TESTING LABORATORY
CERTIFICATE #4820.01

FCC PART 15.247

TEST REPORT

For

Shenzhen Soundsoul Information Technology Co., Ltd.

Room 1308-1309, Building B,Huihai Square,Chuangye Road, Longhua District,Shenzhen China.

FCC ID: 2AFTUYL001

Report Type:	**Product Name:**
Original Report	Bluetooth Headset

Report Number: RDG181011001-00A

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Reviewed By: Dean Lau
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	Bluetooth Headset
EUT Model:	TrueFree
Multiple Model(s):	Q32, TrueFree+, TrueFree², Truebuds, True, TrueFree mini, TrueFree Pro, TrueFree Air, TrueFree Max
FCC ID:	2AFTUYL001
Rated Input Voltage:	DC 3.7V from battery or DC 5V from charger box
External Dimension:	24mm(L)*21.9mm(W)*16mm(H)
Serial Number:	181011001
EUT Received Date:	2018-10-11

Note: The series product, model Q32, TrueFree+, TrueFree², Truebuds, True, TrueFree mini, TrueFree Pro, TrueFree Air, TrueFree Max are electrically identical with TrueFree, we selected TrueFree for fully testing. The difference between them was explained in the attached declaration letter. The left ear headset and right ear headset is electorally identical, we select left ear for fully testing

Objective

This report is prepared on behalf of *Shenzhen Soundsoul Information 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: 2AFTUYL001.

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" and KDB 558074 D01 15.247 Meas Guidance v05.

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℃
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 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. : 897218,the FCC Designation No. : CN1220.

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

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in engineering mode, which was provided by manufacturer.

EUT Exercise Software

Test software: ' RTLBTAPP.exe ' was used in test, the system configured maximum power level as default setting.

Equipment Modifications

No modification was made to the EUT.

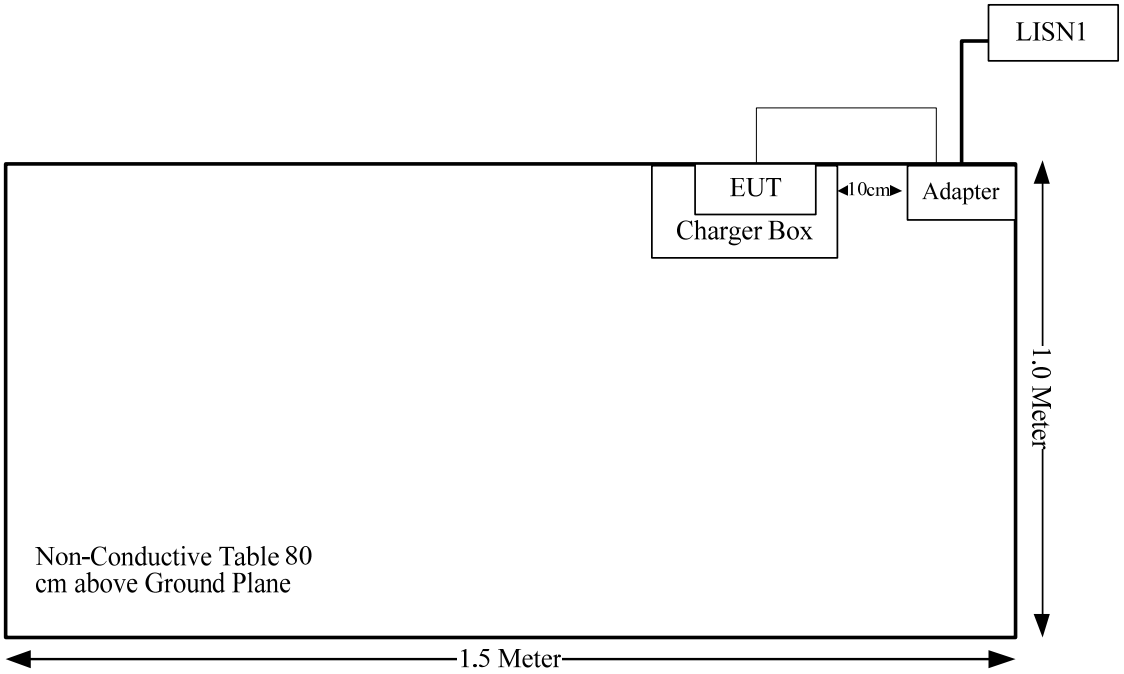
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
unknown	adapter	HJ-0502000W2-US	/

Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
USB cable	No	No	1	adapter	charger box

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i) & §1.1310 & §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(1)	20 dB 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

FCC §15.247 (i) & §1.1310 & §2.1093- RF EXPOSURE

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 ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB447498 D01 General RF Exposure Guidance v06:

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:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

Measurement Result

The max conducted power including tune-up tolerance is 5.0 dBm (3.16 mW).
[(max. power of channel, mW)/(min. test separation distance, mm)][√f(GHz)]
=3.16/5*(√2.480) = 1.0< 3.0

So the stand-alone SAR evaluation is not necessary.

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 for BT, and the antenna gain is 2.5 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

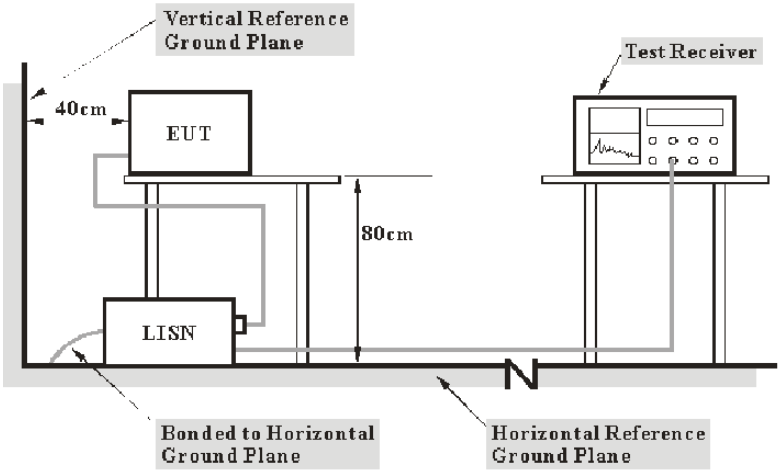
Result: Compliance.

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 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 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 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:

Margin = Limit – 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	2017-12-11	2018-12-11
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	2017-12-08	2018-12-08

*** 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

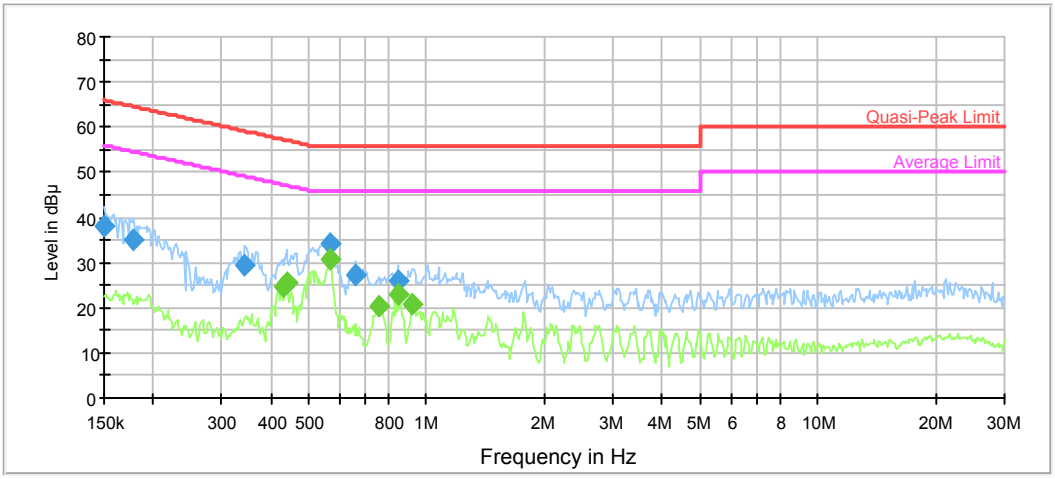
Temperature:	28.1 °C
Relative Humidity:	53 %
ATM Pressure:	100.4 kPa

The testing was performed by Lily Xie on 2018-10-27.

Test Mode: *Transmitting (GFSK low channel was the worst)*

For Charging Box#1

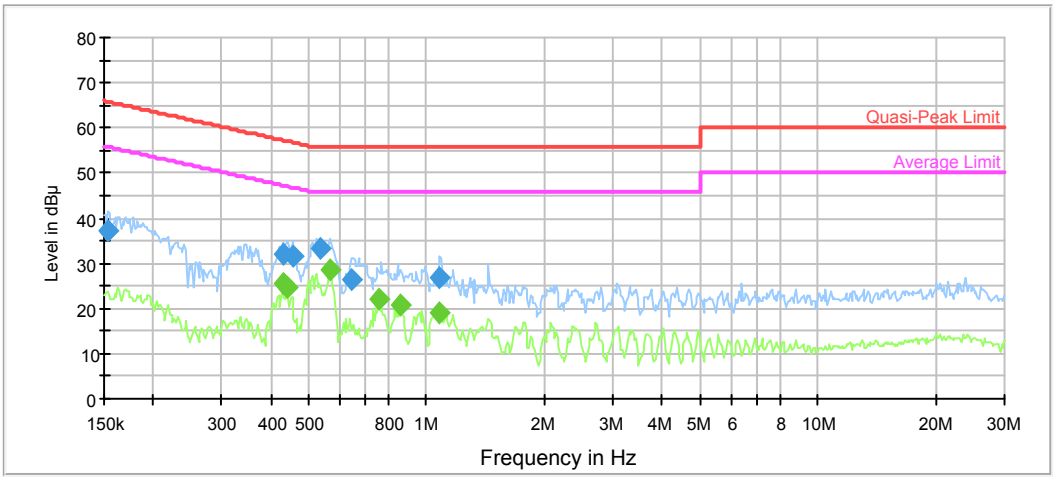
AC120V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.150000	38.1	9.000	L1	11.2	27.9	66.0	Compliance
0.178741	34.8	9.000	L1	10.8	29.7	64.5	Compliance
0.343548	29.3	9.000	L1	10.0	29.8	59.1	Compliance
0.567545	34.0	9.000	L1	9.8	22.0	56.0	Compliance
0.660314	27.3	9.000	L1	9.8	28.7	56.0	Compliance
0.845331	26.0	9.000	L1	9.8	30.0	56.0	Compliance

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.429420	24.7	9.000	L1	9.9	22.6	47.3	Compliance
0.439808	25.6	9.000	L1	9.9	21.5	47.1	Compliance
0.567545	30.7	9.000	L1	9.8	15.3	46.0	Compliance
0.756101	20.5	9.000	L1	9.8	25.5	46.0	Compliance
0.845331	22.9	9.000	L1	9.8	23.1	46.0	Compliance
0.915445	20.9	9.000	L1	9.8	25.1	46.0	Compliance

AC120V, 60 Hz, Neutral:

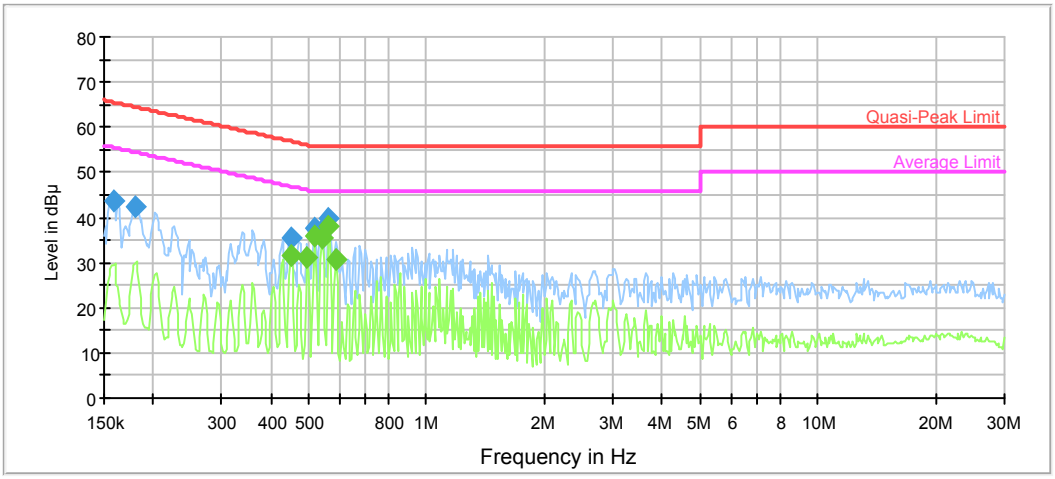


Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.153629	37.3	9.000	N	11.1	28.5	65.8	Compliance
0.429420	32.1	9.000	N	9.9	25.2	57.3	Compliance
0.454052	31.5	9.000	N	9.9	25.3	56.8	Compliance
0.536756	33.3	9.000	N	9.9	22.7	56.0	Compliance
0.644717	26.2	9.000	N	9.8	29.8	56.0	Compliance
1.082190	26.6	9.000	N	9.8	29.4	56.0	Compliance

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.429420	25.3	9.000	N	9.9	21.9	47.2	Compliance
0.439808	24.8	9.000	N	9.9	22.3	47.1	Compliance
0.567545	28.7	9.000	N	9.8	17.3	46.0	Compliance
0.756101	21.9	9.000	N	9.8	24.1	46.0	Compliance
0.858911	20.9	9.000	N	9.8	25.1	46.0	Compliance
1.073601	19.0	9.000	N	9.8	27.0	46.0	Compliance

For Charging Box#2

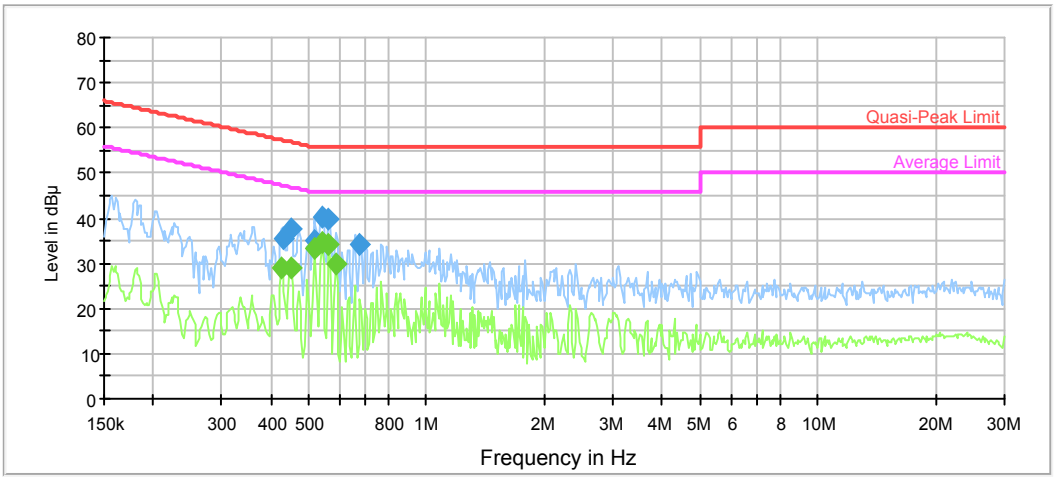
AC120V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.158604	43.6	9.000	L1	11.1	22.0	65.6	Compliance
0.180171	42.3	9.000	L1	10.8	22.2	64.5	Compliance
0.450448	35.5	9.000	L1	9.9	21.4	56.9	Compliance
0.519918	37.5	9.000	L1	9.9	18.5	56.0	Compliance
0.541050	37.2	9.000	L1	9.9	18.8	56.0	Compliance
0.563041	39.9	9.000	L1	9.8	16.1	56.0	Compliance

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.450448	31.7	9.000	L1	9.9	15.2	46.9	Compliance
0.495646	31.2	9.000	L1	9.9	14.9	46.1	Compliance
0.519918	35.9	9.000	L1	9.9	10.1	46.0	Compliance
0.541050	35.3	9.000	L1	9.9	10.7	46.0	Compliance
0.563041	38.0	9.000	L1	9.8	8.0	46.0	Compliance
0.585926	30.7	9.000	L1	9.8	15.3	46.0	Compliance

AC120V, 60 Hz, Neutral:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.429420	35.6	9.000	N	9.9	21.7	57.3	Compliance
0.450448	37.8	9.000	N	9.9	19.1	56.9	Compliance
0.515791	35.1	9.000	N	9.9	20.9	56.0	Compliance
0.541050	40.4	9.000	N	9.8	15.6	56.0	Compliance
0.563041	39.8	9.000	N	9.8	16.2	56.0	Compliance
0.676289	34.4	9.000	N	9.8	21.6	56.0	Compliance

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.426011	28.9	9.000	N	9.9	18.4	47.3	Compliance
0.450448	28.9	9.000	N	9.9	18.0	46.9	Compliance
0.519918	33.1	9.000	N	9.9	12.9	46.0	Compliance
0.541050	34.4	9.000	N	9.8	11.6	46.0	Compliance
0.563041	34.2	9.000	N	9.8	11.8	46.0	Compliance
0.585926	30.0	9.000	N	9.8	16.0	46.0	Compliance

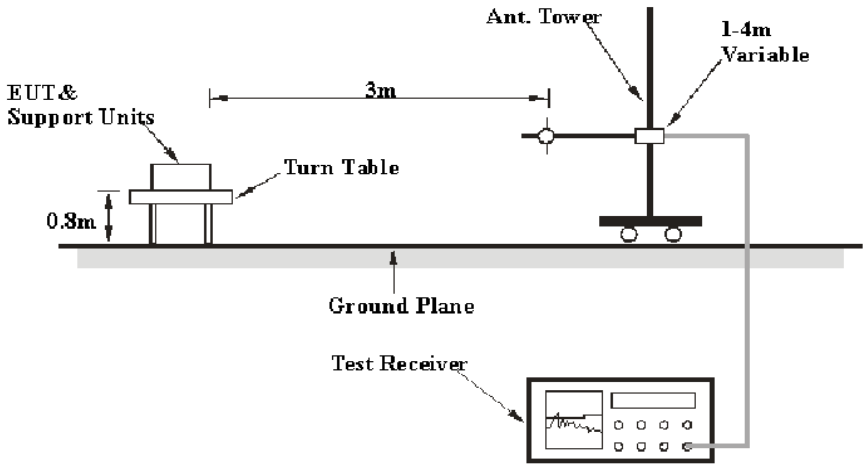
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

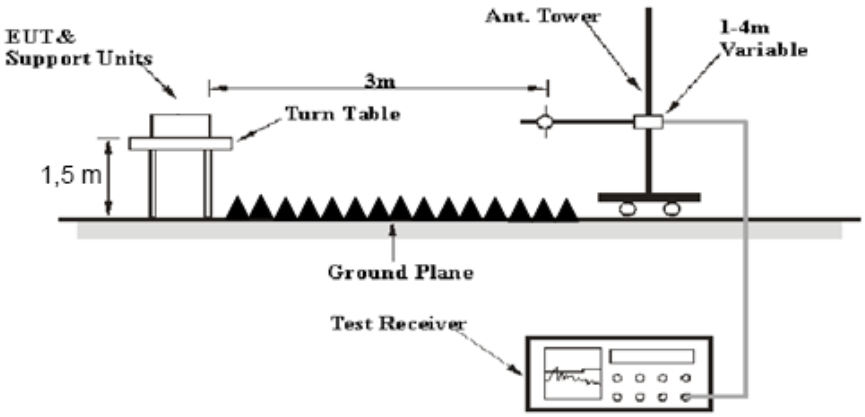
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emission below 1GHz tests were performed in the 10 meters chamber test site , 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.

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

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.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESCI	100035	2018-08-03	2019-08-03
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Sunol Sciences	Antenna	JB3	A060611-3	2017-07-21	2019-07-21
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-02	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-2200-01	2018-09-05	2019-09-05
HP	Amplifier	8447F	2443A01912	2018-09-05	2019-09-05
Agilent	Spectrum Analyzer	E4440A	SG43360054	2018-01-04	2019-01-04
ETS-Lindgren	Horn Antenna	3115	000 527 35	2016-01-05	2019-01-04
Ducommun Technolagies	Horn Antenna	ARH-4223-02	1007726-01 1304	2016-11-18	2019-11-18
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
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
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).

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:

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - 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:

Margin = Limit – Corrected Amplitude

Test Data

Environmental Conditions

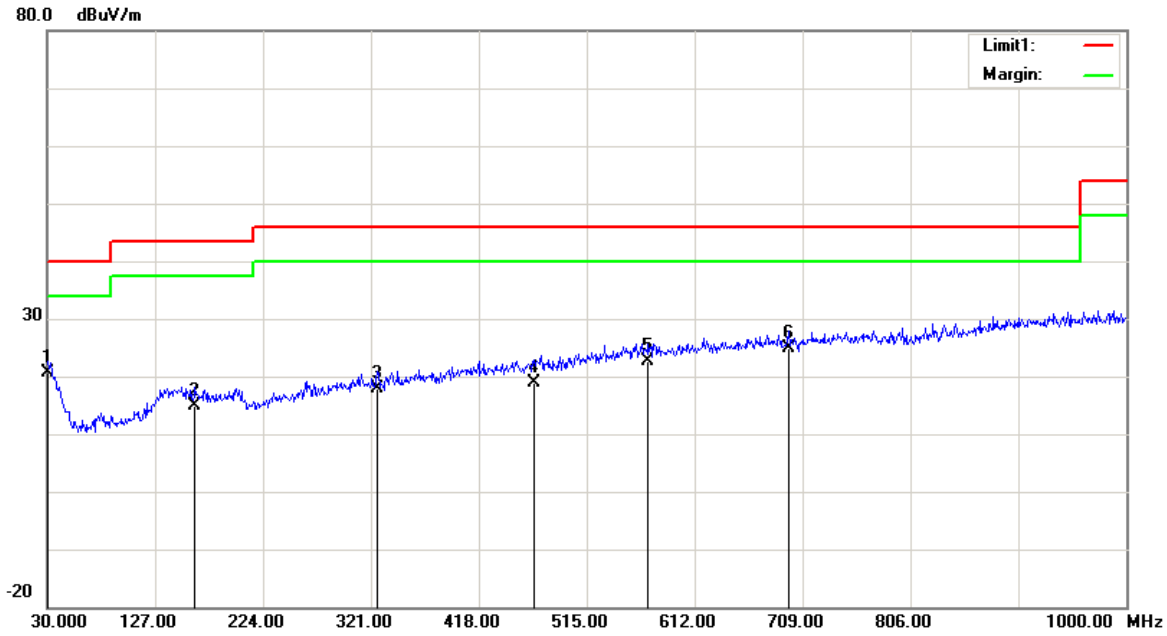
Temperature:	24.8~26.8°C
Relative Humidity:	36~48 %
ATM Pressure:	100.6~101 kPa

** The testing was performed by Alex You & Kami Zhou from 2018-10-29 to 2018-11-02.*

Test Mode: Transmitting(left ear headset was the worst)

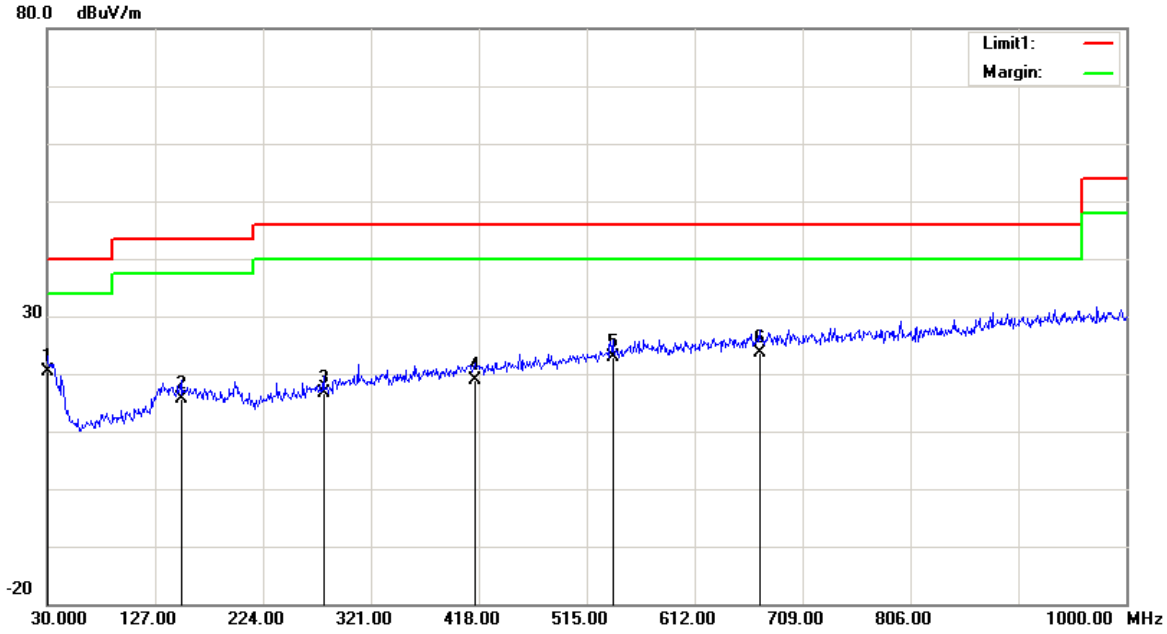
1) 30MHz-1GHz (GFSK High channel was the worst)

Horizontal:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.9700	25.48	QP	-4.88	20.60	40.00	19.40
162.8900	24.66	QP	-9.66	15.00	43.50	28.50
326.8200	25.00	QP	-7.10	17.90	46.00	28.10
467.4700	22.78	QP	-3.98	18.80	46.00	27.20
570.2900	24.04	QP	-1.44	22.60	46.00	23.40
696.3900	24.59	QP	0.21	24.80	46.00	21.20

Vertical:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	24.73	QP	-4.33	20.40	40.00	19.60
150.2800	25.30	QP	-9.60	15.70	43.50	27.80
278.3200	25.20	QP	-8.60	16.60	46.00	29.40
414.1200	23.66	QP	-4.86	18.80	46.00	27.20
538.2800	24.94	QP	-2.14	22.80	46.00	23.20
670.2000	23.41	QP	0.19	23.60	46.00	22.40

2) 1GHz-25GHz:

BDR Mode (GFSK):

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	64.02	PK	H	28.10	1.80	0.00	93.92	N/A	N/A
2402.00	53.43	AV	H	28.10	1.80	0.00	83.33	N/A	N/A
2402.00	64.10	PK	V	28.10	1.80	0.00	94.00	N/A	N/A
2402.00	52.97	AV	V	28.10	1.80	0.00	82.87	N/A	N/A
2390.00	25.51	PK	H	28.08	1.80	0.00	55.39	74.00	18.61
2390.00	13.37	AV	H	28.08	1.80	0.00	43.25	54.00	10.75
4804.00	60.94	PK	H	32.91	3.17	37.20	59.82	74.00	14.18
4804.00	50.58	AV	H	32.91	3.17	37.20	49.46	54.00	4.54
7206.00	50.50	PK	H	35.74	4.82	37.23	53.83	74.00	20.17
7206.00	43.29	AV	H	35.74	4.82	37.23	46.62	54.00	7.38
Middle Channel: 2441 MHz									
2441.00	65.22	PK	H	28.18	1.82	0.00	95.22	N/A	N/A
2441.00	54.76	AV	H	28.18	1.82	0.00	84.76	N/A	N/A
2441.00	63.65	PK	V	28.18	1.82	0.00	93.65	N/A	N/A
2441.00	52.09	AV	V	28.18	1.82	0.00	82.09	N/A	N/A
4882.00	62.26	PK	H	33.06	3.27	37.21	61.38	74.00	12.62
4882.00	51.42	AV	H	33.06	3.27	37.21	50.54	54.00	3.46
7323.00	50.78	PK	H	36.04	4.62	37.38	54.06	74.00	19.94
7323.00	44.72	AV	H	36.04	4.62	37.38	48.00	54.00	6.00
High Channel: 2480 MHz									
2480.00	65.53	PK	H	28.26	1.84	0.00	95.63	N/A	N/A
2480.00	54.68	AV	H	28.26	1.84	0.00	84.78	N/A	N/A
2480.00	64.95	PK	V	28.26	1.84	0.00	95.05	N/A	N/A
2480.00	54.21	AV	V	28.26	1.84	0.00	84.31	N/A	N/A
2483.50	26.20	PK	H	28.27	1.84	0.00	56.31	74.00	17.69
2483.50	14.04	AV	H	28.27	1.84	0.00	44.15	54.00	9.85
4960.00	64.45	PK	H	33.22	3.23	37.25	63.65	74.00	10.35
4960.00	52.31	AV	H	33.22	3.23	37.25	51.51	54.00	2.49
7440.00	48.73	PK	H	36.34	4.41	37.52	51.96	74.00	22.04
7440.00	39.45	AV	H	36.34	4.41	37.52	42.68	54.00	11.32

EDR Mode (π/4-DQPSK):

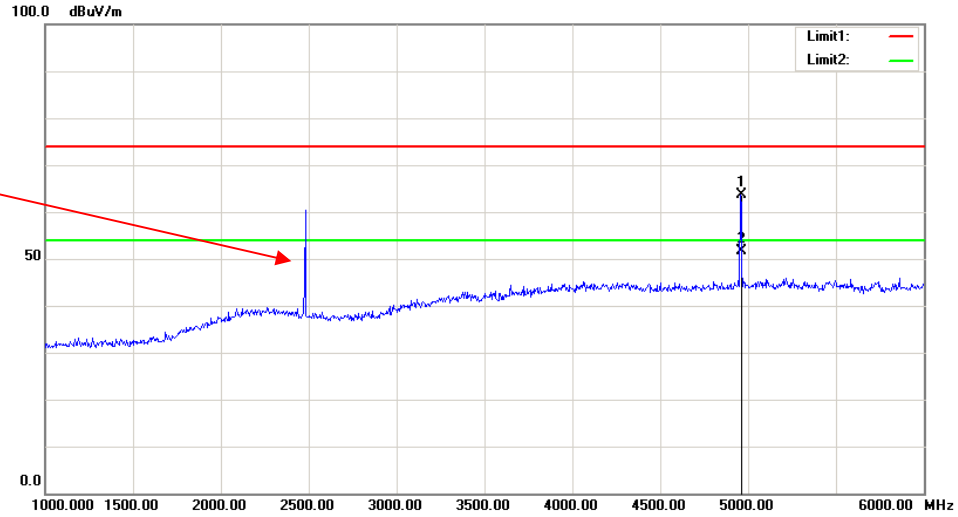
Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2402.00	61.88	PK	H	28.10	1.80	0.00	91.78	N/A	N/A
2402.00	49.08	AV	H	28.10	1.80	0.00	78.98	N/A	N/A
2402.00	60.83	PK	V	28.10	1.80	0.00	90.73	N/A	N/A
2402.00	48.31	AV	V	28.10	1.80	0.00	78.21	N/A	N/A
2390.00	25.54	PK	H	28.08	1.80	0.00	55.42	74.00	18.58
2390.00	14.38	AV	H	28.08	1.80	0.00	44.26	54.00	9.74
4804.00	59.50	PK	H	32.91	3.17	37.20	58.38	74.00	15.62
4804.00	47.76	AV	H	32.91	3.17	37.20	46.64	54.00	7.36
7206.00	51.20	PK	H	35.74	4.82	37.23	54.53	74.00	19.47
7206.00	38.54	AV	H	35.74	4.82	37.23	41.87	54.00	12.13
Middle Channel: 2441 MHz									
2441.00	62.36	PK	H	28.18	1.82	0.00	92.36	N/A	N/A
2441.00	49.73	AV	H	28.18	1.82	0.00	79.73	N/A	N/A
2441.00	61.45	PK	V	28.18	1.82	0.00	91.45	N/A	N/A
2441.00	48.66	AV	V	28.18	1.82	0.00	78.66	N/A	N/A
4882.00	62.19	PK	H	33.06	3.27	37.21	61.31	74.00	12.69
4882.00	50.20	AV	H	33.06	3.27	37.21	49.32	54.00	4.68
7323.00	47.80	PK	H	36.04	4.62	37.38	51.08	74.00	22.92
7323.00	34.51	AV	H	36.04	4.62	37.38	37.79	54.00	16.21
High Channel: 2480 MHz									
2480.00	64.18	PK	H	28.26	1.84	0.00	94.28	N/A	N/A
2480.00	50.82	AV	H	28.26	1.84	0.00	80.92	N/A	N/A
2480.00	63.05	PK	V	28.26	1.84	0.00	93.15	N/A	N/A
2480.00	50.27	AV	V	28.26	1.84	0.00	80.37	N/A	N/A
2483.50	25.67	PK	H	28.27	1.84	0.00	55.78	74.00	18.22
2483.50	14.83	AV	H	28.27	1.84	0.00	44.94	54.00	9.06
4960.00	64.49	PK	H	33.22	3.23	37.25	63.69	74.00	10.31
4960.00	51.13	AV	H	33.22	3.23	37.25	50.33	54.00	3.67
7440.00	47.01	PK	H	36.34	4.41	37.52	50.24	74.00	23.76
7440.00	34.10	AV	H	36.34	4.41	37.52	37.33	54.00	16.67

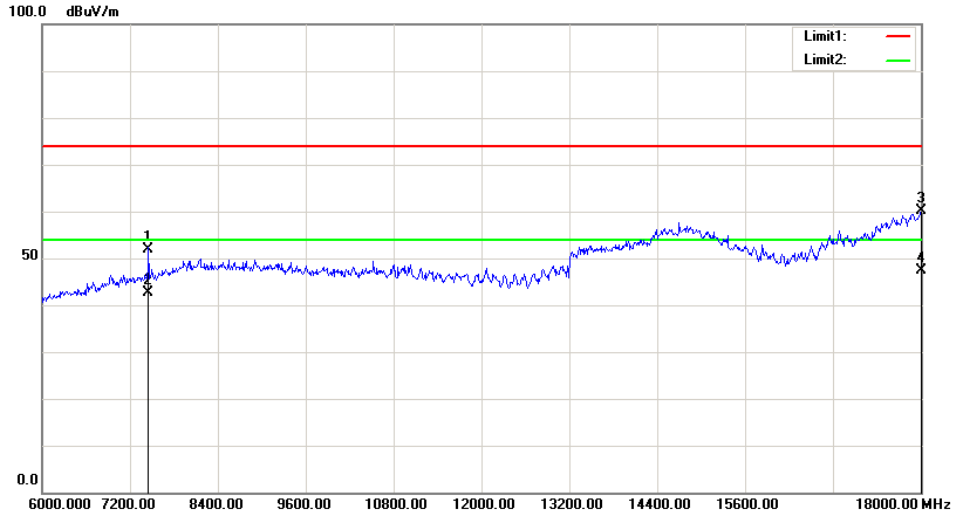
EDR Mode (8DPSK):

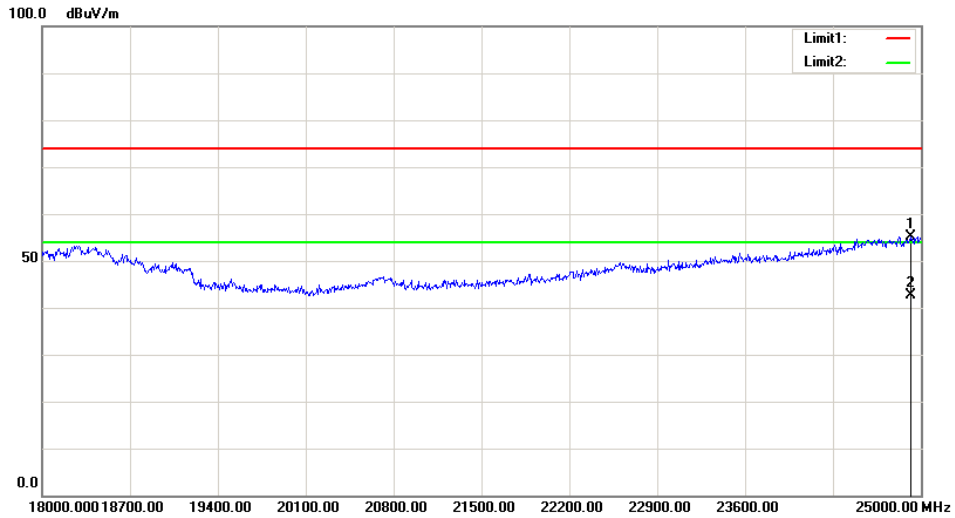
Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
	Reading (dBµV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2402.00	61.71	PK	H	28.10	1.80	0.00	91.61	N/A	N/A
2402.00	48.16	AV	H	28.10	1.80	0.00	78.06	N/A	N/A
2402.00	58.75	PK	V	28.10	1.80	0.00	88.65	N/A	N/A
2402.00	45.21	AV	V	28.10	1.80	0.00	75.11	N/A	N/A
2390.00	24.81	PK	H	28.08	1.80	0.00	54.69	74.00	19.31
2390.00	13.25	AV	H	28.08	1.80	0.00	43.13	54.00	10.87
4804.00	61.87	PK	H	32.91	3.17	37.20	60.75	74.00	13.25
4804.00	47.79	AV	H	32.91	3.17	37.20	46.67	54.00	7.33
7206.00	51.87	PK	H	35.74	4.82	37.23	55.20	74.00	18.80
7206.00	37.06	AV	H	35.74	4.82	37.23	40.39	54.00	13.61
Middle Channel: 2441 MHz									
2441.00	63.15	PK	H	28.18	1.82	0.00	93.15	N/A	N/A
2441.00	50.07	AV	H	28.18	1.82	0.00	80.07	N/A	N/A
2441.00	60.87	PK	V	28.18	1.82	0.00	90.87	N/A	N/A
2441.00	47.65	AV	V	28.18	1.82	0.00	77.65	N/A	N/A
4882.00	62.34	PK	H	33.06	3.27	37.21	61.46	74.00	12.54
4882.00	46.98	AV	H	33.06	3.27	37.21	46.10	54.00	7.90
7323.00	49.54	PK	H	36.04	4.62	37.38	52.82	74.00	21.18
7323.00	36.37	AV	H	36.04	4.62	37.38	39.65	54.00	14.35
High Channel: 2480 MHz									
2480.00	62.41	PK	H	28.26	1.84	0.00	92.51	N/A	N/A
2480.00	49.71	AV	H	28.26	1.84	0.00	79.81	N/A	N/A
2480.00	59.73	PK	V	28.26	1.84	0.00	89.83	N/A	N/A
2480.00	47.34	AV	V	28.26	1.84	0.00	77.44	N/A	N/A
2483.50	25.30	PK	H	28.27	1.84	0.00	55.41	74.00	18.59
2483.50	13.91	AV	H	28.27	1.84	0.00	44.02	54.00	9.98
4960.00	65.32	PK	H	33.22	3.23	37.25	64.52	74.00	9.48
4960.00	50.90	AV	H	33.22	3.23	37.25	50.10	54.00	3.90
7440.00	46.97	PK	H	36.34	4.41	37.52	50.20	74.00	23.80
7440.00	33.86	AV	H	36.34	4.41	37.52	37.09	54.00	16.91

Worst plots (GFSK High channel)
Horizontal

Fundamental Test with Band Rejection Filter

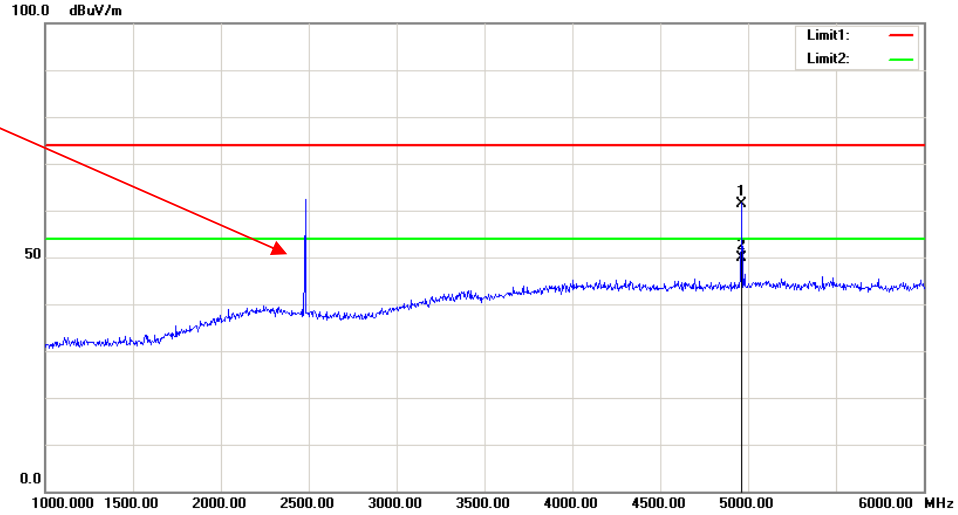


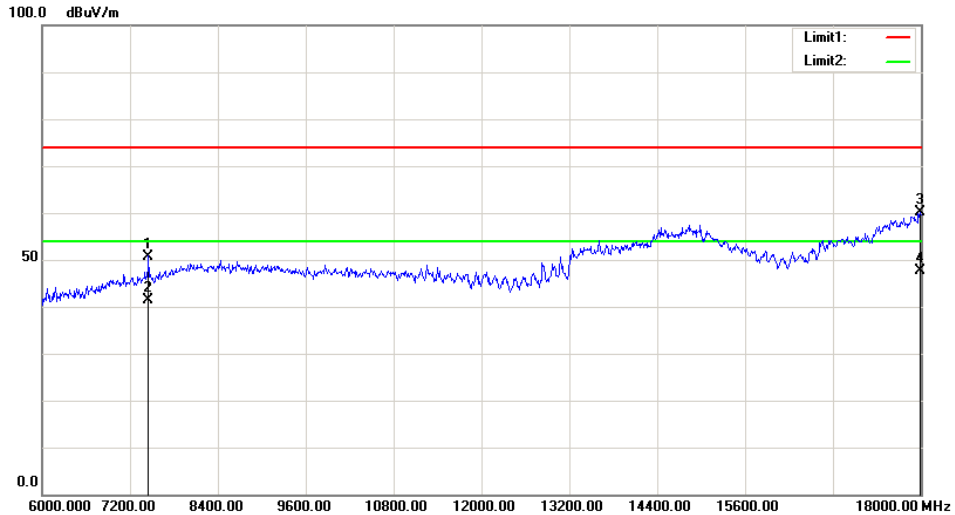


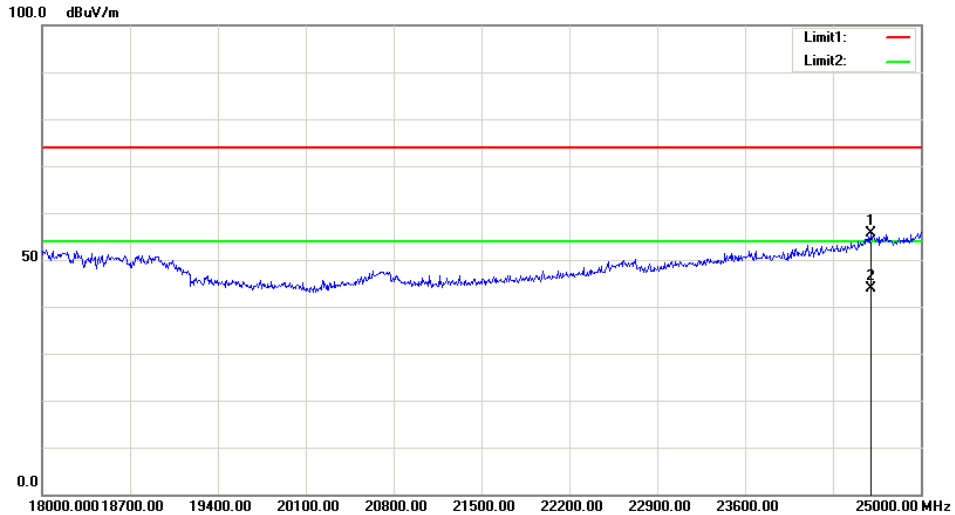


Vertical

Fundamental Test with Band Rejection Filter







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

Applicable Standard

Frequency hopping systems shall have hoping 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	2017-12-08	2018-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	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:	28.7 °C
Relative Humidity:	27 %
ATM Pressure:	100.6 kPa

** The testing was performed by Tiago Huang on 2018-11-01.*

Test Result: Compliance.

Please refer to following tables and plots

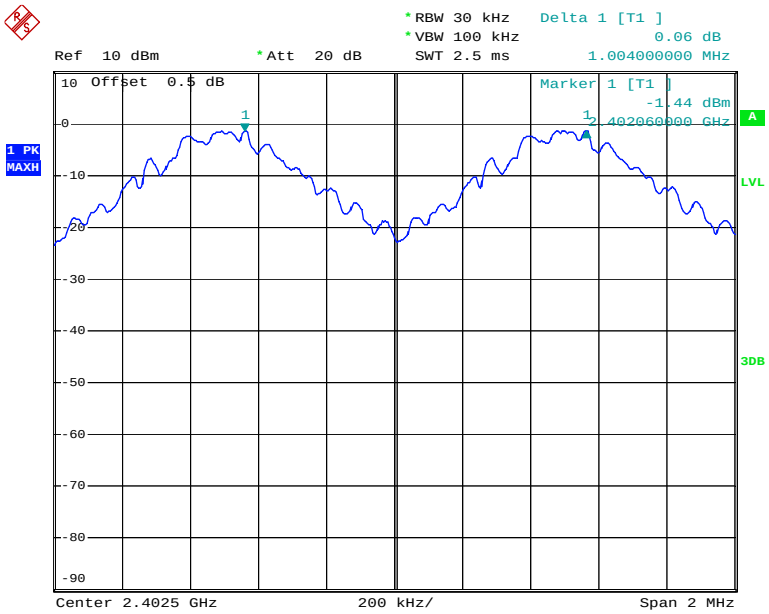
Test Mode: Transmitting

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
BDR (GFSK)	Low	2402	1.004	0.65
	Middle	2441	1.004	0.64
	High	2480	1.004	0.64
EDR (π/4-DQPSK)	Low	2402	1.000	0.91
	Middle	2441	1.000	0.91
	High	2480	1.004	0.91
EDR (8DPSK)	Low	2402	1.000	0.9
	Middle	2441	1.000	0.9
	High	2480	1.000	0.9

Note: Limit= (2/3) × 20dB bandwidth

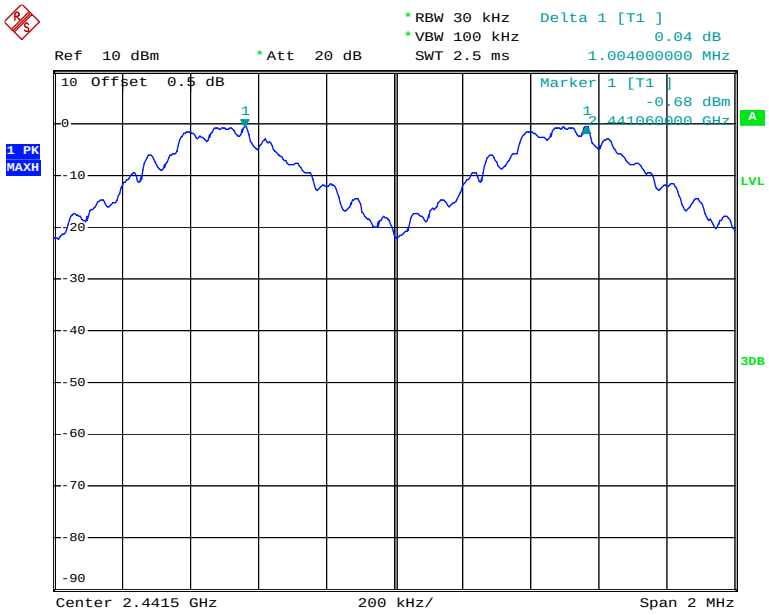
BDR Mode (GFSK):

Low Channel



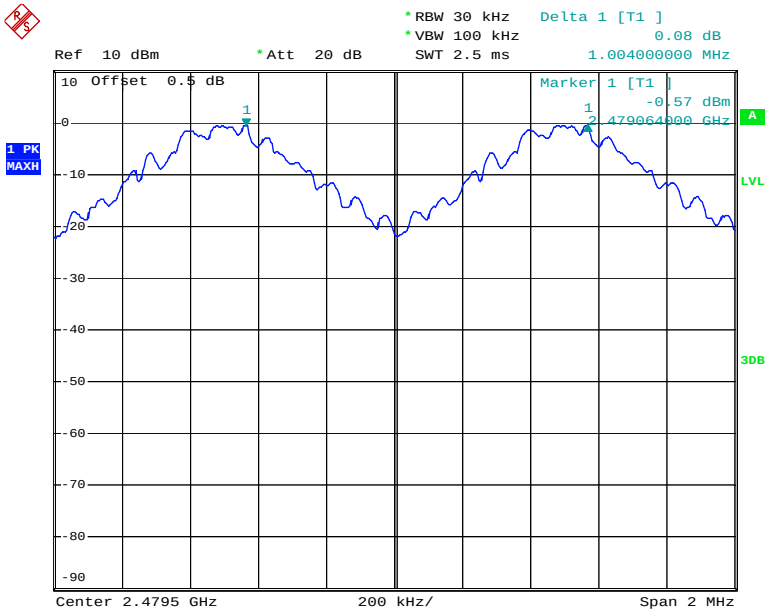
Date: 1.NOV.2018 17:04:49

Middle Channel



Date: 1.NOV.2018 17:05:29

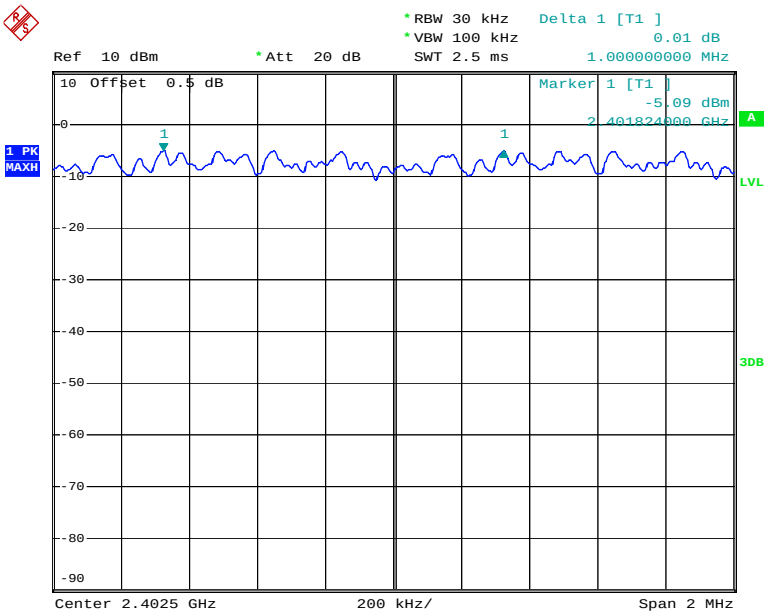
High Channel



Date: 1.NOV.2018 17:06:03

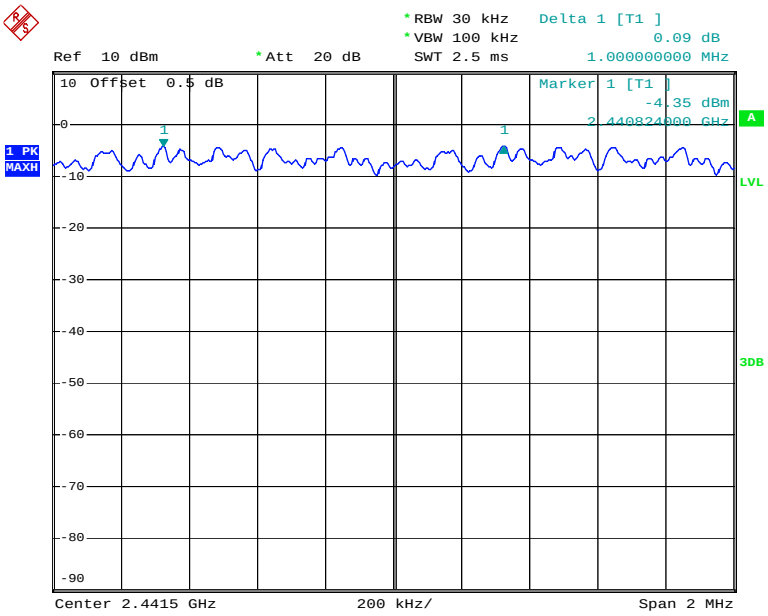
EDR Mode (π/4-DQPSK):

Low Channel



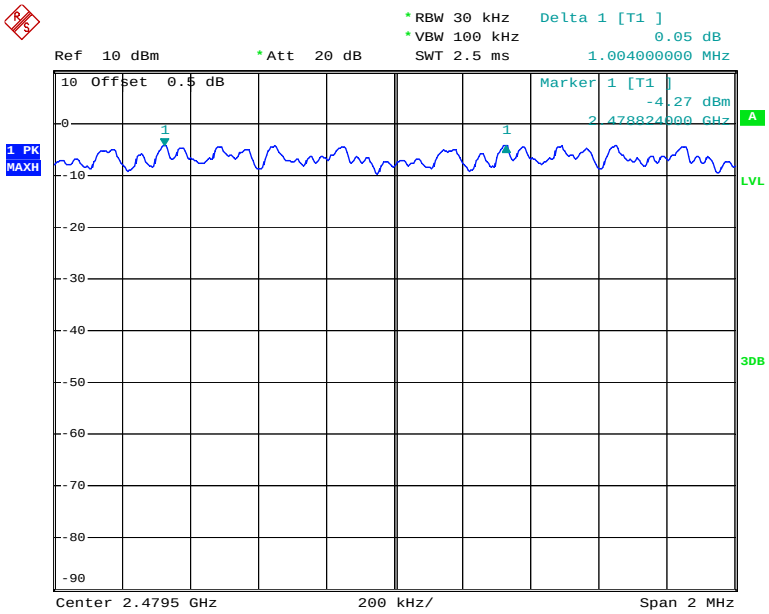
Date: 1.NOV.2018 17:08:04

Middle Channel



Date: 1.NOV.2018 17:07:21

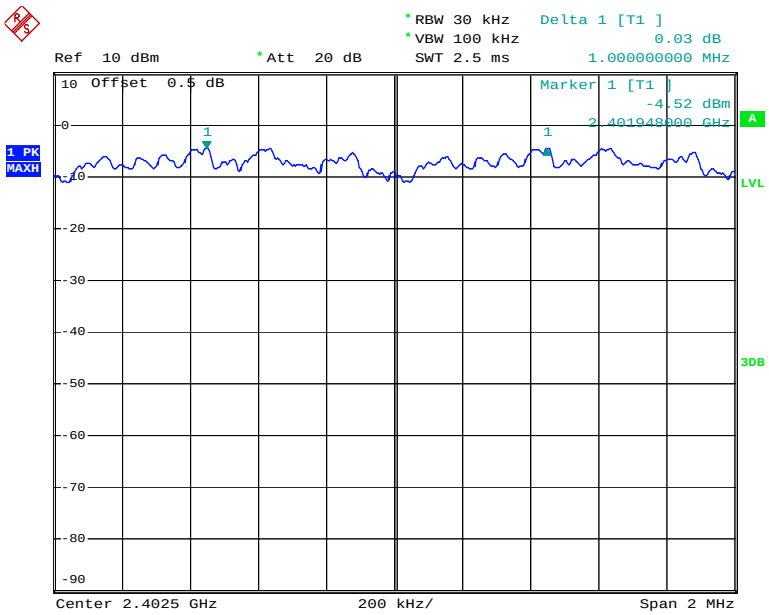
High Channel



Date: 1.NOV.2018 17:06:42

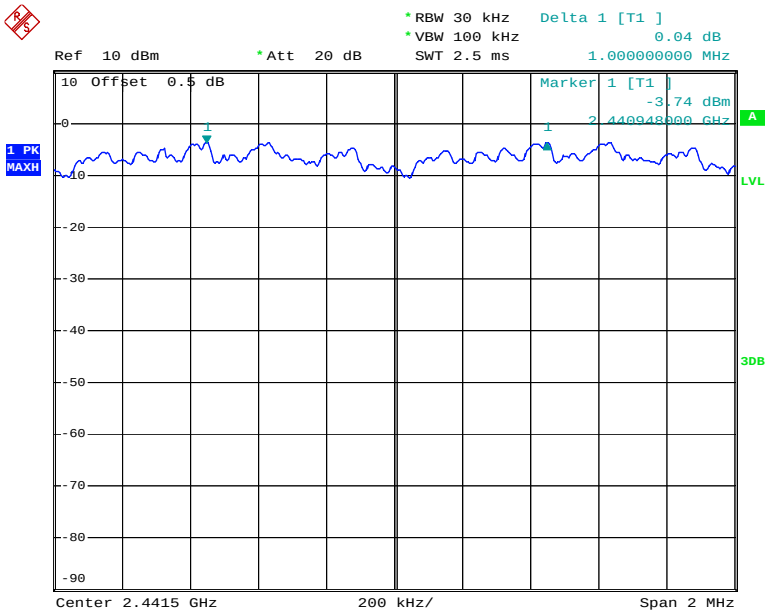
EDR Mode (8DPSK):

Low Channel



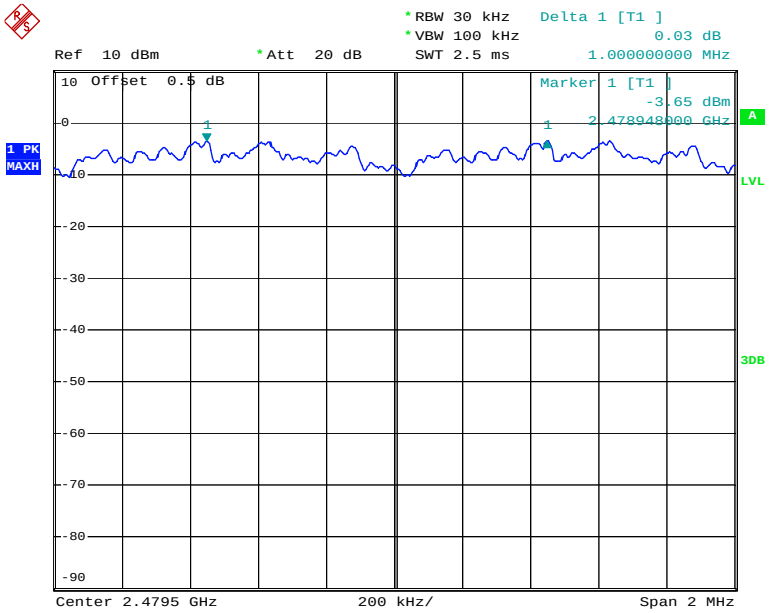
Date: 1.NOV.2018 17:08:40

Middle Channel



Date: 1.NOV.2018 17:09:14

High Channel



Date: 1.NOV.2018 17:09:54

FCC §15.247(a) (1) – 20 dB BANDWIDTH TESTING

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 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	2017-12-08	2018-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	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:	28.7 °C
Relative Humidity:	27 %
ATM Pressure:	100.6 kPa

** The testing was performed by Tiago Huang on 2018-11-01.*

Test Result: Compliance.

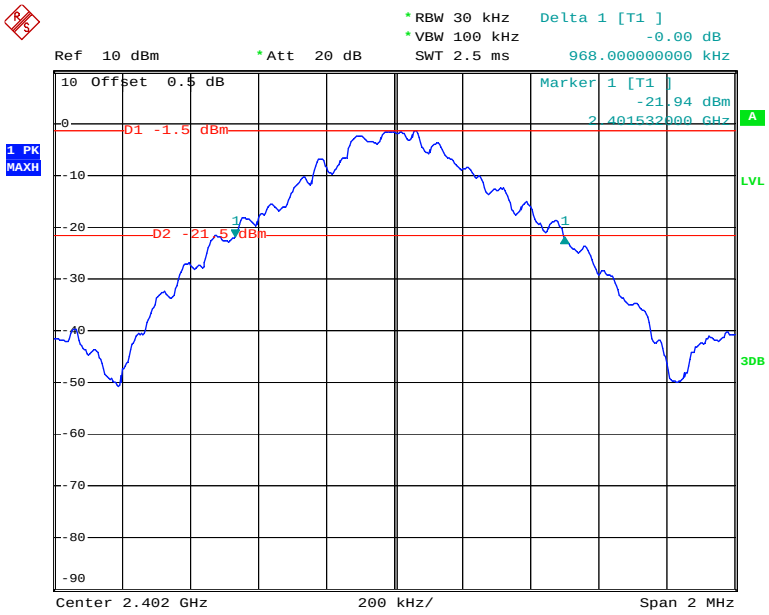
Please refer to following tables and plots

Test Mode: Transmitting

Mode	Channel	Frequency (MHz)	20 dB Bandwidth (MHz)
BDR Mode (GFSK)	Low	2402	0.968
	Middle	2441	0.960
	High	2480	0.964
EDR Mode (π/4-DQPSK)	Low	2402	1.372
	Middle	2441	1.372
	High	2480	1.372
EDR Mode (8DPSK)	Low	2402	1.356
	Middle	2441	1.356
	High	2480	1.356

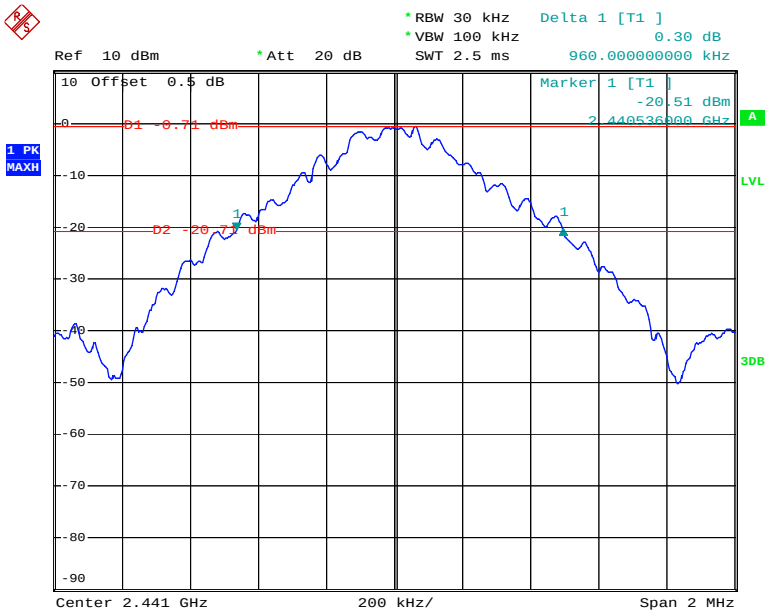
BDR Mode (GFSK):

Low Channel



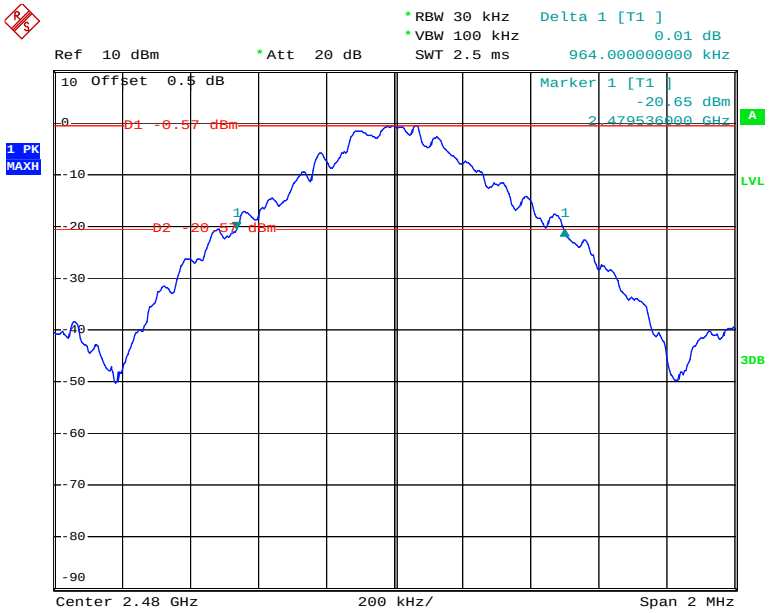
Date: 1.NOV.2018 16:51:26

Middle Channel



Date: 1.NOV.2018 16:53:02

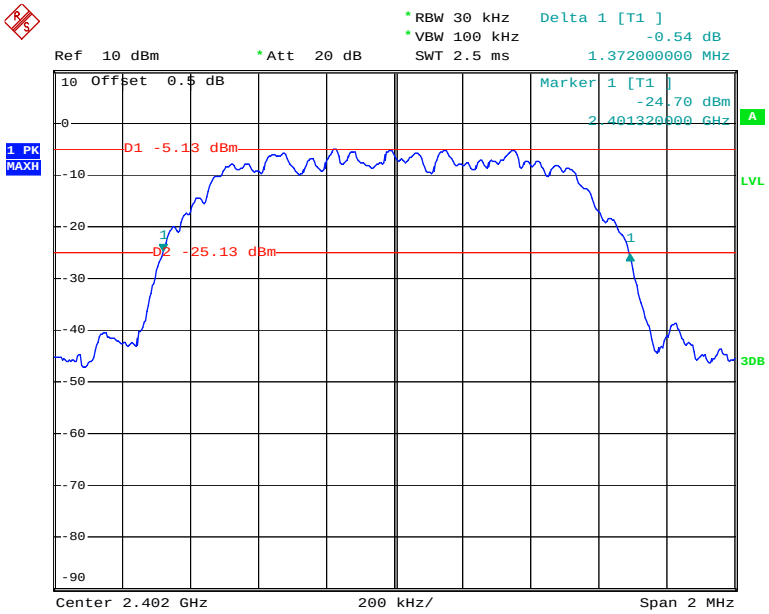
High Channel



Date: 1.NOV.2018 16:53:55

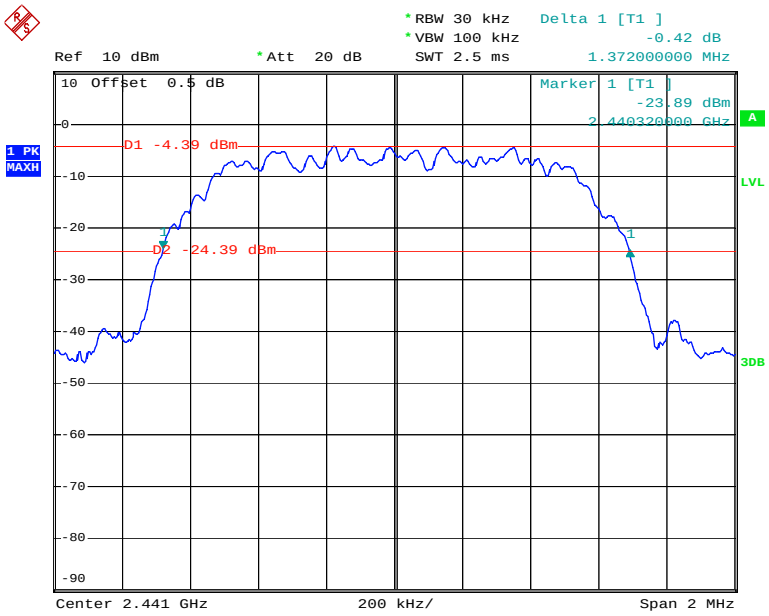
EDR Mode (π/4-DQPSK):

Low Channel



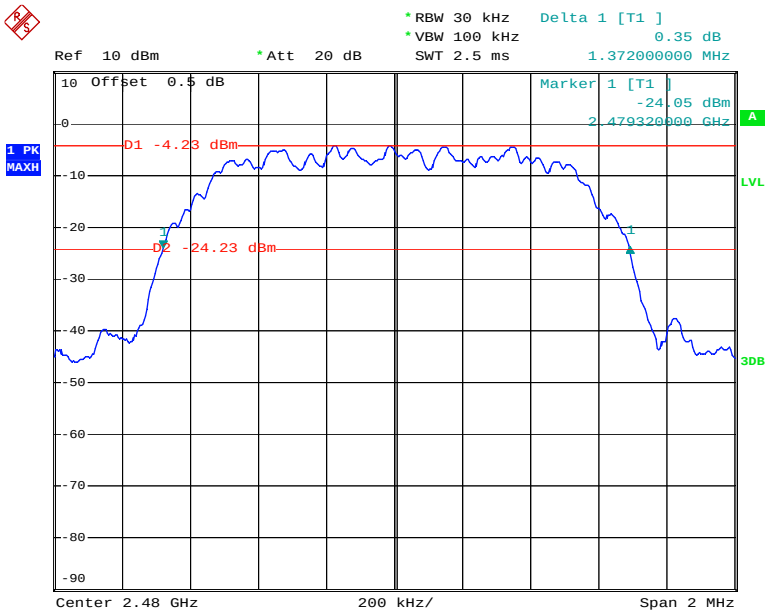
Date: 1.NOV.2018 16:55:29

Middle Channel



Date: 1.NOV.2018 16:57:00

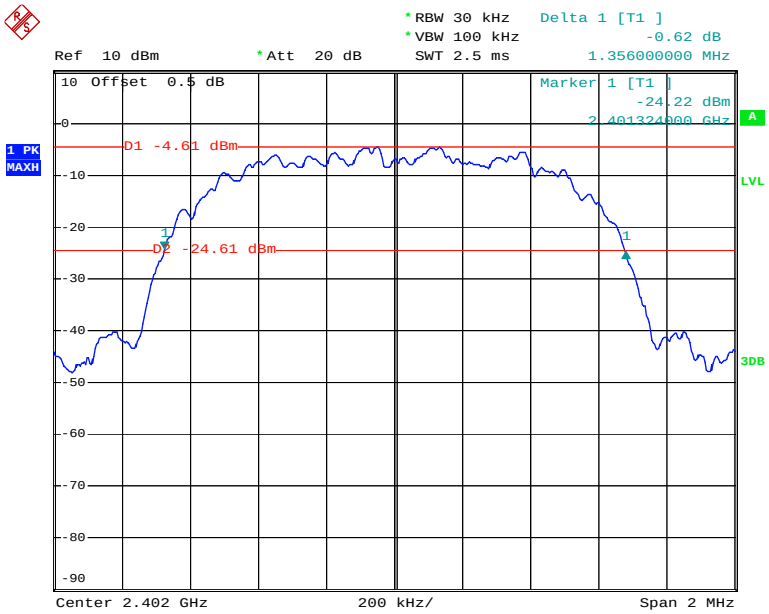
High Channel



Date: 1.NOV.2018 16:57:58

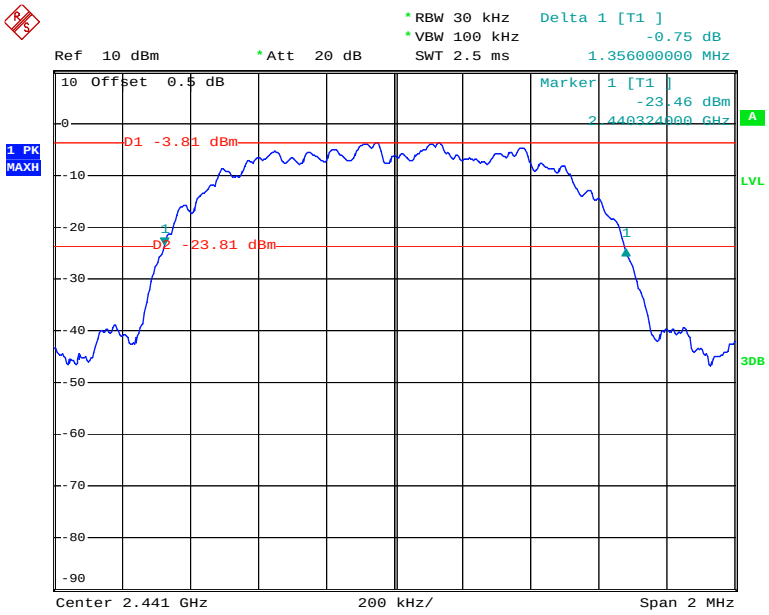
EDR Mode (8DPSK):

Low Channel



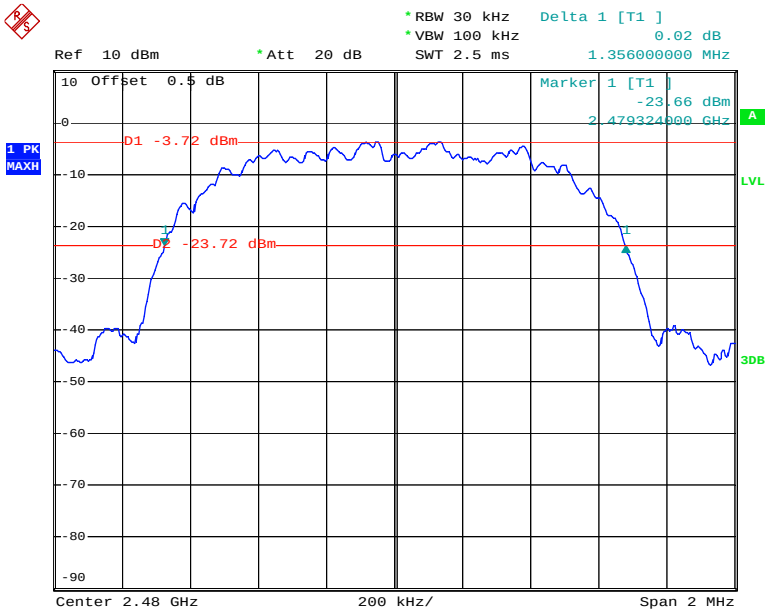
Date: 1.NOV.2018 17:01:57

Middle Channel



Date: 1.NOV.2018 17:00:46

High Channel



Date: 1.NOV.2018 16:59:21

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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2017-12-08	2018-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	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:	28.7 °C
Relative Humidity:	27 %
ATM Pressure:	100.6 kPa

** The testing was performed by Tiago Huang on 2018-11-01.*

Test Result: Compliance.

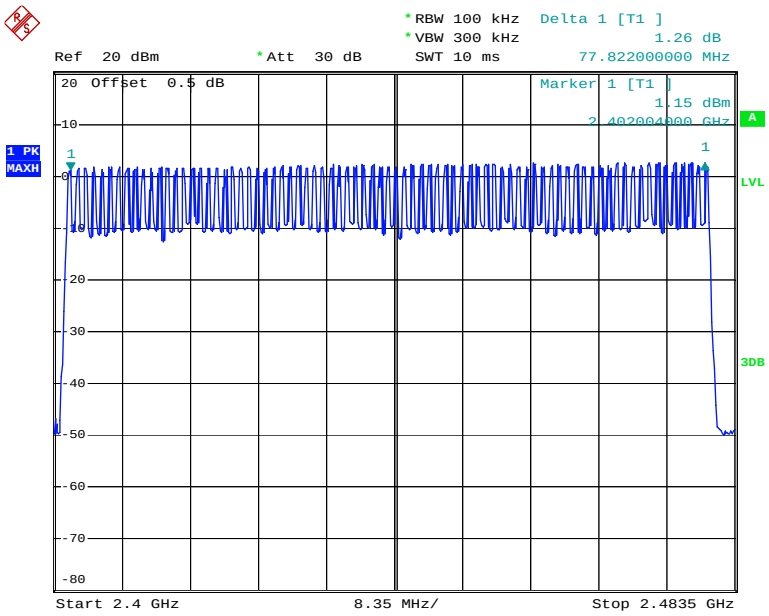
Please refer to following tables and plots

Test Mode: Transmitting

BDR Mode (GFSK):

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

Number of Hopping Channels

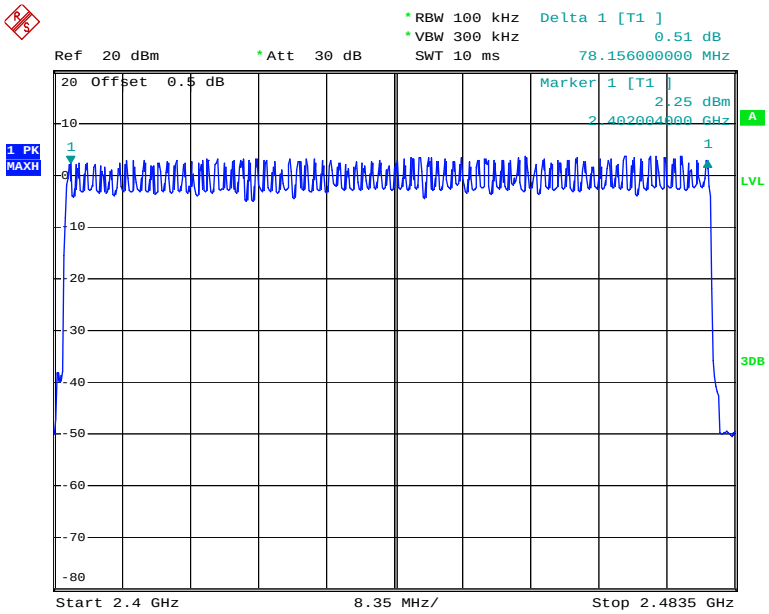


Date: 1.NOV.2018 17:18:56

EDR Mode (π/4-DQPSK):

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

Number of Hopping Channels

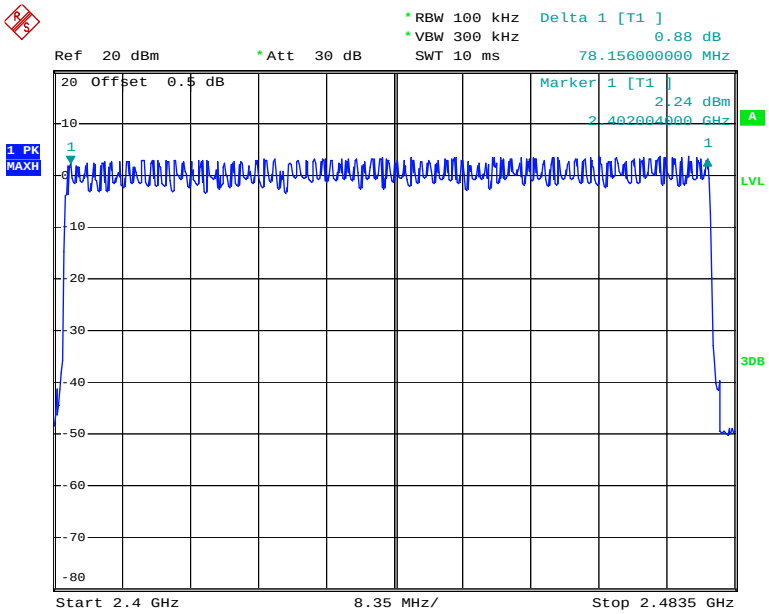


Date: 1.NOV.2018 17:22:11

EDR Mode (8DPSK):

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

Number of Hopping Channels



Date: 1.NOV.2018 17:27:56

FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL 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 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	2017-12-08	2018-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	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:	28.7 °C
Relative Humidity:	27 %
ATM Pressure:	100.6 kPa

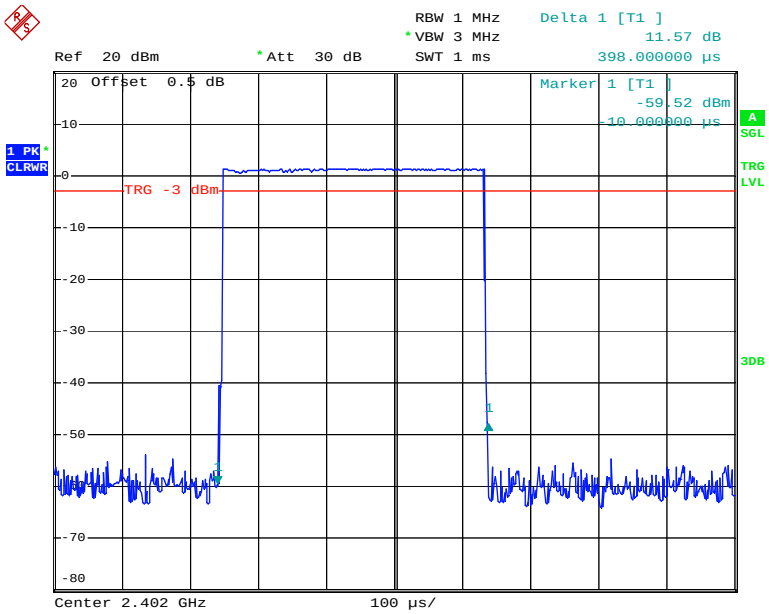
** The testing was performed by Tiago Huang on 2018-11-01.*

Test Mode: Transmitting

BDR Mode (GFSK):

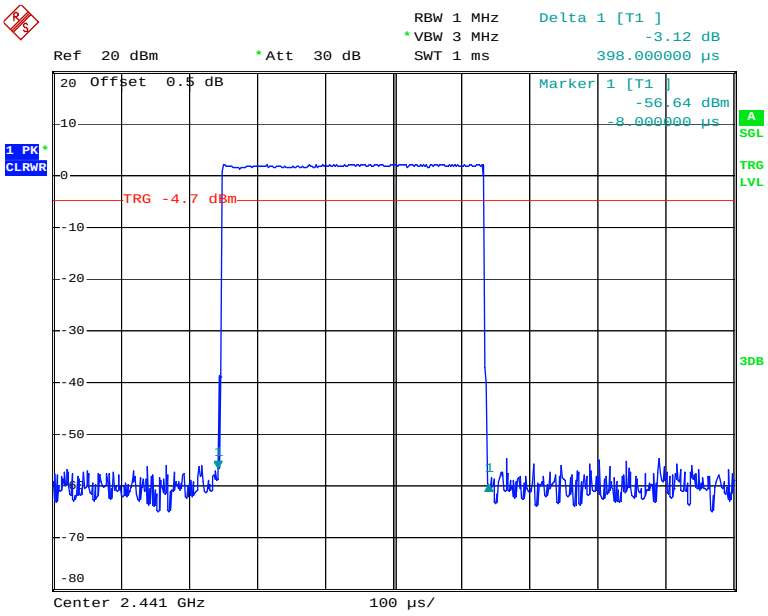
Mode	Channel	Pulse Width (ms)	Dwell Time (s)	Limit (s)	Result
DH1	Low	0.398	0.127	0.4	Compliance
	Middle	0.398	0.127	0.4	Compliance
	High	0.398	0.127	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/2/79) ×31.6 s				
DH3	Low	1.668	0.267	0.4	Compliance
	Middle	1.668	0.267	0.4	Compliance
	High	1.668	0.267	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/4/79) ×31.6 s				
DH5	Low	2.920	0.311	0.4	Compliance
	Middle	2.920	0.311	0.4	Compliance
	High	2.930	0.313	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/6/79) ×31.6 s				

DH1: Low Channel



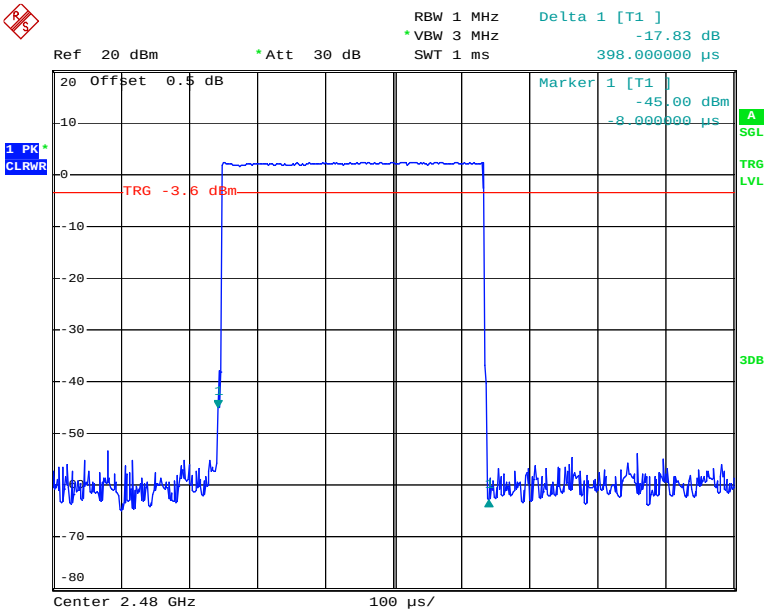
Date: 1.NOV.2018 17:28:58

DH1: Middle Channel



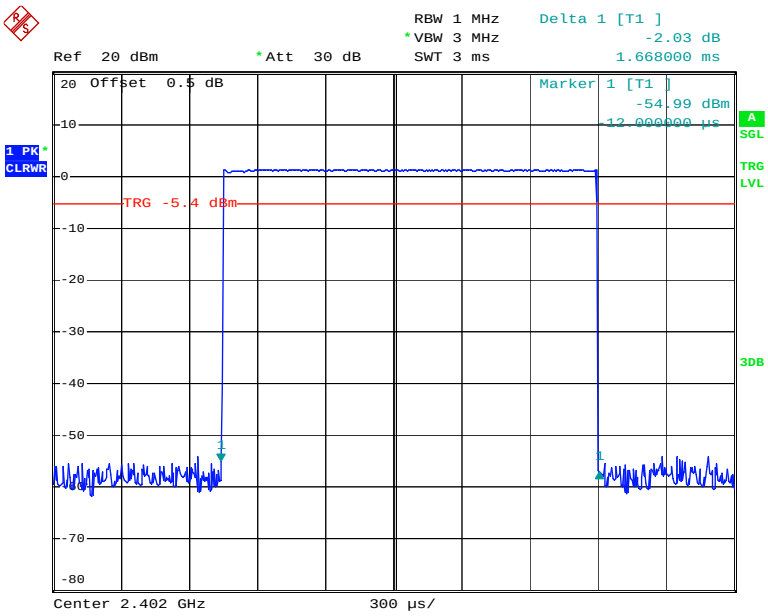
Date: 1.NOV.2018 17:29:02

DH1: High Channel



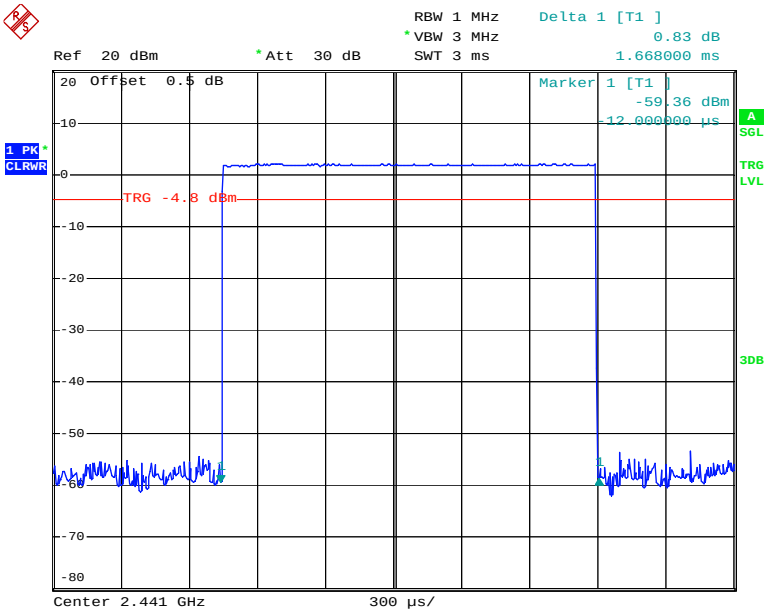
Date: 1.NOV.2018 17:29:06

DH3: Low Channel



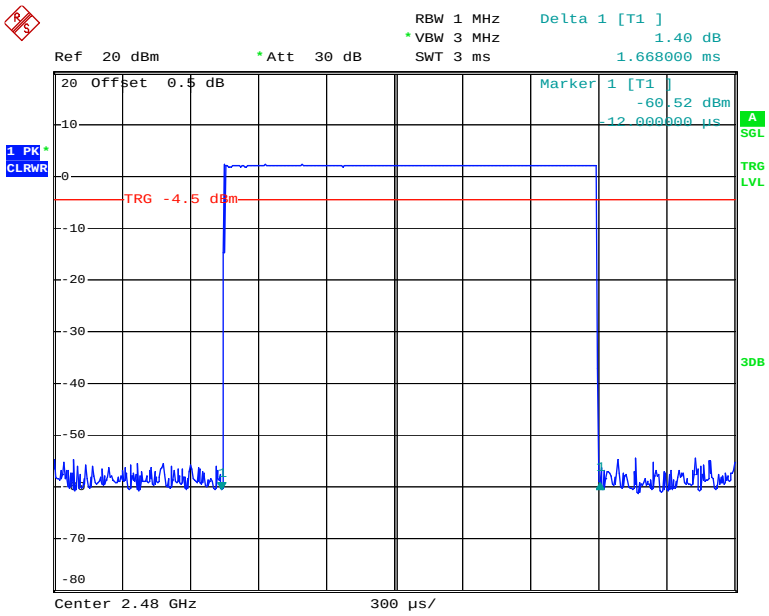
Date: 1.NOV.2018 17:29:23

DH3: Middle Channel



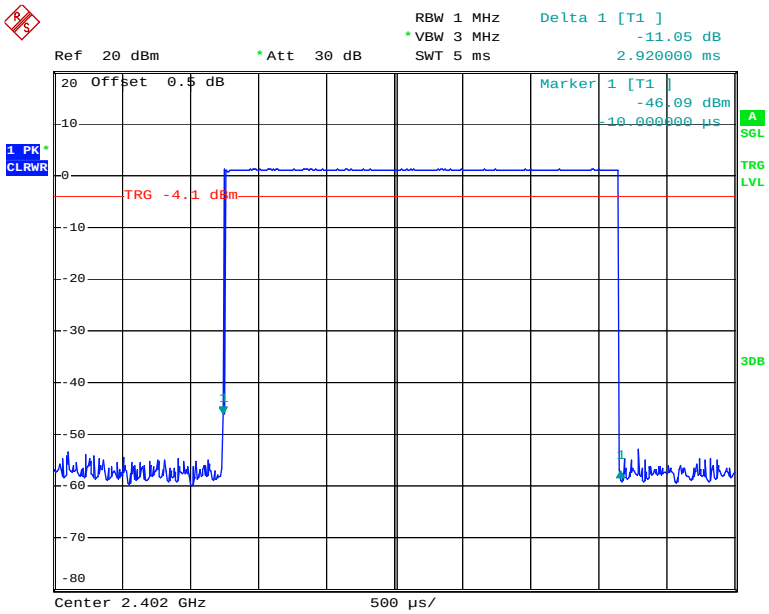
Date: 1.NOV.2018 17:29:27

DH3: High Channel



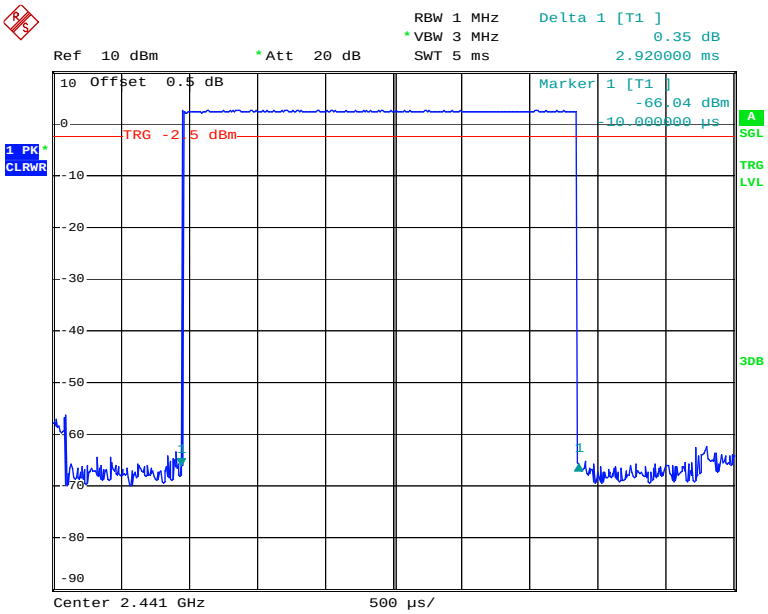
Date: 1.NOV.2018 17:29:31

DH5: Low Channel



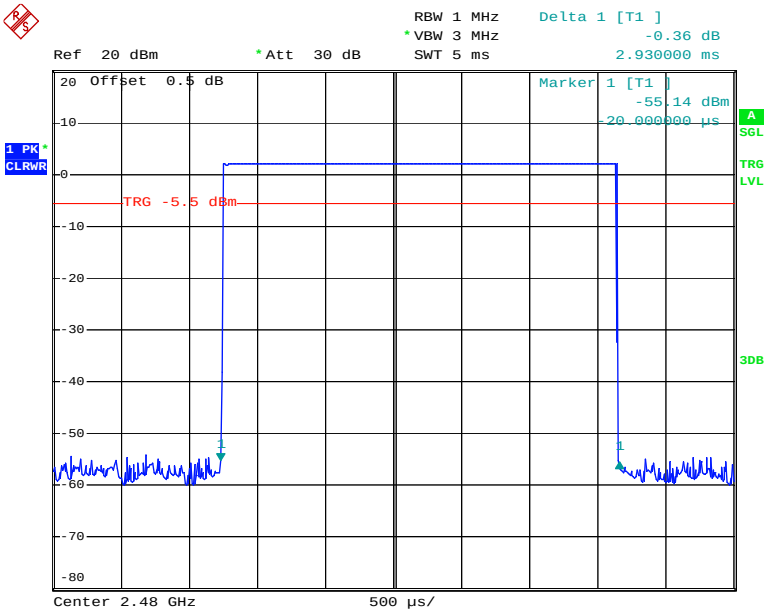
Date: 1.NOV.2018 17:29:51

DH5: Middle Channel



Date: 1.NOV.2018 21:00:54

DH5: High Channel

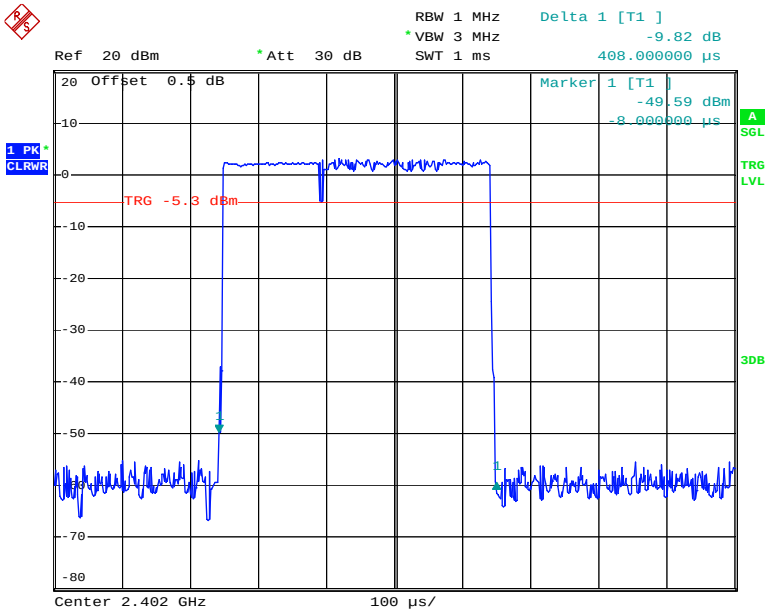


Date: 1.NOV.2018 17:30:00

EDR Mode (π/4-DQPSK):

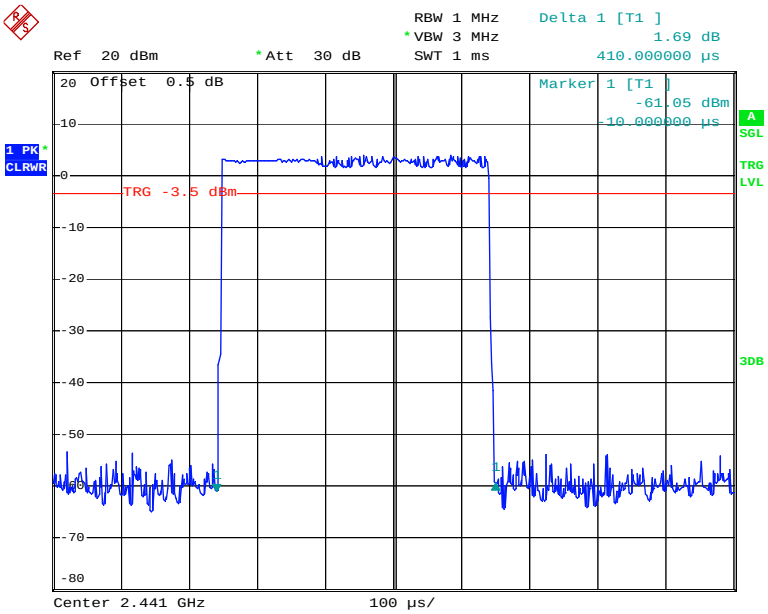
Mode	Channel	Pulse Width (ms)	Dwell Time (s)	Limit (s)	Result
2DH1	Low	0.408	0.131	0.4	Compliance
	Middle	0.410	0.131	0.4	Compliance
	High	0.410	0.131	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/2/79) ×31.6 s				
2DH3	Low	1.674	0.268	0.4	Compliance
	Middle	1.674	0.268	0.4	Compliance
	High	1.698	0.272	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/4/79) ×31.6 s				
2DH5	Low	2.930	0.313	0.4	Compliance
	Middle	2.930	0.313	0.4	Compliance
	High	2.930	0.313	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/6/79) ×31.6 s				

2DH1: Low Channel



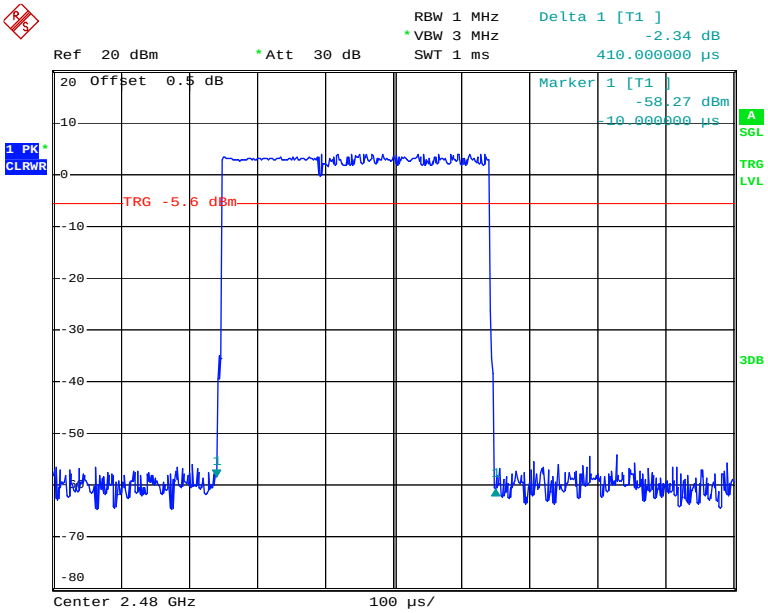
Date: 1.NOV.2018 17:30:26

2DH1: Middle Channel



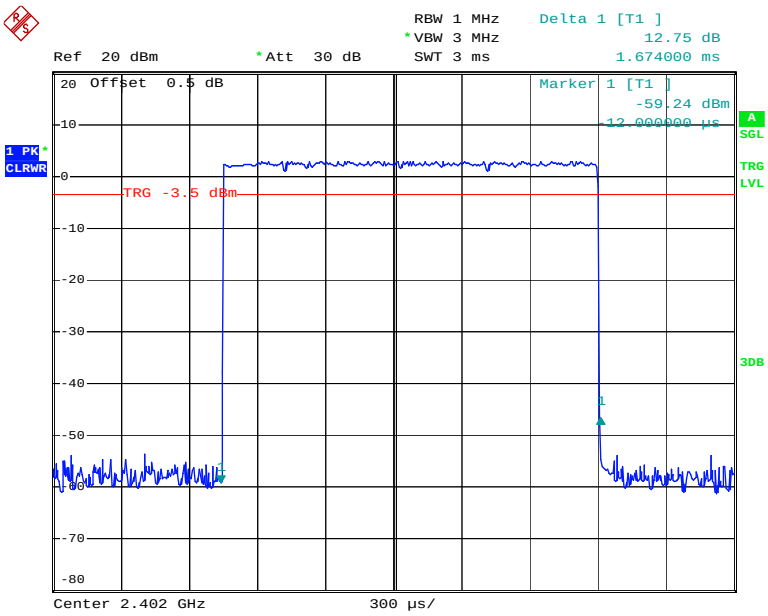
Date: 1.NOV.2018 17:30:33

2DH1: High Channel



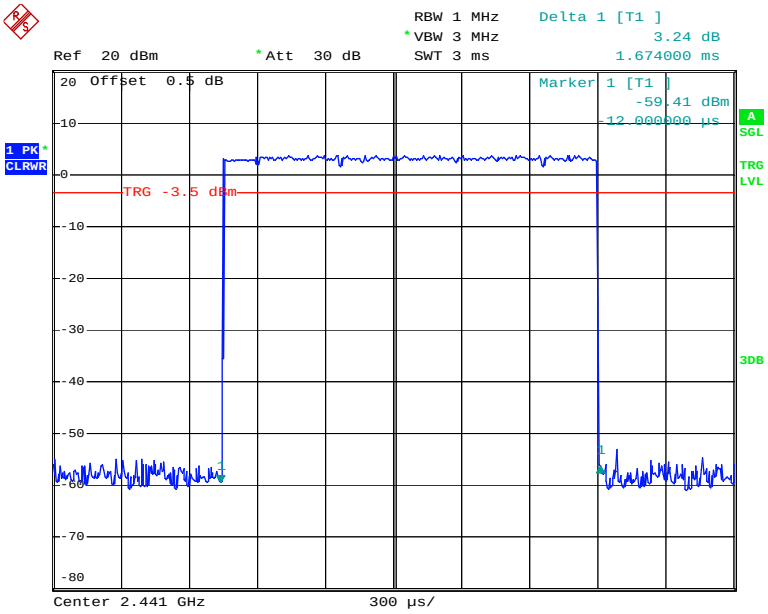
Date: 1.NOV.2018 17:30:39

2DH3: Low Channel



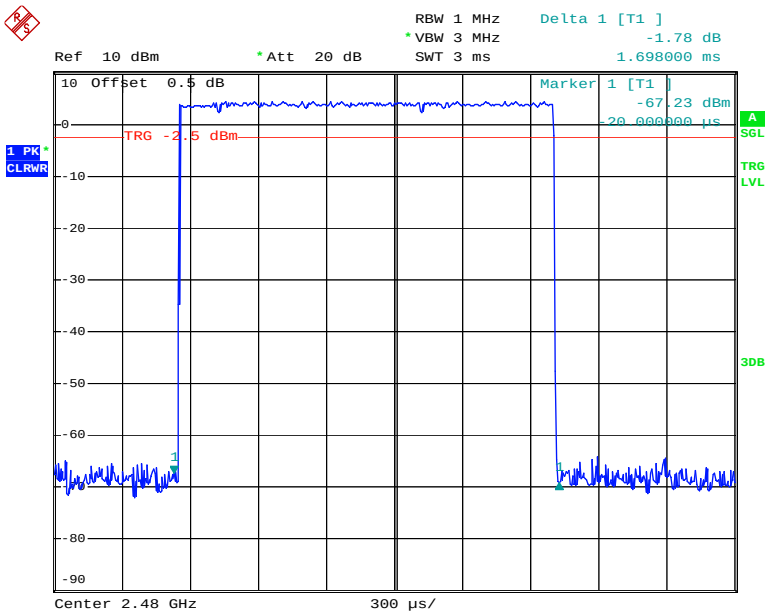
Date: 1.NOV.2018 17:31:29

2DH3: Middle Channel



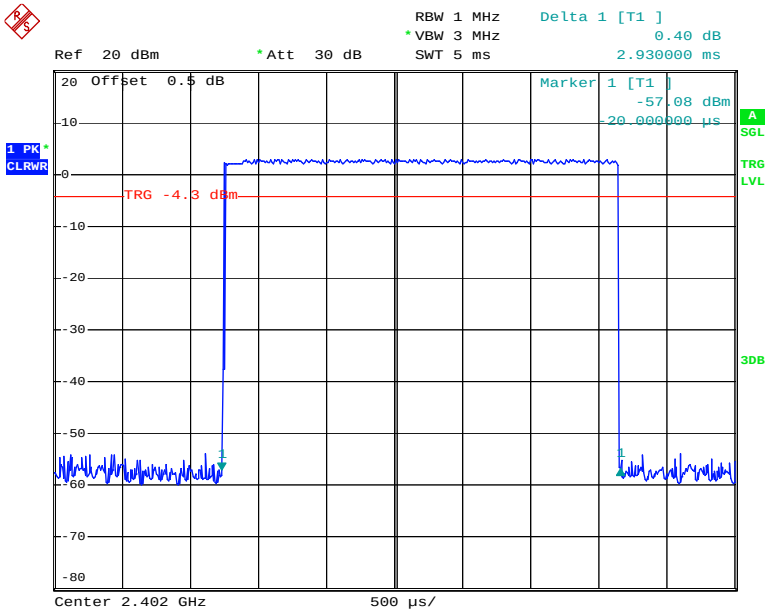
Date: 1.NOV.2018 17:31:33

2DH3: High Channel



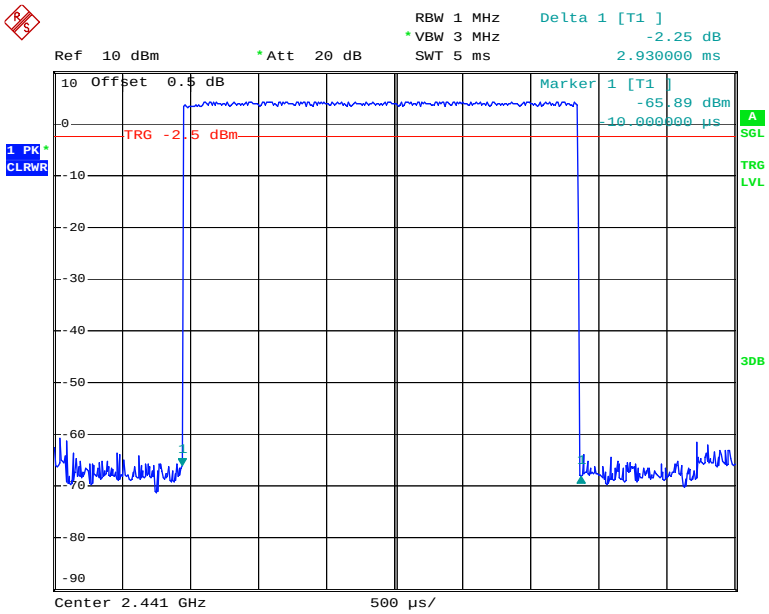
Date: 1.NOV.2018 21:03:16

2DH5: Low Channel



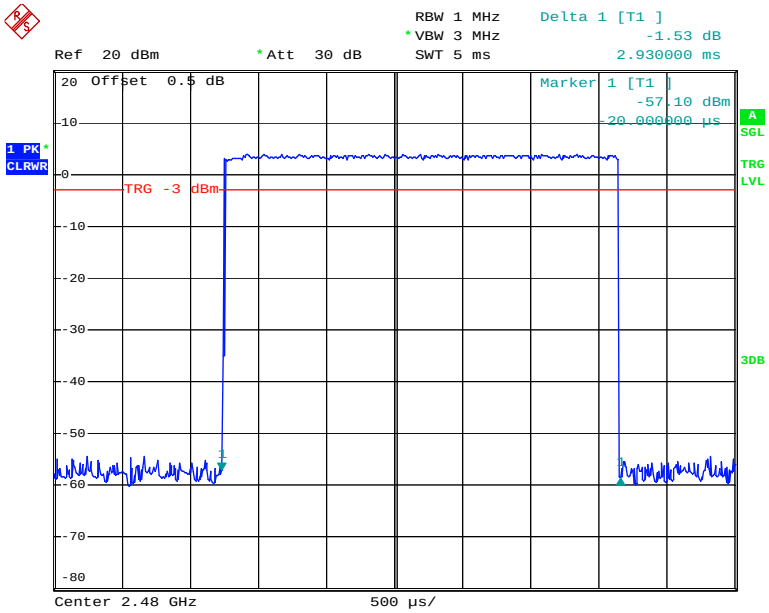
Date: 1.NOV.2018 17:31:54

2DH5: Middle Channel



Date: 1.NOV.2018 21:01:36

2DH5: High Channel

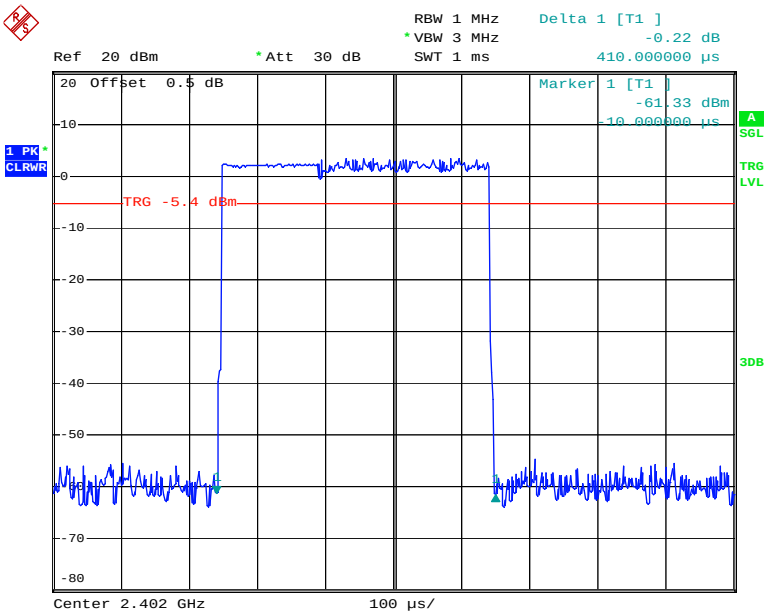


Date: 1.NOV.2018 17:32:02

EDR Mode (8DPSK):

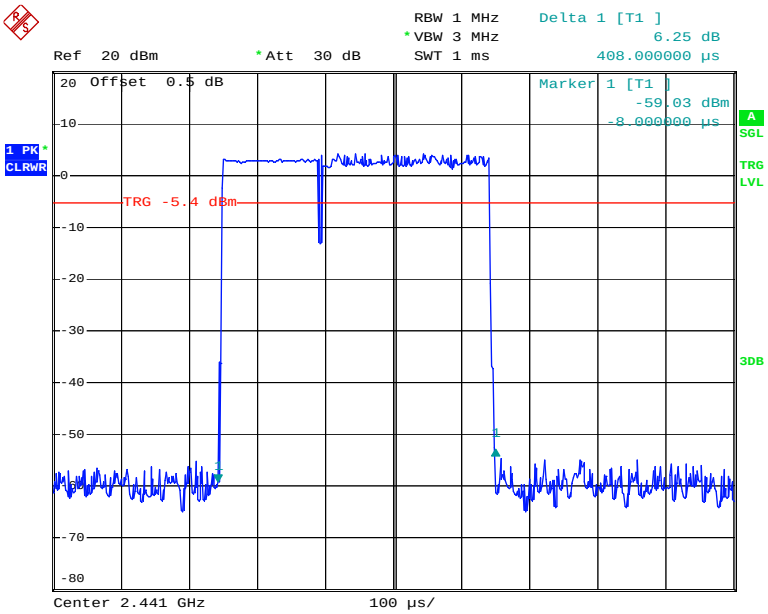
Mode	Channel	Pulse Width (ms)	Dwell Time (s)	Limit (s)	Result
3DH1	Low	0.410	0.131	0.4	Compliance
	Middle	0.408	0.131	0.4	Compliance
	High	0.408	0.131	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/2/79) ×31.6 s				
3DH3	Low	1.674	0.268	0.4	Compliance
	Middle	1.698	0.272	0.4	Compliance
	High	1.674	0.268	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/4/79) ×31.6 s				
3DH5	Low	2.940	0.314	0.4	Compliance
	Middle	2.940	0.314	0.4	Compliance
	High	2.940	0.314	0.4	Compliance
	Note: Dwell time=Pulse time (ms) × (1600/6/79) ×31.6 s				

3DH1: Low Channel



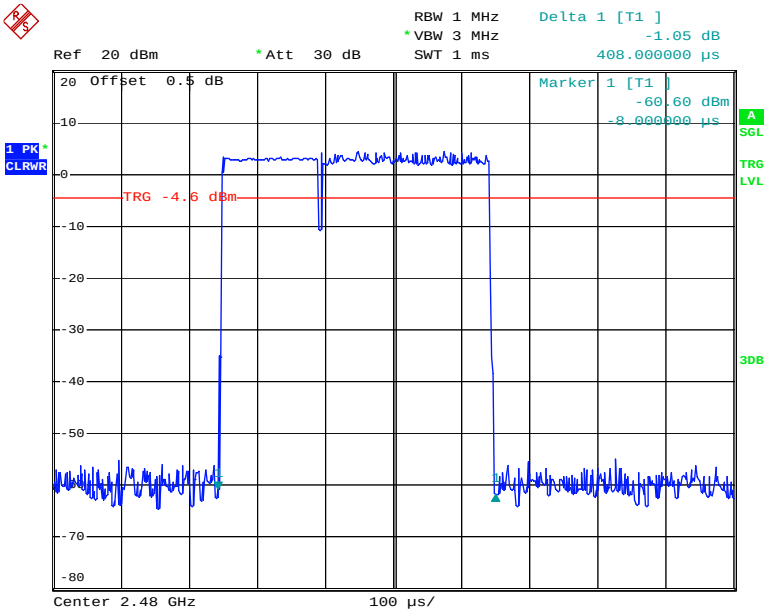
Date: 1.NOV.2018 17:34:19

3DH1: Middle Channel



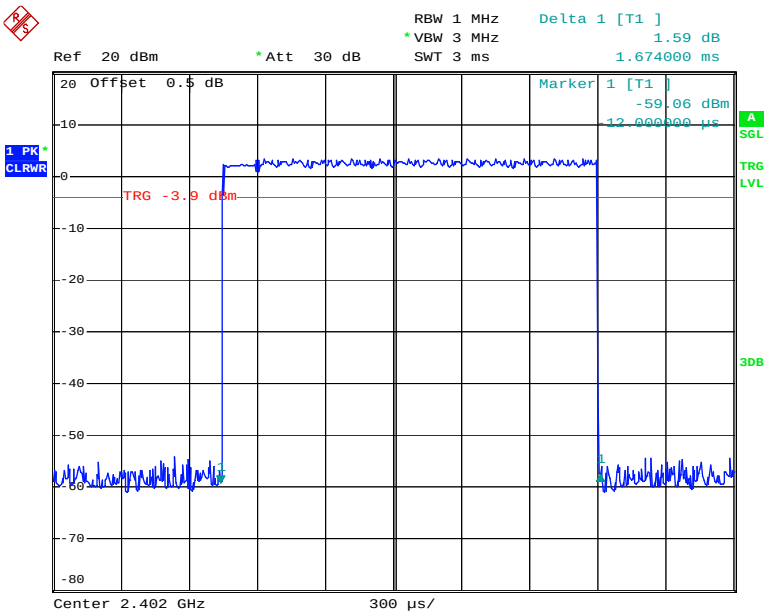
Date: 1.NOV.2018 17:34:23

3DH1: High Channel



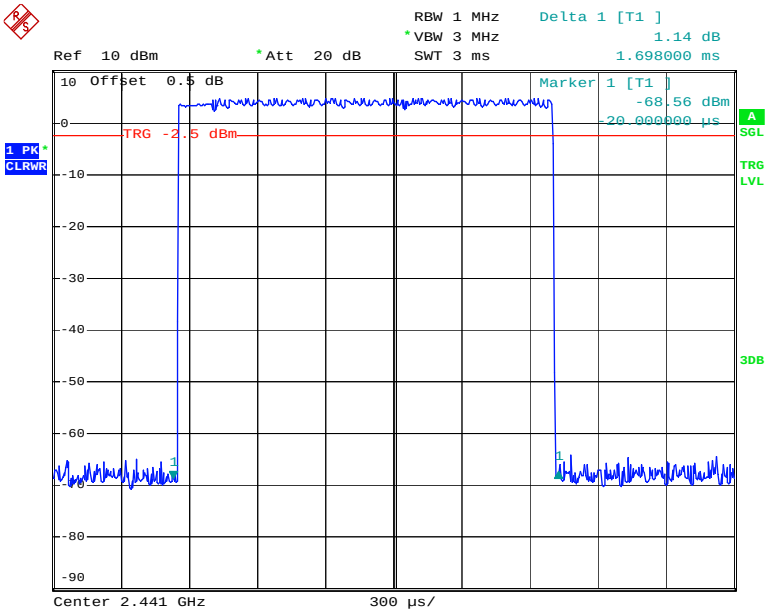
Date: 1.NOV.2018 17:34:26

3DH3: Low Channel



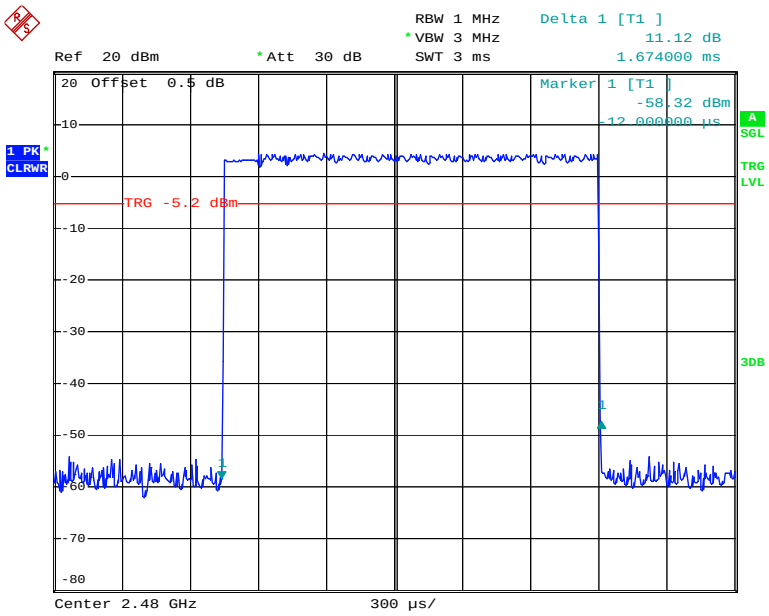
Date: 1.NOV.2018 17:35:20

3DH3: Middle Channel



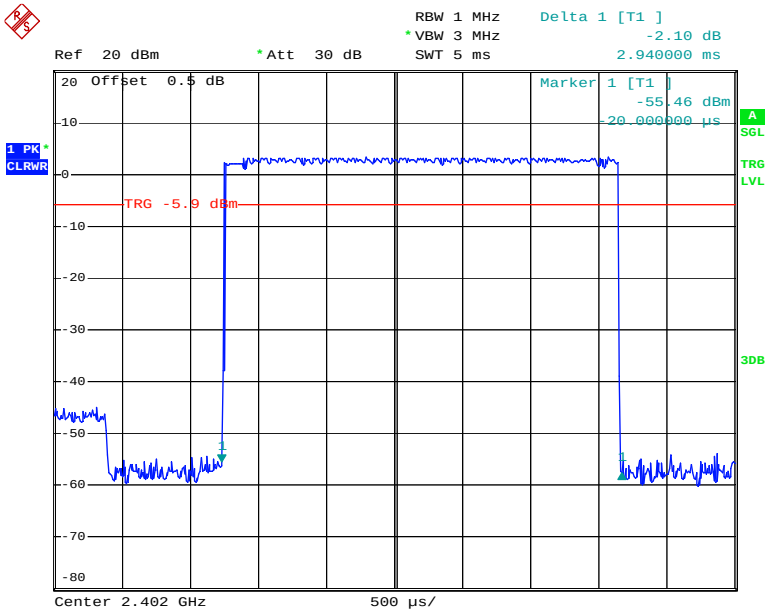
Date: 1.NOV.2018 21:04:24

3DH3: High Channel



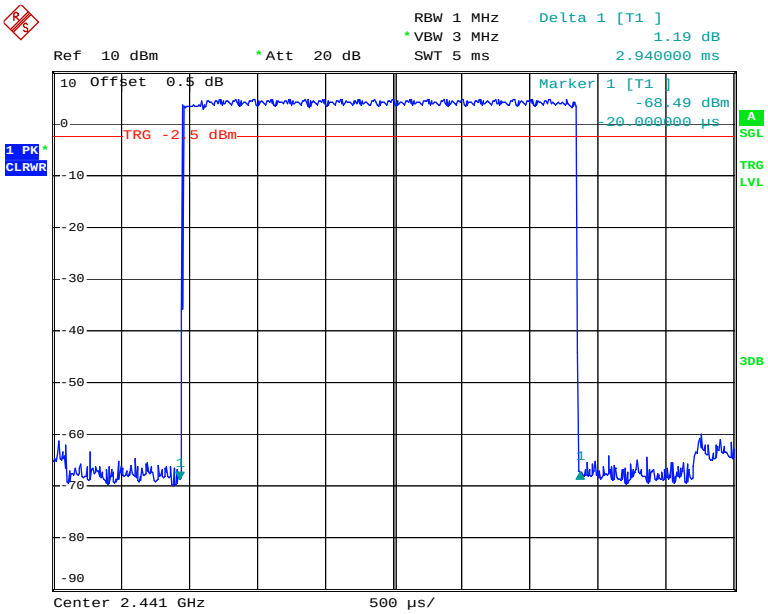
Date: 1.NOV.2018 17:35:28

3DH5: Low Channel



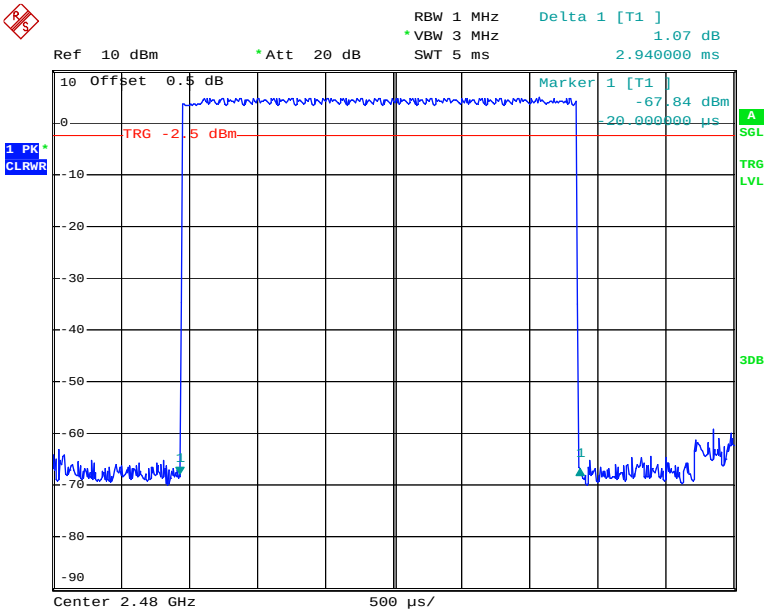
Date: 1.NOV.2018 17:36:05

3DH5: Middle Channel



Date: 1.NOV.2018 21:02:12

3DH5: High Channel



Date: 1.NOV.2018 21:02:32

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
R&S	Spectrum Analyzer	FSP 38	100478	2017-12-08	2018-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	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:	28.7 °C
Relative Humidity:	27 %
ATM Pressure:	100.6 kPa

** The testing was performed by Tiago Huang on 2018-11-01.*

Test Result: Compliance.

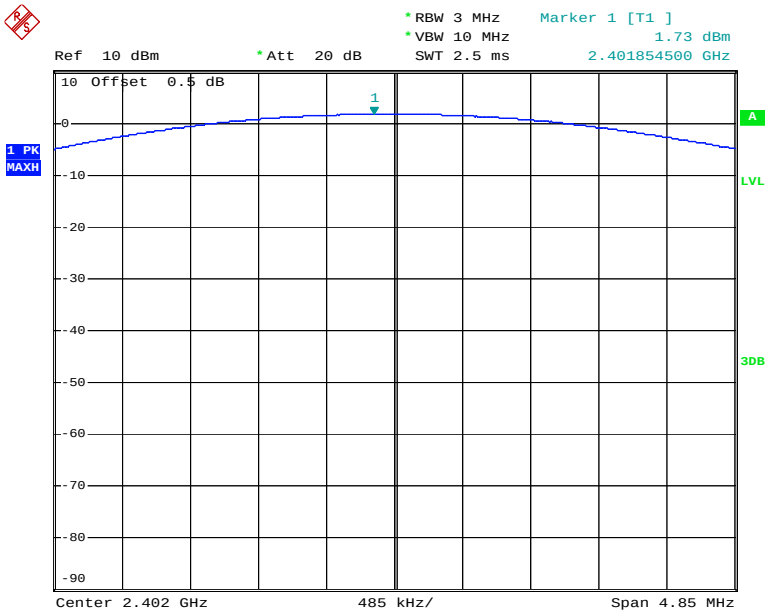
Test Mode: Transmitting

Mode	Frequency (MHz)	Peak Conducted Output power (dBm)	Limit (dBm)
BDR Mode (GFSK)	2402	1.73	21
	2441	1.79	21
	2480	1.94	21
EDR Mode (π/4-DQPSK)	2402	3.47	21
	2441	4.17	21
	2480	4.32	21
EDR Mode (8DPSK)	2402	3.93	21
	2441	4.66	21
	2480	4.78	21

Note: The data above was tested in conducted mode.

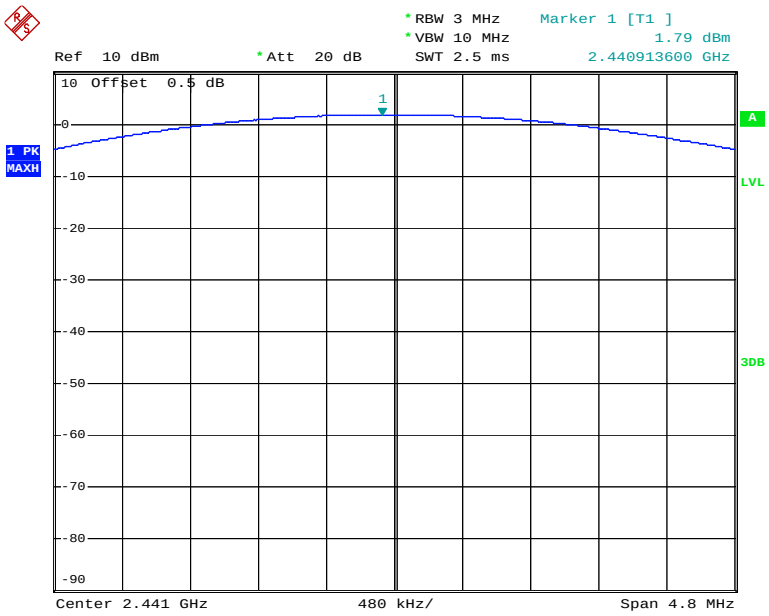
BDR Mode (GFSK):

Low Channel



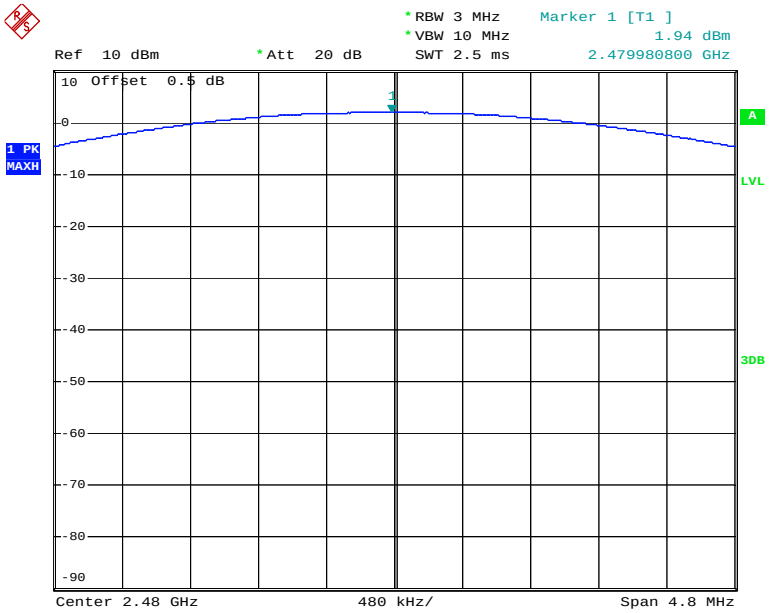
Date: 1.NOV.2018 20:28:37

Middle Channel



Date: 1.NOV.2018 16:53:28

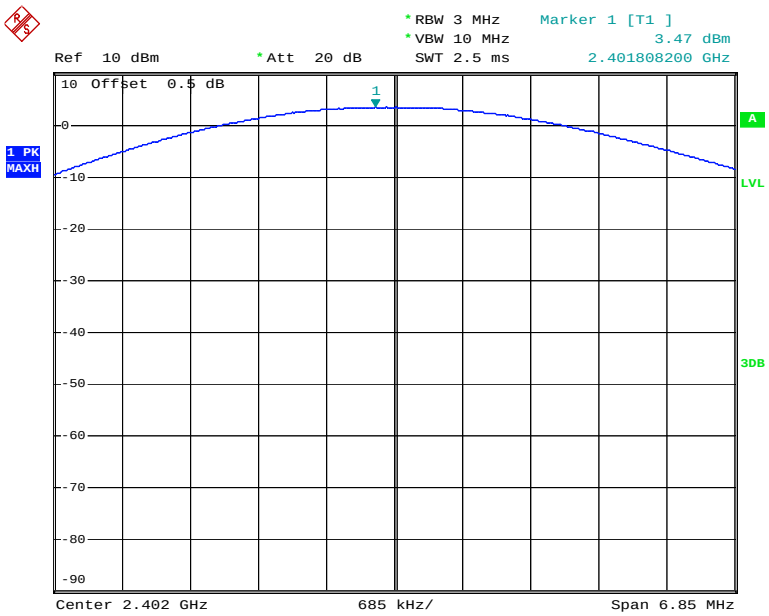
High Channel



Date: 1.NOV.2018 16:54:24

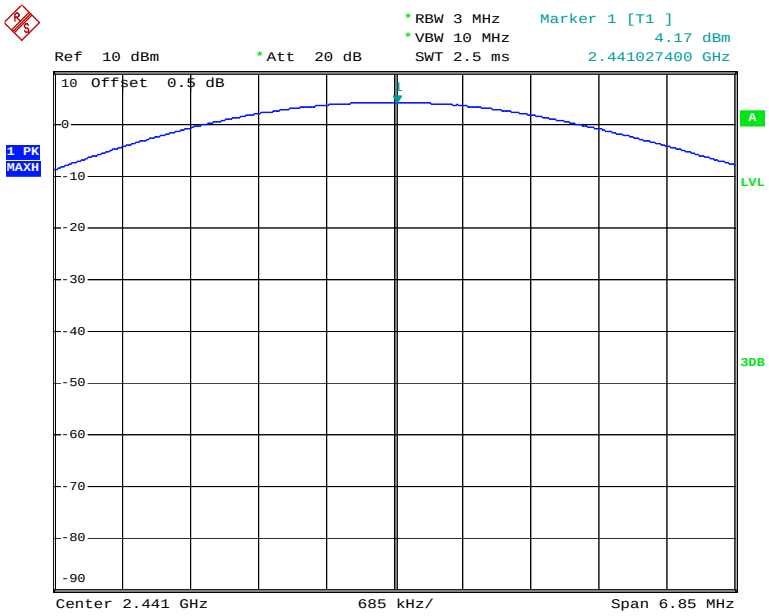
EDR Mode (π/4-DQPSK):

Low Channel



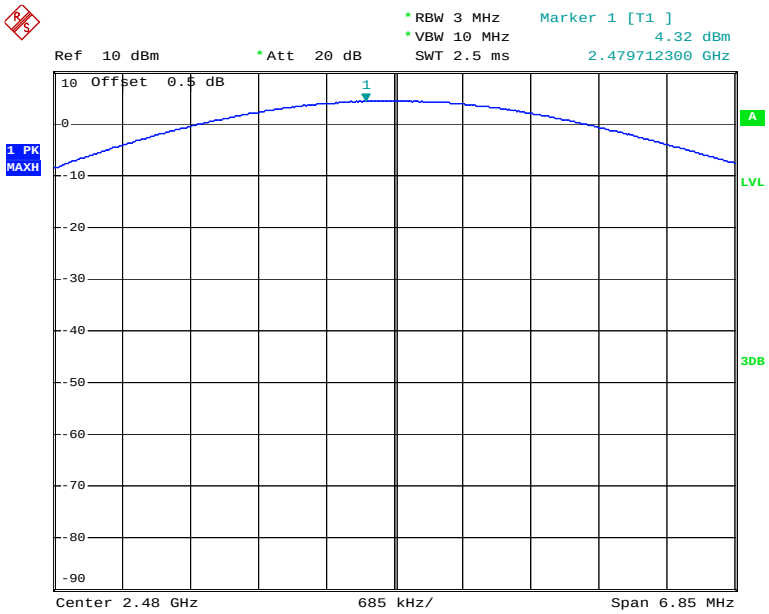
Date: 1.NOV.2018 16:56:03

Middle Channel



Date: 1.NOV.2018 16:57:29

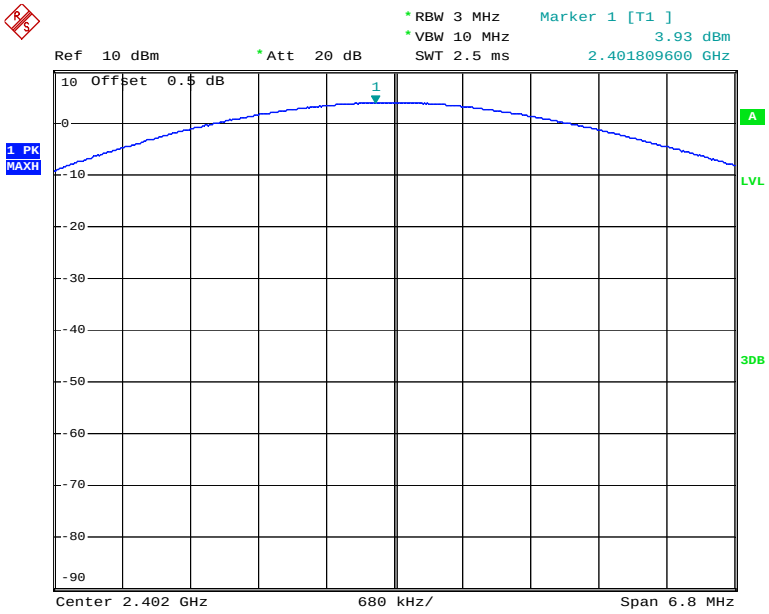
High Channel



Date: 1.NOV.2018 16:58:28

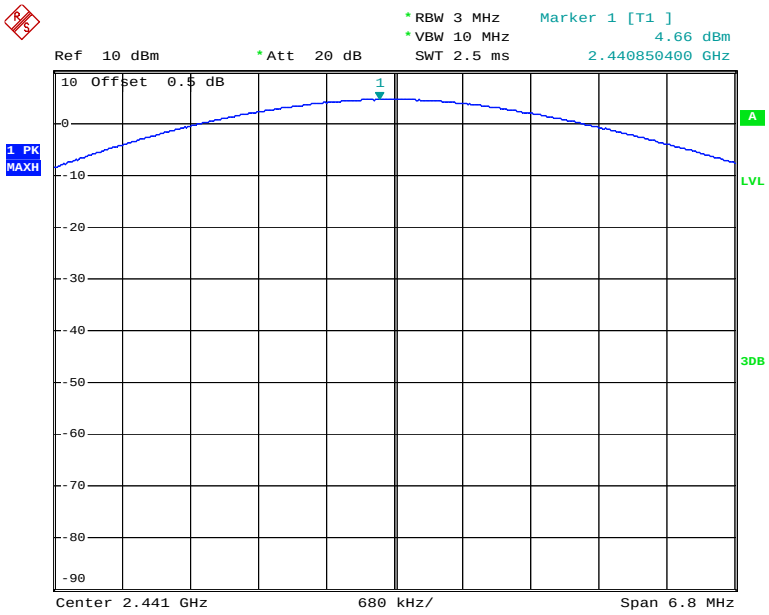
EDR Mode (8-DPSK):

Low Channel



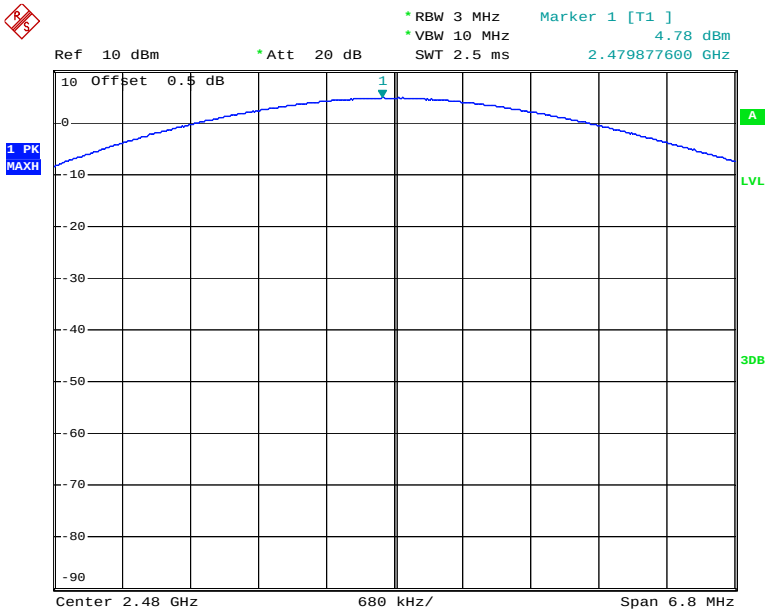
Date: 1.NOV.2018 17:02:35

Middle Channel



Date: 1.NOV.2018 17:01:19

High Channel



Date: 1.NOV.2018 16:59:50

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/ 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	2017-12-08	2018-12-08
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	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

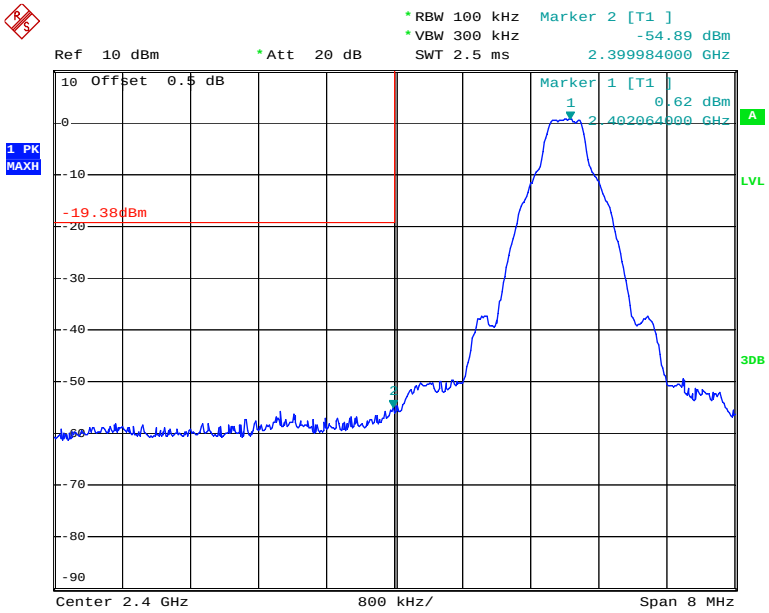
Temperature:	28.7 °C
Relative Humidity:	27 %
ATM Pressure:	100.6 kPa

** The testing was performed by Tiago Huang on 2018-11-01.*

Test Result: Compliance

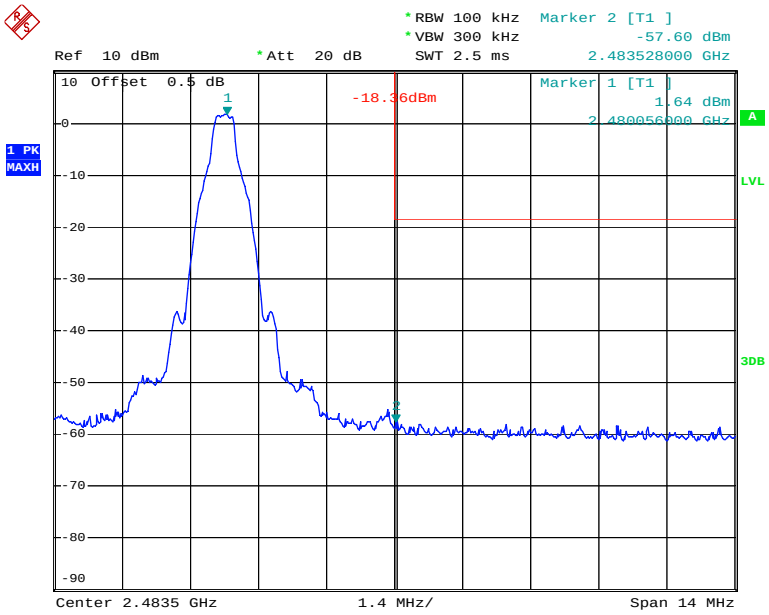
Single mode:
BDR Mode (GFSK):

Band Edge, Left Side



Date: 1.NOV.2018 16:52:26

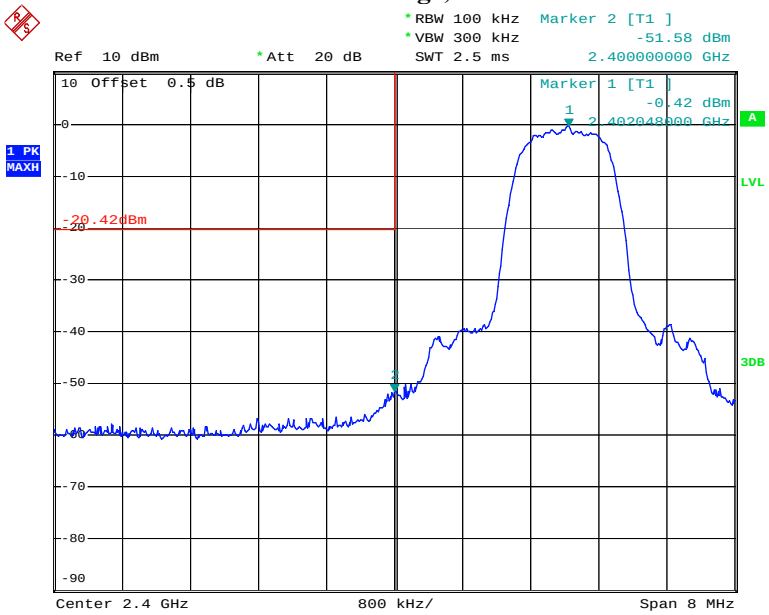
Band Edge, Right Side



Date: 1.NOV.2018 16:54:55

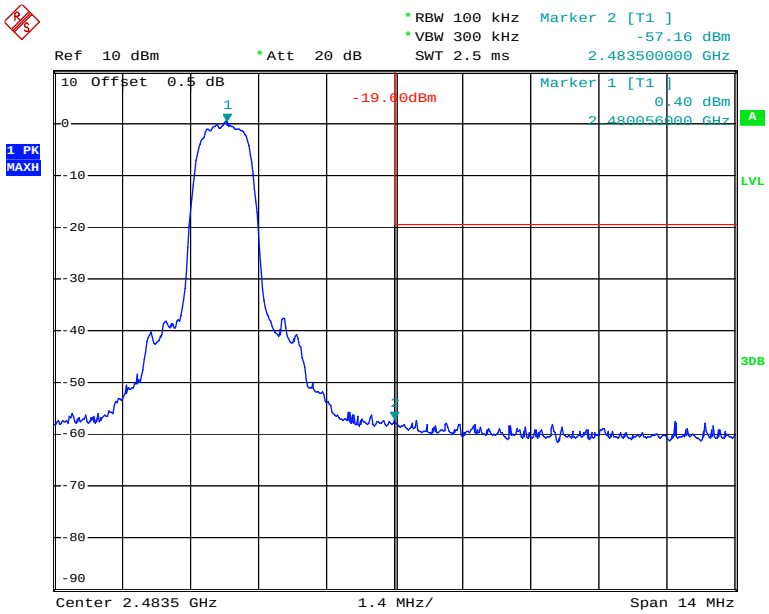
EDR Mode (π/4-DQPSK):

Band Edge, Left Side



Date: 1.NOV.2018 16:56:29

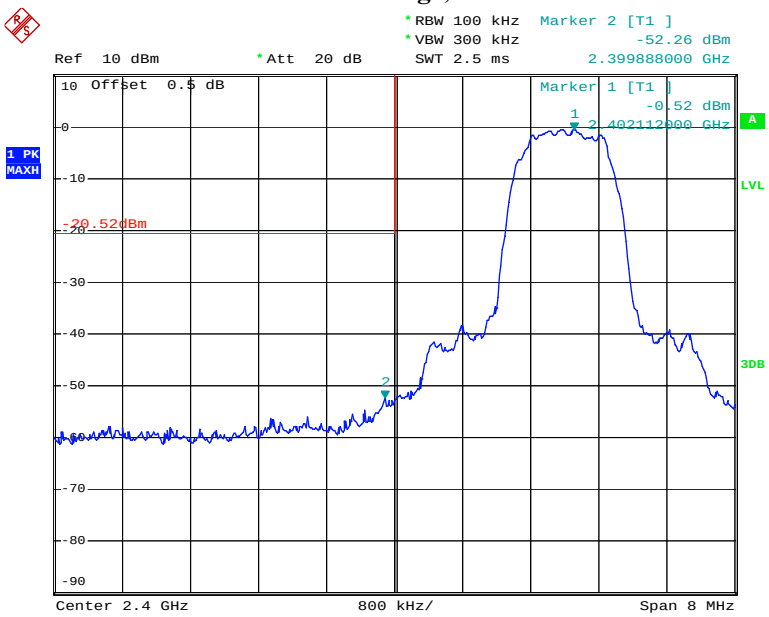
Band Edge, Right Side



Date: 1.NOV.2018 16:58:54

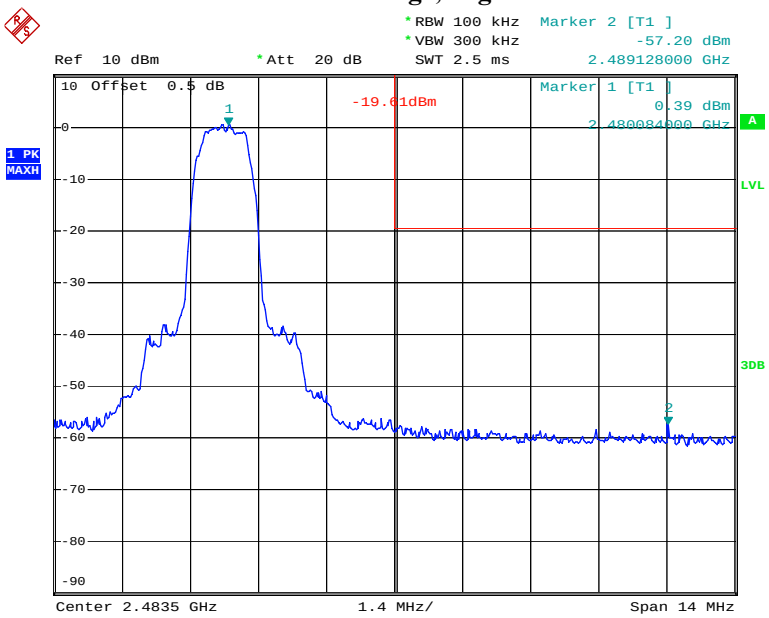
EDR Mode (8DPSK):

Band Edge, Left Side



Date: 1.NOV.2018 17:02:57

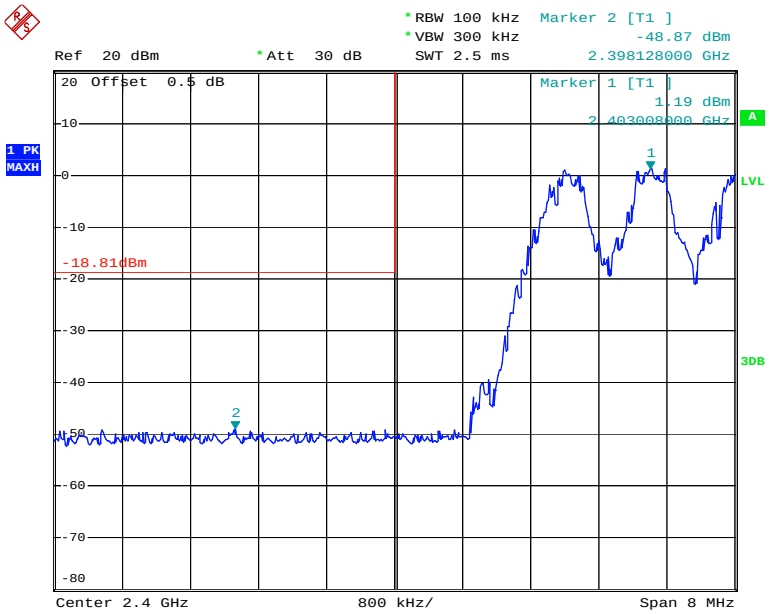
Band Edge, Right Side



Date: 1.NOV.2018 17:00:14

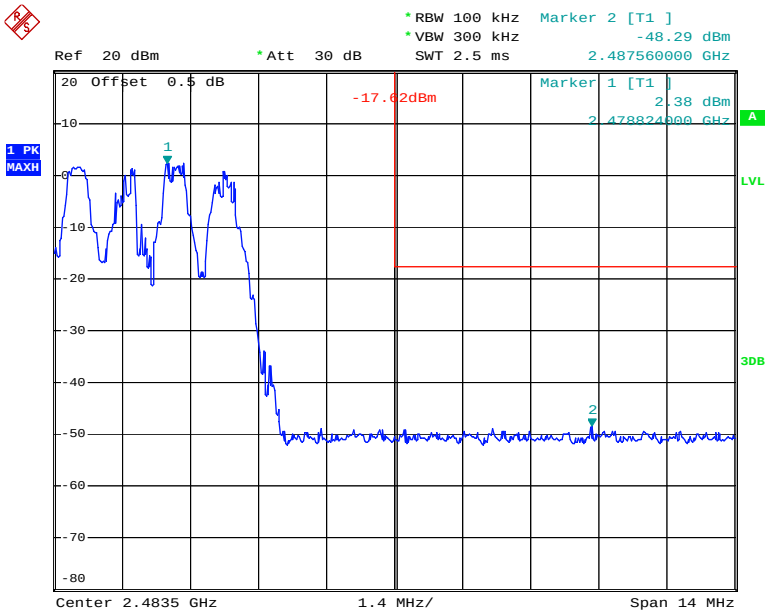
Hopping mode:
BDR Mode (GFSK):

Band Edge, Left Side



Date: 1.NOV.2018 17:37:25

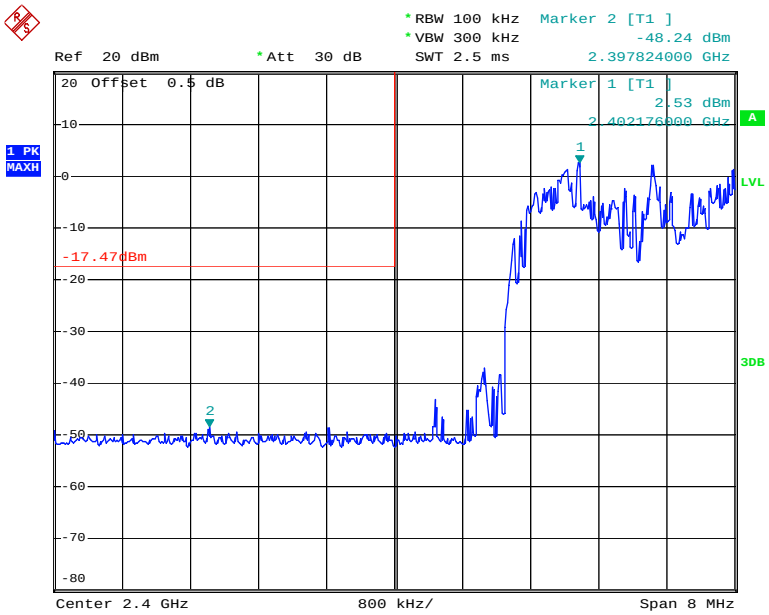
Band Edge, Right Side



Date: 1.NOV.2018 17:38:05

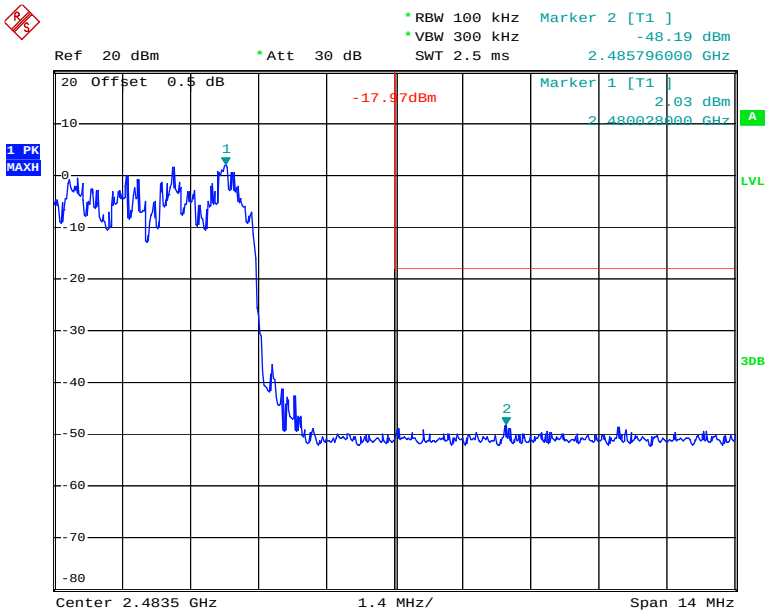
EDR Mode (π/4-DQPSK):

Band Edge, Left Side



Date: 1.NOV.2018 17:39:15

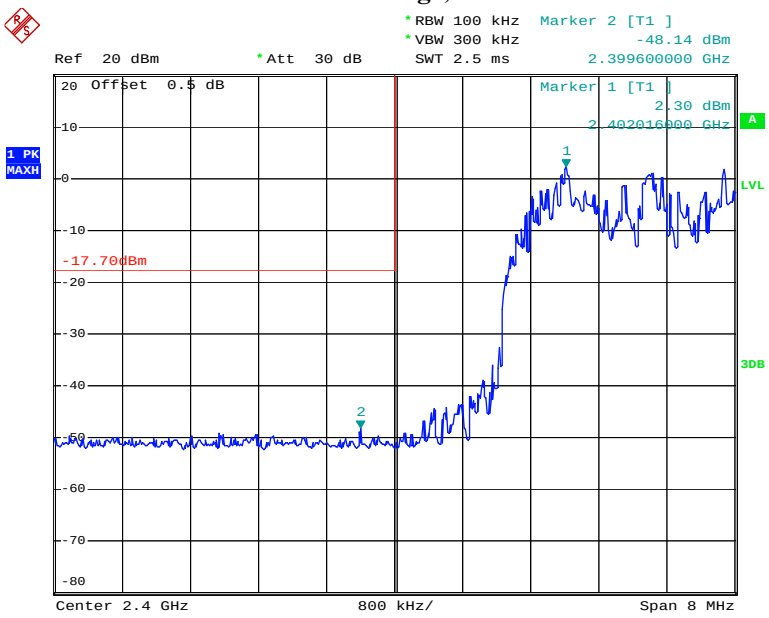
Band Edge, Right Side



Date: 1.NOV.2018 17:38:40

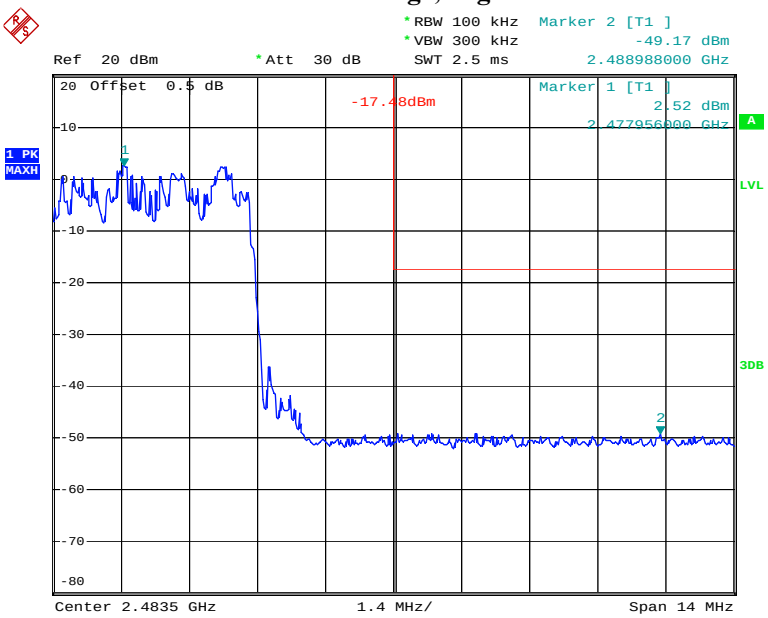
EDR Mode (8DPSK):

Band Edge, Left Side



Date: 1.NOV.2018 17:39:50

Band Edge, Right Side



Date: 1.NOV.2018 17:40:27

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