

FCC LISTED, REGISTRATION  
NUMBER: 720267

Informe de ensayo nº:  
Test report No:

IC LISTED REGISTRATION  
NUMBER IC 4621A-1

**NIE: 44054RRF.001**

## Test report

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

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

|                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Identificación del objeto ensayado.....:</b><br>Identification of item tested  | Wireless audio transmitter for hearing impaired people                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Marca .....</b><br>Trade                                                       | ---                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Modelo y/o referencia tipo .....</b><br>Model and /or type reference           | TX17-1V1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Other identification of the product .....</b>                                  | Commercial name: ROGER PEN 1.1<br>FCC ID: KWCTX17-1V1<br>IC: 2262A-TX171V1                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Final HW version .....</b>                                                     | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Final SW version .....</b>                                                     | SVN4921                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Serial number.....</b>                                                         | ---                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Características .....</b><br>Features                                          | Bluetooth 4.0 EDR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Peticionario .....</b><br>Applicant                                            | PHONAK COMMUNICATIONS AG<br>Laenggasse 17, 3280 Murten, Switzerland.<br>VAT: CHE-116.306.385<br>Contact person: Neviana Nikoloski<br>Telephone: +41 26 672 9672<br>e-mail: neviana.nikoloski@phonak.com                                                                                                                                                                                                                                                                                                                               |
| <b>Método de ensayo solicitado, norma.....</b><br>Test method requested, standard | USA FCC Part 15.247 10-1-13 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.<br>USA FCC Part 15.209 10-1-13 Edition: Radiated emission limits; general requirements.<br>CANADA RSS-210 Issue 8 (December 2010).<br>CANADA RSS-Gen Issue 3 (December 2010).<br>FCC part 15.247 and Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum System DA 00-705 Released March 30, 2000.<br>ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices. |
| <b>Resultado.....</b><br>Summary                                                  | IN COMPLIANCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

|                                                                                                 |                              |                                                                                    |                                                                                                    |
|-------------------------------------------------------------------------------------------------|------------------------------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <b>Aprobado por (nombre / cargo y firma) .....</b><br>Approved by (name / position & signature) | A. Llamas<br>RF Lab. Manager |  | Firmado digitalmente por<br>Alejandro Llamas<br>Rodríguez<br>Fecha: 2014.11.26<br>09:07:11 +01'00' |
| <b>Fecha de realización .....</b><br>Date of issue                                              | 2014-11-19                   |                                                                                    |                                                                                                    |
| <b>Formato de informe No. ....</b><br>Report template No                                        | FDT08_15                     |                                                                                    |                                                                                                    |

# Index

|                                                |   |
|------------------------------------------------|---|
| Competences and guarantees.....                | 4 |
| General conditions.....                        | 4 |
| Uncertainty .....                              | 4 |
| Usage of samples.....                          | 4 |
| Test sample description .....                  | 5 |
| Test samples supplier .....                    | 5 |
| Testing period.....                            | 5 |
| Environmental conditions.....                  | 6 |
| Remarks and comments.....                      | 7 |
| Testing verdicts .....                         | 8 |
| Appendix A – Test result “Bluetooth EDR” ..... | 9 |

## Competences and guarantees

AT4 wireless is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction 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

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

## Uncertainty

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

## Usage of samples

Samples undergoing test have been selected by: **the client**

Sample S/01 is composed of the following elements:

| Control N° | Description                             | Model    | Serial N° | Date of reception |
|------------|-----------------------------------------|----------|-----------|-------------------|
| 43721/006  | Audio transmitter with internal antenna | TX17-1V1 | ---       | 2014-10-10        |

1. Sample S/01 has undergone following test(s).  
All radiated tests indicated in appendix A.

Sample S/02 is composed of the following elements:

| Control N° | Description                              | Model    | Serial N° | Date of reception |
|------------|------------------------------------------|----------|-----------|-------------------|
| 43721/012  | Audio transmitter with antenna connector | TX17-1V1 | ---       | 2014-10-10        |

1. Sample S/02 has undergone the test(s) specified in subclause “Test method requested”.

All conducted tests indicated in appendix A.

## Test sample description

The test sample consists of a wireless audio transmitter for hearing impaired people with Bluetooth 4.0 EDR and 40 channels hopping proprietary mode.

## Test samples supplier

PHONAK COMMUNICATIONS AG

Laenggasse 17, 3280 Murten, Switzerland.

VAT: CHE-116.306.385

Contact person: Neviana Nikoloski

Telephone: +41 26 672 9672

e-mail: neviana.nikoloski@phonak.com

## Testing period

The performed test started on 2014-10-24 and finished on 2014-10-31.

The tests have been performed at AT4 wireless.

## Environmental conditions

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

|                                      |                                    |
|--------------------------------------|------------------------------------|
| <b>Temperature</b>                   | Min. = 22.61 °C<br>Max. = 23.57 °C |
| <b>Relative humidity</b>             | Min. = 40.00 %<br>Max. = 60.71 %   |
| <b>Shielding effectiveness</b>       | > 100 dB                           |
| <b>Electric insulation</b>           | > 10 kΩ                            |
| <b>Reference resistance to earth</b> | < 0,5 Ω                            |

In the semianechoic chamber (21 meters x 11 meters x 8 meters), the following limits were not exceeded during the test.

|                                      |                                                                                             |
|--------------------------------------|---------------------------------------------------------------------------------------------|
| <b>Temperature</b>                   | Min. = 21.41 °C<br>Max. = 26.19 °C                                                          |
| <b>Relative humidity</b>             | Min. = 32.21 %<br>Max. = 40.51 %                                                            |
| <b>Air pressure</b>                  | Min. = 1009 mbar<br>Max. = 1014 mbar                                                        |
| <b>Shielding effectiveness</b>       | > 100 dB                                                                                    |
| <b>Electric insulation</b>           | > 10 kΩ                                                                                     |
| <b>Reference resistance to earth</b> | < 0,5 Ω                                                                                     |
| <b>Normal site attenuation (NSA)</b> | < ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz) |
| <b>Field homogeneity</b>             | 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:

|                                      |                                      |
|--------------------------------------|--------------------------------------|
| <b>Temperature</b>                   | Min. = 25.09 °C<br>Max. = 25.93 °C   |
| <b>Relative humidity</b>             | Min. = 41.23 %<br>Max. = 50.69 %     |
| <b>Air pressure</b>                  | Min. = 1011 mbar<br>Max. = 1014 mbar |
| <b>Shielding effectiveness</b>       | > 100 dB                             |
| <b>Electric insulation</b>           | > 10 kΩ                              |
| <b>Reference resistance to earth</b> | < 0,5 Ω                              |

## Remarks and comments

1: Used instrumentation:

### Conducted Measurements

|    |                    |         |            | Last Cal. date | Cal. due date |
|----|--------------------|---------|------------|----------------|---------------|
| 1. | Spectrum analyser  | Agilent | PSA E4440A | 2014/06        | 2016/06       |
| 2. | Bluetooth Test set | Anritsu | MT8852B    | ---            | ---           |

### Radiated Measurements

|     |                                               |     |  | Last Cal. date | Cal. due date |
|-----|-----------------------------------------------|-----|--|----------------|---------------|
| 1.  | Semianechoic Absorber Lined Chamber           |     |  | N.A.           | N.A.          |
|     | ETS FACT3 200STP                              |     |  |                |               |
| 2.  | BiconicalLog antenna                          | ETS |  | 2014/03        | 2017/03       |
|     | LINDGREN 3142E                                |     |  |                |               |
| 3.  | Multi Device Controller EMCO 2090             |     |  | N.A.           | N.A.          |
| 4.  | Double-ridge Guide Horn antenna 1-18 GHz      |     |  | 2013/11        | 2016/11       |
|     | SCHWARZBECK BBHA 9120 D                       |     |  |                |               |
| 5.  | Double-ridge Guide Horn antenna 14-40 GHz     |     |  | 2014/03        | 2017/03       |
|     | SCHWARZBECK BBHA 9170                         |     |  |                |               |
| 6.  | EMI Test Receiver R&S ESU 26                  |     |  | 2013/08        | 2015/08       |
| 7.  | Spectrum analyser Rohde & Schwarz FSW50       |     |  | 2013/10        | 2015/10       |
| 8.  | RF pre-amplifier 10 MHz-6 GHz                 |     |  | 2014/02        | 2015/02       |
|     | SCHWARZBECK BBV9743                           |     |  |                |               |
| 9.  | RF pre-amplifier 1-18 GHz                     |     |  | 2014/02        | 2015/02       |
|     | Schwarzbeck BBV 9718                          |     |  |                |               |
| 10. | RF pre-amplifier BONN BLMA 1840-1M 18-40 GHz. |     |  | 2014/02        | 2016/02       |
| 11. | Bluetooth Test set Anritsu MT8852B            |     |  | ---            | ---           |

## Testing verdicts

|                             |     |
|-----------------------------|-----|
| <b>Not applicable</b> ..... | N/A |
| <b>Pass</b> .....           | P   |
| <b>Fail</b> .....           | F   |
| <b>Not measured</b> .....   | N/M |

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

## Appendix A – Test result “Bluetooth EDR”

## INDEX

|                                                                                                                            |    |
|----------------------------------------------------------------------------------------------------------------------------|----|
| TEST CONDITIONS .....                                                                                                      | 11 |
| FCC Section 15.247 Subclause (a) (1) / RSS-210 Clause A8.1 (b). 20 dB Bandwidth and Carrier frequency separation..         | 12 |
| FCC Section 15.247 Subclause (a) (1) (iii) / RSS-210 Clause A8.1 (d). Number of hopping channels.....                      | 19 |
| FCC Section 15.247 Subclause (a) (1) (iii) / RSS-210 Clause A8.1 (d). Time of occupancy (Dwell Time).....                  | 25 |
| FCC Section 15.247 Subclause (b) / RSS-210 Clause A8.4 (2). Maximum peak output power and antenna gain .....               | 34 |
| FCC Section 15.247 Subclause (d) / RSS-210 Clause A8.5. Band-edge compliance of conducted emissions (Transmitter)<br>..... | 40 |
| FCC Section 15.247 Subclause (d) / RSS-210 Clause A8.5. Emission limitations conducted (Transmitter).....                  | 47 |
| FCC Section 15.247 Subclause (d) / RSS-210 Clause A8.5. Emission limitations radiated (Transmitter) .....                  | 52 |

## TEST CONDITIONS

Power supply (V):

$$V_{\text{nominal}} = 3.7 \text{ Vdc}$$

Type of power supply = DC Voltage from rechargeable battery

Type of antenna = Integral antenna

Declared Gain for antenna (maximum) = 0.2 dBi

## TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2441 MHz

Highest channel: 2480 MHz

## CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to a Bluetooth signalling unit (Bluetooth test set) and to the spectrum analyser using a 6 dB power splitter. The reading in the spectrum analyser is corrected taking into account the power splitter loss.

## RADIATED MEASUREMENTS

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

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

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

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

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

## FCC Section 15.247 Subclause (a) (1) / RSS-210 Clause A8.1 (b). 20 dB Bandwidth and Carrier frequency separation

### SPECIFICATION

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

### RESULTS

(See next plots)

Modulation: GFSK

|                                | Lowest frequency<br>2402 MHz | Middle frequency<br>2441 MHz | Highest frequency<br>2480 MHz |
|--------------------------------|------------------------------|------------------------------|-------------------------------|
| 20 dB Spectrum bandwidth (kHz) | 957.83                       | 965.39                       | 942.48                        |
| Measurement uncertainty (kHz)  | ±11                          |                              |                               |

Modulation: Π/4-DQPSK (2Mbps)

|                                | Lowest frequency<br>2402 MHz | Middle frequency<br>2441 MHz | Highest frequency<br>2480 MHz |
|--------------------------------|------------------------------|------------------------------|-------------------------------|
| 20 dB Spectrum bandwidth (kHz) | 1267.00                      | 1266.00                      | 1261.00                       |
| Measurement uncertainty (kHz)  | ±11                          |                              |                               |

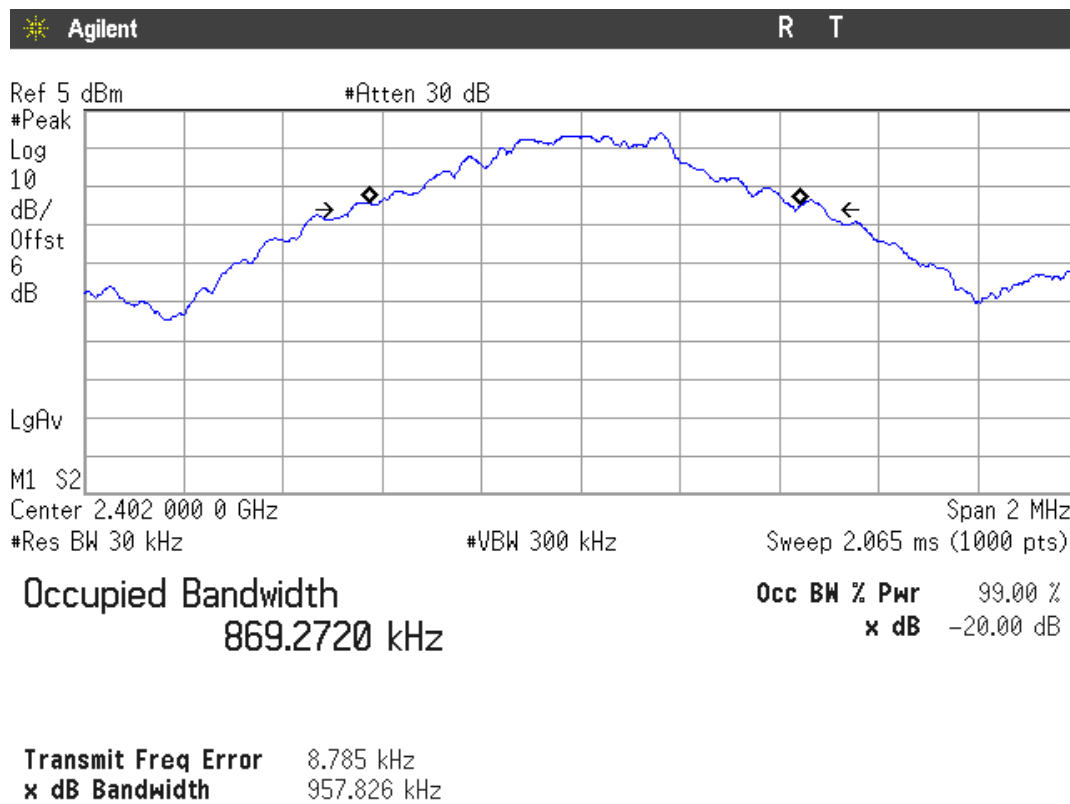
Modulation: 8-DPSK (3Mbps)

|                                | Lowest frequency<br>2402 MHz | Middle frequency<br>2441 MHz | Highest frequency<br>2480 MHz |
|--------------------------------|------------------------------|------------------------------|-------------------------------|
| 20 dB Spectrum bandwidth (kHz) | 1277.00                      | 1282.00                      | 1279.00                       |
| Measurement uncertainty (kHz)  | ±11                          |                              |                               |

## Modulation: GFSK

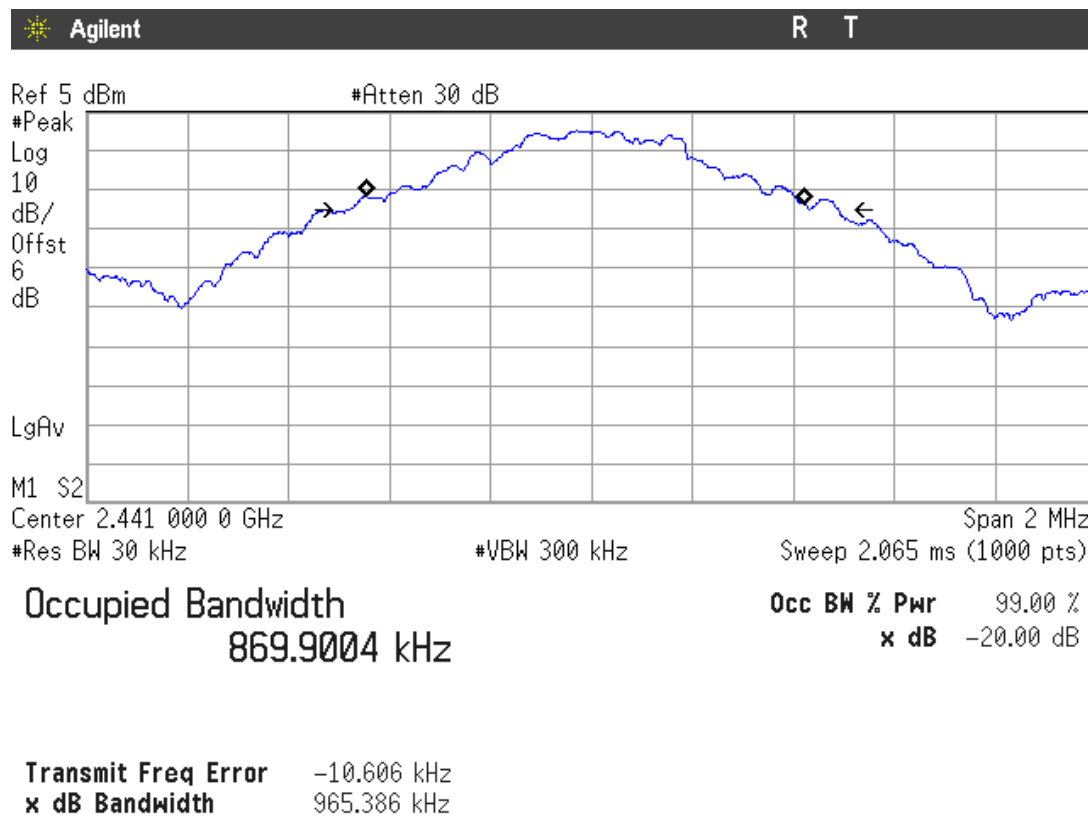
20 dB BANDWIDTH.

Lowest Channel: 2402 MHz.



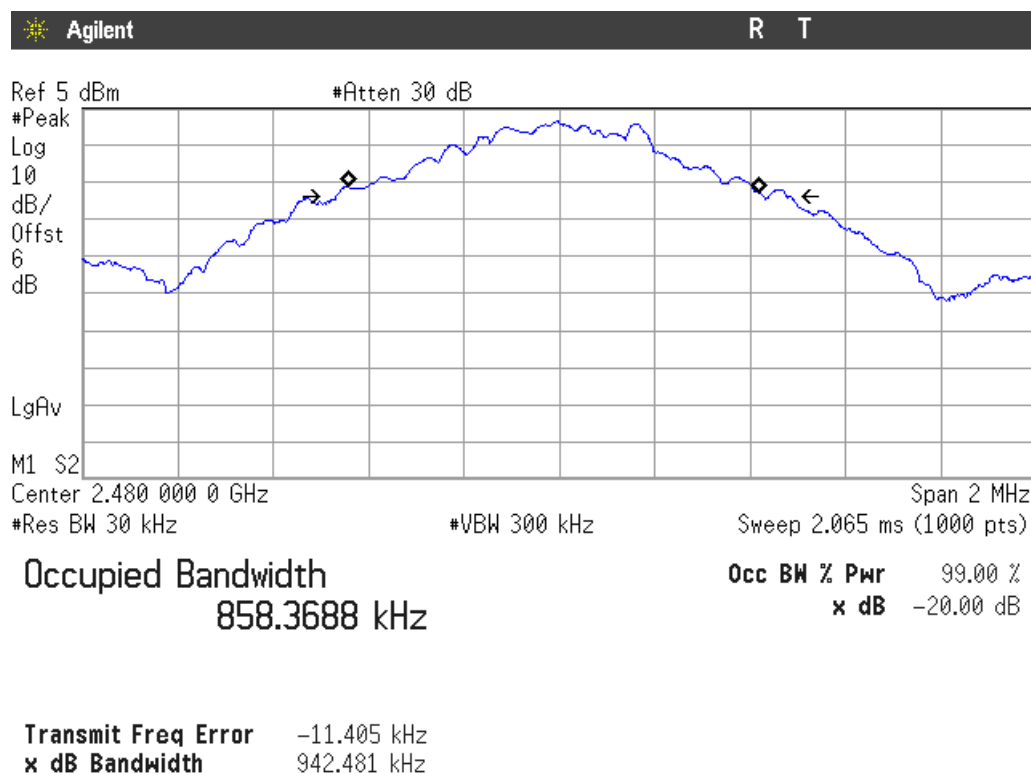
20 dB BANDWIDTH

Middle Channel: 2441 MHz.

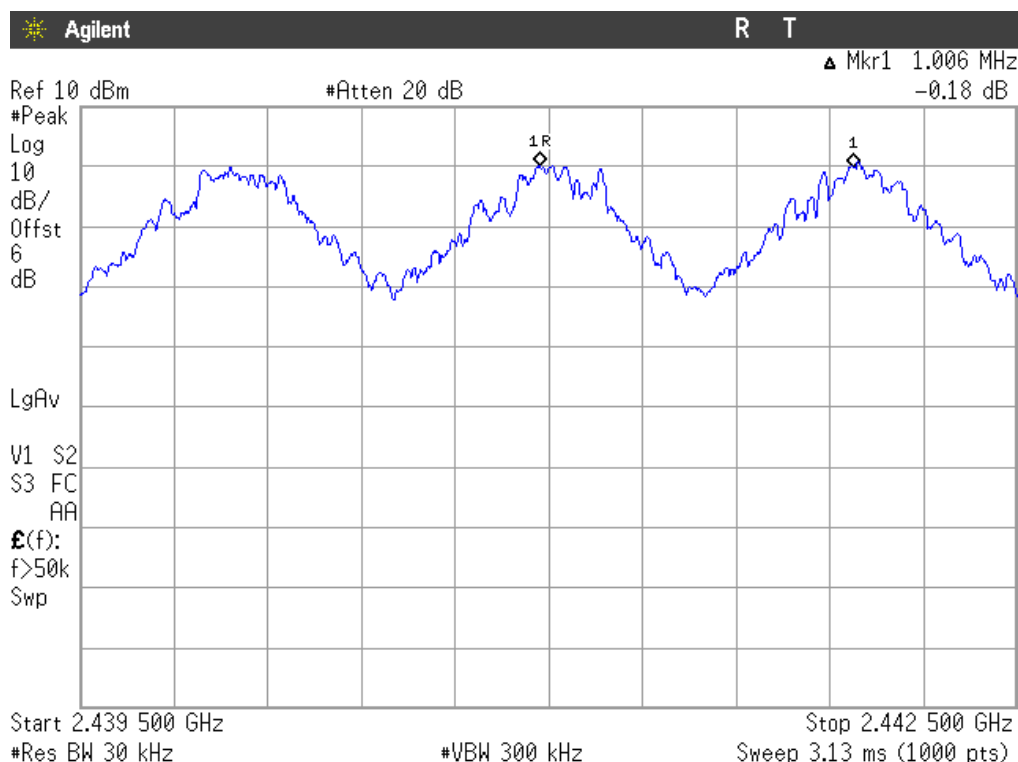


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



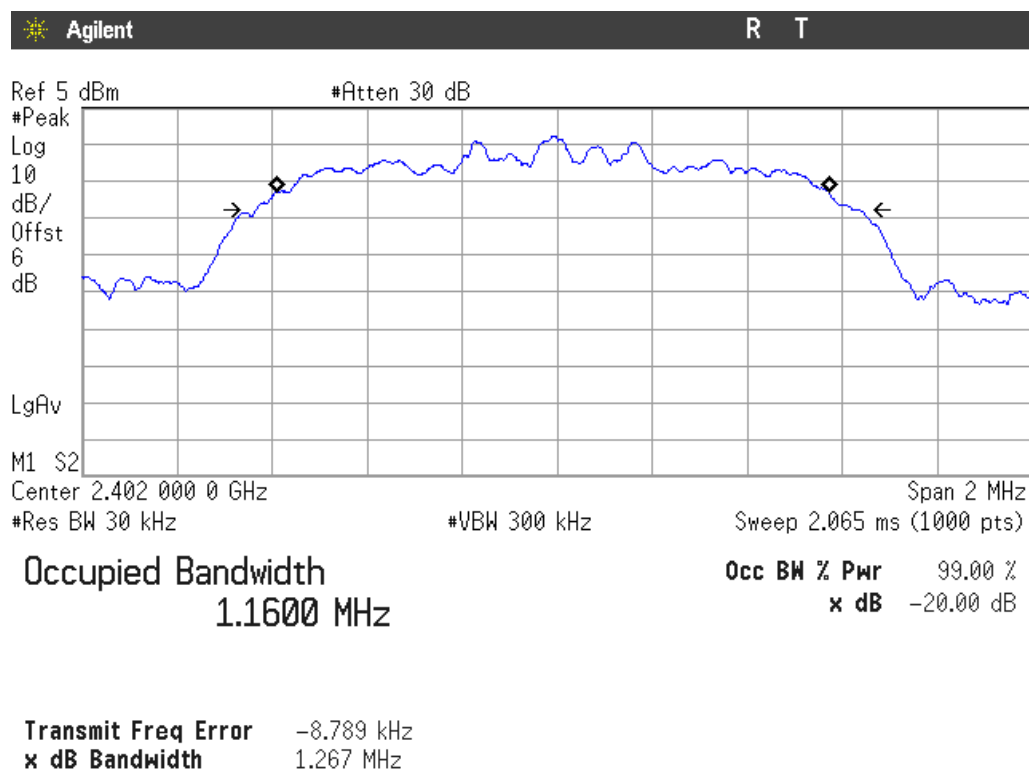
The hopping channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

Verdict: PASS

## Modulation: $\Pi/4$ -DQPSK

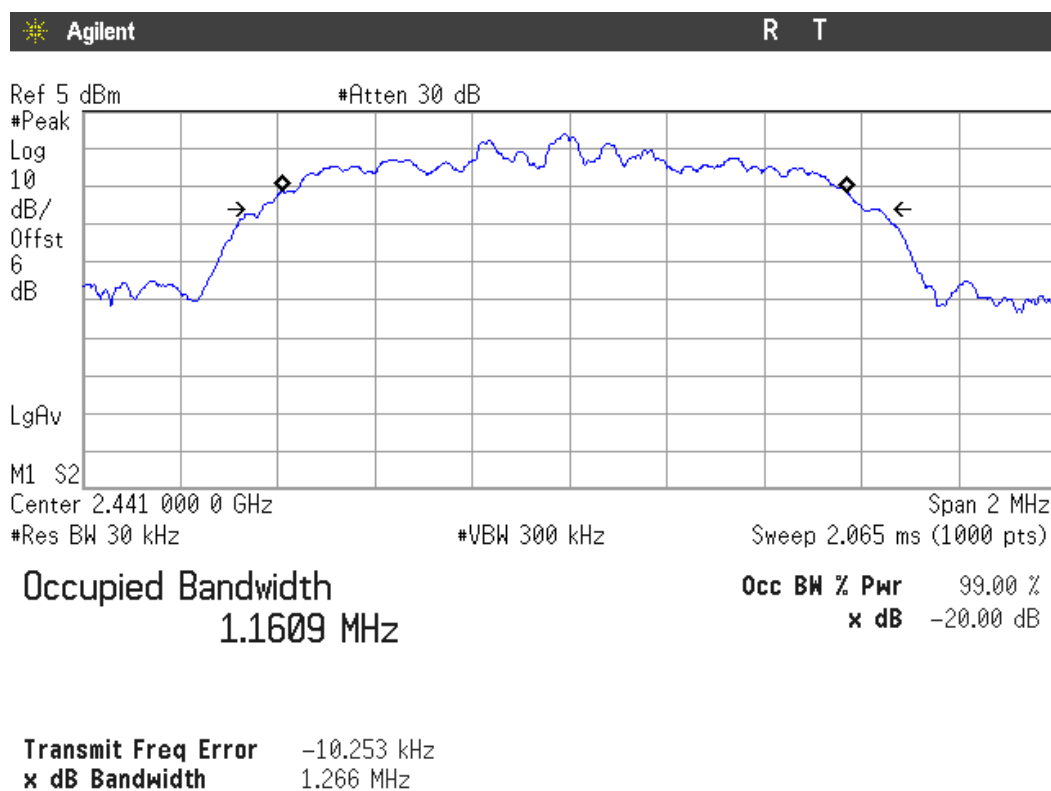
20 dB BANDWIDTH.

Lowest Channel: 2402 MHz.



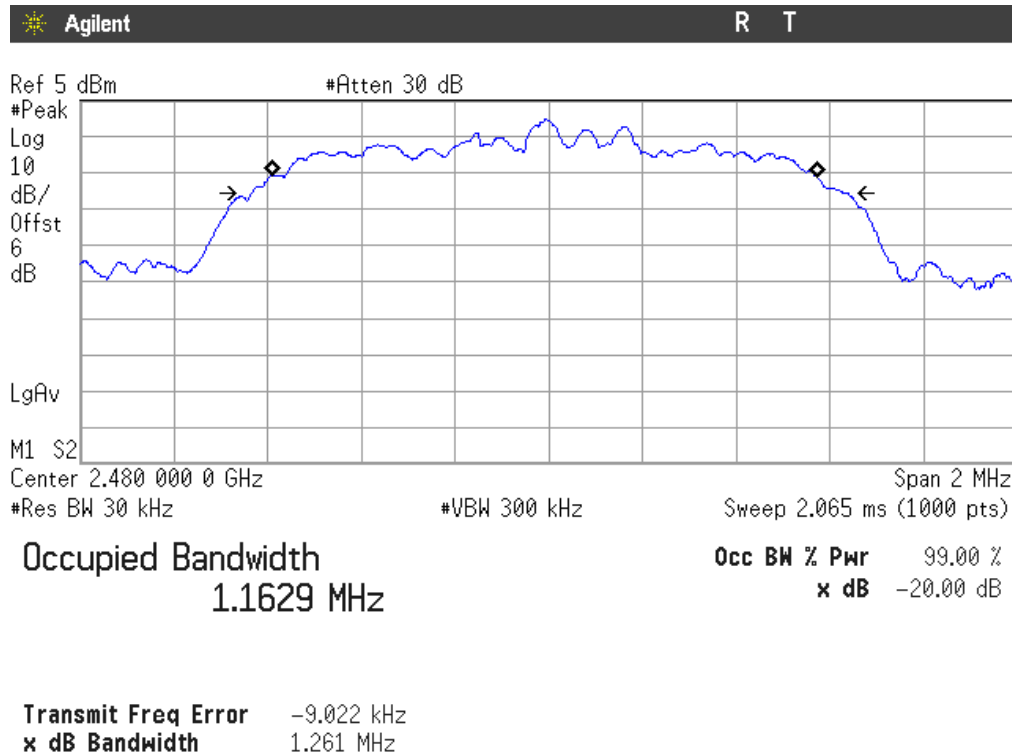
20 dB BANDWIDTH

Middle Channel: 2441 MHz.

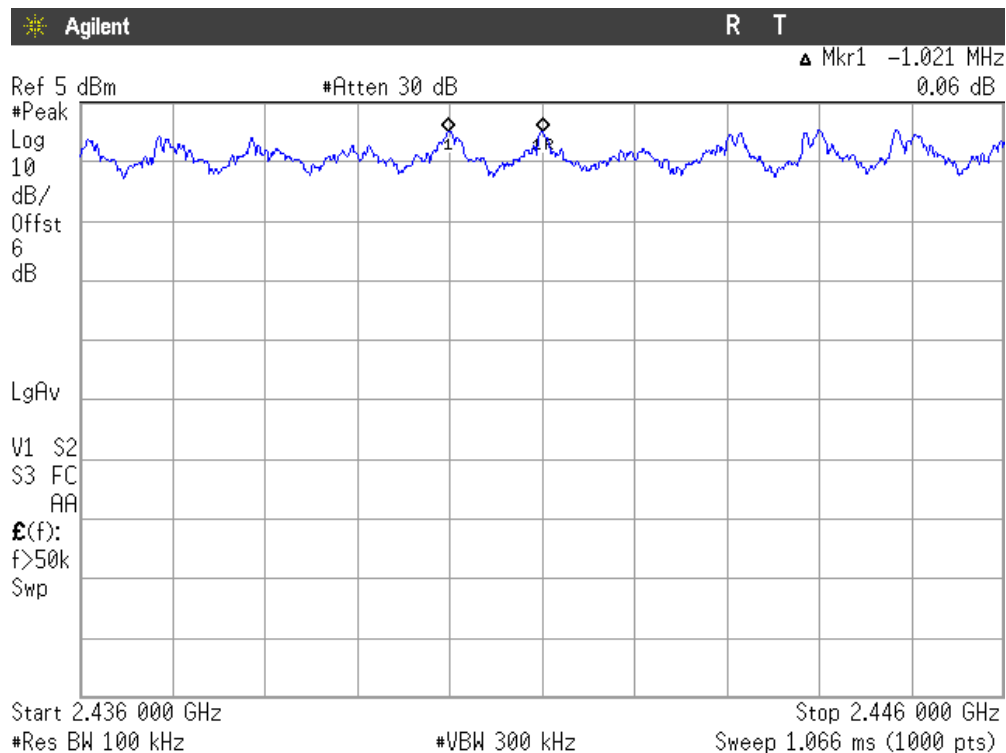


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



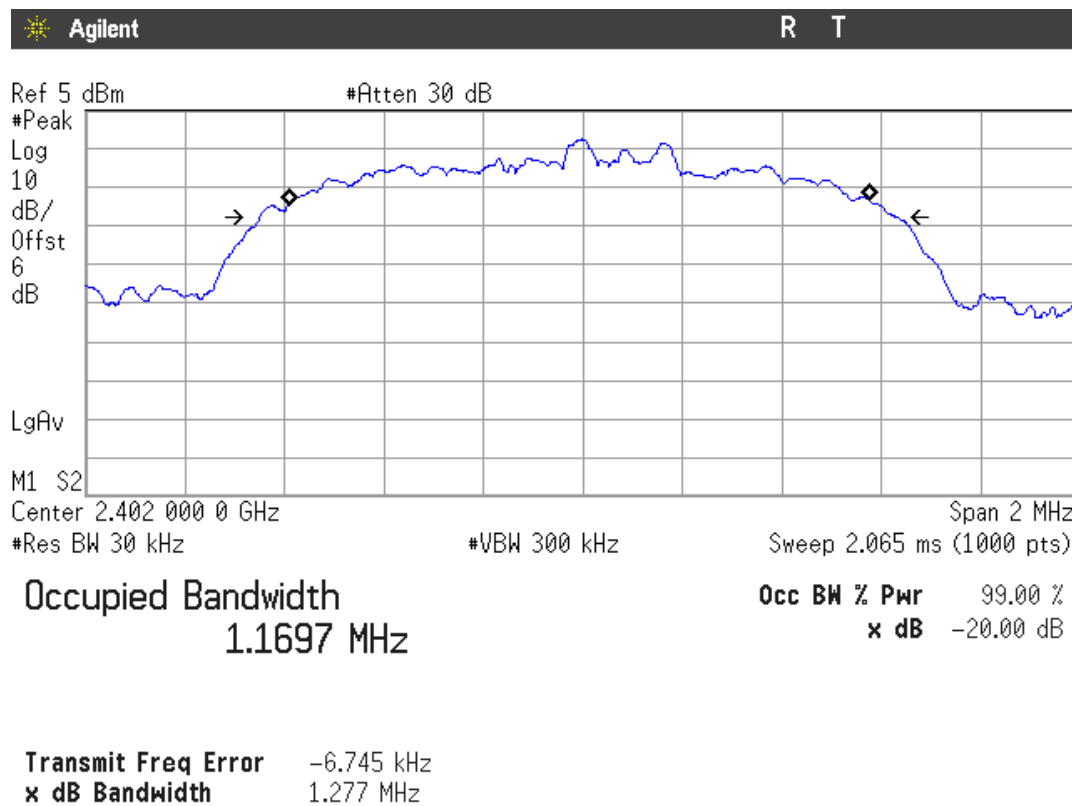
The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel

Verdict: PASS

## Modulation: 8-DPSK

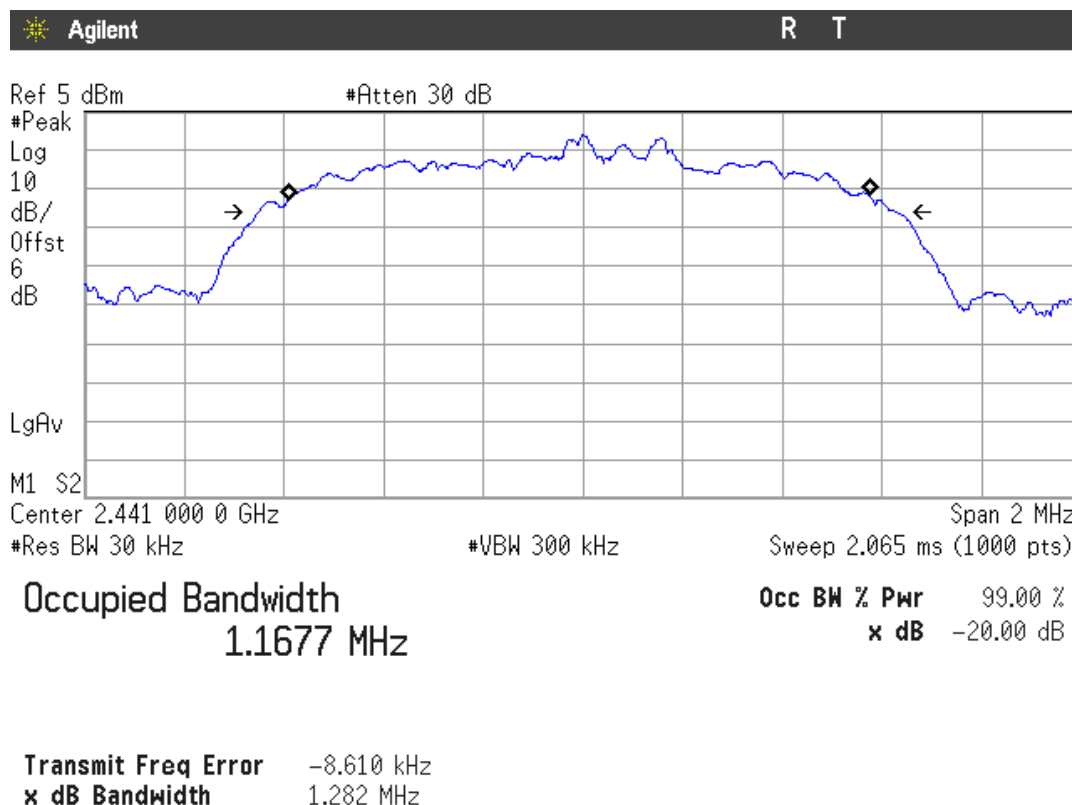
20 dB BANDWIDTH

Lowest Channel: 2402 MHz.



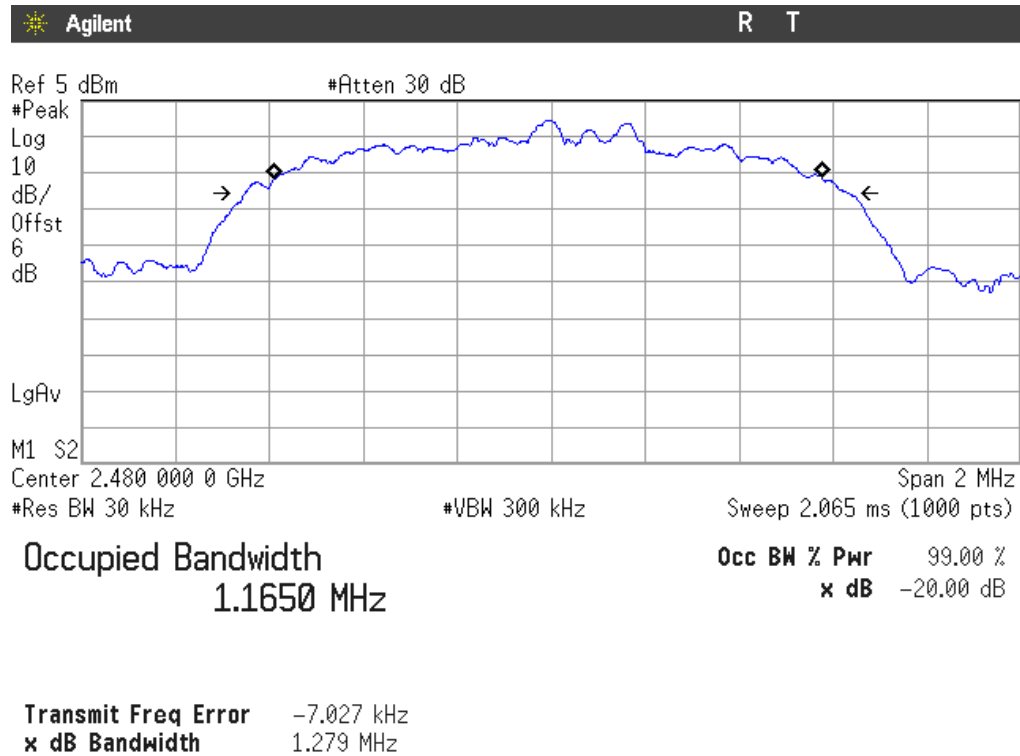
20 dB BANDWIDTH

Middle Channel: 2441 MHz.

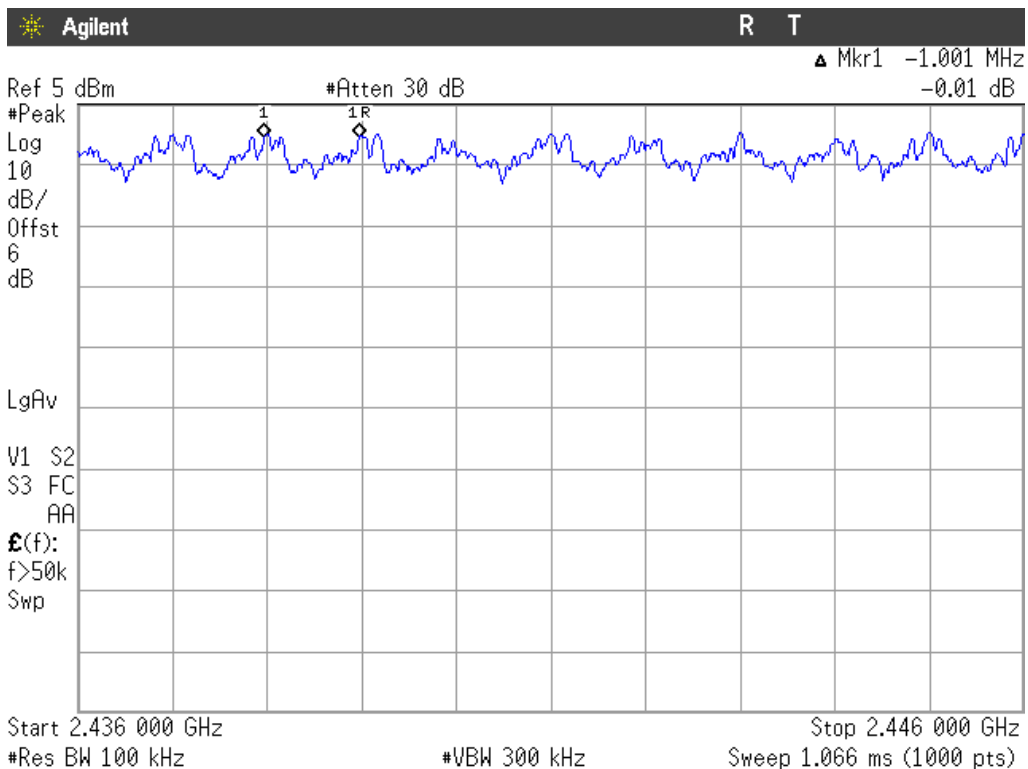


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



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

Verdict: PASS

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

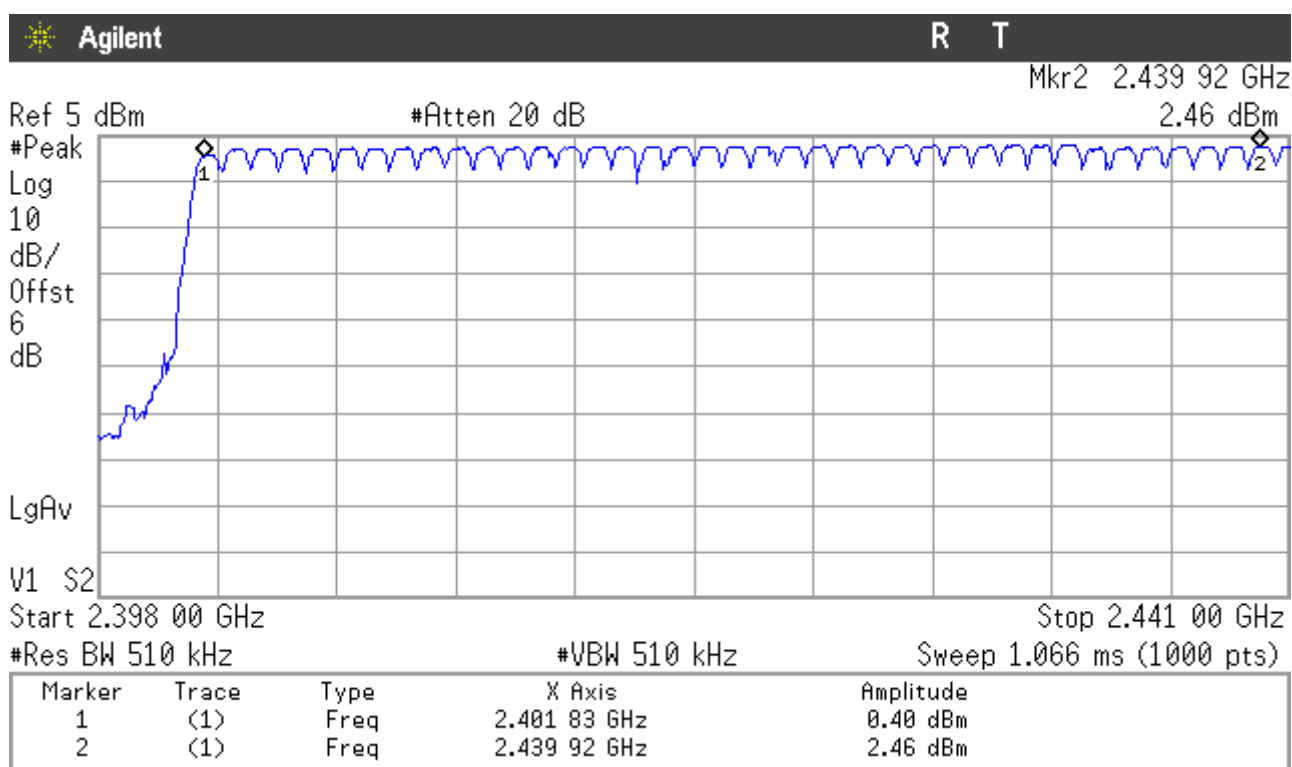
### SPECIFICATION

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

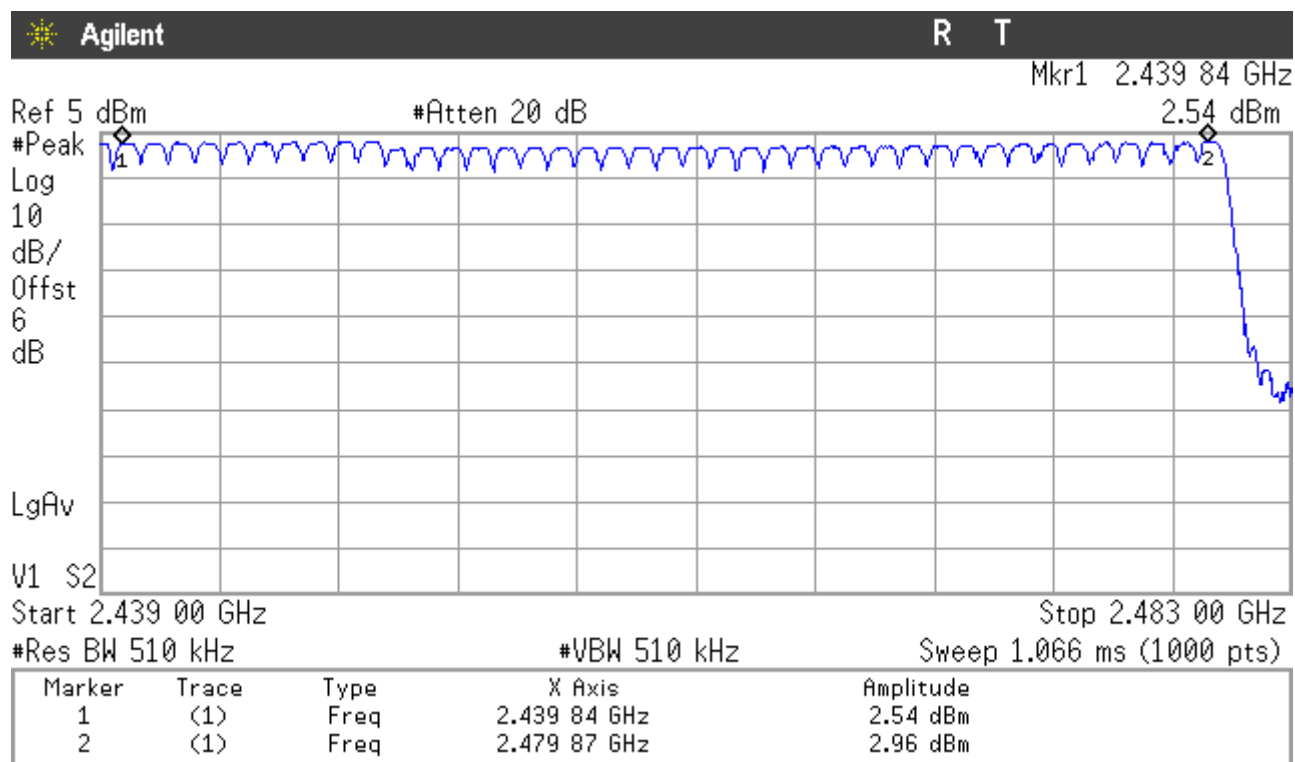
### RESULTS

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

### Modulation: GFSK



Number of hopping frequencies: 39

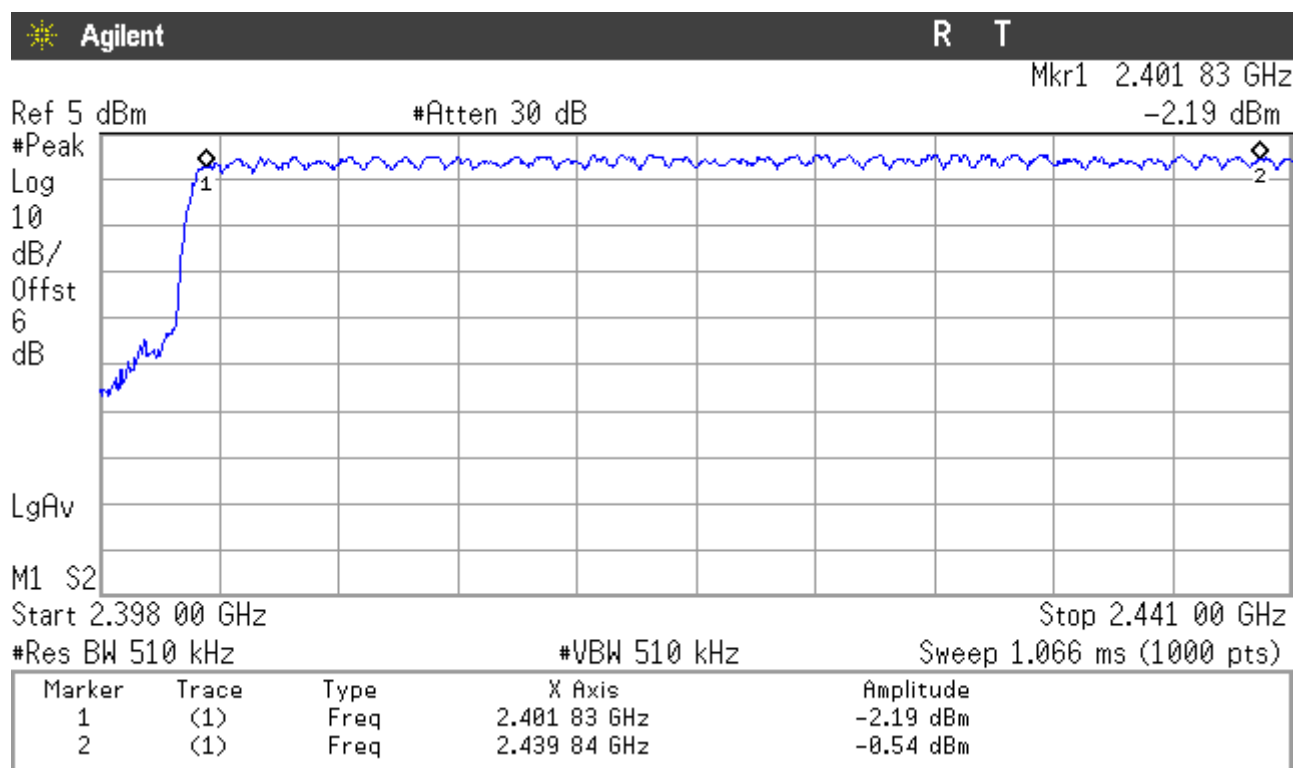


Number of hopping frequencies: 40

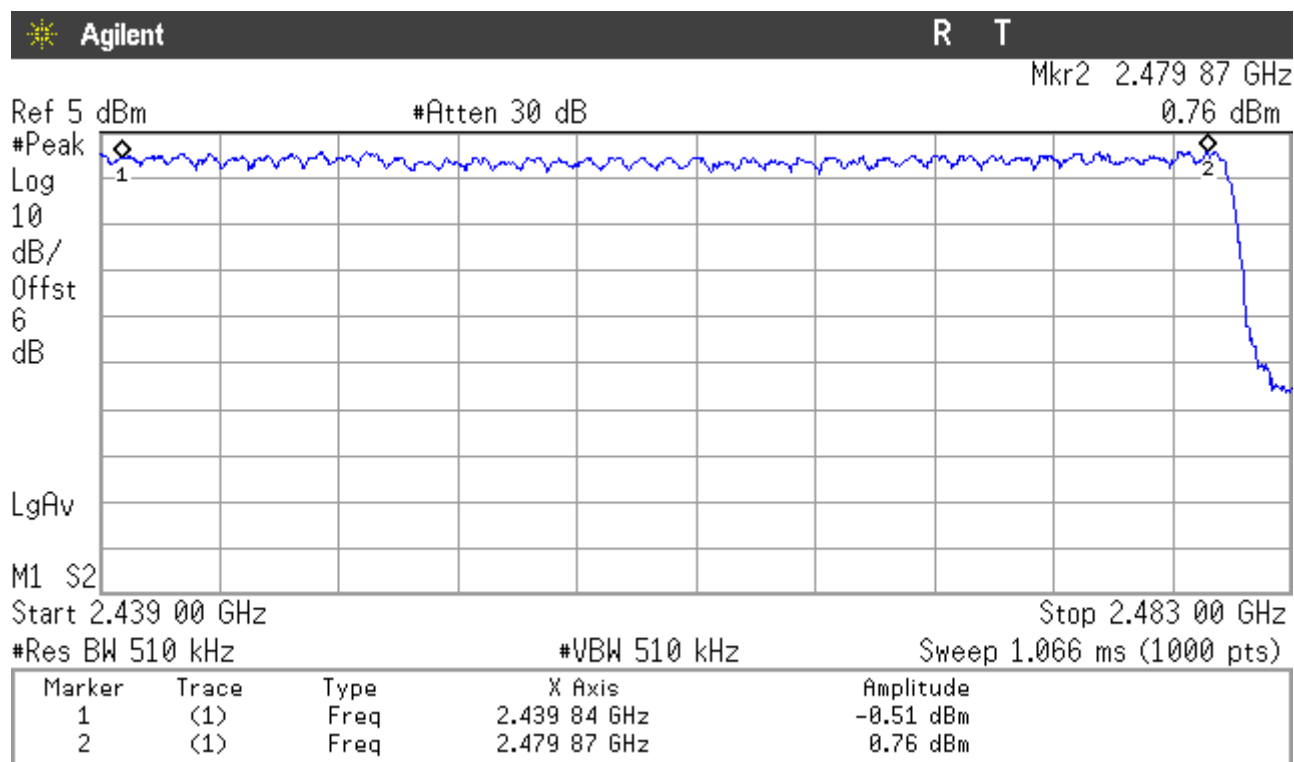
Total number of hopping frequencies: 79

Verdict: PASS

## Modulation: $\Pi/4$ -DQPSK



Number of hopping frequencies: 39

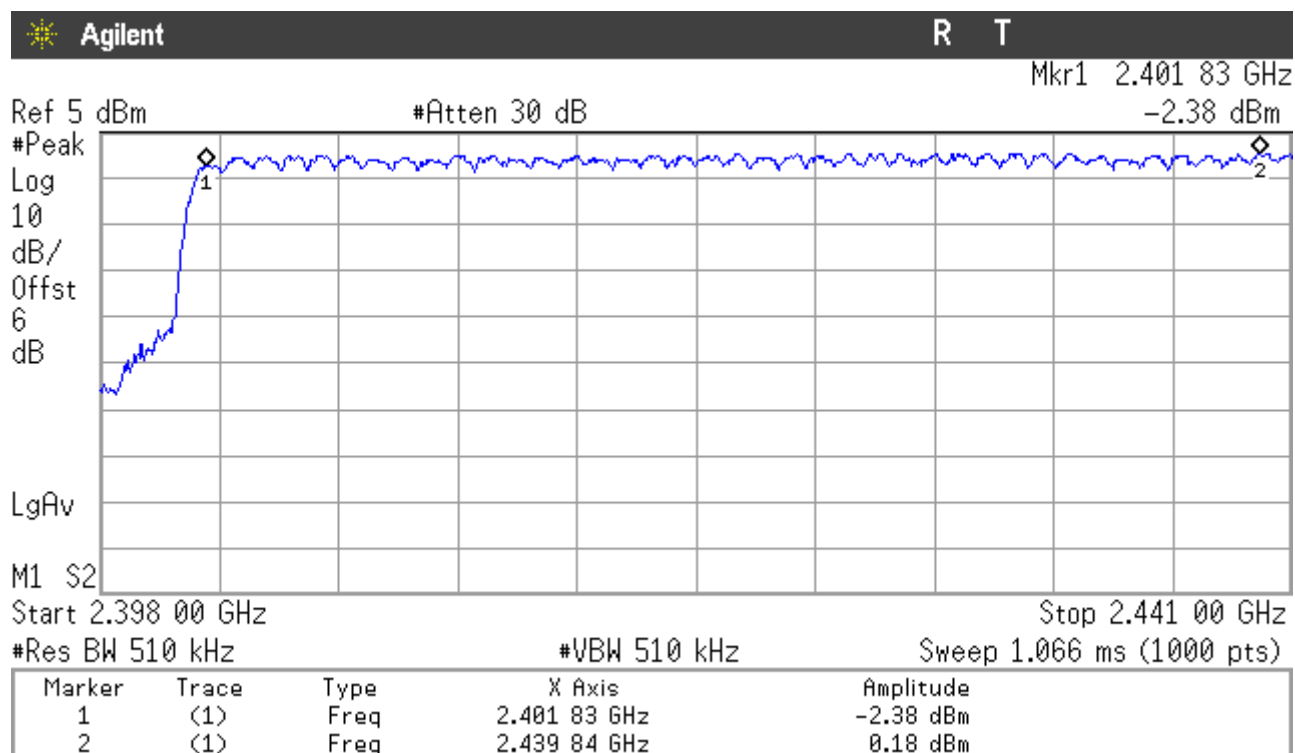


Number of hopping frequencies: 40

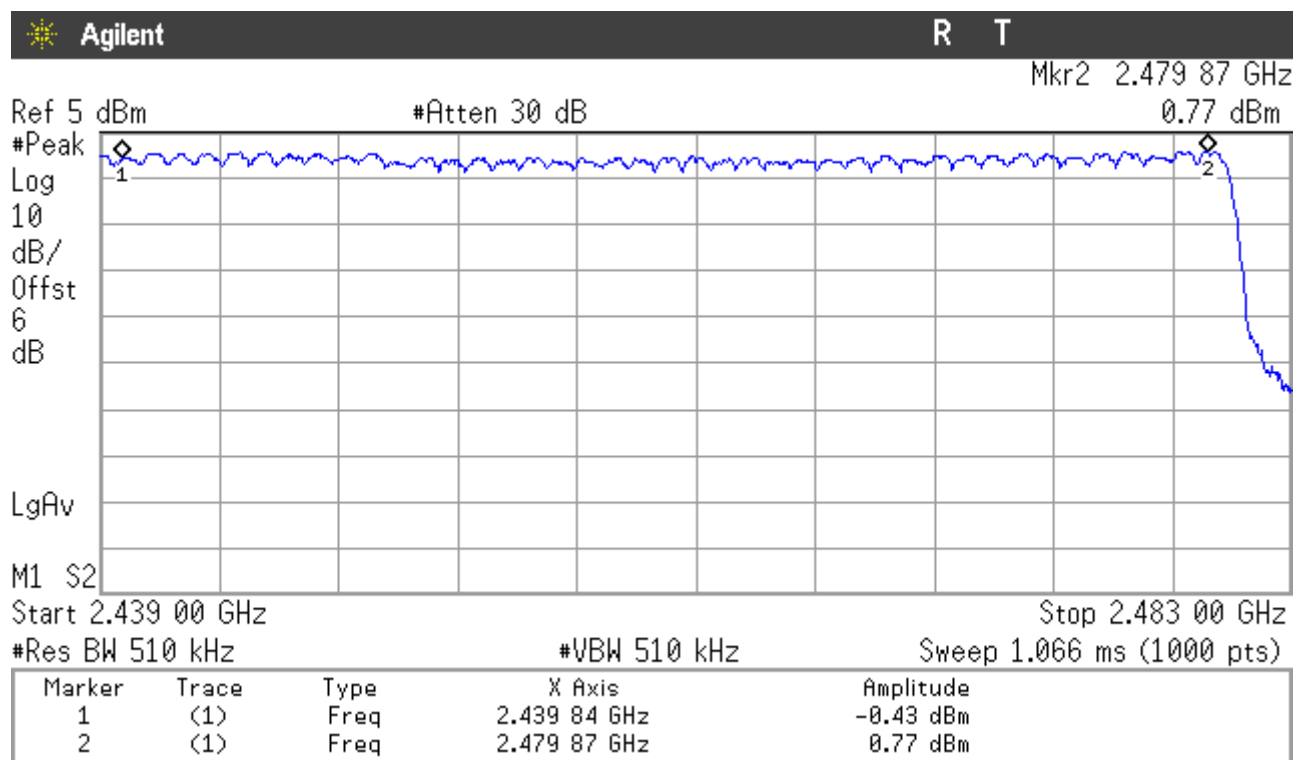
Total number of hopping frequencies: 79

Verdict: PASS

## Modulation: 8-DPSK



Number of hopping frequencies: 39



Number of hopping frequencies: 40

Total number of hopping frequencies: 79

Verdict: PASS

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

### SPECIFICATION

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

### RESULTS

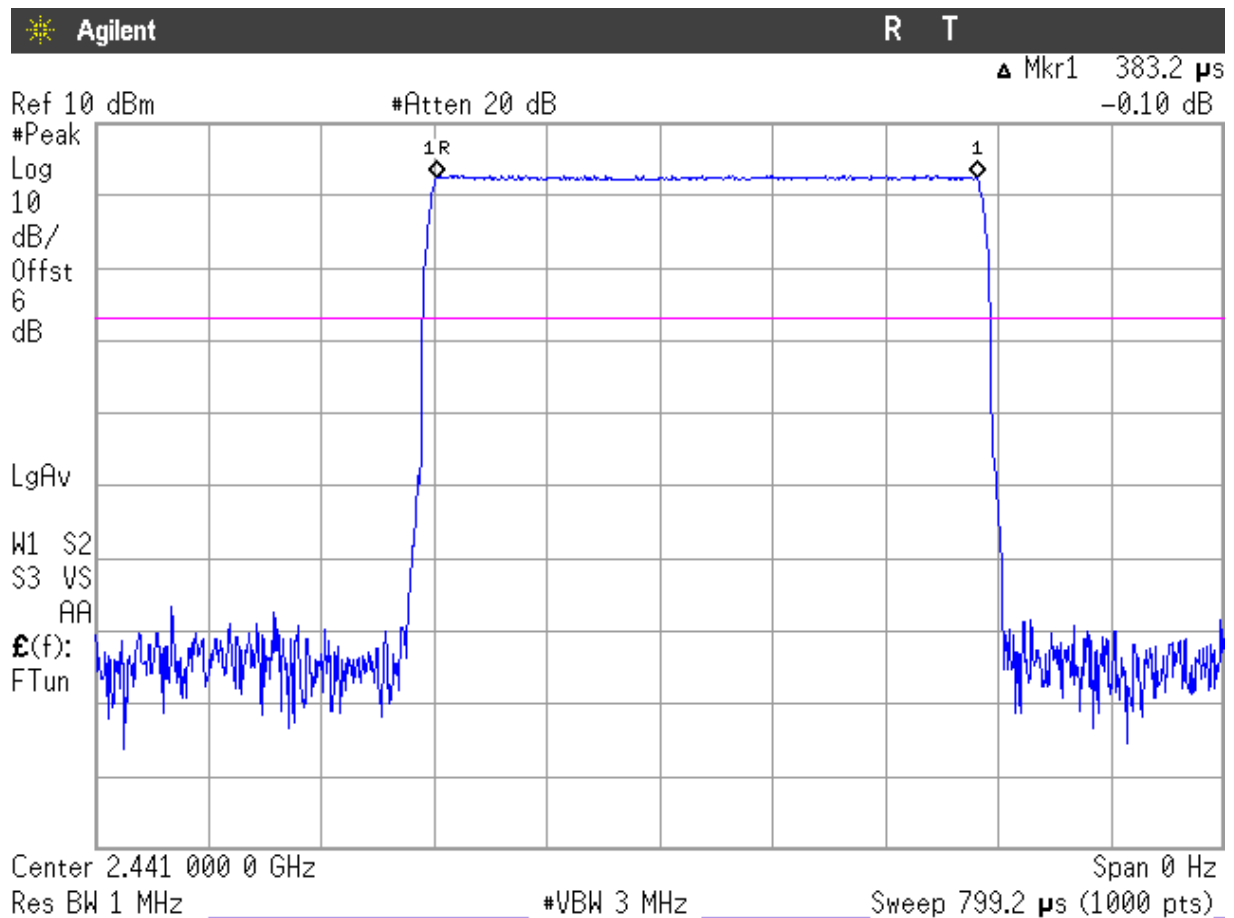
#### Modulation: GFSK

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

The system makes worst case 1600 hops per second or 1 time slot has a length of  $625 \mu\text{s}$  with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/2 = 800$  hops per second with 79 channels. So you have each channel  $800/79 = 10.13$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $10.13 \times 31.6 = 320.11$  times of appearance.

Each Tx-time per appearance is  $383.2 \mu\text{s}$  (see next plot).

So we have  $320.11 \times 383.2 \mu\text{s} = 122.67 \text{ ms}$  per 31.6 seconds.



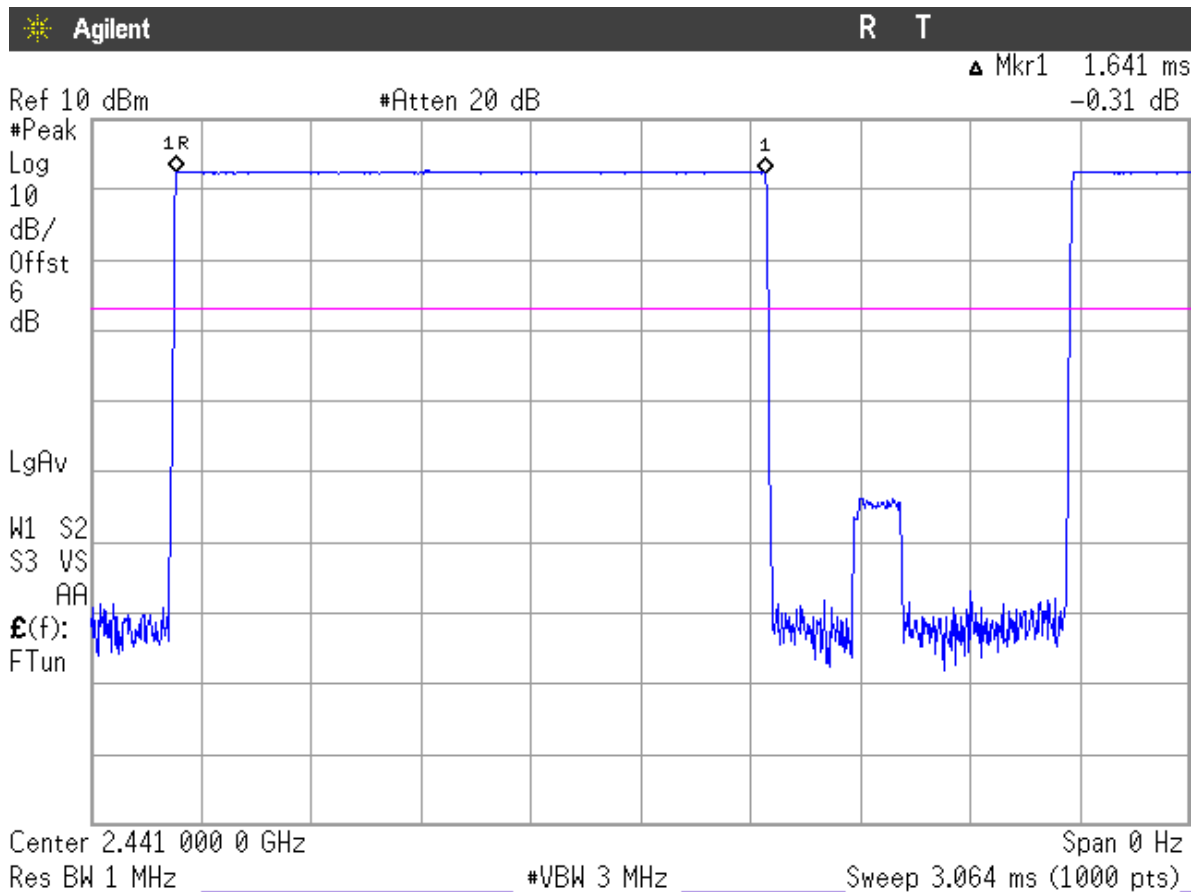
Verdict: PASS

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

A DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/4 = 400$  hops per second with 79 channels. So you have each channel  $400/79 = 5.1$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $5.1 \times 31.6 = 161.16$  times of appearance.

Each Tx-time per appearance is 1.641 ms (see next plot).

So we have  $161.16 \times 1.641 \text{ ms} = 264.46 \text{ ms}$  per 31.6 seconds.



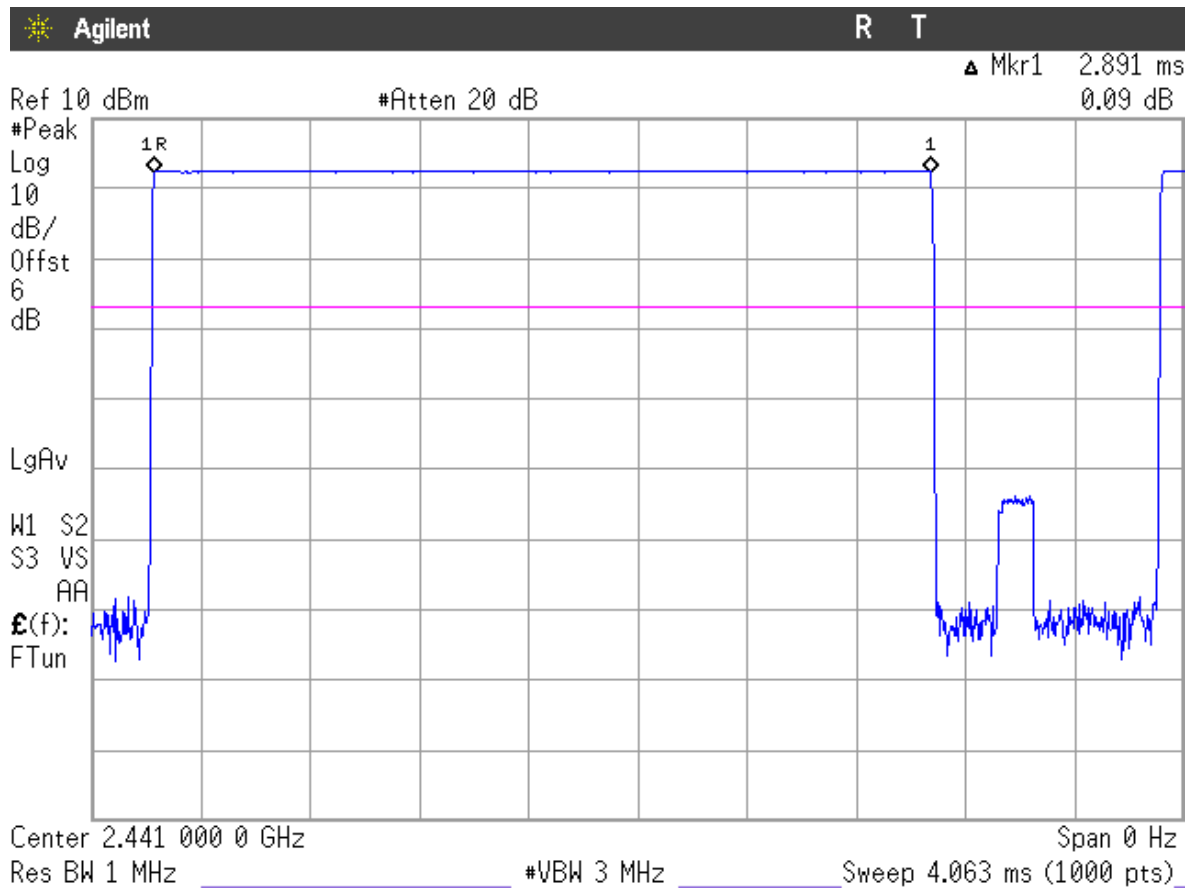
Verdict: PASS

### 3. TIME OF OCCUPANCY (DWEELL TIME) FOR PACKET TYPE DH5.

A DH5 Packet needs 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/6 = 266.67$  hops per second with 79 channels. So you have each channel  $266.67/79 = 3.37$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $3.37 \times 31.6 = 106.49$  times of appearance.

Each Tx-time per appearance is 2.891 ms (see next plot).

So we have  $106.49 \times 2.891 \text{ ms} = 307.86 \text{ ms}$  per 31.6 seconds.



Verdict: PASS

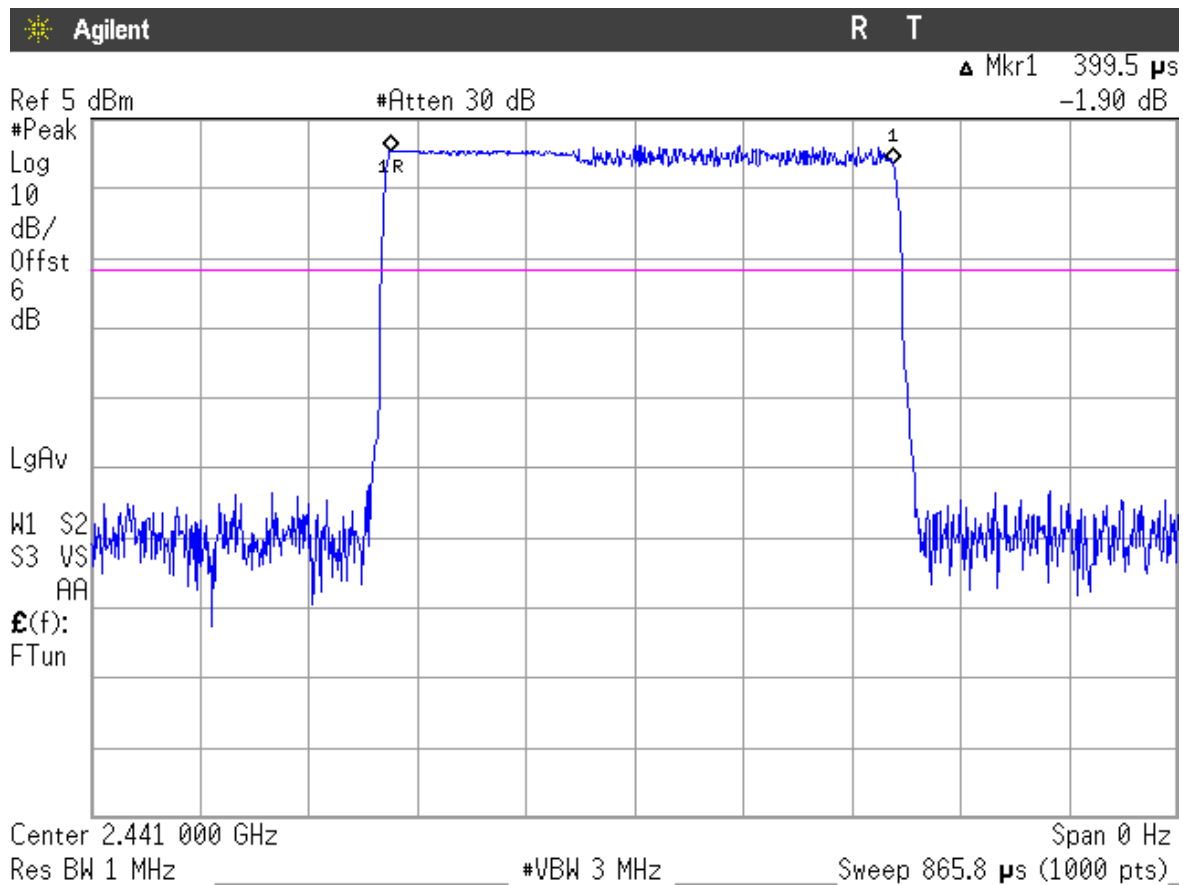
## Modulation: $\Pi/4$ -DQPSK

### 1. TIME OF OCCUPANCY (DWEELL TIME) FOR PACKET TYPE DH1.

The system makes worst case 1600 hops per second or 1 time slot has a length of  $625\mu\text{s}$  with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/2 = 800$  hops per second with 79 channels. So you have each channel  $800/79 = 10.13$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $10.13 \times 31.6 = 320.11$  times of appearance.

Each Tx-time per appearance is  $399.5\mu\text{s}$  (see next plot).

So we have  $320.11 \times 399.5\mu\text{s} = 127.88\text{ ms}$  per 31.6 seconds.



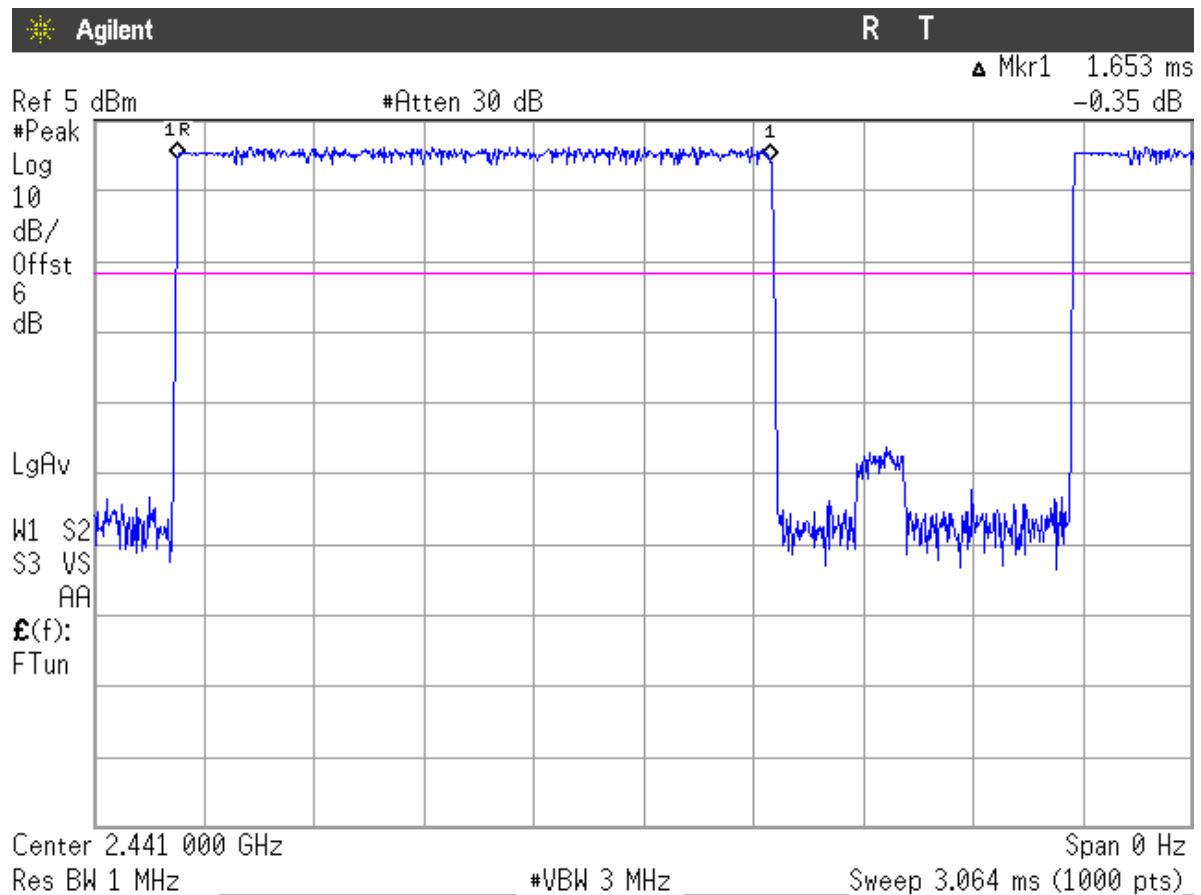
Verdict: PASS

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

A DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/4 = 400$  hops per second with 79 channels. So you have each channel  $400/79 = 5.1$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $5.1 \times 31.6 = 161.16$  times of appearance.

Each Tx-time per appearance is 1.653 ms (see next plot).

So we have  $161.16 \times 1.653 \text{ ms} = 266.40 \text{ ms}$  per 31.6 seconds.



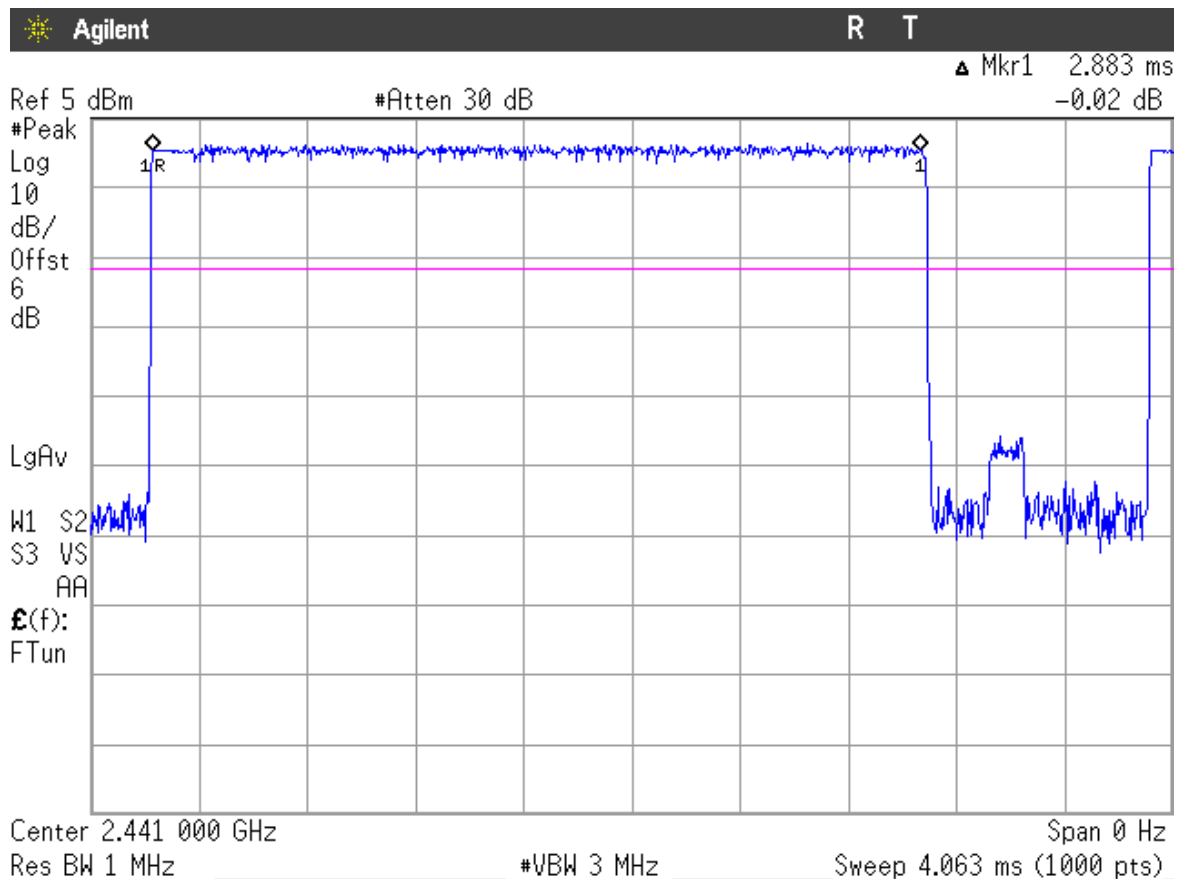
Verdict: PASS

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

A DH5 Packet needs 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/6 = 266.67$  hops per second with 79 channels. So you have each channel  $266.67/79 = 3.37$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $3.37 \times 31.6 = 106.49$  times of appearance.

Each Tx-time per appearance is 2.883 ms (see next plot).

So we have  $106.49 \times 2.883 \text{ ms} = 307.01 \text{ ms}$  per 31.6 seconds.



Verdict: PASS

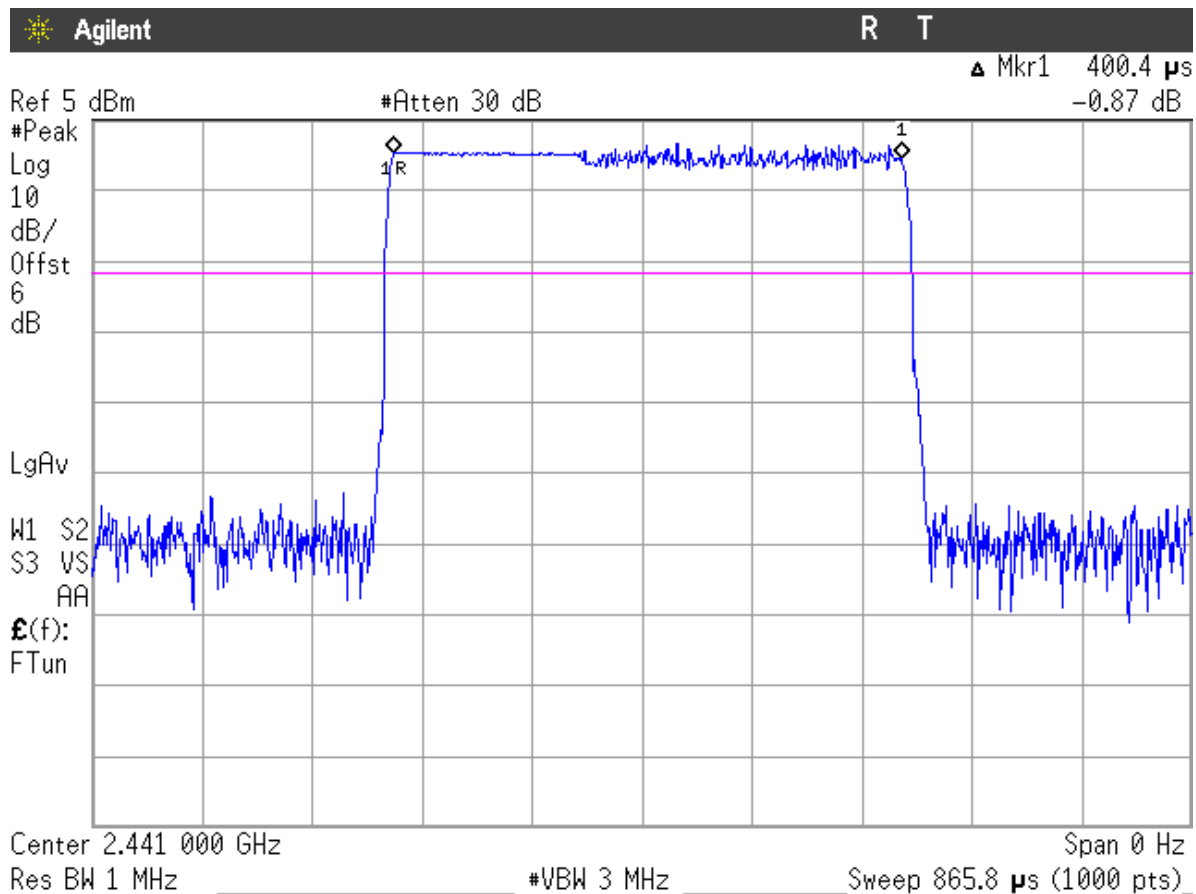
## Modulation: 8-DPSK

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

The system makes worst case 1600 hops per second or 1 time slot has a length of  $625\mu\text{s}$  with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/2 = 800$  hops per second with 79 channels. So you have each channel  $800/79 = 10.13$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $10.13 \times 31.6 = 320.11$  times of appearance.

Each Tx-time per appearance is  $400.4\mu\text{s}$  (see next plot).

So we have  $320.11 \times 400.4\mu\text{s} = 128.17$  ms per 31.6 seconds.



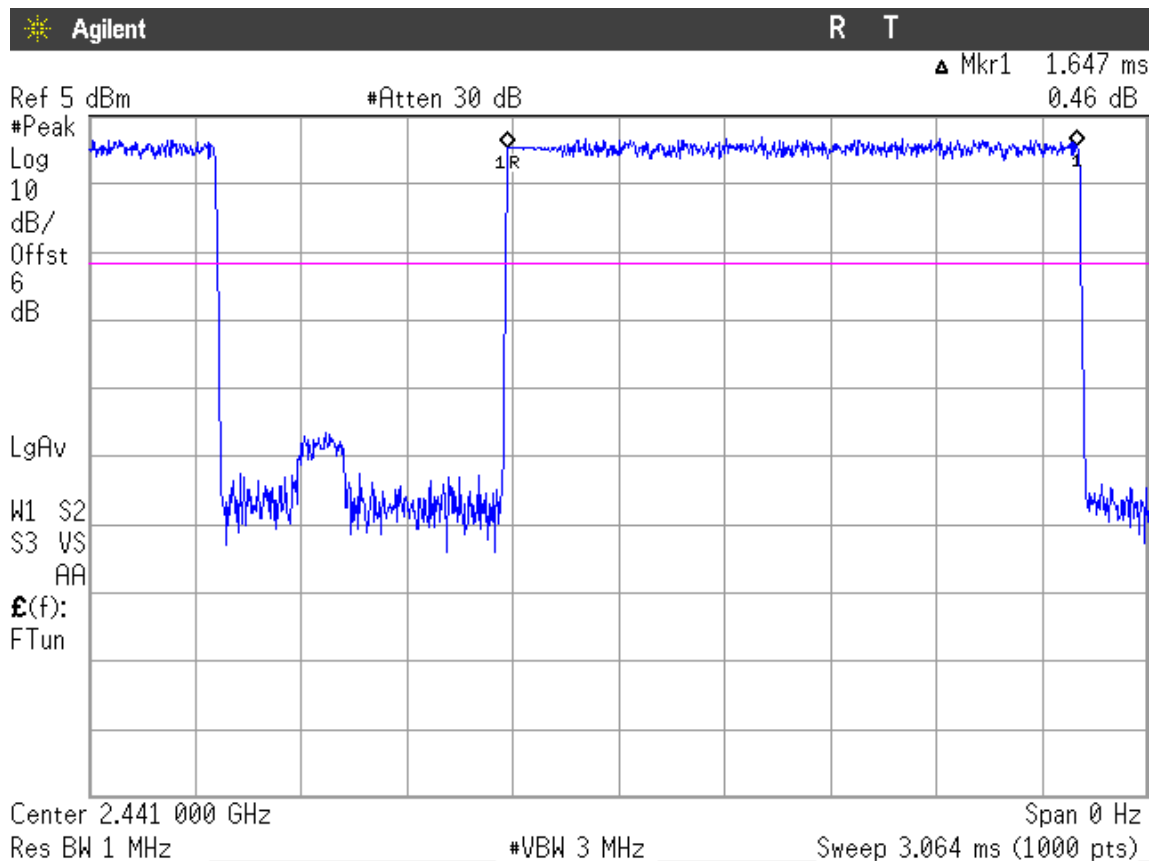
Verdict: PASS

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

A DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/4 = 400$  hops per second with 79 channels. So you have each channel  $400/79 = 5.1$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $5.1 \times 31.6 = 161.16$  times of appearance.

Each Tx-time per appearance is 1.647 ms (see next plot).

So we have  $161.16 \times 1.647 \text{ ms} = 265.43 \text{ ms}$  per 31.6 seconds.



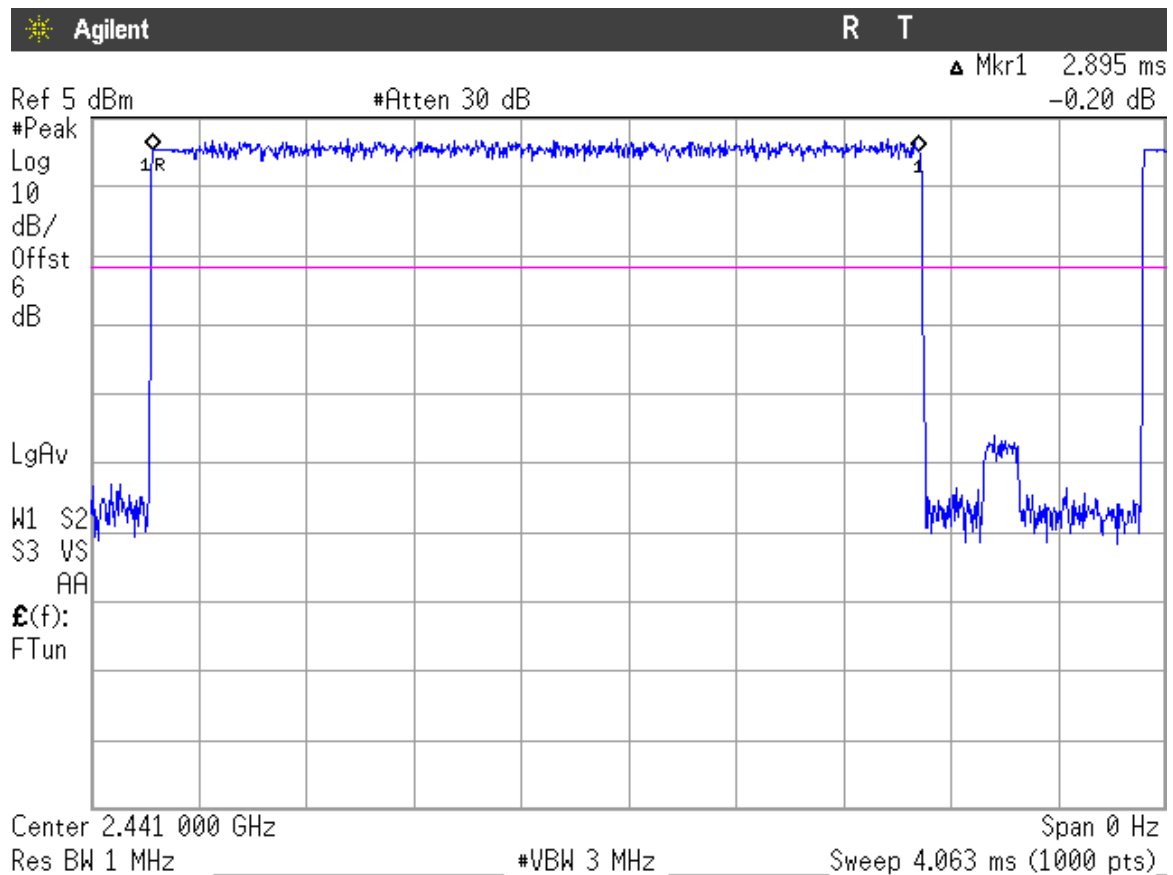
Verdict: PASS

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

A DH5 Packet needs 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/6 = 266.67$  hops per second with 79 channels. So you have each channel  $266.67/79 = 3.37$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $3.37 \times 31.6 = 106.49$  times of appearance.

Each Tx-time per appearance is 2.895 ms (see next plot).

So we have  $106.49 \times 2.895 \text{ ms} = 308.29 \text{ ms}$  per 31.6 seconds.



Verdict: PASS

## FCC Section 15.247 Subclause (b) / RSS-210 Clause A8.4 (2). Maximum peak output power and antenna gain

### SPECIFICATION

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt (30 dBm). The e.i.r.p. shall not exceed 4 W (RSS-210).

MAXIMUM OUTPUT POWER. See next plots.

Declared maximum antenna gain: 0.2 dBi.

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

Modulation: GFSK

|                              | Lowest frequency<br>2402 MHz | Middle frequency<br>2441 MHz | Highest frequency<br>2480 MHz |
|------------------------------|------------------------------|------------------------------|-------------------------------|
| Maximum peak power (dBm)     | 1.14                         | 2.96                         | 3.33                          |
| Maximum EIRP power (dBm)     | 1.34                         | 3.16                         | 3.53                          |
| Measurement uncertainty (dB) | ±1.5                         |                              |                               |

Modulation: Π/4-DQPSK (2Mbps)

|                              | Lowest frequency<br>2402 MHz | Middle frequency<br>2441 MHz | Highest frequency<br>2480 MHz |
|------------------------------|------------------------------|------------------------------|-------------------------------|
| Maximum peak power (dBm)     | 0.22                         | 1.91                         | 2.36                          |
| Maximum EIRP power (dBm)     | 0.42                         | 2.11                         | 2.56                          |
| Measurement uncertainty (dB) | ±1.5                         |                              |                               |

Modulation: 8-DPSK (3Mbps)

|                              | Lowest frequency<br>2402 MHz | Middle frequency<br>2441 MHz | Highest frequency<br>2480 MHz |
|------------------------------|------------------------------|------------------------------|-------------------------------|
| Maximum peak power (dBm)     | 0.76                         | 2.40                         | 2.88                          |
| Maximum EIRP power (dBm)     | 0.96                         | 2.60                         | 3.08                          |
| Measurement uncertainty (dB) | ±1.5                         |                              |                               |

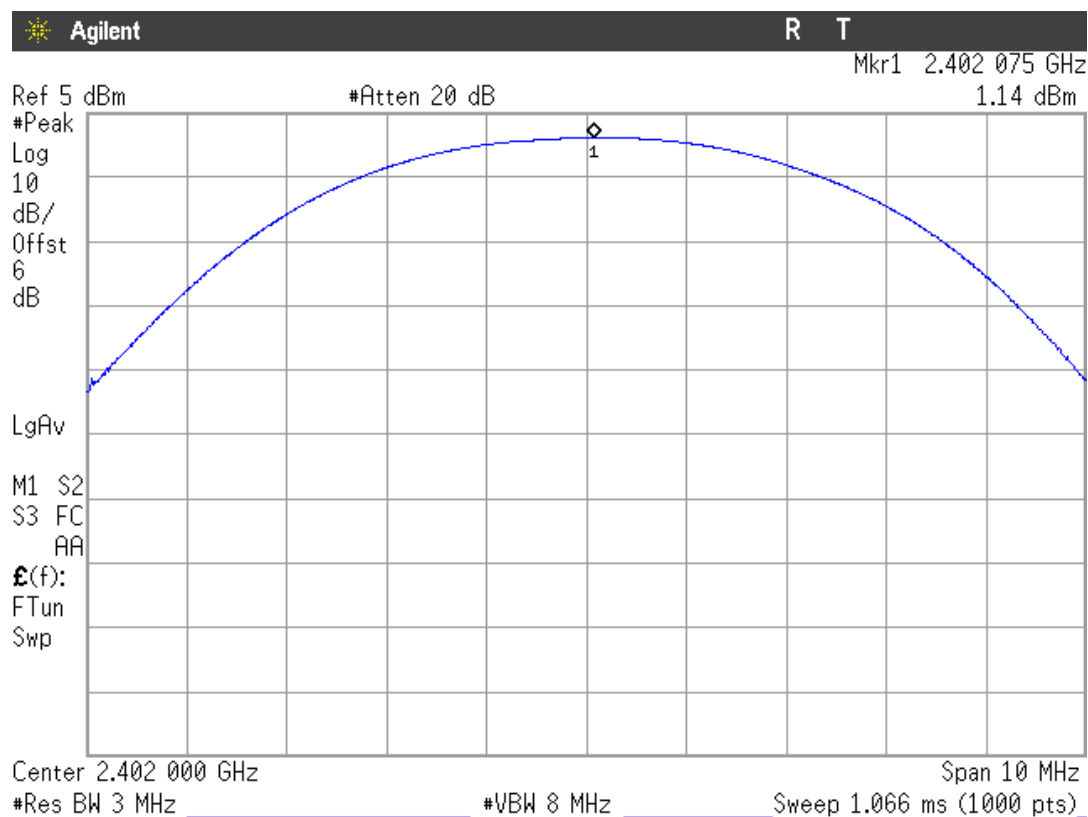
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

## PEAK OUTPUT POWER (CONDUCTED).

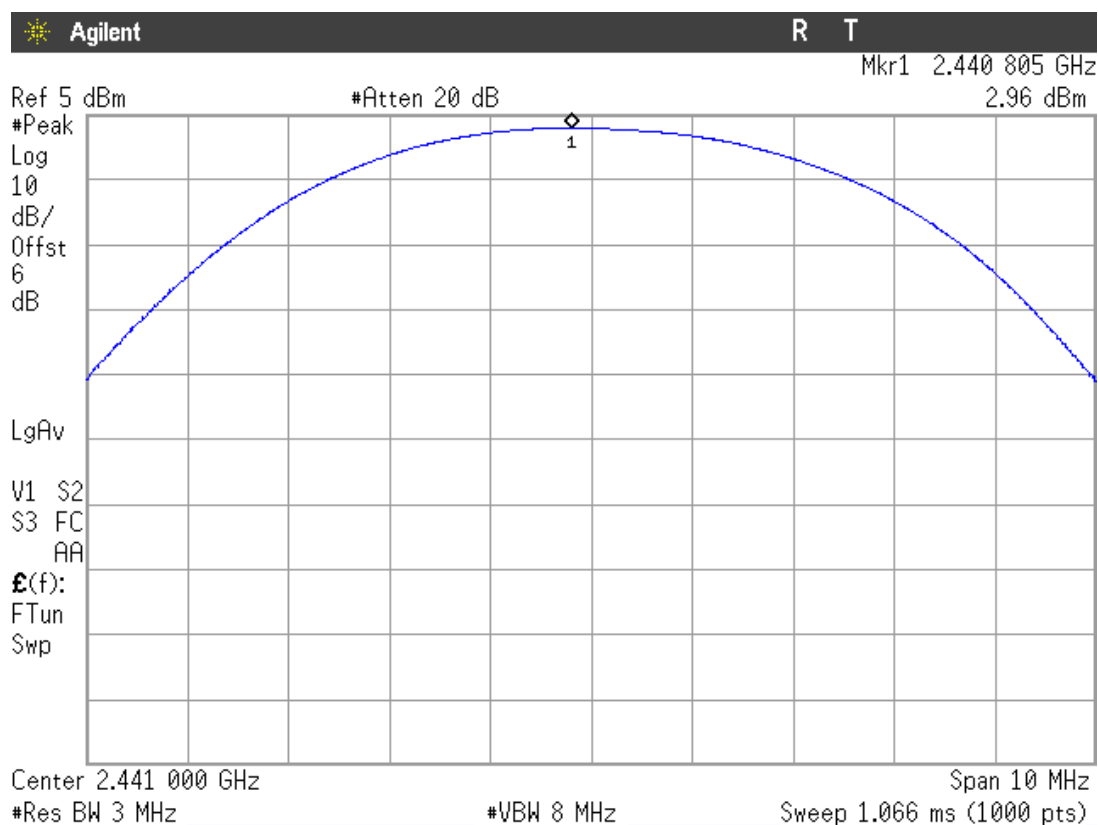
Modulation: GFSK

Lowest Channel: 2402 MHz.



Modulation: GFSK

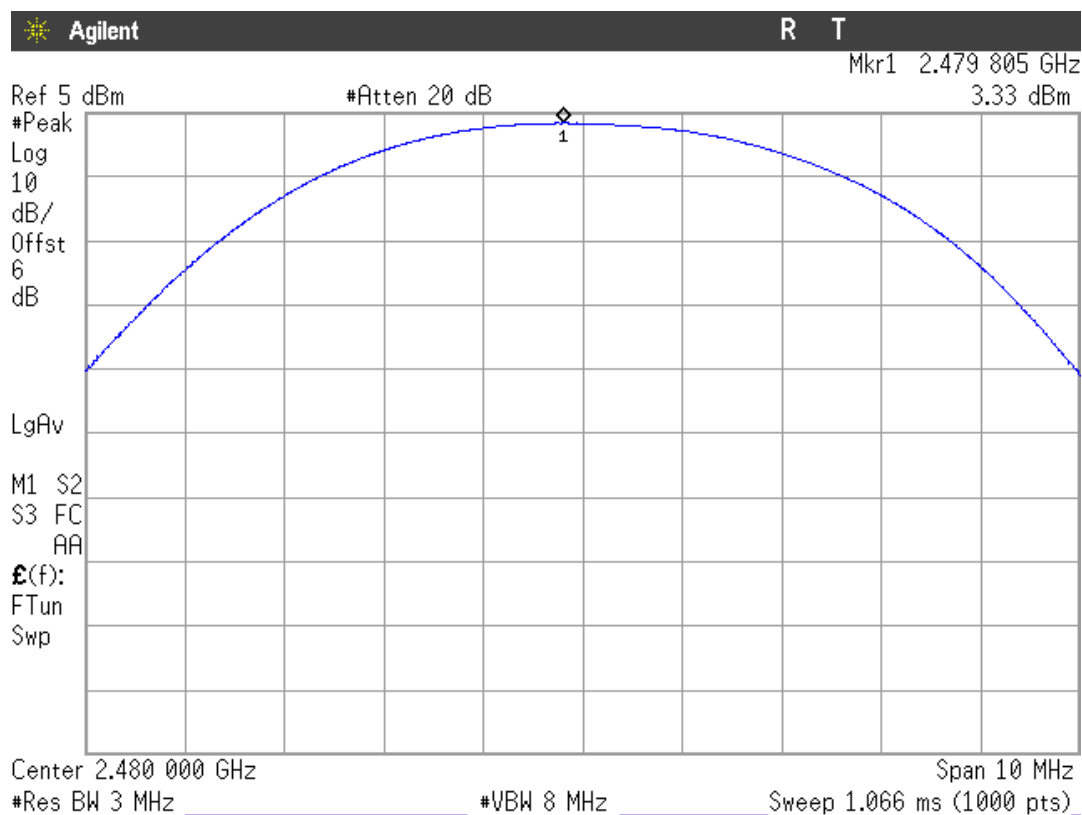
Middle Channel: 2441 MHz.



## PEAK OUTPUT POWER (CONDUCTED).

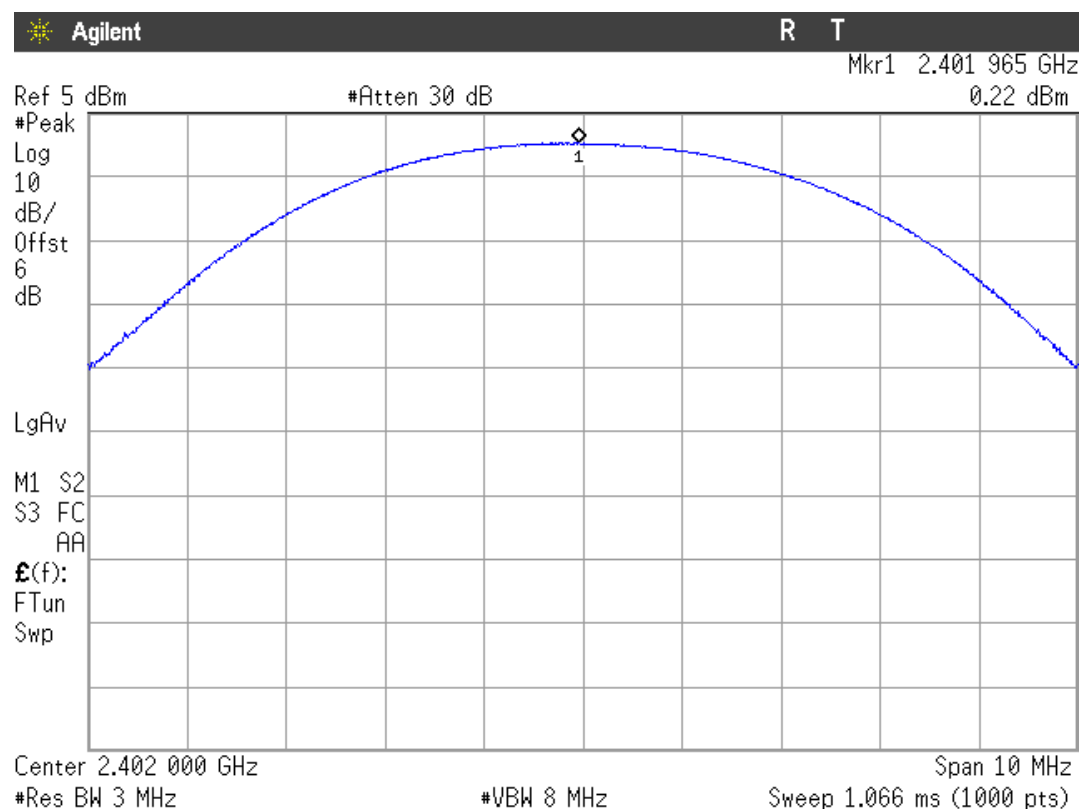
Modulation: GFSK

Highest Channel: 2480 MHz.



Modulation:  $\Pi/4$ -DQPSK

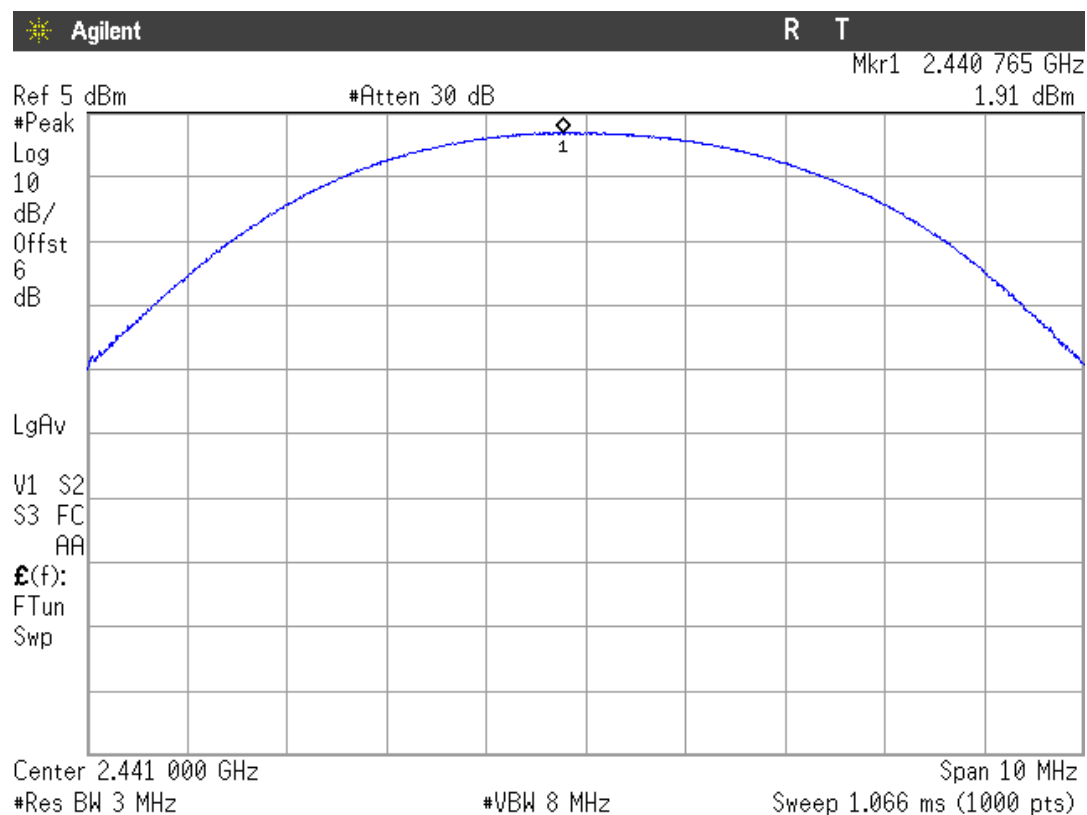
Lowest Channel: 2402 MHz



## PEAK OUTPUT POWER (CONDUCTED)

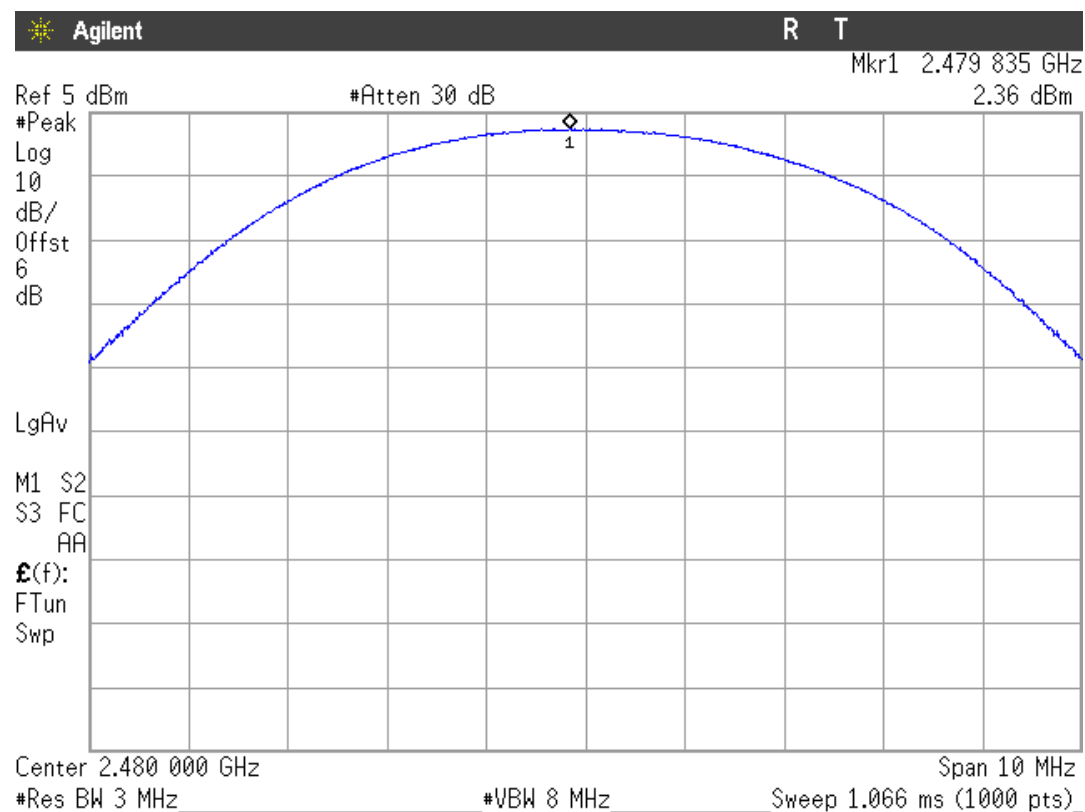
Modulation:  $\Pi/4$ -DQPSK

Middle Channel: 2441 MHz.



Modulation:  $\Pi/4$ -DQPSK

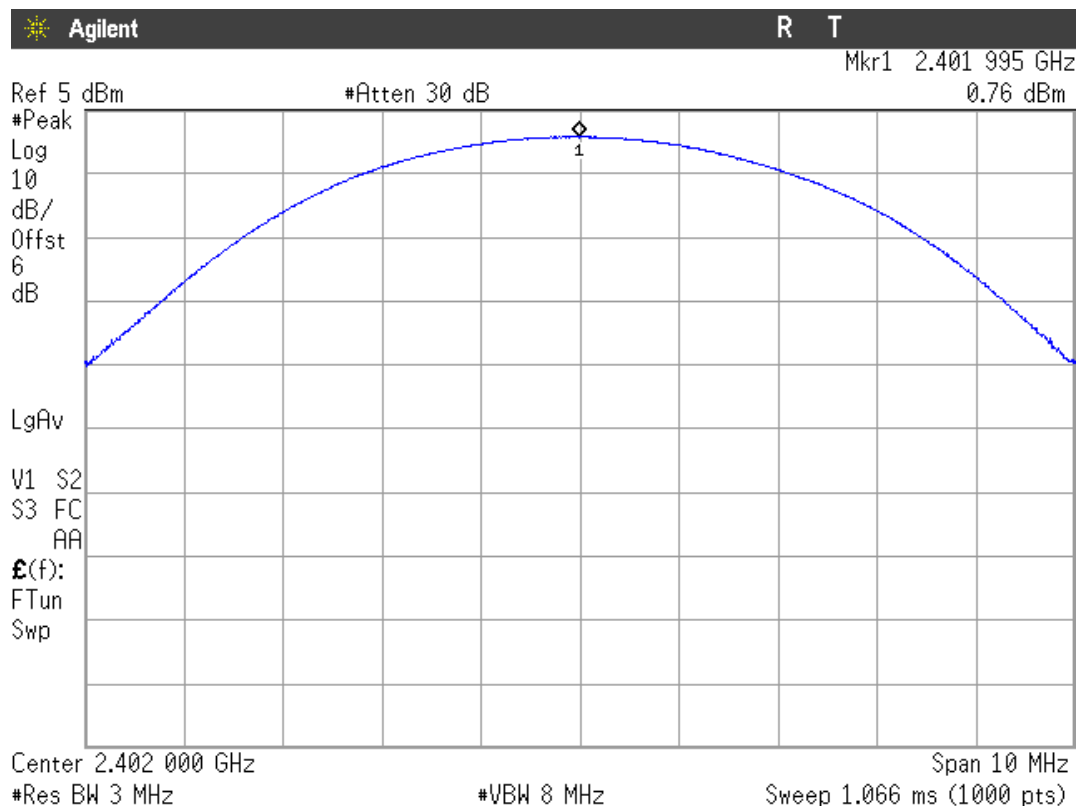
Highest Channel: 2480 MHz.



## PEAK OUTPUT POWER (CONDUCTED).

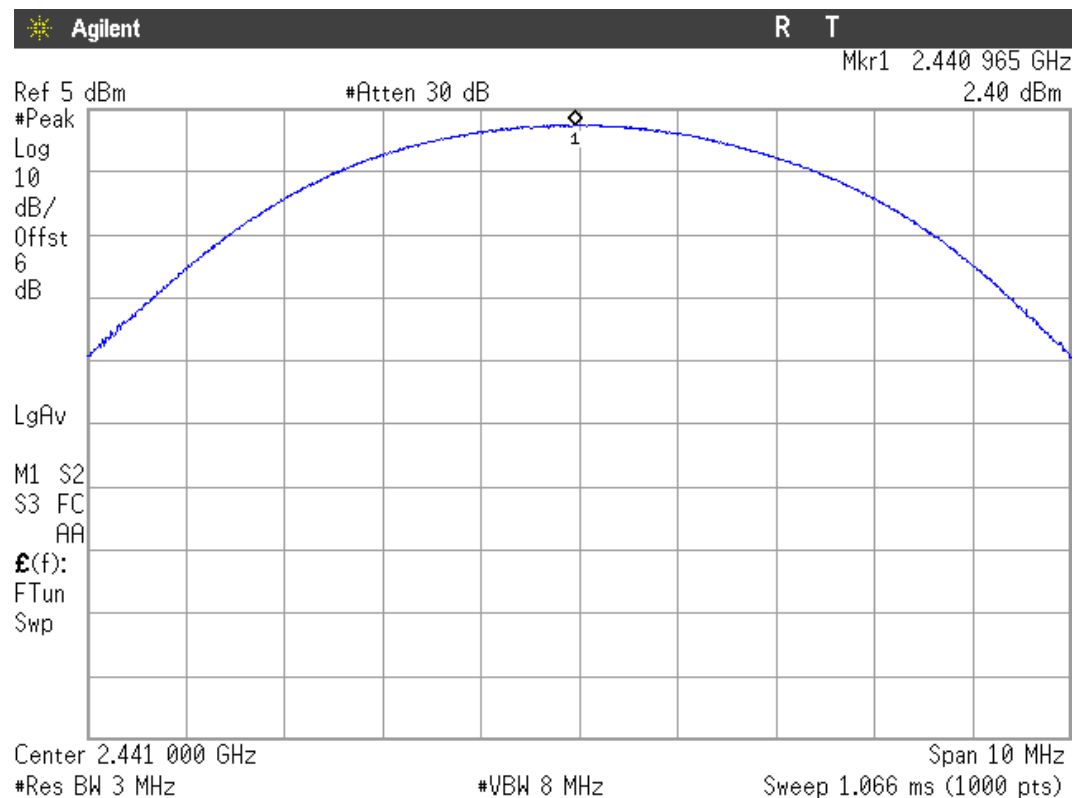
Modulation: 8-DPSK

Lowest Channel: 2402 MHz



Modulation: 8-DPSK

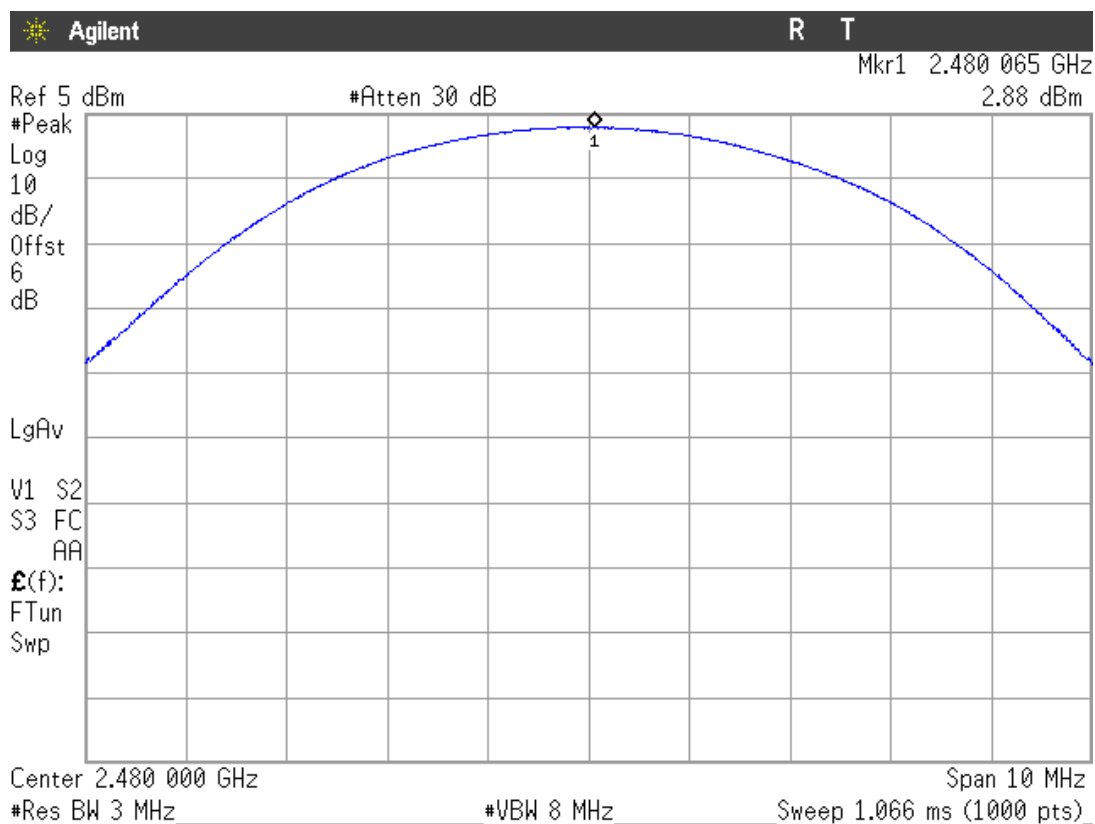
Middle Channel: 2441 MHz.



# PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK

Highest Channel: 2480 MHz.



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

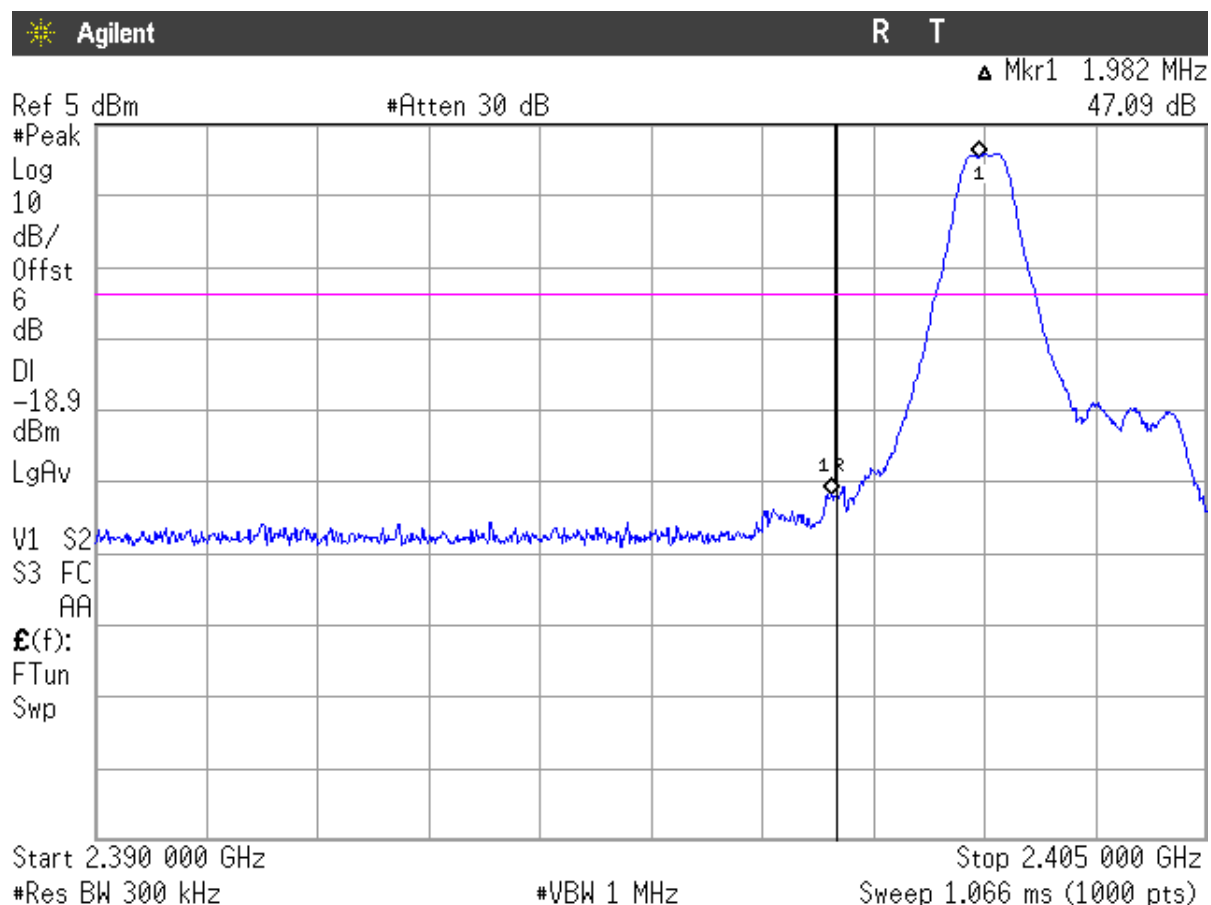
## **SPECIFICATION**

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

## **RESULTS:**

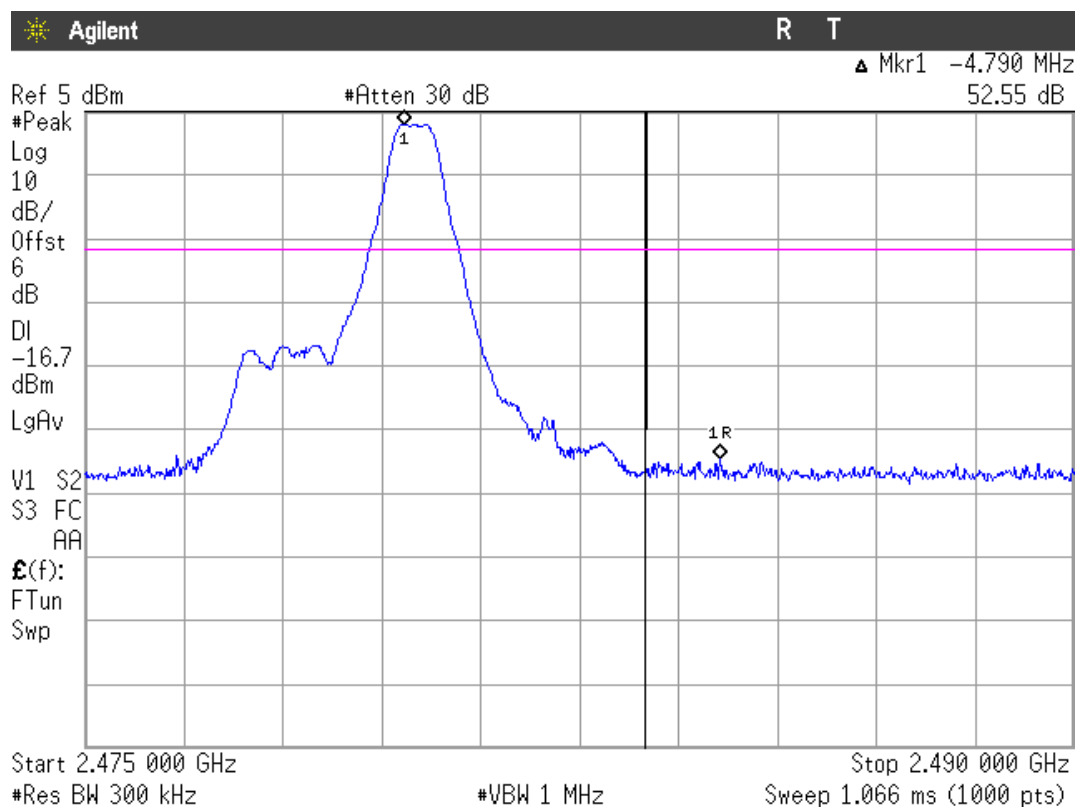
### **Modulation: GFSK**

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



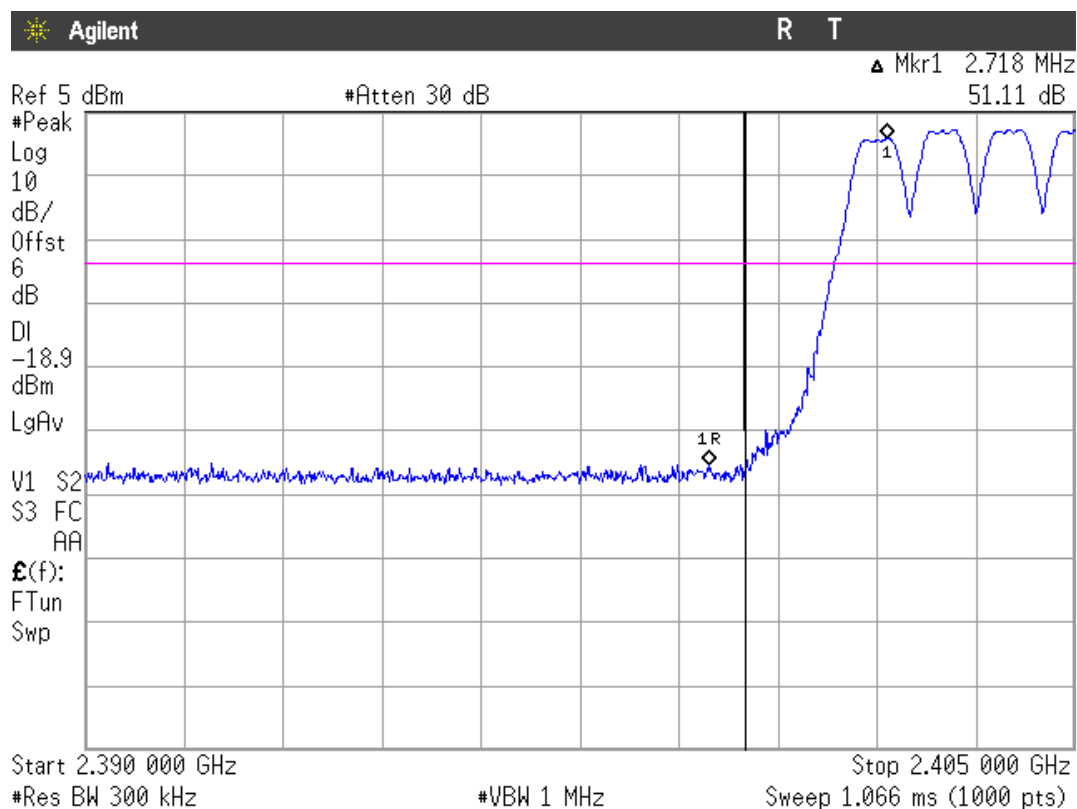
Verdict: PASS

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



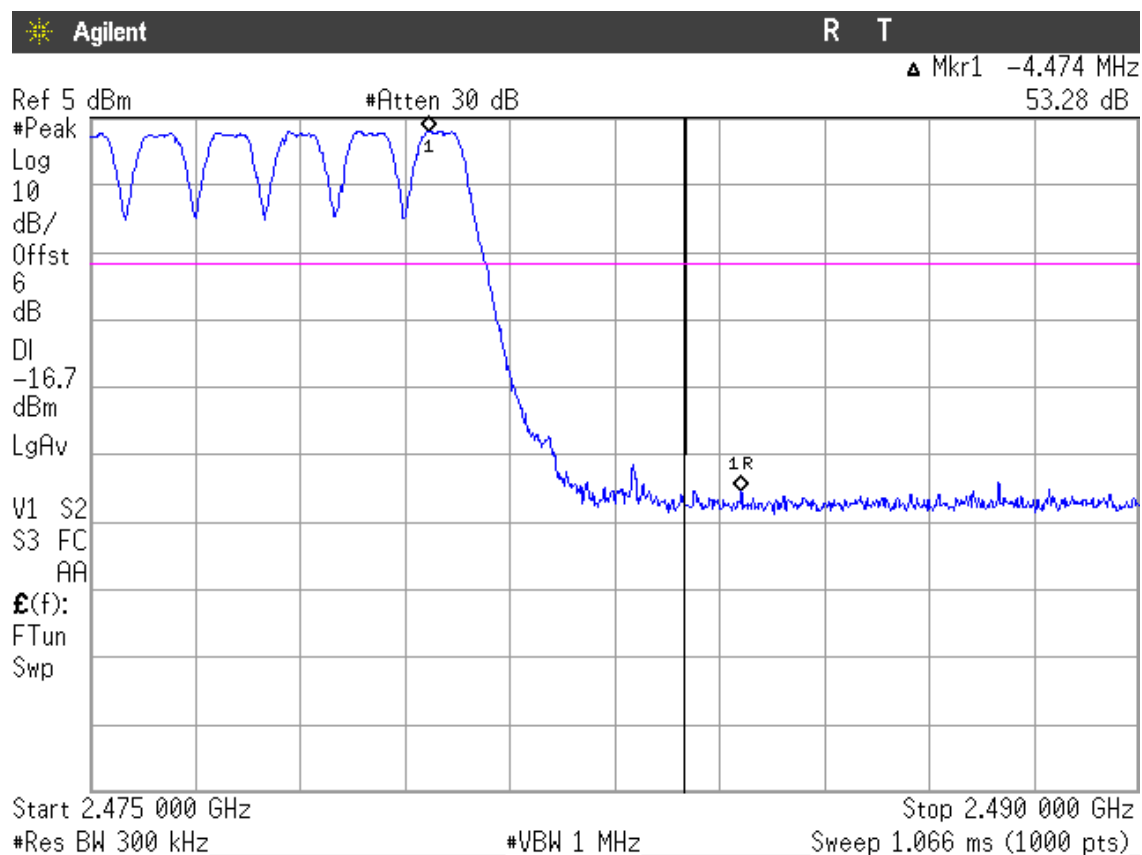
Verdict: PASS

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



Verdict: PASS

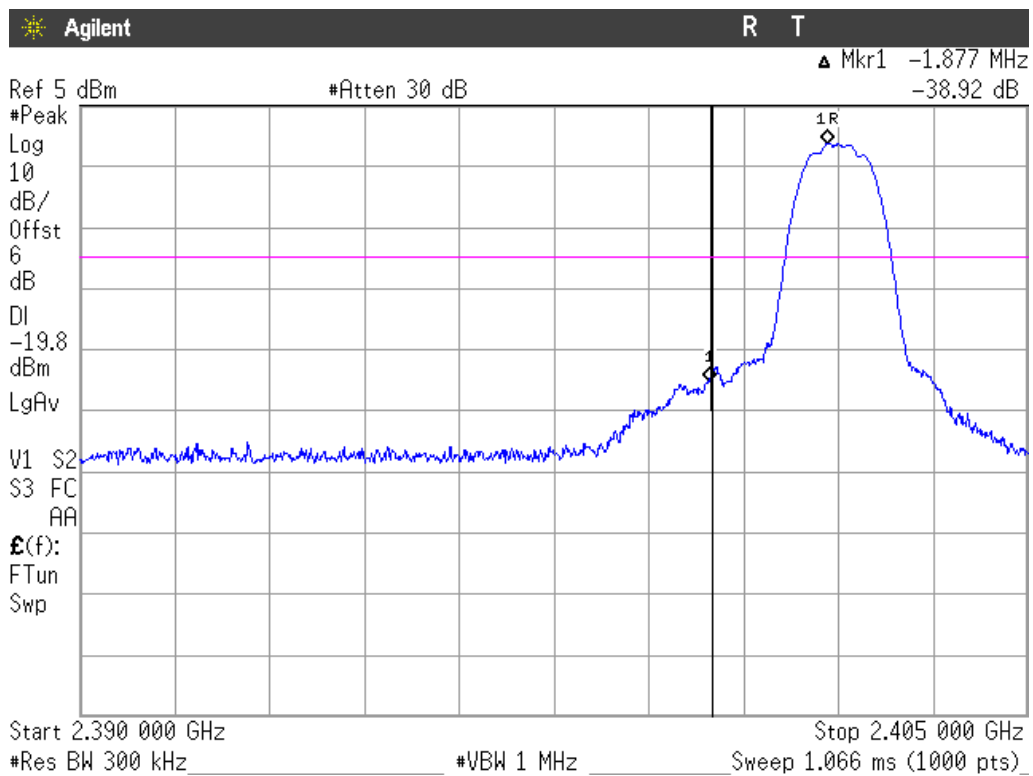
4. HIGH FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

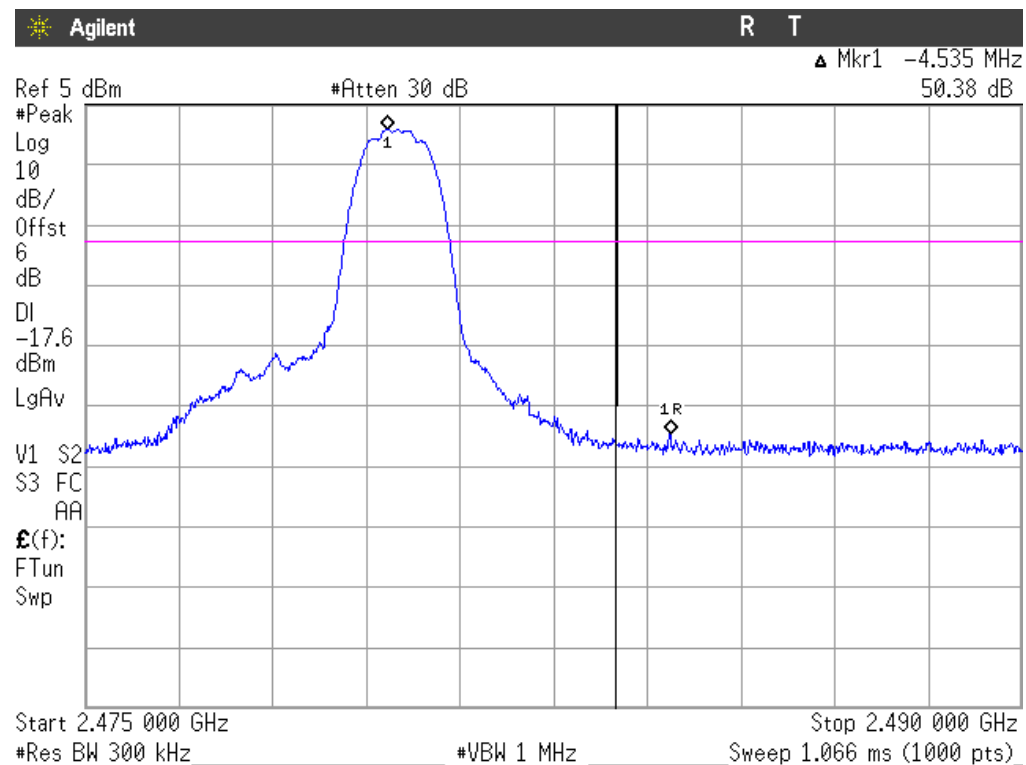
## Modulation: $\Pi/4$ -DQPSK

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



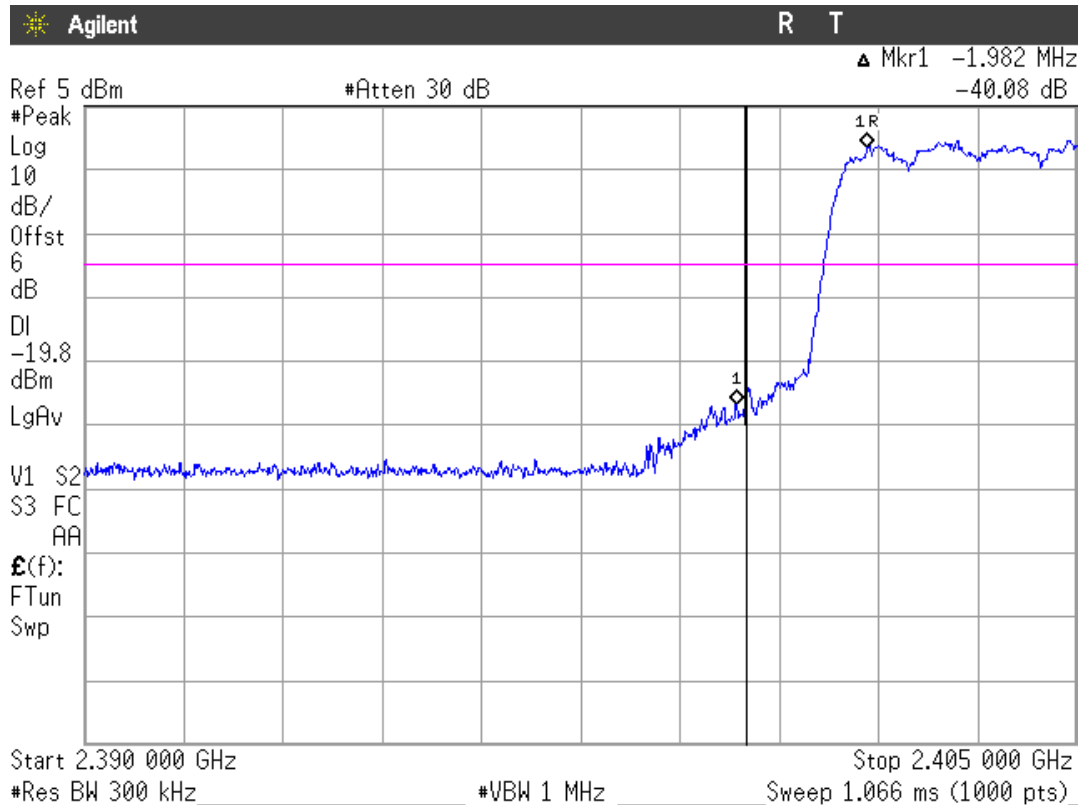
Verdict: PASS

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



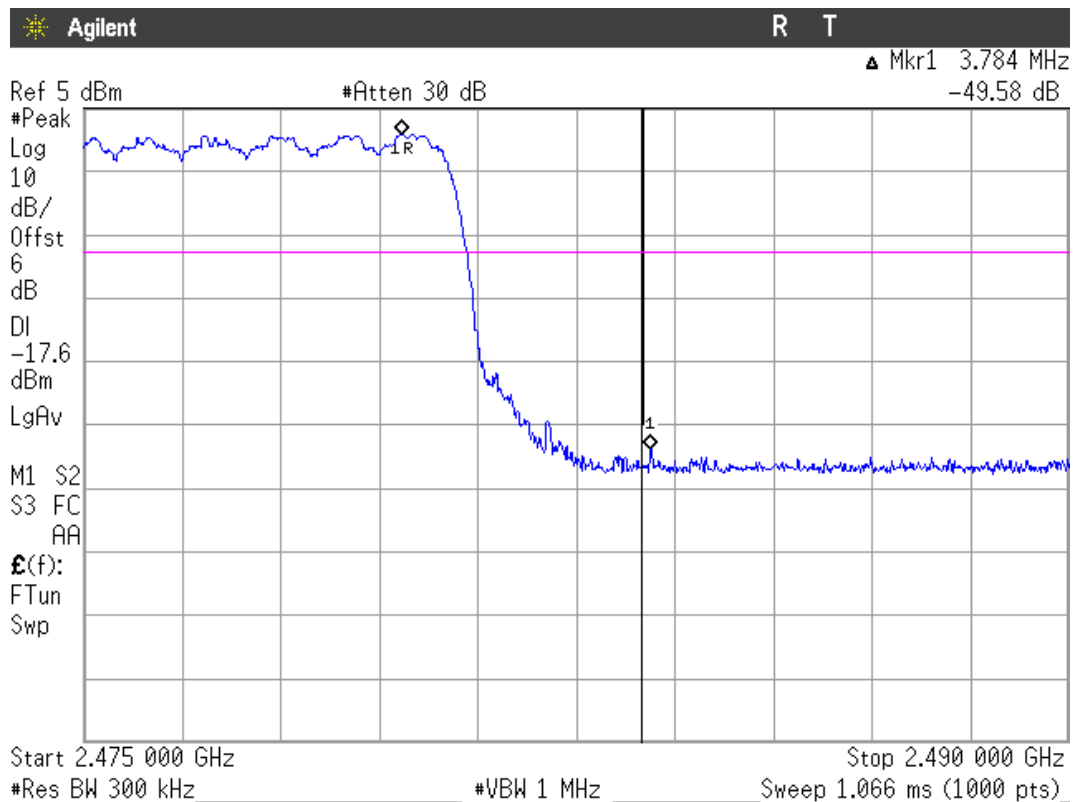
Verdict: PASS

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



Verdict: PASS

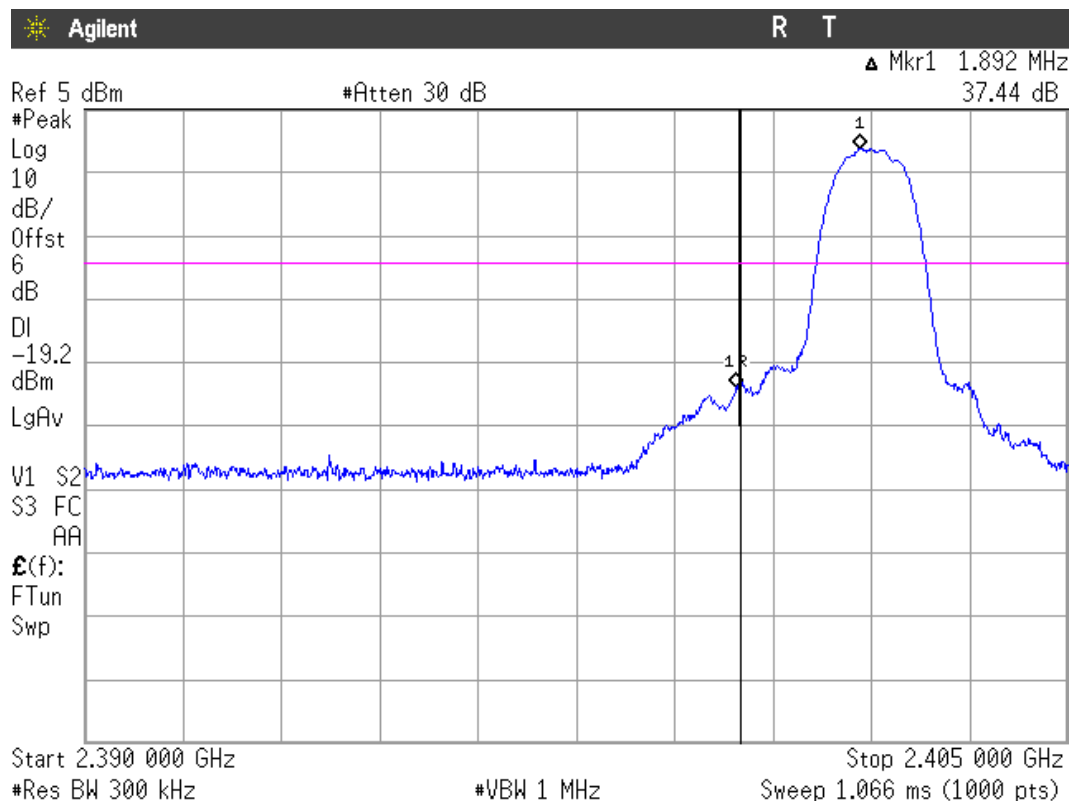
### 4. HIGH FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

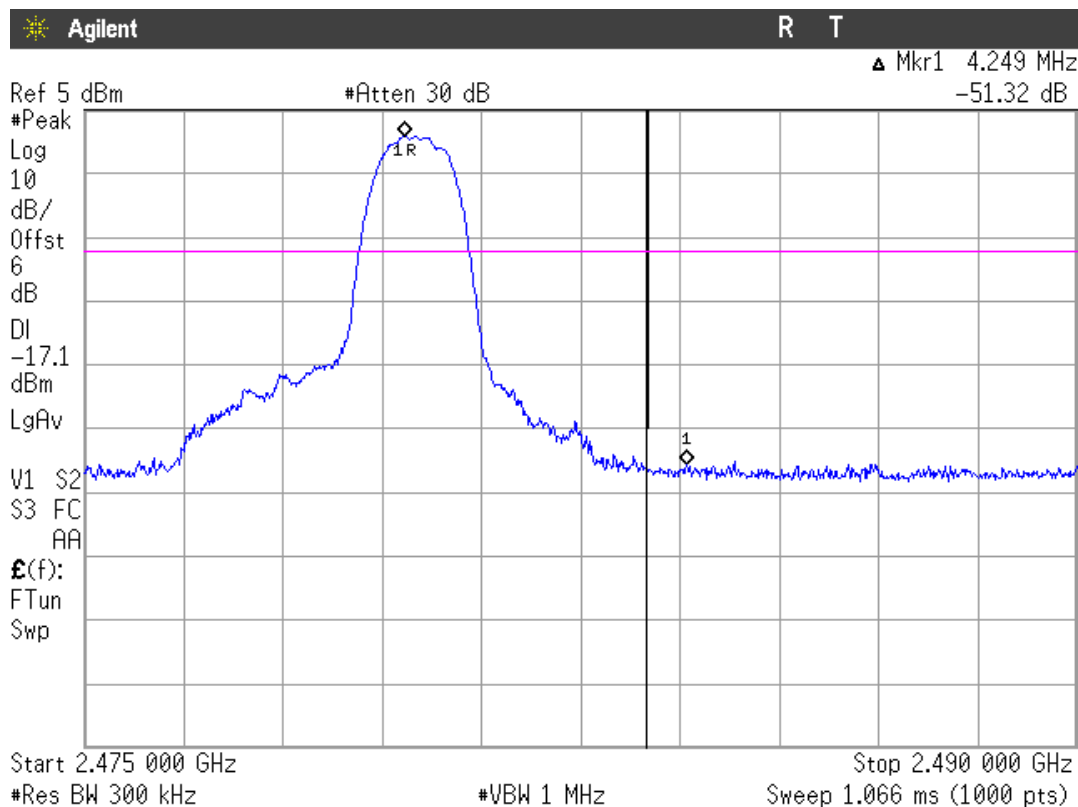
## Modulation: 8-DPSK

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



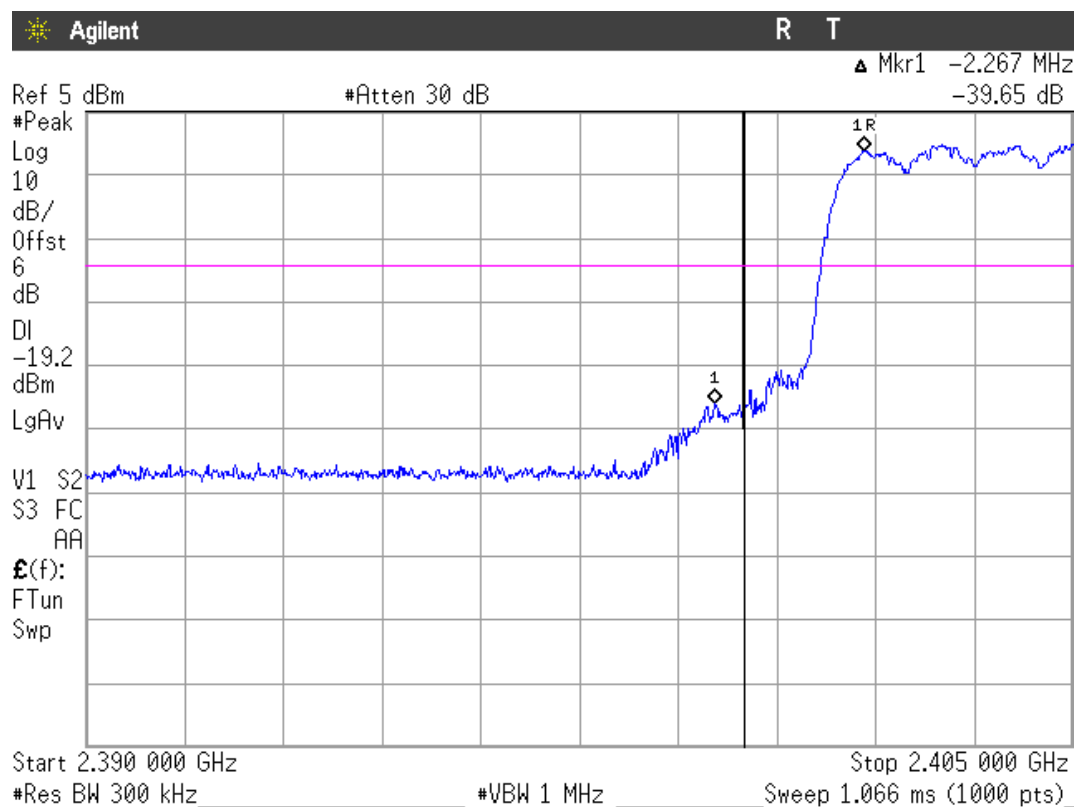
Verdict: PASS

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



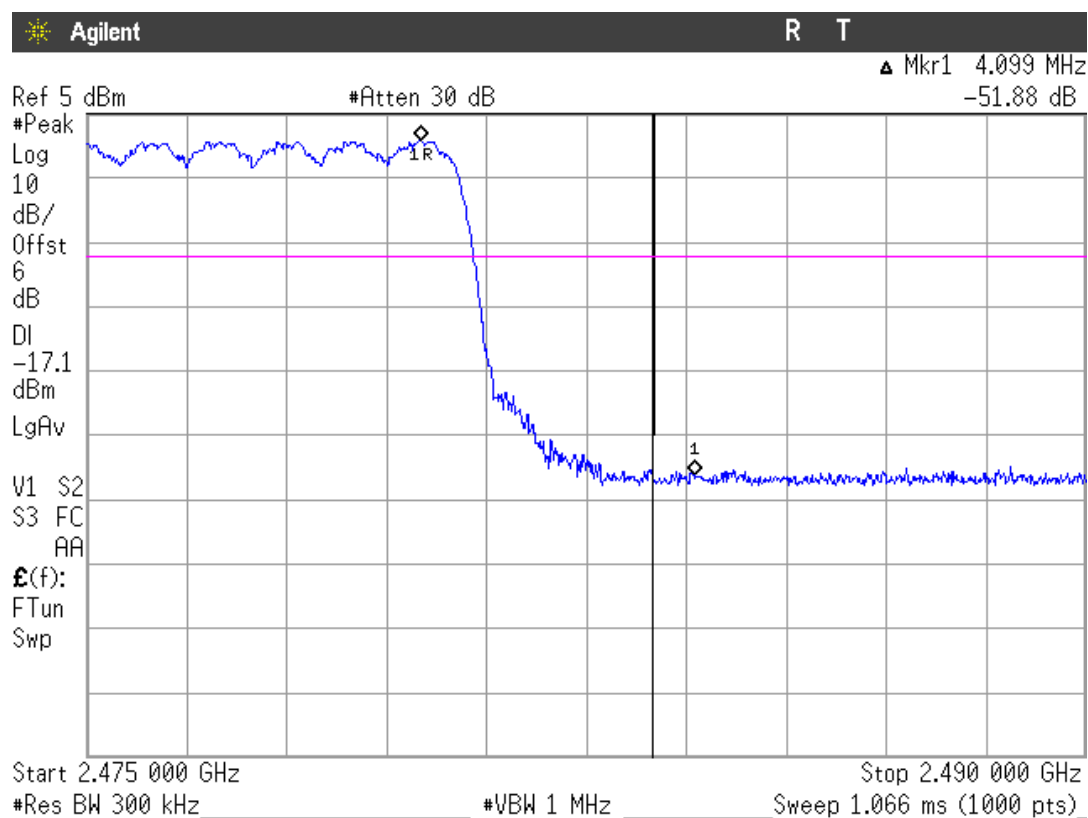
Verdict: PASS

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



Verdict: PASS

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



Verdict: PASS

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

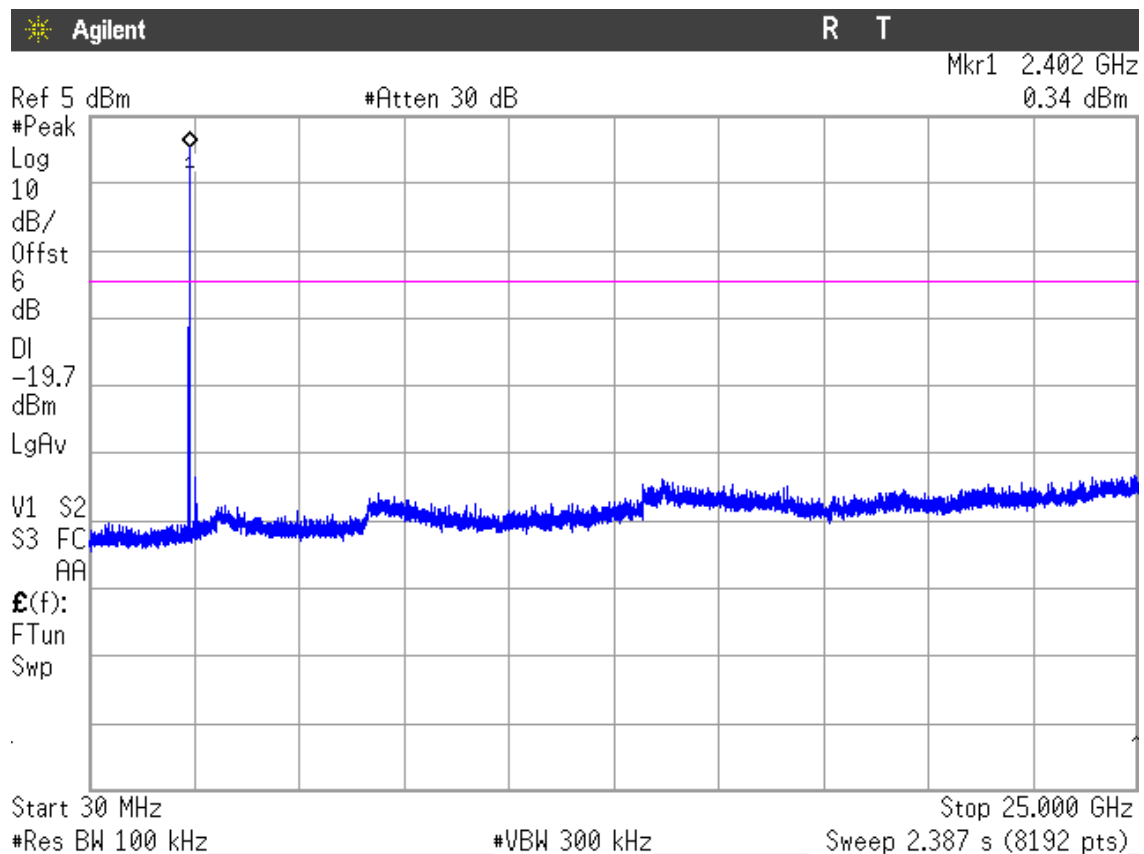
### SPECIFICATION

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

### RESULTS:

#### Modulation: GFSK

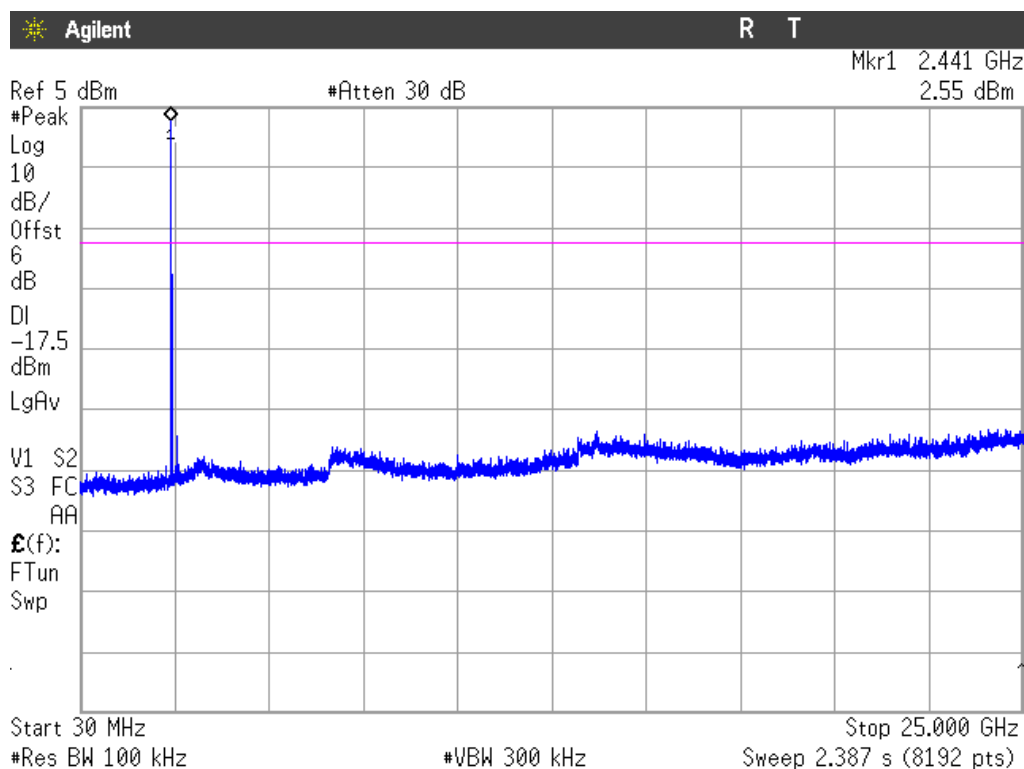
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

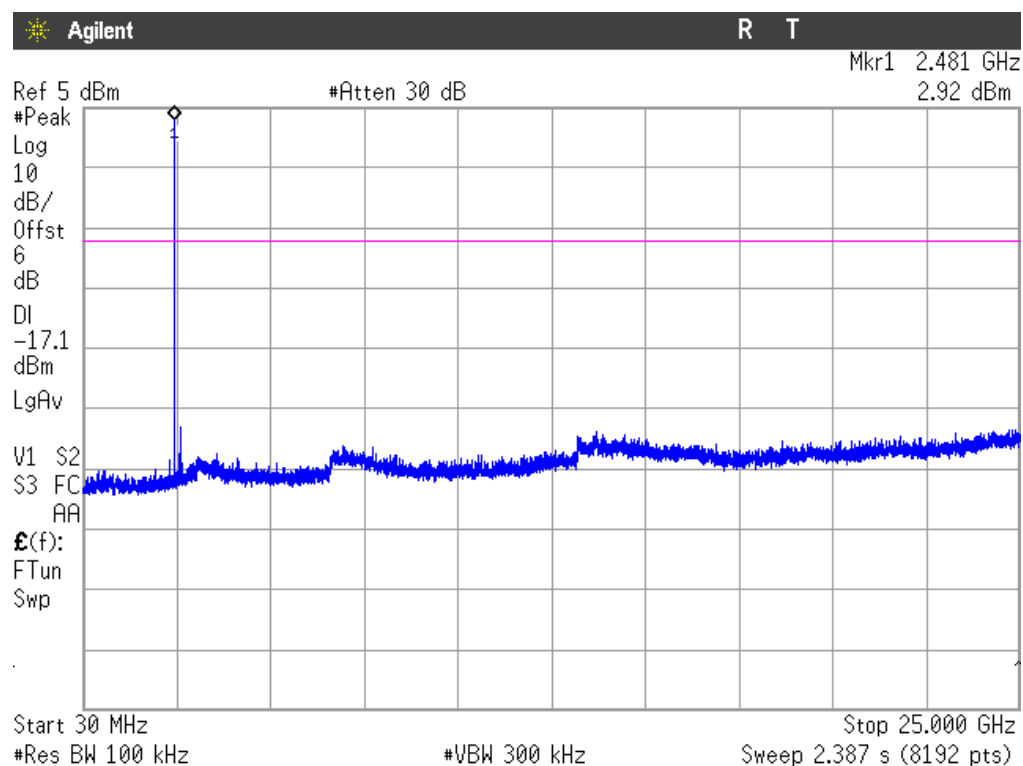
## 2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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

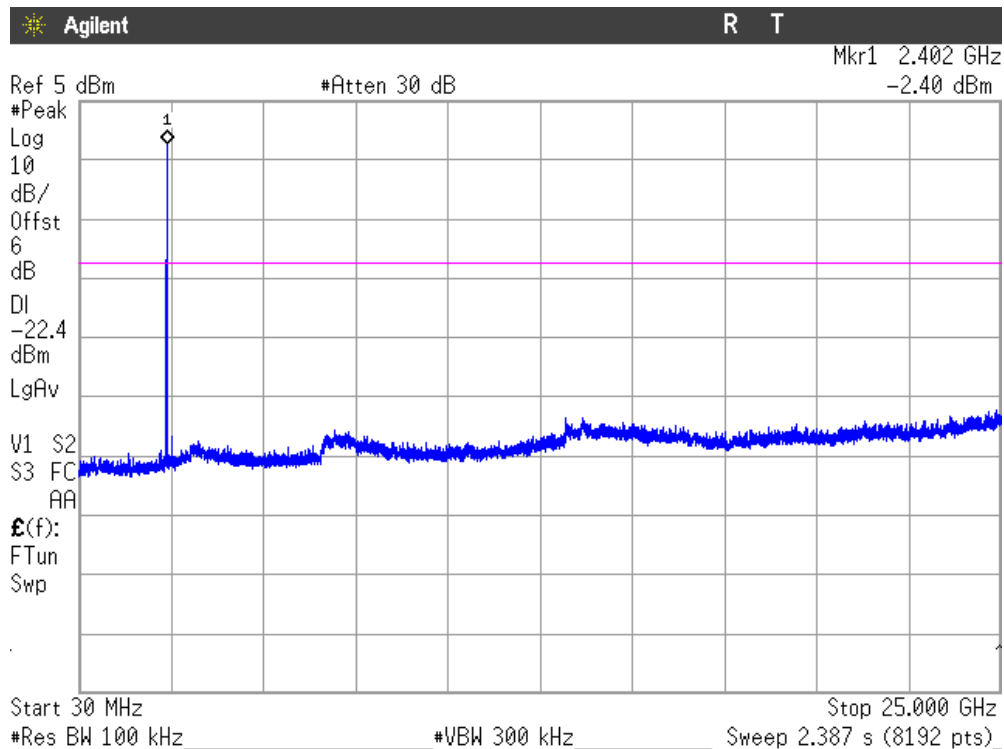


Note: The peak above the limits is the carrier frequency.

Verdict: PASS

## Modulation: $\Pi/4$ -DQPSK

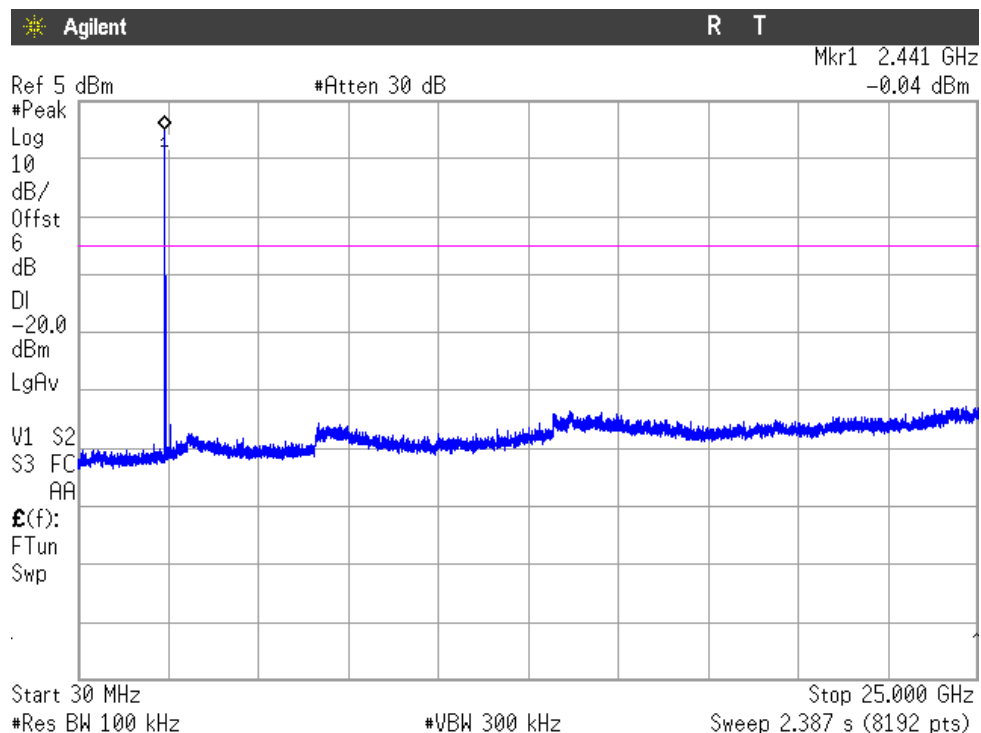
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

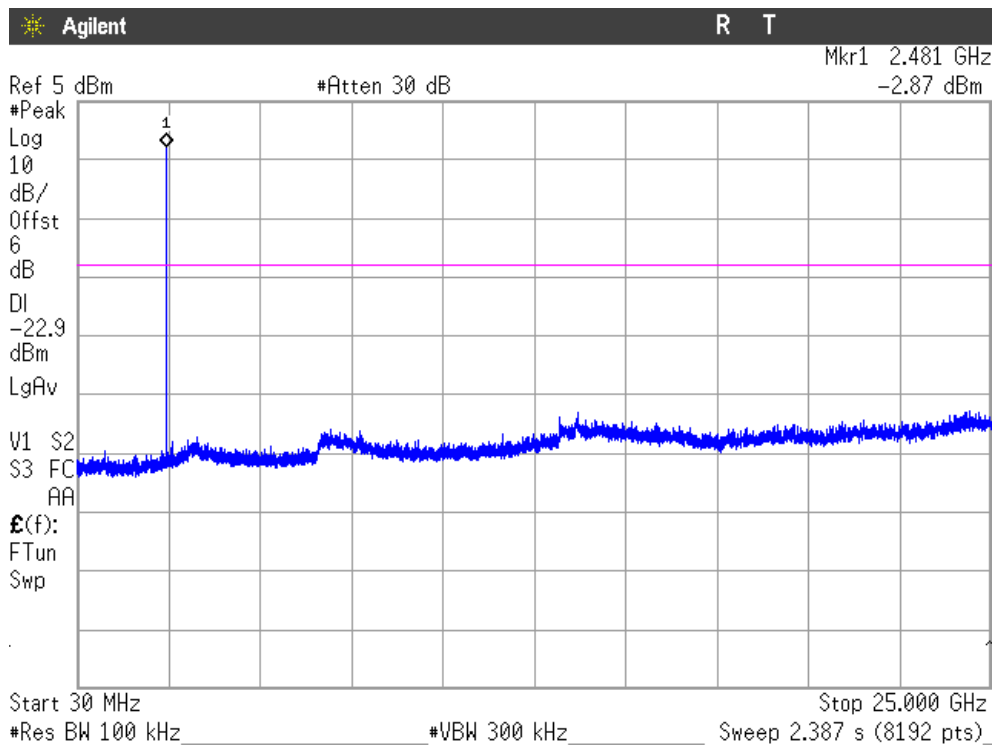
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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

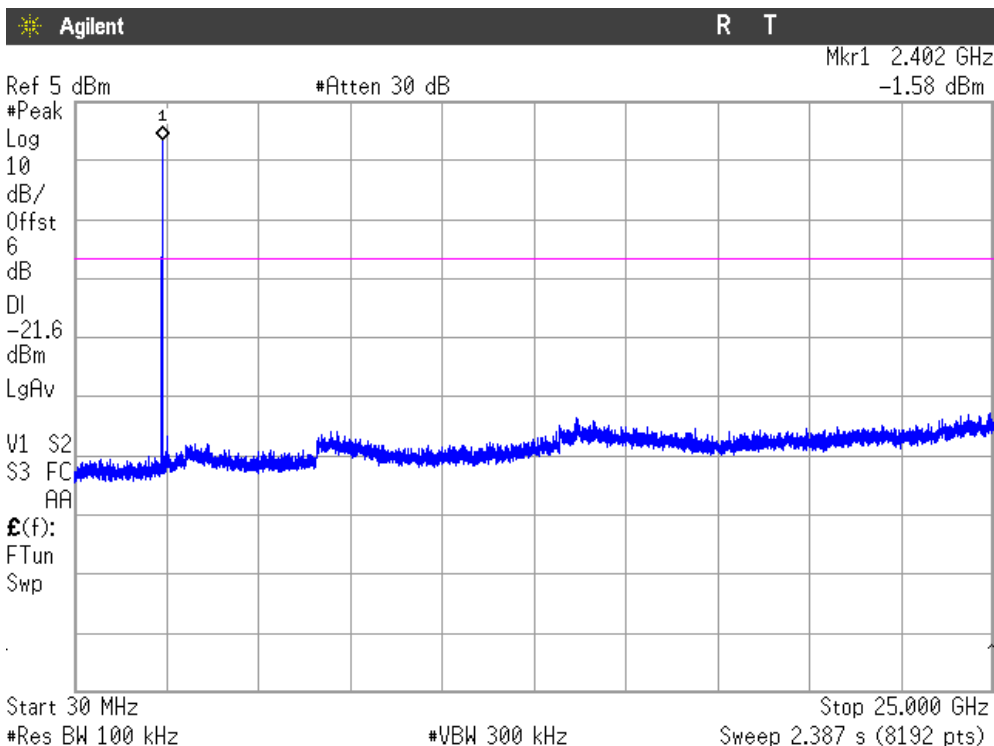


Note: The peak above the limit is the carrier frequency.

Verdict: PASS

### Modulation: 8-DPSK

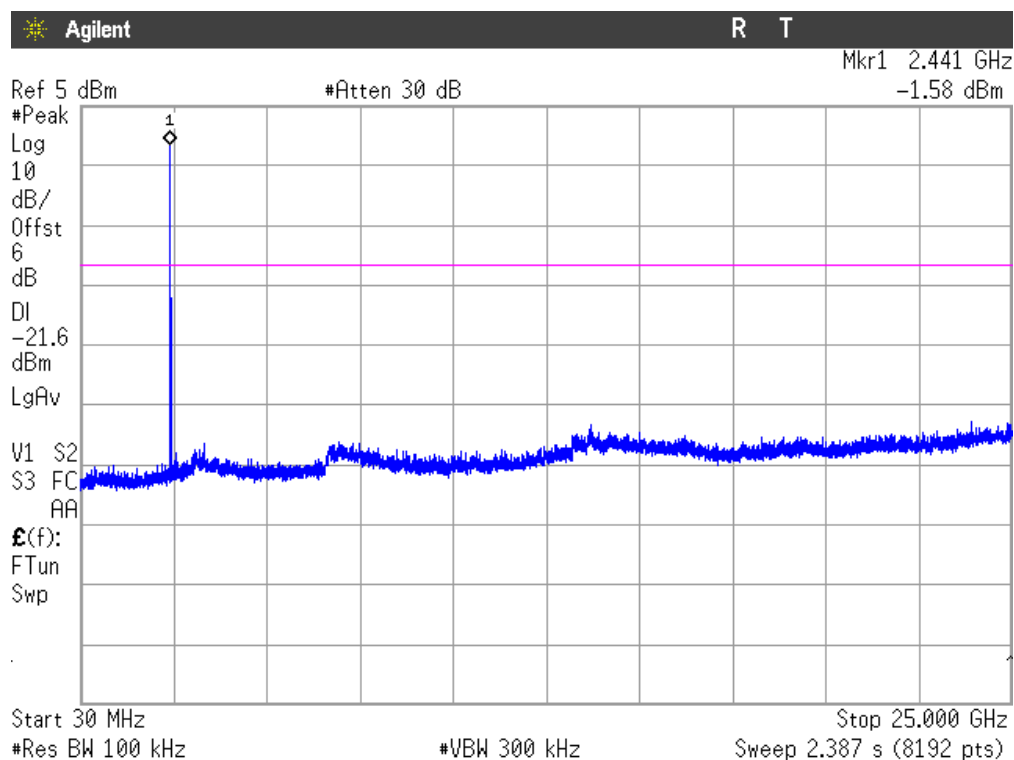
#### 1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

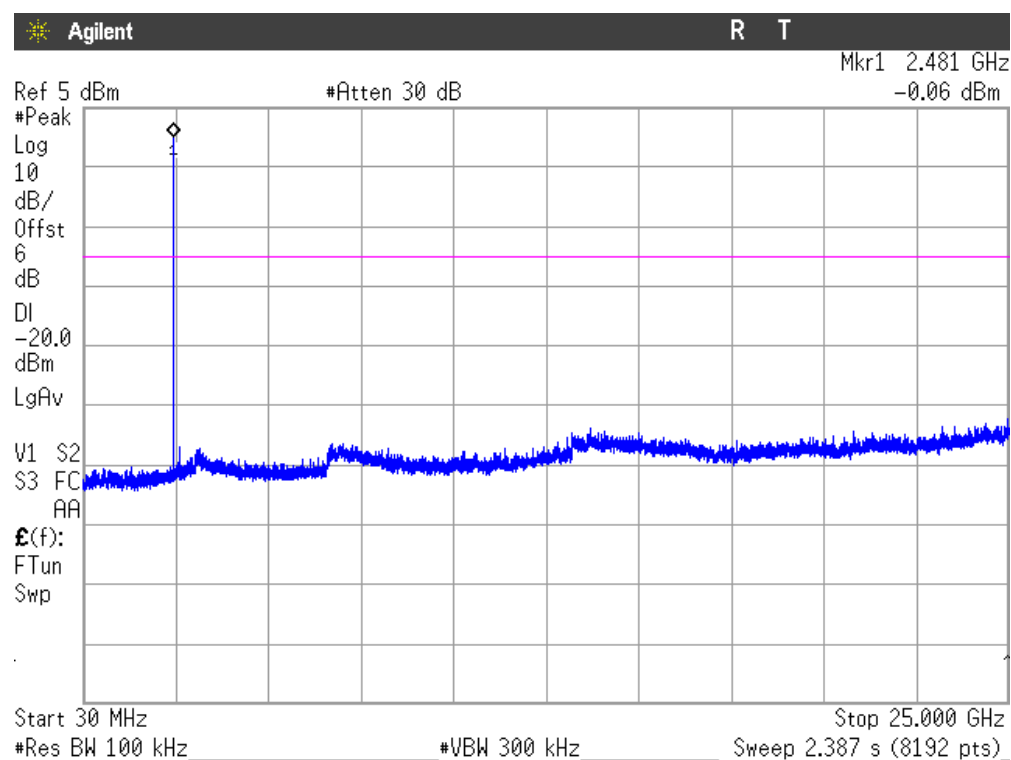
## 2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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



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

Verdict: PASS

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

### SPECIFICATION

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

| Frequency Range (MHz) | Field strength ( $\mu\text{V/m}$ ) | Field strength ( $\text{dB}\mu\text{V/m}$ ) | Measurement distance (m) |
|-----------------------|------------------------------------|---------------------------------------------|--------------------------|
| 0.009-0.490           | 2400/F(kHz)                        | -                                           | 300                      |
| 0.490-1.705           | 24000/F(kHz)                       | -                                           | 300                      |
| 1.705 - 30.0          | 30                                 | -                                           | 30                       |
| 30 - 88               | 100                                | 40                                          | 3                        |
| 88 - 216              | 150                                | 43.5                                        | 3                        |
| 216 - 960             | 200                                | 46                                          | 3                        |
| 960 - 25000           | 500                                | 54                                          | 3                        |

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

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

### RESULTS:

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

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

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

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

## Frequency range 30 MHz-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.

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

## Frequency range 1 GHz-25 GHz

Modulation: GFSK

### 1. CHANNEL: LOWEST (2402 MHz).

| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.33129                  | V            | Peak     | 47.66                   | ± 4.0                        |
|                          |              | RMS      | 37.10                   | ± 4.0                        |
| 2.48401                  | V            | Peak     | 48.58                   | ± 4.0                        |
|                          |              | RMS      | 36.62                   | ± 4.0                        |
| 2.55803                  | V            | Peak     | 49.29                   | ± 4.0                        |
|                          |              | RMS      | 42.93                   | ± 4.0                        |
| 4.80425                  | V            | Peak     | 34.81                   | ± 4.0                        |
|                          |              | RMS      | 28.09                   | ± 4.0                        |

### 2. CHANNEL: MIDDLE (2441 MHz).

| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.38688                  | V            | Peak     | 47.83                   | ± 4.0                        |
|                          |              | RMS      | 37.14                   | ± 4.0                        |
| 2.48987                  | V            | Peak     | 48.47                   | ± 4.0                        |
|                          |              | RMS      | 36.95                   | ± 4.0                        |
| 2.59697                  | V            | Peak     | 47.89                   | ± 4.0                        |
|                          |              | RMS      | 40.94                   | ± 4.0                        |
| 4.88175                  | V            | Peak     | 36.40                   | ± 4.0                        |
|                          |              | RMS      | 28.24                   | ± 4.0                        |

### 3. CHANNEL: HIGHEST (2480 MHz).

| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.31976                  | V            | Peak     | 47.73                   | ± 4.0                        |
|                          |              | RMS      | 36.06                   | ± 4.0                        |
| 2.48519                  | V            | Peak     | 49.73                   | ± 4.0                        |
|                          |              | RMS      | 36.49                   | ± 4.0                        |
| 2.63610                  | V            | Peak     | 47.73                   | ± 4.0                        |
|                          |              | RMS      | 40.59                   | ± 4.0                        |
| 4.96025                  | V            | Peak     | 34.80                   | ± 4.0                        |
|                          |              | RMS      | 28.30                   | ± 4.0                        |

Verdict: PASS

Modulation: Π/4-DQPSK

### 1. CHANNEL: LOWEST (2402 MHz).

| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.354956                 | V            | Peak     | 47.98                   | ± 4.0                        |
|                          |              | RMS      | 36.17                   | ± 4.0                        |
| 2.499996                 | V            | Peak     | 48.49                   | ± 4.0                        |
|                          |              | RMS      | 37.36                   | ± 4.0                        |
| 2.557967                 | V            | Peak     | 48.81                   | ± 4.0                        |
|                          |              | RMS      | 43.23                   | ± 4.0                        |

### 2. CHANNEL: MIDDLE (2441 MHz).

| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.36492                  | V            | Peak     | 47.74                   | ± 4.0                        |
|                          |              | RMS      | 36.52                   | ± 4.0                        |
| 2.49726                  | V            | Peak     | 48.31                   | ± 4.0                        |
|                          |              | RMS      | 36.96                   | ± 4.0                        |
| 2.59717                  | V            | Peak     | 46.03                   | ± 4.0                        |
|                          |              | RMS      | 39.14                   | ± 4.0                        |

### 3. CHANNEL: HIGHEST (2480 MHz).

| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.32413                  | V            | Peak     | 45.61                   | ± 4.0                        |
|                          |              | RMS      | 38.09                   | ± 4.0                        |
| 2.49009                  | V            | Peak     | 45.72                   | ± 4.0                        |
|                          |              | RMS      | 38.34                   | ± 4.0                        |
| 2.63597                  | V            | Peak     | 46.85                   | ± 4.0                        |
|                          |              | RMS      | 38.93                   | ± 4.0                        |

Verdict: PASS

Modulation: 8-DPSK

### 1. CHANNEL: LOWEST (2402 MHz).

| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.38342                  | V            | Peak     | 47.67                   | ± 4.0                        |
|                          |              | RMS      | 36.44                   | ± 4.0                        |
| 2.49472                  | V            | Peak     | 48.80                   | ± 4.0                        |
|                          |              | RMS      | 36.92                   | ± 4.0                        |
| 2.55803                  | V            | Peak     | 48.16                   | ± 4.0                        |
|                          |              | RMS      | 40.70                   | ± 4.0                        |

### 2. CHANNEL: MIDDLE (2441 MHz).

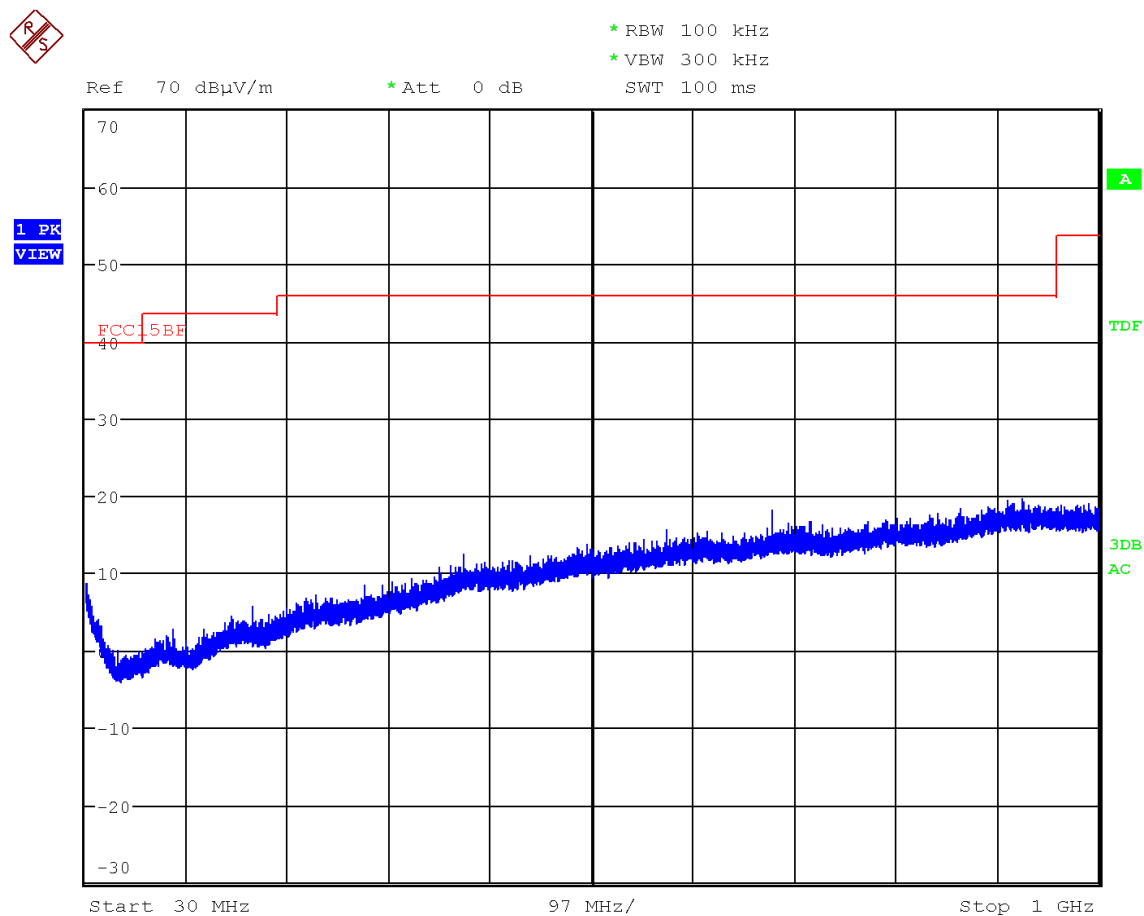
| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.33716                  | V            | Peak     | 48.11                   | ± 4.0                        |
|                          |              | RMS      | 36.23                   | ± 4.0                        |
| 2.49587                  | V            | Peak     | 48.74                   | ± 4.0                        |
|                          |              | RMS      | 37.19                   | ± 4.0                        |
| 2.59697                  | V            | Peak     | 46.86                   | ± 4.0                        |
|                          |              | RMS      | 39.48                   | ± 4.0                        |

### 3. CHANNEL: HIGHEST (2480 MHz).

| Spurious frequency (GHz) | Polarization | Detector | Emission Level (dBμV/m) | Measurement Uncertainty (dB) |
|--------------------------|--------------|----------|-------------------------|------------------------------|
| 2.32413                  | V            | Peak     | 45.67                   | ± 4.0                        |
|                          |              | RMS      | 38.05                   | ± 4.0                        |
| 2.49058                  | V            | Peak     | 46.59                   | ± 4.0                        |
|                          |              | RMS      | 38.30                   | ± 4.0                        |

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

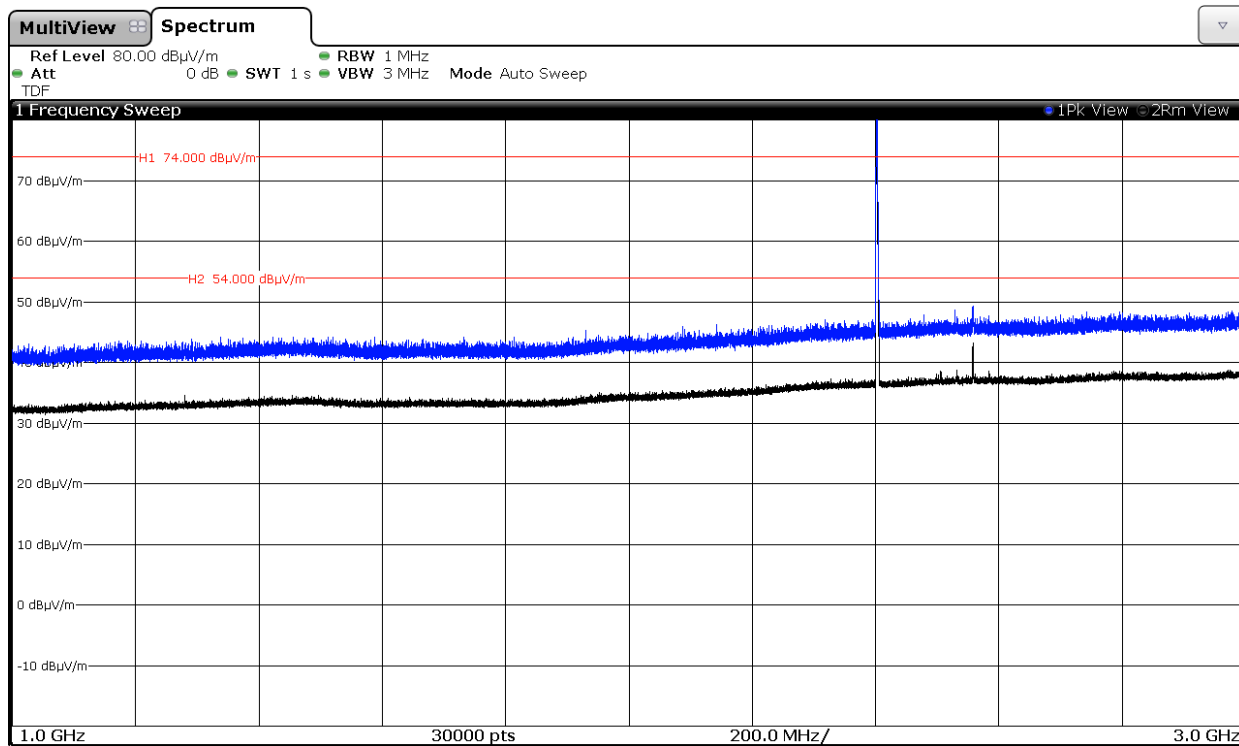


(This plot is valid for all three channels and all modulation modes).

## FREQUENCY RANGE 1 GHz to 3 GHz.

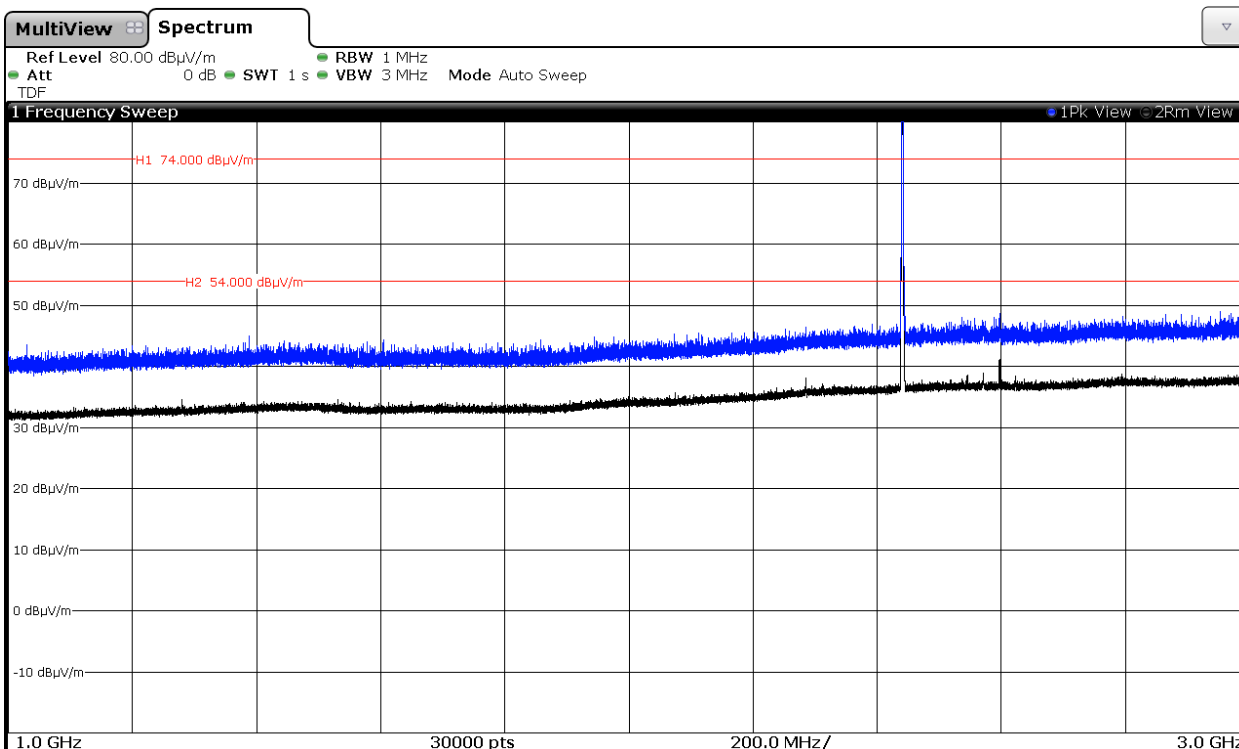
Modulation: GFSK

CHANNEL: Lowest (2402 MHz).



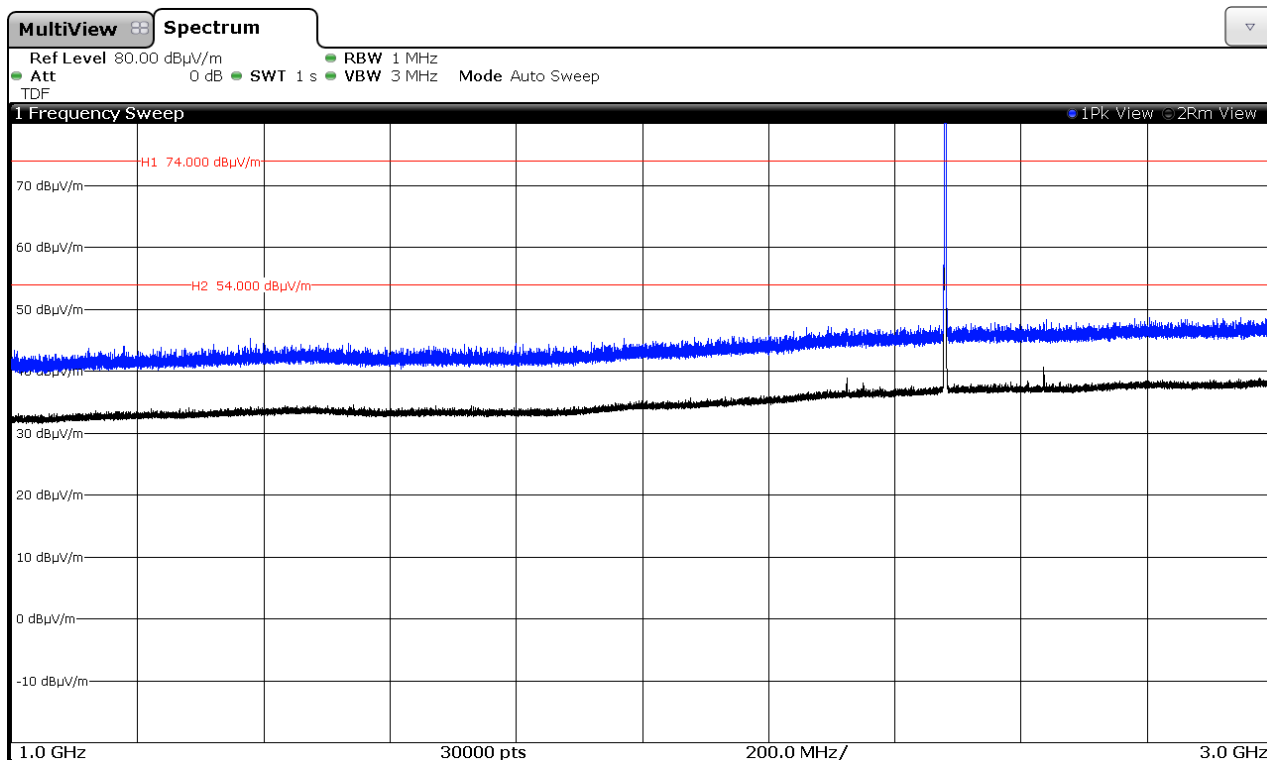
Note: The peak shown in the plot is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

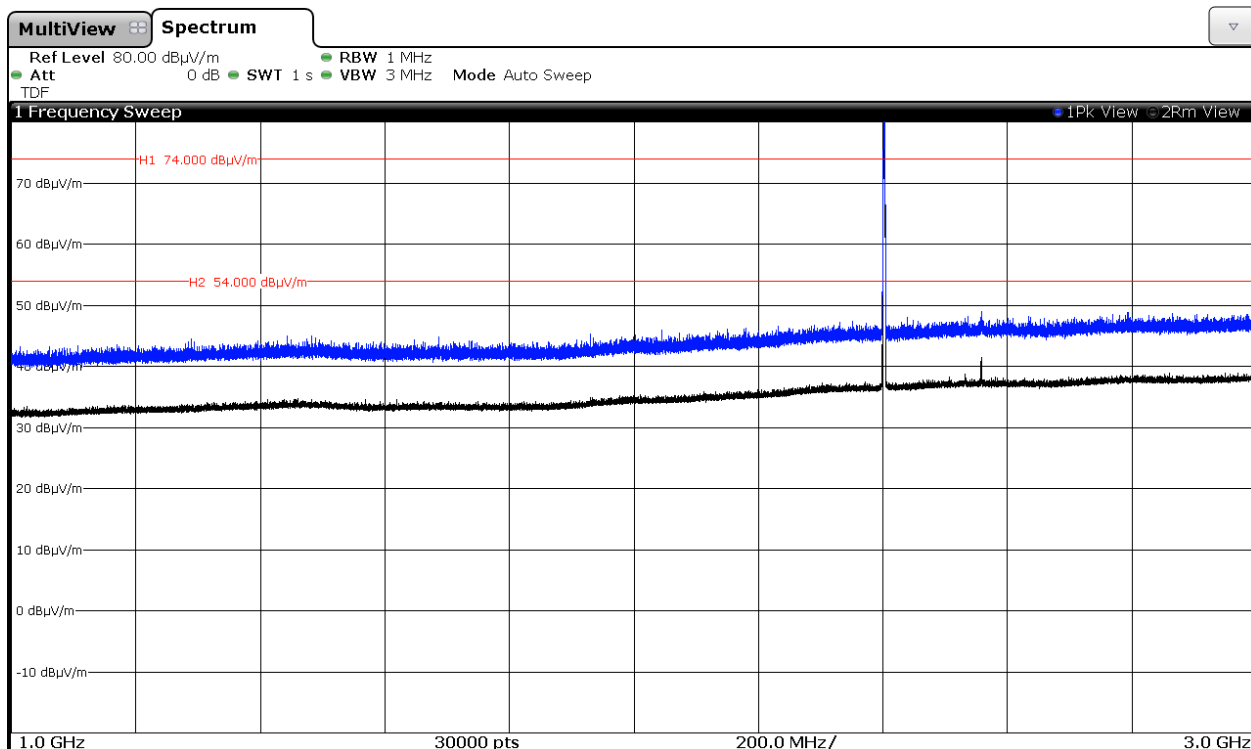
CHANNEL: Highest (2480 MHz).



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

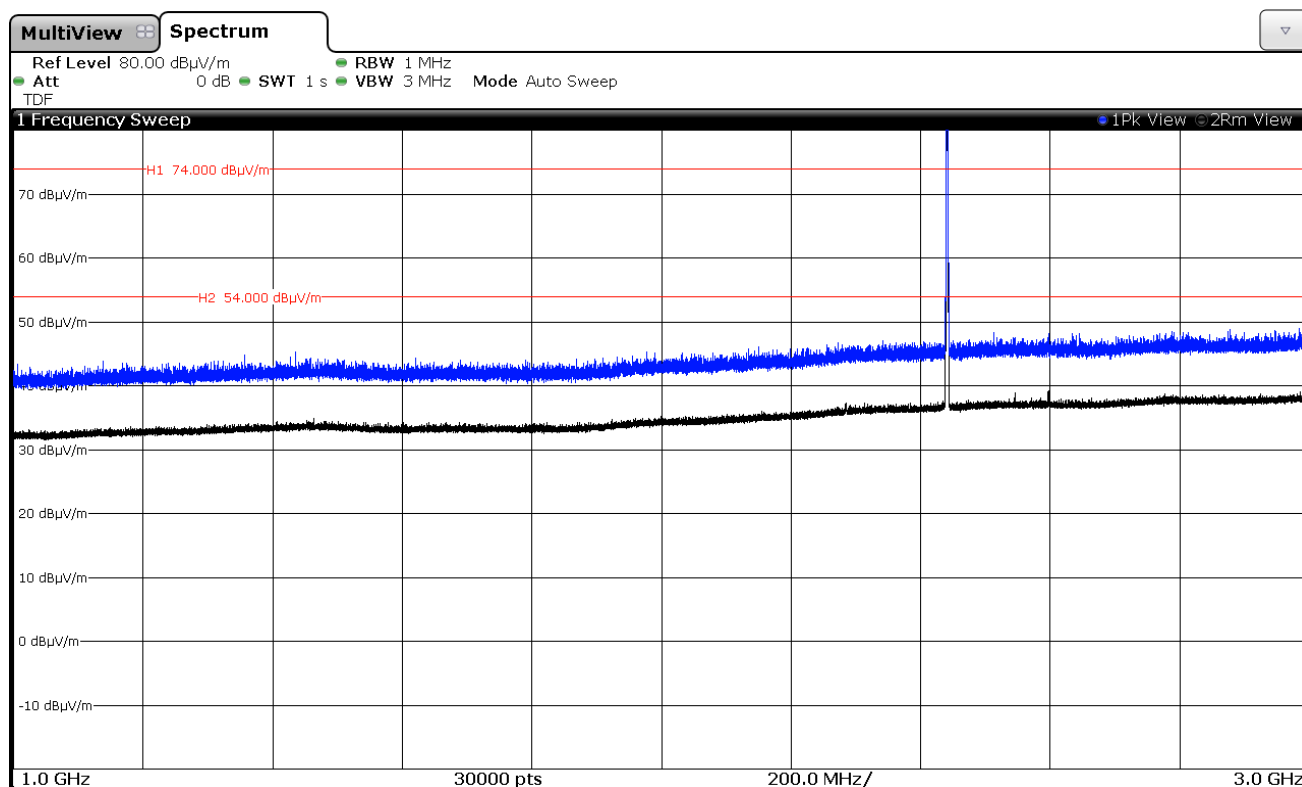
Modulation:  $\Pi/4$ -DQPSK

CHANNEL: Lowest (2402 MHz).



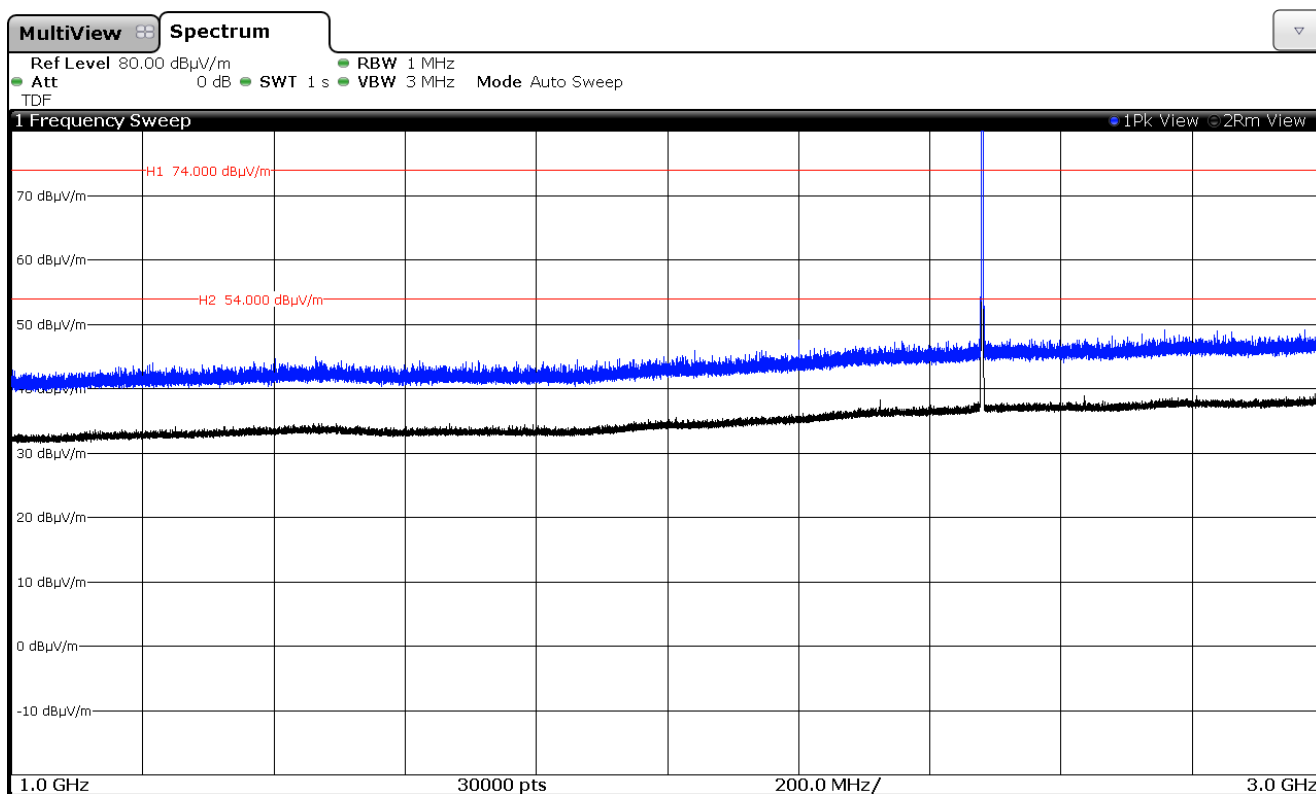
Note: The peak shown in the plot is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

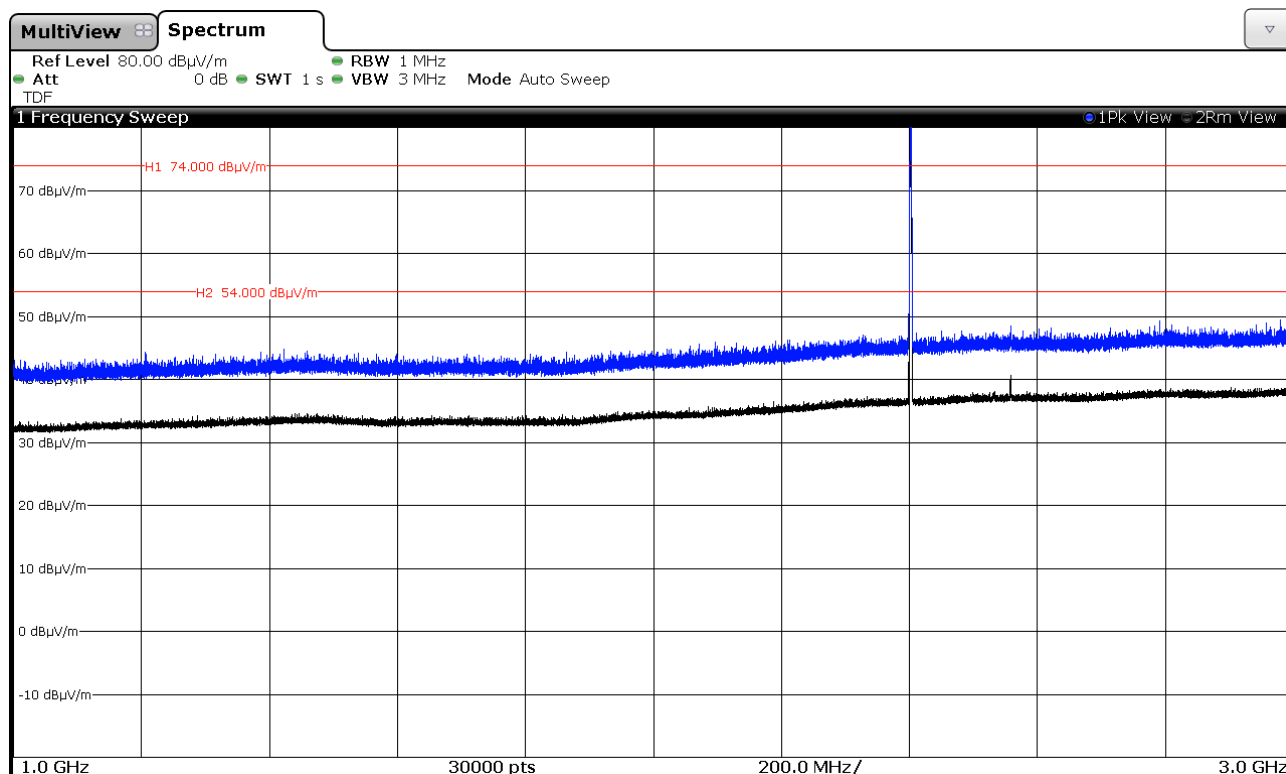
CHANNEL: Highest (2480 MHz).



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

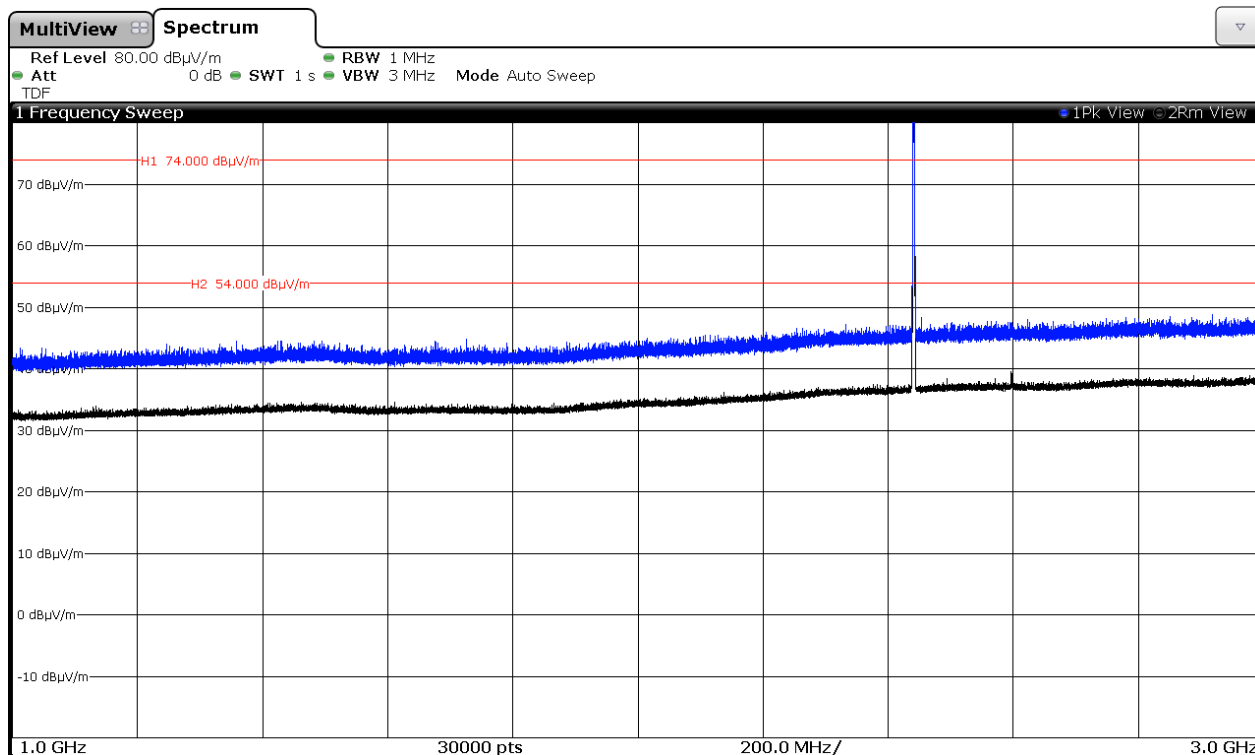
Modulation: 8-DPSK

CHANNEL: Lowest (2402 MHz).



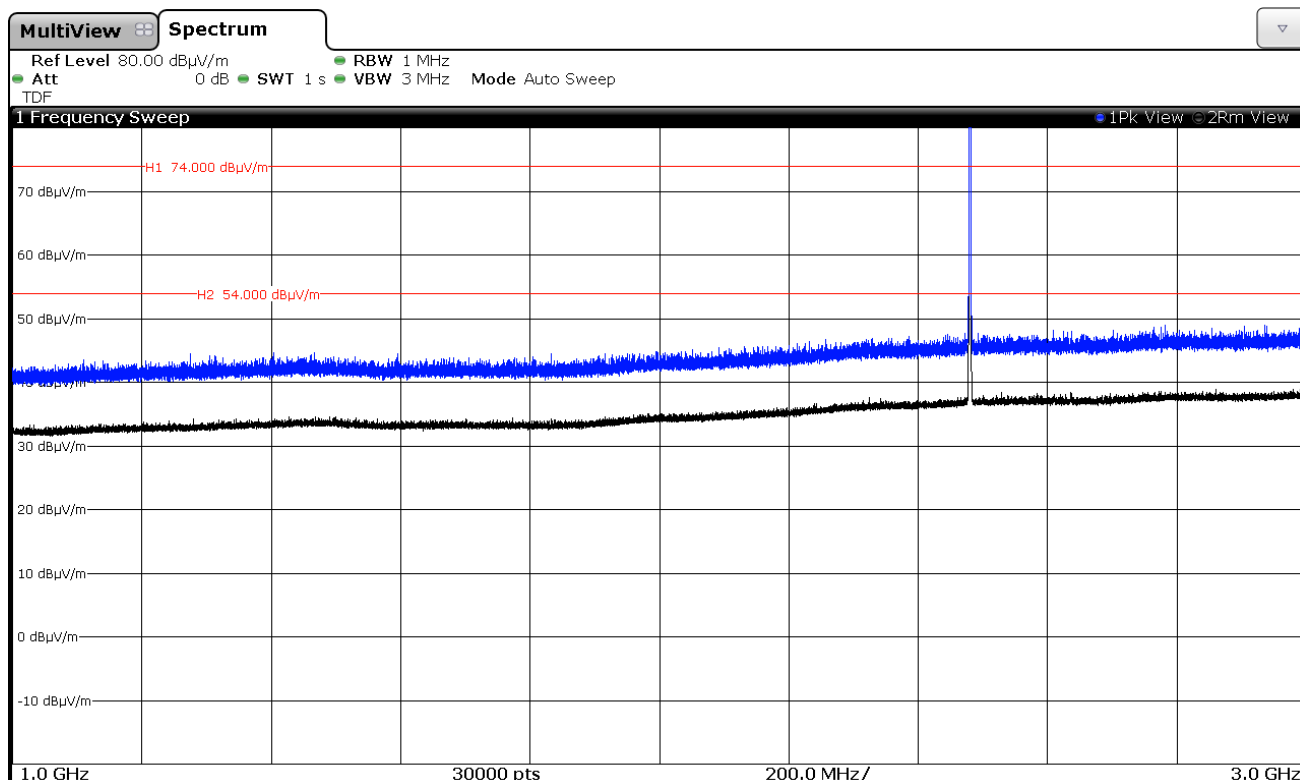
Note: The peak shown in the plot is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

CHANNEL: Highest (2480 MHz).

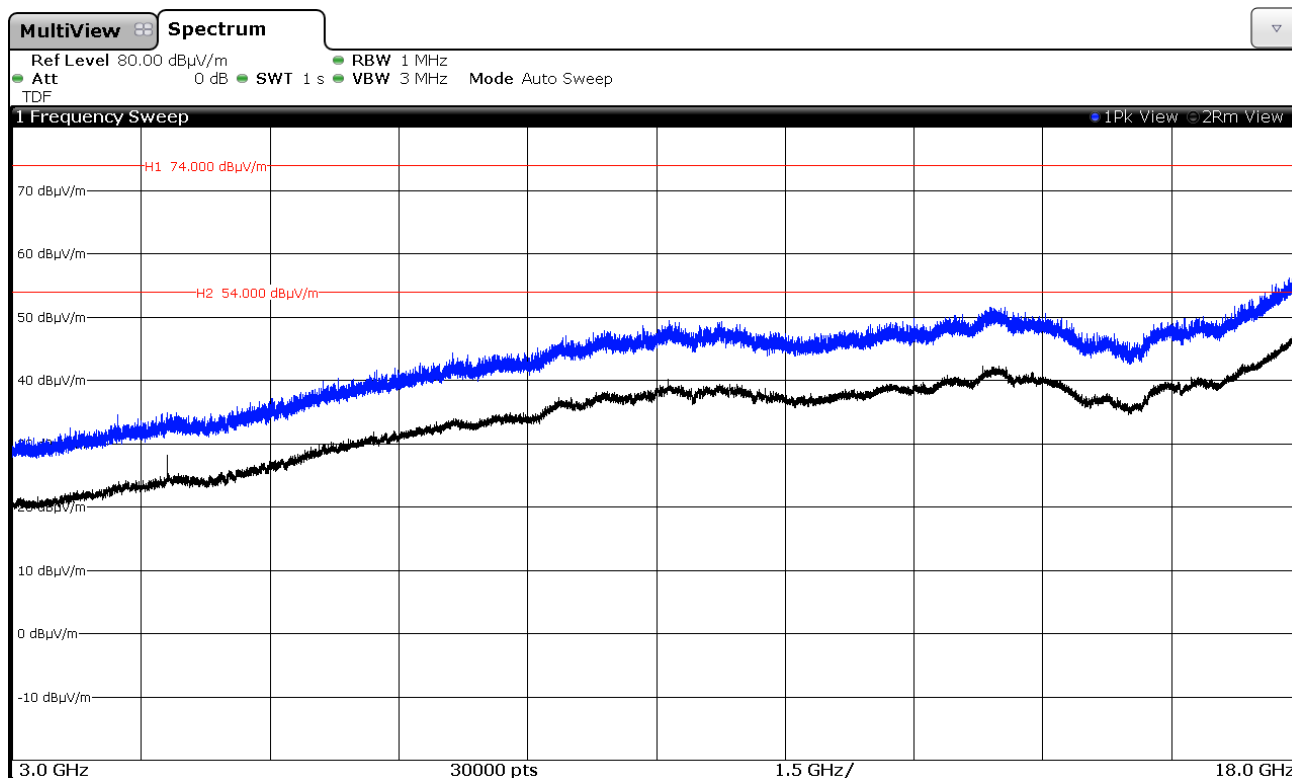


Note: The peak shown in the plot is the carrier frequency.

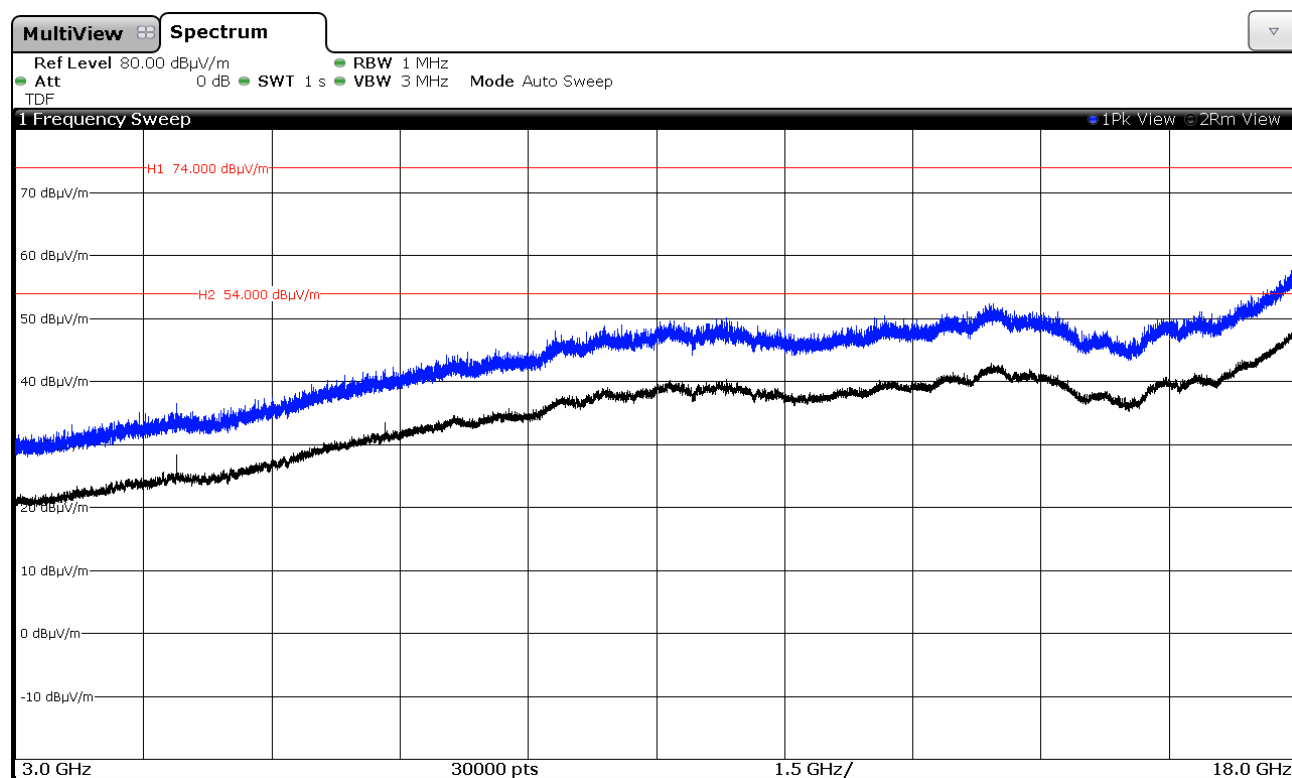
## FREQUENCY RANGE 3 GHz to 18 GHz.

Modulation: GFSK

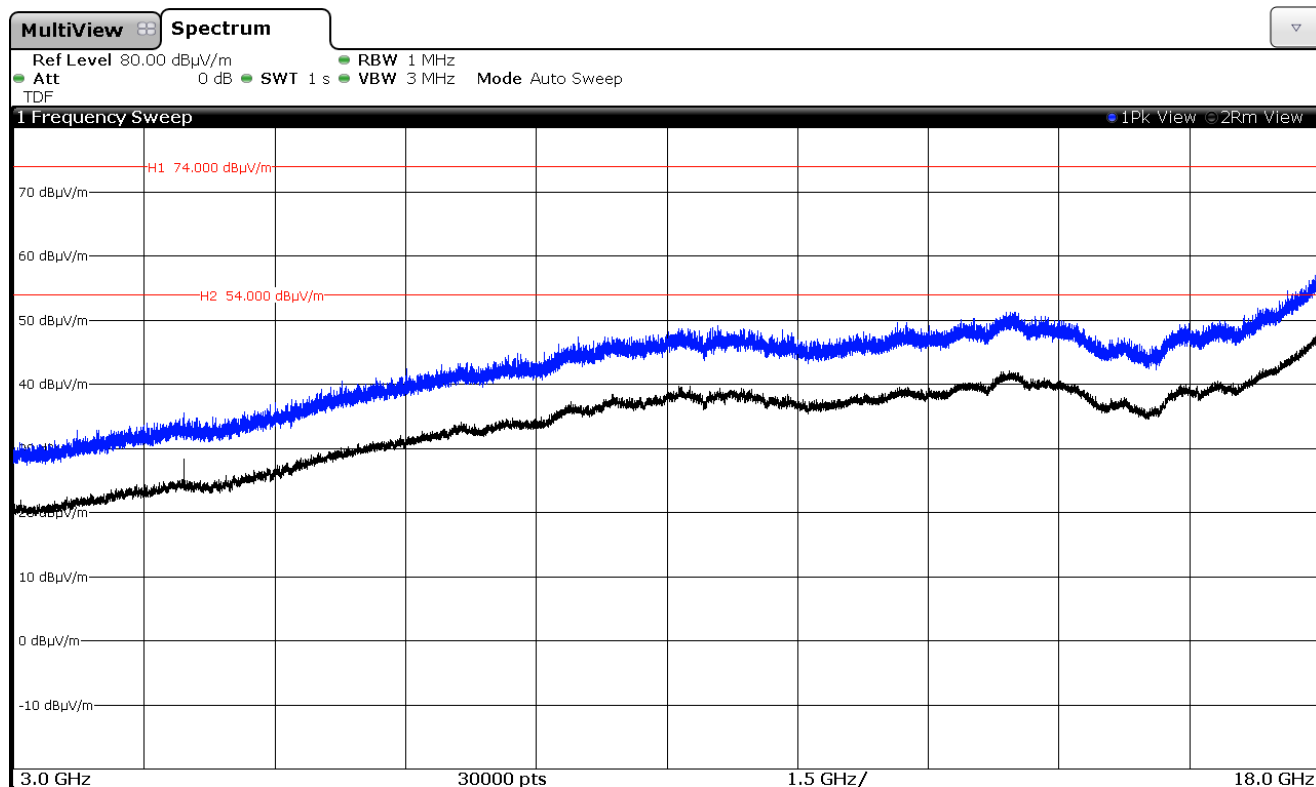
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

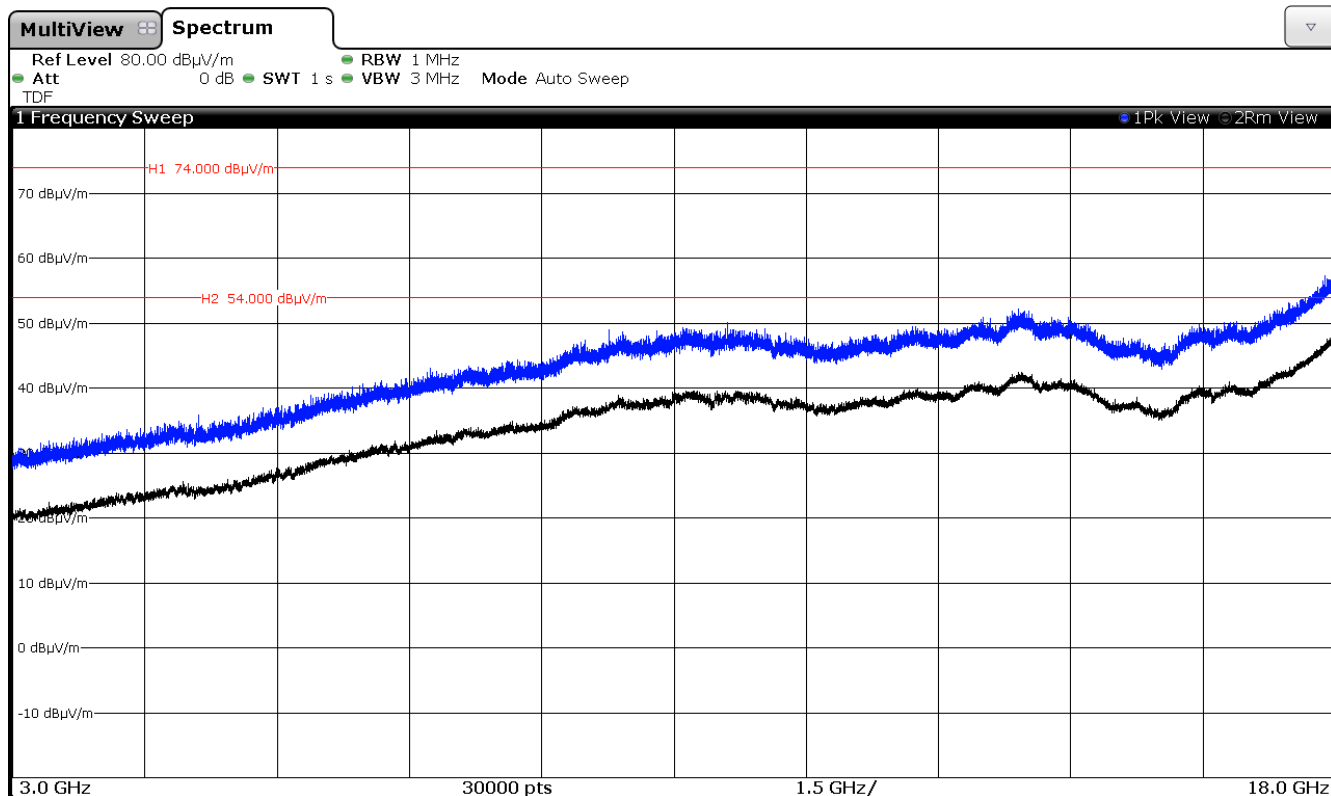


CHANNEL: Highest (2480 MHz).

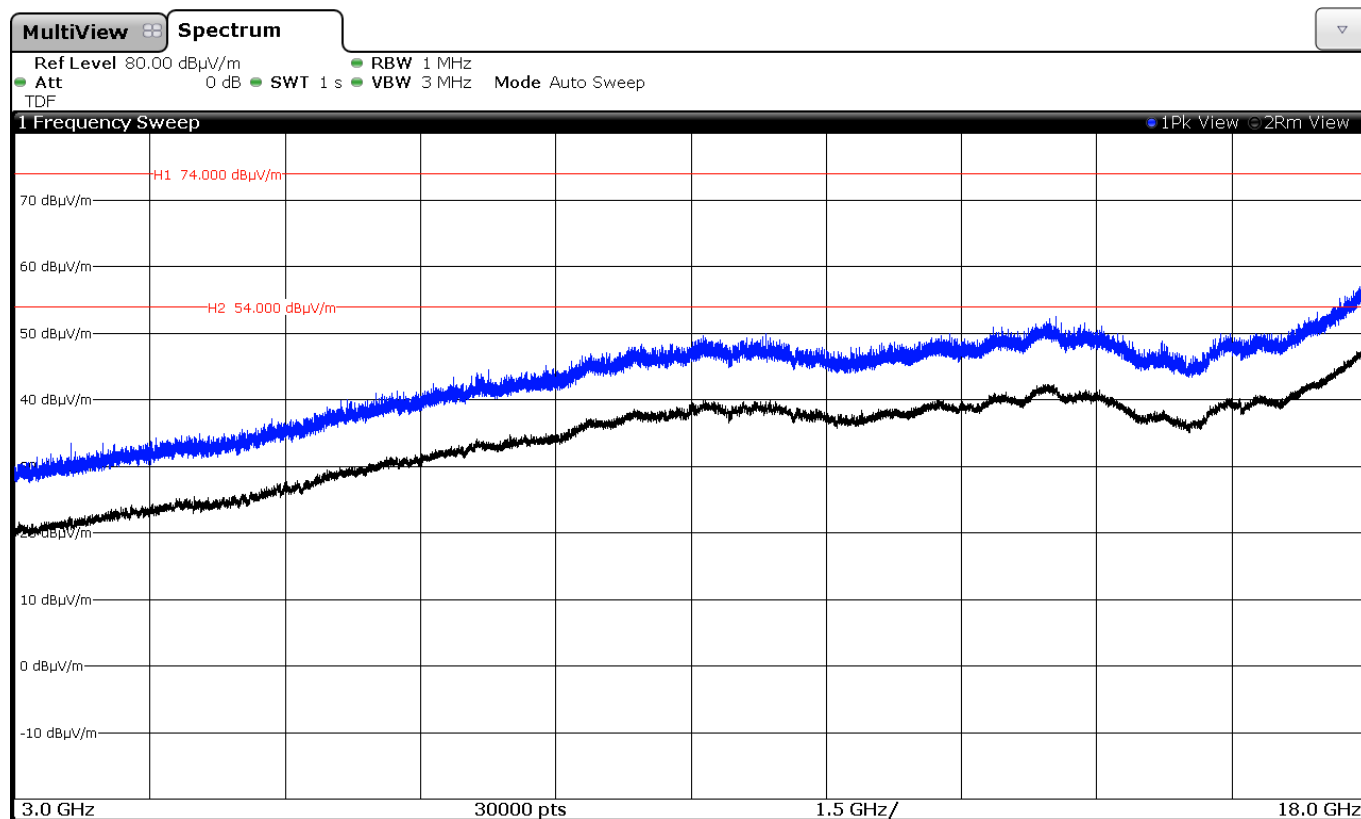


Modulation:  $\Pi/4$ -DQPSK

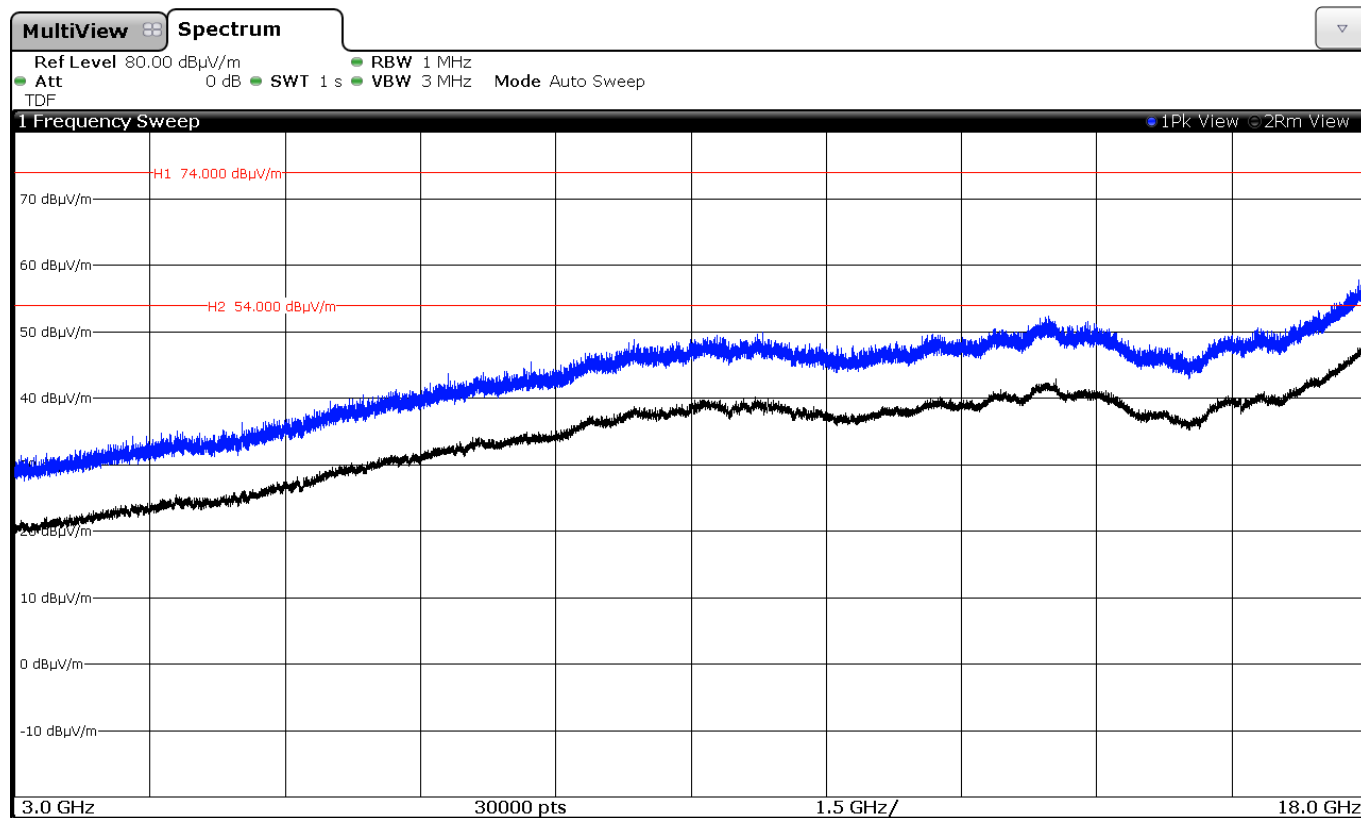
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

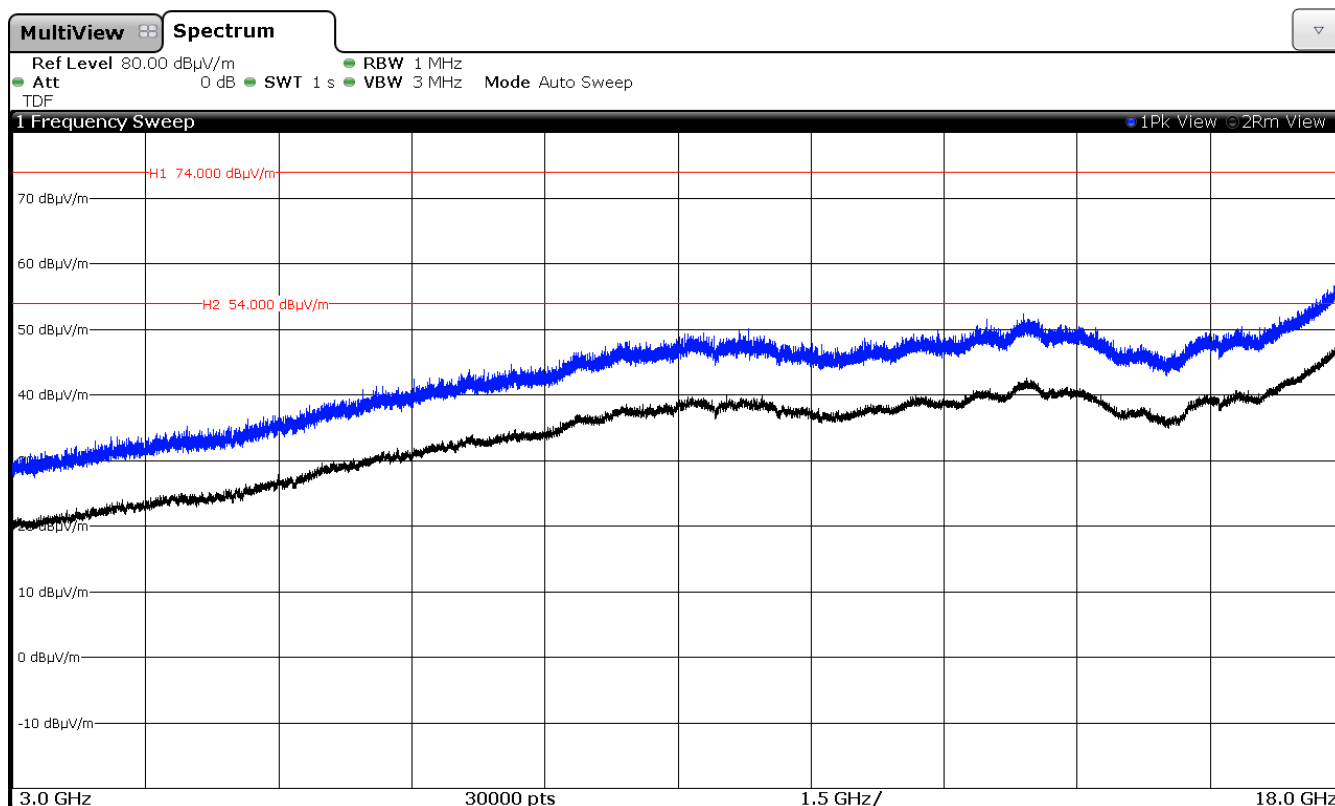


CHANNEL: Highest (2480 MHz).

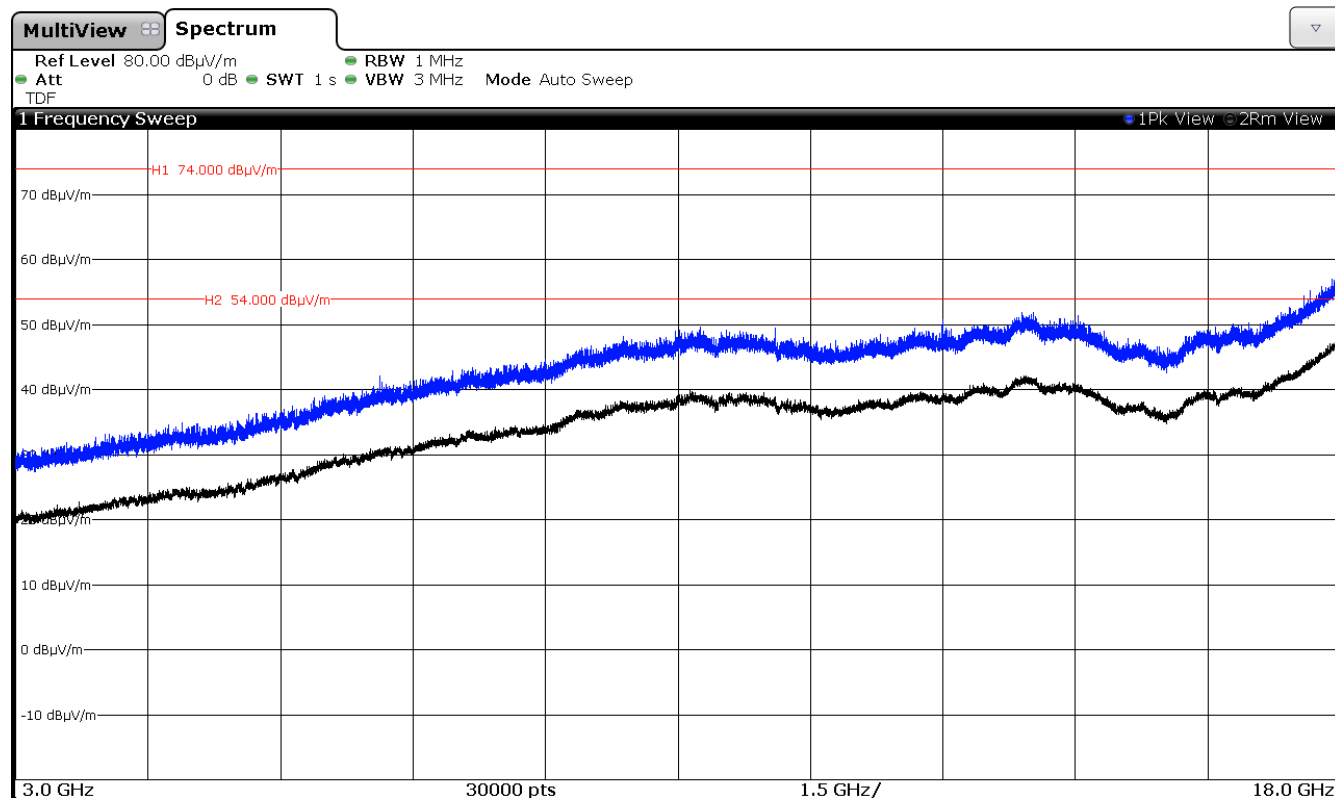


Modulation: 8-DPSK

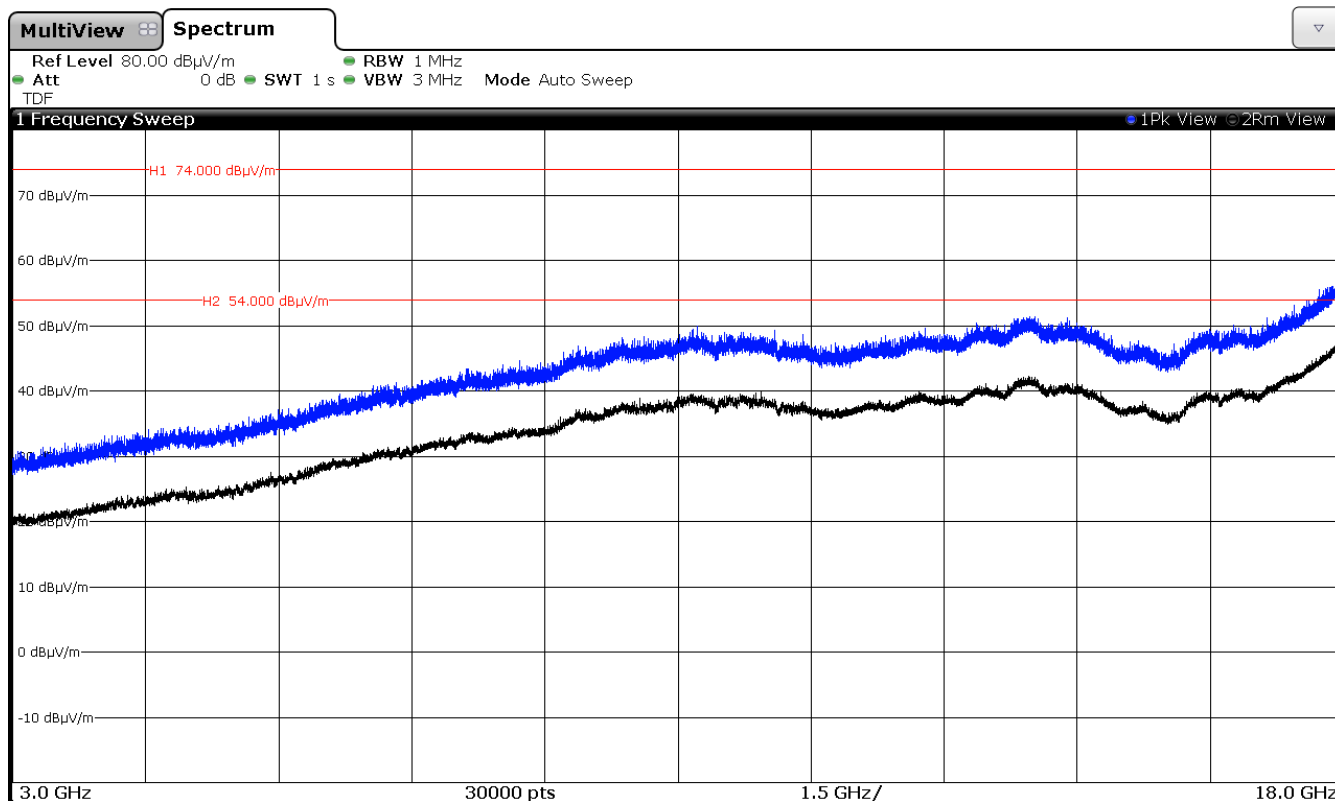
CHANNEL: Lowest (2402 MHz).



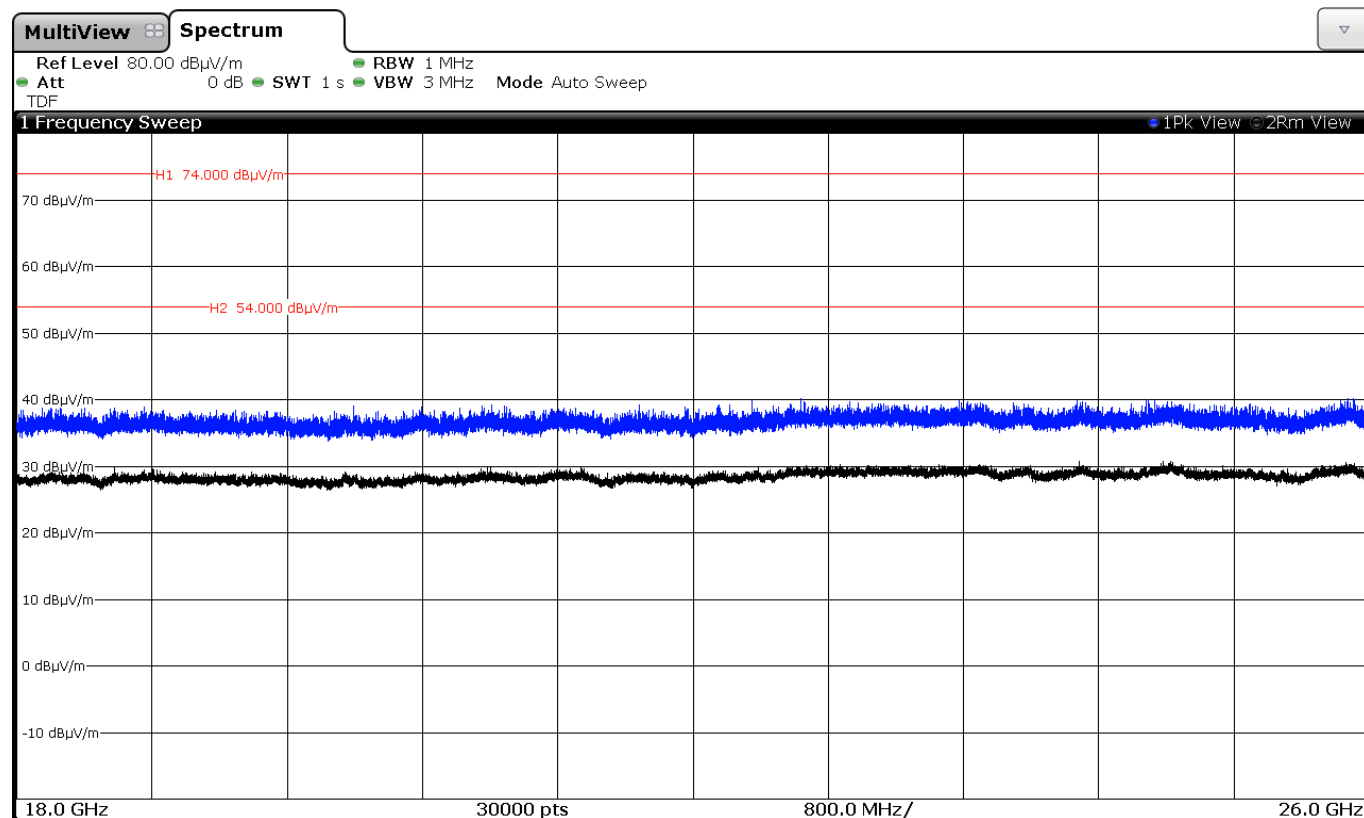
CHANNEL: Middle (2441 MHz).



CHANNEL: Highest (2480 MHz).



## FREQUENCY RANGE 18 GHz to 25 GHz.

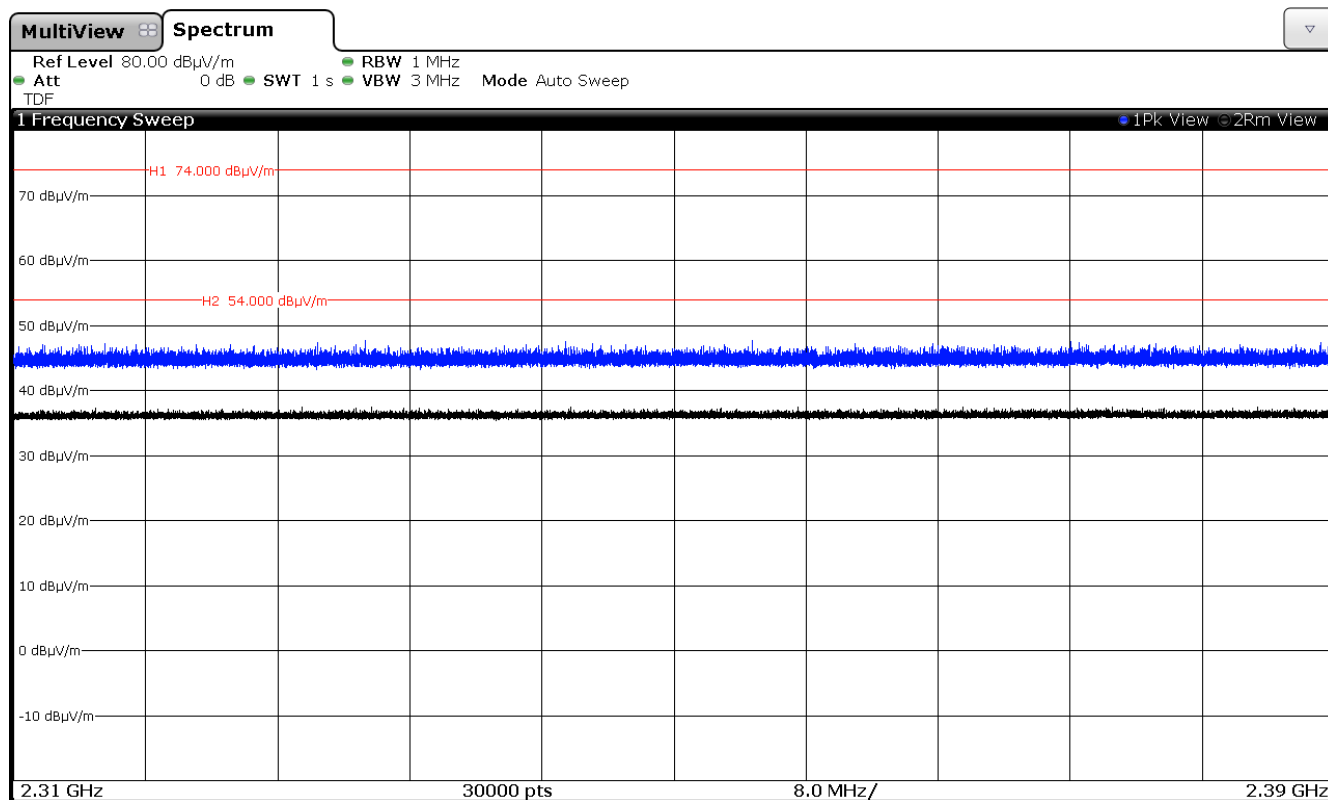


(This plot is valid for all three channels and all modulation modes).

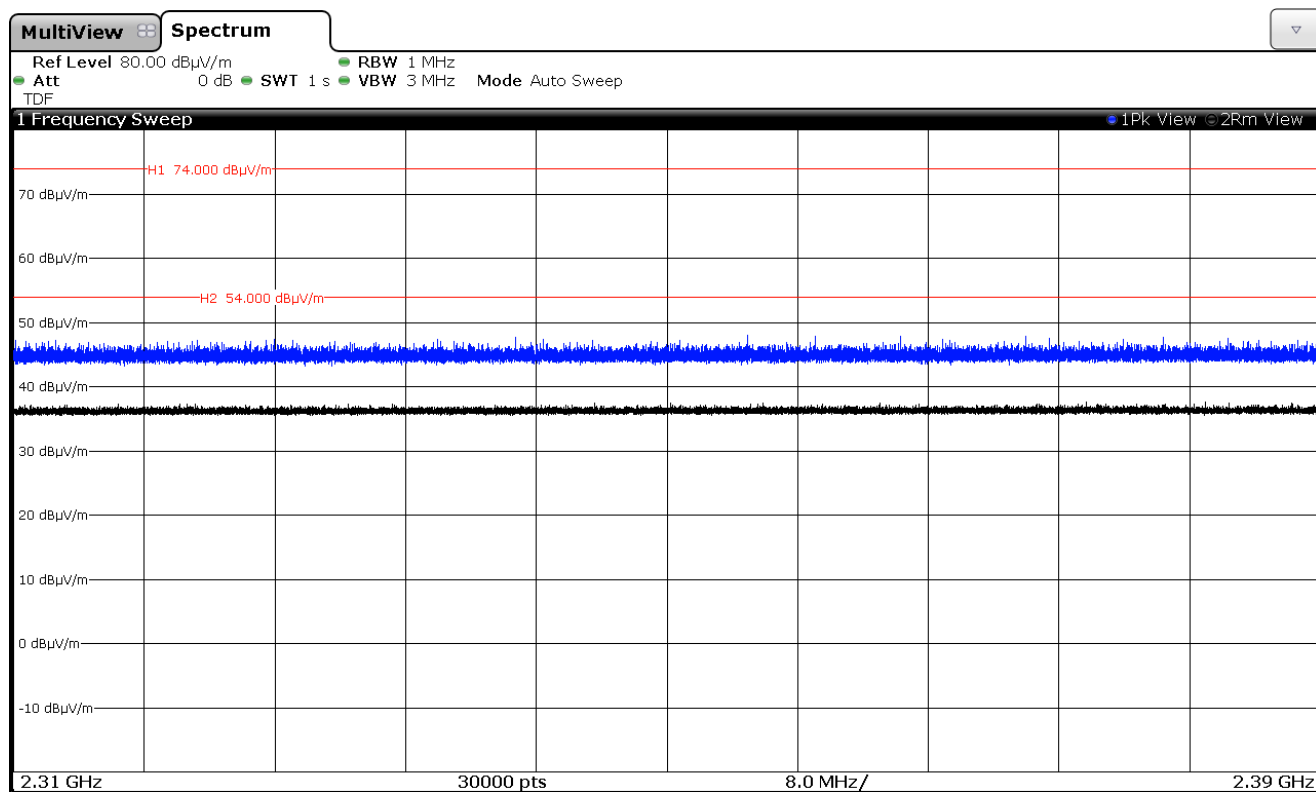
## FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

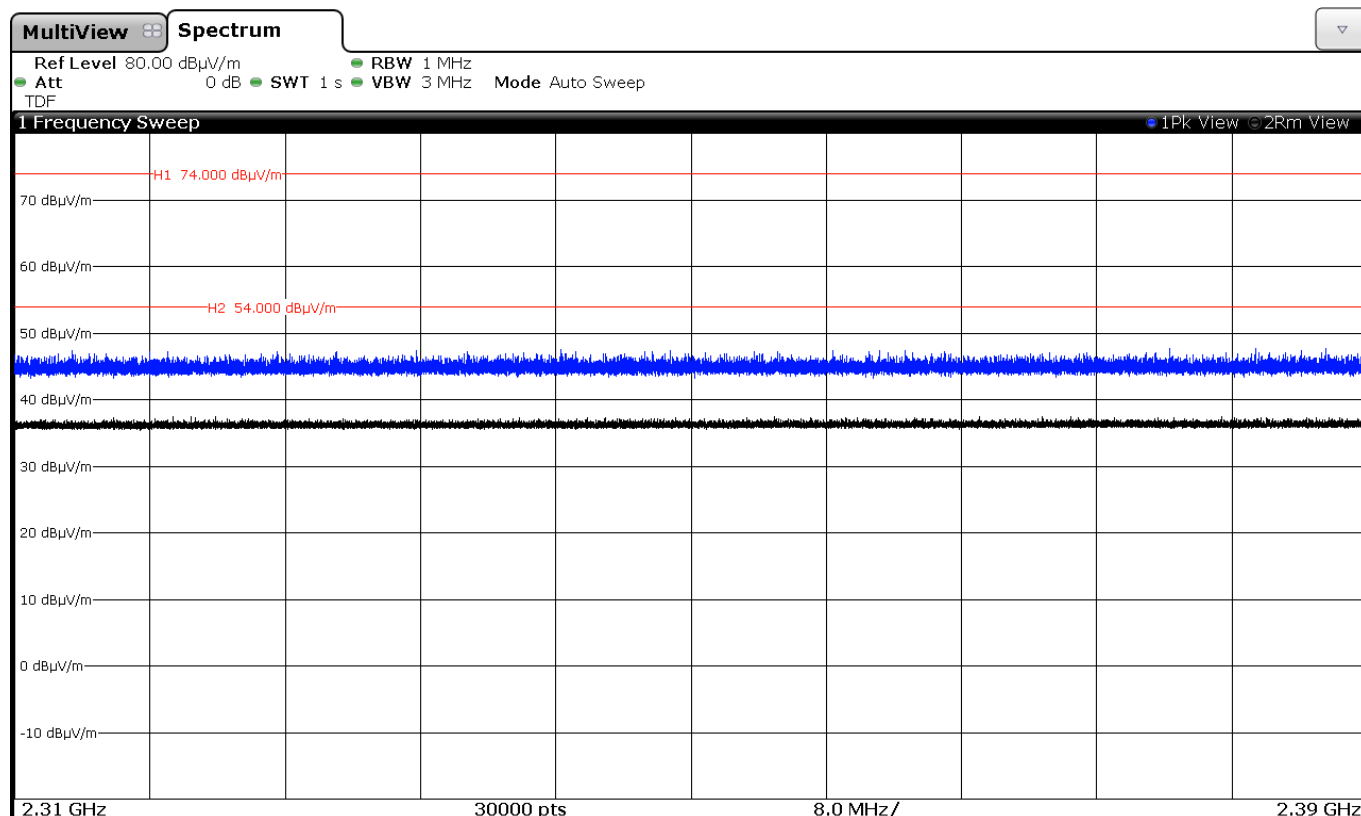
Modulation: GFSK



Modulation:  $\Pi/4$ -DQPSK

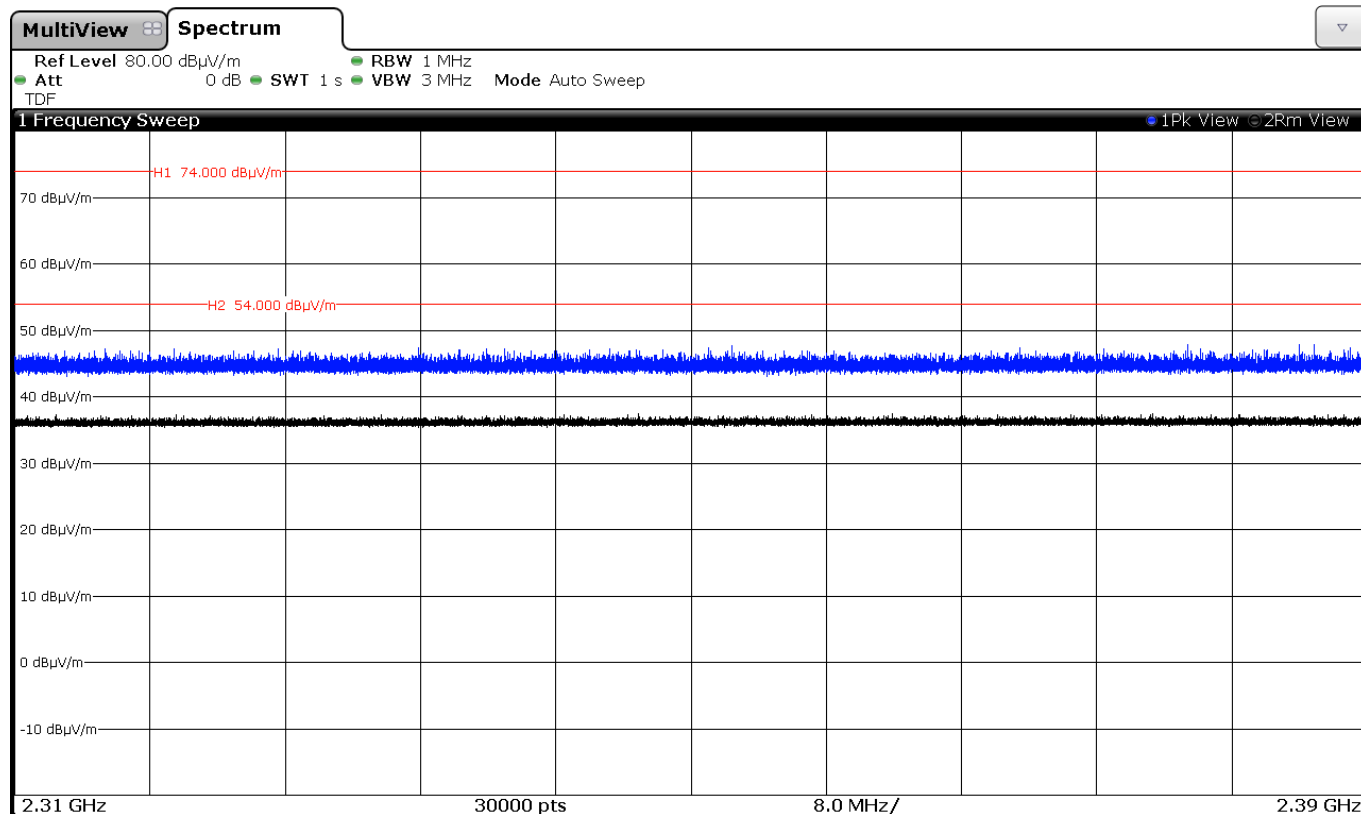


## Modulation: 8-DPSK

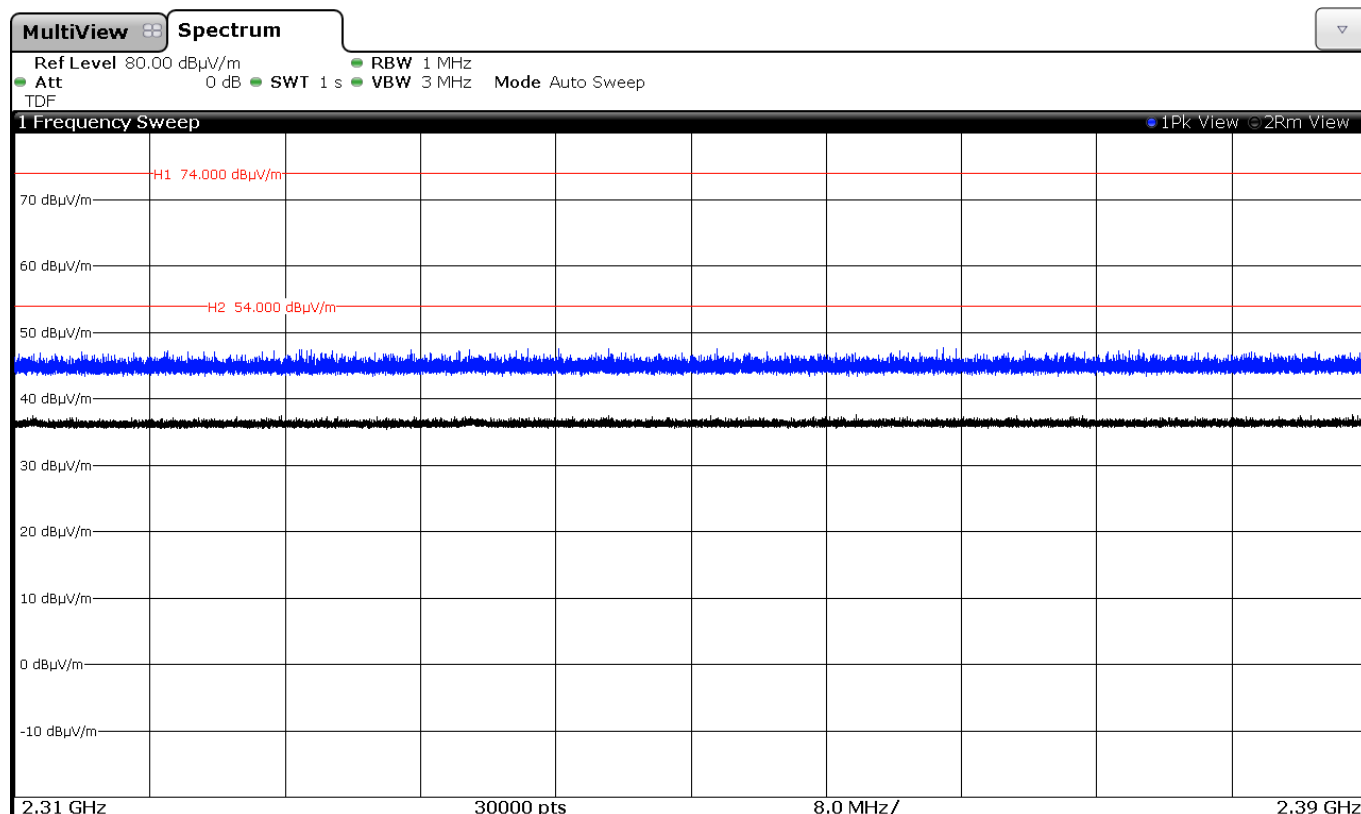


## CHANNEL: Middle

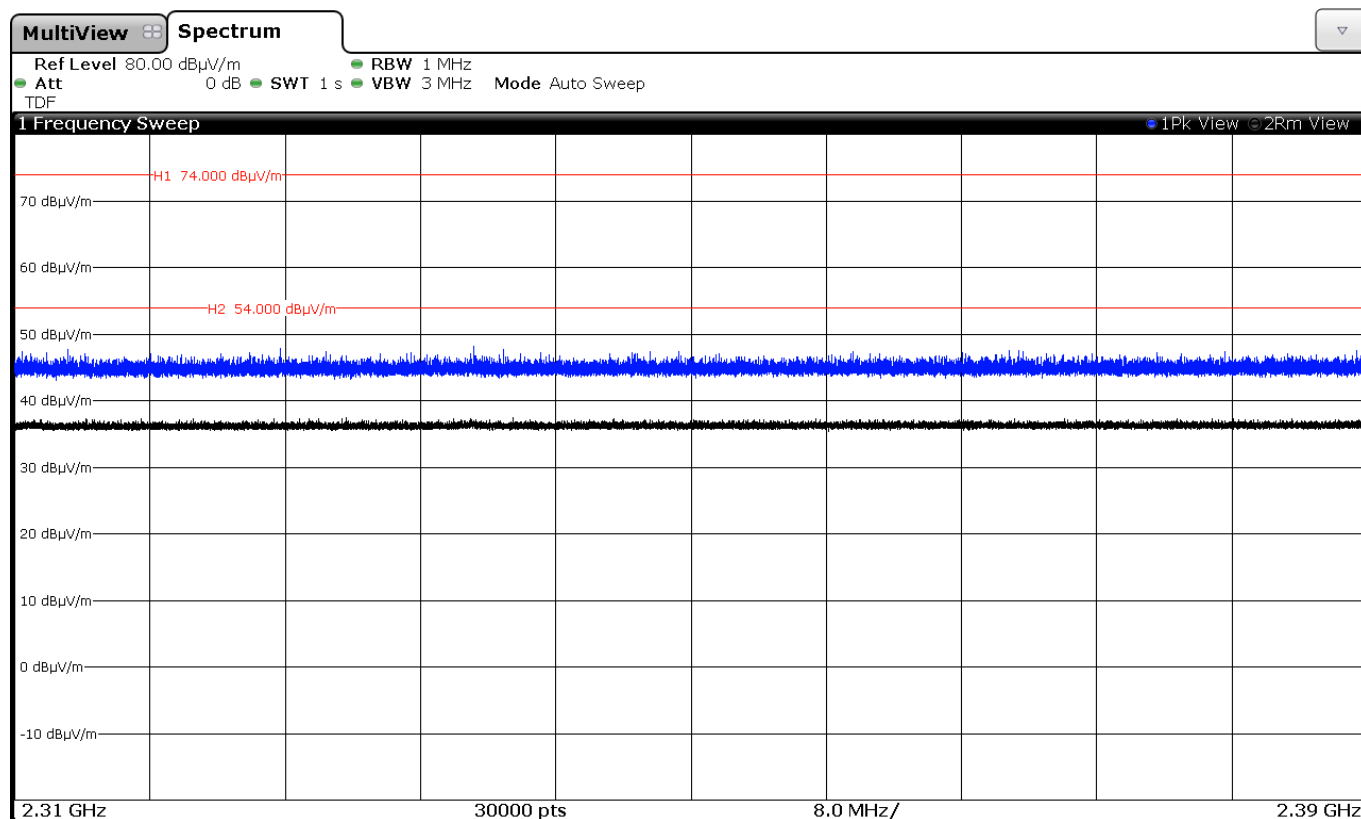
## Modulation: GFSK



## Modulation: $\Pi/4$ -DQPSK

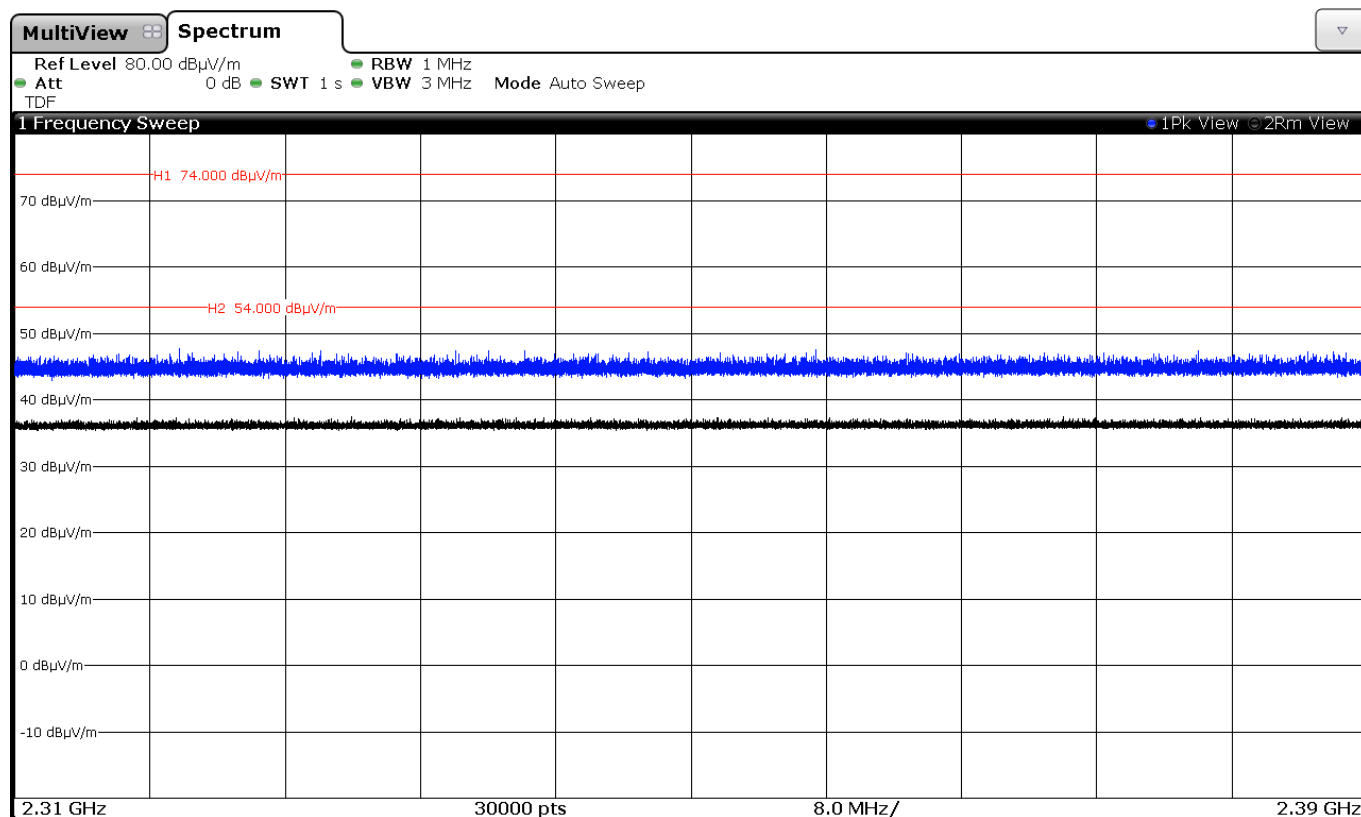


## Modulation: 8-DPSK

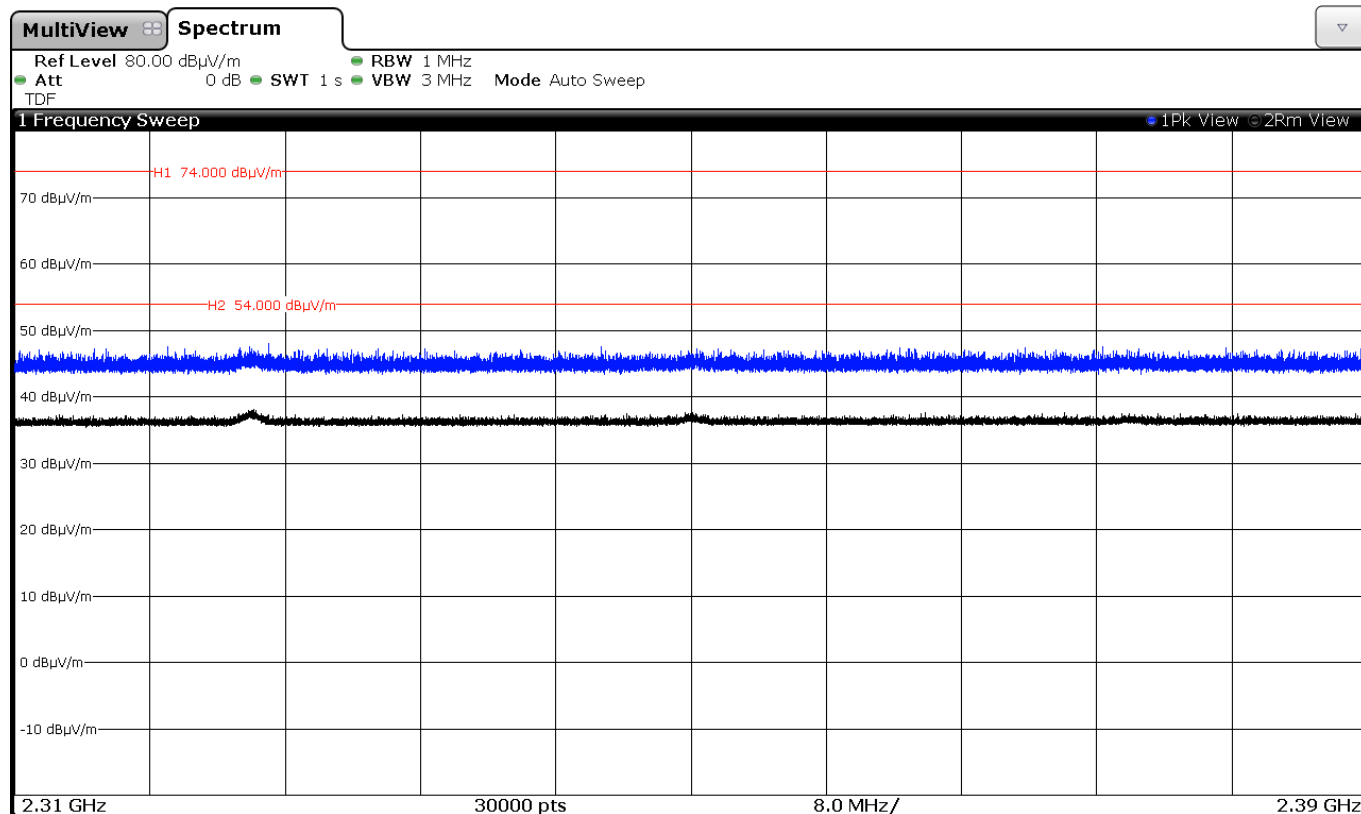


CHANNEL: Highest

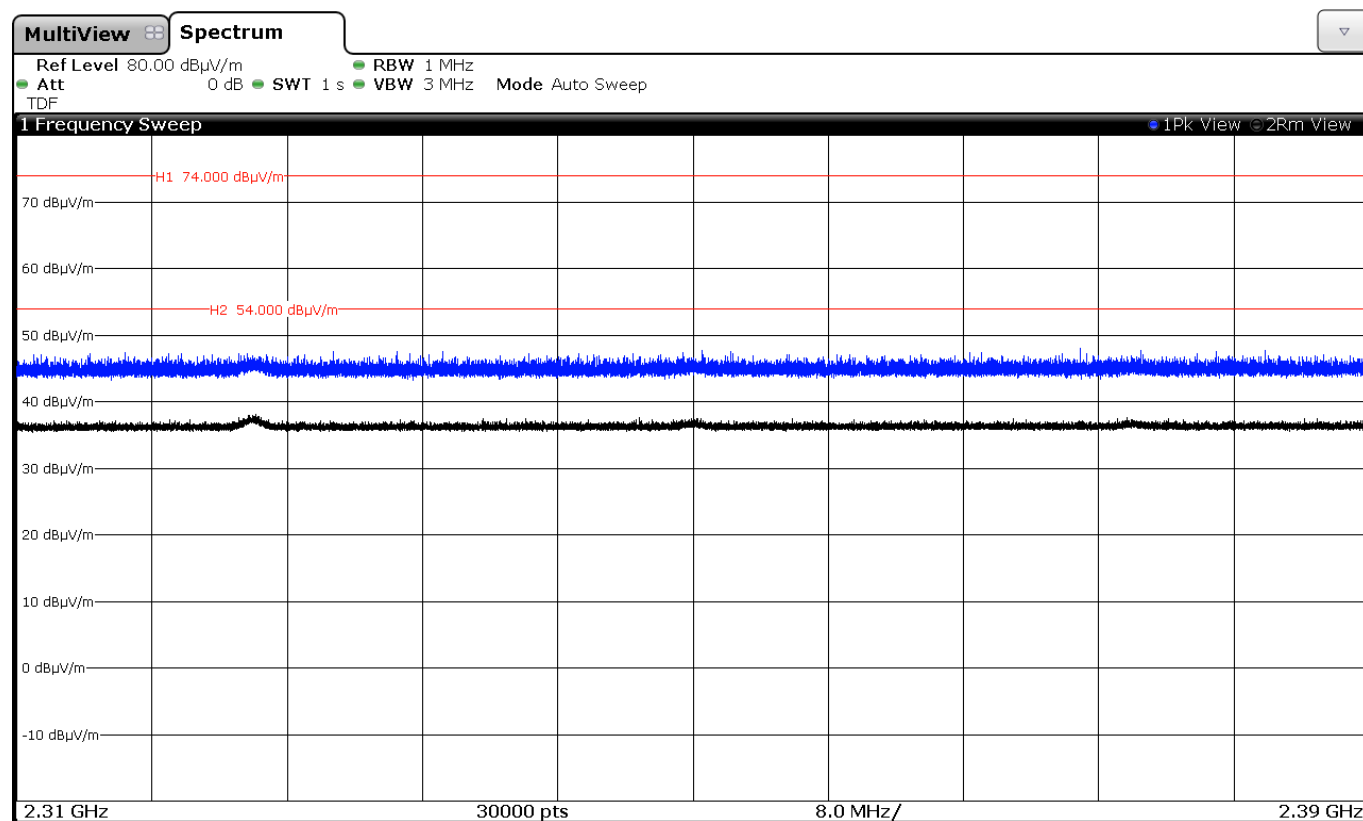
Modulation: GFSK



Modulation: Π/4-DQPSK



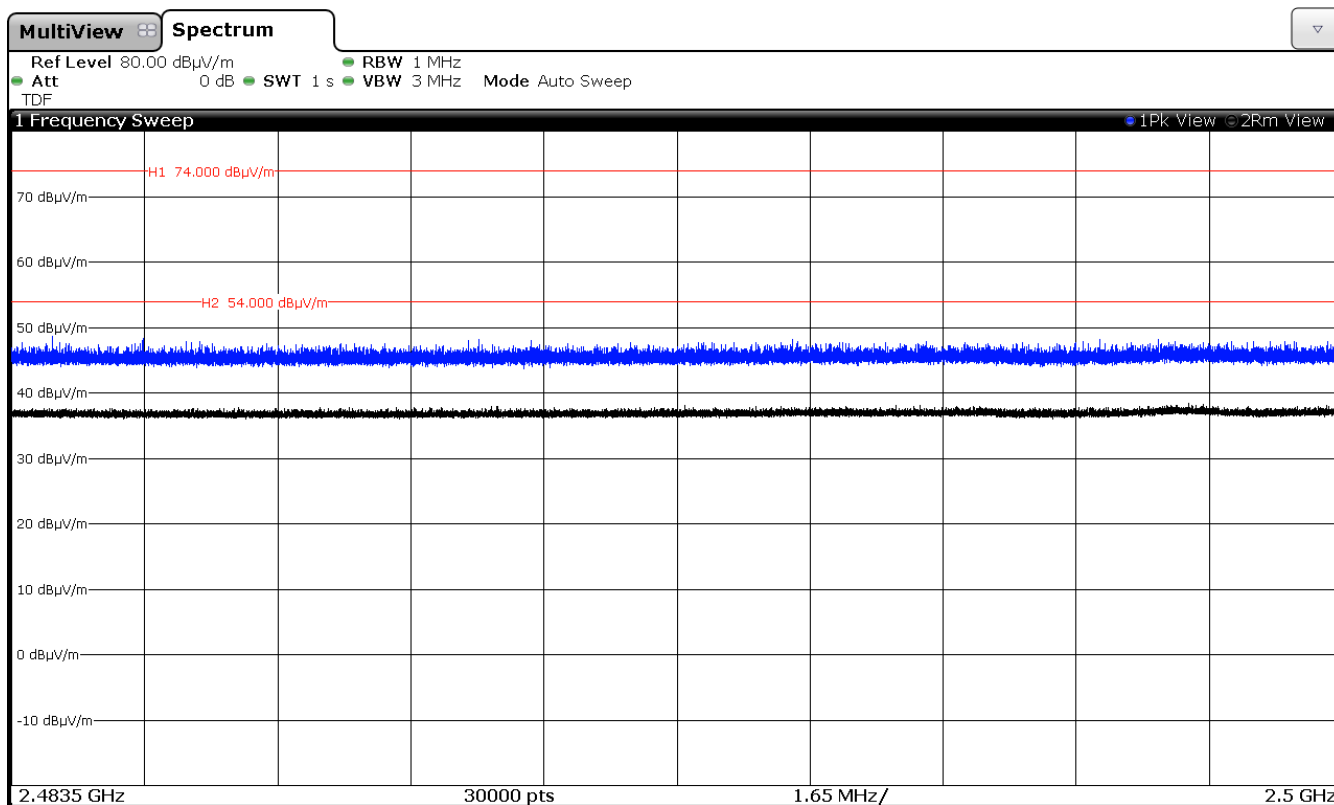
## Modulation: 8-DPSK



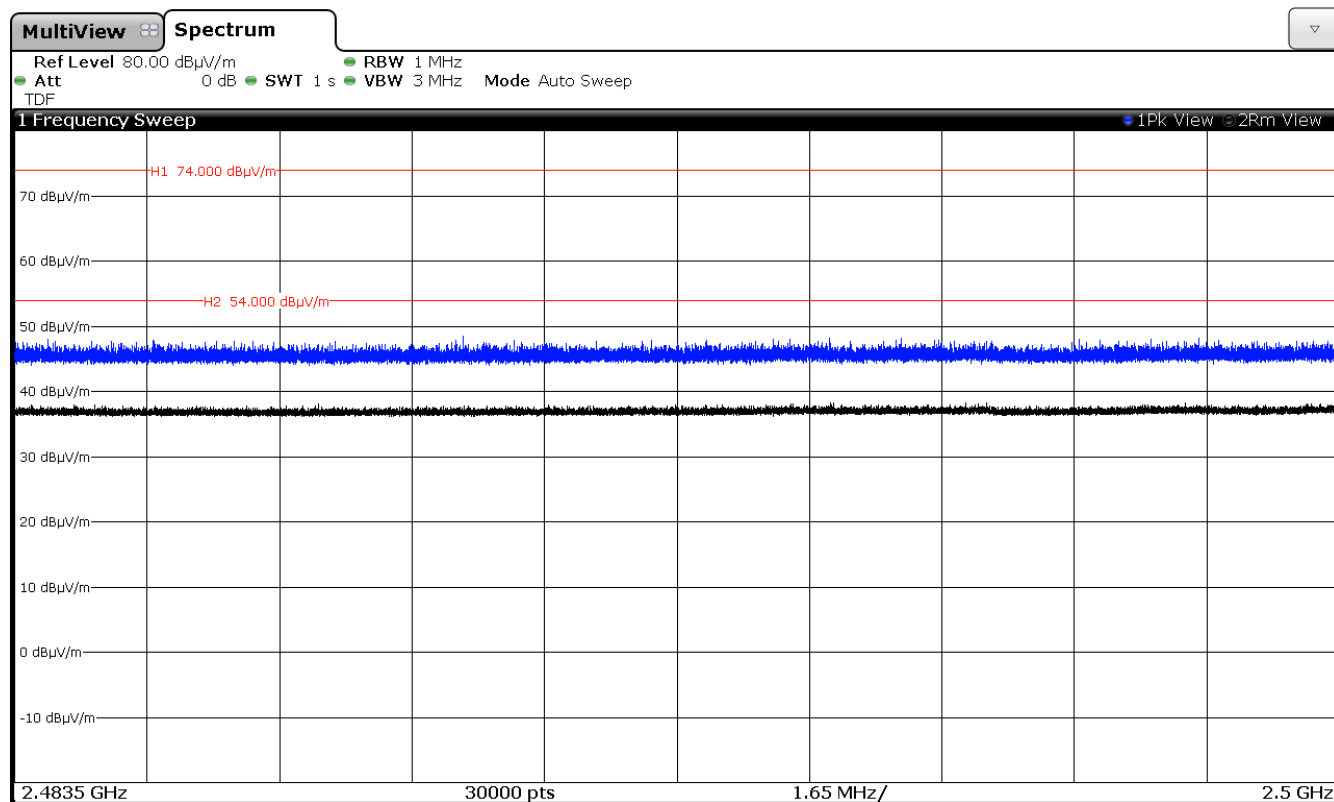
## FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

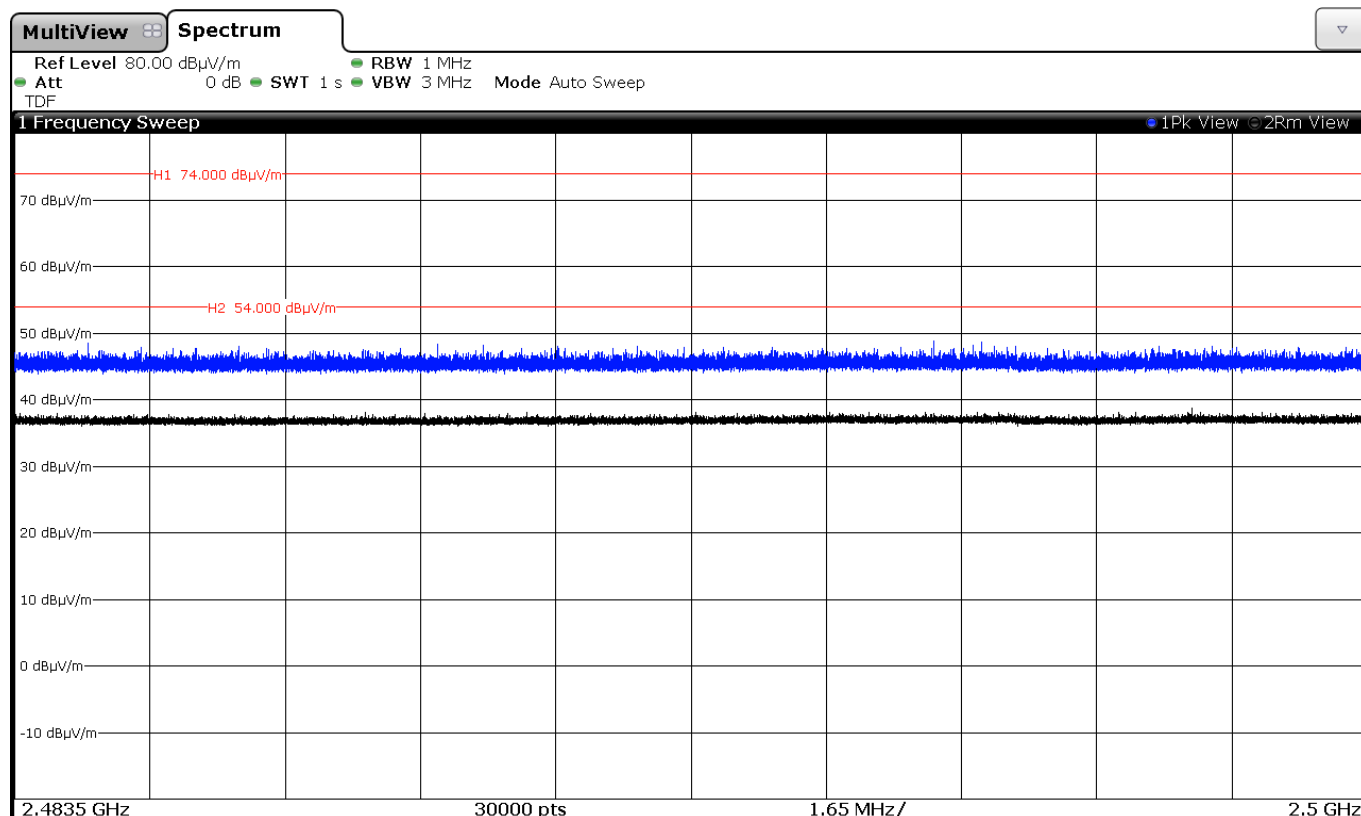
Modulation: GFSK



Modulation:  $\Pi/4$ -DQPSK

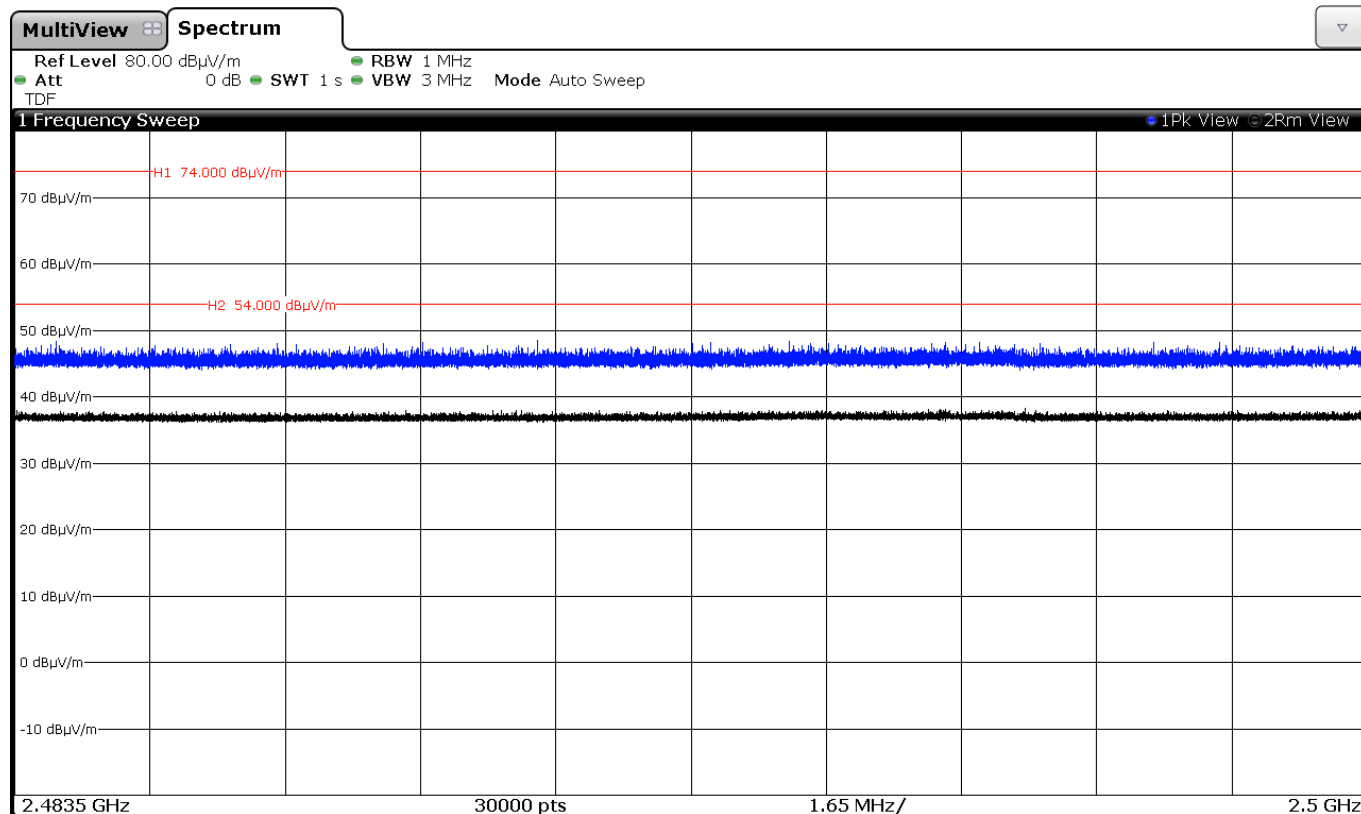


## Modulation: 8-DPSK

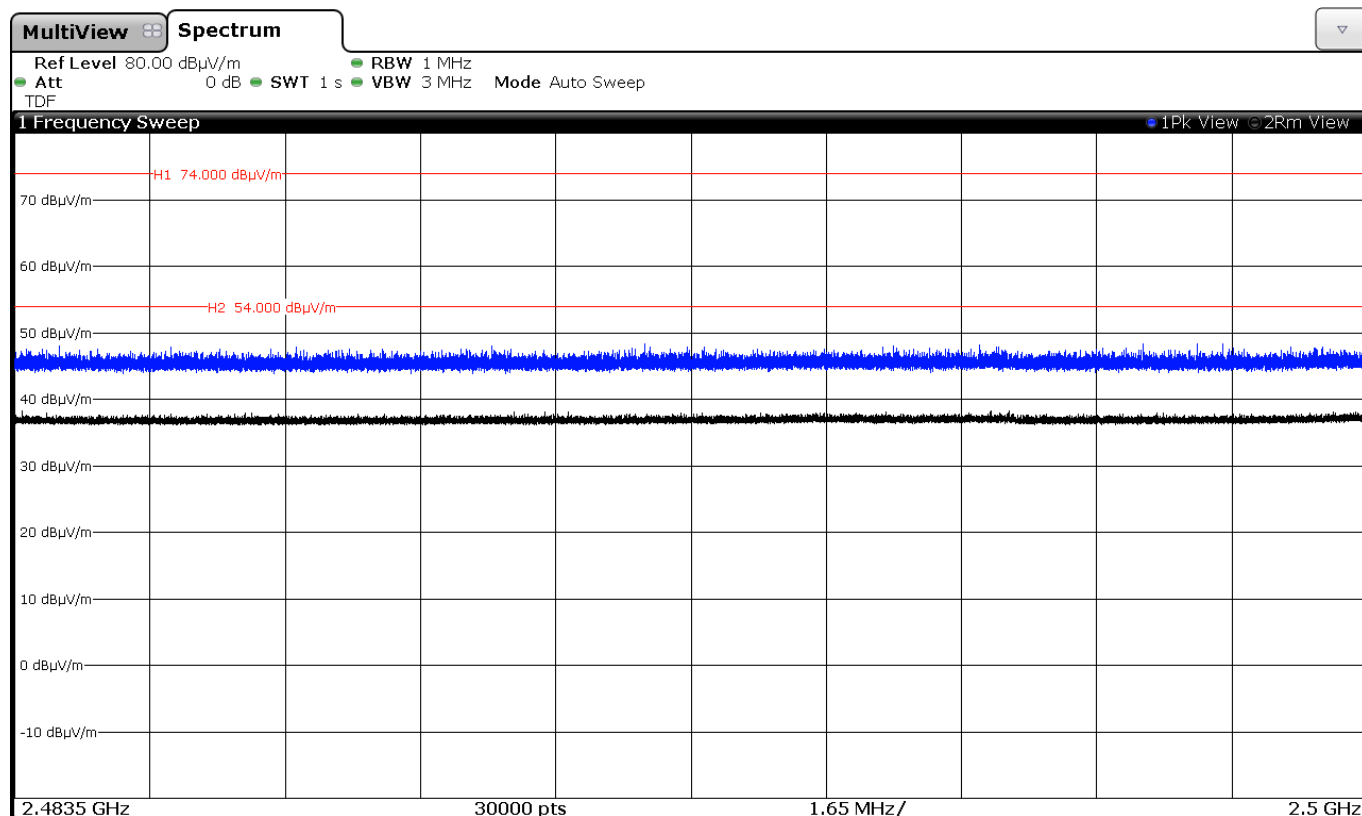


## CHANNEL: Middle

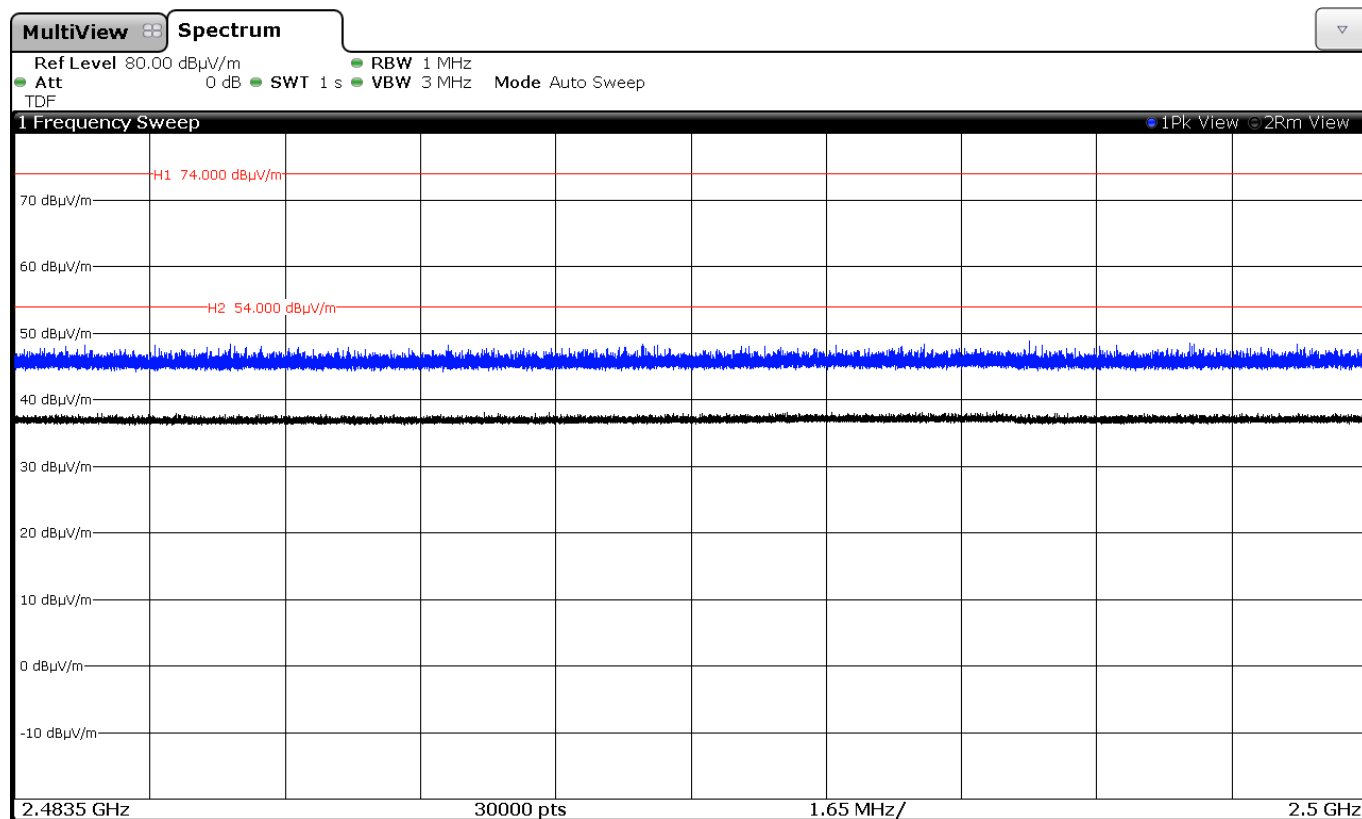
## Modulation: GFSK



## Modulation: $\Pi/4$ -DQPSK

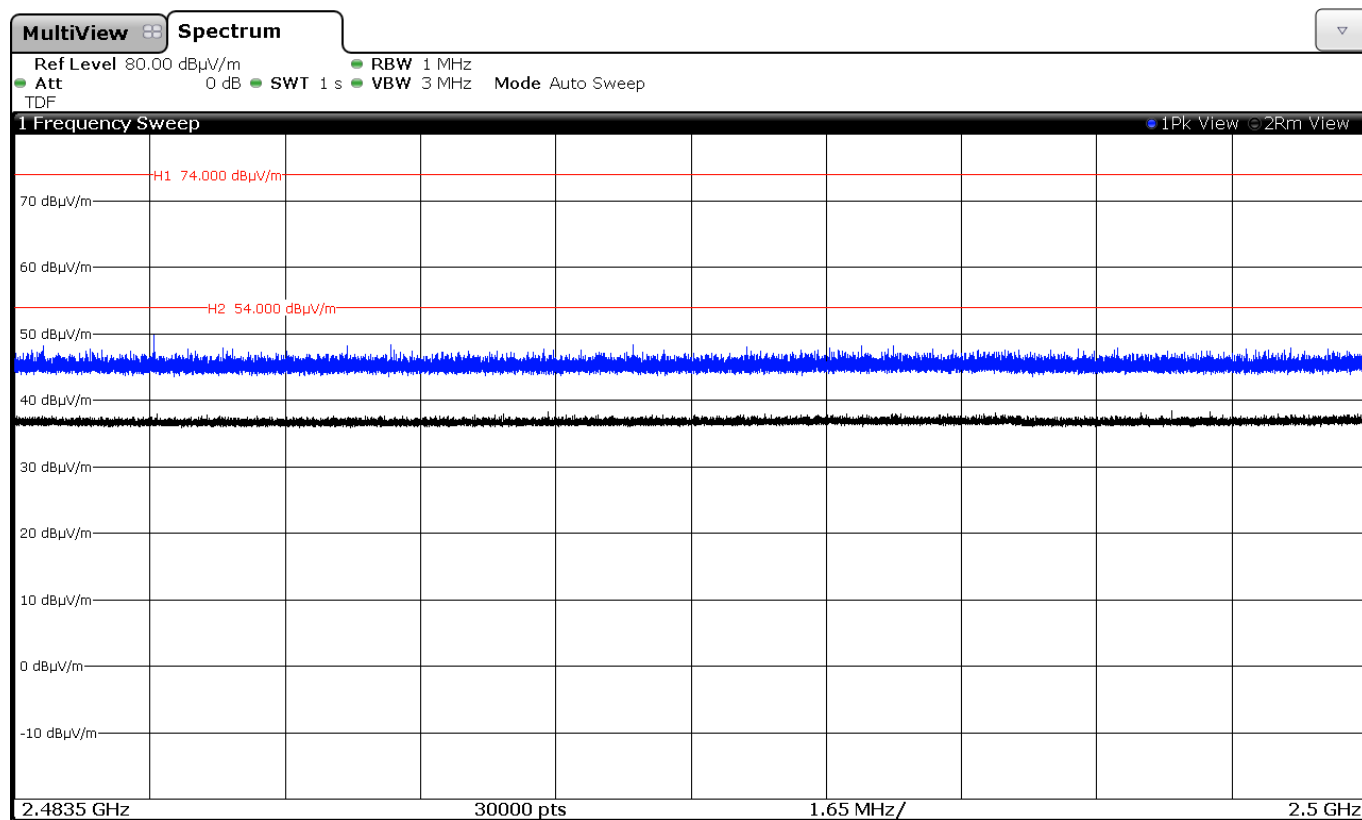


## Modulation: 8-DPSK

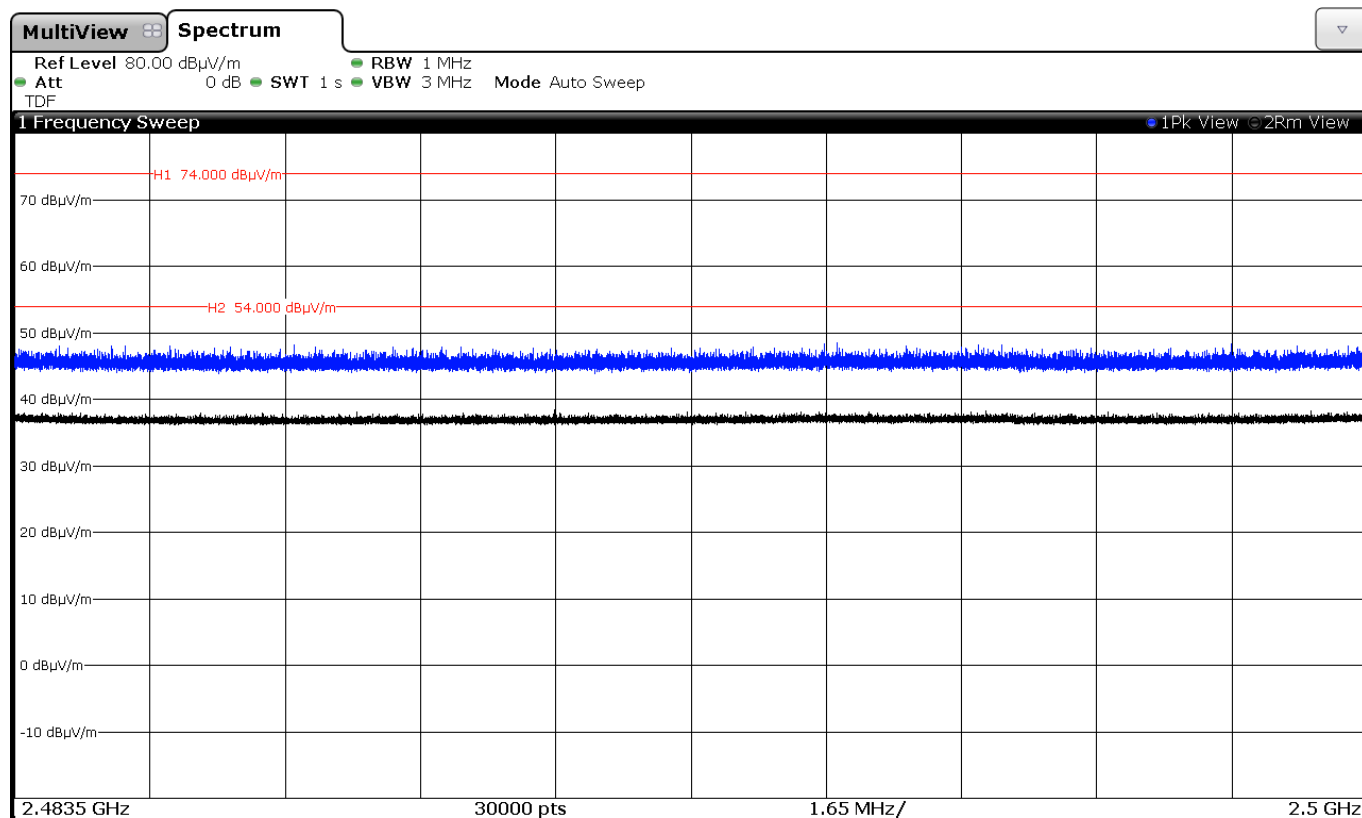


CHANNEL: Highest

Modulation: GFSK



Modulation:  $\pi/4$ -DQPSK



## Modulation: 8-DPSK

