




## FCC PART 15.247 TEST REPORT

For

**PCD, LLC**

1500 Tradeport Drive, Suite A Orlando, FL 32824 United States

**FCC ID: 2ALJJPG03**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Cougar II
<b>Report Number:</b> <u>RGMA191028002-00B</u>	
<b>Report Date:</b> <u>2019-12-12</u>	
Nancy Wang 	
<b>Reviewed By:</b> <u>RF Engineer</u>	
<b>Prepared By:</b> Bay Area Compliance Laboratories Corp. (Shenzhen) 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China Tel: +86-755-33320018 Fax: +86-755-33320008 <a href="http://www.baclcorp.com.cn">www.baclcorp.com.cn</a>	

**Note:** This report must not be used by the customer to claim product certification, approval, or endorsement by A2LA\* or any agency of the Federal Government. This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk “★”.

BACL is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk “\*”. Customer model name, addresses, names, trademarks etc. are not considered data.

This report cannot be reproduced except in full, without prior written approval of the Company. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

## **TABLE OF CONTENTS**

<b>GENERAL INFORMATION.....</b>	<b>4</b>
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) .....	4
OBJECTIVE .....	4
RELATED SUBMITTAL(S)/GRANT(S).....	4
TEST METHODOLOGY .....	4
MEASUREMENT UNCERTAINTY .....	5
TEST FACILITY .....	5
<b>SYSTEM TEST CONFIGURATION.....</b>	<b>6</b>
DESCRIPTION OF TEST CONFIGURATION .....	6
EUT EXERCISE SOFTWARE .....	6
SPECIAL ACCESSORIES.....	6
EQUIPMENT MODIFICATIONS .....	6
SUPPORT EQUIPMENT LIST AND DETAILS .....	6
EXTERNAL I/O CABLE.....	6
BLOCK DIAGRAM OF TEST SETUP .....	7
<b>SUMMARY OF TEST RESULTS .....</b>	<b>8</b>
<b>TEST EQUIPMENT LIST .....</b>	<b>9</b>
<b>FCC§15.247 (i), §1.1307 (b) (1) &amp;§2.1093 – RF EXPOSURE .....</b>	<b>11</b>
APPLICABLE STANDARD .....	11
<b>FCC §15.203 – ANTENNA REQUIREMENT .....</b>	<b>12</b>
APPLICABLE STANDARD .....	12
ANTENNA CONNECTOR CONSTRUCTION .....	12
<b>FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS .....</b>	<b>13</b>
APPLICABLE STANDARD .....	13
EUT SETUP.....	13
EMI TEST RECEIVER SETUP.....	13
TEST PROCEDURE .....	13
CORRECTED FACTOR & MARGIN CALCULATION .....	14
TEST RESULTS SUMMARY .....	14
TEST DATA .....	14
<b>FCC §15.205, §15.209 &amp; §15.247(d) – RADIATED EMISSIONS.....</b>	<b>17</b>
APPLICABLE STANDARD .....	17
EUT SETUP .....	17
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP .....	18
TEST PROCEDURE .....	18
CORRECTED AMPLITUDE & MARGIN CALCULATION .....	18
TEST RESULTS SUMMARY .....	18
TEST DATA .....	18
<b>FCC §15.247(a) (1)-CHANNEL SEPARATION TEST .....</b>	<b>25</b>
APPLICABLE STANDARD .....	25
TEST PROCEDURE .....	25
TEST DATA .....	25
<b>FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH.....</b>	<b>28</b>

APPLICABLE STANDARD .....	28
TEST PROCEDURE .....	28
TEST DATA .....	28
<b>FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST .....</b>	<b>34</b>
APPLICABLE STANDARD .....	34
TEST PROCEDURE .....	34
TEST DATA .....	34
<b>FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....</b>	<b>37</b>
APPLICABLE STANDARD .....	37
TEST PROCEDURE .....	37
TEST DATA .....	37
<b>FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT.....</b>	<b>48</b>
APPLICABLE STANDARD .....	48
TEST PROCEDURE .....	48
TEST DATA .....	48
<b>FCC §15.247(d) - BAND EDGES TESTING .....</b>	<b>49</b>
APPLICABLE STANDARD .....	49
TEST PROCEDURE .....	49
TEST DATA .....	49

## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

Product	Cougar II
Tested Model	PG03
Frequency Range	Bluetooth: 2402~2480MHz
Conducted Peak Power	Bluetooth: 9.35dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification	Monopole Antenna: 1dBi
Voltage Range	DC 3.7 V from battery or DC 5.0V from adapter
Date of Test	2019-11-01 to 2019-12-12
Sample serial number	191028002(Assigned by BACL, Shenzhen)
Received date	2019-10-28
Sample/EUT Status	Good condition
Adapter information	Model: PG03 Input: AC 100-240V, 50/60Hz, 0.15A Output: DC 5V, 500mA

### Objective

This test report is prepared on behalf of *PCD, LLC* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

### Related Submittal(s)/Grant(s)

FCC Part 15B JBP, Part 22H /24E PCE submissions with FCC ID: 2ALJJP03.

### Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For Radiated Emissions testing, please refer to DA 00-705 Released March 30, 2000, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

**Measurement Uncertainty**

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF Output Power with Power meter		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±1 °C
Humidity		±6%
Supply voltages		±0.4%

*Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.*

**Test Facility**

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

## SYSTEM TEST CONFIGURATION

---

### Description of Test Configuration

The system was configured for testing in an engineering mode.

### EUT Exercise Software

No exercise software was made to the EUT tested.

### Special Accessories

No special accessory.

### Equipment Modifications

No modification was made to the EUT tested.

### Support Equipment List and Details

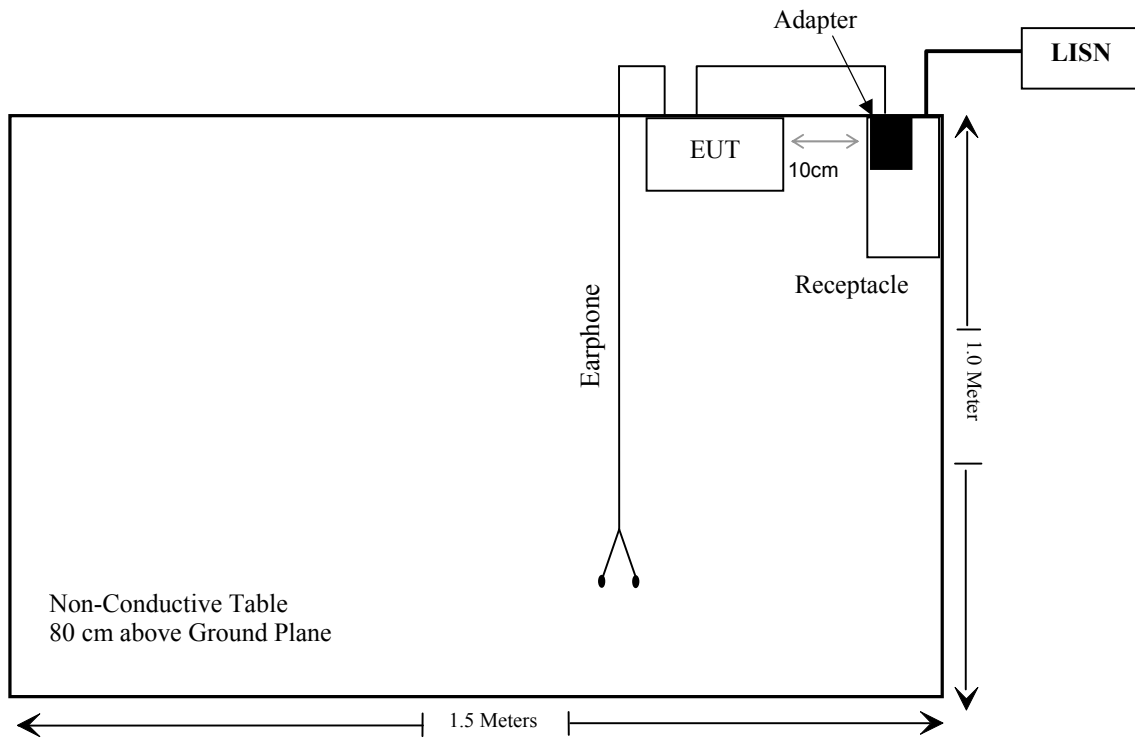
Manufacturer	Description	Model	Serial Number
N/A	N/A	N/A	N/A

### External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable DC Cable	0.8	EUT	Adapter

## Block Diagram of Test Setup

For conducted emission:



**SUMMARY OF TEST RESULTS**

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (1)& §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliance
§15.247(a)(1)	20 dB Emission Bandwidth	Compliance
§15.247(a)(1)	Channel Separation Test	Compliance
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
§15.247(b)(1)	Peak Output Power Measurement	Compliance
§15.247(d)	Band edges	Compliance



**TEST EQUIPMENT LIST**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
<b>Conducted Emissions Test</b>					
Rohde & Schwarz	EMI Test Receiver	ESCS30	100176	2019-07-11	2020-07-11
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2019-01-25	2020-01-25
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2019-03-02	2020-03-01
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Unknown	Conducted Emission Cable	78652	UF A210B-1-0720-504504	2018-11-12	2019-11-12
<b>Radiated Emission Test</b>					
A.H. System	Horn Antenna	SAS-200/571	135	2018-09-01	2021-08-31
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2019-07-22	2020-07-21
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017-12-22	2020-12-21
COM-POWER	Pre-amplifier	PA-122	181919	2019-11-12	2020-11-12
Sonoma Instrument	Amplifier	310N	186238	2018-11-12	2019-11-12
Rohde & Schwarz	EMI Test Receiver	ESR3	102455	2019-07-09	2020-07-08
Ducommun technologies	RF Cable	UFA147A-2362-100100	MFR64639 231029-003	2018-11-12	2019-11-12
Ducommun technologies	RF Cable	104PEA	218124002	2018-11-12	2019-11-12
Ducommun technologies	RF Cable	RG-214	1	2019-11-12	2020-11-12
Ducommun technologies	RF Cable	RG-214	2	2019-11-12	2020-11-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-04	2017-12-29	2020-12-28
Heatsink Required	Amplifier	QLW-18405536-J0	15964001002	2019-11-12	2020-11-12
Sinoscite	Notch Filter	BSF2402-2480MN-0898-001	99632	2019-11-12	2020-11-12
Rohde & Schwarz	Wideband Radio Communication Tester	CMW500	1201.002K50-146520-wh	2019-07-09	2020-07-08
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
ROHDE & SCHWARZ	Signal and Spectrum Analyzer	FSV40	101473	2019-07-22	2020-07-21
Rohde & Schwarz	Wideband Radio Communication Tester	CMW500	1201.002K50-146520-wh	2019-07-09	2020-07-08
Tonscend Corporation	RF control uni	JS0806-2	19D8060154	2019-07-10	2020-07-09
Ducommun technologies	RF Cable	RG-214	3	Each Time	

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

## **FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE**

### **Applicable Standard**

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot$

$[\sqrt{f(\text{GHz})}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR, where

1.  $f(\text{GHz})$  is the RF channel transmit frequency in GHz.

2. Power and distance are rounded to the nearest mW and mm before calculation.

3. The result is rounded to one decimal place for comparison.

4. When the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test Exclusion.

**For worst case:**

Frequency (MHz)	Maximum Tune-up power		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
	(dBm)	(mW)				
2480	9.5	8.91	5	2.81	3.0	Yes

**Result: No Standalone SAR test is required**

---

**FCC §15.203 – ANTENNA REQUIREMENT**

---

**Applicable Standard**

According to FCC § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

**Antenna Connector Construction**

The EUT has one internal antenna arrangement, which was permanently attached and the antenna gain is 1dBi, fulfill the requirement of this section. Please refer to the EUT photos.

**Result:** Compliance.

## FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

### Applicable Standard

FCC §15.207(a)

### EUT Setup



Note: 1. Support units were connected to second LISN.  
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

### EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

### Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

## Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Results Summary

According to the EUT complied with the FCC Part 15.207,

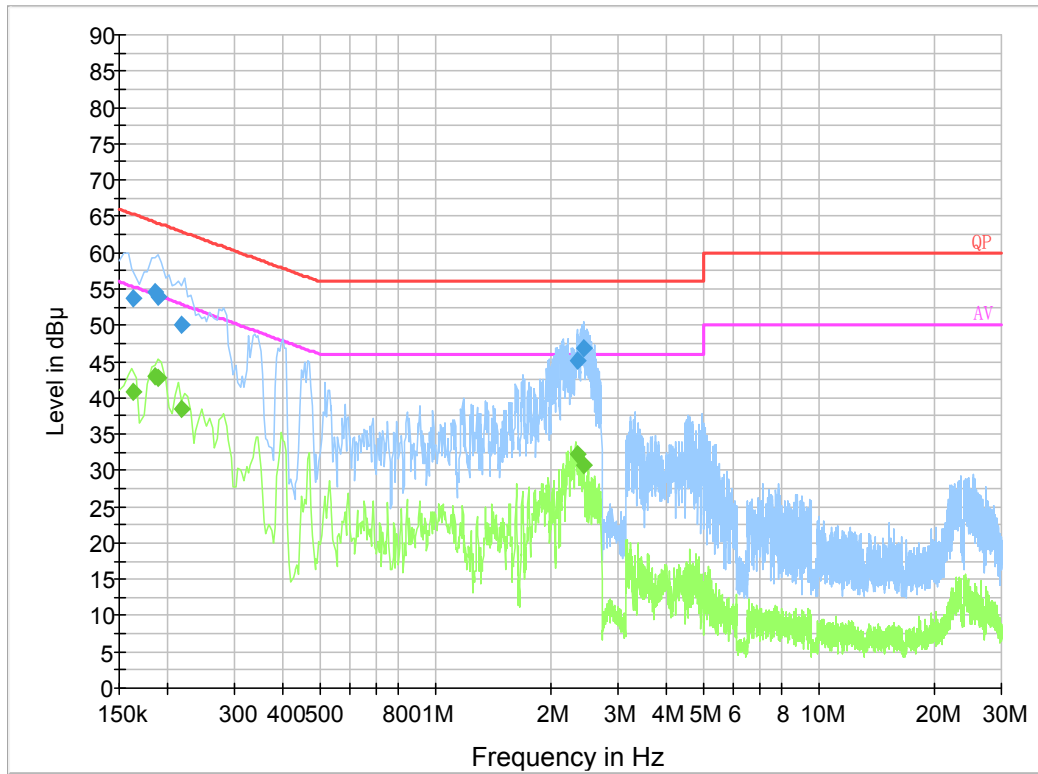
## Test Data

### Environmental Conditions

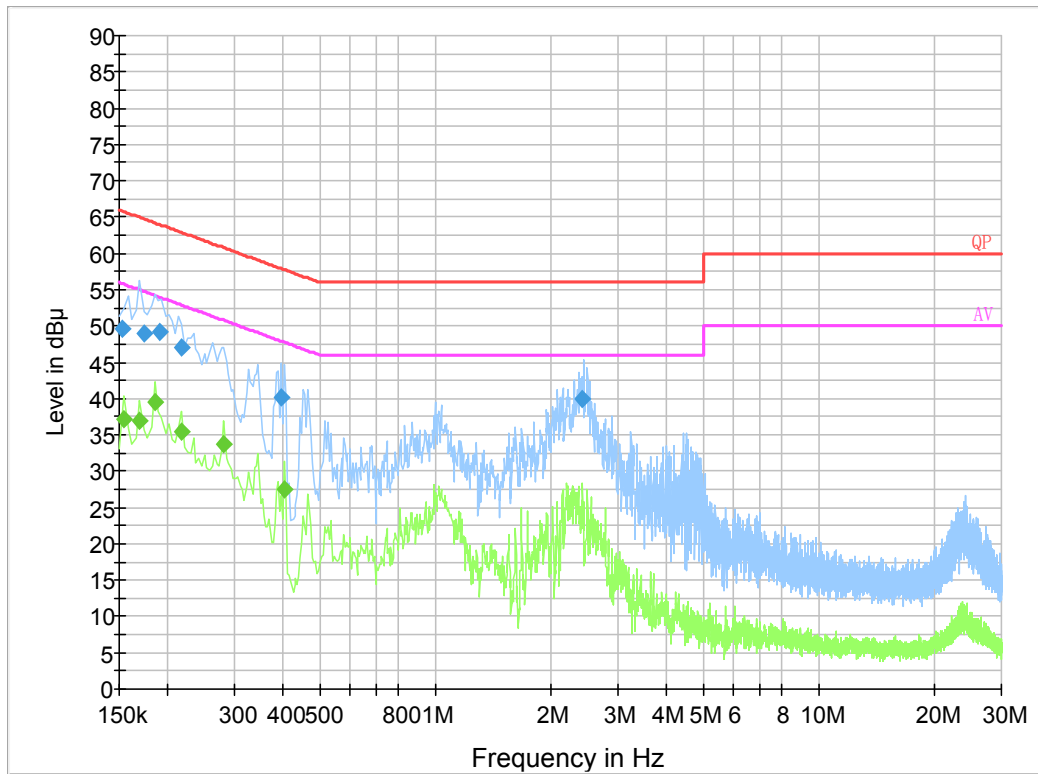
<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	50 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Kiki Geng on 2019-11-01.*

*EUT operation mode: Charging&Transmitting (the worst case is GFSK Mode, High channel)*

**AC 120V/60 Hz, Line**

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.162500	53.8	19.9	65.3	11.5	QP
0.186500	54.5	19.8	64.2	9.7	QP
0.189500	53.8	19.8	64.1	10.3	QP
0.217500	50.0	19.8	62.9	12.9	QP
2.346870	45.2	19.9	56.0	10.8	QP
2.437550	46.9	19.8	56.0	9.1	QP
0.162500	40.8	19.9	55.3	14.5	Ave.
0.186500	42.9	19.8	54.2	11.3	Ave.
0.189500	42.8	19.8	54.1	11.3	Ave.
0.217500	38.3	19.8	52.9	14.6	Ave.
2.346870	32.2	19.9	46.0	13.8	Ave.
2.437550	30.7	19.8	46.0	15.3	Ave.

**AC 120V/60 Hz, Neutral**

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.153500	49.6	19.8	65.8	16.2	QP
0.174500	49.0	19.8	64.7	15.7	QP
0.190501	49.2	19.8	64.0	14.8	QP
0.218501	47.1	19.8	62.9	15.8	QP
0.396030	40.3	19.8	57.9	17.6	QP
2.417430	39.9	19.8	56.0	16.1	QP
0.154000	37.1	19.8	55.8	18.7	Ave.
0.170000	37.0	19.9	55.0	18.0	Ave.
0.186000	39.5	19.8	54.2	14.7	Ave.
0.218000	35.5	19.8	52.9	17.4	Ave.
0.282000	33.7	19.7	50.8	17.1	Ave.
0.406000	27.4	19.8	47.7	20.3	Ave.

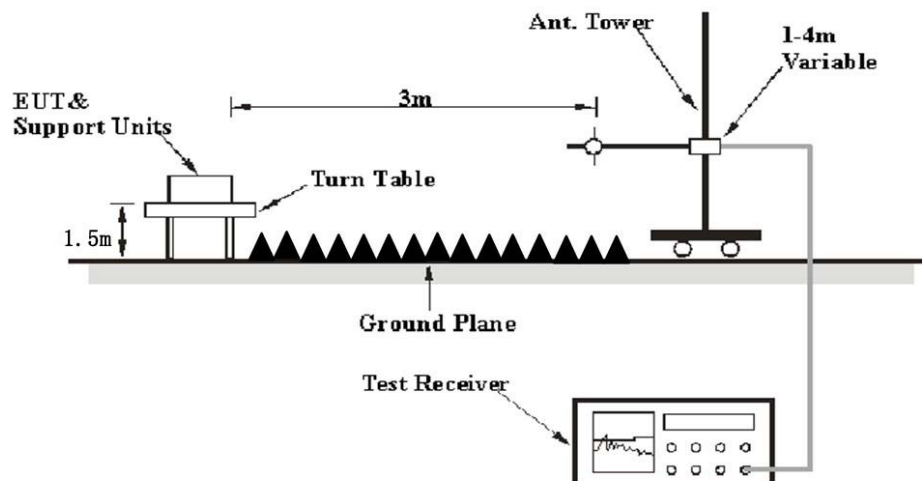
**Note:**

- 1) Correction Factor = LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
- 2) Corrected Amplitude = Reading + Correction Factor
- 3) Margin = Limit – Corrected Amplitude



**FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS****Applicable Standard**

FCC §15.205; §15.209; §15.247(d)

**EUT Setup****Below 1 GHz:****Above 1GHz:**

The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

## EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, according to the DA 00-705 Released March 30, 2000, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Average

## Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

## Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Results Summary

According to the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

## Test Data

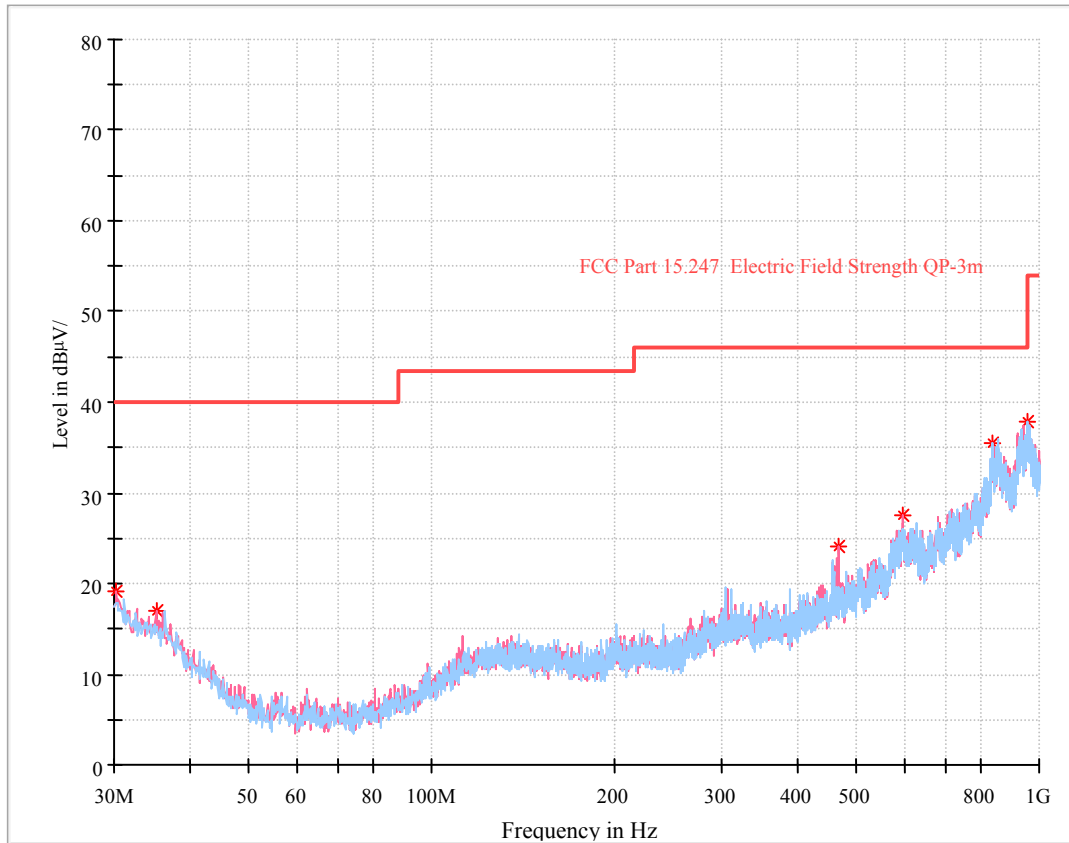
### Environmental Conditions

<b>Temperature:</b>	23~25 °C
<b>Relative Humidity:</b>	50~52 %
<b>ATM Pressure:</b>	100.9~101.0 kPa

*The testing was performed by Zero Yan on 2019-11-01 for below 1G and Charlie Cha from 2019-11-26 for above 1G.*

*EUT operation mode: Transmitting (Scan with GFSK,  $\pi/4$ -DQPSK, 8DPSK mode, the worst case is GFSK Mode)*

**30 MHz~1 GHz:** (the worst case is GFSK Mode, High channel)



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
30.242500	19.07	300.0	V	0.0	-7.8	40.00	20.93
35.213750	16.95	202.0	V	344.0	-10.6	40.00	23.05
466.742500	24.03	202.0	V	0.0	-7.9	46.00	21.97
595.388750	27.61	300.0	V	74.0	-1.9	46.00	18.39
838.737500	35.59	300.0	V	199.0	5.8	46.00	10.41
957.926250	37.75	102.0	H	3.0	9.3	46.00	8.25

**1 GHz - 25 GHz:**

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2362.27	28.95	PK	352	1.1	V	31.87	60.82	74	13.18
2362.27	14.65	Ave.	352	1.1	V	31.87	46.52	54	7.48
2496.07	28.93	PK	347	1.3	V	32.13	61.06	74	12.94
2496.07	14.62	Ave.	347	1.3	V	32.13	46.75	54	7.25
4804.00	48.04	PK	74	2.5	V	5.40	53.44	74	20.56
4804.00	38.79	Ave.	74	2.5	V	5.40	44.19	54	9.81
Middle Channel (2441 MHz)									
4882.00	46.77	PK	178	1.1	V	5.40	52.17	74	21.83
4882.00	36.54	Ave.	178	1.1	V	5.40	41.94	54	12.06
High Channel (2480 MHz)									
2347.11	28.53	PK	45	1.4	V	31.64	60.17	74	13.83
2347.11	14.72	Ave.	45	1.4	V	31.64	46.36	54	7.64
2486.62	28.89	PK	331	2.5	V	32.13	61.02	74	12.98
2486.62	14.89	Ave.	331	2.5	V	32.13	47.02	54	6.98
4960.00	45.69	PK	308	2.1	V	5.40	51.09	74	22.91
4960.00	34.19	Ave.	308	2.1	V	5.40	39.59	54	14.41

Note:

Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

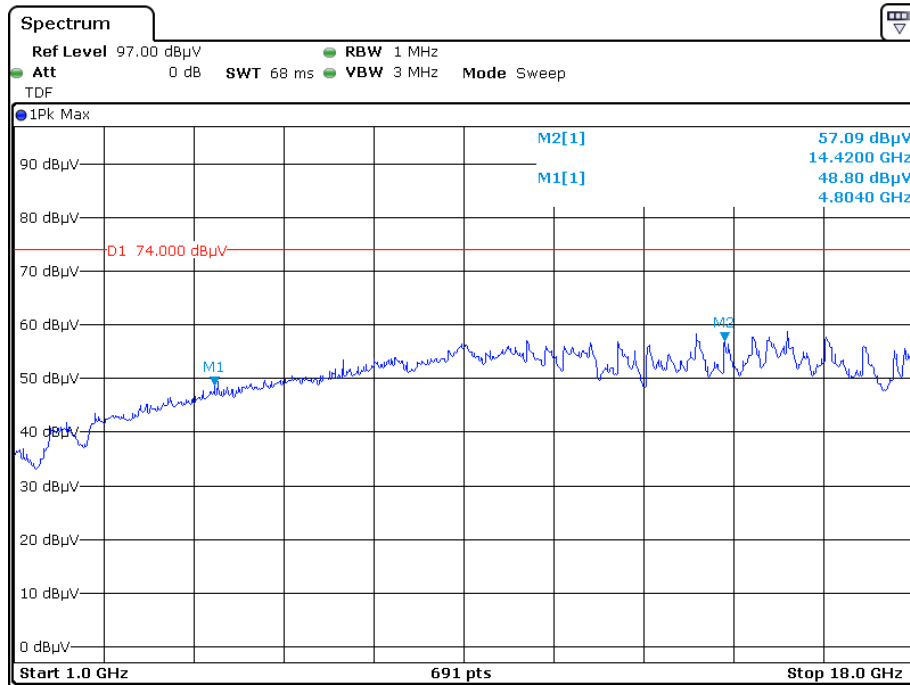
Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

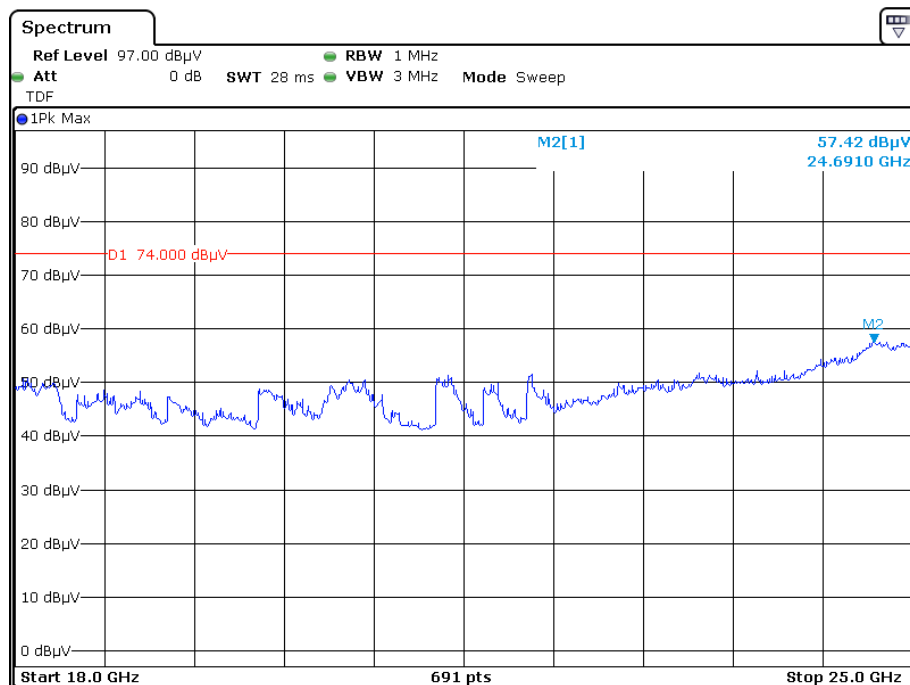
The other spurious emission which is 20dB to the limit was not recorded.

And for the pre-scan is performed with the 2400-2483.5MHz band filter.

### Pre-scan with low channel Peak Horizontal

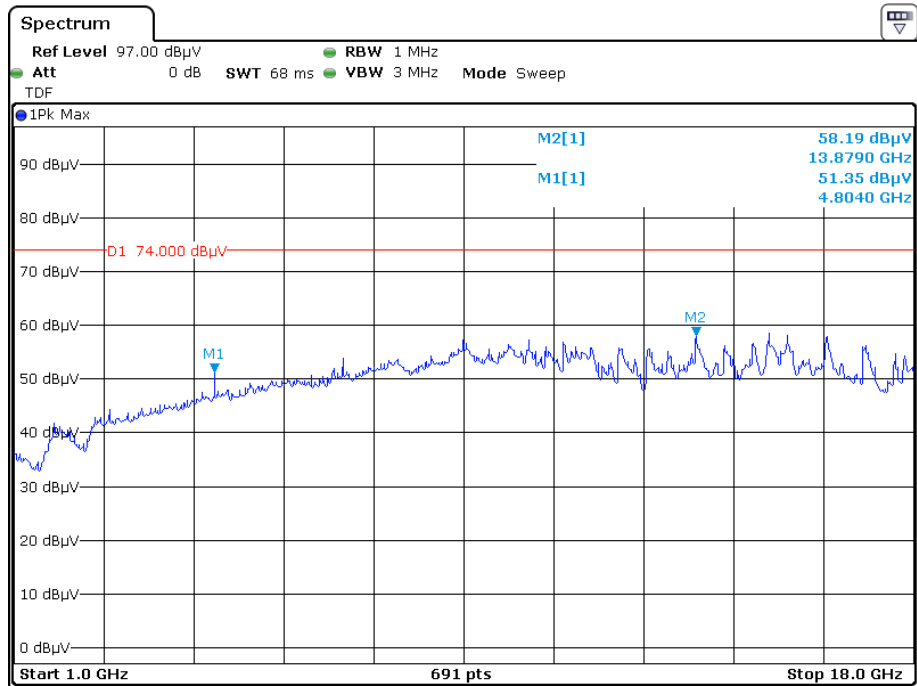


Date: 26.NOV.2019 05:02:48

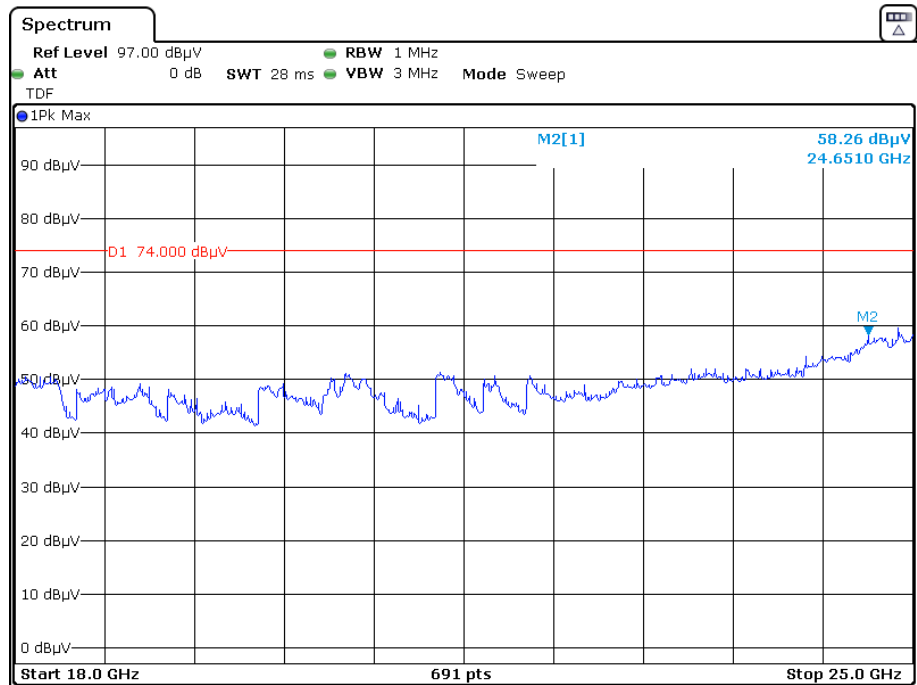


Date: 26.NOV.2019 05:48:43

# Vertical

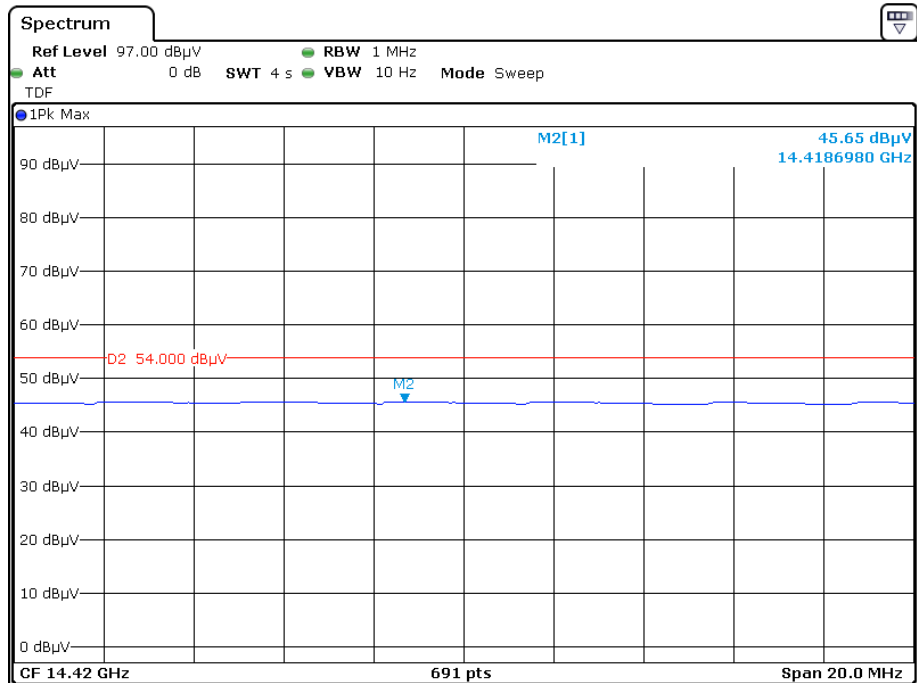


Date: 26.NOV.2019 05:11:28

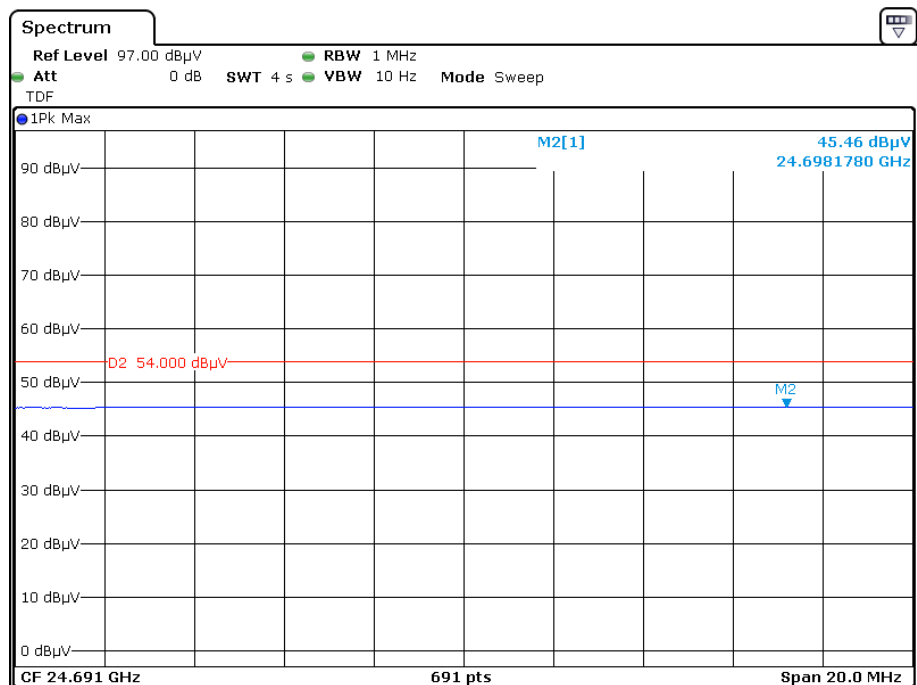


Date: 26.NOV.2019 05:54:59

### Pre-scan for Average Horizontal

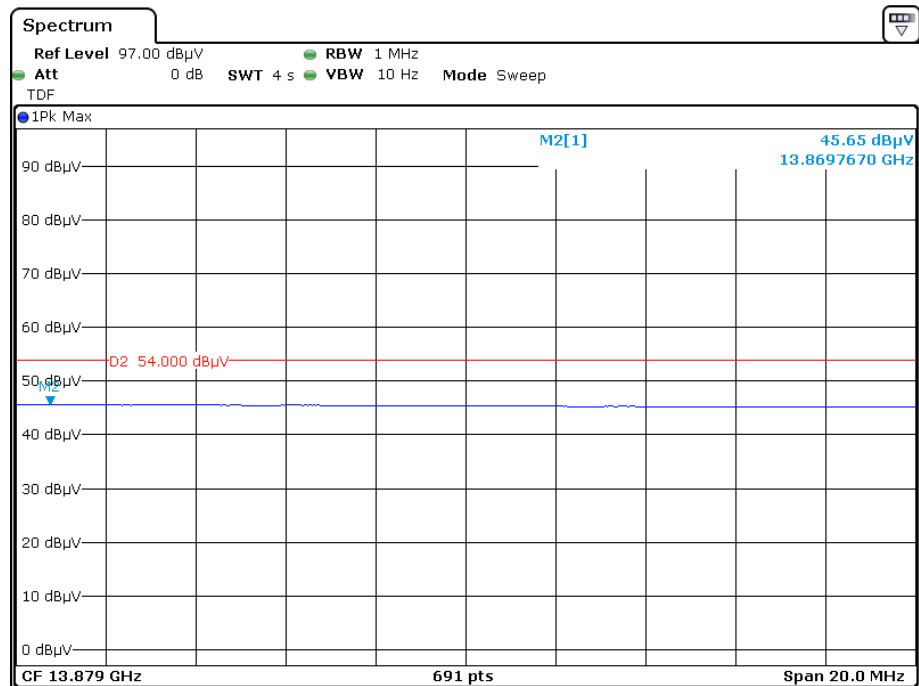


Date: 26.NOV.2019 05:05:17

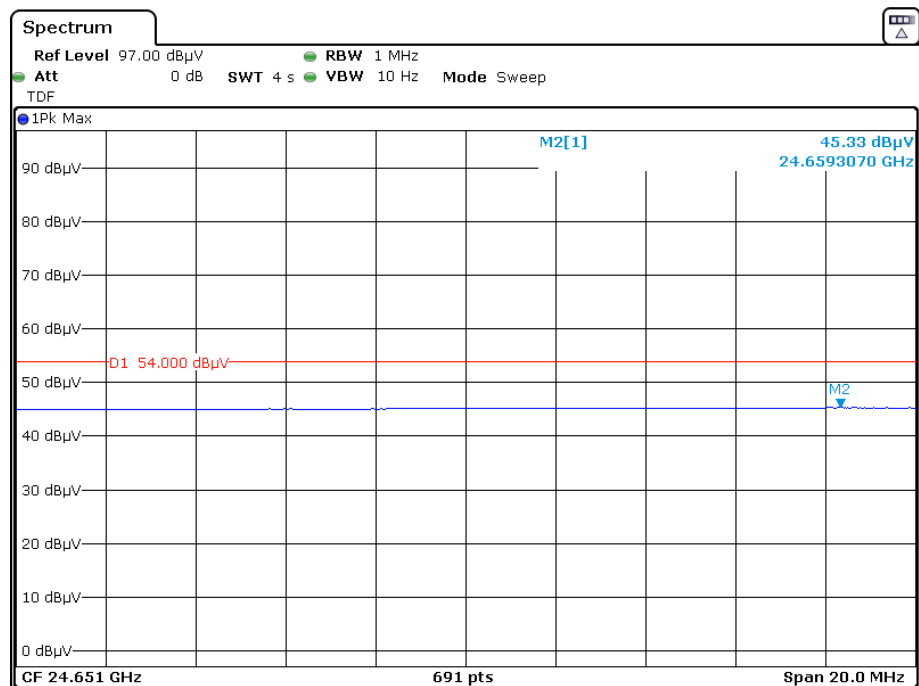


Date: 26.NOV.2019 05:51:08

# Vertical



Date: 26.NOV.2019 05:15:46



Date: 26.NOV.2019 05:58:41



## FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

### Applicable Standard

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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

### Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

### Test Data

#### Environmental Conditions

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	52 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Cary Guan on 2019-11-04.*

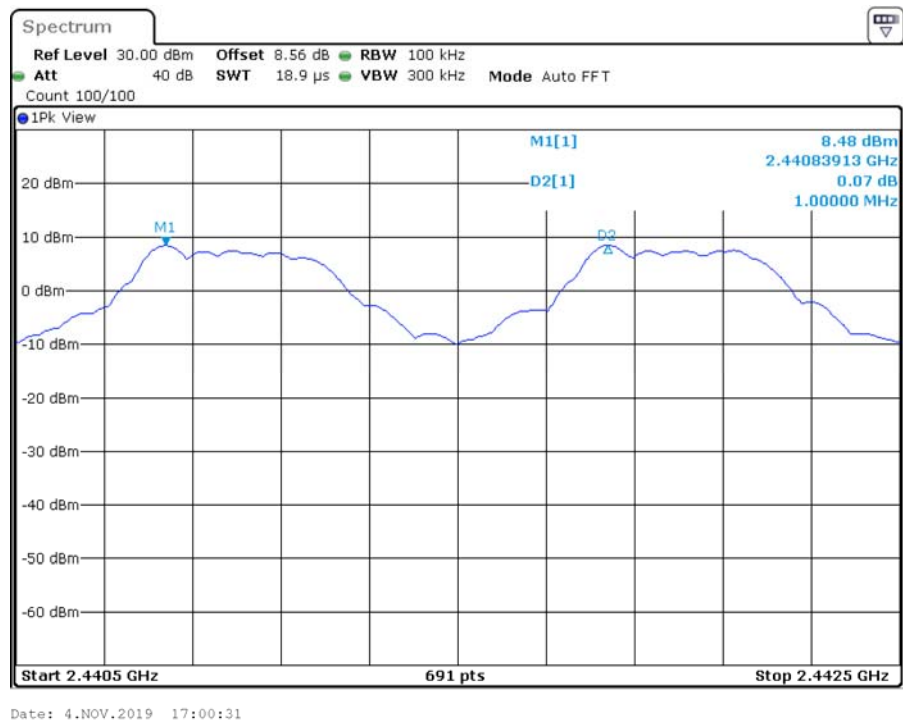
*EUT operation mode: Transmitting*

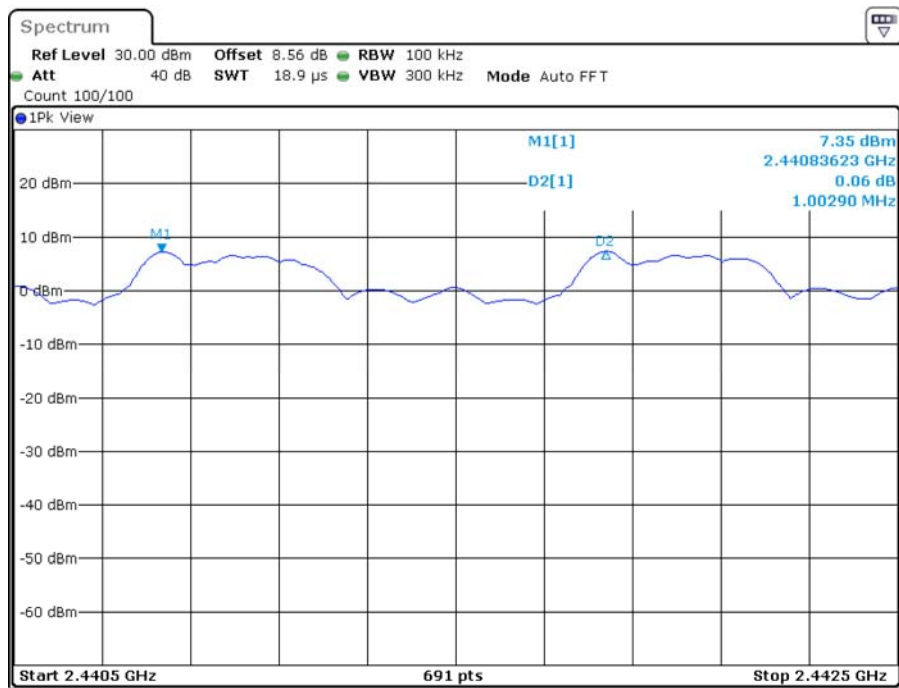
*Test Result: Compliance. Please refer to following table and plots.*

TestMode	Channel	Result[MHz]	Limit[MHz]	Verdict
BDR(GFSK)	Hop	1.000	$\geq 0.566$	PASS
EDR( $\pi/4$ -DQPSK)	Hop	1.003	$\geq 0.752$	PASS
EDR(8DPSK)	Hop	1.003	$\geq 0.788$	PASS

Please refer to the following plots.

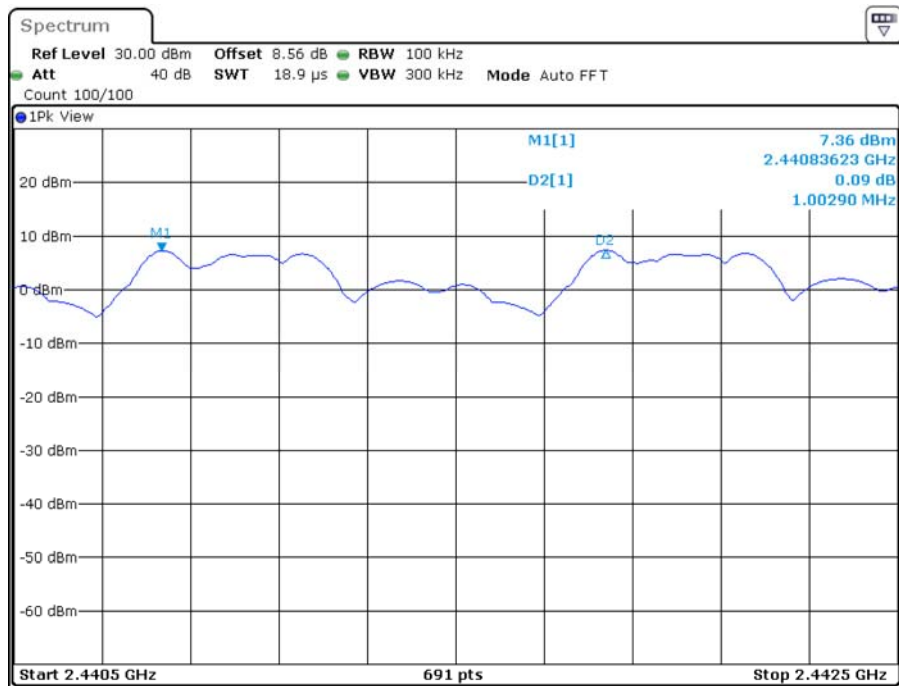
### BDR(GFSK)\_Hop



EDR( $\pi/4$ -DQPSK) \_Hop

Date: 4.NOV.2019 17:08:49

## EDR(8DPSK) \_Hop



Date: 4.NOV.2019 17:17:34

**FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH**

---

**Applicable Standard**

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.

**Test Procedure**

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

**Test Data****Environmental Conditions**

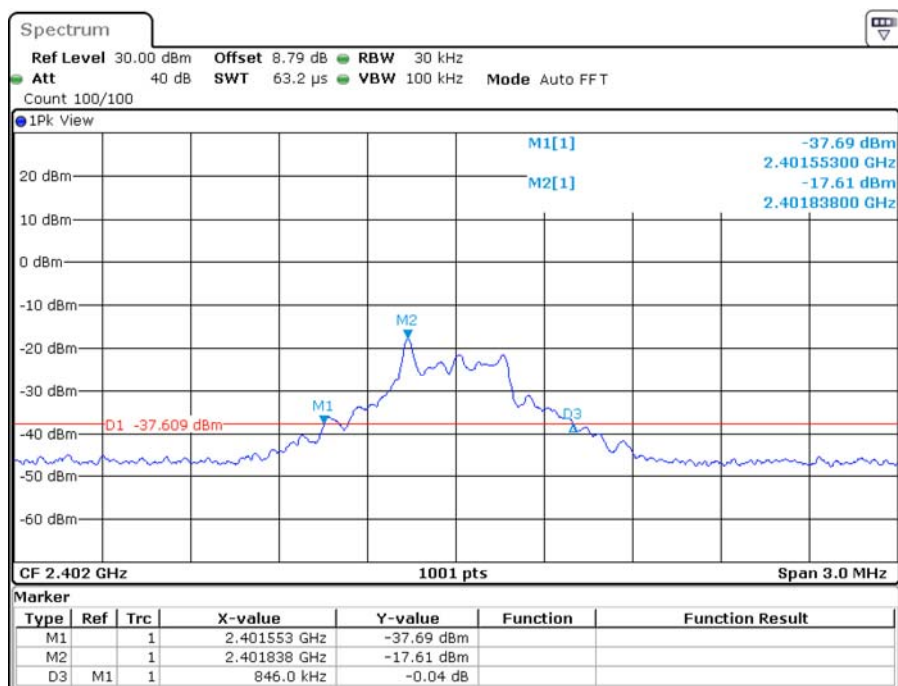
<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	52%
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Carry Guan on 2019-11-04.*

*EUT operation mode: Transmitting*

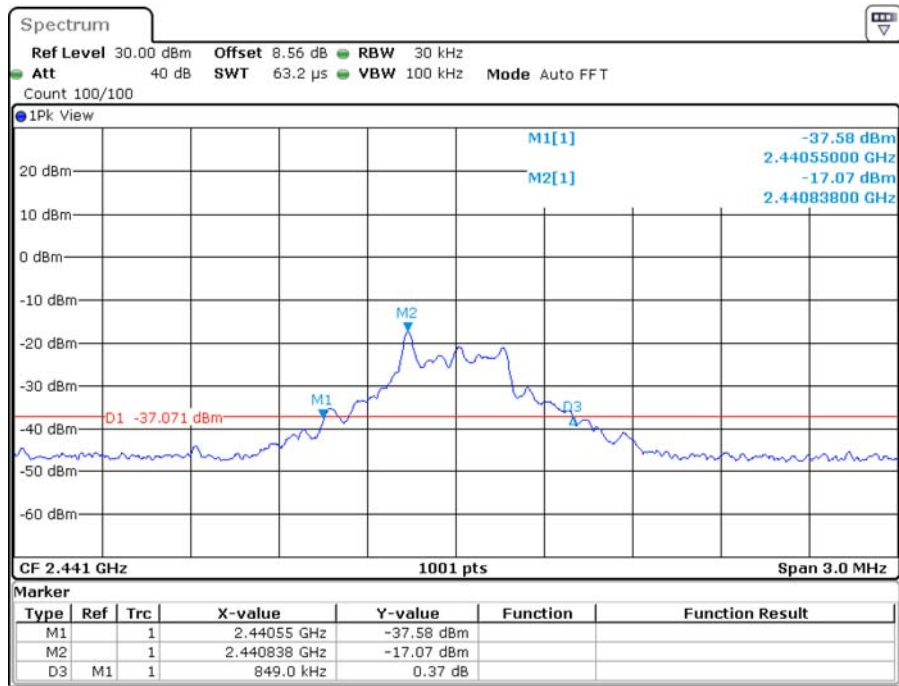
*Test Result: Compliance. Please refer to following table and plots.*

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
<b>BDR (GFSK)</b>	Low	2402	0.846
	Middle	2441	0.849
	High	2480	0.846
<b>EDR (<math>\pi/4</math>-DQPSK)</b>	Low	2402	1.125
	Middle	2441	1.128
	High	2480	1.122
<b>EDR (8DPSK)</b>	Low	2402	1.182
	Middle	2441	1.182
	High	2480	1.167

**BDR (GFSK): Low Channel**

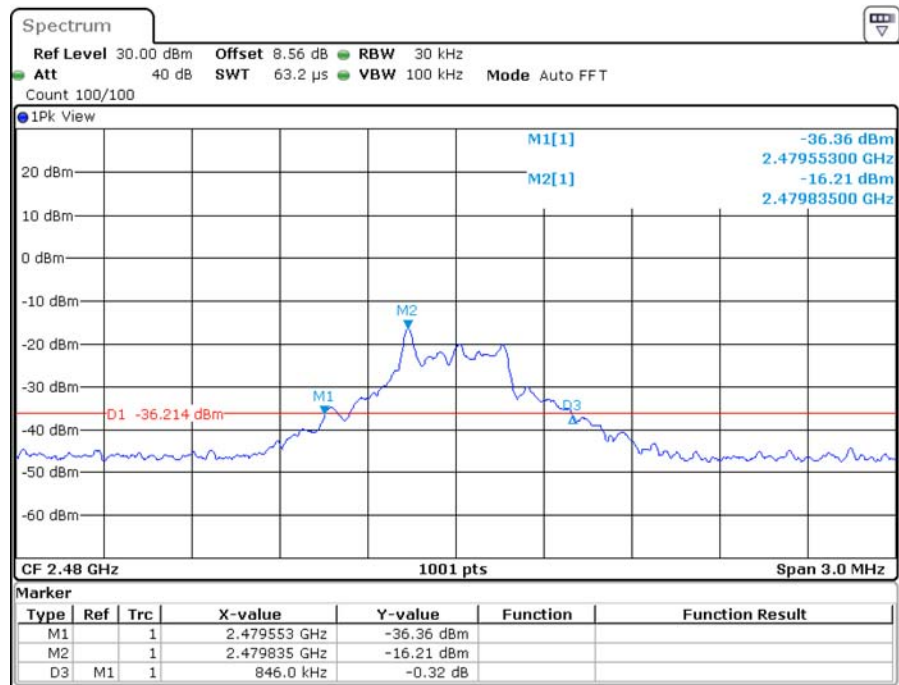
Date: 4.NOV.2019 16:38:46

### BDR (GFSK): Middle Channel

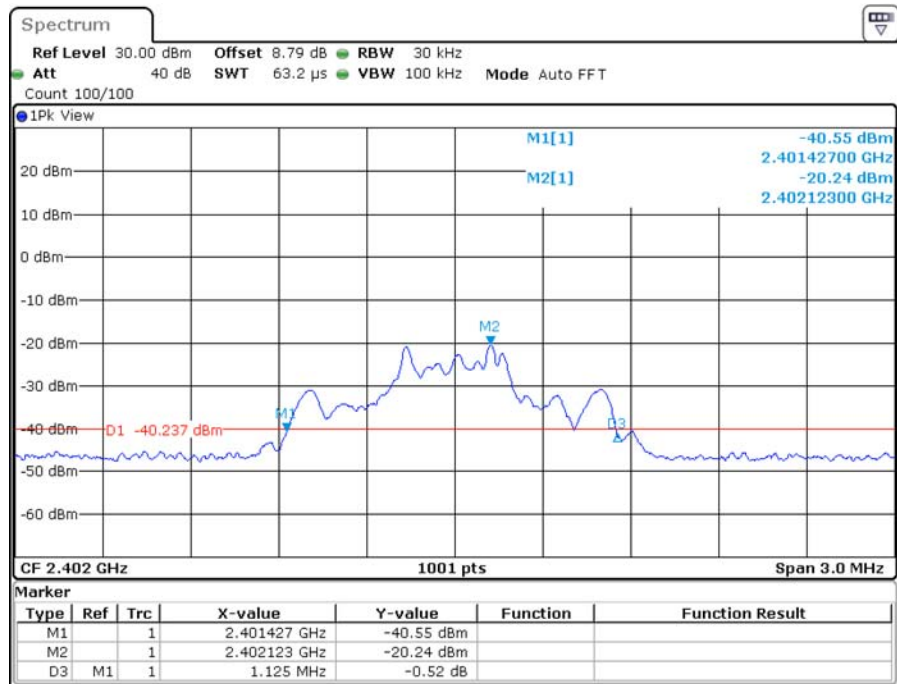


Date: 4.NOV.2019 16:40:11

### BDR (GFSK): High Channel



Date: 4.NOV.2019 16:41:11

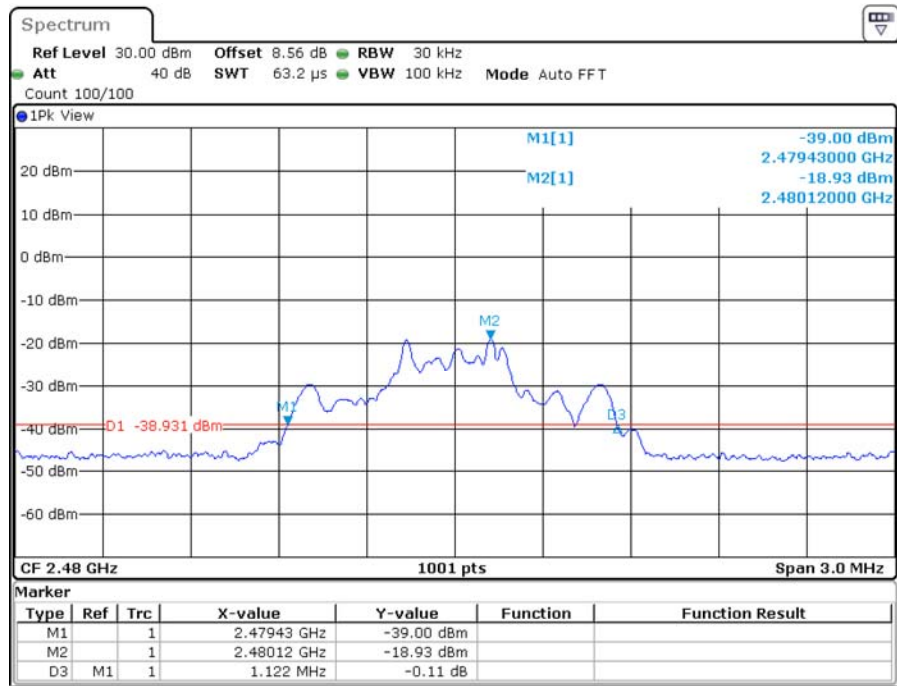
EDR ( $\pi/4$ -DQPSK): Low Channel

Date: 4.NOV.2019 16:42:39

EDR ( $\pi/4$ -DQPSK): Middle Channel

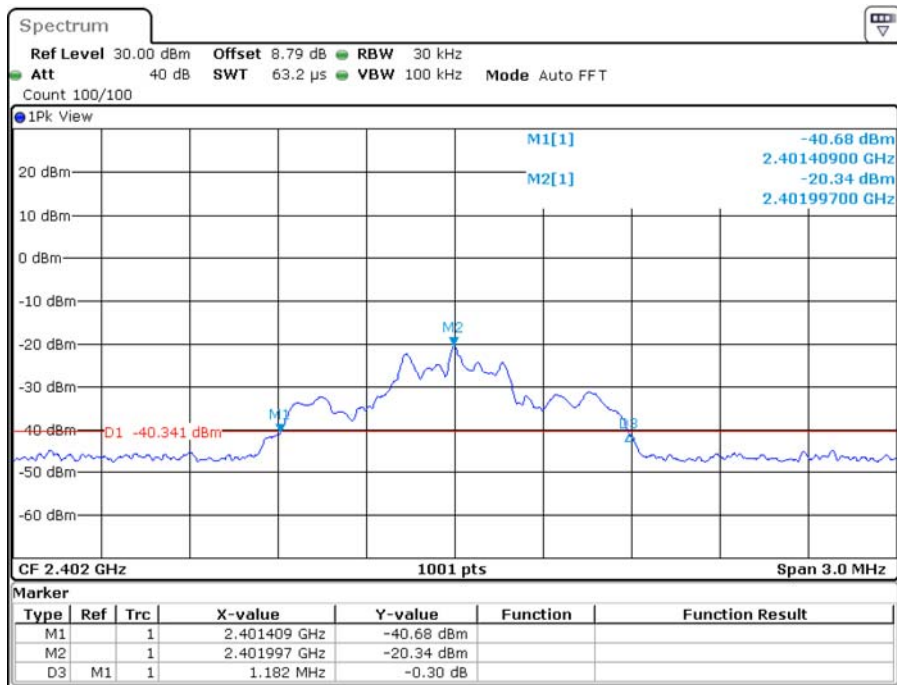
Date: 4.NOV.2019 16:43:45

### EDR ( $\pi/4$ -DQPSK): High Channel



Date: 4.NOV.2019 16:44:29

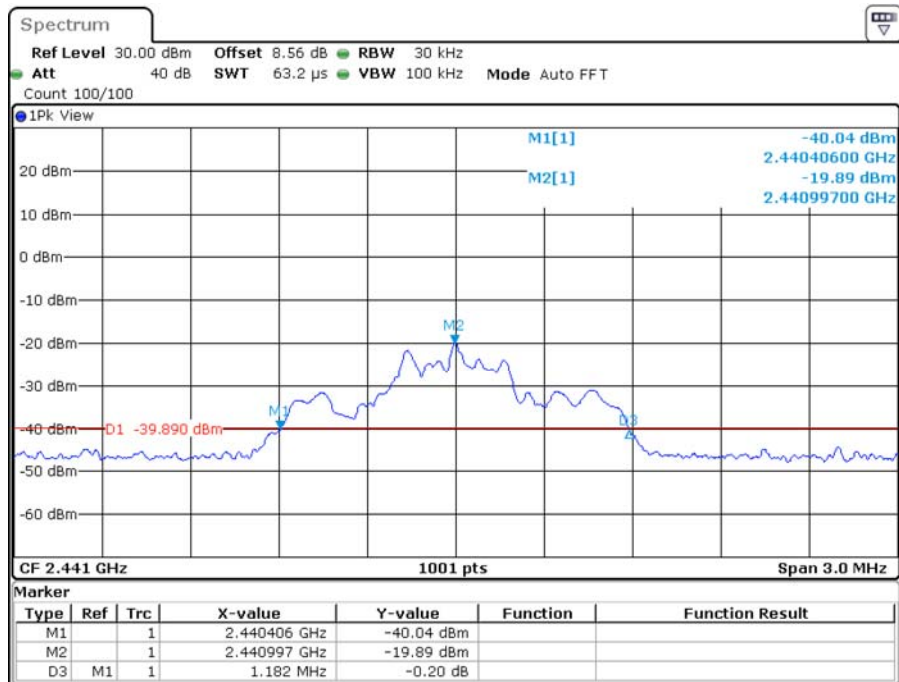
### EDR (8DPSK): Low Channel



Date: 4.NOV.2019 16:46:01



## EDR (8DPSK): Middle Channel



Date: 4.NOV.2019 16:47:13

## EDR (8DPSK): High Channel



Date: 4.NOV.2019 16:58:04

**FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST****Applicable Standard**

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

**Test Procedure**

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

**Test Data****Environmental Conditions**

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	52%
<b>ATM Pressure:</b>	101.0 kPa

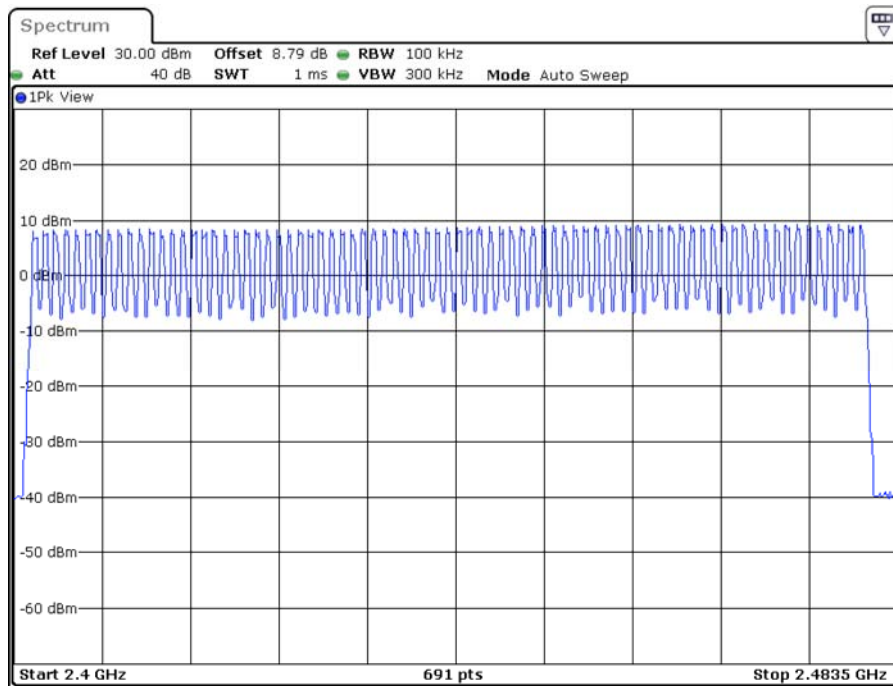
*The testing was performed by Carry Guan on 2019-11-04.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table and plots.*

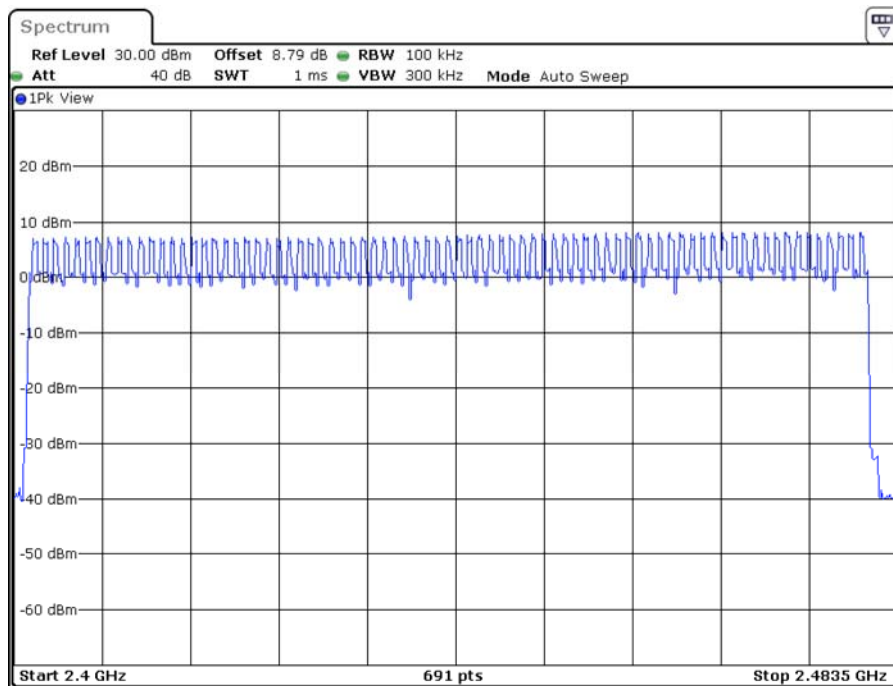
TestMode	Channel	Result[Num]	Limit[Num]	Verdict
BDR (GFSK)	Hop	79	$\geq 15$	PASS
EDR ( $\pi/4$ -DQPSK)	Hop	79	$\geq 15$	PASS
EDR (8DPSK)	Hop	79	$\geq 15$	PASS

### BDR (GFSK): Number of Hopping Channels



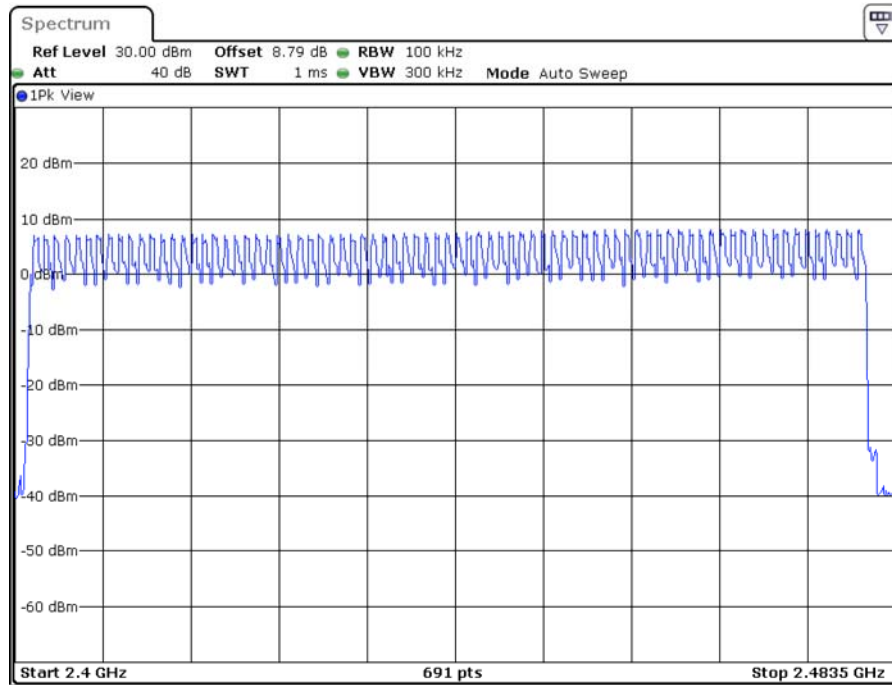
Date: 4.NOV.2019 17:03:10

### EDR ( $\pi/4$ -DQPSK): Number of Hopping Channels



Date: 4.NOV.2019 17:12:07

### EDR (8DPSK): Number of Hopping Channels



Date: 4.NOV.2019 17:22:04

**FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWEELL TIME)****Applicable Standard**

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

**Test Procedure**

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW  $\geq 3 \times$  RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

**Test Data****Environmental Conditions**

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	52%
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Carry Guan on 2019-11-04.*

*EUT operation mode: Transmitting*

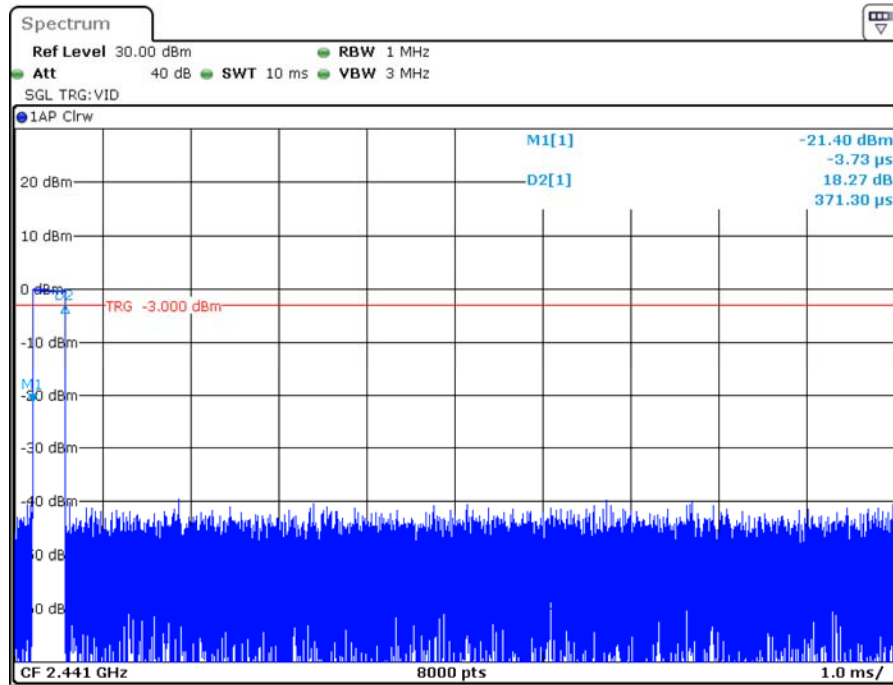
*Test Result: Compliance. Please refer to following table and plots*

Test Mode		Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
BDR (GFSK)	DH1	Hop	0.37	130	0.048	<=0.4	PASS
	DH3	Hop	1.62	150	0.243	<=0.4	PASS
	DH5	Hop	2.86	90	0.257	<=0.4	PASS
EDR ( $\pi/4$ -DQPSK)	2DH1	Hop	0.38	70	0.026	<=0.4	PASS
	2DH3	Hop	1.62	130	0.211	<=0.4	PASS
	2DH5	Hop	2.86	90	0.258	<=0.4	PASS
EDR (8DPSK)	3DH1	Hop	0.38	40	0.015	<=0.4	PASS
	3DH3	Hop	1.62	130	0.210	<=0.4	PASS
	3DH5	Hop	2.86	90	0.258	<=0.4	PASS

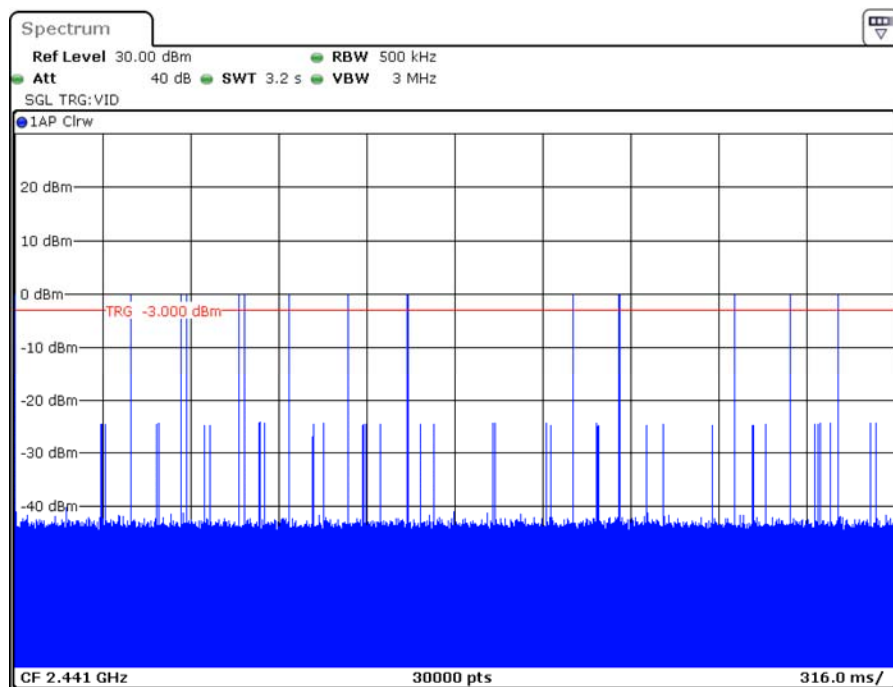
Note 1: A period time= $0.4 \times 79 = 31.6(s)$ , Total of Dwell=Pluse Time\*Hopping Number

Note 2: Hopping Number= Hopping Number in 3.16s\*10

Note 3: Hopping Number in 3.16s = Total of highest signals in 3.16s.(Second high signals were other channel)

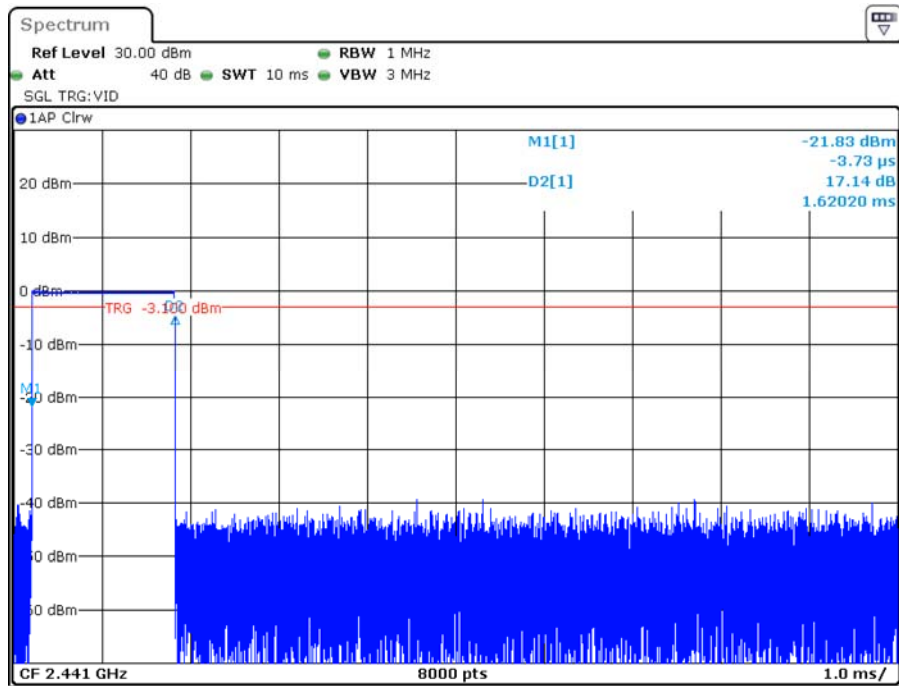
**BDR (GFSK):****DH1\_Hop**

Date: 4.NOV.2019 17:03:23

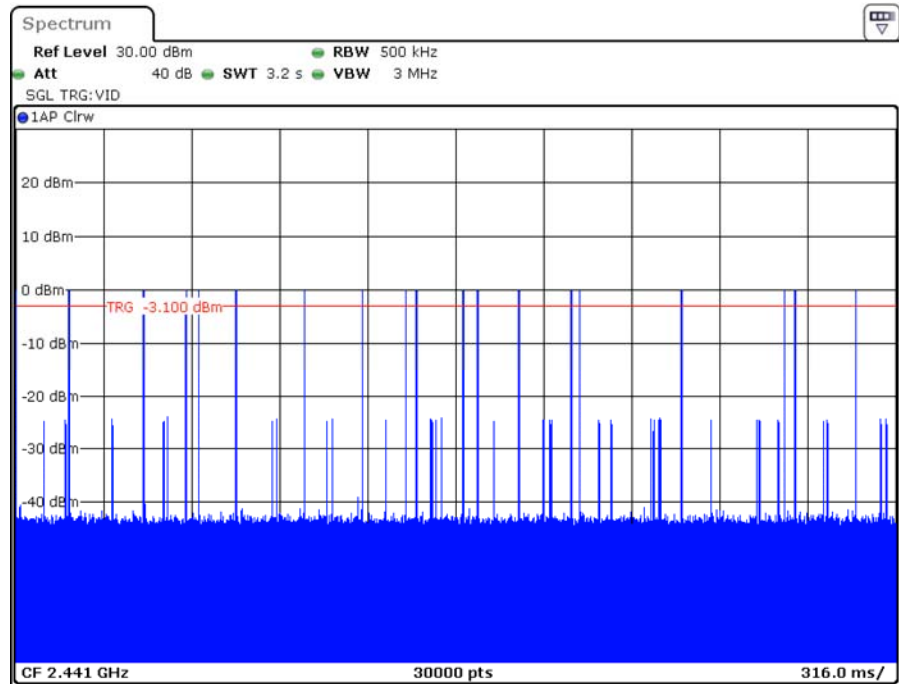


Date: 4.NOV.2019 17:03:28

### DH3\_Hop



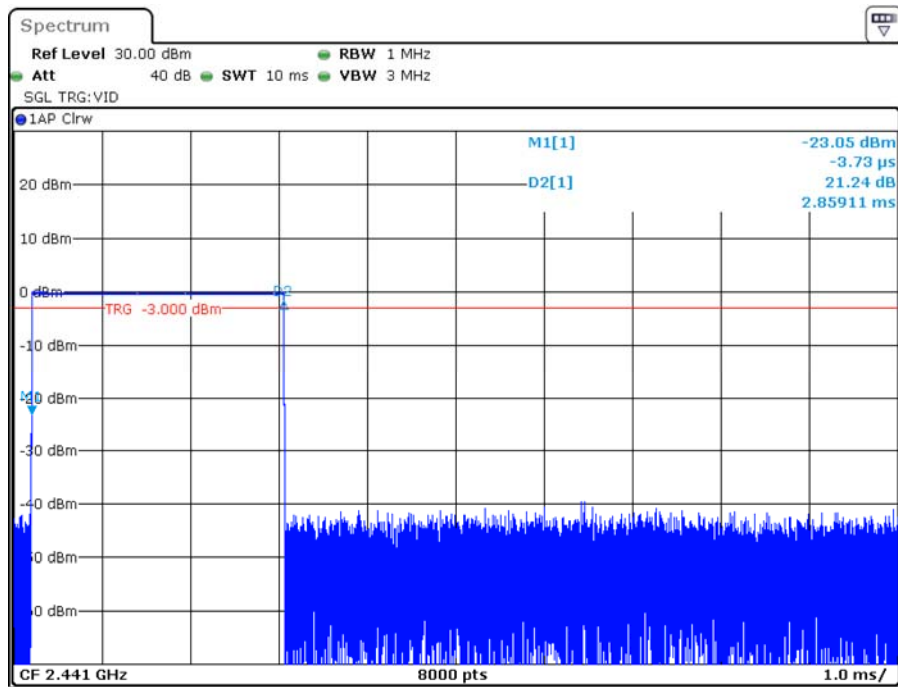
Date: 4.NOV.2019 17:04:16



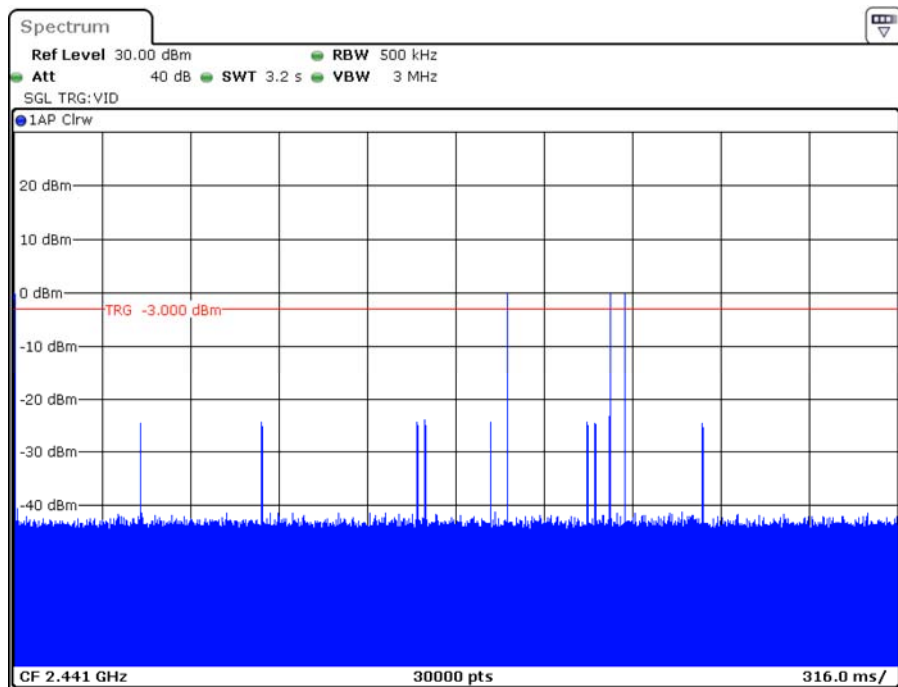
Date: 4.NOV.2019 17:04:21



## DH5\_Hop

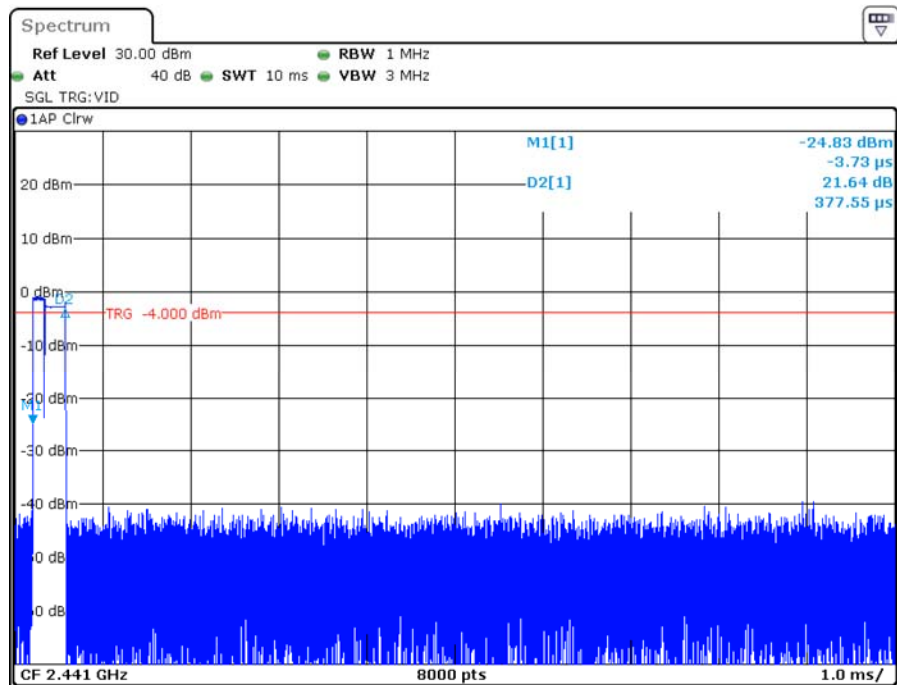


Date: 4.NOV.2019 17:05:55

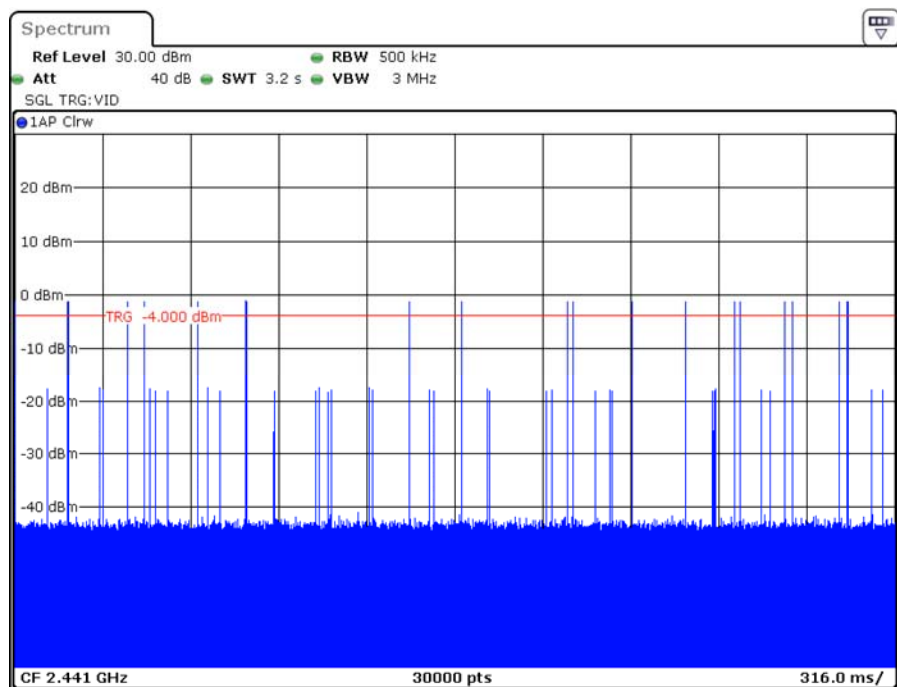


Date: 4.NOV.2019 17:06:01

**EDR ( $\pi/4$ -DQPSK):**  
**2DH1\_Hop**

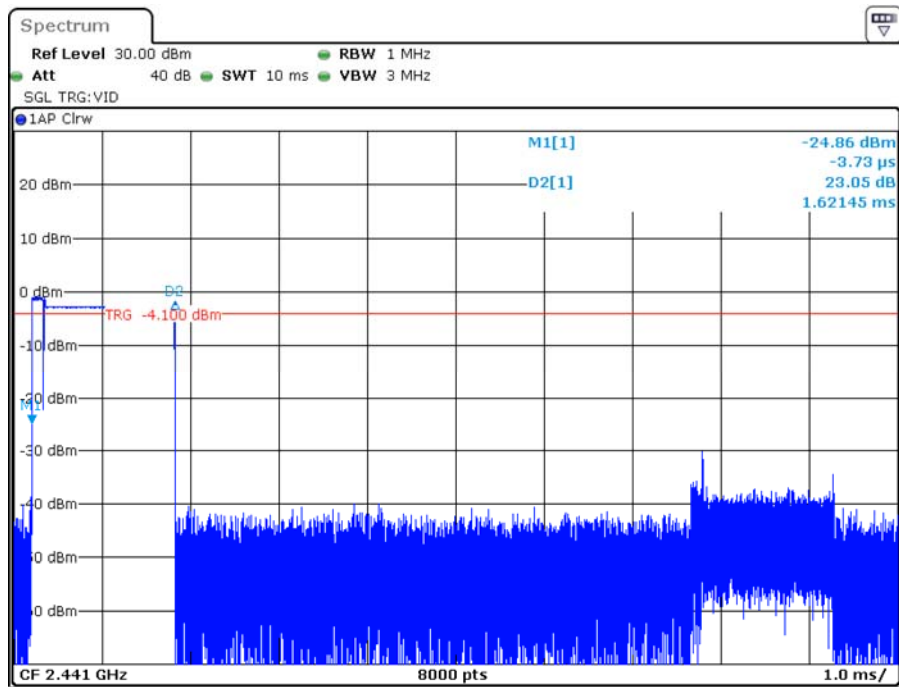


Date: 4.NOV.2019 17:12:19

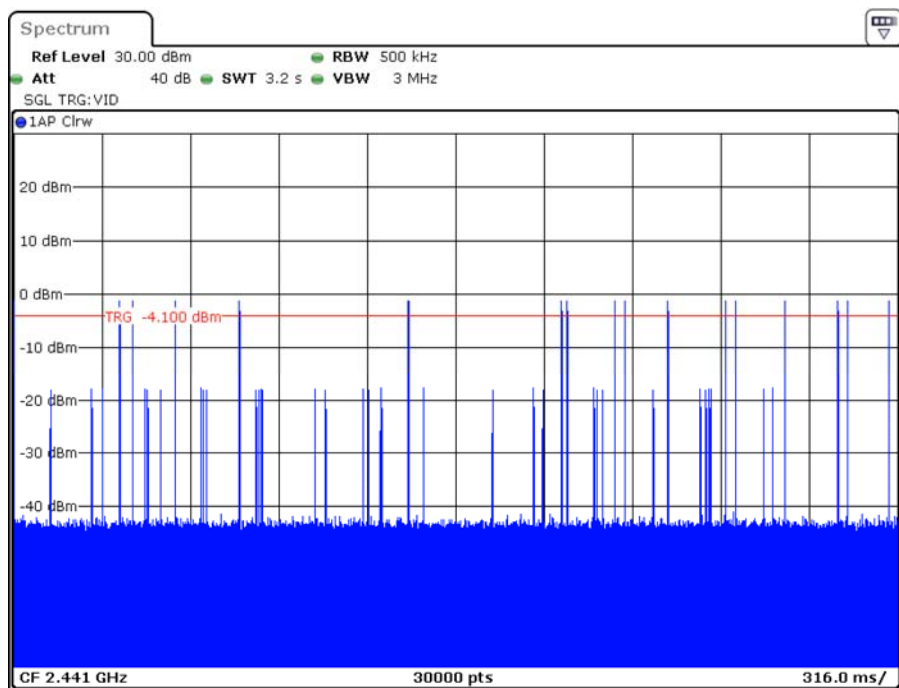


Date: 4.NOV.2019 17:12:25

## 2DH3\_Hop

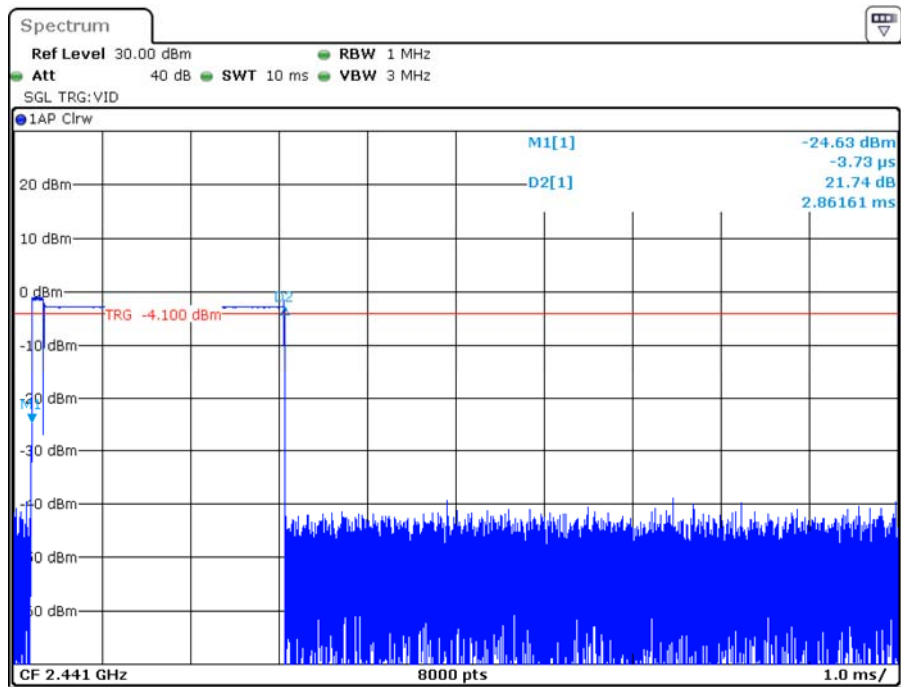


Date: 4.NOV.2019 17:13:07

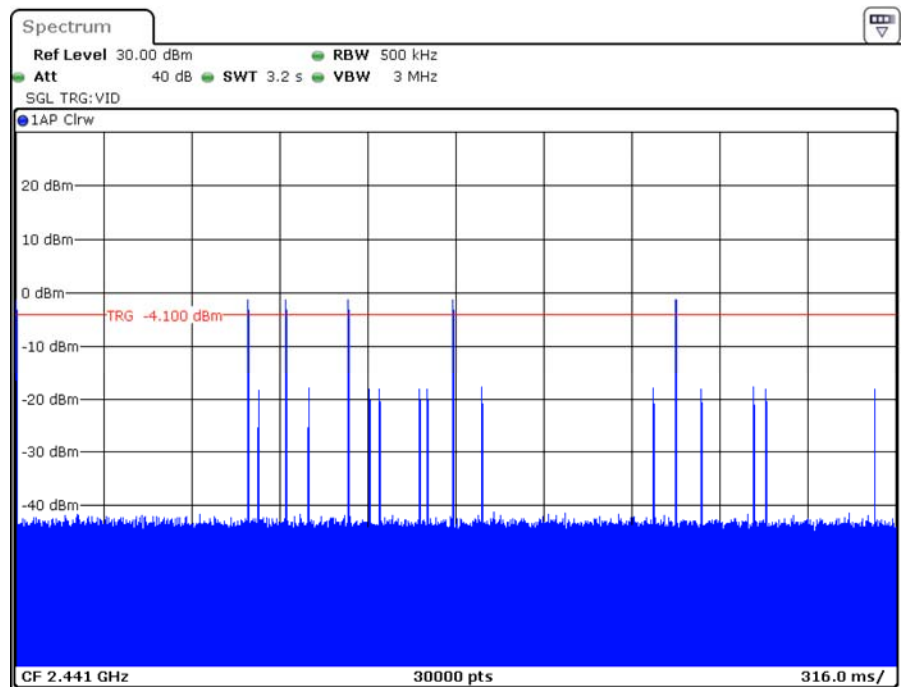


Date: 4.NOV.2019 17:13:12

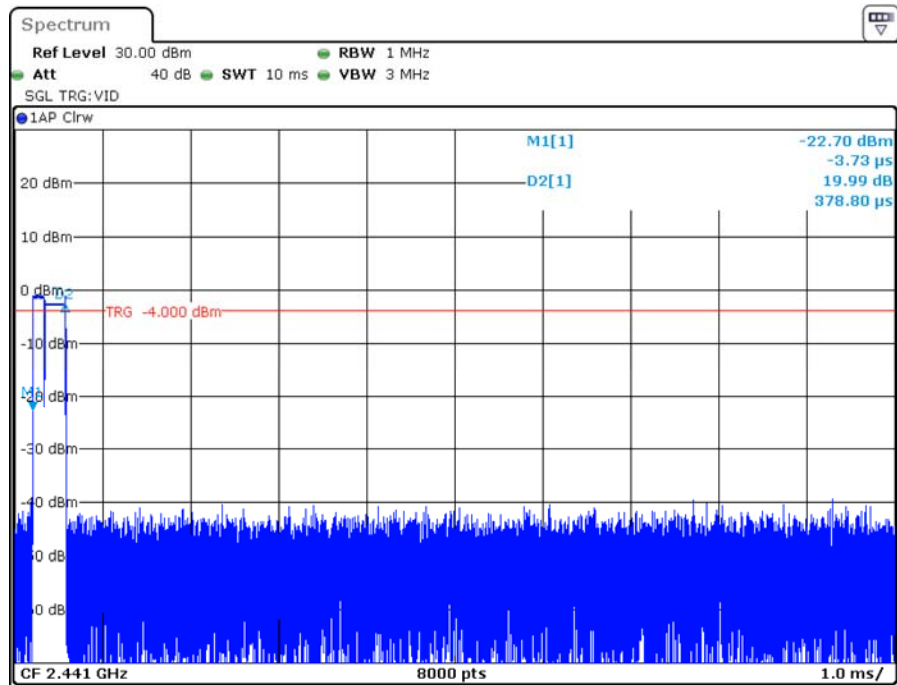
## 2DH5\_Hop



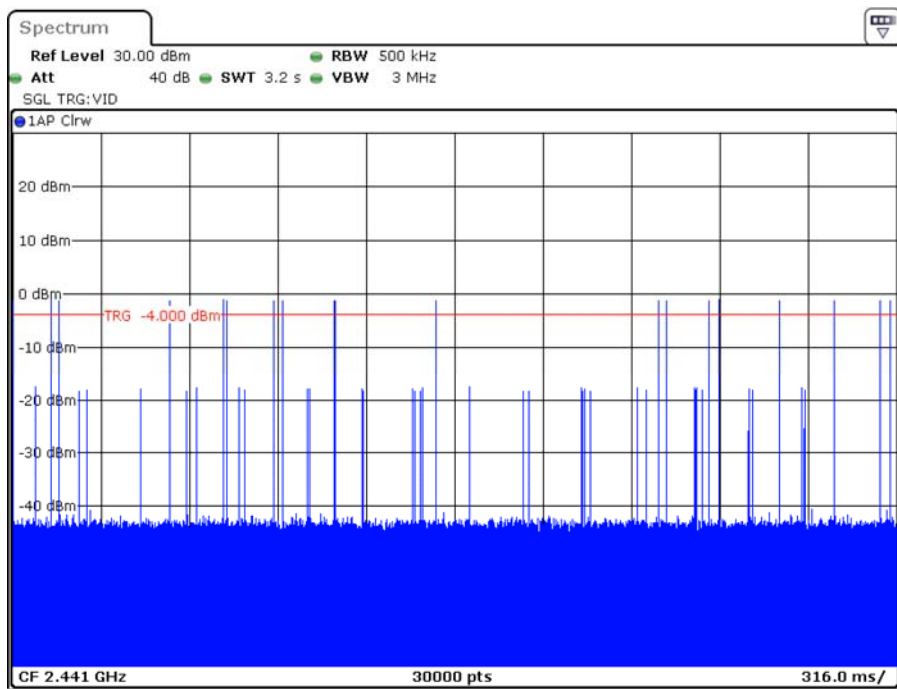
Date: 4.NOV.2019 17:14:07



Date: 4.NOV.2019 17:14:12

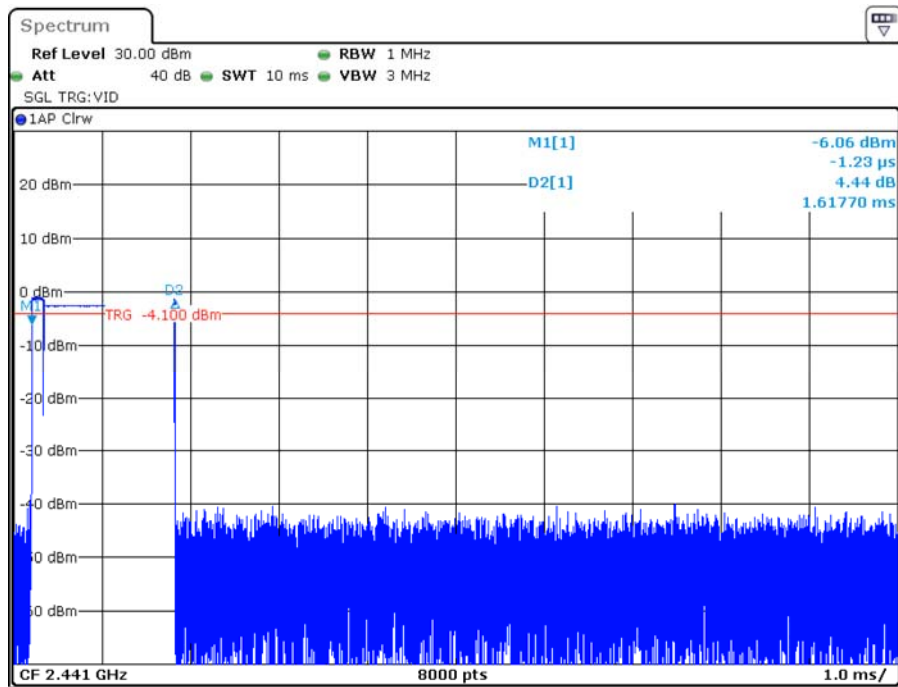
**EDR (8DPSK):****3DH1\_Hop**

Date: 4.NOV.2019 17:23:05

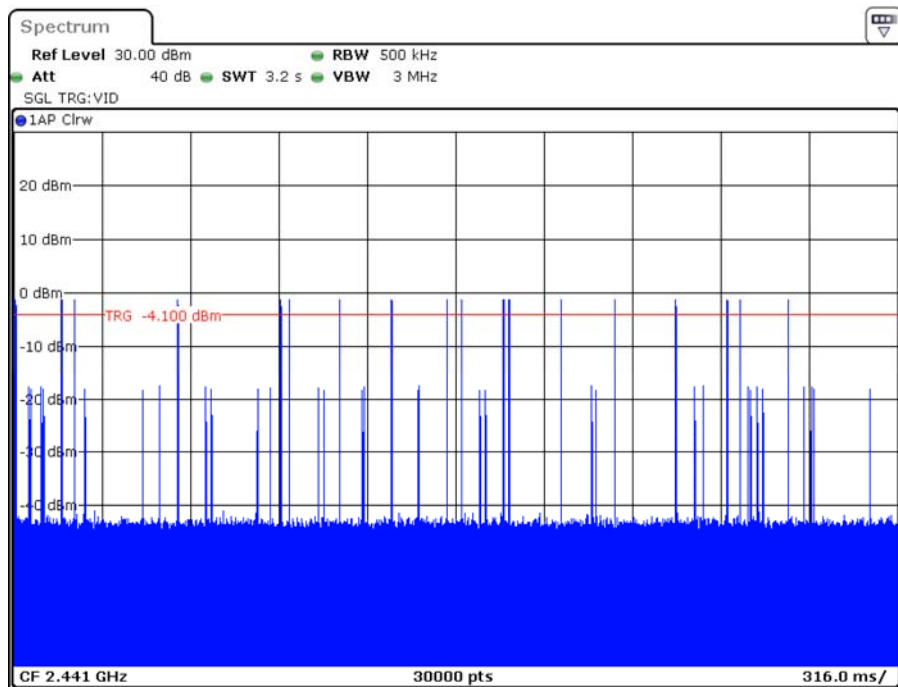


Date: 4.NOV.2019 17:23:10

## 3DH3\_Hop

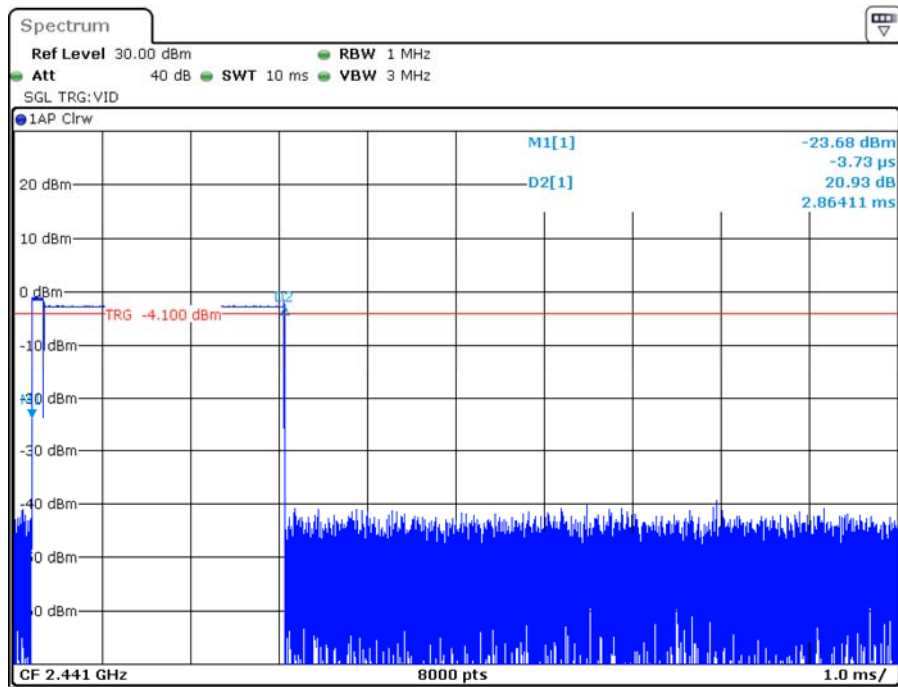


Date: 4.NOV.2019 17:36:40

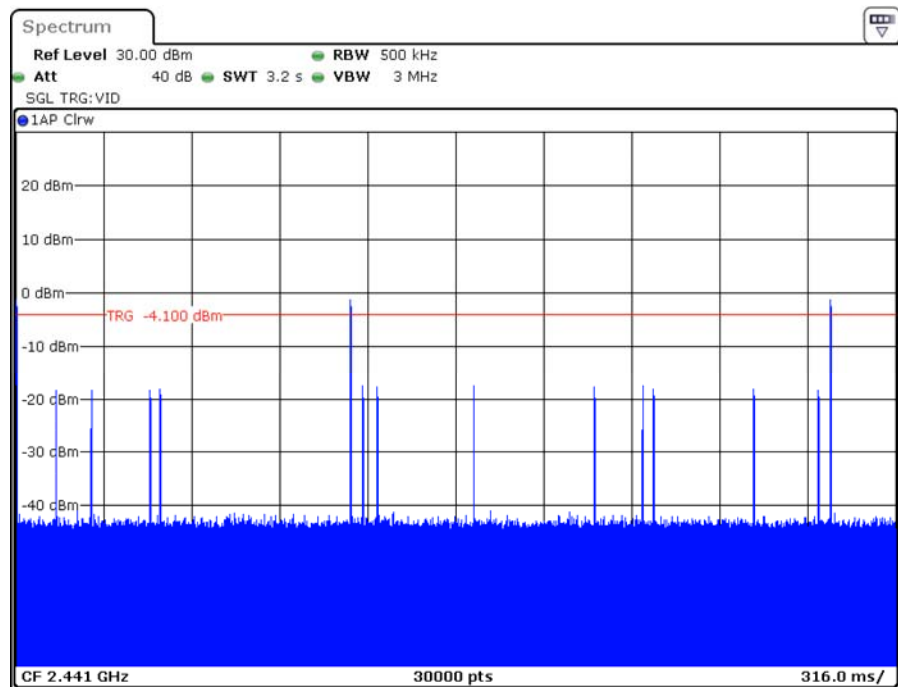


Date: 4.NOV.2019 17:36:46

### 3DH5\_Hop



Date: 4.NOV.2019 17:37:35



Date: 4.NOV.2019 17:37:41

## FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

### Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

### Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

### Test Data

#### Environmental Conditions

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	52%
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Carry Guan on 2019-11-04.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table.*

TestMode	Channel	Result[dBm]	Limit[dBm]	Verdict
<b>BDR (GFSK)</b>	2402	8.63	<=20.97	PASS
	2441	8.68	<=20.97	PASS
	2480	9.35	<=20.97	PASS
<b>EDR (<math>\pi/4</math>- DQPSK)</b>	2402	7.86	<=20.97	PASS
	2441	8.05	<=20.97	PASS
	2480	8.58	<=20.97	PASS
<b>EDR (8DPSK)</b>	2402	7.98	<=20.97	PASS
	2441	8.17	<=20.97	PASS
	2480	8.73	<=20.97	PASS



## FCC §15.247(d) - BAND EDGES TESTING

### Applicable Standard

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. In addition, 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)).

### Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

### Test Data

#### Environmental Conditions

Temperature:	25 °C
Relative Humidity:	52%
ATM Pressure:	101.0 kPa

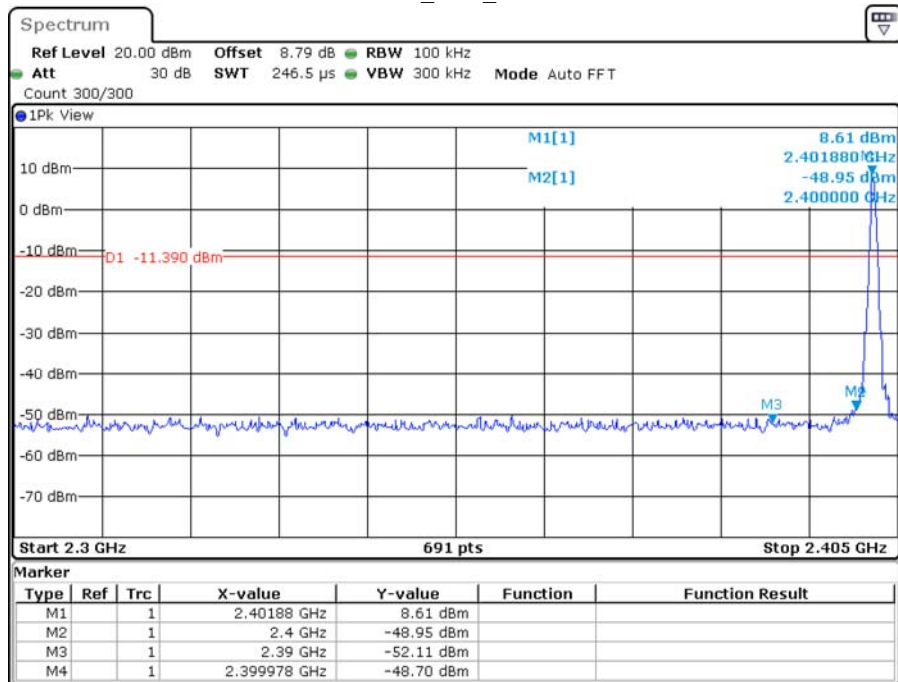
*The testing was performed by Carry Guan on 2019-12-12.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following plots.*

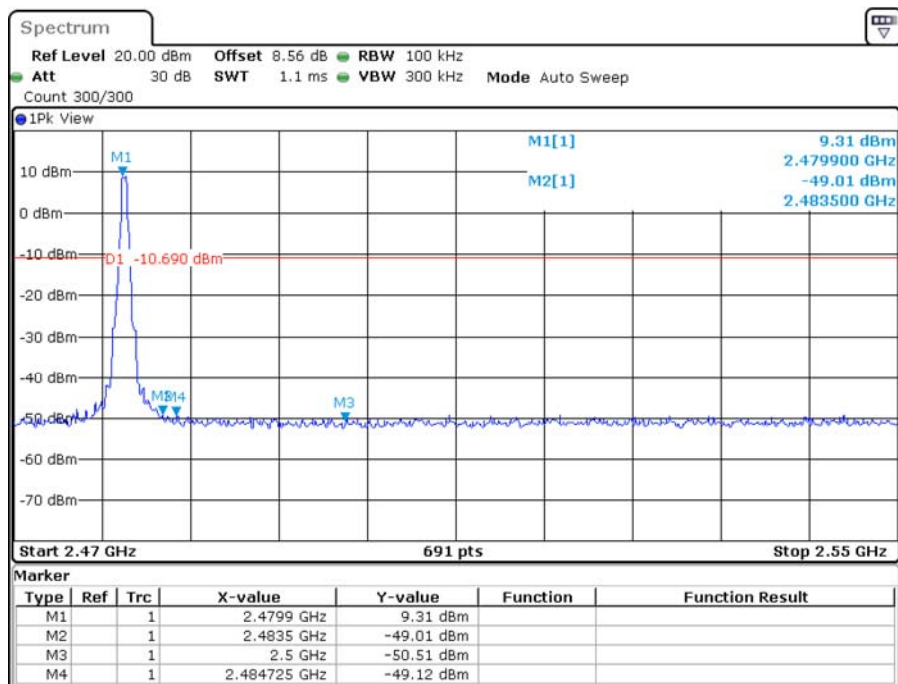
## BDR (GFSK): Band Edge

## DH1\_Low\_2402



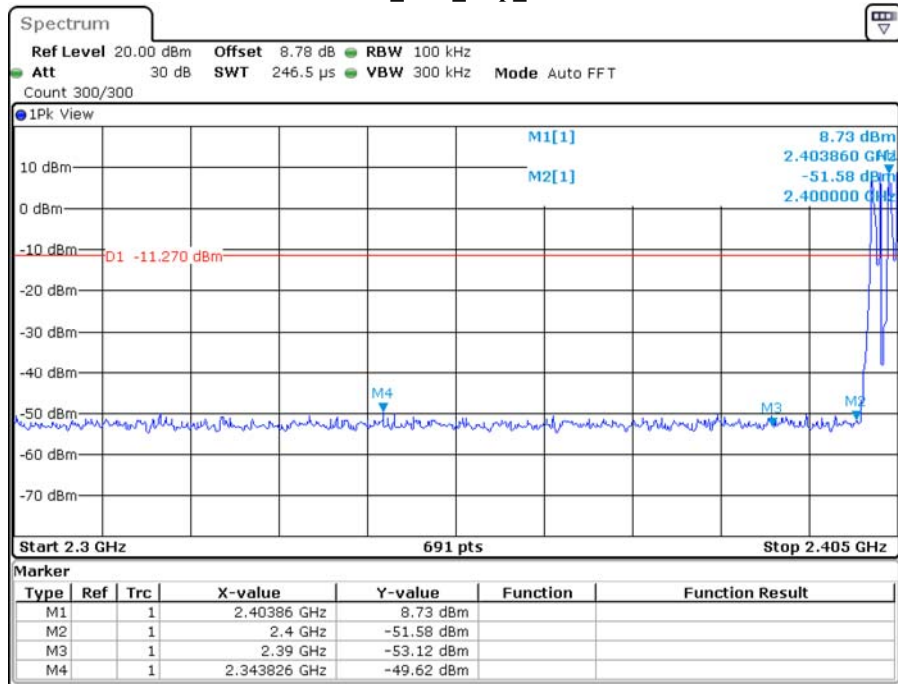
Date: 12.DEC.2019 10:51:02

## DH1\_High\_2480



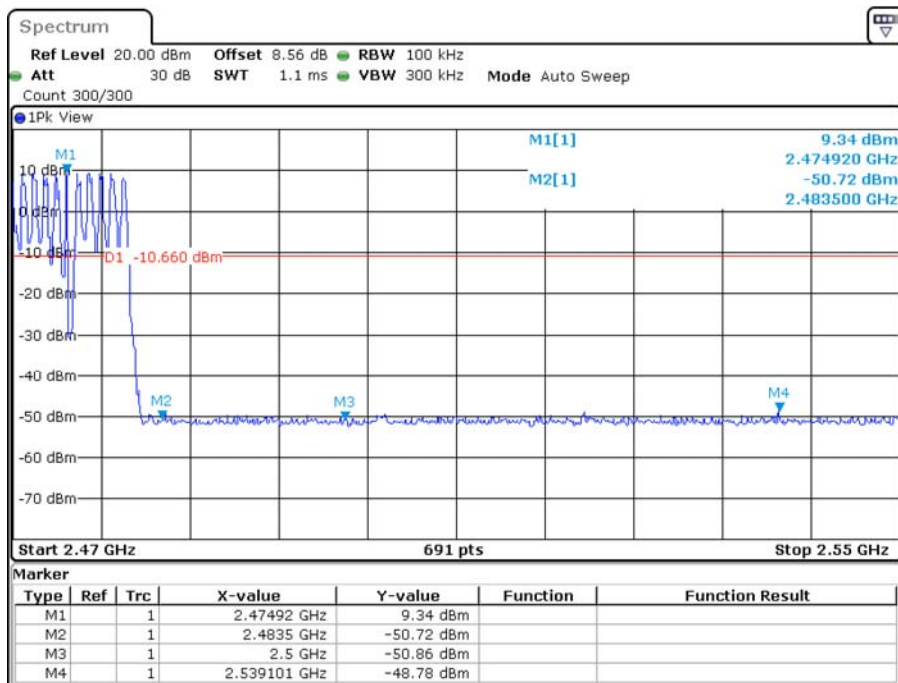
Date: 12.DEC.2019 10:51:52

## DH1\_Low\_Hop\_2402



Date: 12.DEC.2019 10:56:26

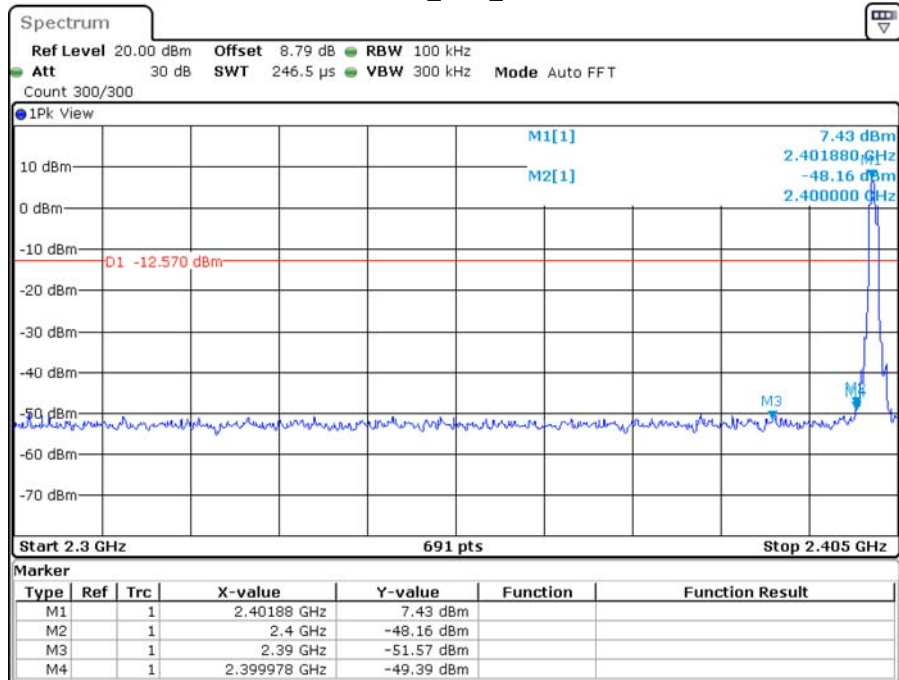
## DH1\_High\_Hop\_2480



Date: 12.DEC.2019 10:58:04

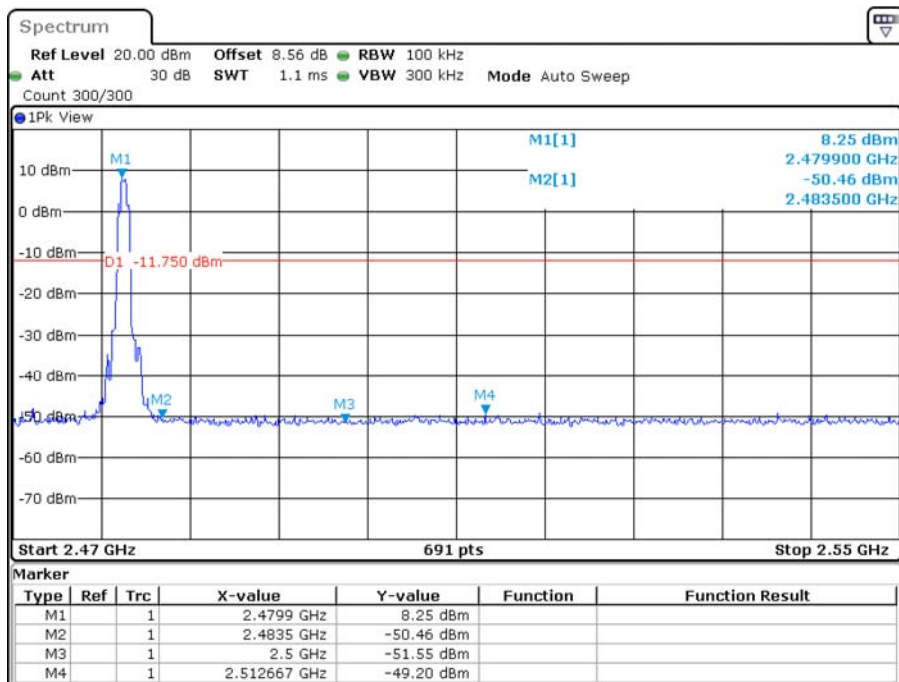
EDR ( $\pi/4$ -DQPSK): Band Edge

## 2DH1\_Low\_2402



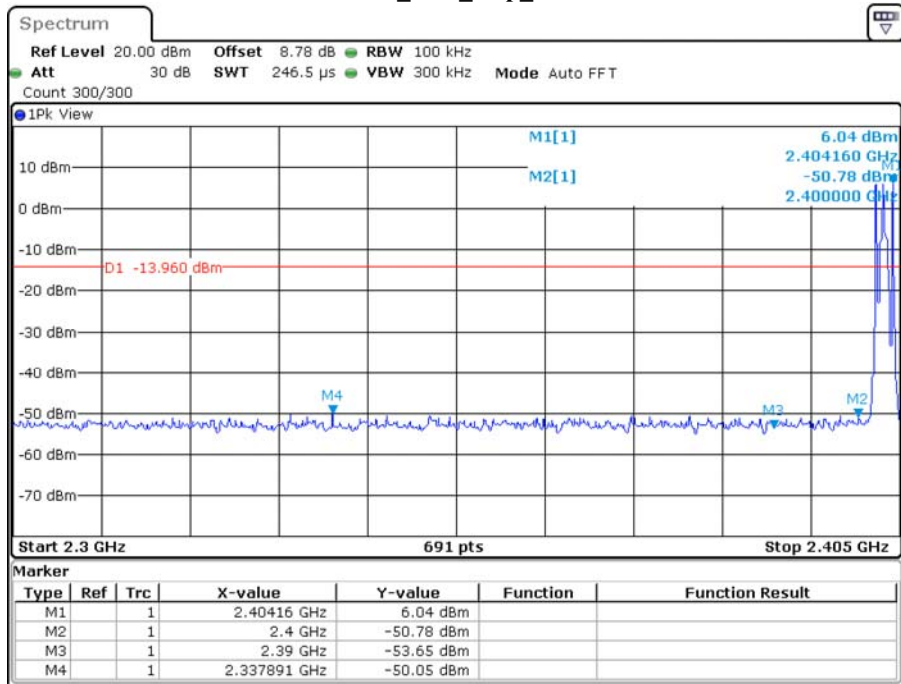
Date: 12.DEC.2019 10:52:36

## 2DH1\_High\_2480



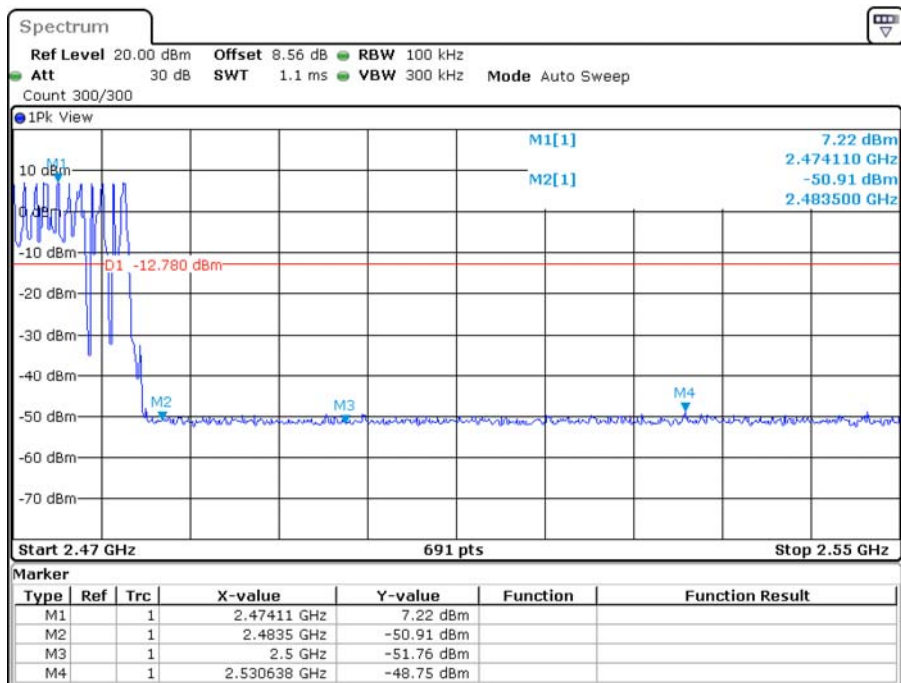
Date: 12.DEC.2019 10:53:02

### 2DH1\_Low\_Hop\_2402



Date: 12.DEC.2019 10:58:44

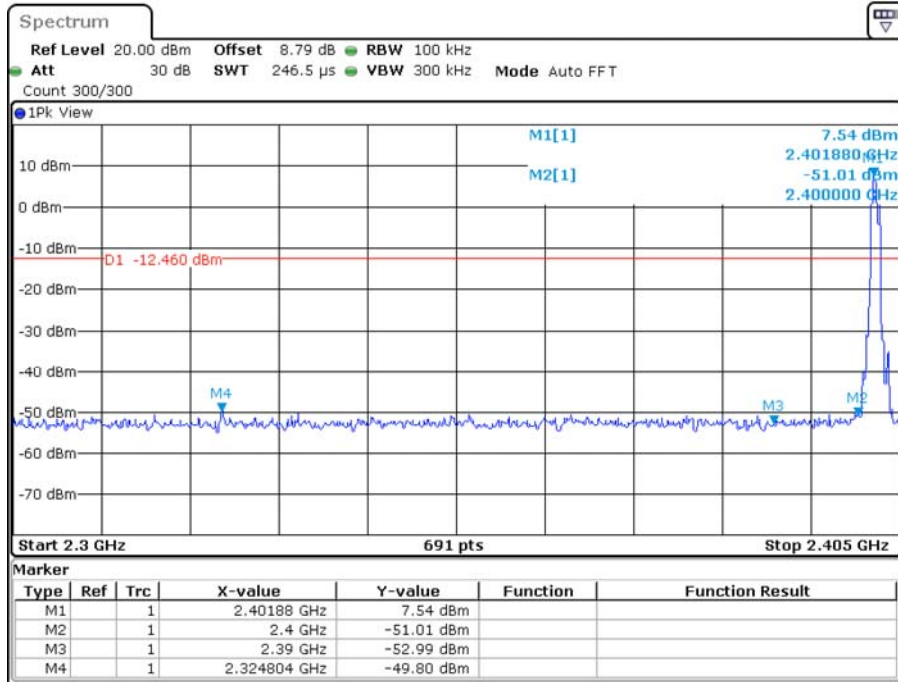
### 2DH1\_High\_Hop\_2480



Date: 12.DEC.2019 10:59:13

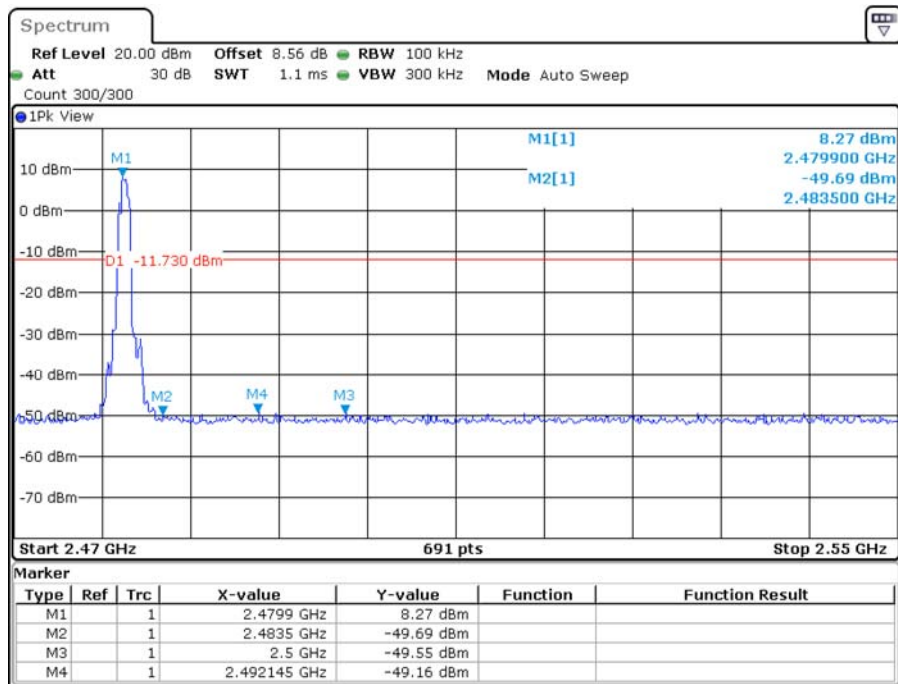
### EDR (8DPSK): Band Edge

#### 3DH1\_Low\_2402



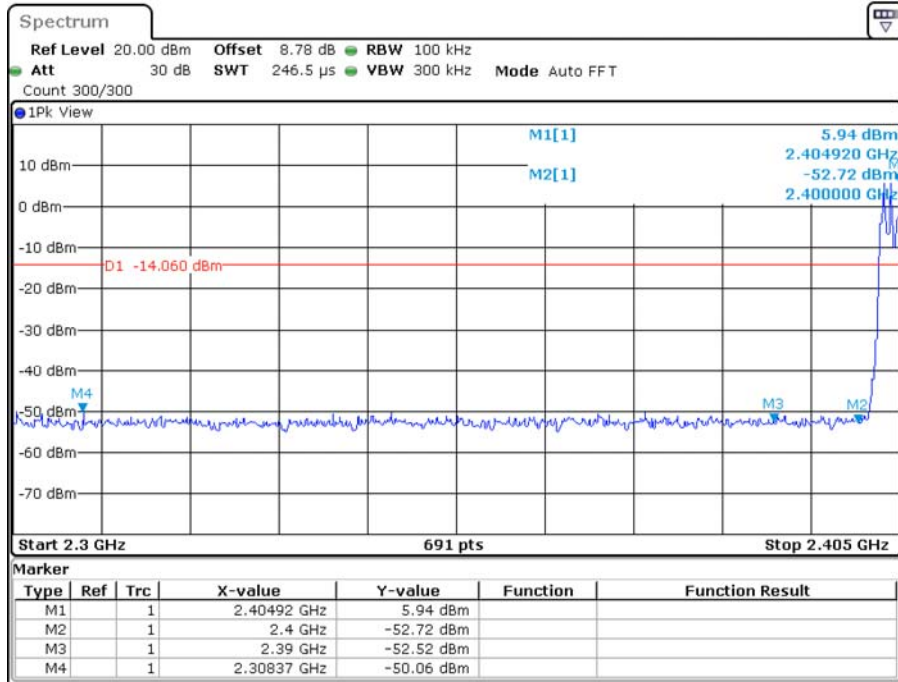
Date: 12.DEC.2019 10:53:41

#### 3DH1\_High\_2480



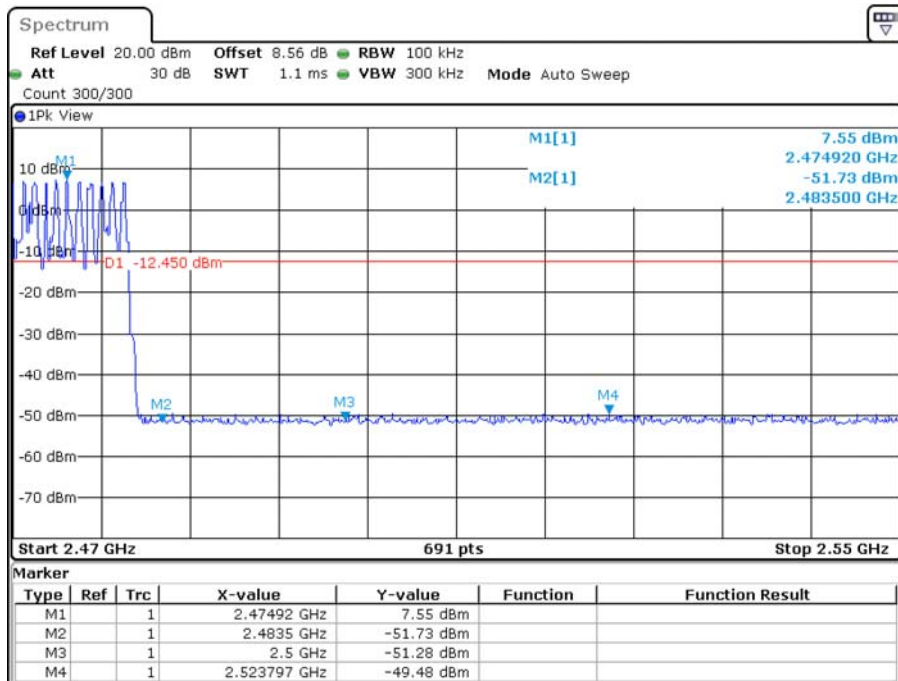
Date: 12.DEC.2019 10:55:39

### 3DH1\_Low\_Hop\_2402



Date: 12.DEC.2019 10:59:48

### 3DH1\_High\_Hop\_2480



Date: 12.DEC.2019 11:00:14

\*\*\*\*\* END OF REPORT \*\*\*\*\*