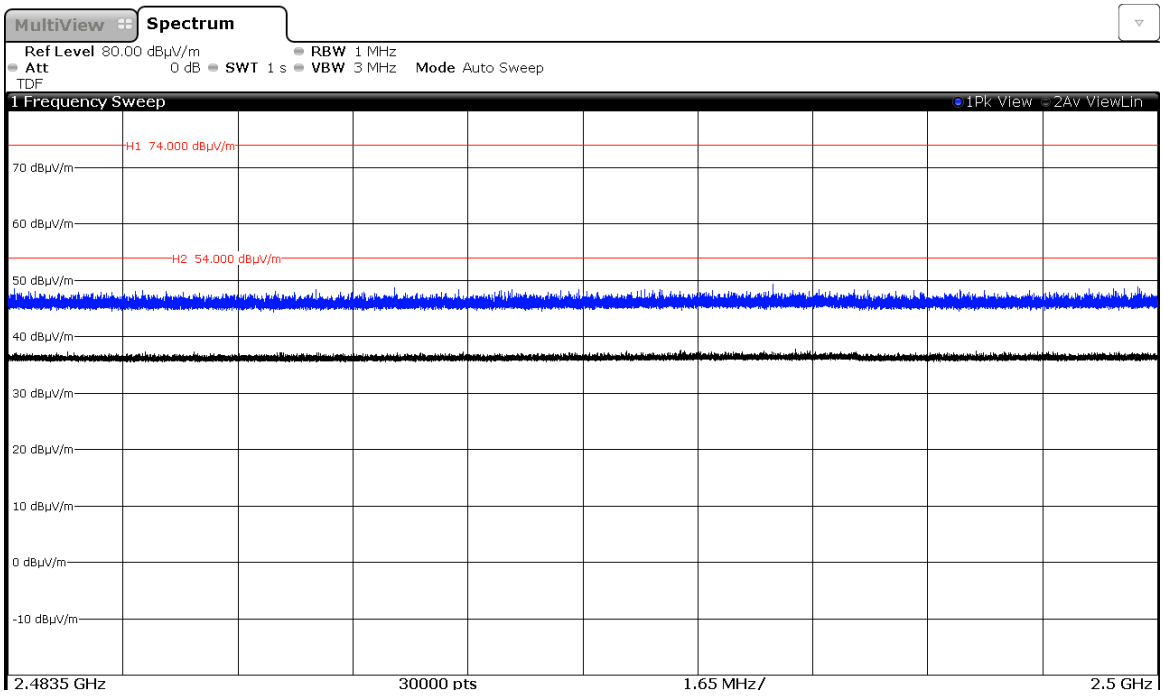
Modulation: GFSK



Modulation: Π/4-DQPSK

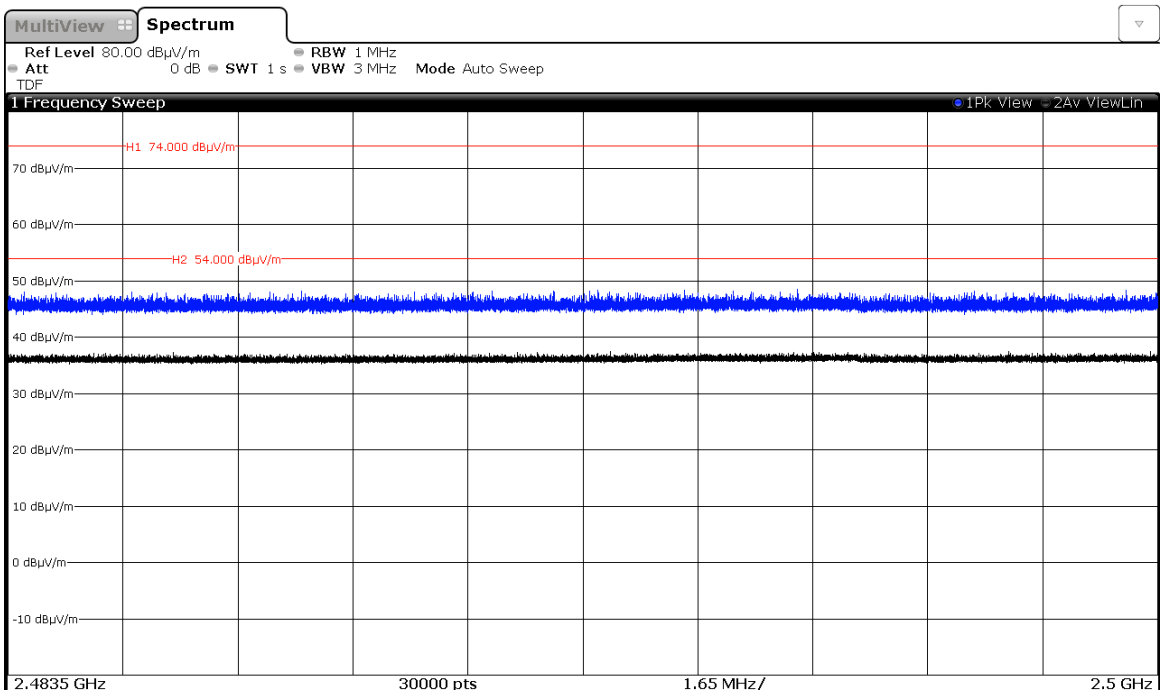


Modulation: 8-DPSK

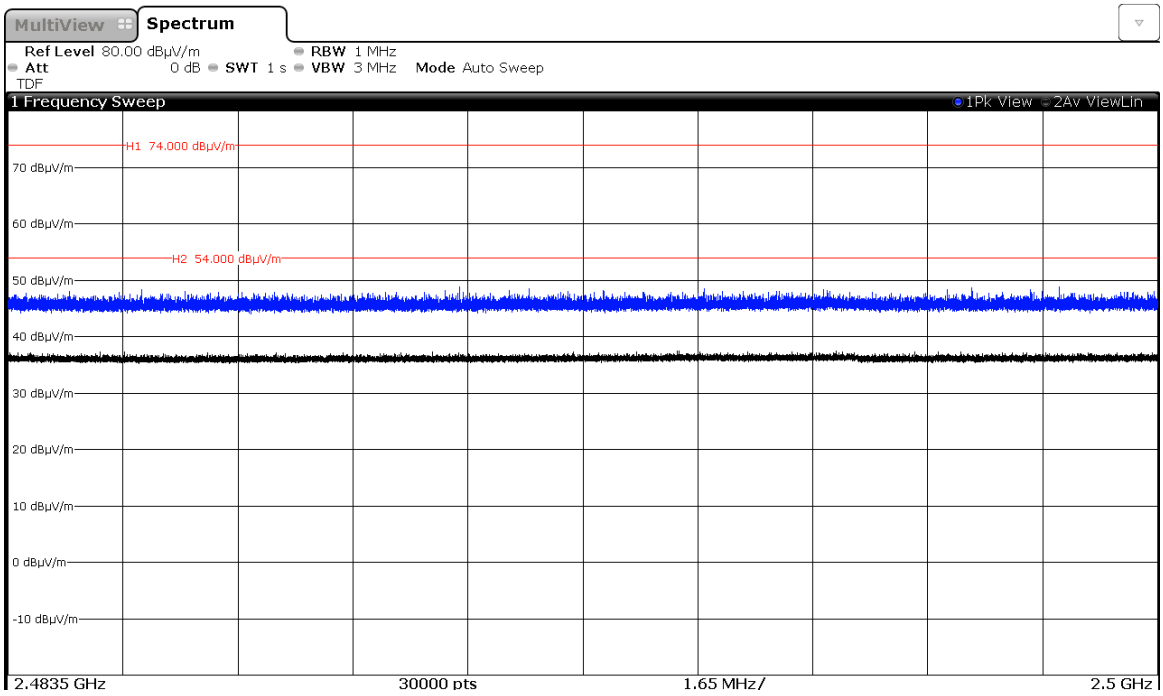


CHANNEL: Middle (2441 MHz).

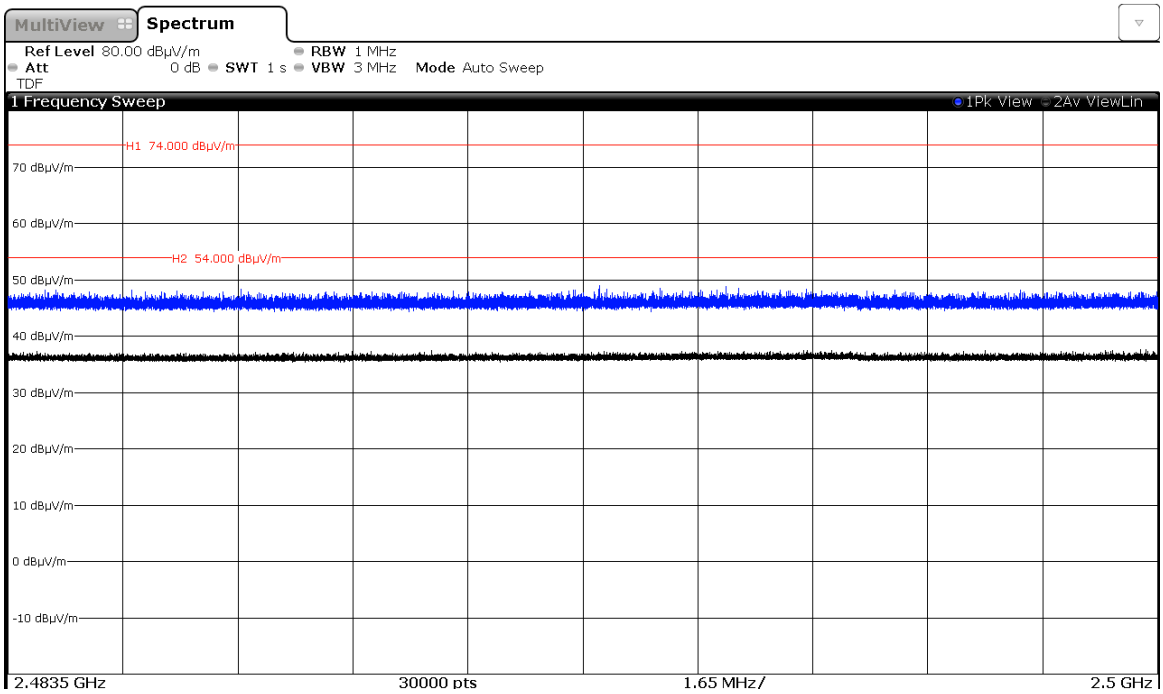
Modulation: GFSK



Modulation: Π/4-DQPSK

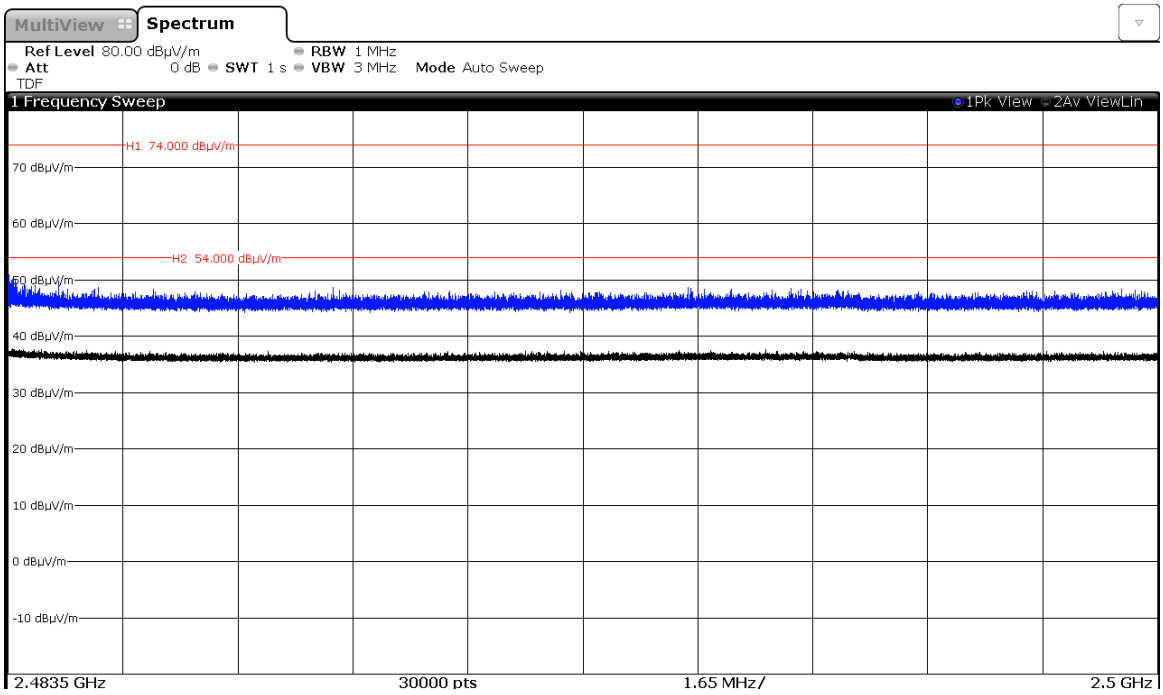


Modulation: 8-DPSK

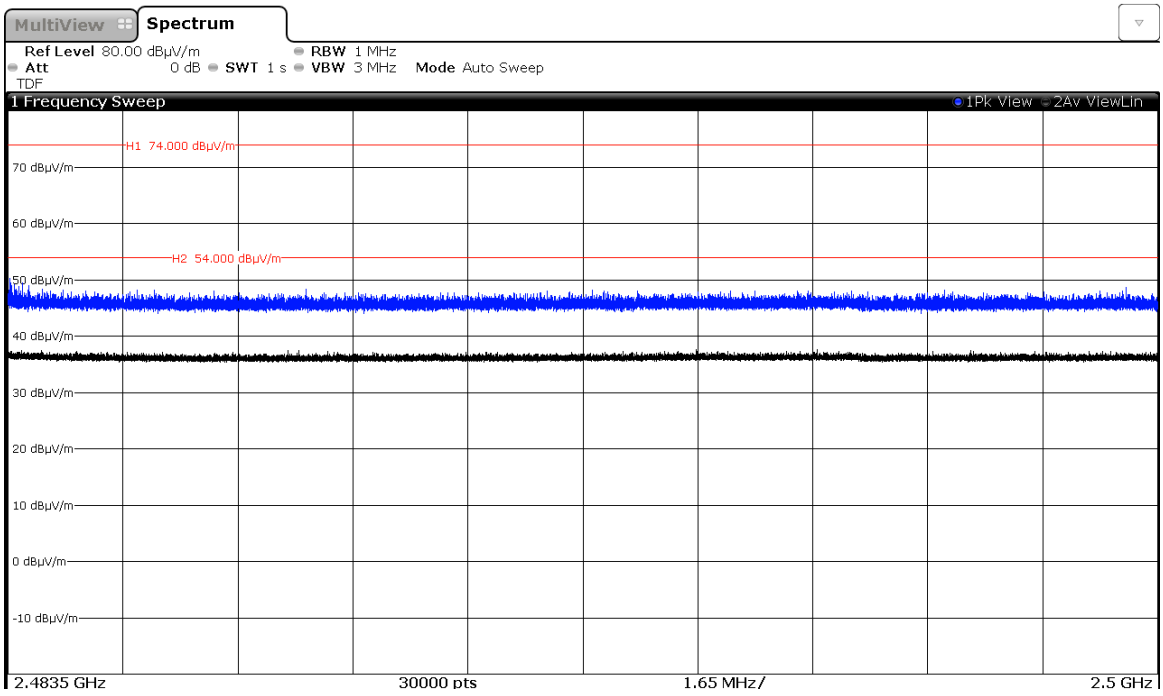


CHANNEL: Highest (2480 MHz).

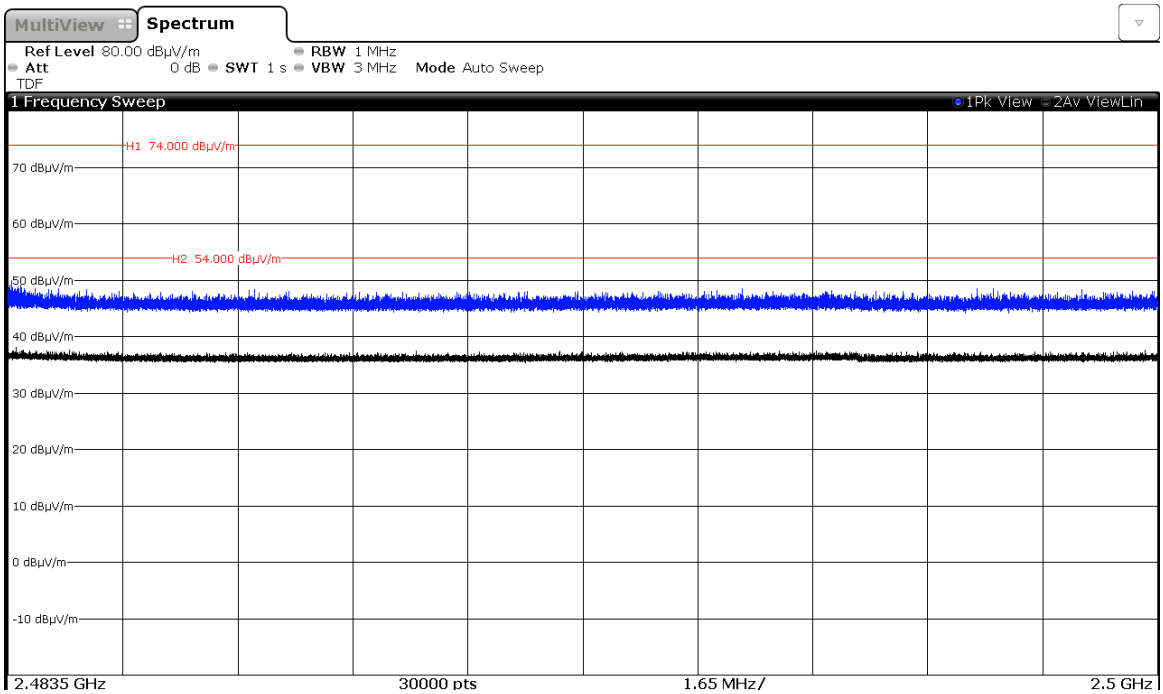
Modulation: GFSK



Modulation: Π/4-DQPSK



Modulation: 8-DPSK



Appendix B – Test result (Bluetooth Low Energy)

INDEX

TEST CONDITIONS

Power supply (V):

V_{nom} = 4.2 Vdc

V_{max} = N/A

V_{min} = N/A

The subscripts nom, min and max indicate voltage test conditions (nominal, minimum and maximum respectively, as declared by the applicant).

Type of power supply = DC Voltage from rechargeable battery

Type of antenna = PIFA antenna 2400-2500MHz (-0.3dBi).

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2440 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

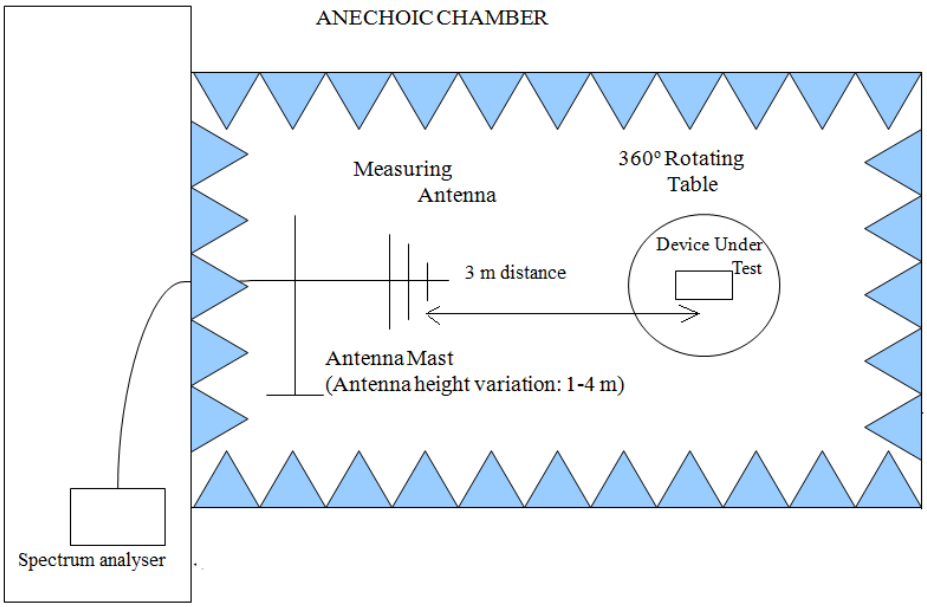
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40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

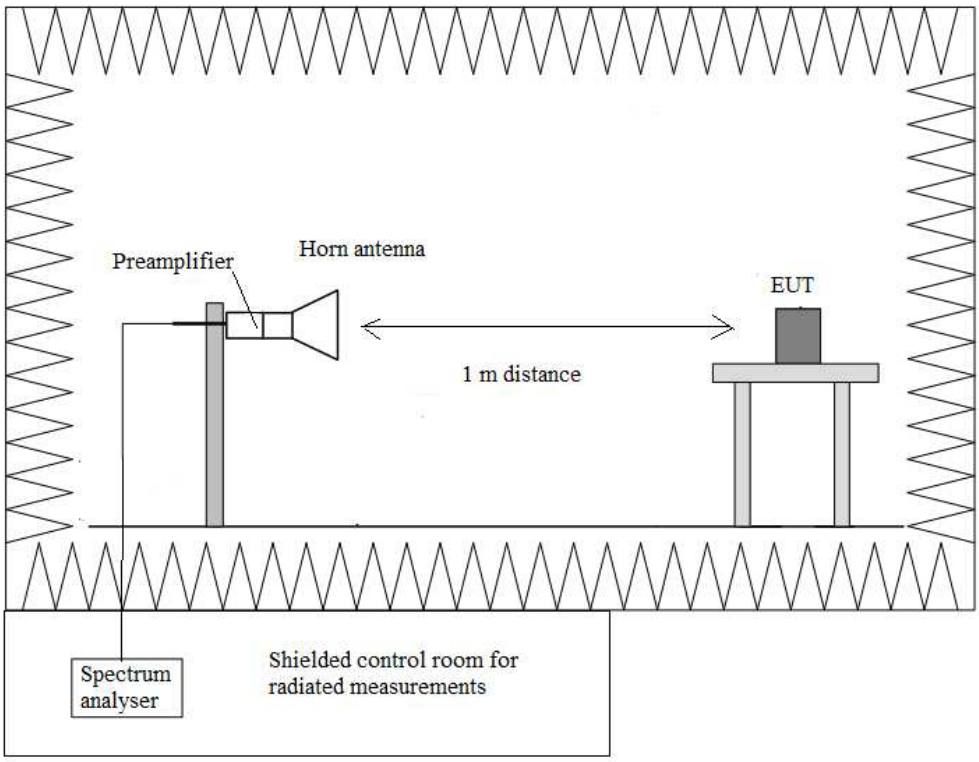
Measurements were made in both horizontal and vertical planes of polarization.

Radiated measurements setup f < 1 GHz



Shielded Control Room For Radiated Measurements

Radiated measurements setup f > 1 GHz



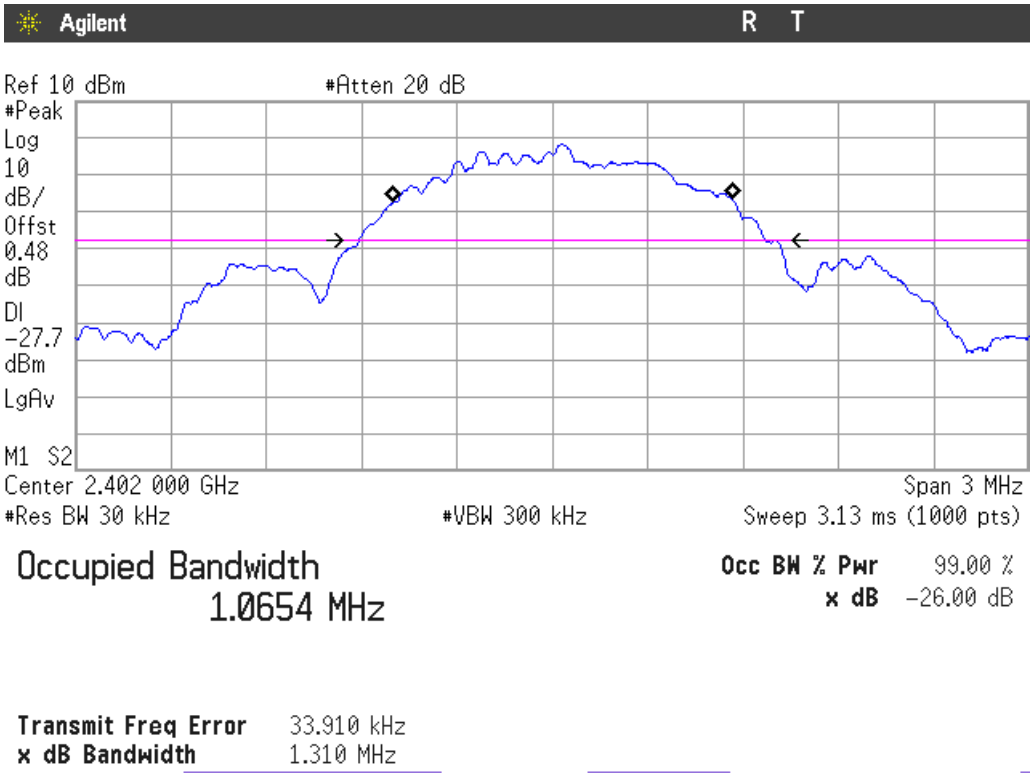
Occupied Bandwidth

RESULTS

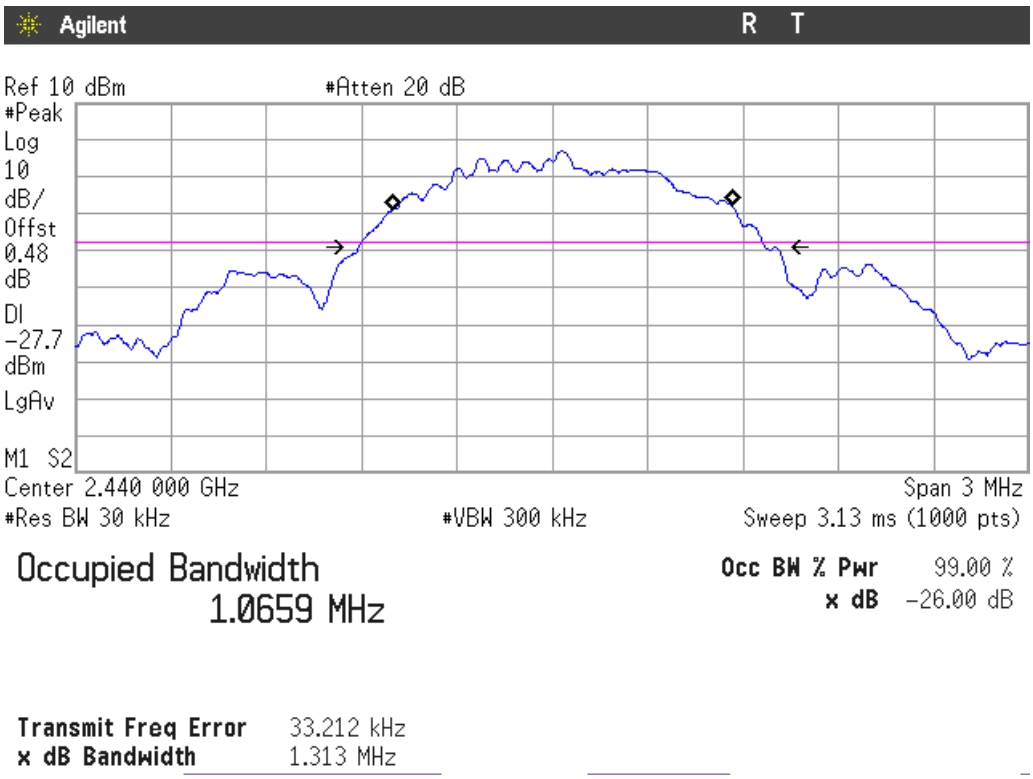
(see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
99% bandwidth (MHz)	1.065	1.066	1.064
-26 dBc bandwidth (MHz)	1.310	1.313	1.279
Measurement uncertainty (kHz)	<± 5.0		

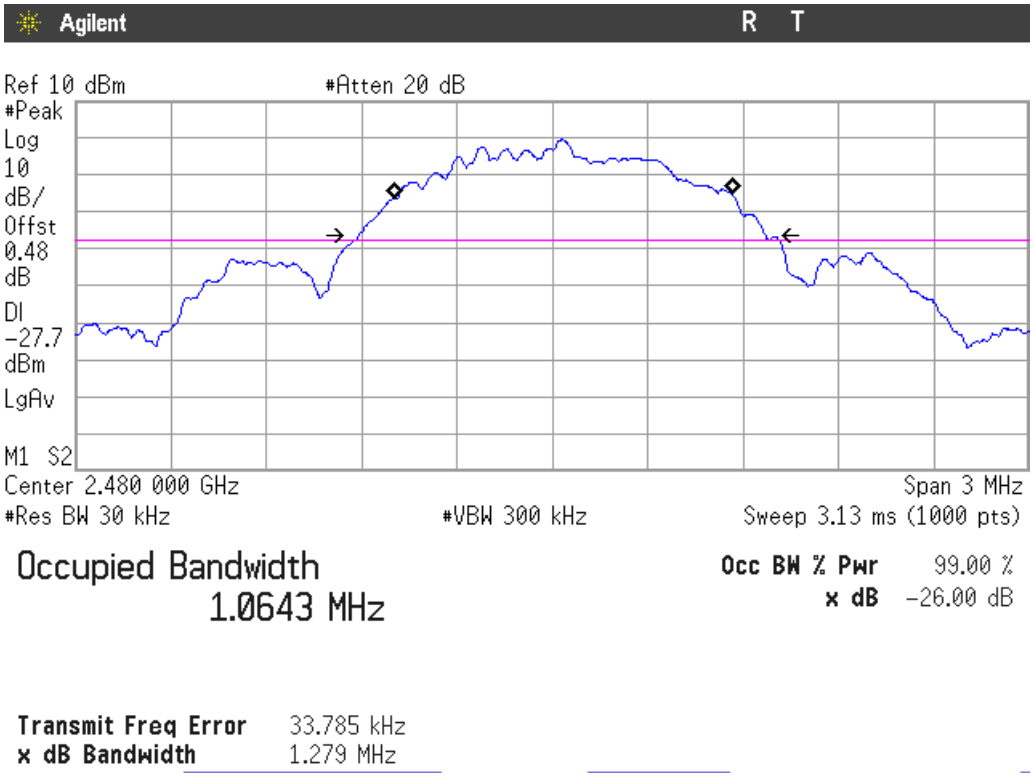
Lowest Channel



Middle Channel



Highest channel



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

SPECIFICATION

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

RESULTS

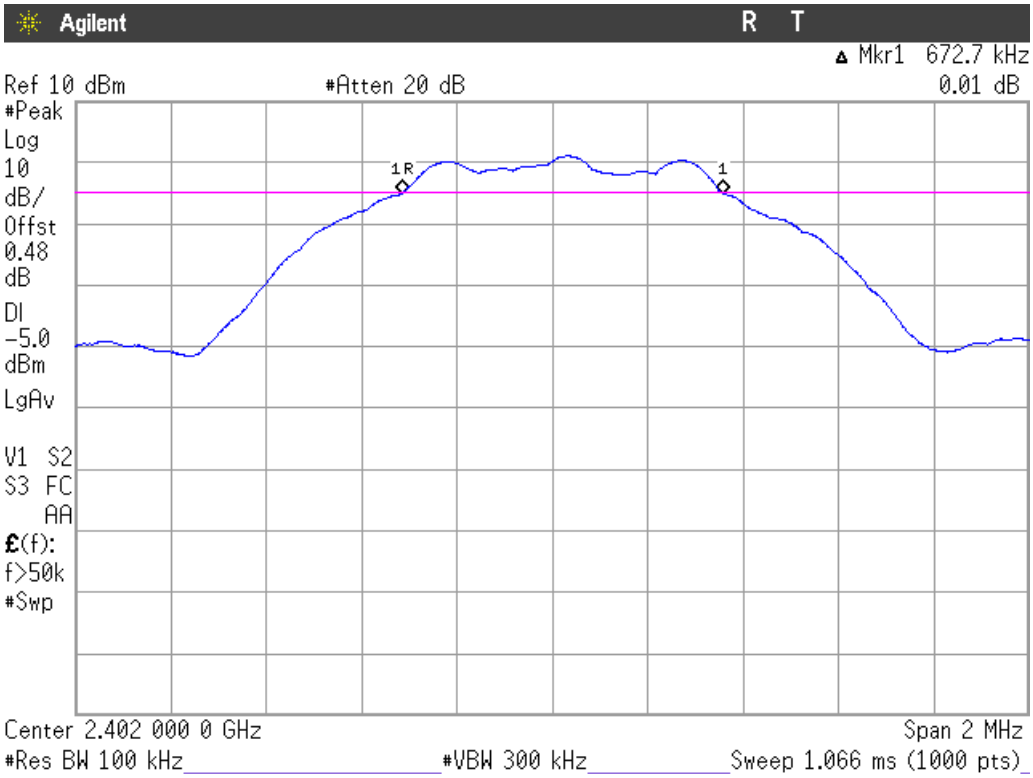
6 dB Bandwidth (see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
6 dB Spectrum bandwidth (kHz)	672.7	670.7	668.7
Measurement uncertainty (kHz)	<±11.0		

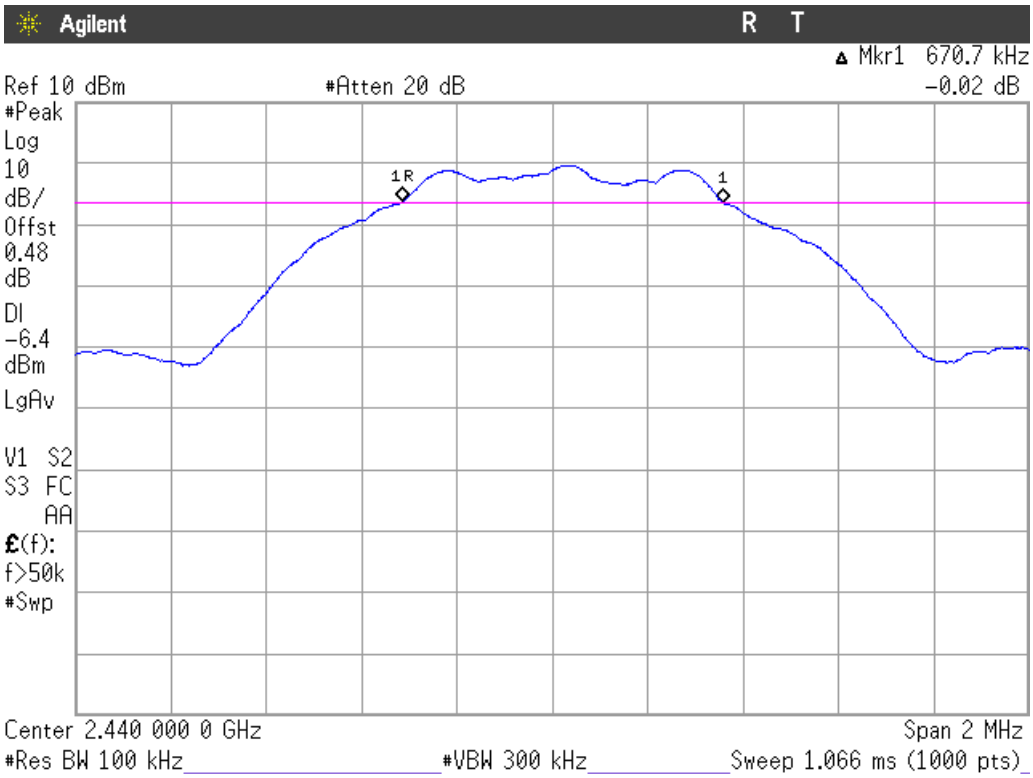
Verdict: PASS

6 dB BANDWIDTH.

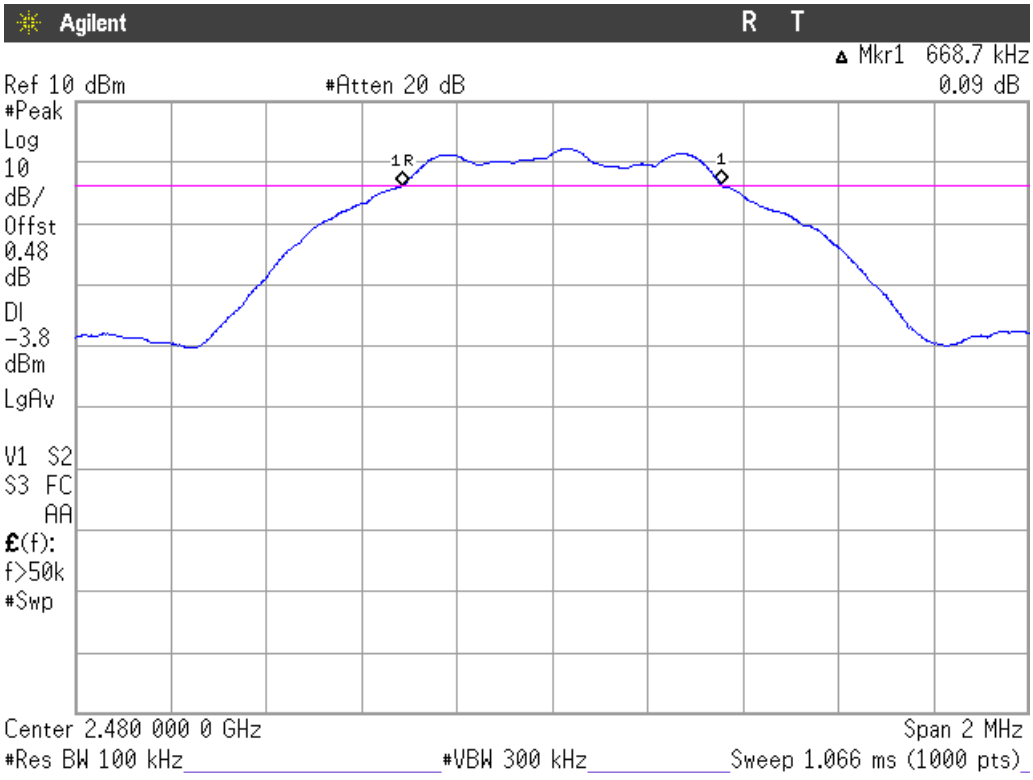
Lowest Channel



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 peak conducted output power was measured using the method according to point 9.1.1. 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.

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: -0.3 dBi.

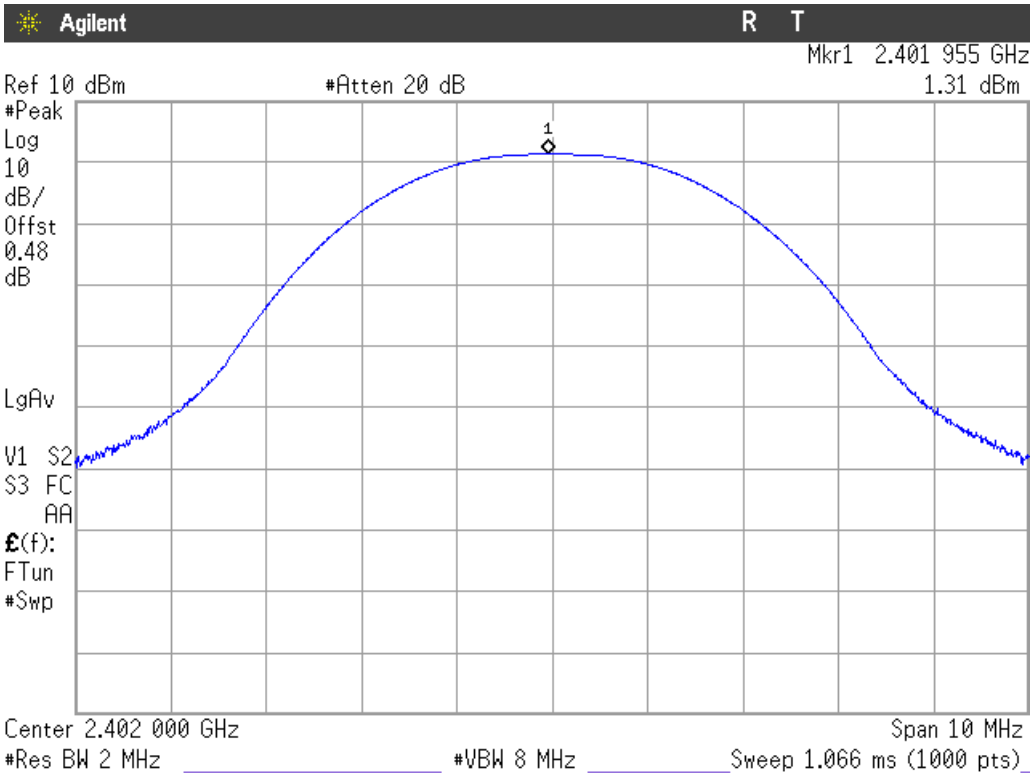
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum conducted power (dBm)	1.31	-0.04	2.46
Maximum EIRP power (dBm)	1.01	-0.34	2.16
Measurement uncertainty (dB)	<±0.78		

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.

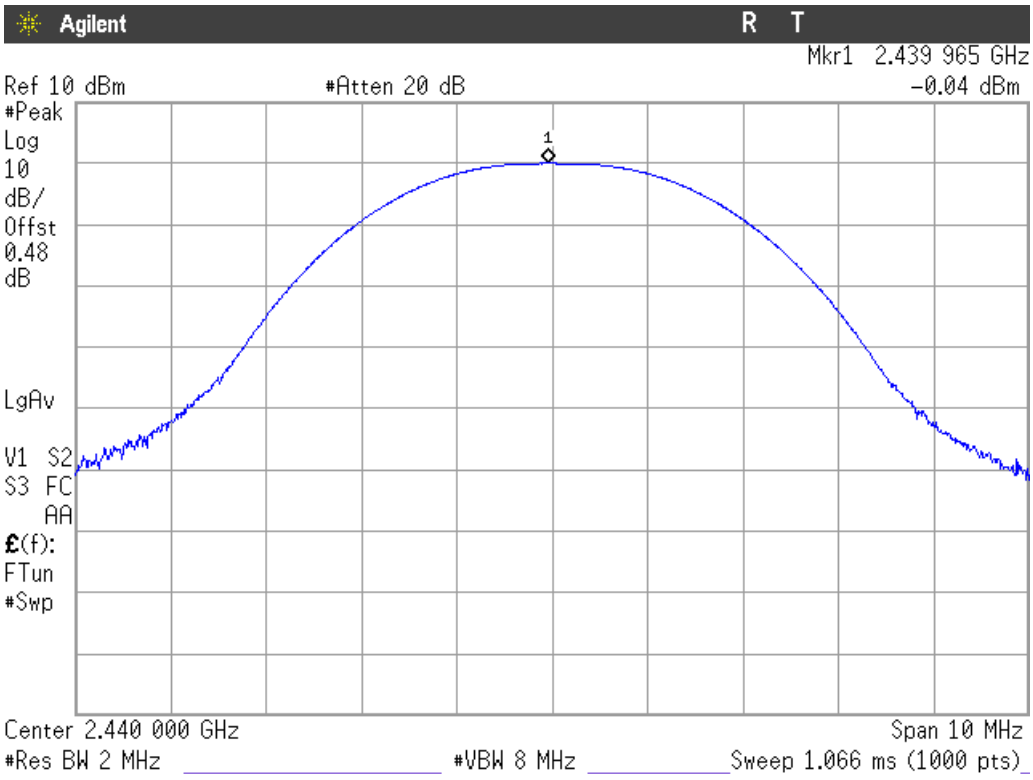
Verdict: PASS

CONDUCTED PEAK POWER.

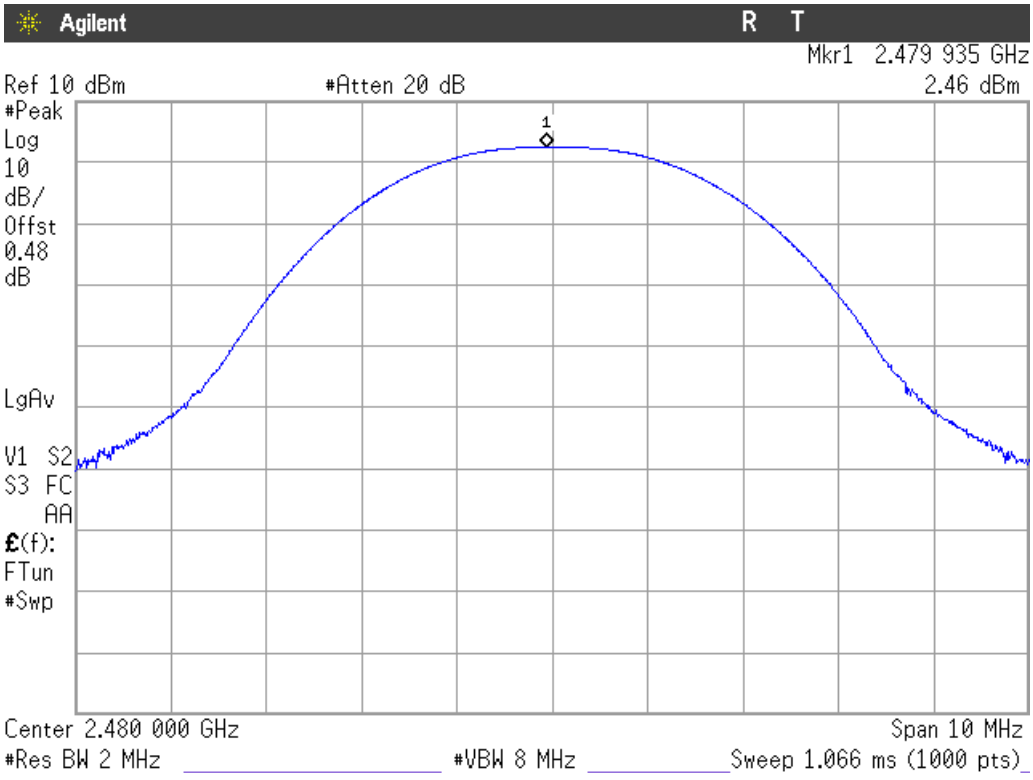
Lowest frequency



Middle frequency



Highest frequency



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

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Reference Level Measurement (dBm)	1.03	-0.32	2.20
Measurement uncertainty (dB)	<±0.78		

Lowest frequency 2402 MHz:

All peaks are more than 20 dB below the limit.

Middle frequency 2440 MHz:

All peaks are more than 20 dB below the limit.

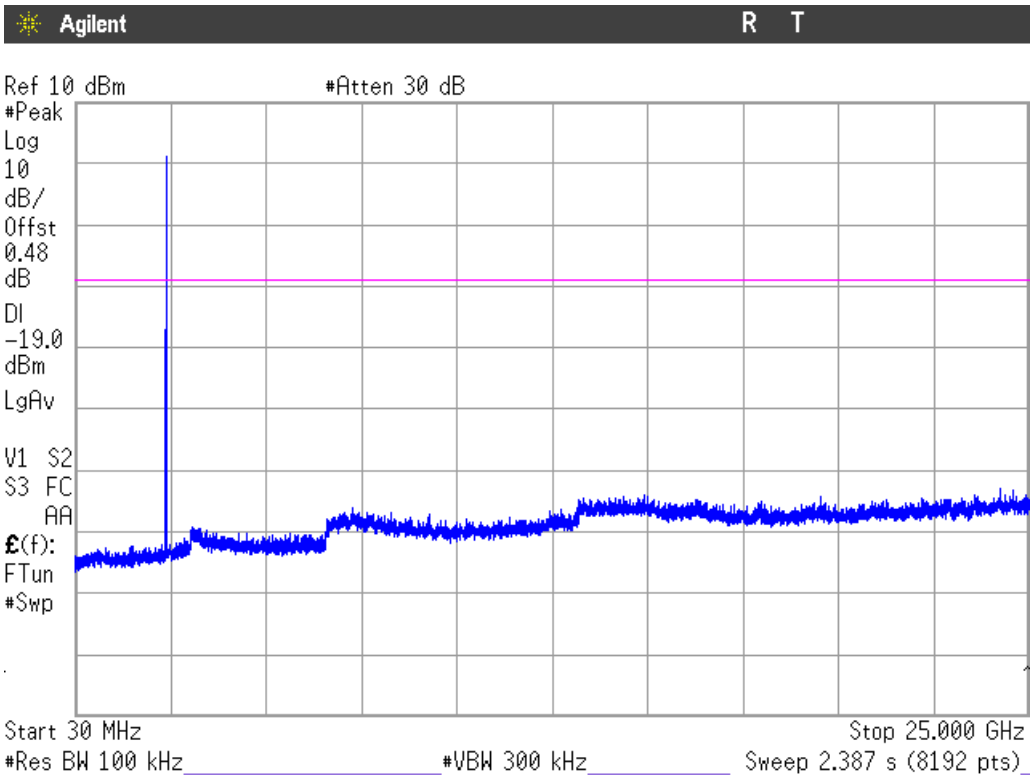
Highest frequency 2480 MHz:

All peaks are more than 20 dB below the limit.

Measurement uncertainty (dB): < 2.03

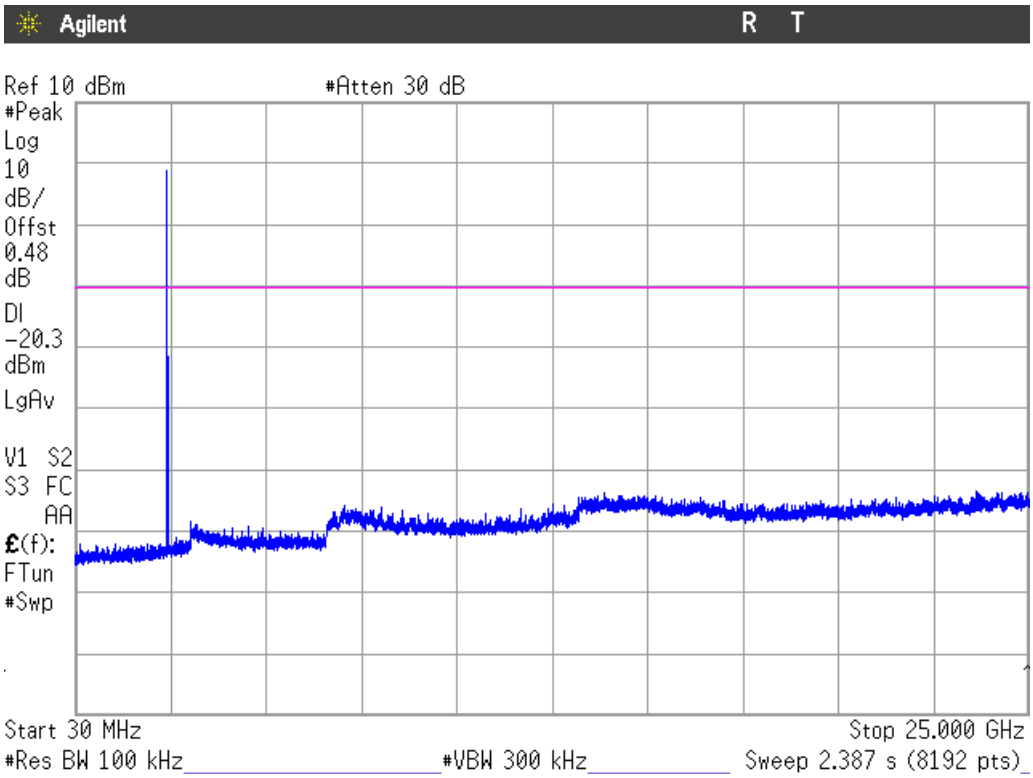
Verdict: PASS

Lowest frequency



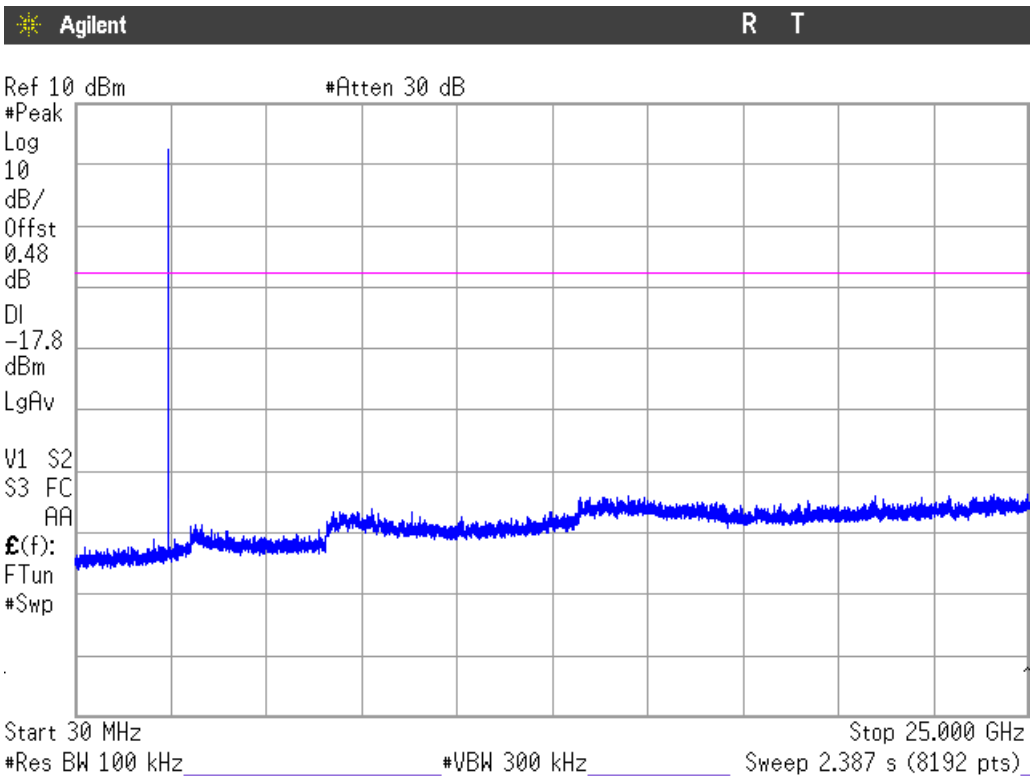
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle frequency



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

Highest frequency



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

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

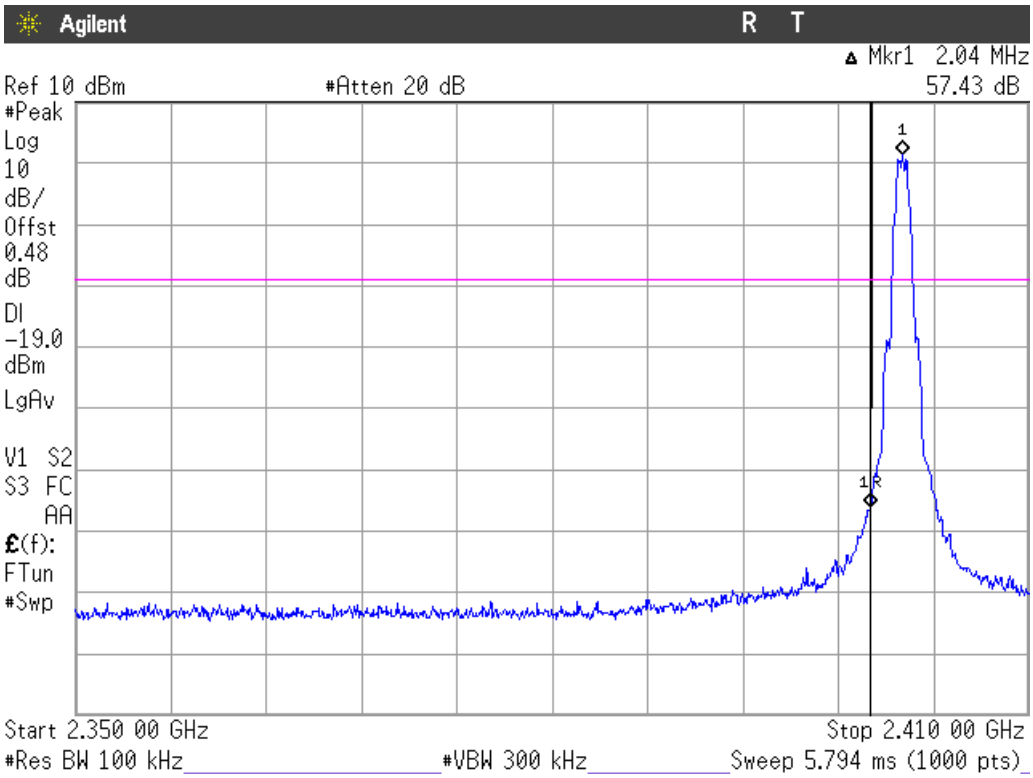
SPECIFICATION

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:

1. LOW FREQUENCY SECTION. CONDUCTED.

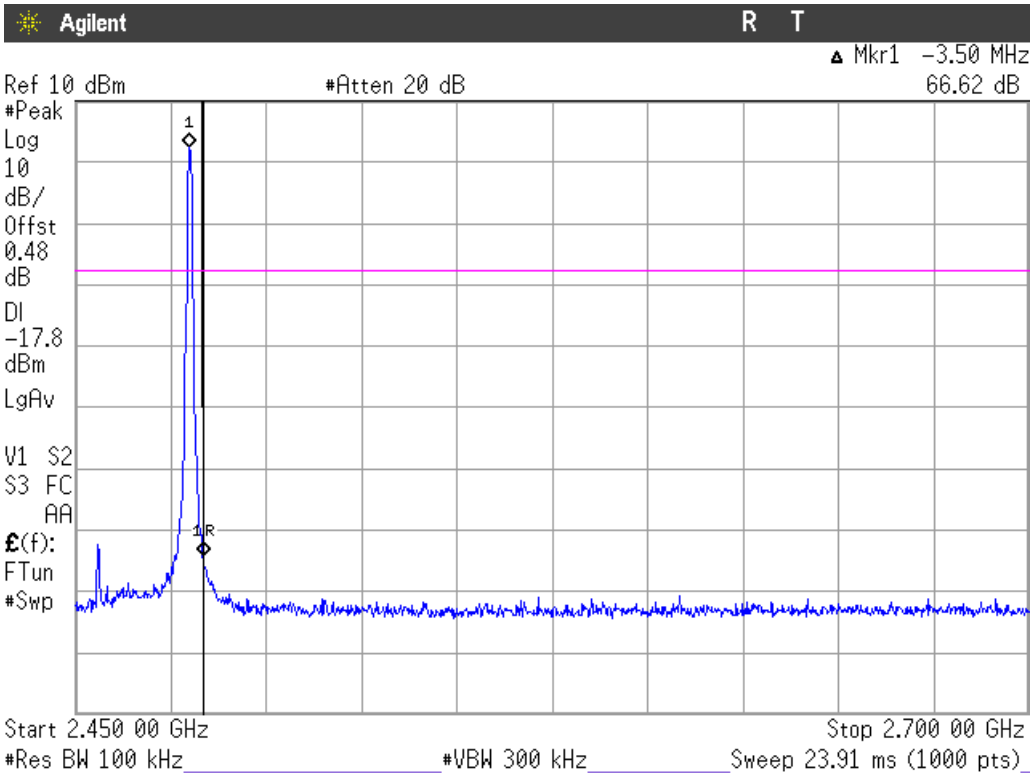
See next plot.



Verdict: PASS

2. HIGH FREQUENCY SECTION. CONDUCTED.

See next plot.



Measurement uncertainty (dB)	< ±2.03

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 PKPSD (Peak PSD) according to point 10.2. 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.

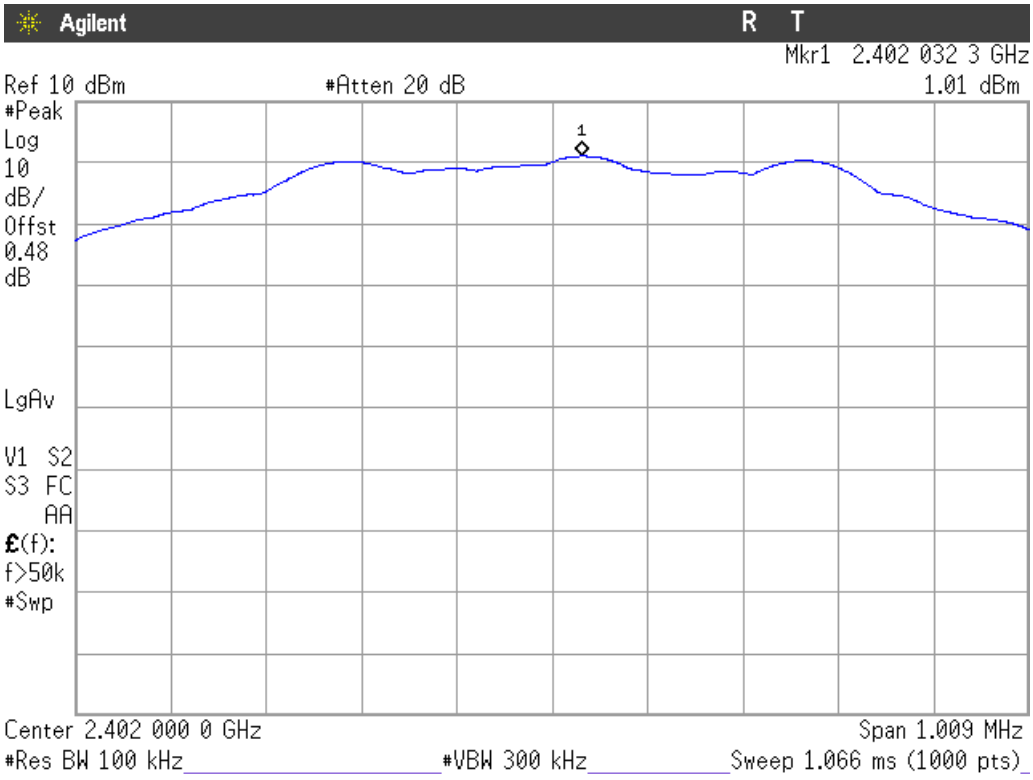
Power spectral density (see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Power spectral density (dBm)	1.01	-0.36	2.17
Measurement uncertainty (dB)	<±0.78		

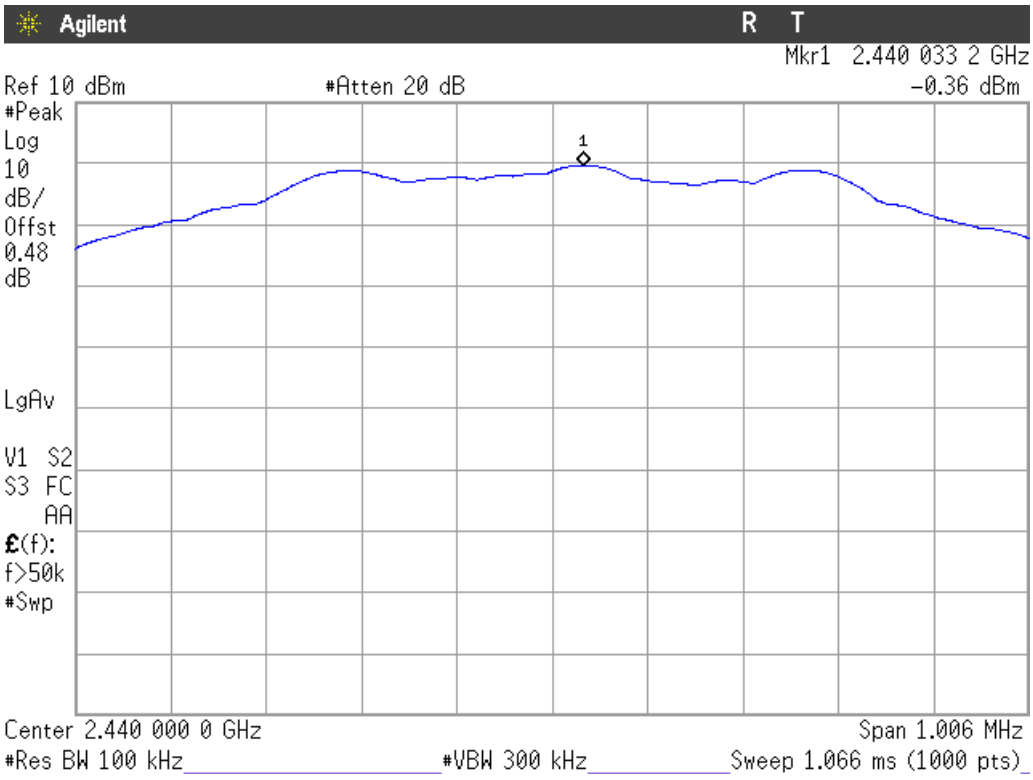
Verdict: PASS

POWER SPECTRAL DENSITY

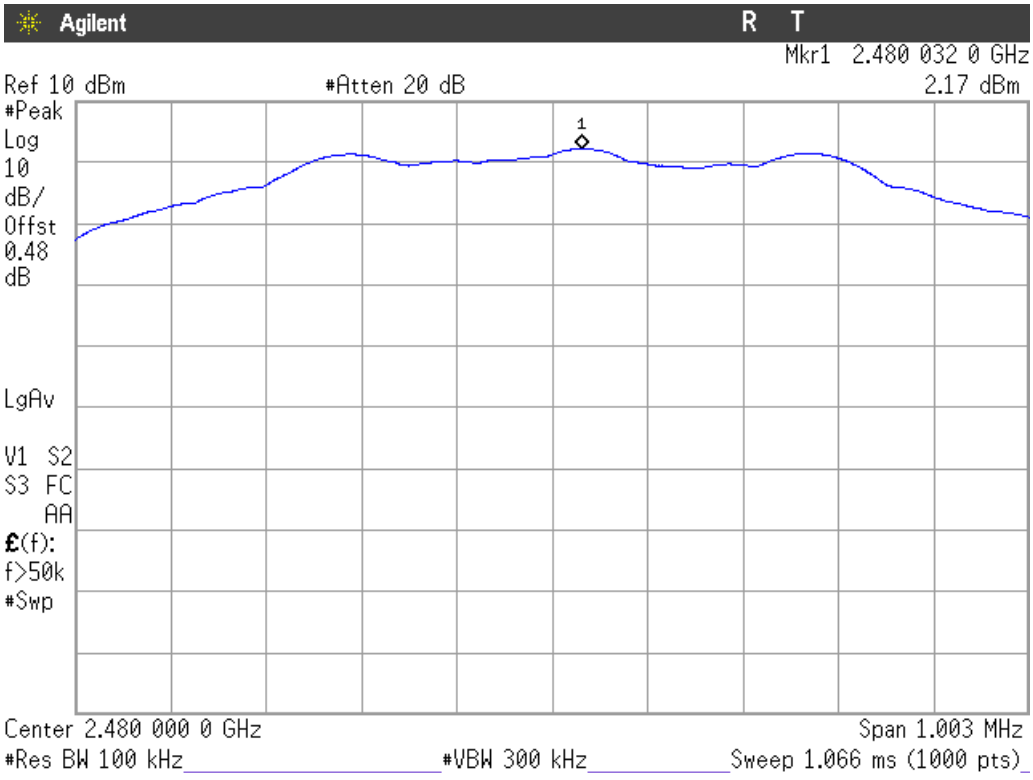
Lowest Channel



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)):

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 the operating channel selected in the EUT.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
37.501	V	Quasi-Peak	26.12	± 3.88
43.289	V	Quasi-Peak	23.29	± 3.88
57.580	V	Quasi-Peak	22.99	± 3.88

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).

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

1. CHANNEL: LOWEST (2402 MHz).

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE (2440 MHz).

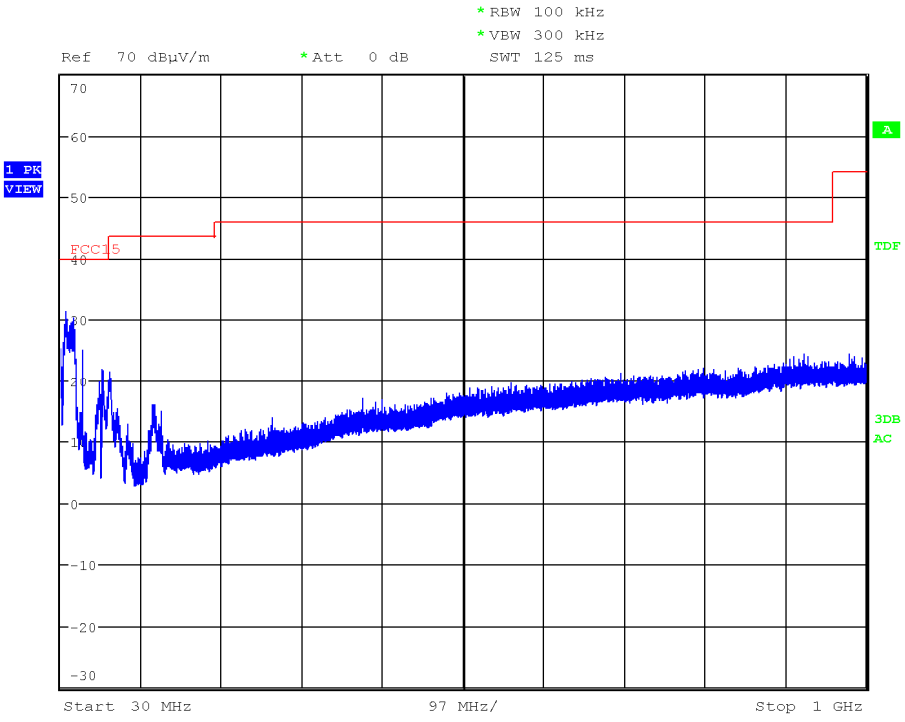
No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST (2480 MHz).

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Verdict: PASS

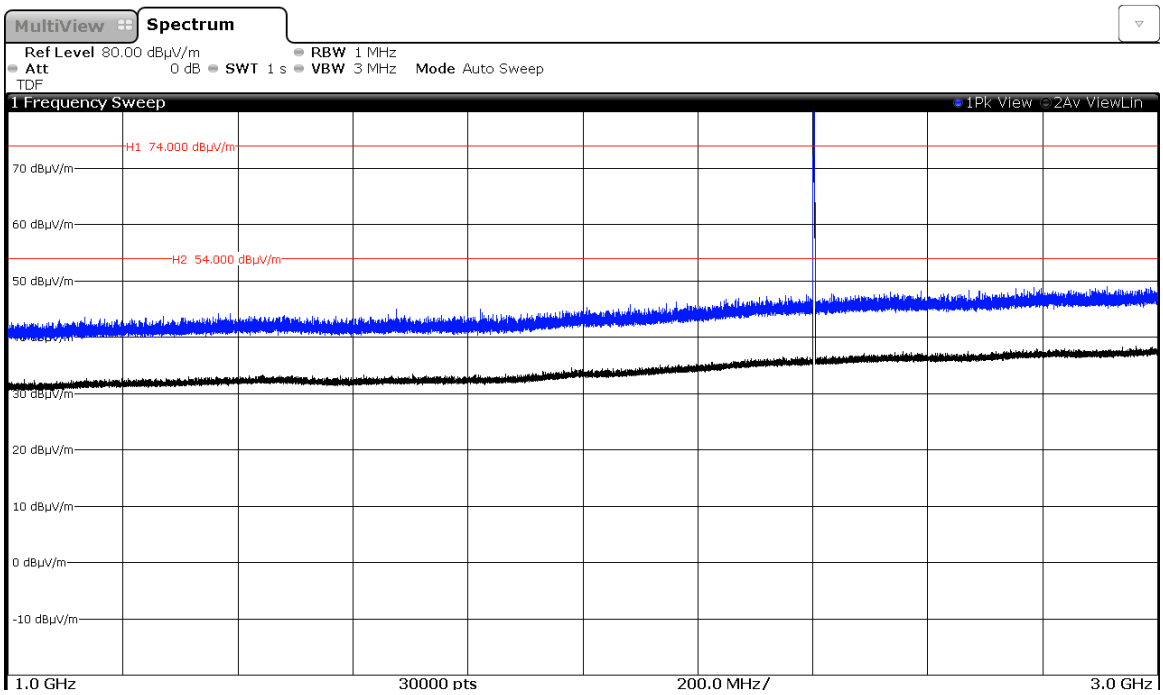
FREQUENCY RANGE 30 MHz-1000 MHz.



(This plot is valid for all three channels).

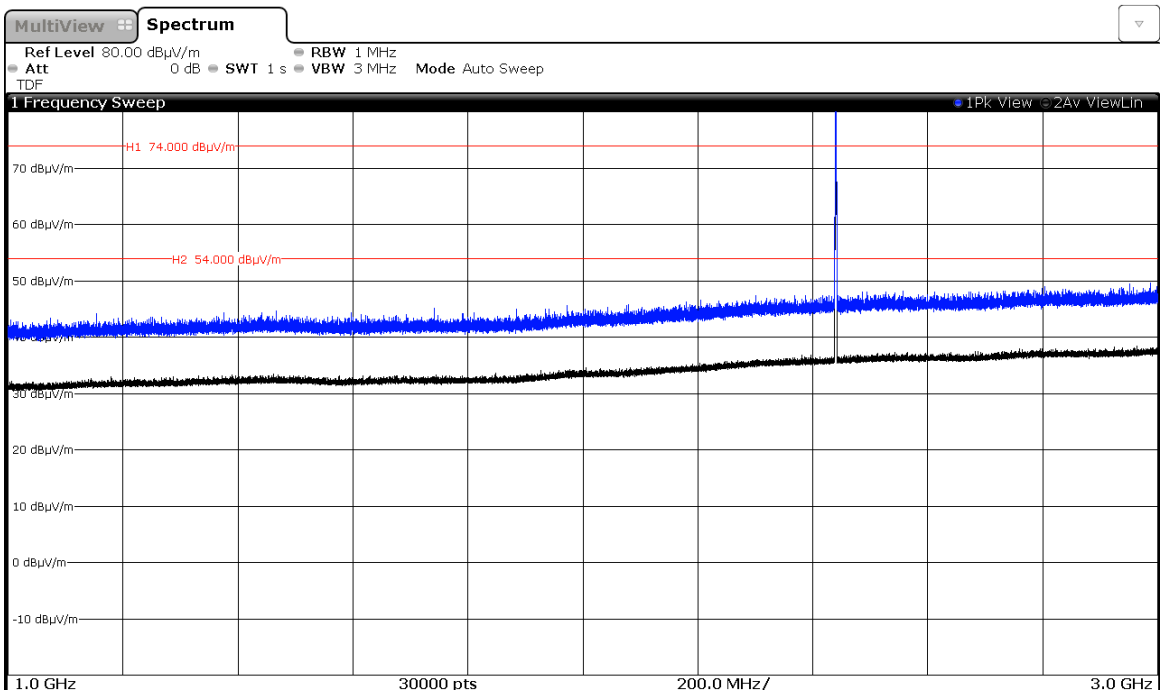
FREQUENCY RANGE 1 GHz to 3 GHz.

CHANNEL: Lowest (2402 MHz).



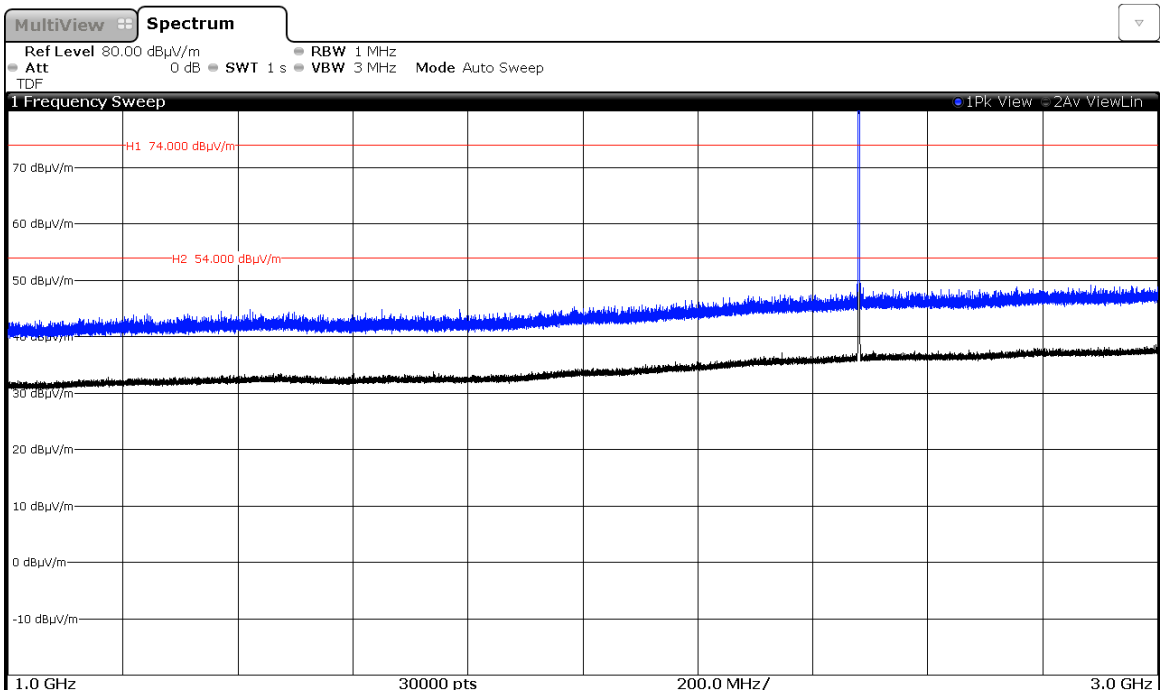
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2440 MHz).



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

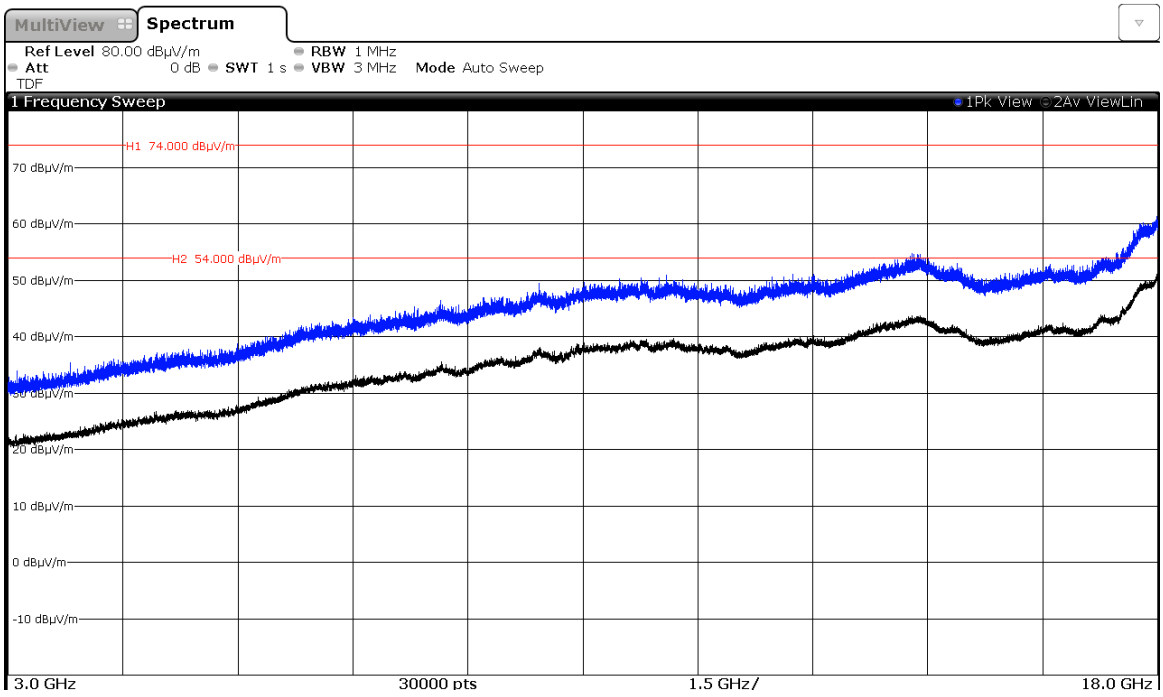
CHANNEL: Highest (2480 MHz).



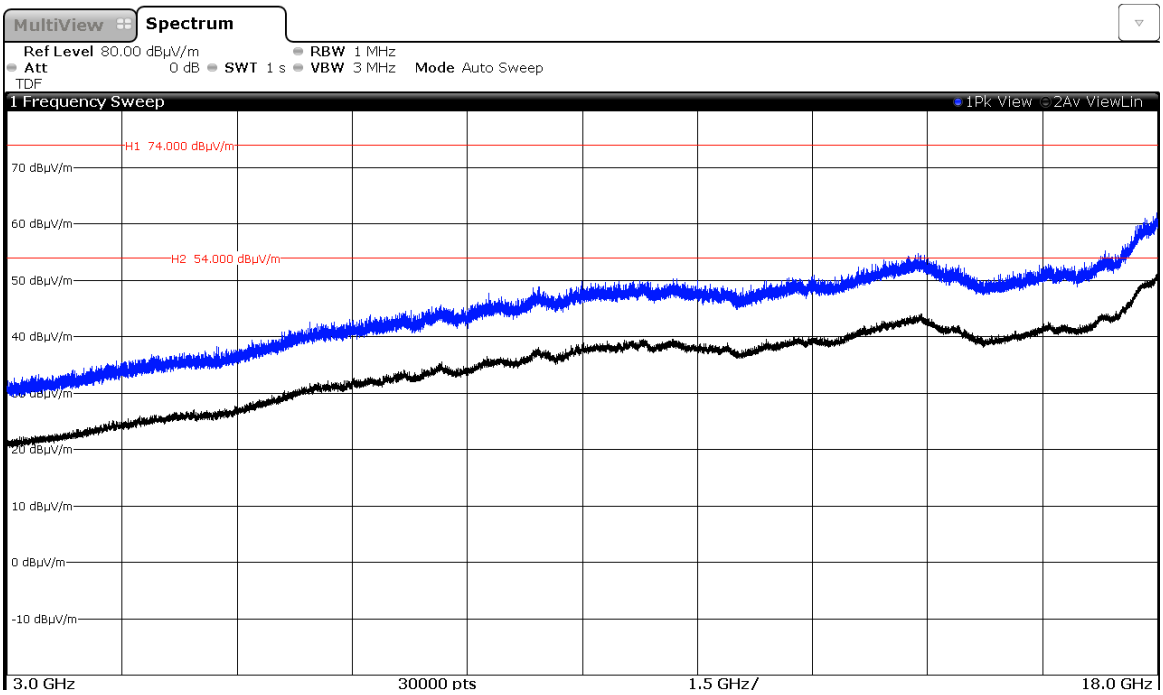
Note: The peak shown in the plot above the limit is the carrier frequency.

FREQUENCY RANGE 3 GHz to 18 GHz.

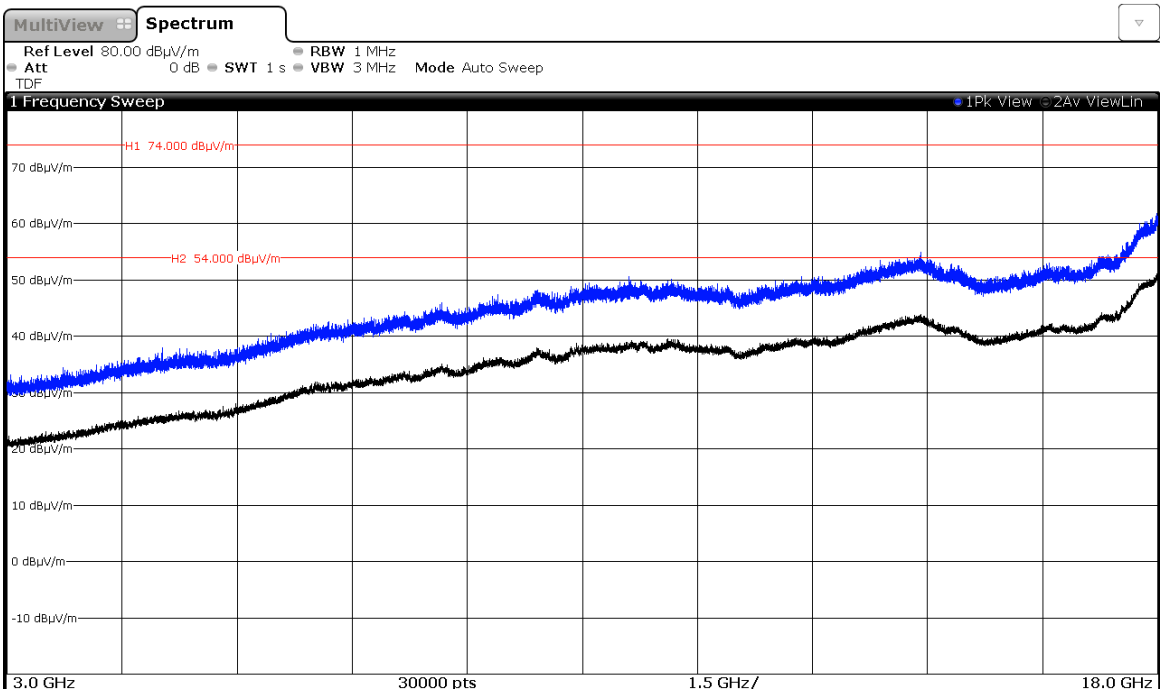
CHANNEL: Lowest (2402 MHz).



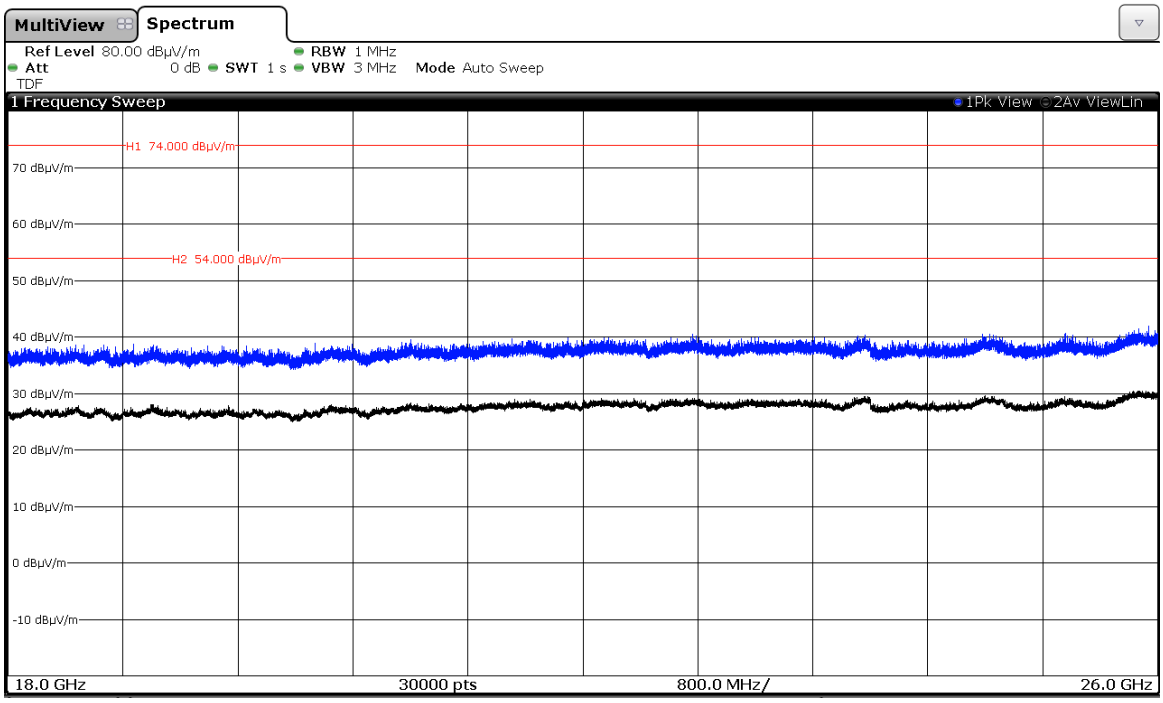
CHANNEL: Middle (2440 MHz).



CHANNEL: Highest (2480 MHz).

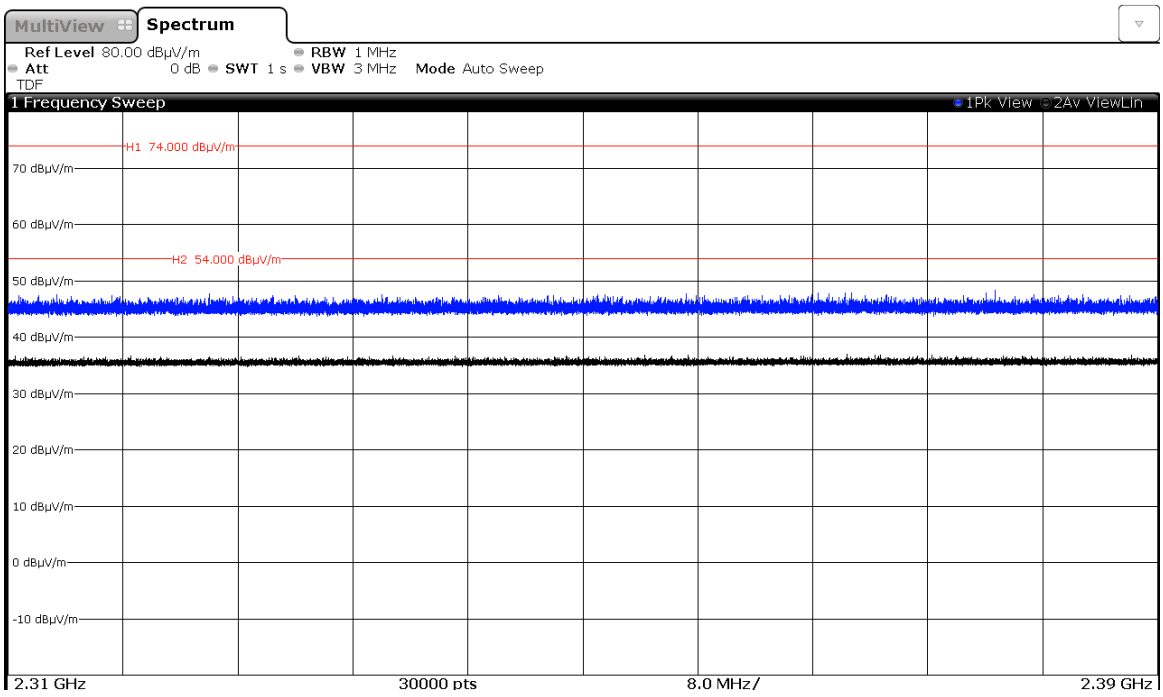


FREQUENCY RANGE 18 GHz to 26 GHz.



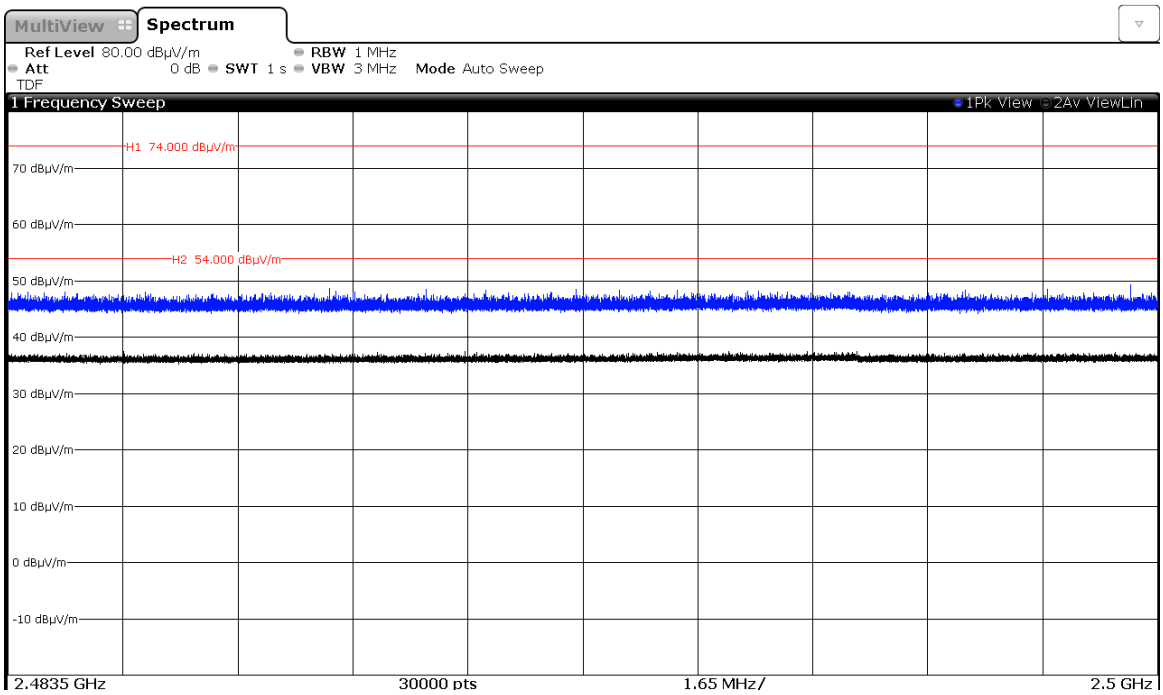
(This plot is valid for all 3 channels).

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



(This plot is valid for all 3 channels).

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



(This plot is valid for all 3 channels).