**DEKRA Testing and Certification, S.A.U.**
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España

FCC LISTED, REGISTRATION NUMBER: 720267

ISED LISTED REGISTRATION NUMBER 4621A-2

Nº 51/LE147

Informe de ensayo nº:
Test report No:

**NIE: 55472RRF.003**

# 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.

| | |
|---|---|
| **Identificación del objeto ensayado**.....: Identification of item tested | Automotive infotainment System |
| **Marca** .....: Trademark | BMW |
| **Modelo y/o referencia tipo** .....: Model and /or type reference | MGU |
| **Other identification of the product** .....: | FCC ID: T8GMGU<br>IC: 6434A-MGU |
| **Final HW version** .....: | 1.4 |
| **Final SW version** .....: | A415_17w46.1-2 |
| **Características** .....: Features | Bluetooth, WLAN, GNSS. |
| **Solicitante**.....: Applicant | HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH<br>BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY |
| **Método de ensayo solicitado, norma**.....: Test method requested, standard | USA FCC Part 15.247 10-1-17 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.<br>USA FCC Part 15.209 10-1-17 Edition: Radiated emission limits; general requirements.<br>CANADA RSS-247 Issue 2 (February 2017).<br>CANADA RSS-Gen Issue 4 (November 2014).<br>Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v04 dated 05/04/2017.<br>ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices. |
| **Resultado**.....: Summary | IN COMPLIANCE |
| **Aprobado por (nombre / cargo y firma)** .....: Approved by (name / position & signature) | A. Llamas<br>RF Lab. Manager<br>Firmado digitalmente por ALEJANDRO LLAMAS RODRIGUEZ<br>Fecha: 2018.02.27 09:03:17 +01'00' |

| | |
|---|---|
| **Fecha de realización .....:**<br>Date of issue | 2018-02-27 |
| **Formato de informe No. .....:**<br>Report template No | FDT08_20 |

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# Competences and guarantees

DEKRA Testing and Certification 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 laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjuction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

DEKRA Testing and Certification 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: ISED 4621A-2.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification 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 at the time of performance of the test.

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

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

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# General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
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4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification and the Accreditation Bodies.

# Uncertainty

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

# Usage of samples

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

Sample S/01 is composed of the following elements:

| Control Nº | Description | Model | Serial Nº | Date of reception |
|---|---|---|---|---|
| 54472/001 | Automotive infotainment System | MGU | B298J70H7524612 | 2017-11-30 |
| 55472/002 | Test Board | --- | --- | 2017-11-30 |
| 55472/003 | Ethernet/USB adapter | EU-4306 | EU430677MA00946 | 2017-11-30 |
| 55472/005 | Ethernet cable | --- | --- | 2017-11-30 |
| 55472/034 | Harness + Antennas | --- | --- | 2017-12-07 |

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

   All radiated tests indicated in appendix A.

Sample S/02 is composed of the following elements:

| Control Nº | Description | Model | Serial Nº | Date of reception |
|---|---|---|---|---|
| 54472/011 | Automotive infotainment System | MGU | B298J70H7524619 | 2017-11-30 |
| 55472/002 | Test Board | --- | --- | 2017-11-30 |
| 55472/003 | Ethernet/USB adapter | EU-4306 | EU430677MA00946 | 2017-11-30 |
| 55472/005 | Ethernet cable | --- | --- | 2017-11-30 |
| 55472/034 | Harness + Antennas | --- | --- | 2017-12-07 |

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

   All radiated tests indicated in appendix B.

Sample S/03 is composed of the following elements:

| Control Nº | Description | Model | Serial Nº | Date of reception |
|---|---|---|---|---|
| 54472/011 | Automotive infotainment System | MGU | B298J70H7524619 | 2017-11-30 |
| 55472/002 | Test Board | --- | --- | 2017-11-30 |
| 55472/003 | Ethernet/USB adapter | EU-4306 | EU430677MA00946 | 2017-11-30 |
| 55472/004 | Harness | --- | --- | 2017-11-30 |
| 55472/005 | Ethernet cable | --- | --- | 2017-11-30 |

1. Sample S/03 has undergone following test(s).

   All conducted tests indicated in appendixes A and B.

# Test sample description

The test sample consists of an automotive head unit to be installed in cars with the following features: Bluetooth, WLAN and GNSS.

# Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH

BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY

# Testing period

The performed test started on 2017-12-12 and finished on 2018-01-03.

The tests have been performed at DEKRA Testing and Certification.

# Environmental conditions

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

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

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

| | |
|---|---|
| **Temperature** | Min. = 15 ºC<br>Max. = 35 ºC |
| **Relative humidity** | Min. = 20 %<br>Max. = 75 % |
| **Air pressure** | Min. = 860 mbar<br>Max. = 1060 mbar |
| **Shielding effectiveness** | > 100 dB |
| **Electric insulation** | > 10 kΩ |
| **Reference resistance to earth** | < 1 Ω |
| **Normal site attenuation (NSA)** | < ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz) |
| **Field homogeneity** | More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz). |

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

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

## Remarks and comments

1; The tests have been performed by the technical personnel: Carlos Alberto Contreras and Carolina Postigo.

2: Used instrumentation:

Conducted Measurements

| | | Last Cal. date | Cal. due date |
|---|---|---|---|
| 1. | Spectrum analyser Rohde & Schwarz FSV40 | 2017/07 | 2019/07 |
| 2. | Power supply DC 30 V/ 5 A U8002A KEYSIGHT TECHNOLOGIES | --- | --- |
| 3. | Digital Multimeter Fluke 179 | 2017/05 | 2018/05 |

Radiated Measurements

| | | Last Cal. date | Cal. due date |
|---|---|---|---|
| 1. | Semianechoic Absorber Lined Chamber ETS FACT3 200STP | N.A. | N.A. |
| 2. | BiconicalLog antenna ETS LINDGREN 3142E | 2017/07 | 2020/04 |
| 3. | Multi Device Controller EMCO 2090 | N.A. | N.A. |
| 4. | Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D | 2016/11 | 2019/11 |
| 5. | Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170 | 2017/03 | 2020/03 |
| 6. | EMI Test Receiver R&S ESU 40 | 2016/03 | 2018/03 |
| 7. | Spectrum analyser Rohde & Schwarz FSW50 | 2015/12 | 2017/12 |
| 8. | RF pre-amplifier 30 MHz-6 GHz BONN BLNA 0360-01N | 2017/07 | 2018/07 |
| 9. | RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M | 2016/02 | 2018/02 |
| 10. | RF pre-amplifier 18-40 GHz BONN ELEKTRONIK BLMA 1840-1M | 2015/12 | 2017/12 |

# Testing verdicts

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

## 1. - BT EDR

| FCC PART 15 PARAGRAPH | | VERDICT | | | |
|---|---|---|---|---|---|
| | | NA | P | F | NM |
| FCC 15.247 Subclause (a) (1) / RSS-247 Clause 5.1 (b) | 20 dB Bandwidth and Carrier frequency separation | | P | | |
| FCC 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) | Number of hopping channels | | P | | |
| FCC 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) | Time of occupancy (Dwell Time) | | P | | |
| FCC 15.247 Subclause (b) / RSS-247 Clause 5.4 (b) | Maximum peak output power and antenna gain | | P | | |
| FCC 15.247 Subclause (d) / RSS-247 Clause 5.5. | Band-edge compliance of conducted emissions (Transmitter) | | P | | |
| FCC 15.247 Subclause (d) / RSS-247 Clause 5.5 | Emission limitations conducted (Transmitter) | | P | | |
| FCC 15.247 Subclause (d) / RSS-247 Clause 5.5 | Emission limitations radiated (Transmitter) | | P | | |

## 2. WiFi 2.4 GHz (802.11b/g/n20/n40).

| FCC PART 15 PARAGRAPH | | VERDICT | | | |
|---|---|---|---|---|---|
| | | NA | P | F | NM |
| 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 .... | Emission limitations conducted (Transmitter) | | 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 | | |

# **Appendix A –** Test result (Bluetooth EDR)

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## TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 13.2 Vdc

Type of power supply = External power supply (Battery).

Type of antenna: External antenna.

Declared Gain for antennas WLAN/Bluetooth (maximum) = -6.2 dBi.

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2441 MHz

Highest channel: 2480 MHz

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

BTEDR FCC:
./IuK_prepare_wlanbt_testing.sh

GFSK
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 39 4 DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 39 4 DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 DH5 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 40 4 DH5 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 DH5 100

hopping

./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 on x 4 DH5 100

pi4DQPSK
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 2DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 39 4 2DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 2DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 2DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 39 4 2DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 2DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 2DH5 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 40 4 2DH5 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 2DH5 100

hopping

./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 on x 4 2DH5 100

8DPSK
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 3DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 39 4 3DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 3DH1 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 3DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 39 4 3DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 3DH3 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 1 4 3DH5 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 40 4 3DH5 100
./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 single 79 4 3DH5 100

hopping

./hbhcitool.sh emctesttx ttyS1 74:6f:f7:00:3e:88 on x 4 3DH5 100

The field strength at the band edges was evaluated for each mode for the channel under test.
During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

CONDUCTED MEASUREMENTS

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


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

RADIATED MEASUREMENTS

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

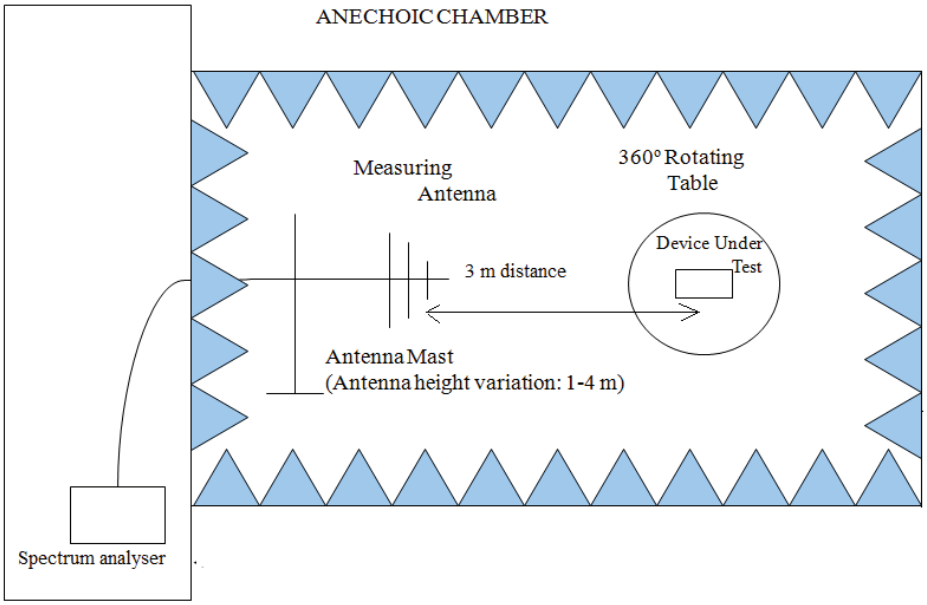
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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

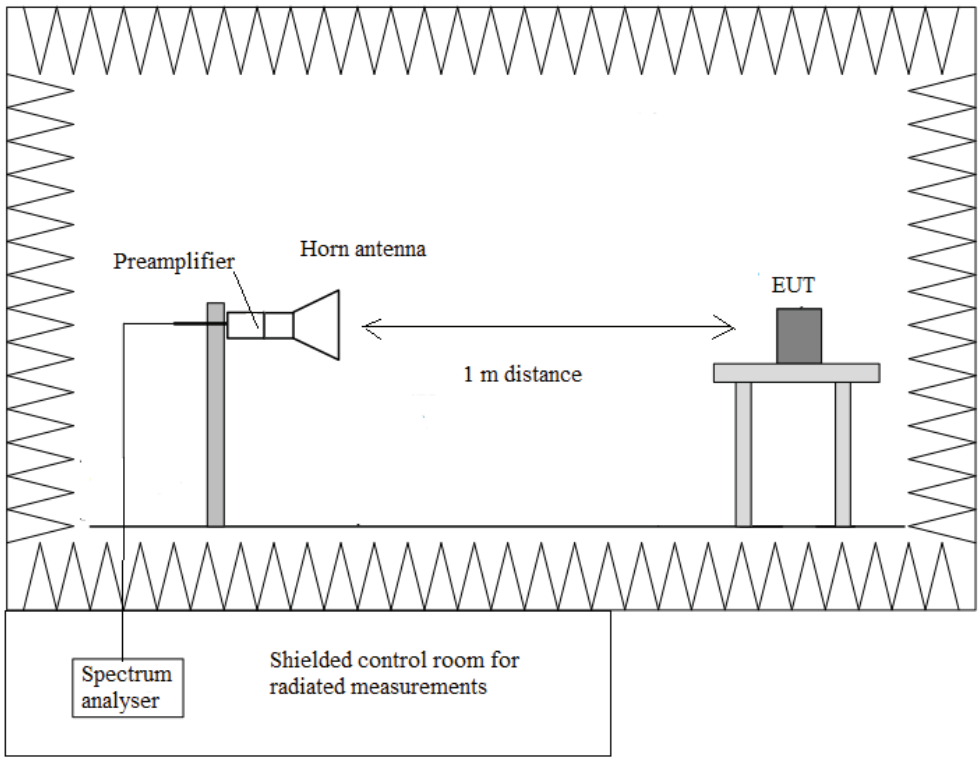
It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup f < 1 GHz



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

(See next plots)

Modulation: GFSK

| | Lowest frequency 2402 MHz | Middle frequency 2441 MHz | Highest frequency 2480 MHz |
|---|---|---|---|
| 20 dB Spectrum bandwidth (kHz) | 939.0 | 939.5 | 942.0 |
| Measurement uncertainty (kHz) | <±1.80 | | |

Modulation: Π/4-DQPSK (2Mbps)

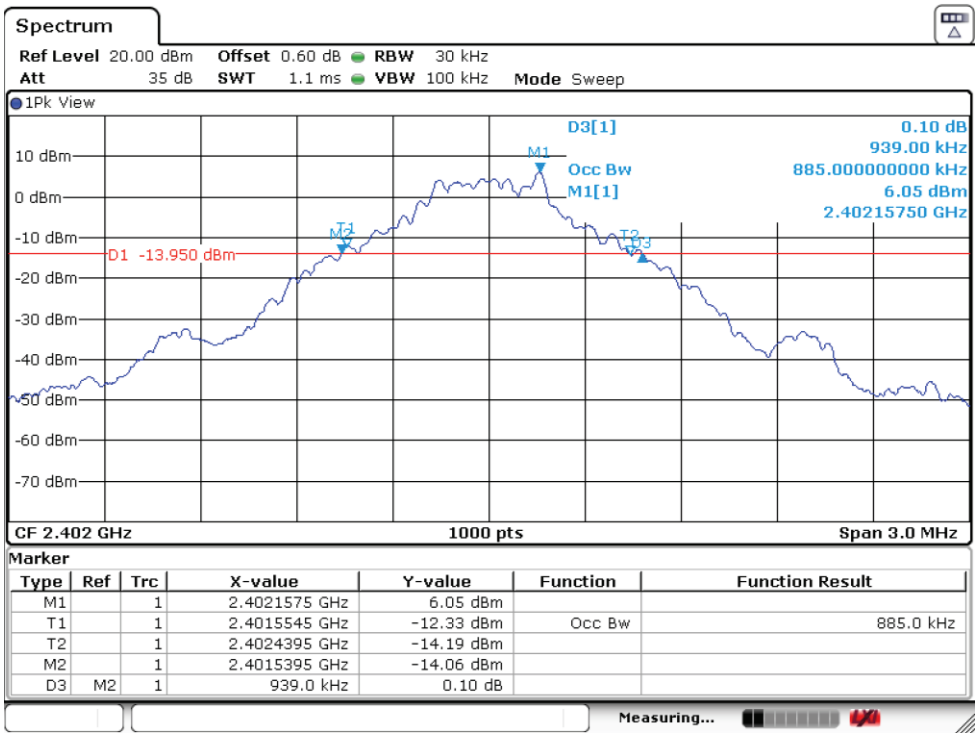
| | Lowest frequency 2402 MHz | Middle frequency 2441 MHz | Highest frequency 2480 MHz |
|---|---|---|---|
| 20 dB Spectrum bandwidth (kHz) | 1359 | 1363.5 | 1359 |
| Measurement uncertainty (kHz) | <±1.80 | | |

Modulation: 8-DPSK (3Mbps)

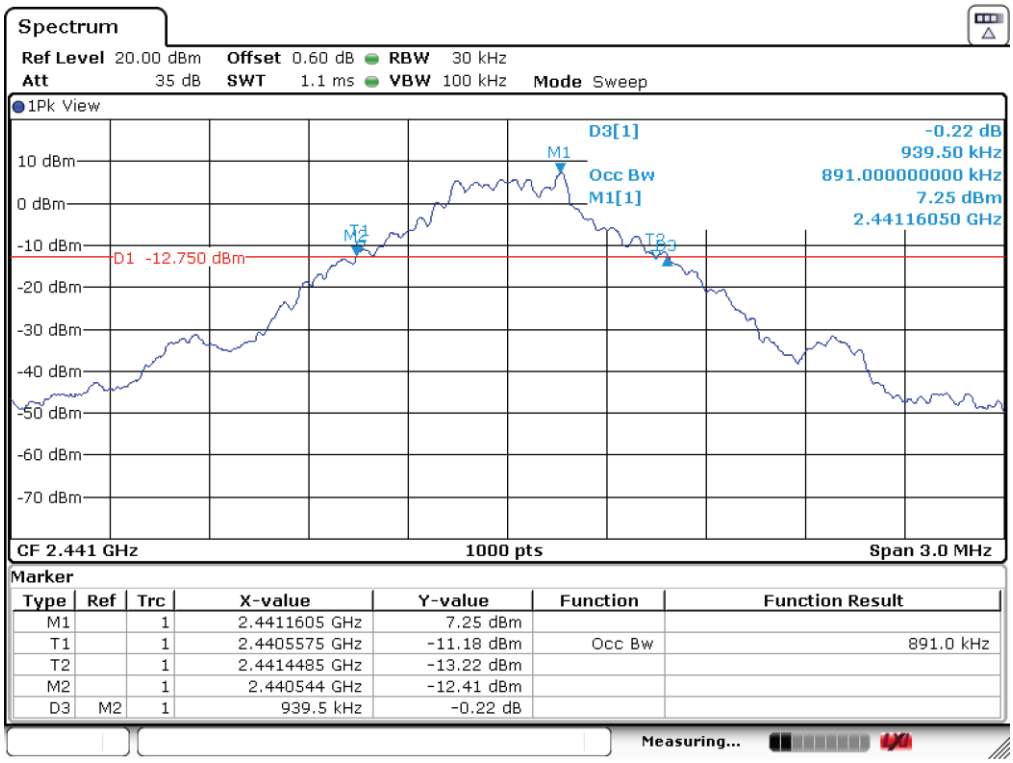
| | Lowest frequency 2402 MHz | Middle frequency 2441 MHz | Highest frequency 2480 MHz |
|---|---|---|---|
| 20 dB Spectrum bandwidth (kHz) | 1314 | 1324 | 1323 |
| Measurement uncertainty (kHz) | <±1.80 | | |

## Modulation: GFSK

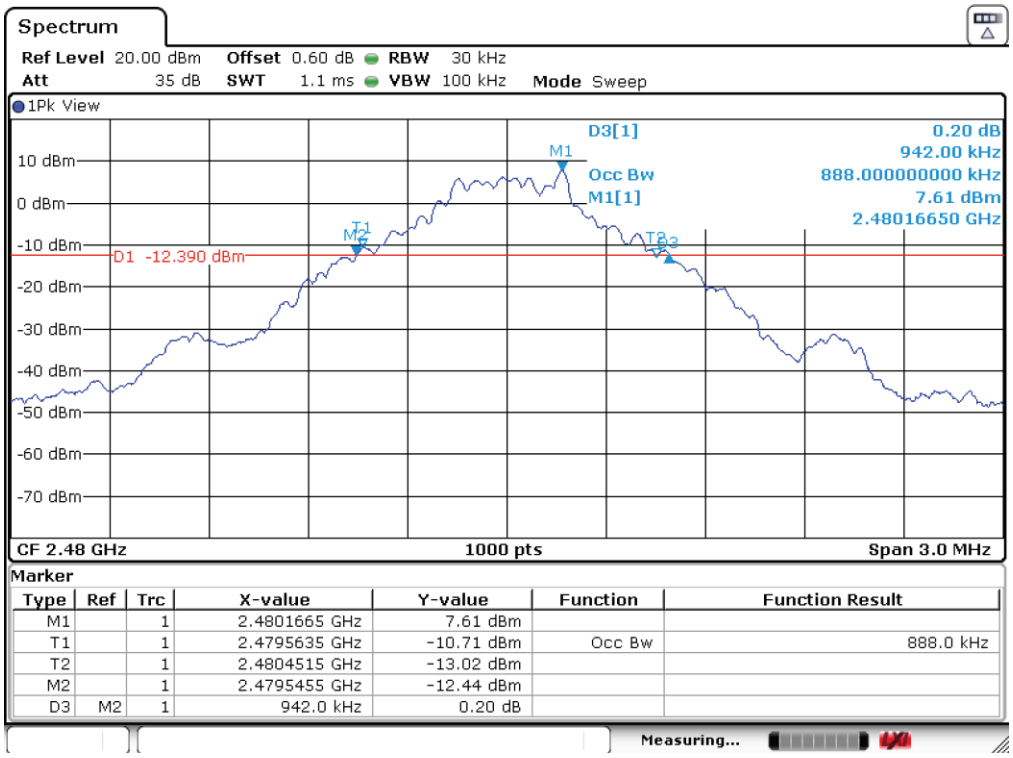
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



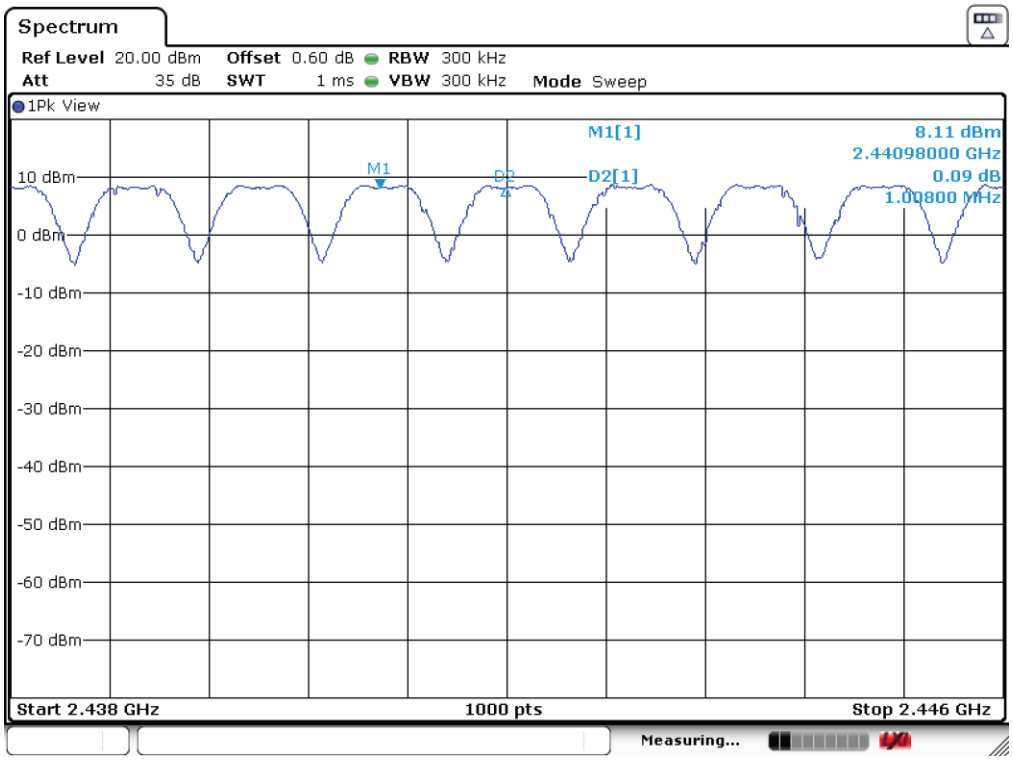

20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.




Carrier frequency separation

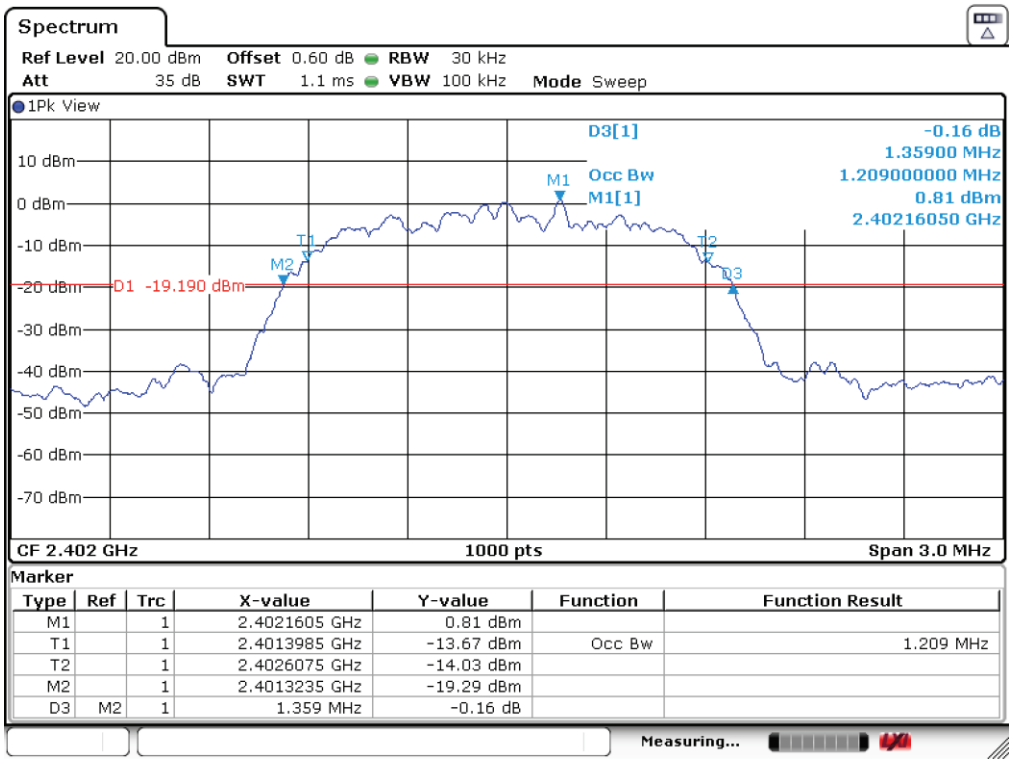



The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel.

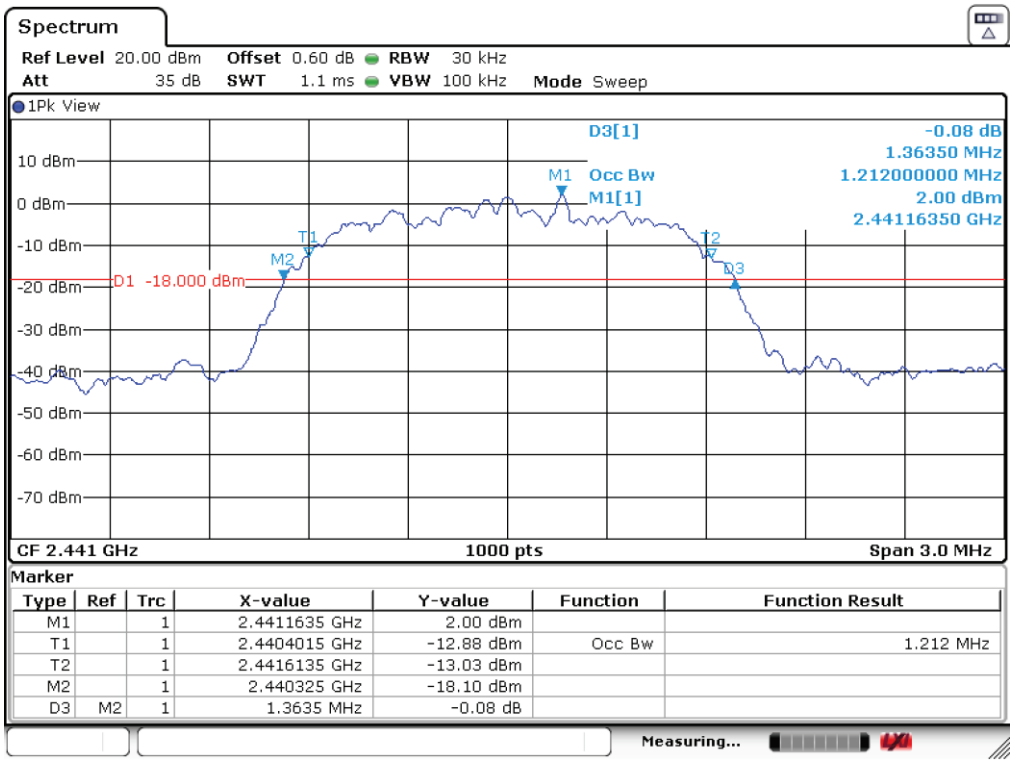
Verdict: PASS

## Modulation: Π/4-DQPSK

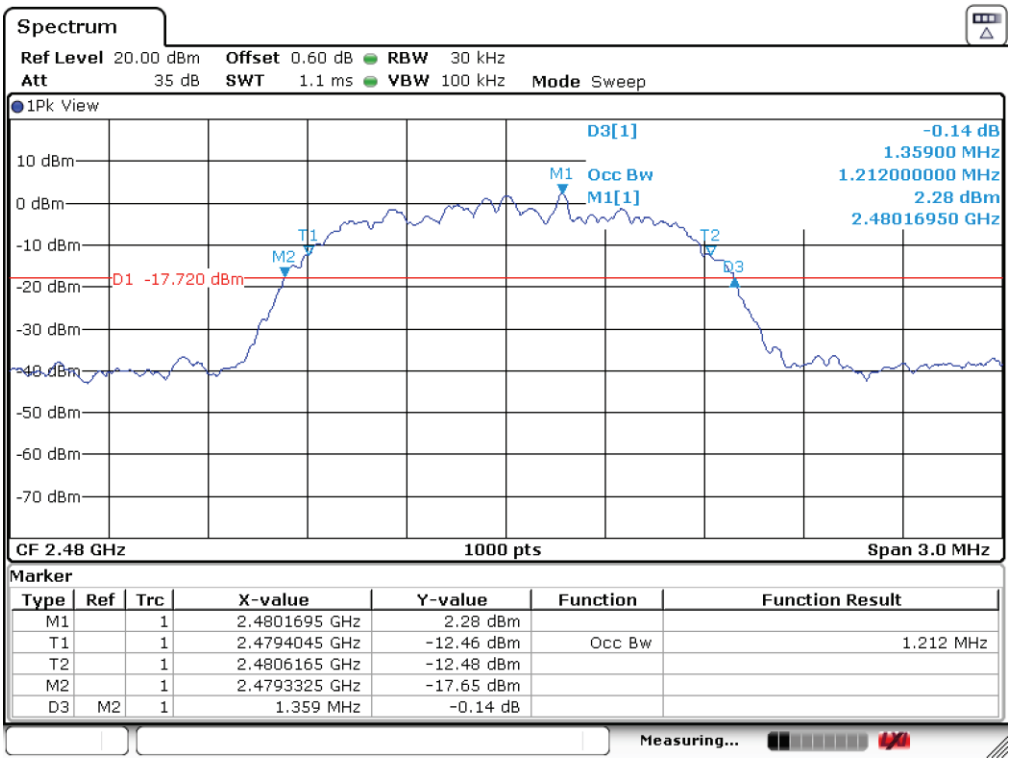
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



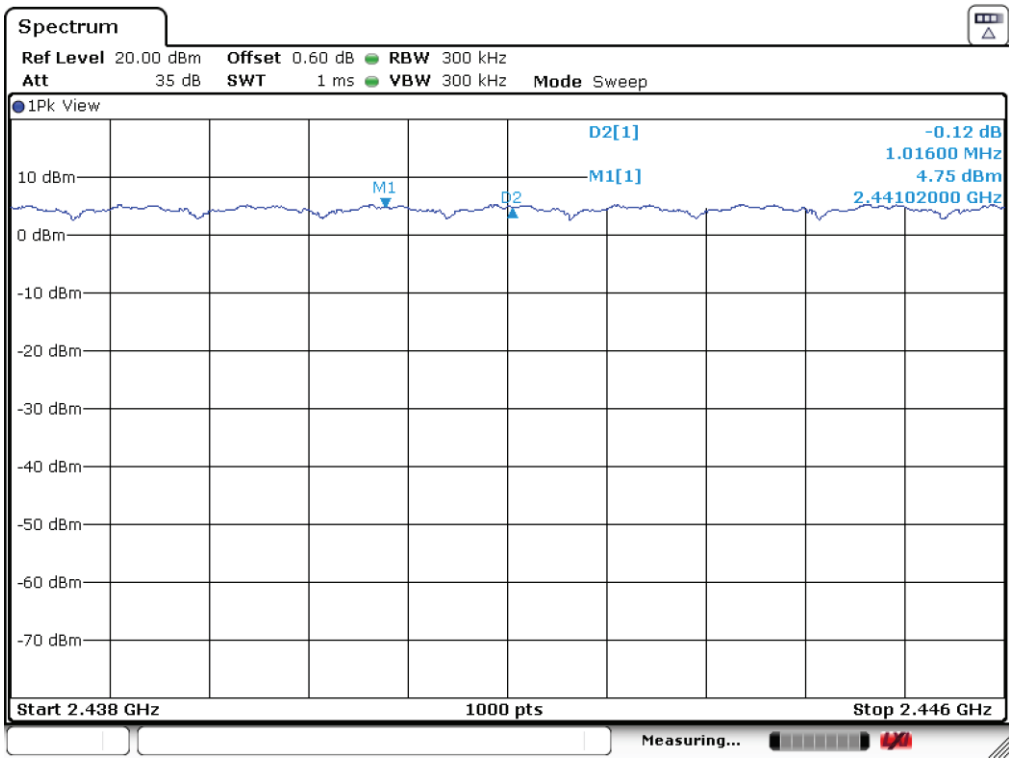

20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.




Carrier frequency separation

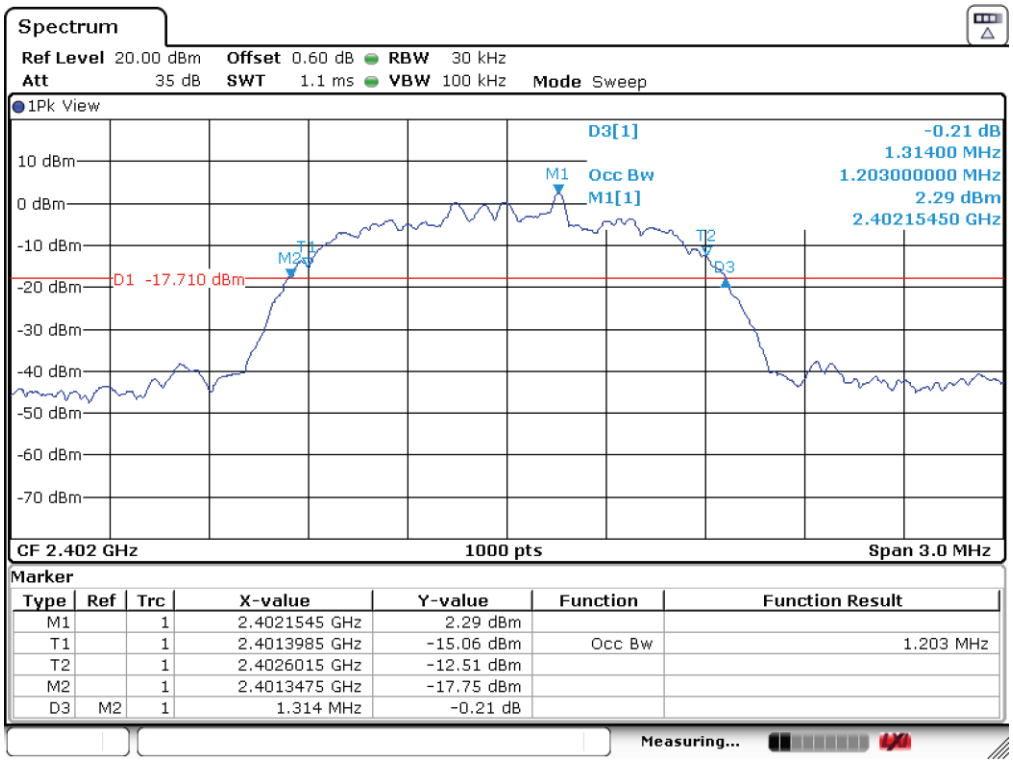



The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel

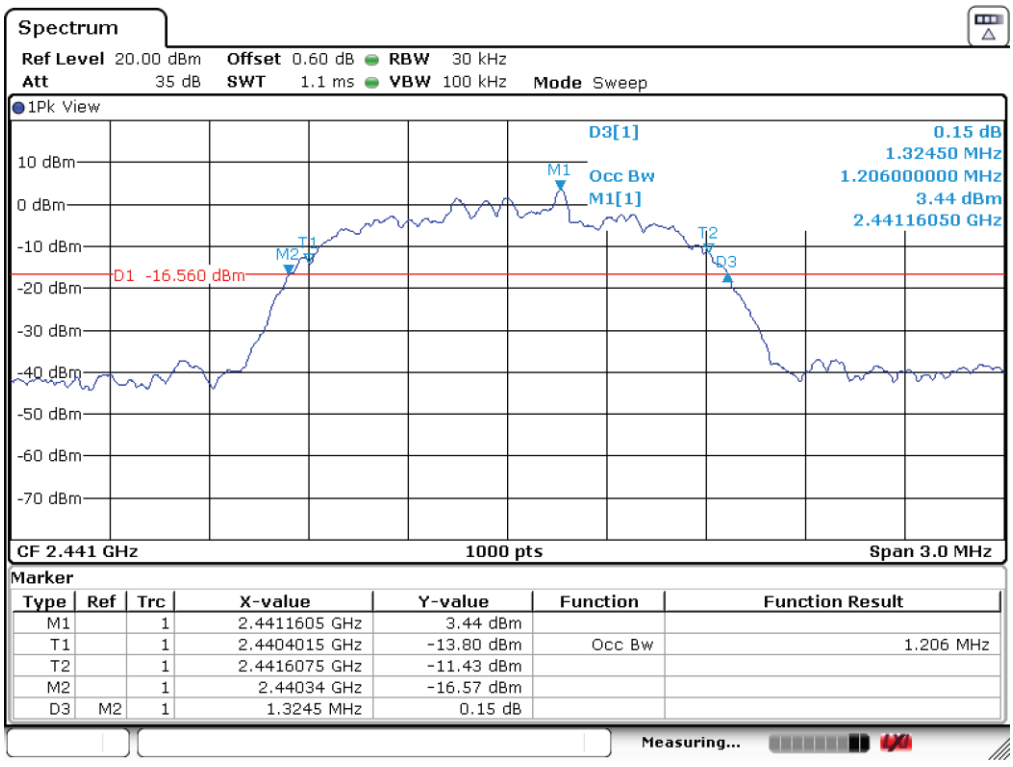
Verdict: PASS

## Modulation: 8-DPSK

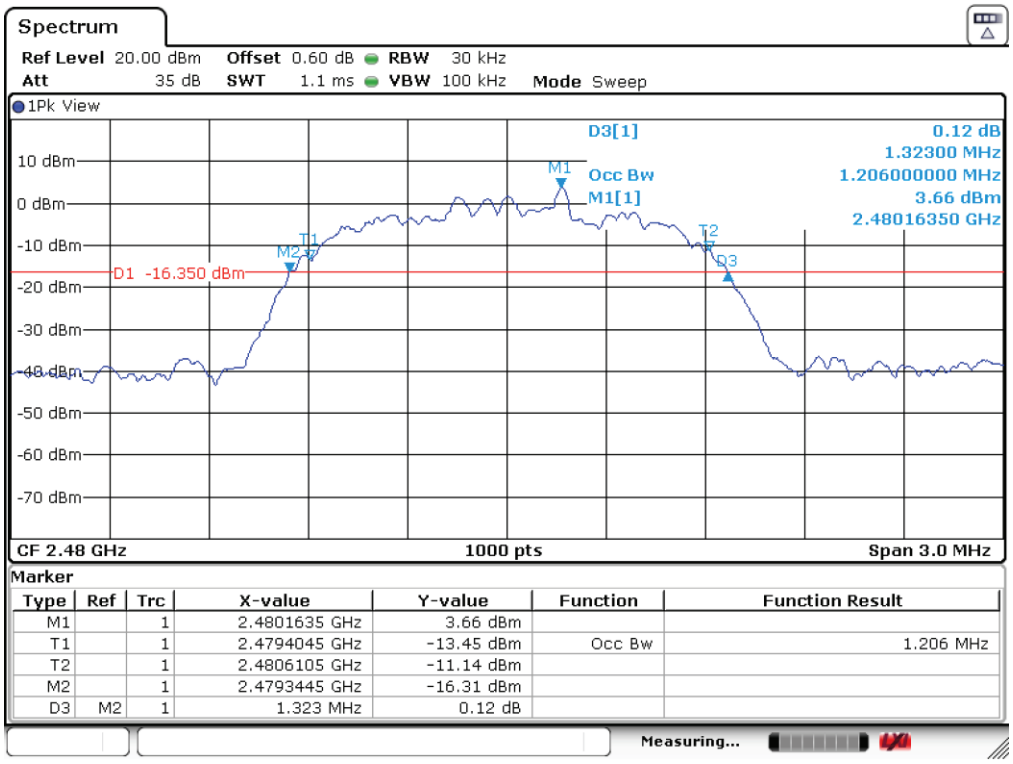
20 dB BANDWIDTH Lowest Channel: 2402 MHz.



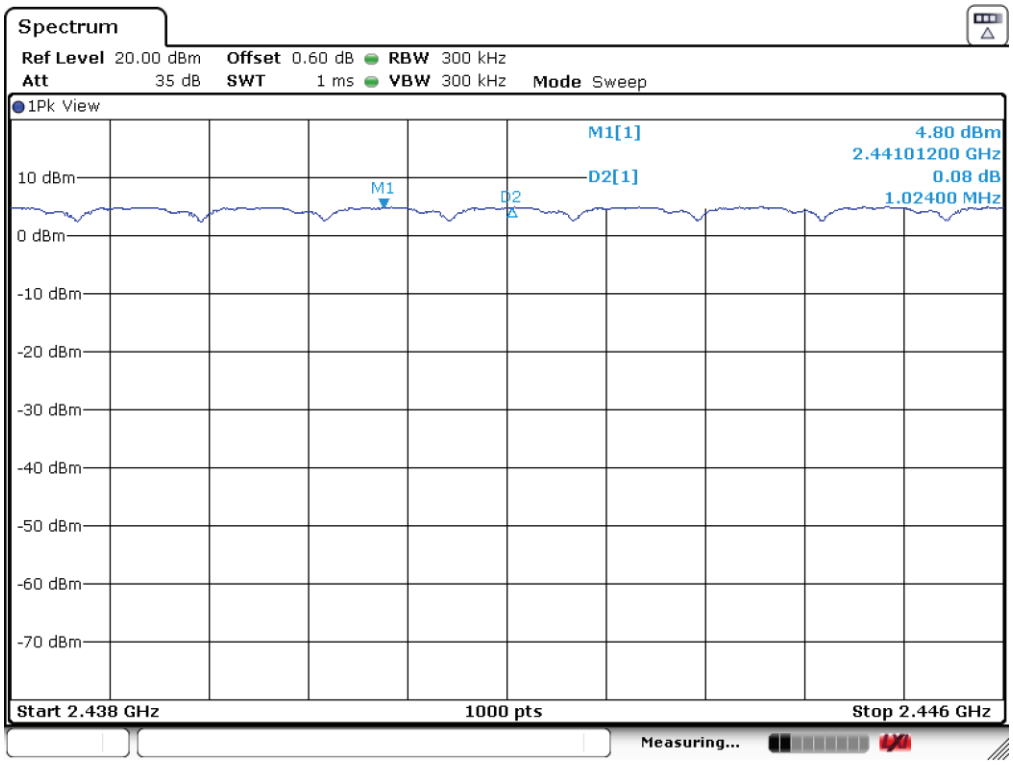

20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.




Carrier frequency separation




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

Verdict: PASS

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

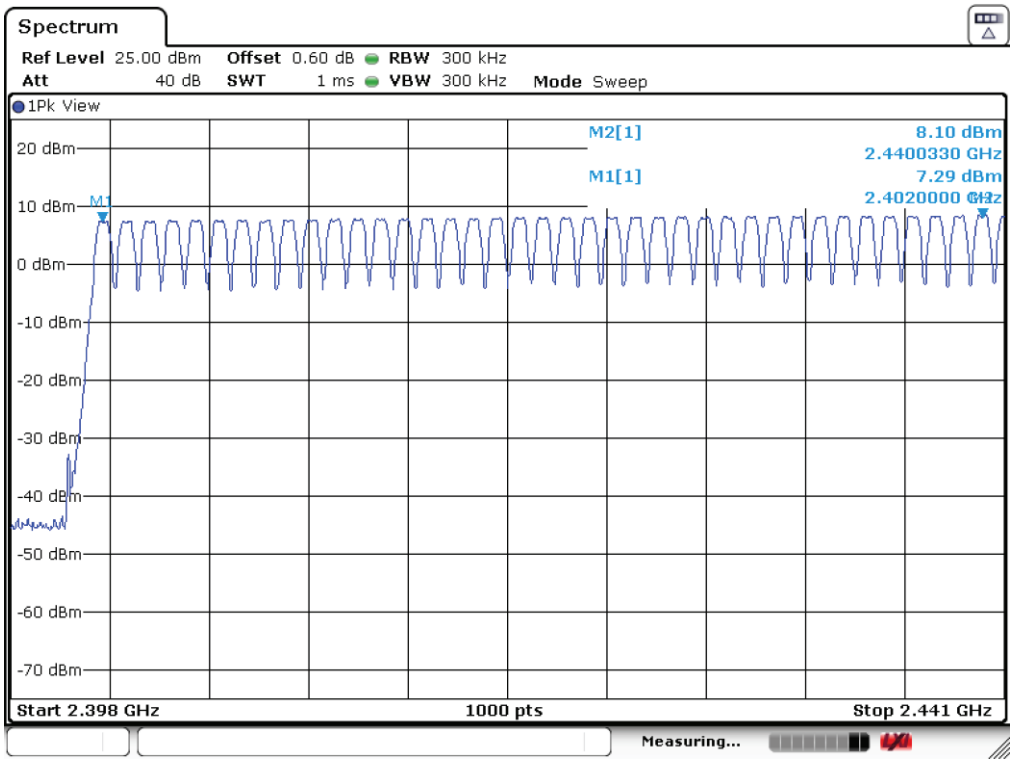
SPECIFICATION

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

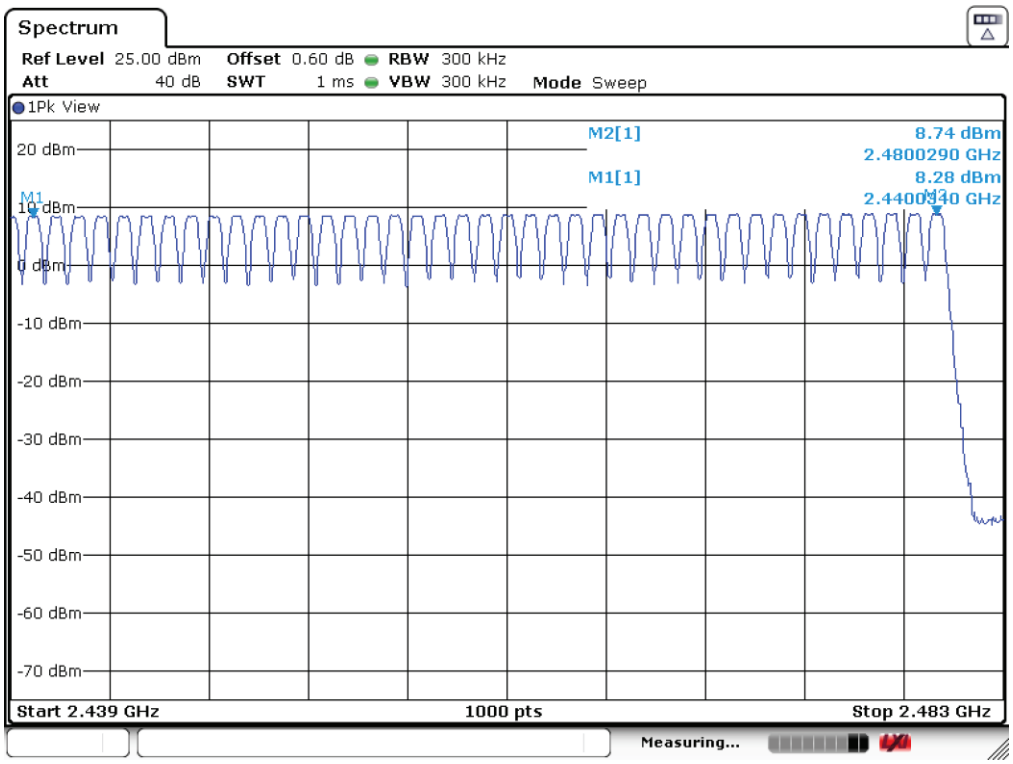
RESULTS

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

**Modulation: GFSK**




Number of hopping frequencies: 39

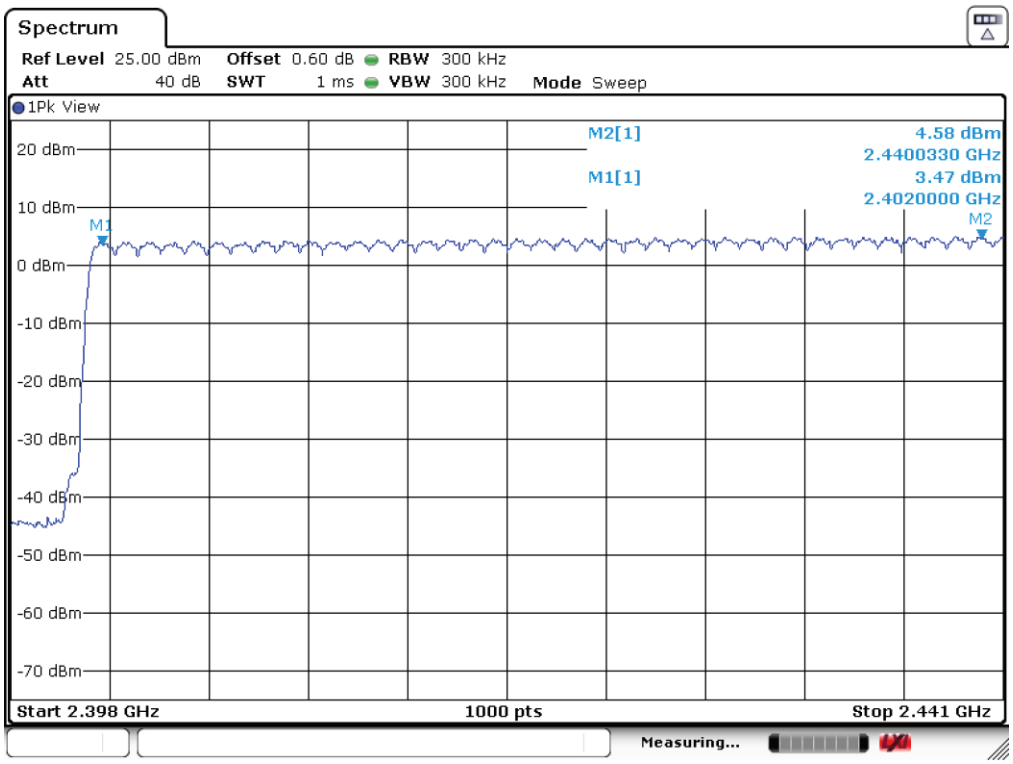



Number of hopping frequencies: 40

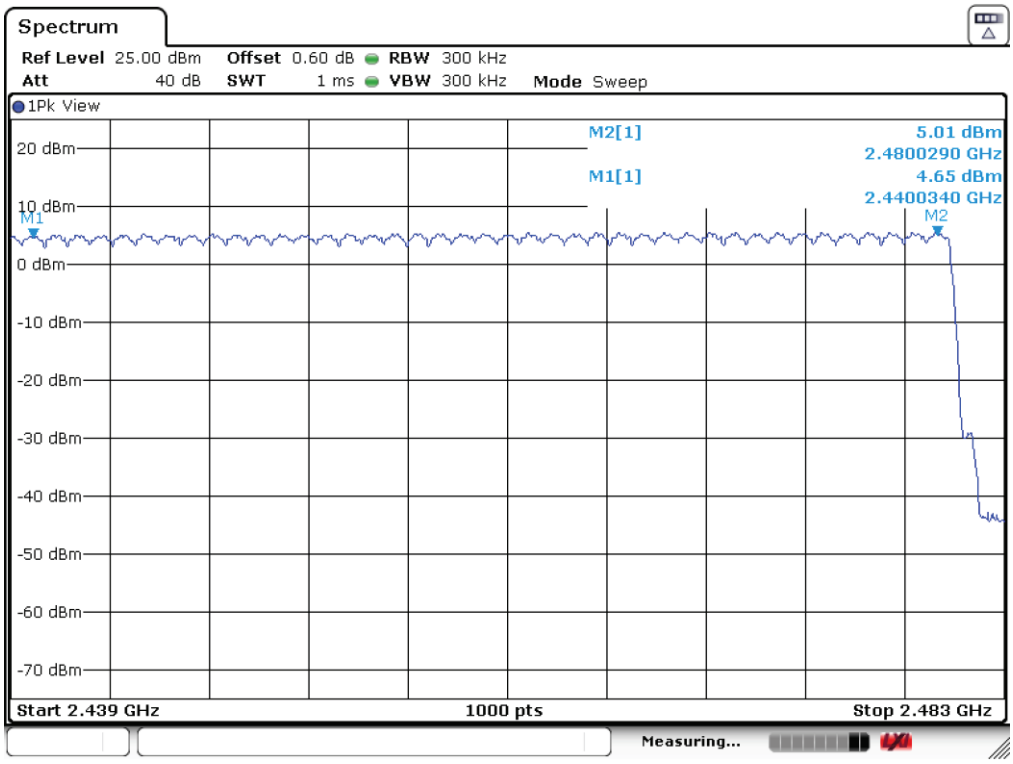
Total number of hopping frequencies: 79

Verdict: PASS

## Modulation: Π/4-DQPSK




Number of hopping frequencies: 39

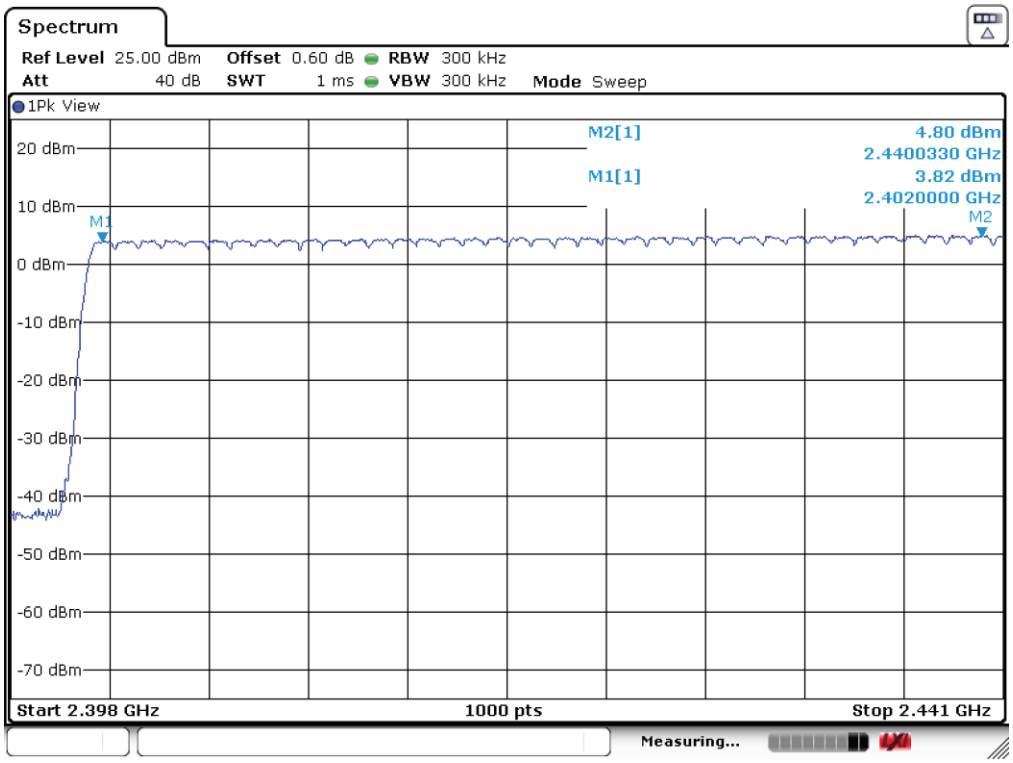



Number of hopping frequencies: 40

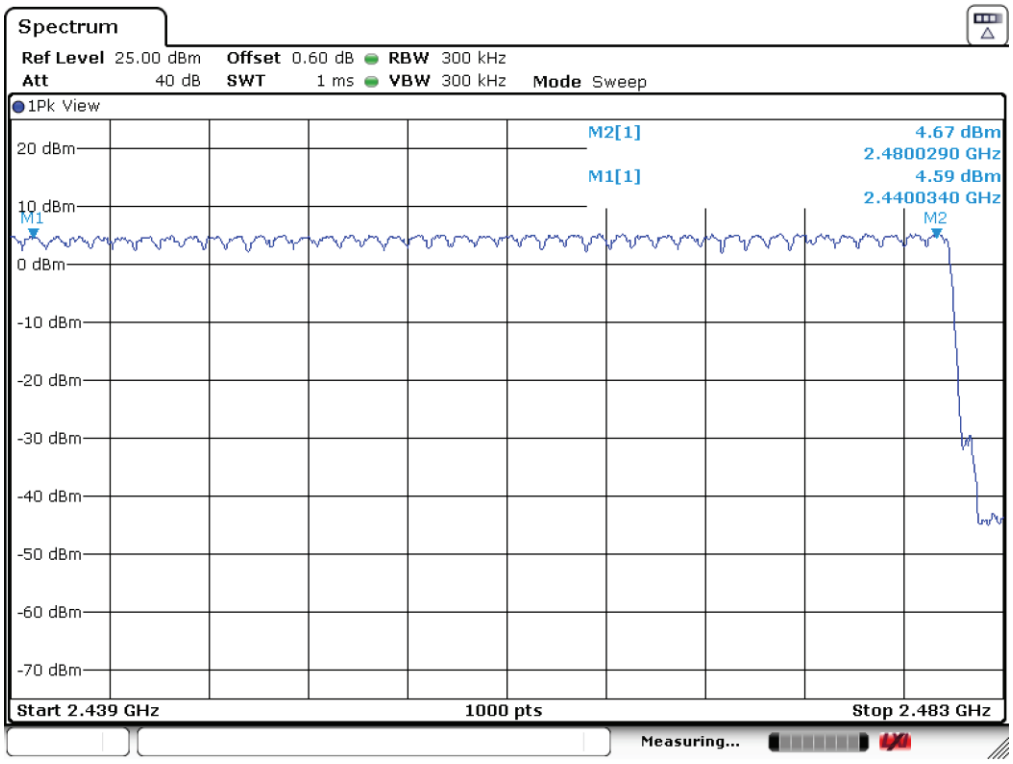
Total number of hopping frequencies: 79

Verdict: PASS

## Modulation: 8-DPSK




Number of hopping frequencies: 39




Number of hopping frequencies: 40

Total number of hopping frequencies: 79

Verdict: PASS

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

SPECIFICATION

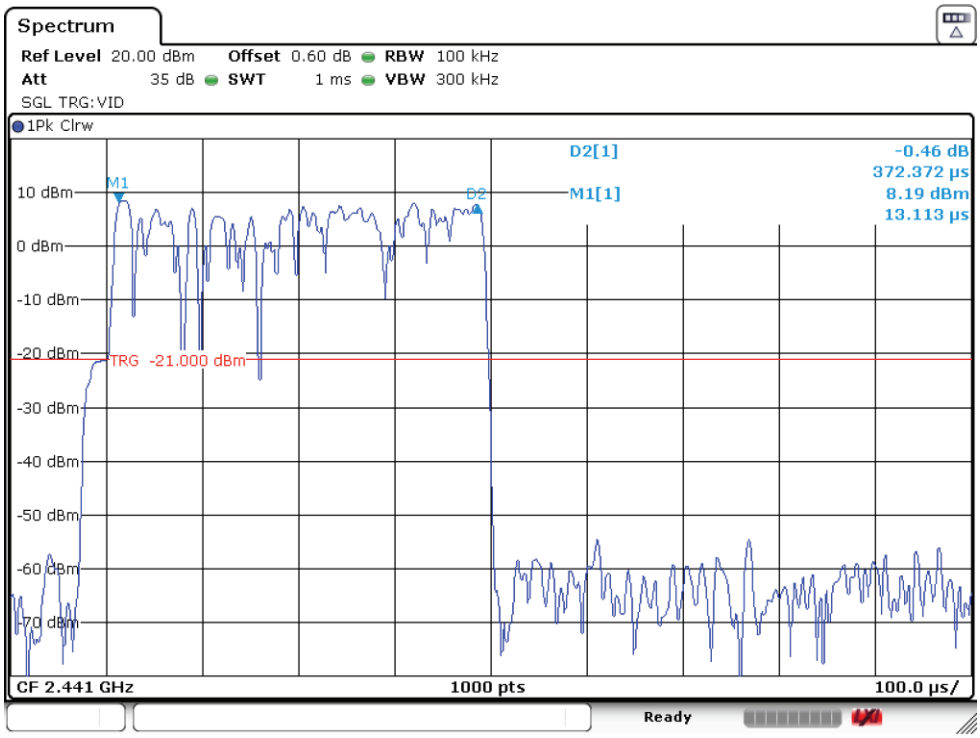
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = 0.4 x 79= 31.6 seconds.

RESULTS

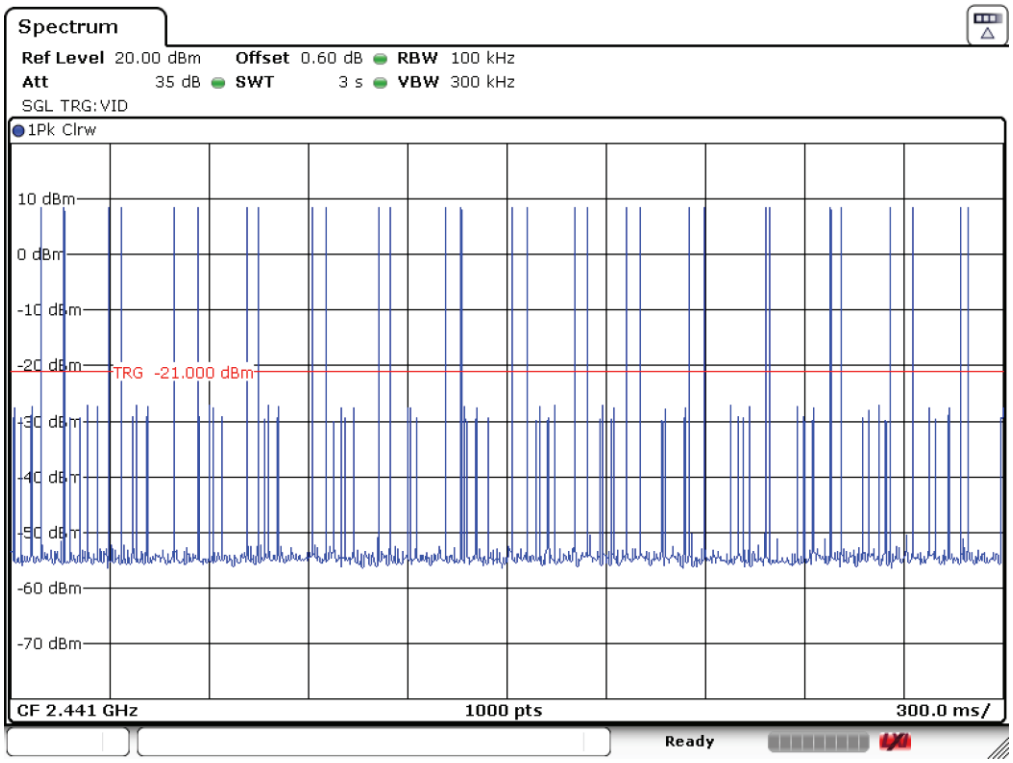
**Modulation: GFSK**

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

- Tx- time per hop = 372.37 µs (see next plot).



-Number of hops over a period of 3 seconds = 30 (see next plot).




Number of hops in the period specified in the requirements = (30 hops) x (31.6 s / 3 s) = 316 hops.

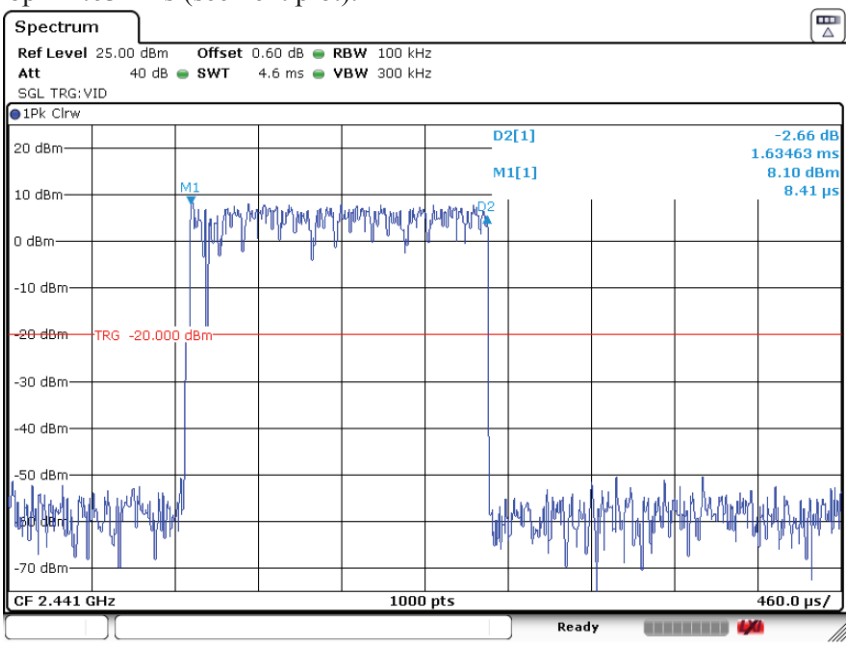
Averaging time of occupancy = 372.37 µs x 316 hops = 117.67 ms per 31.6 seconds.

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

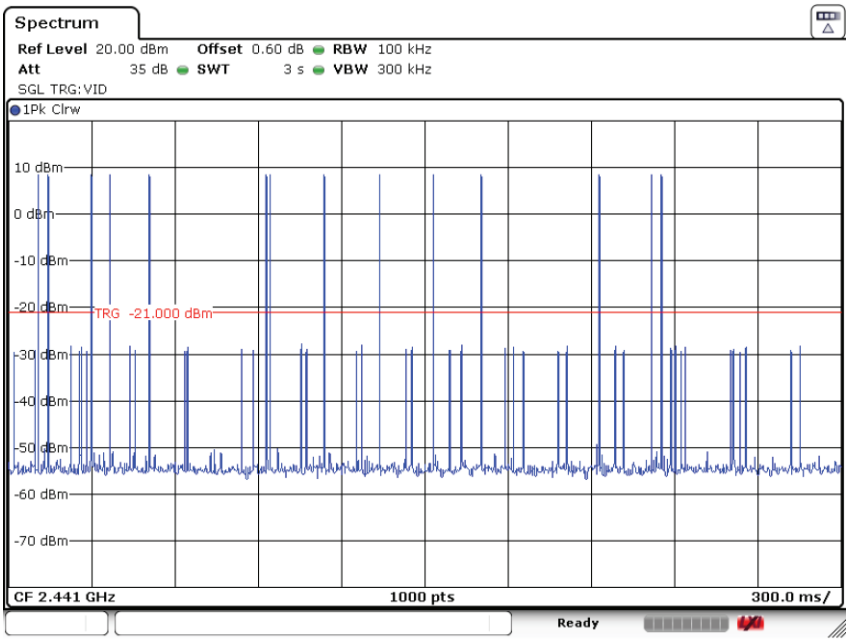
Verdict: PASS

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

- Tx- time per hop = 1.634 ms (see next plot).




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




Number of hops in the period specified in the requirements = (14 hops) x (31.6 s / 3 s) = 147.46 hops.

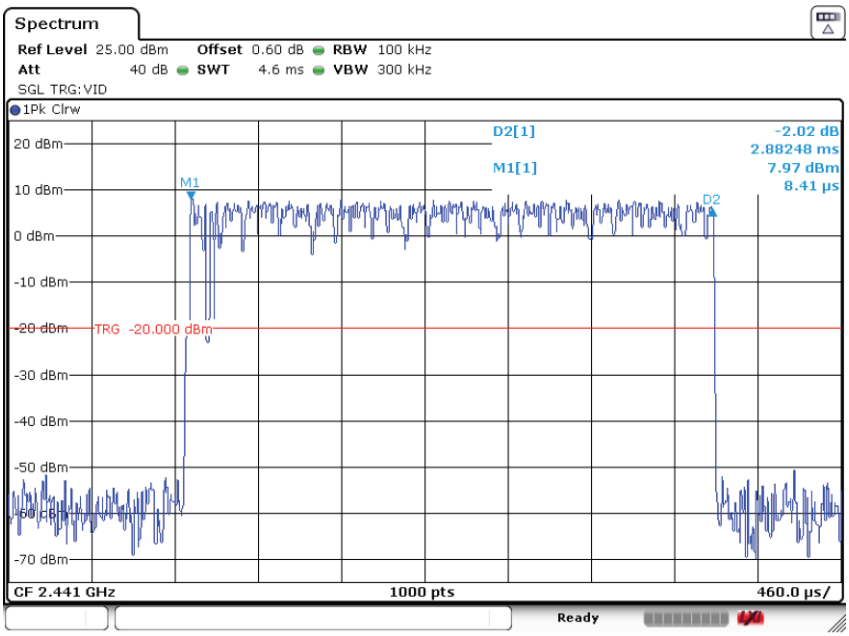
Averaging time of occupancy = 1.634 ms x 147.46 hops = 240.96 ms per 31.6 seconds.

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

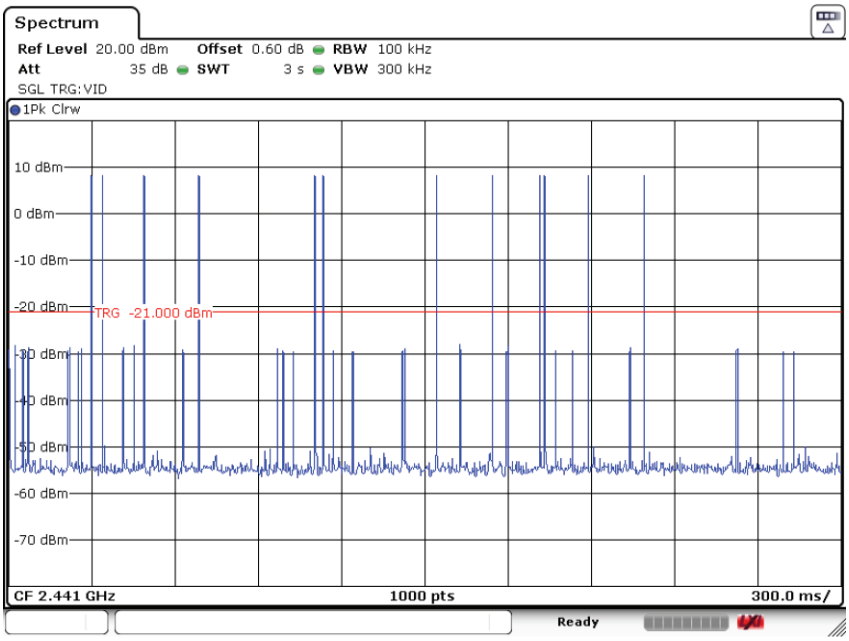
Verdict: PASS

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

- Tx- time per hop = 2.882 ms (see next plot).




- Number of hops over a period of 3 seconds = 12 (see next plot).




Number of hops in the period specified in the requirements = (12 hops) x (31.6 s / 3 s) = 126.4 hops.
Averaging time of occupancy =2.882 ms x 126.4 hops = 364.28 ms per 31.6 seconds.

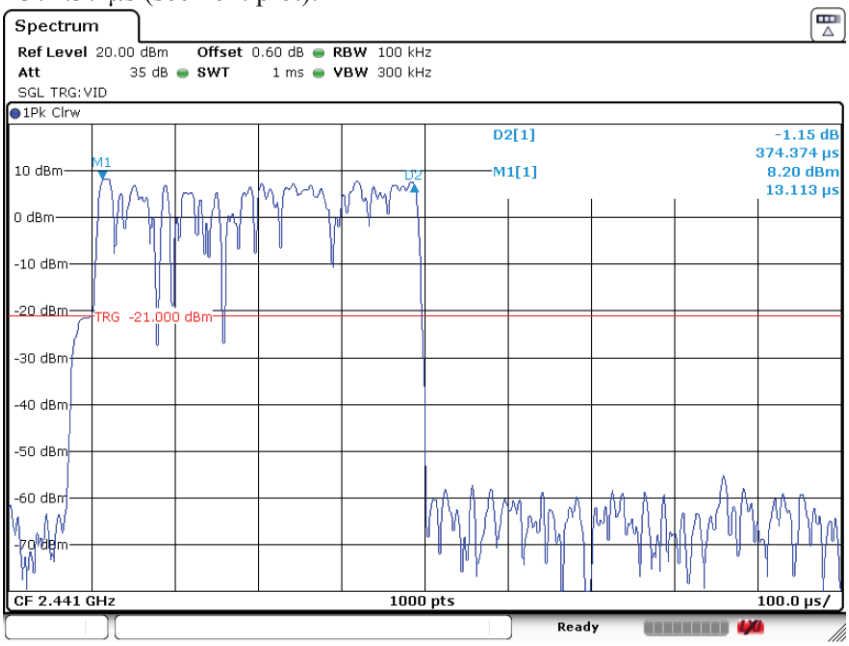
| | |
|---|---|
| Measurement uncertainty (%) | <±0.01 |

Verdict: PASS

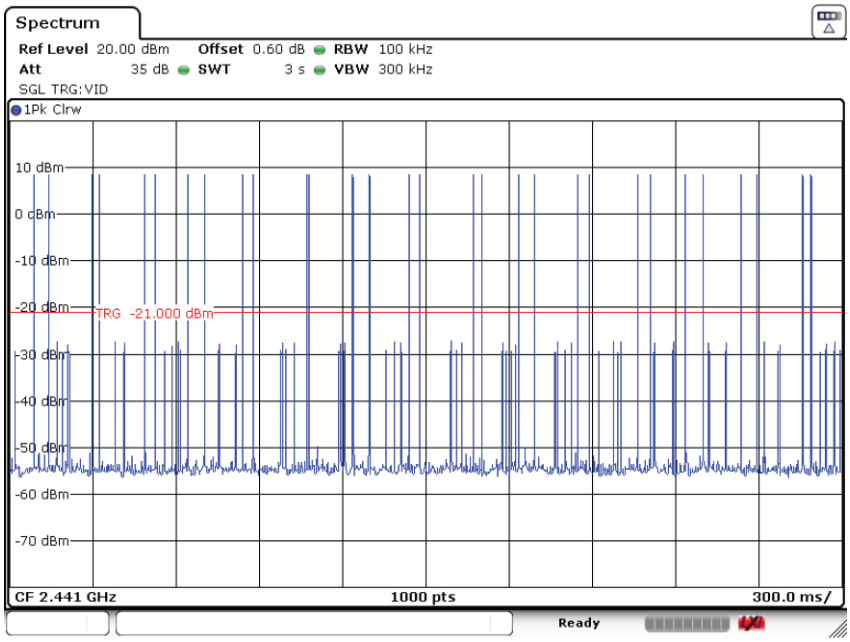
**Modulation: Π/4-DQPSK**

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

- Tx- time per hop = 374.37 µs (see next plot).




- Number of hops over a period of 3 second = 28 (see next plot).



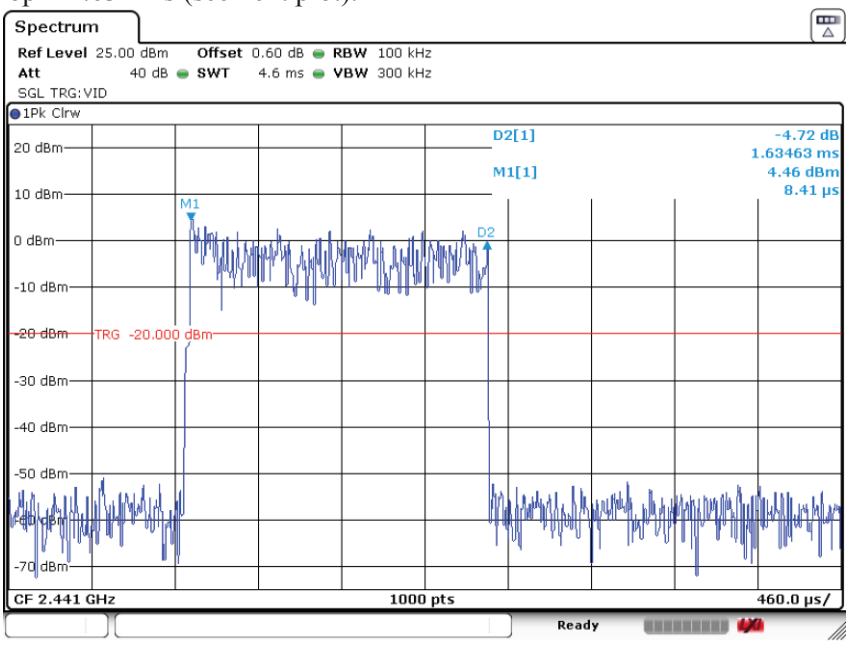

Number of hops in the period specified in the requirements = (28 hops) x (31.6 s / 3 s) = 294.93 hops.
Averaging time of occupancy = 374.37 µs x 294.93 hops = 110.41 ms per 31.6 seconds.

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

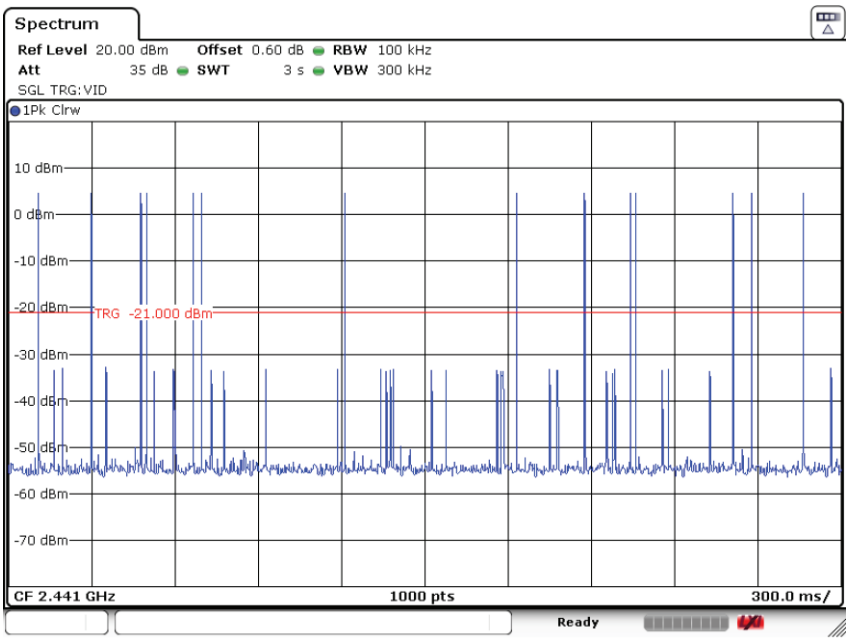
Verdict: PASS

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

- Tx- time per hop = 1.634 ms (see next plot).




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




Number of hops in the period specified in the requirements = (14 hops) x (31.6 s / 3 s) = 147.46 hops.

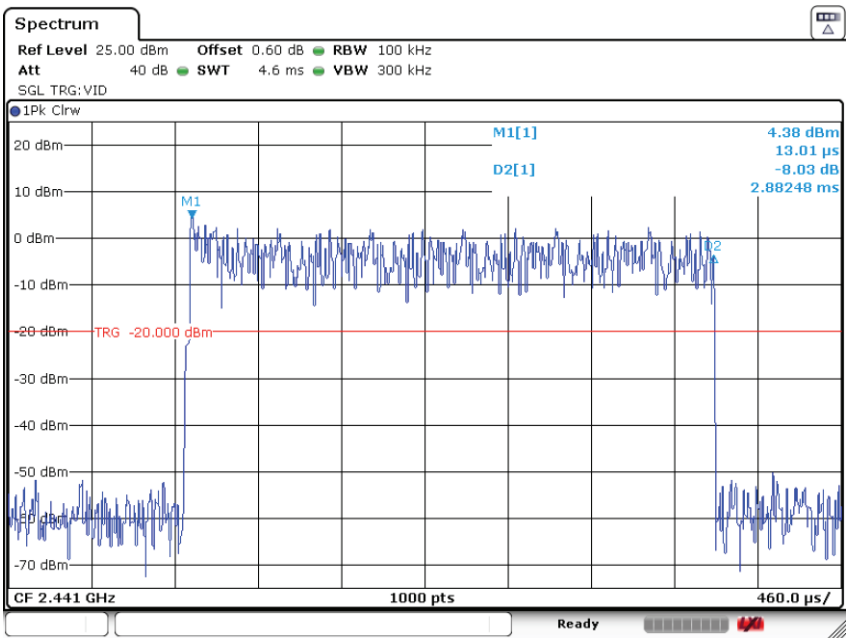
Averaging time of occupancy = 1.634 ms x 147.46 hops = 240.96 ms per 31.6 seconds.

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

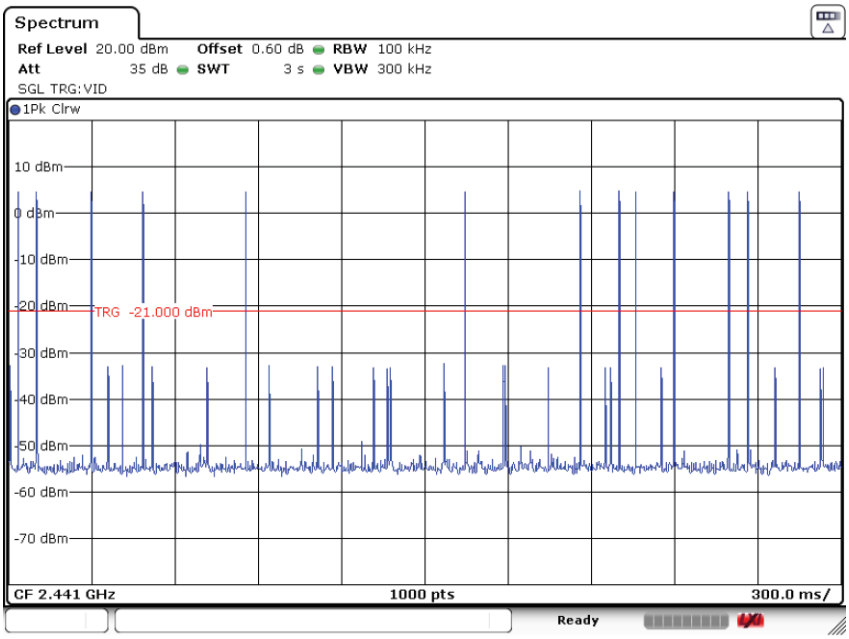
Verdict: PASS

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

- Tx- time per hop = 2.882 s (see next plot).




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




Number of hops in the period specified in the requirements = (13 hops) x (31.6 s / 3 s) = 136.93 hops.
Averaging time of occupancy =2.882 ms x 136.93 hops = 394.64 ms per 31.6 seconds.

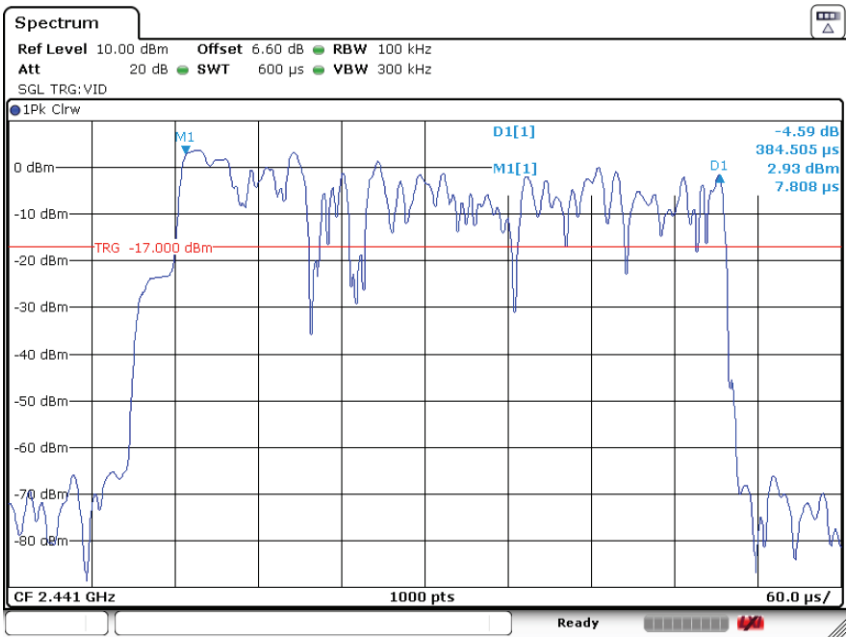
| | |
|---|---|
| Measurement uncertainty (%) | <±0.01 |

Verdict: PASS

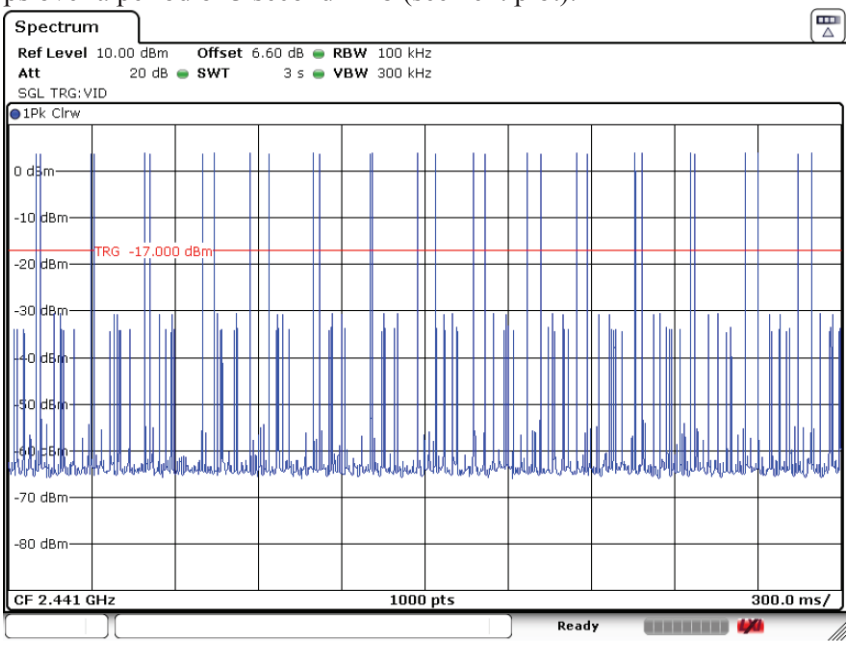
**Modulation: 8-DPSK**

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

- Tx- time per hop = 384.5 µs (see next plot).




- Number of hops over a period of 3 second = 28 (see next plot).



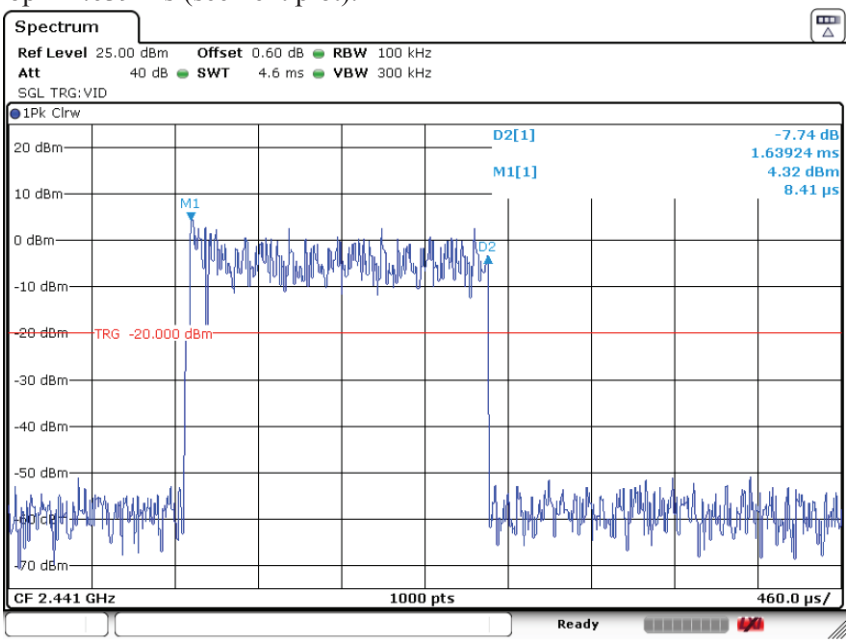

Number of hops in the period specified in the requirements = (28 hops) x (31.6 s / 3 s) = 294.93 hops.
Averaging time of occupancy = 384.5 µs x 294.93 hops = 113.40 ms per 31.6 seconds.

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

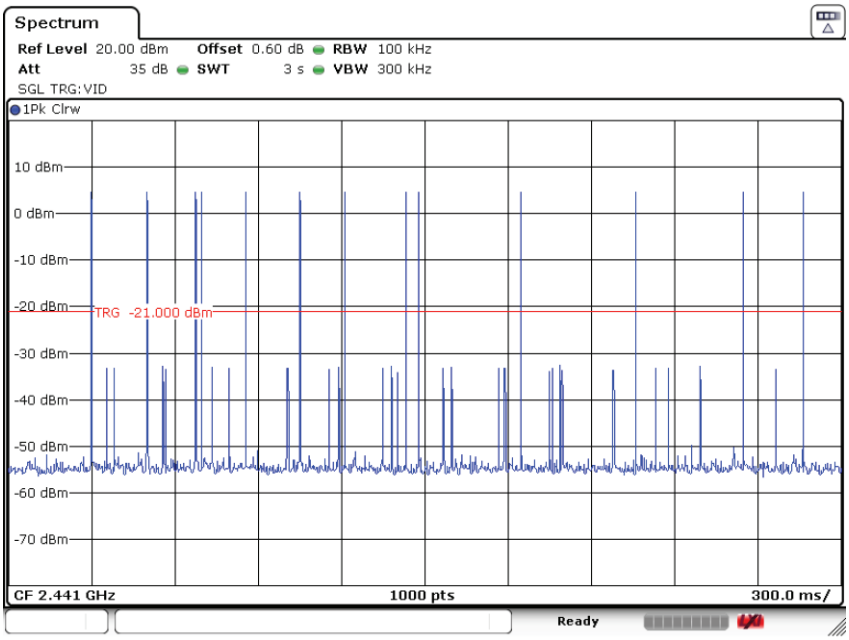
Verdict: PASS

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

- Tx- time per hop = 1.639 ms (see next plot).




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




Number of hops in the period specified in the requirements = (14 hops) x (31.6 s / 3 s) = 147.46 hops.

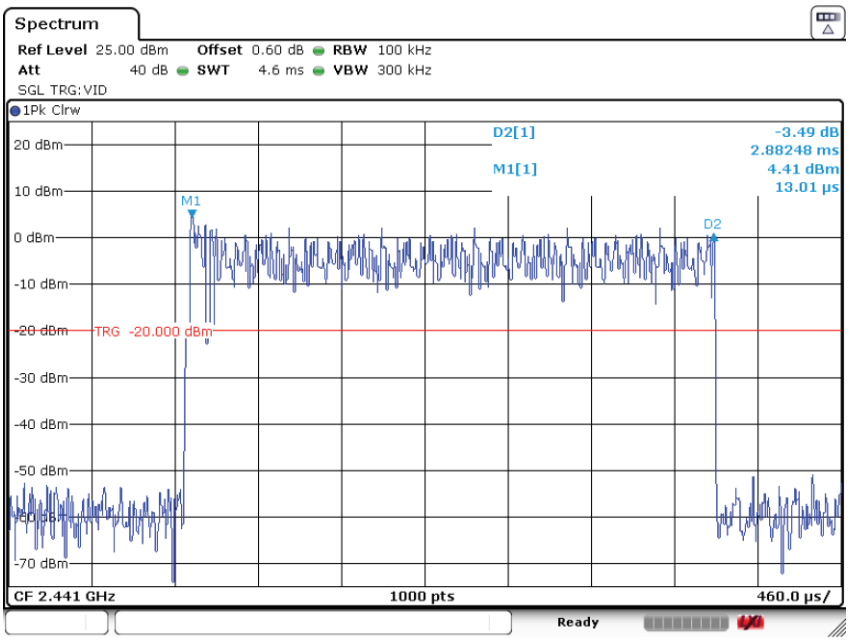
Averaging time of occupancy = 1.639 ms x 147.46 hops = 241.73 ms per 31.6 seconds.

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

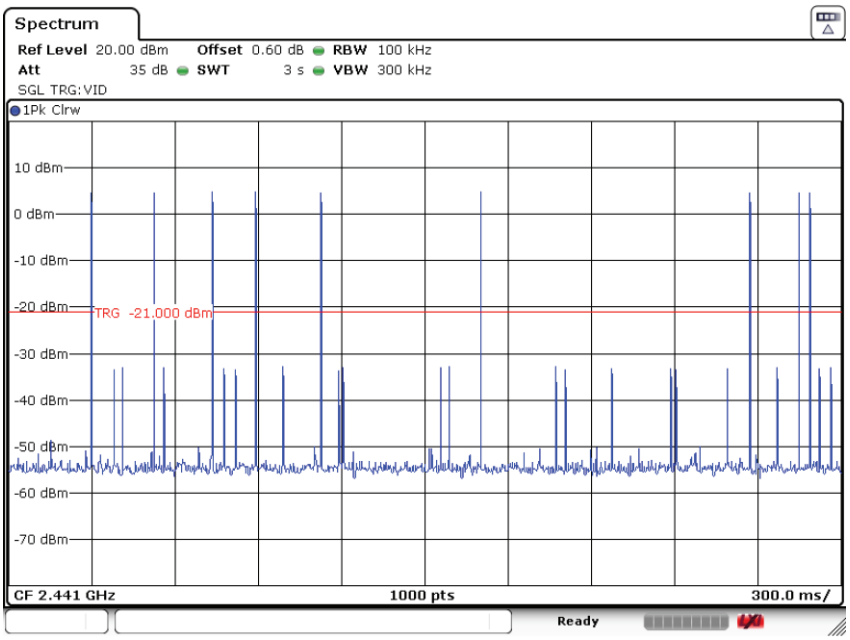
Verdict: PASS

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

- Tx- time per hop = 2.882 ms (see next plot).




- Number of hops over a period of 3 seconds = 9 (see next plot).




Number of hops in the period specified in the requirements = (9 hops) x (31.6 s / 3 s) = 94.8 hops.
Averaging time of occupancy =2.882 ms x 94.80 hops = 273.26 ms per 31.6 seconds.

| | |
|---|---|
| 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).

MAXIMUM OUTPUT POWER. See next plots.

Declared Gain for antenna RF port 3 (maximum) = -6.2 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) | 7.10 | 8.30 | 8.83 |
| Maximum EIRP power (dBm) | 0.90 | 2.10 | 2.63 |
| Measurement uncertainty (dB) | <±1.20 | | |

Modulation: Π/4-DQPSK (2Mbps)

| | Lowest frequency 2402 MHz | Middle frequency 2441 MHz | Highest frequency 2480 MHz |
|---|---|---|---|
| Maximum peak power (dBm) | 5.97 | 6.80 | 7.16 |
| Maximum EIRP power (dBm) | -0.23 | 0.60 | 0.96 |
| Measurement uncertainty (dB) | <±1.20 | | |

Modulation: 8-DPSK (3Mbps)

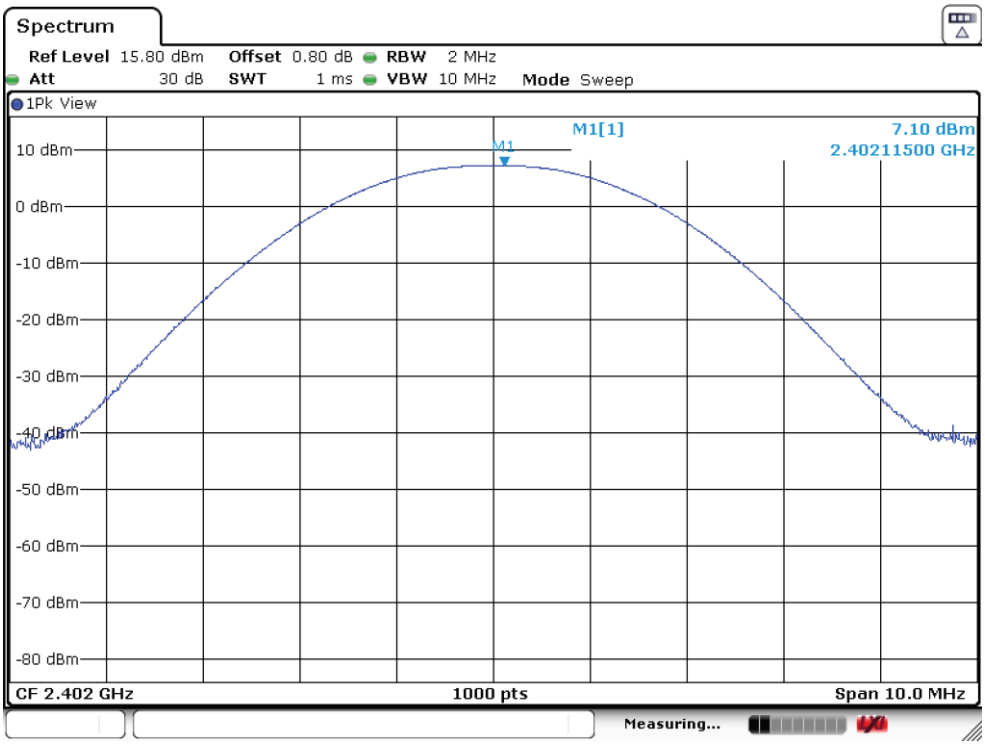
| | Lowest frequency 2402 MHz | Middle frequency 2441 MHz | Highest frequency 2480 MHz |
|---|---|---|---|
| Maximum peak power (dBm) | 6.28 | 7.26 | 7.58 |
| Maximum EIRP power (dBm) | 0.08 | 1.06 | 1.38 |
| Measurement uncertainty (dB) | <±1.20 | | |

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

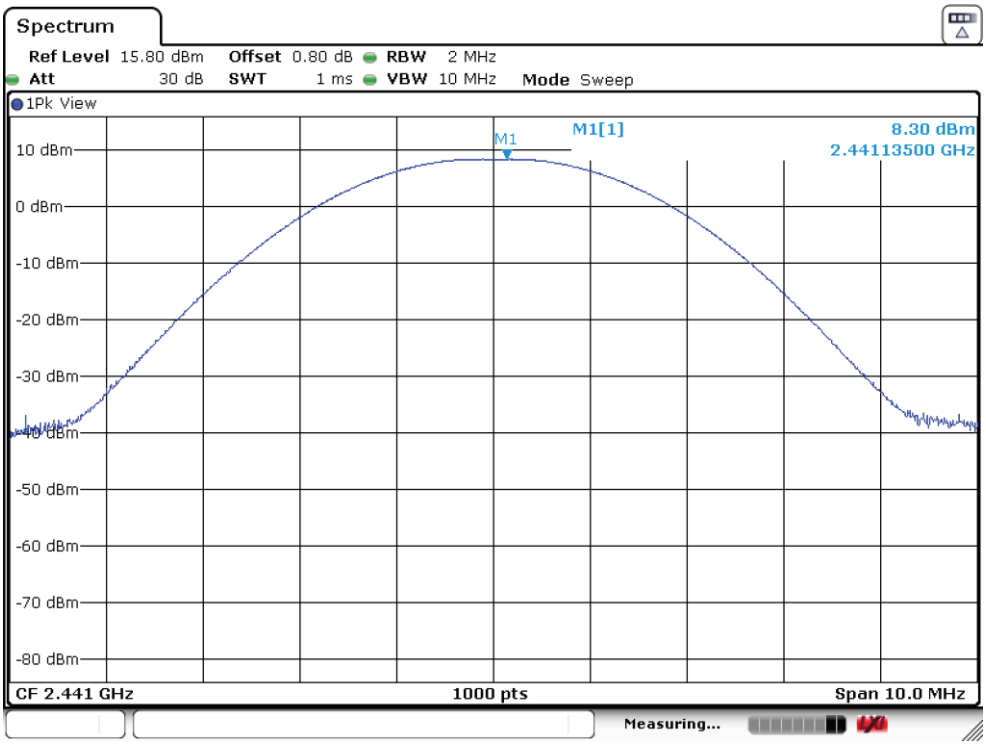
Verdict: PASS

PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK Lowest Channel: 2402 MHz.

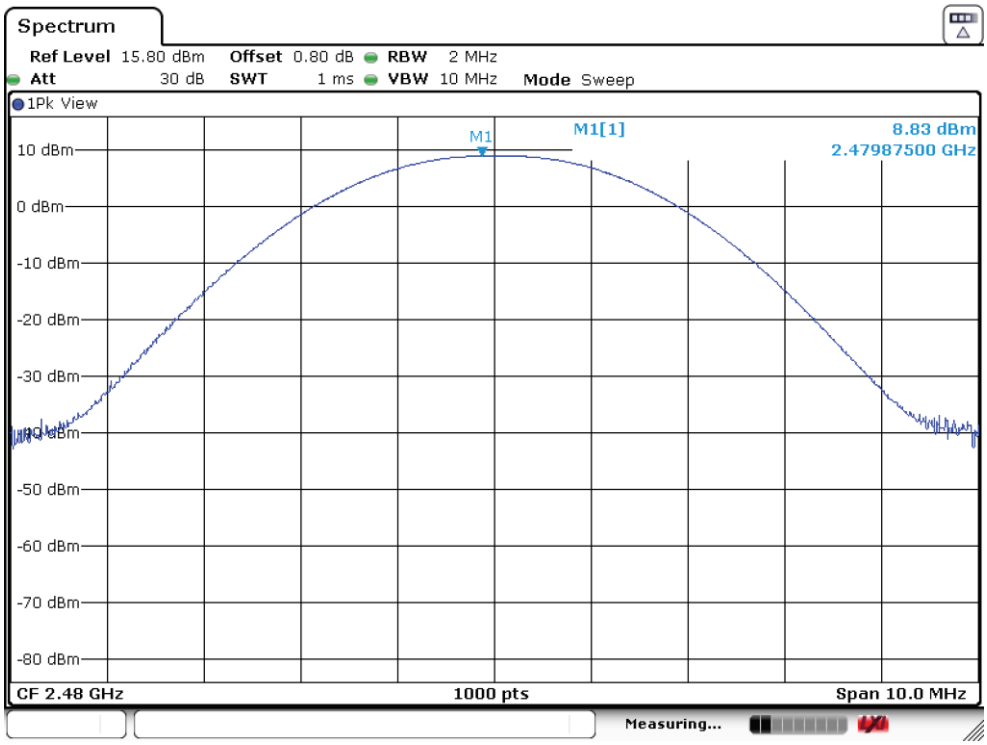



Modulation: GFSK Middle Channel: 2441 MHz.

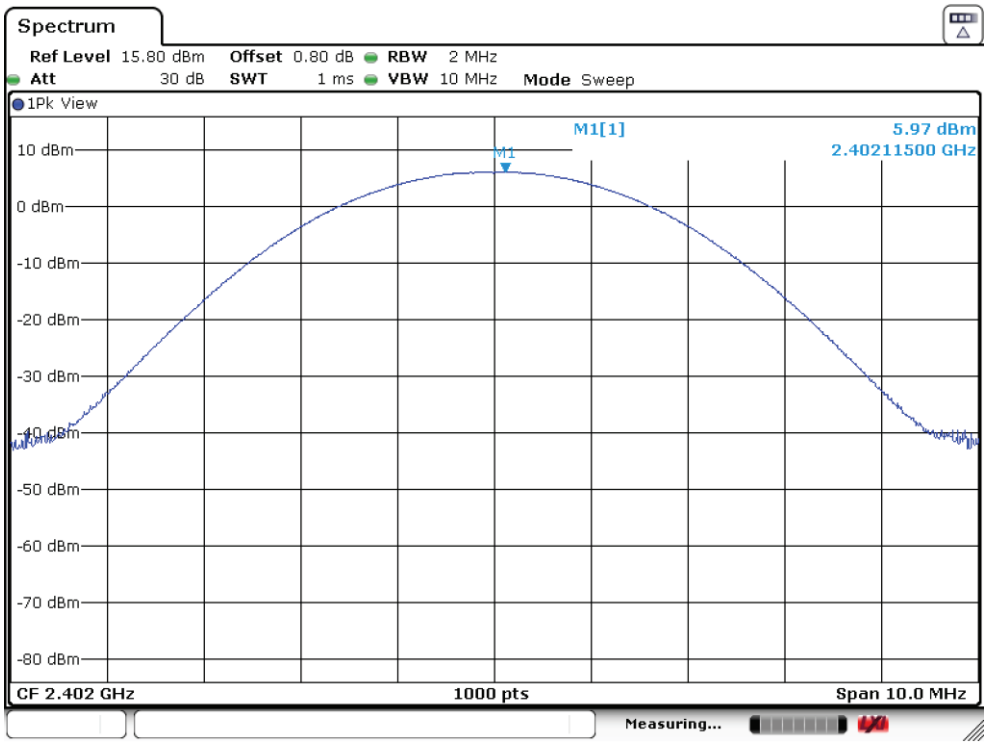


PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK Highest Channel: 2480 MHz.

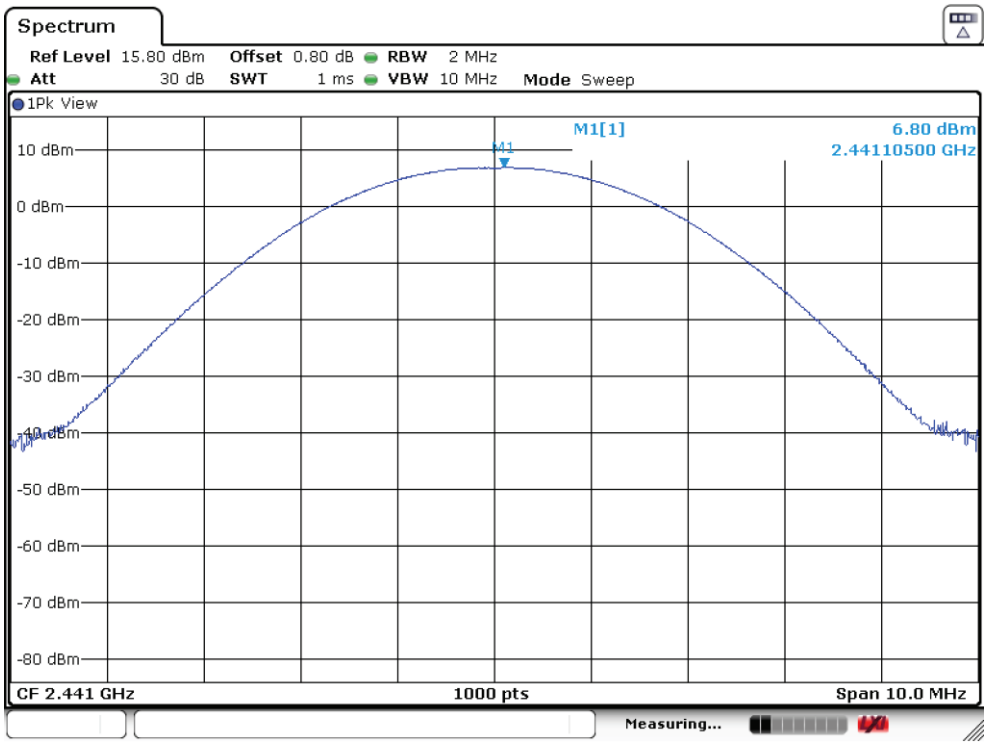



Modulation: Π/4-DQPSK Lowest Channel: 2402 MHz

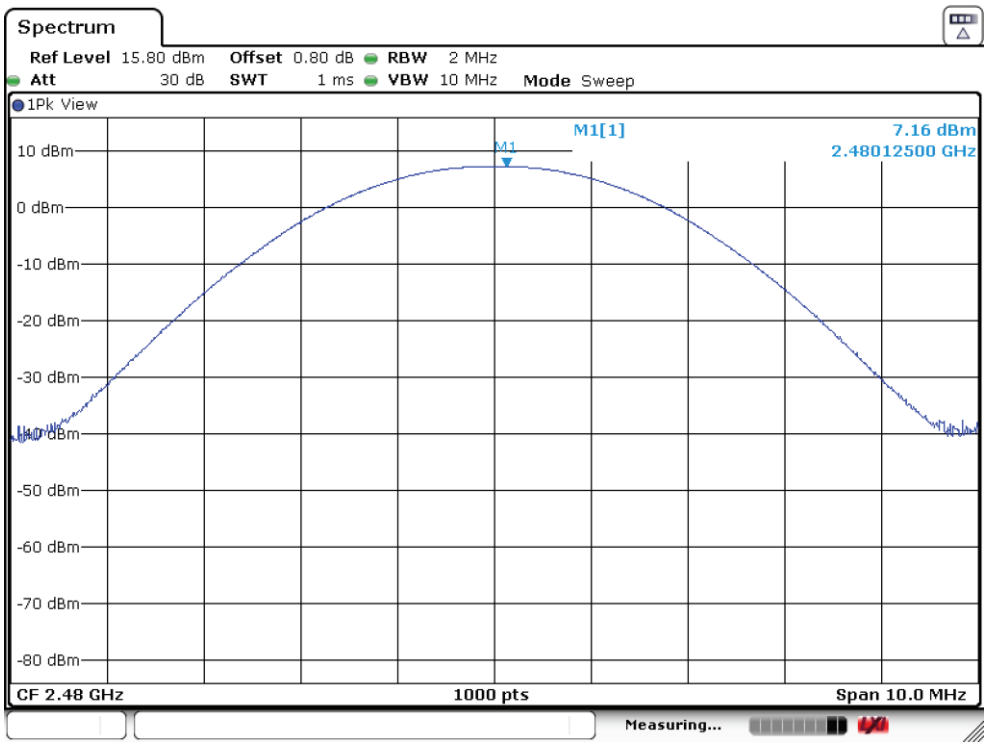


PEAK OUTPUT POWER (CONDUCTED)

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

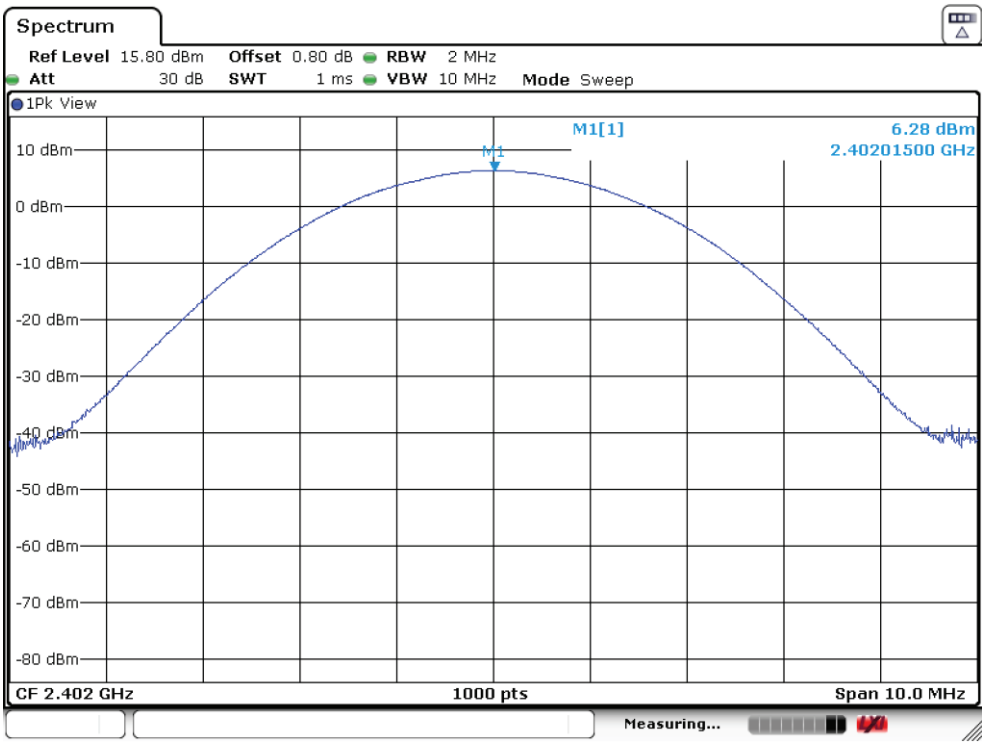



Modulation: Π/4-DQPSK Highest Channel: 2480 MHz.

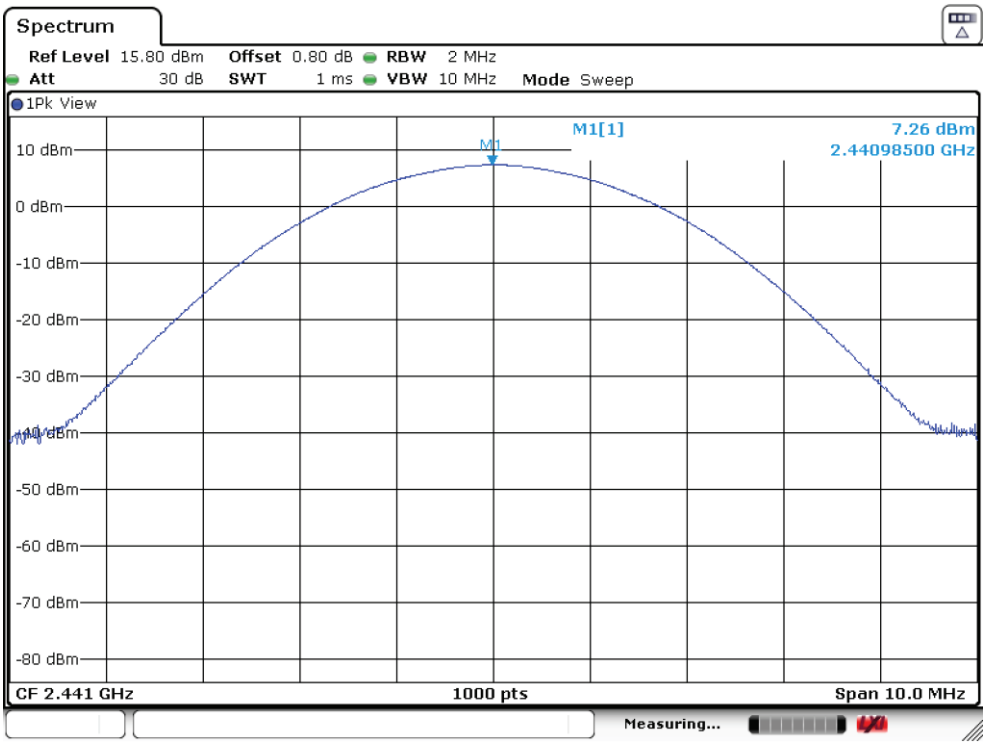


PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK Lowest Channel: 2402 MHz

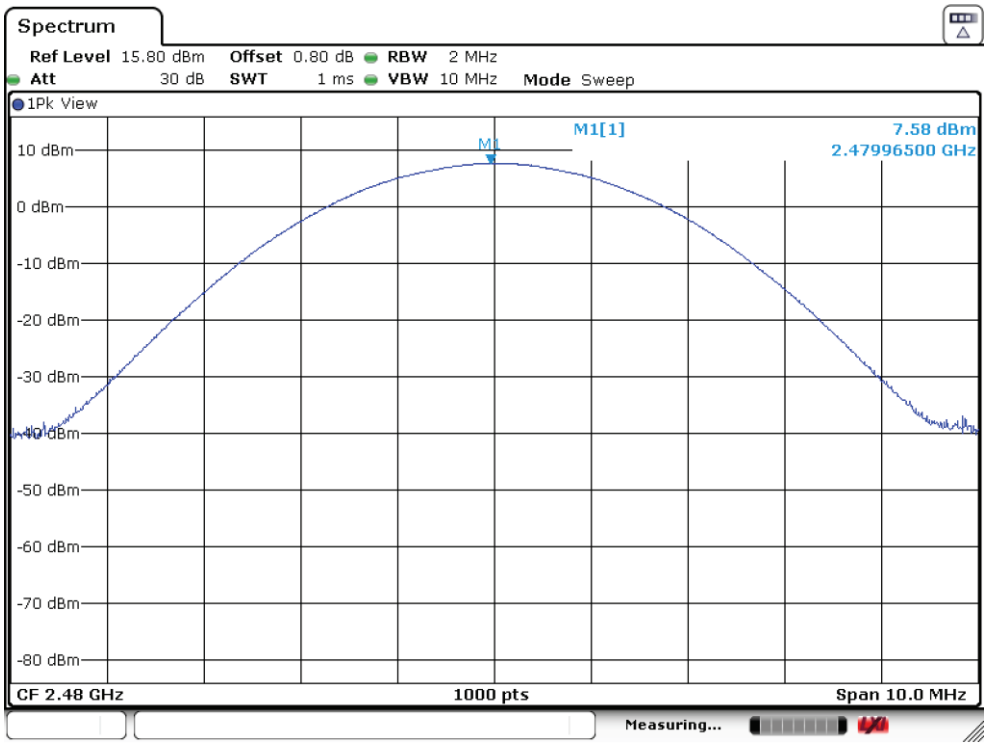



Modulation: 8-DPSK Middle Channel: 2441 MHz.



PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK Highest Channel: 2480 MHz.



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

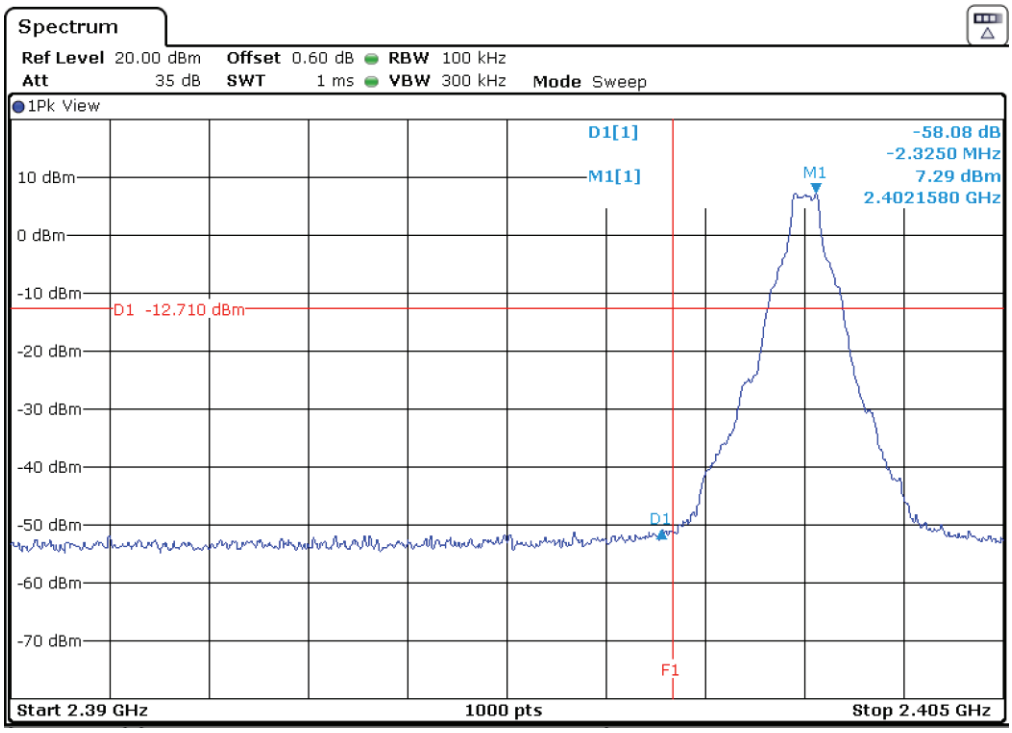
SPECIFICATION

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:

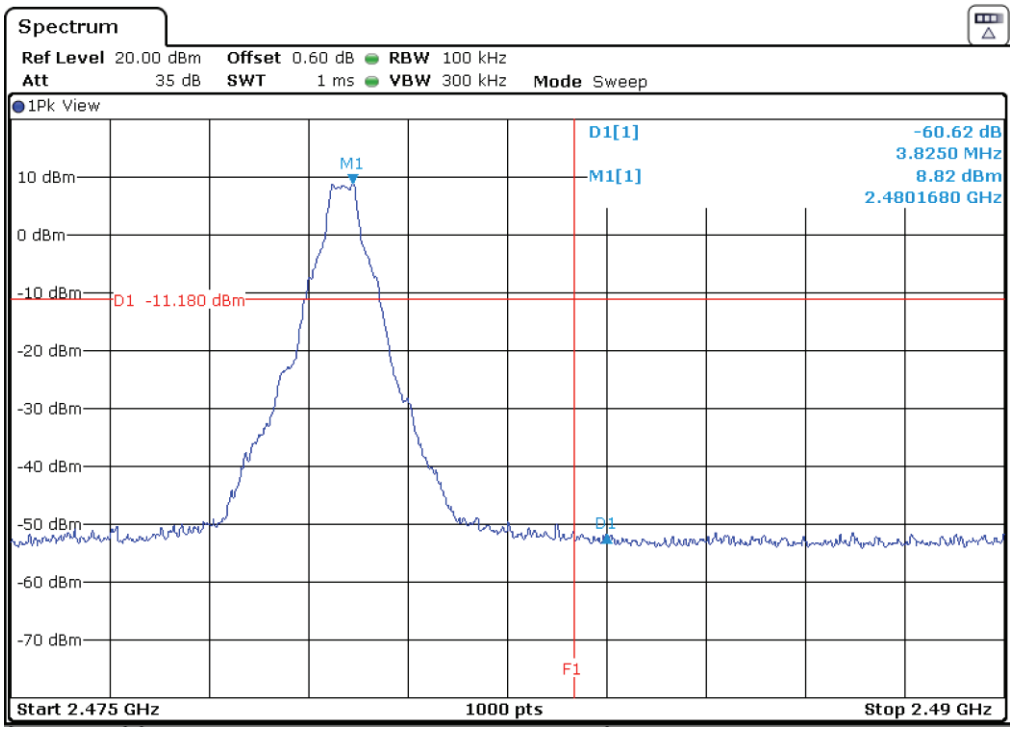
**Modulation: GFSK**

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



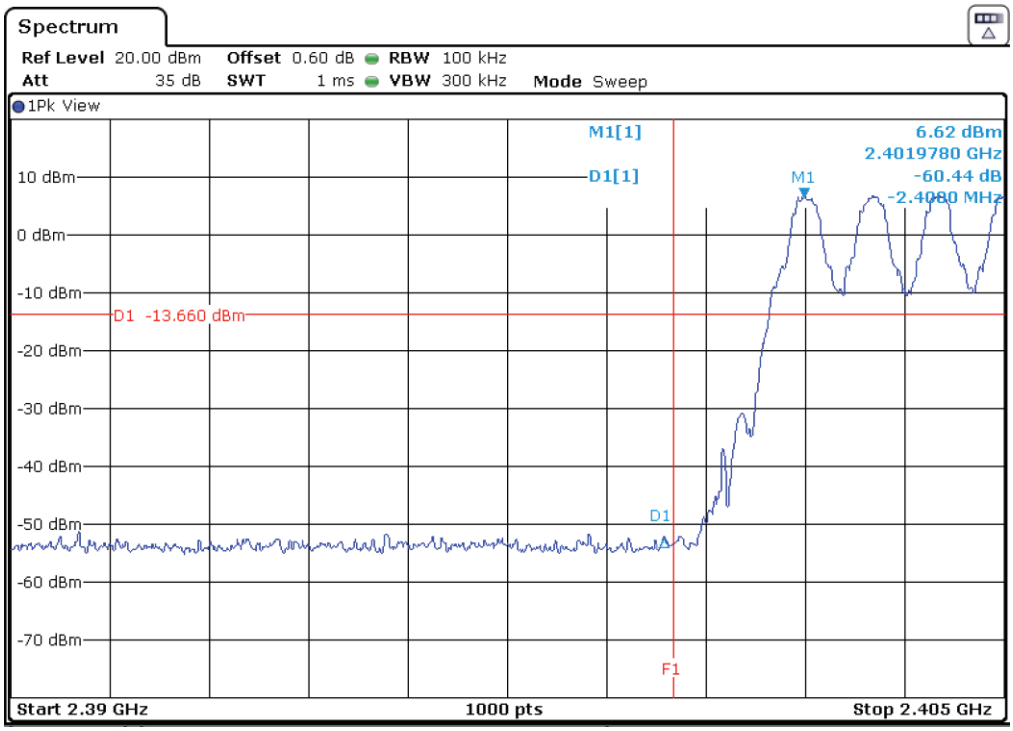

Verdict: PASS

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



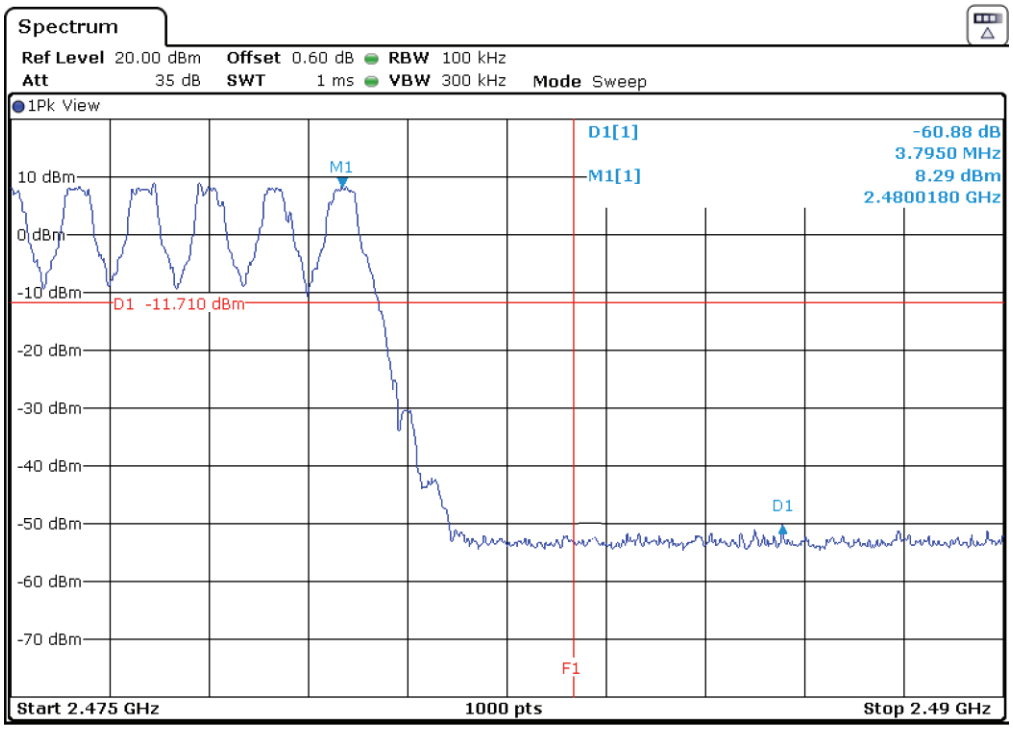

Verdict: PASS

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




Verdict: PASS

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

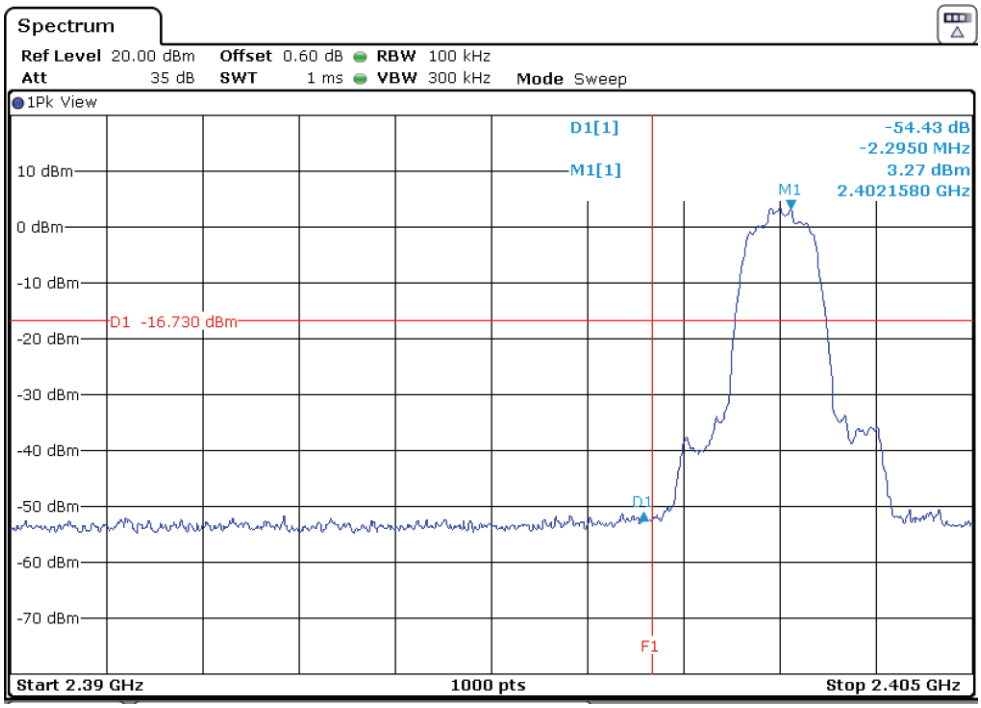



Verdict: PASS

| | |
|---|---|
| Measurement uncertainty (dB) | <±1.20 |

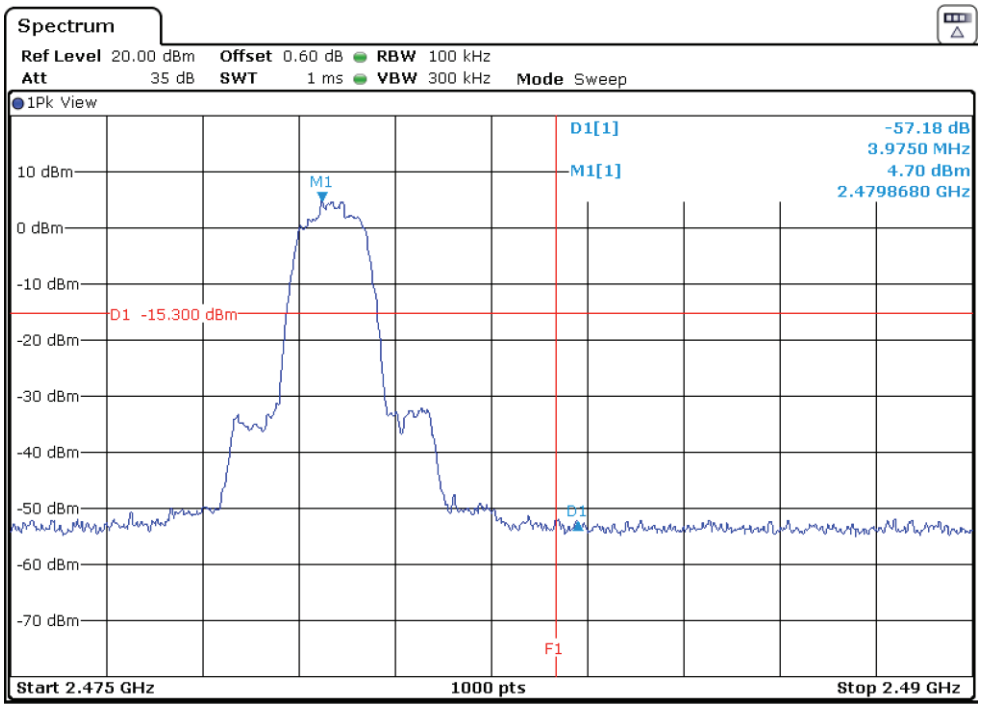
## Modulation: Π/4-DQPSK

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



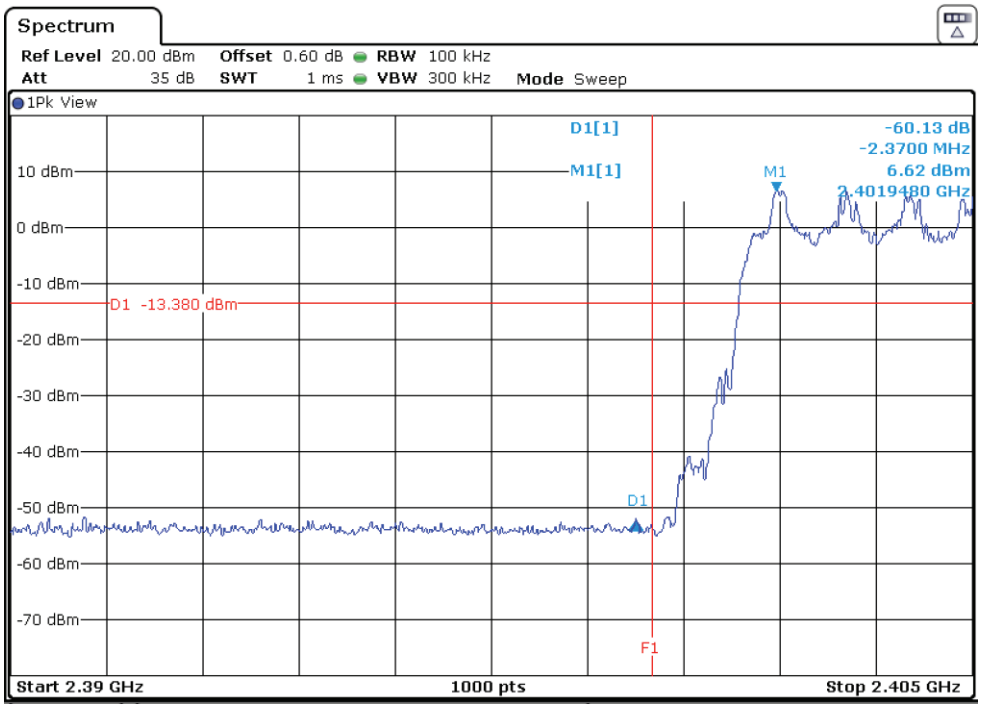

Verdict: PASS

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



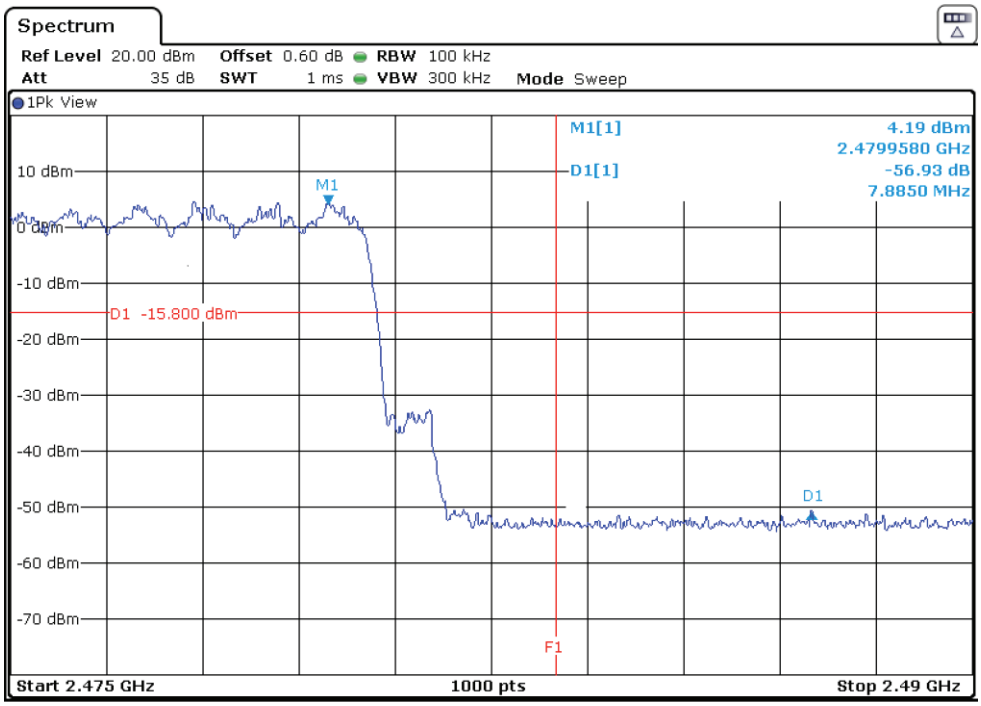

Verdict: PASS

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




Verdict: PASS

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

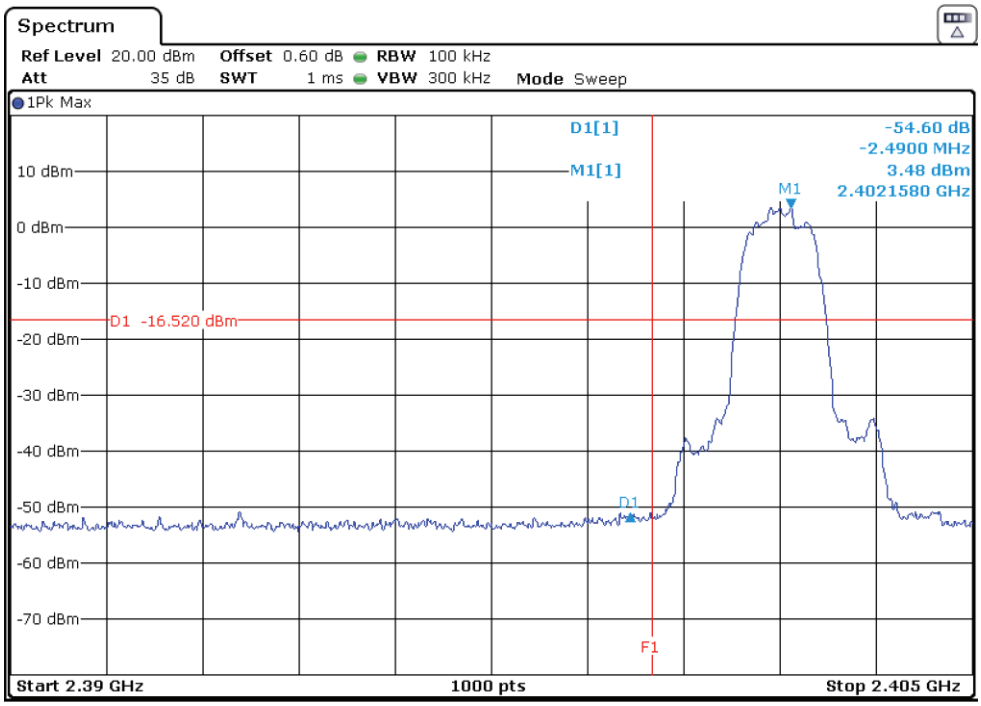



Verdict: PASS

| | |
|---|---|
| Measurement uncertainty (dB) | <±1.20 |

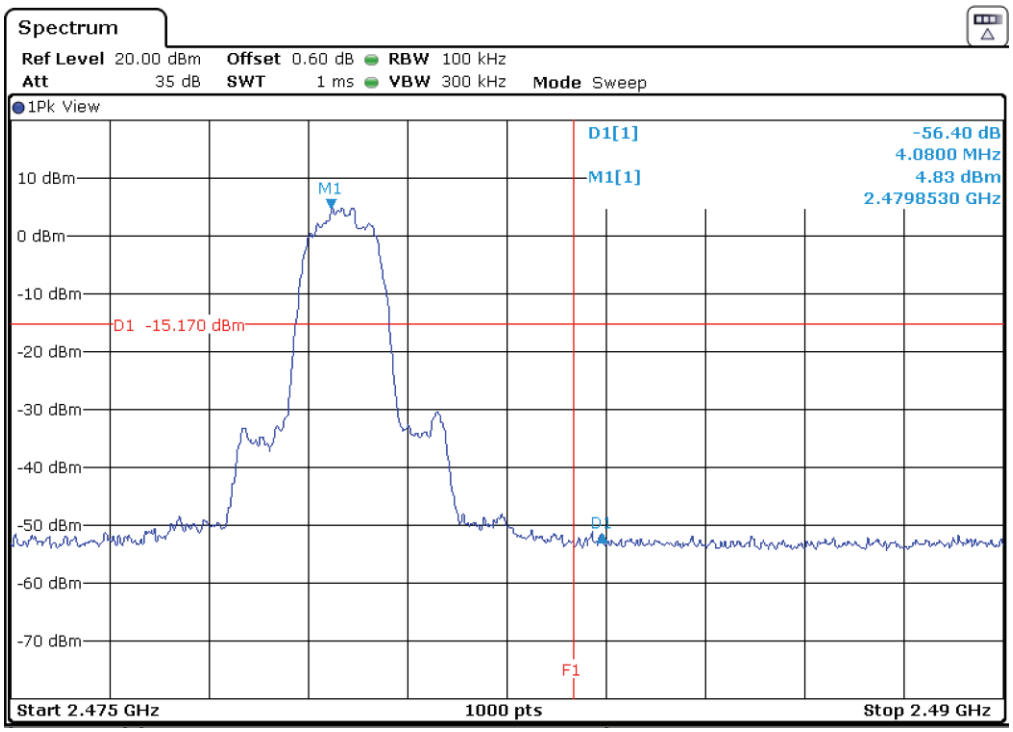
## Modulation: 8-DPSK

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



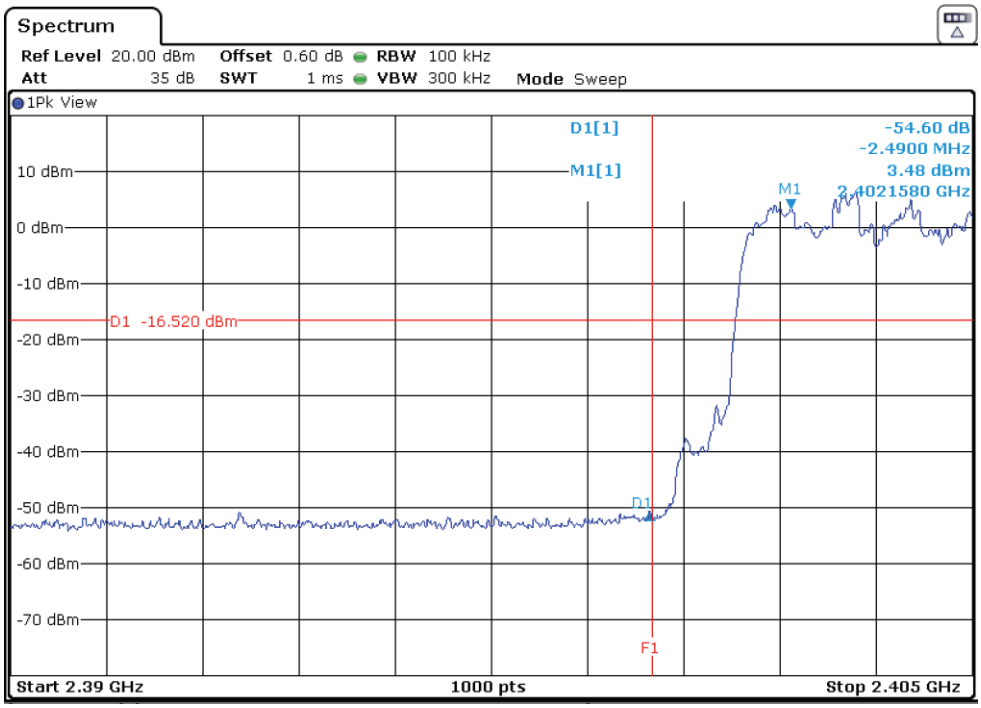

Verdict: PASS

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



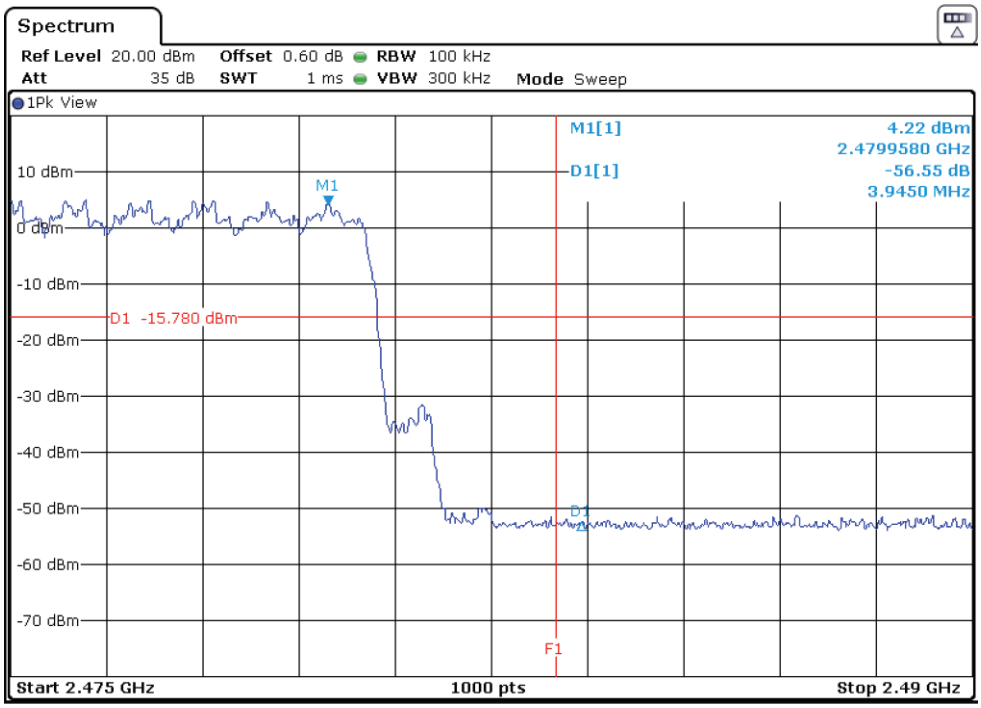

Verdict: PASS

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




Verdict: PASS

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




Verdict: PASS

| | |
|---|---|
| Measurement uncertainty (dB) | <±1.20 |

## FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. 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.LOW CHANNEL (2402 MHz).
All peaks are more than 20 dB below the limit.

2. MIDDLE CHANNEL (2441 MHz)
All peaks are more than 20 dB below the limit.

3. HIGH CHANNEL (2480 MHz)
All peaks are more than 20 dB below the limit.

**Modulation: Π/4-DQPSK**

1. LOW CHANNEL (2402 MHz).
All peaks are more than 20 dB below the limit.

2. MIDDLE CHANNEL (2441 MHz)
All peaks are more than 20 dB below the limit.

3. HIGH CHANNEL (2480 MHz)
All peaks are more than 20 dB below the limit.

**Modulation: 8-DPSK**

1. LOW CHANNEL (2402 MHz).
All peaks are more than 20 dB below the limit.

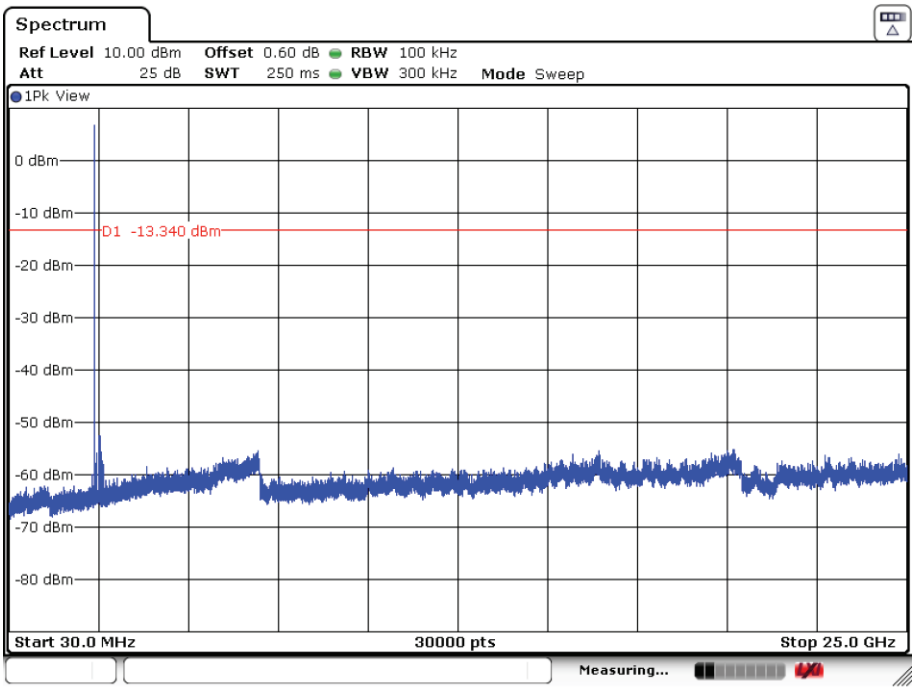
2. MIDDLE CHANNEL (2441 MHz)
All peaks are more than 20 dB below the limit.

3. HIGH CHANNEL (2480 MHz)
All peaks are more than 20 dB below the limit.

Verdict: PASS

**Modulation: GFSK**

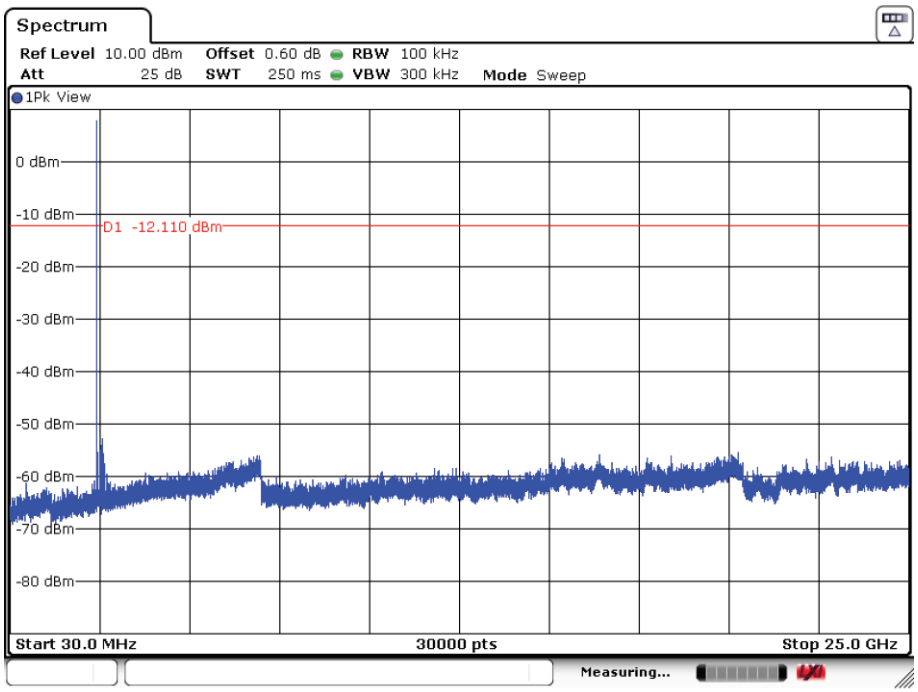
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).




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