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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 an FCC-recognized accredited testing laboratory with appropriate scope of accreditation that covers the performed tests in this report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory, CABid: ES1909, Company Number: 4621A, with the appropriate scope of accreditation that covers the performed tests in this report.

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.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
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 S.A.U. and the Accreditation Bodies.

Uncertainty

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

The total uncertainty of the measurement system for the radiated emissions of EUT from 30 MHz to 1 GHz is: Measurement uncertainty ≤ ± 5.35 dB with factor (k = 2).

The total uncertainty of the measurement system for the radiated emissions of EUT from 1 GHz to 17 GHz is: Measurement uncertainty ≤ ± 4.32 dB with factor (k = 2).

The total uncertainty of the measurement system for the radiated emissions of EUT from 17 GHz to 26 GHz is: Measurement uncertainty ≤ ± 5.51 dB with factor (k = 2).

The total uncertainty of the measurement system for the conducted testing of EUT is:

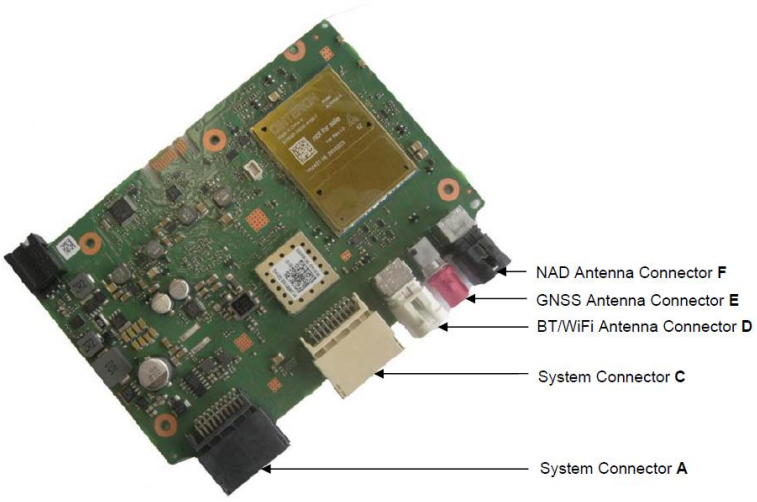
RF Peak Output Power: Measurement uncertainty ≤ ± 0.80 dB
RF Average Output Power: Measurement uncertainty ≤ 0.99 dB
Power Spectral Density: Measurement uncertainty ≤ 0.99 dB
Accumulated Dwell Time: Measurement uncertainty ≤ ± 0.16 %
Minimum Frequency Occupation Time: Measurement uncertainty ≤ ± 0.53 %
Hopping Frequency Separation: Measurement uncertainty ≤ ± 1.74 %
Occupied Channel Bandwidth: Measurement uncertainty ≤ ± 1.40 %
6dB Bandwidth: Measurement uncertainty ≤ ± 1.14 %
Conducted Band-edge spurious emissions: Measurement uncertainty ≤ ± 1.76 dB

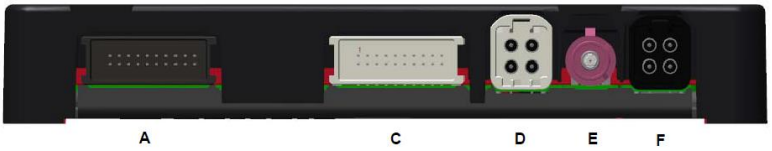
Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample of the model ConBox HIGH RD is a Telematics control unit with wireless technologies, used in automotive, equipped with one modem, OEM. This unit was designed for automotive usage and contains the following features: GSM, UMTS, LTE, GNSS, Wifi (a, b, g, n, ac), Bluetooth Low Energy (BTLE) and Bluetooth EDR.





3. Declaration of Comparability

HARMAN
A SAMSUNG COMPANY

Declaration of Comparability

HARMAN BECKER
Automotive Systems GmbH
Becker-Göring-Str. 16
D-76307 Karlsbad, Germany

declares under our sole responsibility, that the product

Description of object	:	Telematic system with BT, WLAN, GNSS, GSM, UMTS, LTE
Brand/ Customer	:	VW-Group / VW AG/ Audi
Model name **Variant**	:	CONBOX-HIGH RD A970, A971, A972, A973, A974, A975, A976, A977, A978, A979, A980, A981, A982, A983, A984, P114, P115, P119
Hardware / Software version	:	045 / 0489 **(corresponds CL37)**

is comparable to:

Description of object	:	Telematic system with BT, WLAN, GNSS, GSM, UMTS, LTE
Customer / Brand	:	VW-Group / VW AG/ Audi
Model **Variant**	:	CONBOX-HIGH RD A970, A971, A972, A973, A974, A975, A976, A977, A978, A979, A980, A981, A982, A983, A984, P114, P115, P119
Hardware / SW	:	045 / 0494 **(corresponds CL37)**

We declare as authorized responsible person, that the products above have HW and SW changes which have no impact for the certification activities.

The HW version used on CONBOX-HIGH RD will have the same schematics, the same layout, with the same BT/WLAN-Module and the same country specific NAD module and the HW index will remain 045.

The application SW will be changed to 0494 version. These SW changes do not impact the following parameters: used frequency ranges / used frequency bands, the used modulation type, the maximum RF power, the circumstances under which the transmitter operates, the basic frequency and/or stabilizing circuitry, frequency multiplication stages, the basic modulator circuitry or maximum RF power, the field strength ratings, slew rates for clocking of output pins and drivers.

More details about the HW/SW updates are included in: "CON-BOX-HIGH-RD_temp_test_20230120".

In conclusion, we can say the new SW/HW configuration do not influence the type-approval for all variants (listed above) on CONBOX-High RD - Cluster 37 (045/0494).

Declared by: **checked by: Thomas Roesch (S-PM) / 28.03.2023**

i.V.

Mr. STOICA Iulian, Product Compliance Expert

Bucharest	28.03.2023	
(Place)	**(Date)**	**(Signature)**

i.V.

Mr. OLTEANU Marius, Product Compliance Expert.

Bucharest	28.03.2023	
(Place)	**(Date)**	**(Signature)**

HW Changes on TCU side

From HW perspective, the main modifications are :
- replacing of unnecessary coupling capacitors C5940/C5941 220nF in PCIe bus with 0 Ohm resistors
- coupling capacitors are already on Qisda NXP module, therefore not needed on main PCB
- no change is made on the layout of main PCB.

The HW version used on CONBOX-HIGH RD will have the same schematics, the same layout, with the same BT/WLAN-Module and the same country specific NAD module and the HW index will remain 045.

SW Changes on TCU side

From SW perspective, the main updates are :
- change of BT/Wifi driver
- change of PCIe speed

There have been:
- No changes of the used frequency ranges / bands
- No changes of the used modulation type
- No changes of the maximum RF power
- No changes of the circumstances under which the transmitter operates
- No changes of the basic frequency and/or stabilizing circuitry
- No changes of the frequency multiplication stages
- No changes of the basic modulator circuitry or maximum RF power
- No changes of the field strength ratings
- No changes of slew rates for clocking of output pins and drivers

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

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.	Reception
72779/002	Telematic control unit	ConBox HIGH RD	351998105026439	2022/10/17
72779/054	Harness	-	-	2022/10/17

Auxiliary elements used with the Sample S/01:

Control No.	Description	Model	Serial No.	Reception
72779/011	Ethernet Cable	-	-	2022/10/17
72779/013	OABR-Converter PCB Board	-	-	2022/10/17
72779/014	Power Cable	-	-	2022/10/17
72779/048	Fakra 4 to 1 Cable	-	-	2022/10/17
72779/066	Cable Antenna 4 to 1	-	-	2022/10/17

Sample S/01 has undergone the test(s): The Conducted tests indicated in the Appendixes A, B.

- Sample S/02 is composed of the following elements:

Control No.	Description	Model	Serial No.	Reception
72779/002	Telematic control unit	ConBox HIGH RD	351998105026439	2022/10/17
72779/054	Harness	-	-	2022/10/17
72779/067	Antenna VW ConBox	-	-	2022/10/17
72779/068	Antenna VW ConBox	-	-	2022/10/17
72779/069	Antenna VW ConBox	-	-	2022/10/17
72779/070	Antenna VW ConBox	-	-	2022/10/17

Auxiliary elements used with the Sample S/02:

Control No.	Description	Model	Serial No.	Reception
72779/011	Ethernet Cable	-	-	2022/10/17
72779/013	OABR-Converter PCB Board	-	-	2022/10/17
72779/014	Power Cable	-	-	2022/10/17
72779/048	Fakra 4 to 1 Cable	-	-	2022/10/17
72779/066	Cable Antenna 4 to 1	-	-	2022/10/17

Sample S/02 has undergone the test(s): The Radiated tests indicated in the Appendixes A, B.

Test sample description

Ports……:	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient(3)
	RF connector – code		☐	☒	☐
	RF connector – code		☒	☒	☐
	RF connector – code		☒	☐	☐
Supplementary information to the ports……:					

Rated power supply ..... :	Voltage and Frequency		Reference poles			
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: 12V car battery (4.8 VDC inside of TCU)					

Rated Power..... :	12V DC
Clock frequencies..... :	25MHz; 26MHz; 32,768kHz; 49,58MHz;
Other parameters ..... :	See Technical description
Software version..... :	0494
Hardware version ..... :	045
Dimensions in cm (W x H x D) ... :	--

Mounting position ..... :	☐	Table top equipment
	☐	Wall/Ceiling mounted equipment
	☐	Floor standing equipment
	☐	Hand-held equipment
	☒	Other: automotive telematics control unit

Modules/parts..... :	Module/parts of test item	Type	Manufacturer
	--	-	-
	--	-	-

Accessories (not part of the test item) ..... :	Description	Type	Manufacturer
	Cable Harness	-	-
	2G/3G/4G/5G Antenna	-	Hirschmann/ Molex
	eCall button/LED	-	-
	SOS Loudspeaker	-	-
	Wake-up unit Box	-	-

Documents as provided by the applicant..... :	Description	File name	Issue date
	Technical Description	-	-

(3) Only for Medical Equipment

Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH

BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2022-10-26
Date (finish)	2022-11-28

Document history

Report number	Date	Description
72779RRF.007	2022-12-12	First release
72779RRF.007A1	2023-04-12	Second release. Modification due to typos.

Environmental conditions

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

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

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

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

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

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Miguel Manuel López, Pablo Redondo, Rafael Fernández.

Used instrumentation:

Control No.	Equipment	Model	Manufacturer	Next Calibration
6791	SEMIANECHOIC ABSORBER LINED CHAMBER IV	FACT 3 200 STP	ETS LINDGREN	2024-06-07
6792	SHIELDED ROOM	S101	ETS LINDGREN	N/A
7445	DC POWER SUPPLY 30V/5A	U8002A	KEYSIGHT TECHNOLOGIES	--
7760	DIGITAL MULTIMETER	175	FLUKE	2023-11-14
7817	EMI TEST RECEIVER 2Hz-44GHz	ESW44	ROHDE AND SCHWARZ	2023-12-30
6165	EMI TEST RECEIVER 9kHz-7GHz	ESR7	ROHDE AND SCHWARZ	2023-11-08
4716	SIGNAL AND SPECTRUM ANALYZER 2Hz-50GHz	FSW50	ROHDE AND SCHWARZ	2024-08-12
2942	EMI TEST RECEIVER 20Hz-40GHz	ESU40	ROHDE AND SCHWARZ	2023-11-22
6496	HORN ANTENNA 1-18GHz	BBHA 9120 D	SCHWARZBECK	2023-08-24
4657	HORN ANTENNA 18-40GHz	BBHA 9170	SCHWARZBECK	2023-05-05
6143	HYBRID BILOG ANTENNA 30MHz-6GHz	3142E	ETS LINDGREN	2023-10-29
8856	PRE-AMPLIFIER G>30dB 18-40GHz	BLMA 1840-4A	BONN ELEKTRONIK	2023-11-02
3783	PRE-AMPLIFIER G>30dB 1GHz-18GHz	BLMA 0118-3A	BONN ELEKTRONIK	2022-12-01
6144	PRE-AMPLIFIER G>40dB 10MHz-6GHz	BLNA 0160-01N	BONN ELEKTRONIK	2023-03-17
4848	SOFTWARE FOR EMC/RF TESTING	EMC32	ROHDE AND SCHWARZ	N/A
6793	SHIELDED ROOM	S101	ETS LINDGREN	N/A
7794	SIGNAL AND SPECTRUM ANALYZER 10Hz-40GHz	FSV40	ROHDE AND SCHWARZ	2023-02-26
8848	OPEN SWITCH UNIT UP TO 7.5 GHz	OSP-B157W8 PLUS	ROHDE & SCHWARZ	2023-08-20
0922	POWER SUPPLY DC 40 V / 40 A	NGPE 40/40	ROHDE AND SCHWARZ	--
7798	EMC/RF MEASUREMENT SOFTWARE	WMS32	ROHDE AND SCHWARZ	N/A

Testing verdicts

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

Summary

1. Bluetooth EDR:

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

2. Bluetooth Low Energy 5.0 (1M):

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

3. WLAN 2.4 GHz (802.11 b/g/n20 1x1):

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

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

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TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

Vnominal:	12 Vdc
Type of Power Supply:	External DC (Vehicle Battery).

ANTENNA (*):

Type of Antenna:	External.
Maximum Declared Antenna Gain:	+0.11 dBi

TEST FREQUENCIES (*):

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

During transmitter test the EUT was being controlled by the SW tool provided by the client to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The EUT has four separate antennas which correspond to one port of the equipment.

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and connected to the TS8997 test bench system using a low-loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

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

RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) and 1 GHz-18 GHz Double ridge horn antenna is situated at a distance of 3 m and a distance of 1.5 m for the frequency range 17 GHz-26 GHz (18 GHz-40 GHz horn antenna).

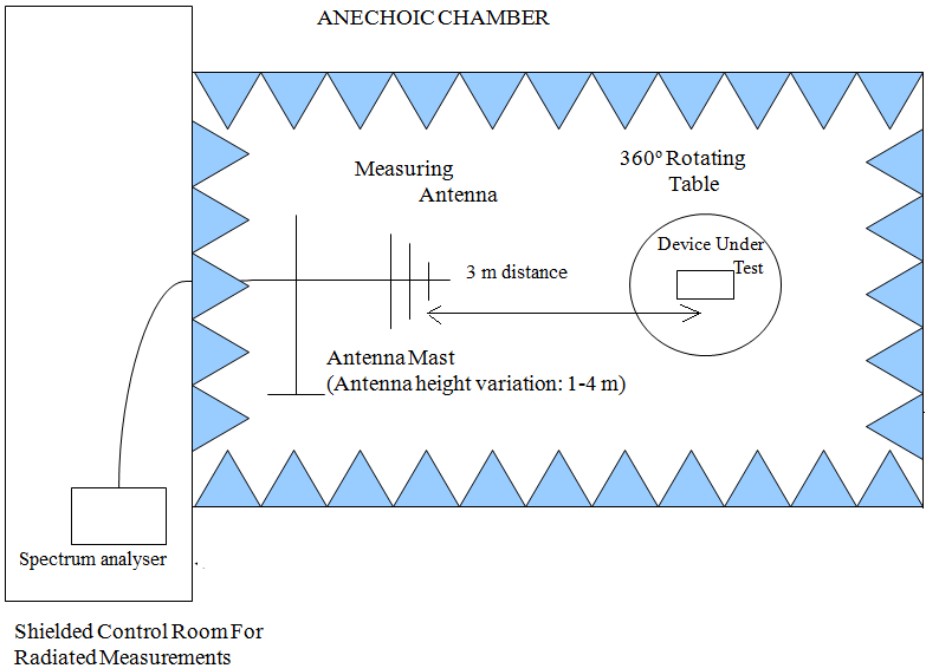
For radiated emissions in the range 17 GHz-26 GHz performed at a distance closer than the distance specified in the standard, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and its situation and orientation were varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission (up to 17 GHz).

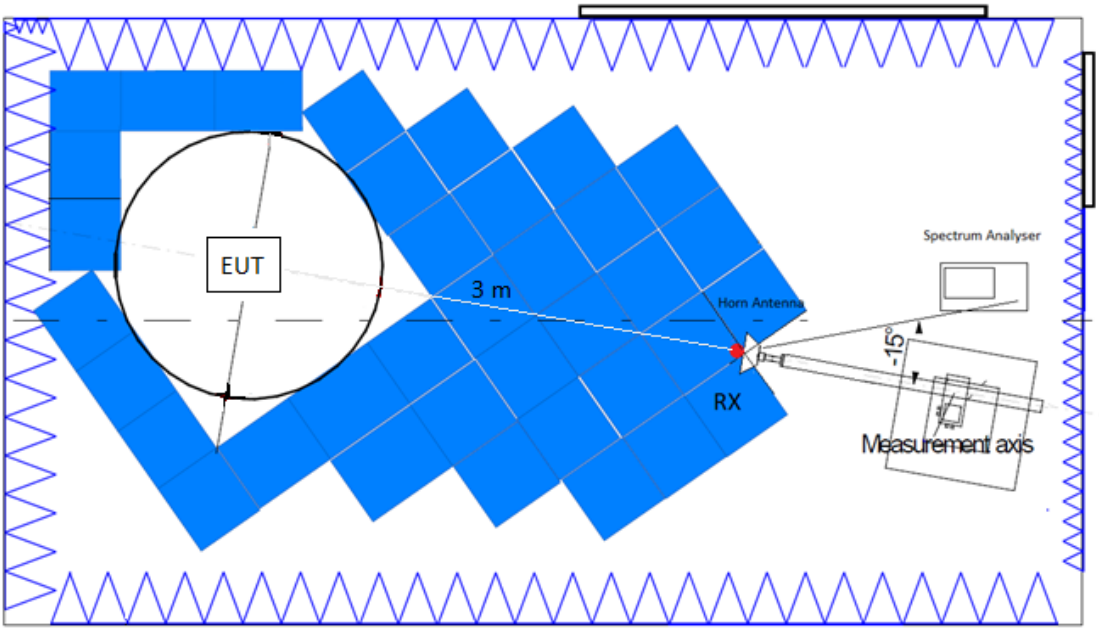
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

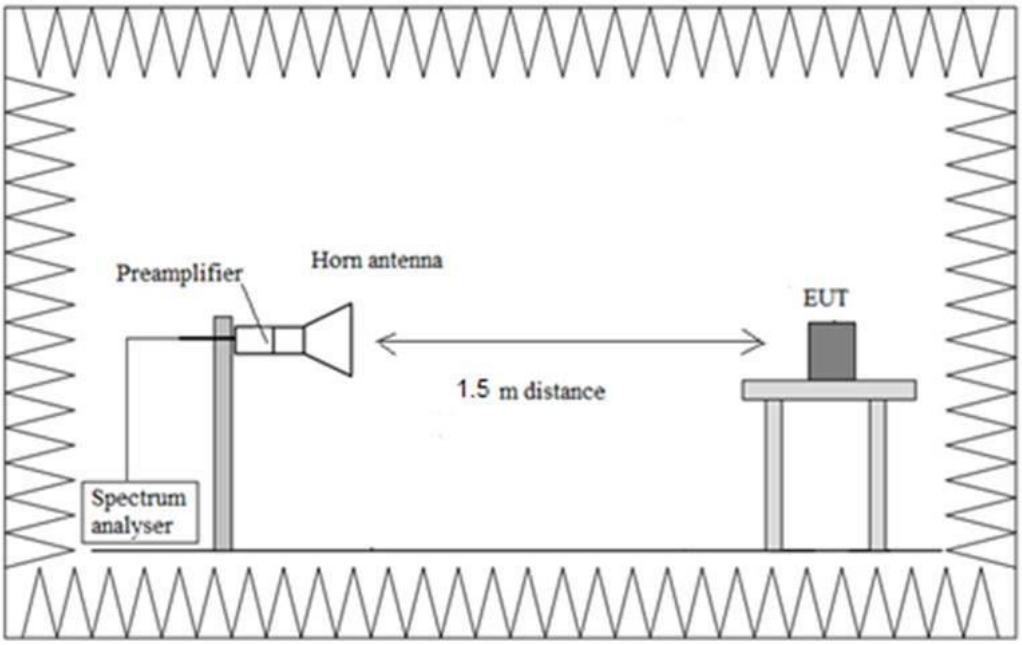
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup f > 17 GHz:



Occupied Bandwidth

Results

Modulation: BT (GFSK 1-DH5)

Frequency (MHz)	99% Occupied Channel Bandwidth (MHz)
2402.00	0.872
2441.00	0.872
2480.00	0.872

Modulation: BT (Pi/4 DQPSK 2-DH5)

Frequency (MHz)	99% Occupied Channel Bandwidth (MHz)
2402.00	1.173
2441.00	1.173
2480.00	1.173

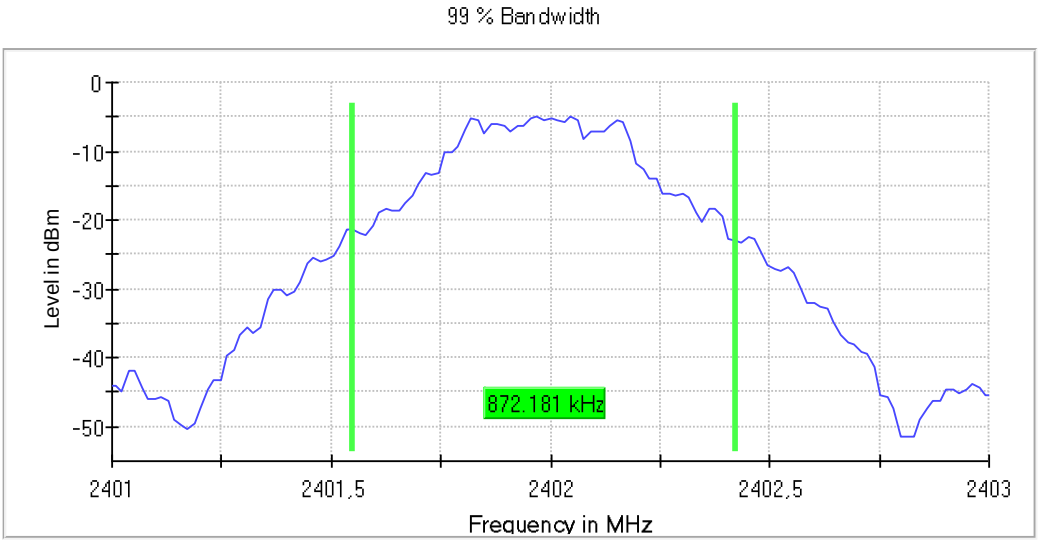
Modulation: BT (8DPSK 3-DH5)

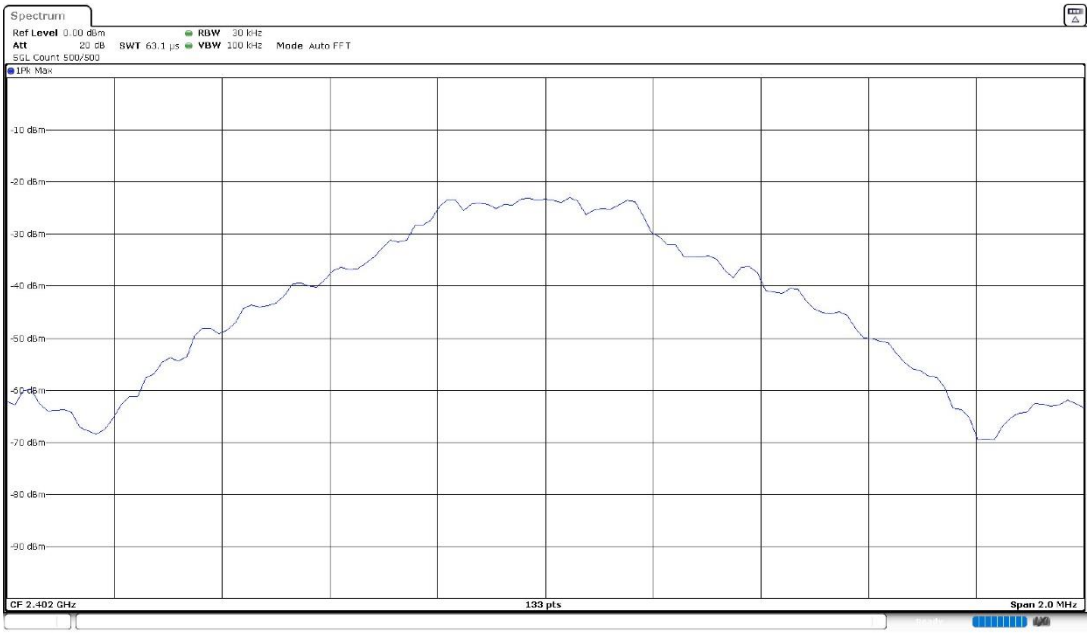
Frequency (MHz)	99% Occupied Channel Bandwidth (MHz)
2402.00	1.173
2441.00	1.173
2480.00	1.173

Attachments

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

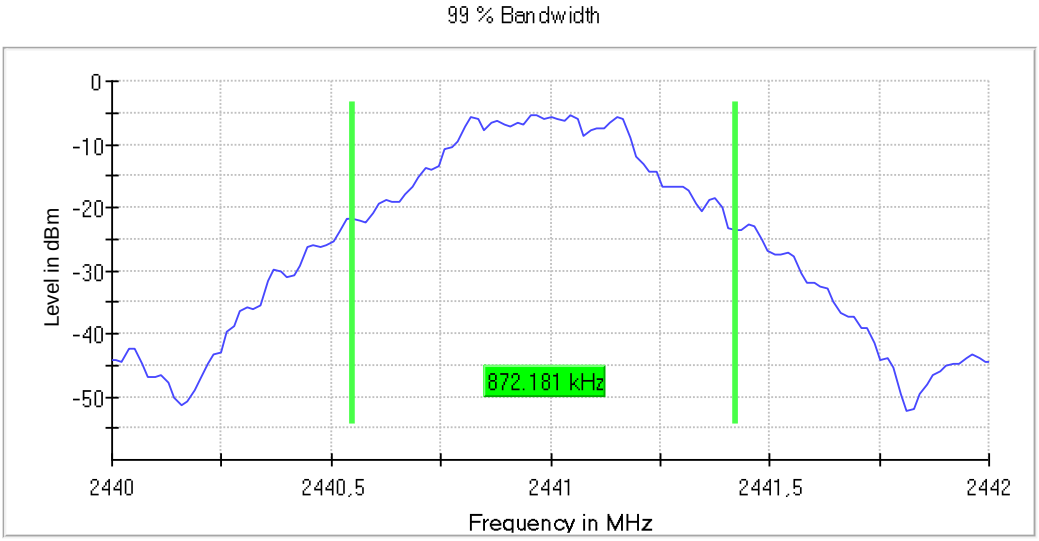
Figures:

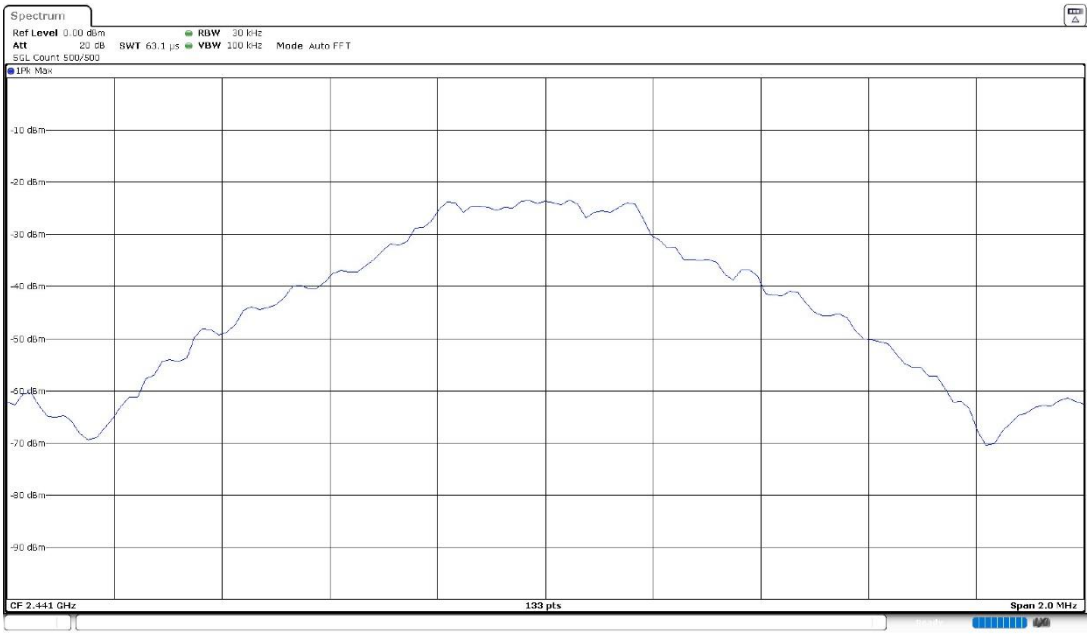




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

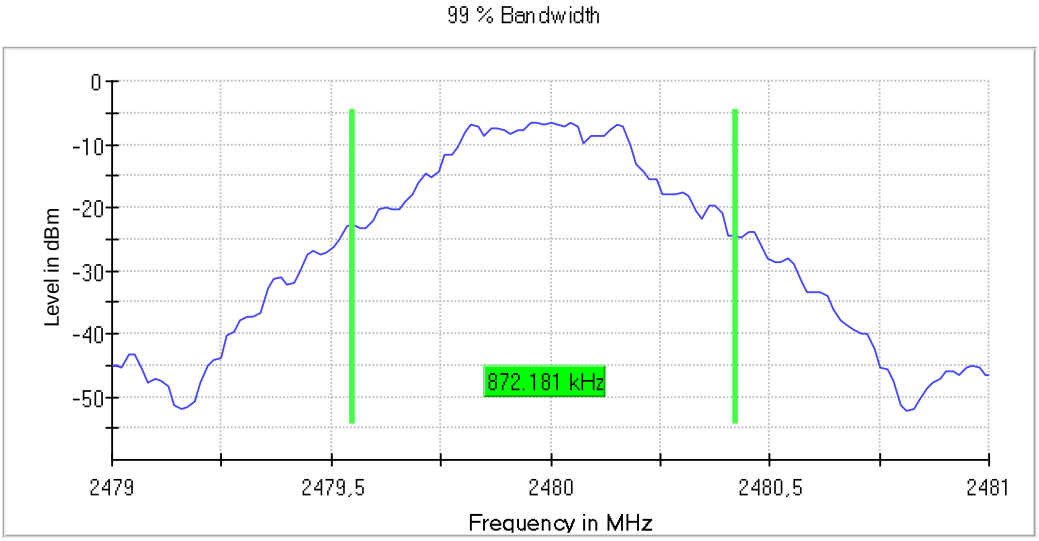
Figures:

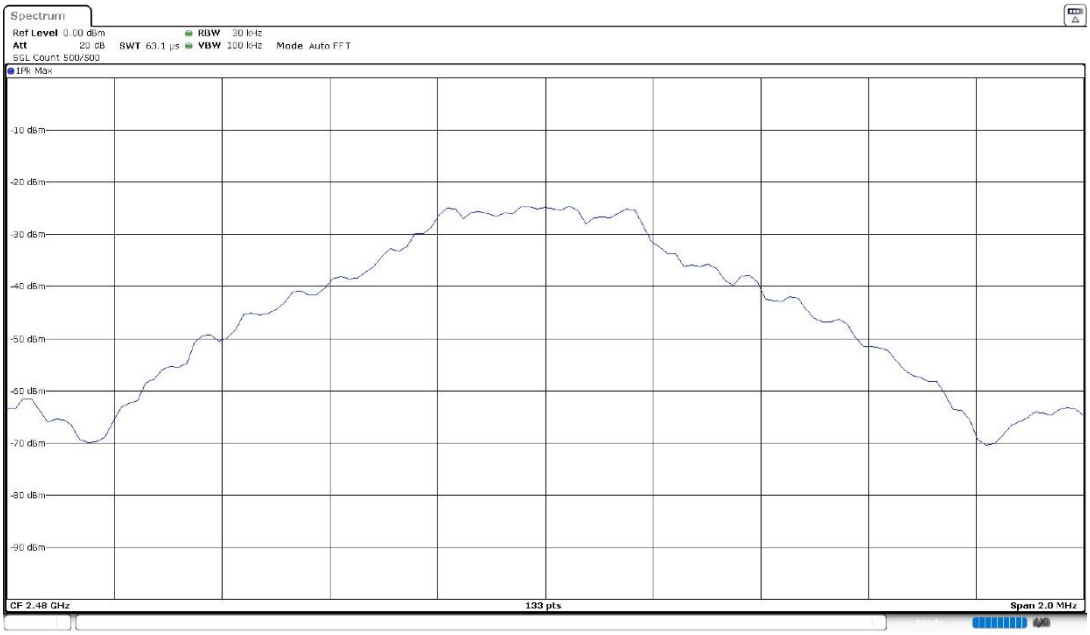




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

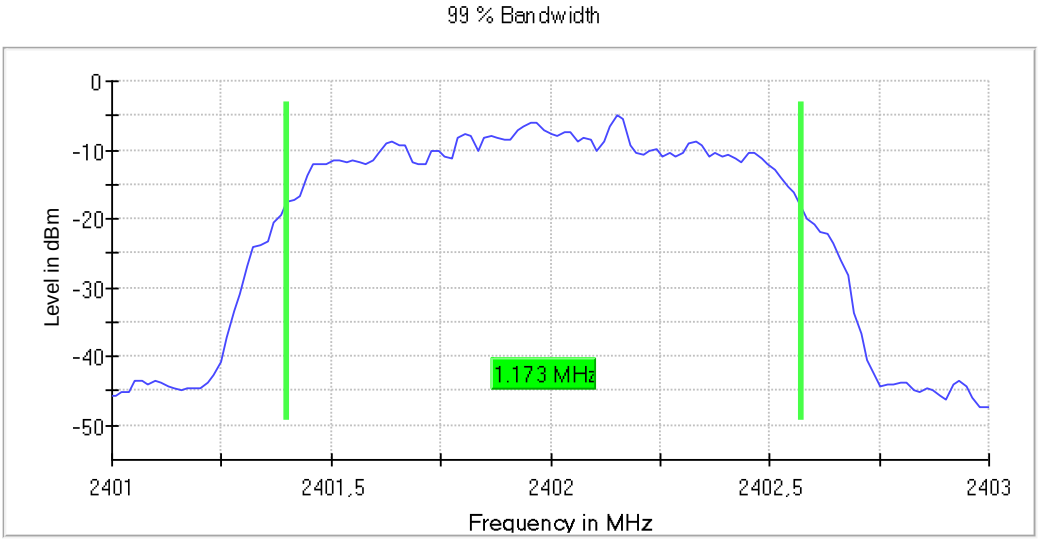
Figures:

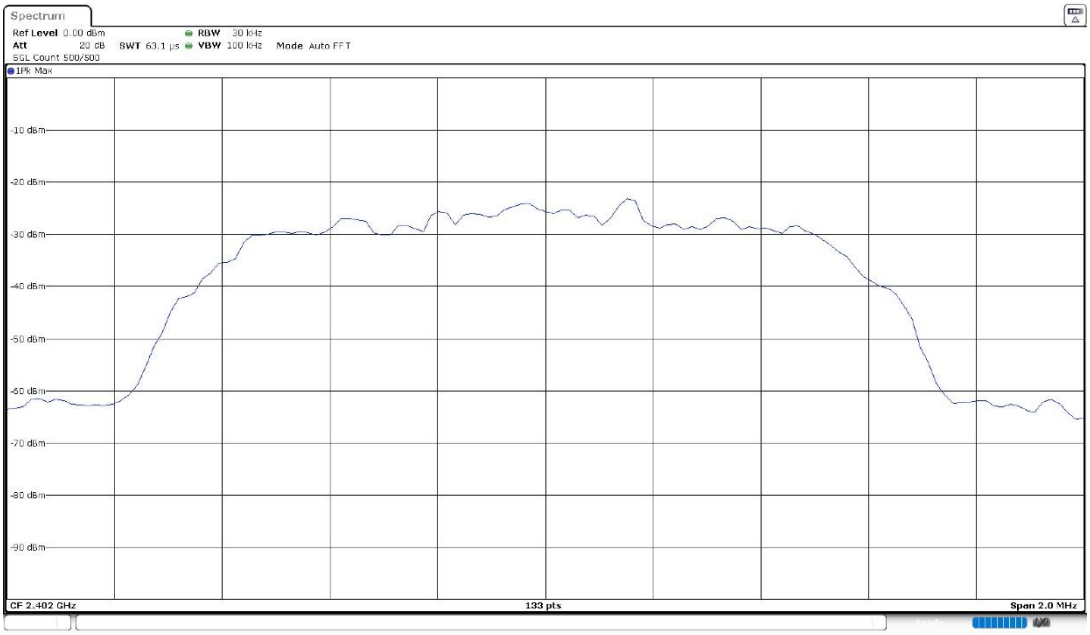




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

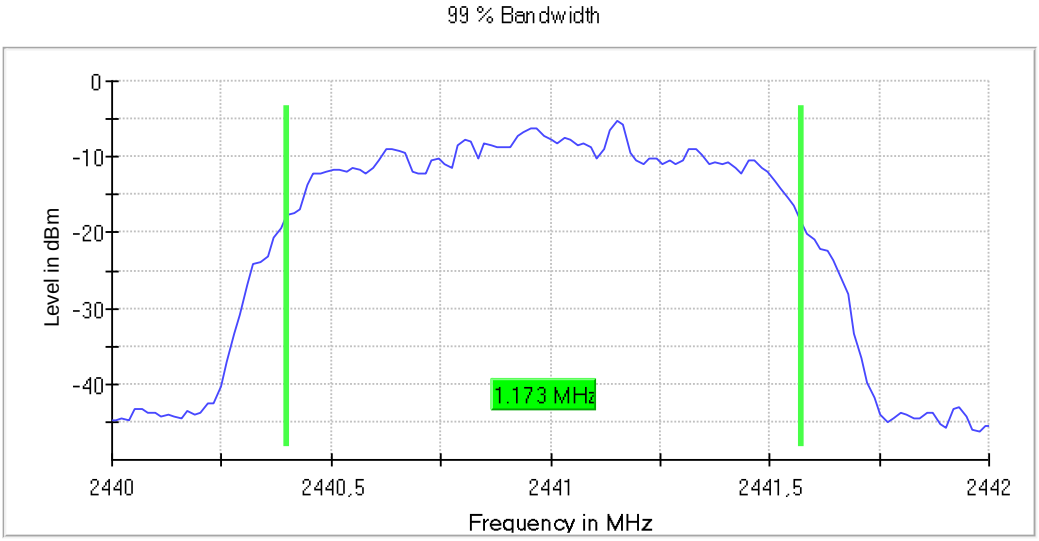
Figures:

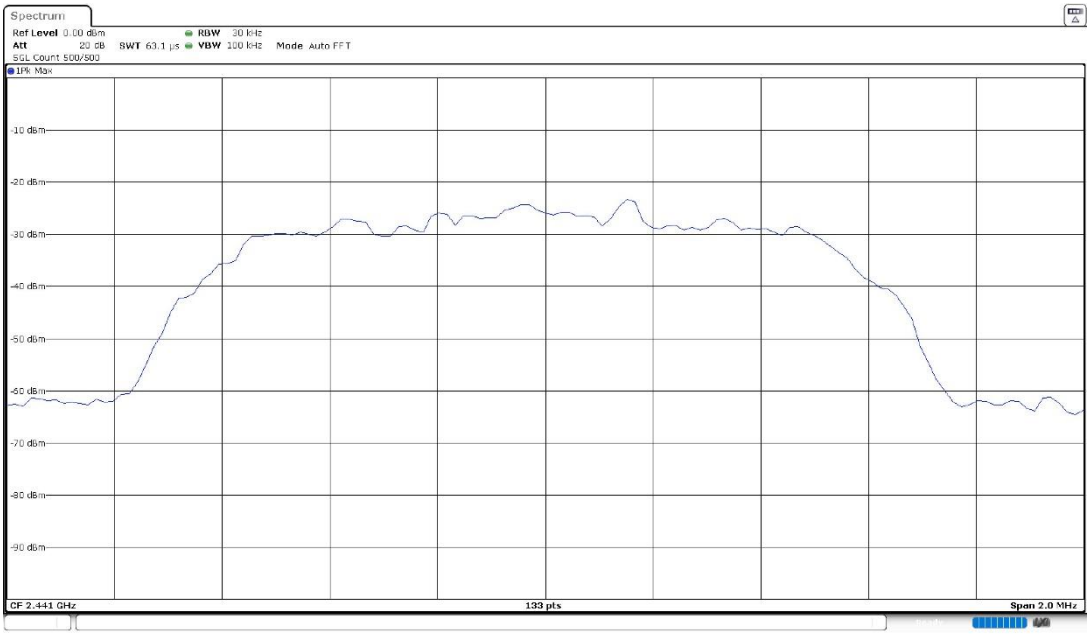




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

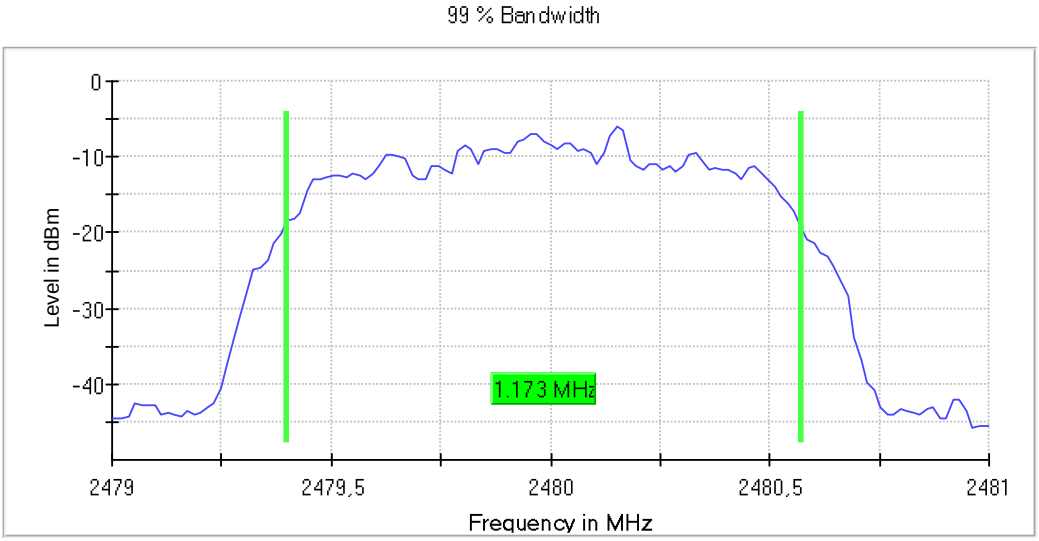
Figures:

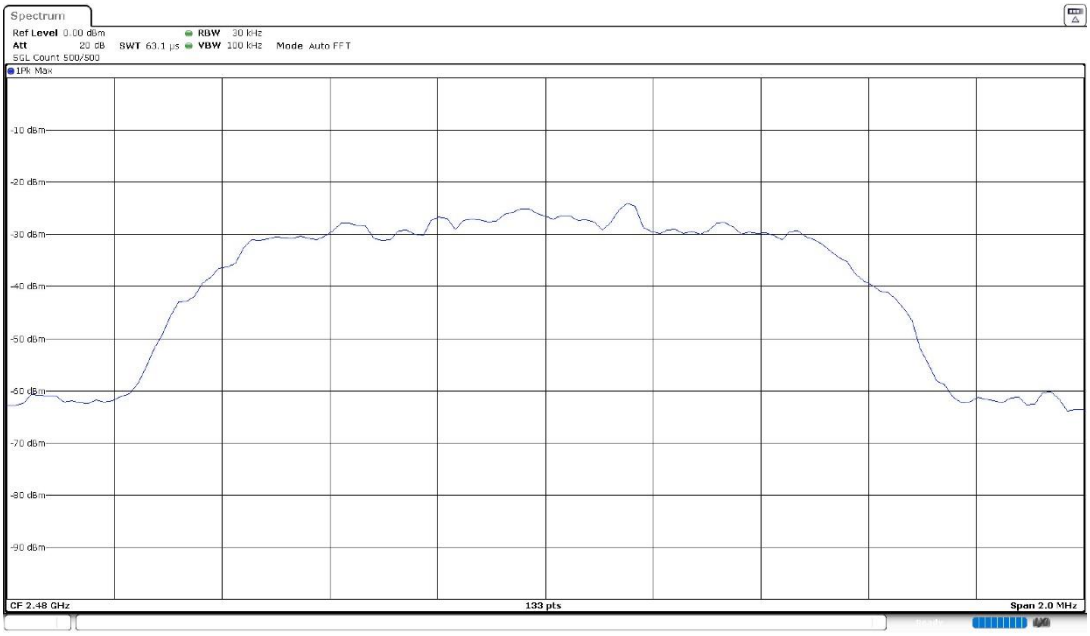




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

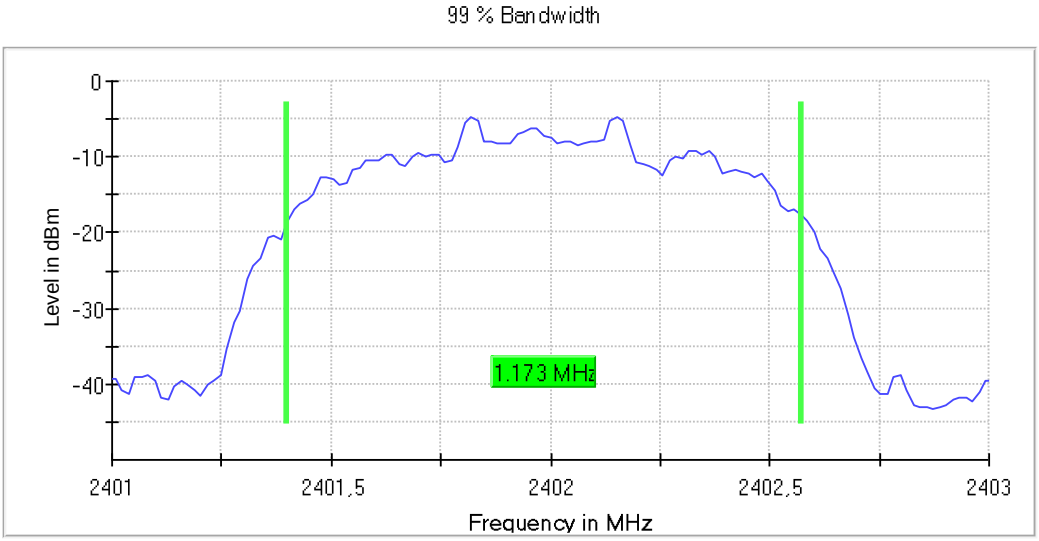
Figures:

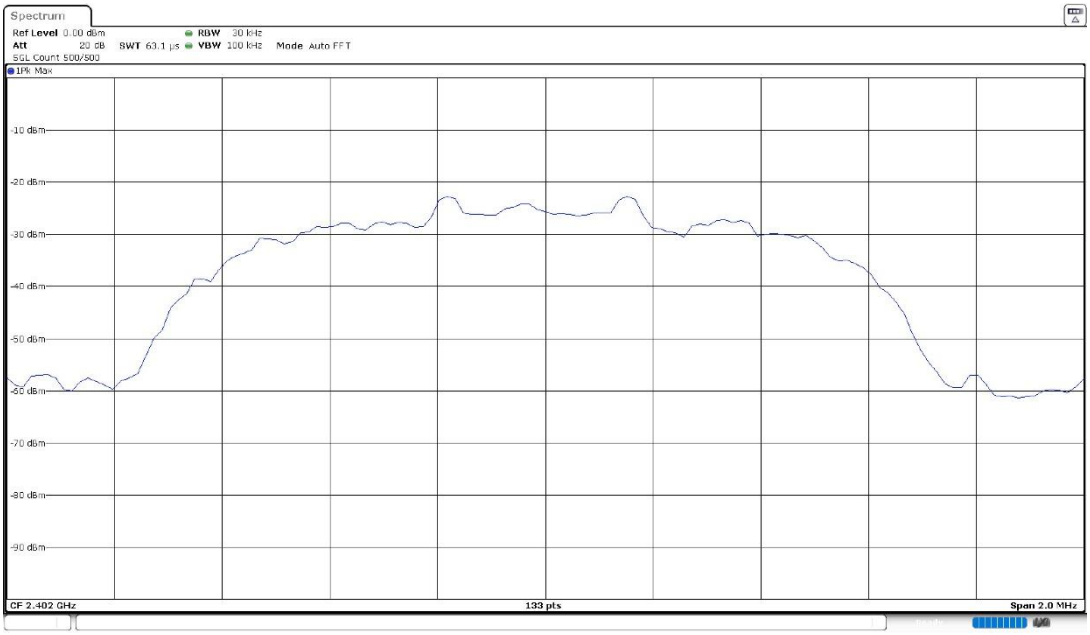




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

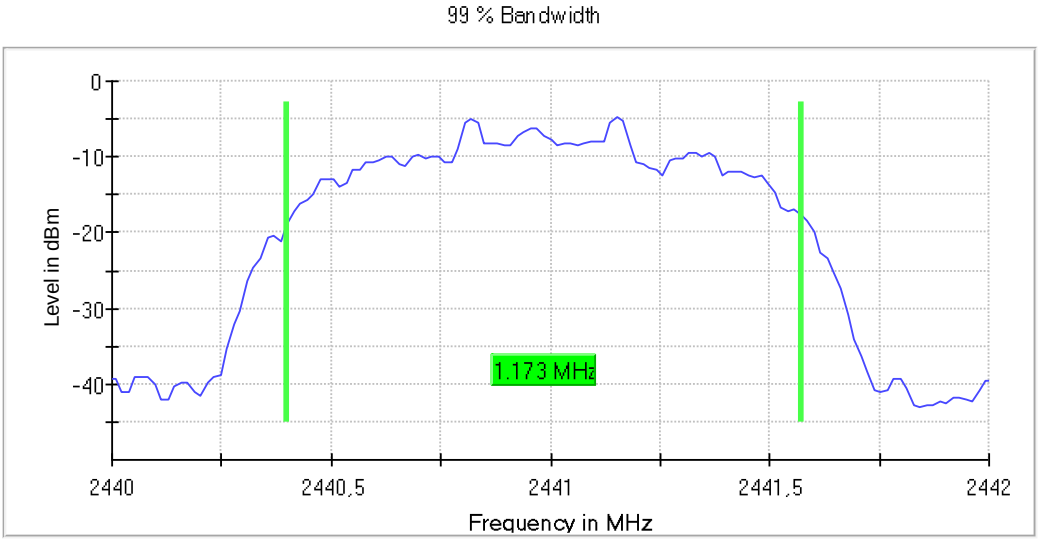
Figures:

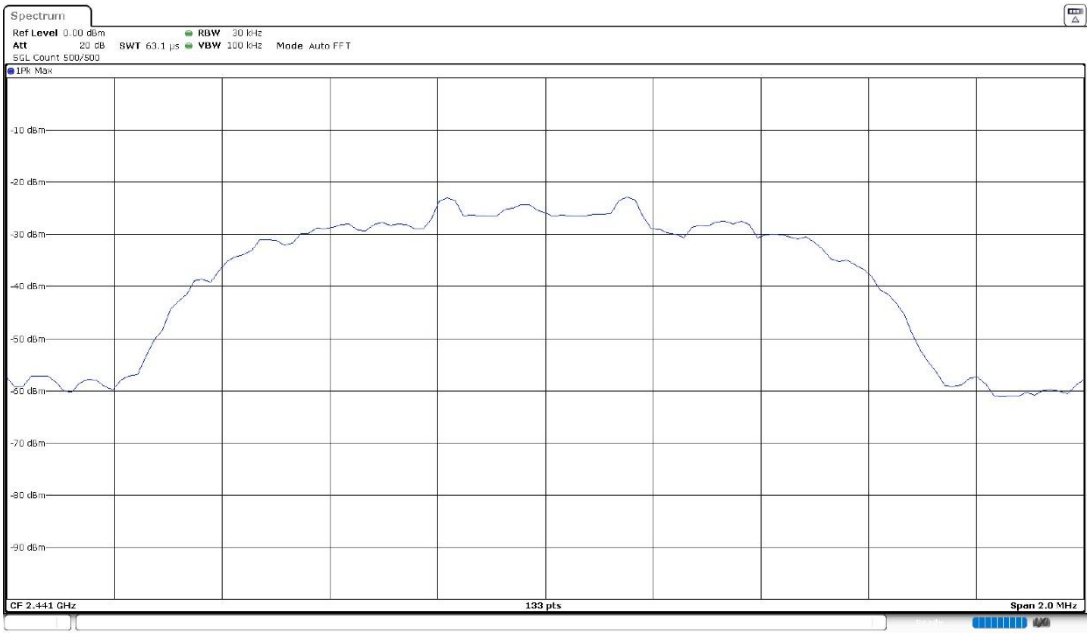




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

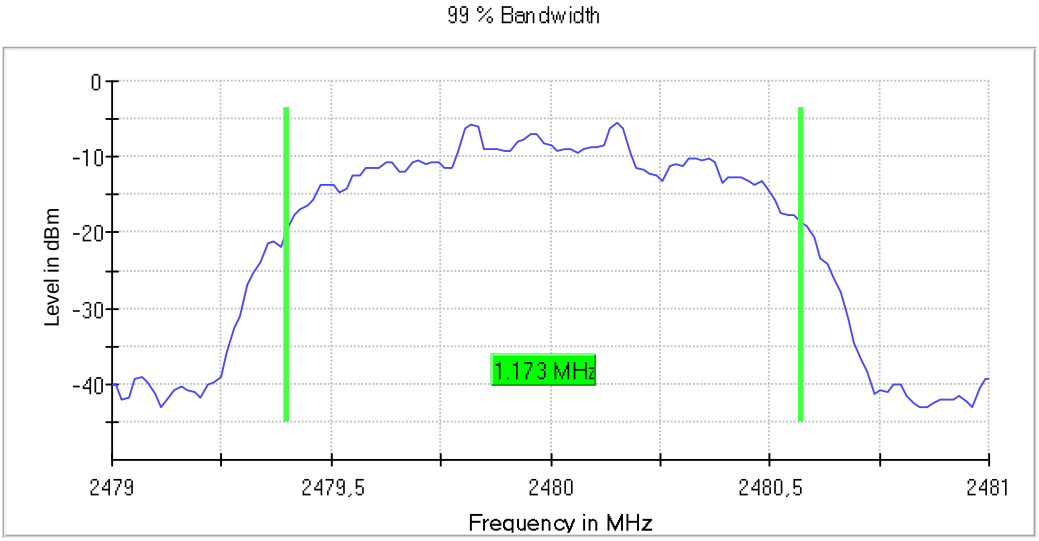
Figures:

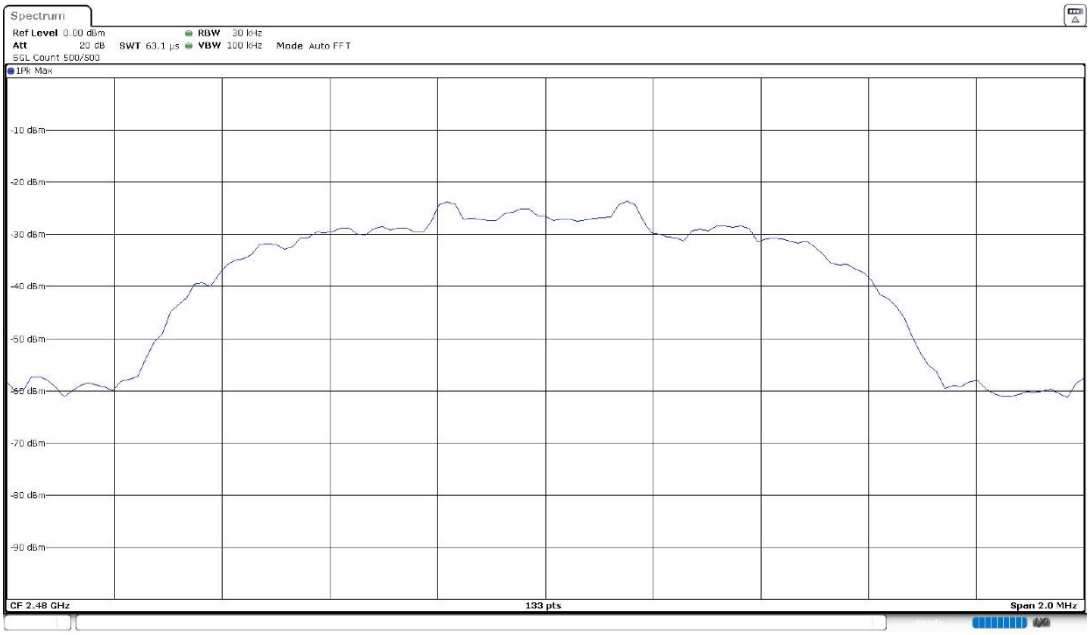




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Figures:





FCC 15.247 (a)(1) / RSS-247 5.1 (b)
20 dB Bandwidth and Carrier frequency separation

Limits

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

Results

- **GFSK:**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (MHz)	0.900000	0.900000	0.900000

Carrier Frequency Separation: 0.980198 MHz

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

- **Pi/4 DQPSK:**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (MHz)	1.265000	1.285000	1.290000

Carrier Frequency Separation: 1.012800 MHz

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

- **8DPSK:**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (MHz)	1.270000	1.280000	1.275000

Carrier Frequency Separation: 1.003800 MHz

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

Verdict

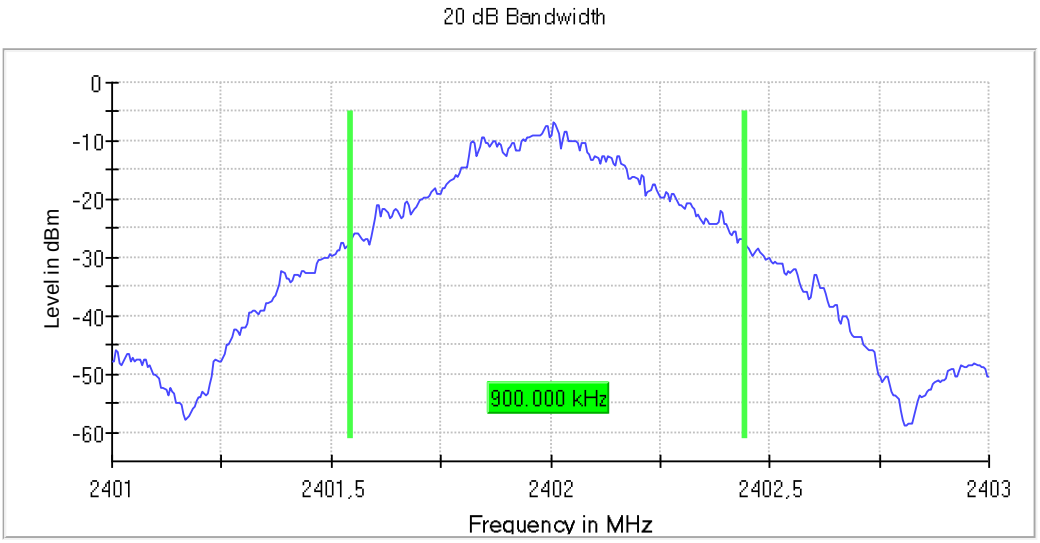
Pass

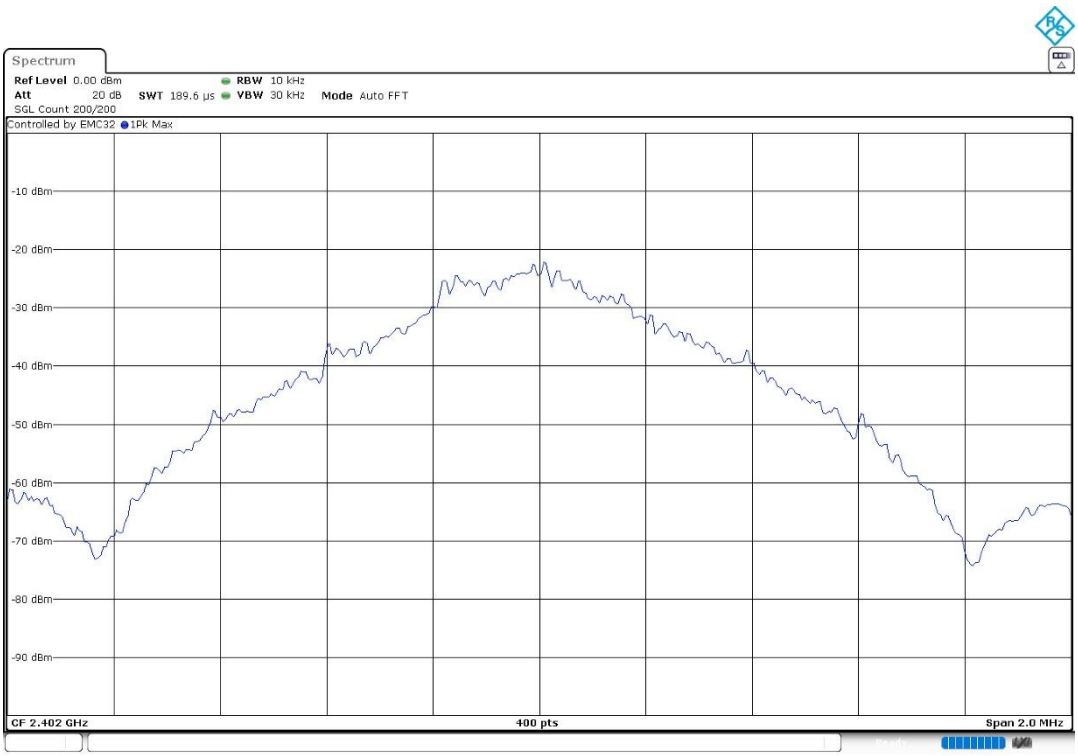
Attachments

- **GFSK – 20 dB Bandwidth**

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

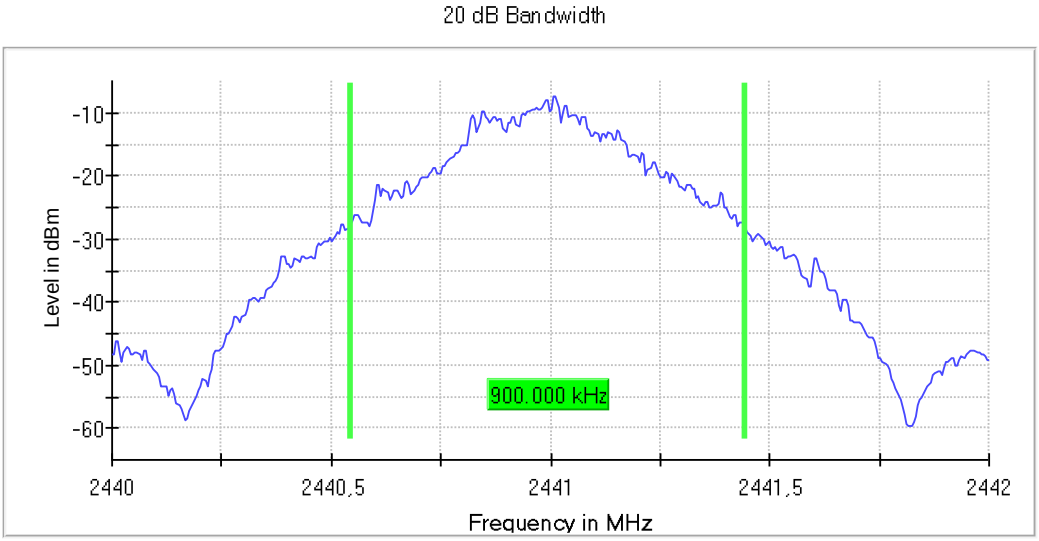
Figures:

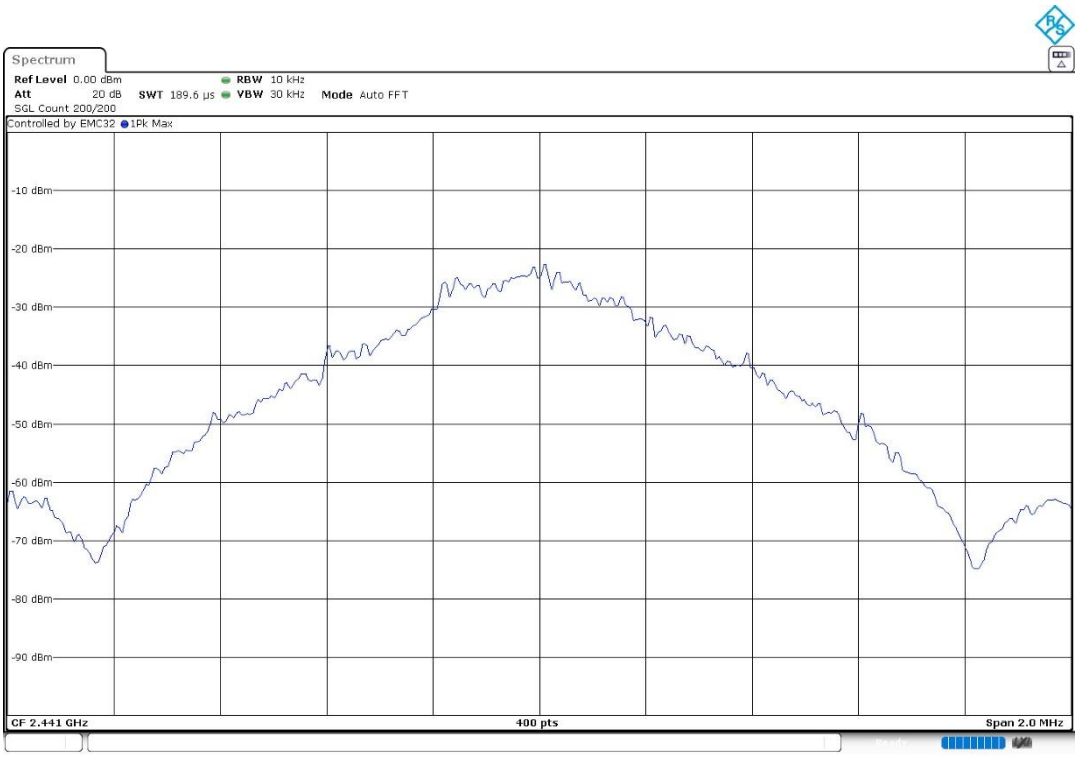




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

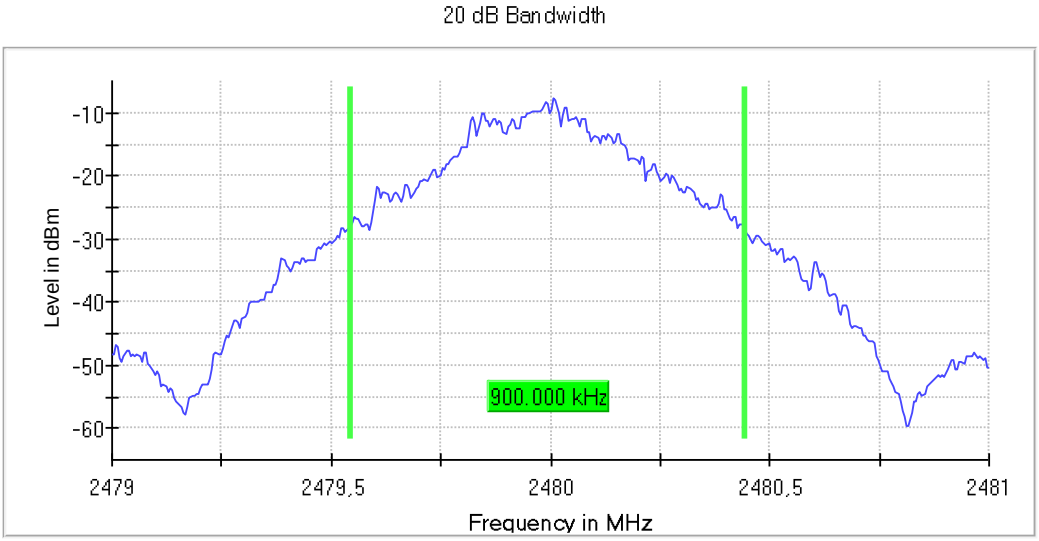
Figures:

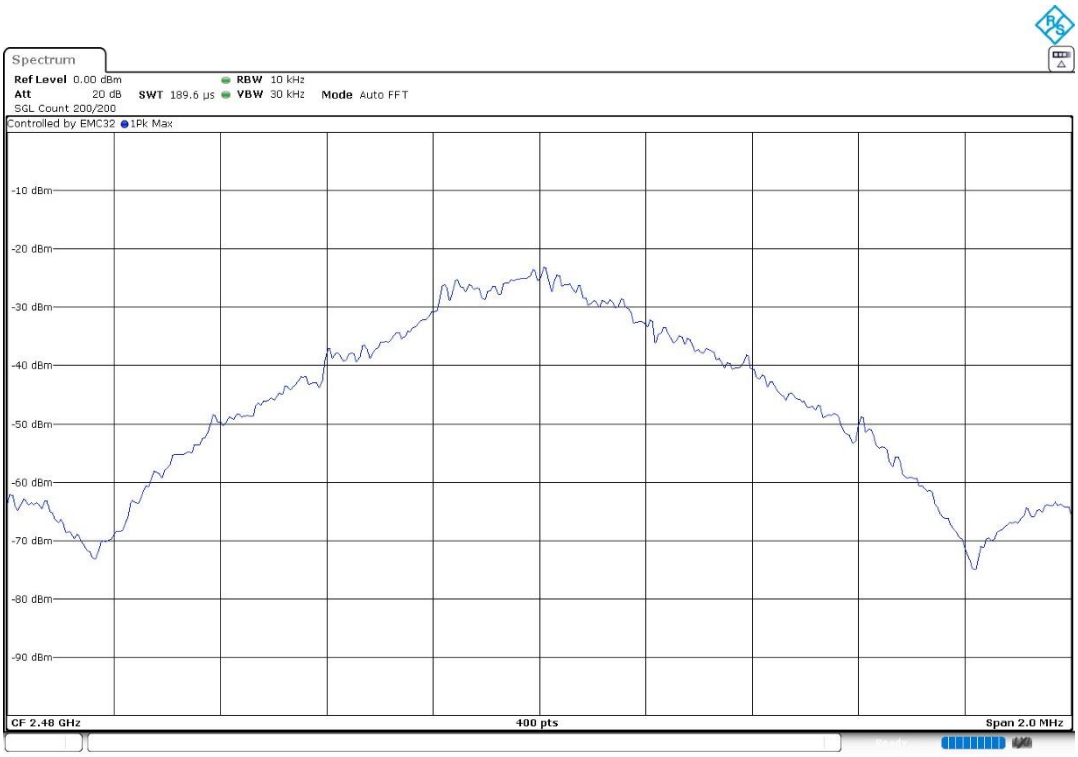




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Figures:

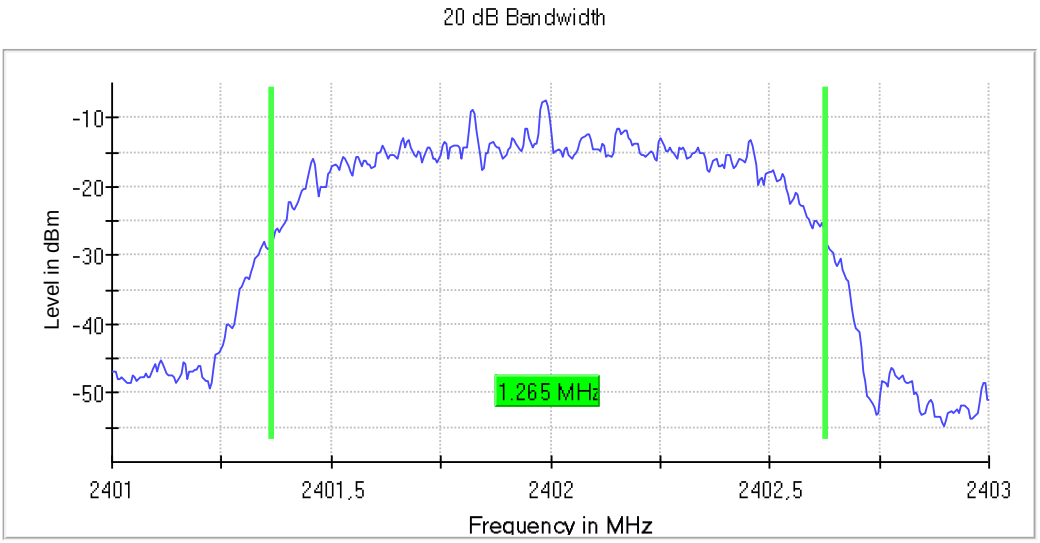


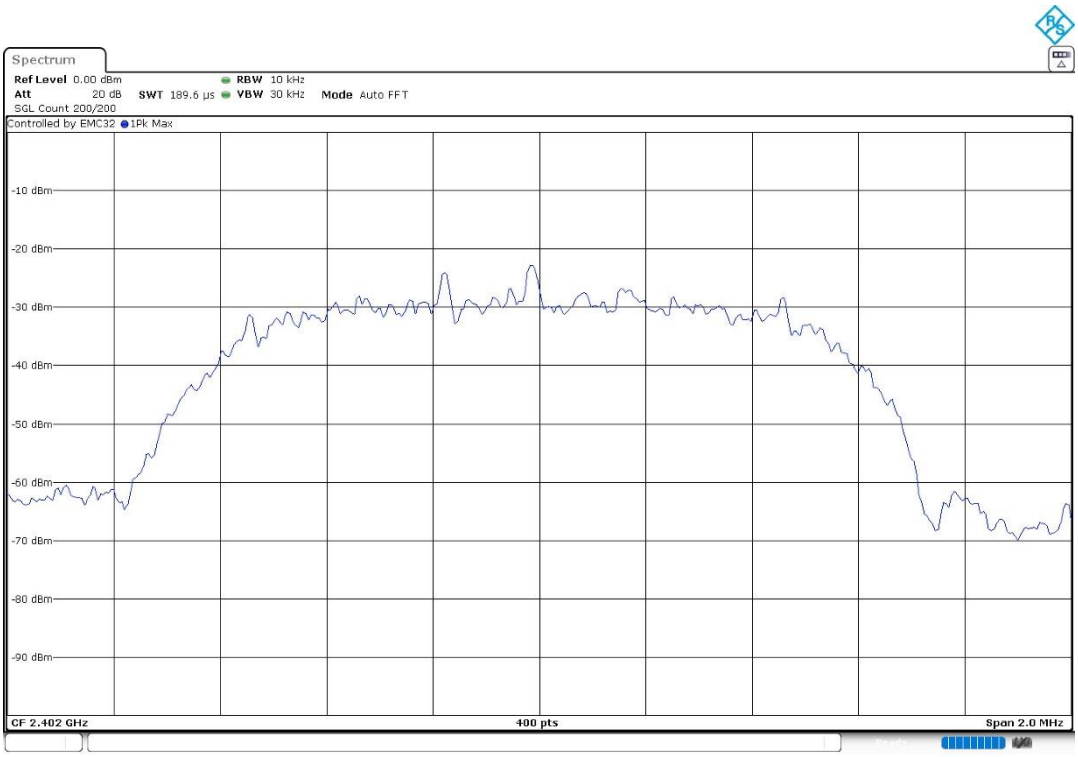


- **Pi/4 DQPSK – 20 dB Bandwidth**

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

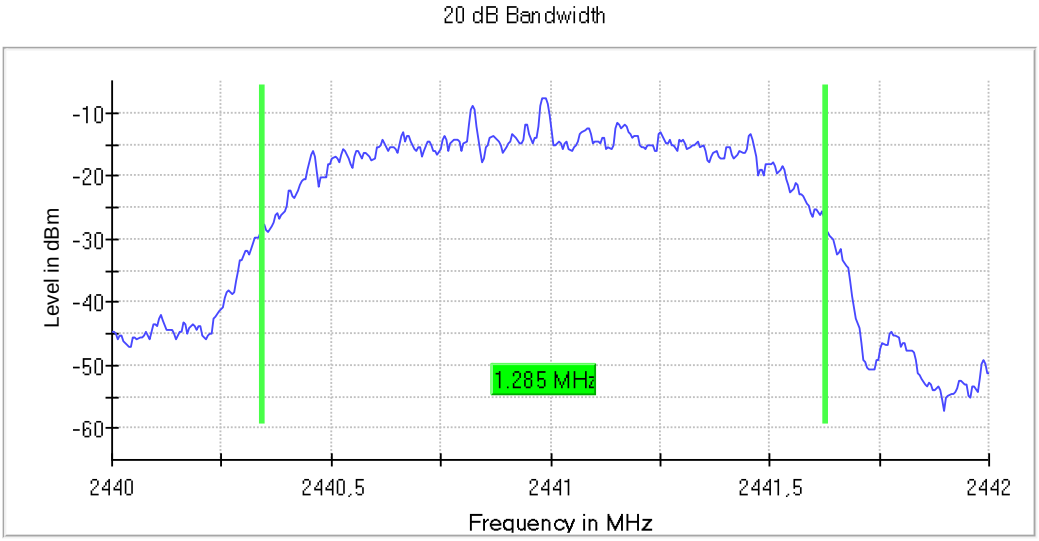
Figures:

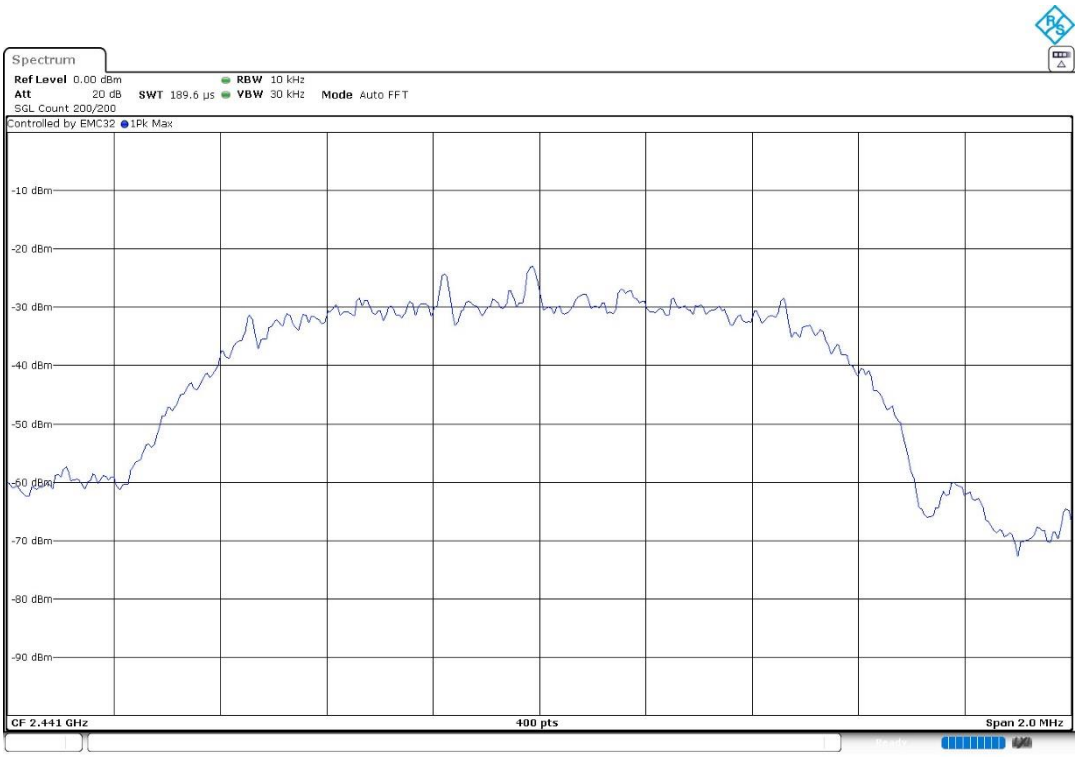




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

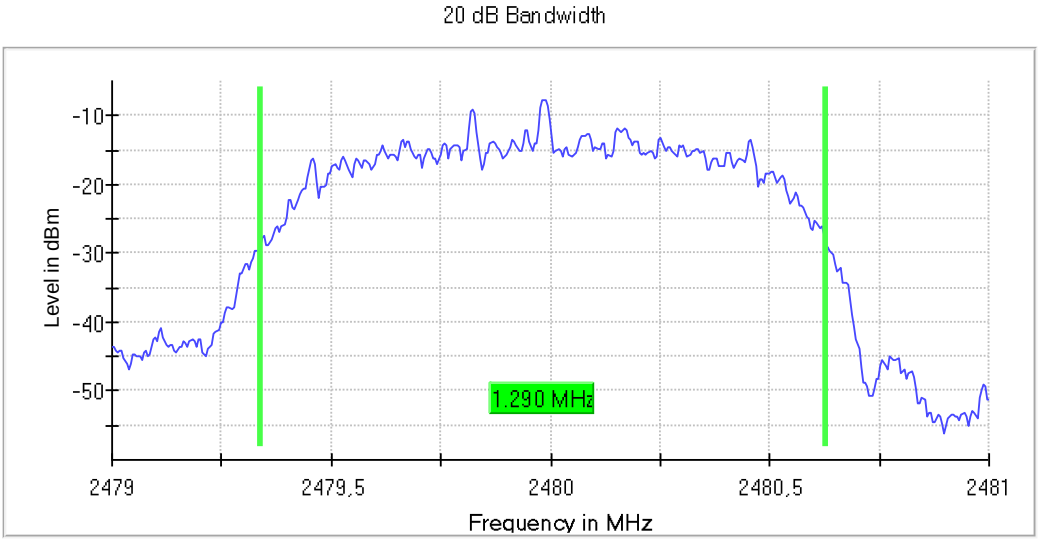
Figures:

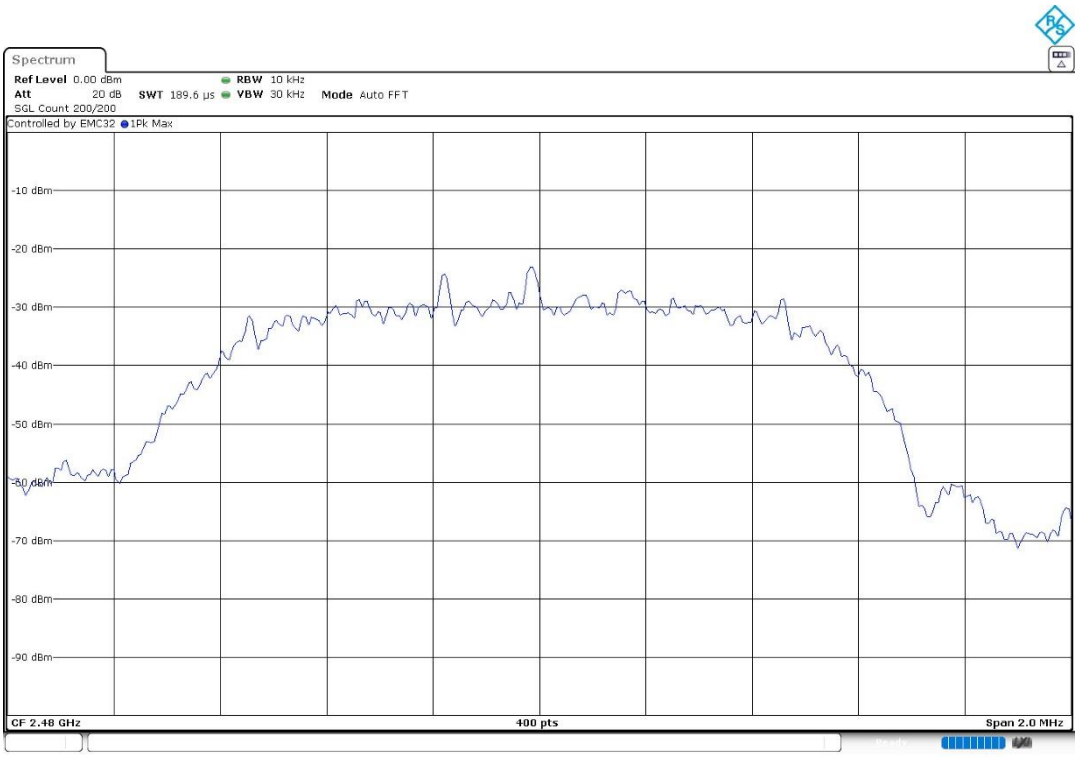




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Figures:

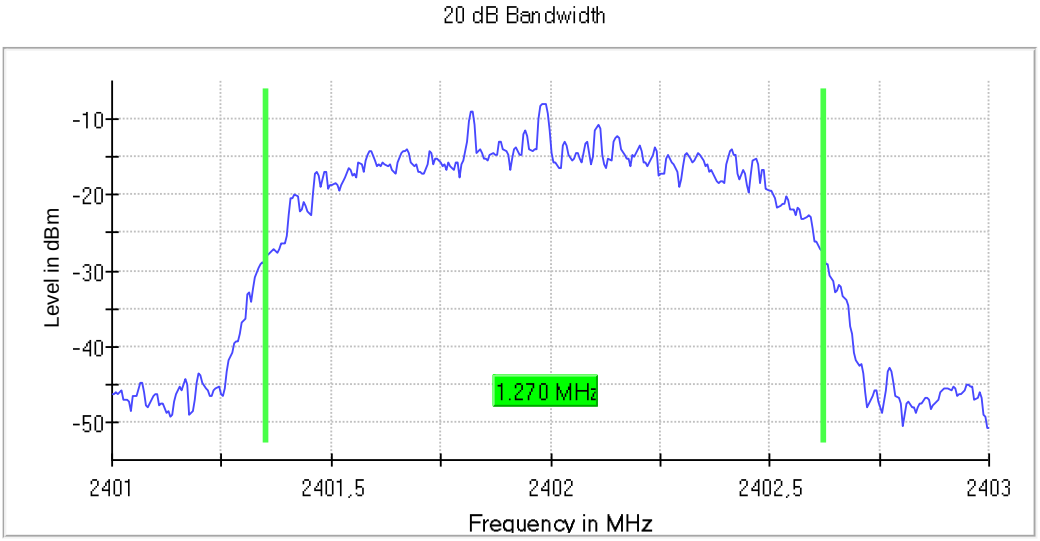


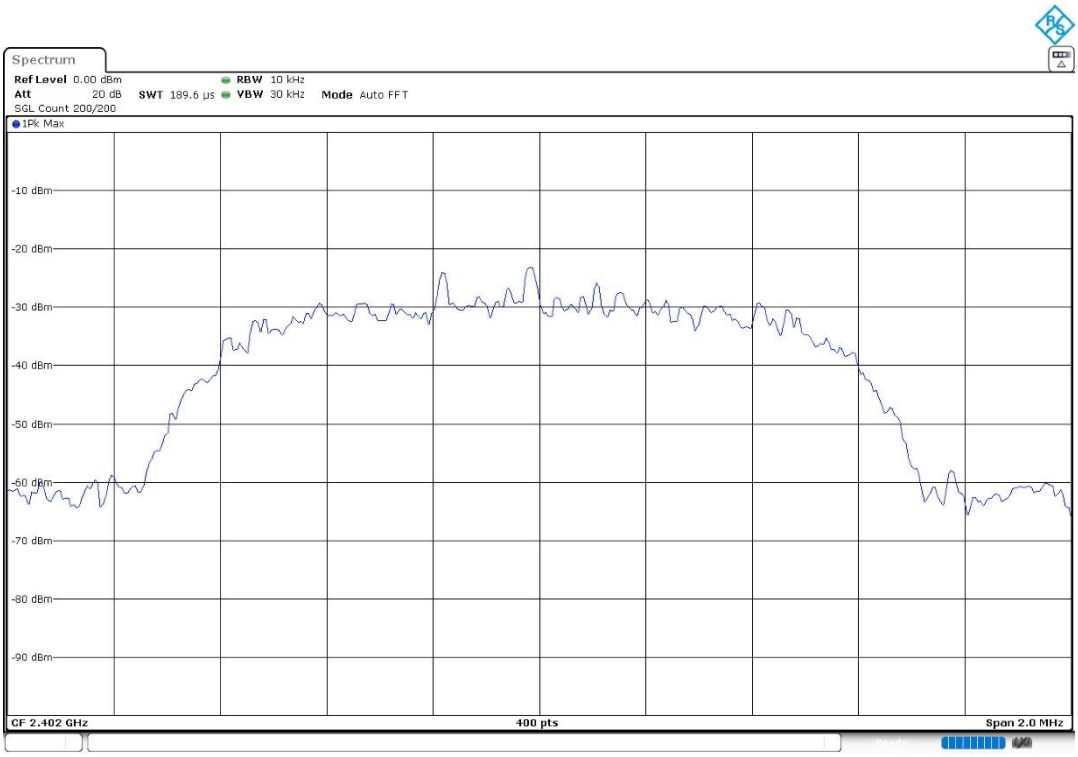


- **8DPSK – 20 dB Bandwidth**

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

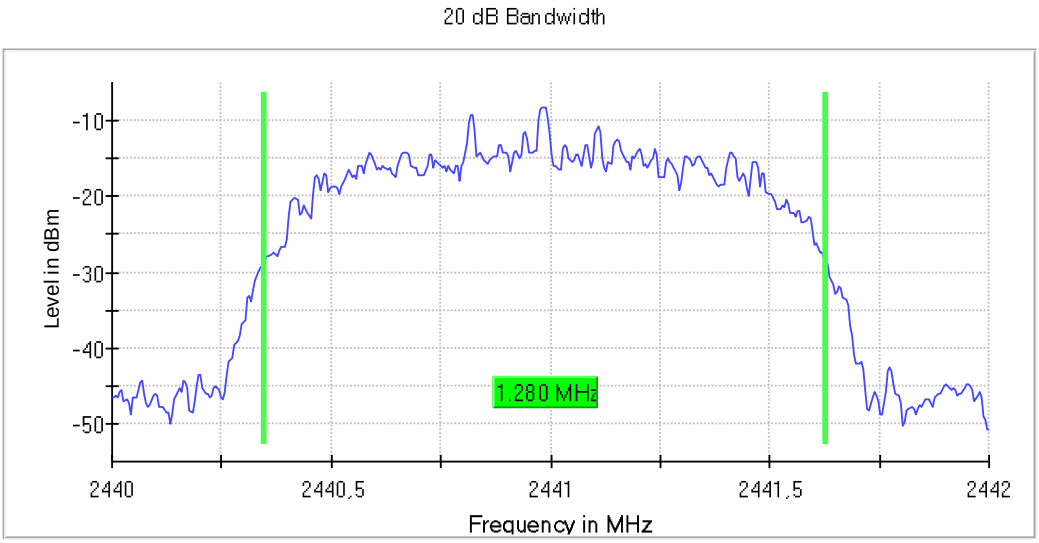
Figures:

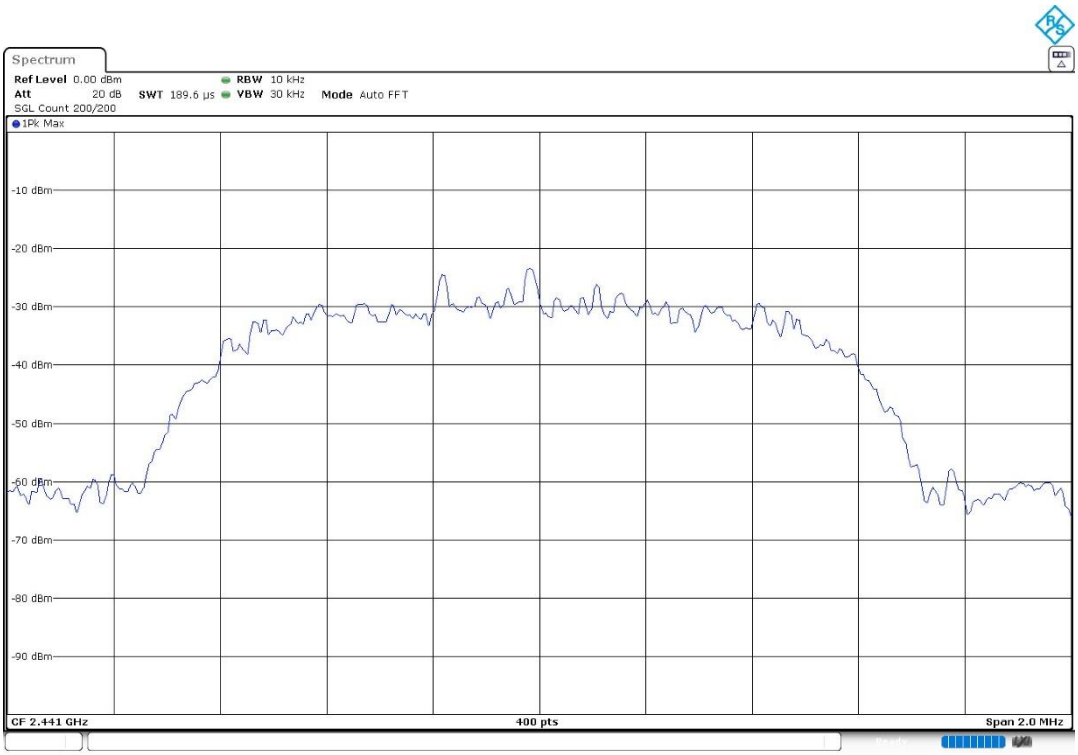




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

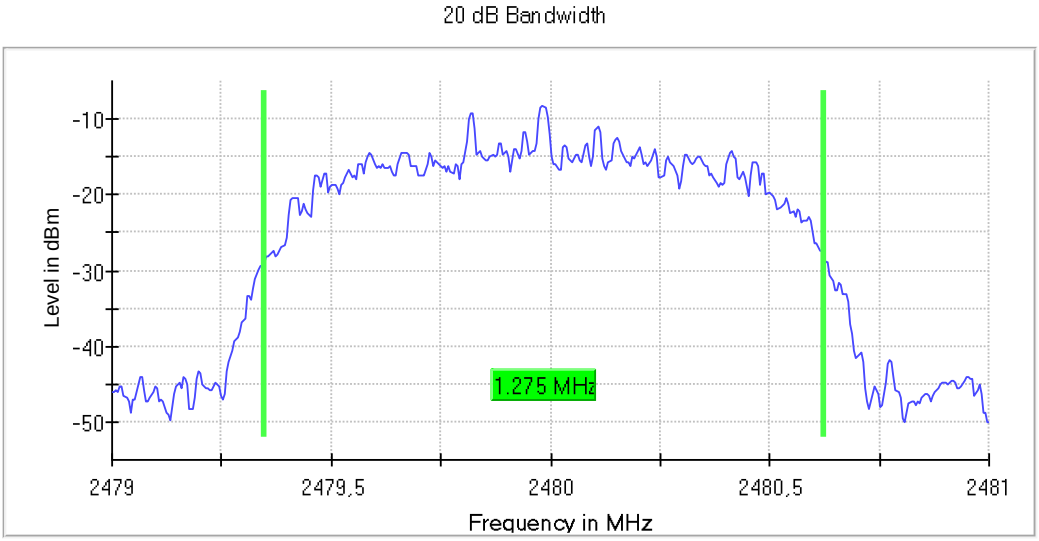
Figures:

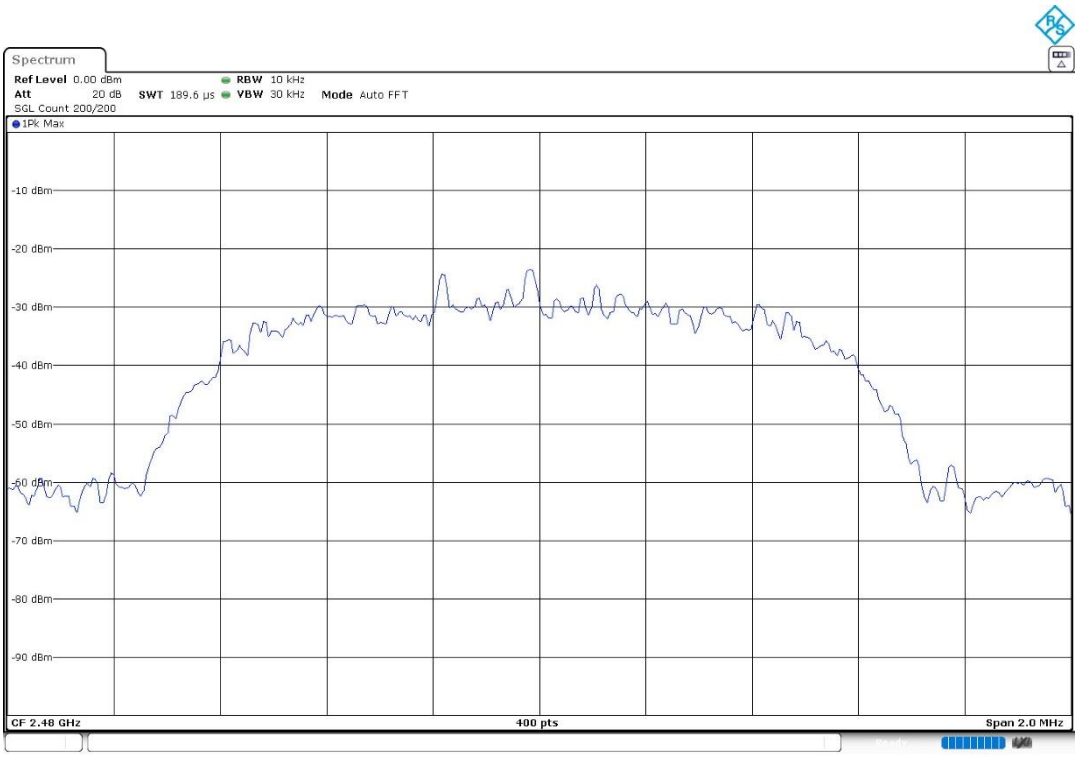




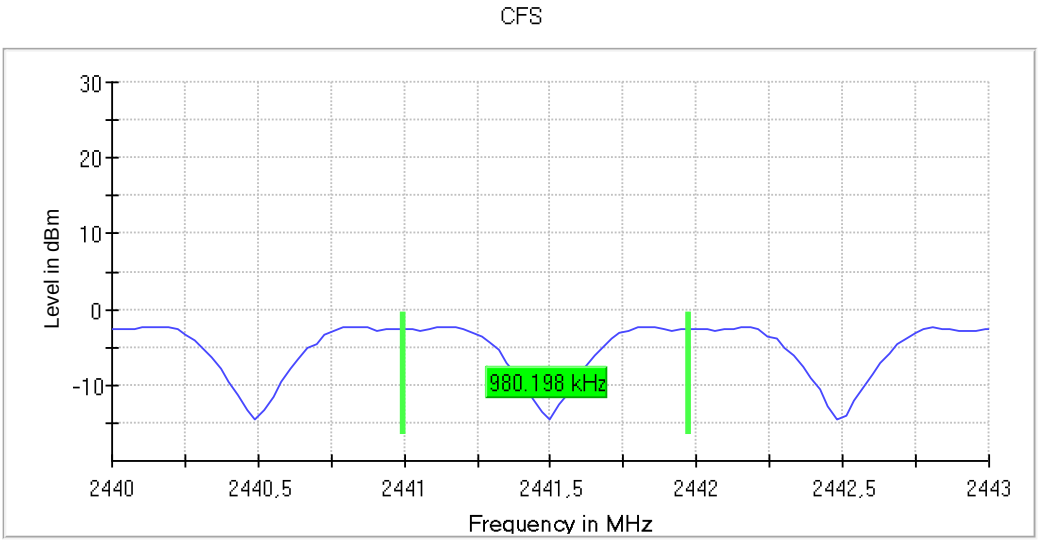
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

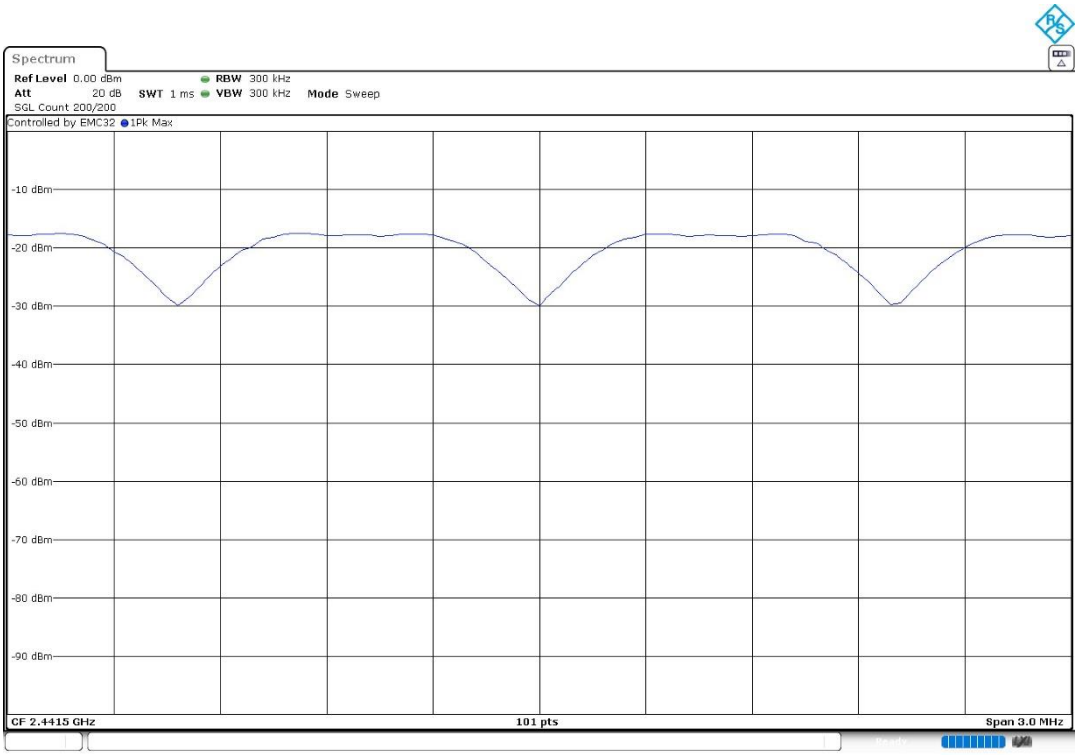
Figures:



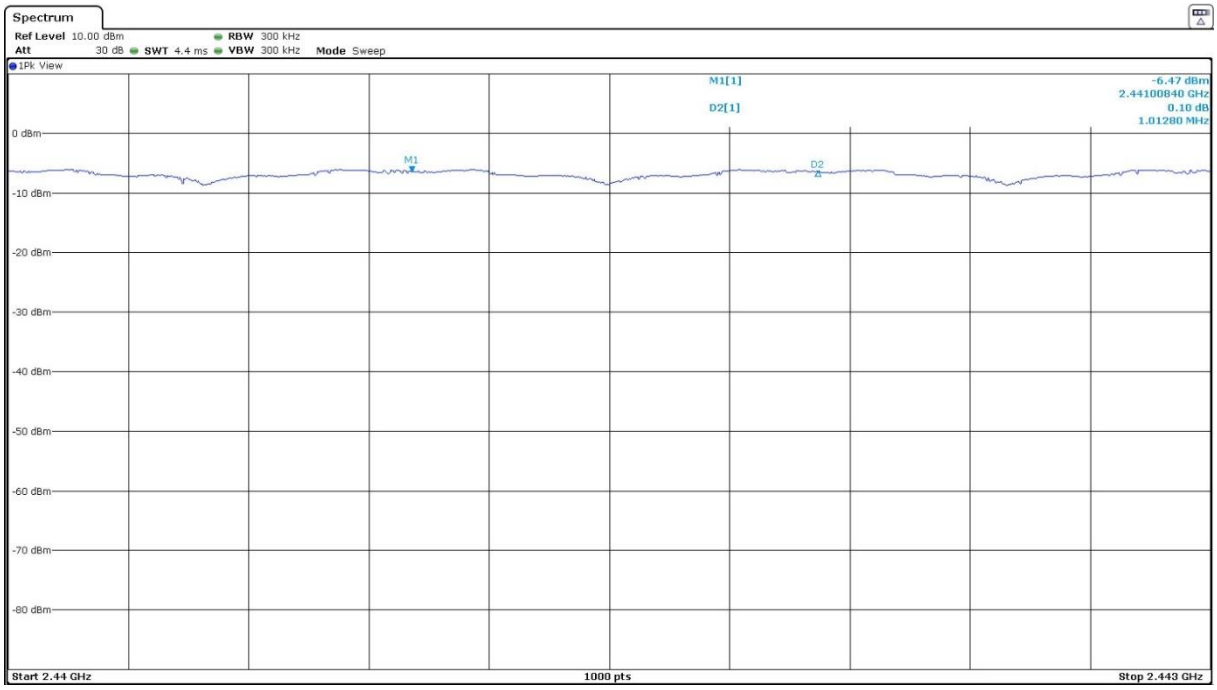


Carrier frequency separation – GFSK

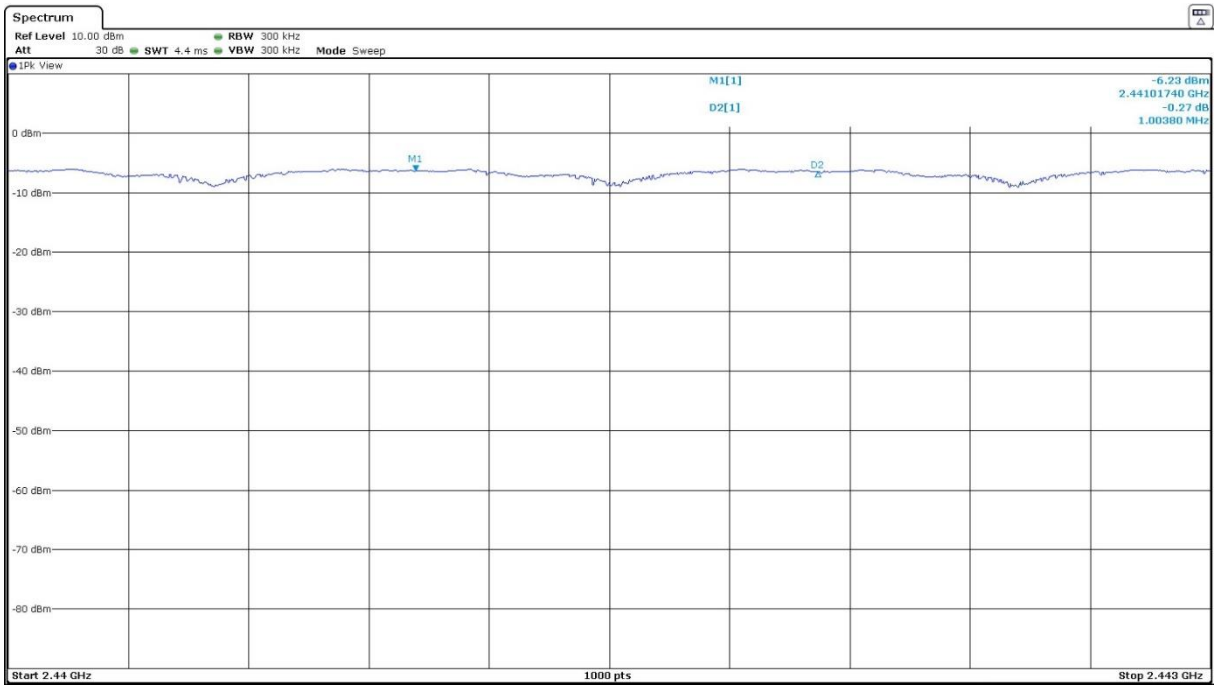




Carrier frequency separation – Pi/4 DQPSK



Carrier frequency separation – 8DPSK



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

Limits

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

Results

Modulation: BT (GFSK 1-DH5)

Operation Band (MHz)	Equipment	Number of Hopping Channels
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	79

Modulation: BT (Pi/4 DQPSK 2-DH5)

Operation Band (MHz)	Equipment	Number of Hopping Channels
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	79

Modulation: BT (8DPSK 3-DH5)

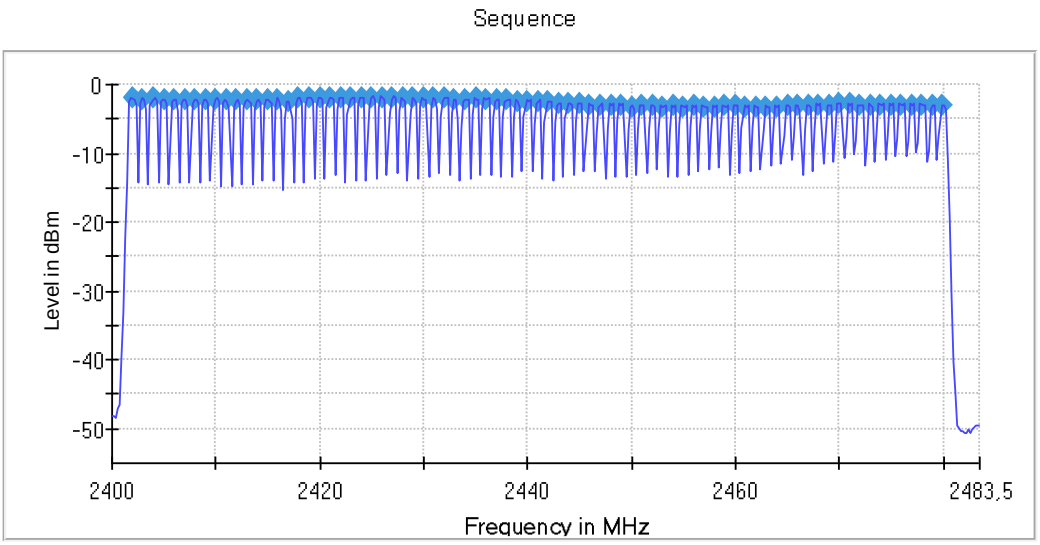
Operation Band (MHz)	Equipment	Number of Hopping Channels
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	79

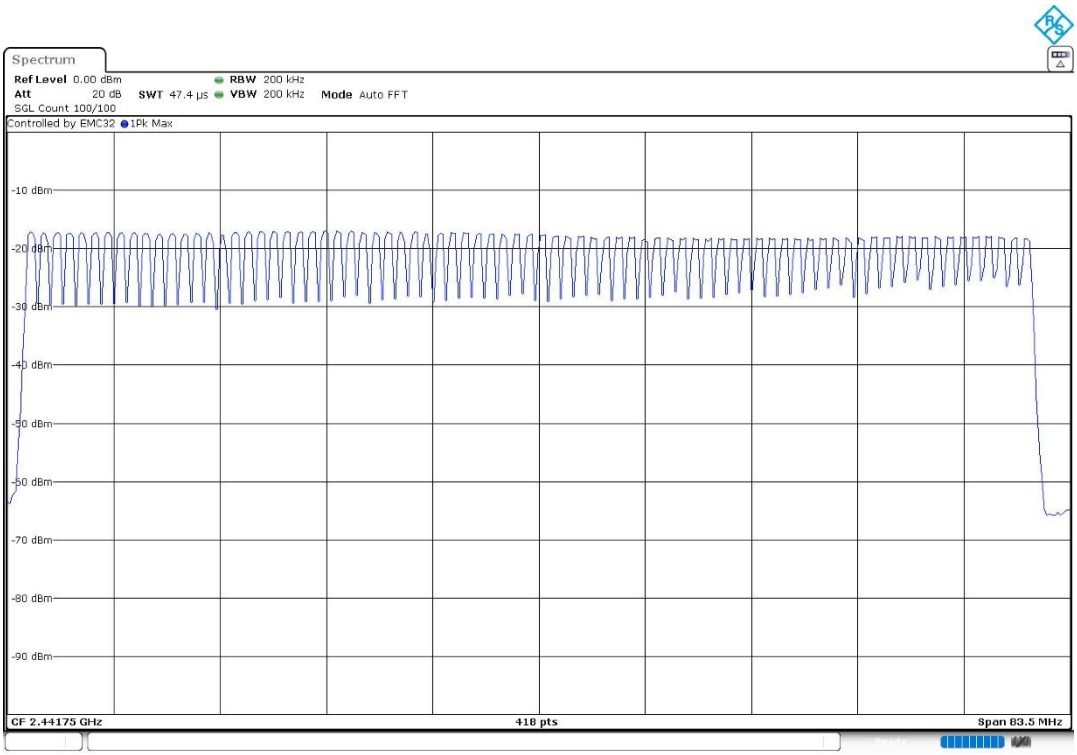
Verdict

Pass

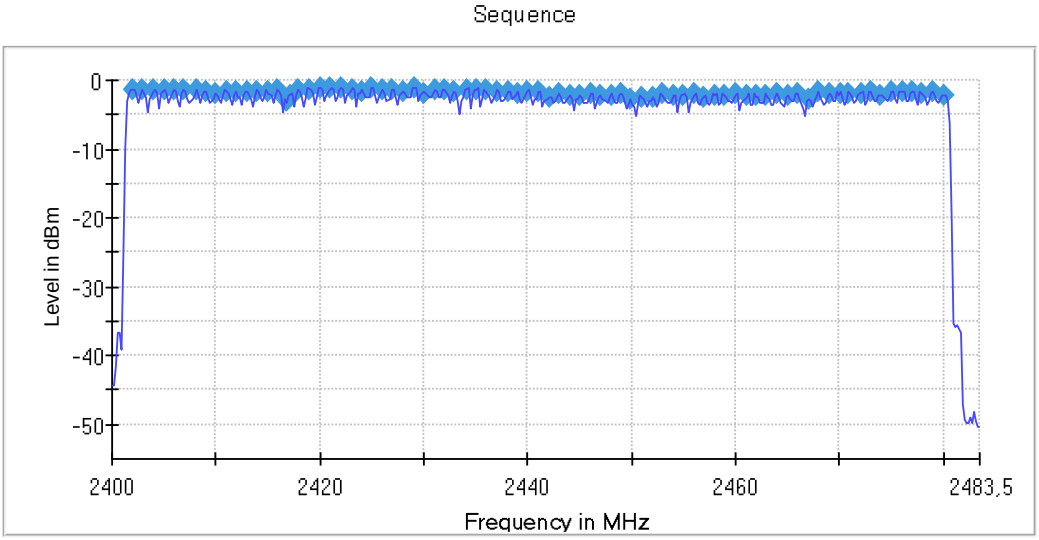
Attachments

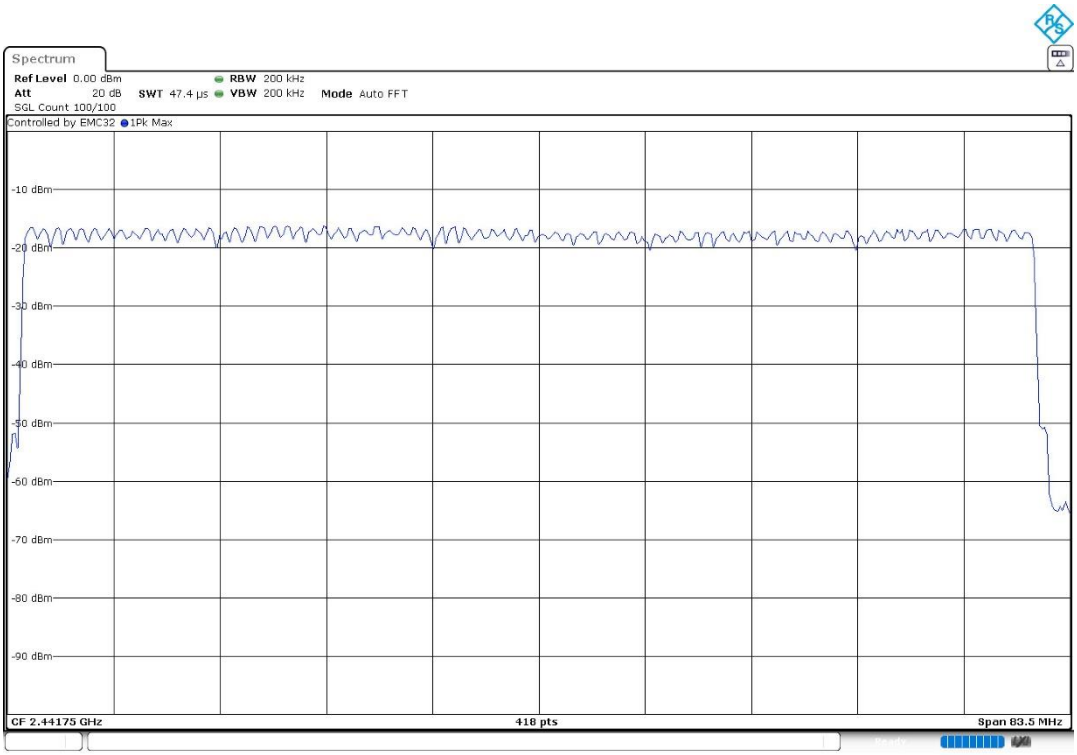
GFSK – Number of hopping channels



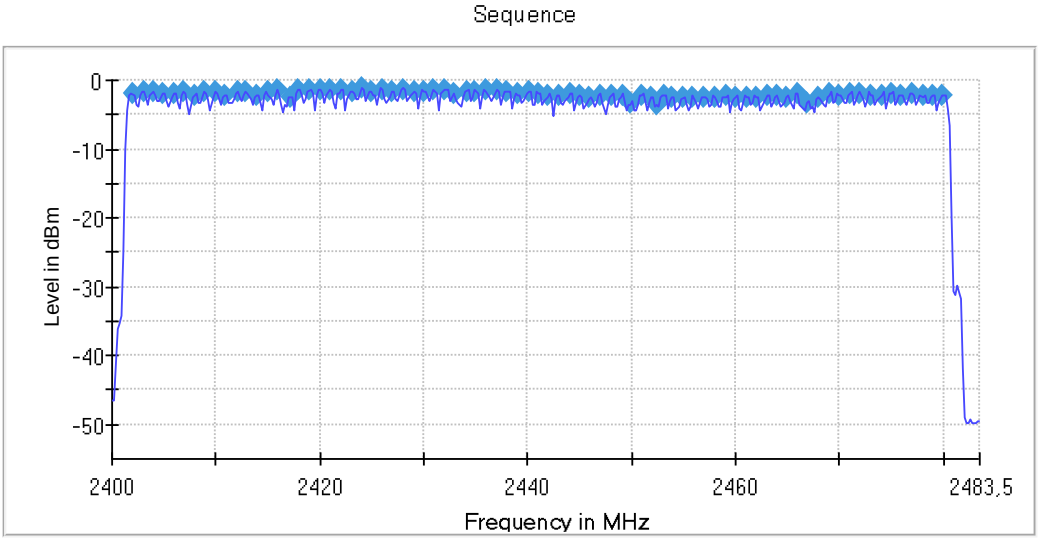


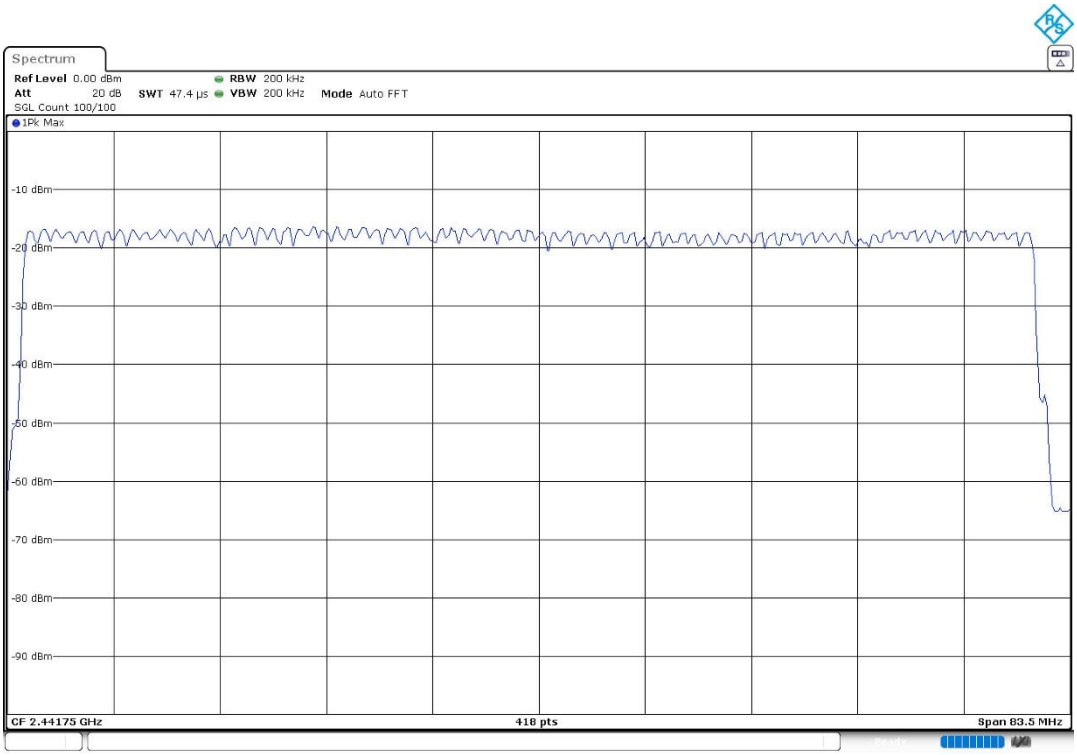
Pi/4 DQPSK – Number of hopping channels





8DPSK – Number of hopping channels





FCC 15.247 (a)(1)(iii) / RSS-247 5.1 (d) Time of occupancy (Dwell Time)

Limits

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

The average time of occupancy was measured on low, middle and high channels for each modulation and worst case (highest Avg COT) is reported.

- **GFSK (packet type DH5) – Time of Occupancy (Dwell Time)**
  - Time of Occupancy:

No. of hops over the period	100	
Average Time of Occupancy	295.750	ms

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

No. of hops over the period	111	
Average Time of Occupancy	317.470	ms

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

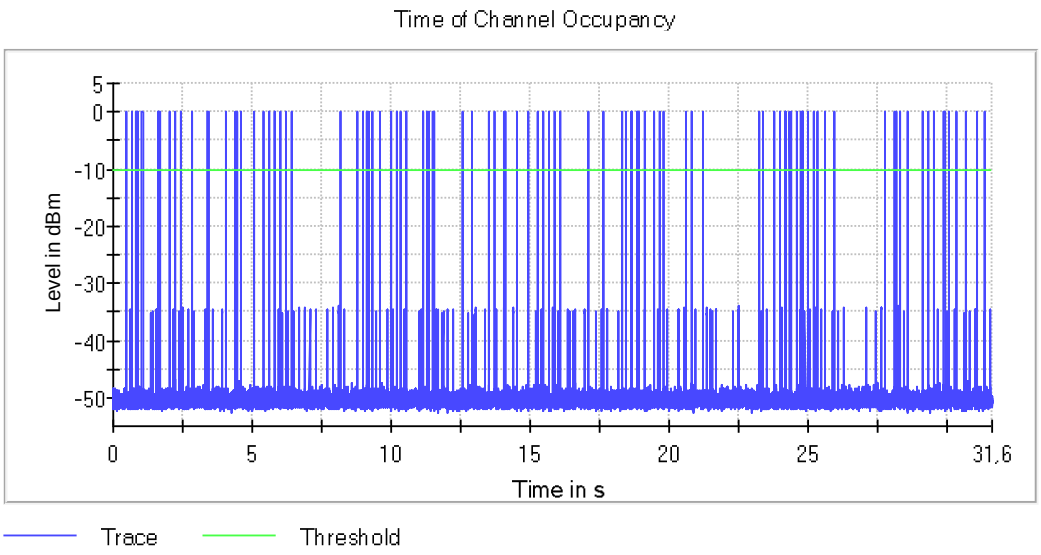
No. of hops over the period	102	
Average Time of Occupancy	288.900	ms

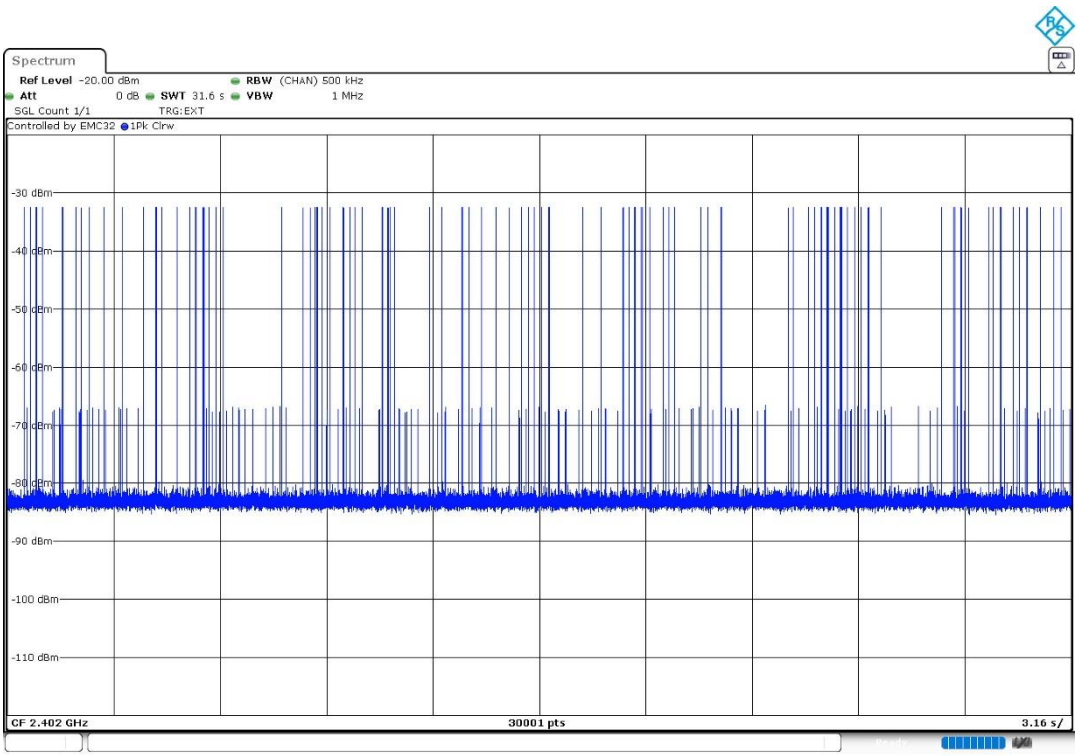
Verdict

Pass

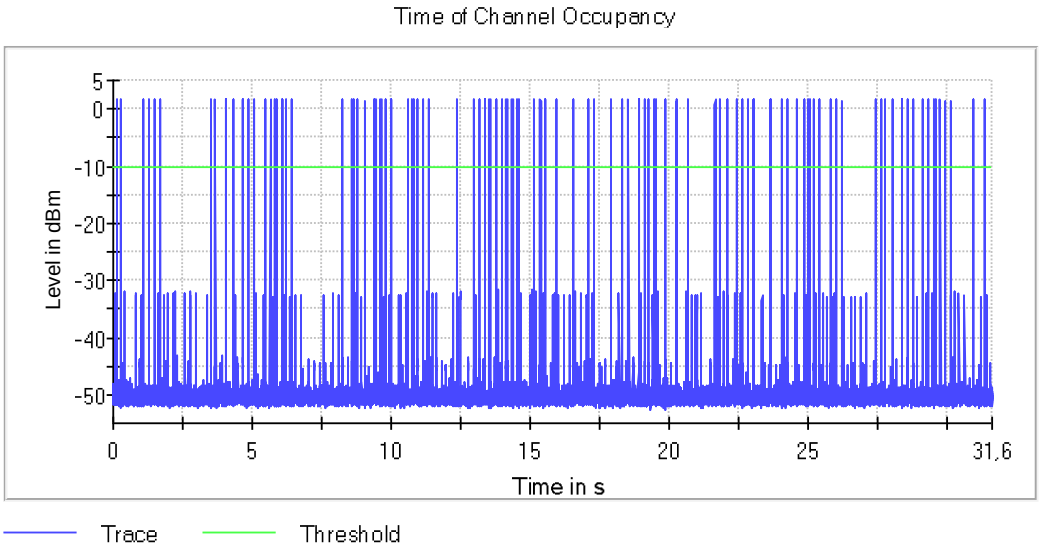
Attachments

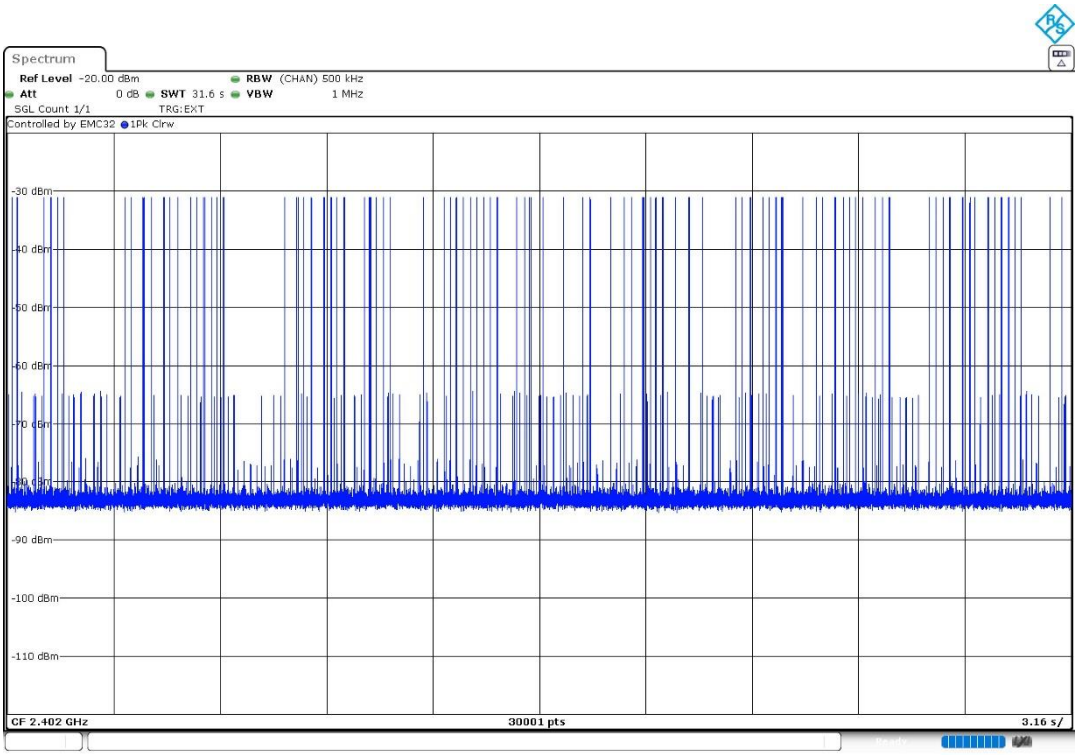
GFSK (packet type DH5) – Time of Occupancy (Dwell Time)



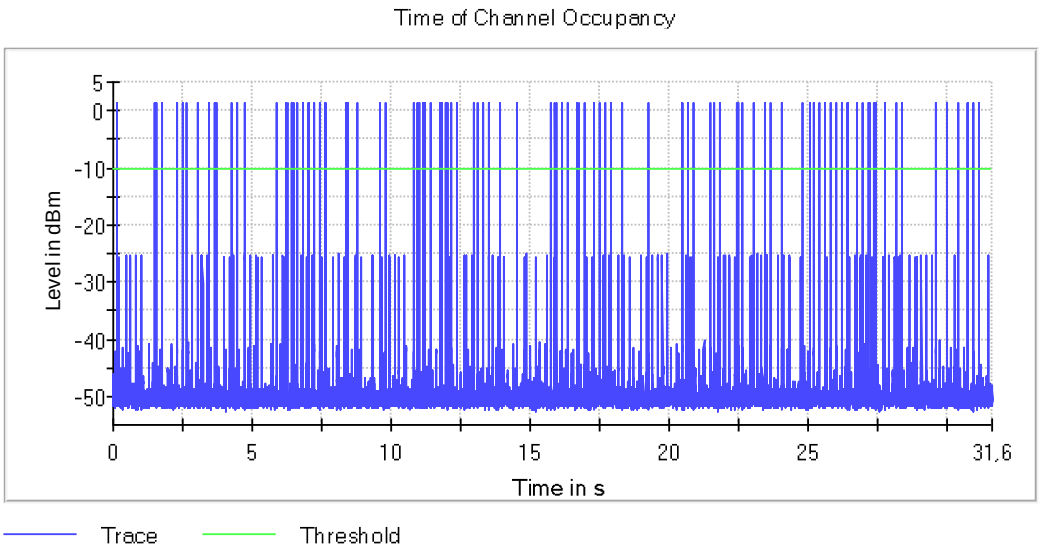


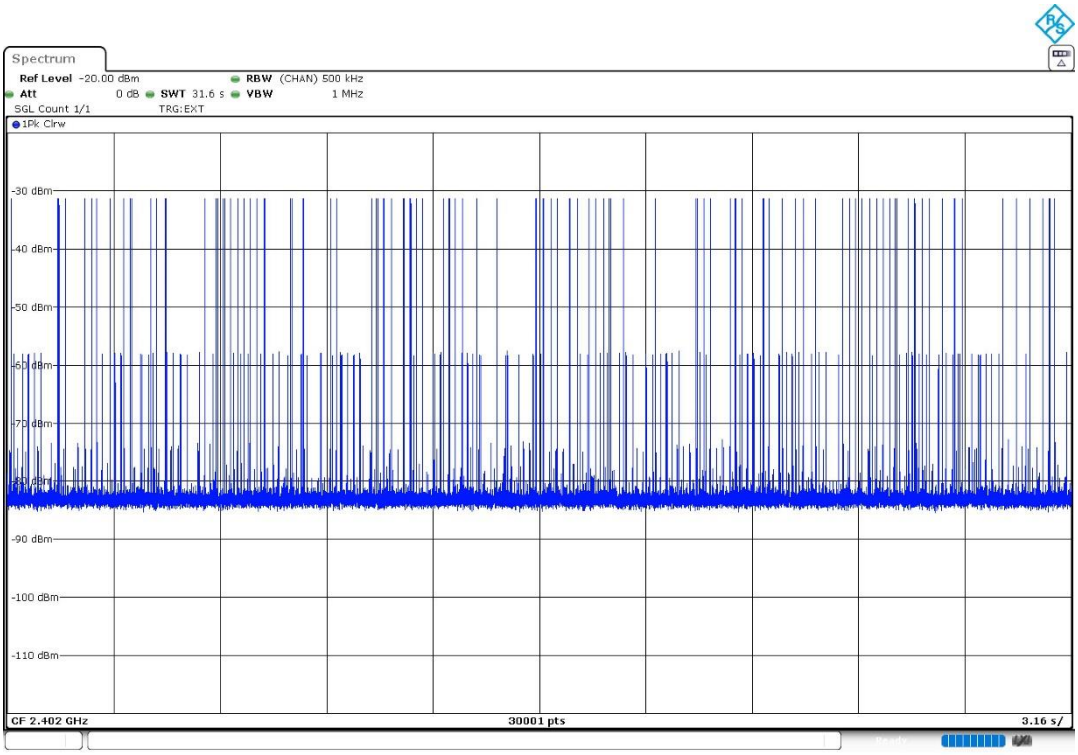
Pi/4 DQPSK (packet type 2DH5) – Time of Occupancy (Dwell Time)





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





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

Limits

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

RSS-247:

The e.i.r.p. shall not exceed 4 W.

Results

The maximum peak conducted output power level of the fundamental emission was measured according to clause 7.8.5 “Output power test procedure for frequency-hopping spread-spectrum (FHSS) devices” of ANSI C63.10-2013.

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

Maximum Declared Antenna Gain: +0.11 dBi

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

- **GFSK:**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Peak Conducted Output Power (dBm)	-1.661	-2.144	-2.525
Maximum EIRP Power (dBm)	-1.551	-2.034	-2.415

- **Pi/4 DQPSK:**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Peak Conducted Output Power (dBm)	0.656	0.388	0.257
Maximum EIRP Power (dBm)	0.766	0.498	0.367

- **8DPSK:**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Peak Conducted Output Power (dBm)	0.818	0.363	0.447
Maximum EIRP Power (dBm)	0.928	0.473	0.557

Verdict

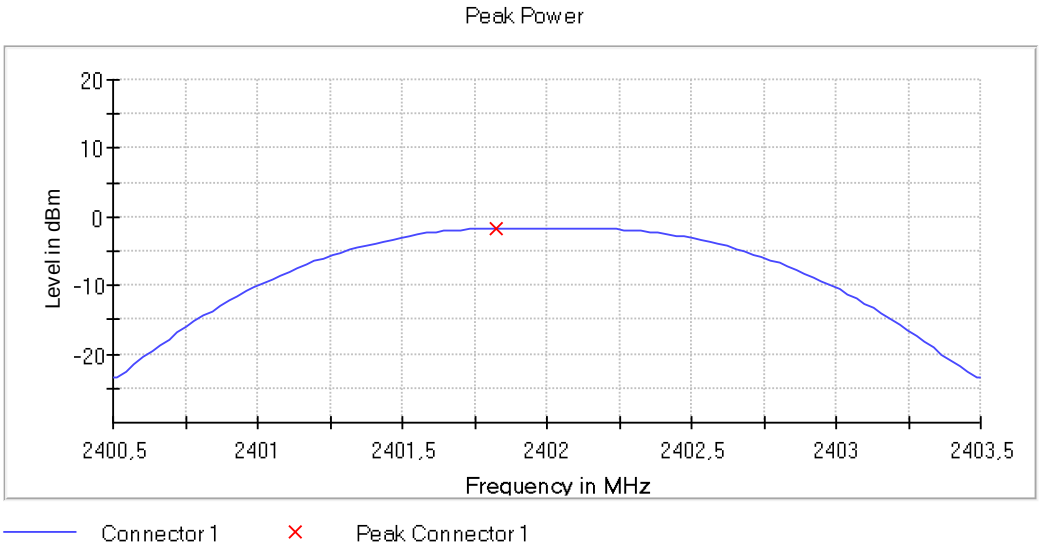
Pass

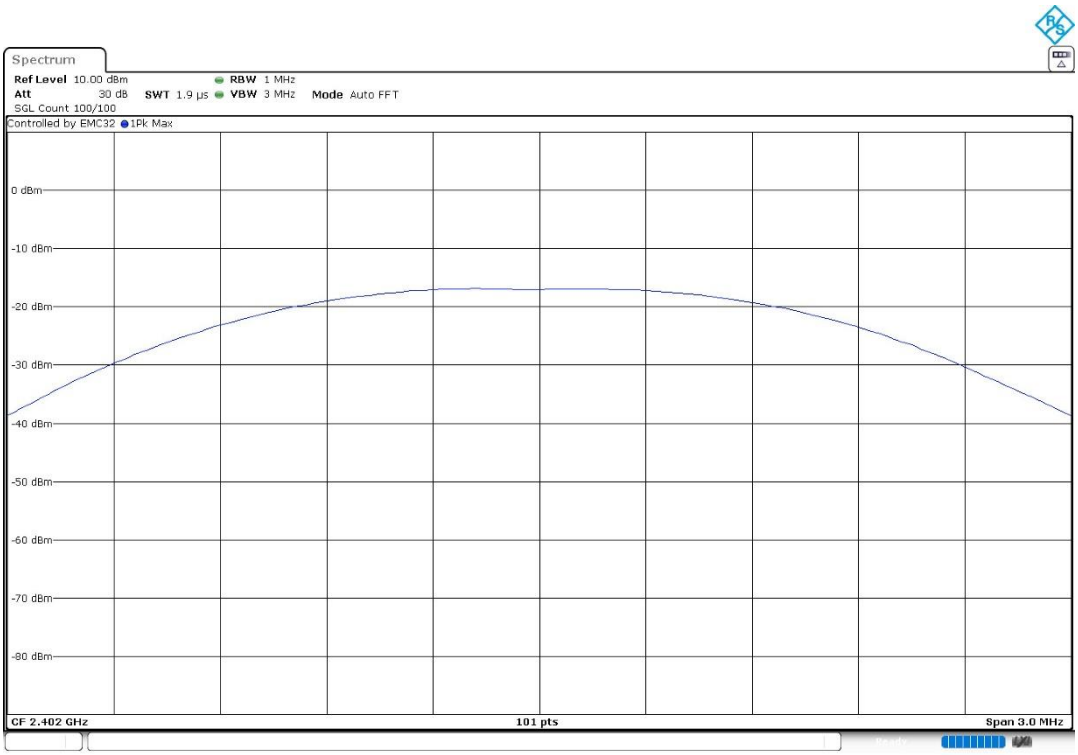
Attachments

- **GFSK – Peak Output Power**

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

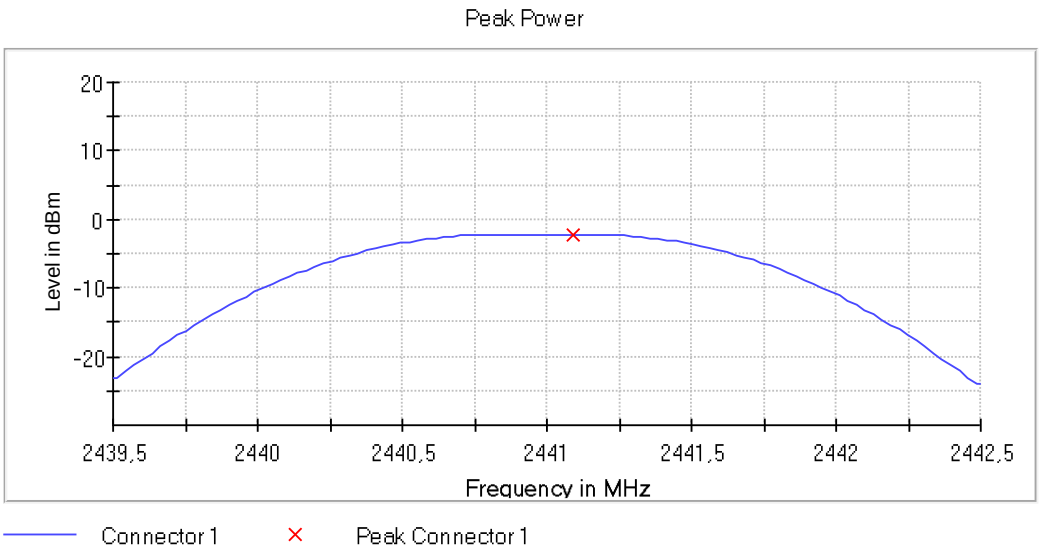
Figures:

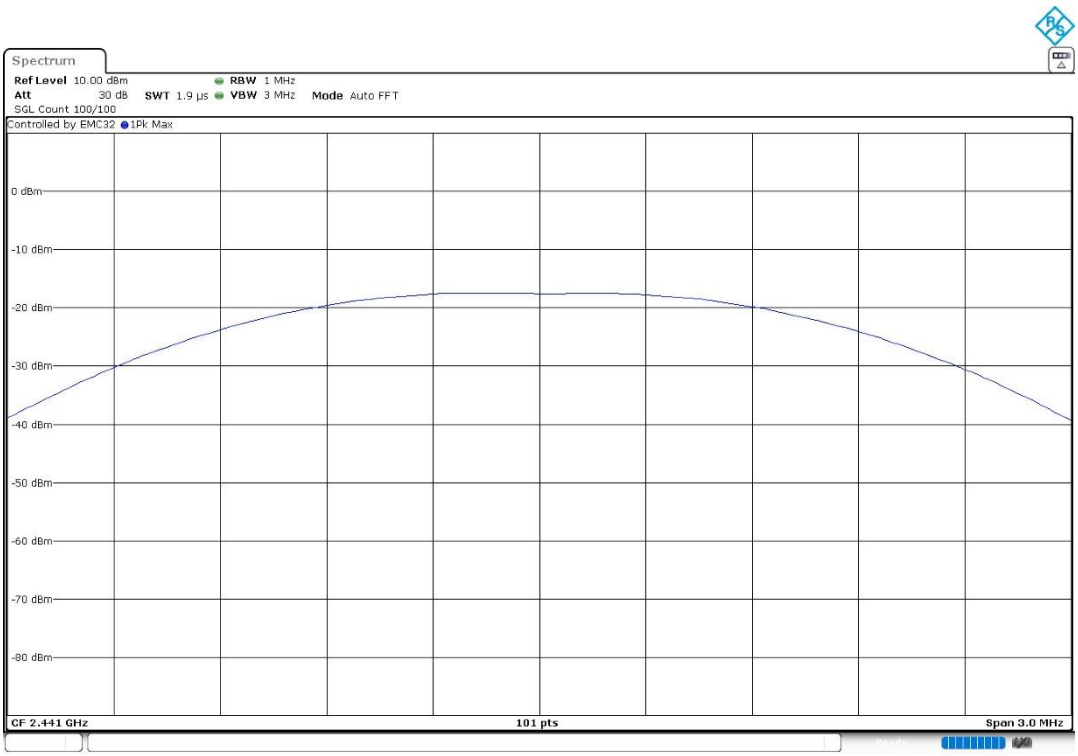




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

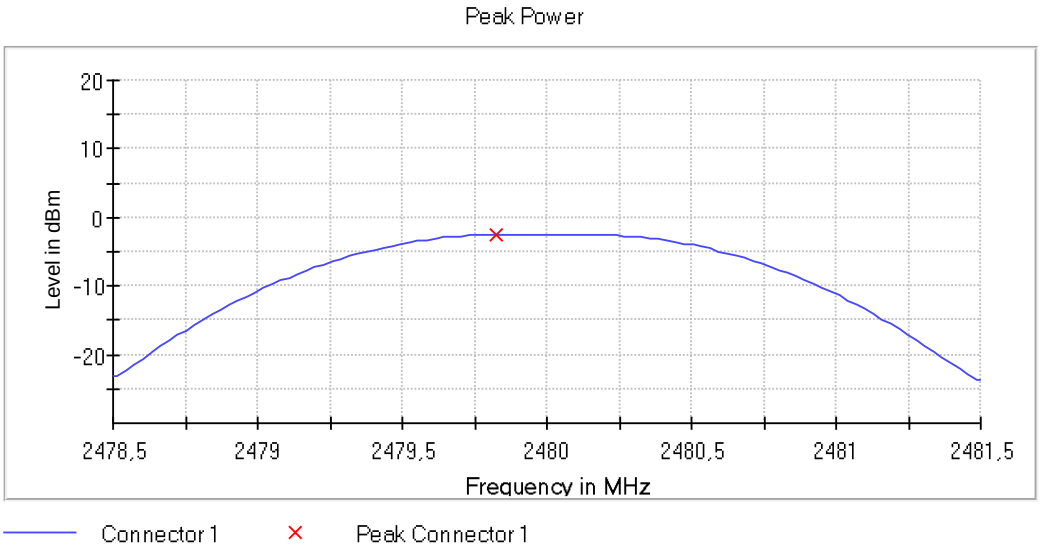
Figures:

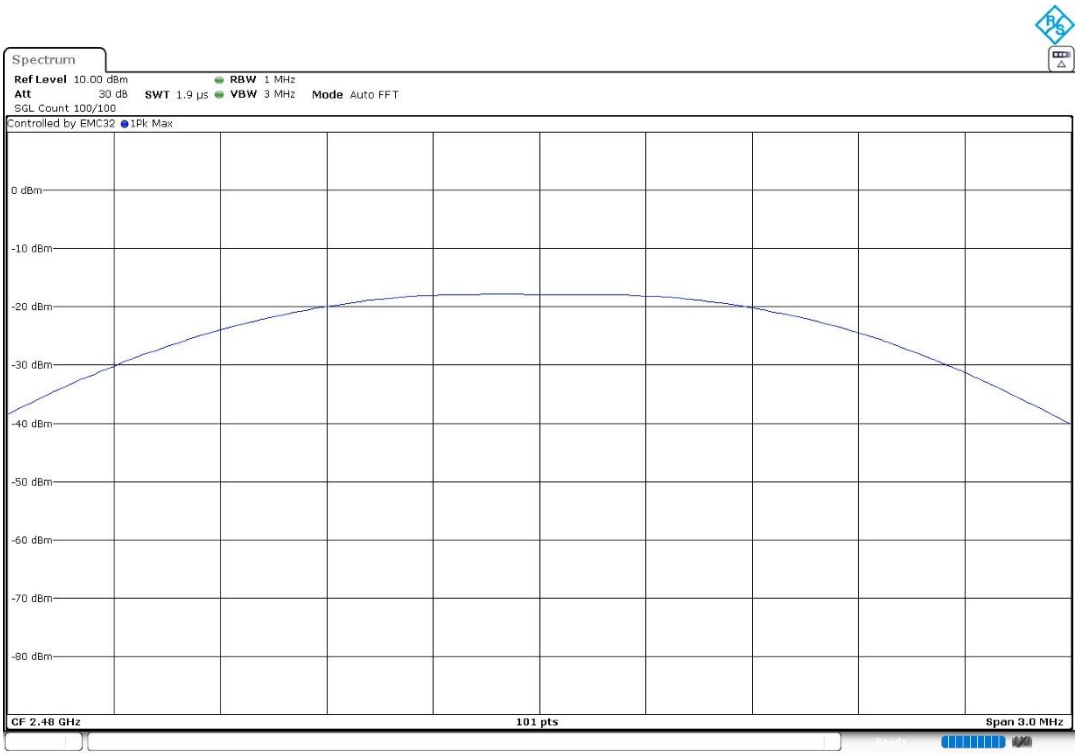




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Figures:

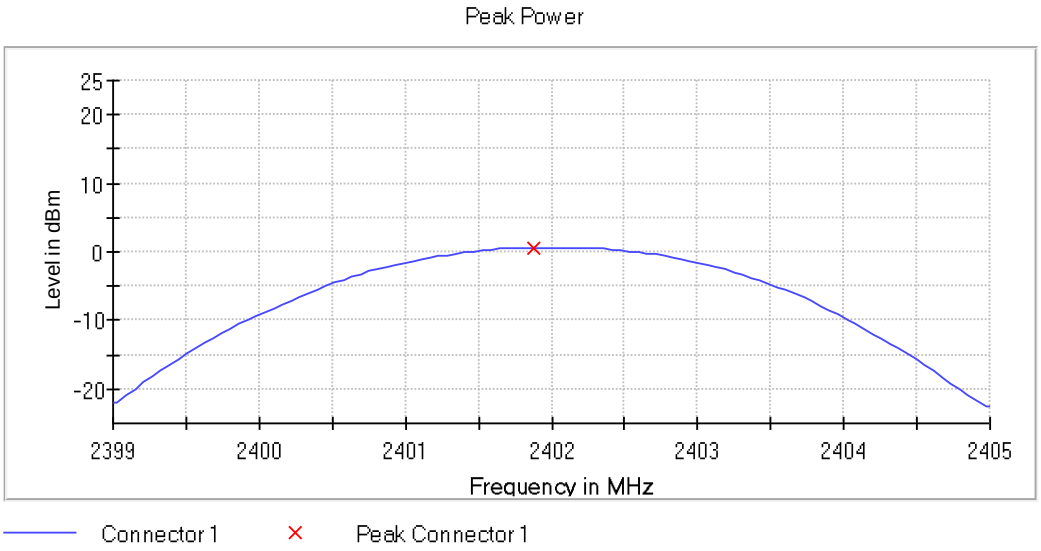


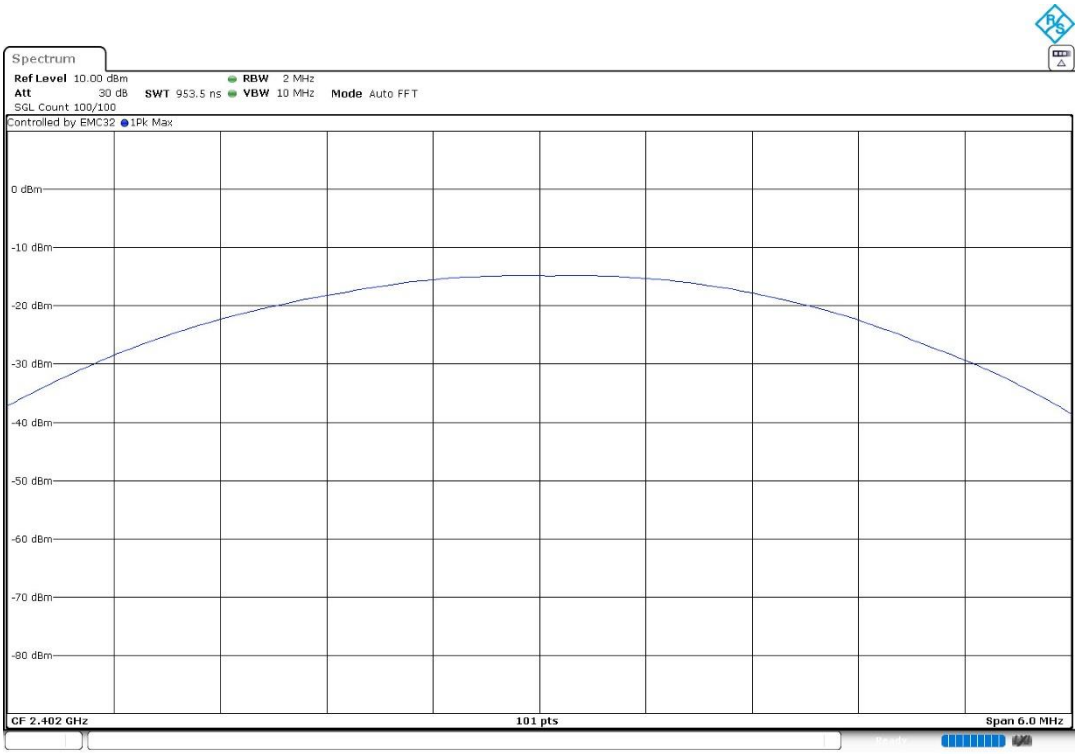


- **Pi/4 DQPSK – Peak Output Power**

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

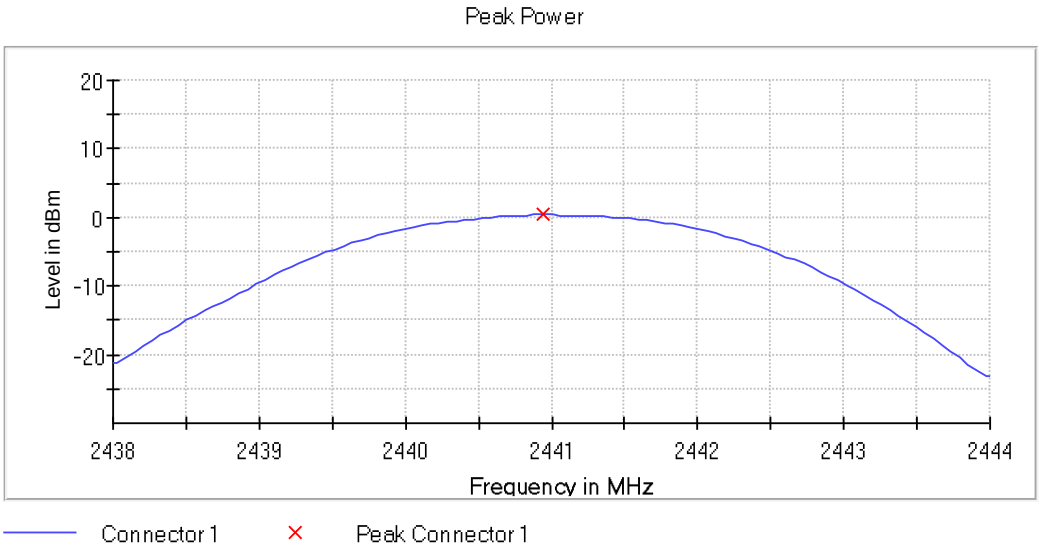
Figures:

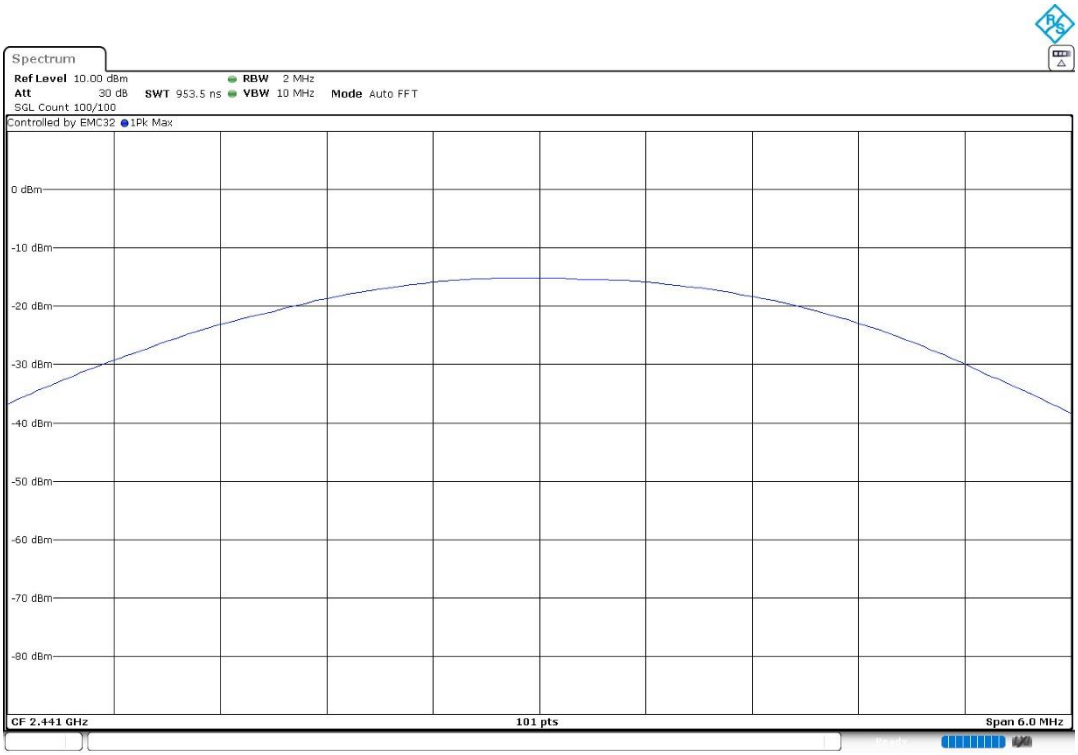




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

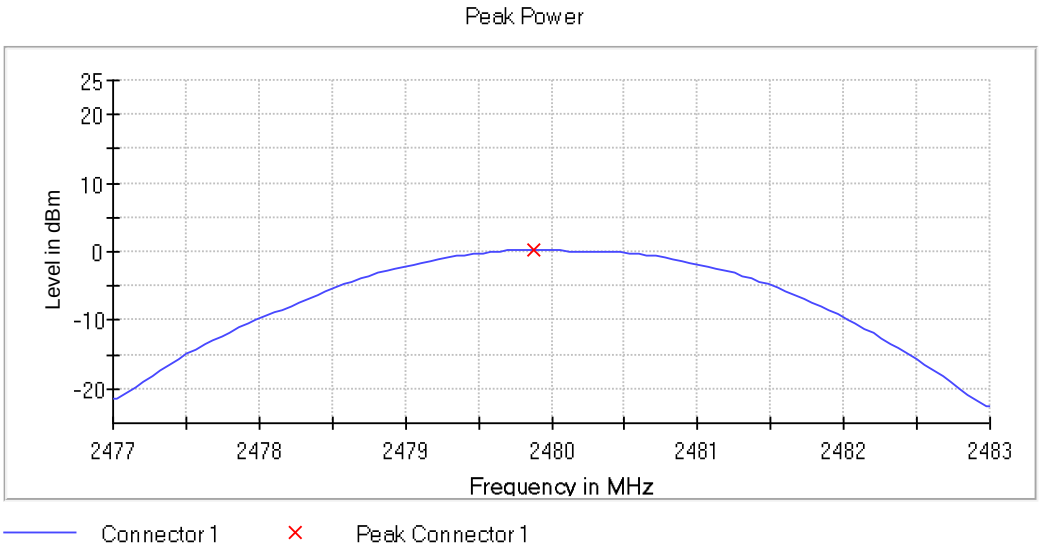
Figures:

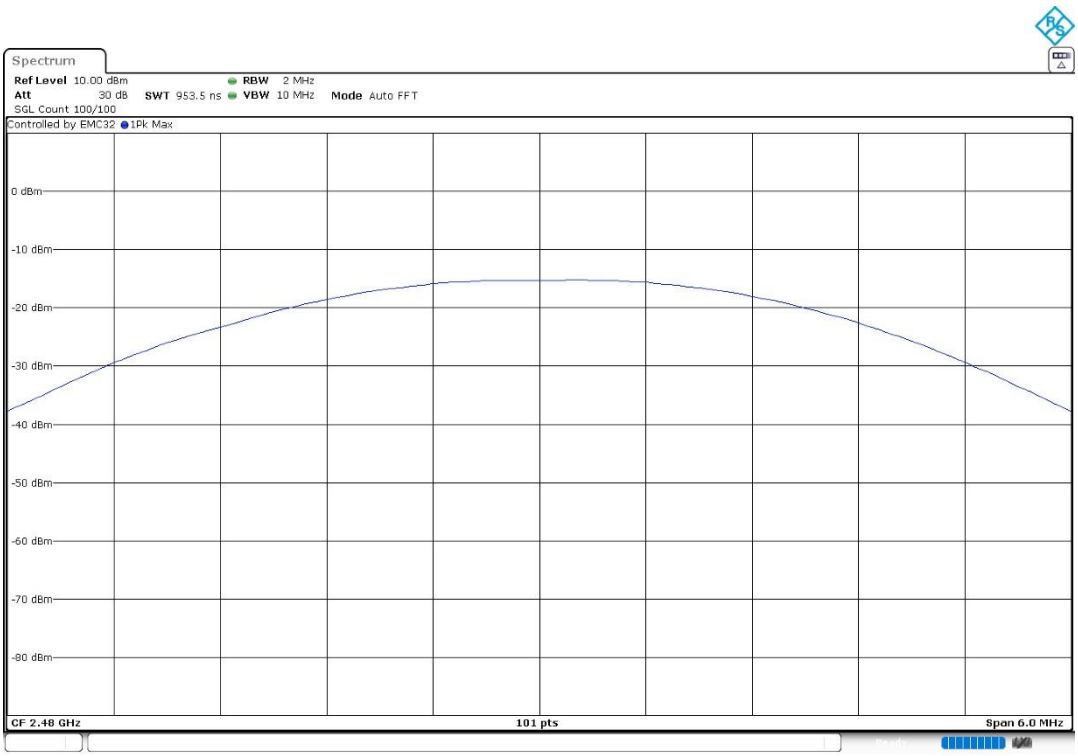




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Figures:

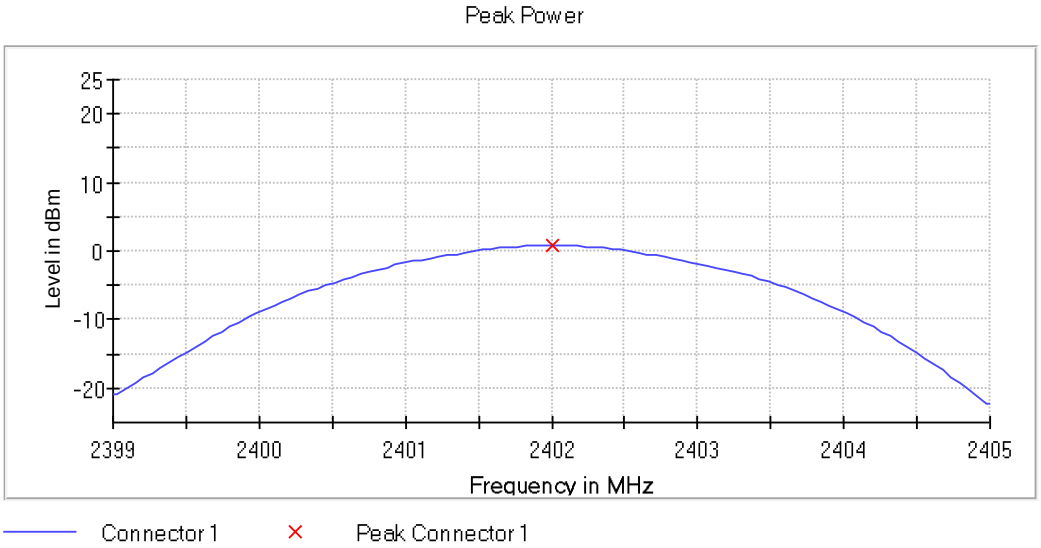


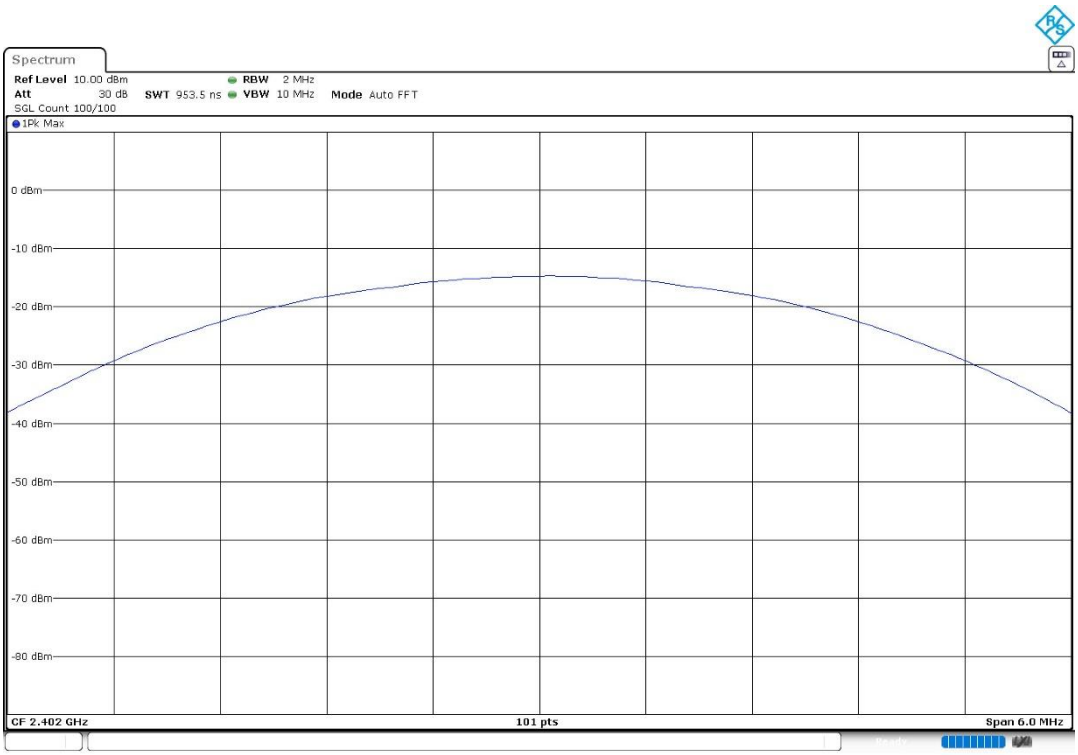


- **8DPSK – Peak Output Power**

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

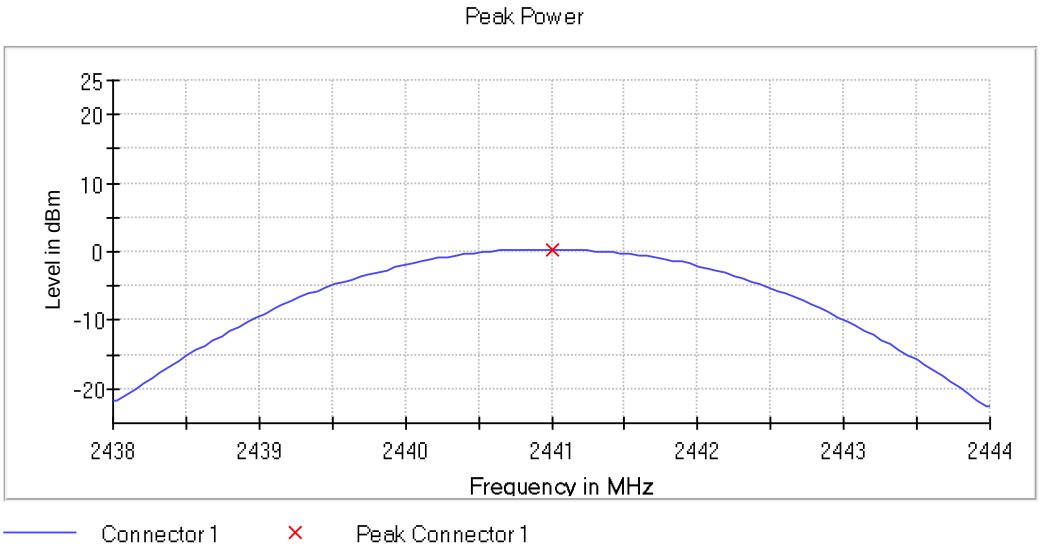
Figures:

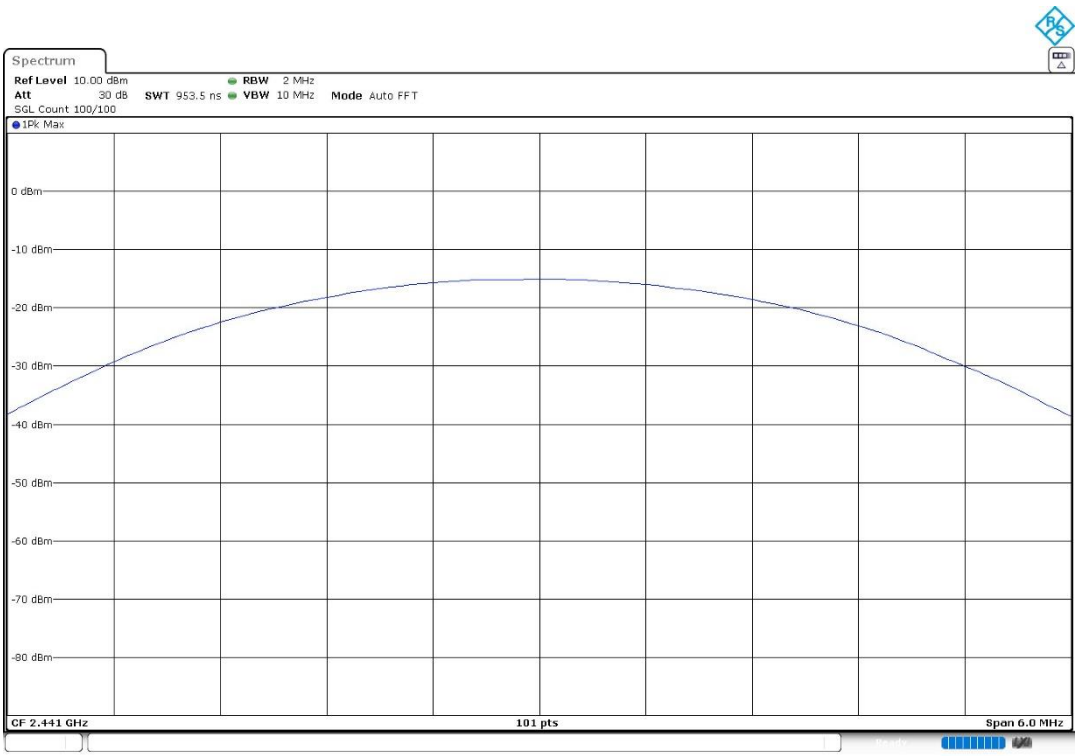




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

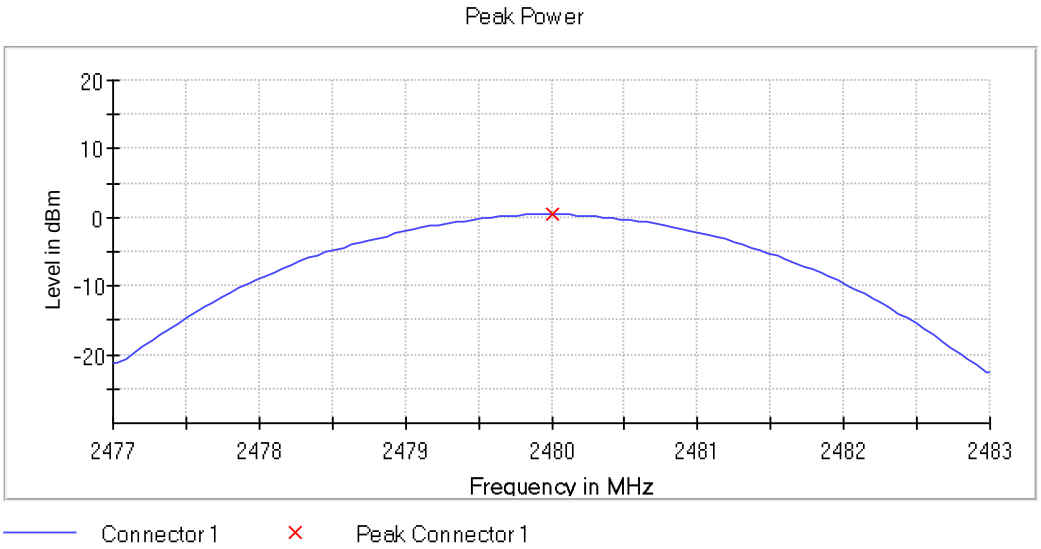
Figures:

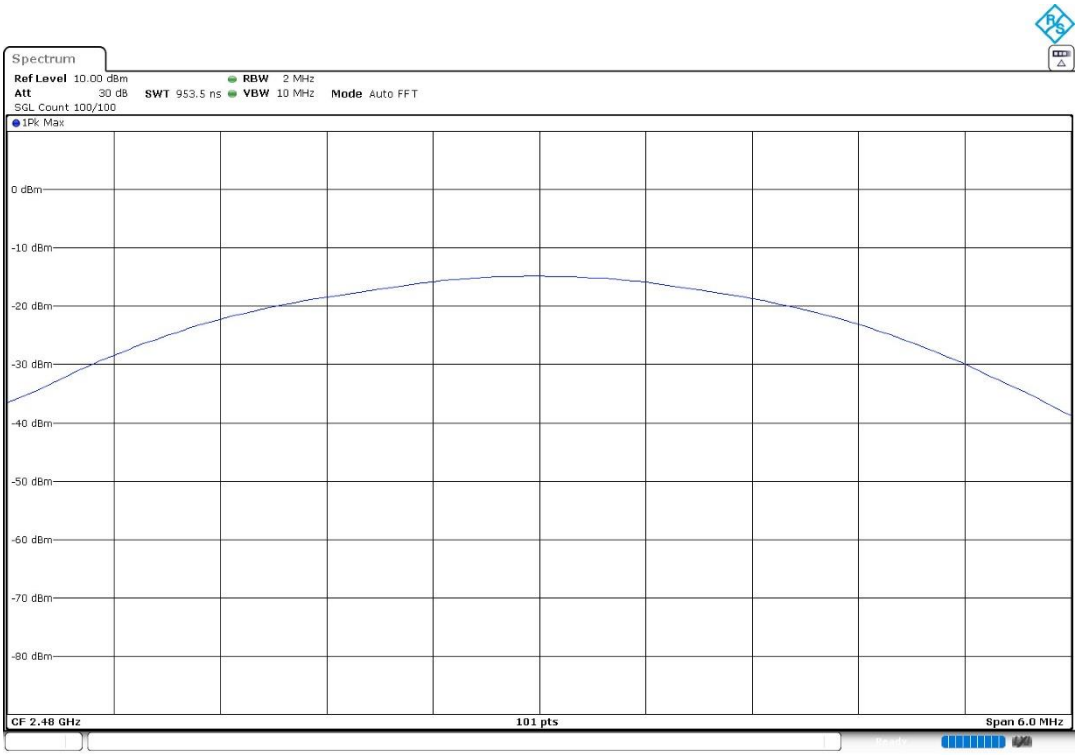




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Figures:





FCC 15.247 (d) / RSS-247 5.5 Band-edge emissions compliance (Transmitter)

Limits

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

Results

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

Verdict

Pass