



TESTING LABORATORY
CERTIFICATE #4820.01



FCC PART 15.247

TEST REPORT

For

Beijing Beebox Technology Co., Ltd.

#2207, 22nd Floor, No.1-2 Building, ShangDi 10th street, Haidian District, Beijing, China

FCC ID: 2AR80-BSD01ST

Report Type: Original Report	Product Name: Biometric Recognition Device (Microcomputer)
Report Number: RBJ181108054-00C	
Report Date: 2019-03-13	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	Biometric Recognition Device (Microcomputer)
EUT Model:	BRD-ST-SD1
Multiple Model:	BRD-ST-SD2, BRD-ST-SD3, BRD-ST-SD* (* = 1-9, only for different model name)
Operation Frequency:	2402-2480 MHz
Output Power(Conducted):	3.57 dBm
Modulation Type:	GFSK, $\pi/4$ -DQPSK, 8-DPSK
Rated Input Voltage:	AC120V or DC12V from adapter
External Dimension:	305mm(L)*170mm(W)*1270mm(H)
Serial Number:	181108054
EUT Received Date:	2018.11.12

Note: The series product model BRD-ST-SD2, BRD-ST-SD3, BRD-ST-SD is electrically identical with model BRD-ST-SD1, we selected BRD-ST-SD1 for fully testing, the differences details was explained in the declaration letter.*

Objective

This report is prepared on behalf of *Beijing Beebox Technology Co., Ltd.* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules.

The tests were performed in order to determine the Bluetooth BDR and EDR mode of EUT compliance with FCC Rules Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

FCC Part 15C DTS submissions with FCC ID: 2AR8O-BSD01ST.

FCC Part 15E NII submissions with FCC ID: 2AR8O-BSD01ST.

Test Methodology

All measurements detailed in this test report were performed in accordance with ANSI C63.10-2013 "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices".

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Dongguan).

Measurement Uncertainty

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.61dB
Unwanted Emissions, radiated	30M~200MHz: 4.55 dB, 200M~1GHz: 5.92 dB, 1G~6GHz: 4.98 dB, 6G~18GHz: 5.89 dB, 18G~26.5G: 5.47 dB, 26.5G~40G: 5.63 dB
Unwanted Emissions, conducted	±1.5 dB
Temperature	±1 °C
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%
AC Power Lines Conducted Emission	3.12 dB (150 kHz to 30 MHz)

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 897218, the FCC Designation No. : CN1220.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier : CN0022.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in engineering mode. This device can be power by AC/DC adapter or AC power directly.

EUT Exercise Software

The software “Engineering Mode” was used for testing, which was provided by manufacturer. The maximum power was configured system default setting.

Equipment Modifications

No modification was made to the EUT.

Local Support Equipment List and Details

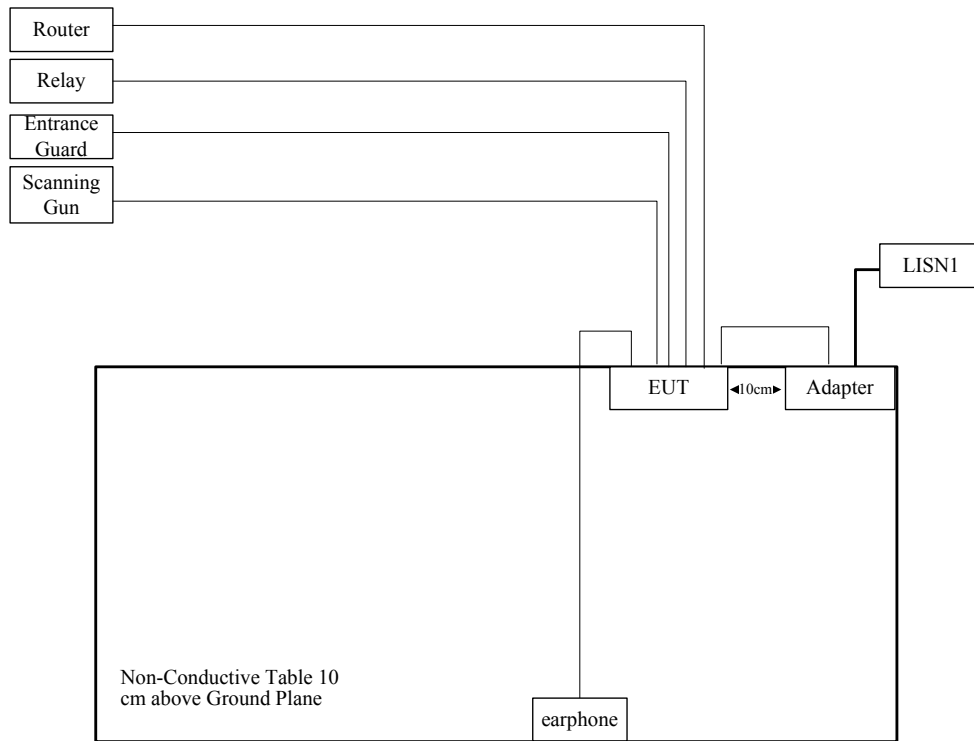
Manufacturer	Description	Model	Serial Number
Huawei	Earphone	N/A	N/A
Sandisk	U-DISK	N/A	N/A
URSALINK	Router	UR75	621273906928
TP-LINK	Switch	TL-SF1008P	114A297001782
Lotus	Entrance guard	L8MF-W	N/A
Schneider	Relay	RXM2LB2BD	N/A

Support Cable List and Details

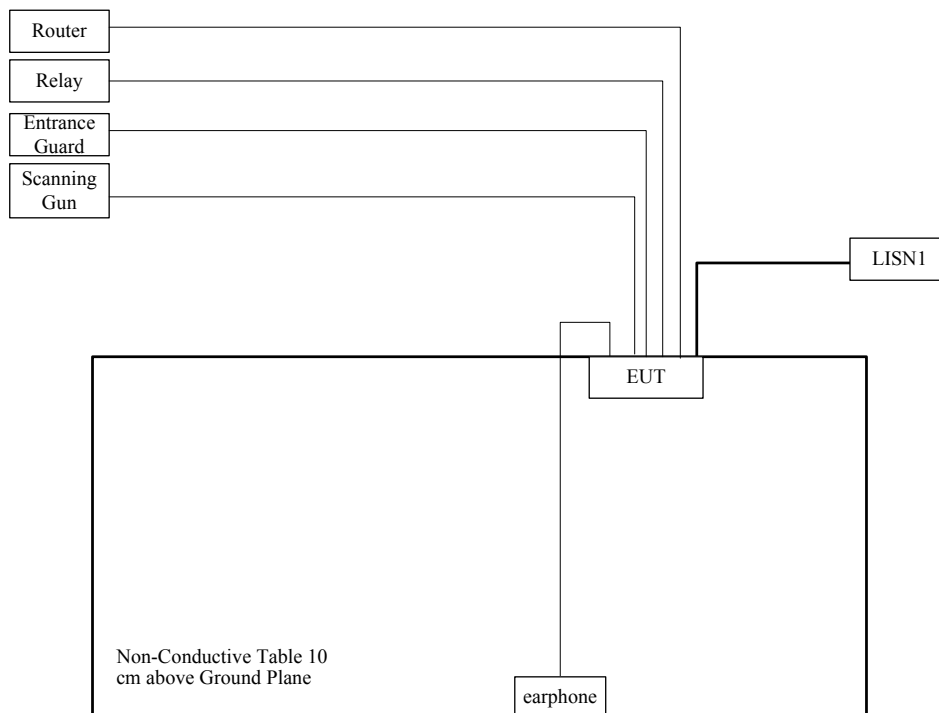
Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
RJ45 Cable	No	No	5.00	RJ45 Port of EUT	Router
Adapter Cable	No	No	1.20	Adapter	EUT
Signal Cable	No	No	10.0	EUT	Entrance guard
Signal Cable	No	No	5.00	EUT	Relay
Signal Cable	No	No	5.00	EUT	Scanning Gun

Block Diagram of Test Setup

AC/DC Adapter:



AC Power:



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
FCC §15.247 (i) & §1.1310 & §2.1091	Maximum Permissible Exposure(MPE)	Compliance
FCC§15.203	Antenna Requirement	Compliance
FCC§15.207 (a)	Conducted Emissions	Compliance
FCC§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
FCC§15.247 (a)(1)	Bandwidth Test	Compliance
FCC§15.247(a)(1)	Channel Separation Test	Compliance
FCC§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
FCC§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
FCC§15.247(b)(1)	Peak Output Power Measurement	Compliance
FCC§15.247(d)	Band Edges	Compliance

FCC §15.247 (i) & §1.1310 & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to §15.247(i) and §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500	/	/	f/1500	30
1500–100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm²);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Calculated Data:

Frequency Range (MHz)	Antenna Gain		Max. Target Power including Tolerance		Evaluation Distance (cm)	Power Density (W/m ²)	MPE Limit (W/m ²)
	(dBi)	(numeric)	(dBm)	(mW)			
2402-2480	3	2.00	4	2.51	20.00	0.001	1.0

Note 1: the Max. Target Power including Tolerance was declared by manufacturer.

Note 2: Bluetooth and wifi can't transmit simultaneously.

Result: Compliance, The device meets MPE requirement for Devices Used by the General Public (Uncontrolled Environment) at distance ≥ 20 cm.

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.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

Antenna Connector Construction

The EUT has one internal antenna arrangement for BT and 2.4GHz wifi, the antenna gain is 3 dBi, one internal antenna for 5G wifi, the antenna gain is 3 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

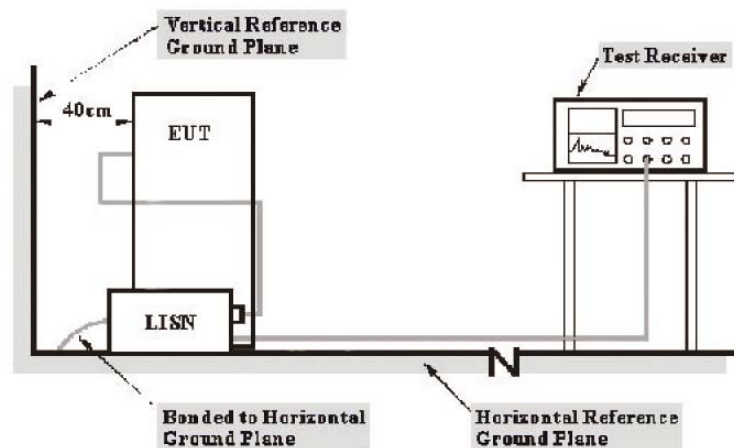
Result: Compliance.

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 30 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

The spacing between the peripherals was 10 cm.

The adapter or AC Cable was connected to the main LISN with a 120 V/60 Hz AC power source.

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 or AC Cable r was connected to the outlet of the first LISN.

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

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

Corrected Amplitude & Margin Calculation

The basic equation is as follows:

$$V_C = V_R + A_C + VDF$$

Herein,

V_C : corrected voltage amplitude

V_R : reading voltage amplitude

A_C : attenuation caused by cable loss

VDF: voltage division factor of AMN or ISN

The “**Margin**” column of the following data tables indicates the degree of compliance within 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESCS 30	830245/006	2018-12-10	2019-12-10
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-01	2018-09-05	2019-09-05
R&S	Test Software	EMC32	Version8.53.0	N/A	N/A
R&S	Two-line V-network	ENV 216	101614	2018-12-10	2019-12-10

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

Test Data

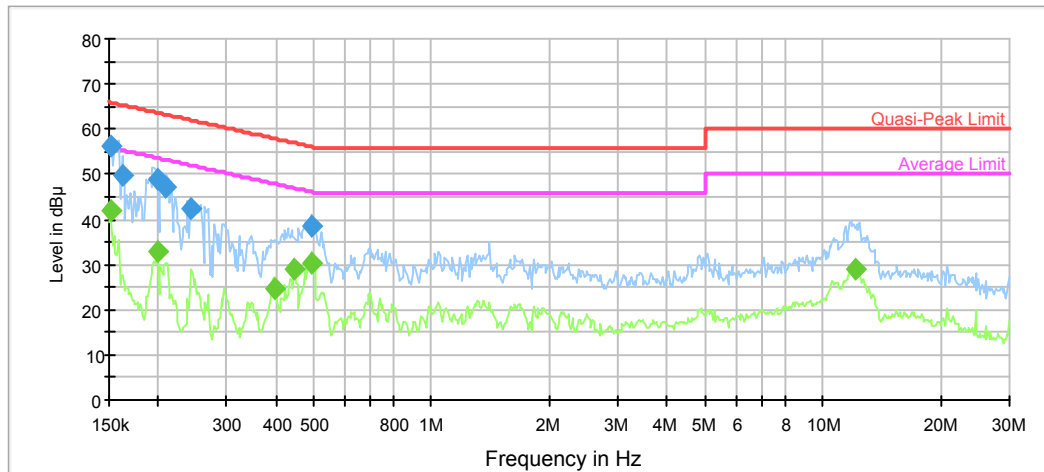
Environmental Conditions

Temperature:	24.4 °C
Relative Humidity:	39%
ATM Pressure:	100.3 kPa

The testing was performed by Ade Xiao on 2019-01-16.

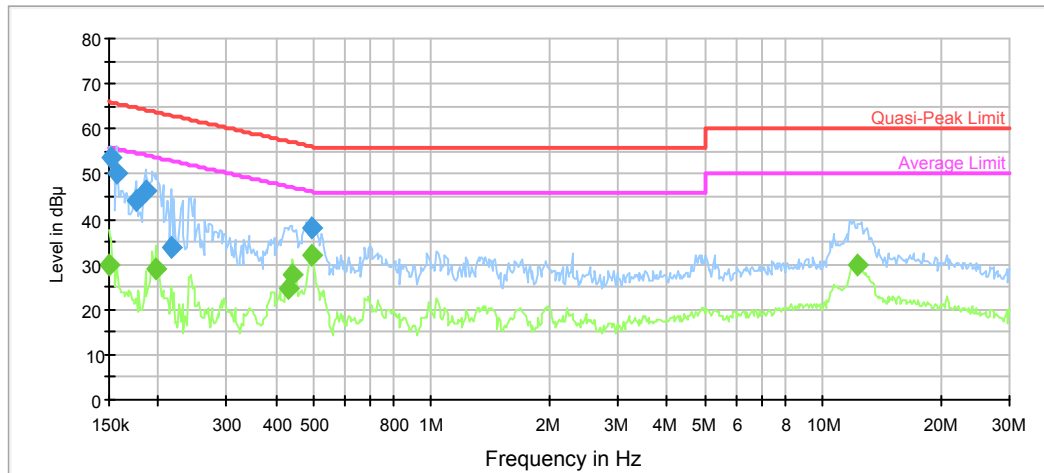
Test Mode: *Transmitting*

AC/DC Adapter:

AC120V, 60 Hz, Line:

Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.151200	56.0	9.000	L1	11.2	9.9	65.9
0.162441	49.5	9.000	L1	11.0	15.8	65.3
0.199835	48.9	9.000	L1	10.6	14.7	63.6
0.209621	47.2	9.000	L1	10.6	16.0	63.2
0.243884	42.5	9.000	L1	10.3	19.5	62.0
0.491712	38.2	9.000	L1	9.9	17.9	56.1

Frequency (MHz)	Average (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.151200	41.9	9.000	L1	11.2	14.0	55.9
0.199835	32.8	9.000	L1	10.6	20.8	53.6
0.396530	24.6	9.000	L1	10.0	23.3	47.9
0.446873	29.1	9.000	L1	9.9	17.8	46.9
0.491712	30.3	9.000	L1	9.9	15.8	46.1
12.101654	28.8	9.000	L1	9.9	21.2	50.0

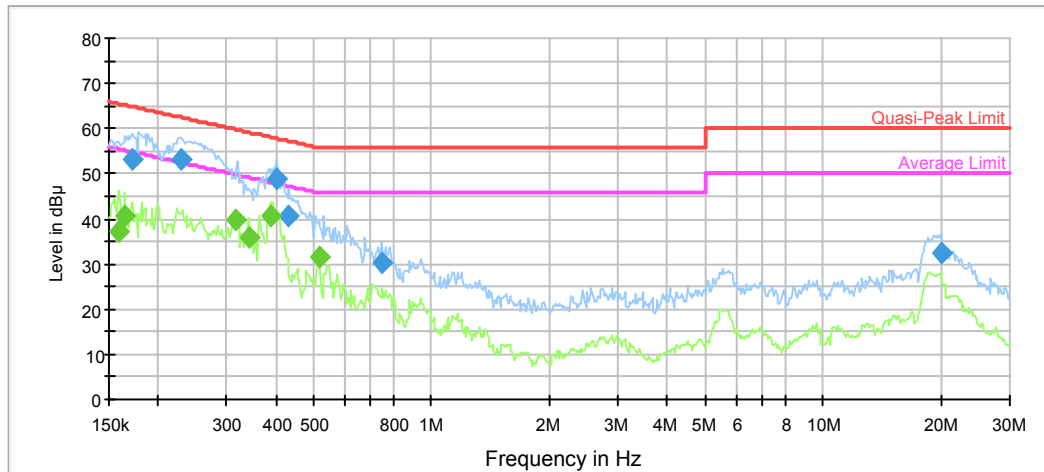
AC120V, 60 Hz, Neutral:

Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.151200	53.6	9.000	N	11.1	12.3	65.9
0.157346	50.1	9.000	N	11.1	15.5	65.6
0.175915	44.2	9.000	N	10.8	20.5	64.7
0.186006	46.3	9.000	N	10.7	17.9	64.2
0.216409	33.9	9.000	N	10.5	29.1	63.0
0.491712	38.1	9.000	N	9.9	18.0	56.1

Frequency (MHz)	Average (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	29.7	9.000	N	11.2	26.3	56.0
0.198249	29.1	9.000	N	10.6	24.6	53.7
0.429420	24.8	9.000	N	9.9	22.5	47.3
0.443327	27.6	9.000	N	9.9	19.4	47.0
0.491712	32.1	9.000	N	9.9	14.0	46.1
12.198467	29.8	9.000	N	9.9	20.2	50.0

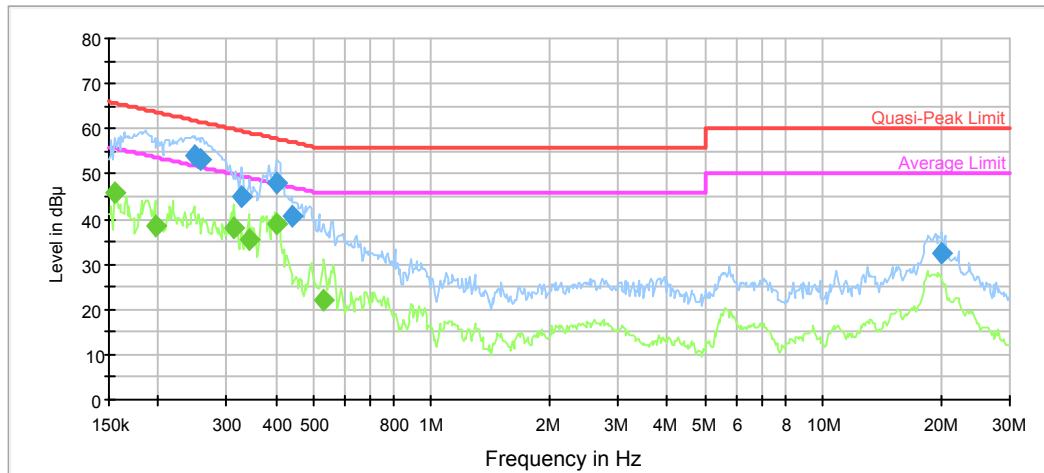
AC power:

AC120V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.171759	53.2	9.000	L1	10.9	11.7	64.9
0.228823	53.0	9.000	L1	10.4	9.5	62.5
0.402900	49.0	9.000	L1	10.0	8.8	57.8
0.432855	40.7	9.000	L1	9.9	16.5	57.2
0.744147	30.2	9.000	L1	9.8	25.8	56.0
19.992093	32.3	9.000	L1	10.1	27.7	60.0

Frequency (MHz)	Average (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.158604	37.1	9.000	L1	11.1	18.4	55.5
0.165051	40.7	9.000	L1	11.0	14.5	55.2
0.317235	39.6	9.000	L1	10.1	10.2	49.8
0.340821	35.9	9.000	L1	10.1	13.3	49.2
0.387164	40.6	9.000	L1	10.0	7.5	48.1
0.515791	31.4	9.000	L1	9.9	14.6	46.0

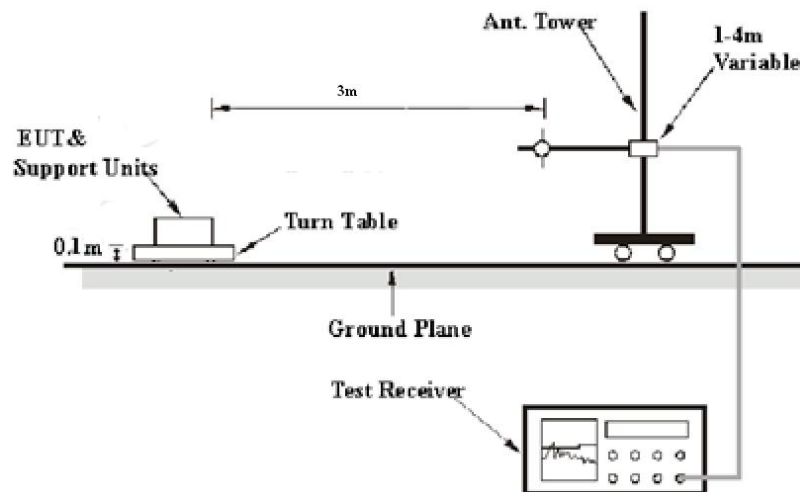
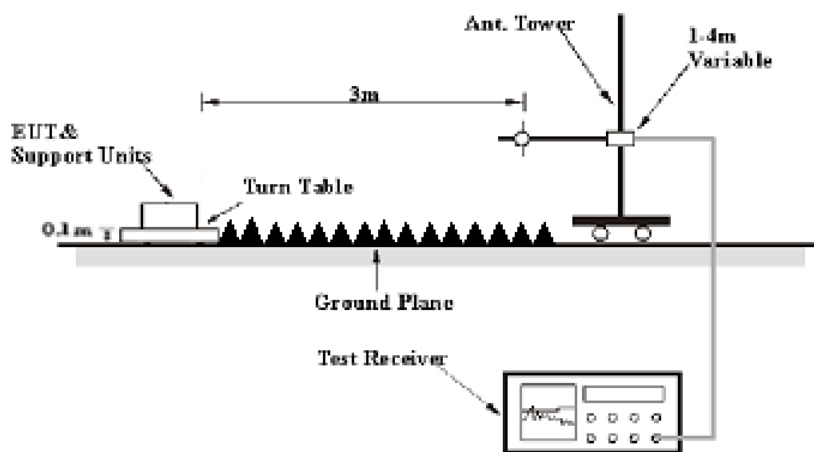
AC120V, 60 Hz, Neutral:

Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.249785	53.9	9.000	N	10.3	7.9	61.8
0.257874	53.3	9.000	N	10.3	8.2	61.5
0.327509	45.0	9.000	N	10.1	14.5	59.5
0.402900	47.8	9.000	N	10.0	10.0	57.8
0.439808	40.7	9.000	N	9.9	16.4	57.1
20.152030	32.5	9.000	N	10.0	27.5	60.0

Frequency (MHz)	Average (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.156097	45.9	9.000	N	11.1	9.8	55.7
0.196675	38.6	9.000	N	10.6	15.1	53.7
0.312220	37.9	9.000	N	10.1	12.0	49.9
0.340821	35.5	9.000	N	10.1	13.7	49.2
0.402900	39.0	9.000	N	10.0	8.8	47.8
0.532496	22.1	9.000	N	9.9	23.9	46.0

FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS**Applicable Standard**

FCC §15.247 (d); §15.209; §15.205.

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

The radiated emission below 1GHz tests were performed in the 3 meters chamber test site A, above 1GHz tests were performed in the 3 meters chamber test site B, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

According to FCC public notice: DA-00-705, During the radiated emission test, 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	120 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	AV

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

Test Procedure

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

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz - 1 GHz, 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESCI	100224	2018-12-10	2019-12-10
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Sunol Sciences	Antenna	JB3	A060611-1	2017-11-10	2020-11-10
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-1400-01	2018-05-06	2019-05-06
HP	Amplifier	8447D	2727A05902	2018-09-05	2019-09-05
Agilent	Spectrum Analyzer	E4440A	SG43360054	2019-01-04	2020-01-04
ETS-Lindgren	Horn Antenna	3115	000 527 35	2018-10-12	2021-10-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-01 1304	2016-11-18	2019-11-18
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-2.4J2.4J-50	C-0700-02	2018-06-27	2019-06-27
MITEQ	Amplifier	AFS42-00101800-25-S-42	2001271	2018-09-05	2019-09-05
Quinstar	Amplifier	QLW-18405536-JO	15964001001	2018-06-27	2019-06-27
E-Microwave	Band-stop Filters	OBSF-2400-2483.5-S	OE01601525	2018-06-16	2019-06-16
Micro-tronics	High Pass Filter	HPM50111	S/N-G217	2018-06-16	2019-06-16

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

Test Data**Environmental Conditions**

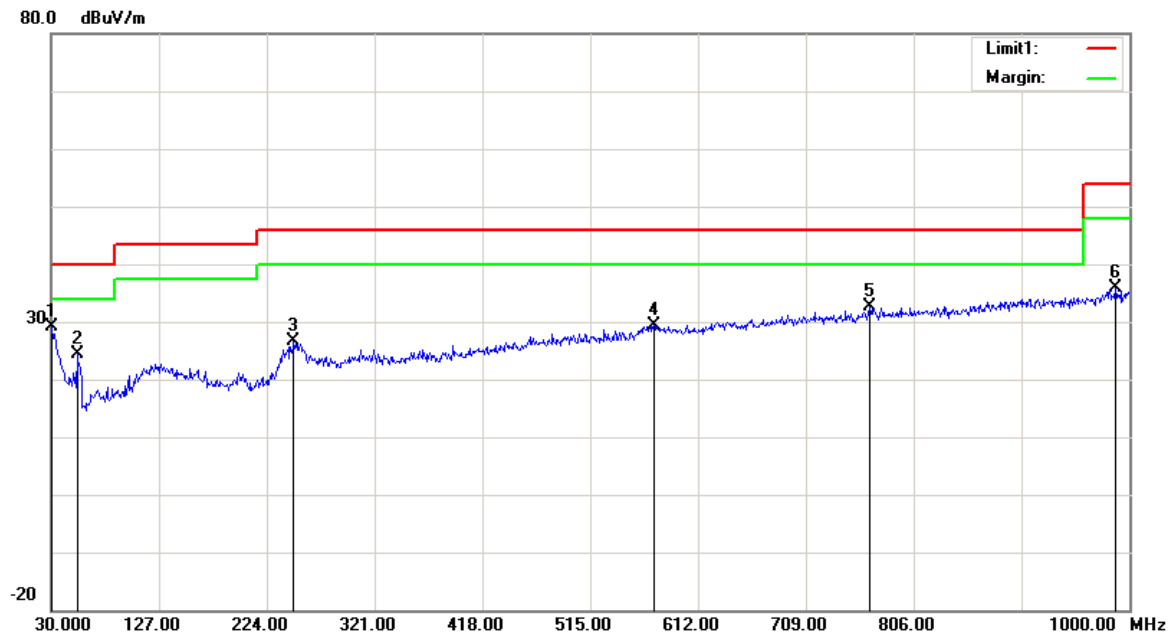
Temperature:	18.4~26.6°C
Relative Humidity:	31~61 %
ATM Pressure:	99.5~102.3 kPa

* The testing was performed by Tyler Pan, Kami Zhou from 2019-01-12 to 2019-02-28.

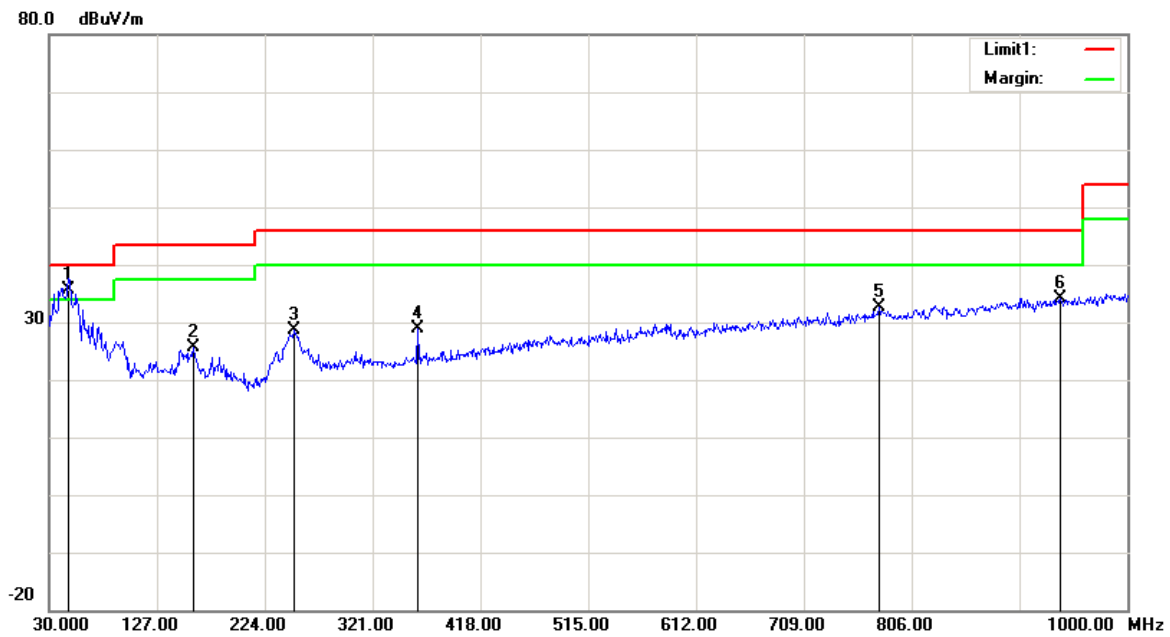
Test Mode: Transmitting(AC power was the worst and reported)

1) 30MHz-1GHz(GFSK High channel was the worst)

Horizontal:



Frequency (MHz)	Receiver Reading (dBμV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
30.9700	28.17	peak	0.95	29.12	40.00	10.88
53.2800	36.36	peak	-11.94	24.42	40.00	15.58
248.2500	32.43	peak	-5.90	26.53	46.00	19.47
572.2300	28.31	peak	1.03	29.34	46.00	16.66
766.2300	28.32	peak	4.25	32.57	46.00	13.43
987.3900	12.67	peak	23.10	35.77	54.00	18.23

Vertical:

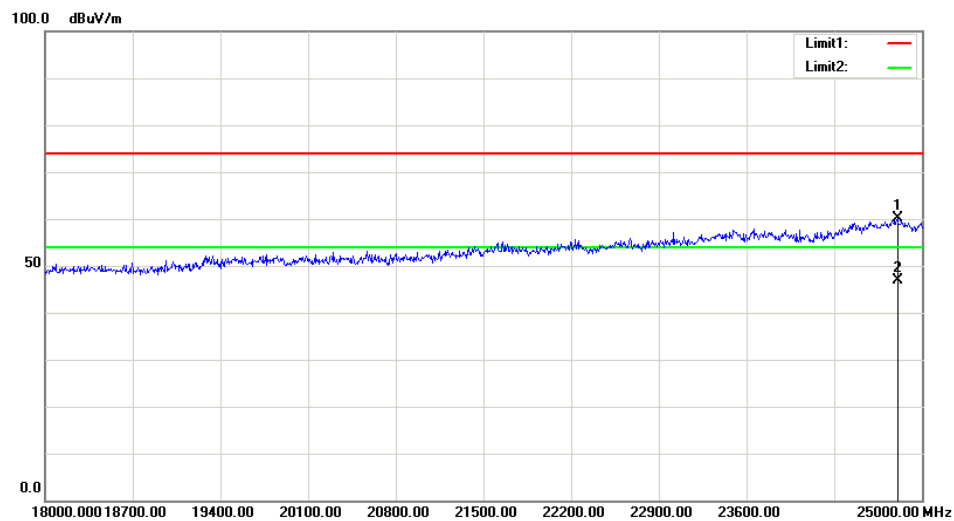
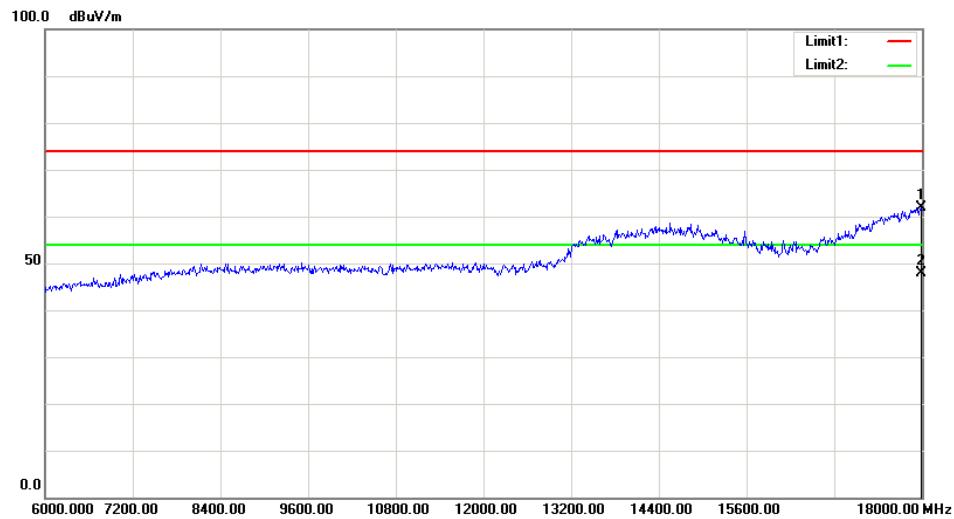
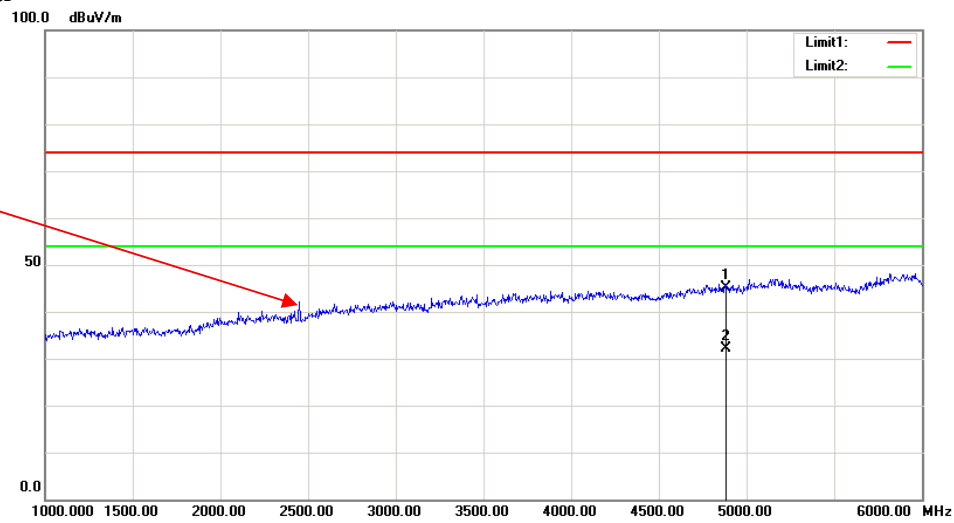
Frequency (MHz)	Receiver Reading (dBμV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
47.4600	45.99	QP	-10.35	35.64	40.00	4.36
159.9800	31.50	peak	-5.85	25.65	43.50	17.85
250.1900	34.58	peak	-6.03	28.55	46.00	17.45
361.7400	31.61	peak	-2.79	28.82	46.00	17.18
776.9000	28.17	peak	4.39	32.56	46.00	13.44
939.8600	37.56	peak	-3.42	34.14	46.00	11.86

2) 1GHz-25GHz:*BDR Mode (GFSK) was worst*

Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2402.00	59.47	PK	H	28.10	1.80	0.00	89.37	N/A	N/A
2402.00	48.02	AV	H	28.10	1.80	0.00	77.92	N/A	N/A
2402.00	63.15	PK	V	28.10	1.80	0.00	93.05	N/A	N/A
2402.00	51.53	AV	V	28.10	1.80	0.00	81.43	N/A	N/A
2390.00	25.22	PK	V	28.08	1.80	0.00	55.10	74.00	18.90
2390.00	12.73	AV	V	28.08	1.80	0.00	42.61	54.00	11.39
4804.00	46.29	PK	V	32.91	3.17	37.20	45.17	74.00	28.83
4804.00	33.42	AV	V	32.91	3.17	37.20	32.30	54.00	21.70
7206.00	45.74	PK	V	35.74	4.82	37.23	49.07	74.00	24.93
7206.00	32.41	AV	V	35.74	4.82	37.23	35.74	54.00	18.26
Middle Channel: 2441 MHz									
2441.00	60.84	PK	H	28.18	1.82	0.00	90.84	N/A	N/A
2441.00	49.15	AV	H	28.18	1.82	0.00	79.15	N/A	N/A
2441.00	64.95	PK	V	28.18	1.82	0.00	94.95	N/A	N/A
2441.00	53.47	AV	V	28.18	1.82	0.00	83.47	N/A	N/A
4882.00	46.96	PK	V	33.06	3.27	37.21	46.08	74.00	27.92
4882.00	33.74	AV	V	33.06	3.27	37.21	32.86	54.00	21.14
7323.00	45.68	PK	V	36.04	4.62	37.38	48.96	74.00	25.04
7323.00	32.54	AV	V	36.04	4.62	37.38	35.82	54.00	18.18
High Channel: 2480 MHz									
2480.00	58.46	PK	H	28.26	1.84	0.00	88.56	N/A	N/A
2480.00	47.81	AV	H	28.26	1.84	0.00	77.91	N/A	N/A
2480.00	62.94	PK	V	28.26	1.84	0.00	93.04	N/A	N/A
2480.00	51.61	AV	V	28.26	1.84	0.00	81.71	N/A	N/A
2483.50	26.02	PK	V	28.27	1.84	0.00	56.13	74.00	17.87
2483.50	13.79	AV	V	28.27	1.84	0.00	43.90	54.00	10.10
4960.00	46.84	PK	V	33.22	3.23	37.25	46.04	74.00	27.96
4960.00	33.57	AV	V	33.22	3.23	37.25	32.77	54.00	21.23
7440.00	45.66	PK	V	36.34	4.41	37.52	48.89	74.00	25.11
7440.00	32.48	AV	V	36.34	4.41	37.52	35.71	54.00	18.29

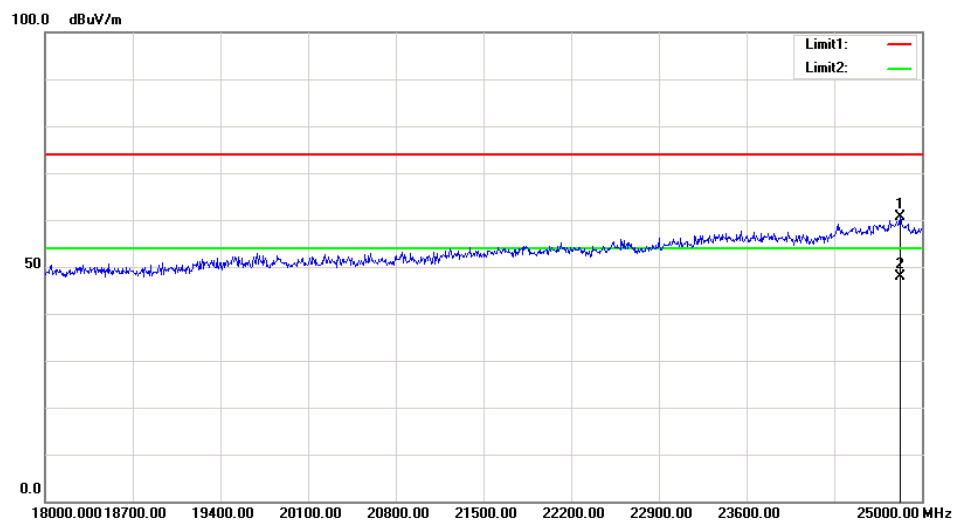
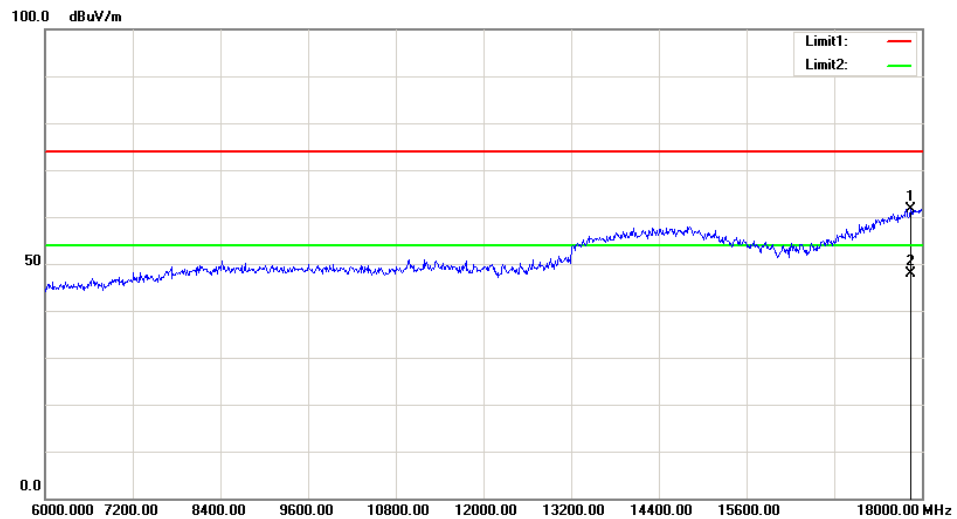
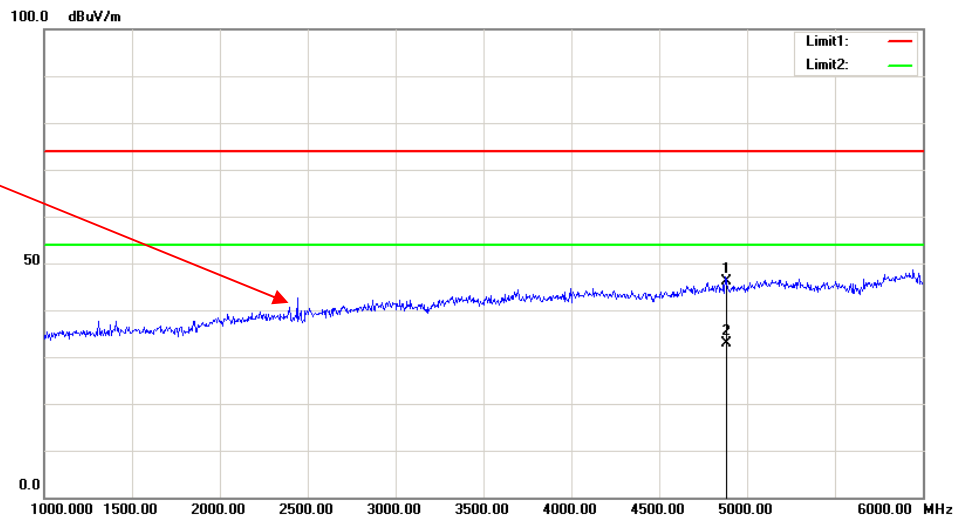
Worst plots (GFSK Middle channel)
Horizontal

Fundamental
Test with Band
Rejection Filter



Vertical

Fundamental
Test with Band
Rejection Filter



FCC §15.247(a) (1) - CHANNEL SEPARATION TEST**Applicable Standard**

According to FCC §15.247(a) (1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.50 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-08	2019-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Procedure

1. Set the EUT in transmitting mode, spectrum Bandwidth was set at 30 kHz, maxhold the channel.
2. Set the adjacent channel of the EUT maxhold another trace.
3. Measure the channel separation.

Test Data**Environmental Conditions**

Temperature:	23.9 °C
Relative Humidity:	46 %
ATM Pressure:	100.6 kPa

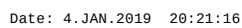
* The testing was performed by Blake Yang on 2019-01-04.

Test Result: Compliance.

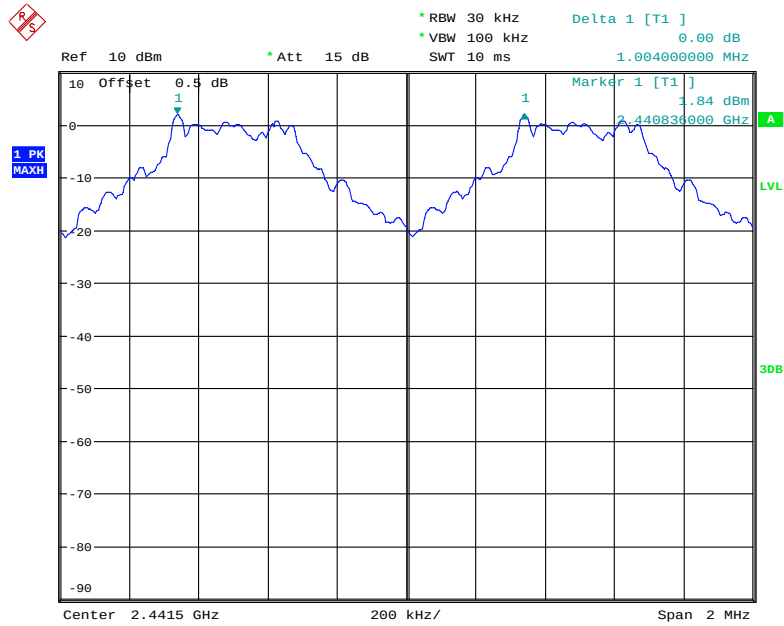
Please refer to following tables and plots

Note: Limit= $(2/3) \times 20dB$ bandwidth

Low Channel

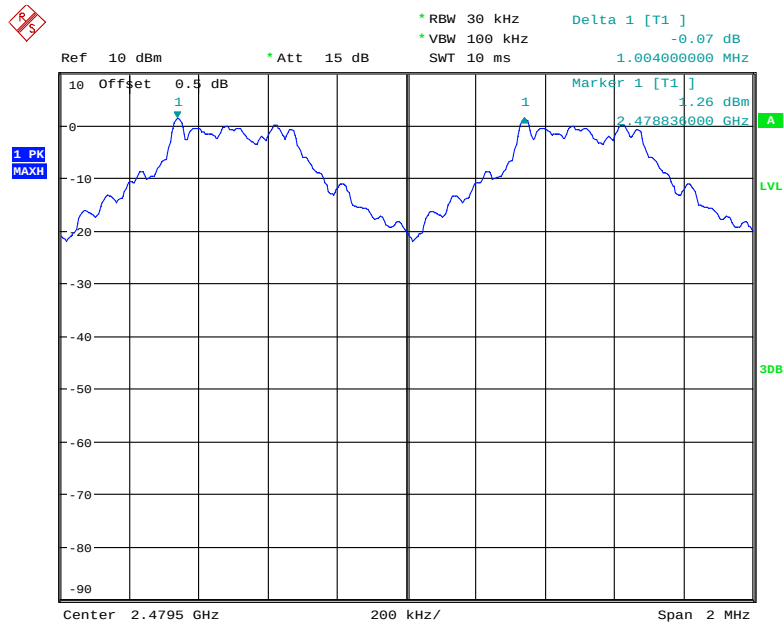


Middle Channel



Date: 4.JAN.2019 20:22:20

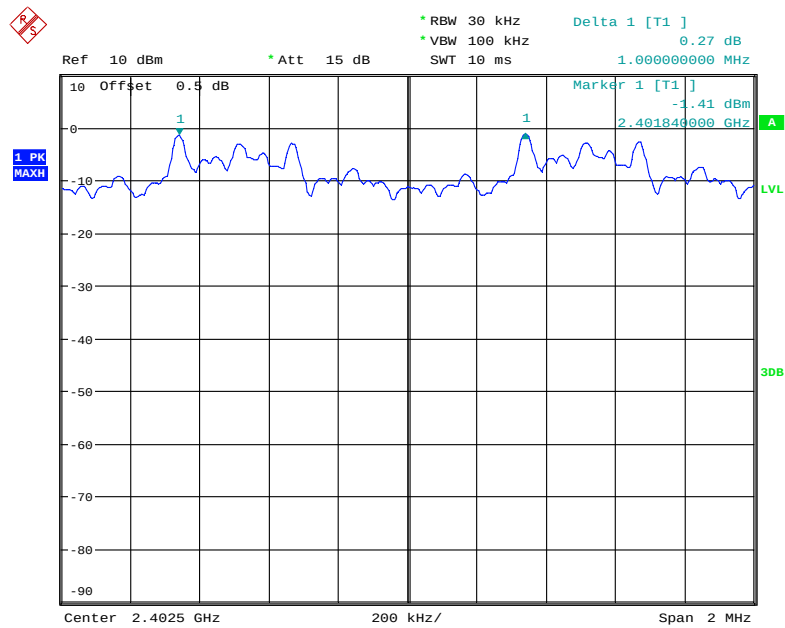
High Channel



Date: 4.JAN.2019 20:23:03

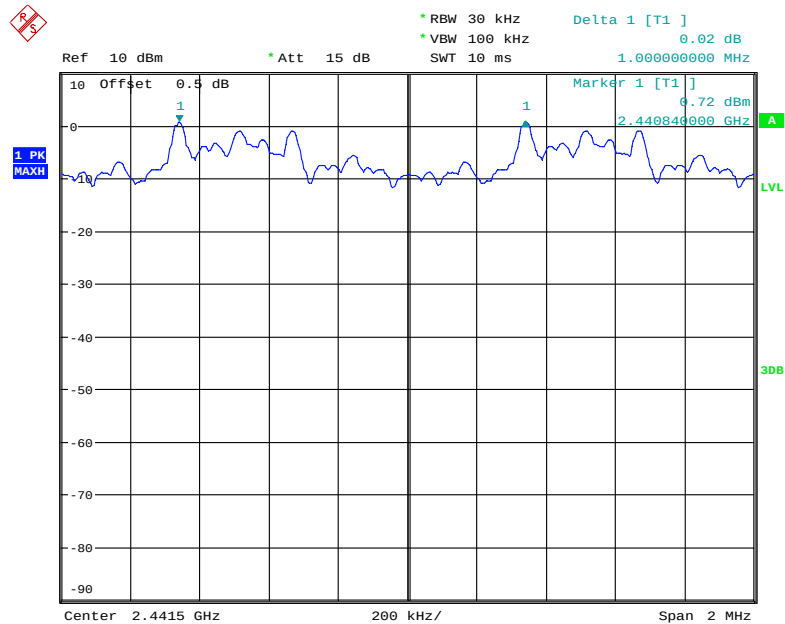
EDR Mode ($\pi/4$ -DQPSK):

Low Channel



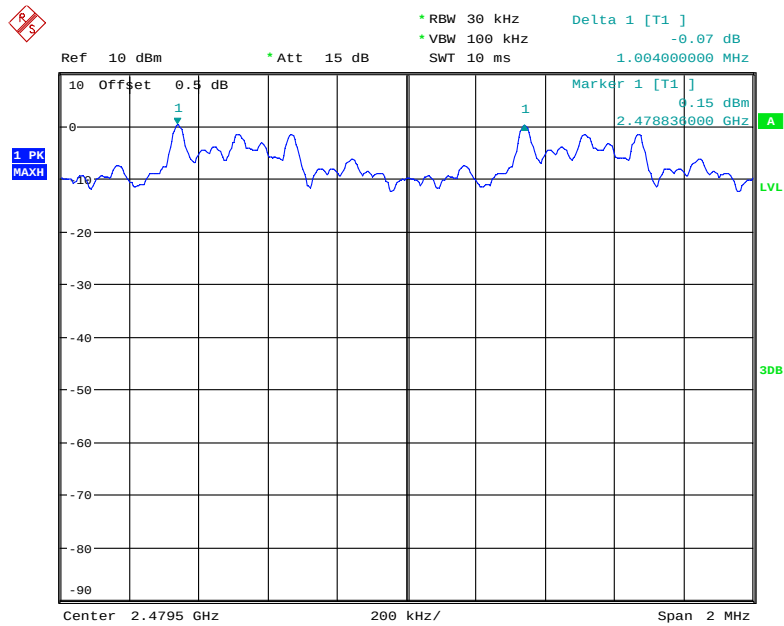
Date: 4.JAN.2019 20:25:32

Middle Channel



Date: 4.JAN.2019 20:24:46

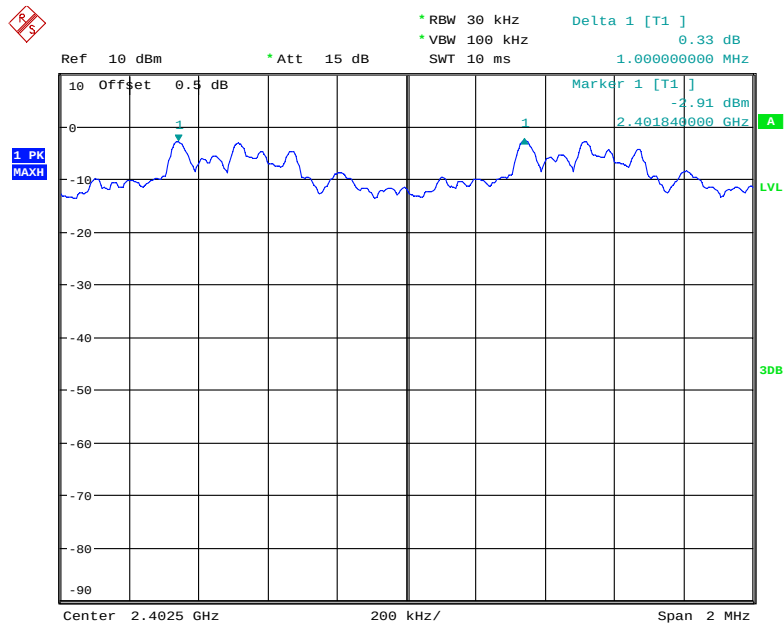
High Channel



Date: 4. JAN. 2019 20:23:59

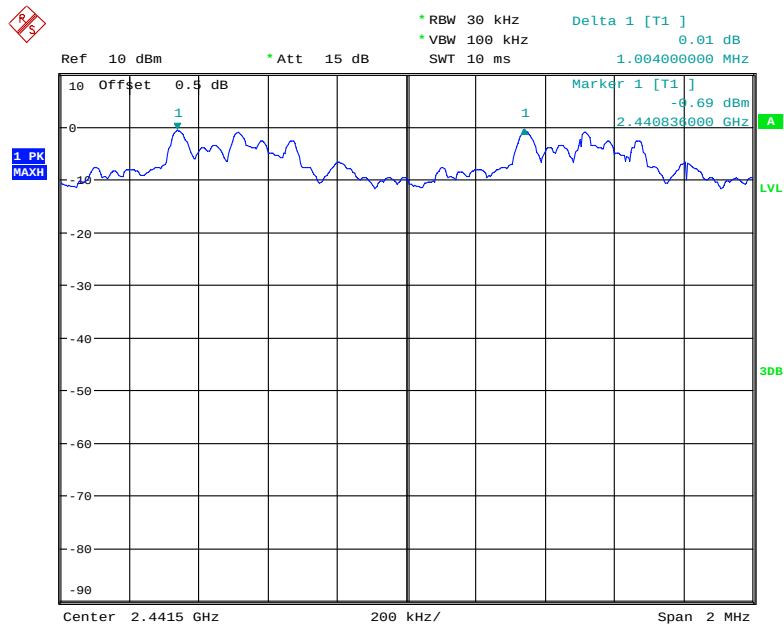
EDR Mode (8-DPSK):

Low Channel



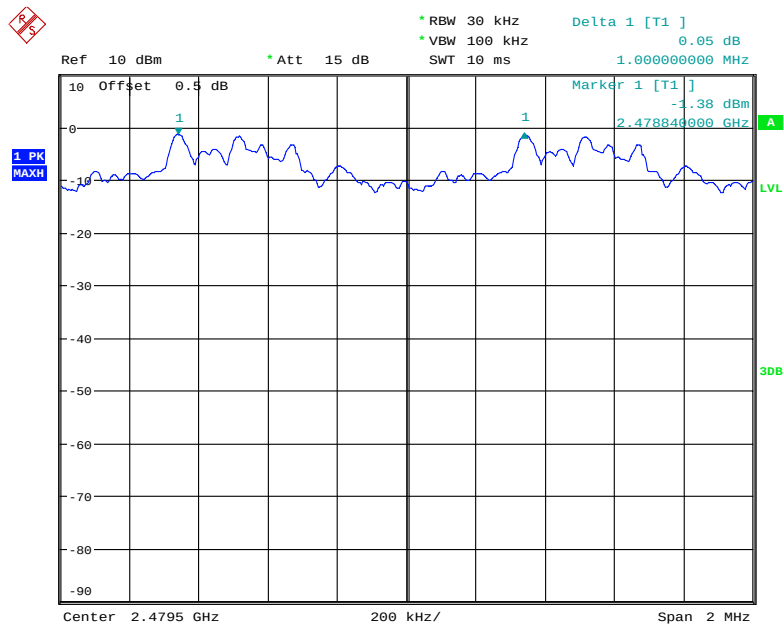
Date: 4. JAN. 2019 20:26:35

Middle Channel



Date: 4.JAN.2019 20:27:35

High Channel



Date: 4.JAN.2019 20:28:17

FCC §15.247(a) (1)–BANDWIDTH TESTING

Applicable Standard

According to FCC §15.247(a) (1):

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 on the test table without connection to measurement instrument. Turn on the EUT. 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-08	2019-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Data

Environmental Conditions

Temperature:	23.9 °C
Relative Humidity:	46 %
ATM Pressure:	100.6 kPa

* The testing was performed by Blake Yang on 2019-01-04.

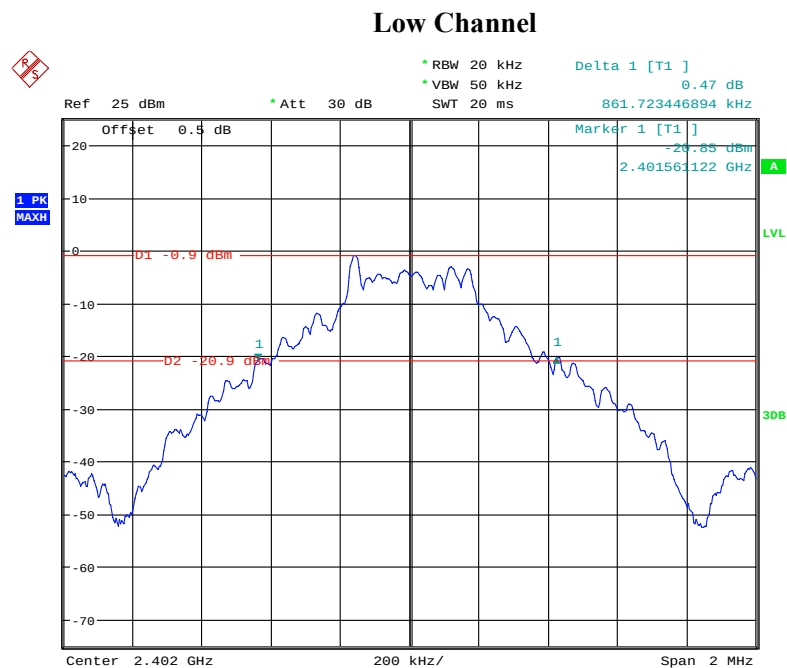
Test Result: Compliance.

Please refer to following tables and plots

Test Mode: Transmitting

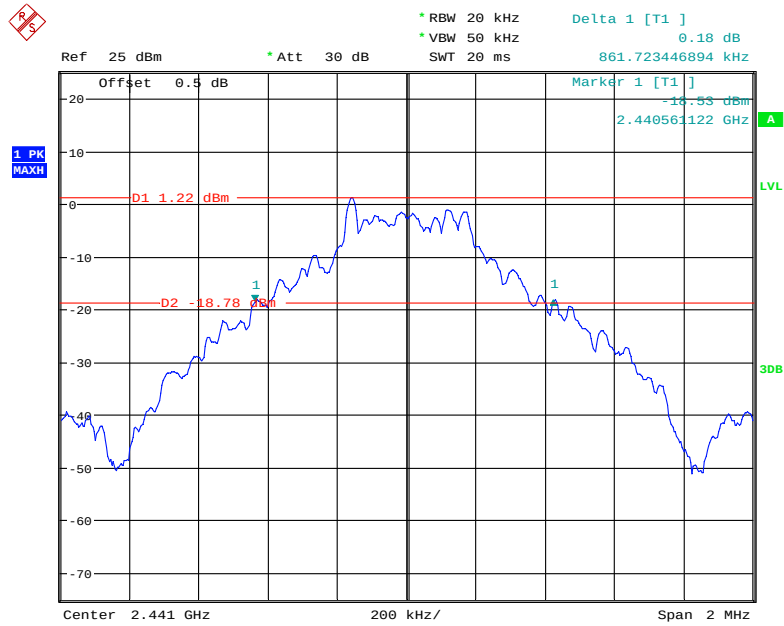
Mode	Channel	Frequency (MHz)	20 dB Bandwidth (MHz)
BDR Mode (GFSK)	Low	2402	0.862
	Middle	2441	0.862
	High	2480	0.862
EDR Mode ($\pi/4$ -DQPSK)	Low	2402	1.222
	Middle	2441	1.198
	High	2480	1.198
EDR Mode (8-DPSK)	Low	2402	1.206
	Middle	2441	1.202
	High	2480	1.206

BDR Mode (GFSK):



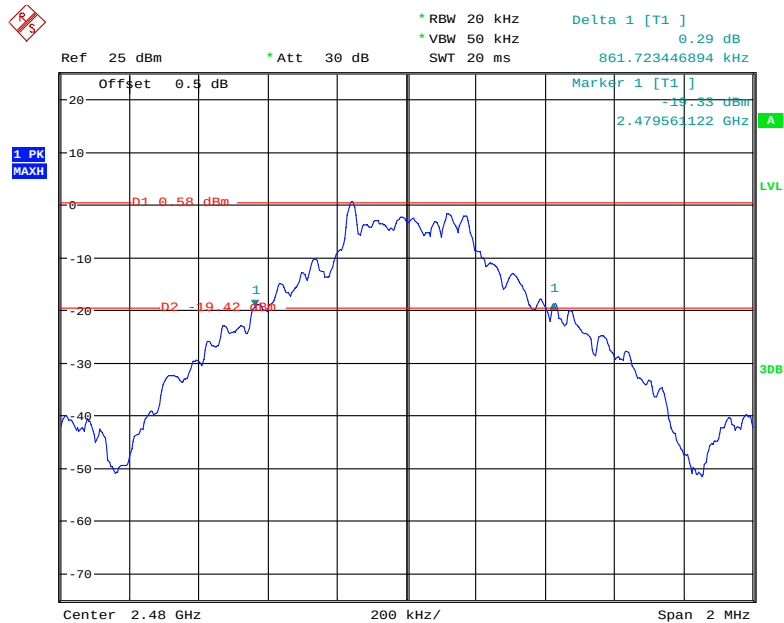
Date: 4.JAN.2019 21:16:09

Middle Channel

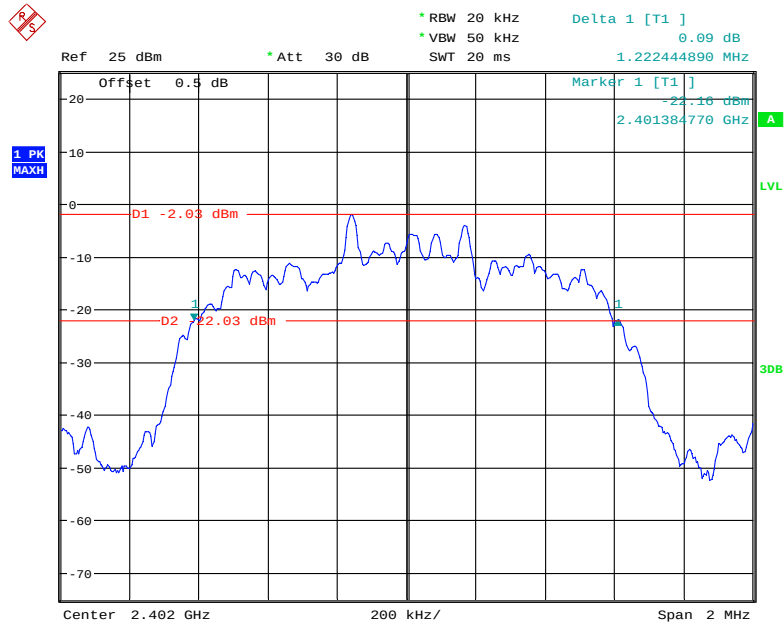


Date: 4.JAN.2019 21:20:22

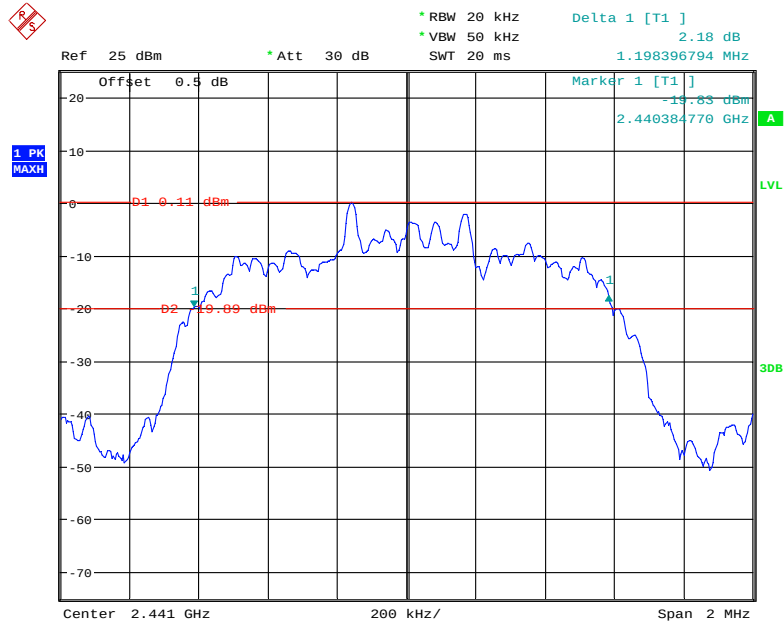
High Channel



Date: 4.JAN.2019 21:18:01

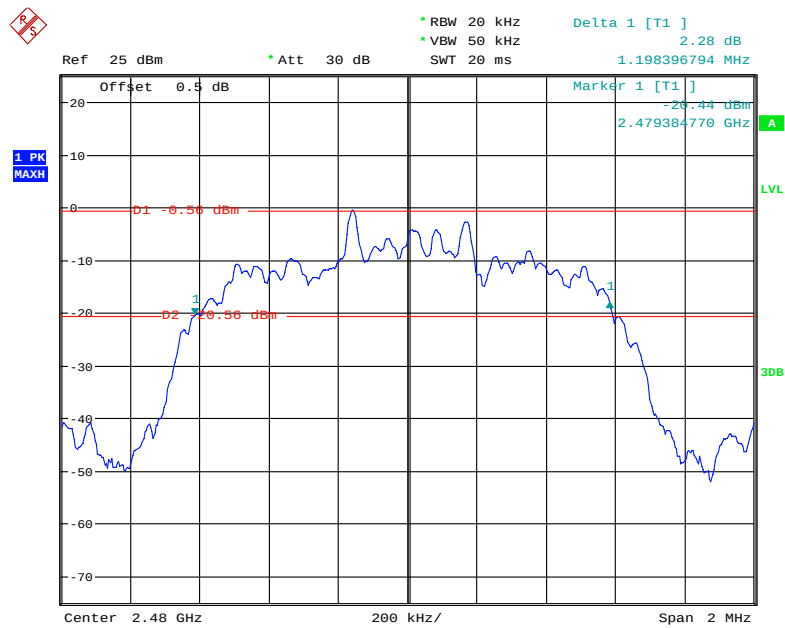
*EDR Mode ($\pi/4$ -DQPSK):***Low Channel**

Date: 4.JAN.2019 21:23:49

Middle Channel

Date: 4.JAN.2019 21:22:52

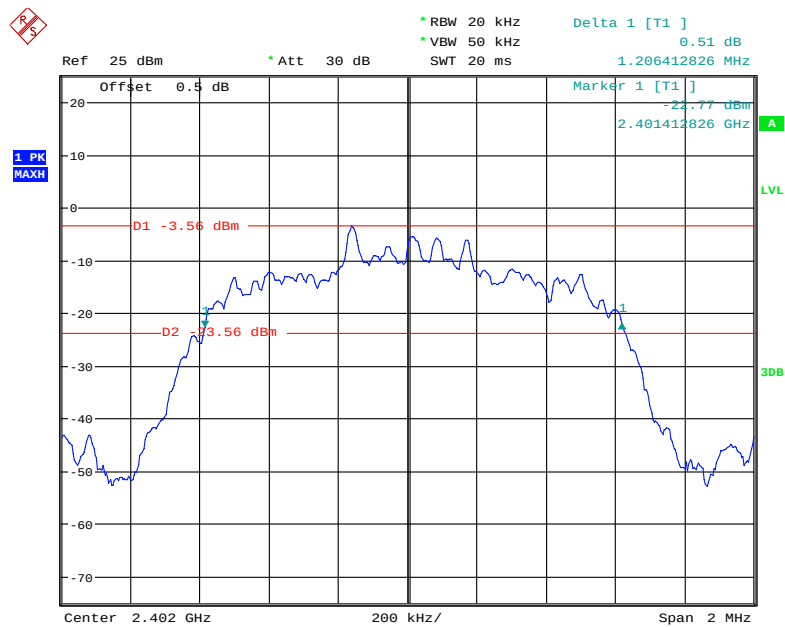
High Channel



Date: 4.JAN.2019 21:25:08

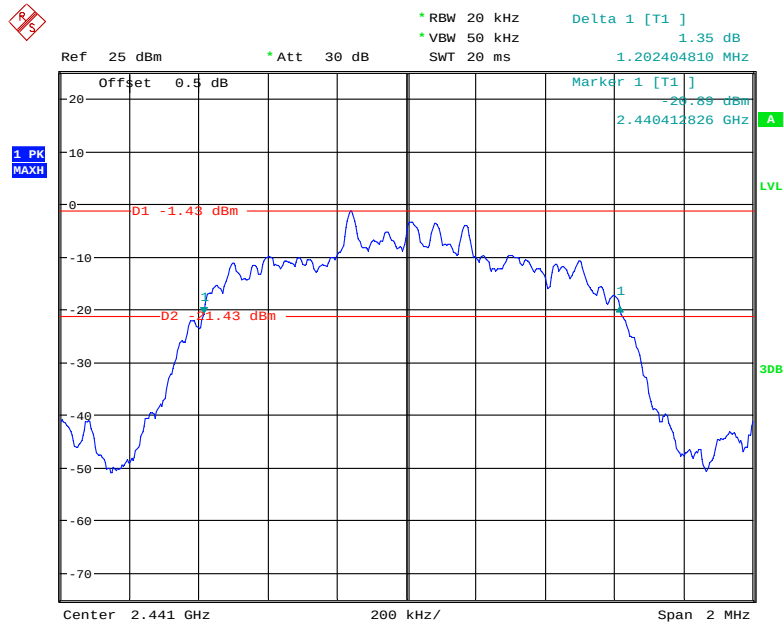
EDR Mode (8-DPSK):

Low Channel



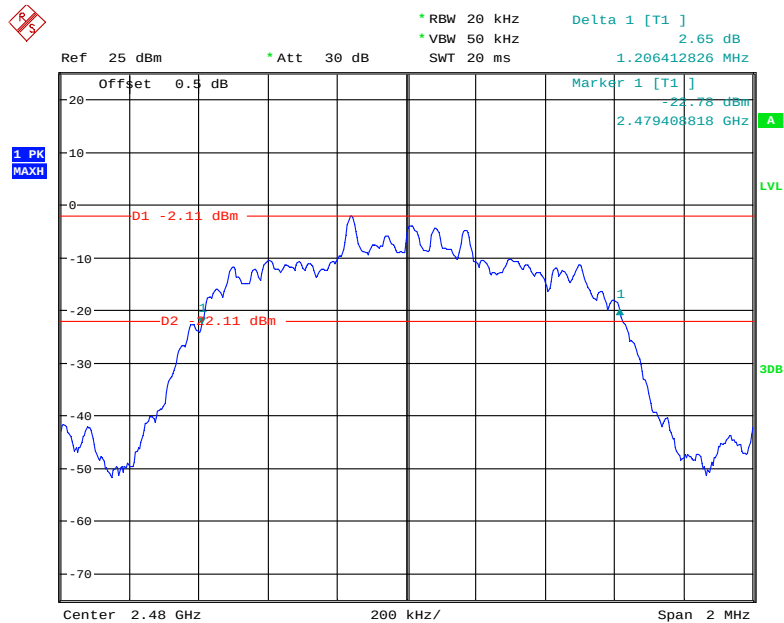
Date: 4.JAN.2019 21:28:10

Middle Channel



Date: 4.JAN.2019 21:30:15

High Channel



Date: 4.JAN.2019 21:26:36

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

According to FCC §15.247(a) (1) (iii)

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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-08	2019-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Data**Environmental Conditions**

Temperature:	23.9 °C
Relative Humidity:	46 %
ATM Pressure:	100.6 kPa

* The testing was performed by Blake Yang on 2019-01-04.

Test Result: Compliance.

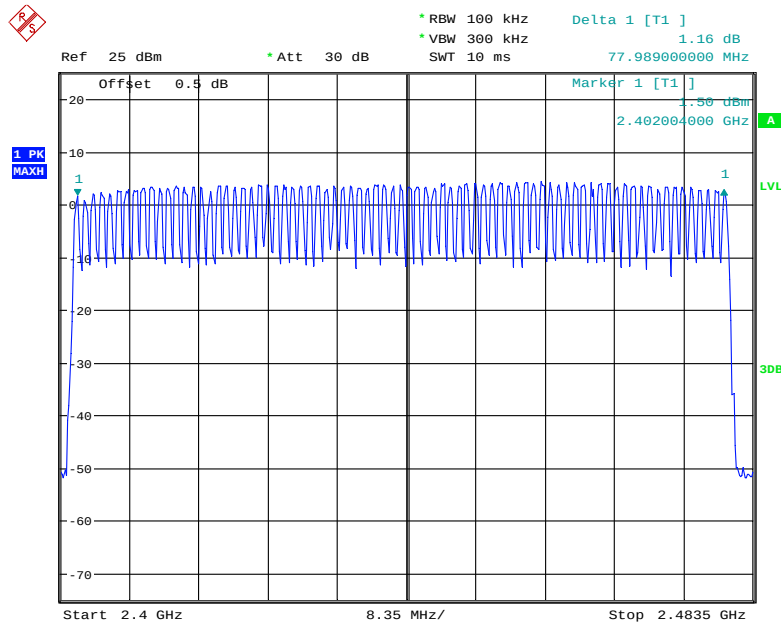
Please refer to following tables and plots

Test Mode: Transmitting

BDR Mode (GFSK):

Frequency Range (MHz)	Number of Hopping Channel	Limit
2400-2483.5	79	≥15

Number of Hopping Channels

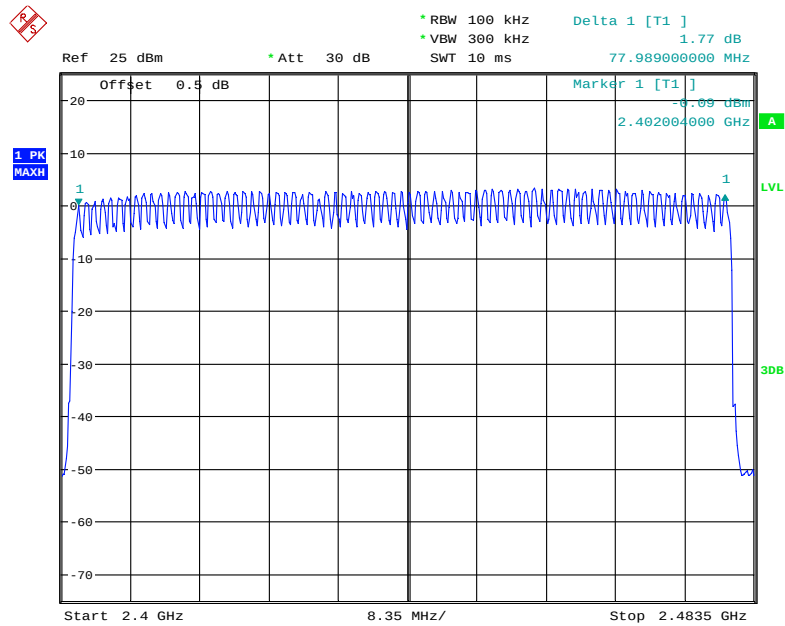


Date: 4.JAN.2019 21:47:03

EDR Mode ($\pi/4$ -DQPSK):

Frequency Range (MHz)	Number of Hopping Channel	Limit
2400-2483.5	79	≥ 15

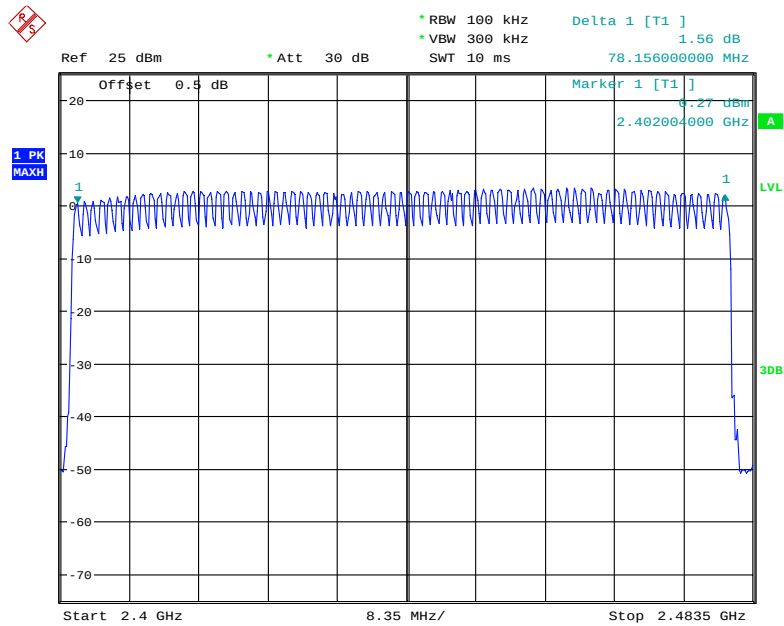
Number of Hopping Channels



Date: 4.JAN.2019 21:55:26

EDR Mode (8-DPSK):

Frequency Range (MHz)	Number of Hopping Channel	Limit
2400-2483.5	79	≥15

Number of Hopping Channels

Date: 4.JAN.2019 22:24:31

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

According to FCC §15.247(a) (1) (iii):

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 was worked in channel hopping; the time of single pulses was tested.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-08	2019-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Data**Environmental Conditions**

Temperature:	23.9 °C
Relative Humidity:	46 %
ATM Pressure:	100.6 kPa

* The testing was performed by Blake Yang on 2019-01-04.

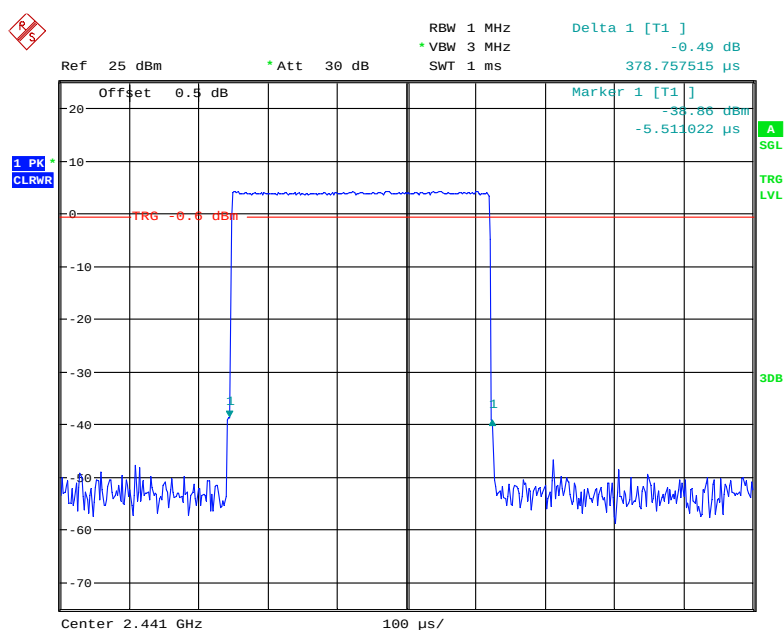
Test Result: Compliance.

Please refer to following tables and plots

Test Mode: Transmitting

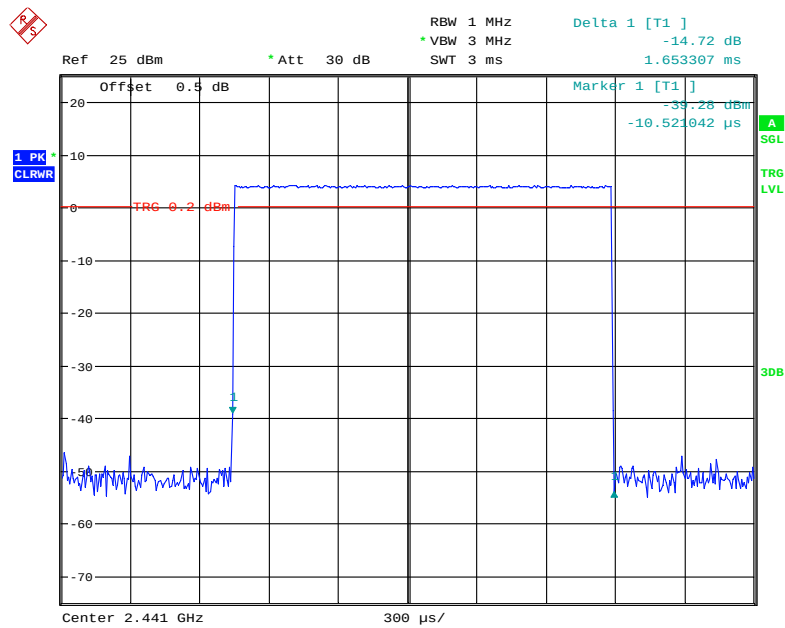
Mode	Packet type	Channel	Frequency (MHz)	Pulse width (ms)	Result (s)	Limit (s)
GFSK	DH1	Middle	2441	0.379	0.12	0.4
	DH3	Middle	2441	1.653	0.26	
	DH5	Middle	2441	2.906	0.31	
$\pi/4$ DQPSK	2DH1	Middle	2441	0.391	0.13	
	2DH3	Middle	2441	1.653	0.26	
	2DH5	Middle	2441	2.916	0.31	
8-DPSK	3DH1	Middle	2441	0.389	0.12	
	3DH3	Middle	2441	1.659	0.27	
	3DH5	Middle	2441	2.916	0.31	

Note:

DH1:Dwell time=Pulse time (ms) $\times$ (1600/2/79) $\times$ 31.6 sDH3:Dwell time=Pulse time (ms) $\times$ (1600/4/79) $\times$ 31.6 sDH5:Dwell time=Pulse time (ms) $\times$ (1600/6/79) $\times$ 31.6 s*BDR Mode (GFSK):***DH1: Middle Channel**

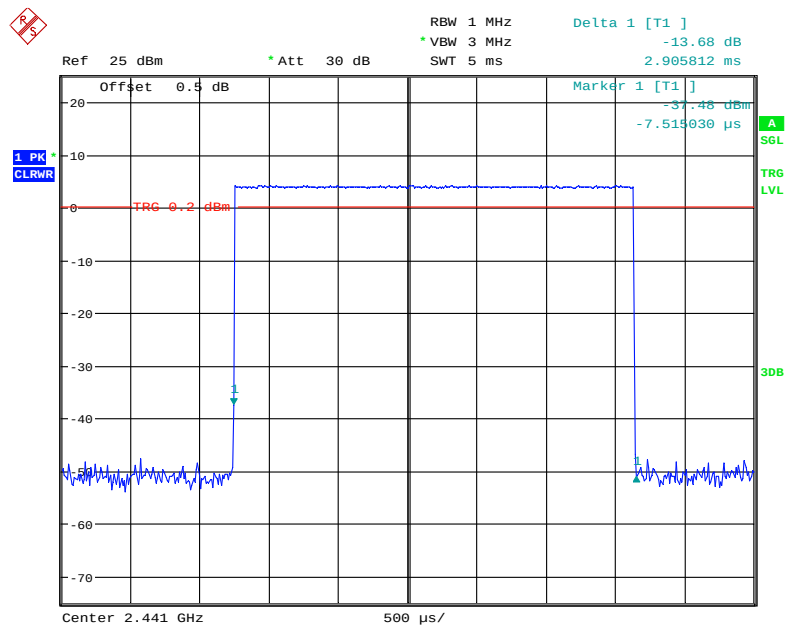
Date: 4. JAN. 2019 21:32:31

DH3: Middle Channel



Date: 4.JAN.2019 21:36:22

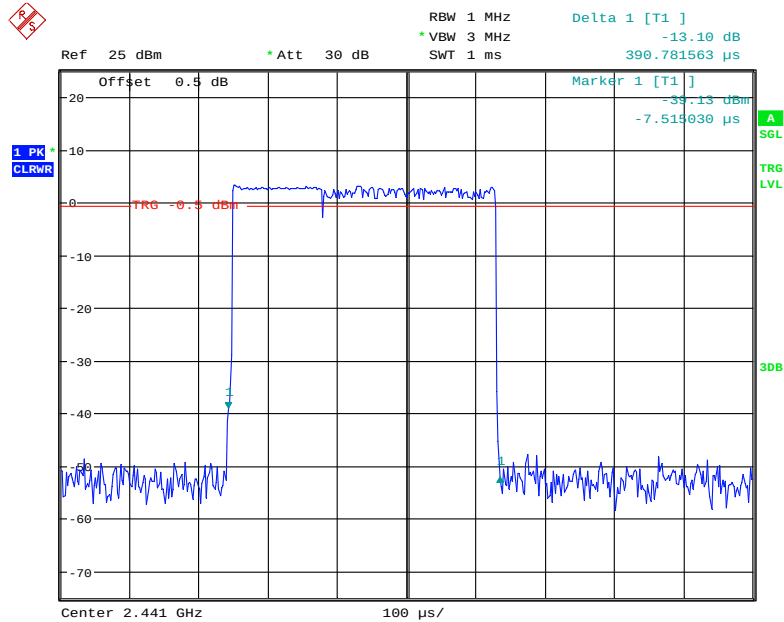
DH5: Middle Channel



Date: 4.JAN.2019 21:37:00

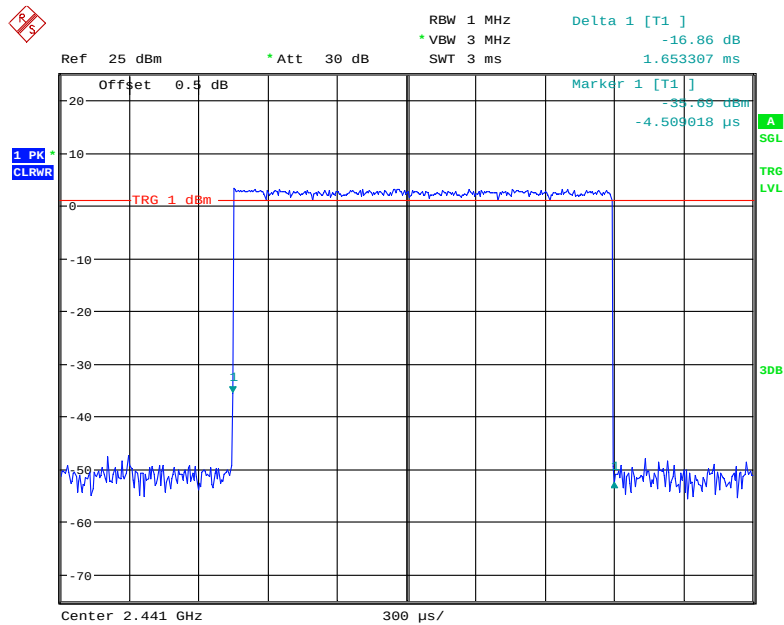
EDR Mode ($\pi/4$ -DQPSK):

2DH1: Middle Channel



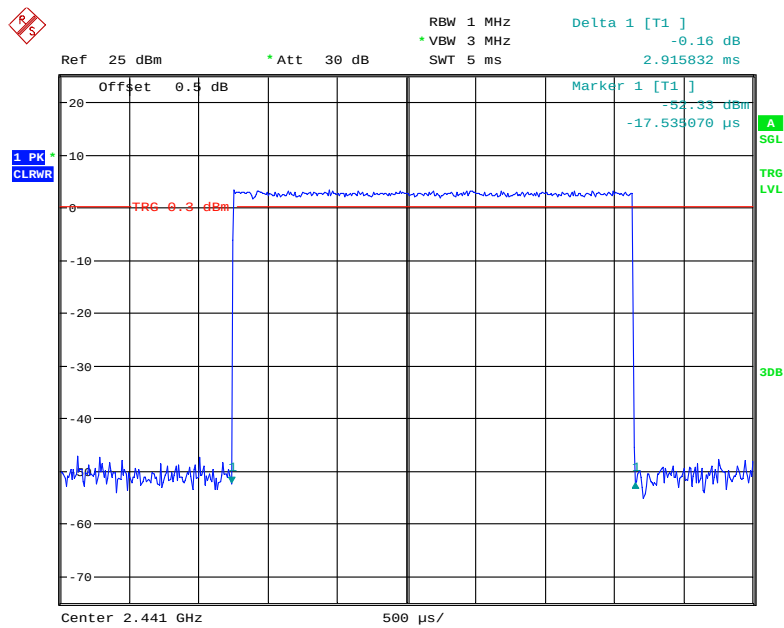
Date: 4.JAN.2019 21:37:38

2DH3: Middle Channel



Date: 4.JAN.2019 21:38:15

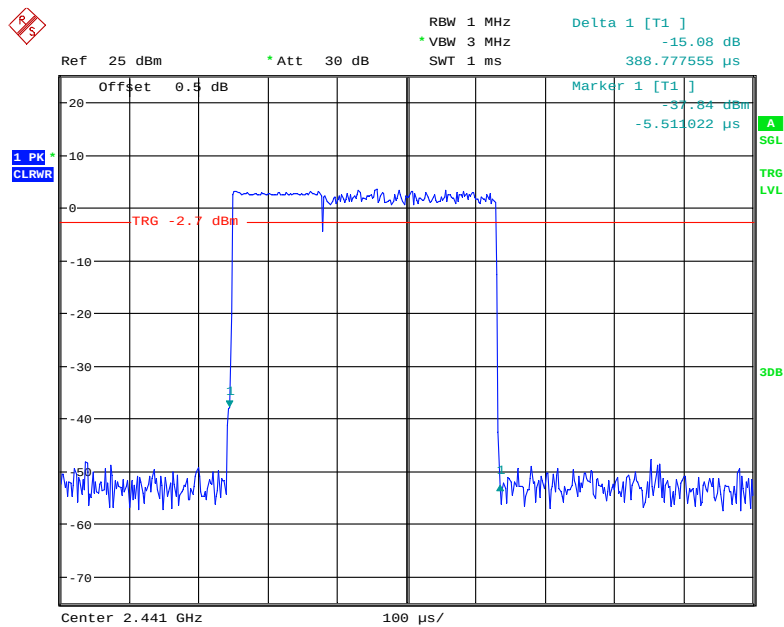
2DH5: Middle Channel



Date: 4.JAN.2019 21:38:55

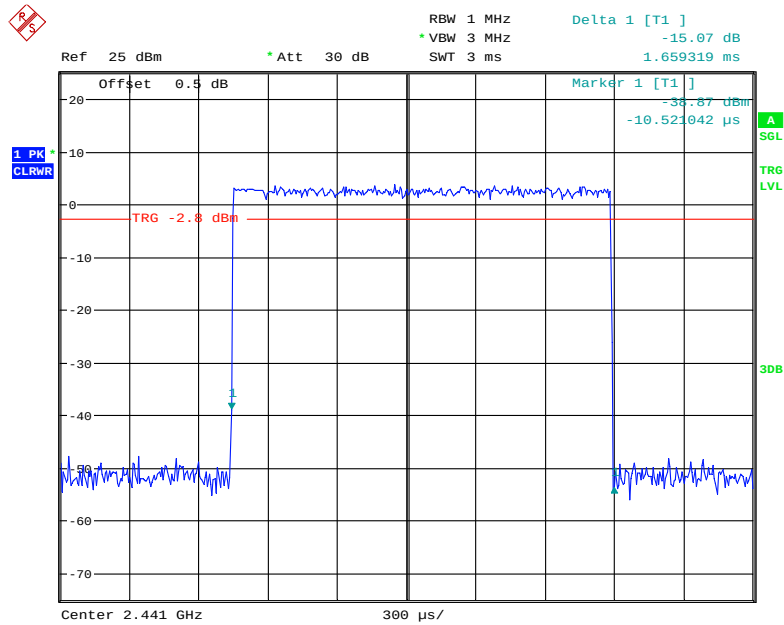
EDR Mode (8DPSK):

3DH1: Middle Channel



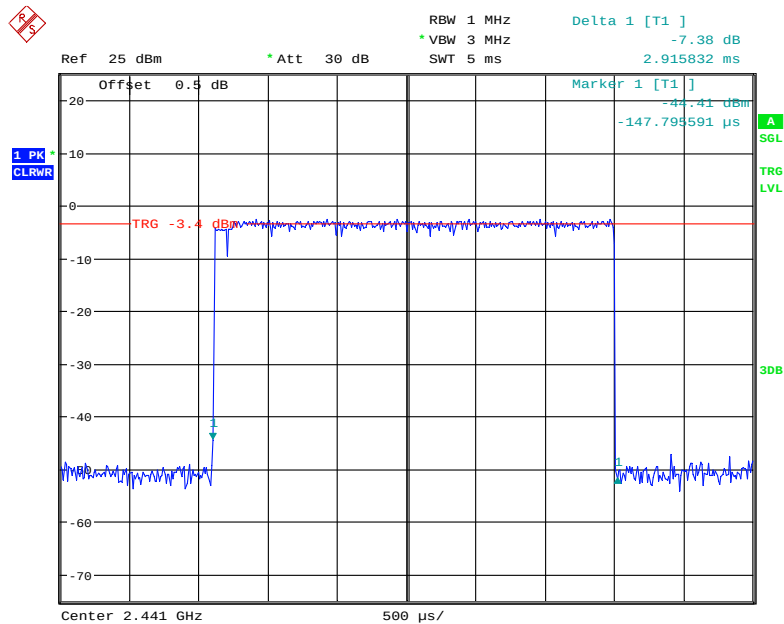
Date: 4.JAN.2019 21:42:45

3DH3: Middle Channel



Date: 4.JAN.2019 21:43:29

3DH5: Middle Channel



Date: 4.JAN.2019 21:44:05

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. 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A
Agilent	USB Wideband Power Sensor	U2022XA	MY5417006	2018-12-10	2019-12-10

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

Test Data**Environmental Conditions**

Temperature:	23.9 °C
Relative Humidity:	46 %
ATM Pressure:	100.6 kPa

* The testing was performed by Blake Yang on 2019-01-04.

Test Result: Compliance.

Test Mode: Transmitting

Mode	Frequency (MHz)	Peak Conducted Output power (dBm)	Limit (dBm)
BDR Mode (GFSK)	2402	1.47	21
	2441	3.57	21
	2480	2.91	21
EDR Mode ($\pi/4$ -DQPSK)	2402	0.44	21
	2441	2.51	21
	2480	1.81	21
EDR Mode (8-DPSK)	2402	0.34	21
	2441	2.45	21
	2480	1.74	21

Note: The data above was tested in conducted mode and the antenna gain is 3.0dBi

FCC §15.247(d)- BAND EDGES TESTING

Applicable Standard

According to FCC §15.247(d):

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/ VBW of spectrum analyzer to 100/300 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-08	2019-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Data**Environmental Conditions**

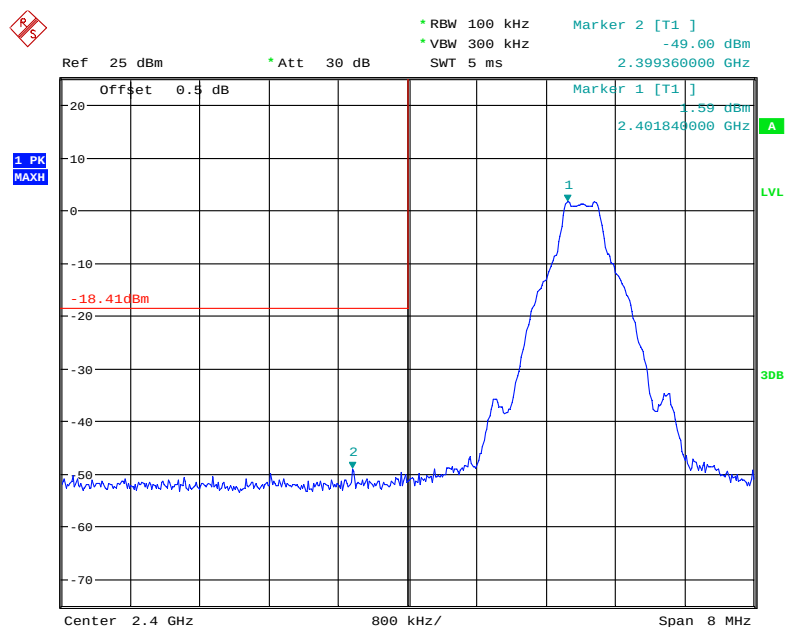
Temperature:	19.9~20.9 °C
Relative Humidity:	43~52 %
ATM Pressure:	100.6~101.6 kPa

* The testing was performed by Blake Yang from 2019-01-04 to 2019-01-06 .

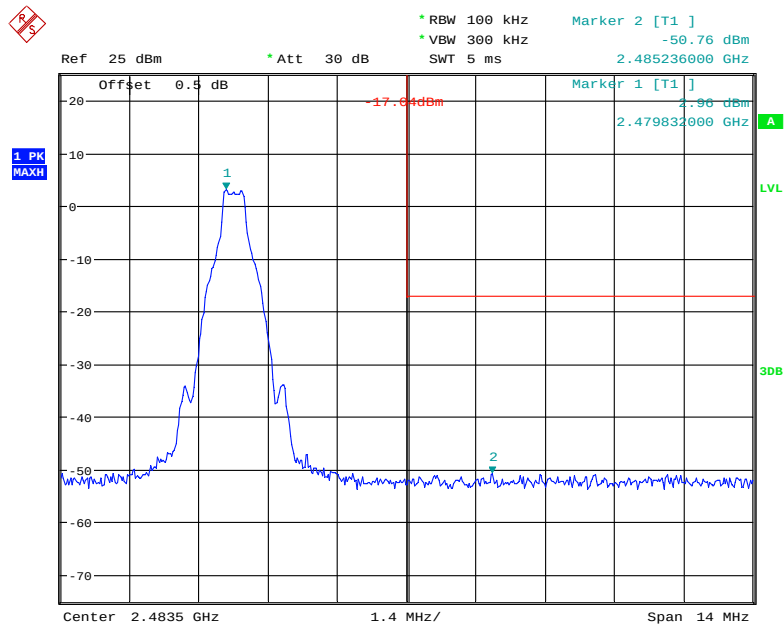
Test Result: Compliance

Single mode:

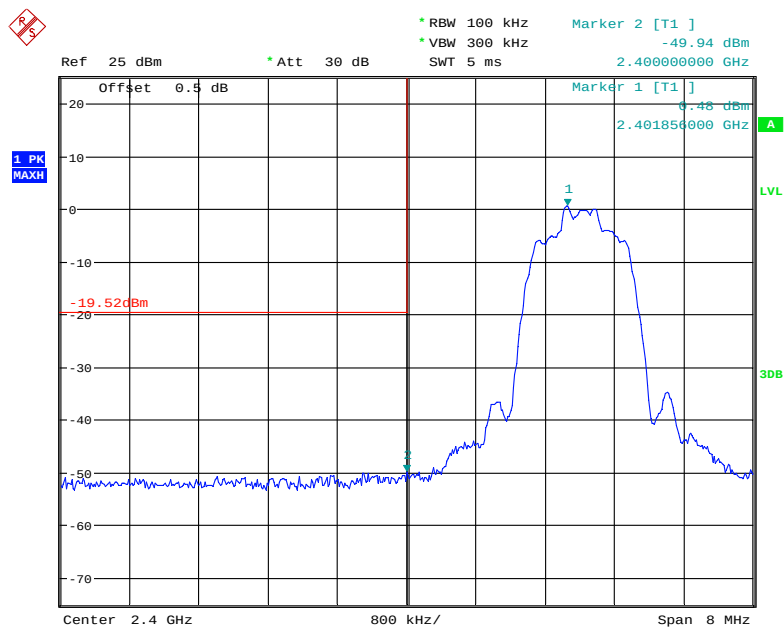
BDR Mode (GFSK):

Band Edge, Left Side

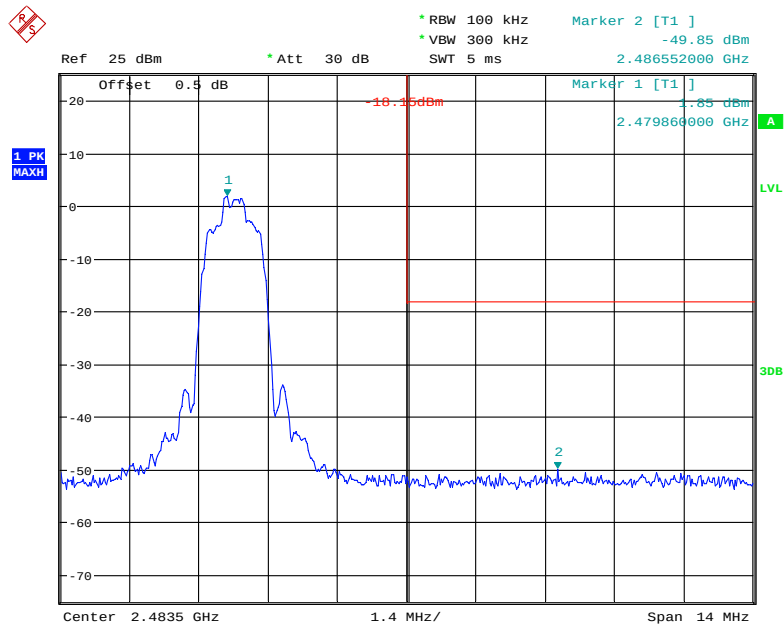
Date: 4.JAN.2019 21:16:58

Band Edge, Right Side

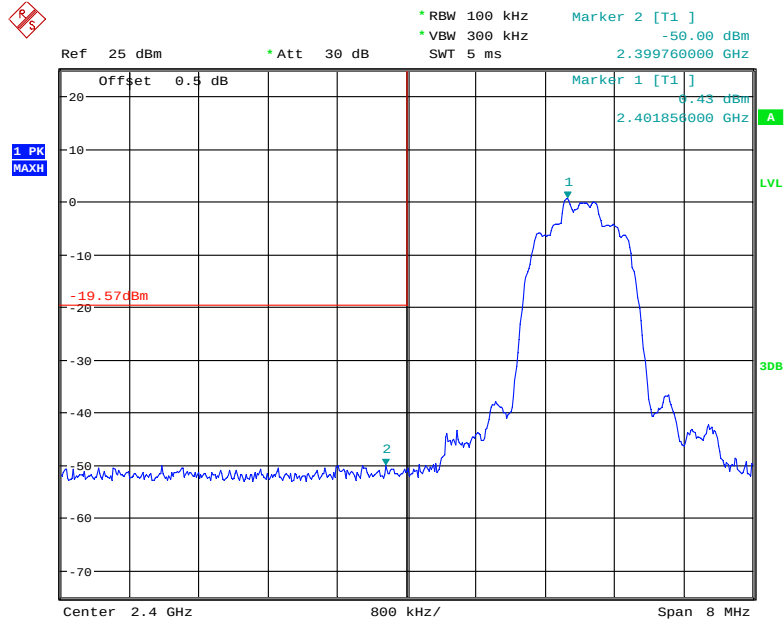
Date: 4. JAN. 2019 21:18:43

*EDR Mode ($\pi/4$ -DQPSK):***Band Edge, Left Side**

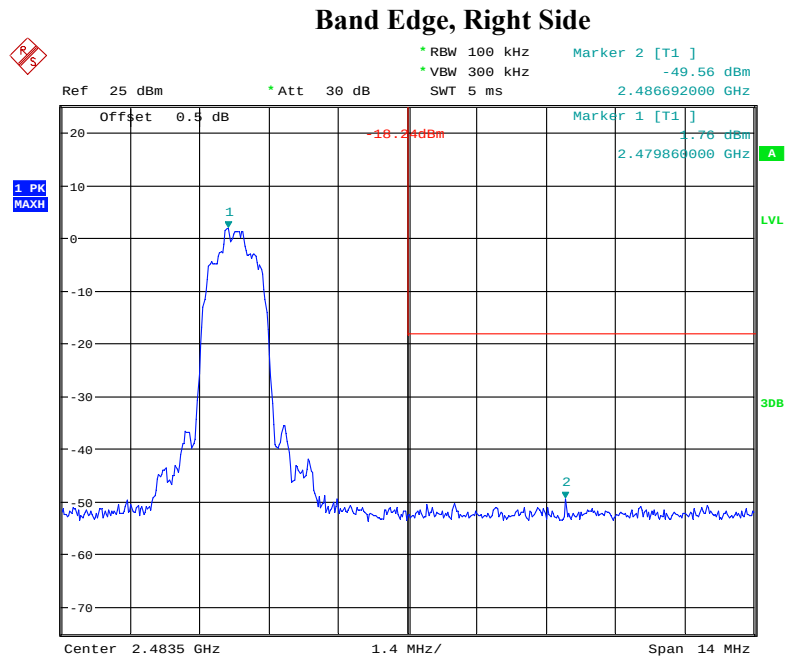
Date: 4. JAN. 2019 21:24:38

Band Edge, Right Side

Date: 4.JAN.2019 21:25:57

*EDR Mode (8-DPSK):***Band Edge, Left Side**

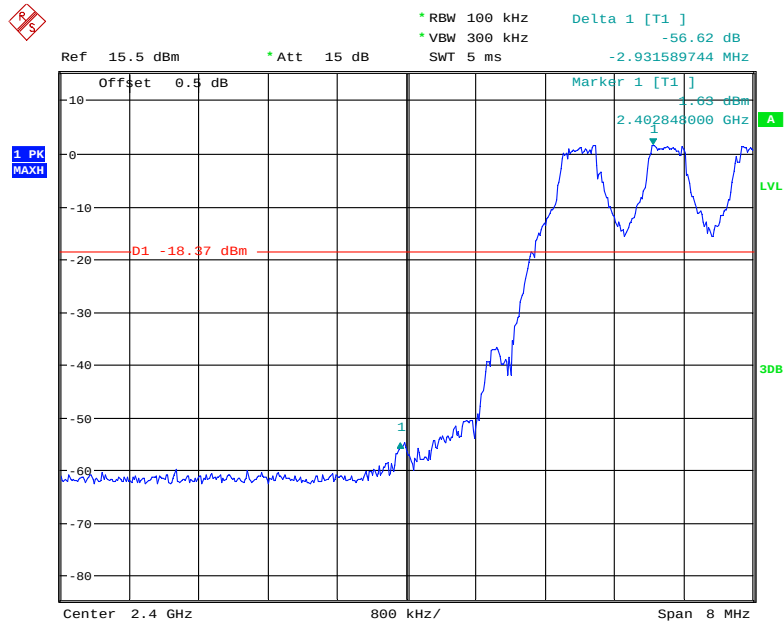
Date: 4.JAN.2019 21:28:54



Date: 4.JAN.2019 21:27:18

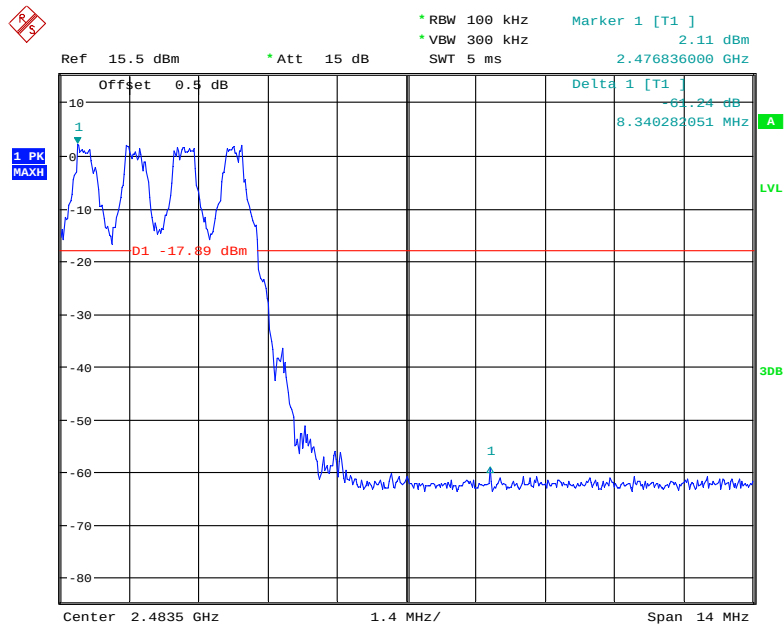
Hopping mode:
BDR Mode (GFSK):

Band Edge, Left Side

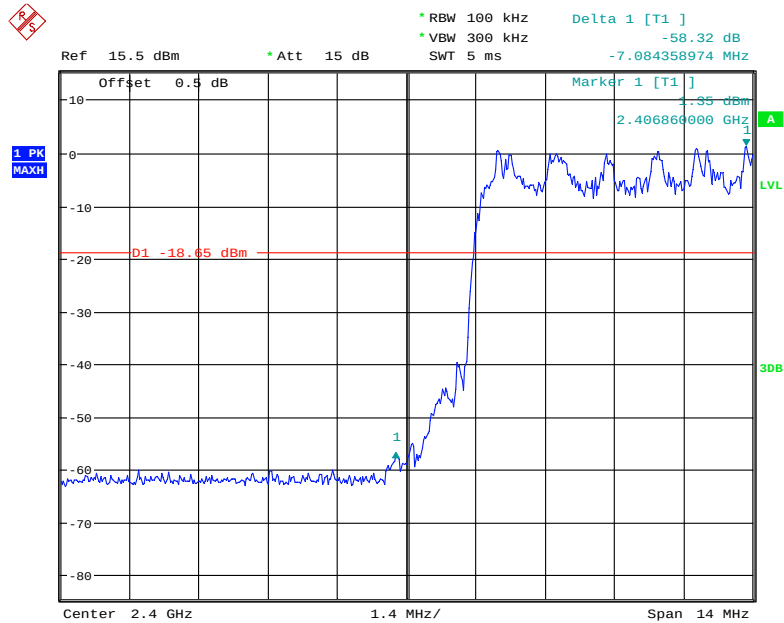


Date: 6.JAN.2019 17:35:05

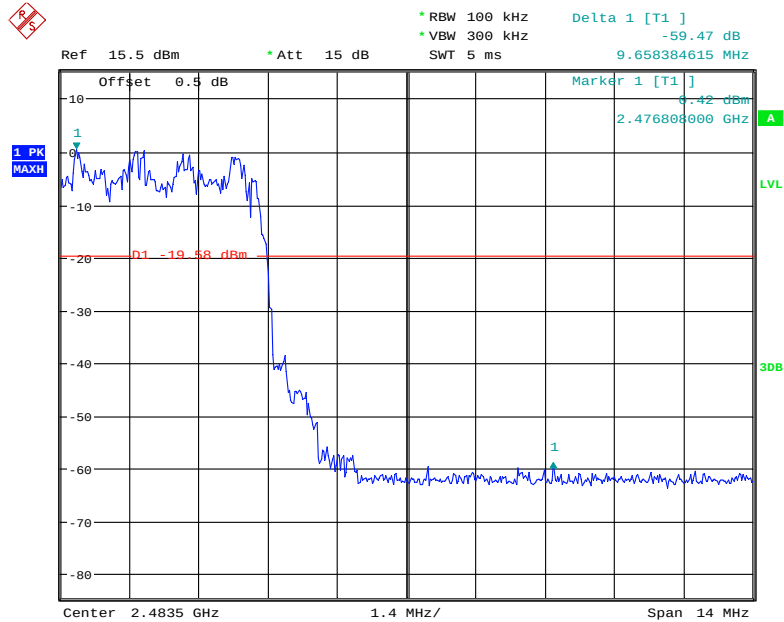
Band Edge, Right Side



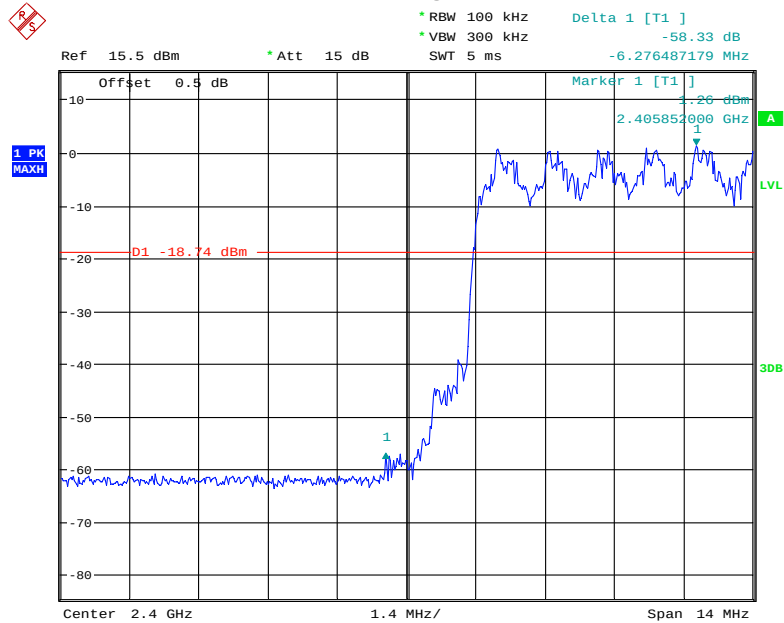
Date: 6.JAN.2019 17:37:33

*EDR Mode ($\pi/4$ -DQPSK):***Band Edge, Left Side**

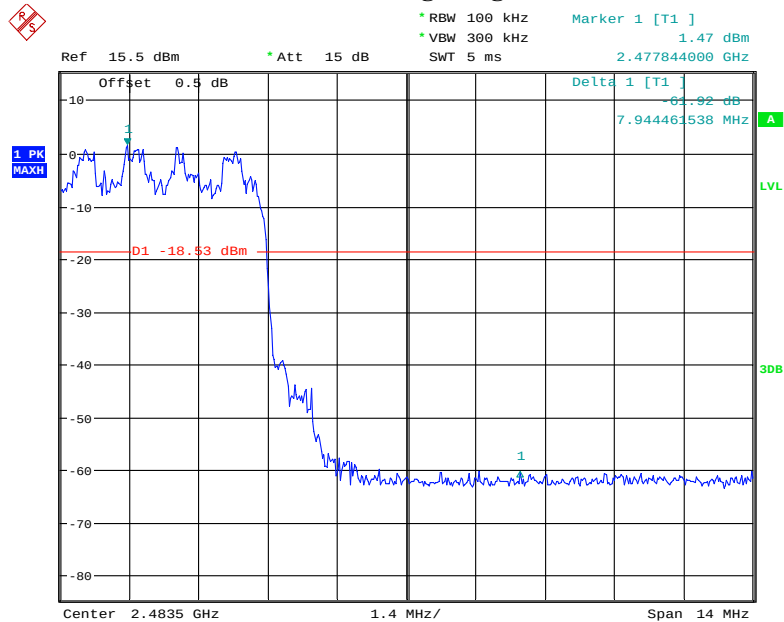
Date: 6.JAN.2019 17:44:08

Band Edge, Right Side

Date: 6.JAN.2019 17:41:19

*EDR Mode (8-DPSK):***Band Edge, Left Side**

Date: 6.JAN.2019 17:47:42

Band Edge, Right Side

Date: 6.JAN.2019 17:51:23

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