

FCC PART 15.247
TEST REPORT

For

AEC Lighting Solutions Co., Ltd.

No.2548, Baoan Road, Jiading District, Shanghai, China

FCC ID: 2ANLP-AUD501H

Report Type: Original Report	Product Type: LED audio light
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Report Number: RSHA170816003-00A	
Report Date: 2017-11-05	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	AEC Lighting Solutions Co., Ltd.
Tested Model	AUD501H
Product Type	LED audio light
Dimension	318.2 mm(L)*205.3mm(W)*81.5 mm(H)
Power Supply	DC12.6V powered by DC source (DC 10.8 V from battery)

**All measurement and test data in this report was gathered from production sample serial number: 20170816003. (Assigned by the BACL. The EUT supplied by the applicant was received on 2017-08-16)*

Objective

This test report is prepared on behalf of AEC Lighting Solutions Co., Ltd. in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

FCC Part 15.247 DTS submission with FCC ID: 2ANLP-AUD501H.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19 dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
Occupied Bandwidth		0.5kHz
Temperature		1.0°C
Humidity		6%

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road,Kunshan,Jiangsu province,China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 under the FCC KDB 974614 D01. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For BlueTooth, 79 channels are provided for testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	40	2442
1	2403
...
...	...	77	2479
39	2441	78	2480

EUT was tested with Channel 0, 39 and 78.

EUT Exercise Software

RF Test Tool: BlueTest3

GFSK: Power level 50

π /4-DQPSK: Power level 50

8-DPSK: Power level 50

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

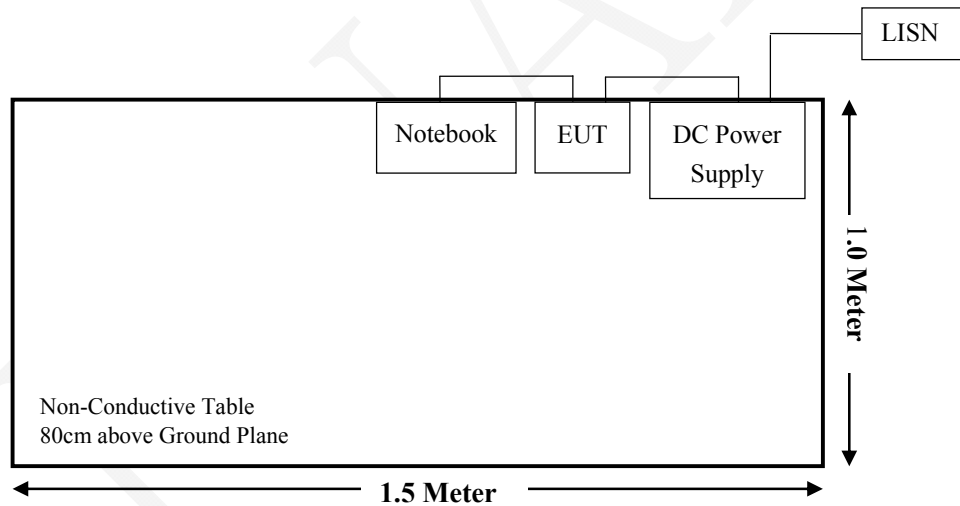
Manufacturer	Description	Model	Serial Number
DELL	Notebook	GX620	D65874152
EAST	Regulated DC Power Supply	MCH-303D-II	14070562
SCR	CSR USB-SPI	/	/

External I/O Cable

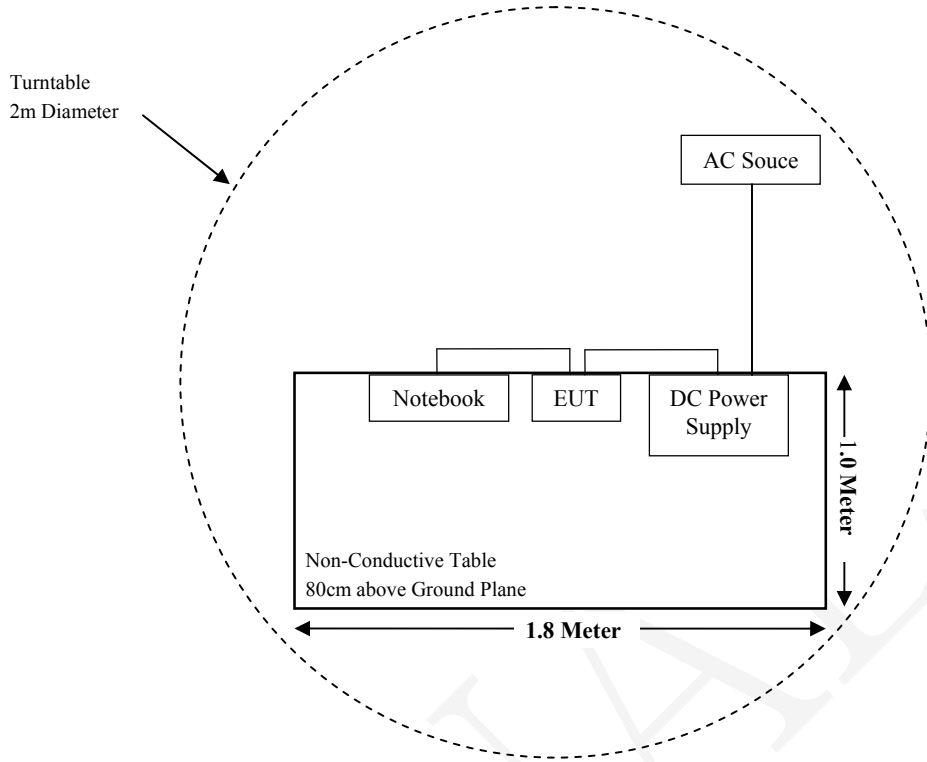
Cable Description	Length (m)	From Port	To
USB Cable	0.8	Notebook	CSR USB-SPI
Power Cable	0.8	EUT	DC Power Supply

Block Diagram of Test Setup

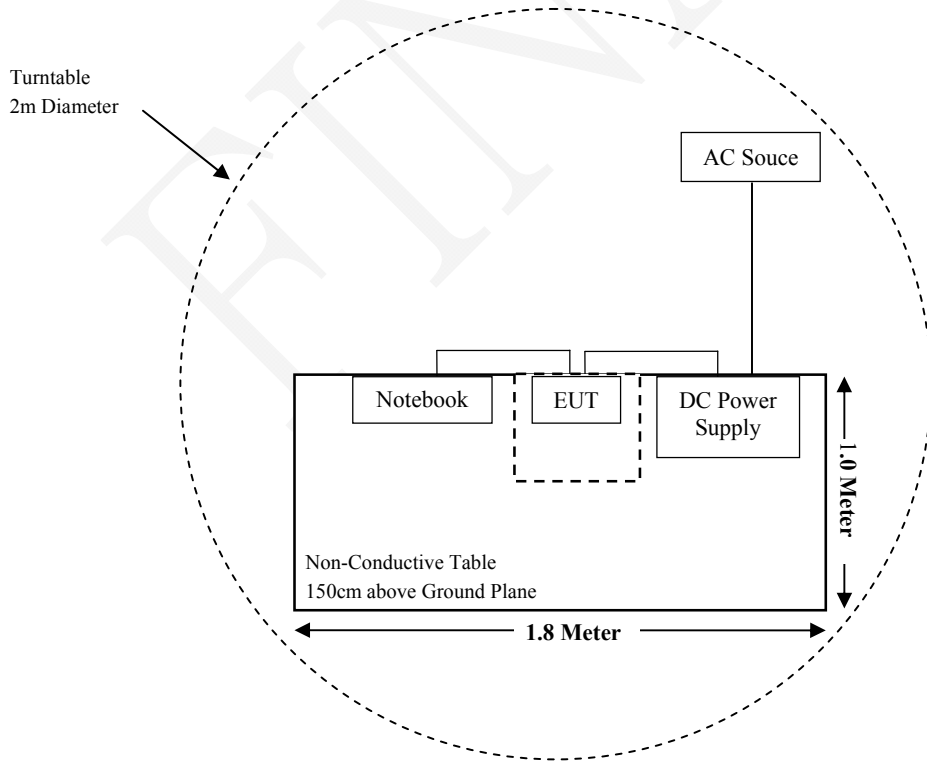
For Conducted Emissions:



For Radiated Emissions(Below 1GHz):



For Radiated Emissions(Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliance
§15.247(a)(1)	20 dB Emission Bandwidth	Compliance
§15.247(a)(1)	Channel Separation Test	Compliance
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
§15.247(b)(1)	Peak Output Power Measurement	Compliance
§15.247(d)	Band edges	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test (Chamber 1#)					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Sunol Sciences	Broadband Antenna	JB3	A040914-2	2016-01-09	2019-01-08
Sonoma Instrument	Pre-amplifier	310N	171205	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
EAST	Regulated DC Power Supply	MCH-303D-II	14070562	2017-09-23	2018-09-22
MICRO-COAX	Coaxial Cable	Cable-8	008	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2017-08-15	2018-08-14
Radiated Emission Test (Chamber 2#)					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2017-08-27	2018-08-26
ETS-LINDGREN	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Narda	Pre-amplifier	AFS42-00101800	2001270	2016-12-12	2017-12-11
Heatsink Required	Amplifier	QLW-18405536-J0	15964001009	2016-12-12	2017-12-11
SINOSCITE	Band Reject Filter	BSF2402-2480MN-0898	/	2017-08-05	2018-08-04
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
EAST	Regulated DC Power Supply	MCH-303D-II	14070562	2017-09-23	2018-09-22
MICRO-COAX	Coaxial Cable	Cable-6	006	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2017-08-15	2018-08-14
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Rohde & Schwarz	EMI Test Receiver	ESIB26	100146	2017-09-05	2018-09-04
Picosecond	DC Block	5500A-110	131047	2017-09-23	2018-09-22
EAST	Regulated DC Power Supply	MCH-303D-II	14070562	2017-09-23	2018-09-22
AEC	RF Cable	/	/	/	/
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Rohde & Schwarz	LISN	ESH3-Z5	862770/011	2017-10-10	2018-10-09
Rohde & Schwarz	LISN	ENV216	3560655016	2016-11-25	2017-11-24
BACL	BACL-EMC	V1.0	CE001	/	/
Narda	Attenuator/6dB	10690812-2	26850-6	2017-01-10	2018-01-09
MICRO-COAX	Coaxial Cable	Cable-15	015	2017-08-15	2018-08-14
EAST	Regulated DC Power Supply	MCH-303D-II	14070562	2017-09-23	2018-09-22

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

FCC §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/cm²)	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

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

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

Calculated Formulary:

Predication of MPE limit at a given distance

S = PG/4 π R² = power density (in appropriate units, e.g. mW/cm²);

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

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

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

Measurement Result

Mode	Frequency Range (MHz)	Antenna Gain		Output Power		Evaluation Distance (cm)	Power Density (mW/cm²)	MPE Limit (mW/cm²)	MPE Ratio
		(dBi)	(numeric)	(dBm)	(mW)				
BT 3.0	2402-2480	0.00	1.00	7.00	5.01	20	0.0010	1.0	0.0010
BLE	2402-2480	0.00	1.00	2.50	1.78	20	0.0004	1.0	0.0004

Note:

(1) The target output powers are all declared by the manufacturer.

(2) BT3.0 and BLE can transmit simultaneously, the worst condition is as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0010/1.0+0.0004/1.0=0.0010+0.0004=0.0014 < 1.0$$

Result: The device meet FCC MPE at 20 cm distance.

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 a PCB antenna arrangement for BT3.0, which the antenna gain is 0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

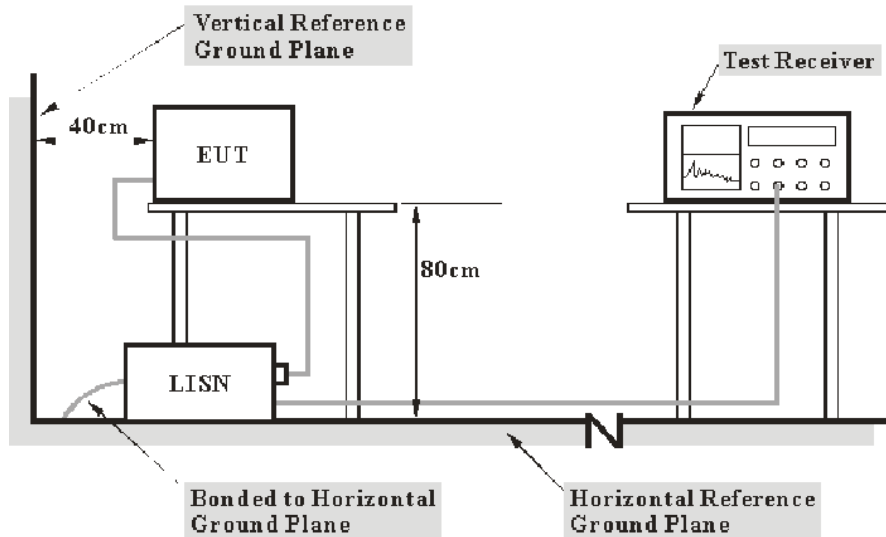
Result: Compliance.

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 measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

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

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

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Reading}$$

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

Test Data

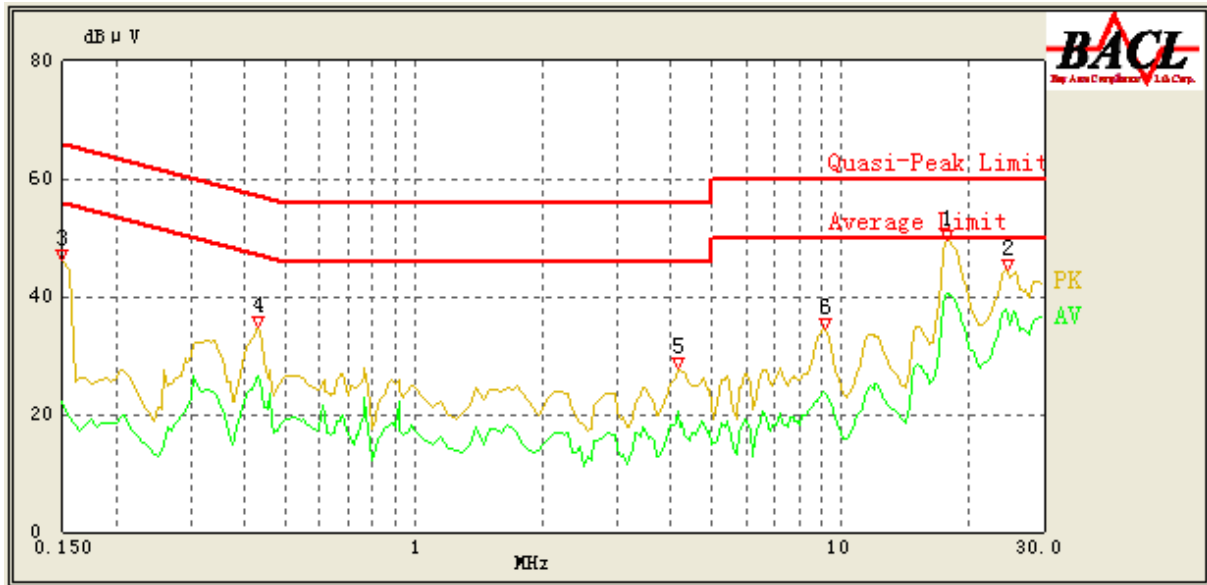
Environmental Conditions

Temperature:	20.2 °C
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-10-22.

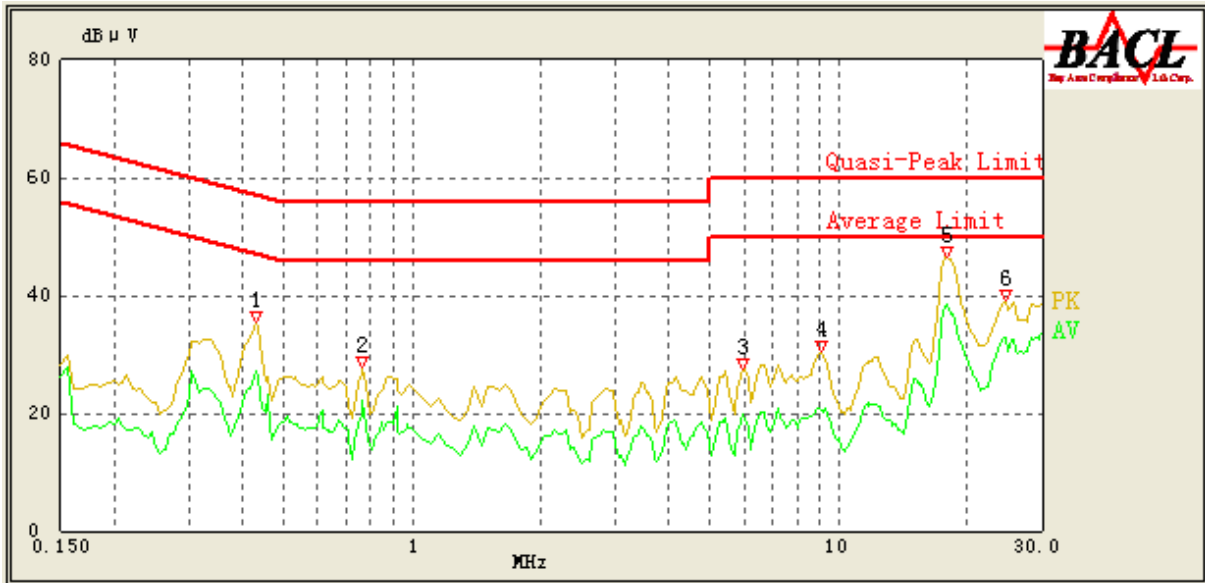
EUT operation mode: Transmitting in middle channel of GFSK (Worst case)

AC 120V/60 Hz, Line



Frequency (MHz)	Reading (dBμV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Correction (dB)	Limit (dBμV)	Margin (dB)	Comment
17.750	49.59	QP	9.000	L1	16.34	60.00	10.41	Compliance
17.850	40.52	AV	9.000	L1	16.34	50.00	9.48	Compliance
24.650	44.53	QP	9.000	L1	16.46	60.00	15.47	Compliance
24.650	37.19	AV	9.000	L1	16.46	50.00	12.81	Compliance
0.150	46.04	QP	9.000	L1	16.06	66.00	19.96	Compliance
0.150	22.09	AV	9.000	L1	16.06	56.00	33.91	Compliance
0.430	34.77	QP	9.000	L1	16.06	58.00	23.23	Compliance
0.430	26.53	AV	9.000	L1	16.06	48.00	21.47	Compliance
4.150	27.85	QP	9.000	L1	15.85	56.00	28.15	Compliance
4.150	20.48	AV	9.000	L1	15.85	46.00	25.52	Compliance
9.200	34.62	QP	9.000	L1	16.04	60.00	25.38	Compliance
9.200	23.60	AV	9.000	L1	16.04	50.00	26.40	Compliance

AC 120V/60 Hz, Neutral



Frequency (MHz)	Reading (dBμV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Correction (dB)	Limit (dBμV)	Margin (dB)	Comment
0.430	35.36	QP	9.000	N	16.10	58.00	22.64	Compliance
0.430	27.08	AV	9.000	N	16.10	48.00	20.92	Compliance
0.765	27.83	QP	9.000	N	15.98	56.00	28.17	Compliance
0.765	22.06	AV	9.000	N	15.98	46.00	23.94	Compliance
5.950	27.47	QP	9.000	N	15.89	60.00	32.53	Compliance
5.950	19.67	AV	9.000	N	15.89	50.00	30.33	Compliance
9.150	30.35	QP	9.000	N	15.97	60.00	29.65	Compliance
9.200	20.20	AV	9.000	N	15.97	50.00	29.80	Compliance
17.900	46.58	QP	9.000	N	16.10	60.00	13.42	Compliance
17.950	38.39	AV	9.000	N	16.10	50.00	11.61	Compliance
24.600	39.12	QP	9.000	N	16.23	60.00	20.88	Compliance
24.600	32.76	AV	9.000	N	16.23	50.00	17.24	Compliance

Note:

- 1) Corr.=LISN VDF (Voltage Division Factor) + Cable Loss
- 2) Margin = Limit – Reading

FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

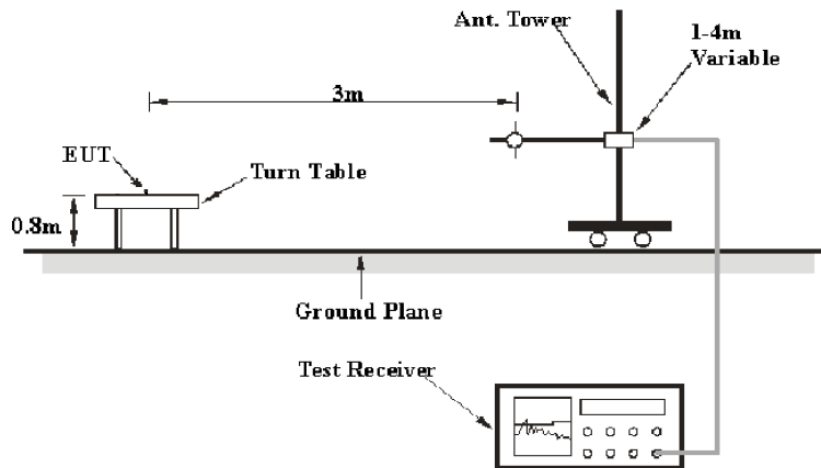
FCC §15.205; §15.209; §15.247(d)

Measurement Uncertainty

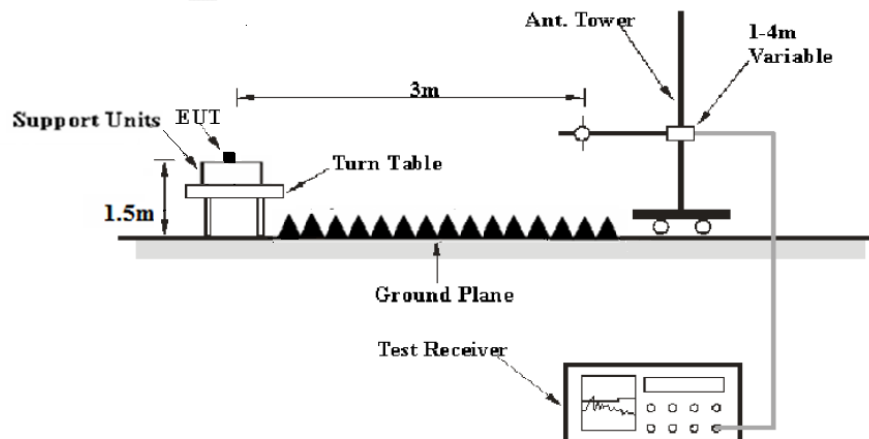
All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

EMI Test Receiver Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver Setup was set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Detector
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP
Above 1GHz	1MHz	3 MHz	/	PK
	1MHz	3 MHz	/	Ave.

Test Procedure

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

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz, peak and average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Test Data

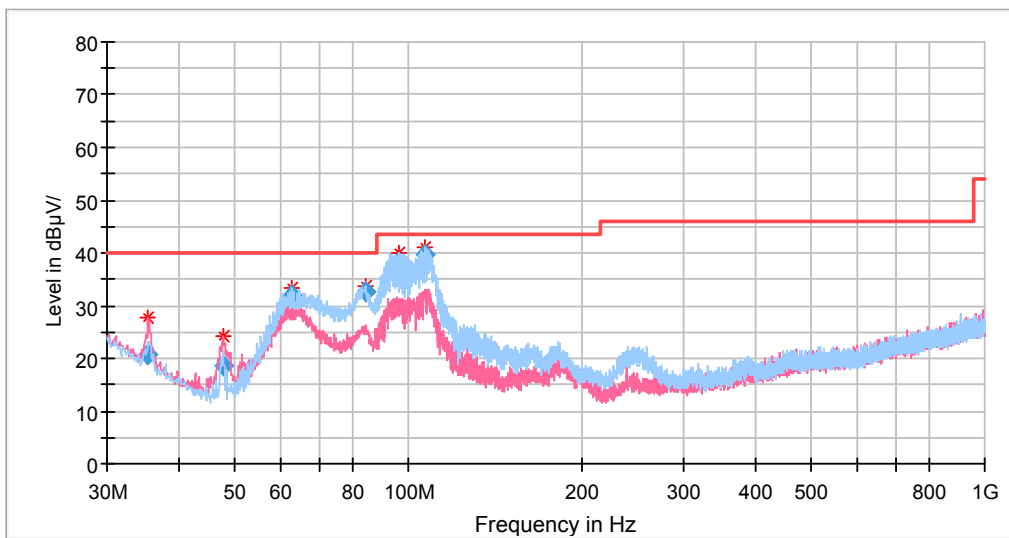
Environmental Conditions

Temperature:	20.2 °C
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-11-05.

EUT operation mode: Transmitting(Scan with GFSK, $\pi/4$ -DQPSK, 8-DPSK mode, the worst case is GFSK Mode)

30MHz-1GHz:



Frequency (MHz)	Corrected Amplitude QuasiPeak (dB μ V/m)	Rx Antenna		Turntable Degree	Corr. (dB)	Limit (dB μ V/m)	Margin (dB)
		Height (cm)	Polar (H/V)				
35.335100	20.56	101.0	V	39.0	-8.8	40.00	19.44
47.702530	18.52	101.0	V	326.0	-16.8	40.00	21.48
62.616280	31.83	199.0	H	169.0	-18.4	40.00	8.17
84.077500	32.66	199.0	H	184.0	-18.3	40.00	7.34
95.960000	38.15	199.0	H	169.0	-16.6	43.50	5.35
106.636000	39.44	199.0	H	158.0	-14.3	43.50	4.06

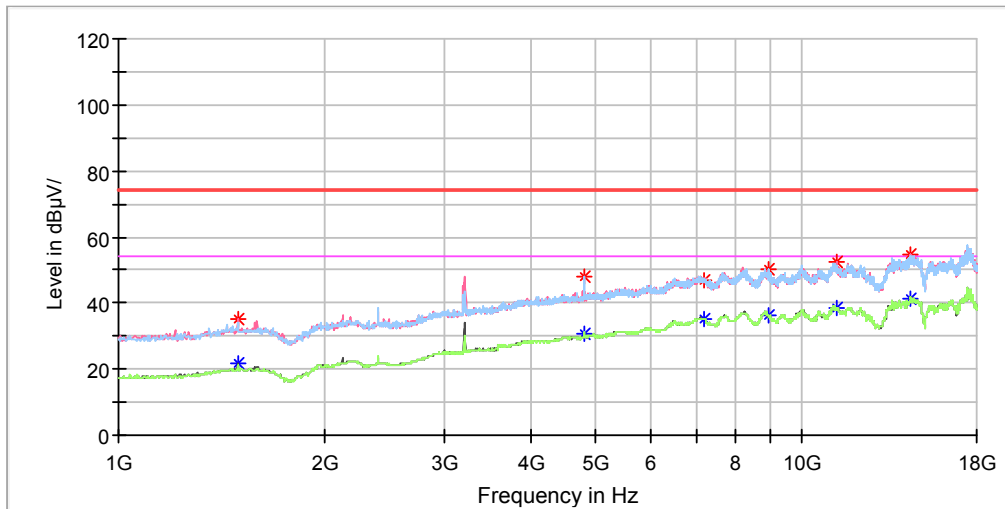
1GHz-25GHz:

Note:

1. This test is performed with the 2.4-2.4835GHz band reject filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
 Corrected Amplitude = Corrected Factor + Reading
 Margin = Limit - Corrected. Amplitude
3. The other spurious emission which is 20dB to the limit was not recorded.

Low Channel: 2402MHz

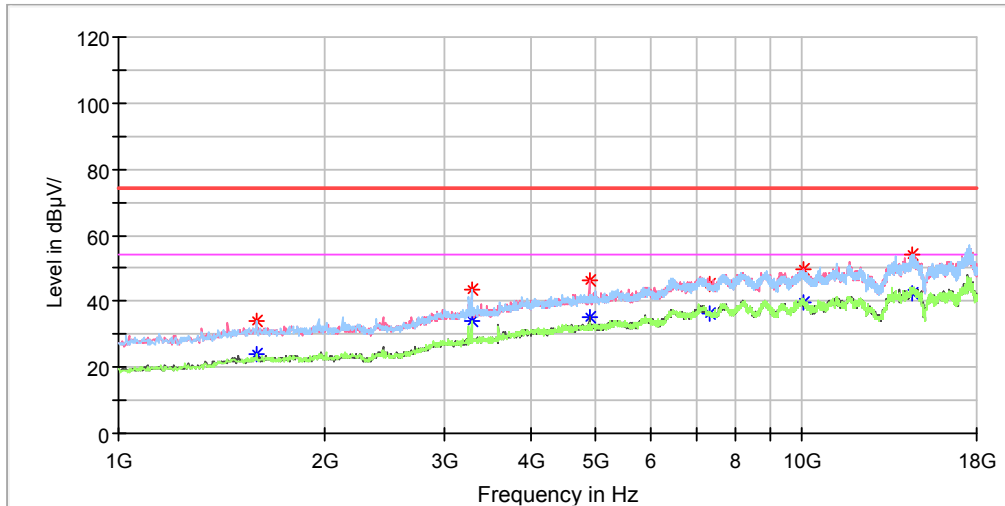
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1496.400000	---	22.02	150.0	V	252.0	-10.3	54.00	31.98
1496.400000	35.27	---	150.0	V	252.0	-10.3	74.00	38.73
4804.600000	---	30.95	200.0	H	128.0	-0.6	54.00	23.05
4804.600000	47.92	---	200.0	H	128.0	-0.6	74.00	26.08
7205.000000	---	34.98	250.0	V	128.0	6.3	54.00	19.02
7205.000000	46.80	---	200.0	V	0.0	6.3	74.00	27.20
8925.400000	---	36.40	150.0	H	232.0	8.5	54.00	17.60
8925.400000	50.36	---	150.0	H	232.0	8.5	74.00	23.64
11203.400000	---	38.30	250.0	V	0.0	12.0	54.00	15.70
11203.400000	52.40	---	150.0	V	131.0	12.0	74.00	21.60
14379.000000	---	41.05	250.0	V	249.0	16.7	54.00	12.95
14379.000000	54.48	---	150.0	V	0.0	16.7	74.00	19.52

Middle Channel: 2441MHz

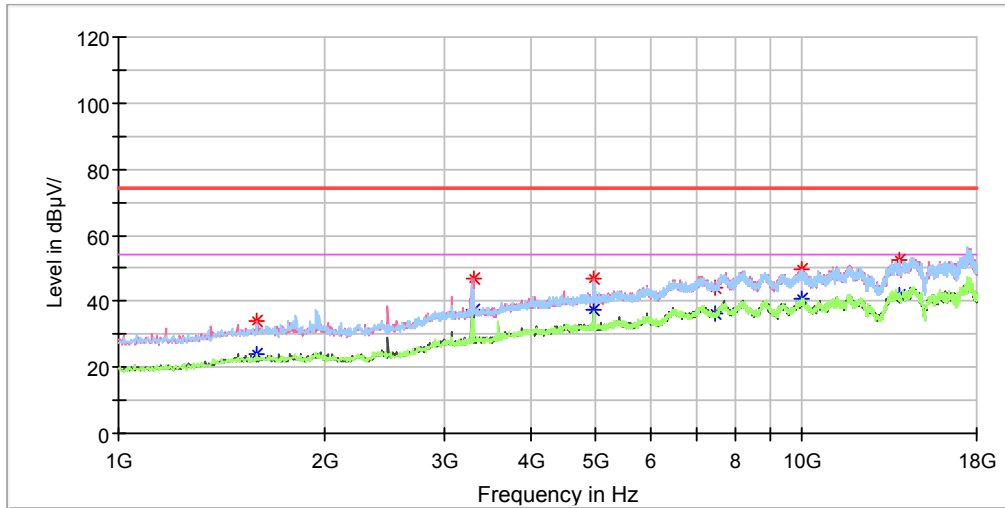
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1591.600000	34.28	---	250.0	H	18.0	-9.8	74.00	39.72
1591.600000	---	23.80	250.0	H	18.0	-9.8	54.00	30.20
3281.400000	43.49	---	250.0	H	232.0	-4.2	74.00	30.51
3281.400000	---	33.88	250.0	H	232.0	-4.2	54.00	20.12
4882.800000	46.40	---	200.0	V	198.0	-0.4	74.00	27.60
4882.800000	---	35.06	250.0	V	144.0	-0.4	54.00	18.94
7324.000000	---	36.08	200.0	V	278.0	6.7	54.00	17.92
7324.000000	44.99	---	250.0	V	165.0	6.7	74.00	29.01
10030.400000	---	39.86	250.0	V	359.0	9.2	54.00	14.14
10030.400000	49.42	---	250.0	V	359.0	9.2	74.00	24.58
14504.800000	---	42.68	250.0	H	93.0	16.7	54.00	11.32
14504.800000	54.14	---	150.0	H	129.0	16.7	74.00	19.86

High Channel: 2480MHz

Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1595.000000	---	23.92	200.0	V	97.0	-9.8	54.00	30.08
1595.000000	34.11	---	200.0	V	97.0	-9.8	74.00	39.89
3308.600000	---	37.27	150.0	V	214.0	-4.2	54.00	16.73
3308.600000	46.95	---	150.0	V	214.0	-4.2	74.00	27.05
4957.600000	---	37.34	200.0	V	285.0	-0.3	54.00	16.66
4957.600000	46.78	---	200.0	V	285.0	-0.3	74.00	27.22
7439.600000	44.10	---	150.0	H	69.0	7.0	74.00	29.90
7439.600000	---	36.49	150.0	H	69.0	7.0	54.00	17.51
10013.400000	---	40.60	200.0	H	350.0	9.1	54.00	13.40
10013.400000	49.52	---	200.0	H	350.0	9.1	74.00	24.48
13879.200000	---	42.01	200.0	H	339.0	16.8	54.00	11.99
13879.200000	52.70	---	200.0	H	339.0	16.8	74.00	21.30

Radiation spurious Restricted Band edge:

Note:

1. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
2. Corrected Amplitude = Corrected Factor + Reading
3. Margin = Limit - Corrected. Amplitude

Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2402MHz								
2390.00	---	25.64	230	V	313	-4.96	54.00	28.36
2390.00	40.71	---	230	V	313	-4.96	74.00	33.29
High Channel: 2480MHz								
2483.50	---	26.24	139	V	141	-4.71	54.00	27.76
2483.50	41.88	---	139	V	141	-4.71	74.00	32.12

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

Applicable Standard

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

Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	20.3 °C
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-10-24.

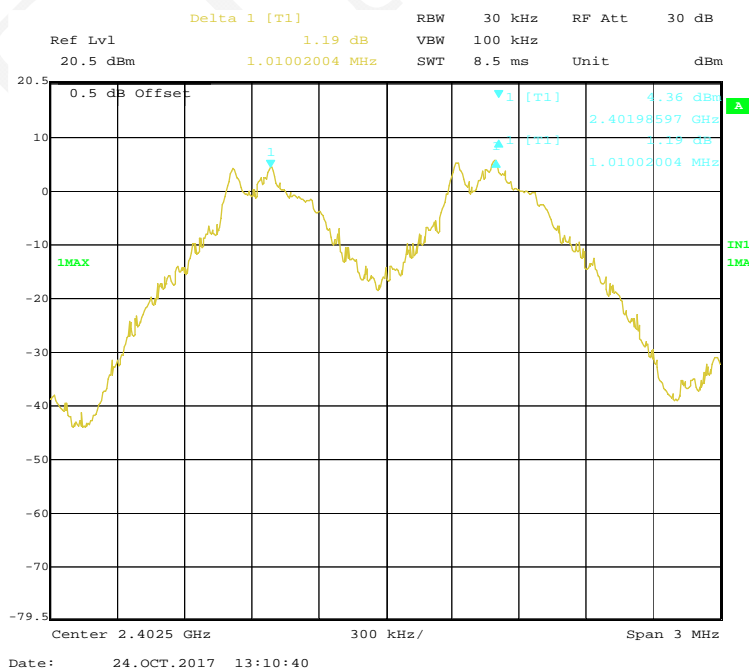
EUT operation mode: Transmitting

Test Result: Compliance.

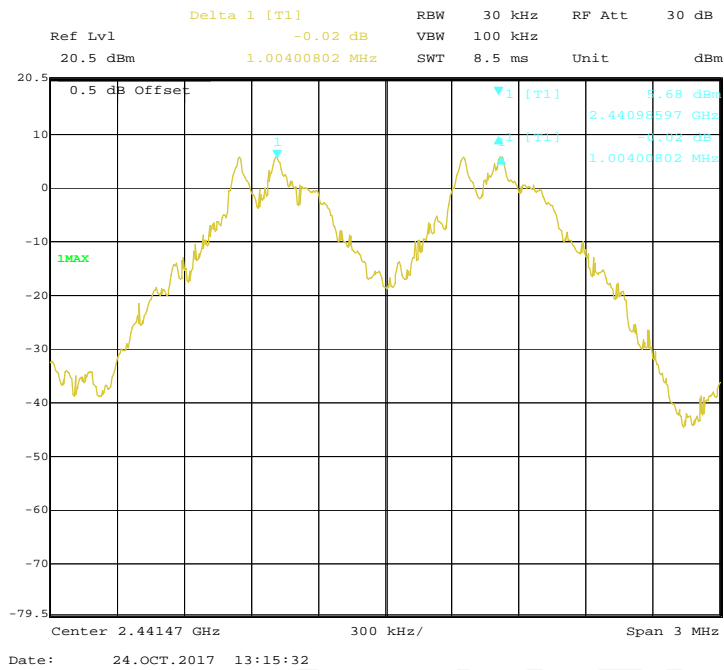
Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit	Result
BDR (GFSK)	Low	2402	1.010	0.629	Pass
	Adjacent	2403			
	Middle	2441	1.004	0.629	Pass
	Adjacent	2442			
	High	2480	0.998	0.621	Pass
	Adjacent	2479			
EDR ($\pi/4$-DQPSK)	Low	2402	1.004	0.805	Pass
	Adjacent	2403			
	Middle	2441	1.004	0.797	Pass
	Adjacent	2442			
	High	2480	0.998	0.813	Pass
	Adjacent	2479			
EDR (8-DPSK)	Low	2402	1.004	0.781	Pass
	Adjacent	2403			
	Middle	2441	1.004	0.797	Pass
	Adjacent	2442			
	High	2480	1.004	0.797	Pass
	Adjacent	2479			

Note: Limit = 20 dB bandwidth*2/3

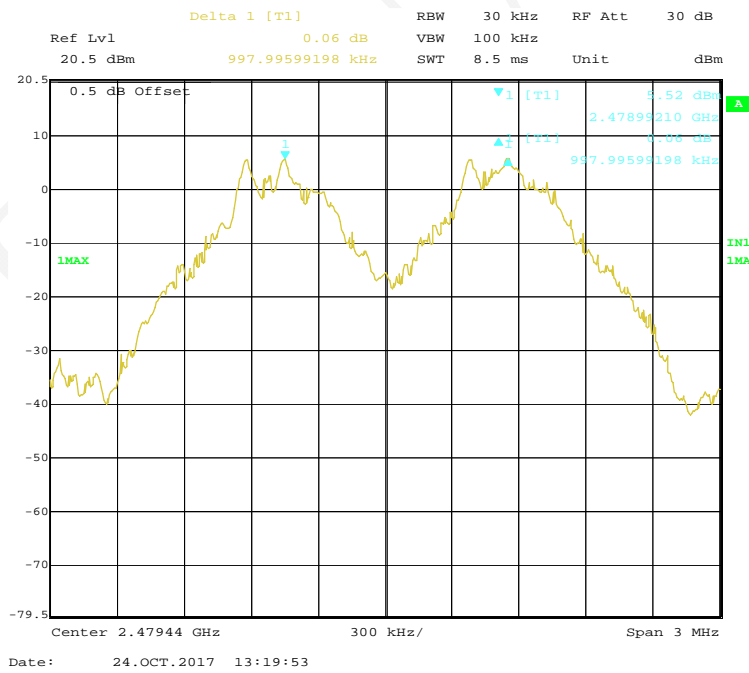
BDR (GFSK): Low Channel



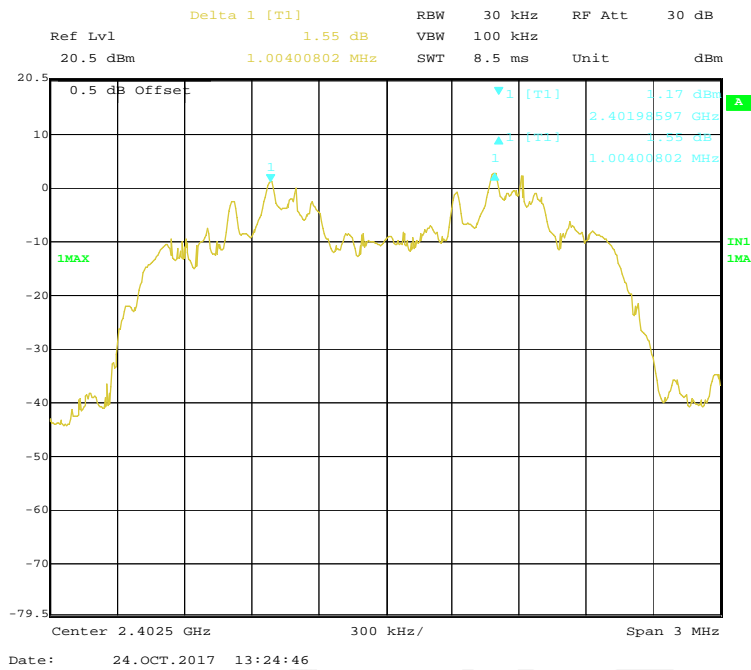
BDR (GFSK): Middle Channel



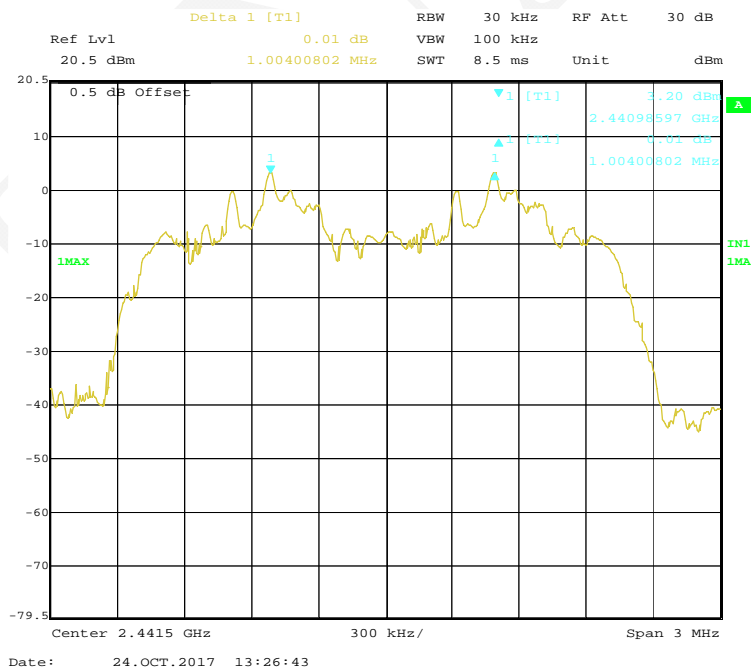
BDR (GFSK): High Channel



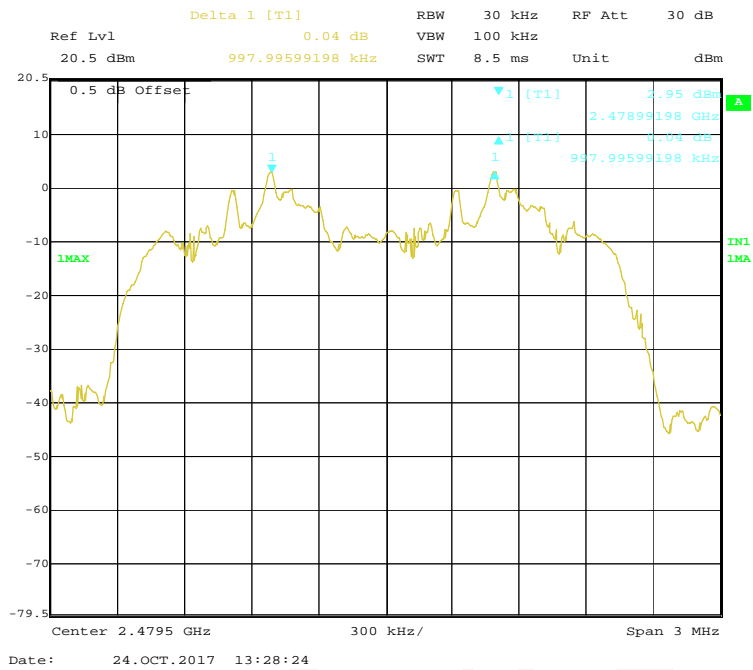
EDR ($\pi/4$ -DQPSK): Low Channel



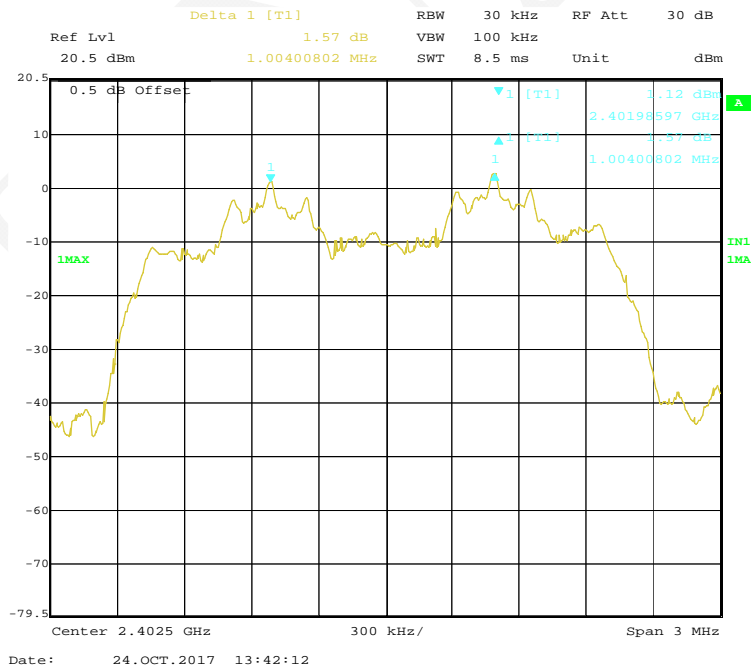
EDR ($\pi/4$ -DQPSK): Middle Channel



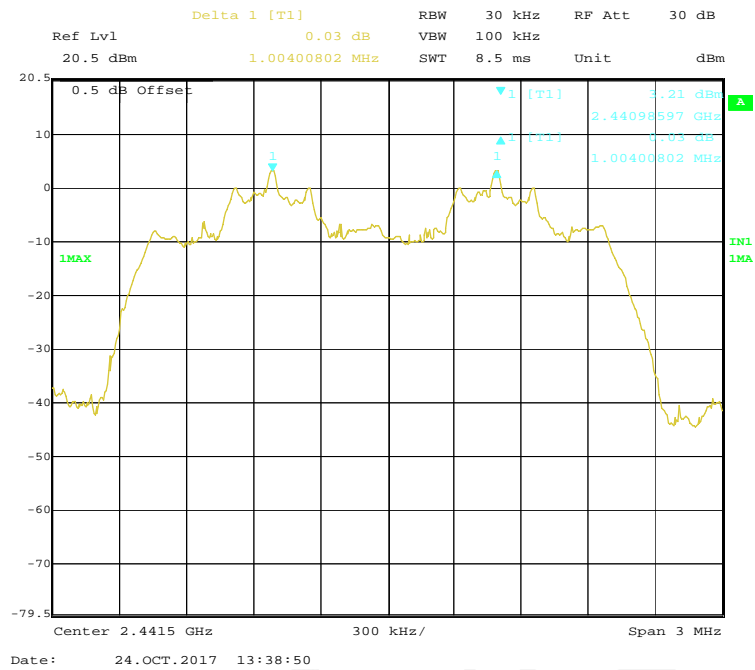
EDR ($\pi/4$ -DQPSK): High Channel



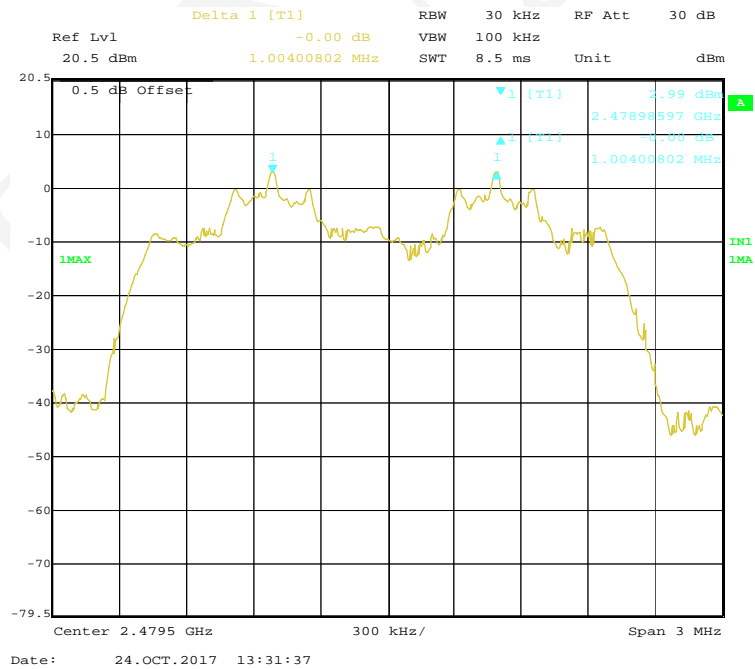
EDR (8-DPSK): Low Channel



EDR (8-DPSK): Middle Channel



EDR (8-DPSK): High Channel



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

Applicable Standard

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

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

Test Data

Environmental Conditions

Temperature:	20.3 °C
Relative Humidity:	55 %
ATM Pressure:	101.3 kPa

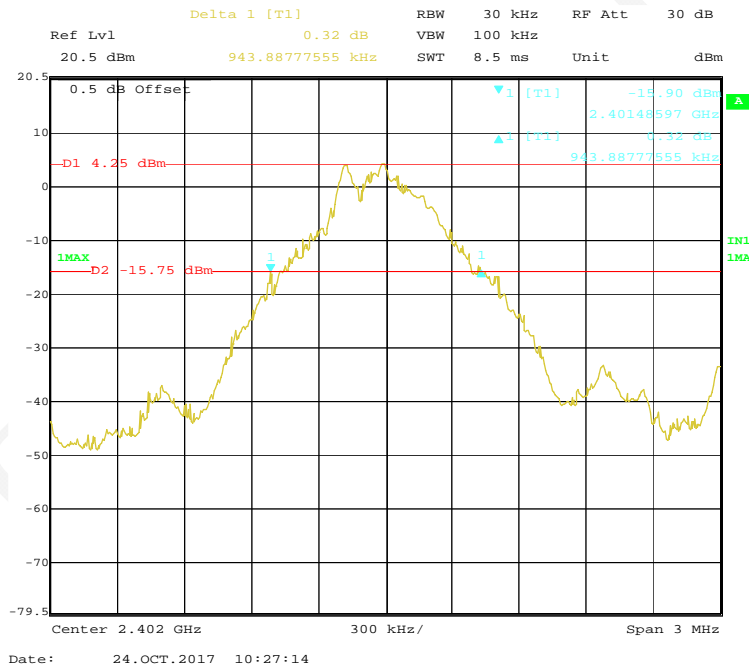
The testing was performed by Ada Yu on 2017-10-24.

EUT operation mode: Transmitting

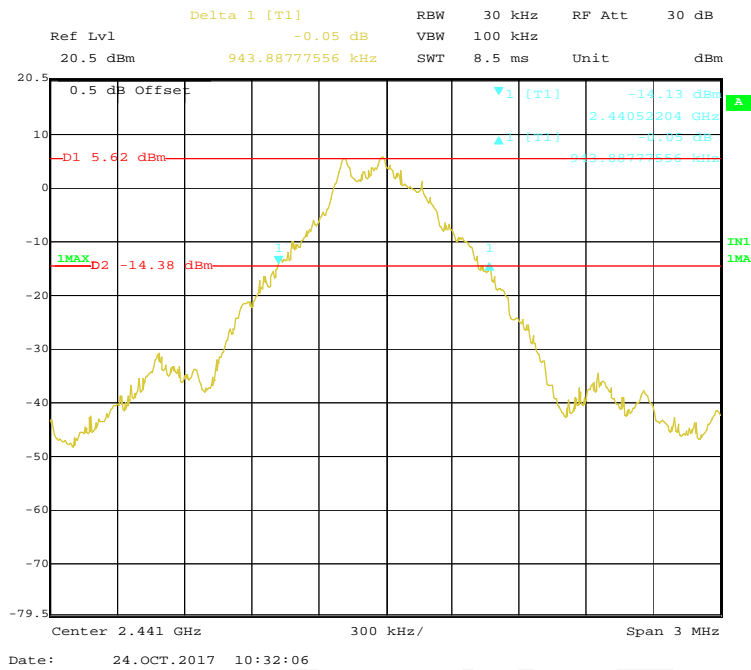
Test Result: Compliance.

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.944
	Middle	2441	0.944
	High	2480	0.932
EDR ($\pi/4$-DQPSK)	Low	2402	1.208
	Middle	2441	1.196
	High	2480	1.220
EDR (8-DPSK)	Low	2402	1.172
	Middle	2441	1.196
	High	2480	1.196

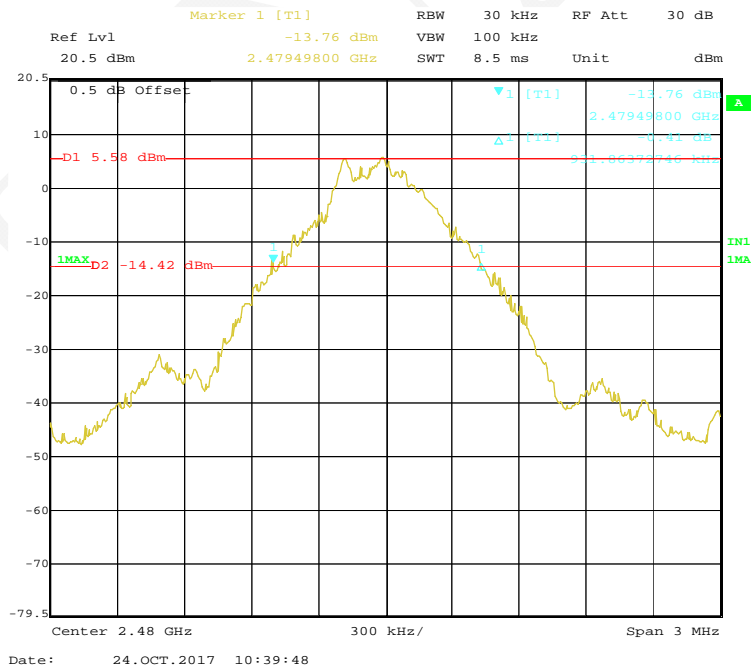
BDR (GFSK): Low Channel



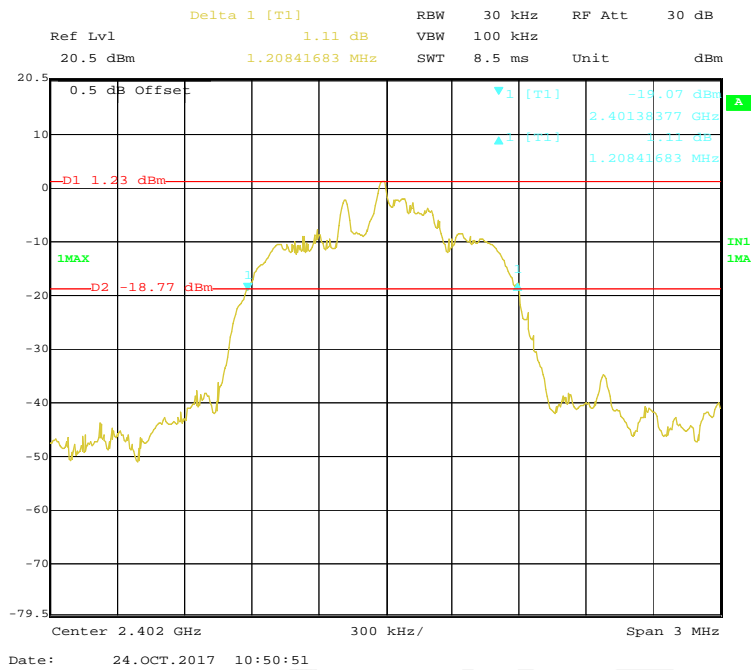
BDR (GFSK): Middle Channel



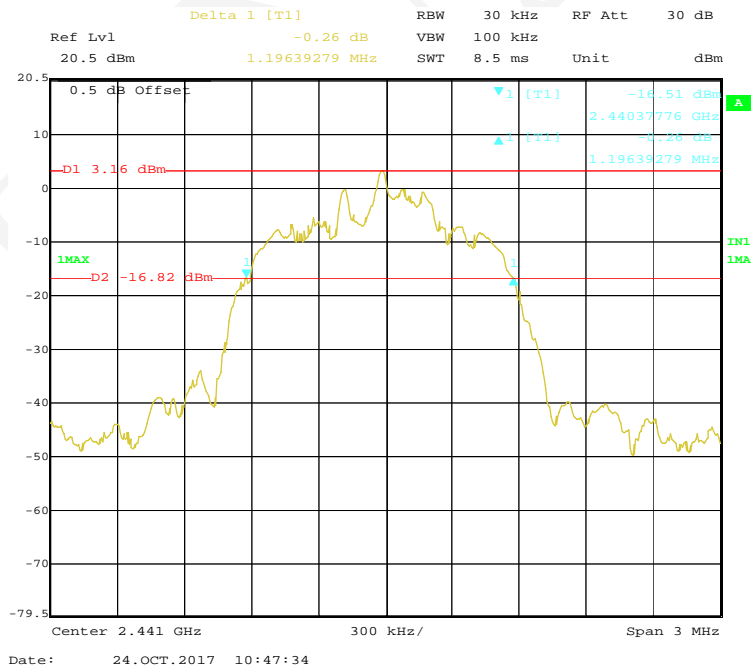
BDR (GFSK): High Channel



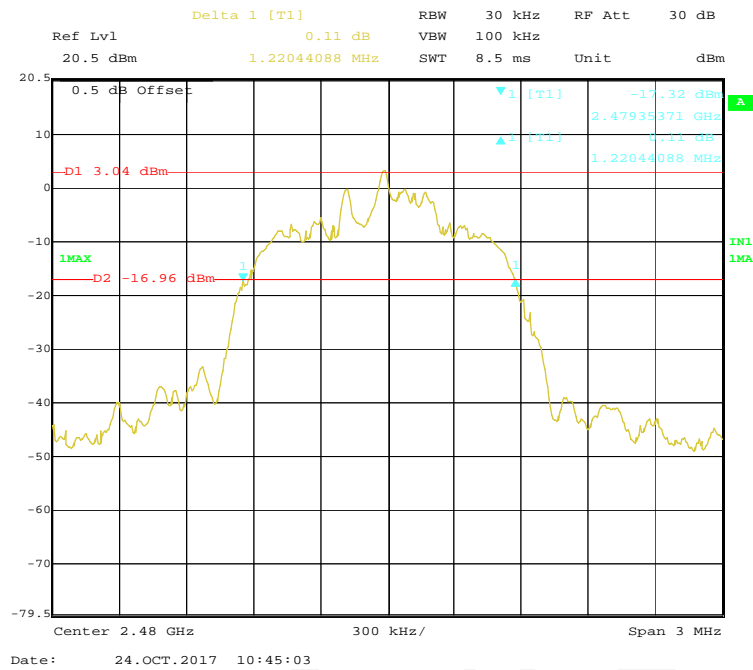
EDR ($\pi/4$ -DQPSK): Low Channel



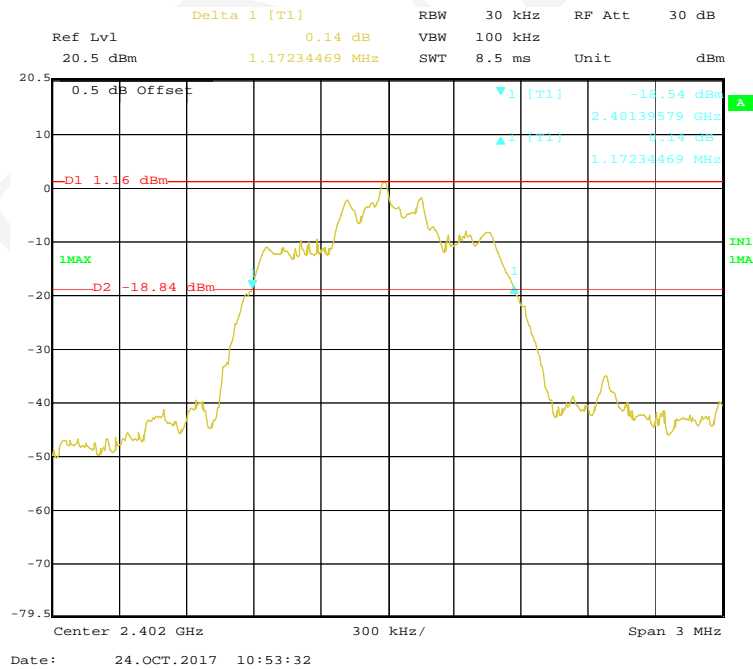
EDR($\pi/4$ -DQPSK): Middle Channel



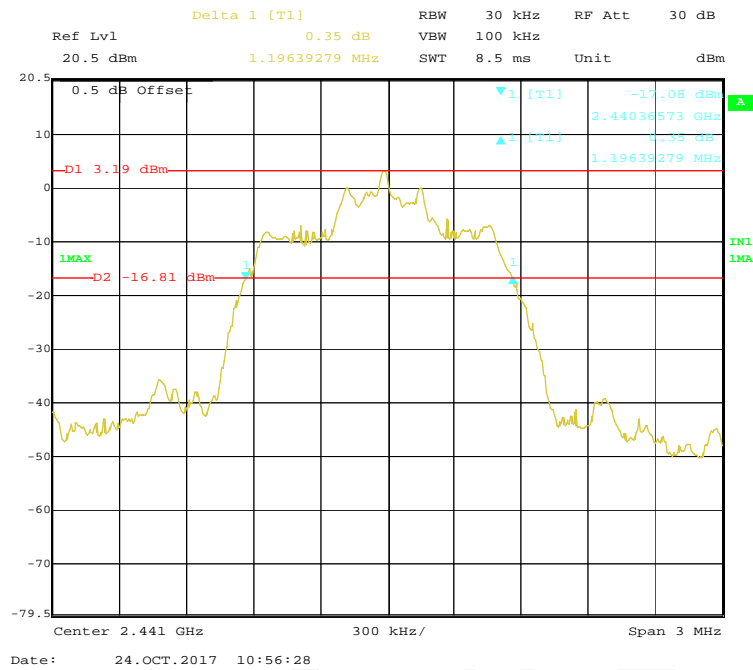
EDR ($\pi/4$ -DQPSK): High Channel



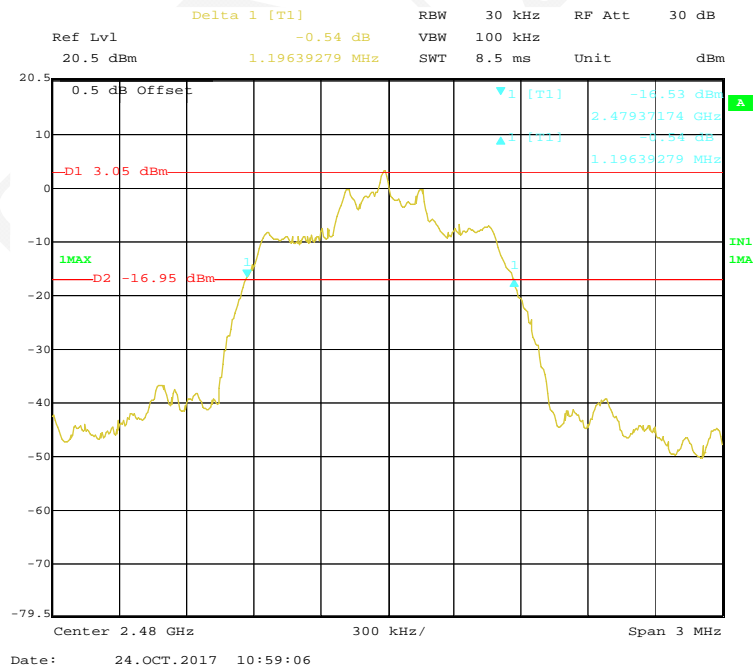
EDR (8-DPSK): Low Channel



EDR (8-DPSK): Middle Channel



EDR (8-DPSK): High Channel



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

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

Test Data**Environmental Conditions**

Temperature:	20.1 °C
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

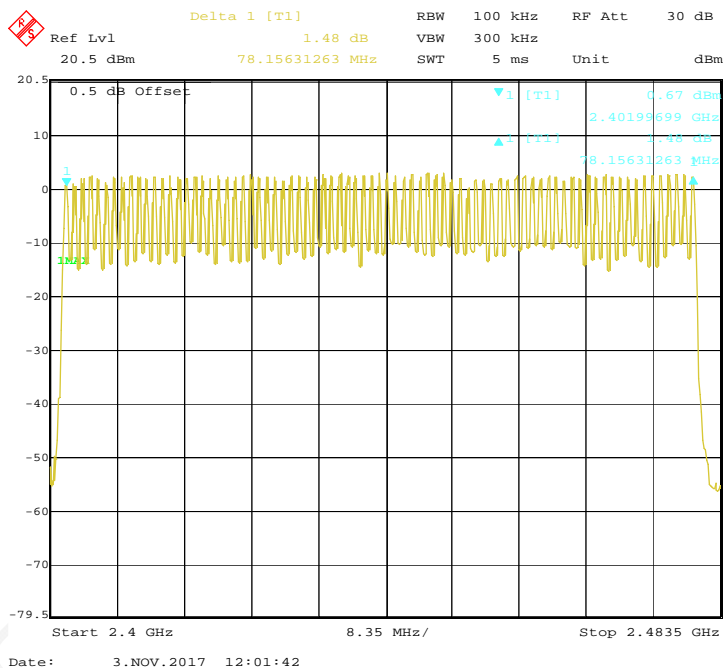
The testing was performed by Ada Yu on 2017-11-03.

EUT operation mode: Transmitting

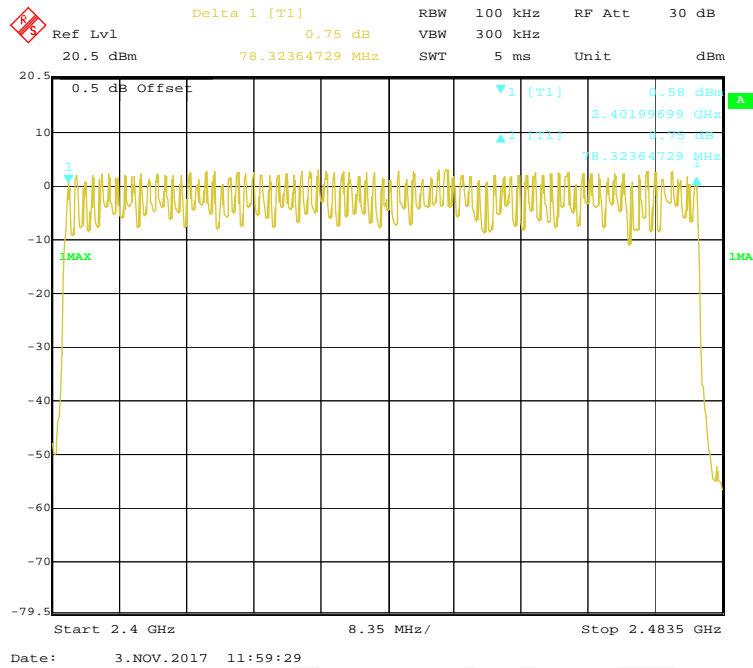
Test Result: Compliance.

Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥15
EDR (π/4-DQPSK)	2400-2483.5	79	≥15
EDR (8-DPSK)	2400-2483.5	79	≥15

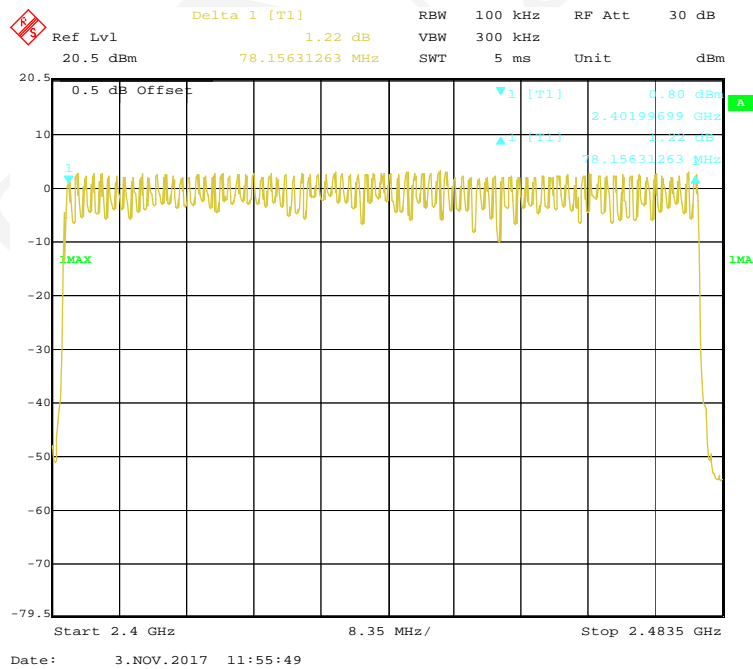
BDR (GFSK): Number of Hopping Channels



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



EDR (8-DPSK): 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

1 Span: Zero span, centered on a hopping channel.

2 RBW shall be \leq channel spacing and where possible RBW should be set $\gg 1 / T$, where T is the expected dwell time per channel.

3 Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.

4 Detector function: Peak.

5 Trace: Max hold.

Test Data**Environmental Conditions**

Temperature:	20.1 °C
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

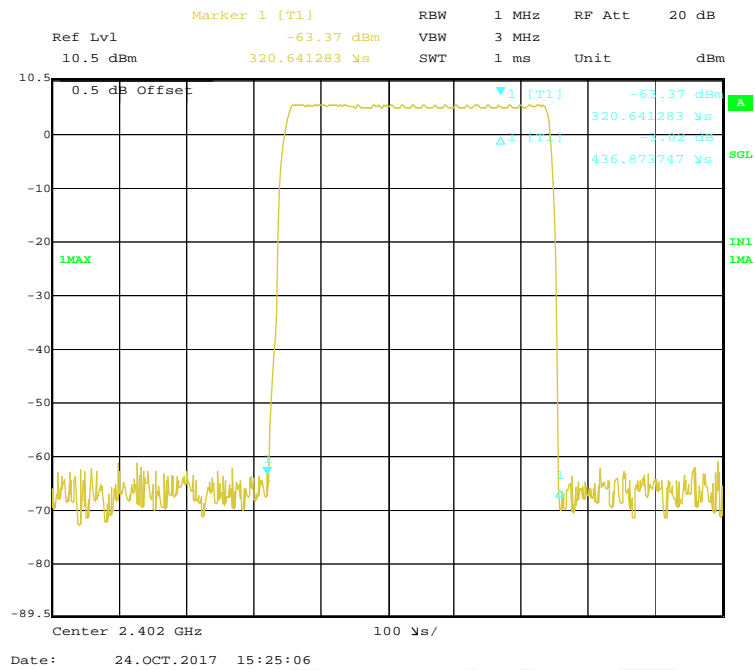
The testing was performed by Ada Yu on 2017-10-24.

EUT operation mode: Transmitting

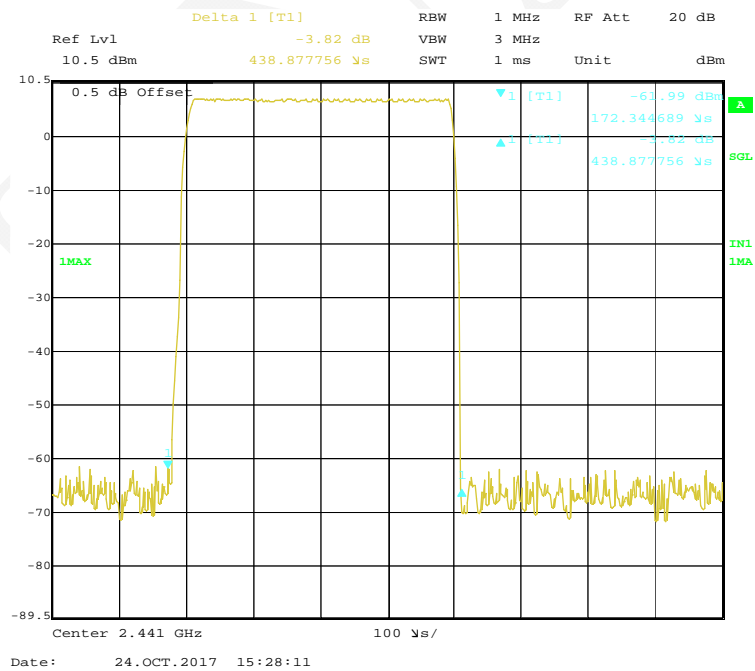
Test Result: Compliance.

Mode		Channel	Pulse Width (ms)	Dwell Time (s)	Limit (s)	Result	
BDR (GFSK)	DH 1	Low	0.437	0.140	0.4	Pass	
		Middle	0.439	0.140	0.4	Pass	
		High	0.437	0.140	0.4	Pass	
	Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S						
	DH 3	Low	1.699	0.272	0.4	Pass	
		Middle	1.709	0.273	0.4	Pass	
		High	1.709	0.273	0.4	Pass	
	Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S						
	DH 5	Low	2.965	0.316	0.4	Pass	
		Middle	2.957	0.315	0.4	Pass	
		High	2.957	0.315	0.4	Pass	
	Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S						
EDR ($\pi/4$ -DQPSK)	2DH 1	Low	0.452	0.145	0.4	Pass	
		Middle	0.452	0.145	0.4	Pass	
		High	0.452	0.145	0.4	Pass	
	Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S						
	2DH 3	Low	1.704	0.273	0.4	Pass	
		Middle	1.709	0.273	0.4	Pass	
		High	1.709	0.273	0.4	Pass	
	Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S						
	2DH 5	Low	2.968	0.317	0.4	Pass	
		Middle	2.976	0.317	0.4	Pass	
		High	2.968	0.317	0.4	Pass	
	Note: 2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S						
EDR (8-DPSK)	3DH 1	Low	0.447	0.143	0.4	Pass	
		Middle	0.447	0.143	0.4	Pass	
		High	0.449	0.144	0.4	Pass	
	Note:3 DH1:Dwell time = Pulse time*(1600/2/79)*31.6S						
	3DH 3	Low	1.706	0.273	0.4	Pass	
		Middle	1.701	0.272	0.4	Pass	
		High	1.706	0.273	0.4	Pass	
	Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S						
	3DH 5	Low	2.965	0.316	0.4	Pass	
		Middle	2.981	0.318	0.4	Pass	
		High	2.965	0.316	0.4	Pass	
	Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S						

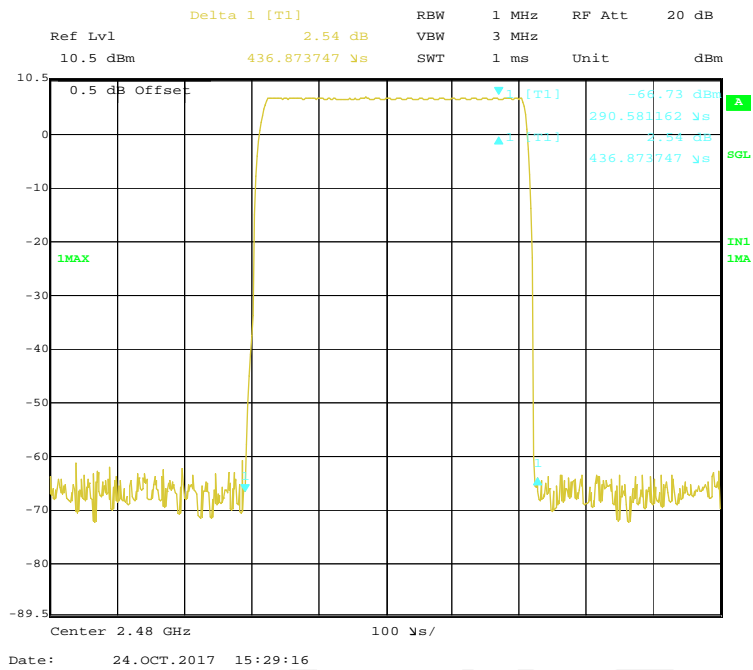
BDR (GFSK): Pulse time, Low Channel, DH1



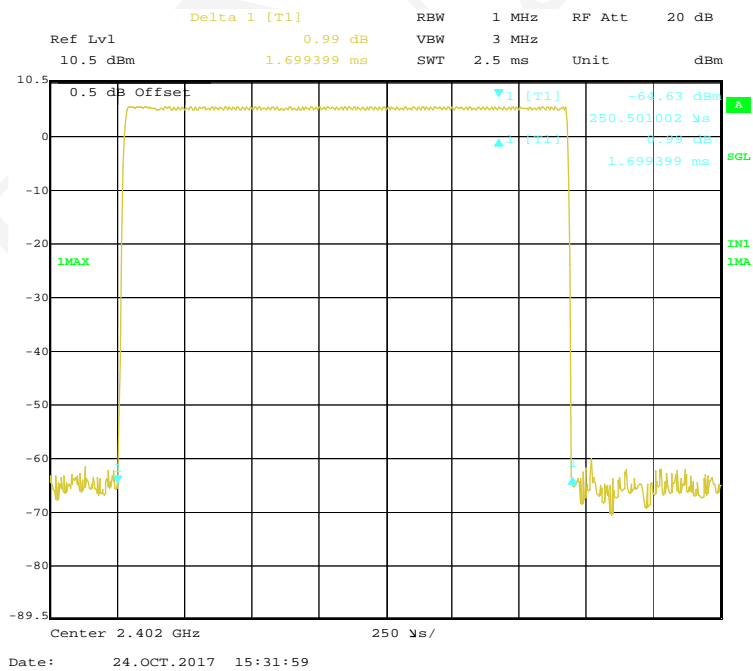
BDR (GFSK): Pulse time, Middle Channel, DH1



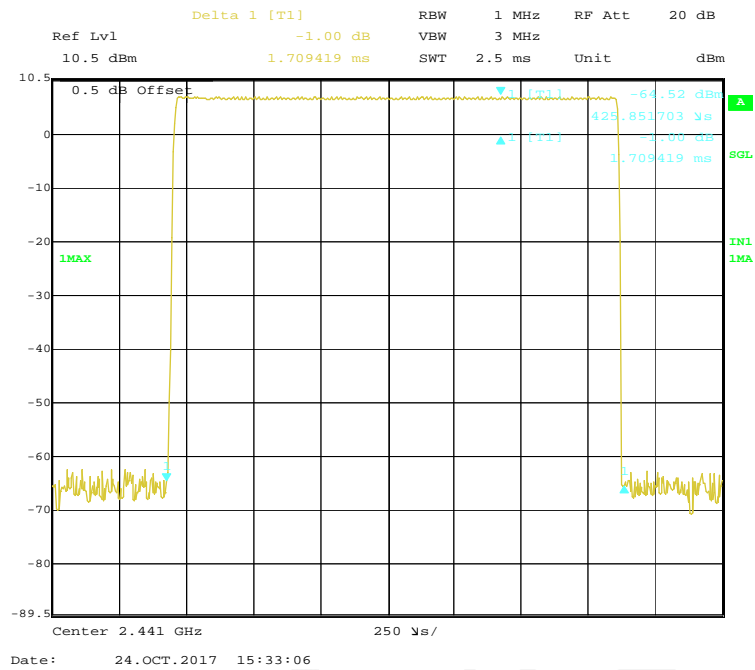
BDR (GFSK): Pulse time, High Channel, DH1



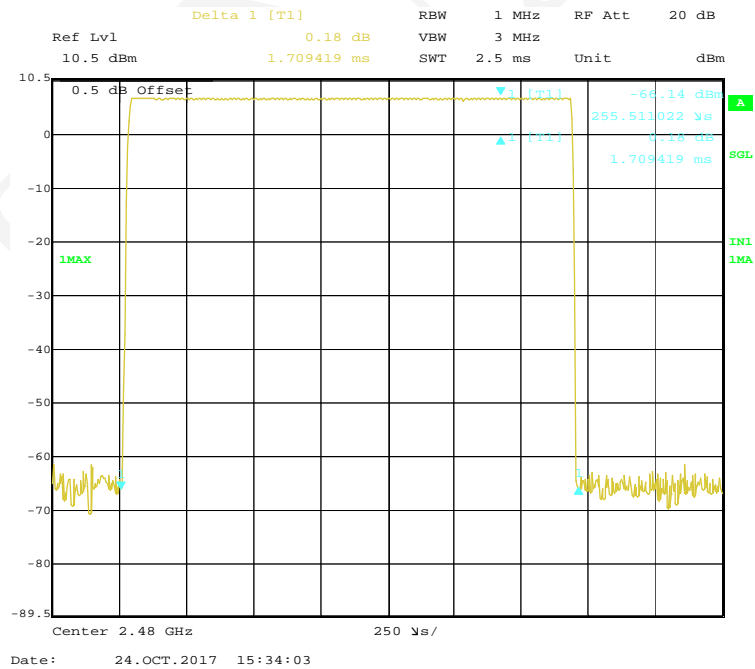
BDR (GFSK): Pulse time, Low Channel, DH3



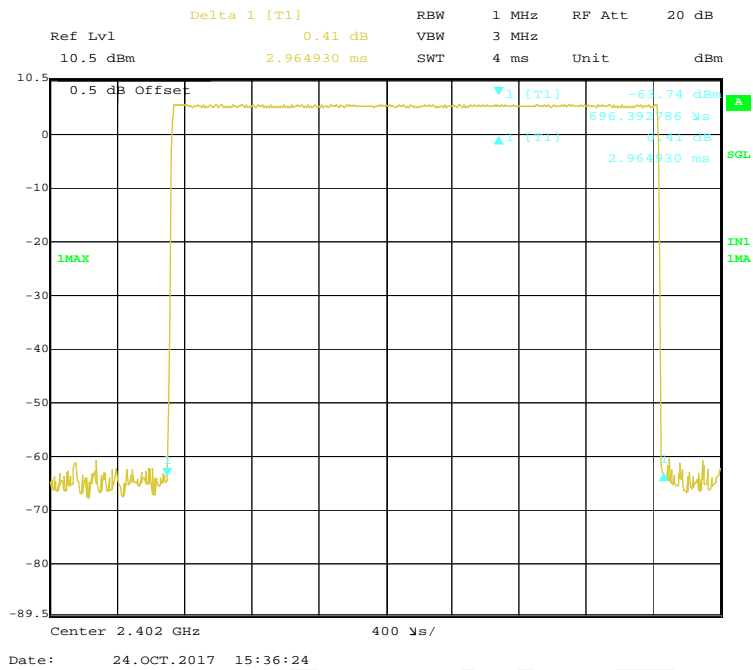
BDR (GFSK): Pulse time, Middle Channel, DH3



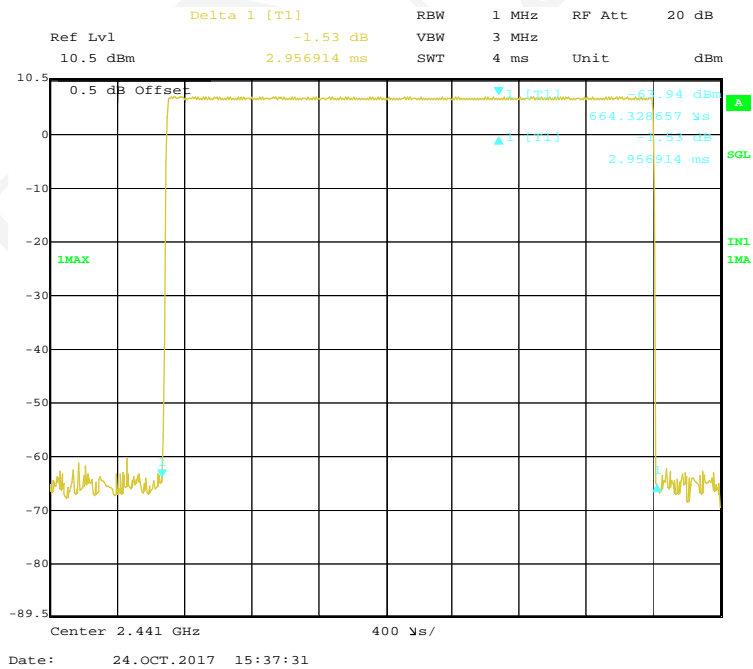
BDR (GFSK): Pulse time, High Channel, DH3



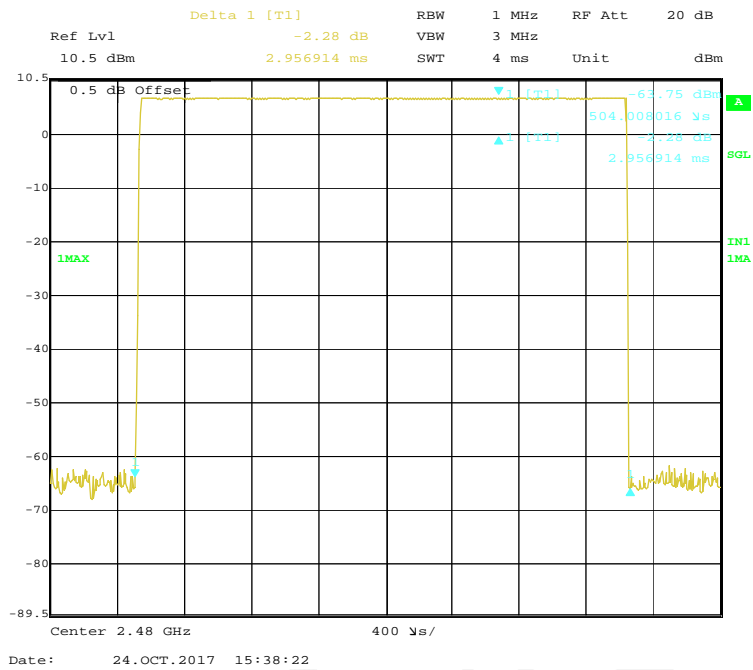
BDR (GFSK): Pulse time, Low Channel, DH5



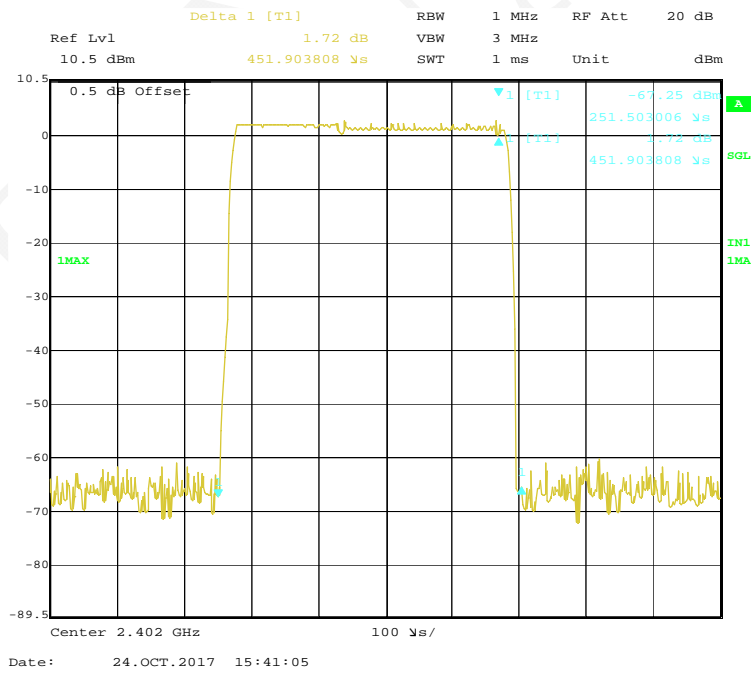
BDR (GFSK): Pulse time, Middle Channel, DH5



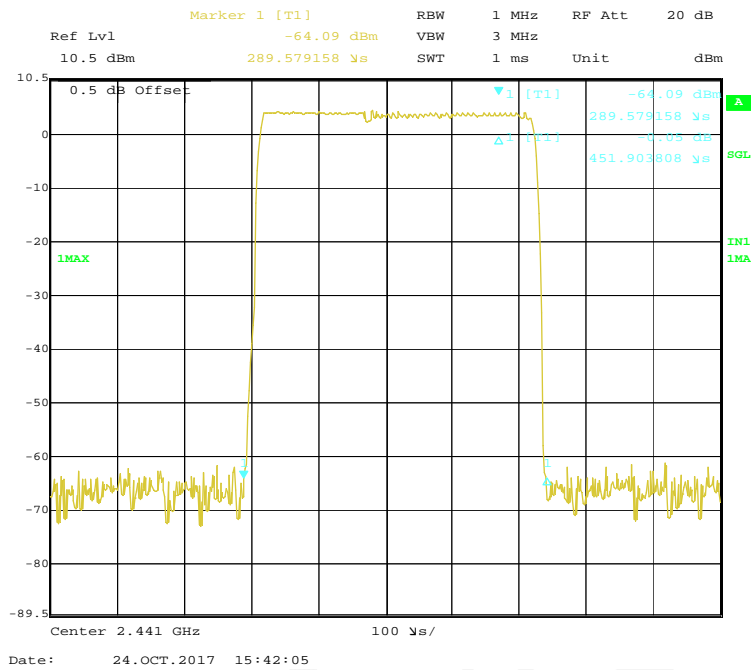
BDR (GFSK): Pulse time, High Channel, DH5



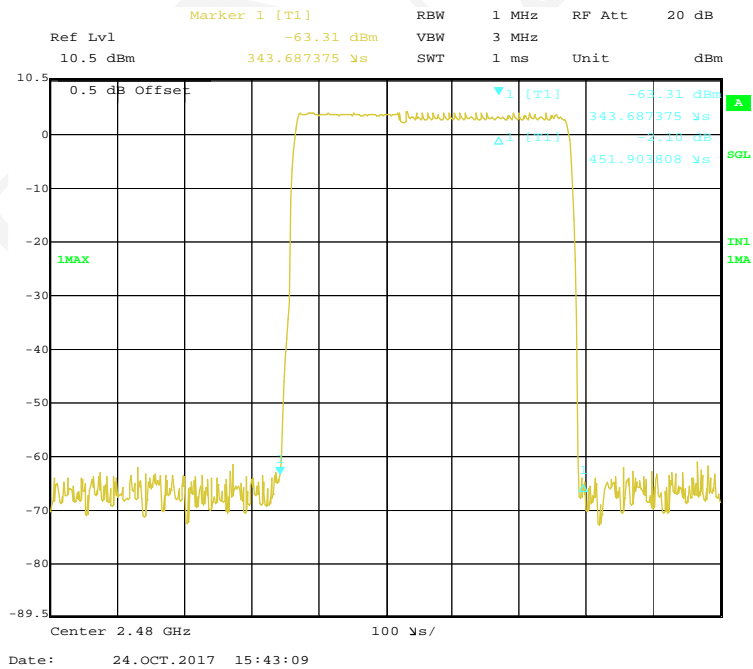
EDR ($\pi/4$ -DQPSK): Pulse time, Low Channel, 2DH1



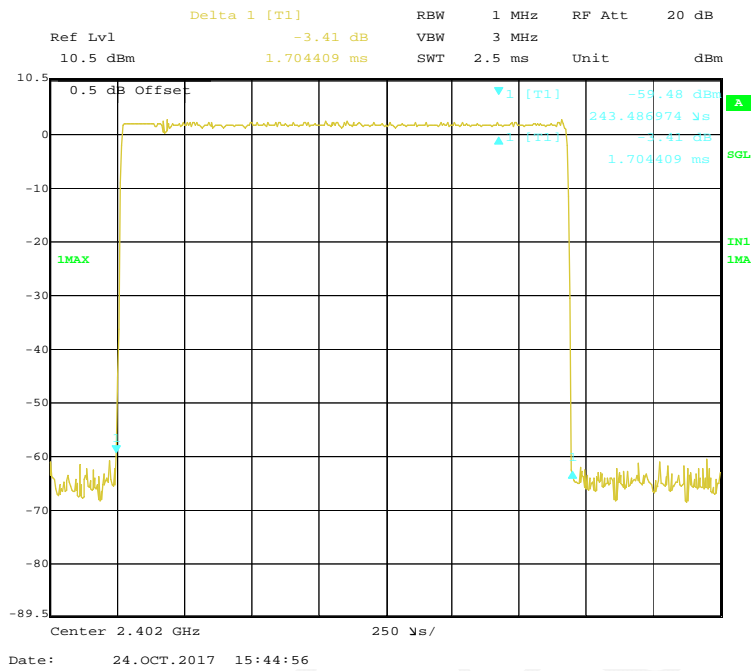
EDR ($\pi/4$ -DQPSK):Pulse time, Middle Channel, 2DH1



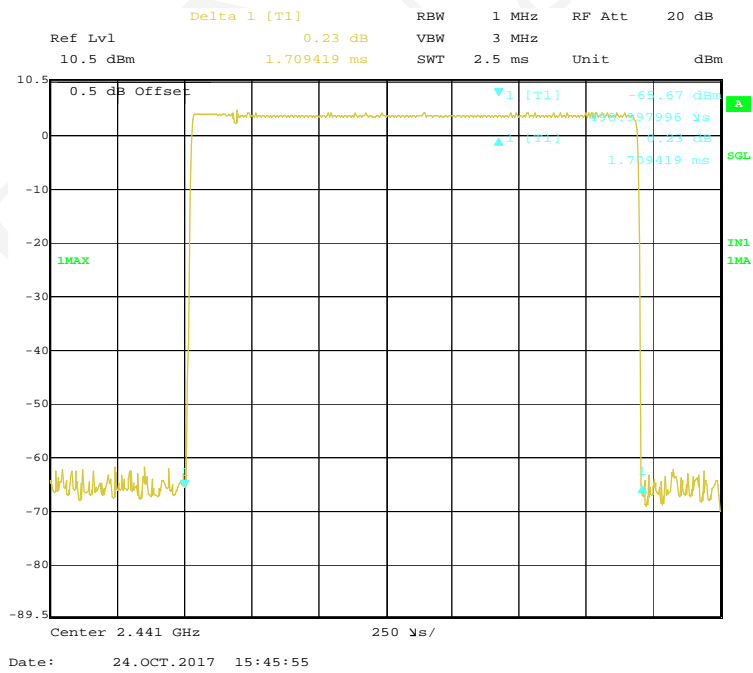
EDR ($\pi/4$ -DQPSK):Pulse time, High Channel, 2DH1



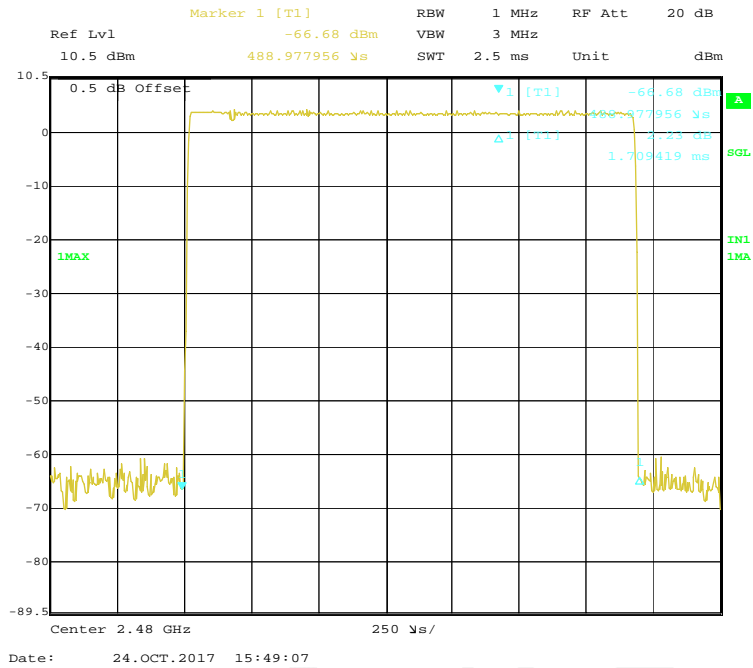
EDR ($\pi/4$ -DQPSK):Pulse time, Low Channel, 2DH3



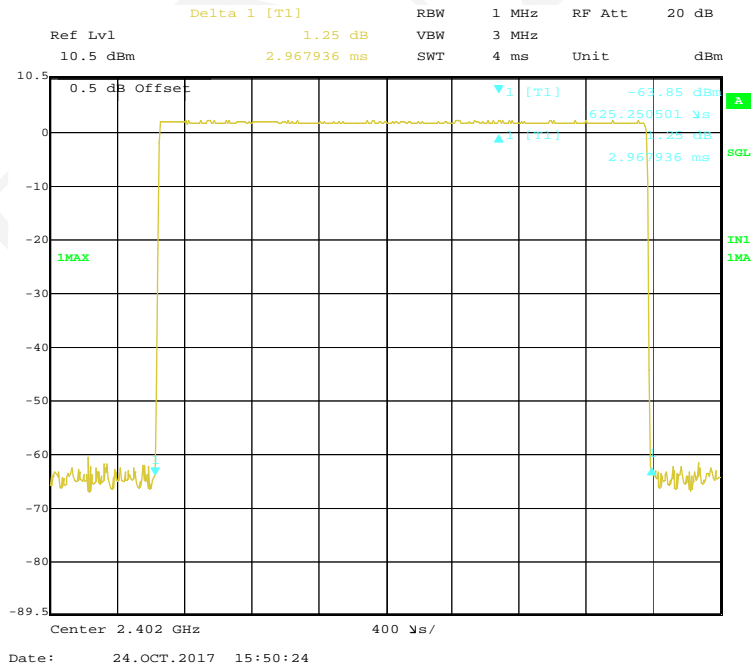
EDR ($\pi/4$ -DQPSK):Pulse time, Middle Channel, 2DH3



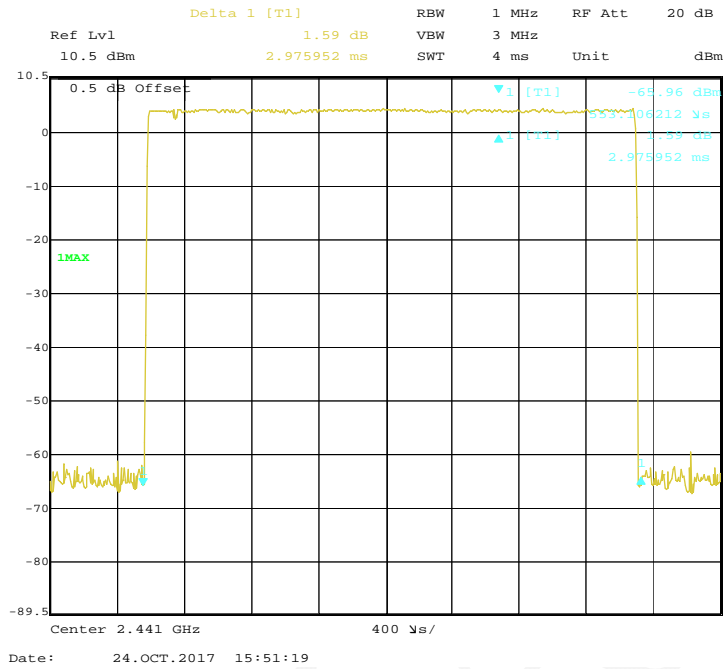
EDR ($\pi/4$ -DQPSK):Pulse time, High Channel, 2DH3



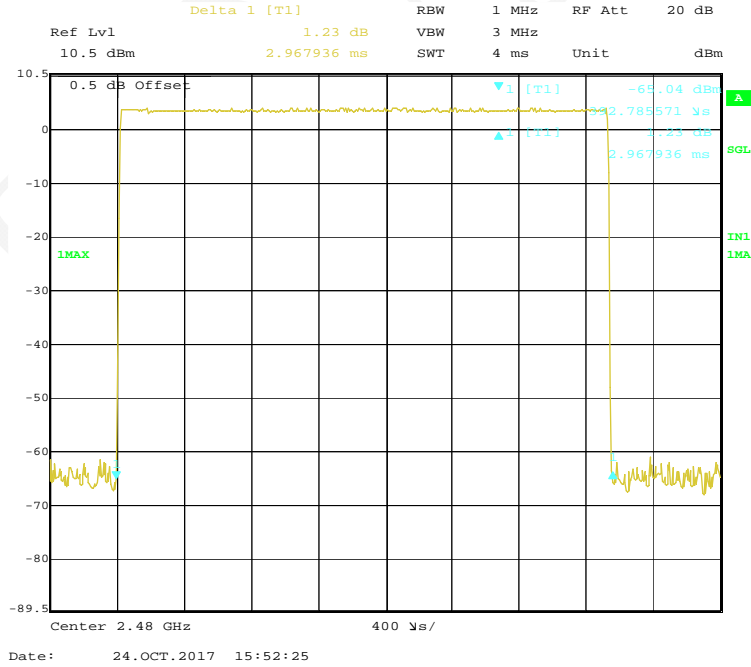
EDR ($\pi/4$ -DQPSK):Pulse time, Low Channel, 2DH5



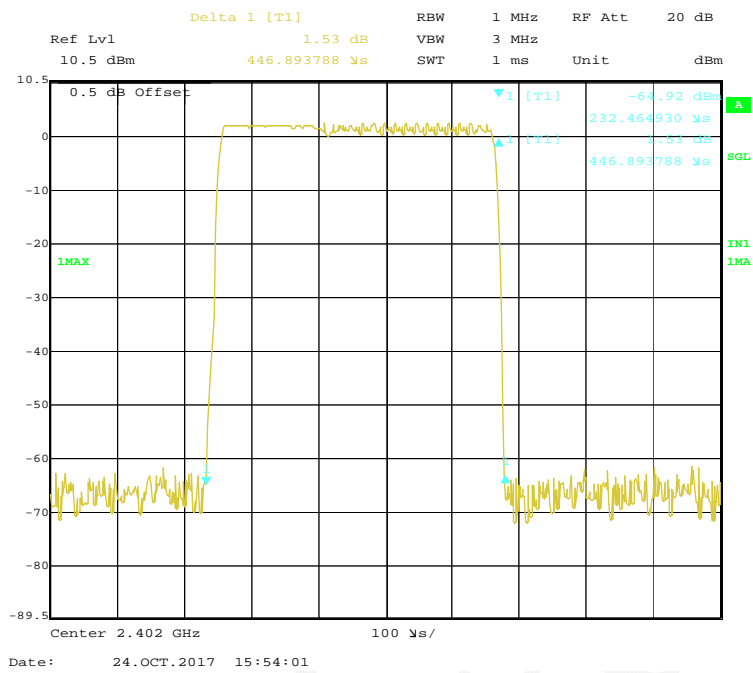
EDR ($\pi/4$ -DQPSK):Pulse time, Middle Channel, 2DH5



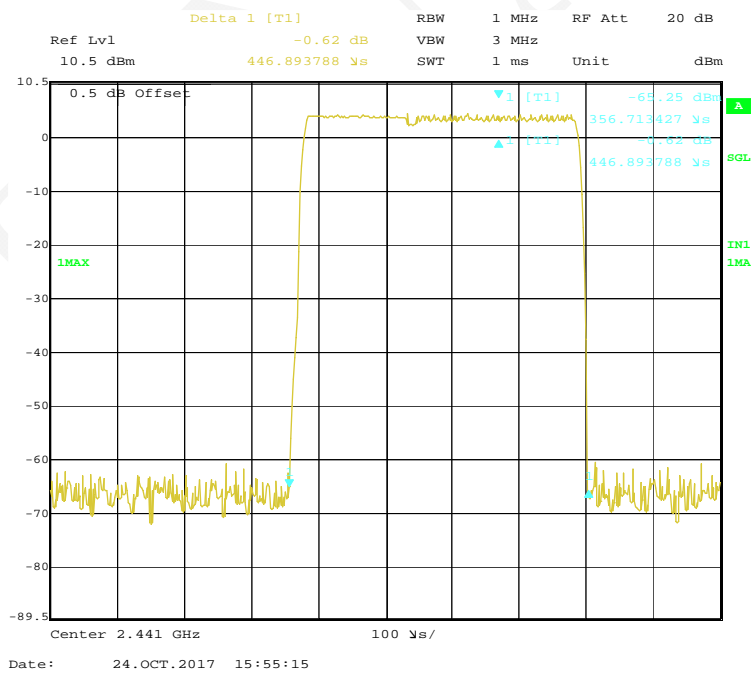
EDR ($\pi/4$ -DQPSK):Pulse time, High Channel, 2DH5



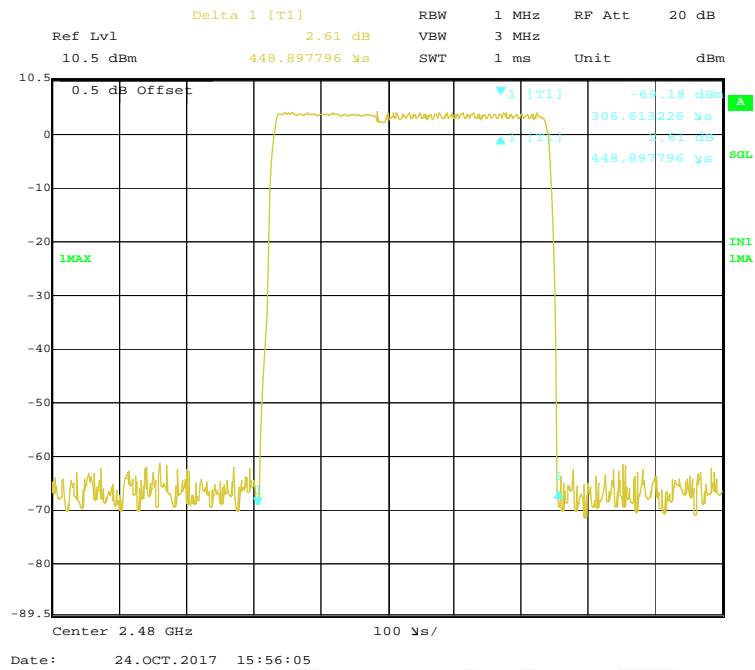
EDR (8-DPSK): Pulse time, Low Channel, 3DH1



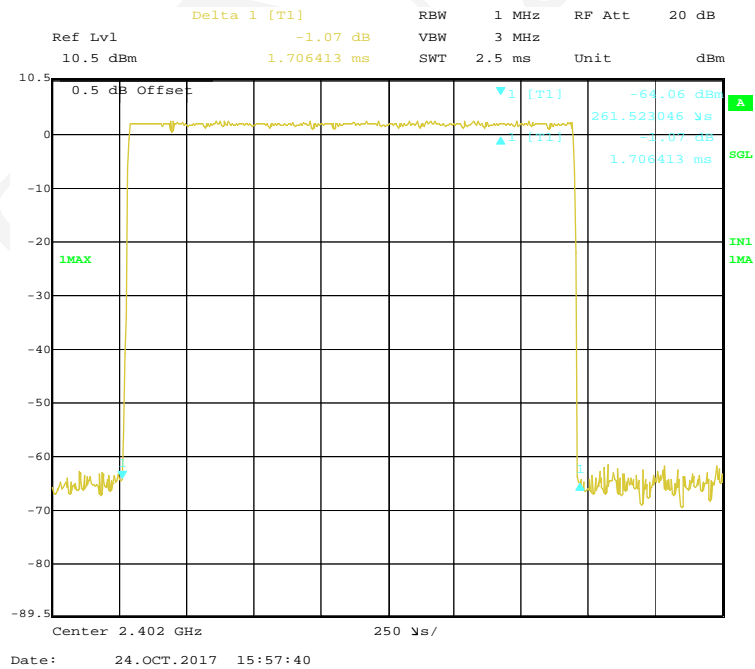
EDR (8-DPSK): Pulse time, Middle Channel, 3DH1



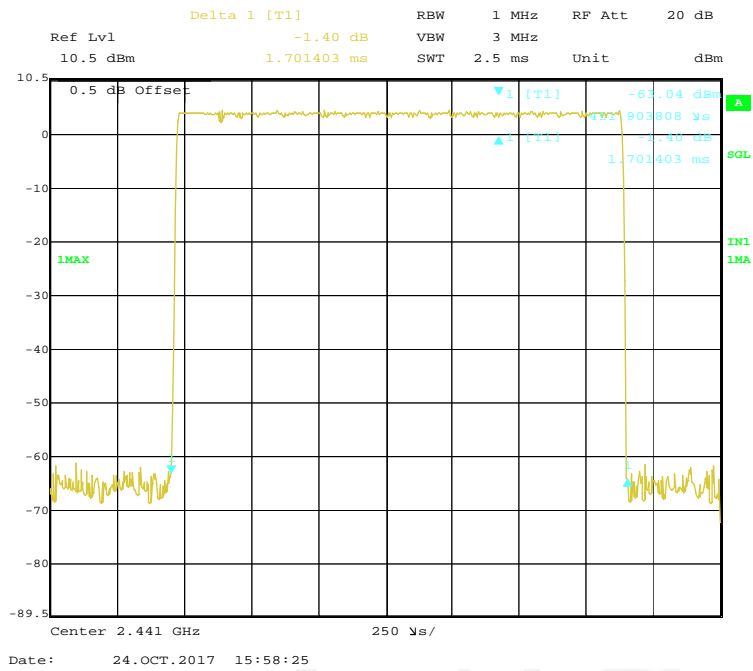
EDR (8-DPSK): Pulse time, High Channel, 3DH1



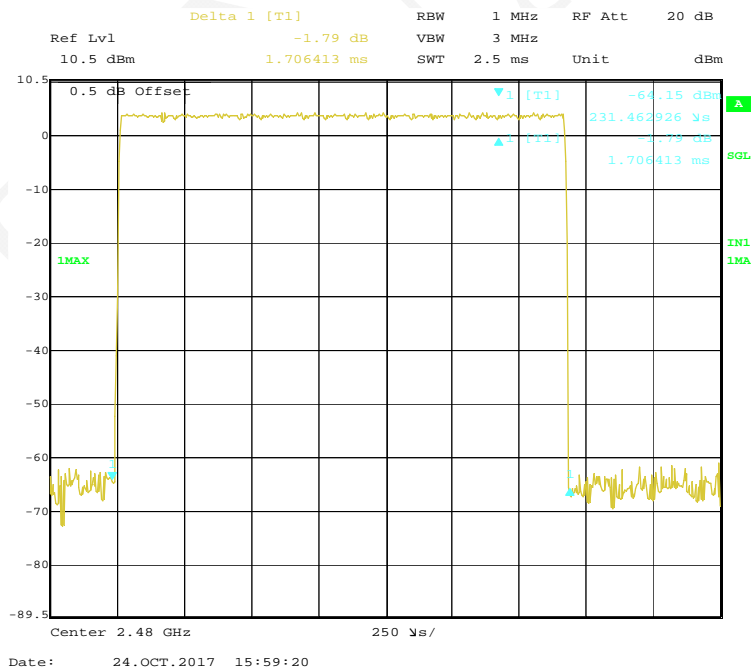
EDR (8-DPSK): Pulse time, Low Channel, 3DH3



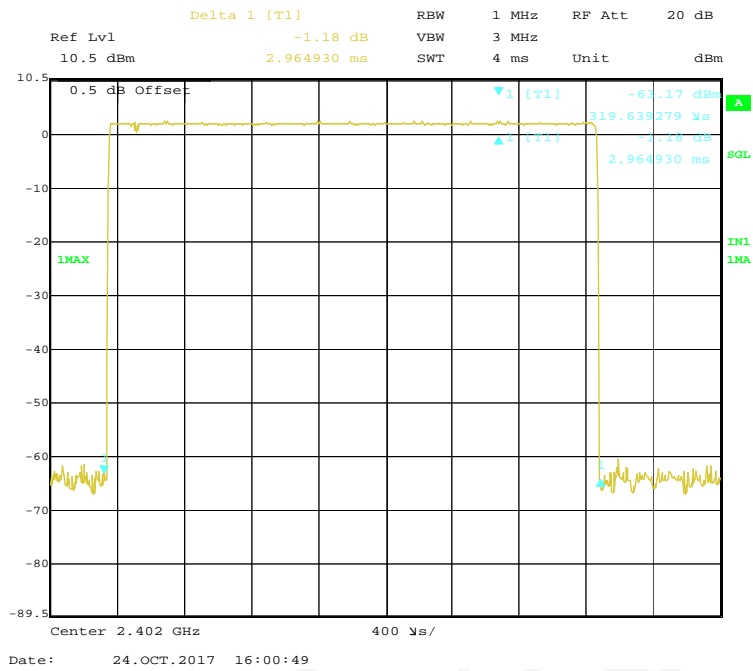
EDR (8-DPSK): Pulse time, Middle Channel, 3DH3



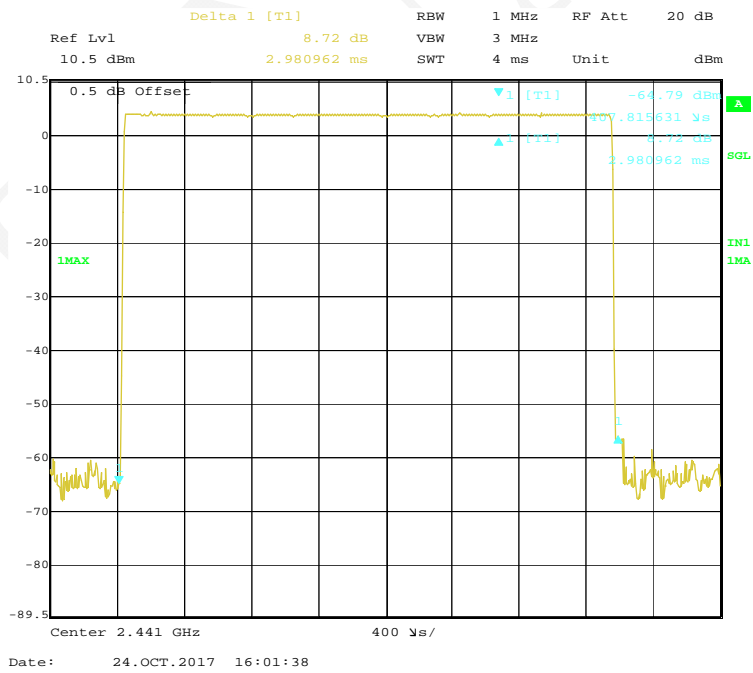
EDR (8-DPSK): Pulse time, High Channel, 3DH3



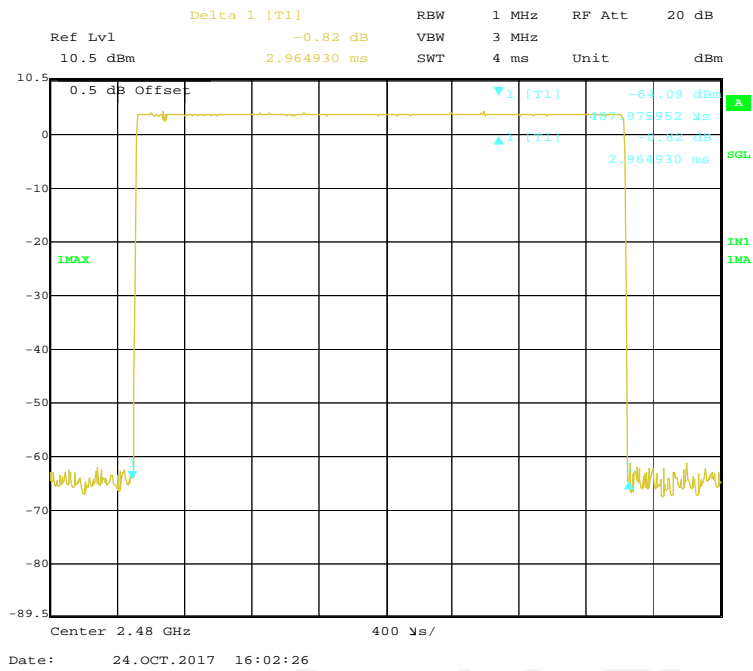
EDR (8-DPSK): Pulse time, Low Channel, 3DH5



EDR (8-DPSK): Pulse time, Middle Channel, 3DH5



EDR (8-DPSK): Pulse time, High Channel, 3DH5



FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

Test Data

Environmental Conditions

Temperature:	20.2 °C
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

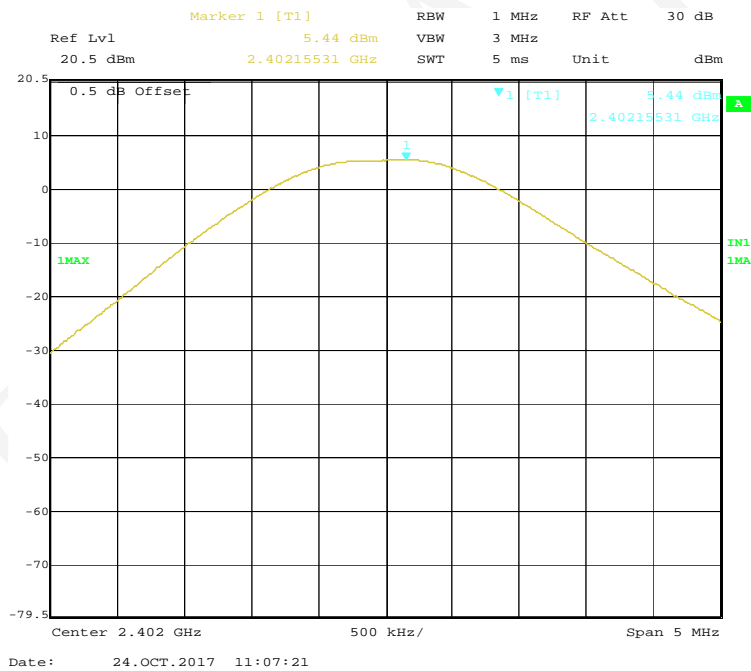
The testing was performed by Ada Yu on 2017-10-24 & 2017-11-03.

EUT operation mode: Transmitting

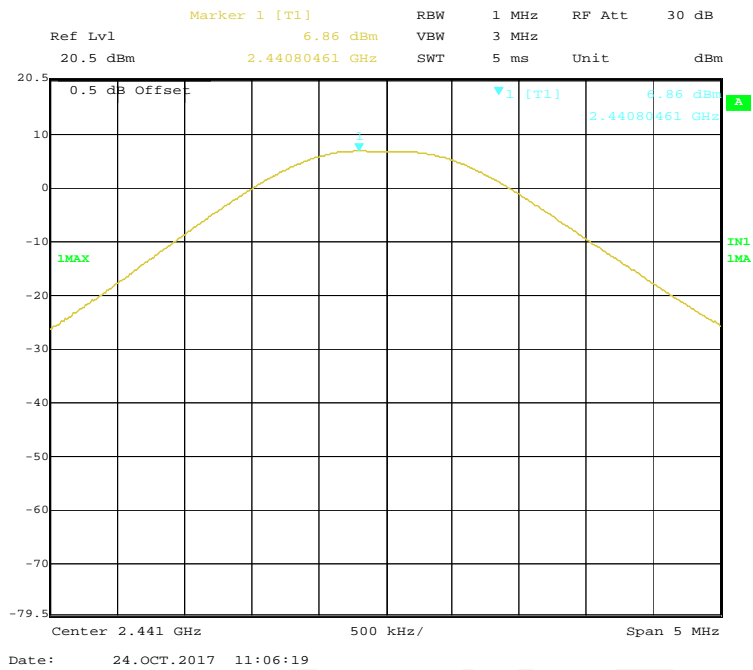
Test Result: Compliance.

Mode	Frequency (MHz)	Output Power		Limit (mW)
		(dBm)	(mW)	
BDR (GFSK)	2402	5.44	3.50	1000
	2441	6.86	4.85	1000
	2480	6.69	4.67	1000
EDR ($\pi/4$ -DQPSK)	2402	2.72	1.87	1000
	2441	4.62	2.90	1000
	2480	4.49	2.81	1000
EDR (8-DPSK)	2402	2.97	1.98	1000
	2441	4.88	3.08	1000
	2480	4.88	3.08	1000

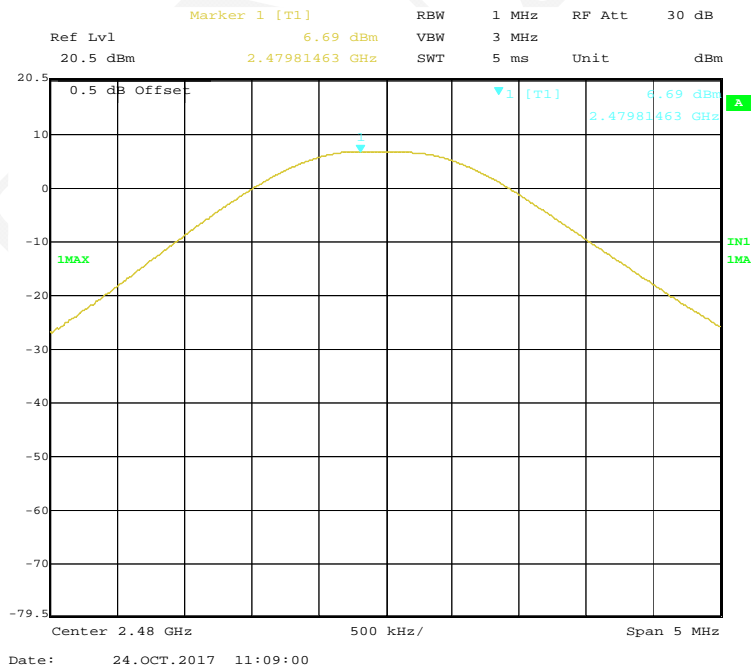
BDR (GFSK): Low Channel



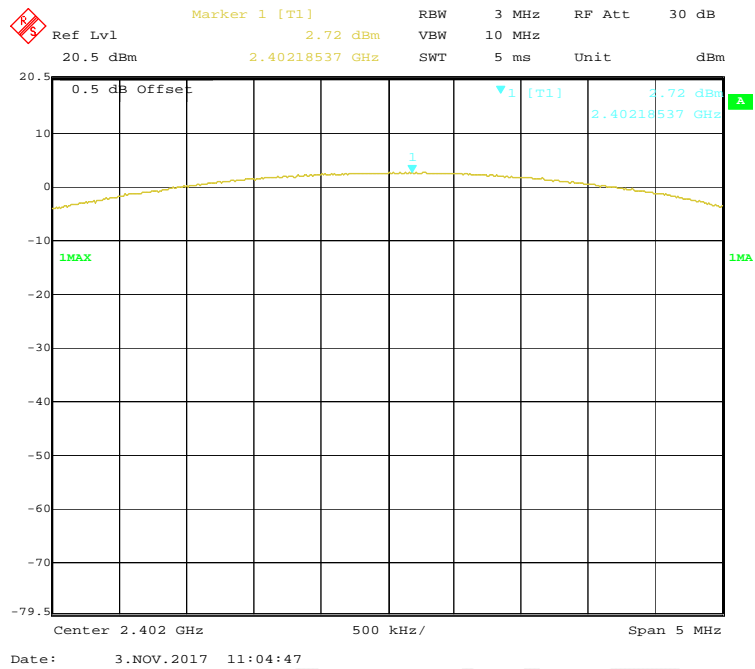
BDR (GFSK): Middle Channel



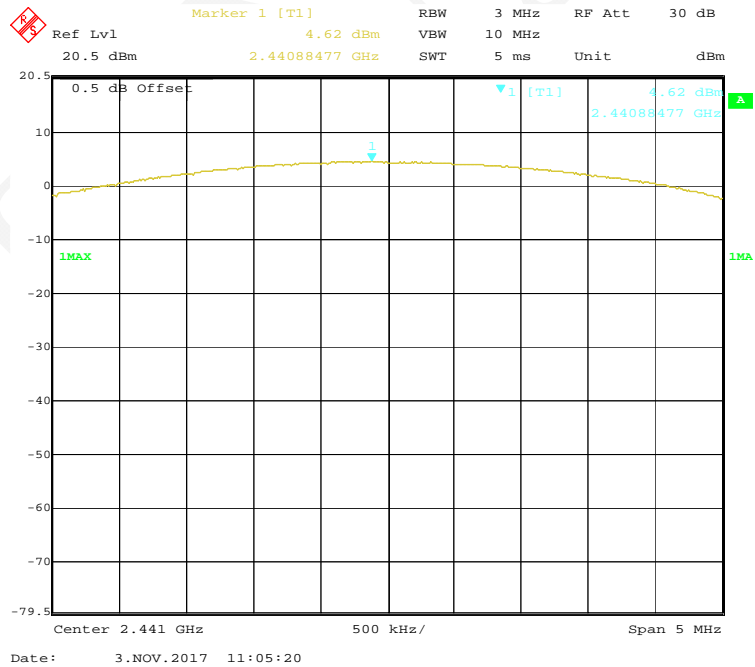
BDR (GFSK): High Channel



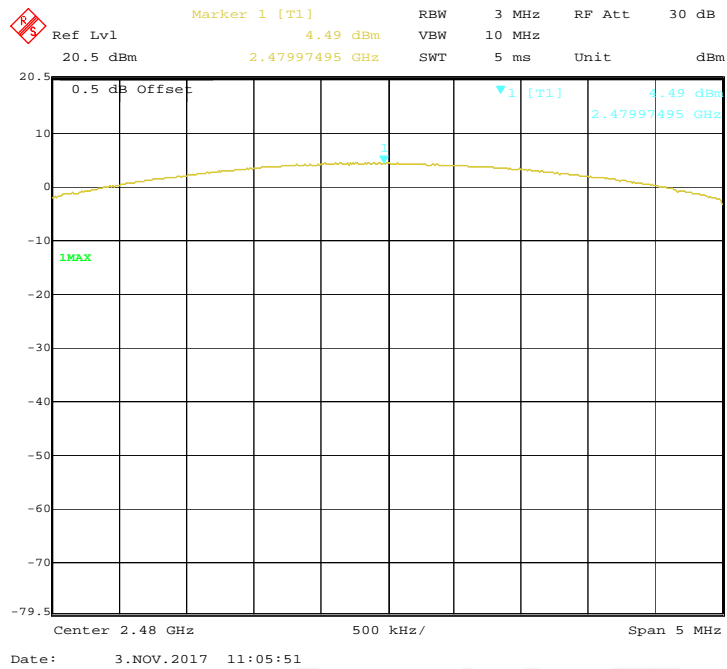
EDR($\pi/4$ -DQPSK): Low Channel



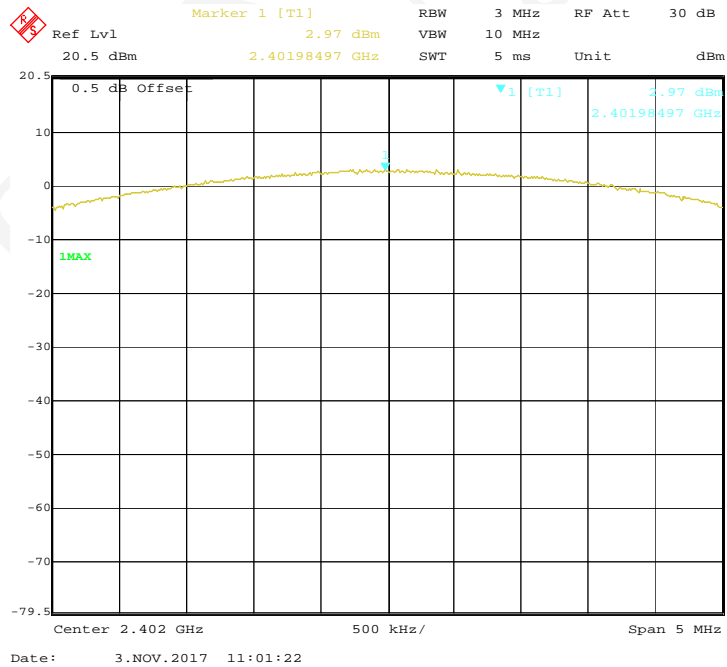
EDR($\pi/4$ -DQPSK): Middle Channel



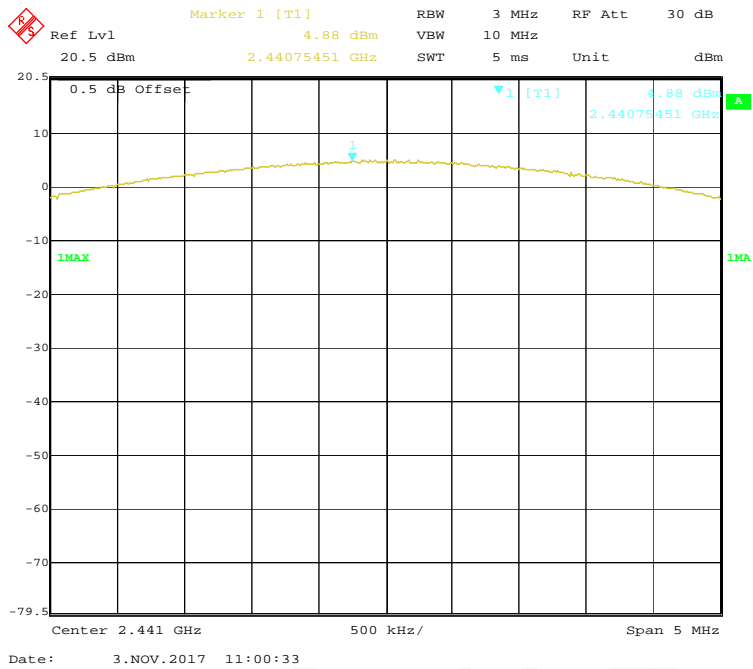
EDR($\pi/4$ -DQPSK): High Channel



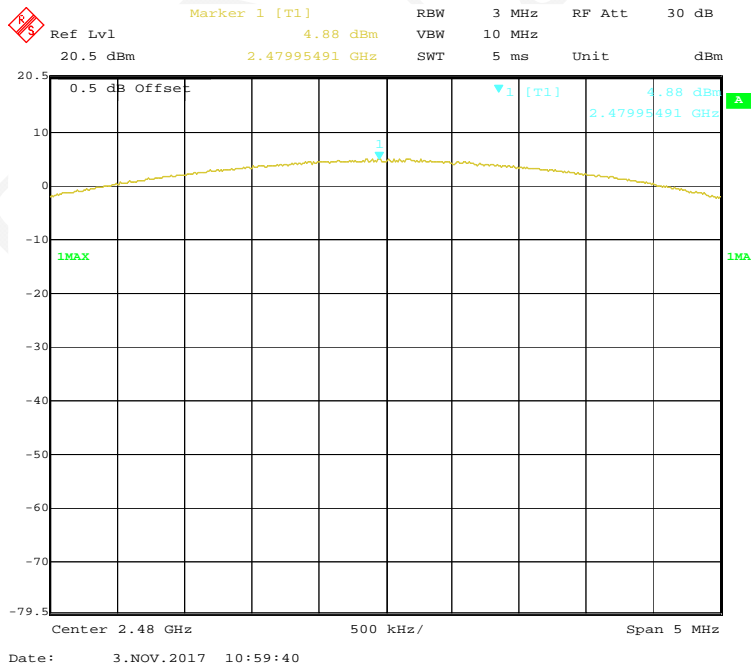
EDR(8-DPSK): Low Channel



EDR(8-DPSK): Middle Channel



EDR(8-DPSK): High Channel



FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

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

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data

Environmental Conditions

Temperature:	20.2 °C
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

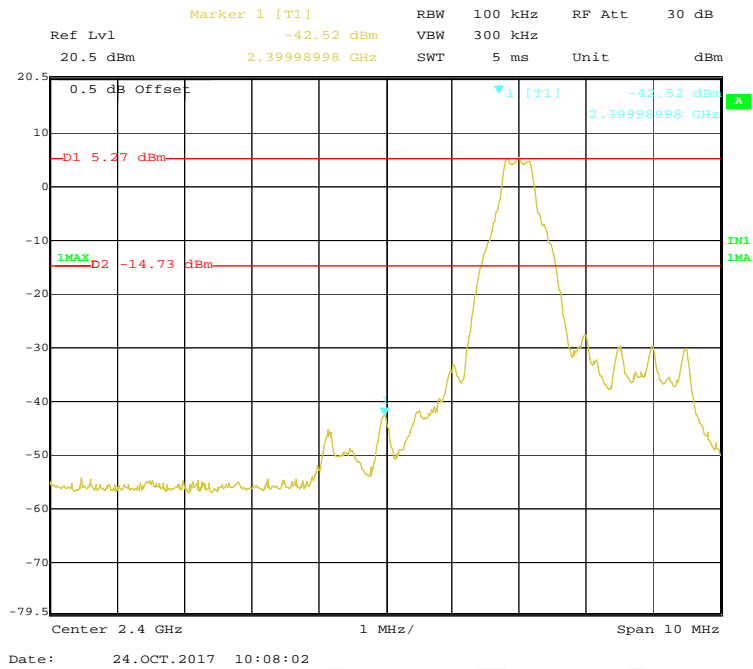
The testing was performed by Ada Yu on 2017-10-24 to 2017-10-27.

EUT operation mode: Transmitting

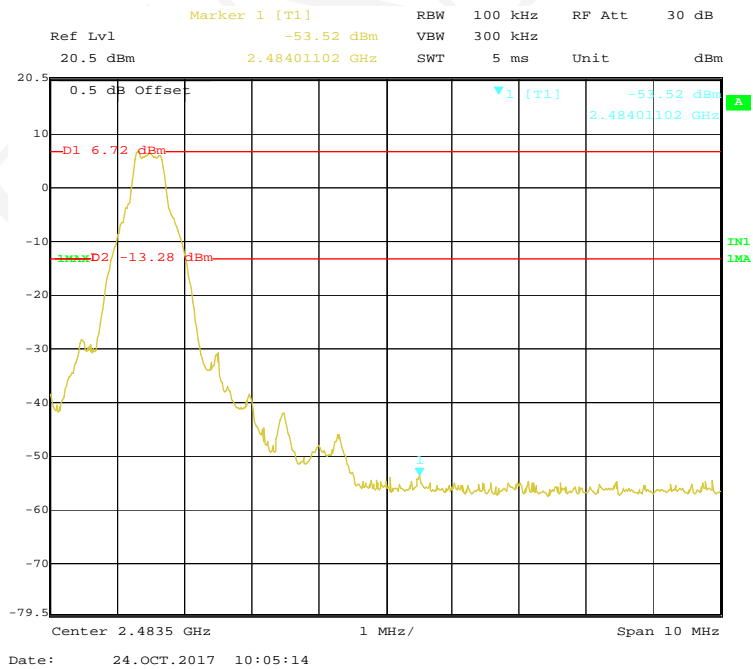
Test Result: Compliance.

Band Edge

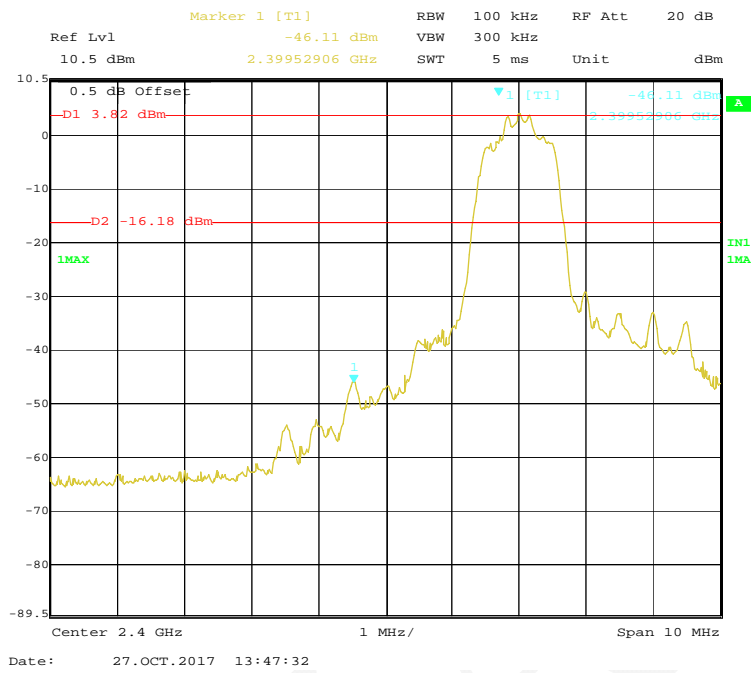
BDR (GFSK): Left Side



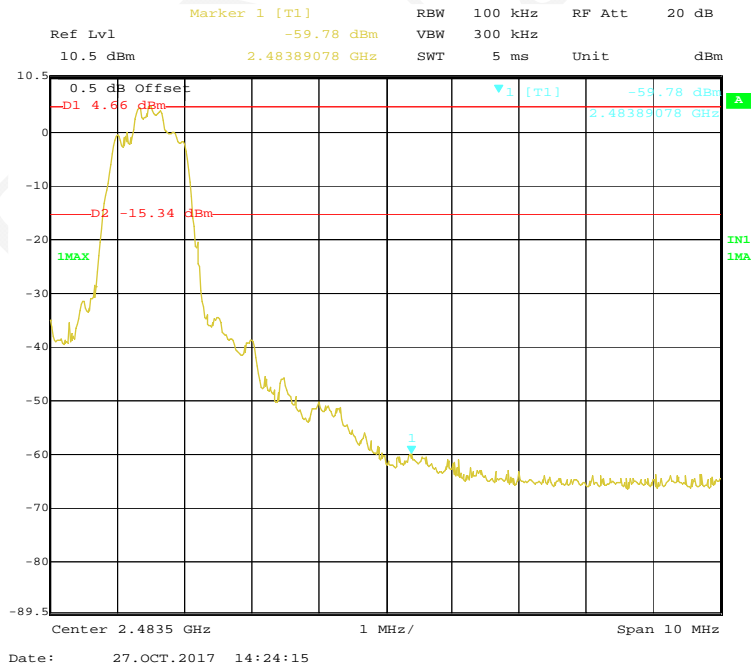
BDR (GFSK): Right Side



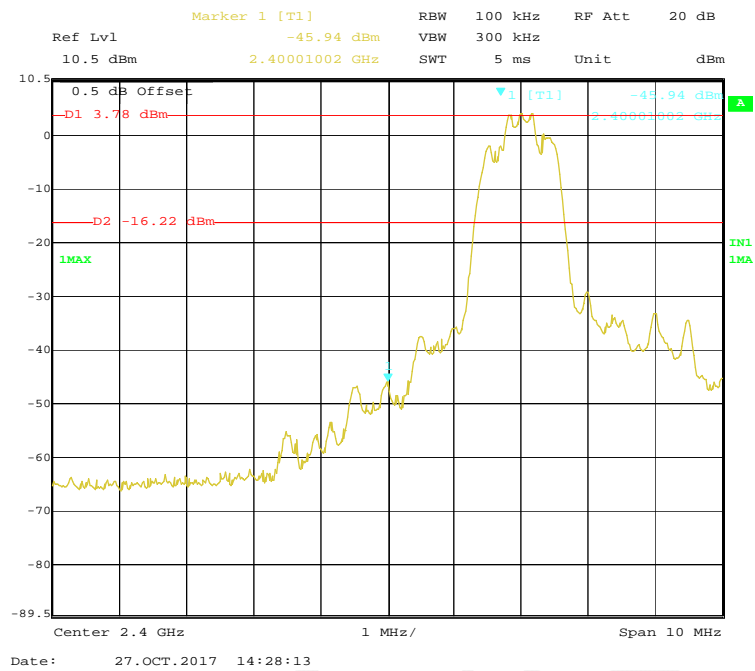
EDR ($\pi/4$ -DQPSK): Left Side



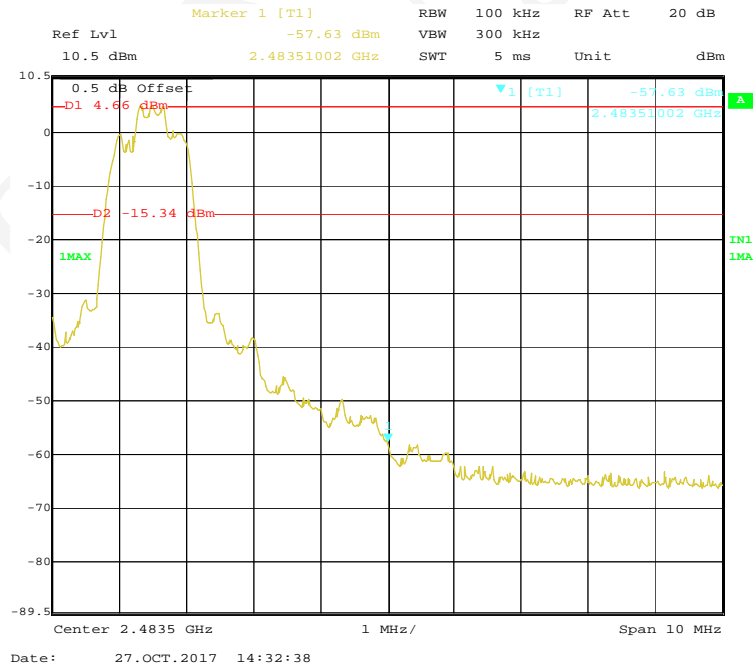
EDR ($\pi/4$ -DQPSK): Right Side



EDR (8-DPSK): Left Side

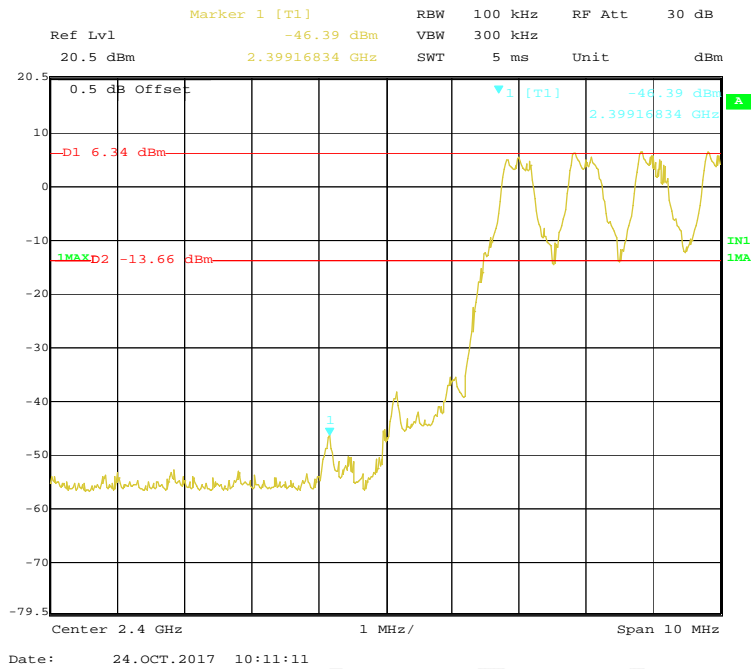


EDR (8-DPSK): Right Side

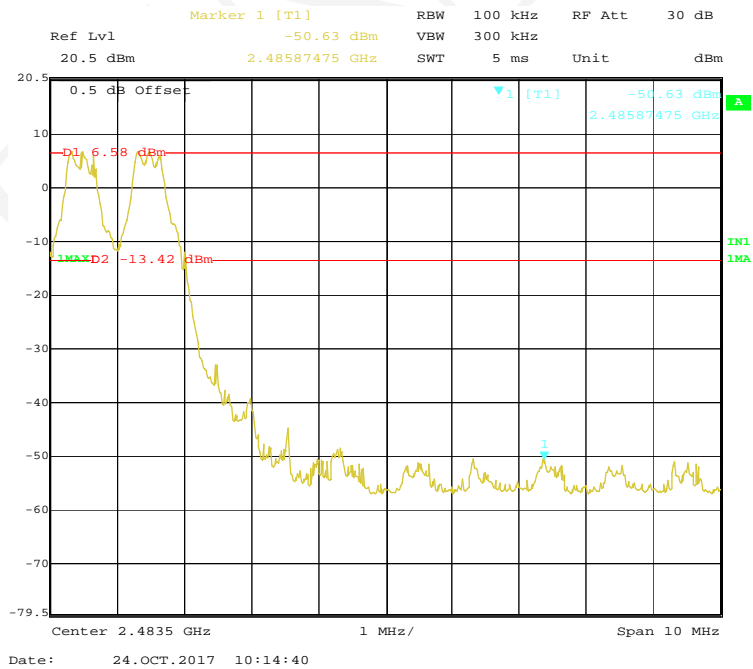


Band Edge-Hopping

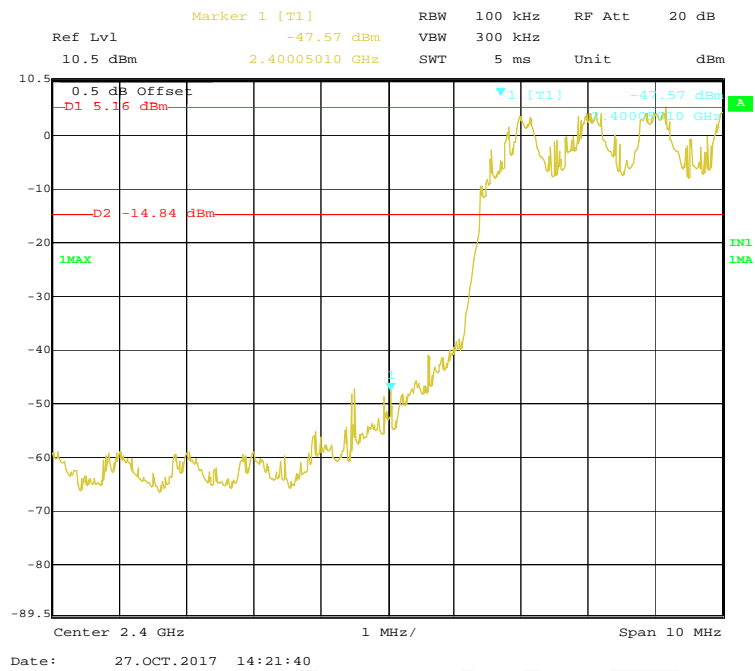
BDR (GFSK): Left Side



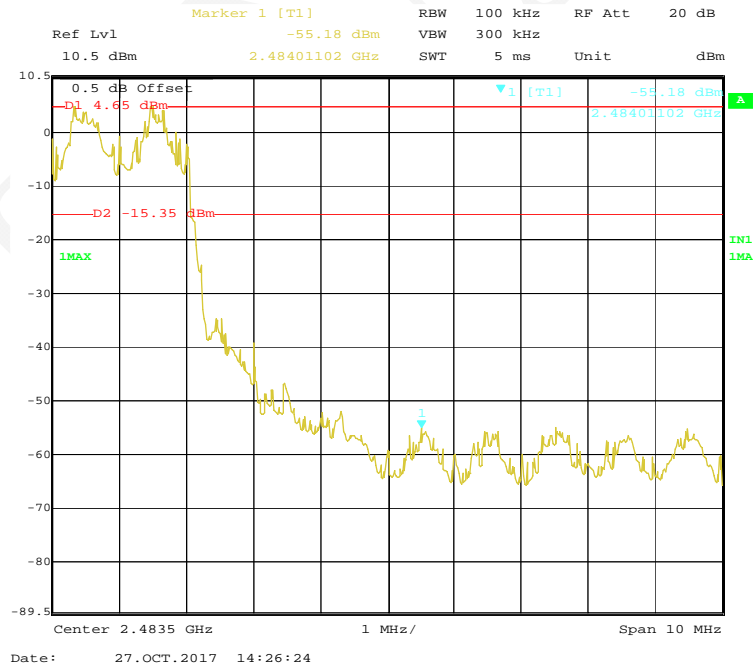
BDR (GFSK): Right Side



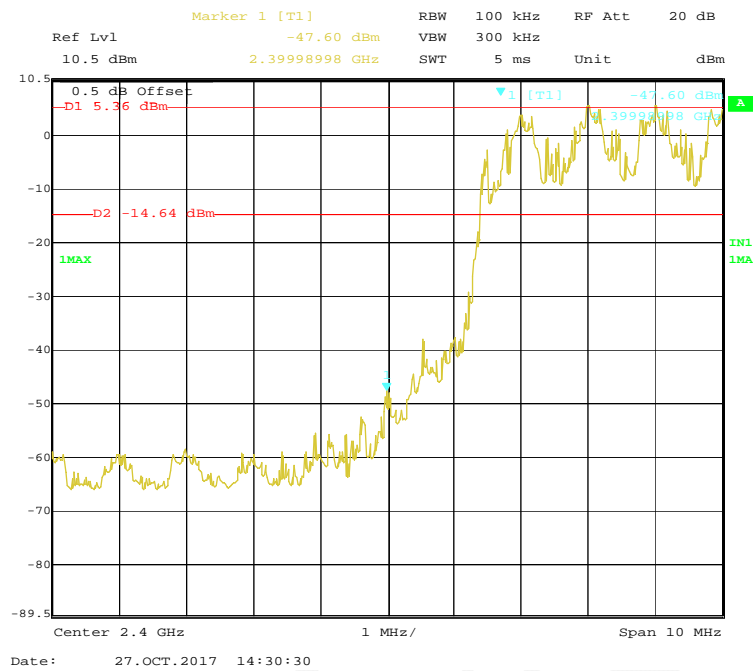
EDR ($\pi/4$ -DQPSK): Left Side



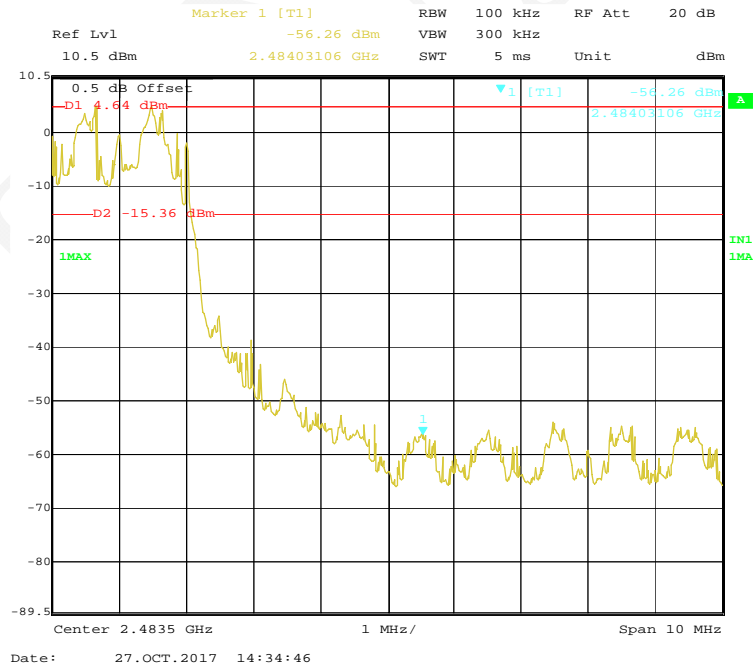
EDR ($\pi/4$ -DQPSK): Right Side



EDR (8-DPSK): Left Side



EDR (8-DPSK): Right Side



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