

FCC PART 15.247

TEST REPORT

For

Zeeva International Limited

Suite 1007B, 10th Floor, Exchange Tower, 33 Wang Chiu Road, Kowloon Bay, Hong Kong

FCC ID: 2ADM5-EP-0609

Report Type: Original Report	Product Type: BT RANGE BUDS AST
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Xiangguang Kong <i>Xiangguang . Kong</i>	
Reviewed By: Engineer	
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TABLE OF CONTENTS

GENERAL INFORMATION.....	4
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
SYSTEM TEST CONFIGURATION.....	6
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
SUMMARY OF TEST RESULTS	8
TEST EQUIPMENT LIST	9
FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE	11
APPLICABLE STANDARD	11
FCC §15.203 – ANTENNA REQUIREMENT	12
APPLICABLE STANDARD	12
ANTENNA CONNECTOR CONSTRUCTION	12
FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS	13
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
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS.....	17
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	19
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST	25
APPLICABLE STANDARD	25
TEST PROCEDURE	25
TEST DATA	25

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH.....	30
APPLICABLE STANDARD	30
TEST PROCEDURE	30
TEST DATA	30
FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST	35
APPLICABLE STANDARD	35
TEST PROCEDURE	35
TEST DATA	35
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....	37
APPLICABLE STANDARD	37
TEST PROCEDURE	37
TEST DATA	37
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT	45
APPLICABLE STANDARD	45
TEST PROCEDURE	45
TEST DATA	45
FCC §15.247(d) - BAND EDGES TESTING	46
APPLICABLE STANDARD	46
TEST PROCEDURE	46
TEST DATA	46

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	BT RANGE BUDS AST
Model	EP-0609
UPC Number [#]	192234033838
SKU Number [#]	3188638
Frequency Range	2402~2480 MHz
Transmit Power	-3.72dBm
Modulation Technique	GFSK, $\pi/4$ -DQPSK
Antenna Specification	PCB Antenna, -0.58 dBi
Voltage Range	Powered: DC 3.7V by internal battery Recharged: DC 5V through micro-USB port
Date of Test	2019/05/27~2019/06/09
Sample serial number	190524831
Received date	2019/05/24
Sample/EUT Status	Good condition

Note: Model EP-0609 contains various color which is black, white or blue on product shell due to marketing purpose, they are electrically identical except for different color and the product with blue shell was selected for fully testing.

Objective

This test report is prepared on behalf of *Zeeva International Limited* 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)

No Related Submittal(s)/Grant(s).

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		±0.5dB
RF conducted test with spectrum		±1.5dB
AC Power Lines Conducted Emissions		±1.95dB
Radiated Emissions	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±3°C
Humidity		±6%
Supply voltages		±0.4%

Note: 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

“FCCAssist 2.4” exercise software was used, and the power level is 10.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

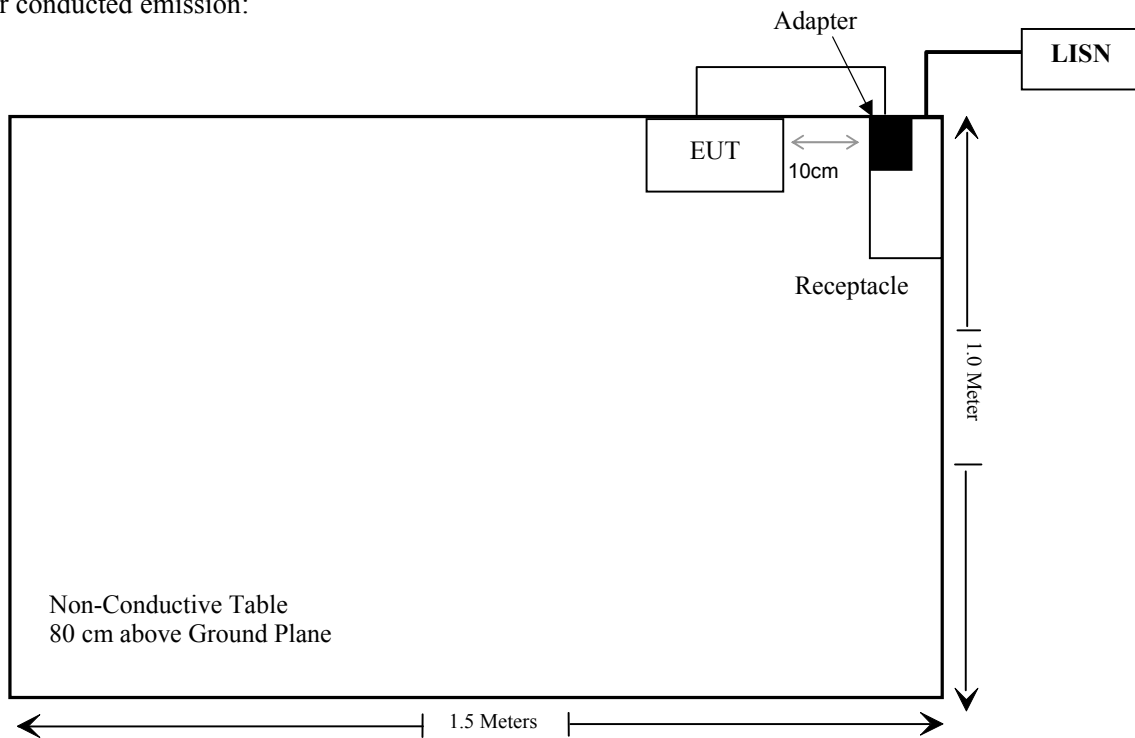
Manufacturer	Description	Model	Serial Number
CUI INC	Adapter	DSA-5PFU1-05 FCA 050100	Unknown
BULL	Socket	GN-415K	5503290068073

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cable	0.4	EUT	Adapter
Un-shielding Un-detachable AC Cable	1.0	LISN	Socket

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
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	100176	2018-07-11	2019-07-11
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2019-01-25	2020-01-25
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2019-03-02	2020-03-02
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Un-known	Conducted Emission Cable	78652	UF A210B-1-0720-504504	2018-11-12	2019-11-12
Radiated Emission Test					
A.H. System	Horn Antenna	SAS-200/571	135	2018-09-01	2021-08-31
Rohde & Schwarz	Signal Analyzer	FSEM	845987/005	2018-06-23	2019-06-23
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017-12-22	2020-12-21
COM-POWER	Pre-amplifier	PA-122	181919	2018-11-12	2019-11-12
Sonoma Instrument	Amplifier	310N	186238	2018-11-12	2019-11-12
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2018-07-11	2019-07-11
Ducommun technologies	RF Cable	UFA147A-2362-100100	MFR64639231029-003	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	2018-11-12	2019-11-12
Ducommun technologies	RF Cable	RG-214	2	2018-11-12	2019-11-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-04	2017-12-29	2020-12-28
Heatsink Required	Amplifier	QLW-18405536-J0	15964001002	2018-11-12	2019-11-12
Sinoscite	Notch Filter	BSF2402-2480MN-0898-001	99632	2018-11-12	2019-11-12
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	2018-06-22	2019-06-22
Tonscend Corporation	SRD/BT/WIFI Test System	JS0806-2	19D8060154	NCR	NCR
Ducommun technologies	RF Cable	RG-214	3	Each Time	
TIMESMICROWAVE SYSTEMS	RF Cable	SFT205-NMSWSM-1.50M	454575-0008	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 ≤ 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 ≤ 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	-3.5	0.45	5	0.14	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 PCB antenna arrangement for bluetooth which was permanently attached and the antenna gain is -0.58 dBi, 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 recorded data in following table, the EUT complied with the FCC Part 15.207,

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(Lm)} \leq L_{\text{lim}} + U_{\text{cisp}}r$$

In BACL, $U_{(Lm)}$ is less than $U_{\text{cisp}}r$, if L_m is less than L_{lim} , it implies that the EUT complies with the limit.

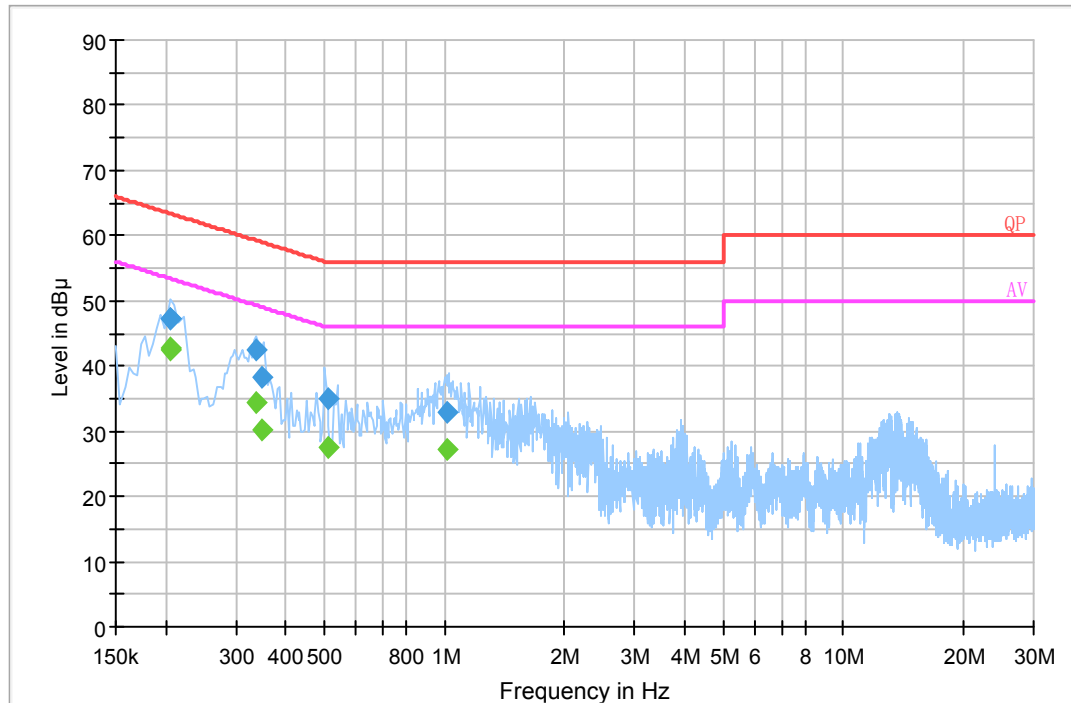
Test Data

Environmental Conditions

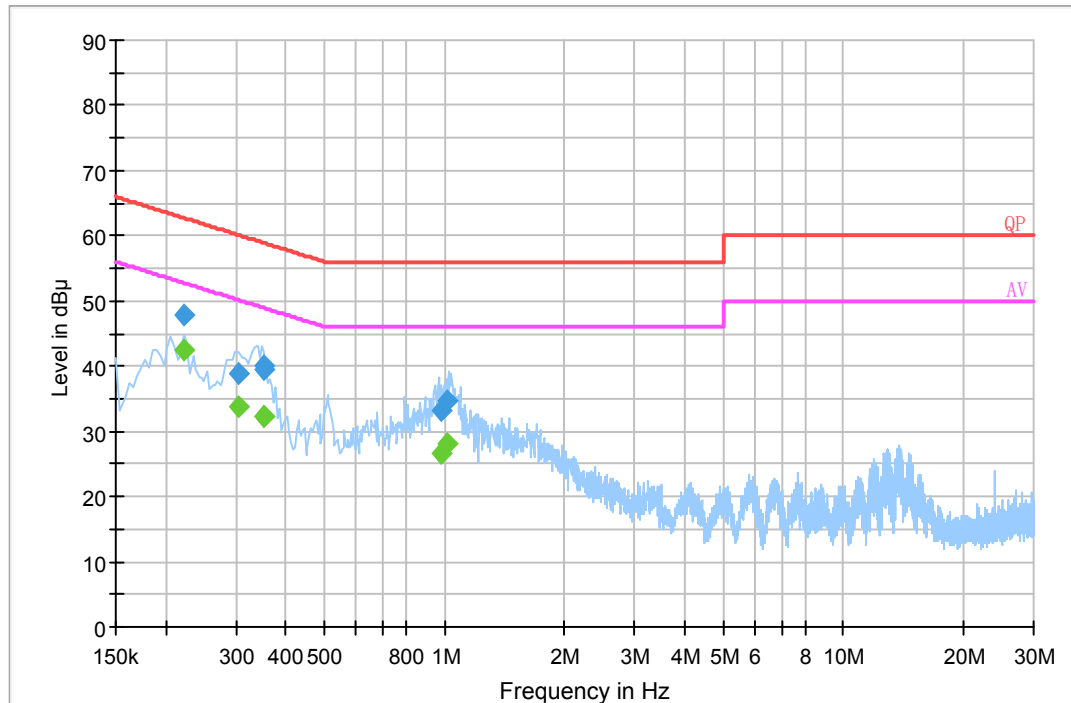
Temperature:	25 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2019-05-27.

EUT operation mode: Charging (the worst case is $\pi/4$ -DQPSK Mode, High channel)

AC 120V/60 Hz, Line

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.205500	47.2	19.8	63.4	16.2	QP
0.206300	47.2	19.8	63.4	16.2	QP
0.336930	42.3	19.8	59.3	17.0	QP
0.348690	38.1	19.9	59.0	20.9	QP
0.509530	35.0	19.8	56.0	21.0	QP
1.018610	32.9	19.9	56.0	23.1	QP
0.205500	42.5	19.8	53.4	10.9	Ave.
0.206300	42.7	19.8	53.4	10.7	Ave.
0.336930	34.4	19.8	49.3	14.9	Ave.
0.348690	30.1	19.9	49.0	18.9	Ave.
0.509530	27.5	19.8	46.0	18.5	Ave.
1.018610	27.2	19.9	46.0	18.8	Ave.

AC 120V/60 Hz, Neutral

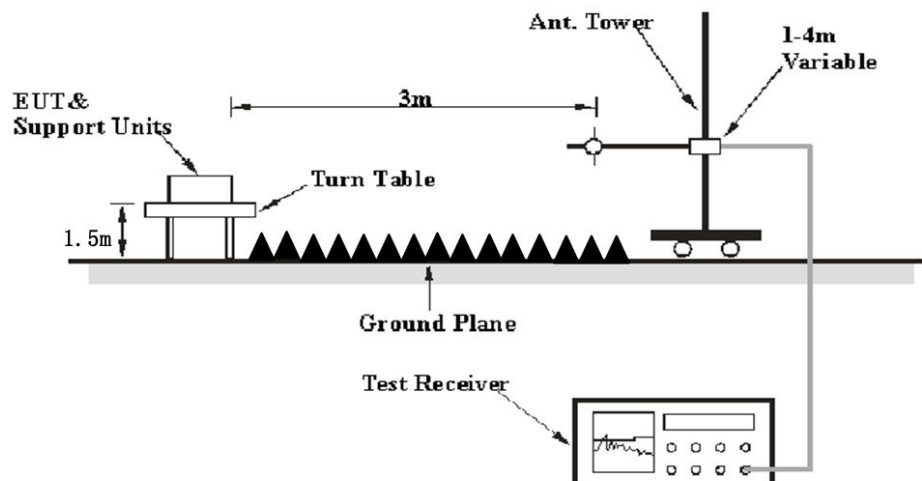
Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.221500	48.0	19.8	62.8	14.8	QP
0.305410	39.0	19.7	60.1	21.1	QP
0.352690	40.1	19.9	58.9	18.8	QP
0.352750	39.5	19.9	58.9	19.4	QP
0.979510	33.2	19.8	56.0	22.8	QP
1.018670	34.8	19.8	56.0	21.2	QP
0.221500	42.5	19.8	52.8	10.3	Ave.
0.305410	33.9	19.7	50.1	16.2	Ave.
0.352690	32.2	19.9	48.9	16.7	Ave.
0.352750	32.3	19.9	48.9	16.6	Ave.
0.979510	26.6	19.8	46.0	19.4	Ave.
1.018670	28.1	19.8	46.0	17.9	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 recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(L_m)} \leq L_{\text{lim}} + U_{\text{cispr}}$$

In BAEL, $U_{(L_m)}$ is less than U_{cispr} , if L_m is less than L_{lim} , it implies that the EUT complies with the limit.

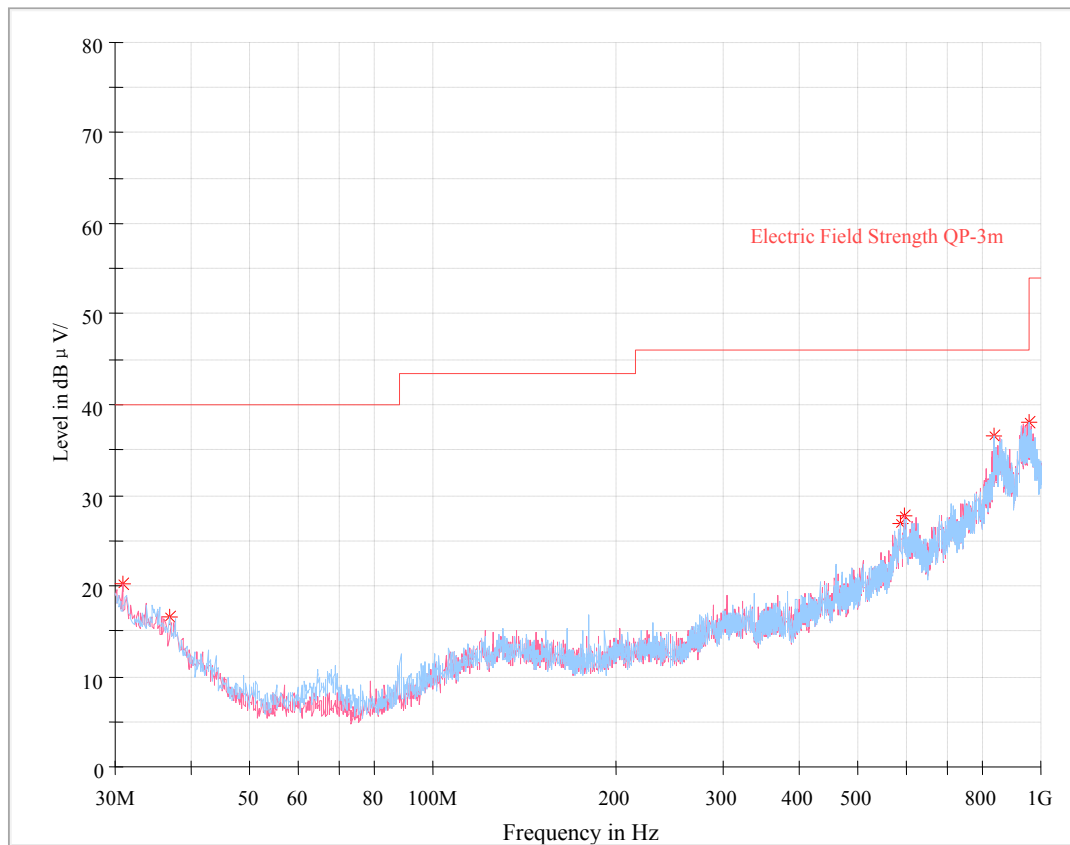
Test Data**Environmental Conditions**

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

The testing was performed by Baston Chen on 2019-05-29 and by Alan He on 2019-05-31.

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

30 MHz~1 GHz: (the worst case is $\pi/4$ -DQPSK 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)
30.848750	20.14	202.0	V	326.0	-8.1	40.00	19.86
36.790000	16.64	300.0	H	194.0	-11.7	40.00	23.36
588.720000	26.86	300.0	H	30.0	-2.4	46.00	19.14
596.480000	27.81	300.0	V	0.0	-1.8	46.00	18.19
838.616250	36.50	102.0	H	147.0	5.8	46.00	9.50
958.047500	38.11	102.0	H	17.0	9.3	46.00	7.89

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)									
2320.42	28.15	PK	91	1.8	H	31.64	59.79	74	14.21
2320.42	13.97	Ave.	91	1.8	H	31.64	45.61	54	8.39
2491.67	26.88	PK	49	2.5	H	32.13	59.01	74	14.99
2491.67	13.42	Ave.	49	2.5	H	32.13	45.55	54	8.45
4804.00	52.68	PK	350	1.6	H	6.28	58.96	74	15.04
4804.00	38.18	Ave.	350	1.6	H	6.28	44.46	54	9.54
7206.00	56.52	PK	95	1.7	H	11.93	68.45	74	5.55
7206.00	37.27	Ave.	95	1.7	H	11.93	49.20	54	4.80
9608.00	56.03	PK	148	2.3	H	14.29	70.32	74	3.68
9608.00	36.47	Ave.	148	2.3	H	14.29	50.76	54	3.24
Middle Channel (2441 MHz)									
4882.00	58.94	PK	35	1.9	H	6.76	65.70	74	8.30
4882.00	41.68	Ave.	35	1.9	H	6.76	48.44	54	5.56
7323.00	53.21	PK	51	2.4	H	11.66	64.87	74	9.13
7323.00	35.43	Ave.	51	2.4	H	11.66	47.09	54	6.91
9764.00	53.41	PK	226	1.4	H	15.42	68.83	74	5.17
9764.00	34.02	Ave.	226	1.4	H	15.42	49.44	54	4.56
High Channel (2480 MHz)									
2322.18	27.66	PK	287	1.3	H	31.64	59.30	74	14.70
2322.18	14.17	Ave.	287	1.3	H	31.64	45.81	54	8.19
2489.98	27.50	PK	305	1.4	H	32.13	59.63	74	14.37
2489.98	14.00	Ave.	305	1.4	H	32.13	46.13	54	7.87
4960.00	60.27	PK	271	1.6	H	6.80	67.07	74	6.93
4960.00	41.80	Ave.	271	1.6	H	6.80	48.60	54	5.40

Note:

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

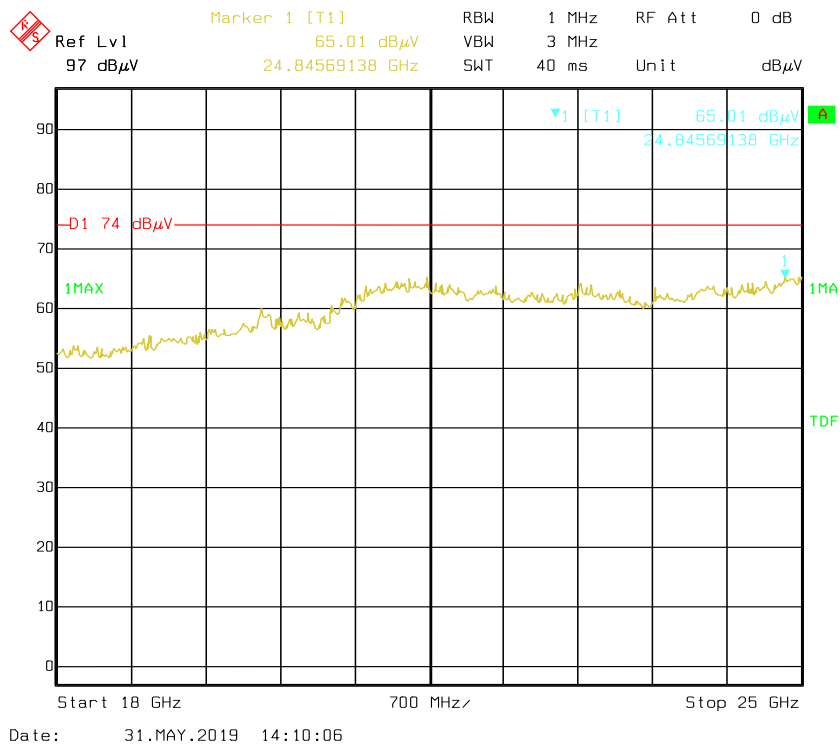
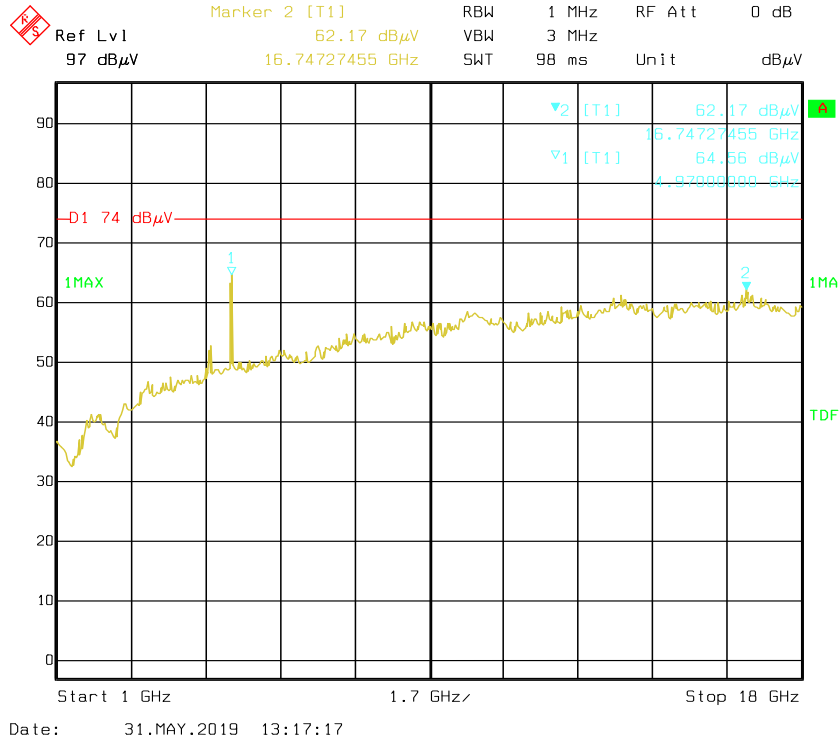
Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

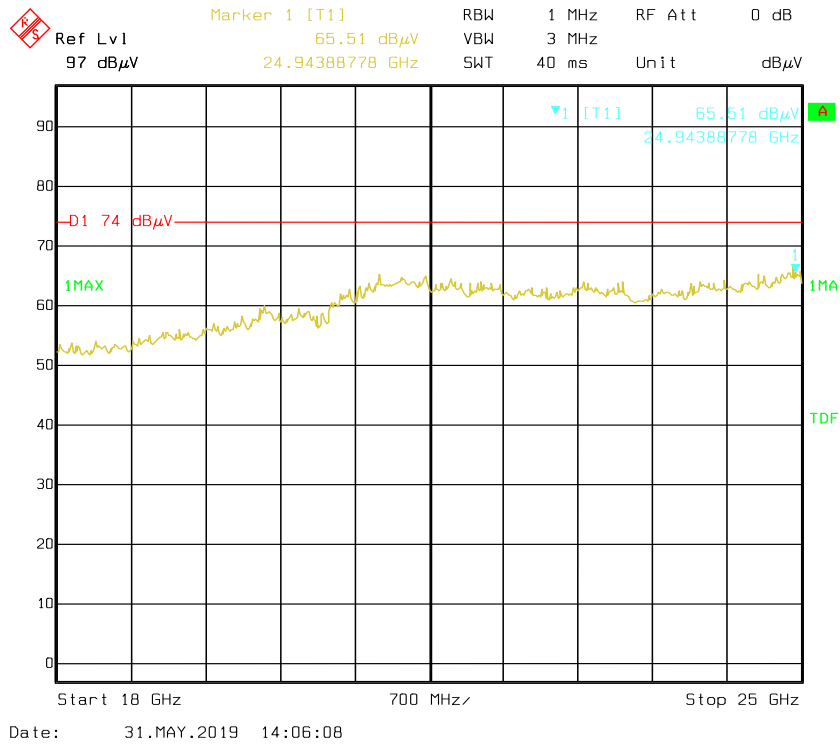
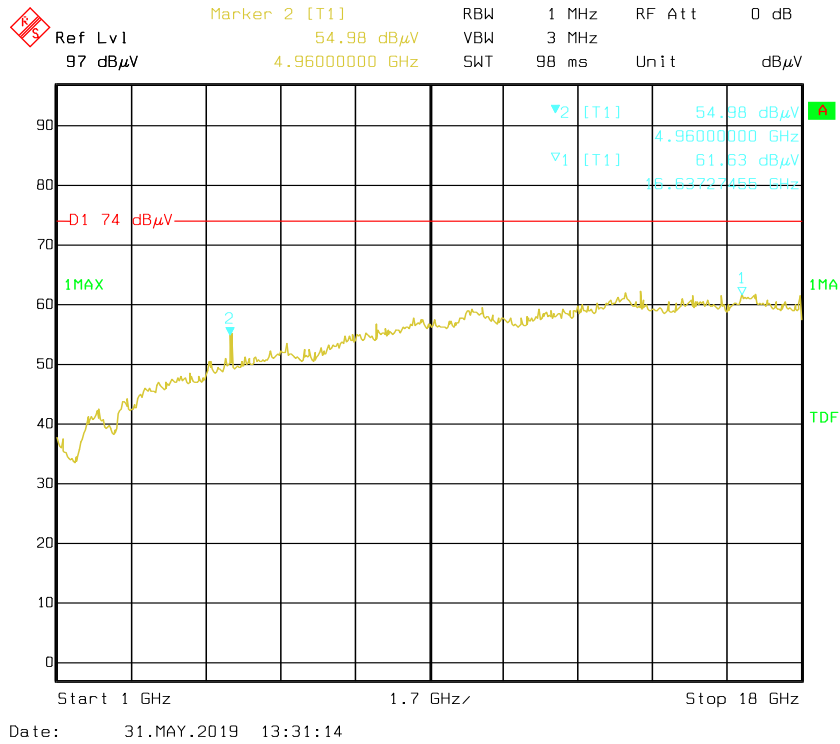
The other spurious emission which is 20dB to the limit was not recorded.

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

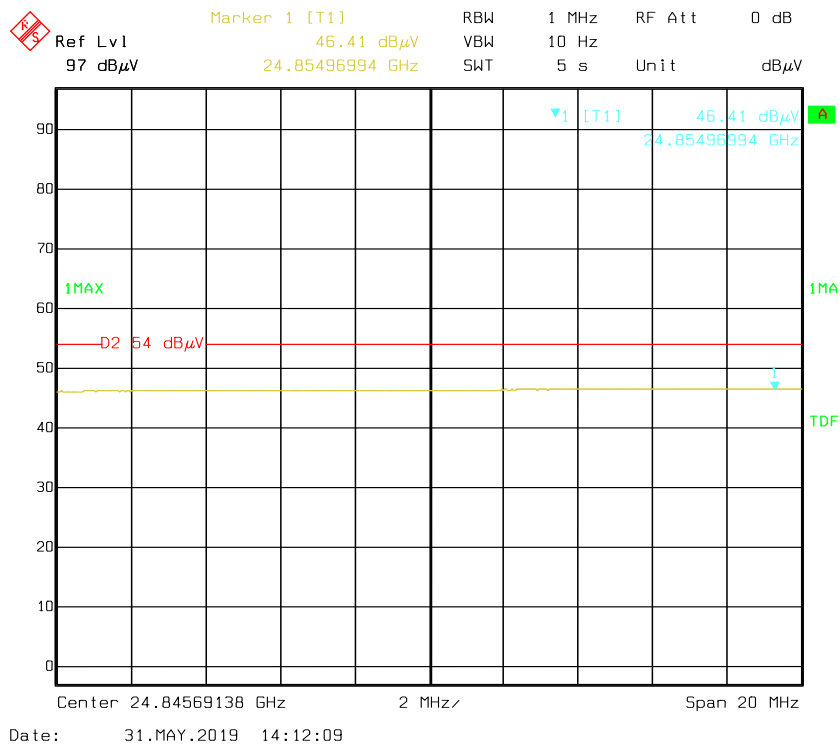
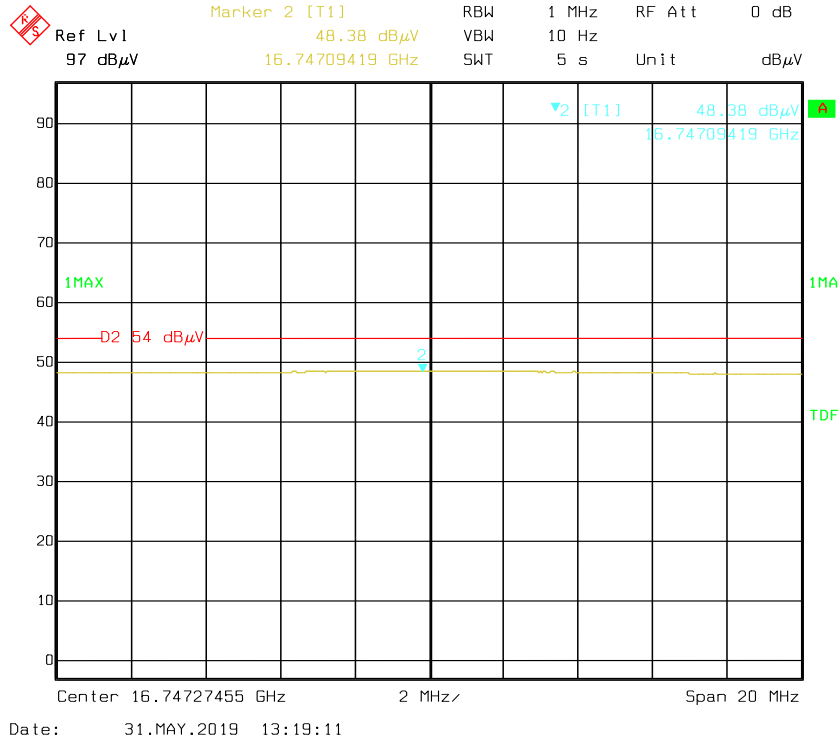
Pre-scan with high channel Peak Horizontal



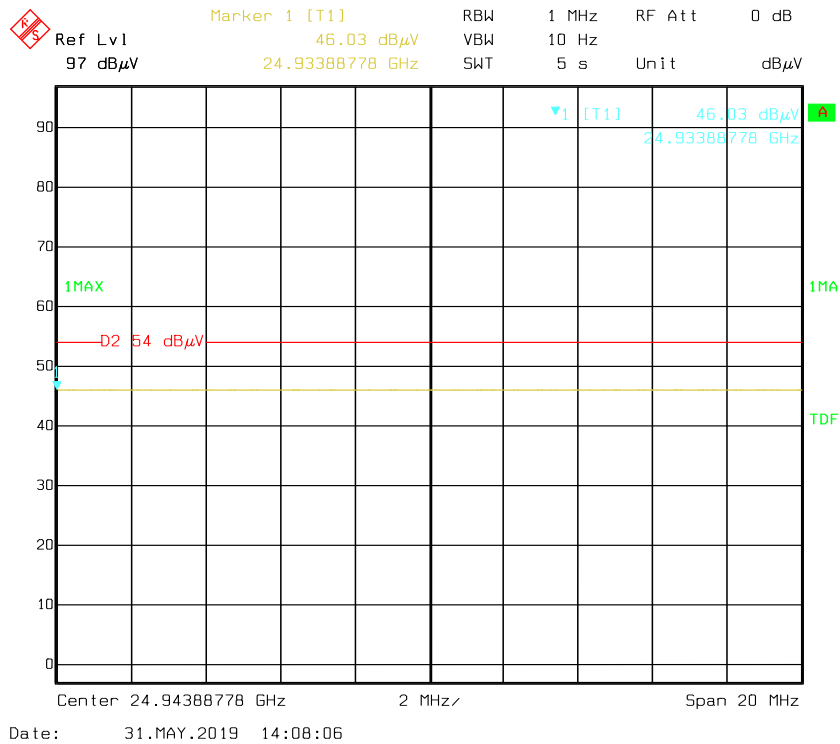
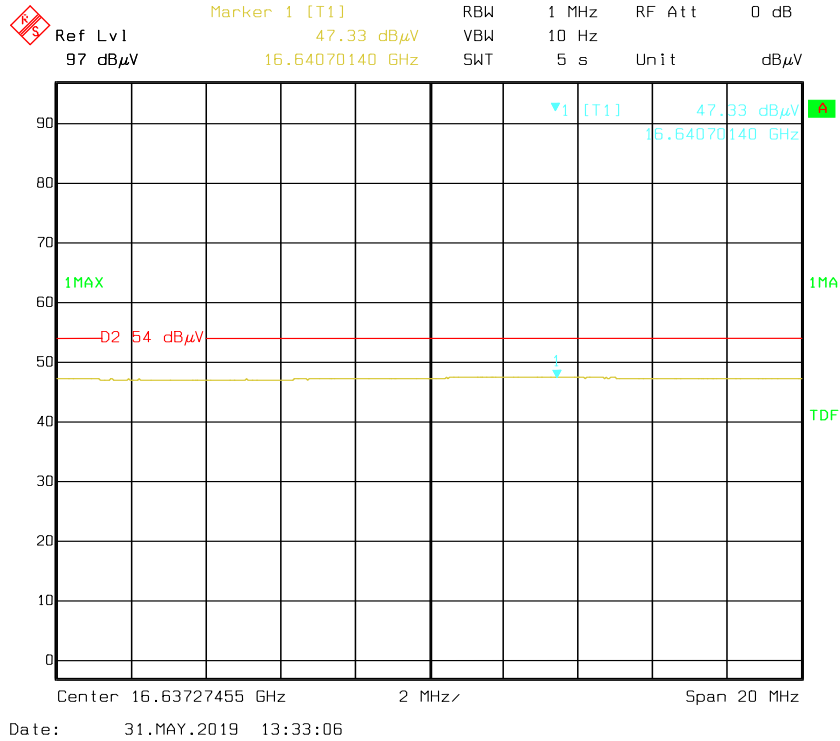
Vertical



Pre-scan for Average Horizontal



Vertical



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**

Temperature:	23~25 °C
Relative Humidity:	50~52 %
ATM Pressure:	101.0 kPa

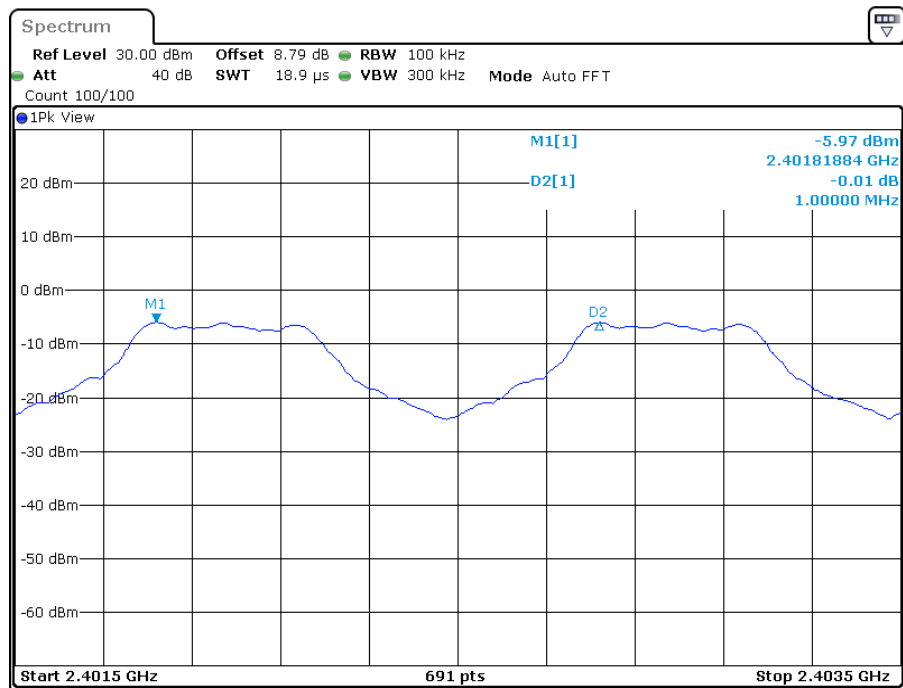
The testing was performed by Kieron Luo from 2019-06-01 to 2019-06-09.

EUT operation mode: Transmitting

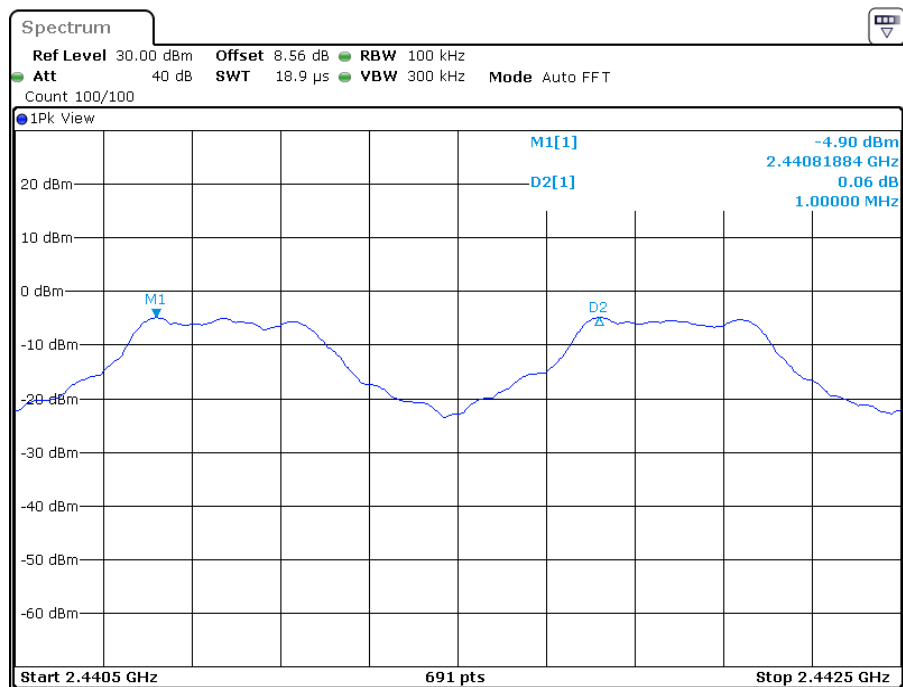
Test Result: Compliance. Please refer to following table and plots.

Channel	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit	Result
BDR(GFSK)					
Low	1.000	0.888	0.592	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.000	0.888	0.592	> two-thirds of the 20 dB bandwidth	Compliance
High	1.003	0.888	0.592	> two-thirds of the 20 dB bandwidth	Compliance
EDR($\pi/4$-DQPSK)					
Low	1.003	1.233	0.822	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.003	1.269	0.846	> two-thirds of the 20 dB bandwidth	Compliance
High	1.000	1.284	0.856	> two-thirds of the 20 dB bandwidth	Compliance

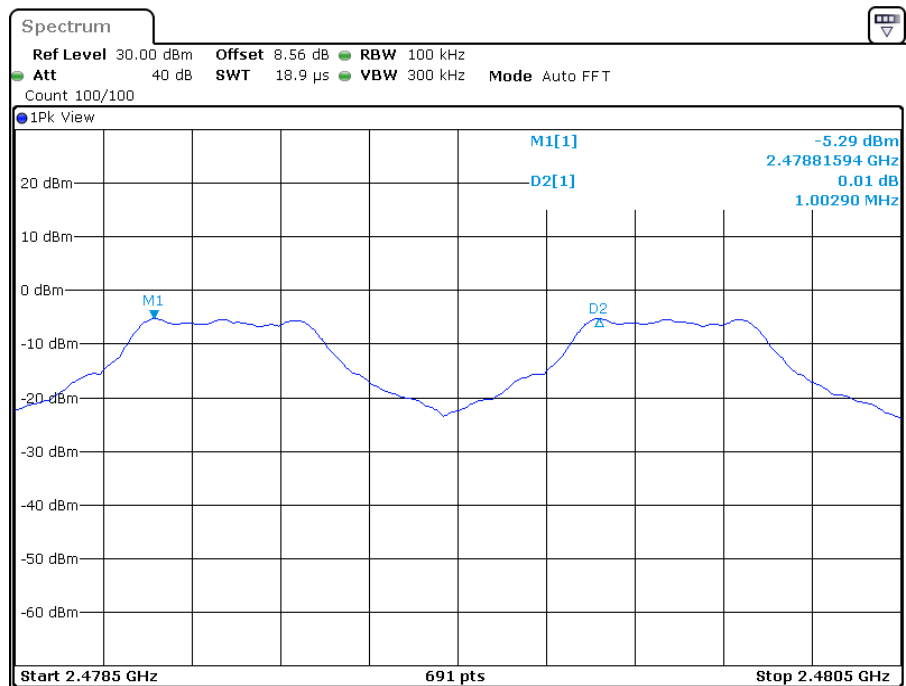
Please refer to the following plots.

BDR (GFSK): Low Channel

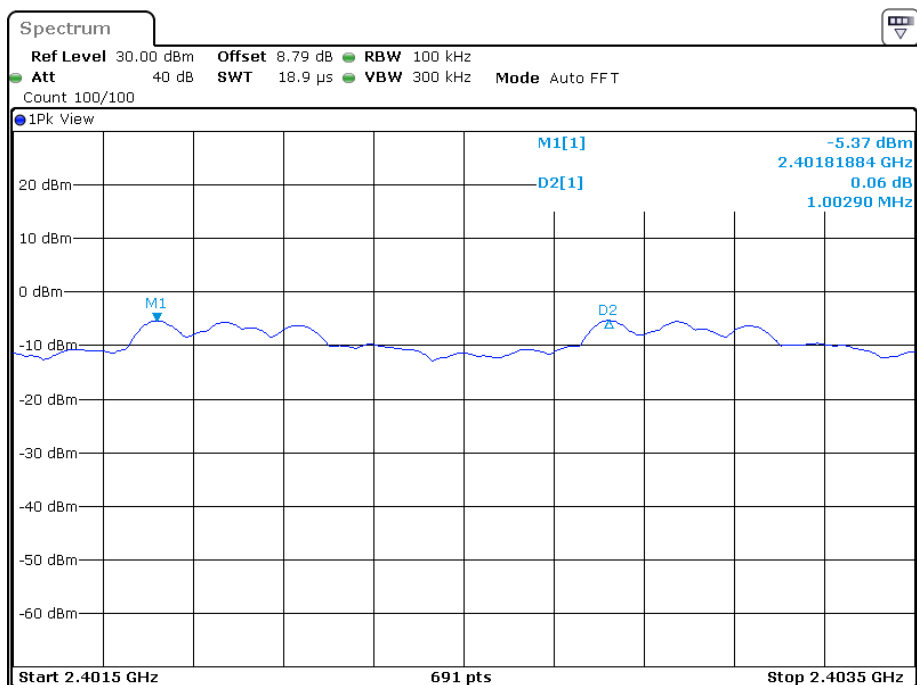
Date: 9.JUN.2019 12:56:22

BDR (GFSK): Middle Channel

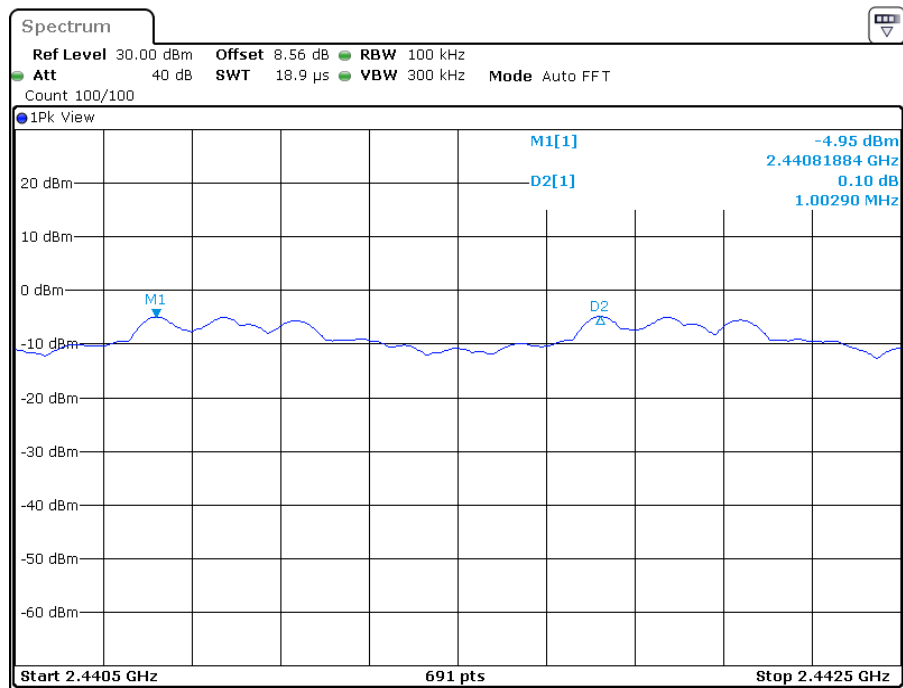
Date: 4.JUN.2019 16:16:51

BDR (GFSK): High Channel

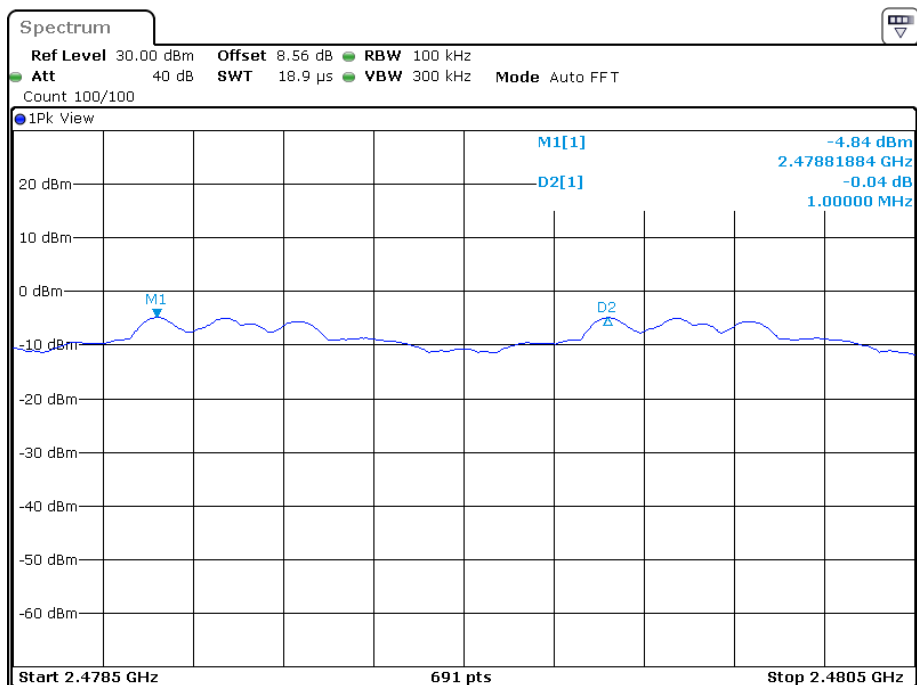
Date: 9.JUN.2019 12:55:29

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

Date: 1.JUN.2019 17:41:18

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

Date: 4.JUN.2019 16:37:07

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

Date: 1.JUN.2019 17:35:15

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**

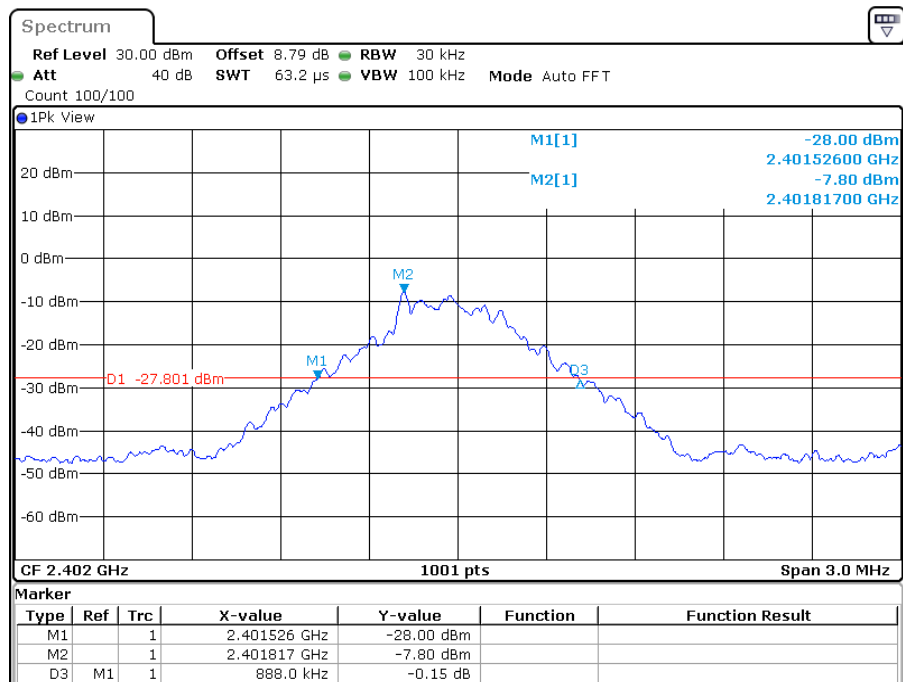
Temperature:	25 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Kieron Luo on 2019-06-09.

EUT operation mode: Transmitting

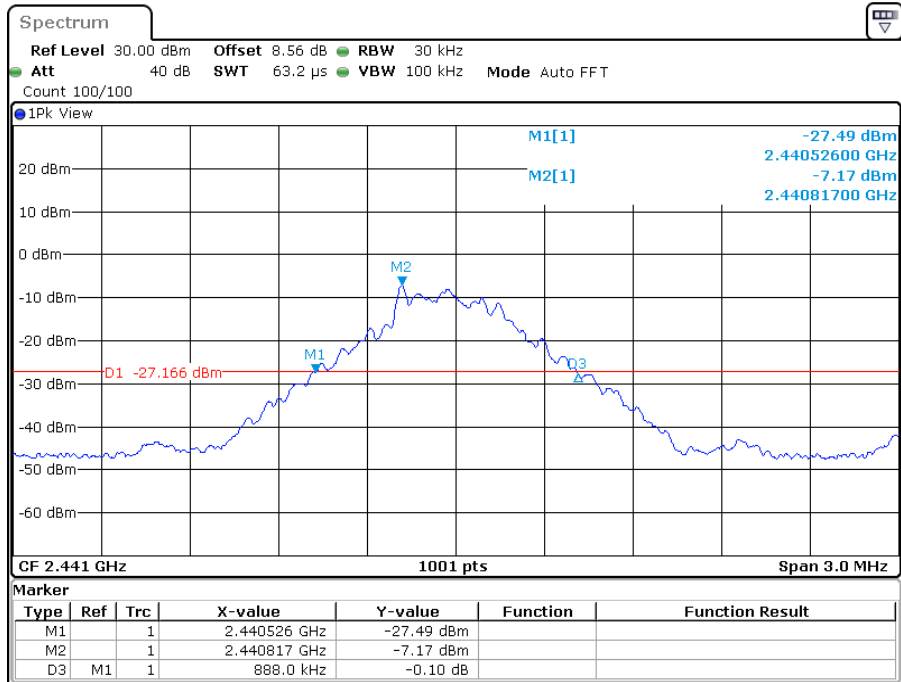
Test Result: Compliance. Please refer to following table and plots.

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.888
	Middle	2441	0.888
	High	2480	0.888
EDR ($\pi/4$-DQPSK)	Low	2402	1.233
	Middle	2441	1.269
	High	2480	1.284

BDR (GFSK): Low Channel

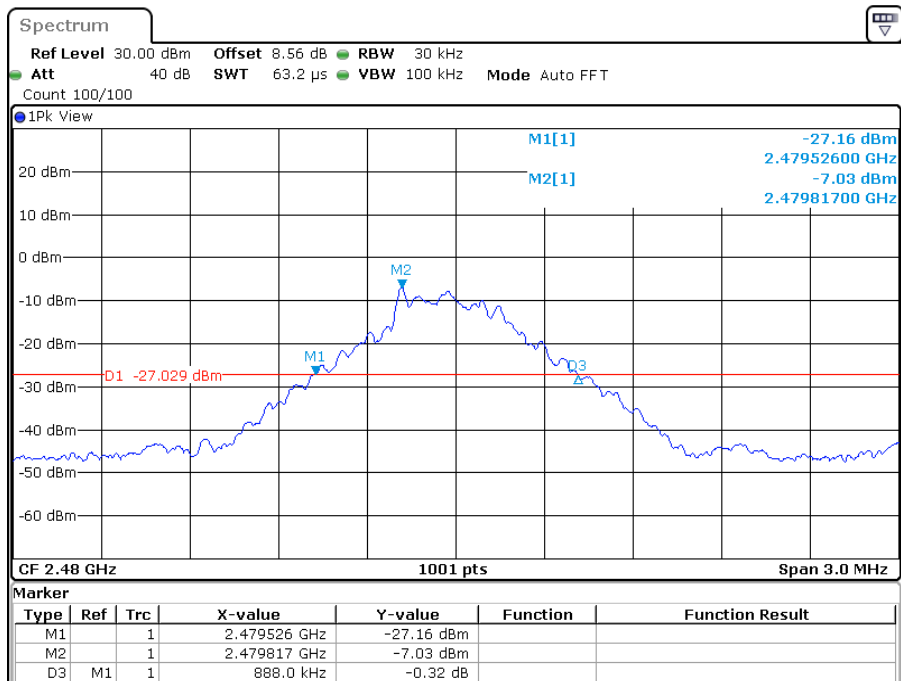
Date: 9.JUN.2019 13:00:08

BDR (GFSK): Middle Channel



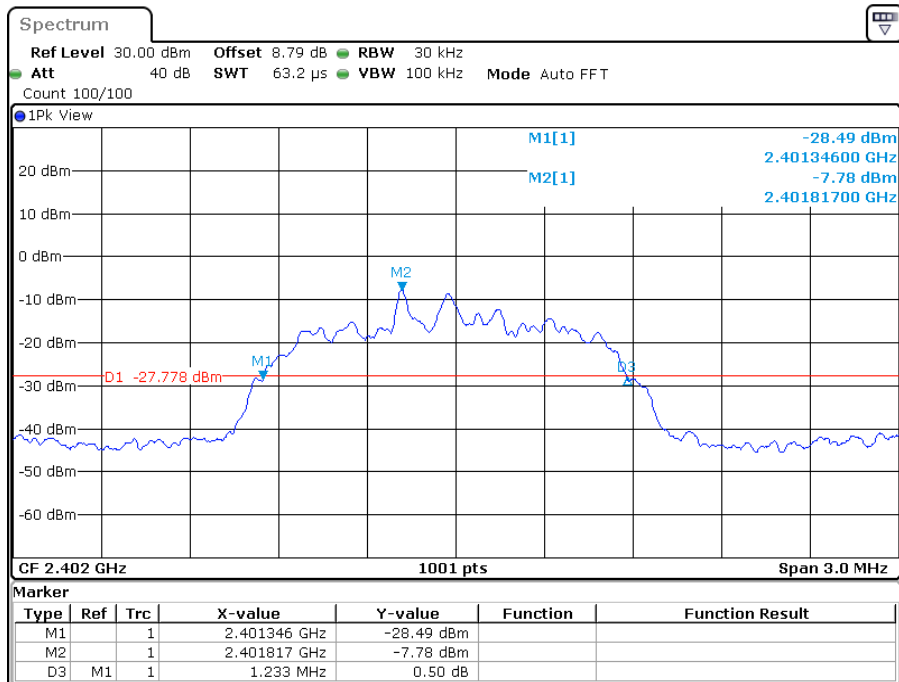
Date: 9.JUN.2019 13:01:20

BDR (GFSK): High Channel



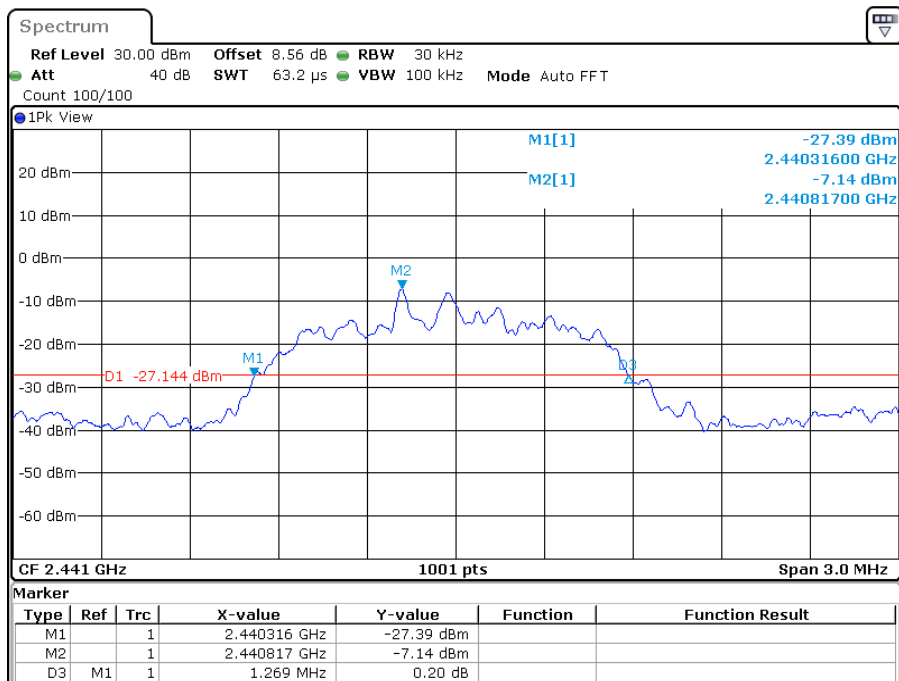
Date: 9.JUN.2019 13:02:00

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



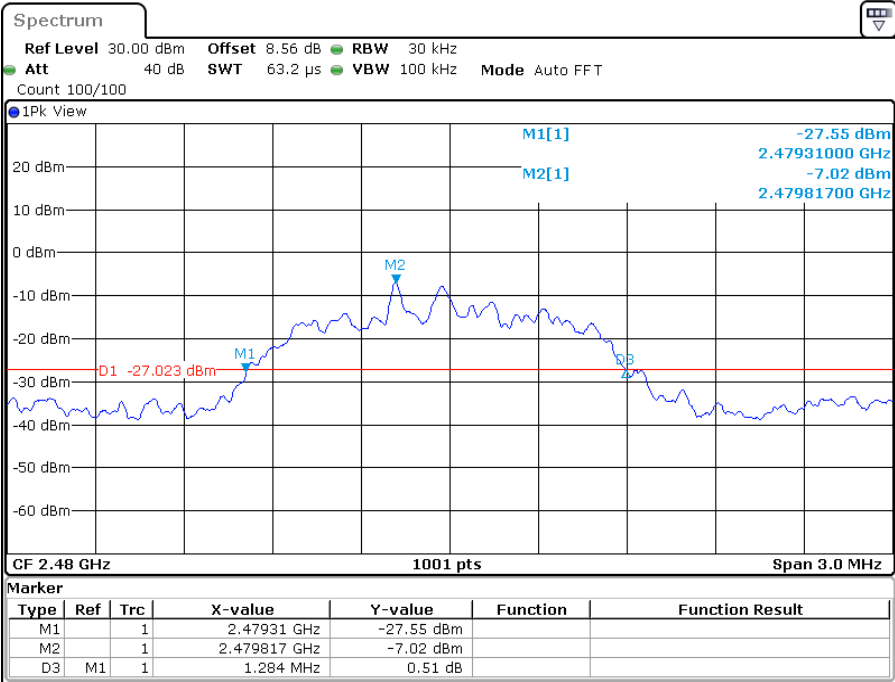
Date: 9.JUN.2019 13:04:10

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



Date: 9.JUN.2019 13:04:49

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



Date: 9.JUN.2019 13:05:28

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

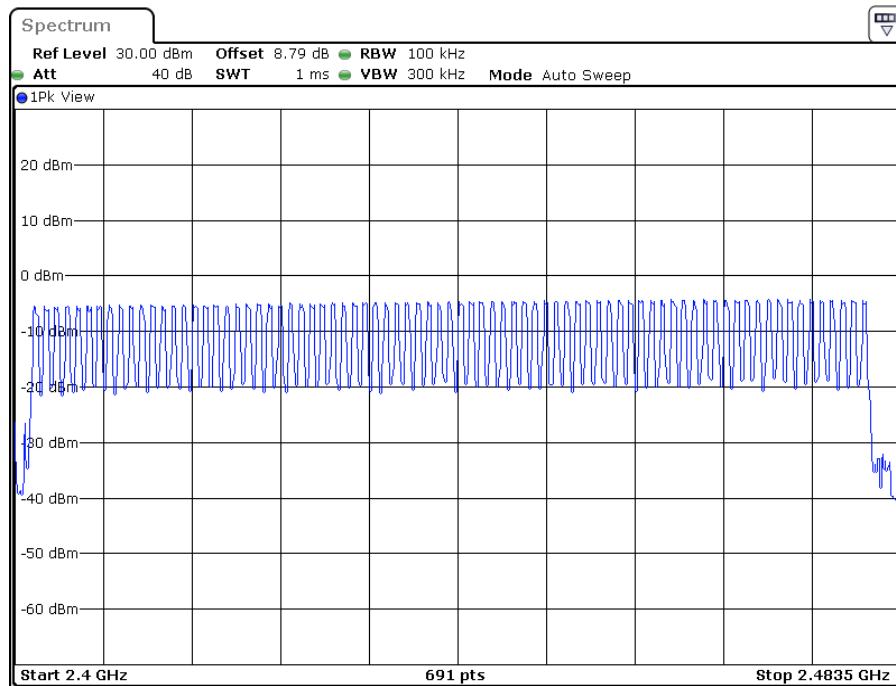
Temperature:	25 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Kieron Luo on 2019-06-04.

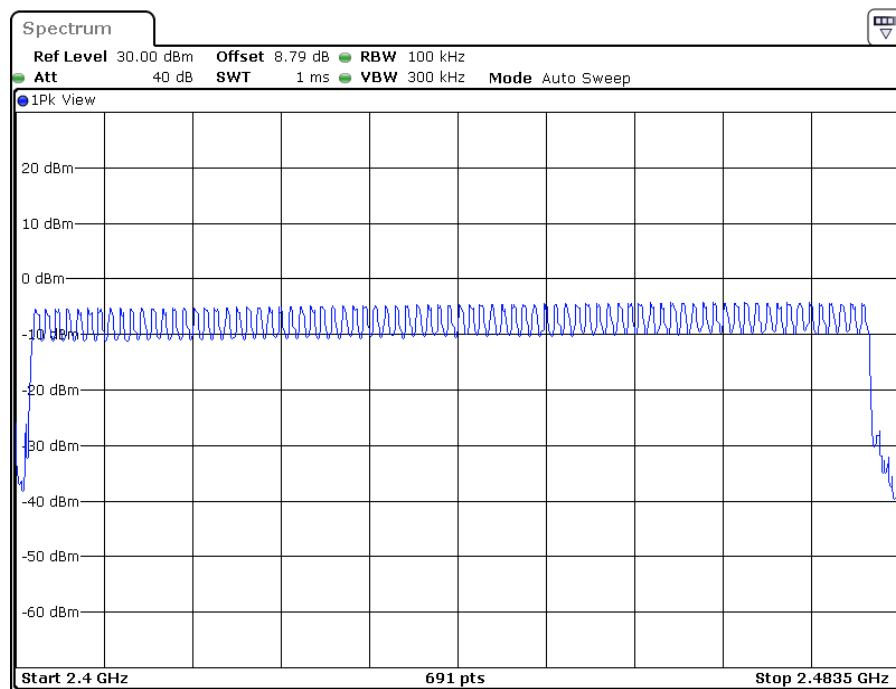
EUT operation mode: Transmitting

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

Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥15
EDR (π/4-DQPSK)	2400-2483.5	79	≥15

BDR (GFSK): Number of Hopping Channels

Date: 4.JUN.2019 16:17:53

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

Date: 4.JUN.2019 16:41:38

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

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- a) Span: Zero span, centered on a hopping channel.
- b) RBW shall be \leq channel spacing and where possible RBW should be set $\gg 1 / T$, where T is the expected dwell time per channel.
- c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- d) Detector function: Peak.
- e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test or each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) =

(number of hops on spectrum analyzer) \times (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of ops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

Test Data

Environmental Conditions

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

The testing was performed by Kieron Luo on 2019-06-04.

EUT operation mode: Transmitting

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

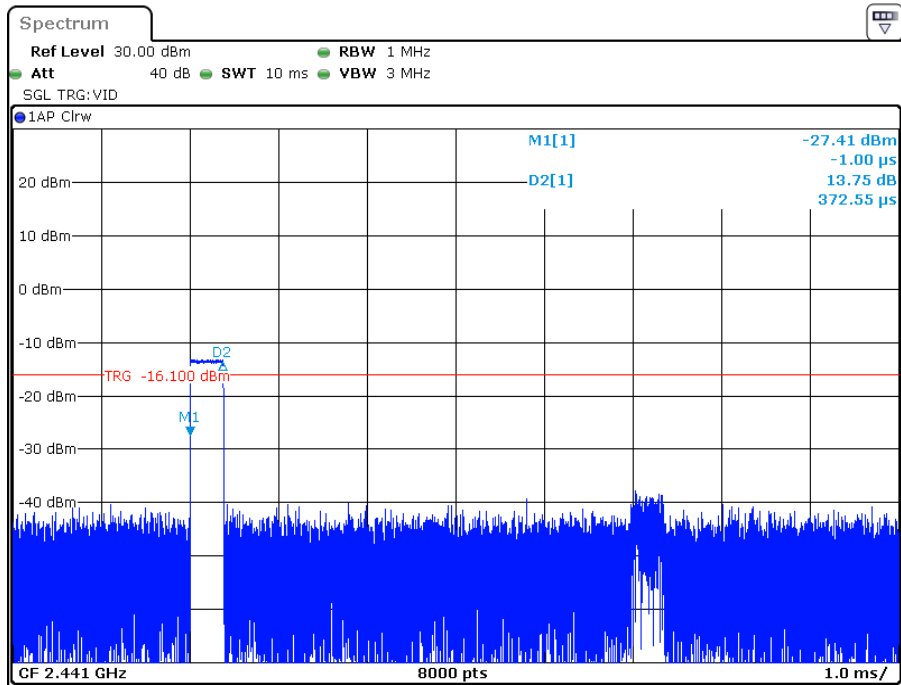
Mode		Pulse Time (ms)	Hopping Number	Period Time (s)	Total of Dwell (ms)	Limit (ms)	Result
BDR (GFSK)	DH 1	0.373	320	31.6	119.36	400	Pass
	DH 3	1.621	150	31.6	243.15	400	Pass
	DH 5	2.862	70	31.6	200.34	400	Pass
EDR ($\pi/4$ -DQPSK)	2DH 1	0.383	320	31.6	122.56	400	Pass
	2DH 3	1.628	100	31.6	162.80	400	Pass
	2DH 5	2.867	80	31.6	229.36	400	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

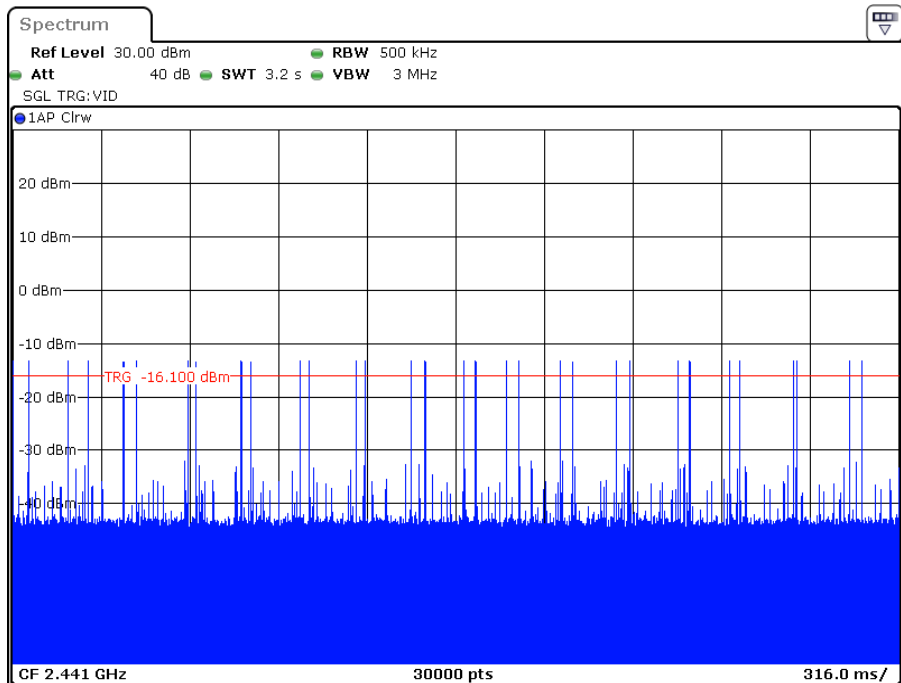
Note 3: Hopping Number in 3.16s = Total of highest signals in 3.16s.(Second high signals were other channel)

BDR (GFSK): **Pulse Time, DH1**



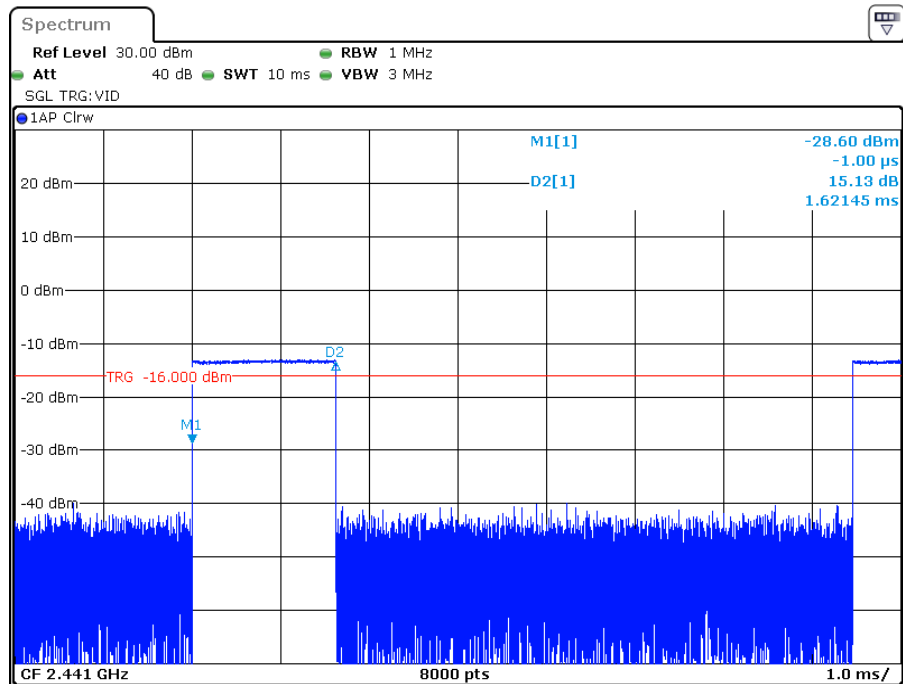
Date: 4.JUN.2019 16:20:23

Hopping number in 3.16s, DH1



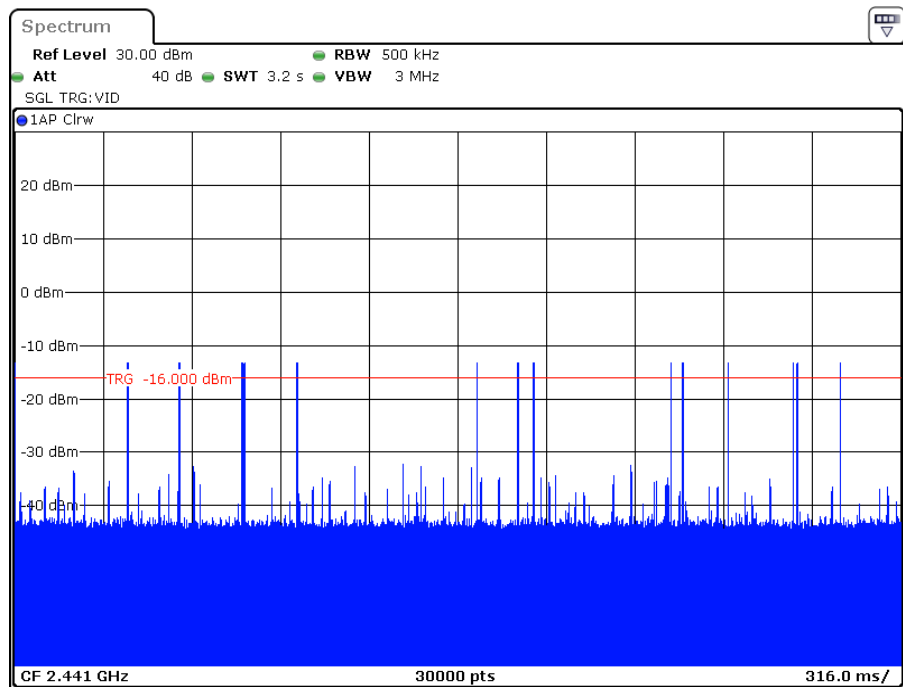
Date: 4.JUN.2019 16:20:32

Pulse Time, DH3



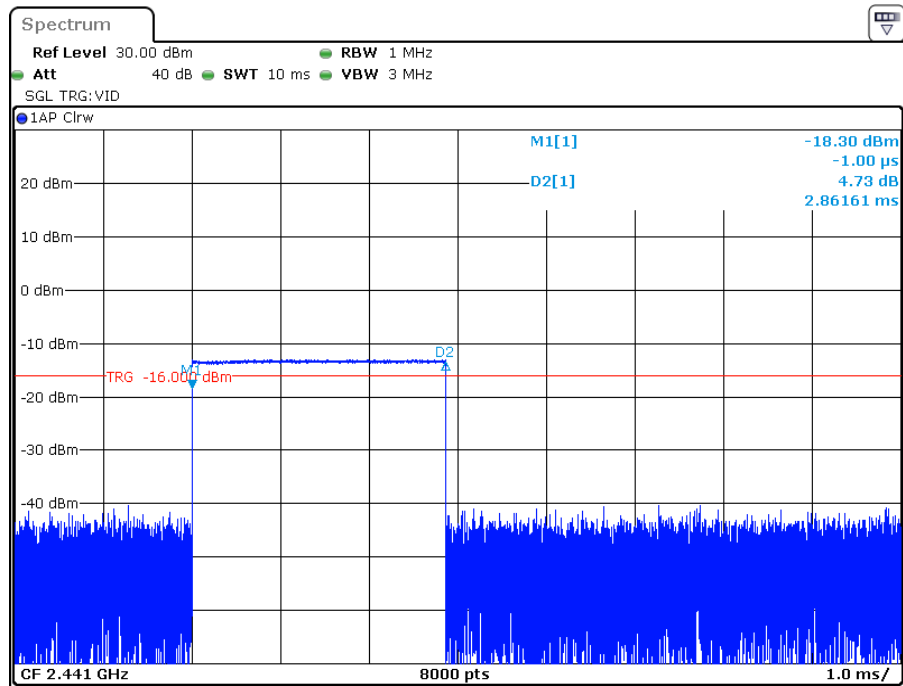
Date: 4.JUN.2019 17:00:27

Hopping number in 3.16s, DH3



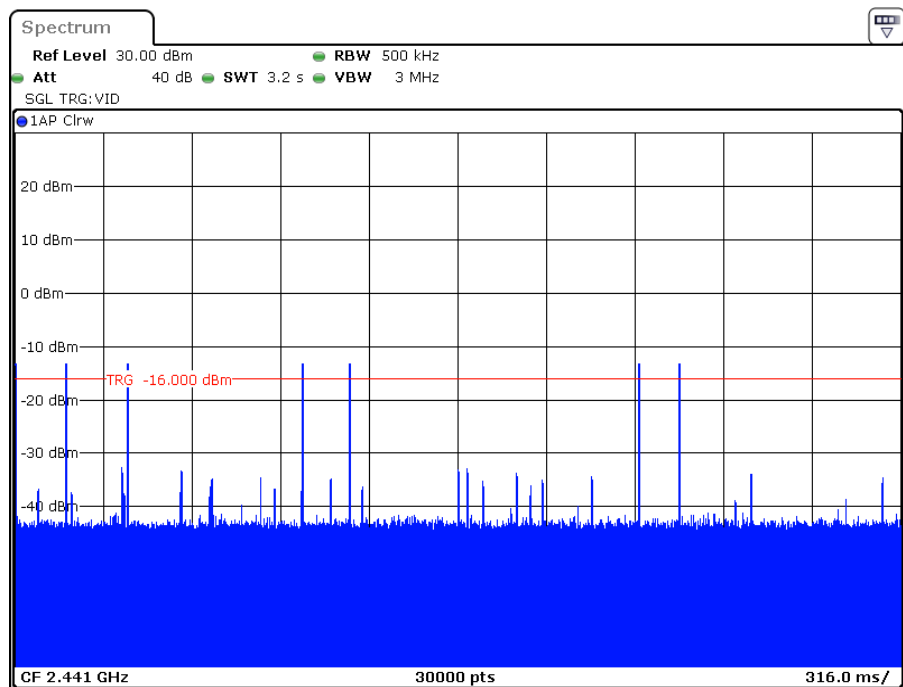
Date: 4.JUN.2019 17:00:37

Pulse Time, DH5

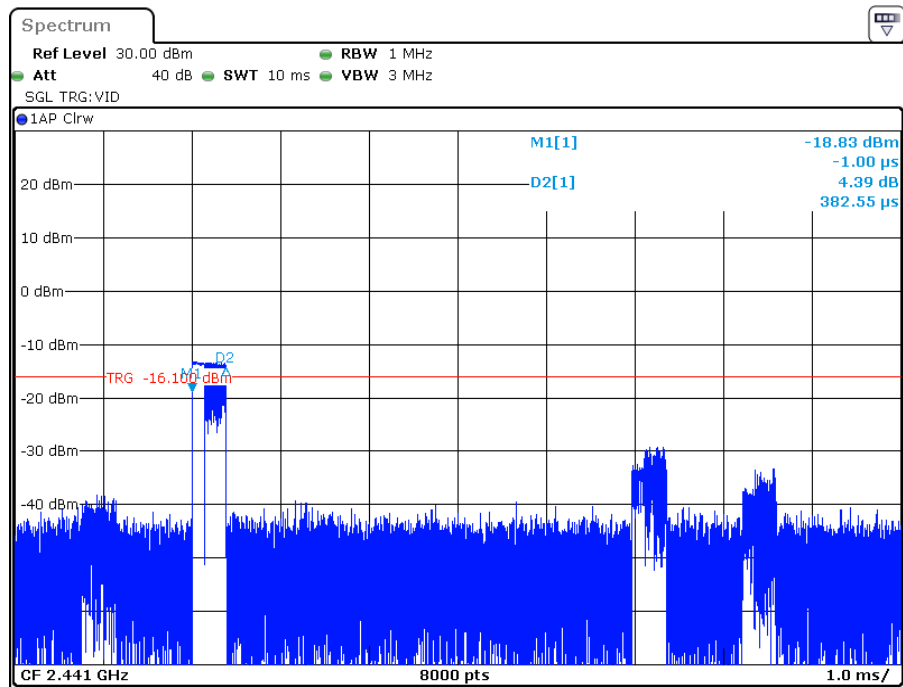


Date: 4.JUN.2019 17:01:21

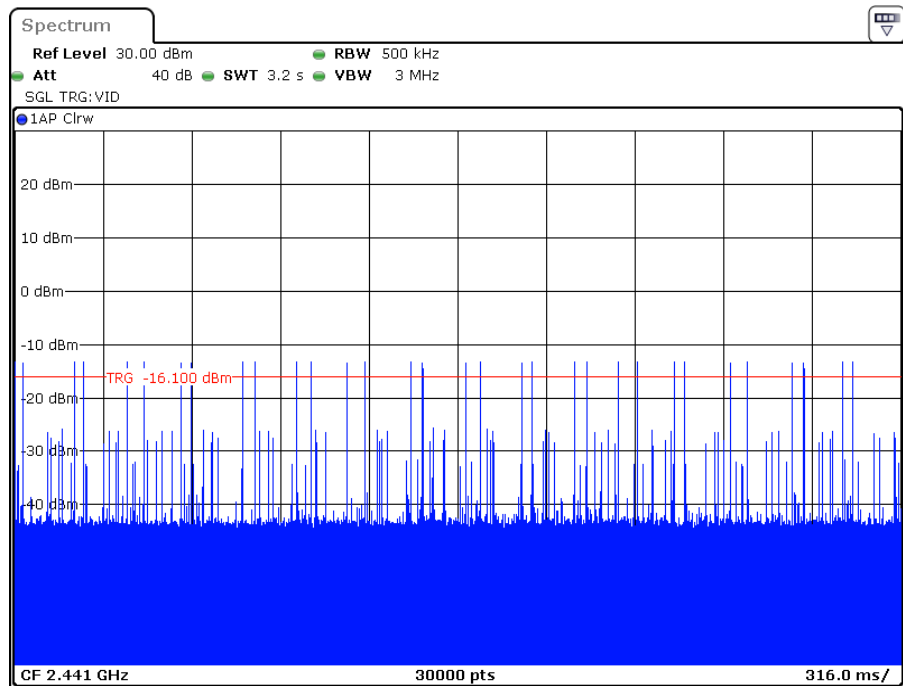
Hopping number in 3.16s, DH5



Date: 4.JUN.2019 17:01:30

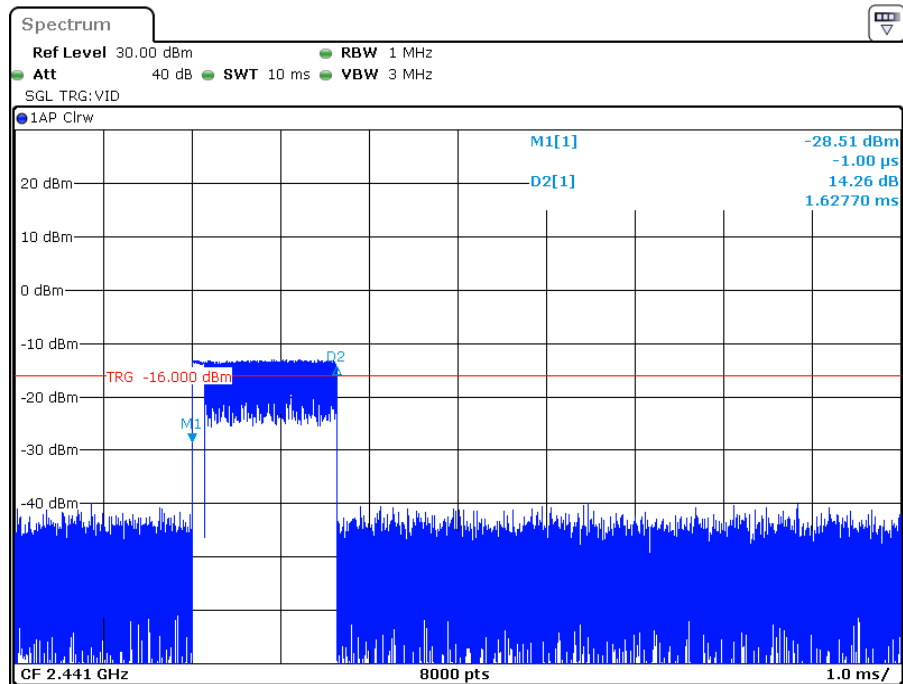
EDR ($\pi/4$ -DQPSK):**Pulse Time, 2DH1**

Date: 4.JUN.2019 16:41:59

Hopping number in 3.16s, 2DH1

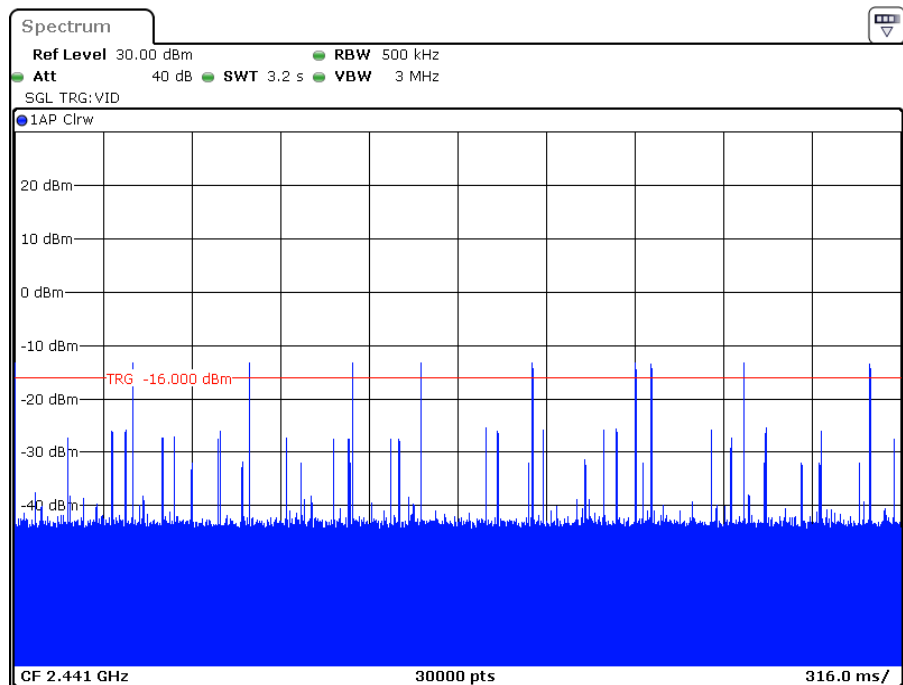
Date: 4.JUN.2019 16:42:08

Pulse Time, 2DH3



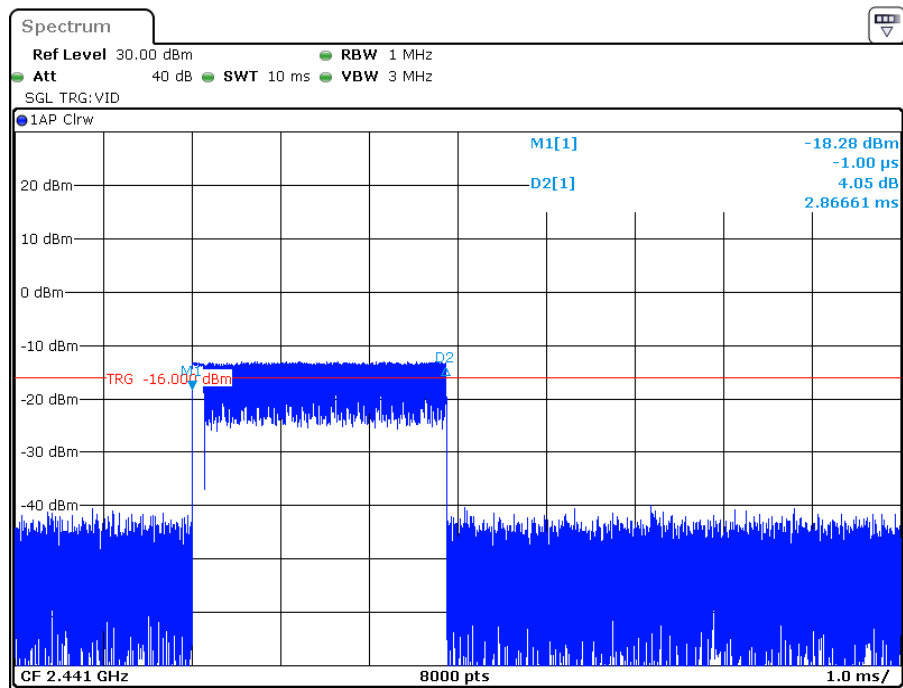
Date: 4.JUN.2019 17:02:16

Hopping number in 3.16s, 2DH3



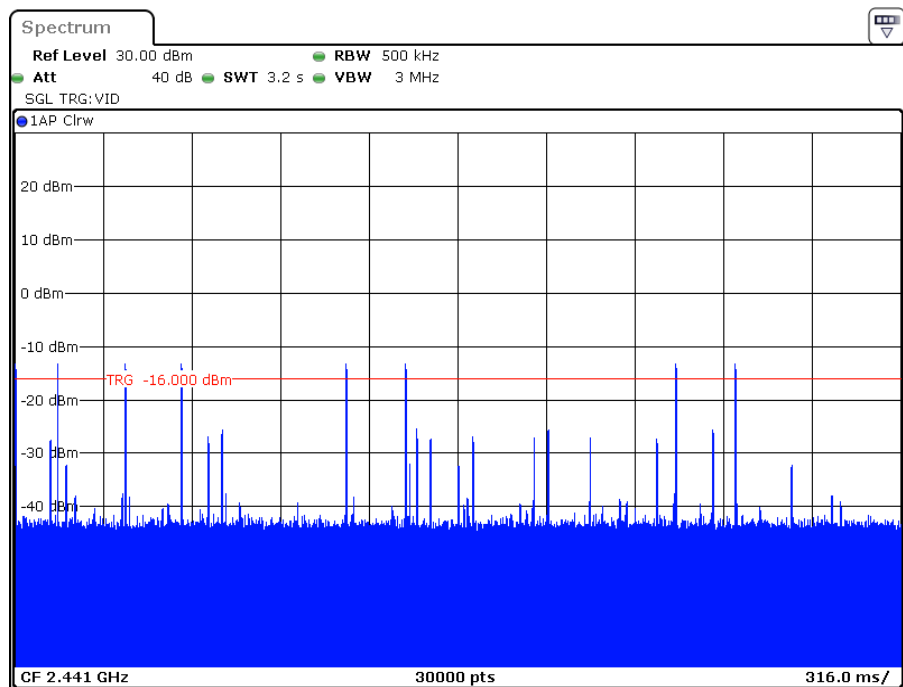
Date: 4.JUN.2019 17:02:26

Pulse Time, 2DH5



Date: 4.JUN.2019 17:03:08

Hopping number in 3.16s, 2DH5



Date: 4.JUN.2019 17:03:18

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

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

The testing was performed by Kieron Luo on 2019-06-04.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table.

Mode	Channel	Frequency (MHz)	Peak Output Power		Limit (mW)
			(dBm)	(mW)	
BDR (GFSK)	Low	2402	-4.39	0.36	125
	Middle	2441	-4.08	0.39	125
	High	2480	-3.76	0.42	125
EDR ($\pi/4$-DQPSK)	Low	2402	-3.93	0.40	125
	Middle	2441	-3.94	0.40	125
	High	2480	-3.72	0.42	125

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

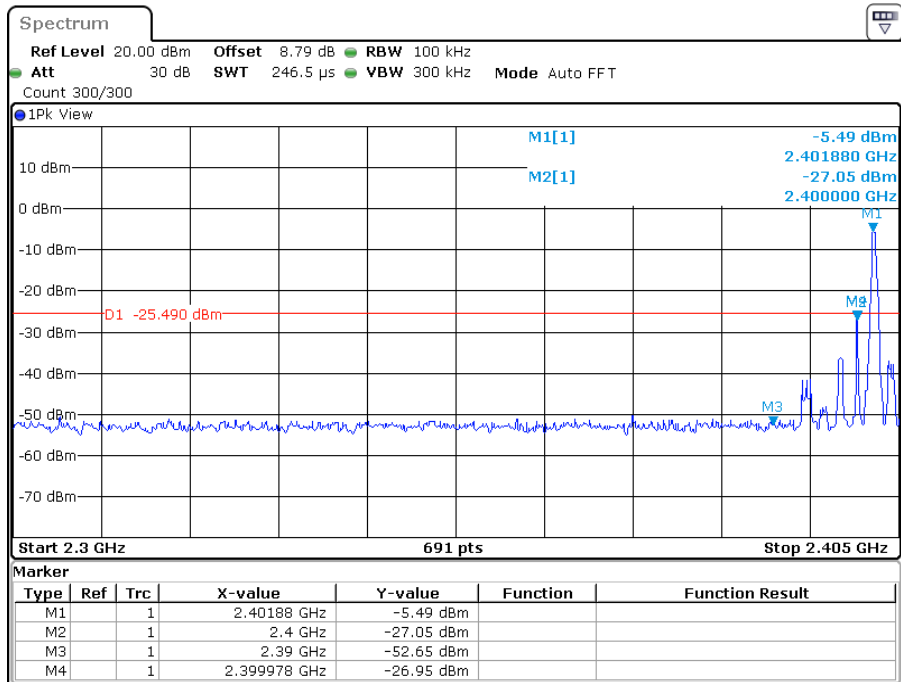
The testing was performed by Kieron Luo on 2019-06-04 to 2019-06-09.

EUT operation mode: Transmitting

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

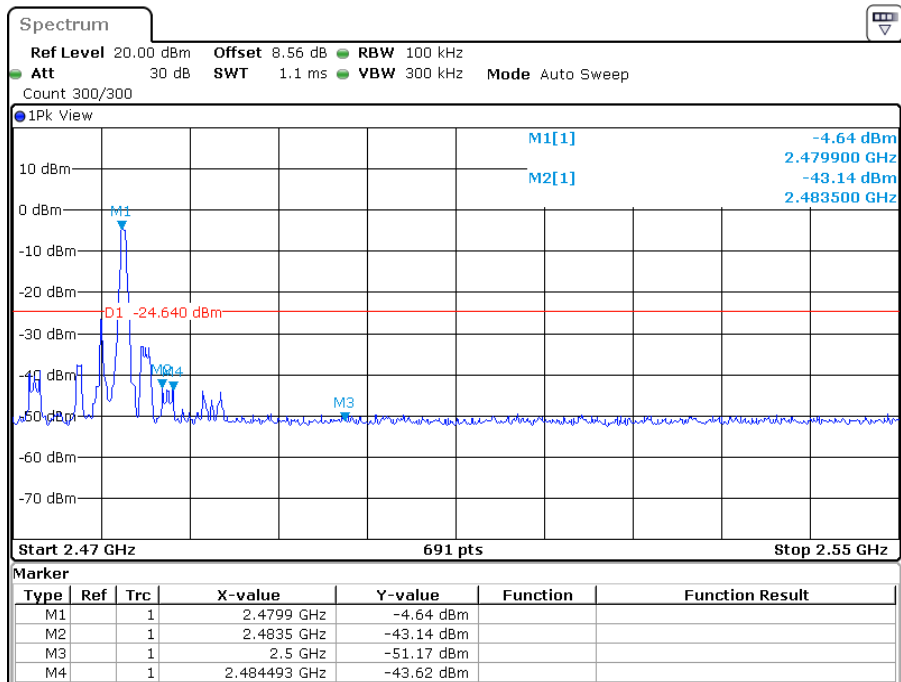
TestMode	ChName	Channel	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH1	Low	2402	-5.49	-26.95	<=-25.49	PASS
	High	2480	-4.64	-43.62	<=-24.64	PASS
	Low	Hop_2402	-5.39	-27.2	<=-25.39	PASS
	High	Hop_2480	-4.49	-44.79	<=-24.49	PASS
2DH1	Low	2402	-5.49	-26.59	<=-25.49	PASS
	High	2480	-4.63	-43.73	<=-24.63	PASS
	Low	Hop_2402	-7.22	-27.38	<=-27.22	PASS
	High	Hop_2480	-4.62	-43.87	<=-24.62	PASS

BDR (GFSK): Band Edge Low Channel – Single



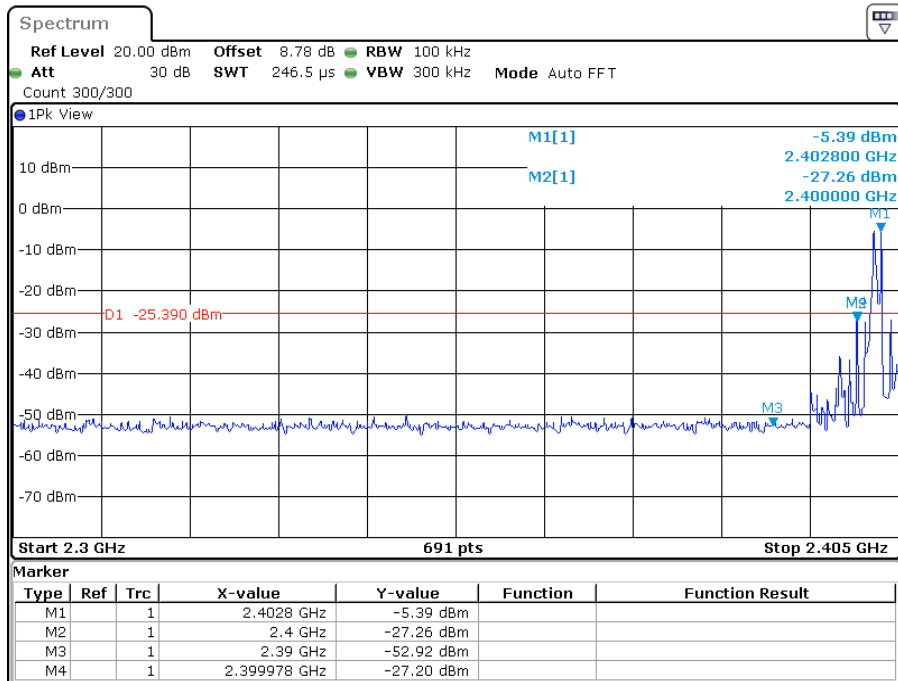
Date: 4.JUN.2019 16:46:01

High Channel – Single



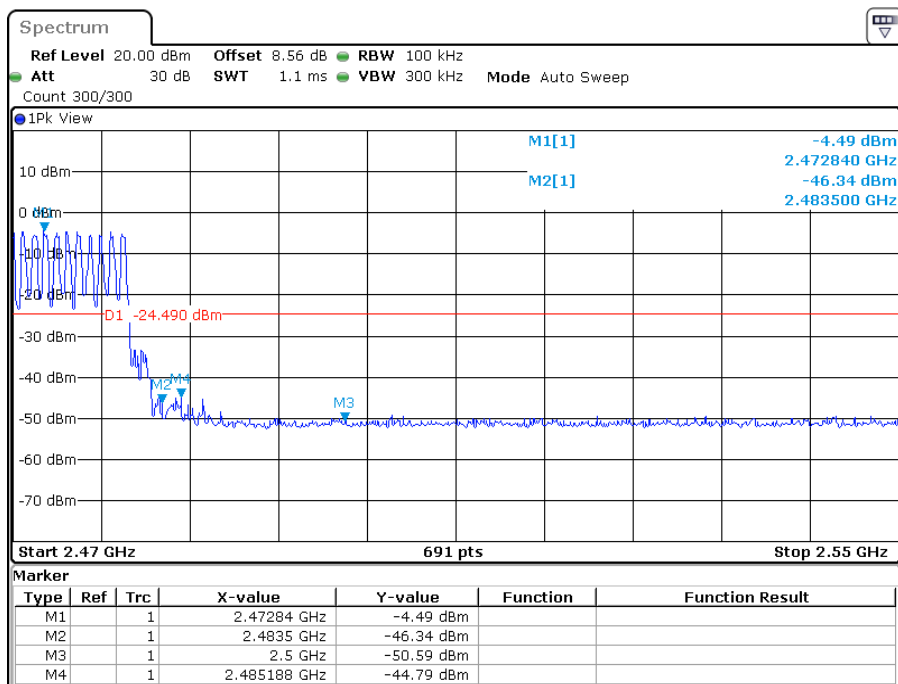
Date: 4.JUN.2019 16:50:47

Low Channel – Hopping



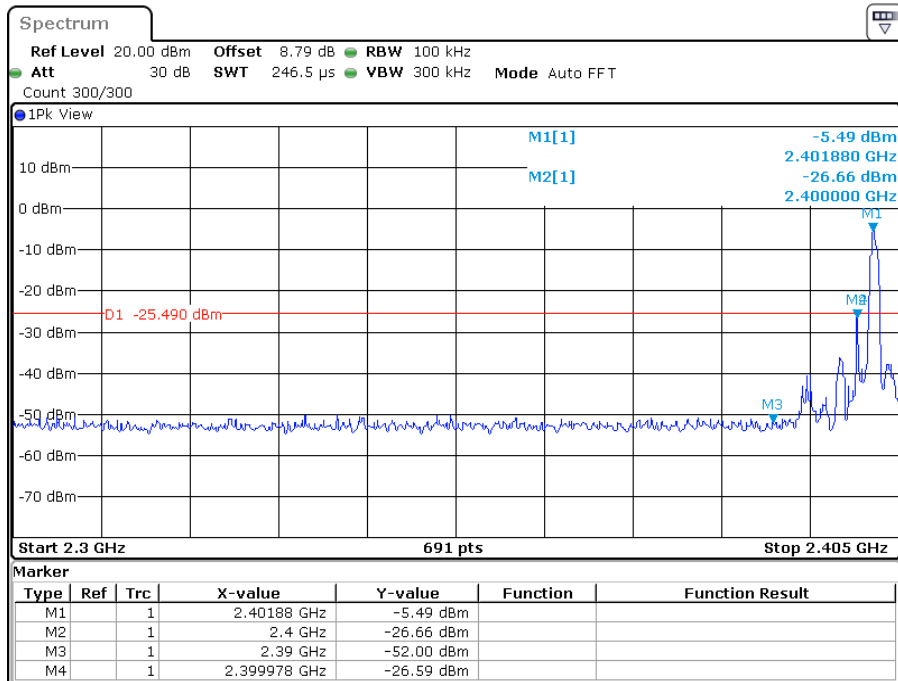
Date: 4.JUN.2019 16:16:23

High Channel – Hopping



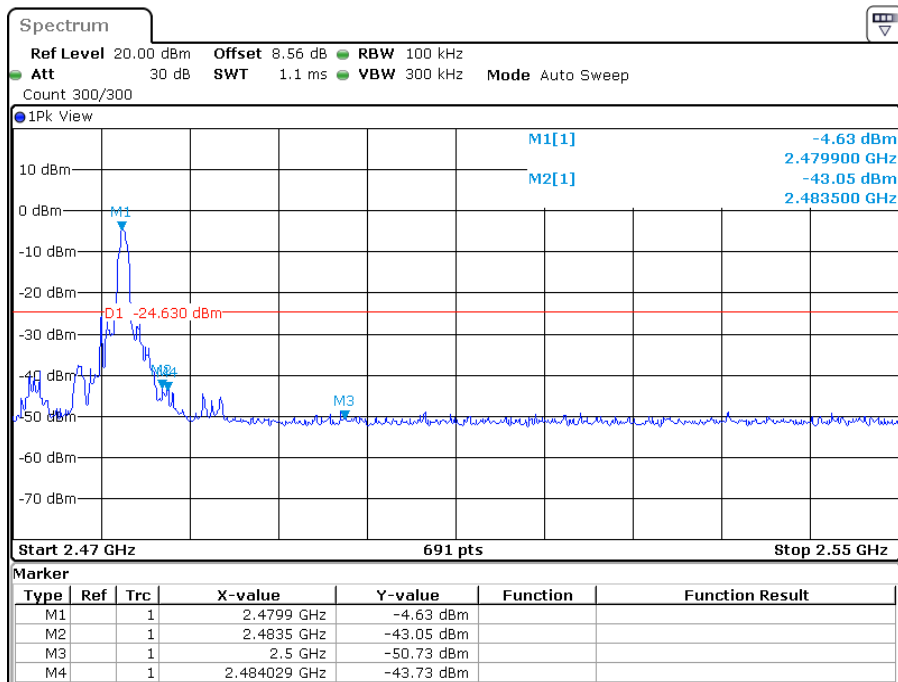
Date: 4.JUN.2019 16:19:18

EDR ($\pi/4$ -DQPSK): Band Edge Low Channel – Single



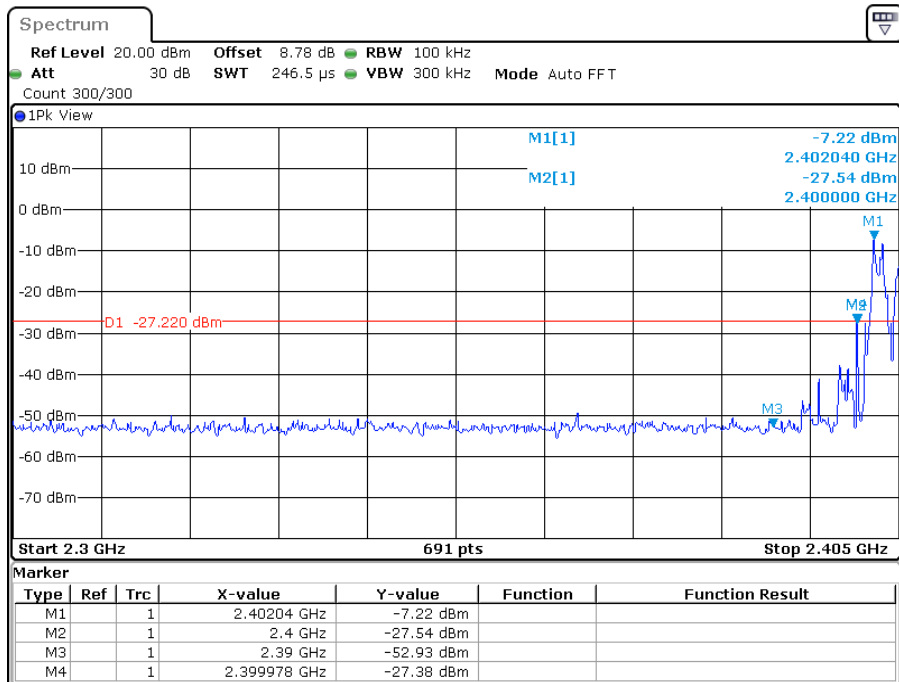
Date: 4.JUN.2019 16:57:06

High Channel – Single



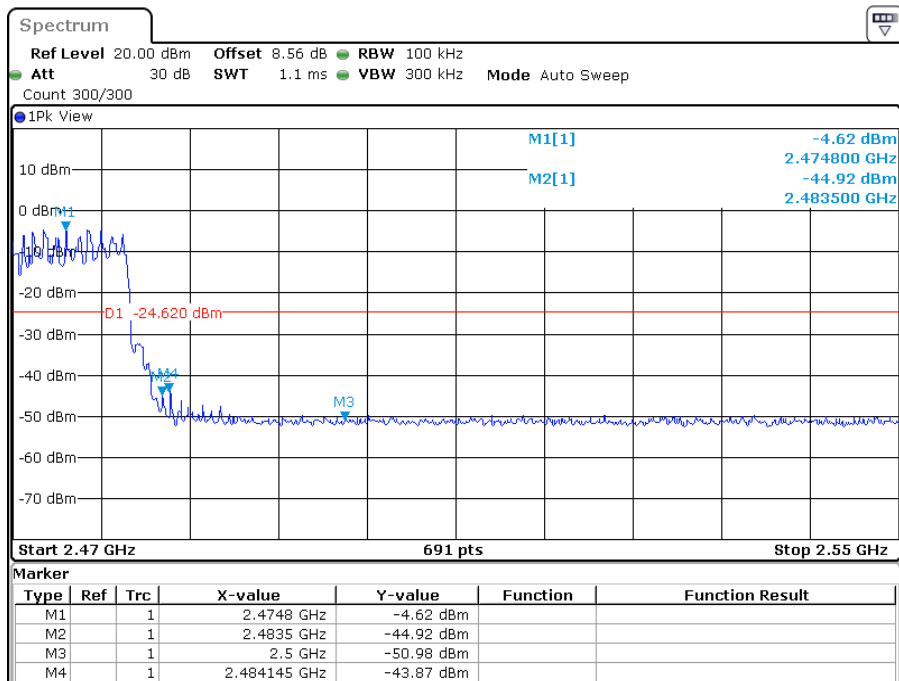
Date: 4.JUN.2019 16:53:53

Low Channel – Hopping



Date: 9.JUN.2019 13:08:13

High Channel – Hopping



Date: 4.JUN.2019 16:42:30

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