



Test report No:  
NIE: 61299RRF.001

## Test Report

### USA FCC Part 15.247, 15.209 CANADA RSS-247, RSS-Gen

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

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

General Requirements and Information for the Certification of Radio Apparatus.

|                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                             |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (*) Identification of item tested         | Automotive Infotainment System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                             |
| (*) Trademark                             | BMW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                             |
| (*) Model and /or type reference          | MGU_F APN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                             |
| Other identification of the product       | HW version: HW 3.1<br>SW version: 19w20.5-1-16<br>FCC ID: A269ZUA160<br>IC: 700B-UA160                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                             |
| (*) Features                              | BT, WiFi, USB2/3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                             |
| Applicant                                 | ALPSALPINE INC.<br>20-1 YOSHIMA INDUSTRIAL PARK, IWAKI, FUKUSHIMA 970-1192, JAPAN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                             |
| Test method requested, standard           | USA FCC Part 15.247 (10-1-18) Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.<br>USA FCC Part 15.209 (10-1-18) Edition: Radiated emission limits; general requirements.<br>CANADA RSS-247 Issue 2 (February 2017).<br>CANADA RSS-Gen Issue 5 (April 2018).<br>Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules. 558074 D01 Meas Guidance v05r02 dated April 2, 2019.<br>ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices. |                                                                                                                                                             |
| Summary                                   | IN COMPLIANCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                             |
| Approved by (name / position & signature) | J. Carlos Luque<br>RF Lab. Supervisor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 74841983Y<br>JOSE CARLOS<br>LUQUE<br>(C:A29507456)<br>Firmado digitalmente por 74841983Y JOSE CARLOS LUQUE (C:A29507456) Fecha: 2019.12.19 13:05:25 +01'00' |
| Date of issue                             | 2019-12-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                             |
| Report template No                        | FDT08_22<br>(*) "Data provided by the client"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                             |

Index

Competences and guarantees .....3

General conditions.....3

Uncertainty.....3

Data provided by the client .....3

Usage of samples .....3

Test sample description.....6

Identification of the client .....7

Testing period and place .....7

Document history.....7

Environmental conditions .....8

Remarks and comments.....9

Testing verdicts.....10

Summary .....10

Appendix A: Test results. Bluetooth EDR (GFSK, Pi/4 DQPSK, 8DPSK).....11

Appendix B: Test results. 802.11 bgn20 1x1.....67

## Competences and guarantees

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DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

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DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

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

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## General conditions

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1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
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## Uncertainty

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Uncertainty (factor  $k=2$ ) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

## Data provided by the client

---

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample of MGU\_F APN is a device for entertainment and communication inside the car, this includes playing music from several external sources or internal flash-memory, connecting mobile devices (e.g. Apple Car Play) and a navigation system.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of result.

## Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

| Control N° | Description                    | Model     | Serial N°       | Date of reception |
|------------|--------------------------------|-----------|-----------------|-------------------|
| 61299/057  | Automotive Infotainment System | MGU_F APN | ALB314K0673026  | 2019/07/24        |
| 61299/046  | Display                        | --        | --              | 2019/07/16        |
| 61299/059  | CAN Box                        | --        | 80008147        | 2019/07/24        |
| 61299/061  | Ethernet Board                 | --        | --              | 2019/07/24        |
| 61299/064  | Ethernet-USB Adapter           | EU-4306   | EU430693MA00744 | 2019/07/24        |
| 61299/065  | Harness                        | --        | --              | 2019/07/24        |
| 61299/111  | Antenna                        |           |                 | 2019/08/30        |
| 61299/112  | Antenna                        |           |                 | 2019/08/30        |

Sample S/01 has undergone the 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 |
|------------|--------------------------------|-----------|-----------------|-------------------|
| 61299/057  | Automotive Infotainment System | MGU_F APN | ALB314K0673026  | 2019/07/24        |
| 61299/046  | Display                        | --        | --              | 2019/07/16        |
| 61299/059  | CAN Box                        | --        | 80008147        | 2019/07/24        |
| 61299/061  | Ethernet Board                 | --        | --              | 2019/07/24        |
| 61299/064  | Ethernet-USB Adapter           | EU-4306   | EU430693MA00744 | 2019/07/24        |
| 61299/065  | Harness                        | --        | --              | 2019/07/24        |

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

- Sample S/03 is composed of the following elements:

| Control N° | Description                    | Model     | Serial N°       | Date of reception |
|------------|--------------------------------|-----------|-----------------|-------------------|
| 61299/058  | Automotive Infotainment System | MGU_F APN | ALB314K0672284  | 2019/07/24        |
| 61299/046  | Display                        | --        | --              | 2019/07/16        |
| 61299/043  | CAN Box                        | --        | 80008147        | 2019/07/24        |
| 61299/061  | Ethernet Board                 | --        | --              | 2019/07/24        |
| 61299/064  | Ethernet-USB Adapter           | EU-4306   | EU430693MA00744 | 2019/07/24        |
| 61299/065  | Harness                        | --        | --              | 2019/07/24        |
| 61299/111  | Antenna                        |           |                 | 2019/08/30        |
| 61299/112  | Antenna                        |           |                 | 2019/08/30        |

Sample S/03 has undergone the following test(s): All RADIATED tests for n40 mode indicated in Appendix A.

## Test sample description

|                                               |                                      |                                        |                                     |                          |              |   |    |
|-----------------------------------------------|--------------------------------------|----------------------------------------|-------------------------------------|--------------------------|--------------|---|----|
| Ports..... :                                  | Port name and description            | Cable                                  |                                     |                          |              |   |    |
|                                               |                                      | Specified length [m]                   | Attached during test                | Shielded                 |              |   |    |
|                                               | BT                                   |                                        | <input checked="" type="checkbox"/> | <input type="checkbox"/> |              |   |    |
|                                               | WLAN                                 |                                        | <input checked="" type="checkbox"/> | <input type="checkbox"/> |              |   |    |
|                                               | USB2                                 |                                        | <input checked="" type="checkbox"/> | <input type="checkbox"/> |              |   |    |
|                                               | USB3                                 |                                        | <input checked="" type="checkbox"/> | <input type="checkbox"/> |              |   |    |
|                                               | APIX                                 |                                        | <input checked="" type="checkbox"/> | <input type="checkbox"/> |              |   |    |
|                                               | OABR                                 |                                        | <input checked="" type="checkbox"/> | <input type="checkbox"/> |              |   |    |
| Supplementary information to the ports..... : | N/A                                  |                                        |                                     |                          |              |   |    |
| Rated power supply .....                      | Voltage and Frequency                |                                        | Reference poles                     |                          |              |   |    |
|                                               |                                      |                                        | L1                                  | L2                       | L3           | N | PE |
|                                               | <input checked="" type="checkbox"/>  | DC: 12Vdc.                             |                                     |                          |              |   |    |
| Rated Power .....                             | 12V                                  |                                        |                                     |                          |              |   |    |
| Clock frequencies .....                       | Not provided data                    |                                        |                                     |                          |              |   |    |
| Other parameters..... :                       | FCC ID: A269ZUA160<br>IC: 700B-UA160 |                                        |                                     |                          |              |   |    |
| Software version .....                        | 19w20.5-1-16                         |                                        |                                     |                          |              |   |    |
| Hardware version..... :                       | HW 3.1                               |                                        |                                     |                          |              |   |    |
| Dimensions in cm (L x W x D) .....            | Not provided data                    |                                        |                                     |                          |              |   |    |
| Mounting position..... :                      | <input checked="" type="checkbox"/>  | Table top equipment                    |                                     |                          |              |   |    |
|                                               | <input checked="" type="checkbox"/>  | Other: Vehicular environment equipment |                                     |                          |              |   |    |
| Modules/parts .....                           | Module/parts of test item            |                                        | Type                                |                          | Manufacturer |   |    |
|                                               | BT                                   |                                        |                                     |                          | WNC          |   |    |
|                                               | WiFi                                 |                                        |                                     |                          | WNC          |   |    |
| Accessories (not part of the test item) ..... | Description                          |                                        | Type                                |                          | Manufacturer |   |    |
|                                               | Can Box                              |                                        |                                     |                          | Harman       |   |    |
|                                               | Display                              |                                        |                                     |                          | Visteon      |   |    |
|                                               | OABR-concerter                       |                                        |                                     |                          | Harman       |   |    |
| Documents as provided by the                  | Description                          |                                        | File name                           |                          | Issue date   |   |    |

|                 |                                |                                                                         |           |
|-----------------|--------------------------------|-------------------------------------------------------------------------|-----------|
| applicant.....: | Testing manual for BT and WLAN | I&k-<br>MGU_Testing<br>Manual<br>(Radio_WLAN-<br>BT)_v11_2018-<br>01-18 | 18.1.2018 |
|                 | -                              |                                                                         |           |
|                 | -                              |                                                                         |           |

## Identification of the client

ALPINE ELECTRONICS GMBH  
 Ohmstrasse 4, 85716 Unterschleißheim, Germany

## Testing period and place

|               |                                        |
|---------------|----------------------------------------|
| Test Location | DEKRA Testing and Certification S.A.U. |
| Date (start)  | 2019-09-04                             |
| Date (finish) | 2019-09-13                             |

## Document history

| Report number | Date       | Description   |
|---------------|------------|---------------|
| 61299RRF.001  | 2019-12-19 | First release |

## Environmental conditions

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

|                   |              |
|-------------------|--------------|
| Temperature       | Min. = 15 °C |
|                   | Max. = 35 °C |
| Relative humidity | Min. = 20 %  |
|                   | Max. = 75 %  |

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

|                   |                  |
|-------------------|------------------|
| Temperature       | Min. = 15 °C     |
|                   | Max. = 35 °C     |
| Relative humidity | Min. = 20 %      |
|                   | Max. = 75 %      |
| Air pressure      | Min. = 860 mbar  |
|                   | Max. = 1060 mbar |

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

|                   |                  |
|-------------------|------------------|
| Temperature       | Min. = 15 °C     |
|                   | Max. = 35 °C     |
| Relative humidity | Min. = 20 %      |
|                   | Max. = 35 %      |
| Air pressure      | Min. = 860 mbar  |
|                   | Max. = 1060 mbar |

## Remarks and comments

The tests have been performed by the technical personnel: José Manuel Jiménez, Cristina Calle, Jaime Barranquero, Jesús García, Nicolás Salguero, José Gabriel Pendón, Ignacio Cabra.

Used instrumentation:

### Conducted Measurements:

|    |                                                                   | Last Calibration | Due Calibration |
|----|-------------------------------------------------------------------|------------------|-----------------|
| 1. | Spectrum Analyzer PSA 3Hz-26.5 GHz<br>AGILENT TECHNOLOGIES E4440A | 2017/10          | 2019/10         |
| 2. | EMI Test Receiver ROHDE AND SCHWARZ<br>ESR7                       | 2018/10          | 2020/10         |
| 3. | DC power supply R&S NGPE 40/40                                    | 2018/02          | 2021/02         |
| 4. | Signal and Spectrum Analyzer ROHDE AND<br>SCHWARZ FSV40           | 2017/10          | 2019/10         |

### Radiated Measurements:

|     |                                                                       | Last Calibration | Due Calibration |
|-----|-----------------------------------------------------------------------|------------------|-----------------|
| 1.  | Semianechoic Absorber Lined Chamber ETS<br>FACT3 200STP               | N.A.             | N.A.            |
| 2.  | EMI Test Receiver ROHDE AND SCHWARZ<br>ESR7                           | 2018/10          | 2020/10         |
| 3.  | BiconicalLog antenna ETS LINDGREN<br>3142E                            | 2017/09          | 2020/09         |
| 4.  | RF Pre-amplifier 40 dB, 10 MHz-6 GHz<br>BONN ELEKTRONIK BLNA 0160-01N | 2019/02          | 2020/08         |
| 5.  | Signal and Spectrum Analyzer ROHDE AND<br>SCHWARZ FSV40               | 2018/02          | 2020/02         |
| 6.  | RF Pre-amplifier, 30 dB, 1-18 GHz BONN<br>ELEKTRONIK BLMA 0118-3A     | 2019/04          | 2020/04         |
| 7.  | Broadband Horn antenna 1-18 GHz<br>SCHWARZBECK BBHA 9120 D            | 2018/01          | 2021/01         |
| 8.  | RF Pre-amplifier 30 dB, 18 GHz-40 GHz<br>BONN ELEKTRONIK BLMA 1840-1M | 2019/02          | 2021/02         |
| 9.  | Broadband Horn antenna 18-40 GHz<br>SCHWARZBECK BBHA 9170             | 2018/07          | 2021/07         |
| 10. | DC Power Supply Keysight Technologies<br>U8002A                       | ---              | ---             |
| 12. | Biconical/Log Antenna 30 MHz - 6 GHz ETS<br>LINDGREN 3142E            | 2017/04          | 2020/04         |

## Testing verdicts

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

## Summary

### 1. Bluetooth EDR

| FCC PART 15 PARAGRAPH / RSS-247                               |                                                  |         |        |
|---------------------------------------------------------------|--------------------------------------------------|---------|--------|
| Requirement – Test case                                       |                                                  | Verdict | Remark |
| Section 15.247 Subclause (a) (1) / RSS-247 5.1. (b)           | 20 dB Bandwidth and Carrier frequency separation | P       |        |
| Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) | Number of hopping channels                       | P       |        |
| Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) | Time of occupancy (Dwell Time)                   | P       |        |
| Section 15.247 Subclause (b) / RSS-247 5.4. (b)               | Maximum peak output power and antenna gain       | P       |        |
| Section 15.247 Subclause (d) / RSS-247 5.5.                   | Band-edge emissions compliance (Transmitter)     | P       |        |
| Section 15.247 Subclause (d) / RSS-247 5.5.                   | Emission limitations radiated (Transmitter)      | P       |        |
| <u>Supplementary information and remarks:</u><br>None.        |                                                  |         |        |

### 2. WLAN 2.4 GHz (802.11 b/g/n20/n40 1x1).

| FCC PART 15 PARAGRAPH / RSS-247                        |                                              |         |        |
|--------------------------------------------------------|----------------------------------------------|---------|--------|
| Requirement – Test case                                |                                              | Verdict | Remark |
| Section 15.247 Subclause (a) (2) / RSS-247 5.2. (a)    | 6 dB Bandwidth                               | P       |        |
| Section 15.247 Subclause (b) / RSS-247 5.4. (d)        | Maximum output power and antenna gain        | P       |        |
| Section 15.247 Subclause (d) / RSS-247 5.5.            | Band-edge emissions compliance (Transmitter) | P       |        |
| Section 15.247 Subclause (e) / RSS-247 5.2. (b)        | Power spectral density                       | P       |        |
| Section 15.247 Subclause (d) / RSS-247 5.5.            | Emission limitations radiated (Transmitter)  | P       |        |
| <u>Supplementary information and remarks:</u><br>None. |                                              |         |        |

## Appendix A: Test results. Bluetooth EDR (GFSK, Pi/4 DQPSK, 8DPSK)

INDEX

TEST CONDITIONS .....13

FCC Section 15.247 Subclause (a) (1) / RSS-247 Clause 5.1. (b) 20 dB Bandwidth and Carrier frequency separation. ....16

FCC Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) Number of hopping channels. ....26

FCC Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) Time of occupancy (Dwell Time).....29

FCC Section 15.247 Subclause (b) / RSS-247 Clause 5.4 (b) Maximum peak output power and antenna gain .....35

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Band-edge emissions compliance (Transmitter) (conducted) .....41

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations radiated. (Transmitter) .....48

## TEST CONDITIONS

### POWER SUPPLY (V):

|                                |                                                  |
|--------------------------------|--------------------------------------------------|
| V nominal:                     | 12 Vdc.                                          |
| Type of Power Supply:          | External power supply (Car Battery).             |
| Type of Antenna:               | External antenna.                                |
| Maximum Declared Antenna Gain: | -6.2 dBi (Antenna gain plus antenna cable loss). |

### TEST FREQUENCIES:

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

### CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



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

### RADIATED MEASUREMENTS:

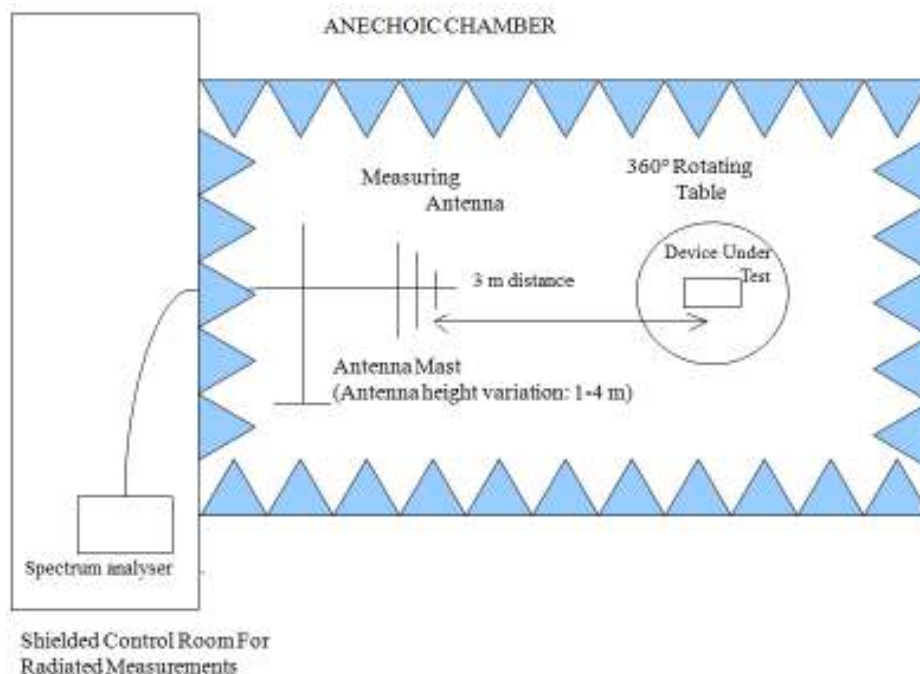
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) is situated at a distance of 3 m and at a distance of 1m for the frequency range 1 GHz-26 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

For radiated emissions in the range 1 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

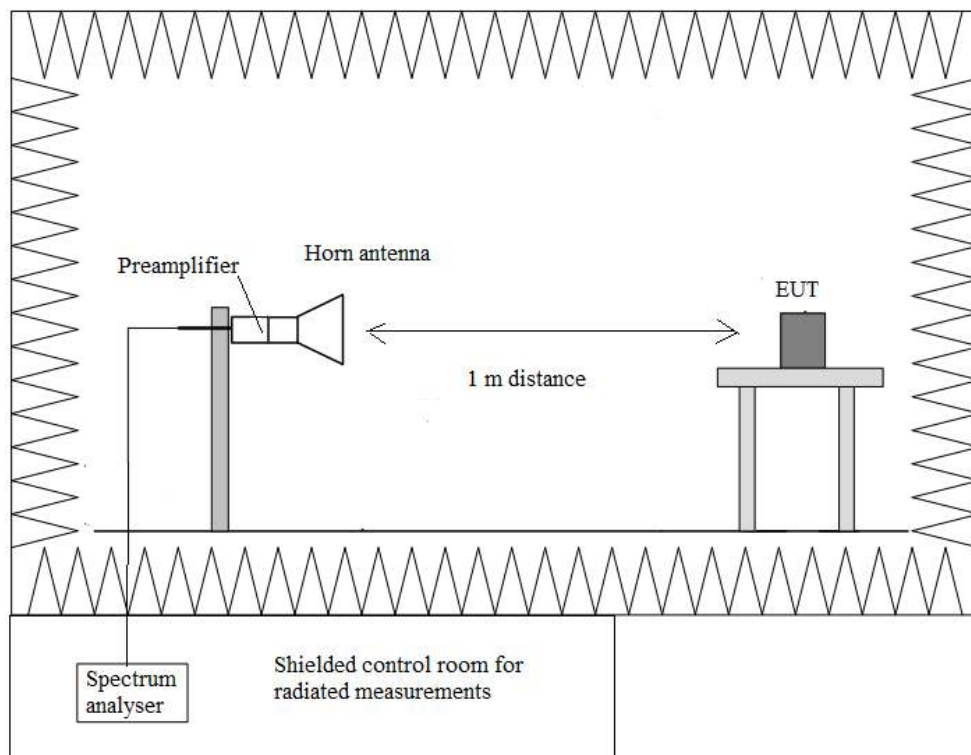
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup  $f > 1$  GHz:



## FCC Section 15.247 Subclause (a) (1) / RSS-247 Clause 5.1. (b) 20 dB Bandwidth and Carrier frequency separation.

### SPECIFICATION:

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

### RESULTS:

- GFSK**

|                                | Low Channel<br>2402 MHz | Middle Channel<br>2441 MHz | High Channel<br>2480 MHz |
|--------------------------------|-------------------------|----------------------------|--------------------------|
| 20 dB Spectrum Bandwidth (kHz) | 941.846                 | 945.303                    | 941.838                  |
| 99% Bandwidth (kHz)            | 878.564                 | 878.724                    | 878.670                  |
| Measurement uncertainty (kHz)  | <±5.0                   |                            |                          |

- Pi/4 DQPSK**

|                                | Low Channel<br>2402 MHz | Middle Channel<br>2441 MHz | High Channel<br>2480 MHz |
|--------------------------------|-------------------------|----------------------------|--------------------------|
| 20 dB Spectrum Bandwidth (kHz) | 1359                    | 1361                       | 1361                     |
| 99% Bandwidth (kHz)            | 1206.8                  | 1208.4                     | 1208.4                   |
| Measurement uncertainty (kHz)  | <±5.0                   |                            |                          |

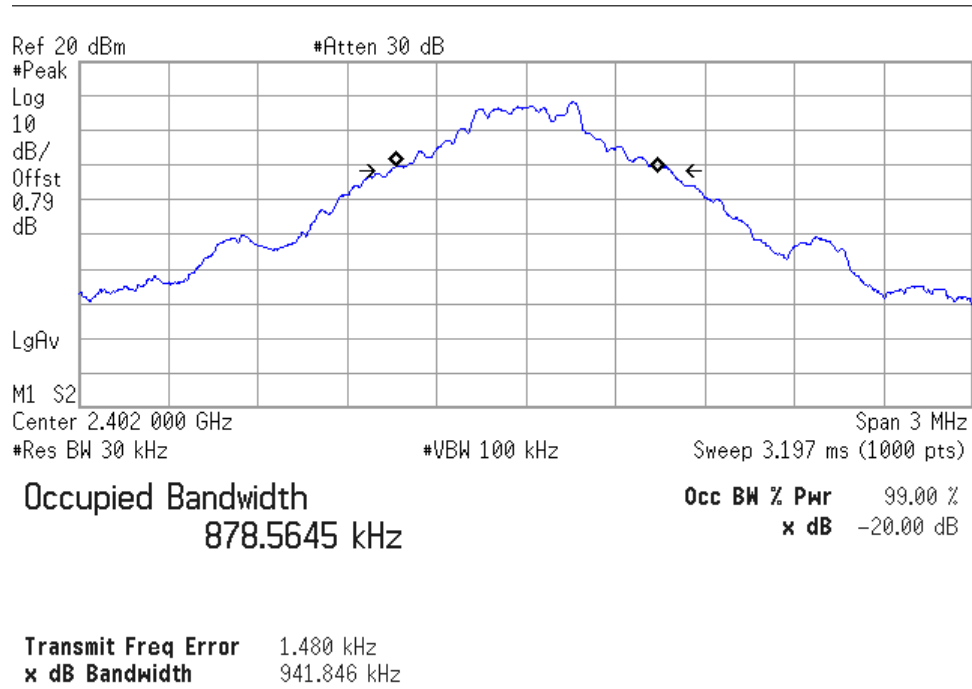
- 8DPSK**

|                                | Low Channel<br>2402 MHz | Middle Channel<br>2441 MHz | High Channel<br>2480 MHz |
|--------------------------------|-------------------------|----------------------------|--------------------------|
| 20 dB Spectrum Bandwidth (kHz) | 1317                    | 1339                       | 1317                     |
| 99% Bandwidth (kHz)            | 1208.4                  | 1212.3                     | 1209.2                   |
| Measurement uncertainty (kHz)  | <±5.0                   |                            |                          |

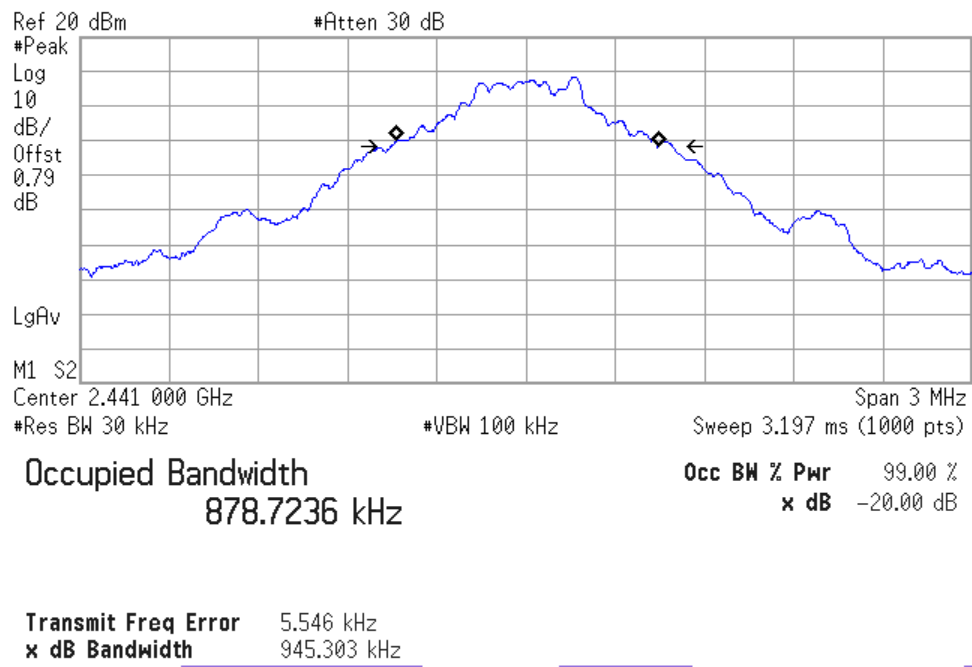
Verdict: PASS

GFSK – Bandwidths

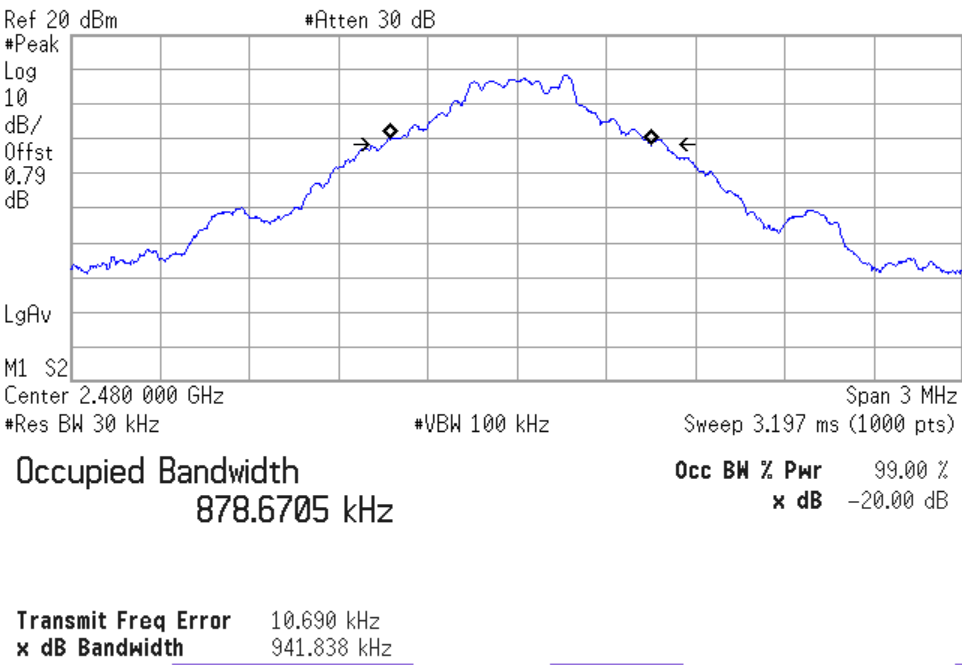
- Low Channel:



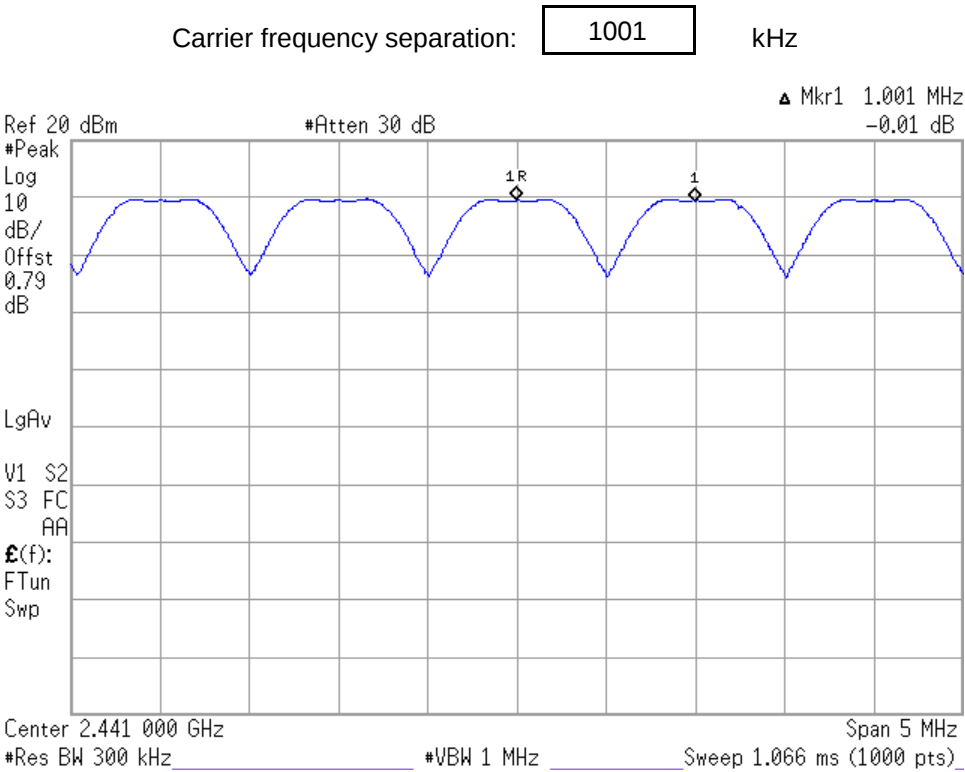
- Middle Channel:



- High Channel:



Carrier frequency separation - GFSK

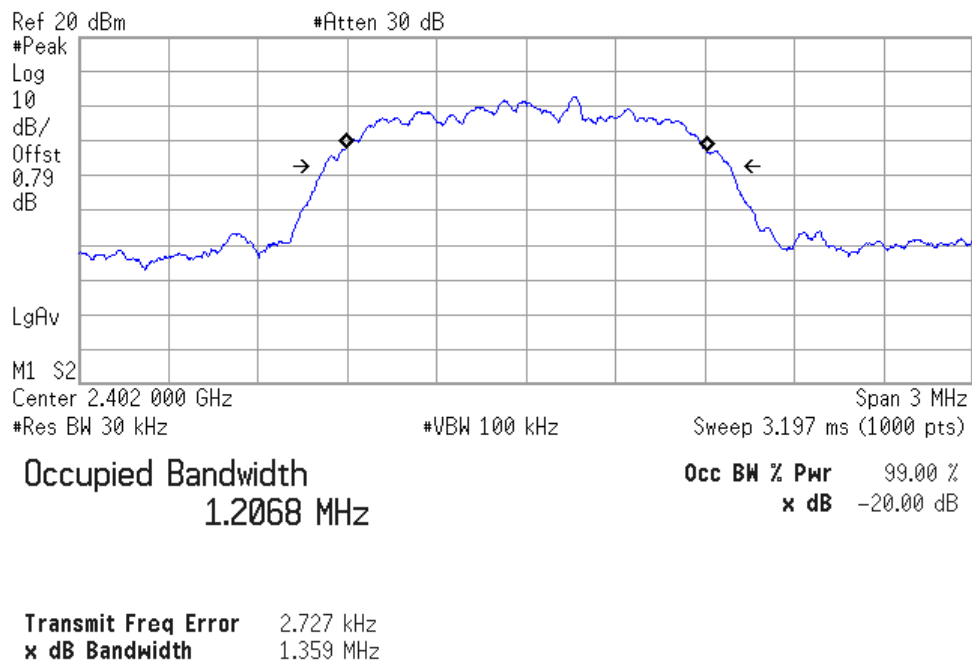


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

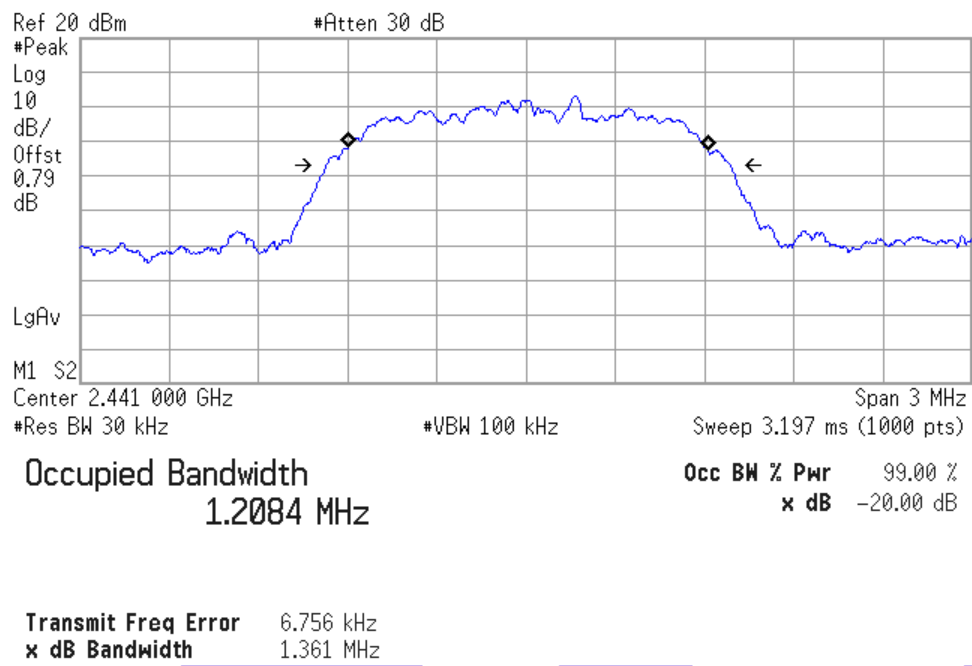
Verdict: PASS

• **PI/4 DQPSK – Bandwidths**

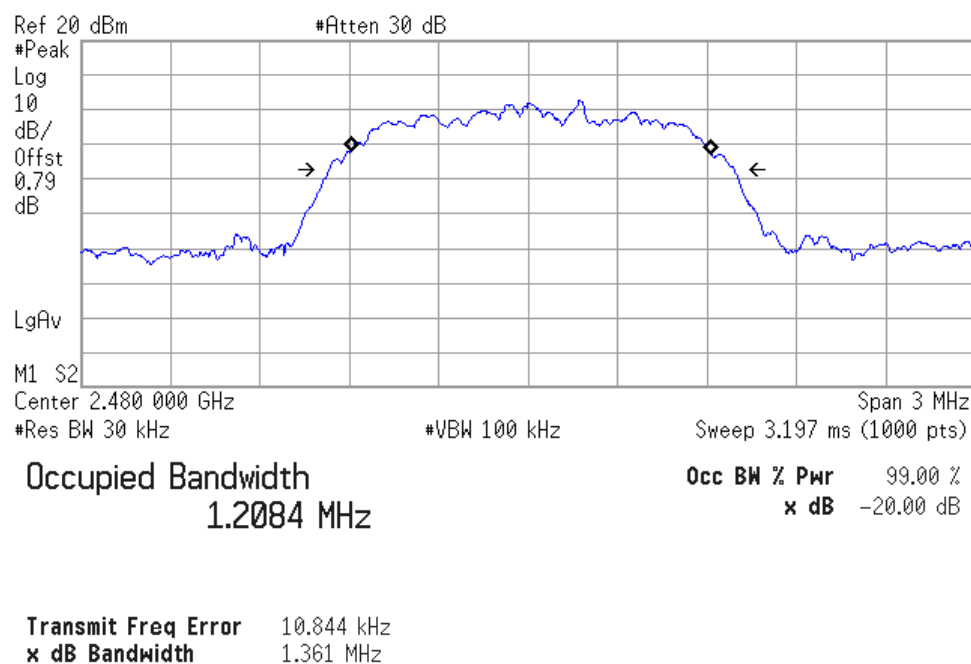
- Low Channel:



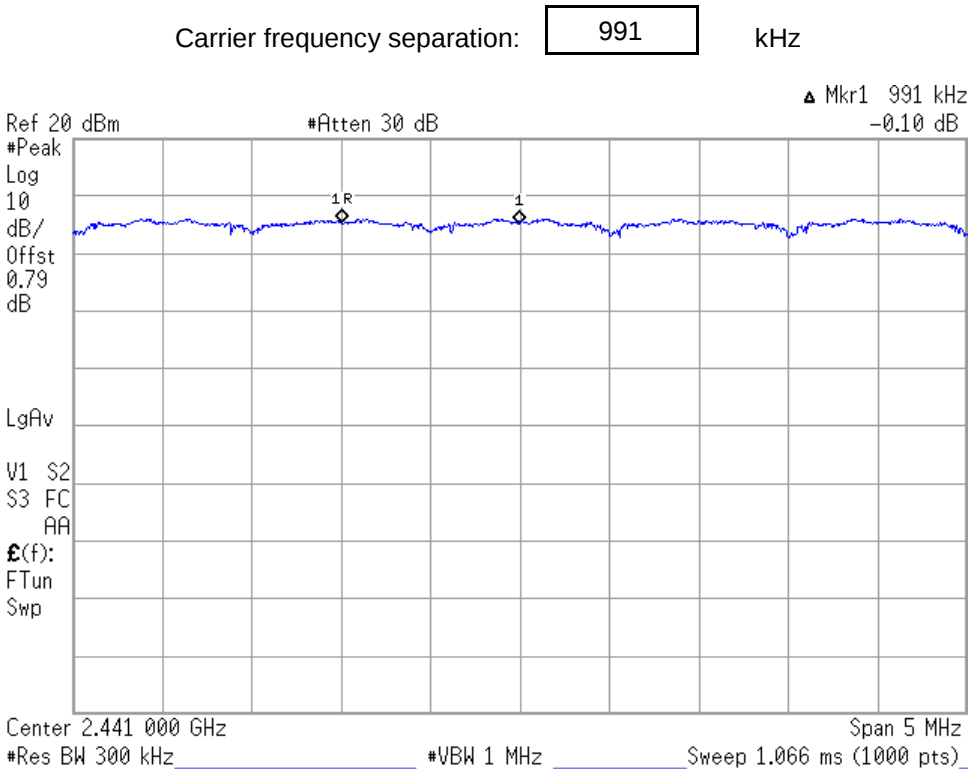
- Middle Channel:



- High Channel:



Carrier frequency separation - Pi/4 DQPSK

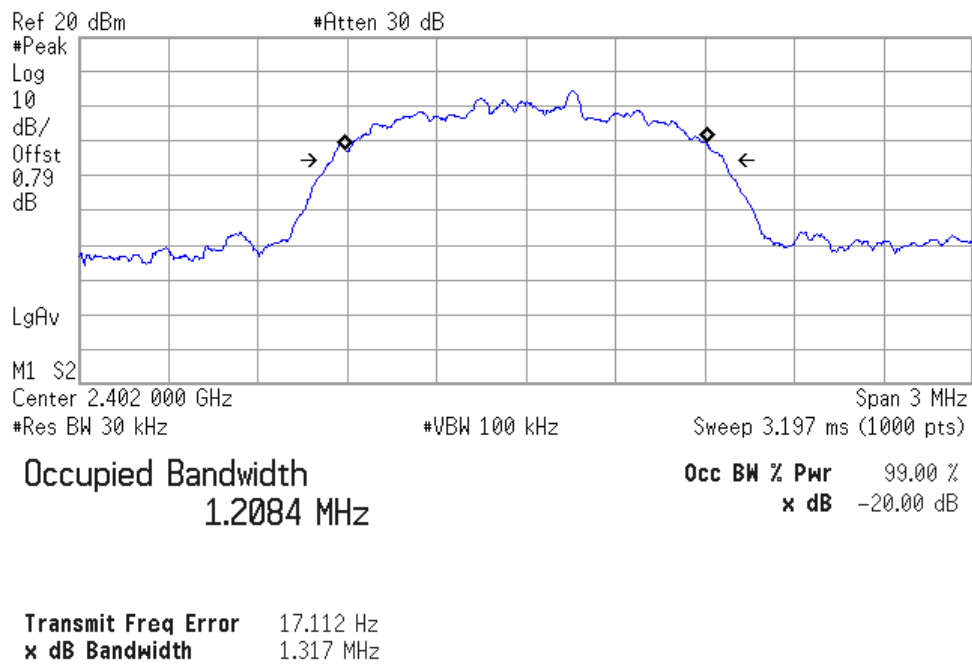


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

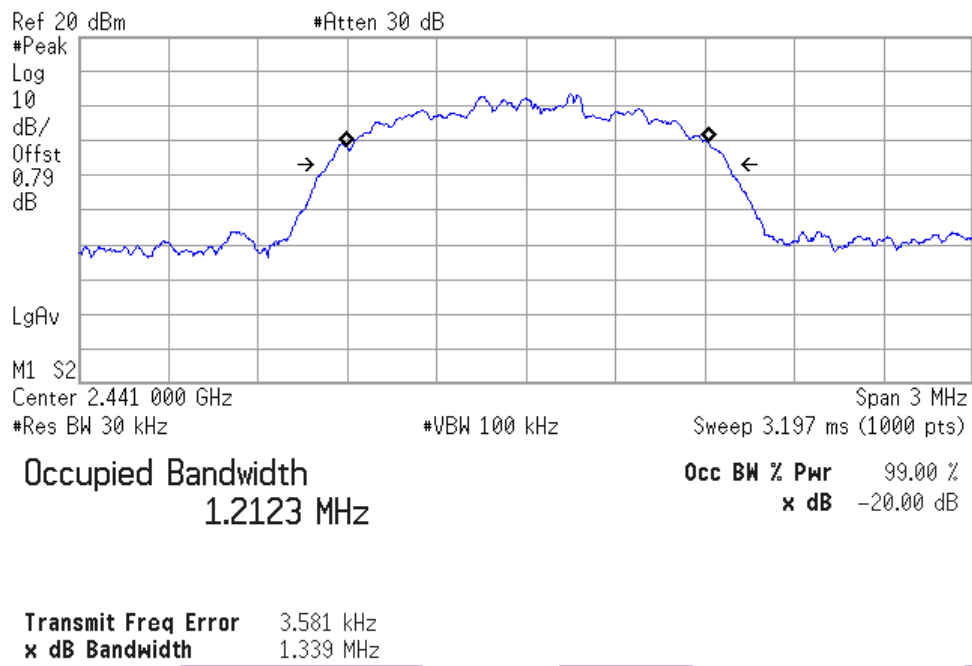
Verdict: PASS

8DPSK – Bandwidths

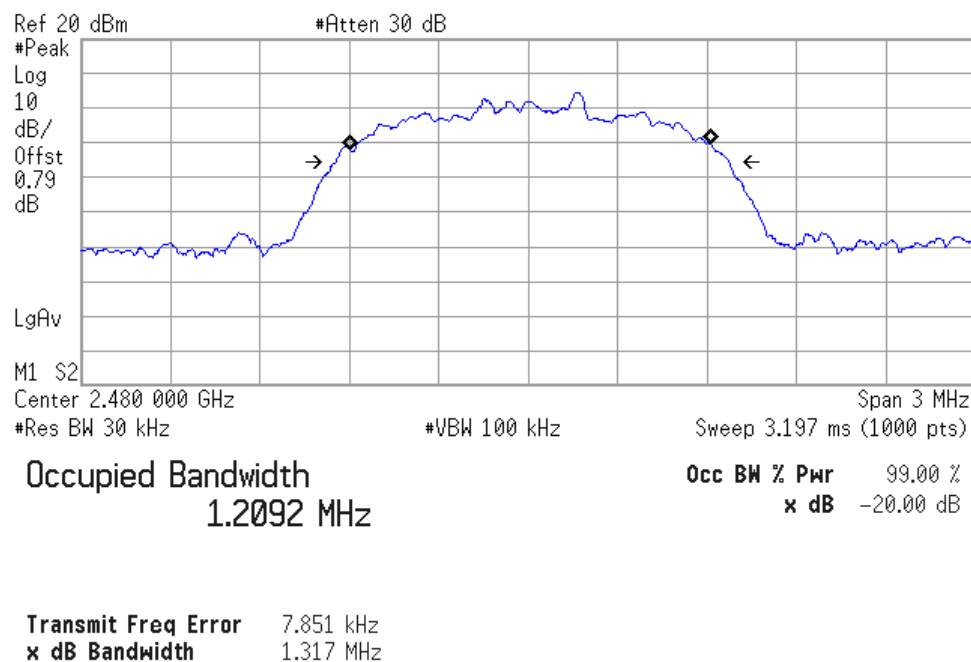
- Low Channel:



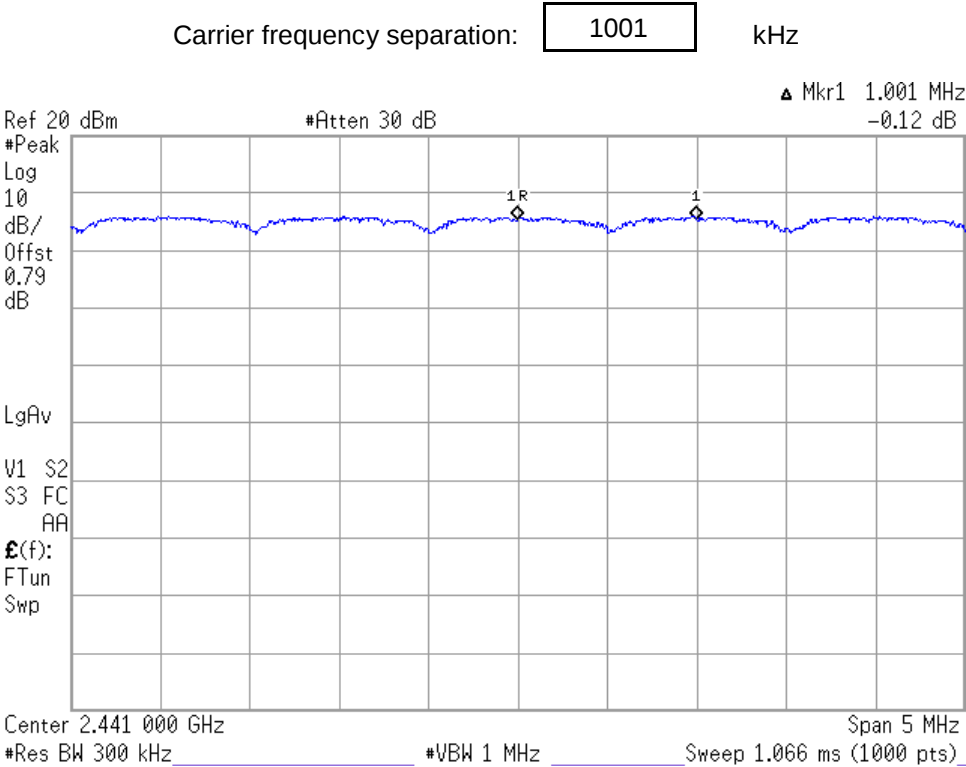
- Middle Channel:



- High Channel:



Carrier frequency separation - 8DPSK



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

Verdict: PASS

FCC Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) Number of hopping channels.

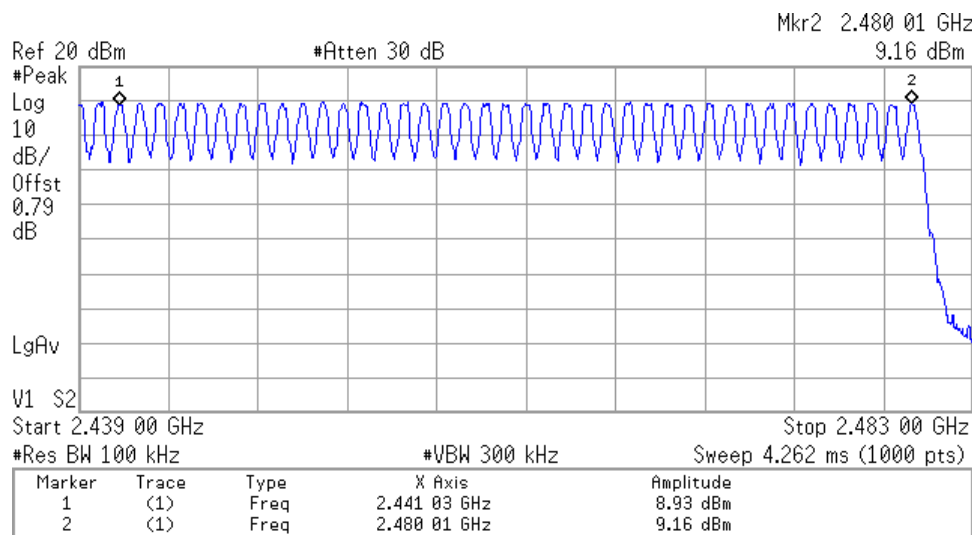
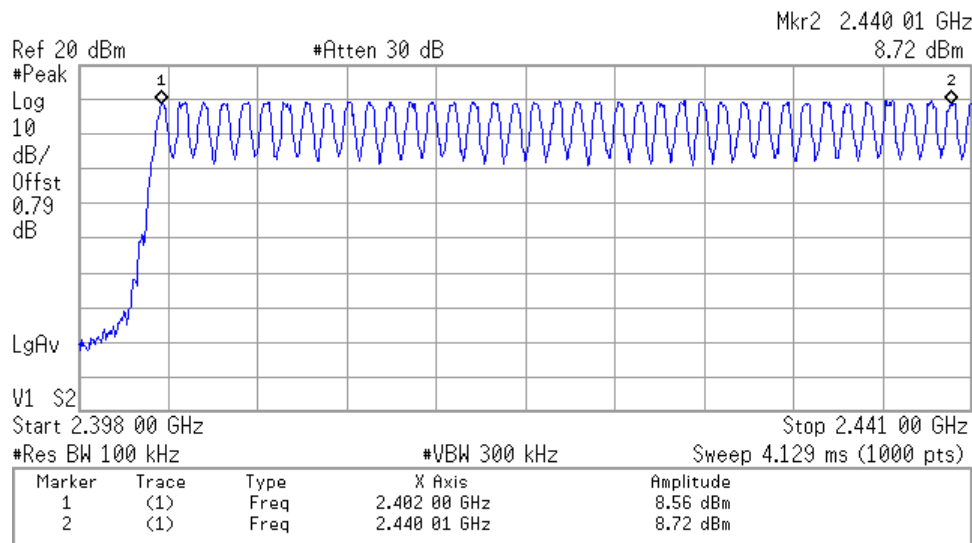
SPECIFICATION:

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

RESULTS:

The number of hopping channels is 79 for all three modes.

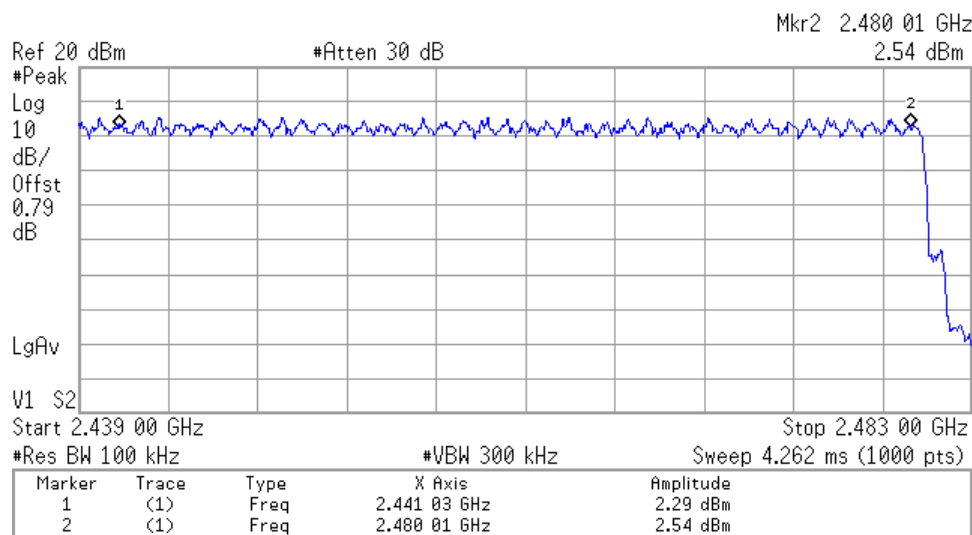
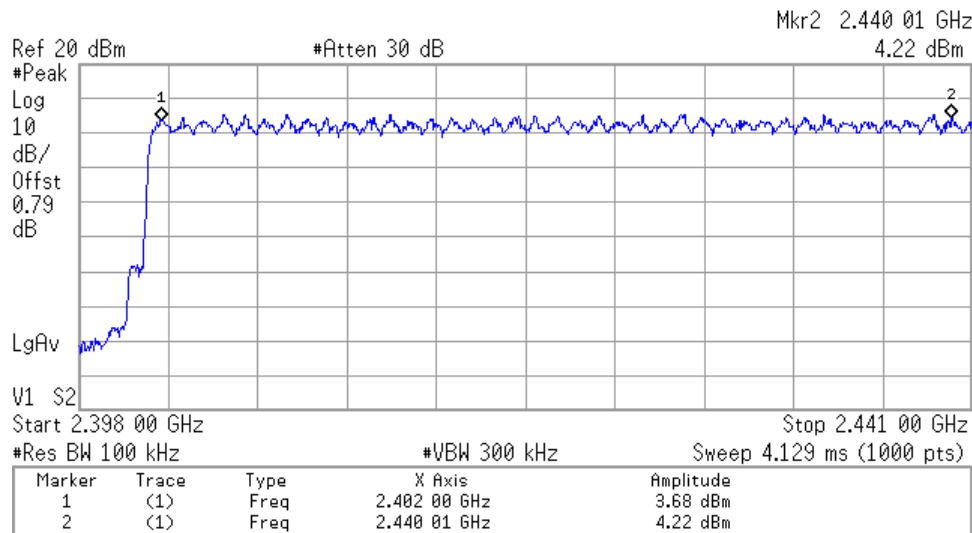
- GFSK – Number of hopping channels



Total number of hopping channels 79

Verdict: PASS

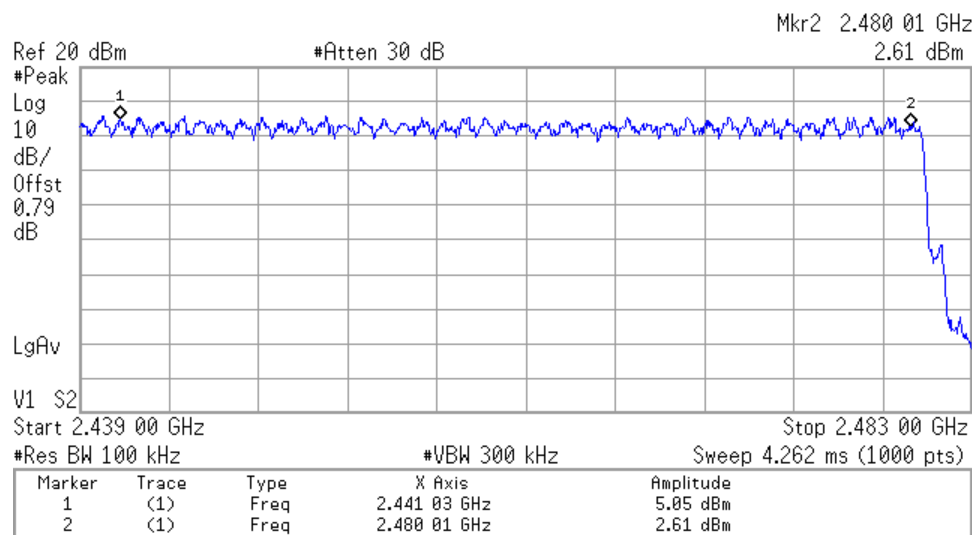
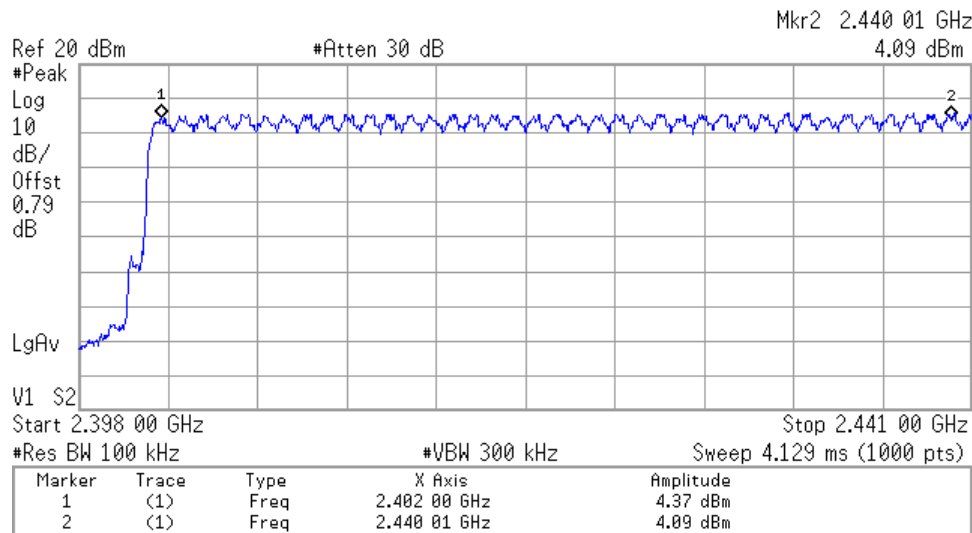
• Pi/4 DQPSK – Number of hopping channels



Total number of hopping channels 79

Verdict: PASS

• 8DPSK – Number of hopping channels



Total number of hopping channels 79

Verdict: PASS

## FCC Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) Time of occupancy (Dwell Time).

### SPECIFICATION:

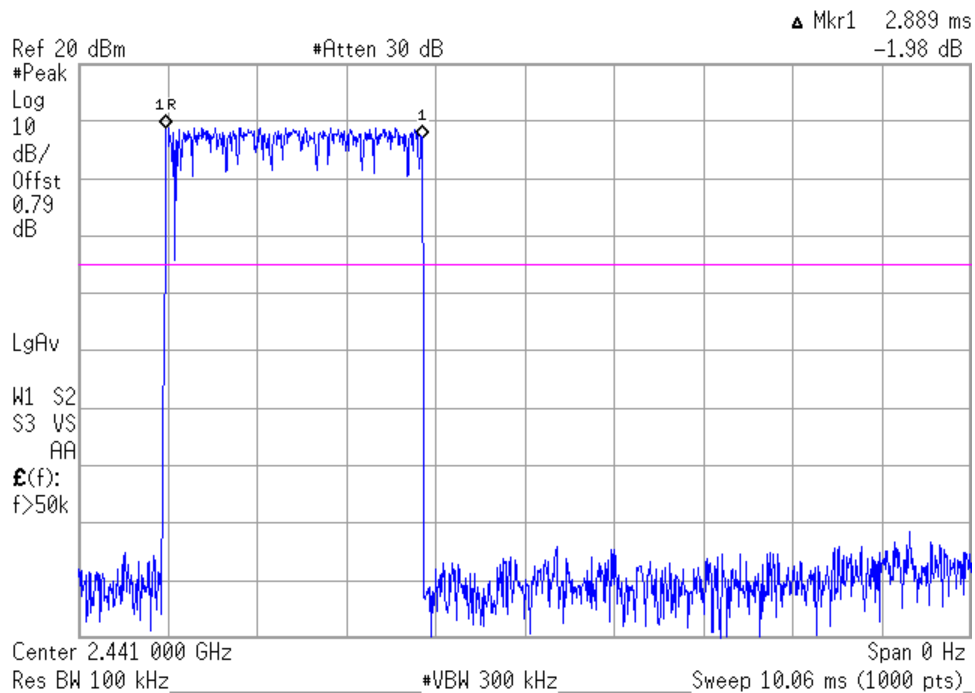
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed =  $0.4 \times 79 = 31.6$  seconds.

### RESULTS:

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

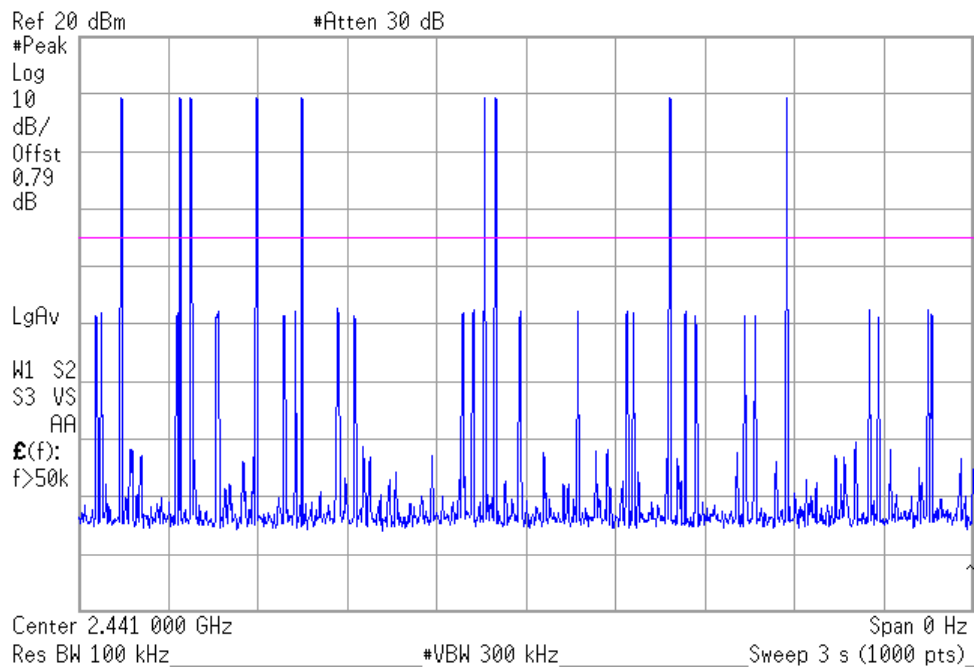
- Transmit Time per Hop:

2.889 ms



Time of Occupancy:

|                                 |             |
|---------------------------------|-------------|
| Nº of hops on spectrum analyzer | 9           |
| Nº of hops over the period      | 94.8        |
| Average Time of Occupancy       | 273.8772 ms |



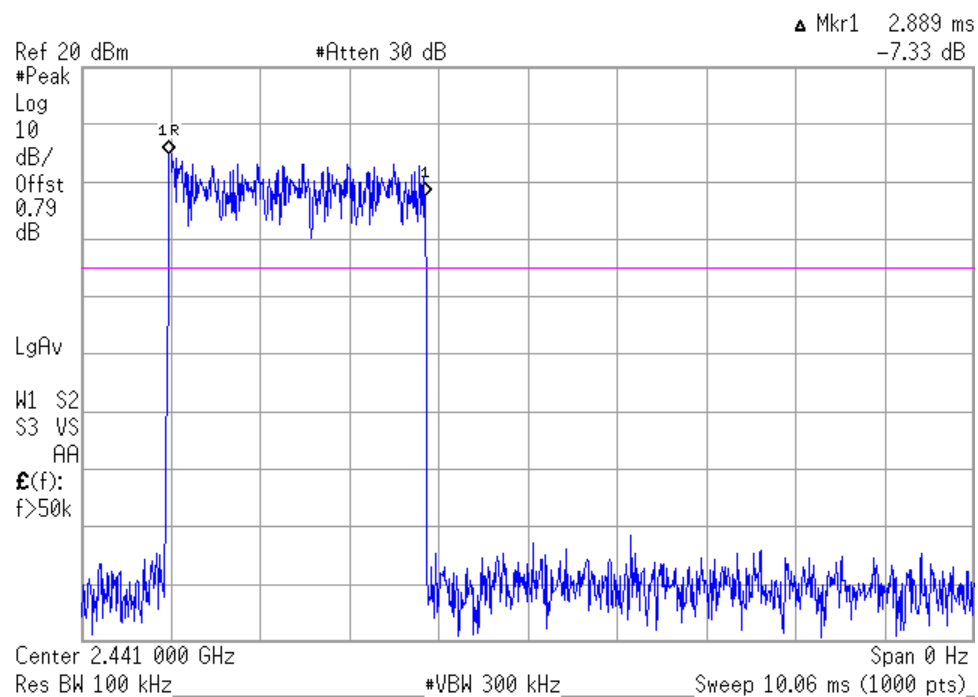
|                             |        |
|-----------------------------|--------|
| Measurement uncertainty (%) | <±0.01 |
|-----------------------------|--------|

Verdict: PASS

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

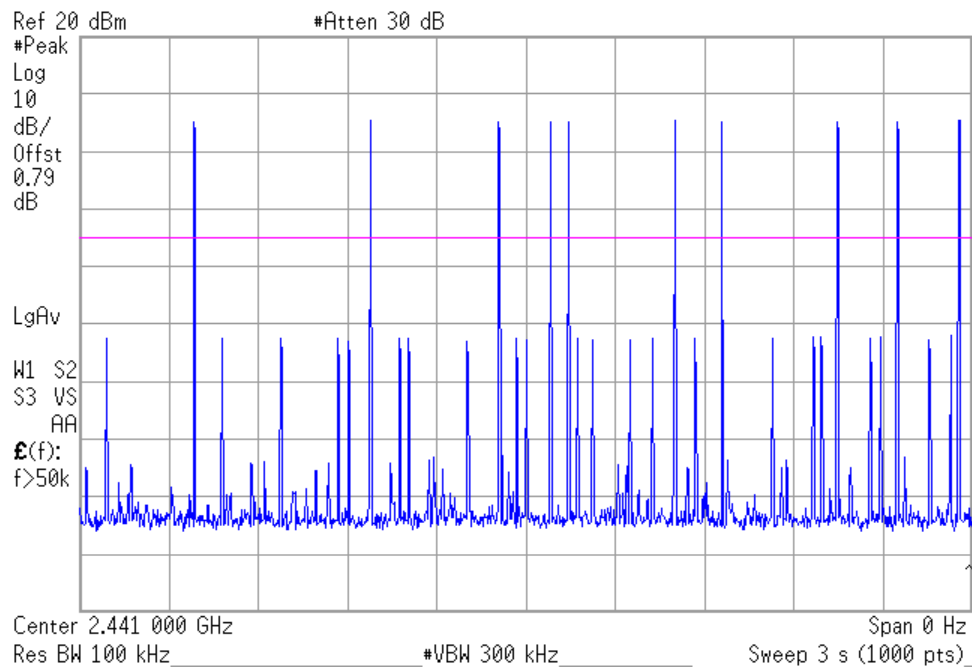
- Transmit Time per Hop:

**2.889** ms



Time of Occupancy:

|                                 |             |
|---------------------------------|-------------|
| Nº of hops on spectrum analyzer | 10          |
| Nº of hops over the period      | 105.3333333 |
| Average Time of Occupancy       | 304.308 ms  |



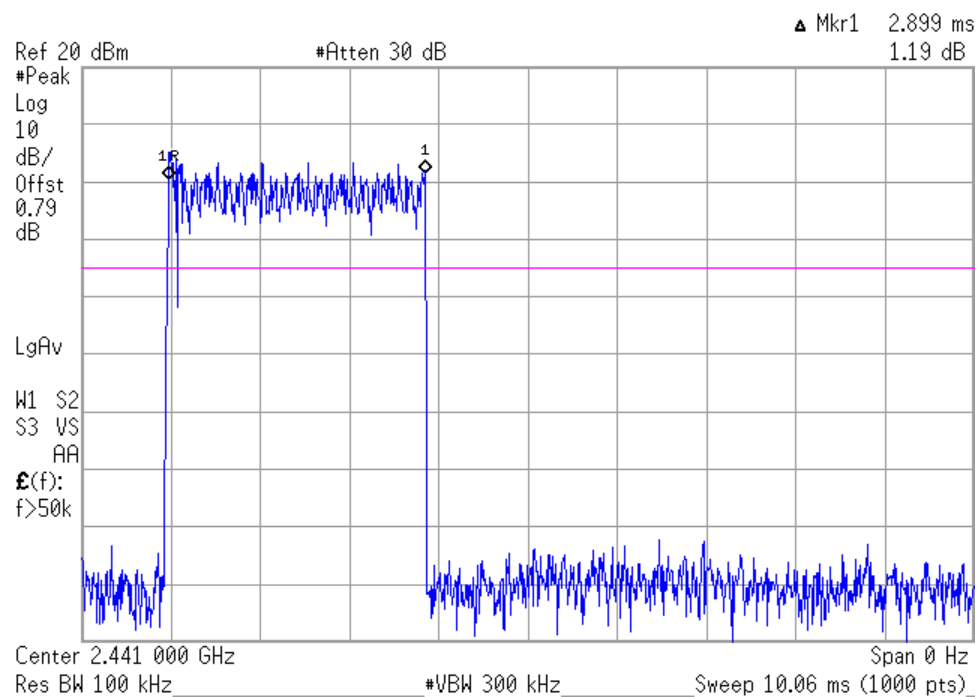
|                             |        |
|-----------------------------|--------|
| Measurement uncertainty (%) | <±0.01 |
|-----------------------------|--------|

Verdict: PASS

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

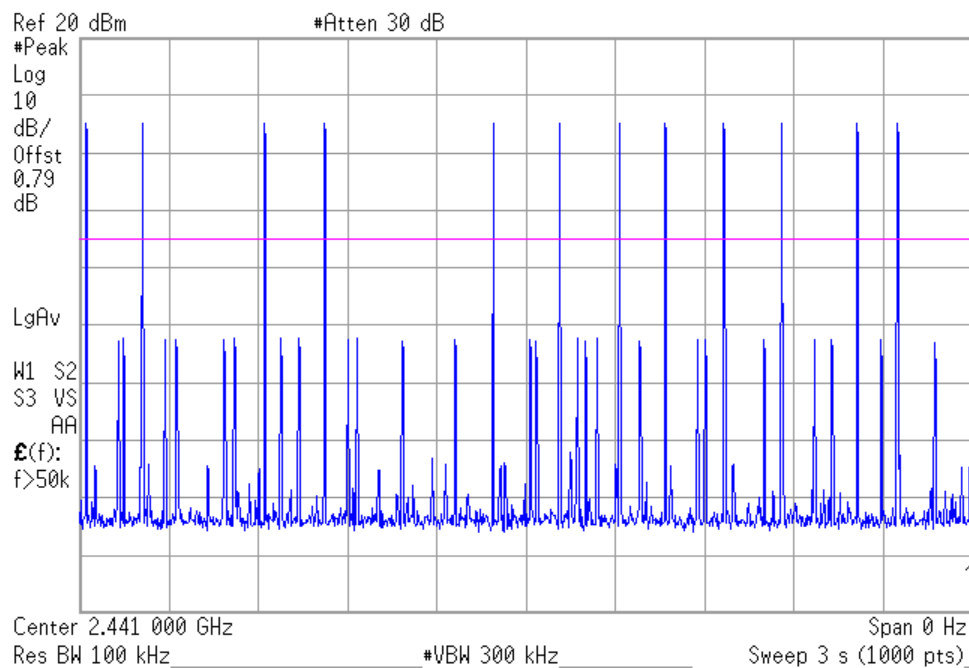
- Transmit Time per Hop:

**2.899** ms



▪ Time of Occupancy:

|                                 |             |
|---------------------------------|-------------|
| Nº of hops on spectrum analyzer | 12          |
| Nº of hops over the period      | 126.4       |
| Average Time of Occupancy       | 366.4336 ms |



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

Verdict: PASS

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

### SPECIFICATION:

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt (30 dBm). The e.i.r.p. shall not exceed 4 W (RSS-247).

### RESULTS:

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

Maximum Declared Antenna Gain: -6.2 dBi

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

- GFSK (1 Mbps)**

| Peak Conducted Output Power   | Low Channel<br>2402 MHz | Middle Channel<br>2441 MHz | High Channel<br>2480 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| Maximum Conducted Power (dBm) | 9.23                    | 9.79                       | 9.73                     |
| Maximum EIRP Power (dBm)      | 3.03                    | 3.59                       | 3.53                     |
| Measurement uncertainty (dB)  | <±0.78                  |                            |                          |

- Pi/4 DQPSK (2 Mbps)**

| Peak Conducted Output Power   | Low Channel<br>2402 MHz | Middle Channel<br>2441 MHz | High Channel<br>2480 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| Maximum Conducted Power (dBm) | 7.62                    | 7.97                       | 7.81                     |
| Maximum EIRP Power (dBm)      | 1.42                    | 1.77                       | 1.61                     |
| Measurement uncertainty (dB)  | <±0.78                  |                            |                          |

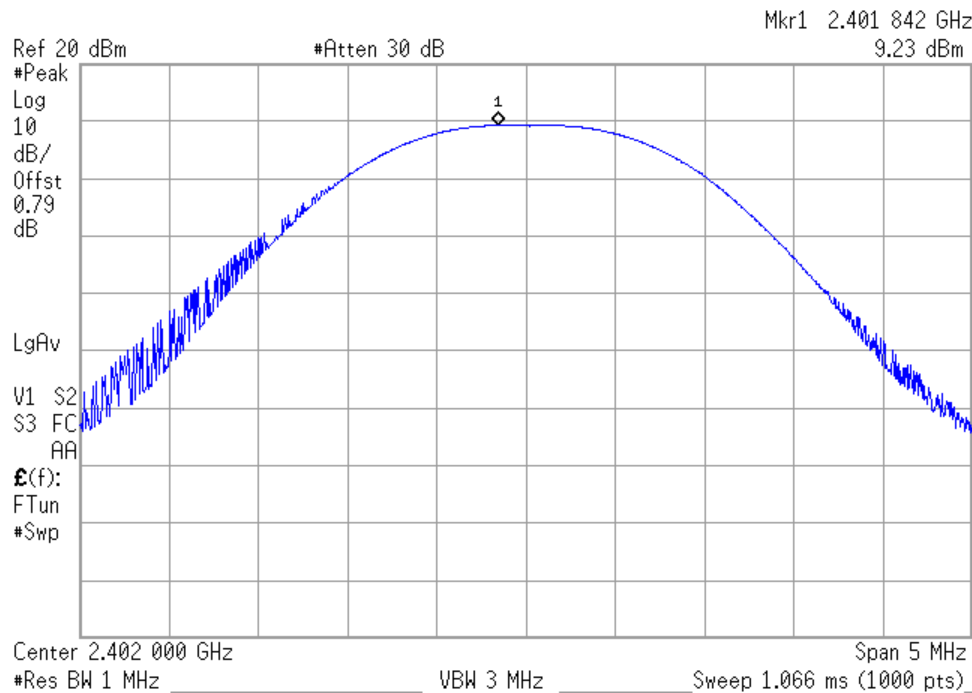
- 8DPSK (3 Mbps)**

| Peak Conducted Output Power   | Low Channel<br>2402 MHz | Middle Channel<br>2441 MHz | High Channel<br>2480 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| Maximum Conducted Power (dBm) | 7.85                    | 8.24                       | 8.05                     |
| Maximum EIRP Power (dBm)      | 1.65                    | 2.04                       | 1.85                     |
| Measurement uncertainty (dB)  | <±0.78                  |                            |                          |

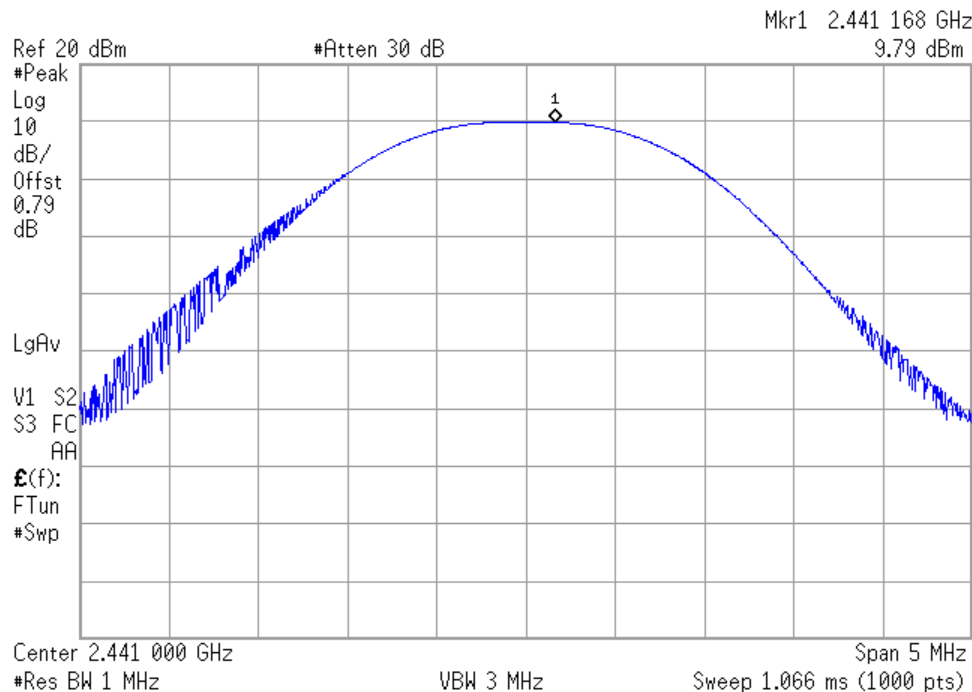
Verdict: PASS

GFSK – Peak Output Power

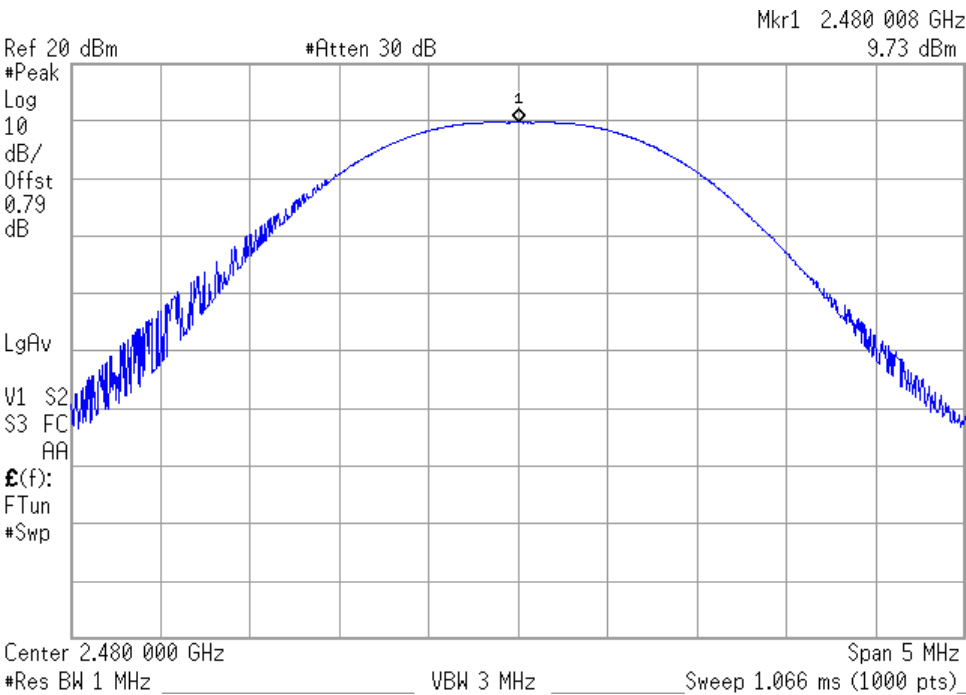
- Low Channel:



- Middle Channel:

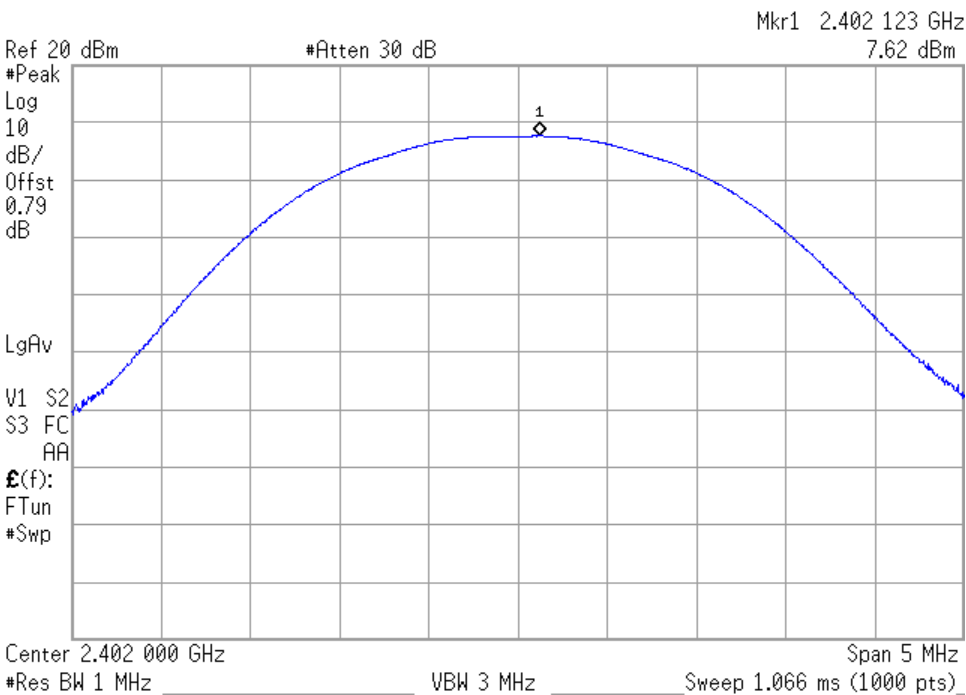


- High Channel:

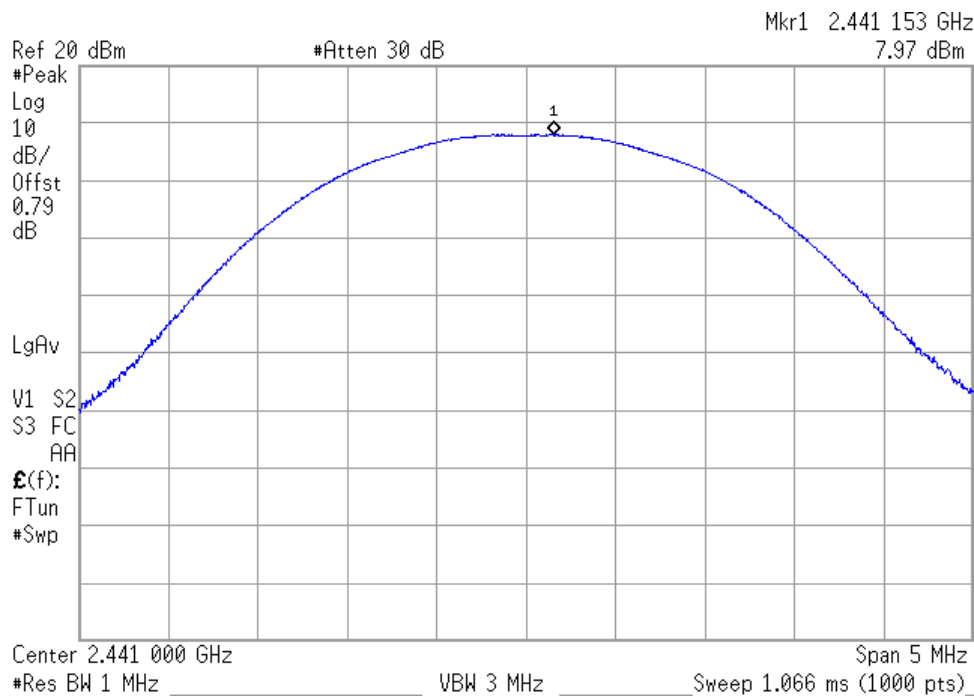


• Pi/4 DQPSK – Peak Output Power

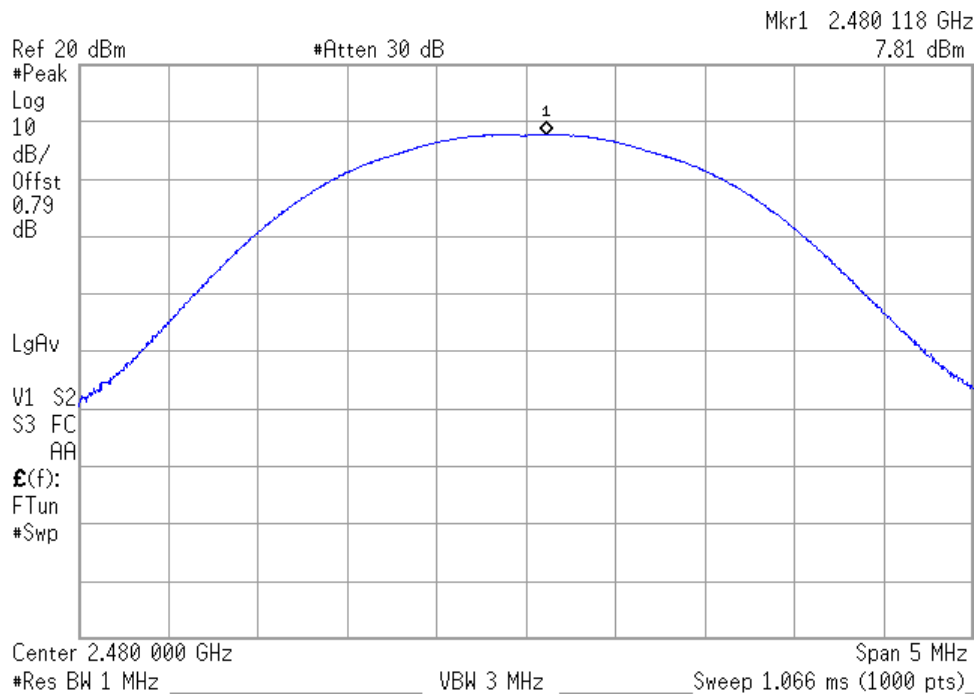
- Low Channel:



- Middle Channel:

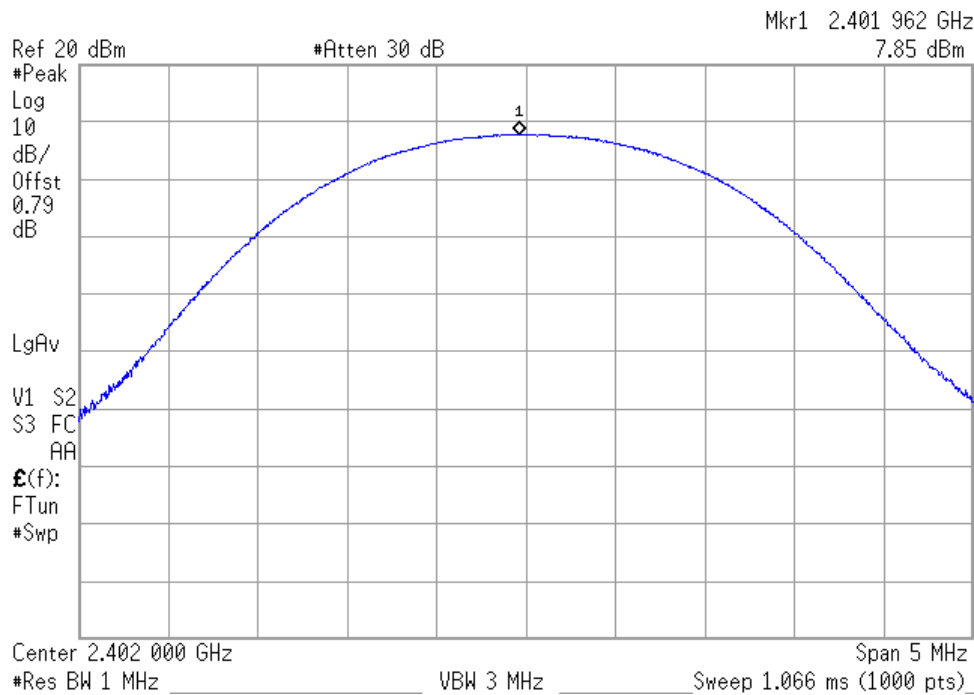


- High Channel:

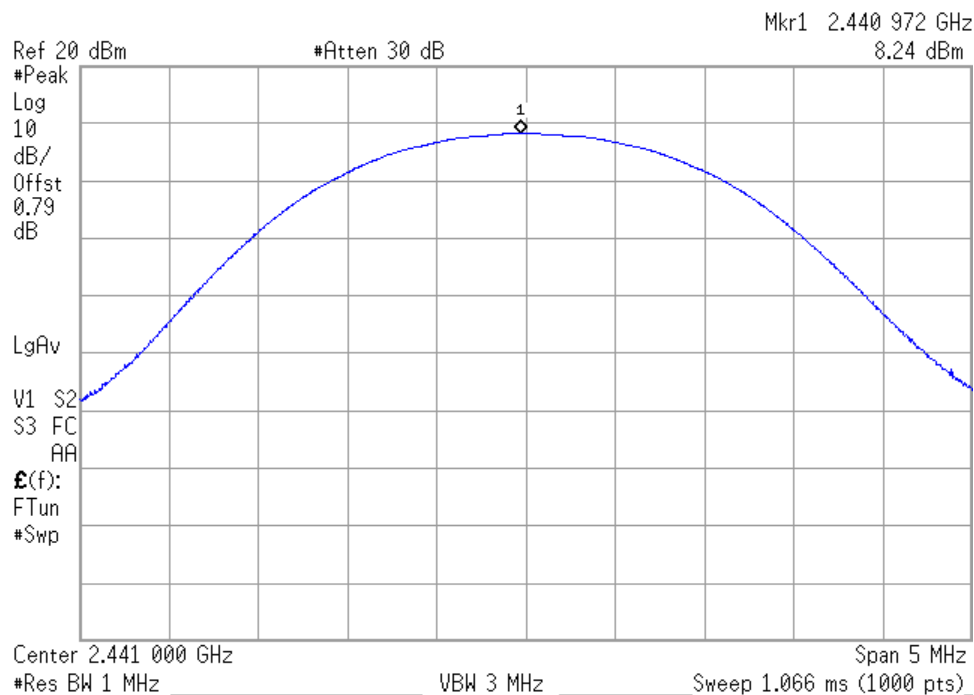


• 8DPSK – Peak Output Power

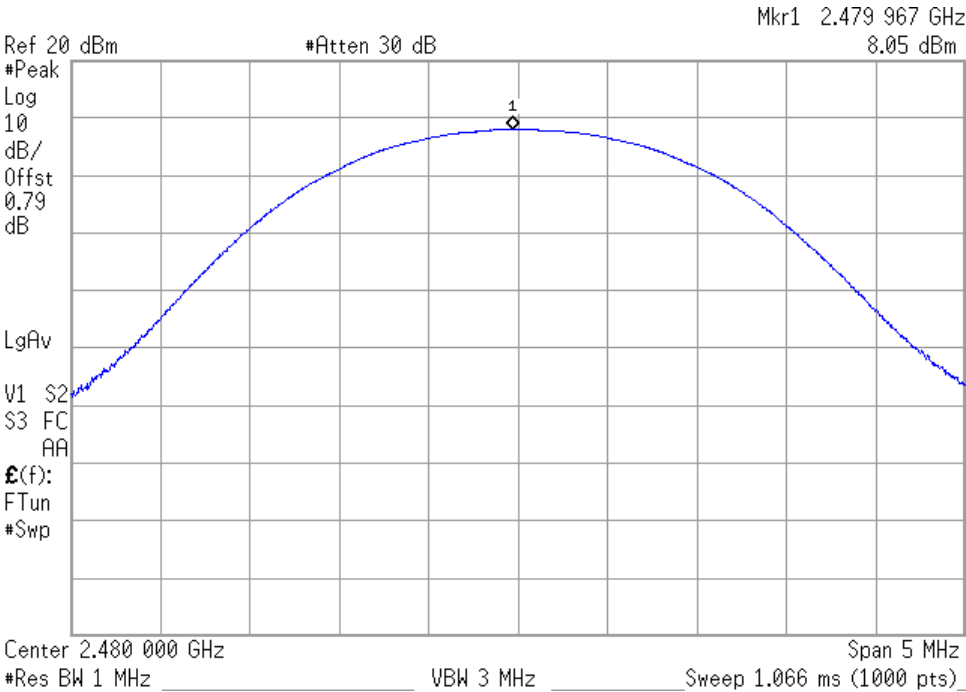
- Low Channel:



- Middle Channel:



- High Channel:



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

### SPECIFICATION:

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

### RESULTS:

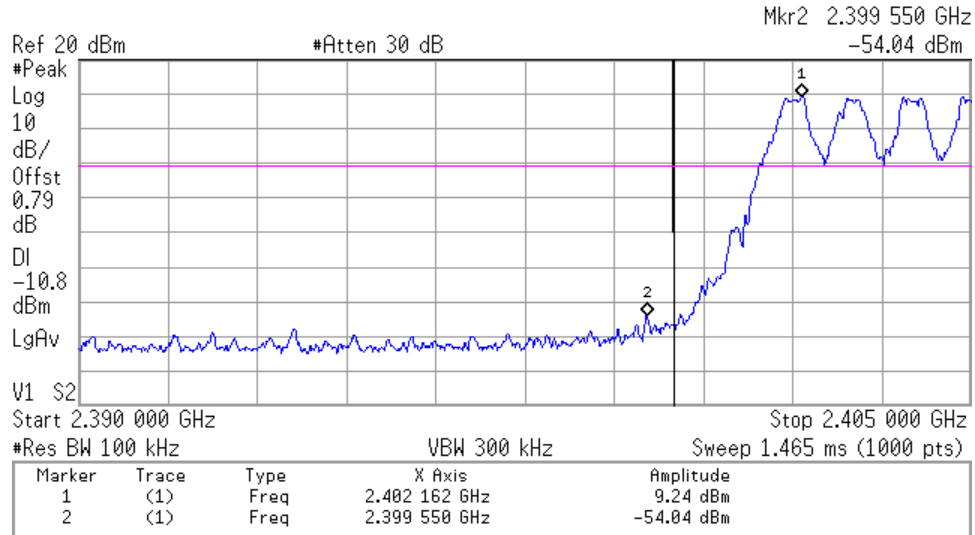
Radiated measurements were used to show compliance with the limits in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

|                              |        |
|------------------------------|--------|
| Measurement uncertainty (dB) | <±2.03 |
|------------------------------|--------|

- **GFSK – Band-edge emissions compliance**

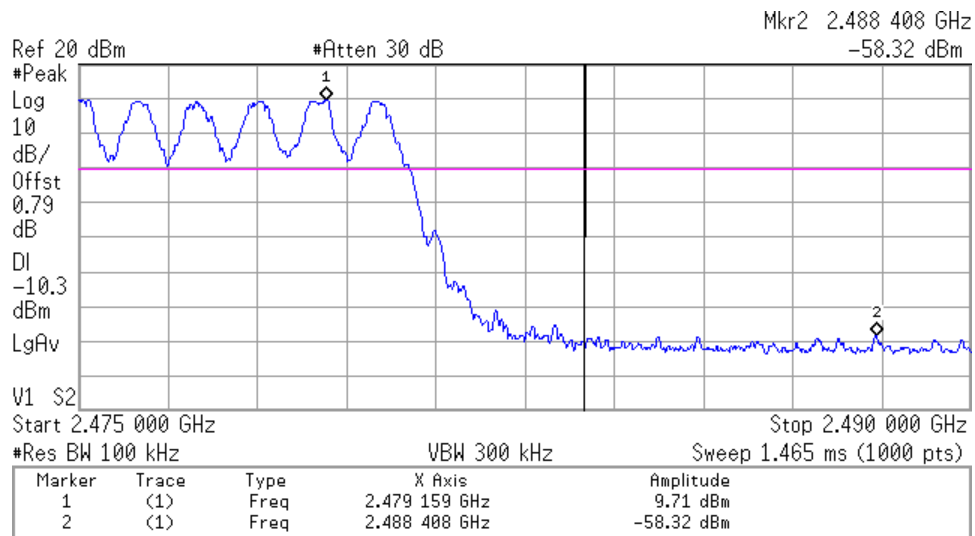
- ❖ **HOPPING ON:**

- **Low Frequency Section 2402 MHz:**



Verdict: PASS

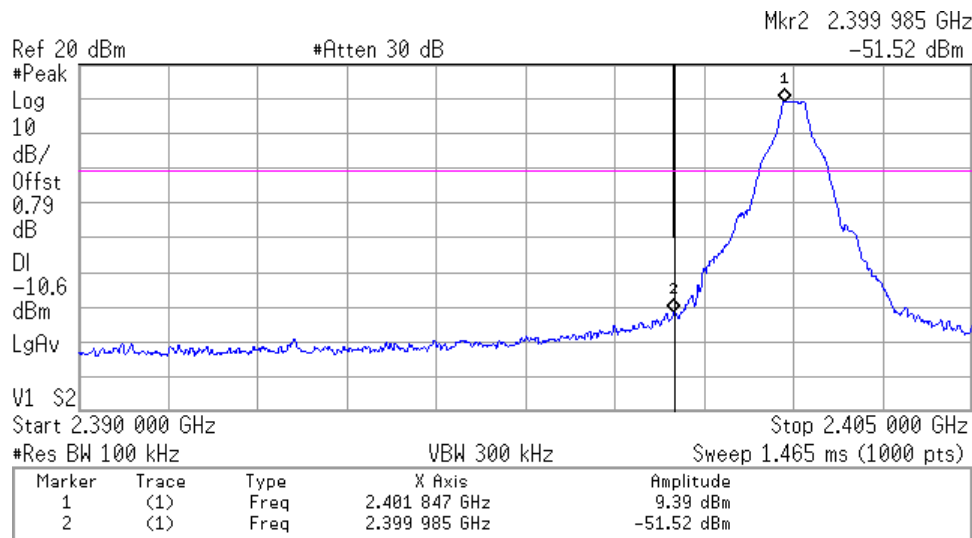
- **High Frequency Section 2480 MHz:**



Verdict: PASS

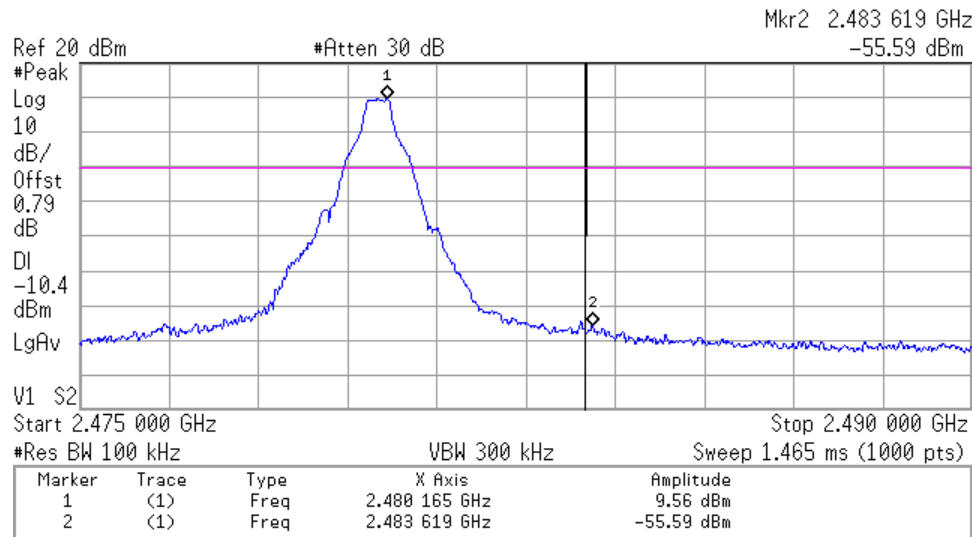
❖ HOPPING OFF:

- Low Frequency Section 2402 MHz:



Verdict: PASS

- High Frequency Section 2480 MHz:

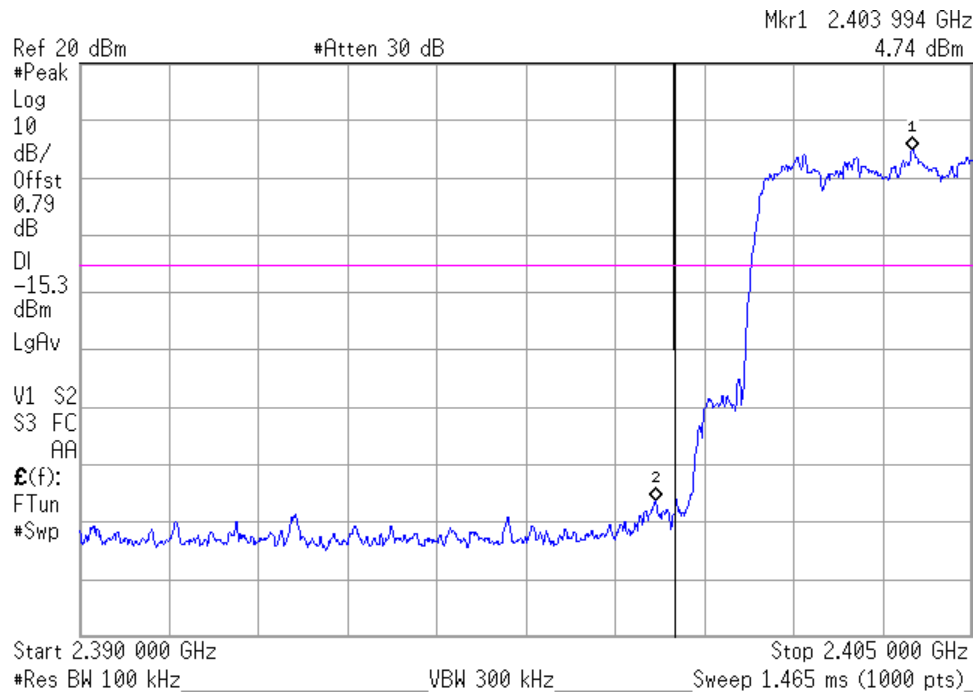


Verdict: PASS

• **PI/4 DQPSK – Band-edge emissions compliance**

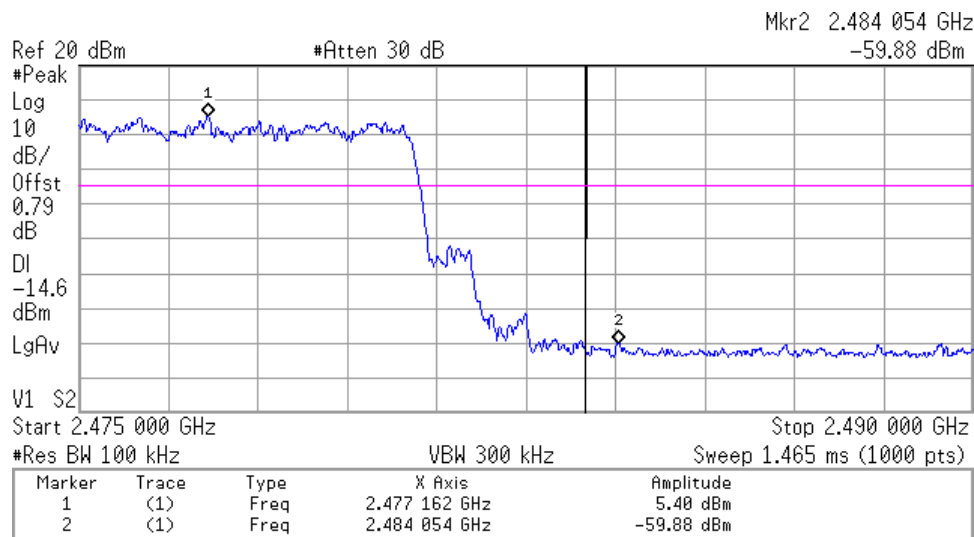
❖ **HOPPING ON:**

- **Low Frequency Section 2402 MHz:**



Verdict: PASS

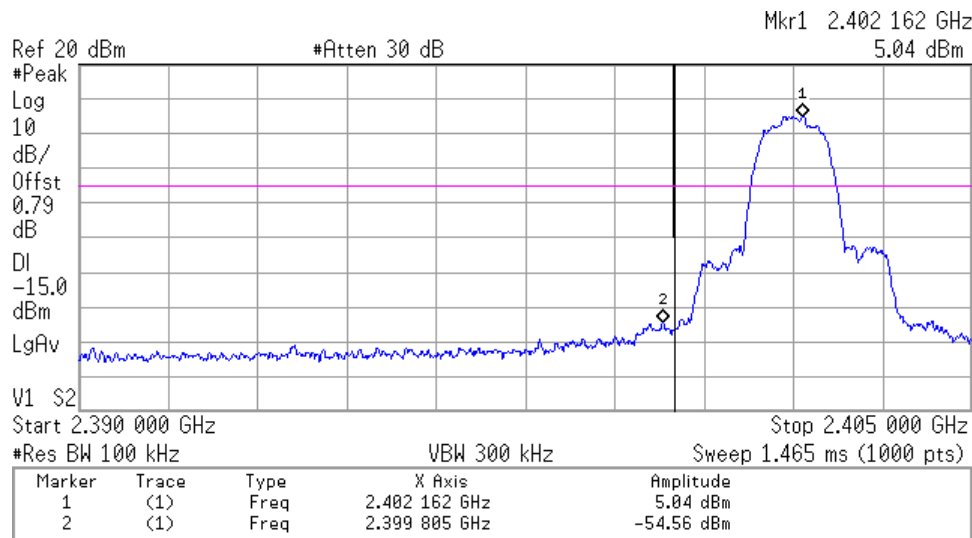
- **High Frequency Section 2480 MHz:**



Verdict: PASS

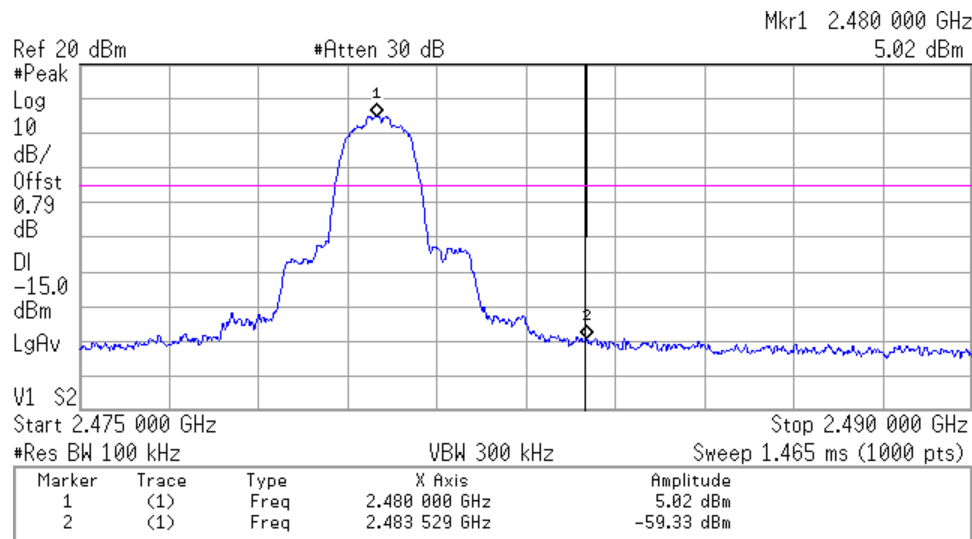
❖ HOPPING OFF:

- Low Frequency Section 2402 MHz:



Verdict: PASS

- High Frequency Section 2480 MHz:

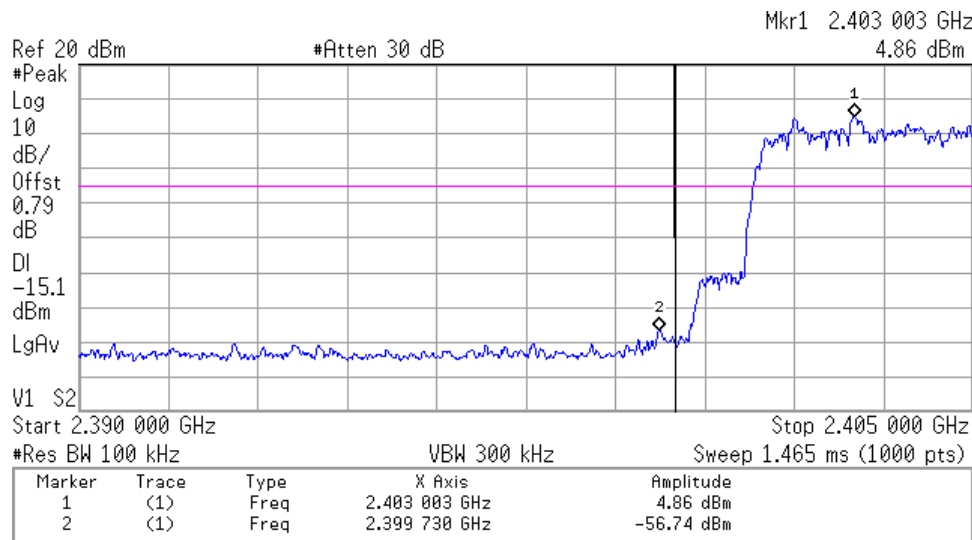


Verdict: PASS

• 8DPSK – Band-edge emissions compliance

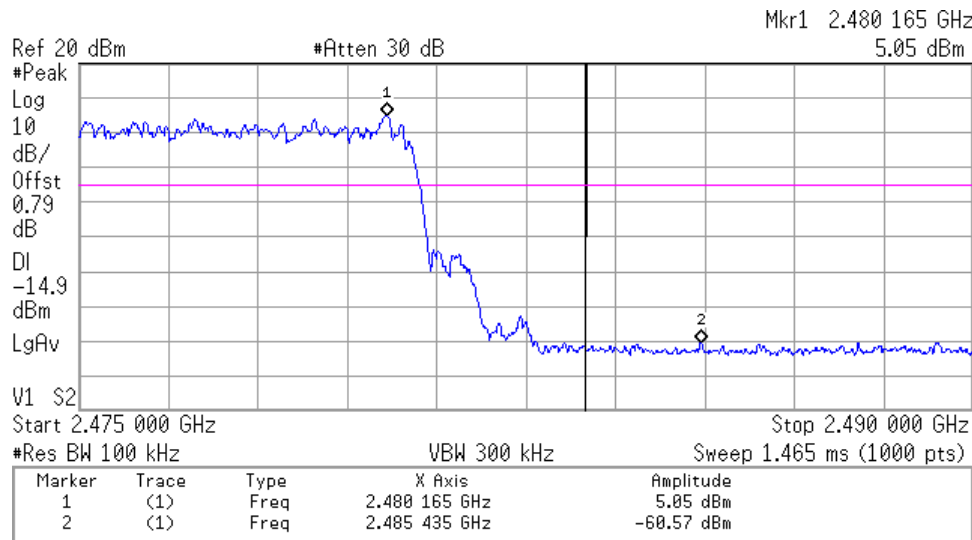
❖ HOPPING ON:

- Low Frequency Section 2402 MHz:



Verdict: PASS

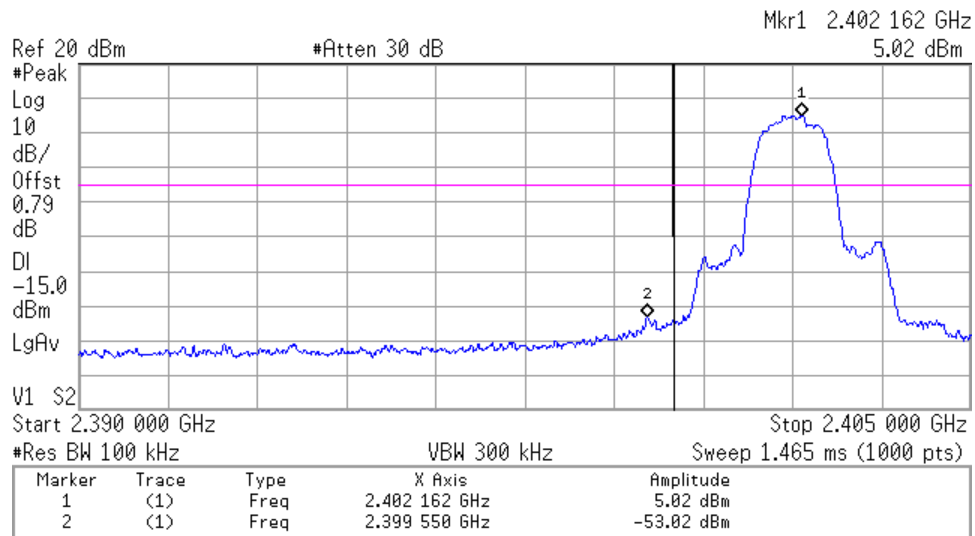
- High Frequency Section 2480 MHz:



Verdict: PASS

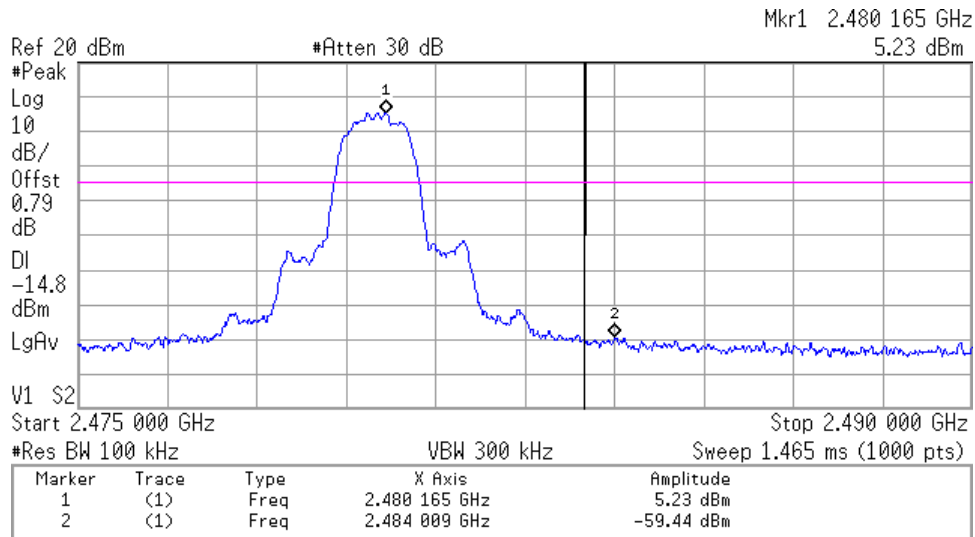
❖ HOPPING OFF:

▪ Low Frequency Section 2402 MHz:



Verdict: PASS

▪ High Frequency Section 2480 MHz:



Verdict: PASS

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

### SPECIFICATION:

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

| Frequency Range (MHz) | Field strength (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.

RSS-247. Attenuation below the general field strength limits specified in RSS-Gen is not required.

### RESULTS:

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

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

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

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

### Frequency range 30 MHz - 1 GHz:

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

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

| Spurious frequency (MHz) | Detector   | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|------------|-------------------------|--------------|------------------------------|
| 31.374                   | Quasi peak | 28.6                    | V            | <± 2.07                      |
| 375.013                  | Quasi peak | 32.9                    | H            | <± 2.07                      |
| 542.888                  | Quasi peak | 26.9                    | V            | <± 2.07                      |
| 562.514                  | Quasi peak | 33.8                    | H            | <± 2.07                      |
| 750.015                  | Quasi peak | 32.1                    | H            | <± 2.07                      |
| 937.516                  | Quasi peak | 31.7                    | H            | <± 2.07                      |

### Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequencies 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.

#### • GFSK modulation (DH5)

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 1.39657                  | Peak     | 48.86                   | H            | <± 3.04                      |
| 2.37621                  | Peak     | 51.91                   | V            | <± 3.04                      |

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 1.39880                  | Peak     | 48.94                   | H            | <± 3.04                      |

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 1.39807                  | Peak     | 49.34                   | H            | <± 3.04                      |
| 2.48442                  | Peak     | 53.01                   | V            | <± 3.04                      |

Verdict: PASS

- **Pi/4-DQPSK modulation (2-DH5)**

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 1.39687                  | Peak     | 48.75                   | H            | <± 3.04                      |
| 2.31211                  | Peak     | 52.08                   | V            | <± 3.04                      |
| 2.35615                  | Peak     | 51.83                   | H            | <± 3.04                      |
| 6.00000                  | Peak     | 40.15                   | V            | <± 4.88                      |

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 1.40007                  | Peak     | 49.36                   | H            | <± 3.04                      |

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 1.39713                  | Peak     | 48.48                   | H            | <± 3.04                      |
| 2.49423                  | Peak     | 52.45                   | V            | <± 3.04                      |

Verdict: PASS

- **8-DPSK modulation (3DH5)**

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

| Spurious frequency (GHz) | Detector | Emission Level (dB $\mu$ V/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------------|--------------|------------------------------|
| 1.39960                  | Peak     | 49.22                         | H            | < $\pm$ 3.04                 |
| 2.34564                  | Peak     | 52.07                         | H            | < $\pm$ 3.04                 |

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

| Spurious frequency (GHz) | Detector | Emission Level (dB $\mu$ V/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------------|--------------|------------------------------|
| 1.39533                  | Peak     | 48.65                         | H            | < $\pm$ 3.04                 |

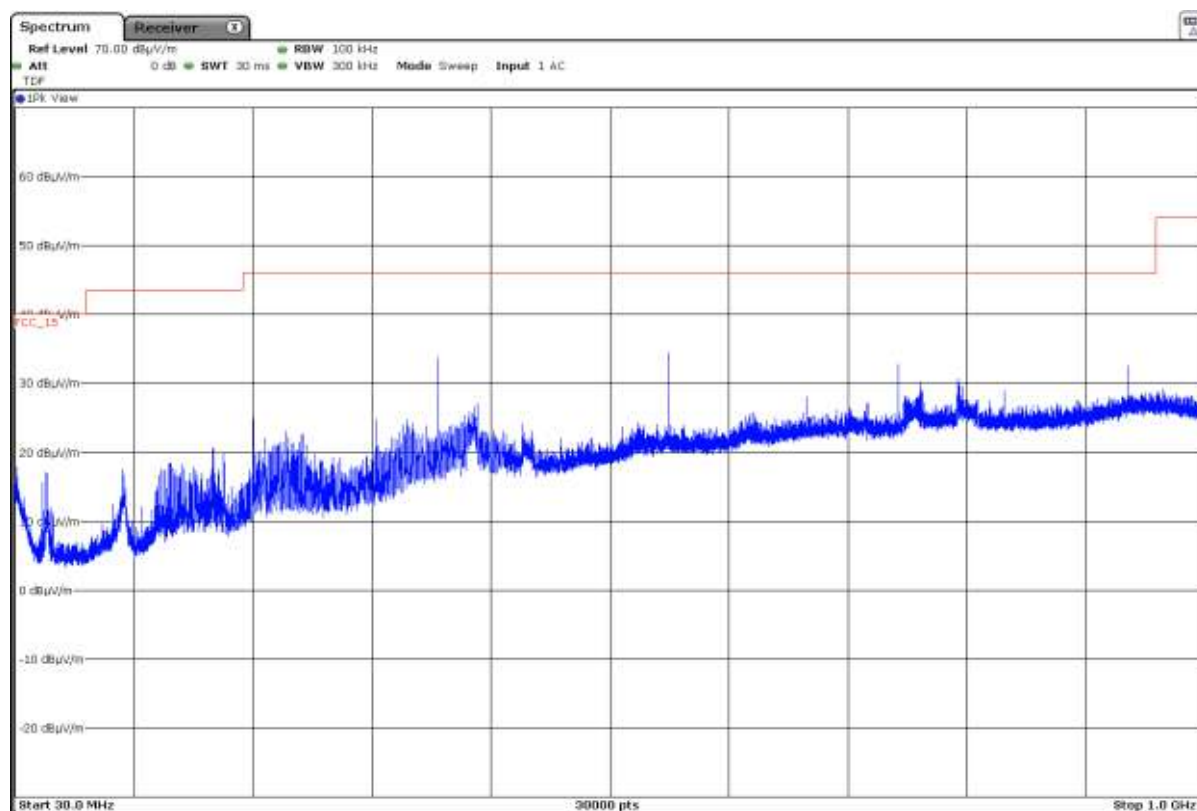
- High Channel (2480 MHz). Spurious frequencies detected at less than 20 dB below the limit:

| Spurious frequency (GHz) | Detector | Emission Level (dB $\mu$ V/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------------|--------------|------------------------------|
| 1.39834                  | Peak     | 48.88                         | H            | < $\pm$ 3.04                 |
| 2.49796                  | Peak     | 52.63                         | H            | < $\pm$ 3.04                 |

Verdict: PASS

## FREQUENCY RANGE 30 MHz - 1 GHz:

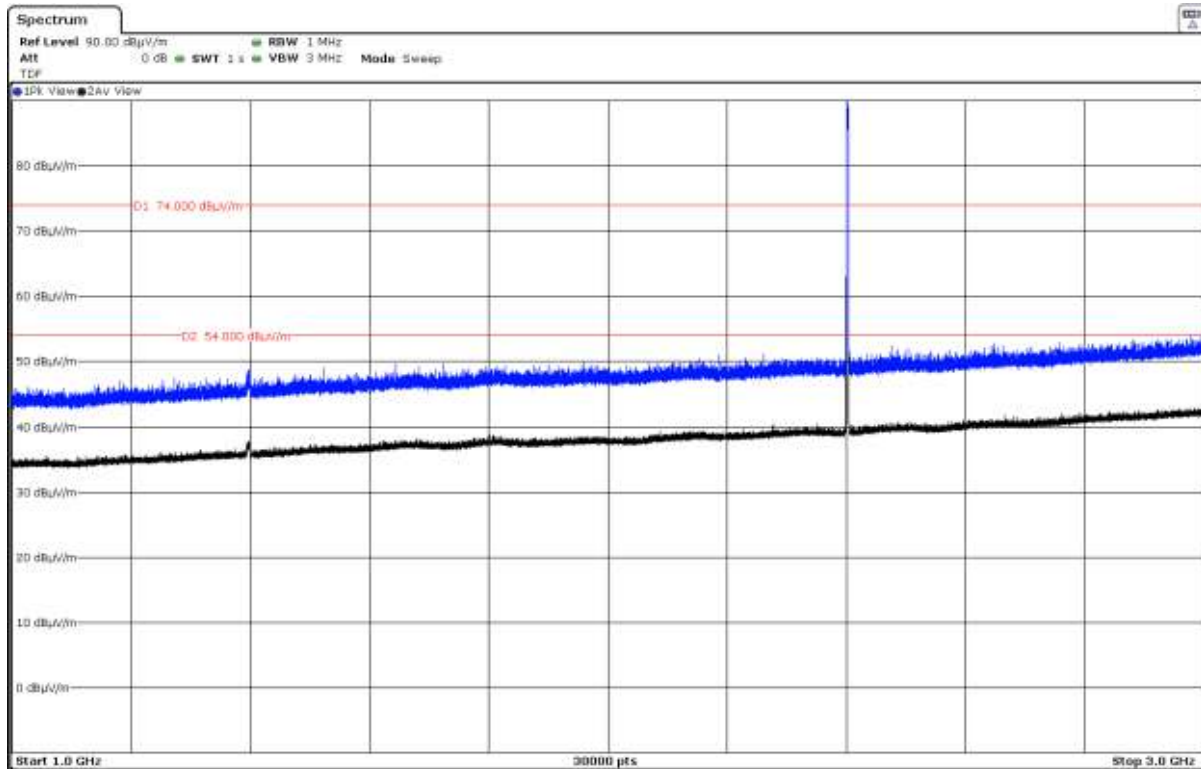
The spurious signals detected do not depend on either the operating channel or the modulation mode.



## FREQUENCY RANGE 1 - 3 GHz:

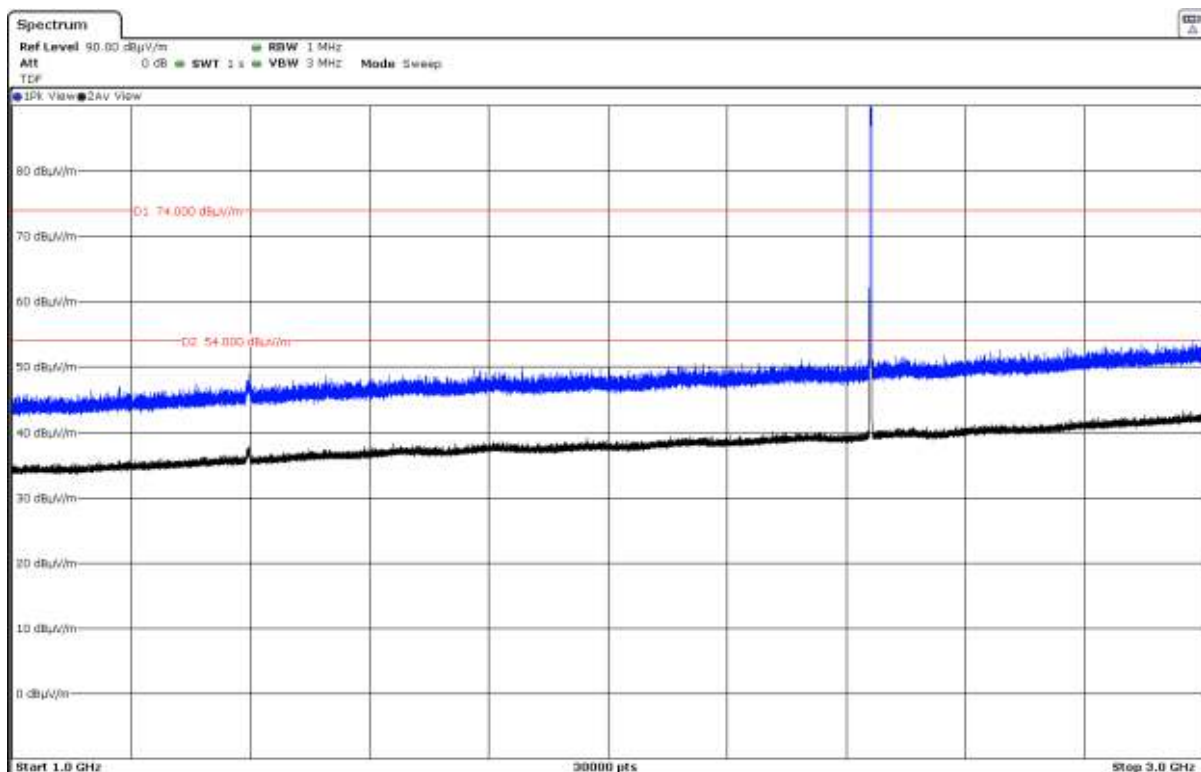
- **GFSK modulation (DH5)**

- Low Channel (2402 MHz):



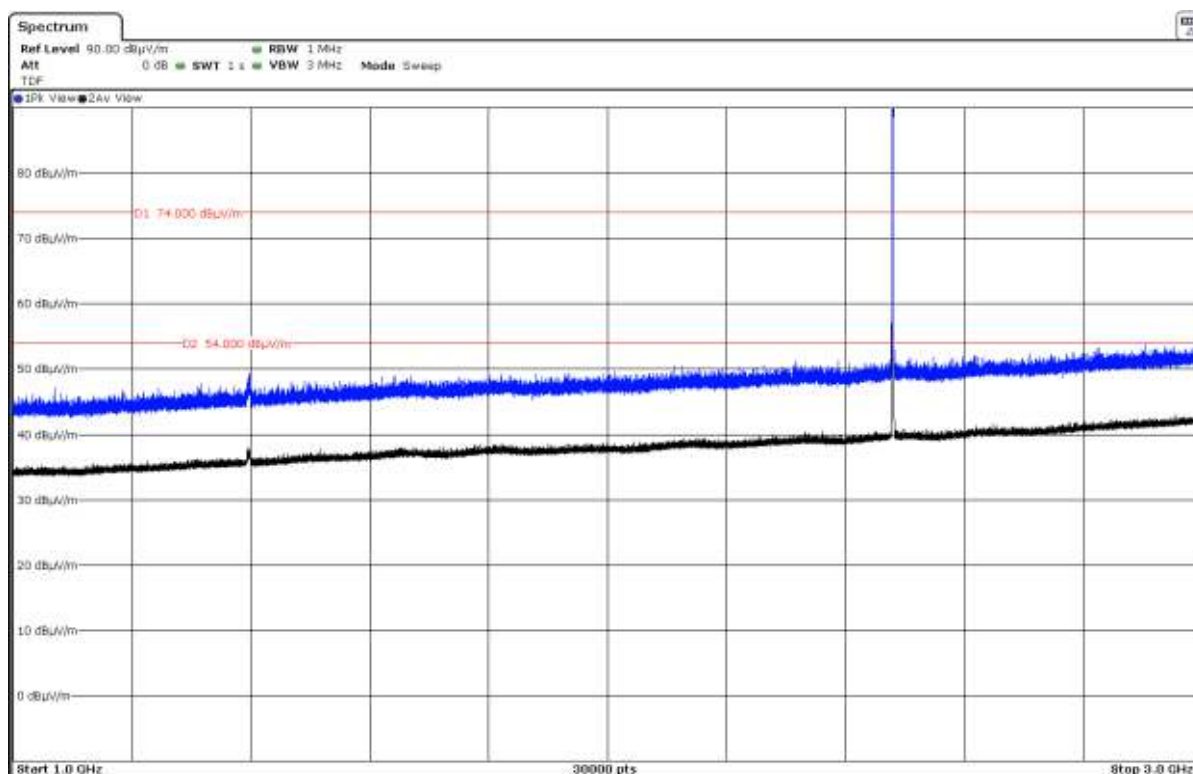
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

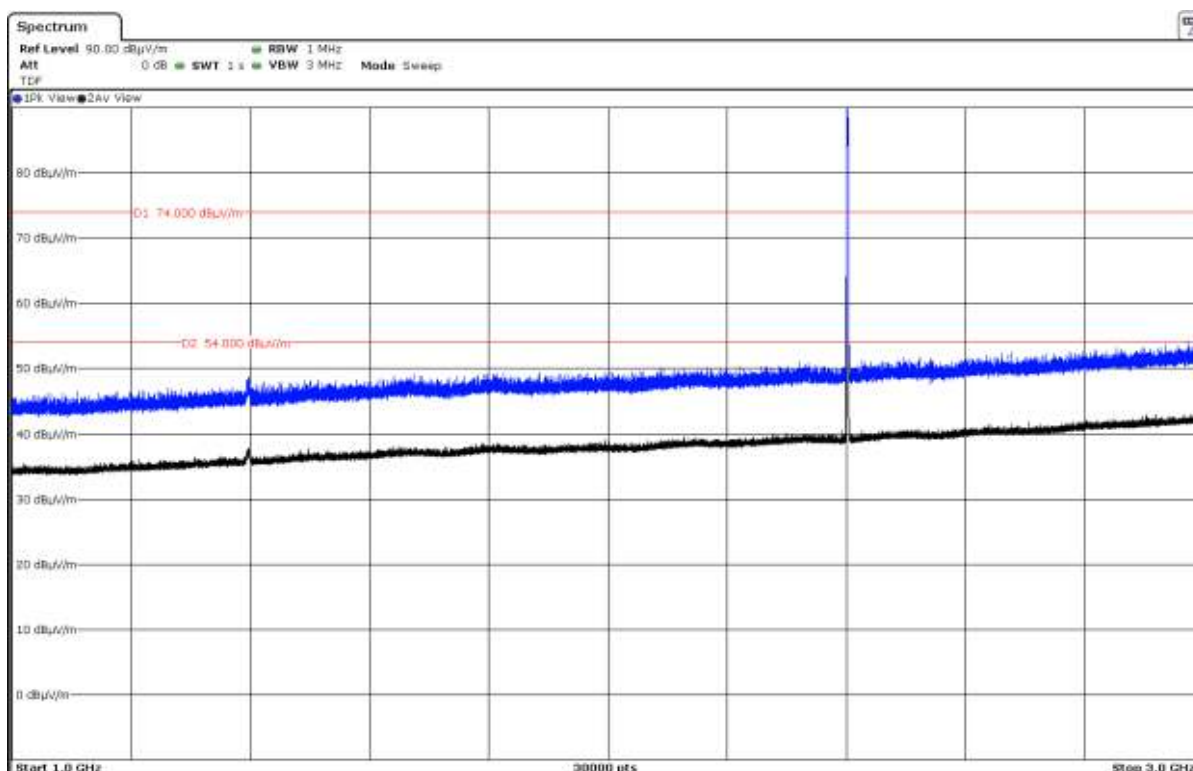
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

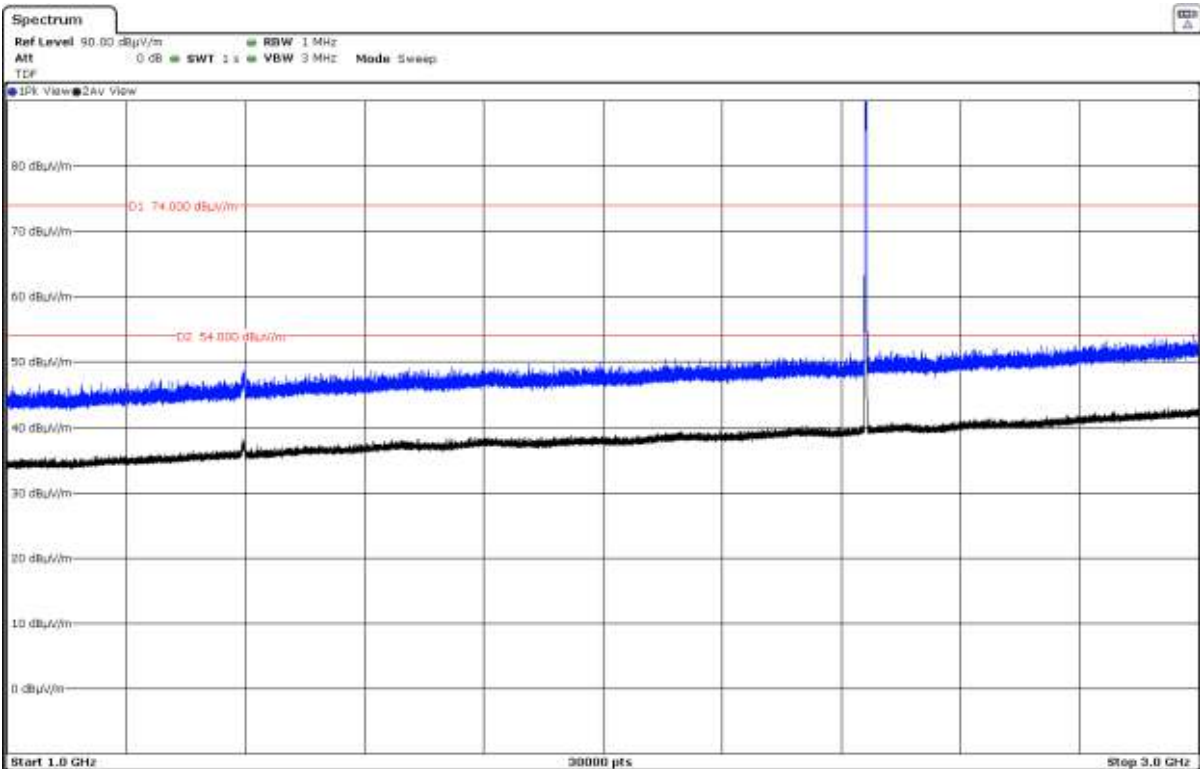
- **Pi/4-DQPSK modulation (2DH5)**

- Low Channel (2402 MHz):



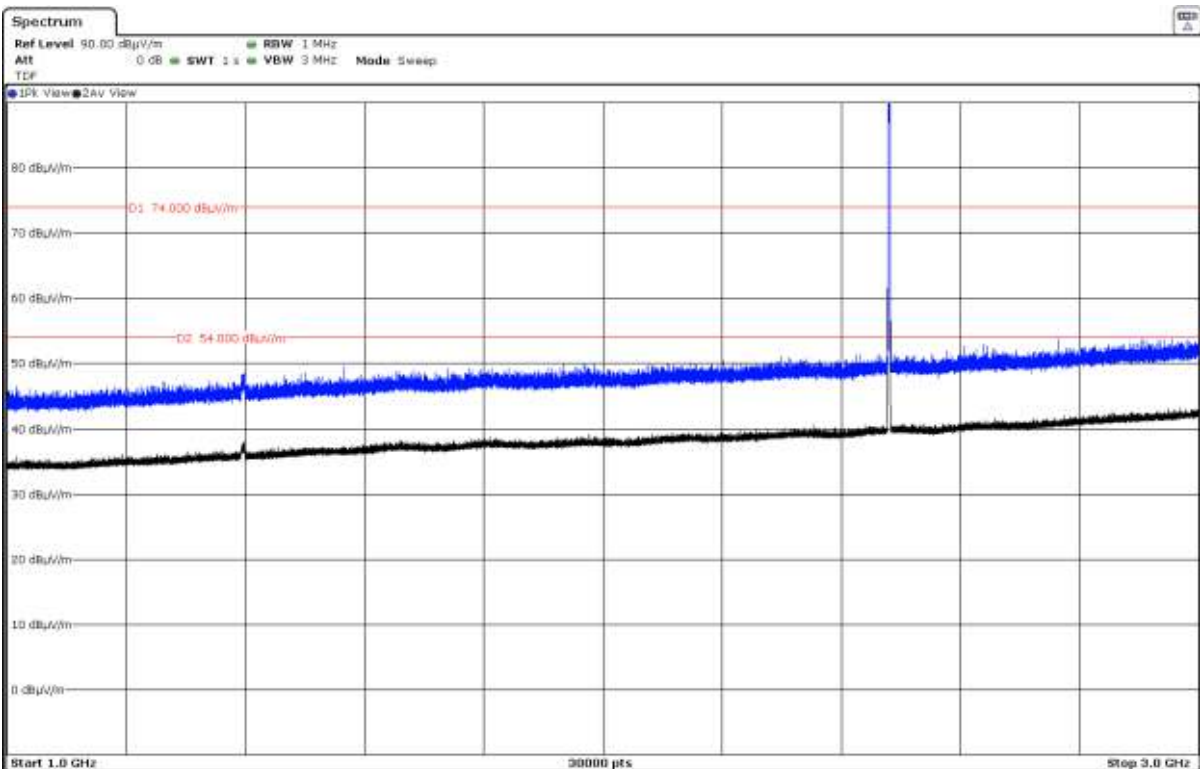
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

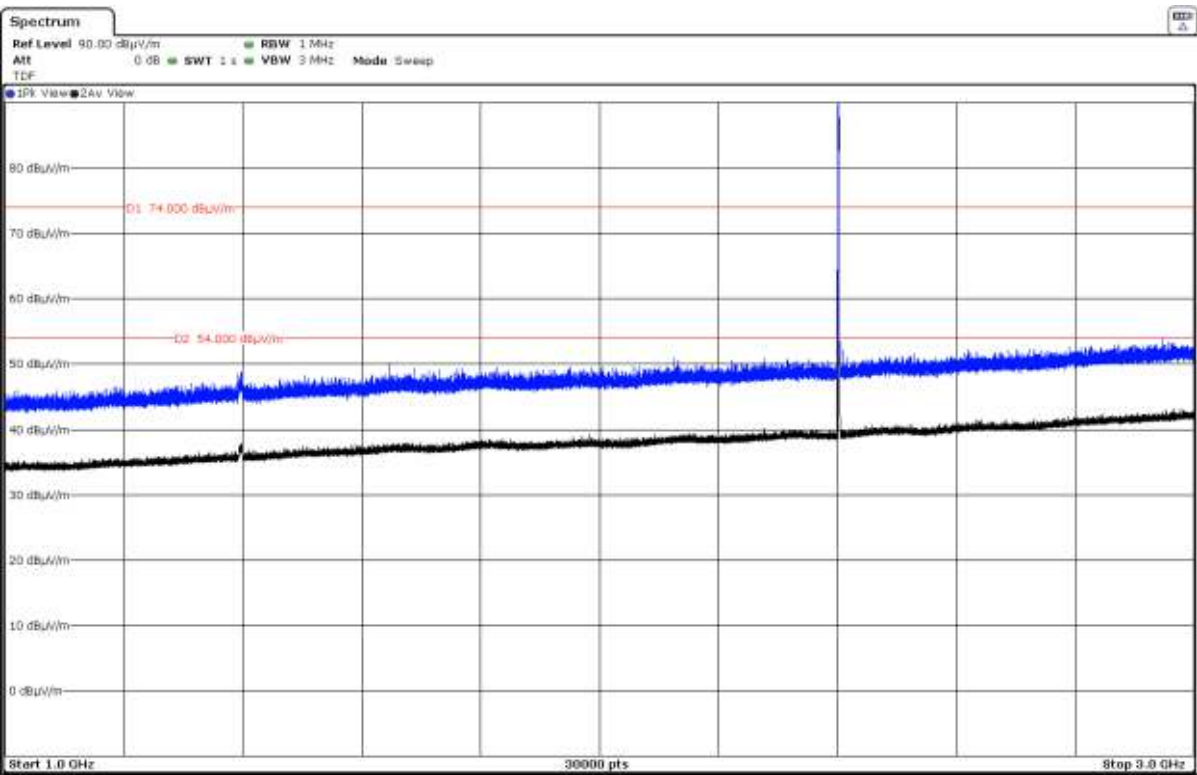
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

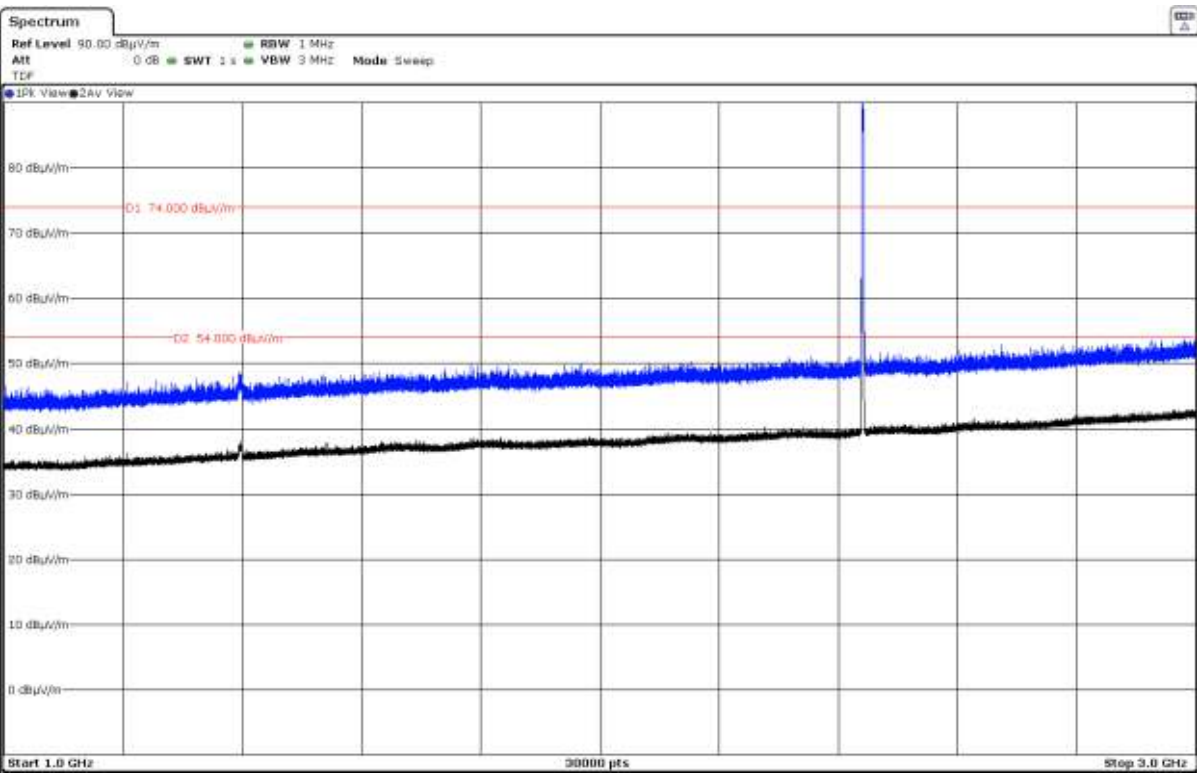
- 8-DPSK modulation (3DH5)

- Low Channel (2402 MHz):



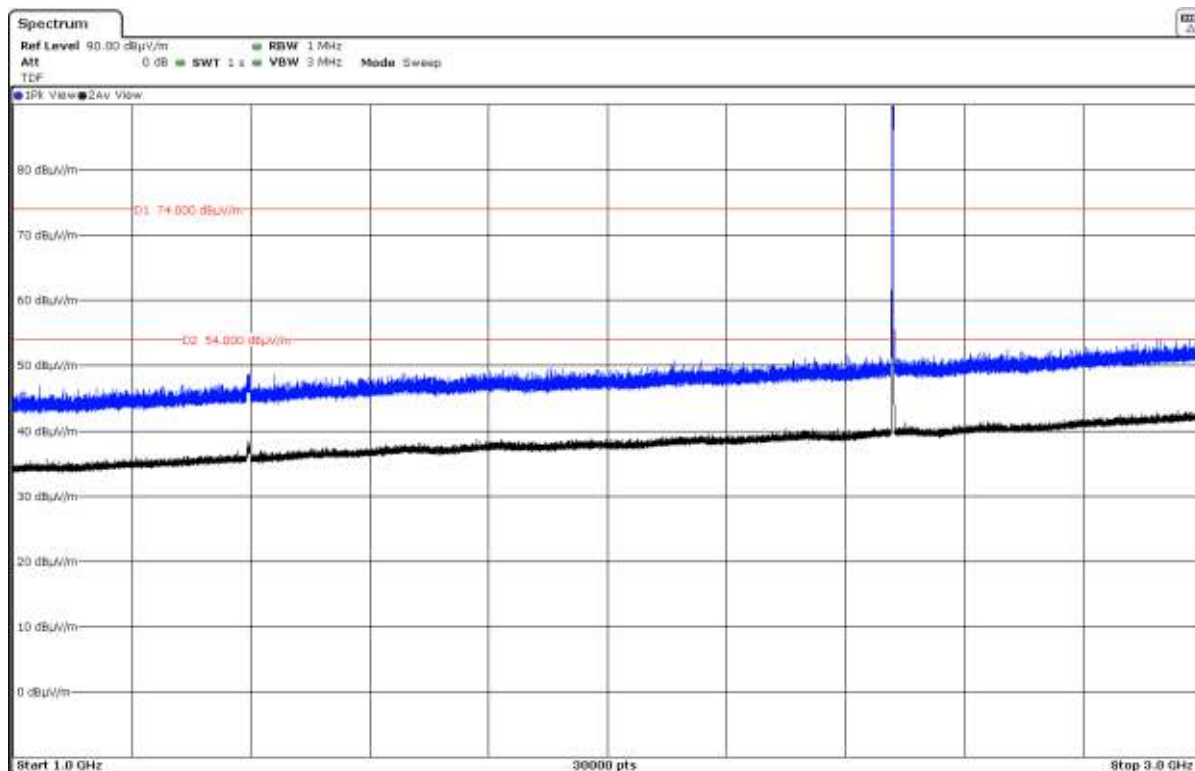
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

- High Channel (2480 MHz):

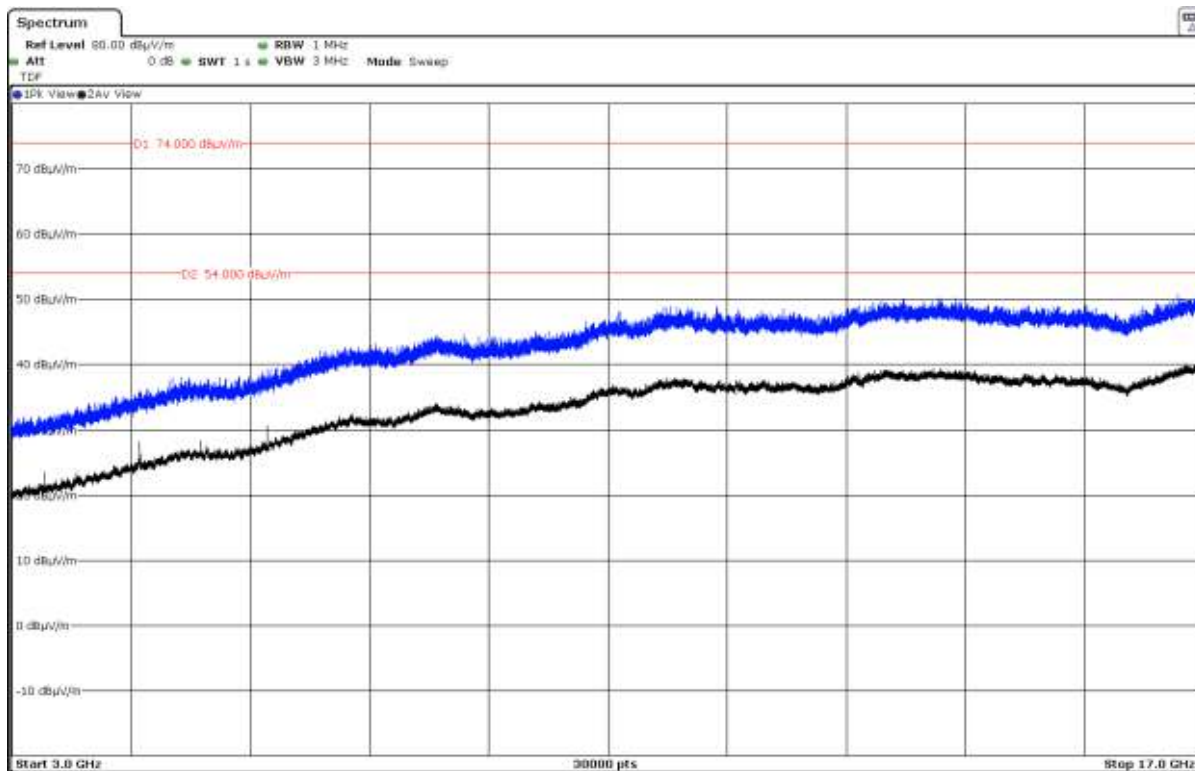


The peak above the limit is the carrier frequency.

## FREQUENCY RANGE 3 - 17 GHz:

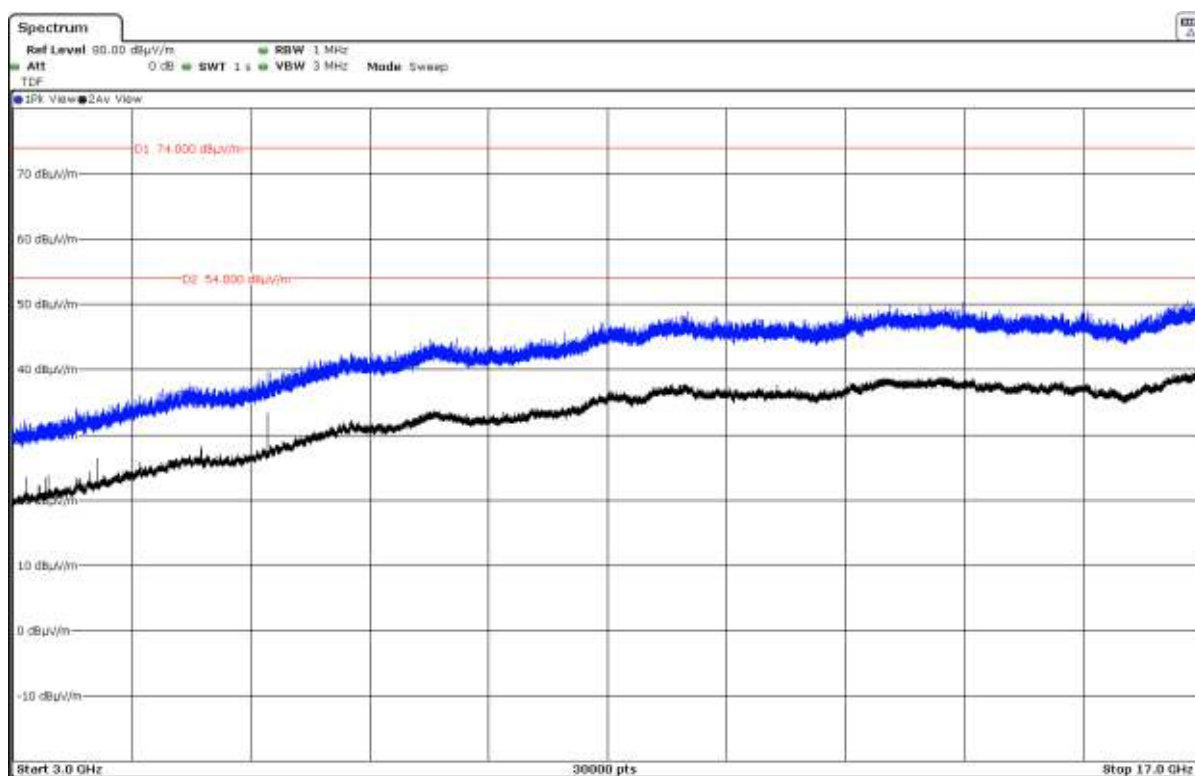
- **GFSK modulation (DH5)**

- Low Channel (2402 MHz):



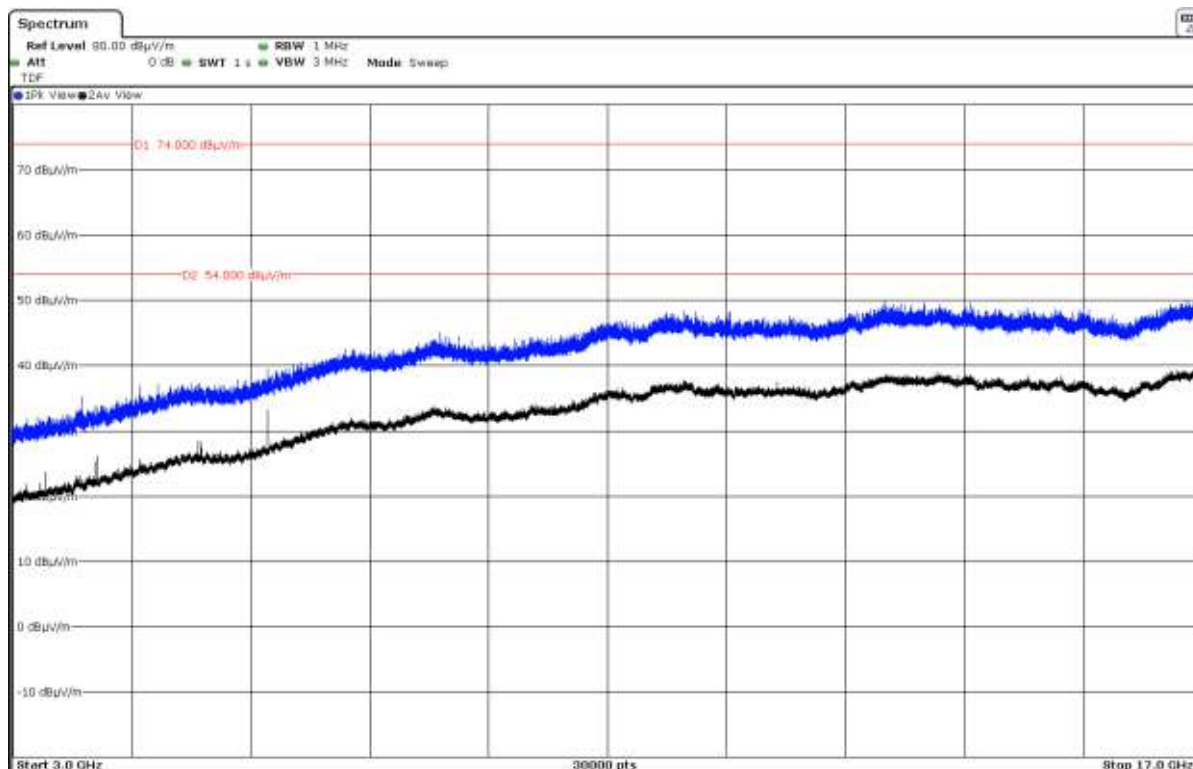
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

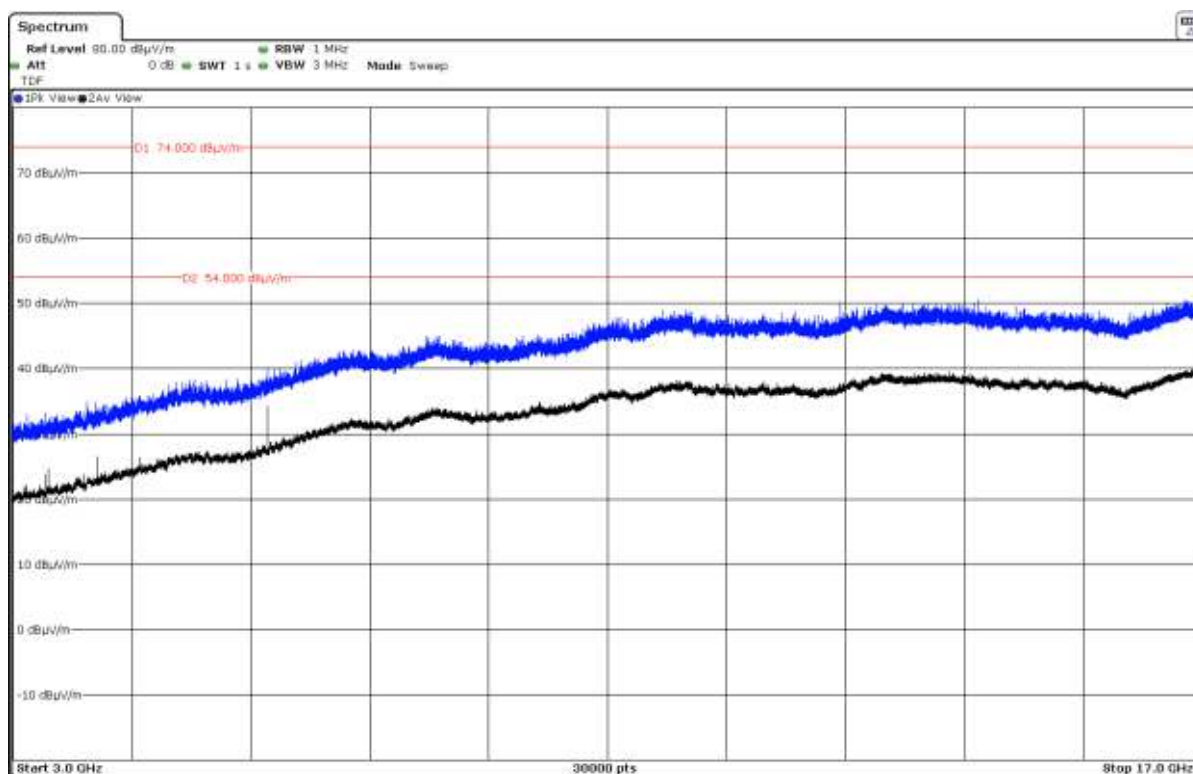
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

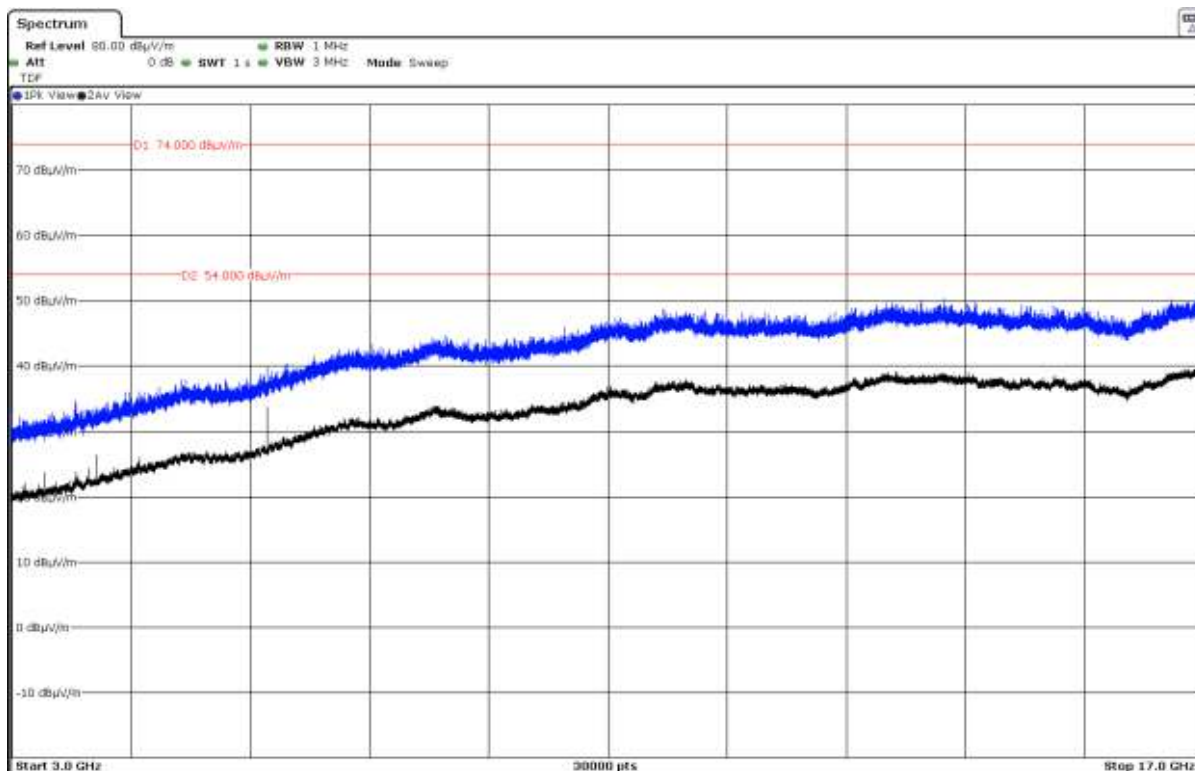
- **Pi/4-DQPSK modulation (2DH5)**

- Low Channel (2402 MHz):



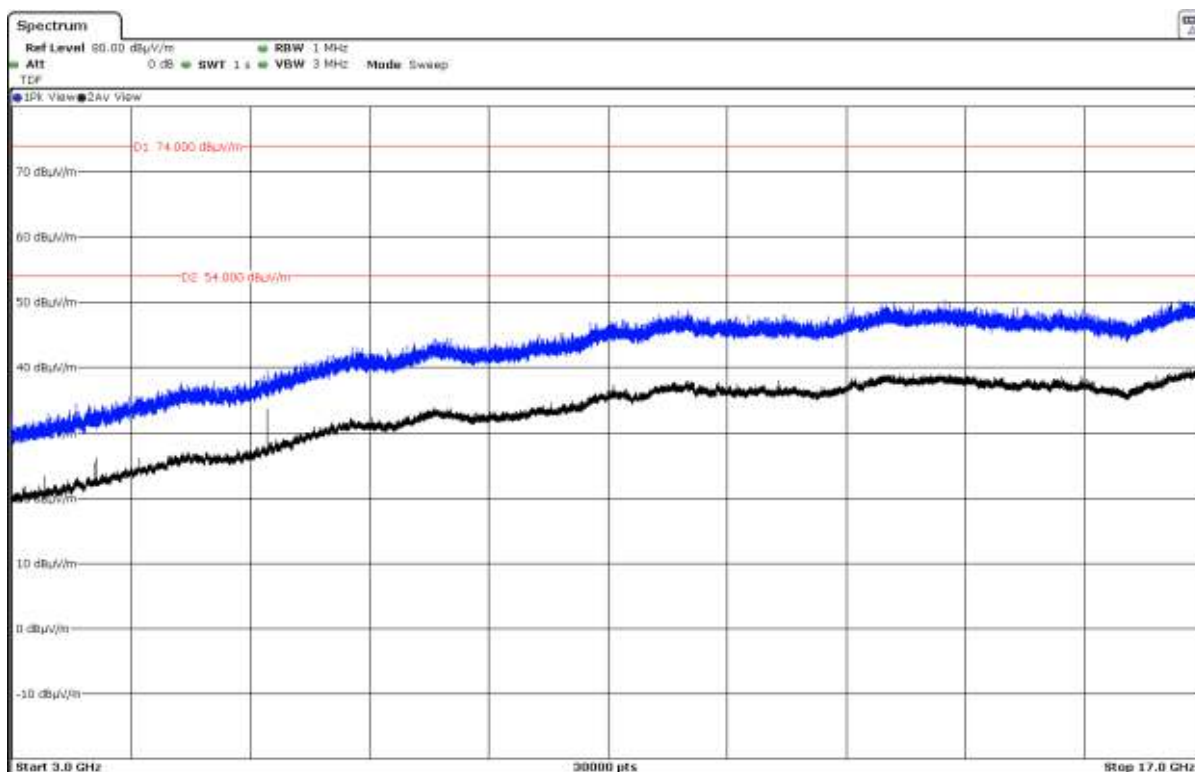
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

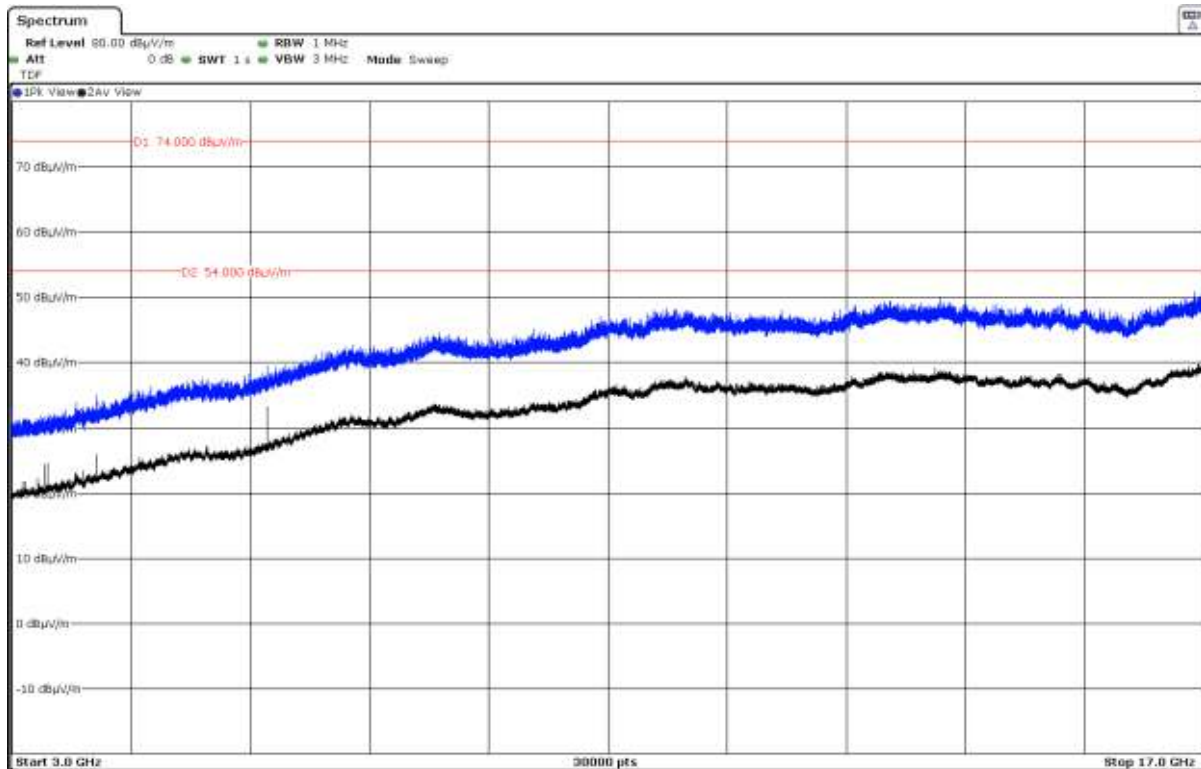
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

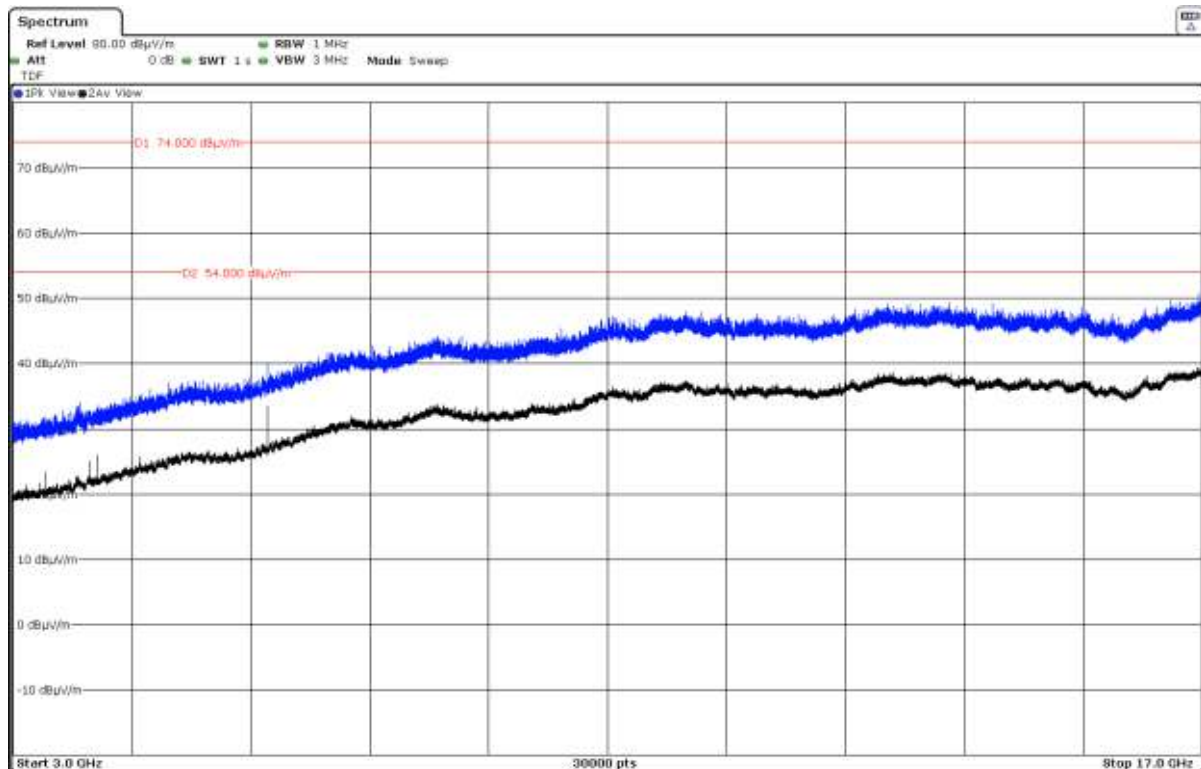
- **8-DPSK modulation (3DH5)**

- Low Channel (2402 MHz):



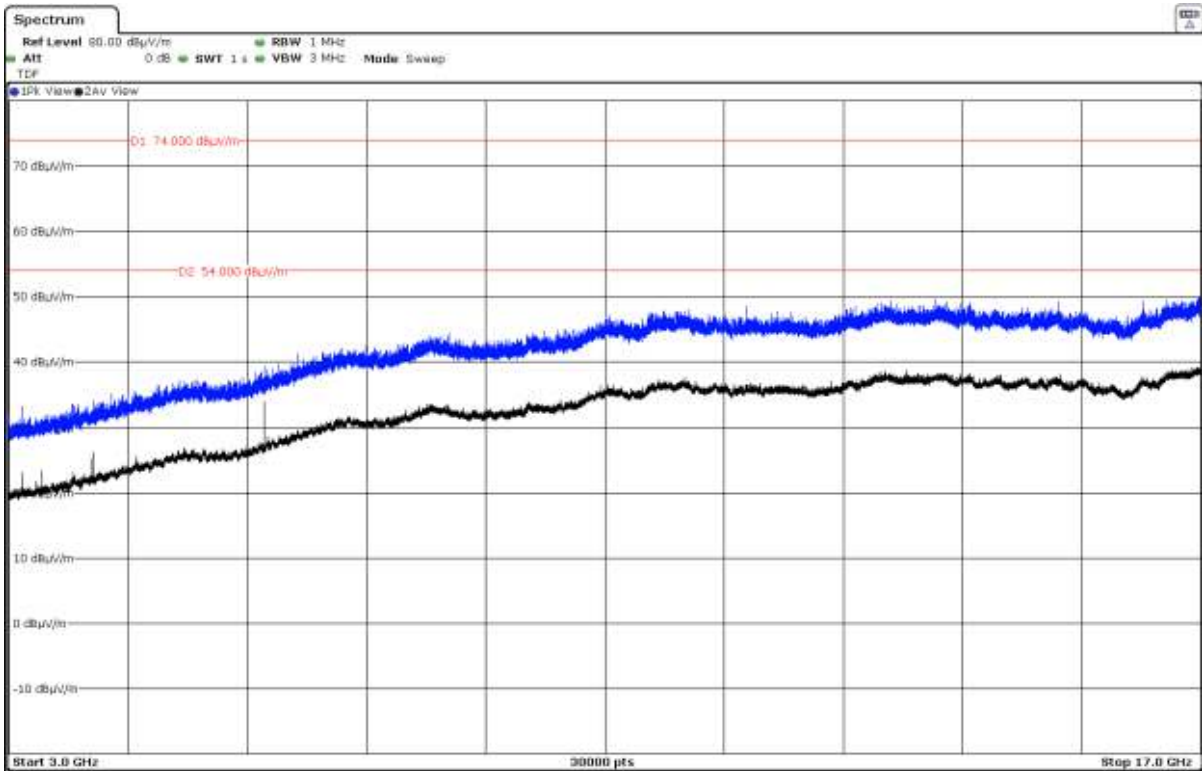
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

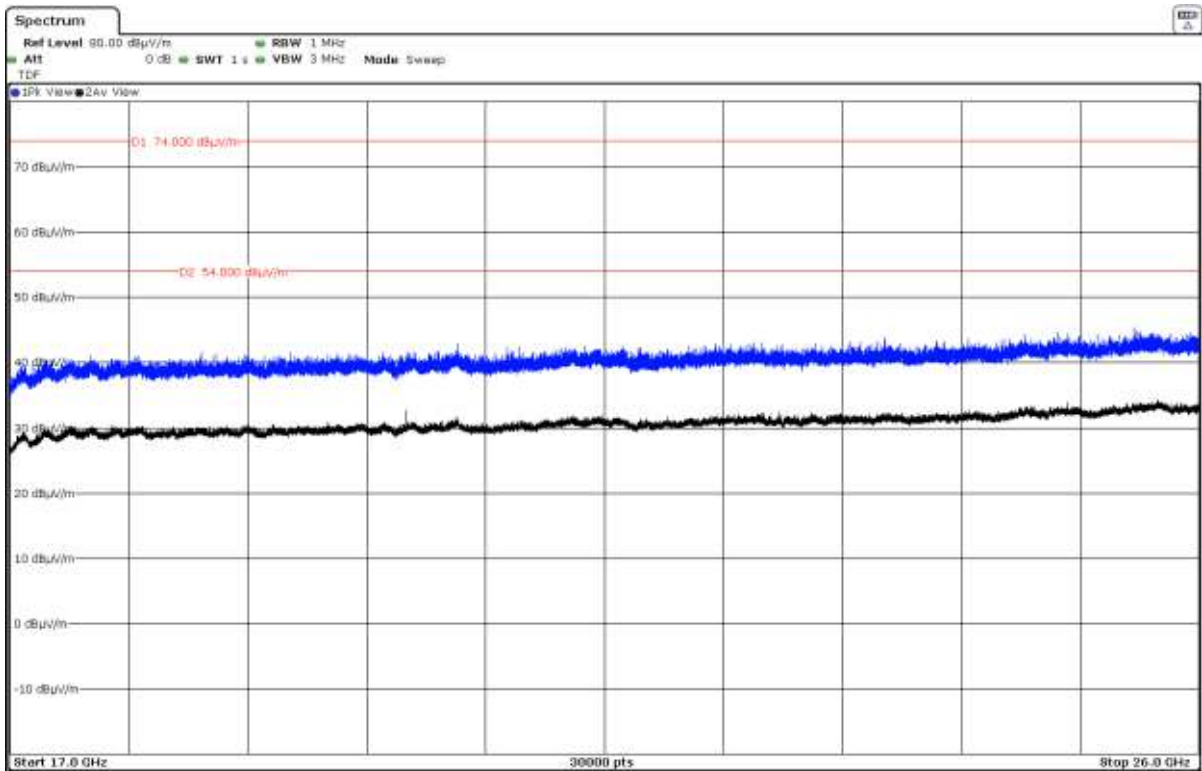
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

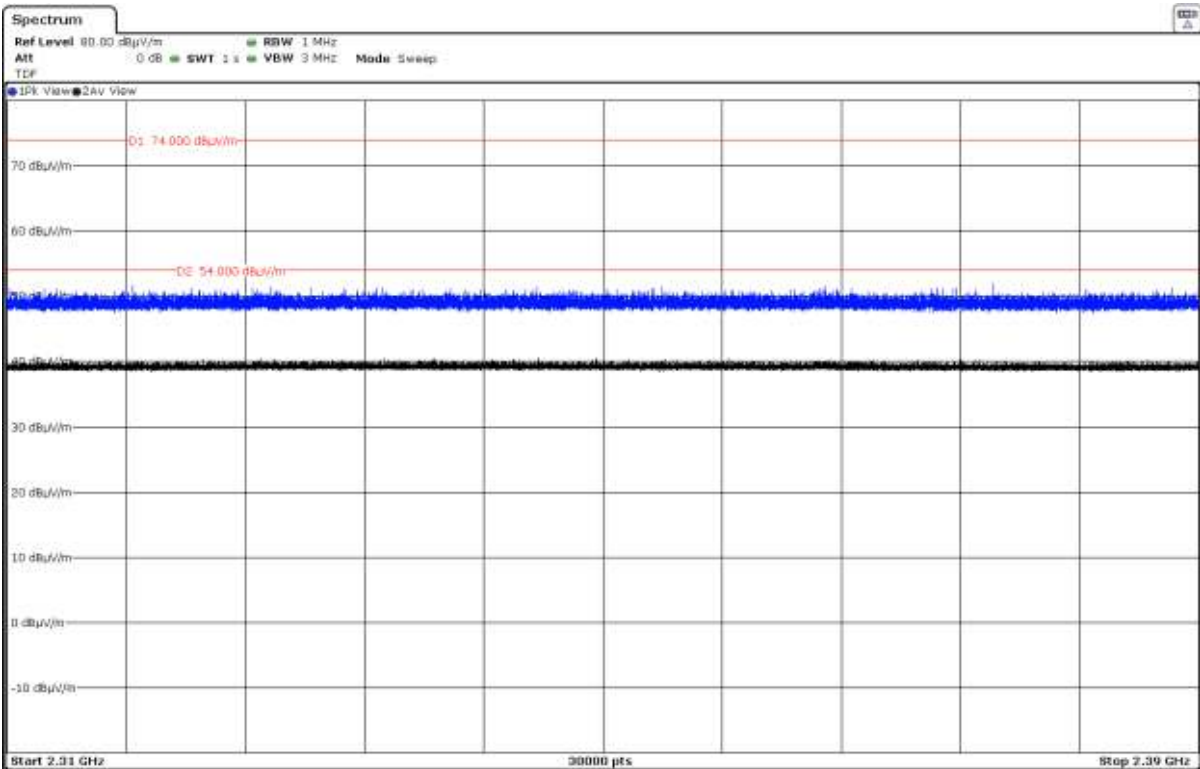
**FREQUENCY RANGE 17 - 26 GHz:**

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

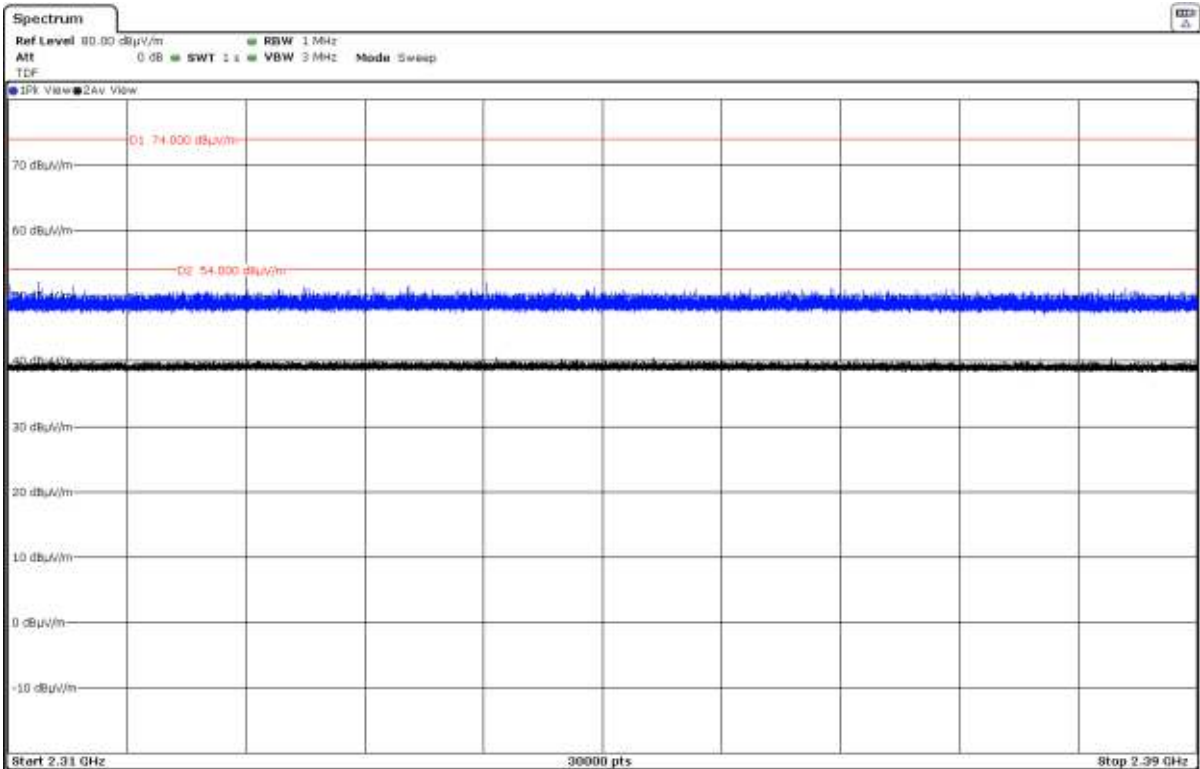


**FREQUENCY RANGE 2.31-2.39 GHz (Restricted Band):**

- **GFSK modulation (DH5)**
  - Low Channel (2402 MHz):

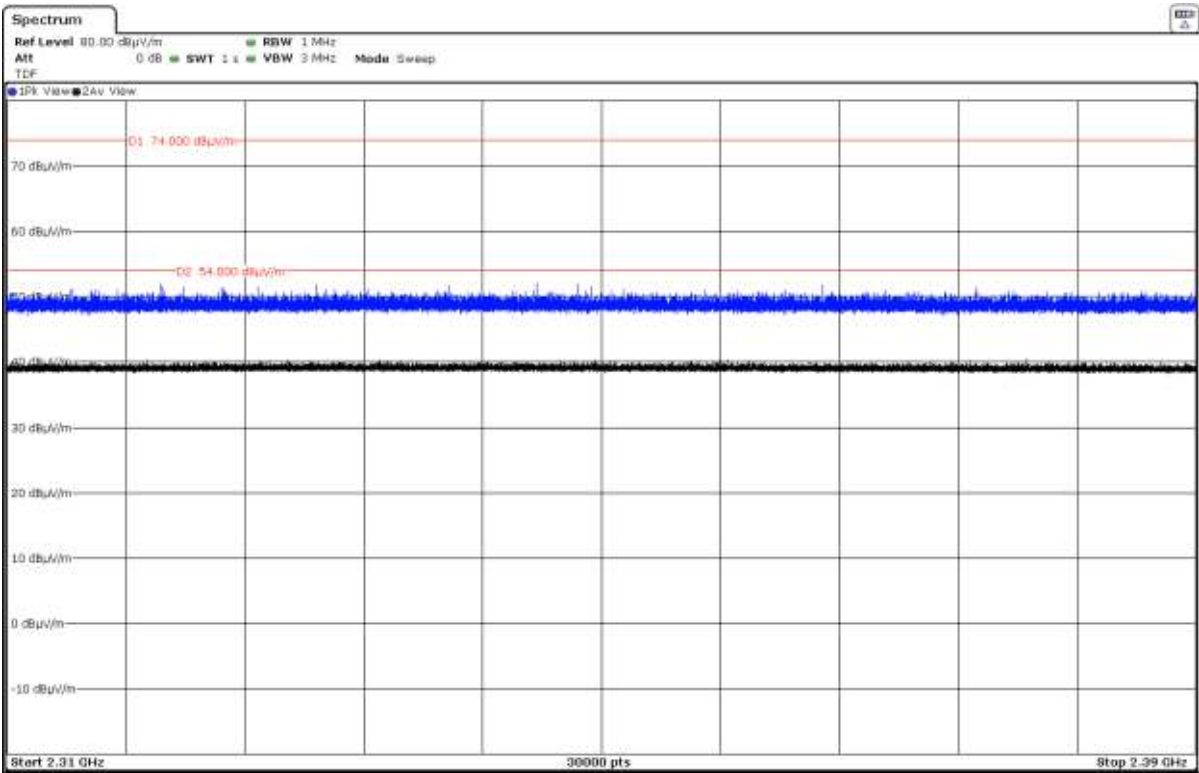


- **Pi/4-DQPSK modulation (2DH5)**
  - Low Channel (2402 MHz):



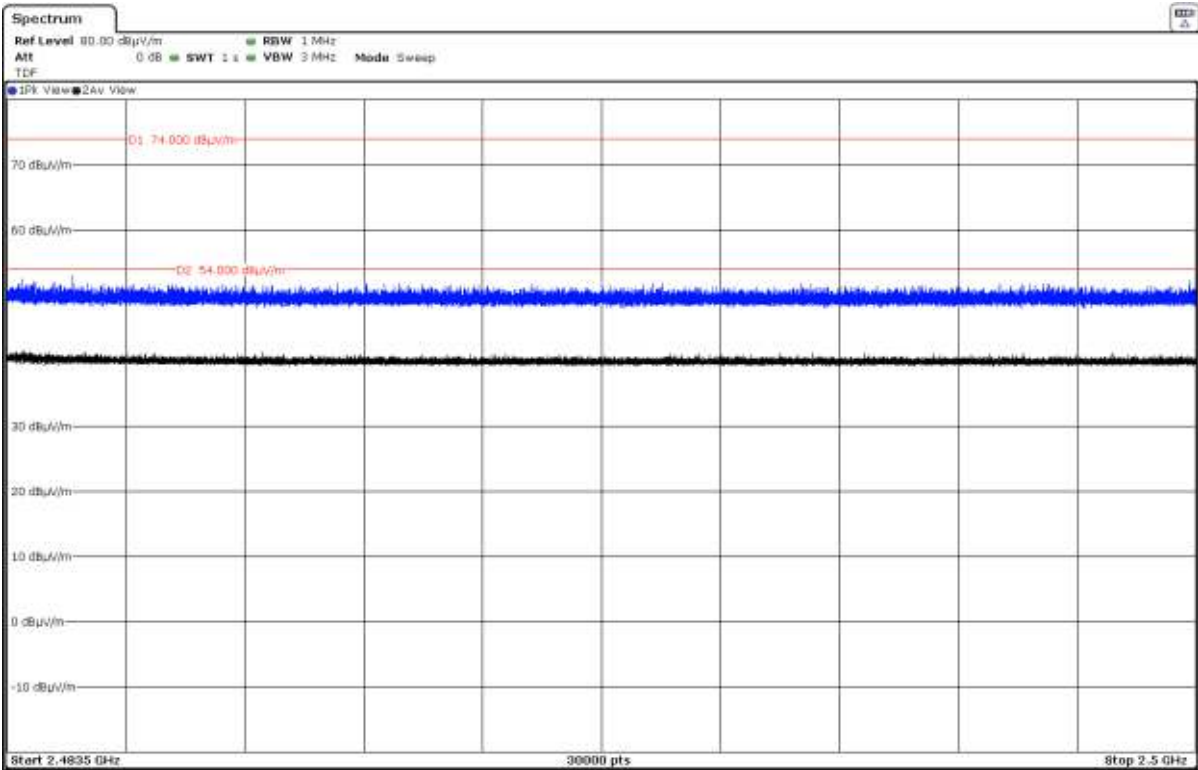
• 8-DPSK modulation (3DH5)

- Low Channel (2402 MHz):

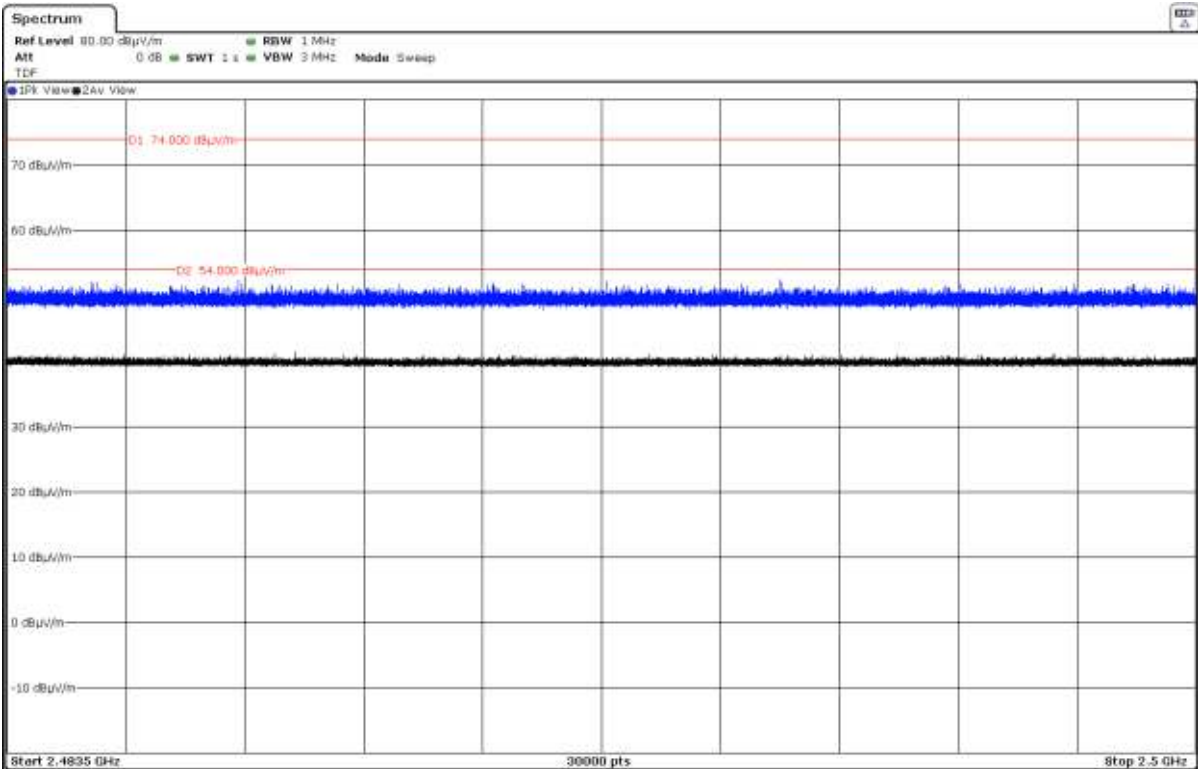


**FREQUENCY RANGE 2.4835-2.5 GHz (Restricted Band):**

- **GFSK modulation (DH5)**
  - High Channel (2480 MHz):

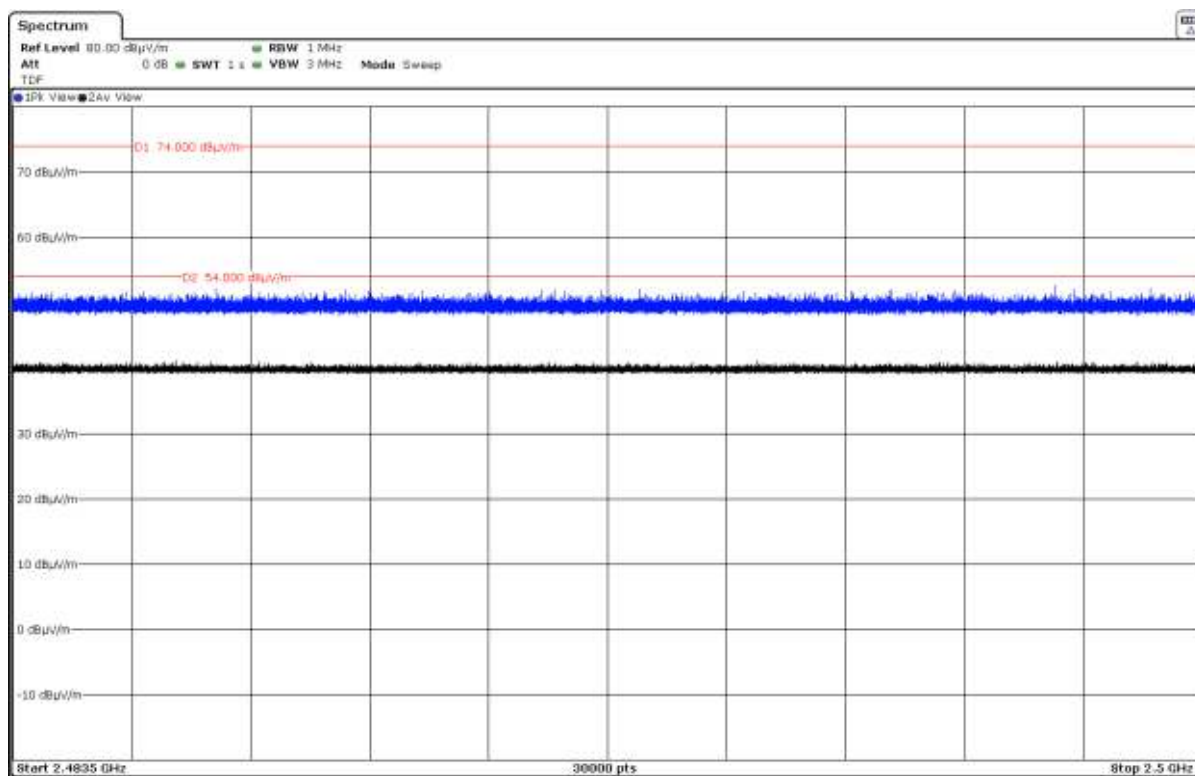


- **Pi/4-DQPSK modulation (2DH5)**
  - High Channel (2480 MHz):



- **8-DPSK modulation (3DH5)**

- High Channel (2480 MHz):



## Appendix B: Test results. 802.11 bgn2040 1x1

INDEX

TEST CONDITIONS .....69

Occupied Bandwidth .....71

FCC Section 15.247 Subclause (a) (2) / RSS-247 Clause 5.2 (a) 6 dB Bandwidth.....78

FCC Section 15.247 Subclause (b) / RSS-247 Clause 5.4 (d) Maximum output power and antenna gain .....85

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Band-edge emissions compliance (Transmitter) .....87

FCC Section 15.247 Subclause (e) / RSS-247 Clause 5.2. (b) Power spectral density .....90

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations radiated (Transmitter) .....97

## TEST CONDITIONS

### POWER SUPPLY (V):

|                                |                                                  |
|--------------------------------|--------------------------------------------------|
| V nominal:                     | 12 Vdc.                                          |
| Type of Power Supply:          | External power supply (Car Battery).             |
| Type of Antenna:               | External antenna.                                |
| Maximum Declared Antenna Gain: | -6.2 dBi (Antenna gain plus antenna cable loss). |

### TEST FREQUENCIES:

#### 802.11 bgn20:

|                 |          |
|-----------------|----------|
| Low Channel:    | 2412 MHz |
| Middle Channel: | 2437 MHz |
| High Channel:   | 2462 MHz |

#### 802.11 n40:

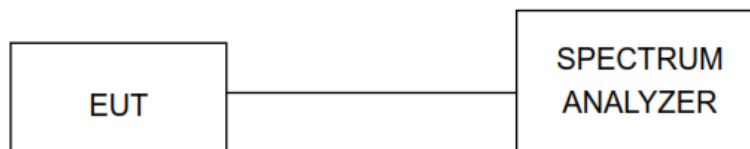
|                 |          |
|-----------------|----------|
| Low Channel:    | 2422 MHz |
| Middle Channel: | 2437 MHz |
| High Channel:   | 2452 MHz |

The lowest data rate for all modes supported were used.

| Mode | Data rate |
|------|-----------|
| b    | 1Mbps     |
| g    | 6Mbps     |
| n20  | MCS0      |
| n40  | MCS0      |

### CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



### RADIATED MEASUREMENTS

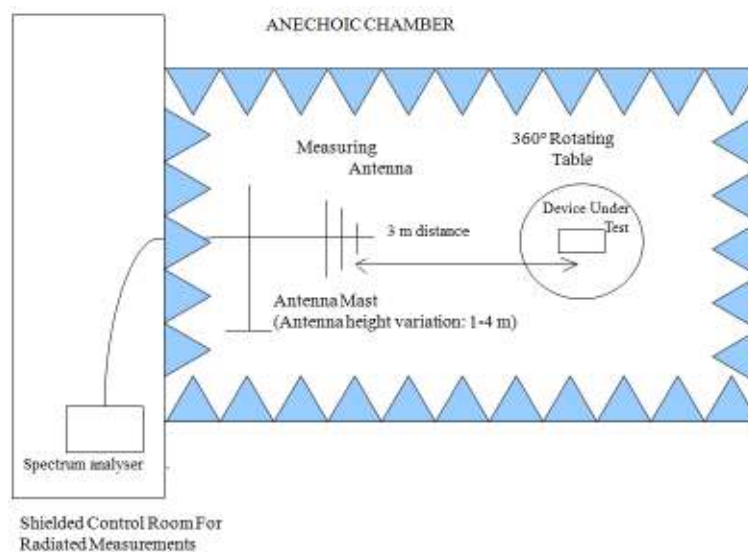
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) is situated at a distance of 3 m and at a distance of 1m for the frequency range 1 GHz-26 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-26 GHz horn antenna).

For radiated emissions in the range 1 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

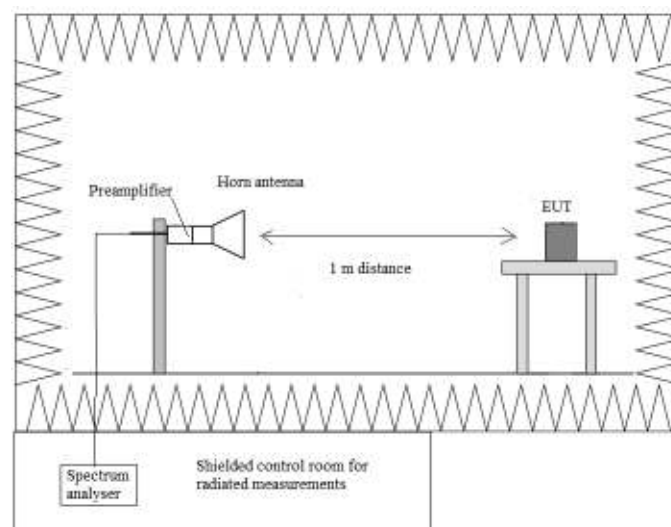
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup f > 1 GHz:



## Occupied Bandwidth

### RESULTS:

- Mode 802.11 b**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 11.448                  | 11.717                     | 11.424                   |
| -26 dBc bandwidth (MHz)       | 14.512                  | 15.095                     | 14.407                   |
| Measurement uncertainty (kHz) | <± 50                   |                            |                          |

- Mode 802.11 g**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 17.077                  | 17.027                     | 16.971                   |
| -26 dBc bandwidth (MHz)       | 22.670                  | 24.489                     | 21.734                   |
| Measurement uncertainty (kHz) | <± 83.33                |                            |                          |

- Mode 802.11 n20**

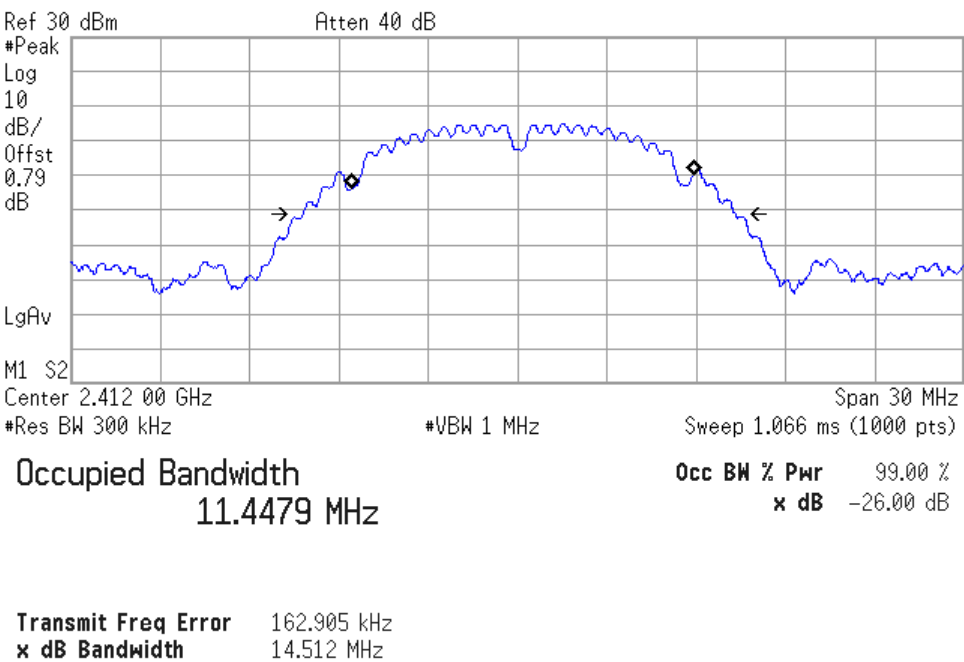
|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 18.076                  | 18.039                     | 18.000                   |
| -26 dBc bandwidth (MHz)       | 23.258                  | 22.234                     | 21.556                   |
| Measurement uncertainty (kHz) | <± 83.33                |                            |                          |

- Mode 802.11 n40**

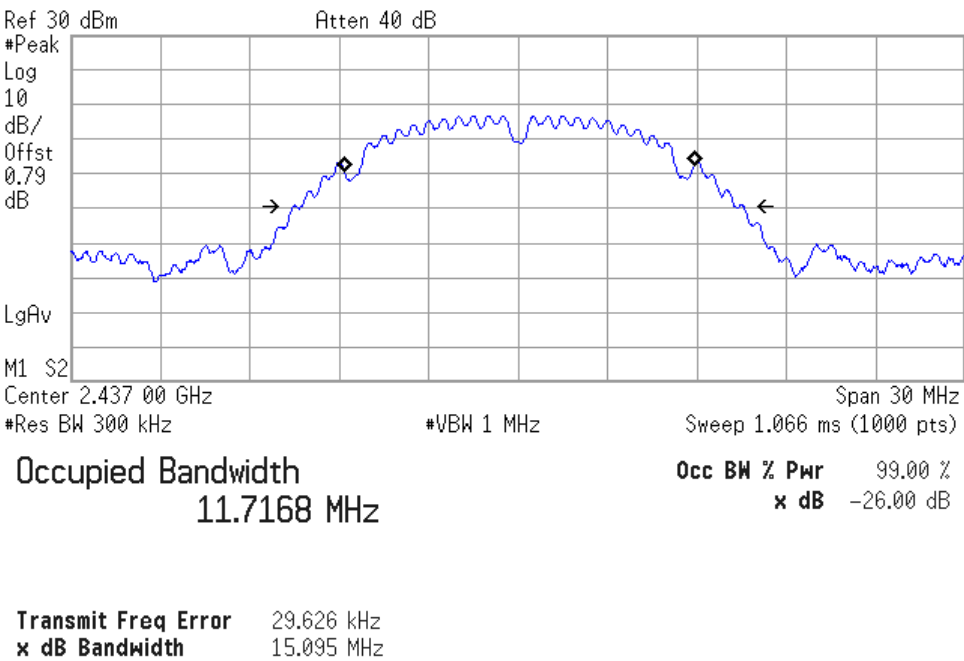
|                               | Low Channel<br>2422 MHz | Middle Channel<br>2437 MHz | High Channel<br>2452 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 36.400                  | 36.480                     | 36.480                   |
| -26 dBc bandwidth (MHz)       | 40.773                  | 40.953                     | 40.810                   |
| Measurement uncertainty (kHz) | <± 14.01                |                            |                          |

• Mode 802.11 b – Occupied Bandwidth

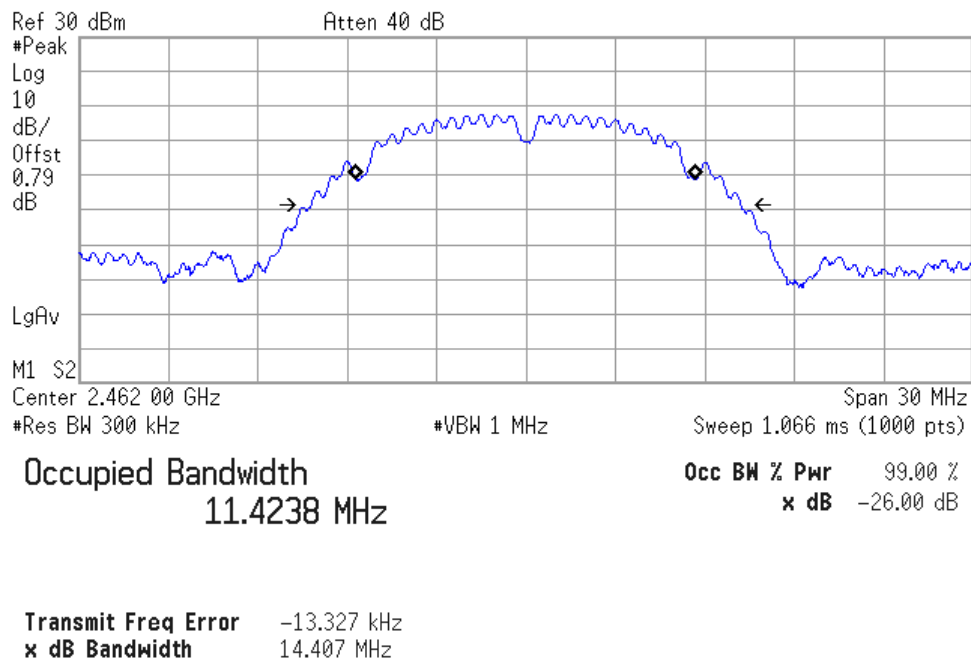
- Low Channel:



- Middle Channel:

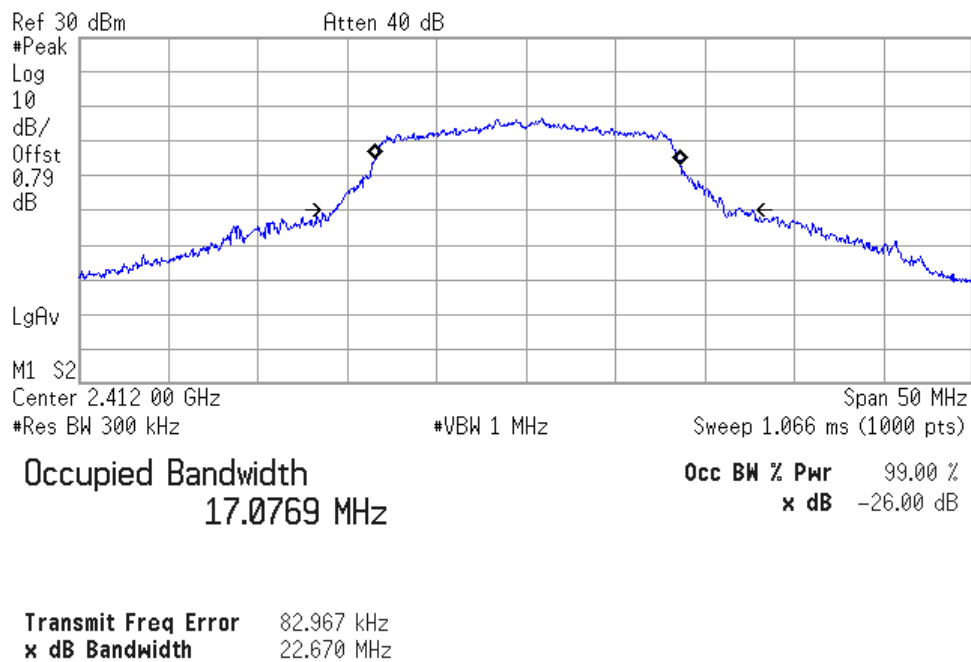


- High Channel:

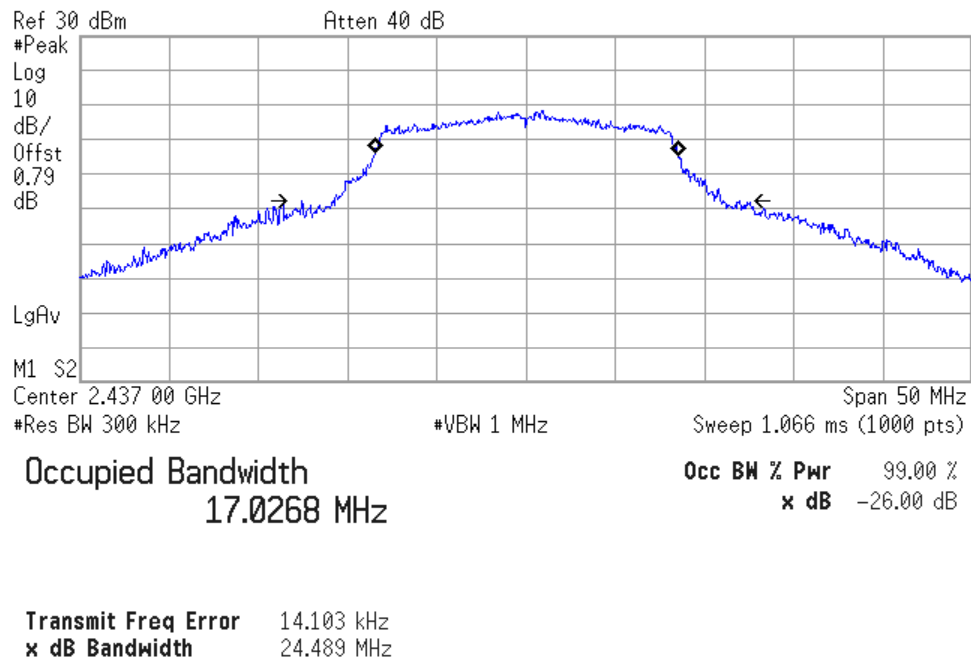


• Mode 802.11 g – Occupied Bandwidth

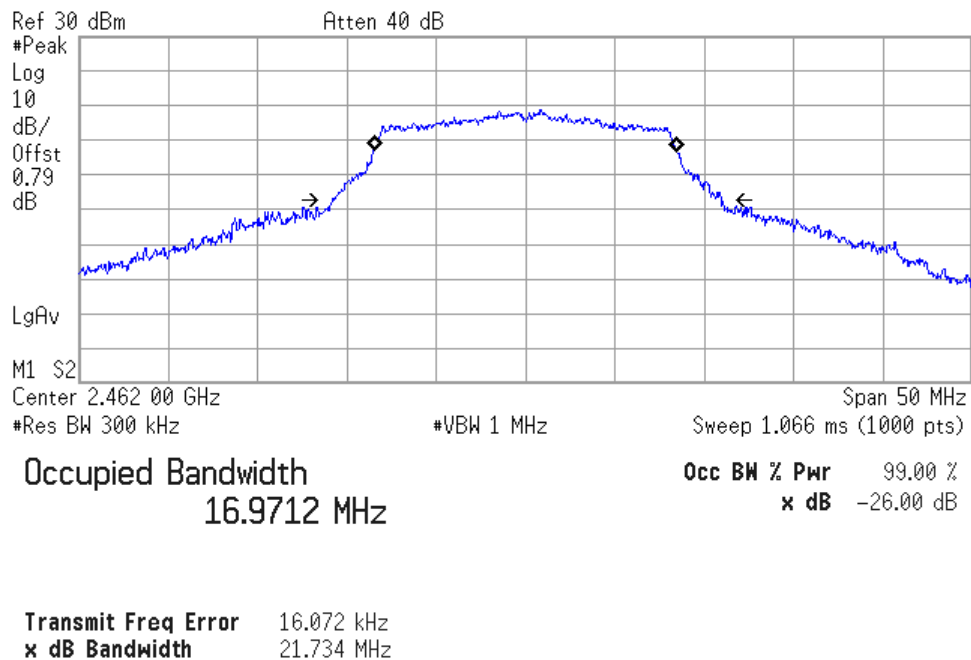
- Low Channel:



- Middle Channel:

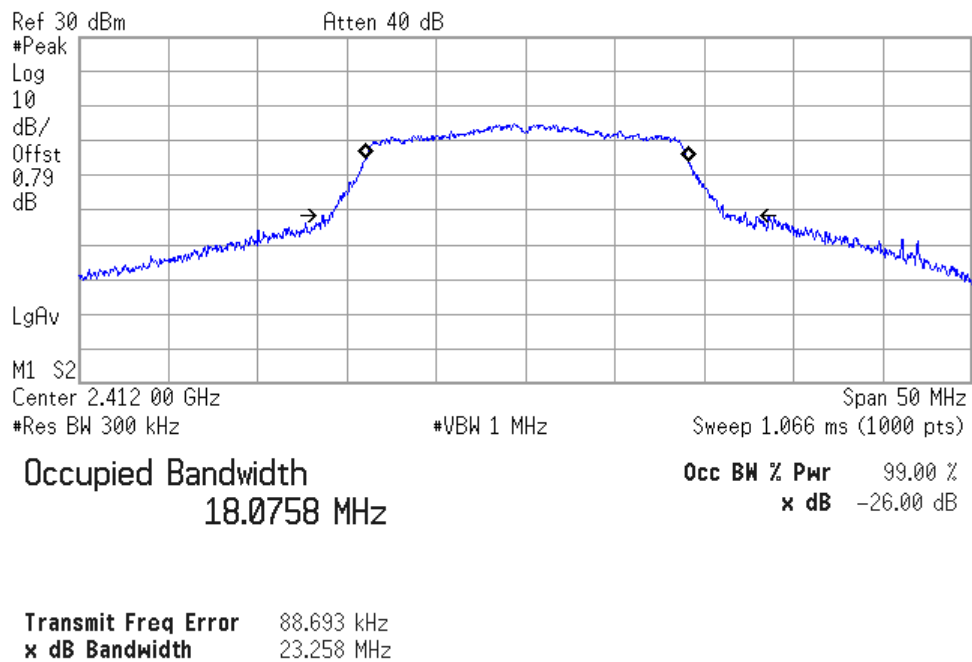


- High Channel:

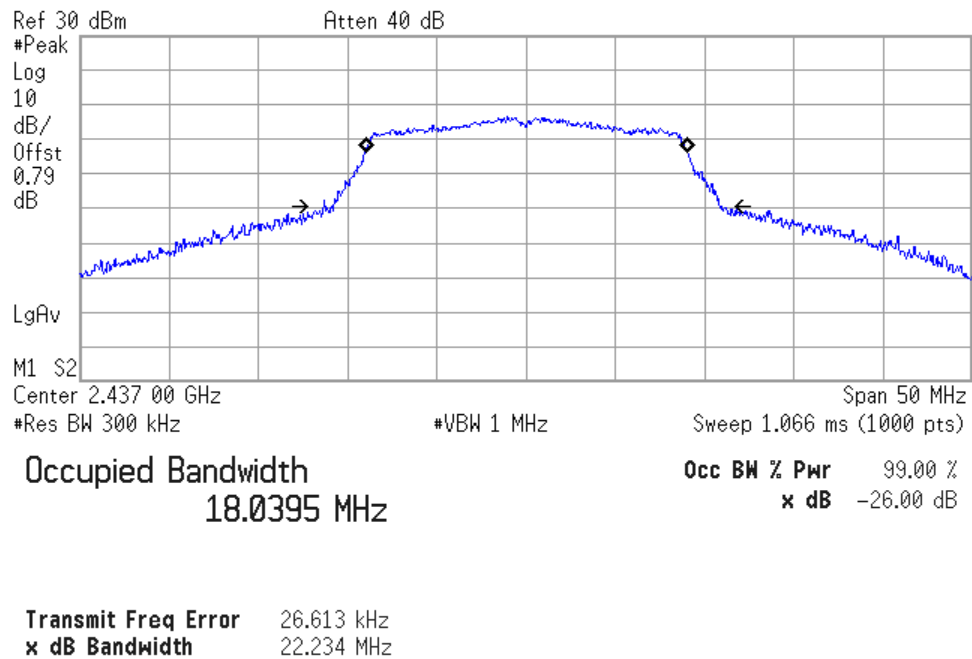


- Mode 802.11 n20 – Occupied Bandwidth

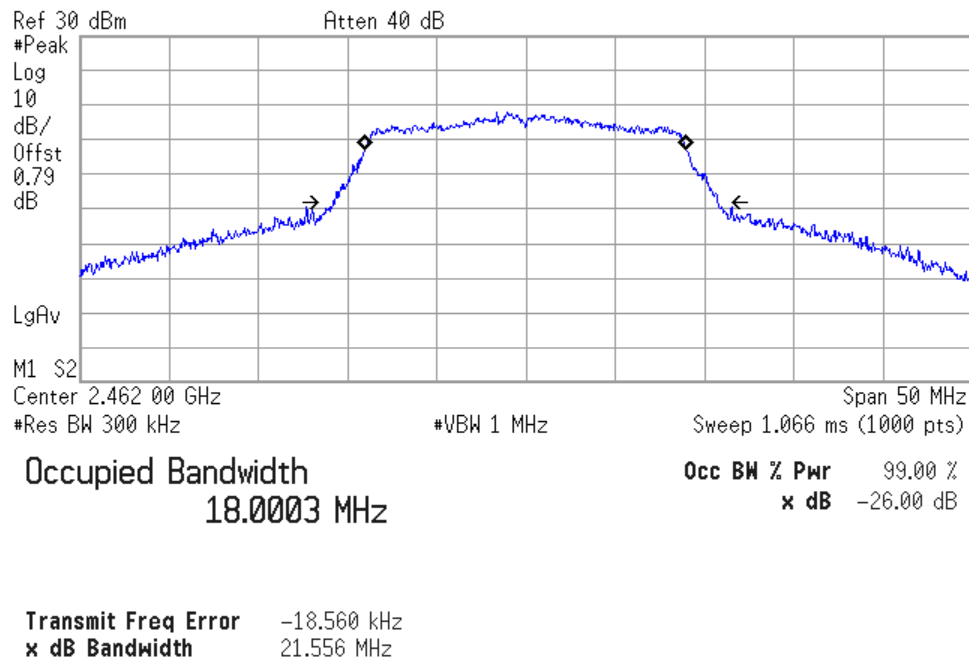
- Low Channel:



- Middle Channel:

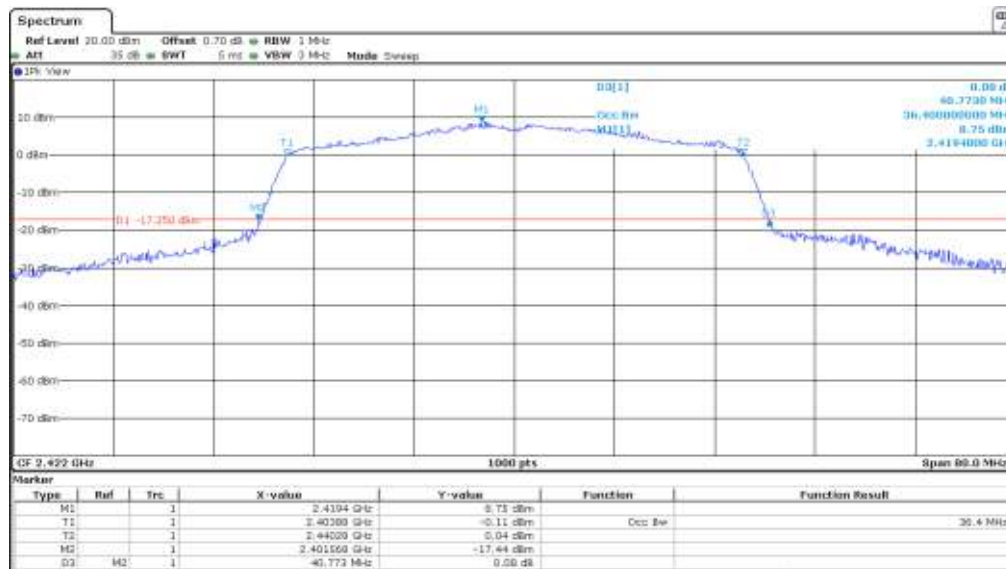


- High Channel:

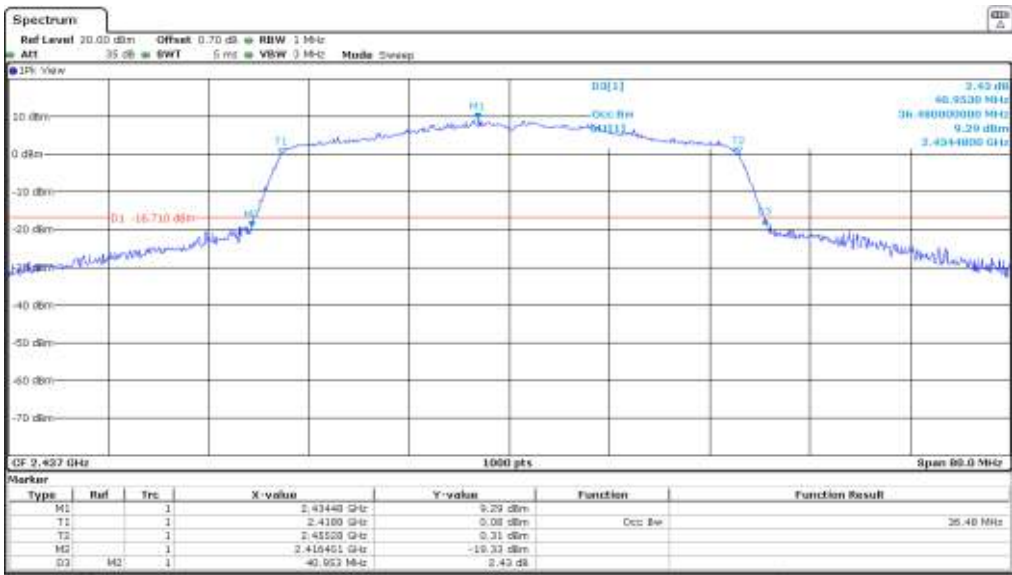


- Mode 802.11 n40 – Occupied Bandwidth

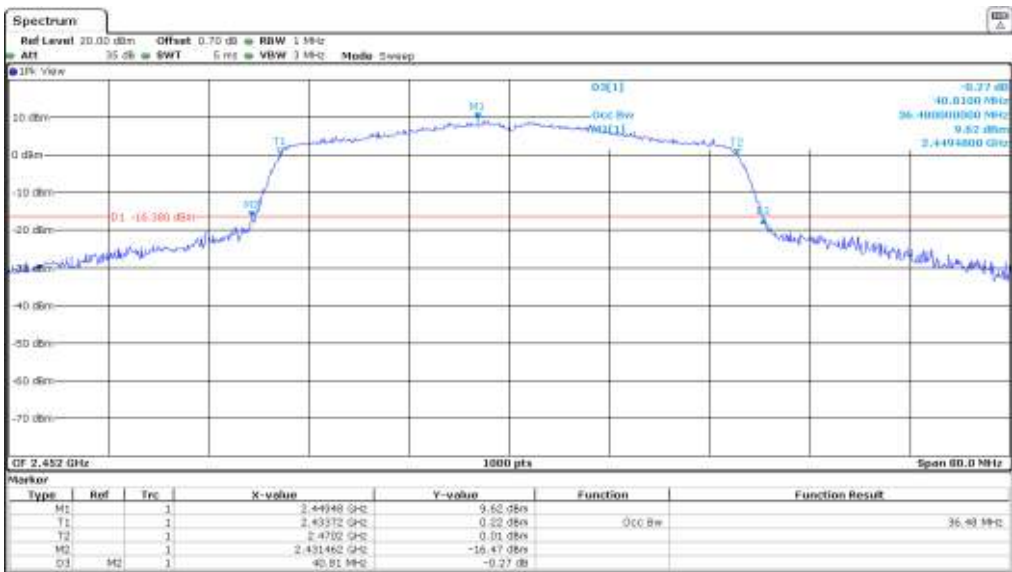
- Low Channel:



- Middle Channel:



- High Channel:



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

### SPECIFICATION:

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

### RESULTS:

- Mode 802.11 b**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 6 dB Spectrum Bandwidth (MHz) | 8.5514                  | 8.5704                     | 9.0426                   |
| Measurement uncertainty (kHz) | <±3.50                  |                            |                          |

- Mode 802.11 g**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 6 dB Spectrum Bandwidth (MHz) | 16.0418                 | 16.2496                    | 16.0545                  |
| Measurement uncertainty (kHz) | <±3.50                  |                            |                          |

- Mode 802.11 n20**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 6 dB Spectrum Bandwidth (MHz) | 17.2919                 | 17.527                     | 17.2658                  |
| Measurement uncertainty (kHz) | <±3.50                  |                            |                          |

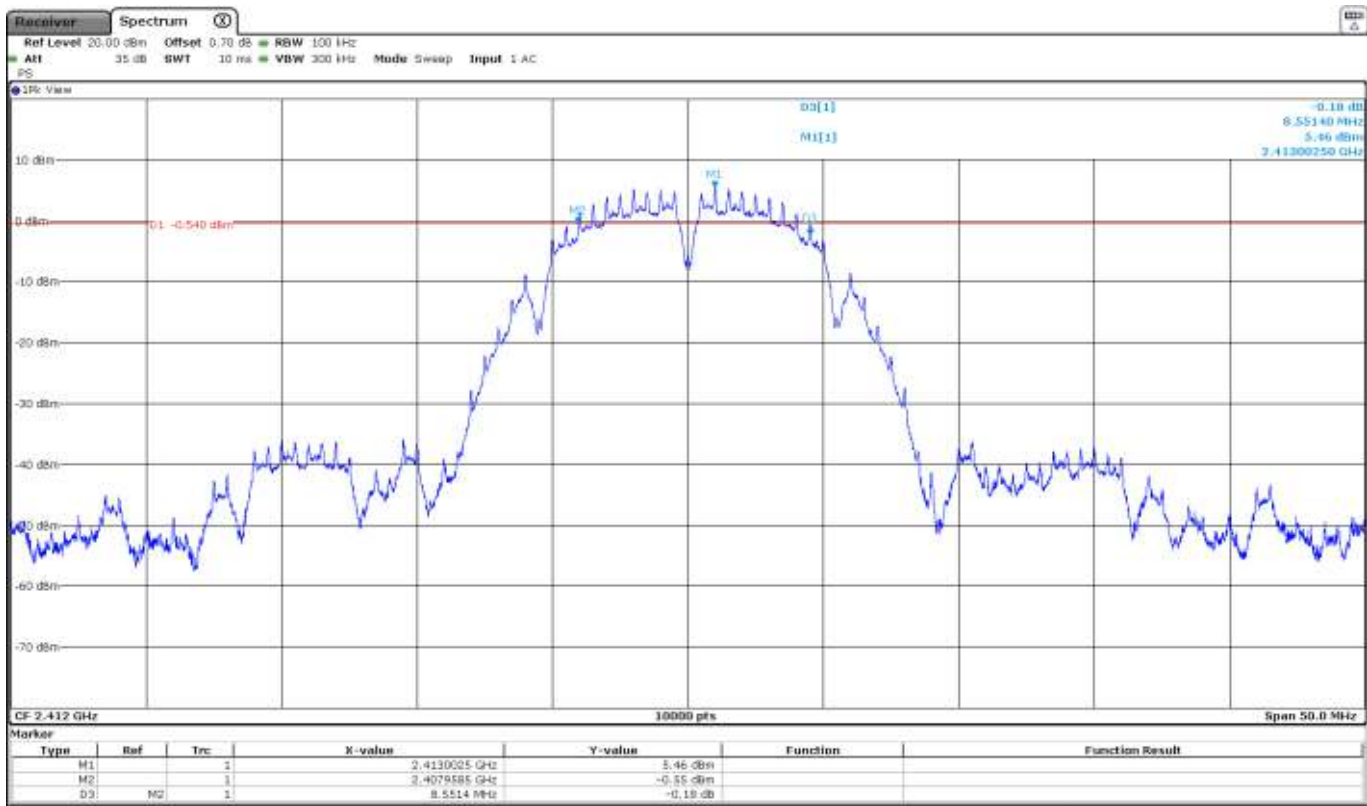
- Mode 802.11 n40**

|                               | Low Channel<br>2422 MHz | Middle Channel<br>2437 MHz | High Channel<br>2452 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 6 dB Spectrum Bandwidth (MHz) | 35.300                  | 35.279                     | 35.482                   |
| Measurement uncertainty (kHz) | <±41.04                 |                            |                          |

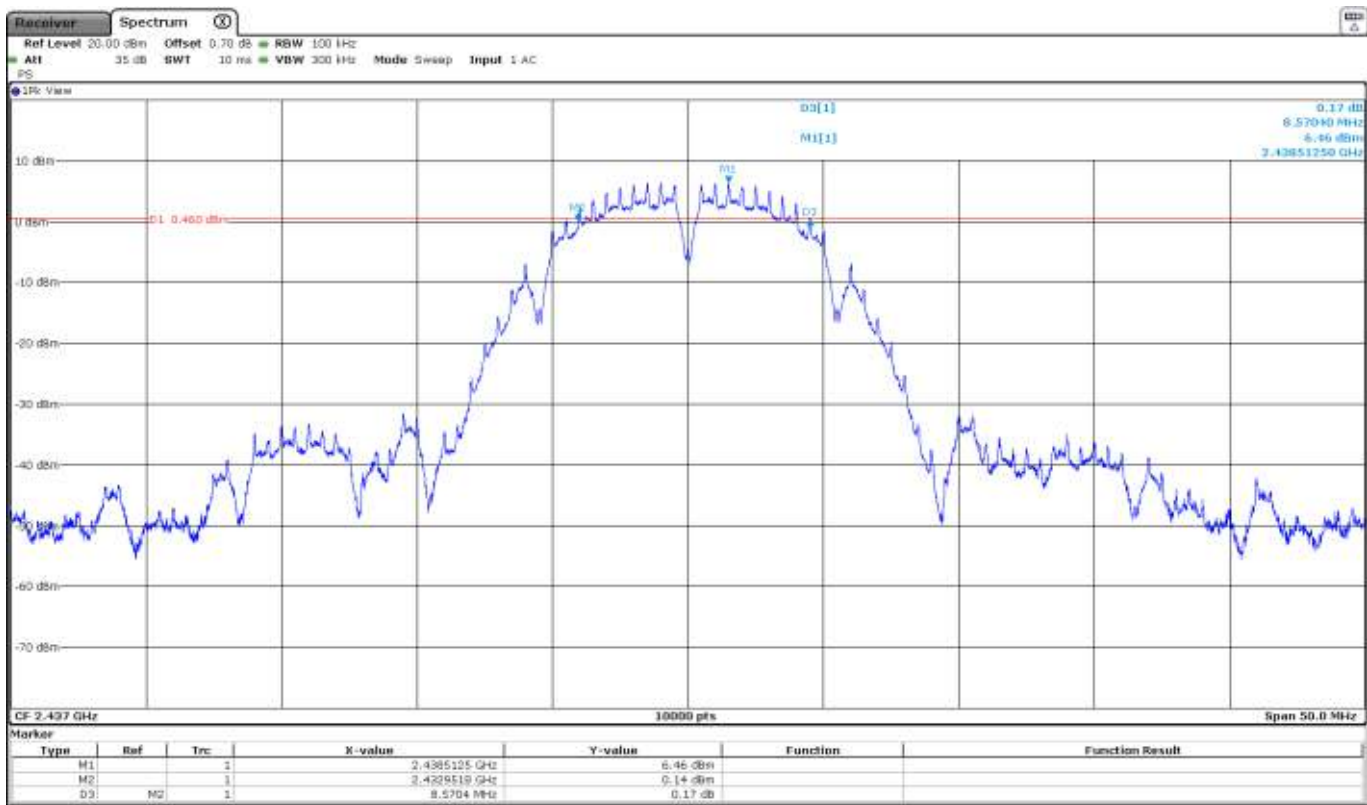
Verdict: PASS

• Mode 802.11 b – 6 dB Bandwidth

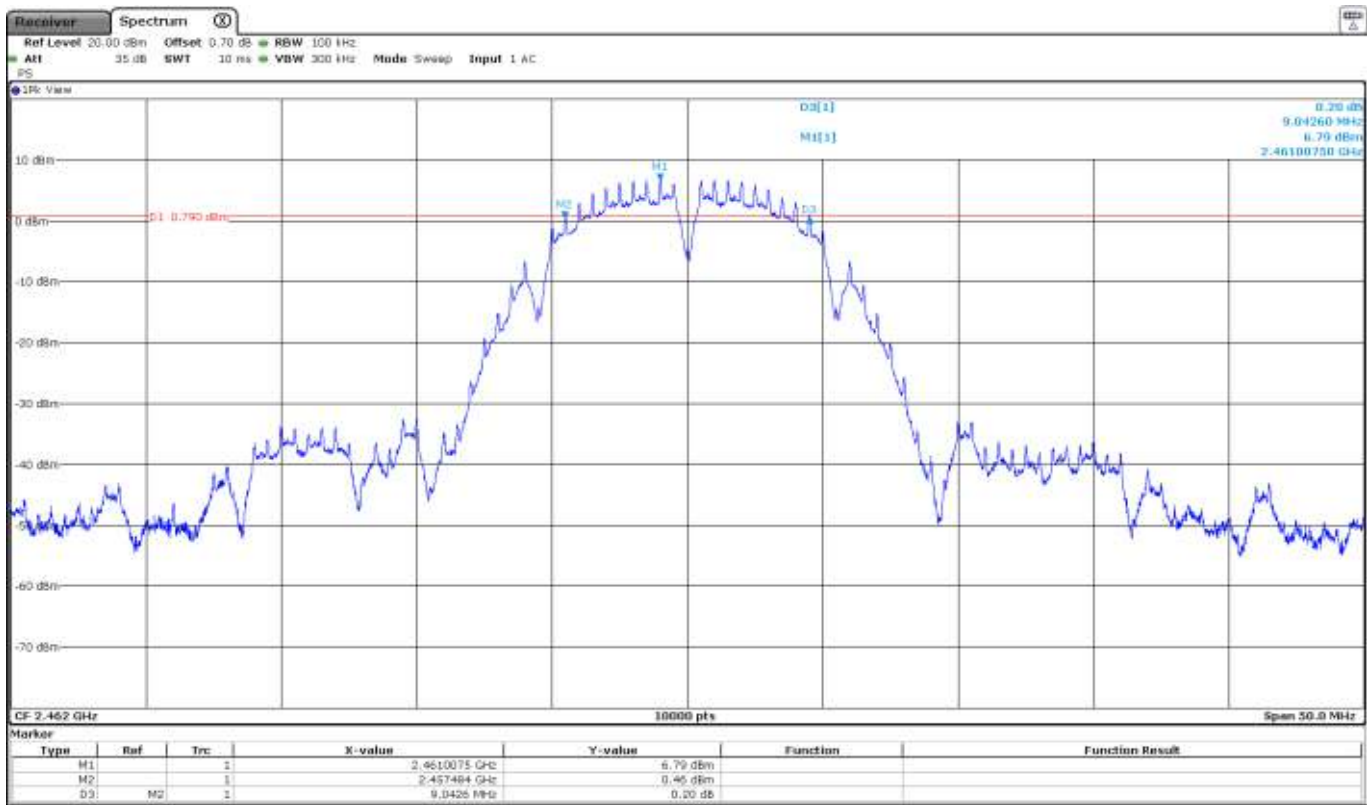
- Low Channel:



- Middle Channel:

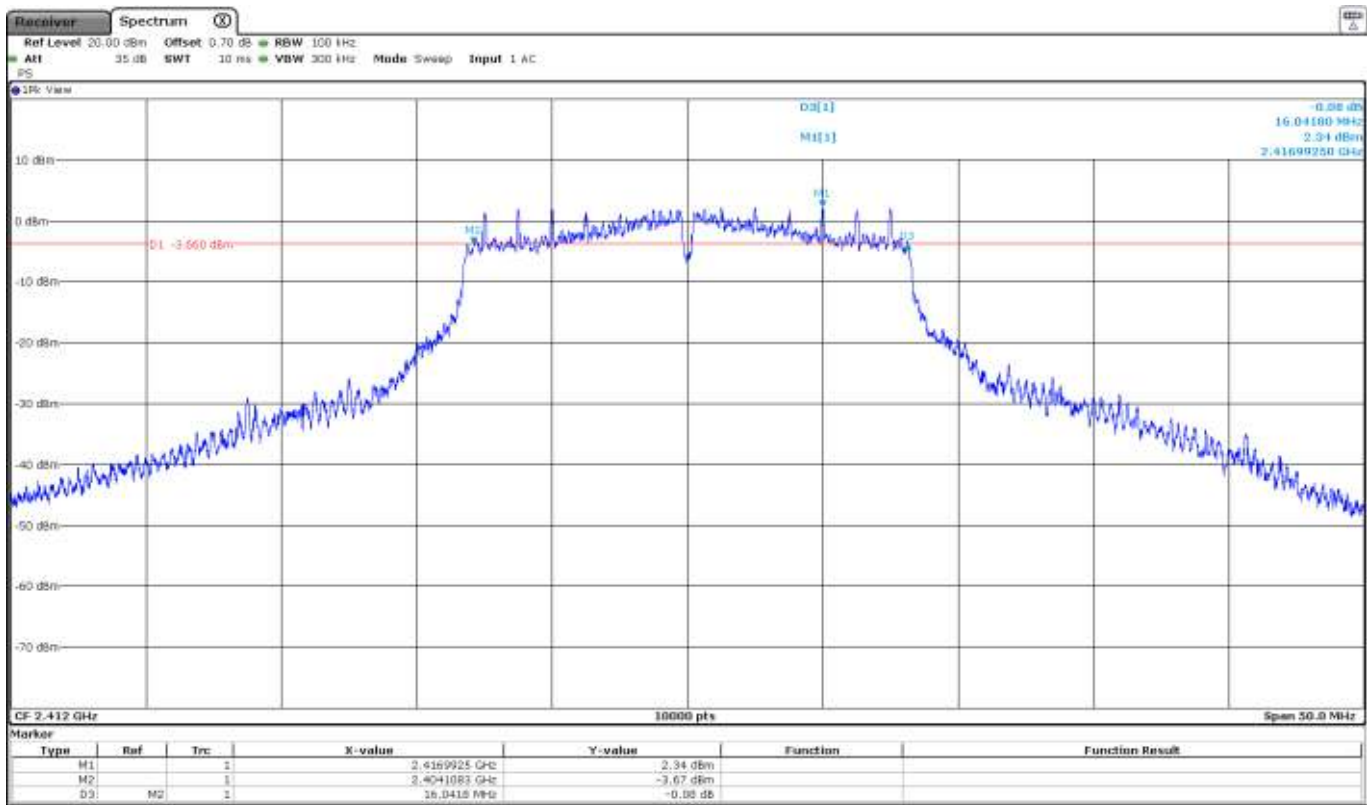


- High Channel:

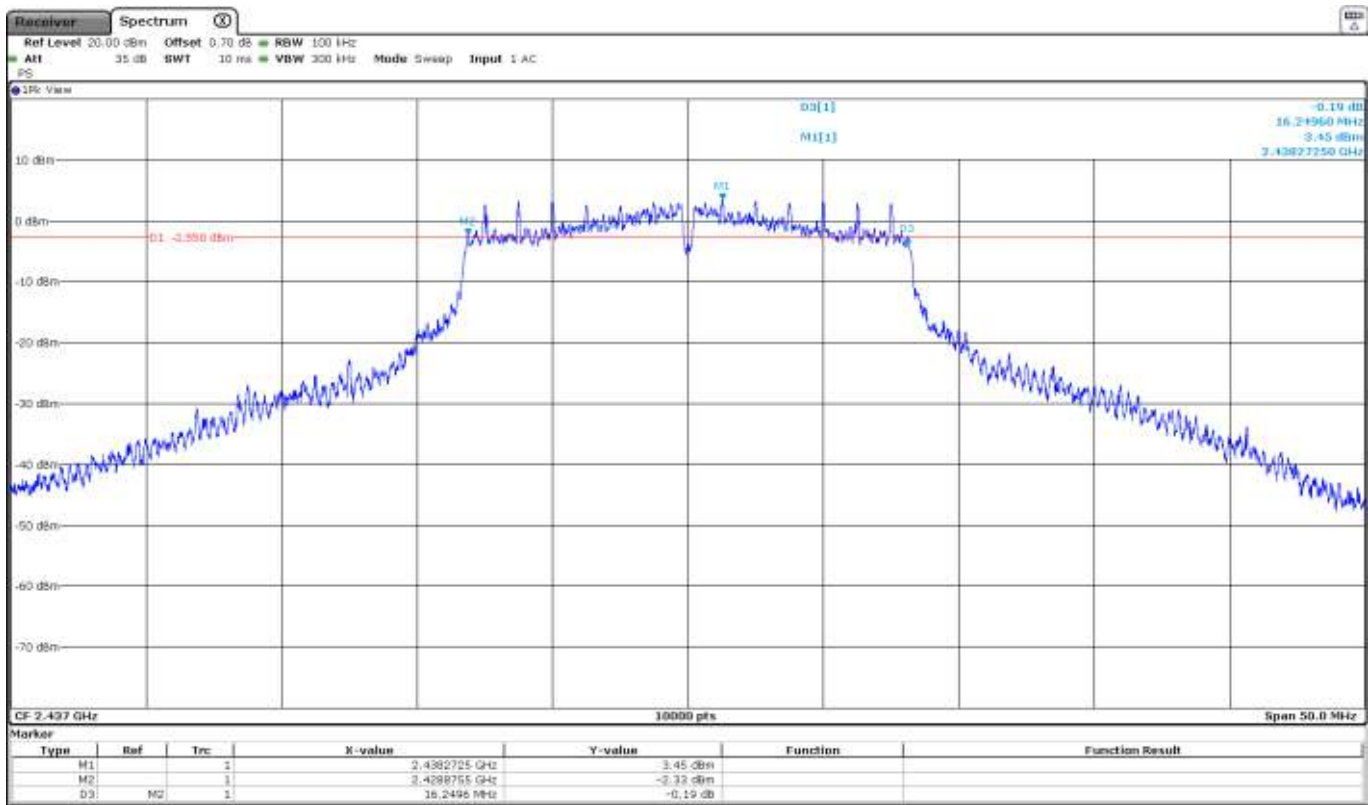


- Mode 802.11 g – 6 dB Bandwidth

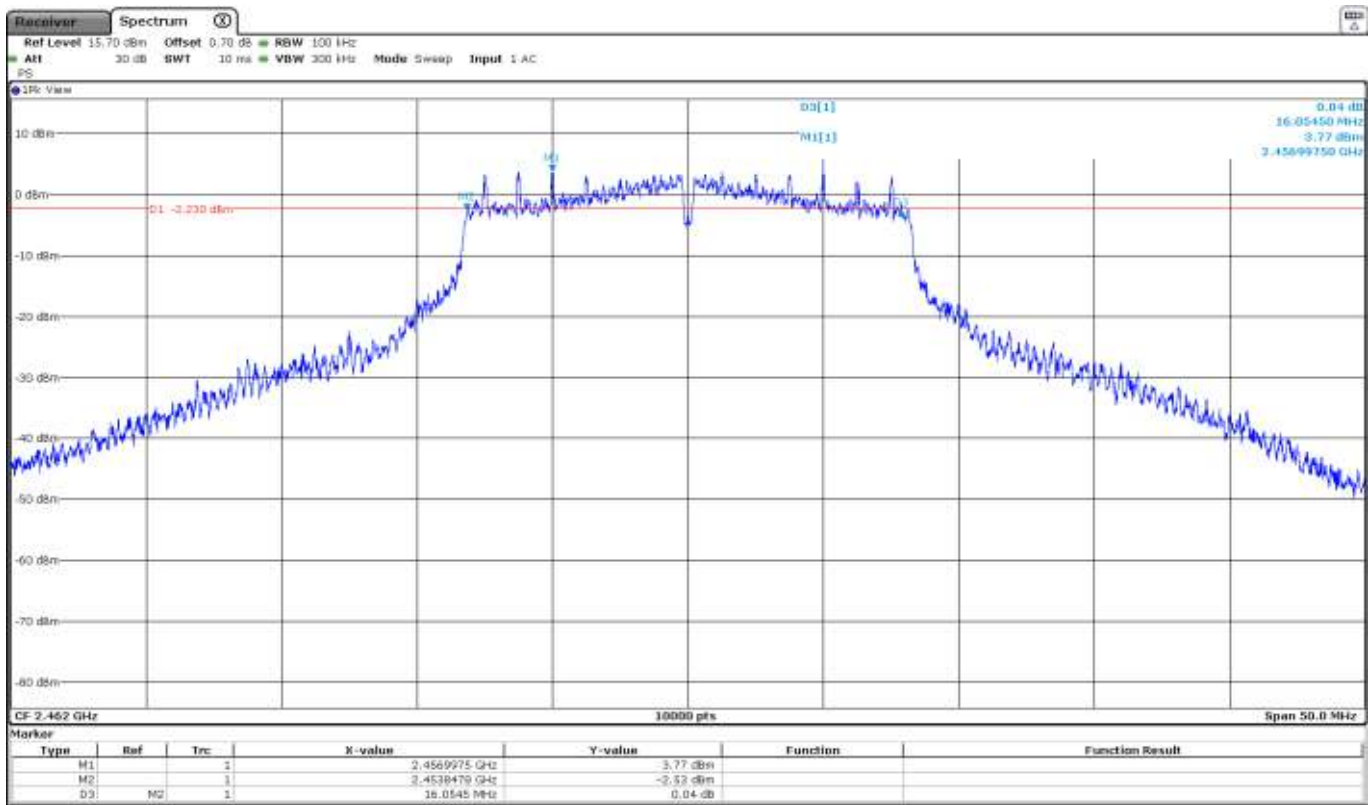
- Low Channel:



- Middle Channel:

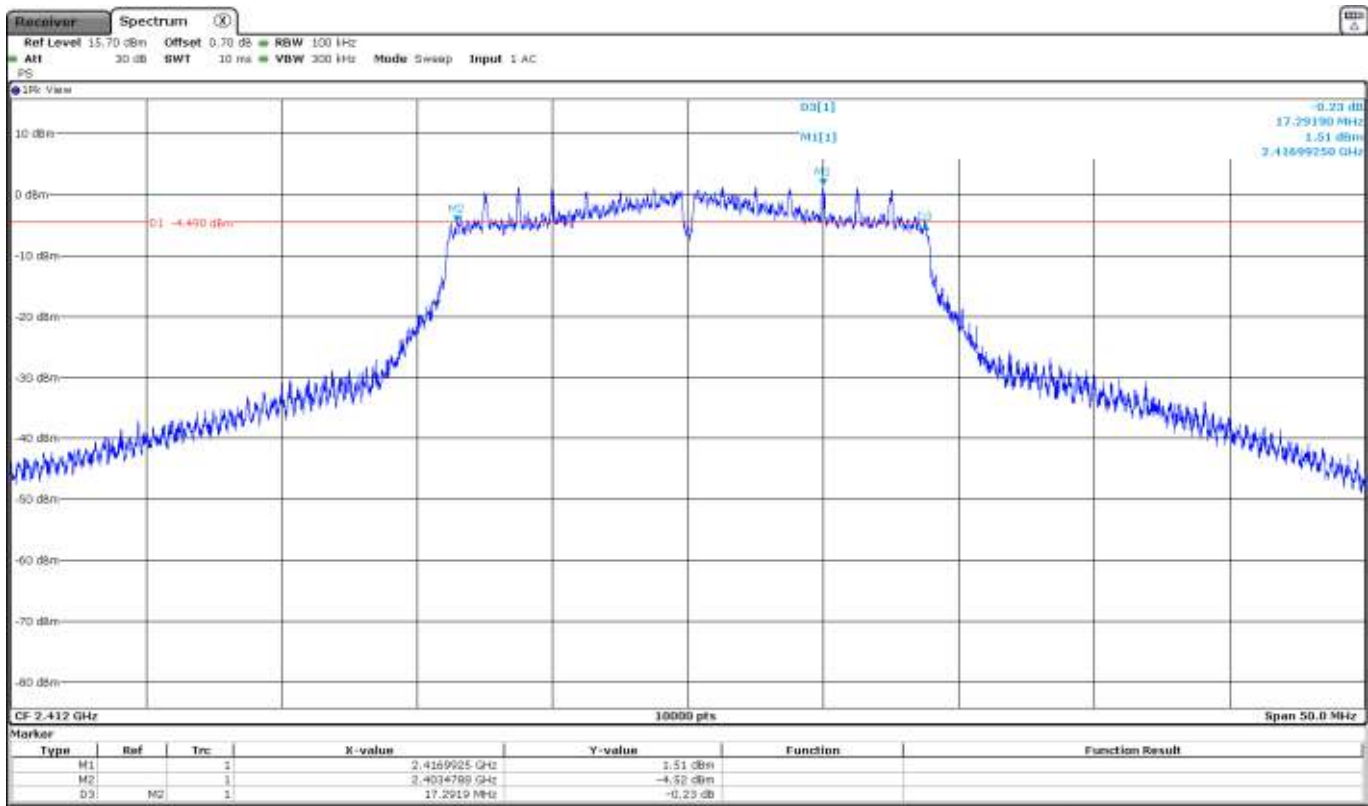


- High Channel:

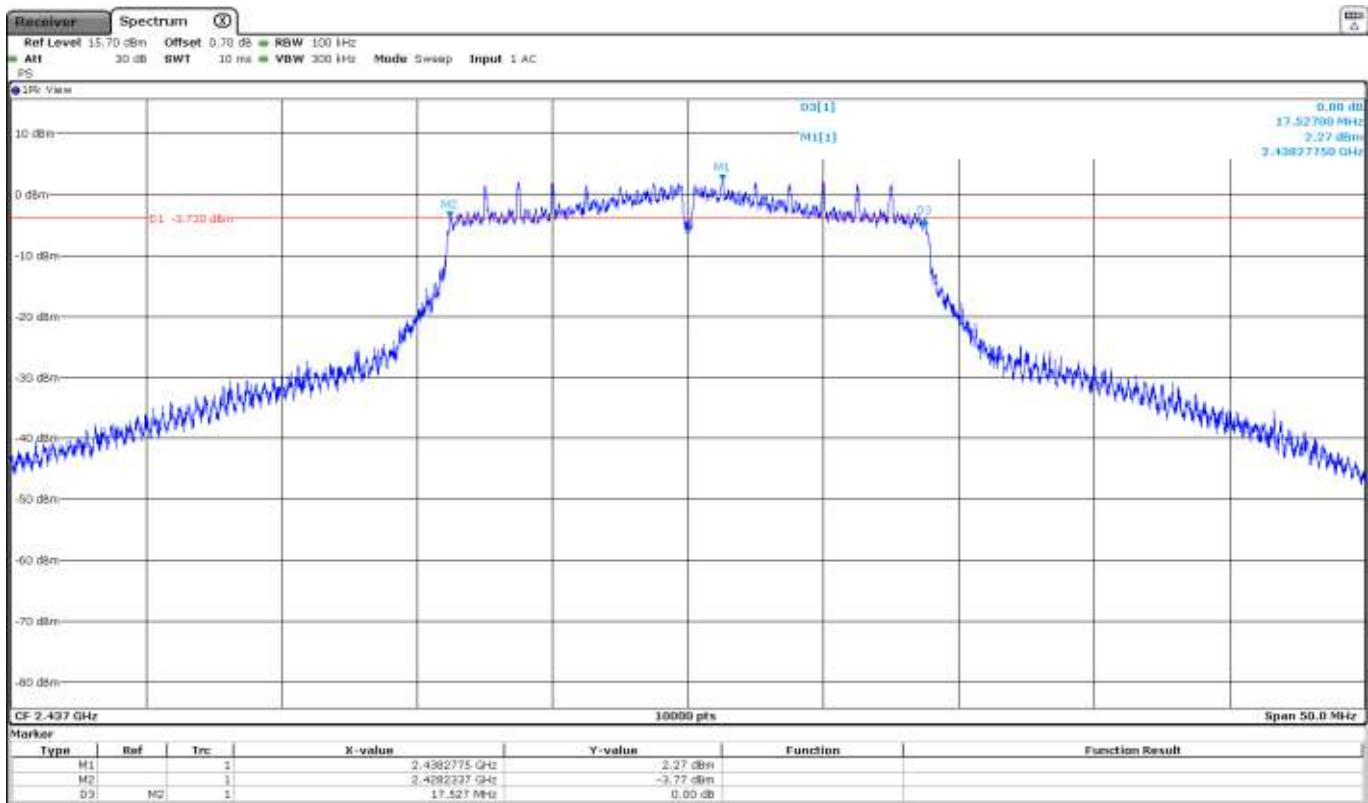


• Mode 802.11 n20 – 6 dB Bandwidth

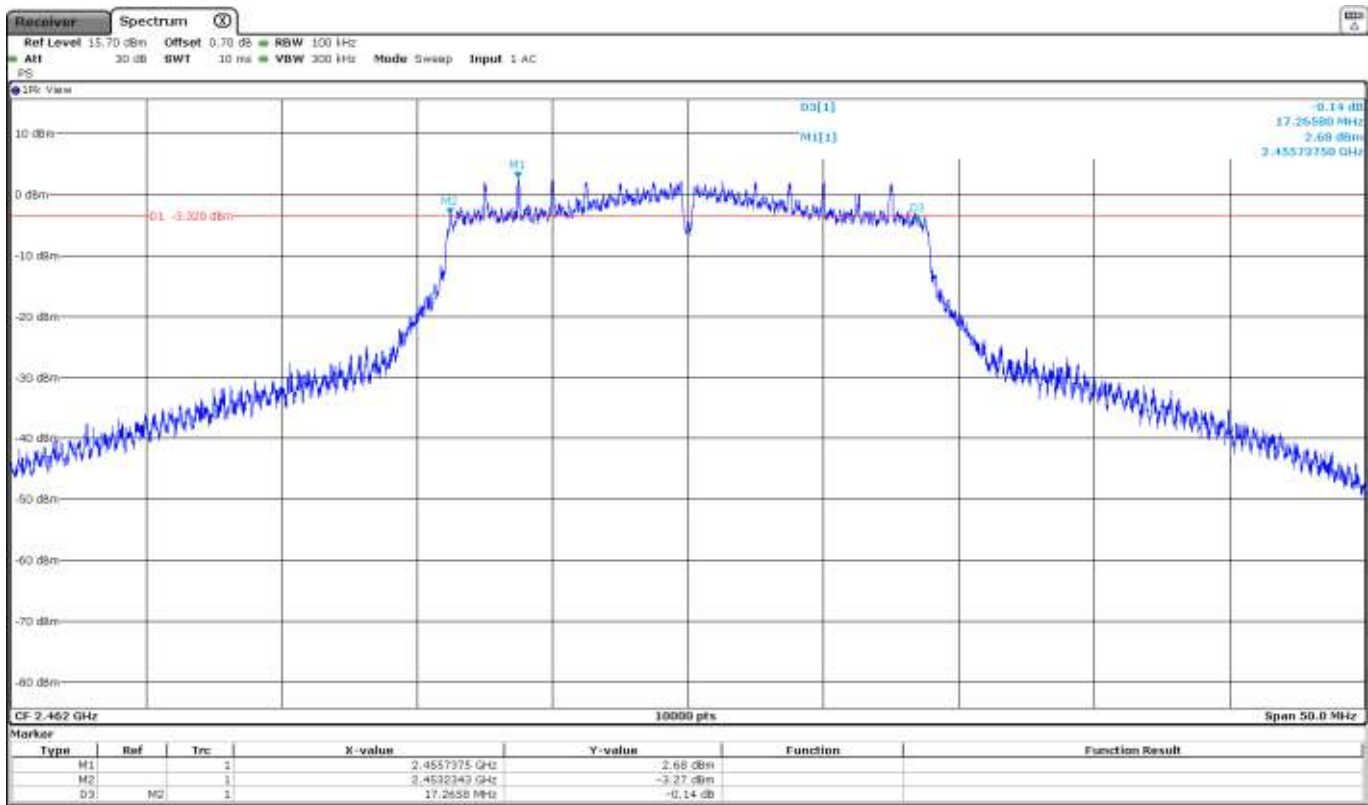
- Low Channel:



- Middle Channel:

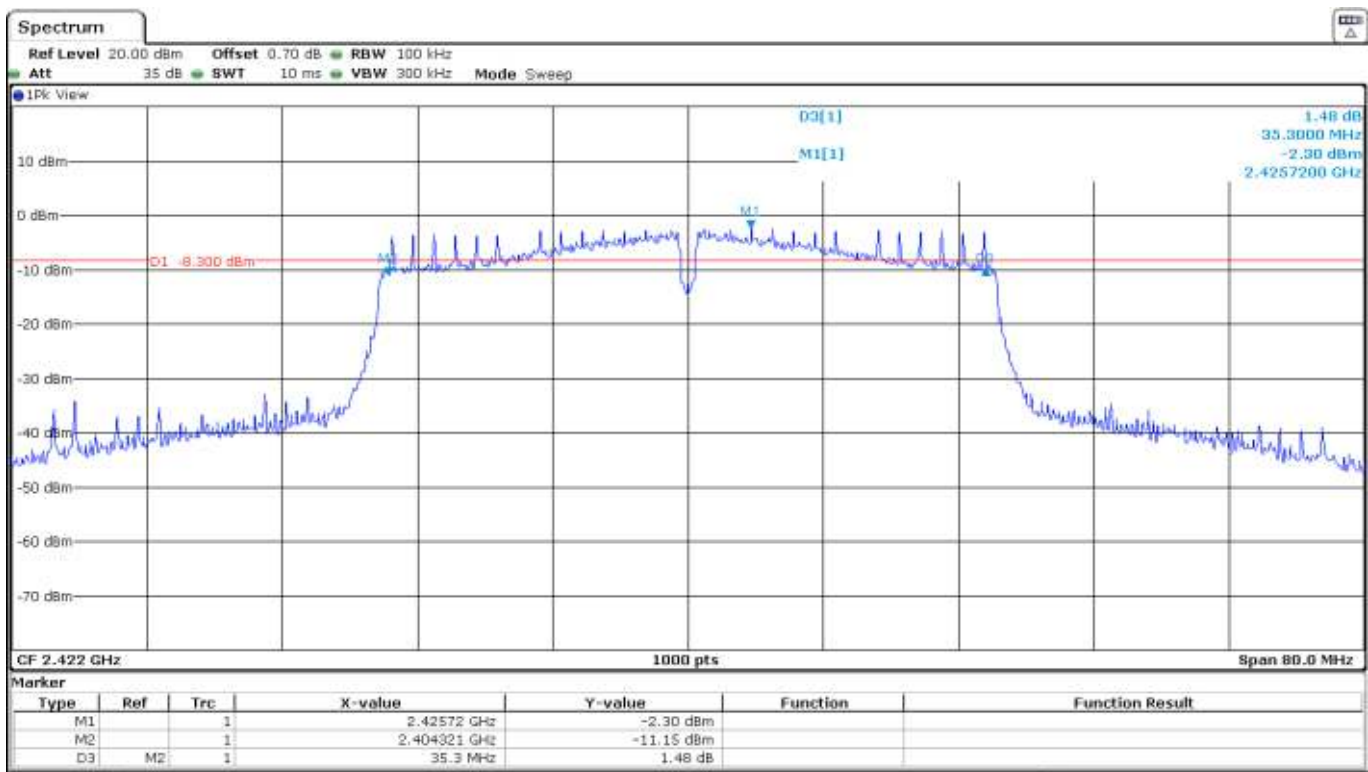


- High Channel:

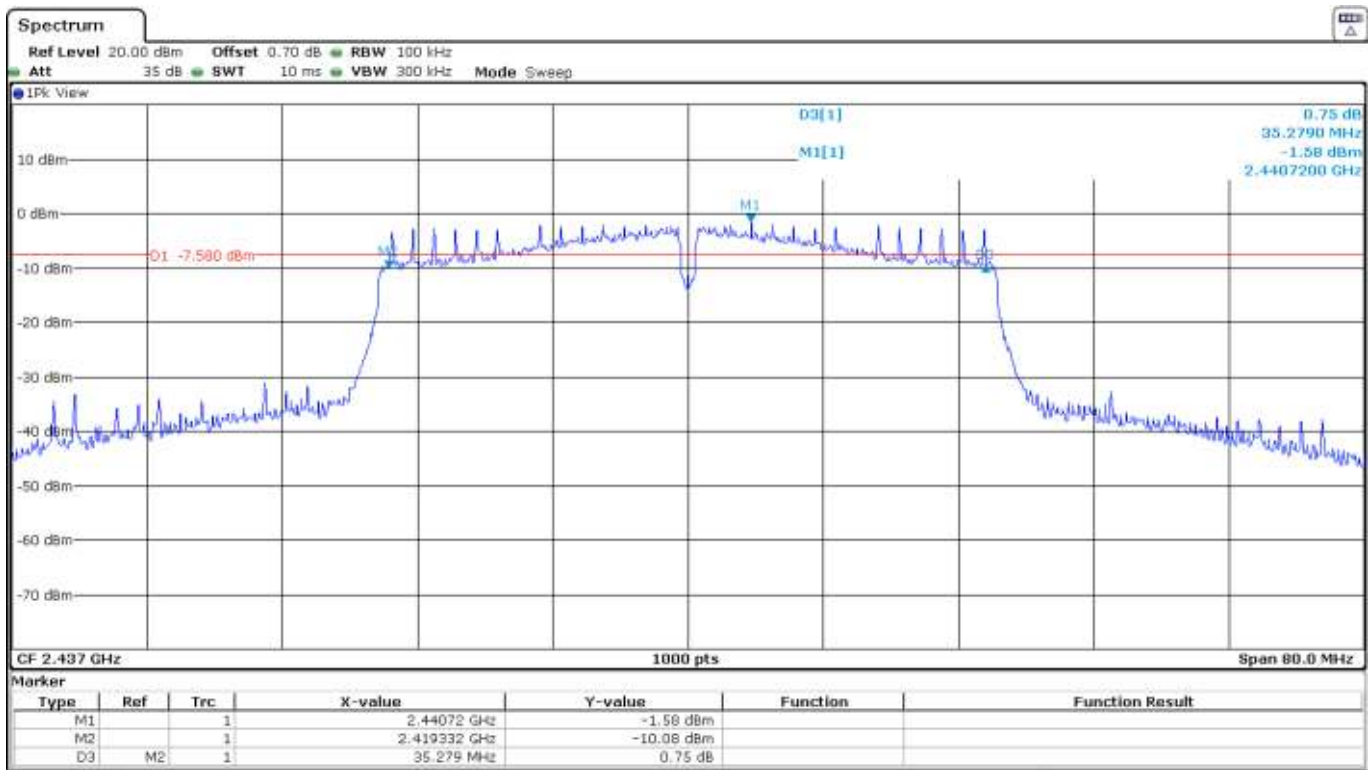


• Mode 802.11 n40 – 6 dB Bandwidth

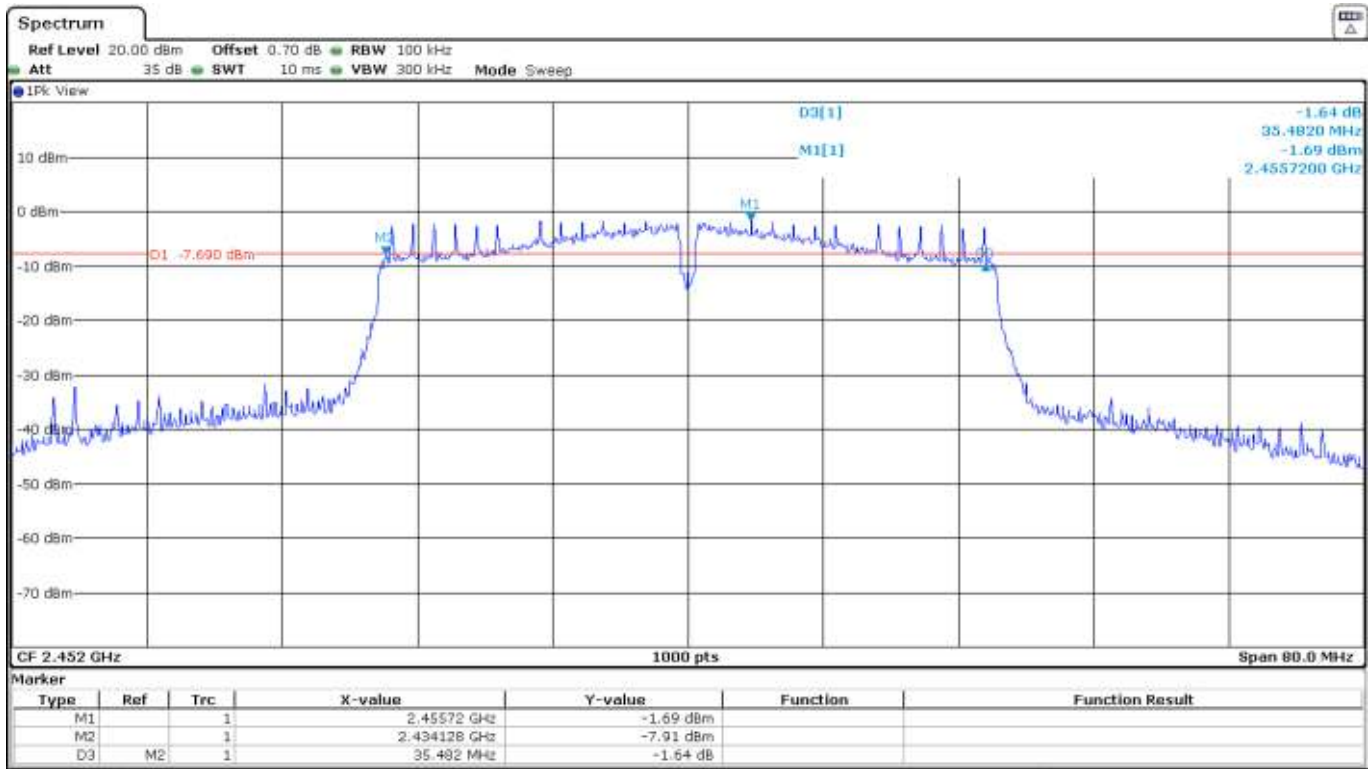
- Low Channel:



- Middle Channel:



- High Channel:



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

### SPECIFICATION:

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

### RESULTS:

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

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

Maximum Declared Antenna Gain: -6.2 dBi

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

#### **Mode 802.11 b**

|                              | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|------------------------------|-------------------------|----------------------------|--------------------------|
| Max. Conducted Power (dBm)   | 17.77                   | 19.1                       | 19.34                    |
| Maximum EIRP Power (dBm)     | 11.57                   | 12.9                       | 13.14                    |
| Measurement uncertainty (dB) | <±0.33                  |                            |                          |

#### **Mode 802.11 g**

|                              | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|------------------------------|-------------------------|----------------------------|--------------------------|
| Max. Conducted Power (dBm)   | 22.52                   | 23.64                      | 24.02                    |
| Maximum EIRP Power (dBm)     | 16.32                   | 17.44                      | 17.82                    |
| Measurement uncertainty (dB) | <±0.33                  |                            |                          |

#### **Mode 802.11 n20**

|                              | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|------------------------------|-------------------------|----------------------------|--------------------------|
| Max. Conducted Power (dBm)   | 21.73                   | 22.34                      | 23.77                    |
| Maximum EIRP Power (dBm)     | 15.53                   | 16.14                      | 17.57                    |
| Measurement uncertainty (dB) | <±0.33                  |                            |                          |

**Mode 802.11 n40**

|                              | Low Channel<br>2422 MHz | Middle Channel<br>2437 MHz | High Channel<br>2452 MHz |
|------------------------------|-------------------------|----------------------------|--------------------------|
| Max. Conducted Power (dBm)   | 21.79                   | 21.97                      | 22.30                    |
| Maximum EIRP Power (dBm)     | 15.59                   | 15.77                      | 16.10                    |
| Measurement uncertainty (dB) | <±0.33                  |                            |                          |

Verdict: PASS

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

SPECIFICATION:

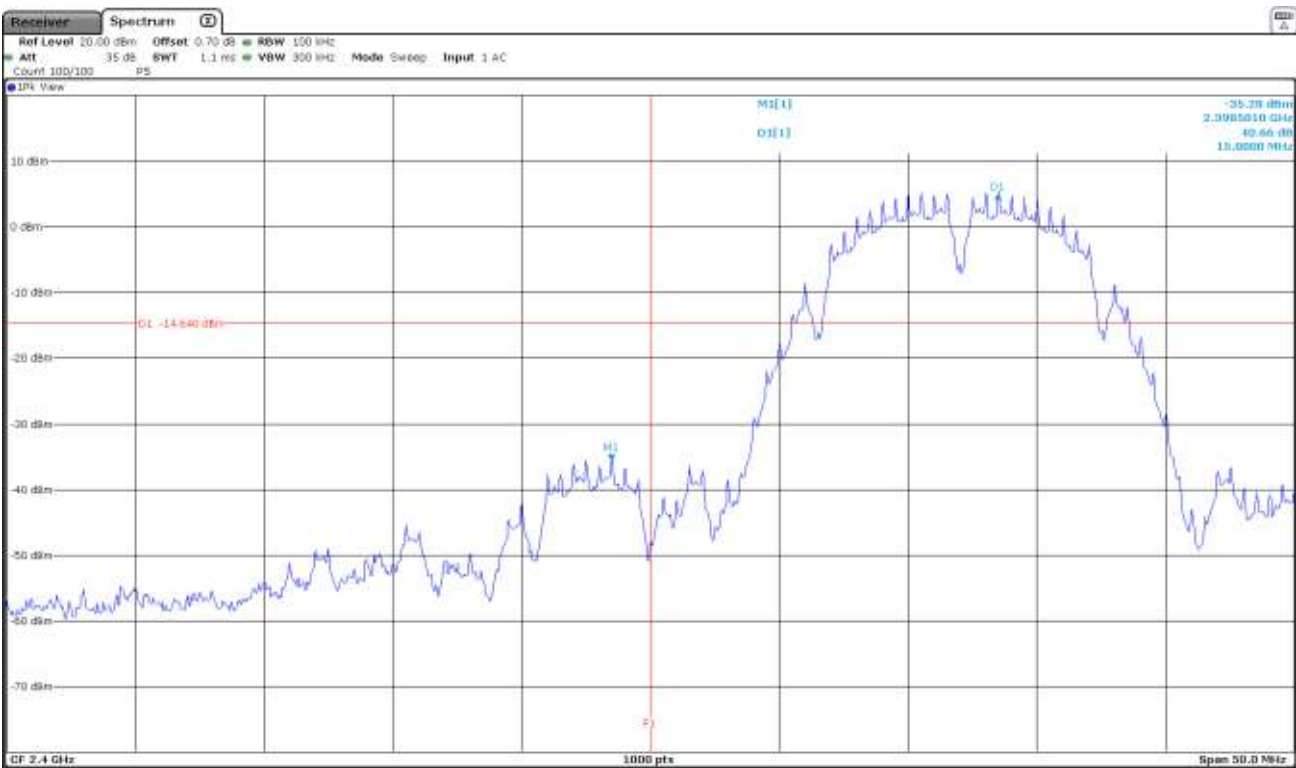
In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

RESULTS:

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

|                              |        |
|------------------------------|--------|
| Measurement uncertainty (dB) | <±1.56 |
|------------------------------|--------|

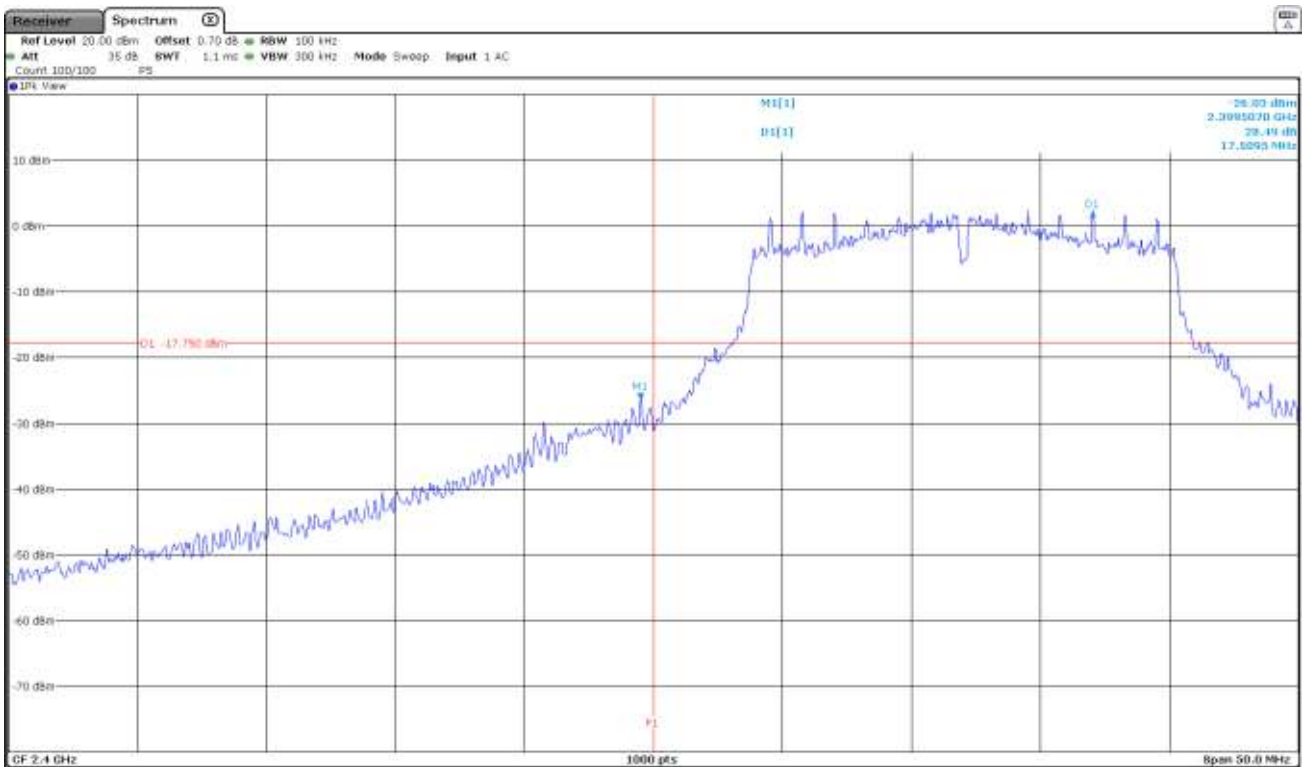
- Mode 802.11 b – Band-edge emissions compliance
  - Low Channel:



Verdict: PASS

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

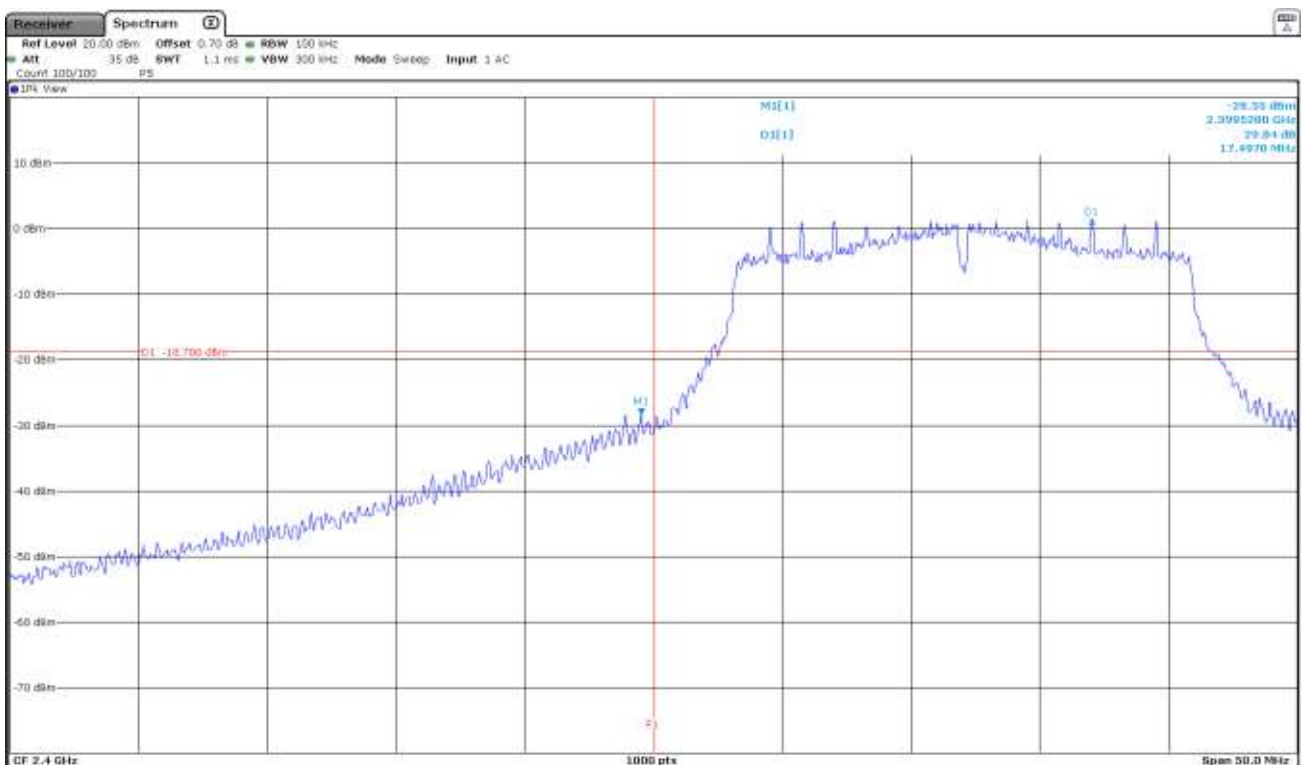
- Low Channel:



Verdict: PASS

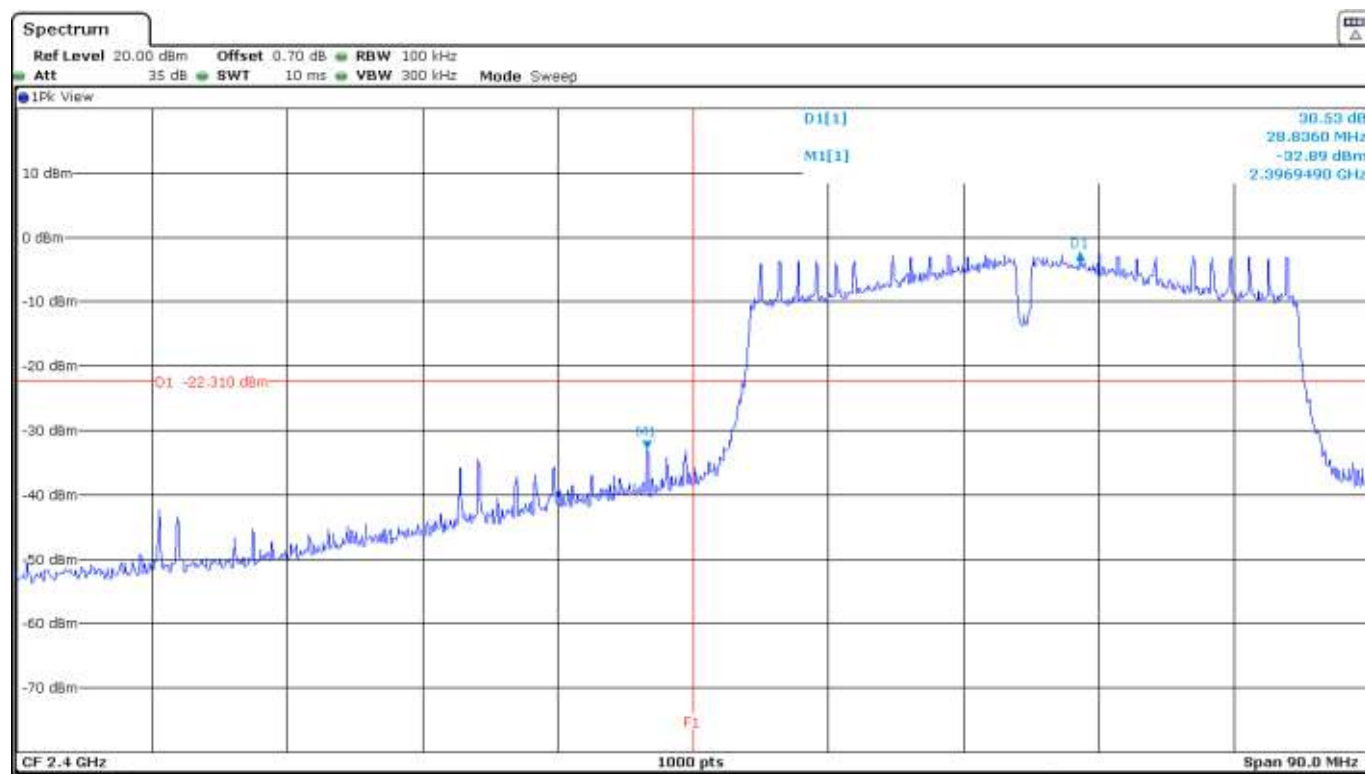
- **Mode 802.11 n20 – Band-edge emissions compliance**

- Low Channel:



- **Mode 802.11 n40 – Band-edge emissions compliance**

- Low Channel:



Verdict: PASS

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

### SPECIFICATION:

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

### RESULTS:

The maximum power spectral density level in the fundamental emission was measured using the method according to point 11.10.2." Method PKPSD (peak PSD)" of ANSI C.63.10-2013.

- **Mode 802.11 b**

|                              | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|------------------------------|-------------------------|----------------------------|--------------------------|
| Power Spectral Density (dBm) | 5.38                    | 6.49                       | 7.05                     |
| Measurement uncertainty (dB) | <±0.78                  |                            |                          |

- **Mode 802.11 g**

|                              | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|------------------------------|-------------------------|----------------------------|--------------------------|
| Power Spectral Density (dBm) | 2.55                    | 3.63                       | 4.07                     |
| Measurement uncertainty (dB) | <±0.78                  |                            |                          |

- **Mode 802.11 n20**

|                              | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|------------------------------|-------------------------|----------------------------|--------------------------|
| Power Spectral Density (dBm) | 1.54                    | 2.32                       | 2.91                     |
| Measurement uncertainty (dB) | <±0.78                  |                            |                          |

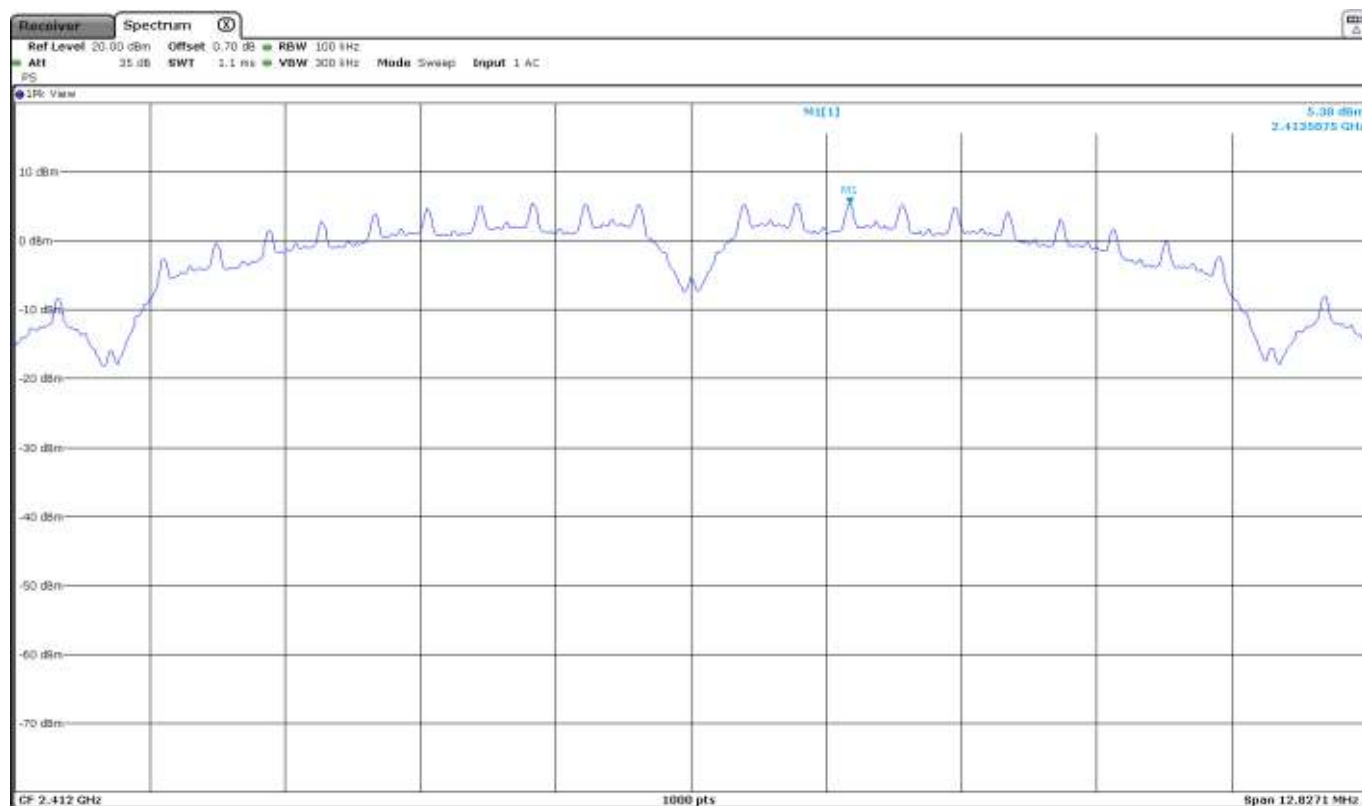
- **Mode 802.11 n40**

|                              | Low Channel<br>2422 MHz | Middle Channel<br>2437 MHz | High Channel<br>2452 MHz |
|------------------------------|-------------------------|----------------------------|--------------------------|
| Power Spectral Density (dBm) | -2.28                   | -1.85                      | -1.67                    |
| Measurement uncertainty (dB) | <±0.78                  |                            |                          |

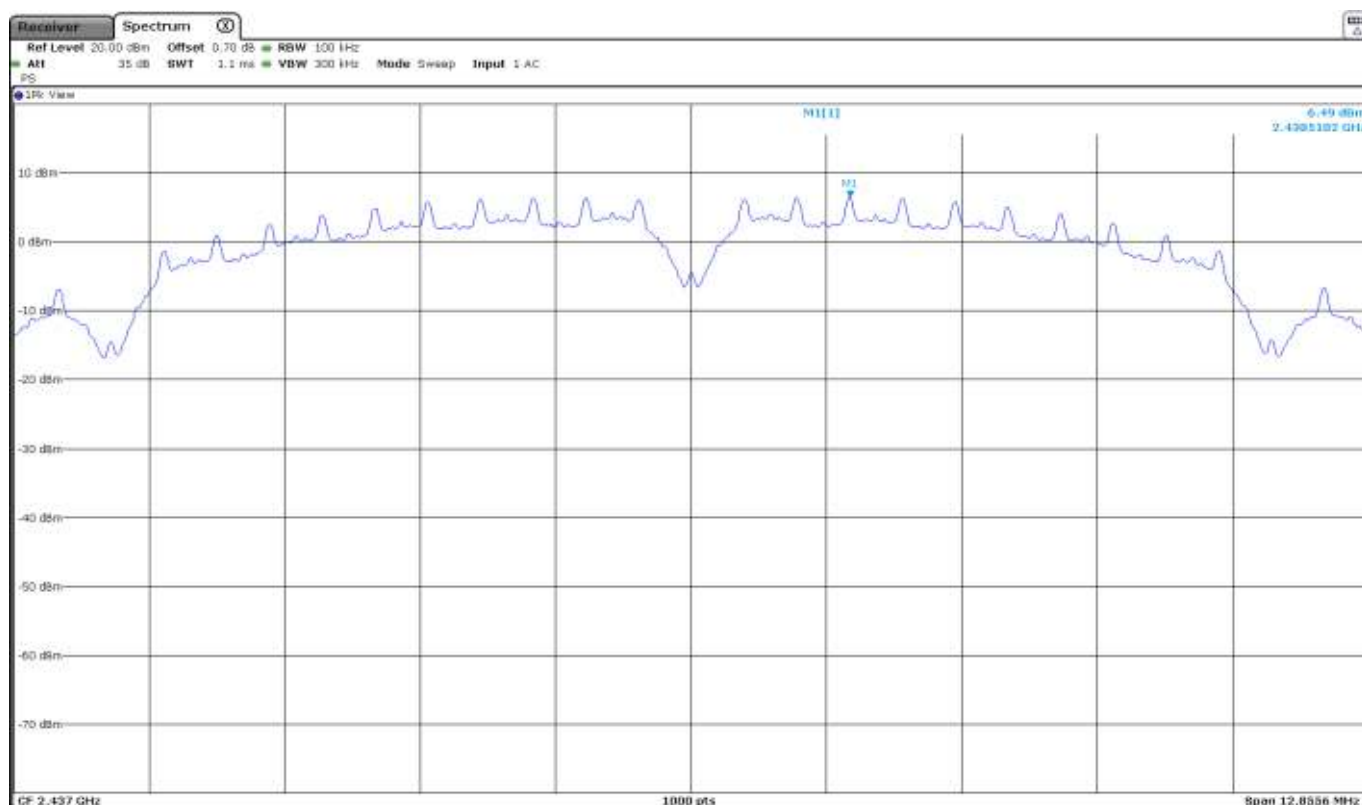
Verdict: PASS

- **Mode 802.11 b – Power Spectral Density**

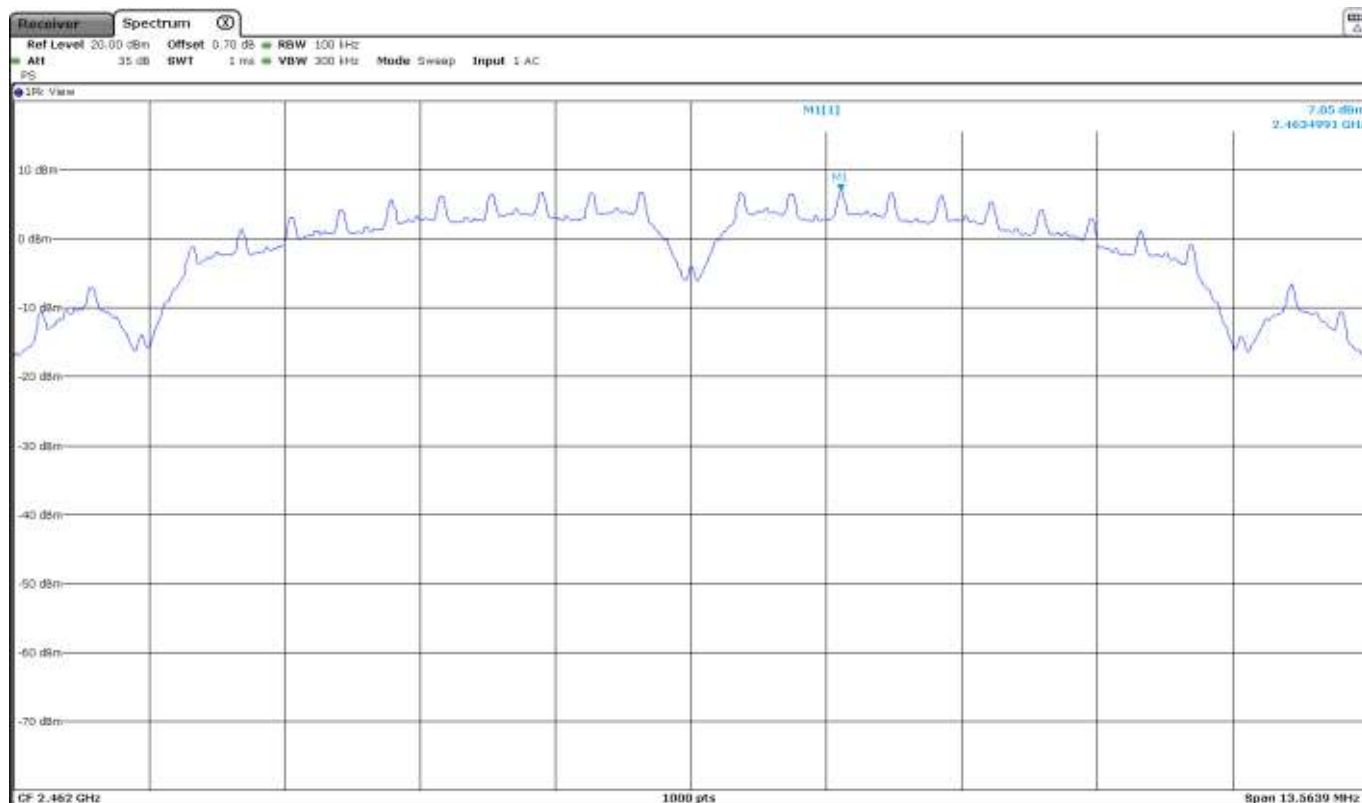
- Low Channel:



- Middle Channel:

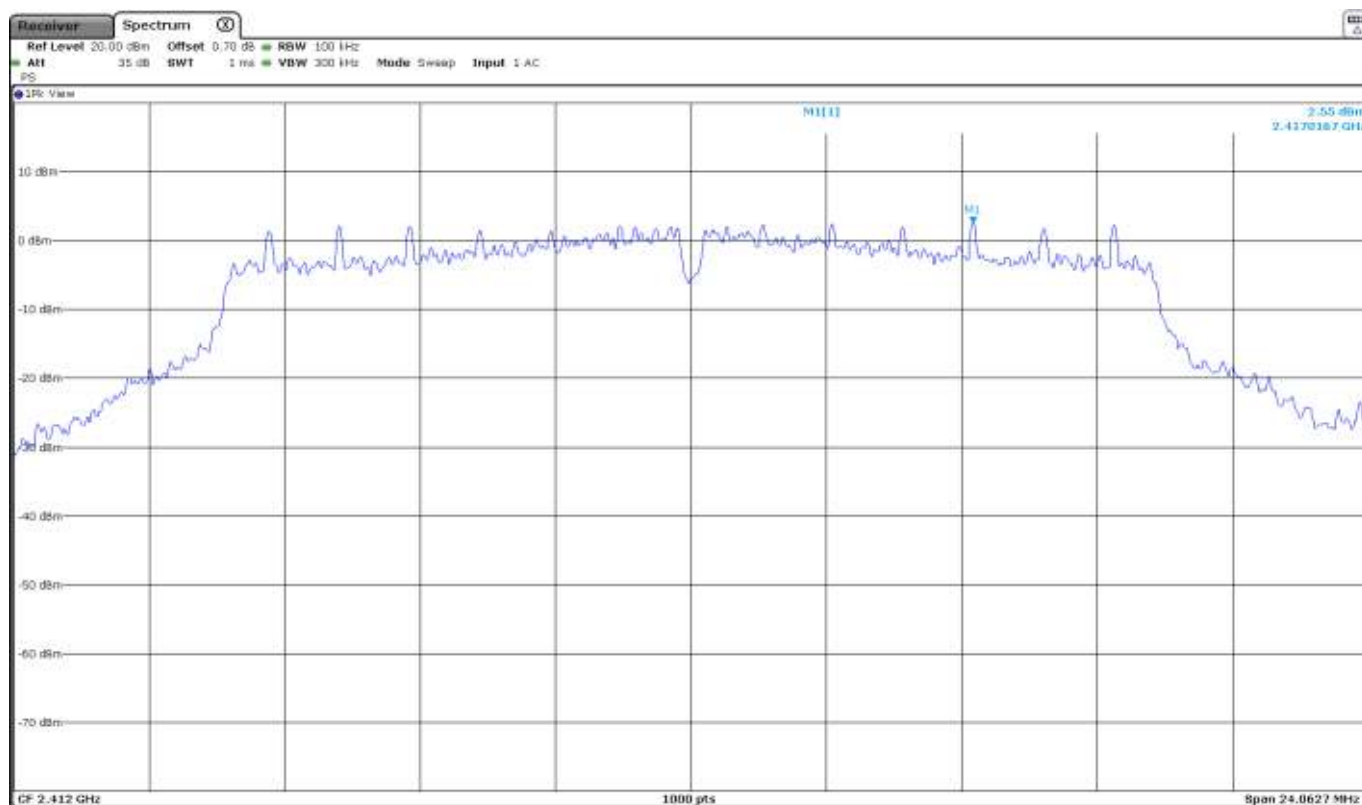


- High Channel:

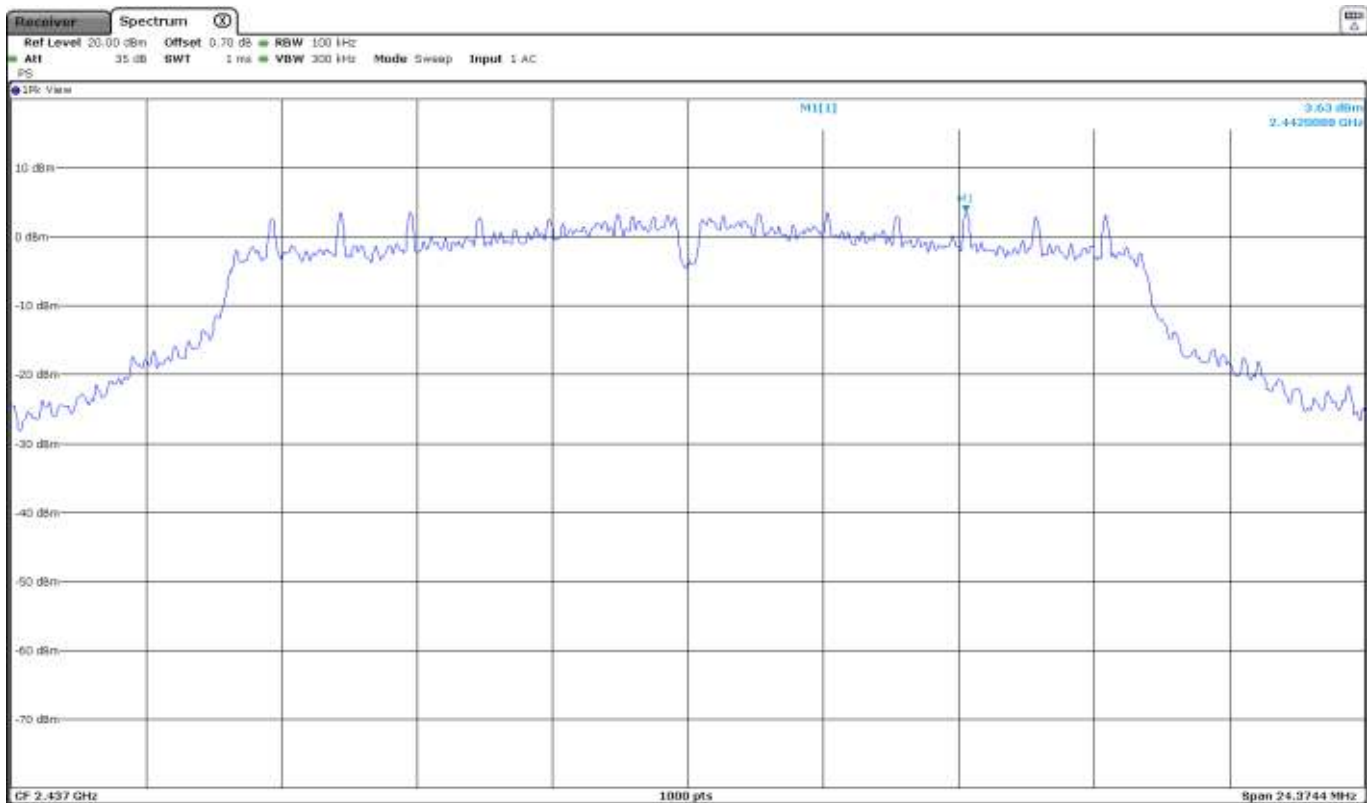


- Mode 802.11 g – Power Spectral Density

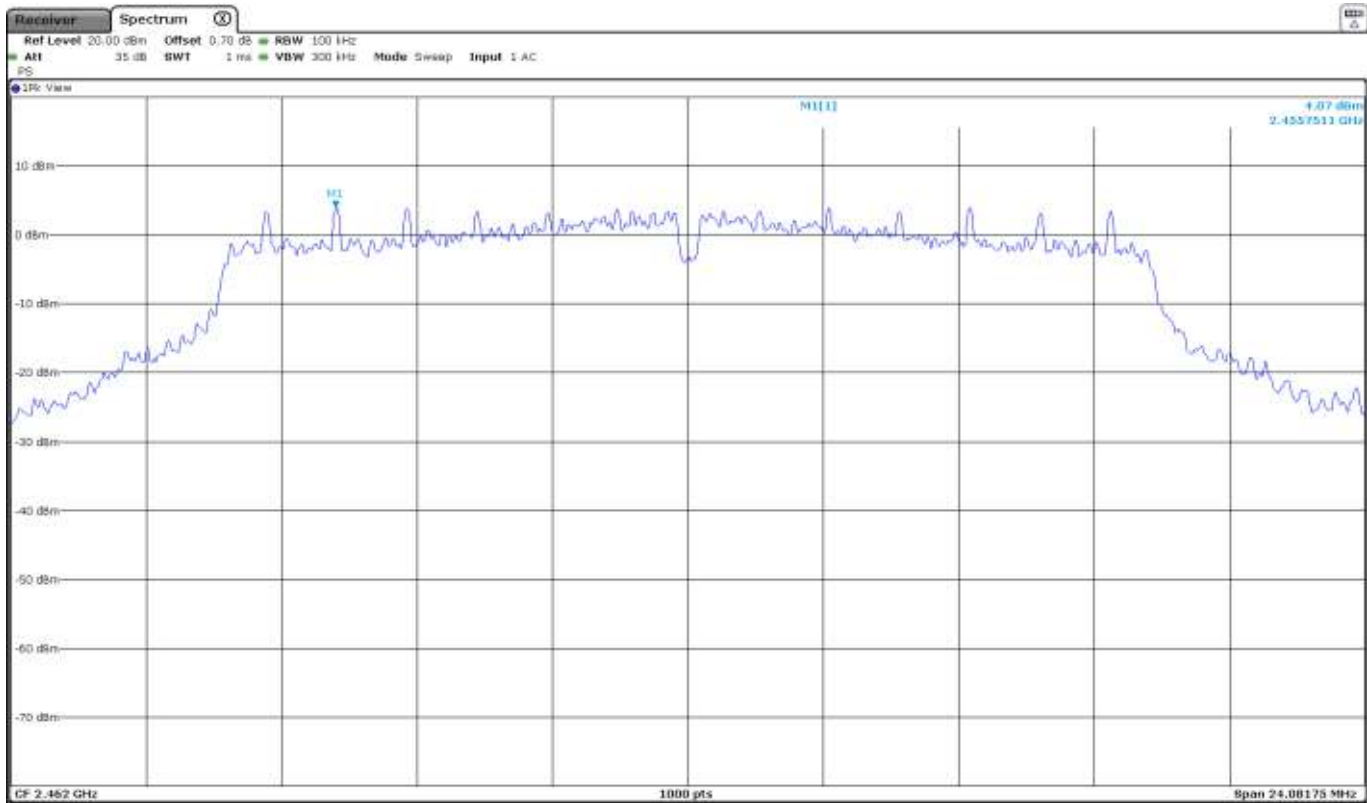
- Low Channel:



- Middle Channel:

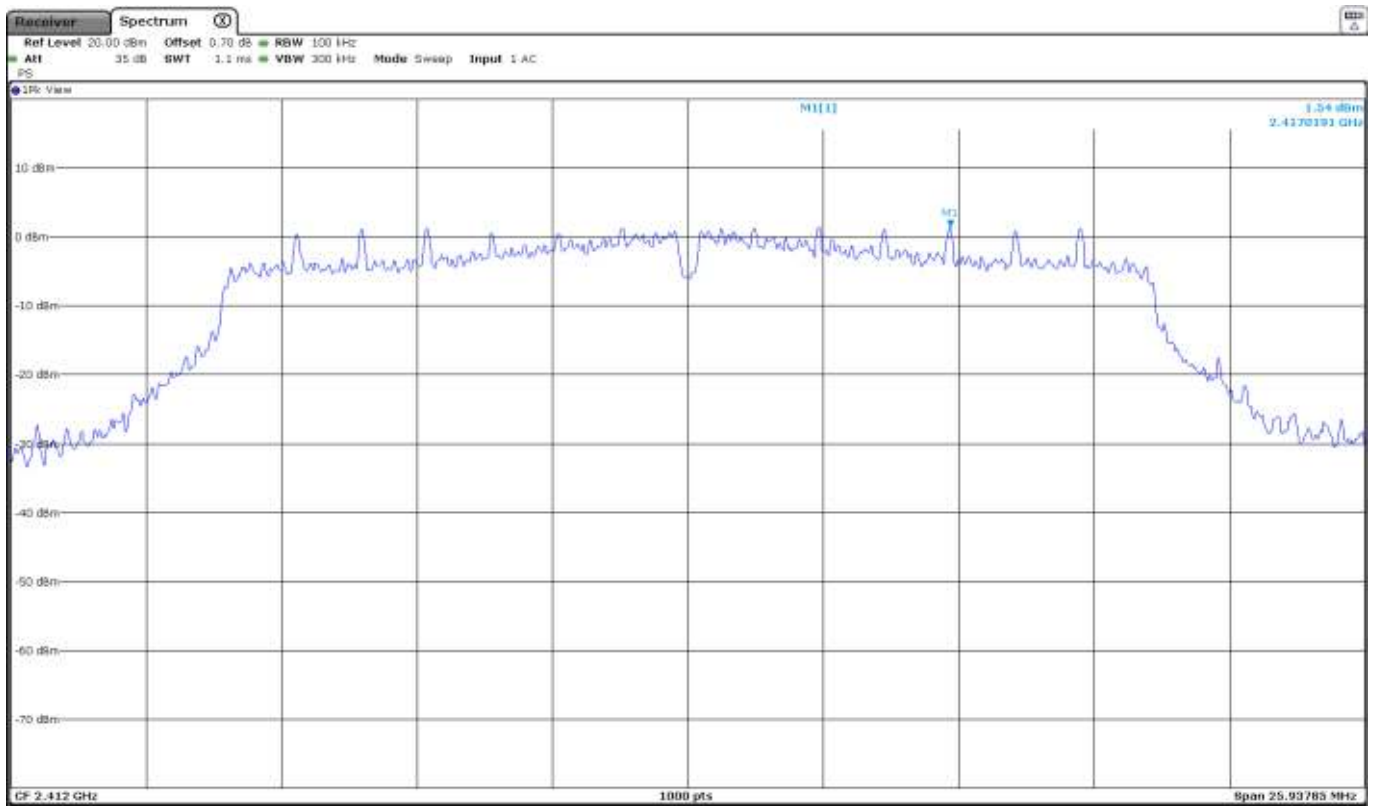


- High Channel:

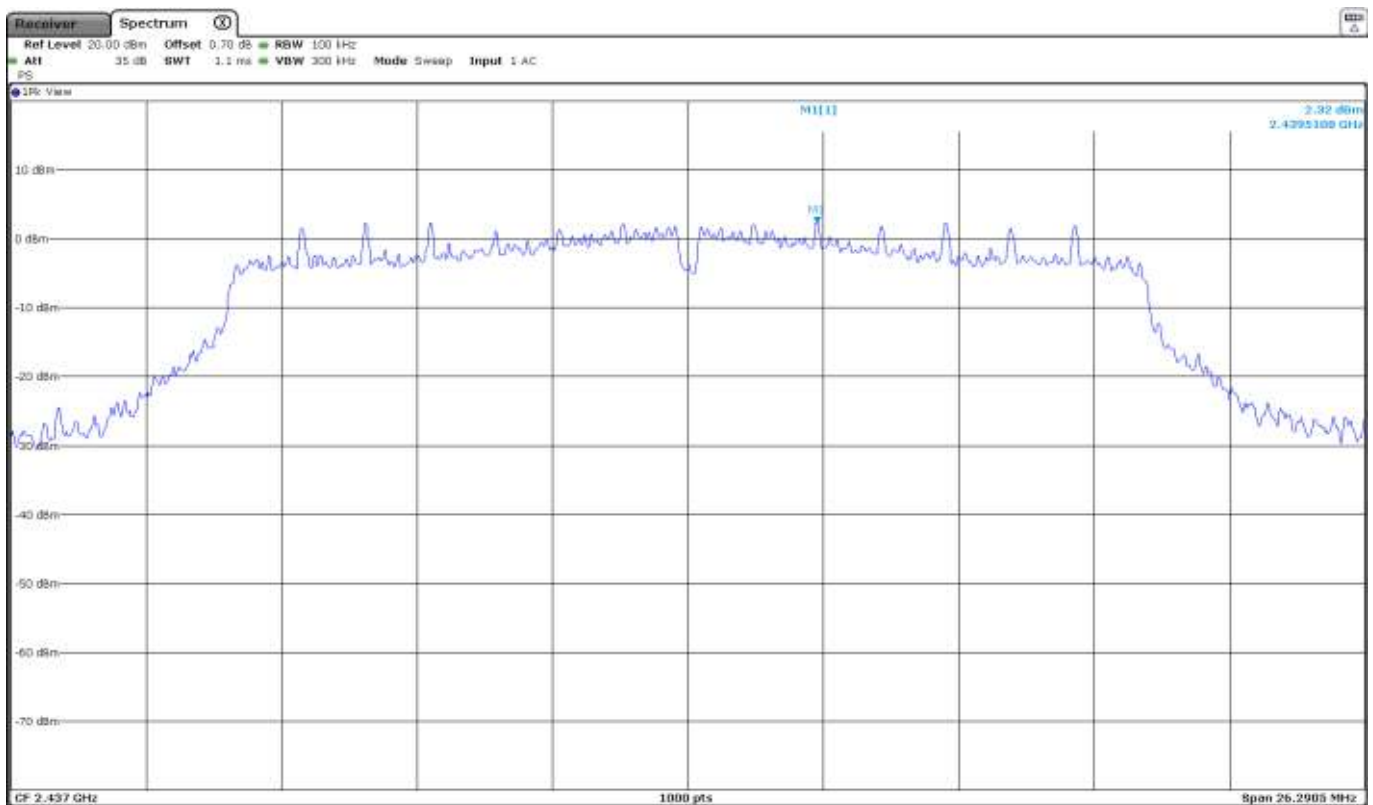


- **Mode 802.11 n20 – Power Spectral Density**

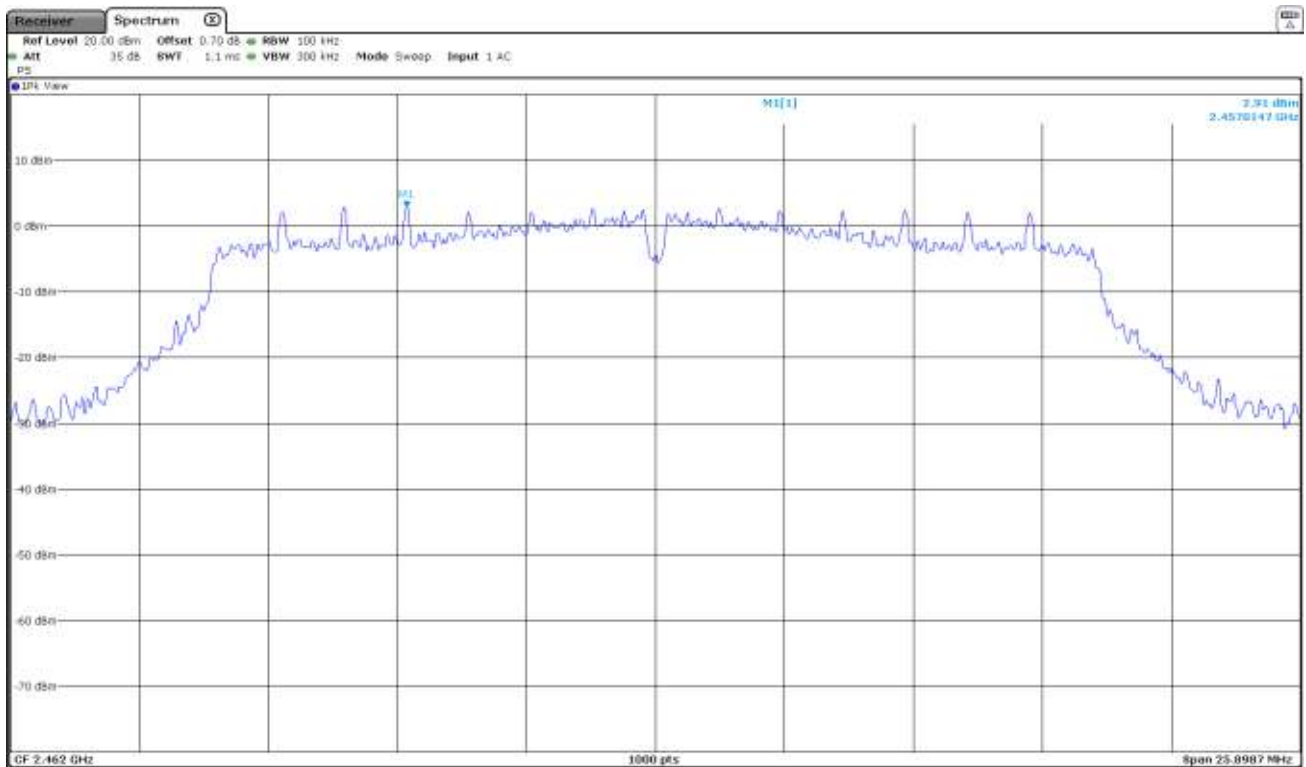
- Low Channel:



- Middle Channel:

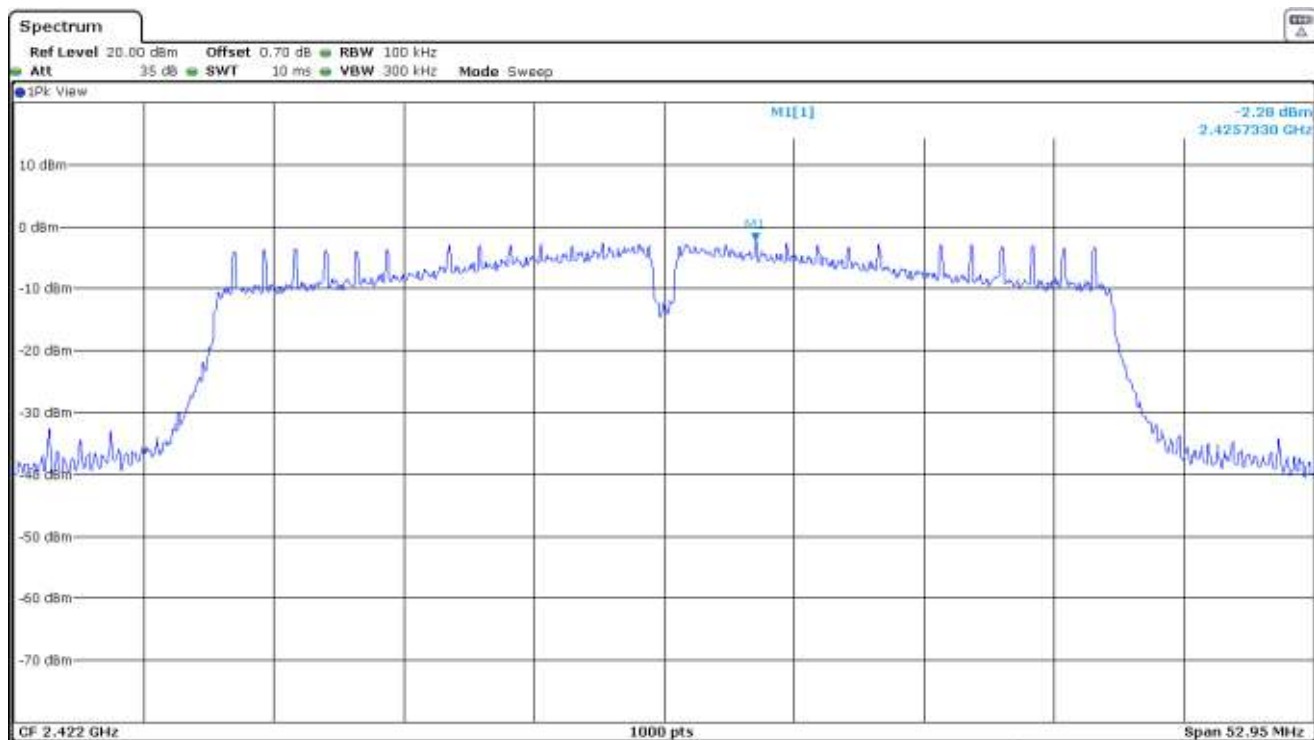


- High Channel:

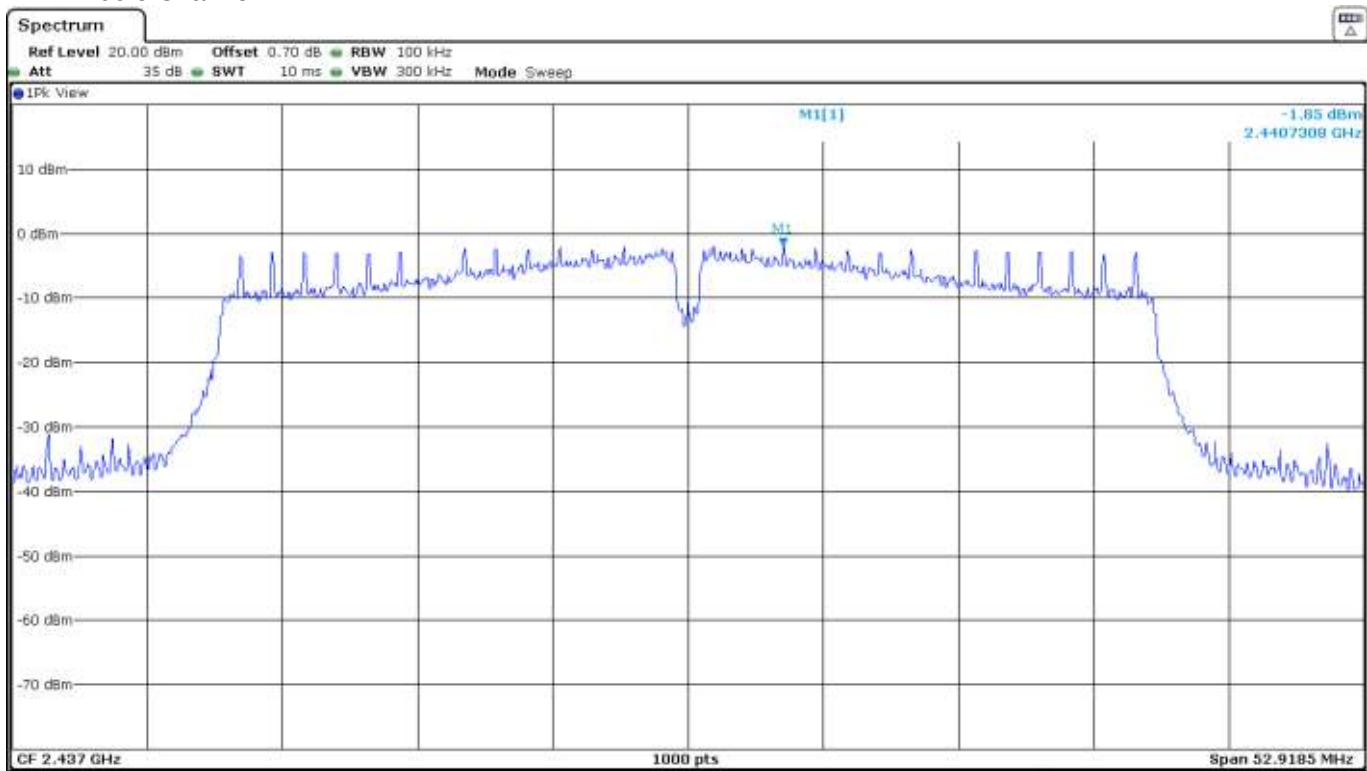


- Mode 802.11 n40 – Power Spectral Density

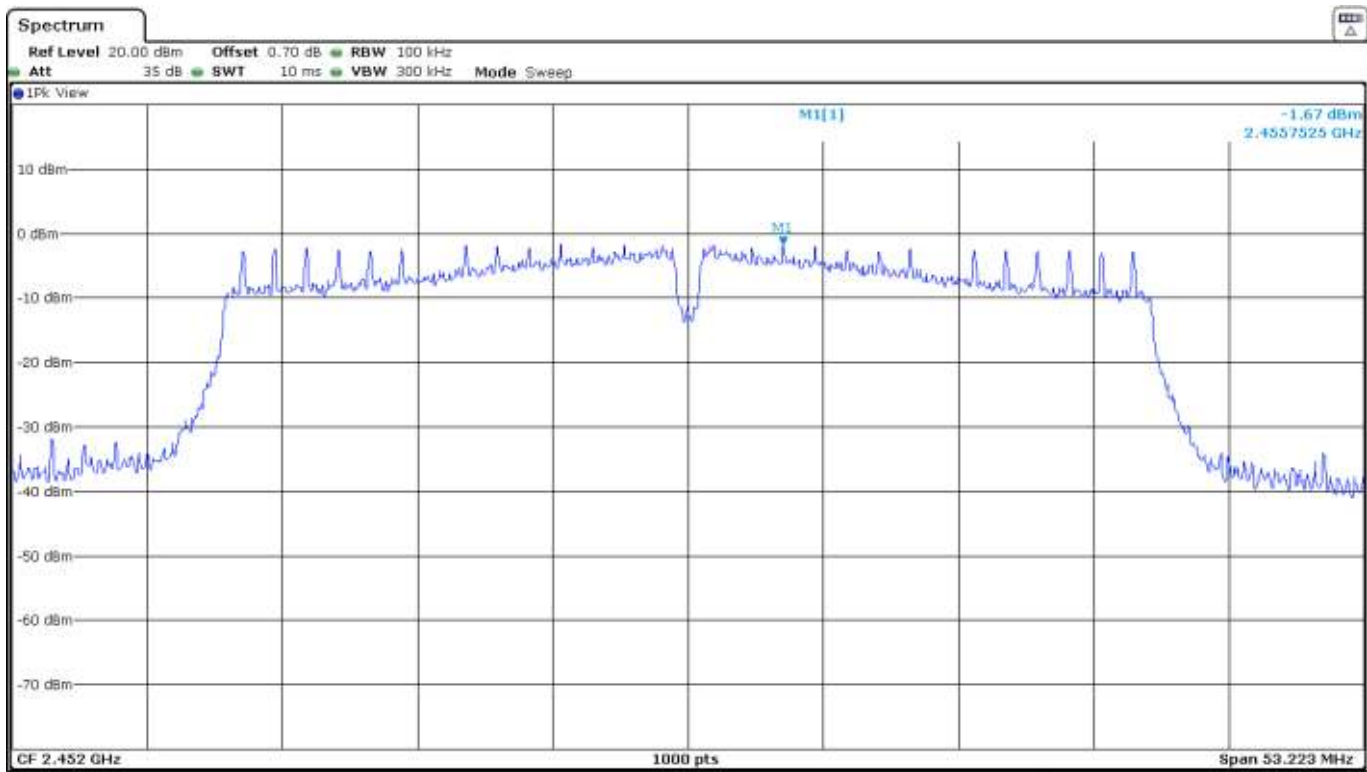
- Low Channel:



- Middle Channel:



- High Channel:



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

### SPECIFICATION:

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

| Frequency Range (MHz) | Field strength ( $\mu\text{V/m}$ ) | Field strength ( $\text{dB}\mu\text{V/m}$ ) | Measurement distance (m) |
|-----------------------|------------------------------------|---------------------------------------------|--------------------------|
| 0.009-0.490           | 2400/F(kHz)                        | -                                           | 300                      |
| 0.490-1.705           | 24000/F(kHz)                       | -                                           | 30                       |
| 1.705 - 30.0          | 30                                 | -                                           | 30                       |
| 30 - 88               | 100                                | 40                                          | 3                        |
| 88 - 216              | 150                                | 43.5                                        | 3                        |
| 216 - 960             | 200                                | 46                                          | 3                        |
| 960 - 10000           | 500                                | 54                                          | 3                        |

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

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

RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

### RESULTS:

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

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

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-26 GHz.

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

### Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT

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

| Spurious frequency (MHz) | Detector   | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|------------|-------------------------|--------------|------------------------------|
| 250.012                  | Quasi peak | 30.2                    | V            | <± 3.04                      |
| 375.013                  | Quasi peak | 34.0                    | H            | <± 3.04                      |
| 525.007                  | Quasi peak | 34.3                    | V            | <± 3.04                      |
| 562.514                  | Quasi peak | 33.6                    | H            | <± 3.04                      |
| 750.015                  | Quasi peak | 31.6                    | H            | <± 3.04                      |
| 937.516                  | Quasi peak | 31.7                    | H            | <± 3.04                      |
| 956.722                  | Quasi peak | 29.8                    | H            | <± 3.04                      |

### • Mode 802.11 b

#### Frequency range 1 - 26 GHz:

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

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

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 3.23614                  | Peak     | 40.60                   | V            | <± 3.04                      |
| 7.23617                  | Peak     | 48.98                   | V            | <± 4.88                      |

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 5.99997                  | Peak     | 40.42                   | V            | <± 4.88                      |
| 7.3127                   | Peak     | 47.54                   | V            | <± 4.88                      |

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

| Spurious frequency (MHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 2.48354                  | Peak     | 53.54                   | V            | <±3.04                       |
| 5.99997                  | Peak     | 40.05                   | V            | <± 4.88                      |

Verdict: PASS

## **OFDM modes:**

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

Spurious emissions in including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz are measured for all modes.

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

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

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

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 2.38995                  | Peak     | 64.2                    | V            | <±3.04                       |
|                          | Average  | 49.57                   |              | <±3.04                       |
| 7.23057                  | Peak     | 52.55                   | V            | <± 4.88                      |

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 7.3127                   | Peak     | 49.89                   | V            | <± 4.88                      |

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

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 2.48408878               | Peak     | 63.46                   | H            | <±3.04                       |
|                          | Average  | 49.45                   |              | <±3.04                       |

Verdict: PASS

• **Mode 802.11 n20**

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

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

- RESTRICTED BAND 2.31 - 2.39 GHz. Spurious frequencies operating at less than 20 dB below the limit:

LOW CHANNEL:

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 2.3888547                | Peak     | 63.73                   | V            | <±3.04                       |
|                          | Average  | 48.68                   |              | <±3.04                       |

- RESTRICTED BAND 2.4835 - 2.5 GHz. Spurious frequencies operating at less than 20 dB below the limit:

HIGH CHANNEL:

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 2.48371533               | Peak     | 70.85                   | V            | <±3.04                       |
|                          | Average  | 52.91                   |              | <±3.04                       |

Verdict: PASS

• **Mode 802.11 n40**

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

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

- RESTRICTED BAND 2.31 - 2.39 GHz. Spurious frequencies operating at less than 20 dB below the limit:

LOW CHANNEL:

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 2.3798173                | Peak     | 59.24                   | V            | <±3.04                       |
|                          | Average  | 49.73                   |              | <±3.04                       |

- RESTRICTED BAND 2.4835 - 2.5 GHz. Spurious frequencies operating at less than 20 dB below the limit:

HIGH CHANNEL:

| Spurious frequency (GHz) | Detector | Emission Level (dBμV/m) | Polarization | Measurement Uncertainty (dB) |
|--------------------------|----------|-------------------------|--------------|------------------------------|
| 2.48540878               | Peak     | 67.25                   | V            | <±3.04                       |
|                          | Average  | 53.91                   |              | <±3.04                       |

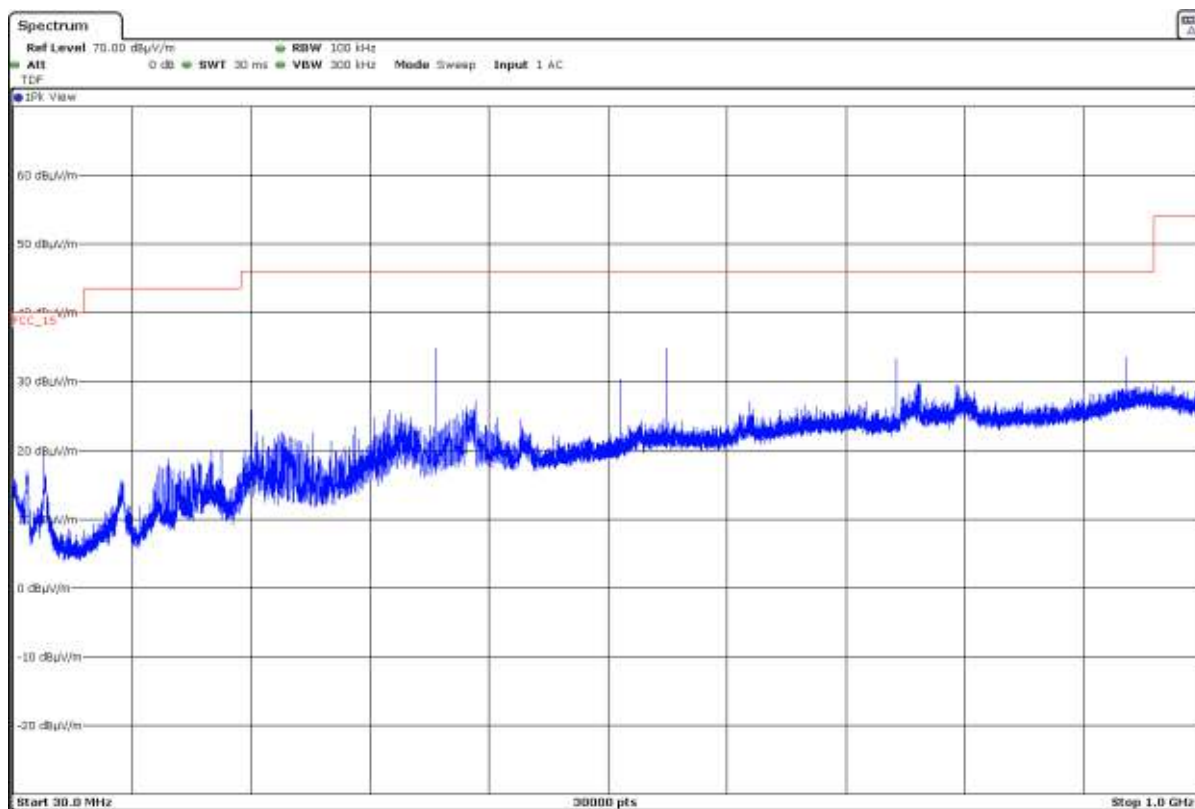
Verdict: PASS

- **Mode 802.11 b**

FREQUENCY RANGE 30 MHz - 1 GHz:

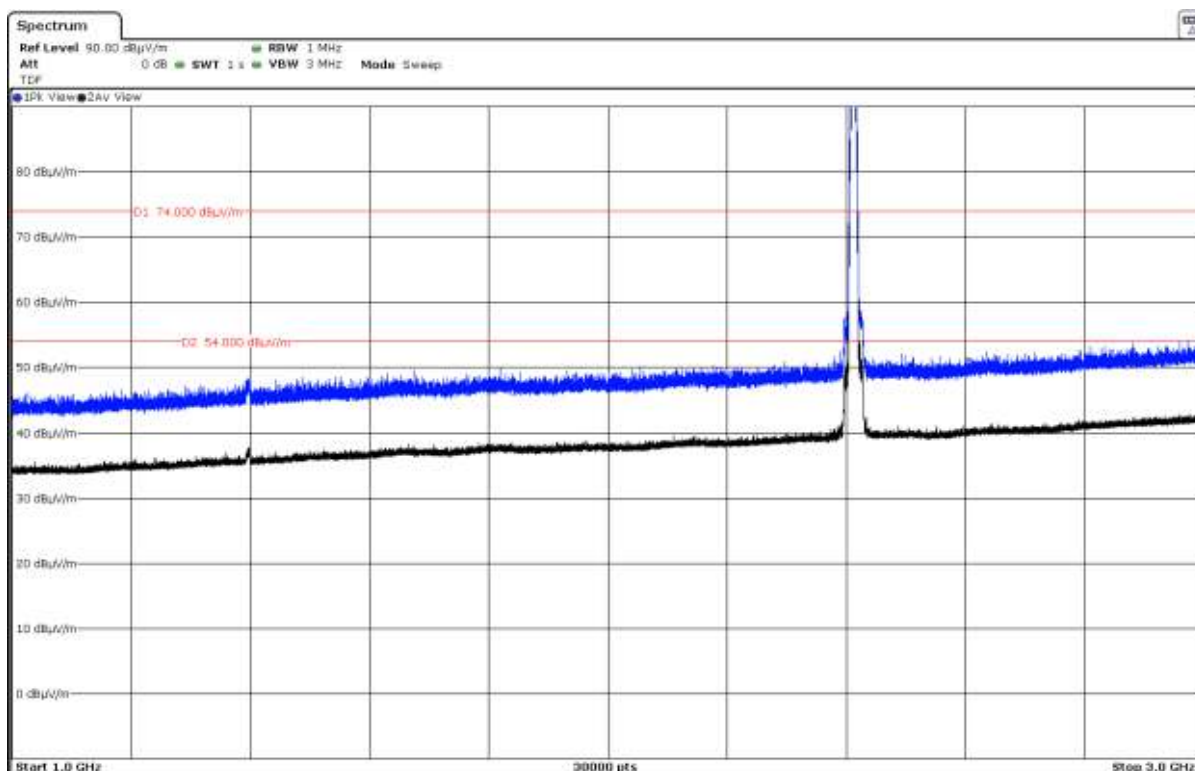
The spurious frequencies detected do not depend on the operating channel.

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



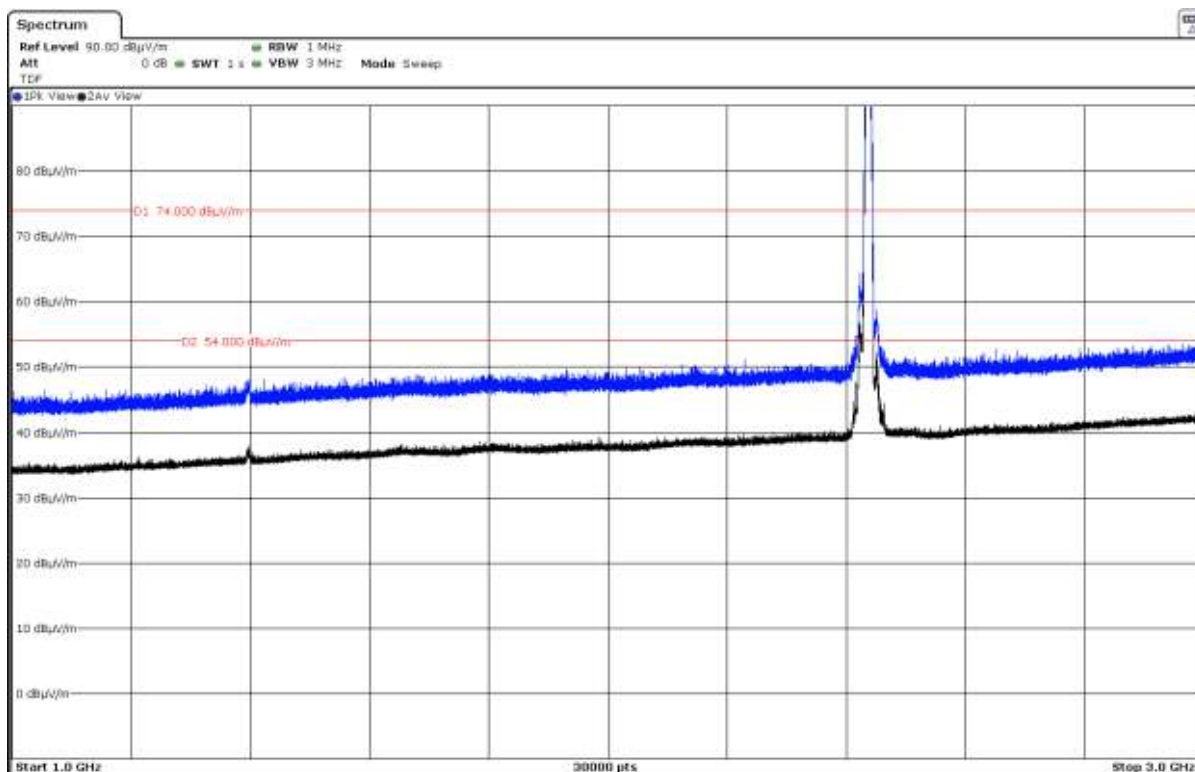
## FREQUENCY RANGE 1 - 3 GHz:

### - Low Channel:



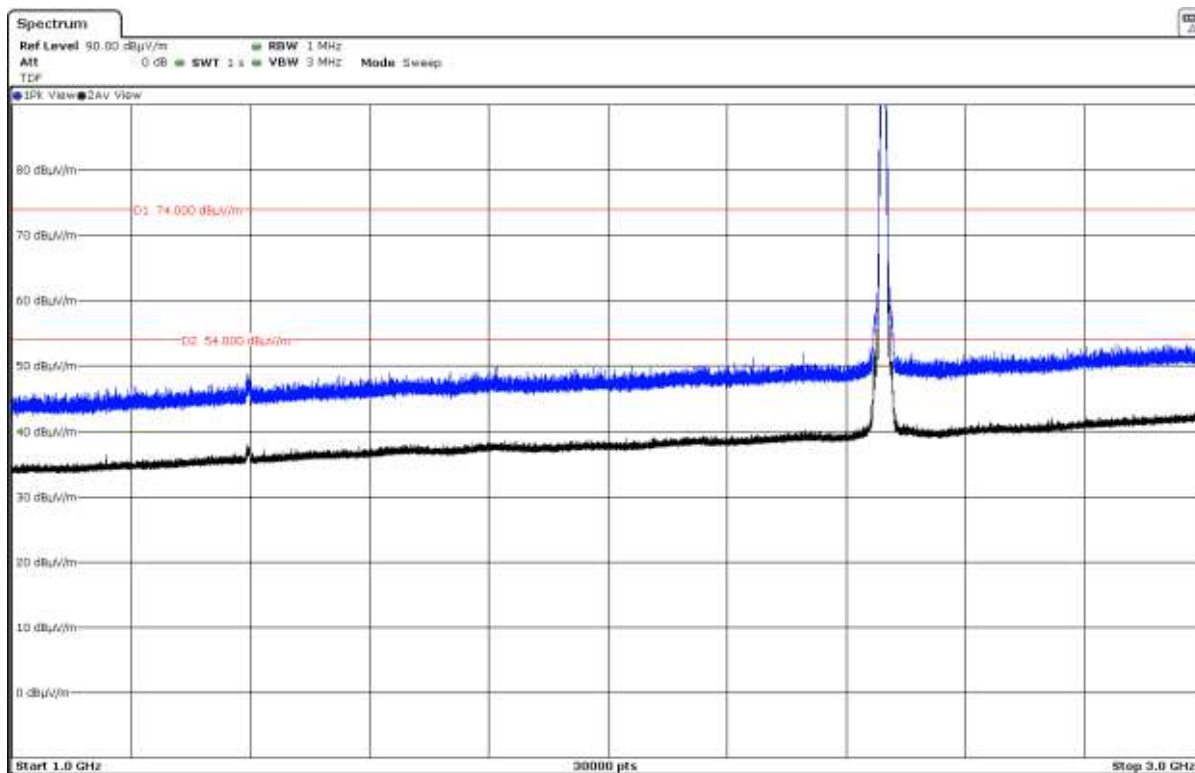
The peak above the limit is the carrier frequency.

### - Middle Channel:



The peak above the limit is the carrier frequency.

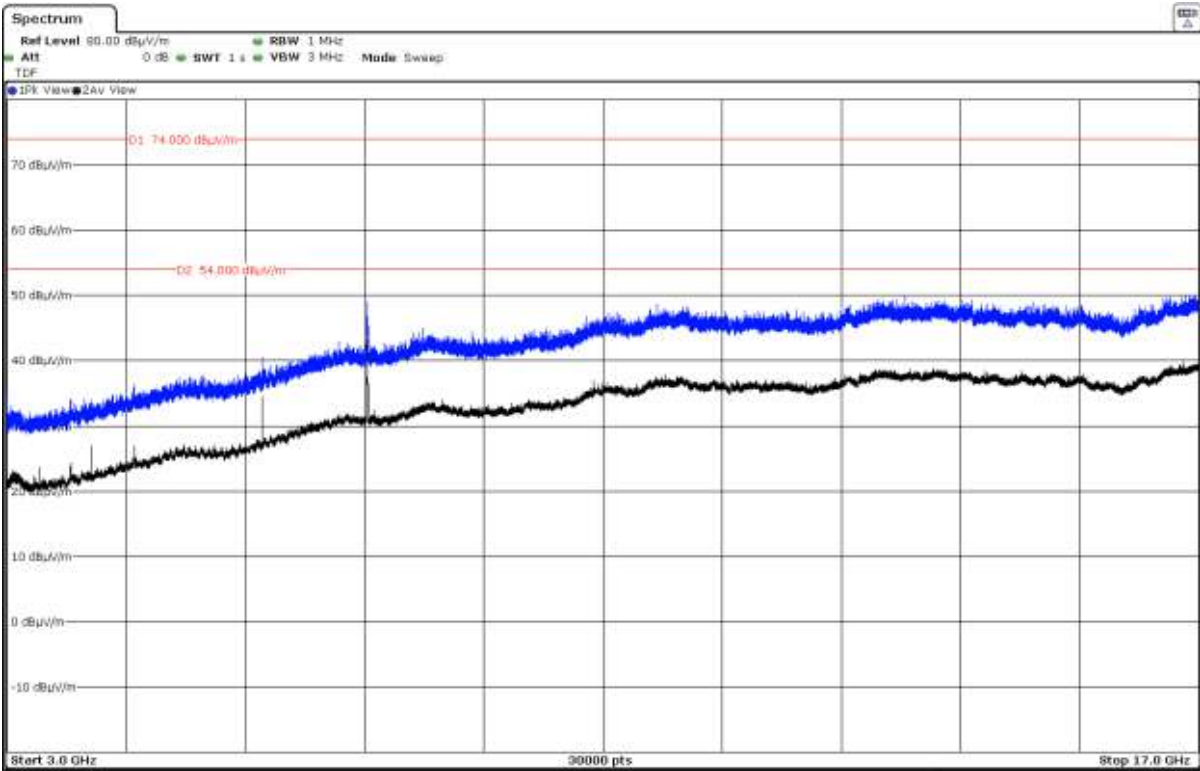
- High Channel:



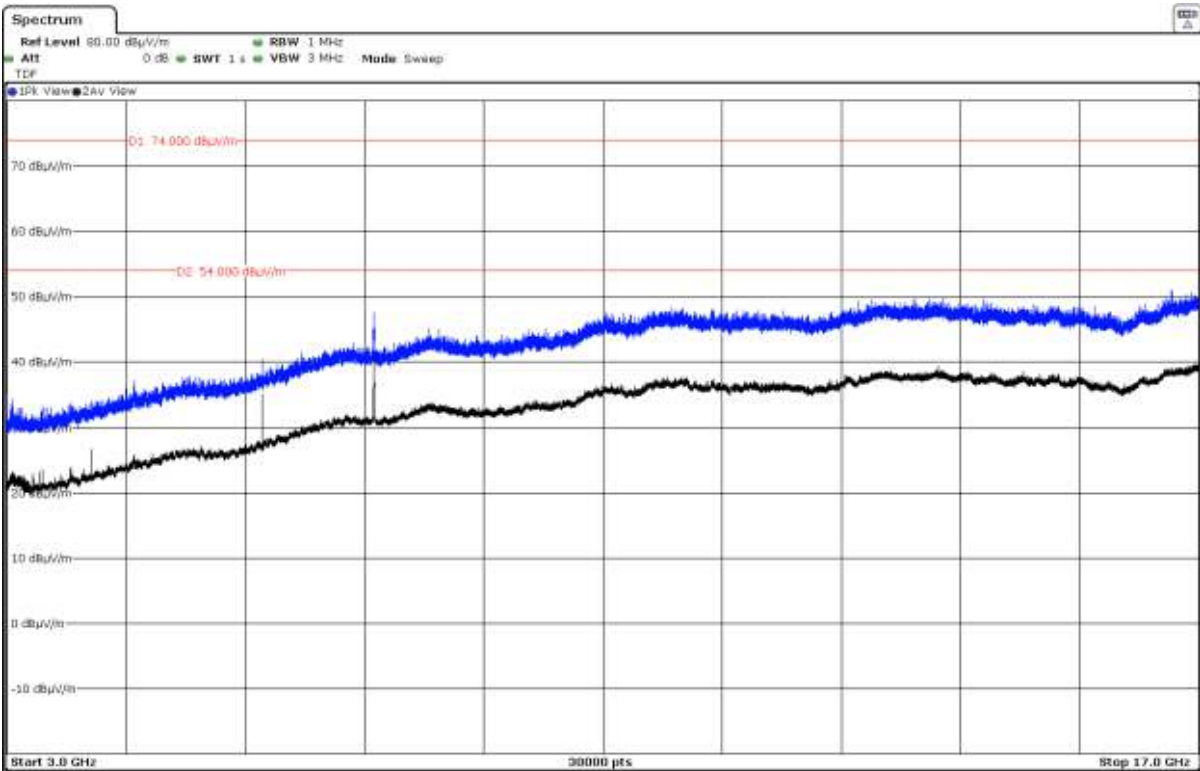
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

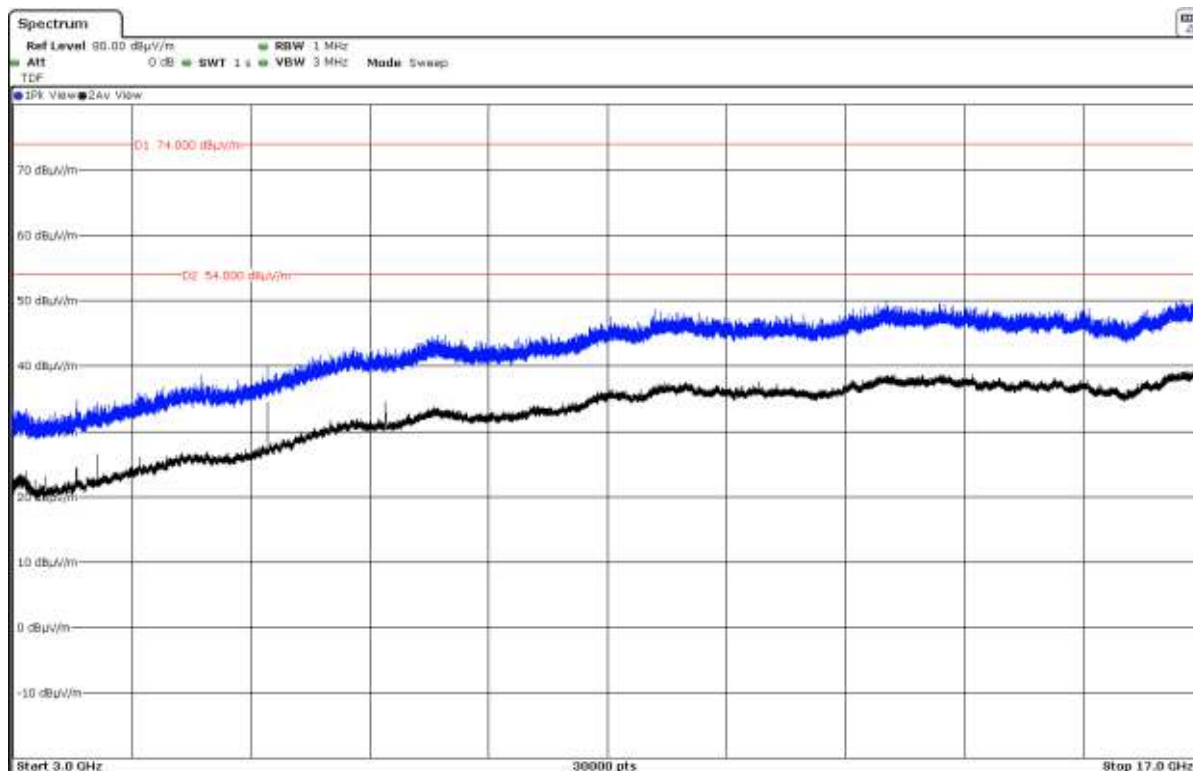
- Low Channel:



- Middle Channel:



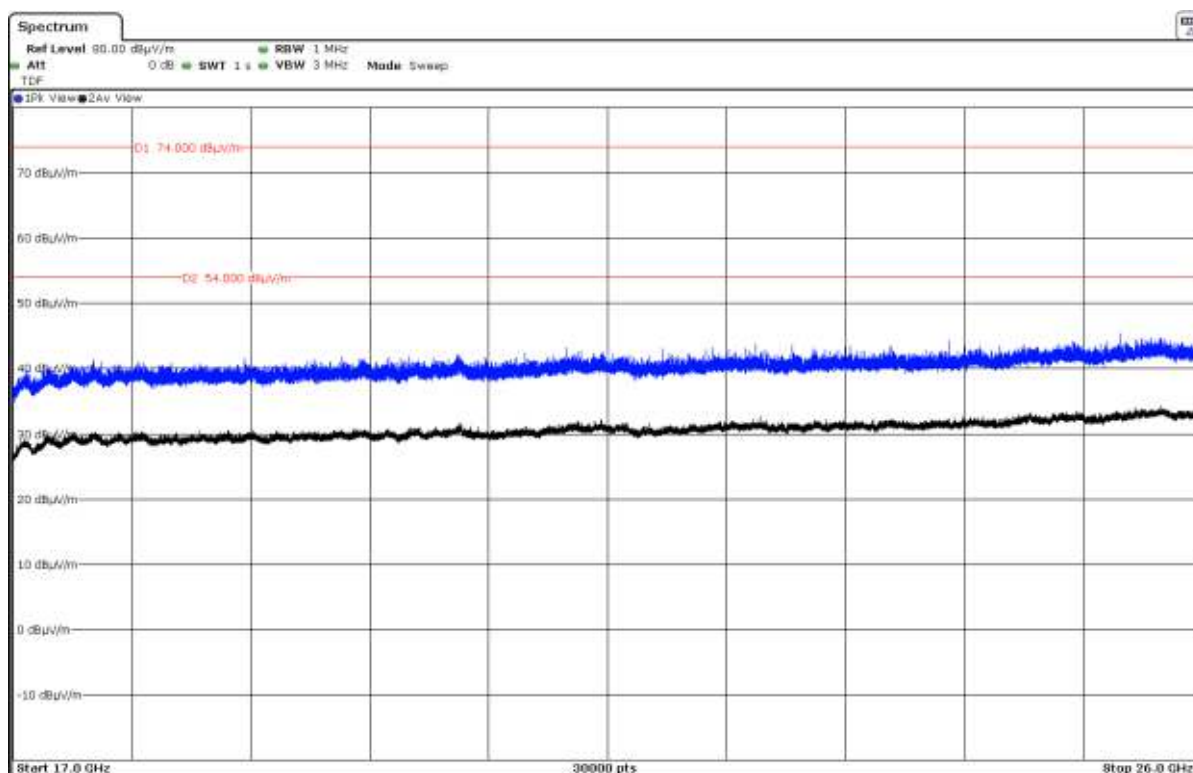
- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

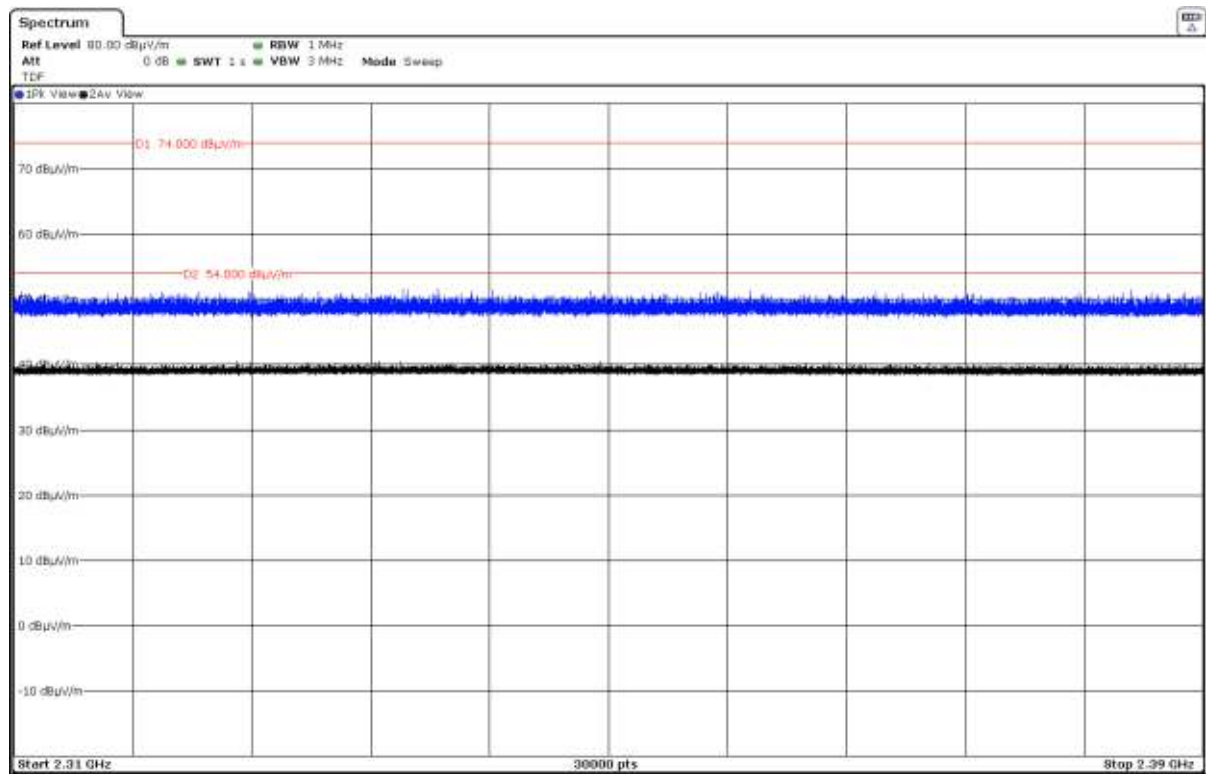
The spurious frequencies detected do not depend on the operating channel.

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



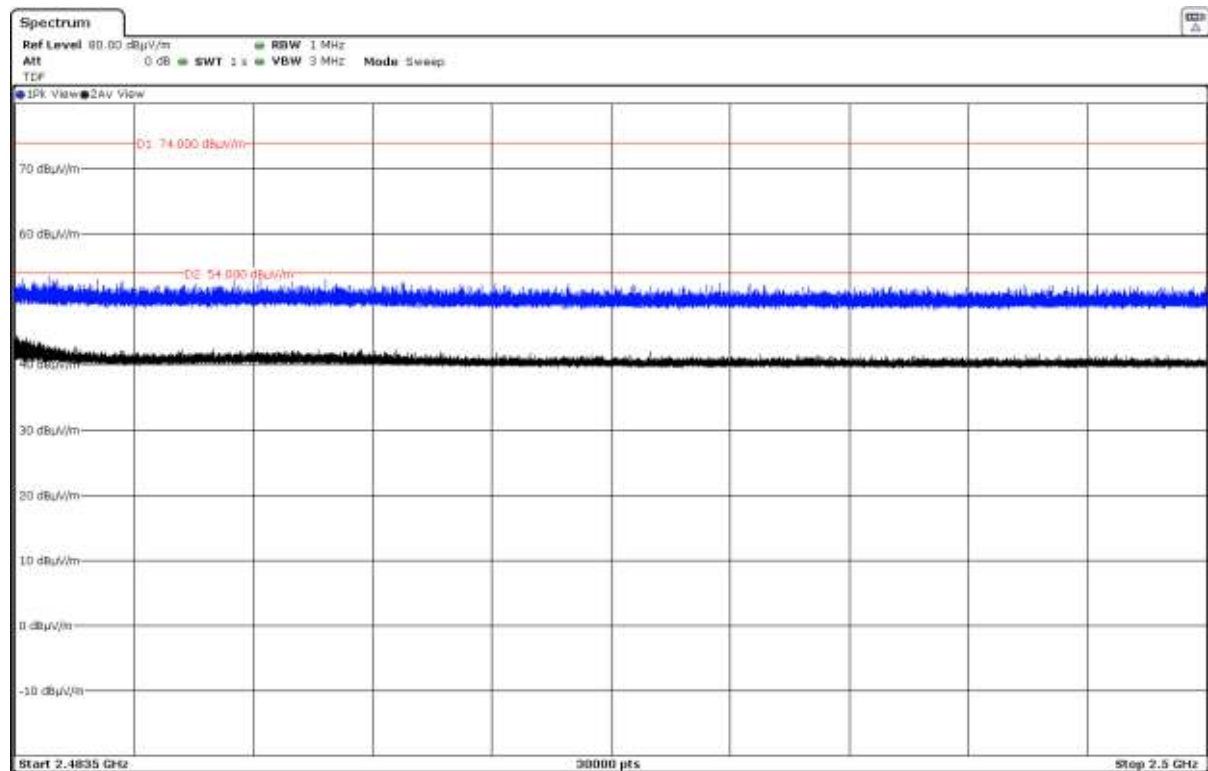
FREQUENCY RANGE 2.31-2.39 GHz:

- Low Channel. CH 1:



FREQUENCY RANGE 2.4835-2.5 GHz:

- High Channel. CH 11:

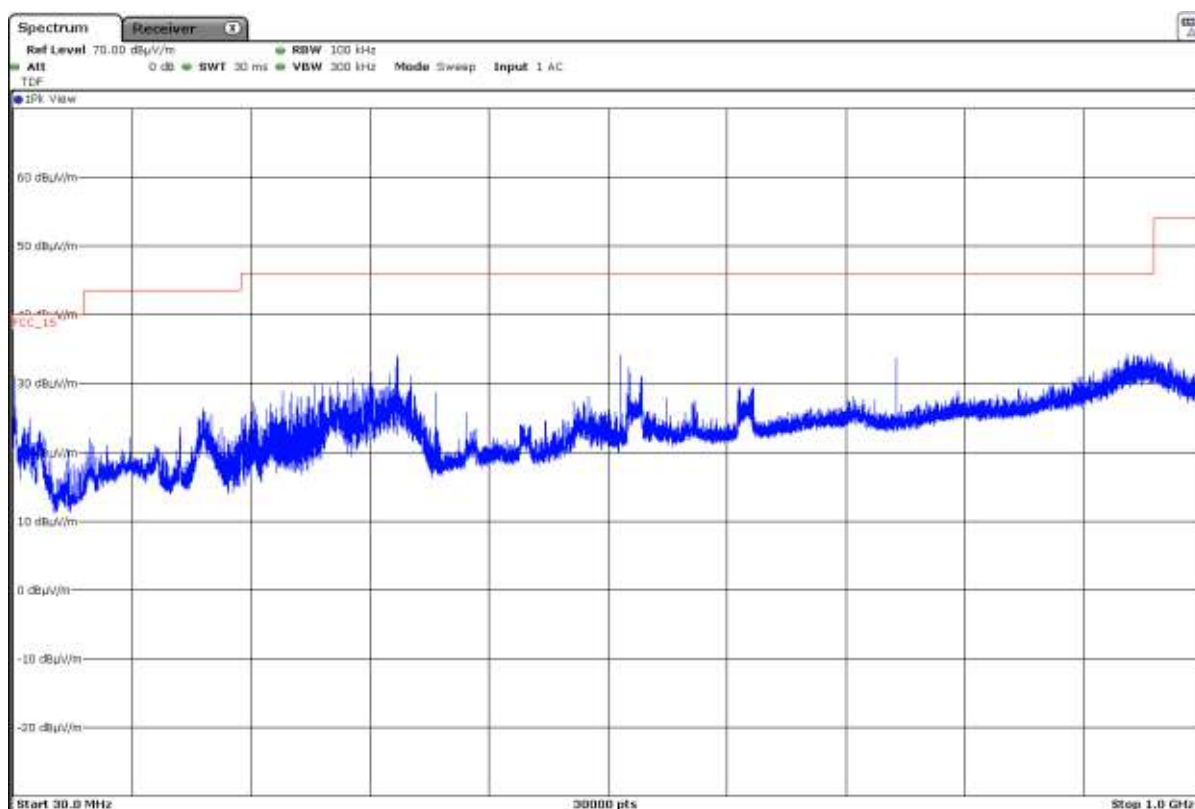


- **Mode 802.11 g (OFDM worst case for spurious emissions)**

FREQUENCY RANGE 30 MHz - 1 GHz:

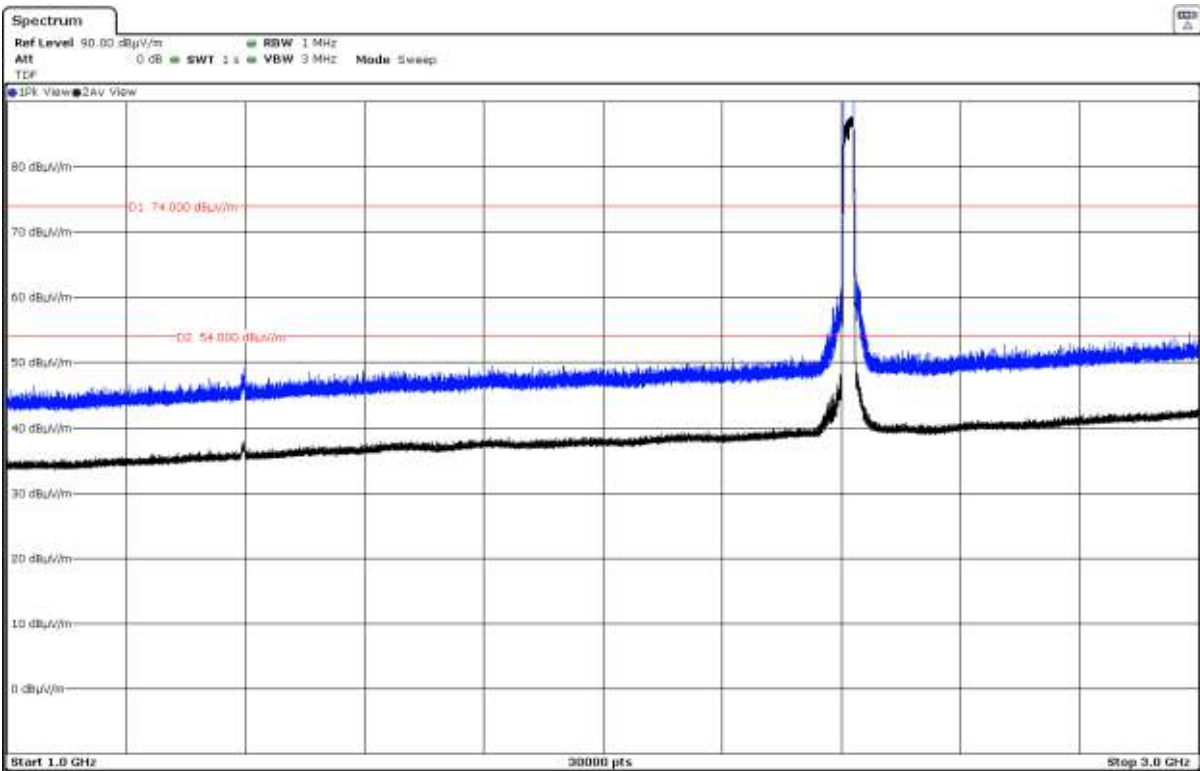
The spurious frequencies detected do not depend on the operating channel.

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



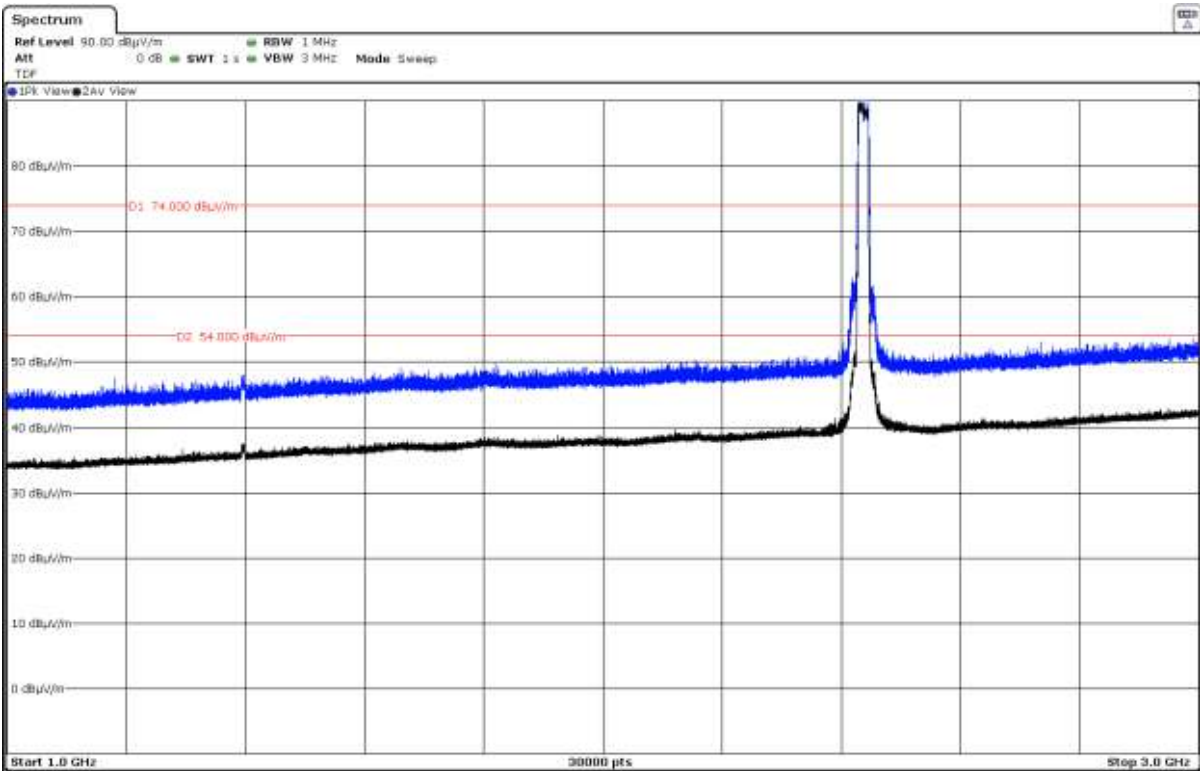
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



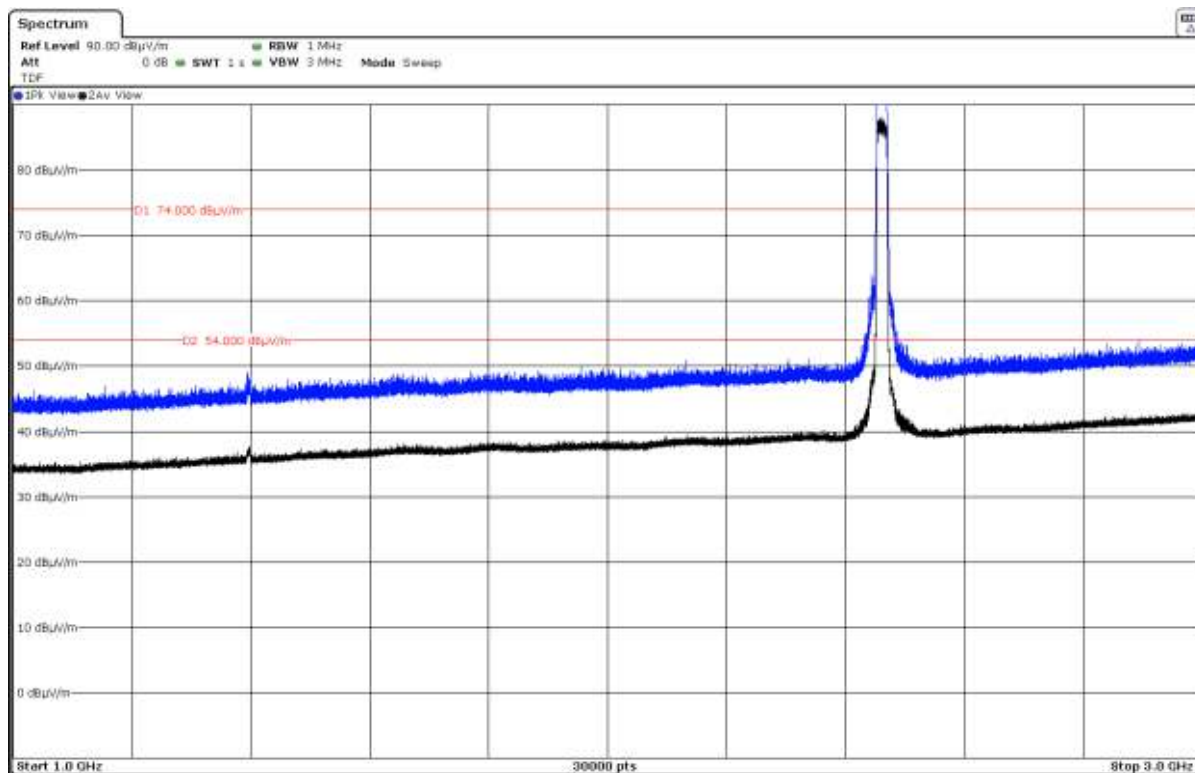
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

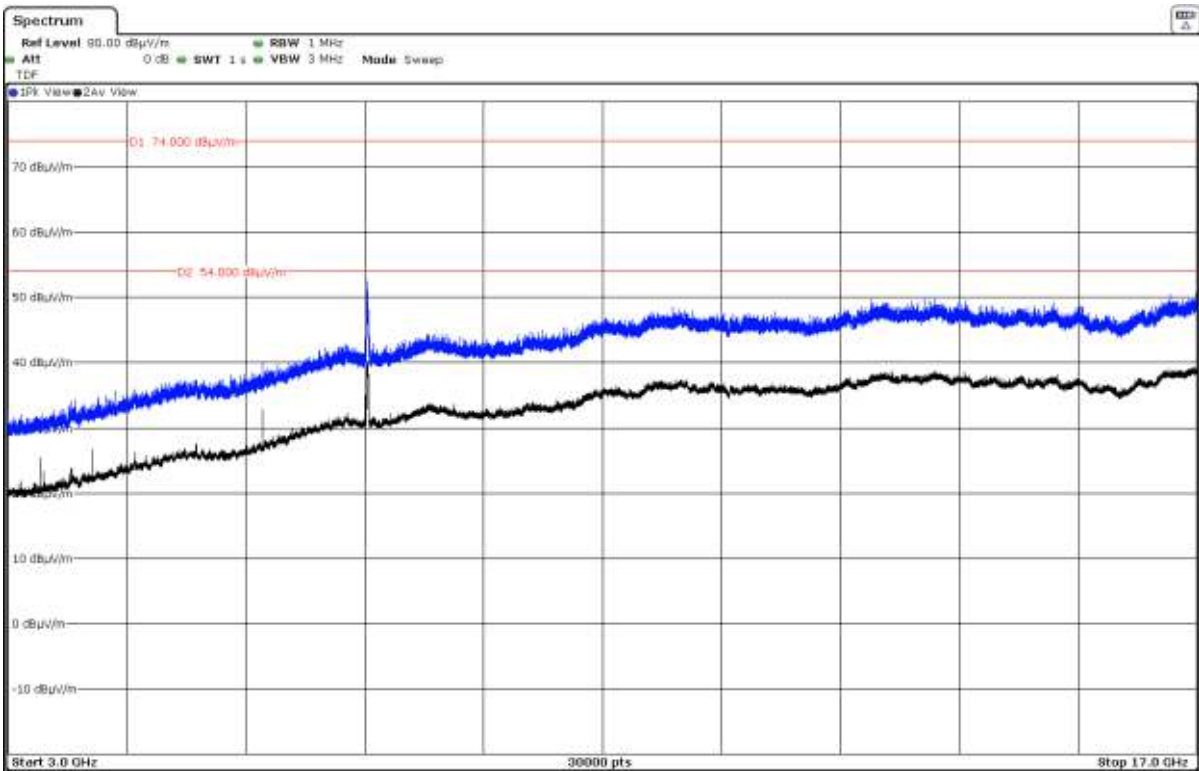
- High Channel:



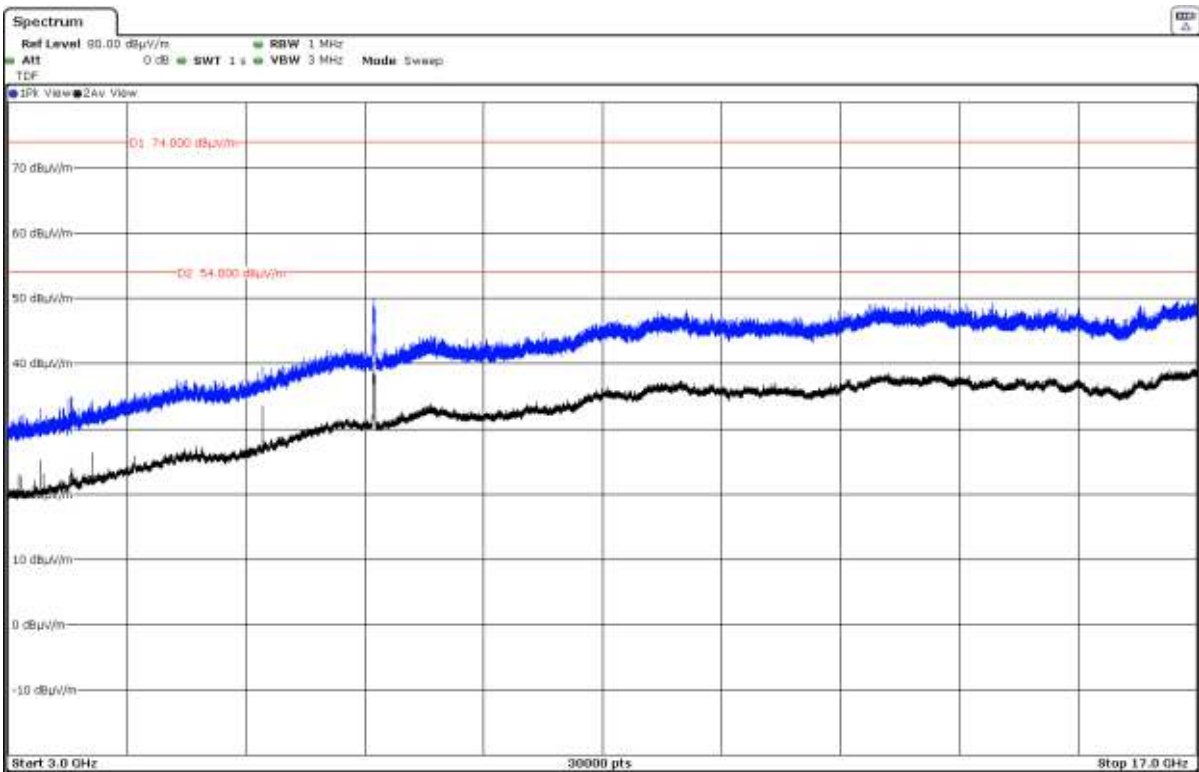
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

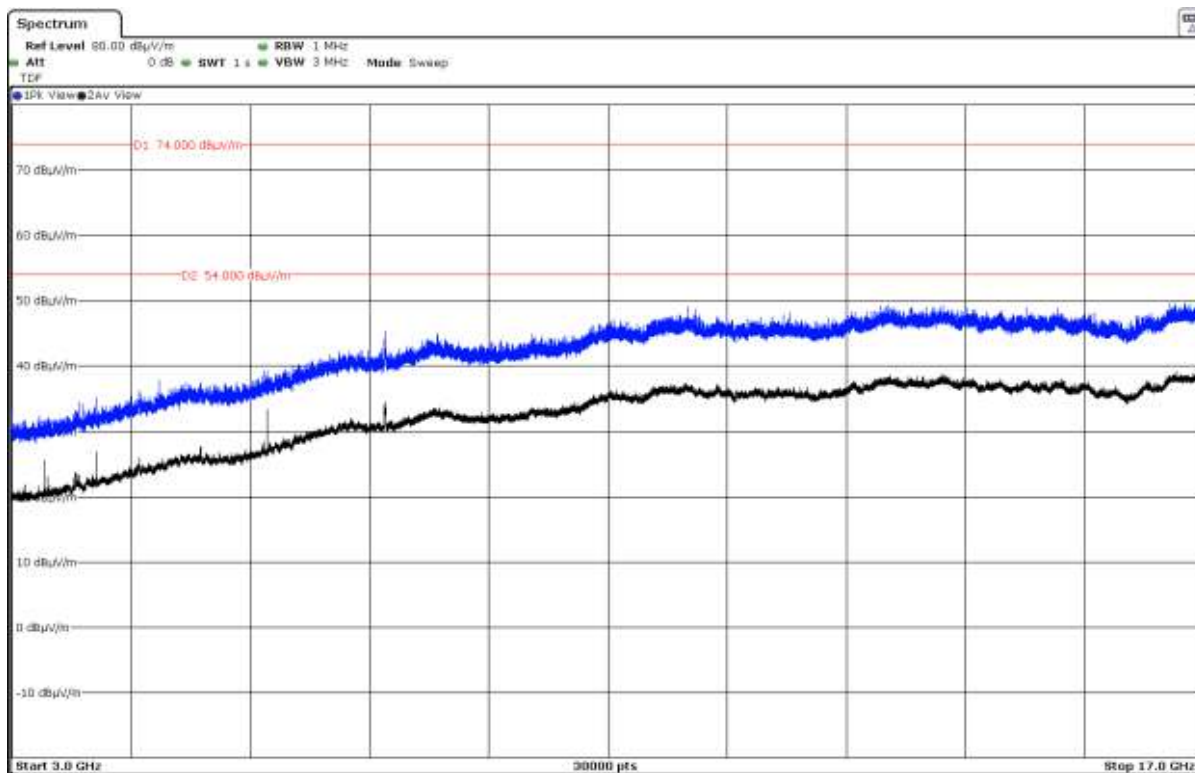
- Low Channel:



- Middle Channel:



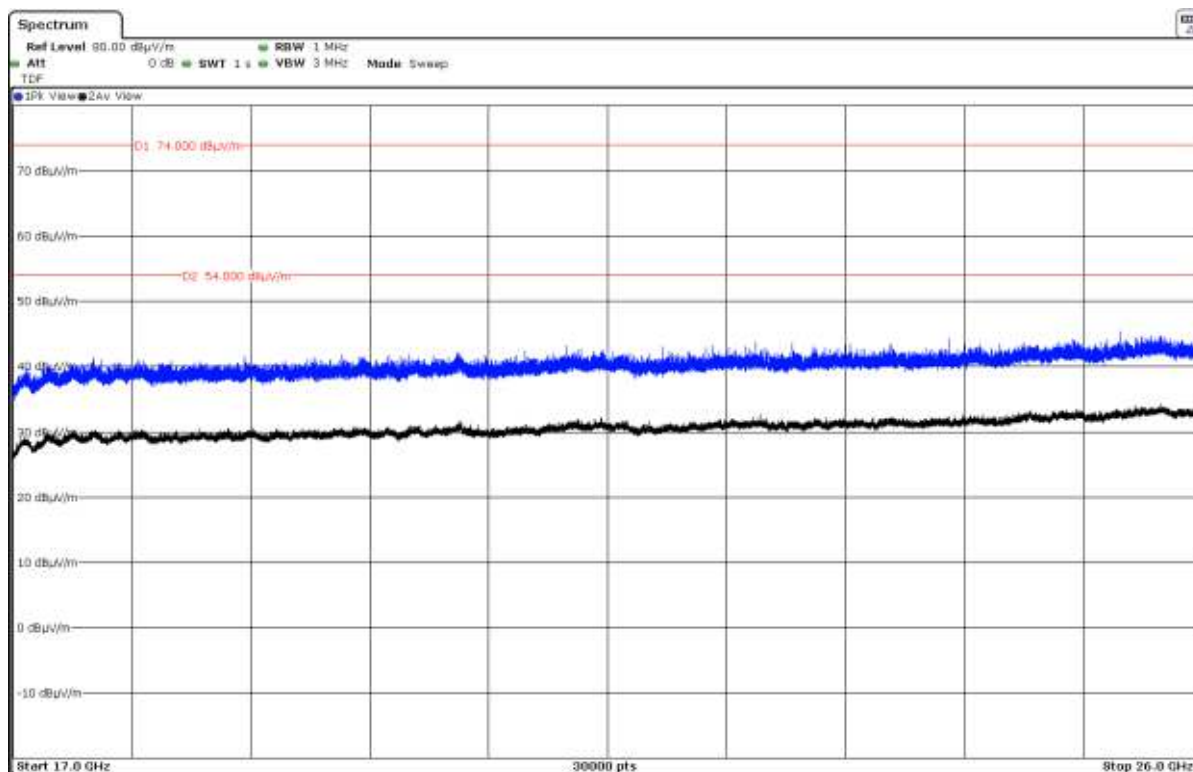
- High Channel:



## FREQUENCY RANGE 17 - 26 GHz:

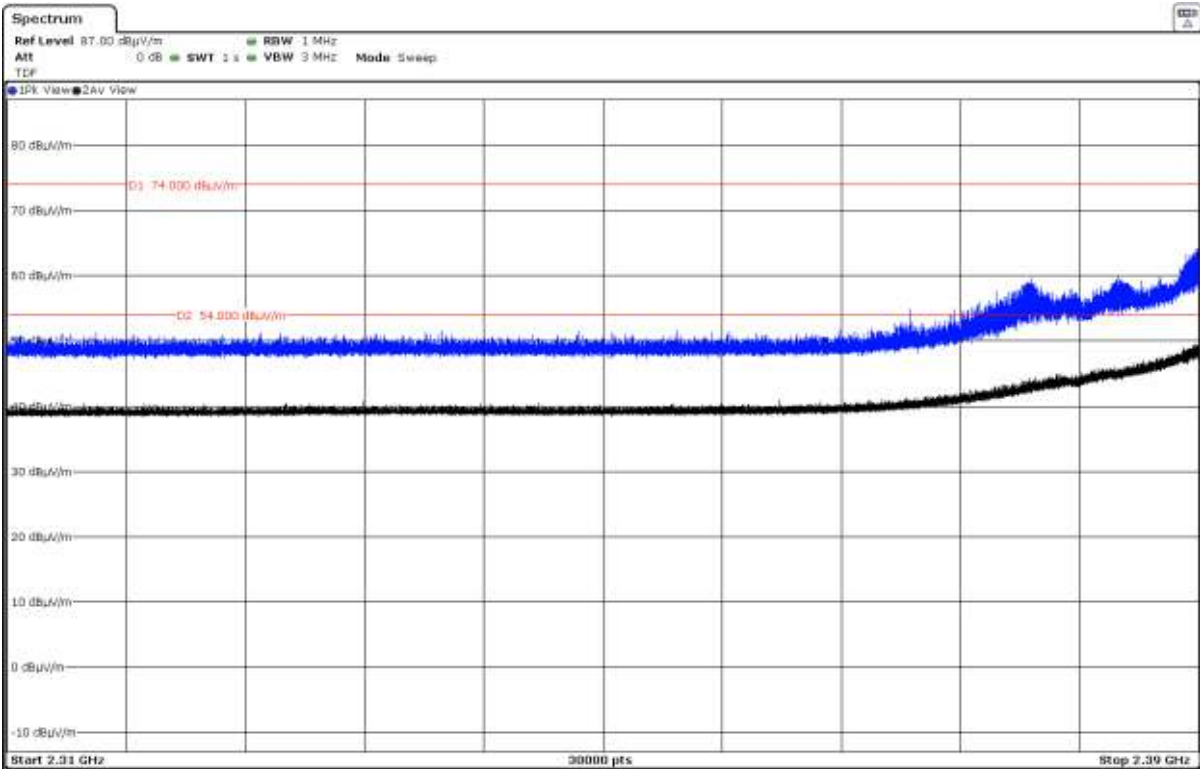
The spurious frequencies detected do not depend on the operating channel.

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



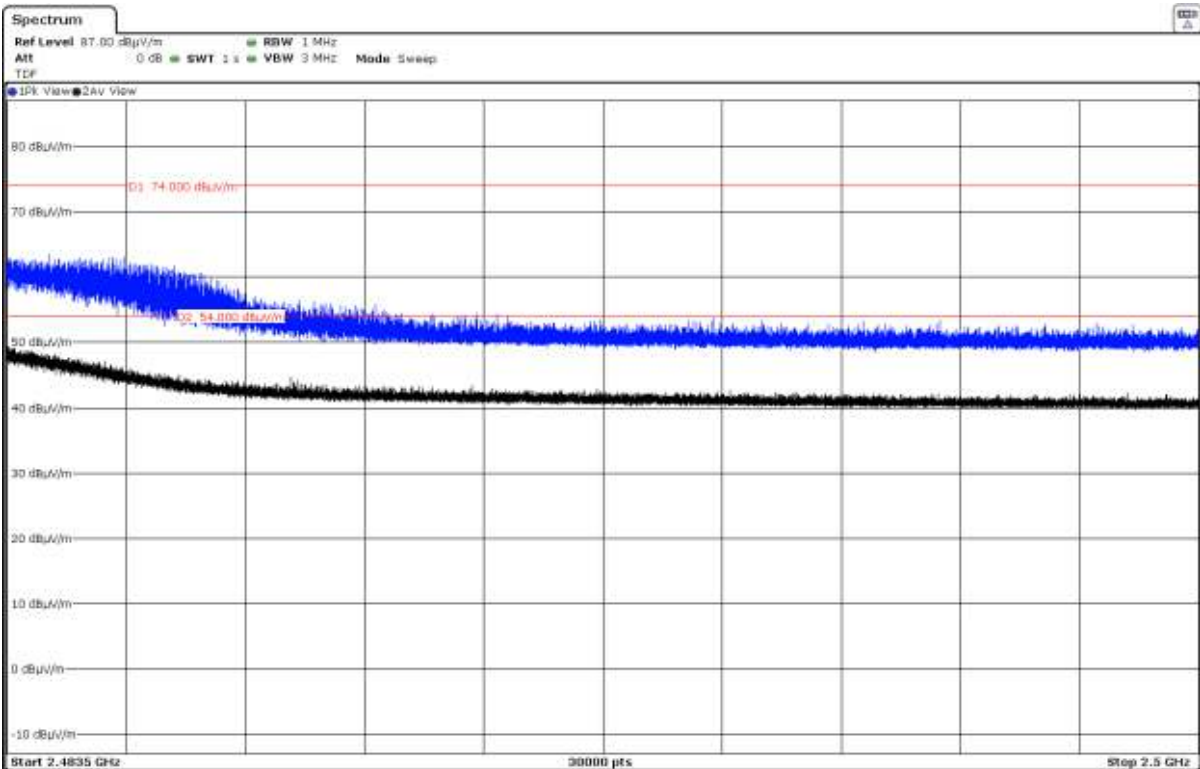
FREQUENCY RANGE 2.31-2.39 GHz

- Low Channel:



FREQUENCY RANGE 2.4835-2.5 GHz:

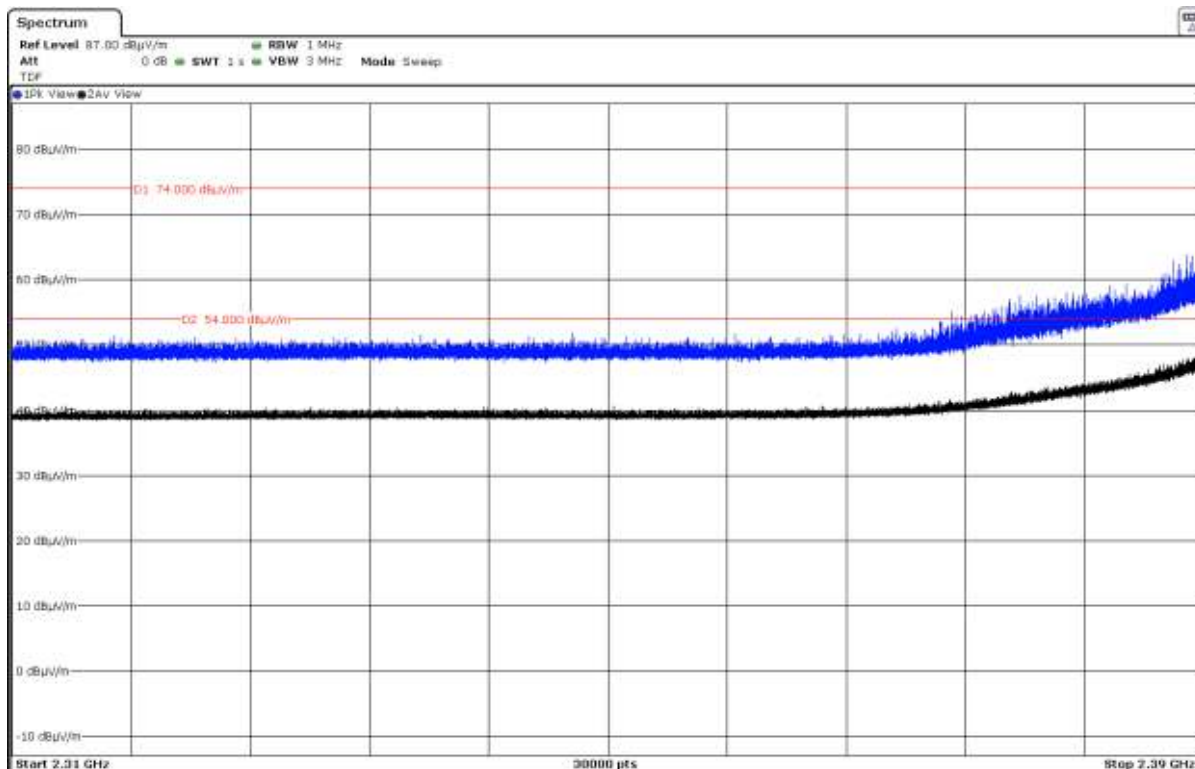
- High Channel:



- **Mode 802.11 n20**

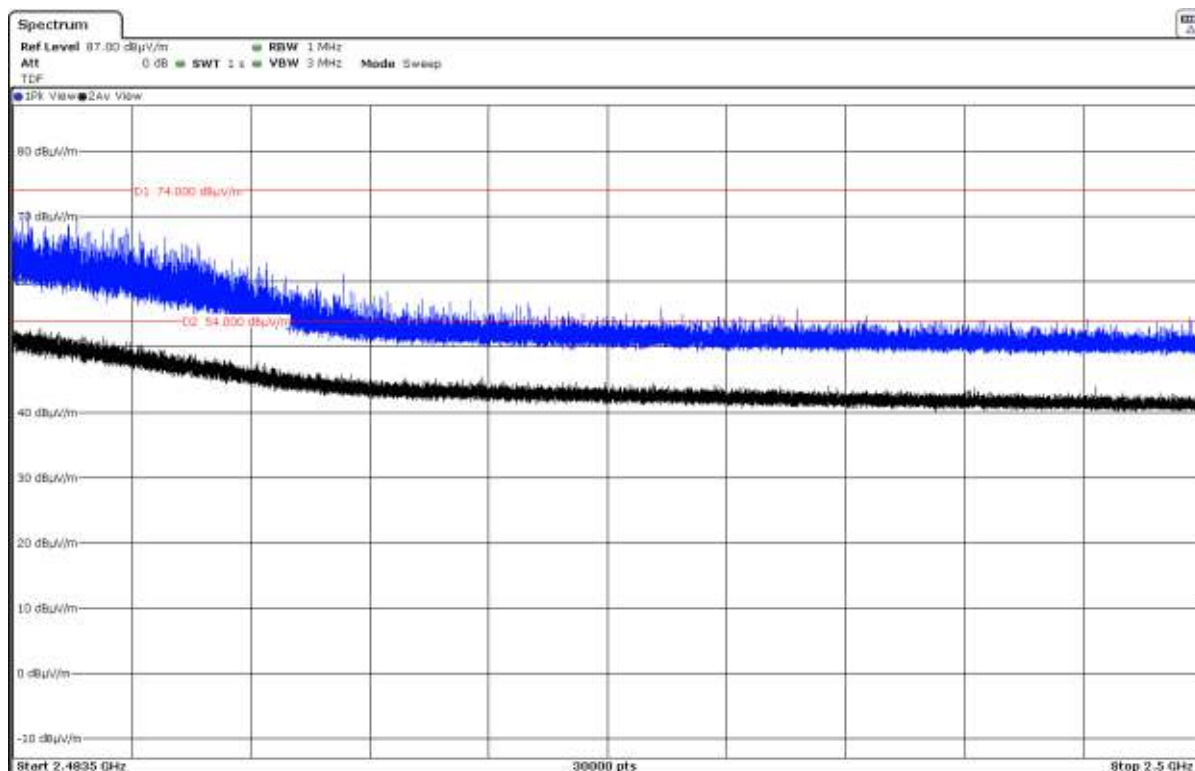
FREQUENCY RANGE 2.31-2.39 GHz:

- Low Channel:



FREQUENCY RANGE 2.4835-2.5 GHz:

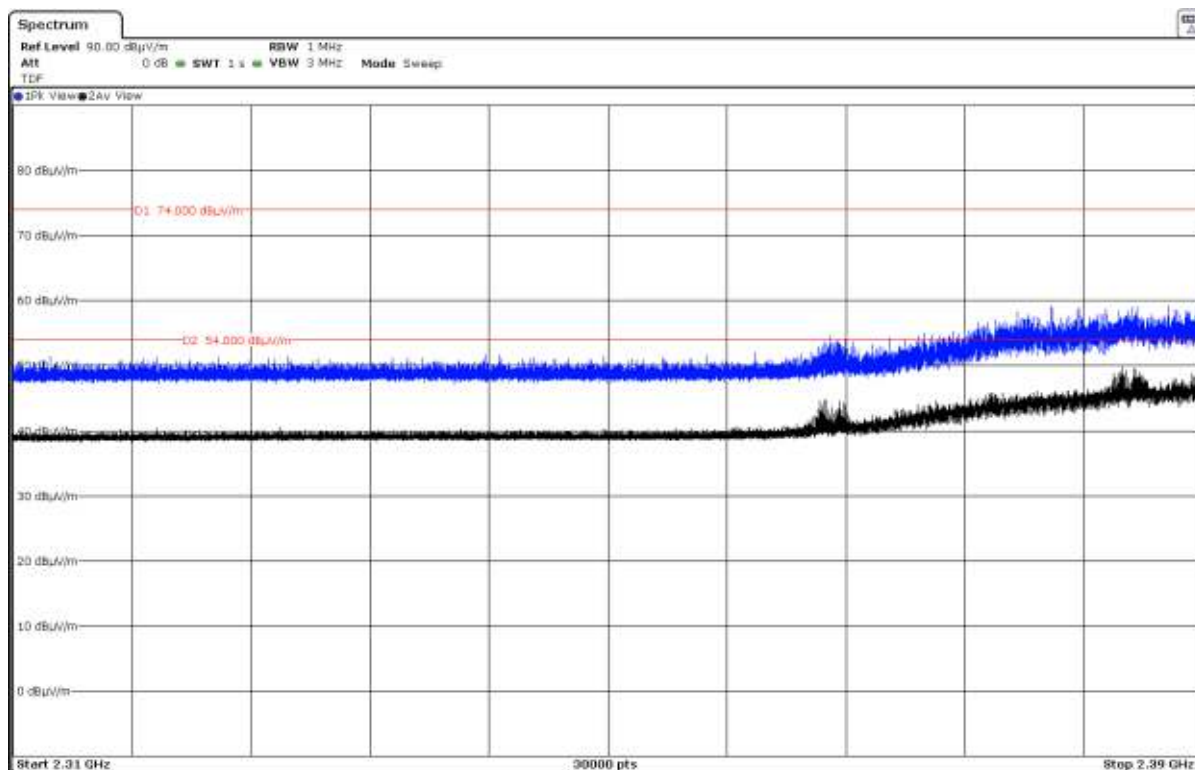
- High Channel:



- **Mode 802.11 n40**

FREQUENCY RANGE 2.31-2.39 GHz:

- Low Channel:



FREQUENCY RANGE 2.4835-2.5 GHz:

- High Channel:

