



Test report No:
 NIE: 64733RRF.002

Test Report

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

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

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

General Requirements and Information for the Certification of Radio Apparatus.

(*) Identification of item tested	Headphone Emitter Module	
(*) Trademark	Jaguar – Land Rover	
(*) Model and /or type reference	HEM	
Other identification of the product	HW version: C2 SW version: 7.2.1 FCC ID: 2AE5I-HEM IC: 2145A-HEM	
(*) Features	Bluetooth	
Applicant	Jaguar Land Rover Jaguar Land Rover, Banbury Road, Gaydon, CV35 0RR, UK	
Test method requested. standard	USA FCC Part 15.247 (10-1-19 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 (10-1-19 Edition): Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). RSS-Gen Issue 5 (March 2019) Amendment 1. General Requirements for Compliance of Radio Apparatus. 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.	
Summary	IN COMPLIANCE	
Approved by (name / position & signature)	José Carlos Luque RF Lab. Supervisor	74841983Y JOSE CARLOS LUQUE (C:A29507456) Firmado digitalmente por 74841983Y JOSE CARLOS LUQUE (C:A29507456) Fecha: 2020.07.30 13:50:52 +02'00'
Date of issue	2020-07-30	
Report template No	FDT08_22 (* "Data provided by the client")	

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Competences and guarantees

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

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

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

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

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

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

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

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General conditions

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

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 HEM is an Original Equipment Telematic Control Unit. Provides in car-connectivity for OEM telematic services.

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

Usage of samples

Samples undergoing test have been selected by: The client.

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

Control N°	Description	Model	Serial N°	Date of reception
62417/002	Headphone Emitter Module	HEM	--	2019/12/26

Auxiliary elements used with the sample S/01:

Control N°	Description	Model	Serial N°	Date of reception
62417/004	Connecting cable	--	--	2019/12/26

Sample S/01 has undergone the following test(s): All Conducted tests indicated in Appendix A.

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

Control N°	Description	Model	Serial N°	Date of reception
62417/210	Headphone Emitter Module	HEM	E440000705	2020/05/19

Auxiliary elements used with the sample S/02:

Control N°	Description	Model	Serial N°	Date of reception
62417/004	Connecting cable	--	--	2019/12/26

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

Test sample description

Ports..... :	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽⁴⁾
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Supplementary information to the ports..... :							
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	<input type="checkbox"/>	AC:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	AC:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	X	DC:13.5V					
<input type="checkbox"/>	DC:						
Rated Power	1W						
Clock frequencies..... :							
Other parameters							
Software version	7.2.1						
Hardware version	C2						
Dimensions in cm (W x H x D)	12.82 x 7.12 x 2.3						
Mounting position	<input type="checkbox"/>	Table top equipment					
	<input type="checkbox"/>	Wall/Ceiling mounted equipment					
	<input type="checkbox"/>	Floor standing equipment					
	<input type="checkbox"/>	Hand-held equipment					
	X	Other: Inside the car					
Modules/parts..... :	Module/parts of test item			Type		Manufacturer	
Accessories (not part of the test item)	Description			Type		Manufacturer	
	M8 ADC Amplifier			C2		Lear	
	Media Converter						
	Pcan CAN-simulator			Pcan		PEAK System	

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

⁽³⁾ Only for Medical Equipment

Identification of the client

Lear Corporation Engineering GmbH
 Butzweilerhofallee 2-4. 50829 Cologne - GERMANY

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-02-11
Date (finish)	2020-05-28

Document history

Report number	Date	Description
64733RRF.002	2020-07-30	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 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

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

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

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

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

Remarks and comments

The tests have been performed by the technical personnel: Miguel Ángel Torres, José Manuel Jiménez and José Gabriel Pendón.

Used instrumentation:

Conducted Measurements:

	Last Calibration	Due Calibration
1. Shielded Room ETS LINDGREN S101	N.A.	N.A.
2. Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/09	2021/09
3. DC Power Supply. 30V/5A KEYSIGHT TECHNOLOGIES U8002A	N.A.	N.A.
4. Digital Multimeter, FLUKE 175	2019/10	2020/10

Radiated Measurements:

	Last Calibration	Due Calibration
1. Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2. Shielded Room ETS LINDGREN S101	N.A.	N.A.
3. Biconical/Log Antenna 30MHz - 6GHz ETS LINDGREN 3142E	2017/09	2020/09
4. RF Pre-amplifier 40 dB, 10 MHz - 6 GHz BONN ELEKTRONIK BLNA 0160-01N	2019/02	2020/08
5. EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2018/10	2020/10
6. Low Pass Filter DC - 1 GHz TEMSTRON /TEMWELL ST-1GA3250-LS	2019/10	2020/10
7. DC Power Supply 30V/5A KEYSIGHT TECHNOLOGIES U8002A	N.A.	N.A.
8. Digital Multimeter, FLUKE 175	2019/10	2020/10
9. Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2018/01	2021/01
10. Broadband Horn Antenna 18 - 40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2018/07	2021/07
11. Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/10	2021/10
12. RF Pre-amplifier G>30dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2019/11	2020/11
13. Low Noise Amplifier G>30dB, 18 - 40 GHz BONN ELEKTRONIK BLMA 1840-1M	2019/02	2021/02

Testing verdicts

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

Summary

1. Bluetooth EDR

FCC PART 15 PARAGRAPH / RSS-247		Verdict	Remark
Requirement – Test case			
15.247 (a) (1) / RSS-247 5.1. (b)	20 dB Bandwidth and Carrier frequency separation	P	
15.247 (a)(1)(iii) / RSS-247 Clause 5.1 (d)	Number of hopping channels	P	
15.247 (a)(1)(iii) / RSS-247 Clause 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	
<u>Supplementary information and remarks:</u>			
This equipment contains four Bluetooth EDR modules: CS0BT1. CS1BT2. CS2BT3. CS3BT4. Preliminary testing determined the worst case is the module CS3BT4. Herein the test results for the worst case are included.			

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

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TEST CONDITIONS

POWER SUPPLY (V):

V nominal: 13.5 Vdc.
 Type of Power Supply: External DC (Car Battery).

ANTENNA:

Type of Antenna: Internal (Microstrip).
 Maximum Declared Antenna Gain: (antenna gain plus antenna cable loss)

Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
+1.17 dBi	+0.71 dBi	+0.09 dBi

TEST FREQUENCIES:

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

This equipment contains four Bluetooth EDR modules: CS0BT1, CS1BT2, CS2BT3, CS3BT4. Preliminary testing determined the worst case is the module CS3BT4. Herein the test results for the worst case are included.

CONDUCTED MEASUREMENTS:

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



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

RADIATED MEASUREMENTS:

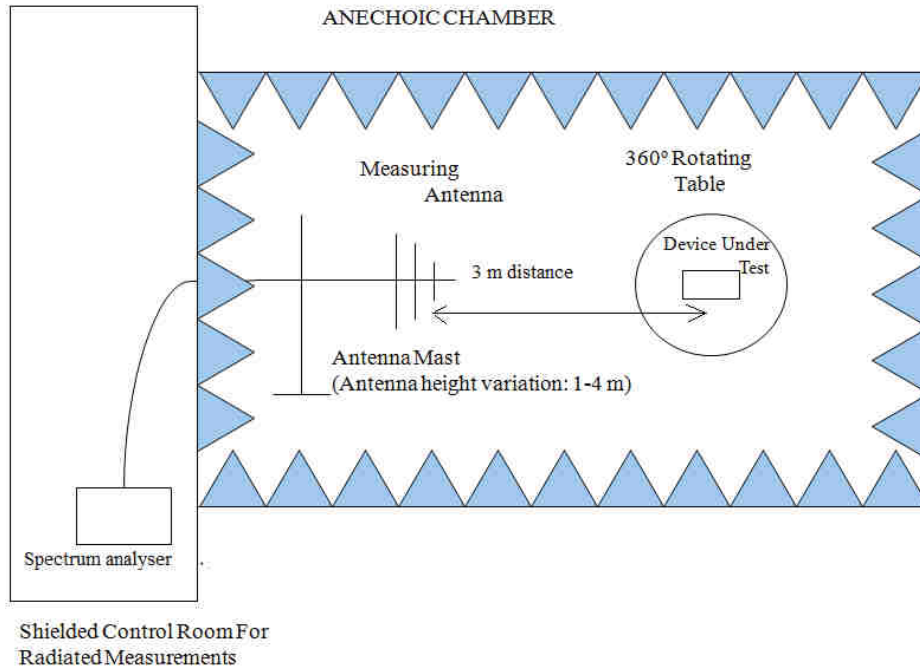
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1 GHz and 1 GHz-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1m for the frequency range 17 GHz-26 GHz (17 GHz-26 GHz horn antenna).

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

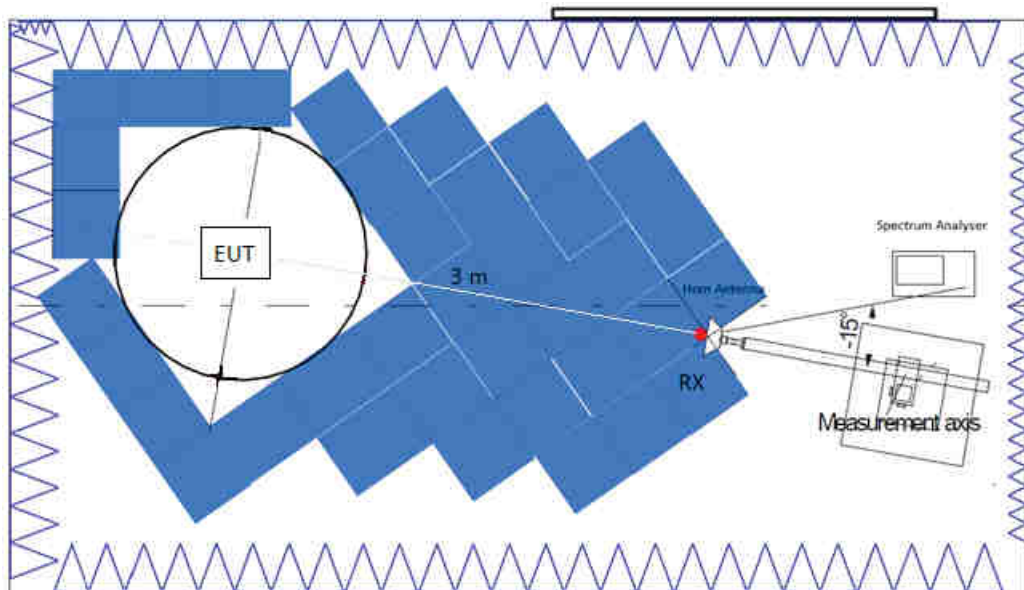
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

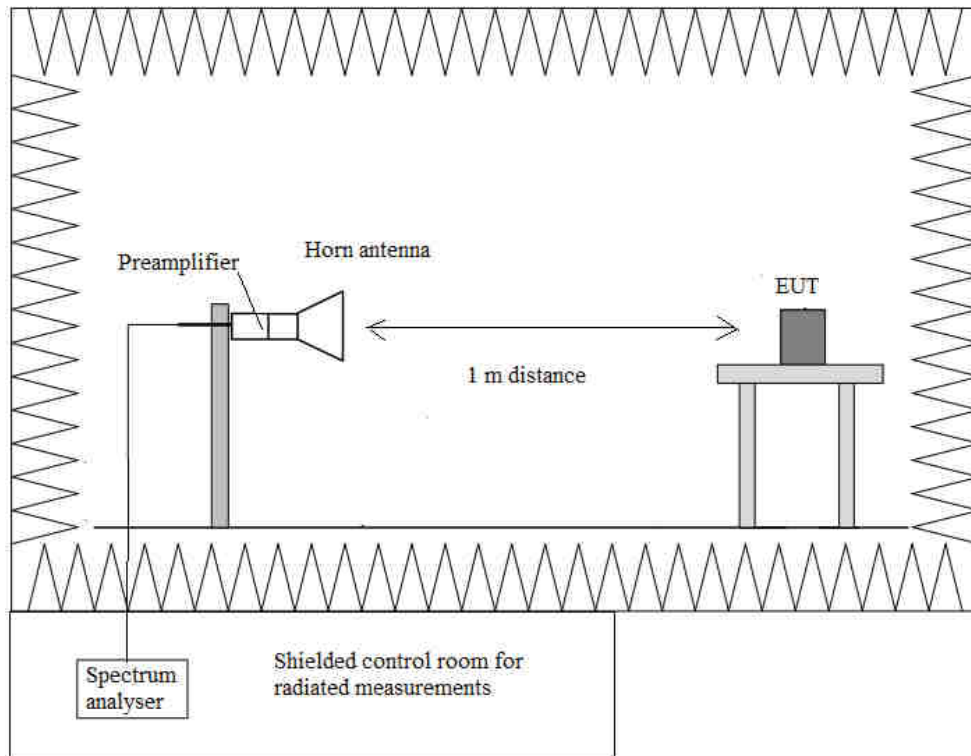
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



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

SPECIFICATION:

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

RESULTS:

- **GFSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	955	941.7	946.8
99% Bandwidth (kHz)	872	876	876
Measurement uncertainty (kHz)	<±5.8		

- **Pi/4 DQPSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	1278.7	1222.5	1339.9
99% Bandwidth (kHz)	1204	1224	1312
Measurement uncertainty (kHz)	<±5.8		

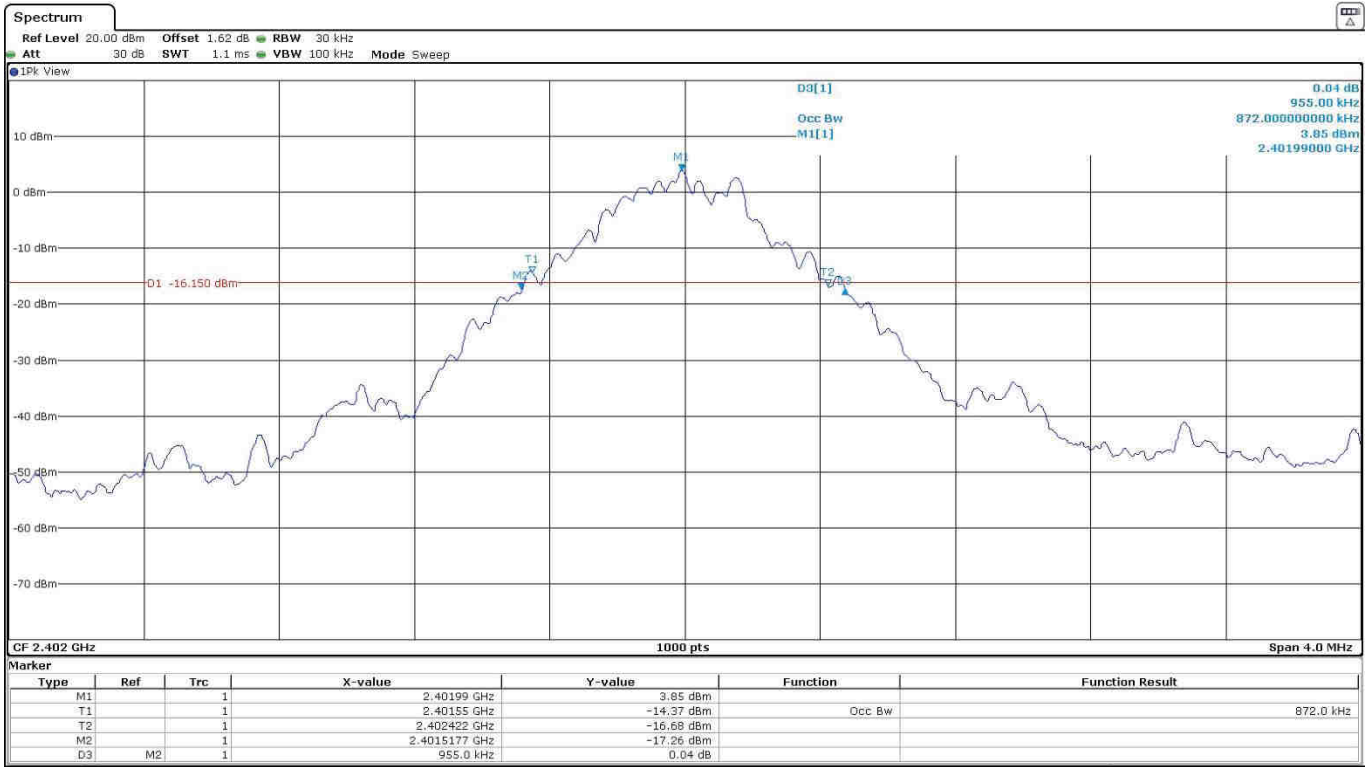
- **8DPSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	1292.4	1290.5	1298.1
99% Bandwidth (kHz)	1204	1220	1284
Measurement uncertainty (kHz)	<±5.8		

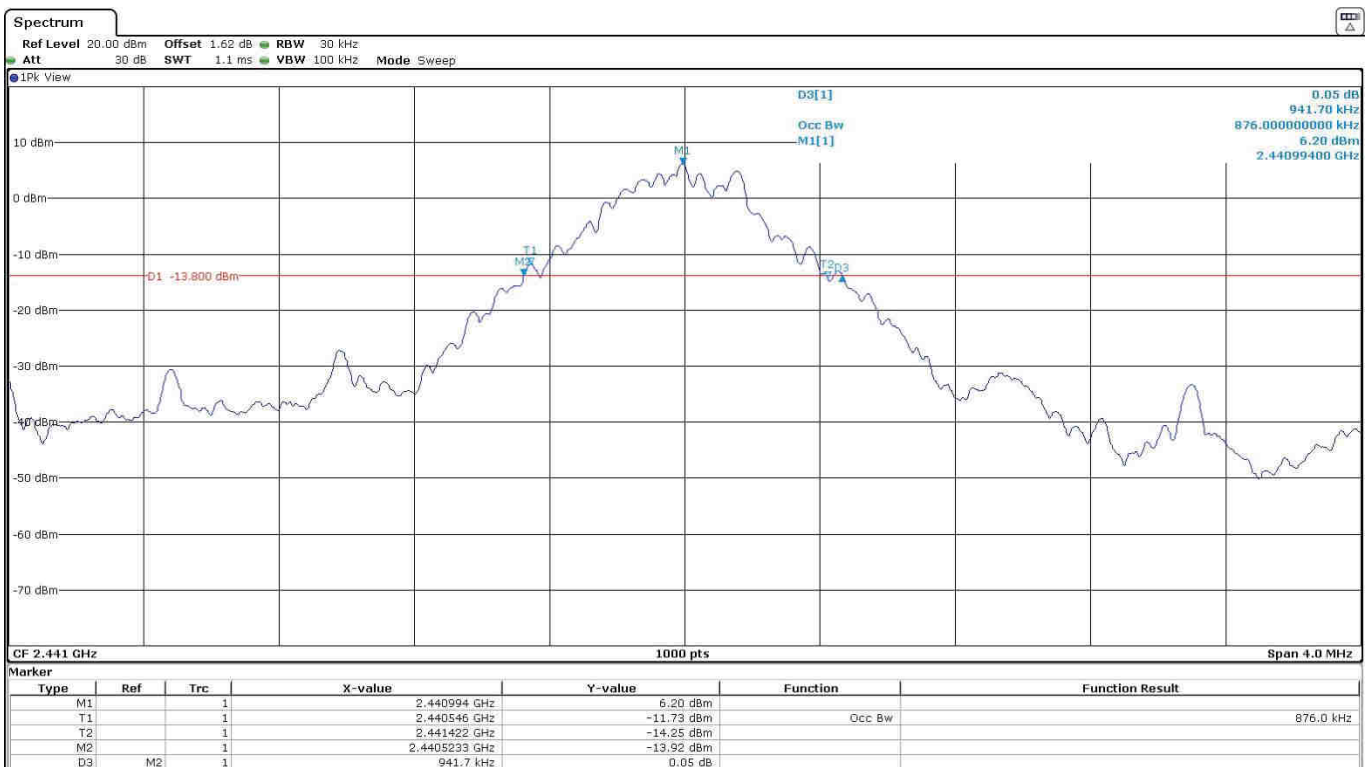
Verdict: PASS

• **GFSK – Bandwidths**

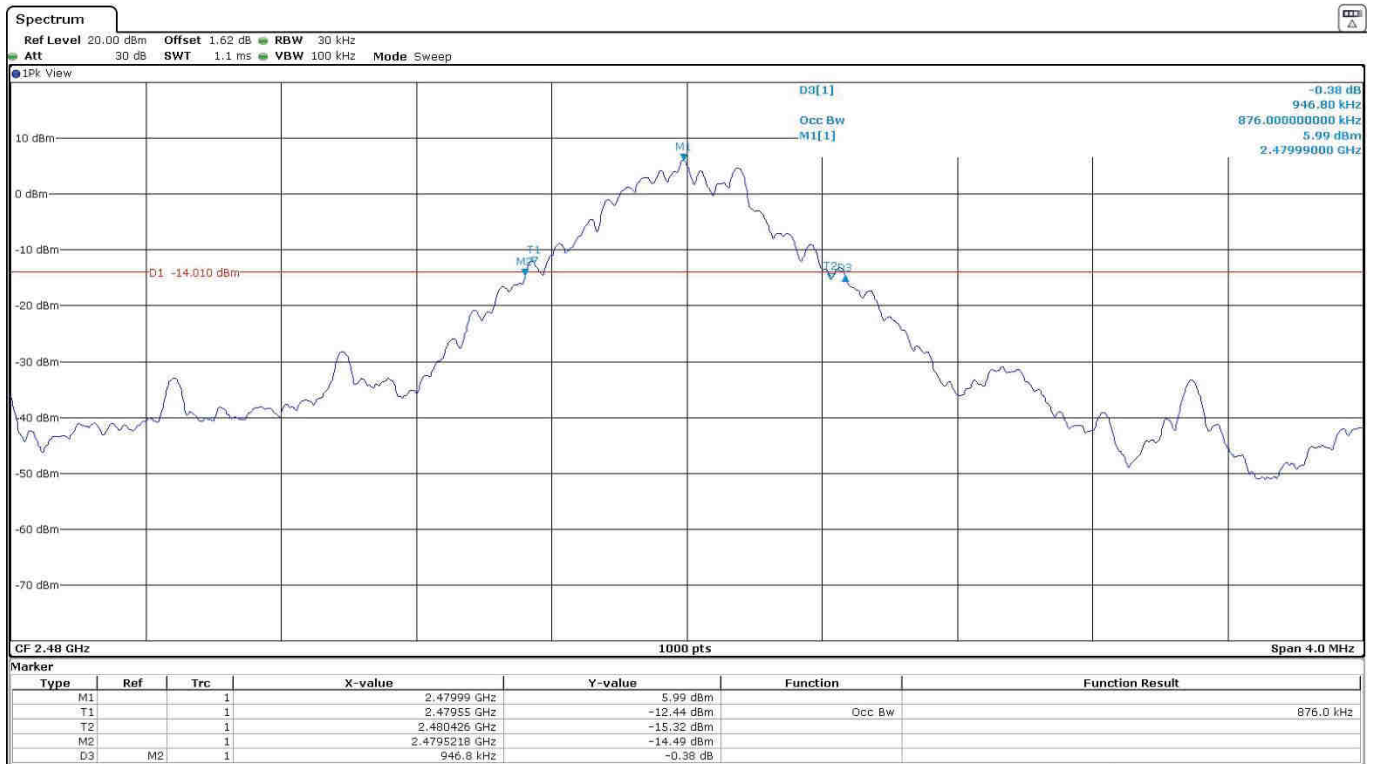
- Low Channel:



- Middle Channel:

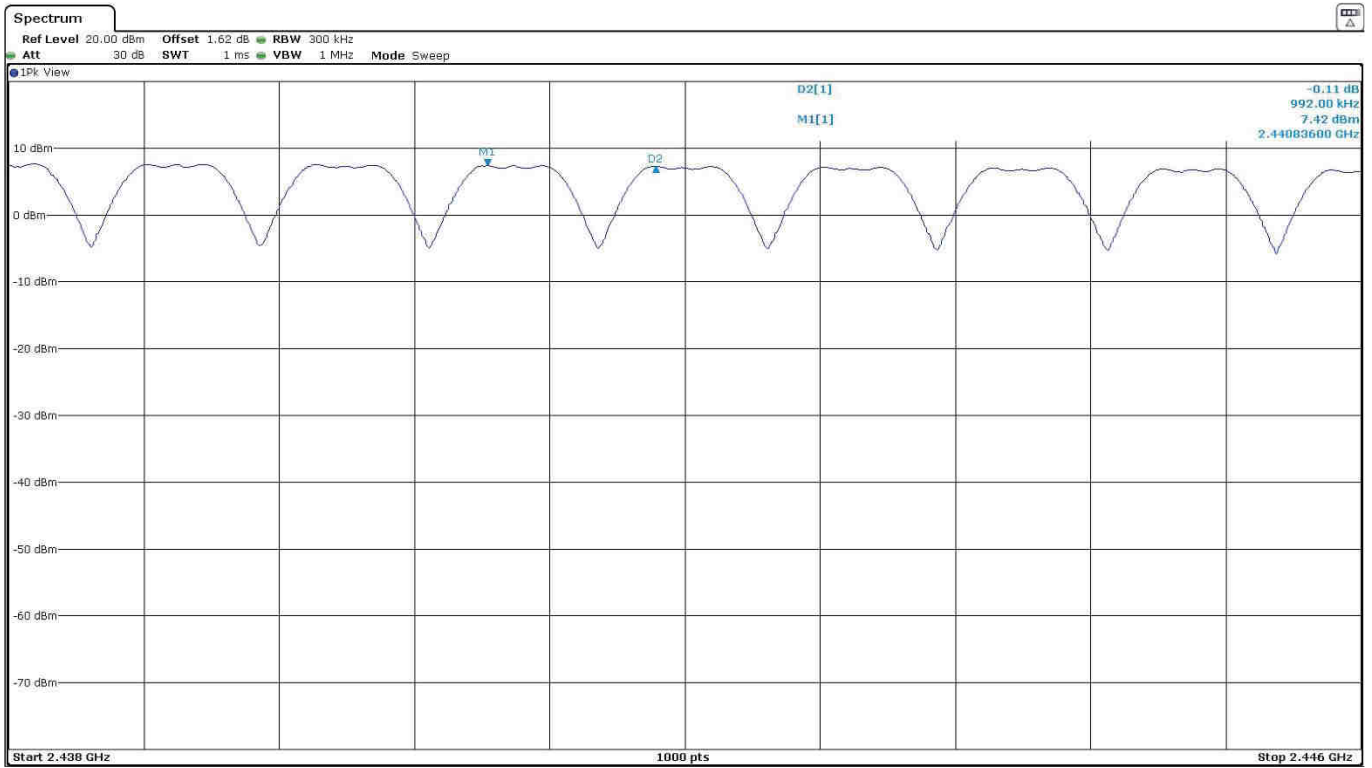


- High Channel:



Carrier frequency separation - GFSK

Carrier frequency separation: kHz

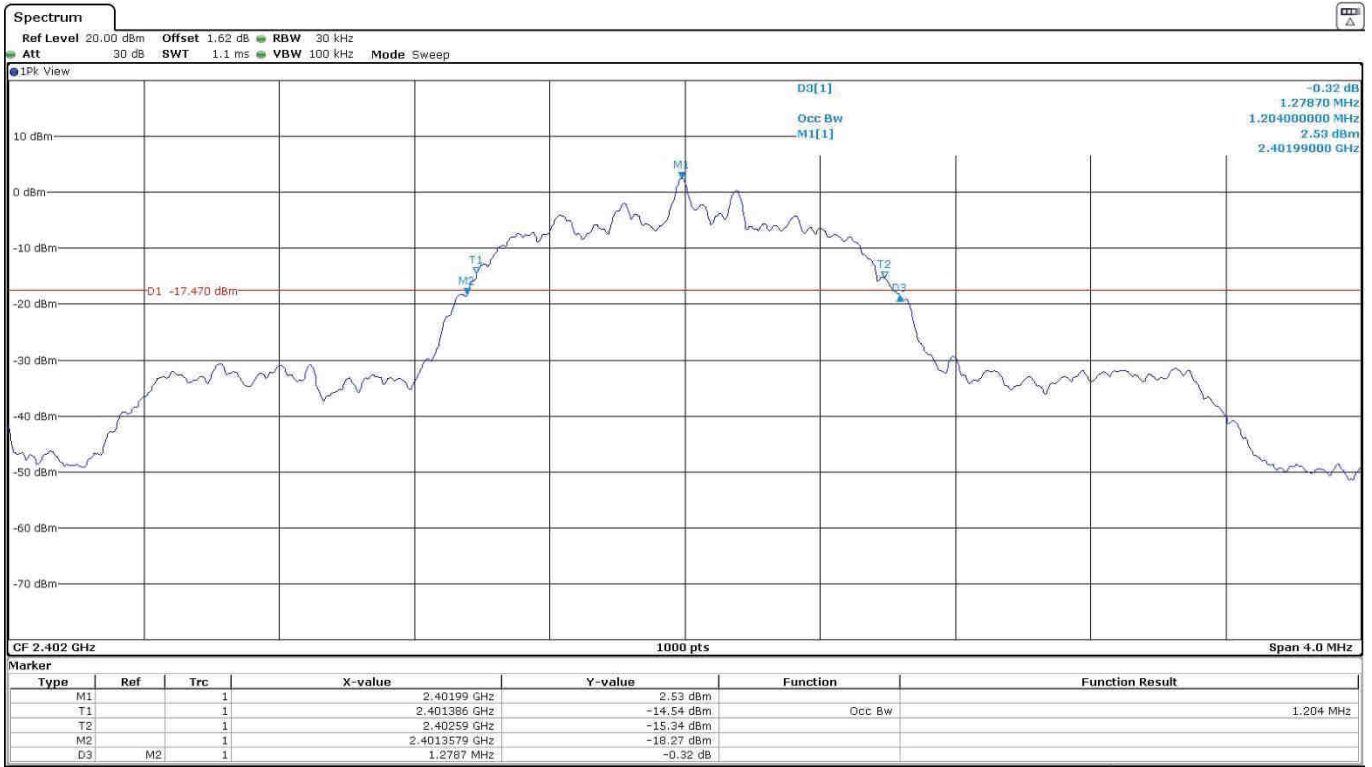


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

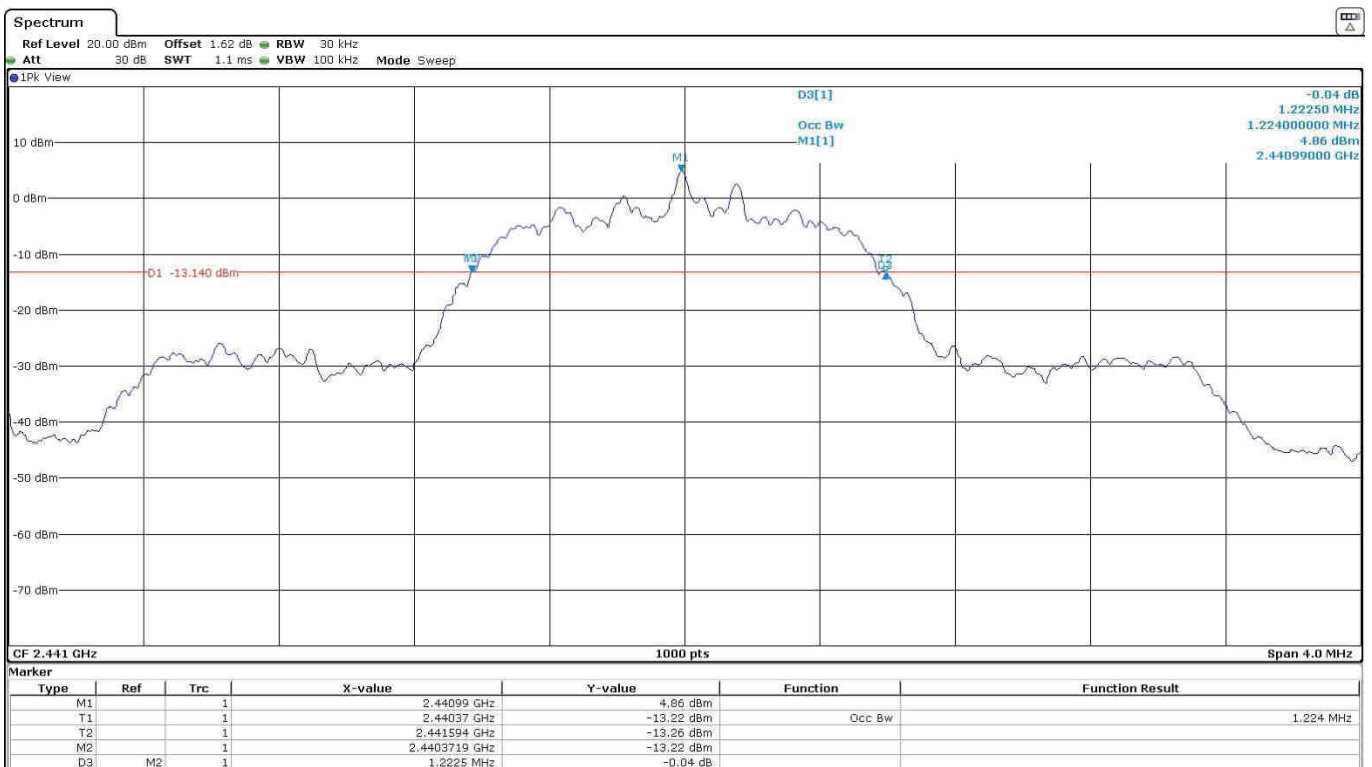
Verdict: PASS

• Pi/4 DQPSK – Bandwidths

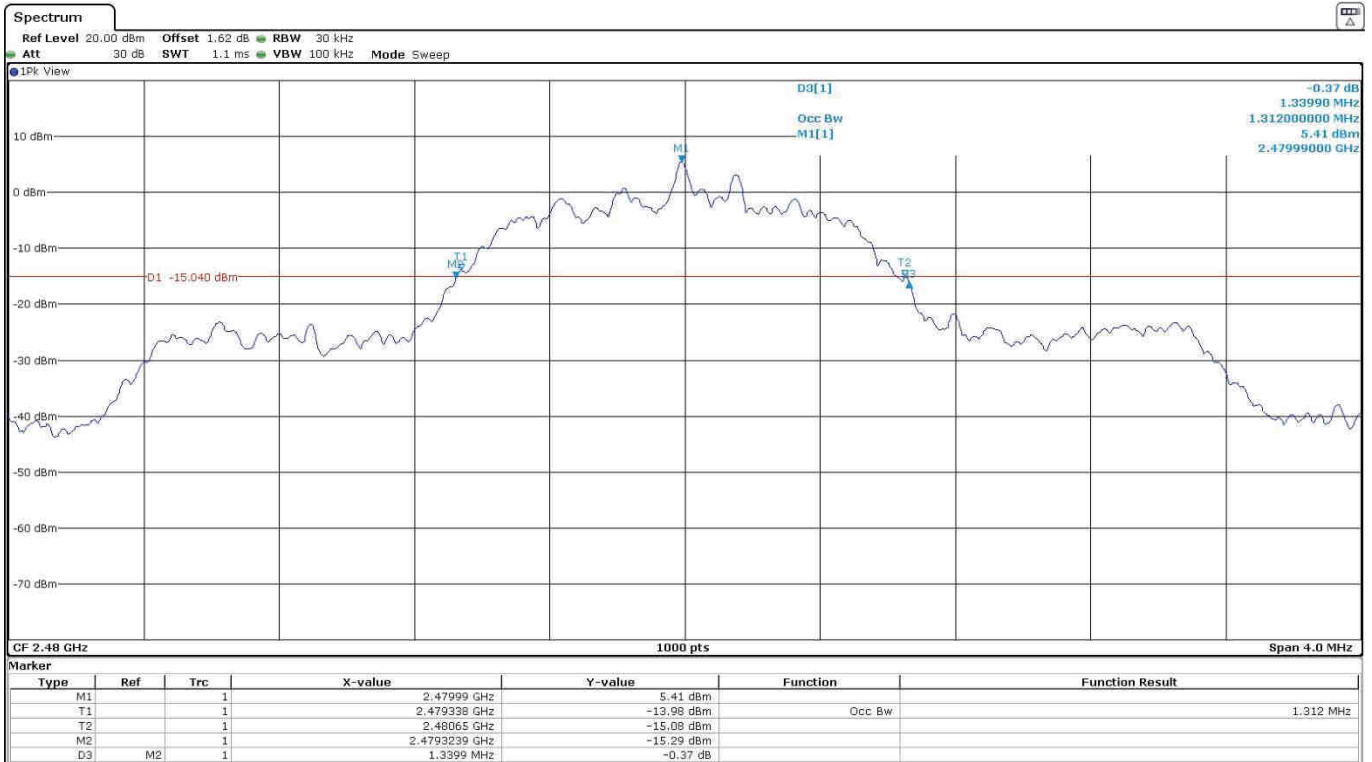
- Low Channel:



- Middle Channel:

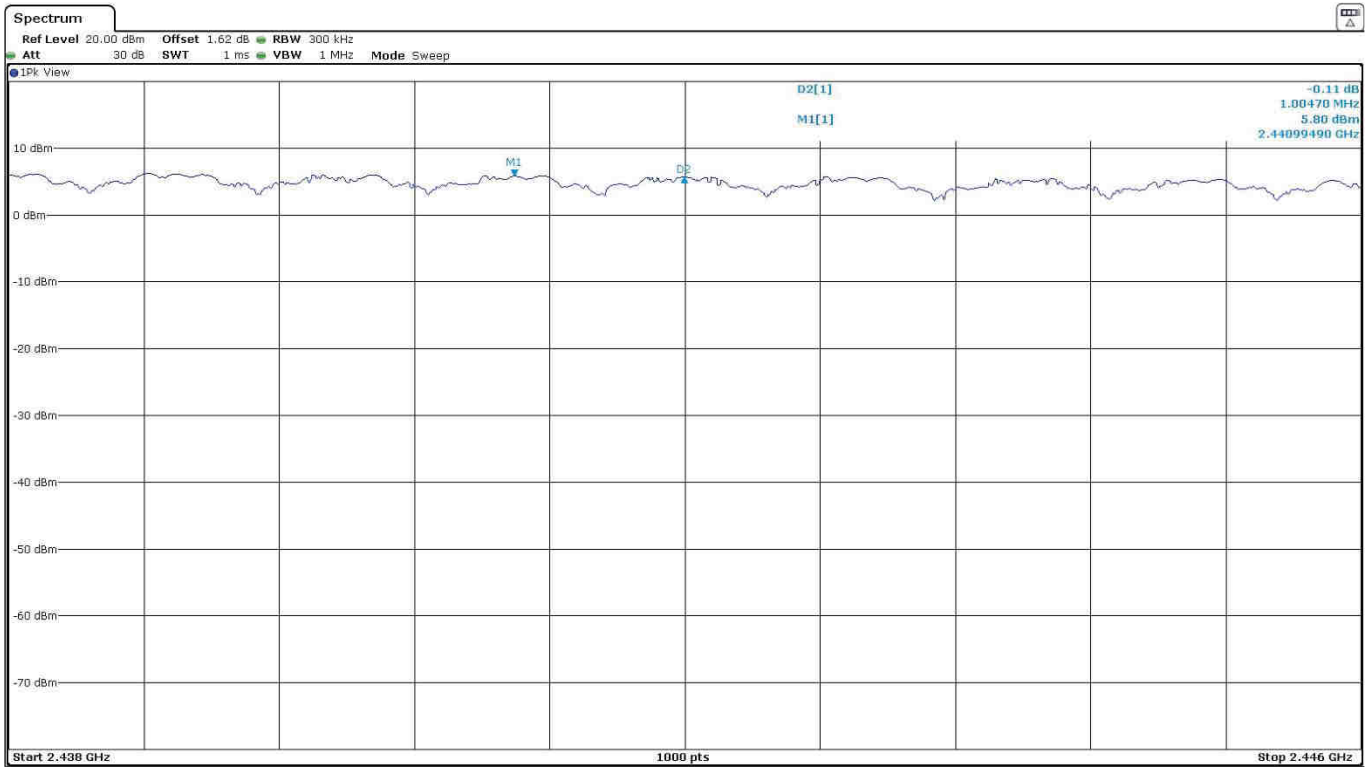


- High Channel:



Carrier frequency separation - Pi/4 DQPSK

Carrier frequency separation: kHz

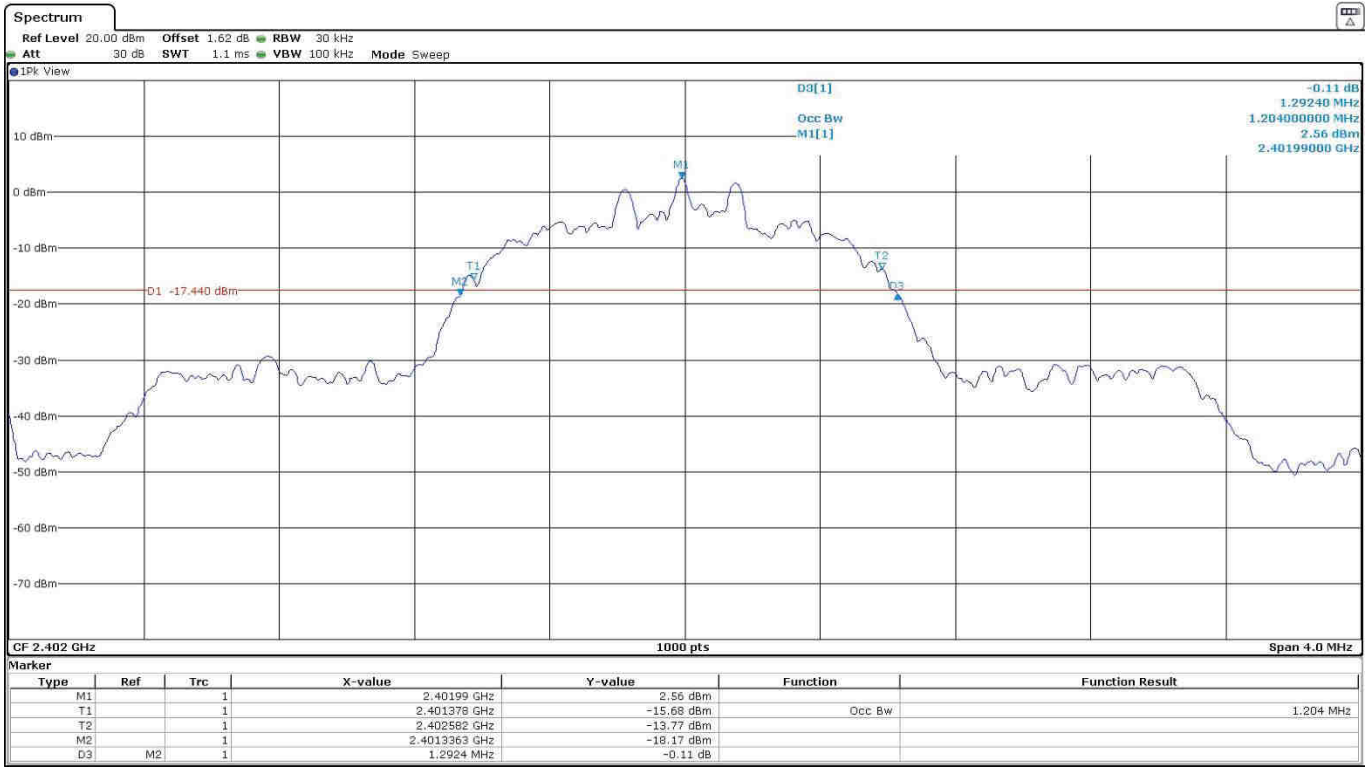


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

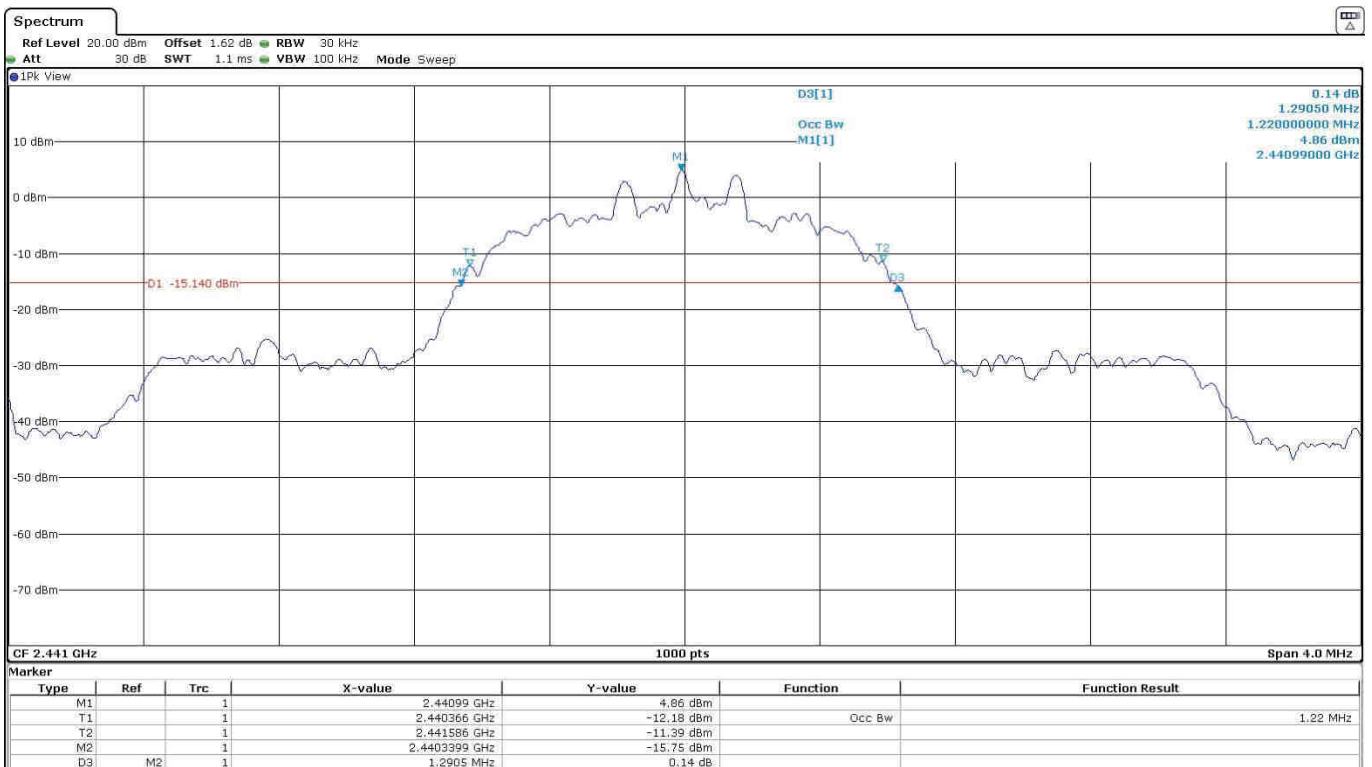
Verdict: PASS

• 8DPSK – Bandwidths

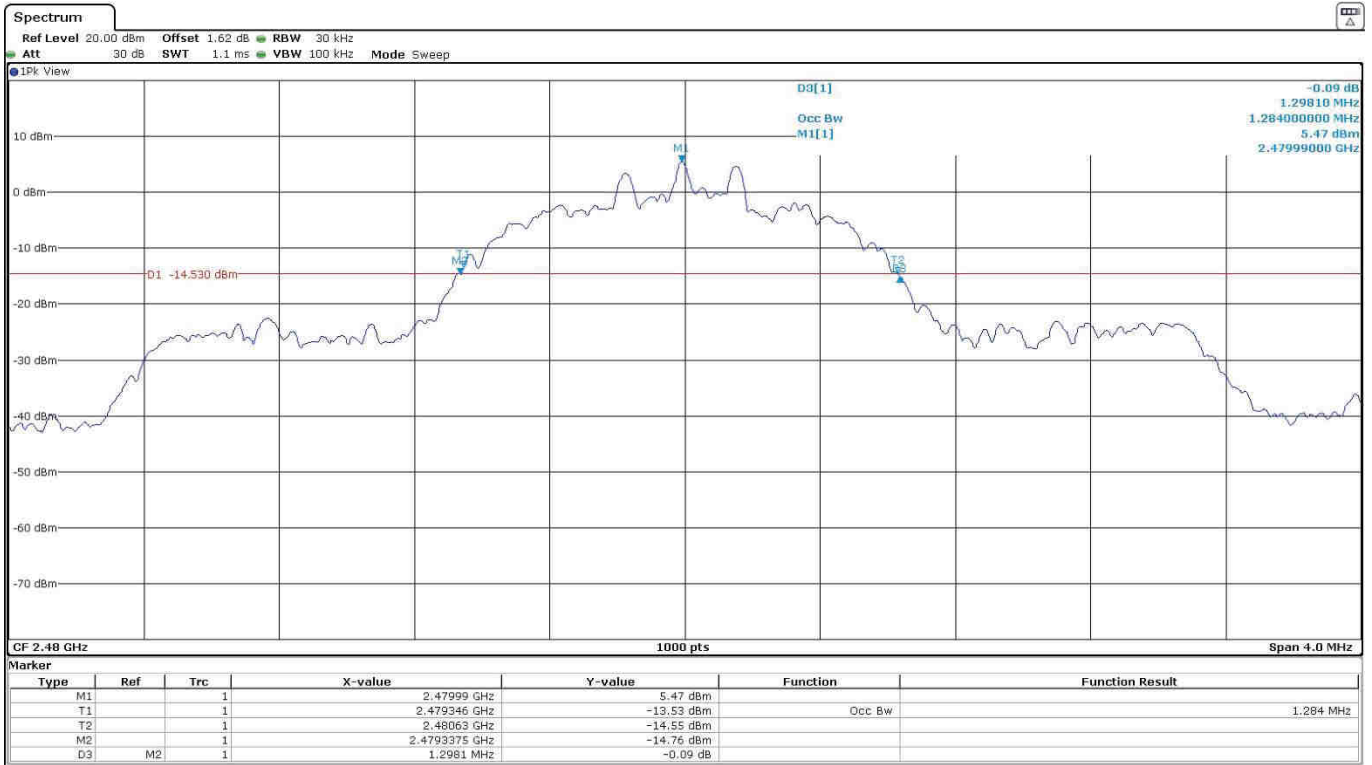
- Low Channel:



- Middle Channel:

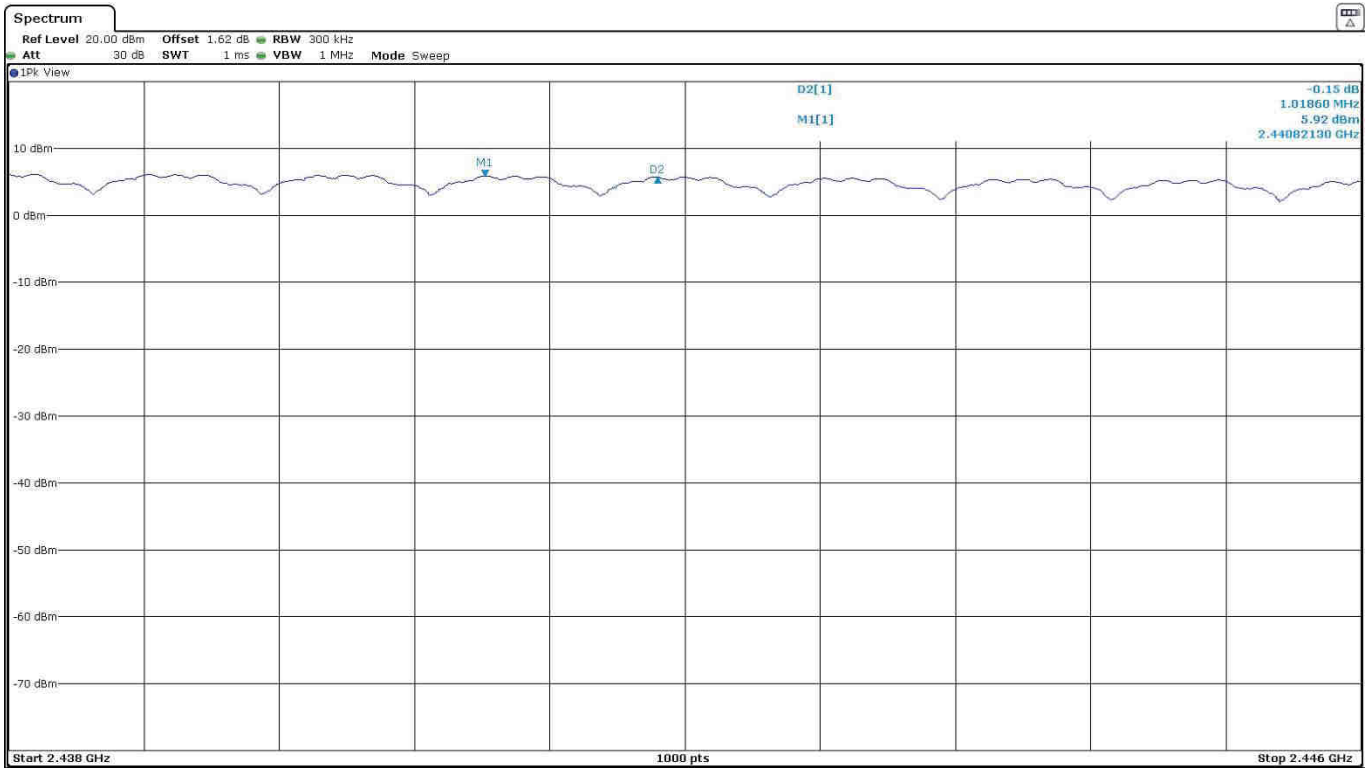


- High Channel:



Carrier frequency separation - 8DPSK

Carrier frequency separation: kHz



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

Verdict: PASS

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

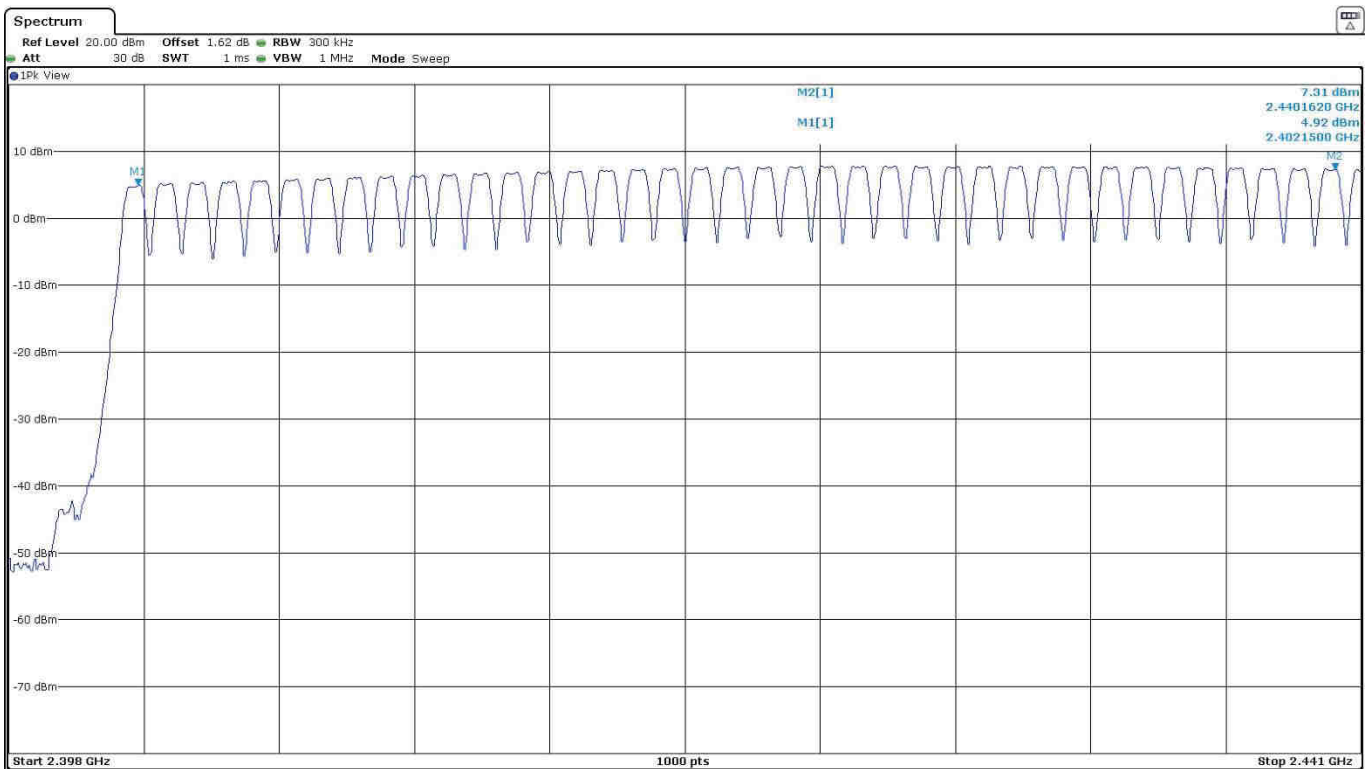
SPECIFICATION:

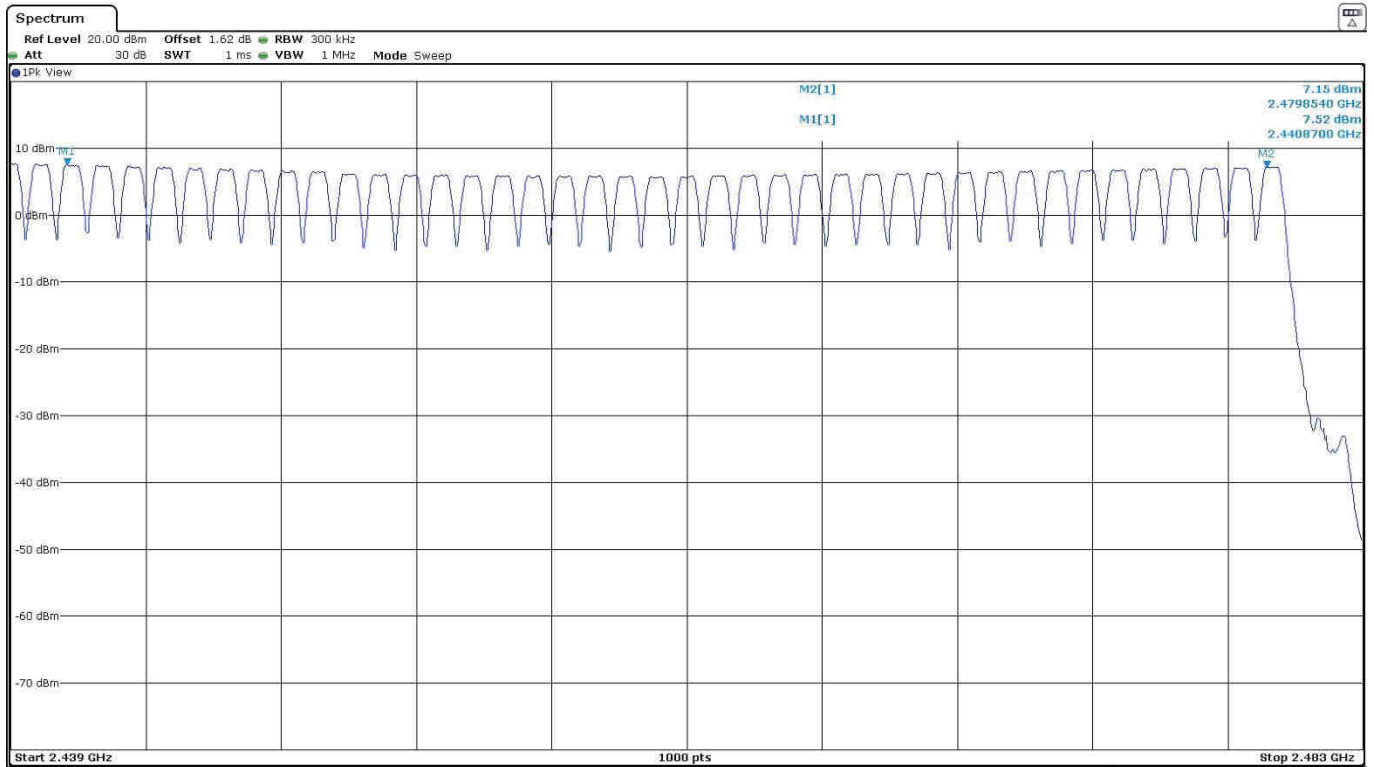
Frequency hopping system in the 2400-2483.5 MHz band shall use at least 15 channels.

RESULTS:

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

- **GFSK – Number of hopping channels**

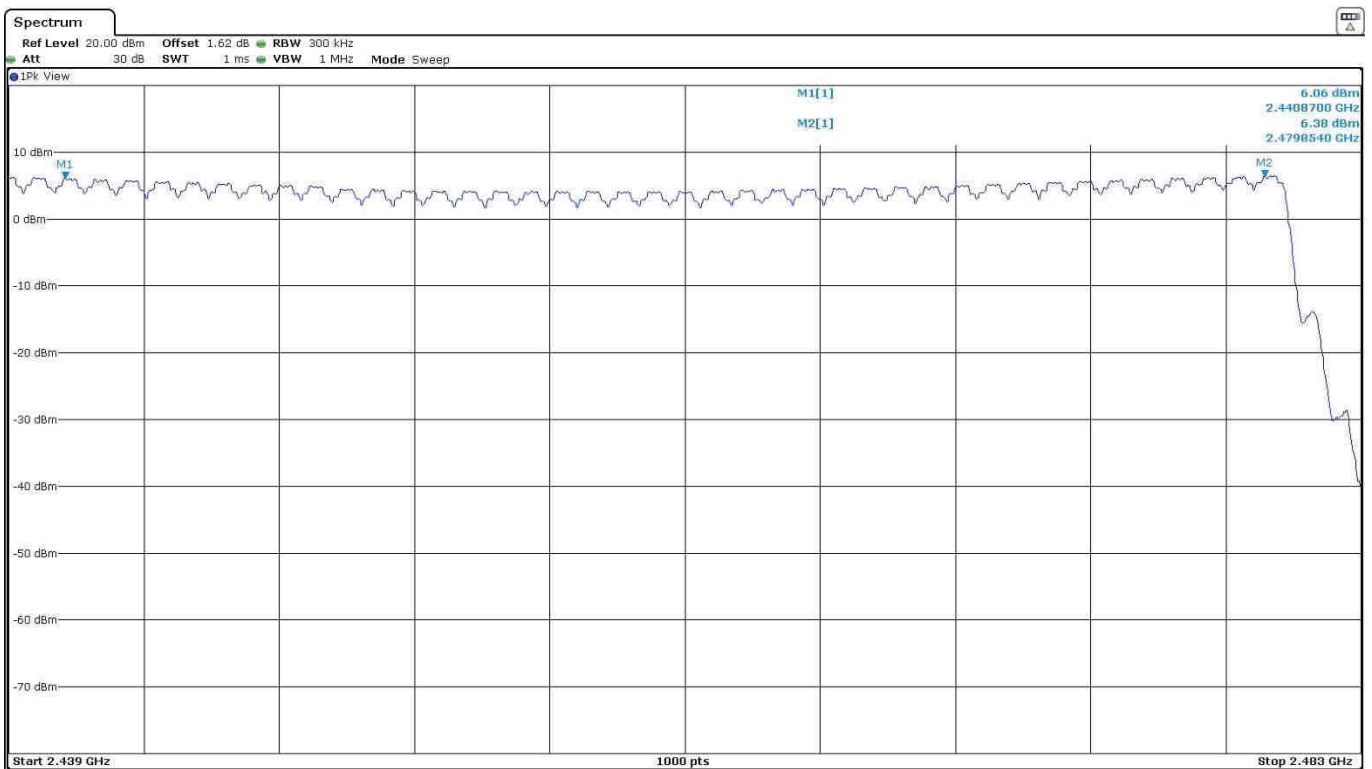
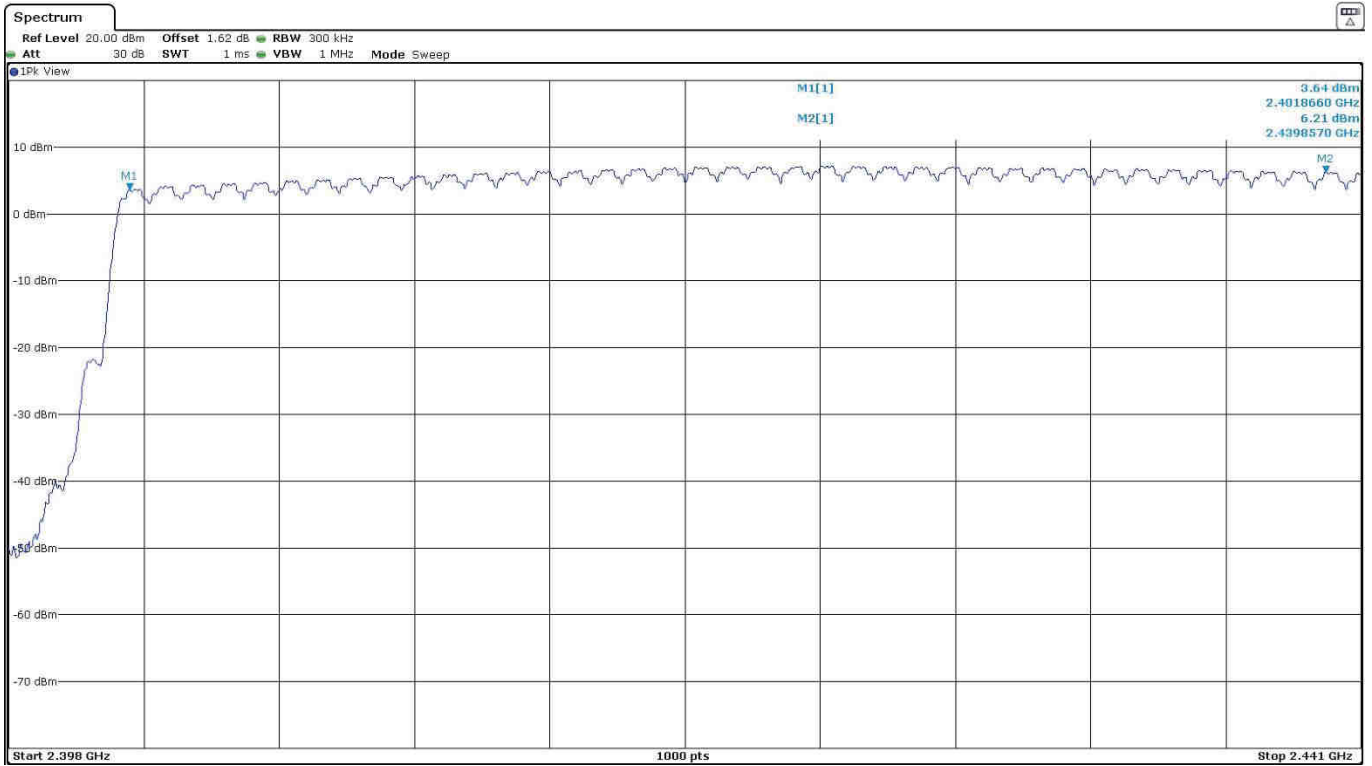




Total number of hopping channels: 79

Verdict: PASS

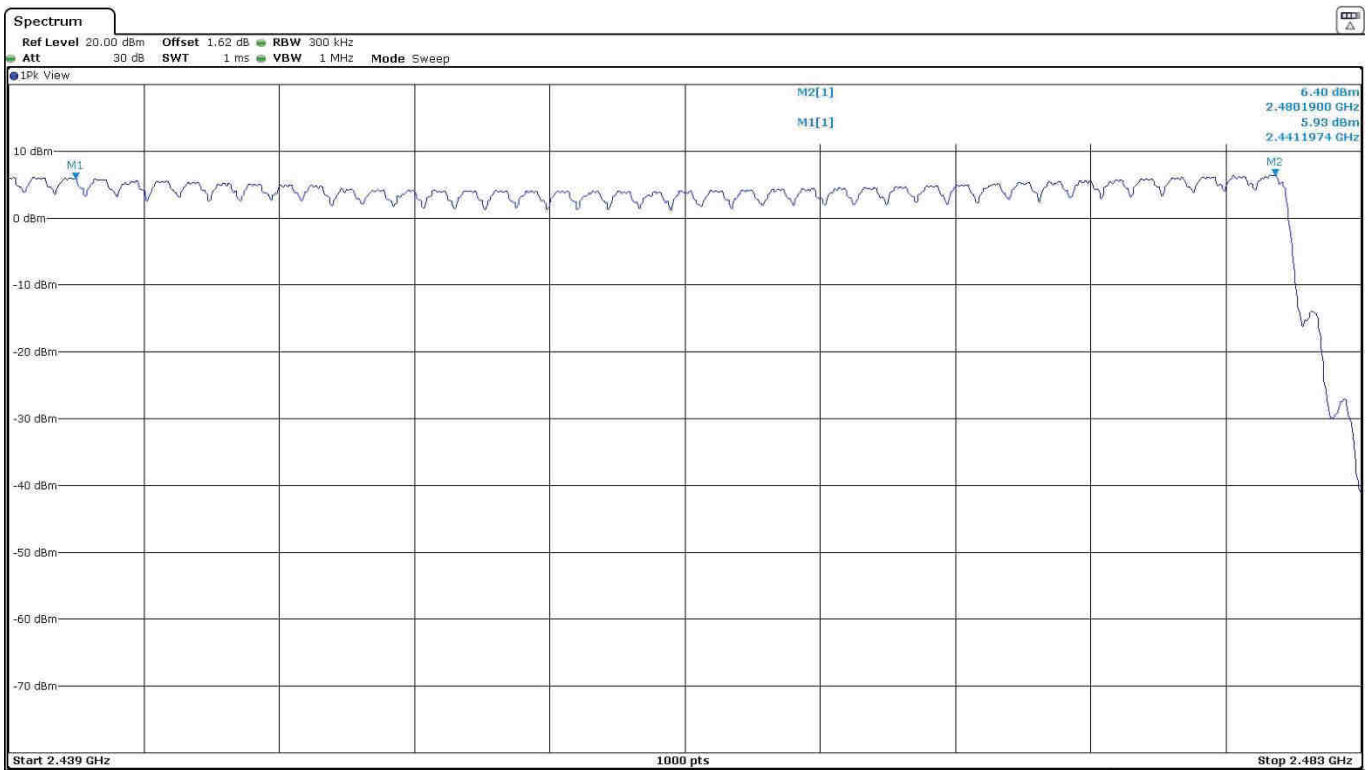
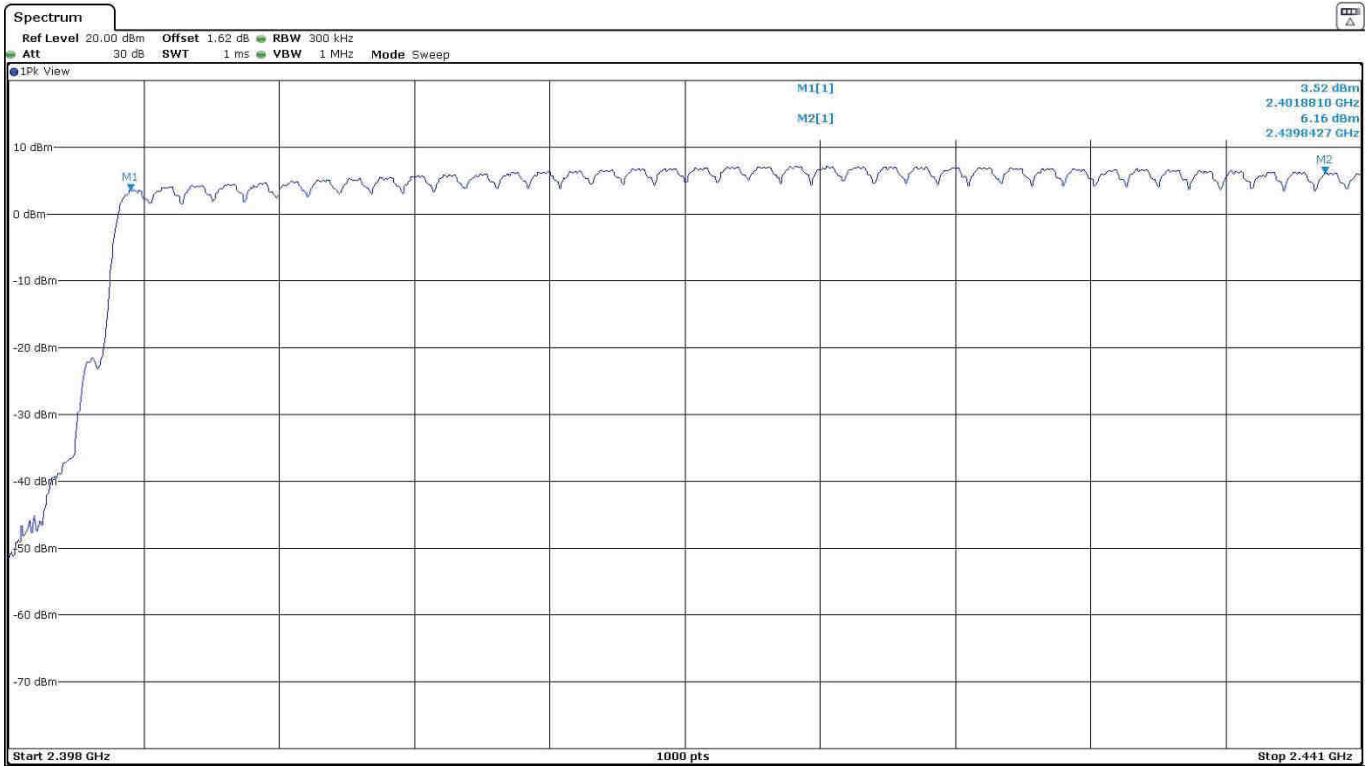
- Pi/4 DQPSK – Number of hopping channels



Total number of hopping channels: 79

Verdict: PASS

- 8DPSK – Number of hopping channels



Total number of hopping channels: 79

Verdict: PASS

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

SPECIFICATION:

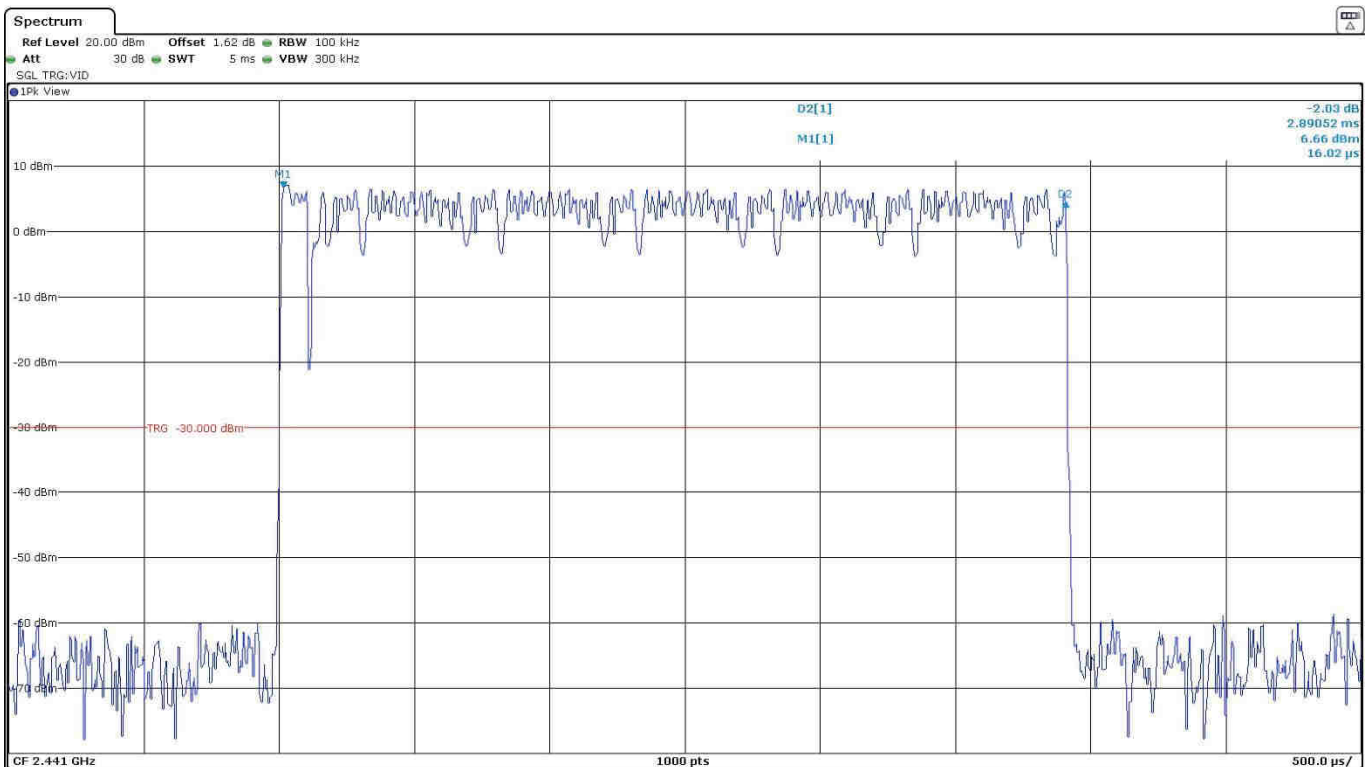
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = $0.4 \times 79 = 31.6$ seconds.

RESULTS:

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

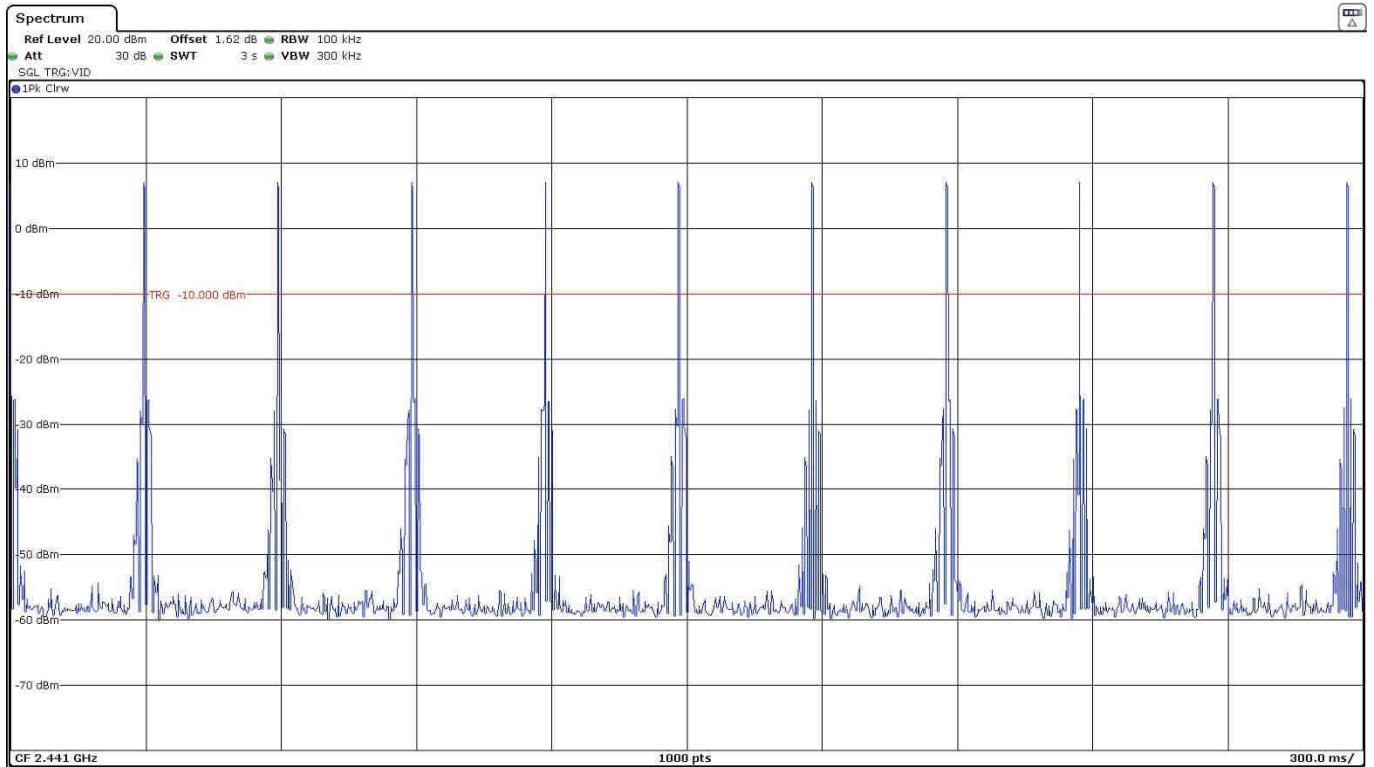
- Transmit Time per Hop:

2.89052 ms



▪ Time of Occupancy:

Nº of hops on spectrum analyzer	11
Nº of hops over the period	115.866
Average Time of Occupancy	334.915 ms



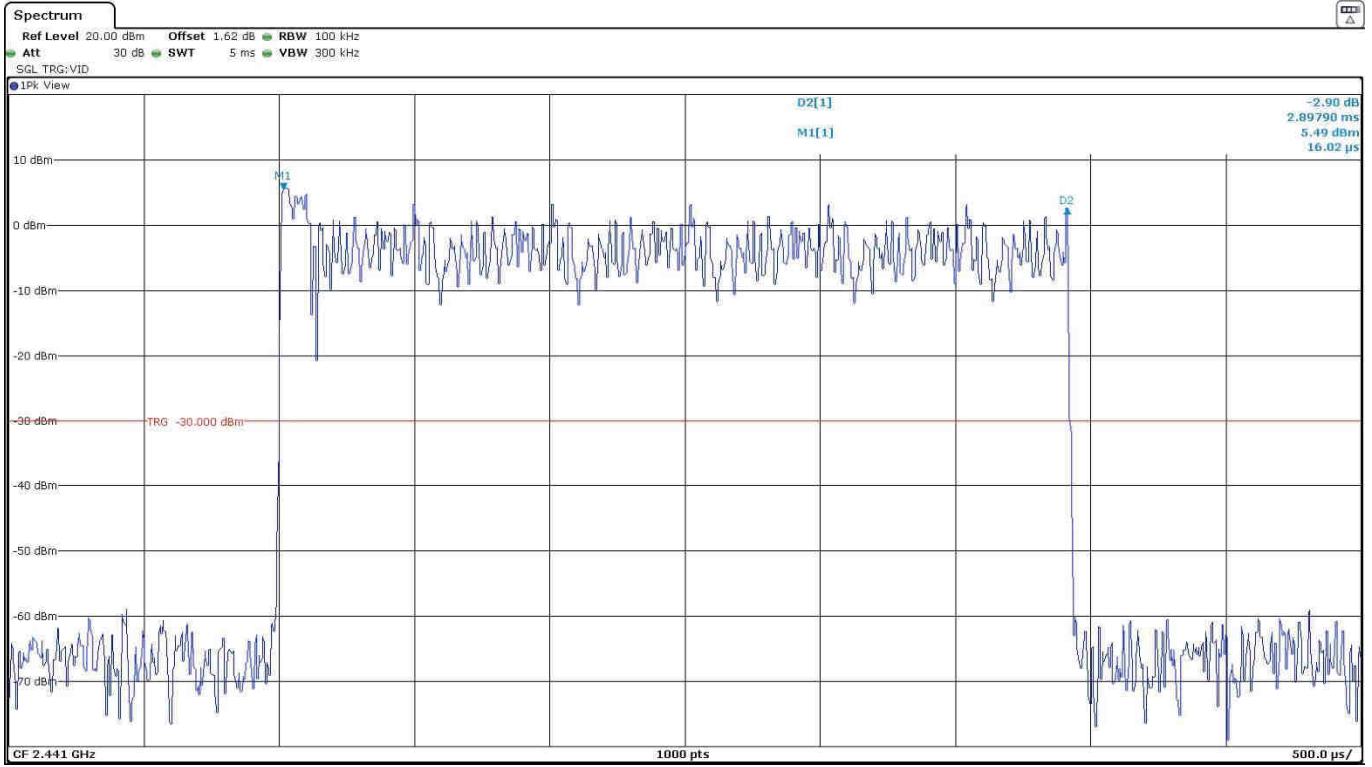
Measurement uncertainty (%)	<±0.12
-----------------------------	--------

Verdict: PASS

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

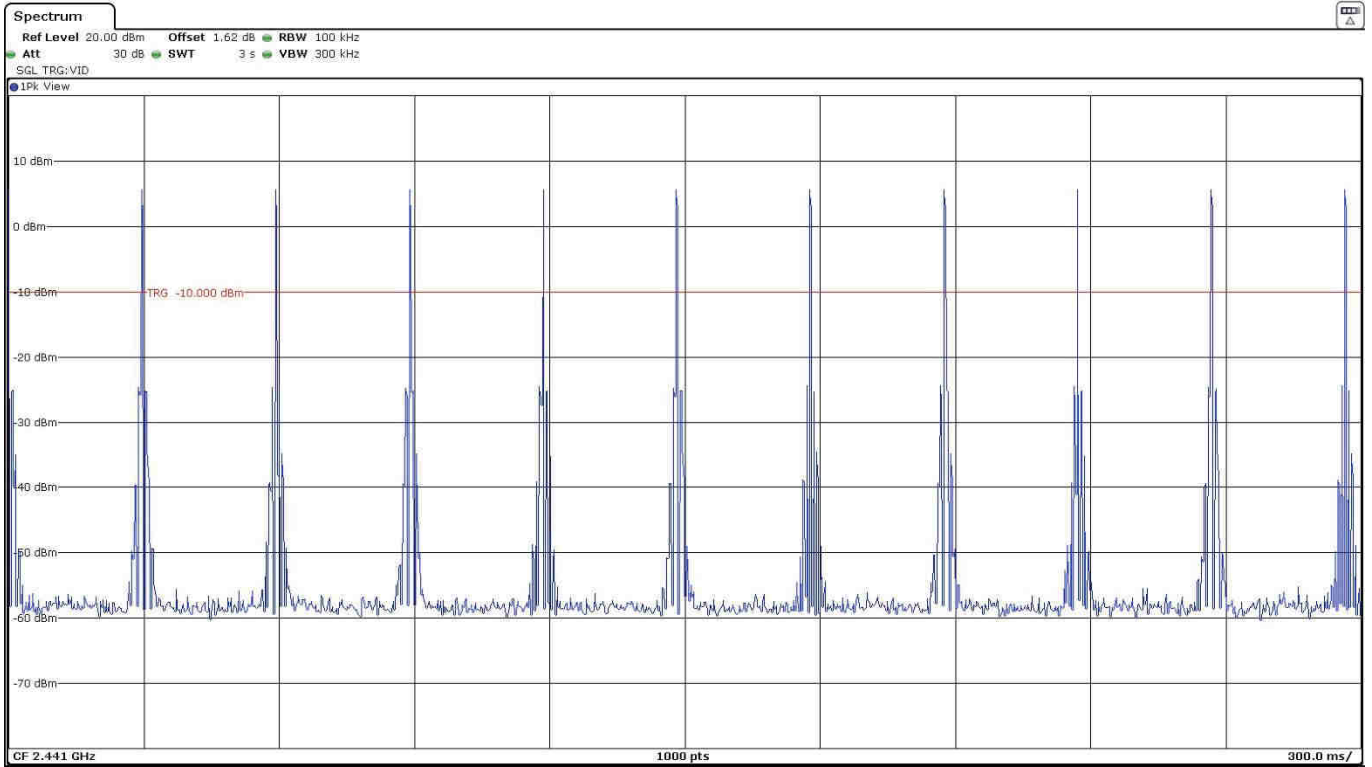
- Transmit Time per Hop:

2.8979 ms



▪ Time of Occupancy:

Nº of hops on spectrum analyzer	11
Nº of hops over the period	115.866
Average Time of Occupancy	335.770 ms



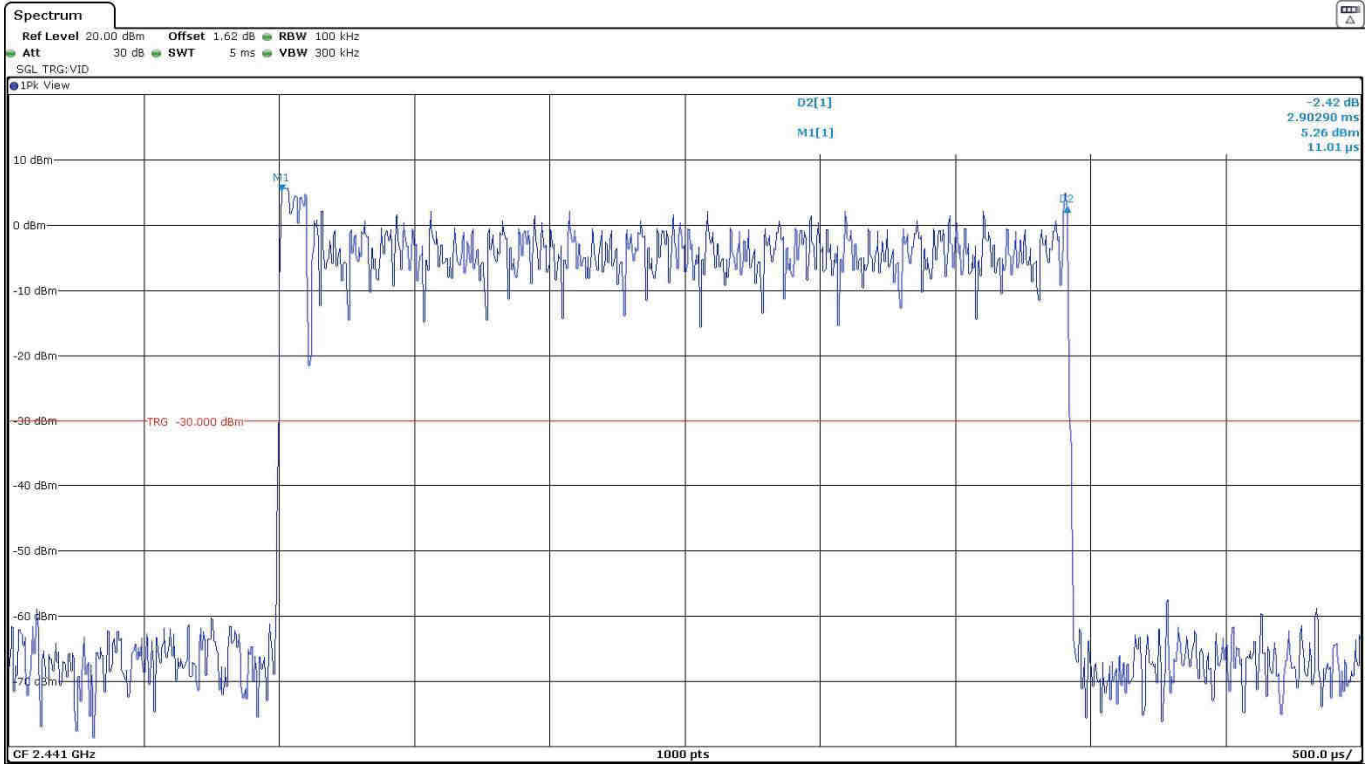
Measurement uncertainty (%)	<±0.12
-----------------------------	--------

Verdict: PASS

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

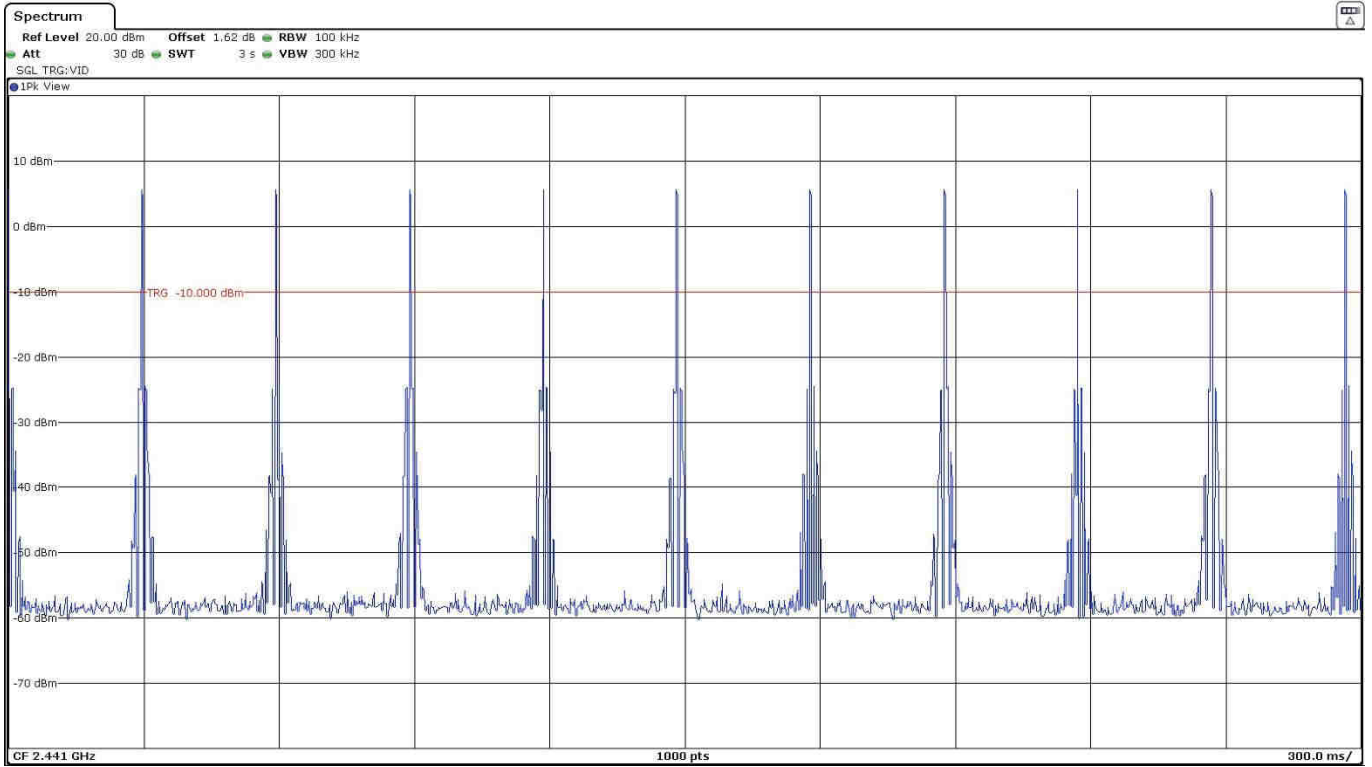
- Transmit Time per Hop:

2.9029 ms



▪ Time of Occupancy:

Nº of hops on spectrum analyzer	11	
Nº of hops over the period	115.866	
Average Time of Occupancy	336.349	ms



Measurement uncertainty (%)	<±0.12
-----------------------------	--------

Verdict: PASS

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

SPECIFICATION:

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

RESULTS:

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

Maximum Declared Antenna Gain:

Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
+1.17 dBi	+0.71 dBi	+0.09 dBi

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

- **GFSK (1 Mbps)**

Peak Conducted Output Power	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	5.22	7.37	7.18
Maximum EIRP Power (dBm)	6.39	8.08	7.27
Measurement uncertainty (dB)	<±2.57		

- **Pi/4 DQPSK (2 Mbps)**

Peak Conducted Output Power	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	4.33	6.54	6.75
Maximum EIRP Power (dBm)	5.5	7.25	6.84
Measurement uncertainty (dB)	<±2.57		

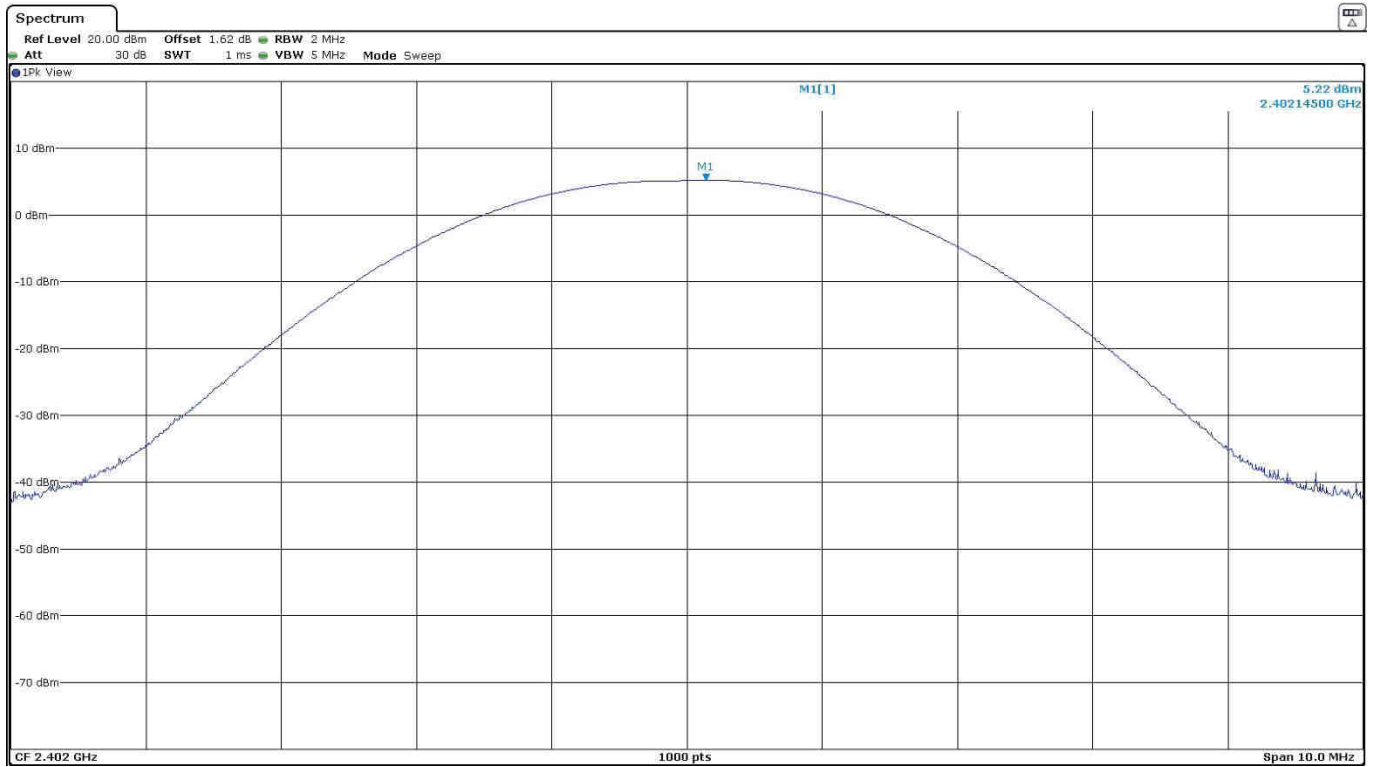
- **8DPSK (3 Mbps)**

Peak Conducted Output Power	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	4.49	6.64	6.81
Maximum EIRP Power (dBm)	5.66	7.35	6.9
Measurement uncertainty (dB)	<±2.57		

Verdict: PASS

- GFSK – Peak Output Power

- Low Channel:



- Middle Channel:

