DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29 507 456

DEKRA

ENAC ENSAYOS Nº 51/LE147

FCC LISTED,
REGISTRATION NUMBER:
720267

ISED LISTED
REGISTRATION NUMBER
4621A-2, 4621A-4

Test report No:
NIE: 56944RRF.001

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	27-inch iMAC with Retina 5K display
Trademark	Apple
Model and /or type reference	A2115
Other identification of the product	FCC ID: BCGA2115 IC: 579C-A2115
Features	IEEE 802.11 a/b/g/n/ac radio and Bluetooth radio
Applicant	APPLE INC One Apple Park Way, Cupertino, California 95014, USA
Test method requested, standard	USA FCC Part 15.247 10-1-17 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-17 Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 (April 2018). 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 v05 dated August 24, 2018. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	A. Llamas p.a. RF Lab. Manager Firmado digitalmente por FRANCISCO CAÑAS ESCRIBANO Fecha: 2019.03.06 15:42:38 +01'00'

Date of issue	2019-03-06
Report template No	FDT08_21

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Competences and guarantees

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

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

DEKRA Testing and Certification is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: ISED 4621A-2 and ISED 4621A-4.

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.

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

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Uncertainty

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

Data provided by the client

iMac desktop computer with IEEE 802.11 a/b/g/n/ac radio and Bluetooth radio.

DEKRA 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	Date of reception
56944/06	iMAC	A2155	C02WW002K1R4	2018-08-16

Auxiliary elements used with the sample S/01

Control Nº	Description	Model	Serial Nº	Date of reception
56943/03	Keyboard	A1243	---	2018-04-09
56943/05	Power Cable	---	---	2018-04-09
56943/07	Mouse	A1152	---	2018-04-09
56943/09	USB-C to VGA converter	A1620	---	2018-04-09
56943/11	USB to thunderbolt	A1790	---	2018-04-09
56943/13	Earphones	---	---	2018-04-09

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

Preliminary tests for determining worst case of emissions.

Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
56944/05	iMAC	A2155	C02WW01EKFGK	2018-08-16

Auxiliary elements used with the sample S/02

Control Nº	Description	Model	Serial Nº	Date of reception
56943/04	Keyboard	A1243	---	2018-04-09
56943/06	Power Cable	---	---	2018-04-09
56943/08	Mouse	A1152	---	2018-04-09
56943/10	USB-C to VGA converter	A1620	---	2018-04-09
56943/12	USB to thunderbolt	A1790	---	2018-04-09
56943/14	Earphones	---	---	2018-04-09

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

All radiated tests indicated in Appendix A.

Sample S/03 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
56944/14	iMAC	A2155	C02X300EKFDN	2018-09-03

Auxiliary elements used with the sample S/03

Control Nº	Description	Model	Serial Nº	Date of reception
56943/04	Keyboard	A1243	---	2018-04-09
56944/13	Power Cable	---	---	2018-04-09
56943/08	Mouse	A1152	---	2018-04-09

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

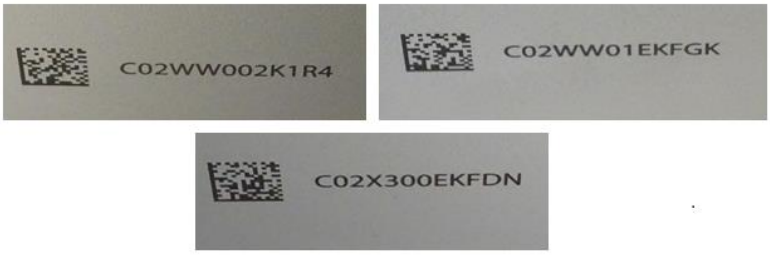
All conducted tests indicated in Appendix A.

Test sample description

Ports…… :	Port name and description		Cable				
			Specified length [m]	Attached during test	Shielded		
				☐	☐		
				☐	☐		
				☐	☐		
				☐	☐		
				☐	☐		
				☐	☐		
Supplementary information to the ports…… :							
Rated power supply .....:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☒	AC: 120 / 60 Hz	☒	☐	☐	☒	☒
	☐	AC:	☐	☐	☐	☐	☐
	☐	DC:					
	☐	DC:					
Rated Power .....:							
Clock frequencies.....:							

Other parameters .....:				
Software version .....:	18A334			
Hardware version .....:	EVT			
Dimensions in cm (W x H x D) ....:	65cm wide, 51.65cm high, 20.3cm deep			
Mounting position .....:	☒	Table top equipment		
	☐	Wall/Ceiling mounted equipment		
	☐	Floor standing equipment		
	☐	Hand-held equipment		
	☐	Other:		
Modules/parts.....:	Module/parts of test item		Type	Manufacturer
Accessories (not part of the test item) .....:	Description		Type	Manufacturer
	Keyboard		A1243	Apple
	Power Cable		---	Apple
	Mouse		A1152	Apple
	USB-C to VGA conversor		A1620	Apple
	USB to thunderbolt		A1790	Apple
	Earphones		---	Apple
Documents as provided by the applicant.....:	Description		File name	Issue date

Copy of marking plate:



Identification of the client

APPLE INC

One Apple Park Way, Cupertino, California 95010, USA

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2018-11-05
Date (finish)	2019-01-17

Document history

Report number	Date	Description
56944RRF.001	2019-03-06	First release

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 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

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

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

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

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

Remarks and comments

The tests have been performed by the technical personnel: Jose Carlos Luque, Carolina Postigo, Jose Alberto Aranda, Ignacio Cabra.

Used instrumentation:

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Positioning Controller INNCO CO3000	N.A.	N.A.
5.	BiconicalLog antenna ETS LINDGREN 3142E	2017/09	2020/09
6.	BiconicalLog antenna ETS LINDGREN 3142E	2018/07	2021/07
7.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
8.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2018/06	2021/06
9.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2017/04	2020/04
10.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2018/07	2021/07
11.	EMI Test Receiver R&S ESR7	2018/10	2020/10
12.	EMI Test Receiver R&S ESR7	2018/10	2020/10
13.	Spectrum analyser Rohde & Schwarz FSV40	2018/02	2020/02
14.	Spectrum analyser Rohde & Schwarz FSV40	2017/07	2019/07
15.	RF pre-amplifier 30MHz-6 GHz Bonn Elektronik BLNA 0360-01N	2018/07	2019/07
16.	RF pre-amplifier 10MHz-6 GHz Bonn Elektronik BLNA 0160-01N	2017/09	2019/03
17.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2018/03	2019/03
18.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-3A	2018/03	2019/03
19.	RF pre-amplifier 18-40 GHz Bonn Elektronik BLMA 1840-1M	2018/03	2019/03
20.	RF pre-amplifier 18-40 GHz NARDA JS44-18004000-33-8P	2018/02	2019/02
21.	RF High Pass Filter 3-18 GHz WAINWRIGHT INSTRUMENTS WHK 3.0/18G-10SS	2017/04	2019/04

22.	RF High Pass Filter 3-18 GHz TEMSTRON ST-3GA2833-HS	2018/09	2019/09
23.	RF Low Pass Filter DC-1GHz WAINWRIGHT INSTRUMENTS WLK1000-6SS	2018/06	2020/06
24.	RF High Pass Filter 18-26.5 GHz MicroWave Circuits H18G26G1	2017/04	2019/04
25.	AC Power Supply Elgar CS-AC35(351SL)	2016/05	2019/05
26.	AC Power Supply California Instruments 5001iM-400	2016/11	2020/11

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Rohde & Schwarz FSV40	2017/07	2019/07
2.	AC Power Supply Elgar CS-AC35(351SL)	2016/05	2019/05

Testing verdicts

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

Summary

FCC PART 15 PARAGRAPH / RSS-247 Requirement – Test case	Verdict	Remark
Part 15.247 (a)(1) / RSS-247 Clause 5.1 (a),(b) …….20dB Bandwidth and Transmitter Carrier Frequency Separation	P	
Part 15.247 (a)(1)(iii) / RSS-247 Clause 5.1 (d) ……..Transmitter Number of Hopping Frequencies and Average Time of Ocuppancy	P	
Part 15.247 (a)(1)(iii) / RSS-247 Clause 5.1 (d) ……..Transmitter Average Time of Ocuppancy	P	
Part 15.247(b)(1) / RSS-247 Clause 5.4 (b)……..Transmitter Maximum Peak Output Power	P	
Part 15.247(d) & 15.209(a) / RSS-247 Clause 5.5 …..Emission limitations radiated (Transmitter)	P	
Part 15.247 Subclause (d) / RSS-247 Clause 5.5……Transmitter Band Edge Radiated Emissions	P	

Supplementary information and remarks:

(1) There are two manufacturer of the WiFi/Bluetooth radio modules, manufacturer 1 and manufacturer 2.
(2) The WiFi/Bluetooth radio modules have the same mechanical outline (i.e. the same packaging dimension and pin layout), use the same on-board antenna matching circuit, have an identical antenna structure and are built and tested to conform to the same specification and to operate within the same tolerances.
(3) Preliminary testing was performed on the two manufacturers to determine the worst case.

Appendix A: Test results.

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TEST CONDITIONS

Power supply (V):

Vnominal = 120 Vac

Type of power supply = AC voltage main supply.

Type of antenna = Internal antenna.

Declared Gain for antenna (maximum) = + 6.56 dBi.

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2441 MHz

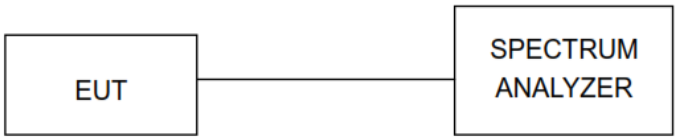
Highest channel: 2480 MHz

The EUT was tested in the following operating mode(s):

- The sample was used to configure the EUT to continuously transmit at maximum power in all channels in Basic Rate (DH5 packets) or EDR (2DH5 or 3DH5 packets) as required.
- The sample was used to configure the EUT to continuously transmit at maximum power in hopping mode on on all channels in Basic Rate (DH5 packets) or EDR (2DH5 or 3DH5 packets) as required.

CONDUCTED MEASUREMENTS

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



The AC supply voltage is applied using an external power supply.

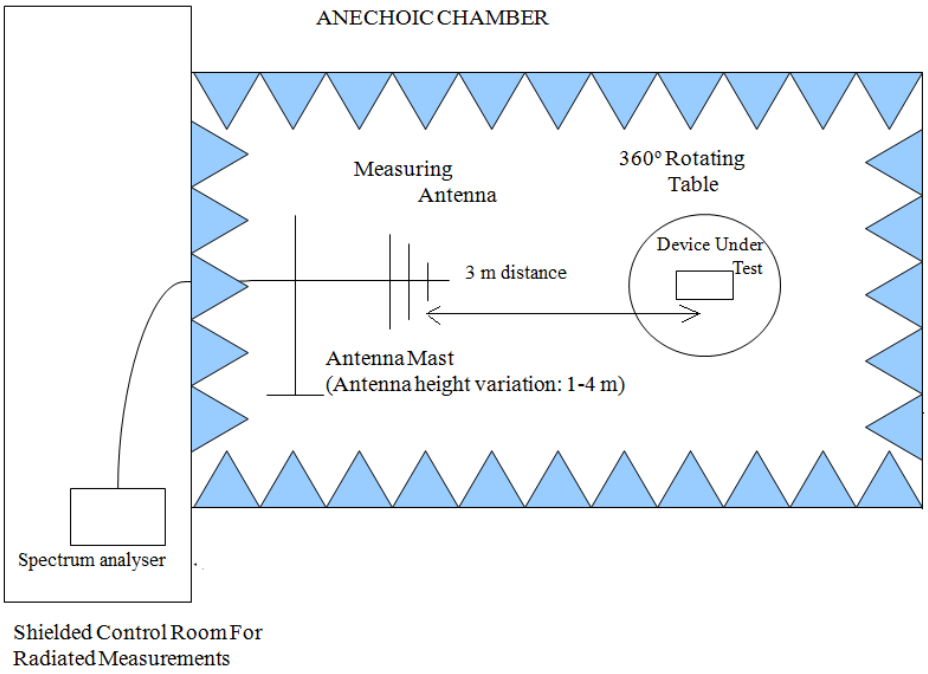
RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the center of the chamber turntable to perform the measurements below 1GHz and The EUT was placed at a height of 1.5 meters above the test chamber floor in the center of the chamber turntable to perform the measurements above 1GHz. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

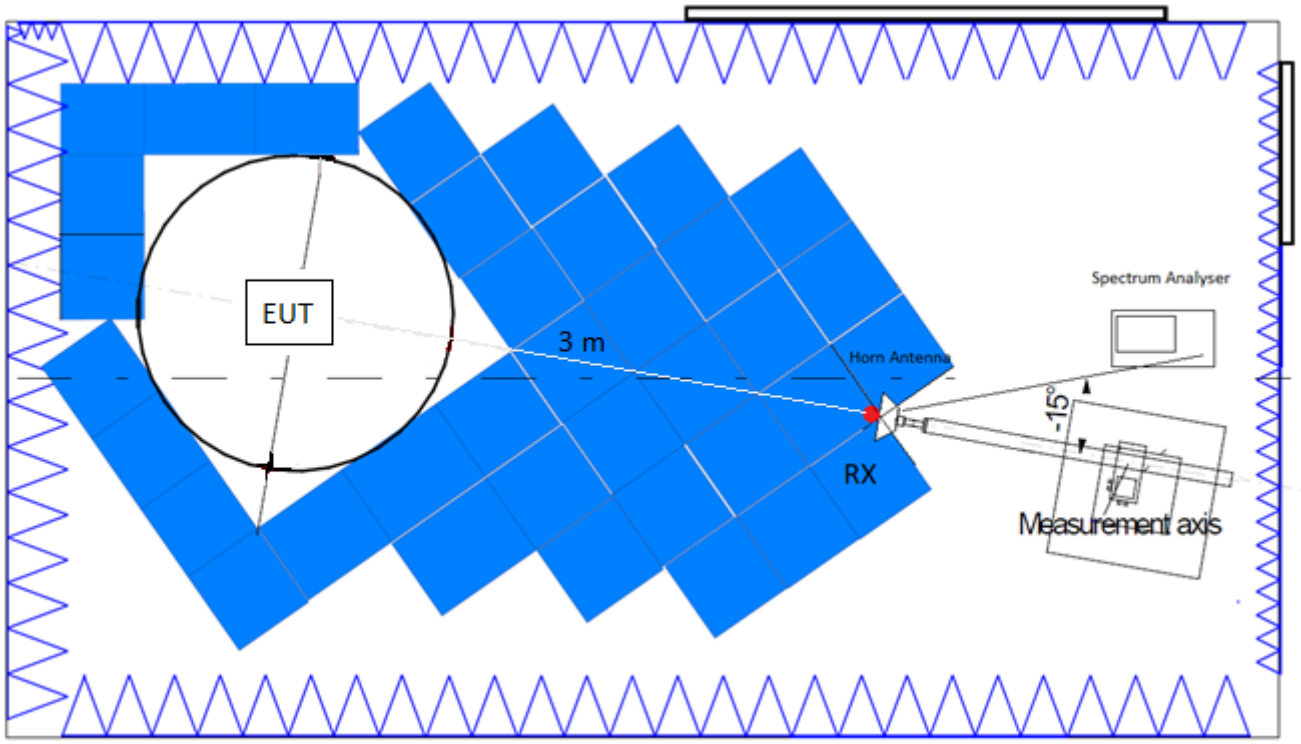
Measurements were made in both horizontal and vertical planes of polarization.

The final measured value, for the given emission, in the tables below incorporates the calibrated antenna factor and cable loss.

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



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

SPECIFICATION

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

RESULTS

(See next plots)

Modulation: GFSK (DH5)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	975	978	963
Measurement uncertainty (kHz)	<±1.80		

Modulation: Π/4-DQPSK (2DH5)

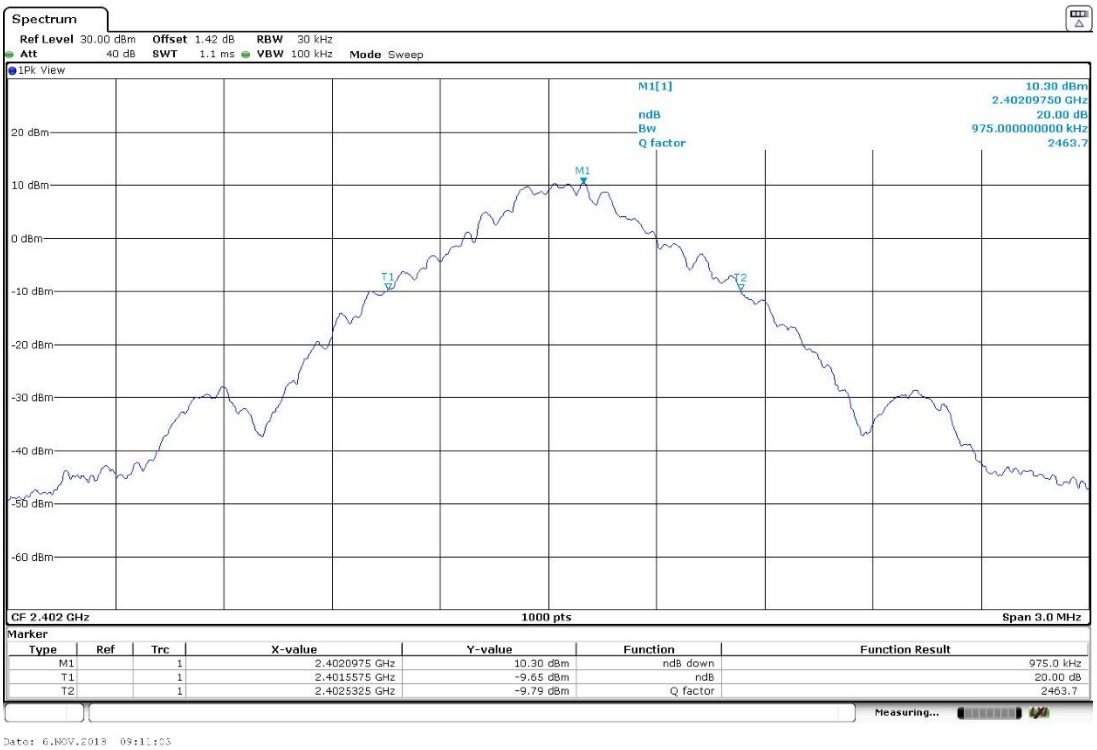
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1398	1371	1395
Measurement uncertainty (kHz)	<±1.80		

Modulation: 8-DPSK (3DH5)

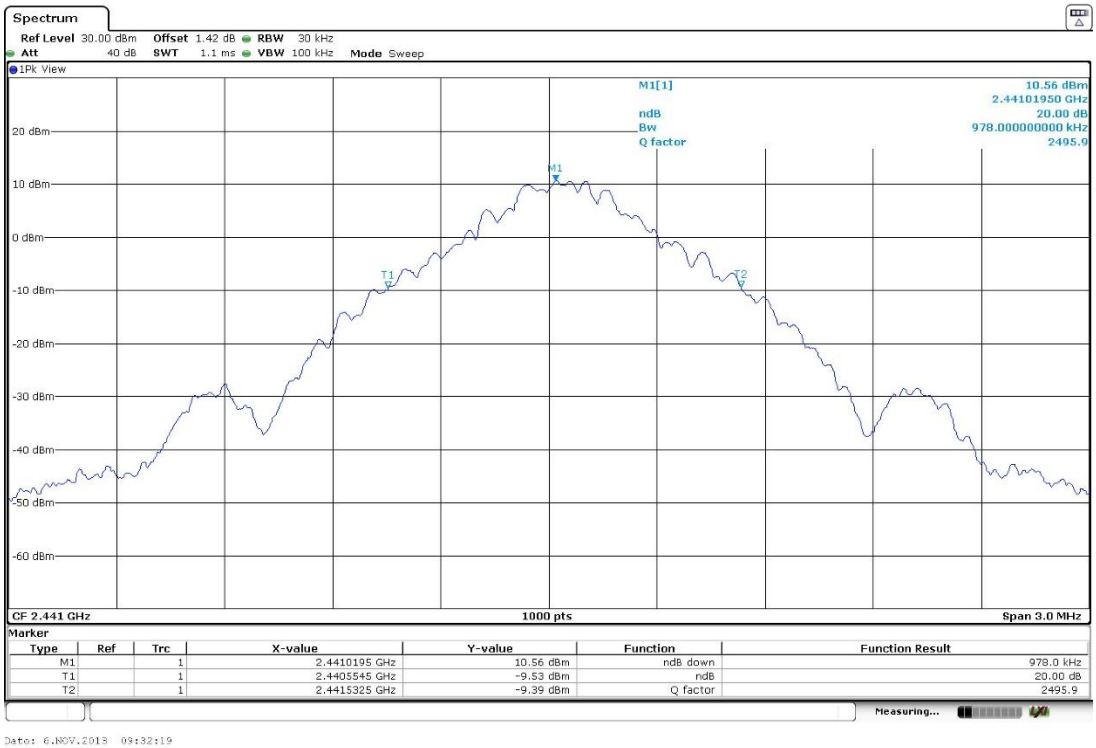
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1389	1392	1380
Measurement uncertainty (kHz)	<±1.80		

Modulation: GFSK (DH5)

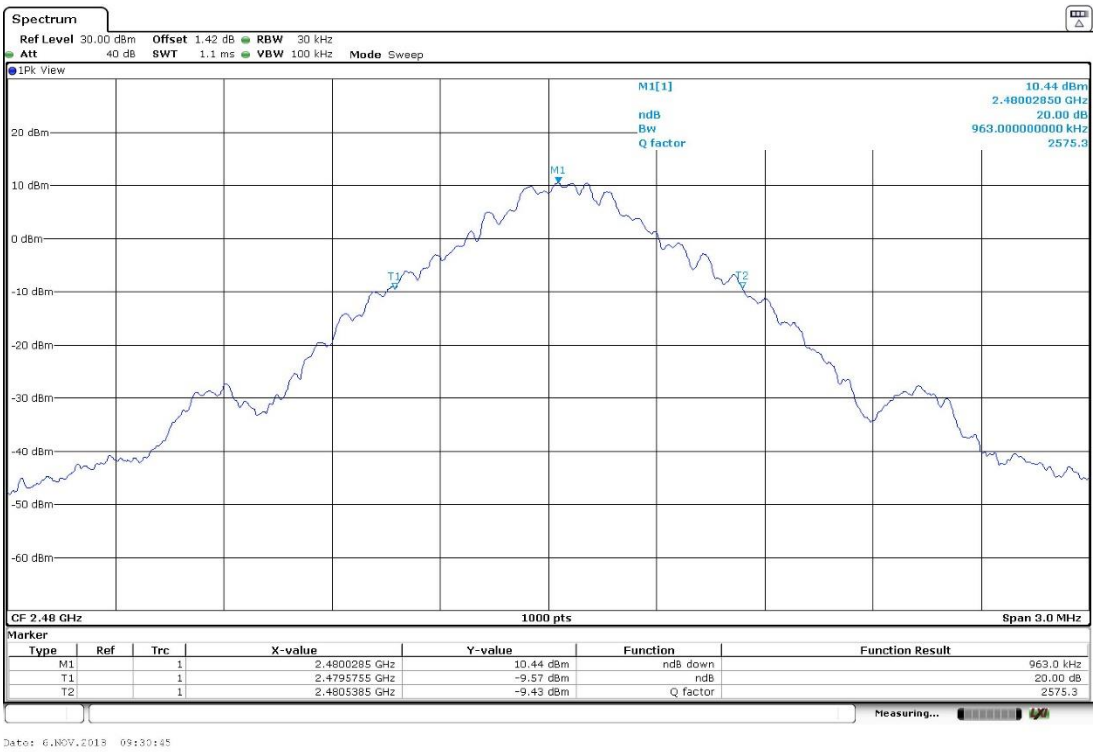
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



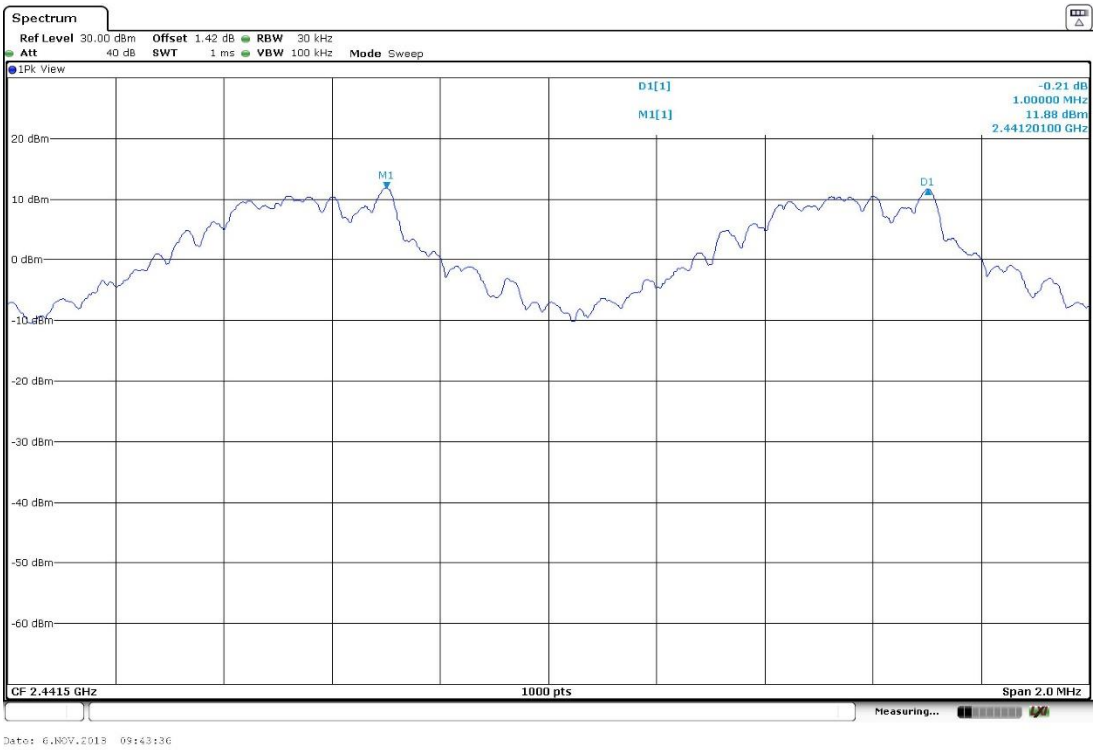
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation

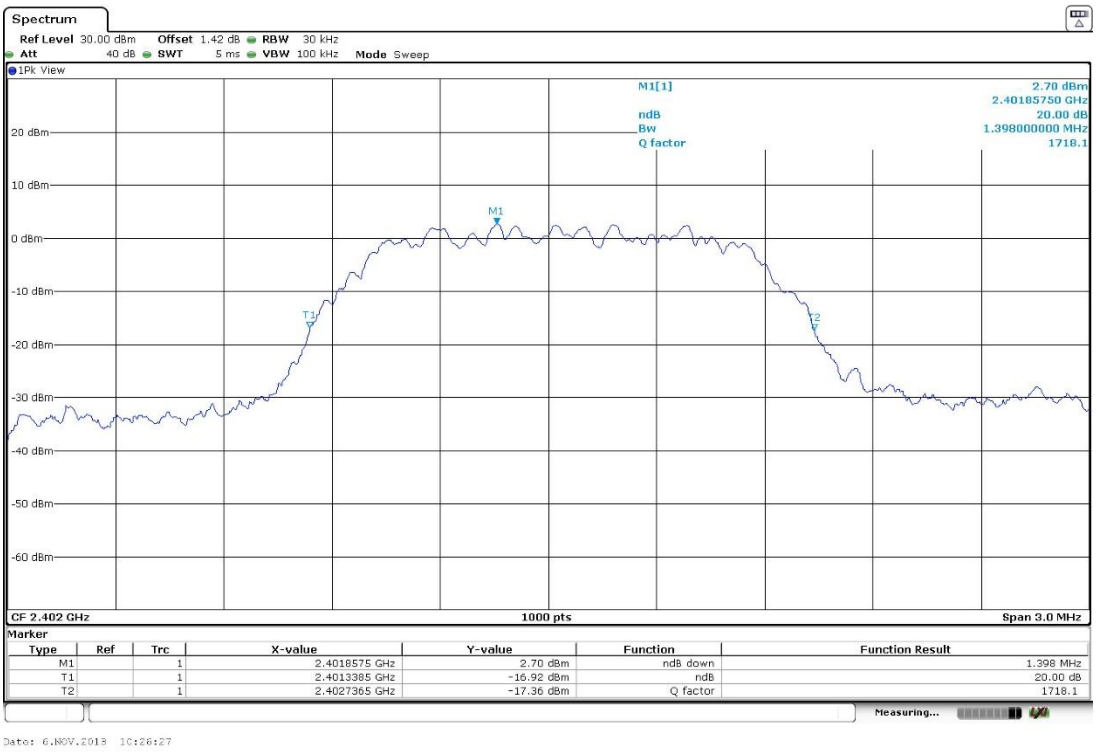


The hopping channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

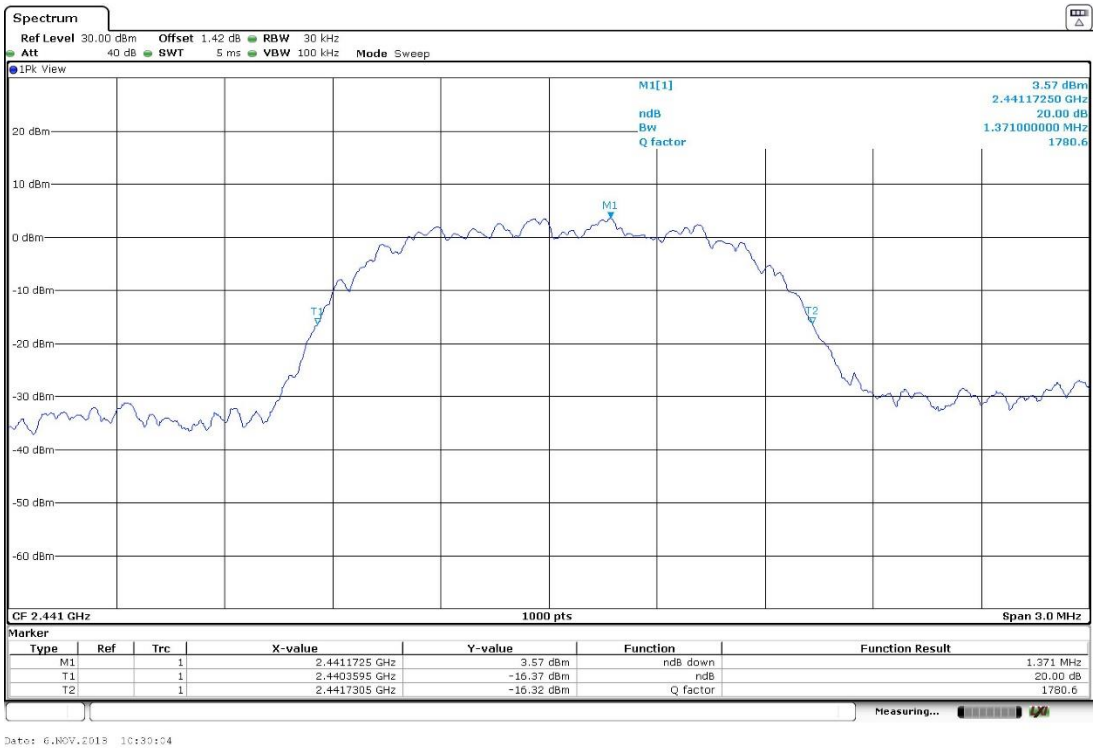
Verdict: PASS

Modulation: Π/4-DQPSK (2DH5)

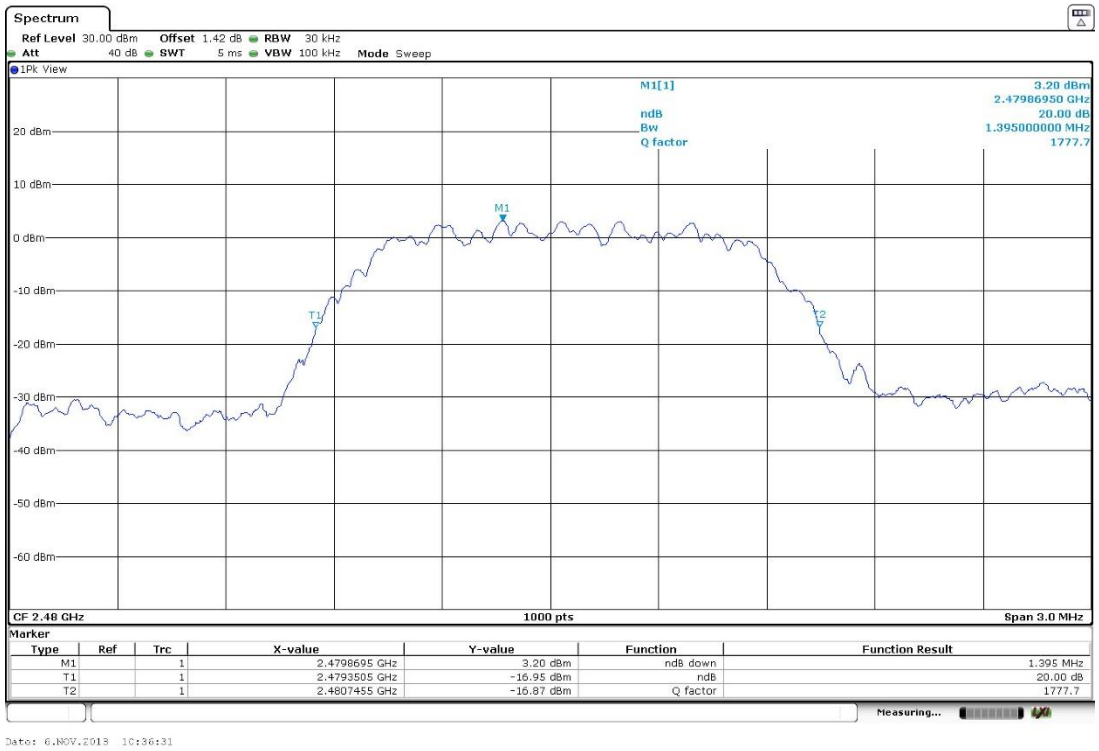
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



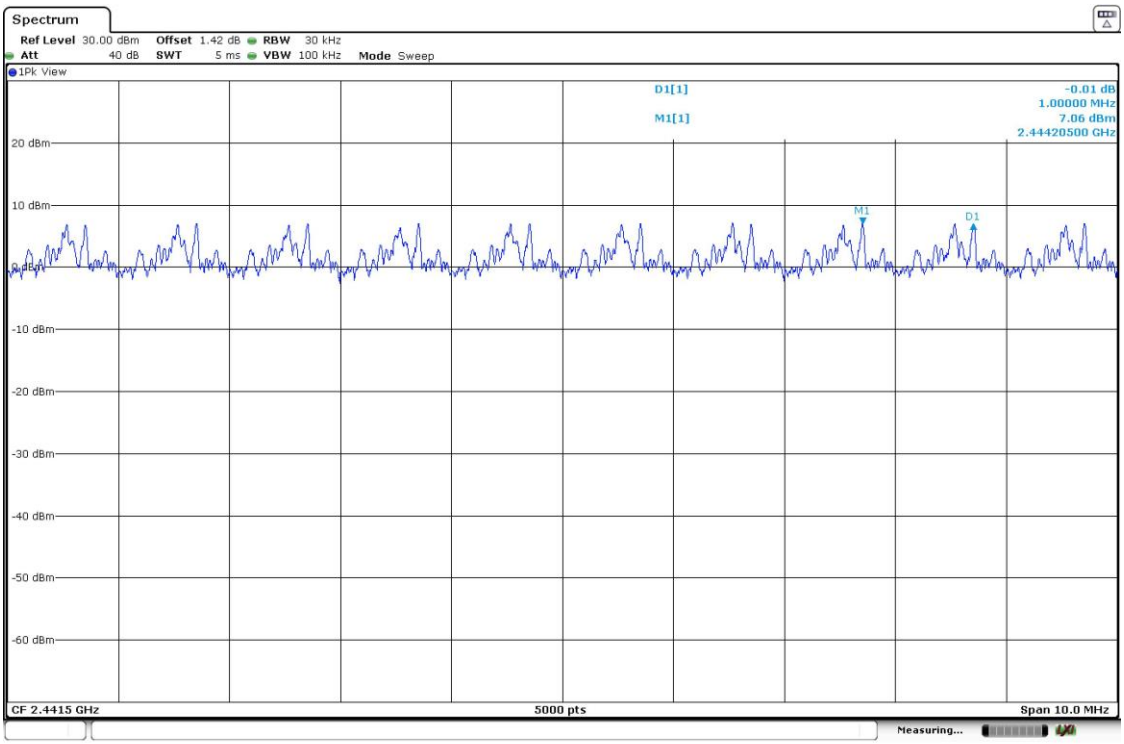
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation

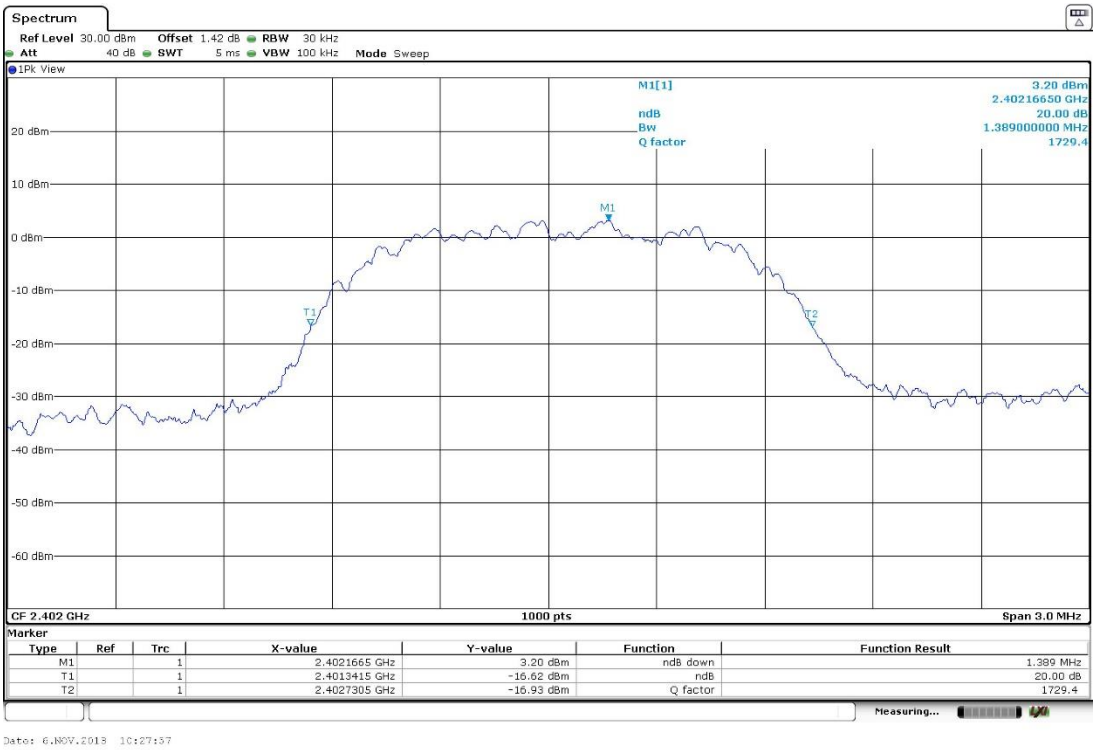


The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel

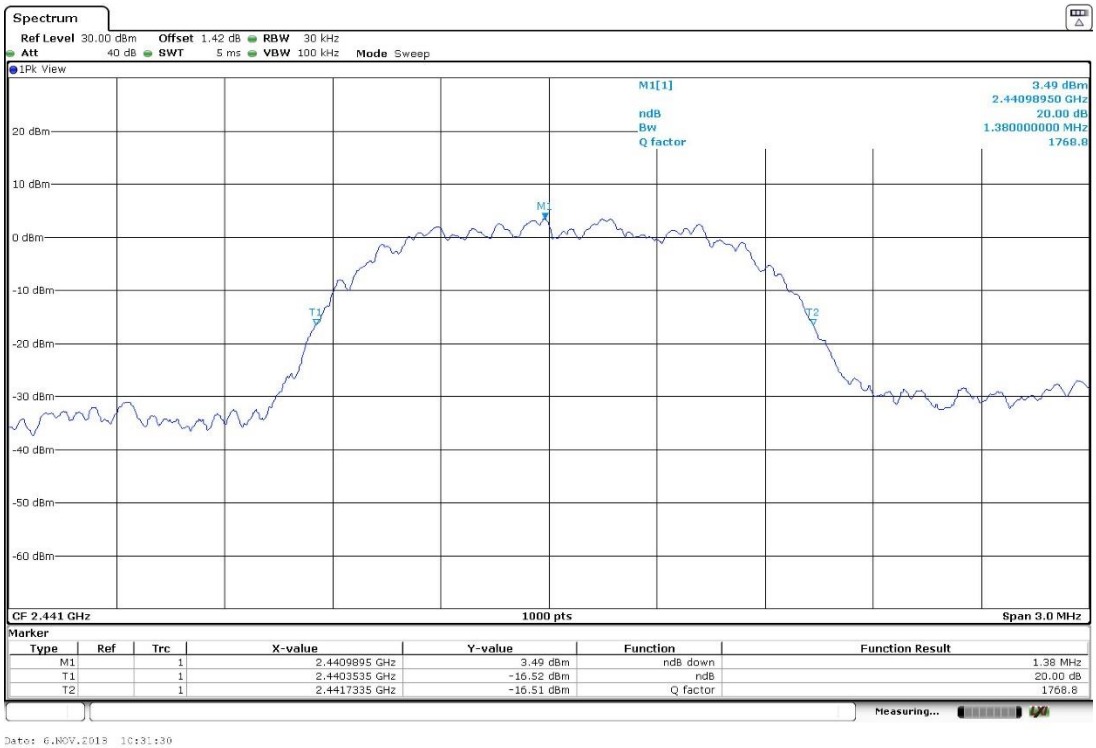
Verdict: PASS

Modulation: 8-DPSK (3DH5)

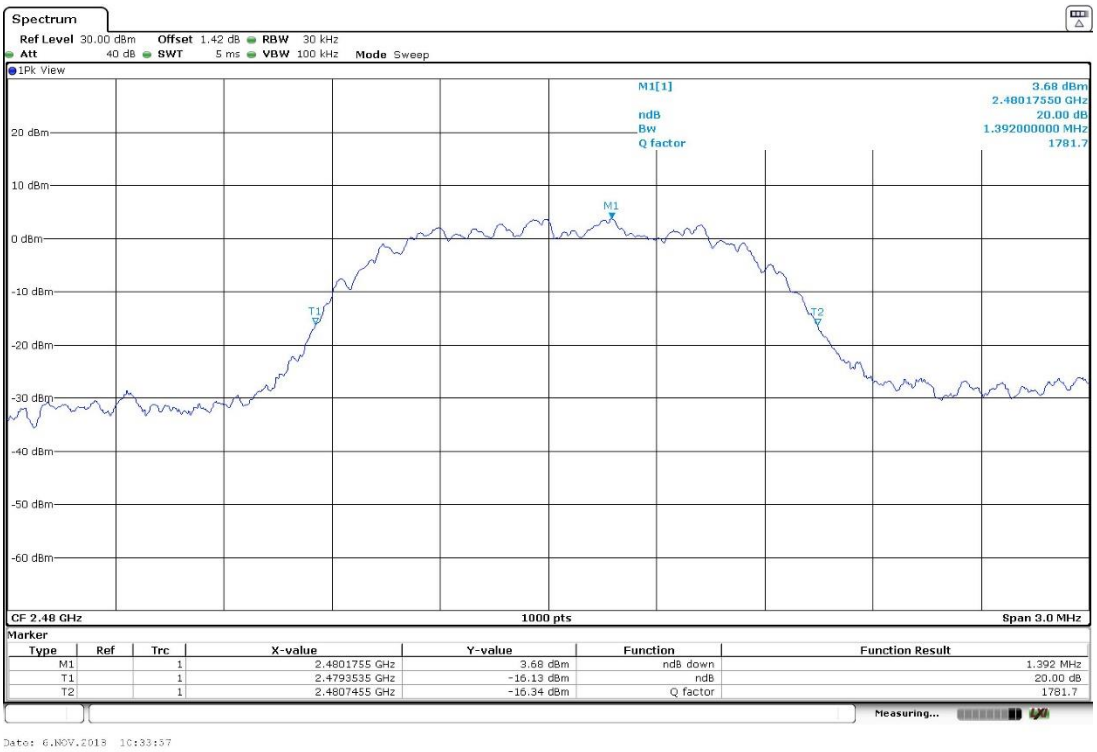
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



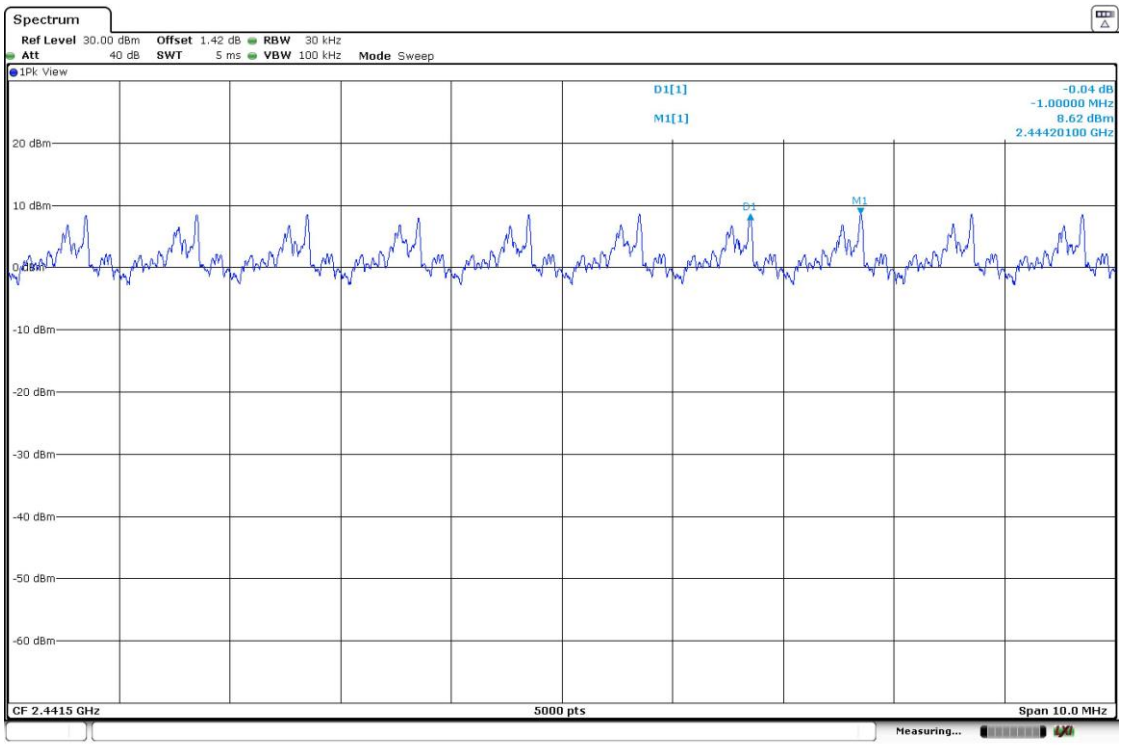
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation



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

Verdict: PASS

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

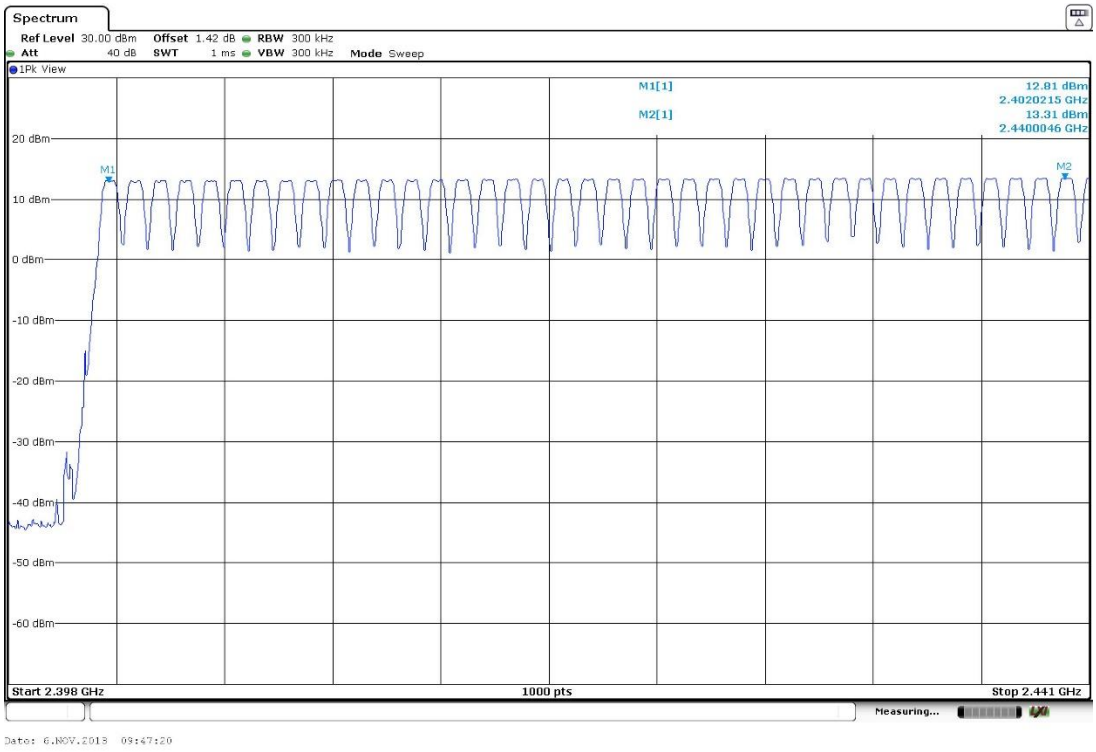
SPECIFICATION

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

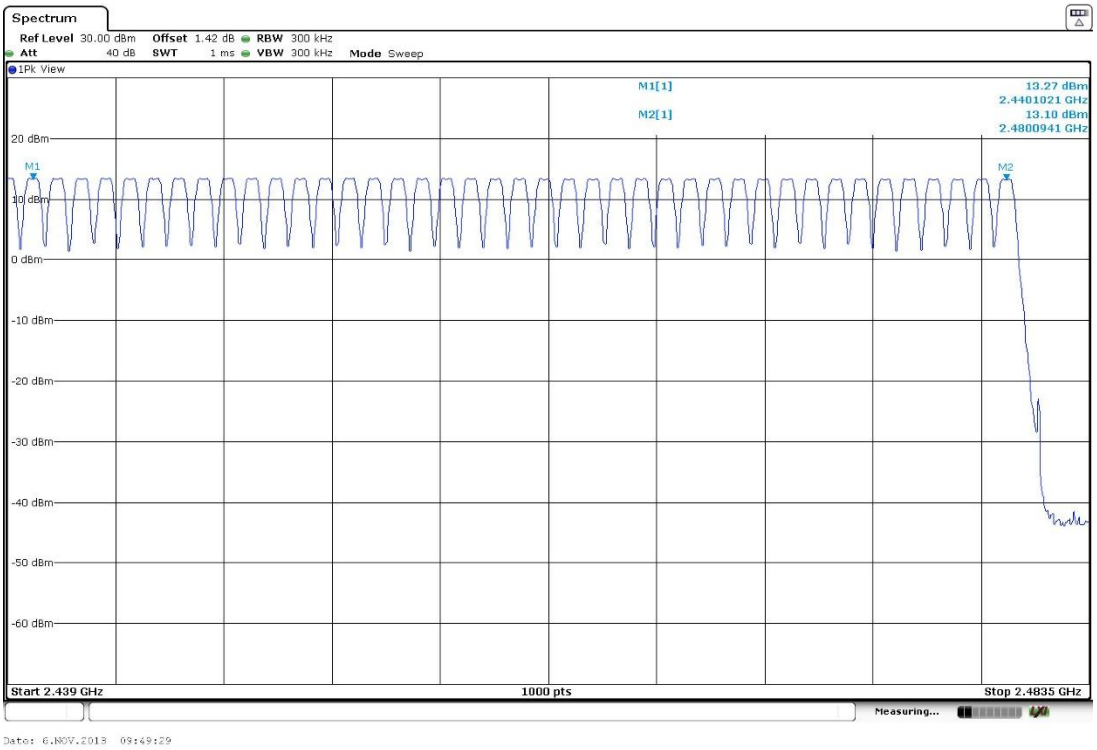
RESULTS

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

Modulation: GFSK (DH5)



Number of hopping frequencies: 39

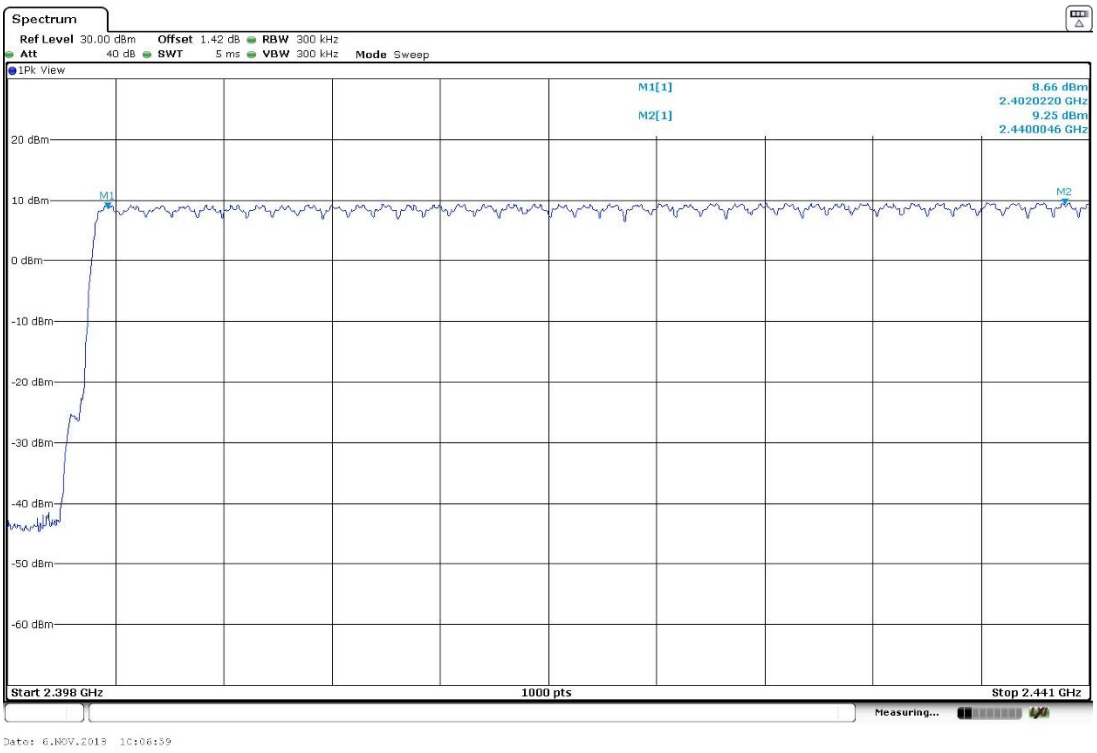


Number of hopping frequencies: 40

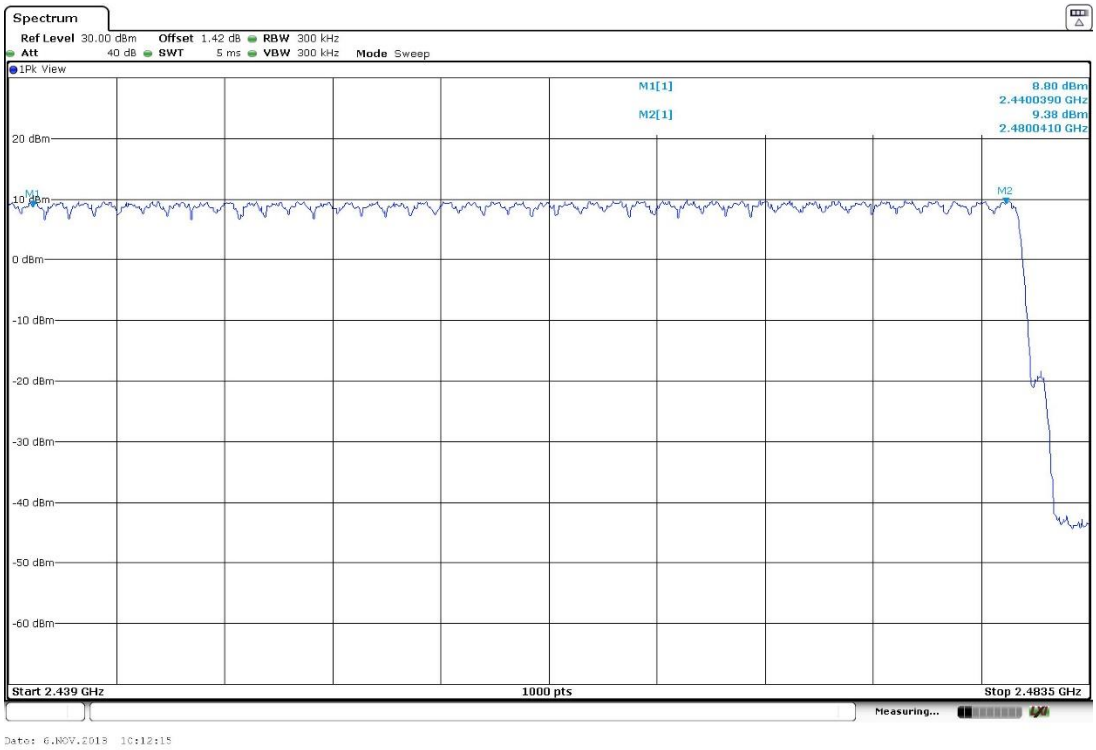
Total number of hopping frequencies: 79

Verdict: PASS

Modulation: Π/4-DQPSK (2DH5)



Number of hopping frequencies: 39

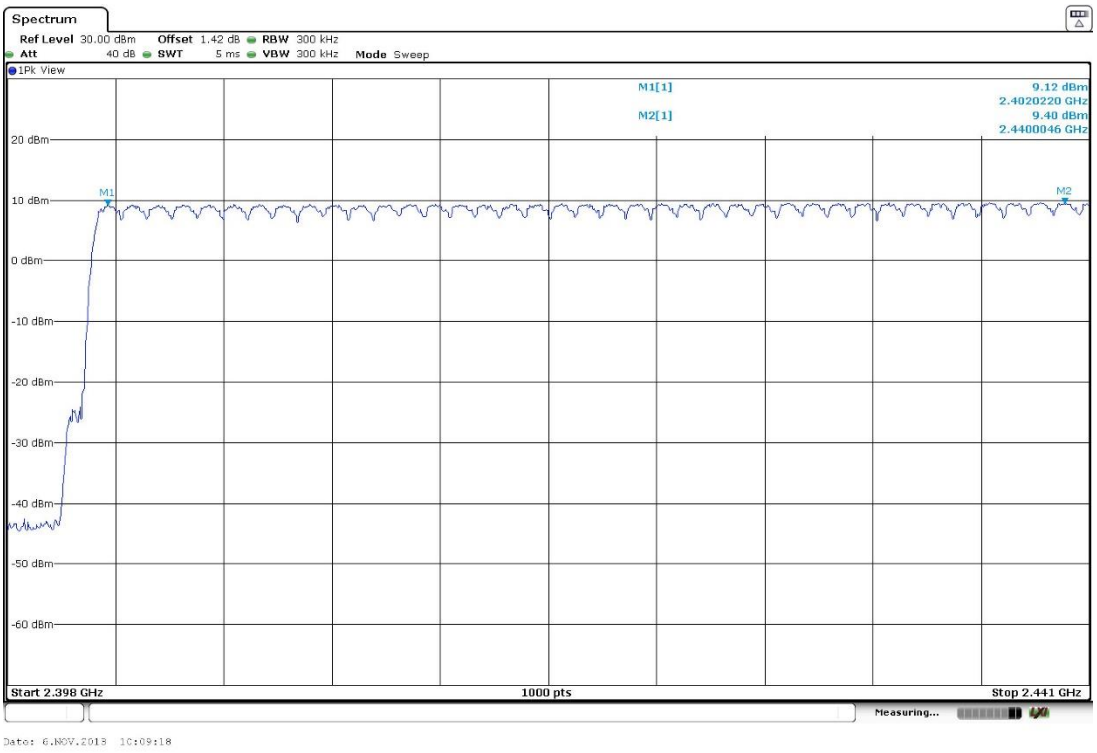


Number of hopping frequencies: 40

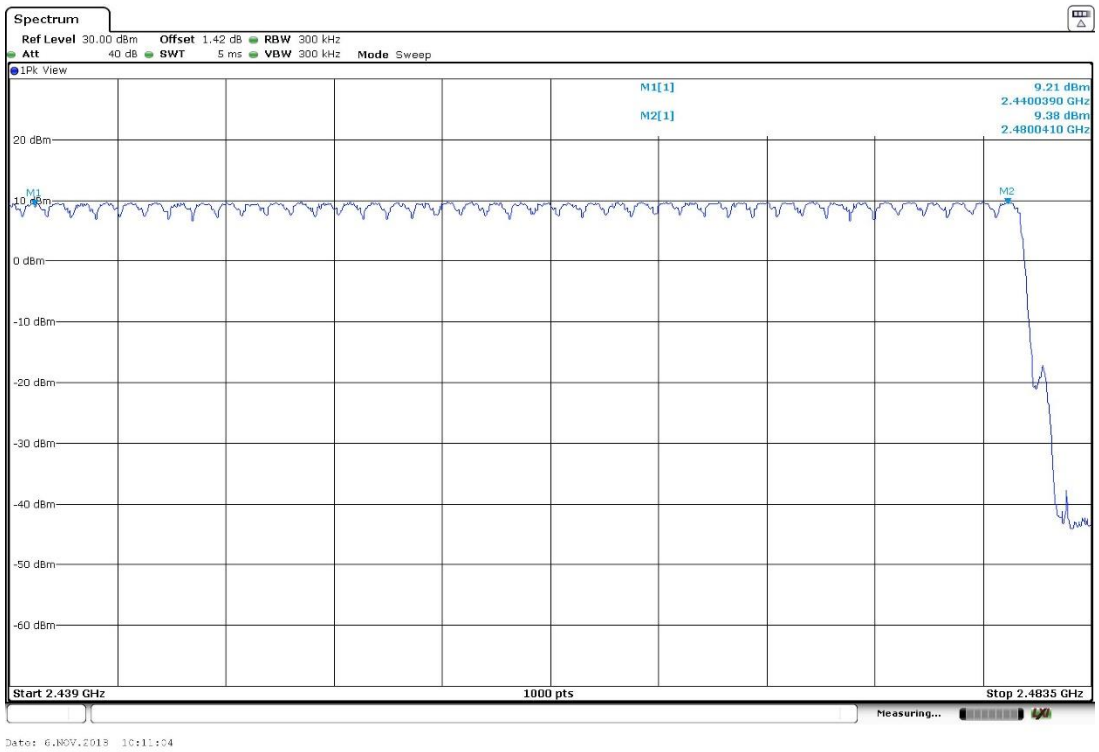
Total number of hopping frequencies: 79

Verdict: PASS

Modulation: 8-DPSK (3DH5)



Number of hopping frequencies: 39



Number of hopping frequencies: 40

Total number of hopping frequencies: 79

Verdict: PASS

FCC Section 15.247 Subclause (a) (1) (iii) / RSS-247 Clause 5.1 (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 x 79= 31.6 seconds.

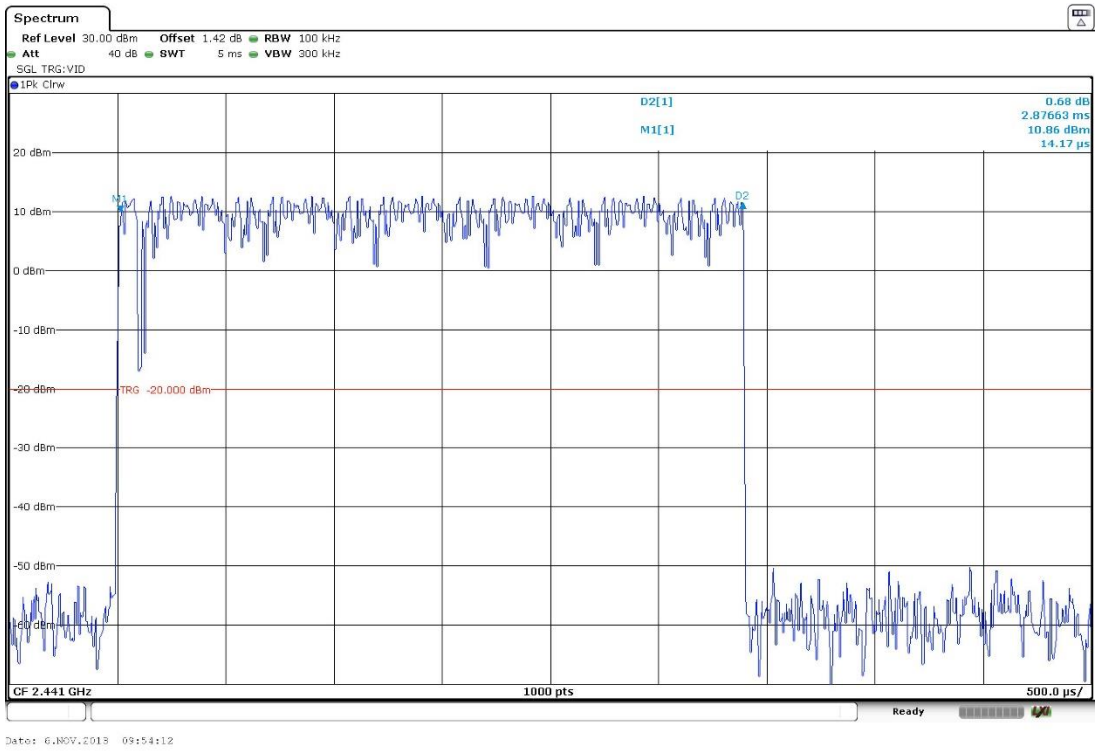
RESULTS

The worst case is for the longest packets DH5, 2DH5 and 3DH5.

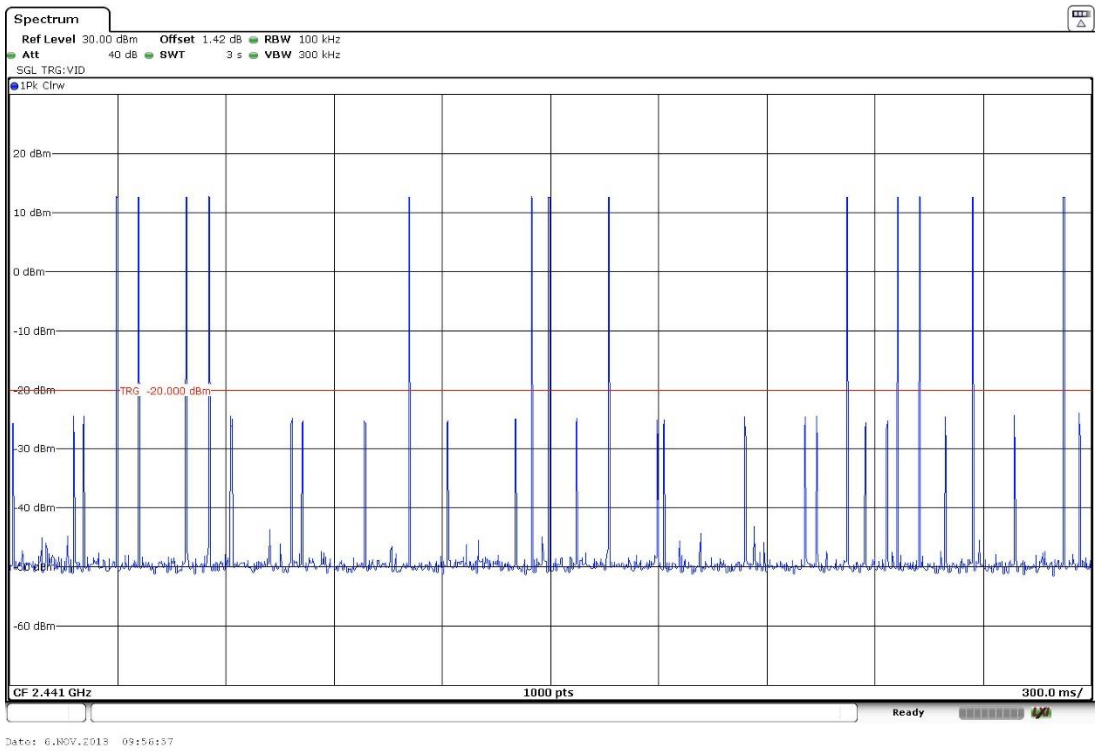
Modulation: GFSK

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

- Tx- time per hop = 2.876 ms (see next plot).



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



Number of hops in the period specified in the requirements = (13 hops) x (31.6 s / 3 s) = 136.9 hops.
Averaging time of occupancy =2.876 ms x 136.9 hops = 393.90 ms per 31.6 seconds.

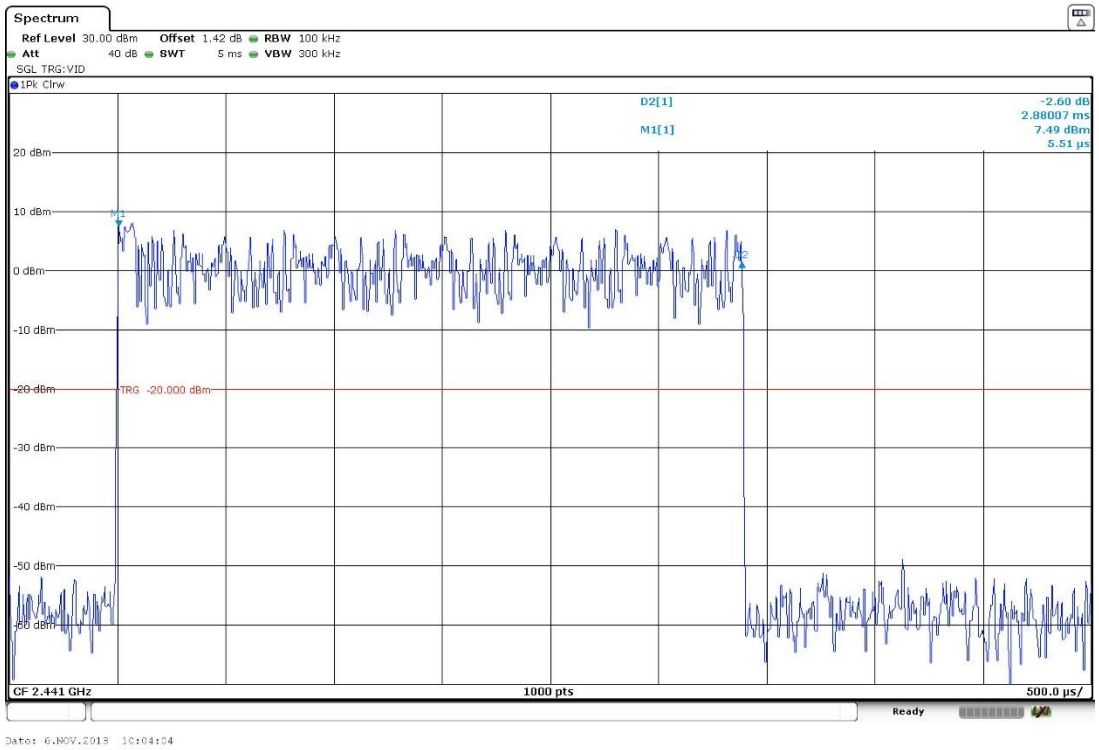
Measurement uncertainty (%)	<±0.01

Verdict: PASS

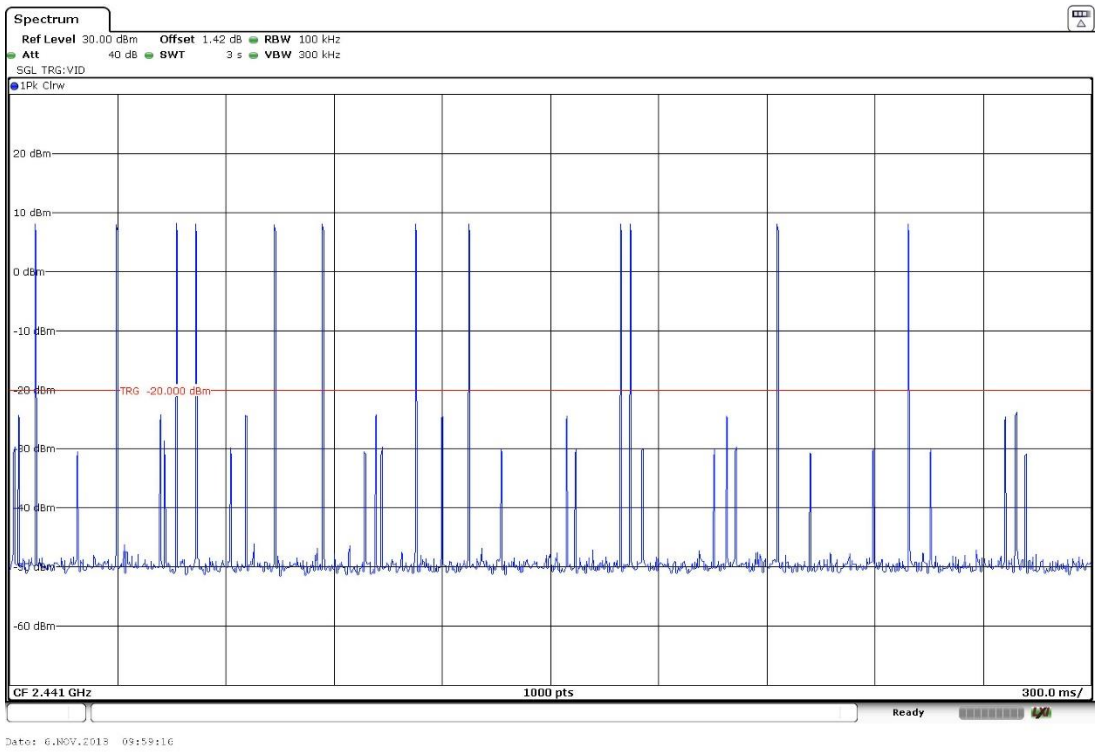
Modulation: Π/4-DQPSK

TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 2DH5.

- Tx- time per hop = 2.880 s (see next plot).



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



Number of hops in the period specified in the requirements = (12 hops) x (31.6 s / 3 s) = 126.40 hops.
Averaging time of occupancy =2.880 ms x 126.40 hops = 364.04 ms per 31.6 seconds.

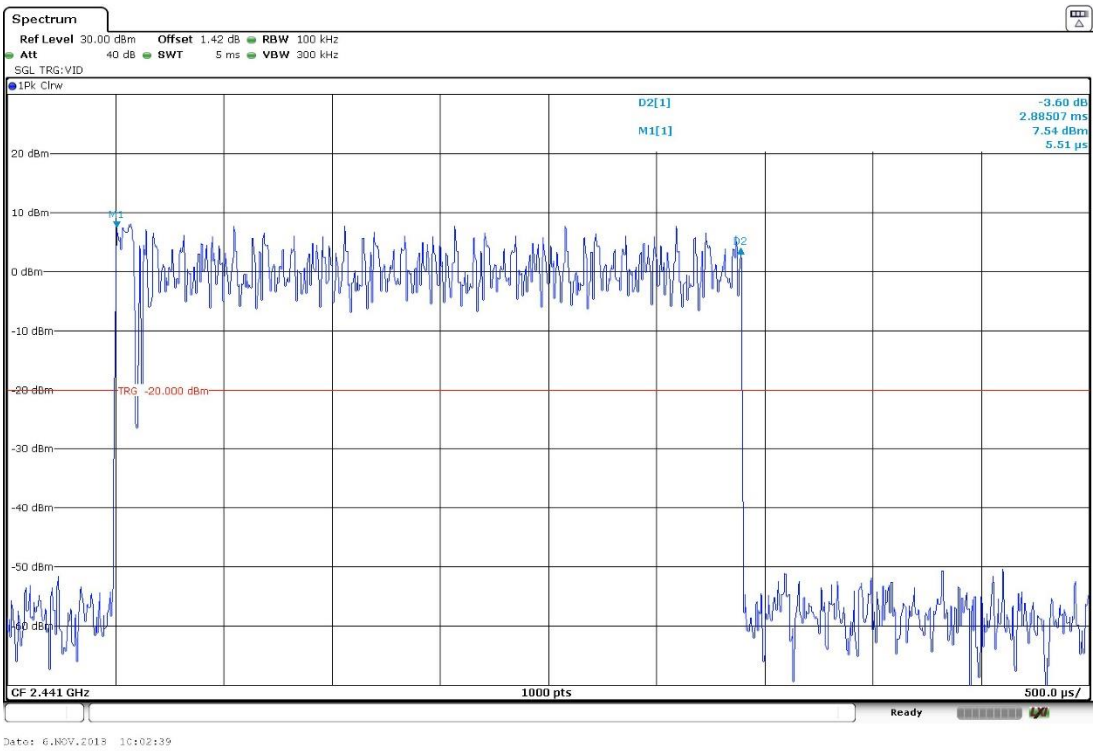
Measurement uncertainty (%)	<±0.01

Verdict: PASS

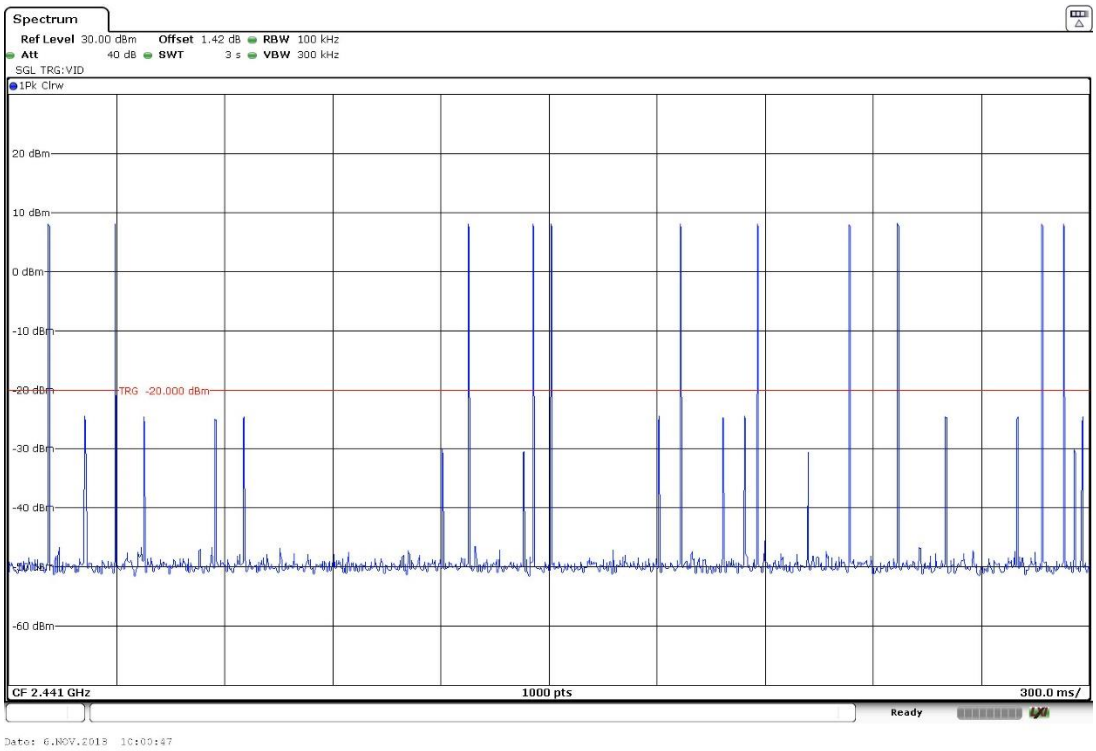
Modulation: 8-DPSK

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

- Tx- time per hop = 2.885 ms (see next plot).



- Number of hops over a period of 3 seconds = 11 (see next plot).



Number of hops in the period specified in the requirements = (11 hops) x (31.6 s / 3 s) = 115.87 hops.
Averaging time of occupancy =2.885 ms x 115.87 hops = 334.28 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01

Verdict: PASS

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

SPECIFICATION

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

MAXIMUM OUTPUT POWER. See next plots.

Declared Gain for antenna RF port (maximum) = +6.56 dBi.

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

As declared in the 15.247 (b) (4), the conducted output power is reduced by the amount in dB that the directional gain of the antenna exceeds 6dB. The applicable output power limit shall be calculated as follows:

$$P_{Out} = P_{Limit} - (G_{Tx} - 6)$$

Modulation: GFSK (DH5)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	12.94	13.40	13.29
Conducted Peak Power Limit (dBm)	30	30	30
Corrected Limit (dBm)	29.44	29.44	29.44
Margin (dB)	16.50	16.04	16.15
Measurement uncertainty (dB)	<±1.20		

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	12.94	13.40	13.29
Maximum EIRP power (dBm)	19.50	19.96	19.85
EIRP power Limit (dBm)	36	36	36
Margin (dB)	16.50	16.04	16.15
Measurement uncertainty (dB)	<±1.20		

Modulation: Π/4-DQPSK (2DH5)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	11.18	11.62	11.61
Conducted Peak Power Limit (dBm)	30	30	30
Corrected Limit (dBm)	29.44	29.44	29.44
Margin (dB)	18.26	17.82	17.83
Measurement uncertainty (dB)	<±1.20		

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	11.18	11.62	11.61
Maximum EIRP power (dBm)	17.74	18.18	18.17
EIRP power Limit (dBm)	36	36	36
Margin (dB)	18.26	17.82	17.83
Measurement uncertainty (dB)	<±1.20		

Modulation: 8-DPSK (3DH5)

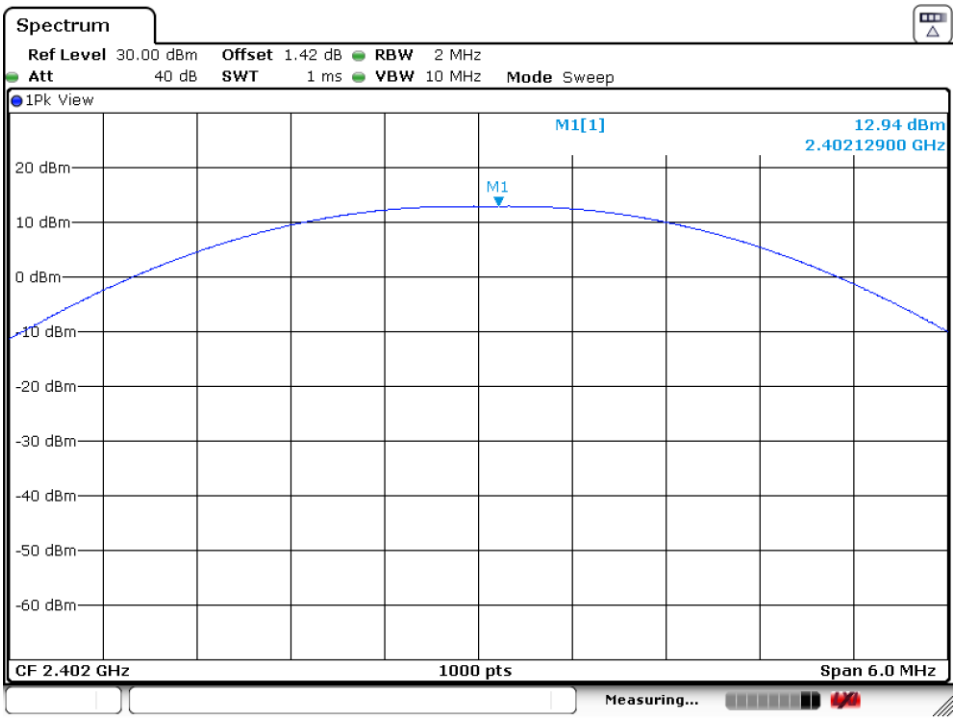
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	11.51	11.85	11.86
Conducted Peak Power Limit (dBm)	30	30	30
Corrected Limit (dBm)	29.44	29.44	29.44
Margin (dB)	17.93	17.59	17.58
Measurement uncertainty (dB)	<±1.20		

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	11.51	11.85	11.86
Maximum EIRP power (dBm)	18.07	18.41	18.42
EIRP power Limit (dBm)	36	36	36
Margin (dB)	17.93	17.59	17.58
Measurement uncertainty (dB)	<±1.20		

Verdict: PASS

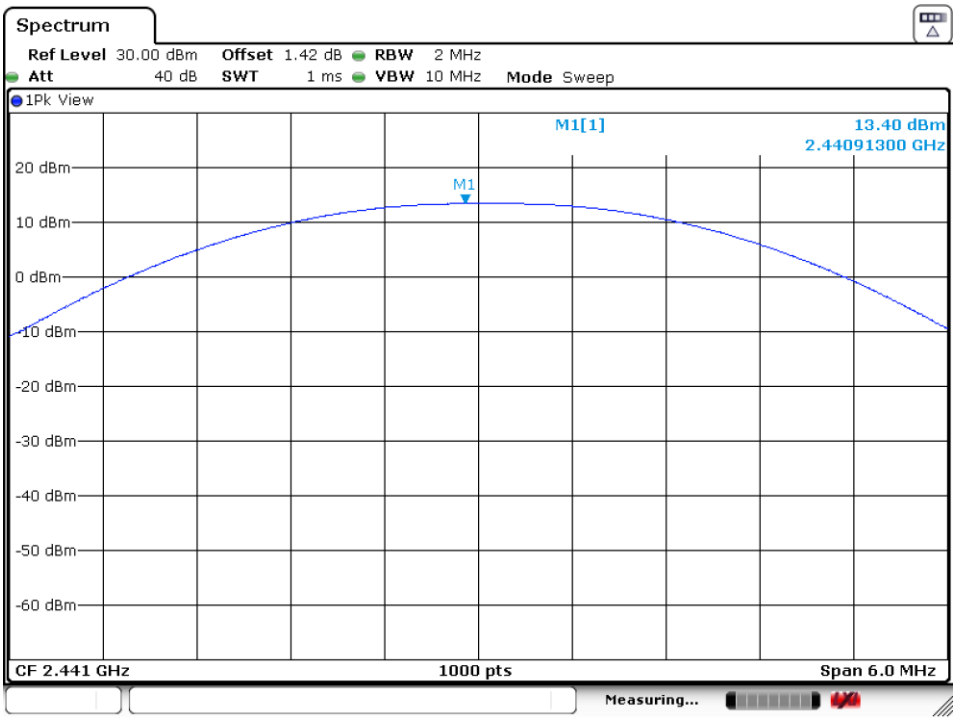
PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK (DH5) Lowest Channel: 2402 MHz.



Date: 5.NOV.2018 10:14:03

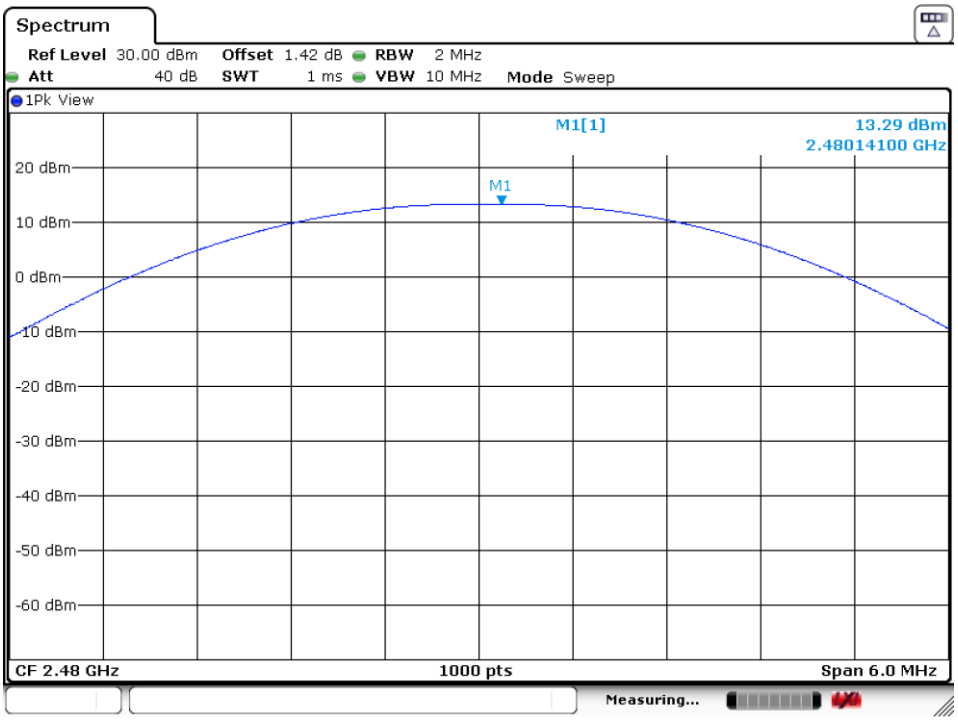
Modulation: GFSK (DH5) Middle Channel: 2441 MHz.



Date: 5.NOV.2018 10:16:51

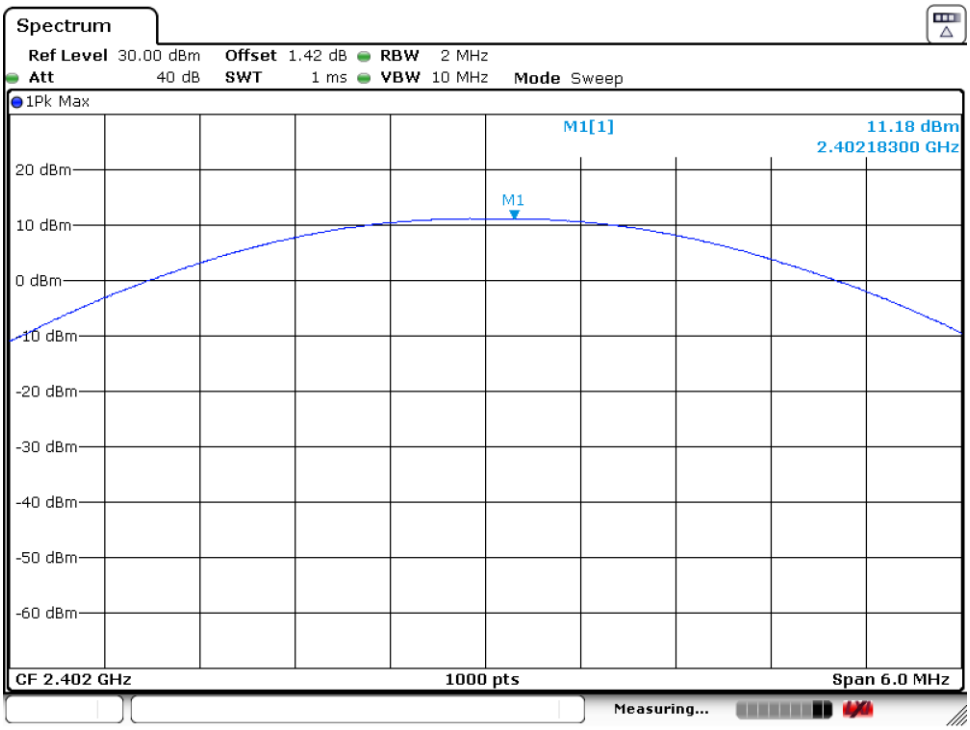
PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK (DH5) Highest Channel: 2480 MHz.



Date: 5.NOV.2018 10:18:07

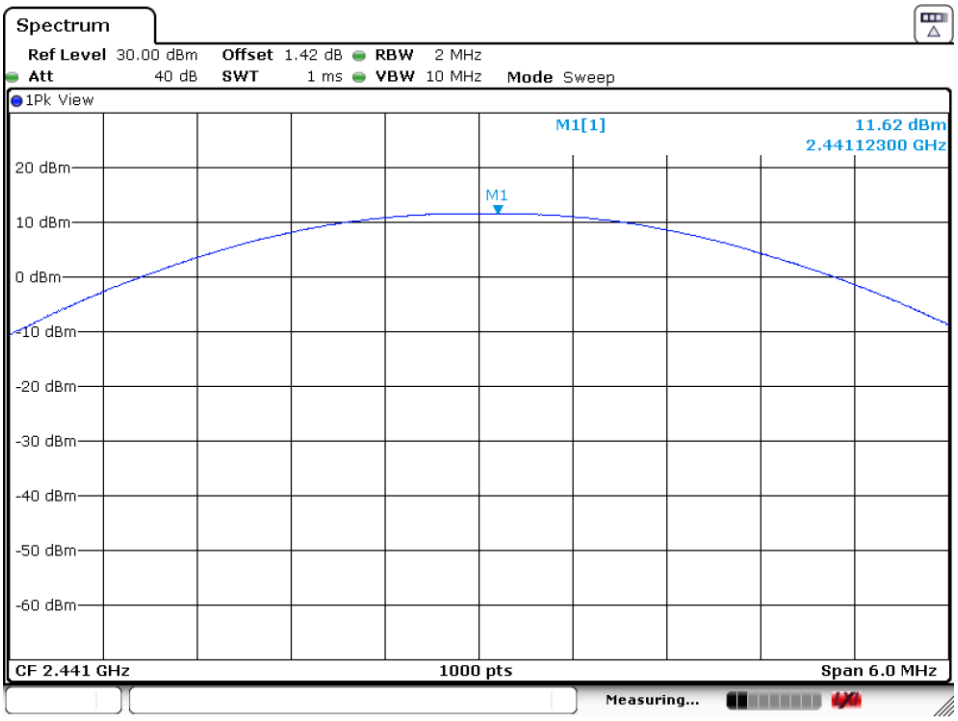
Modulation: Π/4-DQPSK (2DH5) Lowest Channel: 2402 MHz



Date: 5.NOV.2018 10:19:56

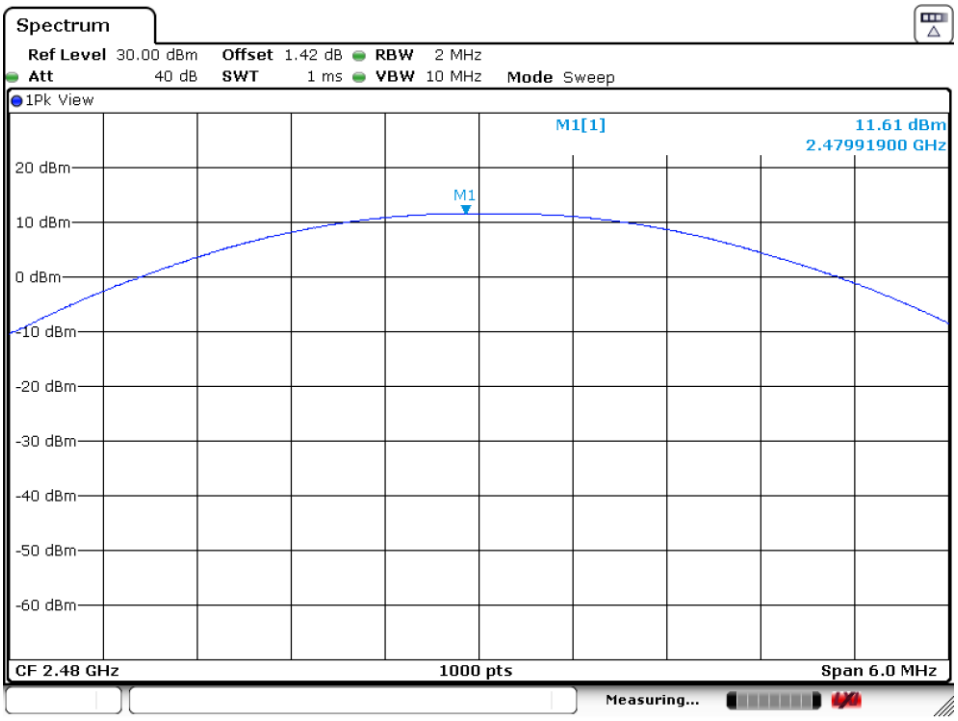
PEAK OUTPUT POWER (CONDUCTED)

Modulation: Π/4-DQPSK (2DH5) Middle Channel: 2441 MHz.



Date: 5.NOV.2018 10:21:39

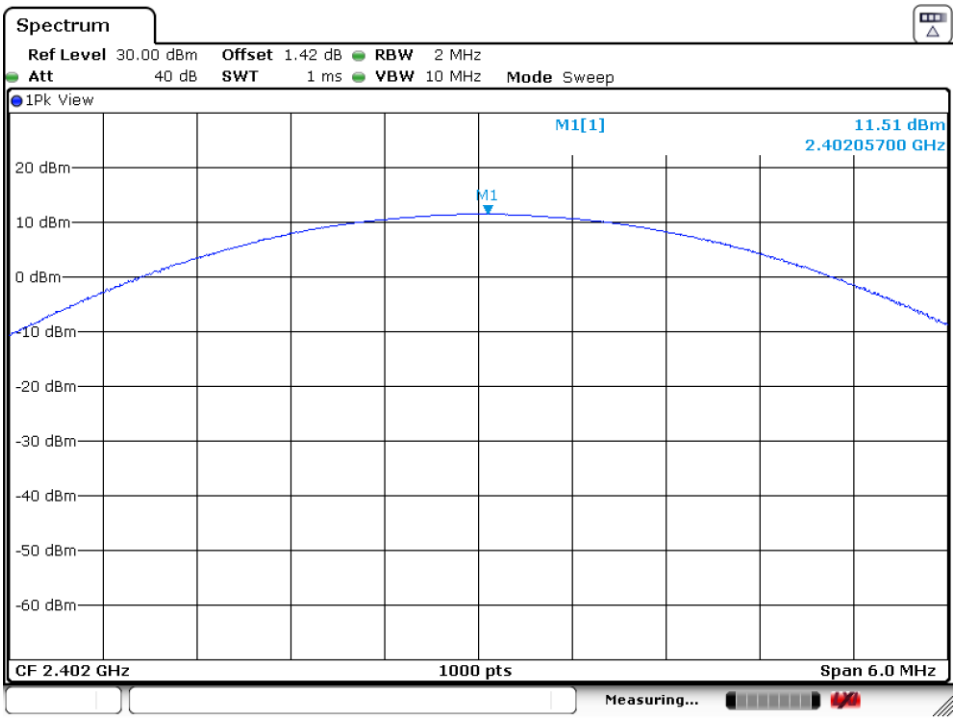
Modulation: Π/4-DQPSK (2DH5) Highest Channel: 2480 MHz.



Date: 5.NOV.2018 10:22:59

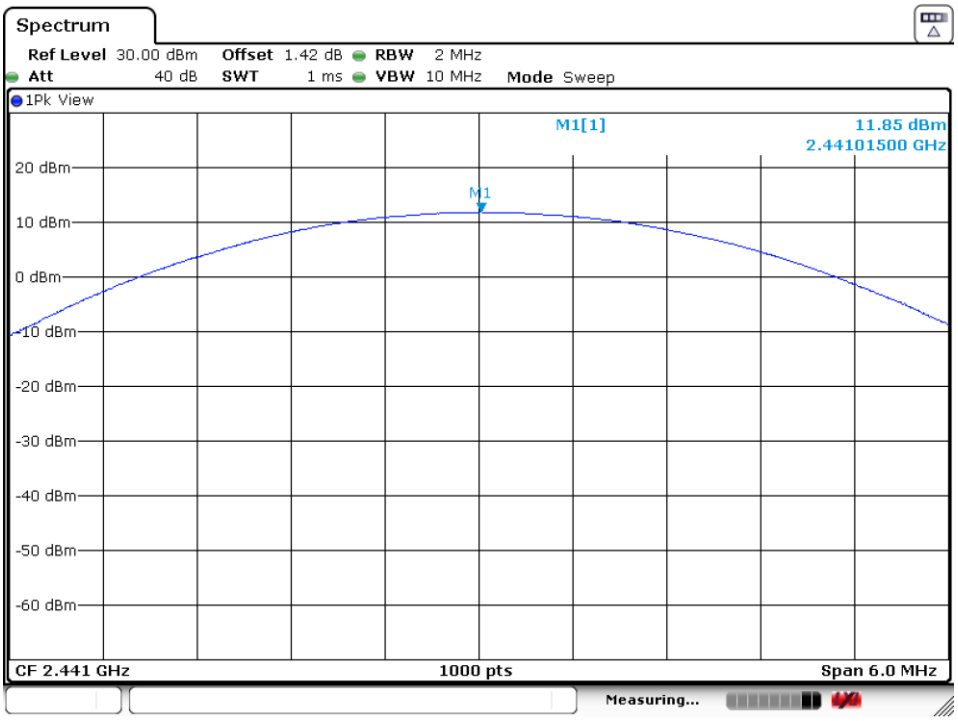
PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK (3DH5) Lowest Channel: 2402 MHz



Date: 5.NOV.2018 10:24:29

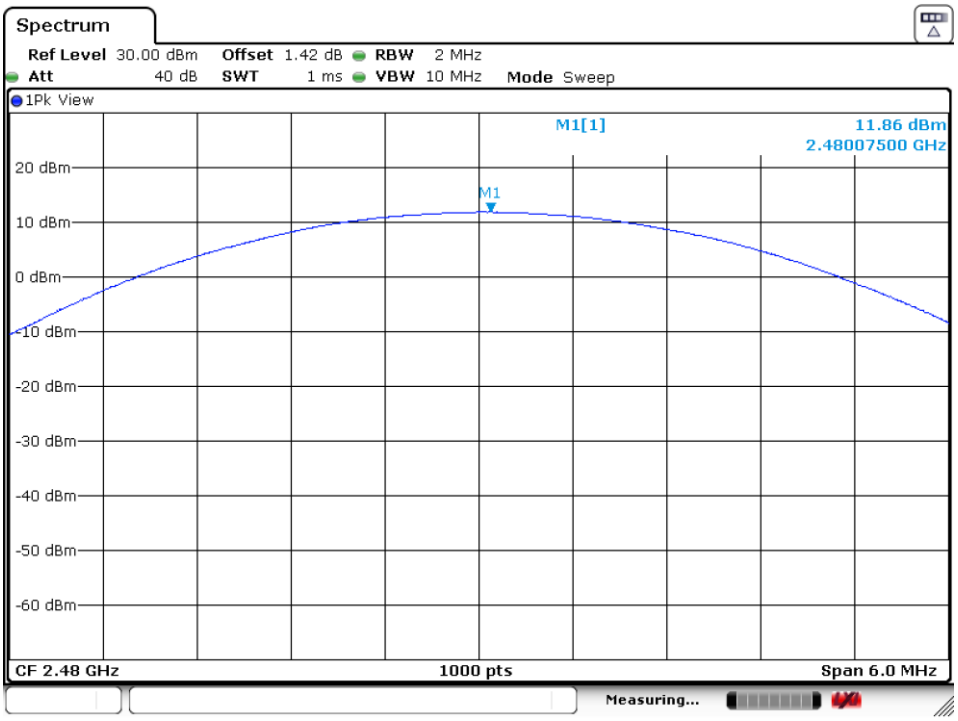
Modulation: 8-DPSK (3DH5) Middle Channel: 2441 MHz.



Date: 5.NOV.2018 10:25:43

PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK (3DH5) Highest Channel: 2480 MHz.



FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5 Emission limitations radiated (Transmitter)

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)/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 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

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

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

RSS-247. Attenuation below the general field strength limits specified in RSS-Gen is not required.

RESULTS:

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

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

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

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

Frequency range 30 MHz-1000 MHz.

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

Spurious levels operating (radiated) closest to limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
71.338	Vertical	Quasi-Peak	26.2	40	13.8	± 3.88
69.8161	Vertical	Quasi-Peak	27.2	40	12.8	± 3.88
168.4015	Vertical	Quasi-Peak	35.2	43.5	8.3	± 3.88
365.6152	Vertical	Quasi-Peak	27.5	46	18.5	± 3.88
446.8571	Vertical	Quasi-Peak	28.5	46	17.5	± 3.88
902.4665	Vertical	Quasi-Peak	39.6	46	16.4	± 3.88
167.239	Horizontal	Quasi-Peak	33.8	43.5	9.7	± 3.88
191.0718	Horizontal	Quasi-Peak	31.4	43.5	12.1	± 3.88
288.6863	Horizontal	Quasi-Peak	27.0	46	19.0	± 3.88

Frequency range 1 GHz-25 GHz

The results in the next tables show the maximum measured levels in the 1-25 GHz frequency range.

Modulation: GFSK (DH5)

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5391.350	Vertical	Peak	45.05	74	28.95	± 4.87
5390.969		Average	39.86	54	14.14	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5391.35	Vertical	Peak	45.35	74	28.65	± 4.87
5387.62		Average	40.18	54	13.82	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5388,550	Vertical	Peak	45.76	74	28.24	± 4.87
5391.820		Average	40.98	54	13.02	± 4.87

Verdict: PASS

Modulation: Π/4-DQPSK (2DH5)

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5390.890	Vertical	Peak	44.58	74	29.42	± 4.87
5391.350		Average	40.05	54	13.95	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5391.350	Vertical	Peak	45.97	74	28.03	± 4.87
5389.020		Average	41.18	54	12.82	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5391.350	Vertical	Peak	45.27	74	28.73	± 4.87
5394.150		Average	39.78	54	14.22	± 4.87

Verdict: PASS

Modulation: 8-DPSK (3DH5)

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5391.350	Vertical	Peak	45.29	74	28.71	± 4.87
		Average	40.58	54	13.42	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

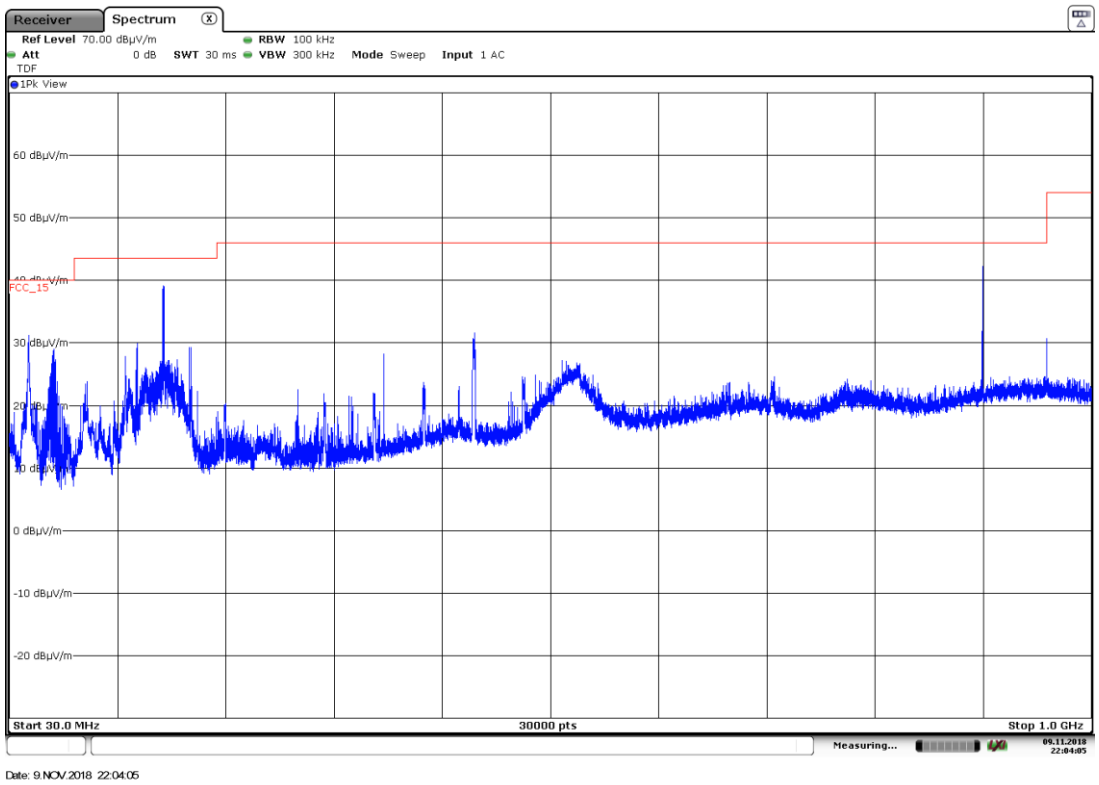
Spurious frequency (MHz)	c	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5391.350	Vertical	Peak	45.85	74	28.15	± 4.87
		Average	40.35	54	13.65	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
5388.090	Vertical	Peak	45.15	74	28.85	± 4.87
		Average	40.33	54	13.67	± 4.87

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

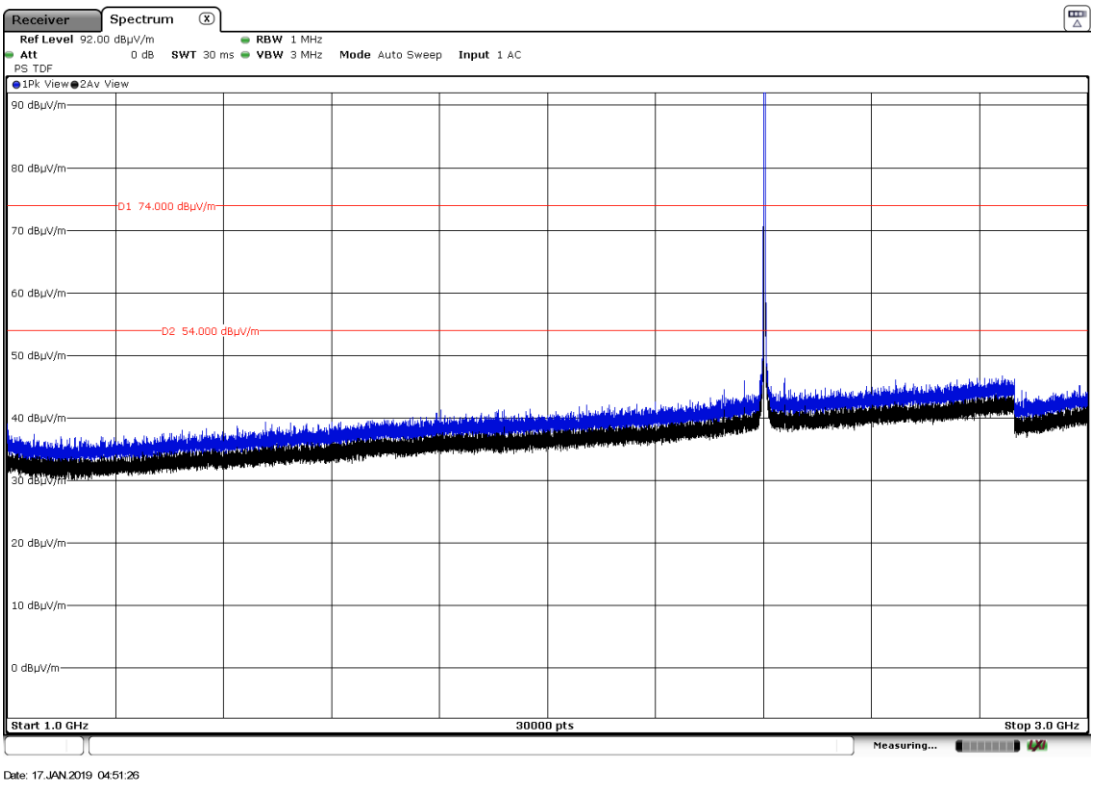


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

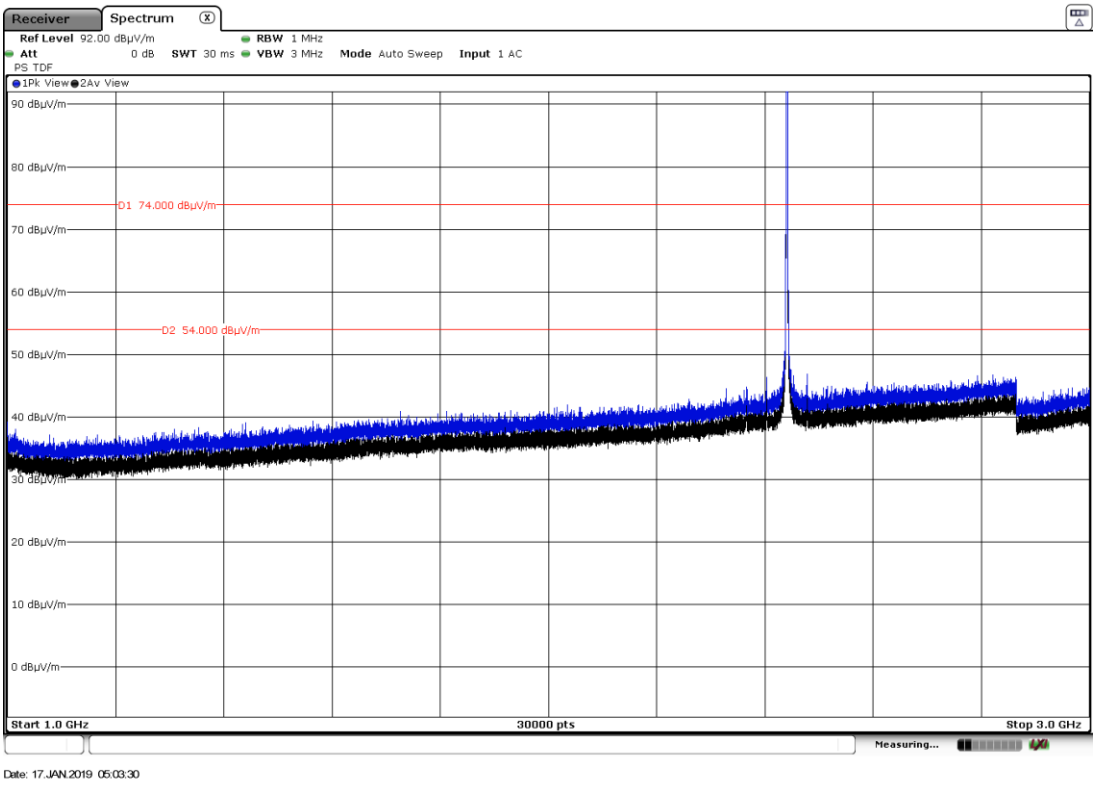
Modulation: GFSK (DH5)

CHANNEL: Lowest (2402 MHz).



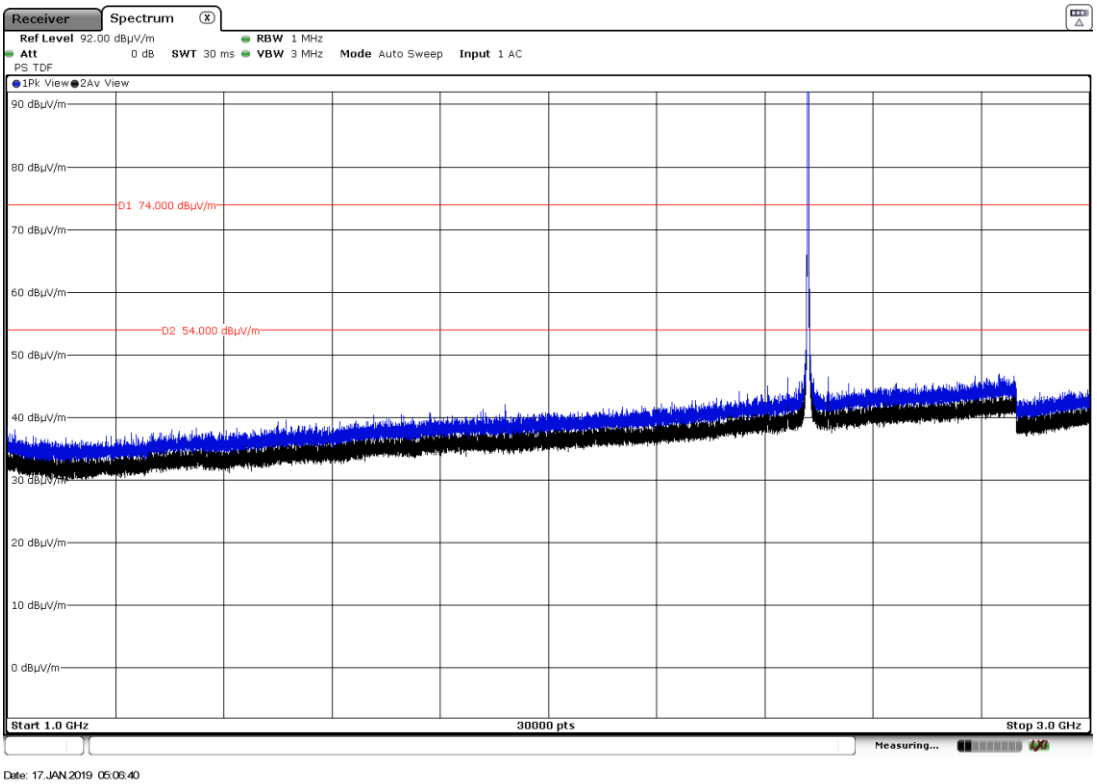
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

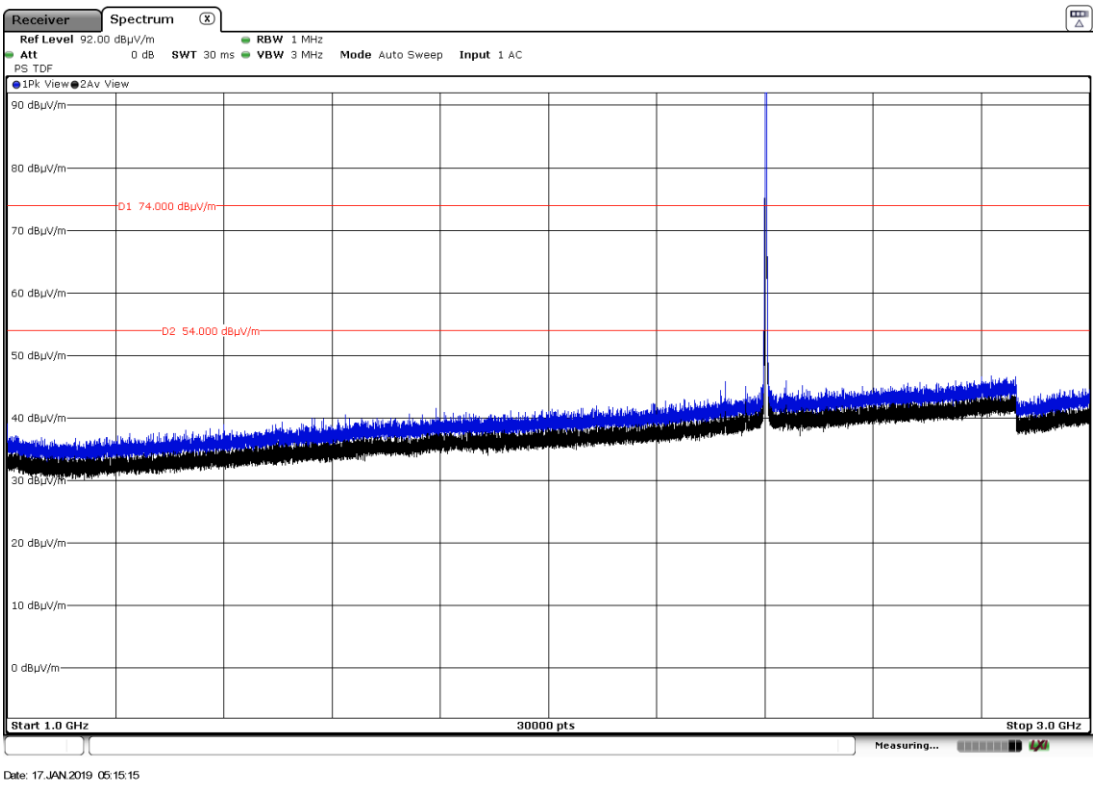
CHANNEL: Highest (2480 MHz).



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

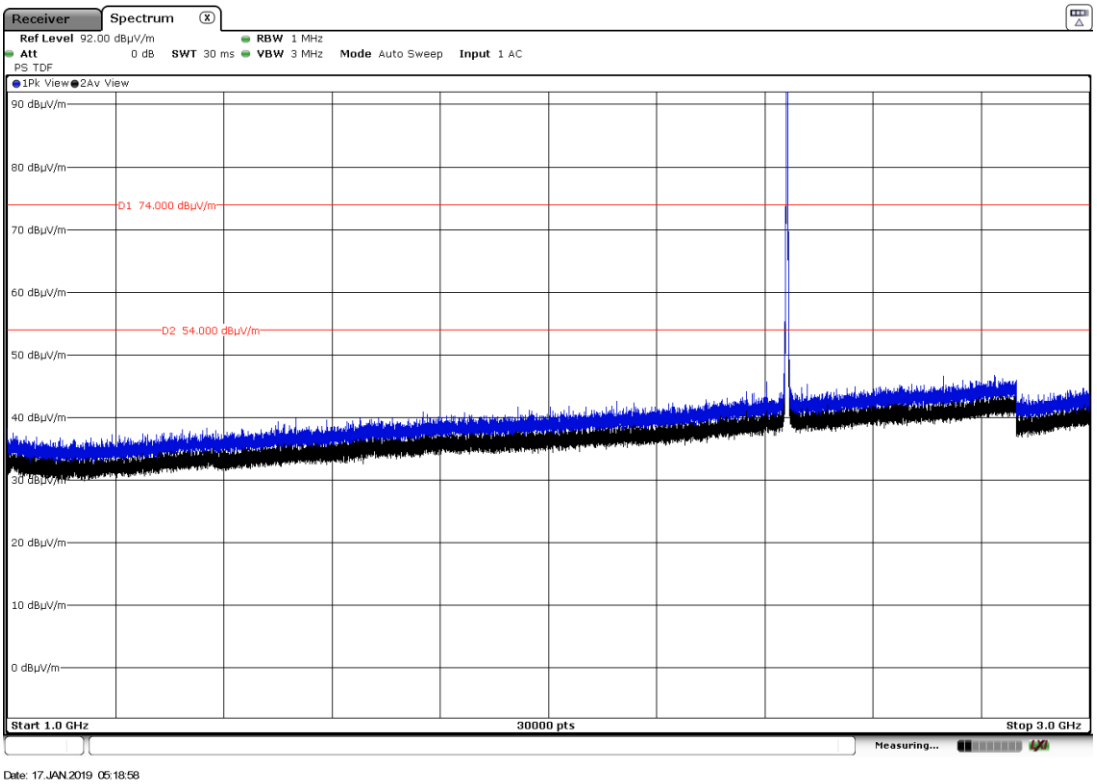
Modulation: Π/4-DQPSK (2DH5)

CHANNEL: Lowest (2402 MHz).



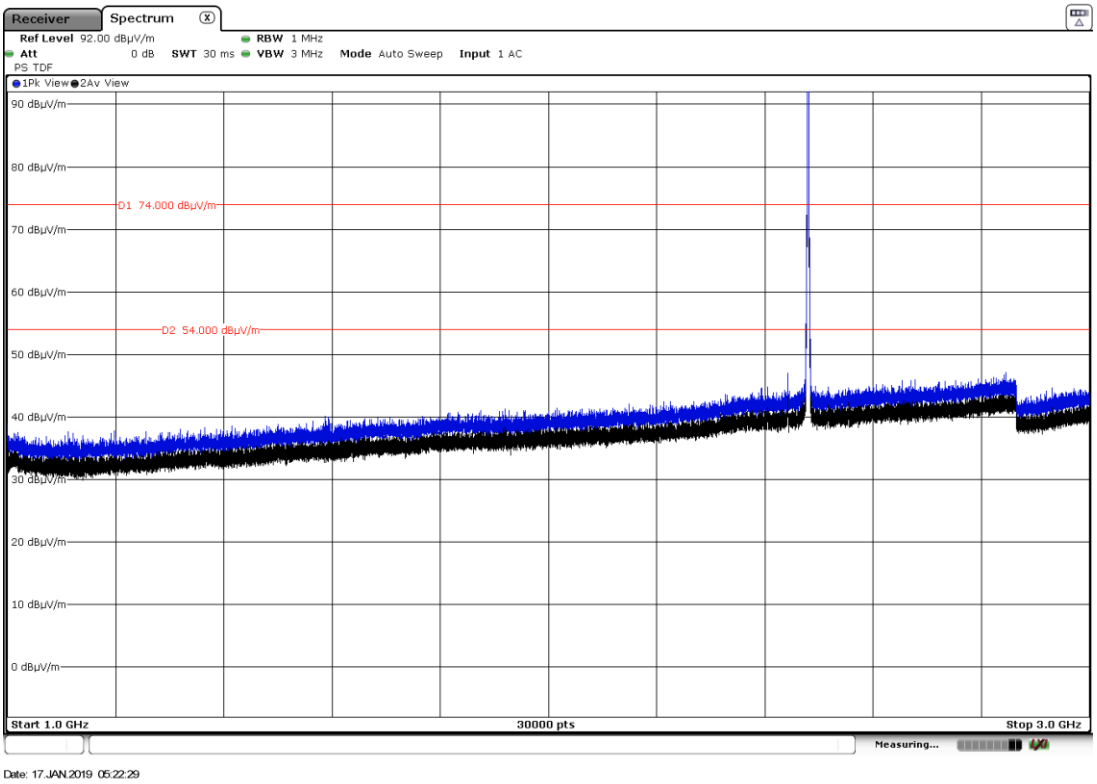
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

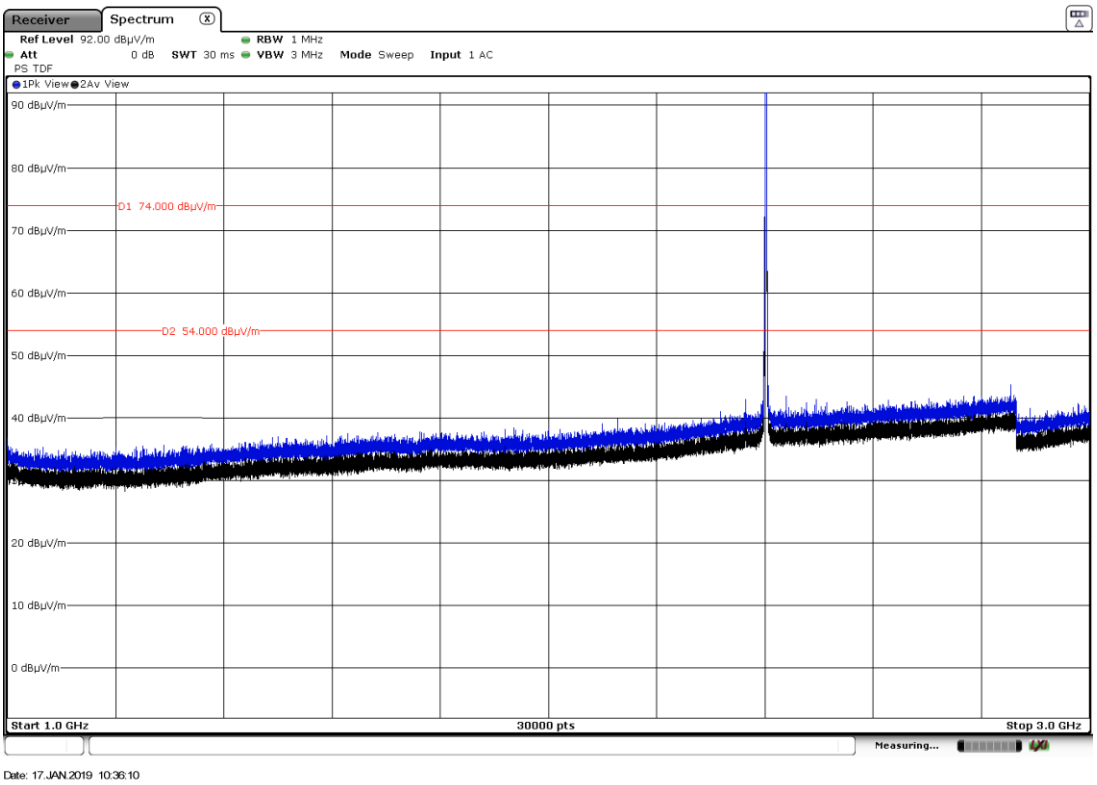
CHANNEL: Highest (2480 MHz).



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

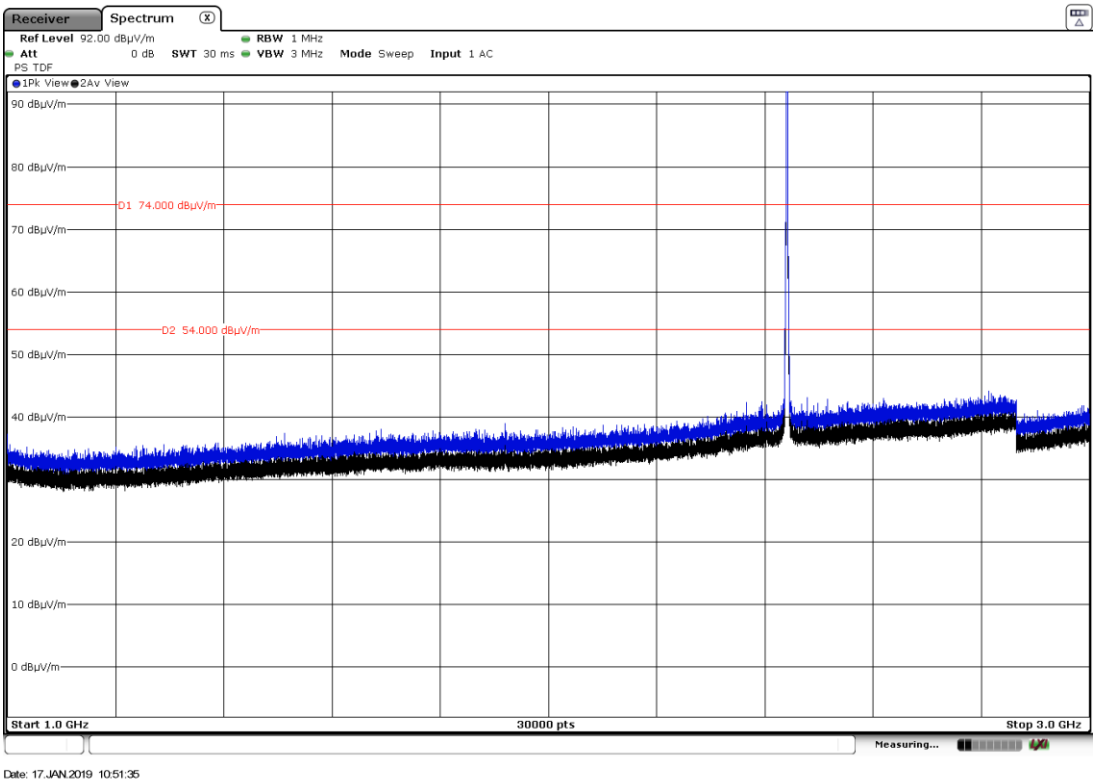
Modulation: 8-DPSK (3DH5)

CHANNEL: Lowest (2402 MHz).



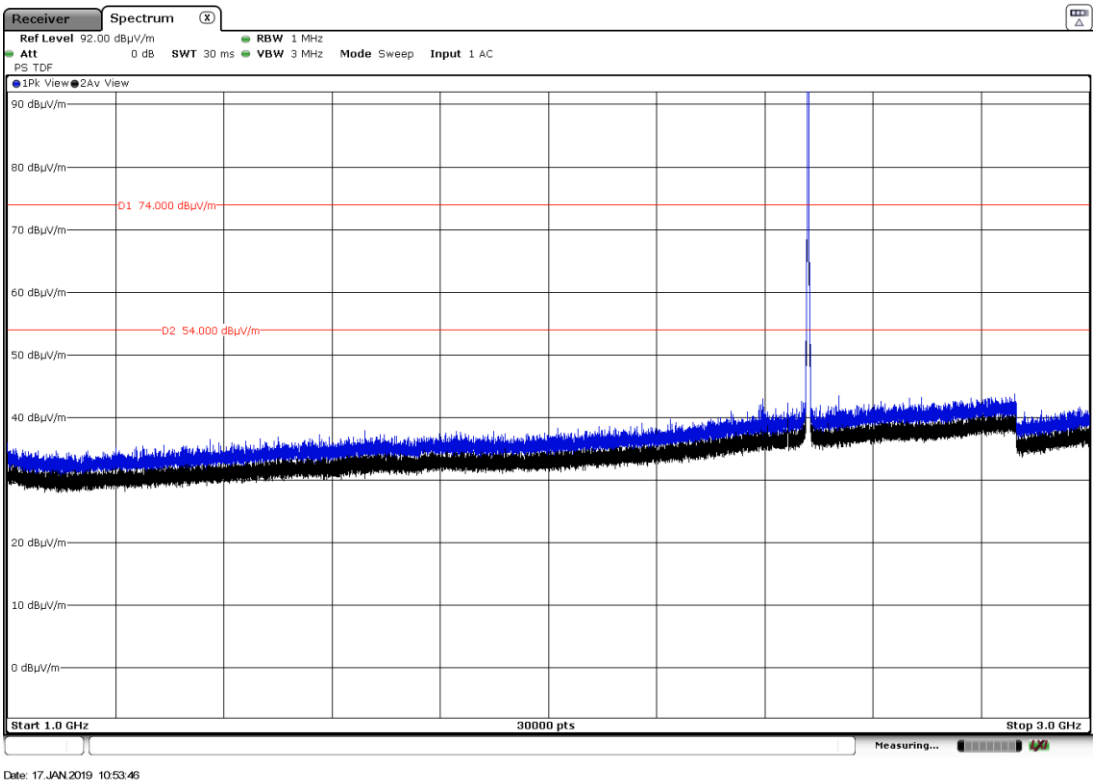
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

CHANNEL: Highest (2480 MHz).

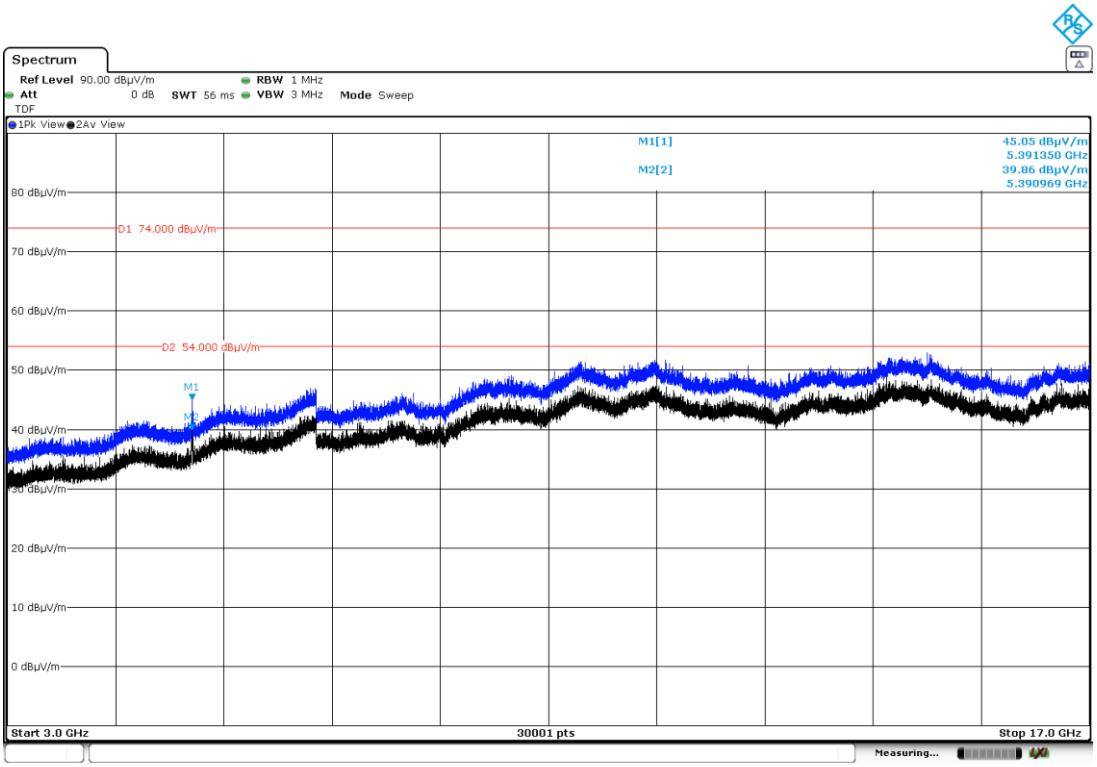


Note: The peak shown in the plot above the limits is the carrier frequency.

FREQUENCY RANGE 3 GHz to 17 GHz.

Modulation: GFSK (DH5)

CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).