TESTING LABORATORY
CERTIFICATE #4820.01

FCC PART 15.247

TEST REPORT

For

freeVoice AG

Industriestrasse 4a CH-8604 Volketswil Switzerland

FCC ID: 2APKR-FBT650B

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

Report Number:	RXM190125055-00B
Report Date:	2019-05-15
Reviewed By:	Jerry Zhang EMC Manager Jerry Zhang
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TABLE OF CONTENTS

GENERAL INFORMATION **4**
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) 4
OBJECTIVE 4
RELATED SUBMITTAL(S)/GRANT(S) 4
TEST METHODOLOGY 4
MEASUREMENT UNCERTAINTY 5
TEST FACILITY 5
SYSTEM TEST CONFIGURATION **6**
DESCRIPTION OF TEST CONFIGURATION 6
EUT EXERCISE SOFTWARE 6
EQUIPMENT MODIFICATIONS 6
LOCAL SUPPORT EQUIPMENT LIST AND DETAILS 7
SUPPORT CABLE LIST AND DETAILS 7
BLOCK DIAGRAM OF TEST SETUP 7
SUMMARY OF TEST RESULTS **9**
FCC §15.247 (i) & §1.1310 & §2.1093- RF EXPOSURE **10**
APPLICABLE STANDARD 10
FCC §15.203 - ANTENNA REQUIREMENT **11**
APPLICABLE STANDARD 11
ANTENNA CONNECTOR CONSTRUCTION 11
FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS **12**
APPLICABLE STANDARD 12
EUT SETUP 12
EMI TEST RECEIVER SETUP 12
TEST PROCEDURE 12
CORRECTED AMPLITUDE & MARGIN CALCULATION 13
TEST EQUIPMENT LIST AND DETAILS 13
TEST DATA 13
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS **18**
APPLICABLE STANDARD 18
EUT SETUP 18
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP 19
TEST PROCEDURE 19
CORRECTED AMPLITUDE & MARGIN CALCULATION 19
TEST EQUIPMENT LIST AND DETAILS 20
TEST DATA 20
FCC §15.247(a) (1) - CHANNEL SEPARATION TEST **26**
APPLICABLE STANDARD 26
TEST EQUIPMENT LIST AND DETAILS 26
TEST PROCEDURE 26
TEST DATA 26
FCC §15.247(a) (1) – 20 dB BANDWIDTH TESTING **32**
APPLICABLE STANDARD 32
TEST PROCEDURE 32
TEST EQUIPMENT LIST AND DETAILS 32
TEST DATA 32

FCC §15.247(a) (1) (iii) - QUANTITY OF HOPPING CHANNEL TEST 38
APPLICABLE STANDARD 38
TEST PROCEDURE 38
TEST EQUIPMENT LIST AND DETAILS 38
TEST DATA 38
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME) 42
APPLICABLE STANDARD 42
TEST PROCEDURE 42
TEST EQUIPMENT LIST AND DETAILS 42
TEST DATA 42
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT 48
APPLICABLE STANDARD 48
TEST PROCEDURE 48
TEST EQUIPMENT LIST AND DETAILS 48
TEST DATA 48
FCC §15.247(d) - BAND EDGES TESTING 50
APPLICABLE STANDARD 50
TEST PROCEDURE 50
TEST EQUIPMENT LIST AND DETAILS 50
TEST DATA 51

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	freeVoice Space Bluetooth Headset
EUT Model:	FBT650B
Multiple Models:	9605 BT, ZUMBTP-400
Operation Frequency:	2402-2480 MHz
Output Power(Conducted):	6.38 dBm
Modulation Type:	GFSK, π/4-DQPSK, 8-DPSK
Rated Input Voltage:	DC3.7V from Battery
External Dimension:	176mm(L)*134mm(W)*57 mm(H)
Serial Number:	190125055
EUT Received Date:	2019.03.13

Note: The series products models 9605 BT, ZUMBTP-400 are electrically identical with FBT650B, we selected FBT650B for fully testing, the details of the difference between them were explained in the attached declaration letter.

Objective

This report is prepared on behalf of *freeVoice AG* 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 15B JAB submissions with FCC ID: 2APKR-FBT650B.
Part of system submissions with FCC ID: 2APKR-FCT170

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℃
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.

EUT Exercise Software

The software "CSR BlueSuite 2.4.8" was used during testing.

Software and version CSR BlueSuite 2.4.8

Mode	Packet type	Channel	Frequency (MHz)	Packet length	Power Level
GFSK	DH1	Low	2402	27	50
		Middle	2441	27	50
		High	2480	27	50
	DH3	Low	2402	183	50
		Middle	2441	183	50
		High	2480	183	50
	DH5	Low	2402	339	50
		Middle	2441	339	50
		High	2480	339	50
π/4 DQPSK	2DH1	Low	2402	54	50
		Middle	2441	54	50
		High	2480	54	50
	2DH3	Low	2402	367	50
		Middle	2441	367	50
		High	2480	367	50
	2DH5	Low	2402	679	50
		Middle	2441	679	50
		High	2480	679	50
8DPSK	3DH1	Low	2402	83	50
		Middle	2441	83	50
		High	2480	83	50
	3DH3	Low	2402	552	50
		Middle	2441	552	50
		High	2480	552	50
	3DH5	Low	2402	1021	50
		Middle	2441	1021	50
		High	2480	1021	50

Equipment Modifications

No modification was made to the EUT.

Local Support Equipment List and Details

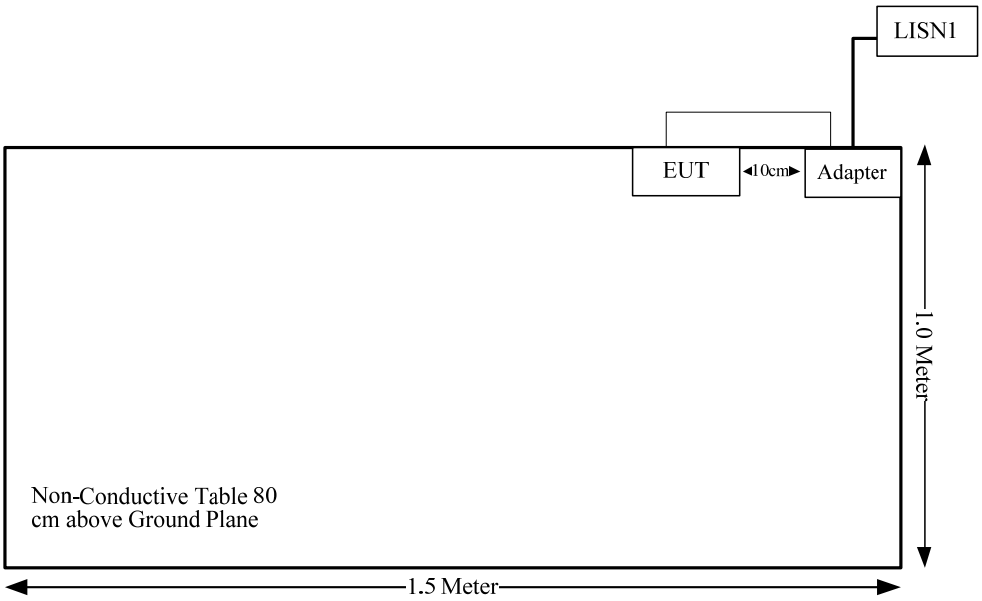
Manufacturer	Description	Model	Serial Number
Mobistel	Adapter	HJ-0501000B3	/

Support Cable List and Details

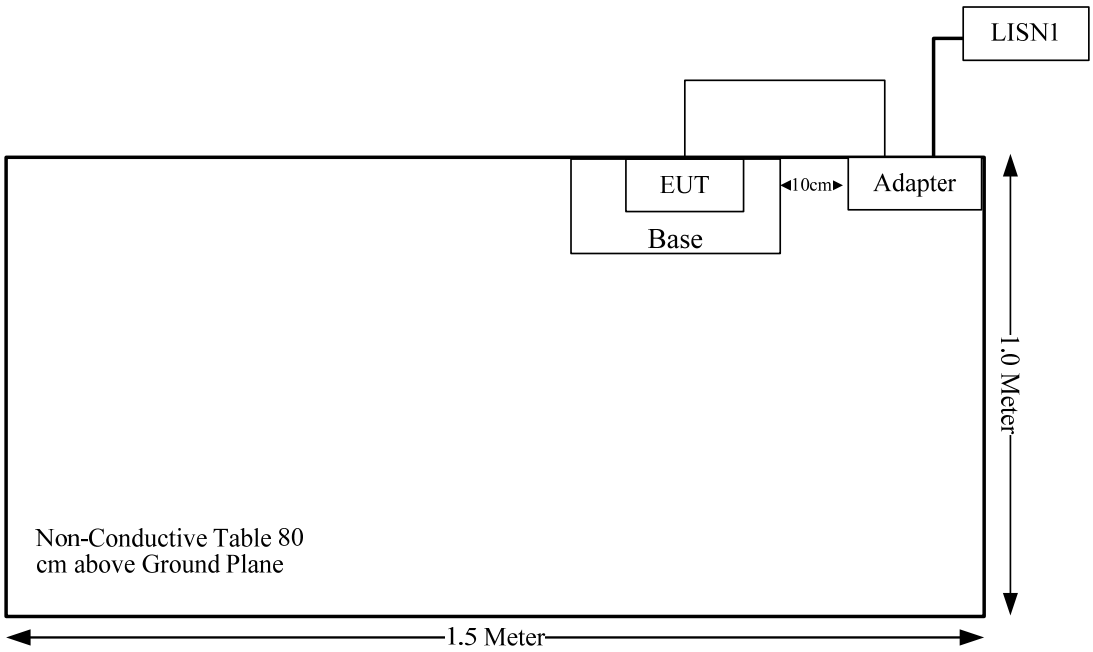
Cable Description	Shielding Type	Ferrite Core	Length (m)	From	To
Adapter Cable	No	No	1.5	Adapter or Base	EUT

Block Diagram of Test Setup

USB Charging



Base Charging



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 6.5 dBm (4.47 mW).
[(max. power of channel, mW)/(min. test separation distance, mm)][√f(GHz)]
=4.47/5*(√2.480) = 1.4< 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, and the antenna gain is 0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

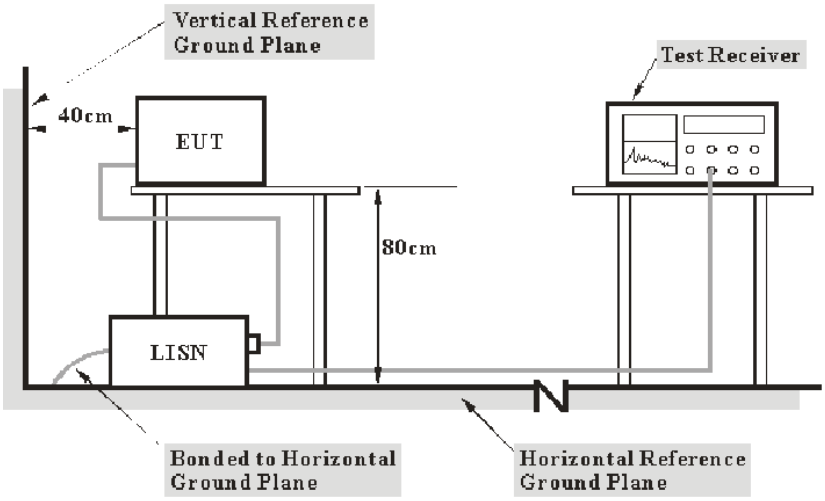
Result: Compliance.

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	ESCI	101121	2019-03-23	2020-03-23
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

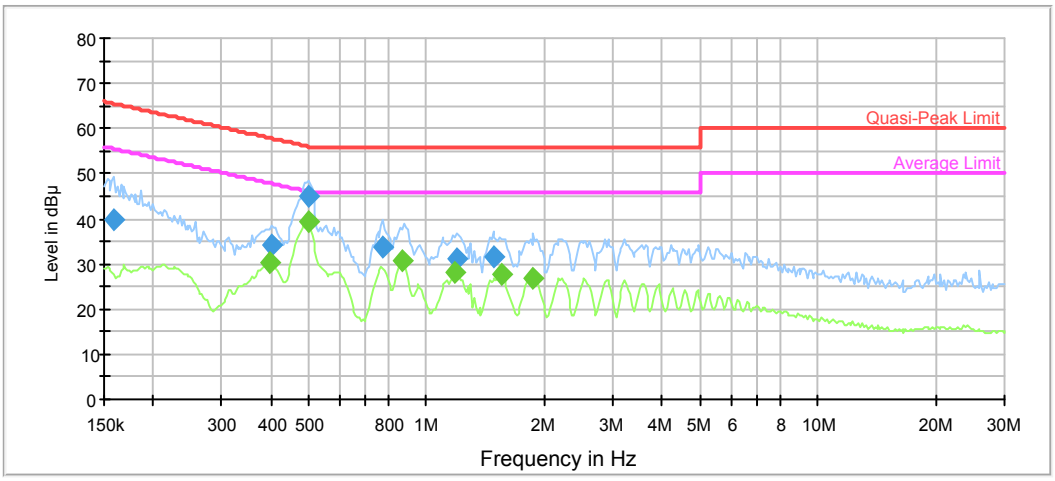
Environmental Conditions

Temperature:	24 °C
Relative Humidity:	54%
ATM Pressure:	100.7kPa

** The testing was performed by Ade Xiao on 2019-05-07*

Test Mode: USB Charging & Tranmitting (GFSK high channel was the worst case)

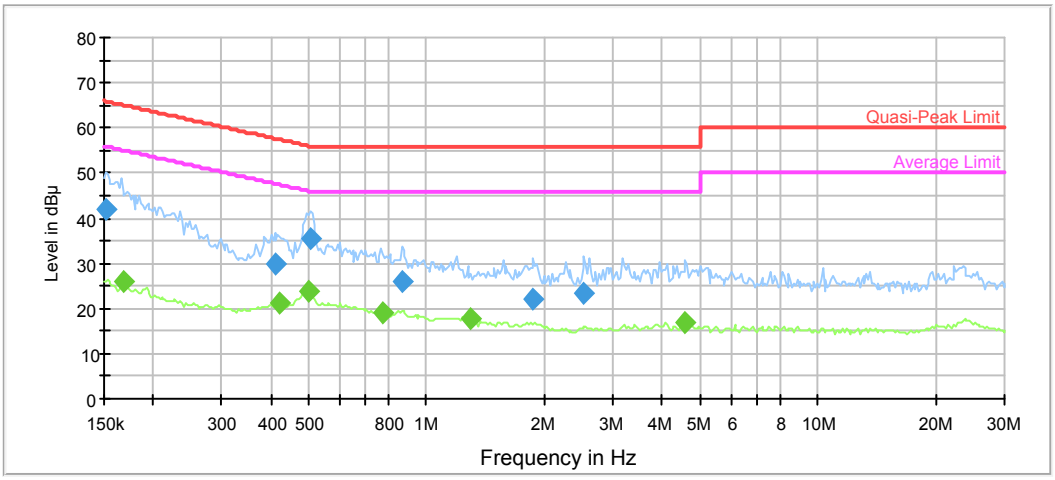
AC120V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.159228	39.7	9.000	L1	11.1	25.8	65.5
0.401705	34.3	9.000	L1	10.0	23.5	57.8
0.500009	45.0	9.000	L1	9.9	11.0	56.0
0.774673	33.6	9.000	L1	9.8	22.4	56.0
1.200214	31.3	9.000	L1	9.8	24.7	56.0
1.479134	31.4	9.000	L1	9.8	24.6	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.397728	30.1	9.000	L1	10.0	17.8	47.9
0.500009	39.5	9.000	L1	9.9	6.5	46.0
0.864278	30.7	9.000	L1	9.8	15.3	46.0
1.188331	27.9	9.000	L1	9.8	18.1	46.0
1.554585	27.8	9.000	L1	9.7	18.2	46.0
1.878108	27.0	9.000	L1	9.7	19.0	46.0

AC120V, 60 Hz, Neutral:

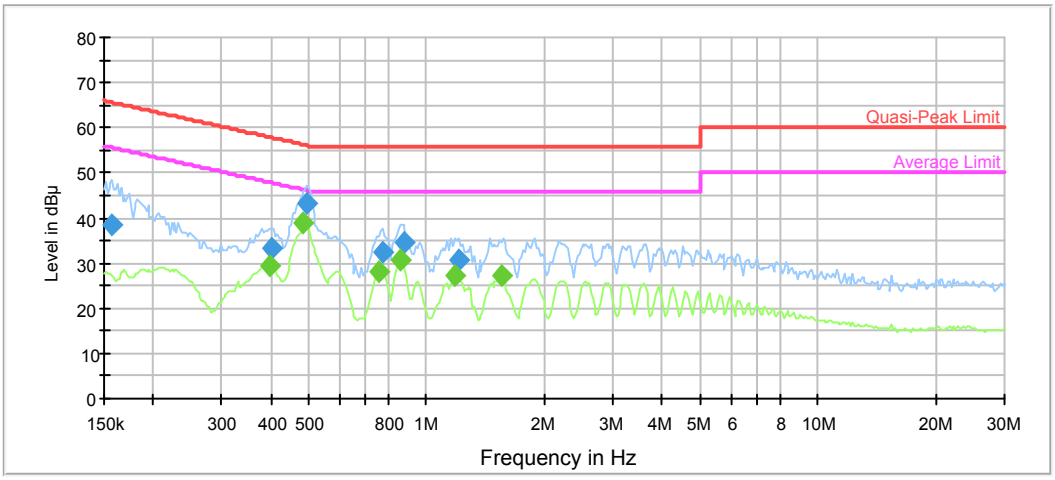


Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.151500	41.8	9.000	N	11.1	24.1	65.9
0.409780	29.8	9.000	N	10.0	27.9	57.7
0.505009	35.5	9.000	N	9.9	20.5	56.0
0.864278	25.8	9.000	N	9.8	30.2	56.0
1.878108	21.9	9.000	N	9.8	34.1	56.0
2.531405	23.5	9.000	N	9.8	32.5	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.169024	26.1	9.000	N	10.9	28.9	55.0
0.422196	21.2	9.000	N	9.9	26.2	47.4
0.500009	23.9	9.000	N	9.9	22.1	46.0
0.774673	19.1	9.000	N	9.8	26.9	46.0
1.299660	17.5	9.000	N	9.8	28.5	46.0
4.553263	16.9	9.000	N	9.8	29.1	46.0

Test Mode: Base Charging& Tranmitting (GFSK high channel was the worst case)

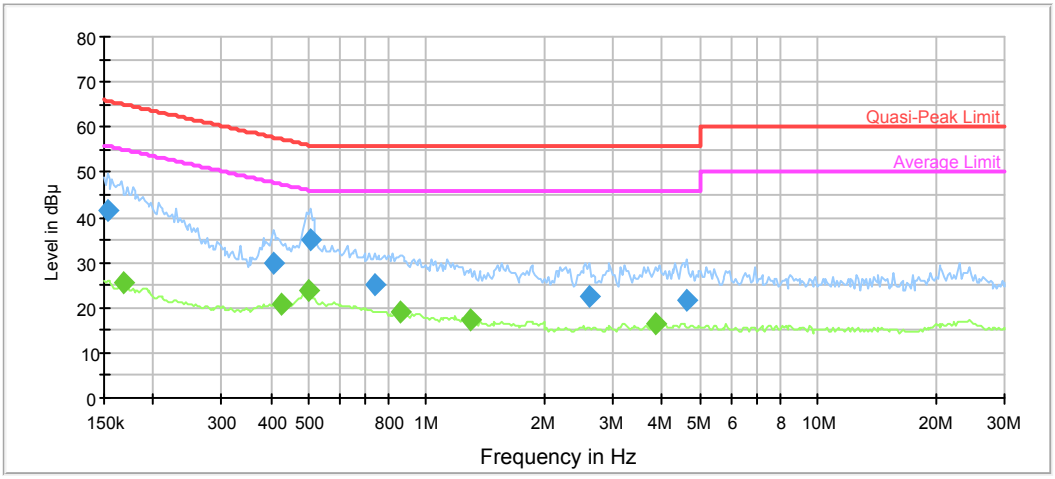
AC120V, 60Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.157652	38.7	9.000	L1	11.1	26.9	65.6
0.401705	33.3	9.000	L1	10.0	24.5	57.8
0.495058	43.2	9.000	L1	9.9	12.9	56.1
0.774673	32.3	9.000	L1	9.8	23.7	56.0
0.872921	34.4	9.000	L1	9.8	21.6	56.0
1.212216	30.9	9.000	L1	9.8	25.1	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.397728	29.6	9.000	L1	10.0	18.3	47.9
0.485304	39.1	9.000	L1	9.9	7.1	46.2
0.759409	28.2	9.000	L1	9.8	17.8	46.0
0.855721	30.8	9.000	L1	9.8	15.2	46.0
1.188331	27.1	9.000	L1	9.8	18.9	46.0
1.554585	27.0	9.000	L1	9.7	19.0	46.0

AC120V, 60Hz, Neutral:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.153015	41.6	9.000	N	11.1	24.2	65.8
0.405722	29.9	9.000	N	10.0	27.8	57.7
0.505009	35.0	9.000	N	9.9	21.0	56.0
0.737074	24.9	9.000	N	9.8	31.1	56.0
2.608110	22.3	9.000	N	9.8	33.7	56.0
4.644784	21.7	9.000	N	9.8	34.3	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.167350	25.5	9.000	N	10.9	29.6	55.1
0.426418	20.7	9.000	N	9.9	26.6	47.3
0.500009	24.0	9.000	N	9.9	22.0	46.0
0.855721	19.1	9.000	N	9.8	26.9	46.0
1.299660	17.3	9.000	N	9.8	28.7	46.0
3.844673	16.6	9.000	N	9.8	29.4	46.0

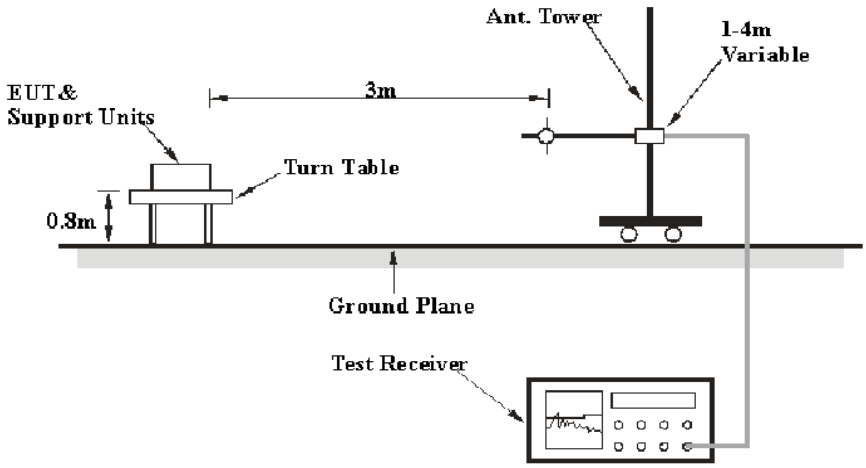
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

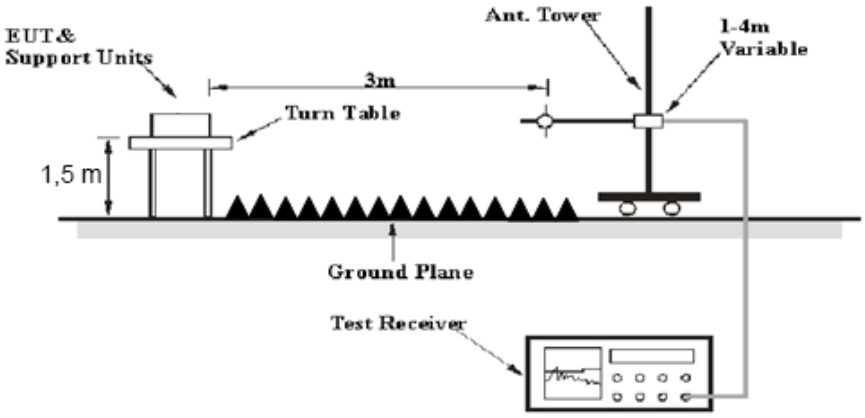
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emission below 1GHz tests were performed in the 3 meters chamber A, above 1GHz tests were performed in the 3 meters chamber test site A, 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:

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 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-1000-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0530-01	2018-09-24	2019-09-24
HP	Amplifier	8447D	2727A05902	2018-09-05	2019-09-05
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-10	2019-12-10
TDK RF	Horn Antenna	HRN-0118	130 084	2018-10-12	2021-10-12
Ducommun Technolagies	Horn Antenna	ARH-4223-02	1007726-01 1304	2016-11-18	2019-11-18
MICRO-COAX	Coaxial Cable	UFA147-1-2362-100100	64639 231029-001	2019-02-24	2020-02-24
Unknown	Coaxial Cable	C-2.4J2.4J-50	C-0700-02	2018-06-27	2019-06-27
Mini	Pre-amplifier	ZVA-183-S+	5969001149	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

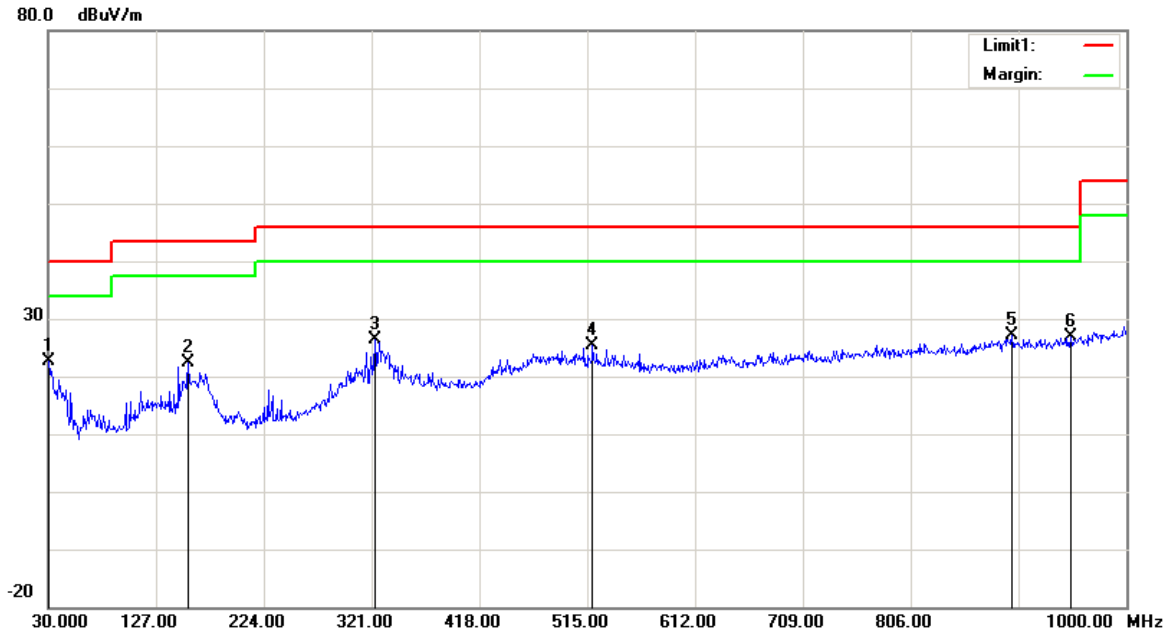
Temperature:	25~26.5 °C
Relative Humidity:	34~54%
ATM Pressure:	100.5~ 100.9kPa

** The testing was performed by Neil Liao & Tyler Pan on 2019-3-17&2019-05-17*

Test Mode: Transmitting

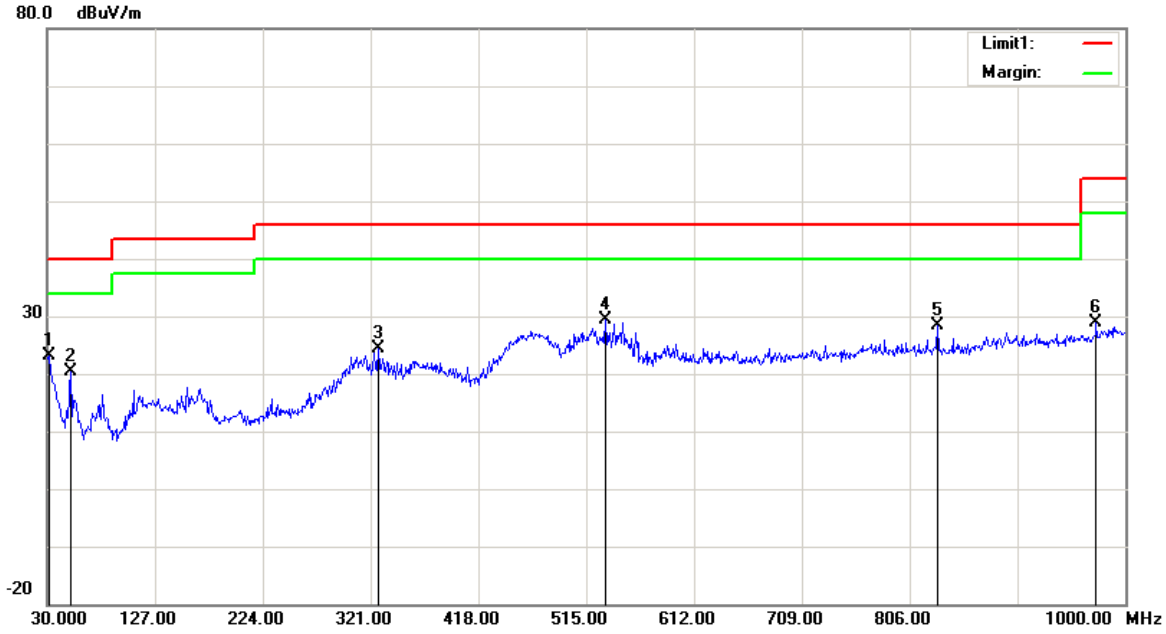
1) 30MHz-1GHz (Base Charging & GFSK Low channel was the worst)

Horizontal:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.9700	27.58	peak	-5.01	22.57	40.00	17.43
156.1000	34.09	peak	-11.82	22.27	43.50	21.23
323.9100	35.70	peak	-9.42	26.28	46.00	19.72
519.8500	31.27	peak	-6.00	25.27	46.00	20.73
897.1800	30.93	peak	-3.90	27.03	46.00	18.97
950.5300	30.14	peak	-3.33	26.81	46.00	19.19

Vertical:



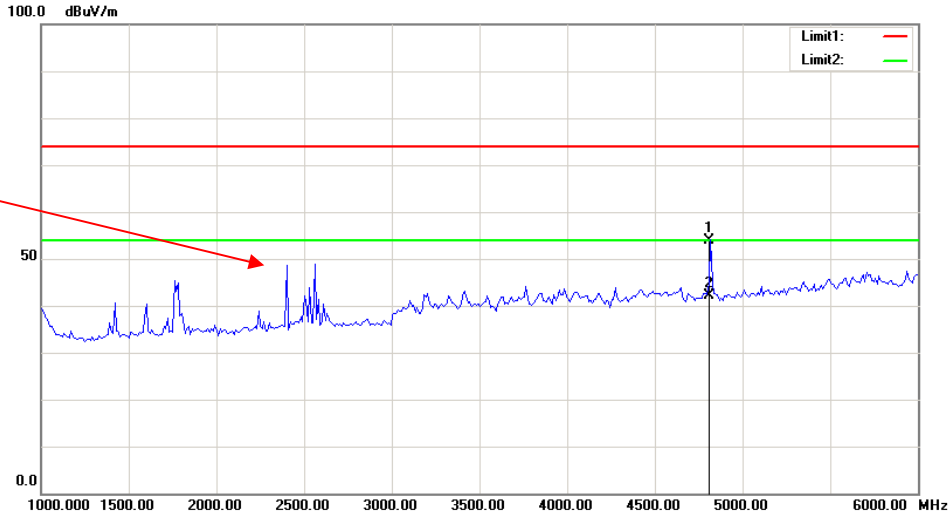
Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
31.9400	28.98	peak	-5.73	23.25	40.00	16.75
51.3400	37.89	peak	-17.52	20.37	40.00	19.63
327.7900	33.73	peak	-9.41	24.32	46.00	21.68
532.4600	35.09	peak	-5.73	29.36	46.00	16.64
831.2200	29.32	peak	-1.04	28.28	46.00	17.72
973.8100	29.68	peak	-0.85	28.83	54.00	25.17

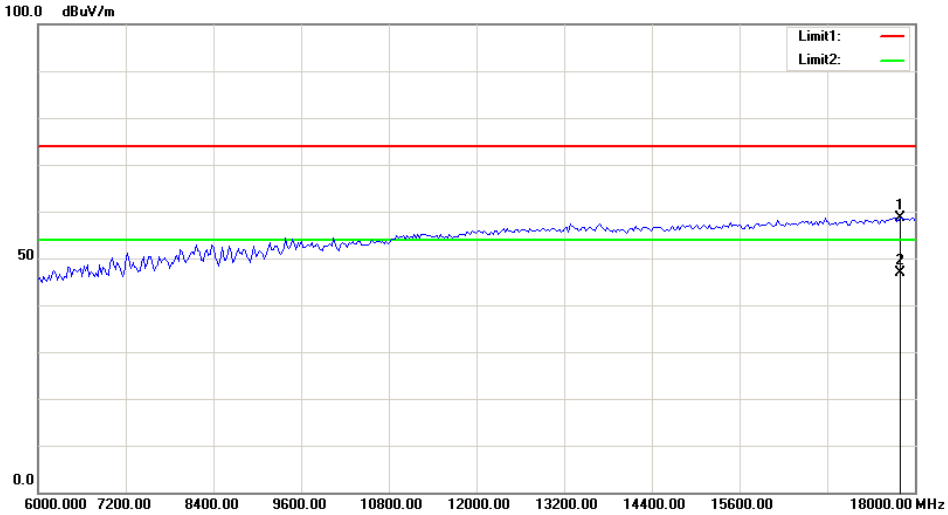
2) 1GHz-25GHz(Pre-scan all modes, GFSK was the worst case)

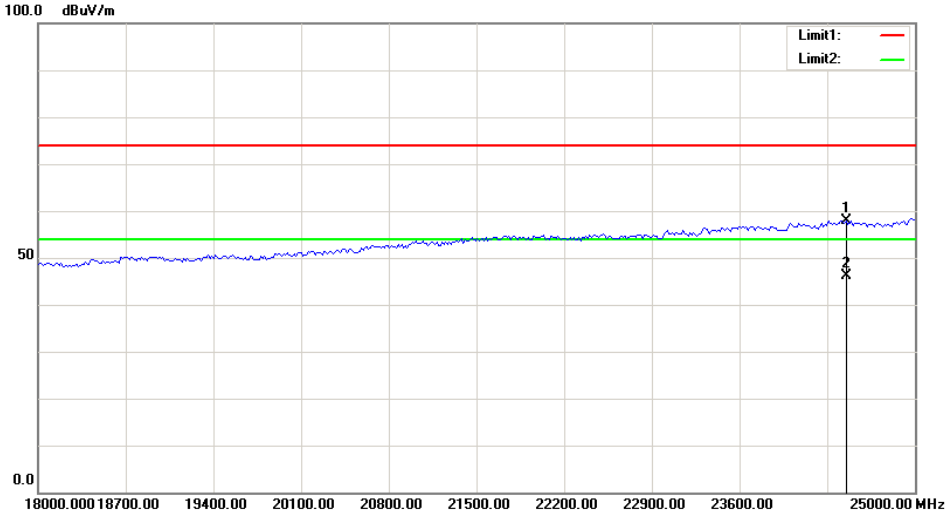
Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
	Reading (dBµV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2402.00	69.93	PK	H	24.82	3.34	0.00	98.09	N/A	N/A
2402.00	59.37	AV	H	24.82	3.34	0.00	87.53	N/A	N/A
2402.00	62.34	PK	V	24.82	3.34	0.00	90.50	N/A	N/A
2402.00	52.10	AV	V	24.82	3.34	0.00	80.26	N/A	N/A
2390.00	25.11	PK	H	24.80	3.33	0.00	53.24	74.00	20.76
2390.00	12.31	AV	H	24.80	3.33	0.00	40.44	54.00	13.56
4804.00	46.87	PK	H	29.71	4.58	27.36	53.80	74.00	20.20
4804.00	35.13	AV	H	29.71	4.58	27.36	42.06	54.00	11.94
7206.00	37.43	PK	H	33.93	5.59	27.19	49.76	74.00	24.24
7206.00	24.17	AV	H	33.93	5.59	27.19	36.50	54.00	17.50
Middle Channel: 2441 MHz									
2441.00	72.02	PK	H	24.89	3.36	0.00	100.27	N/A	N/A
2441.00	62.00	AV	H	24.89	3.36	0.00	90.25	N/A	N/A
2441.00	65.18	PK	V	24.89	3.36	0.00	93.43	N/A	N/A
2441.00	54.76	AV	V	24.89	3.36	0.00	83.01	N/A	N/A
4882.00	45.37	PK	H	29.86	4.56	27.56	52.23	74.00	21.77
4882.00	33.66	AV	H	29.86	4.56	27.56	40.52	54.00	13.48
7323.00	37.43	PK	H	34.12	5.69	27.26	49.98	74.00	24.02
7323.00	24.00	AV	H	34.12	5.69	27.26	36.55	54.00	17.45
High Channel: 2480 MHz									
2480.00	72.92	PK	H	24.96	3.38	0.00	101.26	N/A	N/A
2480.00	62.44	AV	H	24.96	3.38	0.00	90.78	N/A	N/A
2480.00	65.77	PK	V	24.96	3.38	0.00	94.11	N/A	N/A
2480.00	55.70	AV	V	24.96	3.38	0.00	84.04	N/A	N/A
2483.50	34.34	PK	H	24.97	3.38	0.00	62.69	74.00	11.31
2483.50	22.34	AV	H	24.97	3.38	0.00	50.69	54.00	3.31
4960.00	44.47	PK	H	30.02	4.58	27.37	51.70	74.00	22.30
4960.00	33.21	AV	H	30.02	4.58	27.37	40.44	54.00	13.56
7440.00	39.53	PK	H	34.30	5.79	27.22	52.40	74.00	21.60
7440.00	24.50	AV	H	34.30	5.79	27.22	37.37	54.00	16.63

Worst plots (GFSK Low channel)
Horizontal

Fundamental Test with Band Rejection Filter

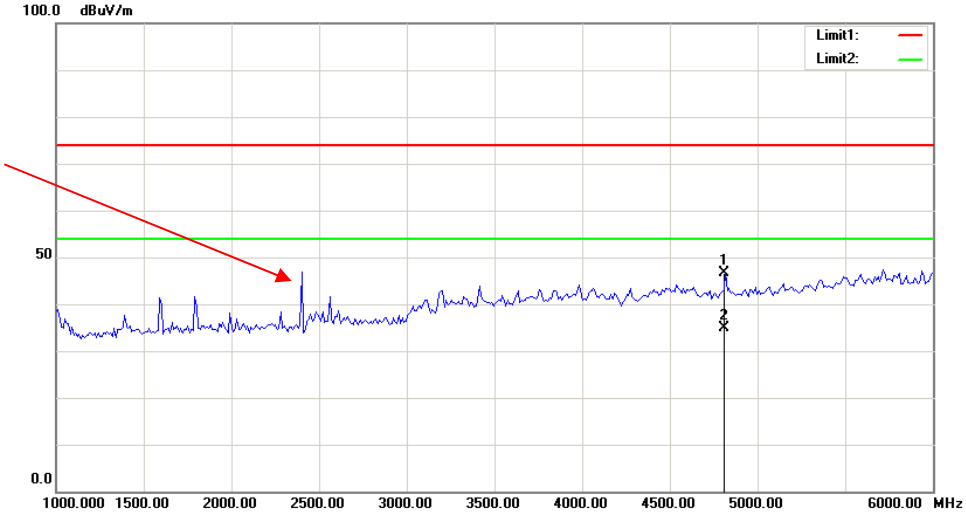


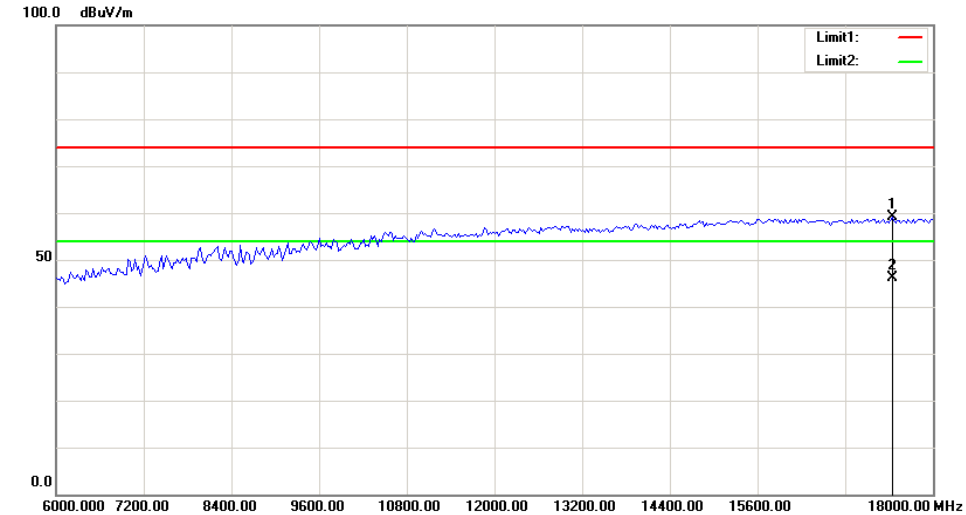


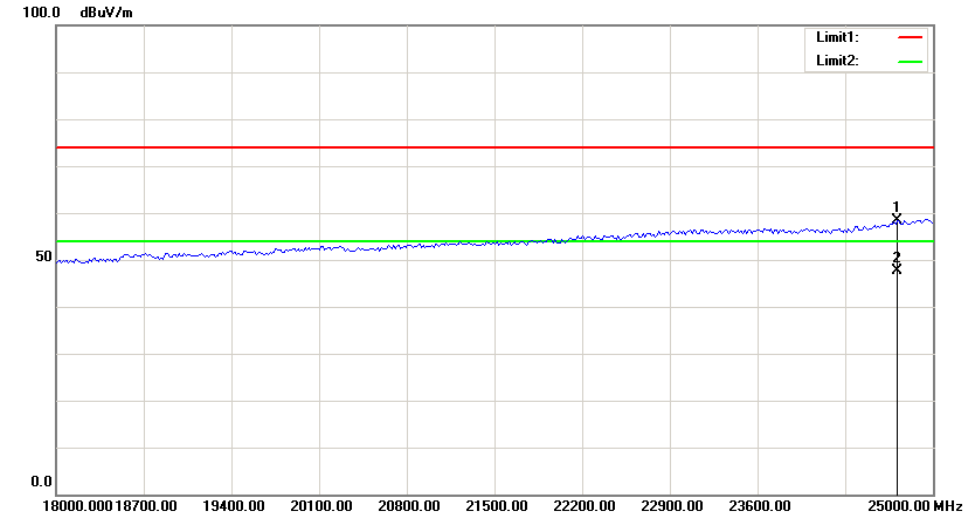


Vertical

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
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
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:	25 °C
Relative Humidity:	54%
ATM Pressure:	100.5 kPa

** The testing was performed by Andy Huang on 2019-03-20*

Test Result: Compliance.

Please refer to following tables and plots

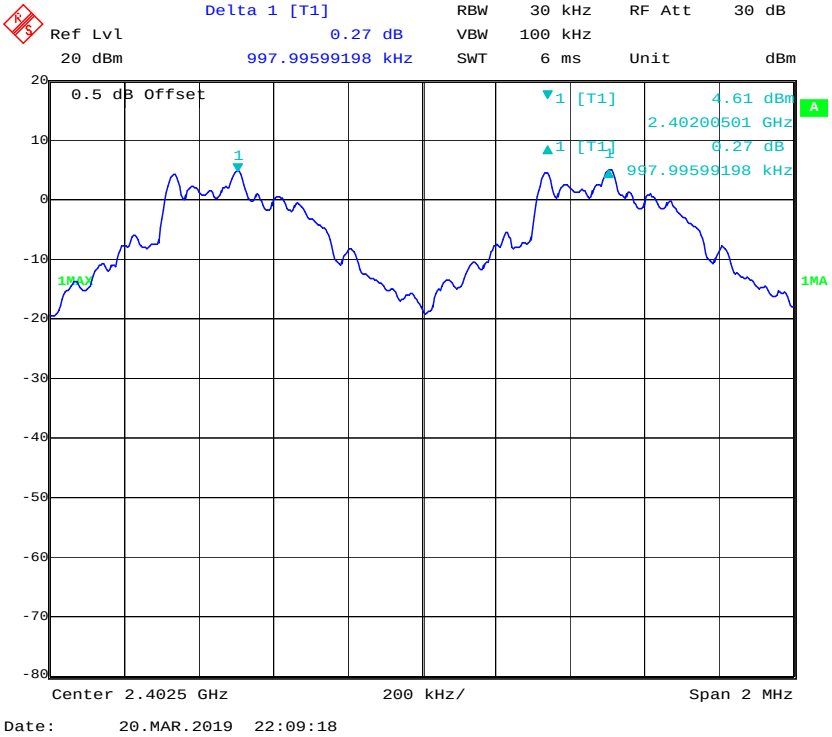
Test Mode: Transmitting

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
BDR (GFSK)	Low	2402	0.998	0.59
	Middle	2441	1.010	0.59
	High	2480	0.998	0.59
EDR (π/4-DQPSK)	Low	2402	1.002	0.81
	Middle	2441	1.006	0.81
	High	2480	1.002	0.81
EDR (8-DPSK)	Low	2402	1.002	0.81
	Middle	2441	1.002	0.81
	High	2480	0.998	0.81

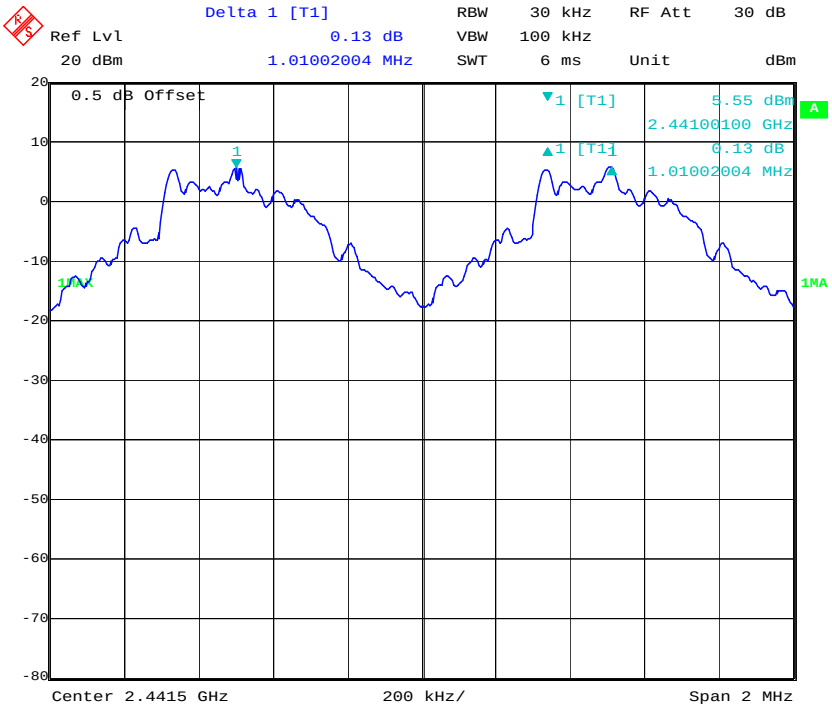
Note: Limit= (2/3) × 20dB bandwidth

BDR Mode (GFSK):

Low Channel

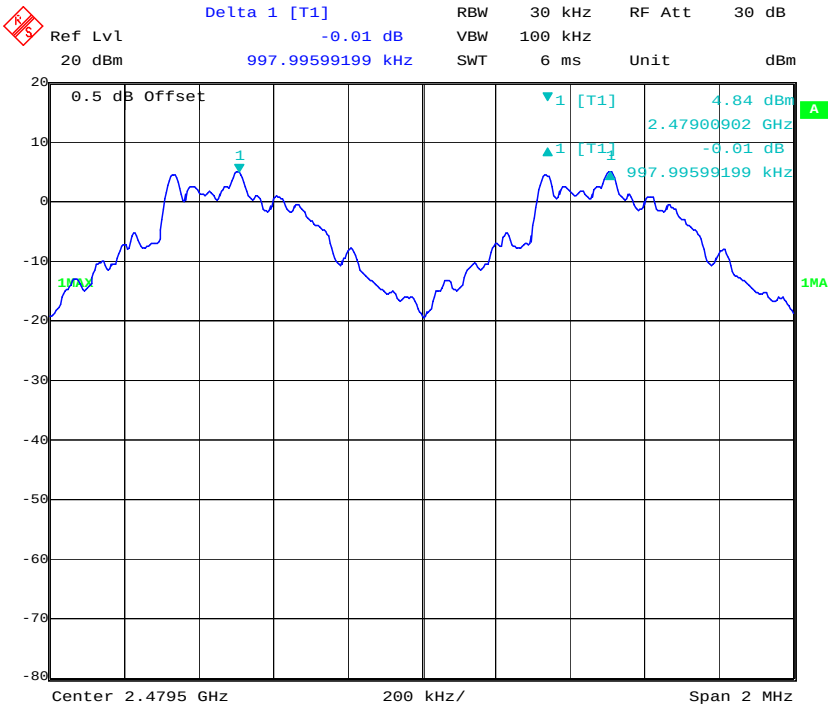


Middle Channel



Date: 20.MAR.2019 22:10:21

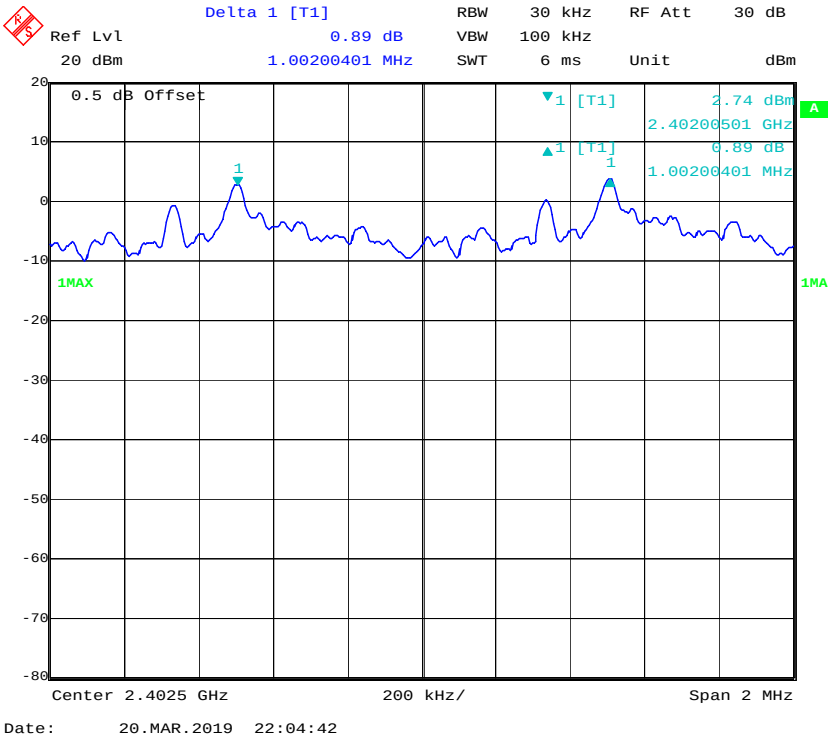
High Channel



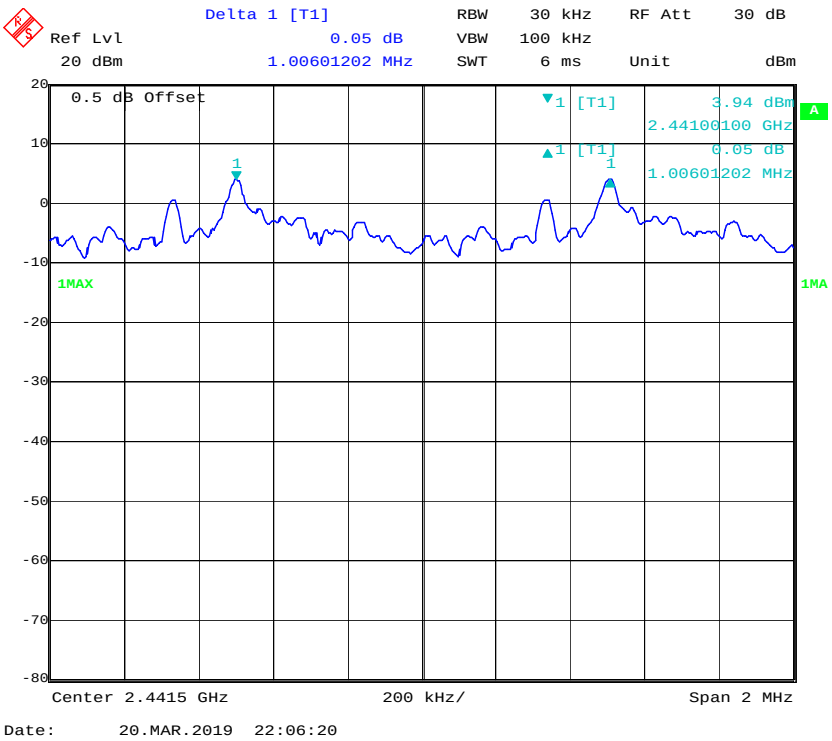
Date: 20.MAR.2019 22:11:27

EDR Mode (π/4-DQPSK):

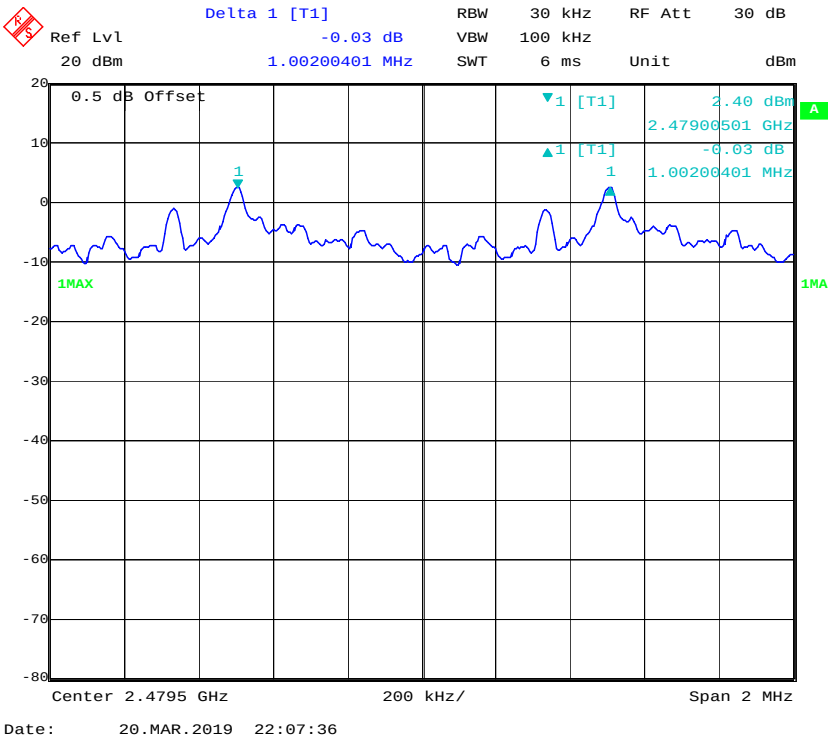
Low Channel



Middle Channel

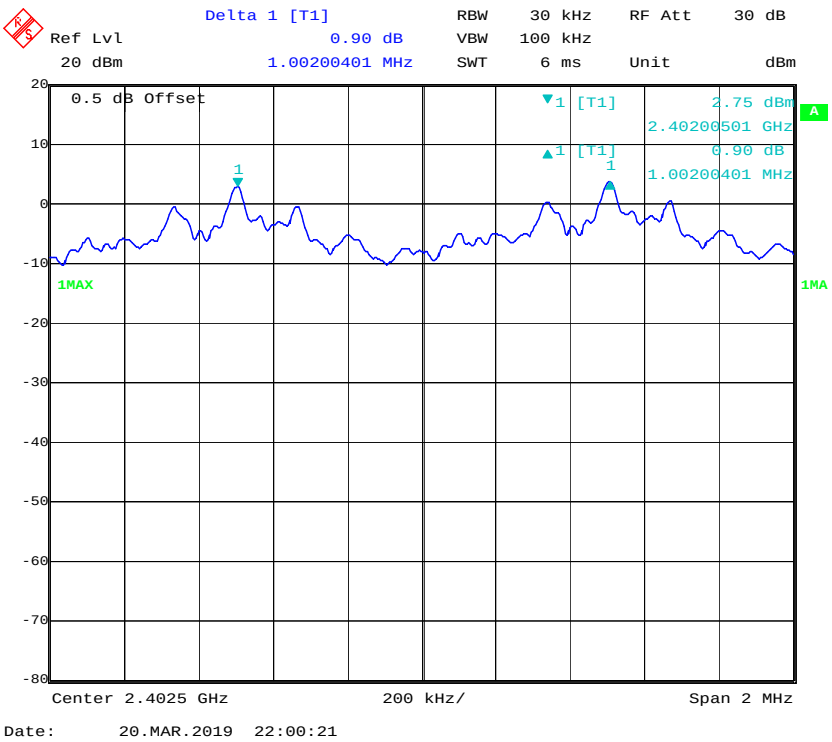


High Channel

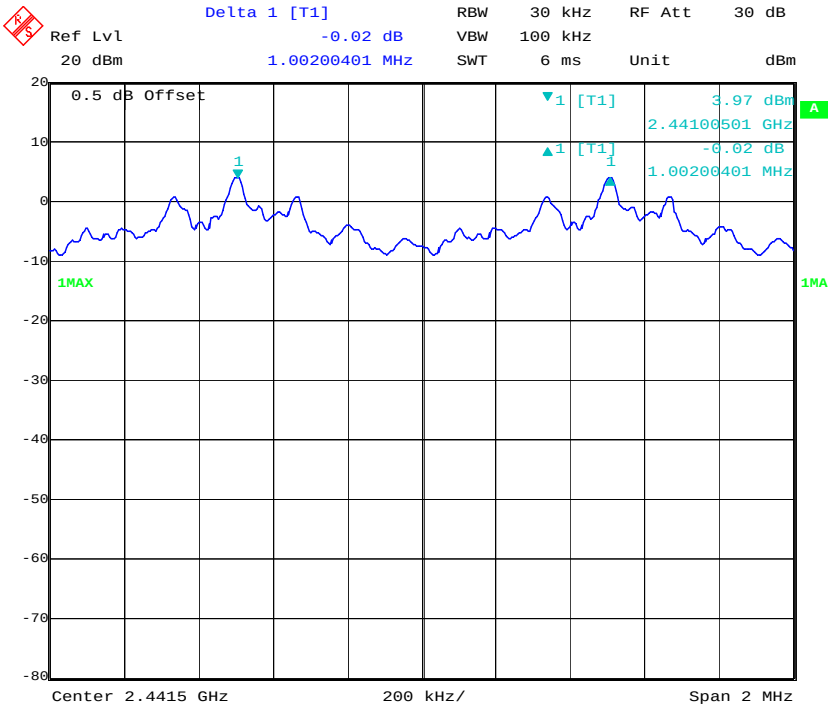


EDR Mode (8-DPSK):

Low Channel

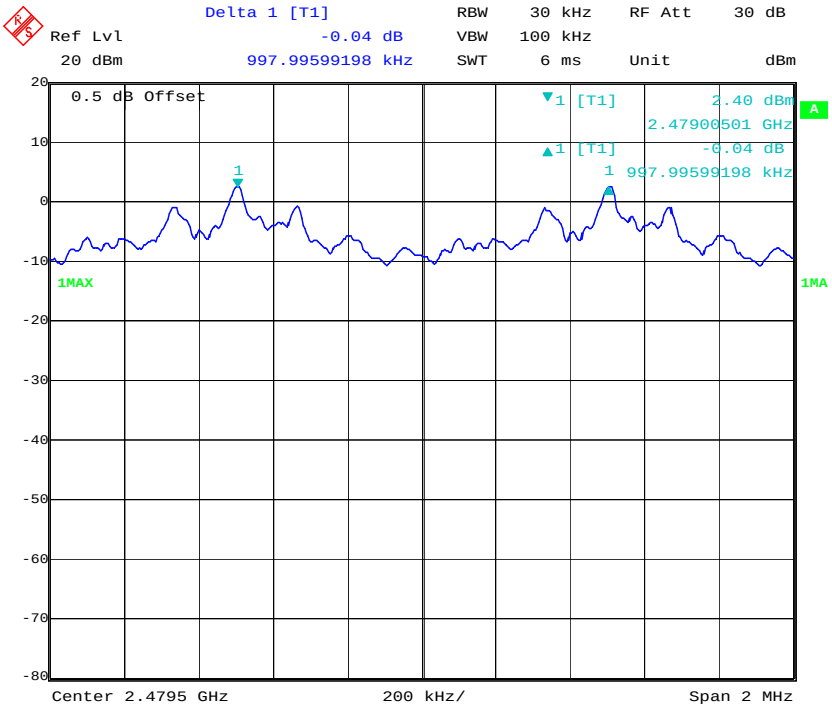


Middle Channel



Date: 20.MAR.2019 22:01:22

High Channel



Date: 20.MAR.2019 22:02:23

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
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
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:	25 °C
Relative Humidity:	54%
ATM Pressure:	100.5 kPa

** The testing was performed by Andy Huang on 2019-03-20*

Test Result: Compliance.

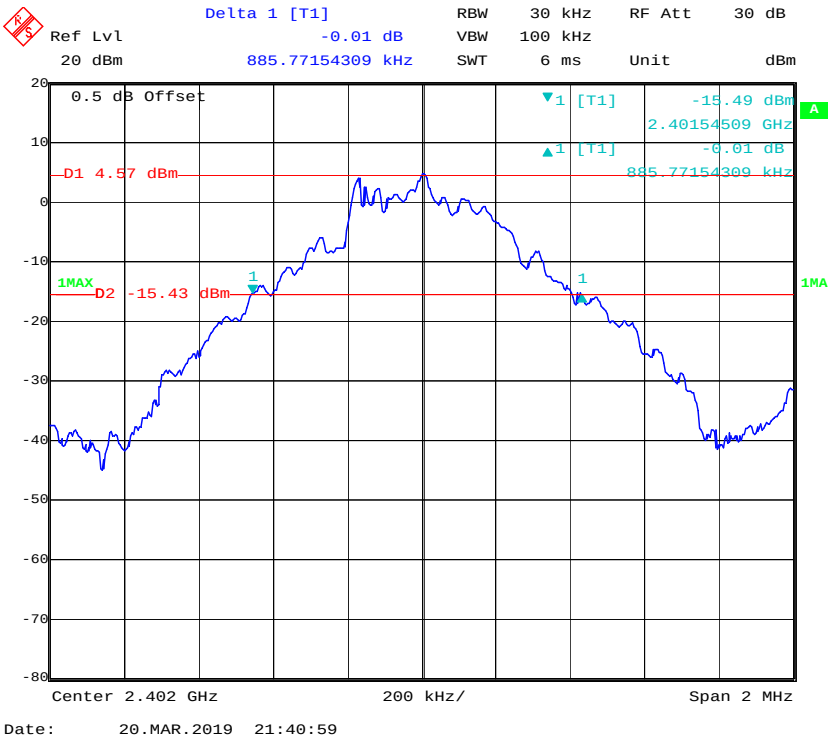
Please refer to following tables and plots

Test Mode: Transmitting

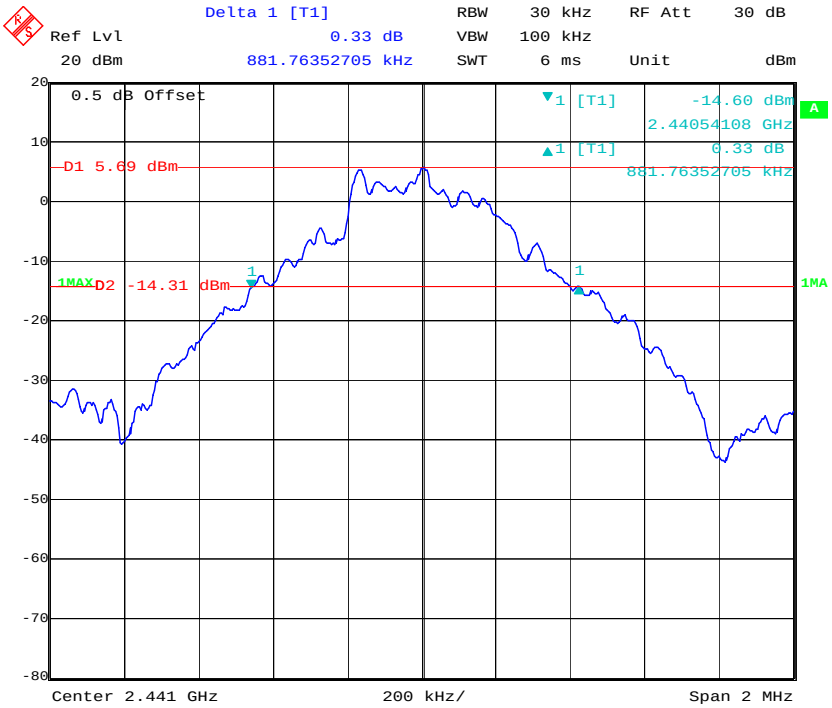
Mode	Channel	Frequency (MHz)	20 dB Bandwidth (MHz)
BDR Mode (GFSK)	Low	2402	0.886
	Middle	2441	0.882
	High	2480	0.882
EDR Mode (π/4-DQPSK)	Low	2402	1.210
	Middle	2441	1.214
	High	2480	1.210
EDR Mode (8-DPSK)	Low	2402	1.214
	Middle	2441	1.218
	High	2480	1.214

BDR Mode (GFSK):

Low Channel

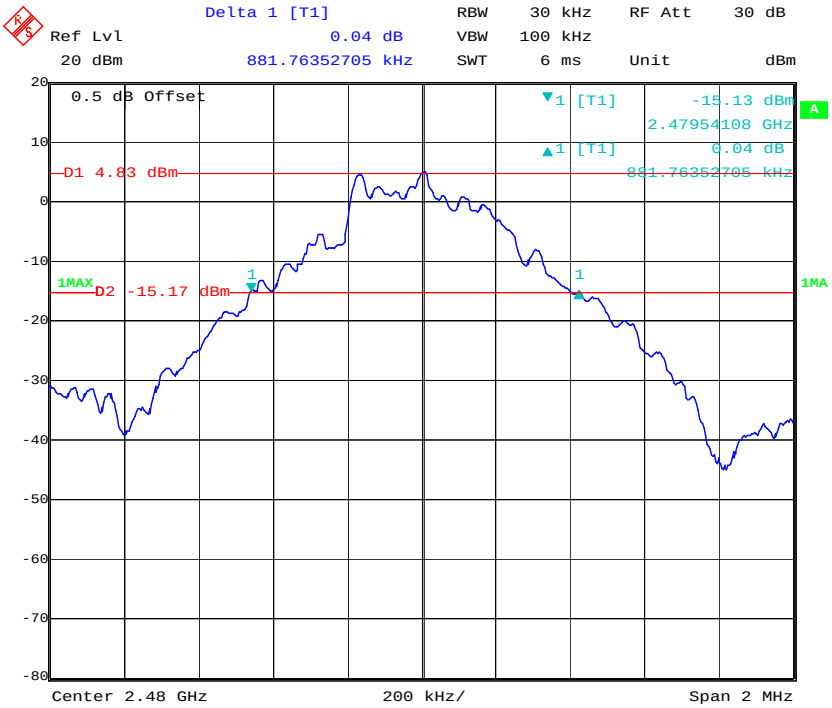


Middle Channel



Date: 20.MAR.2019 23:02:54

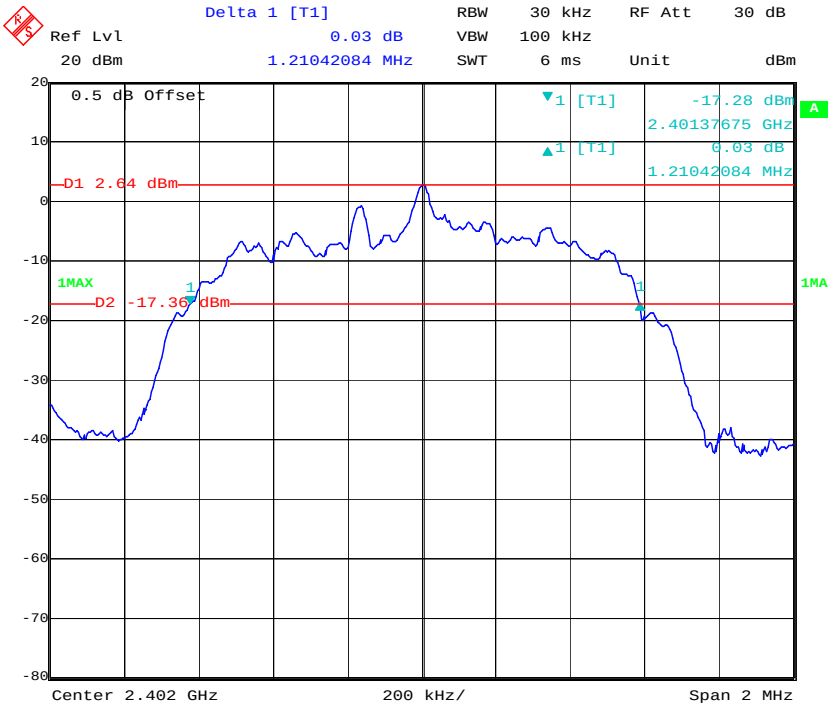
High Channel



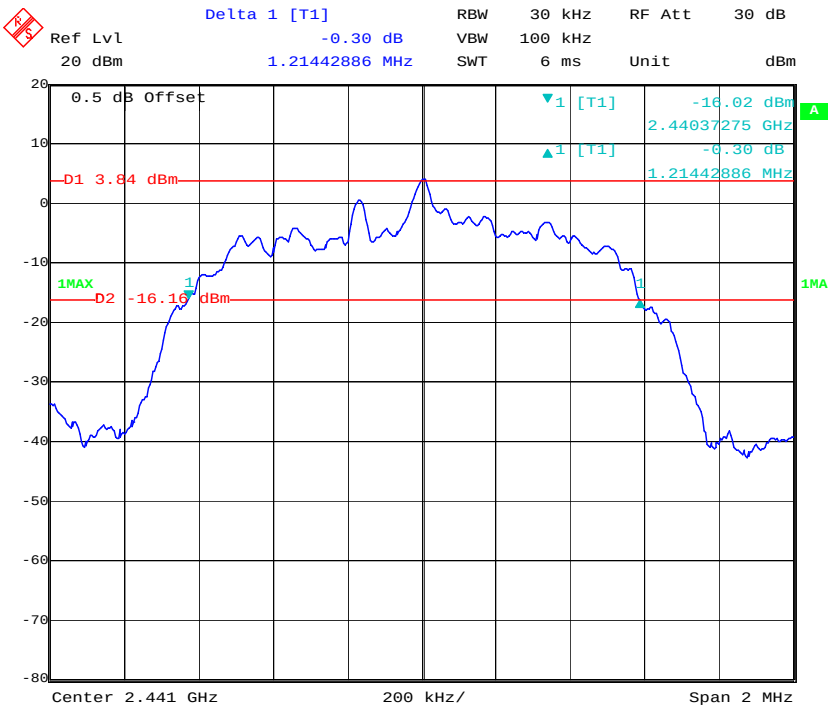
Date: 20.MAR.2019 21:44:29

EDR Mode (π/4-DQPSK):

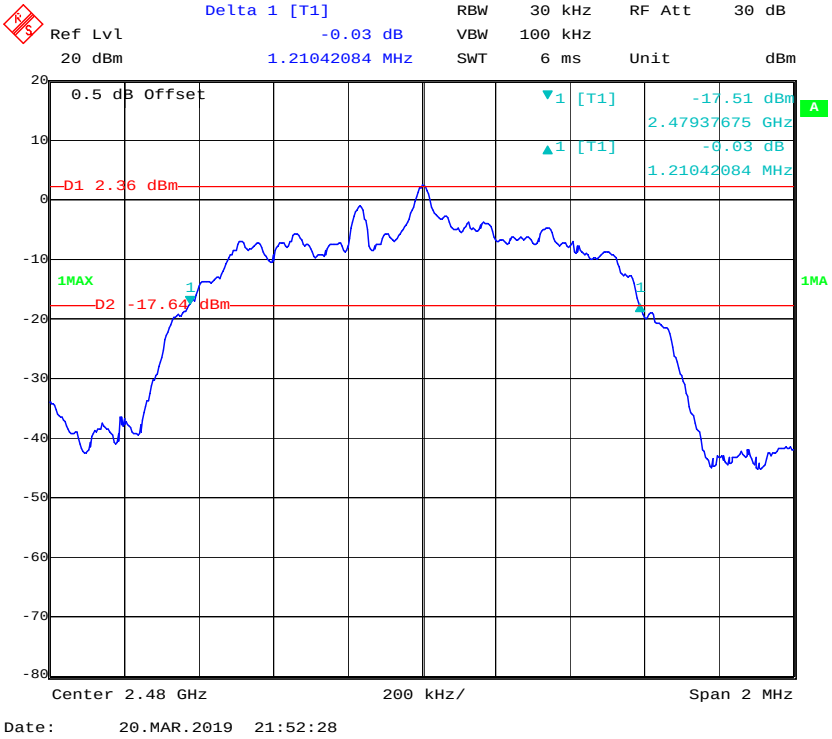
Low Channel



Middle Channel

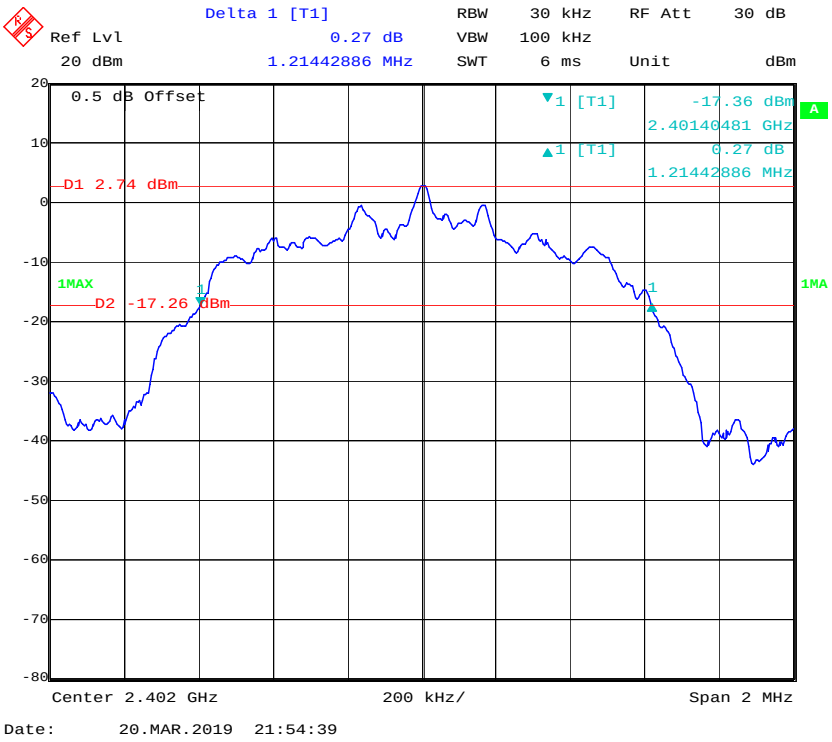


High Channel

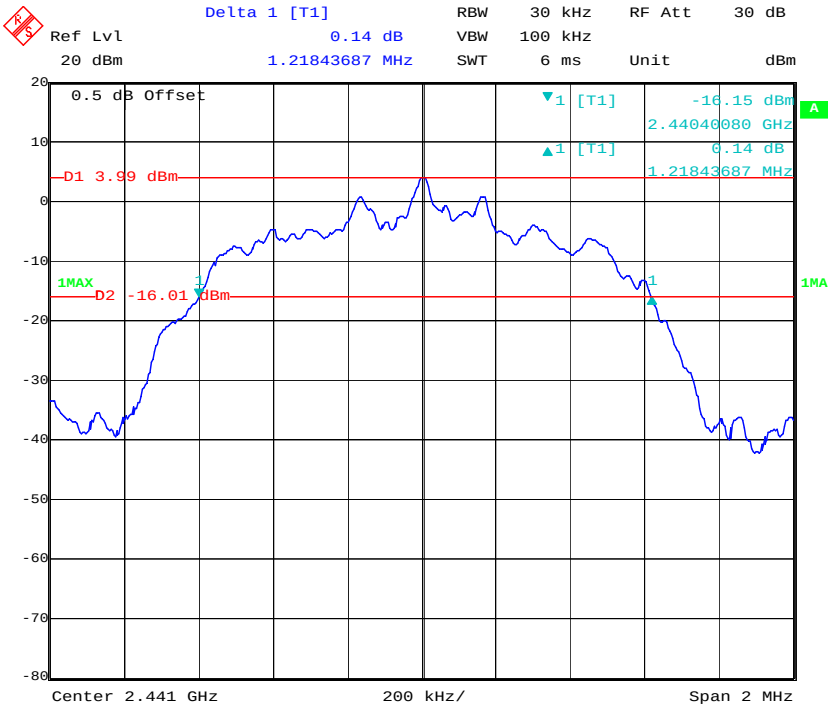


EDR Mode (8-DPSK):

Low Channel

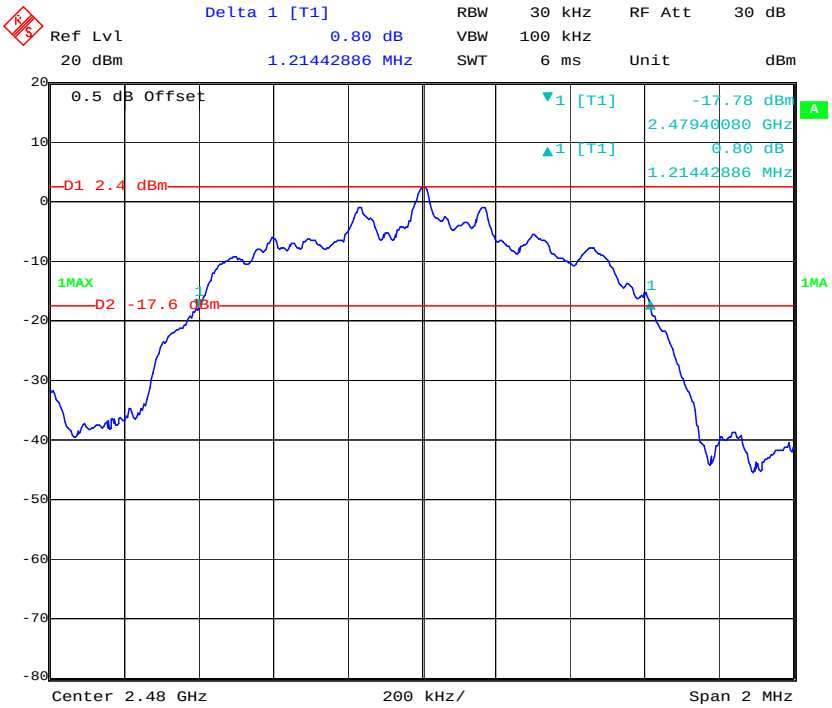


Middle Channel



Date: 20.MAR.2019 21:56:19

High Channel



Date: 20.MAR.2019 21:57:39

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
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
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:	25 °C
Relative Humidity:	54%
ATM Pressure:	100.5 kPa

** The testing was performed by Andy Huang on 2019-03-20*

Test Result: Compliance.

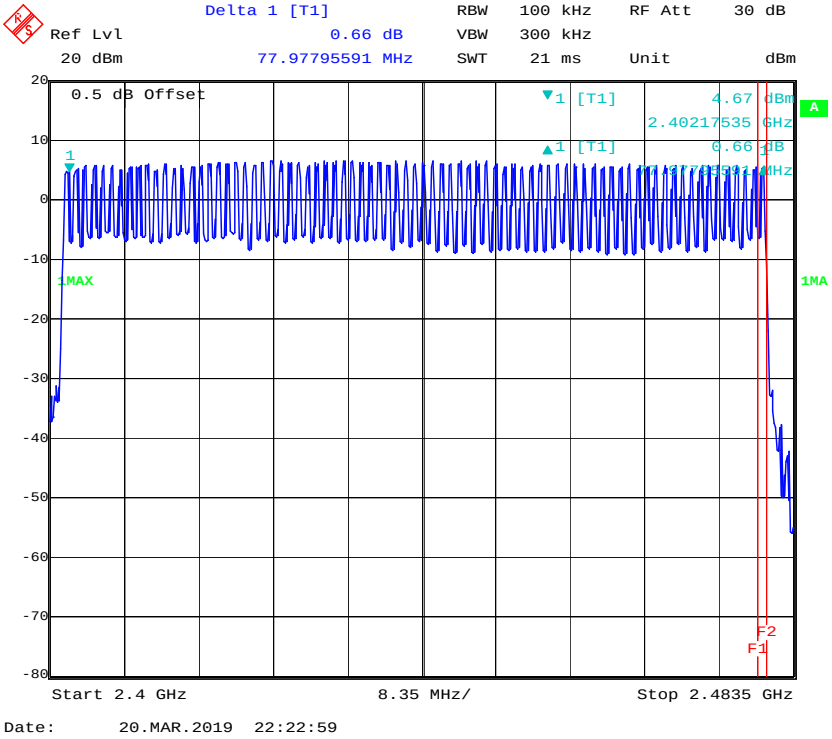
Please refer to following tables and plots

Test Mode: Transmitting

BDR Mode (GFSK):

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

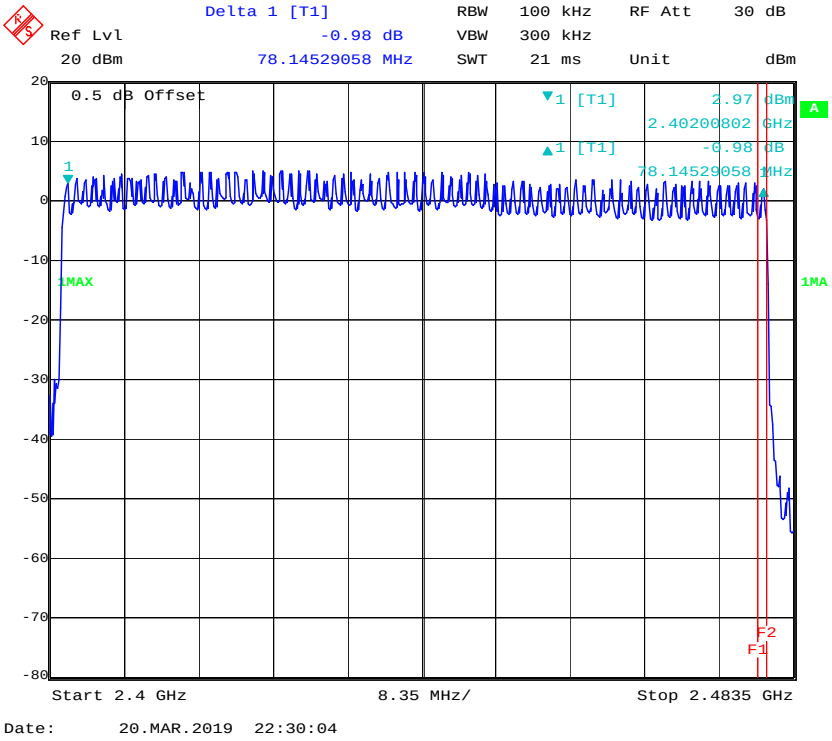
Number of Hopping Channels



EDR Mode (π/4-DQPSK):

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

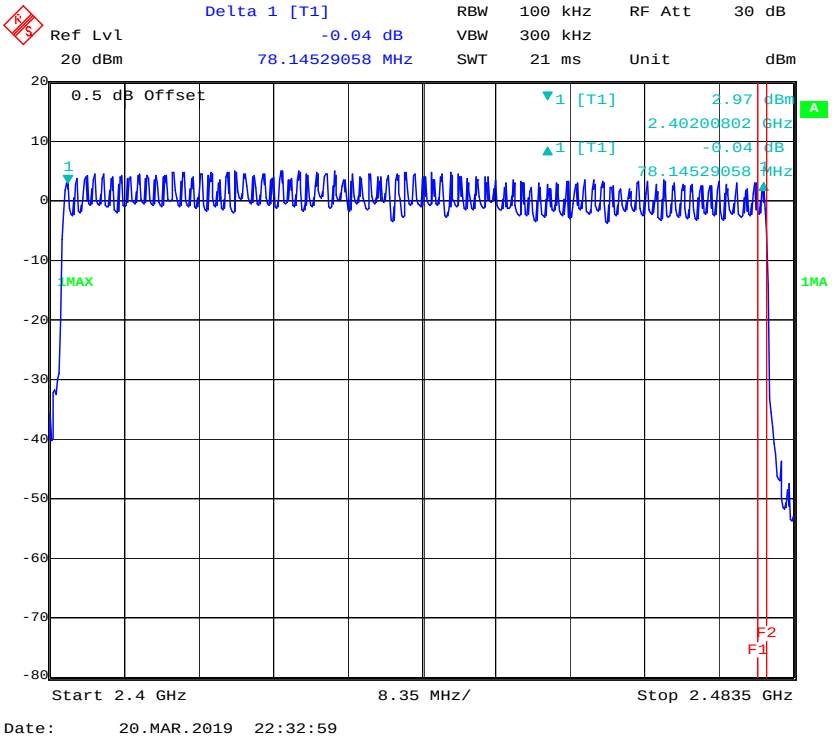
Number of Hopping Channels



EDR Mode (8-DPSK):

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

Number of Hopping Channels



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
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
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:	25 °C
Relative Humidity:	54%
ATM Pressure:	100.5 kPa

** The testing was performed by Andy Huang on 2019-03-20*

Test Result: Compliance.

Please refer to following tables and plots

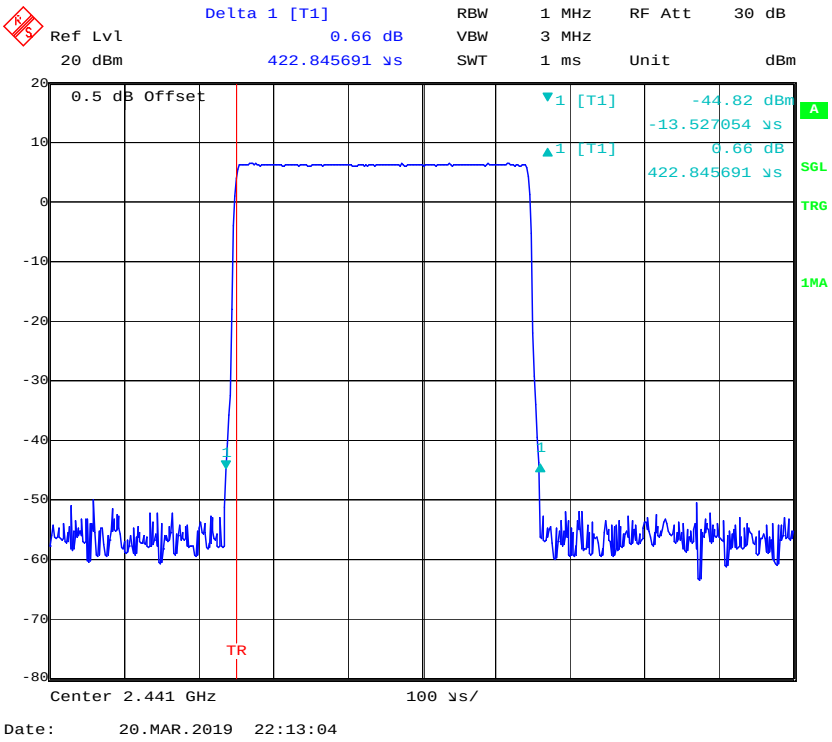
Test Mode: Transmitting

Mode	Packet type	Channel	Frequency (MHz)	Puse width (ms)	Result (s)	Limit (s)
GFSK	DH1	Middle	2441	0.423	0.135	0.4
	DH3	Middle	2441	1.683	0.269	
	DH5	Middle	2441	2.946	0.314	
π/4-DQPSK	2DH1	Middle	2441	0.437	0.140	
	2DH3	Middle	2441	1.695	0.271	
	2DH5	Middle	2441	2.956	0.315	
8-DPSK	3DH1	Middle	2441	0.437	0.140	
	3DH3	Middle	2441	1.695	0.271	
	3DH5	Middle	2441	2.956	0.315	

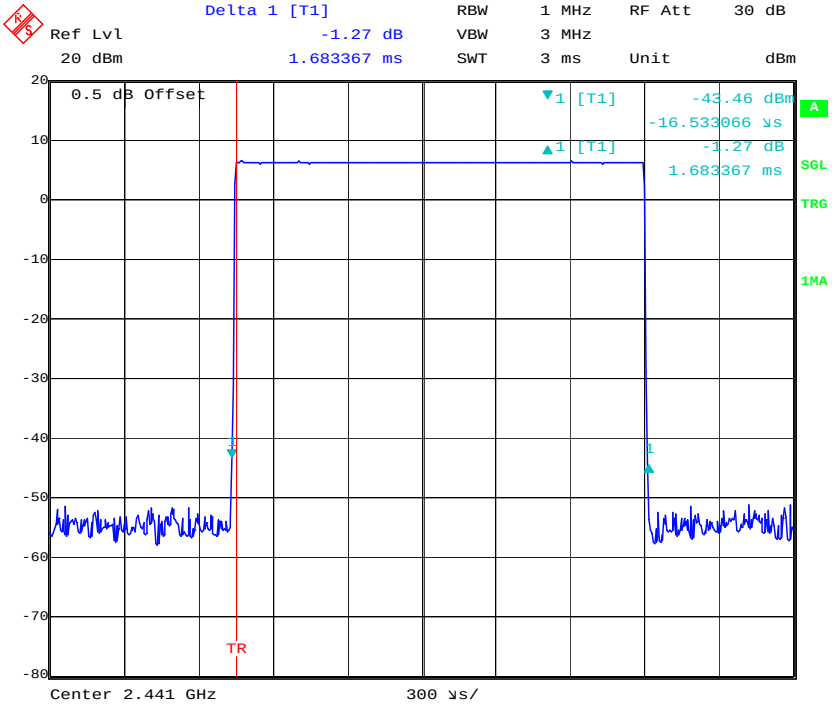
Note:
DH1:Dwell time=Pulse time (ms) × (1600/2/79) ×31.6 s
DH3:Dwell time=Pulse time (ms) × (1600/4/79) ×31.6 s
DH5:Dwell time=Pulse time (ms) × (1600/6/79) ×31.6 s

GFSK:

DH1: Middle Channel

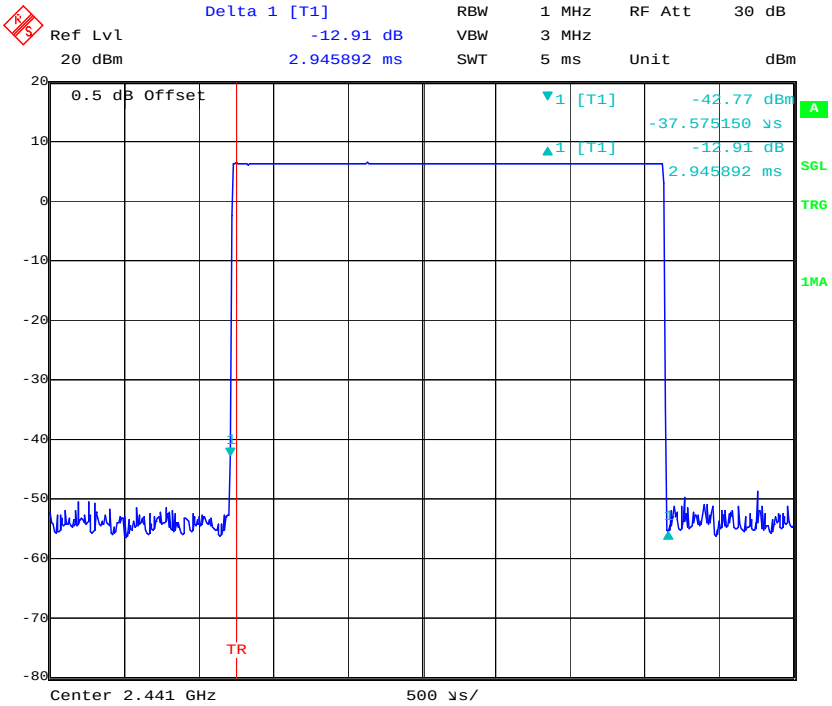


DH3: Middle Channel



Date: 20.MAR.2019 22:13:44

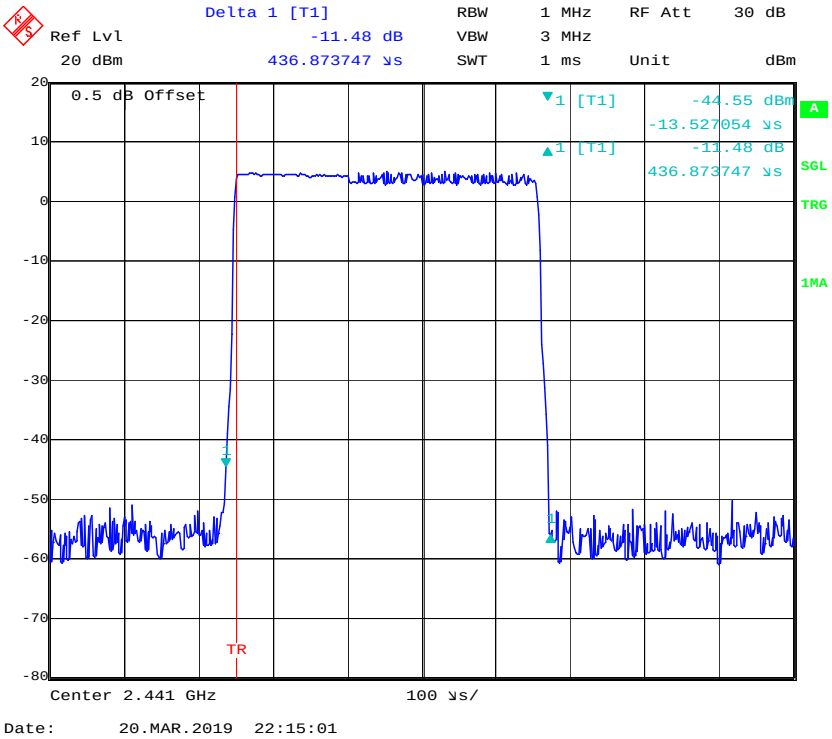
DH5: Middle Channel



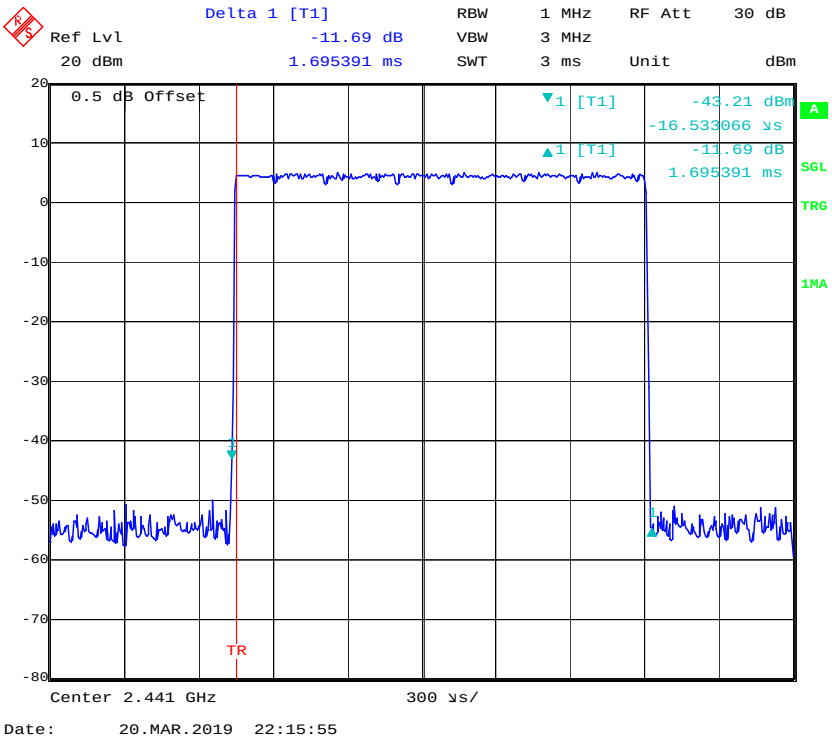
Date: 20.MAR.2019 22:14:22

EDR Mode (π/4-DQPSK):

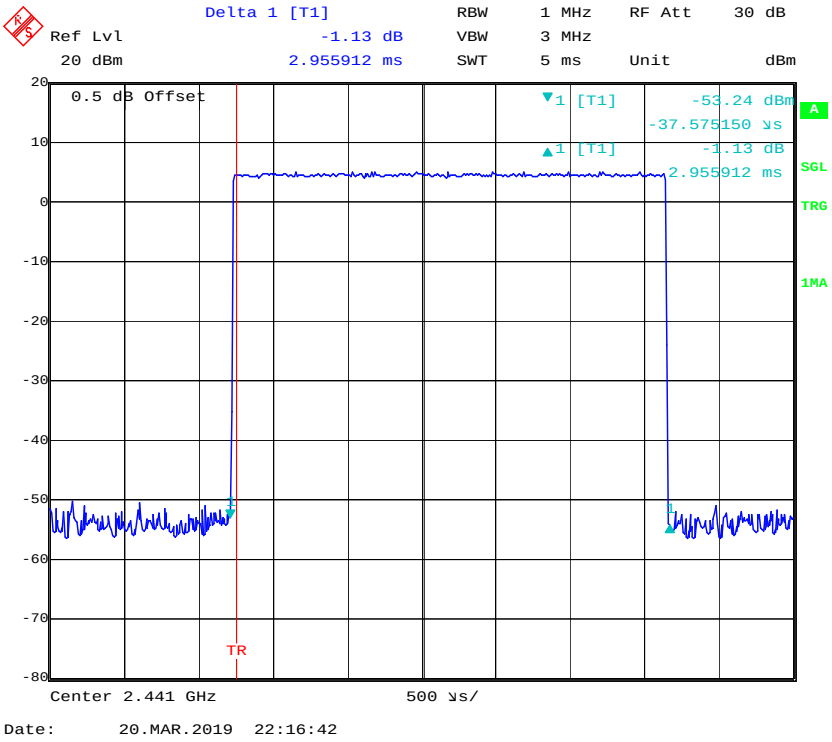
2DH1: Middle Channel



2DH3: Middle Channel

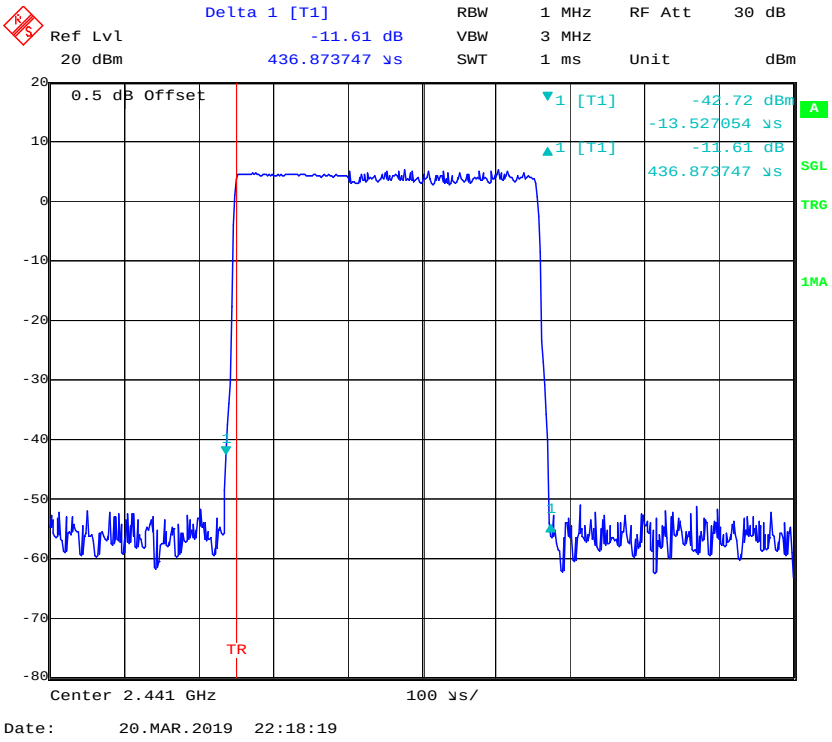


DH5: Middle Channel

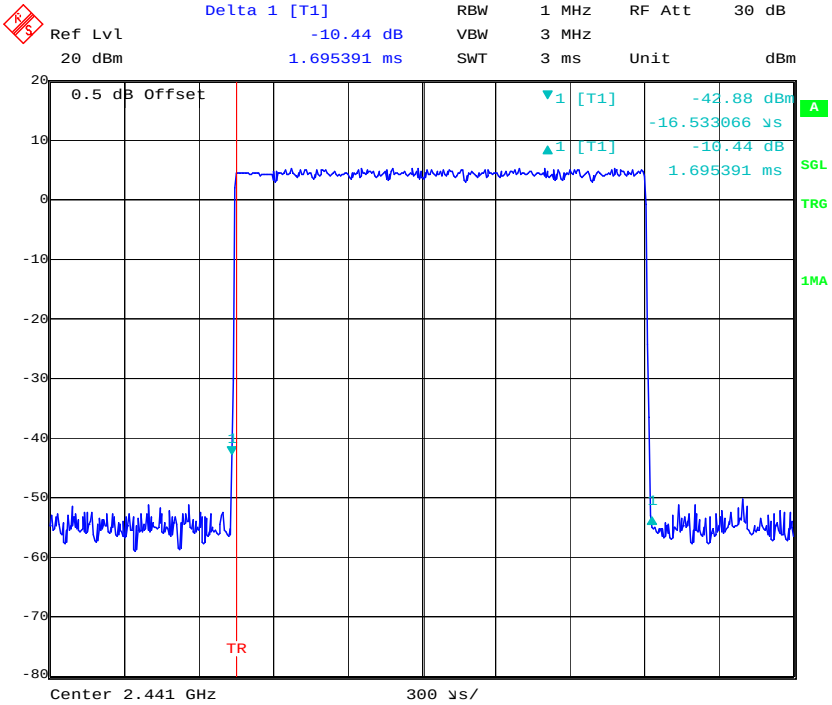


EDR Mode (8-DPSK):

3DH1: Middle Channel



3DH3: Middle Channel



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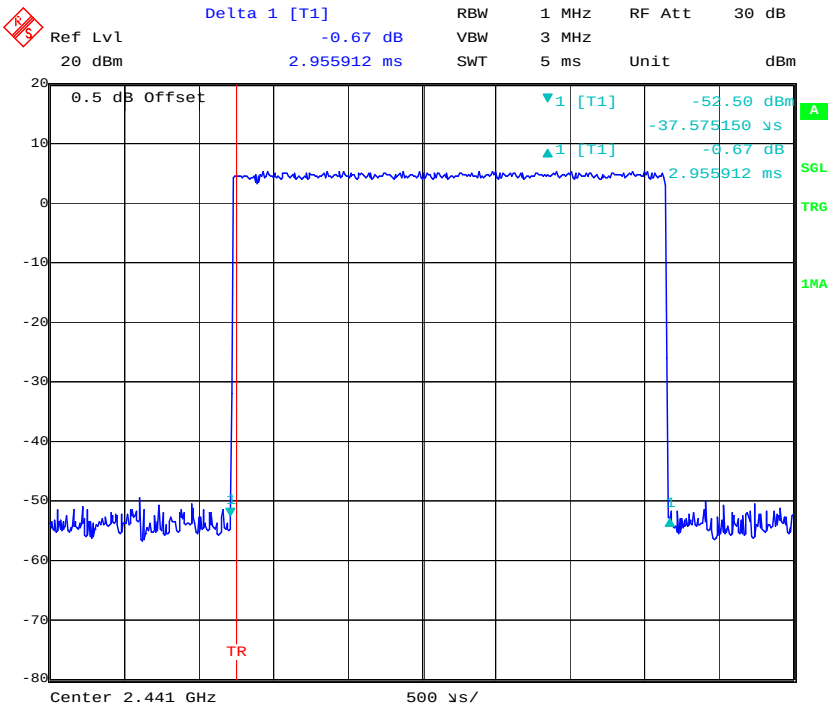
3DH5: Middle Channel



Date: 20.MAR.2019 22:19:52

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
Agilent	USB Wideband Power Sensor	U2022XA	MY5417006	2018-12-10	2019-12-10
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	/

*** 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:	25 °C
Relative Humidity:	54%
ATM Pressure:	100.5 kPa

** The testing was performed by Andy Huang on 2019-03-20*

Test Result: Compliance.

Test Mode: Transmitting

Mode	Frequency (MHz)	Peak Conducted Output power (dBm)	Limit (dBm)
BDR Mode (GFSK)	2402	5.29	21
	2441	6.38	21
	2480	5.80	21
EDR Mode (π/4-DQPSK)	2402	4.18	21
	2441	5.40	21
	2480	4.18	21
EDR Mode (8-DPSK)	2402	4.56	21
	2441	5.70	21
	2480	4.43	21

Note: The data above was tested in conducted mode.

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	2018-12-10	2019-12-10
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

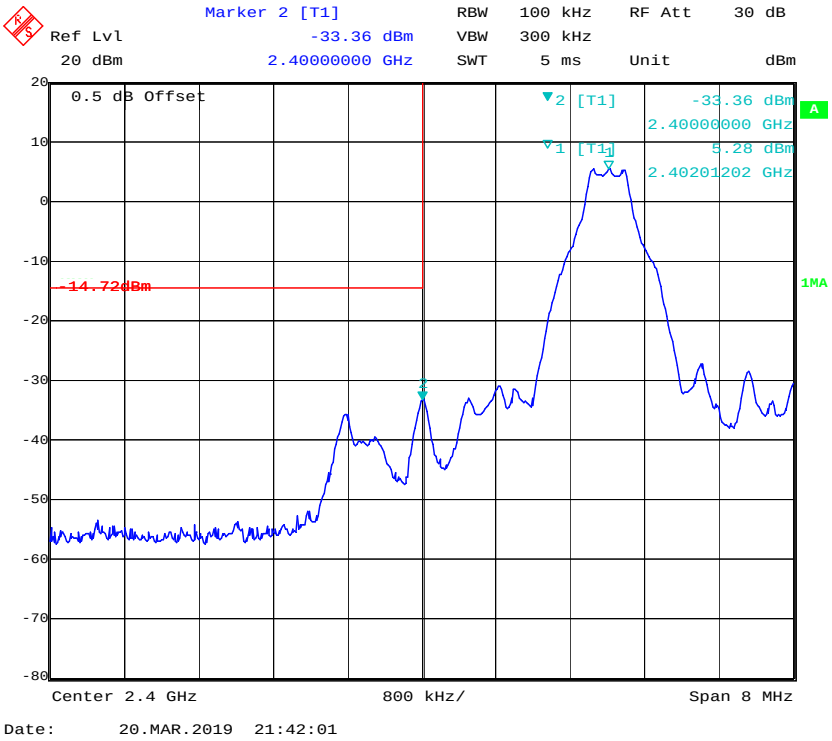
Temperature:	25 °C
Relative Humidity:	54%
ATM Pressure:	100.5 kPa

** The testing was performed by Andy Huang on 2019-03-20*

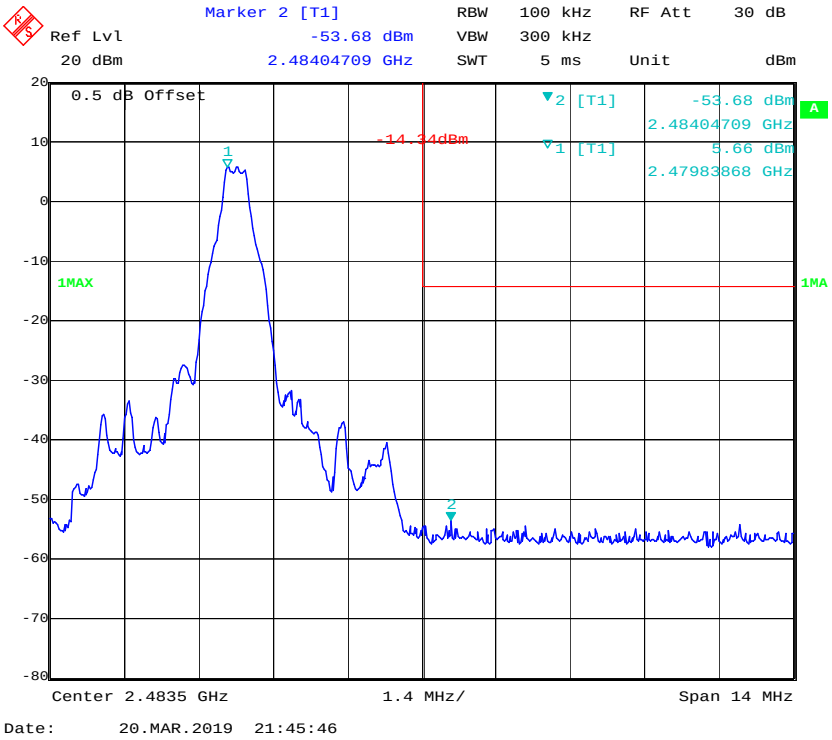
Test Result: Compliance

Single mode:
BDR Mode (GFSK):

Band Edge, Left Side

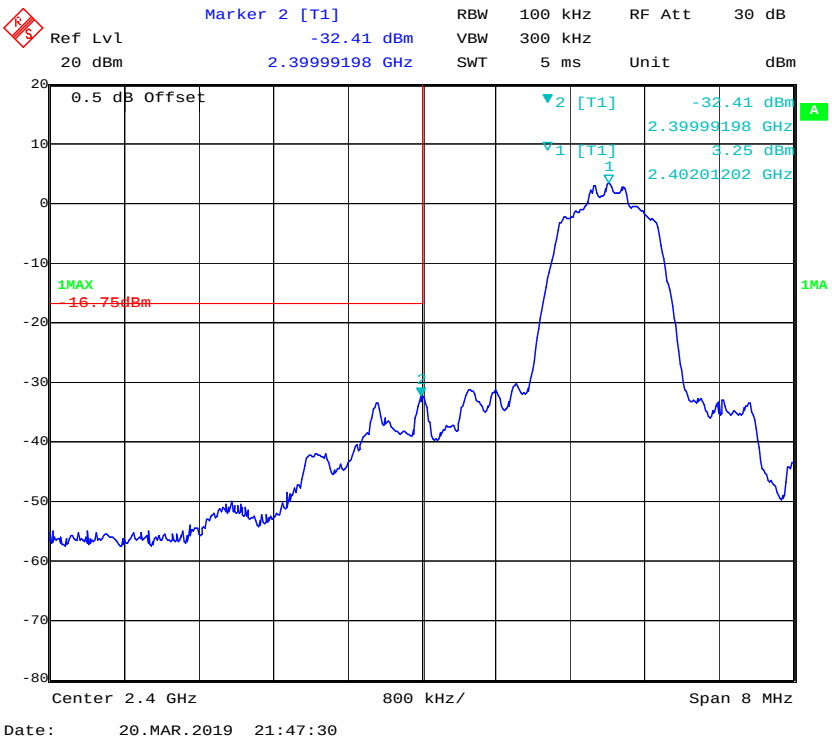


Band Edge, Right Side

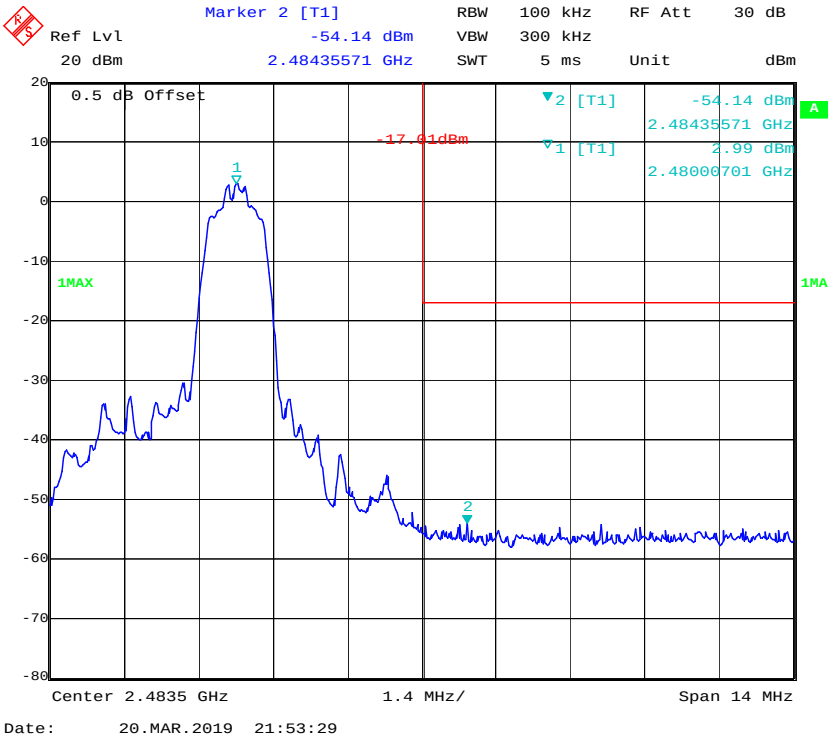


EDR Mode (π/4-DQPSK):

Band Edge, Left Side

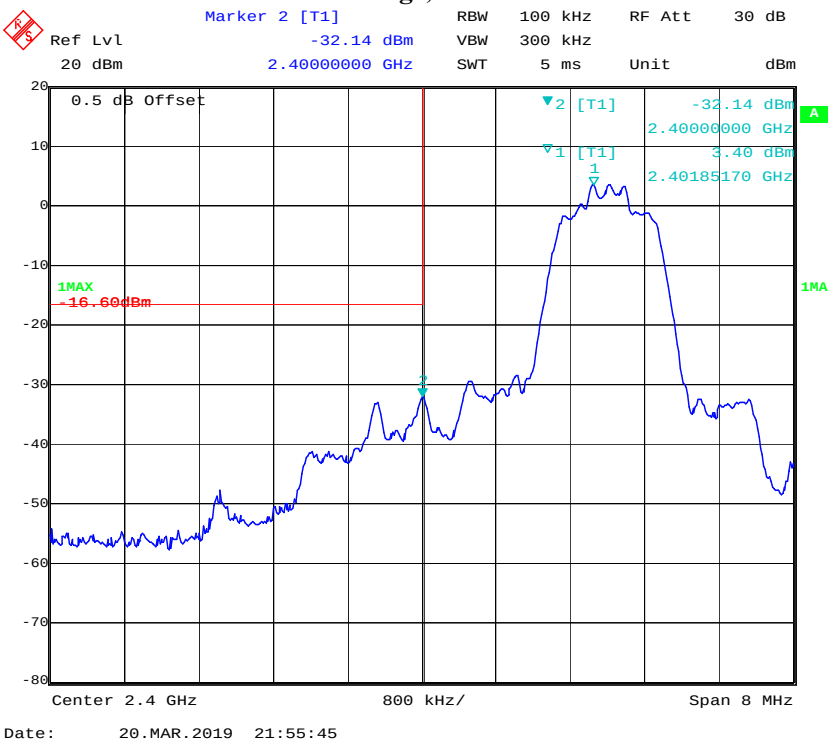


Band Edge, Right Side

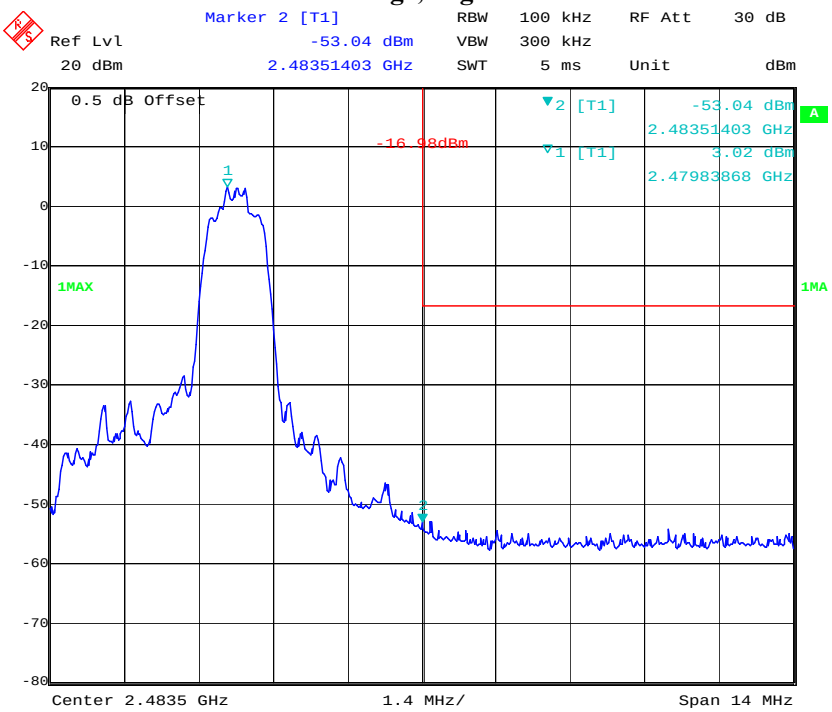


EDR Mode (8-DPSK):

Band Edge, Left Side



Band Edge, Right Side



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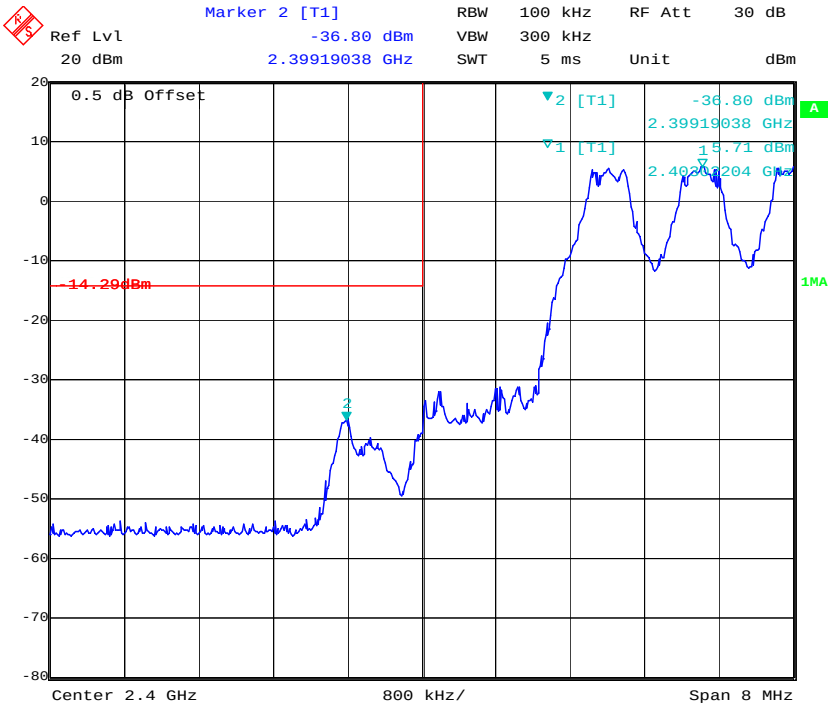
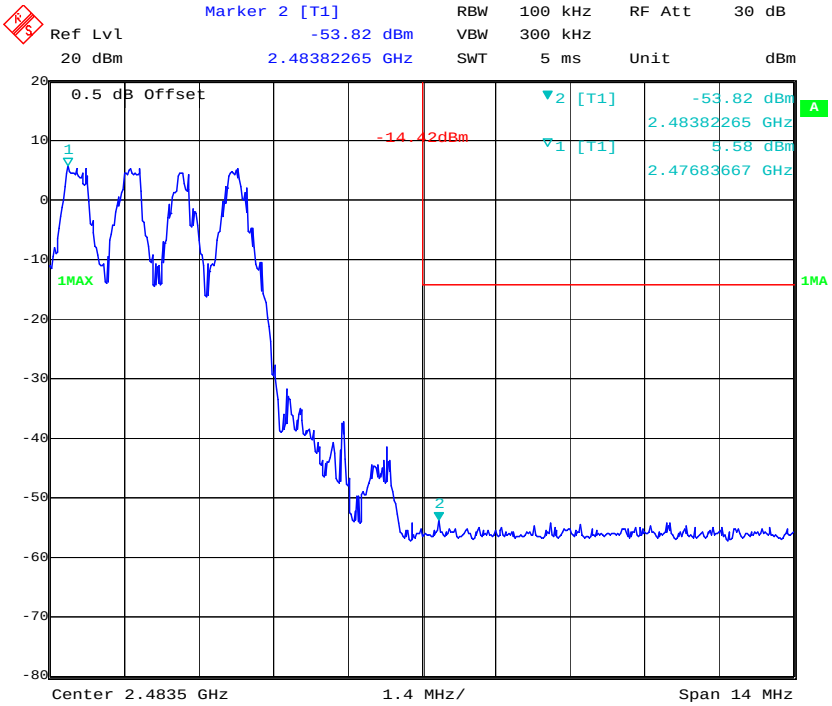
Hopping mode:
BDR Mode (GFSK):

Band Edge, Left Side



Date: 20.MAR.2019 22:36:21

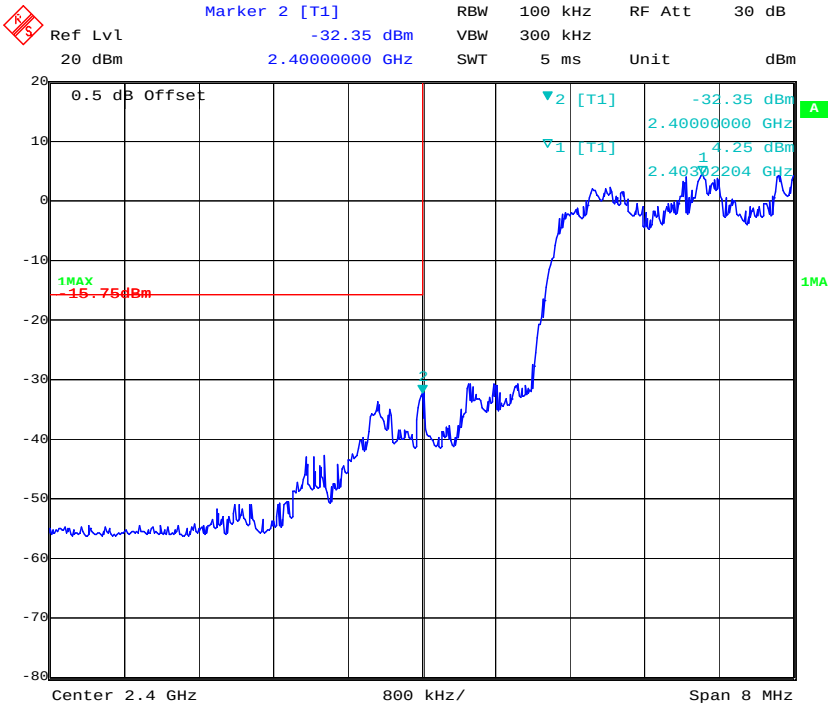
Band Edge, Right Side



Date: 20.MAR.2019 22:37:40

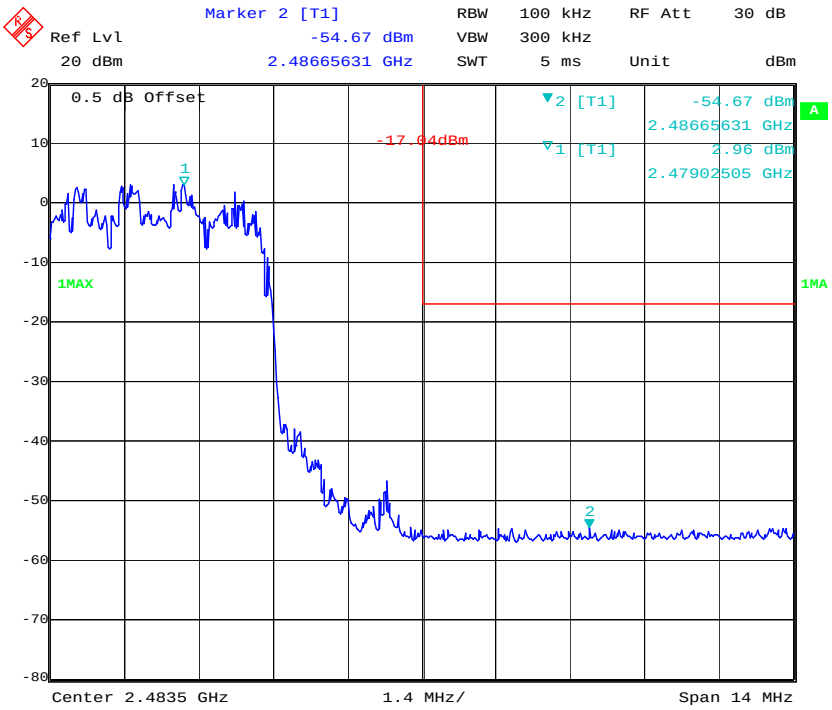
EDR Mode (π/4-DQPSK):

Band Edge, Left Side



Date: 20.MAR.2019 22:41:57

Band Edge, Right Side



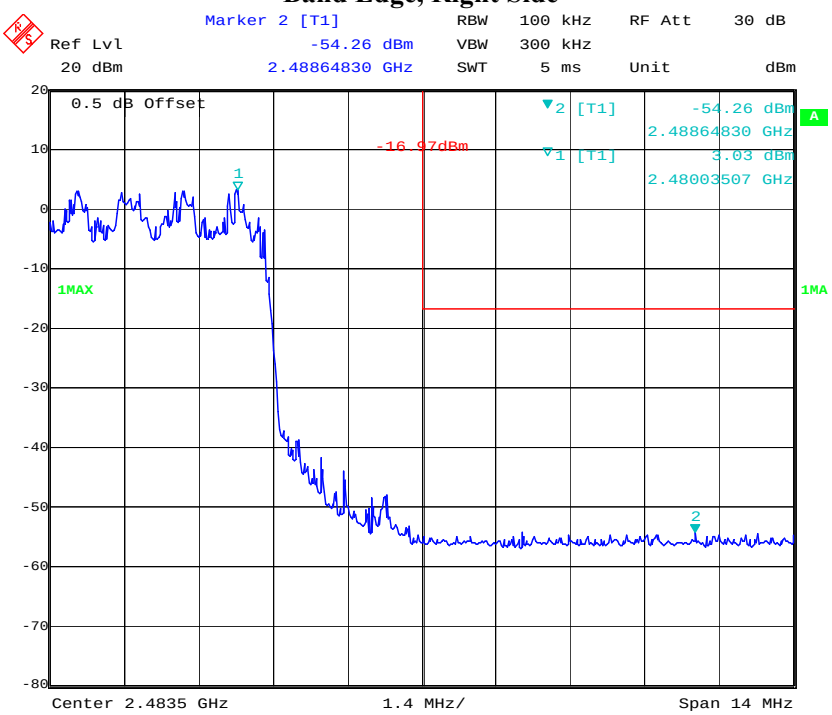
Date: 20.MAR.2019 22:39:38

EDR Mode (8-DPSK):

Band Edge, Left Side

Date: 20.MAR.2019 22:44:38

Band Edge, Right Side



Date: 20.MAR.2019 22:46:31

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