



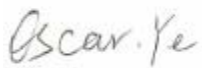
# FCC PART 15.247 TEST REPORT

For

## 3M CONSTRUCTION & HOME IMPROVEMENT MARKETS DIVISION

3M Center, Building 251-01-E-19, St.Paul, Minnesota 55144-1000 U.S.A

**FCC ID: 2AFHL-WTC90543**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Electronic Hearing Protector
<b>Report Number:</b> <u>RSZ170328010-00B</u>	
<b>Report Date:</b> <u>2017-04-17</u>	
Oscar Ye 	
<b>Reviewed By:</b> <u>Engineer</u>	
<b>Prepared By:</b> Bay Area Compliance Laboratories Corp. (Kunshan) No.248 Chenghu Road, Kunshan, Jiangsu province, China Tel: +86-0512-86175000 Fax: +86-0512-88934268 <a href="http://www.baclcorp.com.cn">www.baclcorp.com.cn</a>	

**Note:** This test report is prepared for the customer shown above and for the equipment described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp.

## **TABLE OF CONTENTS**

<b>GENERAL INFORMATION.....</b>	<b>4</b>
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
<b>SYSTEM TEST CONFIGURATION.....</b>	<b>6</b>
SUPPORT EQUIPMENT LIST AND DETAILS .....	6
EXTERNAL I/O CABLE.....	6
BLOCK DIAGRAM OF TEST SETUP .....	7
<b>SUMMARY OF TEST RESULTS .....</b>	<b>8</b>
<b>TEST EQUIPMENT LIST .....</b>	<b>9</b>
<b>FCC§15.247 (i), §1.1307 (b) (1) &amp;§2.1093 – RF EXPOSURE.....</b>	<b>10</b>
APPLICABLE STANDARD .....	10
<b>FCC §15.203 – ANTENNA REQUIREMENT .....</b>	<b>11</b>
APPLICABLE STANDARD .....	11
ANTENNA CONNECTOR CONSTRUCTION .....	11
<b>FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS .....</b>	<b>12</b>
APPLICABLE STANDARD .....	12
EUT SETUP .....	12
EMI TEST RECEIVER SETUP.....	12
TEST PROCEDURE .....	12
CORRECTED FACTOR & MARGIN CALCULATION .....	13
TEST RESULTS SUMMARY .....	13
TEST DATA .....	13
<b>FCC §15.205, §15.209 &amp; §15.247(d) – RADIATED EMISSIONS.....</b>	<b>16</b>
APPLICABLE STANDARD .....	16
EUT SETUP .....	16
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP .....	17
TEST PROCEDURE .....	17
CORRECTED AMPLITUDE & MARGIN CALCULATION .....	17
TEST RESULTS SUMMARY .....	17
TEST DATA .....	18
<b>FCC §15.247(a) (1)-CHANNEL SEPARATION TEST .....</b>	<b>20</b>
APPLICABLE STANDARD .....	20
TEST PROCEDURE .....	20
TEST DATA .....	20
<b>FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH.....</b>	<b>27</b>
APPLICABLE STANDARD .....	27
TEST PROCEDURE .....	27
TEST DATA .....	27
<b>FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST .....</b>	<b>33</b>

APPLICABLE STANDARD .....	33
TEST PROCEDURE .....	33
TEST DATA .....	33
<b>FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....</b>	<b>36</b>
APPLICABLE STANDARD .....	36
TEST PROCEDURE .....	36
TEST DATA .....	36
<b>FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT .....</b>	<b>52</b>
APPLICABLE STANDARD .....	52
TEST PROCEDURE .....	52
TEST DATA .....	52
<b>FCC §15.247(d) - BAND EDGES TESTING .....</b>	<b>53</b>
APPLICABLE STANDARD .....	53
TEST PROCEDURE .....	53
TEST DATA .....	53

---

## GENERAL INFORMATION

---

### Product Description for Equipment under Test (EUT)

The *3M CONSTRUCTION & HOME IMPROVEMENT MARKETS DIVISION*'s product, model number: *WorkTunes Connect Wireless Hearing Protector (FCC ID: 2AFHL-WTC90543)* or the "EUT" in this report was a *Electronic Hearing Protector*, which was measured approximately: 17.8 cm (L) \* 13.8 cm (W) \* 9.6 cm (H), rated with input voltage: DC 3.7V battery.

*\*All measurement and test data in this report was gathered from production sample serial number: 1700540 (Assigned by BACL, Kunshan). The EUT supplied by the applicant was received on 2017-03-28.*

### Objective

This test report is prepared on behalf of *3M CONSTRUCTION & HOME IMPROVEMENT MARKETS DIVISION* 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)

No related submittal(s)/grant(s)

### 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 at 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		±3.26 dB
RF conducted test with spectrum		±0.9dB
RF Output Power with Power meter		±0.5dB
Radiated emission	30MHz~1GHz	±6.11dB
	Above 1G	±4.45dB
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 C63.10-2013.

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 engineering mode.

### EUT Exercise Software

Software “CSR Bluesuite 2.5.8 ” was used.

Power level: 3

### Special Accessories

No special accessory.

### Equipment Modifications

No modification was made to the EUT tested.

### Support Equipment List and Details

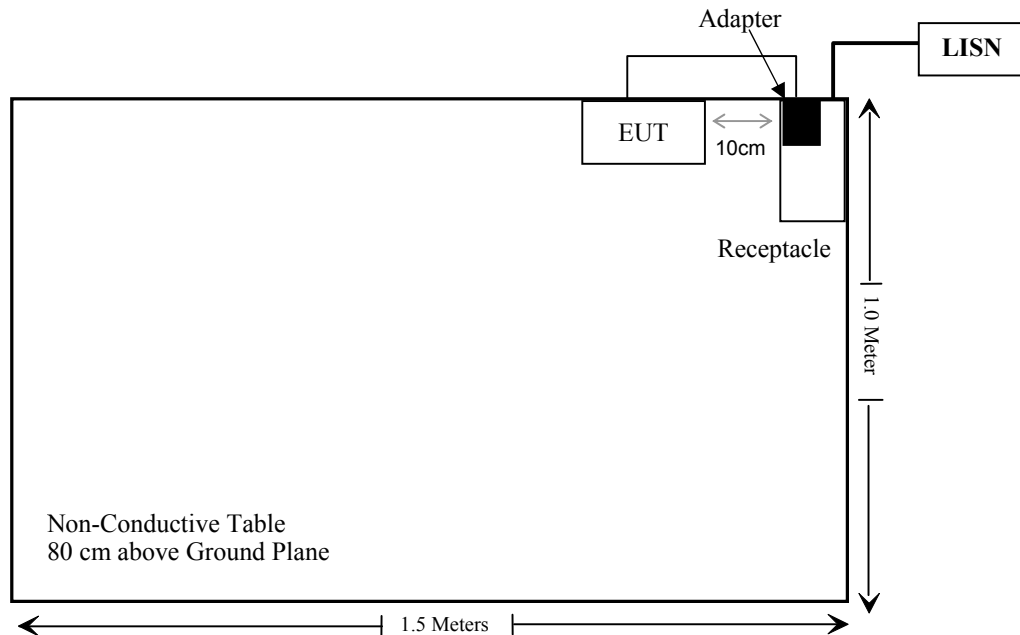
Manufacturer	Description	Model	Serial Number
MASS POWER	Adapter	NBS24J240100VU	1604

### External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cable	1.5	EUT	Adapter

## Block Diagram of Test Setup

For conducted emission



**SUMMARY OF TEST RESULTS**

<b>FCC Rules</b>	<b>Description of Test</b>	<b>Result</b>
§15.247 (i), §2.1093	RF Exposure	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
<b>AC Line Conducted test</b>					
Rohde & Schwarz	EMI Test Receiver	ESCS30	834115/007	2016-11-25	2017-11-25
Rohde & Schwarz	LISN	ESH3-Z5	862770/011	2016-10-10	2017-10-10
Rohde & Schwarz	Pulse limiter	ESH3-Z2	879940/0058	2016-06-19	2017-06-18
MICRO-COAX	Coaxial line	UFB-293B-1-0480-50X50	97F0173	2016-09-08	2017-09-08
Rohde & Schwarz	CE Test software	EMC 32	V 09.10.0	NCR	NCR
<b>Radiation test</b>					
Sonoma Instrument	Amplifier	330	171377	2016-12-12	2017-12-12
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-25
Sunol Sciences	Broadband Antenna	JB3	A090314-2	2016-01-09	2019-01-08
Narda	Pre-amplifier	AFS42-00101800	2001270	2016-09-08	2017-09-08
EMCO	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Rohde & Schwarz	Signal Analyzer	FSIQ26	100048	2016-11-25	2017-11-25
ETS	Horn Antenna	3115	6229	2016-01-11	2019-01-10
R&S	Auto test Software	EMC32	V 09.10.0	NCR	NCR
haojintech	Coaxial Cable	Cable-1	001	2016-12-12	2017-12-12
haojintech	Coaxial Cable	Cable-2	002	2016-12-12	2017-12-12
haojintech	Coaxial Cable	Cable-3	003	2016-12-12	2017-12-12
MICRO-COAX	Coaxial Cable	Cable-4	004	2016-12-12	2017-12-12
MICRO-COAX	Coaxial Cable	Cable-5	005	2016-12-12	2017-12-12
<b>RF Conducted test</b>					
BACL	TS 8997 Cable-01	T-KS-EMC086	T-KS-EMC086	2016-12-09	2017-12-08
BACL	RF cable	KS-LAB-012	KS-LAB-012	2016-12-15	2017-12-15
WEINSCHEL	3dB Attenuator	5326	N/A	2016-06-18	2017-06-18
Agilent	Power Meter	N1912A	MY5000492	2016-11-17	2017-11-16
Agilent	Power Sensor	N1921A	MY54210024	2016-11-17	2017-11-16
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2016-09-21	2017-09-21

\* **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), §1.1307 (b) (1) & §2.1093 – RF EXPOSURE**

### **Applicable Standard**

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot$

$[\sqrt{f(\text{GHz})}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR, where

1.  $f(\text{GHz})$  is the RF channel transmit frequency in GHz.

2. Power and distance are rounded to the nearest mW and mm before calculation.

3. The result is rounded to one decimal place for comparison.

4. When the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test Exclusion.

**For worst case:**

Frequency (MHz)	Maximum conducted Tune-up power		Calculated Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
	Power (dBm)	Power (mW)				
2480	1.5	1.41	5.0	0.4	3.0	Yes

**Result: No SAR test is required**

**FCC §15.203 – ANTENNA REQUIREMENT**

---

**Applicable Standard**

According to FCC § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

**Antenna Connector Construction**

The EUT has one internal antenna arrangement for bluetooth which was permanently attached and the antenna gain is 2.65 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.

The spacing between the peripherals was 10 cm.

### 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

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.

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(Lm)} \leq L_{\text{lim}} + U_{\text{cispr}}$$

In BACL,  $U_{(Lm)}$  is less than  $U_{\text{cispr}}$ , if  $L_m$  is less than  $L_{\text{lim}}$ , it implies that the EUT complies with the limit.

## Test Data

### Environmental Conditions

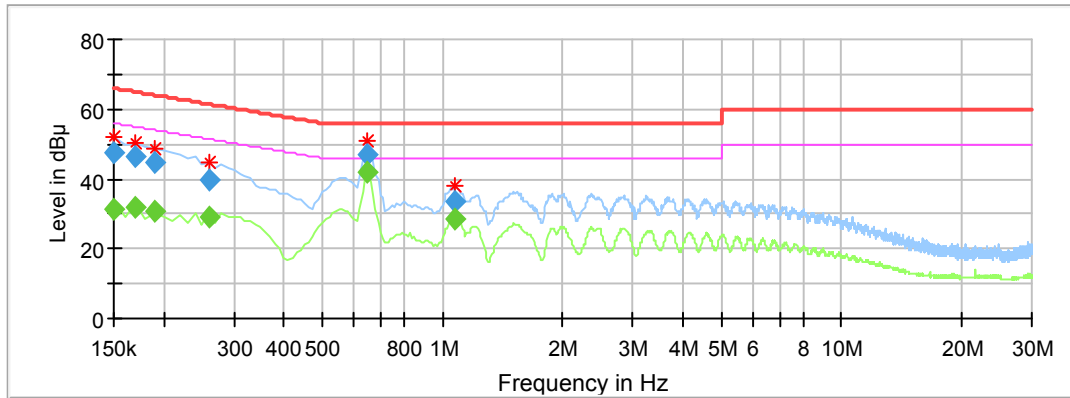
Temperature:	25 °C
Relative Humidity:	49 %
ATM Pressure:	101.0 kPa

*The testing was performed by Layne Li on 2017-04-13.*

EUT operation mode: charging

AC 120V/60 Hz, Line:

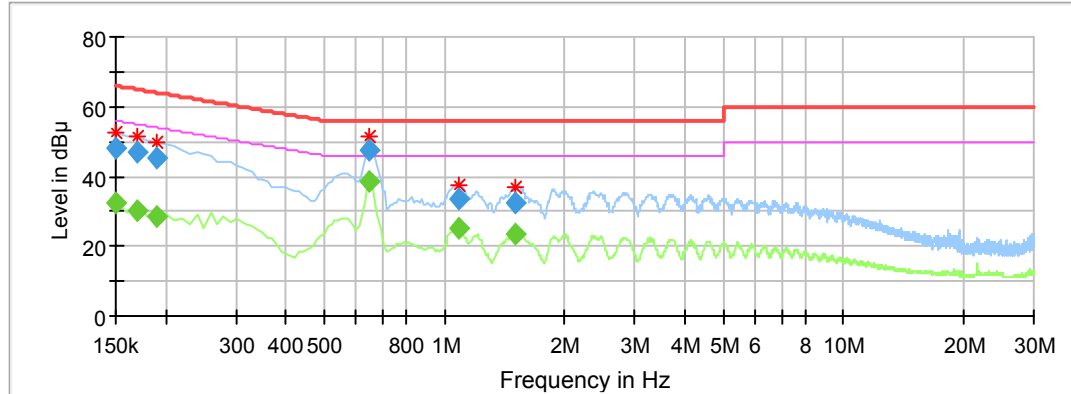
Full Spectrum



Frequency (MHz)	QuasiPeak (dBμV)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.150000	---	31.51	9.000	L1	10.1	24.49	56.00	Compliance
0.150000	47.41	---	9.000	L1	10.1	18.59	66.00	Compliance
0.170000	---	31.98	9.000	L1	10.0	22.98	54.96	Compliance
0.170000	46.60	---	9.000	L1	10.0	18.36	64.96	Compliance
0.190000	---	30.67	9.000	L1	10.0	23.37	54.04	Compliance
0.190000	44.97	---	9.000	L1	10.0	19.07	64.04	Compliance
0.260000	---	28.84	9.000	L1	10.0	22.59	51.43	Compliance
0.260000	39.69	---	9.000	L1	10.0	21.74	61.43	Compliance
0.650000	---	42.17	9.000	L1	10.0	3.83	46.00	Compliance
0.650000	46.92	---	9.000	L1	10.0	9.08	56.00	Compliance
1.080000	---	28.52	9.000	L1	9.9	17.48	46.00	Compliance
1.080000	33.79	---	9.000	L1	9.9	22.21	56.00	Compliance

**AC 120V/60 Hz, Neutral**

Full Spectrum



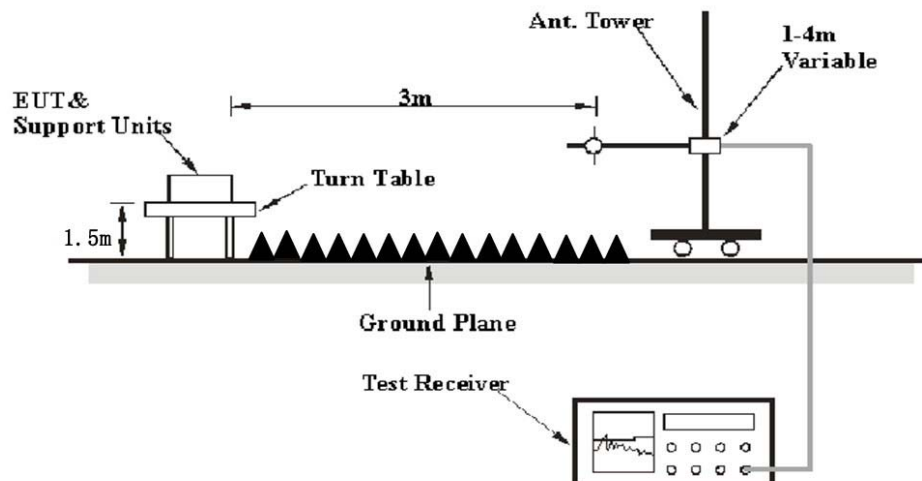
Frequency (MHz)	QuasiPeak (dBμV)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.150000	---	32.34	9.000	N	10.1	23.66	56.00	Compliance
0.150000	48.28	---	9.000	N	10.1	17.72	66.00	Compliance
0.170000	---	30.47	9.000	N	10.1	24.49	54.96	Compliance
0.170000	47.05	---	9.000	N	10.1	17.91	64.96	Compliance
0.190000	---	28.37	9.000	N	10.1	25.67	54.04	Compliance
0.190000	45.28	---	9.000	N	10.1	18.76	64.04	Compliance
0.650000	---	38.84	9.000	N	10.0	7.16	46.00	Compliance
0.650000	47.59	---	9.000	N	10.0	8.41	56.00	Compliance
1.090000	---	25.18	9.000	N	9.9	20.82	46.00	Compliance
1.090000	33.43	---	9.000	N	9.9	22.57	56.00	Compliance
1.500000	---	23.66	9.000	N	9.9	22.34	46.00	Compliance
1.500000	32.54	---	9.000	N	9.9	23.46	56.00	Compliance

Note:

- 1) Corrected Amplitude = Reading + Correction Factor
- 2) Correction Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation
- 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)

**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, 205 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	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	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.

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(L_m)} \leq L_{\text{lim}} + U_{\text{cispr}}$$

In BAEL,  $U_{(L_m)}$  is less than  $U_{\text{cispr}}$ , if  $L_m$  is less than  $L_{\text{lim}}$ , it implies that the EUT complies with the limit.

**Test Data****Environmental Conditions**

<b>Temperature:</b>	22 °C
<b>Relative Humidity:</b>	48 %
<b>ATM Pressure:</b>	101.0 kPa

The testing was performed by Layne Li on 2017-04-14.

EUT operation mode: Transmitting

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

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 (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2402 MHz)									
320.81	43.67	QP	192	2.2	H	-10.37	33.30	46.0	12.70
2402.00	99.84	PK	263	2.2	H	-6.19	93.65	/	/
2402.00	88.6	Ave.	263	2.2	H	-6.19	82.41	/	/
2402.00	99.21	PK	219	2.5	V	-6.19	93.02	/	/
2402.00	88.36	Ave.	219	2.5	V	-6.19	82.17	/	/
2347.83	66.79	PK	162	1.2	H	-6.42	60.37	74	13.63
2347.83	51.5	Ave.	162	1.2	H	-6.42	45.08	54	8.92
2382.94	68.06	PK	101	1.8	H	-6.19	61.87	74	12.13
2382.94	51.38	Ave.	101	1.8	H	-6.19	45.19	54	8.81
2499.66	67.1	PK	186	1.9	H	-5.97	61.13	74	12.87
2499.66	51.66	Ave.	186	1.9	H	-5.97	45.69	54	8.31
4804.00	58.73	PK	69	1.8	H	1.6	60.33	74	13.67
4804.00	45.33	Ave.	69	1.8	H	1.6	46.93	54	7.07

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 (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Middle Channel (2441 MHz)									
320.81	43.83	QP	32	1.1	H	-10.37	33.46	46.0	12.54
2441.00	105.75	PK	101	2.0	H	-6.19	99.56	/	/
2441.00	94.72	Ave.	101	2.0	H	-6.19	88.53	/	/
2441.00	101.77	PK	210	2.3	V	-6.19	95.58	/	/
2441.00	90.62	Ave.	210	2.3	V	-6.19	84.43	/	/
2320.34	67.59	PK	261	2.1	H	-6.42	61.17	74	12.83
2320.34	51.5	Ave.	261	2.1	H	-6.42	45.08	54	8.92
2349.43	66.96	PK	85	2.1	H	-6.42	60.54	74	13.46
2349.43	51.5	Ave.	85	2.1	H	-6.42	45.08	54	8.92
2487.60	67.26	PK	153	1.5	H	-5.97	61.29	74	12.71
2487.60	51.66	Ave.	153	1.5	H	-5.97	45.69	54	8.31
4882.00	57.36	PK	190	1.2	H	1.83	59.19	74	14.81
4882.00	44.15	Ave.	190	1.2	H	1.83	45.98	54	8.02
High Channel(2480 MHz)									
320.81	43.71	QP	358	2.3	H	-10.37	33.34	46.0	12.66
2480.00	105.38	PK	183	2.0	H	-5.97	99.41	/	/
2480.00	94.29	Ave.	183	2.0	H	-5.97	88.32	/	/
2480.00	103.42	PK	269	1.9	V	-5.97	97.45	/	/
2480.00	101.94	Ave.	269	1.9	V	-5.97	95.97	/	/
2318.49	67.58	PK	276	1.6	H	-6.42	61.16	74	12.84
2318.49	51.5	Ave.	276	1.6	H	-6.42	45.08	54	8.92
2483.99	76.24	PK	186	1.6	H	-5.97	70.27	74	3.73
2483.99	54.16	Ave.	186	1.6	H	-5.97	48.19	54	5.81
2486.47	73.95	PK	5	1.8	H	-5.97	67.98	74	6.02
2486.47	51.66	Ave.	5	1.8	H	-5.97	45.69	54	8.31
4960.00	57.83	PK	274	2.0	H	2.06	59.89	74	14.11
4960.00	43.30	Ave.	274	2.0	H	2.06	45.36	54	8.64

Note:

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

Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

**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**

<b>Temperature:</b>	26 °C
<b>Relative Humidity:</b>	48 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Phil Zhu on 2017-04-13.*

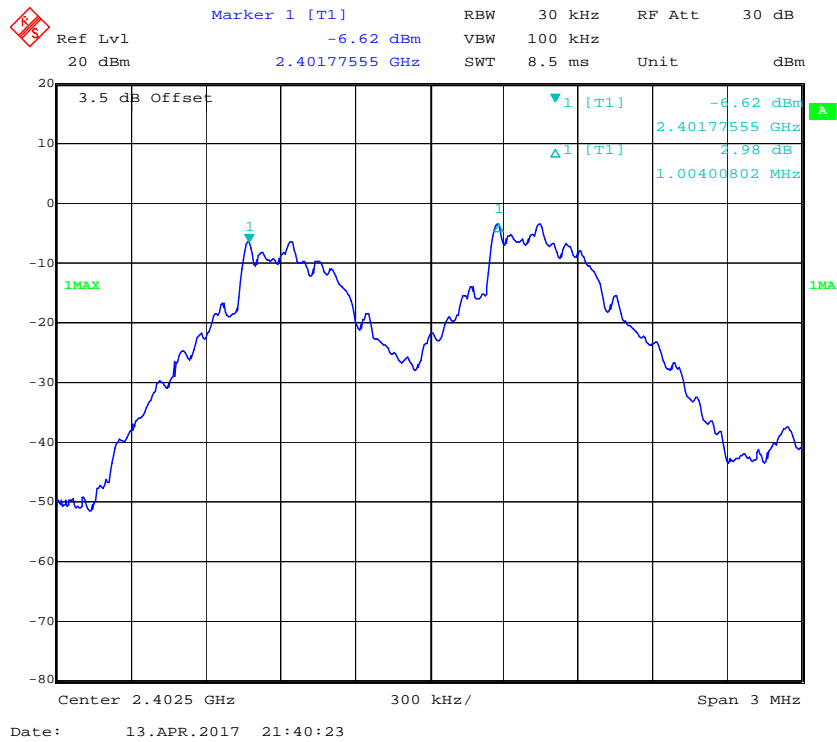
*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table and plots*

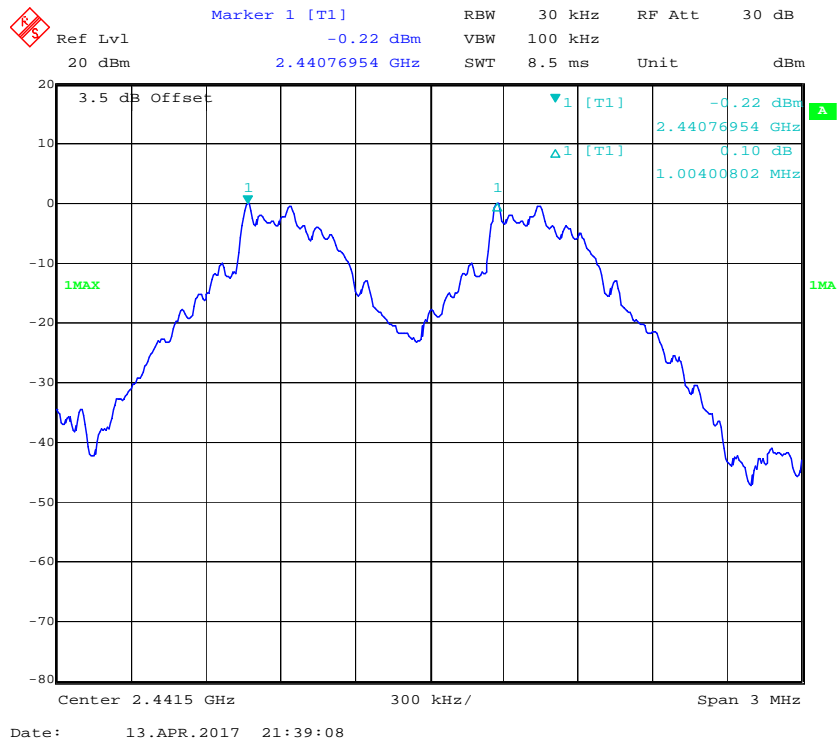
Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	≥Limit (MHz)	Result
<b>BDR (GFSK)</b>	Low	2402	1.004	0.633	Pass
	Adjacent	2403			
	Middle	2441	1.004	0.580	Pass
	Adjacent	2442			
	High	2480	1.004	0.580	Pass
	Adjacent	2479			
<b>EDR (π/4-DQPSK)</b>	Low	2402	1.004	0.813	Pass
	Adjacent	2403			
	Middle	2441	1.004	0.807	Pass
	Adjacent	2442			
	High	2480	1.004	0.813	Pass
	Adjacent	2479			
<b>EDR (8DPSK)</b>	Low	2402	1.004	0.833	Pass
	Adjacent	2403			
	Middle	2441	1.004	0.827	Pass
	Adjacent	2442			
	High	2480	1.004	0.833	Pass
	Adjacent	2479			

Note: Limit = 20 dB bandwidth \*2/3

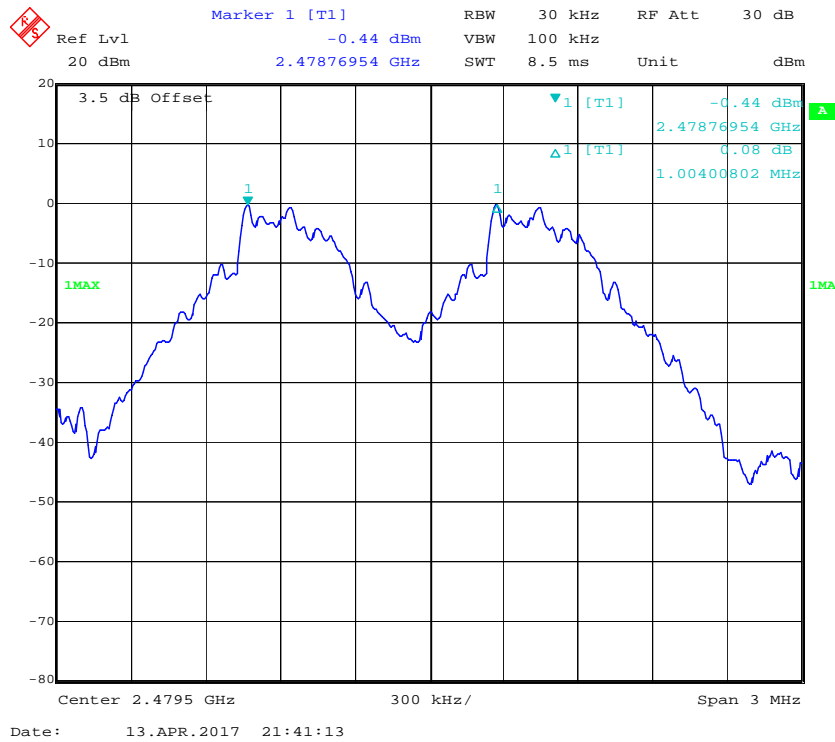
### BDR (GFSK): Low Channel



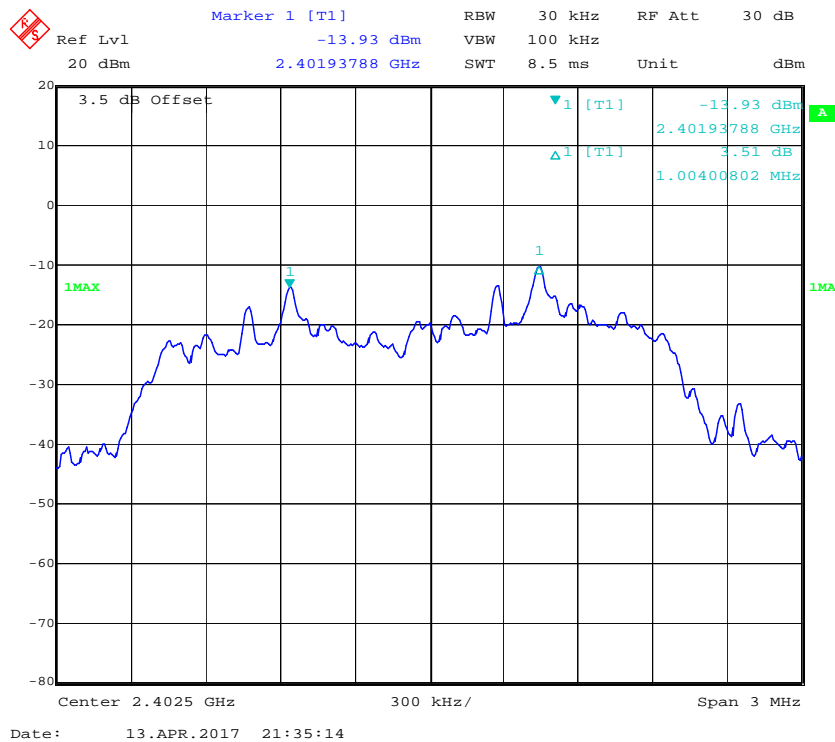
### BDR (GFSK): Middle Channel



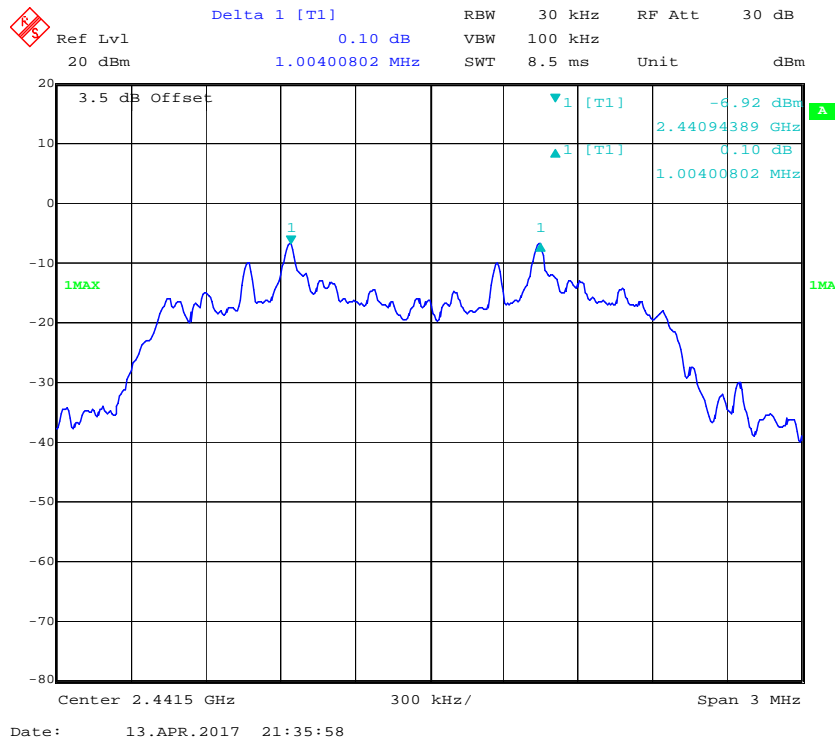
### BDR (GFSK): High Channel



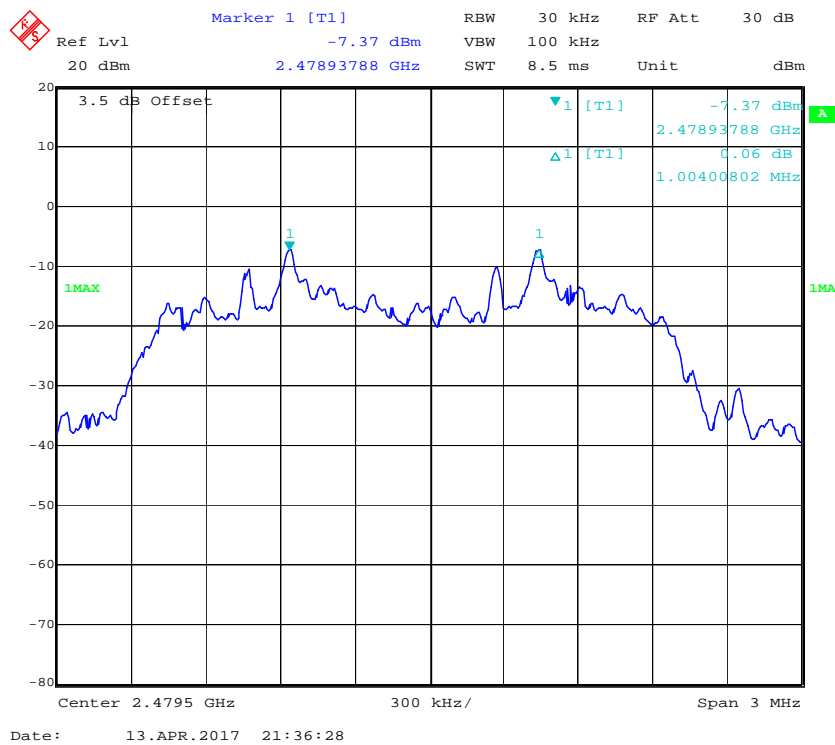
### EDR ( $\pi/4$ -DQPSK): Low Channel



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

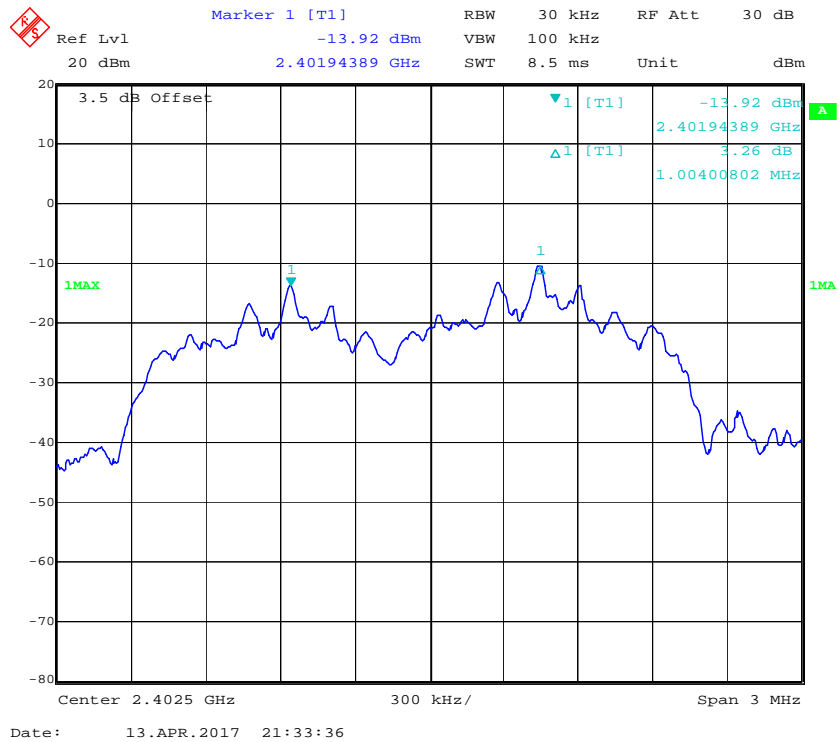


### EDR ( $\pi/4$ -DQPSK): High Channel

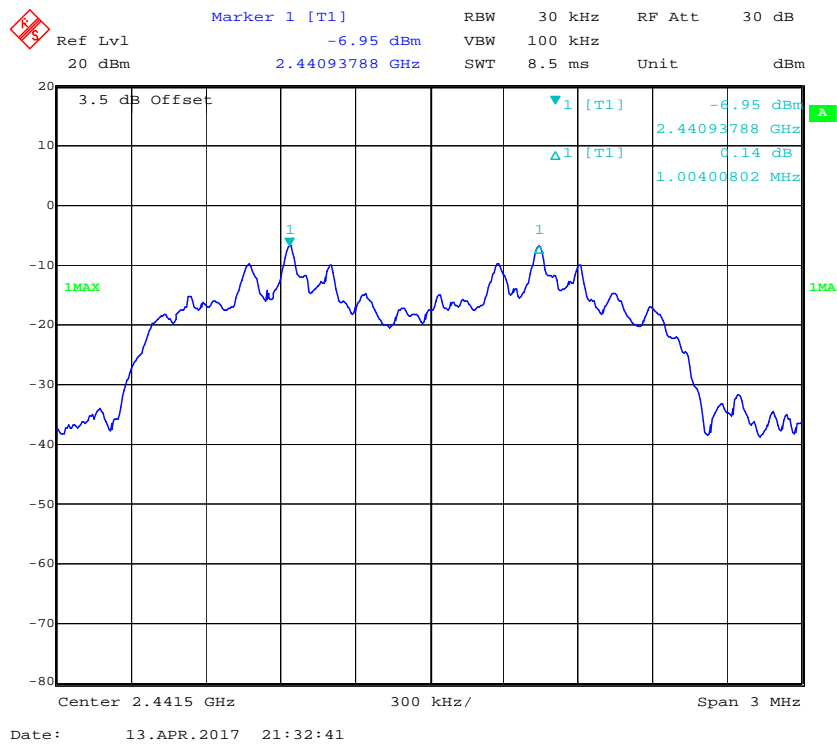




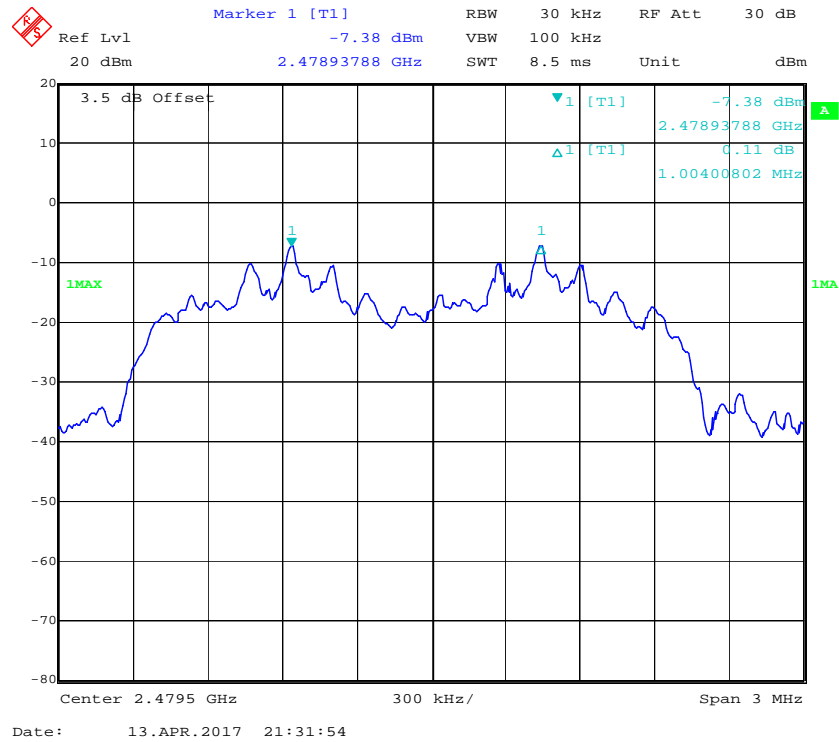
### EDR (8DPSK): Low Channel



### 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**

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	50 %
<b>ATM Pressure:</b>	101.0 kPa

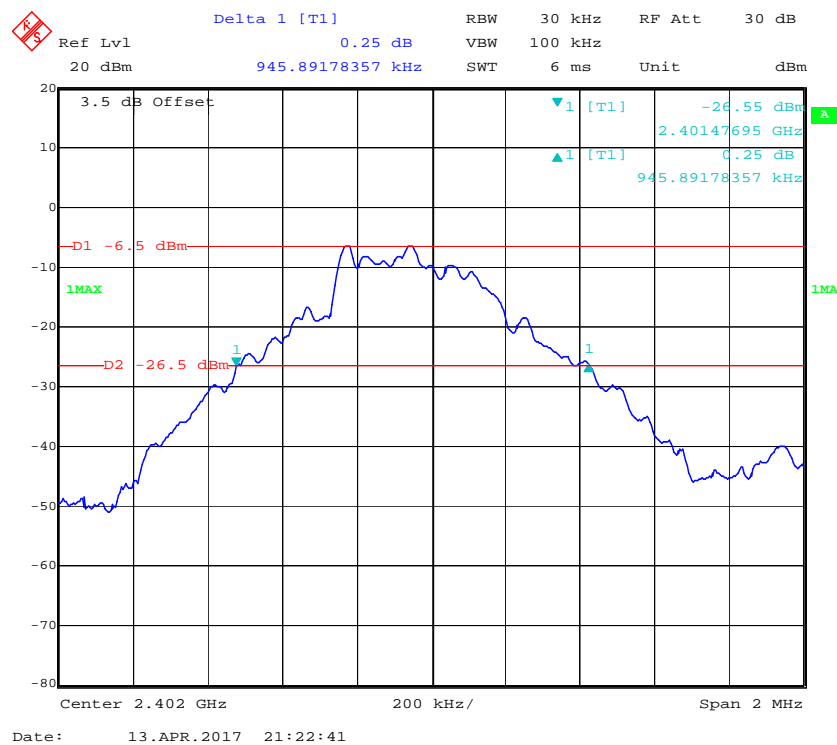
*The testing was performed by Phil Zhu on 2017-04-13.*

EUT operation mode: Transmitting

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

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
<b>BDR (GFSK)</b>	Low	2402	0.95
	Middle	2441	0.87
	High	2480	0.87
<b>EDR (<math>\pi/4</math>-DQPSK)</b>	Low	2402	1.22
	Middle	2441	1.21
	High	2480	1.22
<b>EDR (8DPSK)</b>	Low	2402	1.25
	Middle	2441	1.24
	High	2480	1.25

### BDR (GFSK): Low Channel



A screenshot of a spectrum analyzer interface. The main display shows a blue signal trace on a grid. The vertical axis represents power in dBm, ranging from -80 to 20. The horizontal axis represents frequency in GHz, with a center frequency of 2.441 GHz and a span of 2 MHz. Two horizontal red reference lines are present: one at 0 dBm (labeled 'D1 0 dBm') and another at -20 dBm (labeled 'D2 -20 dBm'). A green trace labeled '1MAX' is also visible. Several markers are placed on the trace: a blue triangle labeled '1 [T1]' at approximately -20 dBm, a green triangle labeled '1 [T1]' at approximately -10 dBm, and a green triangle labeled '1 [T1]' at approximately -20 dBm. The top of the screen displays various parameters: 'Ref Lvl' (20 dBm), 'Marker 1 [T1]' (-20.60 dBm), 'RBW' (30 kHz), 'VBW' (100 kHz), 'RF Att' (30 dB), 'Unit' (dBm), 'SWT' (6 ms), and '3.5 dB Offset'. The bottom of the screen shows the date and time: 'Date: 13.APR.2017 21:24:31'.

Ref Lvl 20 dBm  
 Marker 1 [T1] -20.60 dBm  
 RBW 30 kHz  
 VBW 100 kHz  
 RF Att 30 dB  
 Unit dBm  
 SWT 6 ms  
 3.5 dB Offset

2.44047295 GHz  
 -20.60 dBm  
 2.44047295 GHz  
 0.28 dB  
 869.73947896 kHz

1MAX  
 1 [T1]  
 1 [T1]  
 1 [T1]

Center 2.441 GHz  
 200 kHz/  
 Span 2 MHz

Date: 13.APR.2017 21:24:31

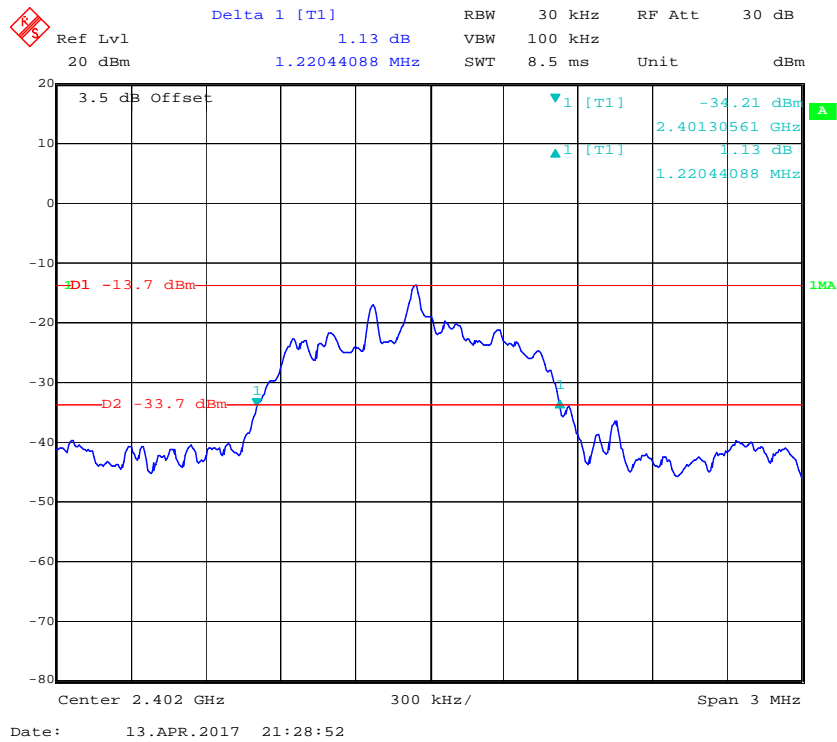
Delta 1 [T1] RBW 30 kHz RF Att 30 dB  
 Ref Lvl -0.20 dB VBW 100 kHz  
 20 dBm 869.73947896 kHz SWT 6 ms Unit dBm

3.5 dB Offset  
 D1 -0.2 dBm  
 D2 -20.2 dBm  
 1MAX  
 1 [T1] -20.47 dBm  
 2.47947295 GHz  
 -0.20 dB  
 869.73947896 kHz  
 1 [T1]

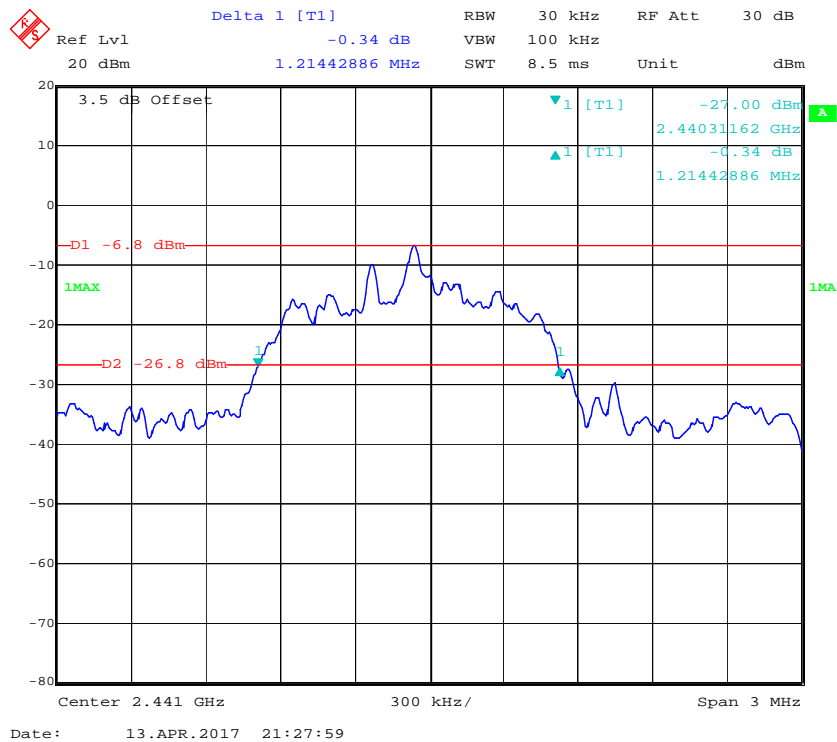
Center 2.48 GHz 200 kHz/ Span 2 MHz

Date: 13.APR.2017 21:25:26

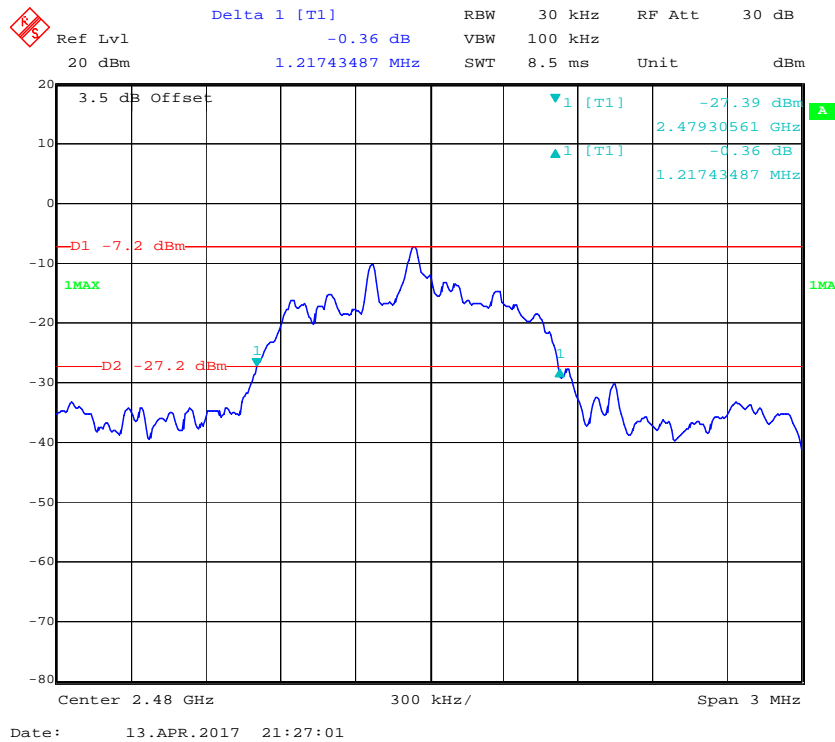
### EDR ( $\pi/4$ -DQPSK): Low Channel



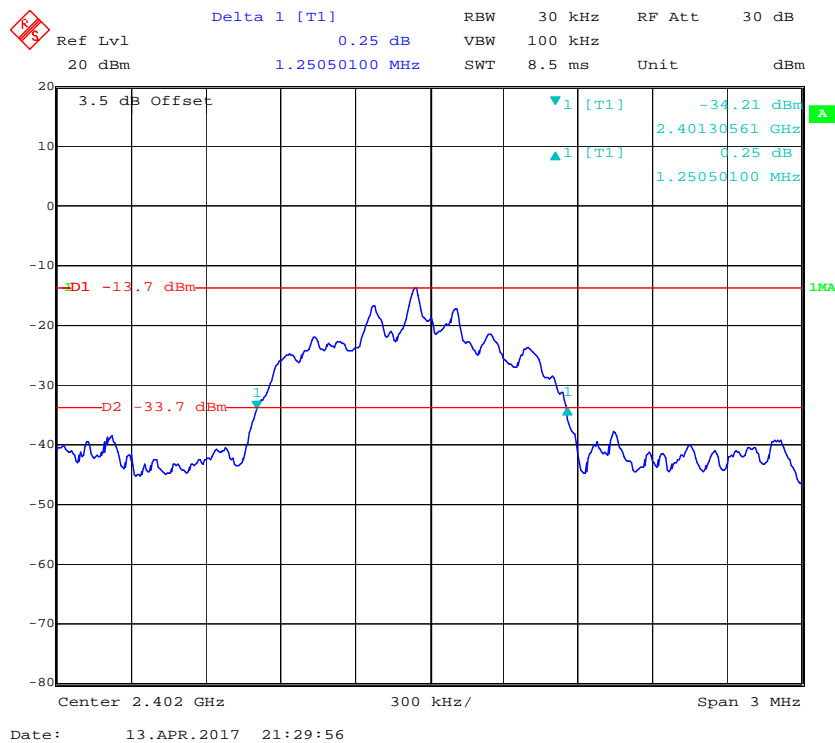
### EDR ( $\pi/4$ -DQPSK): Middle Channel



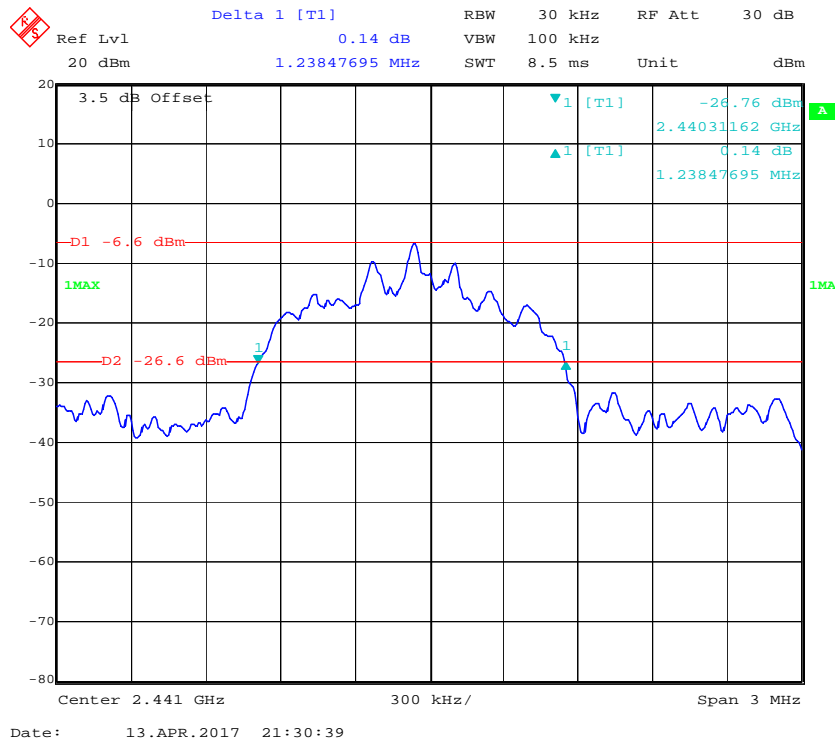
### EDR ( $\pi/4$ -DQPSK): High Channel



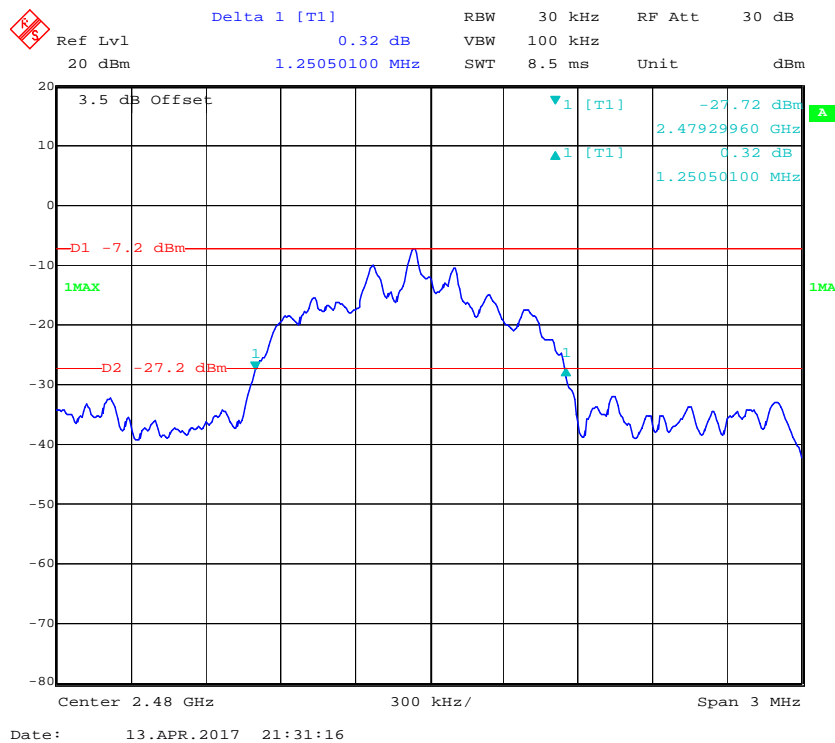
### EDR (8DPSK): Low Channel



### 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**

<b>Temperature:</b>	26 °C
<b>Relative Humidity:</b>	49 %
<b>ATM Pressure:</b>	101.0 kPa

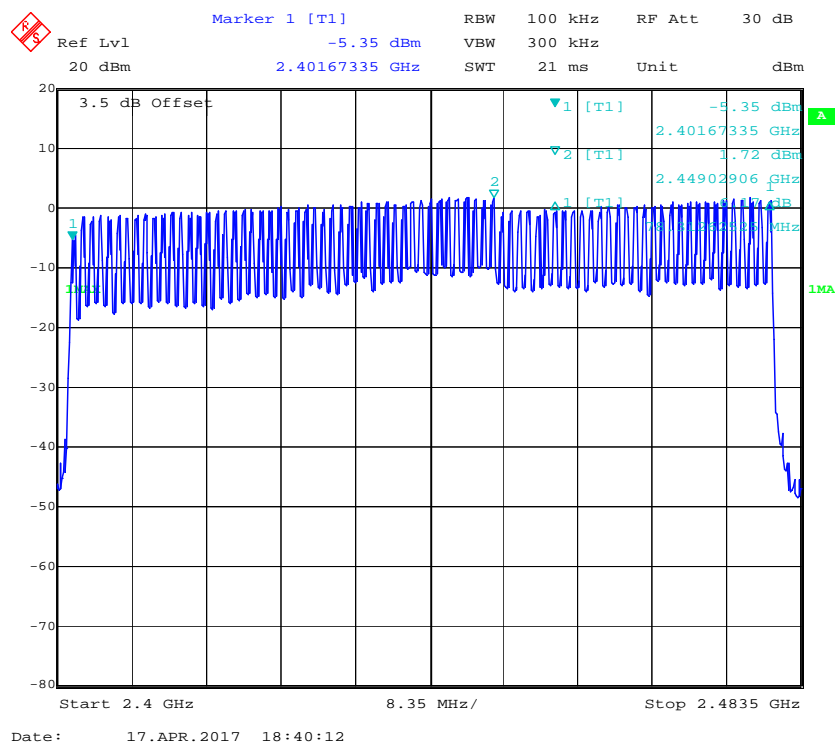
*The testing was performed by Phil Zhu on 2017-04-17.*

*EUT operation mode: Transmitting*

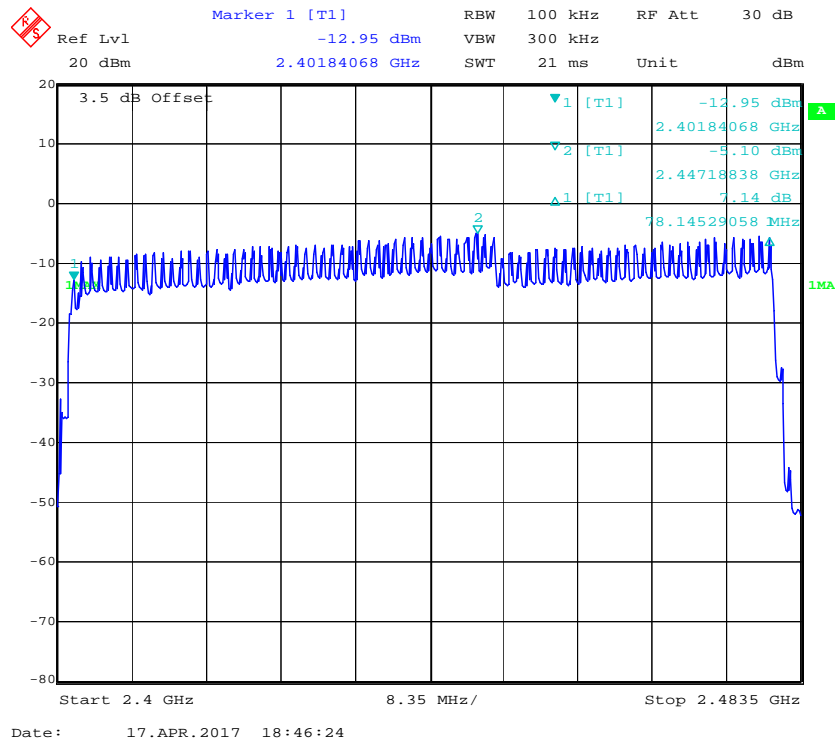
*Test Result: Compliance. Please refer to following table and plots.*

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

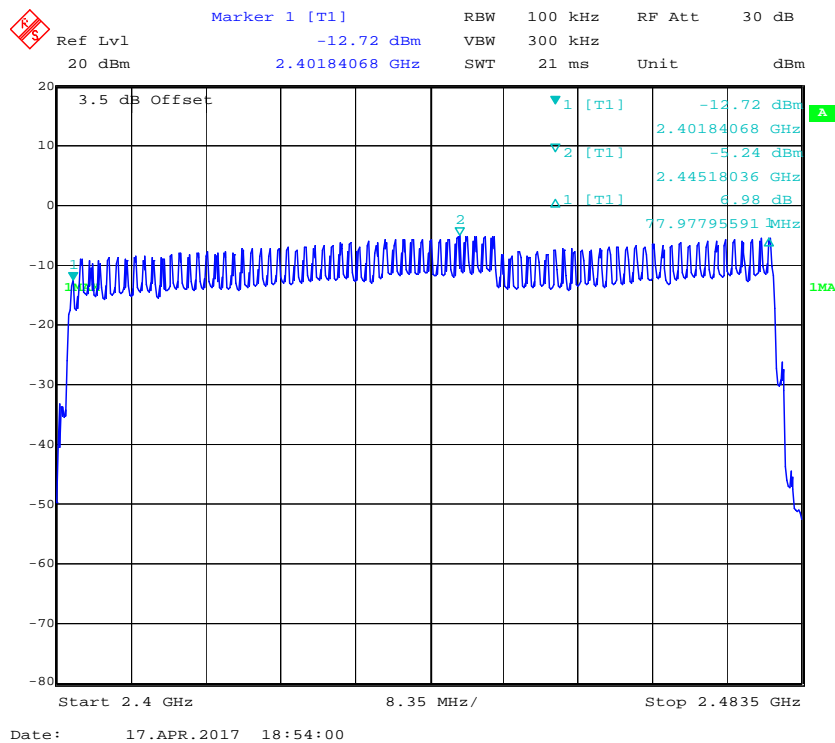
### BDR (GFSK): Number of Hopping Channels



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



### EDR (8DPSK): Number of Hopping Channels



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

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

**Test Procedure**

The EUT was worked in channel hopping; 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**

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	48 %
<b>ATM Pressure:</b>	101.0 kPa

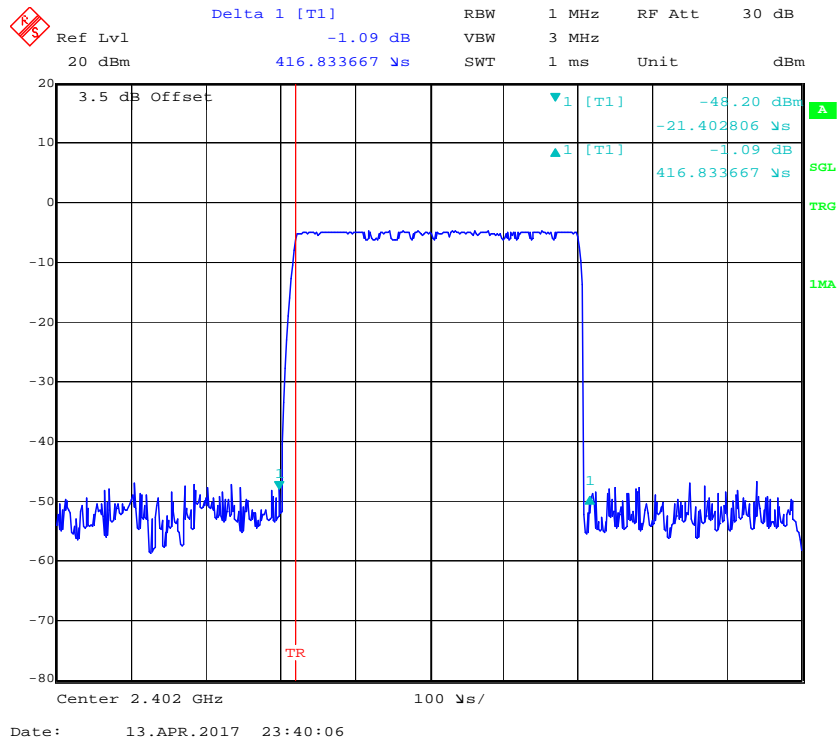
*The testing was performed by Phil Zhu on 2017-04-13.*

*EUT operation mode: Transmitting*

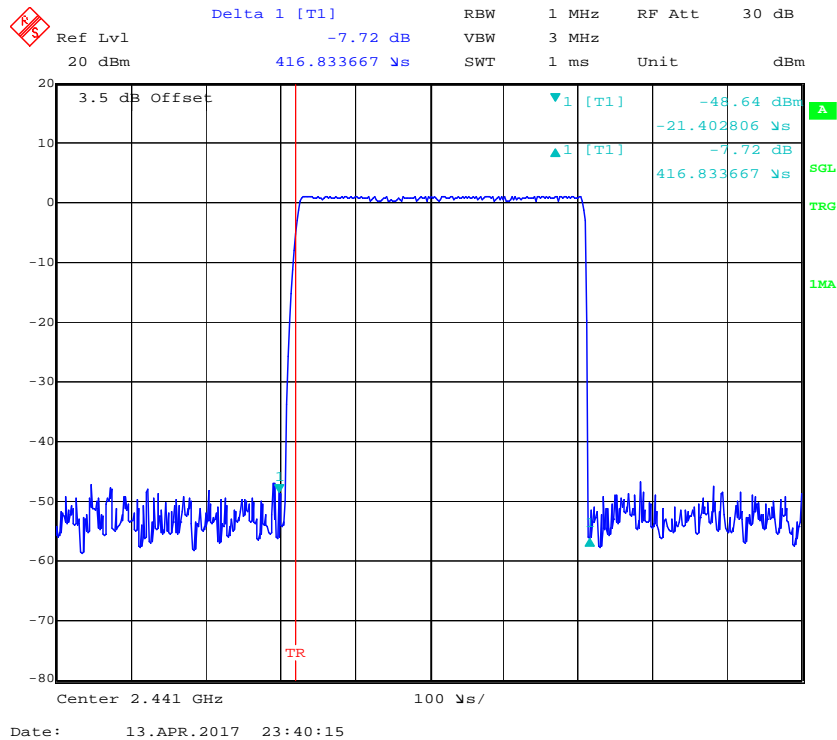
*Test Result: Compliance. Please refer to following table and plots.*

Mode		Channel	Pulse Width (ms)	Dwell Time (S)	Limit (S)	Result
BDR (GFSK)	DH 1	Low	0.417	0.133	0.4	Pass
		Middle	0.417	0.133	0.4	Pass
		High	0.417	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	1.693	0.271	0.4	Pass
		High	1.693	0.271	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6s				
	DH 5	Low	2.966	0.316	0.4	Pass
		Middle	2.966	0.316	0.4	Pass
		High	2.966	0.316	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6s				
EDR ( $\pi/4$ -DQPSK)	2DH 1	Low	0.431	0.138	0.4	Pass
		Middle	0.431	0.138	0.4	Pass
		High	0.431	0.138	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	2.966	0.316	0.4	Pass
		Middle	2.966	0.316	0.4	Pass
		High	2.966	0.316	0.4	Pass
		Note: 2DH5:Dwell time = Pulse time*(1600/6/79)*31.6s				
EDR (8DPSK)	3DH 1	Low	0.431	0.138	0.4	Pass
		Middle	0.431	0.138	0.4	Pass
		High	0.431	0.138	0.4	Pass
		Note: 3DH1:Dwell time = Pulse time*(1600/2/79)*31.6s				
	3DH 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: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6s				
	3DH 5	Low	2.966	0.316	0.4	Pass
		Middle	2.966	0.316	0.4	Pass
		High	2.966	0.316	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6s				

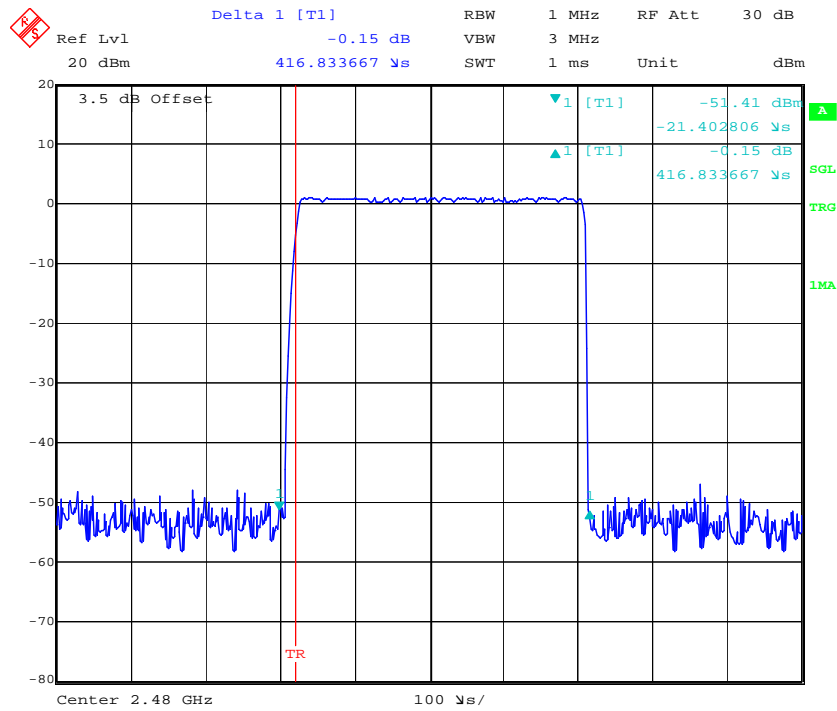
### BDR (GFSK): Pulse time, Low Channel, DH1



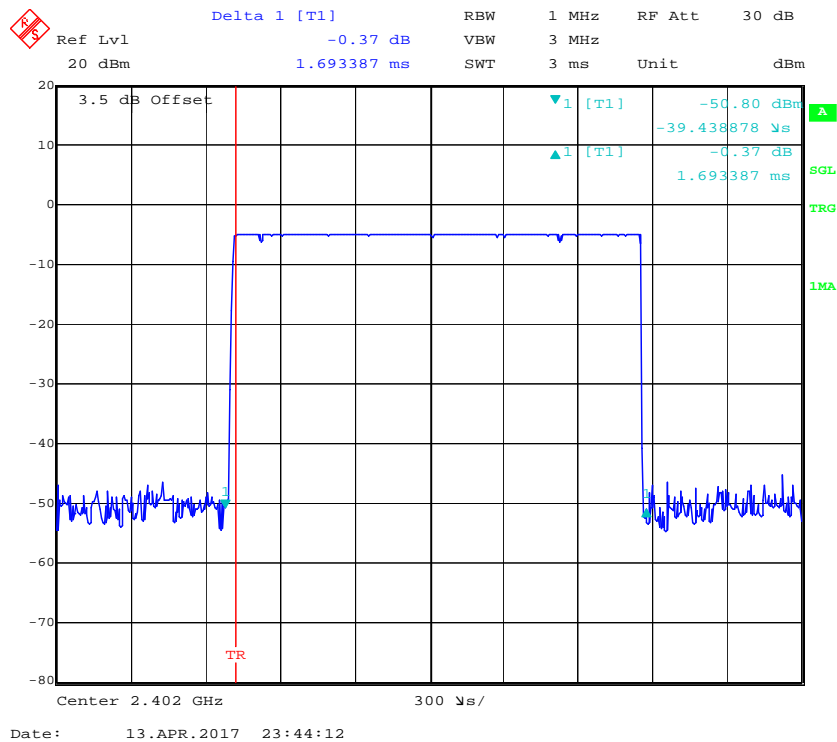
### Pulse time, Middle Channel, DH1



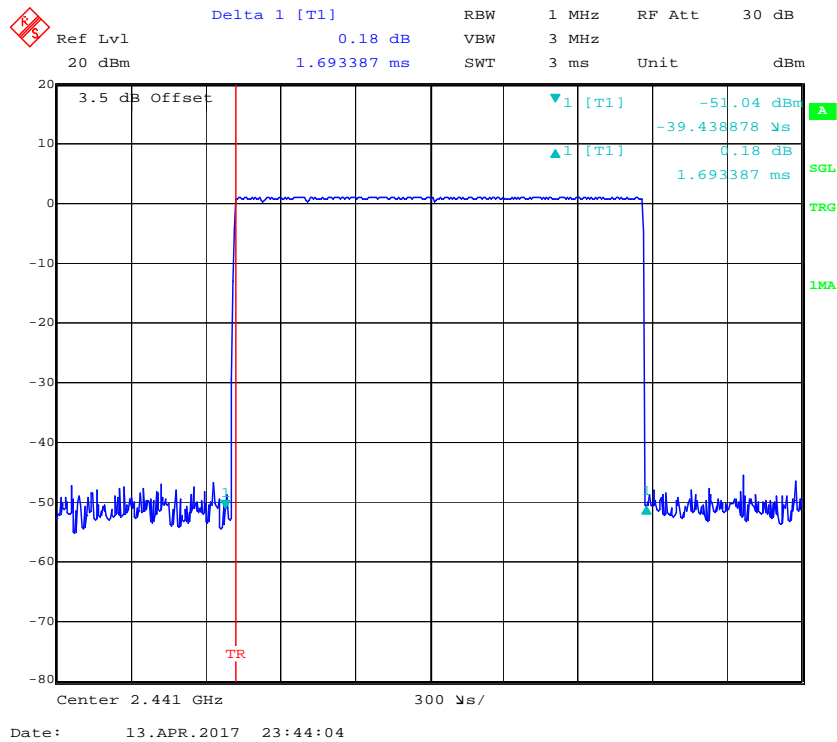
### Pulse time, High Channel, DH1



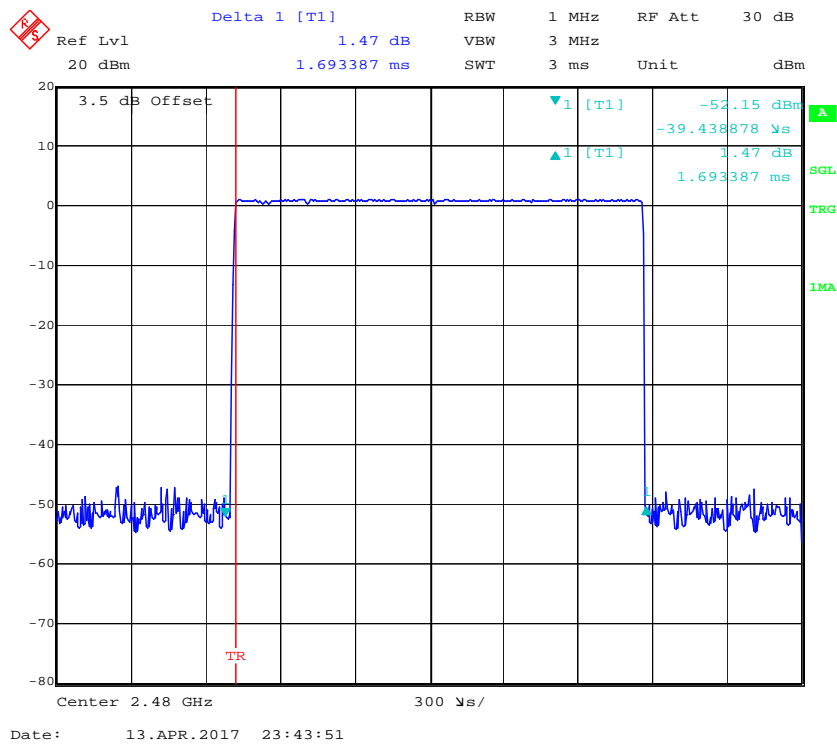
### Pulse time, Low Channel, DH3



### Pulse time, Middle Channel, DH3

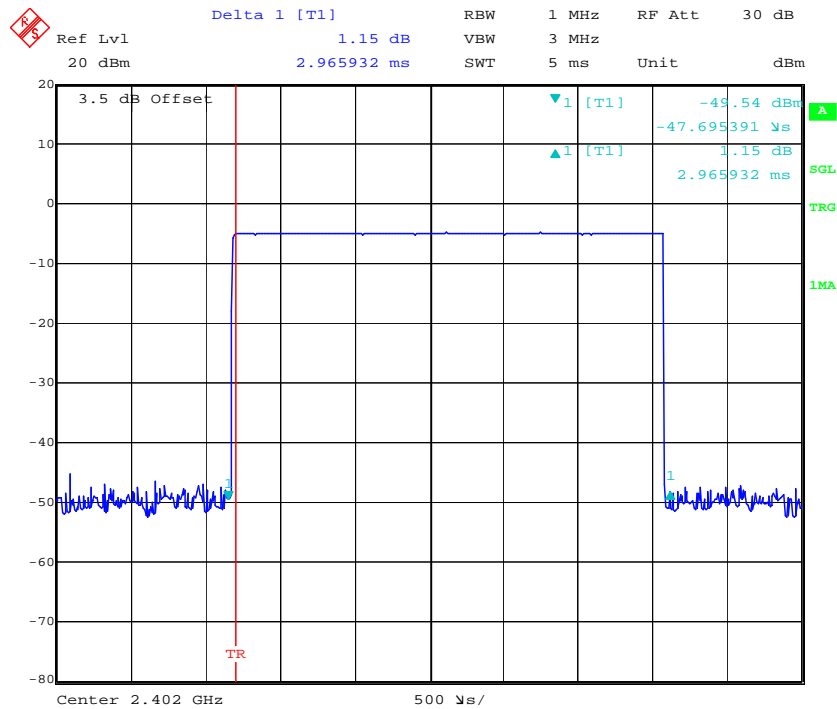


### Pulse time, High Channel, DH3



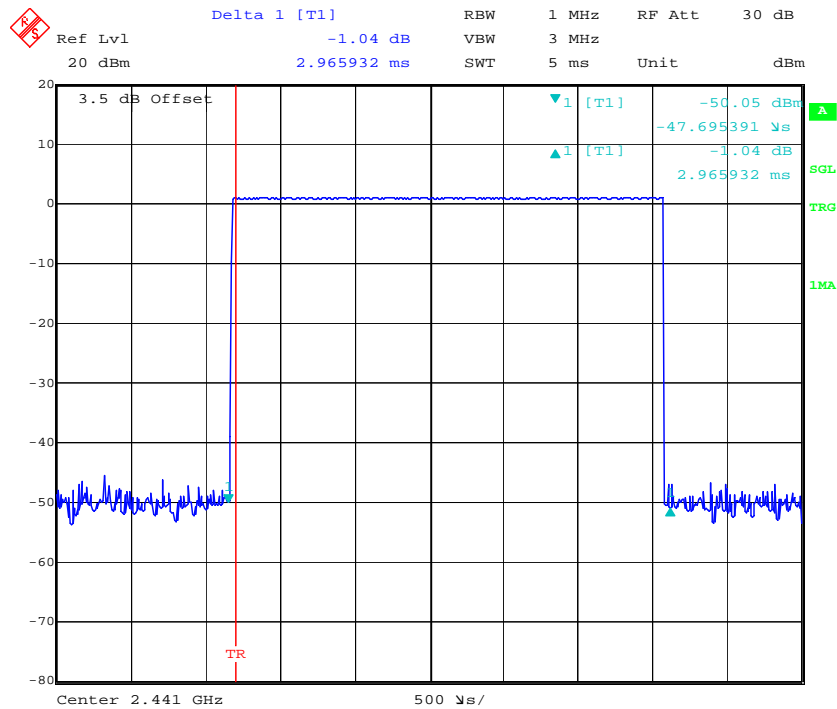


### Pulse time, Low Channel, DH5

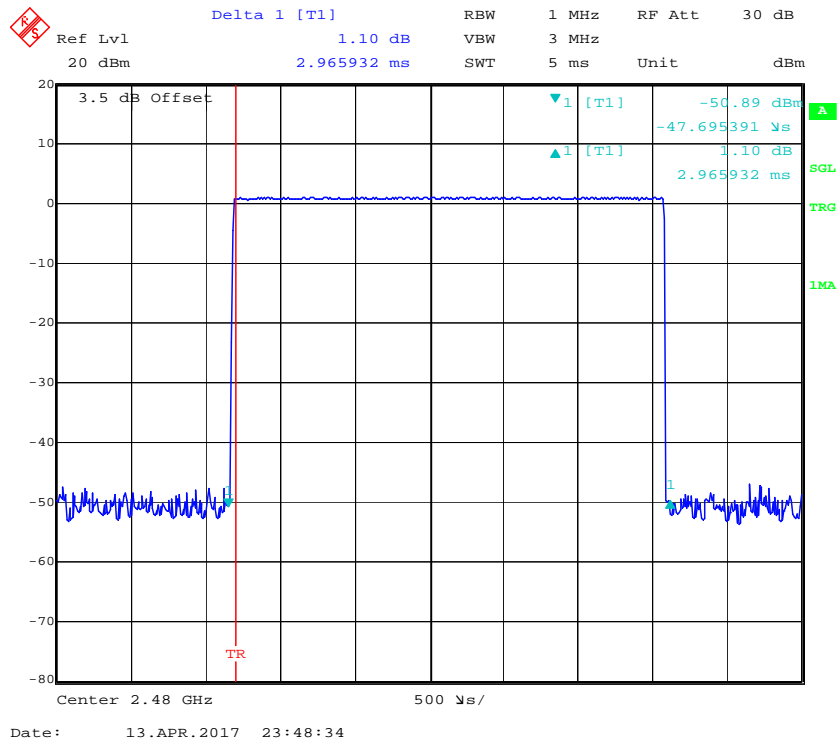
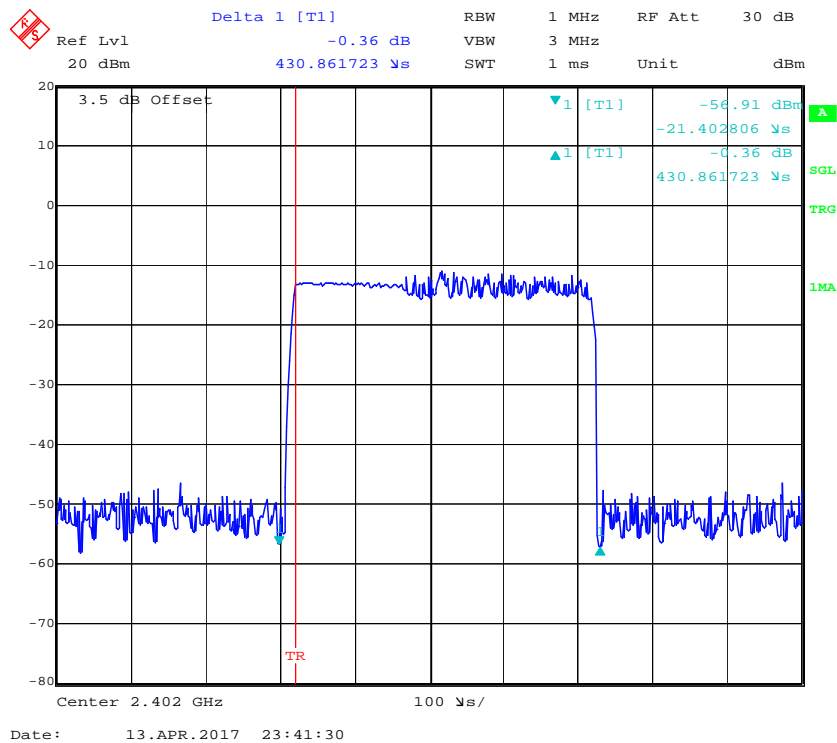


Date: 13.APR.2017 23:48:05

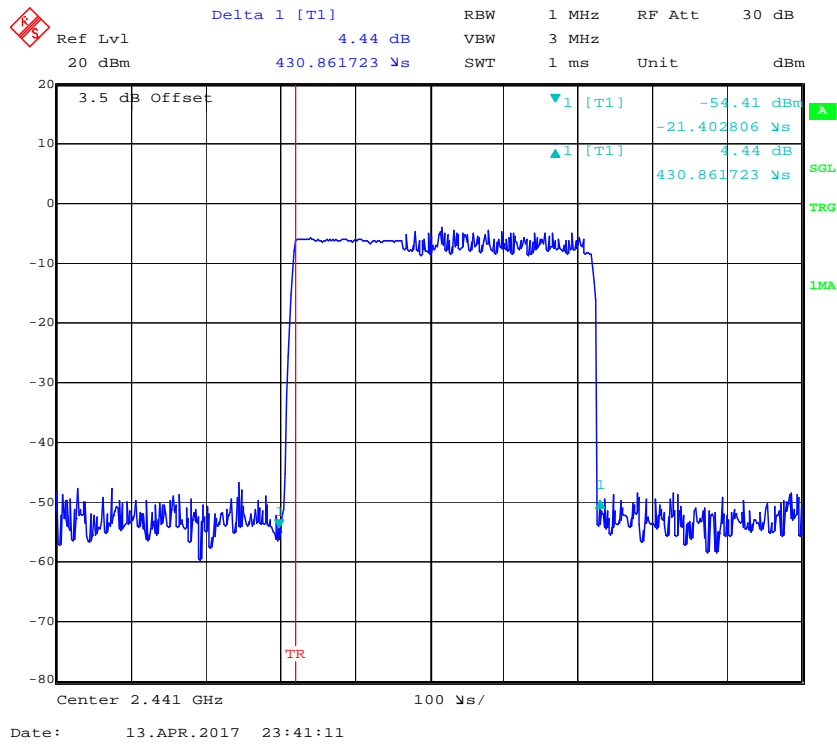
### Pulse time, Middle Channel, DH5



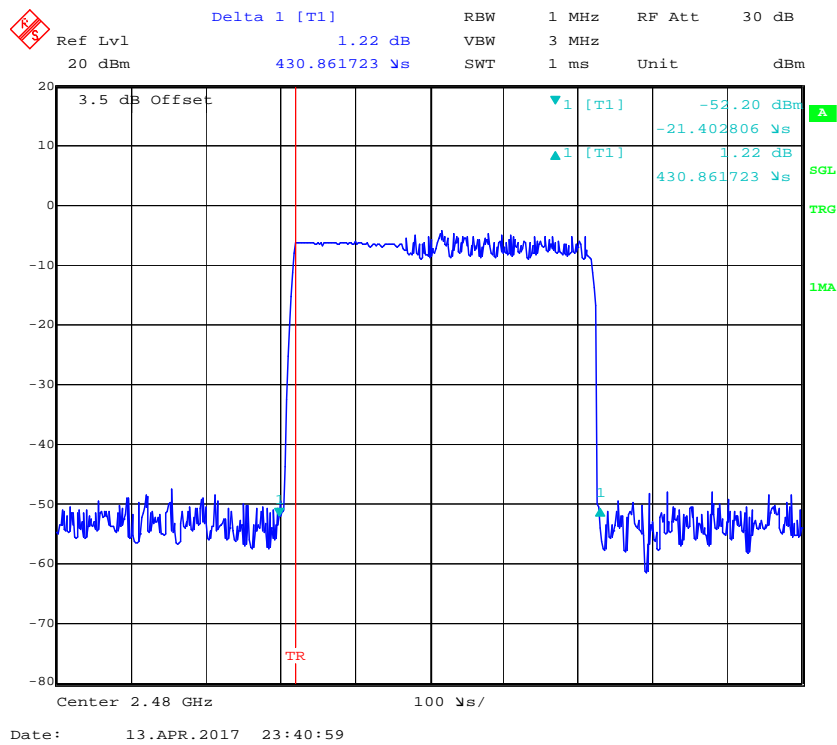
Date: 13.APR.2017 23:48:25

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

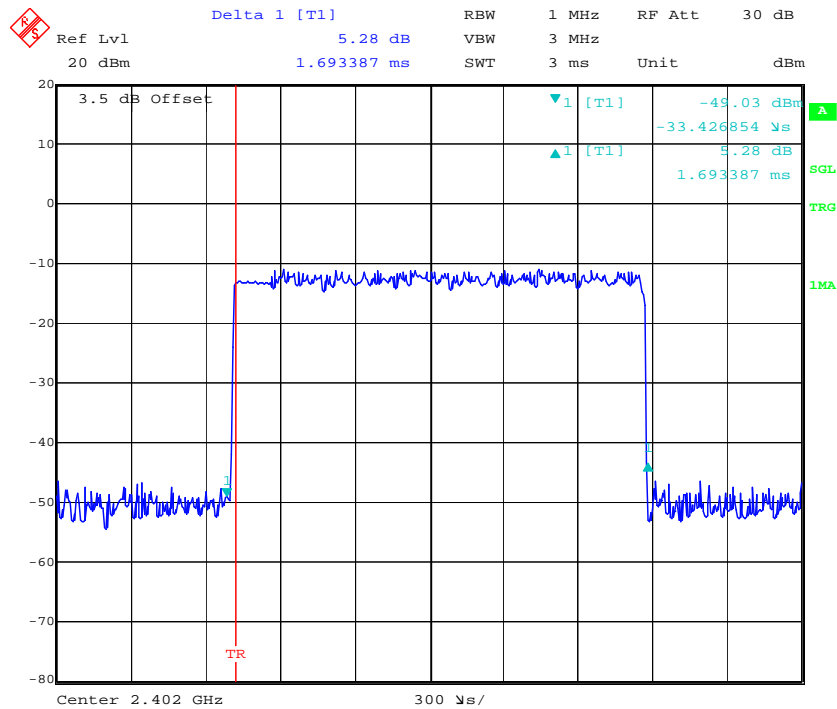
### Pulse time, Middle Channel, 2DH1



### Pulse time, High Channel, 2DH1

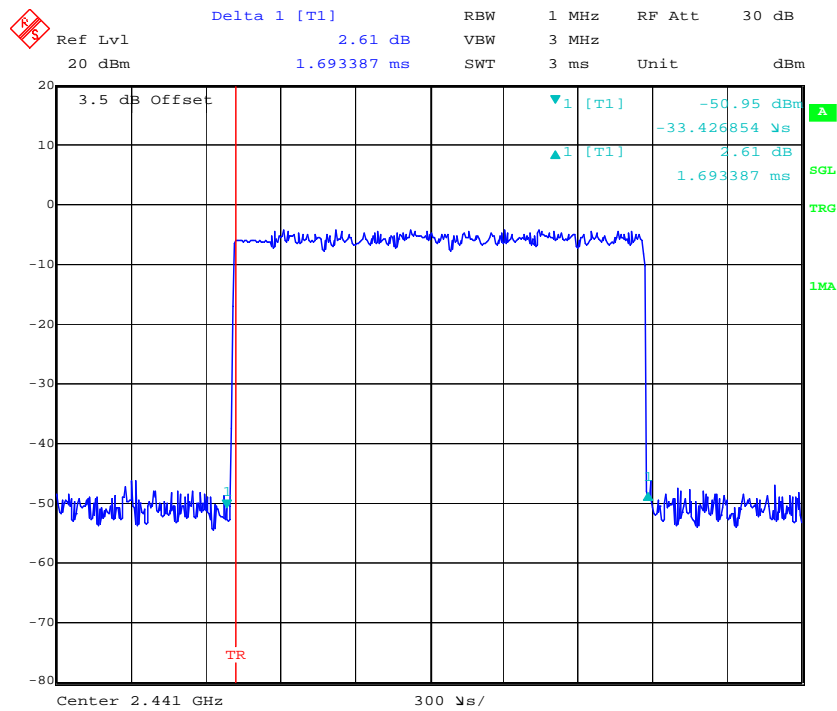


### Pulse time, Low Channel, 2DH3



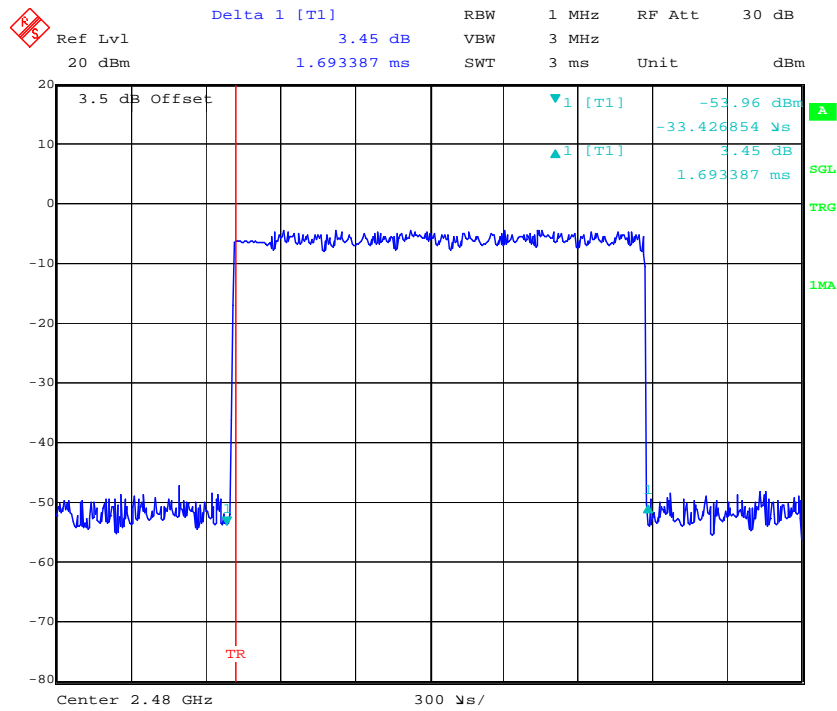
Date: 13.APR.2017 23:45:25

### Pulse time, Middle Channel, 2DH3

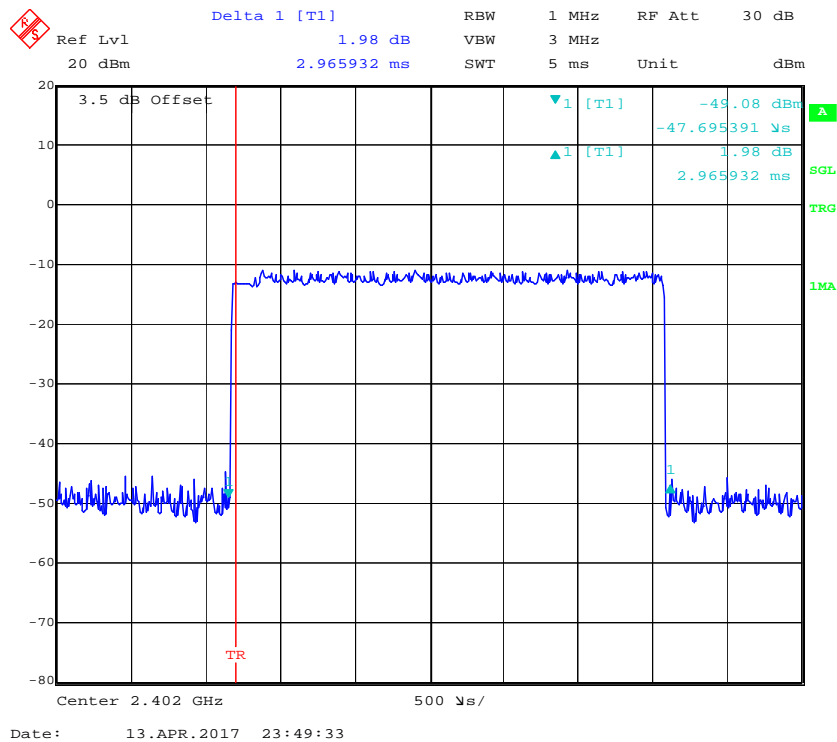


Date: 13.APR.2017 23:45:52

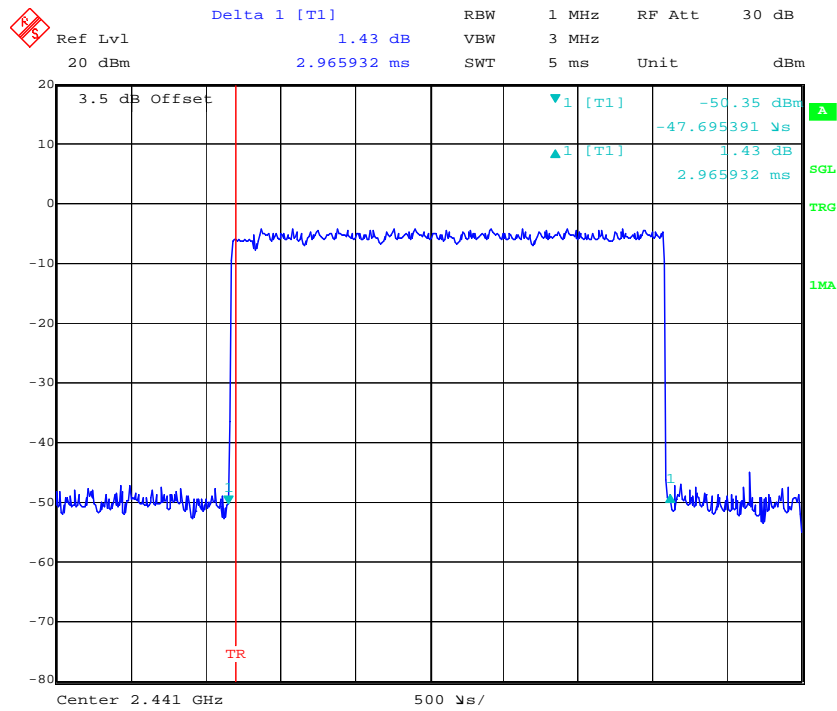
### Pulse time, High Channel, 2DH3



### Pulse time, Low Channel, 2DH5

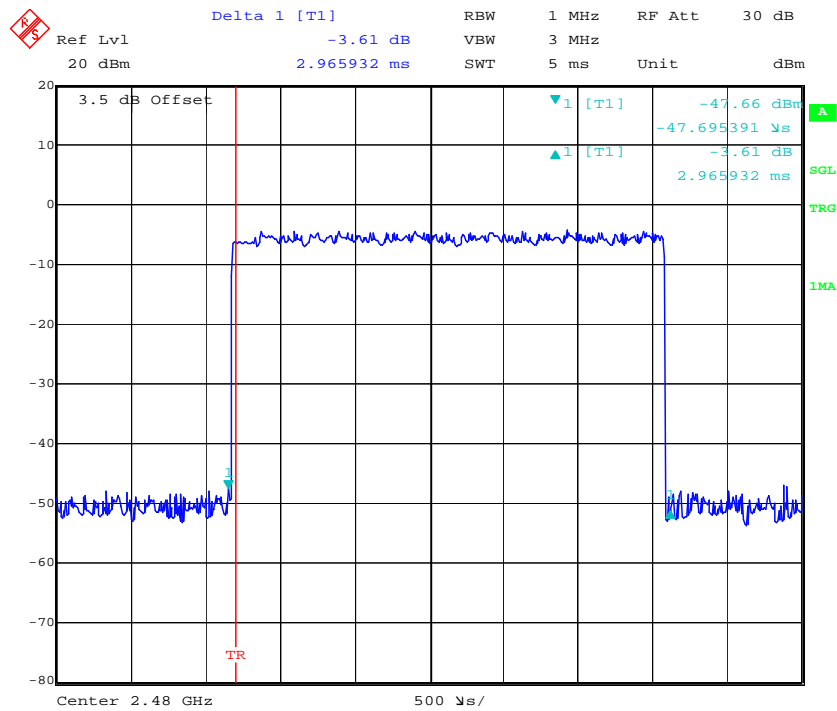


### Pulse time, Middle Channel, 2DH5



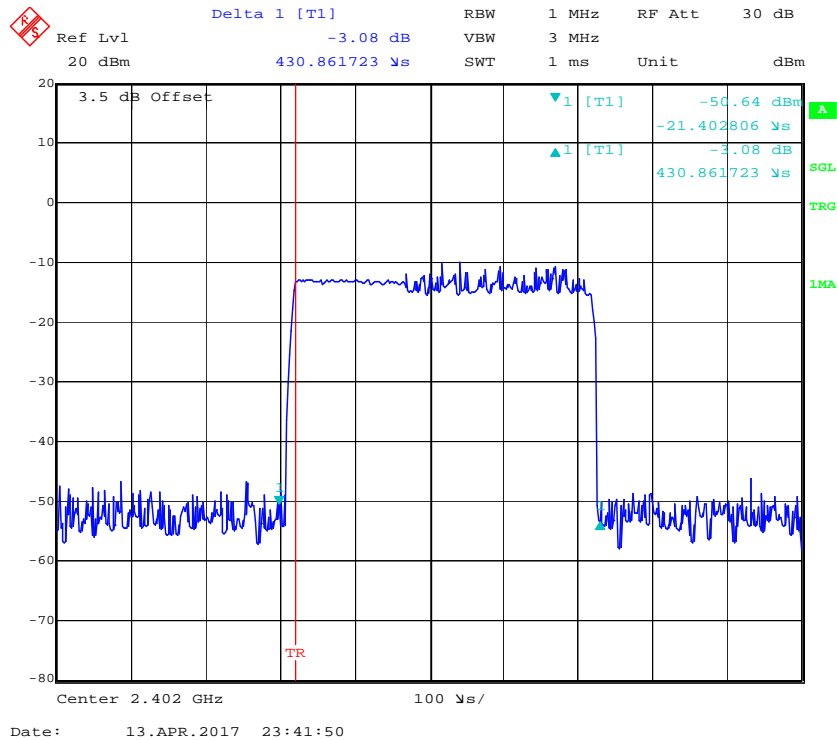
Date: 13.APR.2017 23:49:16

### Pulse time, High Channel, 2DH5

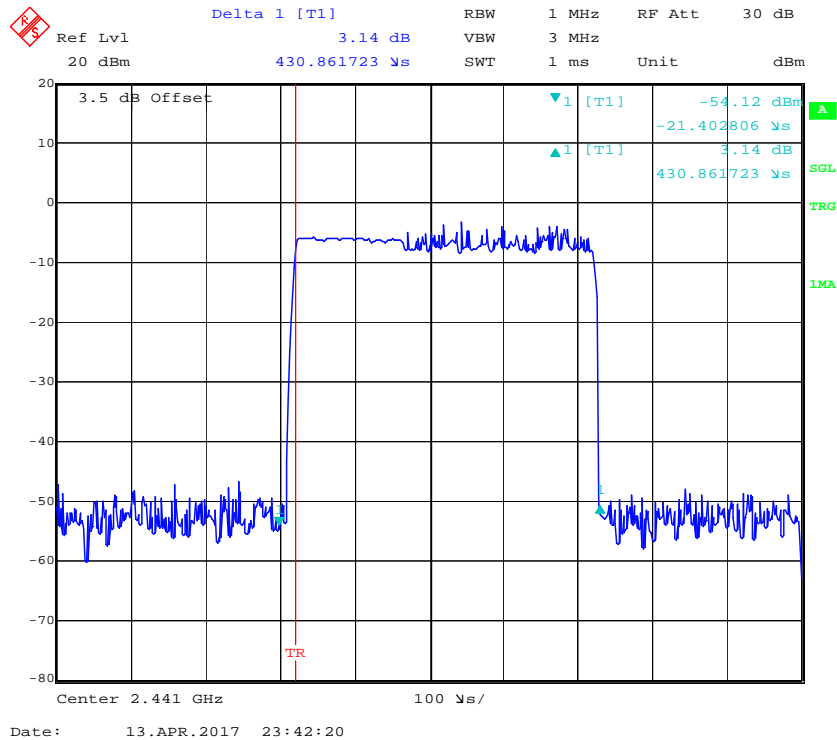


Date: 13.APR.2017 23:49:07

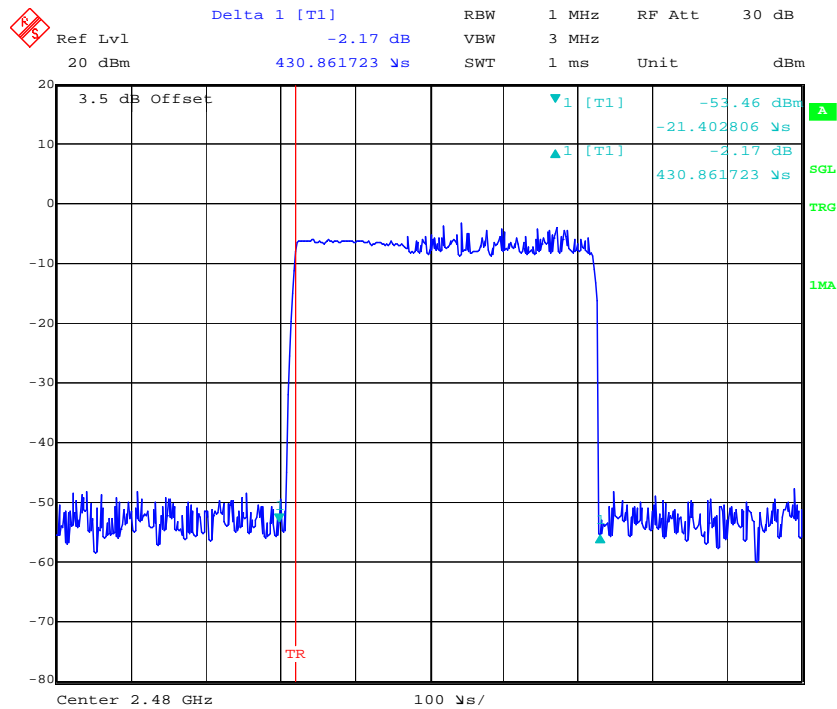
### EDR (8DPSK): Pulse time, Low Channel, 3DH1



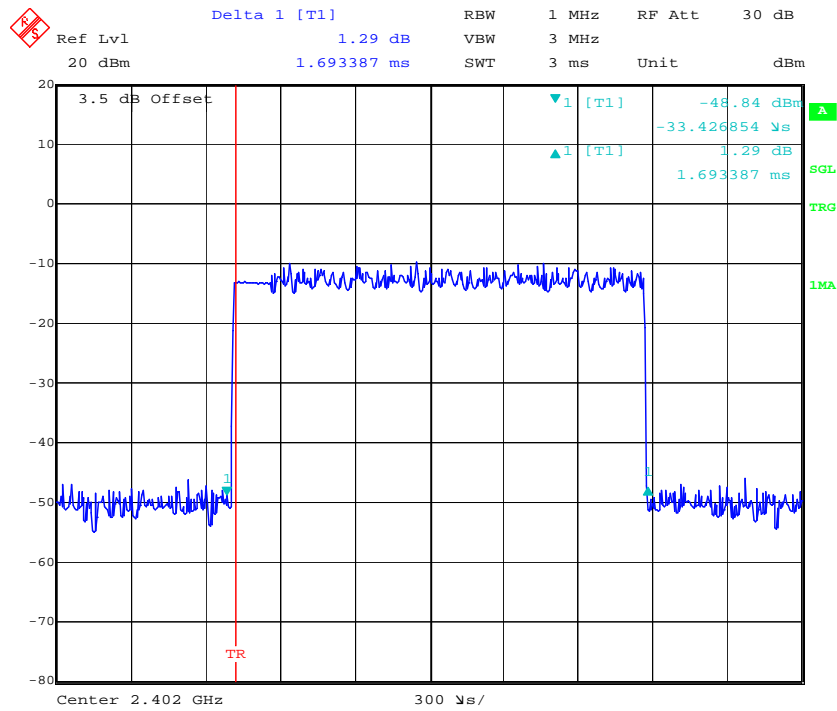
### Pulse time, Middle Channel, 3DH1



### Pulse time, High Channel, 3DH1



### Pulse time, Low Channel, 3DH3





Ref Lvl 20 dBm Delta 1 [T1] -3.65 dB RBW 1 MHz RF Att 30 dB

20 dBm 1.693387 ms SWT 3 ms Unit dBm

3.5 dB Offset

1 [T1] -45.18 dBm

1 [T1] -33.428854 μs

1 [T1] -3.65 dB

1.693387 ms

TR

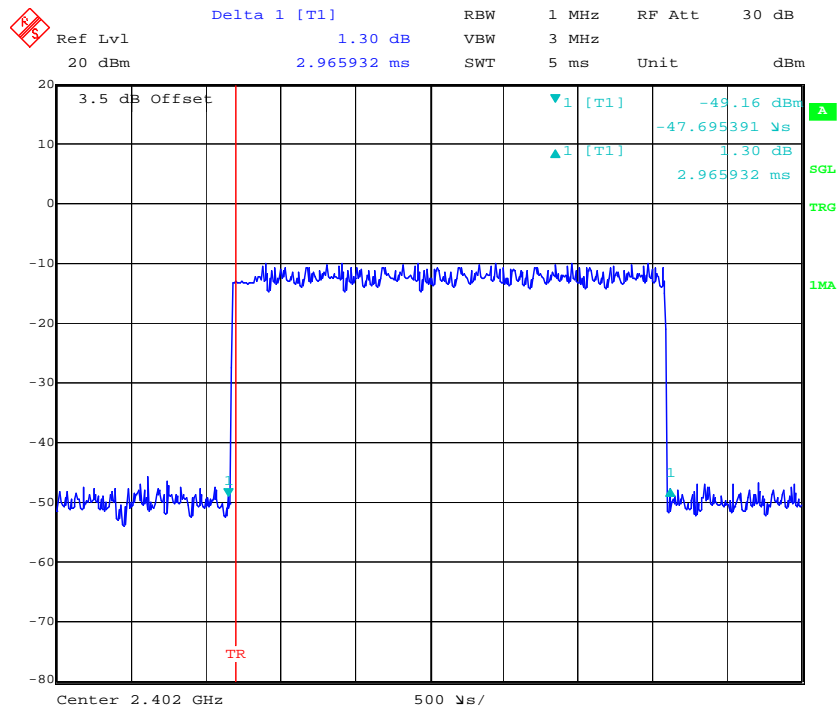
Center 2.441 GHz 300 MHz

Date: 13.APR.2017 23:46:45

[illegible]

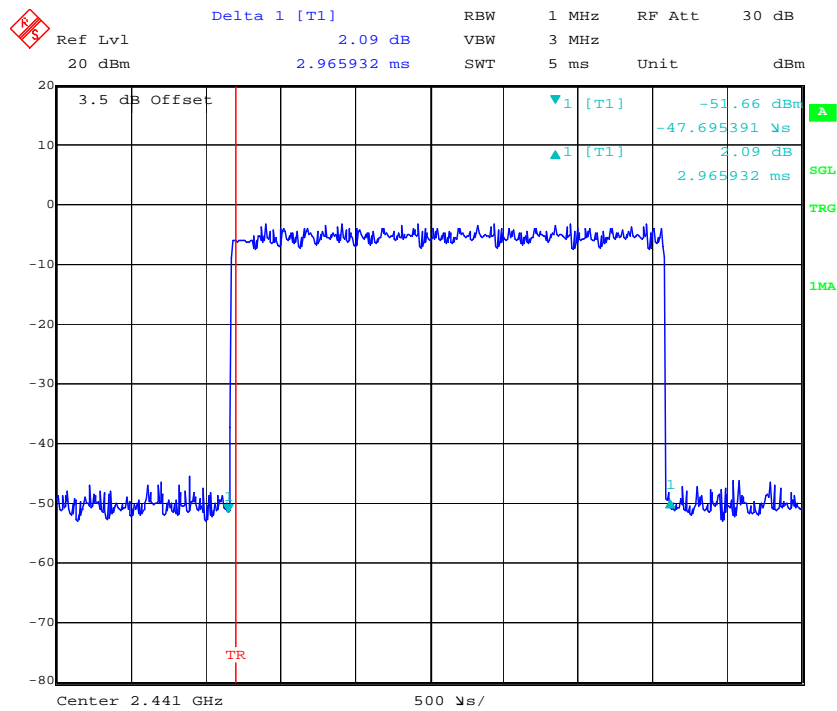
Date: 13.APR.2017 23:46:36

### Pulse time, Low Channel, 3DH5



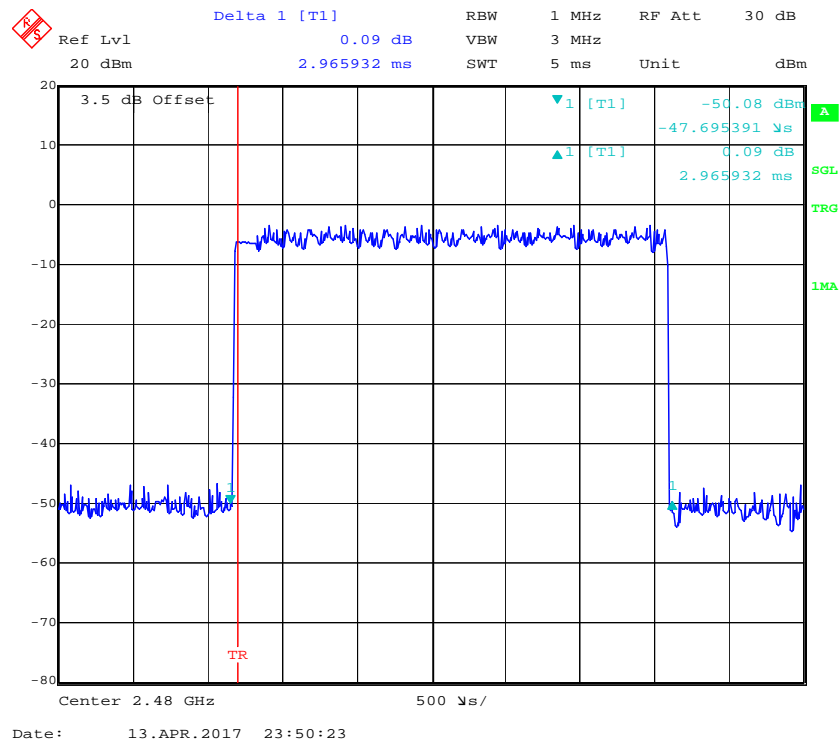
Date: 13.APR.2017 23:49:58

### Pulse time, Middle Channel, 3DH5



Date: 13.APR.2017 23:50:13

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:	25 °C
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Phil Zhu on 2017-04-13.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table.

Mode	Channel	Frequency (MHz)	Reading Power (dBm)	Peak Output Power (mW)	Limit (mW)
<b>BDR (GFSK)</b>	Low	2402	-4.78	0.33	1000
	Middle	2441	1.28	1.34	1000
	High	2480	1.22	1.32	1000
<b>EDR (<math>\pi/4</math>-DQPSK)</b>	Low	2402	-9.92	0.10	1000
	Middle	2441	-3.32	0.47	1000
	High	2480	-3.48	0.45	1000
<b>EDR (8DPSK)</b>	Low	2402	-9.12	0.12	1000
	Middle	2441	-2.44	0.57	1000
	High	2480	-2.64	0.54	1000

## 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

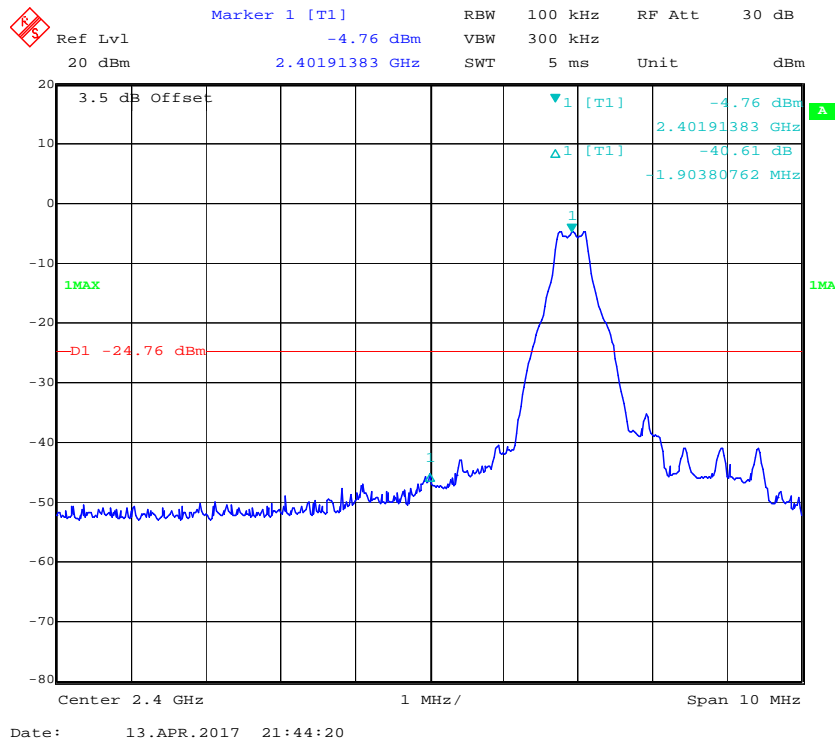
Temperature:	25 °C
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

*The testing was performed by Phil Zhu on 2017-04-13.*

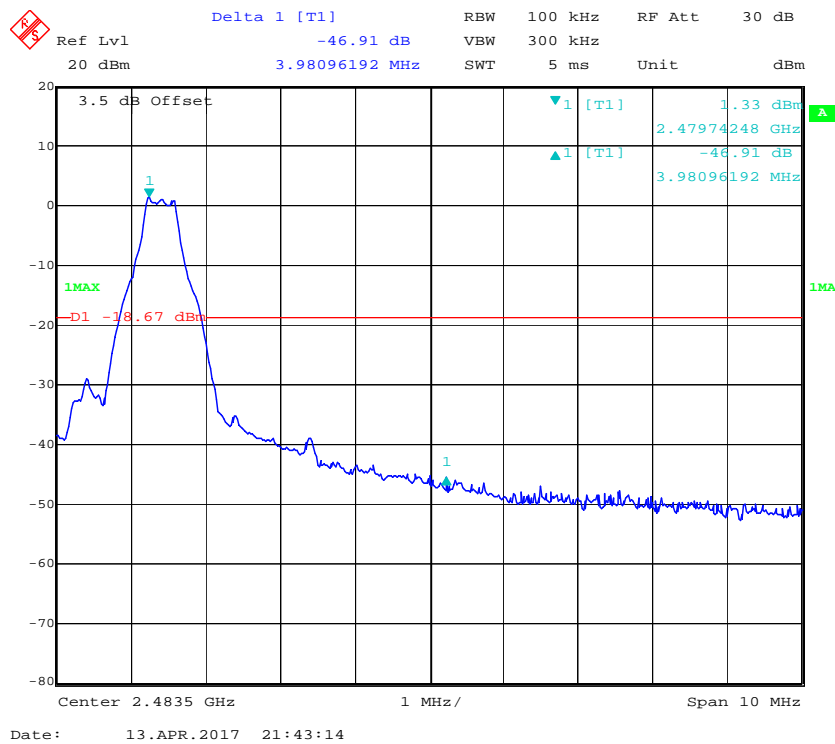
*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following plots.*

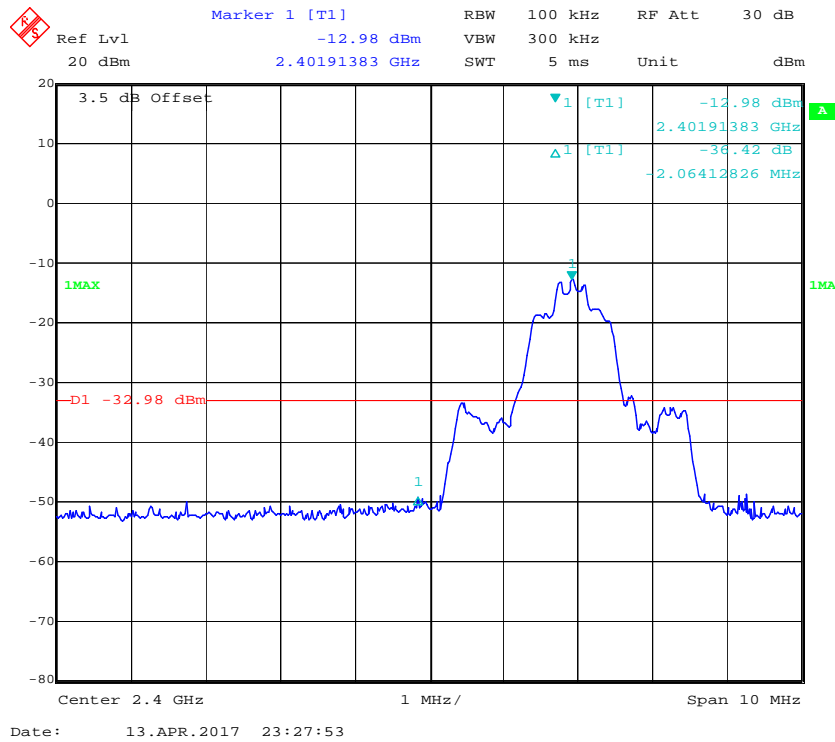
### BDR (GFSK): Band Edge-Left Side



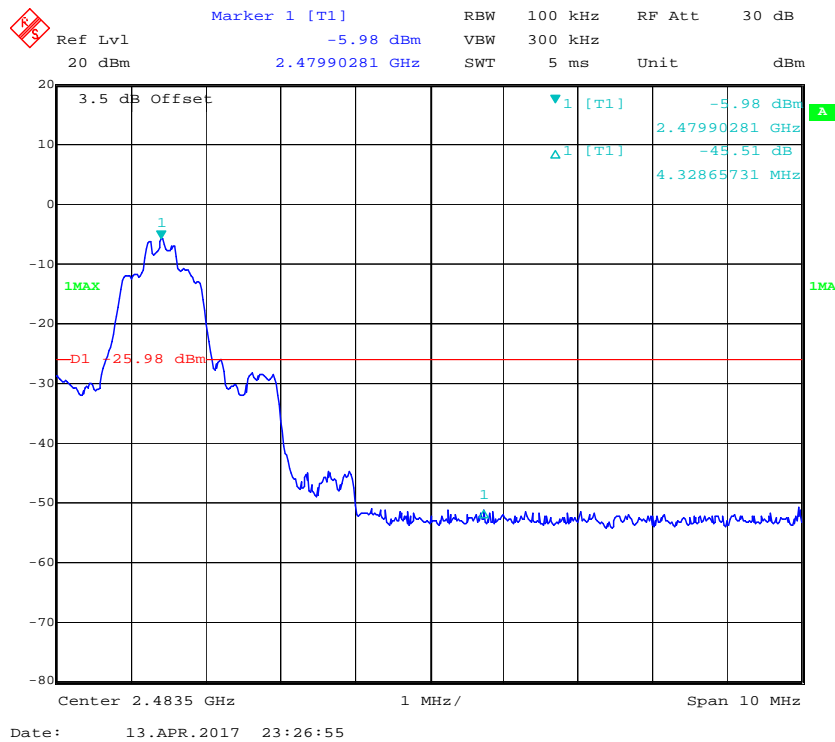
### BDR (GFSK): Band Edge-Right Side



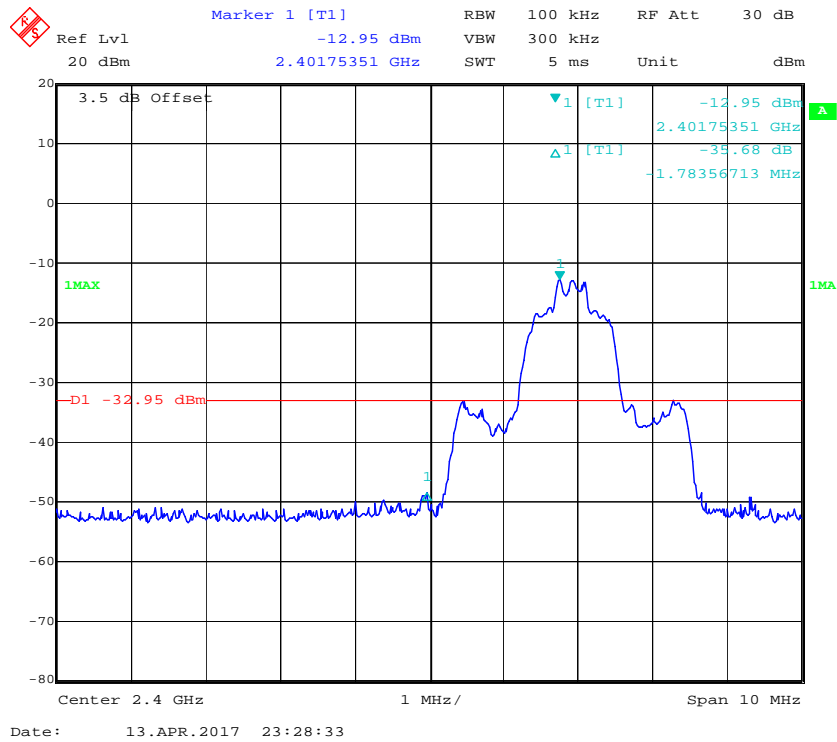
### EDR ( $\pi/4$ -DQPSK): Band Edge-Left Side



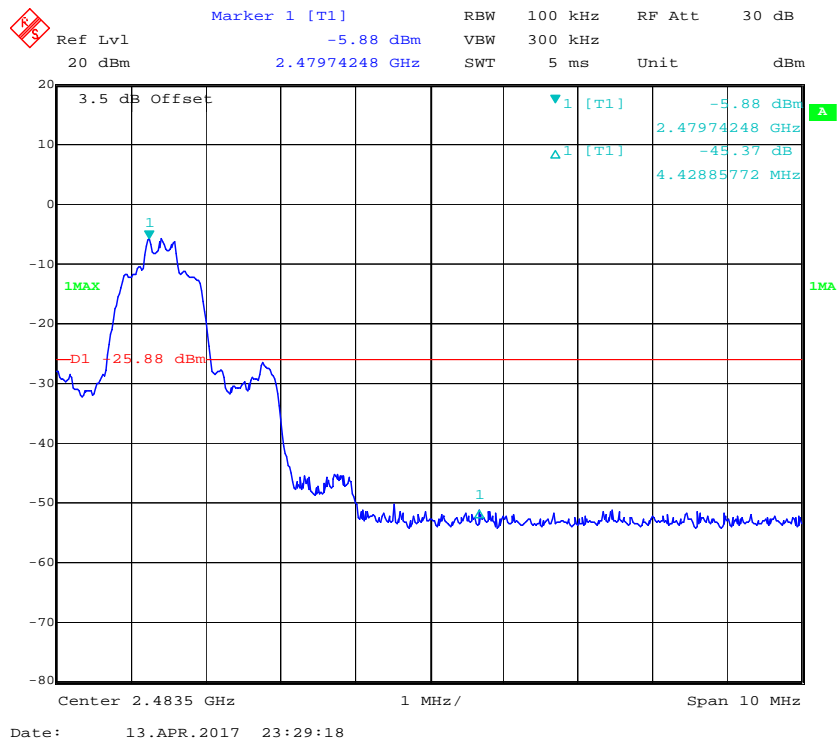
### EDR ( $\pi/4$ -DQPSK): Band Edge-Right Side



### EDR (8DPSK): Band Edge-Left Side



### EDR (8DPSK): Band Edge-Right Side



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