TESTING LABORATORY
CERTIFICATE #4820.01

FCC PART 15.247

RSS-GEN, ISSUE 5, MARCH 2019 AMENDMENT 1

RSS-247, ISSUE 2, FEBRUARY 2017

TEST REPORT

For

Broan - NuTone LLC

926 West State Street Hartford Wisconsin 53027 United States

FCC ID: 2ADLL-1102136
IC: 2143B-1102136

Report Type:	**Product Name:**
Original Report	MODULE LIGHT SPEAKER

Report Number:	RDG191128050-00
Report Date:	2019-12-11
Reviewed By:	Jerry Zhang EMC Manager
Test Laboratory:	Bay Area Compliance Laboratories Corp. (Dongguan) No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China Tel: +86-769-86858888 Fax: +86-769-86858891 www.baclcorp.com.cn

TABLE OF CONTENTS

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	MODULE LIGHT SPEAKER
EUT Model:	1102136
Operation Frequency:	2402-2480 MHz
Maximum Peak Output Power (Conducted):	6.02 dBm
Modulation Type:	GFSK, π/4-DQPSK, 8DPSK
Rated Input Voltage:	120Vac
Serial Number:	RDG191128050-RF
EUT Received Date:	2019/12/2
EUT Received Status:	Good

Objective

This report is prepared on behalf of ***Broan - NuTone LLC*** in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules, RSS-247, Issue 2, February 2017 of the Innovation, Science and Economic Development Canada, RSS-Gen, Issue 5, March 2019 Amendment 1 of the Innovation, Science and Economic Development Canada.

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, RSS-247, Issue 2, February 2017, RSS-Gen, Issue 5, March 2019 Amendment 1 of the Innovation, Science and Economic Development Canada.

Related Submittal(s)/Grant(s)

No related submittal.

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", RSS-247, Issue 2, February 2017 of the Innovation, Science and Economic Development Canada, RSS-Gen Issue 5, March 2019 Amendment 1 of the Innovation, Science and Economic Development Canada.

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)

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

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.

Declarations

BACL is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with a triangle symbol "△ ". Customer model name, addresses, names, trademarks etc. are not considered data.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

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This report may contain data that are not covered by the accreditation scope and shall be marked with an asterisk "★".

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in engineering mode.

EUT Exercise Software

The software:' Blue Test3 ' was used during test, which was provided by manufacturer. The maximum power level was configured by the software as below table:

Test Software Version	Blue Test3		
Test Frequency	2402MHz	2441MHz	2480MHz
GFSK	50	50	50
π/4-DQPSK	50	50	50
8DPSK	50	50	50

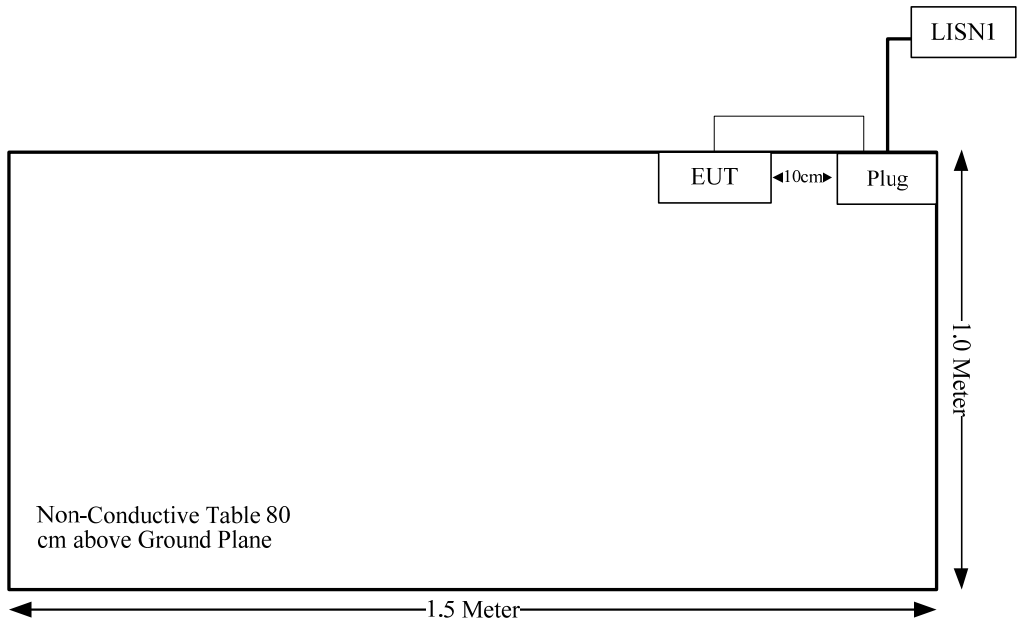
Equipment Modifications

No modification was made to the EUT.

Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From	To
Power Cable	NO	NO	0.2	Plug	EUT

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
FCC§15.247 (i) & §1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliance
RSS-102 Clause 2.5.2	Exemption Limits For Routine Evaluation-RF Exposure Evaluation	Compliance
FCC§15.203; RSS-GEN Clause 6.8	Antenna Requirement	Compliance
FCC§15.207 (a); RSS-Gen Clause 8.8	Conducted Emissions	Compliance
FCC§15.205, §15.209, §15.247(d); RSS-247 Clause 5.5, RSS-Gen Clause 8.10	Spurious Emissions	Compliance
FCC§15.247 (a)(1); RSS-247 Clause 5.1 b) RSS-Gen Clause 6.7	Bandwidth Test	Compliance
FCC§15.247(a)(1); RSS-247 Clause 5.1 b)	Channel Separation Test	Compliance
FCC§15.247(a)(1)(iii); RSS-247 Clause 5.1 d)	Time of Occupancy (Dwell Time)	Compliance
FCC§15.247(a)(1)(iii); RSS-247 Clause 5.1 d)	Quantity of hopping channel Test	Compliance
FCC§15.247(b)(1); RSS-247 Clause 5.4 b)	Peak Output Power Measurement	Compliance
FCC§15.247(d); RSS-247 Clause 5.5	Band Edges	Compliance

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

Applicable Standard

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

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

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

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

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

Calculation formula:

Prediction of power density at the distance of the applicable MPE limit
$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Calculated Data:

Frequency (MHz)	**Antenna Gain**		**Conducted output power including Tune-up Tolerance**		**Evaluation Distance (cm)**	**Power Density (mW/cm^2)**	**MPE Limit (mW/cm^2)**
	(dBi)	**(numeric)**	**(dBm)**	**(mW)**			
2402-2480	-0.61	0.87	7	5.01	20.00	0.0009	1.0

Result: The device meet FCC MPE at 20 cm distance

RSS-102 § 2.5.2 - EXEMPTION LIMITS FOR ROUTINE EVALUATION – RF EXPOSURE EVALUATION

Applicable Standard

According to RSS-102 § (2.5.2):

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2}\ f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Calculated Data:

Frequency (MHz)	Antenna Gain	Conducted output power including Tune-up Tolerance	EIRP		Exemption limits (mW)
	(dBi)	(dBm)	(dBm)	(mW)	
2402-2480	-0.61	7	6.39	4.36	2679

So the device is compliance exemption from Routine Evaluation Limits –RF exposure Evaluation.

Result: Compliance

FCC §15.203, RSS-GEN CLAUSE 6.8 - 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.

According to RSS-Gen §6.8, The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.
For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).
When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer. The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.
For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

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

Antenna Connector Construction

The EUT has one internal PCB antenna arrangement, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	input impedance (Ohm)	Antenna Gain /Frequency Range
PCB	50	-0.61 dBi/2.4~2.5GHz

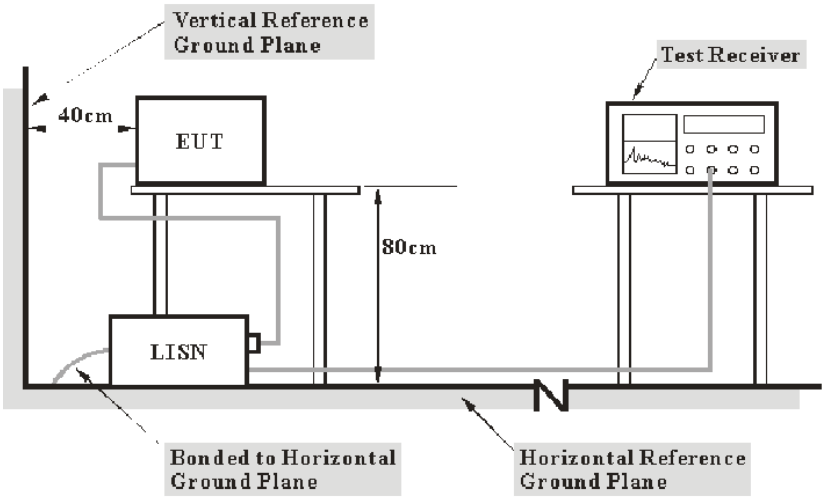
Result: Compliance.

FCC §15.207 (a), RSS-GEN CLAUSE 8.8 – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207(a), RSS-GEN CLAUSE 8.8.

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 and RSS-Gen limits.

The spacing between the peripherals was 10 cm.

The plug 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 plug 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
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-01	2019-09-05	2020-09-05
R&S	Test Software	EMC32	Version8.53.0	N/A	N/A
R&S	Two-line V-network	ENV 216	101614	2019-09-12	2020-09-12
R&S	EMI Test Receiver	ESCI	101121	2019-05-09	2020-05-09

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

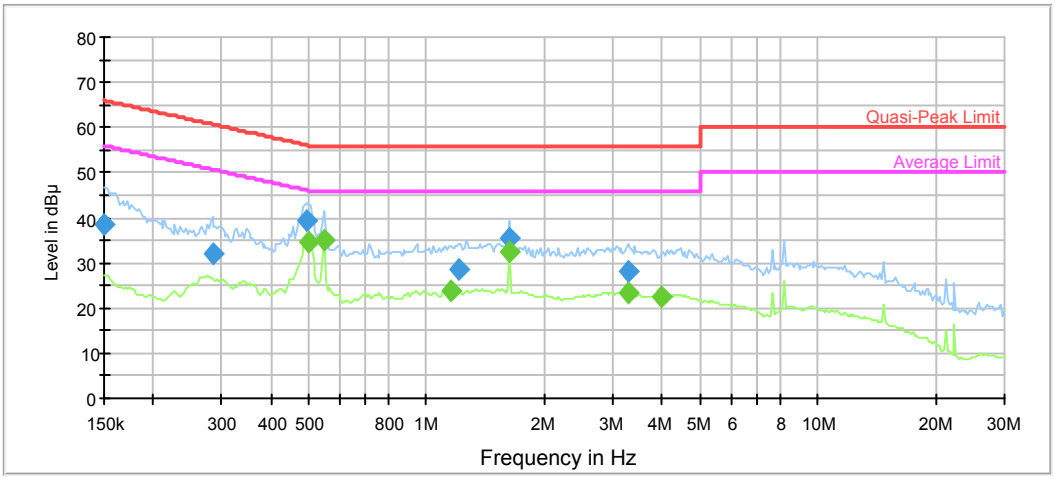
Test Data

Environmental Conditions

Temperature:	23.3℃
Relative Humidity:	28%
ATM Pressure:	100.6kPa
Tester:	Sern Xiang
Test Date:	2019-12-05

Test Mode: *Transmitting*

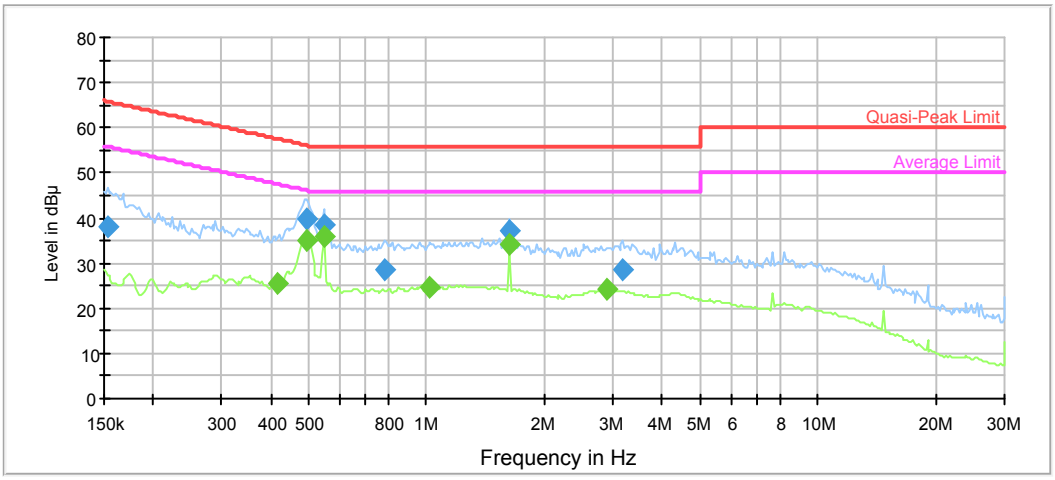
AC120V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	38.7	9.000	L1	11.2	27.3	66.0
0.283569	31.8	9.000	L1	10.2	28.9	60.7
0.495058	39.2	9.000	L1	9.9	16.9	56.1
1.212216	28.4	9.000	L1	9.8	27.6	56.0
1.633884	35.5	9.000	L1	9.7	20.5	56.0
3.278819	28.2	9.000	L1	9.8	27.8	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.500009	34.6	9.000	L1	9.9	11.4	46.0
0.546852	34.8	9.000	L1	9.9	11.2	46.0
1.153382	23.6	9.000	L1	9.8	22.4	46.0
1.633884	32.3	9.000	L1	9.7	13.7	46.0
3.278819	23.3	9.000	L1	9.8	22.7	46.0
4.000782	22.6	9.000	L1	9.8	23.4	46.0

AC120V, 60 Hz, Neutral:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.153015	38.0	9.000	N	11.1	27.8	65.8
0.495058	39.8	9.000	N	9.9	16.3	56.1
0.546852	38.6	9.000	N	9.8	17.4	56.0
0.782419	28.4	9.000	N	9.8	27.6	56.0
1.633884	37.4	9.000	N	9.8	18.6	56.0
3.182389	28.4	9.000	N	9.8	27.6	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.418016	25.6	9.000	N	9.9	21.9	47.5
0.495058	35.1	9.000	N	9.9	11.0	46.1
0.546852	35.7	9.000	N	9.8	10.3	46.0
1.013434	24.7	9.000	N	9.8	21.3	46.0
1.633884	34.0	9.000	N	9.8	12.0	46.0
2.880975	24.1	9.000	N	9.8	21.9	46.0

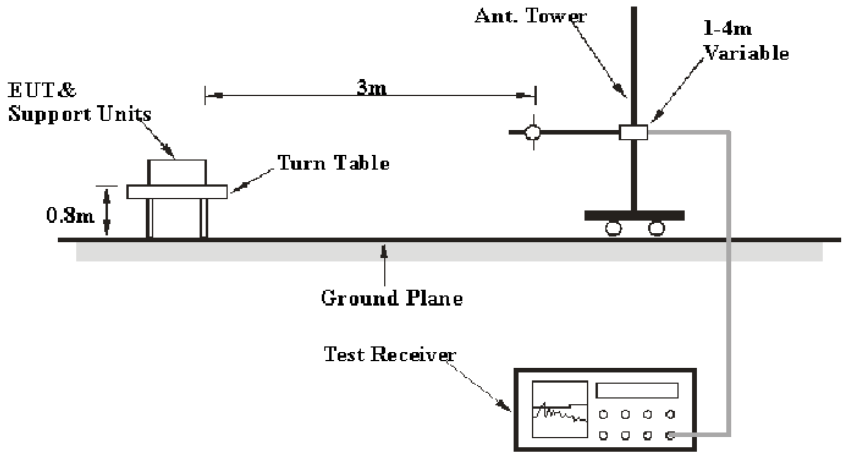
FCC §15.209, §15.205 & §15.247(d) , RSS-247 CLAUSE 5.5,RSS -GEN CLAUSE 8.10 - SPURIOUS EMISSIONS

Applicable Standard

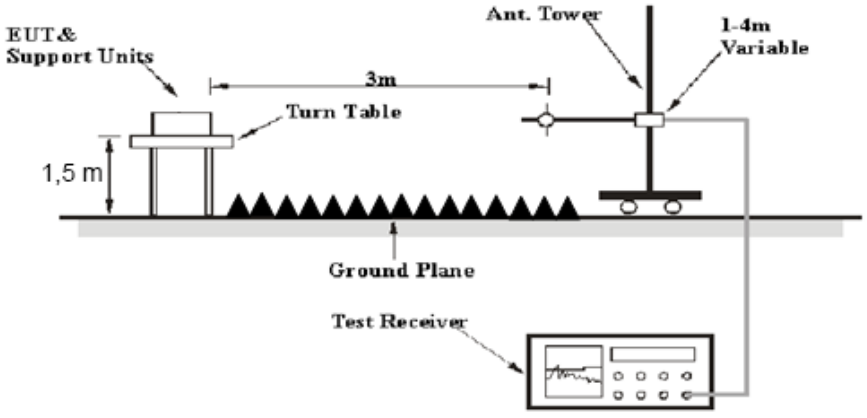
FCC §15.247 (d); §15.209; §15.205; RSS-247 Clause 5.5, RSS-GEN Clause 8.10

EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emission below 1GHz tests were performed in the 3 meters chamber test site A, above 1GHz tests were performed in the 3 meters chamber test site A, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits and the RSS-247 Clause 5.5, RSS-GEN Clause 8.10 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
Below 1GHz					
R&S	EMI Test Receiver	ESR3	102453	2019-09-12	2020-09-12
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Sunol Sciences	Antenna	JB3	A060611-1	2017-11-10	2020-11-10
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-1400-01	2019-05-06	2020-05-06
HP	Amplifier	8447D	2727A05902	2019-09-05	2020-09-05
Above 1GHz					
R&S	Spectrum Analyzer	FSP 38	100478	2019-05-09	2020-05-09
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
TDK RF	Horn Antenna	HRN-0118	130 084	2018-10-12	2021-10-12
Ducommun Technolagies	Horn Antenna	ARH-4223-02	1007726-01 1304	2017-12-06	2020-12-05
MICRO-COAX	Coaxial Cable	UFA147-1-2362-100100	64639 231029-001	2019-02-24	2020-02-24
Mini	Pre-amplifier	ZVA-183-S+	5969001149	2019-09-05	2020-09-05
Quinstar	Amplifier	QLW-18405536-JO	15964001001	2019-06-27	2020-06-27
E-Microwave	Band-stop Filters	OBSF-2400-2483.5-S	OE01601525	2019-06-16	2020-06-16
Micro-tronics	High Pass Filter	HPM50111	S/N-G217	2019-06-16	2020-06-16

*** 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

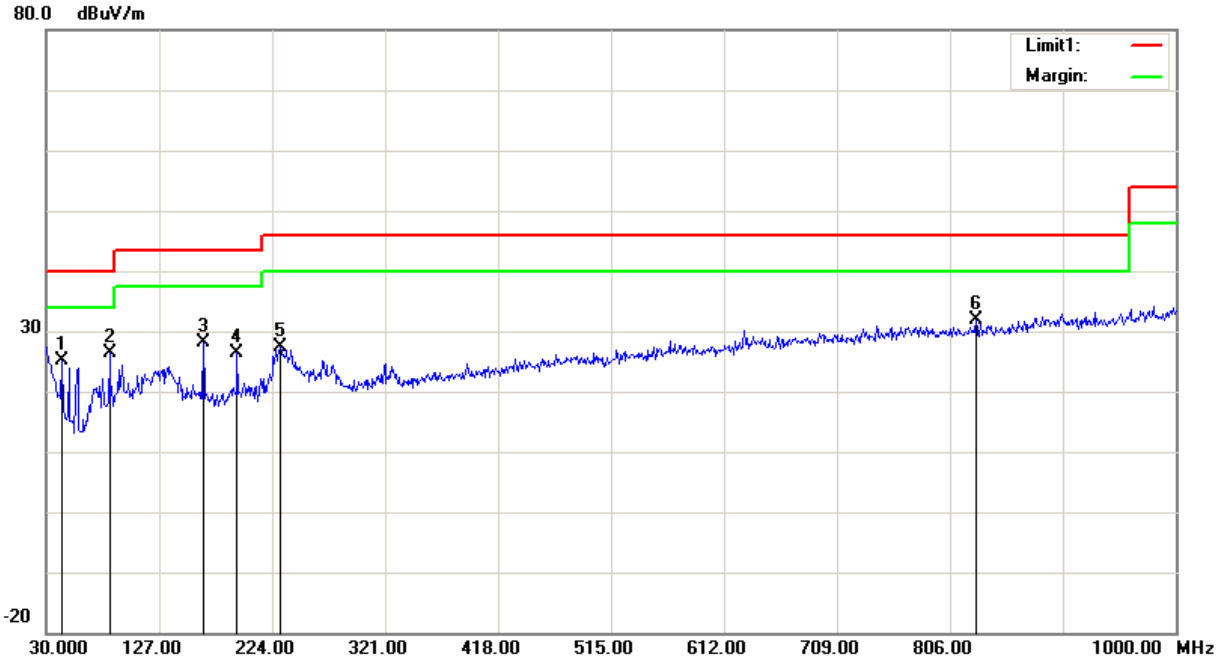
Environmental Conditions

Test Items	Radiation Below 1GHz	Radiation Above 1GHz
Temperature:	23.9°C	21.4 °C
Relative Humidity:	36%	38 %
ATM Pressure:	100.6 kPa	100.6 kPa
Tester:	Tyler Pan	Davy Wang
Test Date:	2019-12-05	2019-12-05

Test Mode: Transmitting

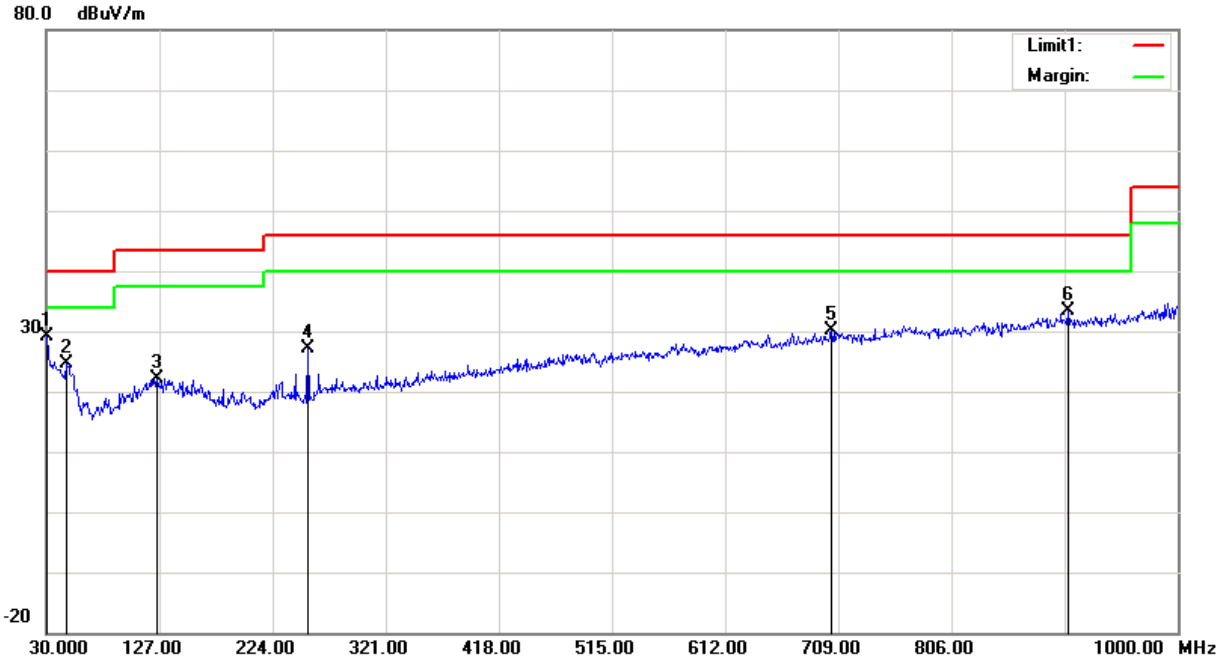
1) 30MHz-1GHz(GFSK High channel was the worst)

Horizontal:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
43.5800	33.45	peak	-8.38	25.07	40.00	14.93
84.3200	37.78	peak	-11.38	26.40	40.00	13.60
164.8300	34.41	peak	-6.19	28.22	43.50	15.28
193.9300	33.27	peak	-6.80	26.47	43.50	17.03
230.7900	33.69	peak	-6.36	27.33	46.00	18.67
828.3100	26.88	peak	5.06	31.94	46.00	14.06

Vertical:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.9700	28.31	peak	0.91	29.22	40.00	10.78
47.4600	34.91	peak	-10.36	24.55	40.00	15.45
125.0600	26.84	peak	-4.64	22.20	43.50	21.30
254.0700	33.04	peak	-6.02	27.02	46.00	18.98
703.1800	26.93	peak	3.11	30.04	46.00	15.96
905.9100	33.21	peak	0.20	33.41	46.00	12.59

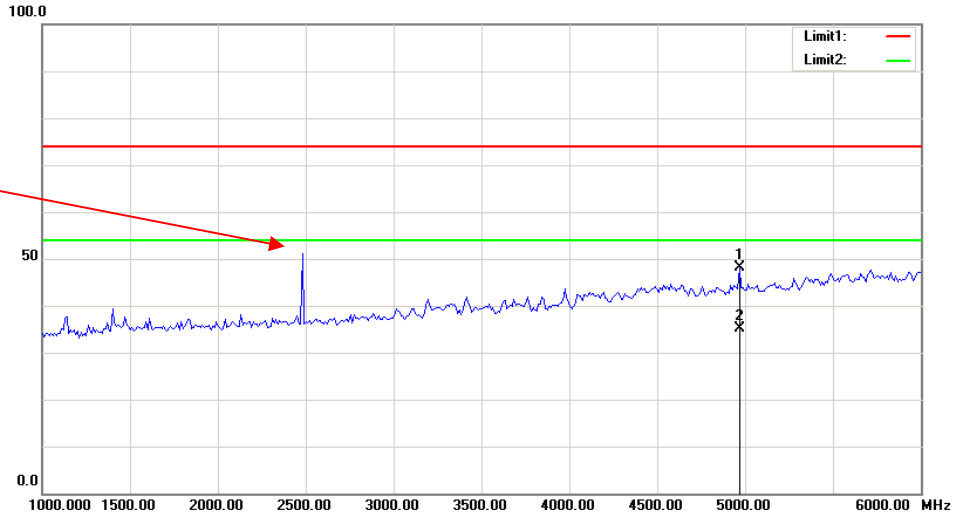
2) 1GHz-25GHz:

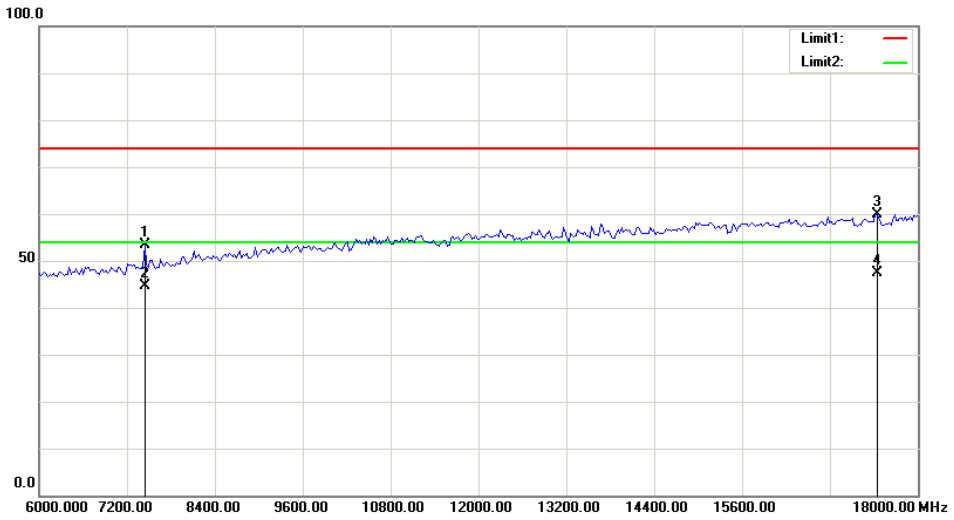
BDR Mode (GFSK) was worst

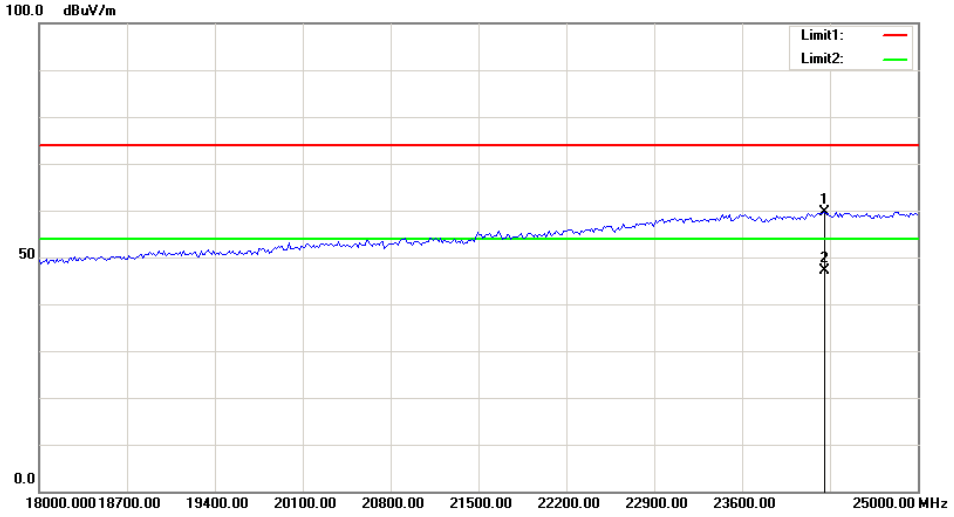
Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
	Reading (dBµV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2390.00	26.00	PK	V	24.80	3.33	0.00	54.13	74.00	19.87
2390.00	12.54	AV	V	24.80	3.33	0.00	40.67	54.00	13.33
4804.00	45.94	PK	V	29.71	4.58	27.36	52.87	74.00	21.13
4804.00	32.98	AV	V	29.71	4.58	27.36	39.91	54.00	14.09
7206.00	39.24	PK	V	33.93	5.59	27.19	51.57	74.00	22.43
7206.00	26.25	AV	V	33.93	5.59	27.19	38.58	54.00	15.42
Middle Channel: 2441 MHz									
4882.00	45.03	PK	V	29.86	4.56	27.56	51.89	74.00	22.11
4882.00	32.77	AV	V	29.86	4.56	27.56	39.63	54.00	14.37
7323.00	39.69	PK	V	34.12	5.69	27.26	52.24	74.00	21.76
7323.00	26.13	AV	V	34.12	5.69	27.26	38.68	54.00	15.32
High Channel: 2480 MHz									
2483.50	31.62	PK	V	24.97	3.38	0.00	59.97	74.00	14.03
2483.50	18.81	AV	V	24.97	3.38	0.00	47.16	54.00	6.84
4960.00	46.34	PK	V	30.02	4.58	27.37	53.57	74.00	20.43
4960.00	33.60	AV	V	30.02	4.58	27.37	40.83	54.00	13.17
7440.00	41.00	PK	V	34.30	5.79	27.22	53.87	74.00	20.13
7440.00	27.07	AV	V	34.30	5.79	27.22	39.94	54.00	14.06

Worst plots (*GFSK High channel*)
Horizontal

Fundamental Test with Band Rejection Filter

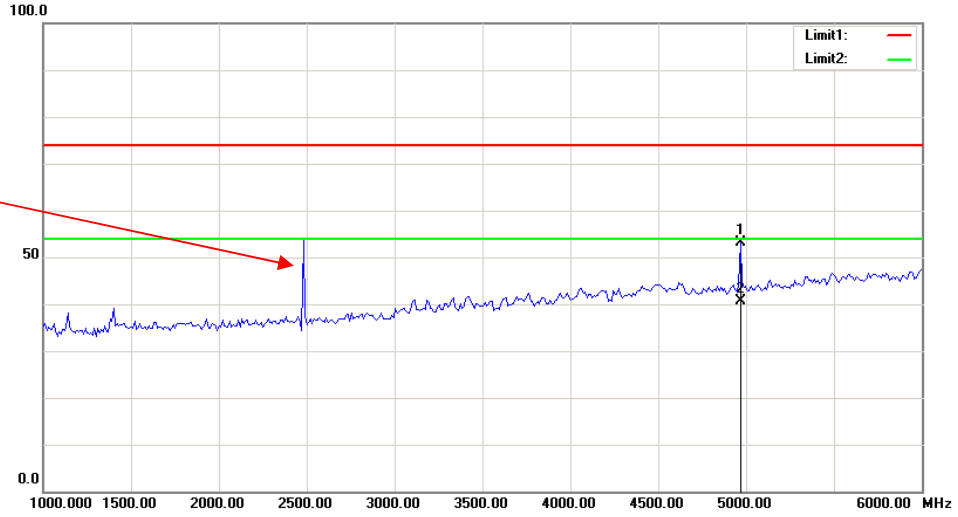


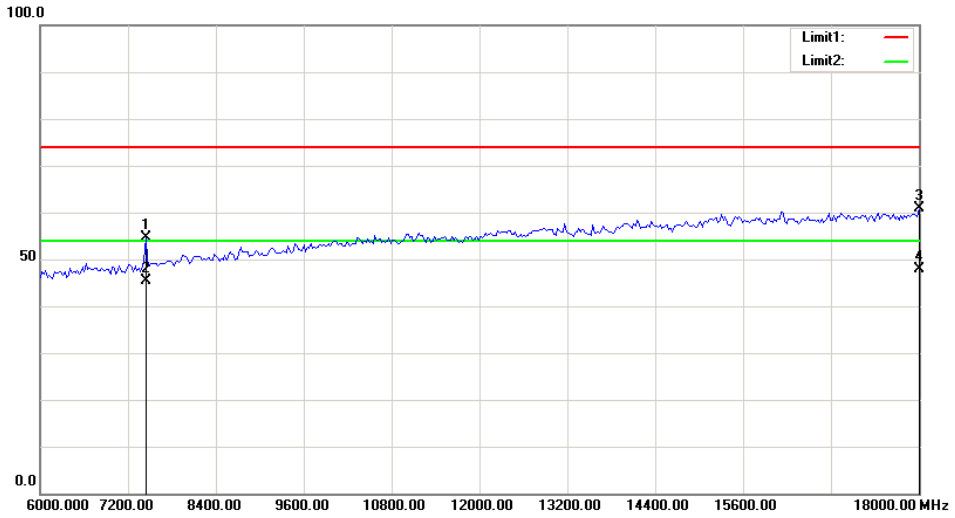


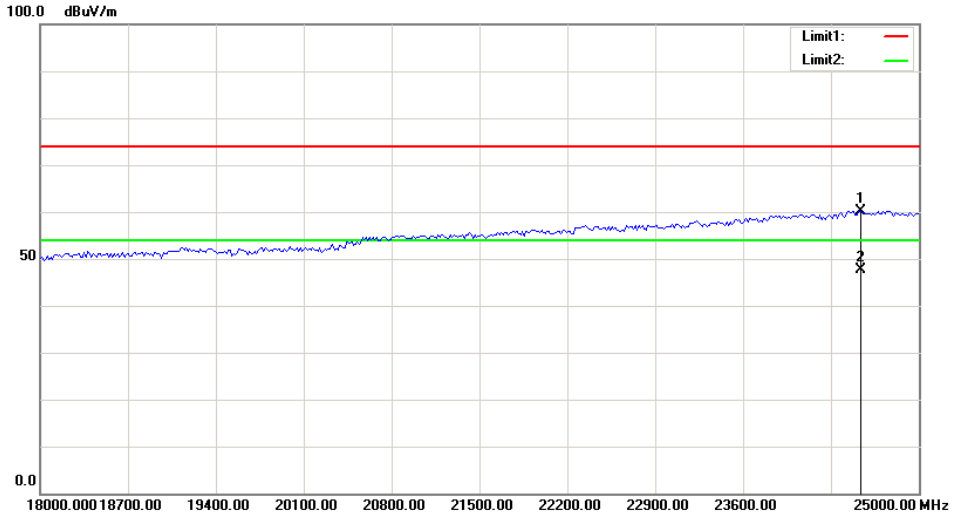


Vertical

Fundamental Test with Band Rejection Filter







FCC §15.247(a) (1), RSS-247 CLAUSE 5.1 b) - CHANNEL SEPARATION TEST

Applicable Standard

According to FCC §15.247(a) (1), RSS-247 Clause 5.1 b)

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	EMI Test Receiver	ESCI	100035	2019-09-19	2020-09-19
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:	22.1 °C
Relative Humidity:	35 %
ATM Pressure:	102.1 kPa
Tester:	Lily Xie
Test Date:	2019-12-09

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

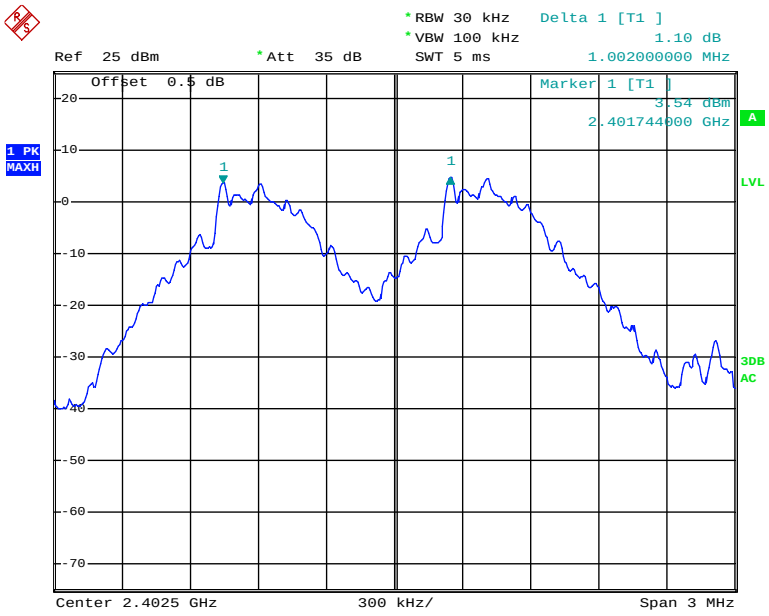
Test Mode: Transmitting

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
BDR (GFSK)	Low	2402	1.002	0.6
	Middle	2441	1.002	0.59
	High	2480	0.996	0.59
EDR (π/4-DQPSK)	Low	2402	0.996	0.82
	Middle	2441	1.002	0.82
	High	2480	1.002	0.82
EDR (8DPSK)	Low	2402	0.996	0.81
	Middle	2441	1.002	0.81
	High	2480	1.002	0.81

Note: Limit= (2/3) × 20dB bandwidth

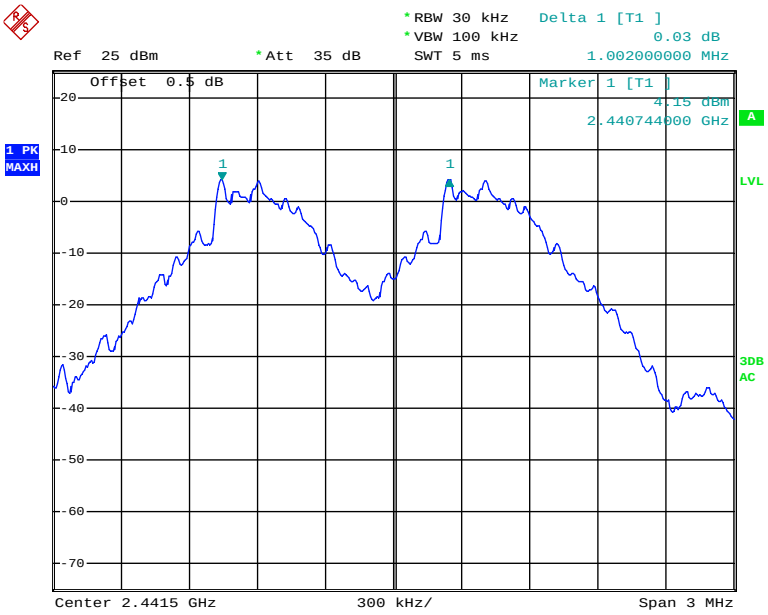
BDR Mode (GFSK):

Low Channel



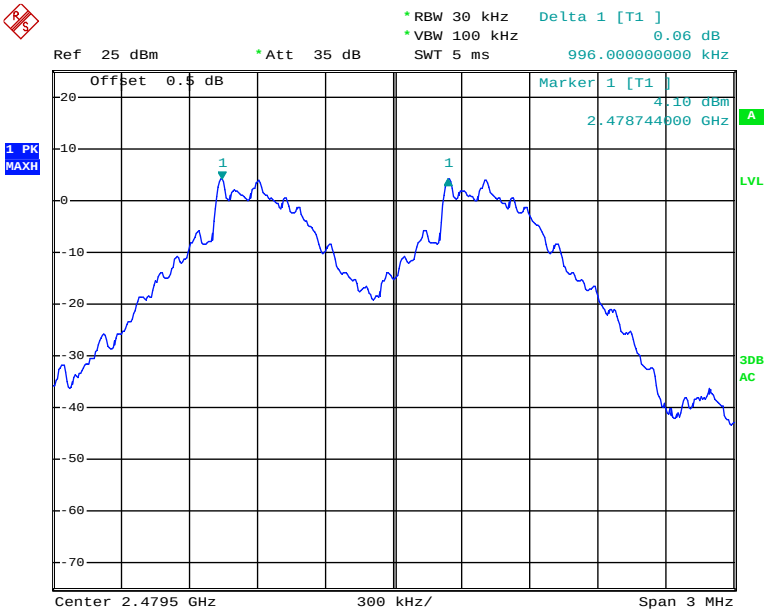
Date: 9.DEC.2019 13:56:10

Middle Channel



Date: 9.DEC.2019 14:09:55

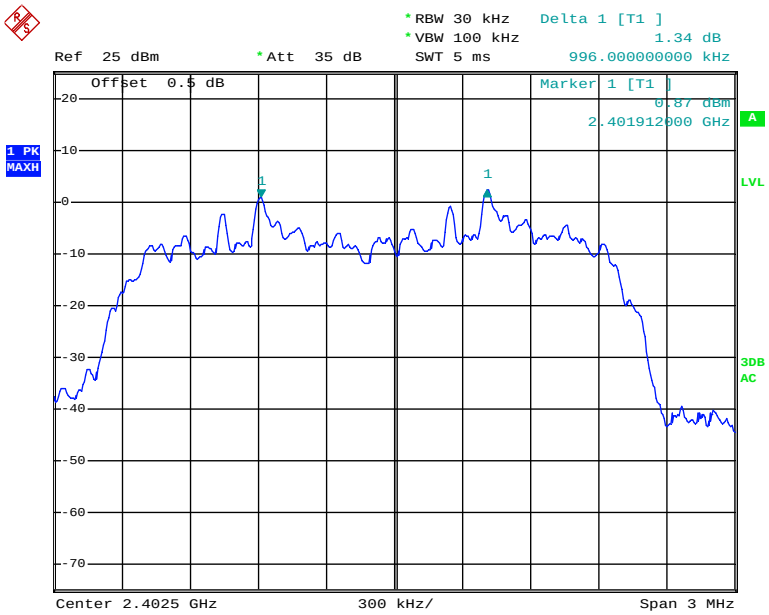
High Channel



Date: 9.DEC.2019 14:10:43

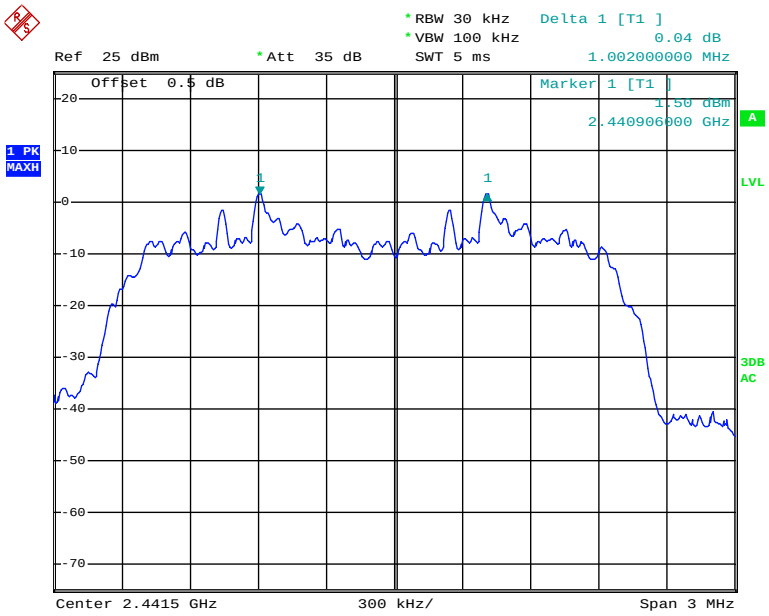
EDR Mode (π/4-DQPSK):

Low Channel



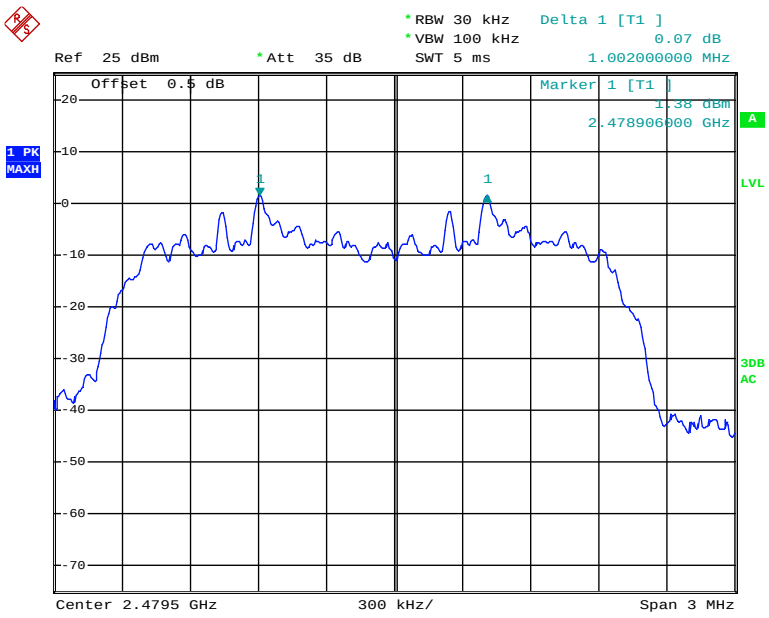
Date: 9.DEC.2019 14:16:32

Middle Channel



Date: 9.DEC.2019 14:19:25

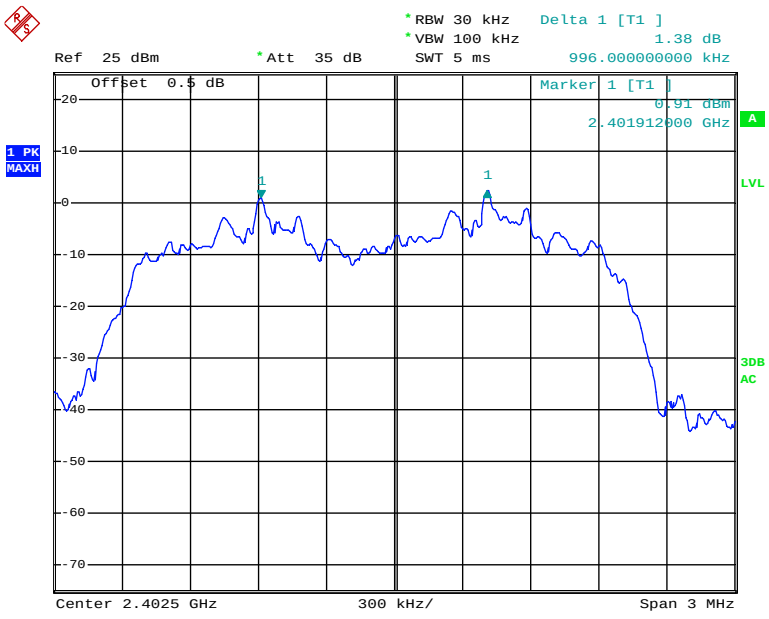
High Channel



Date: 9.DEC.2019 14:21:12

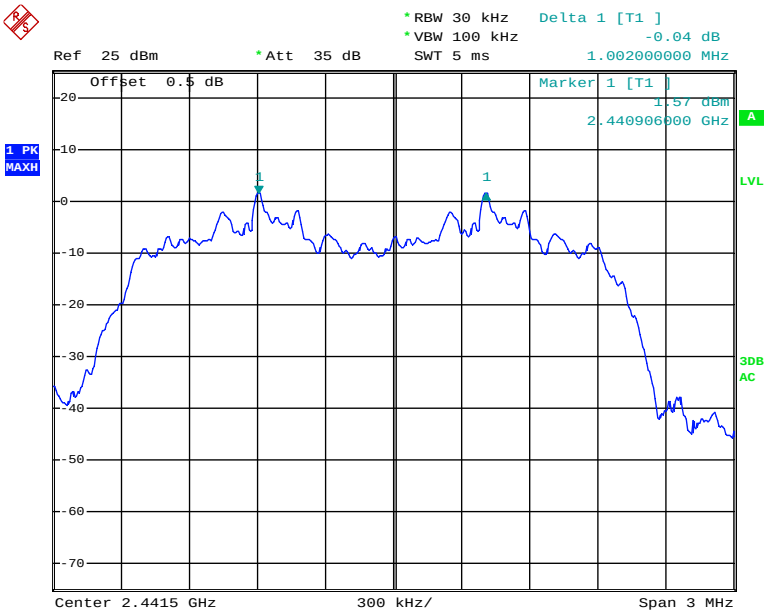
EDR Mode (8-DPSK):

Low Channel



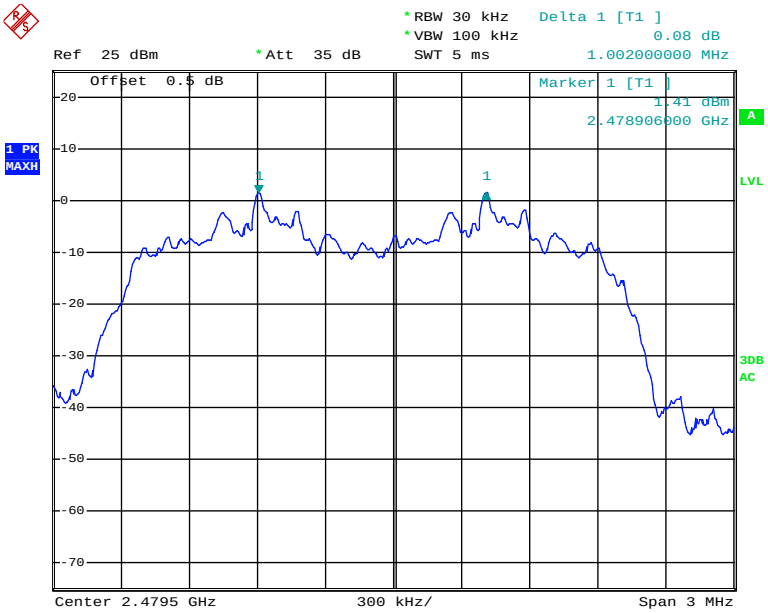
Date: 9.DEC.2019 14:44:55

Middle Channel



Date: 9.DEC.2019 14:43:08

High Channel



Date: 9.DEC.2019 14:47:04

FCC §15.247(a) (1), RSS-247 CLUASE 5.1&RSS-GEN CLAUSE 6.7 – BANDWIDTH TESTING

Applicable Standard

According to FCC §15.247(a) (1):

Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

According to RSS-247 Clause 5.1 b):

b) FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

According to RSS-Gen Clause 6.7:

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

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.
5. Use the OBW test function test the 99% Occupied bandwidth.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESCI	100035	2019-09-19	2020-09-19
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:	22.1 °C
Relative Humidity:	35 %
ATM Pressure:	102.1 kPa
Tester:	Lily Xie
Test Date:	2019-12-09

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

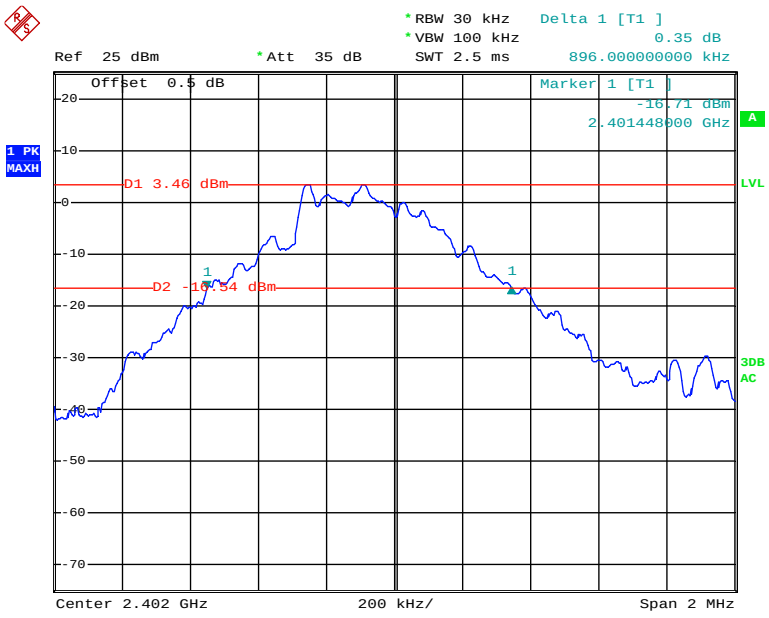
Test Mode: Transmitting

Mode	Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
BDR Mode (GFSK)	Low	2402	0.896	0.840
	Middle	2441	0.888	0.840
	High	2480	0.892	0.840
EDR Mode (π/4-DQPSK)	Low	2402	1.224	1.168
	Middle	2441	1.228	1.164
	High	2480	1.228	1.164
EDR Mode (8DPSK)	Low	2402	1.212	1.140
	Middle	2441	1.216	1.144
	High	2480	1.212	1.140

20 dB Bandwidth

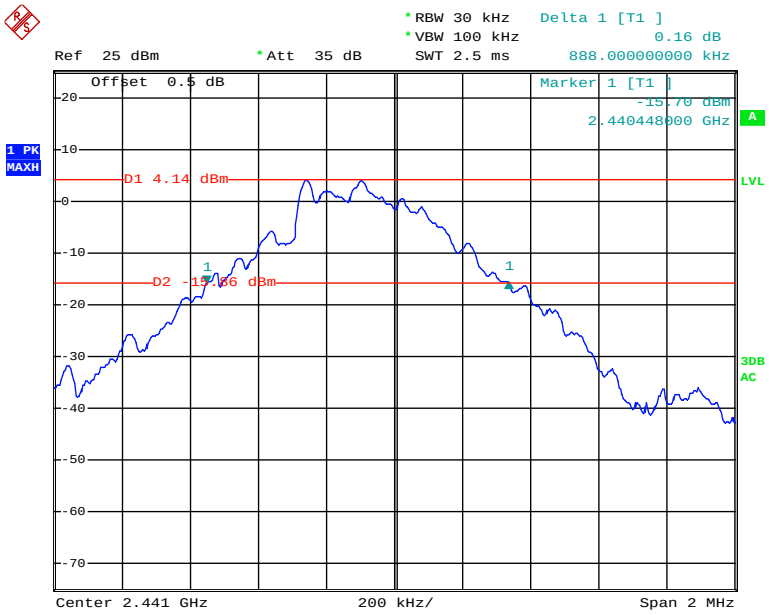
BDR Mode (GFSK):

Low Channel



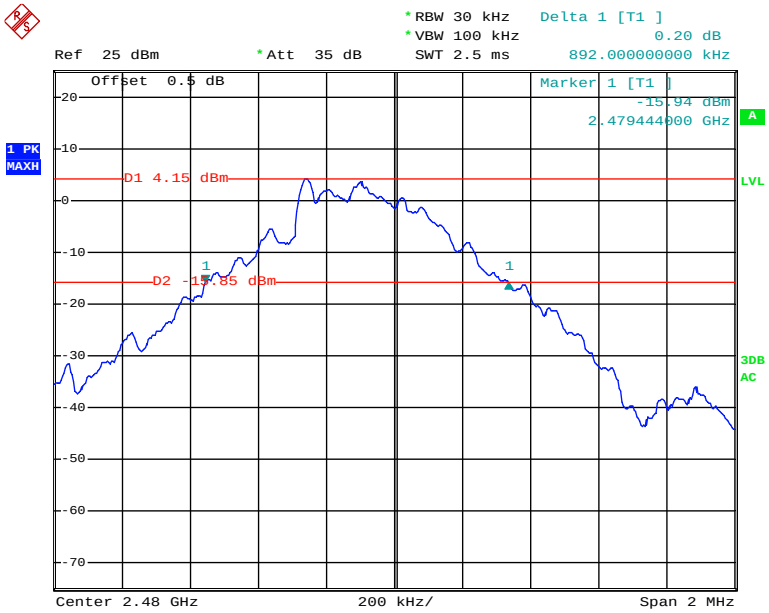
Date: 9.DEC.2019 13:51:32

Middle Channel



Date: 9.DEC.2019 13:56:40

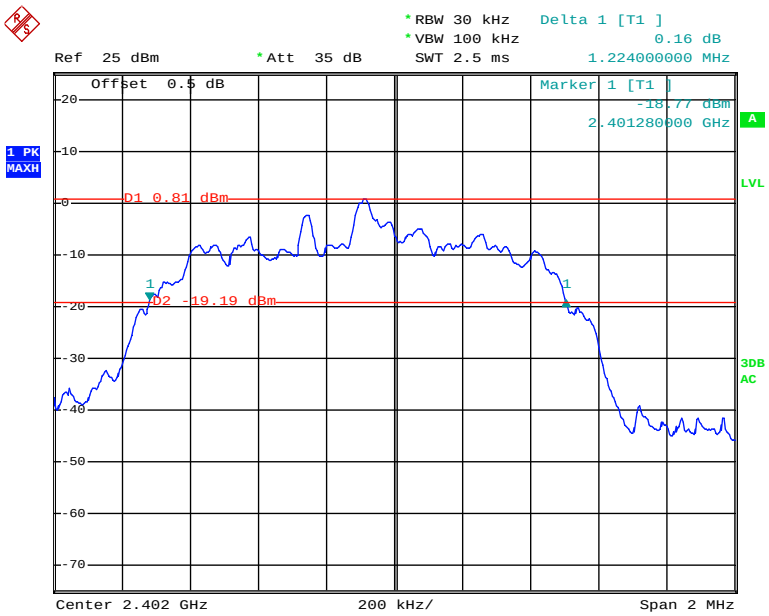
High Channel



Date: 9.DEC.2019 14:11:14

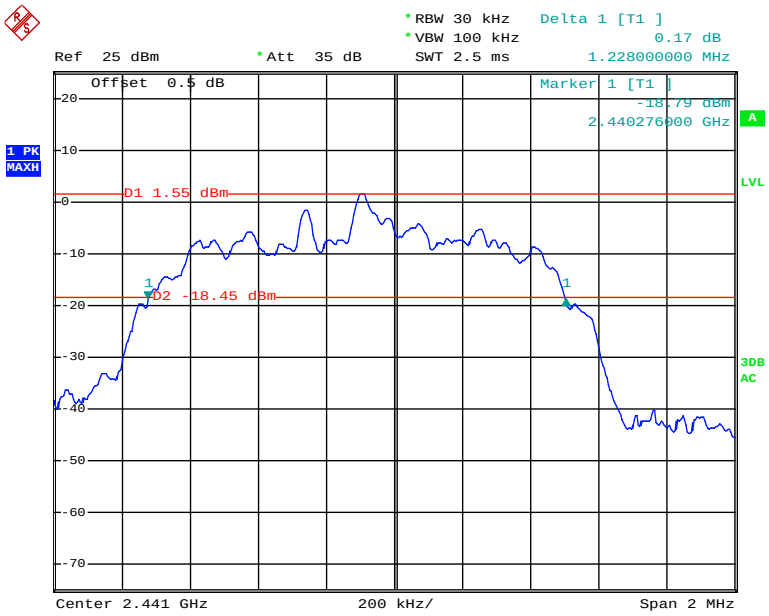
EDR Mode (π/4-DQPSK):

Low Channel



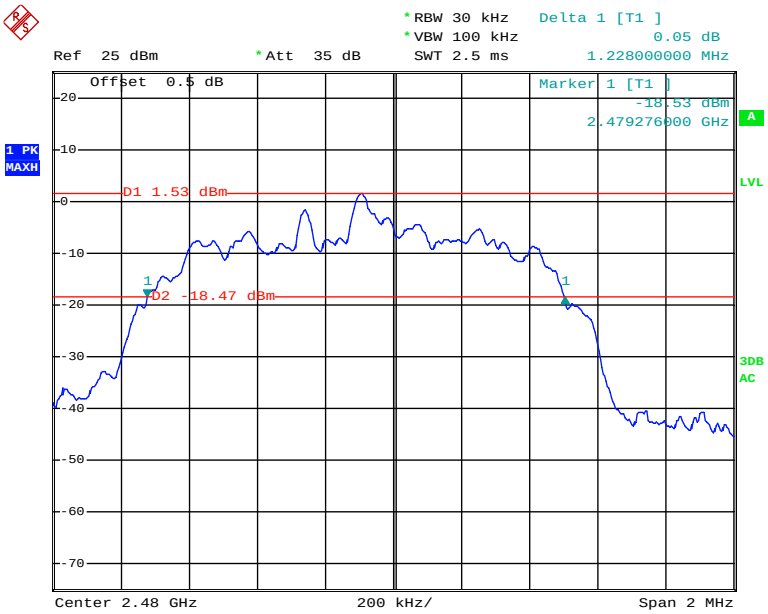
Date: 9.DEC.2019 14:14:06

Middle Channel



Date: 9.DEC.2019 14:17:01

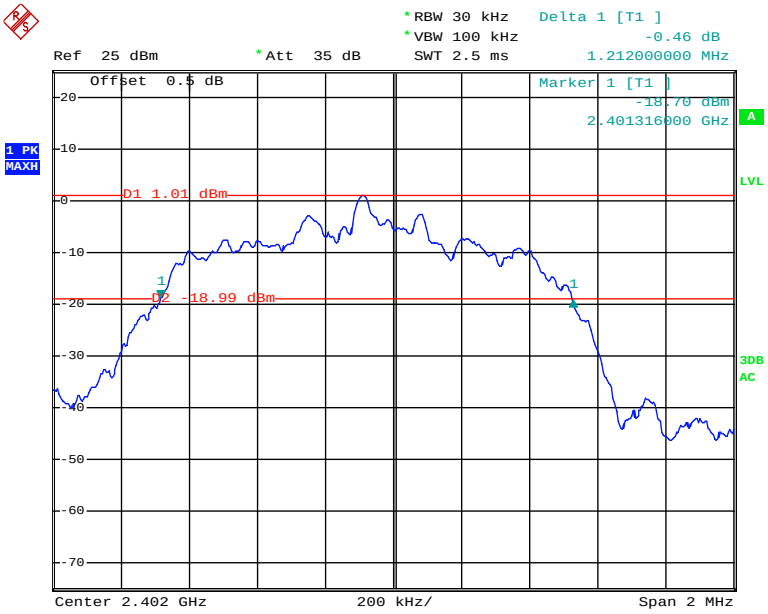
High Channel



Date: 9.DEC.2019 14:19:58

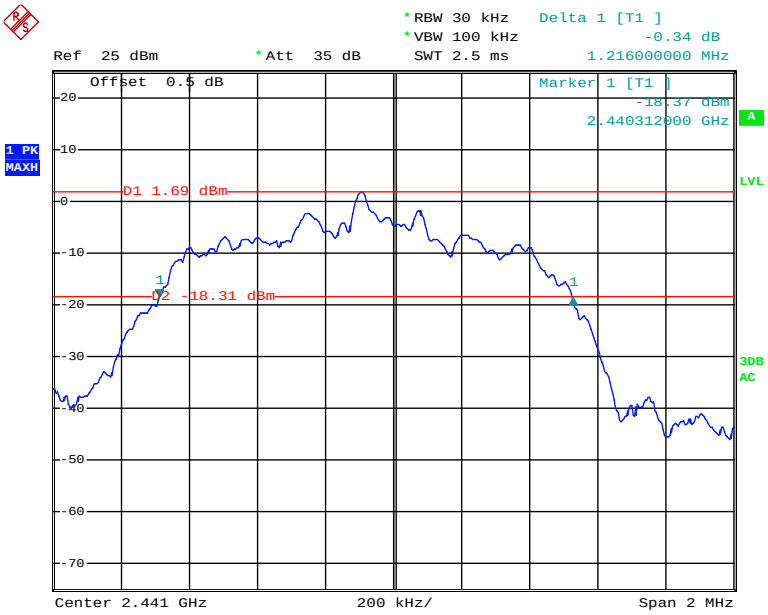
EDR Mode (8DPSK):

Low Channel



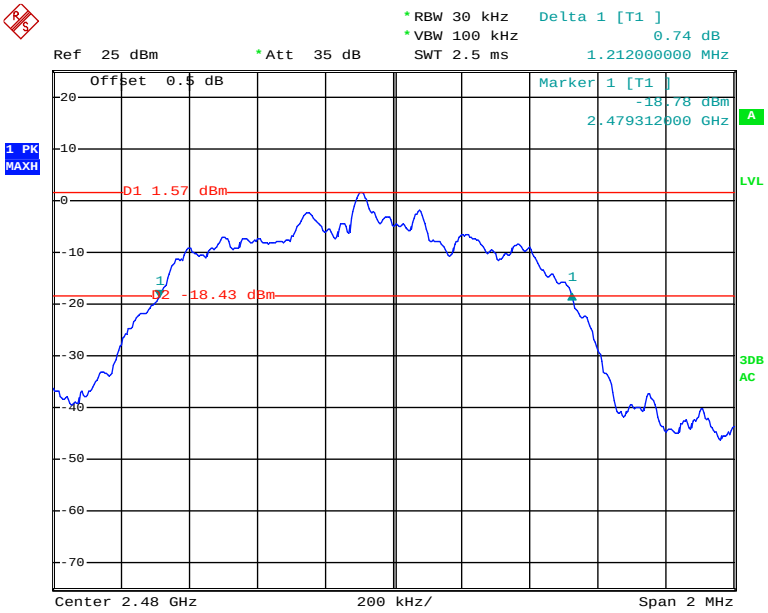
Date: 9.DEC.2019 14:43:35

Middle Channel



Date: 9.DEC.2019 14:41:55

High Channel

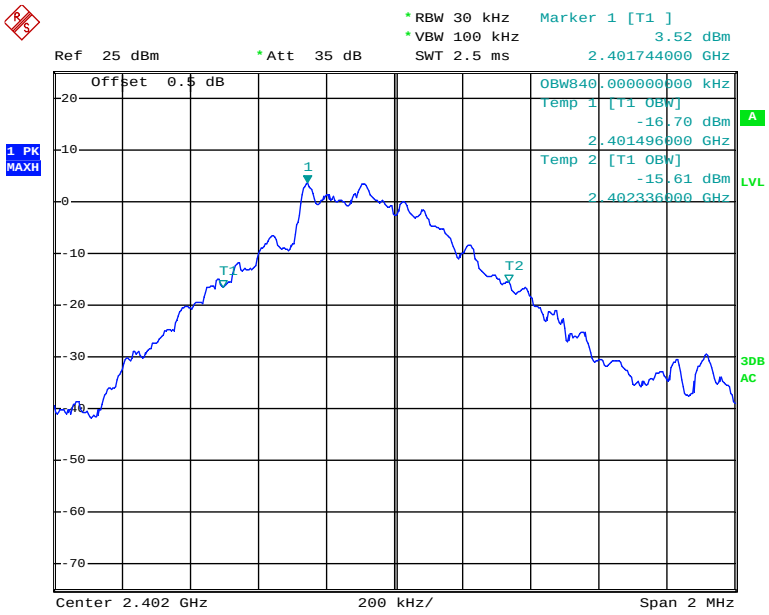


Date: 9.DEC.2019 14:45:17

99% dB Bandwidth

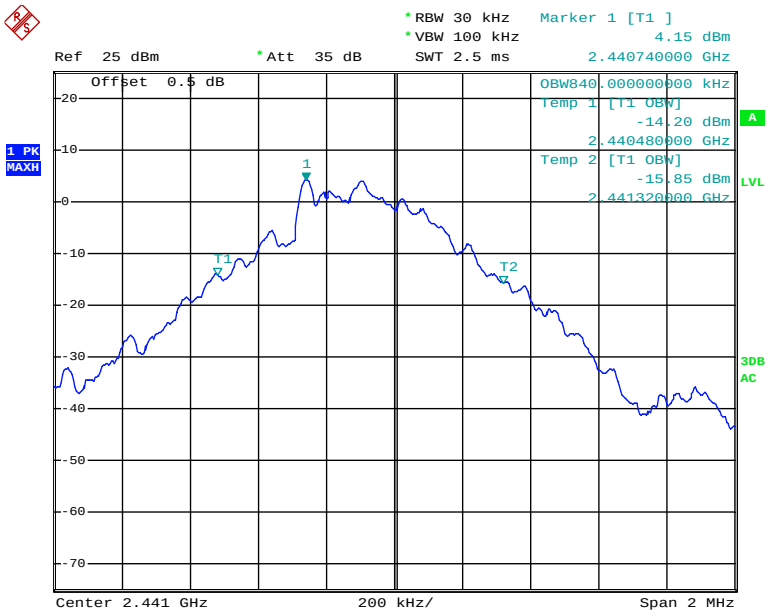
BDR Mode (GFSK):

Low Channel



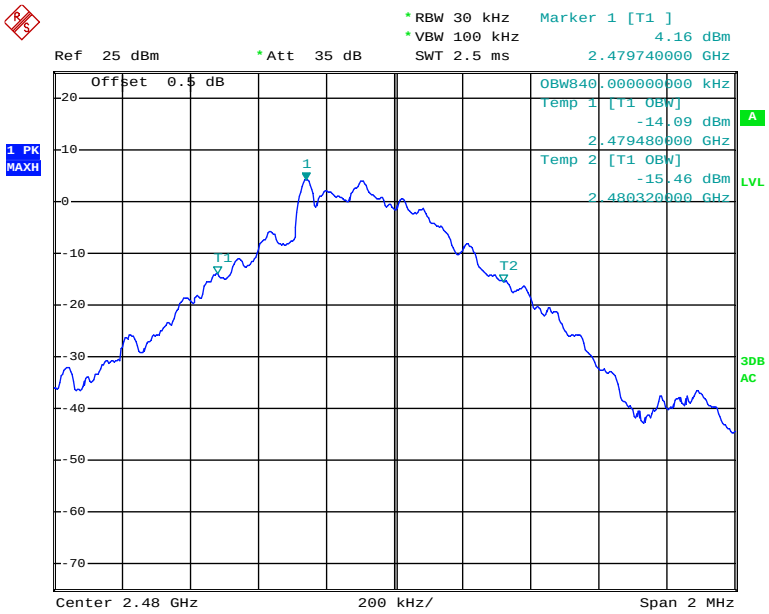
Date: 9.DEC.2019 13:51:47

Middle Channel



Date: 9.DEC.2019 13:56:54

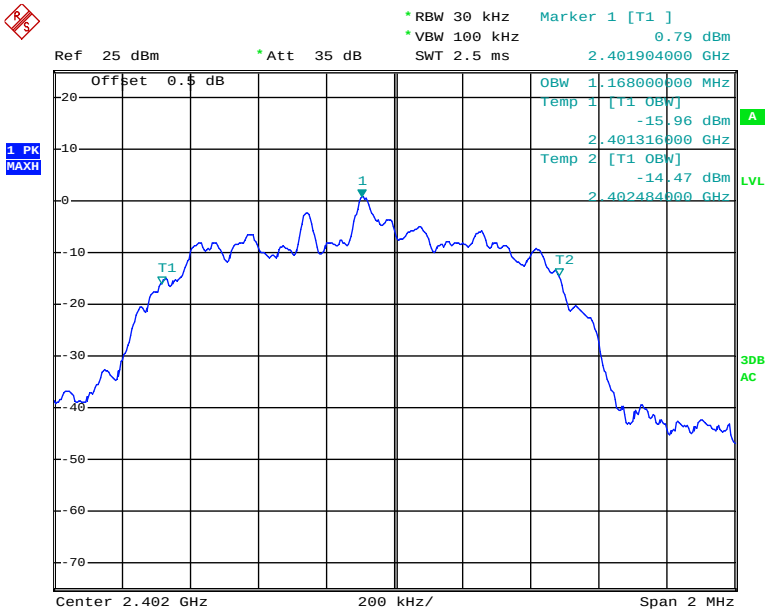
High Channel



Date: 9.DEC.2019 14:11:28

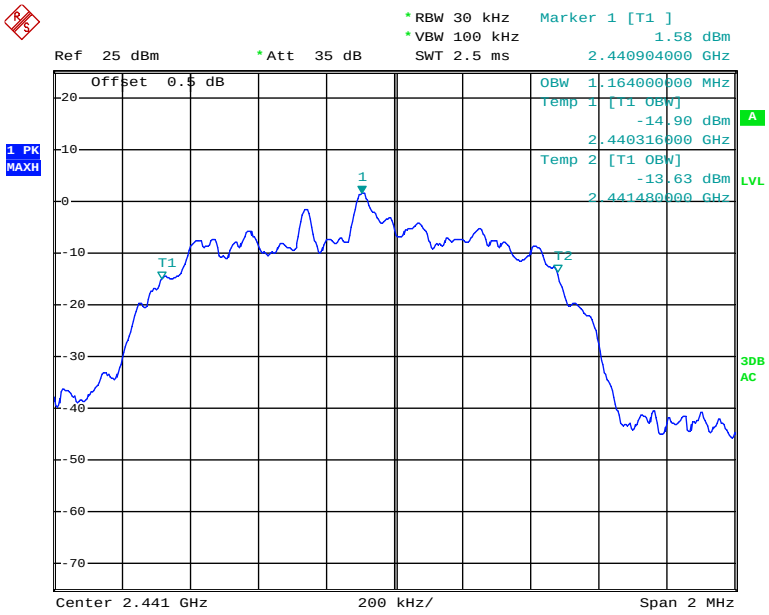
EDR Mode (π/4-DQPSK):

Low Channel



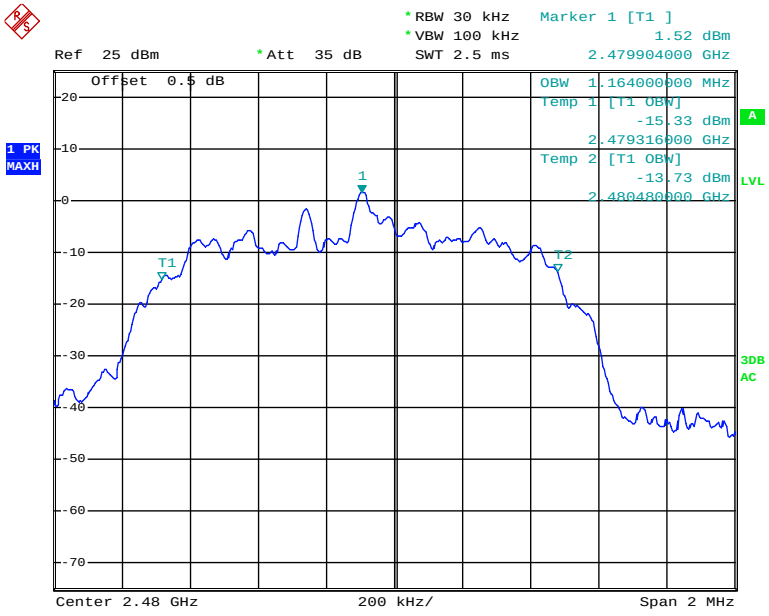
Date: 9.DEC.2019 14:14:24

Middle Channel



Date: 9.DEC.2019 14:17:16

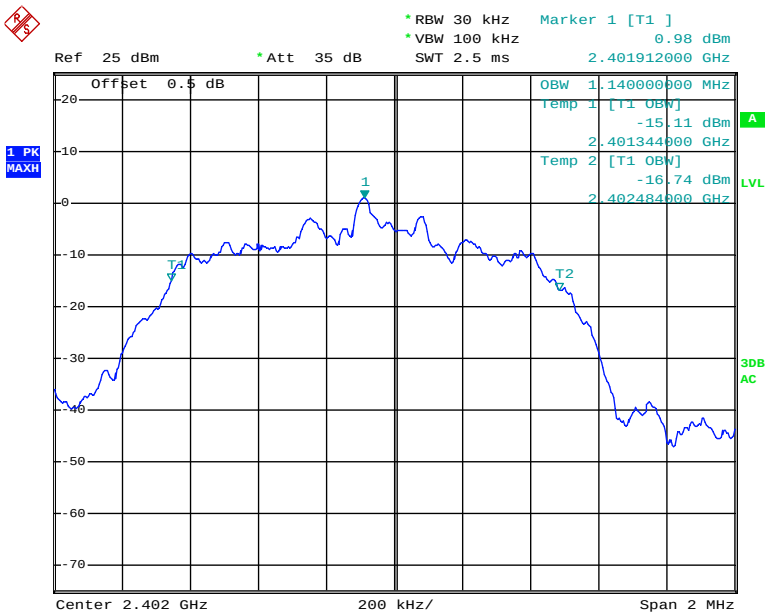
High Channel



Date: 9.DEC.2019 14:20:12

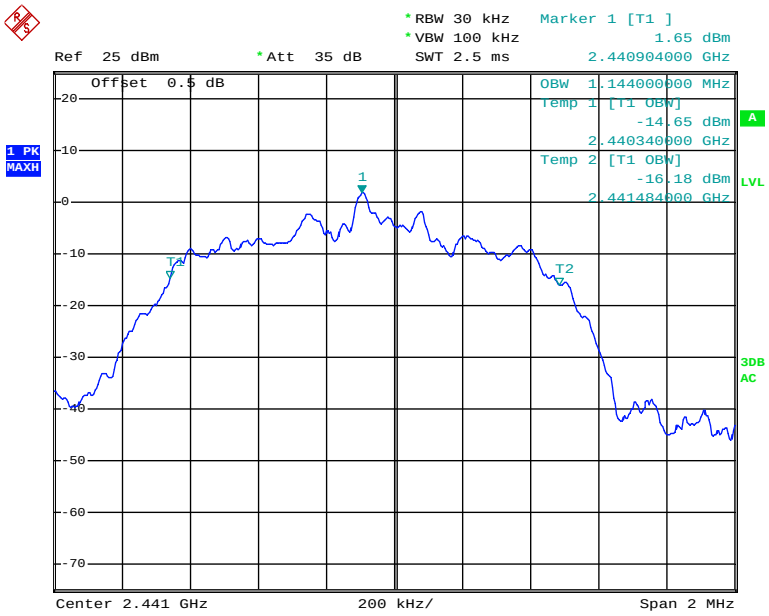
EDR Mode (8DPSK):

Low Channel



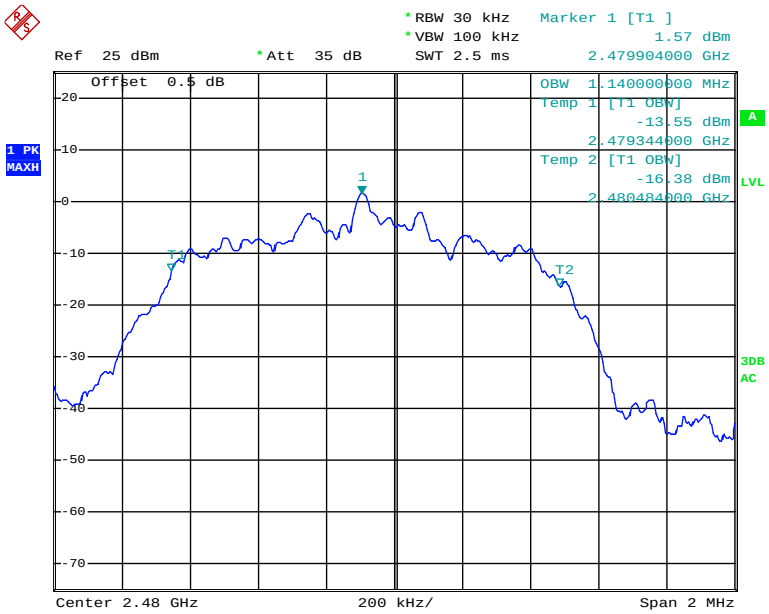
Date: 9.DEC.2019 14:43:49

Middle Channel



Date: 9.DEC.2019 14:42:09

High Channel



Date: 9.DEC.2019 14:45:31

FCC §15.247(a) (1) (iii), RSS-247 CLAUSE 5.1 d) - QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

According to FCC §15.247(a) (1) (iii), RSS-247 Clause 5.1 d)

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	EMI Test Receiver	ESCI	100035	2019-09-19	2020-09-19
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:	22.1 °C
Relative Humidity:	35 %
ATM Pressure:	102.1 kPa
Tester:	Lily Xie
Test Date:	2019-12-09

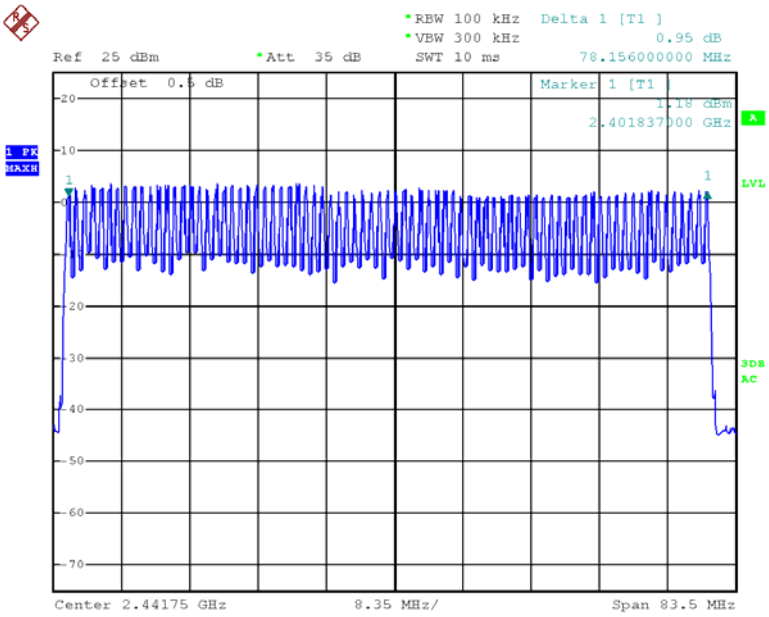
Test Result: Compliance.

Please refer to following tables and plots

Test Mode: Transmitting

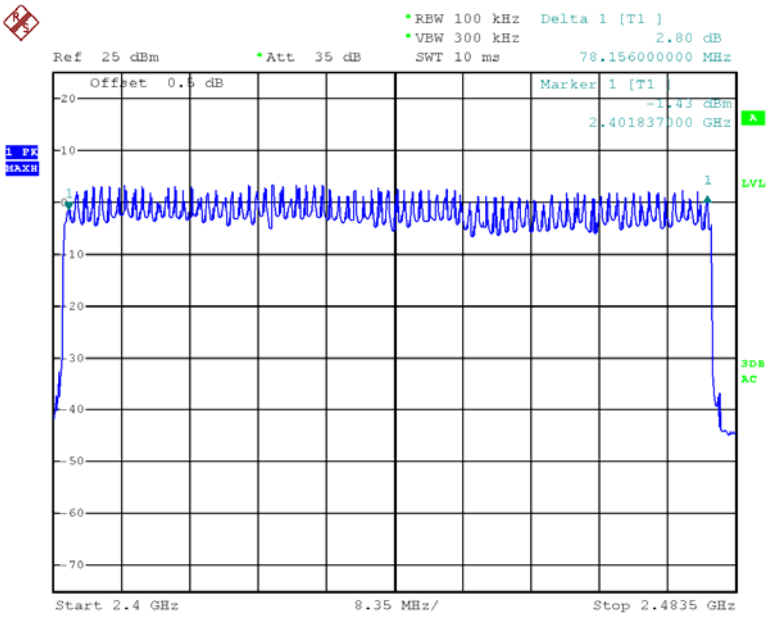
Test mode	Frequency Range (MHz)	Number of Hopping Channel	Limit
GFSK	2400-2483.5	79	≥15
π/4-DQPSK	2400-2483.5	79	≥15
8DPSK	2400-2483.5	79	≥15

BDR Mode (GFSK)



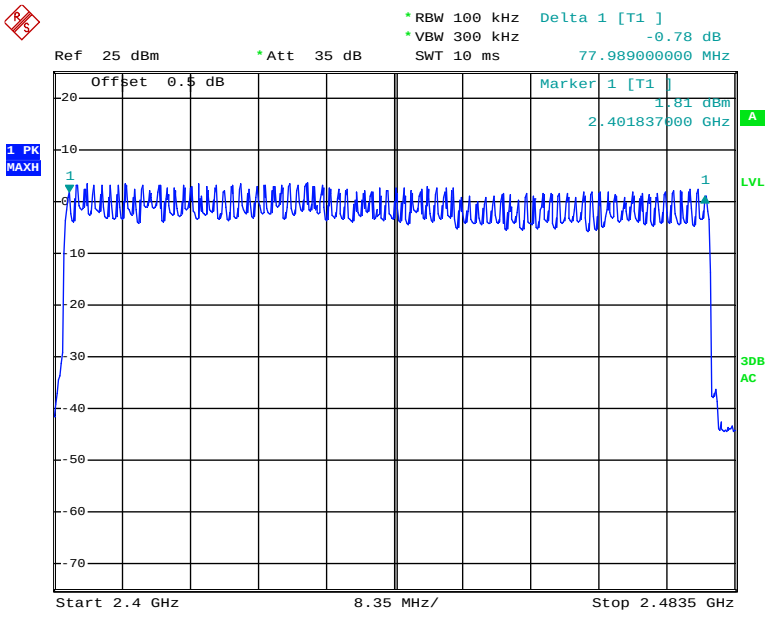
Date: 9.DEC.2019 15:01:38

EDR Mode (π/4-DQPSK)



Date: 9.DEC.2019 14:59:32

EDR Mode (8DPSK)



Date: 9.DEC.2019 14:50:15

FCC §15.247(a) (1) (iii), RSS-247 CLAUSE 5.1 d) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

According to FCC §15.247(a) (1) (iii), RSS-247 Clause 5.1 d):

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	EMI Test Receiver	ESCI	100035	2019-09-19	2020-09-19
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:	22.1 °C
Relative Humidity:	35 %
ATM Pressure:	102.1 kPa
Tester:	Lily Xie
Test Date:	2019-12-09

Test Result: Compliance.

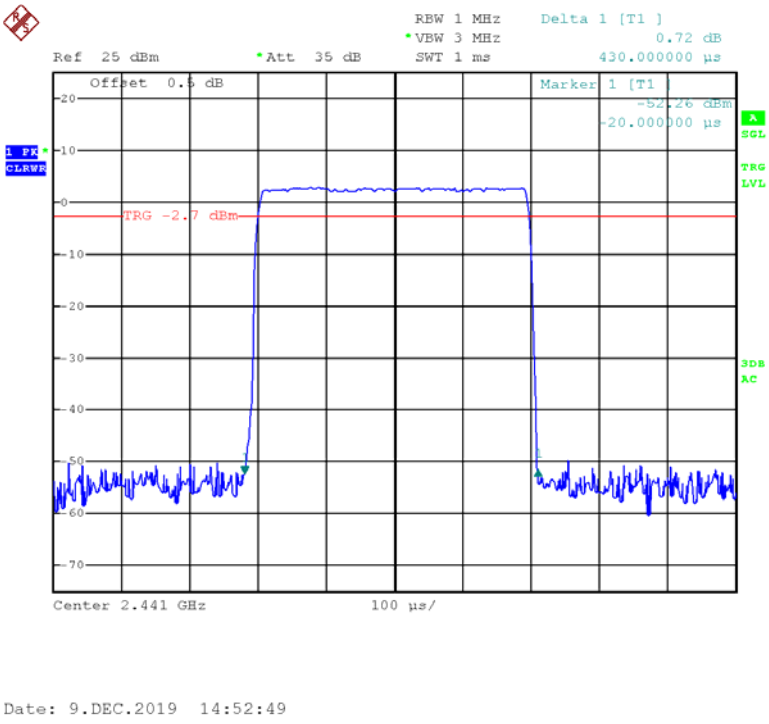
Please refer to following tables and plots

Test Mode: Transmitting

Mode	Packet type	Channel	Frequency (MHz)	Puse width (ms)	Result (s)	Limit (s)
GFSK	DH1	Middle	2441	0.430	0.138	0.4
	DH3	Middle	2441	1.700	0.272	
	DH5	Middle	2441	2.968	0.317	
π/4-DQPSK	2DH1	Middle	2441	0.446	0.143	
	2DH3	Middle	2441	1.718	0.275	
	2DH5	Middle	2441	2.968	0.317	
8DPSK	3DH1	Middle	2441	0.450	0.144	
	3DH3	Middle	2441	1.718	0.275	
	3DH5	Middle	2441	2.968	0.317	
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						

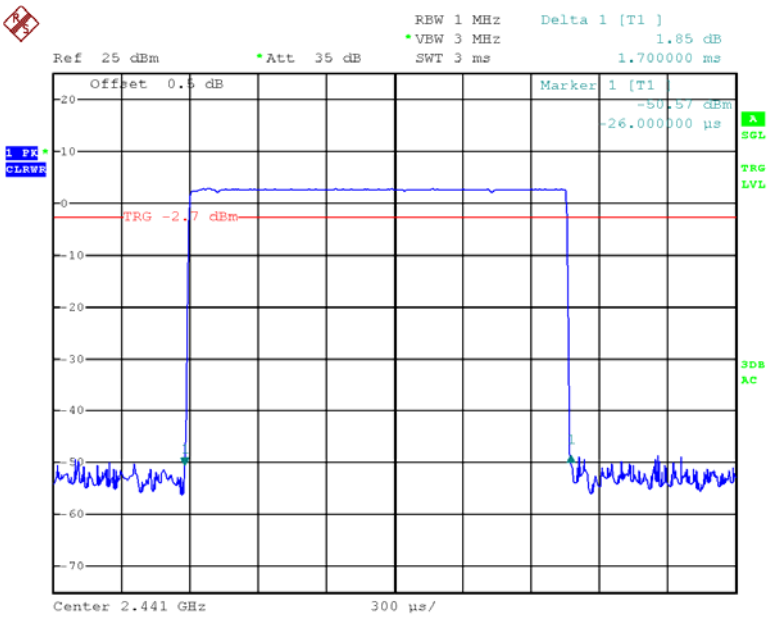
BDR Mode (GFSK):

DH1: Middle Channel



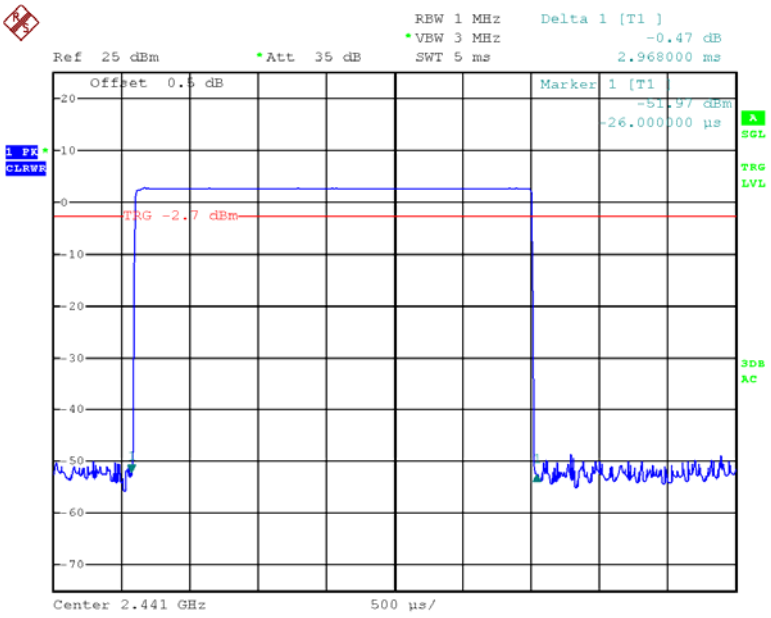
Date: 9.DEC.2019 14:52:49

DH3: Middle Channel



Date: 9.DEC.2019 14:54:00

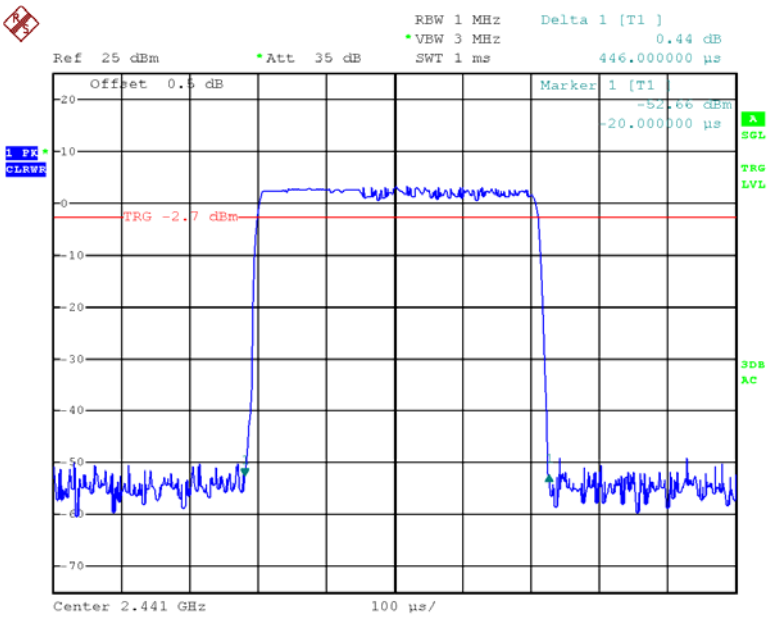
DH5: Middle Channel



Date: 9.DEC.2019 14:56:36

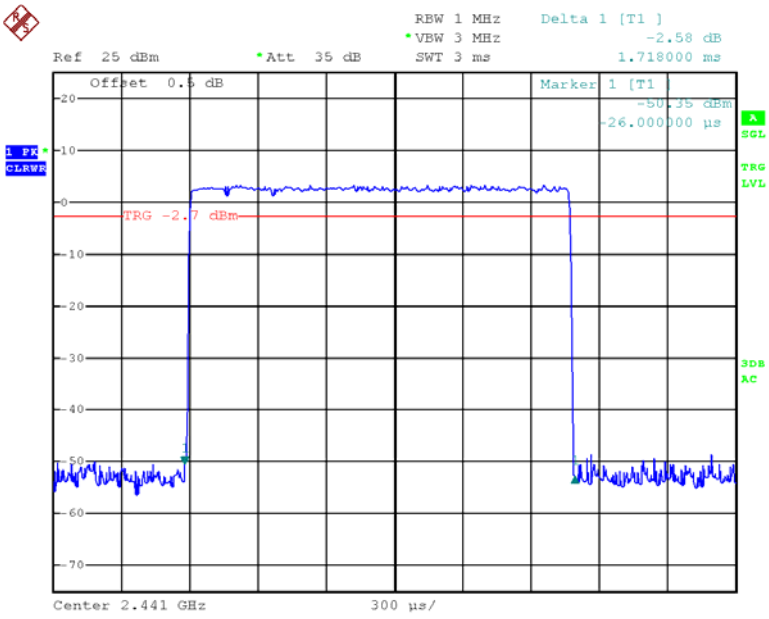
EDR Mode (π/4-DQPSK):

2DH1: Middle Channel



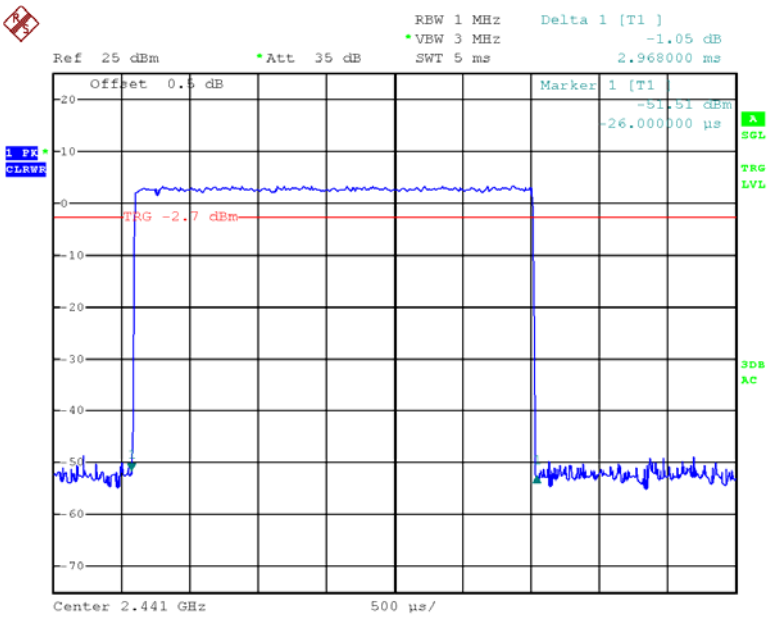
Date: 9.DEC.2019 14:53:16

2DH3: Middle Channel



Date: 9.DEC.2019 14:54:39

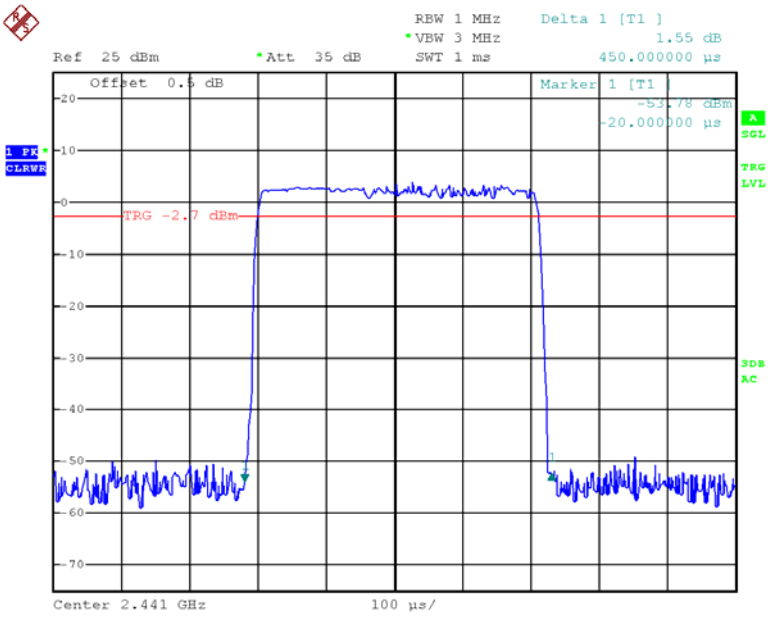
2DH5: Middle Channel



Date: 9.DEC.2019 14:56:09

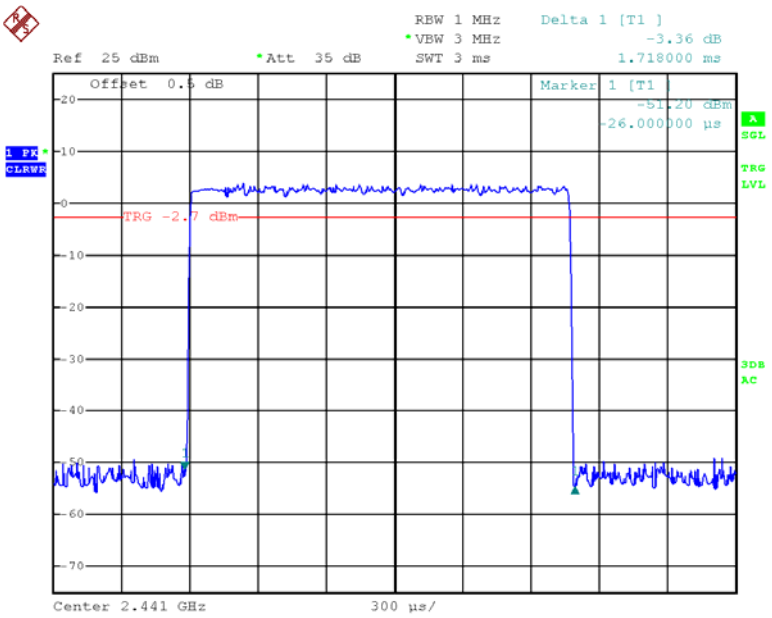
EDR Mode (8DPSK):

3DH1: Middle Channel



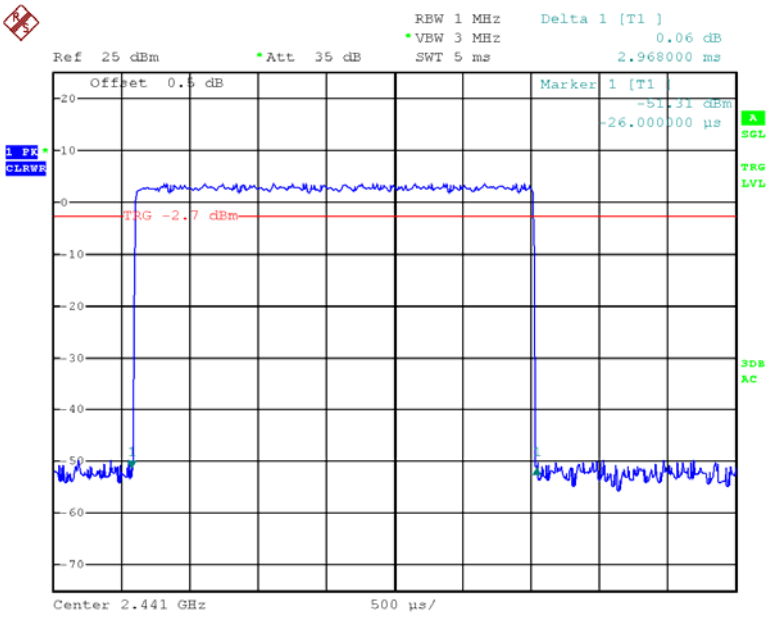
Date: 9.DEC.2019 14:51:38

3DH3: Middle Channel



Date: 9.DEC.2019 14:55:07

3DH5: Middle Channel



Date: 9.DEC.2019 14:55:42

FCC §15.247(b) (1), RSS-247 CLAUSE 5.4 b) - 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

According to RSS-247 Clause 5.4 b)

b) For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

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	C0010/02	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:	22.1 °C
Relative Humidity:	35 %
ATM Pressure:	102.1 kPa
Tester:	Lily Xie
Test Date:	2019-12-09

Test Result: Compliance.

Test Mode: Transmitting

Mode	Frequency (MHz)	Peak Conducted Output power (dBm)	Limit (dBm)
BDR Mode (GFSK)	2402	5.50	21
	2441	6.02	21
	2480	5.99	21
EDR Mode (π/4-DQPSK)	2402	3.36	21
	2441	3.97	21
	2480	3.91	21
EDR Mode (8DPSK)	2402	3.91	21
	2441	4.49	21
	2480	4.40	21

Note: The data above was tested in conducted mode and the antenna gain is -0.61dBi, so it meets the EIRP limit for ISED.

FCC §15.247(d), RSS-247 CLAUSE 5.5 - BAND EDGES TESTING

Applicable Standard

According to FCC §15.247(d):

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

According to RSS-247 Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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	EMI Test Receiver	ESCI	100035	2019-09-19	2020-09-19
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

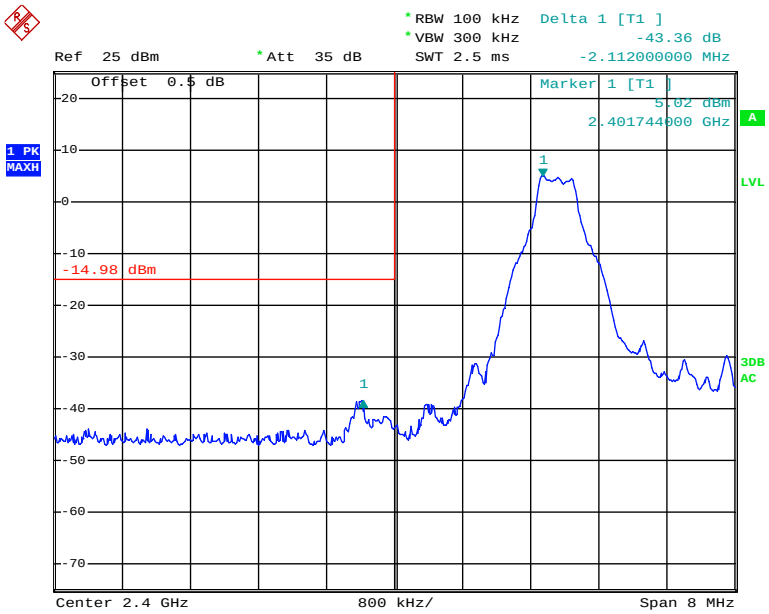
Environmental Conditions

Temperature:	22.1 °C
Relative Humidity:	35 %
ATM Pressure:	102.1 kPa
Tester:	Lily Xie
Test Date:	2019-12-09

Test Result: Compliance

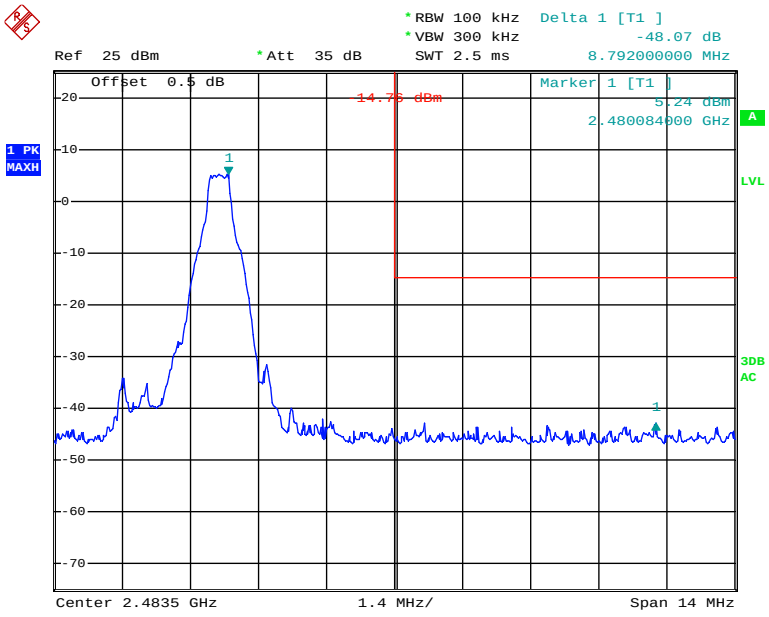
Single mode:
BDR Mode (GFSK):

Band Edge, Left Side



Date: 9.DEC.2019 13:52:17

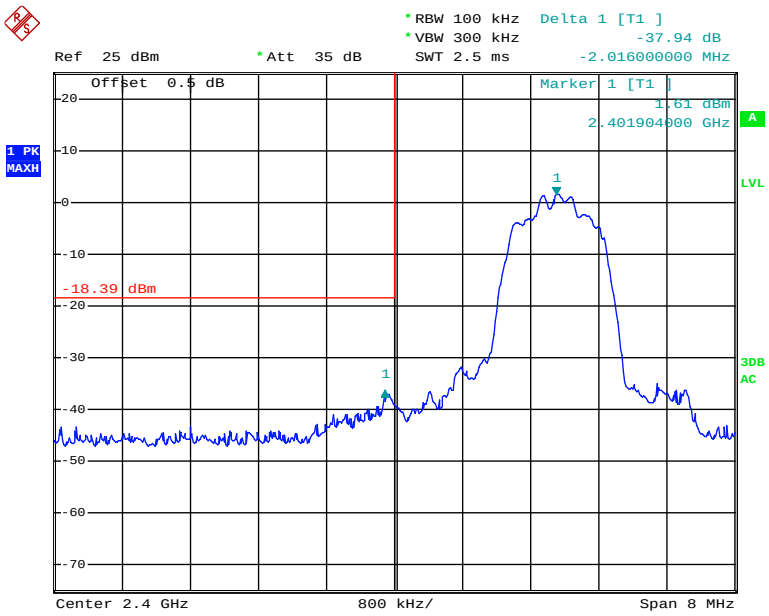
Band Edge, Right Side



Date: 9.DEC.2019 14:11:59

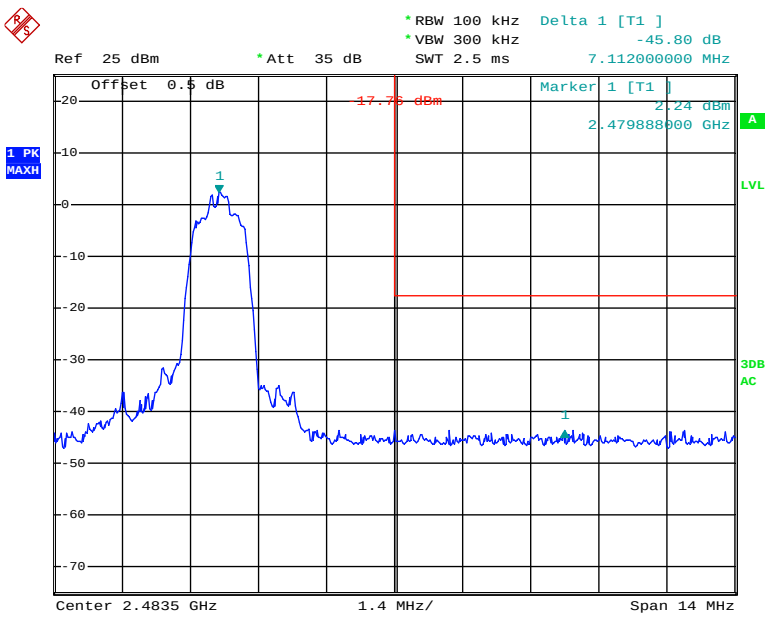
EDR Mode (π/4-DQPSK):

Band Edge, Left Side



Date: 9.DEC.2019 14:14:59

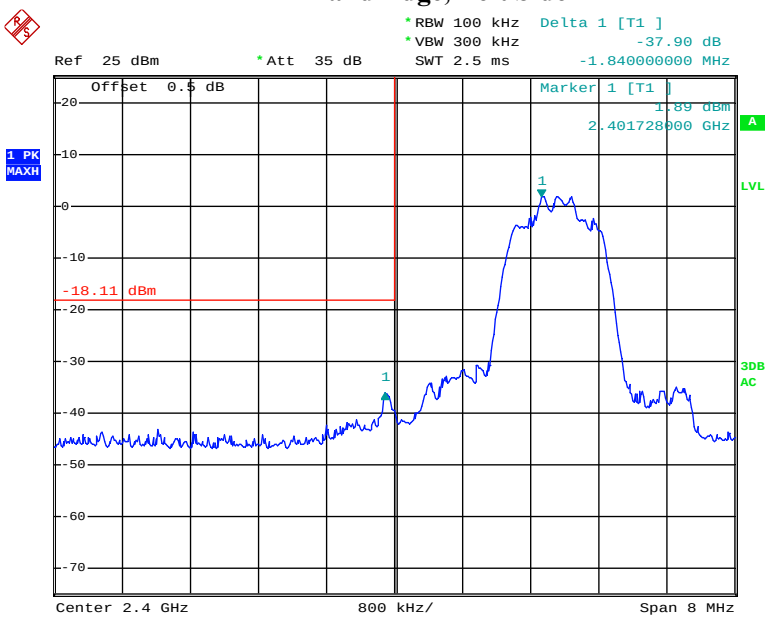
Band Edge, Right Side



Date: 9.DEC.2019 14:20:47

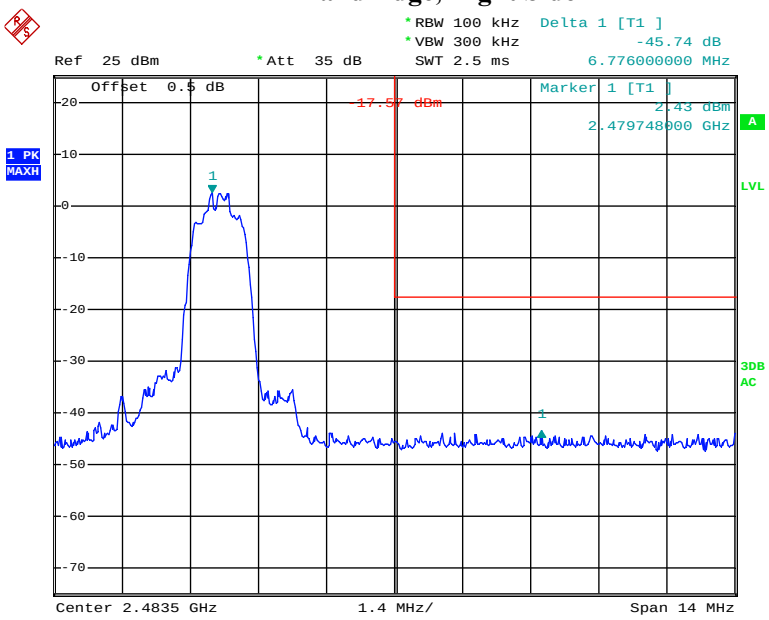
EDR Mode (8DPSK):

Band Edge, Left Side



Date: 9.DEC.2019 14:44:27

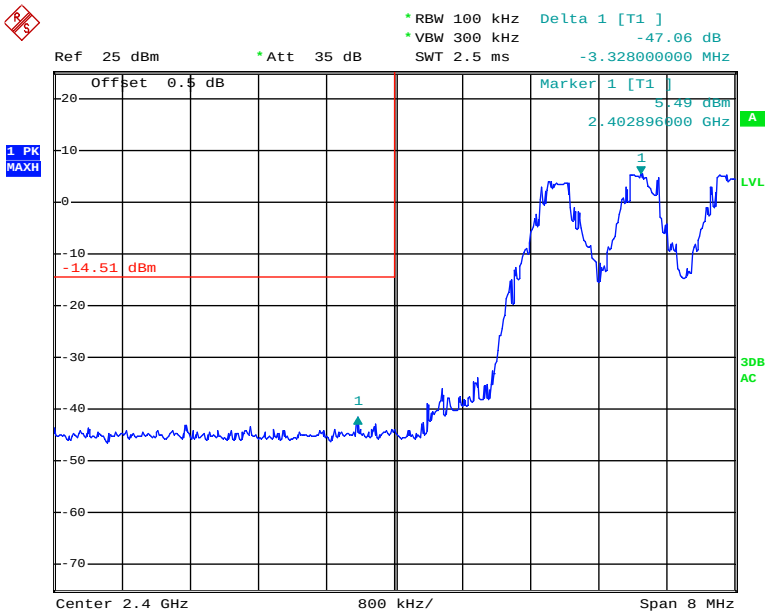
Band Edge, Right Side



Date: 9.DEC.2019 14:46:01

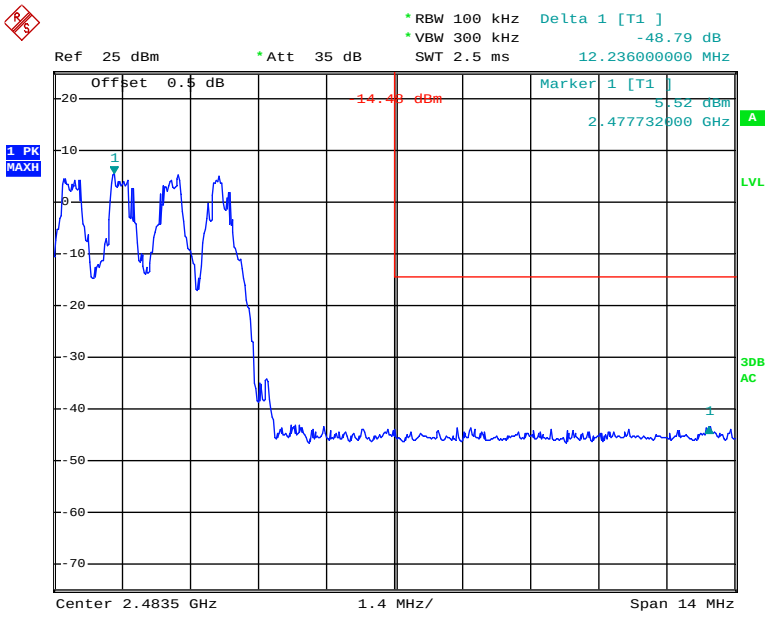
Hopping mode:
BDR Mode (GFSK):

Band Edge, Left Side



Date: 9.DEC.2019 15:06:56

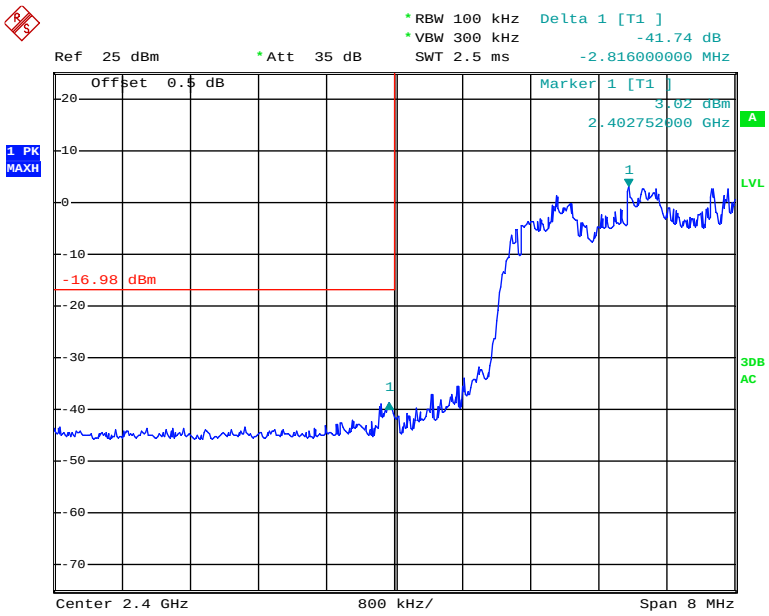
Band Edge, Right Side



Date: 9.DEC.2019 15:08:26

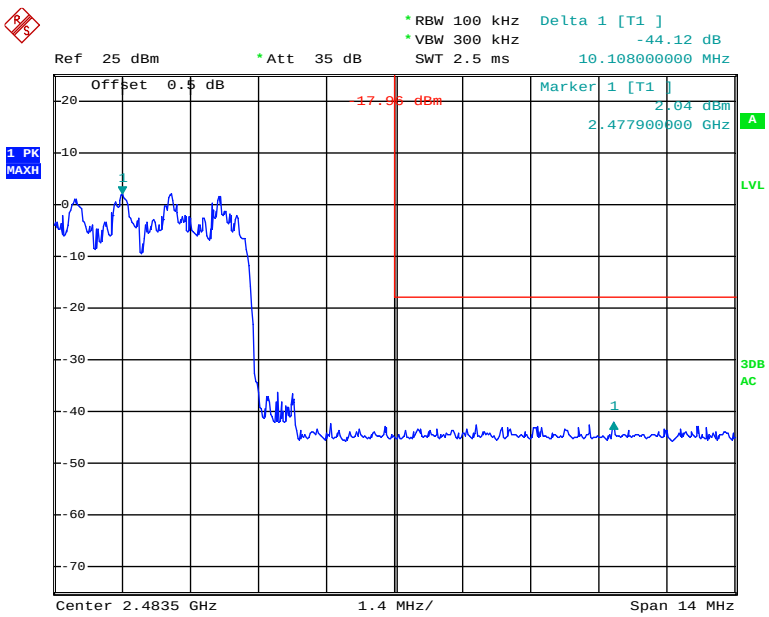
EDR Mode (π/4-DQPSK):

Band Edge, Left Side



Date: 9.DEC.2019 15:12:34

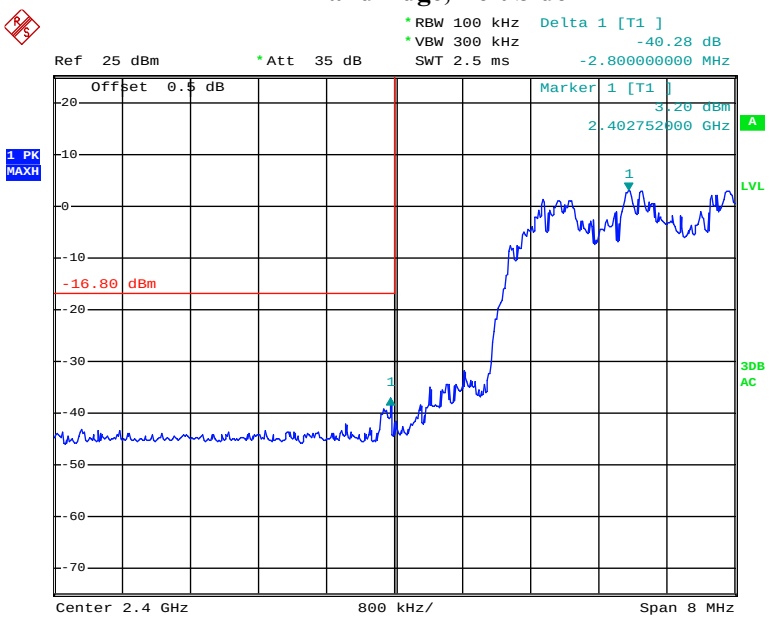
Band Edge, Right Side



Date: 9.DEC.2019 15:14:48

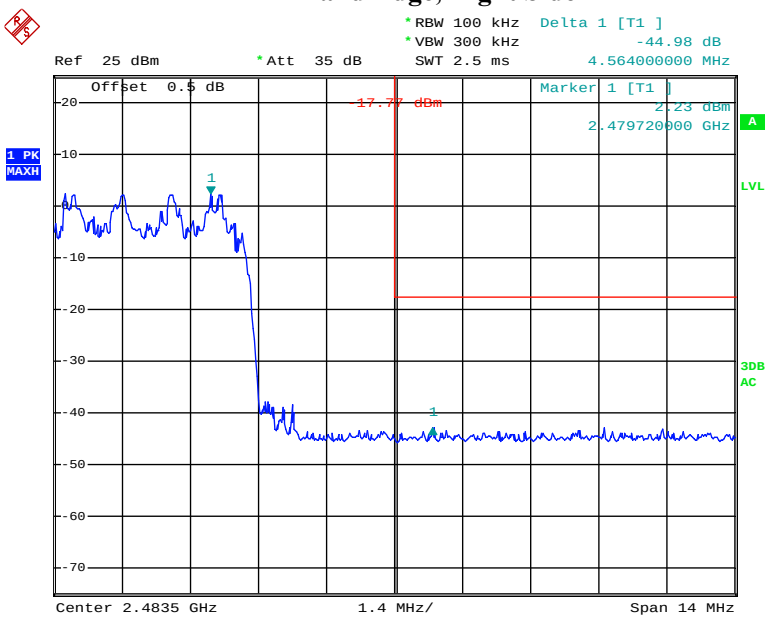
EDR Mode (8DPSK):

Band Edge, Left Side



Date: 9.DEC.2019 15:17:13

Band Edge, Right Side



Date: 9.DEC.2019 15:20:20

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