

FCC PART 15.247 TEST REPORT

For

Ningbo Lumiaudio Electronic Technology LTD

22/F., Building 1, Lisi Plaza, Huifeng East Road, Ningbo, China

FCC ID: 2AKKHBS

Report Type: Original Report	Product Type: LED COLOR LIGHTBULB BLUETOOTH SPEAKER
Test Engineer: Belle Cheng	<i>Belle.cheng</i>
Report Number: RKS170316021-00A	
Report Date: 2017-04-27	
Reviewed By: Oscar Ye RF Leader	<i>Oscar.Ye</i>
Prepared By:	Bay Area Compliance Laboratories Corp. (Kunshan) No.248 Chenghu Road, Kunshan, Jiangsu province, China Tel: +86-0512-86175000 Fax: +86-0512-88934268 www.baclcorp.com.cn

Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

TABLE OF CONTENTS

GENERAL INFORMATION.....	4
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT)	4
OBJECTIVE	4
RELATED SUBMITTAL(S)/GRANT(S).....	4
TEST METHODOLOGY	4
MEASUREMENT UNCERTAINTY	5
TEST FACILITY	5
SYSTEM TEST CONFIGURATION.....	6
DESCRIPTION OF TEST CONFIGURATION	6
EUT EXERCISE SOFTWARE	6
SPECIAL ACCESSORIES.....	6
EQUIPMENT MODIFICATIONS	6
SUPPORT EQUIPMENT LIST AND DETAILS	6
EXTERNAL I/O CABLE.....	6
BLOCK DIAGRAM OF TEST SETUP	7
SUMMARY OF TEST RESULTS	9
TEST EQUIPMENT LIST	10
FCC§15.247 (i), §1.1310& §2.1091 –MAXIMUM PERMISSIBLE EXPOSURE (MPE).....	11
APPLICABLE STANDARD	11
MEASUREMENT RESULT	11
FCC §15.203 – ANTENNA REQUIREMENT	12
APPLICABLE STANDARD	12
ANTENNA CONNECTOR CONSTRUCTION	12
FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS	13
APPLICABLE STANDARD	13
EUT SETUP	13
EMI TEST RECEIVER SETUP.....	13
TEST PROCEDURE	13
CORRECTED FACTOR & MARGIN CALCULATION	14
TEST RESULTS SUMMARY	14
TEST DATA	14
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS.....	17
APPLICABLE STANDARD	17
MEASUREMENT UNCERTAINTY.....	17
EUT SETUP	17
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP	18
TEST PROCEDURE	18
CORRECTED AMPLITUDE & MARGIN CALCULATION	18
TEST RESULTS SUMMARY	19
TEST DATA	20
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST	24
APPLICABLE STANDARD	24
TEST PROCEDURE	24
TEST DATA	24

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH.....	30
APPLICABLE STANDARD	30
TEST PROCEDURE	30
TEST DATA	30
FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST	36
APPLICABLE STANDARD	36
TEST PROCEDURE	36
TEST DATA	36
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....	39
APPLICABLE STANDARD	39
TEST PROCEDURE	39
TEST DATA	39
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT	55
APPLICABLE STANDARD	55
TEST PROCEDURE	55
TEST DATA	55
FCC §15.247(d) - BAND EDGES TESTING	61
APPLICABLE STANDARD	61
TEST PROCEDURE	61
TEST DATA	61

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	Ningbo Lumiaudio Electronic Technology LTD
Tested Model	BLS-01
Product Type	LED COLOR LIGHTBULB BLUETOOTH SPEAKER
Dimension	150 mm(L)×150 mm(W)×98.5 mm(H)
Power Supply	AC 100-240V

**All measurement and test data in this report was gathered from production sample serial number: 20170317002 (Assigned by the BACL. The EUT supplied by the applicant was received on 2017-03-17)*

Objective

This test report is prepared on behalf of Ningbo Lumiaudio Electronic Technology 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 Part15.247 DTS submissions with FCC ID: 2AKKHBL5.

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		3.19dB
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.

Test site at Bay Area Compliance Laboratories Corp. (Kunshan) has been fully described in reports submitted to the Federal Communication Commission (FCC). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on November 06, 2014. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 815570. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode which was controlled by the software.

EUT Exercise Software

RTLBTAPP

GFSK: Power level 0

$\pi/4$ -DQPSK: Power level 0

8DPSK: Power level 0

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

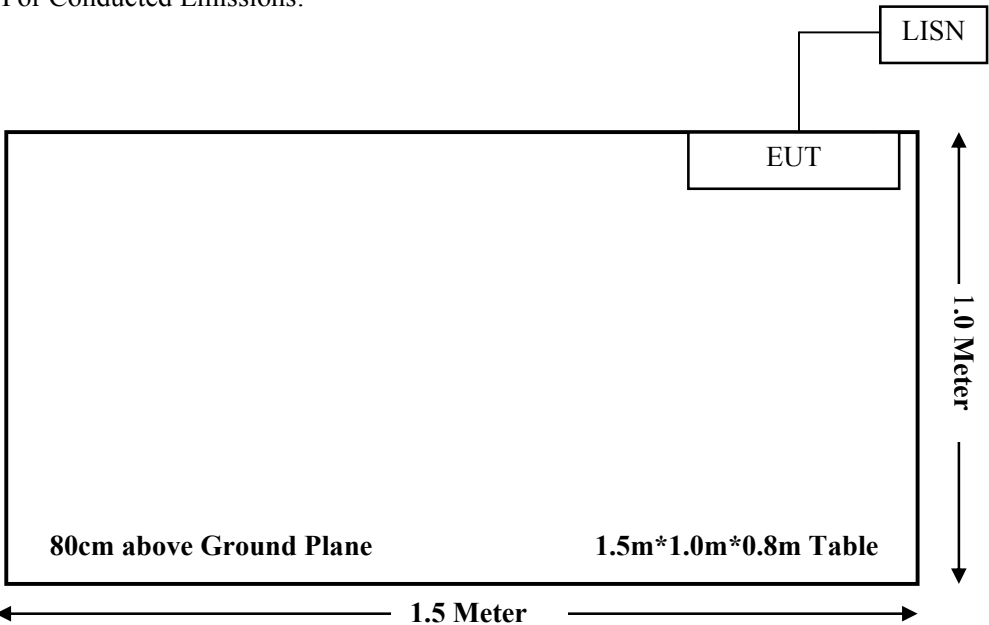
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

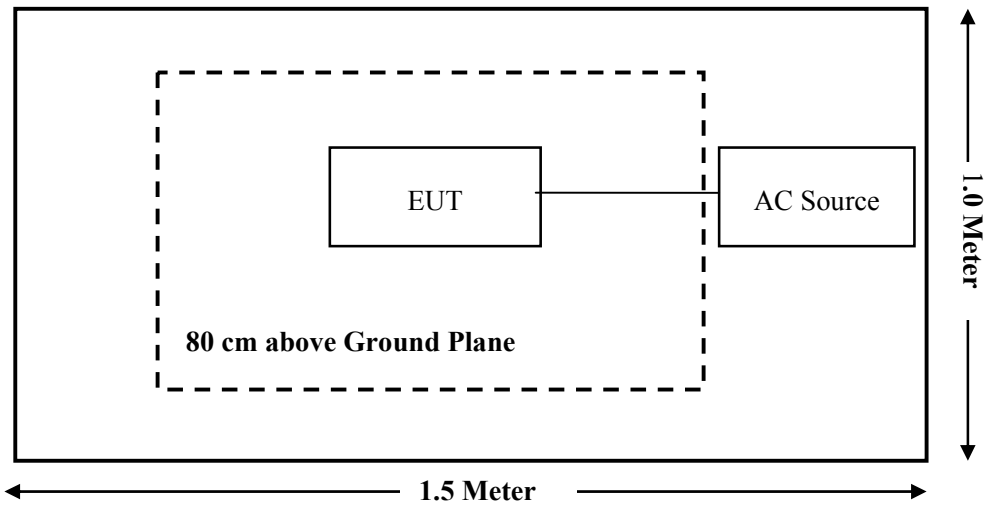
Cable Description	Shielding Type	Length (m)	From Port	To
Power Cable	Unshielding	1.2	EUT	AC Power Source

Block Diagram of Test Setup

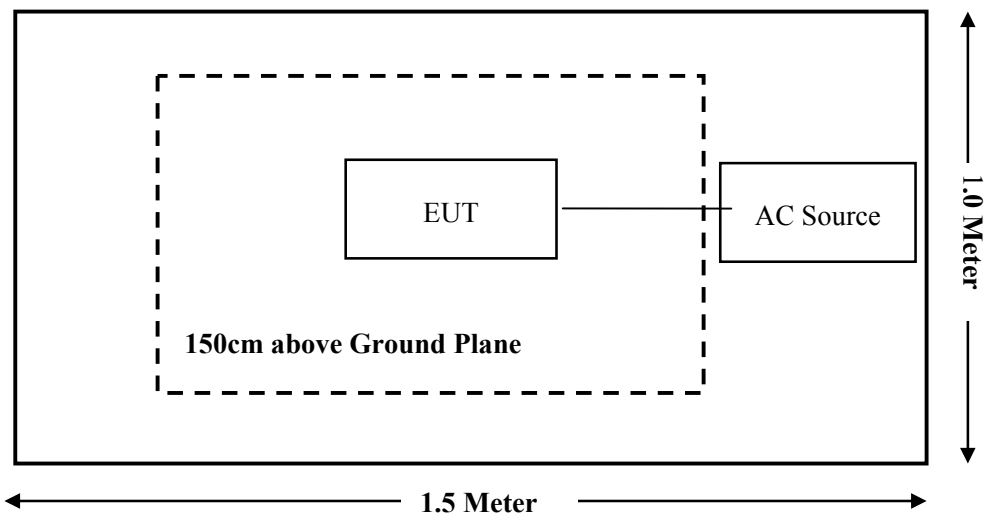
For Conducted Emissions:



For Radiated Emissions (Below 1GHz):



For Radiated Emissions (Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §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					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Rohde & Schwarz	Signal Analyzer	FSIQ26	100048	2016-11-25	2017-11-24
Sunol Sciences	Broadband Antenna	JB3	A090314-2	2016-01-09	2019-01-08
ETS	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Sonoma Instrument	Amplifier	330	171377	2016-12-12	2017-12-11
Narda	Pre-amplifier	AFS42-00101800	2001270	2016-12-12	2017-12-11
R&S	Auto test Software	EMC32	100361	/	/
Haojintech	Coaxial Cable	Cable-1	001	2016-12-12	2017-12-11
Haojintech	Coaxial Cable	Cable-2	002	2016-12-12	2017-12-11
Haojintech	Coaxial Cable	Cable-3	003	2016-12-12	2017-12-11
MICRO-COAX	Coaxial Cable	Cable-4	004	2016-12-12	2017-12-11
MICRO-COAX	Coaxial Cable	Cable-5	005	2016-12-12	2017-12-11
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2016-09-21	2017-09-20
Ningbo Lumiaudio	RF Cable	N/A	N/A	2017-03-22	2018-03-21
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Rohde & Schwarz	LISN	ESH3-Z5	862770/011	2016-10-10	2017-10-09
ROHDE&SCHWARZ	LISN	ENV216	3560655016	2016-11-25	2017-11-24
Rohde & Schwarz	CE Test software	EMC 32	100357	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2016-09-08	2017-09-07

*** 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§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.

Calculated Formulary:

Predication of MPE limit at a given distance

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

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

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

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

Measurement Result

Mode	Frequency Range	Antenna Gain		Output Power		Evaluation Distance	Power Density	MPE Limit
	(MHz)	(dBi)	(numeric)	(dBm)	(mW)	(cm)	(mW/cm ²)	(mW/cm ²)
BLE	2402-2480	-0.48	0.90	6.33	4.30	20	0.0008	1.0
BT3.0	2402-2480	-0.48	0.90	4.18	2.62	20	0.0005	1.0

Note: (1) The target output power:

BLE: 6.33dBm, which declared by the Manufacturer.

BT: 4.18dBm, which declared by the Manufacturer.

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 Bluetooth, which the antenna gain is -0.48 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

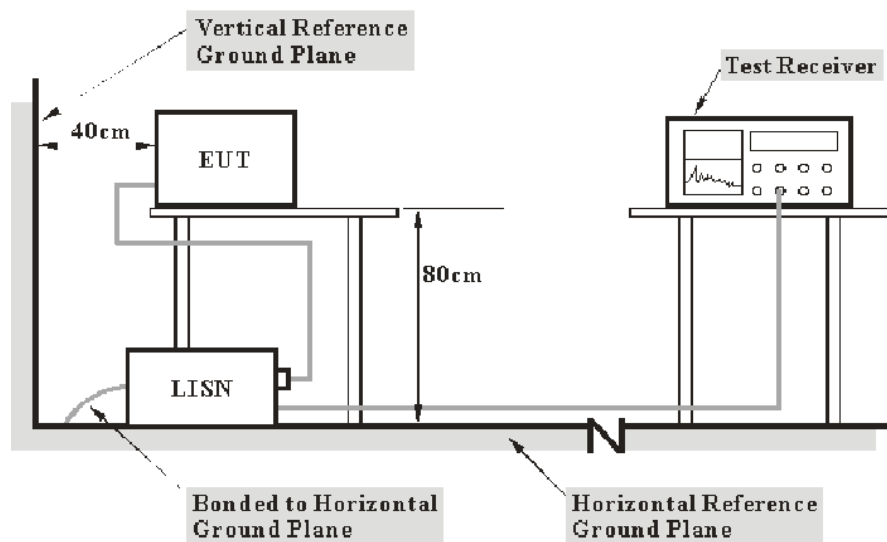
Result: Compliance.

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:

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

Test Results Summary

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

Test Data

Environmental Conditions

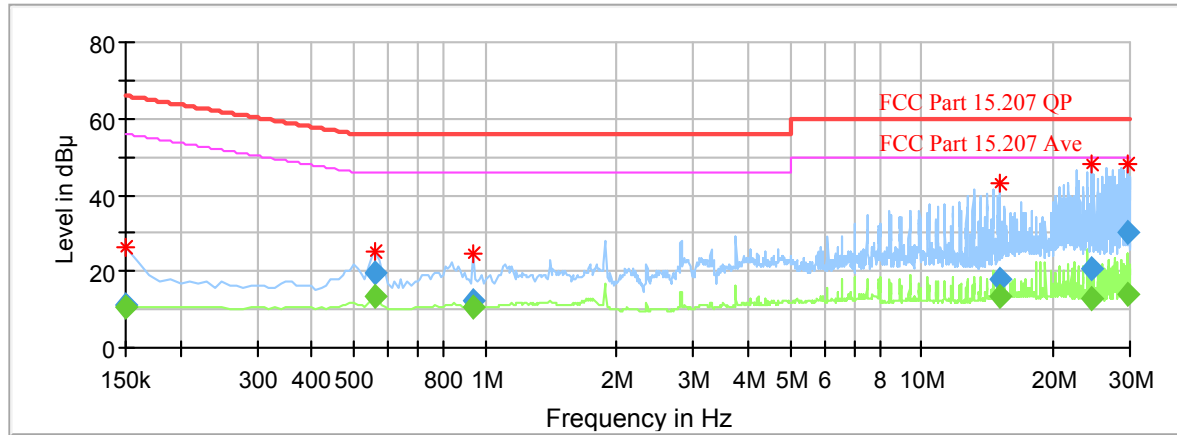
Temperature:	20.2 °C
Relative Humidity:	55 %
ATM Pressure:	101.3 kPa

The testing was performed by Belle Cheng on 2017-03-23.

EUT operation mode: Transmitting in high channel of 8-DPSK (Worst case)

AC 120V/60 Hz, Line

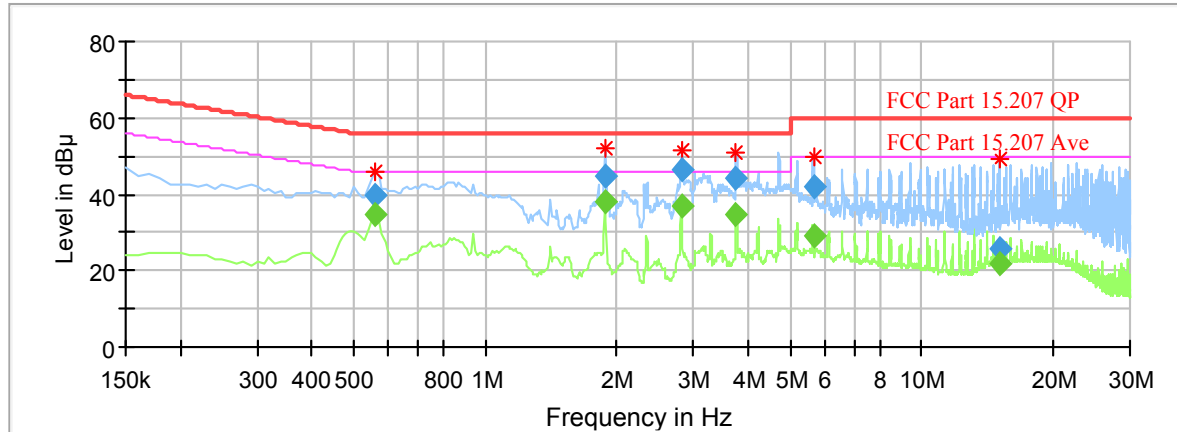
Full Spectrum



Frequency (MHz)	QuasiPeak (dBμV)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.150000	---	10.58	9.000	L1	10.0	45.42	56.00	Compliance
0.150000	11.43	---	9.000	L1	10.0	54.57	66.00	Compliance
0.560000	---	13.42	9.000	L1	9.9	32.58	46.00	Compliance
0.560000	19.54	---	9.000	L1	9.9	36.46	56.00	Compliance
0.940000	---	10.73	9.000	L1	9.8	35.27	46.00	Compliance
0.940000	12.18	---	9.000	L1	9.8	43.82	56.00	Compliance
15.030000	---	13.48	9.000	L1	10.1	36.52	50.00	Compliance
15.030000	18.05	---	9.000	L1	10.1	41.95	60.00	Compliance
24.530000	---	13.03	9.000	L1	10.4	36.97	50.00	Compliance
24.530000	20.42	---	9.000	L1	10.4	39.58	60.00	Compliance
29.630000	---	13.85	9.000	L1	10.5	36.15	50.00	Compliance
29.630000	30.21	---	9.000	L1	10.5	29.79	60.00	Compliance

AC 120V/60 Hz, Neutral

Full Spectrum



Frequency (MHz)	QuasiPeak (dBμV)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.560000	---	34.53	9.000	N	9.9	11.47	46.00	Compliance
0.560000	39.58	---	9.000	N	9.9	16.42	56.00	Compliance
1.880000	---	37.80	9.000	N	9.8	8.20	46.00	Compliance
1.880000	44.64	---	9.000	N	9.8	11.36	56.00	Compliance
2.830000	---	36.80	9.000	N	9.8	9.20	46.00	Compliance
2.830000	46.59	---	9.000	N	9.8	9.41	56.00	Compliance
3.760000	---	34.82	9.000	N	9.8	11.18	46.00	Compliance
3.760000	44.03	---	9.000	N	9.8	11.97	56.00	Compliance
5.650000	---	29.37	9.000	N	9.8	20.63	50.00	Compliance
5.650000	41.94	---	9.000	N	9.8	18.06	60.00	Compliance
15.070000	---	21.72	9.000	N	9.9	28.28	50.00	Compliance
15.070000	25.72	---	9.000	N	9.9	34.28	60.00	Compliance

Note:

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

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

Applicable Standard

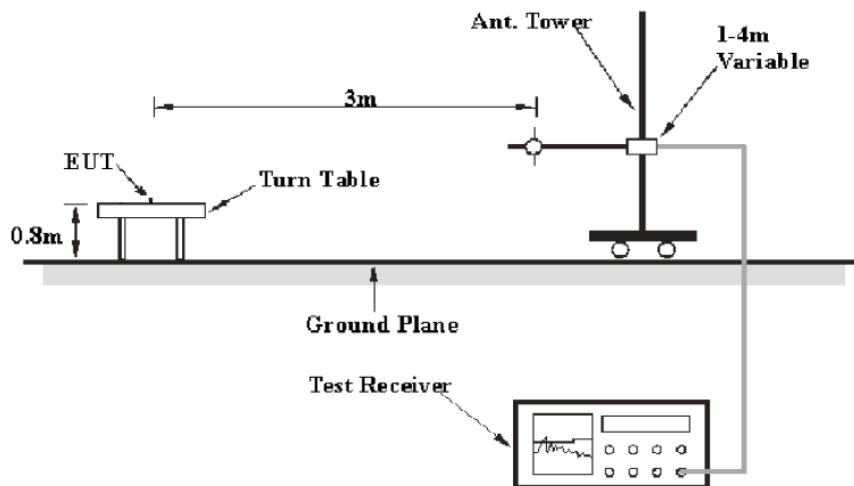
FCC §15.205; §15.209; §15.247(d)

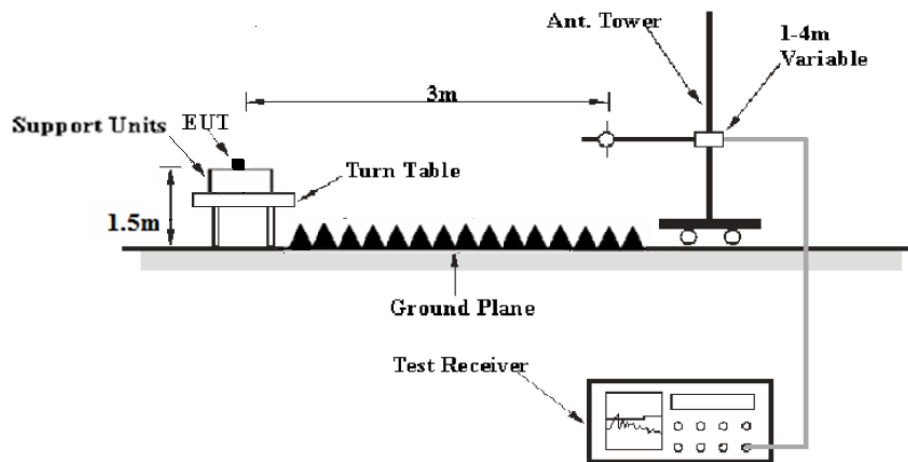
Measurement Uncertainty

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 & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Detector
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP

Frequency Range	RBW	Video B/W	Detector
1GHz – 25GHz	1MHz	3 MHz	PK
	1MHz	10 Hz	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 and 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:	55 %
ATM Pressure:	101.3 kPa

The testing was performed by Belle Cheng on 2017-03-23.

EUT operation mode: Transmitting

30MH -25 GHz: (Scan with GFSK, $\pi/4$ -DQPSK, 8-DPSK mode, the worst case is 8-DPSK Mode)

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/Ave.)		Height (cm)	Polar (H/V)			Limit (dB μ V/m)	Margin (dB)
Low Channel (2402 MHz)									
47.49	37.10	QP	147	197	V	-9.00	28.10	40.00	11.90
2402.00	100.78	PK	146	135	V	-6.19	94.59	/	/
2402.00	92.07	Ave	146	135	V	-6.19	85.88	/	/
2402.00	99.83	PK	275	120	H	-6.19	93.64	/	/
2402.00	90.94	Ave	275	120	H	-6.19	84.75	/	/
2361.00	49.48	PK	141	158	V	-6.28	43.20	74.00	30.80
2361.00	42.01	Ave	141	158	V	-6.28	35.73	54.00	18.27
2400.00	53.33	PK	309	129	H	-6.19	47.14	74.00	26.86
2400.00	42.06	Ave	309	129	H	-6.19	35.87	54.00	18.13
1200.00	51.02	PK	345	213	V	-11.25	39.77	74.00	34.23
1200.00	43.12	Ave	345	213	V	-11.25	31.87	54.00	22.13
4804.00	54.89	PK	34	138	H	1.61	56.50	74.00	17.50
4804.00	45.04	Ave	34	138	H	1.61	46.65	54.00	7.35
7206.00	41.52	PK	52	136	H	7.55	49.07	74.00	24.93
7206.00	33.01	Ave	52	136	H	7.55	40.56	54.00	13.44

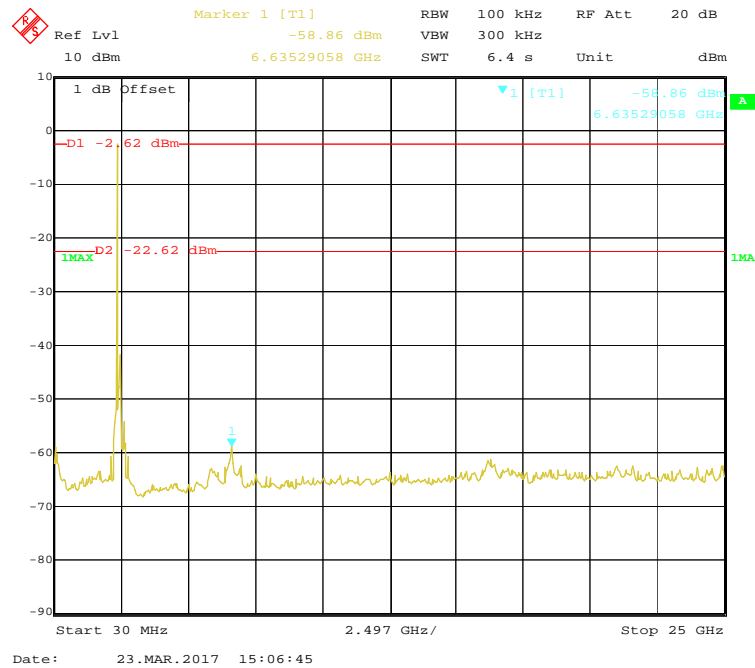
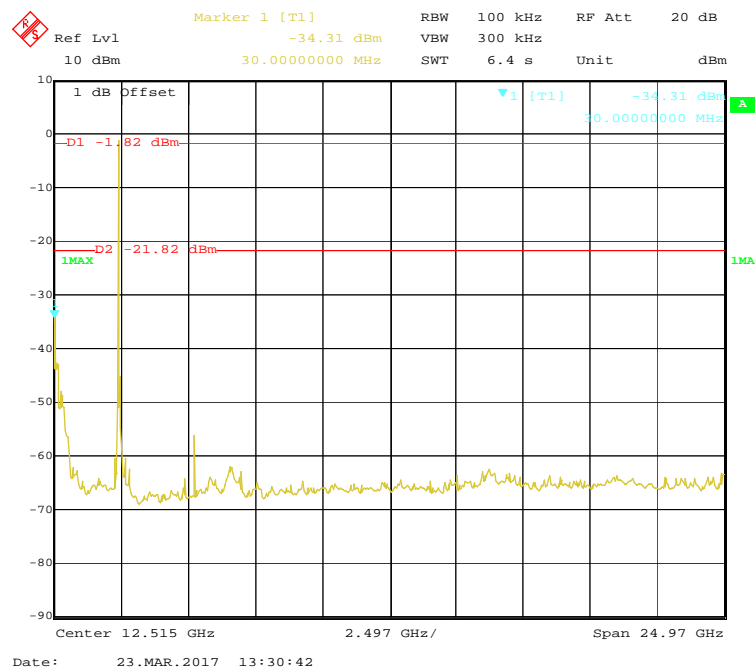
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/Ave.)		Height (cm)	Polar (H/V)			Limit (dB μ V/m)	Margin (dB)
Middle Channel (2441 MHz)									
208.84	30.80	QP	123	108	V	5.90	36.70	43.5	6.8
2441.00	103.15	PK	254	180	V	-6.17	96.98	/	/
2441.00	94.46	Ave	254	180	V	-6.17	88.29	/	/
2441.00	101.89	PK	172	110	H	-6.17	95.72	/	/
2441.00	93.21	Ave	172	110	H	-6.17	87.04	/	/
2540.00	41.28	PK	188	183	H	-5.75	35.53	74.00	38.47
2540.00	34.49	Ave	188	183	H	-5.75	28.74	54.00	25.26
4882.00	53.26	PK	85	166	H	1.97	55.23	74.00	18.77
4882.00	47.25	Ave	85	166	H	1.97	49.22	54.00	4.78
1449.00	51.58	PK	322	177	V	-9.76	41.82	74.00	32.18
1449.00	42.49	Ave	322	177	V	-9.76	32.73	54.00	21.27
6631.00	42.19	PK	64	181	H	6.39	48.58	74.00	25.42
6631.00	38.49	Ave	64	181	H	6.39	44.88	54.00	9.12
7323.00	40.84	PK	178	153	H	7.67	48.51	74.00	25.49
7323.00	32.49	Ave	178	153	H	7.67	40.16	54.00	13.84
High Channel (2480MHz)									
574.29	31.20	QP	236	215	V	1.90	33.10	46.00	12.90
2480.00	104.15	PK	270	240	V	-6.01	98.14	/	/
2480.00	95.88	Ave	270	240	V	-6.01	89.87	/	/
2480.00	103.36	PK	339	193	H	-6.01	97.35	/	/
2480.00	94.85	Ave	339	193	H	-6.01	88.84	/	/
2483.50	40.38	PK	86	126	H	-6.00	34.38	74.00	39.62
2483.50	32.52	Ave	86	126	H	-6.00	26.52	54.00	27.48
1442.00	38.58	PK	245	156	V	-9.37	29.21	74.00	44.79
1442.00	31.58	Ave	245	156	V	-9.37	22.21	54.00	31.79
4960.00	56.99	PK	226	126	H	1.97	58.96	74.00	15.04
4960.00	48.78	Ave	226	126	H	1.97	50.75	54.00	3.25
6621.00	45.60	PK	95	193	H	6.36	51.96	74.00	22.04
6621.00	39.89	Ave	95	193	H	6.36	46.25	54.00	15.04
7440.00	42.57	PK	34	192	H	7.79	50.36	74.00	22.04
7440.00	31.58	Ave	34	192	H	7.79	39.37	54.00	14.63

Note:

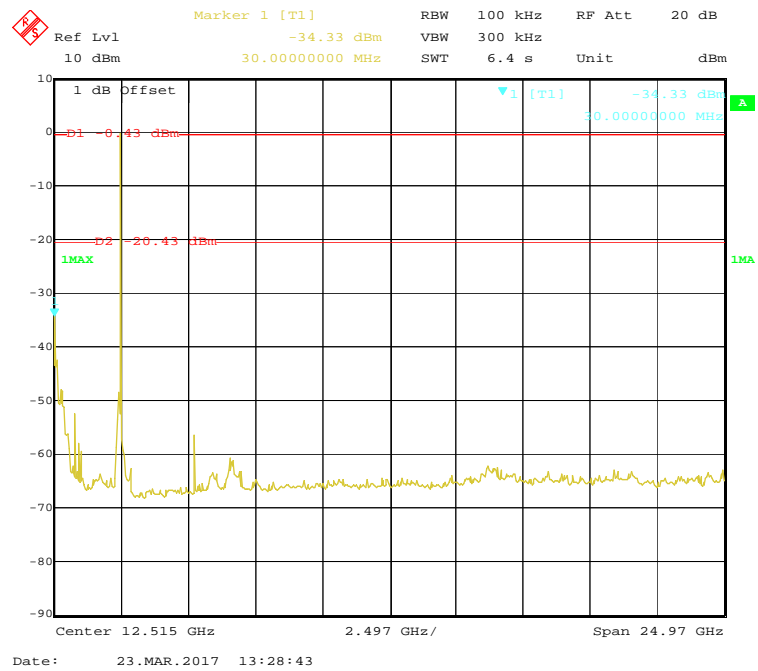
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

Spurious Emissions at Antenna Port:**Low Channel****Middle Channel**

High Channel



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:	55 %
ATM Pressure:	101.3 kPa

The testing was performed by Belle Cheng on 2017-03-24.

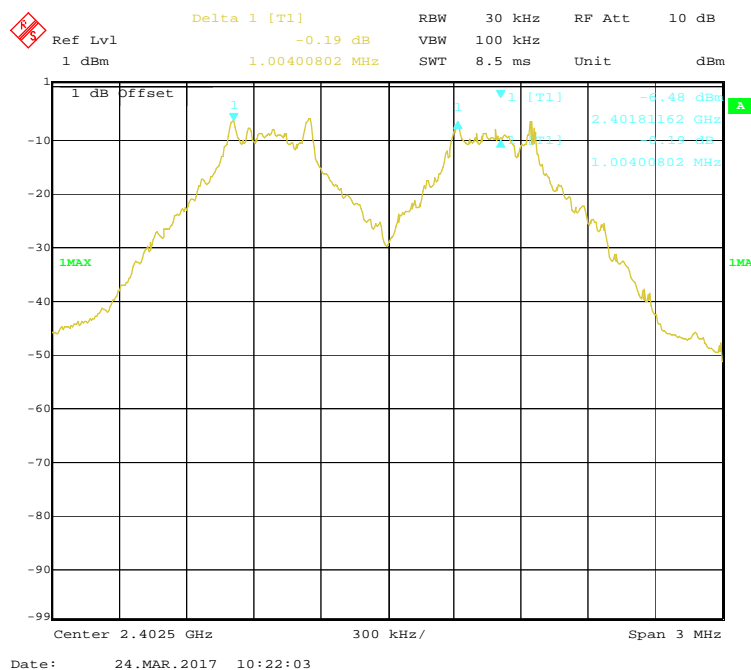
EUT operation mode: Transmitting

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

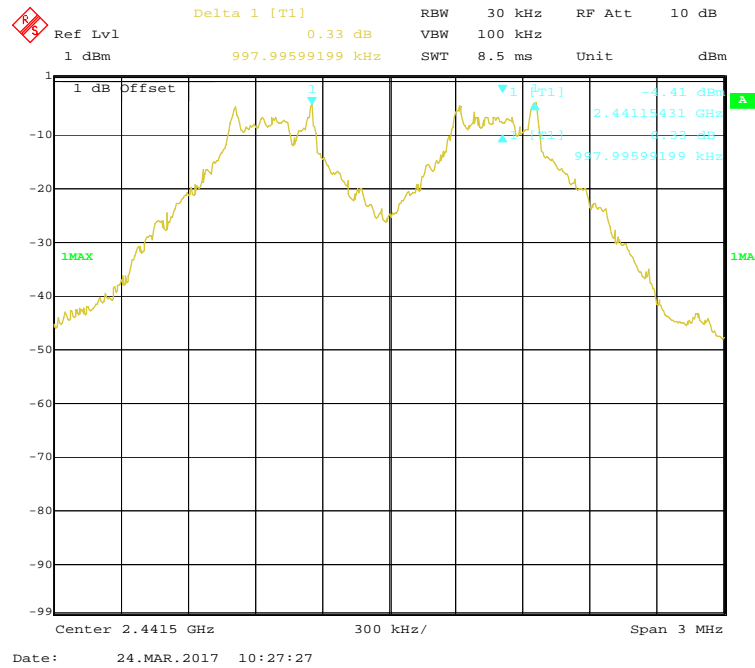
Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Result
BDR (GFSK)	Low	2402	1.004	Pass
	Adjacent	2403		
	Middle	2441	0.998	Pass
	Adjacent	2442		
	High	2480	1.004	Pass
	Adjacent	2479		
EDR ($\pi/4$-DQPSK)	Low	2402	1.004	Pass
	Adjacent	2403		
	Middle	2441	1.004	Pass
	Adjacent	2442		
	High	2480	0.998	Pass
	Adjacent	2479		
EDR (8DPSK)	Low	2402	0.998	Pass
	Adjacent	2403		
	Middle	2441	1.010	Pass
	Adjacent	2442		
	High	2480	0.992	Pass
	Adjacent	2479		

Note: Limit = 20 dB bandwidth

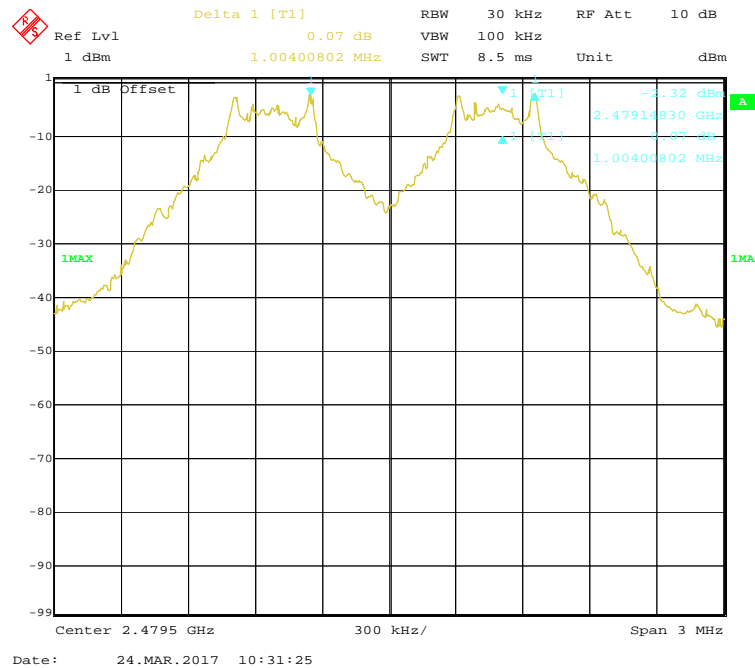
BDR (GFSK): Low Channel



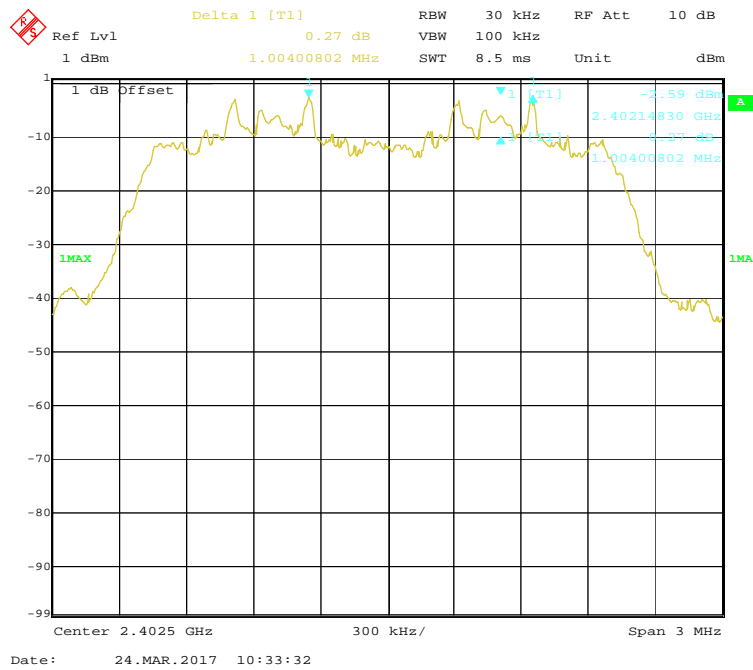
BDR (GFSK): Middle Channel



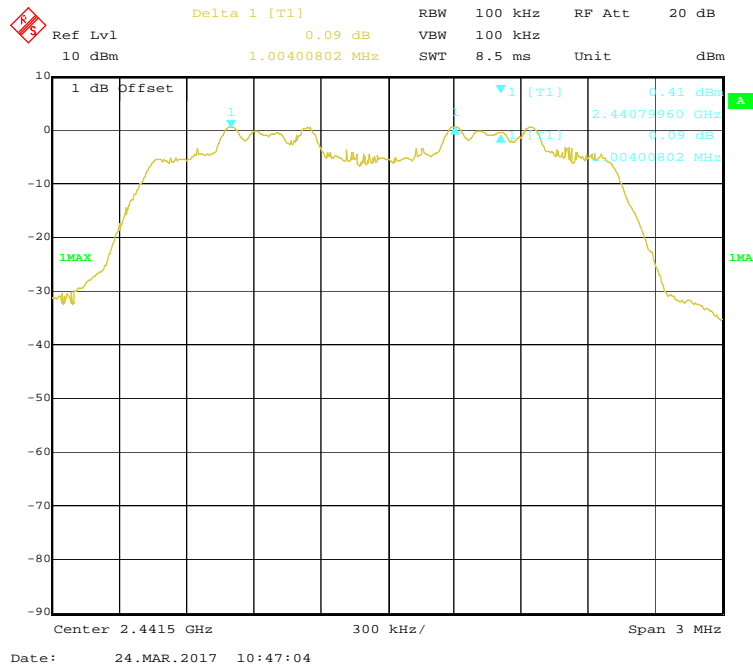
BDR (GFSK): High Channel



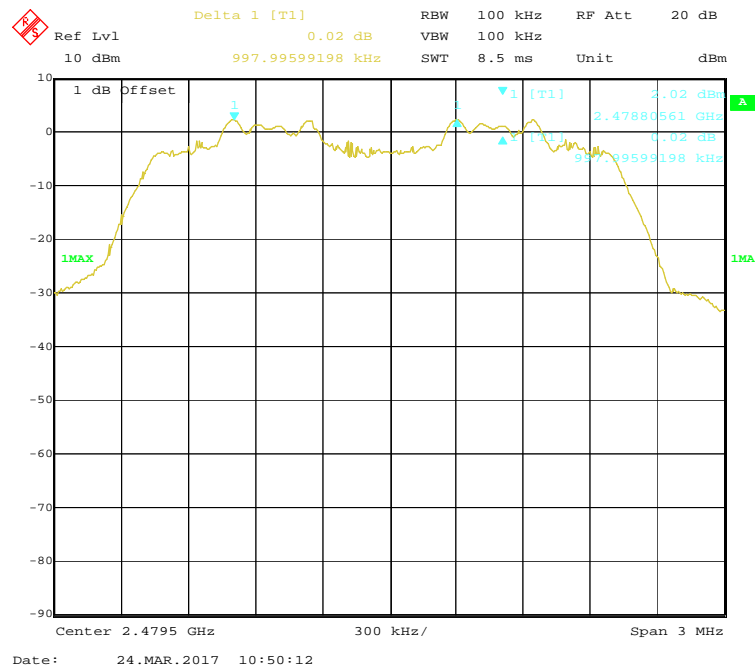
EDR ($\pi/4$ -DQPSK): Low Channel



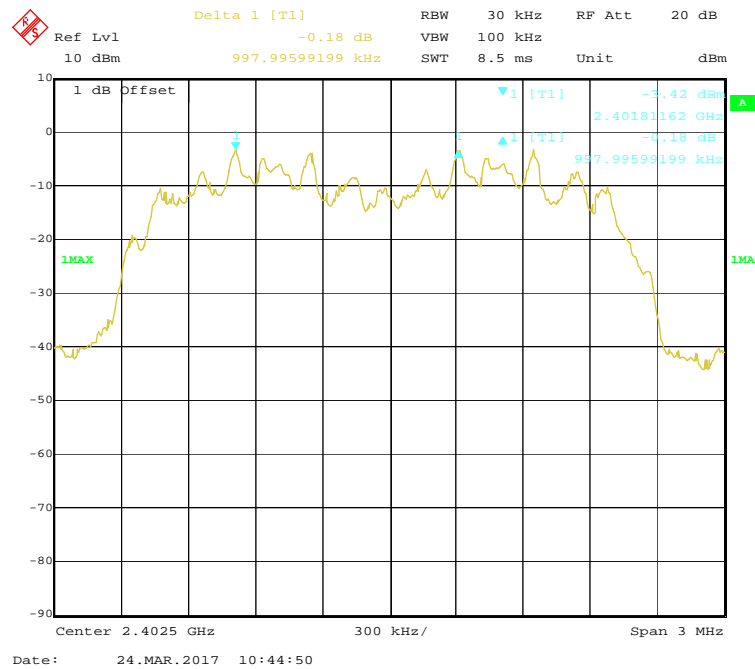
EDR ($\pi/4$ -DQPSK): Middle Channel



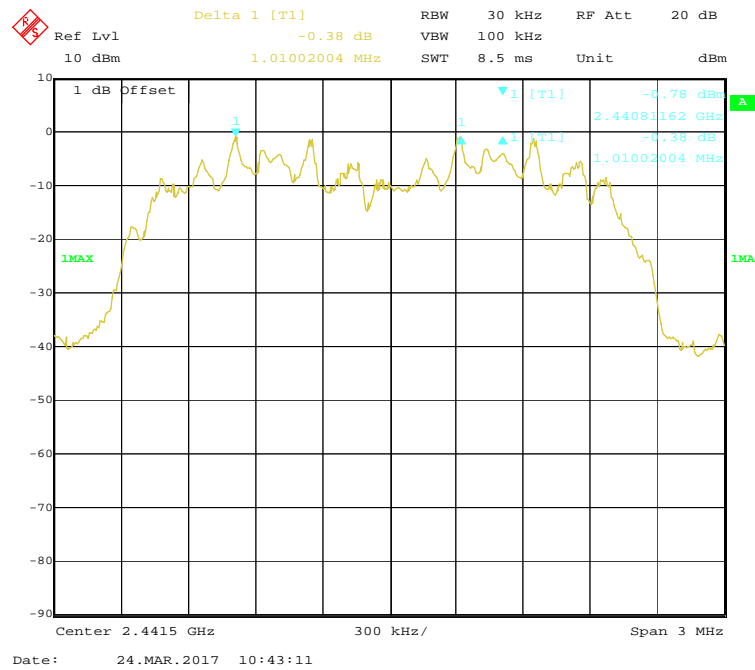
EDR ($\pi/4$ -DQPSK): High Channel



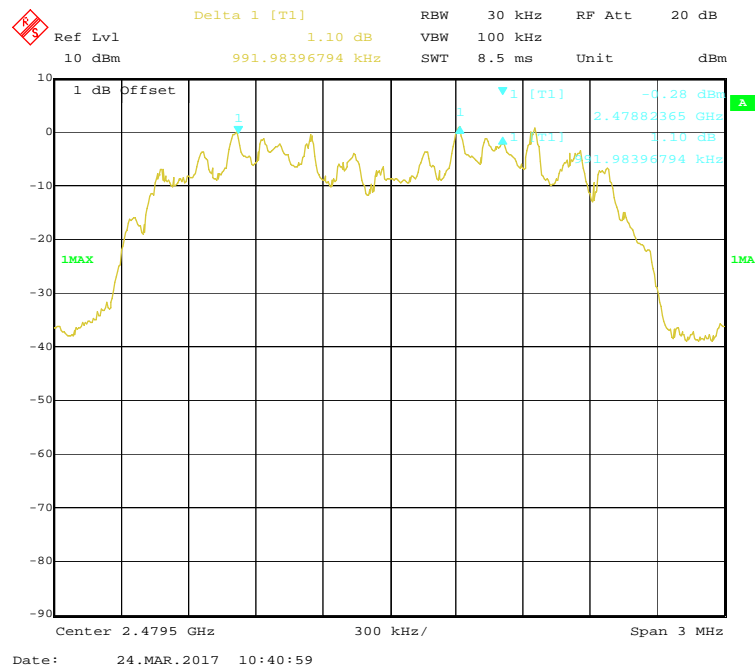
EDR (8DPSK): Low Channel



EDR (8DPSK): Middle Channel



EDR (8DPSK): 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 Belle Cheng on 2017-03-22.

EUT operation mode: Transmitting

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

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	1.05
	Middle	2441	1.06
	High	2480	1.05
EDR ($\pi/4$-DQPSK)	Low	2402	1.38
	Middle	2441	1.38
	High	2480	1.39
EDR (8DPSK)	Low	2402	1.32
	Middle	2441	1.33
	High	2480	1.33

Delta 1 [T1] -0.35 dB RBW 30 kHz RF Att 20 dB

Ref Lvl 11 dBm VBW 100 kHz

11 dBm 1.04609218 MHz SWT 8.5 ms Unit dBm

1 dB Offset

1 [T1] -26.02 dBm

2.40146192 GHz

D1 -6.36 dBm

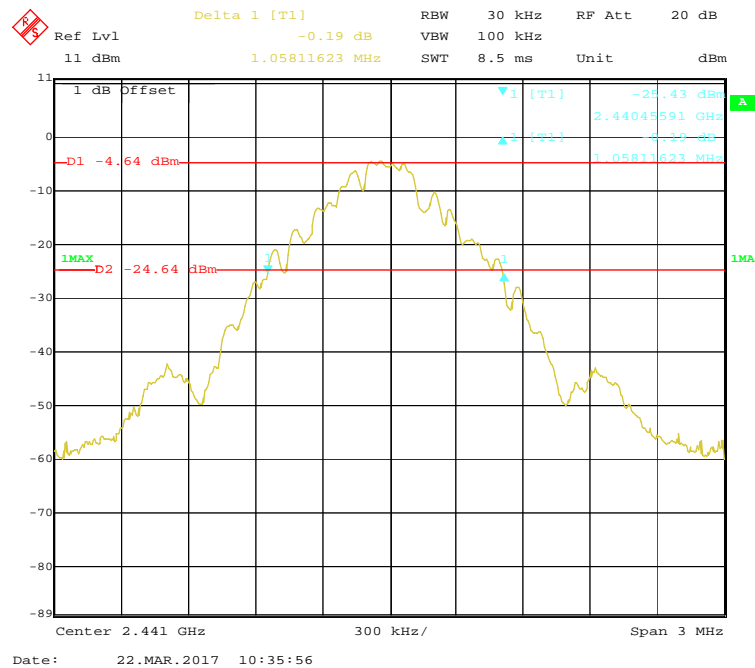
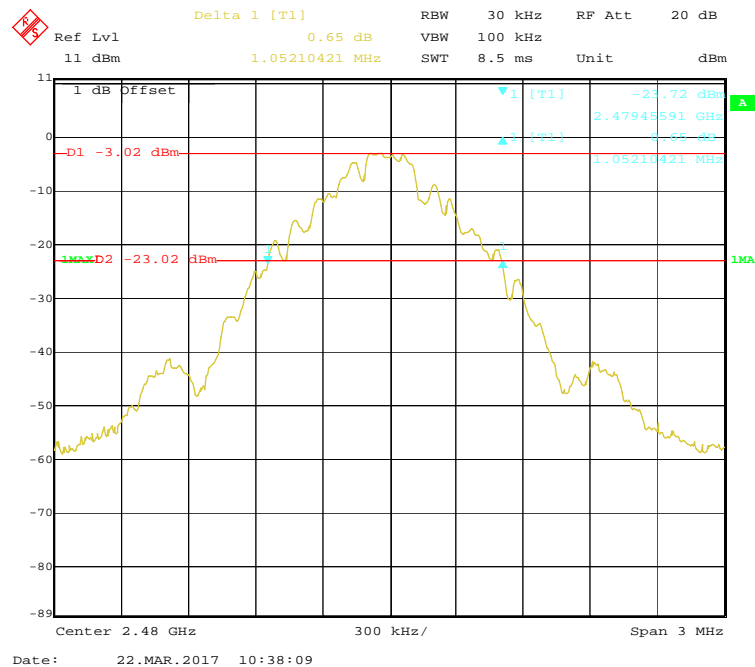
1MAX

D2 -26.36 dBm

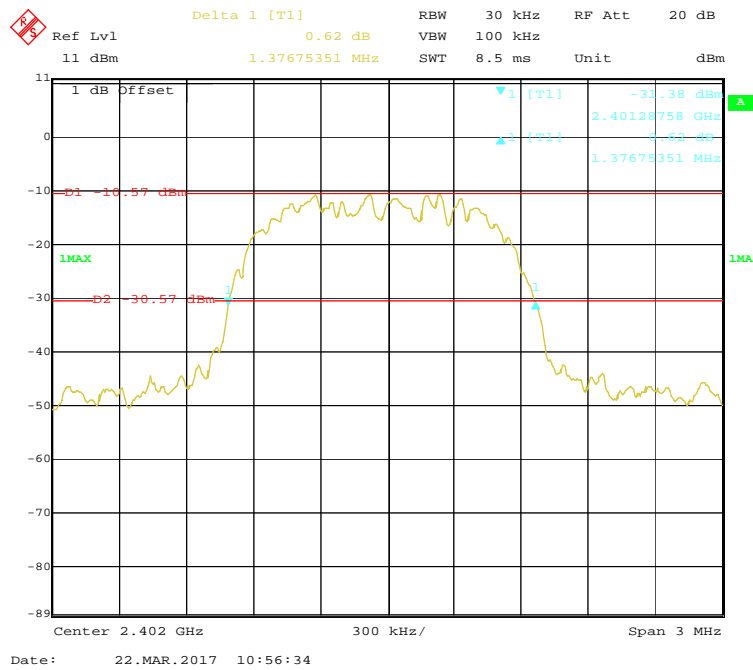
1MAX

Center 2.402 GHz 300 kHz/ Span 3 MHz

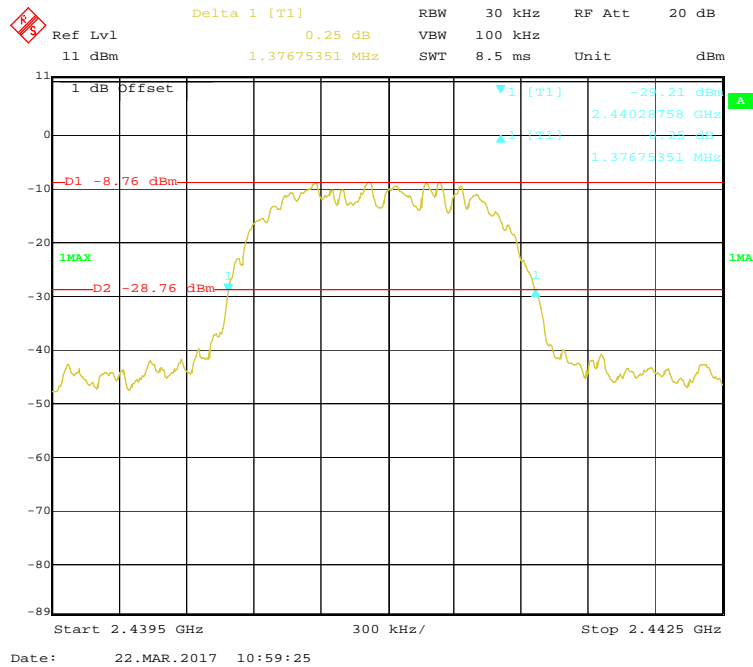
Date: 22.MAR.2017 10:31:56

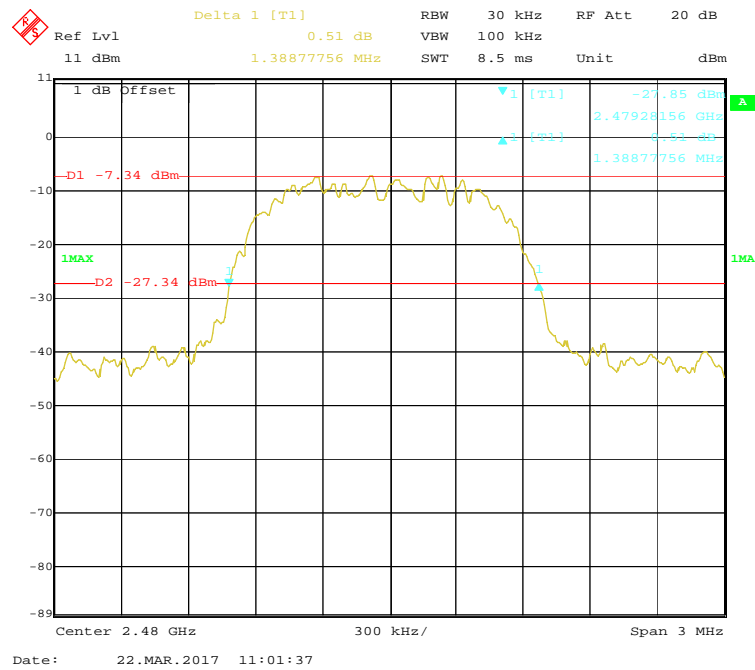
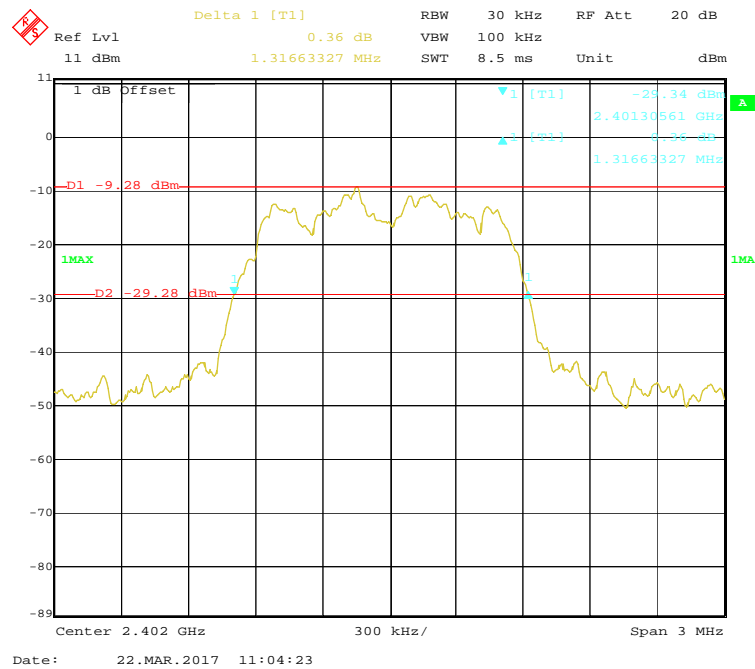
BDR (GFSK): Middle Channel**BDR (GFSK): High Channel**

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

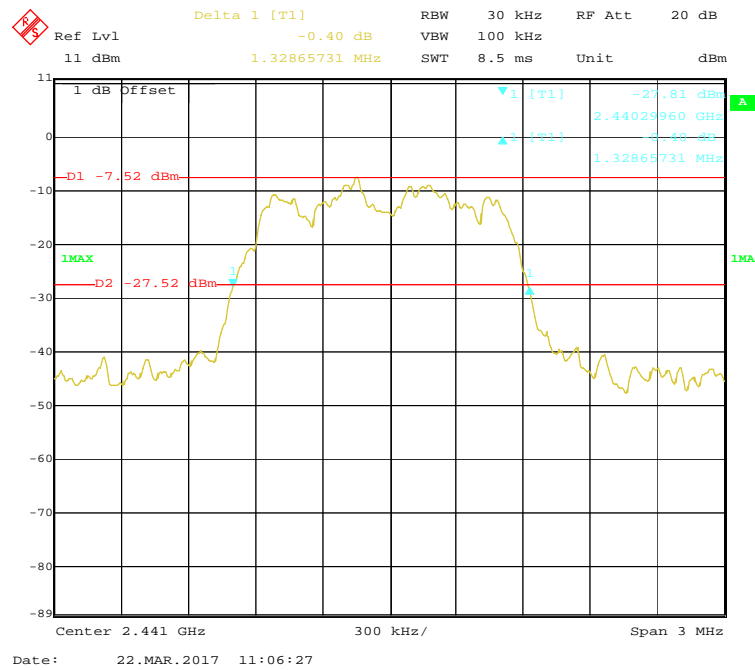


EDR($\pi/4$ -DQPSK): Middle Channel

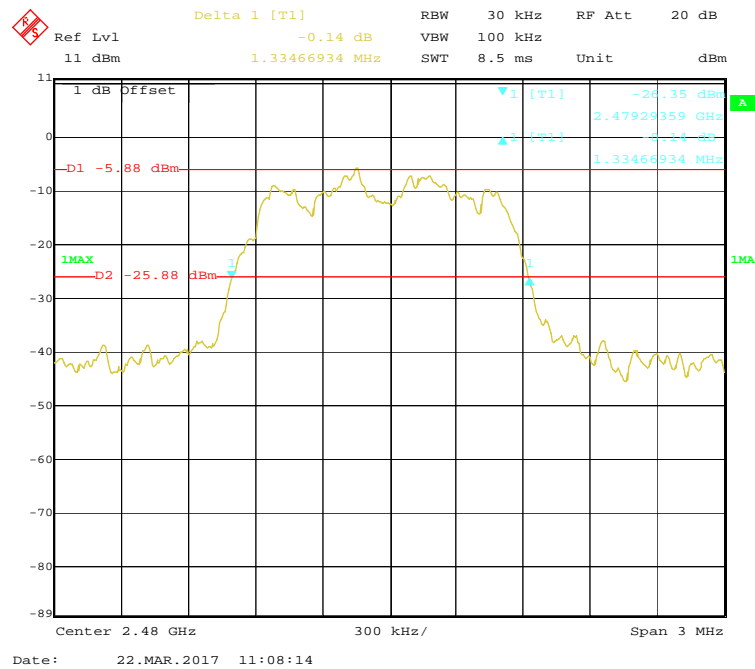


EDR ($\pi/4$ -DQPSK): High Channel**EDR (8DPSK): Low Channel**

EDR (8DPSK): Middle Channel



EDR (8DPSK): 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:	55 %
ATM Pressure:	101.3 kPa

The testing was performed by Belle Cheng on 2017-03-24.

EUT operation mode: Transmitting

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

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

Delta 1 [T1] RBW 100 kHz RF Att 20 dB

Ref Lvl 3.47 dB VBW 300 kHz

10 dBm 78.64729459 MHz SWT 21 ms Unit dBm

1 dB Offset

1 [T1] -8.36 dBm

2.40167335 GHz

1 [T1] 3.47 dB

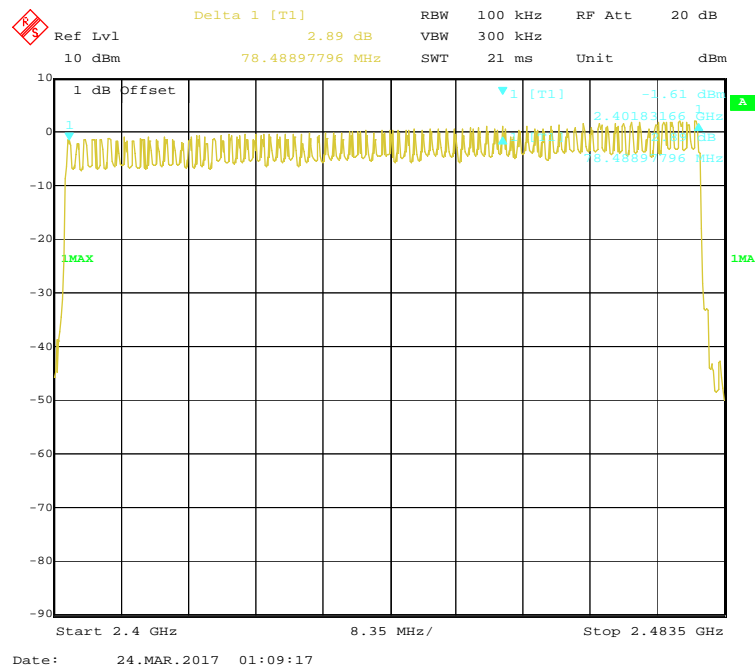
2.4835 GHz

1MAX

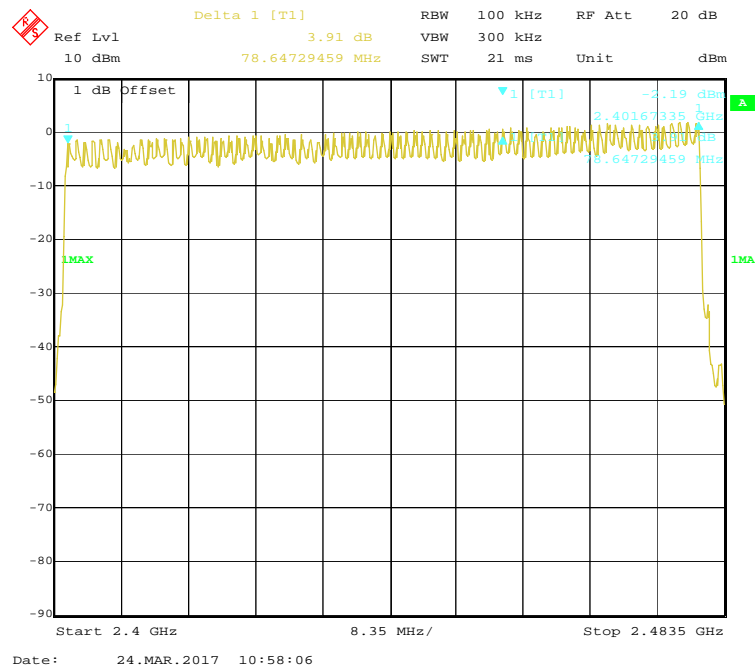
Start 2.4 GHz 8.35 MHz/ Stop 2.4835 GHz

Date: 24.MAR.2017 11:16:34

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



EDR (8DPSK): Number of Hopping Channels



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

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

Test Procedure

The EUT was worked in channel hopping; Spectrum SPAN was set as 0. Sweep was set as 0.4 X channel no. (s), the quantity of pulse was get from single sweep. In addition, the time of single pulses was tested.

Test Data**Environmental Conditions**

Temperature:	20.1 °C
Relative Humidity:	55 %
ATM Pressure:	101.3 kPa

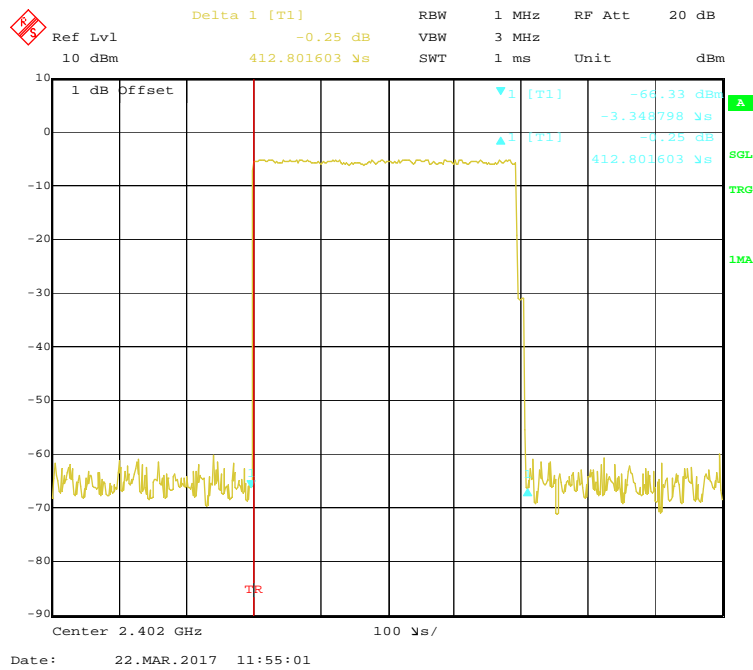
The testing was performed by Belle Cheng on 2017-03-22.

EUT operation mode: Transmitting

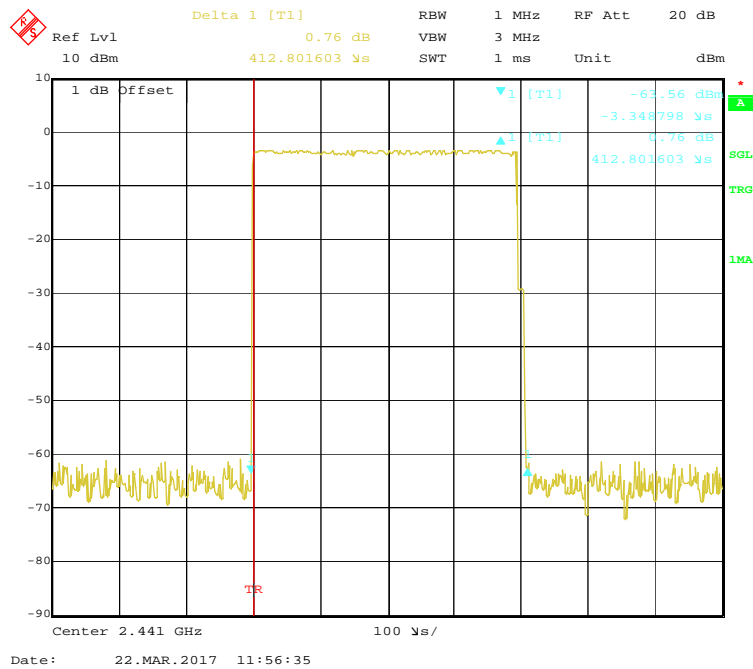
Test Result: Compliance. Please refer to following tables and plots

Mode		Channel	Pulse Width (ms)	Dwell Time (S)	Limit (S)	Result
BDR (GFSK)	DH 1	Low	0.413	0.132	0.4	Pass
		Middle	0.413	0.132	0.4	Pass
		High	0.415	0.133	0.4	Pass
		Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	DH 3	Low	1.693	0.271	0.4	Pass
		Middle	1.675	0.268	0.4	Pass
		High	1.675	0.268	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	DH 5	Low	2.946	0.314	0.4	Pass
		Middle	2.946	0.314	0.4	Pass
		High	2.946	0.314	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR ($\pi/4$ -DQPSK)	2DH 1	Low	0.423	0.135	0.4	Pass
		Middle	0.423	0.135	0.4	Pass
		High	0.423	0.135	0.4	Pass
		Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	2DH 3	Low	1.693	0.271	0.4	Pass
		Middle	1.693	0.271	0.4	Pass
		High	1.693	0.271	0.4	Pass
		Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	2DH 5	Low	2.946	0.314	0.4	Pass
		Middle	2.938	0.313	0.4	Pass
		High	2.938	0.313	0.4	Pass
		Note: 2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (8DPSK)	3DH 1	Low	0.423	0.135	0.4	Pass
		Middle	0.423	0.135	0.4	Pass
		High	0.423	0.135	0.4	Pass
		Note:3 DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	3DH 3	Low	1.681	0.269	0.4	Pass
		Middle	1.681	0.269	0.4	Pass
		High	1.681	0.269	0.4	Pass
		Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	3DH 5	Low	2.938	0.313	0.4	Pass
		Middle	2.938	0.313	0.4	Pass
		High	2.938	0.313	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				

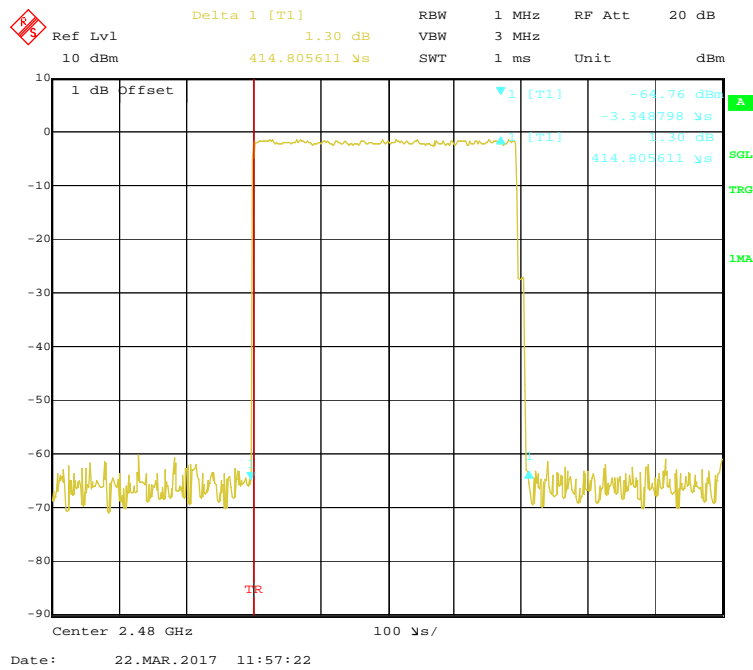
BDR (GFSK): Pulse time, Low Channel, DH1



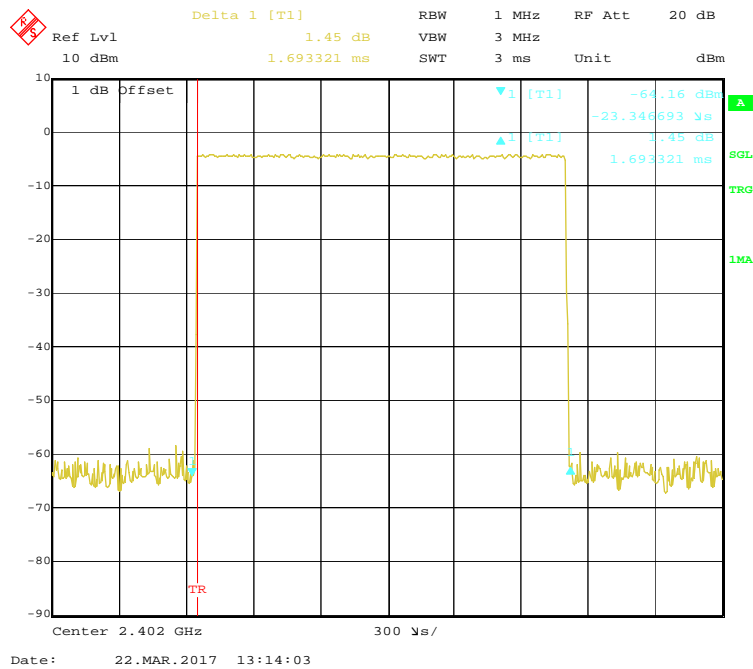
Pulse time, Middle Channel, DH1



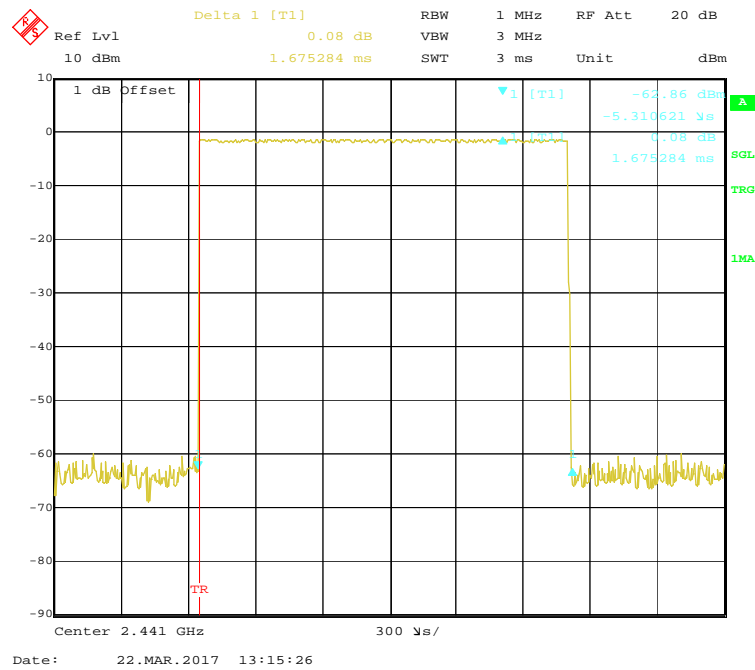
Pulse time, High Channel, DH1



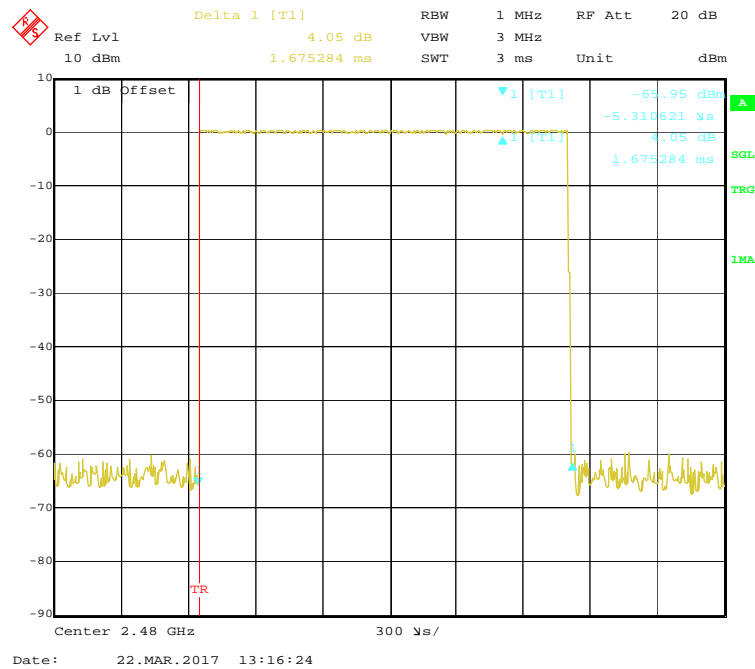
Pulse time, Low Channel, DH3



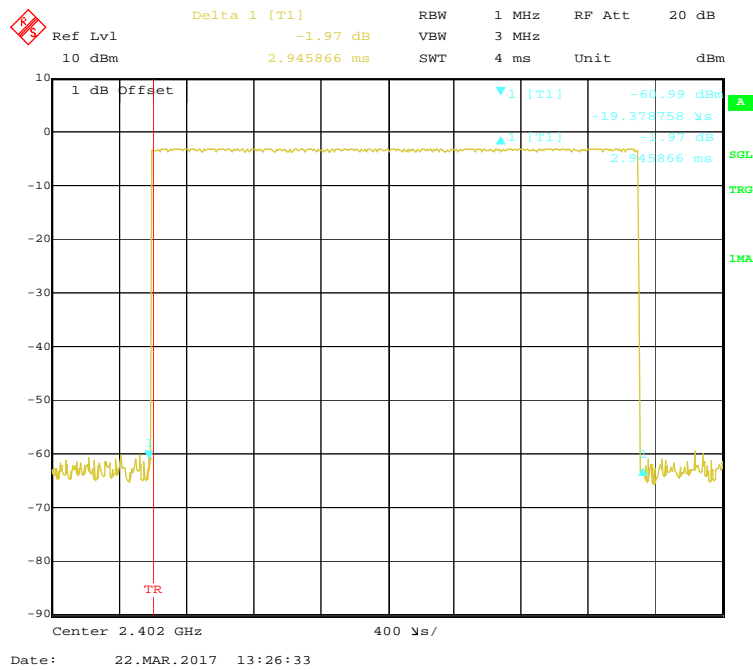
Pulse time, Middle Channel, DH3



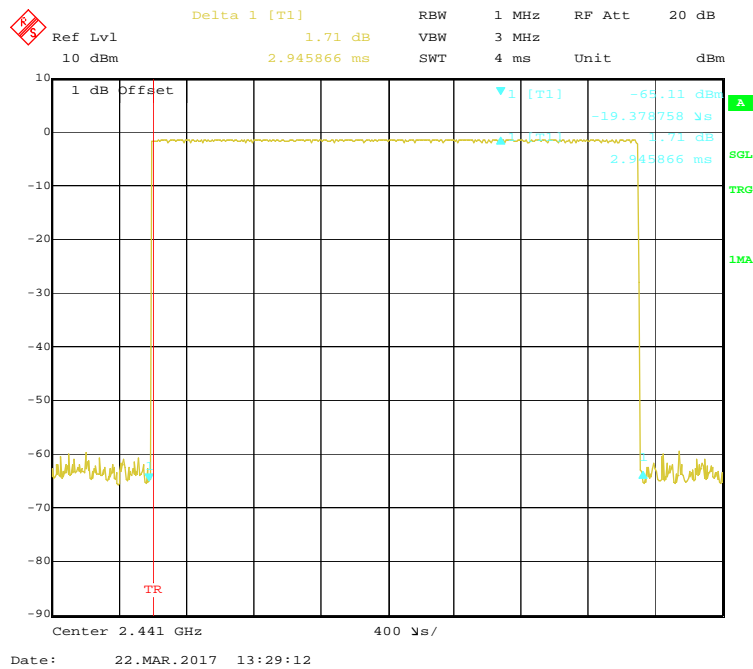
Pulse time, High Channel, DH3

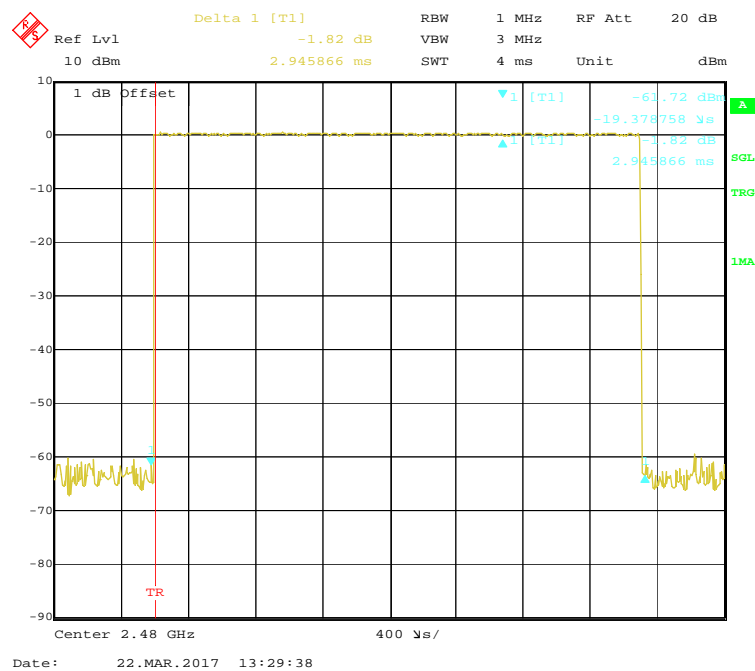
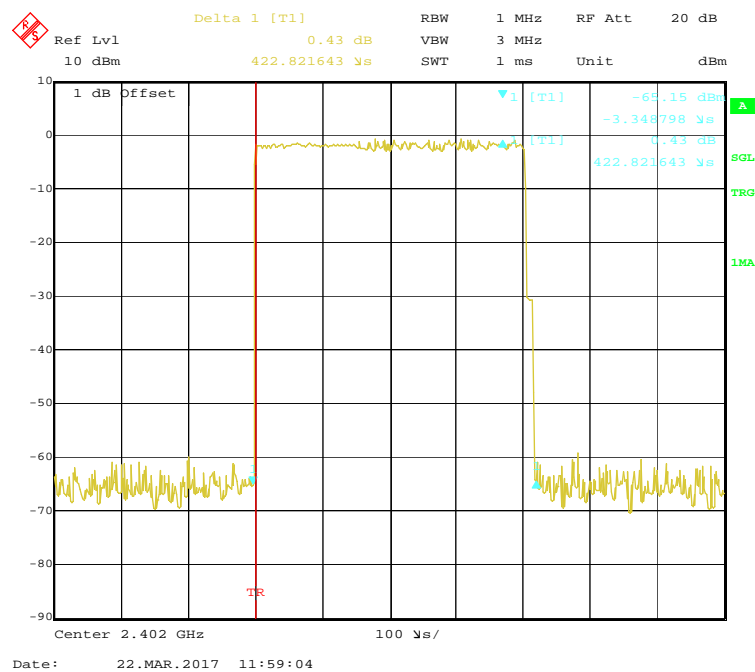


Pulse time, Low Channel, DH5

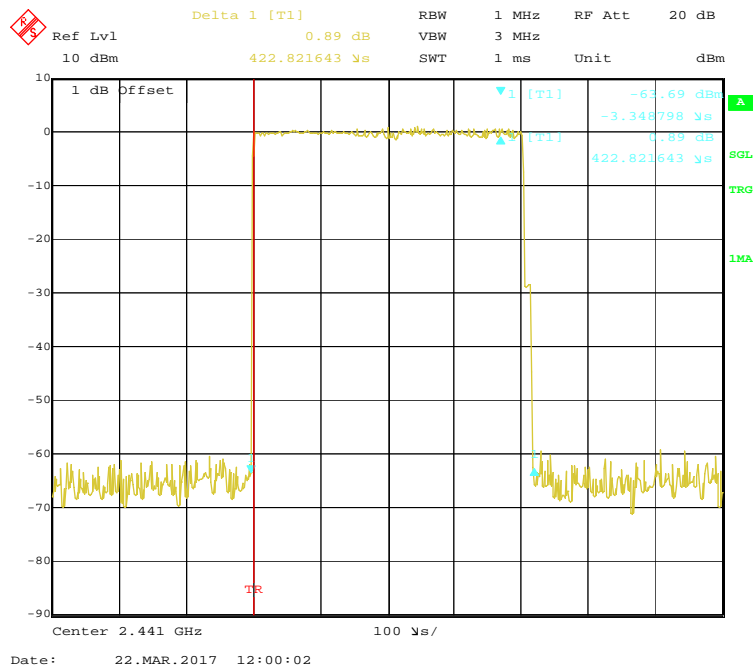


Pulse time, Middle Channel, DH5

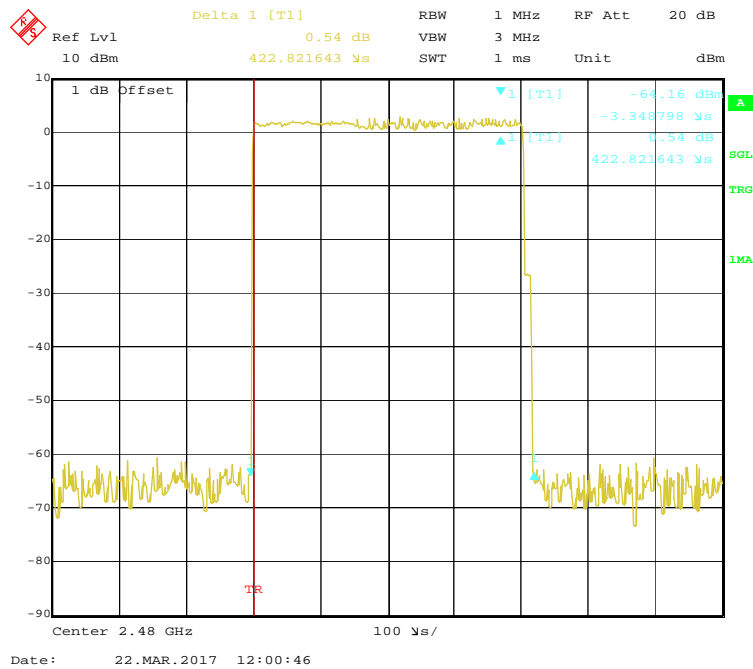


Pulse time, High Channel, DH5**EDR ($\pi/4$ -DQPSK): Pulse time, Low Channel, 2DH1**

Pulse time, Middle Channel, 2DH1



Pulse time, High Channel, 2DH1



Delta 1 [T1]

Ref Lvl 10 dBm

10 dBm

1 dB Offset

1 dB

Offset

TR

1 [T1]

-64.27 dBm

-11.322645 μ s

-1.03 dB

1.693321 ms

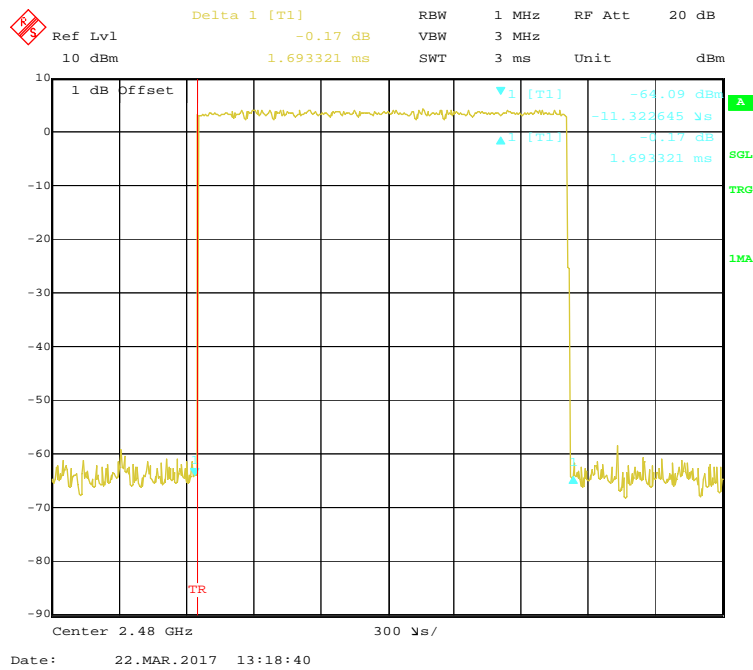
Center 2.402 GHz

300 μ s/

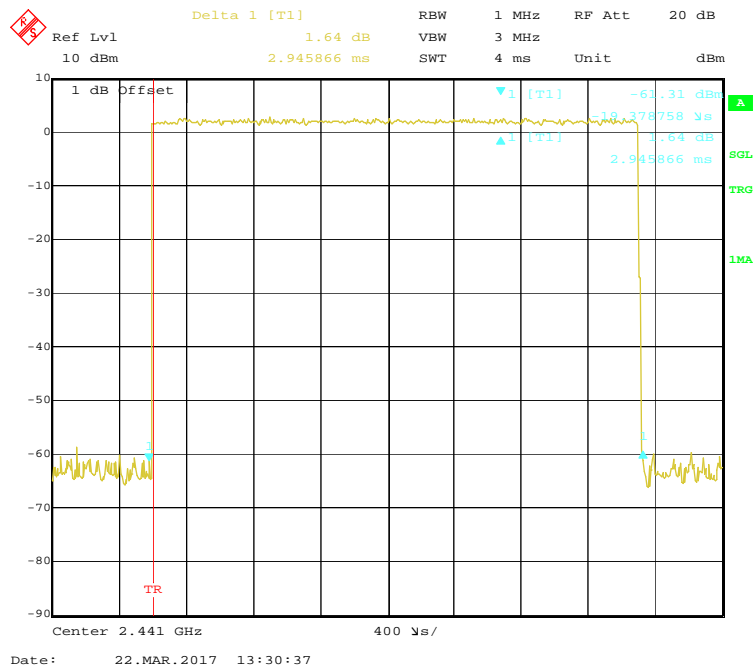
Date: 22.MAR.2017 13:17:25

Delta 1 [T1] 1.18 dB
 RBW 1 MHz
 Ref Lvl 10 dBm
 VBW 3 MHz
 10 dBm
 SWT 3 ms
 Unit dBm
 20 dB
 -83.91 dBm
 -11.322645 μ s
 1.18 dB
 1.693321 ms
 TR
 Center 2.441 GHz
 300 μ s/
 Date: 22.MAR.2017 13:18:04

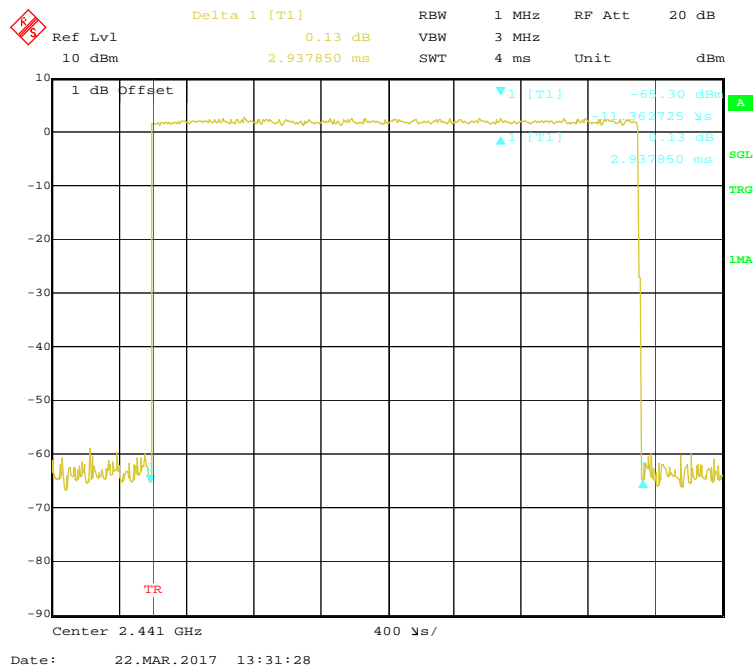
Pulse time, High Channel, 2DH3



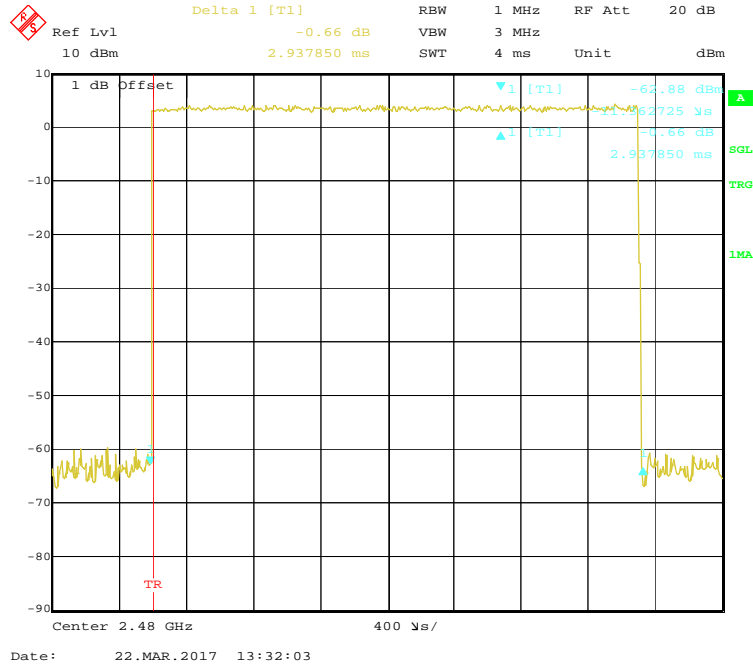
Pulse time, Low Channel, 2DH5



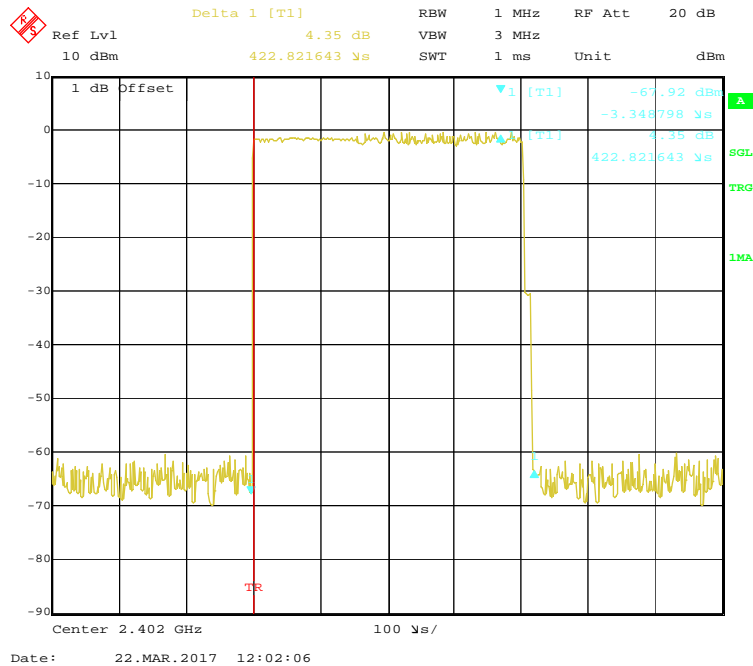
Pulse time, Middle Channel, 2DH5



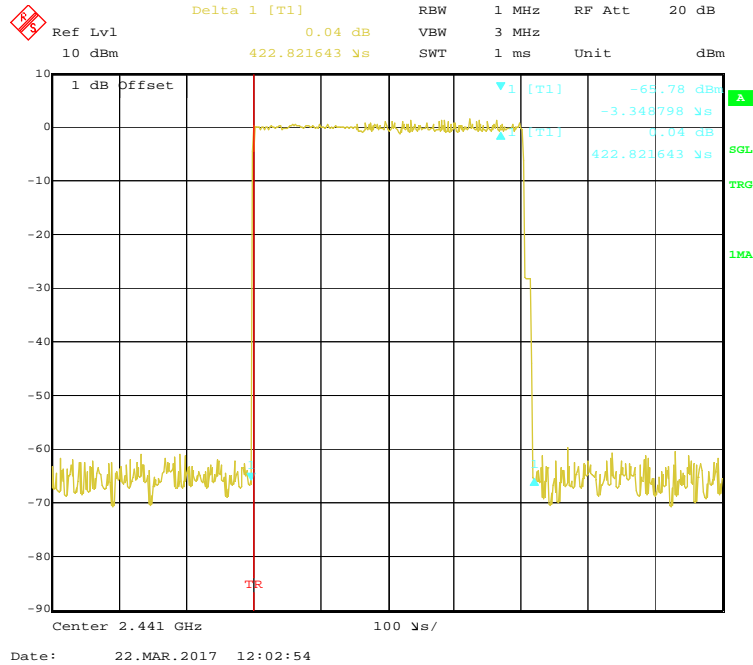
Pulse time, High Channel, 2DH5

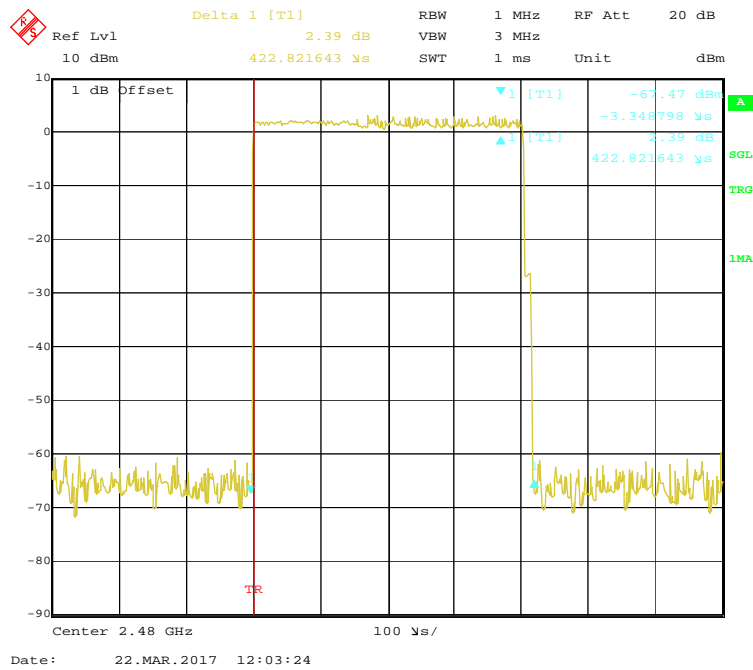
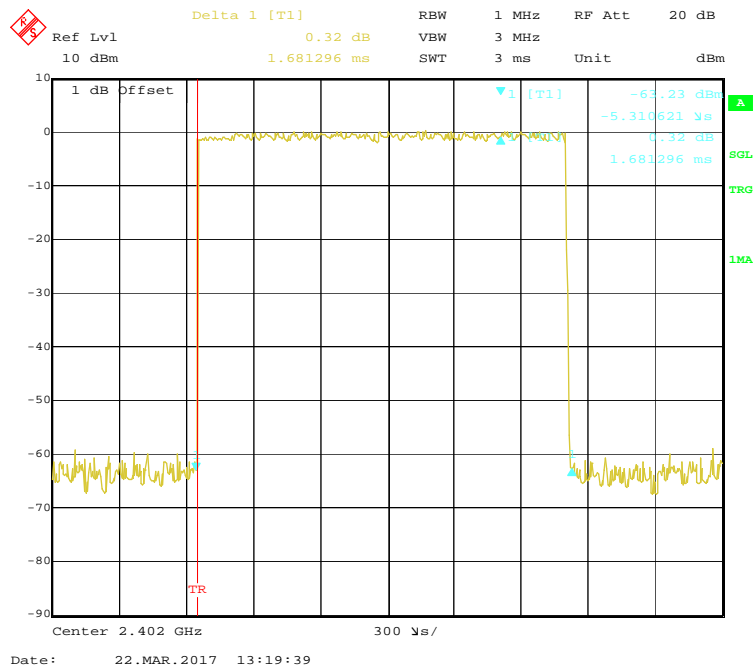


EDR (8DPSK): Pulse time, Low Channel, 3DH1

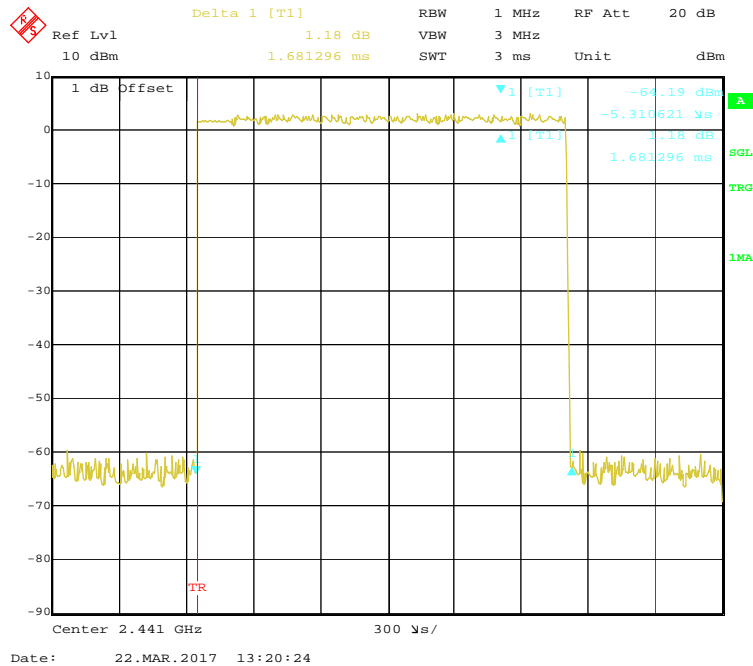


Pulse time, Middle Channel, 3DH1

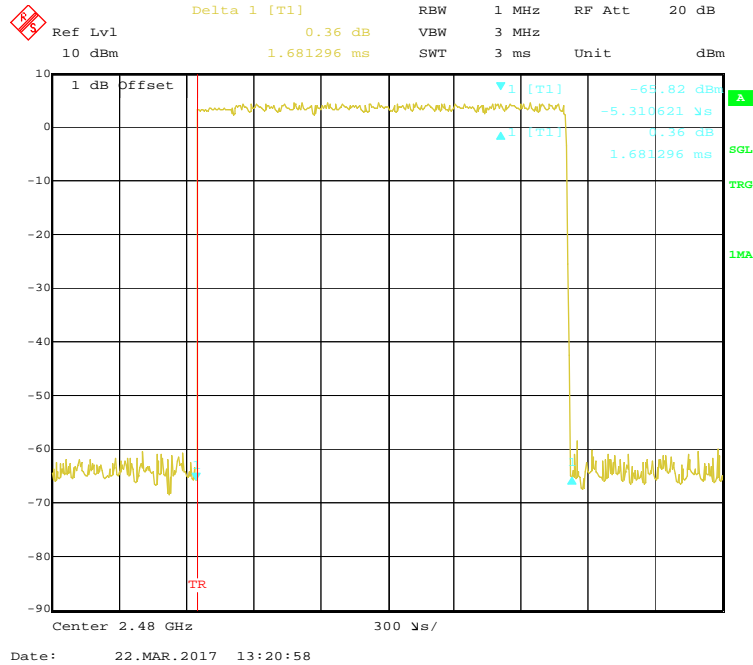


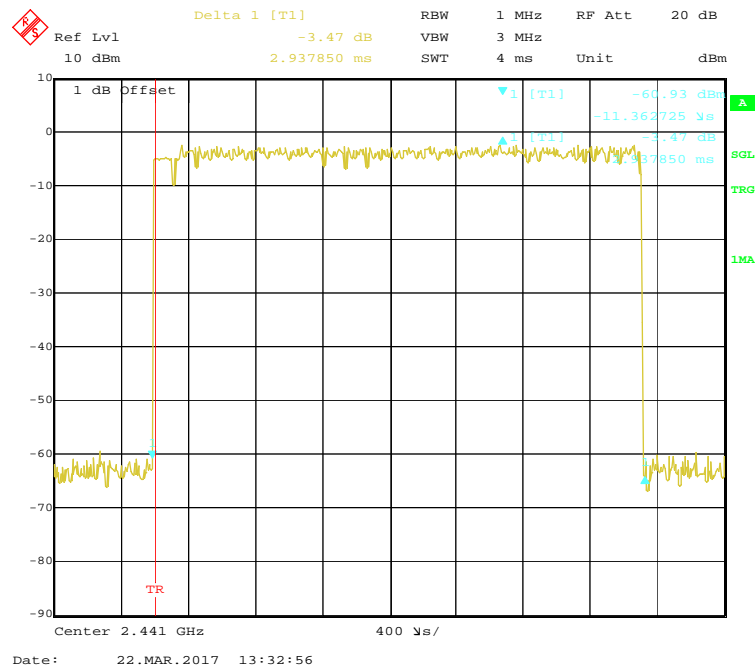
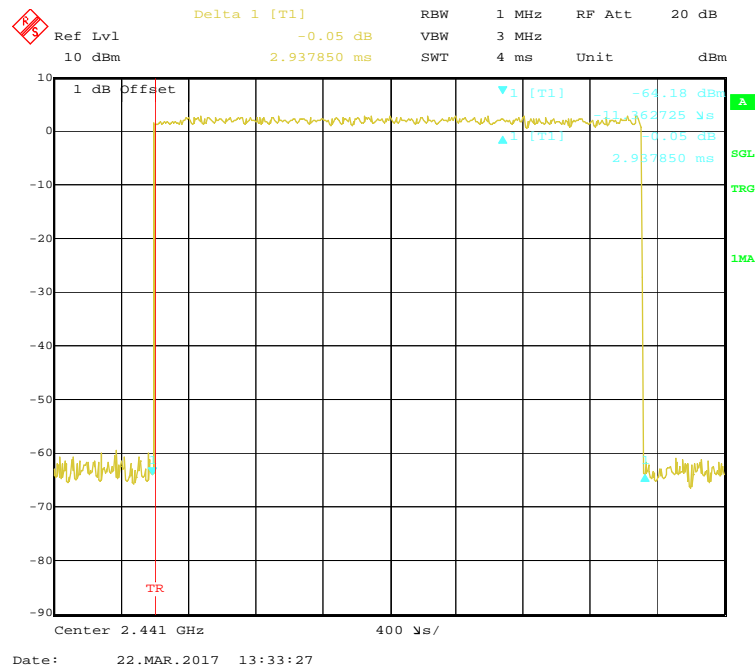
Pulse time, High Channel, 3DH1**Pulse time, Low Channel, 3DH3**

Pulse time, Middle Channel, 3DH3



Pulse time, High Channel, 3DH3



Pulse time, Low Channel, 3DH5**Pulse time, Middle Channel, 3DH5**

Delta 1 [T1] 0.26 dB
 RBW 1 MHz RF Att 20 dB
 Ref Lvl 10 dBm
 SWT 4 ms Unit dBm
 Center 2.48 GHz 400 us/
 TR

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

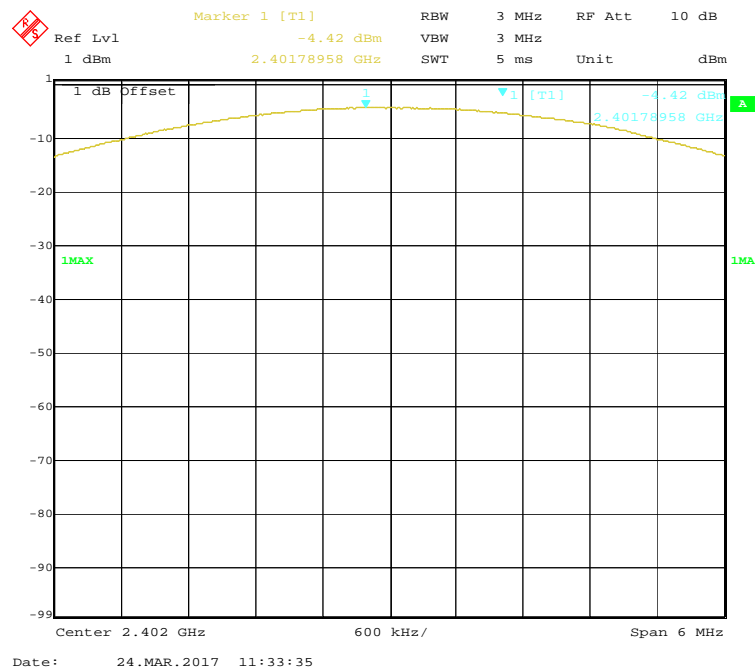
Temperature:	20.2 °C
Relative Humidity:	55 %
ATM Pressure:	101.3 kPa

The testing was performed by Belle Cheng on 2017-03-24 to 2017-04-19.

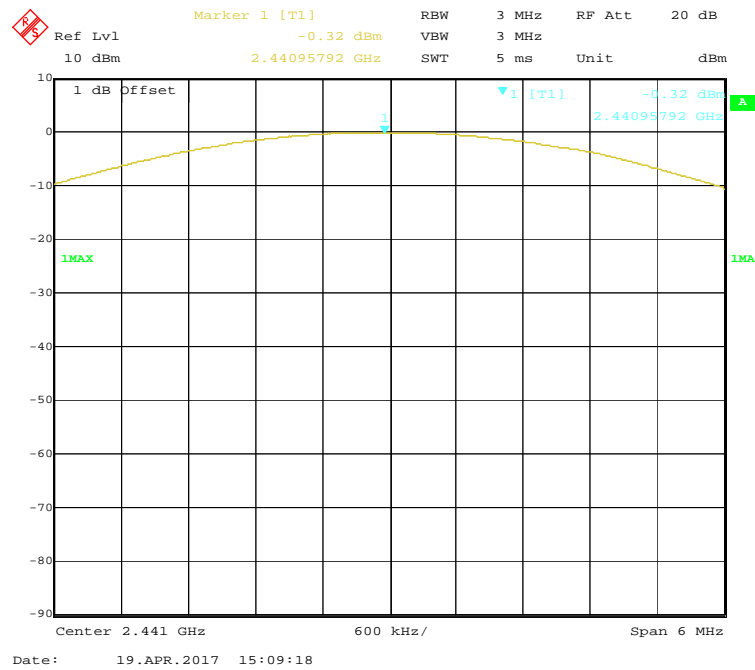
EUT operation mode: Transmitting

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

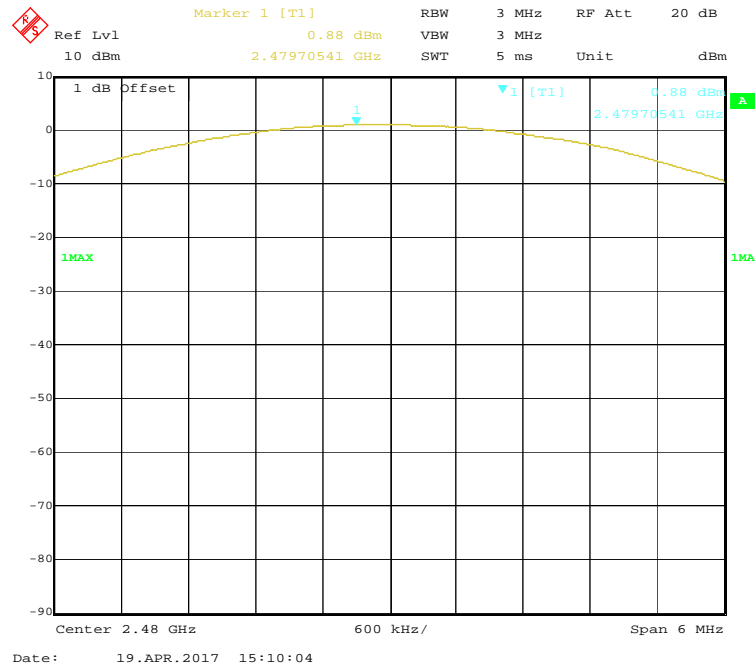
Mode	Channel	Frequency (MHz)	Output Power		Limit (mW)
			(dBm)	(mW)	
BDR (GFSK)	Low	2402	-4.42	0.36	1000
	Middle	2441	-0.32	0.93	1000
	High	2480	0.88	1.22	1000
EDR ($\pi/4$-DQPSK)	Low	2402	0.22	1.05	1000
	Middle	2441	1.94	1.56	1000
	High	2480	3.66	2.32	1000
EDR (8DPSK)	Low	2402	0.60	1.15	1000
	Middle	2441	2.35	1.72	1000
	High	2480	4.18	2.62	1000

BDR (GFSK): Low Channel

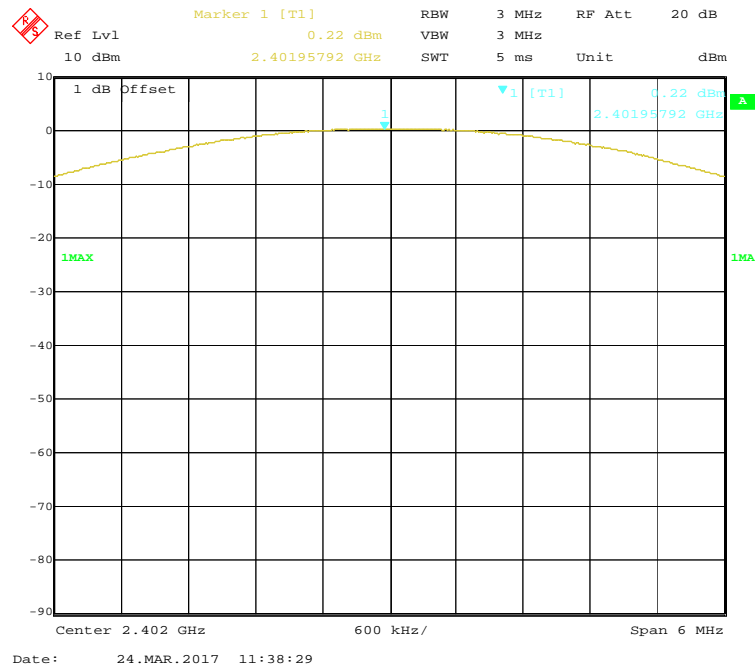
BDR (GFSK): Middle Channel



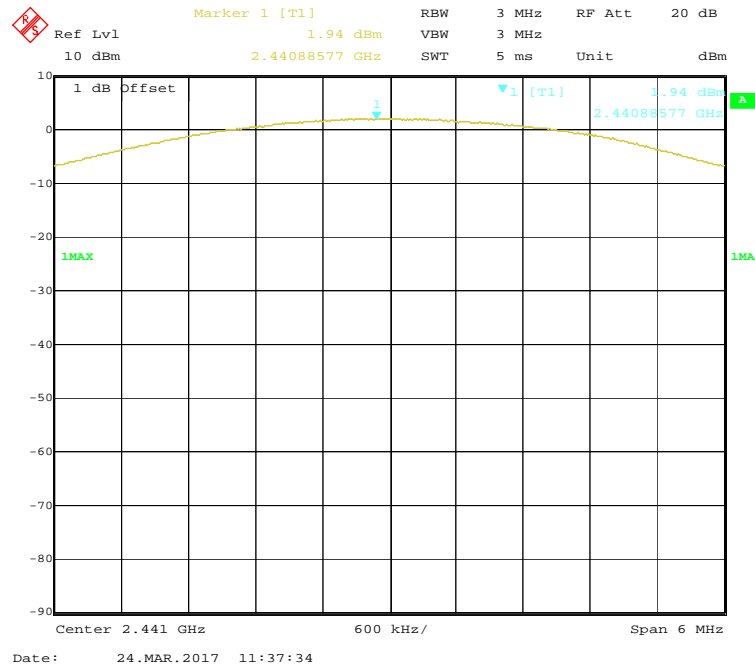
BDR (GFSK): High Channel



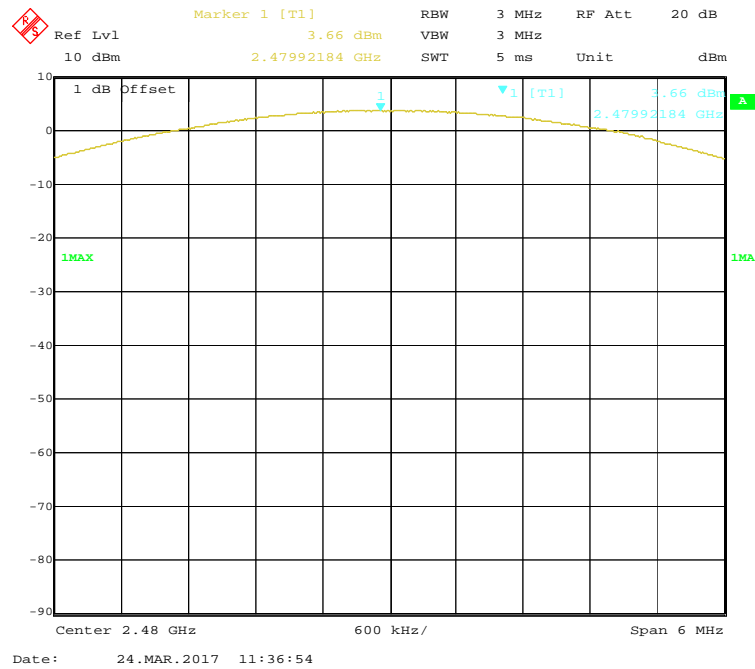
EDR($\pi/4$ -DQPSK): Low Channel



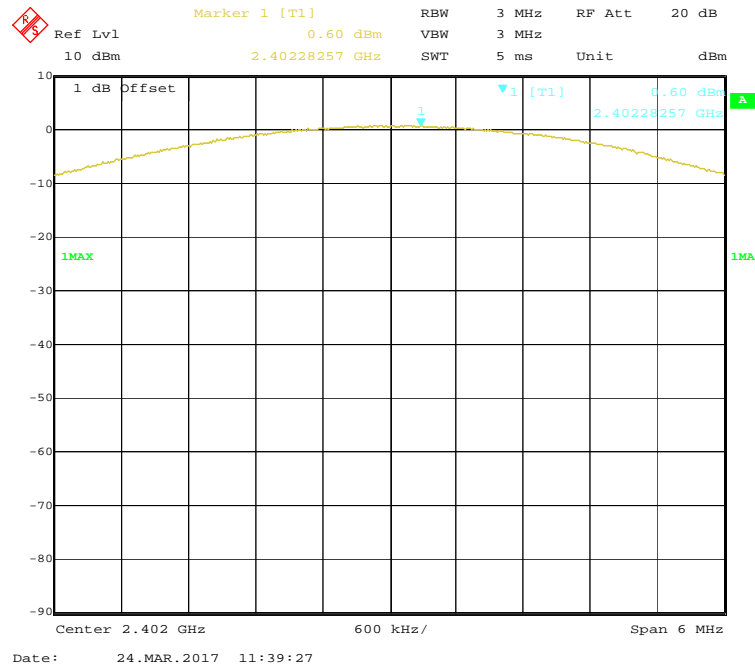
EDR($\pi/4$ -DQPSK): Middle Channel



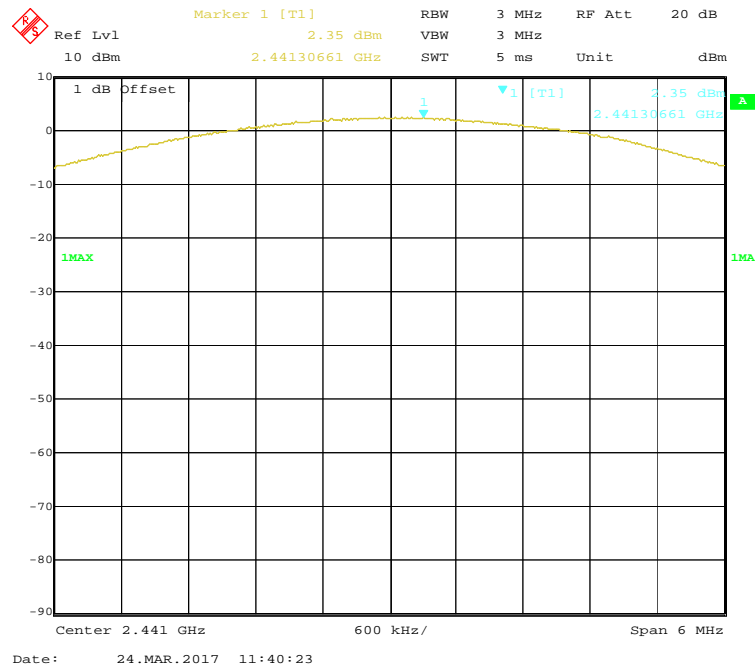
EDR($\pi/4$ -DQPSK): High Channel



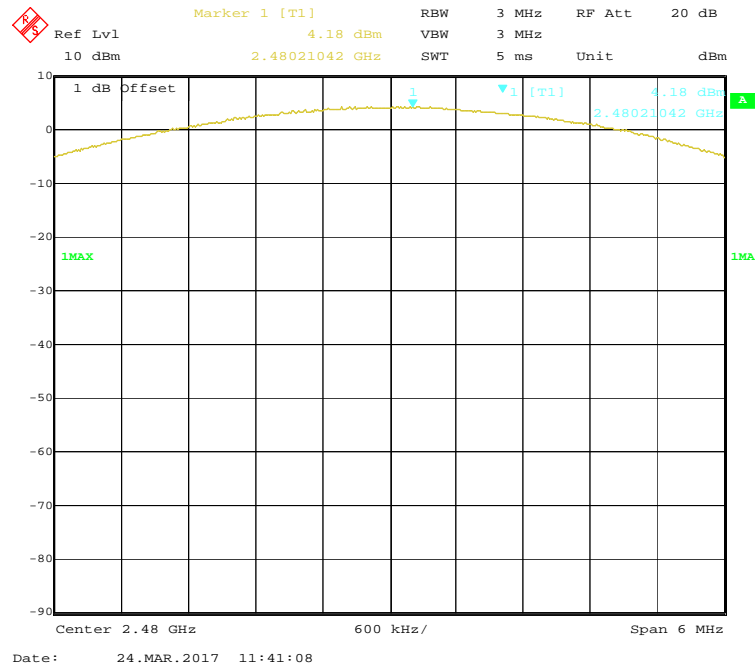
EDR(8DPSK): Low Channel



EDR(8DPSK): Middle Channel



EDR(8DPSK): 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

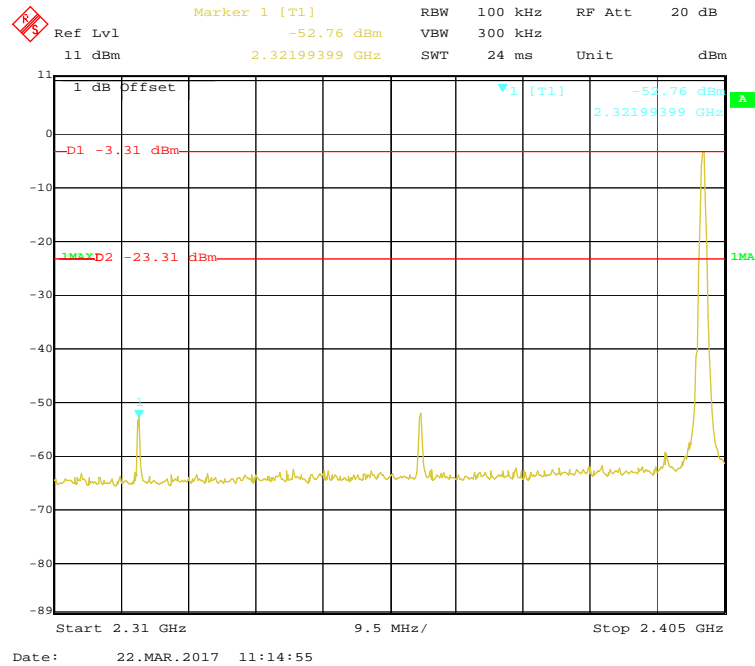
Temperature:	20.2 °C
Relative Humidity:	55 %
ATM Pressure:	101.3 kPa

The testing was performed by Belle Cheng on 2017-03-22.

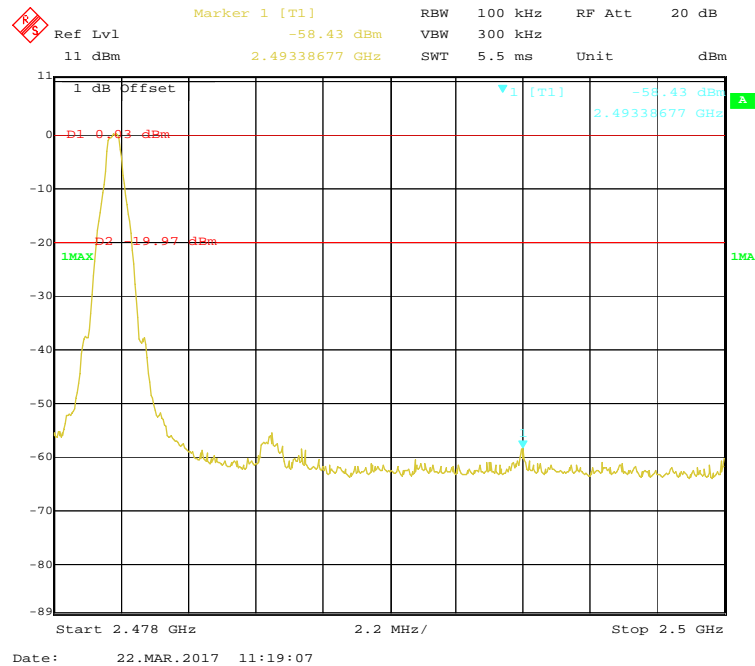
EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following plots.

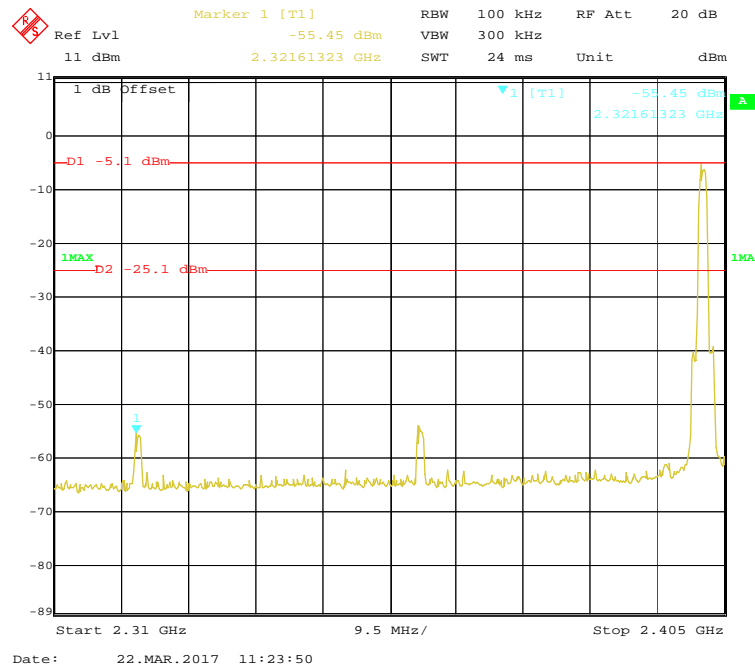
BDR (GFSK): Band Edge-Left Side



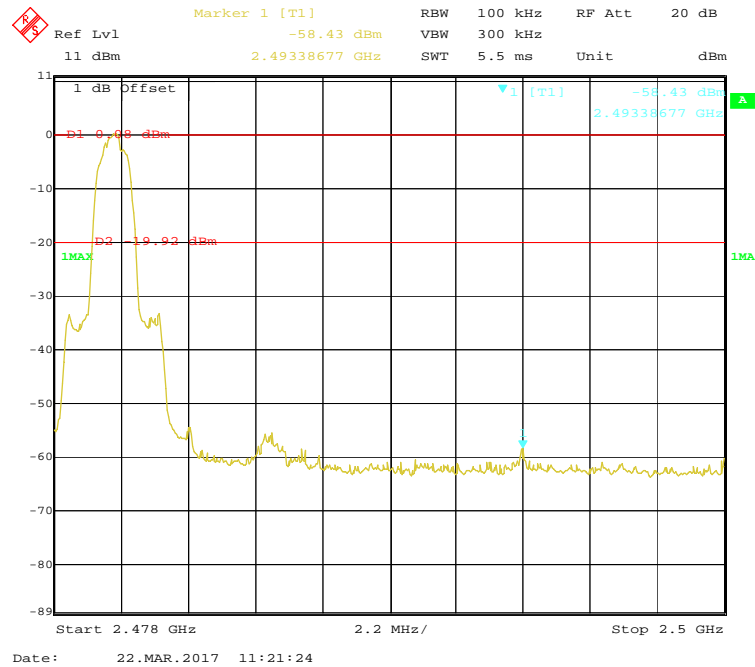
BDR (GFSK): Band Edge-Right Side



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



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



Marker 1 [T1]
 -55.24 dBm
 RBW 100 kHz
 VBW 300 kHz
 RF Att 20 dB
 11 dBm
 2.32180361 GHz
 SWT 24 ms
 Unit dBm

1 dB Offset

▼1 [T1]
 -55.24 dBm
 2.32180361 GHz

-D1 -5.28 dBm

1MAX
 D2 -25.28 dBm

Start 2.31 GHz 9.5 MHz/ Stop 2.405 GHz

Date: 22.MAR.2017 11:25:35

Ref Lvl 11 dBm
 Marker 1 [T1] -60.72 dBm
 RBW 100 kHz RF Att 20 dB
 11 dBm 2.49316633 GHz SWT 5.5 ms Unit dBm

1 dB Offset
 -D1 -1.89 dBm
 -D2 -21.89 dBm
 1 MAX
 1
 -60.72 dBm
 2.49316633 GHz

Start 2.478 GHz 2.2 MHz/ Stop 2.5 GHz

Date: 22.MAR.2017 11:28:10

Page 64 of 64