



FCC LISTED, REGISTRATION  
NUMBER: 905266

IC LISTED REGISTRATION NUMBER  
IC 4621A-1

**AT4 wireless, S.A.**

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Registro Mercantil de Málaga, Tomo 1169,

Libro 82, Folio 133, Hoja MA3729

**TEST REPORT**

**REFERENCE STANDARD:**

**USA FCC Part 15.247, 15.209**

**CANADA RSS-210, RSS-Gen**

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

**Licence-Exempt Radio Apparatus (All Frequency Bands): Category I Equipment.**

**General Requirements and Information for the Certification of Radio Apparatus.**

NIE..... : 40299RRF.001  
Approved by  
(name / position & signature) ..... : A. Llamas / RF Lab. Manager .....  
Elaboration date ..... : 2013-12-17

**Identification of item tested** ..... : Automotive Bluetooth Handsfree Module  
Brand name ..... : Johnson Control Interiors  
Model and/or type reference ..... : CB2-BLUE15M  
Serial number ..... : 2395893J000001T01, 2395893J000001V01, 2395897J000001701  
Other identification of the product ..... :  
Hw version: 1  
Sw version: 01.01.007  
FCC ID: CB2-BLUE15M  
IC ID: 279B-BLUE15M  
Features ..... : Bluetooth v2.1+EDR  
Description ..... : Automotive Bluetooth Handsfree Module

**Applicant** ..... : Johnson Controls INC.  
Address..... : 915 East 32nd Street, Holland, MI 49423 USA  
CIF/NIF/Passport..... : ---  
Contact person: Scott Keller  
Telephone / Fax ..... : +1 616-394-1568  
e-mail: ..... : Scott.R.Keller@jci.com

**Test samples supplier** ..... : Same as applicant

**Manufacturer** ..... : Same as applicant

<b>Test method requested</b> .....	See Standard																																																						
<b>Standard</b> .....	<p>USA FCC Part 15.247 10-01-12 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.</p> <p>USA FCC Part 15.209 10-01-12 Edition: Radiated emission limits; general requirements.</p> <p>CANADA RSS-210 Issue 8 (December 2010).</p> <p>CANADA RSS-Gen Issue 3 (December 2010).</p> <p>FCC part 15.247 and Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum System DA 00-705 Released March 30, 2000.</p> <p>ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices.</p>																																																						
<b>Test procedure</b> .....	PERF010: Medidas radioeléctricas a equipos de radio de espectro ensanchado en la banda de 2,4 GHz.																																																						
<b>Non-standardized test method</b> .....	N/A																																																						
<b>Used instrumentation</b> .....	<p style="text-align: center;"><u>Conducted Measurements</u></p> <table border="0" style="width: 100%;"> <thead> <tr> <th style="width: 70%;"></th> <th style="width: 15%; text-align: right;">Last Cal. date</th> <th style="width: 15%; text-align: right;">Cal. due date</th> </tr> </thead> <tbody> <tr> <td>1. Spectrum analyser Agilent PSA E4440A</td> <td style="text-align: right;">2012/02</td> <td style="text-align: right;">2014/02</td> </tr> <tr> <td>2. Spectrum analyser R&amp;S ESU 40</td> <td style="text-align: right;">2012/03</td> <td style="text-align: right;">2014/03</td> </tr> <tr> <td>3. DC power supply R&amp;S NGPE 40/40</td> <td style="text-align: right;">2011/11</td> <td style="text-align: right;">2014/11</td> </tr> </tbody> </table> <p style="text-align: center;"><u>Radiated Measurements</u></p> <table border="0" style="width: 100%;"> <thead> <tr> <th style="width: 70%;"></th> <th style="width: 15%; text-align: right;">Last Cal. date</th> <th style="width: 15%; text-align: right;">Cal. due date</th> </tr> </thead> <tbody> <tr> <td>1. Semianechoic Absorber Lined Chamber IR 11. BS</td> <td style="text-align: right;">N.A.</td> <td style="text-align: right;">N.A.</td> </tr> <tr> <td>2. Control Chamber IR 12.BC</td> <td style="text-align: right;">N.A.</td> <td style="text-align: right;">N.A.</td> </tr> <tr> <td>3. Hybrid Bilog antenna Sunol Sciences Corporation JB6</td> <td style="text-align: right;">2011/05</td> <td style="text-align: right;">2014/05</td> </tr> <tr> <td>4. Antenna mast EM 1072 NMT</td> <td style="text-align: right;">N.A.</td> <td style="text-align: right;">N.A.</td> </tr> <tr> <td>5. Rotating table EM 1084-4. ON</td> <td style="text-align: right;">N.A.</td> <td style="text-align: right;">N.A.</td> </tr> <tr> <td>6. Double-ridge Guide Horn antenna 1-18 GHz HP 11966E</td> <td style="text-align: right;">2011/05</td> <td style="text-align: right;">2014/05</td> </tr> <tr> <td>7. Double-ridge Guide Horn antenna 18-40 GHz Agilent 119665J</td> <td style="text-align: right;">2011/09</td> <td style="text-align: right;">2014/09</td> </tr> <tr> <td>8. EMI Test Receiver R&amp;S ESIB26</td> <td style="text-align: right;">2013/05</td> <td style="text-align: right;">2015/05</td> </tr> <tr> <td>9. RF pre-amplifier Miteq JS4-12002600-30-5A.</td> <td style="text-align: right;">2012/07</td> <td style="text-align: right;">2014/07</td> </tr> <tr> <td>10. Multi Device Controller EMCO 2090</td> <td style="text-align: right;">N.A.</td> <td style="text-align: right;">N.A.</td> </tr> <tr> <td>11. Spectrum analyser R&amp;S ESU 40</td> <td style="text-align: right;">2012/03</td> <td style="text-align: right;">2014/03</td> </tr> <tr> <td>12. RF pre-amplifier Miteq AFS5-04001300-15-10P-6.</td> <td style="text-align: right;">2012/07</td> <td style="text-align: right;">2014/07</td> </tr> <tr> <td>13. RF pre-amplifier Schaffner CPA 9231.</td> <td style="text-align: right;">2013/06</td> <td style="text-align: right;">2015/06</td> </tr> </tbody> </table>		Last Cal. date	Cal. due date	1. Spectrum analyser Agilent PSA E4440A	2012/02	2014/02	2. Spectrum analyser R&S ESU 40	2012/03	2014/03	3. DC power supply R&S NGPE 40/40	2011/11	2014/11		Last Cal. date	Cal. due date	1. Semianechoic Absorber Lined Chamber IR 11. BS	N.A.	N.A.	2. Control Chamber IR 12.BC	N.A.	N.A.	3. Hybrid Bilog antenna Sunol Sciences Corporation JB6	2011/05	2014/05	4. Antenna mast EM 1072 NMT	N.A.	N.A.	5. Rotating table EM 1084-4. ON	N.A.	N.A.	6. Double-ridge Guide Horn antenna 1-18 GHz HP 11966E	2011/05	2014/05	7. Double-ridge Guide Horn antenna 18-40 GHz Agilent 119665J	2011/09	2014/09	8. EMI Test Receiver R&S ESIB26	2013/05	2015/05	9. RF pre-amplifier Miteq JS4-12002600-30-5A.	2012/07	2014/07	10. Multi Device Controller EMCO 2090	N.A.	N.A.	11. Spectrum analyser R&S ESU 40	2012/03	2014/03	12. RF pre-amplifier Miteq AFS5-04001300-15-10P-6.	2012/07	2014/07	13. RF pre-amplifier Schaffner CPA 9231.	2013/06	2015/06
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### **Competences and guarantees**

AT4 wireless is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 905266.

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

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

AT4 wireless guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at AT4 wireless at the time of performance of the test.

AT4 wireless is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

### **General conditions**

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

### **Uncertainty**

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

PODT000: Procedimiento para el cálculo de incertidumbres de medida.

## Usage of samples

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

Sample S/01 is composed of the following elements:

<u>Control N°</u>	<u>Description</u>	<u>Model</u>	<u>Serial N°</u>	<u>Date of reception</u>
40299B/01	Bluetooth device with connector antenna	CB2-BLUE15M (Sw version: 01.01.000)	2395893J000001T01	31/10/2013
40299B/16	Power supply connector	---	---	31/10/2013

Sample S/02 is composed of the following elements:

<u>Control N°</u>	<u>Description</u>	<u>Model</u>	<u>Serial N°</u>	<u>Date of reception</u>
40299B/04	Bluetooth device with connector antenna	CB2-BLUE15M (Sw version: 01.01.007)	2395897J000001701	31/10/2013
40299B/16	Power supply connector	---	---	31/10/2013

Sample S/03 is composed of the following elements:

<u>Control N°</u>	<u>Description</u>	<u>Model</u>	<u>Serial N°</u>	<u>Date of reception</u>
40299B/06	Bluetooth device with integral antenna	CB2-BLUE15M (Sw version: 01.01.000)	2395893J000001V01	31/10/2013
40299B/16	Power supply connector	---	---	31/10/2013

1. Sample S/01 has undergone following test(s) indicated in appendix A:
  - FCC 15.247 Subclause (a) (1) (iii). Number of hopping channels / RSS-210 Clause A8.1 (d).
  - FCC 15.247 Subclause (a) (1) (iii). Time of occupancy (Dwell Time) / RSS-210 Clause A8.1 (d).
2. Sample S/02 has undergone following test(s) indicated in appendix A:
  - FCC 15.247 Subclause (a) (1). 20 dB Bandwidth and Carrier frequency separation / RSS-210 Clause A8.1 (b).
  - FCC 15.247 Subclause (b). Maximum peak output power and antenna gain / RSS-210, Clause A8.4 (2).
  - FCC 15.247 Subclause (d). Emission limitations conducted (Transmitter) / RSS-210 Clause A8.5.
3. Sample S/03 has undergone following test(s) indicated in appendix A:
  - FCC 15.247 Subclause (d). Emission limitations radiated (Transmitter) / RSS-210 Clause A8.5.

## Testing period

The performed test started on 2013-11-04 and finished on 2013-12-05.

The tests have been performed at AT4 wireless.

## Environmental conditions

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

Temperature	Min. = 19.2 °C Max. = 20.3 °C
Relative humidity	Min. = 38 % Max. = 41 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

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

Temperature	Min. = 19.1 °C Max. = 20.1 °C
Relative humidity	Min. = 46 % Max. = 49 %
Air pressure	Min. = 1016 mbar Max. = 1016 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

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

Temperature	Min. = 23.5 °C Max. = 24.1 °C
Relative humidity	Min. = 41.6 % Max. = 43.2 %
Air pressure	Min. = 1019 mbar Max. = 1019 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

**Summary**

Considering the results of the performed test according to standard USA FCC Parts 15.247 and 15.209 / Canada RSS-210, the item under test is **IN COMPLIANCE** with the requested specifications specified in the standard.

NOTE: The results presented in this Test Report apply only to the particular item under test established in page 1 of this document, as presented for test on the date(s) shown in section, "USAGE OF SAMPLES, TESTING PERIOD AND ENVIRONMENTAL CONDITIONS".

**Remarks and comments**

None.

**Testing verdicts**

Not applicable .....: NA

Pass.....: P

Fail .....: F

Not measured.....: NM

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

## **APPENDIX A: Test result**



## INDEX

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## TEST CONDITIONS

Power supply (V):

$$V_{\text{nominal}} = 13.2 \text{ Vdc}$$

Type of power supply = DC voltage from car battery.

Type of antenna = Integral antenna. Printed inverted F

Declared Gain for antenna (maximum) = 1 dBi

### TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2441 MHz

Highest channel: 2480 MHz

### CONDUCTED MEASUREMENTS

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

### RADIATED MEASUREMENTS

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

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

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

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

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

SPECIFICATION

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

RESULTS

(See next plots)

Modulation: GFSK

	Lowest frequency	Middle frequency	Highest frequency
	2402 MHz	2441 MHz	2480 MHz
20 dB Spectrum bandwidth (kHz)	958.33	955.13	955.13
Measurement uncertainty (kHz)	±11		

Modulation: Π/4-DQPSK (2Mbps)

	Lowest frequency	Middle frequency	Highest frequency
	2402 MHz	2441 MHz	2480 MHz
20 dB Spectrum bandwidth (kHz)	1333.3	1317.3	1320.5
Measurement uncertainty (kHz)	±11		

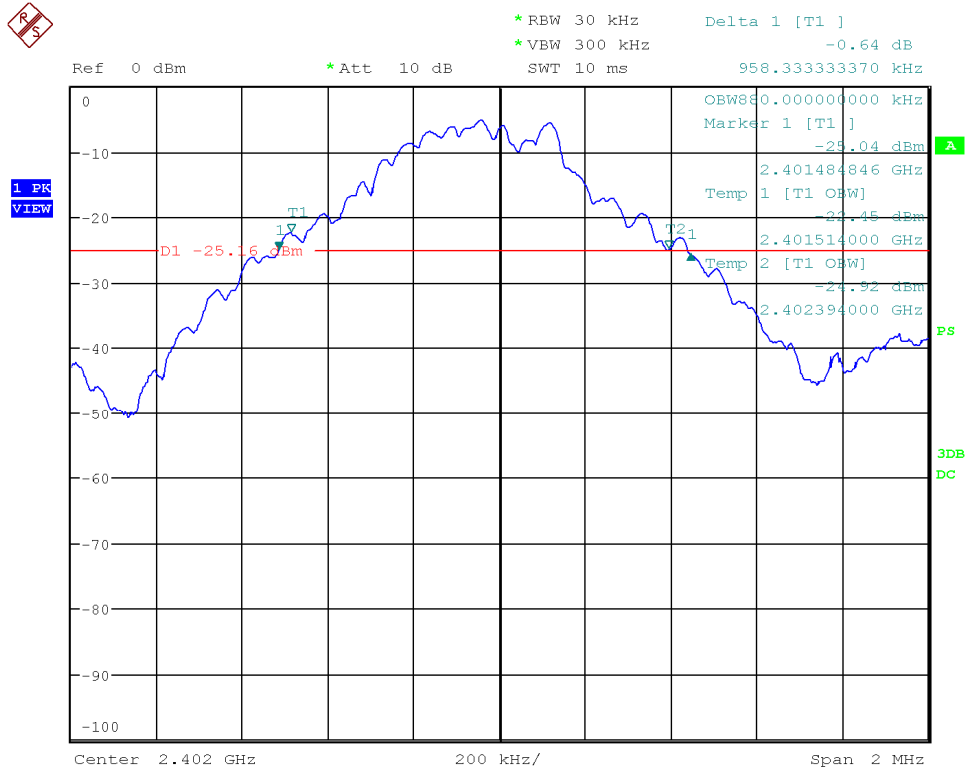
Modulation: 8-DPSK (3Mbps)

	Lowest frequency	Middle frequency	Highest frequency
	2402 MHz	2441 MHz	2480 MHz
20 dB Spectrum bandwidth (kHz)	1314.3	1323.8	1323.7
Measurement uncertainty (kHz)	±11		

Modulation: GFSK

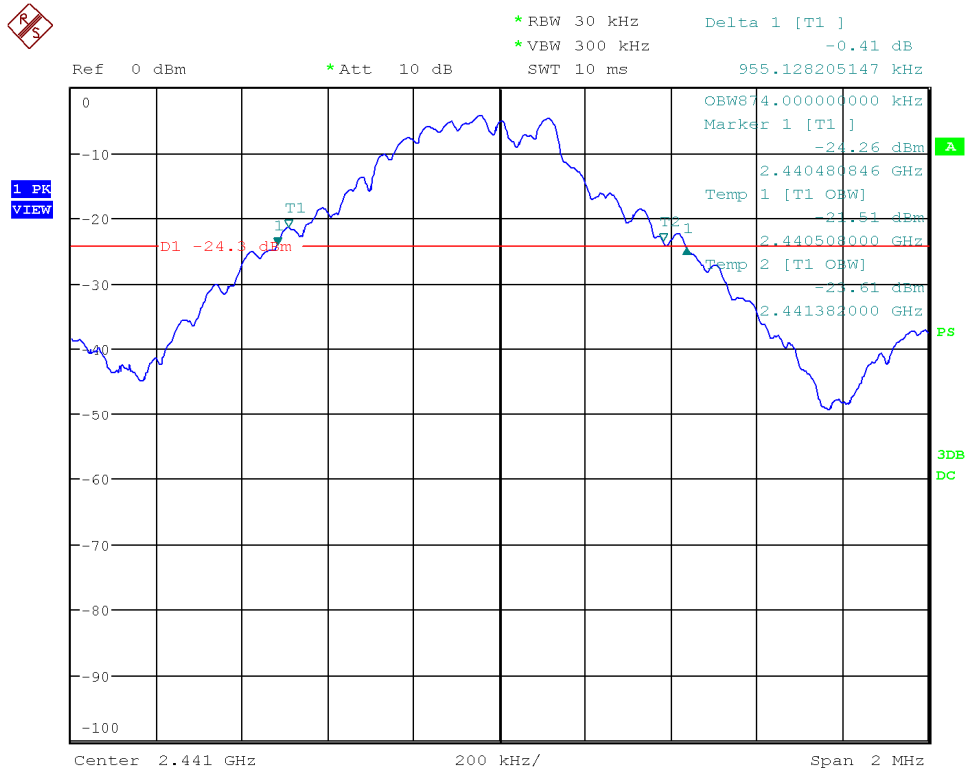
20 dB BANDWIDTH.

Lowest Channel: 2402 MHz.



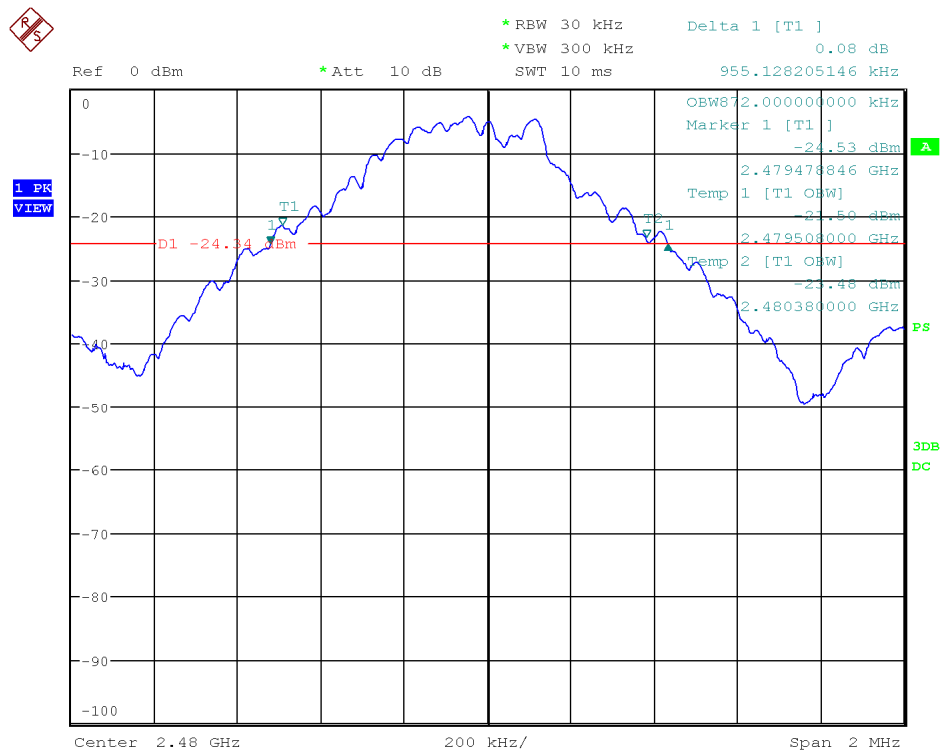
20 dB BANDWIDTH

Middle Channel: 2441 MHz.

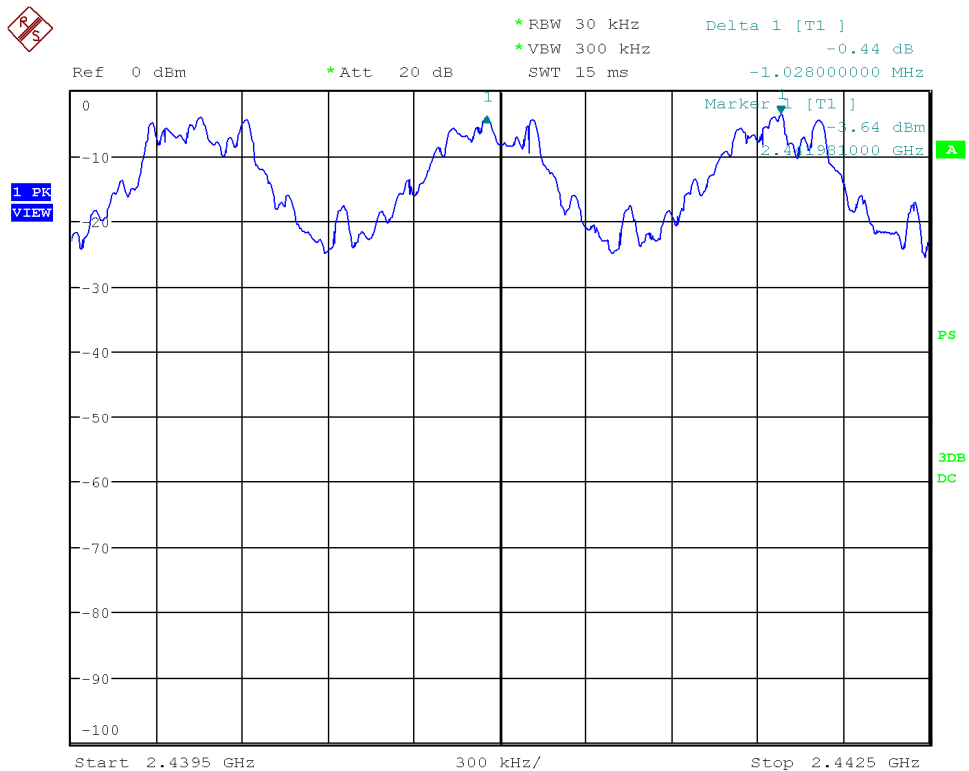


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



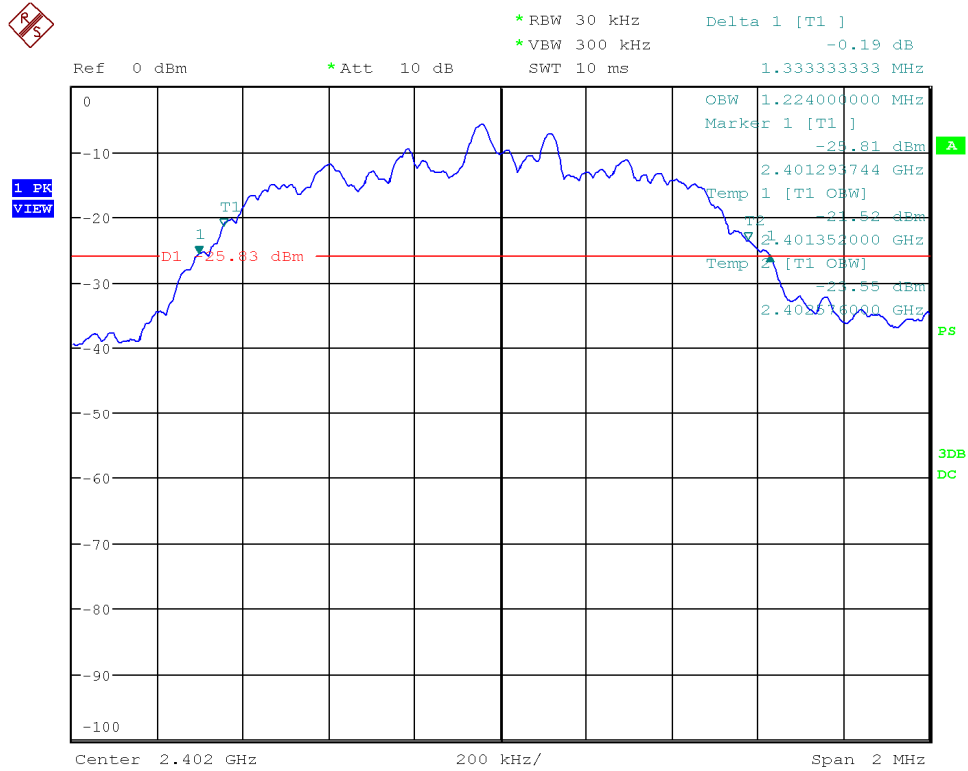
The hopping channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

Verdict: PASS

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

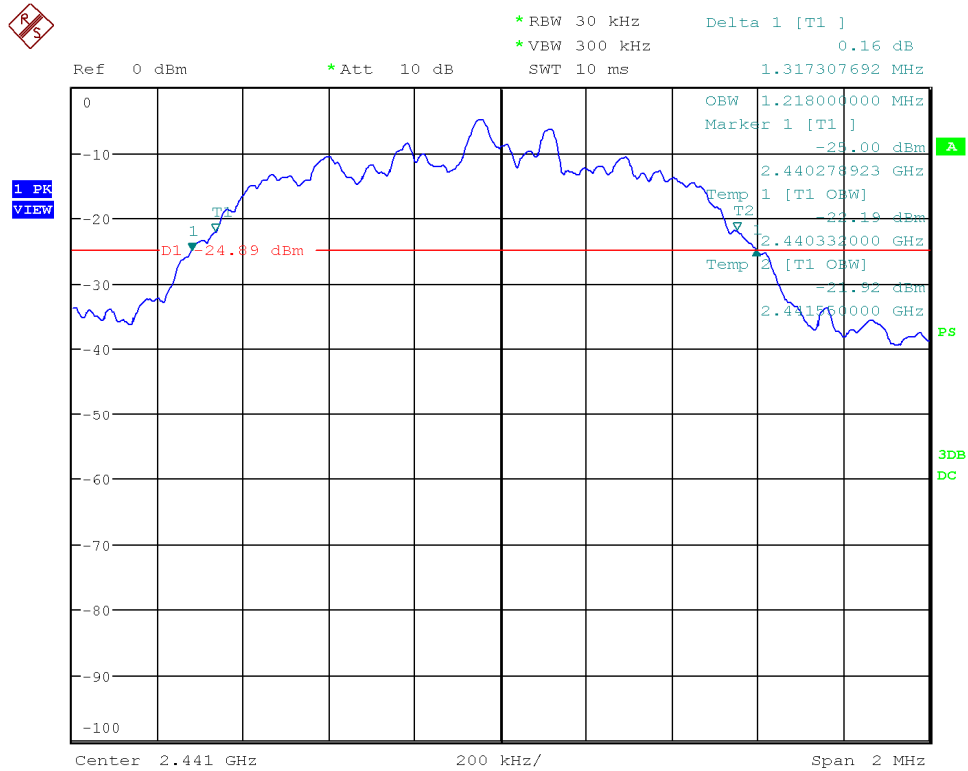
**20 dB BANDWIDTH.**

**Lowest Channel: 2402 MHz.**



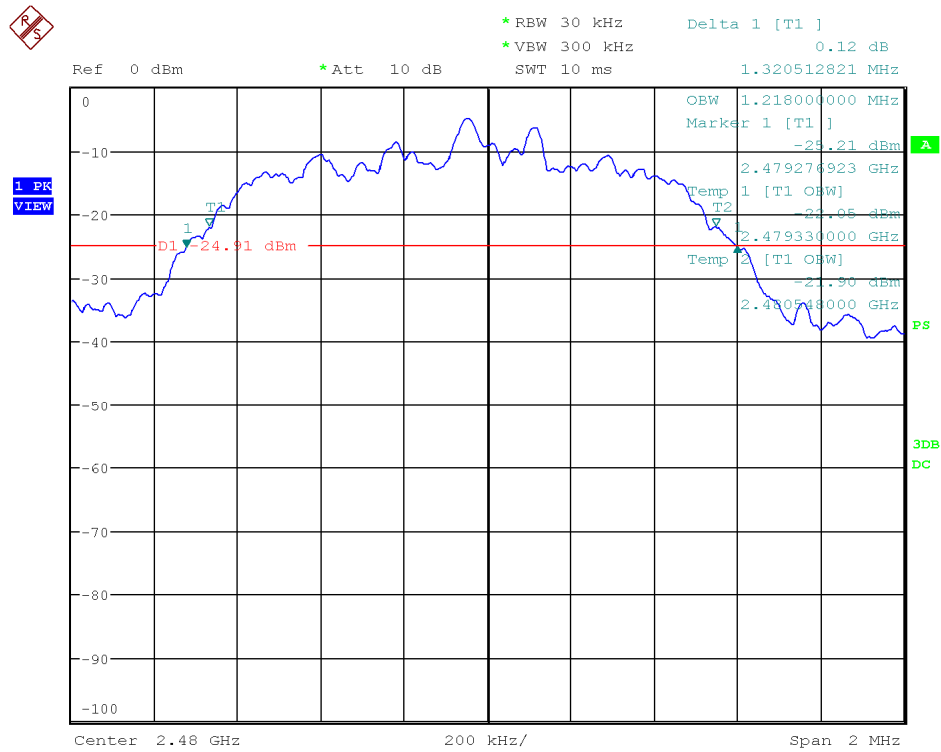
**20 dB BANDWIDTH**

**Middle Channel: 2441 MHz.**

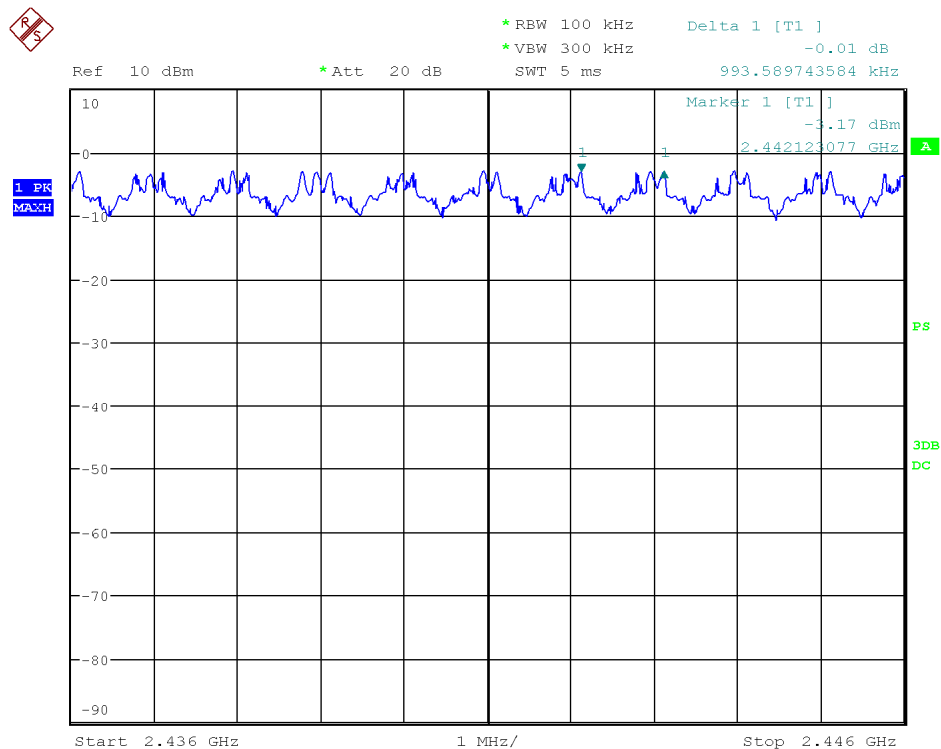


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



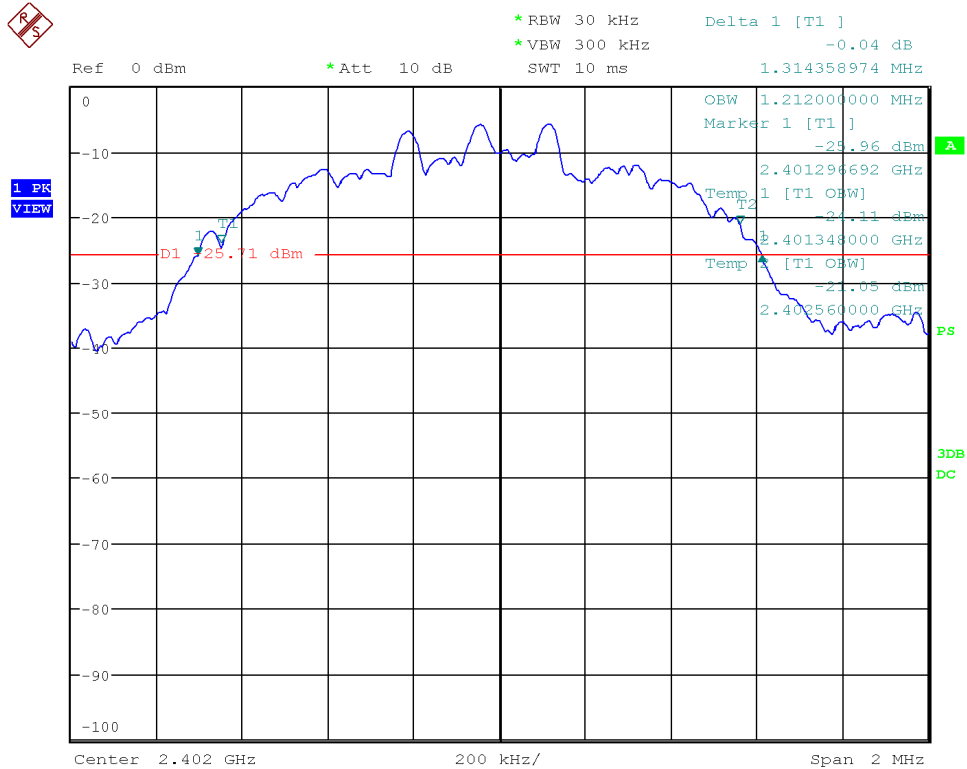
The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel

Verdict: PASS

**Modulation: 8-DPSK**

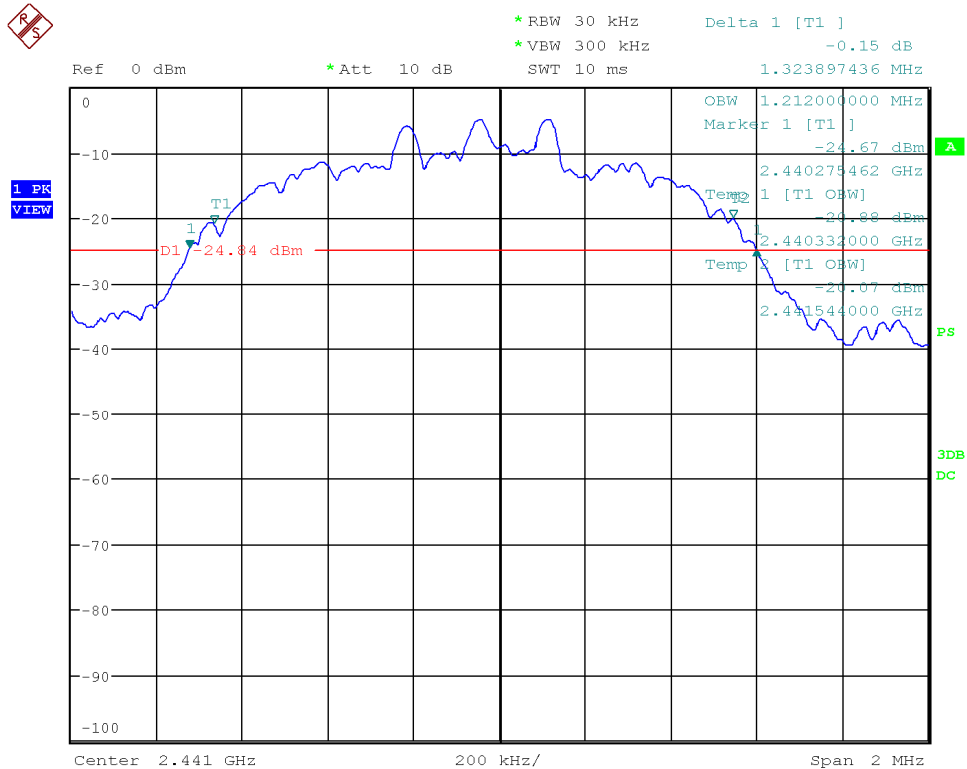
**20 dB BANDWIDTH**

**Lowest Channel: 2402 MHz.**



**20 dB BANDWIDTH**

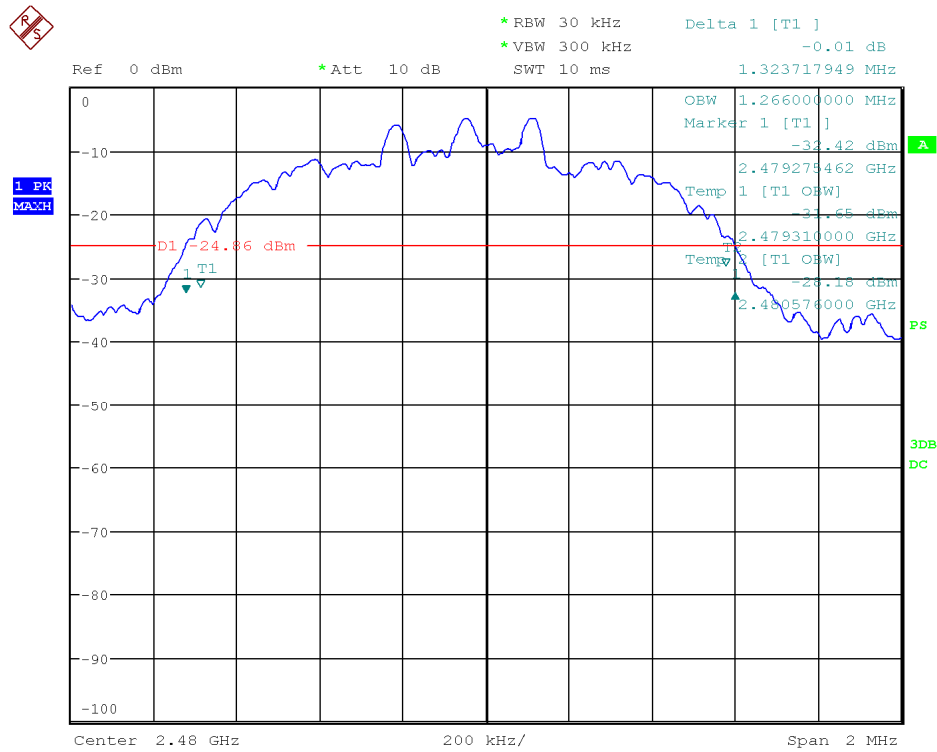
**Middle Channel: 2441 MHz.**



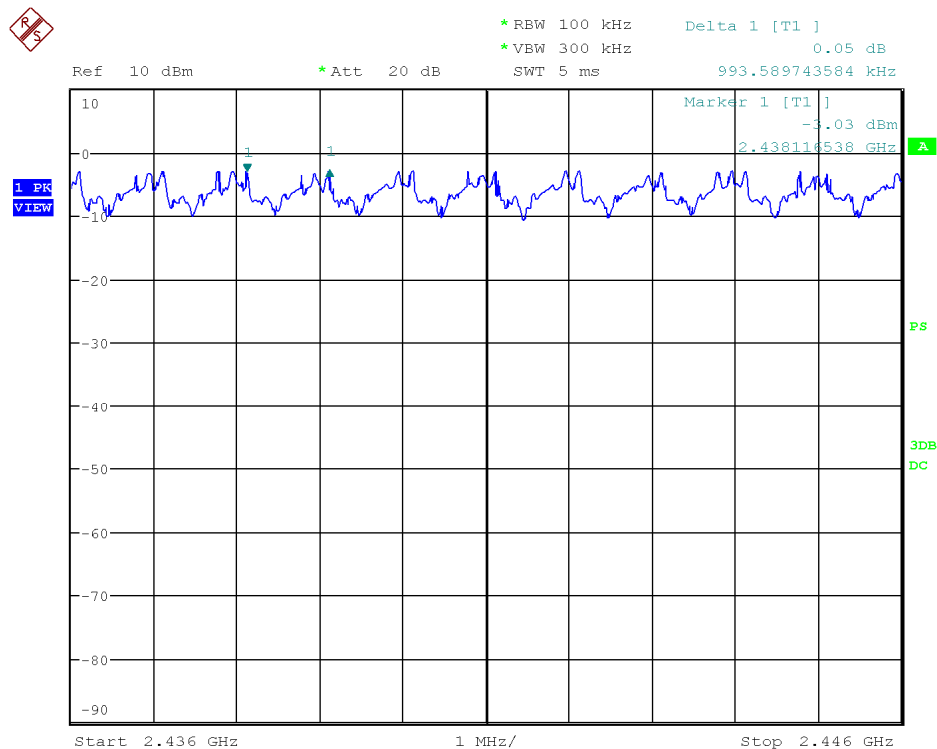


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



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

Verdict: PASS

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

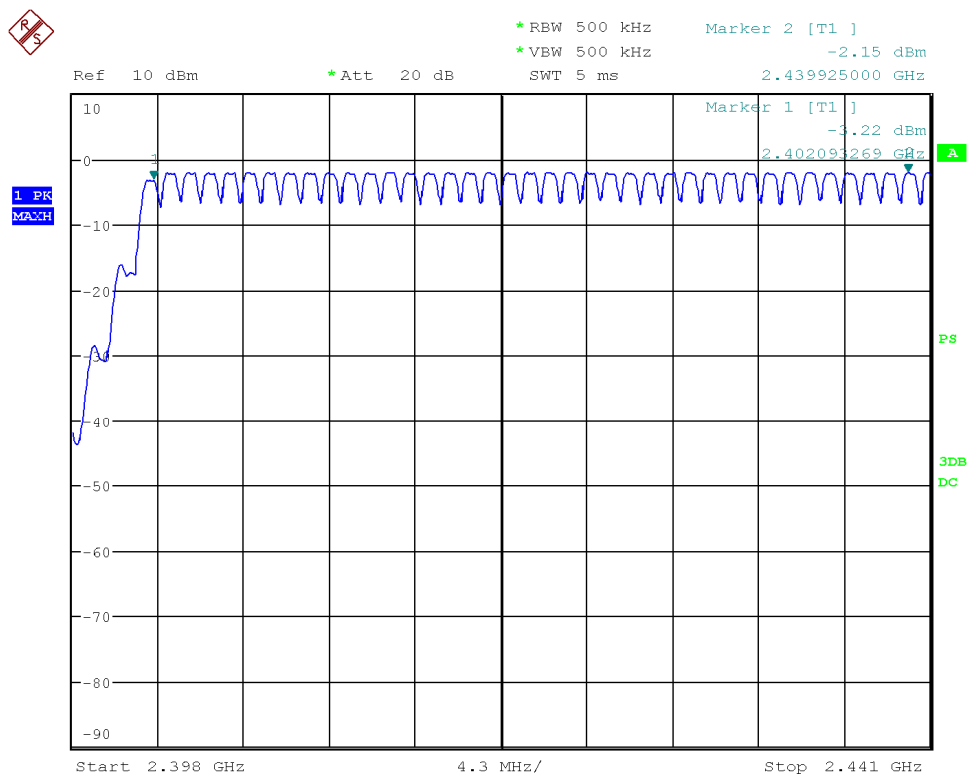
SPECIFICATION

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

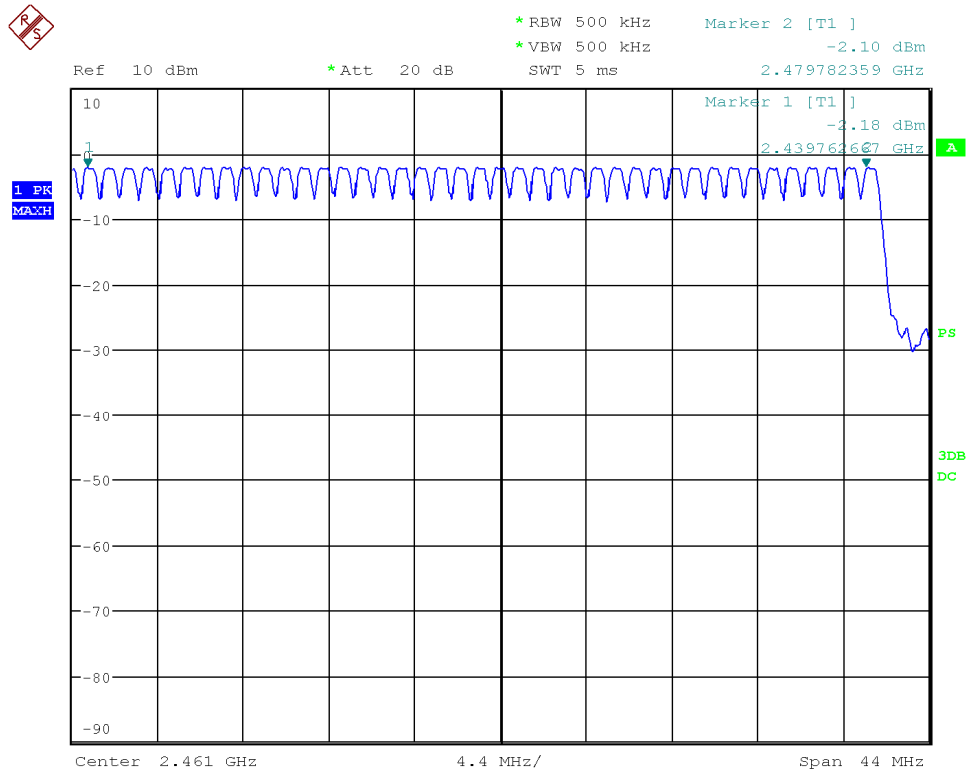
RESULTS

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

**Modulation: GFSK**



Number of hopping frequencies: 39

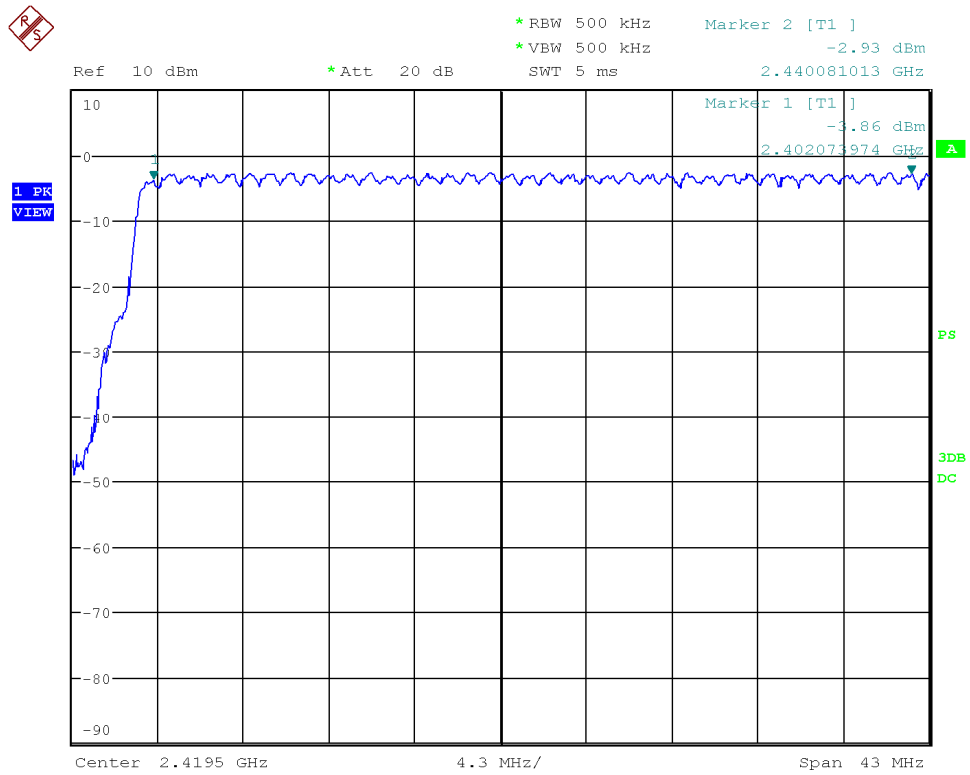


Number of hopping frequencies: 40

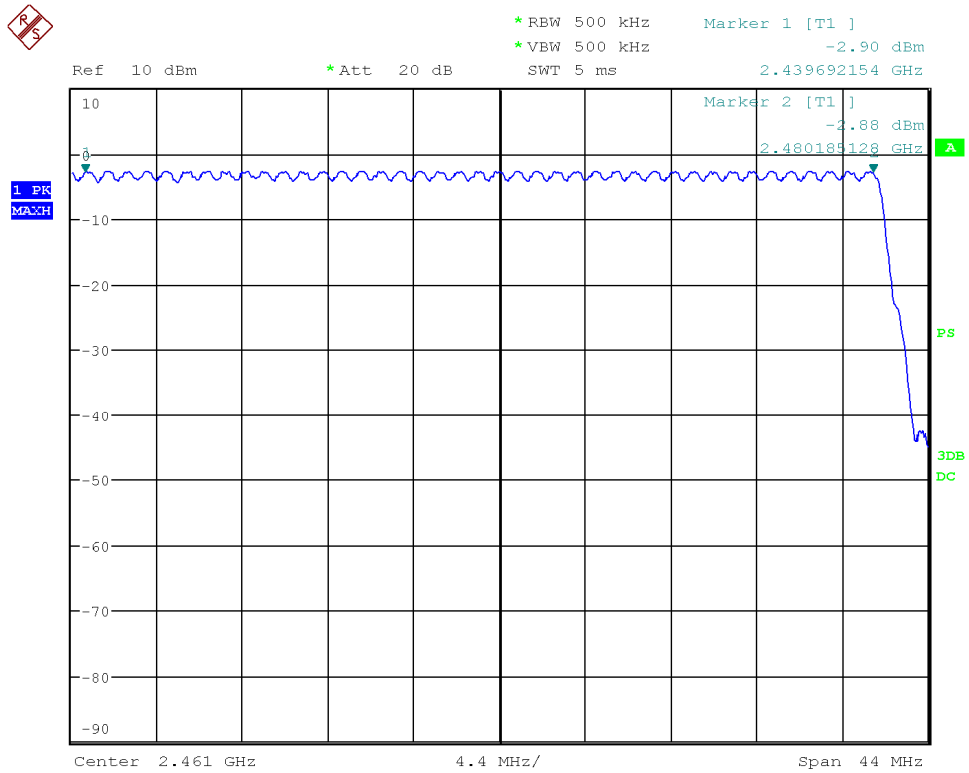
Total number of hopping frequencies: 79

Verdict: PASS

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



Number of hopping frequencies: 39

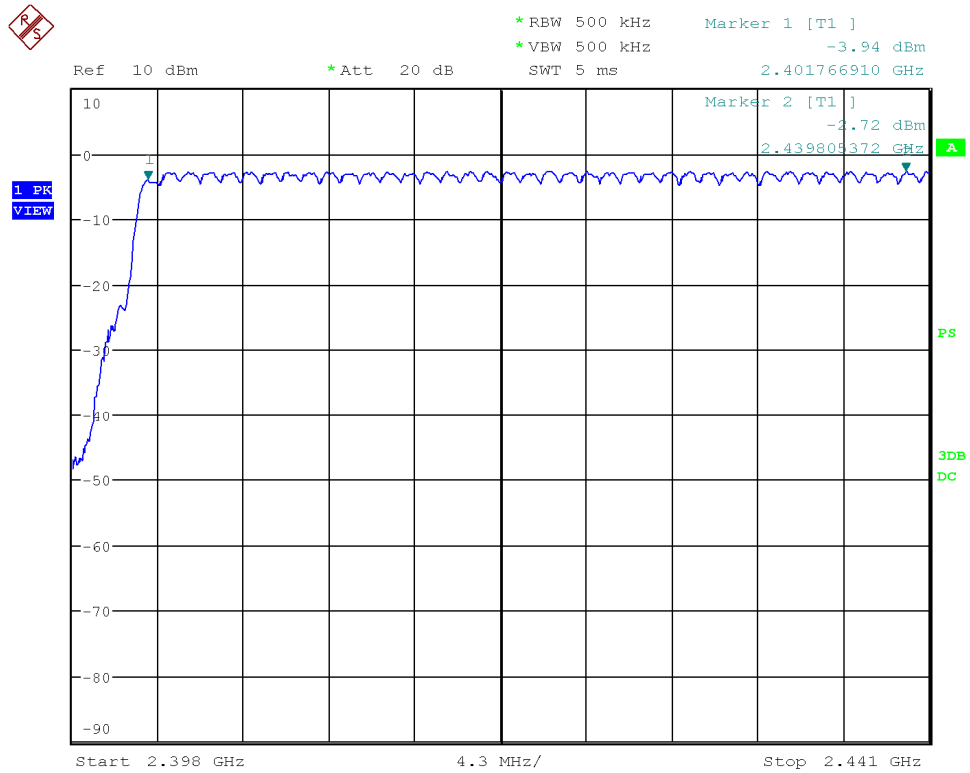


Number of hopping frequencies: 40

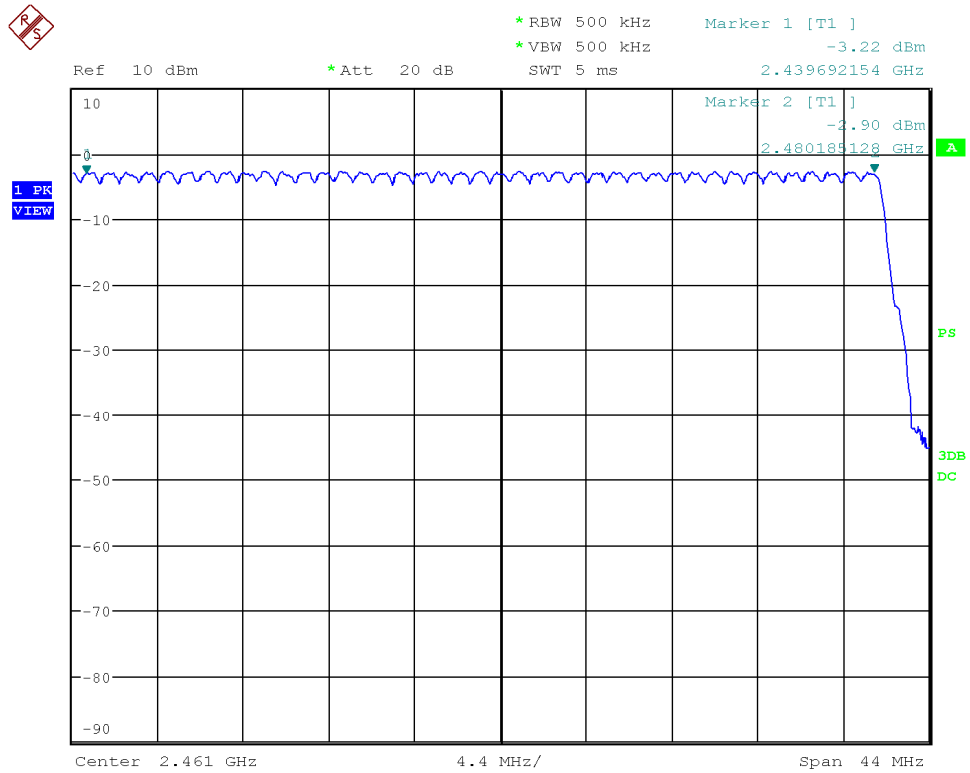
Total number of hopping frequencies: 79

Verdict: PASS

**Modulation: 8-DPSK**



Number of hopping frequencies: 39



Number of hopping frequencies: 40

Total number of hopping frequencies: 79

Verdict: PASS

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

SPECIFICATION

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

RESULTS

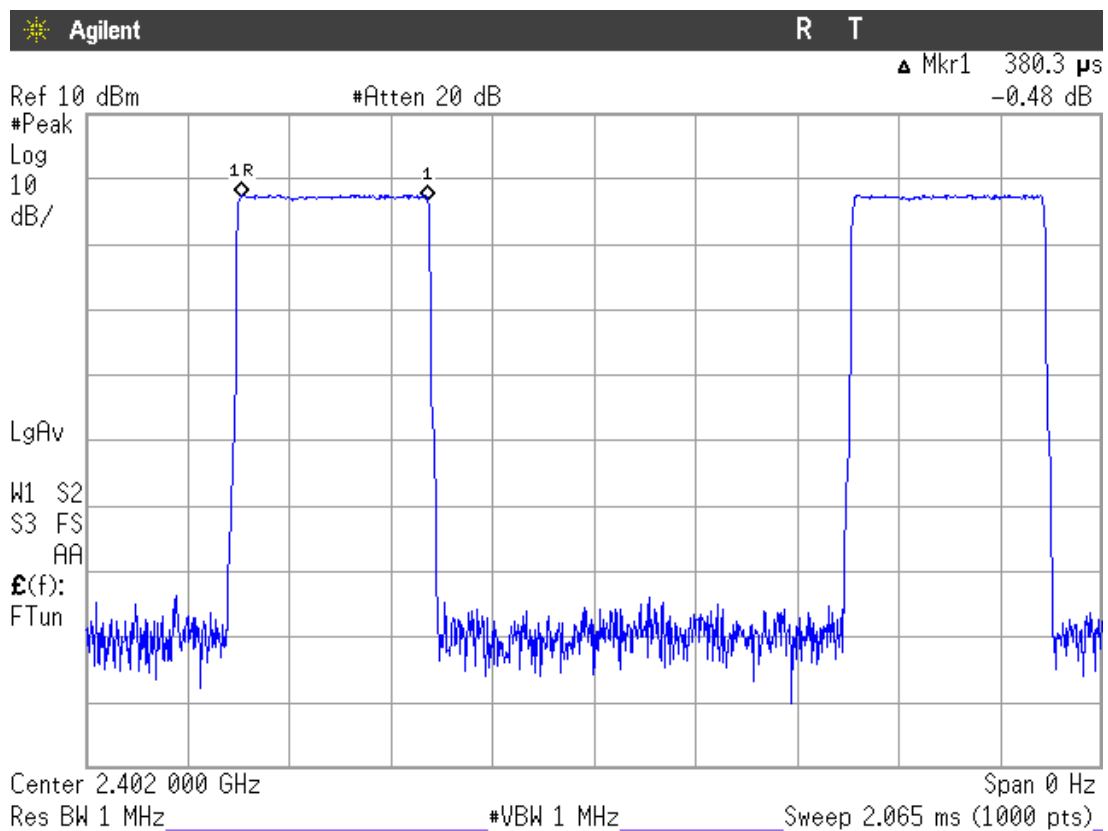
**Modulation: GFSK**

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

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

Each Tx-time per appearance is  $380.3 \mu\text{s}$  (see next plot).

So we have  $320.11 \times 380.3 \mu\text{s} = 121.74 \text{ ms}$  per 31.6 seconds.



Verdict: PASS

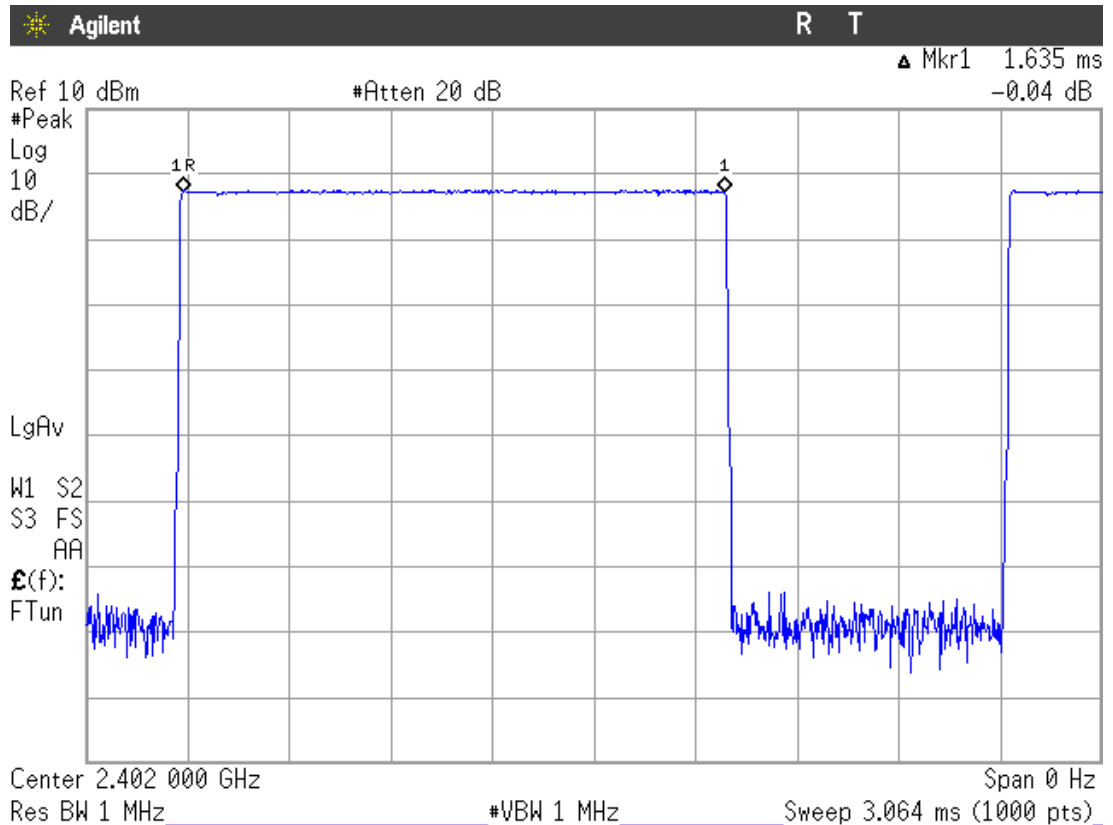


2. TIME OF OCCUPANCY (DWEELL TIME) FOR PACKET TYPE DH3.

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

Each Tx-time per appearance is 1.635 ms (see next plot).

So we have  $161.16 \times 1.635 \text{ ms} = 263.50 \text{ ms}$  per 31.6 seconds.



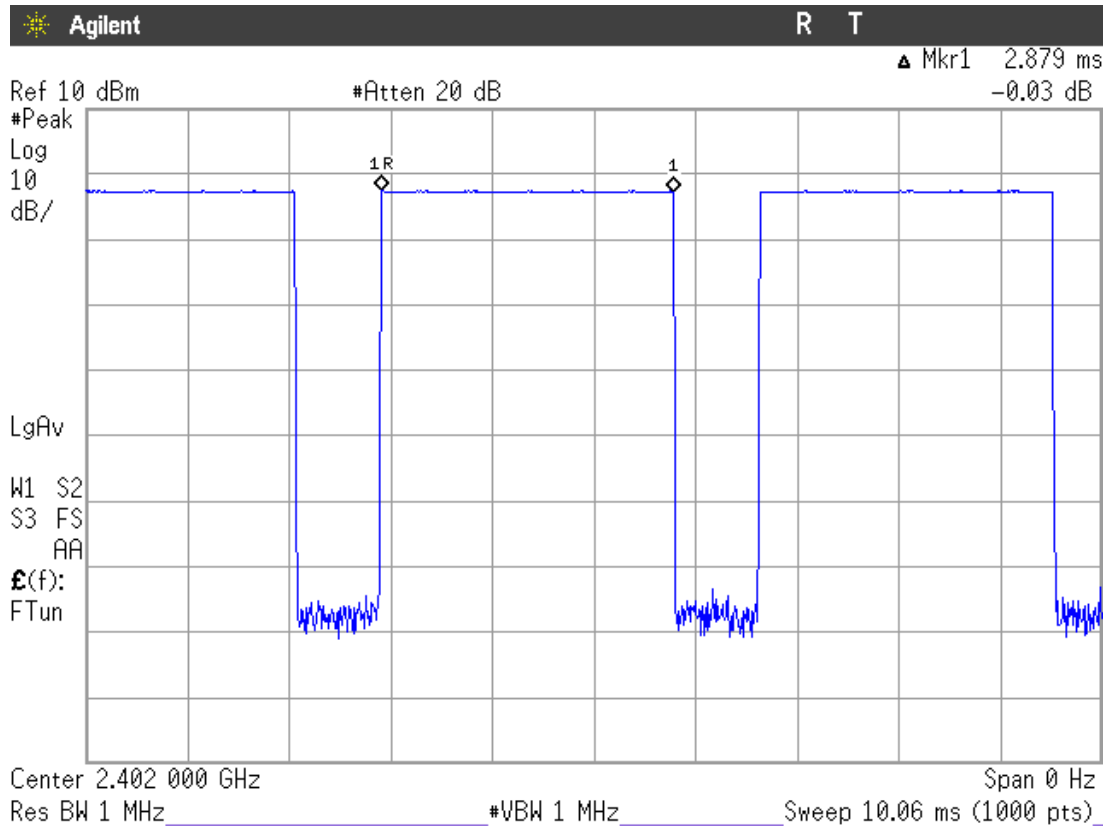
Verdict: PASS

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

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

Each Tx-time per appearance is 2.879 ms (see next plot).

So we have  $106.49 \times 2.879 \text{ ms} = 306.58 \text{ ms}$  per 31.6 seconds.



Verdict: PASS

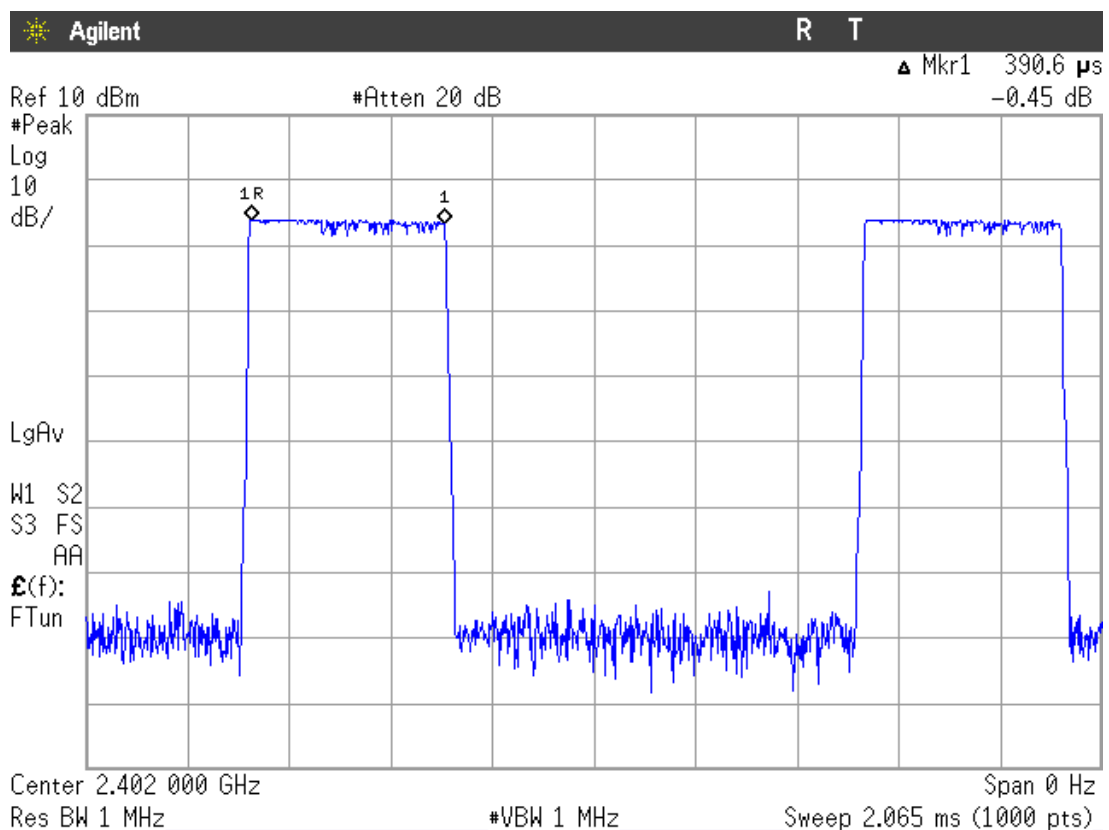
**Modulation:  $\Pi/4$ -DQPSK**

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

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

Each Tx-time per appearance is  $390.6 \mu\text{s}$  (see next plot).

So we have  $320.11 \times 390.6 \mu\text{s} = 125.03 \text{ ms}$  per 31.6 seconds.



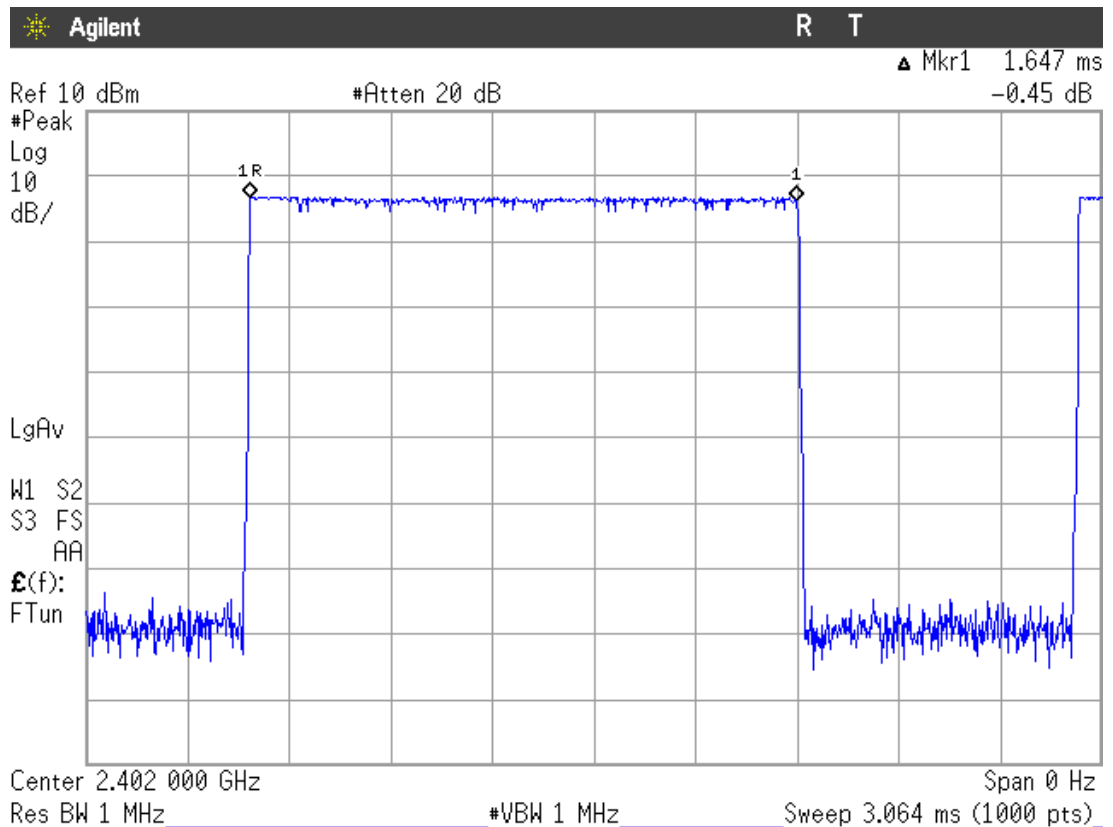
Verdict: PASS

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

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

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

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



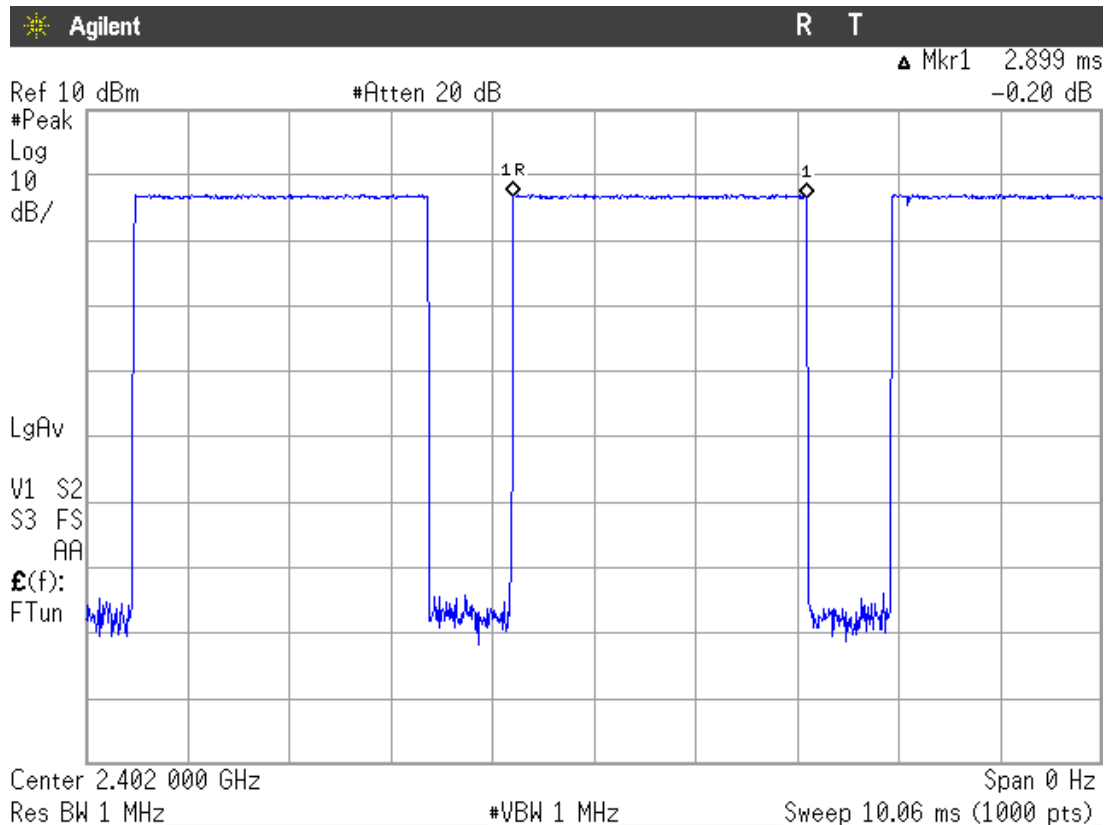
Verdict: PASS

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

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

Each Tx-time per appearance is 2.899 ms (see next plot).

So we have  $106.49 \times 2.899 \text{ ms} = 308.71 \text{ ms}$  per 31.6 seconds.



Verdict: PASS

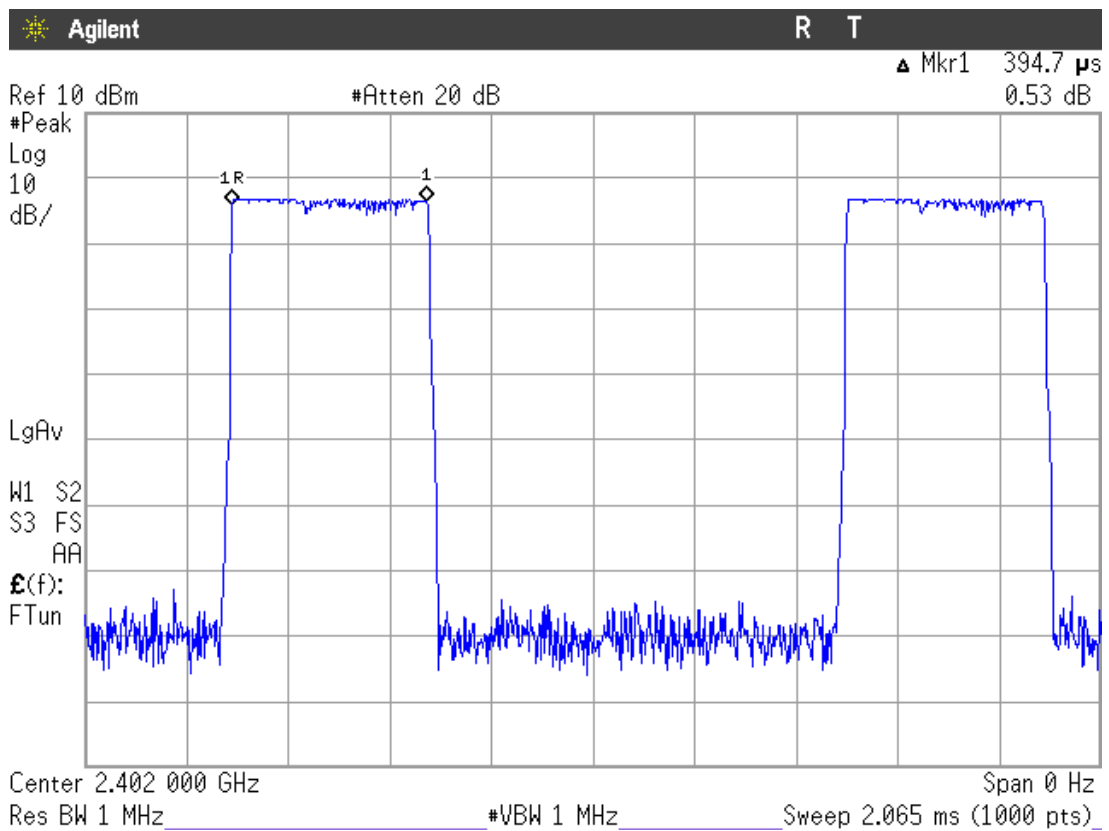
**Modulation: 8-DPSK**

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

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

Each Tx-time per appearance is  $394.7 \mu\text{s}$  (see next plot).

So we have  $320.11 \times 394.7 \mu\text{s} = 126.16 \text{ ms}$  per 31.6 seconds.



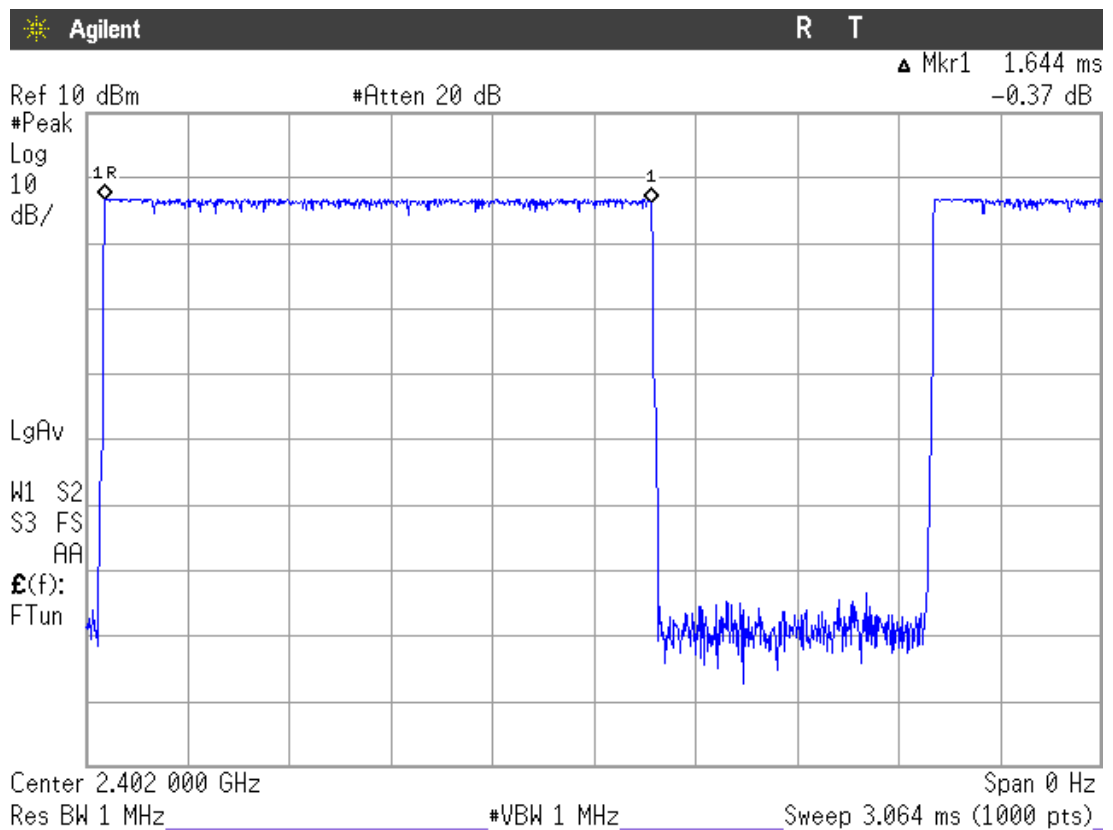
Verdict: PASS

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

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

Each Tx-time per appearance is 1.644 ms (see next plot).

So we have  $161.16 \times 1.644 \text{ ms} = 264.95 \text{ ms}$  per 31.6 seconds.



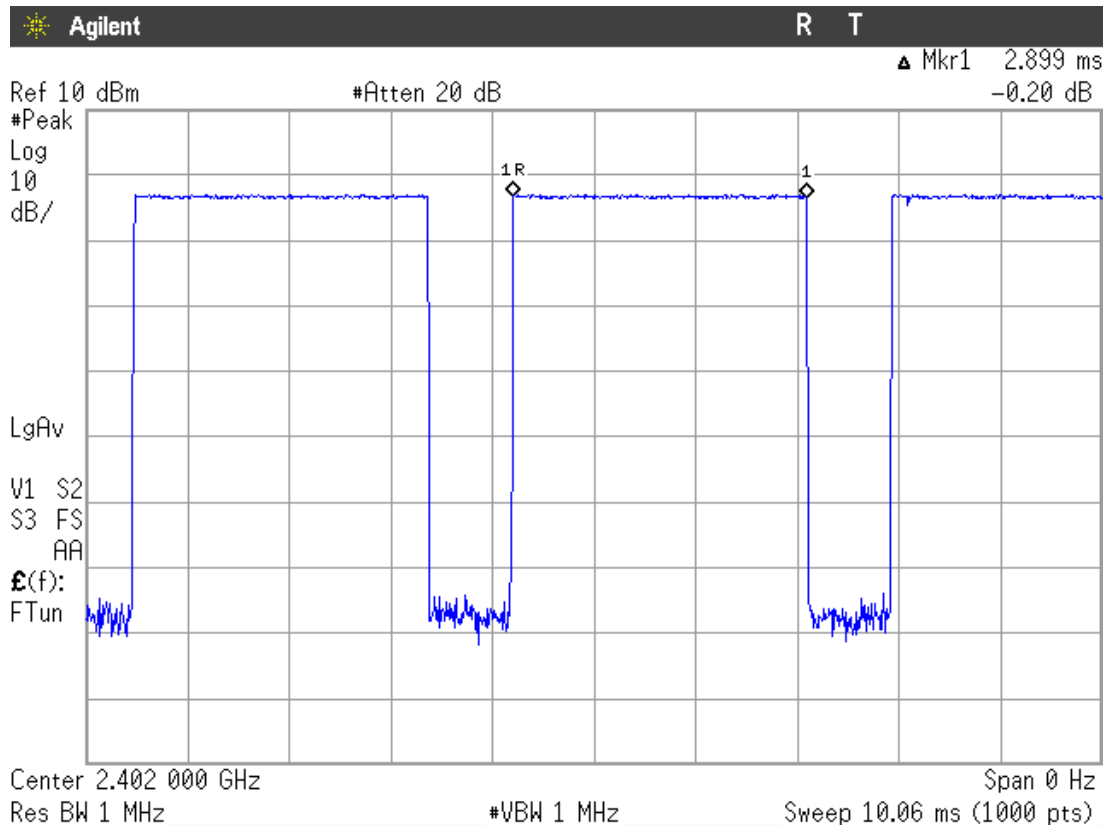
Verdict: PASS

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

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

Each Tx-time per appearance is 2.899 ms (see next plot).

So we have  $106.49 \times 2.899 \text{ ms} = 308.71 \text{ ms}$  per 31.6 seconds.



Verdict: PASS



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

SPECIFICATION

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

MAXIMUM OUTPUT POWER. See next plots.

Declared maximum antenna gain: 1.0 dBi.

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

Modulation: GFSK

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	-1.31	-0.16	0.42
Maximum EIRP power (dBm)	-0.31	0.84	1.42
Measurement uncertainty (dB)	±1.5		

Modulation: Π/4-DQPSK (2Mbps)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	-2.00	-0.93	-0.48
Maximum EIRP power (dBm)	-1.00	0.07	0.52
Measurement uncertainty (dB)	±1.5		

Modulation: 8-DPSK (3Mbps)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	-1.61	-0.44	0.02
Maximum EIRP power (dBm)	-0.61	0.56	1.02
Measurement uncertainty (dB)	±1.5		

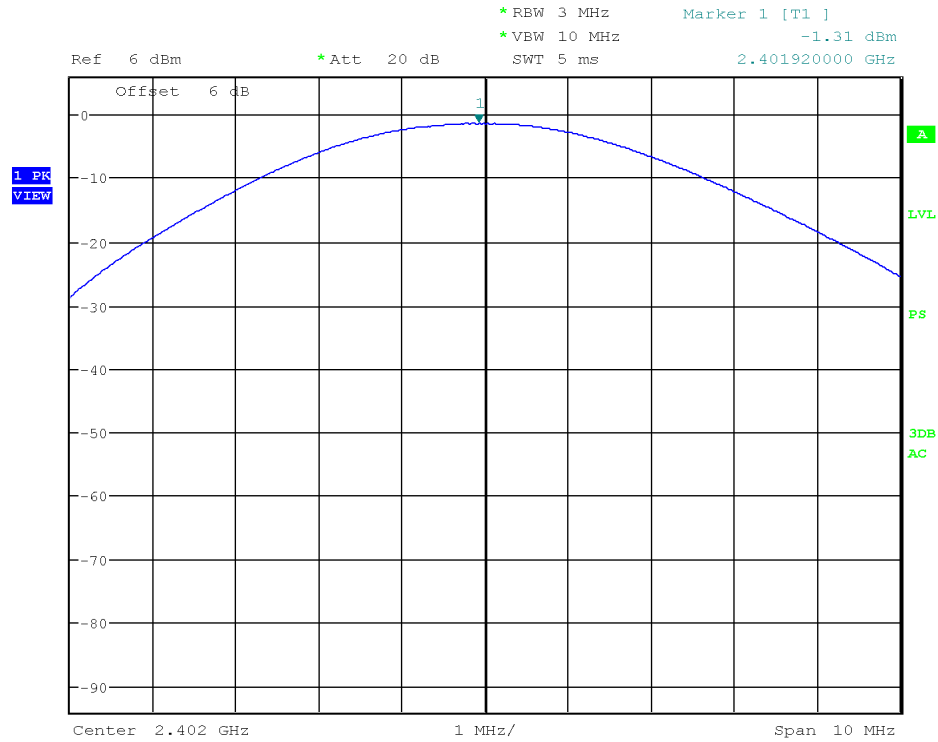
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

PEAK OUTPUT POWER (CONDUCTED).

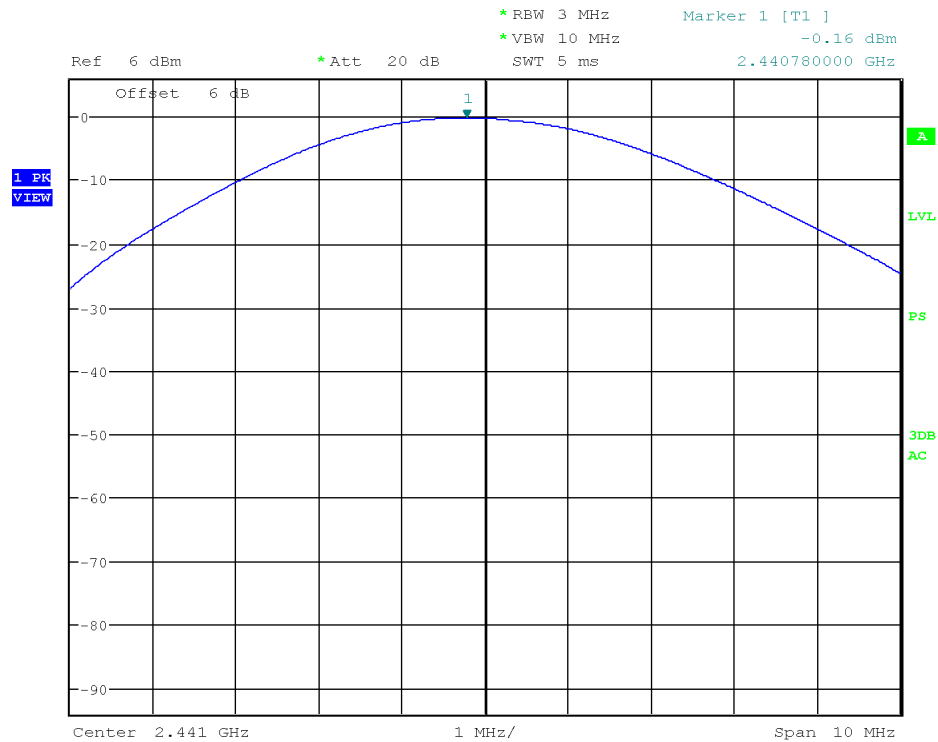
Modulation: GFSK

Lowest Channel: 2402 MHz.



Modulation: GFSK

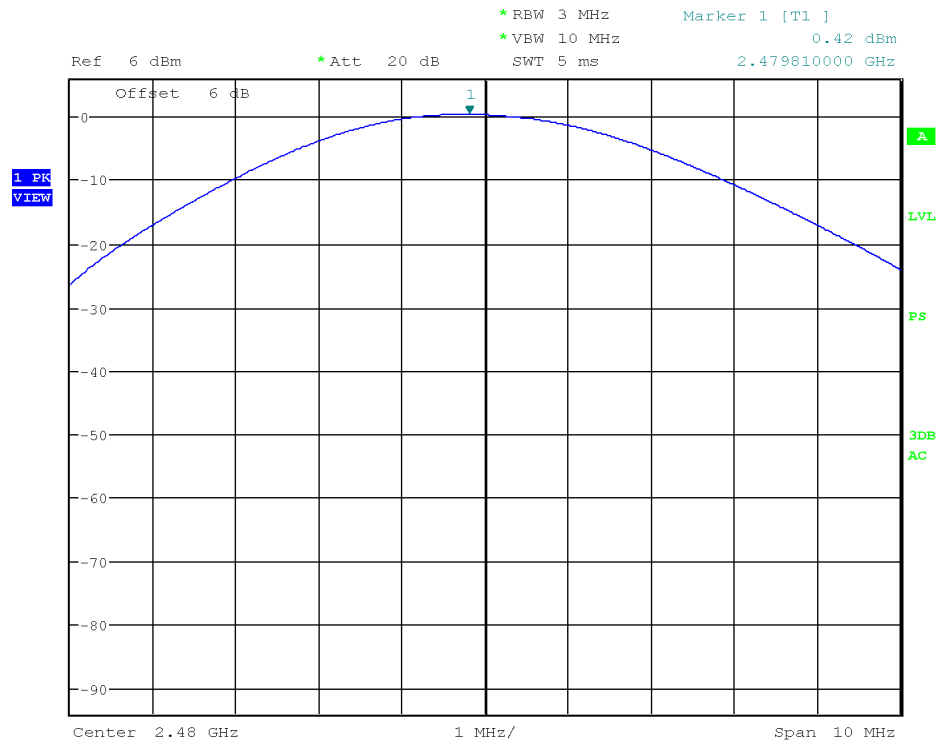
Middle Channel: 2441 MHz.



PEAK OUTPUT POWER (CONDUCTED).

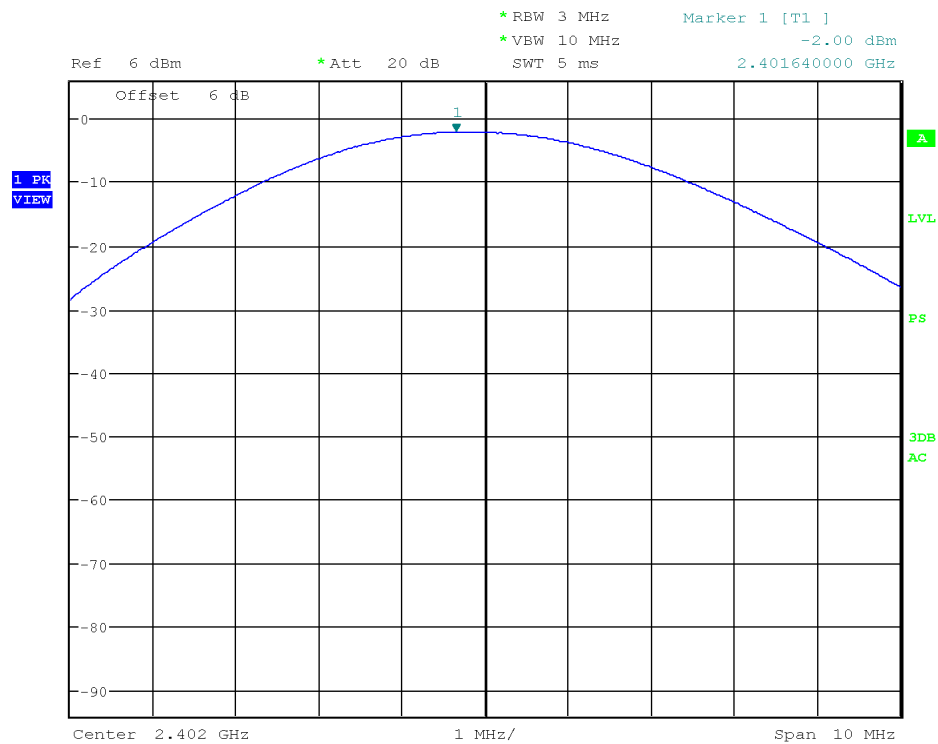
Modulation: GFSK

Highest Channel: 2480 MHz.



Modulation:  $\Pi/4$ -DQPSK

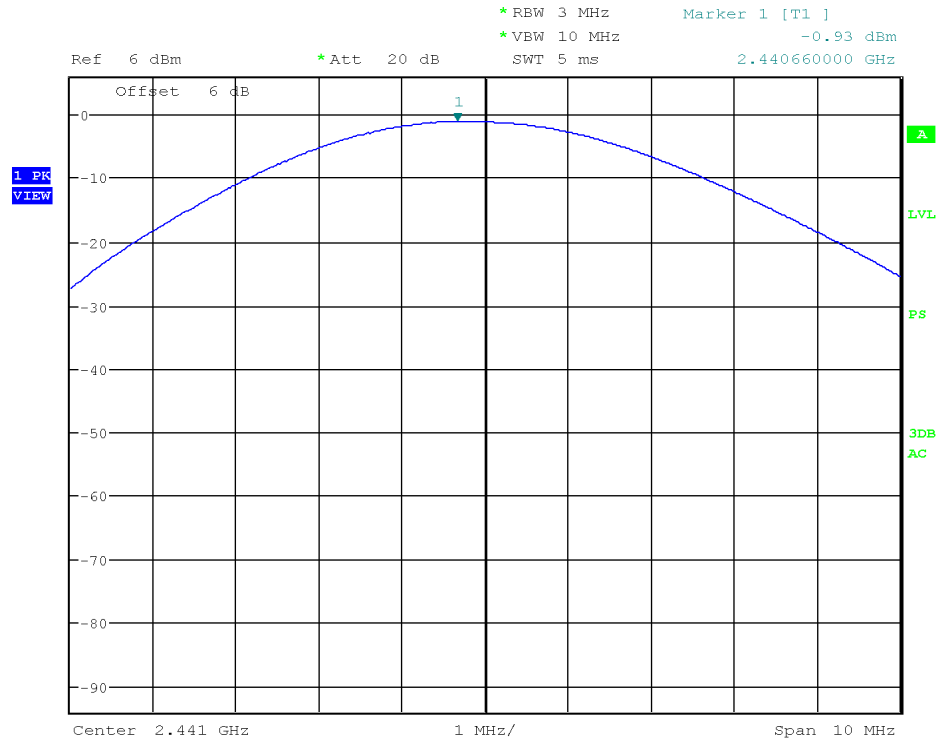
Lowest Channel: 2402 MHz



PEAK OUTPUT POWER (CONDUCTED)

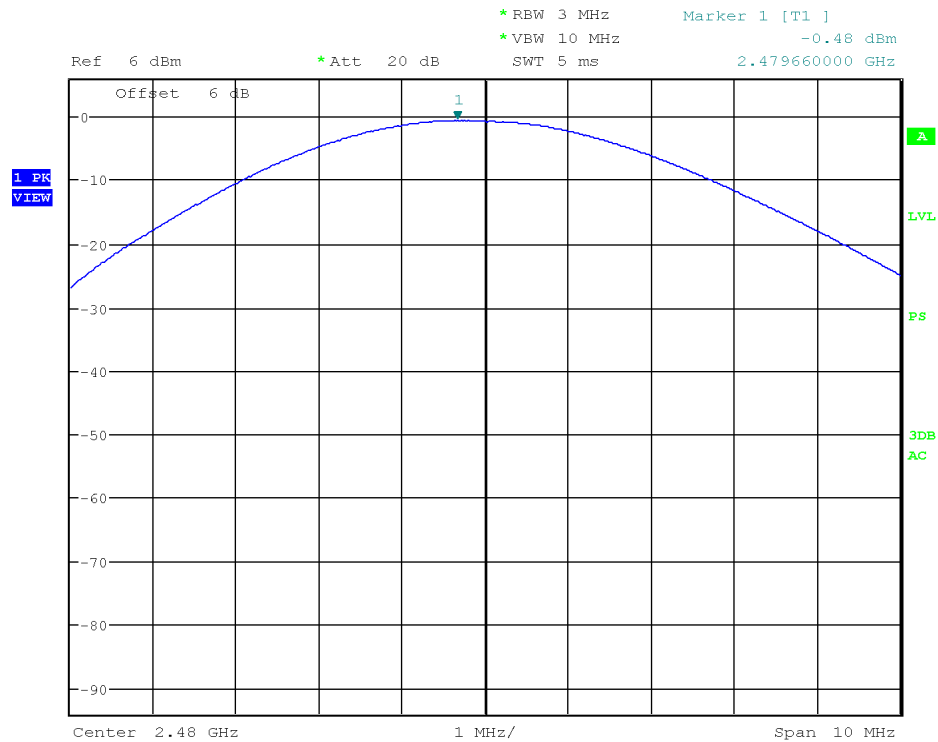
Modulation:  $\Pi/4$ -DQPSK

Middle Channel: 2441 MHz.



Modulation:  $\Pi/4$ -DQPSK

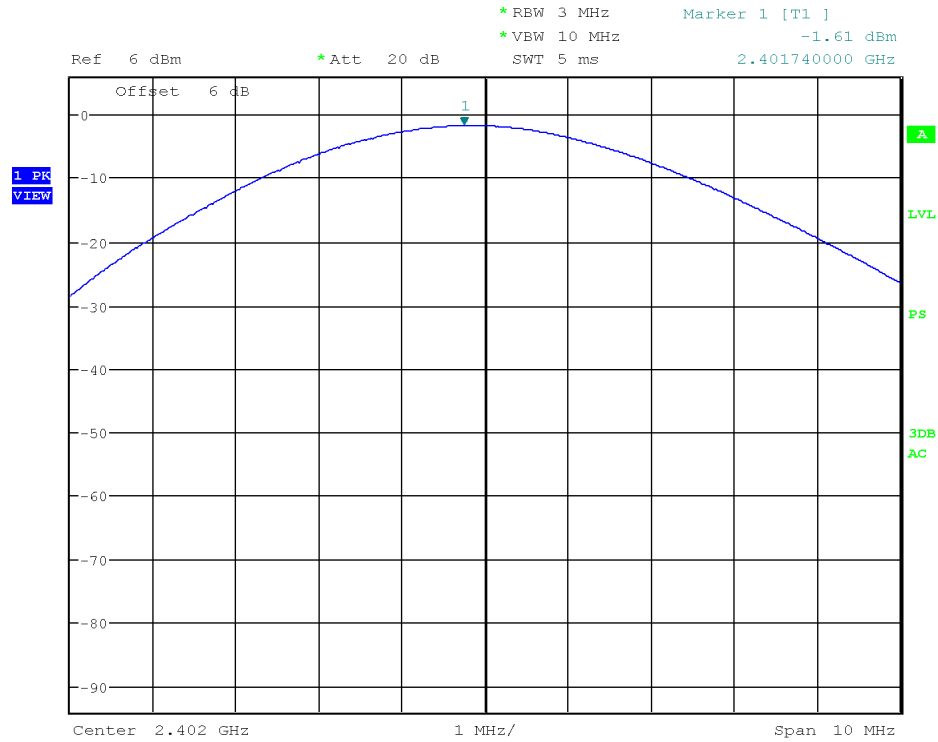
Highest Channel: 2480 MHz.



PEAK OUTPUT POWER (CONDUCTED).

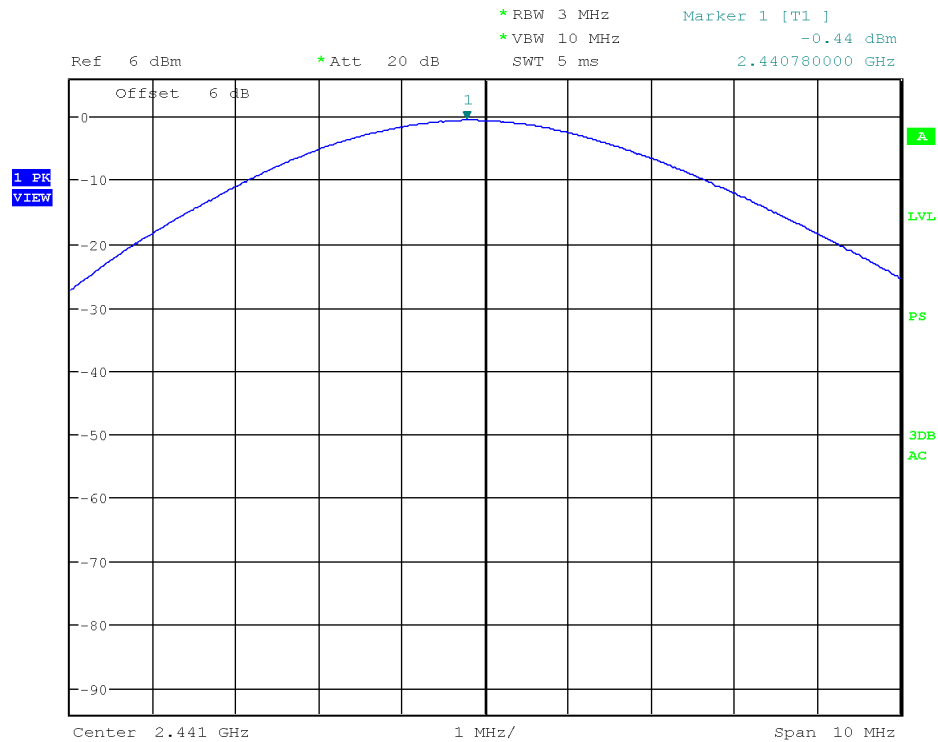
Modulation: 8-DPSK

Lowest Channel: 2402 MHz



Modulation: 8-DPSK

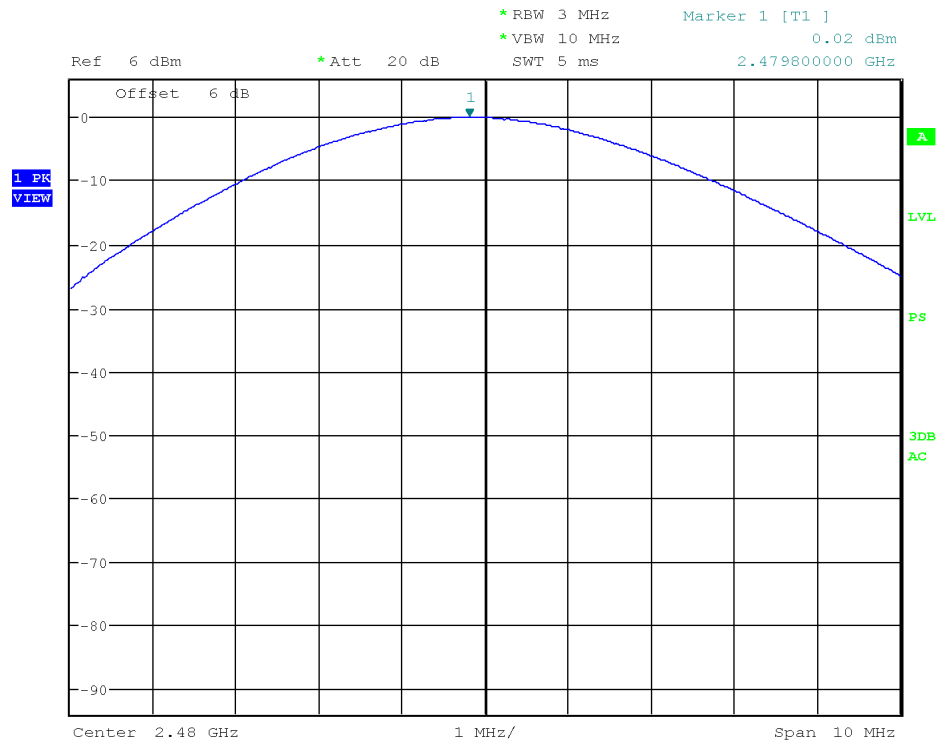
Middle Channel: 2441 MHz.



PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK

Highest Channel: 2480 MHz.



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

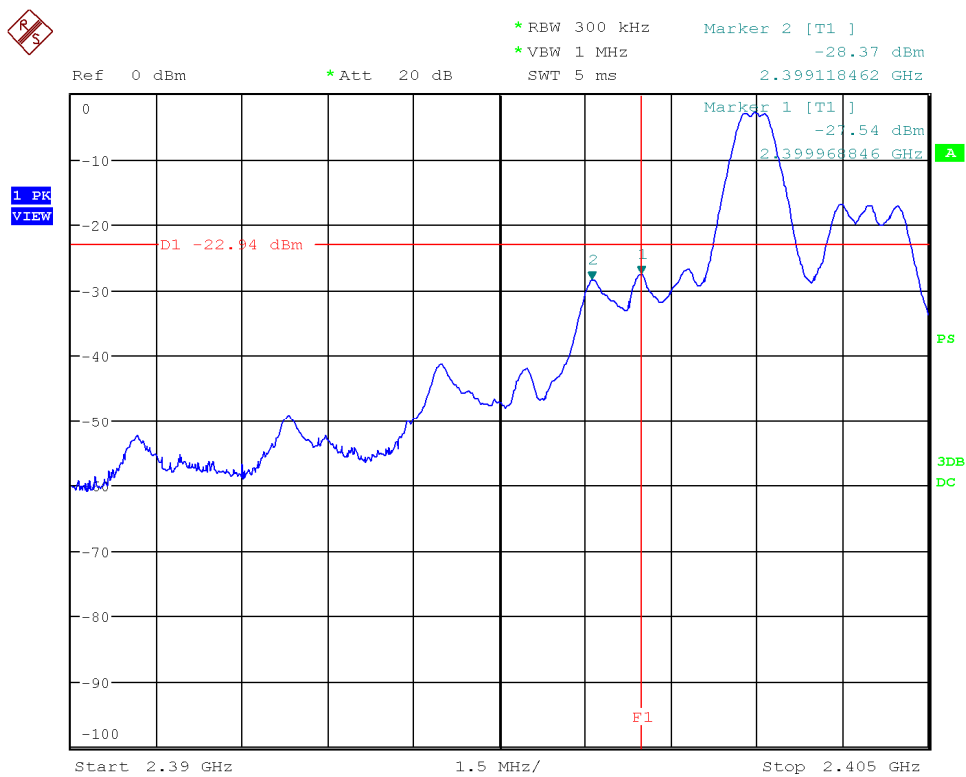
**SPECIFICATION**

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

**RESULTS:**

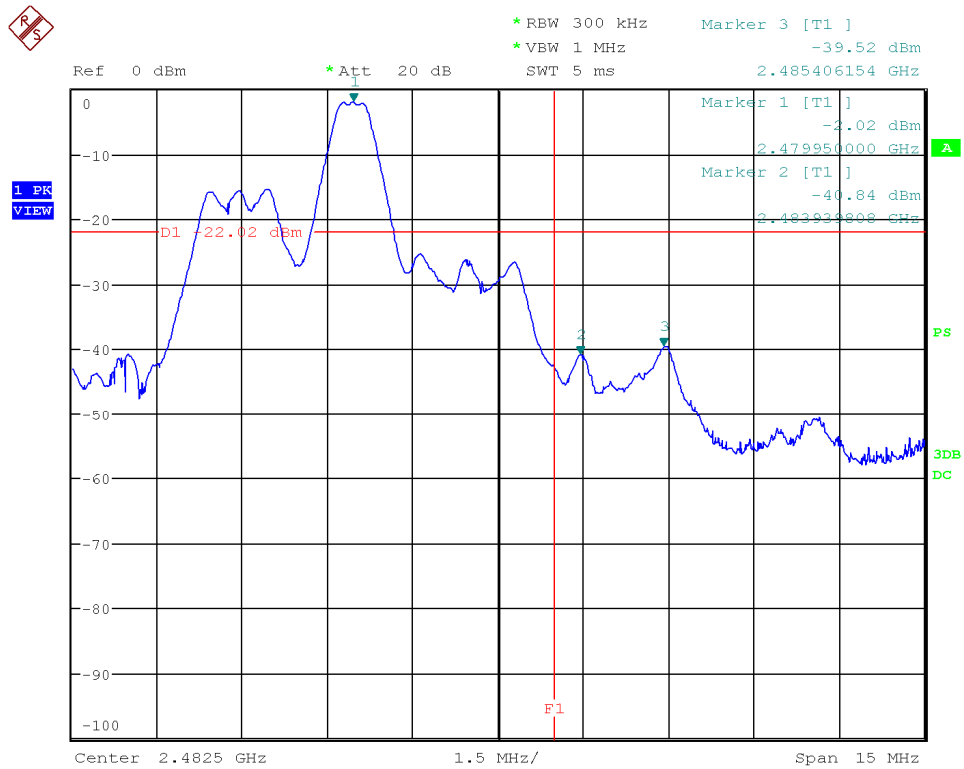
**Modulation: GFSK**

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



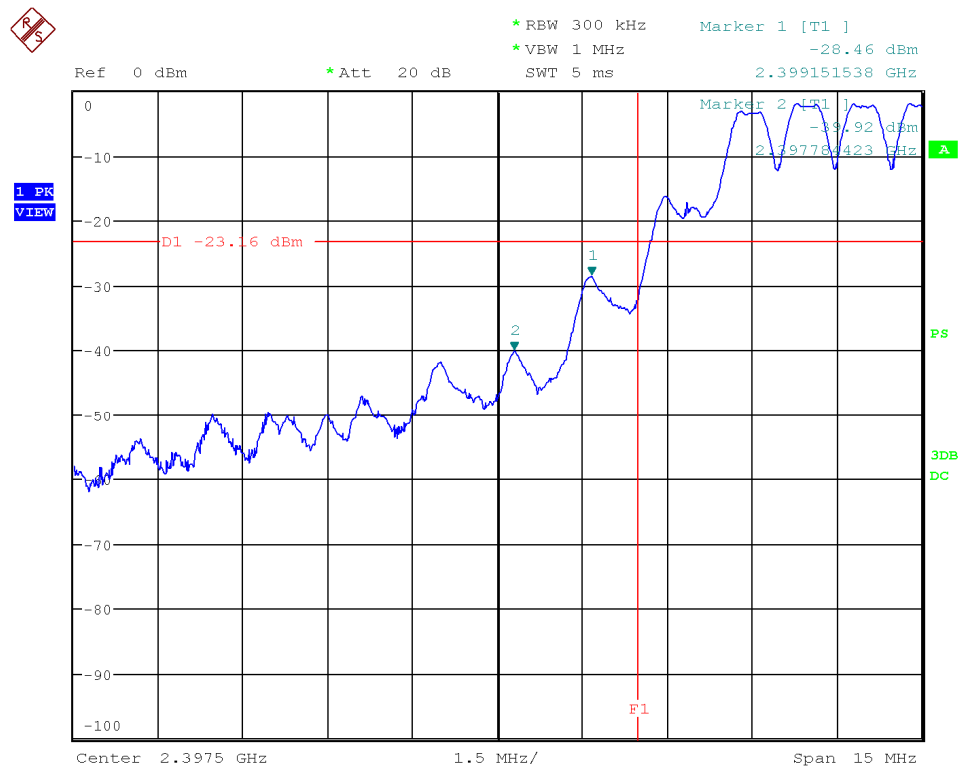
Verdict: PASS

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



Verdict: PASS

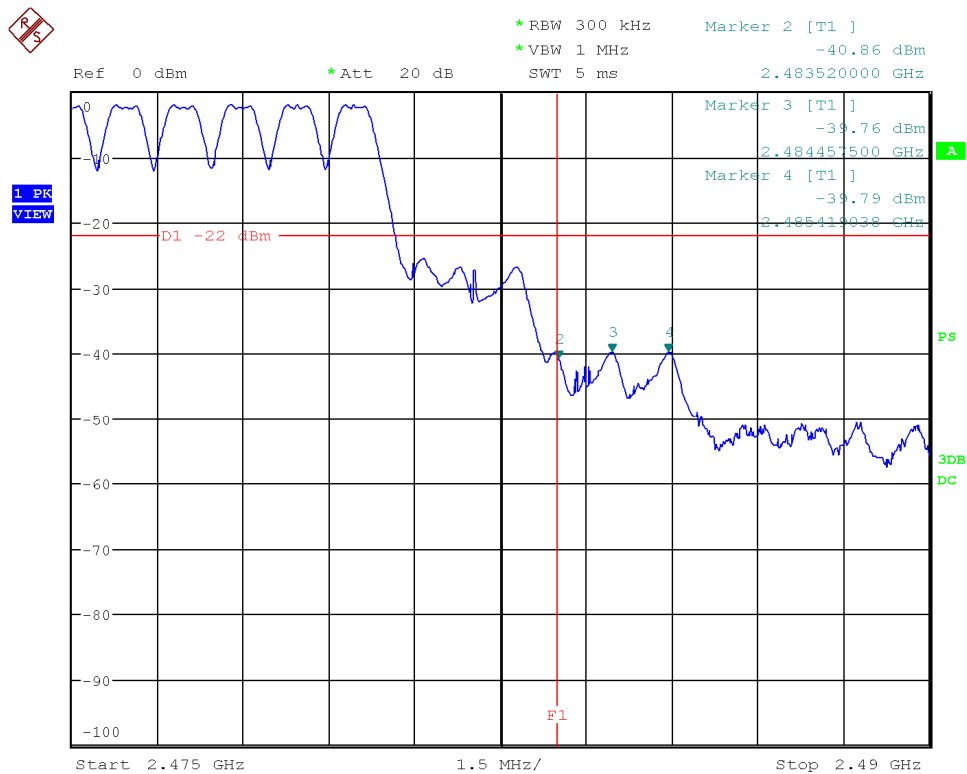
3. LOW FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS



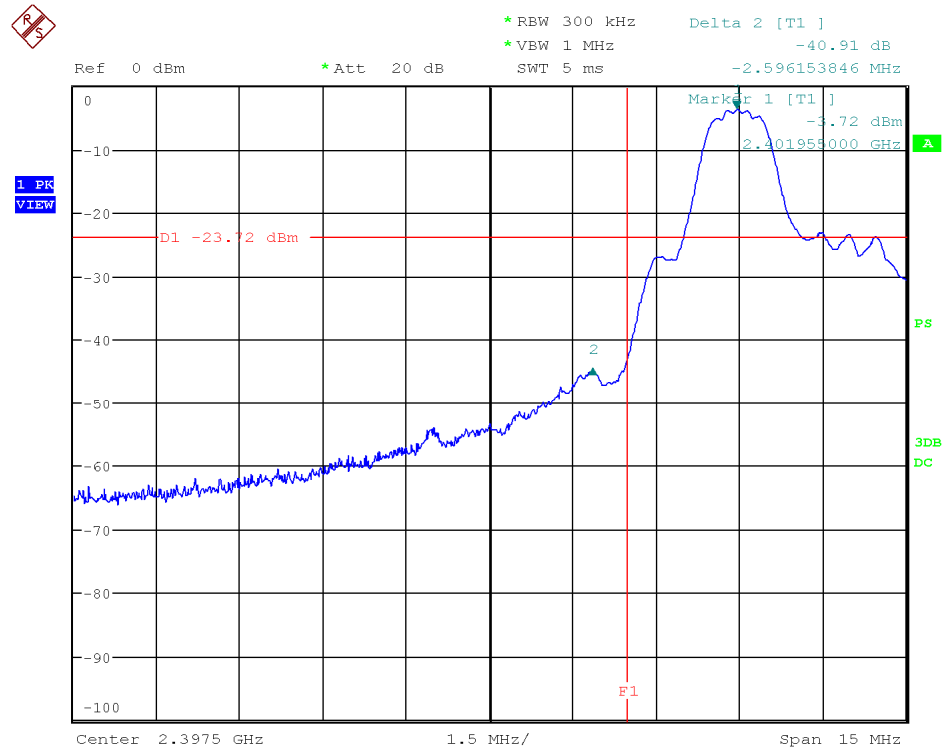
4. HIGH FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

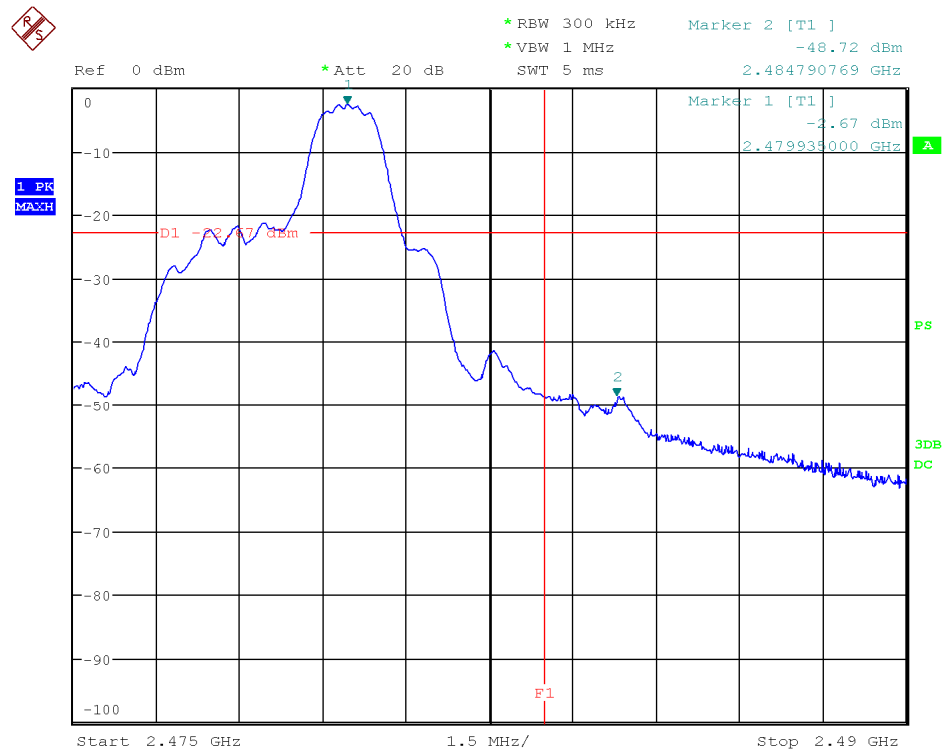
**Modulation:  $\Pi/4$ -DQPSK**

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



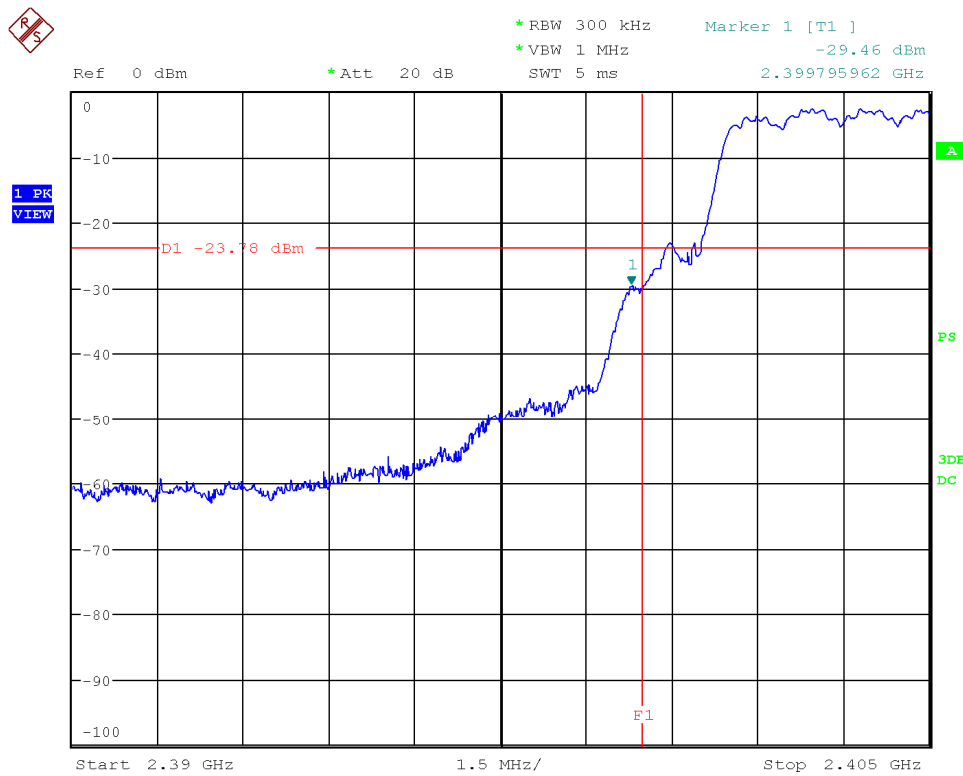
Verdict: PASS

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



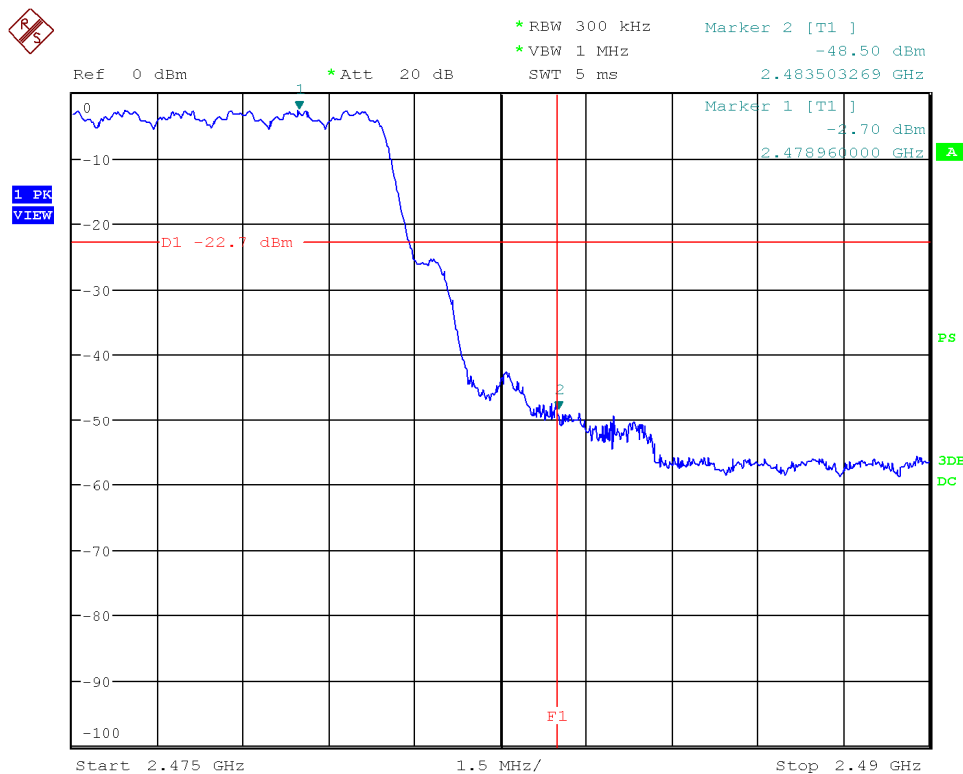
Verdict: PASS

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



Verdict: PASS

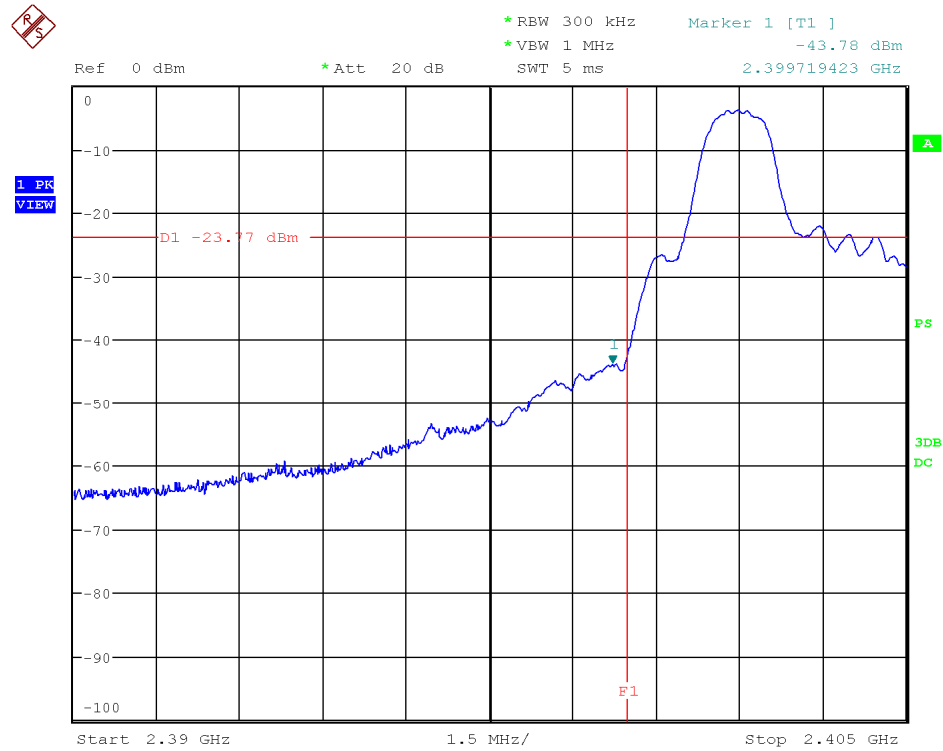
4. HIGH FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

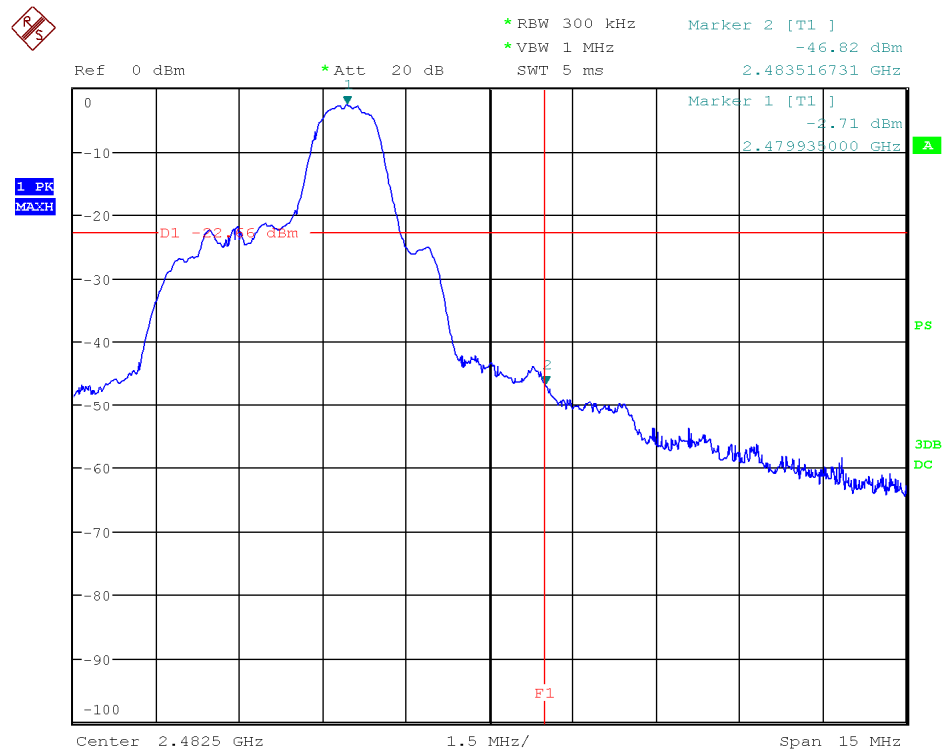
**Modulation: 8-DPSK**

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



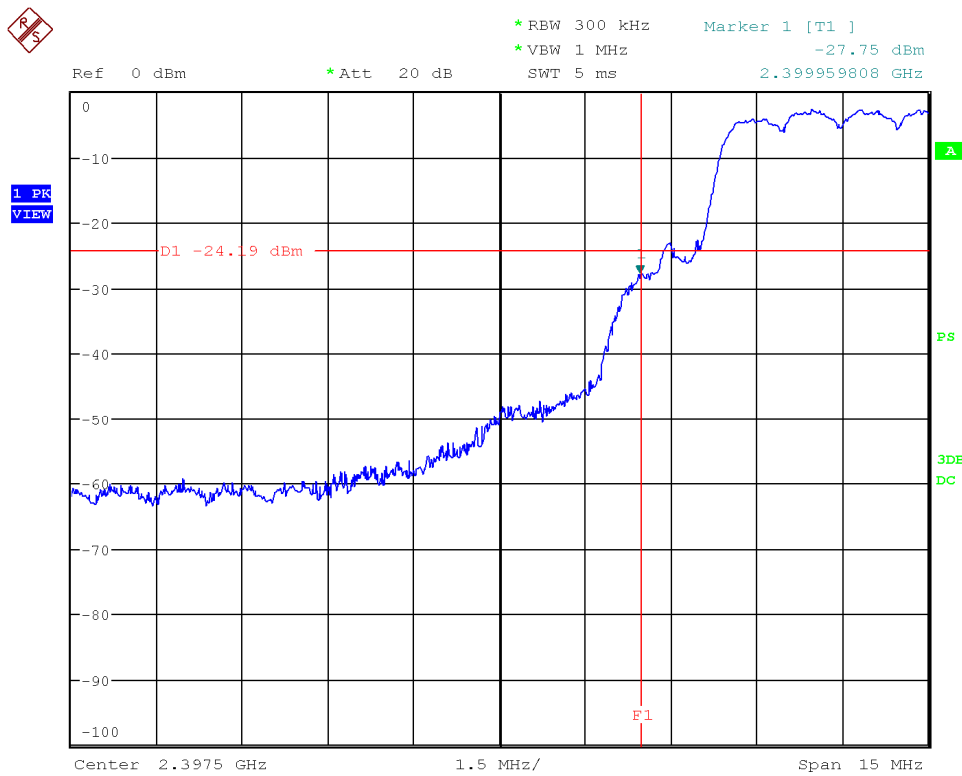
Verdict: PASS

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



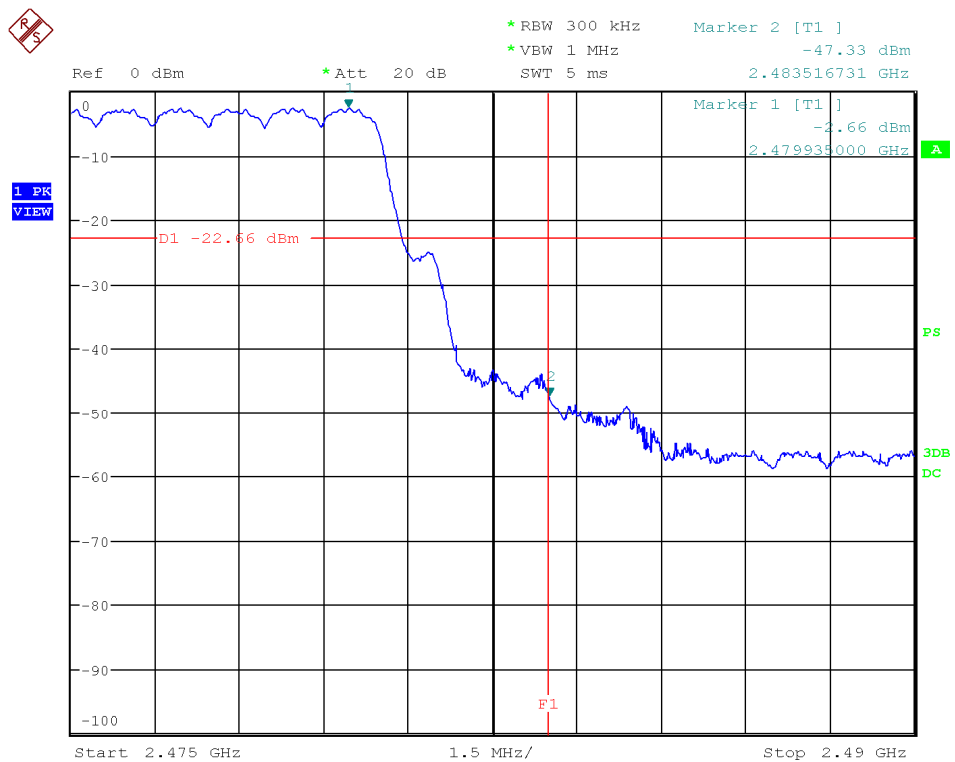
Verdict: PASS

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



Verdict: PASS

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



Verdict: PASS

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

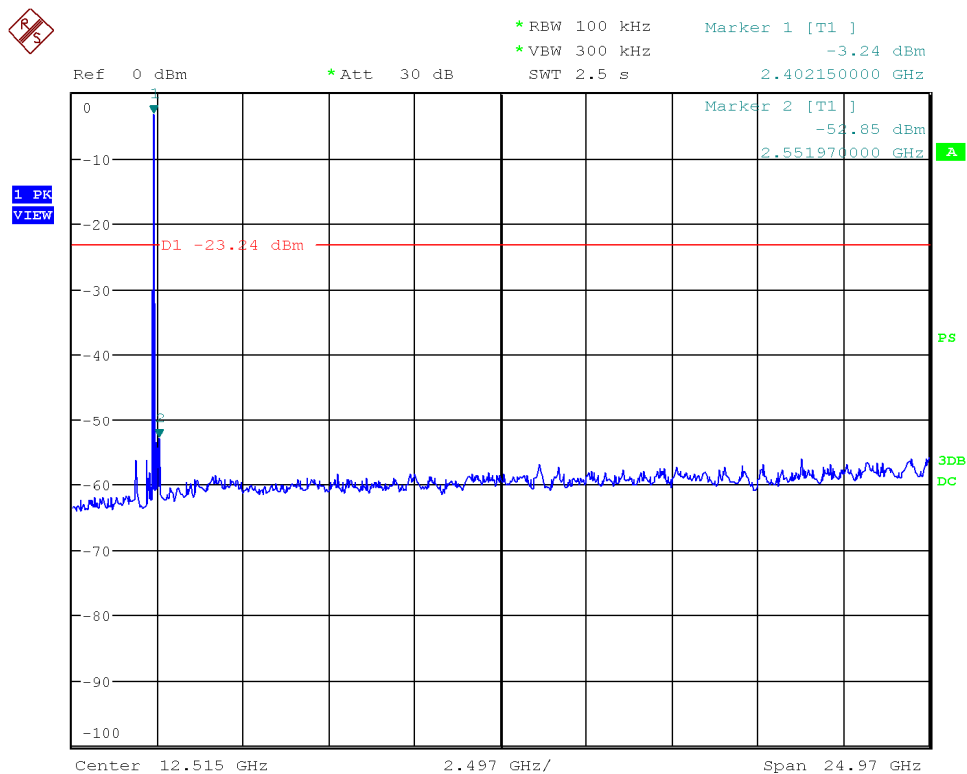
**SPECIFICATION**

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

**RESULTS:**

**Modulation: GFSK**

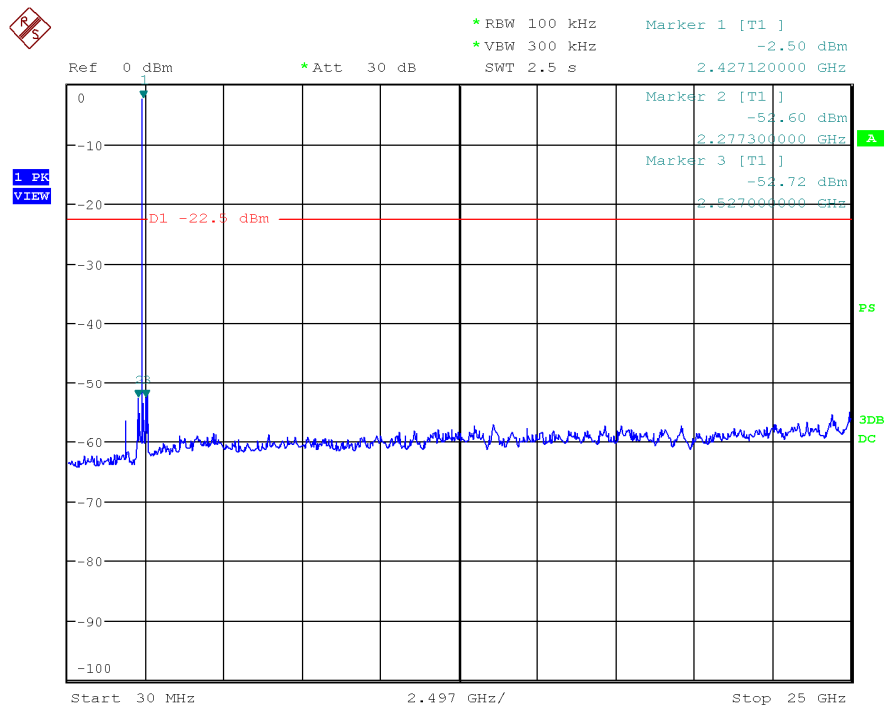
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

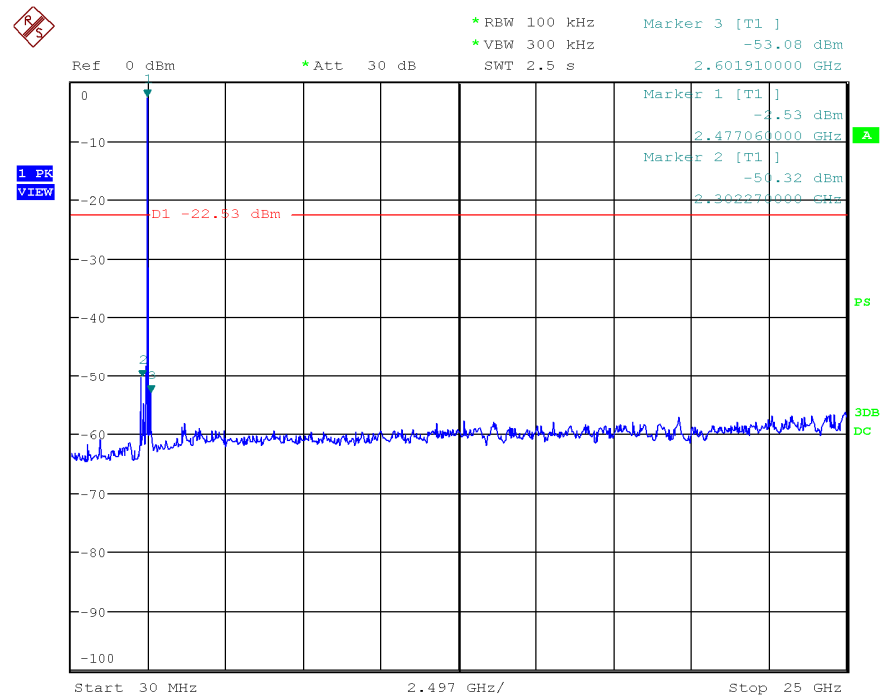
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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

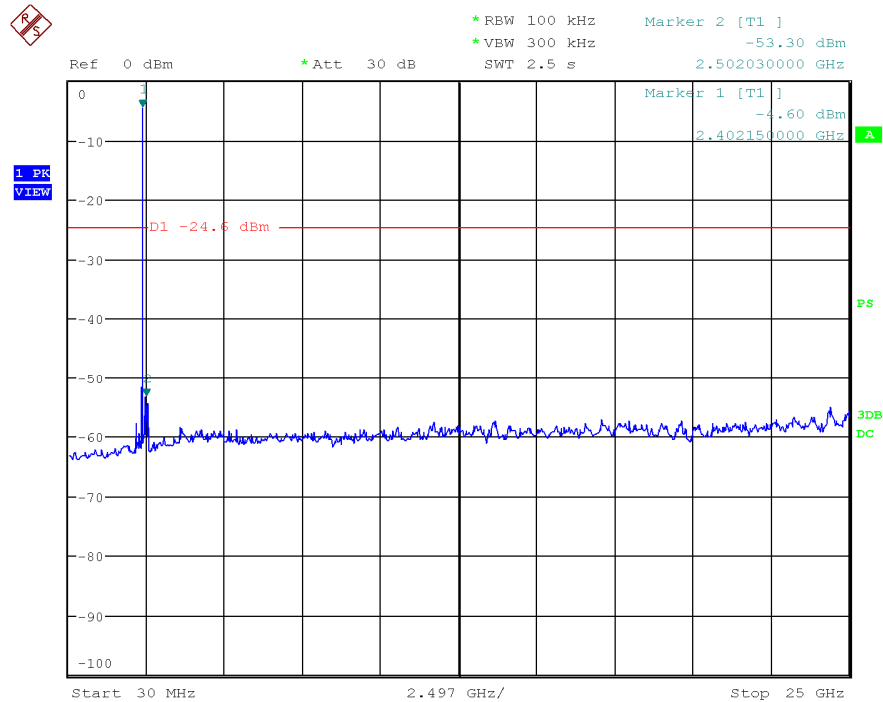


Note: The peak above the limits is the carrier frequency.

Verdict: PASS

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

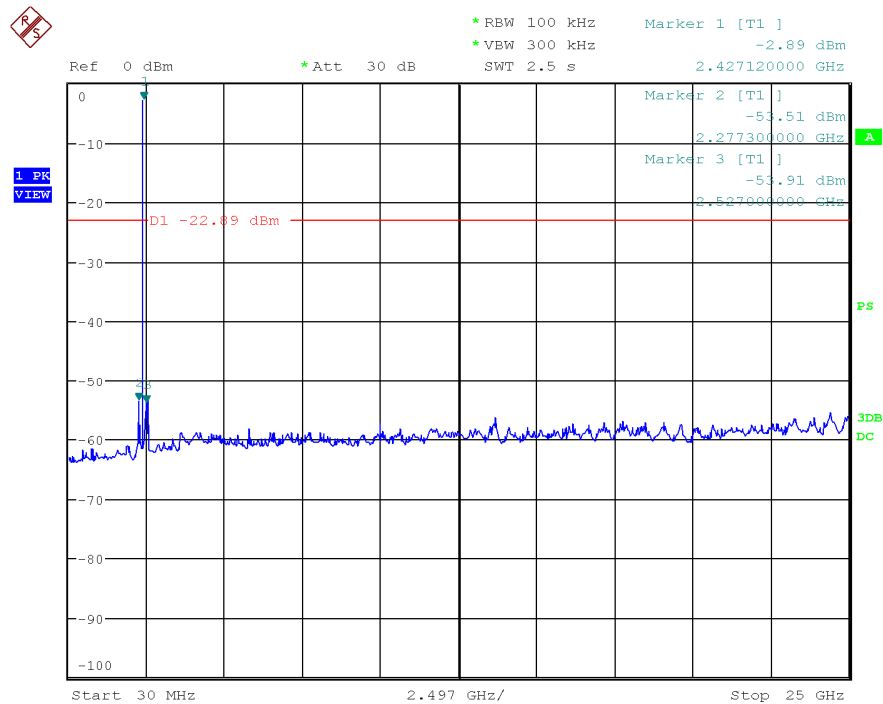
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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

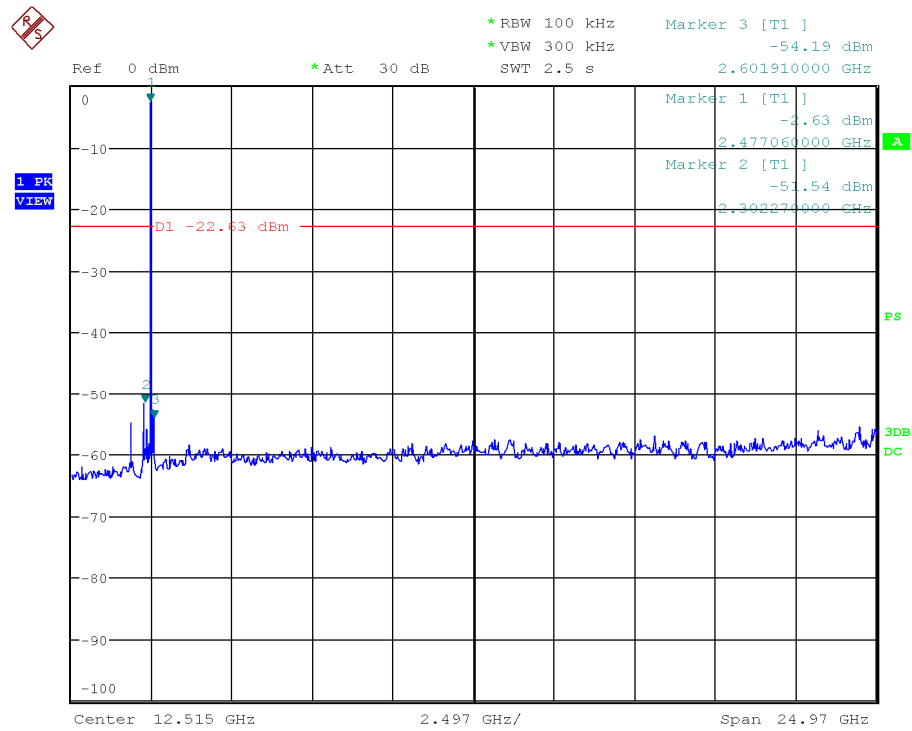


Note: The peaks above the limits are the carrier frequencies.

Verdict: PASS



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

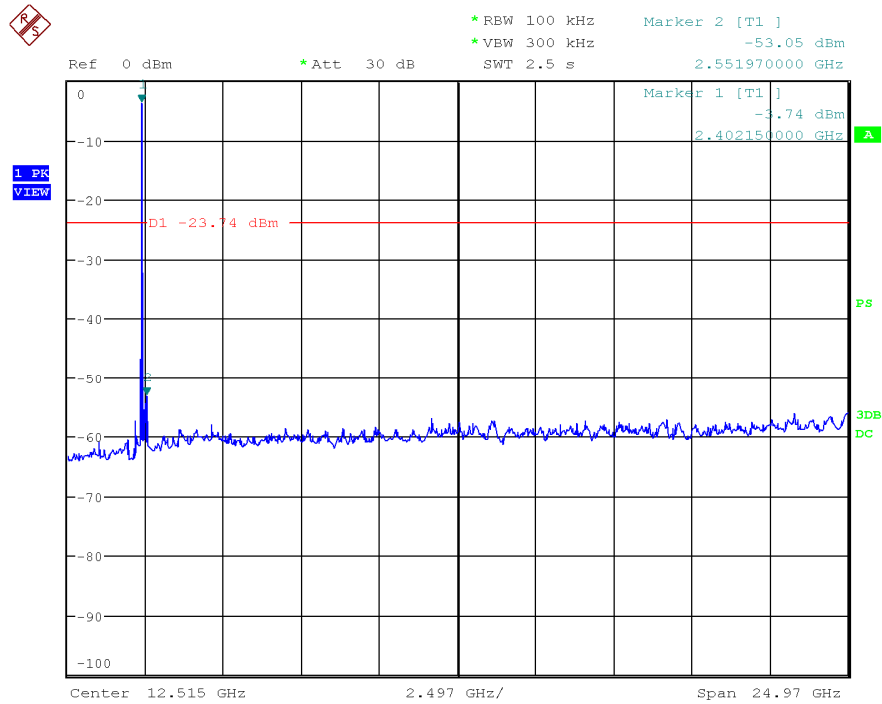


Note: The peak above the limit is the carrier frequency.

Verdict: PASS

**Modulation: 8-DPSK**

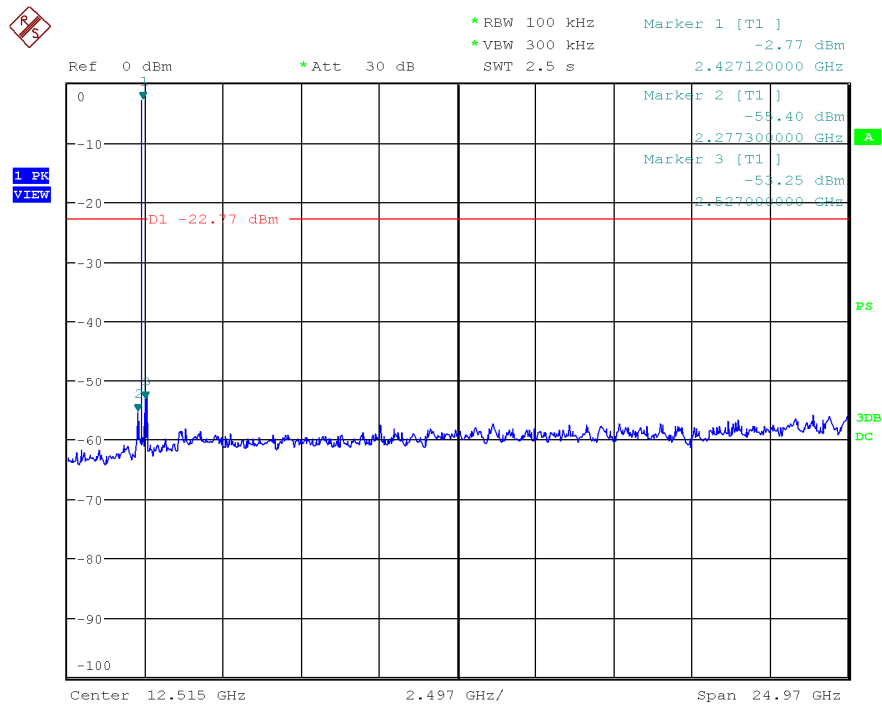
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

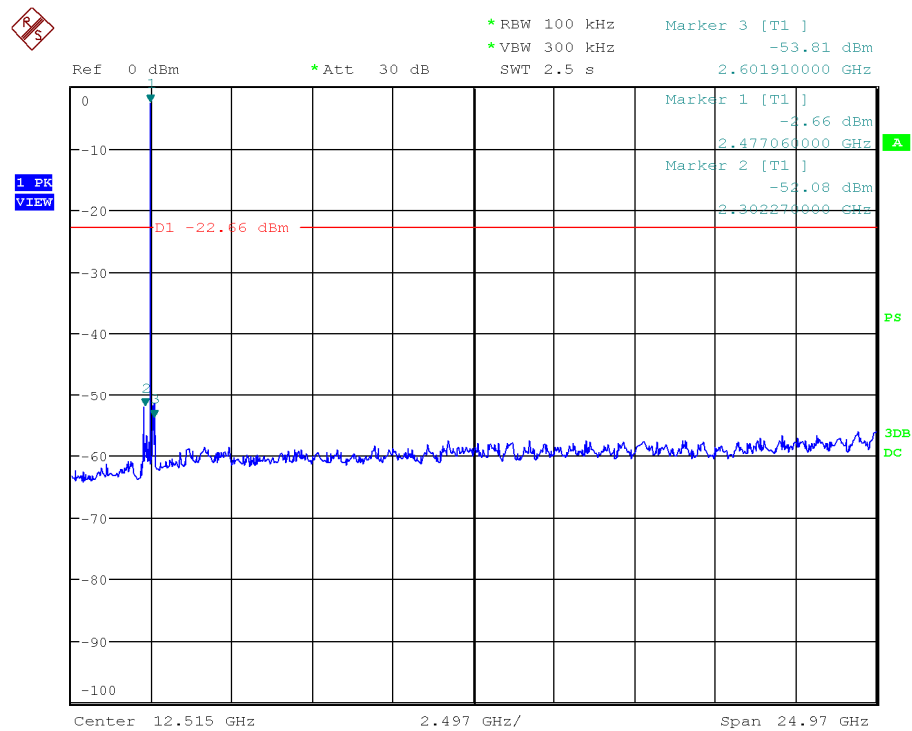
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

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



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

Verdict: PASS

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

SPECIFICATION

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

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

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

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

RESULTS:

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

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

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

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

**Frequency range 30 MHz-1000 MHz.**

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

**Spurious levels operating (radiated) closest to limit.**

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
39.719438	V	Quasi-peak	23.01	$\pm 4.12$

**Frequency range 1 GHz-25 GHz**

Modulation: GFSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.37565	V	Peak	51.97	$\pm 4.0$
	V	Average	40.85	$\pm 4.0$
2.49795	V	Peak	52.31	$\pm 4.0$
	V	Average	41.30	$\pm 4.0$
2.505929	V	Peak	54.22	$\pm 4.0$
	V	Average	43.09	$\pm 4.0$
2.532051	V	Peak	52.94	$\pm 4.0$
	V	Average	42.74	$\pm 4.0$
2.558012	V	Peak	53.51	$\pm 4.0$
	V	Average	44.69	$\pm 4.0$

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.38756	V	Peak	51.75	$\pm 4.0$
	V	Average	40.73	$\pm 4.0$
2.48773	V	Peak	52.14	$\pm 4.0$
	V	Average	41.10	$\pm 4.0$
2.544943	V	Peak	53.44	$\pm 4.0$
	V	Average	44.11	$\pm 4.0$
2.570905	V	Peak	54.15	$\pm 4.0$
	V	Average	44.40	$\pm 4.0$
2.597026	V	Peak	54.04	$\pm 4.0$
	V	Average	44.49	$\pm 4.0$

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.38789	V	Peak	53.80	$\pm 4.0$
	V	Average	40.50	$\pm 4.0$
2.4835	V	Peak	60.15	$\pm 4.0$
	V	Average	53.56	$\pm 4.0$
2.558008	V	Peak	53.42	$\pm 4.0$
	V	Average	43.58	$\pm 4.0$
2.583969	V	Peak	54.28	$\pm 4.0$
	V	Average	45.38	$\pm 4.0$
2.609930	V	Peak	53.75	$\pm 4.0$
	V	Average	43.76	$\pm 4.0$

Verdict: PASS

Modulation:  $\Pi/4$ -DQPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.37885	V	Peak	51.56	$\pm 4.0$
	V	Average	40.64	$\pm 4.0$
2.49773	V	Peak	52.48	$\pm 4.0$
	V	Average	41.08	$\pm 4.0$
2.50945	V	Peak	52.69	$\pm 4.0$
	V	Average	42.20	$\pm 4.0$
2.53214	V	Peak	53.47	$\pm 4.0$
	V	Average	42.20	$\pm 4.0$
2.55810	V	Peak	53.56	$\pm 4.0$
	V	Average	43.28	$\pm 4.0$

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.38210	V	Peak	52.22	$\pm 4.0$
	V	Average	40.77	$\pm 4.0$
2.49911	V	Peak	52.93	$\pm 4.0$
	V	Average	41.27	$\pm 4.0$
2.54508	V	Peak	53.02	$\pm 4.0$
	V	Average	42.90	$\pm 4.0$
2.57104	V	Peak	53.18	$\pm 4.0$
	V	Average	42.96	$\pm 4.0$
2.59724	V	Peak	53.39	$\pm 4.0$
	V	Average	43.03	$\pm 4.0$

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.32375	V	Peak	51.48	$\pm 4.0$
	V	Average	40.93	$\pm 4.0$
2.48352	V	Peak	53.98	$\pm 4.0$
	V	Average	44.14	$\pm 4.0$
2.55812	V	Peak	52.75	$\pm 4.0$
	V	Average	42.02	$\pm 4.0$
2.58408	V	Peak	54.50	$\pm 4.0$
	V	Average	43.64	$\pm 4.0$
2.61004	V	Peak	52.95	$\pm 4.0$
	V	Average	42.74	$\pm 4.0$
2.63600	V	Peak	54.78	$\pm 4.0$
	V	Average	42.78	$\pm 4.0$

Verdict: PASS



Modulation: 8-DPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.38865	V	Peak	52.00	$\pm 4.0$
	V	Average	40.79	$\pm 4.0$
2.49818	V	Peak	52.38	$\pm 4.0$
	V	Average	41.25	$\pm 4.0$
2.50602	V	Peak	53.09	$\pm 4.0$
	V	Average	42.17	$\pm 4.0$
2.53179	V	Peak	53.13	$\pm 4.0$
	V	Average	42.01	$\pm 4.0$
2.55819	V	Peak	53.93	$\pm 4.0$
	V	Average	43.12	$\pm 4.0$

2. CHANNEL: MIDDLE (2441 MHz).

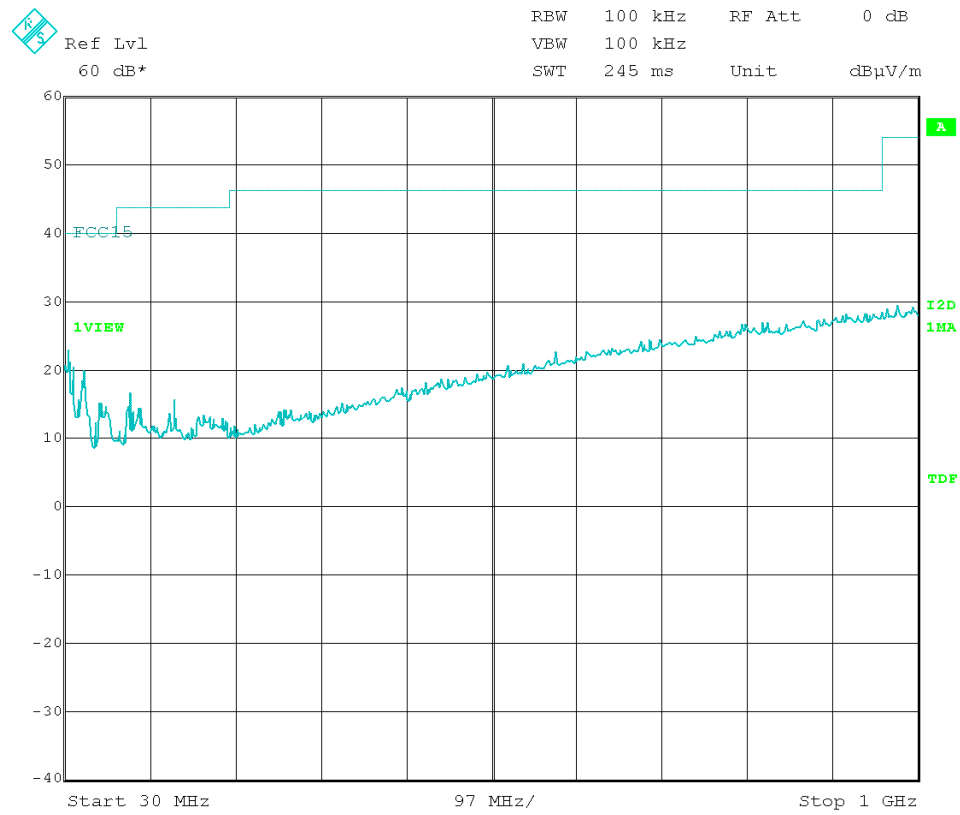
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.38935	V	Peak	51.77	$\pm 4.0$
	V	Average	40.09	$\pm 4.0$
2.49665	V	Peak	52.26	$\pm 4.0$
	V	Average	41.13	$\pm 4.0$
2.54509	V	Peak	53.00	$\pm 4.0$
	V	Average	42.86	$\pm 4.0$
2.57081	V	Peak	54.00	$\pm 4.0$
	V	Average	43.00	$\pm 4.0$
2.59701	V	Peak	54.39	$\pm 4.0$
	V	Average	43.13	$\pm 4.0$

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
2.34685	V	Peak	51.98	$\pm 4.0$
	V	Average	40.73	$\pm 4.0$
2.48352	V	Peak	54.34	$\pm 4.0$
	V	Average	44.00	$\pm 4.0$
2.55804	V	Peak	52.77	$\pm 4.0$
	V	Average	42.06	$\pm 4.0$
2.58736	V	Peak	53.72	$\pm 4.0$
	V	Average	42.06	$\pm 4.0$
2.61020	V	Peak	53.61	$\pm 4.0$
	V	Average	42.32	$\pm 4.0$
2.63616	V	Peak	54.95	$\pm 4.0$
	V	Average	42.46	$\pm 4.0$

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

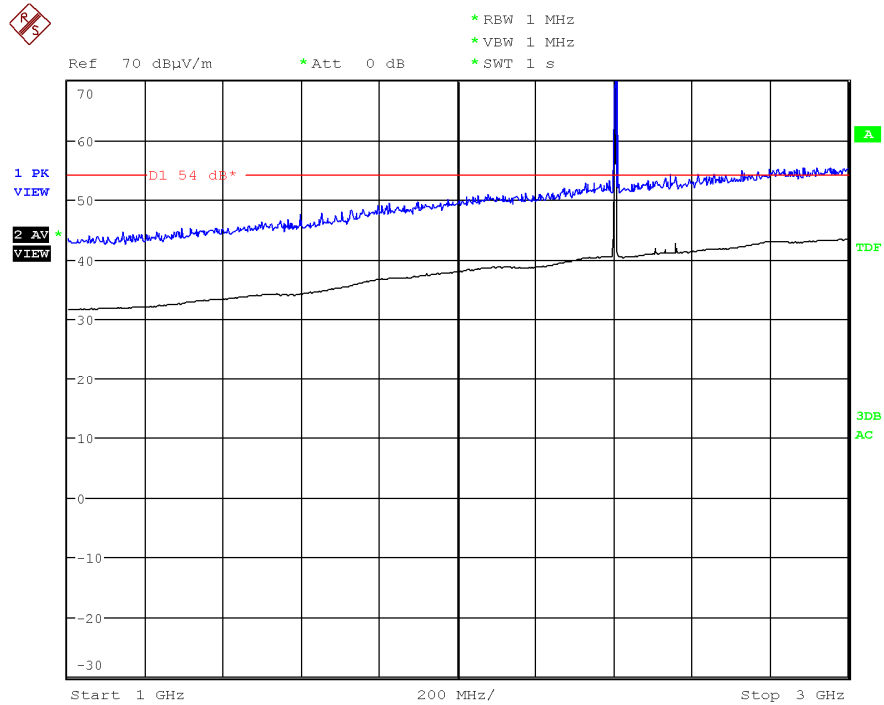


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

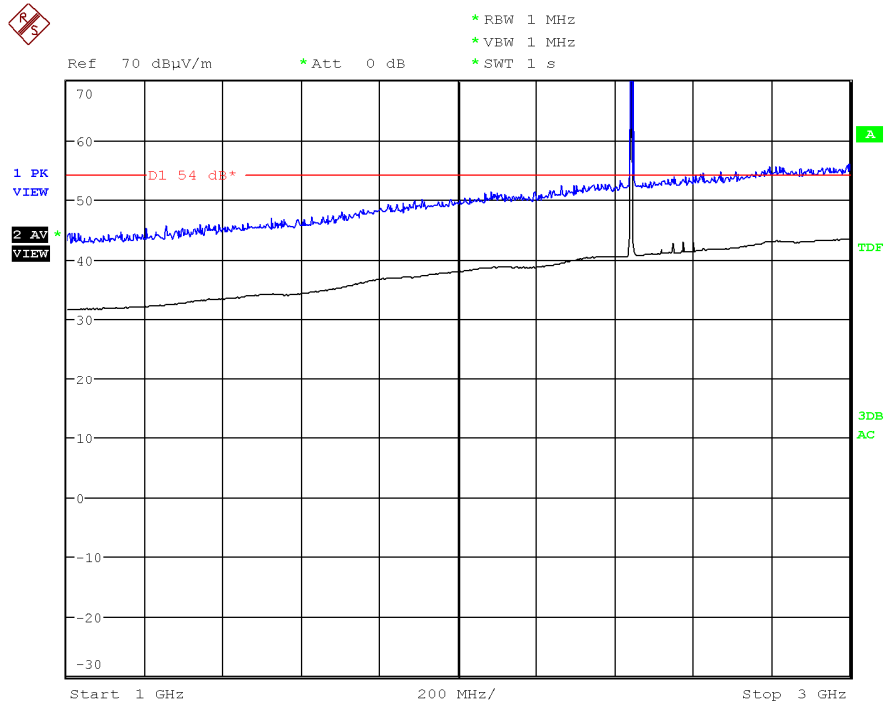
**Modulation: GFSK**

**CHANNEL: Lowest (2402 MHz).**



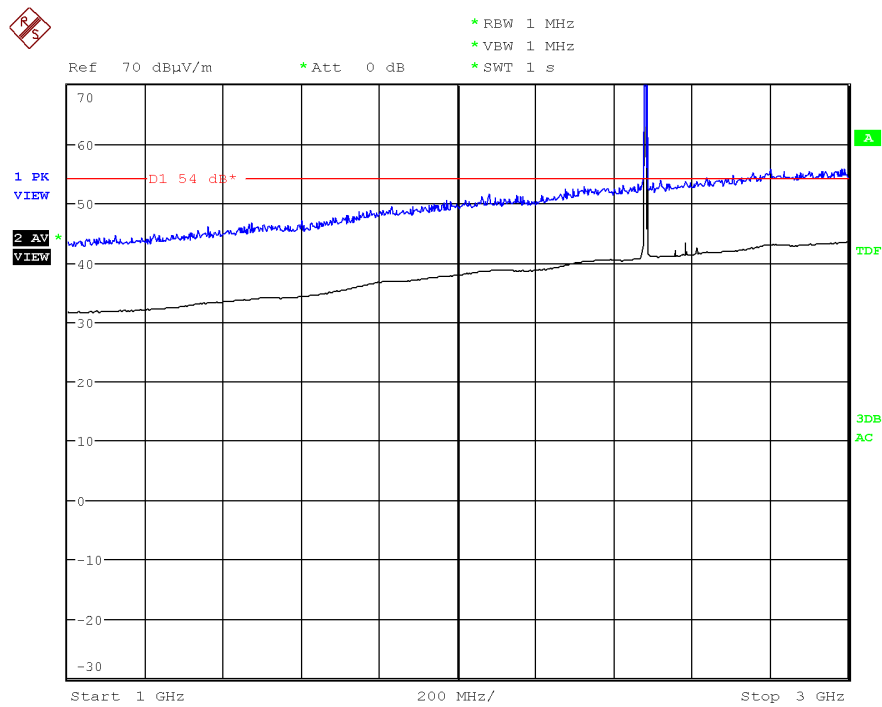
Note: The peak shown in the plot is the carrier frequency.

**CHANNEL: Middle (2441 MHz).**



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

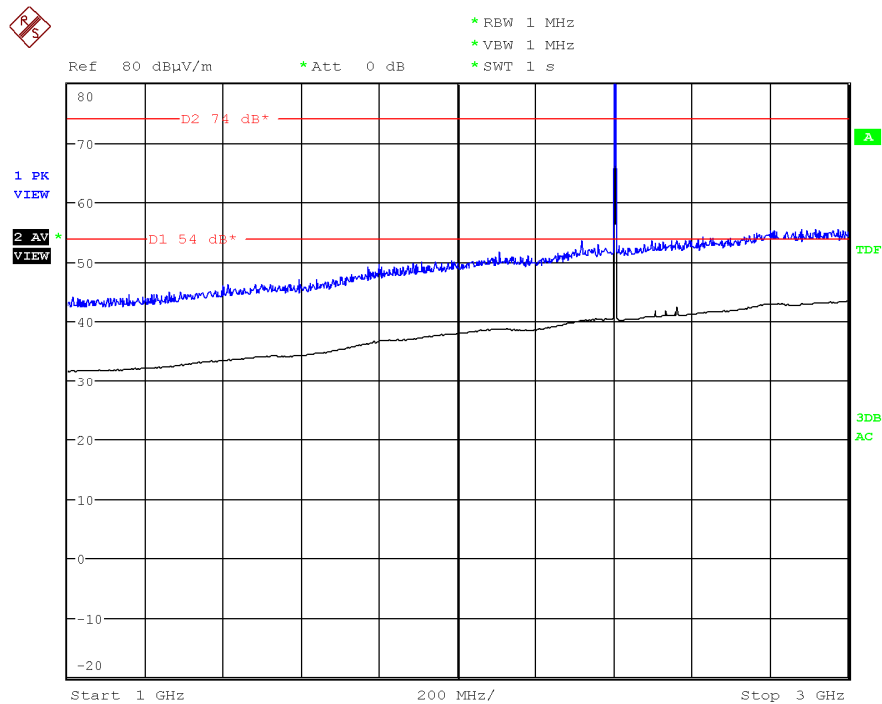
**CHANNEL: Highest (2480 MHz).**



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

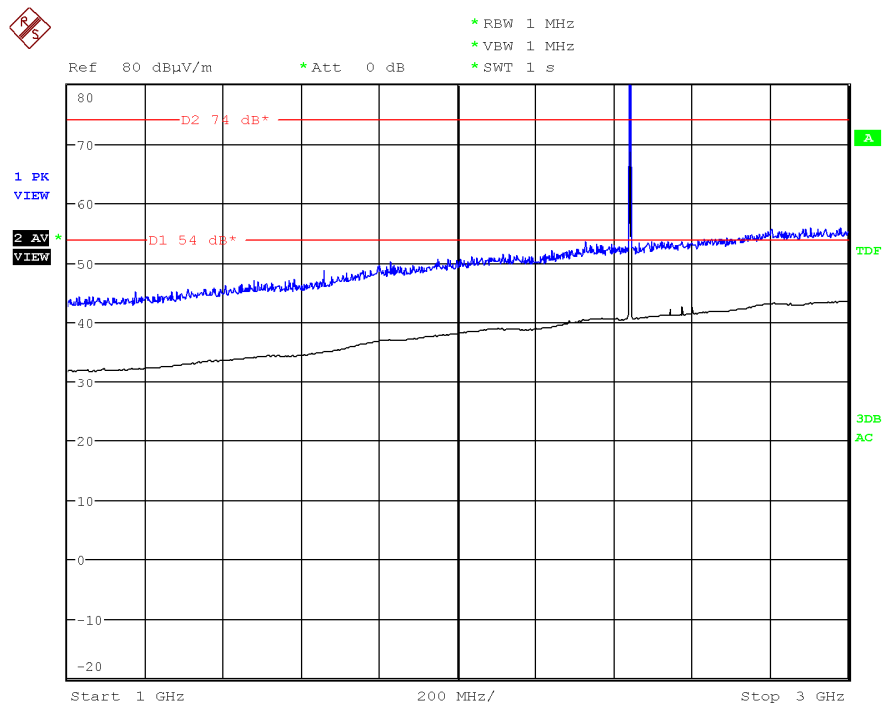
**Modulation: Π/4-DQPSK**

**CHANNEL: Lowest (2402 MHz).**



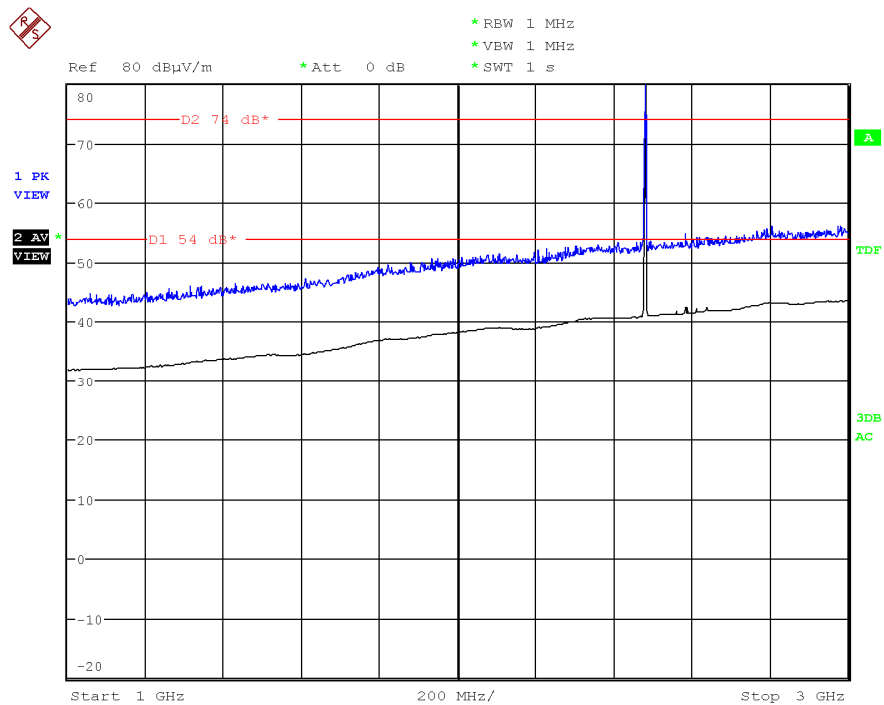
Note: The peak shown in the plot is the carrier frequency.

**CHANNEL: Middle (2441 MHz).**



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

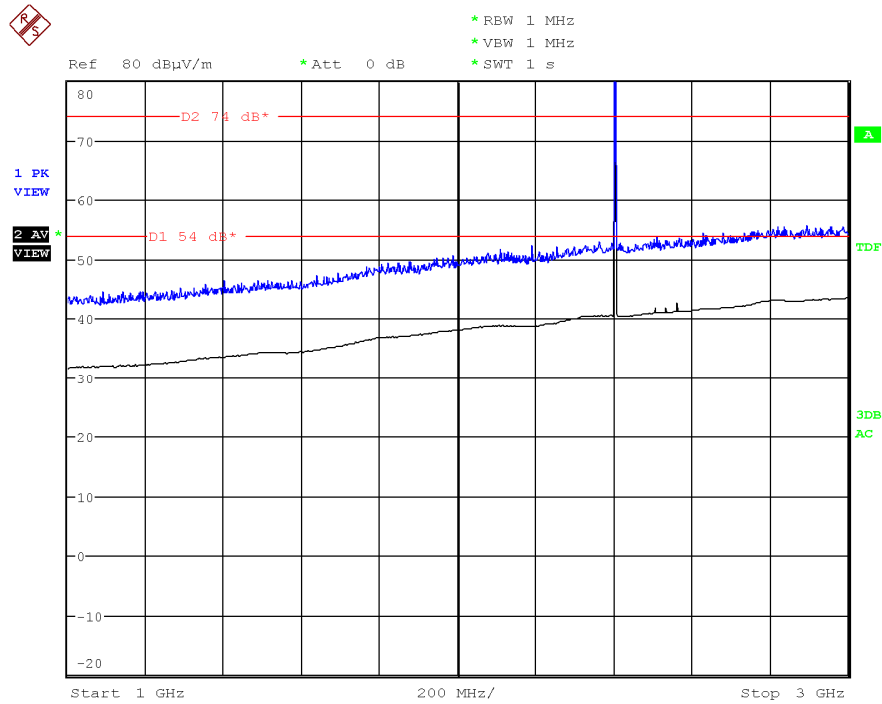
**CHANNEL: Highest (2480 MHz).**



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

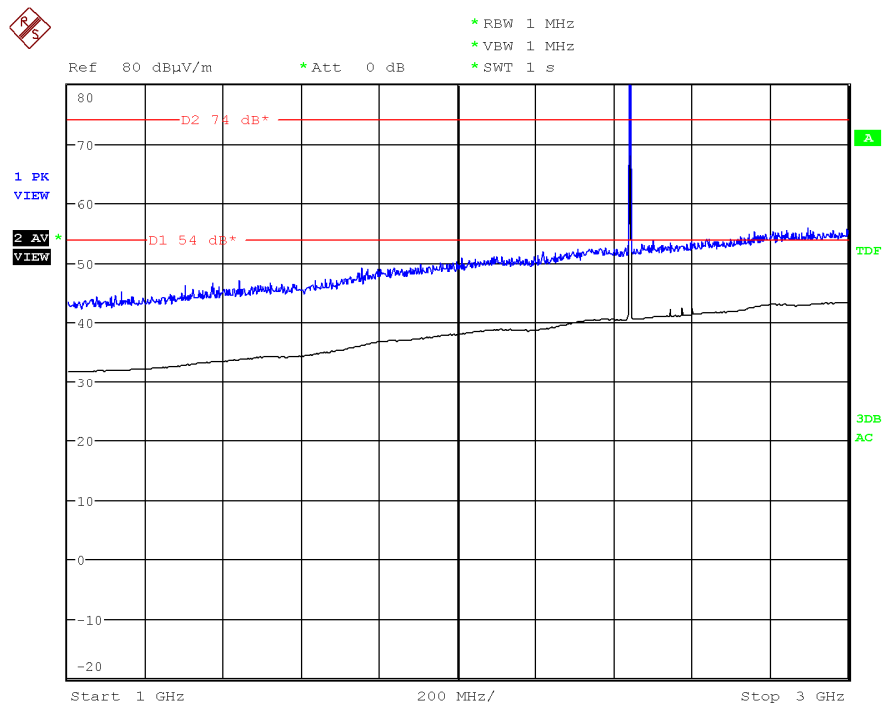
**Modulation: 8-DPSK**

**CHANNEL: Lowest (2402 MHz).**



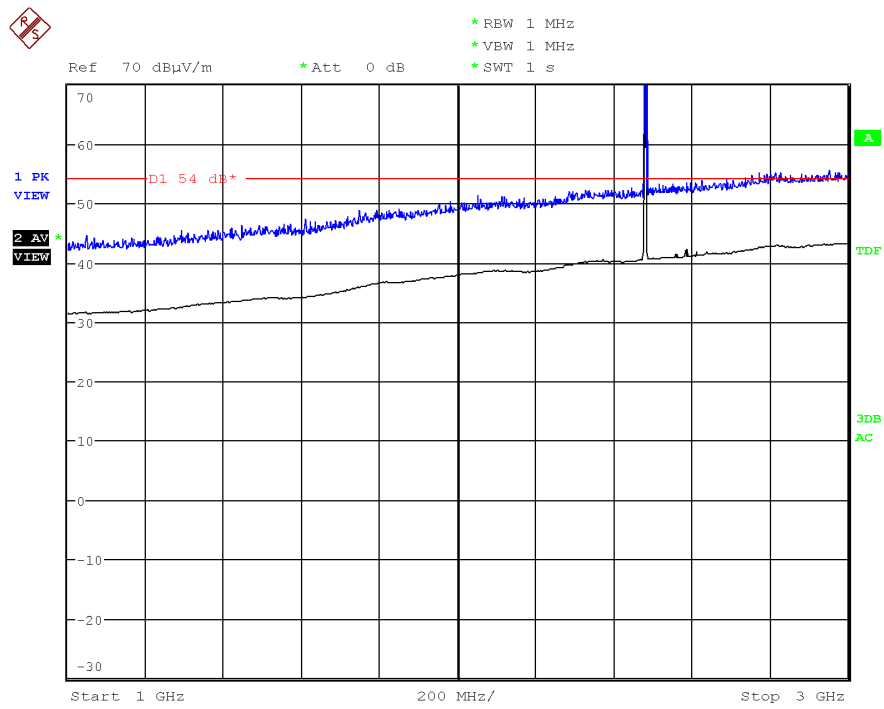
Note: The peak shown in the plot is the carrier frequency.

**CHANNEL: Middle (2441 MHz).**



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

**CHANNEL: Highest (2480 MHz).**



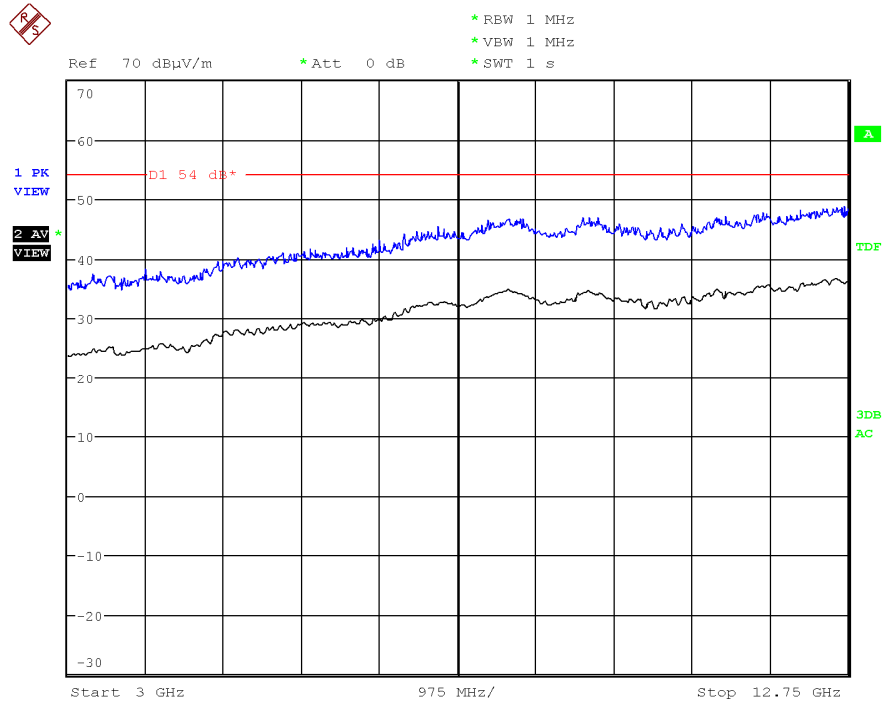
Note: The peak shown in the plot is the carrier frequency.



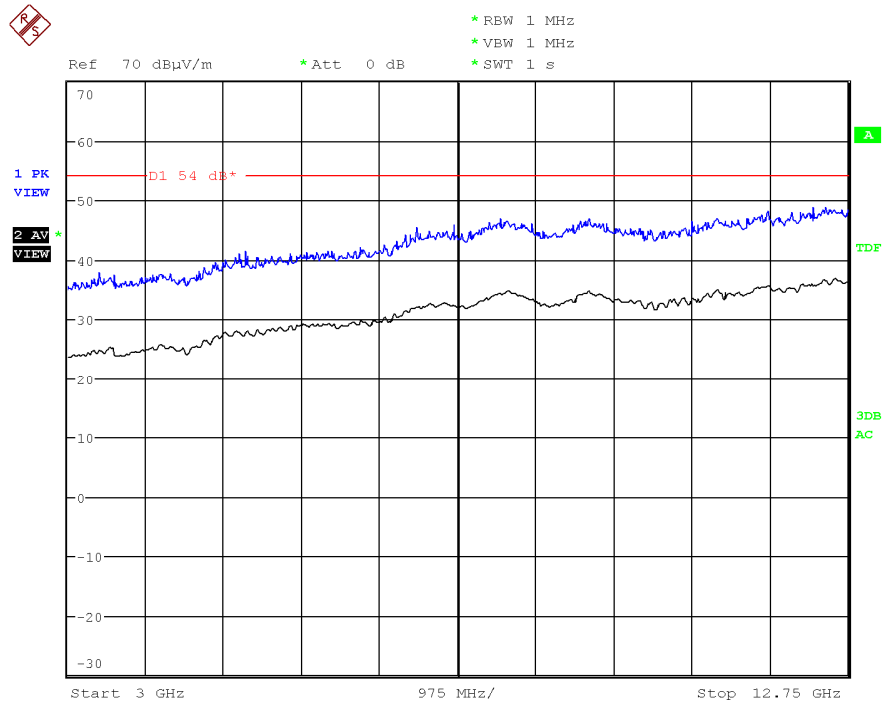
FREQUENCY RANGE 3 GHz to 12.75 GHz.

**Modulation: GFSK**

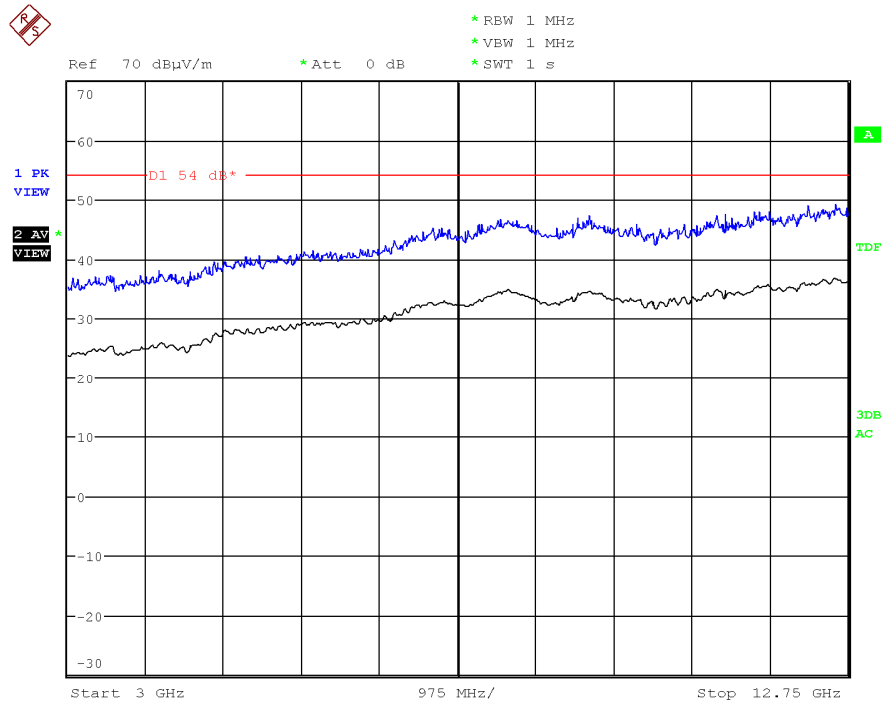
**CHANNEL: Lowest (2402 MHz).**



**CHANNEL: Middle (2441 MHz).**

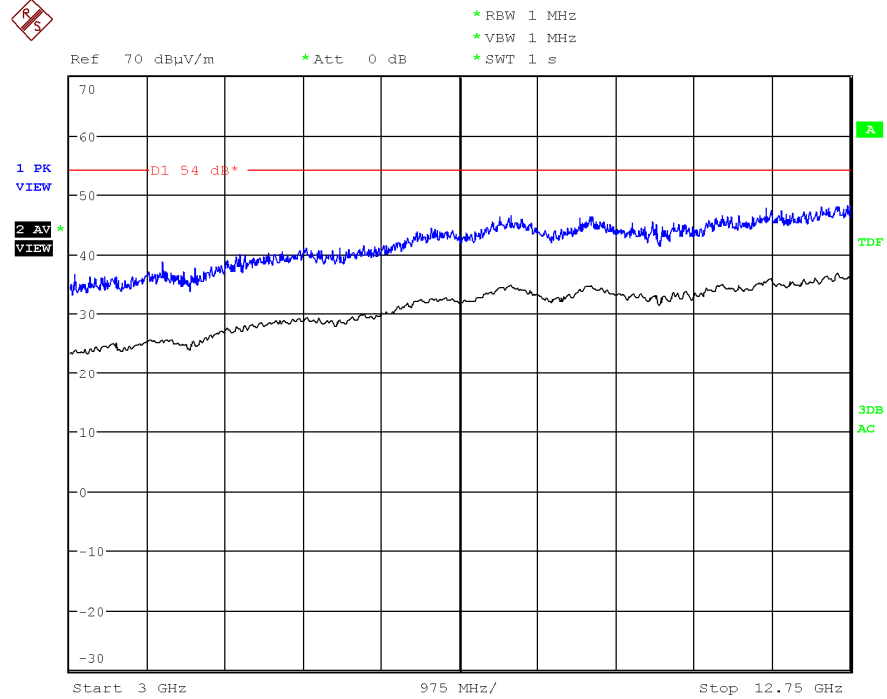


**CHANNEL: Highest (2480 MHz).**

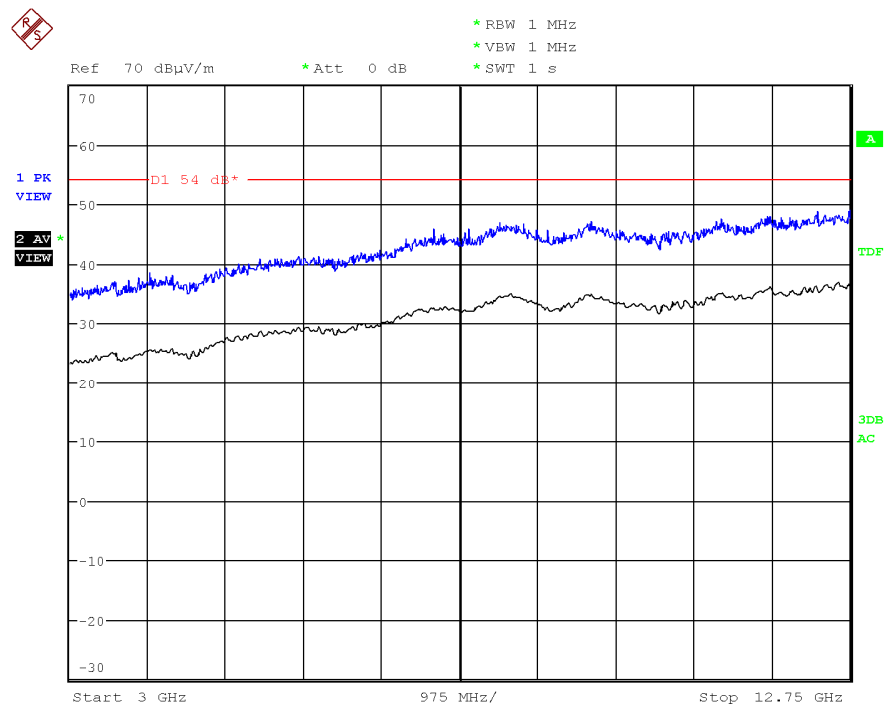


**Modulation:  $\Pi/4$ -DQPSK**

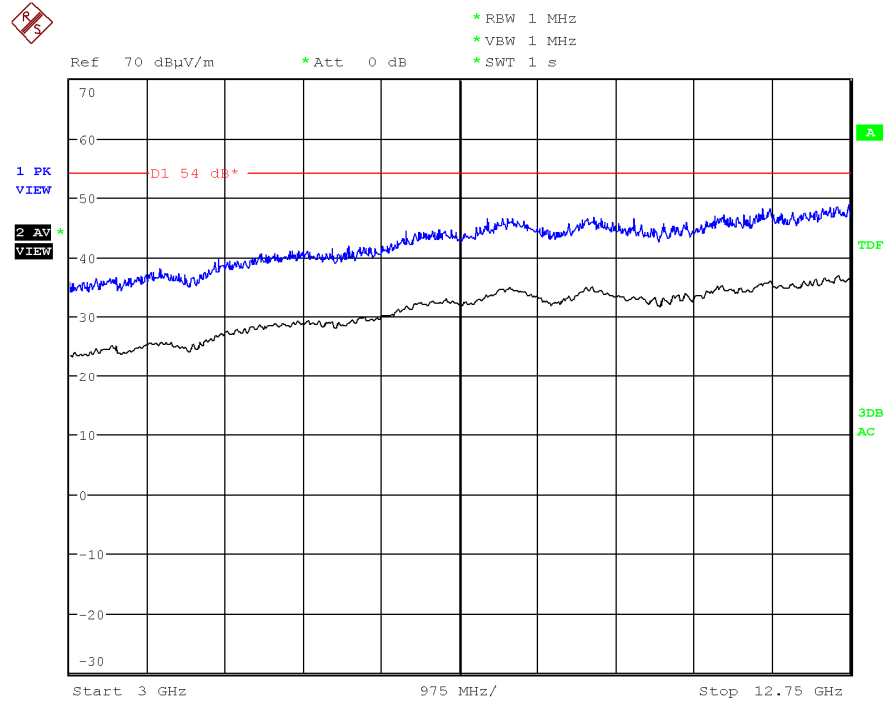
**CHANNEL: Lowest (2402 MHz).**



**CHANNEL: Middle (2441 MHz).**

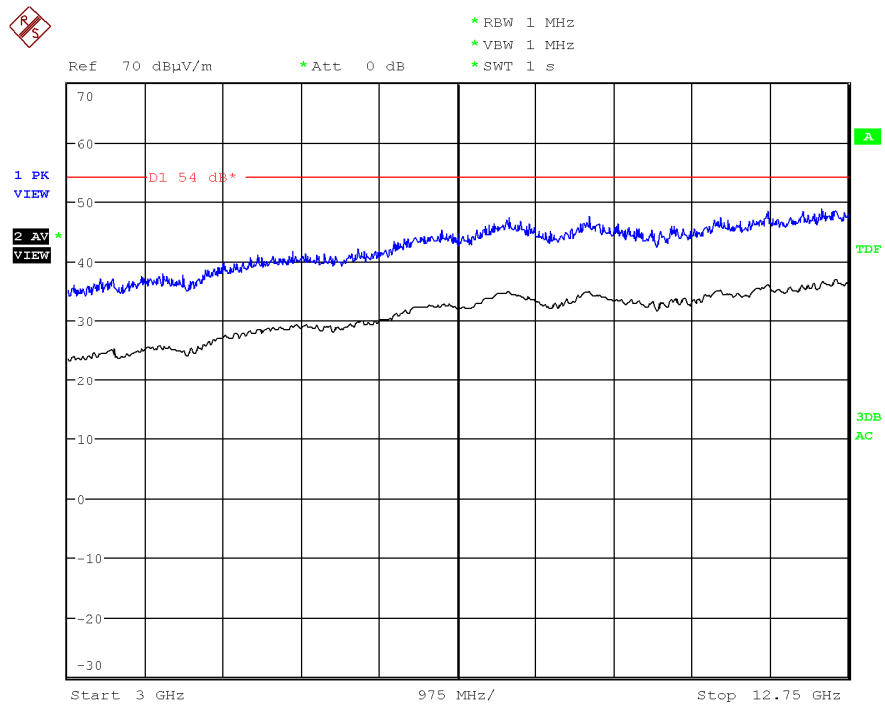


**CHANNEL: Highest (2480 MHz).**

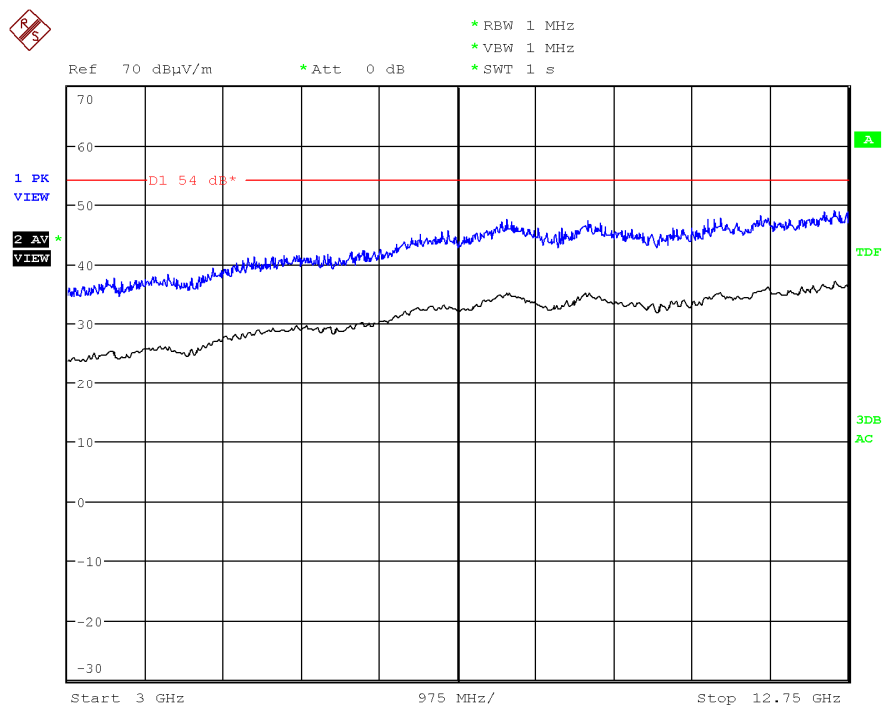


**Modulation: 8-DPSK**

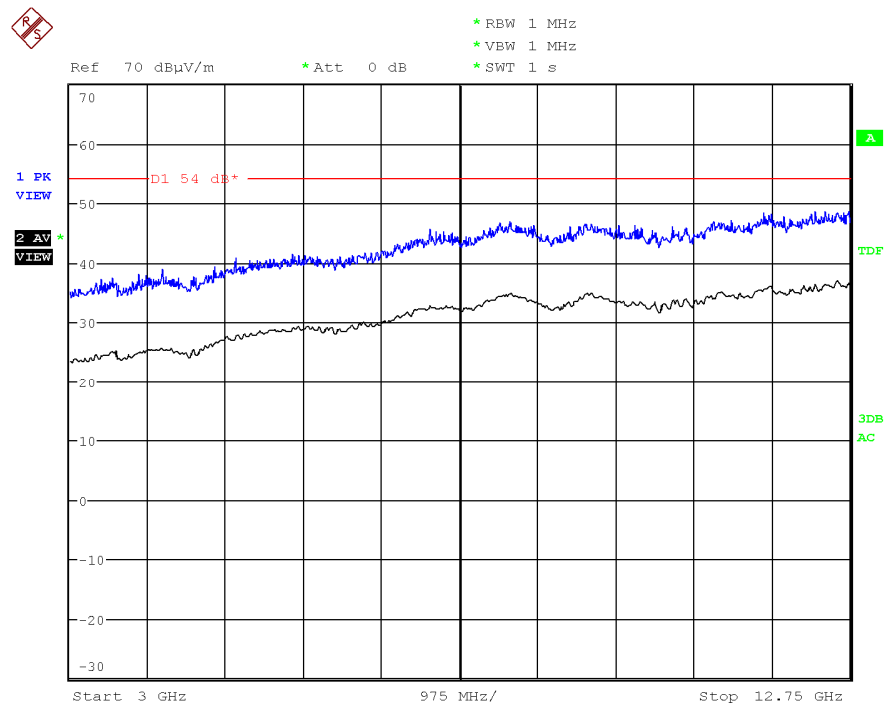
**CHANNEL: Lowest (2402 MHz).**



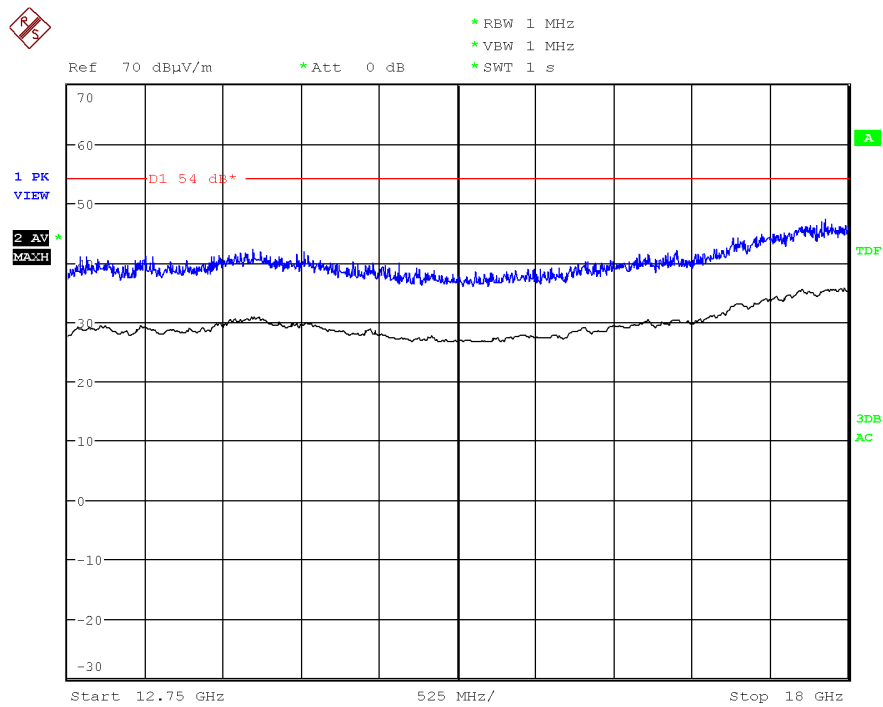
**CHANNEL: Middle (2441 MHz).**



**CHANNEL: Highest (2480 MHz).**

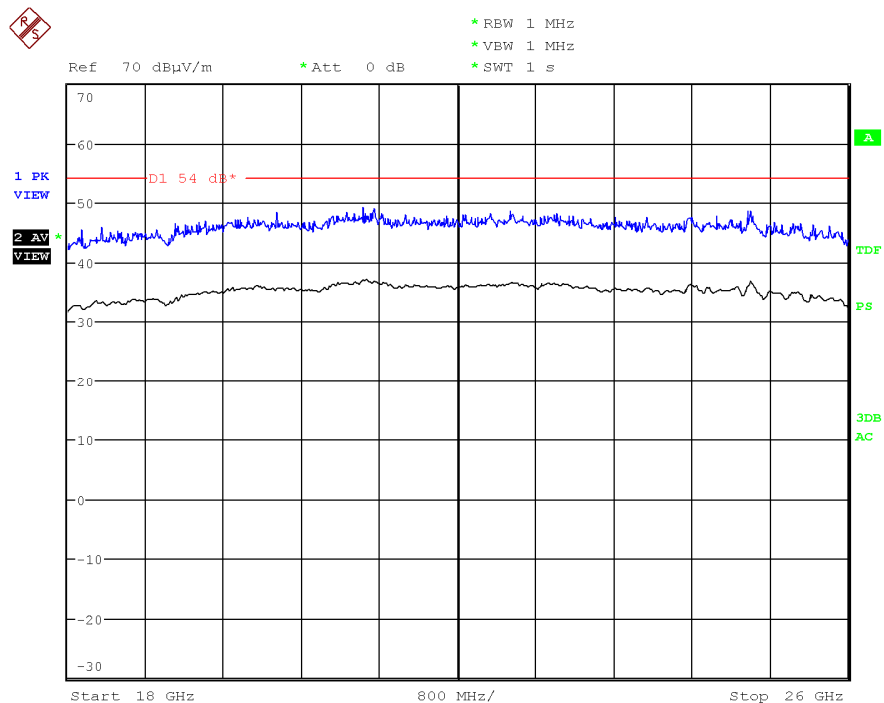


FREQUENCY RANGE 12.75 GHz to 18 GHz.



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

FREQUENCY RANGE 18 GHz to 25 GHz.

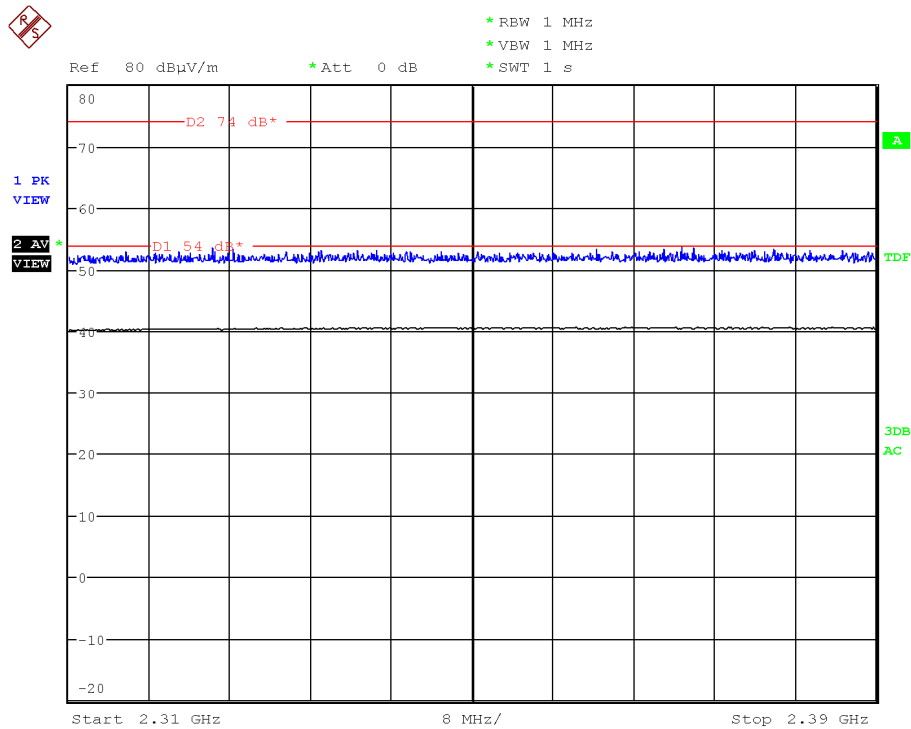


(This plot is valid for all three channels and all modulation modes).

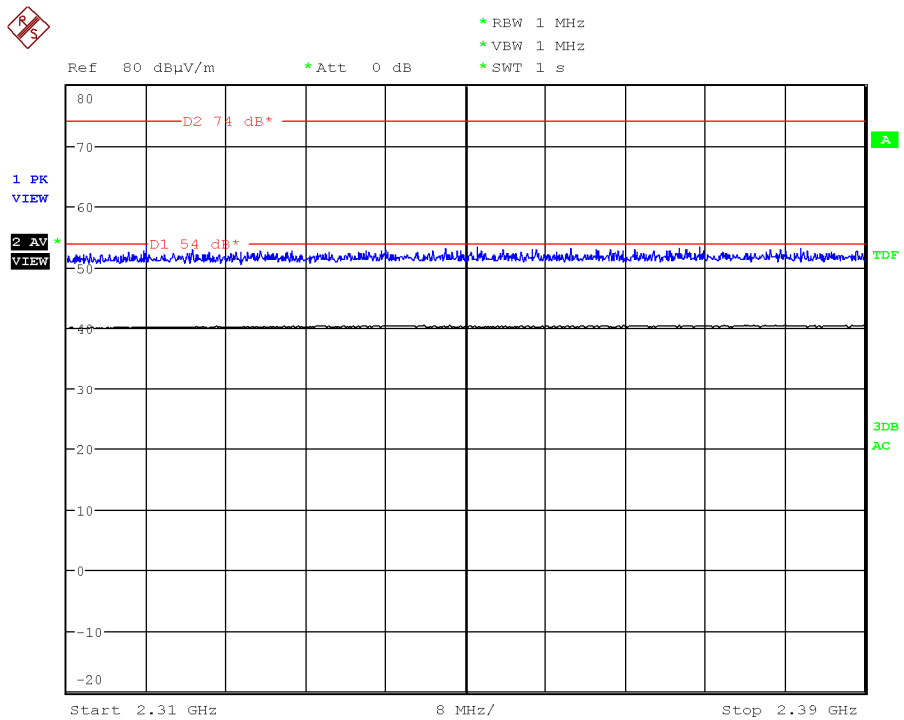
FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

**CHANNEL: Lowest**

**Modulation: GFSK**

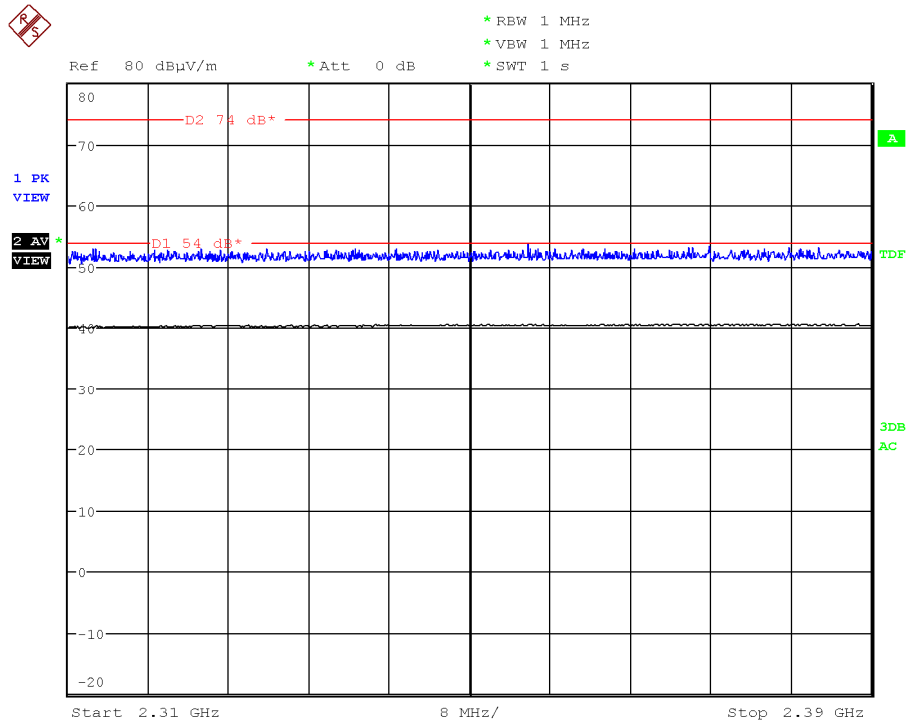


**Modulation: Π/4-DQPSK**



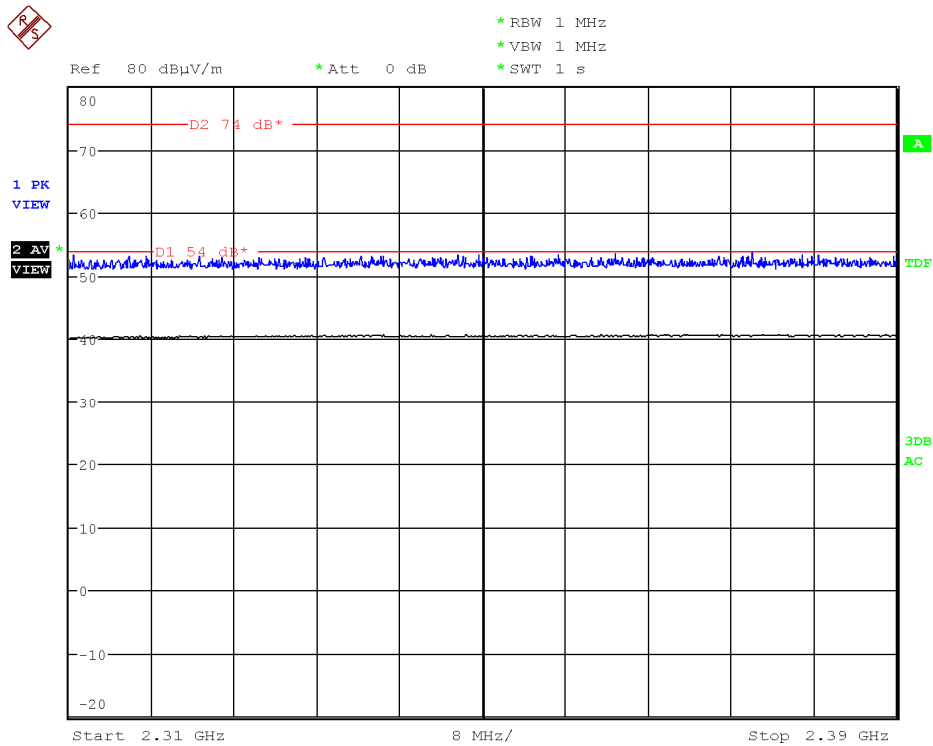


**Modulation: 8-DPSK**

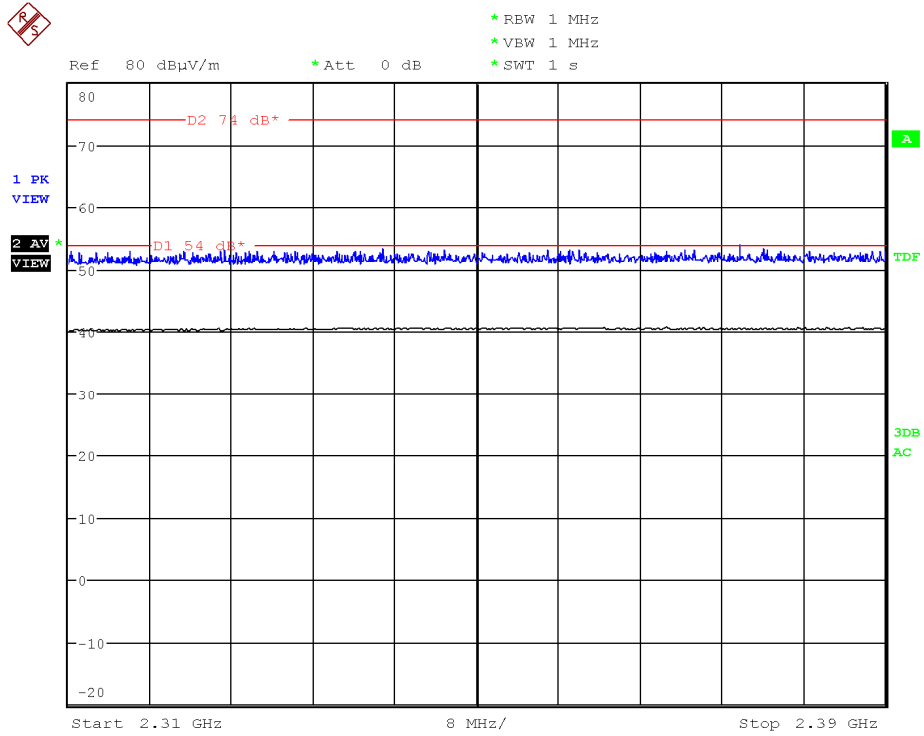


**CHANNEL: Middle**

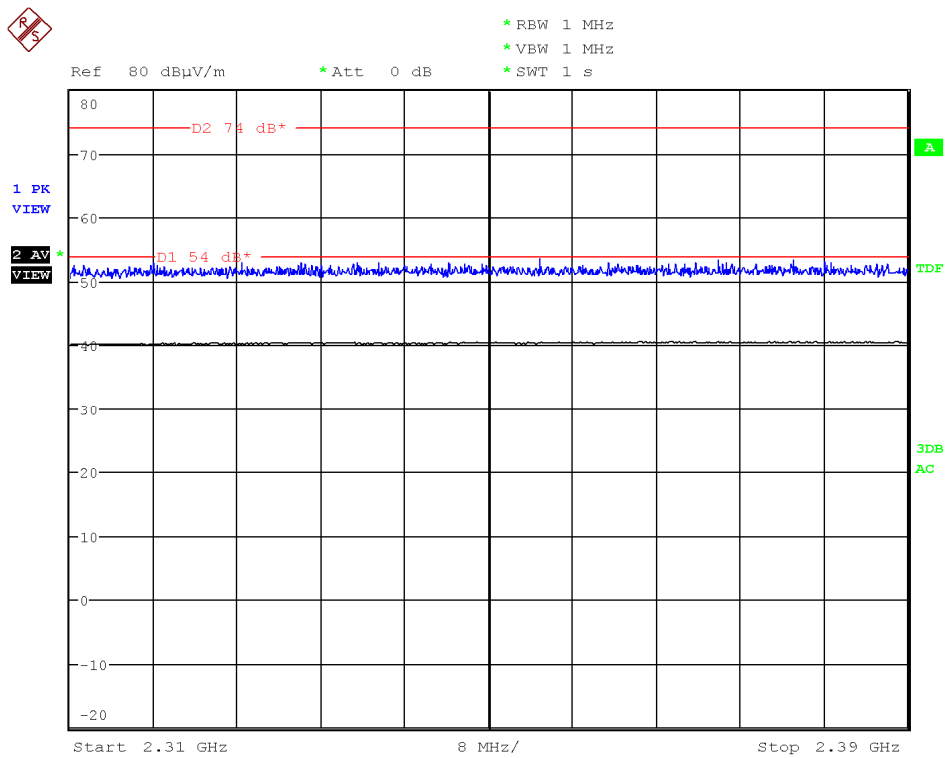
**Modulation: GFSK**



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

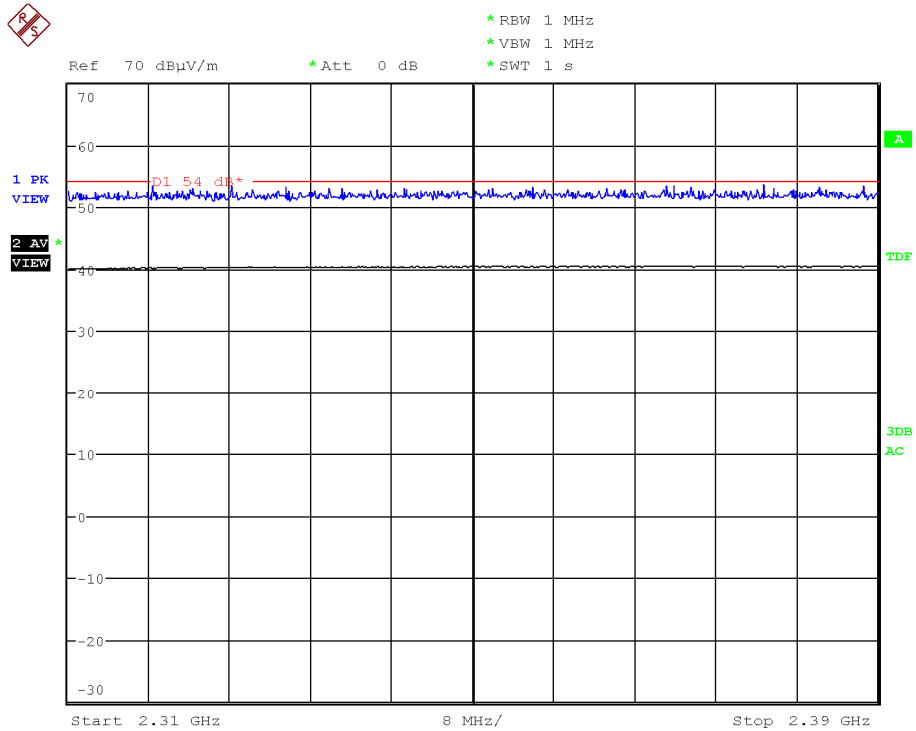


### Modulation: 8-DPSK

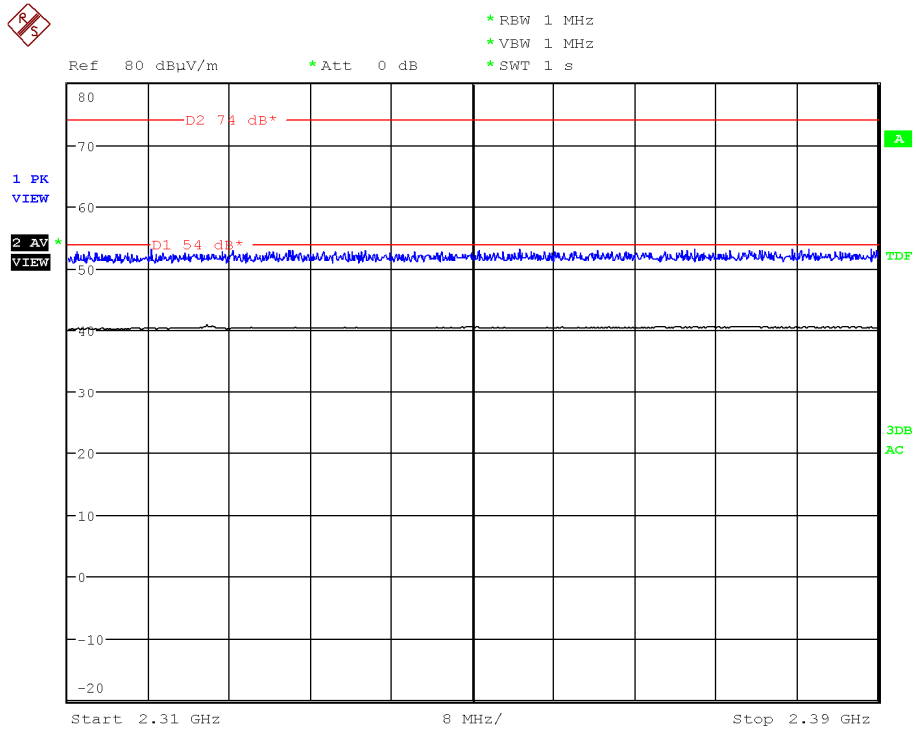


**CHANNEL: Highest**

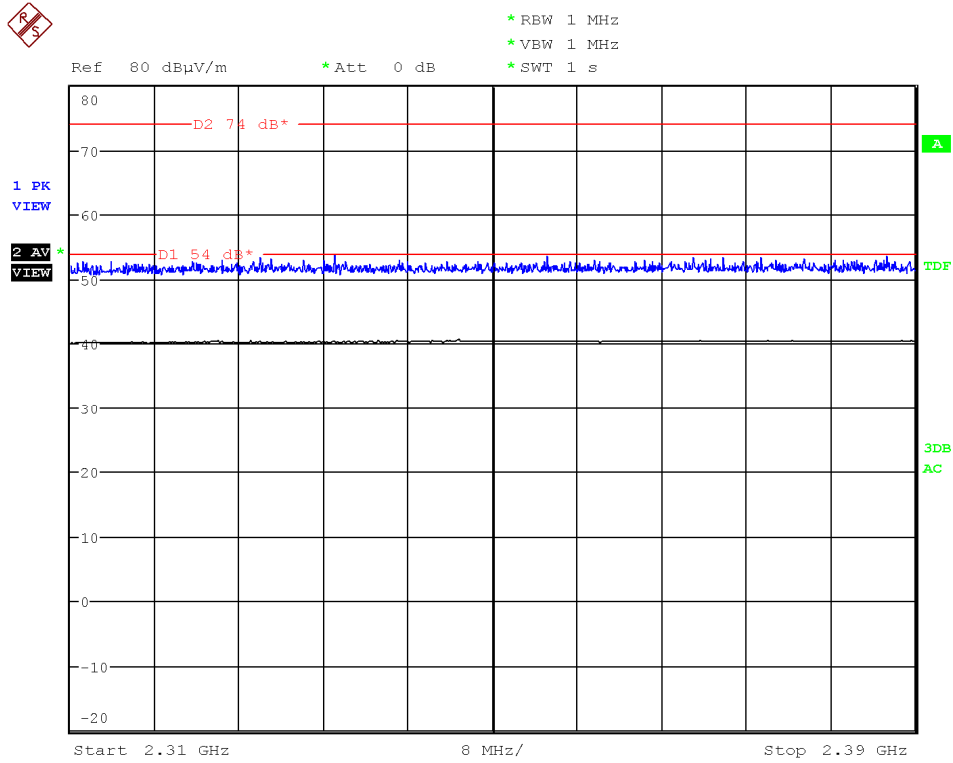
**Modulation: GFSK**



**Modulation: Π/4-DQPSK**



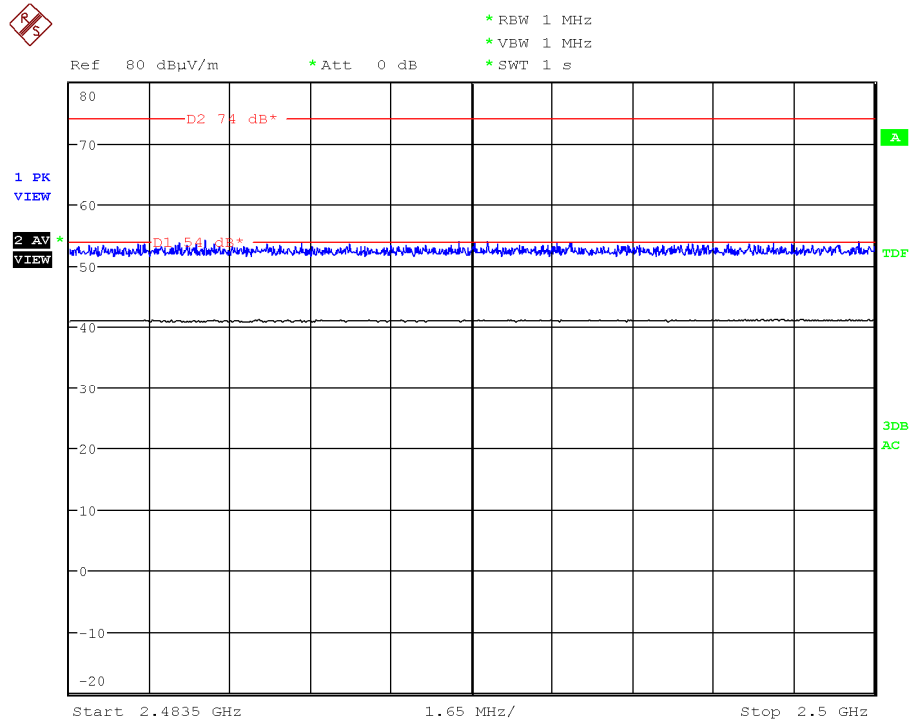
### Modulation: 8-DPSK



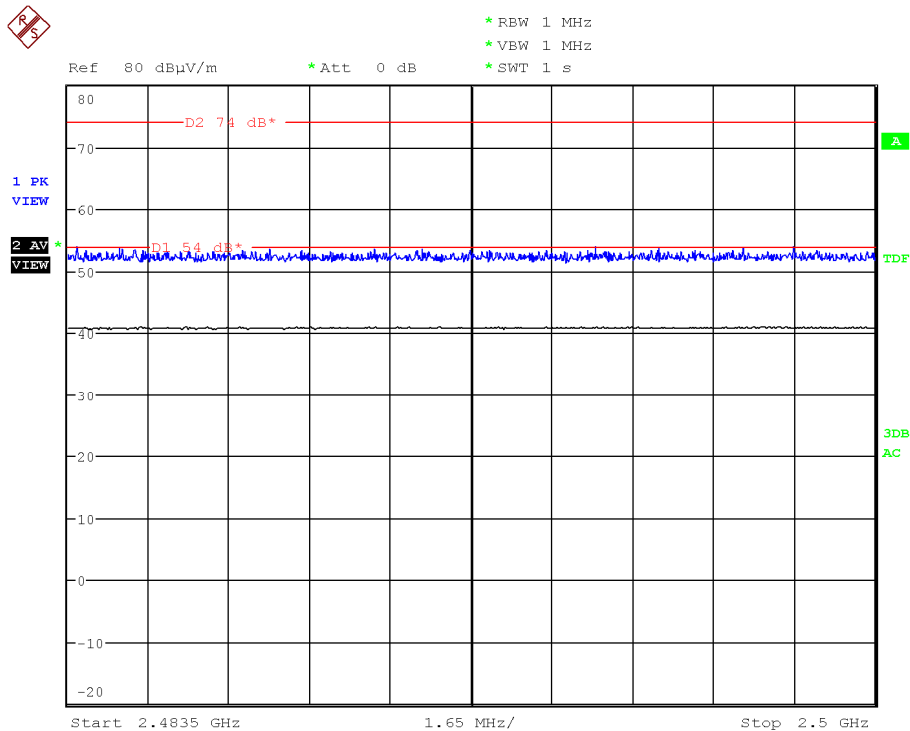
FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

**CHANNEL: Lowest**

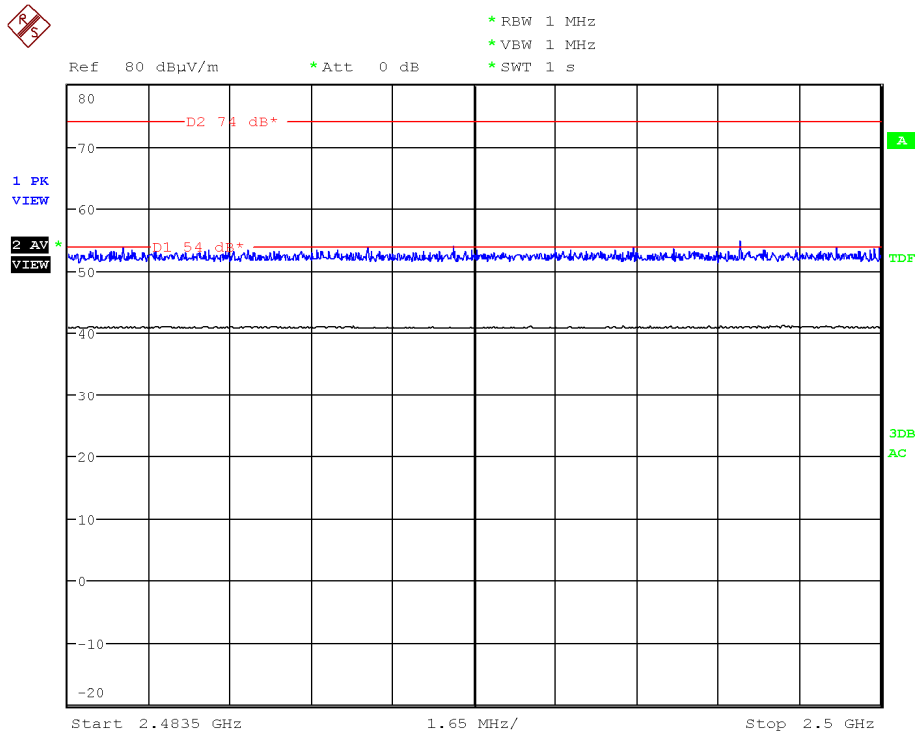
**Modulation: GFSK**



**Modulation: Π/4-DQPSK**

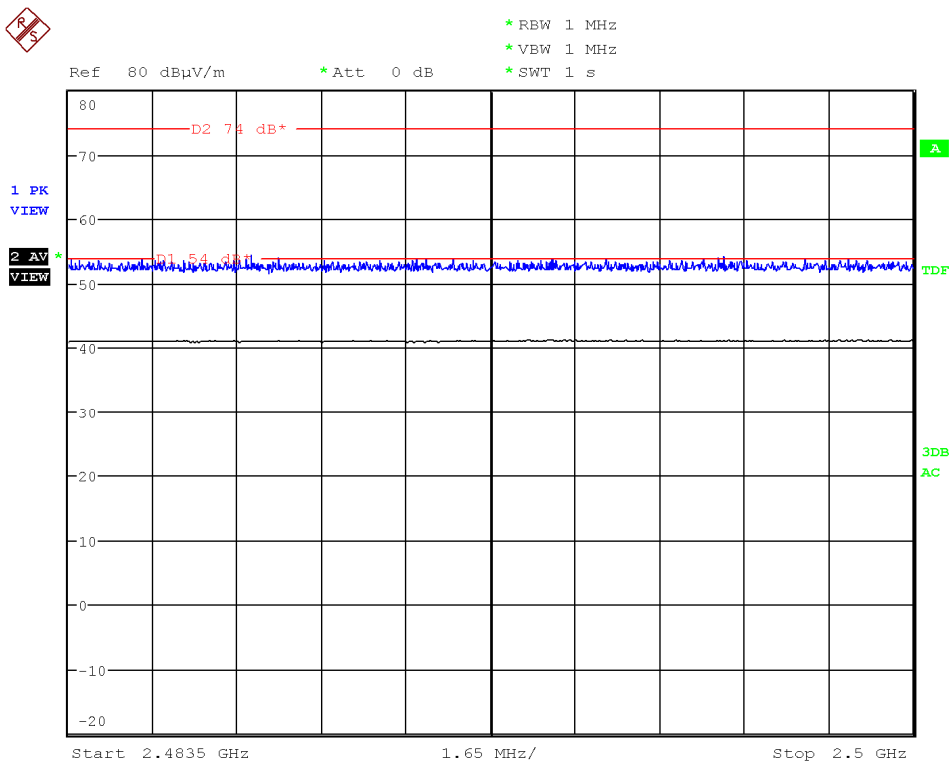


**Modulation: 8-DPSK**

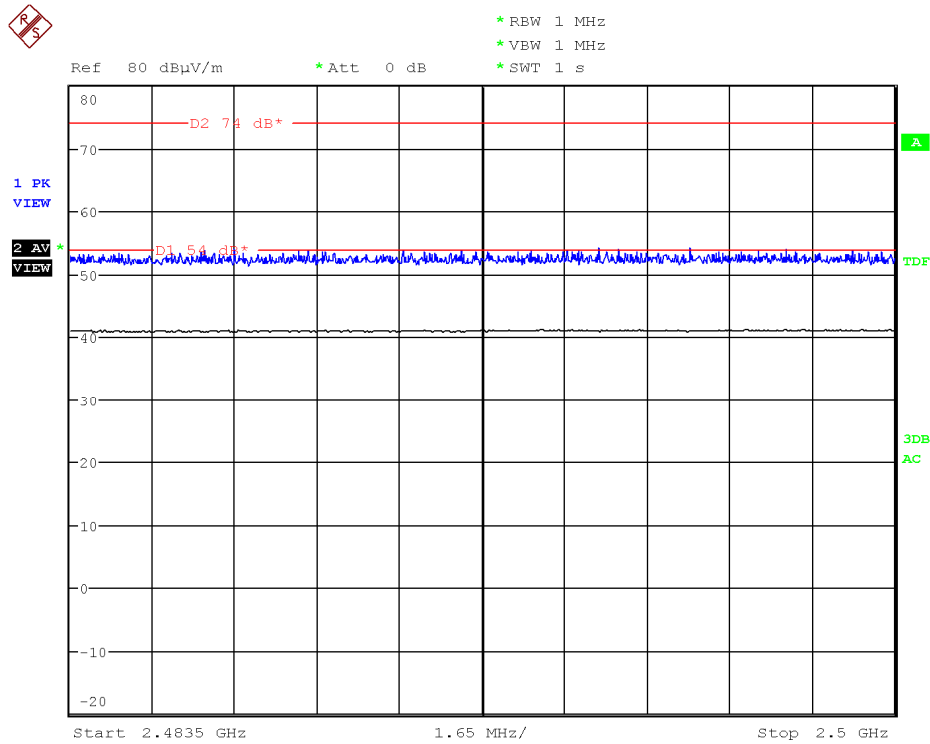


**CHANNEL: Middle**

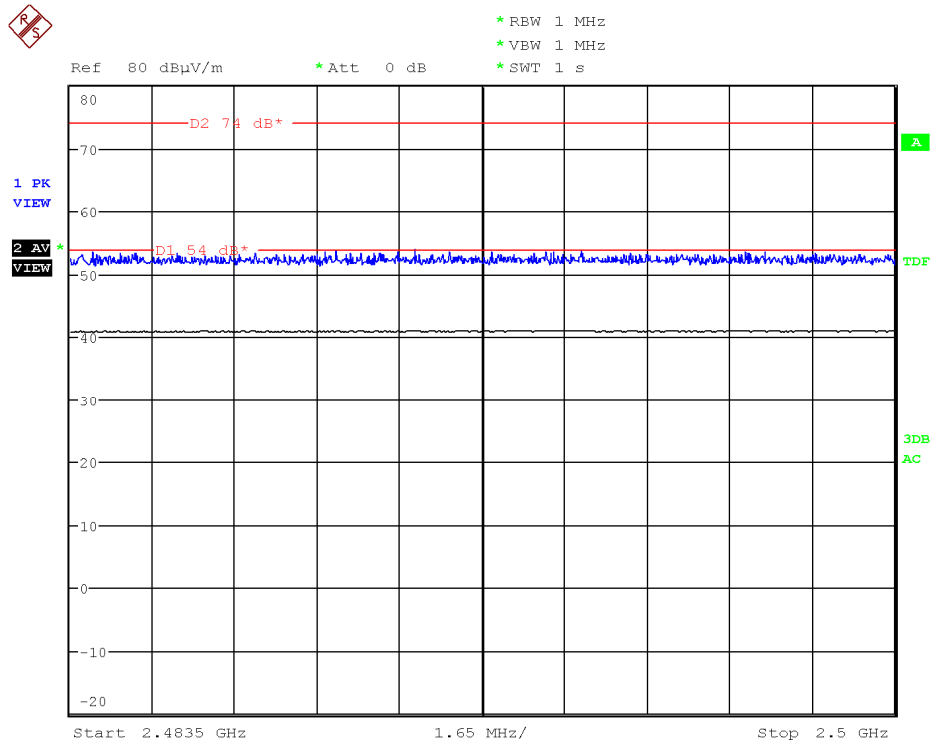
**Modulation: GFSK**



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

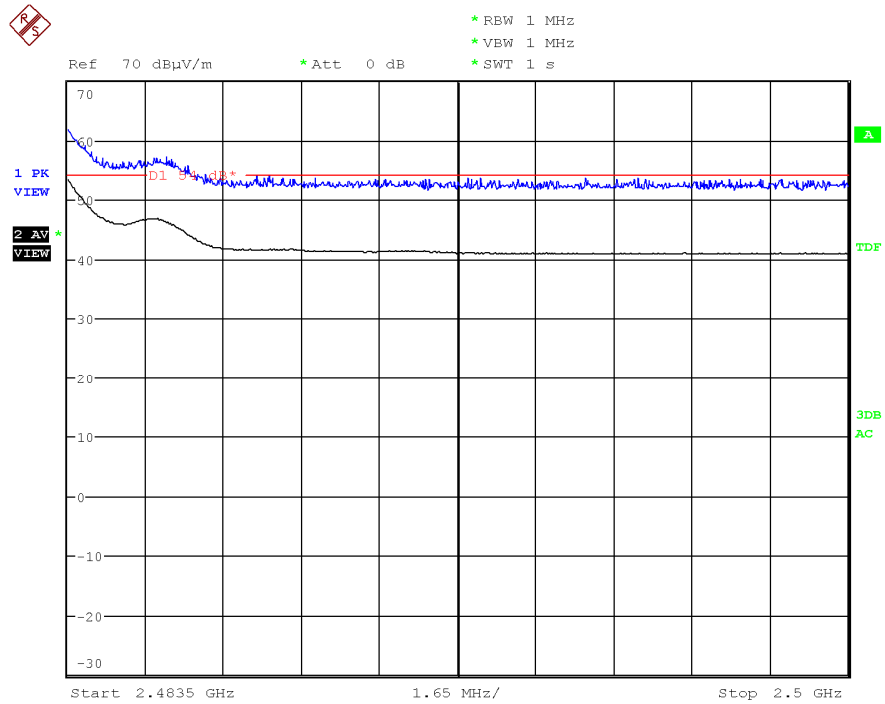


### Modulation: 8-DPSK

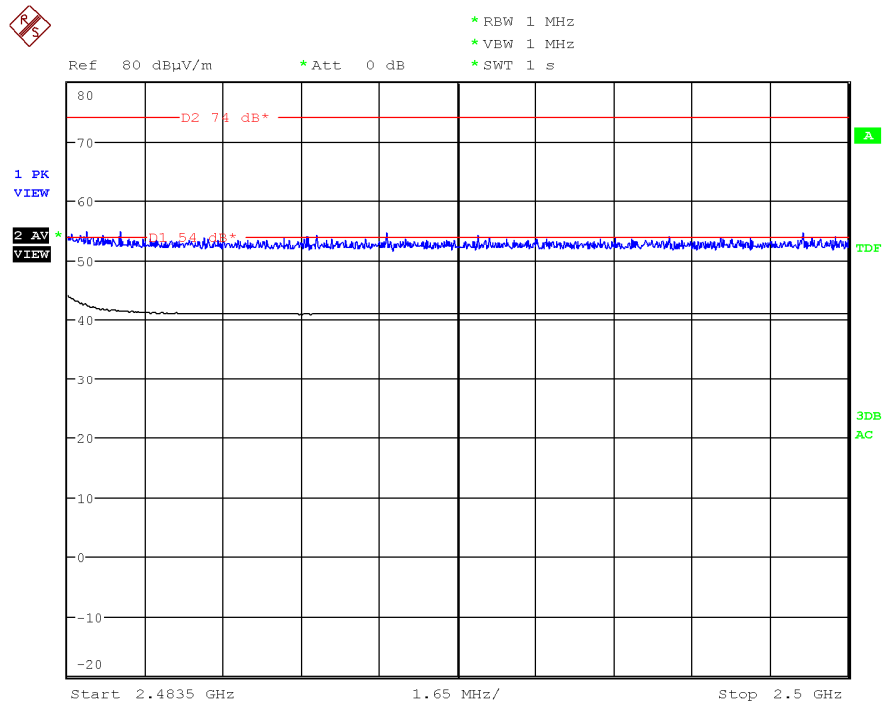


**CHANNEL: Highest**

**Modulation: GFSK**



**Modulation: Π/4-DQPSK**





**Modulation: 8-DPSK**

