



FCC LISTED, REGISTRATION
NUMBER: 720267

ISED LISTED REGISTRATION
NUMBER 4621A-2

Informe de ensayo n°:
Test report No:

NIE: 54022RRF.003A1

Test report (Modification 1)

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

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

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

General Requirements and Information for the Certification of Radio Apparatus.

Identificación del objeto ensayado.....: Identification of item tested	Automotive infotainment System
Marca Trademark	Mercedes-Benz
Modelo y/o referencia tipo Model and /or type reference	NTG6 ENTRY/MID
Other identification of the product	FCC ID: T8GNTG6EM / IC: 6434A-NTG6EM
Final HW version	D4
Final SW version	E22.4.2
Características Features	FM, AM, DAB, USB, Bluetooth, WLAN, GNSS.
Solicitante Applicant	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.247 10-1-16 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-16 Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 4 (November 2014). Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v04 dated 05/04/2017. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Resultado Summary	IN COMPLIANCE
Aprobado por (nombre / cargo y firma) Approved by (name / position & signature)	Rafael López Martín LAB EMC Manager
Fecha de realización Date of issue	2017-12-27
Formato de informe No. Report template No	FDT11_20

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Competences and guarantees

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

DEKRA Testing and Certification is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in 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.

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

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

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

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

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General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification and the Accreditation Bodies.

Uncertainty

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

Usage of samples

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

Sample S/01 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
54022/036	Automotive infotainment System	NTG6 ENTRY/MID	H0034779	2017-09-26
54022/049	CAN Box	NTG6 HMI-CAN	H0034755	2017-09-26
54022/053	Harness	---	---	2017-09-26
54022/050	Double Ethernet cable	---	---	2017-09-26
54022/043	Tel/GPS/VIP antenna	---	---	2017-09-26
54022/021	Dual BT/WLAN antenna	---	---	2017-09-26
54022/022	BT/WLAN antenna	---	---	2017-09-26

- Sample S/01 has undergone following test(s).
All radiated tests indicated in appendixes A and B.

Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
54022/036	Automotive infotainment System	NTG6 ENTRY/MID	H0034779	2017-09-26
54022/049	CAN Box	NTG6 HMI-CAN	H0034755	2017-09-26
54022/053	Harness	---	---	2017-09-26
54022/050	Double Ethernet cable	---	---	2017-09-26

- Sample S/02 has undergone following test(s).
All conducted tests indicated in appendixes A and B.

Test sample description

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

Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH
BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY

Testing period

The performed test started on 2017-09-27 and finished on 2017-10-10.

The tests have been performed at DEKRA Testing and Certification.

Environmental conditions

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

Temperature	Min. = 15 °C Max. = 35 °C
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 °C Max. = 35 °C
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 °C Max. = 35 °C
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

Modifications to the reference test report

It was introduced the following modifications in respect to the test report number 54022RRF.003 related with the same samples, in the next clauses and sub-clauses:

Clauses / Sub-clauses	Modification	Justification
Appendix B/ Section 15.247 Subclause (d) - RSS-247 5.5 Test.	The sentence to determine the worst case was modified to clarify how it was chosen the worst case of radiated spurious emission.	TCB request

This modification test report cancels and replaces the test report 54022RRF.003.

Remarks and comments

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

2: Used instrumentation:

Conducted Measurements

	Last Cal. date	Cal. due date
1. Spectrum analyser Agilent E4440A	2017/10	2019/10
2. DC power supply R&S NGPE 40/40	2014/11	2017/11
3. RF Bluetooth Test Set Anritsu MT8852B	N.A.	N.A.

Radiated Measurements

	Last Cal. date	Cal. due date
1. Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2. BiconicalLog antenna ETS LINDGREN 3142E	2017/07	2020/04
3. Multi Device Controller EMCO 2090	N.A.	N.A.
4. Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
5. Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2017/03	2020/03
6. EMI Test Receiver R&S ESU 40	2016/03	2018/03
7. Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
8. RF pre-amplifier 30 MHz-6 GHz BONN BLNA 0360-01N	2017/07	2018/07
9. RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2016/02	2018/02
10. RF pre-amplifier 18-40 GHz BONN ELEKTRONIK BLMA 1840-1M	2015/12	2017/12
11. RF Bluetooth Test Set Anritsu MT8852B	N.A.	N.A.

Testing verdicts

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

1. - BT EDR

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

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

FCC PART 15 PARAGRAPH		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-247 5.2. (a)	6 dB Bandwidth		P		
Section 15.247 Subclause (b) / RSS-247 5.4. (d)	Maximum output power and antenna gain		P		
Section 15.247 Subclause (d) / RSS-247 5.5	Emission limitations conducted (Transmitter)		P		
Section 15.247 Subclause (d) / RSS-247 5.5. ..	Band-edge emissions compliance (Transmitter)		P		
Section 15.247 Subclause (e) / RSS-247 5.2. (b)	Power spectral density		P		
Section 15.247 Subclause (d) / RSS-247 5.5. ...	Emission limitations radiated (Transmitter)		P		

Appendix A – Test result (Bluetooth EDR)

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TEST CONDITIONS

Power supply (V):

$V_{\text{nominal}} = 12.6 \text{ Vdc}$

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

Type of antenna: External antenna.

Declared Gain for antenna RF port 3 (maximum) = 0.7 dBi. (Antenna gain plus antenna cable loss)

TEST FREQUENCIES:

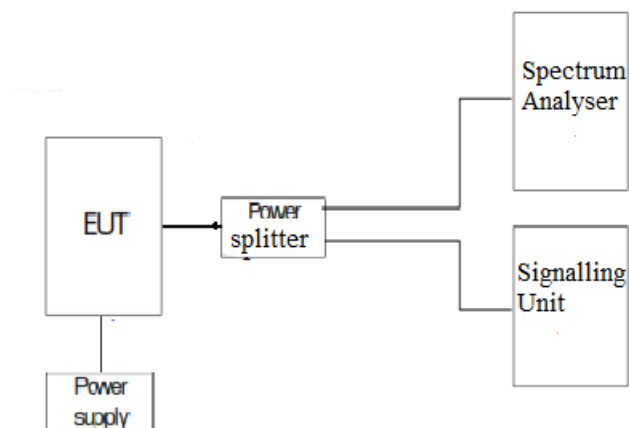
Lowest channel: 2402 MHz

Middle channel: 2441 MHz

Highest channel: 2480 MHz

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to a Bluetooth signalling unit (Bluetooth test set) and to the spectrum analyzer using a 6 dB power splitter. The reading in the spectrum analyzer is corrected taking into account the power splitter loss.



The DC supply voltage is applied using an external calibrated 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 for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

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

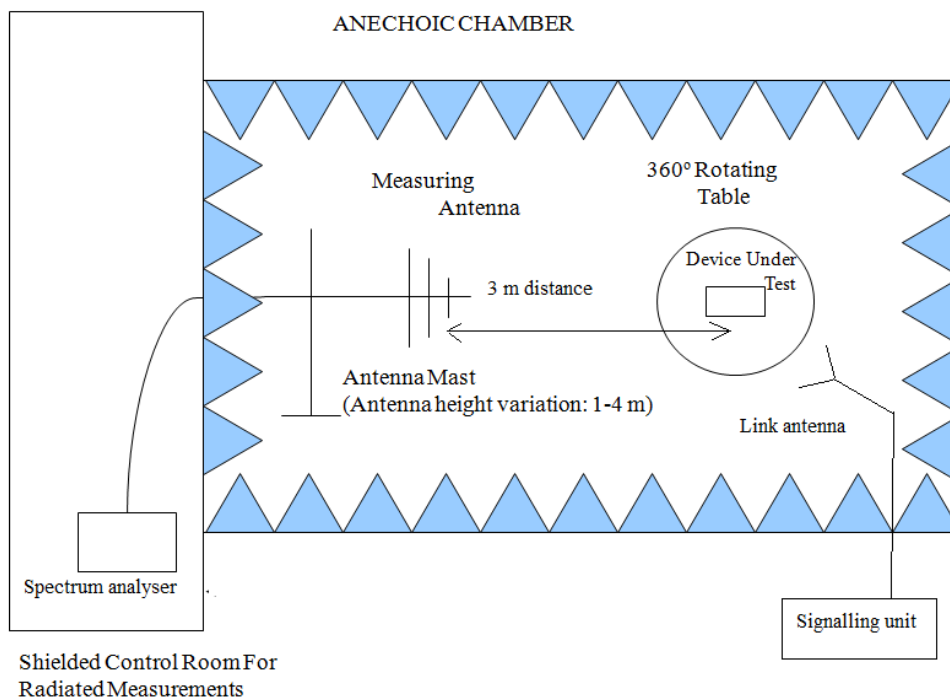
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission.

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

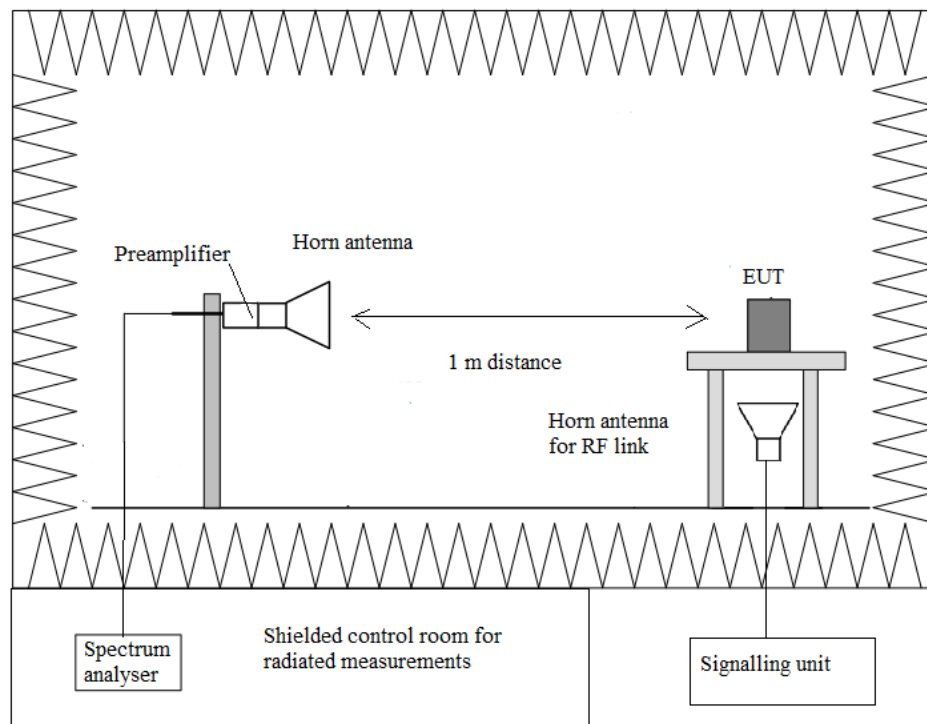
Measurements were made in both horizontal and vertical planes of polarization.

An additional horn antenna is used to control the equipment under test with the Bluetooth signalling unit (Bluetooth test set).

Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz



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

SPECIFICATION

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

RESULTS

(See next plots)

Modulation: GFSK

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1008	943.788	945.995
Measurement uncertainty (kHz)	<±5.00		

Modulation: Π/4-DQPSK (2Mbps)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1360	1361	1361
Measurement uncertainty (kHz)	<±5.00		

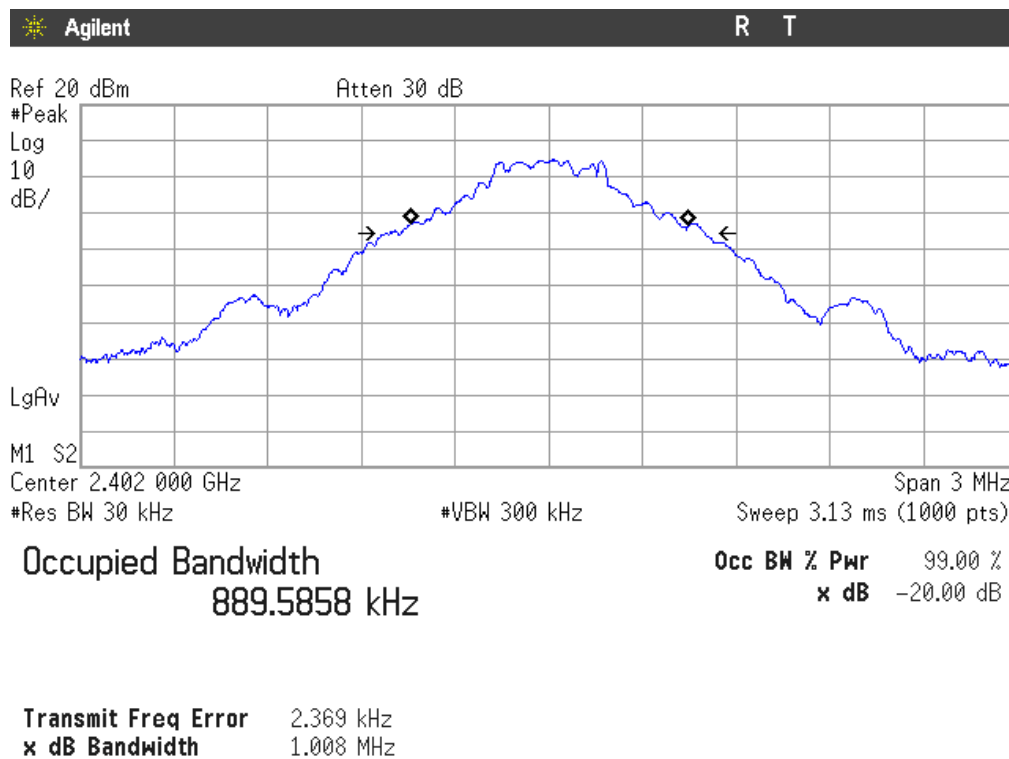
Modulation: 8-DPSK (3Mbps)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1312	1317	1317
Measurement uncertainty (kHz)	<±5.00		

Modulation: GFSK

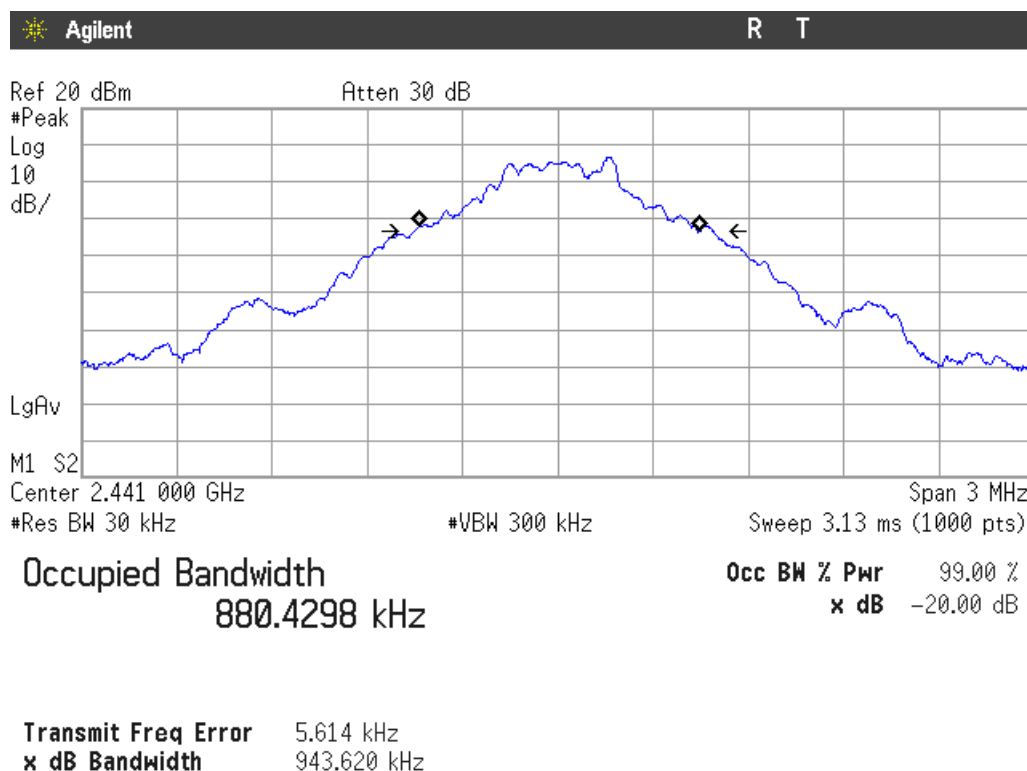
20 dB BANDWIDTH.

Lowest Channel: 2402 MHz.



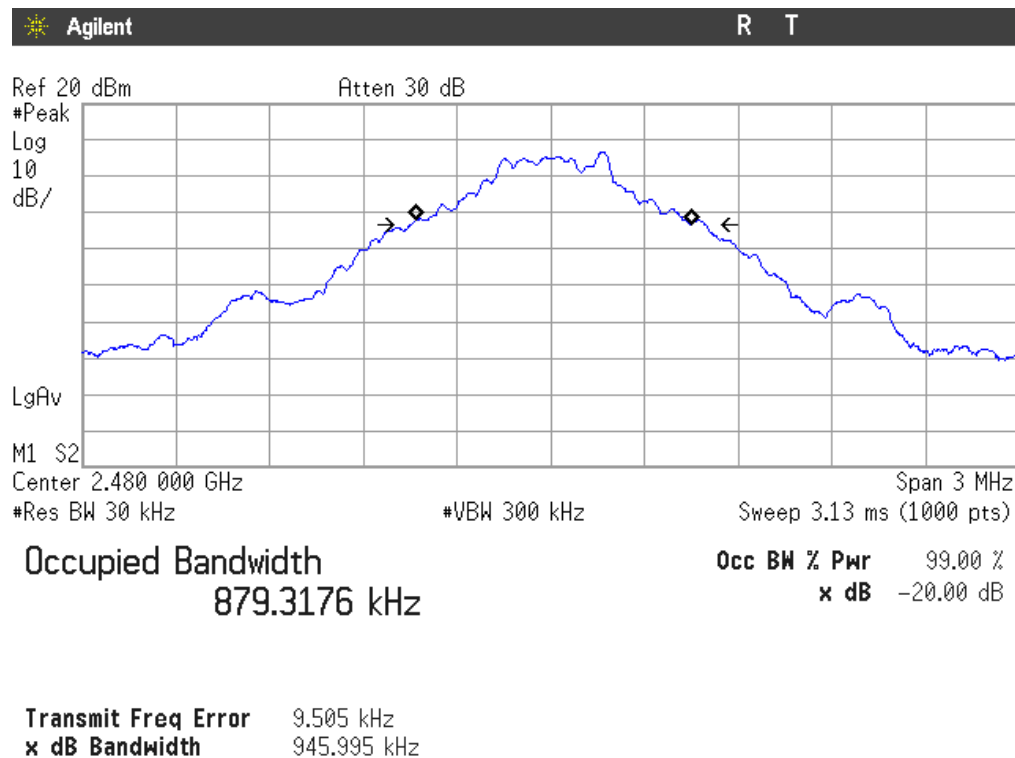
20 dB BANDWIDTH

Middle Channel: 2441 MHz.

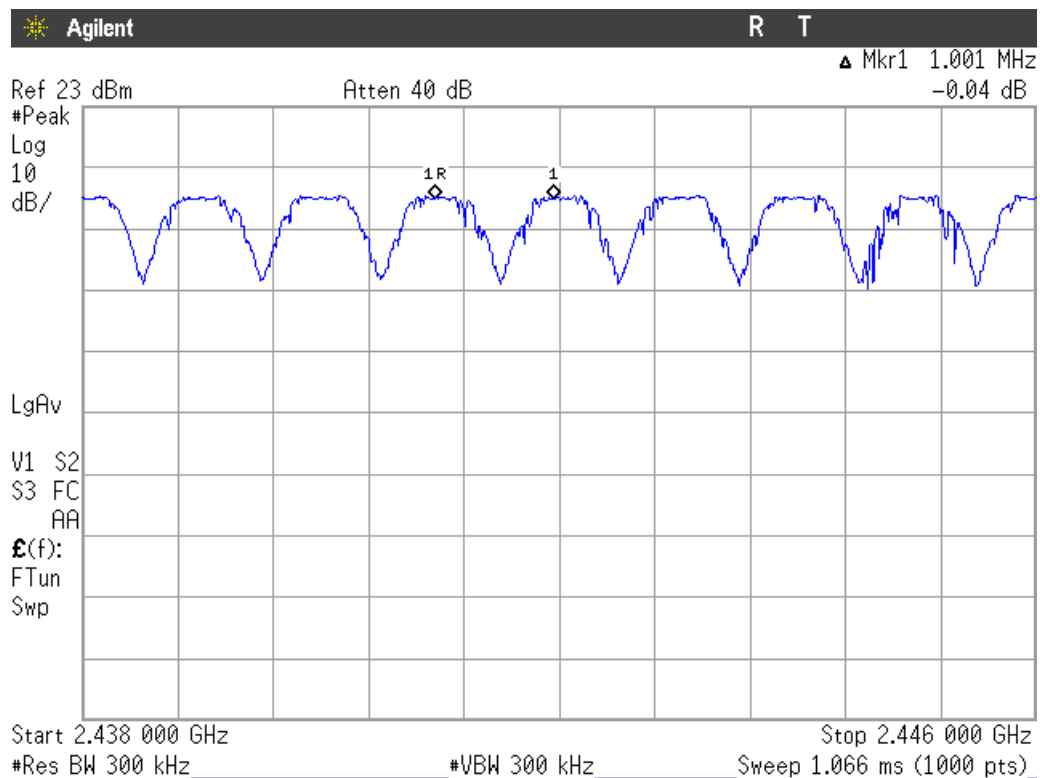


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



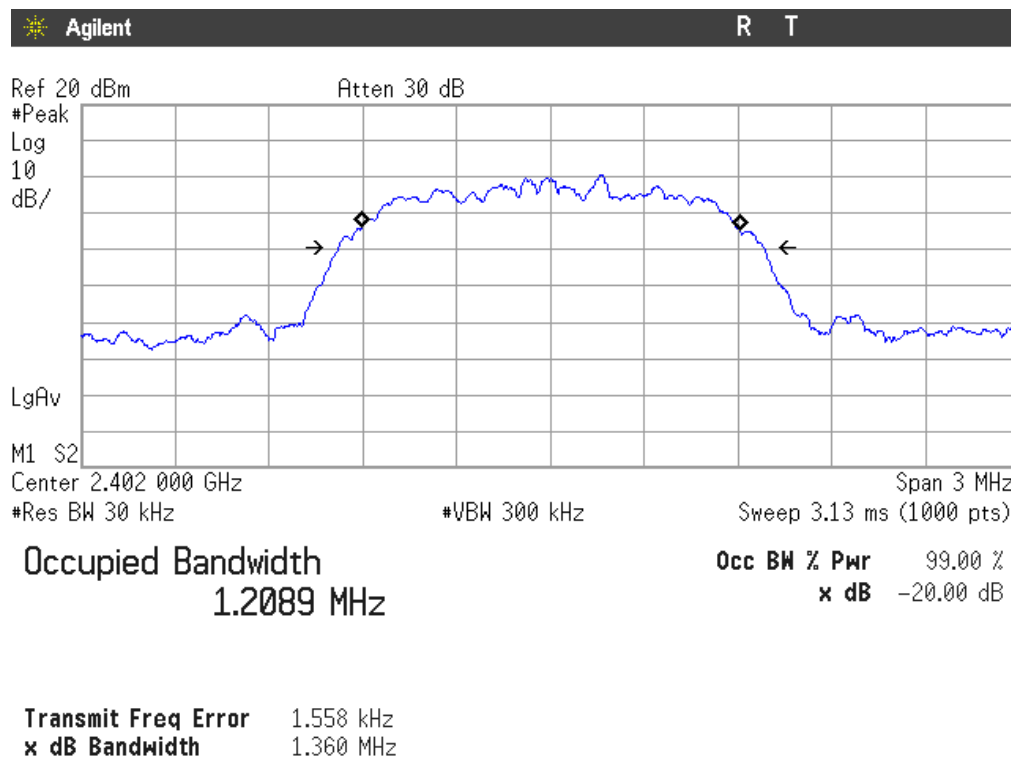
The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel.

Verdict: PASS

Modulation: $\Pi/4$ -DQPSK

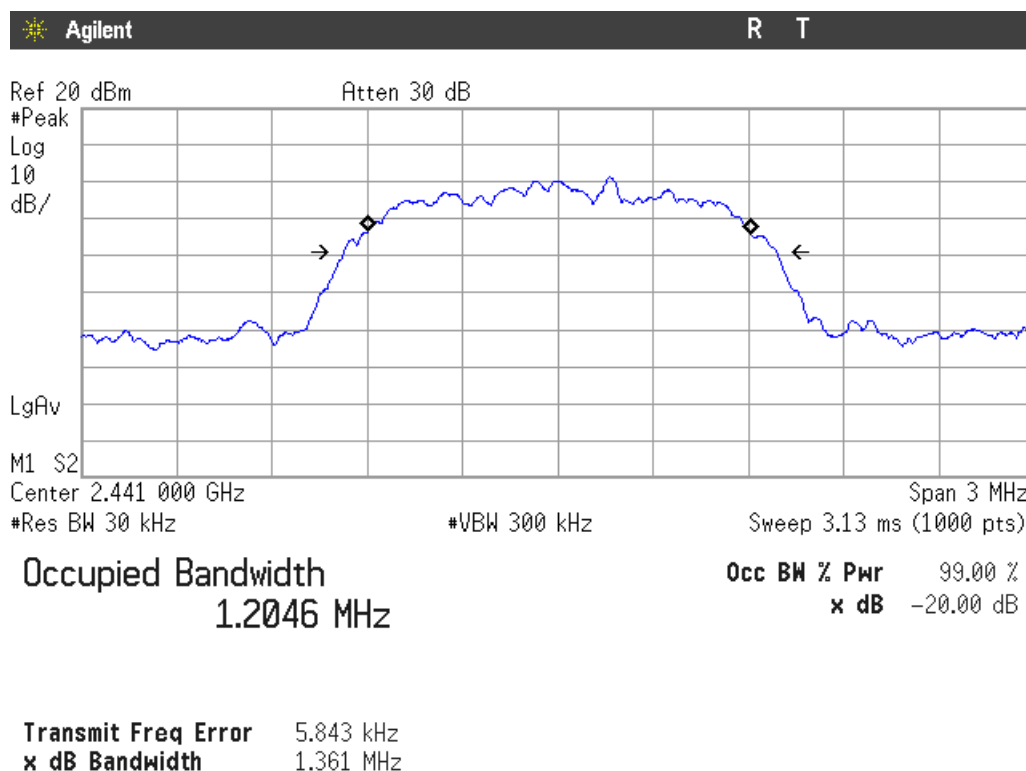
20 dB BANDWIDTH.

Lowest Channel: 2402 MHz.



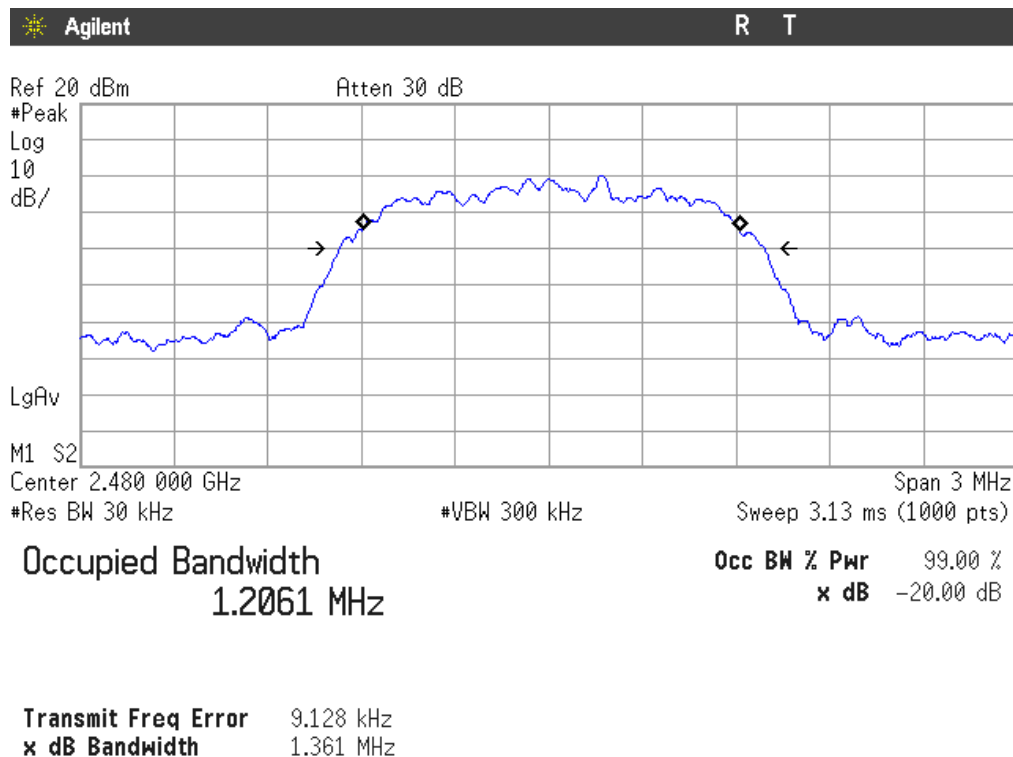
20 dB BANDWIDTH

Middle Channel: 2441 MHz.

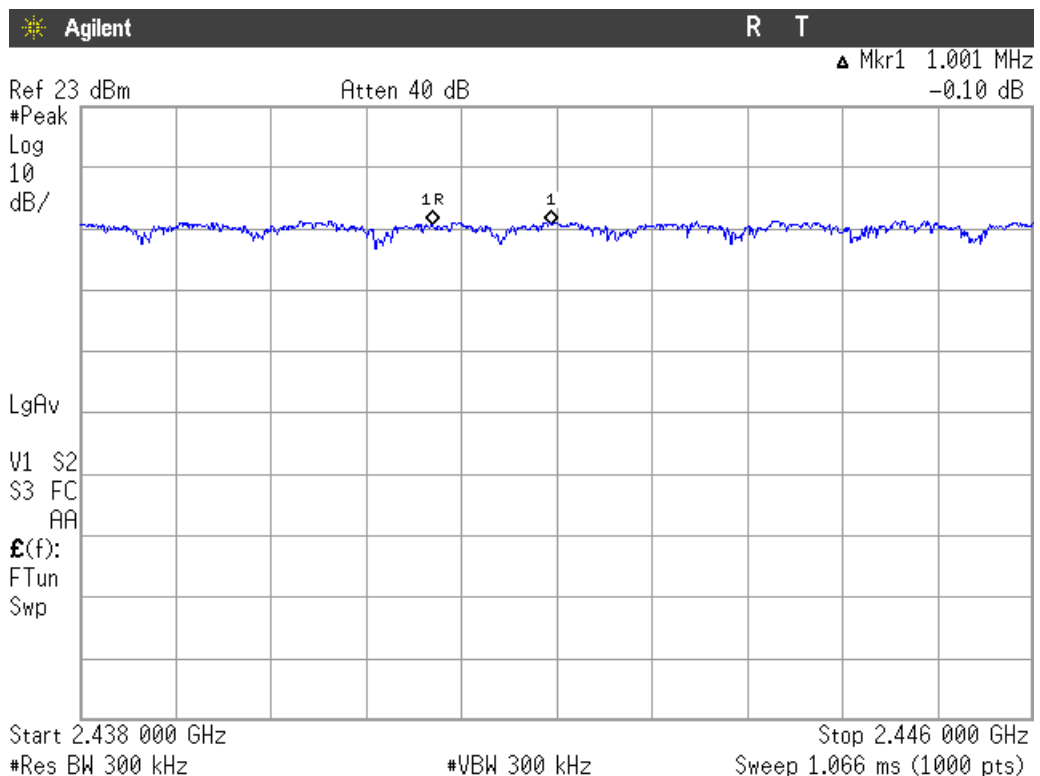


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



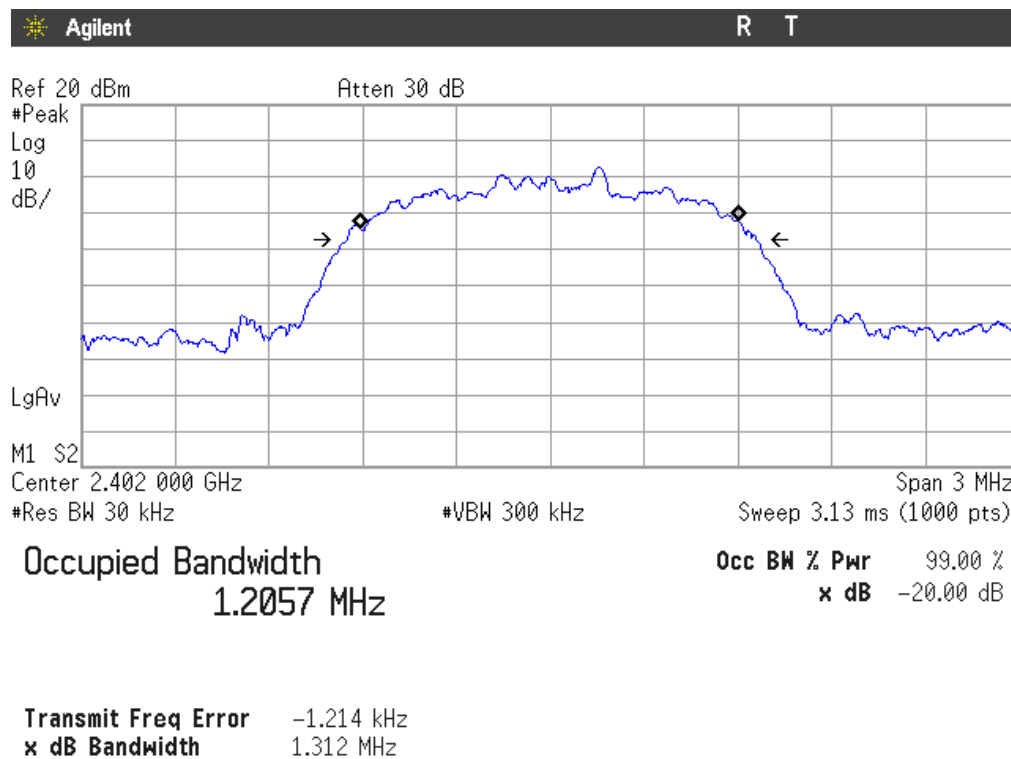
The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel

Verdict: PASS

Modulation: 8-DPSK

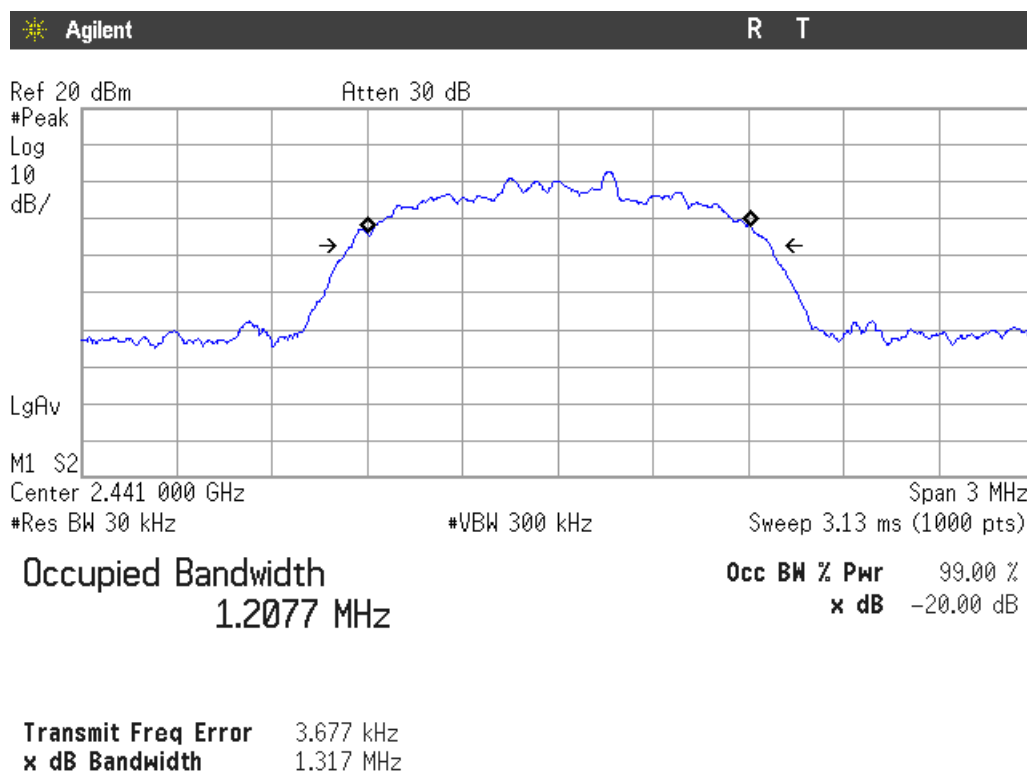
20 dB BANDWIDTH

Lowest Channel: 2402 MHz.



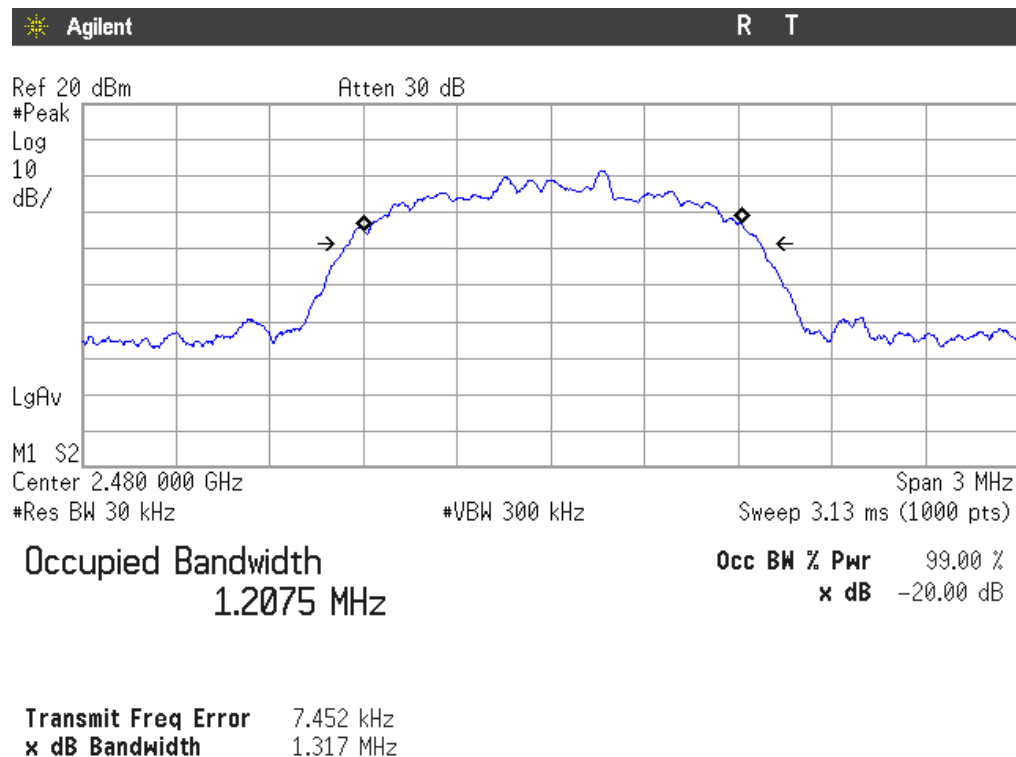
20 dB BANDWIDTH

Middle Channel: 2441 MHz.

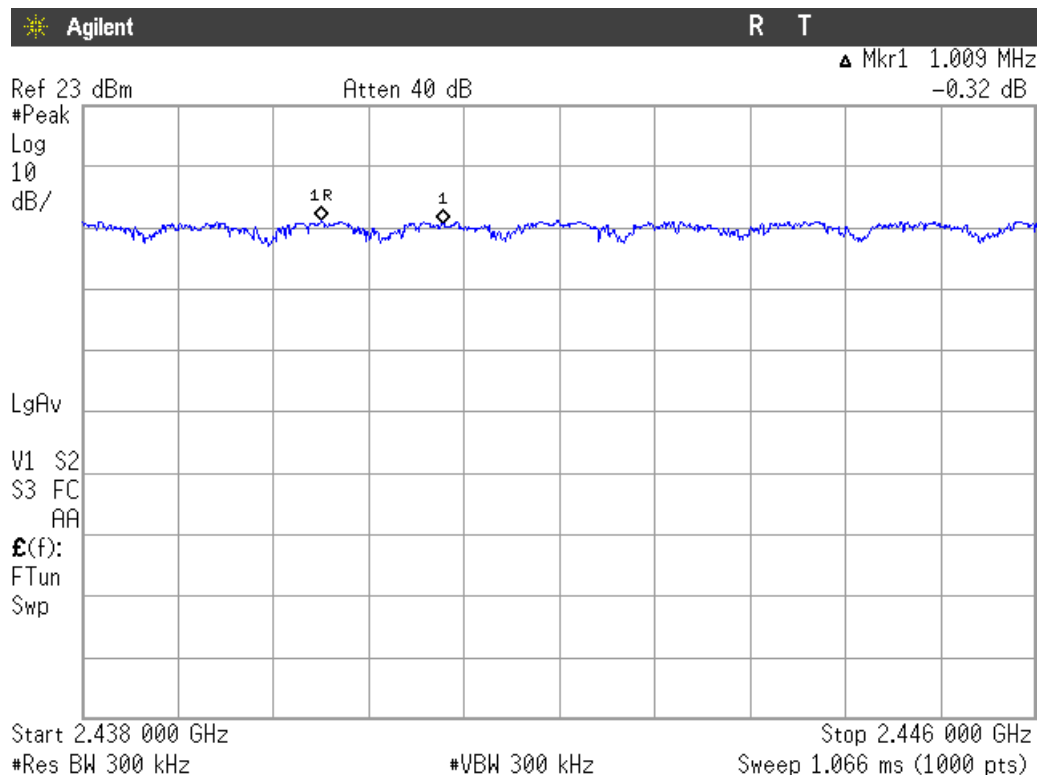


20 dB BANDWIDTH

Highest Channel: 2480 MHz.



Carrier frequency separation



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

Verdict: PASS

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

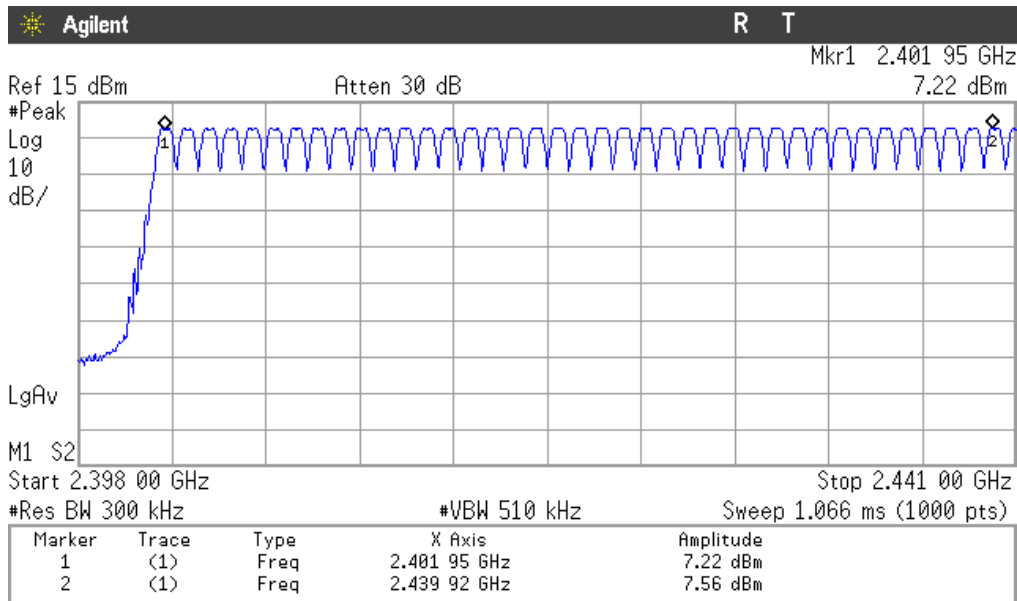
SPECIFICATION

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

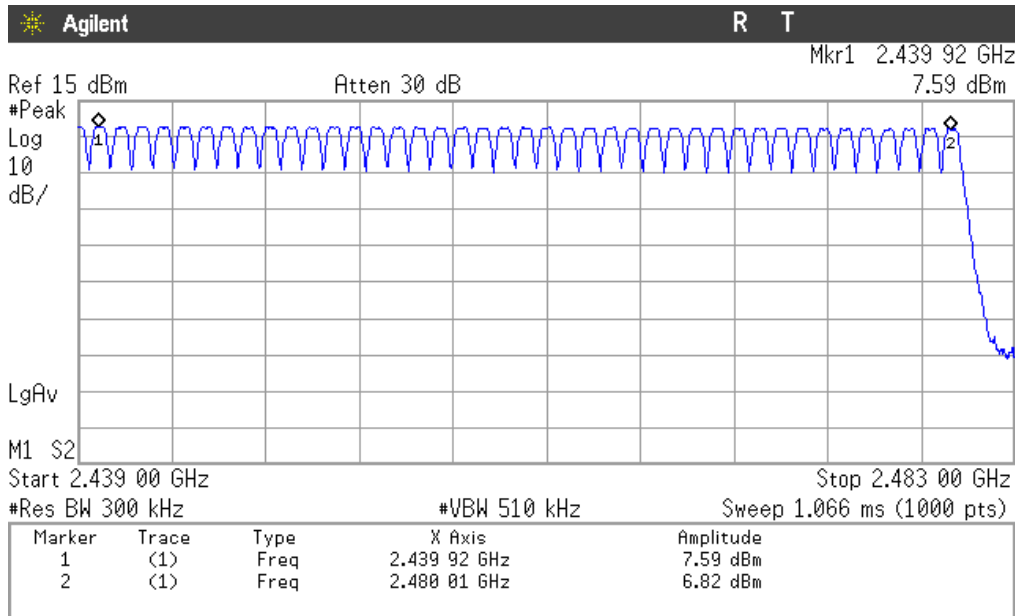
RESULTS

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

Modulation: GFSK



Number of hopping frequencies: 39

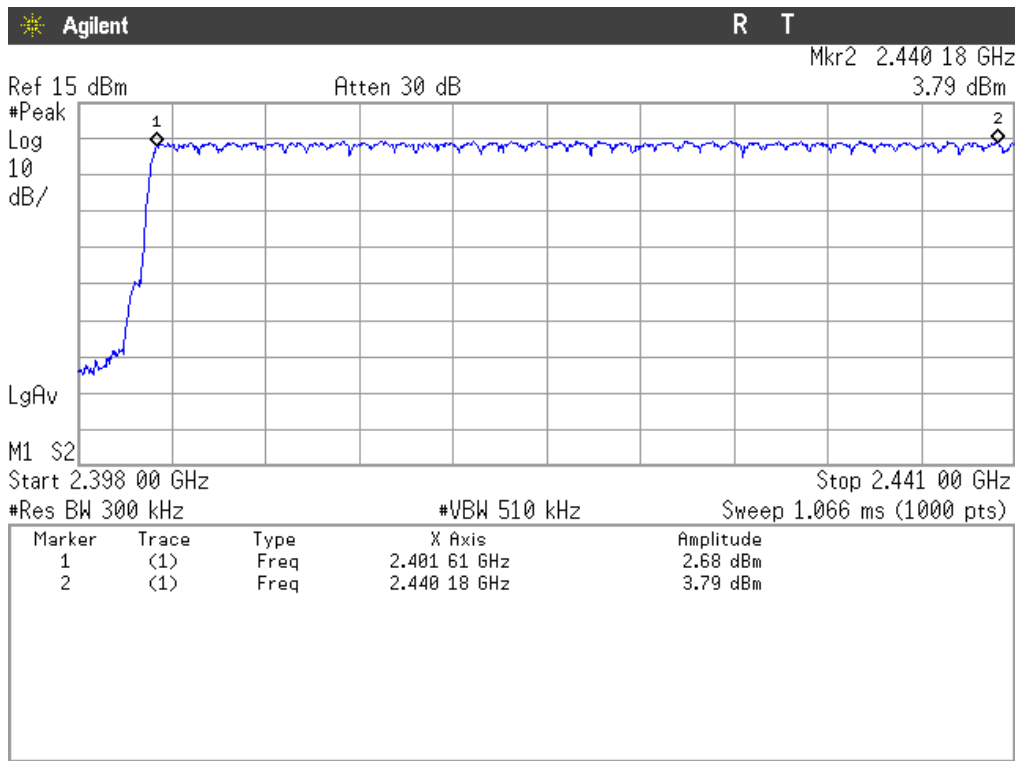


Number of hopping frequencies: 40

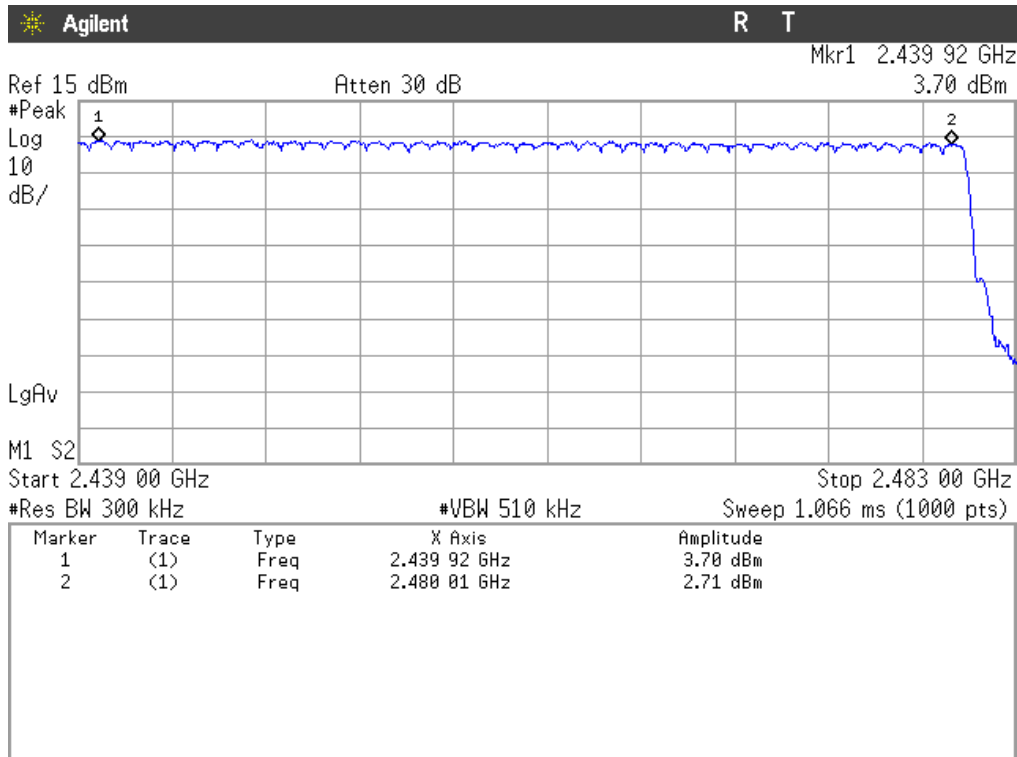
Total number of hopping frequencies: 79

Verdict: PASS

Modulation: $\Pi/4$ -DQPSK



Number of hopping frequencies: 39

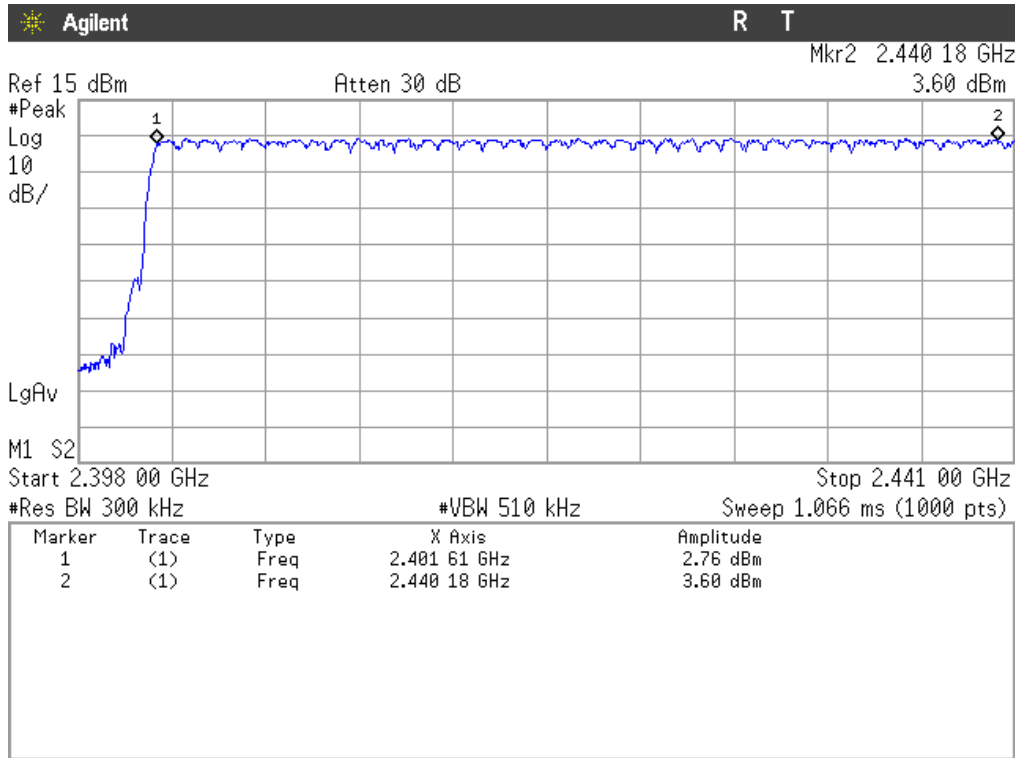


Number of hopping frequencies: 40

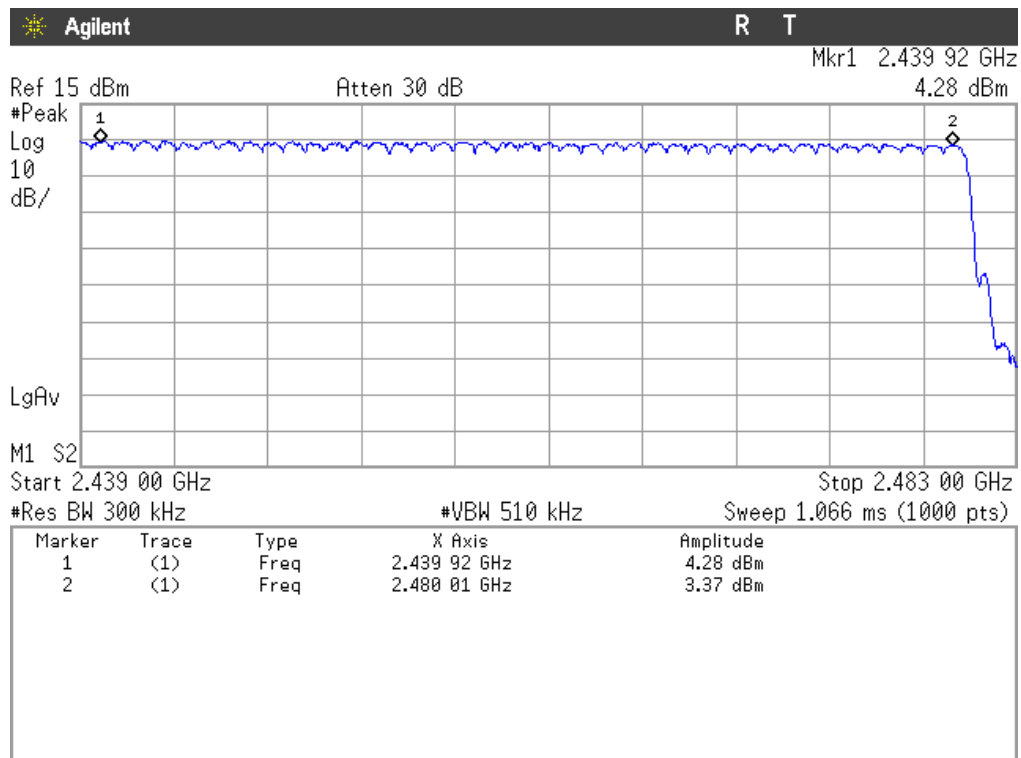
Total number of hopping frequencies: 79

Verdict: PASS

Modulation: 8-DPSK



Number of hopping frequencies: 39



Number of hopping frequencies: 40

Total number of hopping frequencies: 79

Verdict: PASS

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

SPECIFICATION

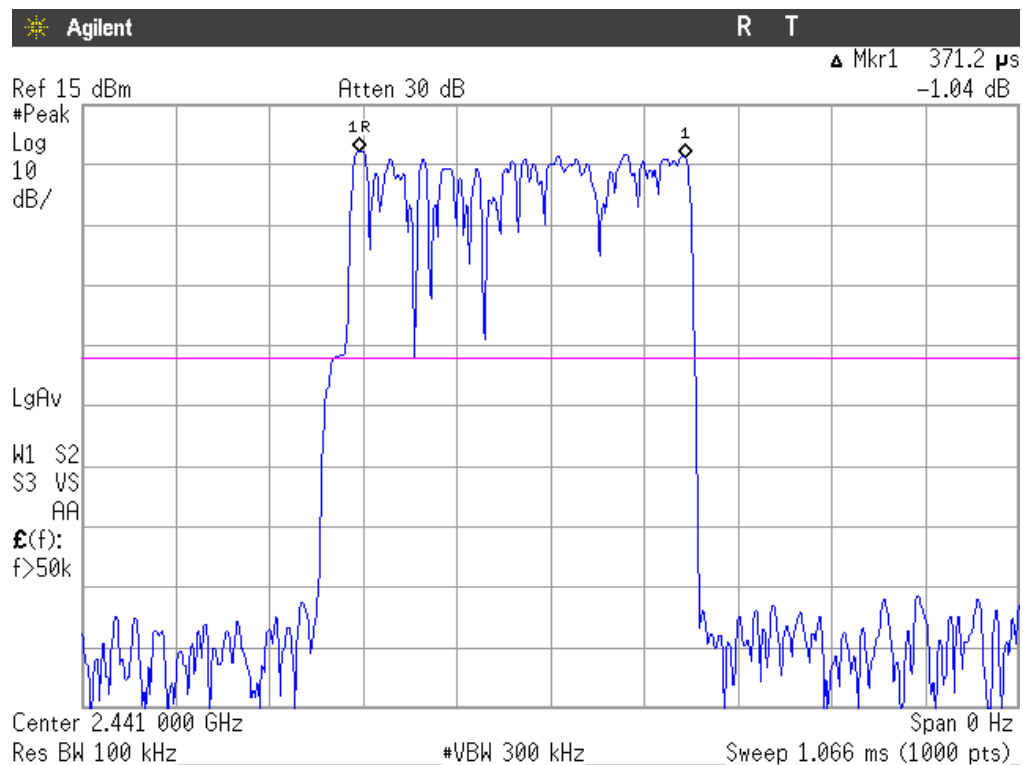
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = $0.4 \times 79 = 31.6$ seconds.

RESULTS

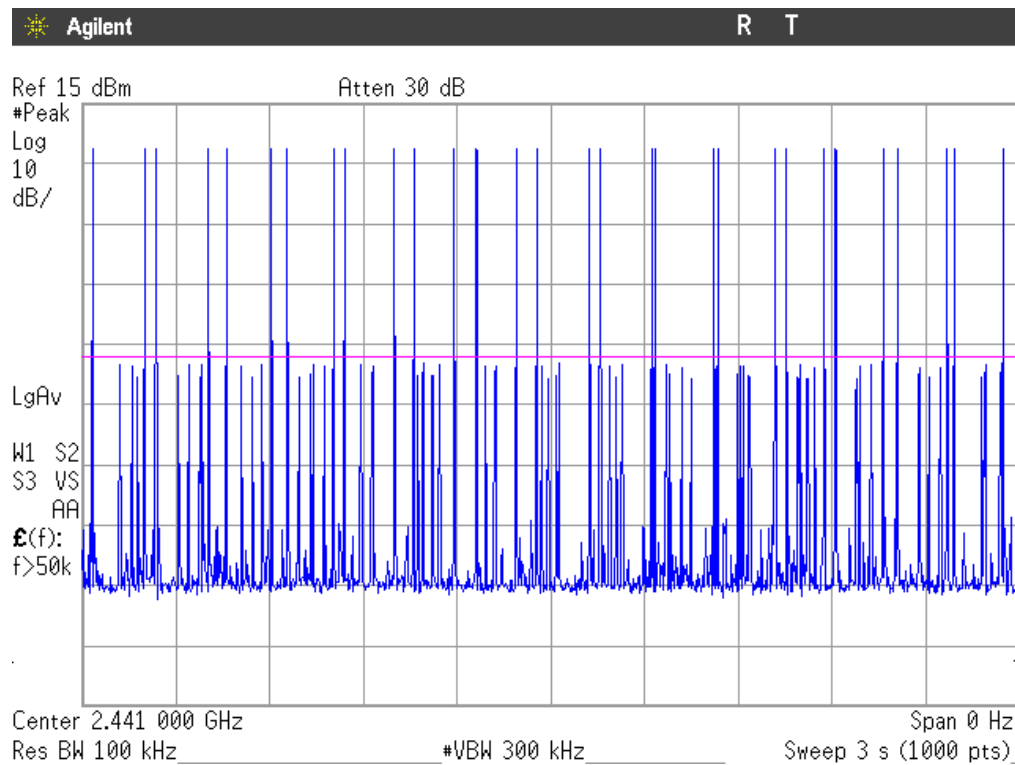
Modulation: GFSK

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

- Tx- time per hop = 371.2 μ s (see next plot).



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



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

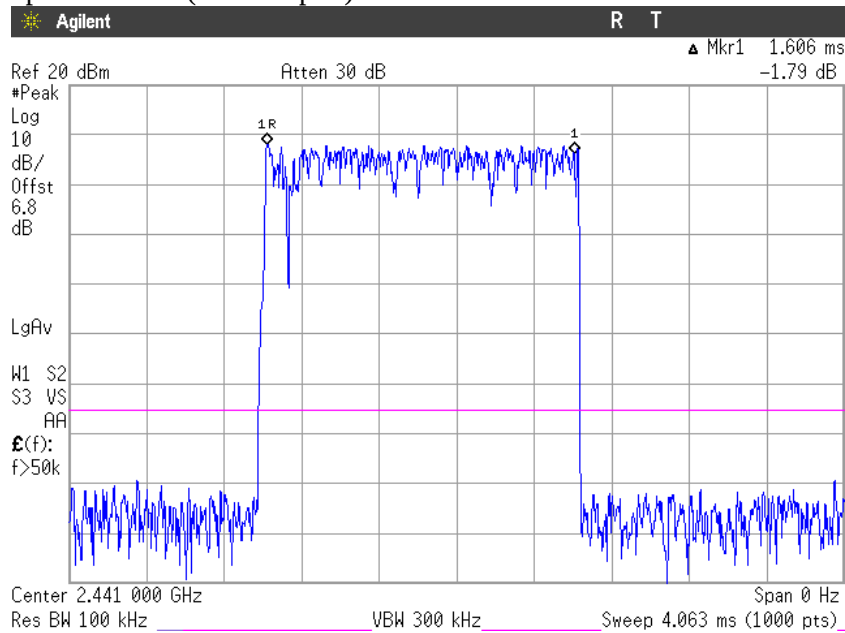
Averaging time of occupancy = 371.2 μ s x 316 hops = 117.3 ms per 31.6 seconds.

Measurement uncertainty (%)	< $\pm$ 0.01
-----------------------------	--------------

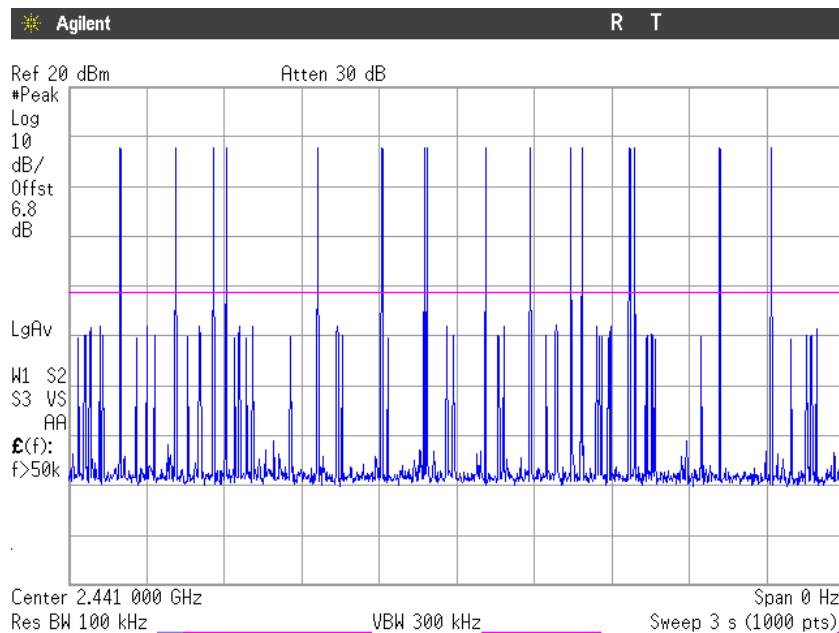
Verdict: PASS

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

- Tx- time per hop = 1.606 ms (see next plot).



- Number of hops over a period of 3 seconds = 15 (see next plot).



Number of hops in the period specified in the requirements = (15 hops) x (31.6 s / 3 s) = 158 hops.

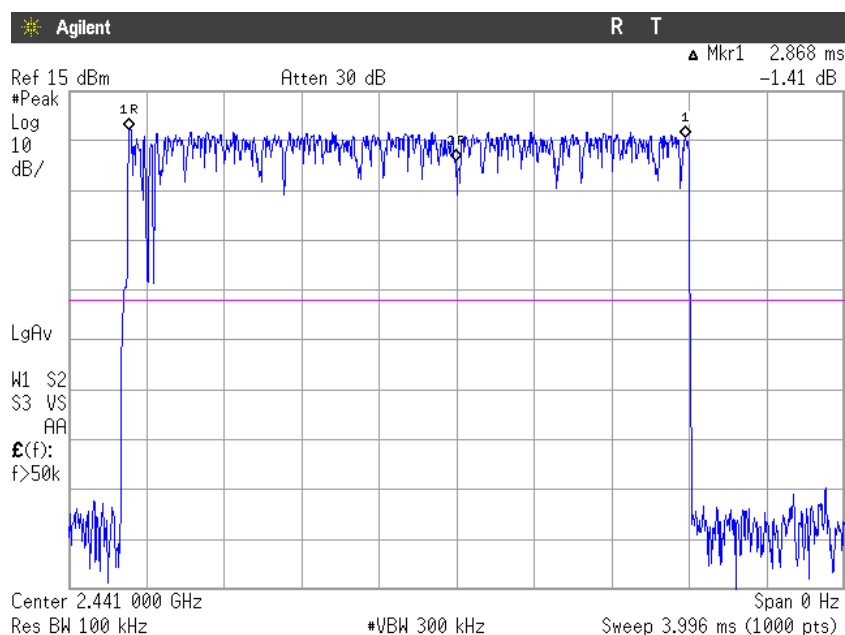
Averaging time of occupancy = 1.606 ms x 158 hops = 253.75 ms per 31.6 seconds.

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

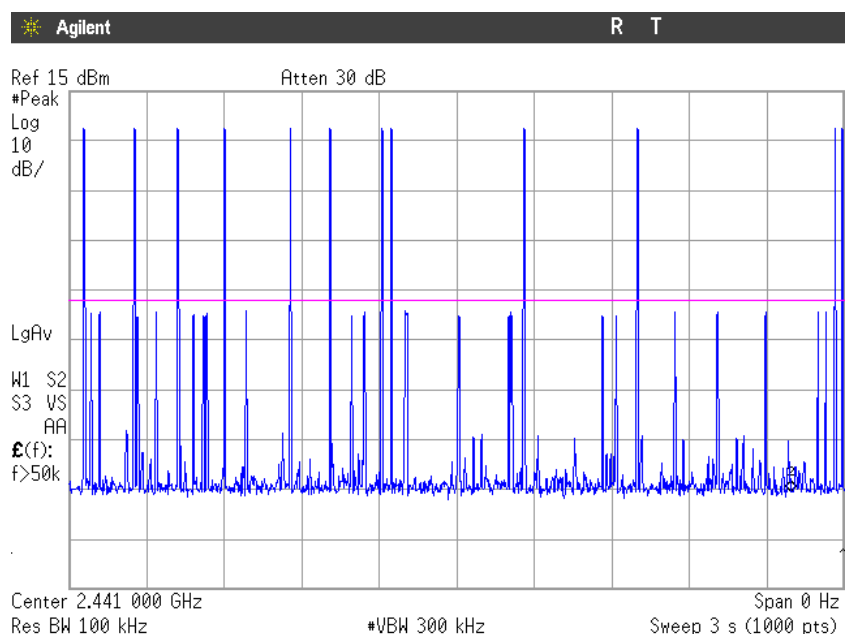
Verdict: PASS

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

- Tx- time per hop = 2.868 ms (see next plot).



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



Number of hops in the period specified in the requirements = (12 hops) x (31.6 s / 3 s) = 126.4 hops.

Averaging time of occupancy = 2.868 ms x 126.4 hops = 362.52 ms per 31.6 seconds.

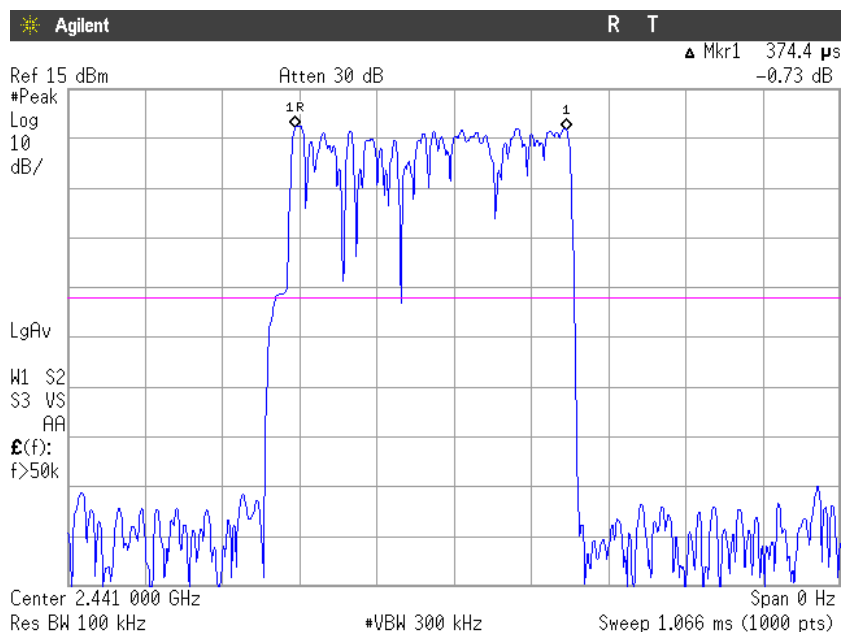
Measurement uncertainty (%)	<±0.01
-----------------------------	--------

Verdict: PASS

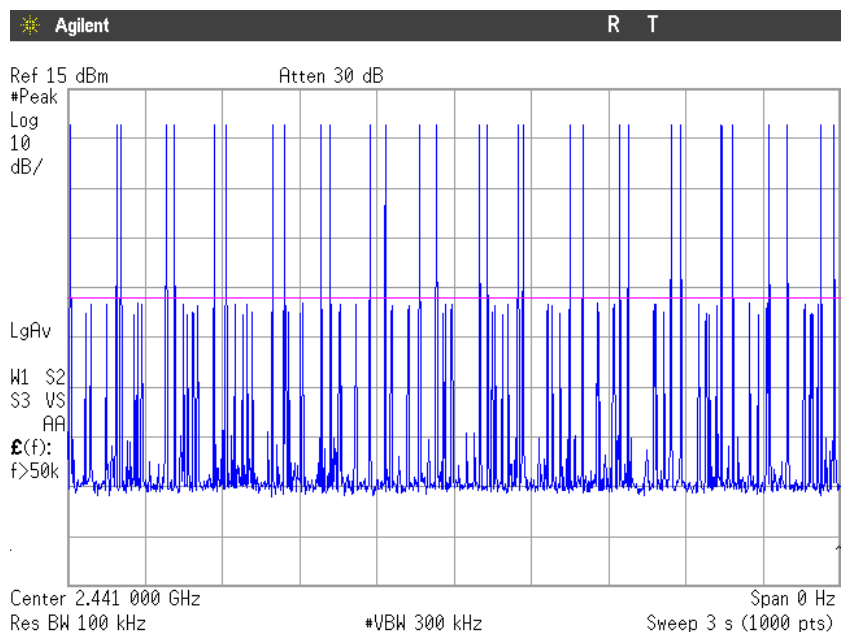
Modulation: Π/4-DQPSK

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

- Tx- time per hop = 374.4 μs (see next plot).



- Number of hops over a period of 3 second = 31 (see next plot).



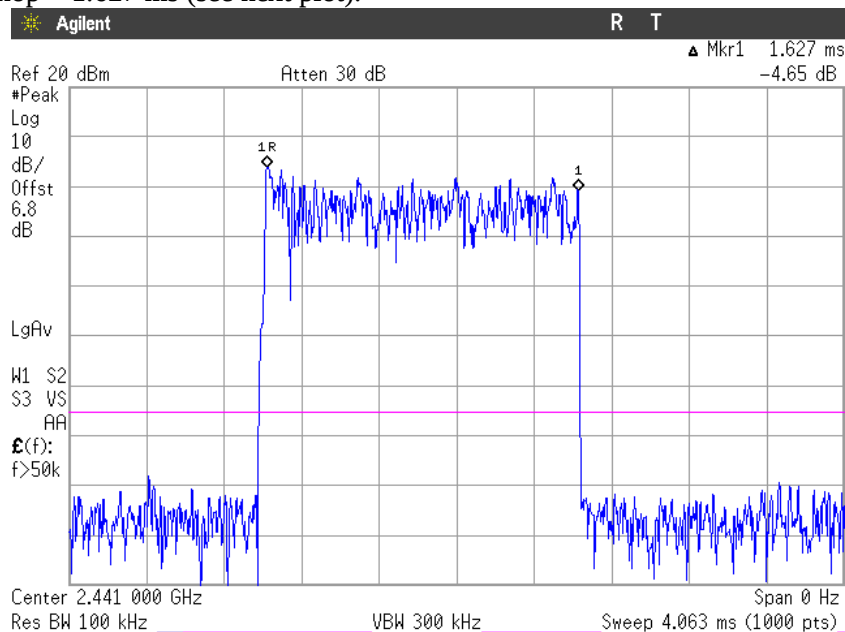
Number of hops in the period specified in the requirements = (31 hops) x (31.6 s / 1 s) = 326.53 hops.
Averaging time of occupancy = 374.4 μs x 326.53 hops = 122.25 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01
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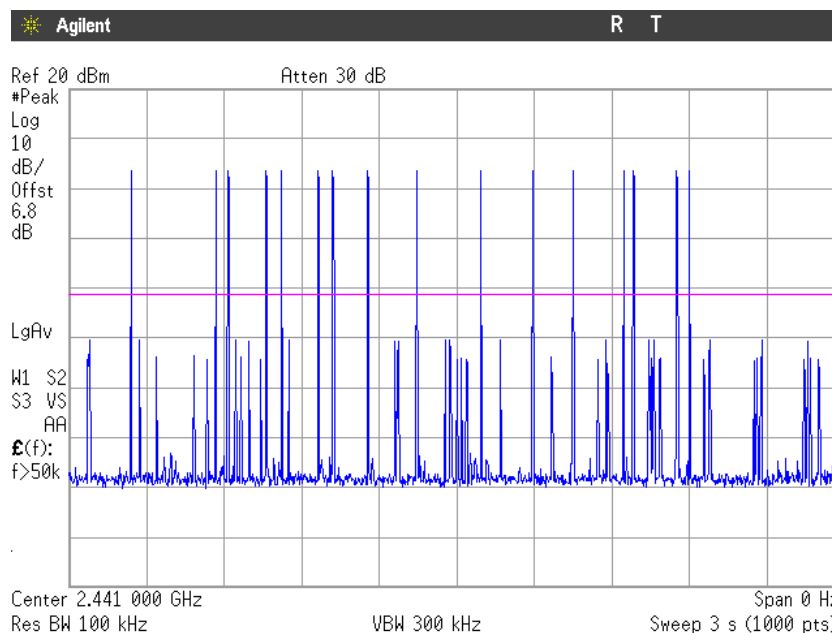
Verdict: PASS

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

- Tx- time per hop = 1.627 ms (see next plot).



- Number of hops over a period of 3 seconds = 15 (see next plot).



Number of hops in the period specified in the requirements = (15 hops) x (31.6 s / 3 s) = 158 hops.

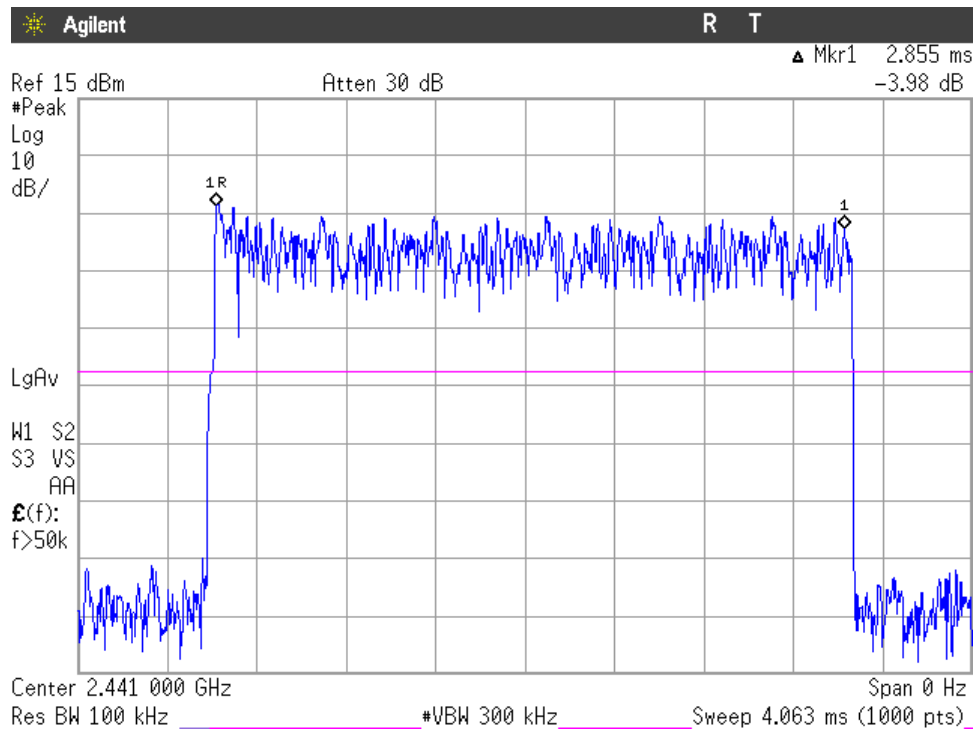
Averaging time of occupancy = 1.627 ms x 158 hops = 257.06 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01
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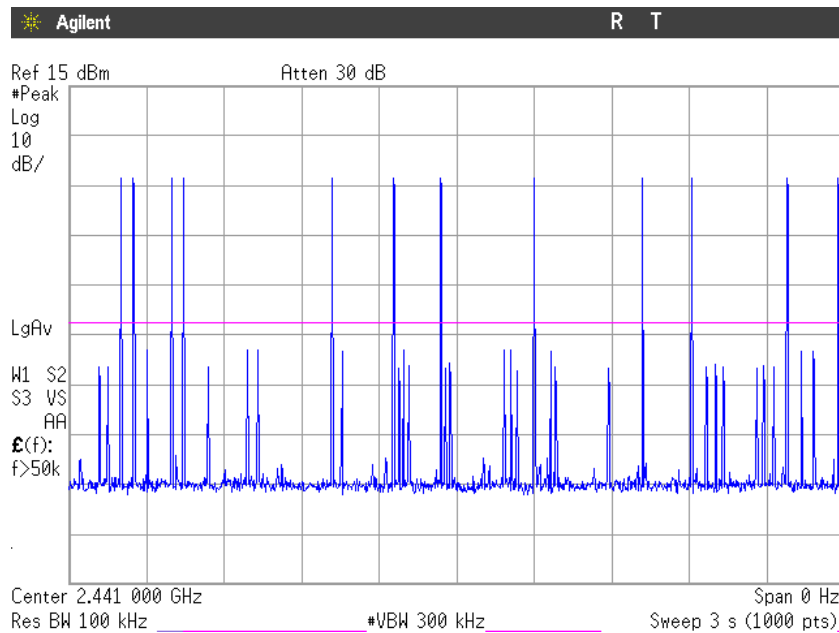
Verdict: PASS

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

- Tx- time per hop = 2.855 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) = 126.4 hops.
Averaging time of occupancy = 2.855 ms x 126.4 hops = 360.872 ms per 31.6 seconds.

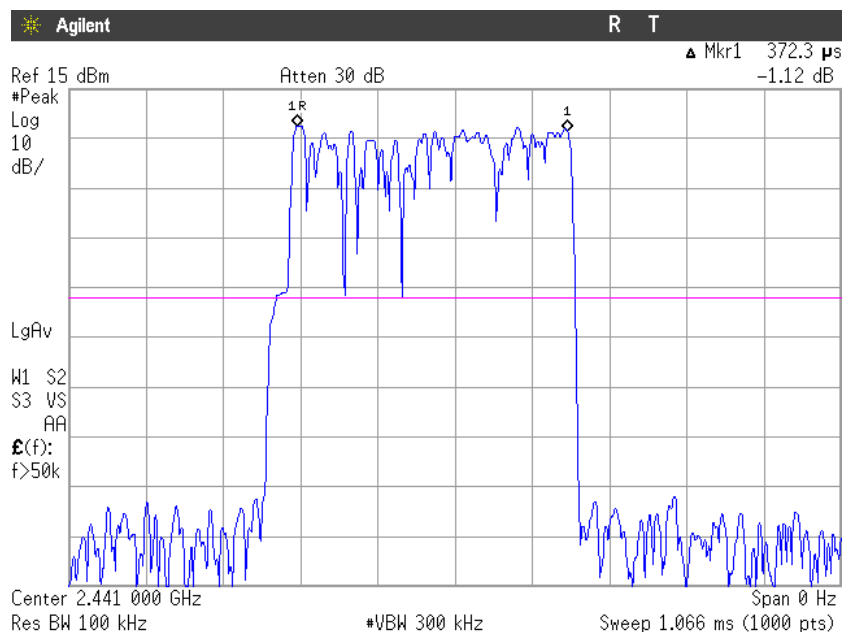
Measurement uncertainty (%)	<±0.01
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Verdict: PASS

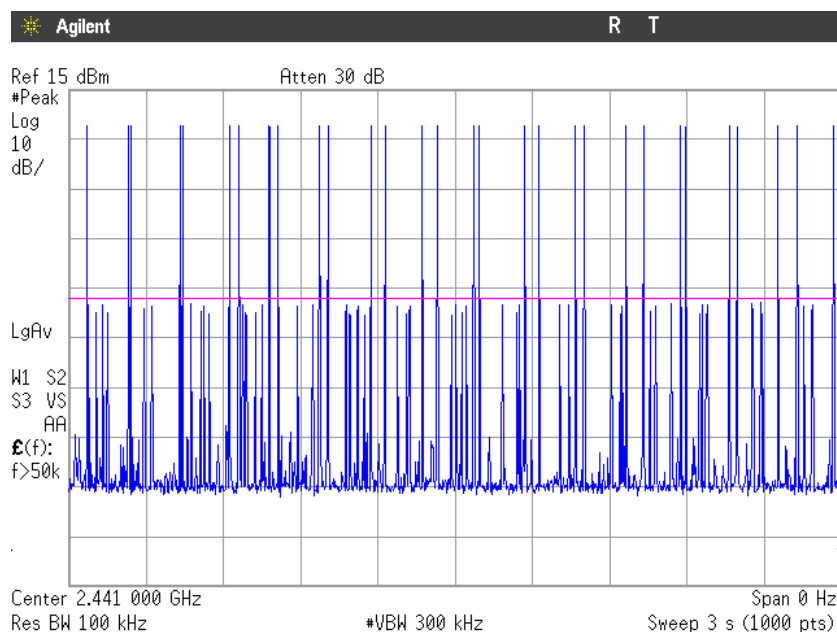
Modulation: 8-DPSK

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

- Tx- time per hop = 372.3 μ s (see next plot).



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



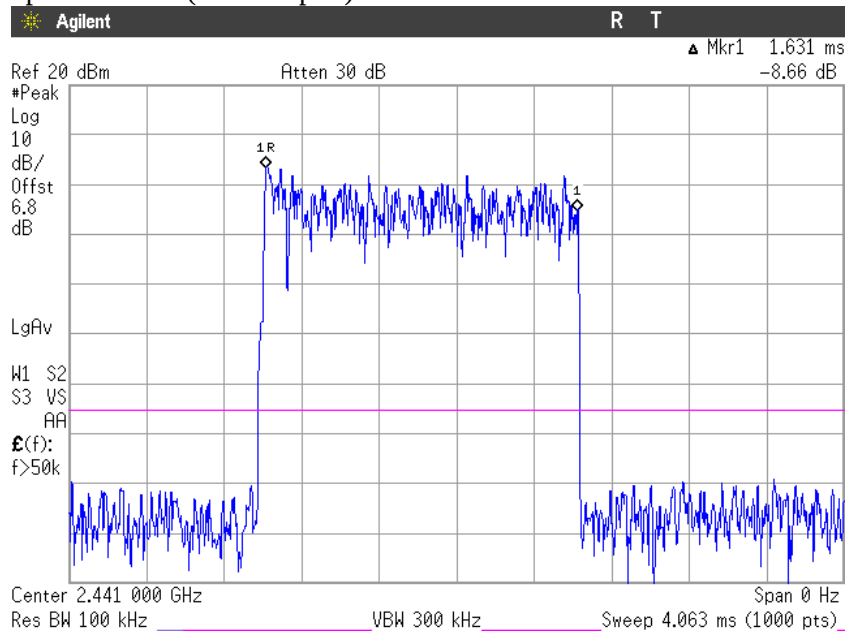
Number of hops in the period specified in the requirements = (30 hops) x (31.6 s / 3 s) = 316 hops.
Averaging time of occupancy = 372.3 μ s x 316 hops = 117.65 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01
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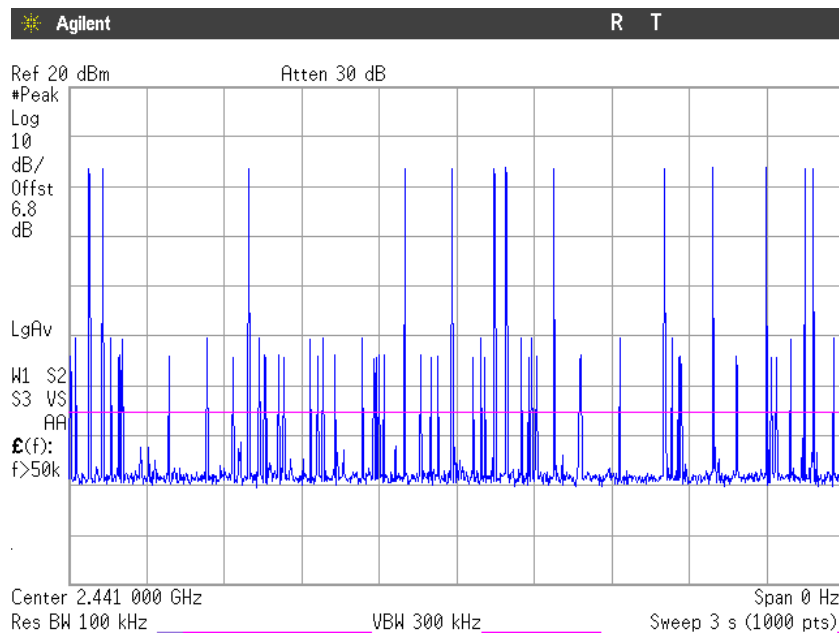
Verdict: PASS

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

- Tx- time per hop = 1.631 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) = 136.93 hops.

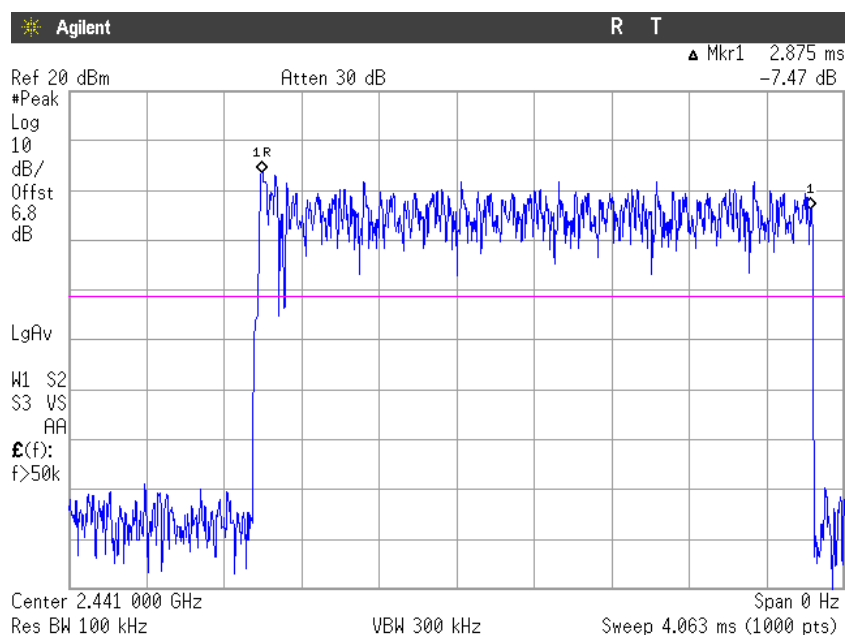
Averaging time of occupancy = 1.631 ms x 136.93 hops = 223.34 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01
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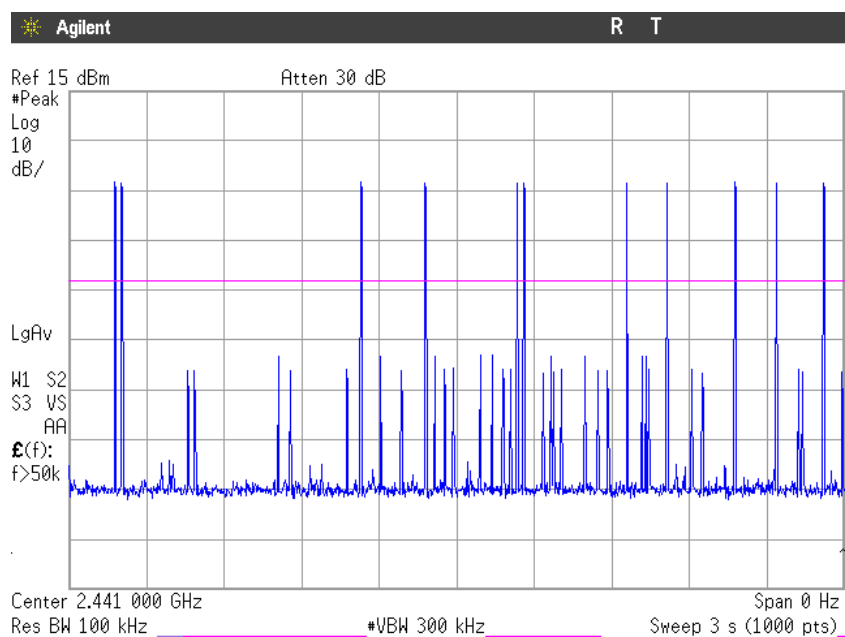
Verdict: PASS

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

- Tx- time per hop = 2.875 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) = 115.86 hops.
Averaging time of occupancy = 2.875 ms x 115.86 hops = 333.11 ms per 31.6 seconds.

Measurement uncertainty (%)	<±0.01
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Verdict: PASS

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

SPECIFICATION

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

MAXIMUM OUTPUT POWER. See next plots.

Declared Gain for antenna RF port 3 (maximum) = 0.7 dBi. (Antenna gain plus antenna cable loss)

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

Modulation: GFSK

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	6,80	7.48	7,25
Maximum EIRP power (dBm)	7.50	8.18	7.95
Measurement uncertainty (dB)	<±0.78		

Modulation: Π/4-DQPSK (2Mbps)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	6,11	5.46	5,06
Maximum EIRP power (dBm)	6.81	6.16	5.76
Measurement uncertainty (dB)	<±0.78		

Modulation: 8-DPSK (3Mbps)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	6,17	5.81	5,62
Maximum EIRP power (dBm)	6.87	6.51	6.32
Measurement uncertainty (dB)	<±0.78		

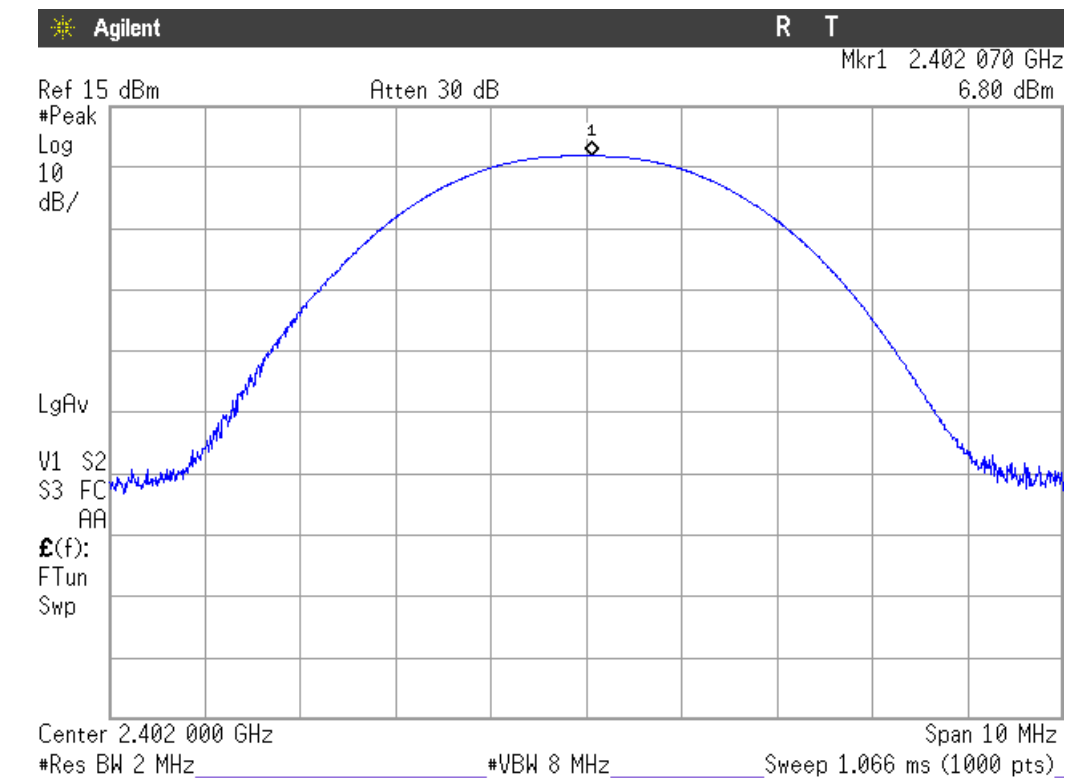
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

PEAK OUTPUT POWER (CONDUCTED).

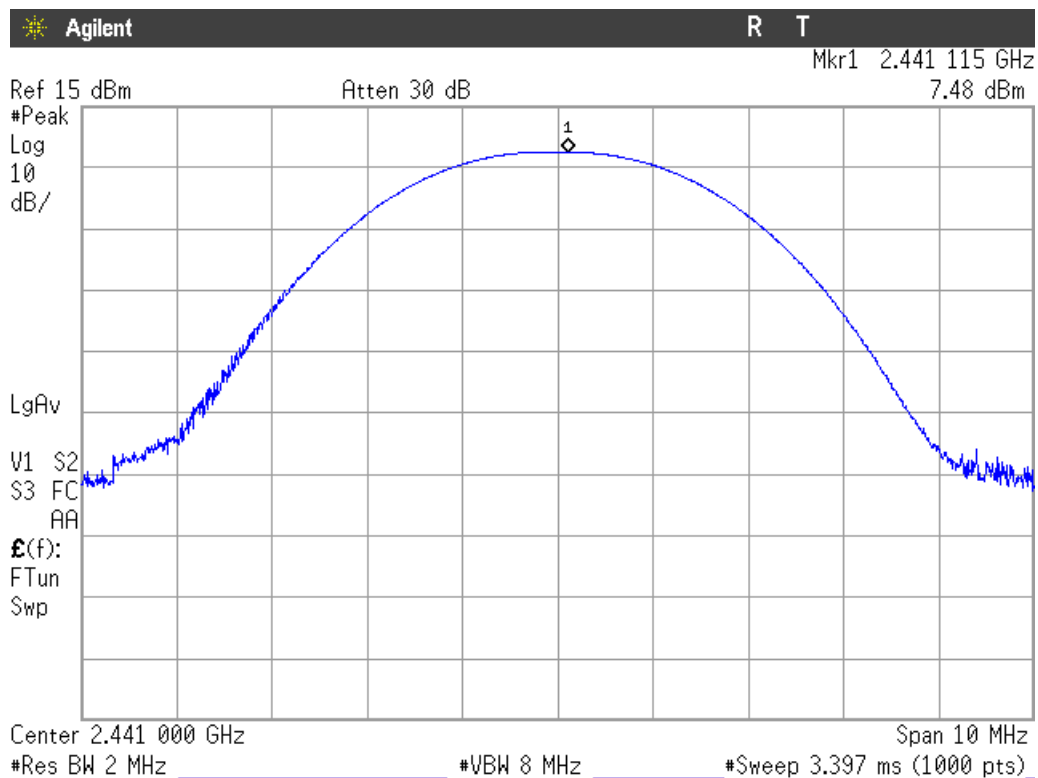
Modulation: GFSK

Lowest Channel: 2402 MHz.



Modulation: GFSK

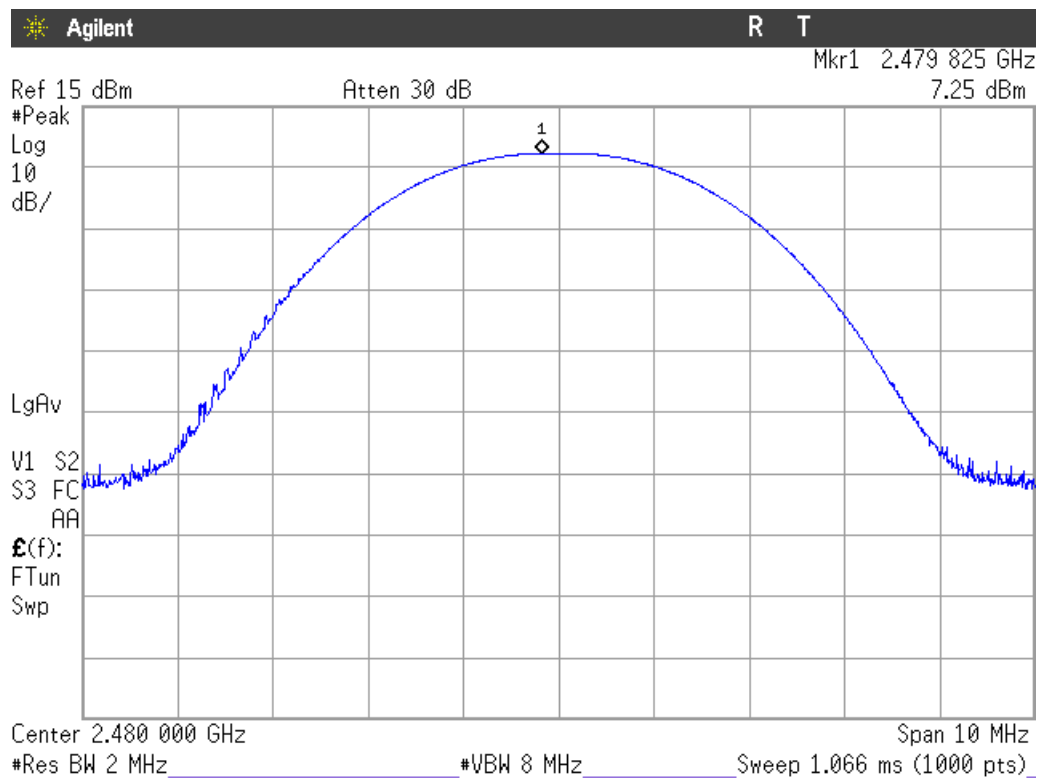
Middle Channel: 2441 MHz.



PEAK OUTPUT POWER (CONDUCTED).

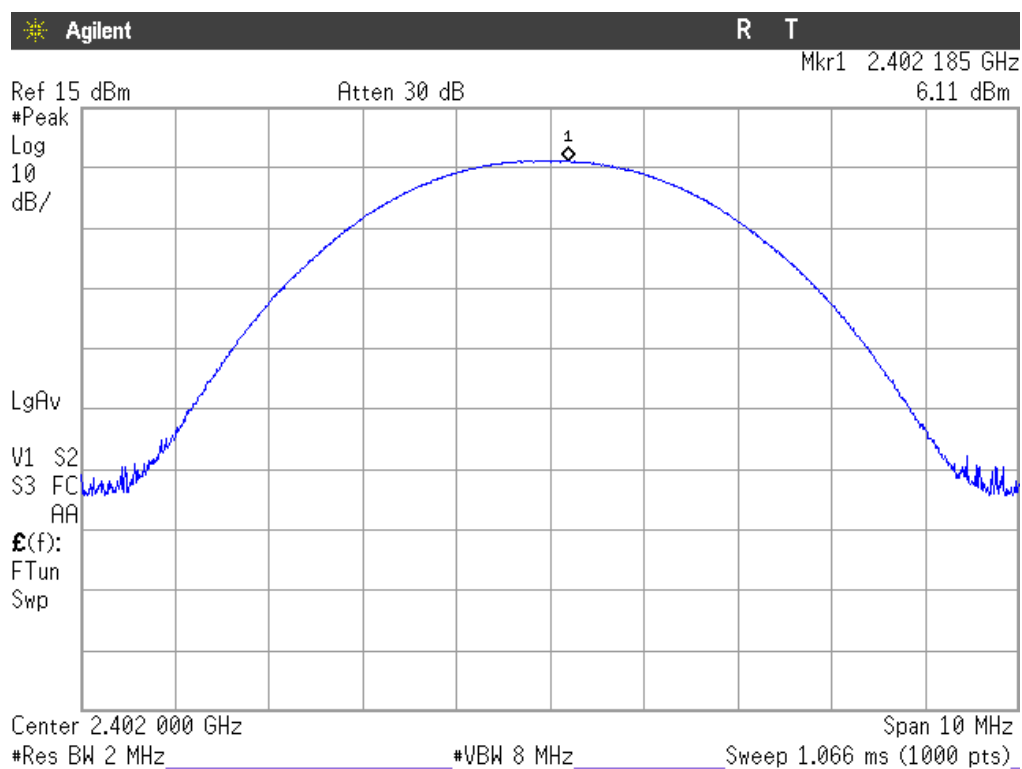
Modulation: GFSK

Highest Channel: 2480 MHz.



Modulation: $\Pi/4$ -DQPSK

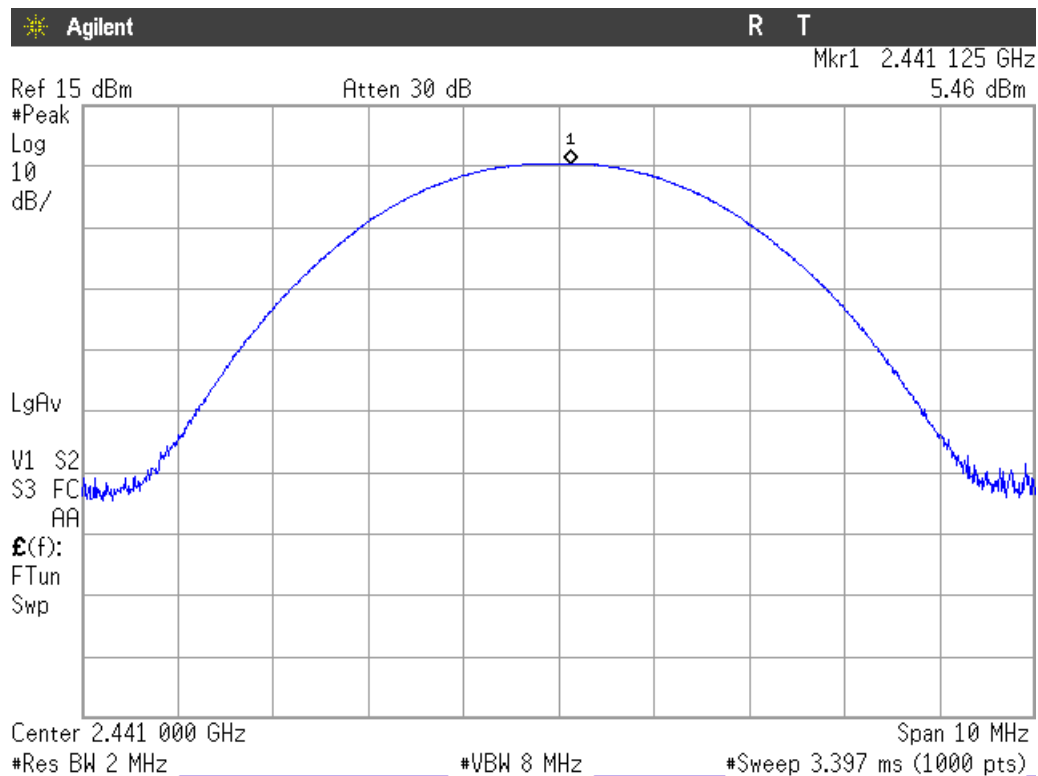
Lowest Channel: 2402 MHz



PEAK OUTPUT POWER (CONDUCTED)

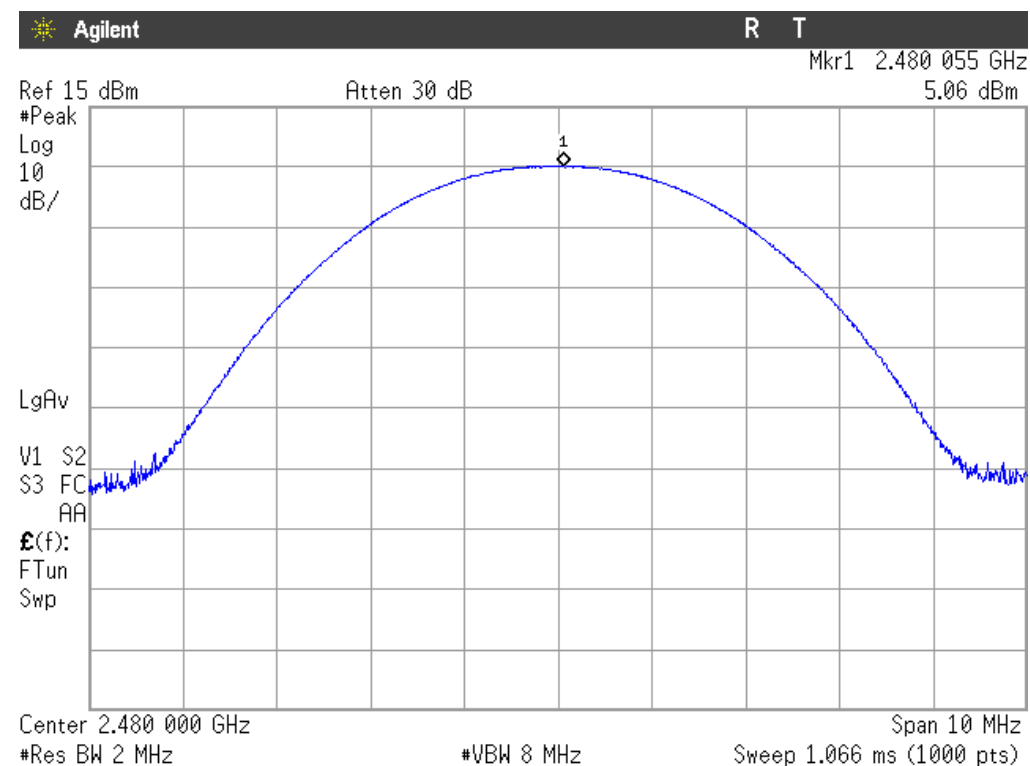
Modulation: $\Pi/4$ -DQPSK

Middle Channel: 2441 MHz.



Modulation: $\Pi/4$ -DQPSK

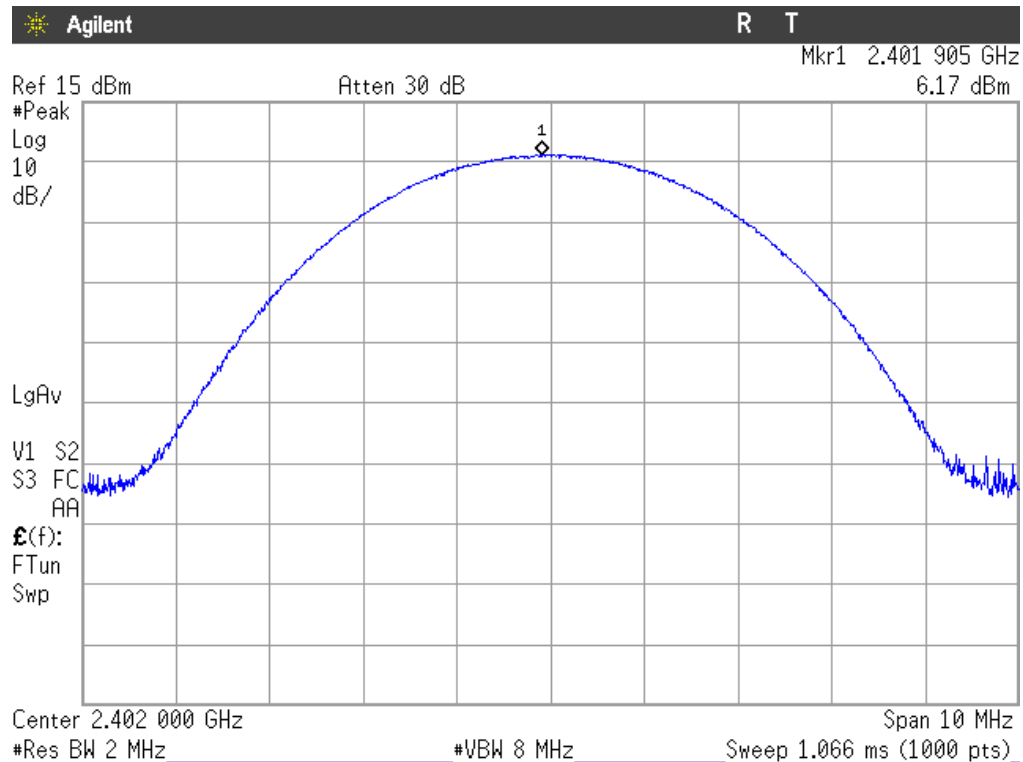
Highest Channel: 2480 MHz.



PEAK OUTPUT POWER (CONDUCTED).

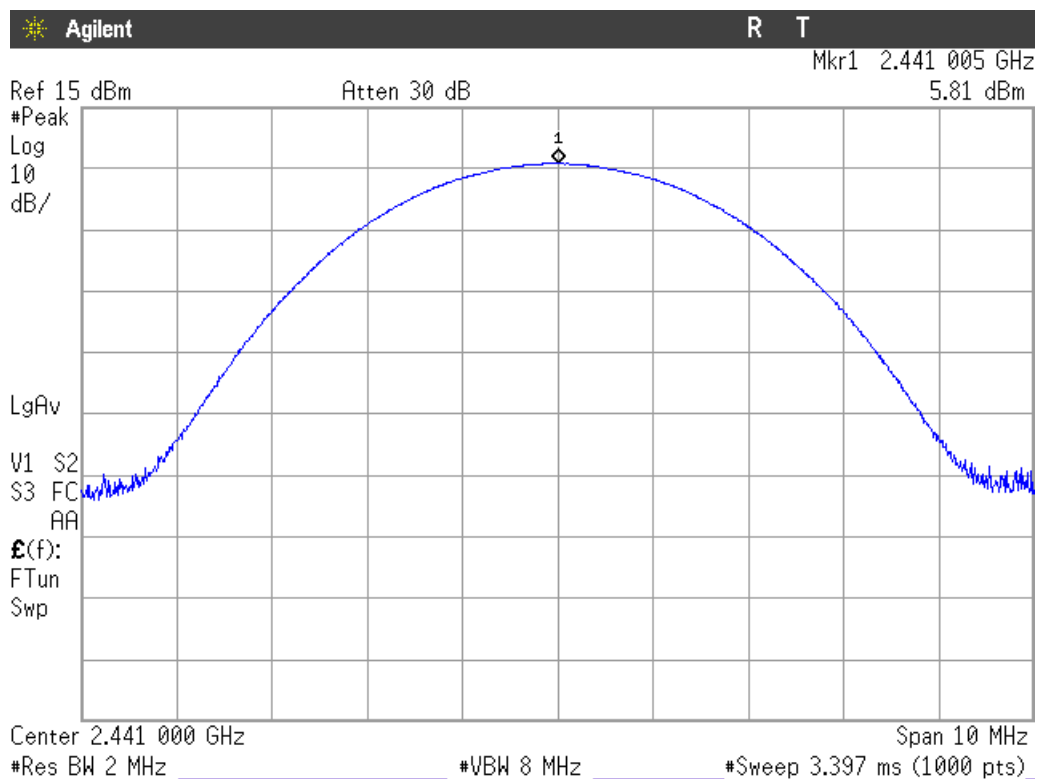
Modulation: 8-DPSK

Lowest Channel: 2402 MHz



Modulation: 8-DPSK

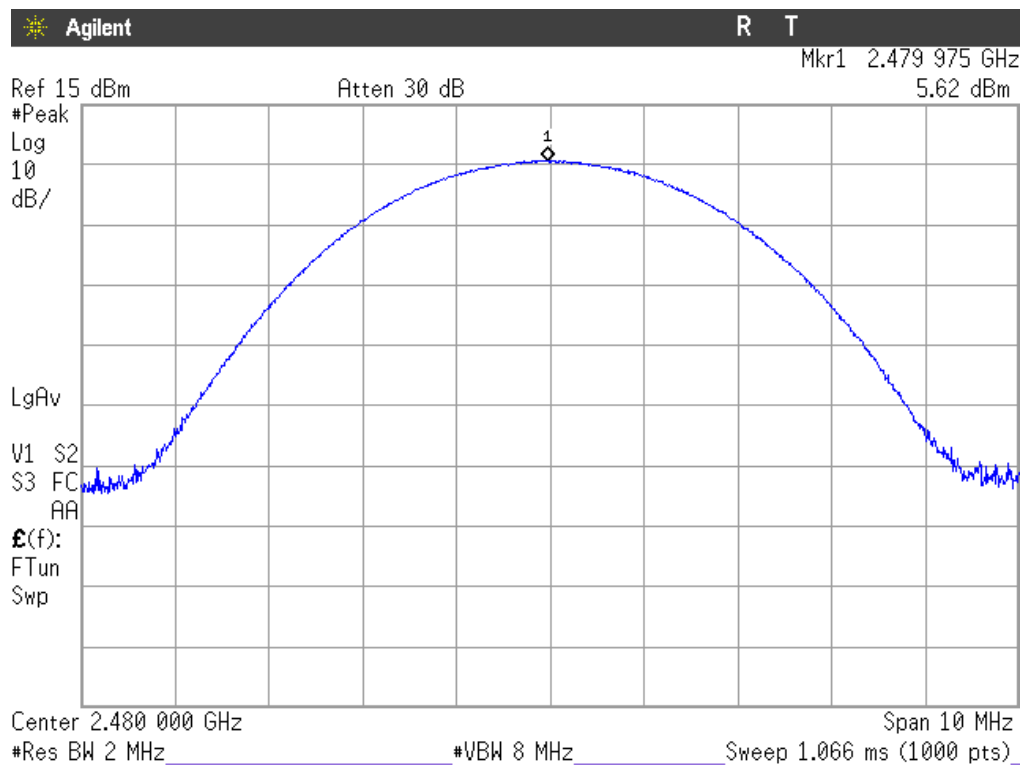
Middle Channel: 2441 MHz.



PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK

Highest Channel: 2480 MHz.



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

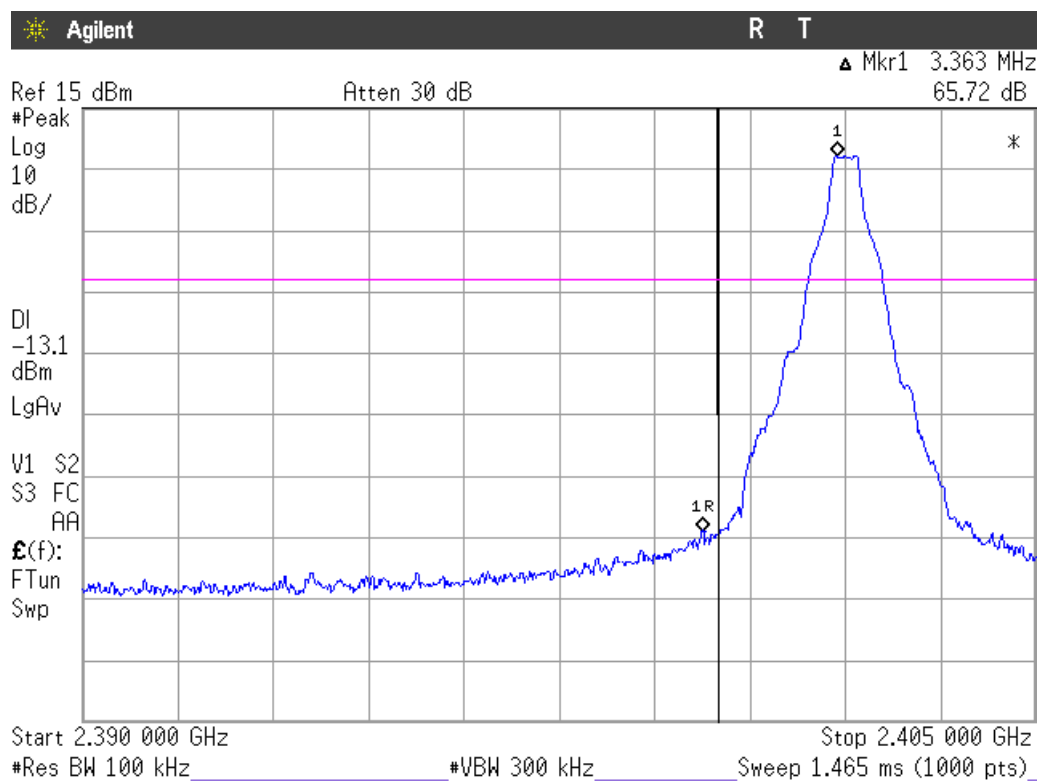
SPECIFICATION

Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below the highest level of the desired power.

RESULTS:

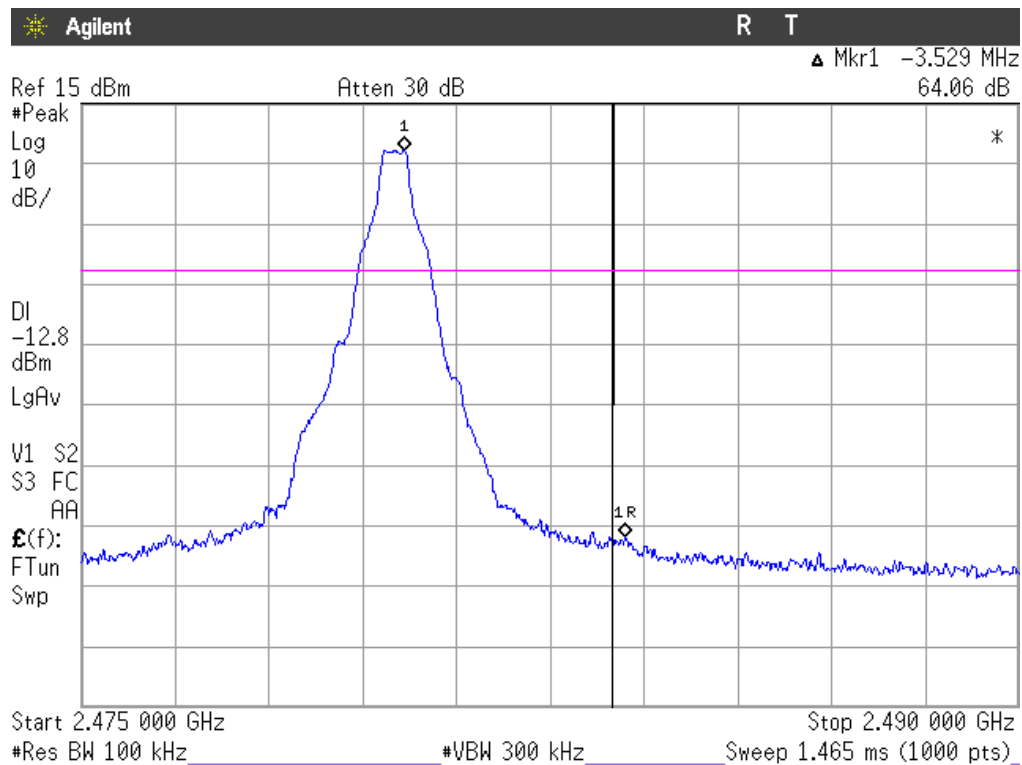
Modulation: GFSK

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



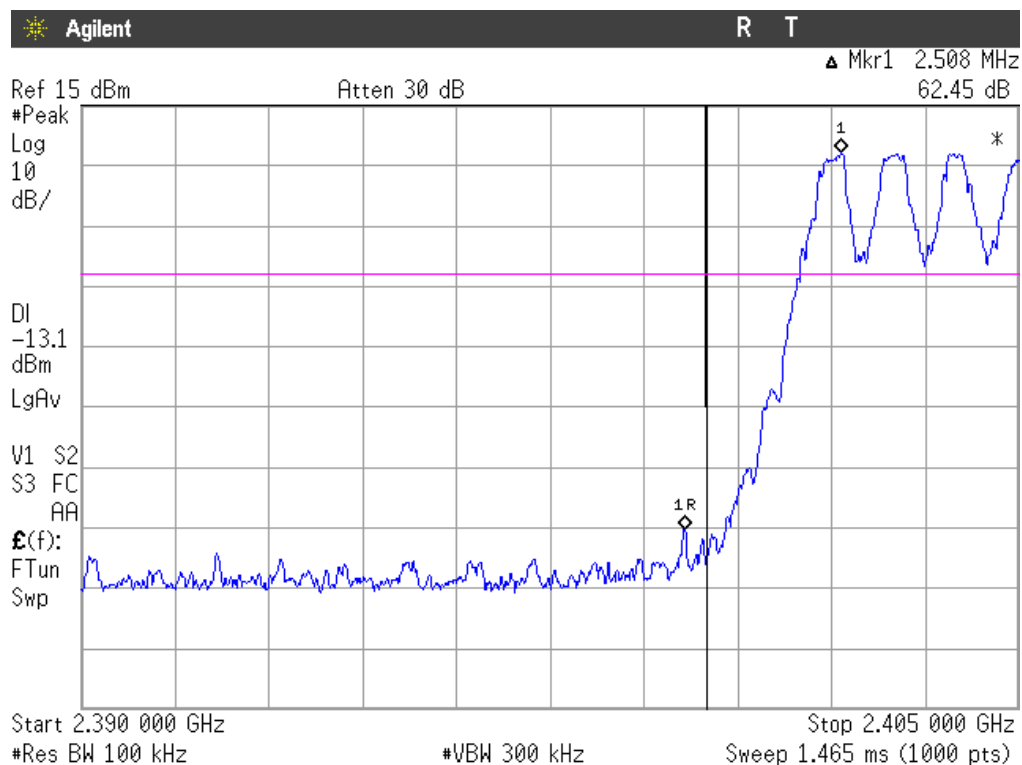
Verdict: PASS

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



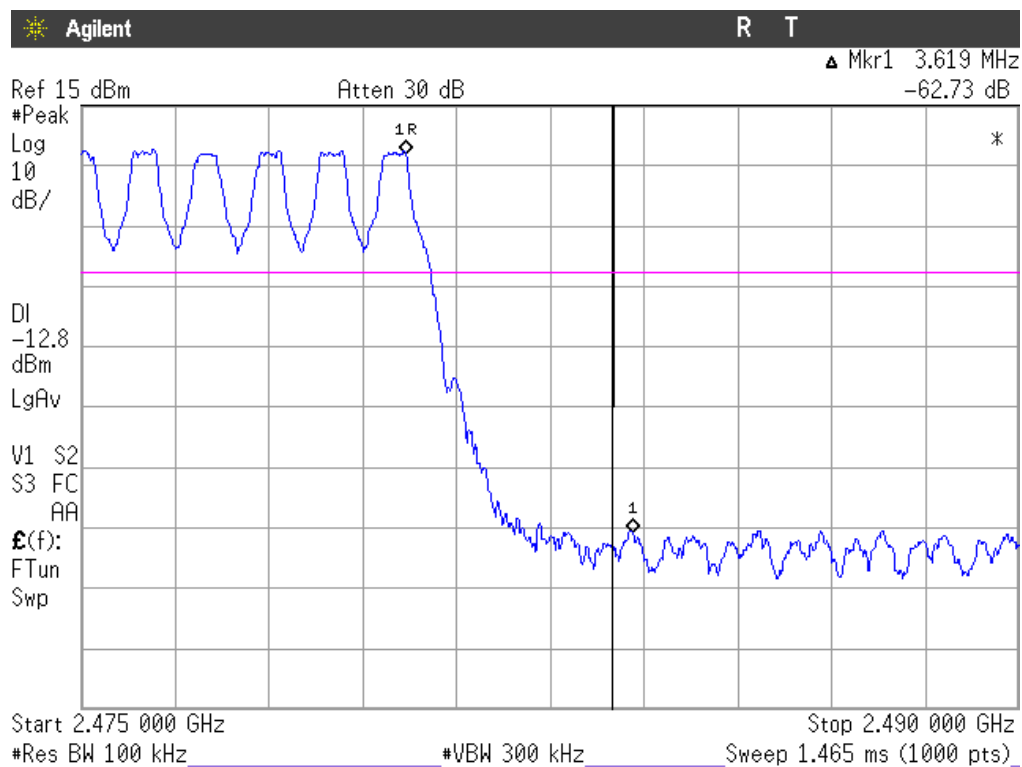
Verdict: PASS

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



Verdict: PASS

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

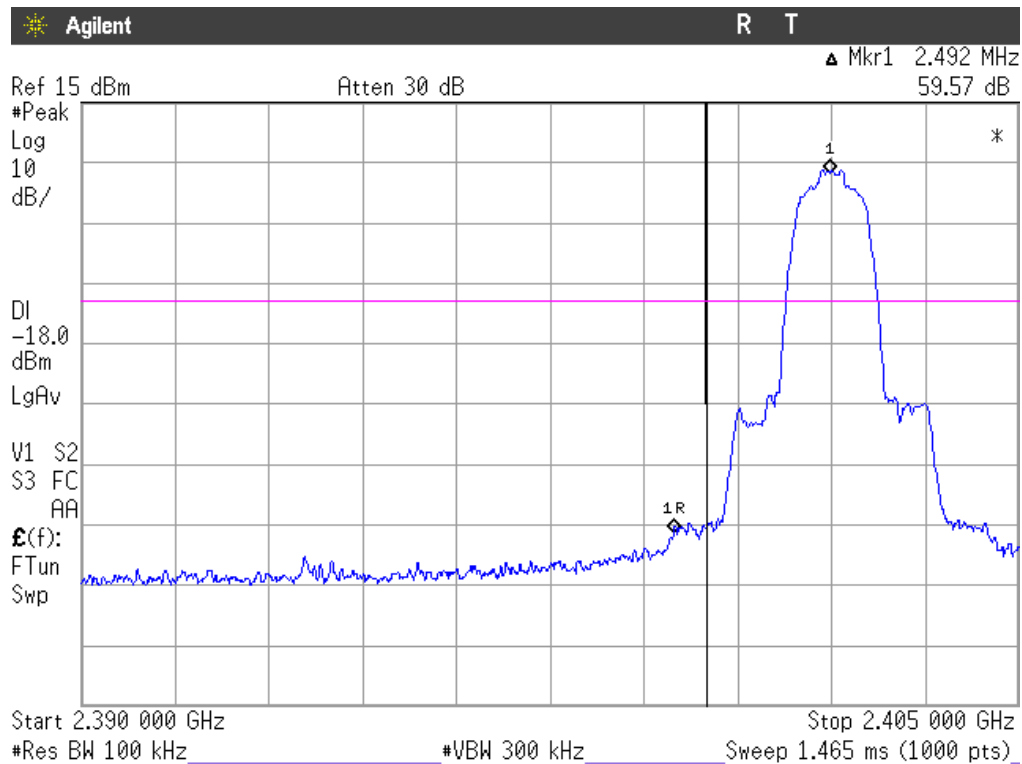


Verdict: PASS

Measurement uncertainty (dB)	<±2.03
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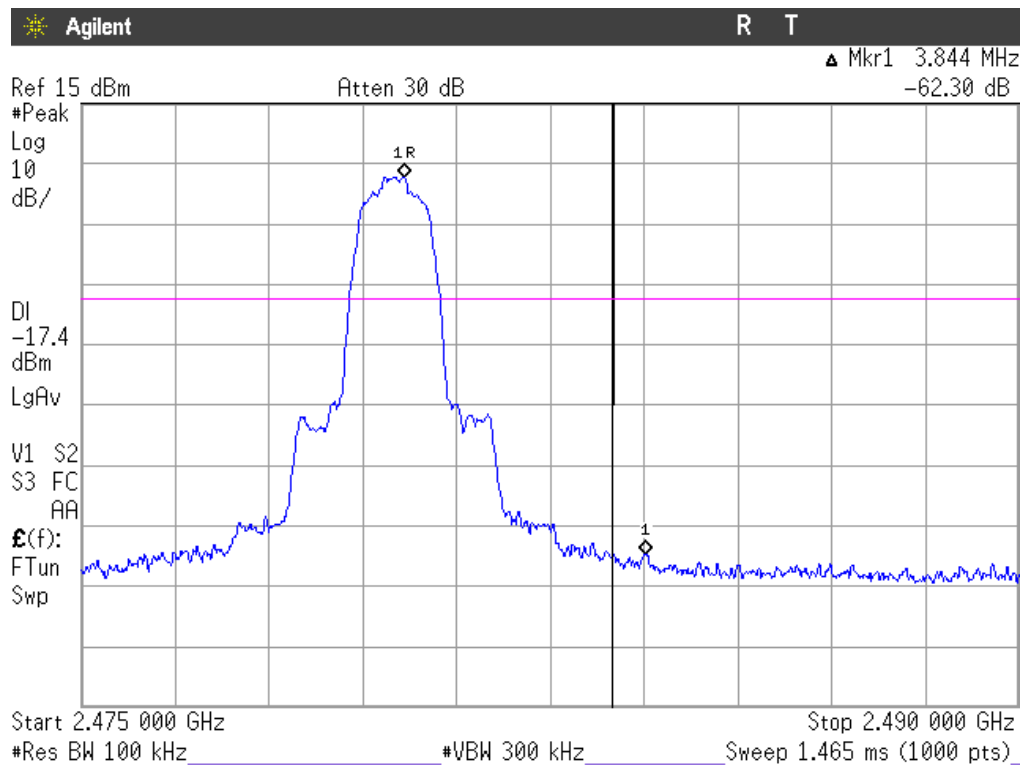
Modulation: $\Pi/4$ -DQPSK

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



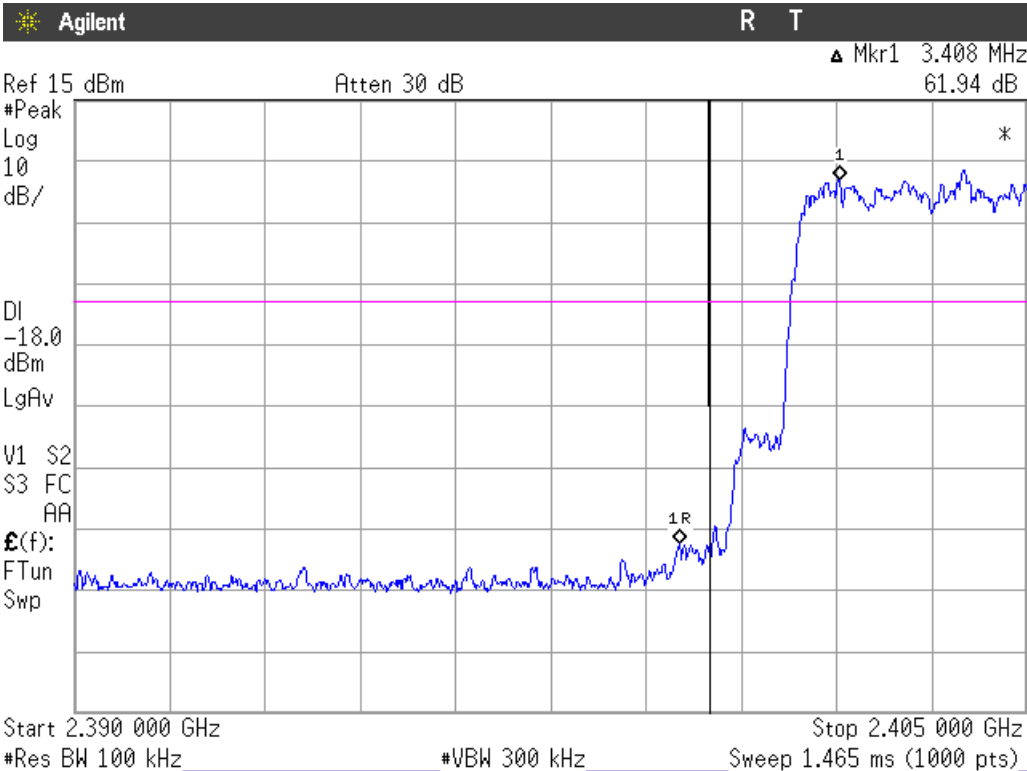
Verdict: PASS

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



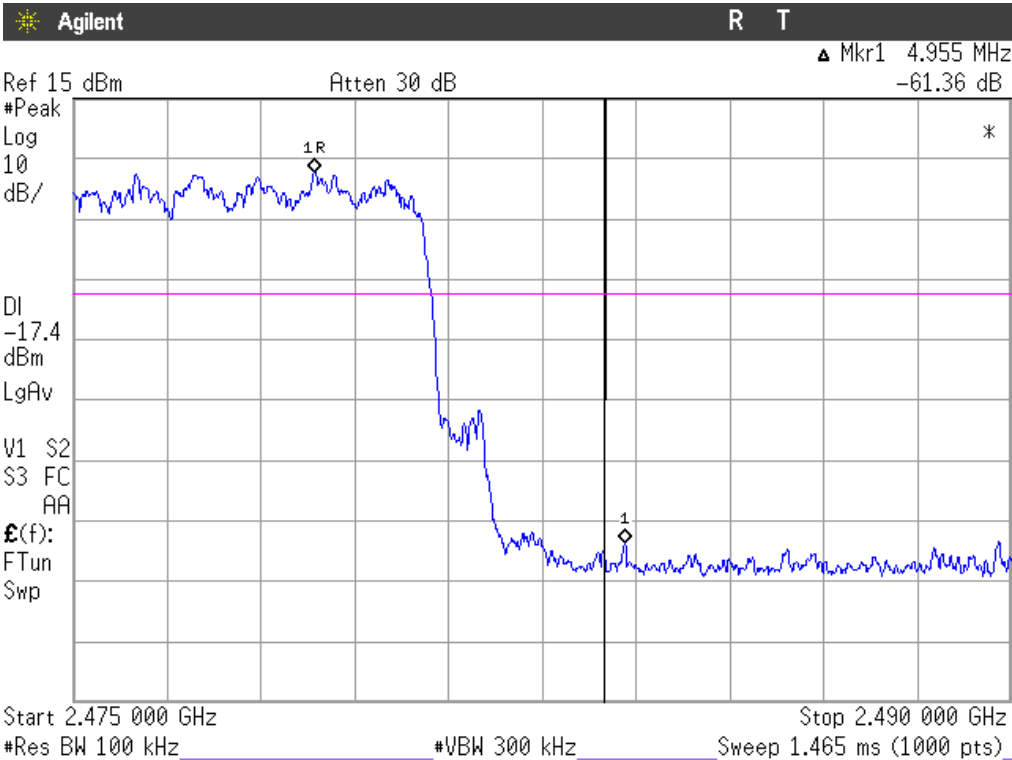
Verdict: PASS

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



Verdict: PASS

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

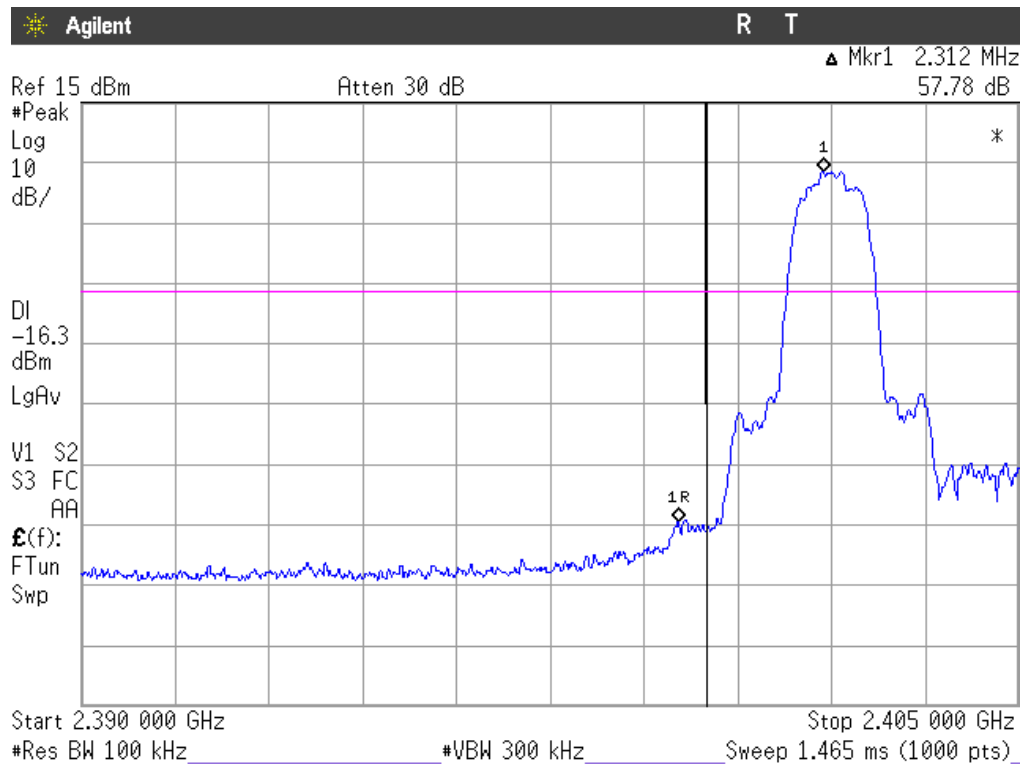


Verdict: PASS

Measurement uncertainty (dB)	< $\pm$ 2.03
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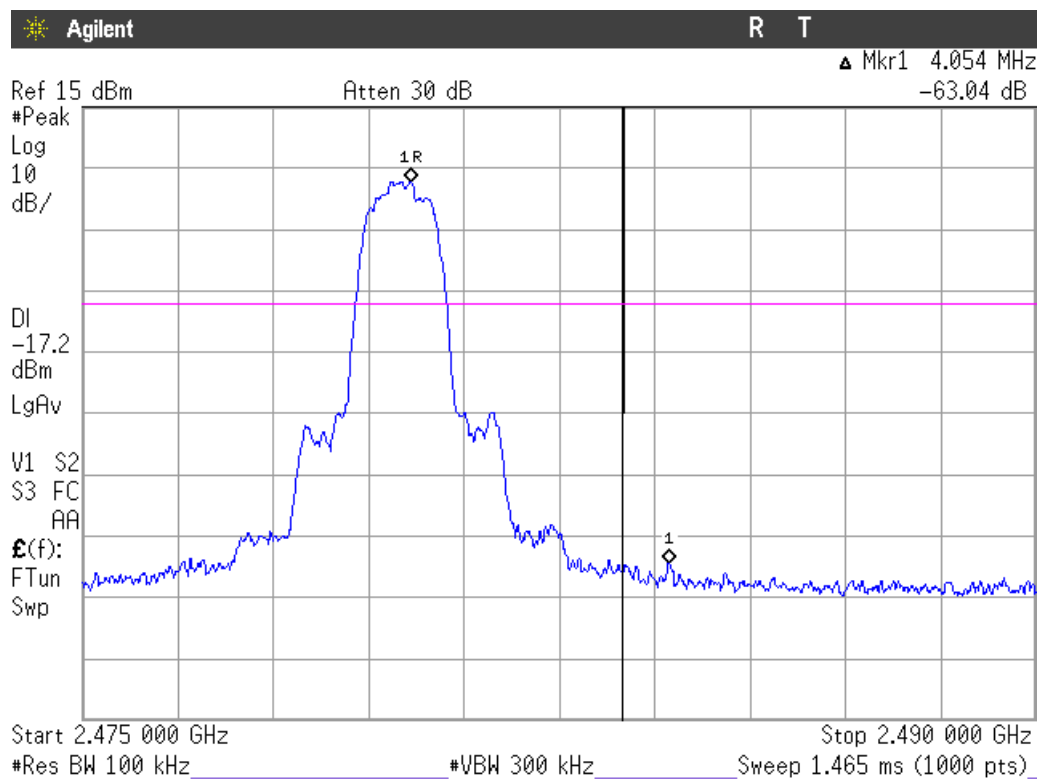
Modulation: 8-DPSK

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



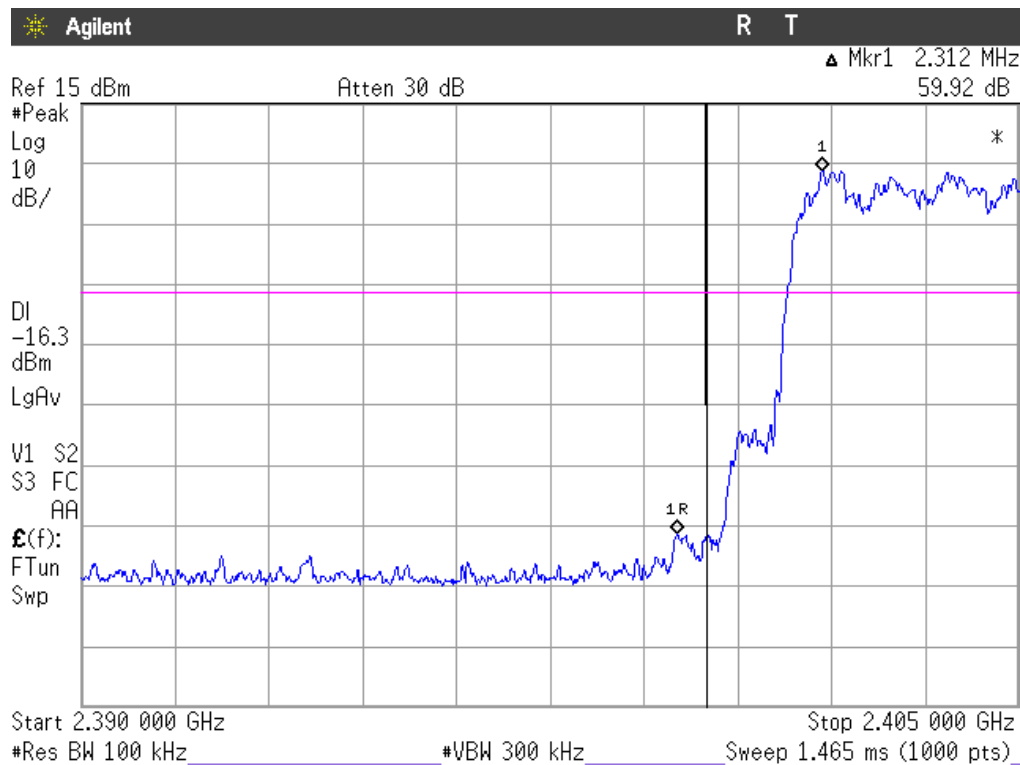
Verdict: PASS

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



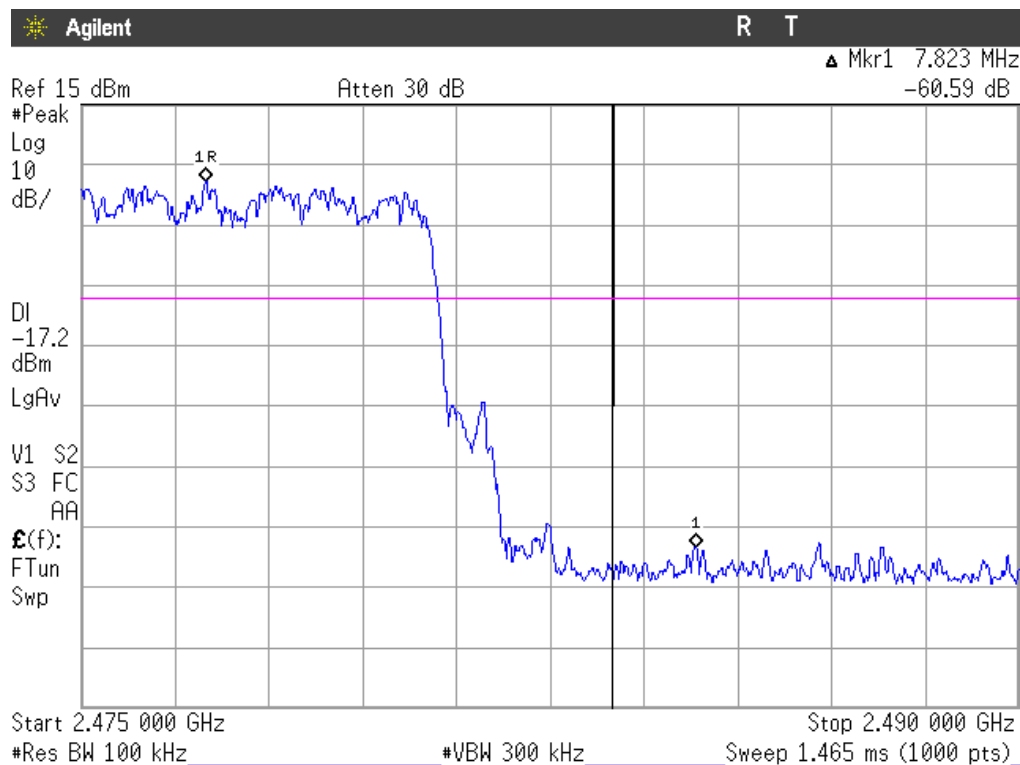
Verdict: PASS

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



Verdict: PASS

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



Verdict: PASS

Measurement uncertainty (dB)	< $\pm$ 2.03
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FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations conducted (Transmitter)

SPECIFICATION

In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

RESULTS:

Modulation: GFSK

1. LOW CHANNEL (2402 MHz).
All peaks are more than 20 dB below the limit.
2. MIDDLE CHANNEL (2441 MHz)
All peaks are more than 20 dB below the limit.
3. HIGH CHANNEL (2480 MHz)
All peaks are more than 20 dB below the limit.

Modulation: $\pi/4$ -DQPSK

1. LOW CHANNEL (2402 MHz).
All peaks are more than 20 dB below the limit.
2. MIDDLE CHANNEL (2441 MHz)
All peaks are more than 20 dB below the limit.
3. HIGH CHANNEL (2480 MHz)
All peaks are more than 20 dB below the limit.

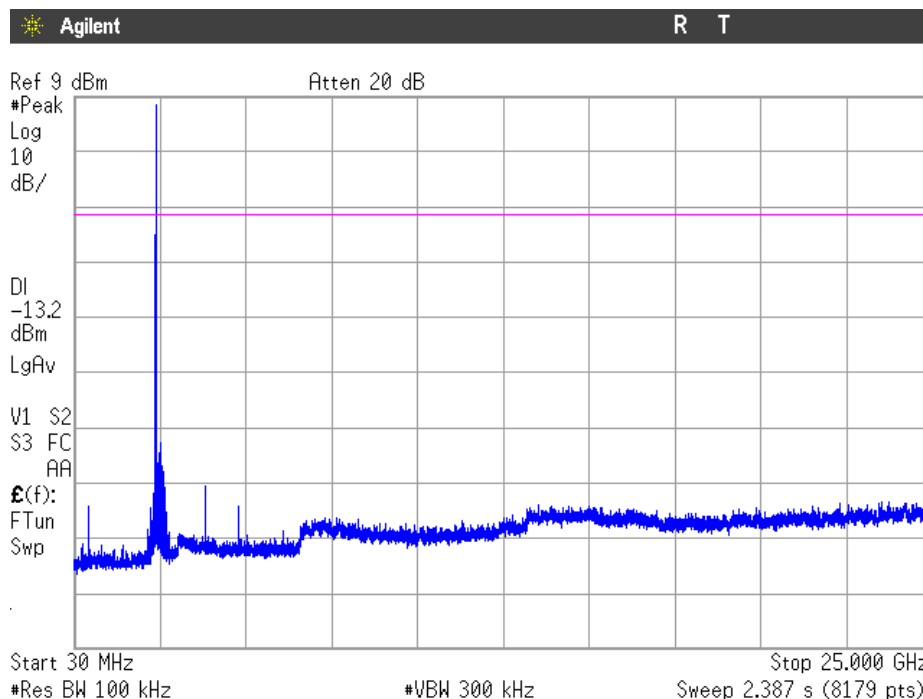
Modulation: 8-DPSK

1. LOW CHANNEL (2402 MHz).
All peaks are more than 20 dB below the limit.
2. MIDDLE CHANNEL (2441 MHz)
All peaks are more than 20 dB below the limit.
3. HIGH CHANNEL (2480 MHz)
All peaks are more than 20 dB below the limit.

Verdict: PASS

Modulation: GFSK

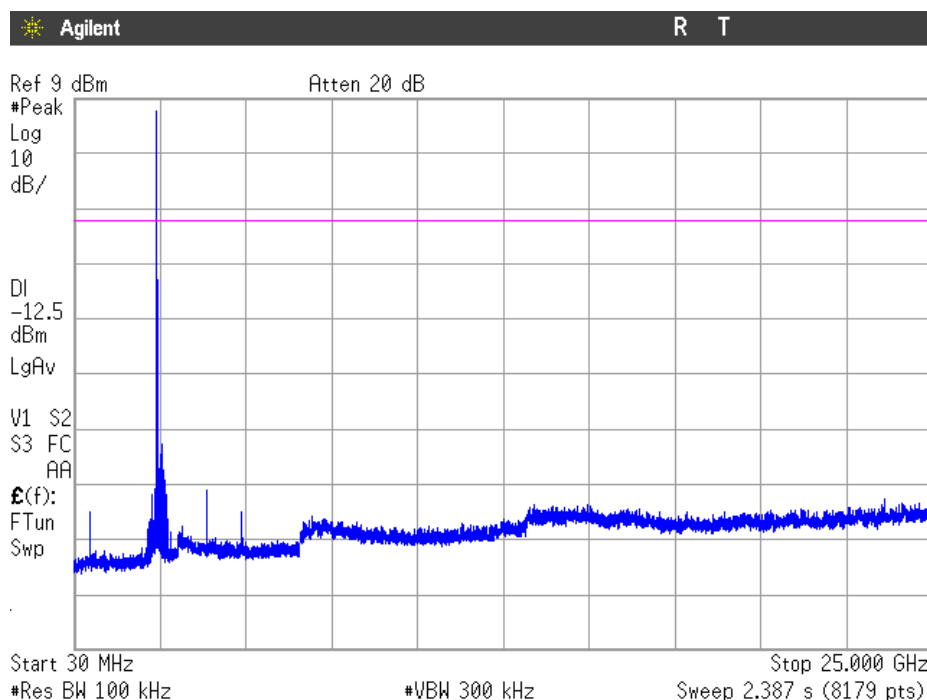
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

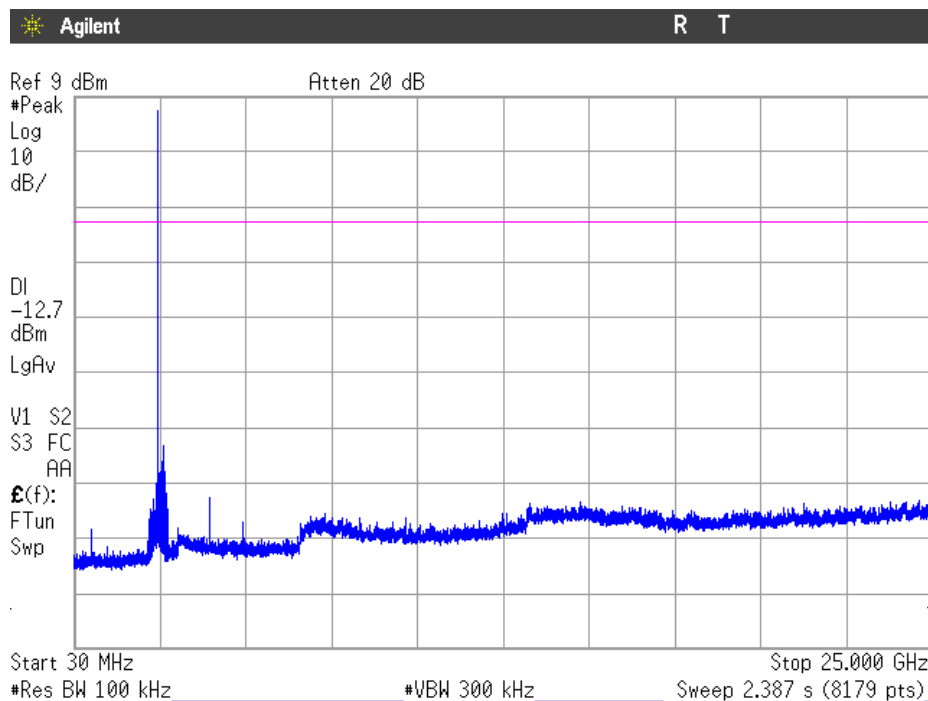
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

3. HIGH CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



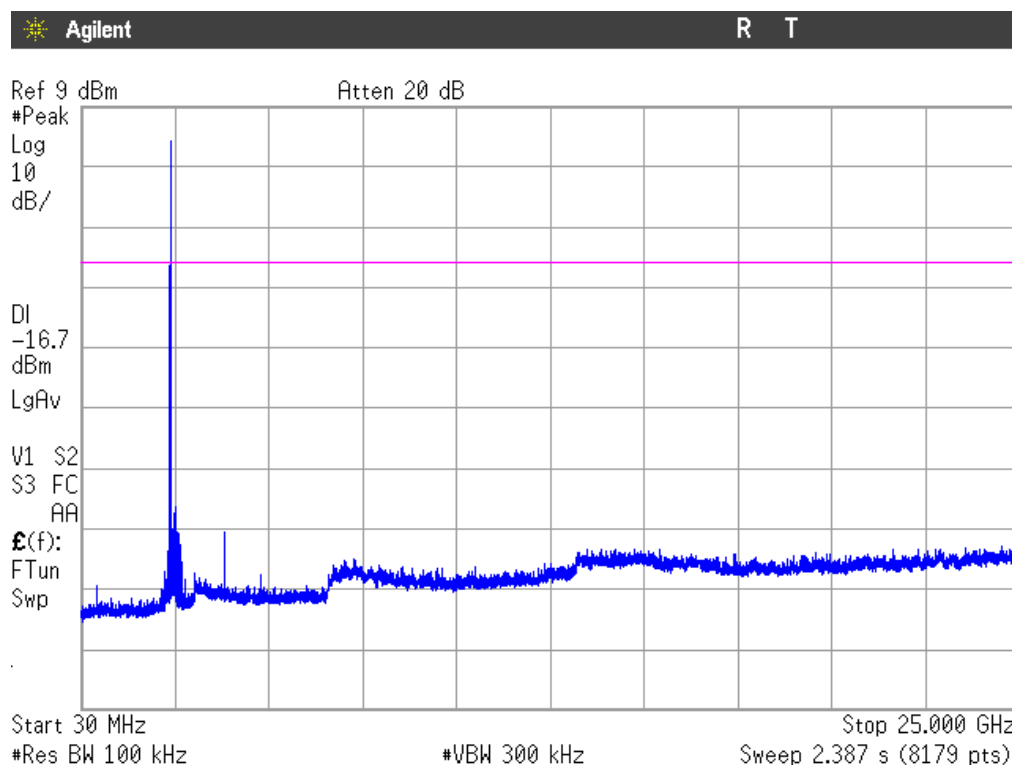
Note: The peak above the limits is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±2.03
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Modulation: $\Pi/4$ -DQPSK

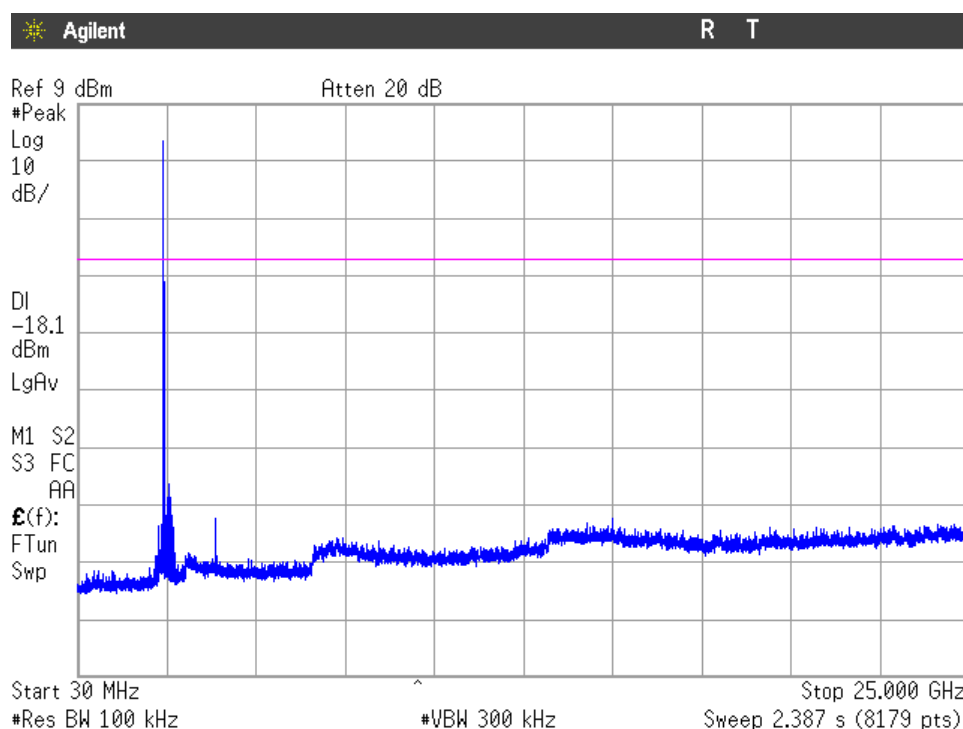
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

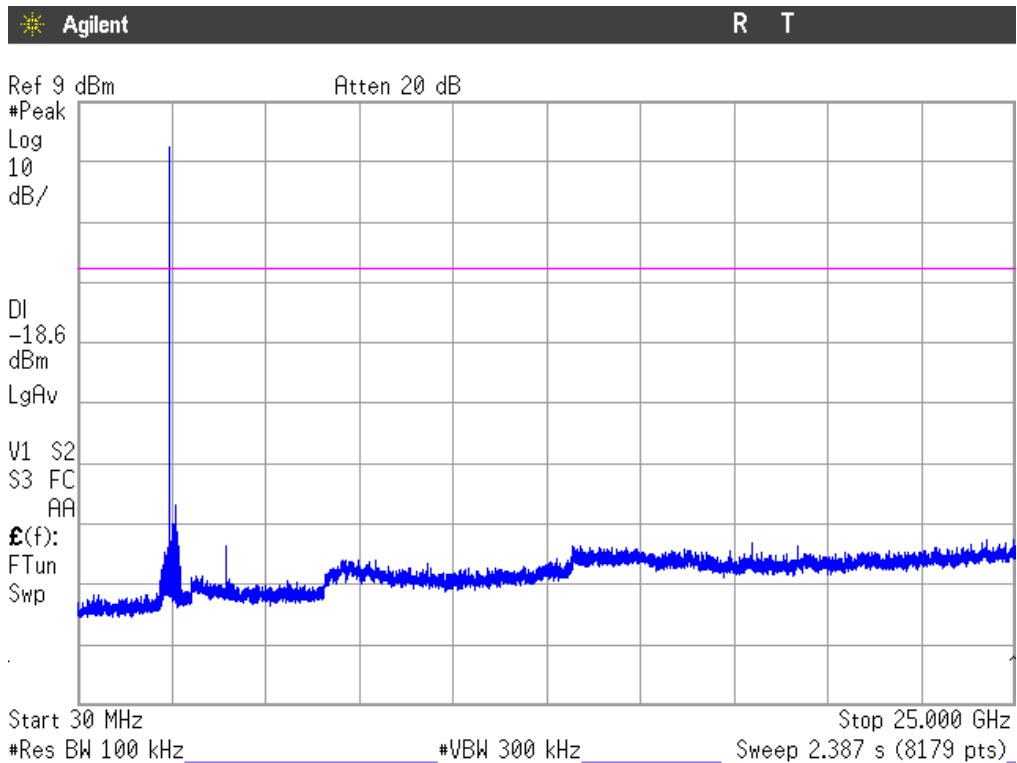
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peaks above the limits are the carrier frequencies.

Verdict: PASS

3. HIGH CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



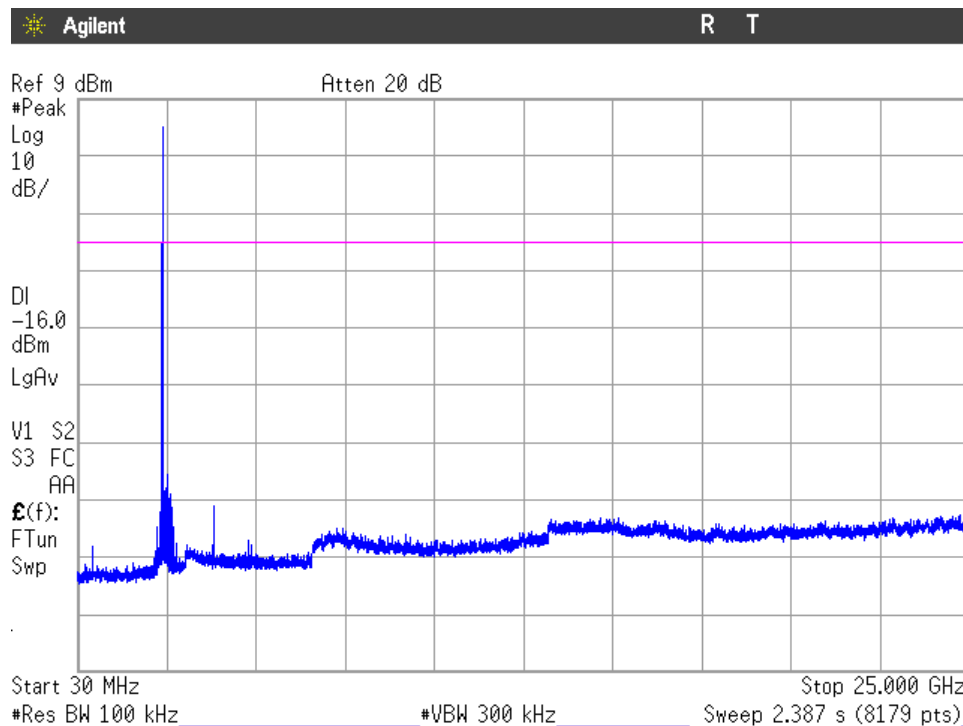
Note: The peak above the limit is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±2.03
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Modulation: 8-DPSK

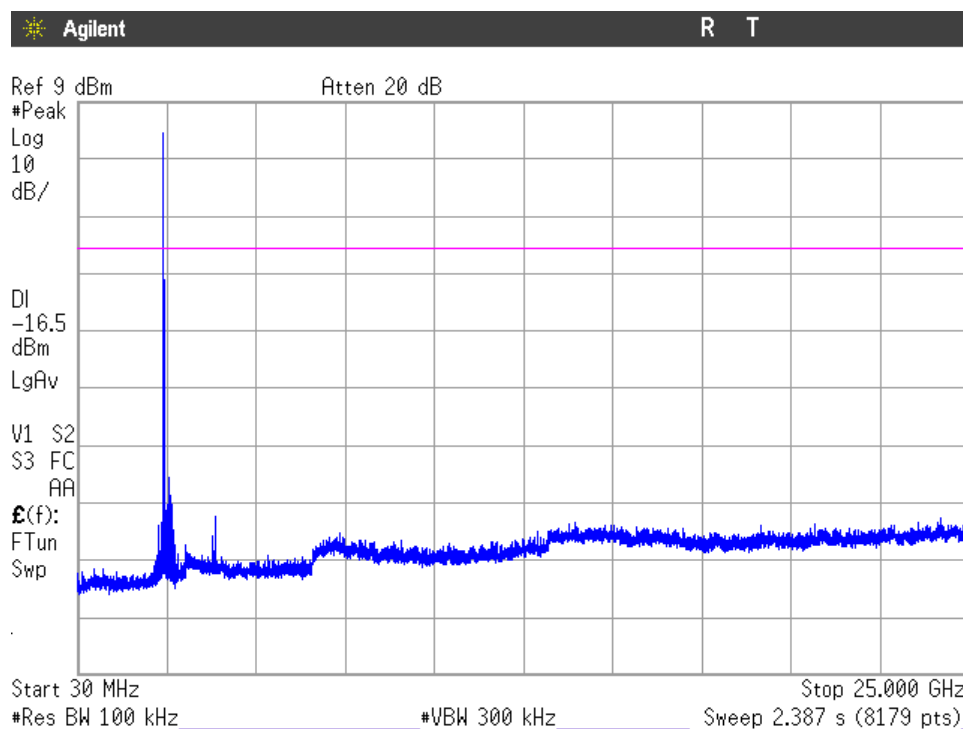
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

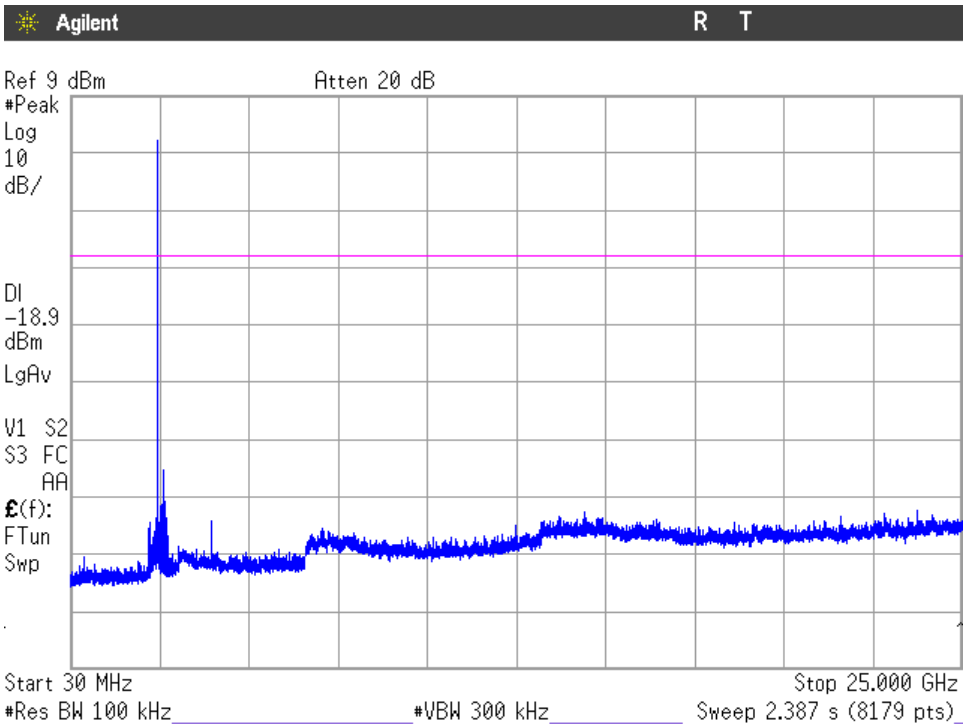
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peaks above the limit are the carrier frequencies.

Verdict: PASS

3. HIGH CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±2.03
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FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5 Emission limitations radiated (Transmitter)

SPECIFICATION

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 ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	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 was varied to find the maximum radiated emission. It was also rotated 360° 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-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

The test was performed with the equipment transmitting first with only the 2.4 GHz BT-EDR (WLAN 0) radio and repeated with the WiFi 2.4GHz (WLAN1 CORE1), SiSo WiFi 5 GHz (WLAN0 CORE0) radios transmitting simultaneously to check the impact of the co-location of the other radio interfaces. The results and plots below show the worst results obtained.

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 (dB μ V/m)	Measurement Uncertainty (dB)
42.4645	V	Quasi-Peak	28.52	± 3.88
87.3180	V	Quasi-Peak	22.02	± 3.88
127.9215	V	Quasi-Peak	27.52	± 3.88
688.1450	V	Quasi-Peak	26.00	± 3.88
786.4545	V	Quasi-Peak	30.52	± 3.88
884.7640	V	Quasi-Peak	32.20	± 3.88

Frequency range 1 GHz-25 GHz

The results in the next tables show the maximum measured levels in the 1-25 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

Modulation: GFSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
5.37475	V	Peak	39.97	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.36716	V	Peak	45.85	± 4.87
5.37475	V	Peak	40.32	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.48357	V	Peak	46.94	± 4.87
5.37425	V	Peak	41.18	± 4.87

Verdict: PASS

Modulation: $\Pi/4$ -DQPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
5.37475	V	Peak	39.10	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
5.37475	V	Peak	39.58	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
5.37475	V	Peak	40.40	± 4.87

Verdict: PASS

Modulation: 8-DPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
5.37475	V	Peak	40.54	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

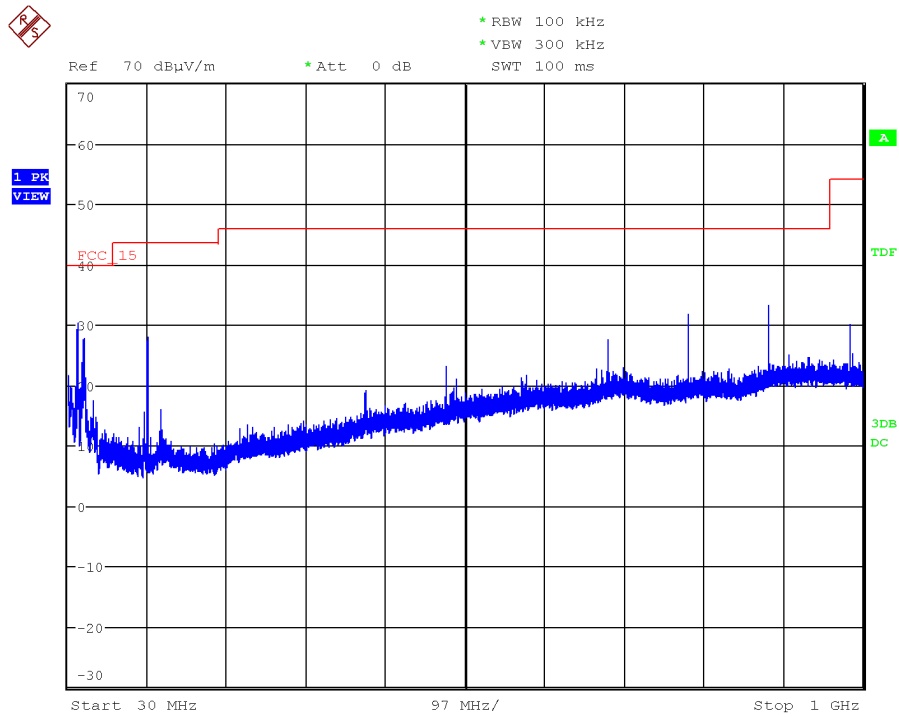
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
5.37475	V	Peak	39.51	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
5.37475	V	Peak	40.22	± 4.87

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

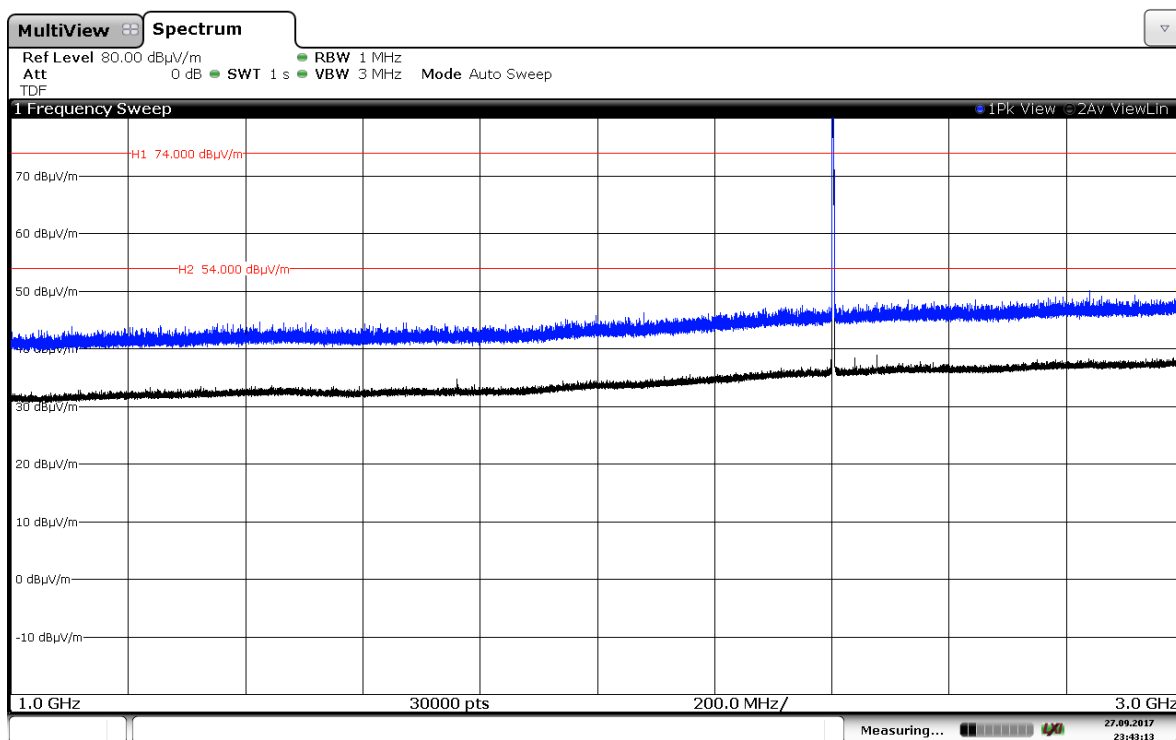


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

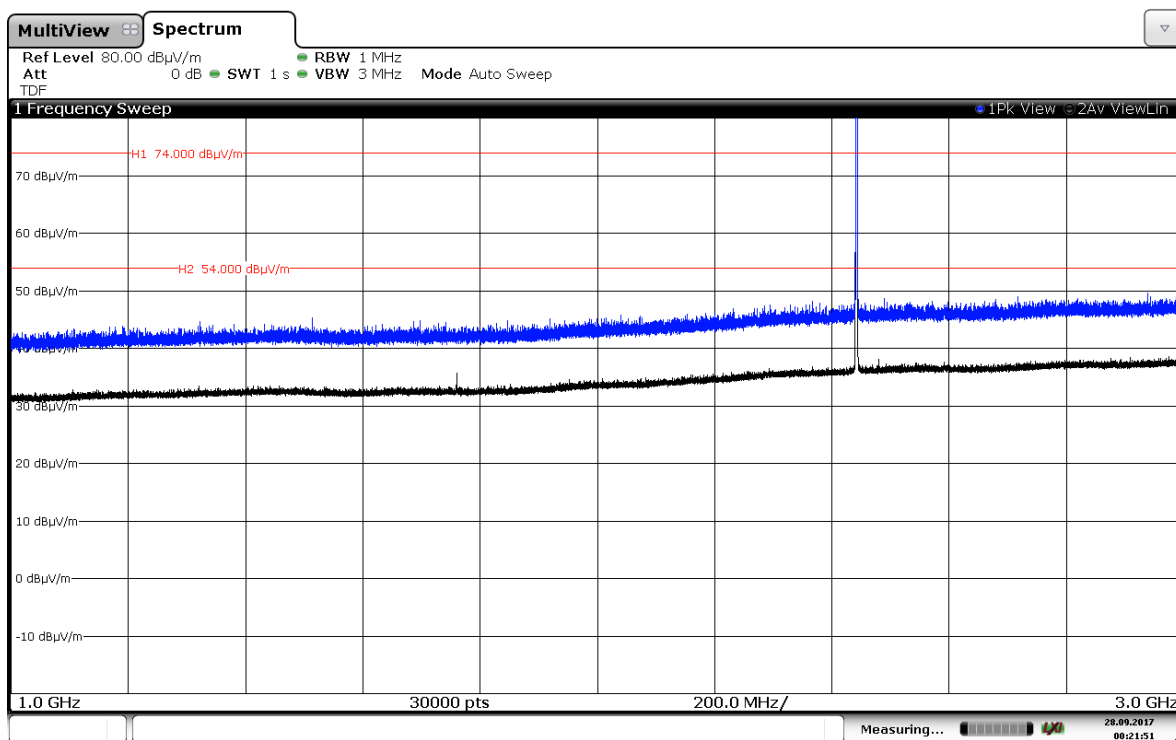
Modulation: GFSK

CHANNEL: Lowest (2402 MHz).



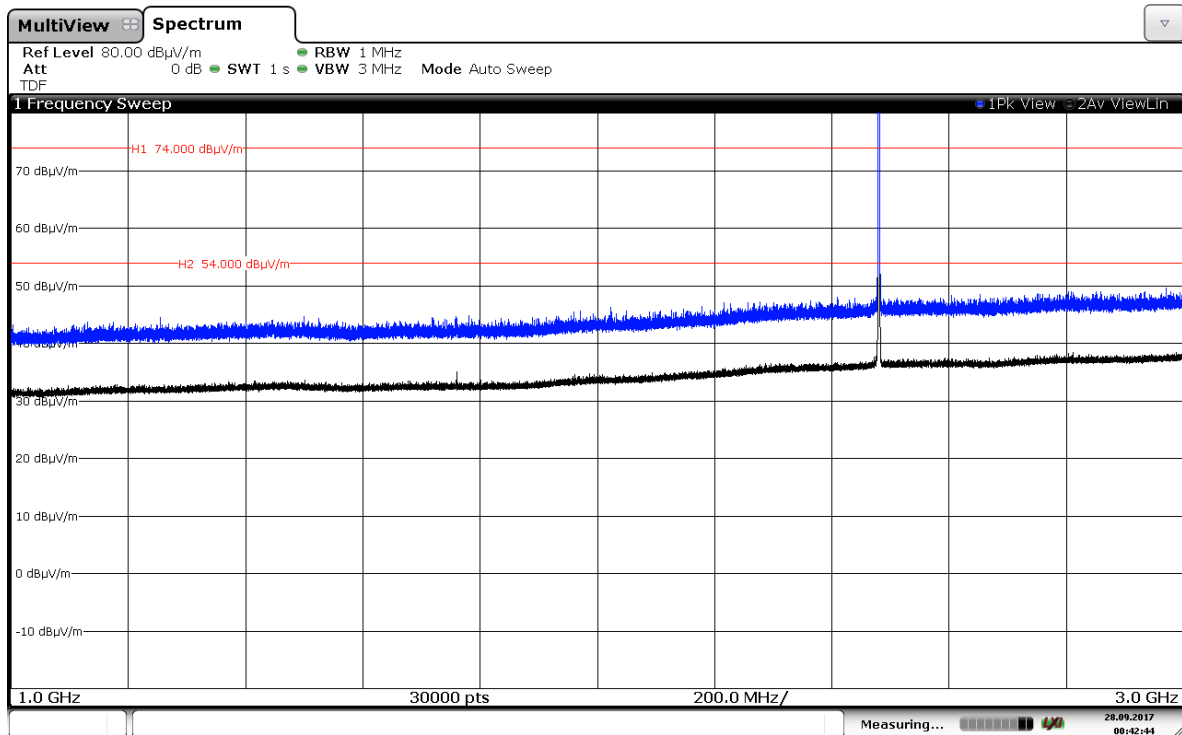
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

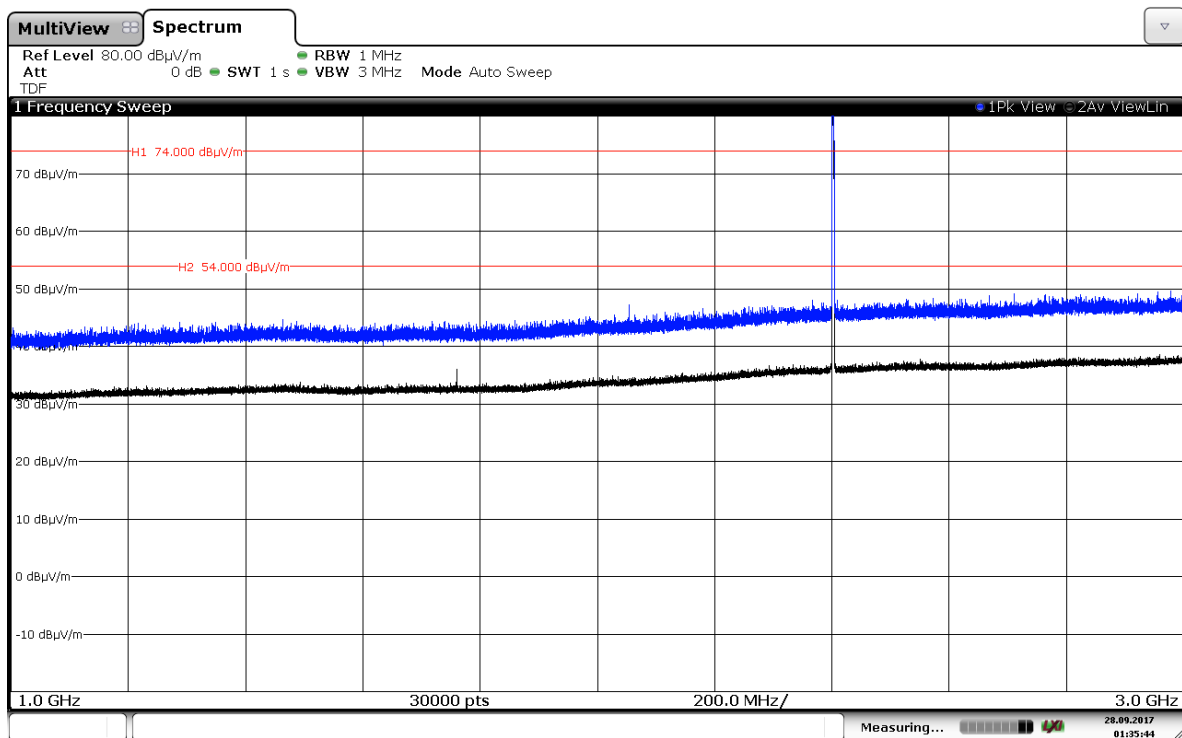
CHANNEL: Highest (2480 MHz).



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

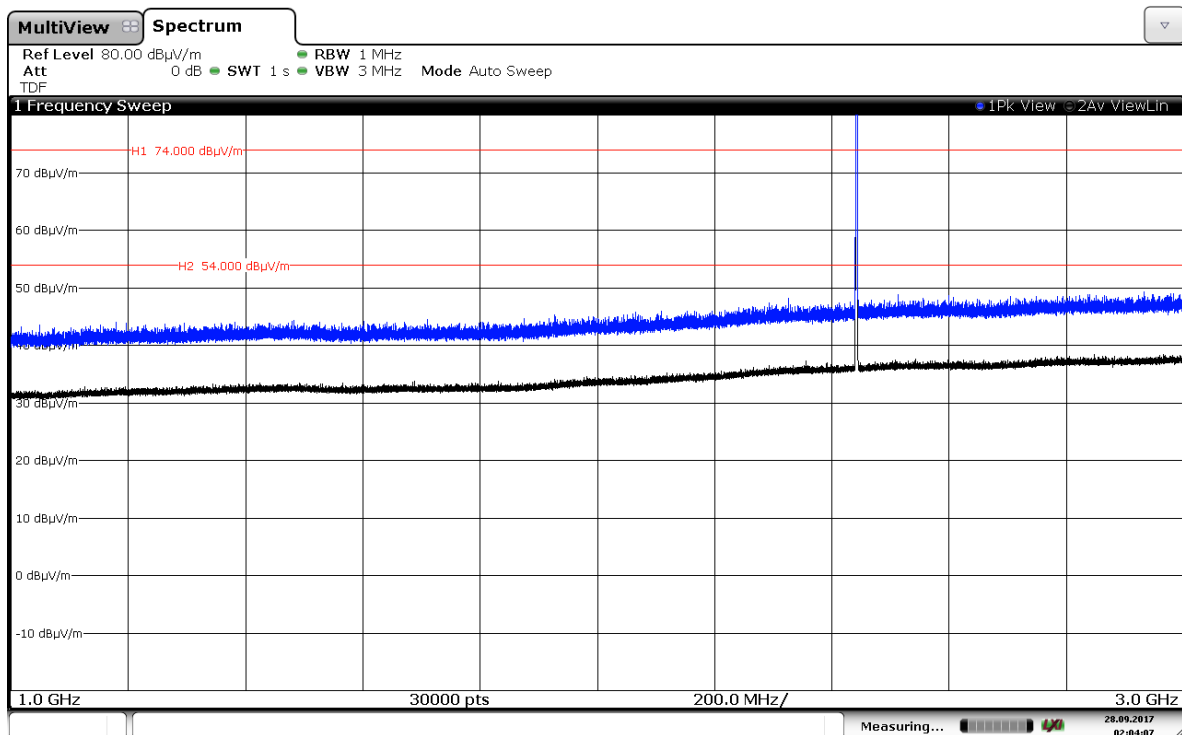
Modulation: $\Pi/4$ -DQPSK

CHANNEL: Lowest (2402 MHz).



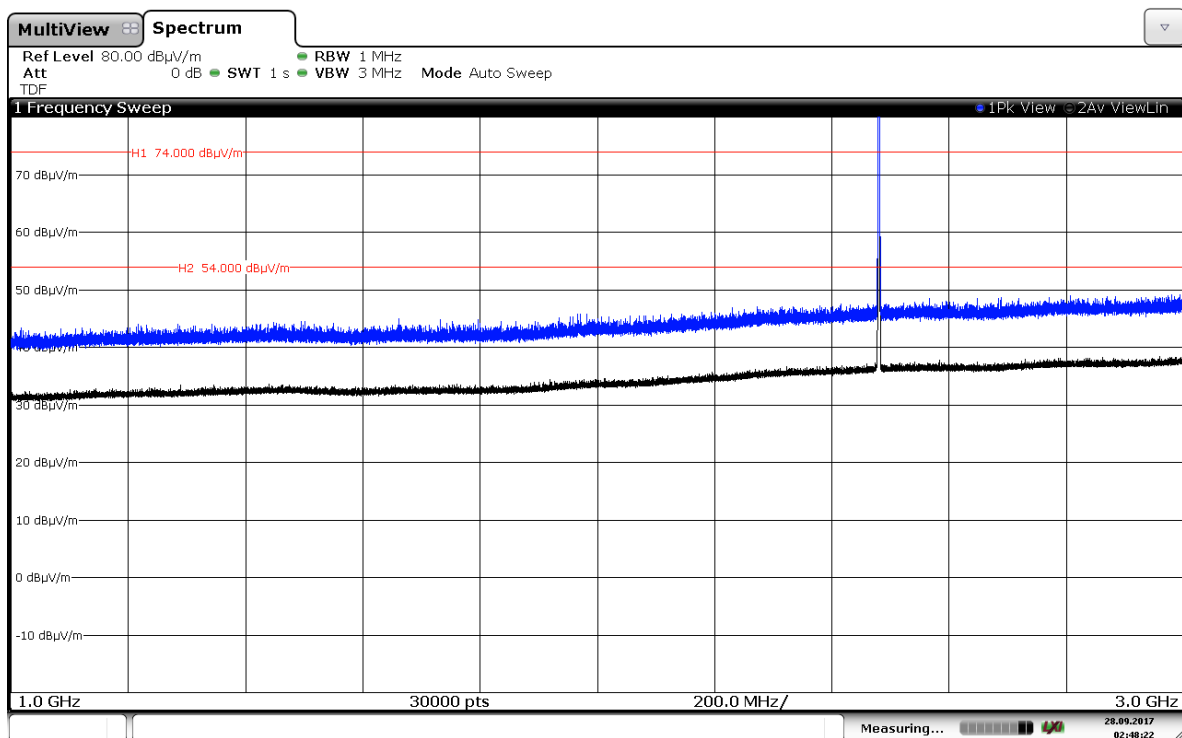
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

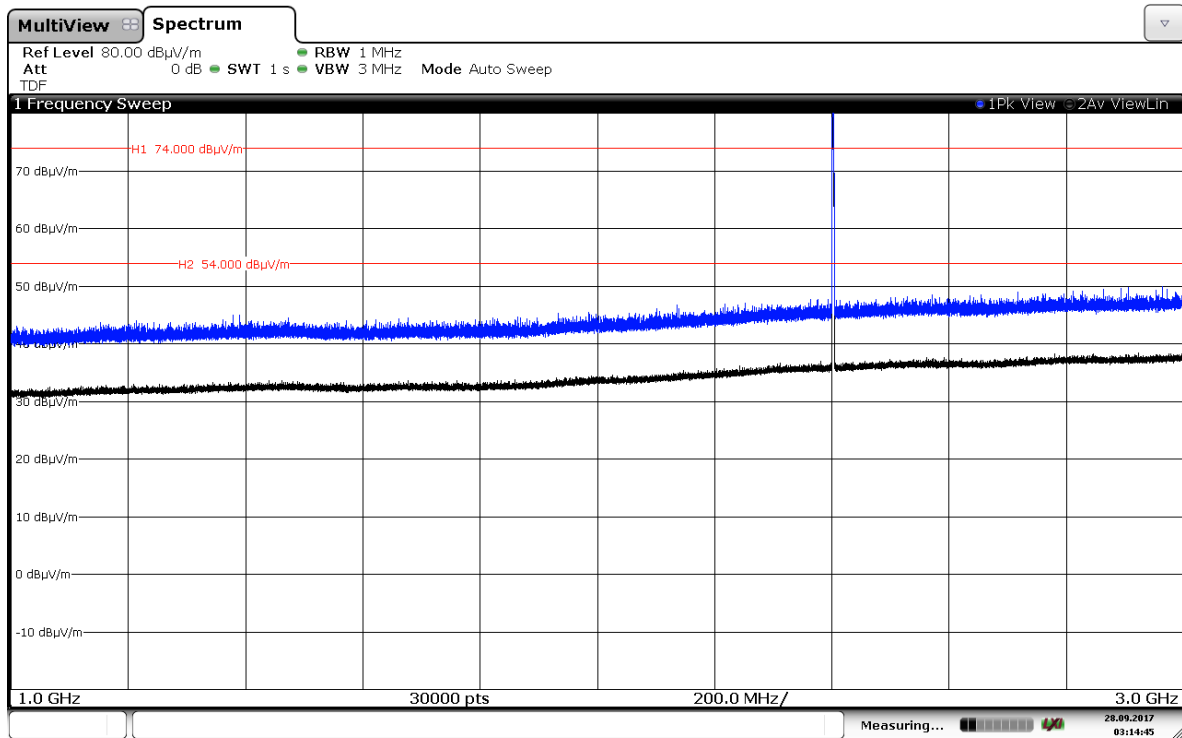
CHANNEL: Highest (2480 MHz).



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

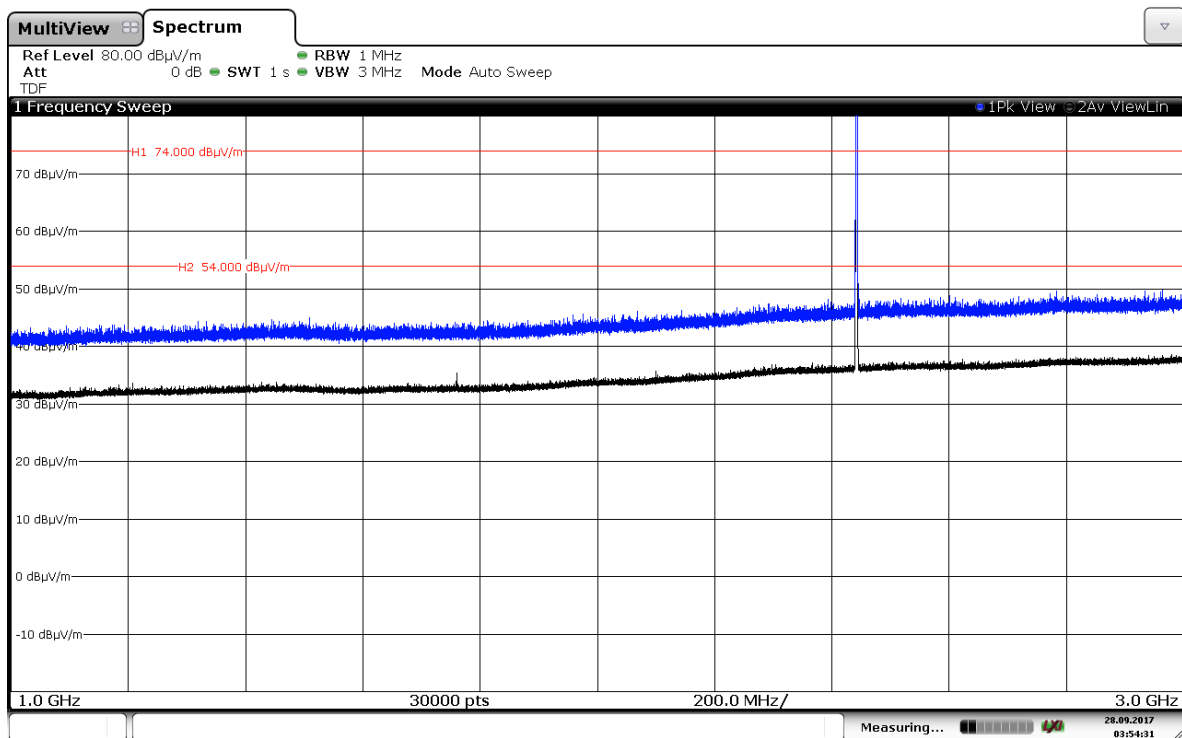
Modulation: 8-DPSK

CHANNEL: Lowest (2402 MHz).



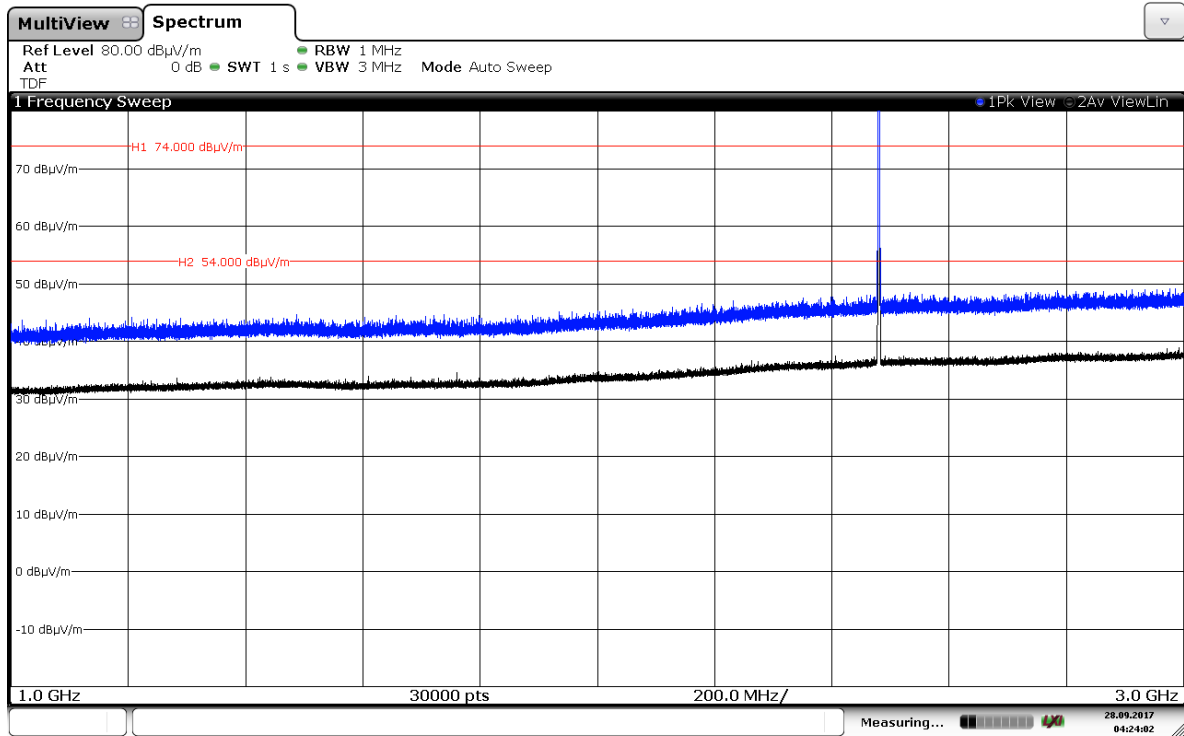
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



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

CHANNEL: Highest (2480 MHz).

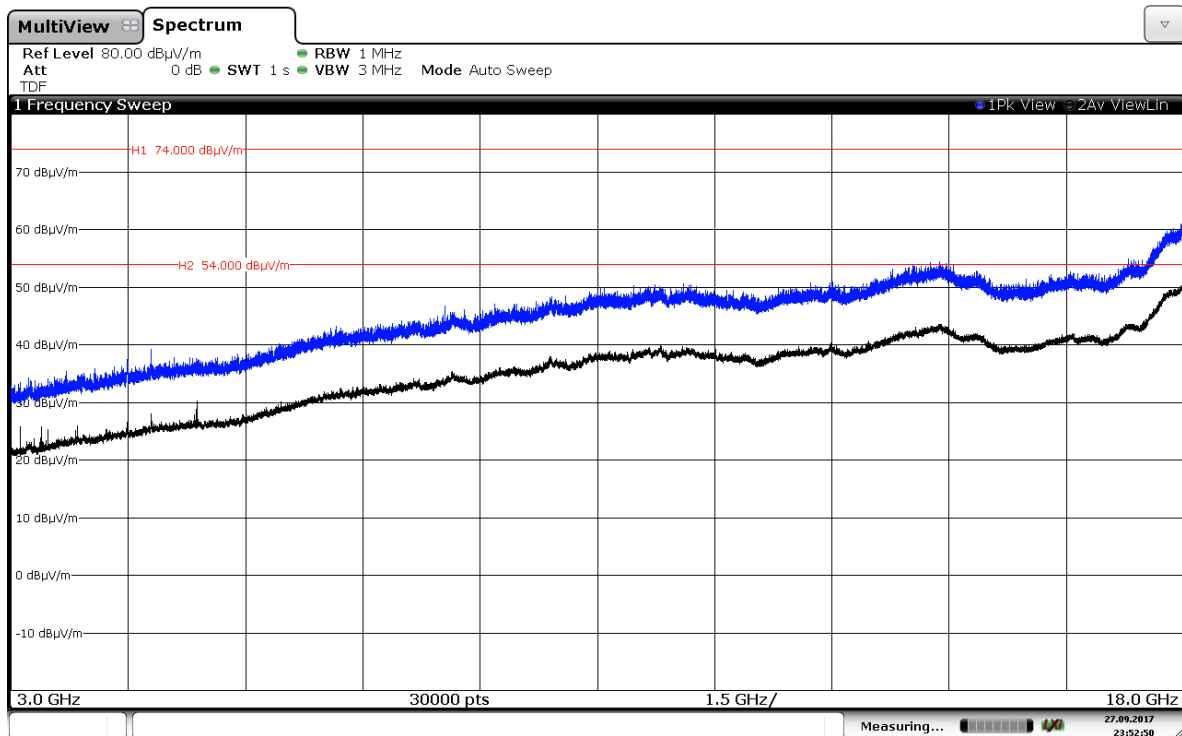


Note: The peak shown in the plot above the limits is the carrier frequency.

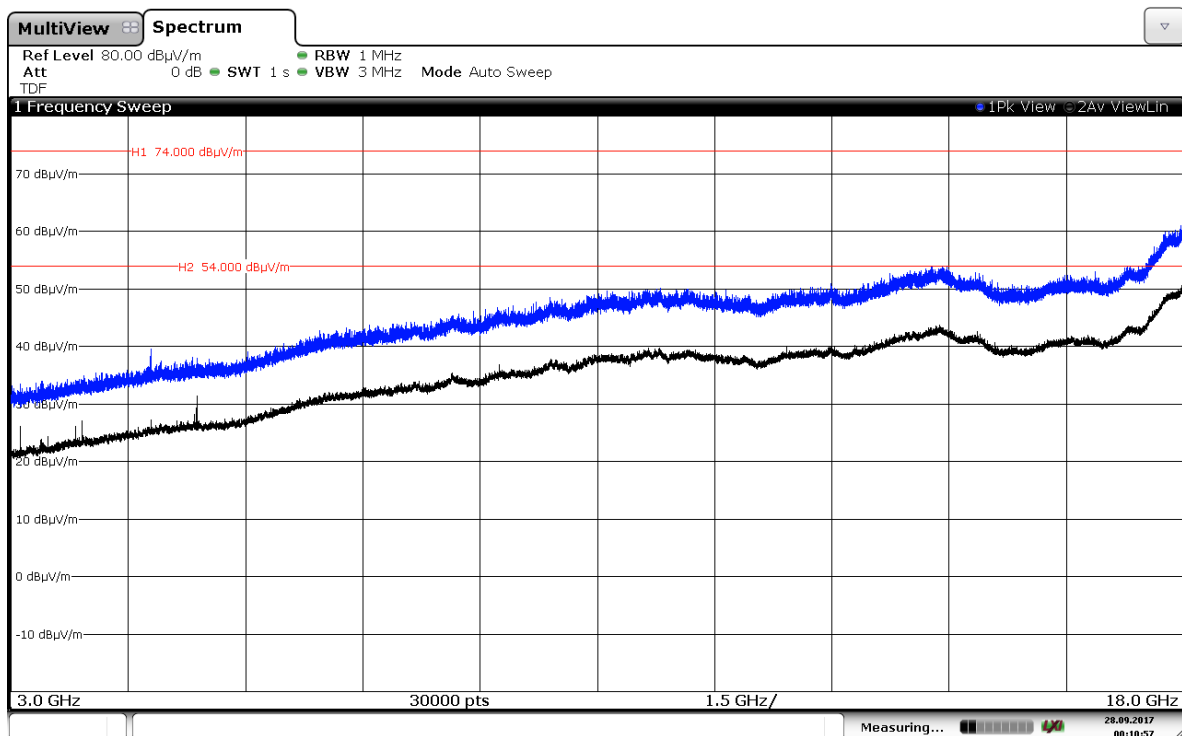
FREQUENCY RANGE 3 GHz to 18 GHz.

Modulation: GFSK

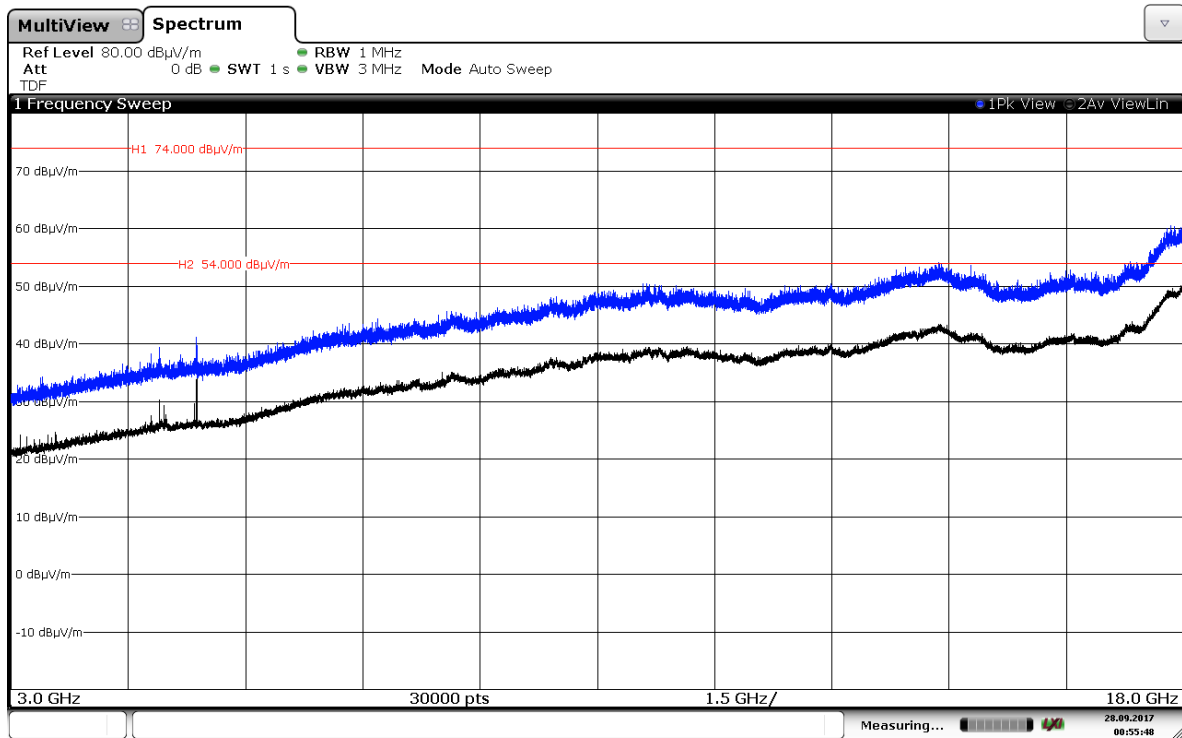
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

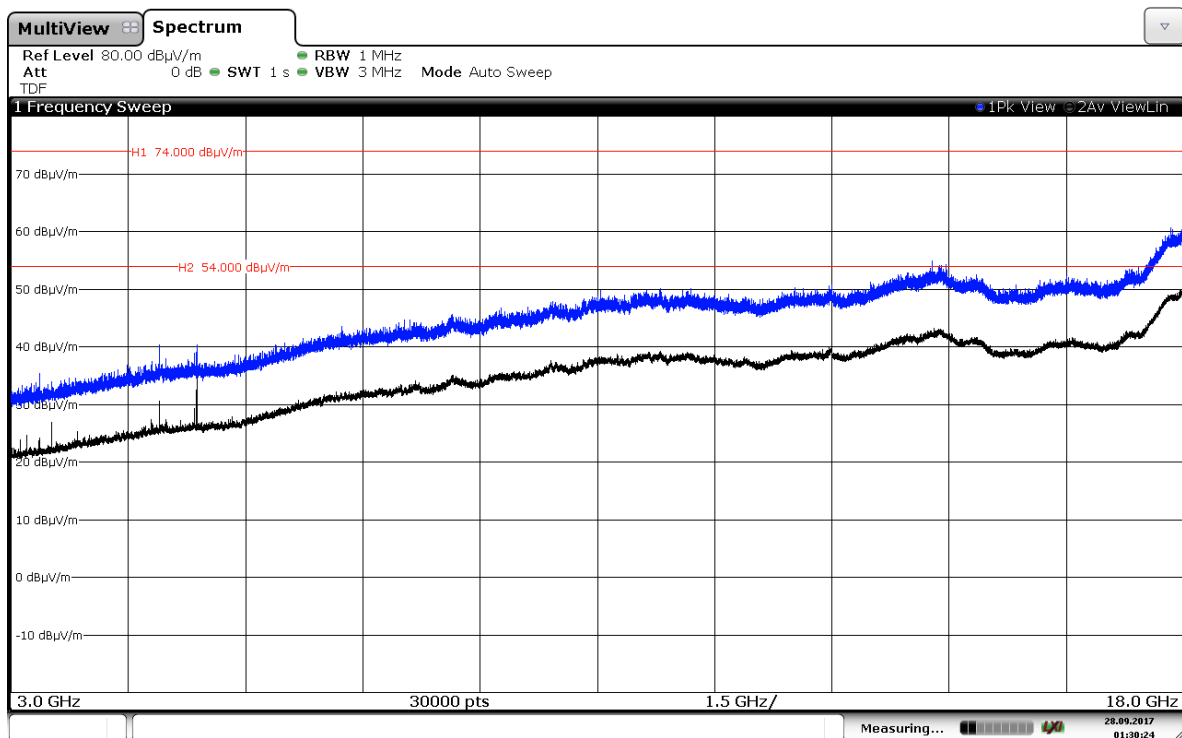


CHANNEL: Highest (2480 MHz).

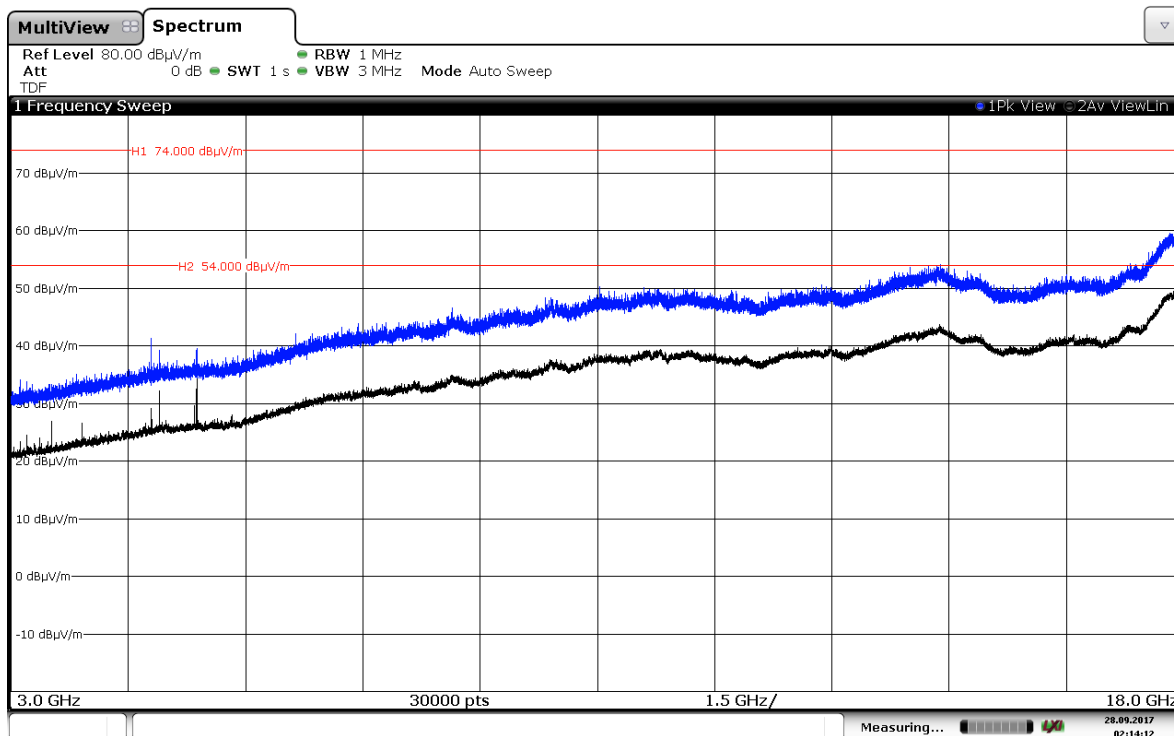


Modulation: $\Pi/4$ -DQPSK

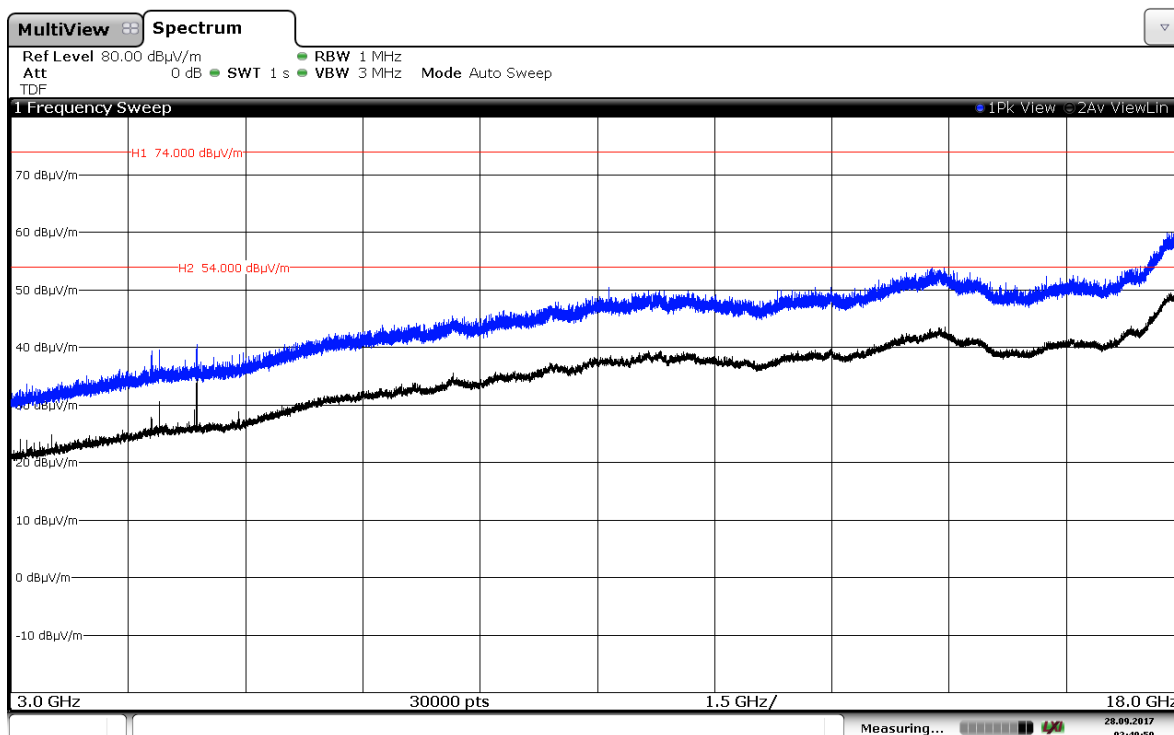
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

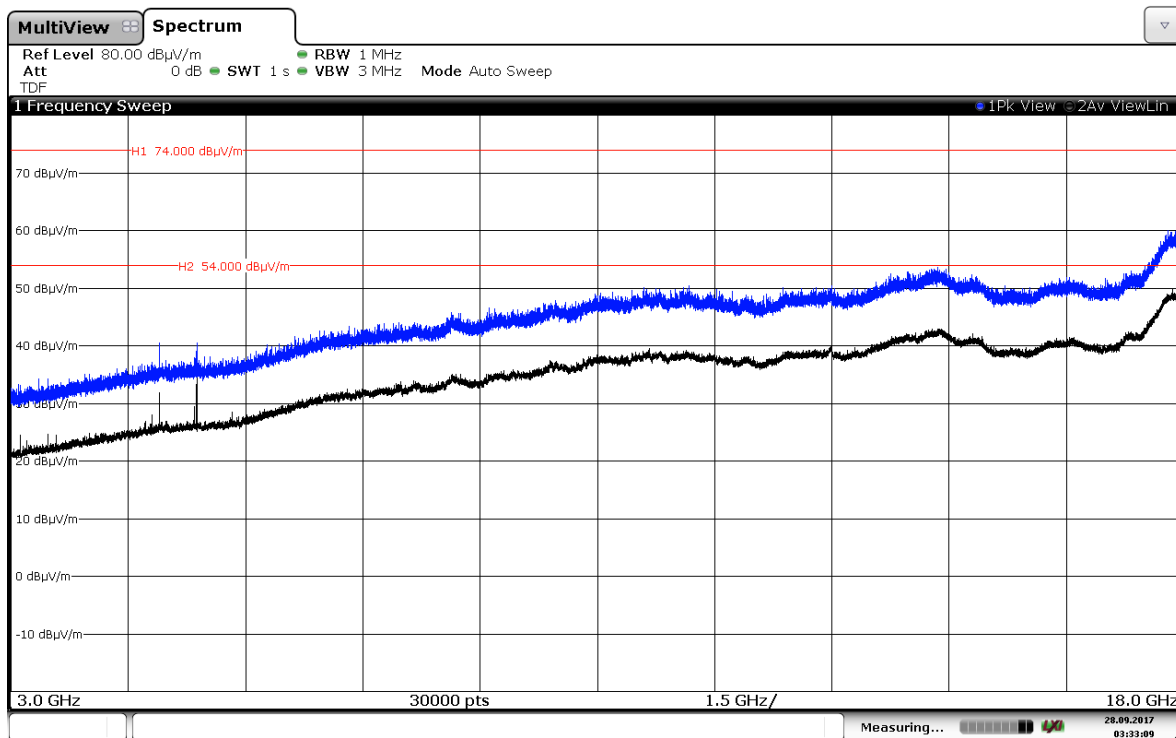


CHANNEL: Highest (2480 MHz).

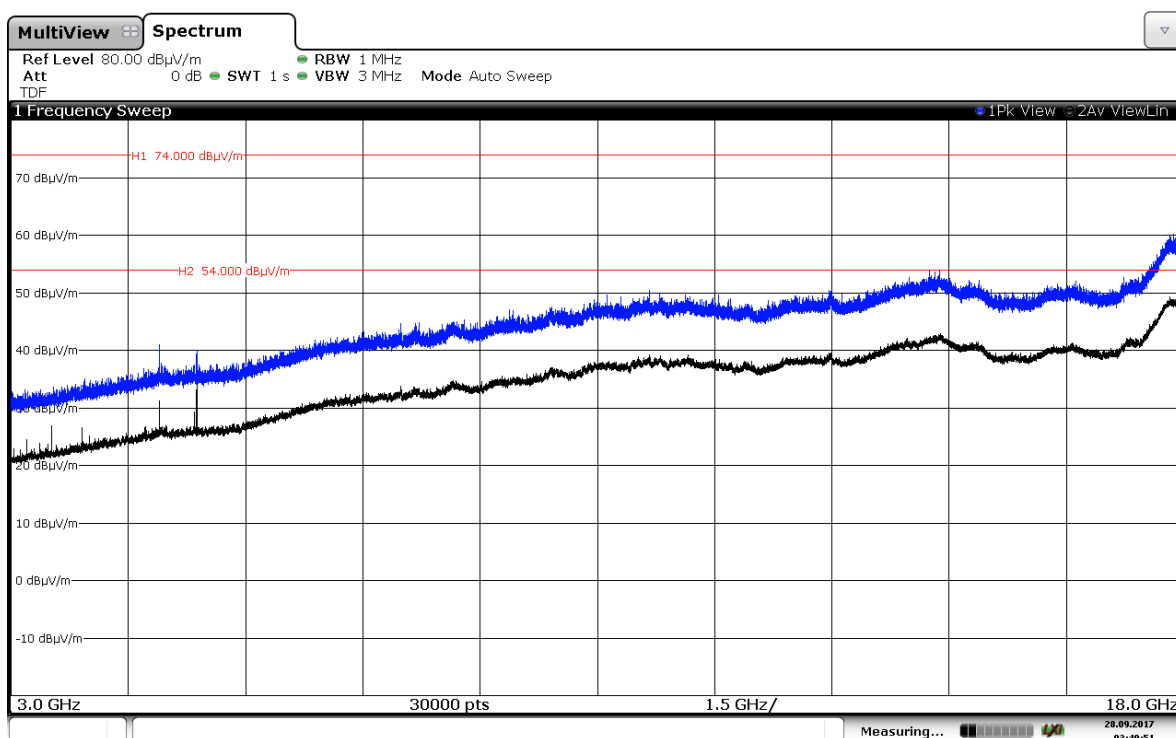


Modulation: 8-DPSK

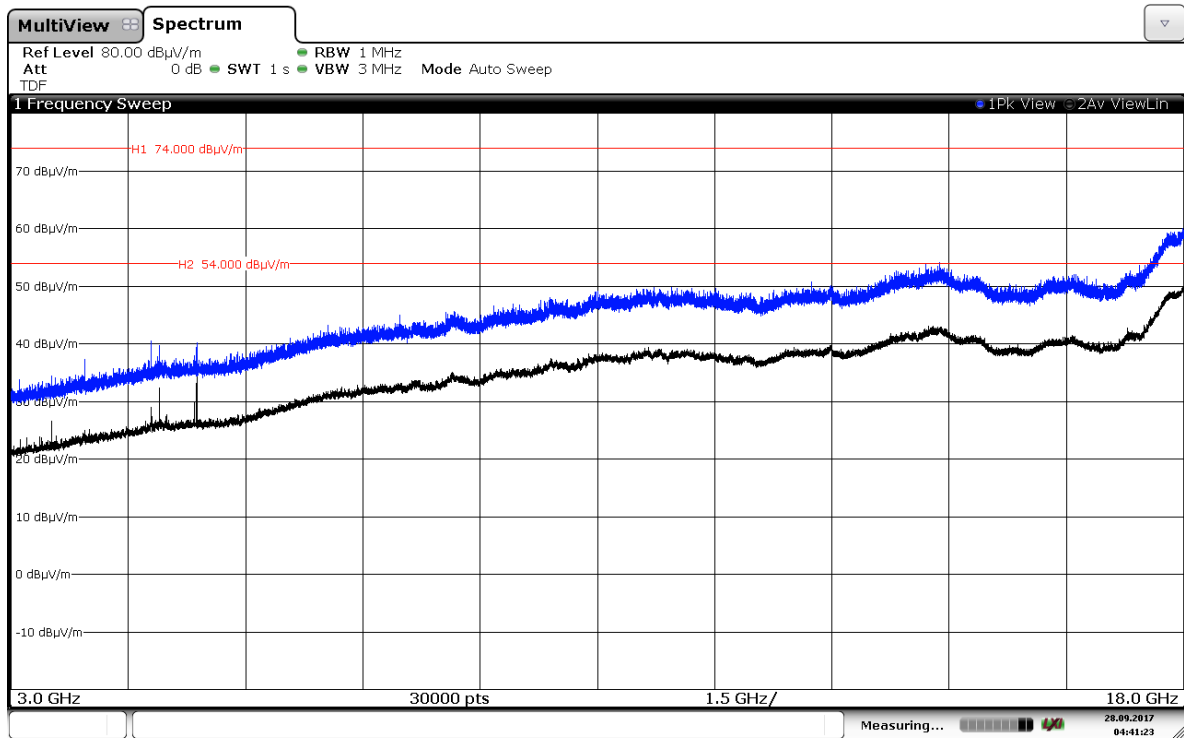
CHANNEL: Lowest (2402 MHz).



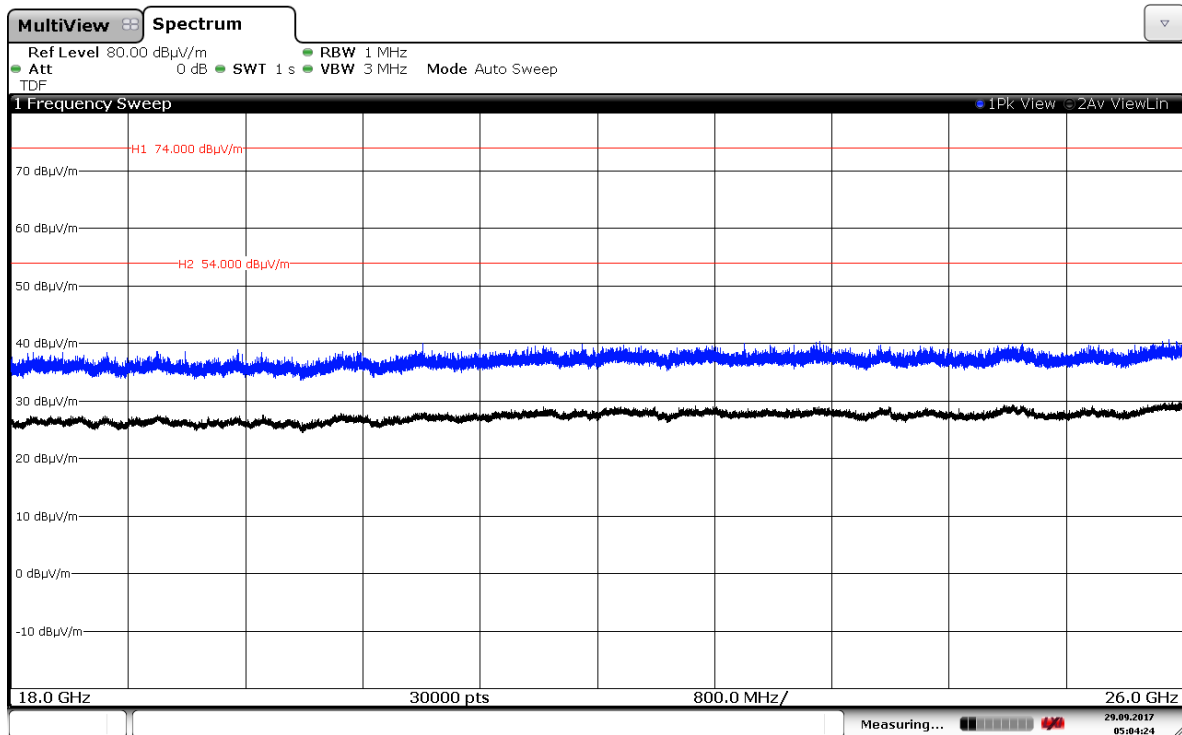
CHANNEL: Middle (2441 MHz).



CHANNEL: Highest (2480 MHz).



FREQUENCY RANGE 18 GHz to 26 GHz.

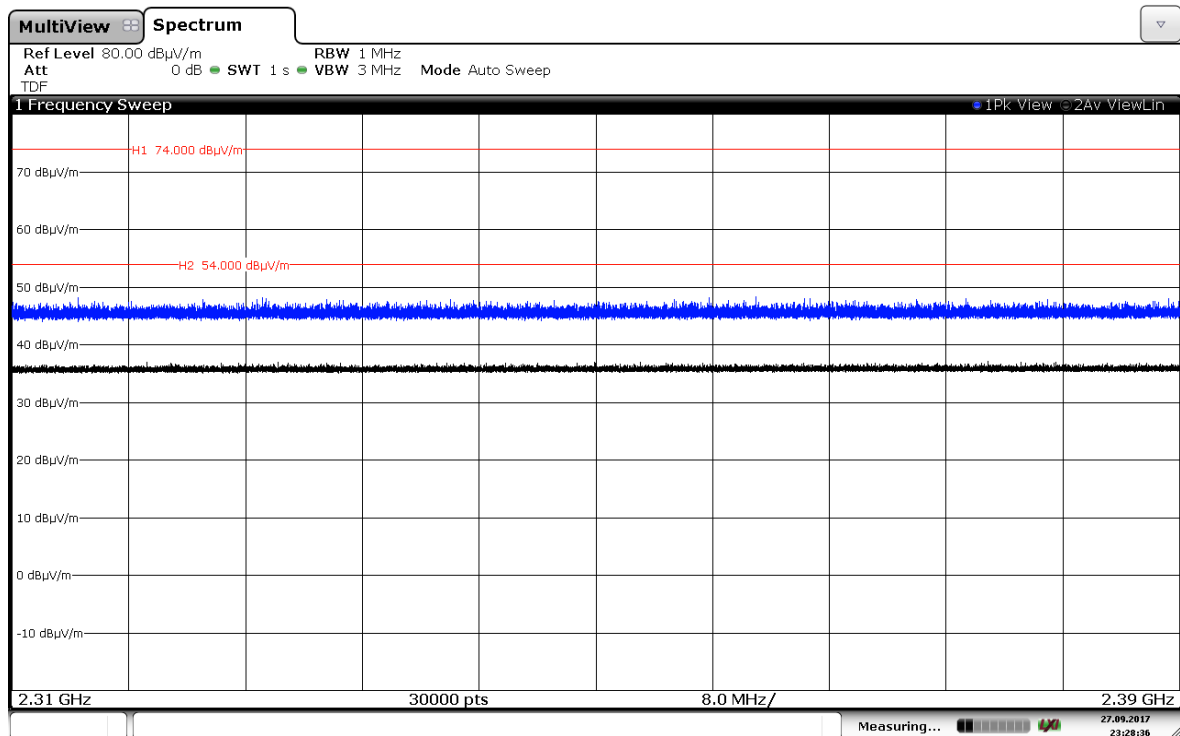


(This plot is valid for all three channels and all modulation modes).

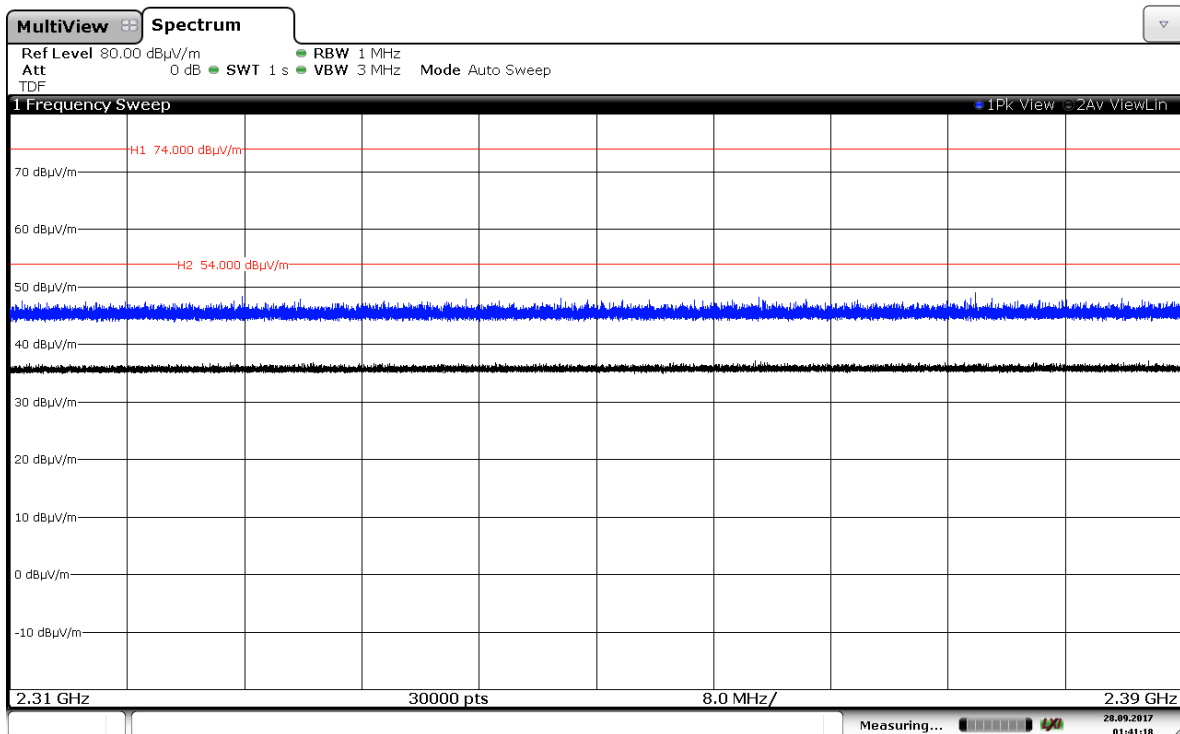
FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

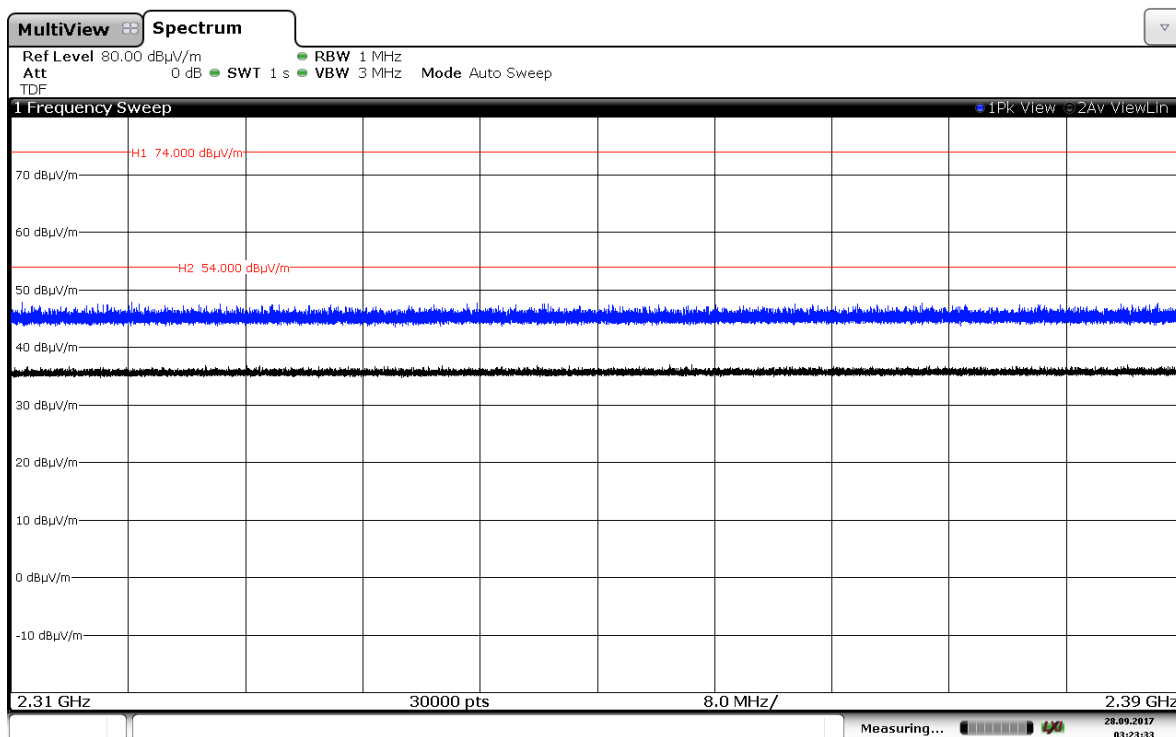
Modulation: GFSK



Modulation: Π/4-DQPSK

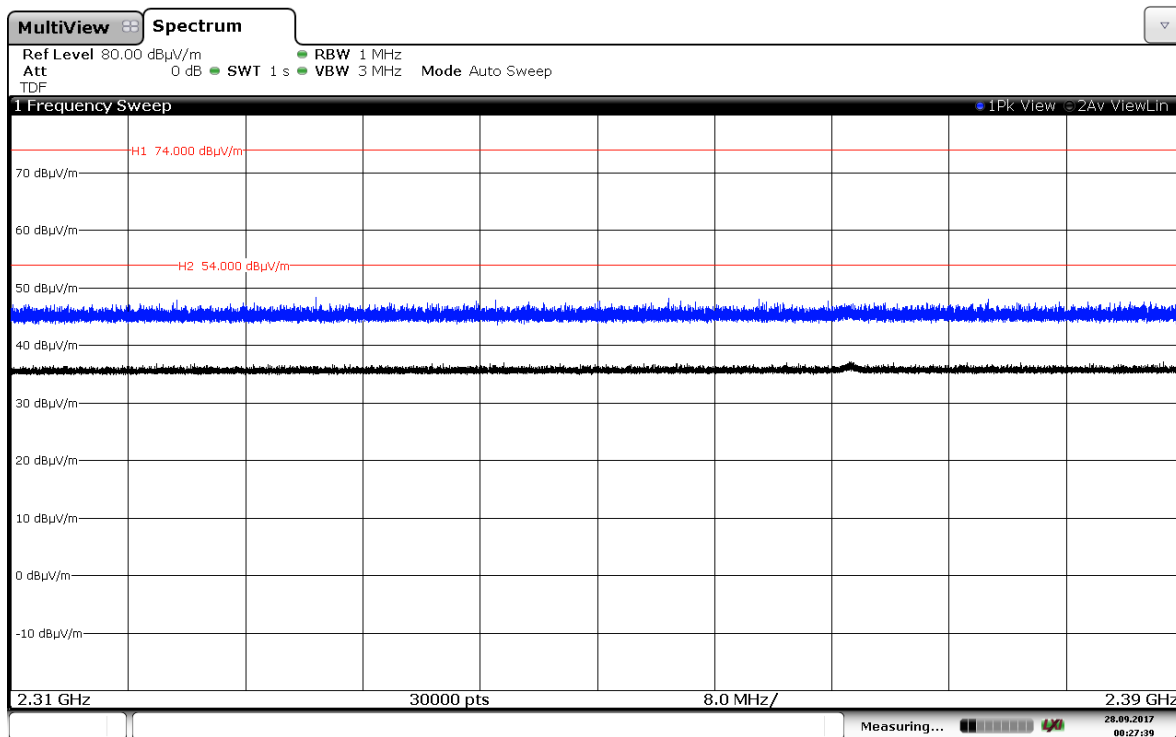


Modulation: 8-DPSK

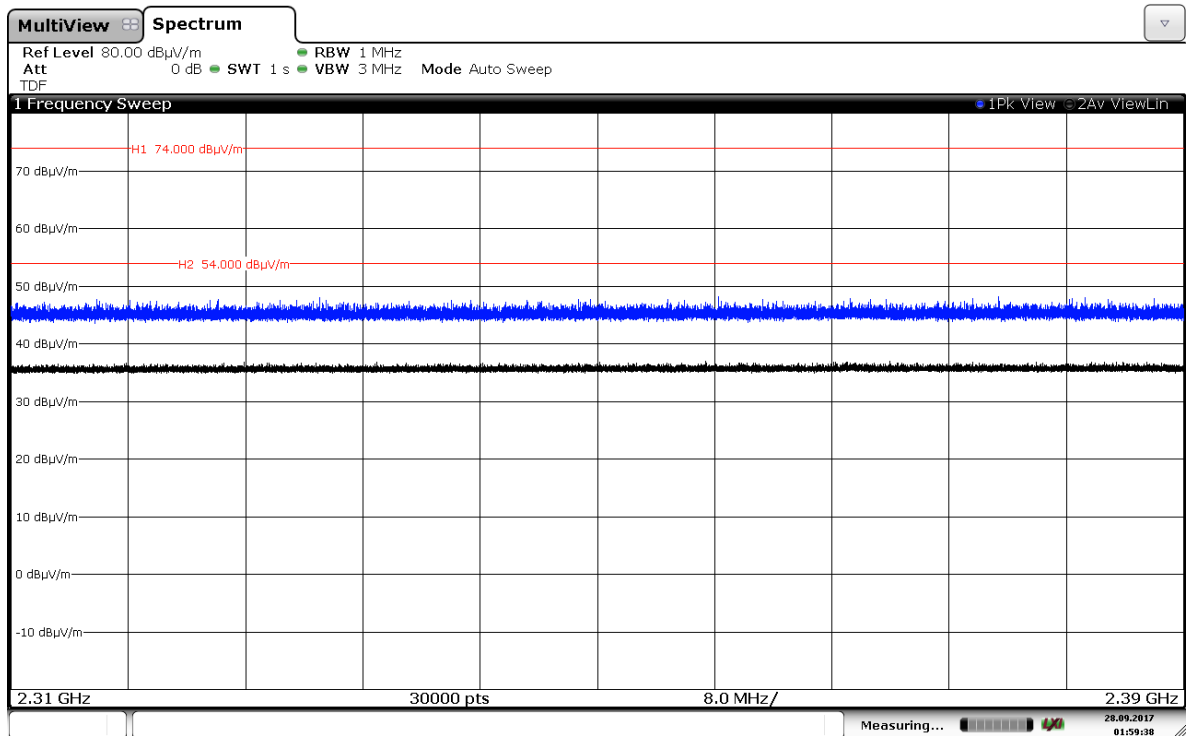


CHANNEL: Middle

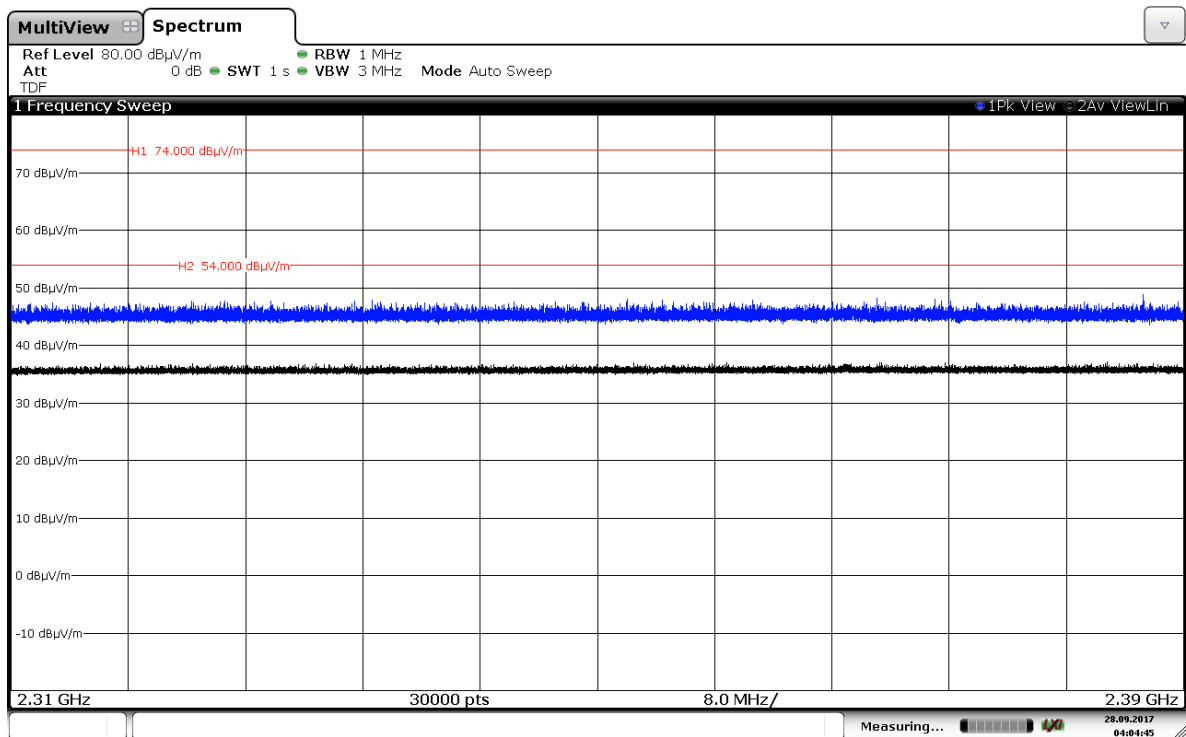
Modulation: GFSK



Modulation: $\Pi/4$ -DQPSK

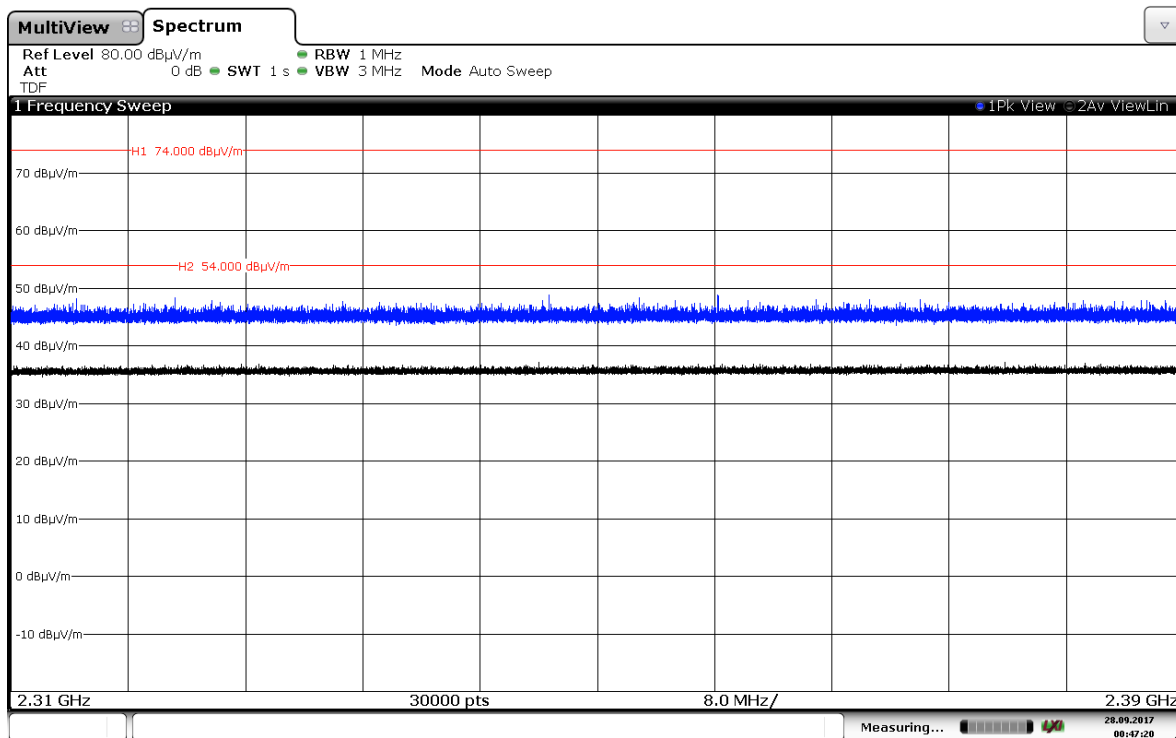


Modulation: 8-DPSK

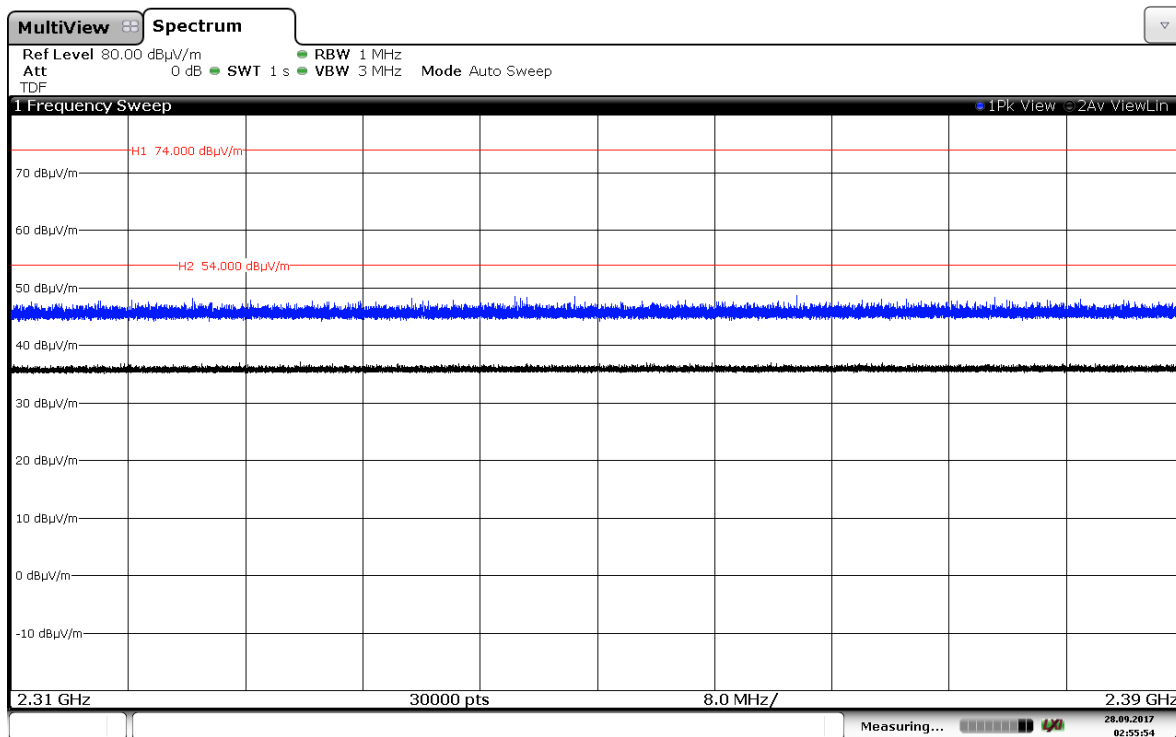


CHANNEL: Highest

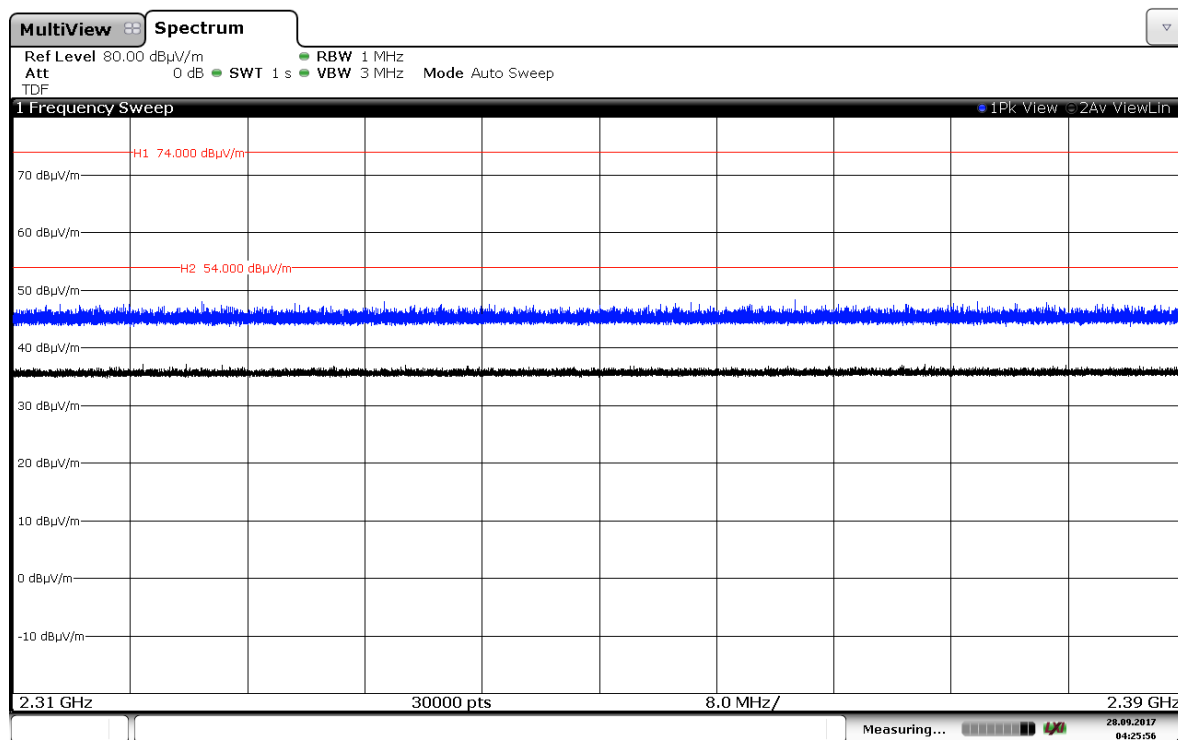
Modulation: GFSK



Modulation: Π/4-DQPSK



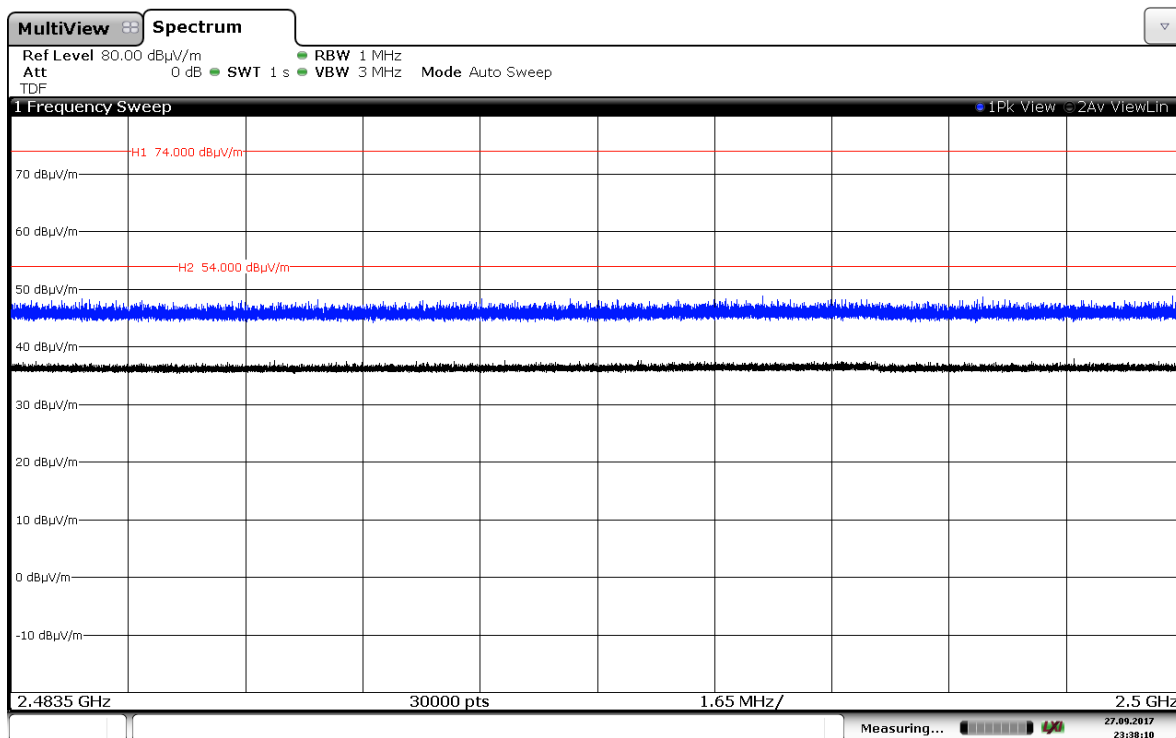
Modulation: 8-DPSK



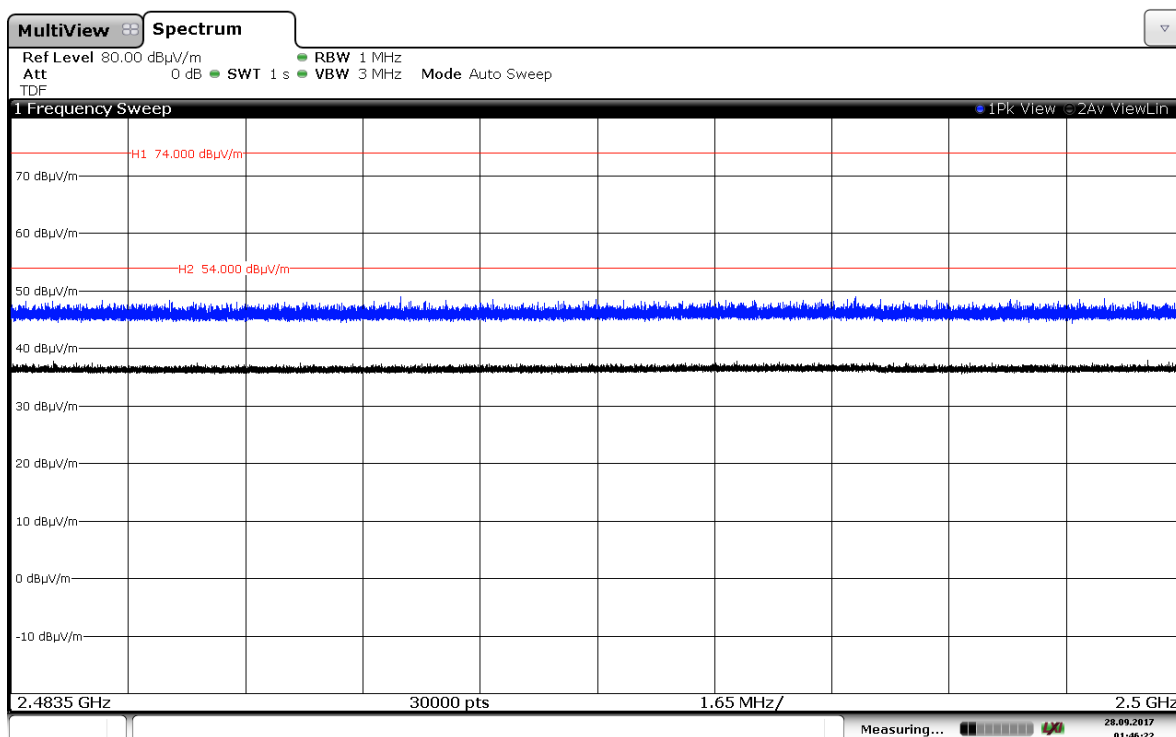
FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

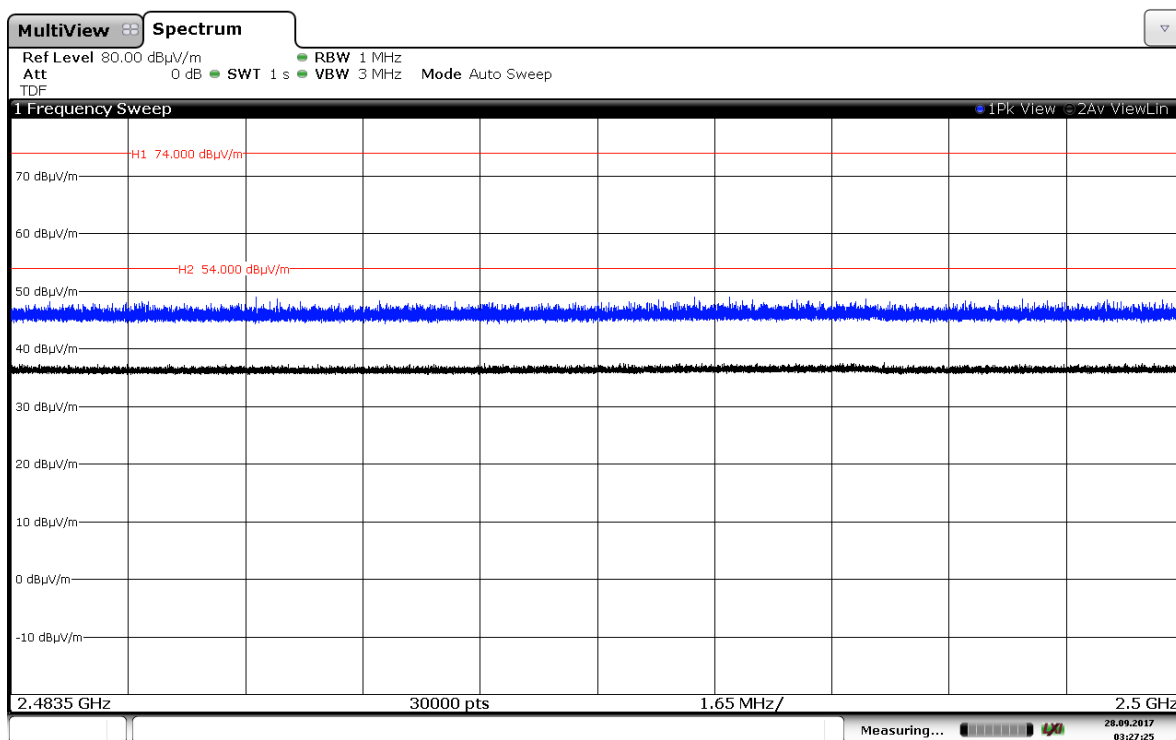
Modulation: GFSK



Modulation: $\Pi/4$ -DQPSK

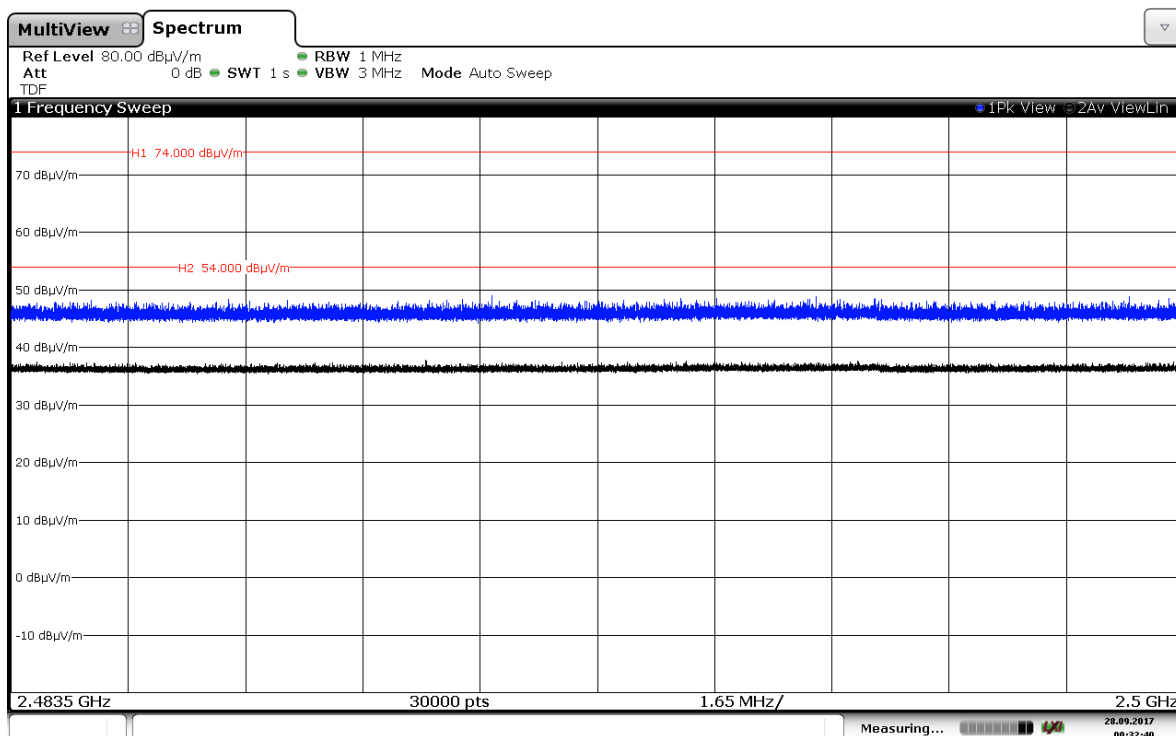


Modulation: 8-DPSK

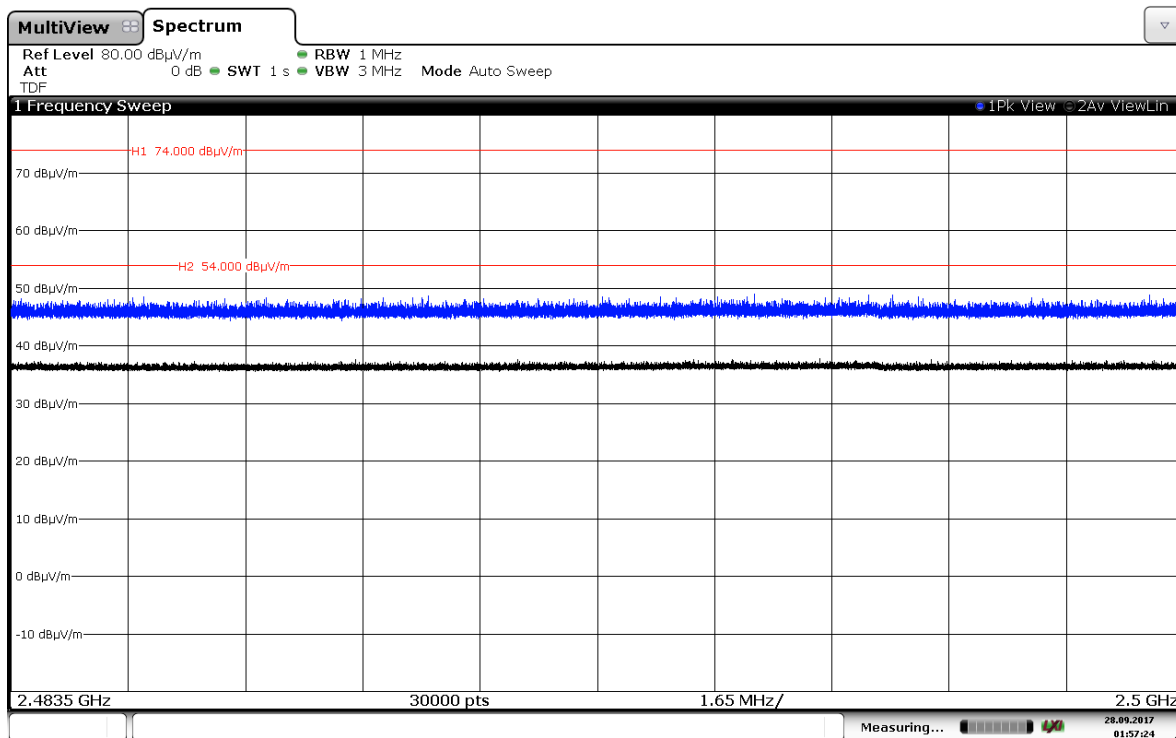


CHANNEL: Middle

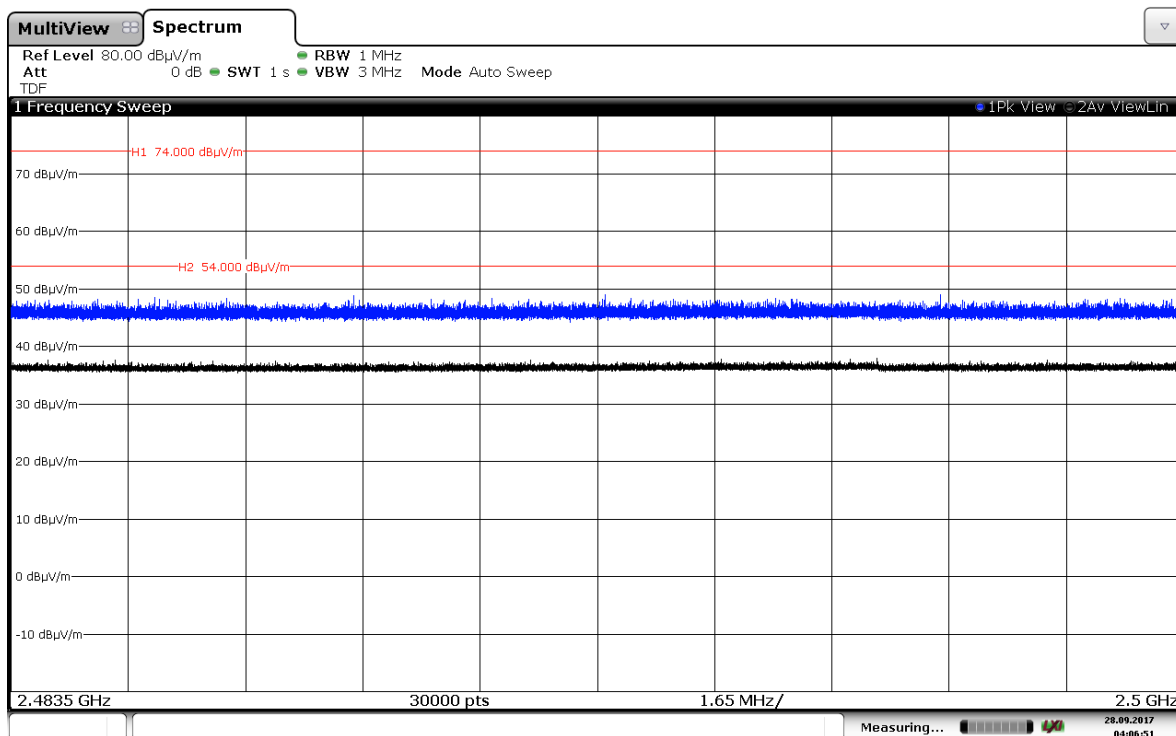
Modulation: GFSK



Modulation: $\Pi/4$ -DQPSK

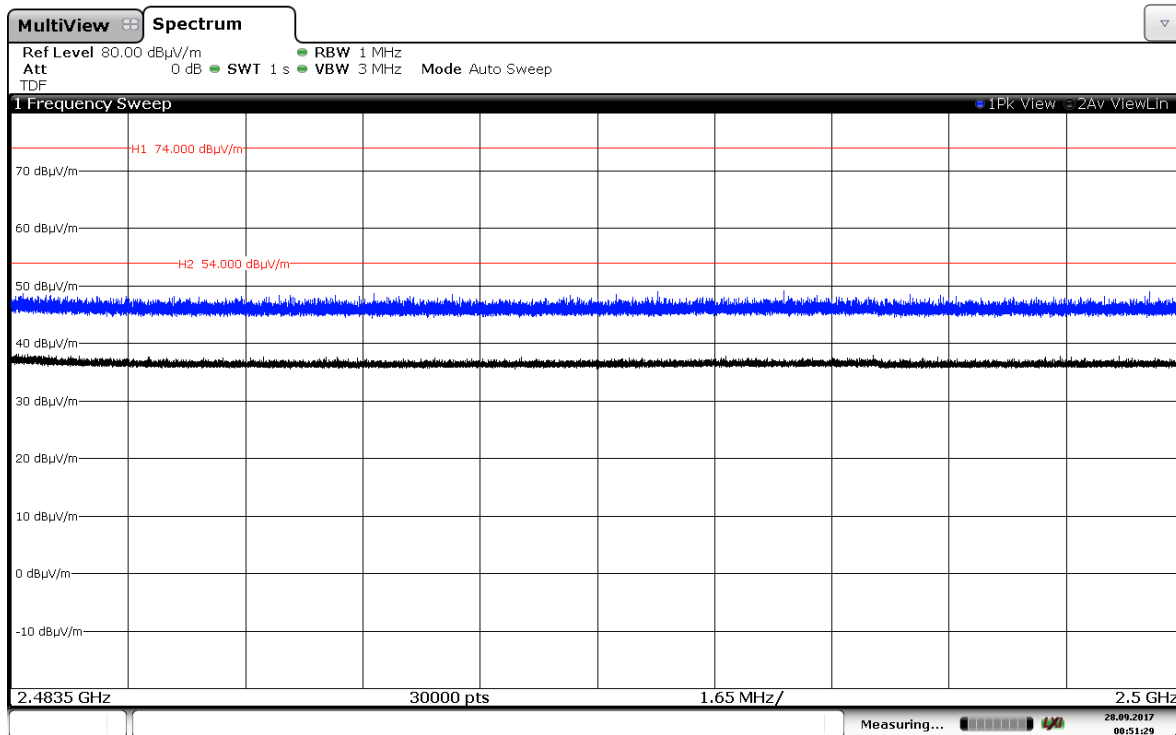


Modulation: 8-DPSK

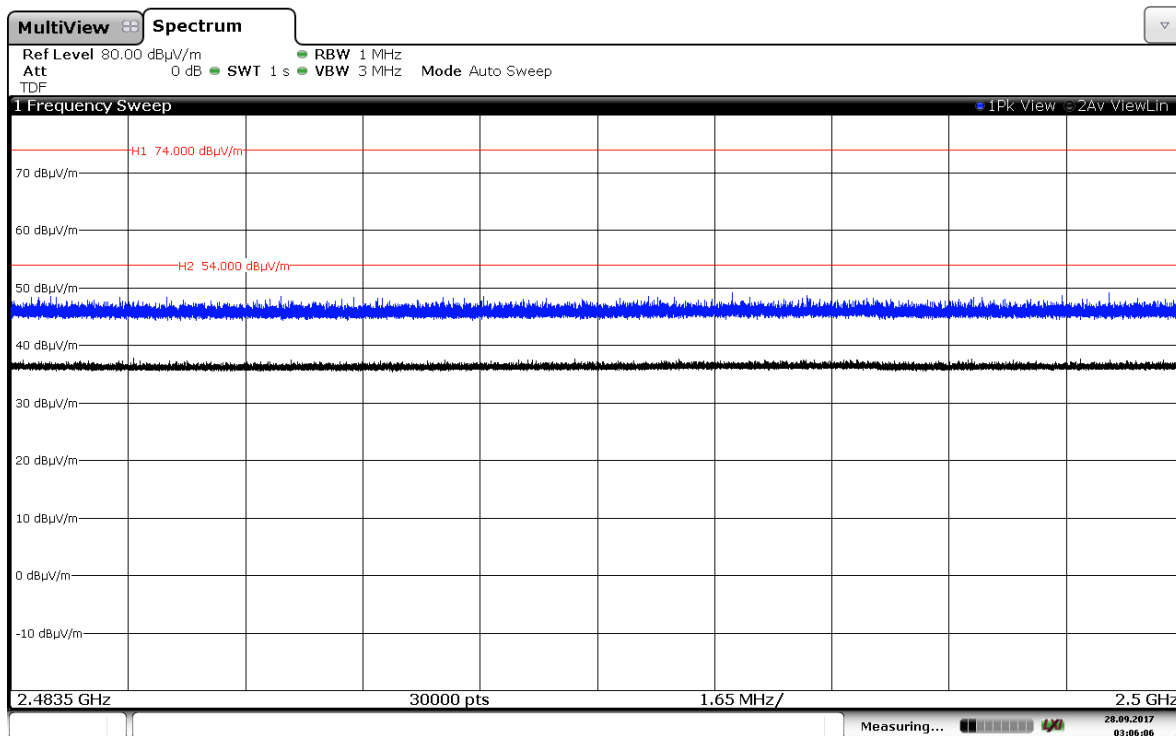


CHANNEL: Highest

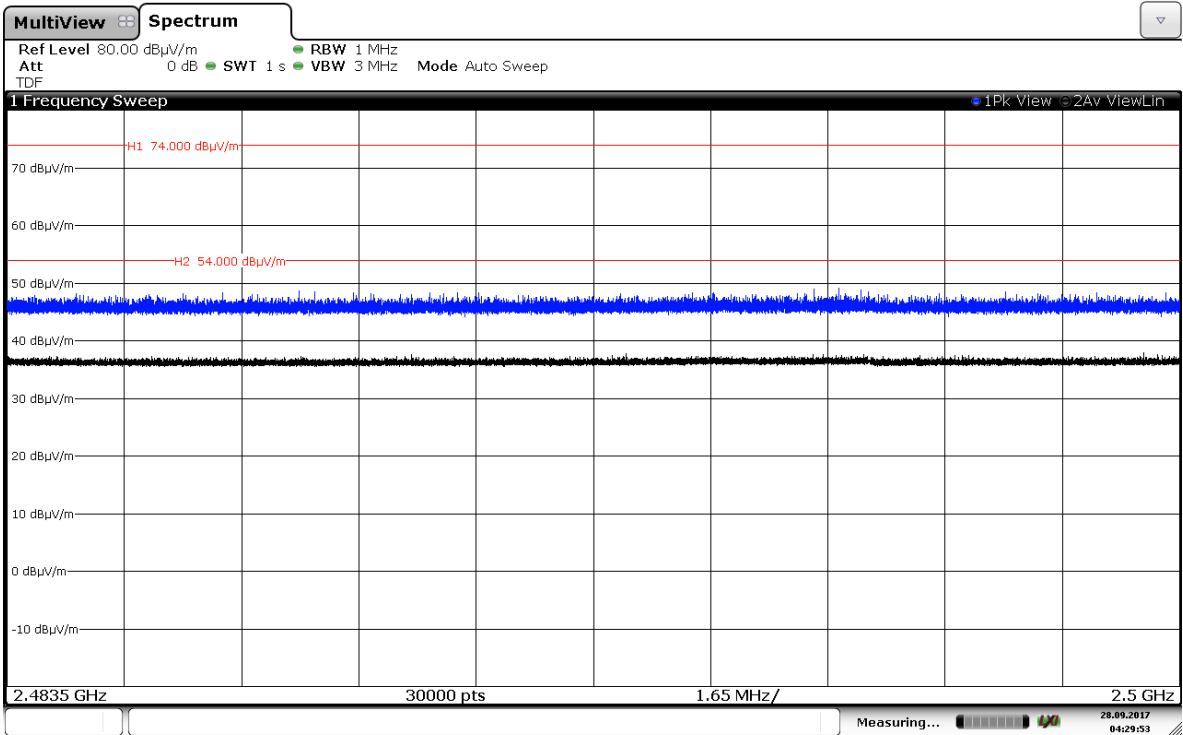
Modulation: GFSK



Modulation: $\Pi/4$ -DQPSK



Modulation: 8-DPSK



Appendix B – Test result “WiFi 2.4 GHz (802.11b/g/n20/n40)”

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TEST CONDITIONS

Power supply (V):

$V_{\text{nominal}} = 12.6 \text{ Vdc}$

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

Type of antenna: External antenna.

Declared Gain for antenna RF port 1 (maximum): +2.2 dBi. (Antenna gain plus antenna cable loss).

TEST FREQUENCIES:

For WiFi 802.11b/g/n20:

Lowest channel (1): 2412 MHz

Middle channel (6): 2437 MHz

Highest channel (11): 2462 MHz

For WiFi 802.11n40:

Lowest channel (3): 2422 MHz

Middle channel (6): 2437 MHz

Highest channel (9): 2452 MHz

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v04 dated 04/05/2017.

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

It was necessary to change between WLAN 0 CORE 1 with antenna RF port 1.

WIFI FCC:

```
tx_test.sh -a wlan0 stop
```

B

```
tx_test.sh -a wlan0 1 1 -d x -r 1 20
```

```
tx_test.sh -a wlan0 6 1 -d x -r 1 20
```

```
tx_test.sh -a wlan0 11 1 -d x -r 1 20
```

G

```
tx_test.sh -a wlan0 1 1 -d x -r 6 20
```

```
tx_test.sh -a wlan0 6 1 -d x -r 6 20
```

```
tx_test.sh -a wlan0 11 1 -d x -r 6 20
```

N20

```
tx_test.sh -a wlan0 1 1 -d x -h 0 20  
tx_test.sh -a wlan0 6 1 -d x -h 0 20  
tx_test.sh -a wlan0 11 1 -d x -h 0 20
```

N40

```
tx_test.sh -a wlan0 5 1 -d x -h 0 40  
tx_test.sh -a wlan0 8 1 -d x -h 0 40  
tx_test.sh -a wlan0 11 1 -d x -h 0 40
```

The field strength at the band edges was evaluated for each mode for the channel under test.

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

The data rates of 1Mb/s for 802.11b, 6.5Mb/s for 802.11g, MSC0 for 802.11n20, MSC0 for 802.11n40 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and band edge levels at restricted bands.

CONDUCTED MEASUREMENTS

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



RADIATED MEASUREMENTS

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

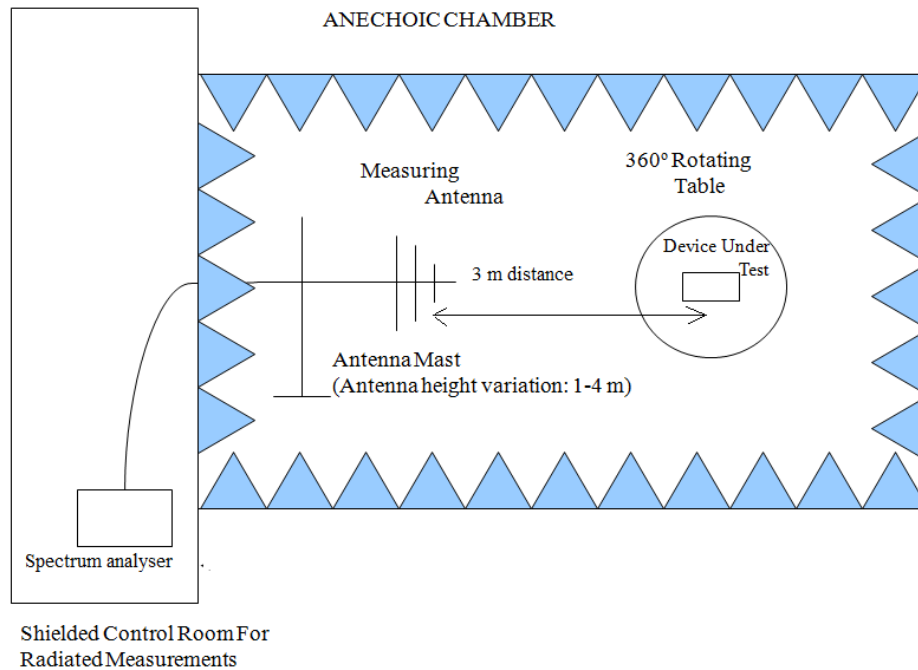
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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

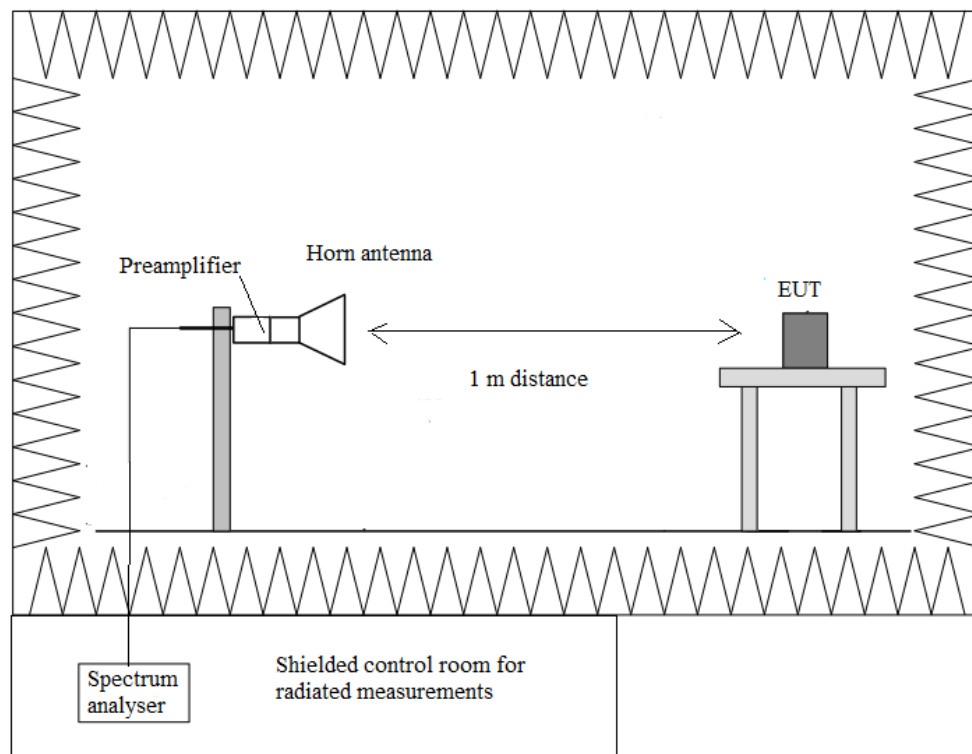
It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz



Occupied Bandwidth

RESULTS

(see next plots)

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	8,169	8,179	8,125
-26 dBc bandwidth (MHz)	10,366	10,372	10,331
Measurement uncertainty (kHz)	<±50		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	16,851	16,819	16,852
-26 dBc bandwidth (MHz)	21,273	21,276	21,353
Measurement uncertainty (kHz)	<±50		

Mode N20

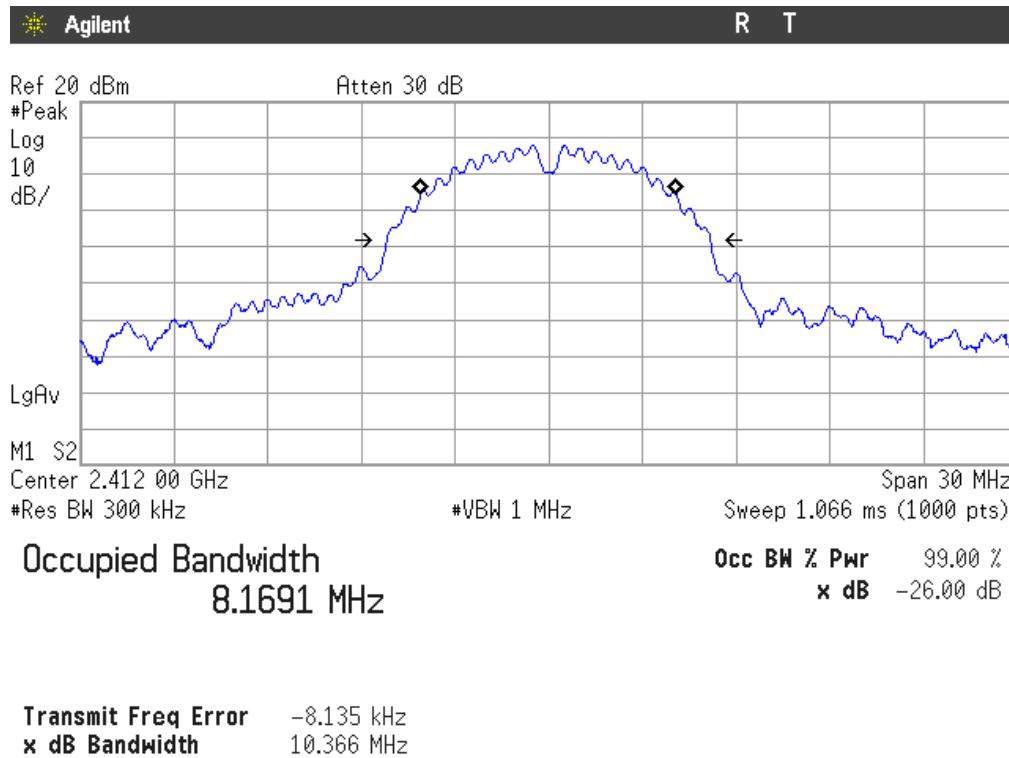
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	17,979	17,883	17,901
-26 dBc bandwidth (MHz)	21,627	21,378	21,506
Measurement uncertainty (kHz)	<±50		

Mode N40

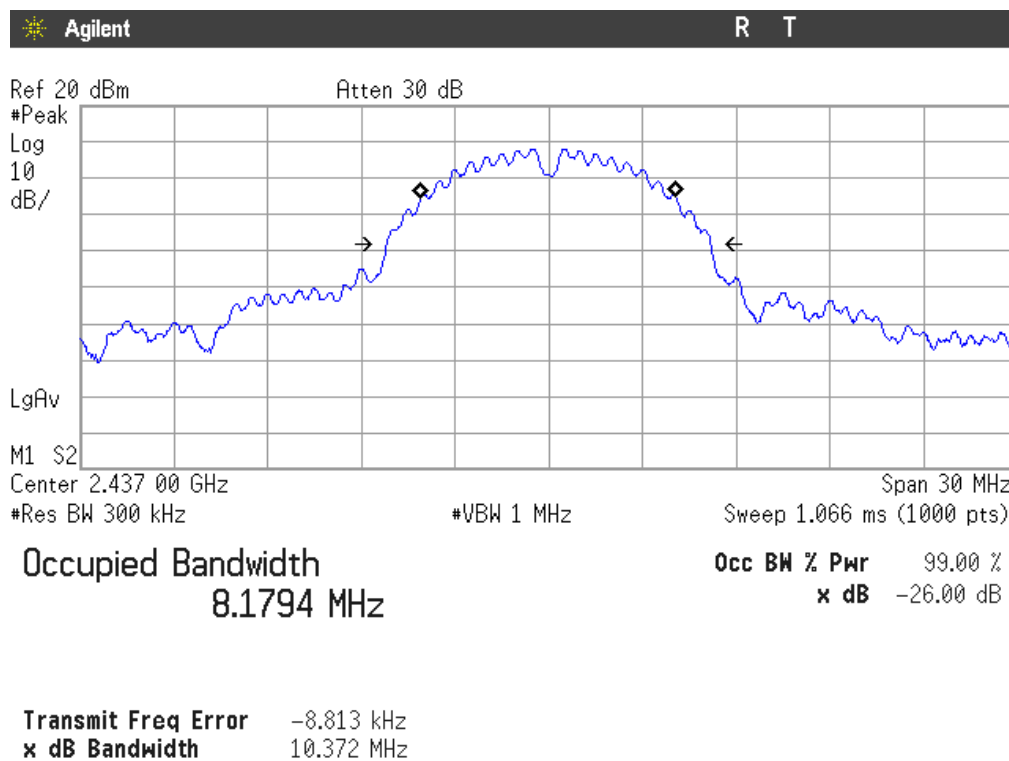
	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
99% bandwidth (MHz)	35,982	35,964	35,980
-26 dBc bandwidth (MHz)	39,922	39,571	39,203
Measurement uncertainty (kHz)	<±100		

Mode B

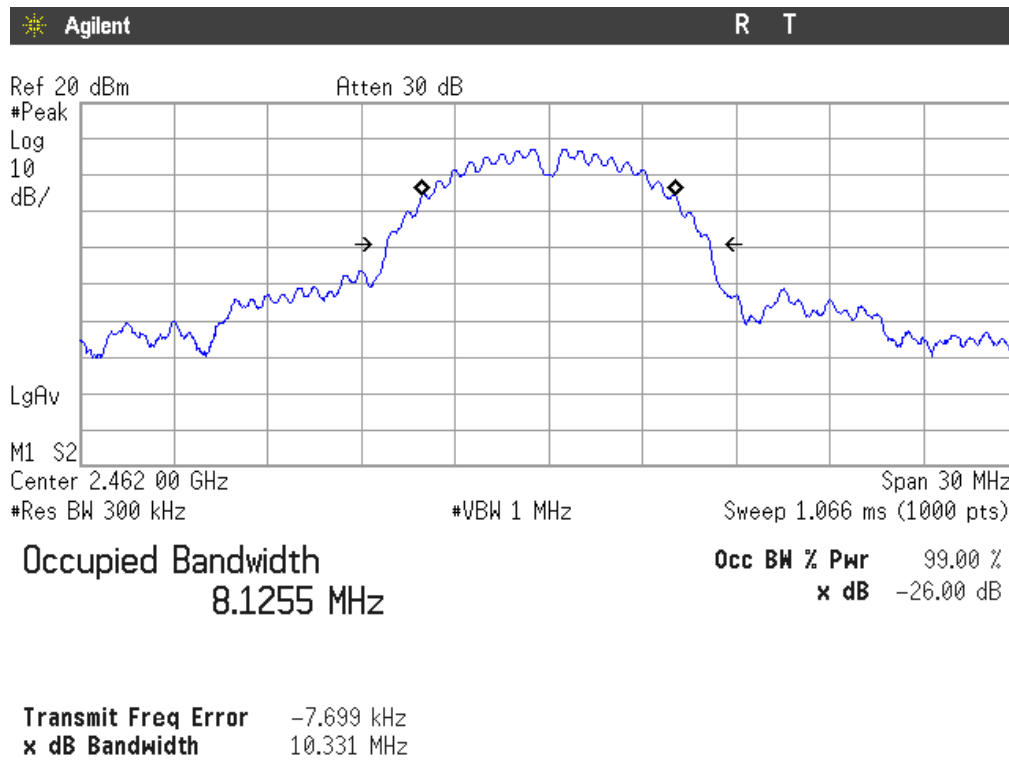
Lowest Channel



Middle Channel

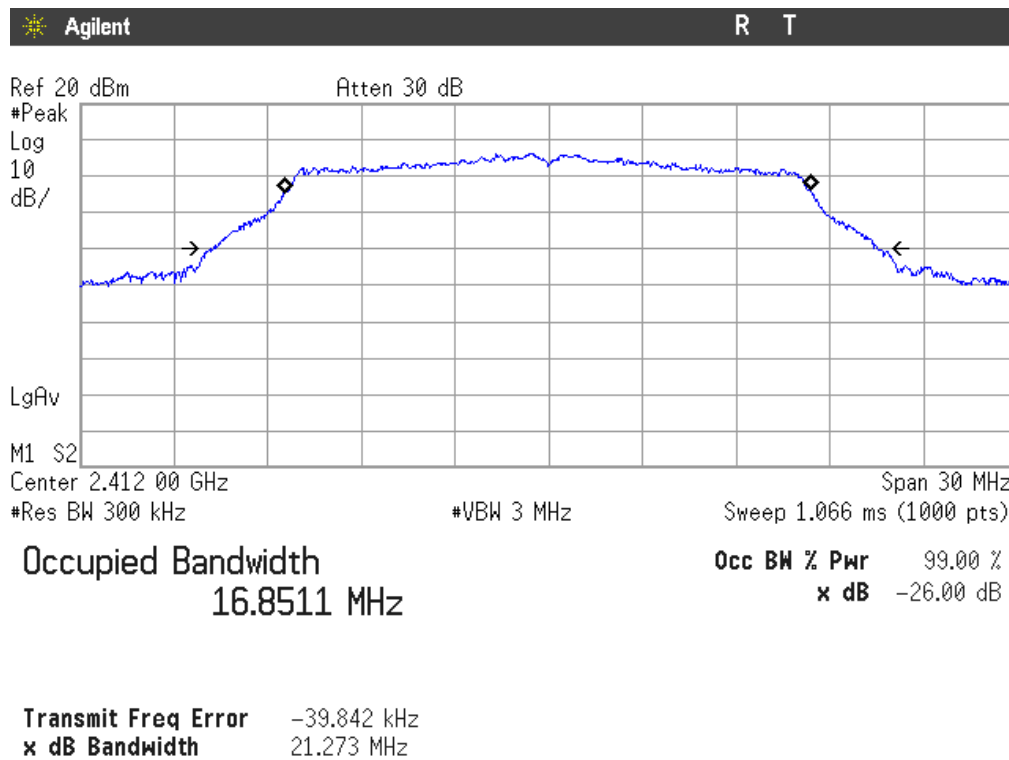


Highest channel

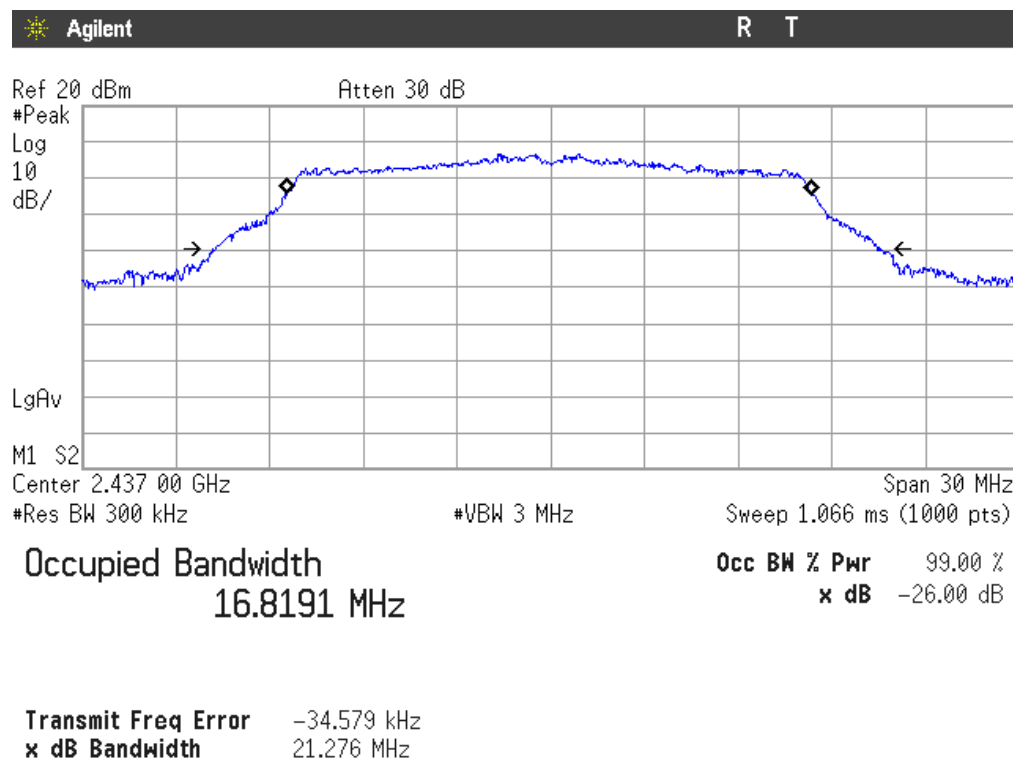


Mode G

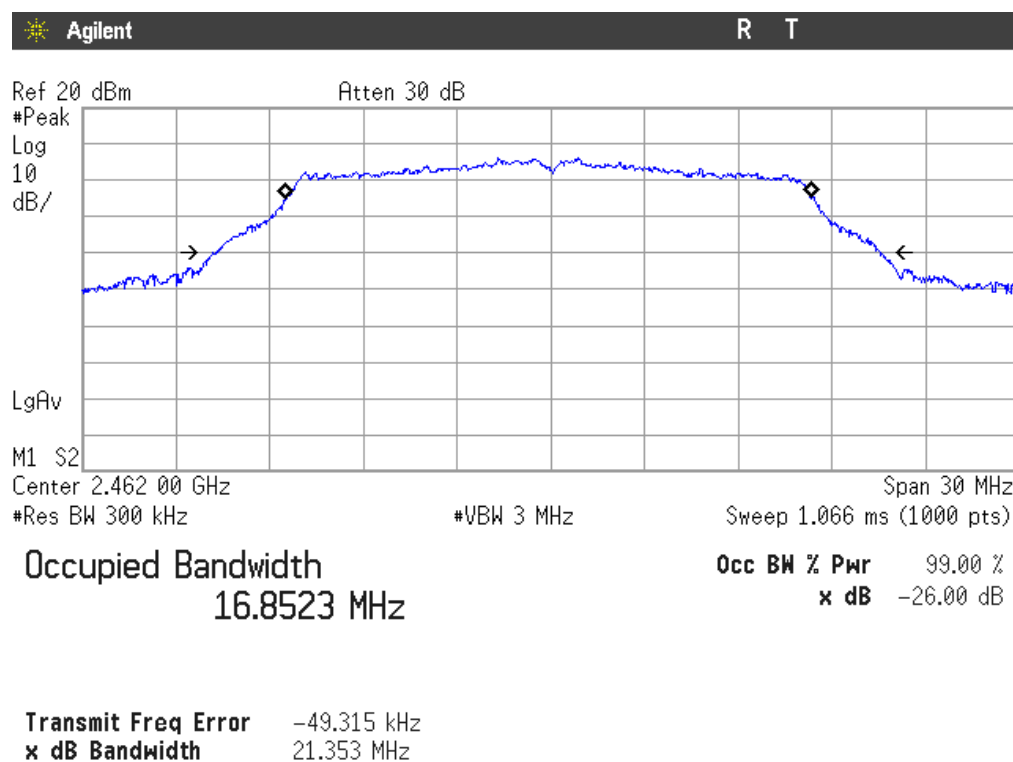
Lowest Channel



Middle Channel

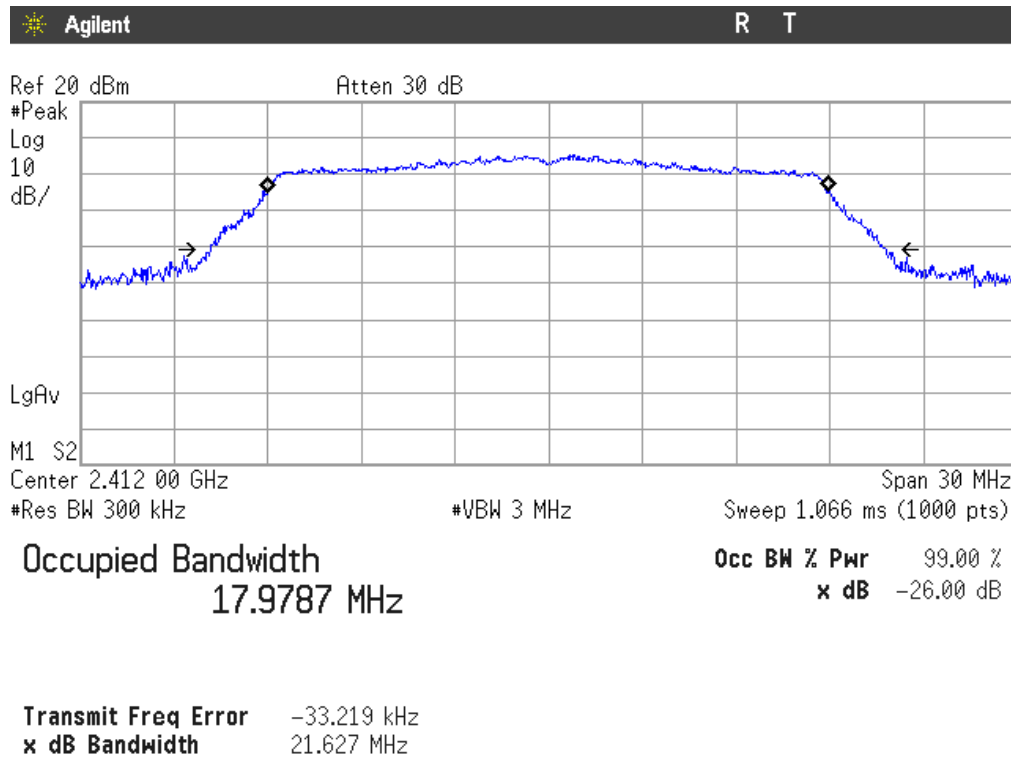


Highest channel

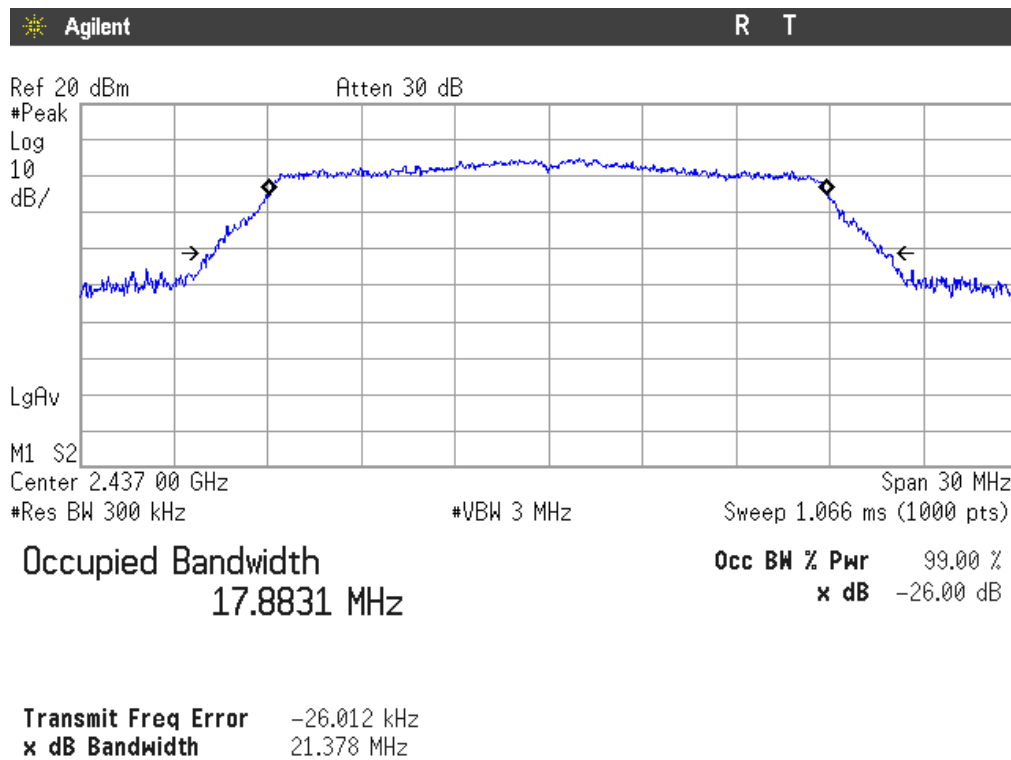


Mode N20

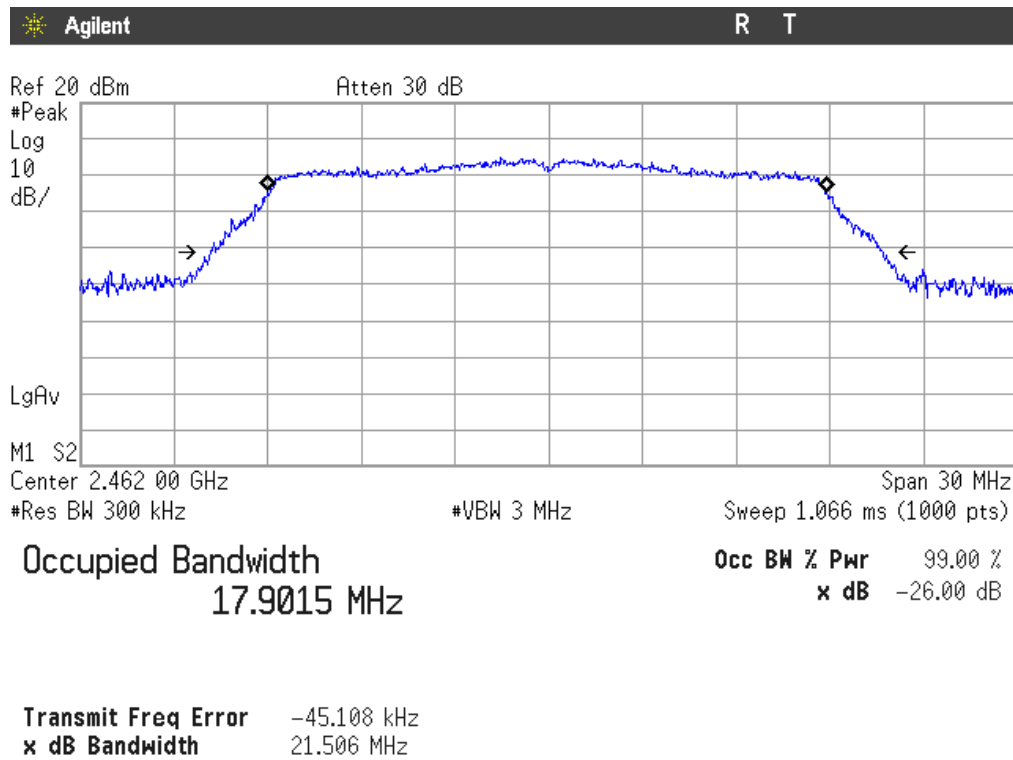
Lowest Channel



Middle Channel

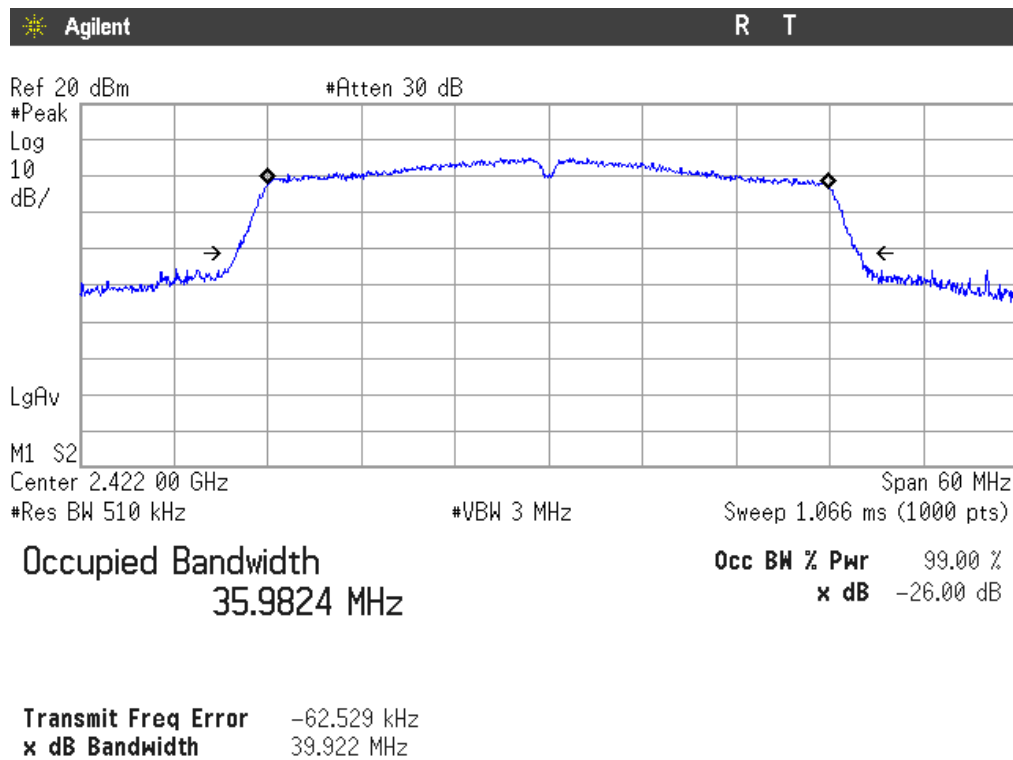


Highest channel

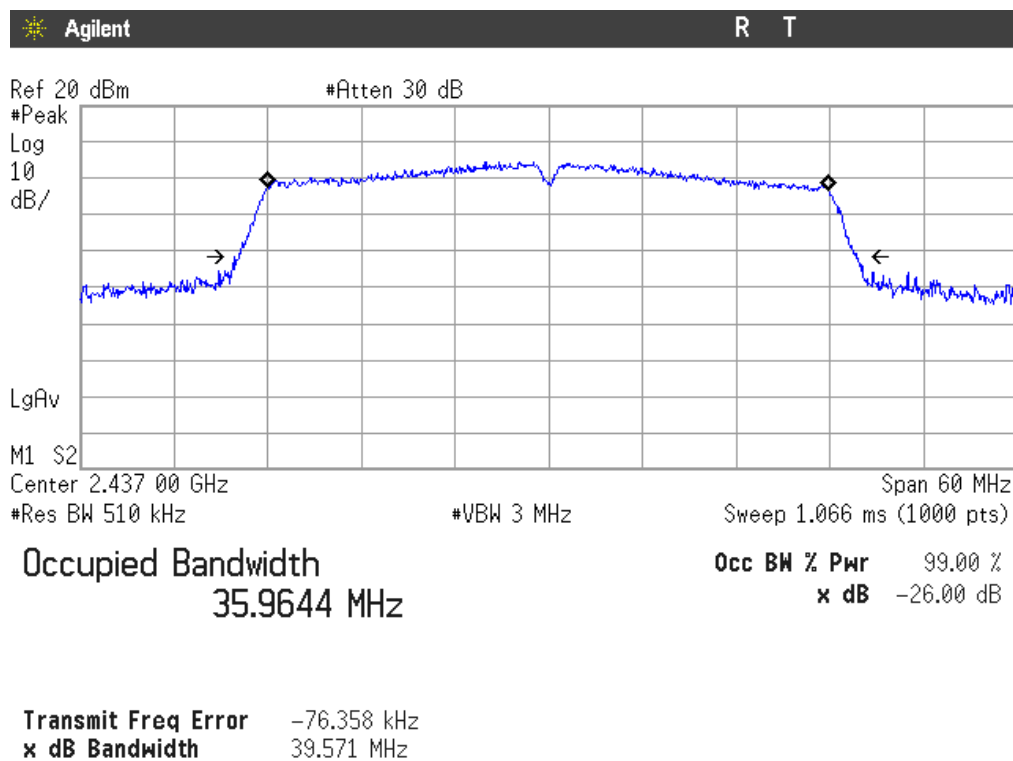


Mode N40

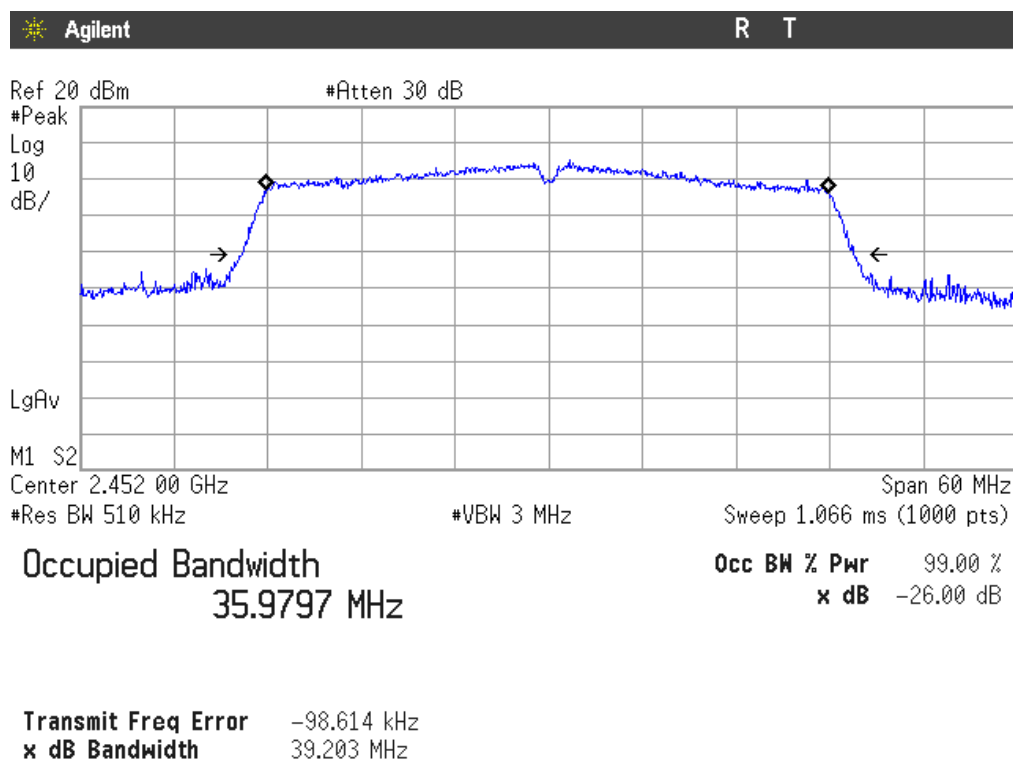
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (a) (2) / RSS-247 5.2. (1). 6 dB Bandwidth

SPECIFICATION

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

6 dB Bandwidth (see next plots).

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	8.589	9.069	8.589
Measurement uncertainty (kHz)	<±65.0		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	16.256	16.276	16.316
Measurement uncertainty (kHz)	<±65.0		

Mode N20

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	17.538	17.518	17.477
Measurement uncertainty (kHz)	<±65.0		

Mode N40

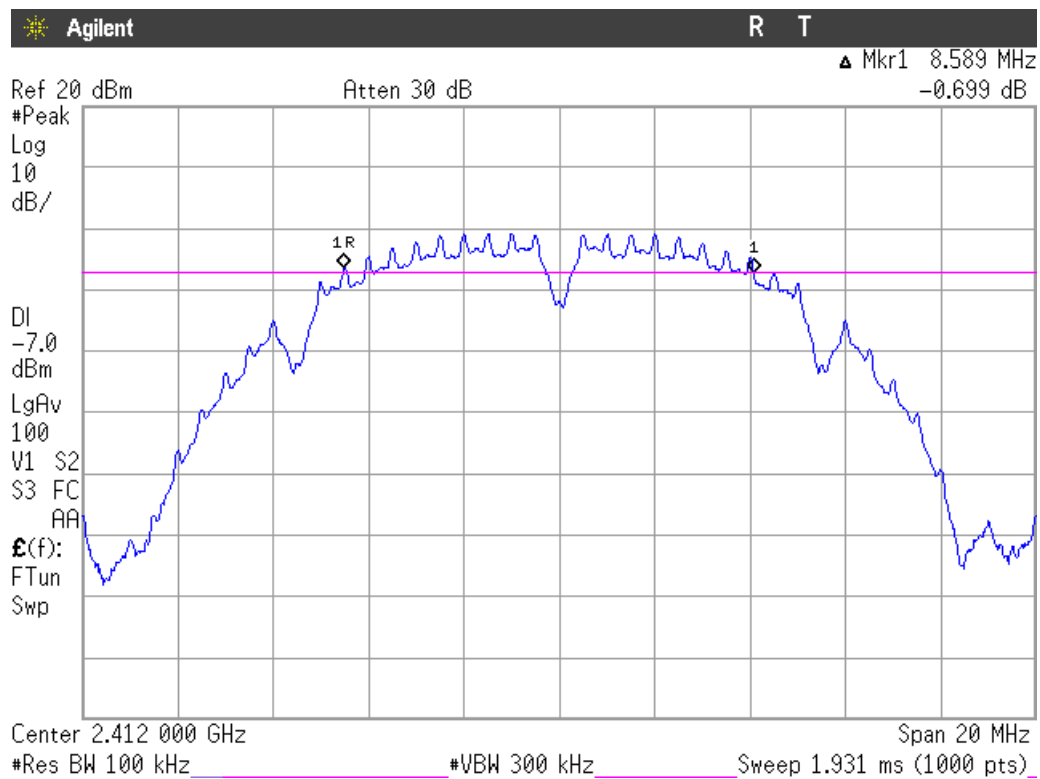
	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
6 dB Spectrum bandwidth (MHz)	35.790	35.490	35.640
Measurement uncertainty (kHz)	<±155.0		

Verdict: PASS

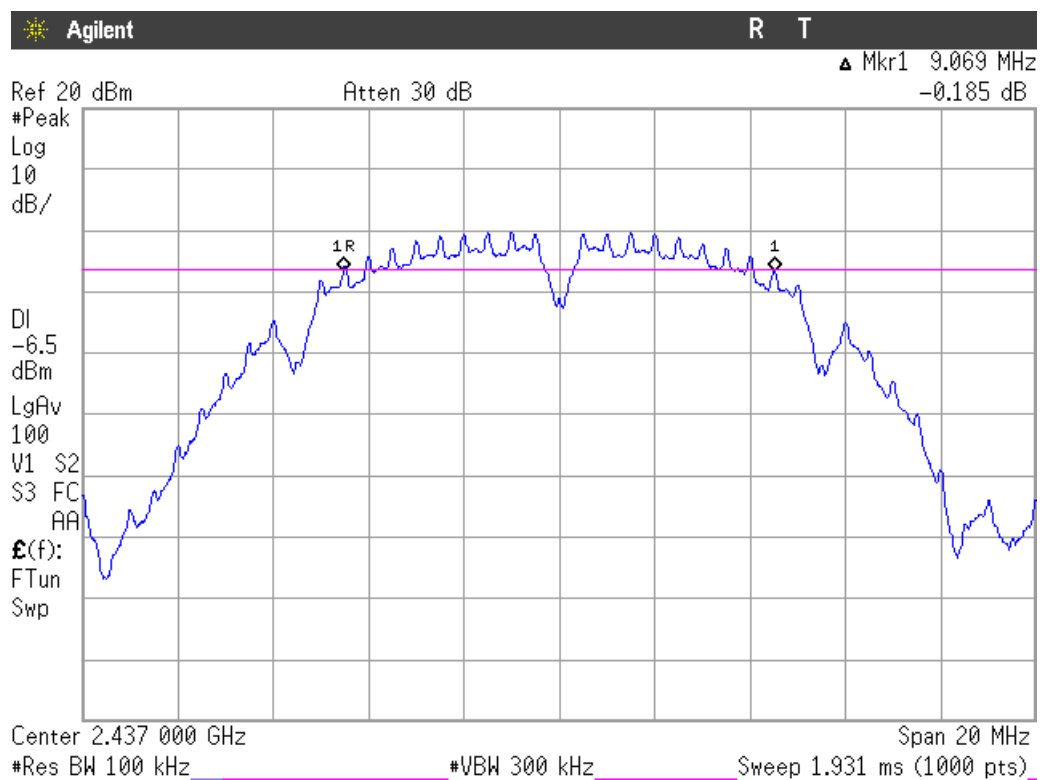
6 dB BANDWIDTH.

Mode B

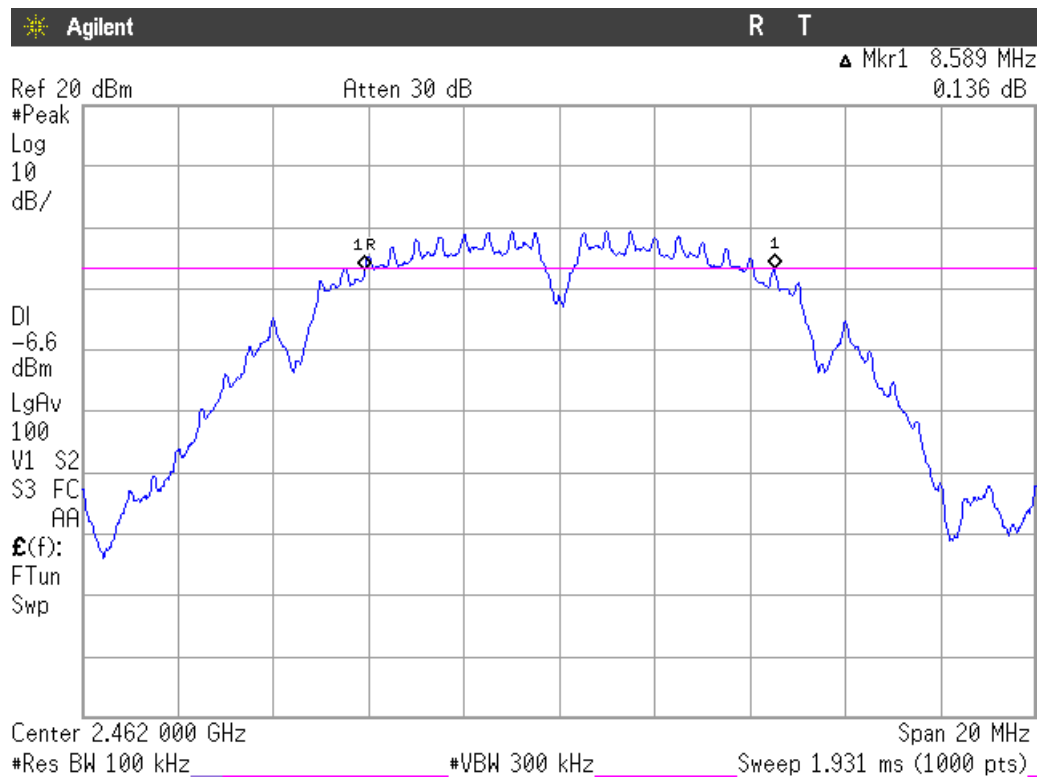
Lowest Channel



Middle Channel

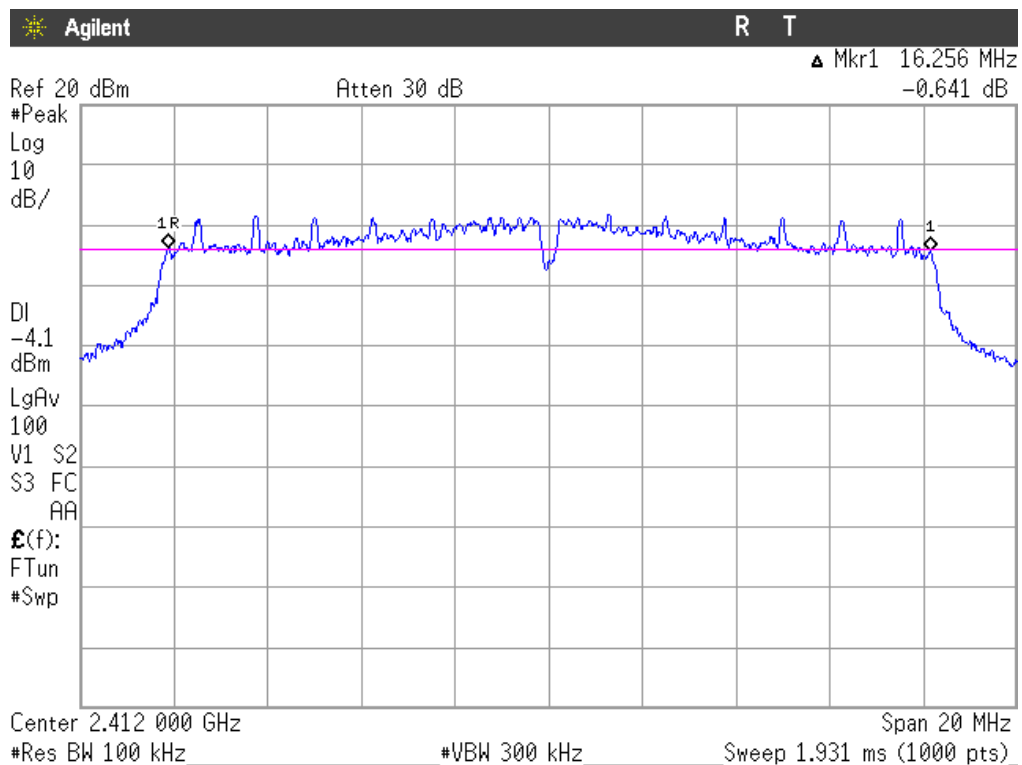


Highest channel

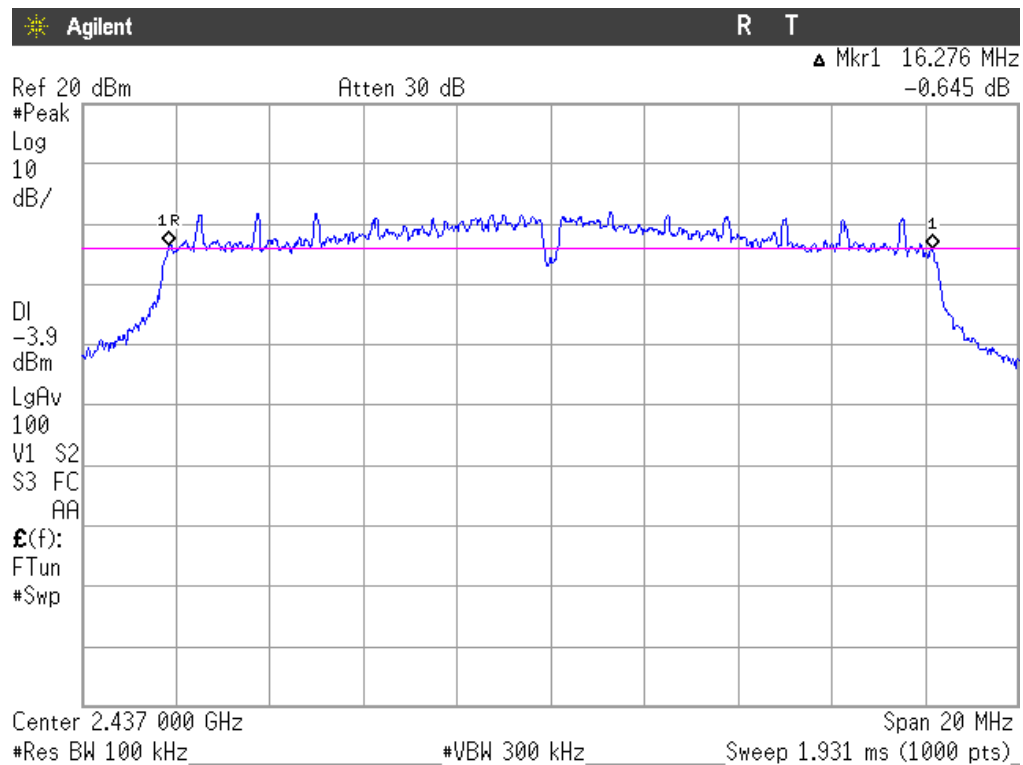


Mode G

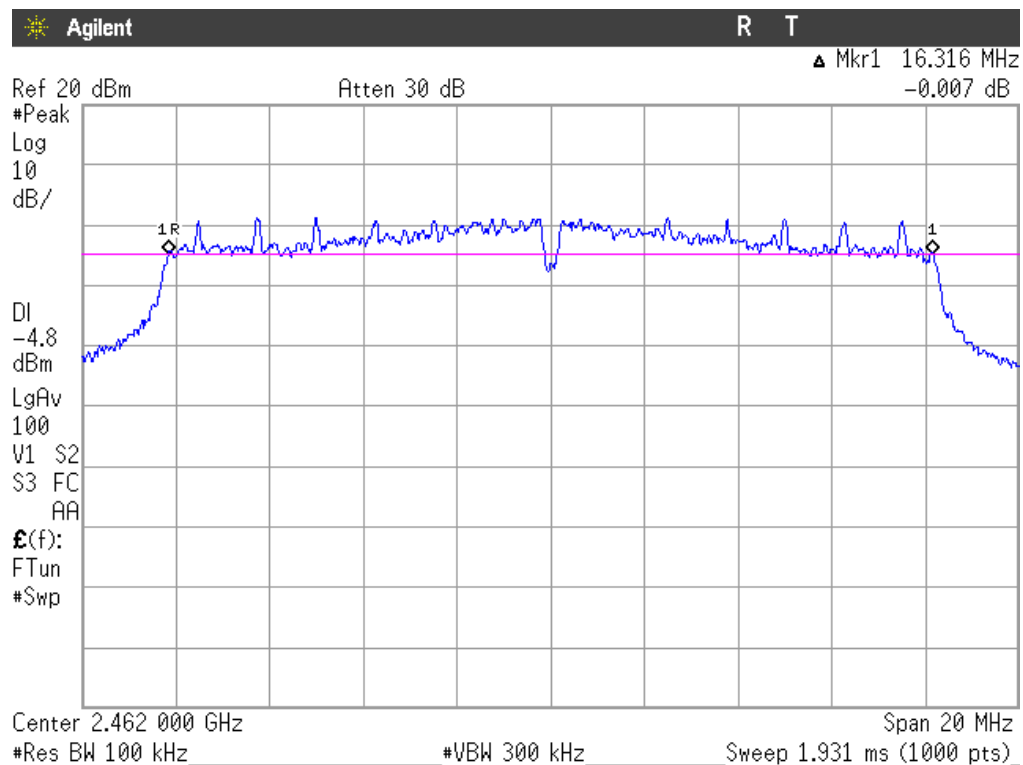
Lowest Channel



Middle Channel

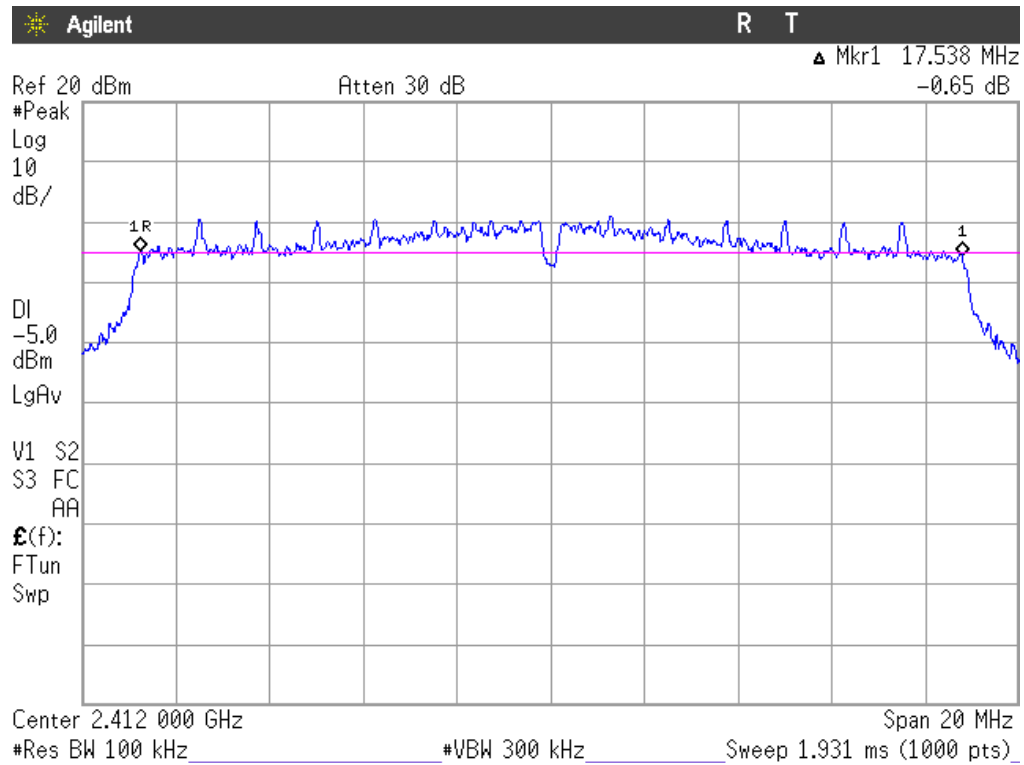


Highest channel

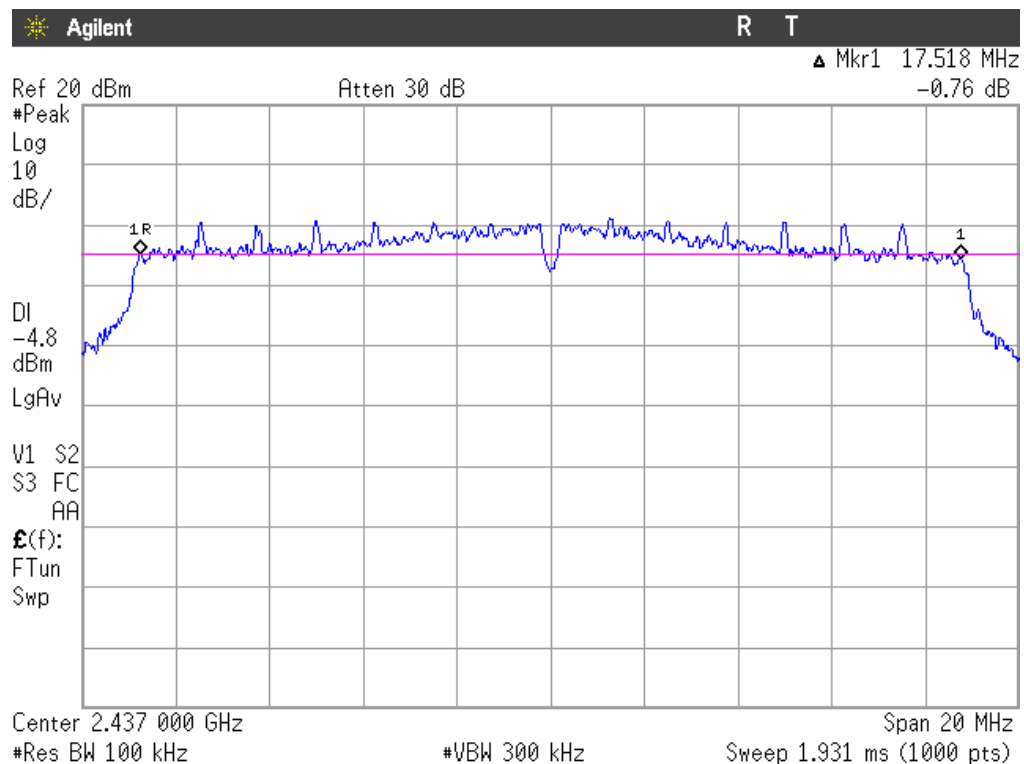


Mode N20

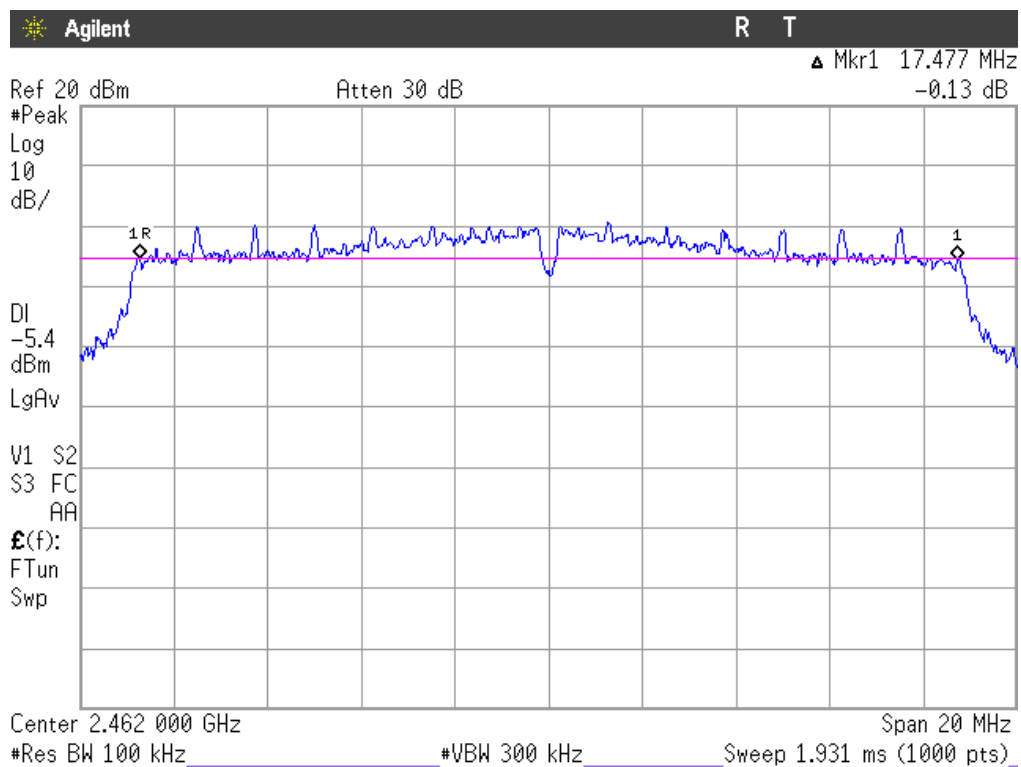
Lowest Channel



Middle Channel

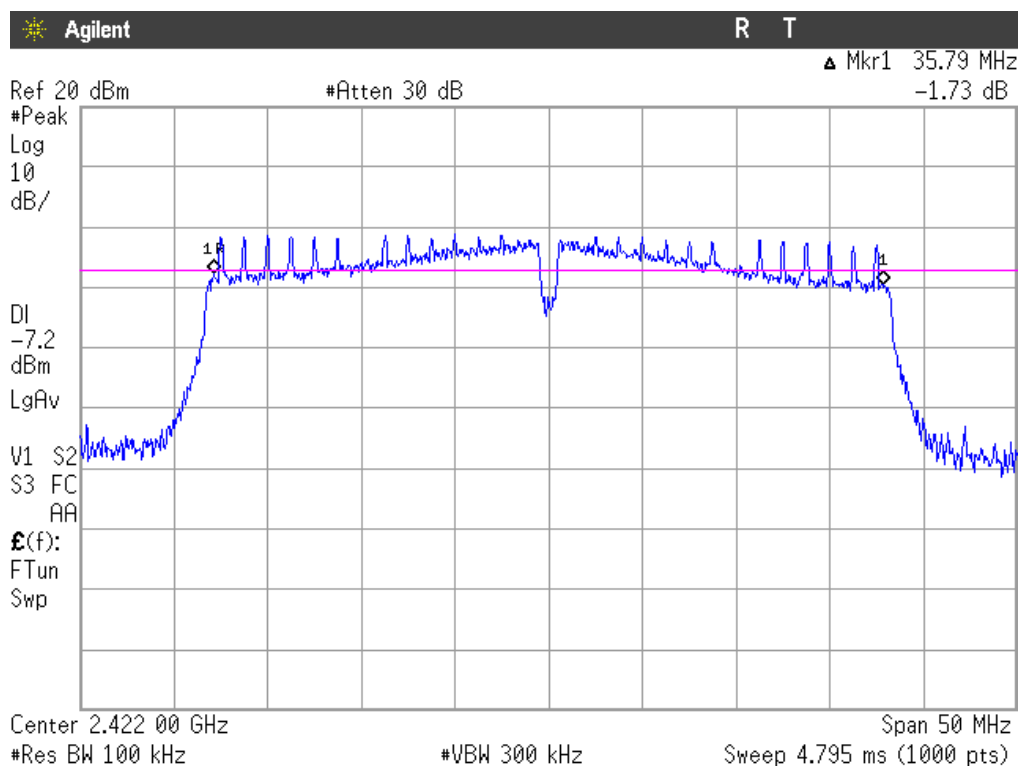


Highest channel

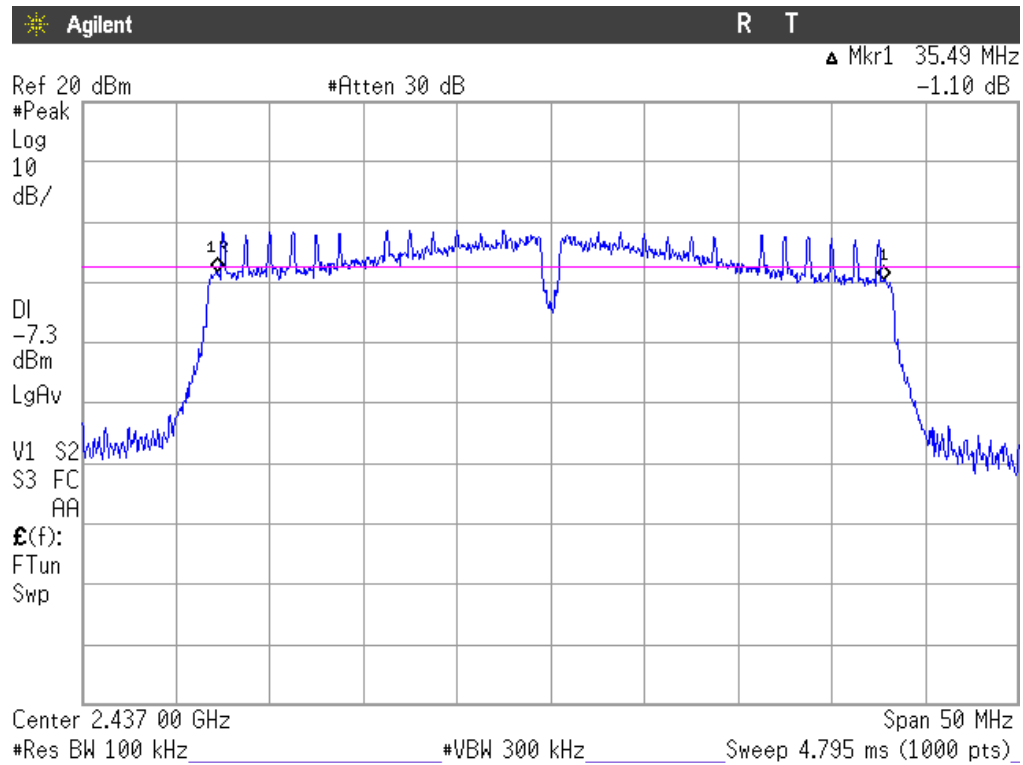


Mode N40

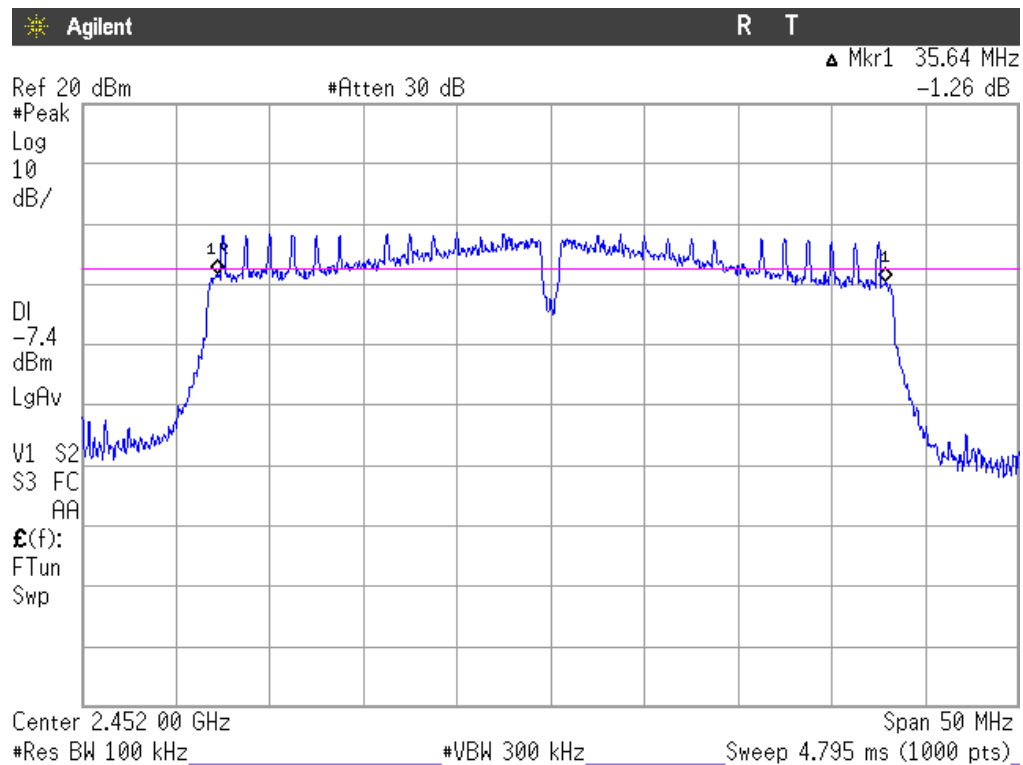
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (b) / RSS-247 5.4. (4). Maximum output power and antenna gain

SPECIFICATION

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS

For all modes, the maximum conducted (average) output power was measured using the method according to point 9.2.2.2 of Guidance for Performing Compliance Measurements on Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v04 dated 05/04/2017.

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

MAXIMUM OUTPUT POWER. See next plots.

Declared Gain for antenna RF port 1 (maximum): +2.2 dBi. (Antenna gain plus antenna cable loss).

Mode B: Average Conducted Output Power:

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	13.35	13.75	13.16
Maximum EIRP power (dBm)	15.55	15.95	15.36
Measurement uncertainty (dB)	<±0.79		

Mode G: Average Conducted Output Power:

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	12.39	12.32	12.01
Maximum EIRP power (dBm)	14.59	14.52	14.21
Measurement uncertainty (dB)	<±0.79		

Mode N20: Average Conducted Output Power:

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	11.78	12.03	11.41
Maximum EIRP power (dBm)	13.98	14.23	13.61
Measurement uncertainty (dB)	<±0.79		

Mode N40: Average Conducted Output Power:

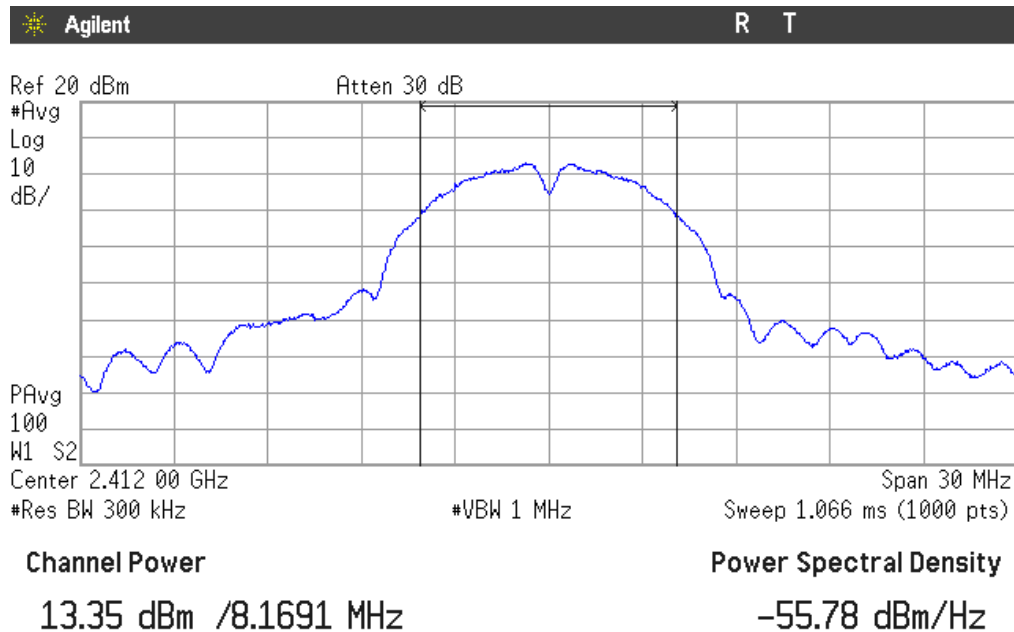
	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
Maximum conducted power (dBm)	10.83	11.31	10.88
Maximum EIRP power (dBm)	13.03	13.51	13.08
Measurement uncertainty (dB)	<±0.79		

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

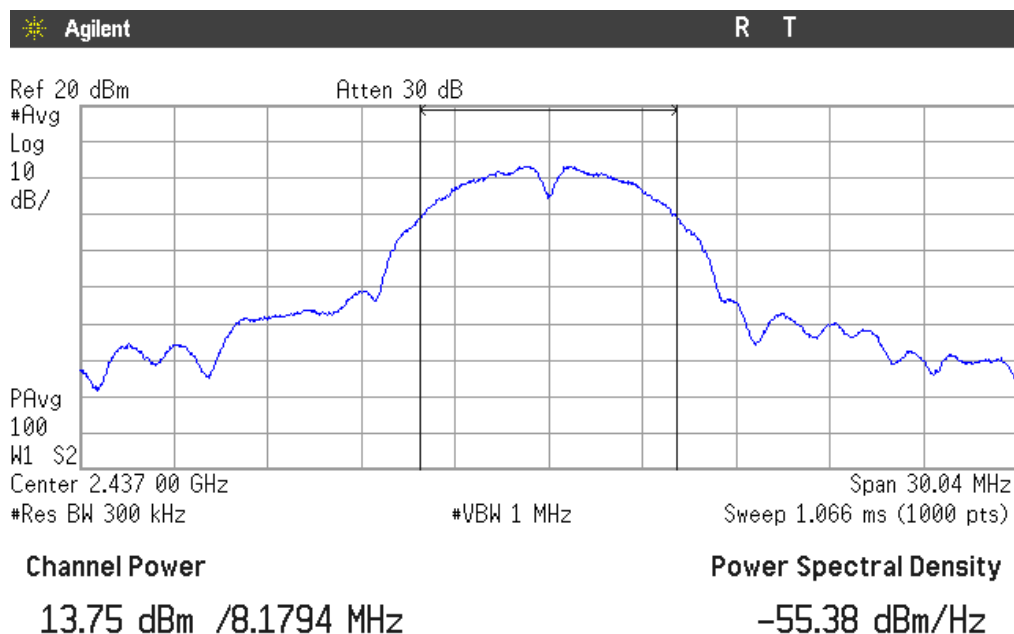
Verdict: PASS

Mode B

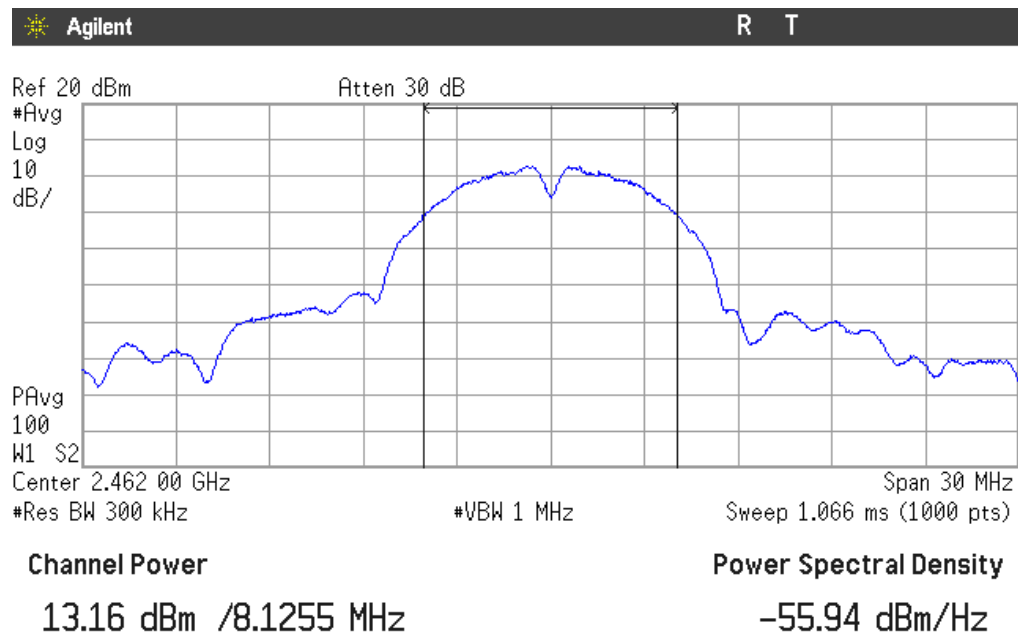
Lowest Channel



Middle Channel

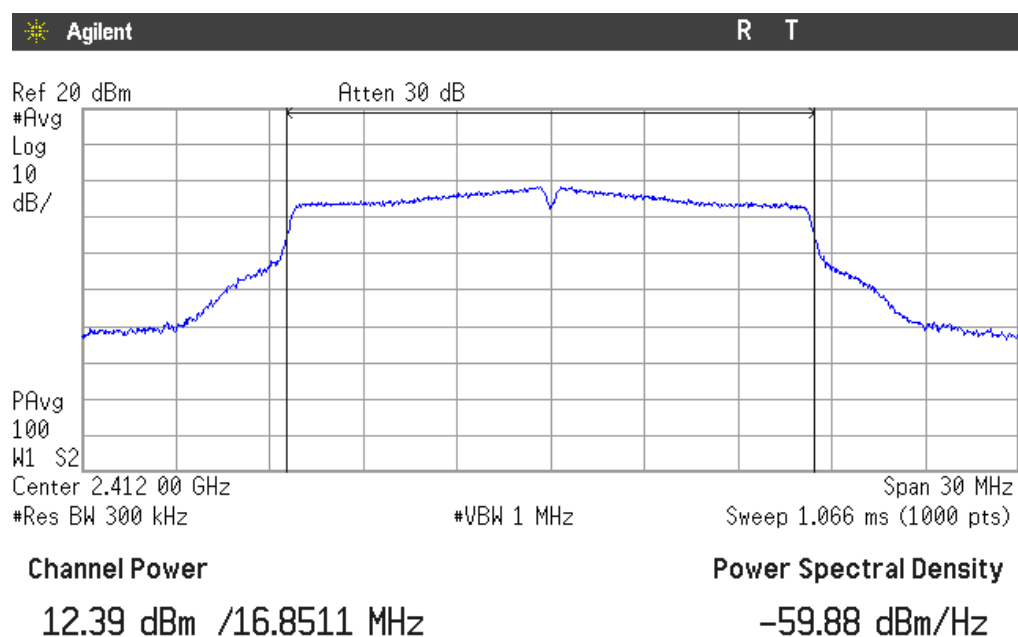


Highest Channel

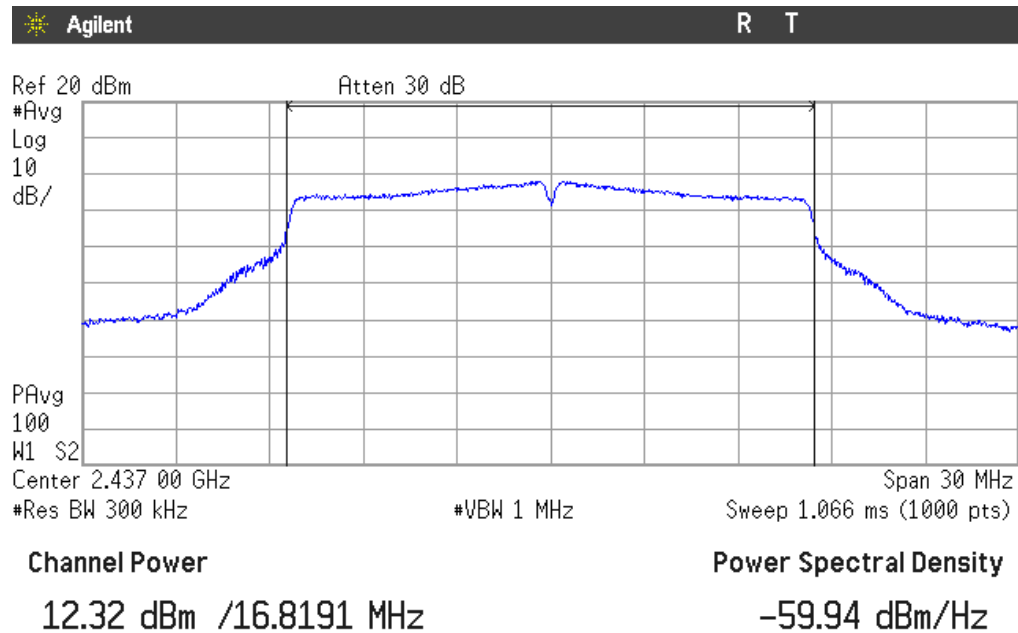


Mode G

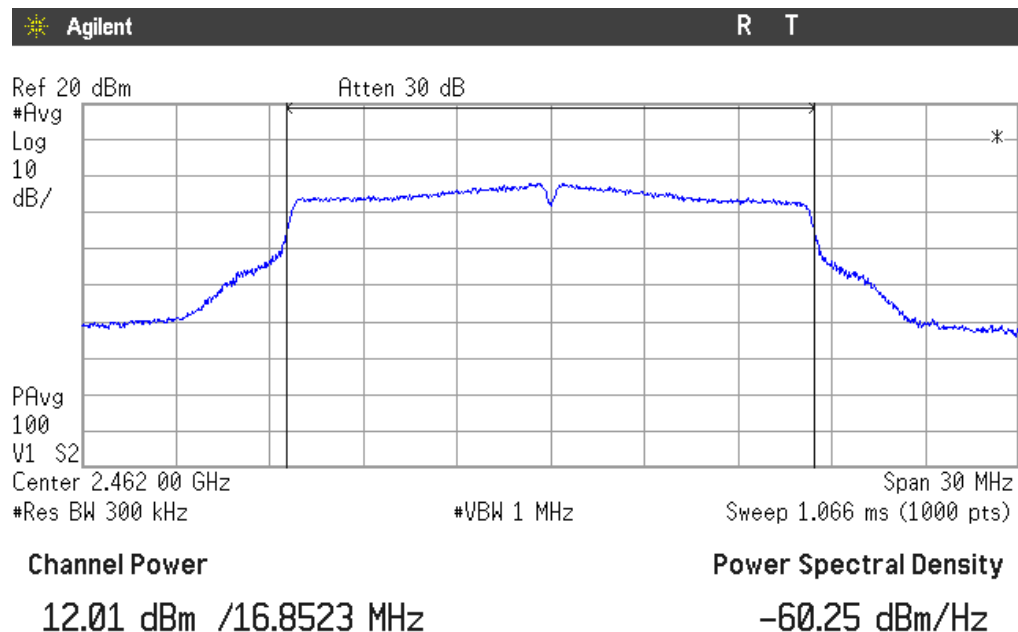
Lowest Channel



Middle Channel

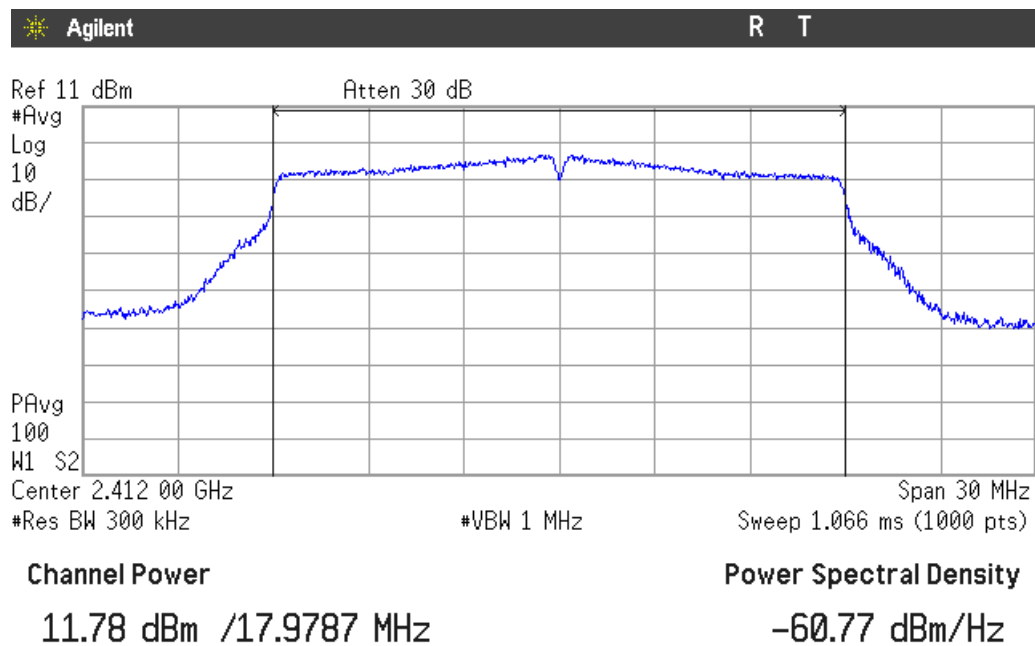


Highest Channel

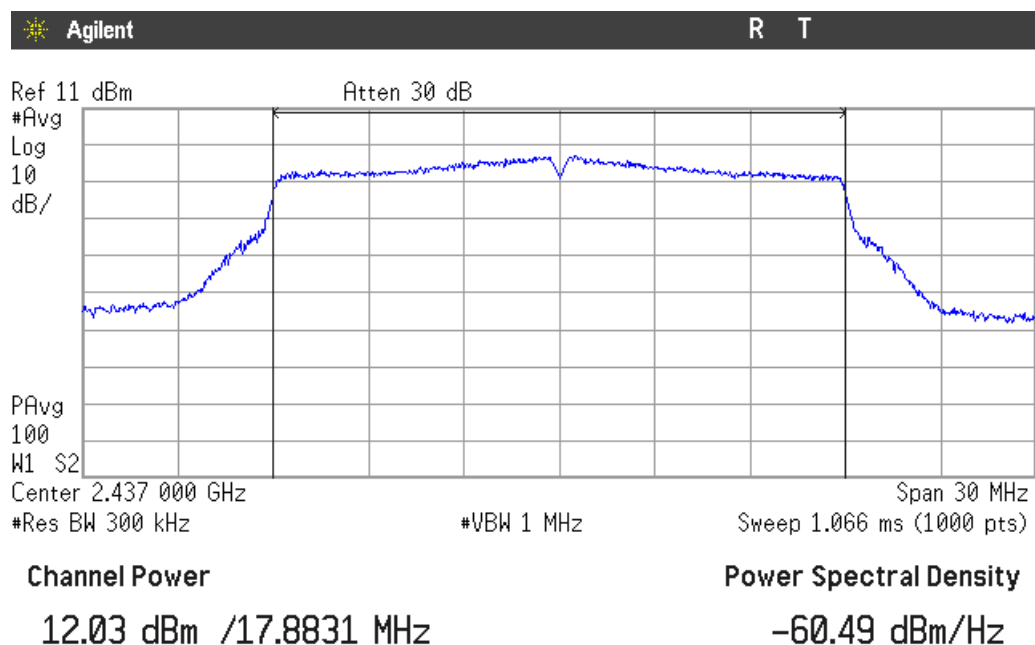


Mode N20

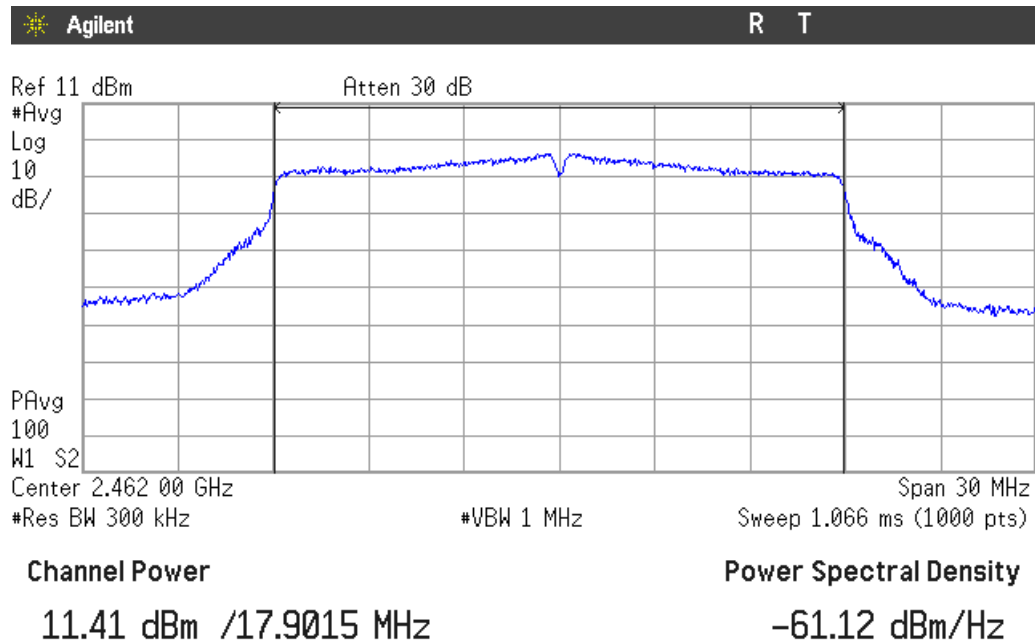
Lowest Channel



Middle Channel

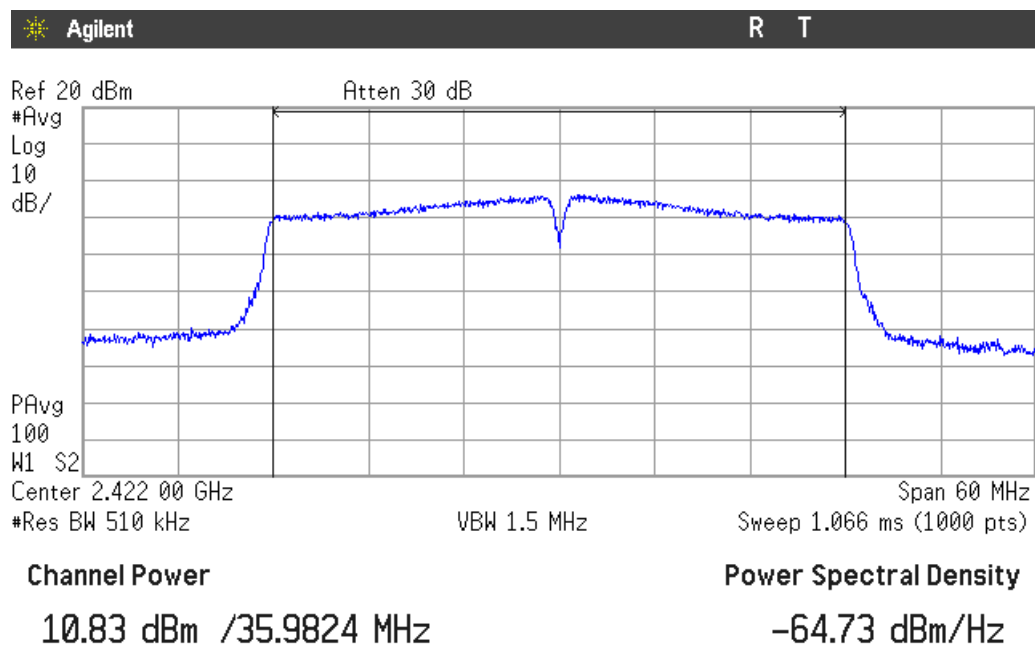


Highest Channel

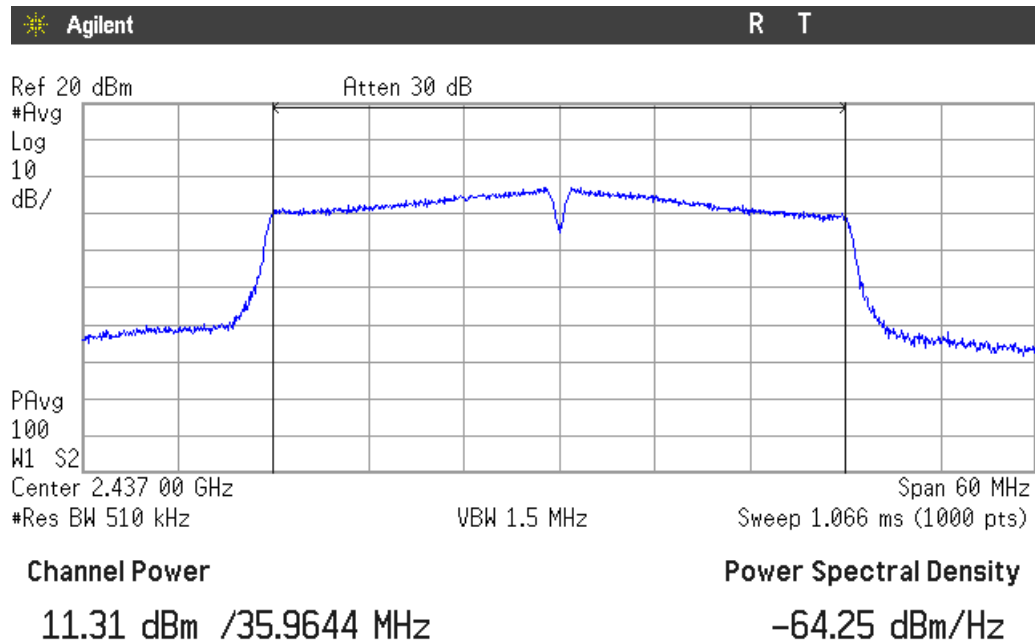


Mode N40

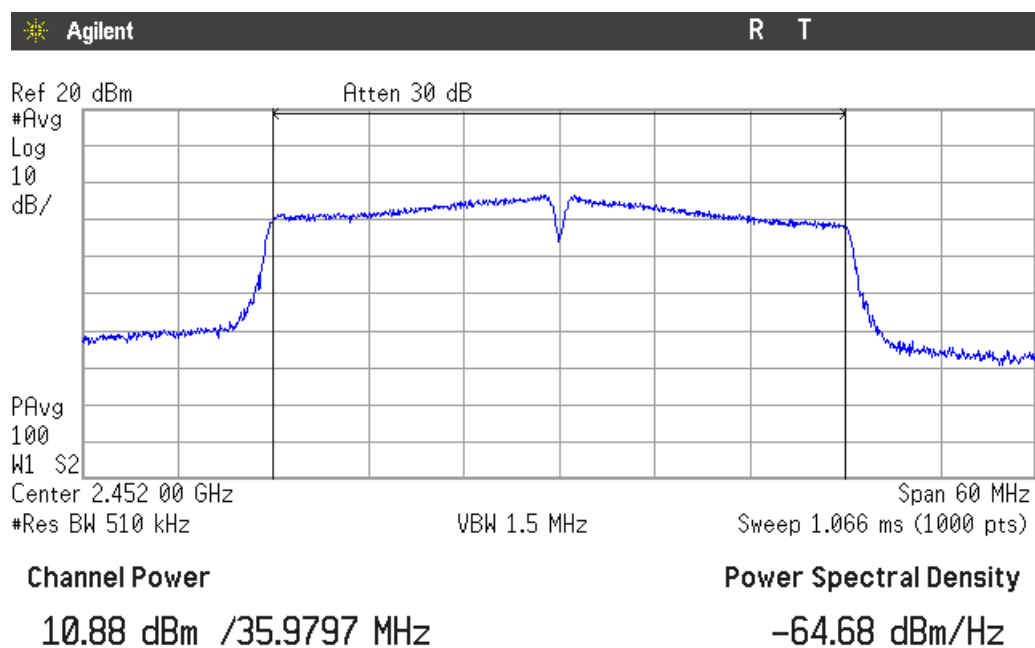
Lowest Channel



Middle Channel



Highest Channel



Section 15.247 Subclause (d) / RSS-247 5.5. Emission limitations conducted (Transmitter)

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

RESULTS:

Reference Level Measurement

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	7,58	7,9	7,39
Measurement uncertainty (dB)	<±0.78		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	1,69	1,74	1,67
Measurement uncertainty (dB)	<±0.78		

Mode N20

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	0,94	1,12	0,74
Measurement uncertainty (dB)	<±0.78		

Mode N40

	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
Reference Level Measurement (dBm)	-1,22	-1,27	-1,53
Measurement uncertainty (dB)	<±0.78		

Mode B

Lowest frequency 2412 MHz

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.42

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.10

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.61

Mode G

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-28.31

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-28.26

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-28.33

Mode N20

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-29.06

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-28.88

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-29.26

Mode N40

Lowest frequency 2422 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-31.22

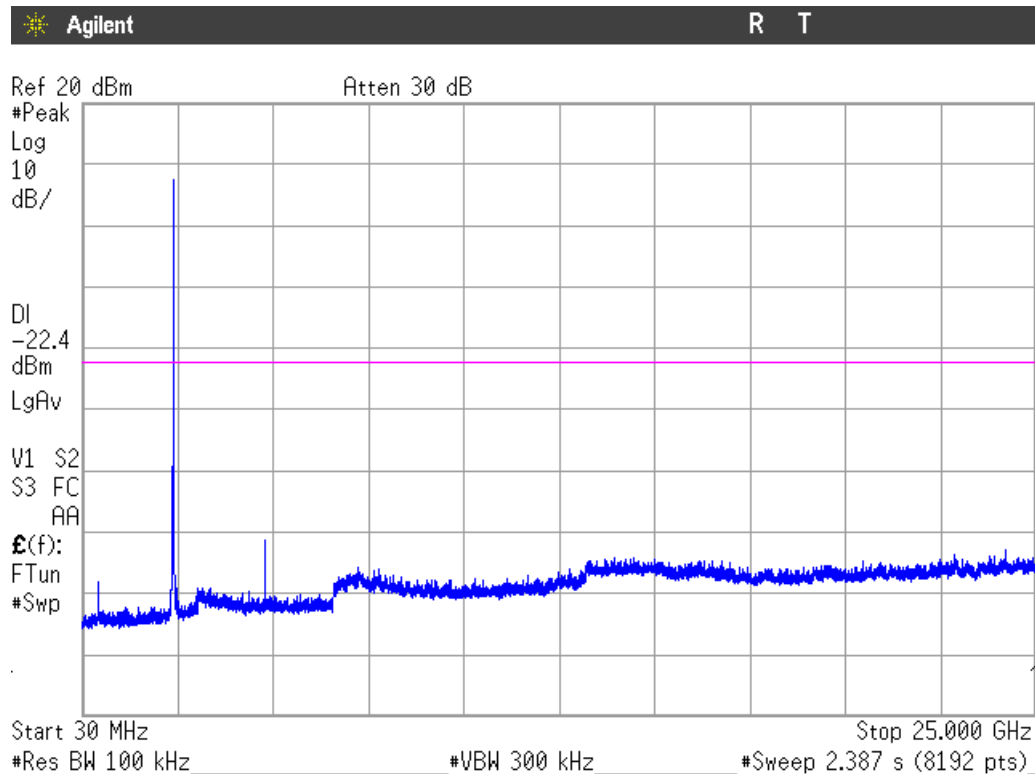
Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-31.27

Highest frequency 2452 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-31.53

Verdict: PASS

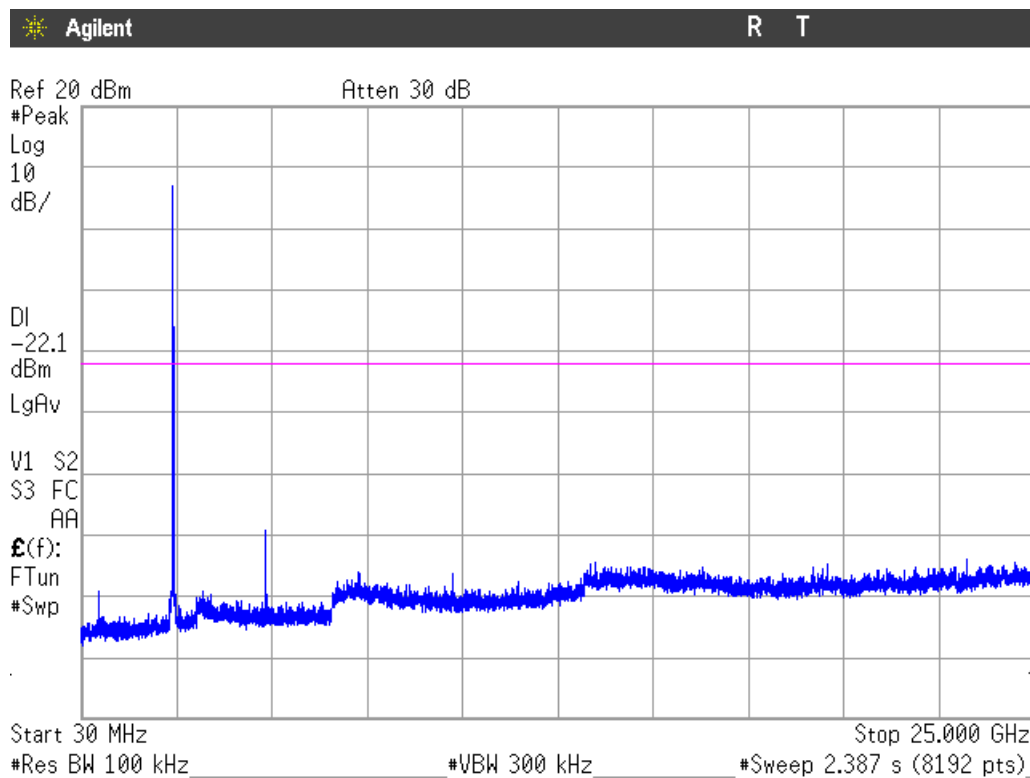
Mode B

Lowest Channel



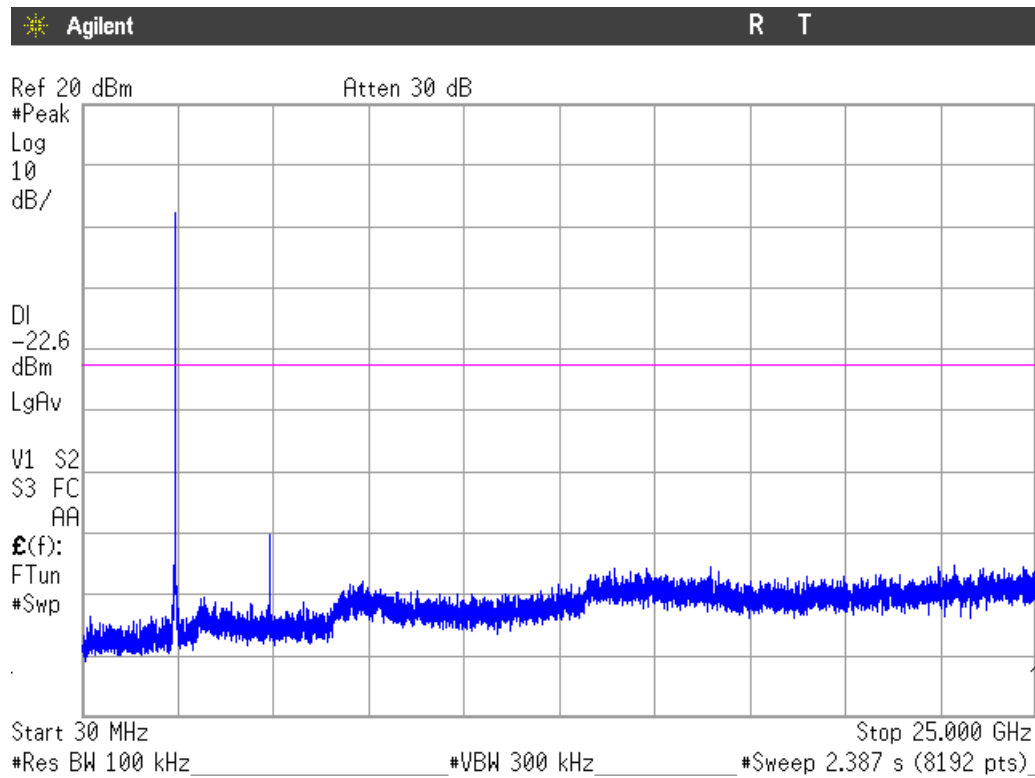
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

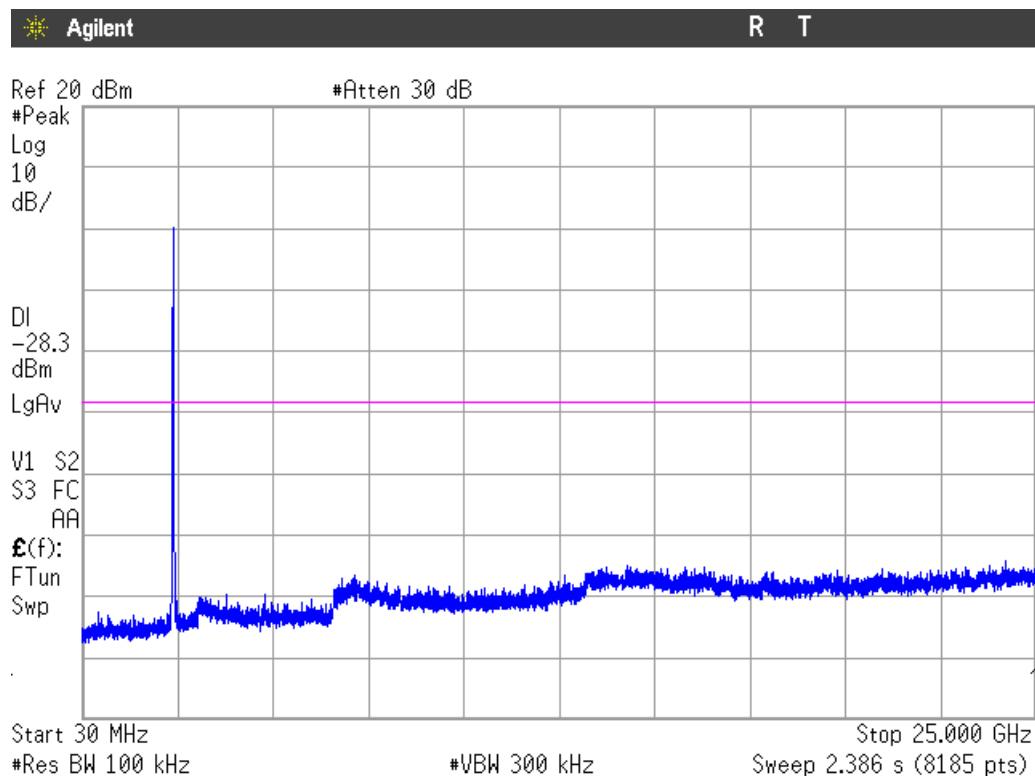
Highest channel



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

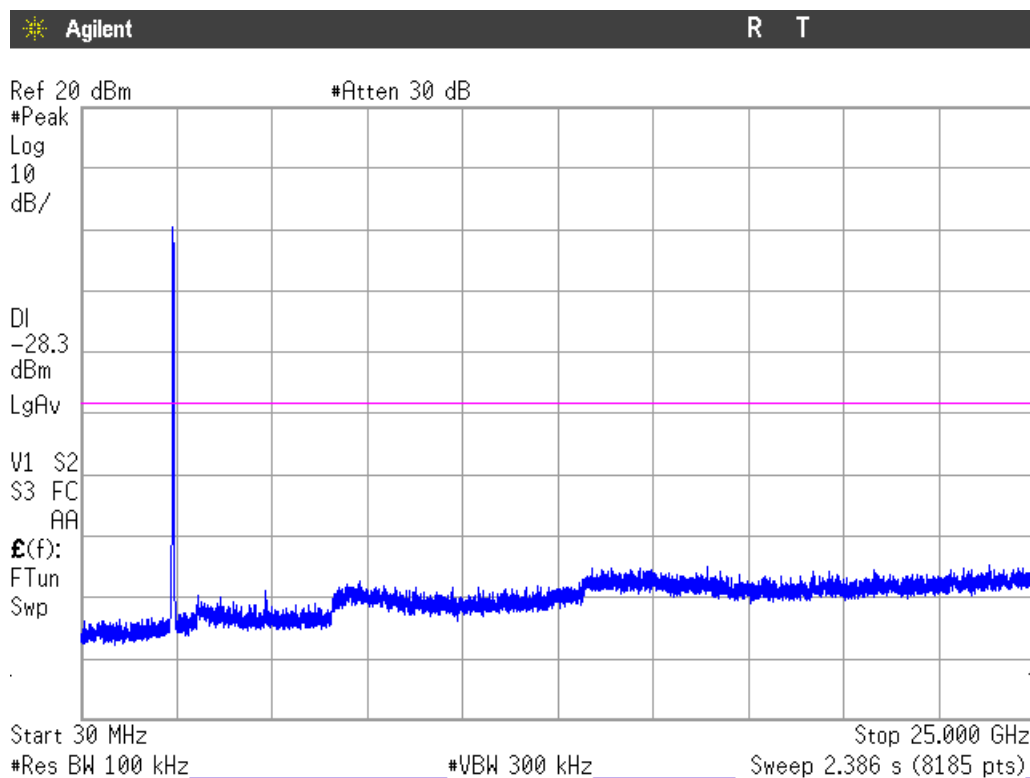
Mode G

Lowest Channel



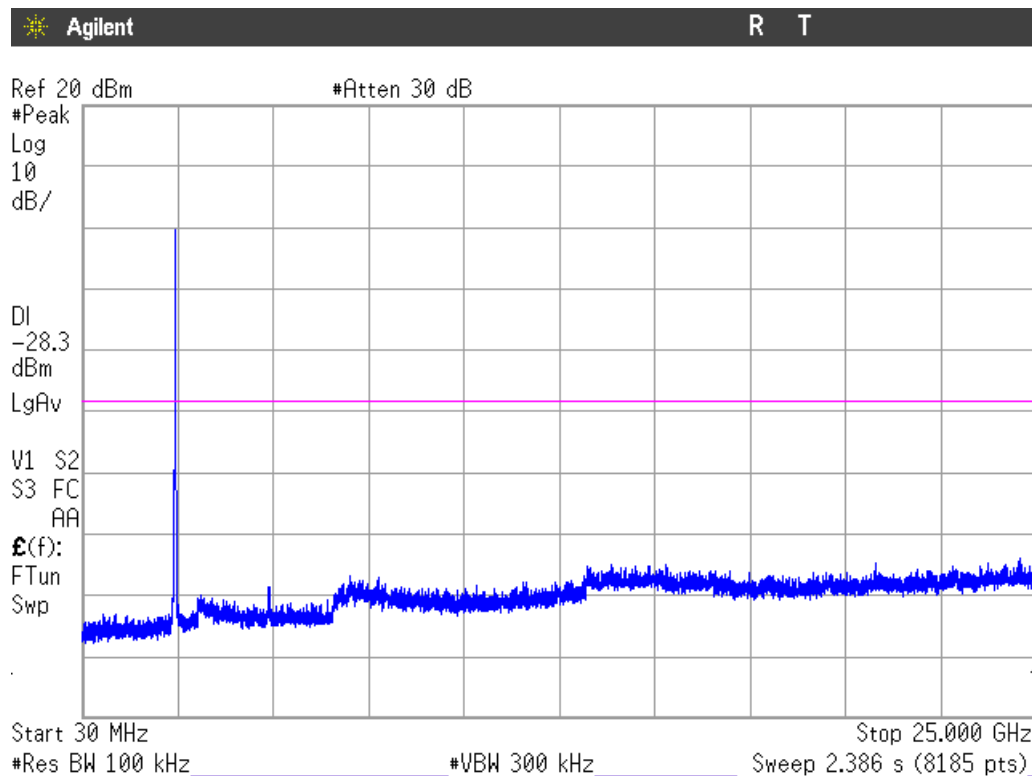
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

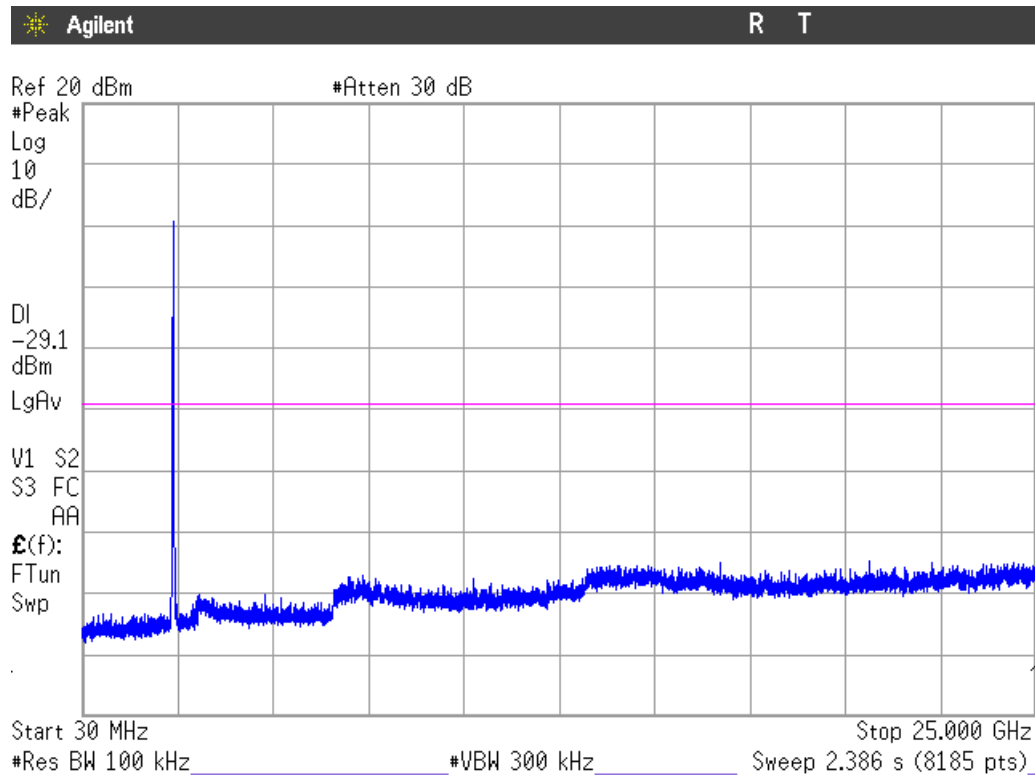
Highest channel



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

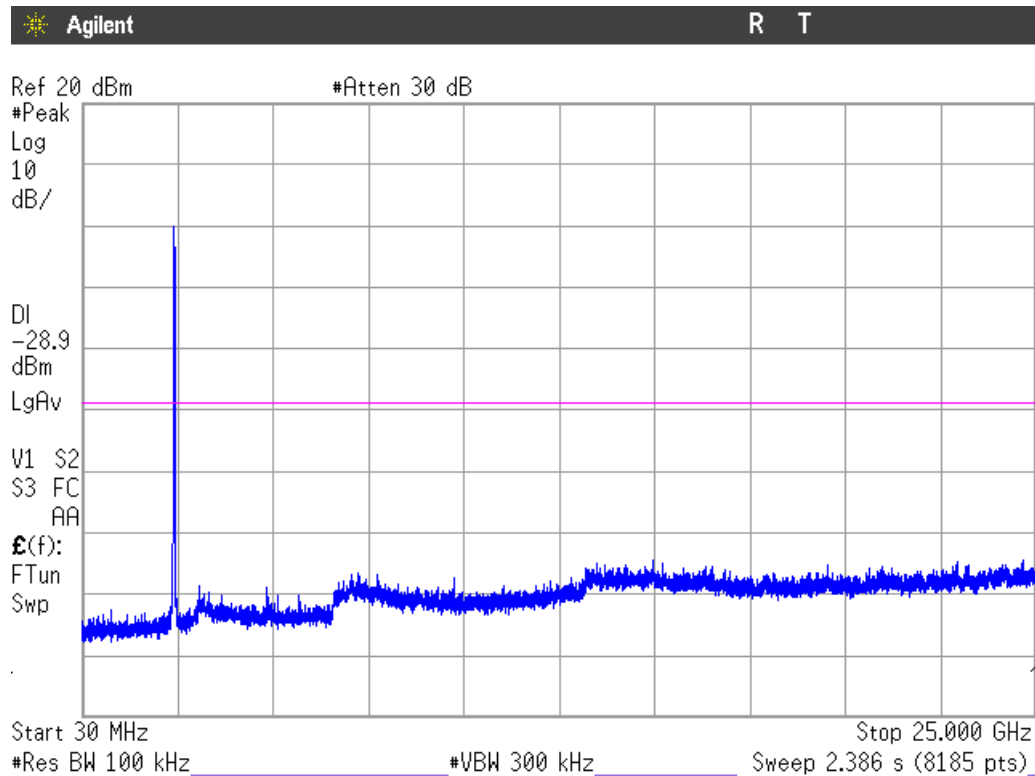
Mode N20

Lowest Channel



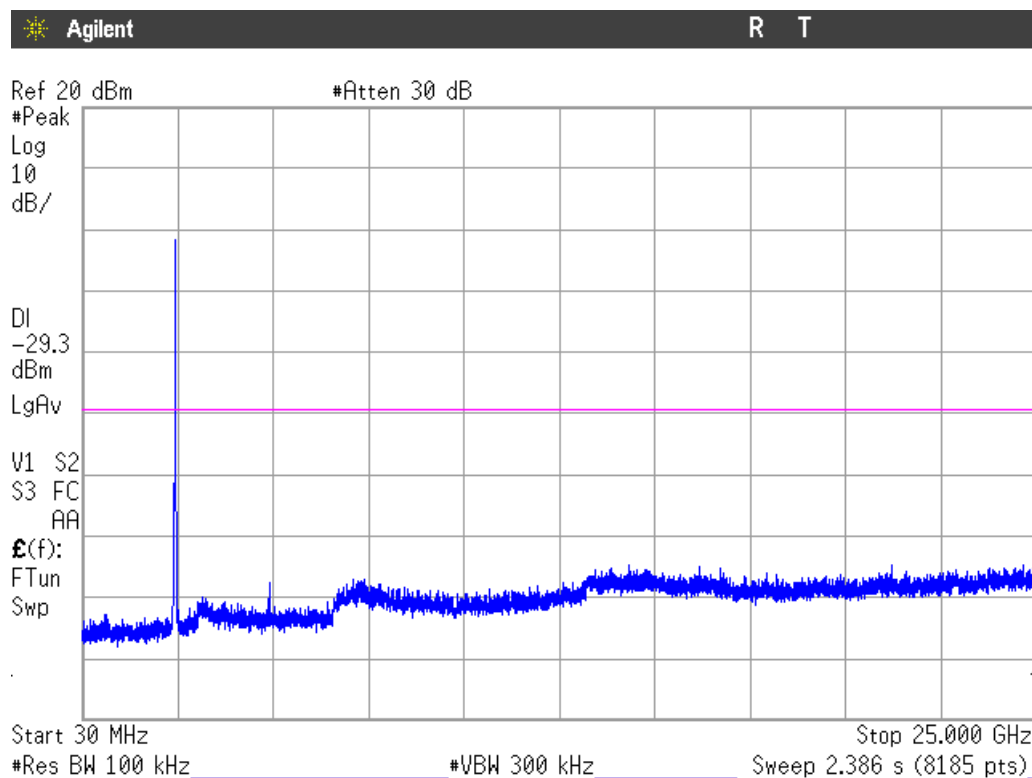
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

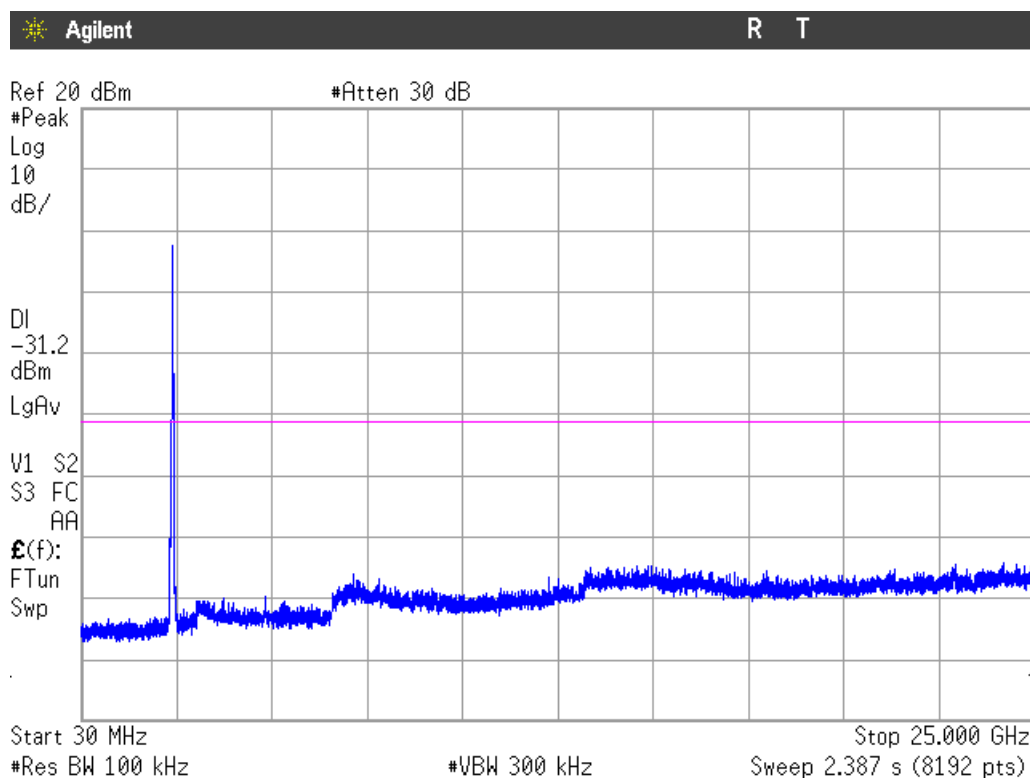
Highest channel



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

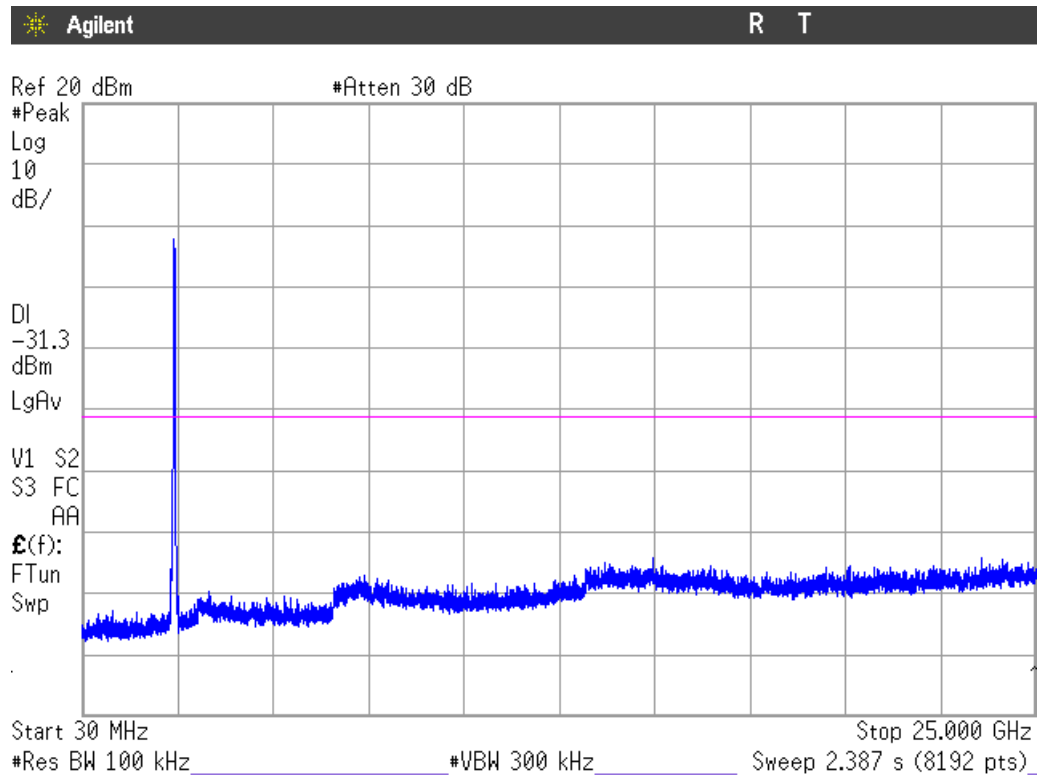
Mode N40

Lowest Channel



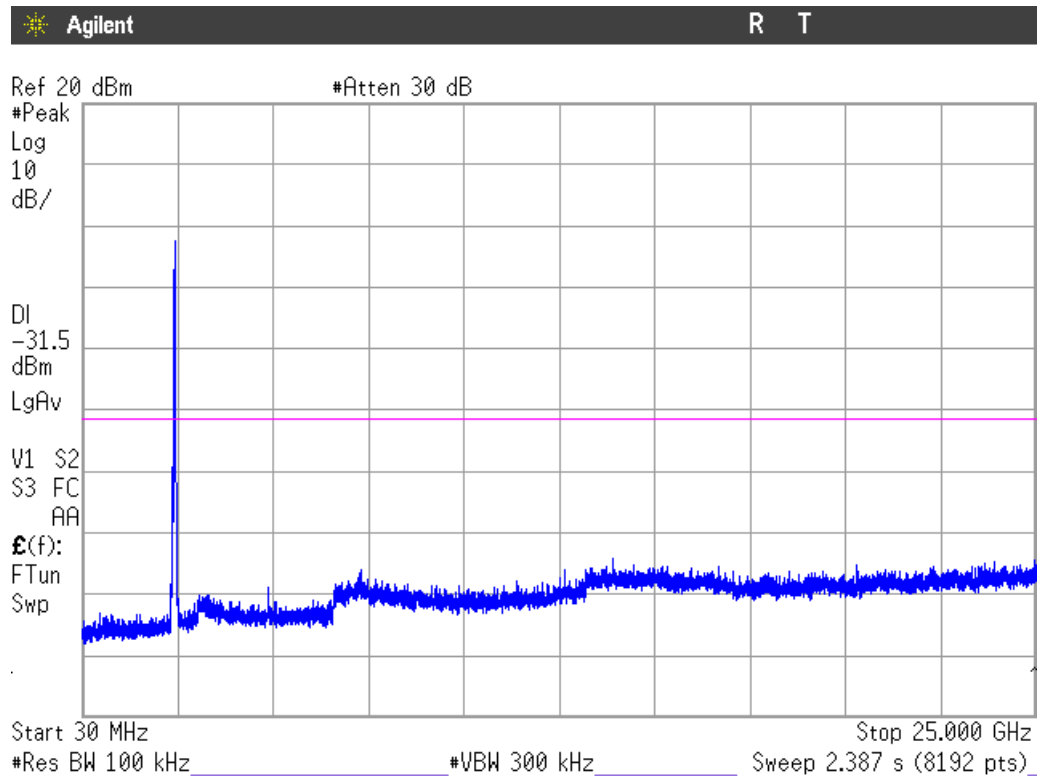
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

Highest Channel



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

Section 15.247 Subclause (d) / RSS-247 5.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

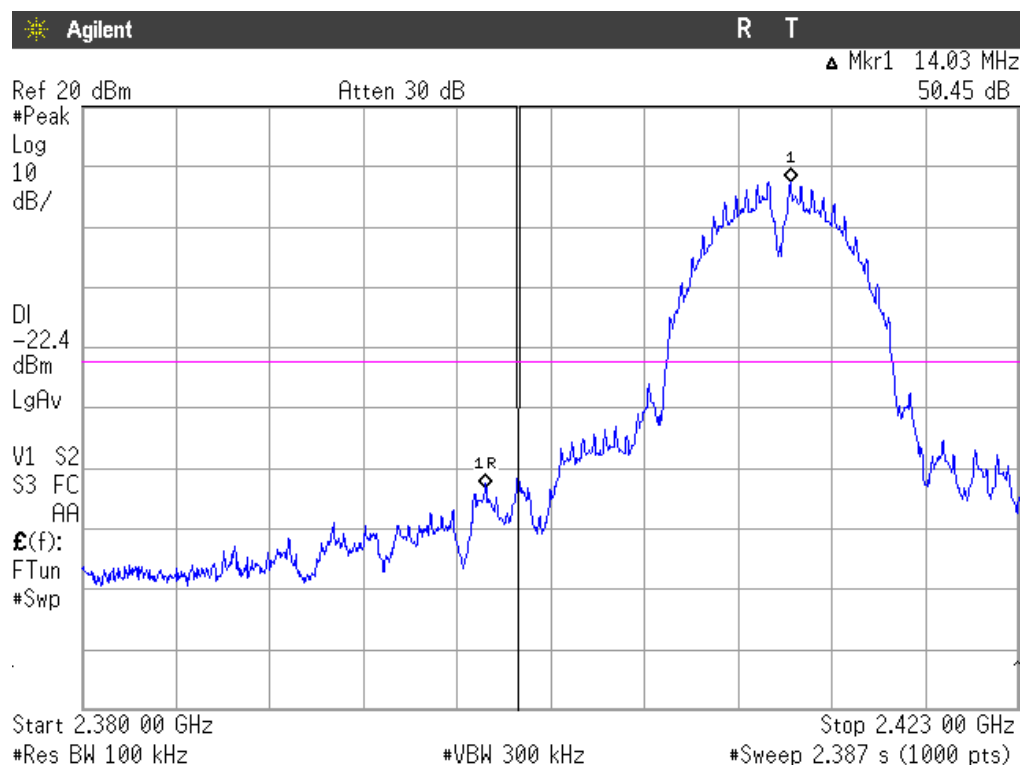
RESULTS:

Note: 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.

LOW FREQUENCY SECTION 2412 MHz (b/g/n20) and LOW FREQUENCY SECTION 2422 MHz (n40) CONDUCTED.

Mode B

See next plot.

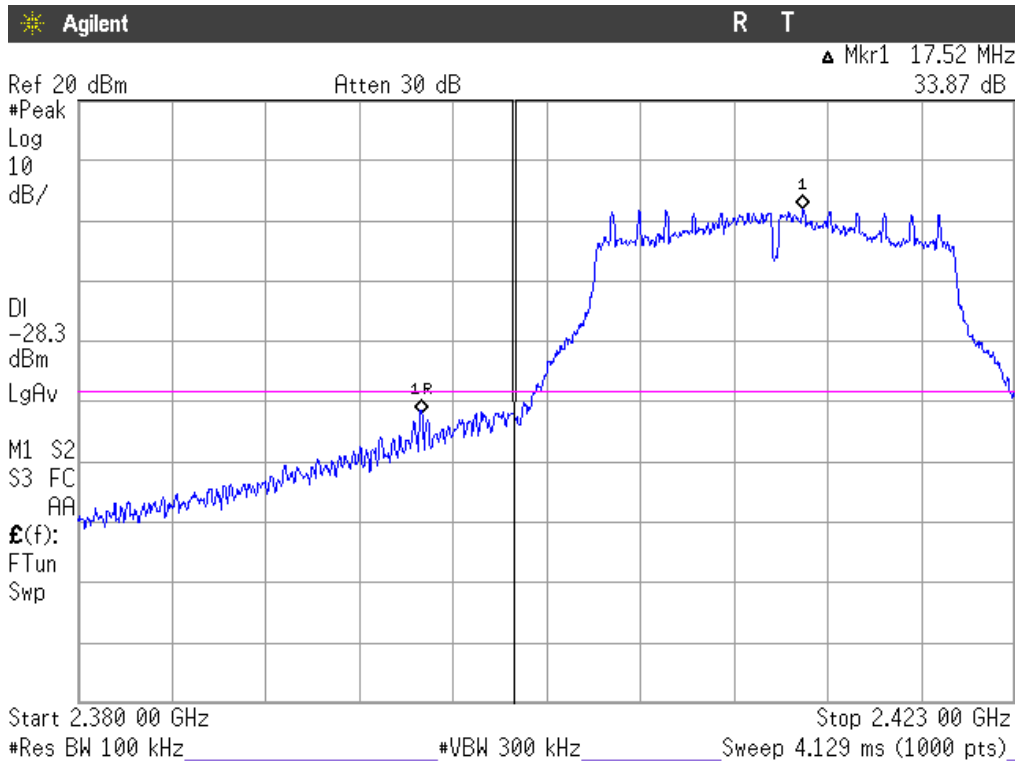


Measurement uncertainty (dB)	< ±2.03
------------------------------	---------

Verdict: PASS

Mode G

See next plot.

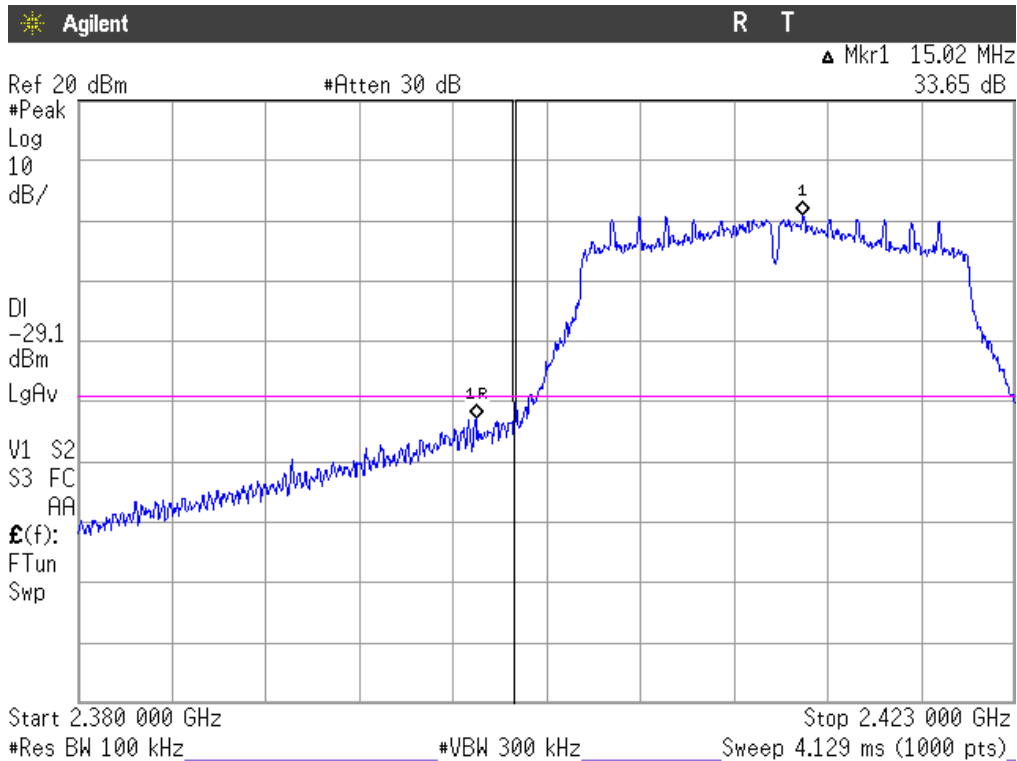


Measurement uncertainty (dB)	< ± 2.03
------------------------------	--------------

Verdict: PASS

Mode N20

See next plot.

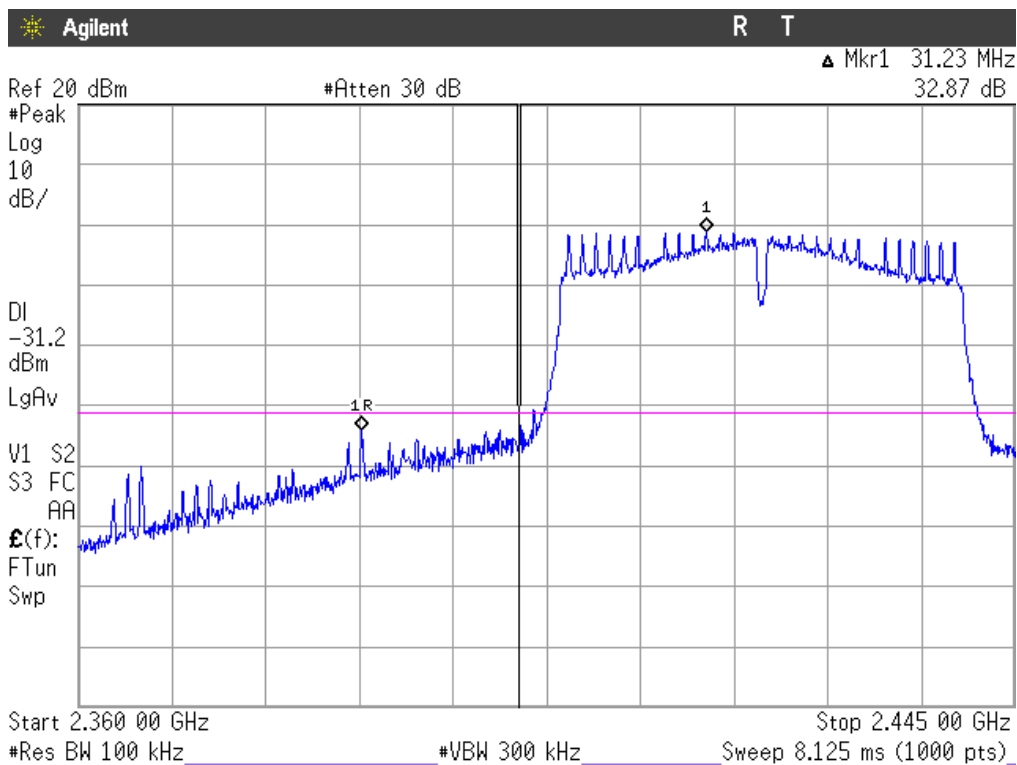


Measurement uncertainty (dB)	< ± 2.03
------------------------------	--------------

Verdict: PASS

Mode N40

See next plot.



Verdict: PASS

Section 15.247 Subclause (e) / RSS-247 5.2. (2) Power spectral density

SPECIFICATION

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

The maximum power spectral density level in the fundamental emission was measured using the method AVGPST-1 (AVG PSD) according to point 10.3. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v04 dated 05/04/2017.

Power spectral density (see next plots).

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-0.513	-0.819	-1.295
Measurement uncertainty (dB)	<±0.78		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-4.956	-4.901	-5.277
Measurement uncertainty (dB)	<±0.78		

Mode N20

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-5.859	-5.871	-6.758
Measurement uncertainty (dB)	<±0.78		

Mode N40

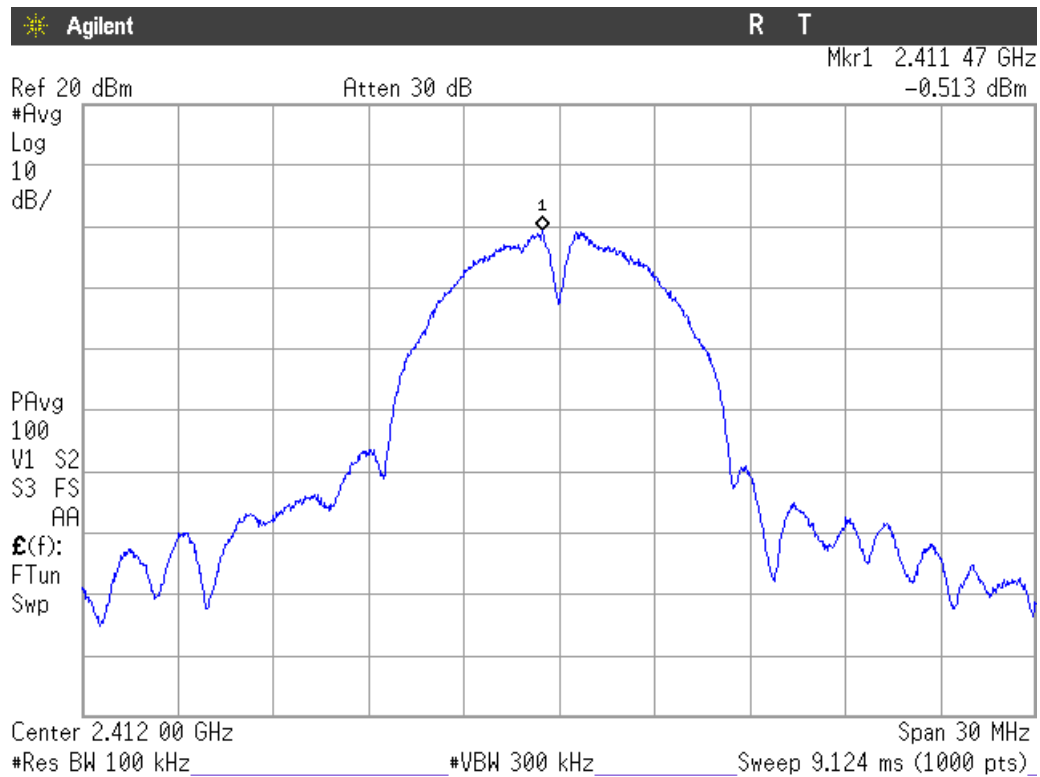
	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
Power spectral density (dBm)	-9.821	-9.309	-10.031
Measurement uncertainty (dB)	<±0.78		

Verdict: PASS

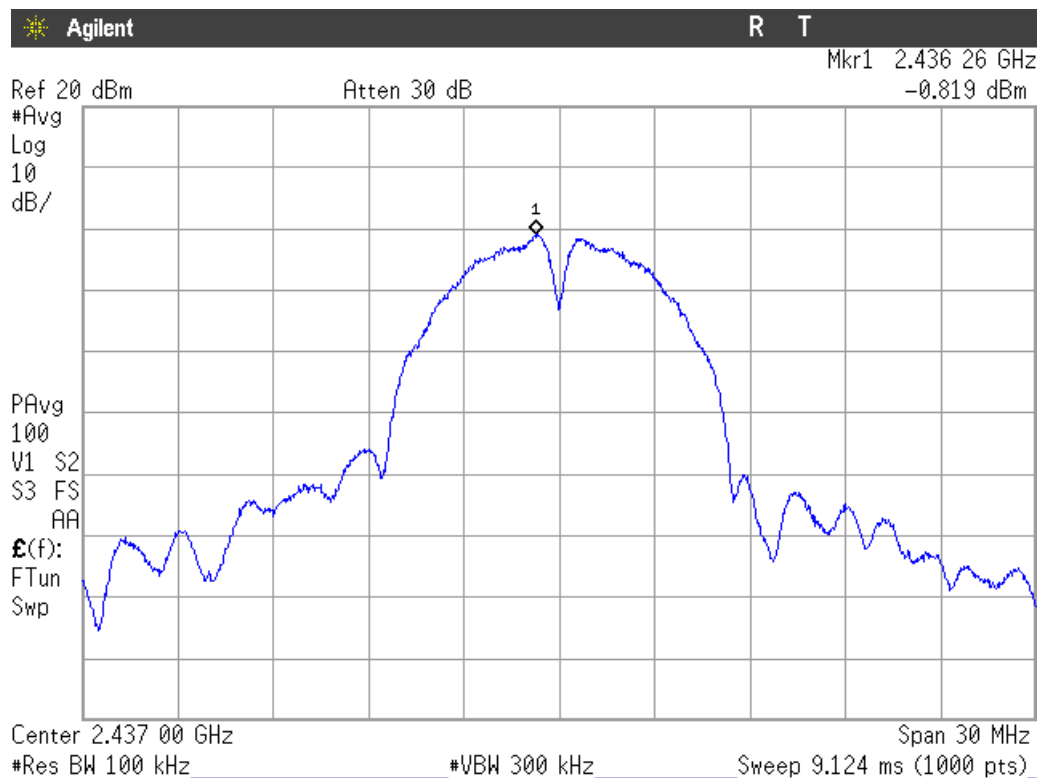
Power spectral density.

Mode B

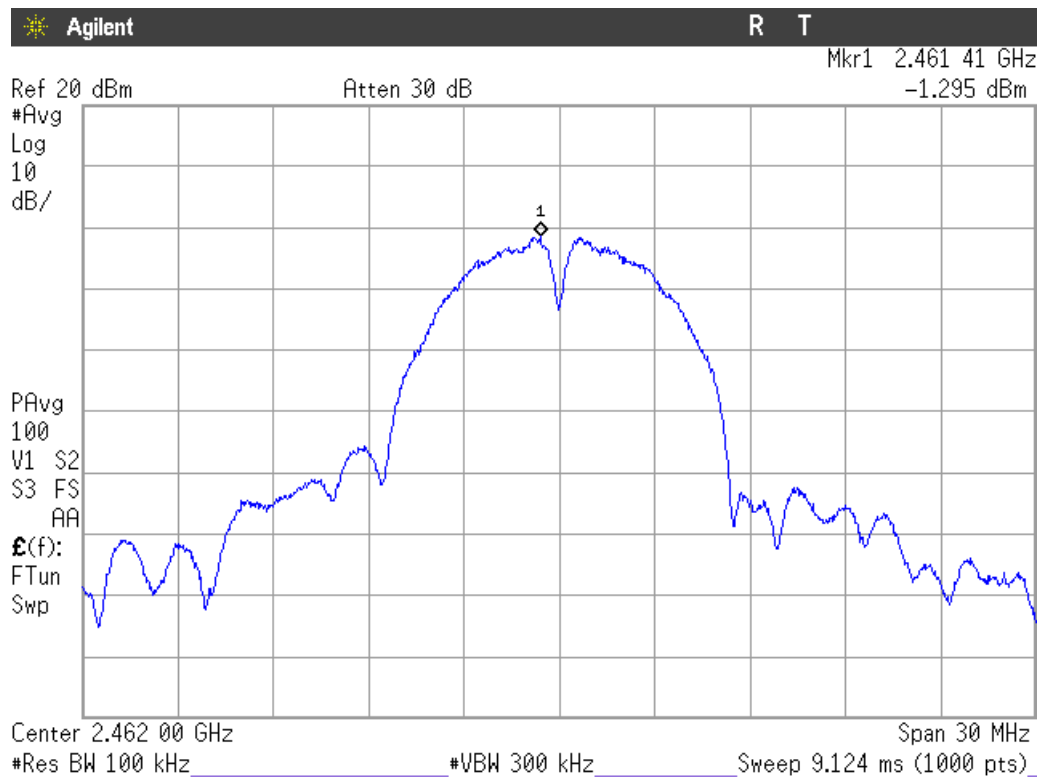
Lowest Channel



Middle Channel

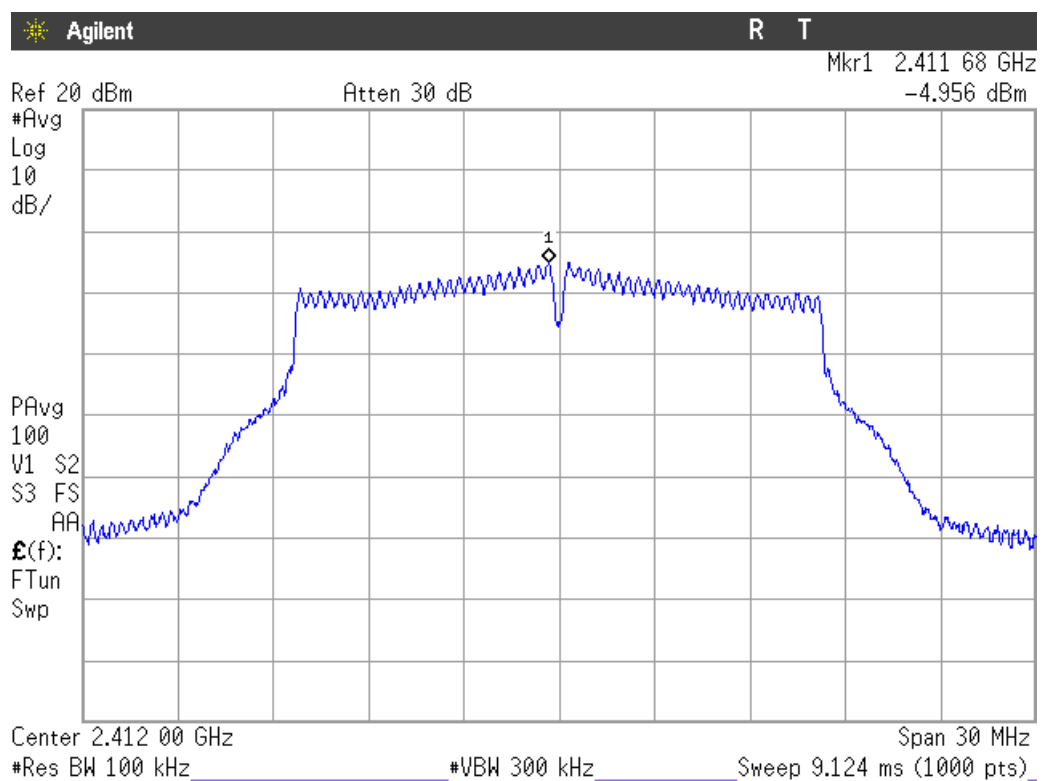


Highest channel

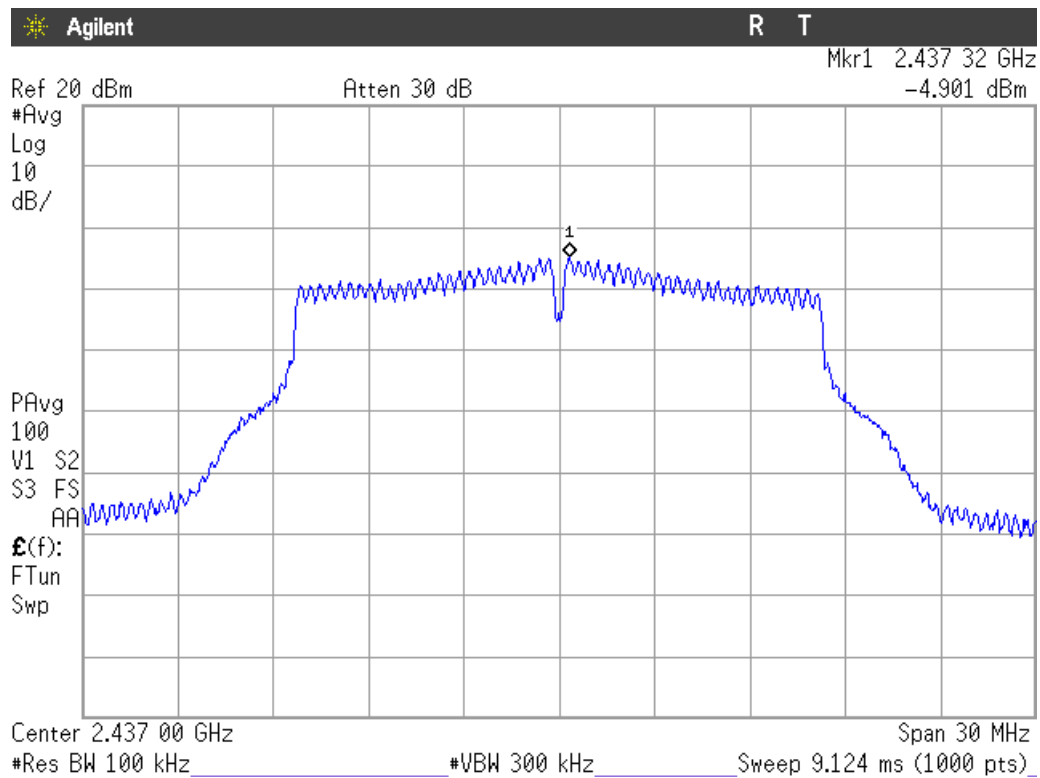


Mode G

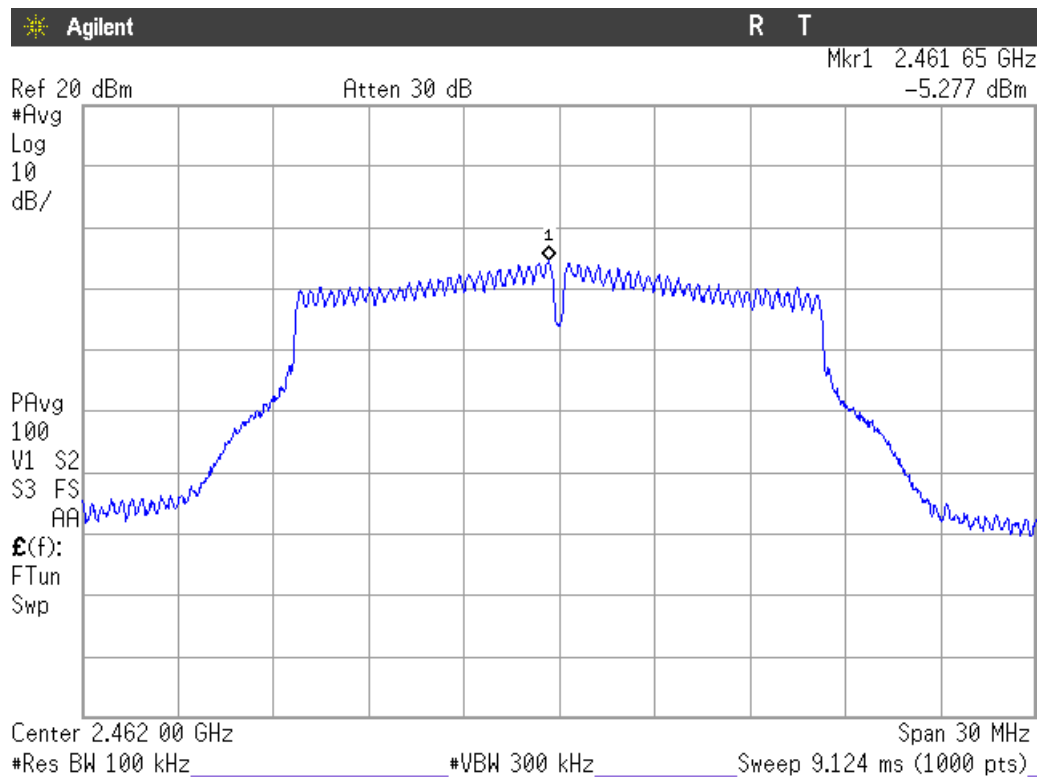
Lowest Channel



Middle Channel

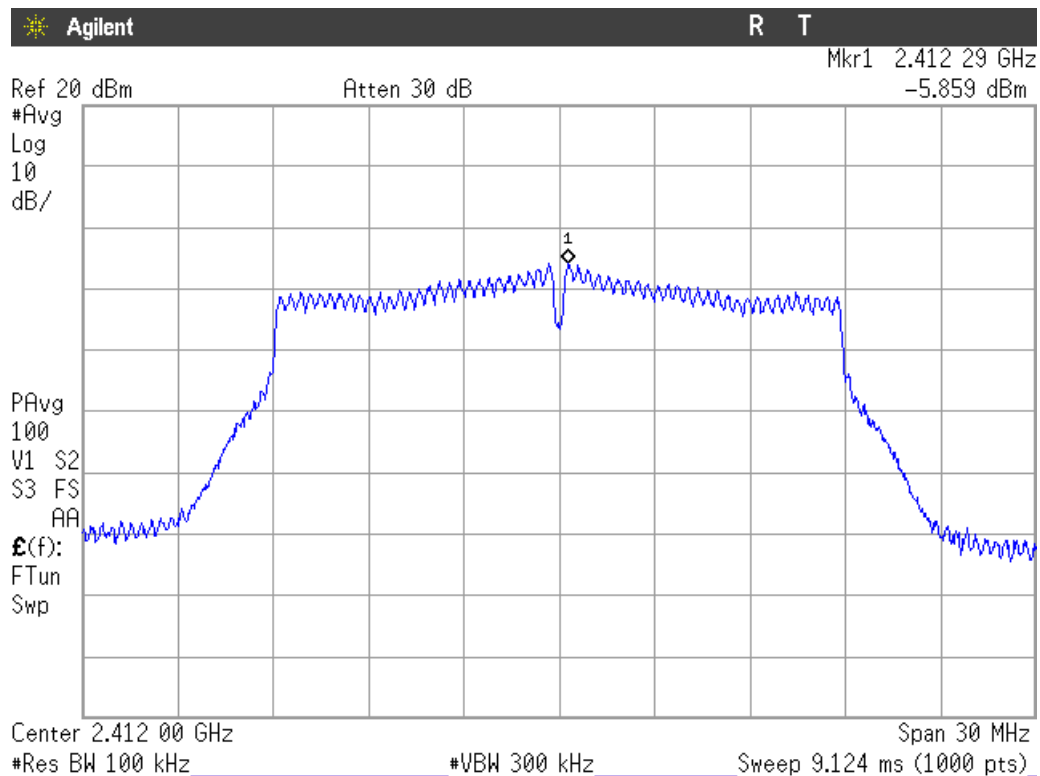


Highest channel

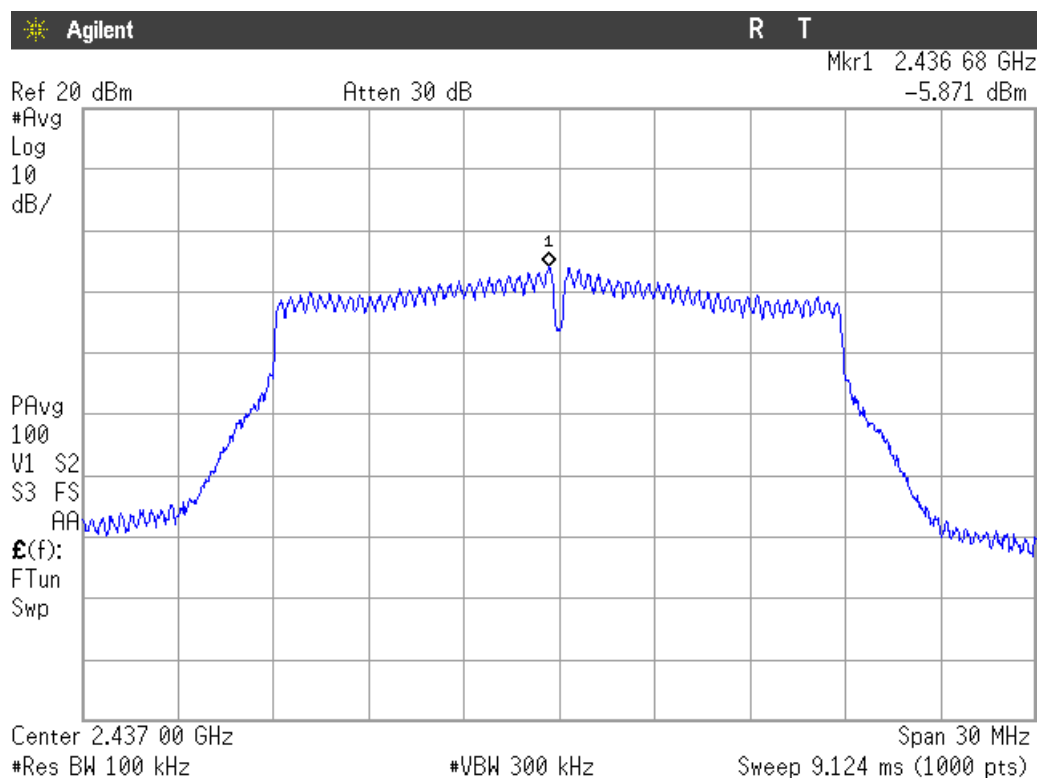


Mode N20

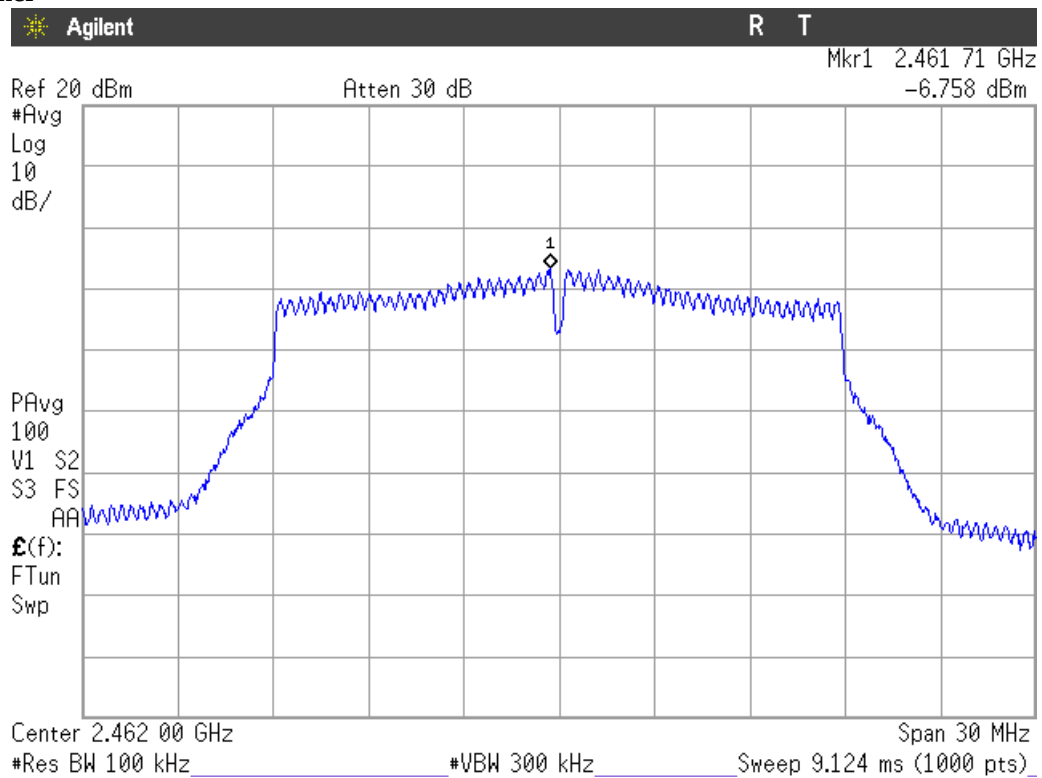
Lowest Channel



Middle Channel

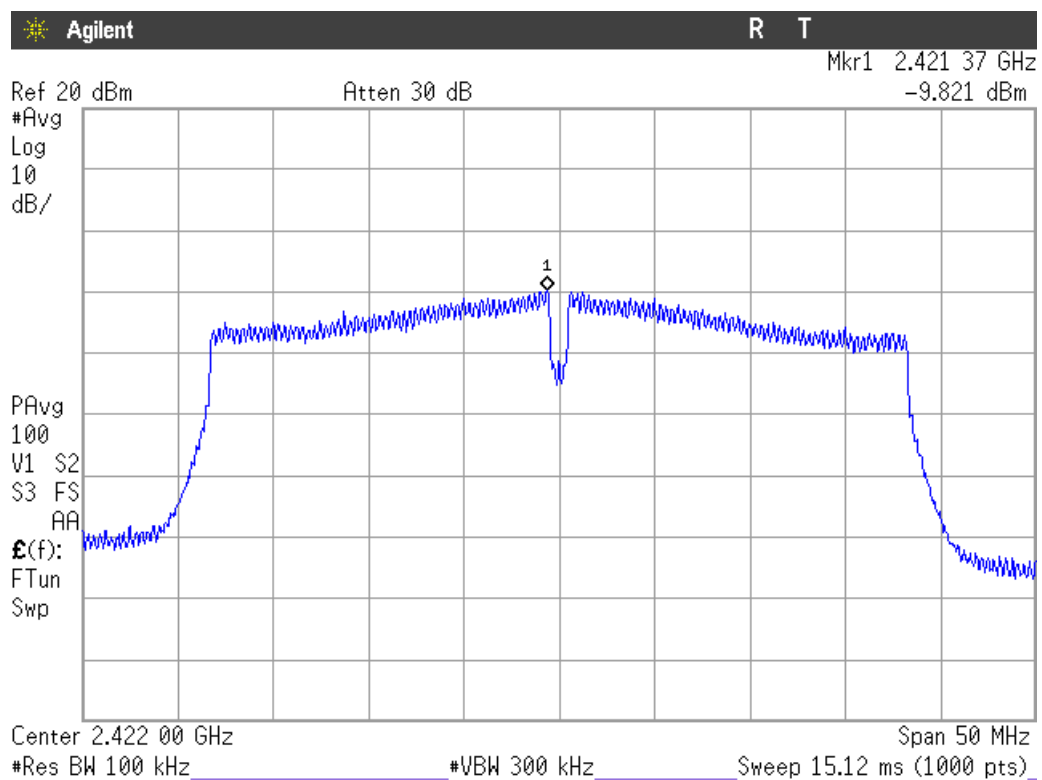


Highest channel

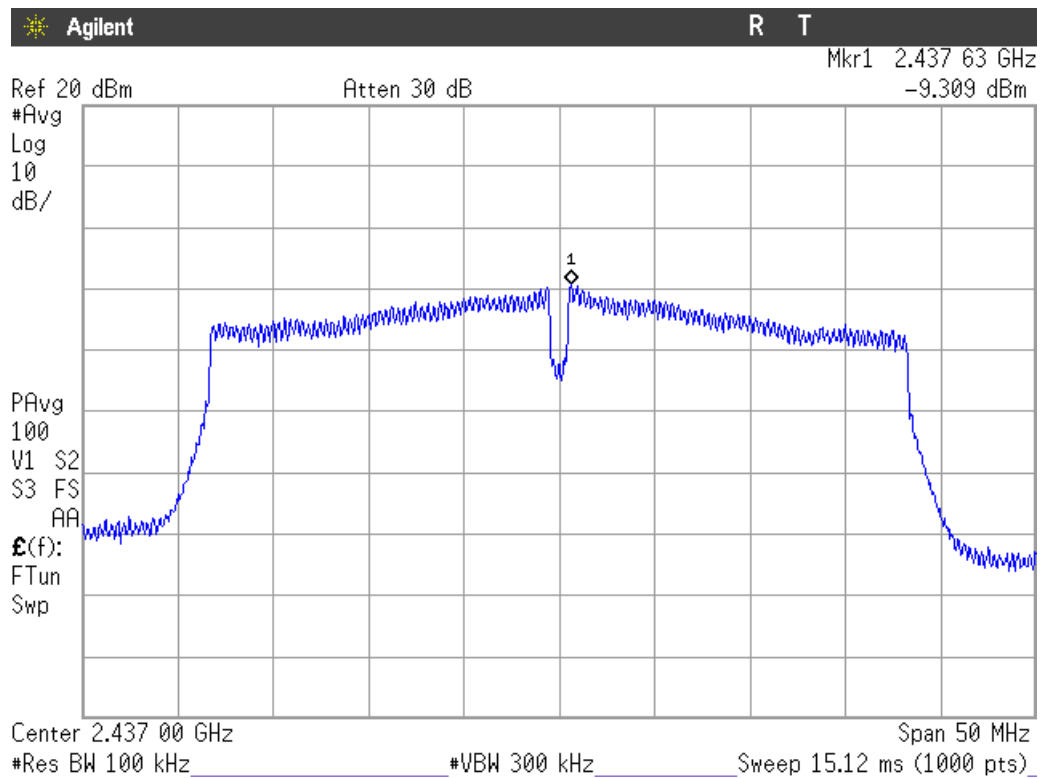


Mode N40

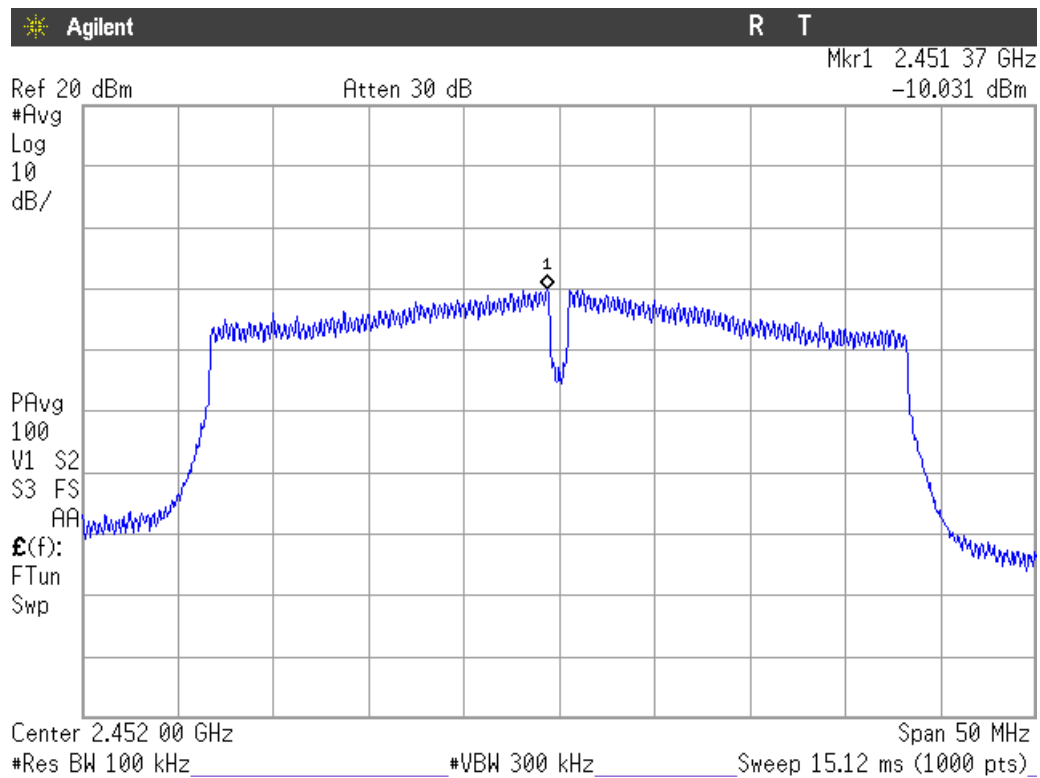
Lowest Channel



Middle Channel



Highest channel



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

SPECIFICATION

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.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° 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-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

The test was performed with the equipment transmitting first with only the WiFi 2.4GHz (WLAN0 CORE1) and repeated with the 2.4 GHz BT-EDR (WLAN 0), SiSo WiFi 5 GHz (WLAN0 CORE0) radios transmitting simultaneously to check the impact of the co-location of the other radio interfaces. The results and plots below show the worst results obtained.

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.

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

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
49.4970	PV	Quasi-peak	22.72	± 3.88
786.4545	PV	Quasi-peak	30.54	± 3.88

Frequency range 1 GHz-25 GHz.

The results in the next tables show the maximum measured levels in the 1-25 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

The field strength at the band edges was evaluated for each mode for the channel under test.

Spurious signals with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with AVG detector for checking compliance with the average limit.

For spurious emissions (except field strength at the band edges that was performed for all possibilities of different bandwidth) for OFDM modes 802.11g, 802.11n20 and 802.11n40 a preliminary scan (highest output power and highest output power spectral density) was performed to determine the worst case. The next tables and plots show the results for the worst case to DSSS modulation (802.11b) and OFDM modulation (802.11g).

1. WiFi 2.4GHz 802.11 b mode.

1.1. CHANNEL 1: LOWEST (2412 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
2.38935	PV	Peak	50.12	± 4.87
5.37475	PV	Peak	39.87	± 4.87
7.23775	PH	Peak	43.94	± 4.87

1.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
4.87425	PV	Peak	47.01	± 4.87
7.31225	PH	Peak	44.02	± 4.87

1.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
4.92375	PV	Peak	48.64	± 4.87
5.37475	PV	Peak	39.97	± 4.87
7.38725	PH	Peak	45.34	± 4.87

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode (worst case OFDM)

2.1. CHANNEL 1: LOWEST (2412 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
2.38986	PV	Peak	65.24	± 4.87
		Average	49.33	± 4.87
5.37475	PV	Peak	40.24	± 4.87

2.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
4.87575	PV	Peak	43.28	± 4.87
5.37475	PV	Peak	40.08	± 4.87

2.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.483534	PV	Peak	60.88	± 4.87
		Average	46.82	± 4.87
2.48508	PV	Peak	59.41	± 4.87
		Average	44.89	± 4.87
4.92225	PV	Peak	46.64	± 4.87
5.37475	PV	Peak	39.85	± 4.87

Verdict: PASS

3. WiFi 2.4GHz 802.11 n40 mode

3.1. CHANNEL 3: LOWEST (2422 MHz). Spurious emissions in restricted band 2.31-2.39 GHz.

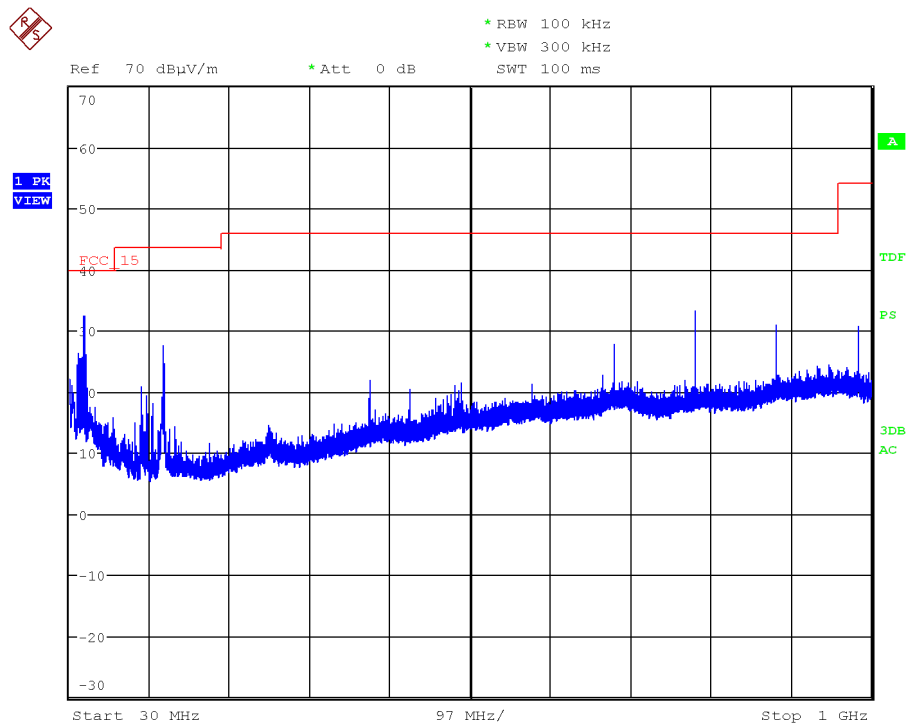
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.38951	PV	Peak	65.60	± 4.87
		Average	53.83	± 4.87
2.38806	PH	Peak	60.28	± 4.87
		Average	47.74	± 4.87

3.2. CHANNEL 9: HIGHEST (2452 MHz). Spurious emissions in restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.48383	PV	Peak	65.71	± 4.87
		Average	48.89	± 4.87
2.48359	PH	Peak	57.22	± 4.87
		Average	42.41	± 4.87

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

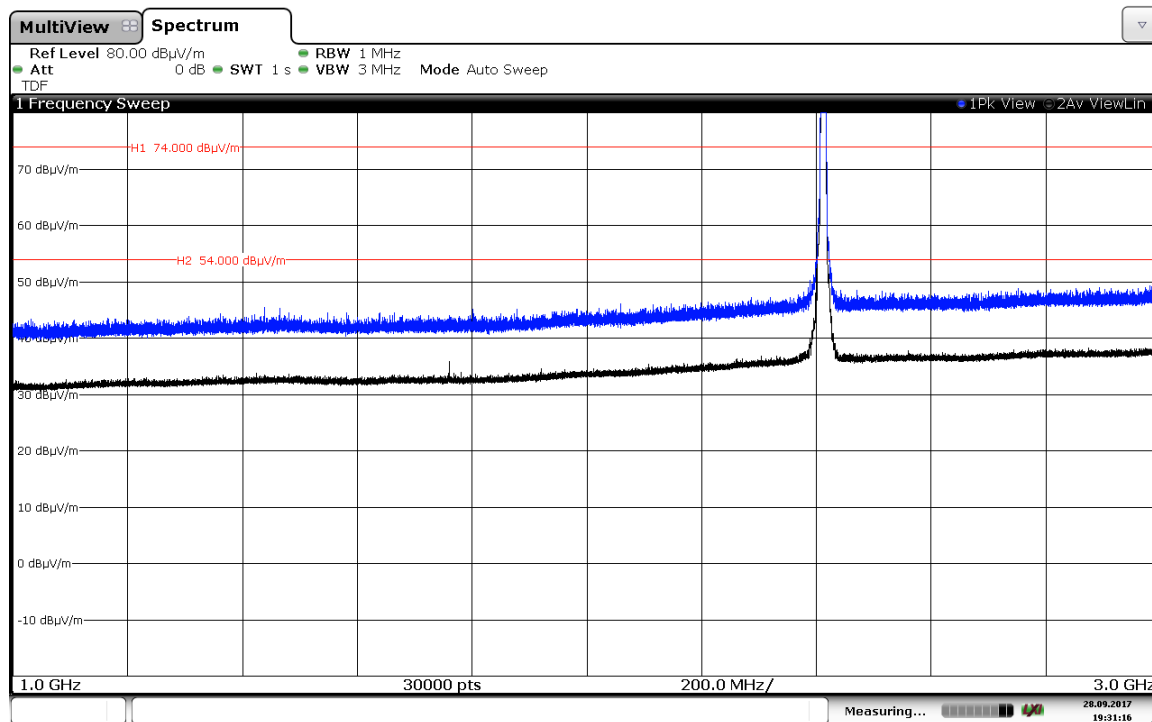


(This plot is valid for all three channels and modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

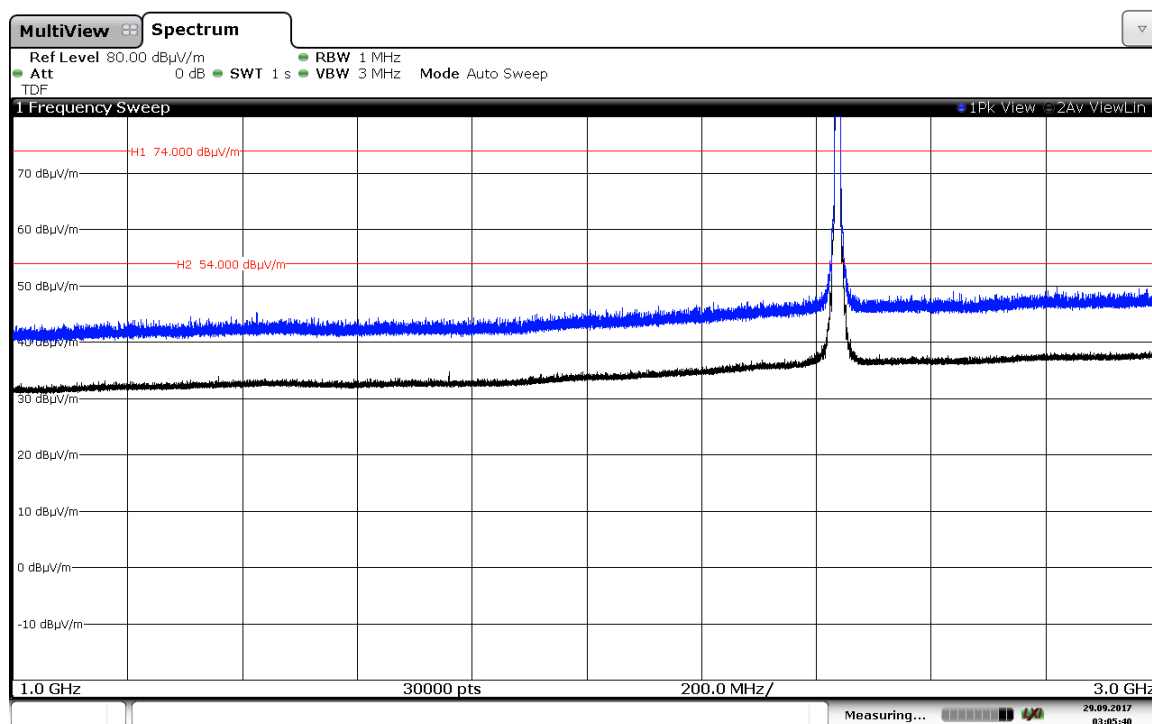
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



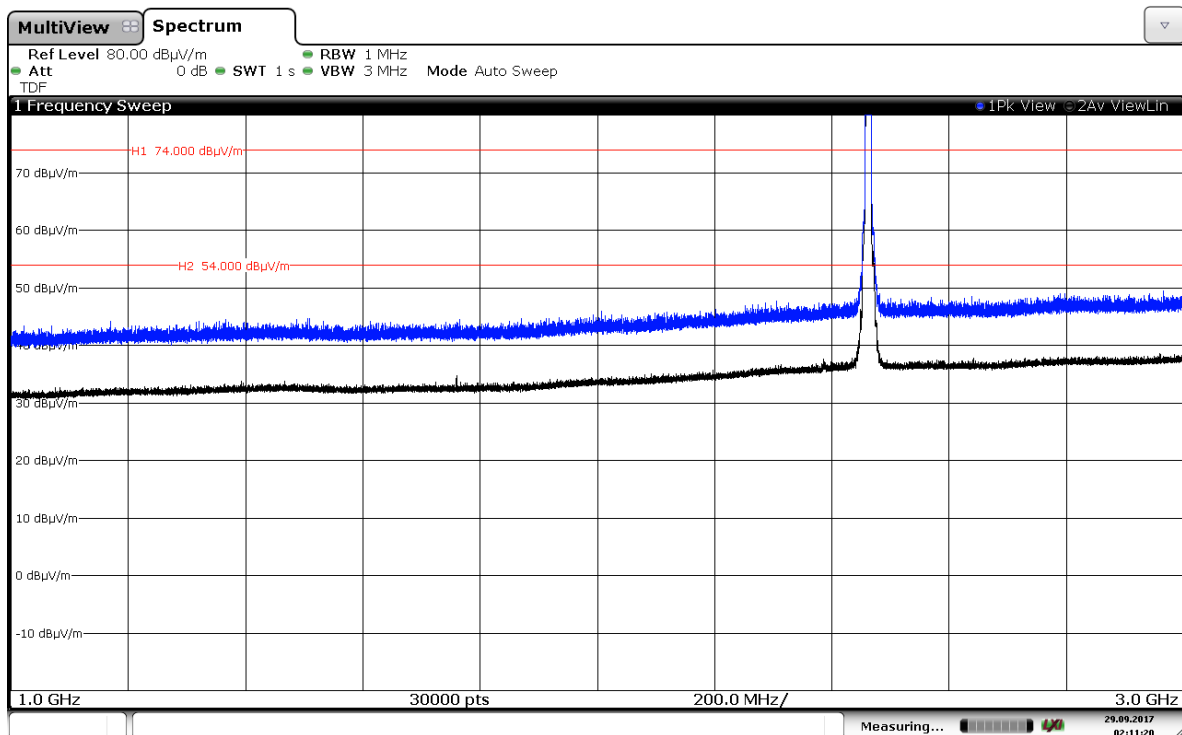
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



Note: The peak above the limit is the carrier frequency.

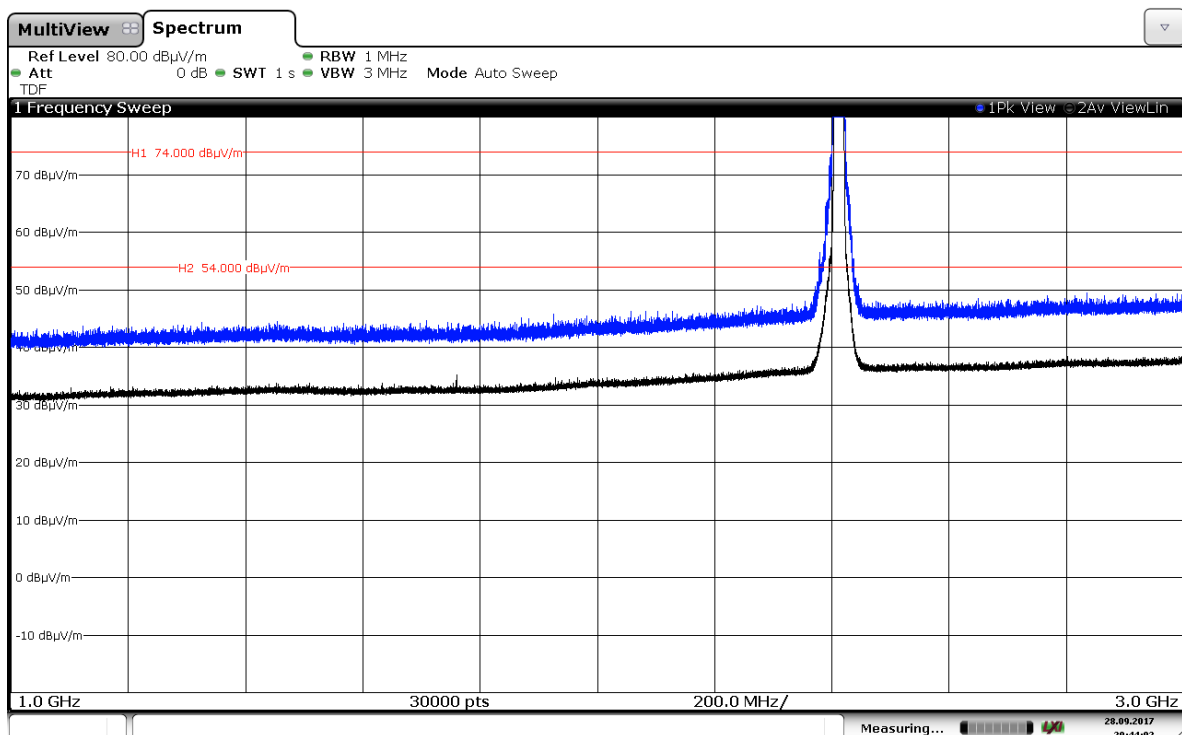
CHANNEL 11 (2462 MHz).



Note: The peak above the limit is the carrier frequency.

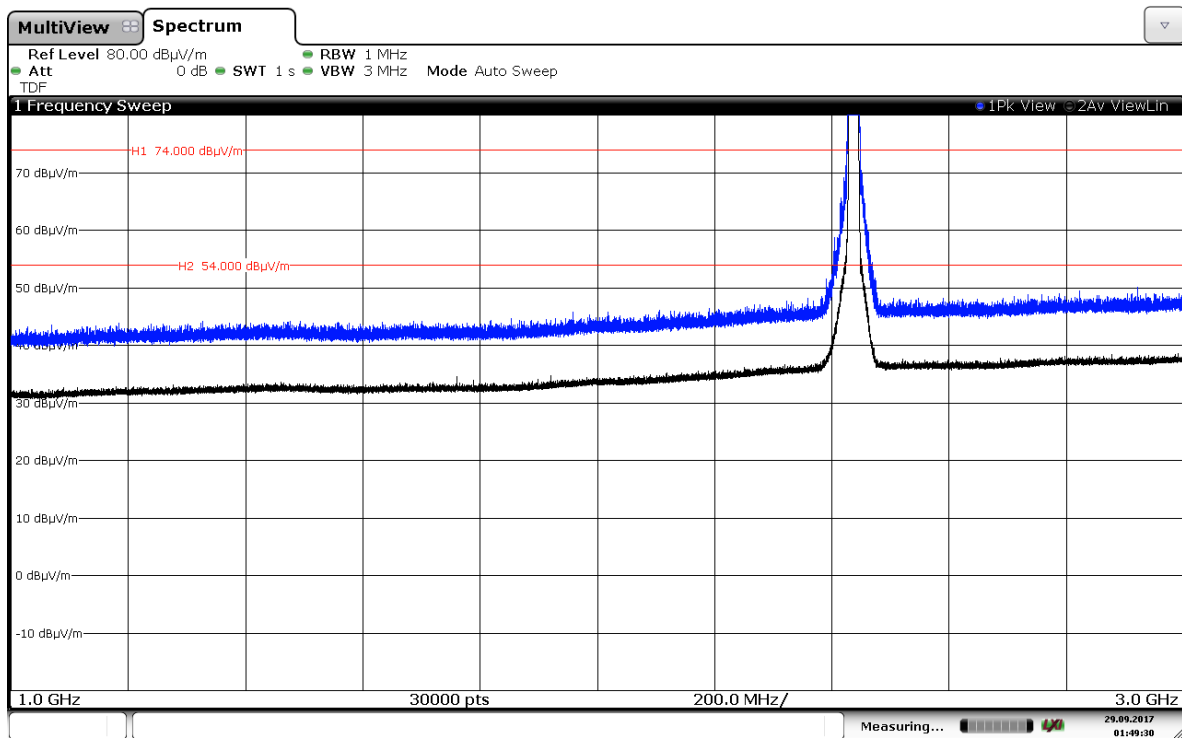
2. WiFi 2.4GHz 802.11 g mode (Worst case OFDM)

CHANNEL 1 (2412 MHz).



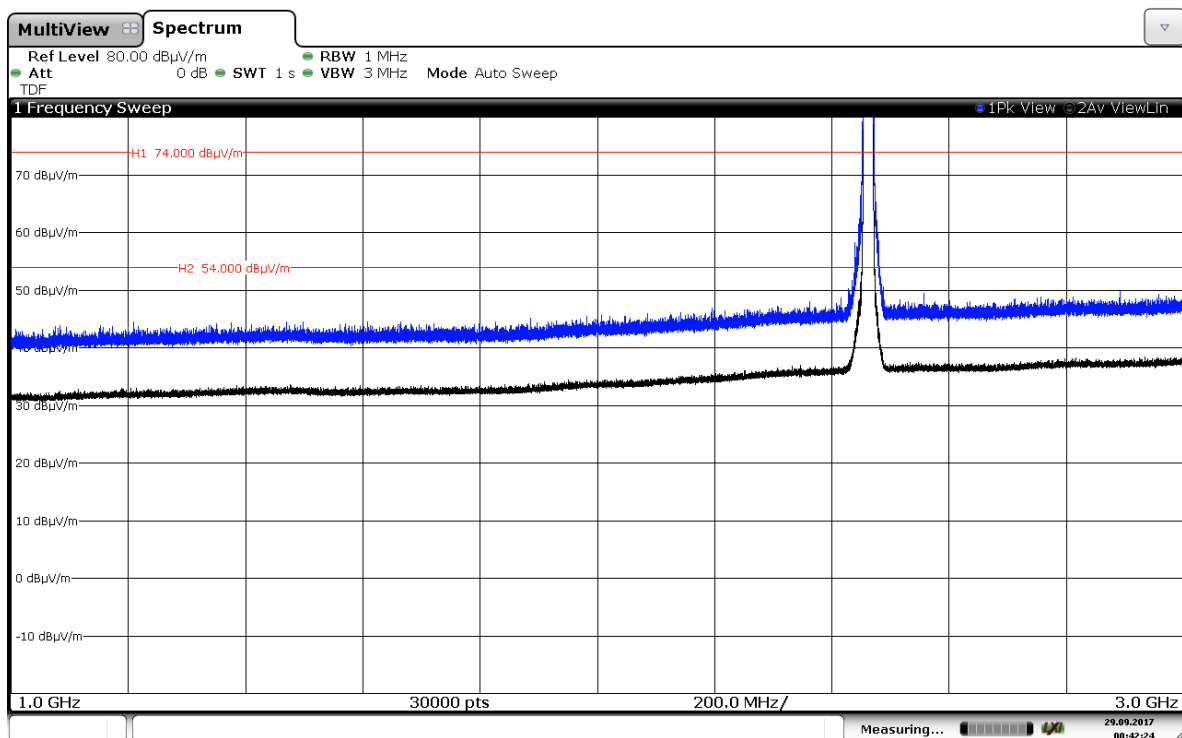
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



Note: The peak above the limit is the carrier frequency.

CHANNEL 11 (2462 MHz).

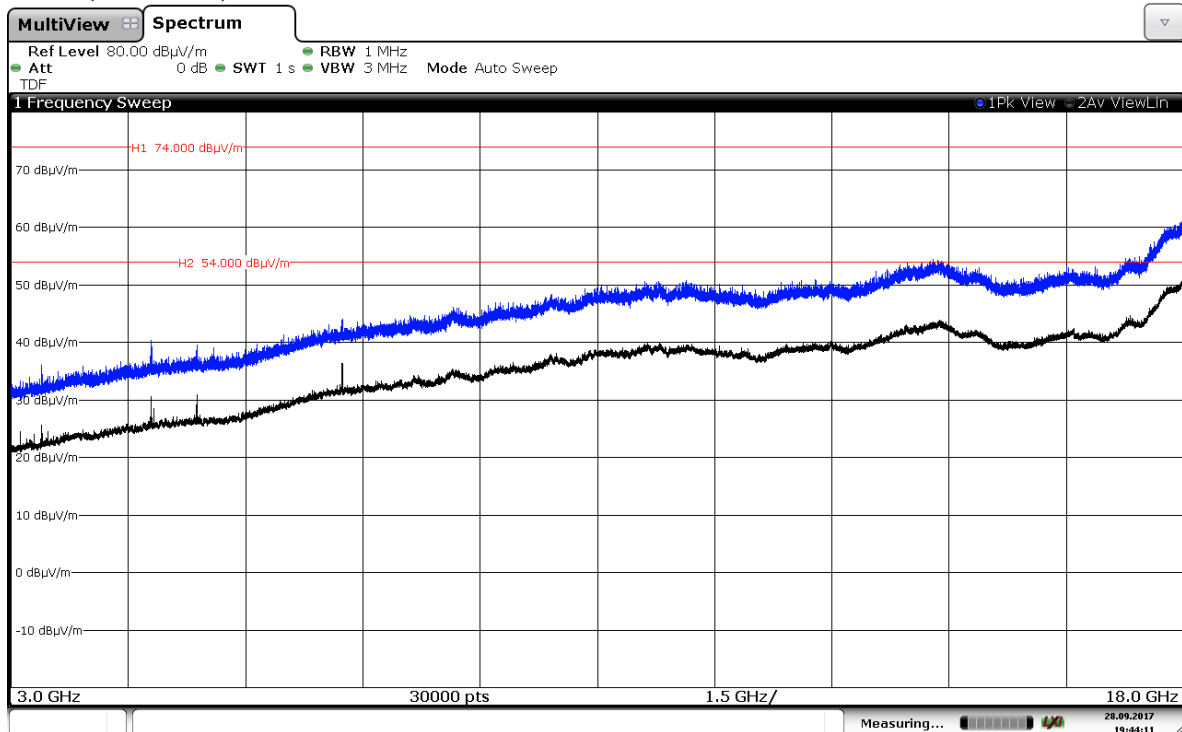


Note: The peak above the limit is the carrier frequency.

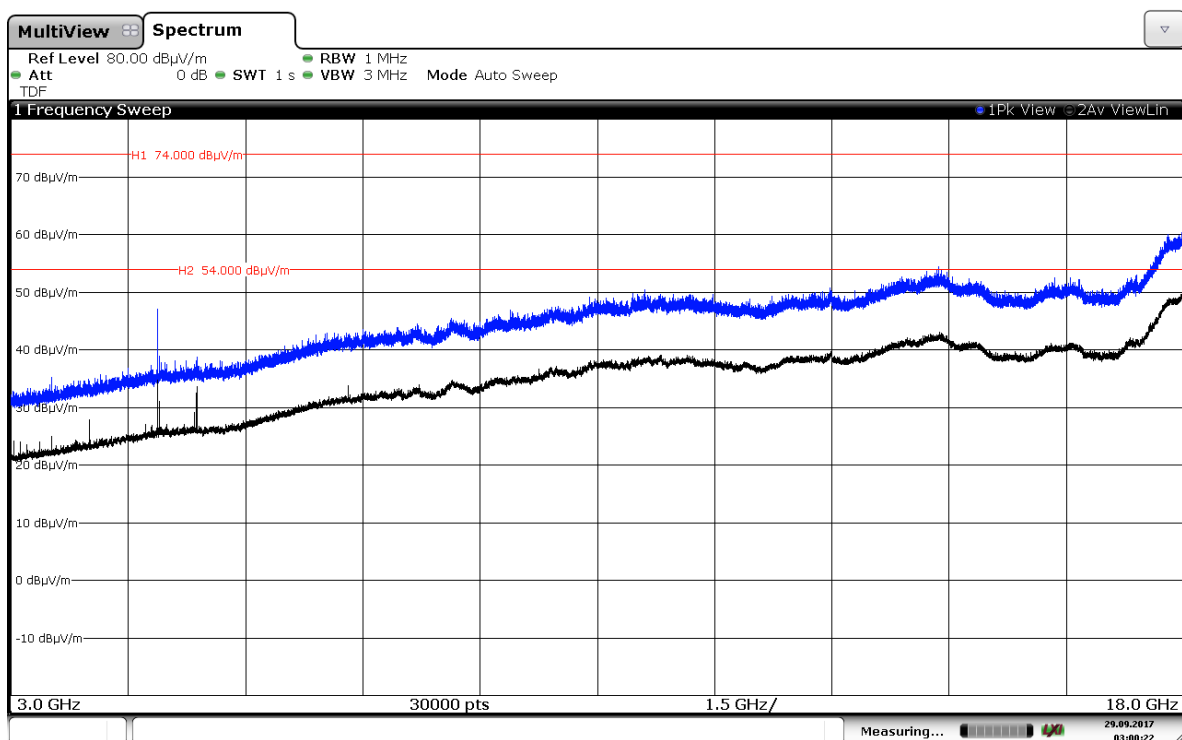
FREQUENCY RANGE 3 GHz to 18 GHz.

1. WiFi 2.4GHz 802.11 b mode

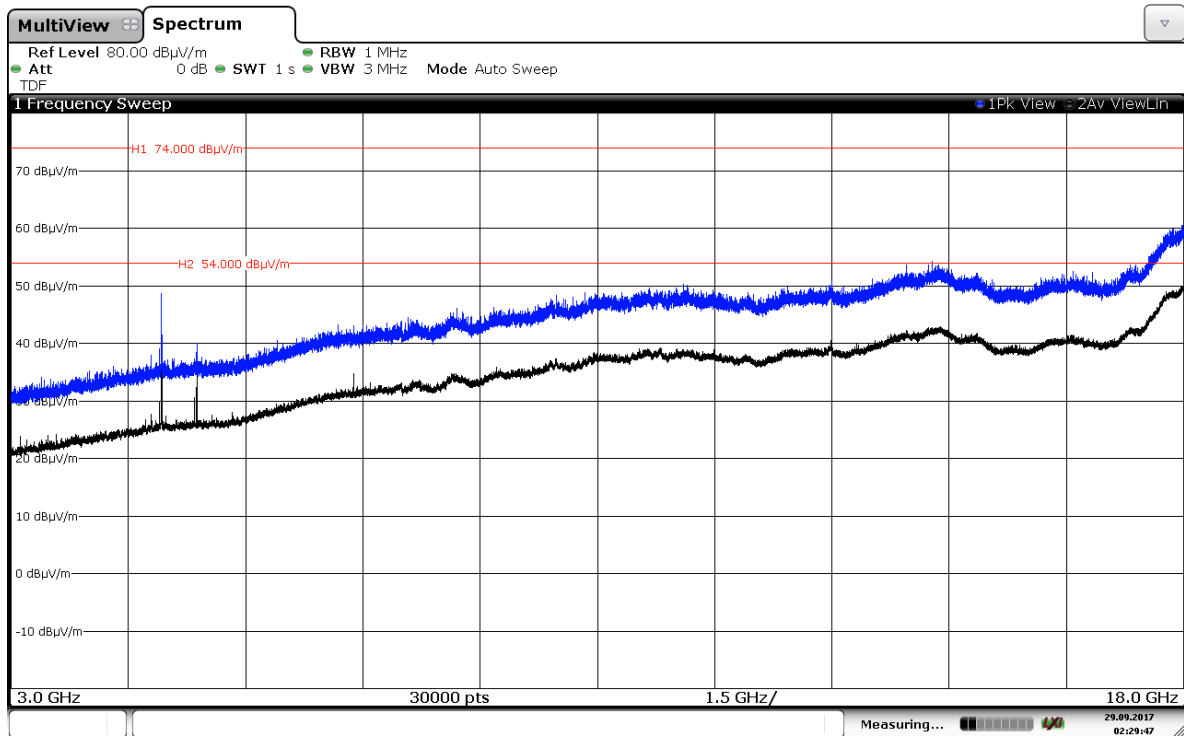
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

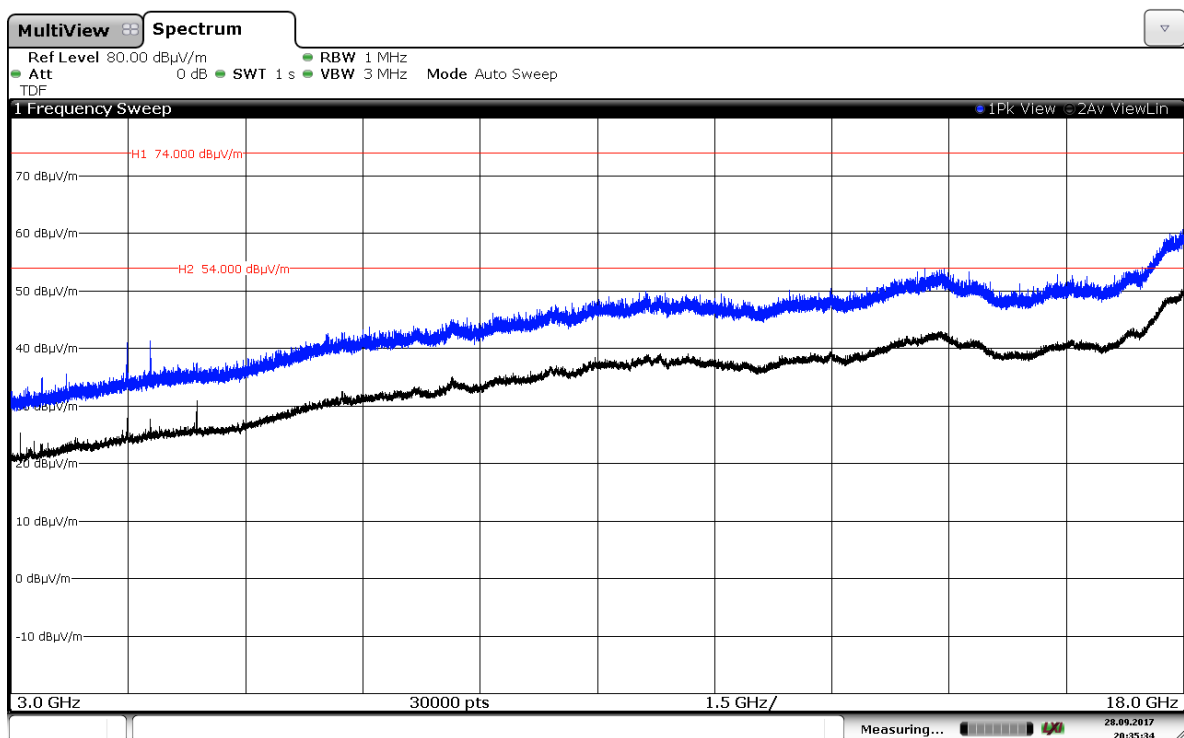


CHANNEL 11 (2462 MHz).

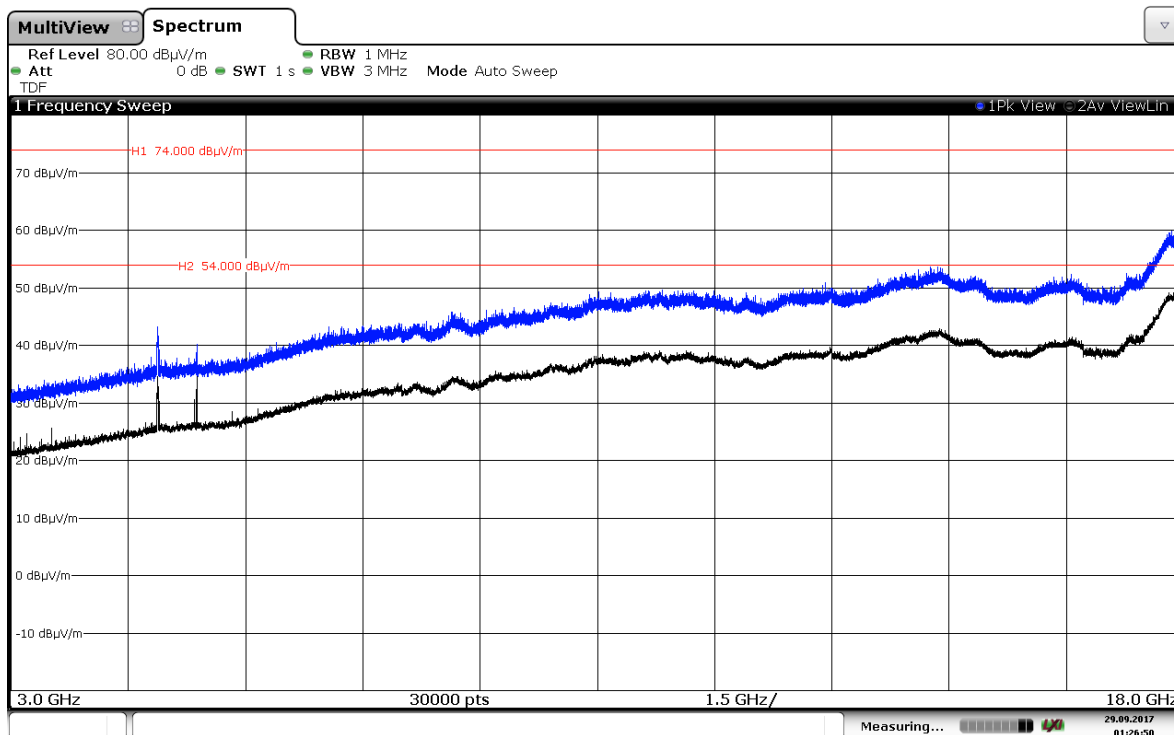


2. WiFi 2.4GHz 802.11 g mode (Worst case OFDM)

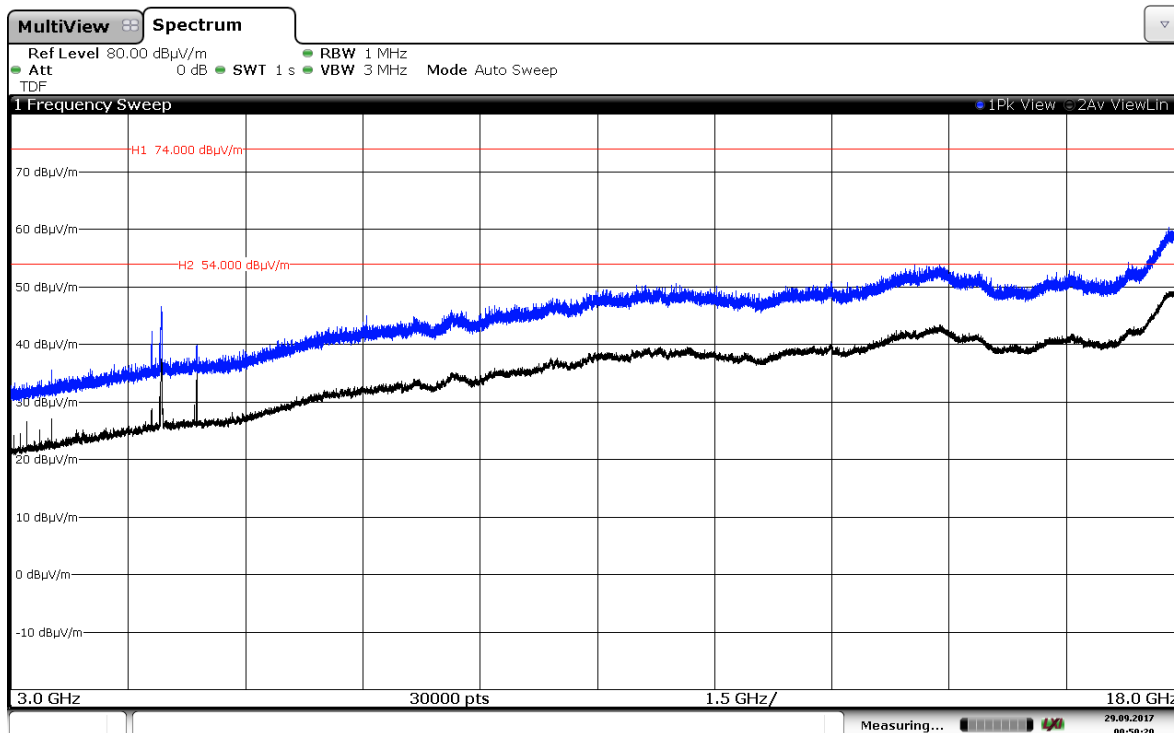
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).



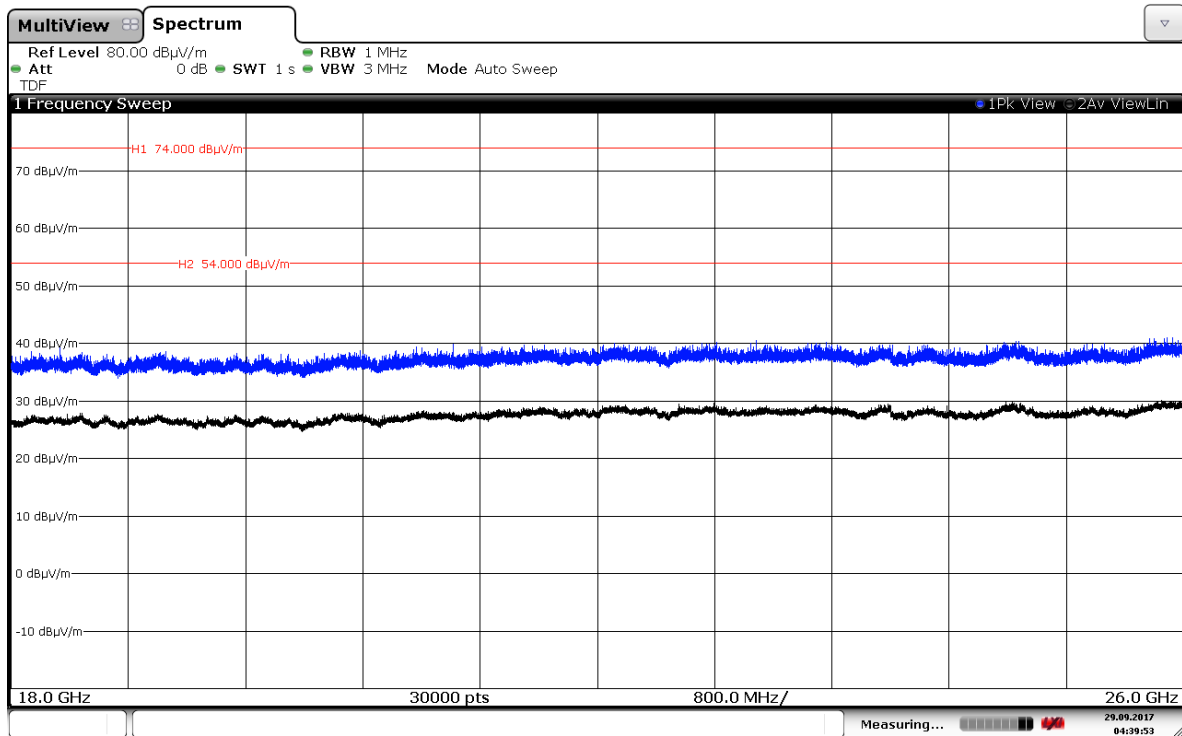
CHANNEL 11 (2462 MHz).



FREQUENCY RANGE 18 GHz to 26 GHz.

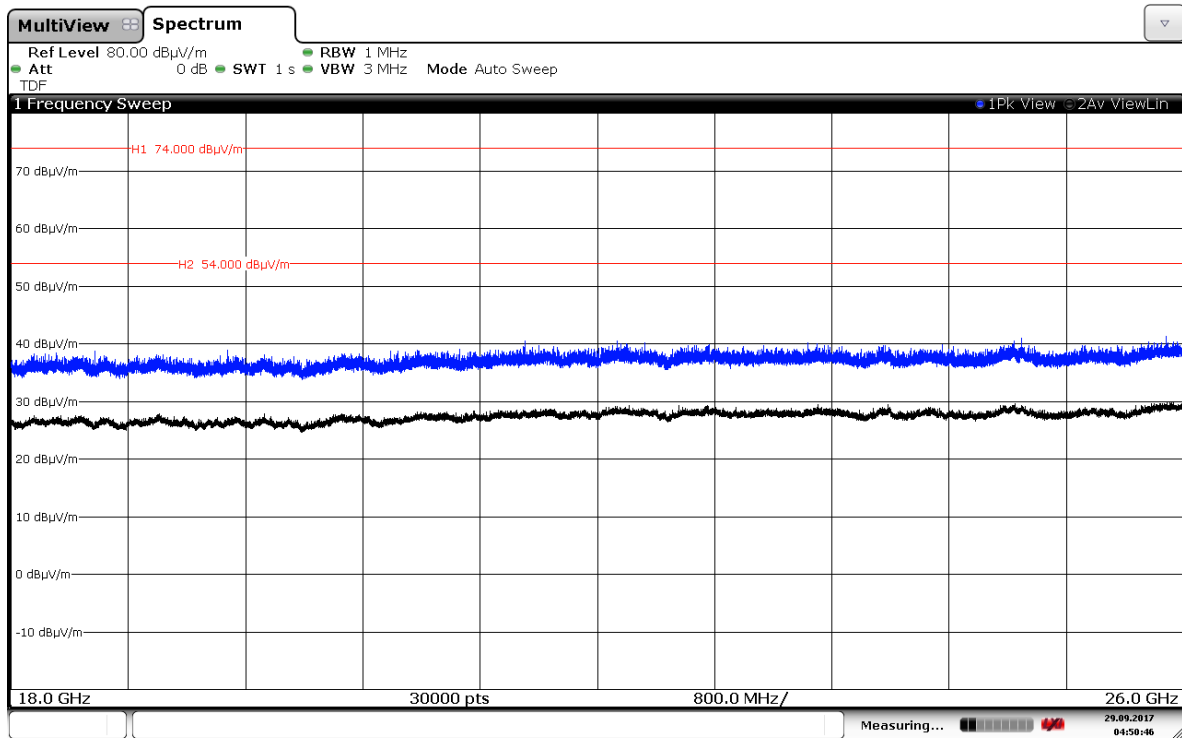
1. WiFi 2.4GHz 802.11 b mode

No spurious signals were found in all channels tested.



2. WiFi 2.4GHz 802.11 g mode (Worst case)

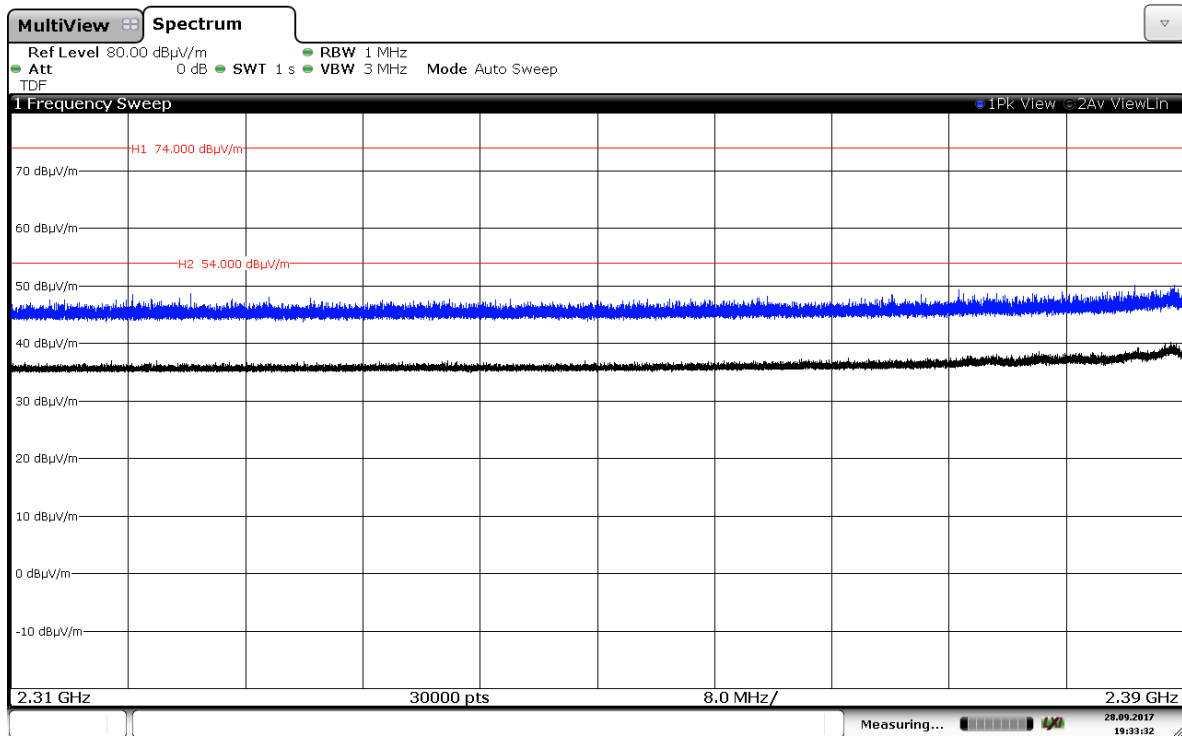
No spurious signals were found in all channels tested.



FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

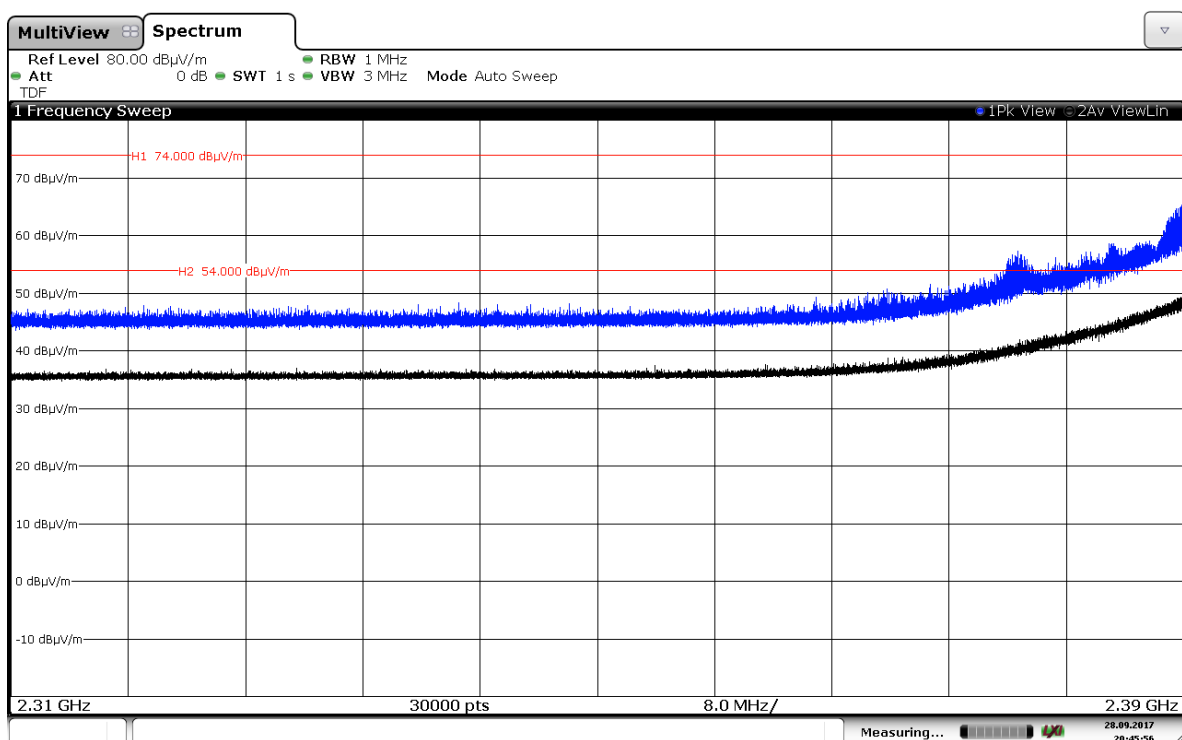
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



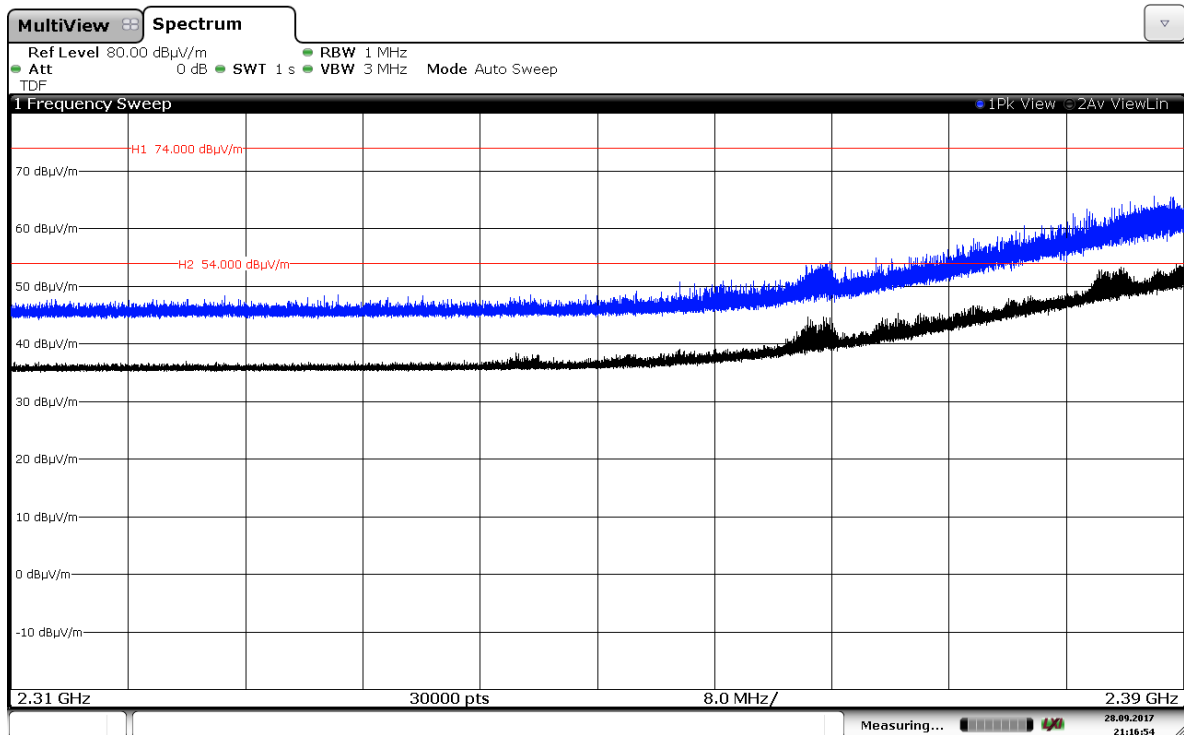
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



3. WiFi 2.4GHz 802.11 n40 mode

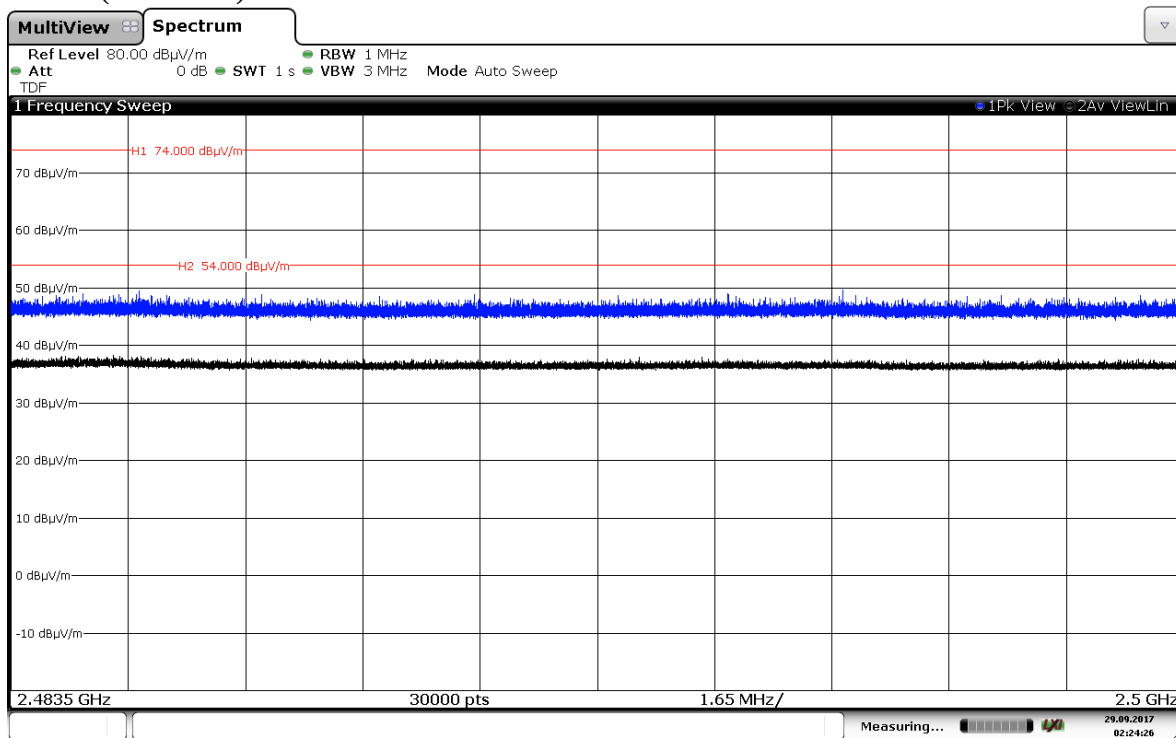
CHANNEL 3 (2422 MHz).



FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

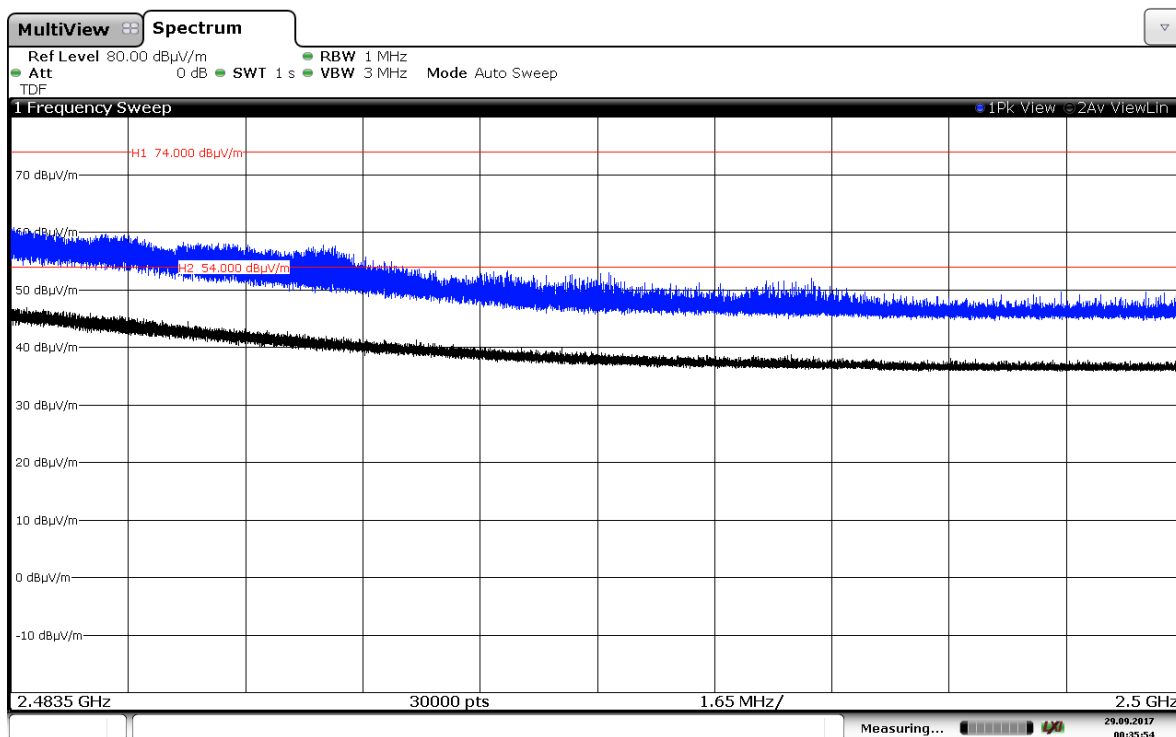
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 11 (2462 MHz).



2. WiFi 2.4GHz 802.11 g mode

CHANNEL 11 (2462 MHz).



3. WiFi 2.4GHz 802.11 n40 mode

CHANNEL 9 (2452 MHz).

