

ISED CABid: ES1909

Test Report No:

NIE: 69743RRF.011

Test Report

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

(*) Identification of item tested	CR50 Communications Controller
(*) Trademark	Leica
(*) Model and /or type reference	CR50
Other identification of the product	FCC ID: RFD-CR50 IC: 3177A-CR50 - Contains FCC ID: N7NEM75 - Contains IC: 2417C-EM75 - Contains FCC ID: MRBSATEL-TA43 - Contains IC: 2422A-SATELTA43
(*) Features	Bluetooth, 802.11@2.4GHz, E, 400/900 MHz Radio HW version: 2A SW version: 0.1.1707
Manufacturer	LEICA GEOSYSTEMS AG Heinrich-Wild-Strasse, 9435 Heerbrugg, Switzerland
Test method requested, standard	USA FCC Part 15.247 (10-1-20 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 (10-1-20 Edition): Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 Amendment 2 (Feb. 2021). Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules. 558074 D01 Meas Guidance v05r02 dated April 2, 2019. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Approved by (name / position & signature)	Rafael López Martín EMC Consumer & RF Lab. Manager
Date of issue	2022-09-13
Report template No.	FDT08_24 (*) "Data provided by the client"

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Acronyms

Acronym ID	Acronym Description
Avg COT	Average Channel Occupancy Time
Detector	Detector used
Equipment	Equipment Type
EUT	Equipment Under Test
Freq	Frequency
Freq Rng	Frequency Range
Freq Sep	Frequency Separation
Inband Peak Lvl	In-band Peak Level
Lvl	Level
Mod	Modulation
NHC	Number of Hopping Channels
NHp	Number of hops over the period
Occ Ch BW	Occupied Channel Bandwidth
Pol	Polarization
PSD	Power Spectral Density
RSE	Radiated Spurious Emissions
Unwanted Freq	Unwanted Emissions Frequency
Unwanted Lvl	Unwanted Emissions Level

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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 $\leq \pm 5.35$ 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 $\leq \pm 4.32$ 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 $\leq \pm 5.51$ 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 $\leq \pm 0.80$ dB
- RF Average Output Power: Measurement uncertainty $\leq \pm 0.99$ dB
- Power Spectral Density: Measurement uncertainty $\leq \pm 0.99$ dB
- Accumulated Dwell Time: Measurement uncertainty $\leq \pm 0.16$ %
- Minimum Frequency Occupation Time: Measurement uncertainty $\leq \pm 0.53$ %
- Hopping Frequency Separation: Measurement uncertainty $\leq \pm 1.74$ %
- Occupied Channel Bandwidth (BT EDR): Measurement uncertainty $\leq \pm 1.24$ %
- Occupied Channel Bandwidth (WLAN 2.4 GHz): Measurement uncertainty $\leq \pm 1.40$ %
- 6dB Bandwidth: Measurement uncertainty $\leq \pm 2.84$ %
- Conducted Band-edge spurious emissions: Measurement uncertainty $\leq \pm 1.76$ 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 consists of an On-machine communication unit CR50.

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.

Id	Control Number	Description	Model	Serial No.	Date of Reception	Application
S/01	69743_12.1	CR50 Communications Controller	CR50	0001004	2021-12-02	Equipment Under Test
S/01	69743_2.1	LTE Dual Antenna	BPCTHPDLTE-SF-MM	24221008	2021-12-02	Equipment Under Test
S/01	69743_82.1	C15 Robust Antenna Cable 5M	--	--	2021-12-02	Equipment Under Test
S/01	69743_83.1	C15 Robust Antenna Cable 5M	--	--	2021-12-02	Equipment Under Test
S/01	69743_88.1	GNSS Antenna	CGA100	4207189	2021-12-02	Equipment Under Test
S/01	69743_89.1	GNSS Antenna	CGA100	4207433	2021-12-02	Equipment Under Test
S/01	69743_17.1	iCG100 GNSS Controller	iCG100	0001002	2021-12-02	Auxiliary Equipment
S/01	69743_24.1	Magnetic Antenna	GMLFML195	--	2021-12-02	Auxiliary Equipment
S/01	69743_44.1	480MHz Antenna	MLPV430	--	2021-12-02	Auxiliary Equipment
S/01	69743_62.1	USB Type A - Jack	--	--	2021-12-02	Auxiliary Equipment
S/01	69743_68.1	USB Type A - Jack	--	--	2021-12-02	Auxiliary Equipment
S/01	69743_73.1	D9+Power Cable	--	--	2021-12-02	Auxiliary Equipment
S/01	69743_98.1	Media Convert	100BASE-T1	050501E0	2021-12-02	Auxiliary Equipment
S/01	69743_110.1	AEC M12T M/F 5,0m cable	950559	--	2021-12-02	Auxiliary Equipment
S/02	69743_17.1	iCG100 GNSS Controller	iCG100	0001002	2021-12-02	Equipment Under Test

Notes referenced to samples during the project:

Id	Type
S/01	Sample used for Radiated tests.
S/02	Sample used for Conducted tests.

Test sample description

Ports..... :	Port name and description	Cable					
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾		
		-	[]	[]	[]		
		-	[]	[]	[]		
Supplementary information to the ports..... :							
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	[X]	DC: 12V					
	[]	DC:					
Rated Power	7.2W						
Clock frequencies.....							
Other parameters	Supply voltage range: 9 V to 36 V DC						
Software version	0.1.1707						
Hardware version	2A						
Dimensions in cm (W x H x D)	150mm x 145mm x 40mm						
Mounting position	[]	Table top equipment					
	[]	Wall/Ceiling mounted equipment					
	[]	Floor standing equipment					
	[]	Hand-held equipment					
	[X]	Other: In cabin of a machine					
Modules/parts..... :	Module/parts of test item		Type		Manufacturer		
	Cellular module		EM7565		Sierra Wireless		
	SRD module		TR489		Satel		
Accessories (not part of the test item)	Description		Type		Manufacturer		
							
							
Documents as provided by the applicant..... :	Description		File name		Issue date		
							
							

⁽³⁾ Only for Medical Equipment

Identification of the client

LEICA GEOSYSTEMS AG
Heinrich-Wild-Strasse, 9435 Heerbrugg, Switzerland

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2022-01-04
Date (finish)	2022-04-29

Document history

Report number	Date	Description
69743RRF.011	2022-09-13	First release.

Environmental conditions

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

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

In the semi-anechoic chamber, the following limits were not exceeded during the test:

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

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

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

Remarks and comments

The tests have been performed by the technical personnel: Alfonso Gutiérrez Martínez, José Manuel Jiménez González and Nicolás Salguero Camarena.

Used instrumentation:

Equipment	Model	Manufacturer	Next Calibration
SEMIANECHOIC ABSORBER LINED CHAMBER II	FACT 3 200 STP	ETS LINDGREN	2023-08-28
SHIELDED ROOM	S101	ETS LINDGREN	N/A
DC POWER SUPPLY 30V/5A	U8002A	KEYSIGHT TECHNOLOGIES	N/A
DIGITAL MULTIMETER	179	FLUKE	2022-10-19
HYBRID BILOG ANTENNA 30MHz-6GHz	3142E	ETS LINDGREN	2023-04-30
HORN ANTENNA 1-18GHz	BBHA 9120 D	SCHWARZBECK MESS-ELEKTRONIK	2022-11-18
HORN ANTENNA 18-40GHz	BBHA 9170	SCHWARZBECK	2023-05-05
PRE-AMPLIFIER G>40dB 10MHz-6GHz	BLNA 0160-01N	BONN ELEKTRONIK	2023-03-17
PRE-AMPLIFIER G>40dB 1-18 GHz	BLMA 0118-1M	BONN ELEKTRONIK	2023-06-10
PRE-AMPLIFIER G>30dB 17-40GHz	BLMA 1840-4A	BONN ELEKTRONIK	2022-09-08
EMI TEST RECEIVER 9kHz-7GHz	ESR7	ROHDE AND SCHWARZ	2022-12-12
SIGNAL AND SPECTRUM ANALYZER 2Hz-50GHz	FSW50	ROHDE AND SCHWARZ	2022-07-06
EMC/RF MEASUREMENT SOFTWARE	EMC32	ROHDE AND SCHWARZ	N/A
SIGNAL AND SPECTRUM ANALYZER 10Hz-40GHz	FSV40	ROHDE AND SCHWARZ	2023-02-26
OPEN SWITCH UNIT UP TO 7.5 GHz	OSP-B157W8 PLUS	ROHDE & SCHWARZ	2023-08-20
EMC/RF MEASUREMENT SOFTWARE	WMS32	ROHDE AND SCHWARZ	N/A

Testing verdicts

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

Summary

1. Bluetooth EDR

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

2. 802.11 b/g/n20/n40 1x1

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

Appendix A: Test results. Bluetooth EDR

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TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

Vnominal: 12 Vdc
Type of Power Supply: External DC.

ANTENNA (*):

- Internal antenna (Antenova SR4W030)
Maximum Declared Antenna Gain: 5.2 dBi

TEST FREQUENCIES (*):

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

POWER SETTINGS:

The EUT was tested in the following operating mode:

Continuous transmission with a modulated carrier on all required channels selecting the supported data rates/modulations types.

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.

The following power settings were used to configure the EUT for the tests:

Modulation	Power setting
BT (GFSK 1-DH5)	8 dBm
BT (Pi/4 DQPSK 2-DH5)	8 dBm
BT (8DPSK 3-DH5)	8 dBm

CONDUCTED MEASUREMENTS:

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



RADIATED MEASUREMENTS:

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

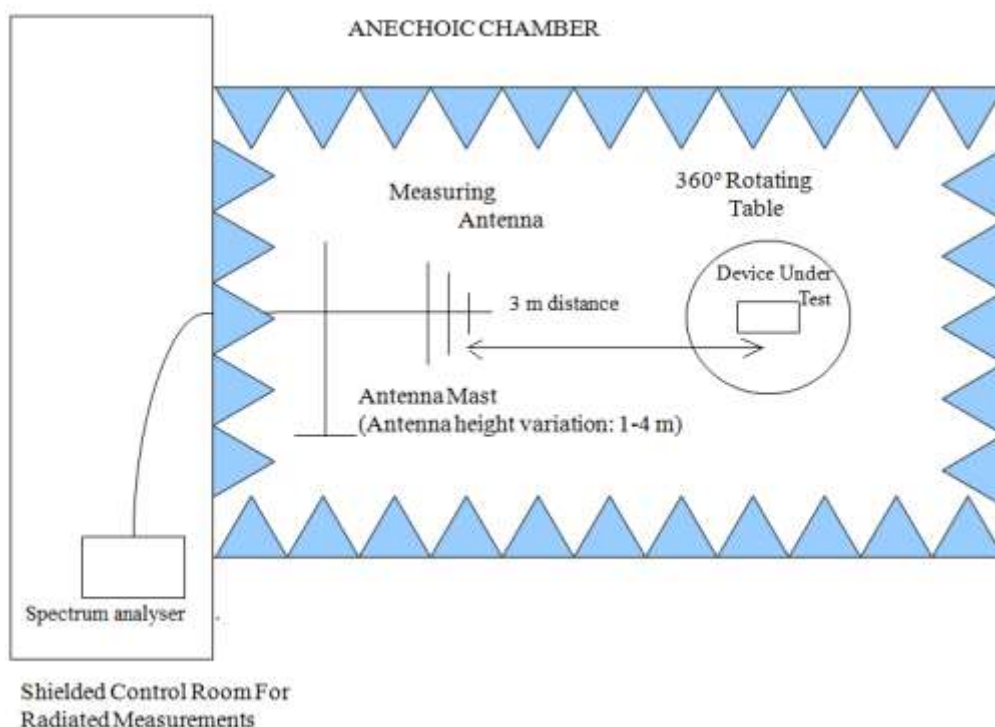
For radiated emissions in the range 17 GHz-26 GHz performed at a distance closer than the specified distance in the standard, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

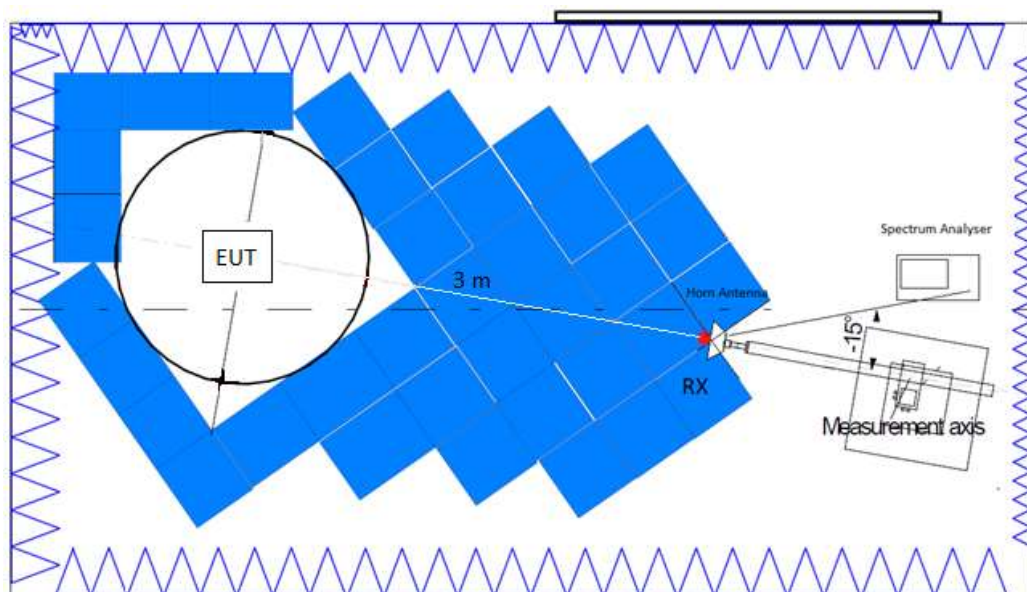
Measurements were made in both horizontal and vertical planes of polarization.

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.

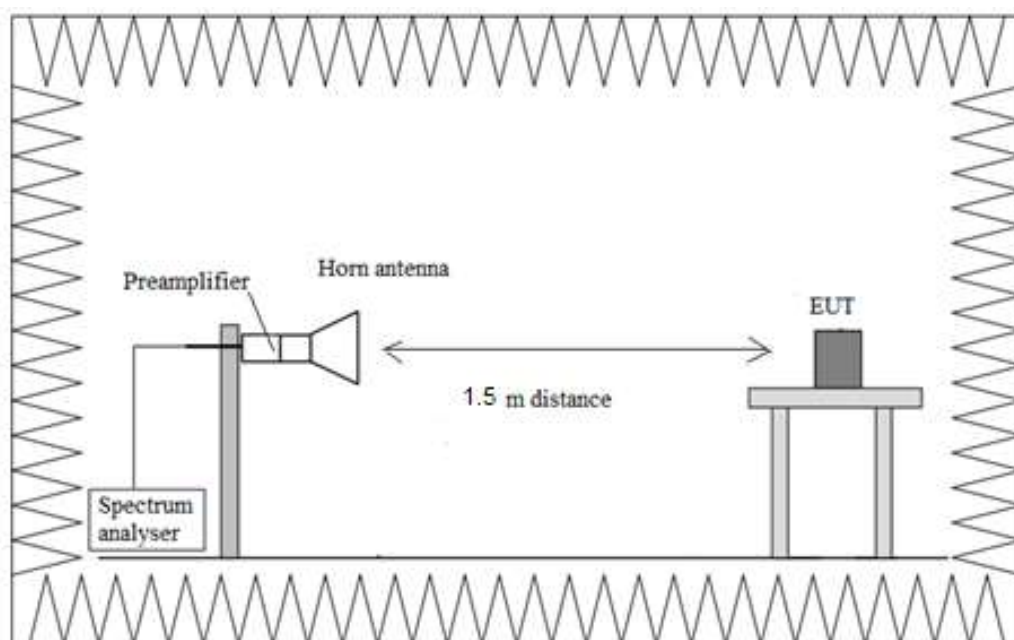
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



TEST CASES DETAILS

FCC 47 CFR Part 15.247 / RSS-247
Occupied Channel Bandwidth 99%

Results

Modulation: BT (GFSK 1-DH5)

Operation Band (MHz)	Freq (MHz)	Equipment	Occ Ch BW (MHz)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	0.910000
	2441.00000		0.910000
	2480.00000		0.905000

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

Operation Band (MHz)	Freq (MHz)	Equipment	Occ Ch BW (MHz)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	1.195000
	2441.00000		1.195000
	2480.00000		1.190000

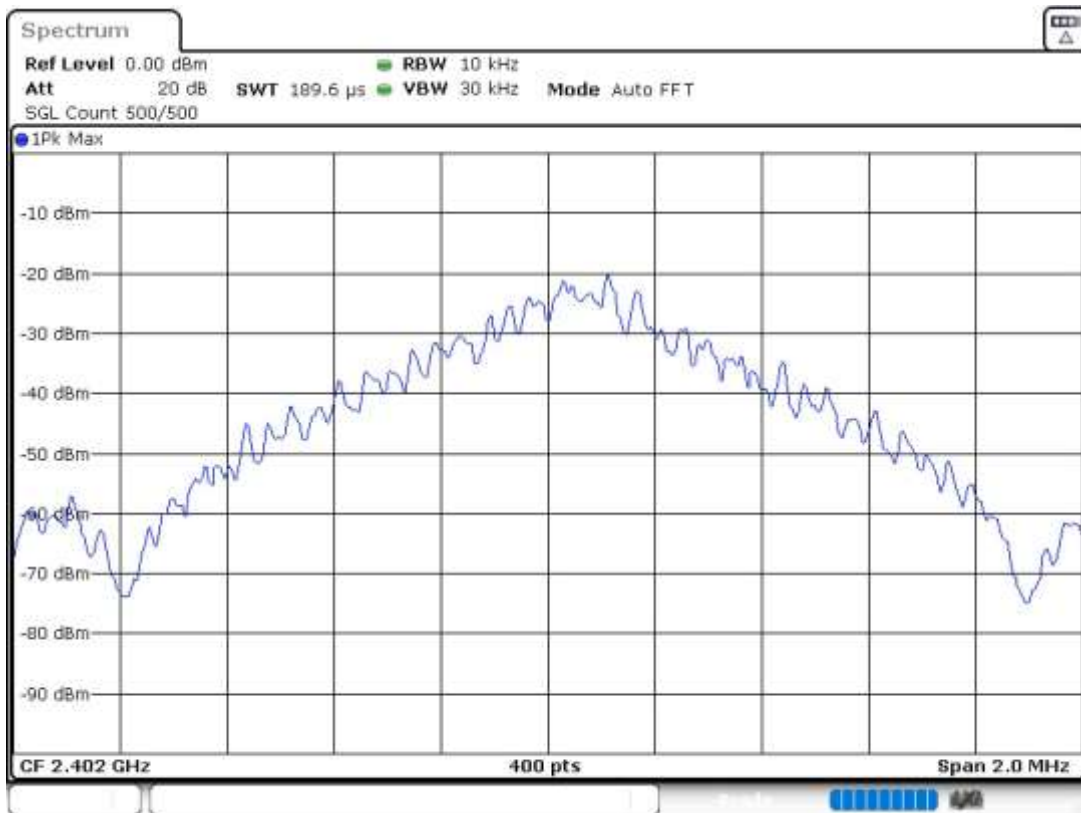
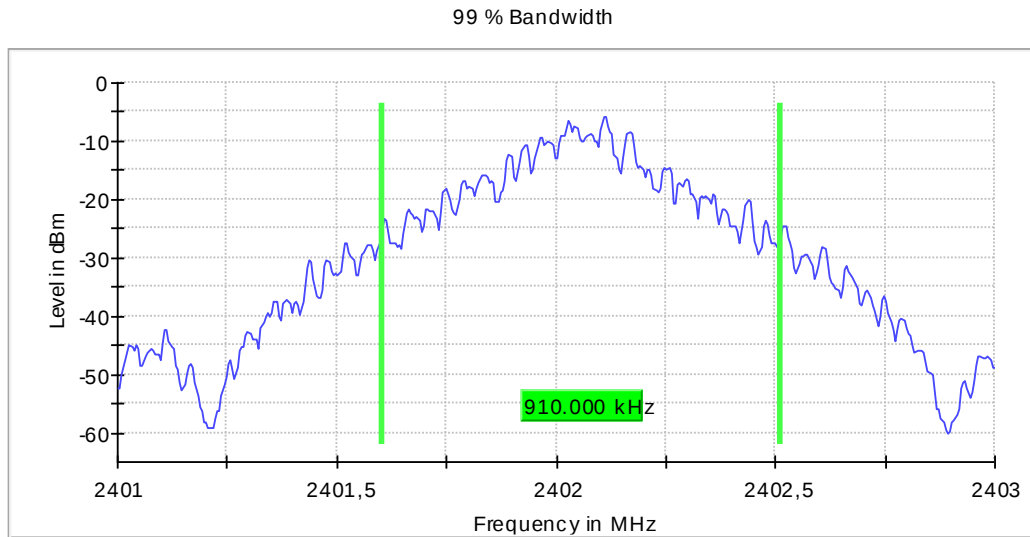
Modulation: BT (8DPSK 3-DH5)

Operation Band (MHz)	Freq (MHz)	Equipment	Occ Ch BW (MHz)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	1.200000
	2441.00000		1.200000
	2480.00000		1.195000

Attachments

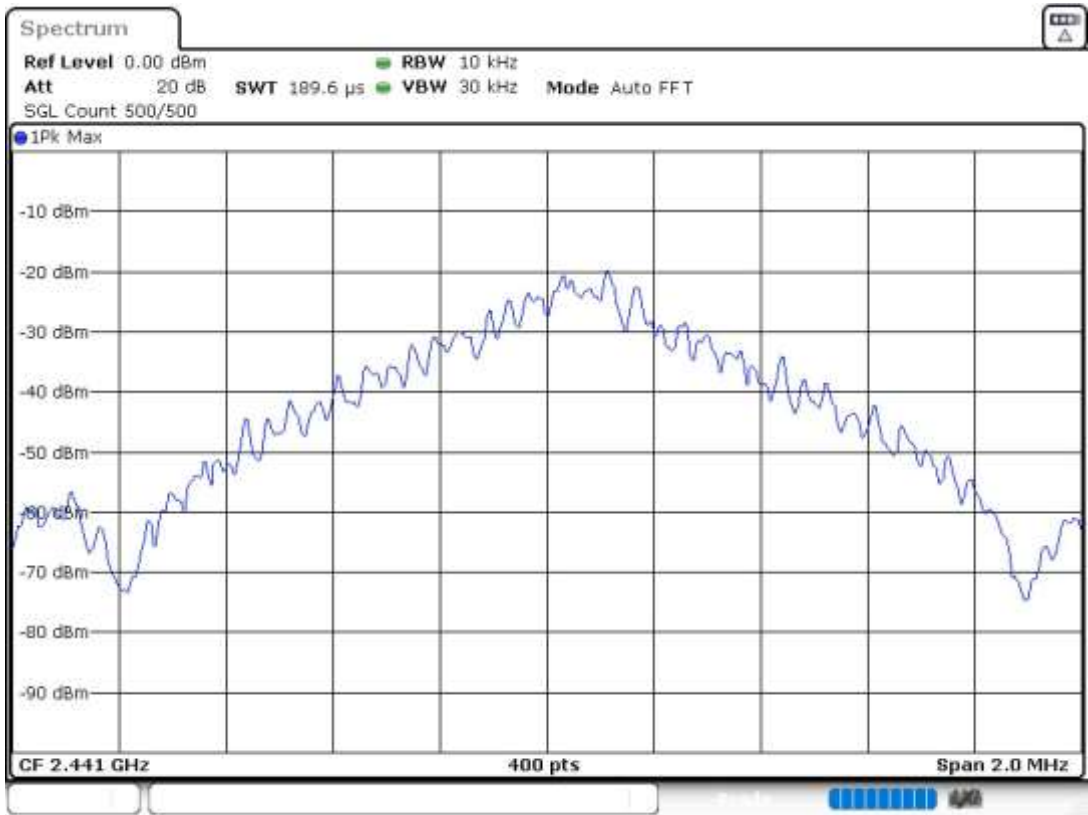
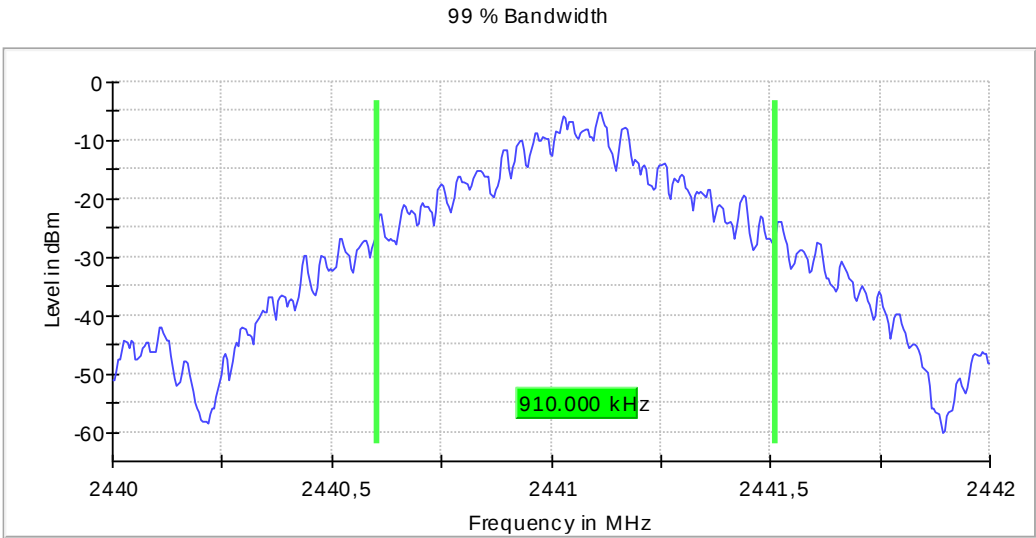
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



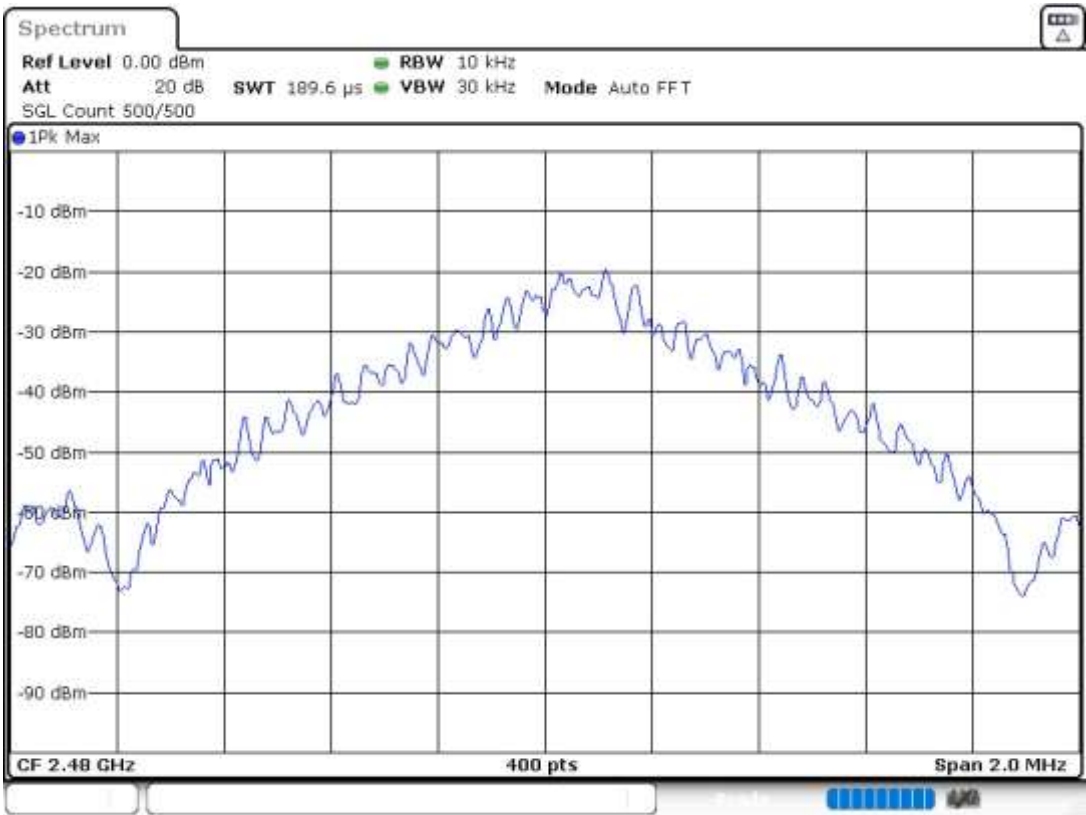
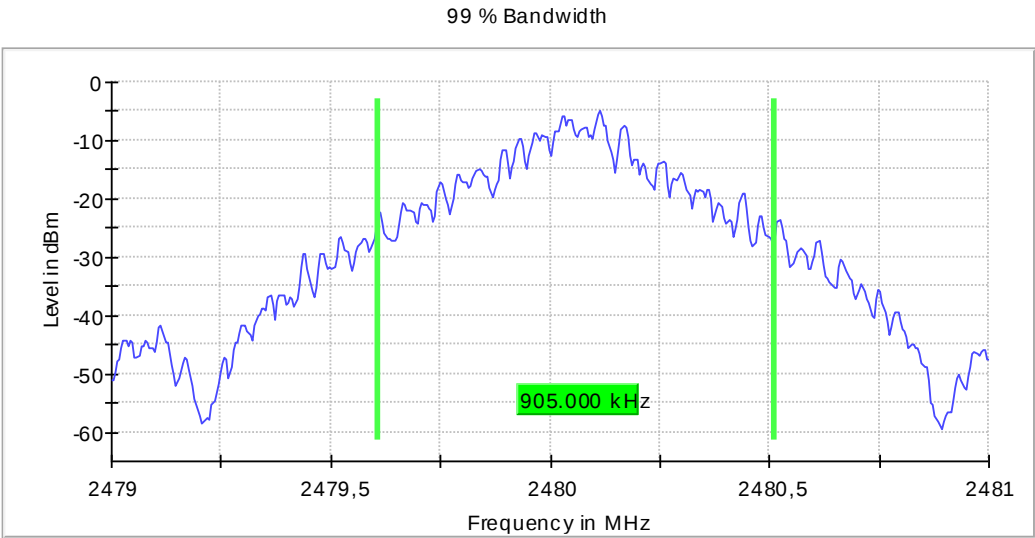
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



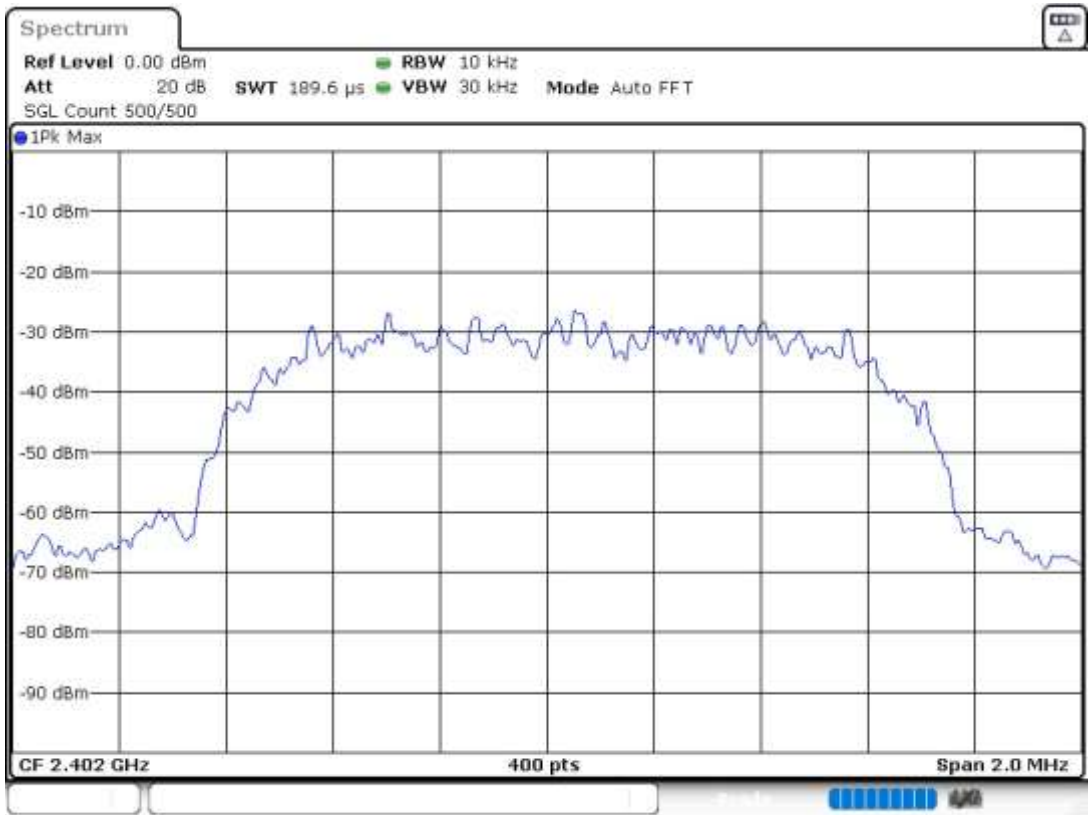
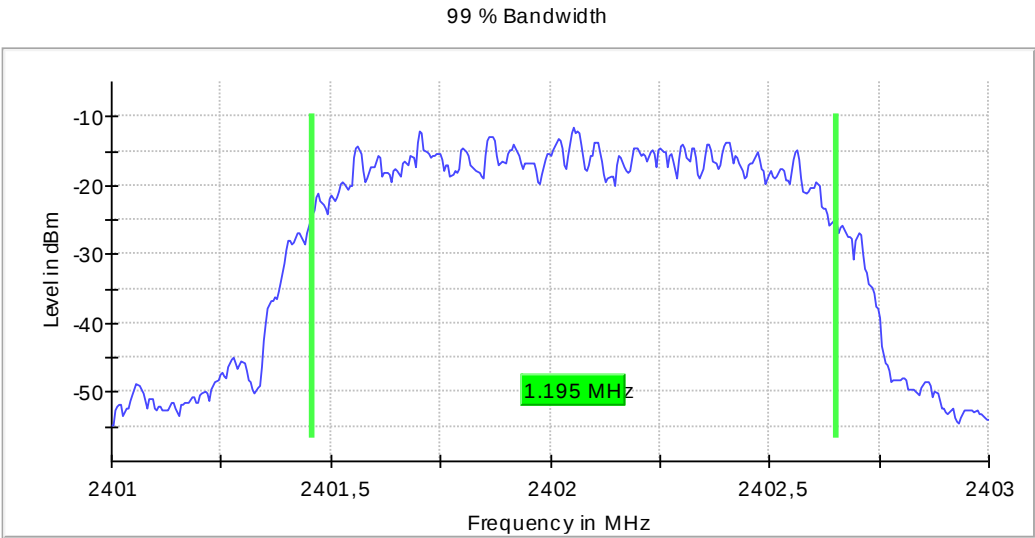
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Plots:



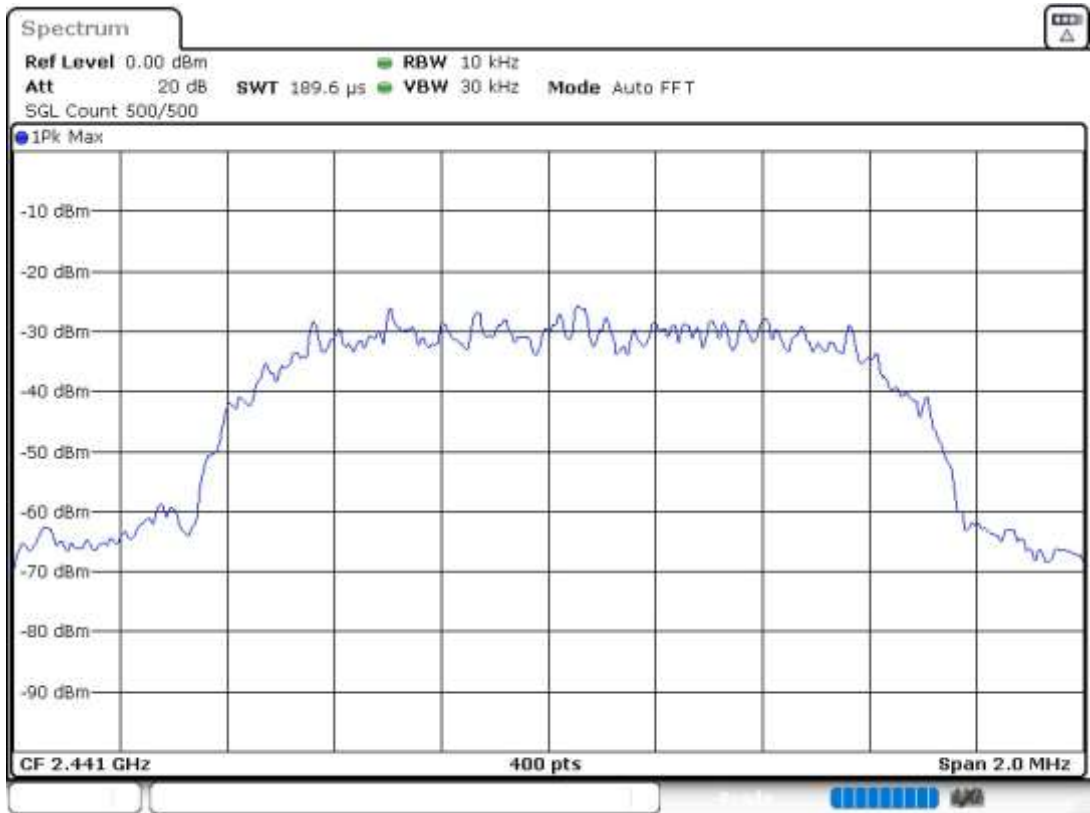
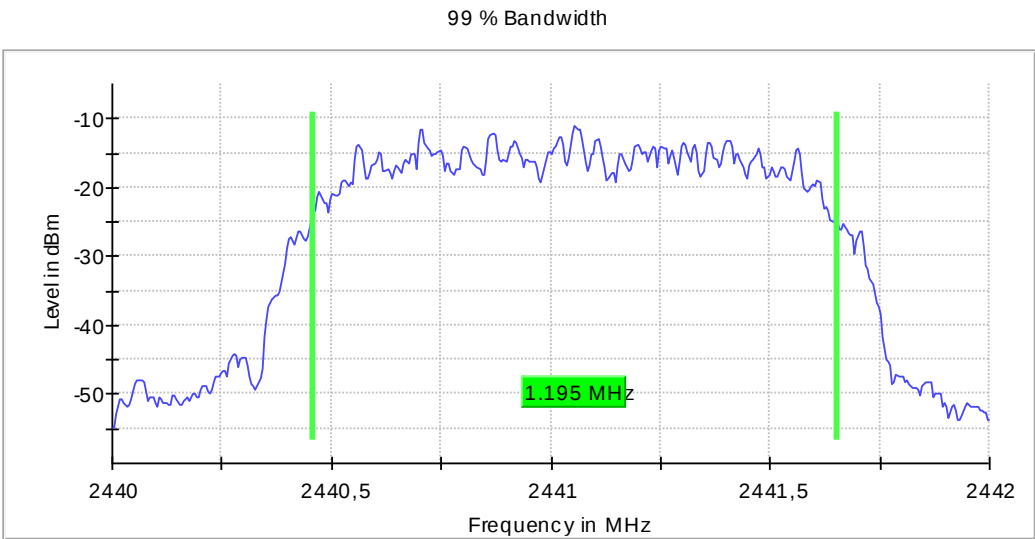
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



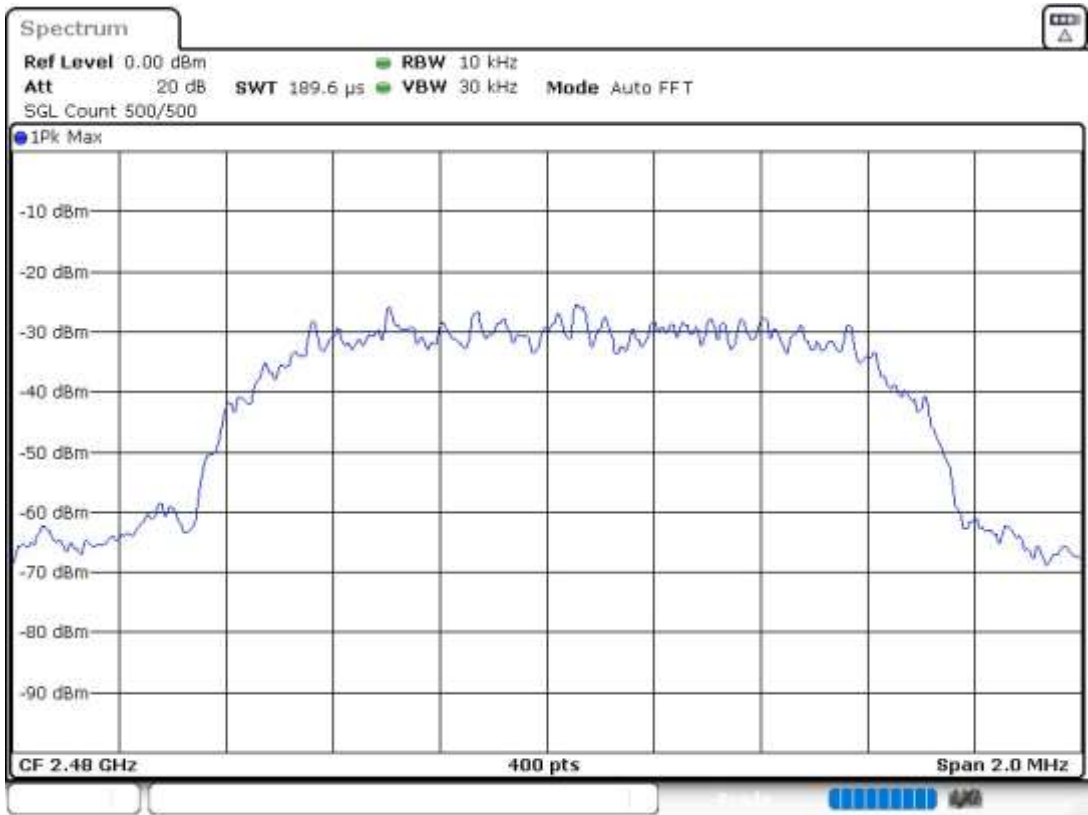
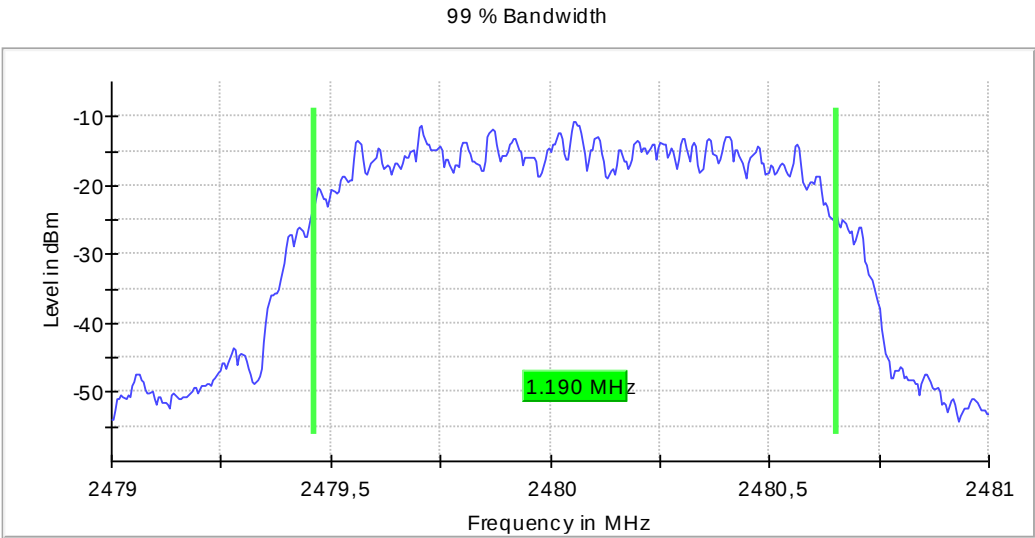
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



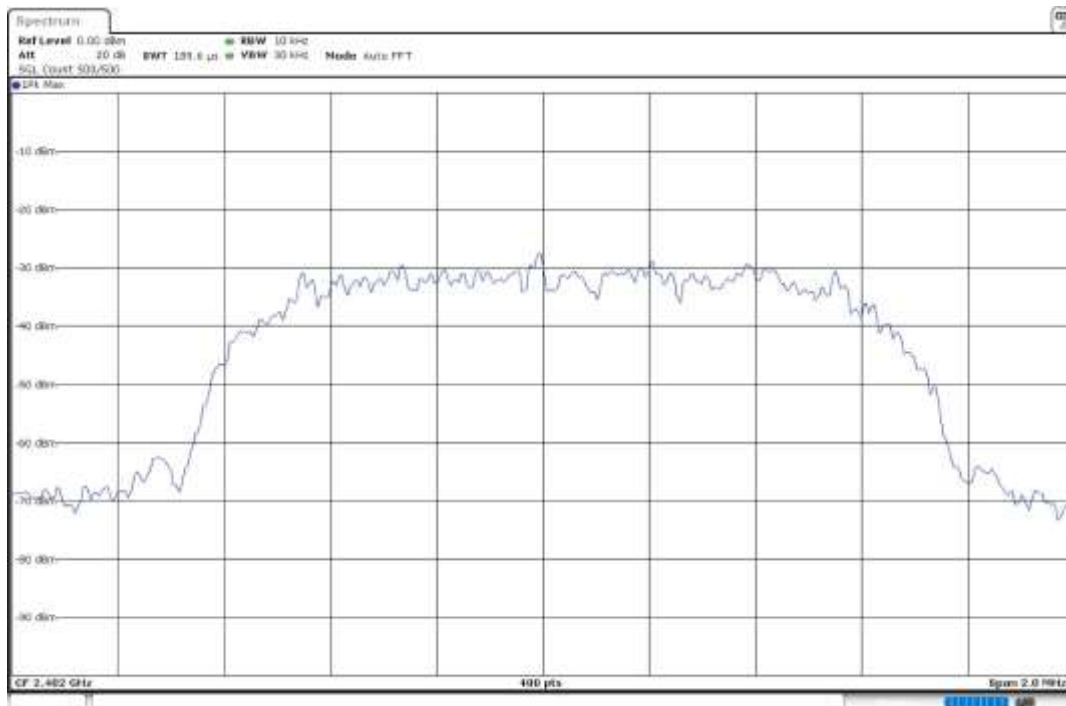
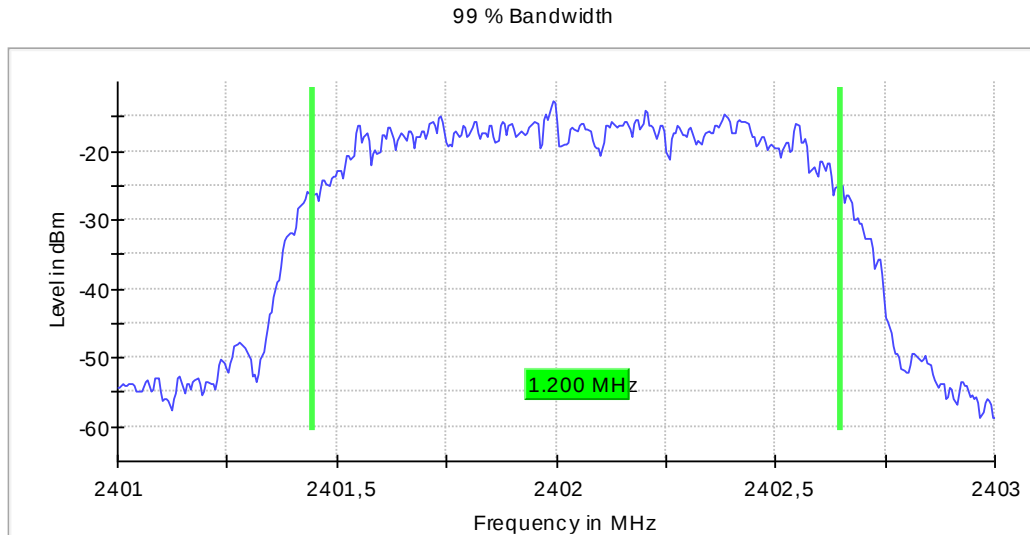
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



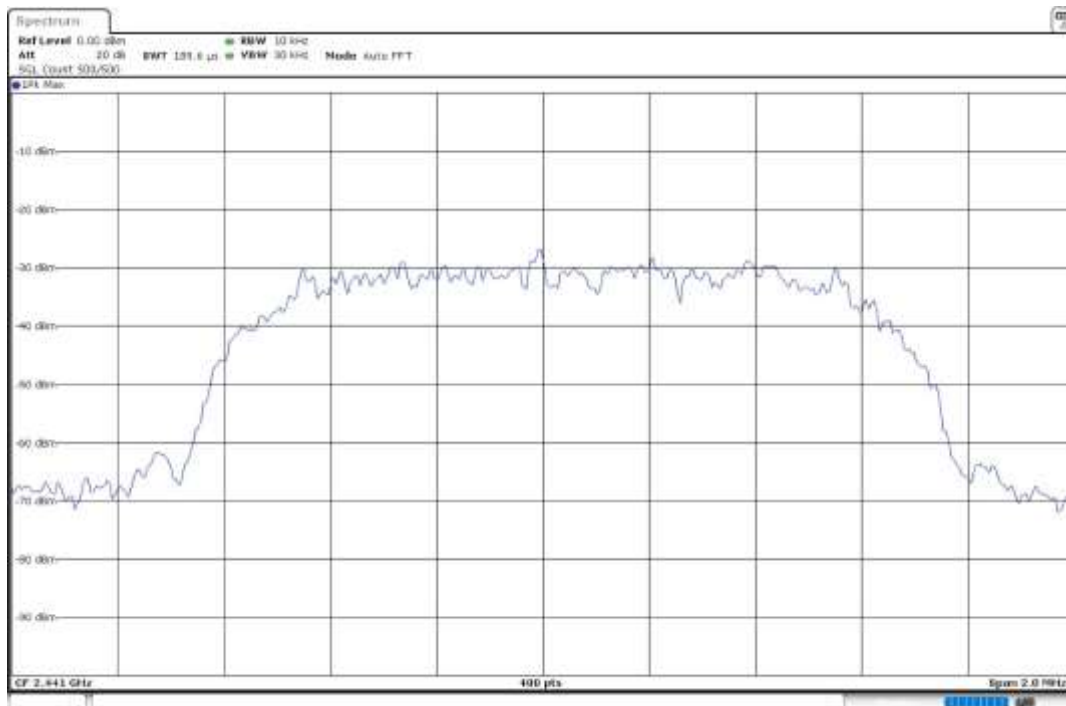
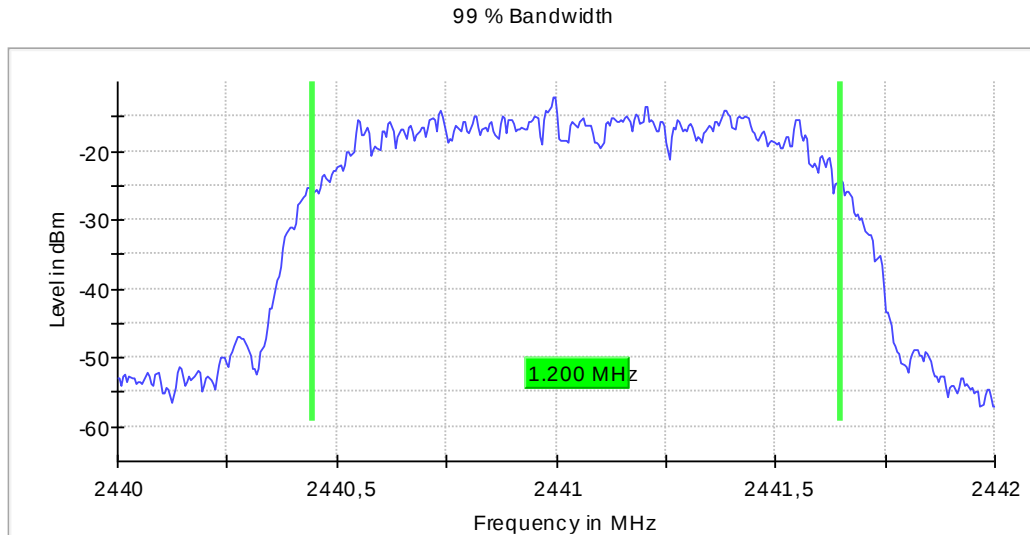
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



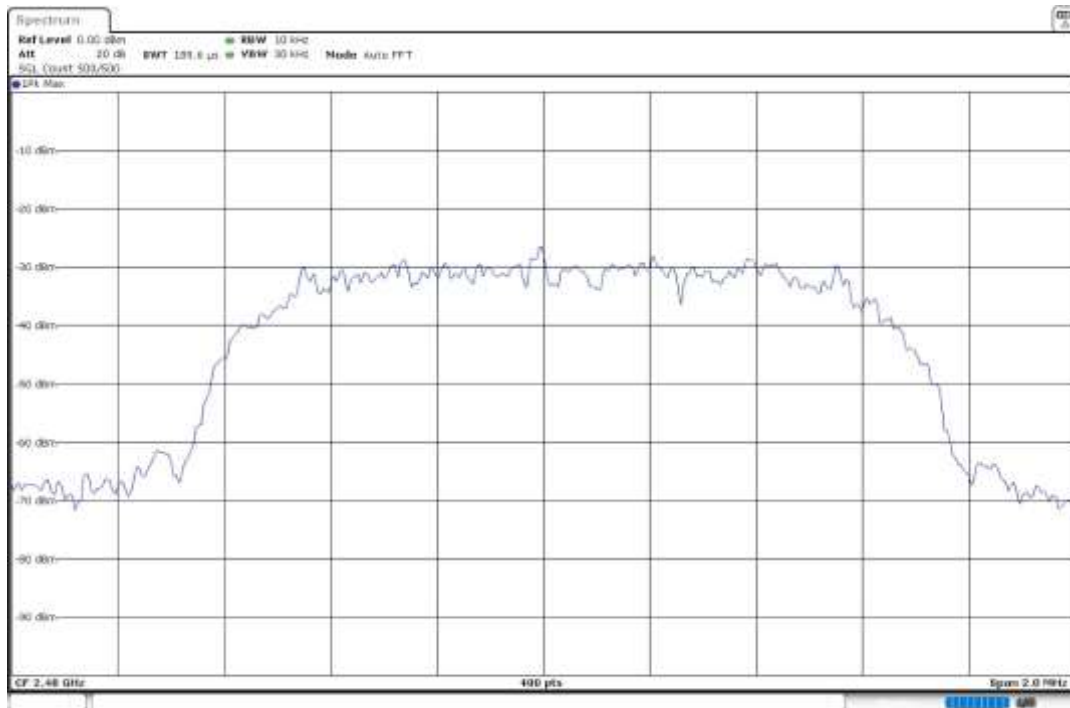
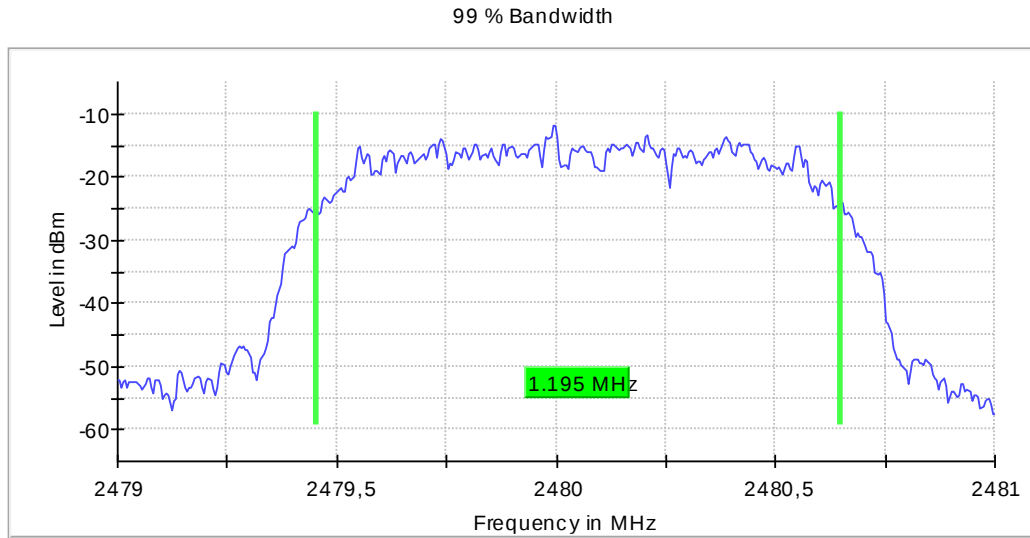
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



RSS-247 5.1 (b) / FCC 15.247 (a)(1) 20 dB Bandwidth

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

Modulation: BT (GFSK 1-DH5)

Operation Band (MHz)	Freq (MHz)	Equipment	20 dB Emission Bandwidth (MHz)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	0.930000
	2441.00000		0.930000
	2480.00000		0.930000

Verdict

Pass

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

Operation Band (MHz)	Freq (MHz)	Equipment	20dB Emission Bandwidth (MHz)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	1.335000
	2441.00000		1.330000
	2480.00000		1.325000

Verdict

Pass

Modulation: BT (8DPSK 3-DH5)

Operation Band (MHz)	Freq (MHz)	Equipment	20 dB Emission Bandwidth (MHz)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	1.340000
	2441.00000		1.325000
	2480.00000		1.335000

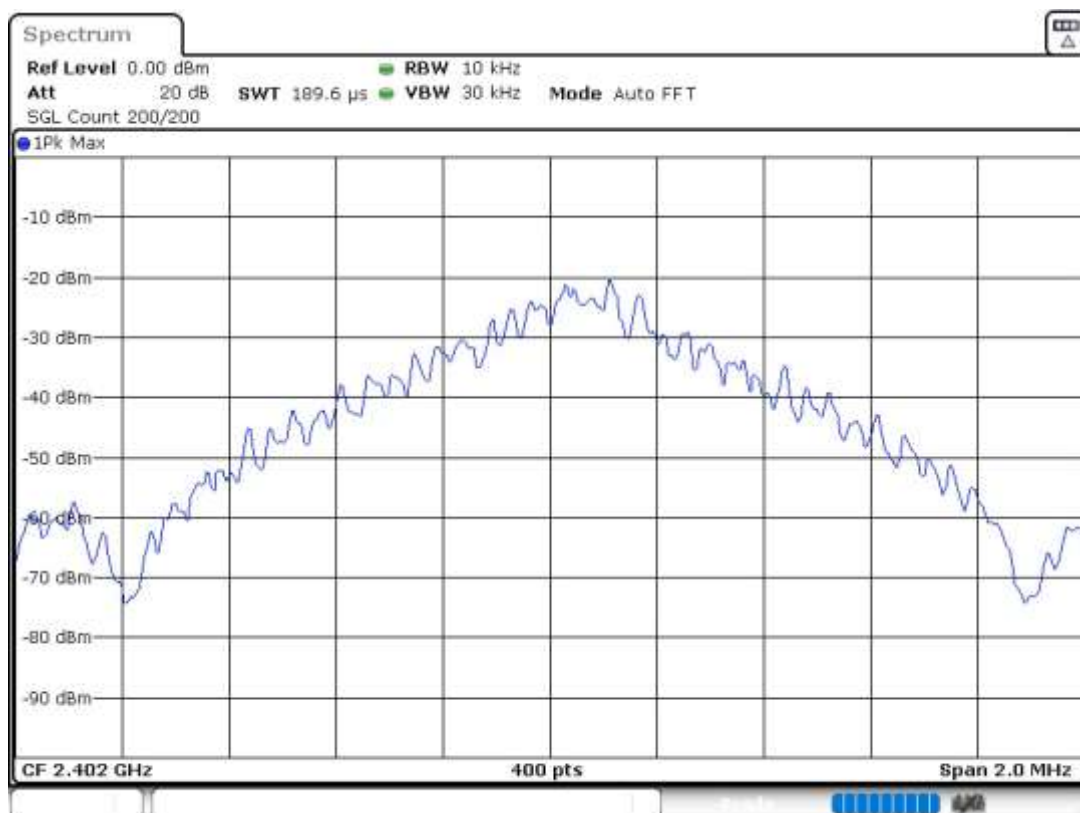
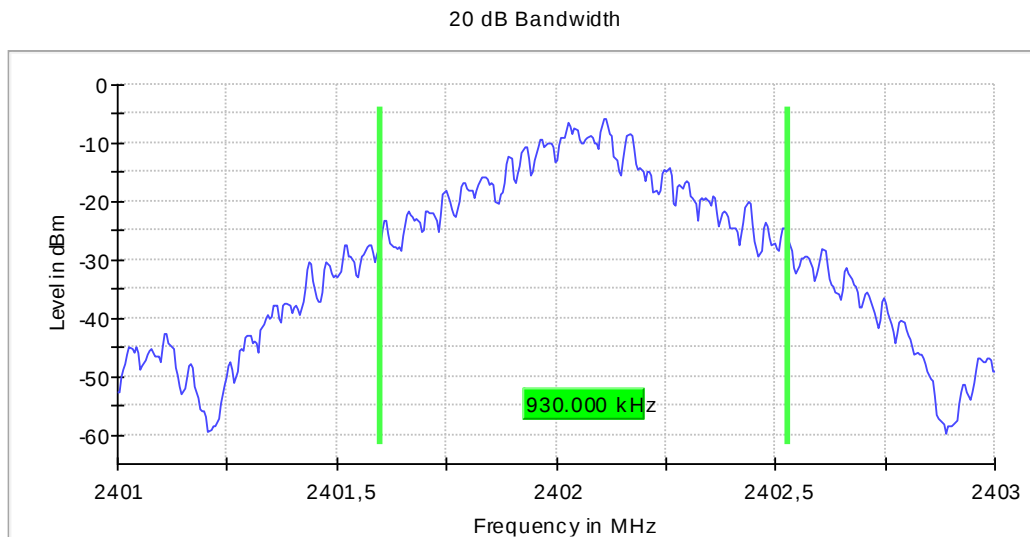
Verdict

Pass

Attachments

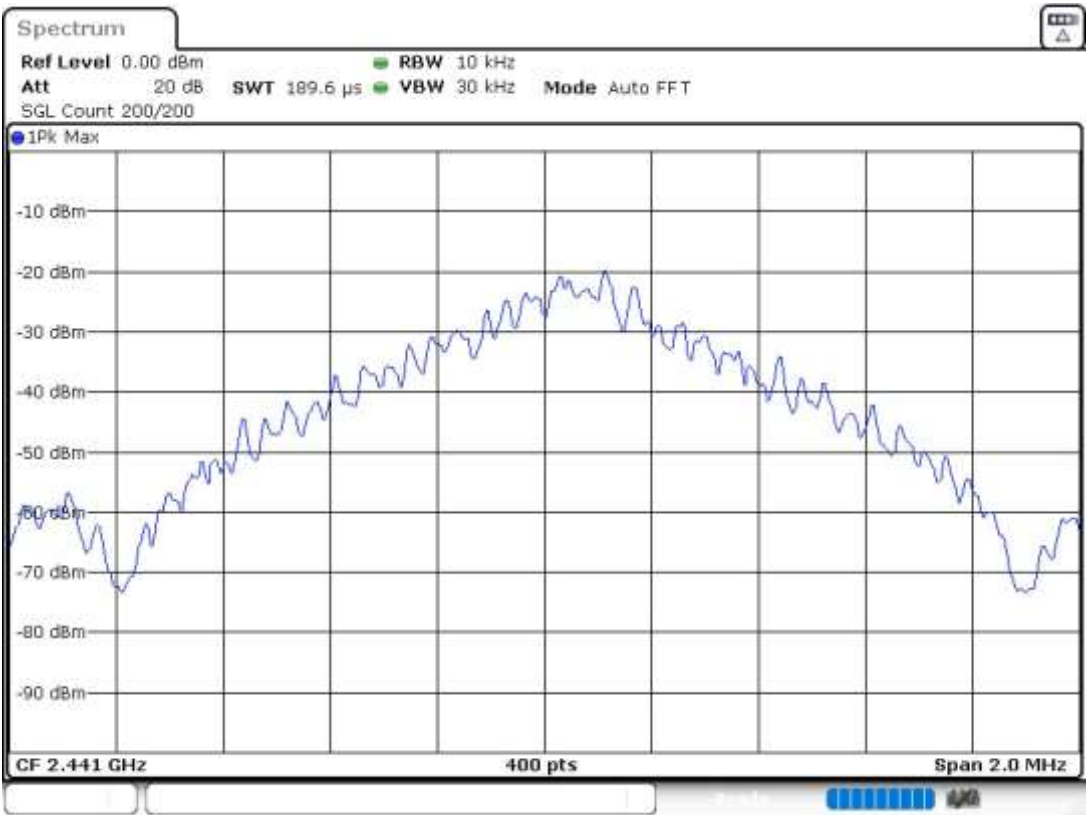
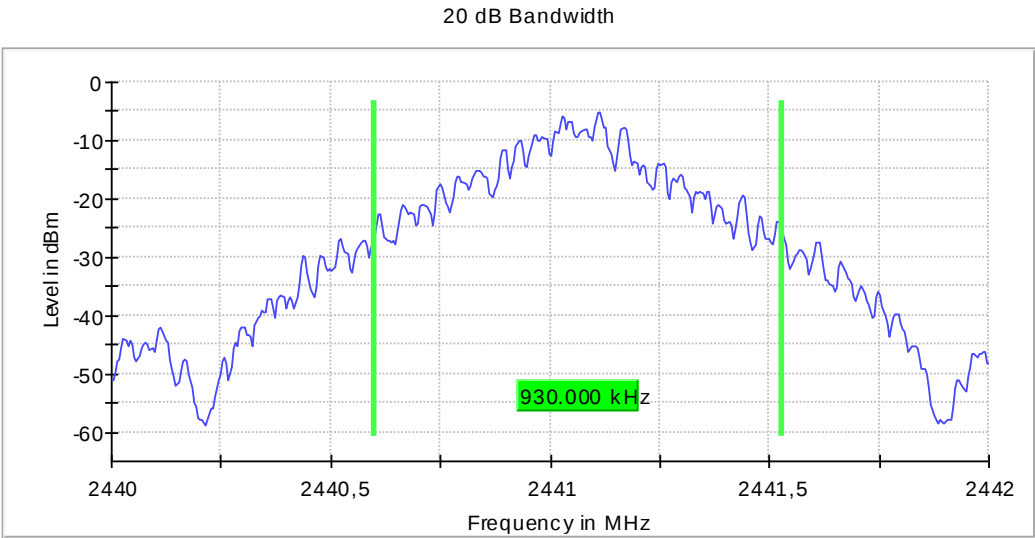
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



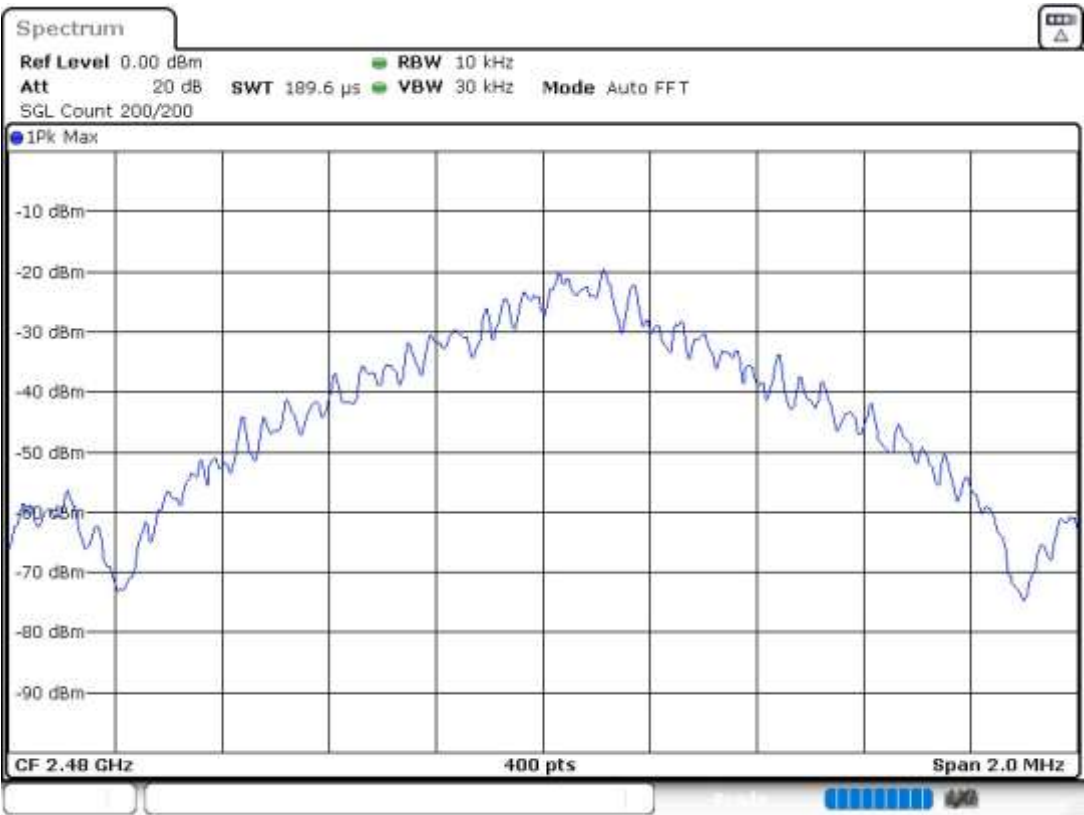
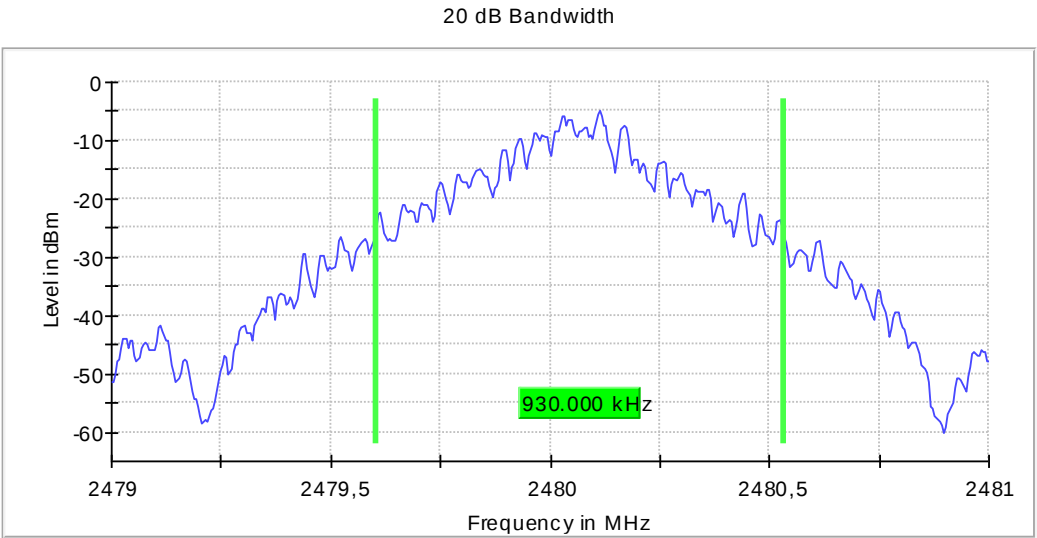
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



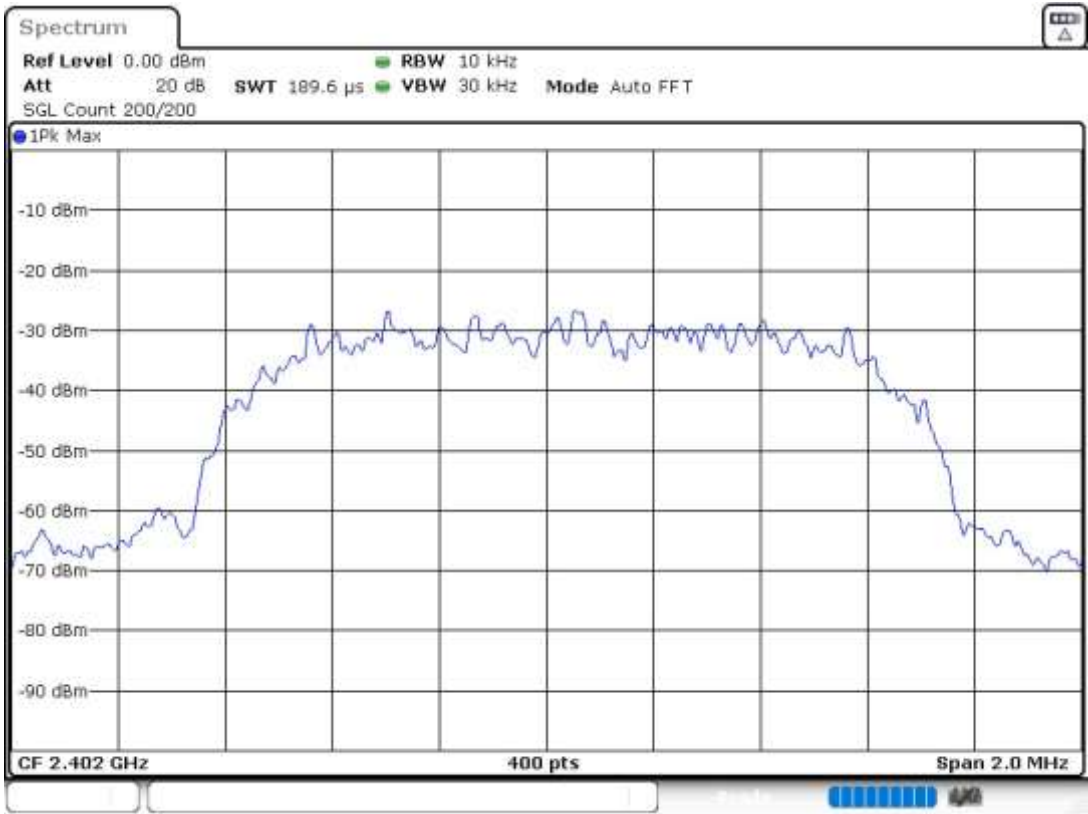
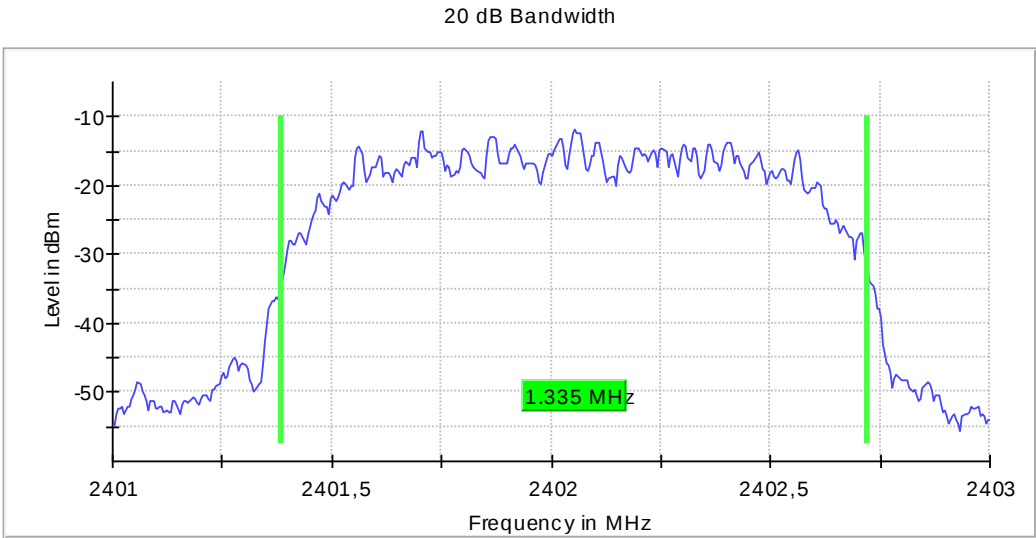
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Plots:



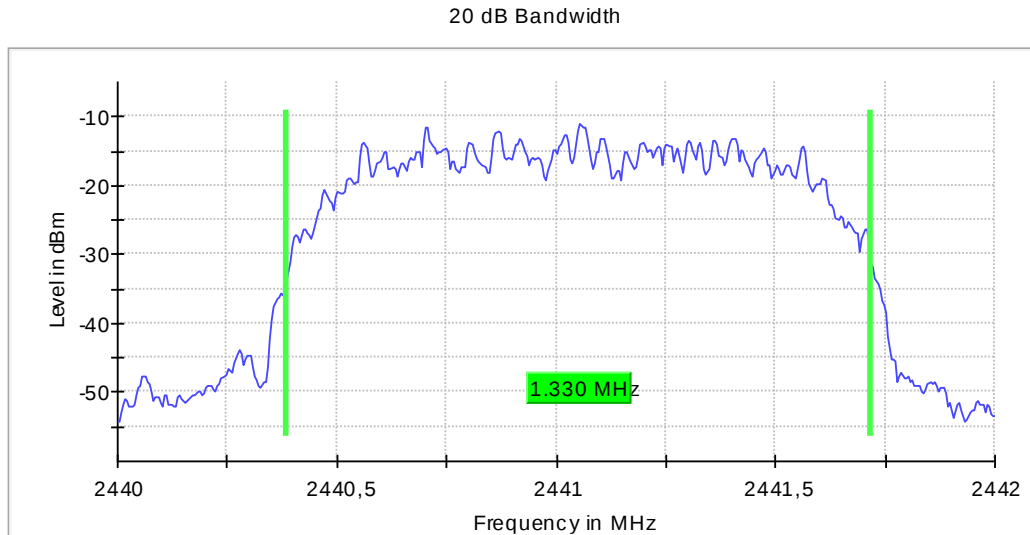
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



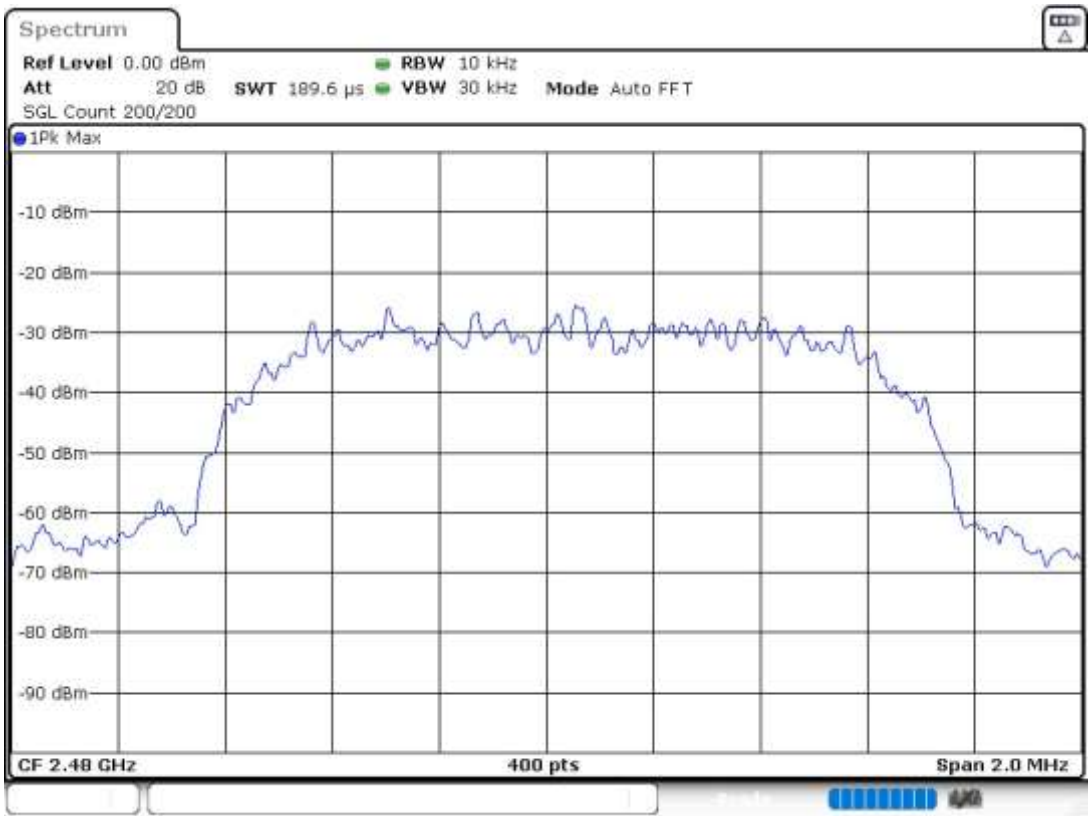
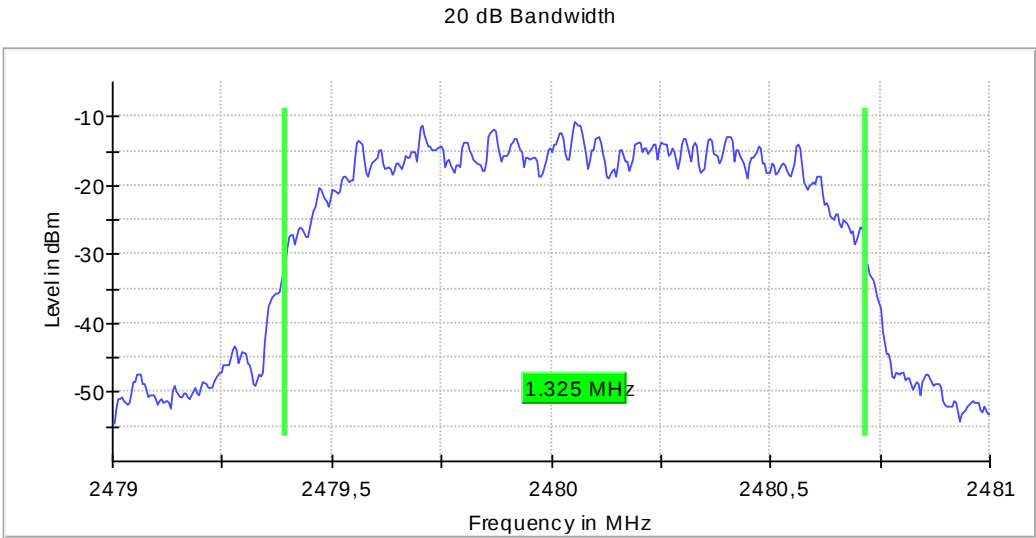
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



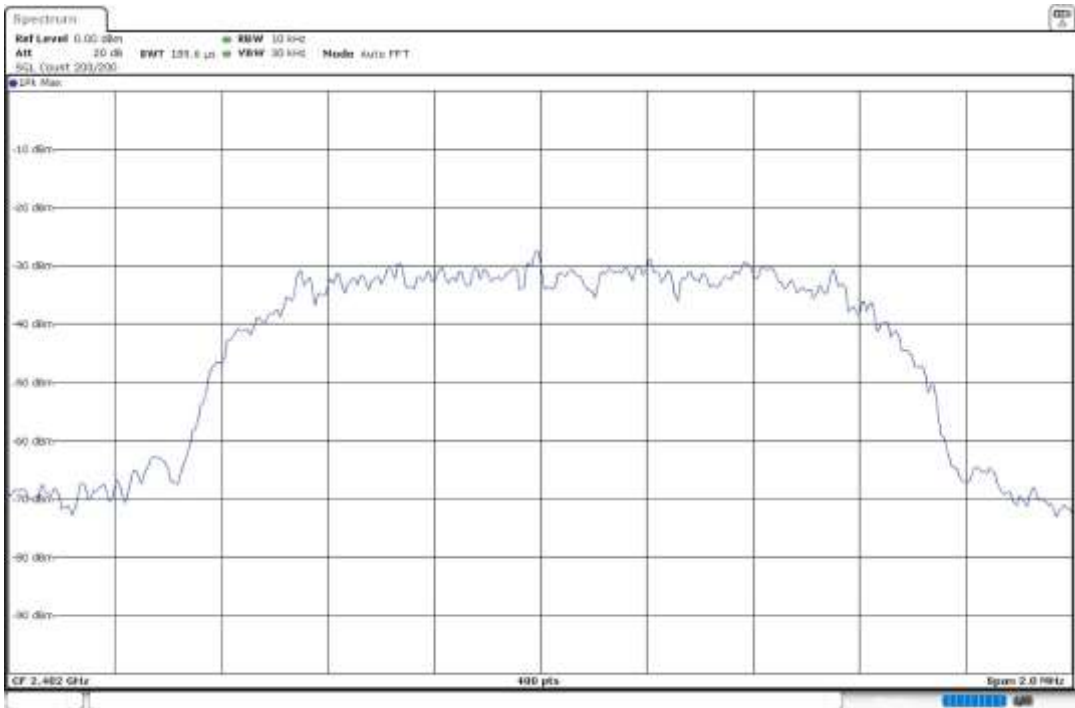
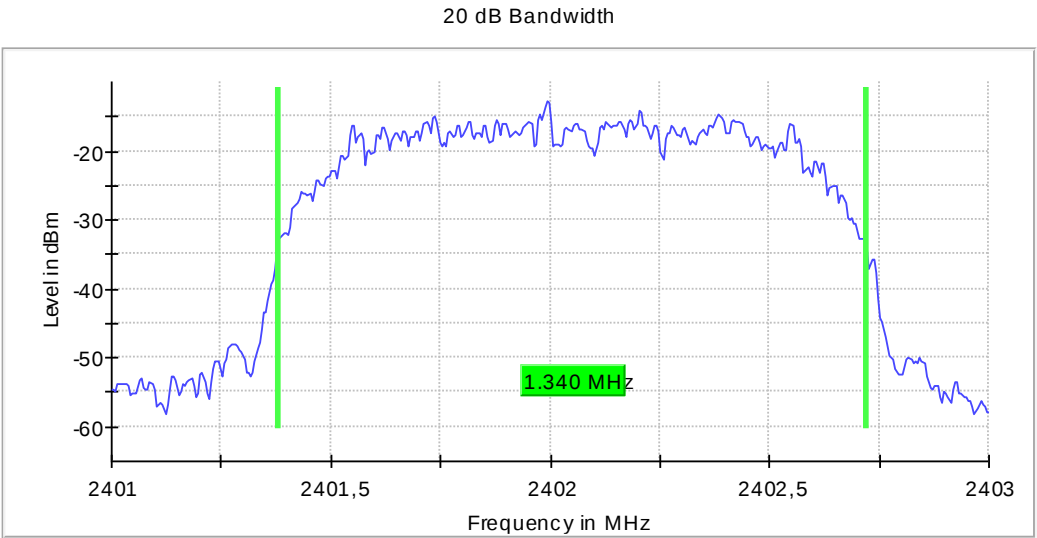
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Plots:



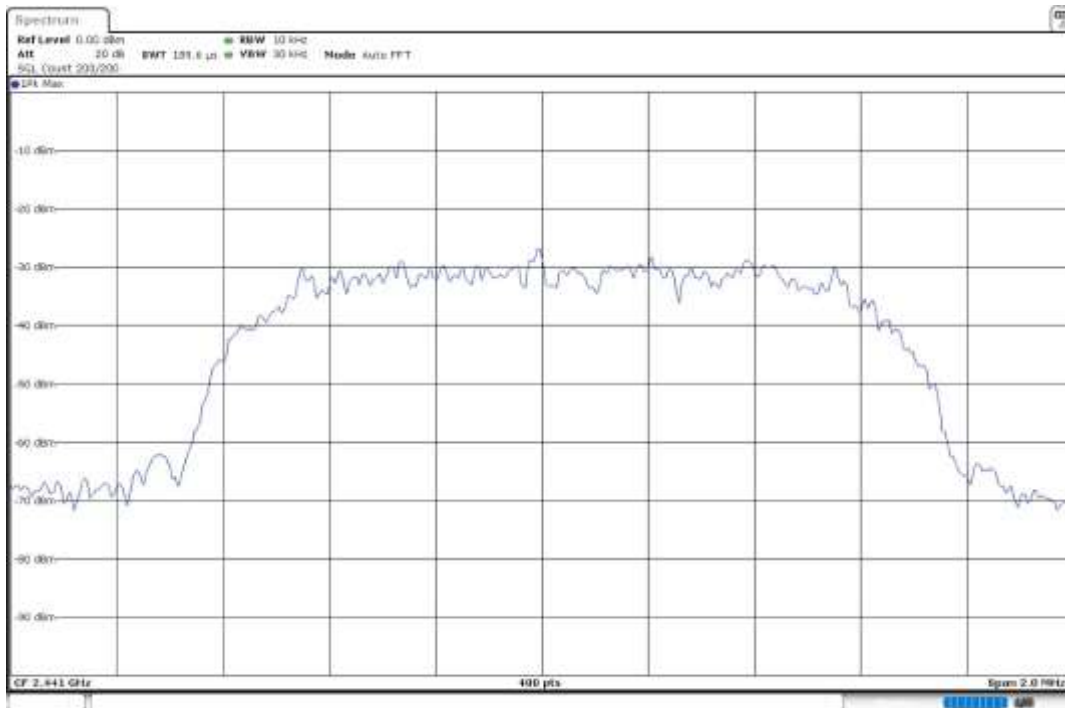
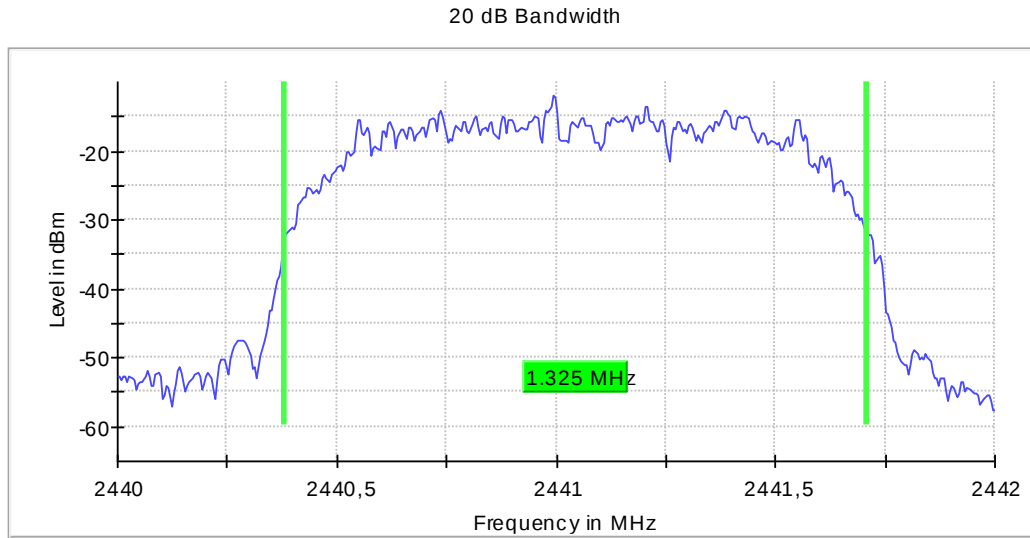
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



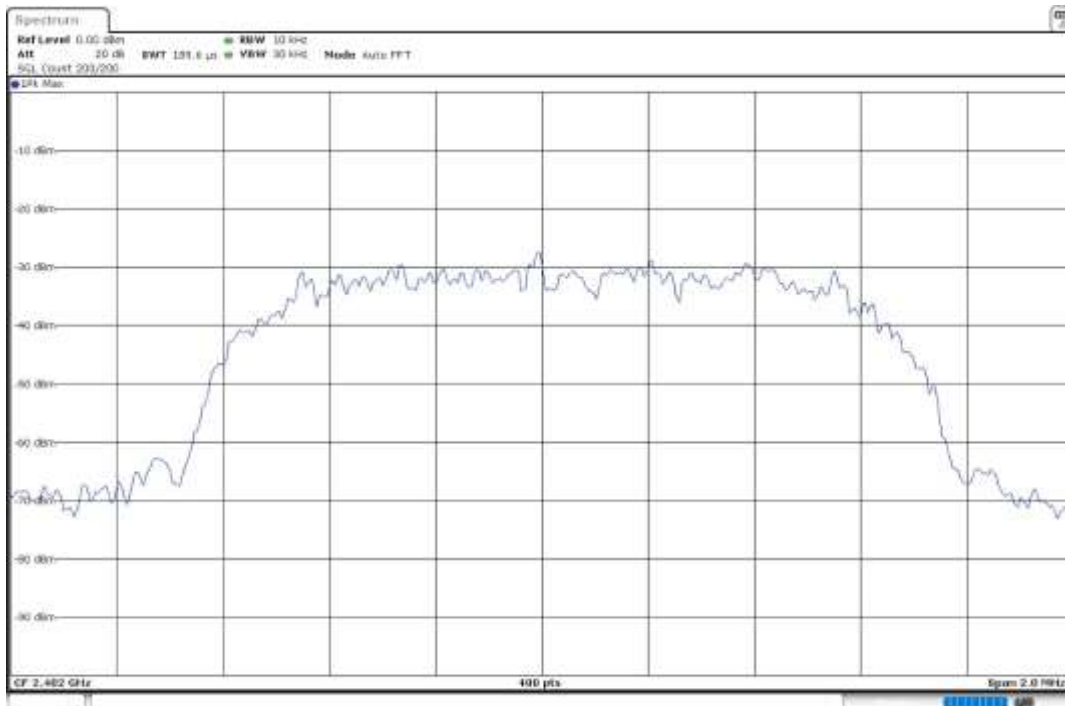
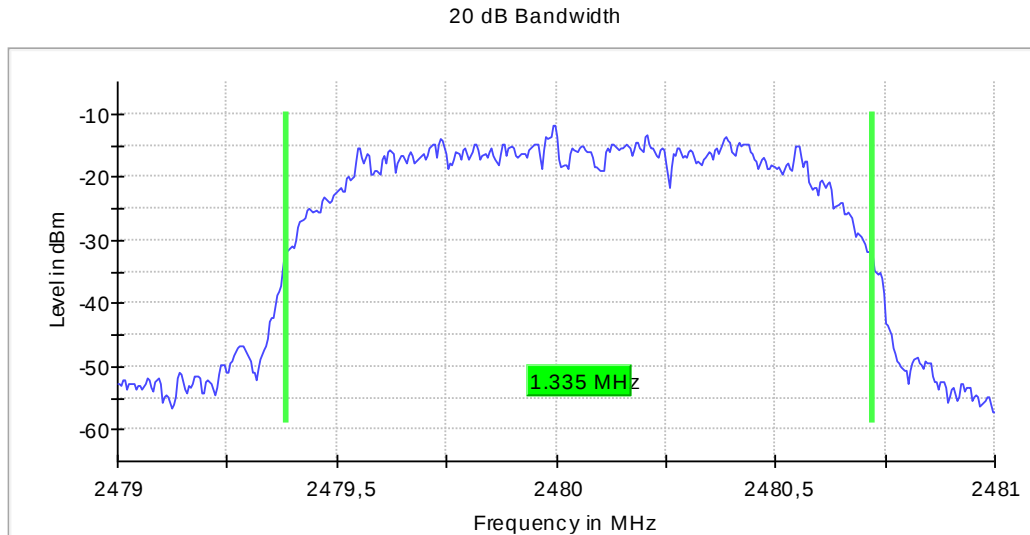
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



RSS-247 5.1 (b) / FCC 15.247 (a)(1) 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

Modulation: BT (GFSK 1-DH5)

Operation Band (MHz)	Equipment	Freq Sep (MHz)
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	1.000110

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

Verdict

Pass

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

Operation Band (MHz)	Equipment	Freq Sep (MHz)
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	1.000110

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

Verdict

Pass

Modulation: BT (8DPSK 3-DH5)

Operation Band (MHz)	Equipment	Freq Sep (MHz)
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	1.000110

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

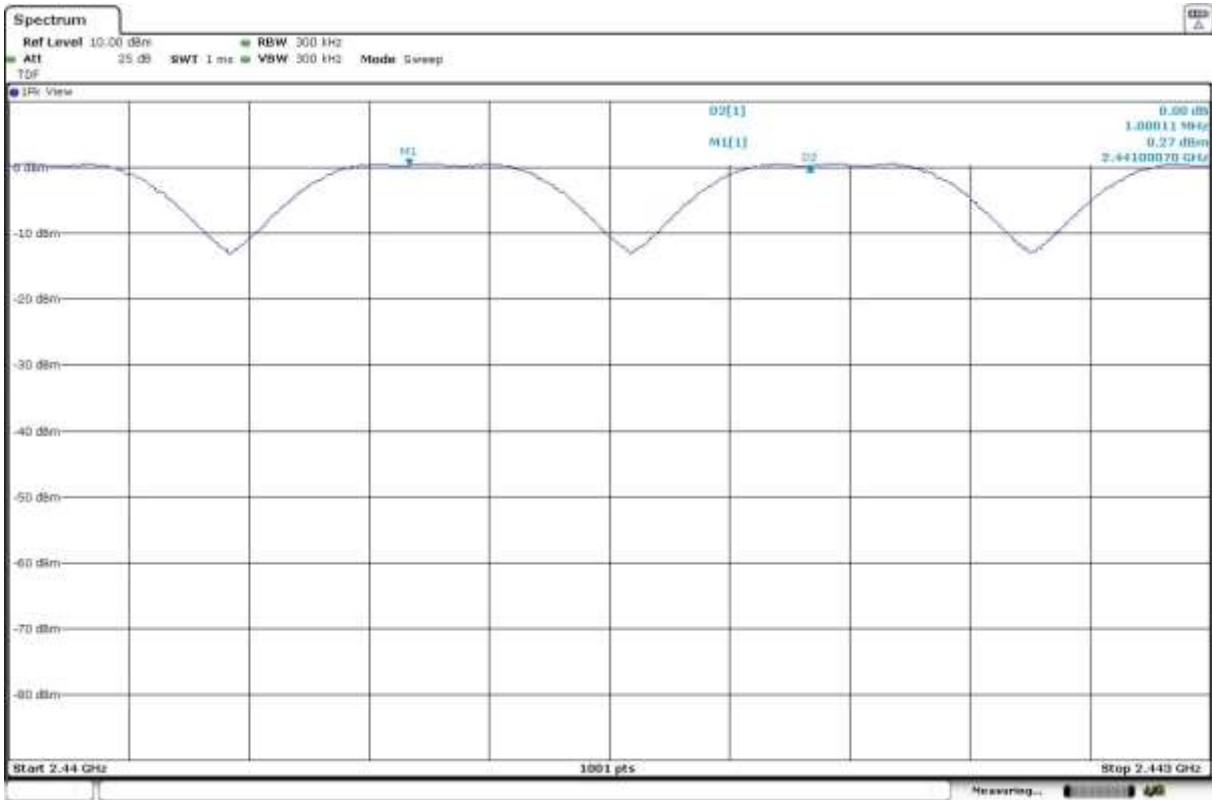
Verdict

Pass

Attachments

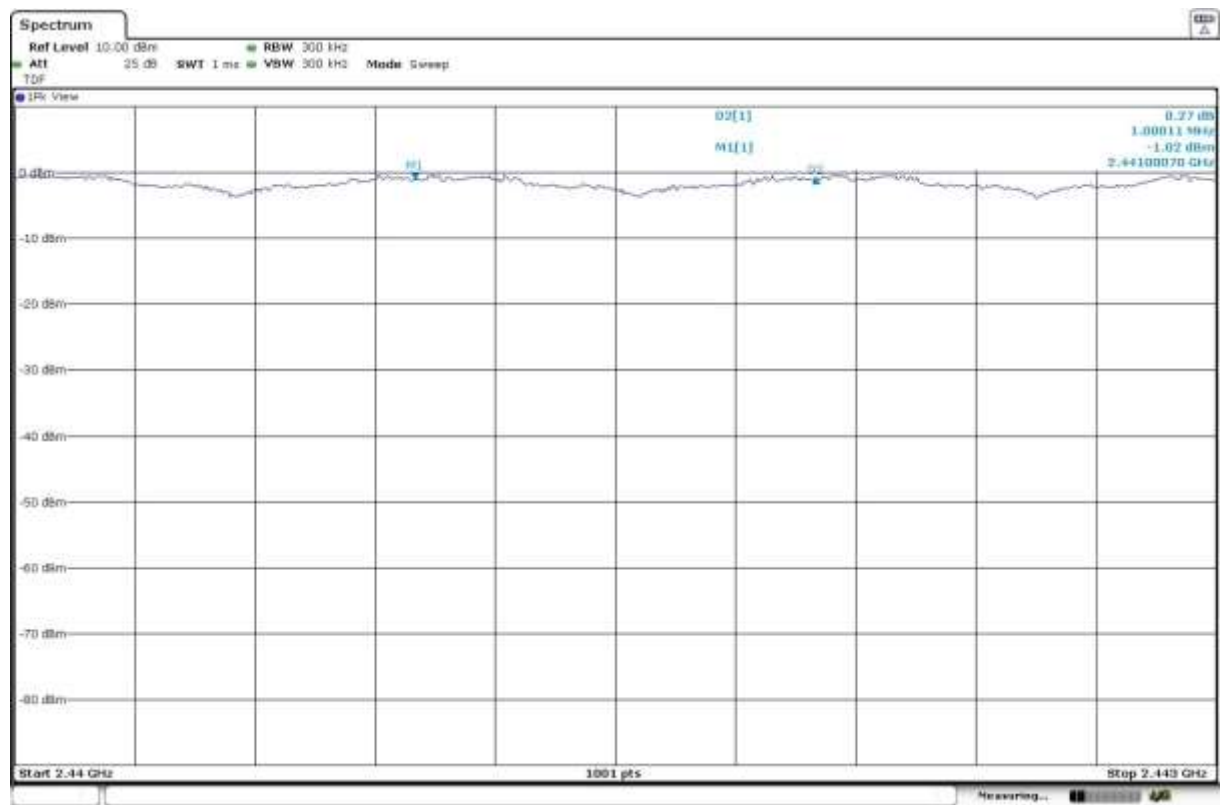
Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



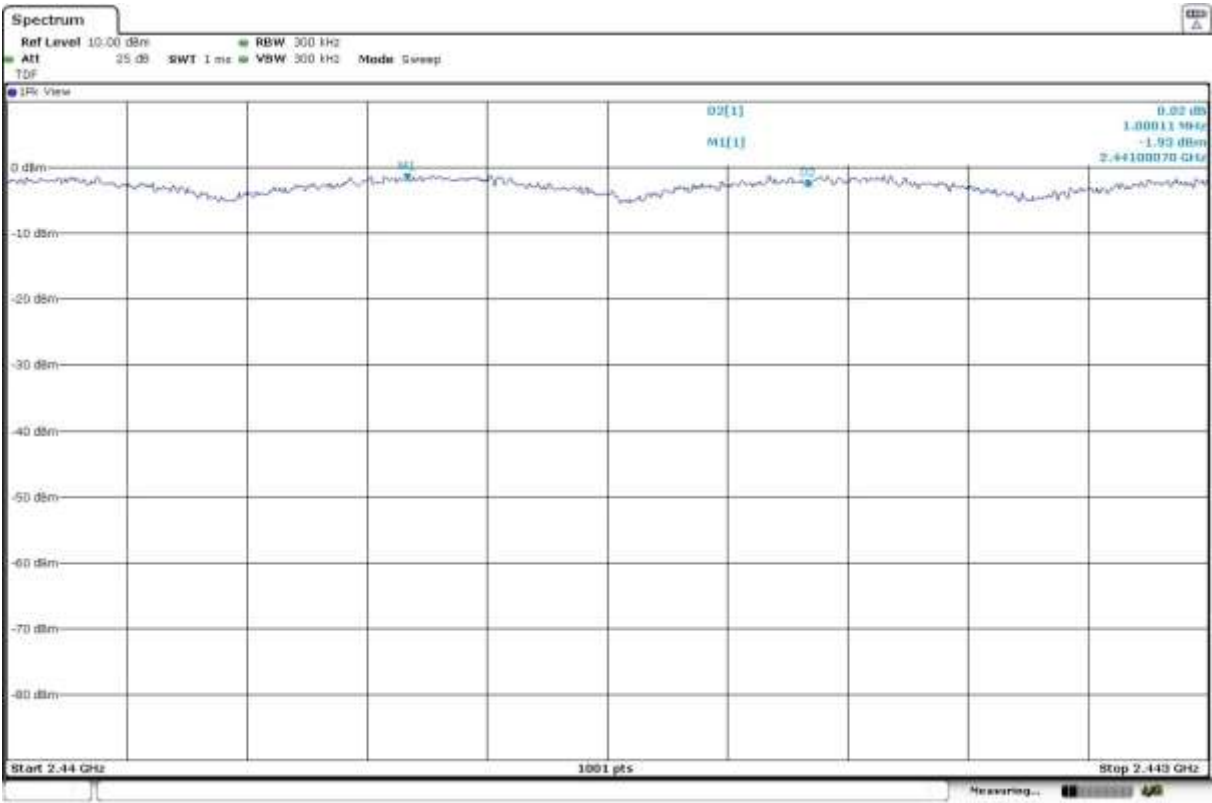
Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



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

Plots:



RSS-247 5.1 (d) / FCC 15.247 (a)(1)(iii) 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 = $0.4 \times 79 = 31.6$ seconds.

Results

Worst-case channel (highest COT) is reported.

Modulation: BT (GFSK 1-DH5)

Operation Band (MHz)	Equipment	NHp	Avg COT (ms)
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	104	304.070

Verdict

Pass

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

Operation Band (MHz)	Equipment	NHp	Avg COT (ms)
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	106	302.650

Verdict

Pass

Modulation: BT (8DPSK 3-DH5)

Operation Band (MHz)	Equipment	NHp	Avg COT (ms)
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	111	312.400

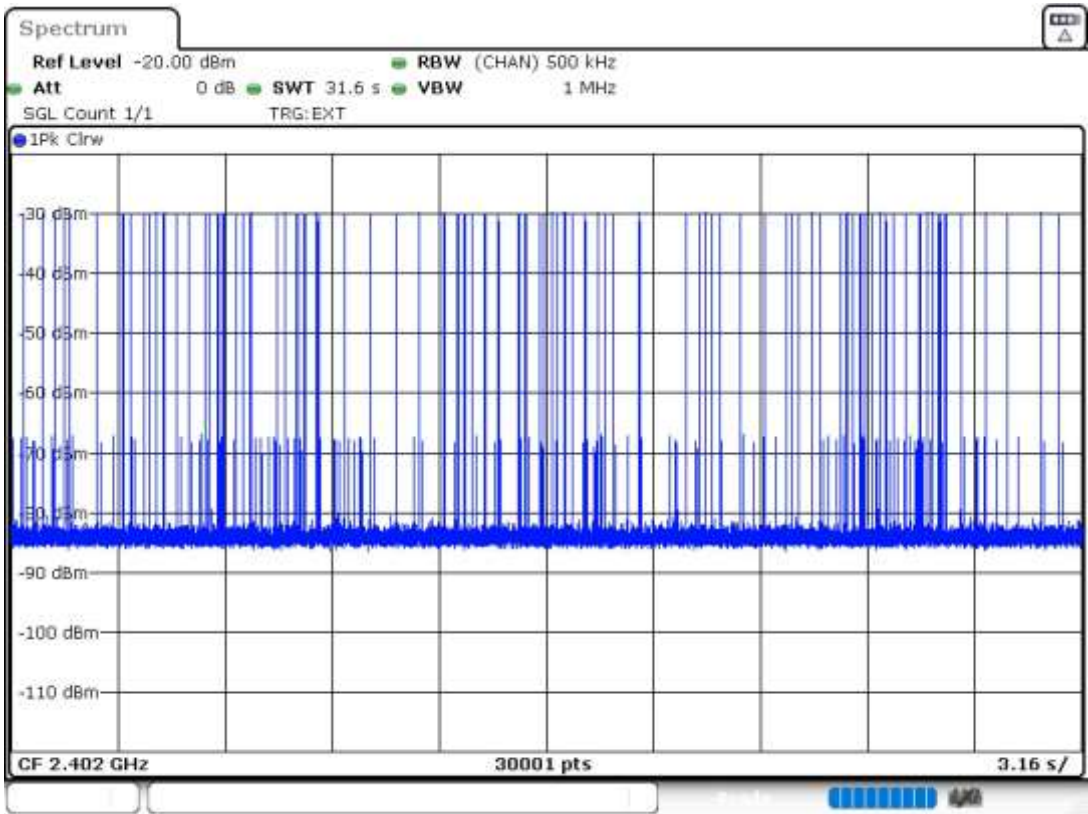
Verdict

Pass

Attachments

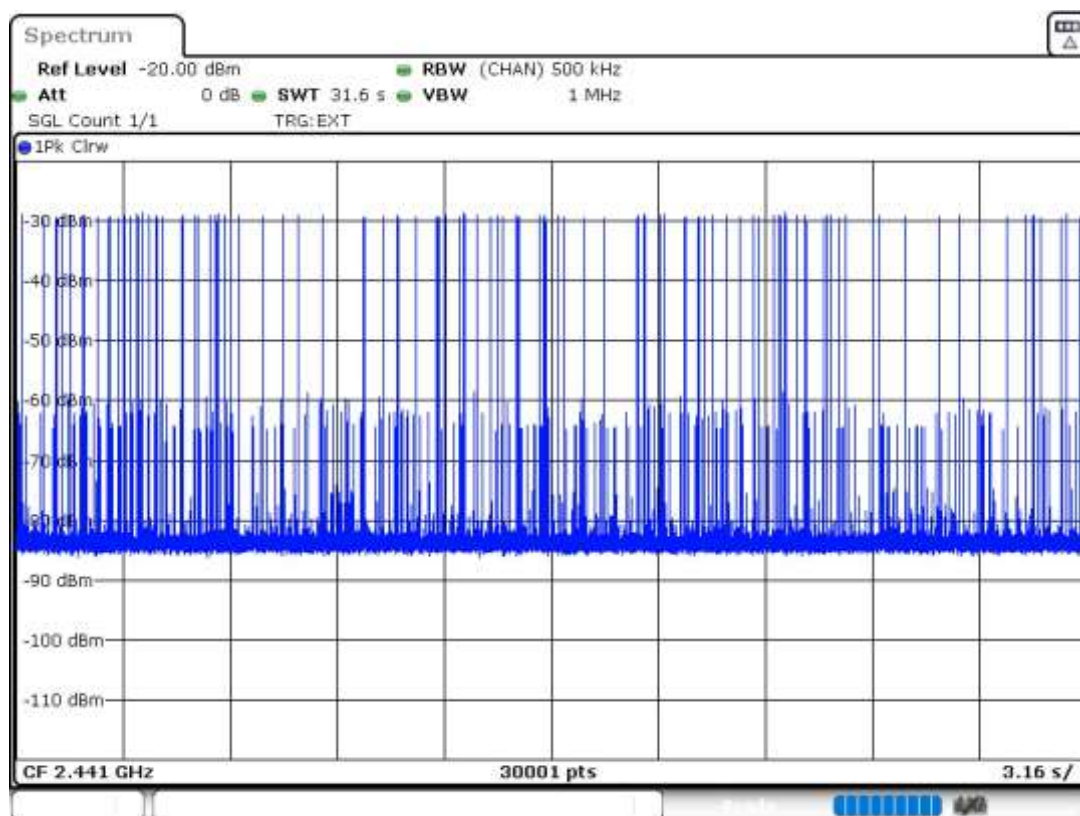
Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



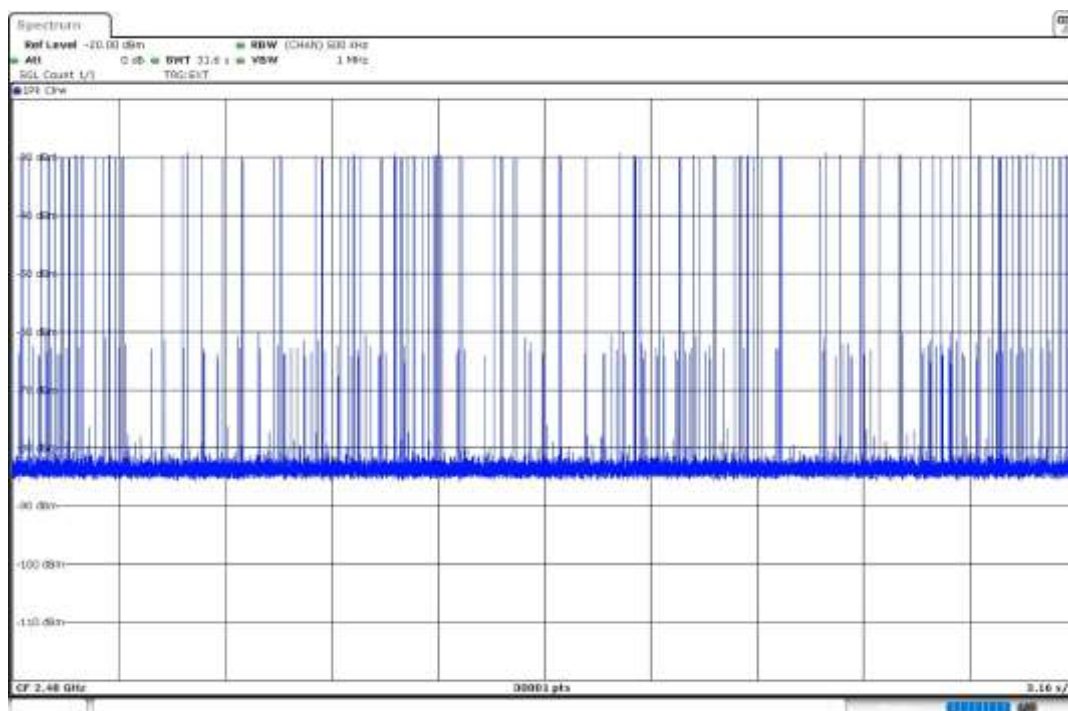
Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



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

Plots:



RSS-247 5.1 (d) / FCC 15.247 (a)(1)(iii) 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	NHC
[2400, 2483.5]	Frequency Hopping Spread Spectrum systems (DSS)	79

Verdict

Pass

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

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

Verdict

Pass

Modulation: BT (8DPSK 3-DH5)

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

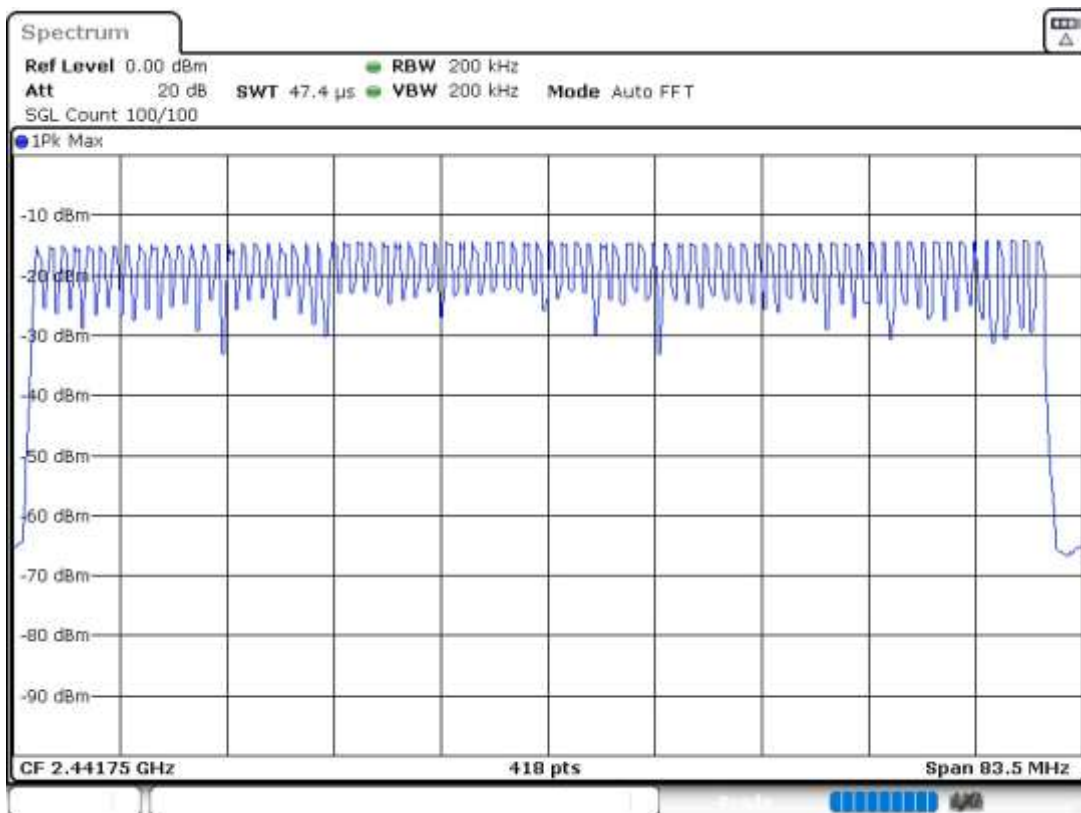
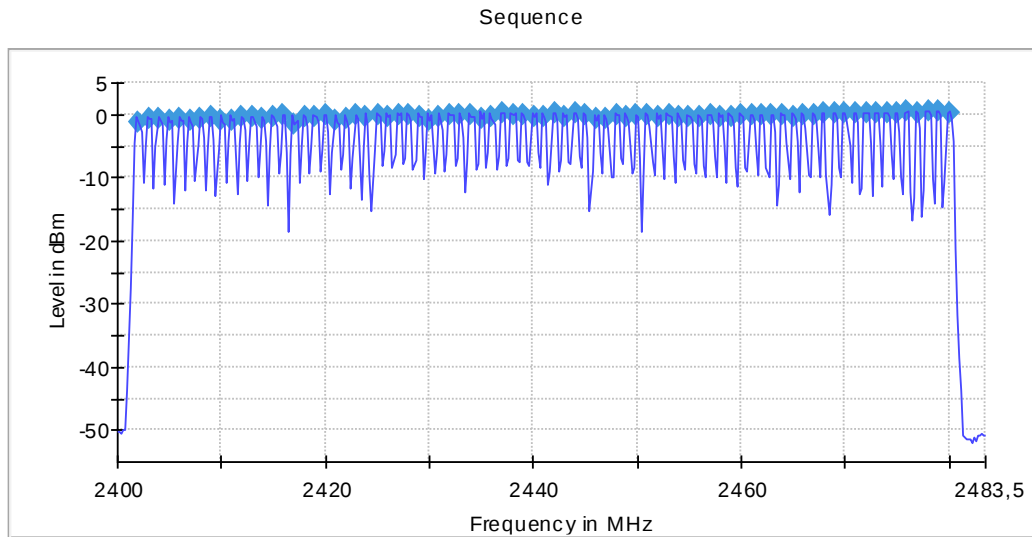
Verdict

Pass

Attachments

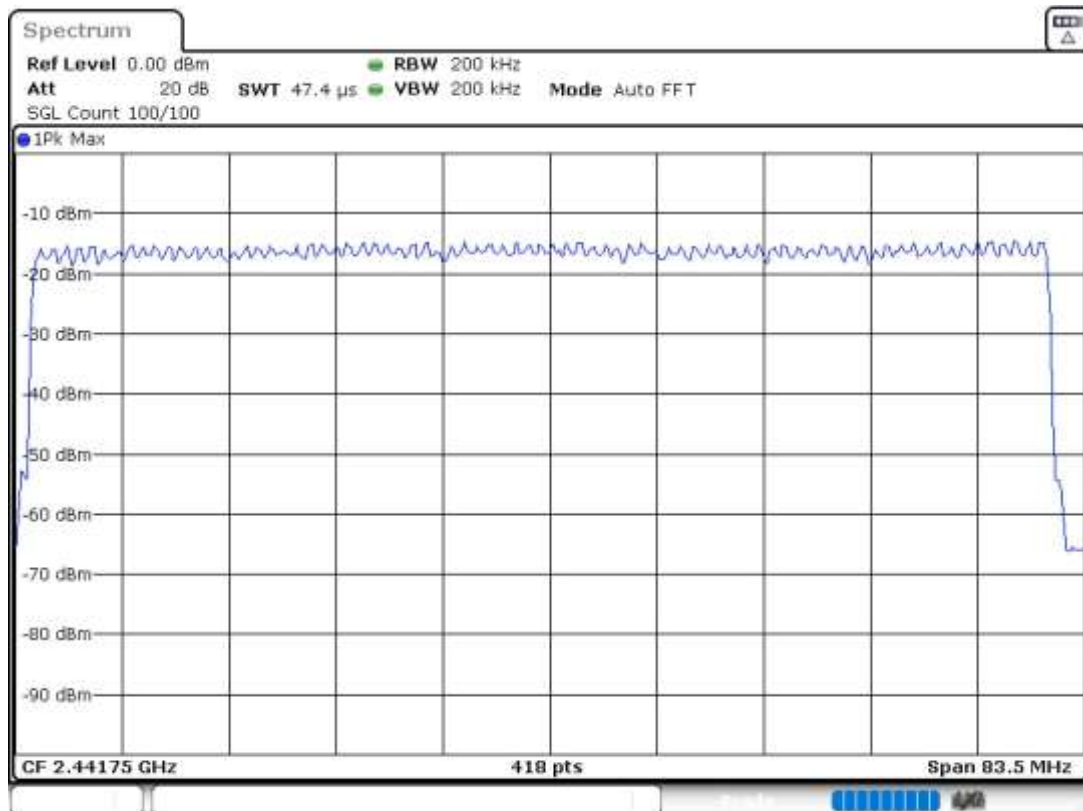
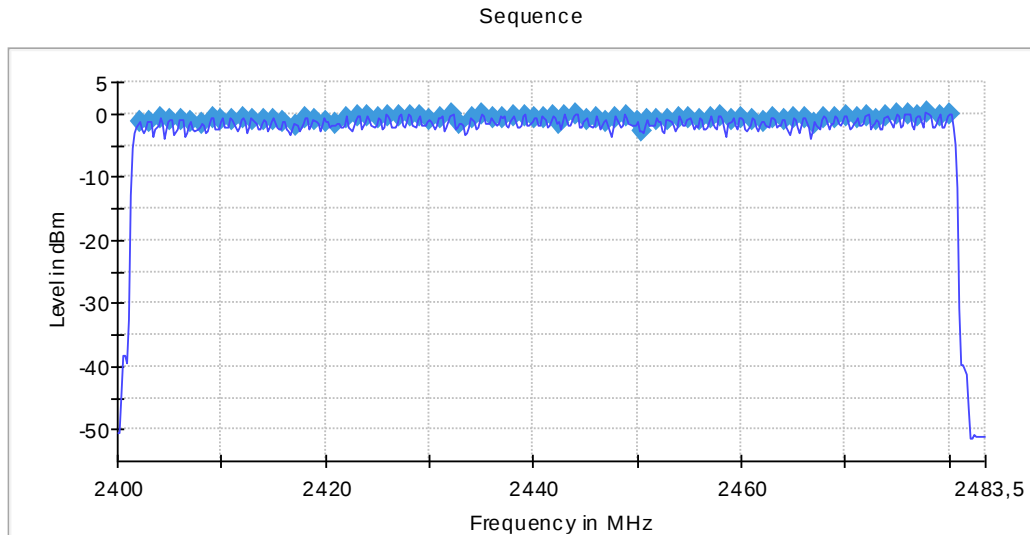
Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



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

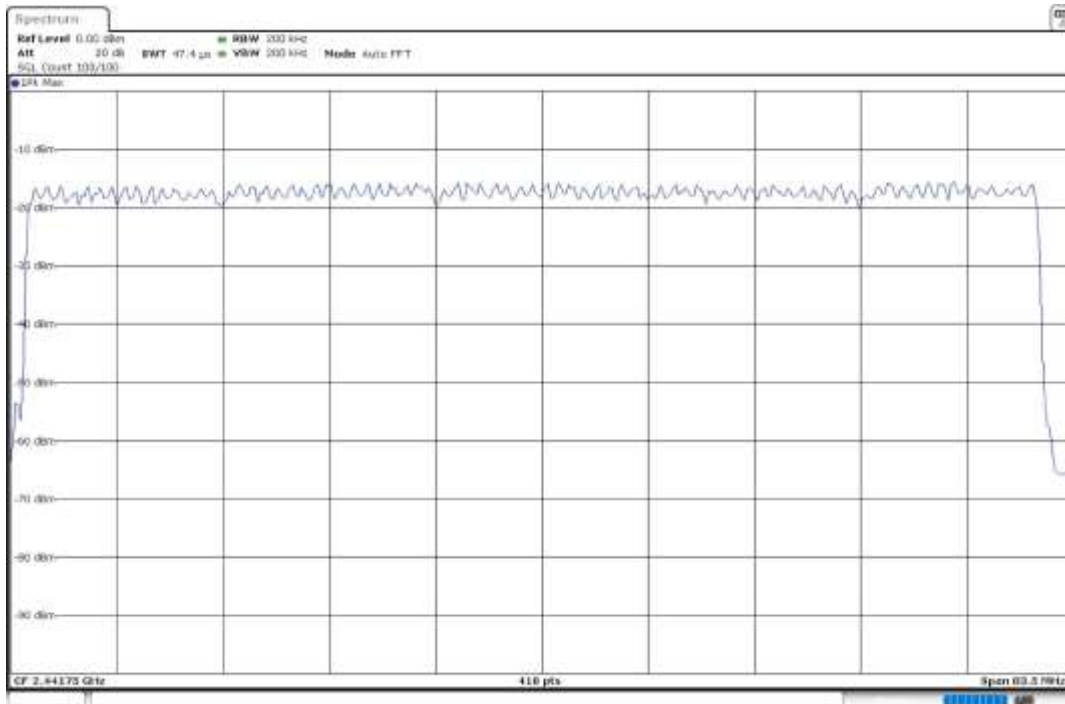
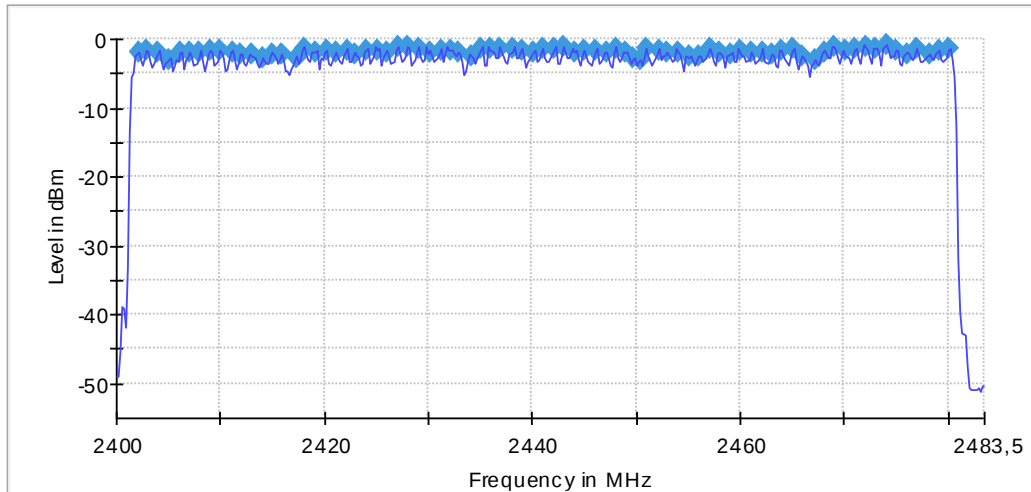
Plots:



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

Plots:

Sequence



RSS-247 5.4 (b) / FCC 15.247 (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). The e.i.r.p. shall not exceed 4 W (RSS-247).

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: 5.2 dBi

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

Modulation: BT (GFSK 1-DH5)

Operation Band (MHz)	Freq (MHz)	Equipment	Maximum Conducted Power (dBm)	Maximum EIRP Power (dBm)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	0.71	5.91
	2441.00000		1.32	6.52
	2480.00000		1.59	6.79

Verdict

Pass

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

Operation Band (MHz)	Freq (MHz)	Equipment	Maximum Conducted Power (dBm)	Maximum EIRP Power (dBm)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	1.19	6.39
	2441.00000		2.03	7.23
	2480.00000		2.23	7.43

Verdict

Pass

Modulation: BT (8DPSK 3-DH5)

Operation Band (MHz)	Freq (MHz)	Equipment	Maximum Conducted Power (dBm)	Maximum EIRP Power (dBm)
[2400, 2483.5]	2402.00000	Frequency Hopping Spread Spectrum systems (DSS)	0.63	5.83
	2441.00000		1.55	6.75
	2480.00000		1.74	6.94

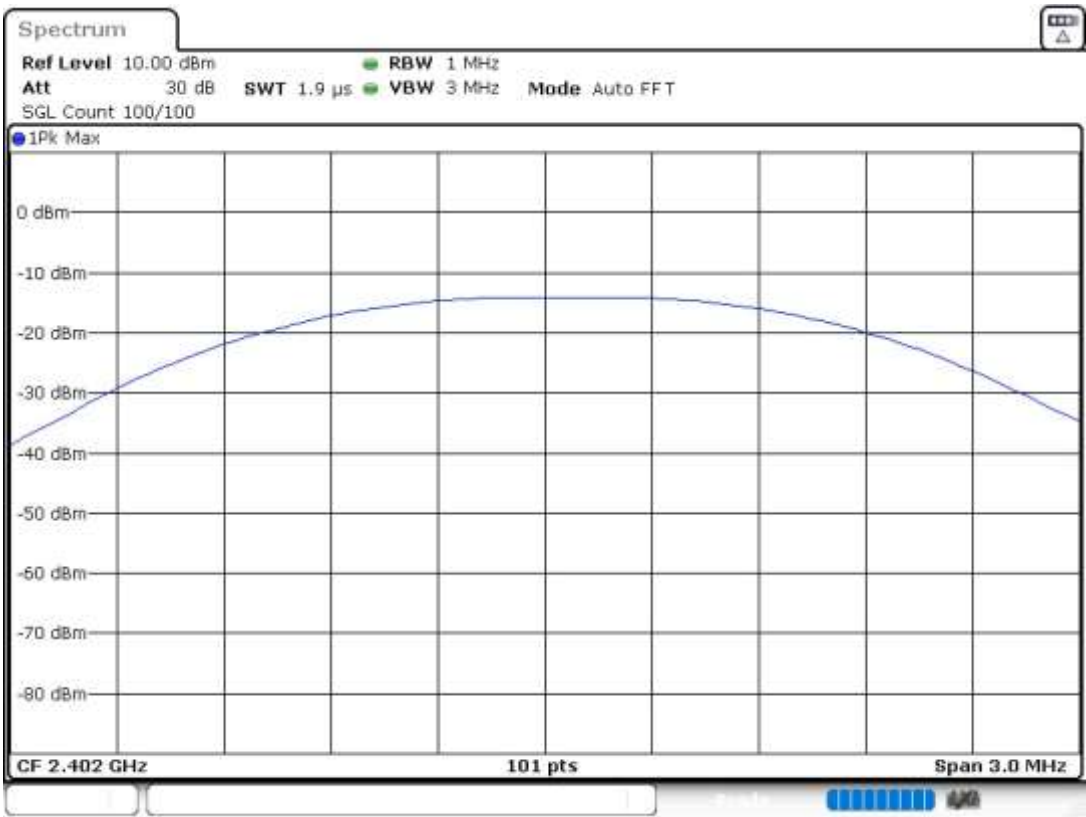
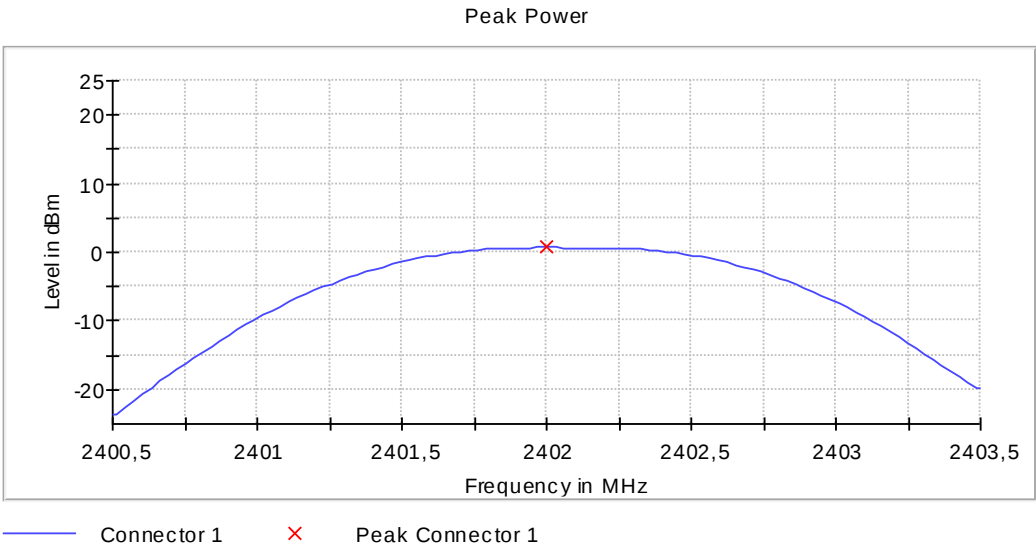
Verdict

Pass

Attachments

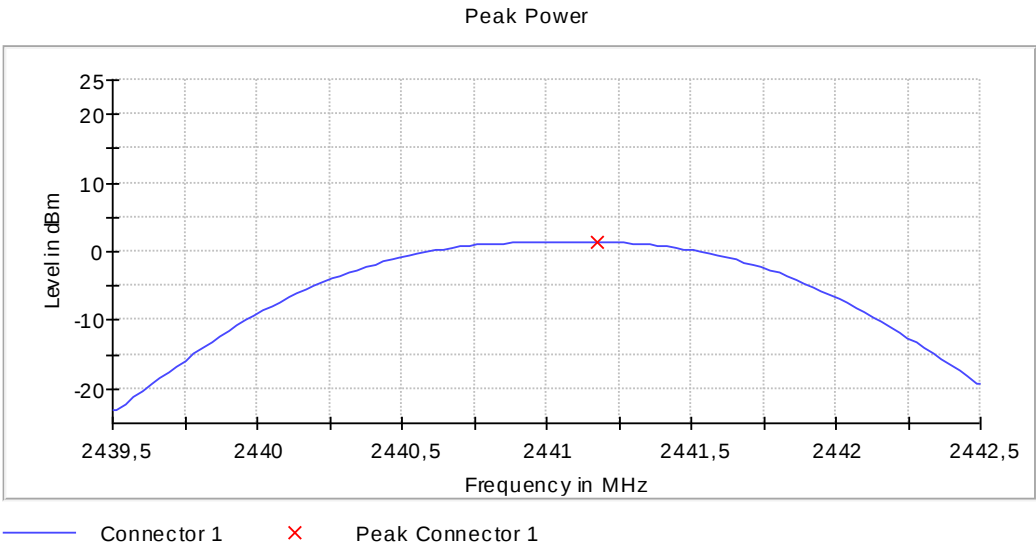
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Plots:



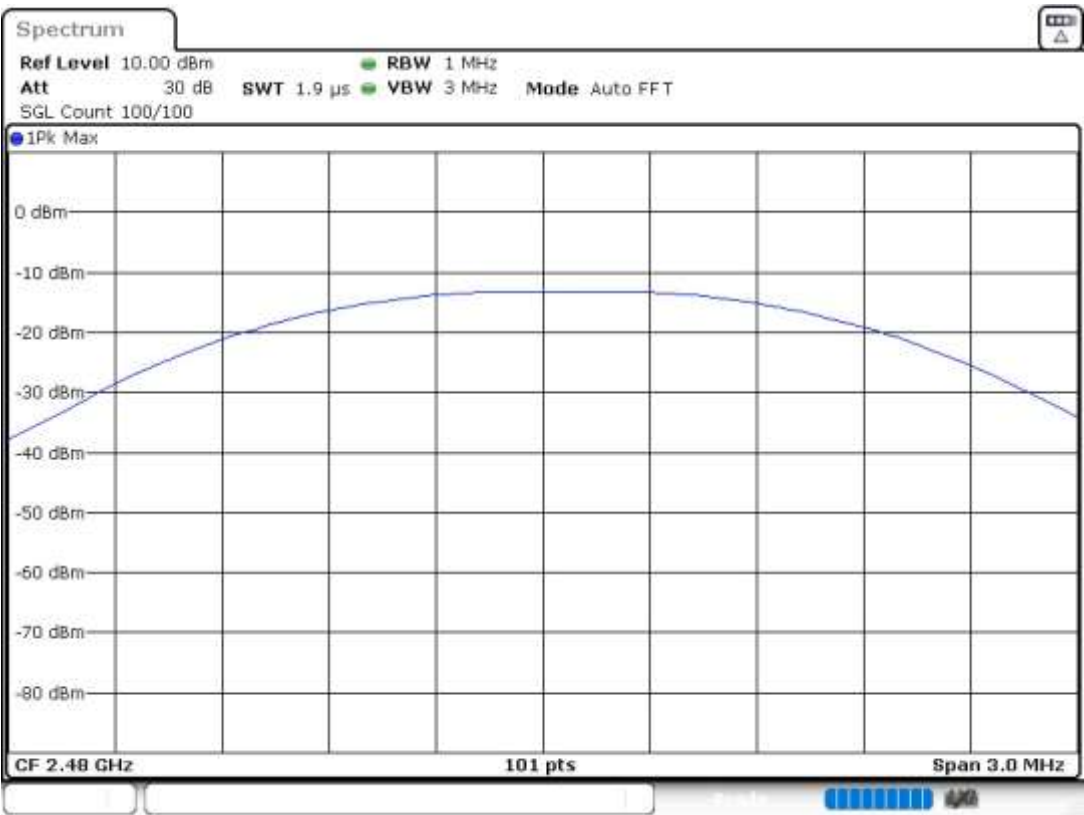
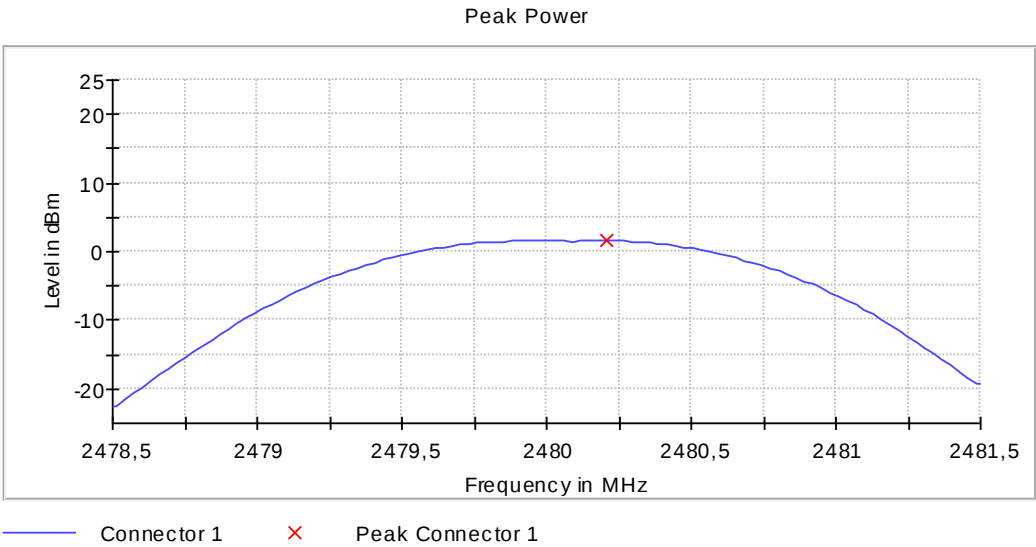
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



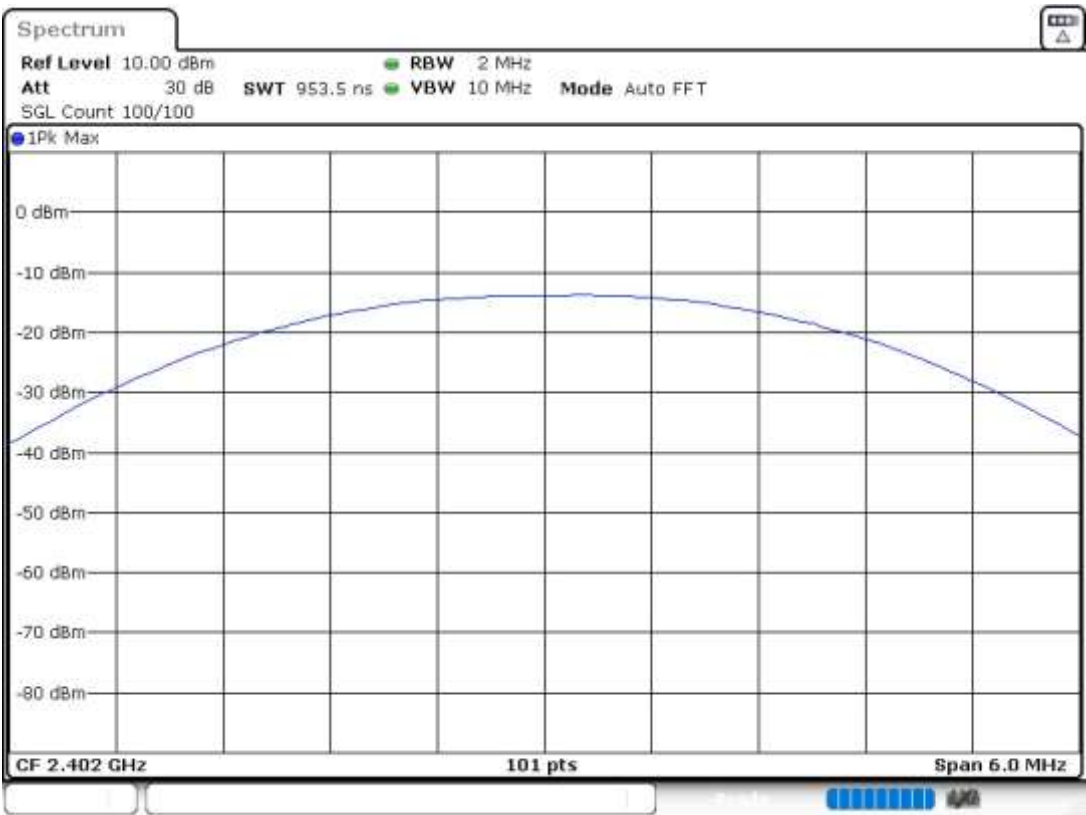
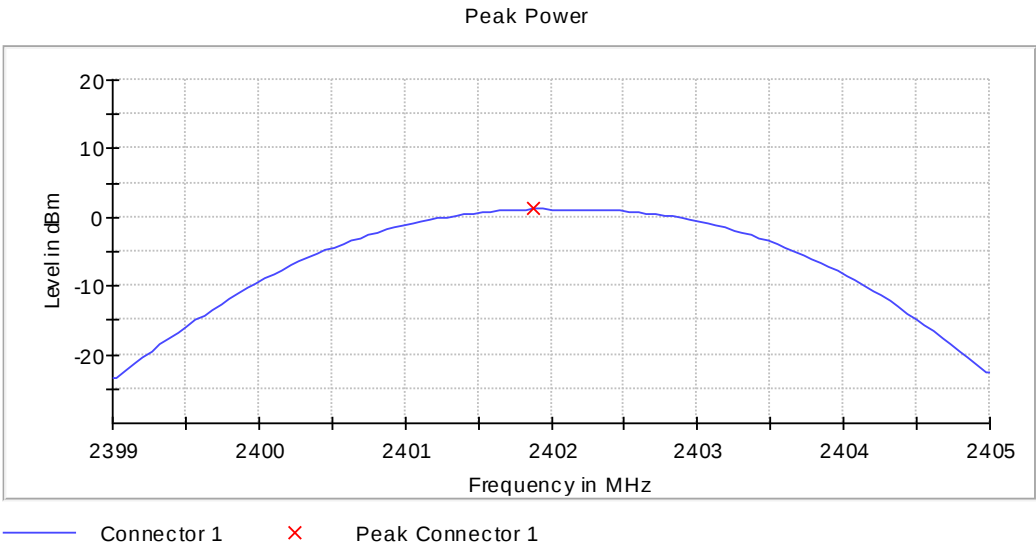
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

Plots:



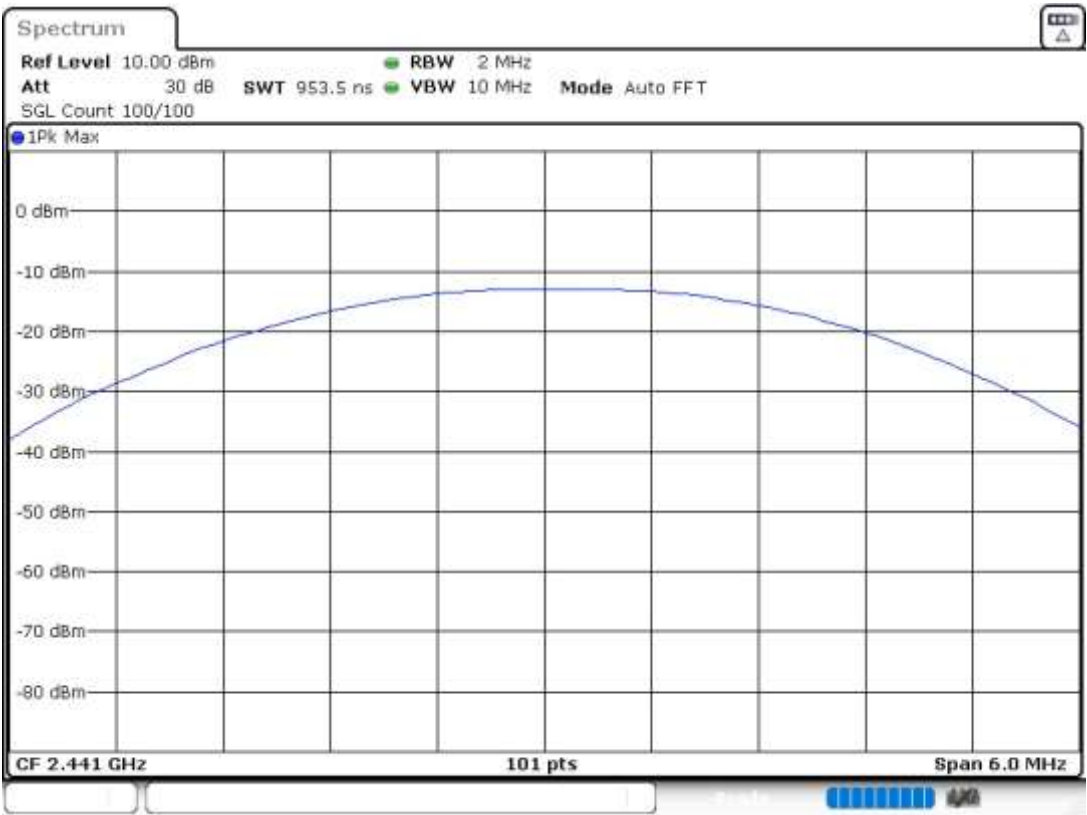
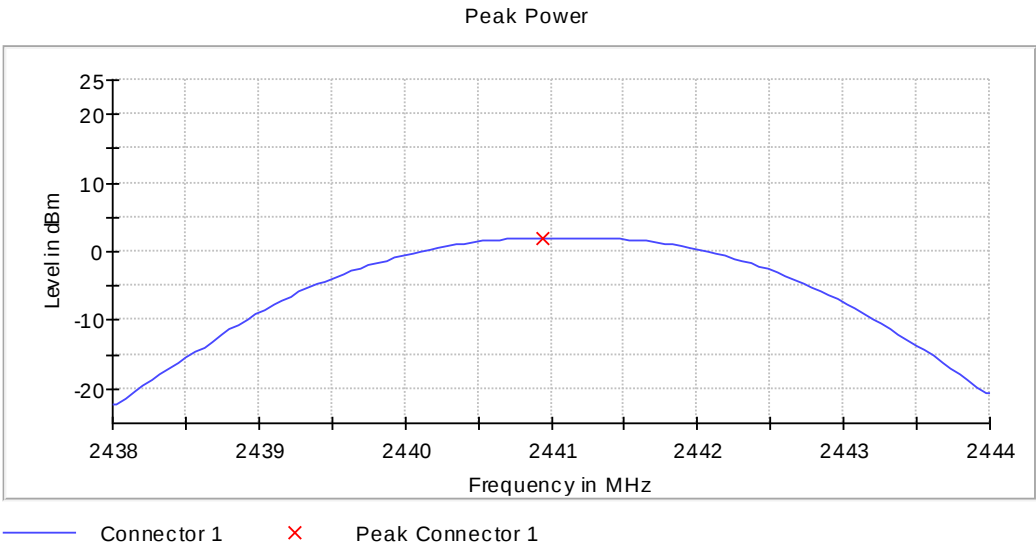
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



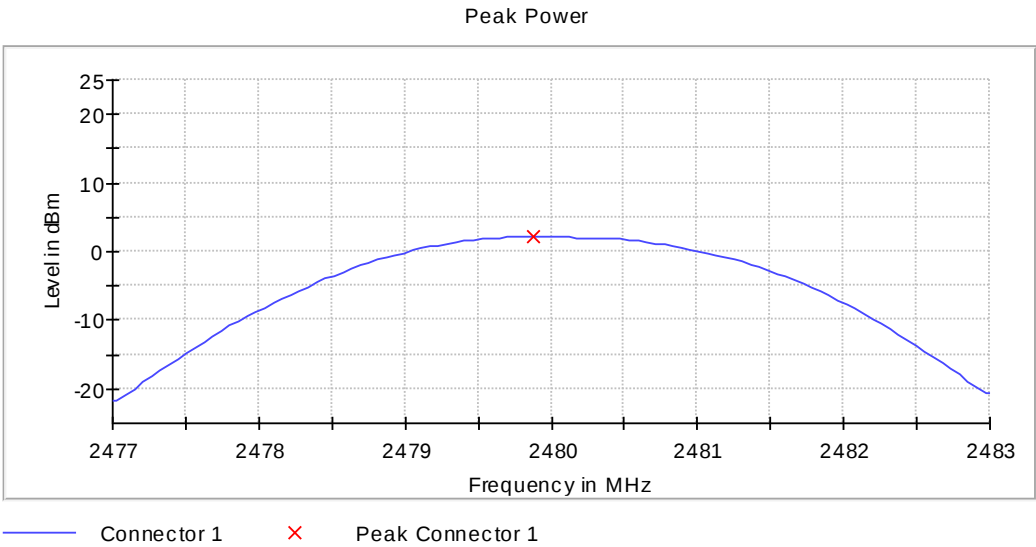
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



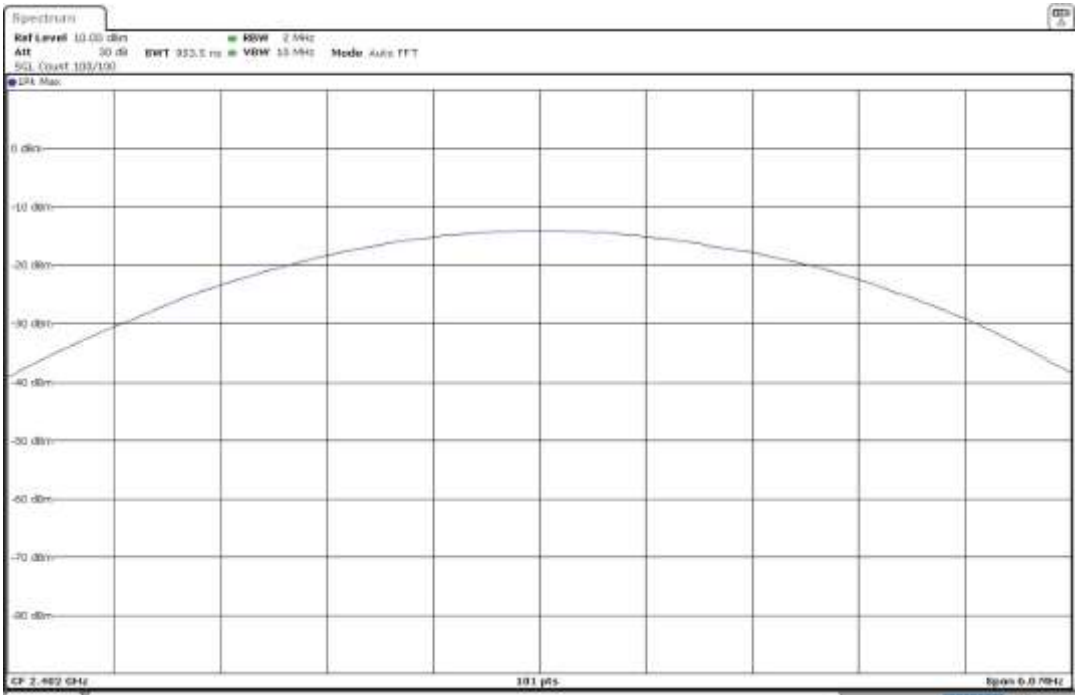
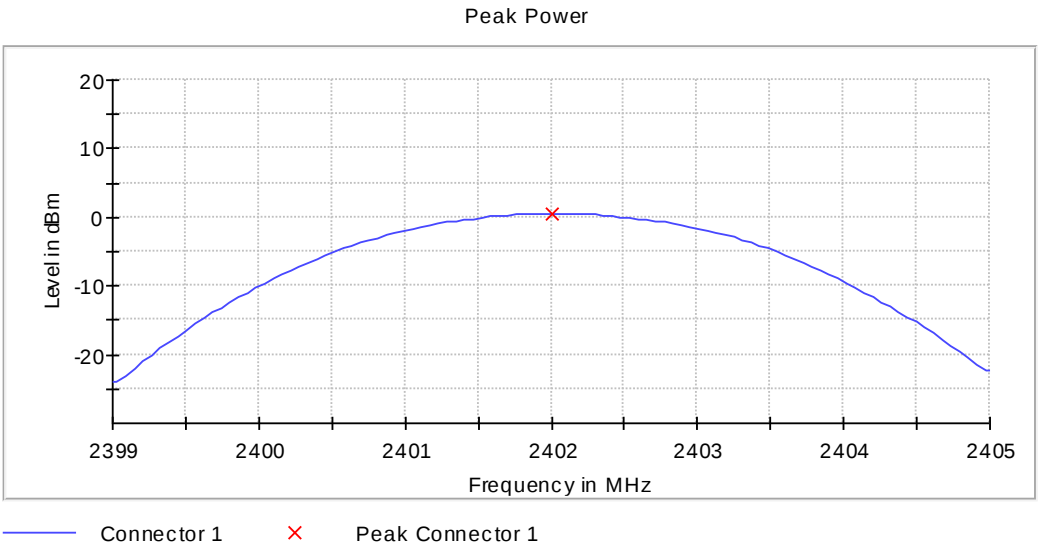
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

Plots:



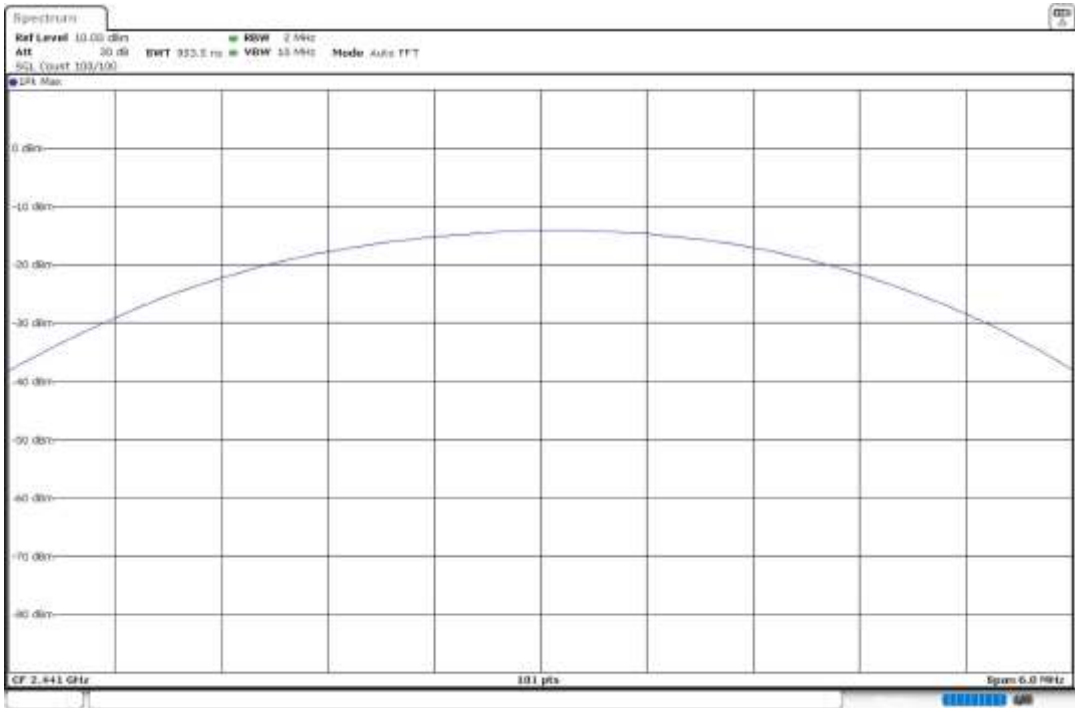
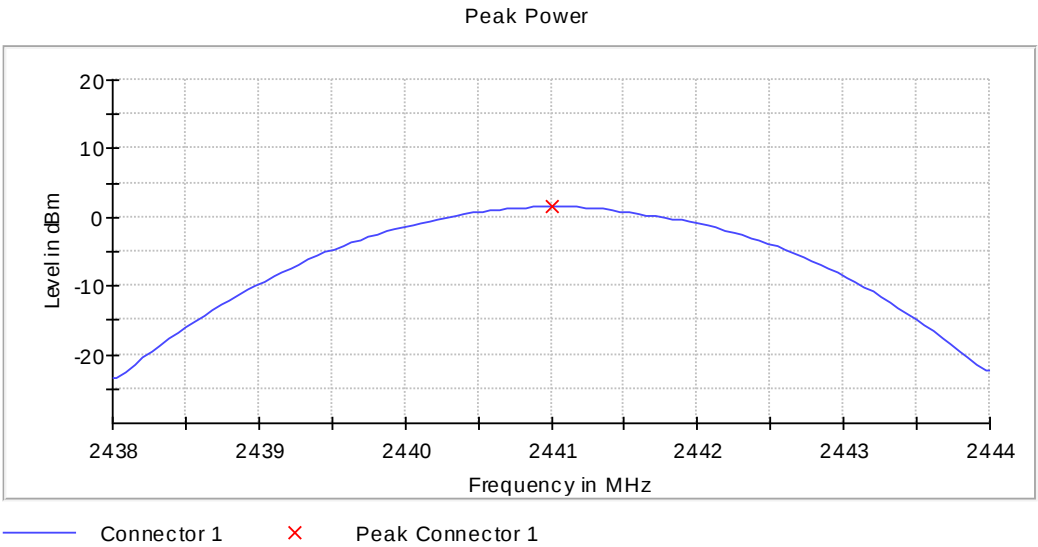
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



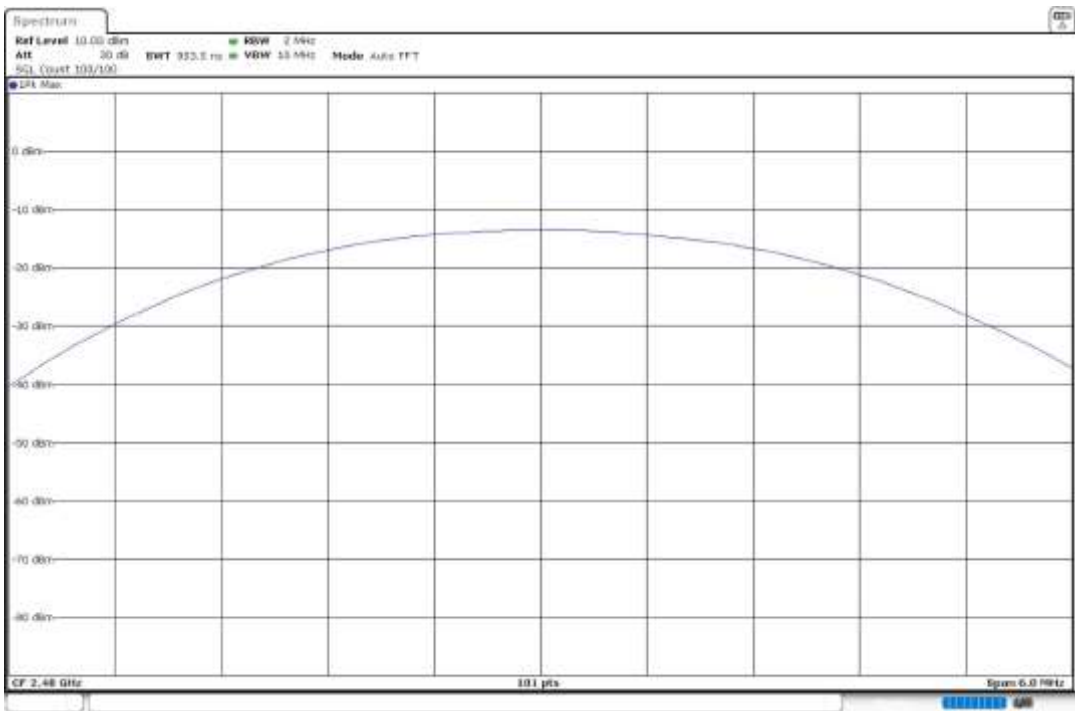
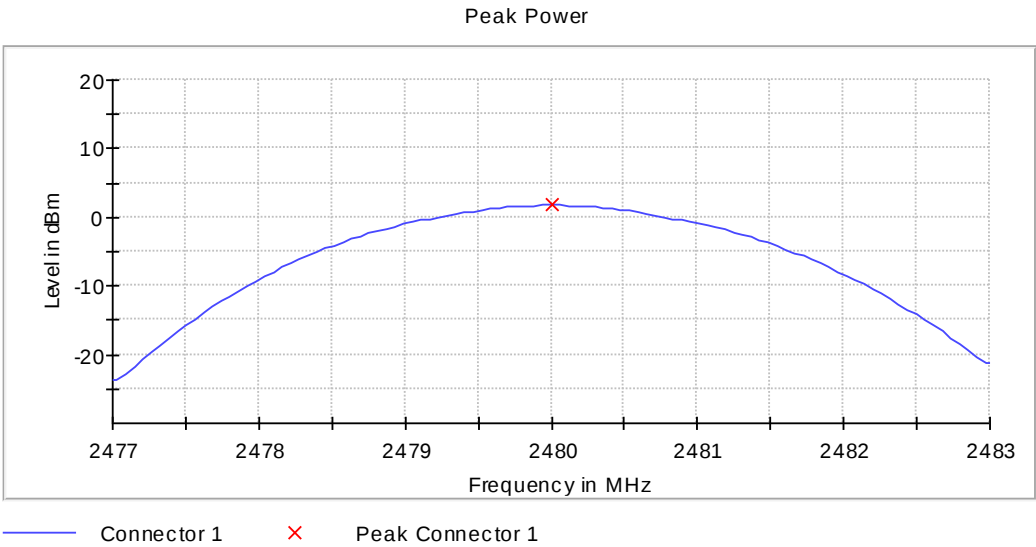
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

Plots:



RSS-247 5.5 / FCC 15.247 (d) 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 under this paragraph shall be 30 dB instead of 20 dB.

Results

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

Modulation: BT (GFSK 1-DH5)

Verdict

Pass

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

Verdict

Pass

Modulation: BT (8DPSK 3-DH5)

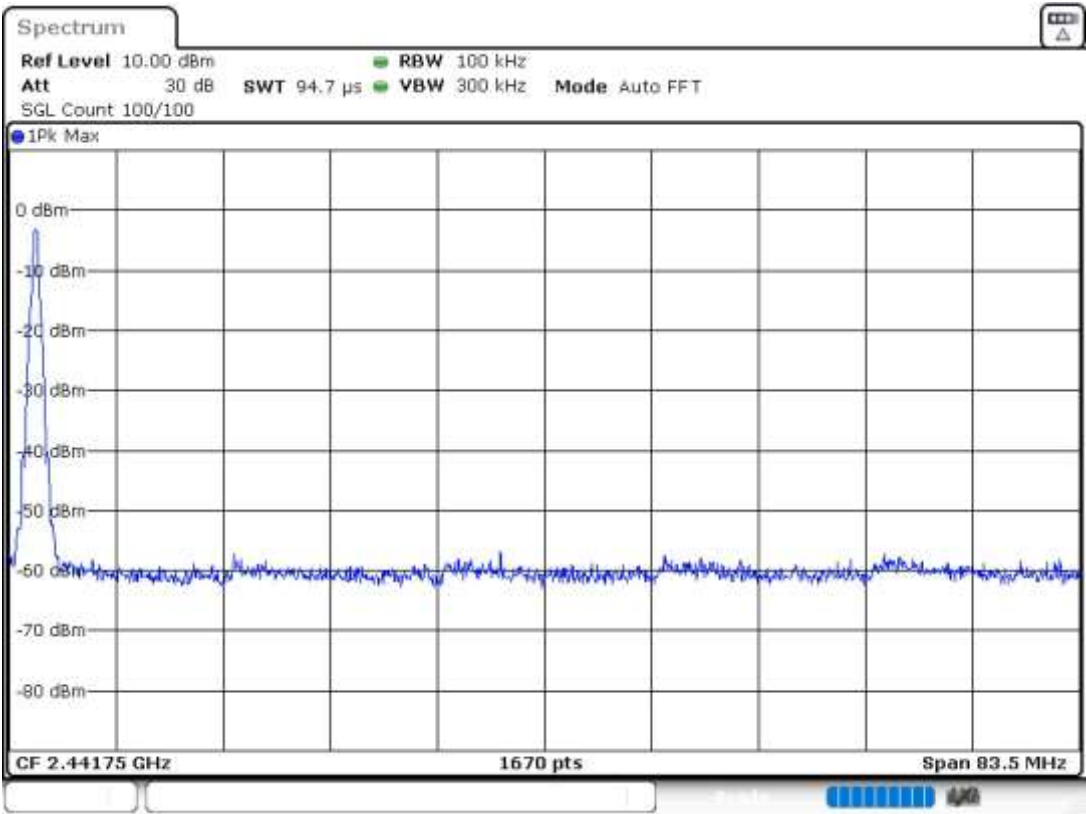
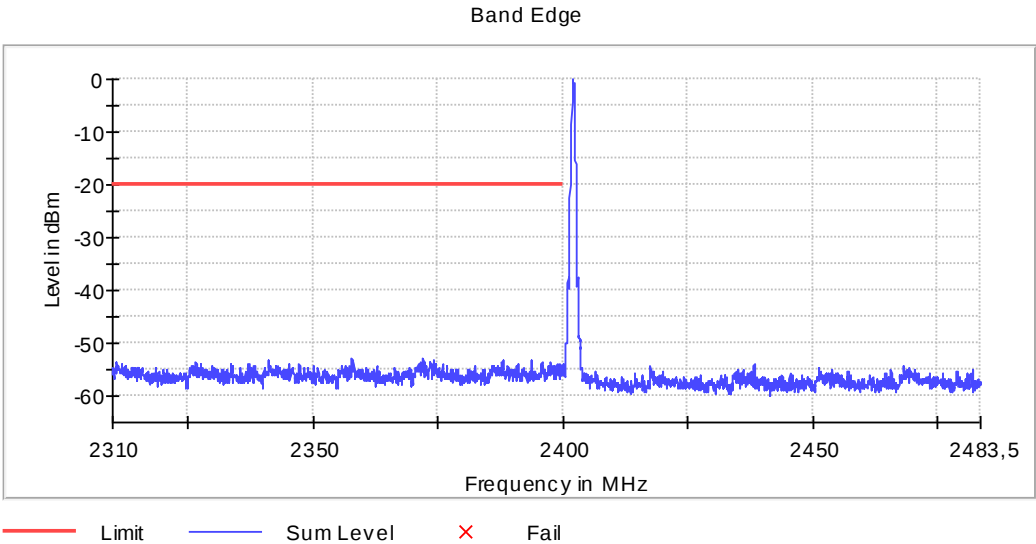
Verdict

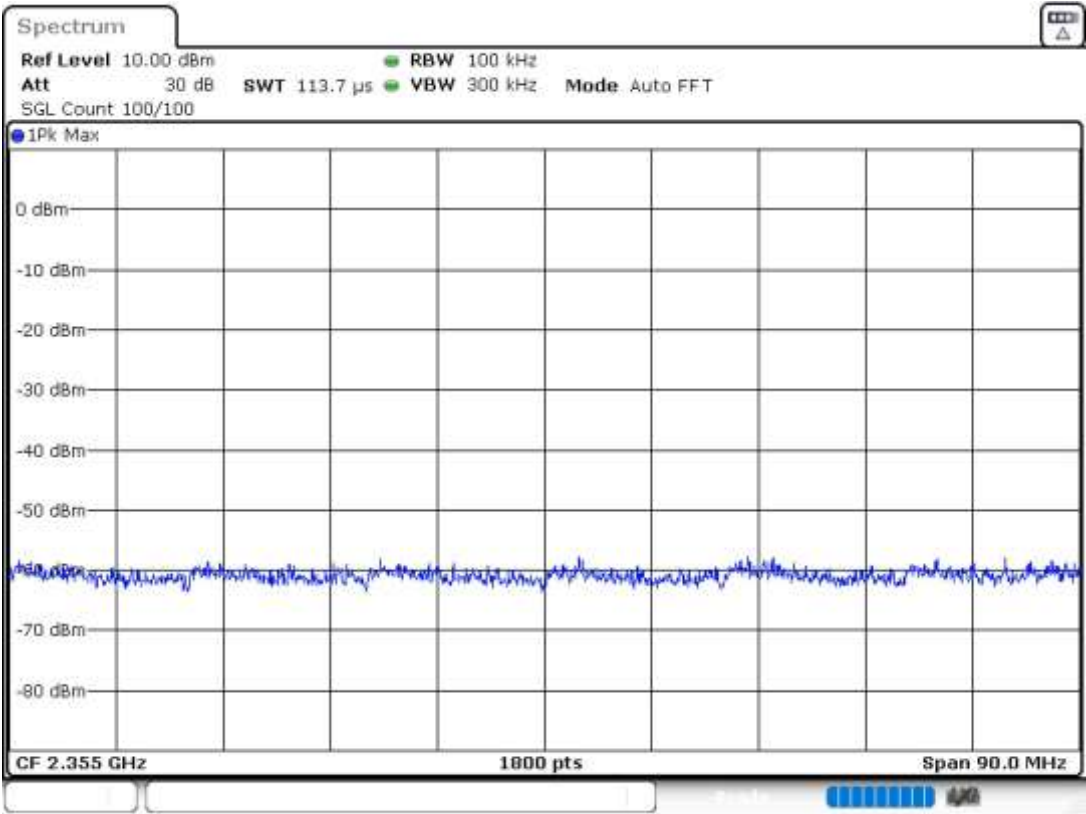
Pass

Attachments

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

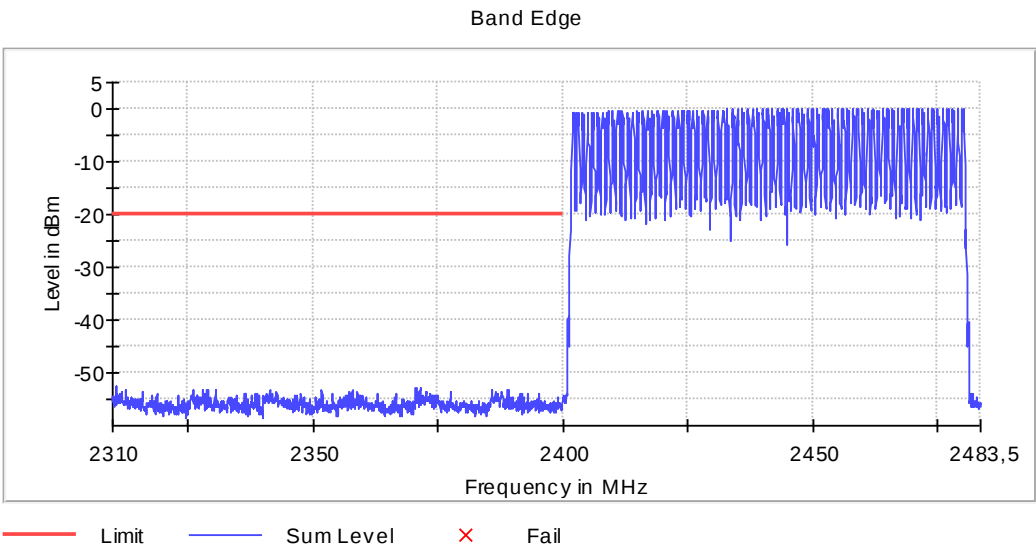
Plots:

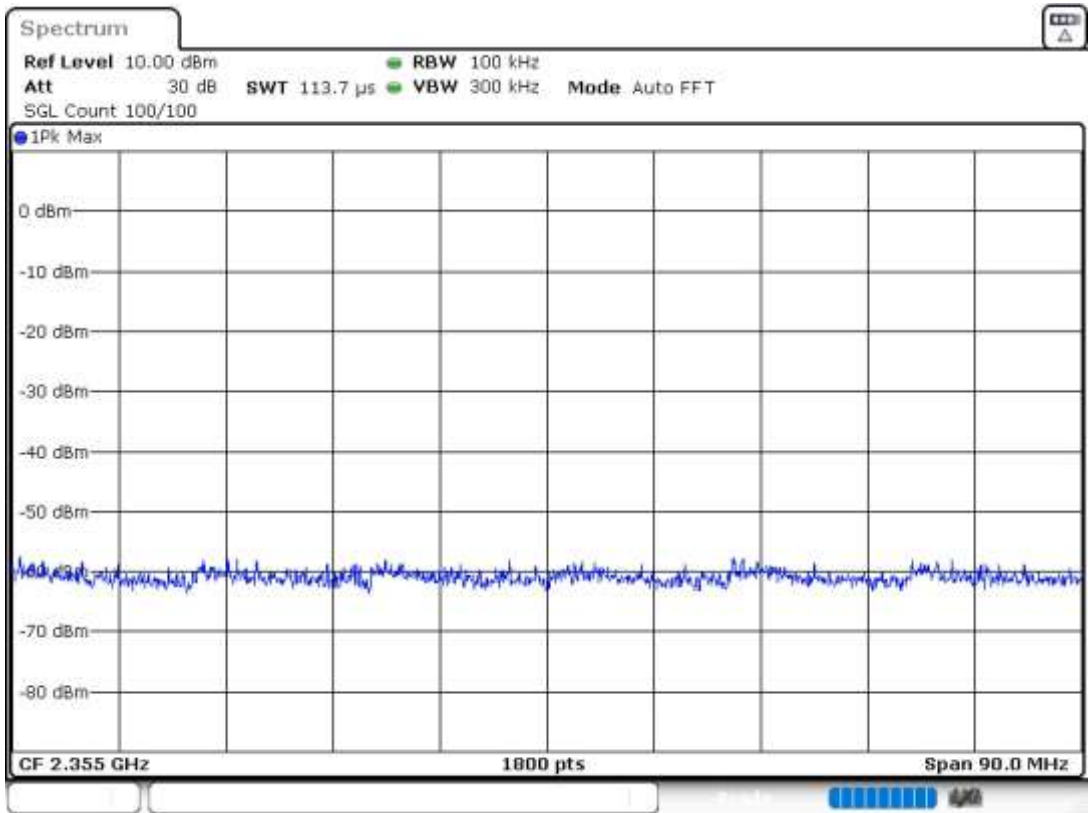
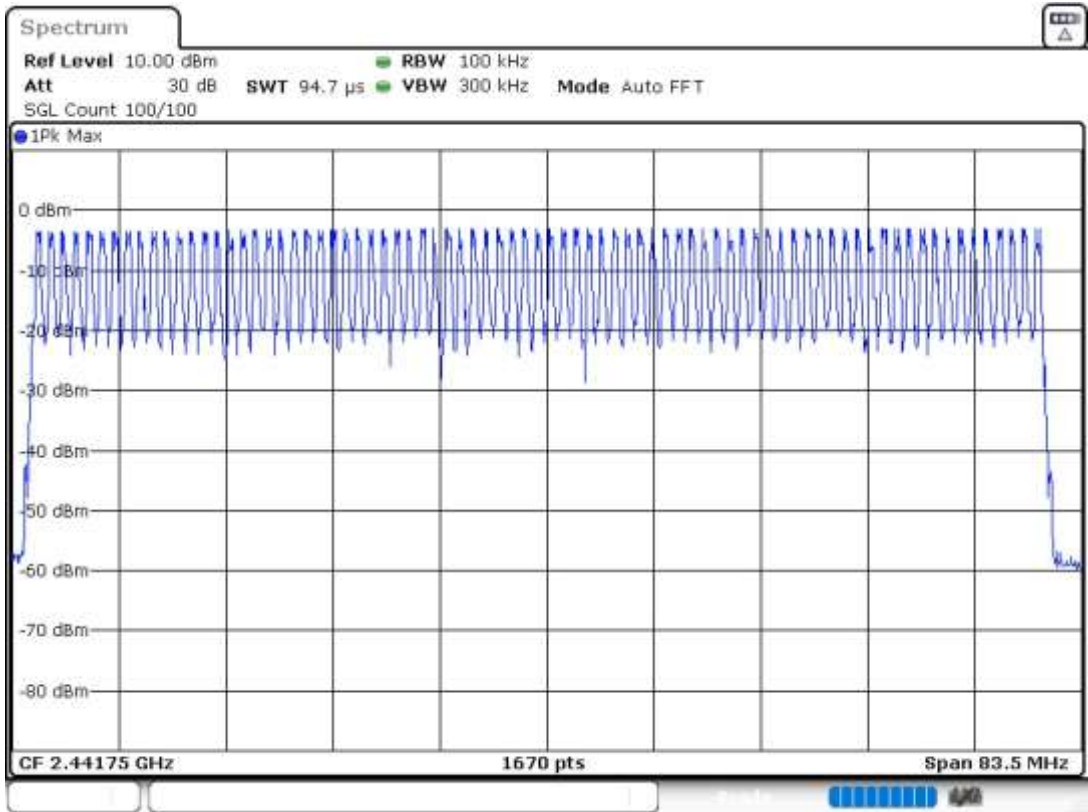




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5) – hopping

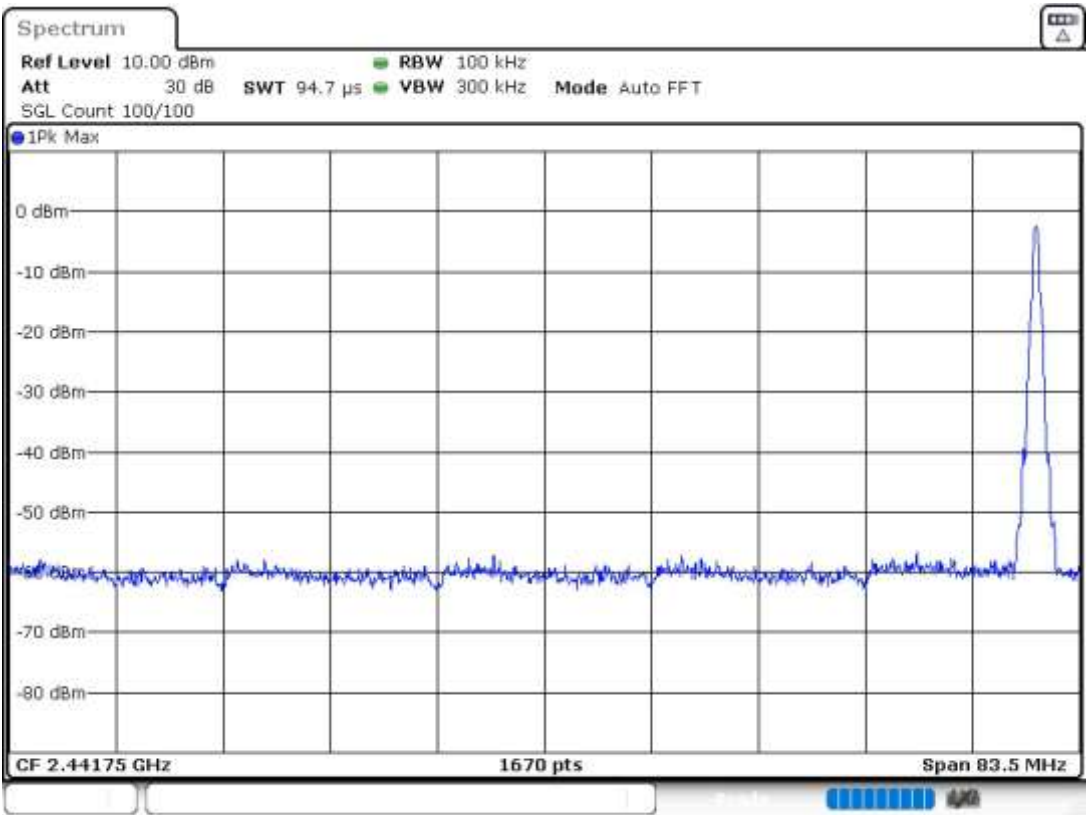
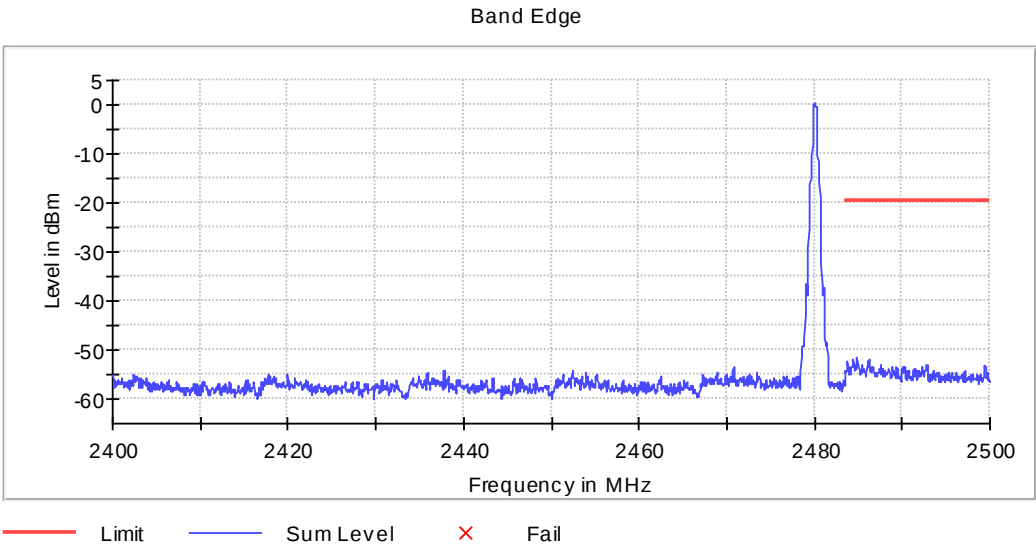
Plots:

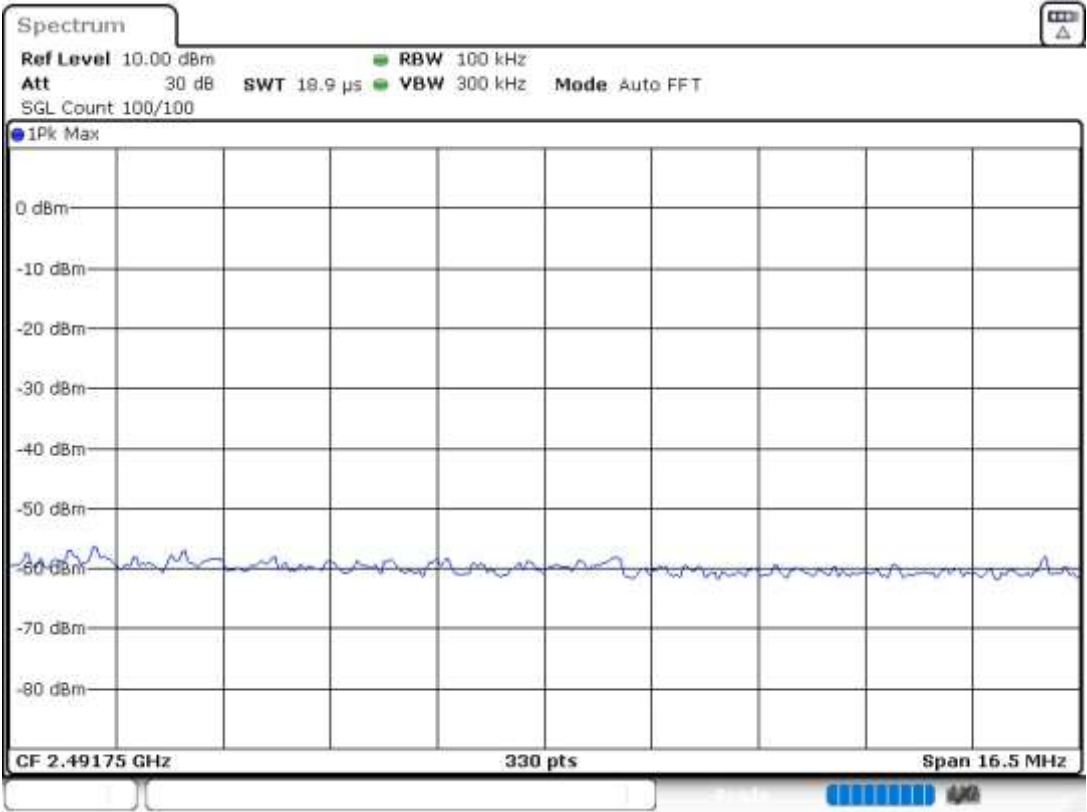




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5)

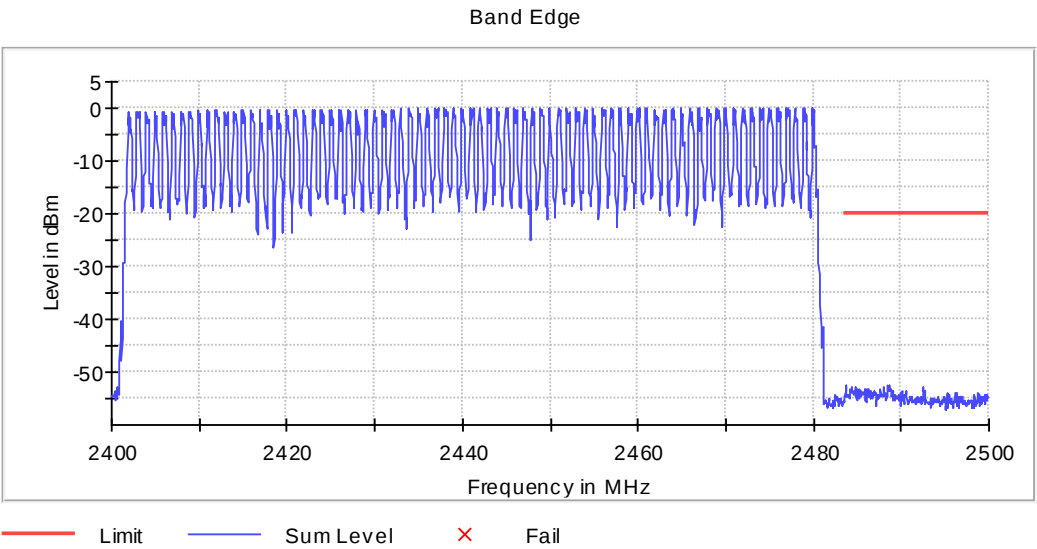
Plots:

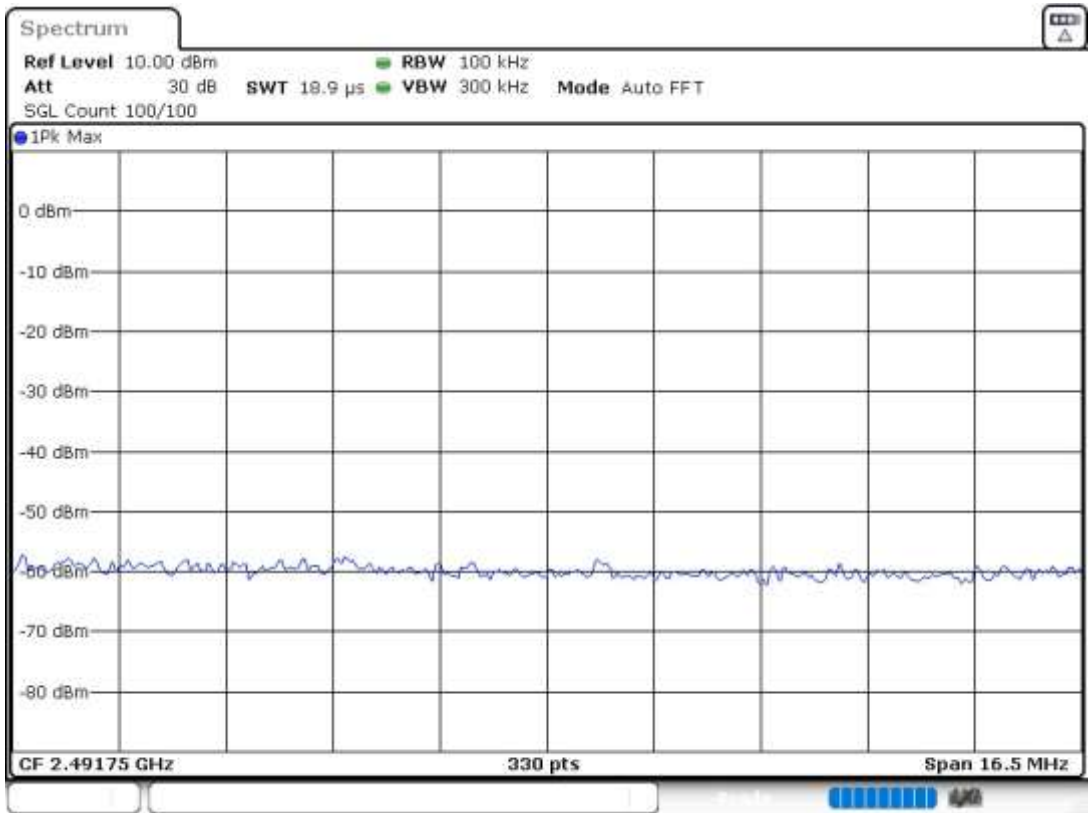
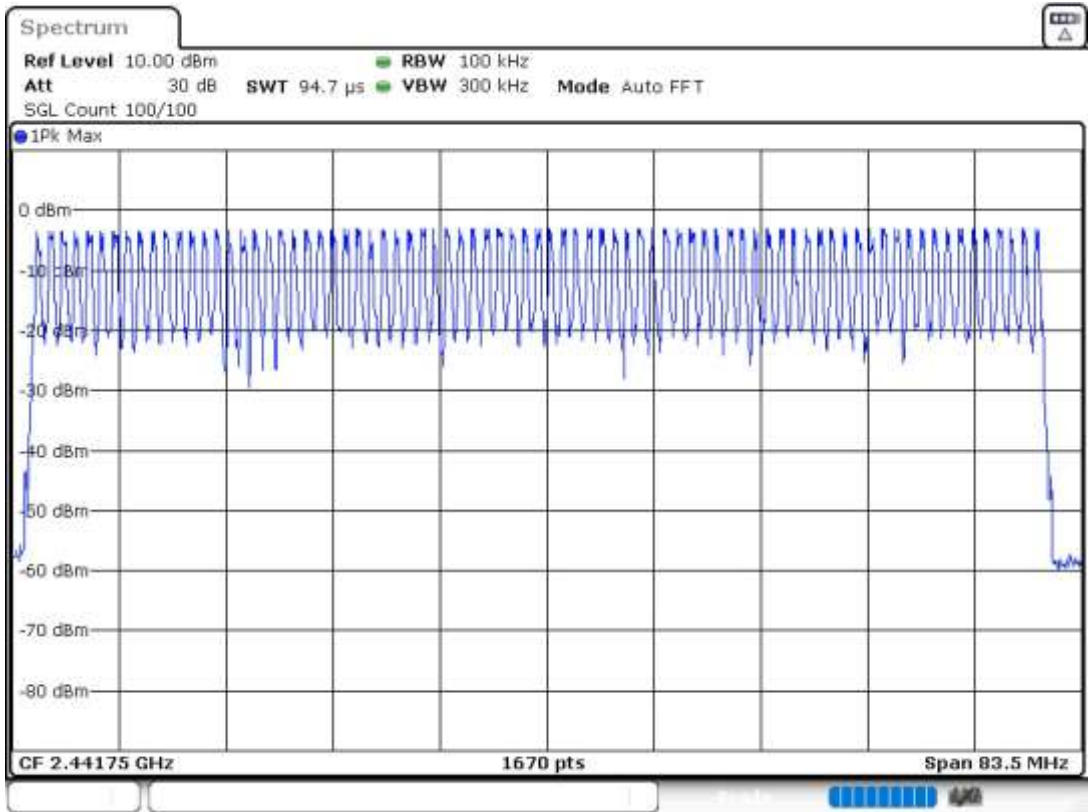




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5) – hopping

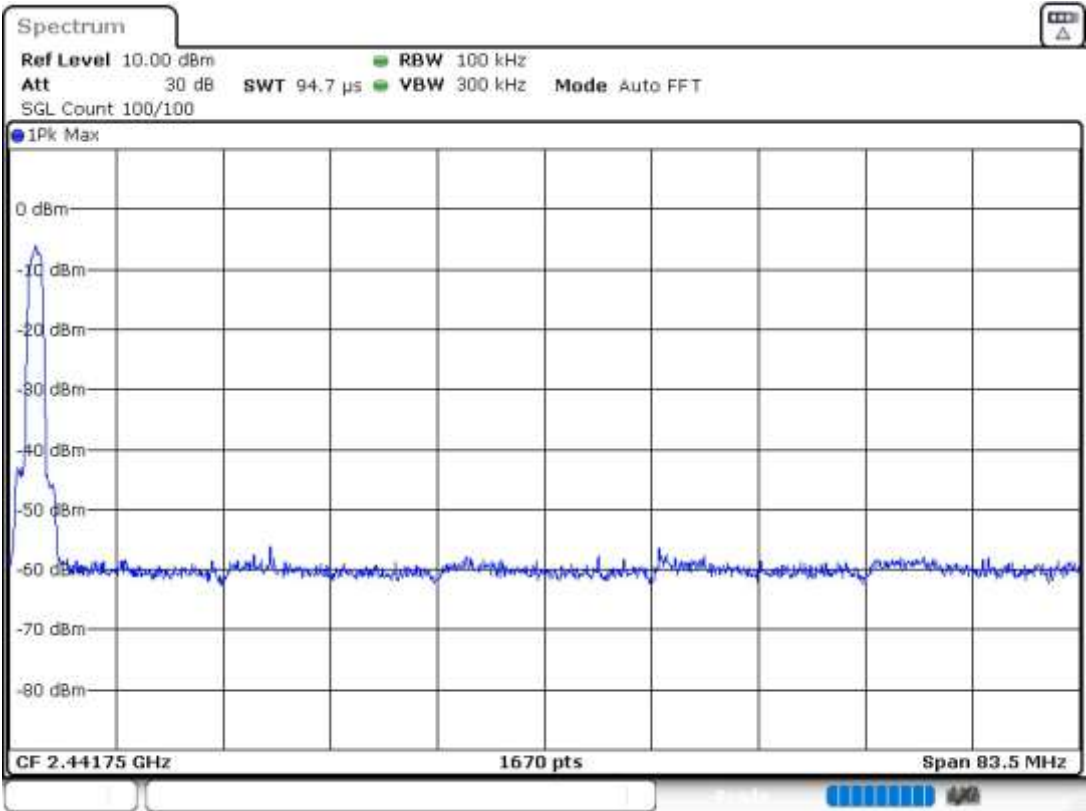
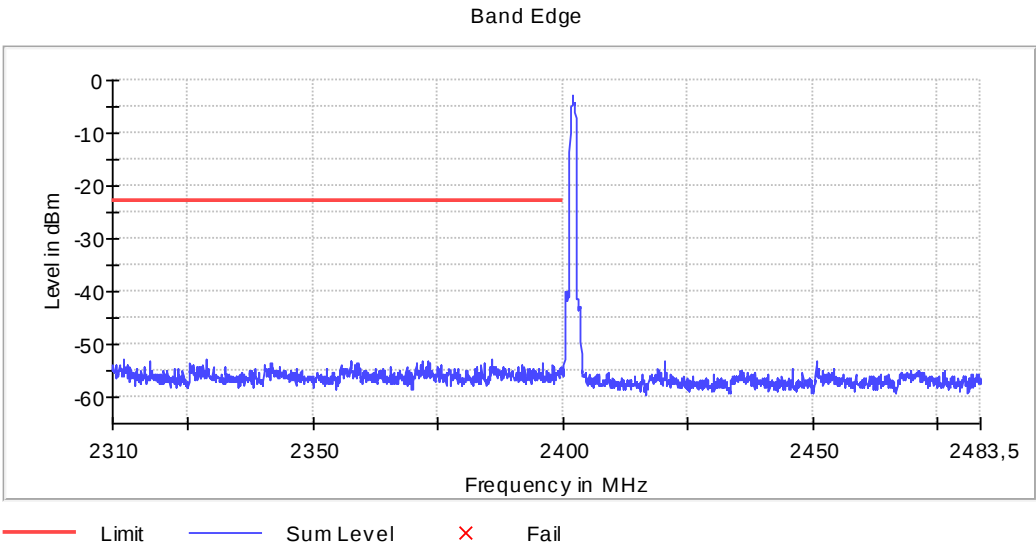
Plots:

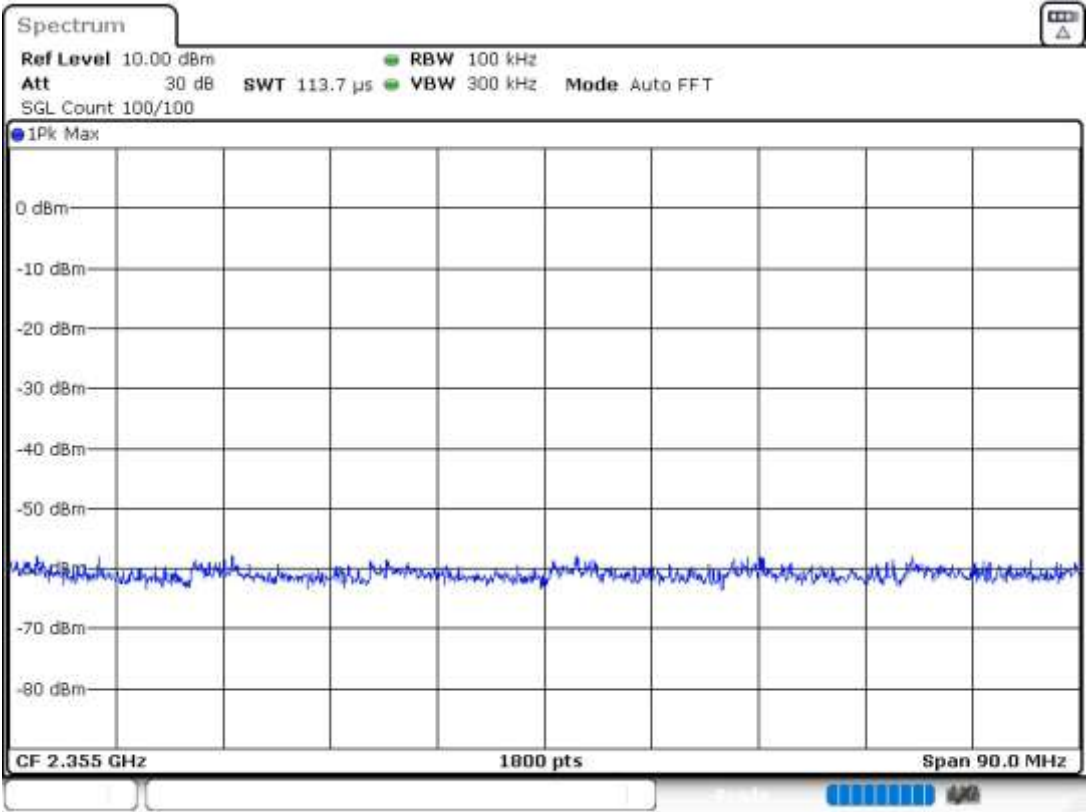




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

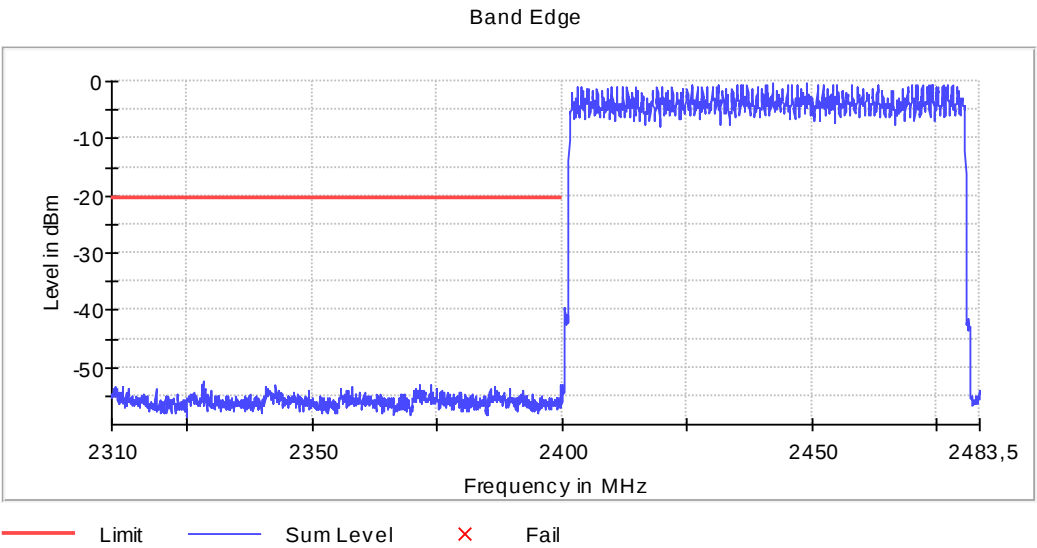
Plots:

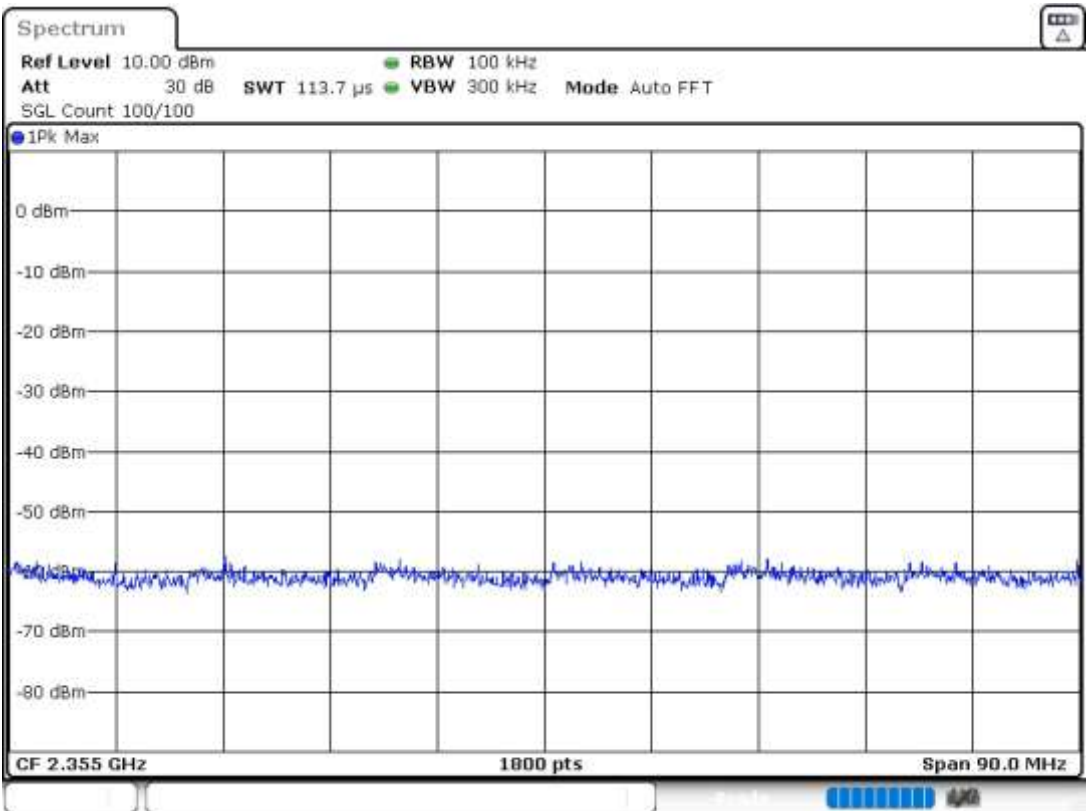
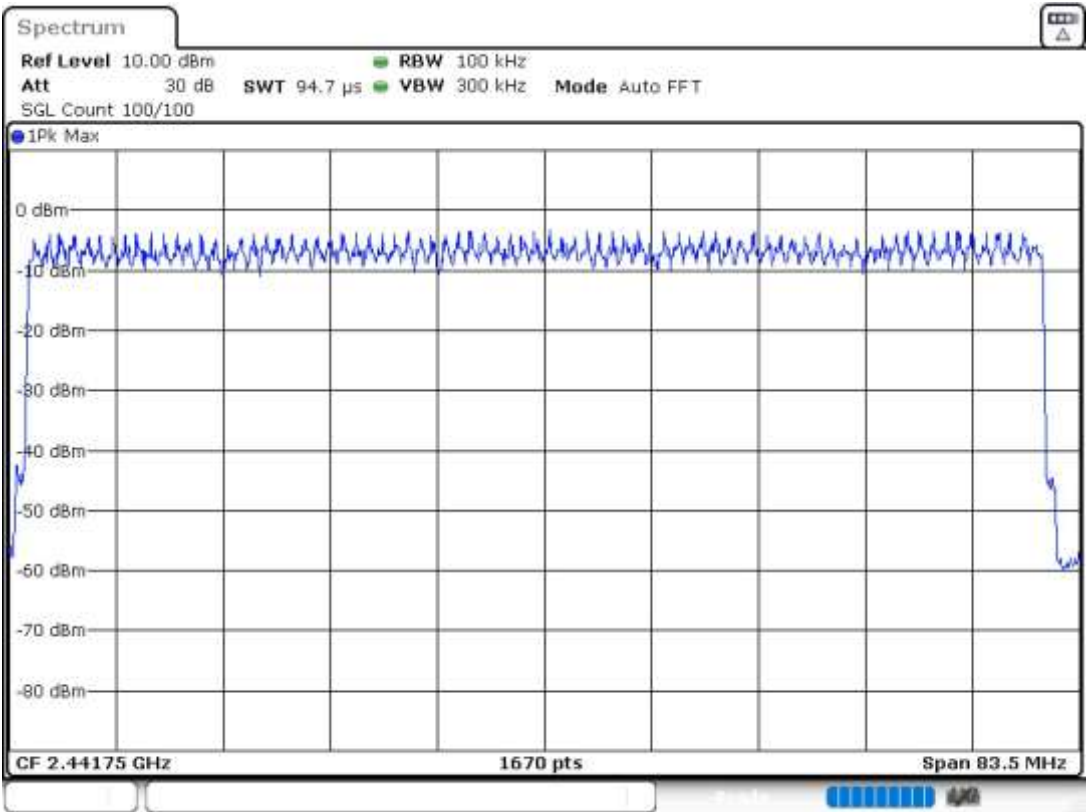




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5) – hopping

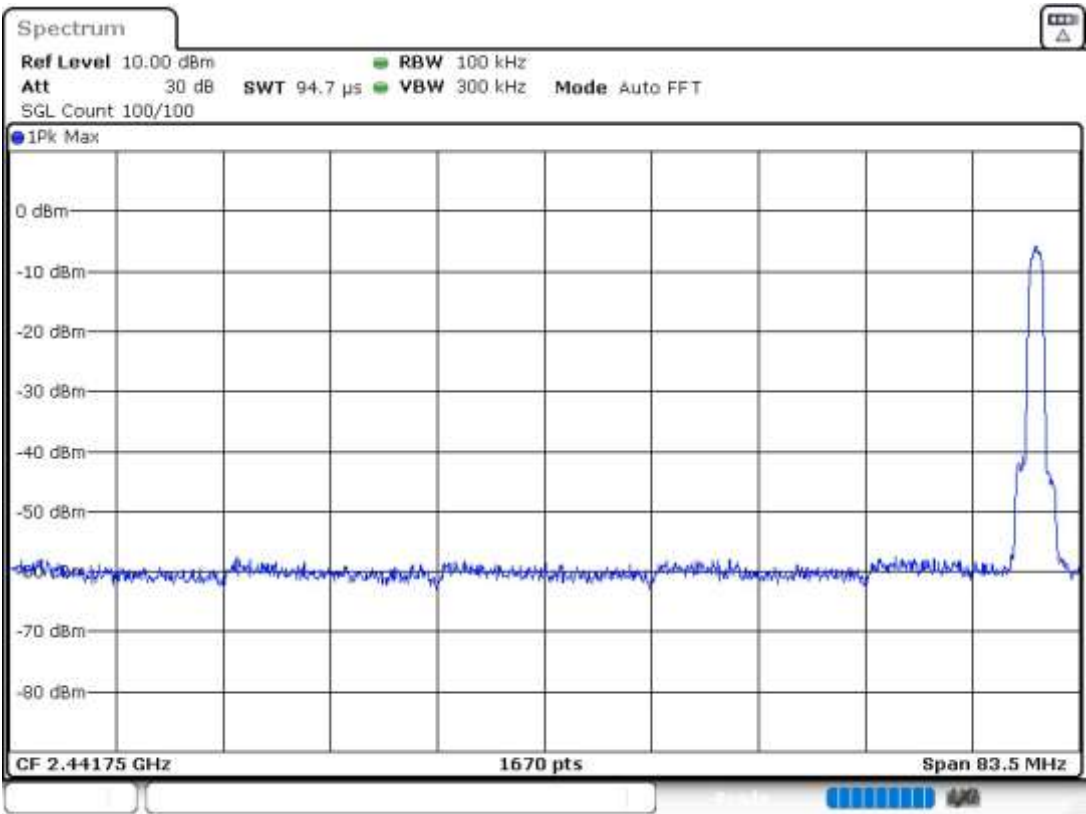
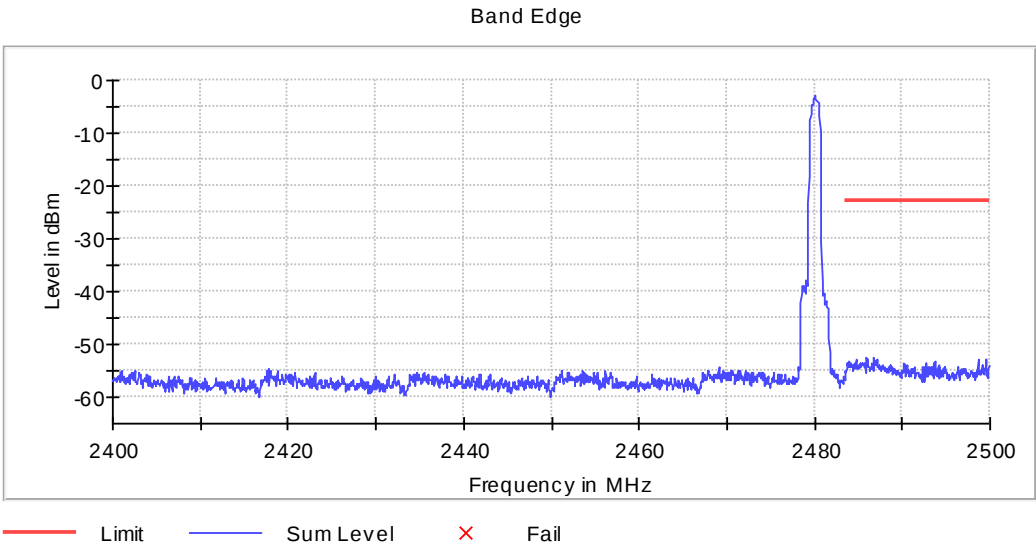
Plots:

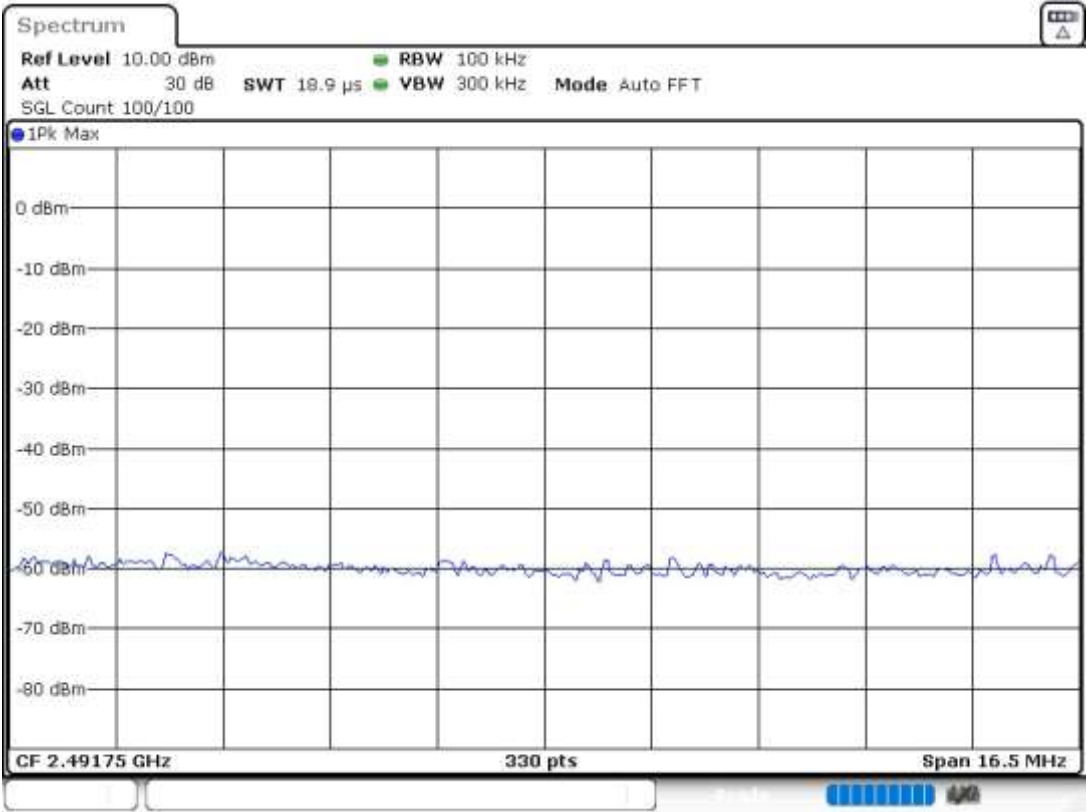




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5)

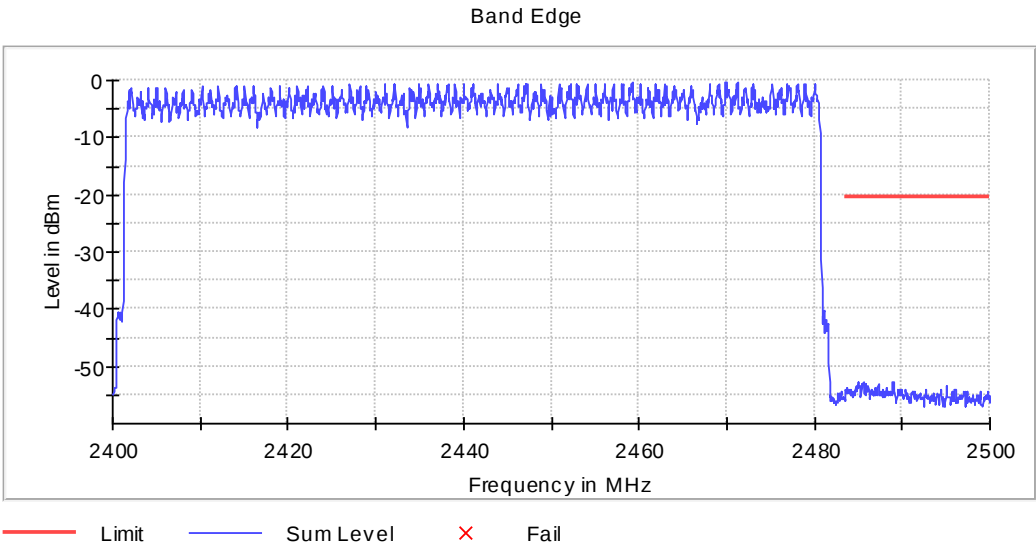
Plots:

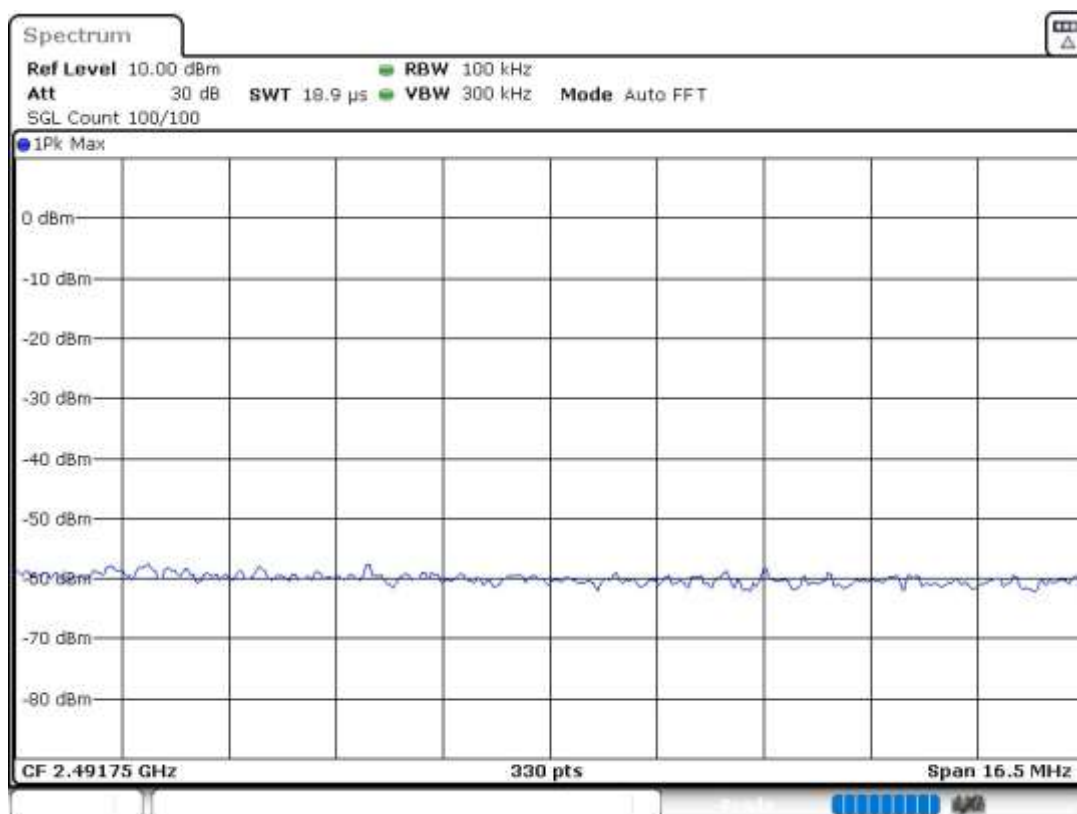
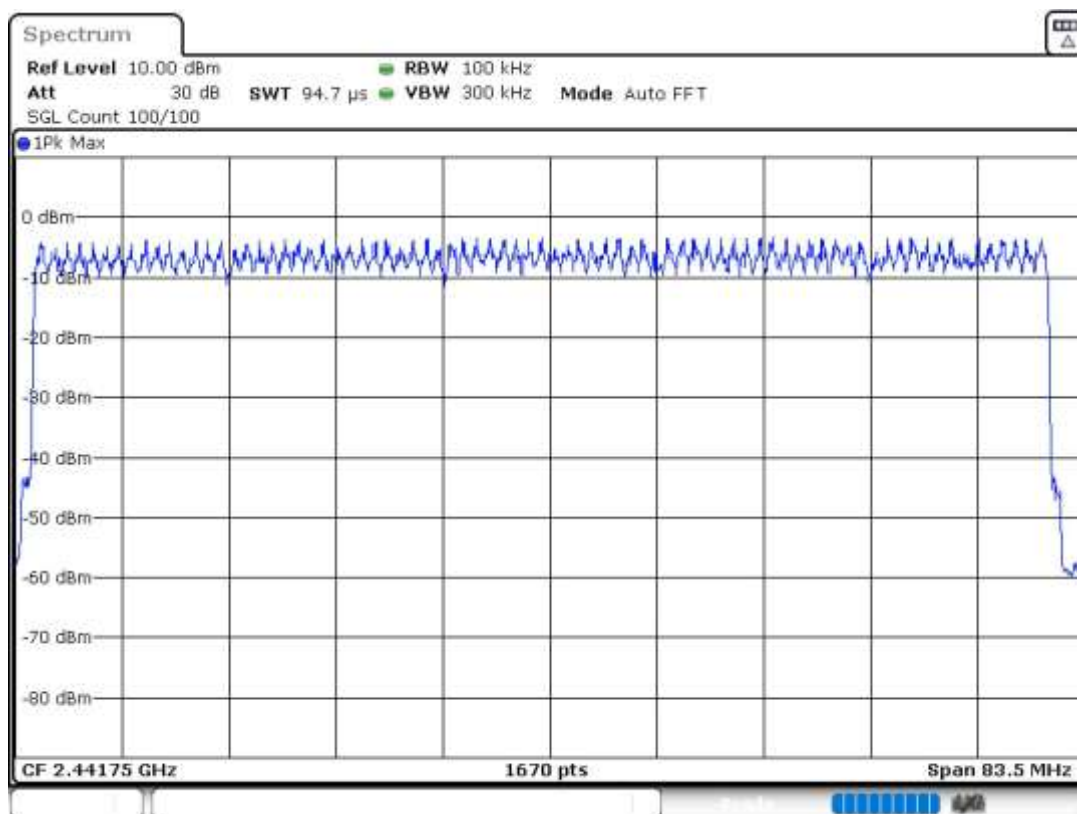




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5) – hopping

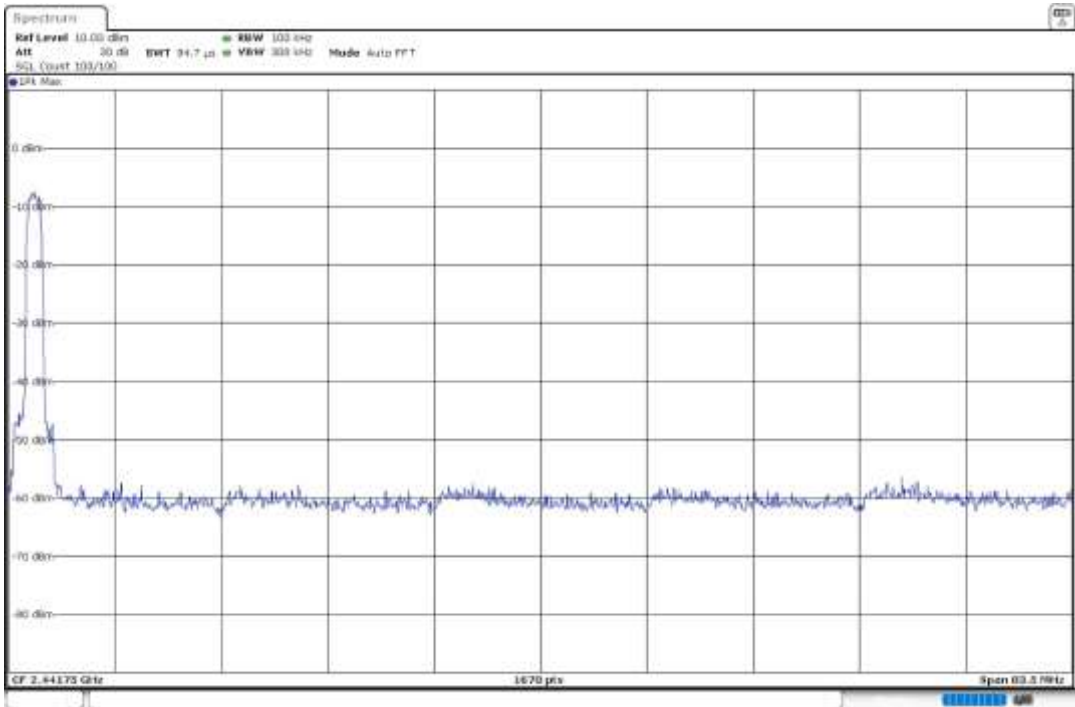
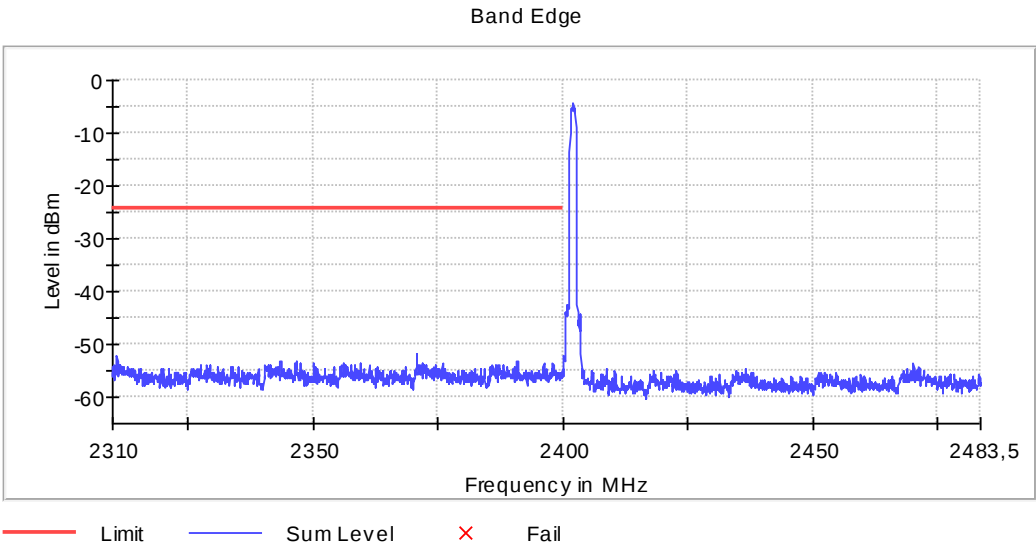
Plots:

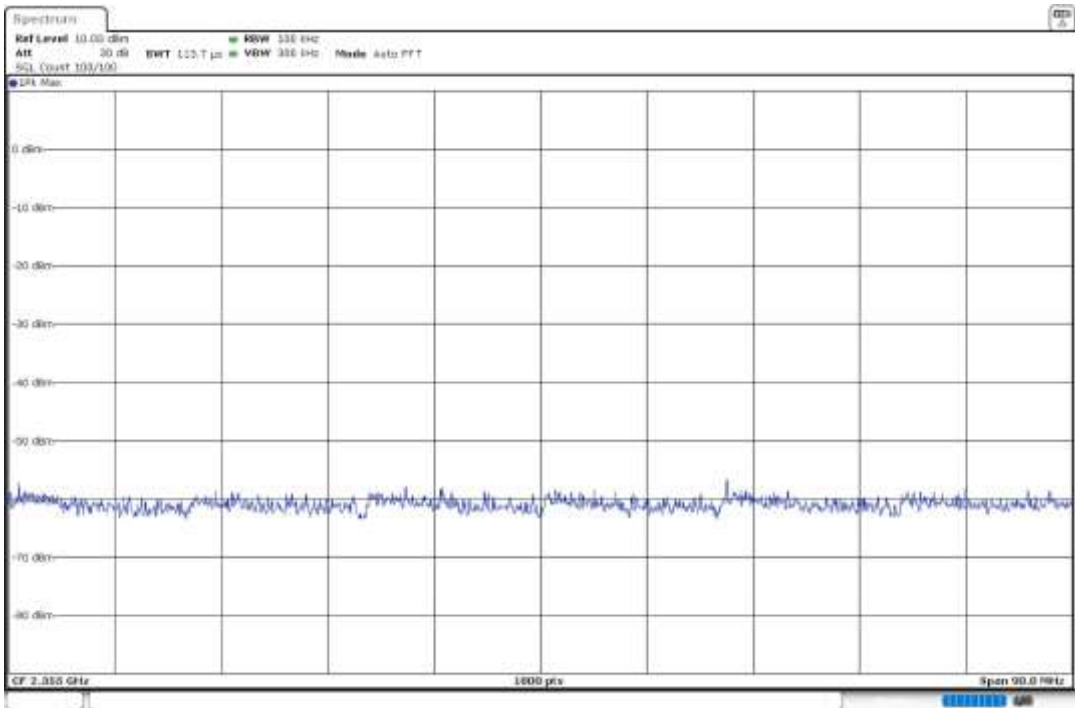




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

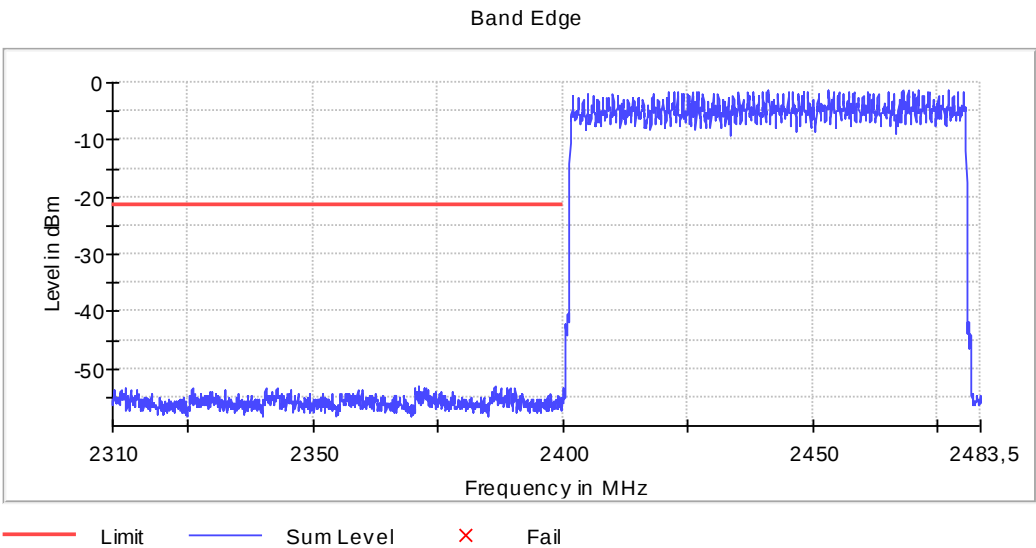
Plots:

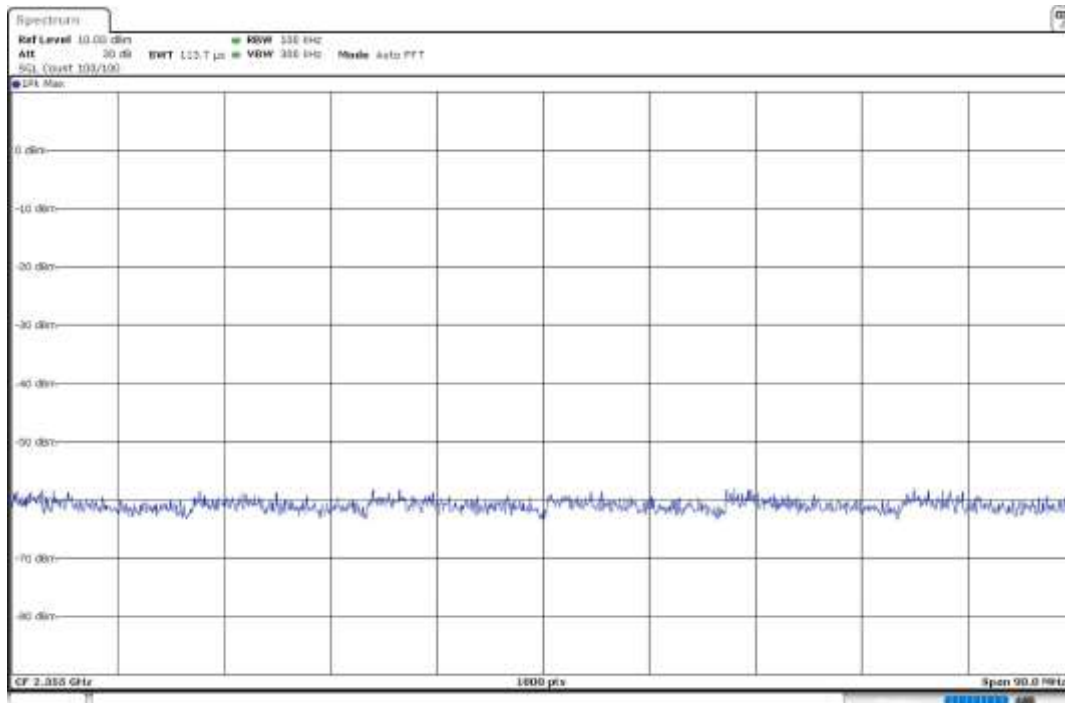
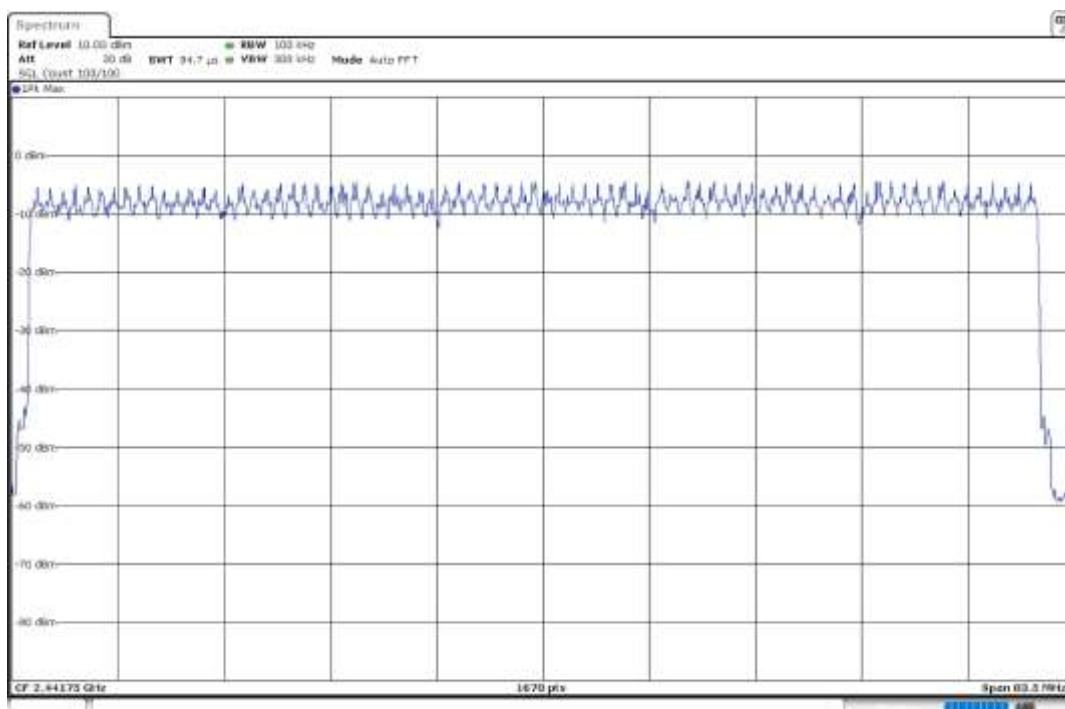




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5) – hopping

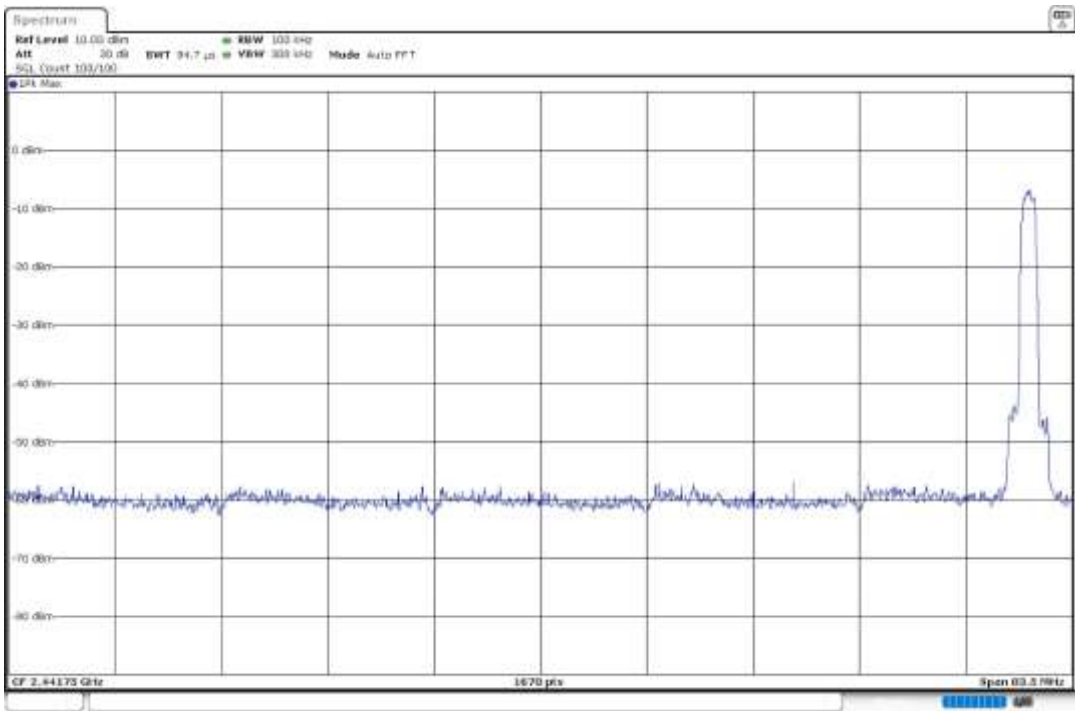
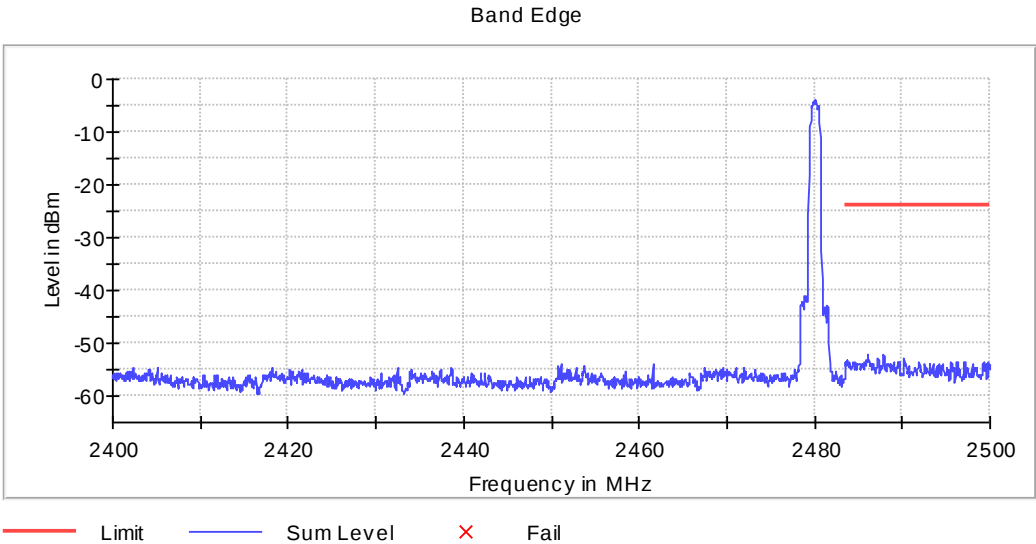
Plots:

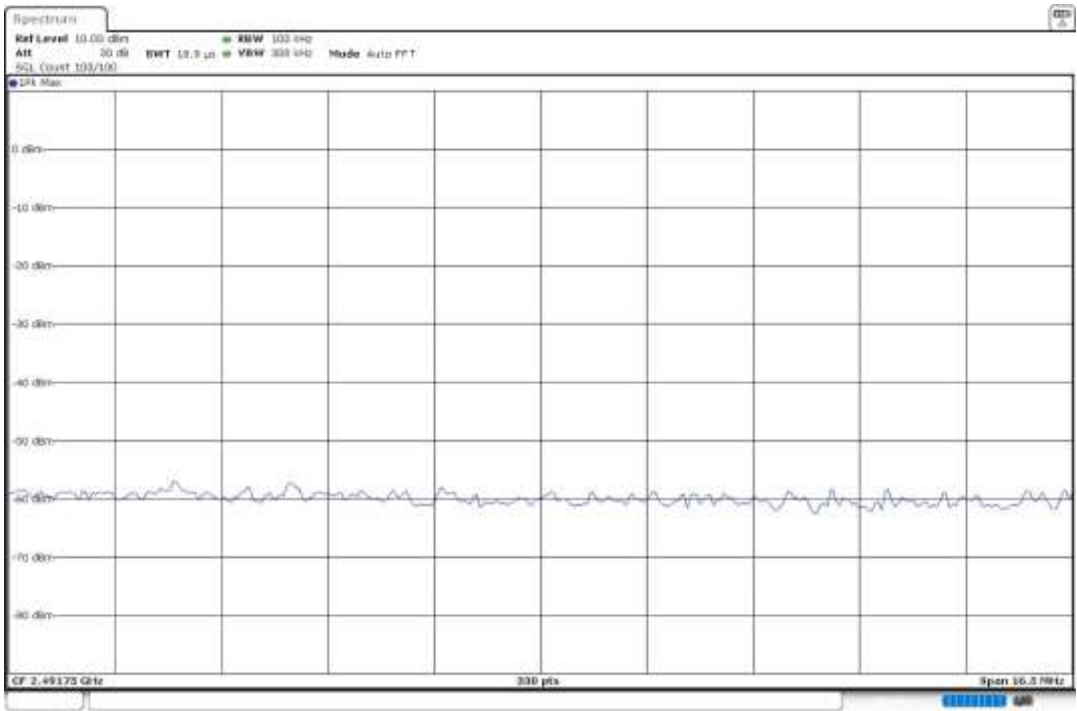




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5)

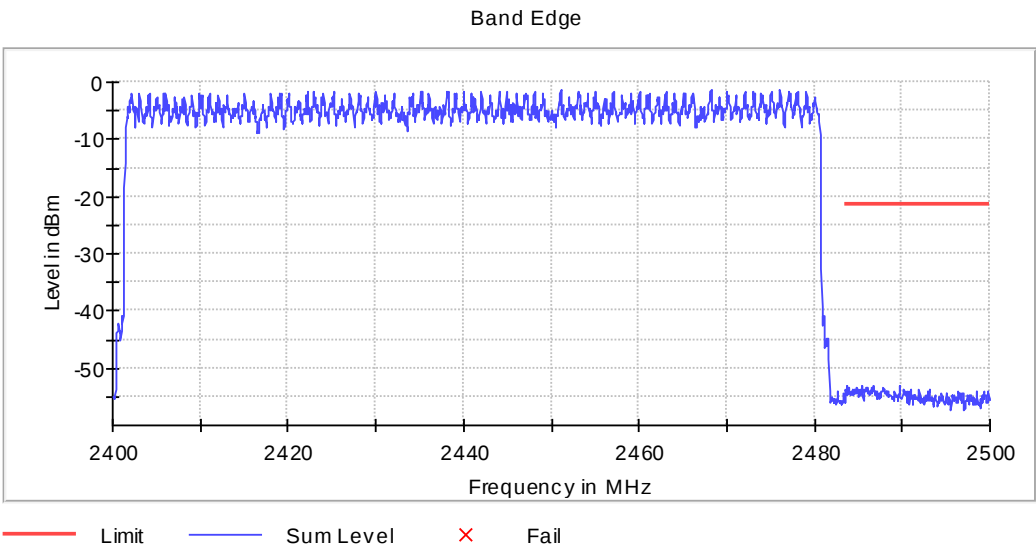
Plots:

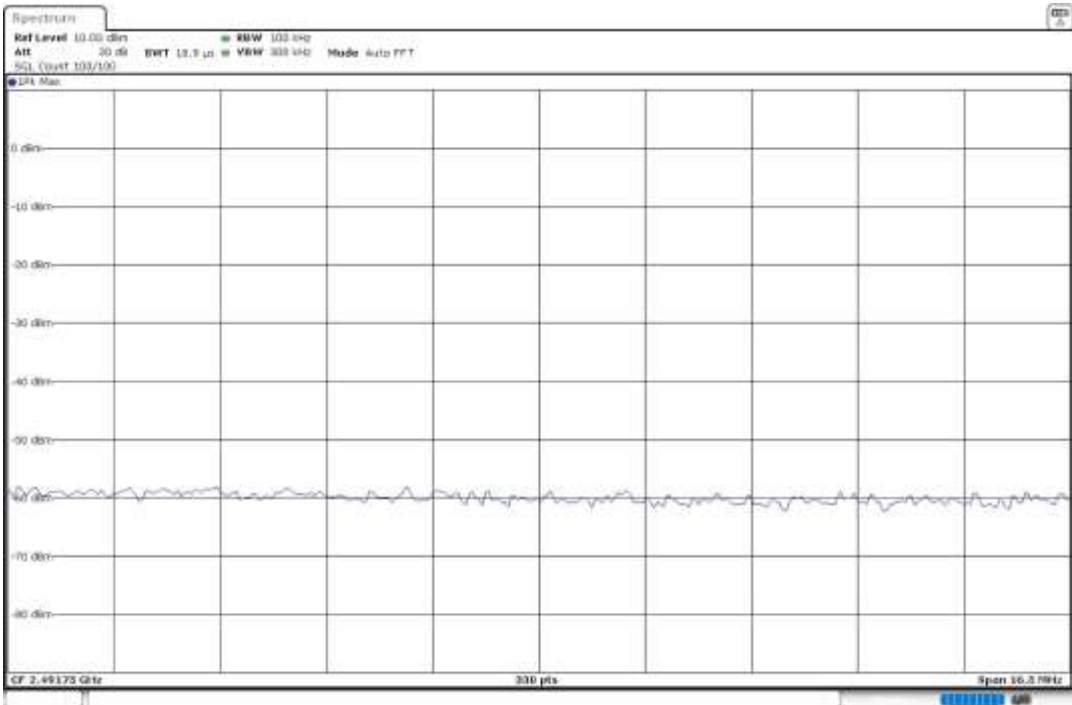
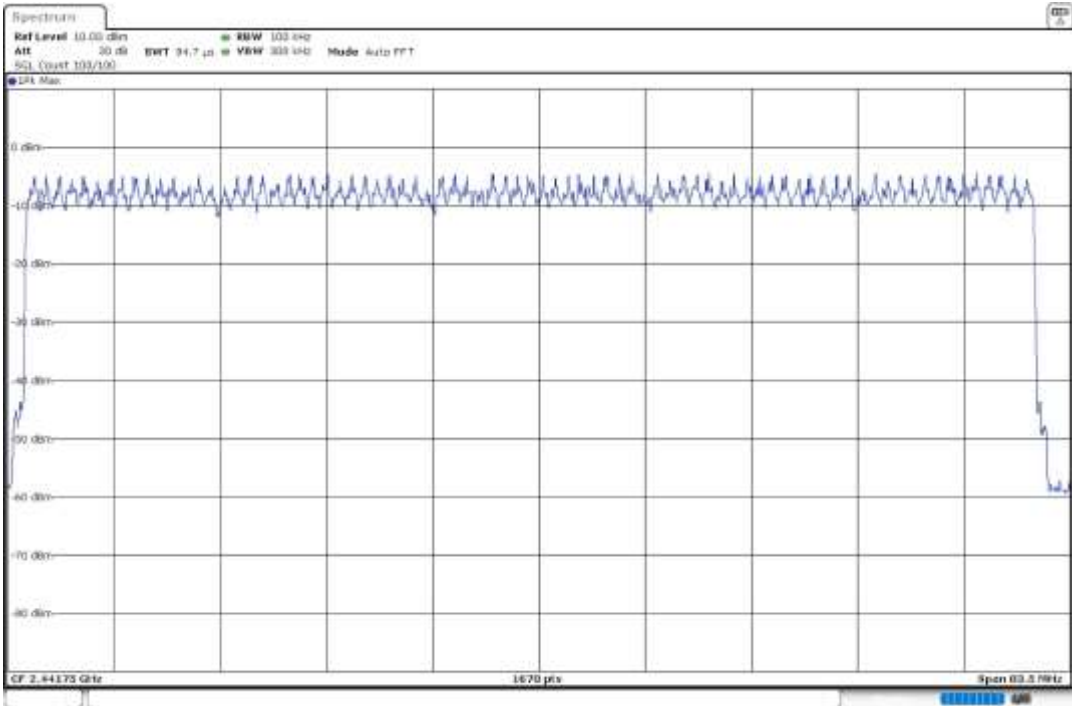




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (8DPSK 3-DH5) – hopping

Plots:





RSS-247 5.5 / FCC 15.247 (d) [RSE] Emission limitations radiated (Transmitter)

Limits

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

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009 – 0.490	2400/F(kHz)	-	300
0.490 – 1.705	24000/F(kHz)	-	30
1.705 – 30	30	-	30
30 – 88	100	40	3
88 – 216	150	43.5	3
216 – 960	200	46	3
Above 960	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 specified when measuring with peak detector function, corresponding to 20 dB above the indicated values in the table.

RSS-247:

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

Results

Frequency range 30 MHz – 1 GHz:

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

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

Unwanted Freq (MHz)	Unwanted Lvl (dBµV/m)	Pol	Detector
203.963438	23.91	H	Quasi-Peak

Verdict

Pass

Modulation: BT (GFSK 1-DH5)

Frequency range 1 GHz – 26 GHz:

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

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl (dBµV/m)	Pol	Detector
2402.00000	[1, 3]	1535.400000	48.85	H	PK
2441.00000	[1, 3]	1535.466667	49.16	H	PK
2480.00000	[1, 3]	1214.266667	48.16	V	PK
		1535.600000	49.60	H	PK

Verdict

Pass

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

Frequency range 1 GHz – 26 GHz:

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

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl (dBµV/m)	Pol	Detector
2402.00000	[1, 3]	1208.133333	47.65	V	PK
2480.00000	[1, 3]	1180.866667	48.81	V	PK

Verdict

Pass

Modulation: BT (8DPSK 3-DH5)

Frequency range 1 GHz – 26 GHz:

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

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl (dBµV/m)	Pol	Detector
2402.00000	[1, 3]	1194.800000	48.58	V	PK
2441.00000	[1, 3]	1193.333333	47.95	V	PK

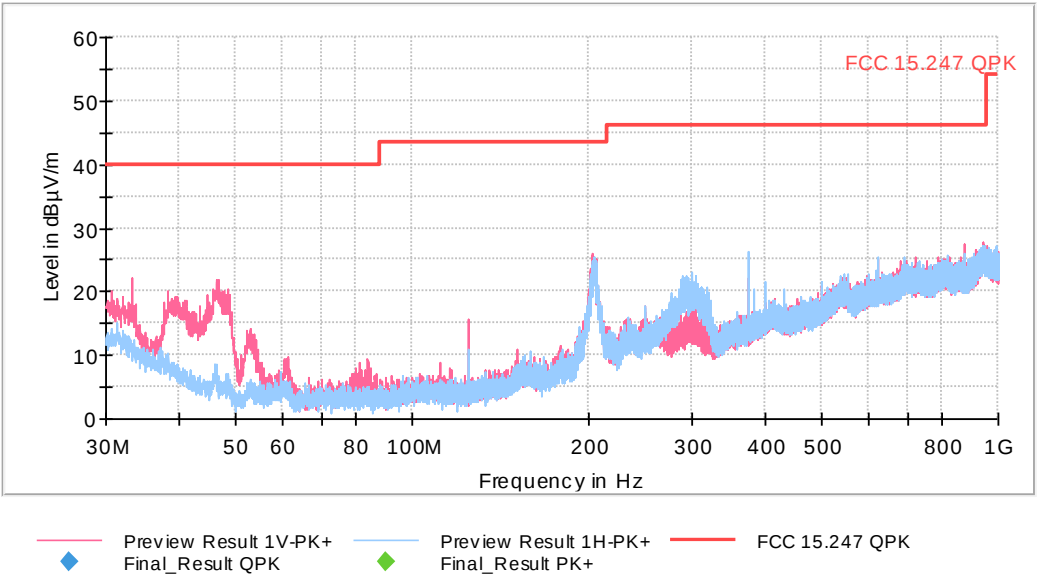
Verdict

Pass

Attachments

Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5),
Frequency Range (GHz) = [0.03, 1]

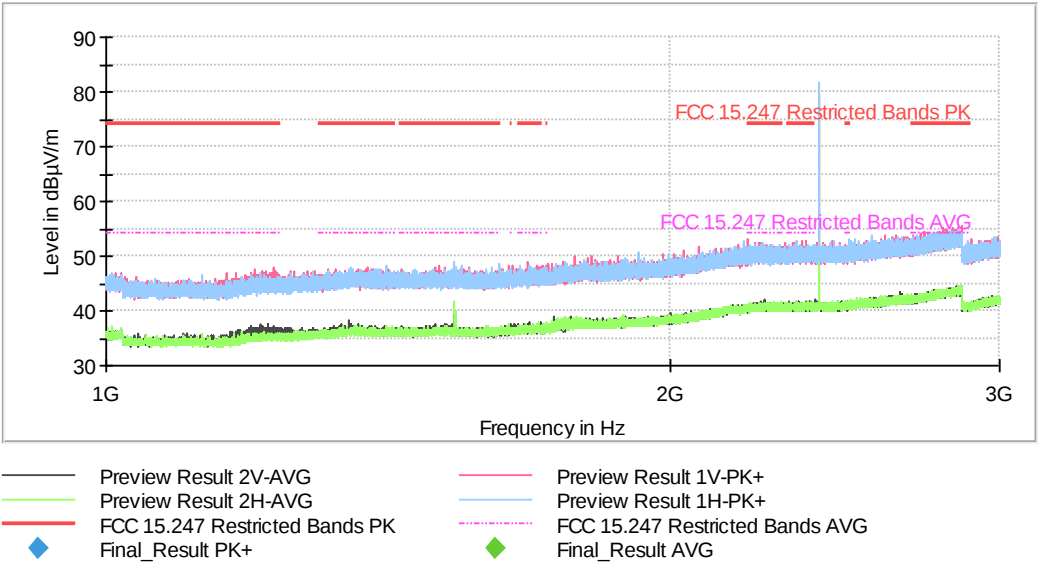
Plots:



This plot is valid for Low, Middle and High Channels.
Settings: RBW = 100 kHz / VBW = 300 kHz / Sweep Time = 1s / Sweep points = 32001

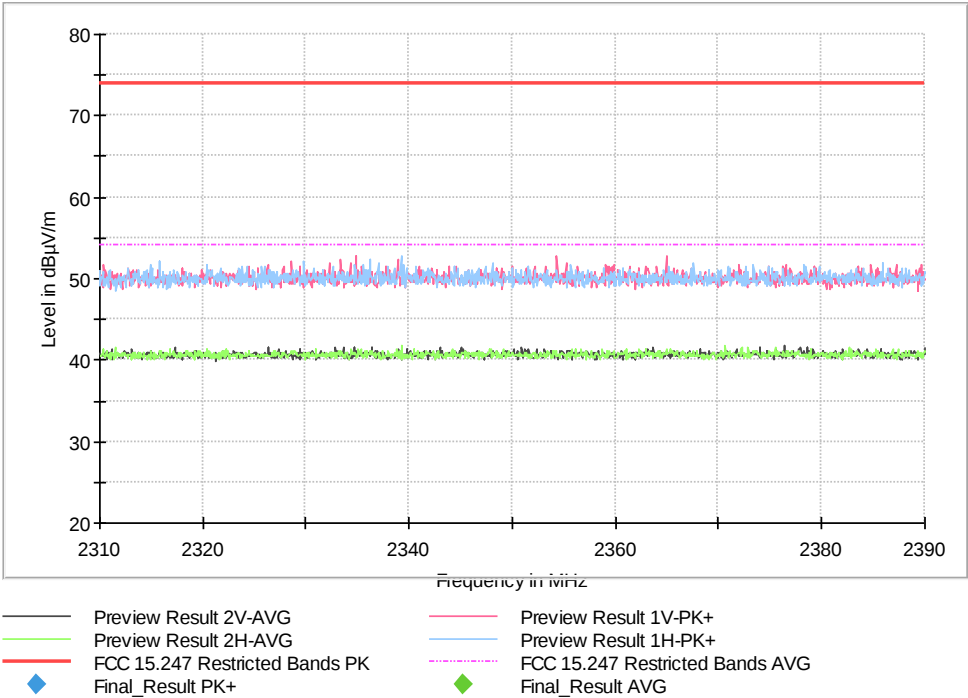
Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
Modulation: BT (GFSK 1-DH5), Frequency Range (GHz) = [1, 3]

Plots:

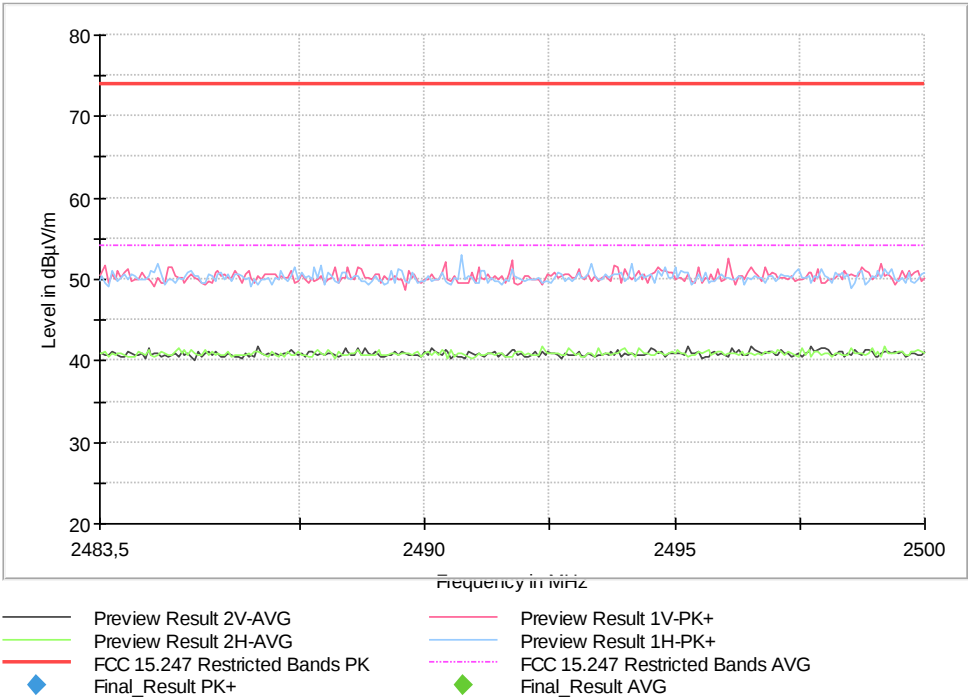


Settings: RBW = 1 MHz / VBW = 3 MHz / Sweep Time = 1s / Sweep points = 30000

Full Spectrum

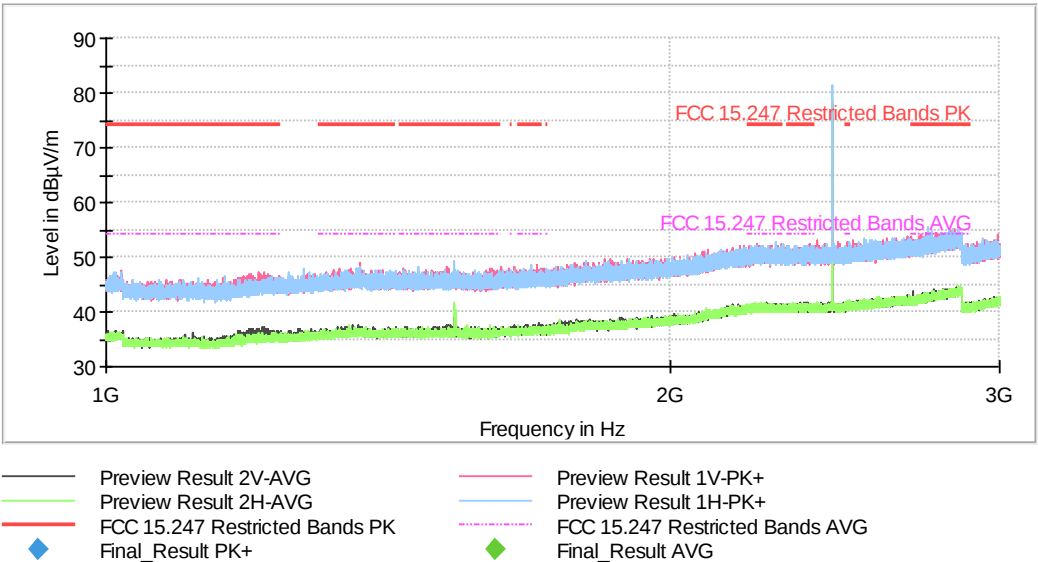


Full Spectrum



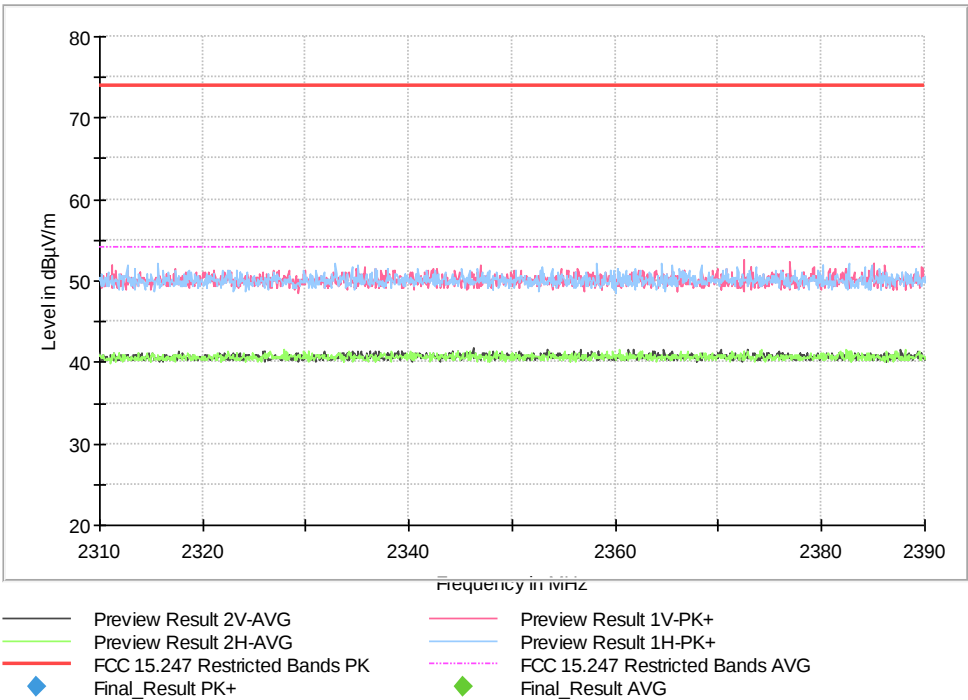
Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
Modulation: BT (GFSK 1-DH5), Frequency Range (GHz) = [1, 3]

Plots:

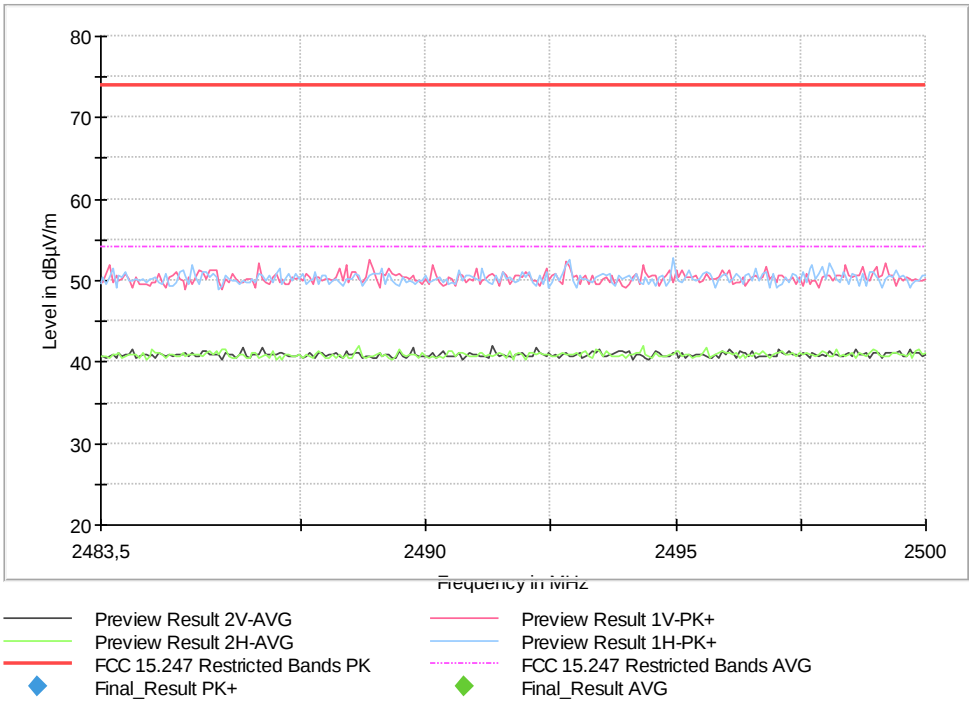


Settings: RBW = 1 MHz / VBW = 3 MHz / Sweep Time = 1s / Sweep points = 30000

Full Spectrum

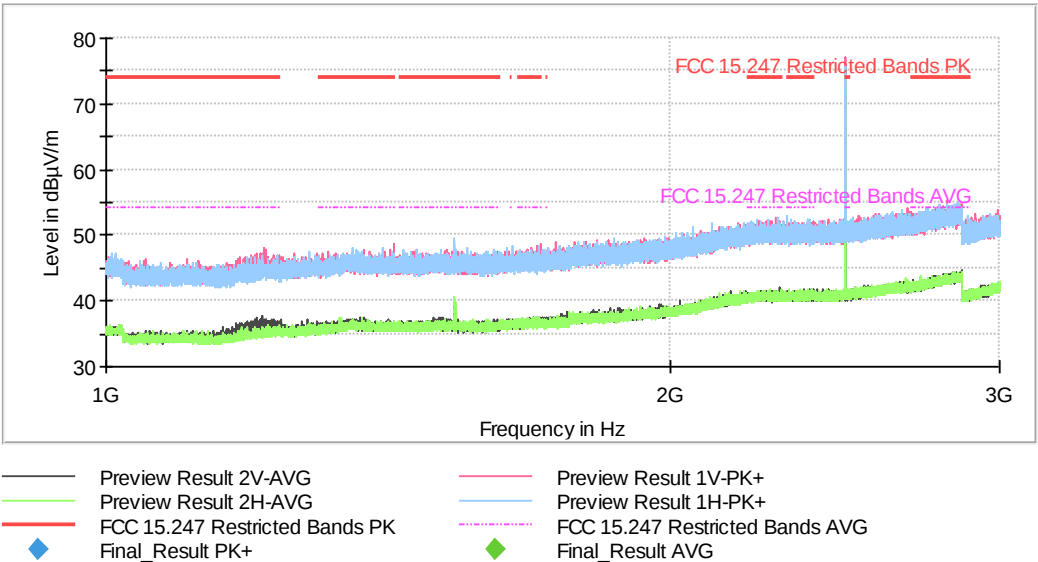


Full Spectrum



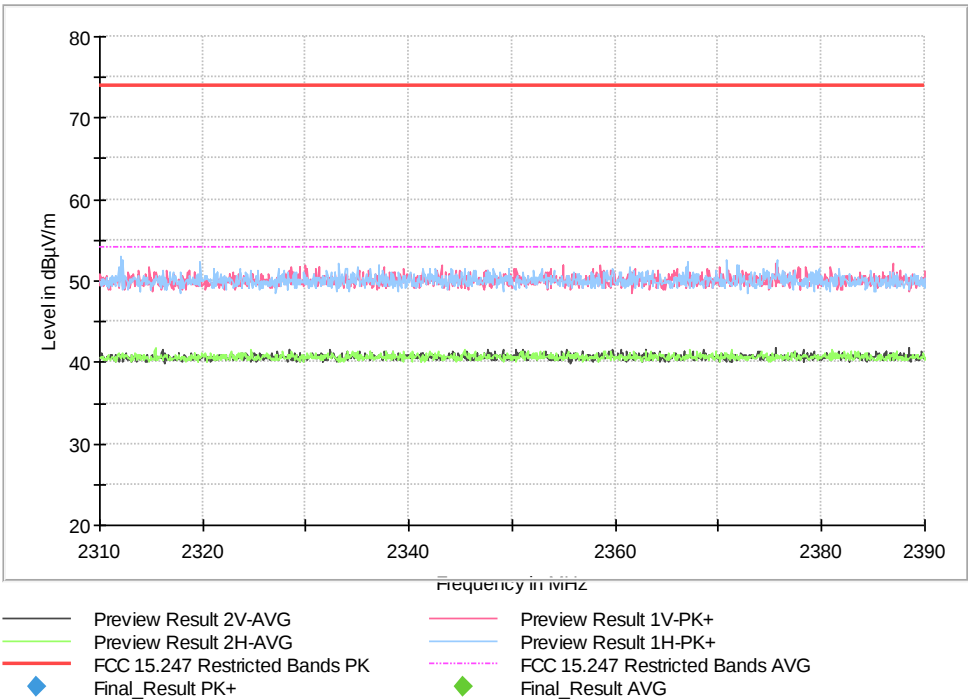
Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
Modulation: BT (GFSK 1-DH5), Frequency Range (GHz) = [1, 3]

Plots:

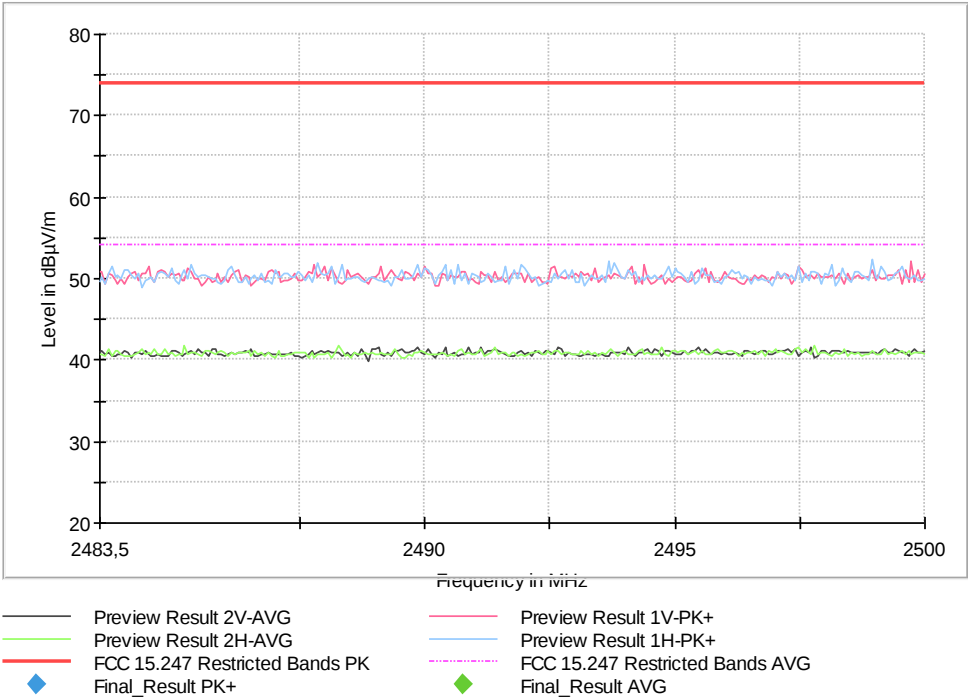


Settings: RBW = 1 MHz / VBW = 3 MHz / Sweep Time = 1s / Sweep points = 30000

Full Spectrum

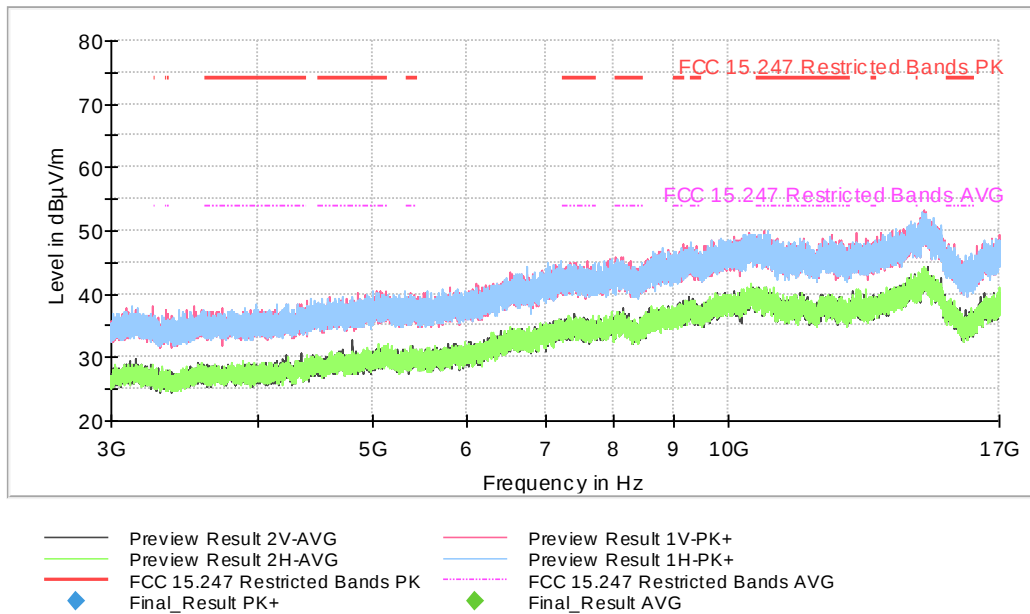


Full Spectrum



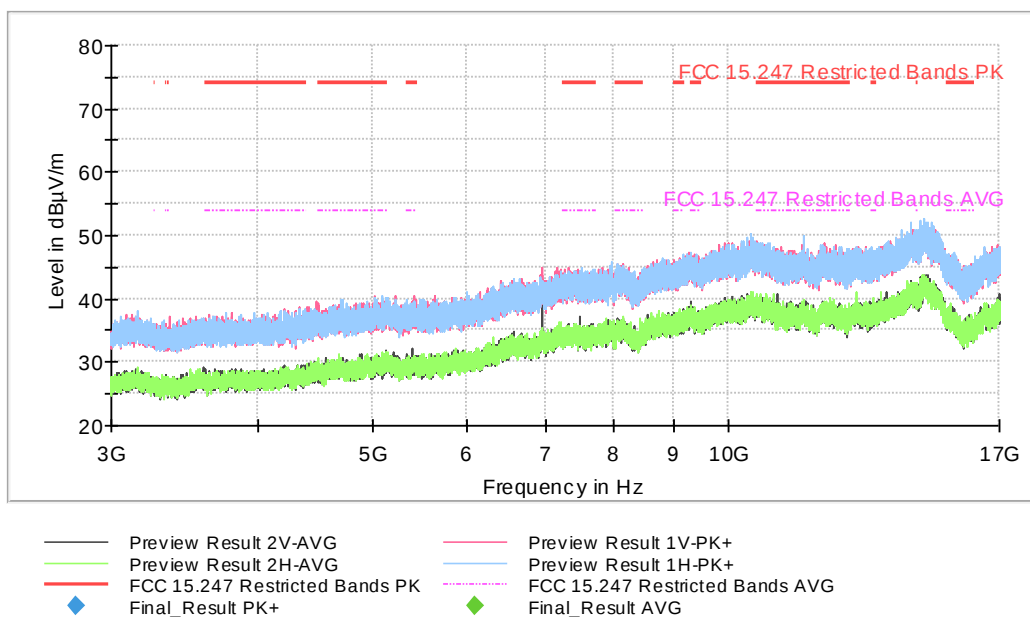
Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
 Modulation: BT (GFSK 1-DH5), Frequency Range (GHz) = [3, 17]

Plots:



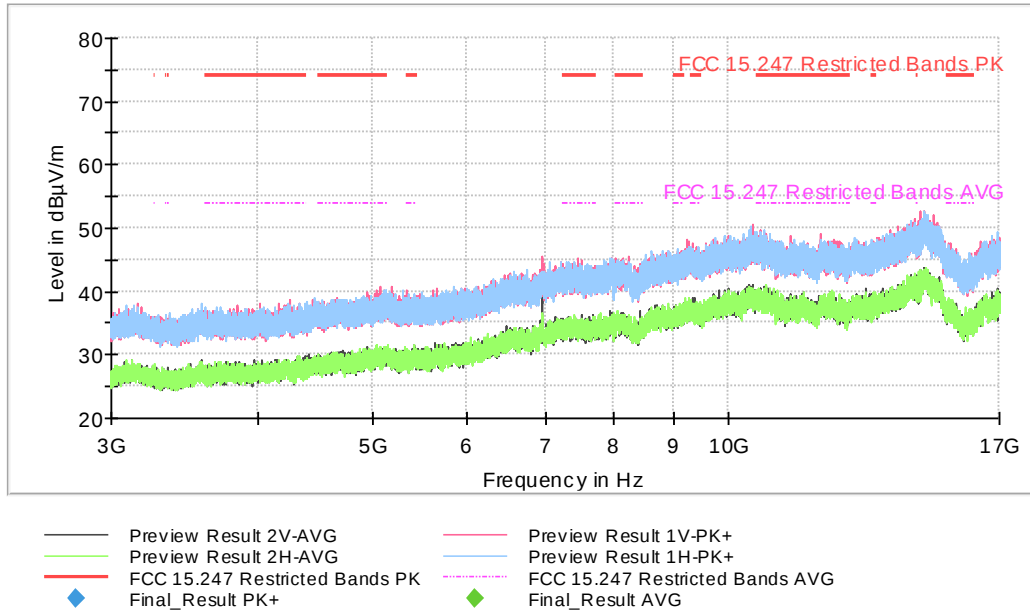
Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
 Modulation: BT (GFSK 1-DH5), Frequency Range (GHz) = [3, 17]

Plots:



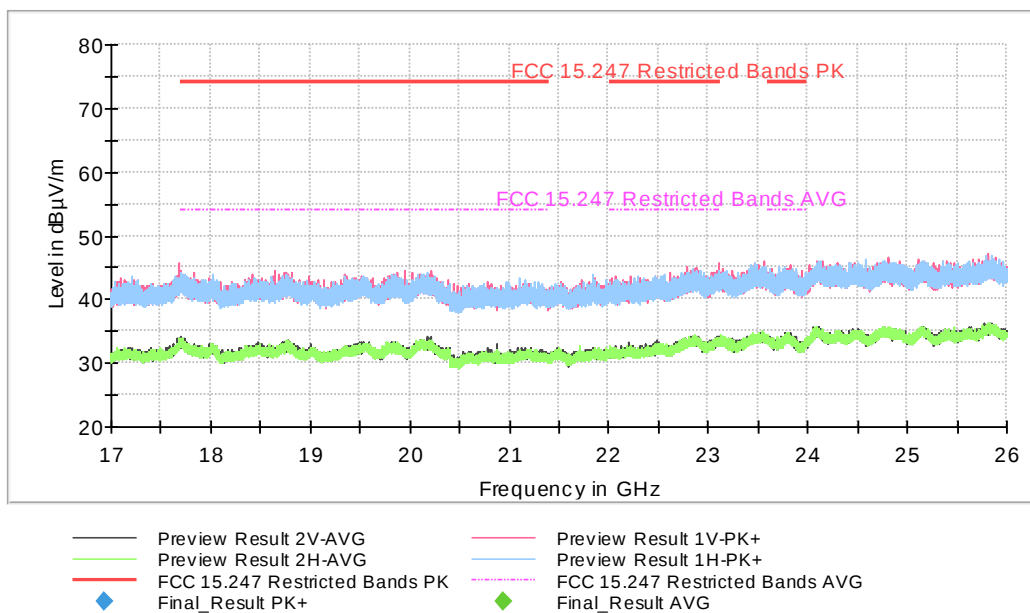
Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
Modulation: BT (GFSK 1-DH5), Frequency Range (GHz) = [3, 17]

Plots:



Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (GFSK 1-DH5),
Frequency Range (GHz) = [17, 26]

Plots:

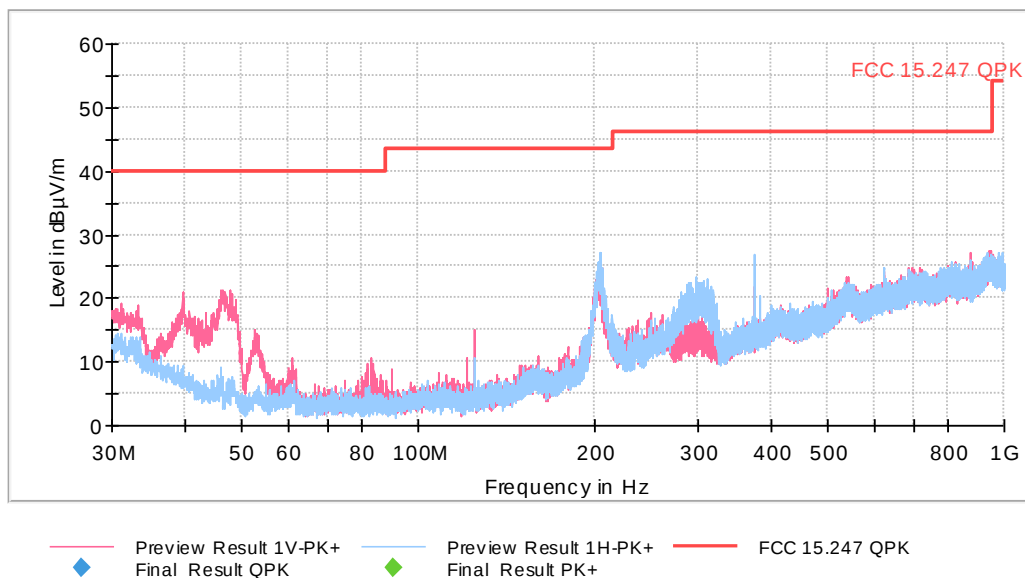


This plot is valid for Low, Middle and High Channels.

Settings: RBW = 1 MHz / VBW = 3 MHz / Sweep Time = 1s / Sweep points = 32001

Equipment Type: Frequency Hopping Spread Spectrum systems (DSS), Modulation: BT (Pi/4 DQPSK 2-DH5), Frequency Range (GHz) = [0.03, 1]

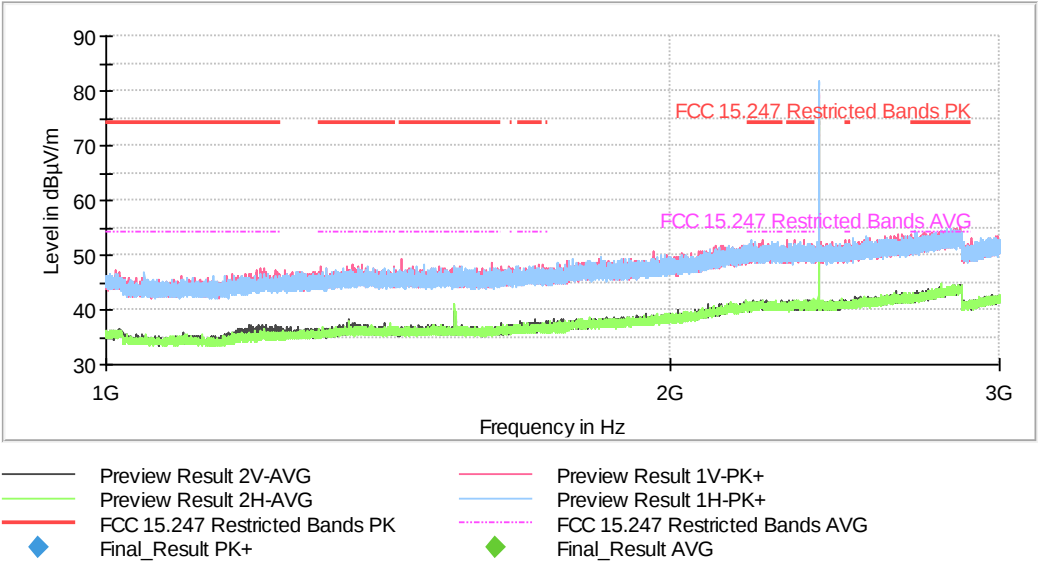
Plots:



This plot is valid for Low, Middle and High Channels.
 Settings: RBW = 100 kHz / VBW = 300 kHz / Sweep Time = 1s / Sweep points = 32001

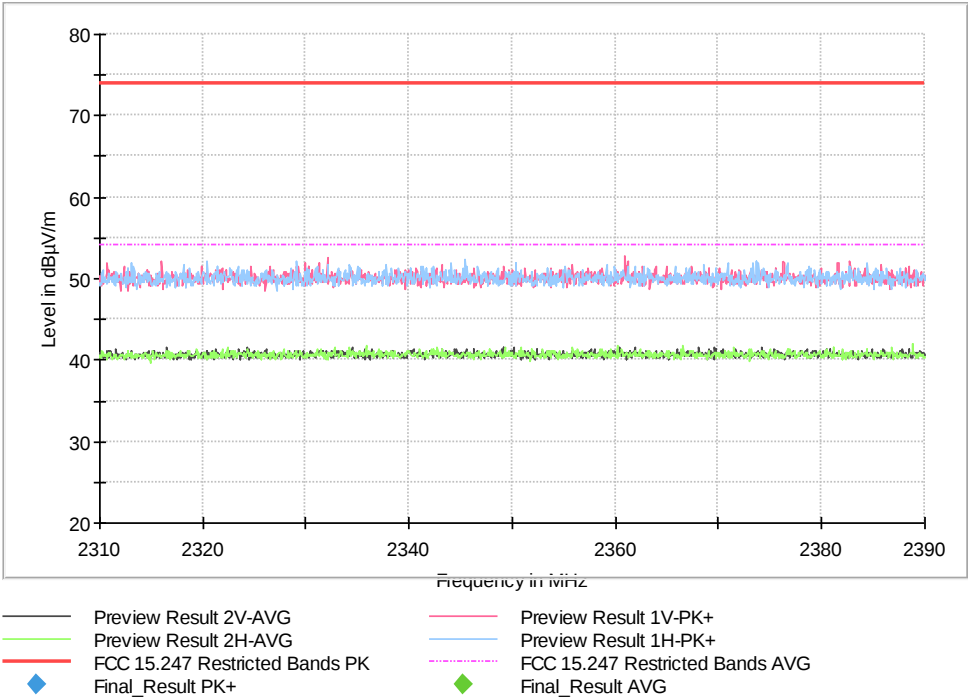
Frequency (MHz) = 2402.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
Modulation: BT (Pi/4 DQPSK 2-DH5), Frequency Range (GHz) = [1, 3]

Plots:

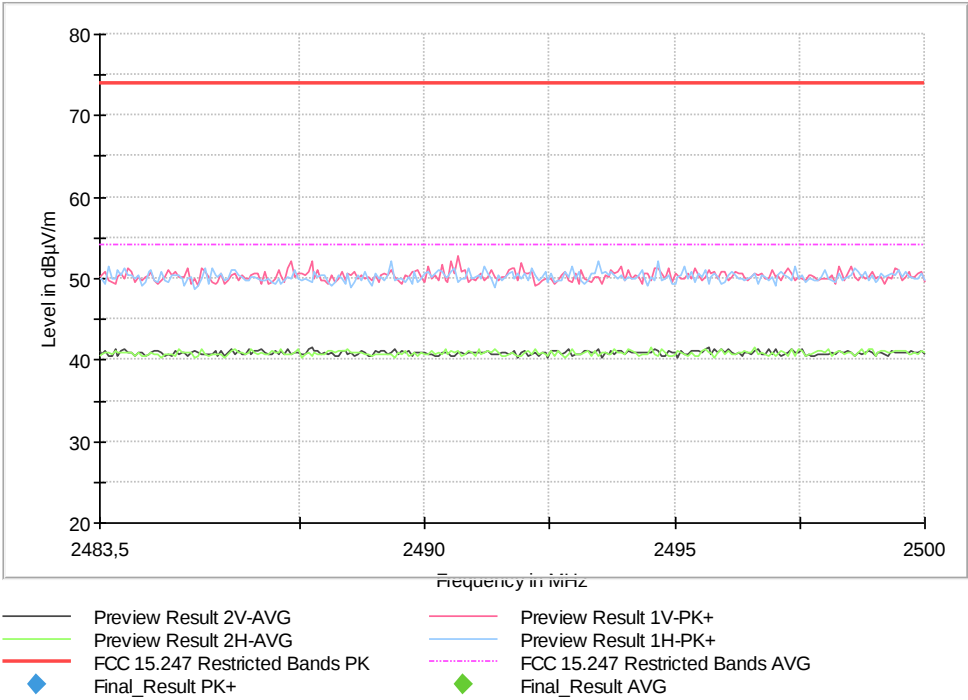


Settings: RBW = 1 MHz / VBW = 3 MHz / Sweep Time = 1s / Sweep points = 30000

Full Spectrum

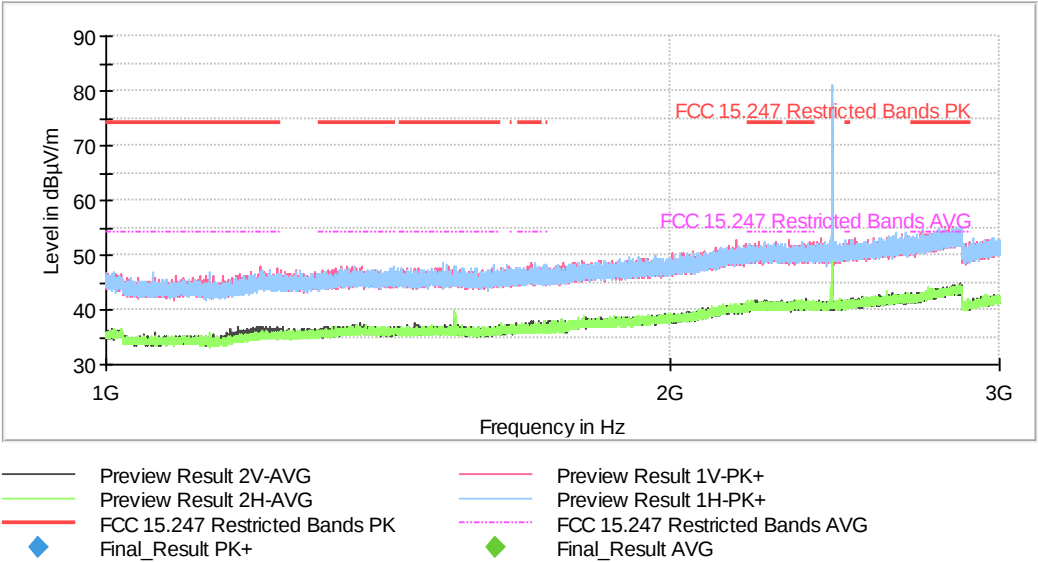


Full Spectrum



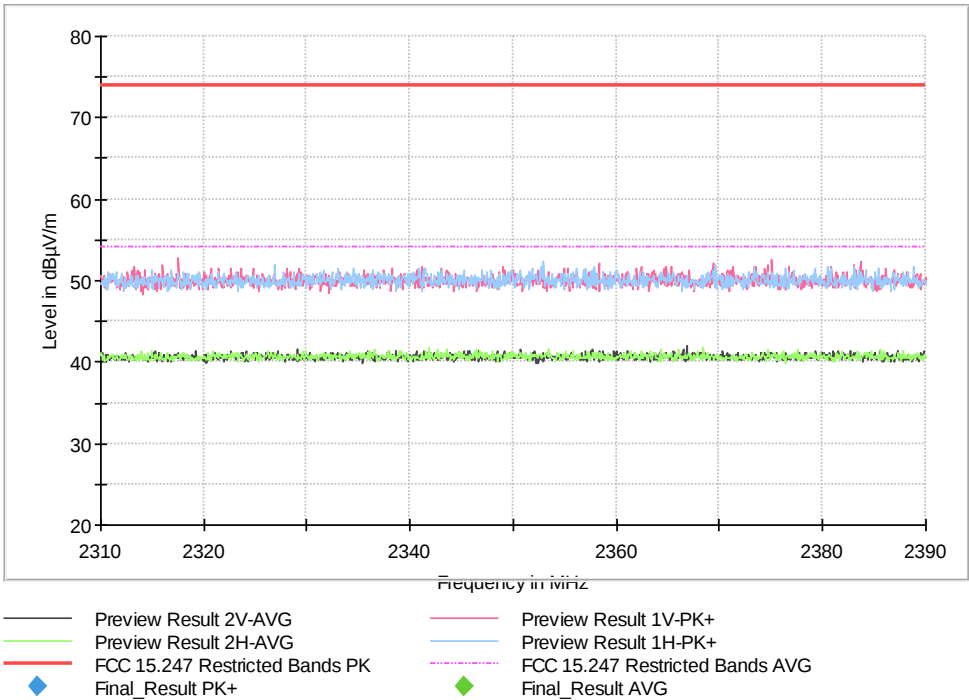
Frequency (MHz) = 2441.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
Modulation: BT (Pi/4 DQPSK 2-DH5), Frequency Range (GHz) = [1, 3]

Plots:

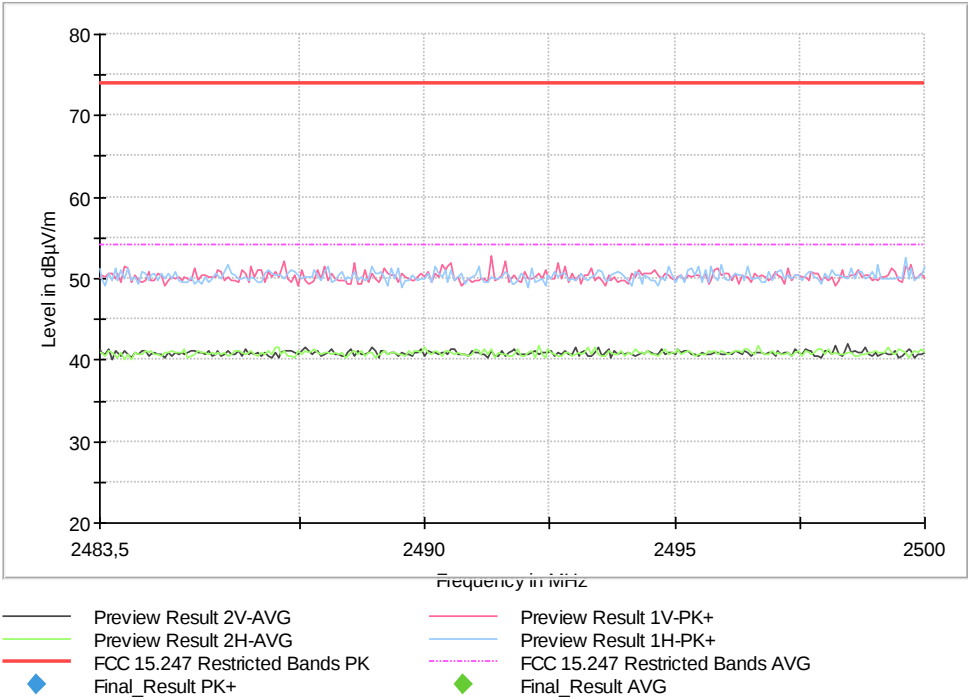


Settings: RBW = 1 MHz / VBW = 3 MHz / Sweep Time = 1s / Sweep points = 30000

Full Spectrum

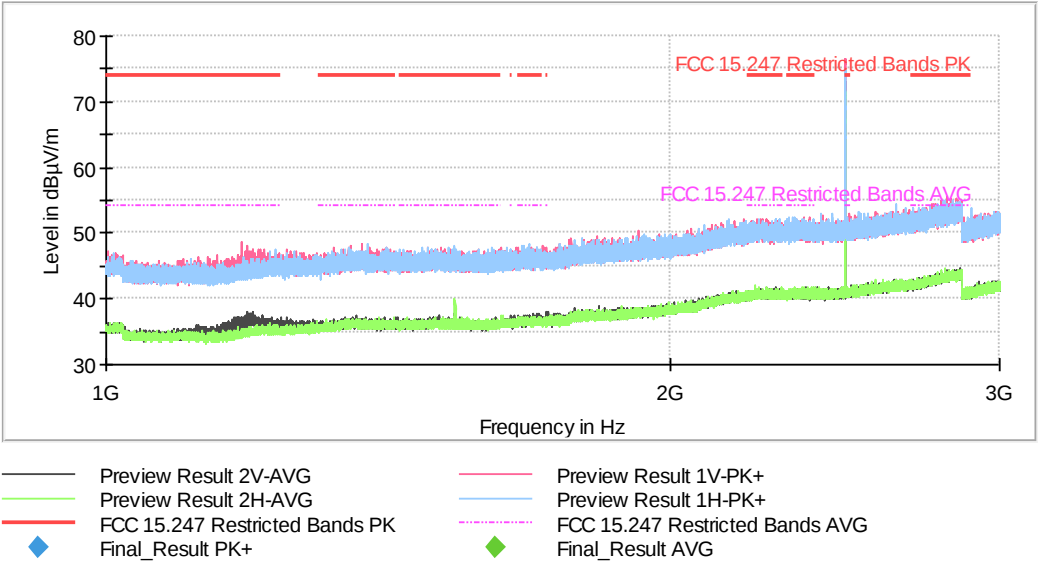


Full Spectrum

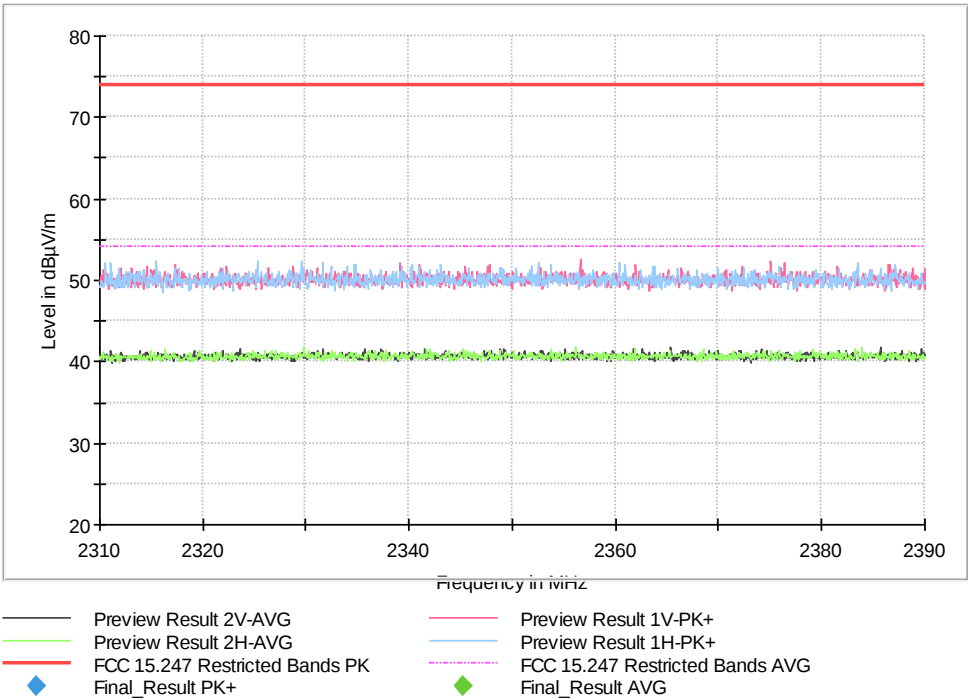


Frequency (MHz) = 2480.00000, Equipment Type: Frequency Hopping Spread Spectrum systems (DSS),
Modulation: BT (Pi/4 DQPSK 2-DH5), Frequency Range (GHz) = [1, 3]

Plots:



Full Spectrum



Full Spectrum

