FCC PART 15.247
TEST REPORT

For

Johnson Industries (Shanghai) CO., LTD

A1, Export Processing Zone, No. 4500 Bao Qian Rd., Jia Ding, Shanghai,China

FCC ID: 2AKDB-WLT2564M

Report Type:	**Product Type:**
Original Report	BT Module

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Report Number:	RKS161031011-00A
Report Date:	2016-11-22
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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.

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

The Johnson Industries (Shanghai) CO., LTD's product, model number: WLT2564M (FCC ID: 2AKDB-WLT2564M) or the "EUT" in this report was a BT Module, which was measured approximately: 35 mm(L) ×18 mm(W)×3 mm(H), rated input voltage: DC 3.3V.

**All measurement and test data in this report was gathered from production sample serial number: 20161103003.*

(Assigned by BACL, Kunshan). The EUT was received on 2016-11-03.

Objective

This test report is prepared on behalf of Johnson Industries (Shanghai) CO., LTD in accordance with Part 2-Subpart J, Part 15-Subparts A, B and C of the Federal Communication Commissions rules.

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

Related Submittal(s)/Grant(s)

FCC Part 15.247 DTS submissions with FCC ID: 2AKDB-WLT2564M.

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 and DA 00-705 DSS.

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		±3.26 dB
RF conducted test with spectrum		±0.9dB
RF Output Power with Power meter		±0.5dB
Radiated emission	30MHz~1GHz	±5.91dB
	Above 1G	±4.92dB
Occupied Bandwidth		±0.5kHz
Temperature		±1.0℃
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 an engineering mode which was controlled by the software.

EUT Exercise Software

AppoTech RF Control Kit

GFSK :Power level 8
π /4-DQPSK :Power level 8
8DPSK :Power level 8

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

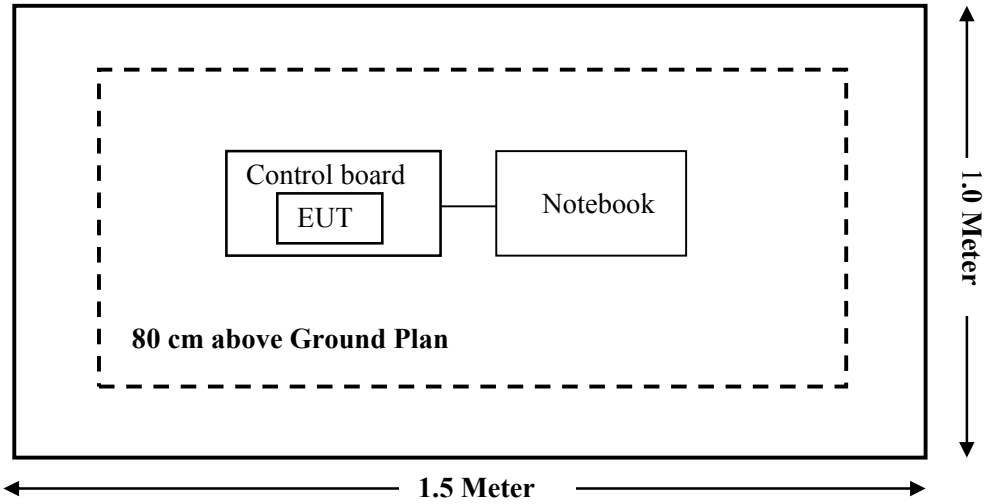
Manufacturer	Description	Model	Serial Number
DELL	Notebook	GX620	D65874152
Johnson	Control Board	N/A	N/A

External I/O Cable

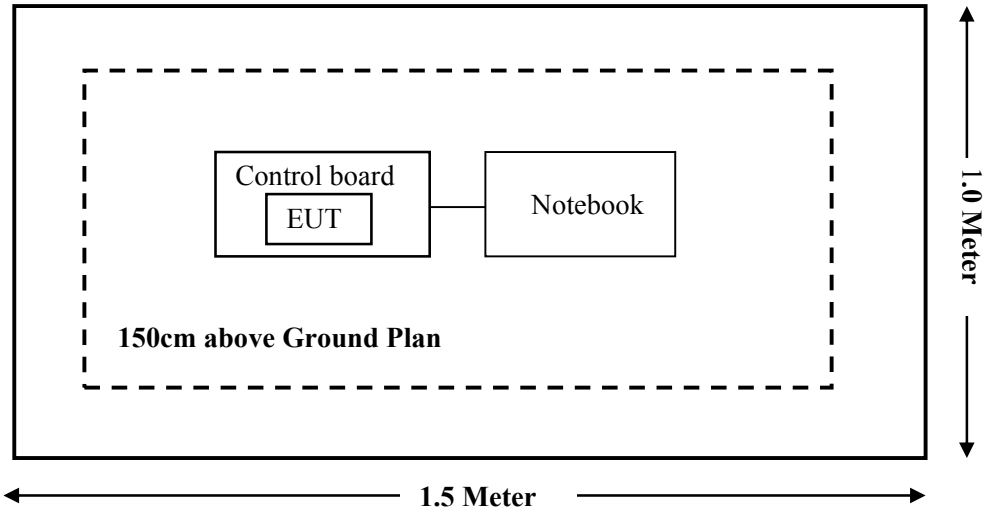
Cable Description	Length (m)	From Port	To
USB Cable	0.3	Control Board	Notebook

Block Diagram of Test Setup

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	2016-11-12	2017-11-11
Rohde & Schwarz	Signal Analyzer	FSIQ26	100048	2016-11-12	2017-11-11
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 Instrunent	Amplifier	330	171377	2016-10-21	2017-10-20
Narda	Pre-amplifier	AFS42-00101800	2001270	2016-09-08	2017-09-07
R&S	Auto test Software	EMC32	100361	/	/
Haojintech	Coaxial Cable	Cable-1	001	2015-12-12	2016-12-11
Haojintech	Coaxial Cable	Cable-2	002	2015-12-12	2016-12-11
Haojintech	Coaxial Cable	Cable-3	003	2015-12-12	2016-12-11
MICRO-COAX	Coaxial Cable	Cable-4	004	2015-12-12	2016-12-11
MICRO-COAX	Coaxial Cable	Cable-5	005	2015-12-12	2016-12-11
RF Conducted Test					
Rohde & Schwarz	OSP120 Base Unit	OSP120	101247	2016-07-04	2017-07-03
BACL	EMC32 Version	EMC 32	V 09.10.0	/	/
Rohde & Schwarz	SMBV100A Vector Signal Generator	SMBV100A	261558	2016-07-04	2017-07-03
Rohde & Schwarz	SMB 100A Signal Generator	SMB100A	110390	2016-07-04	2017-07-03
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2016-09-21	2017-09-20
Agilent	Power Meter	N1912A	MY5000492	2016-11-18	2017-11-17
Agilent	Power Sensor	N1921A	MY54210024	2016-11-18	2017-11-17
Johnson	RF Cable	N/A	N/A	2016-11-19	2017-11-18
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	834115/007	2016-11-12	2017-11-11
Rohde & Schwarz	LISN	ESH3-Z5	862770/011	2016-10-10	2017-10-09
ROHDE&SCHWARZ	LISN	ENV216	3560655016	2015-11-25	2016-11-24
Rohde & Schwarz	CE Test software	EMC 32	100357	/	/
HP	Current probe	11967A	636	2016-07-04	2017-07-03
FCC	ISN	FCC-TLISN-T8-02	20376	2016-07-04	2017-07-03
MICRO-COAX	Coaxial Cable	Cable-6	006	2016-09-08	2017-09-07

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/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Measurement Result

Worst case BDR(GFSK):

Model	Frequency (MHz)	Antenna Gain		Output Power		Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
EDR (8DPSK)	2480	2.5	1.78	9.00	7.94	20	0.0028	1

Note: The target output power: 7±2dBm,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 ceramic antenna arrangement for Bluetooth, which the antenna gain is 2.5 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

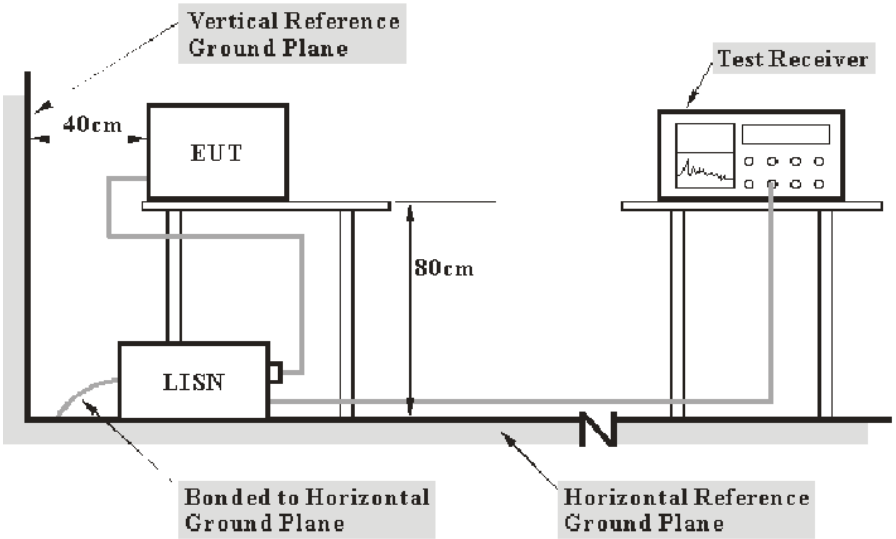
Result: Compliance.

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 adapter was connected to a AC 120 V/60 Hz power source.

EMI Test Receiver Setup

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

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

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

Test Procedure

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

Correction Factor = LISN VDF + Cable Loss + 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:

Margin = Limit – Corrected Amplitude

Test Results Summary

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

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

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

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

Test Data

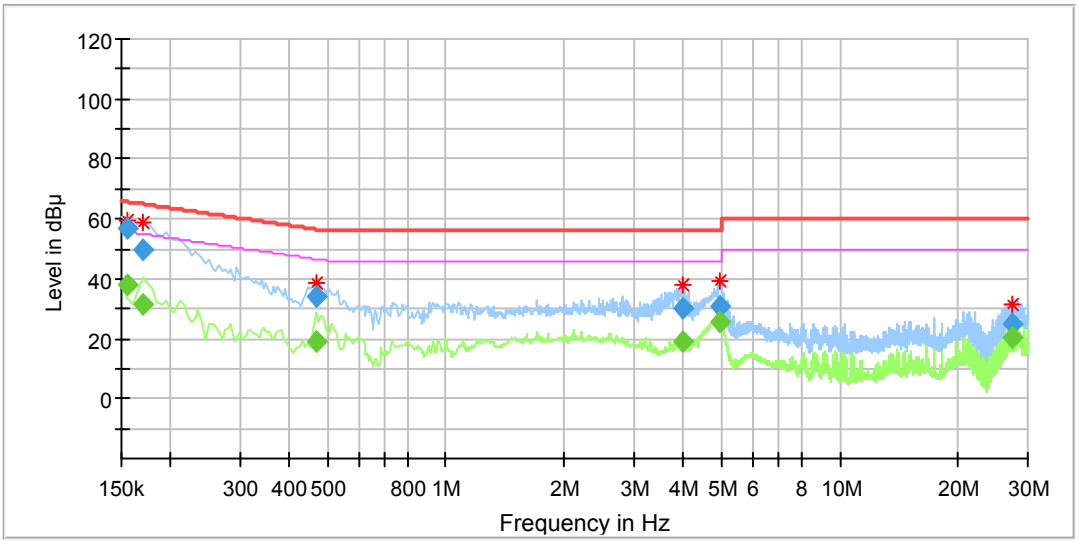
Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	58 %
ATM Pressure:	101.4 kPa

The testing was performed by Peter Jiang on 2016-11-04.

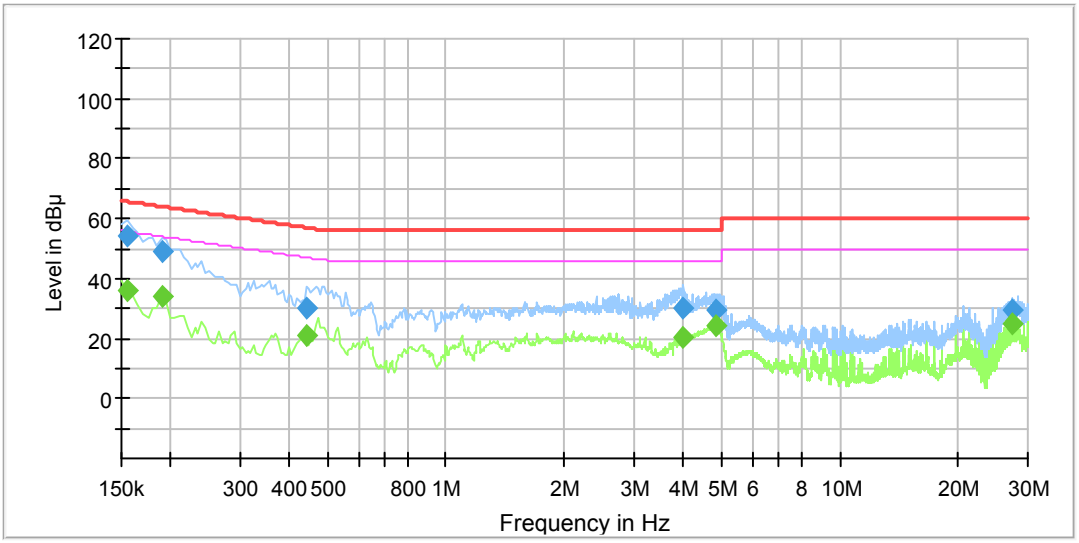
EUT operation mode: Transmitting (Worst case)

AC 120V/60 Hz, Line



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.155000	---	37.99	9.000	L1	10.3	17.74	55.73	Compliance
0.155000	57.03	---	9.000	L1	10.3	8.70	65.73	Compliance
0.170000	---	31.61	9.000	L1	10.3	23.35	54.96	Compliance
0.170000	50.00	---	9.000	L1	10.3	14.96	64.96	Compliance
0.470000	---	19.04	9.000	L1	10.3	27.47	46.51	Compliance
0.470000	33.93	---	9.000	L1	10.3	22.58	56.51	Compliance
3.970000	---	19.18	9.000	L1	10.5	26.82	46.00	Compliance
3.970000	30.46	---	9.000	L1	10.5	25.54	56.00	Compliance
4.960000	---	25.83	9.000	L1	10.5	20.17	46.00	Compliance
4.960000	30.62	---	9.000	L1	10.5	25.38	56.00	Compliance
27.395000	---	20.16	9.000	L1	10.5	29.84	50.00	Compliance
27.395000	24.86	---	9.000	L1	10.5	35.14	60.00	Compliance

AC 120V/60 Hz, Neutral



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.155000	---	36.07	9.000	N	10.3	19.66	55.73	Compliance
0.155000	54.03	---	9.000	N	10.3	11.70	65.73	Compliance
0.190000	---	33.76	9.000	N	10.3	20.28	54.04	Compliance
0.190000	48.73	---	9.000	N	10.3	15.31	64.04	Compliance
0.445000	---	21.21	9.000	N	10.3	25.76	46.97	Compliance
0.445000	30.37	---	9.000	N	10.3	26.60	56.97	Compliance
4.015000	---	20.44	9.000	N	10.5	25.56	46.00	Compliance
4.015000	30.37	---	9.000	N	10.5	25.63	56.00	Compliance
4.835000	---	24.40	9.000	N	10.6	21.60	46.00	Compliance
4.835000	29.43	---	9.000	N	10.6	26.57	56.00	Compliance
27.300000	---	24.80	9.000	N	10.5	25.20	50.00	Compliance
27.300000	29.52	---	9.000	N	10.5	30.48	60.00	Compliance

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

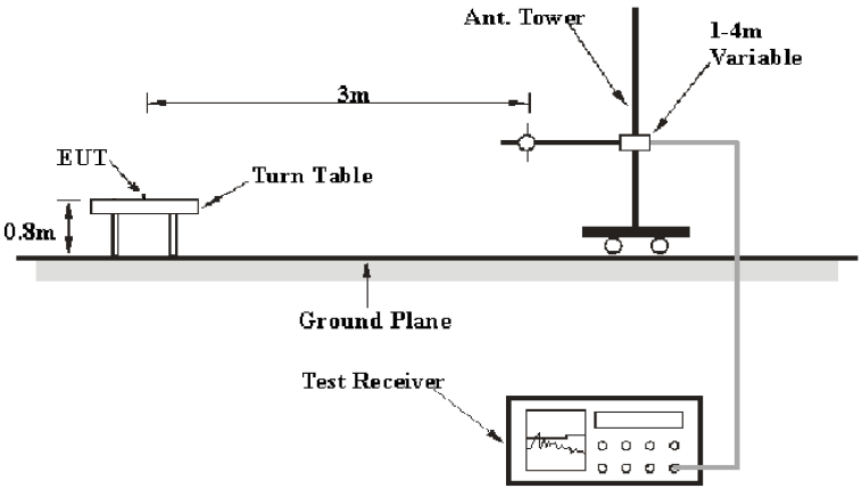
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

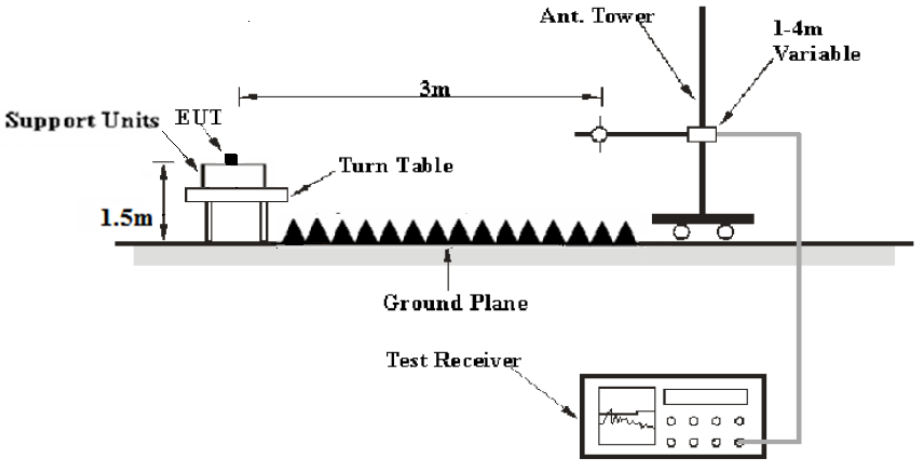
FCC §15.205; §15.209; §15.247(d)

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.

The adapter was connected to a AC 120 V/60 Hz power source.

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	Duty cycle	Detector
1GHz – 25GHz	1MHz	3 MHz	Any	PK
	1MHz	10 Hz	>98%	Ave.
	1MHz	1/T	<98%	

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:

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - Amplifier Gain

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

Margin = Limit – Corrected Amplitude

Test 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 and CISPR 16-4-1, the measured level complies with the limit if

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

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

Test Data

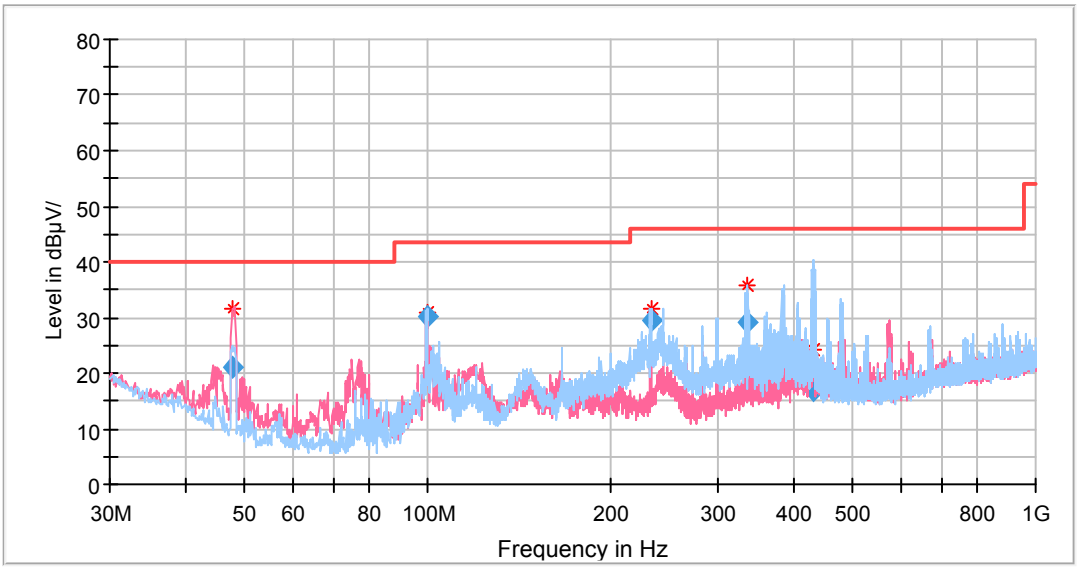
Environmental Conditions

Temperature:	24.3 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Peter Jiang on 2016-11-19.

EUT operation mode: Transmitting

30MHz-1GHz:



Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBµV/m)	FCC Part 15.247/205/209	
	Reading	Detector		Height	Polar			Limit	Margin
	(dBµV)	(PK/QP/Ave.)		(cm)	(H/V)			(dBµV/m)	(dB)
47.91705	36.21	QP	267	100	V	-15.14	21.07	40.0	18.93
99.87620	46.71	QP	239	100	H	-16.66	30.05	43.5	13.45
233.11775	41.89	QP	293	100	H	-12.26	29.63	46.0	16.37
336.49935	38.96	QP	81	100	H	-9.73	29.23	46.0	16.77
384.58750	27.14	QP	47	100	H	-8.77	18.37	46.0	27.63
431.59165	24.52	QP	81	100	H	-7.74	16.78	46.0	29.22

1GHz -25 GHz: (*Scan with GFSK, π/4-DQPSK, 8-DPSK mode, the worst case is BDR Mode (GFSK)*)

Frequency	Receiver		Turntable	Rx Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/205/209	
	Reading	Detector		Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave.)	Degree	(cm)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
Low Channel (2402 MHz)									
2402.00	101.60	PK	210	183	V	-3.04	98.56	/	/
2402.00	97.50	Ave	210	183	V	-3.04	94.46	/	/
2402.00	97.63	PK	144	210	H	-3.04	94.59	/	/
2402.00	93.18	Ave	144	210	H	-3.04	90.14	/	/
2390.00	46.04	PK	331	202	V	-3.05	42.99	74	31.01
2390.00	30.53	Ave	331	202	V	-3.05	27.48	54	26.52
2400.00	42.14	PK	280	232	V	-3.00	39.14	74	34.86
2400.00	35.07	Ave	280	232	V	-3.00	32.07	54	21.93
1613.70	57.25	PK	193	227	H	-6.01	51.24	74	22.76
1613.70	51.76	Ave	193	227	H	-6.01	45.75	54	8.25
4804.00	49.65	PK	326	243	H	7.16	56.81	74	17.19
4804.00	38.21	Ave	326	243	H	7.16	45.37	54	8.63
7206.00	42.69	PK	340	107	V	15.87	58.56	74	15.44
7206.00	32.30	Ave	340	107	V	15.87	48.17	54	5.83

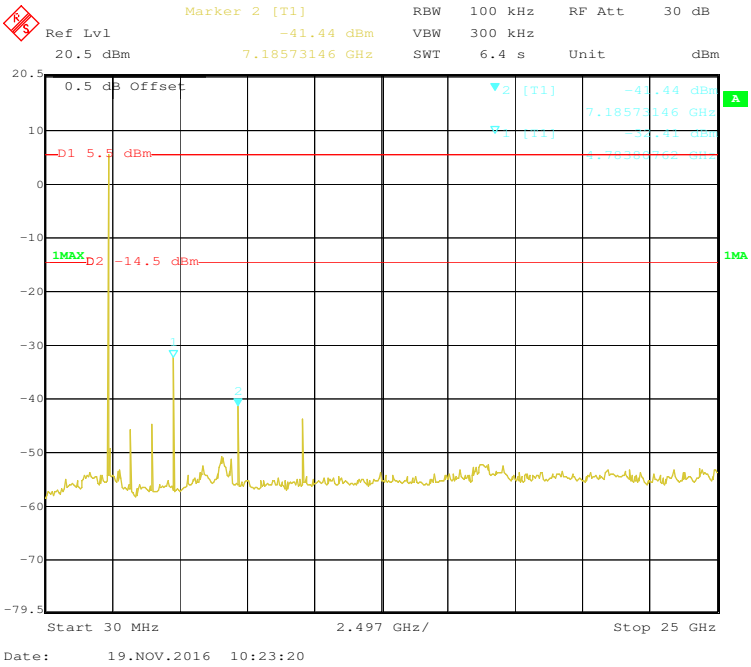
Frequency	Receiver		Turntable	Rx Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/205/209	
	Reading	Detector		Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave.)	Degree	(cm)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
Middle Channel (2441 MHz)									
2441.00	104.36	PK	220	156	V	-3.02	101.34	/	/
2441.00	100.27	Ave	220	156	V	-3.02	97.25	/	/
2441.00	99.80	PK	16	131	H	-3.02	96.78	/	/
2441.00	95.41	Ave	16	131	H	-3.02	92.39	/	/
1477.00	42.59	PK	207	112	V	-6.98	35.61	74	38.39
1477.00	31.72	Ave	207	112	V	-6.98	24.74	54	29.26
1696.00	43.77	PK	249	200	H	-5.43	38.34	74	35.66
1696.00	35.83	Ave	249	200	H	-5.43	30.40	54	23.60
4882.00	50.26	PK	221	241	V	7.28	57.54	74	16.46
4882.00	41.55	Ave	221	241	V	7.28	48.83	54	5.17
6677.30	38.47	PK	351	147	H	13.79	52.26	74	21.74
6677.30	31.84	Ave	351	147	H	13.79	45.63	54	8.37
7323.00	40.77	PK	104	242	H	16.38	57.15	74	16.85
7323.00	31.44	Ave	104	242	H	16.38	47.82	54	6.18

Frequency	Receiver		Turntable	Rx Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/205/209	
	Reading	Detector		Height	Polar			Limit	Margin
(MHz)	(dBµV)	(PK/QP/Ave.)	Degree	(cm)	(H/V)	(dB)	(dBµV/m)	(dB µ V/m)	(dB)
High Channel (2480MHz)									
2480.00	103.17	PK	90	156	V	-2.99	100.18	/	/
2480.00	98.61	Ave	90	156	V	-2.99	95.62	/	/
2480.00	97.26	PK	207	202	H	-2.99	94.27	/	/
2480.00	92.43	Ave	207	202	H	-2.99	89.44	/	/
2483.50	44.81	PK	64	179	V	-2.99	41.82	74	32.18
2483.50	32.96	Ave	64	179	V	-2.99	29.97	54	24.03
2563.00	43.97	PK	23	135	V	-2.58	41.39	74	32.61
2563.00	35.16	Ave	23	135	V	-2.58	32.58	54	21.42
4960.00	50.32	PK	319	132	H	7.40	57.72	74	16.28
4960.00	41.50	Ave	319	132	H	7.40	48.90	54	5.10
6681.00	23.01	PK	246	182	H	13.80	36.81	74	37.19
6681.00	15.69	Ave	246	182	H	13.80	29.49	54	24.51
7440.00	42.20	PK	353	172	H	16.89	59.09	74	14.91
7440.00	31.91	Ave	353	172	H	16.89	48.80	54	5.20

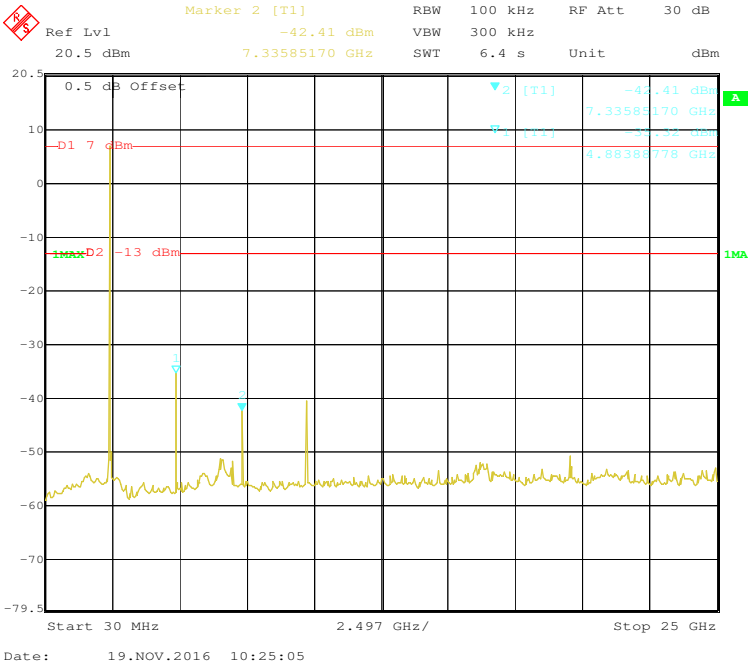
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude

Spurious Emissions at Antenna Port:

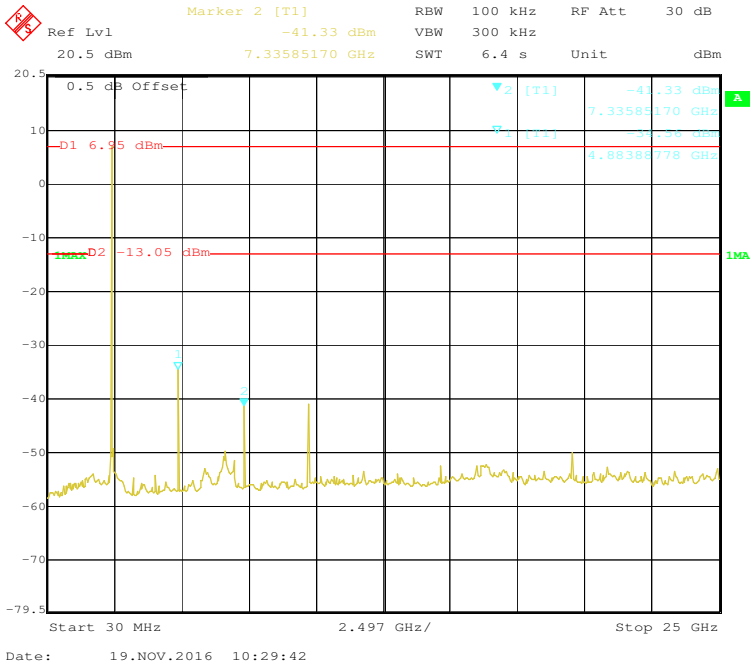
Low Channel



Middle Channel



High Channel



Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude

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

Applicable Standard

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 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:	24.3 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Peter Jiang on 2016-11-19

EUT operation mode: Transmitting

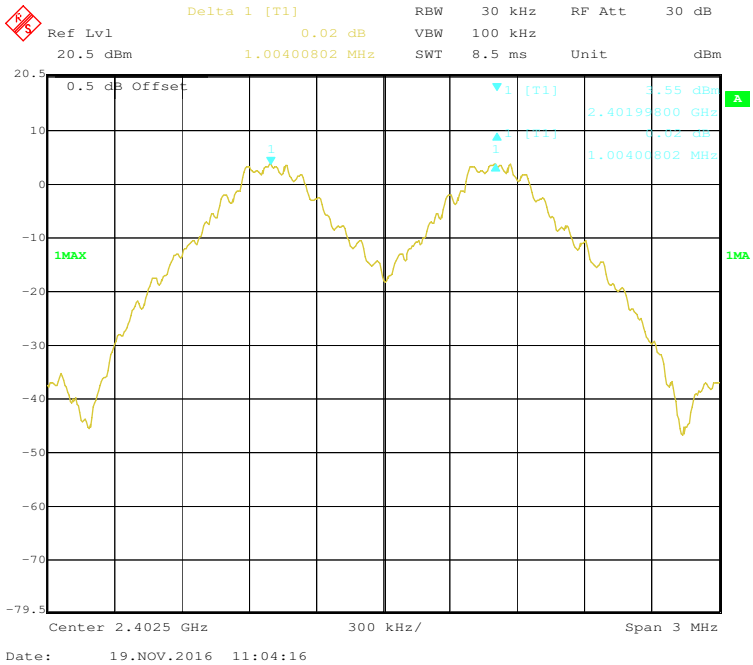
Test Result: *Compliance.*

Please refer to following tables and plots：

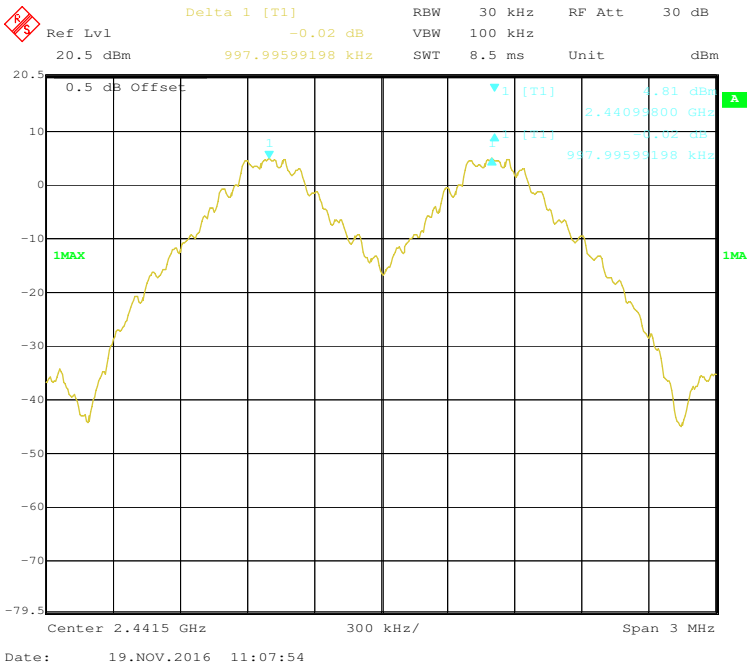
Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Result
BDR (GFSK)	Low	2402	1.004	Pass
	Adjacent	2403		
	Middle	2441	0.998	Pass
	Adjacent	2442		
	High	2480	1.010	Pass
	Adjacent	2479		
EDR (π/4-DQPSK)	Low	2402	1.004	Pass
	Adjacent	2403		
	Middle	2441	1.004	Pass
	Adjacent	2442		
	High	2480	1.004	Pass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

Note: Limit = 20 dB bandwidth *2/3

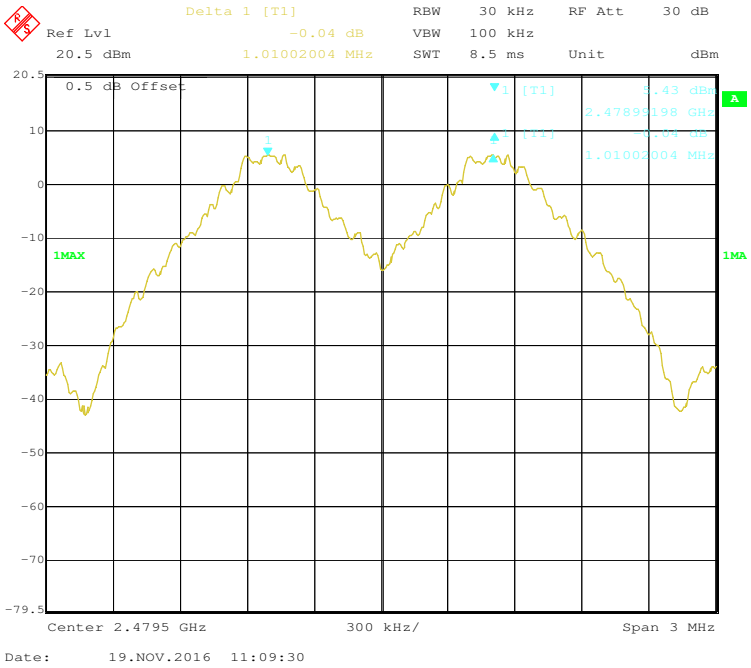
BDR (GFSK): Low Channel



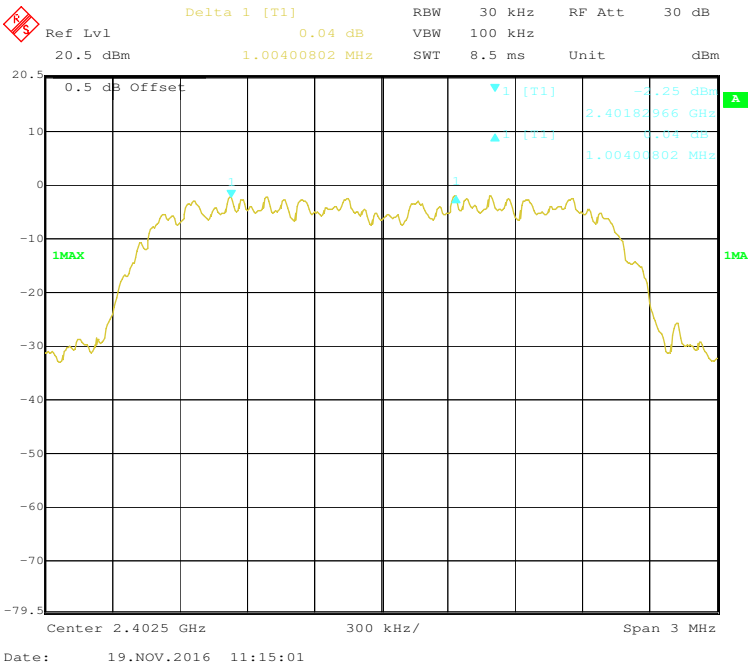
BDR (GFSK): Middle Channel



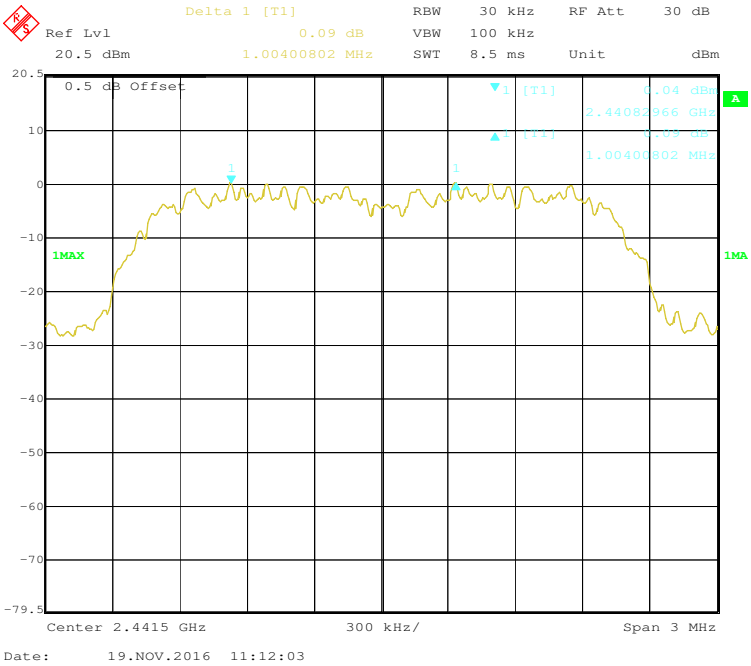
BDR (GFSK): High Channel



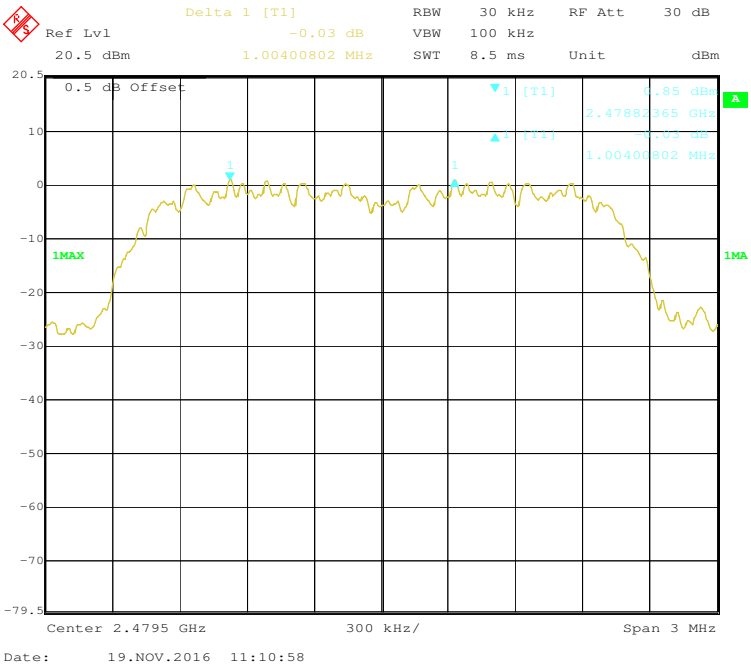
EDR (π/4-DQPSK): Low Channel



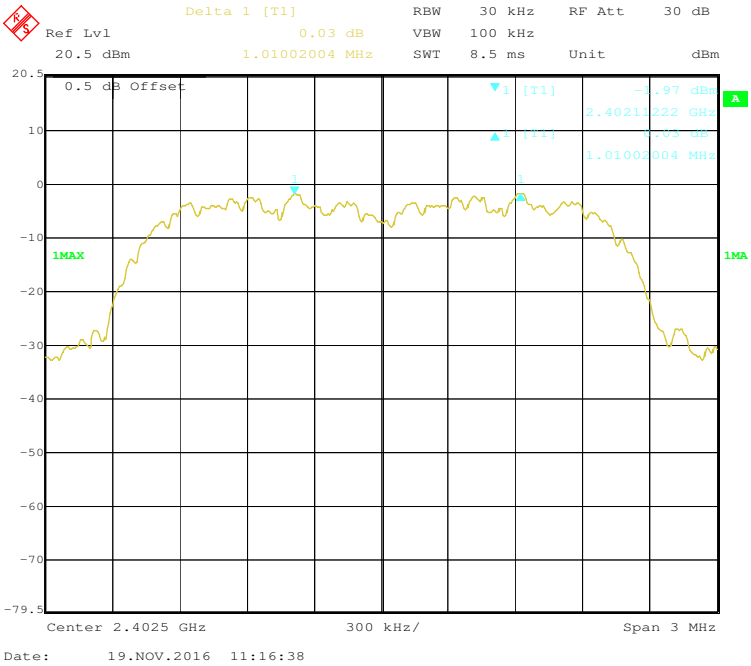
EDR (π/4-DQPSK): Middle Channel



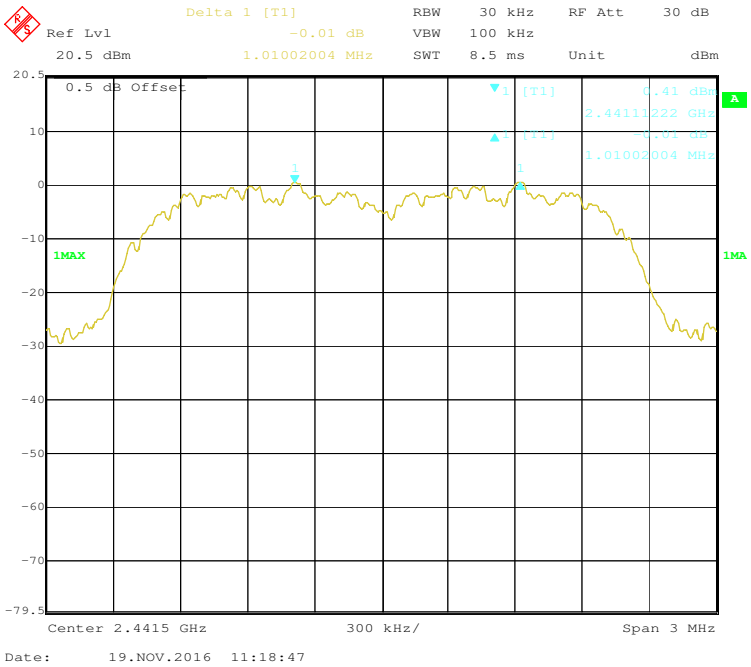
EDR (π/4-DQPSK): High Channel



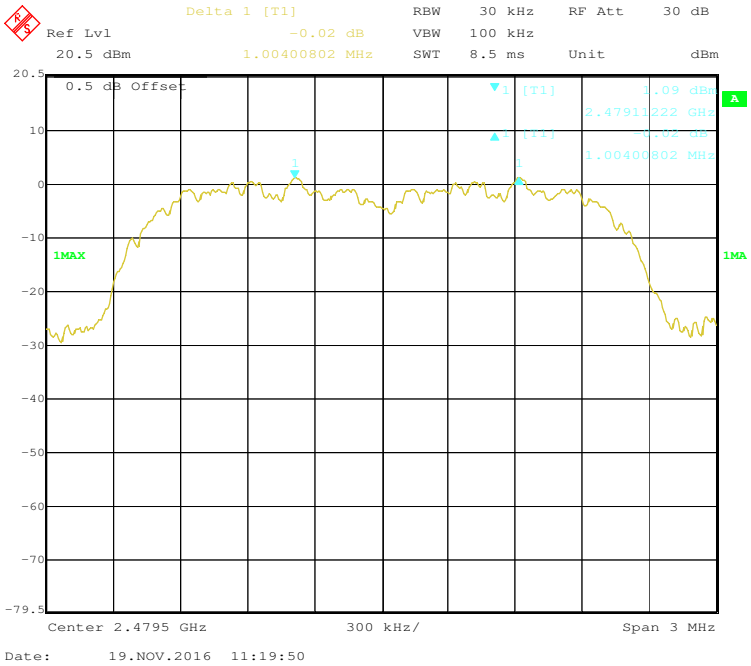
EDR (8DPSK): Low Channel



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:	24 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

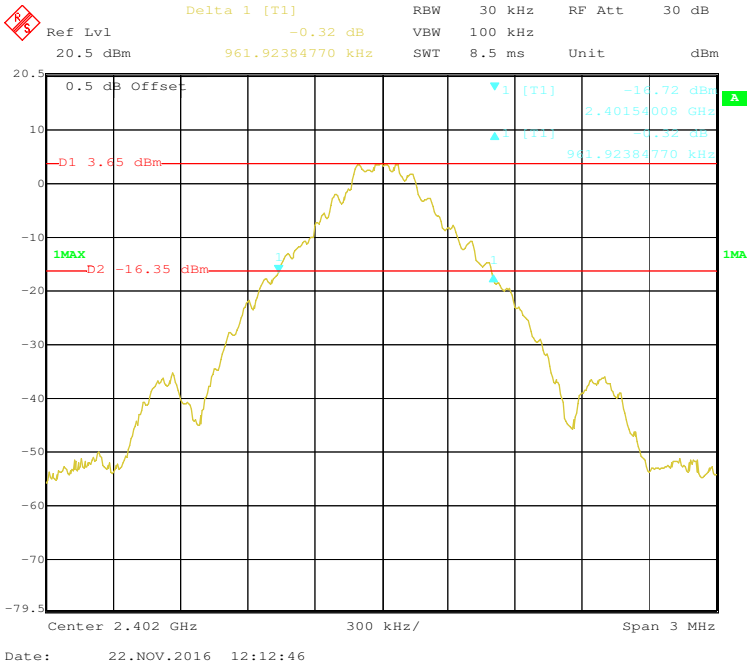
The testing was performed by Peter Jiang on 2016-11-22.

EUT operation mode: Transmitting

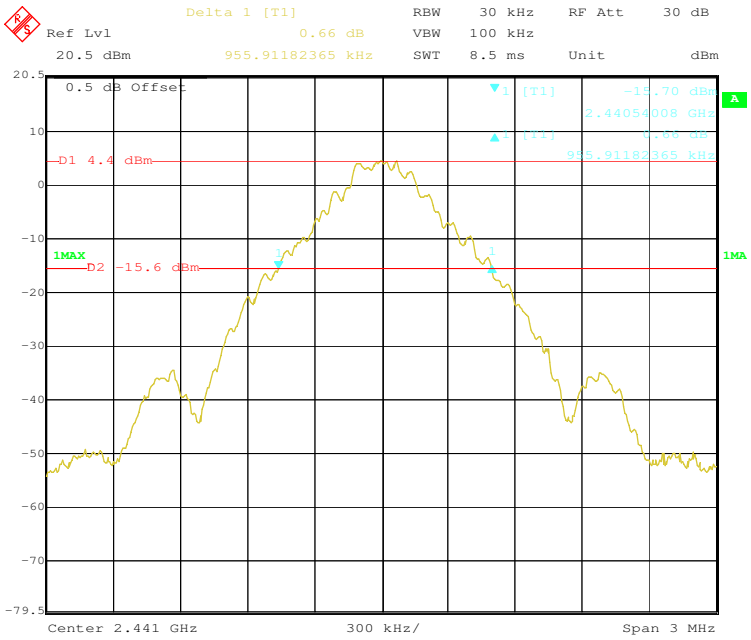
Test Result: Compliance. Please refer to following tables and plots

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.962
	Middle	2441	0.956
	High	2480	0.956
EDR (π/4-DQPSK)	Low	2402	1.401
	Middle	2441	1.413
	High	2480	1.413
EDR (8DPSK)	Low	2402	1.401
	Middle	2441	1.407
	High	2480	1.407

BDR (GFSK): Low Channel

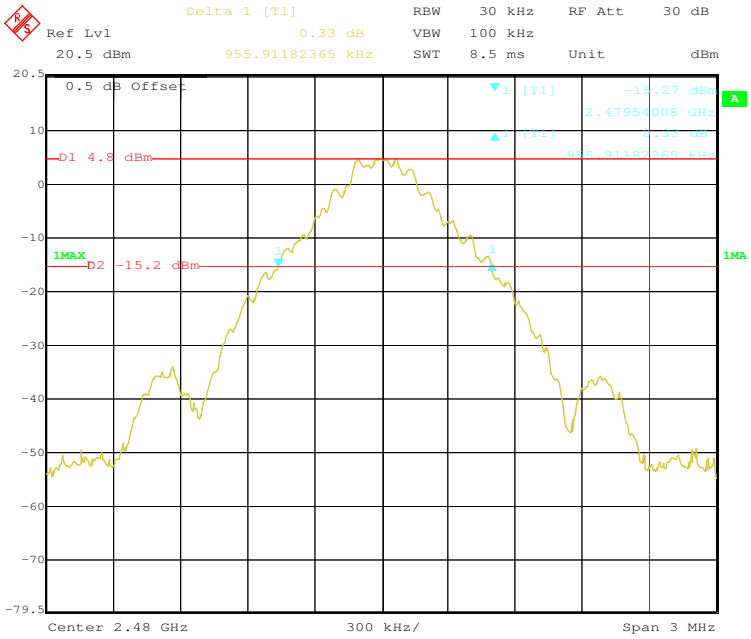


BDR (GFSK): Middle Channel



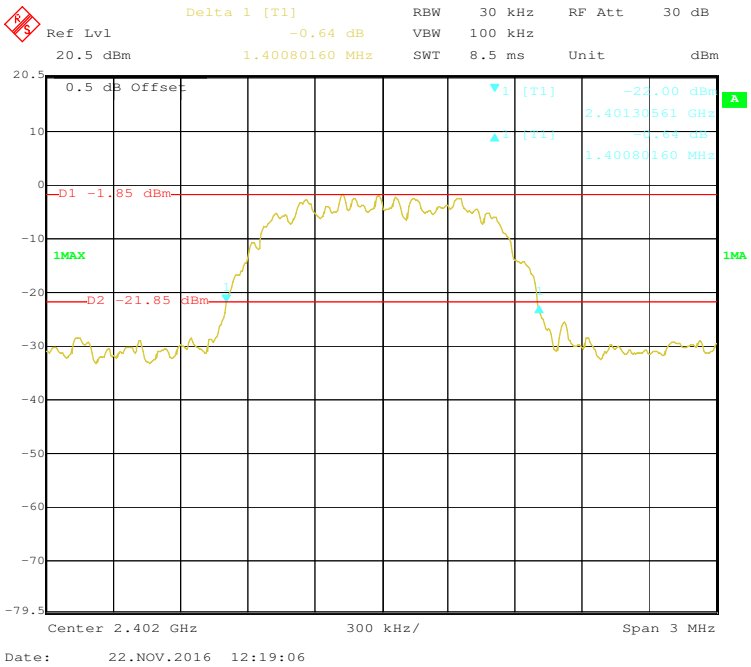
Date: 22.NOV.2016 12:15:13

BDR (GFSK): High Channel

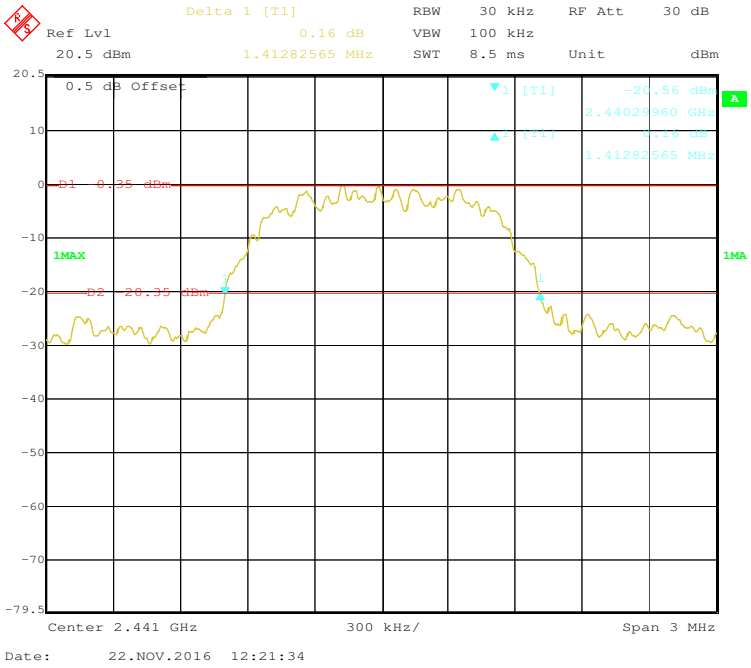


Date: 22.NOV.2016 12:16:35

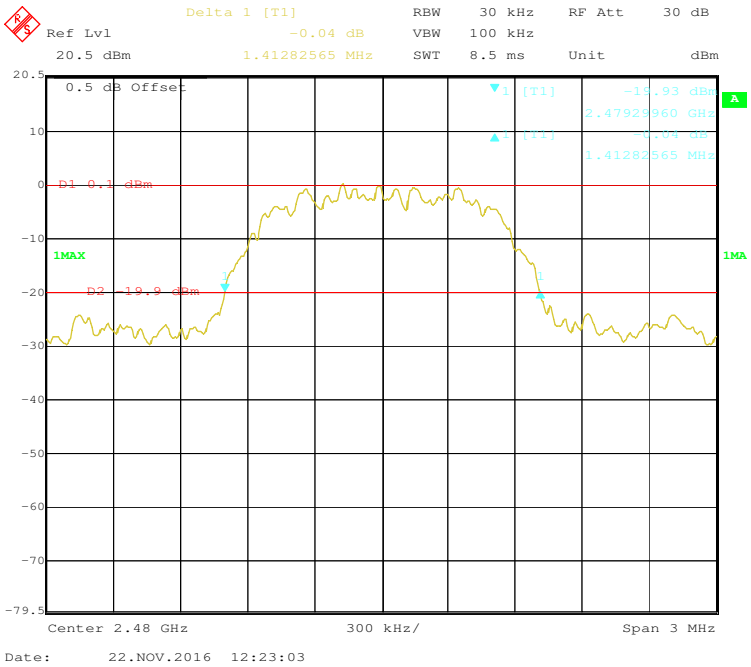
EDR (π/4-DQPSK): Low Channel



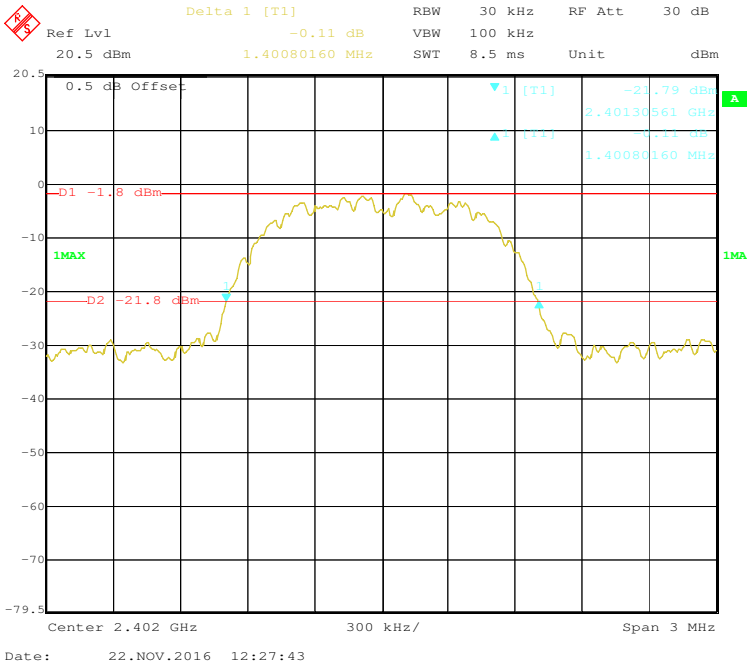
EDR(π/4-DQPSK): Middle Channel



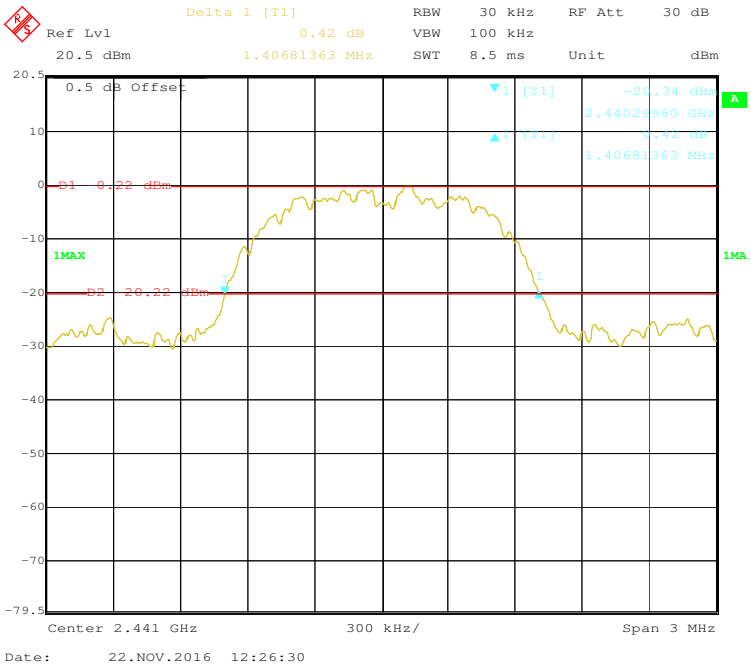
EDR (π/4-DQPSK): High Channel



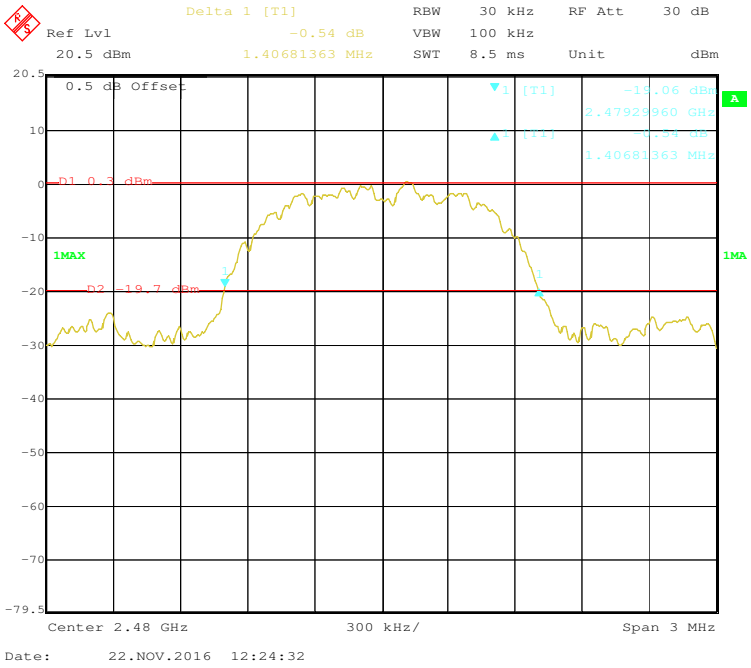
EDR (8DPSK): Low Channel



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:	24.6 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

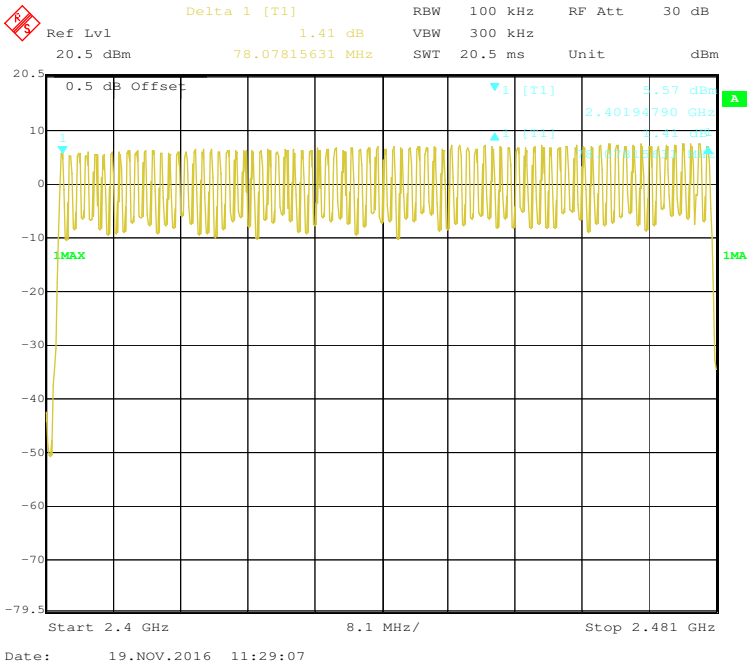
The testing was performed by Peter Jiang on 2016-11-19.

EUT operation mode: Transmitting

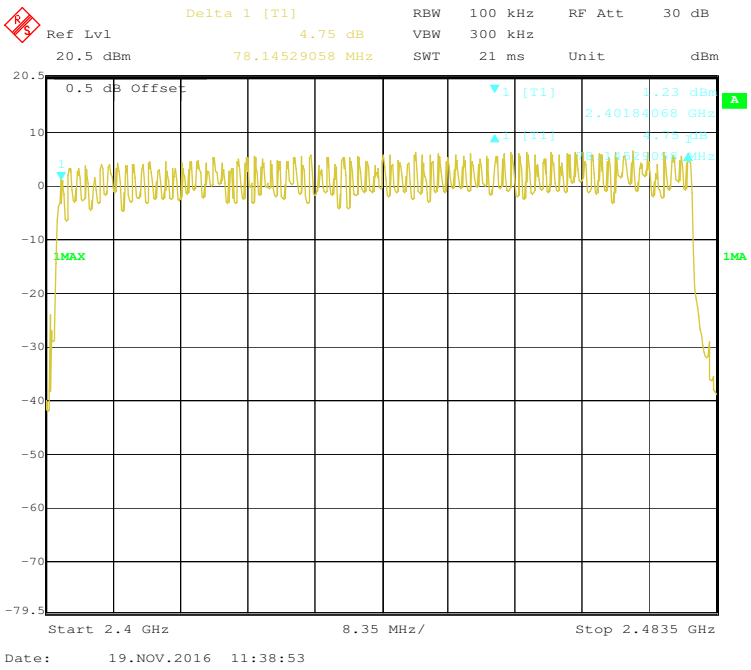
Test Result: Compliance. Please refer to following tables and plots

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

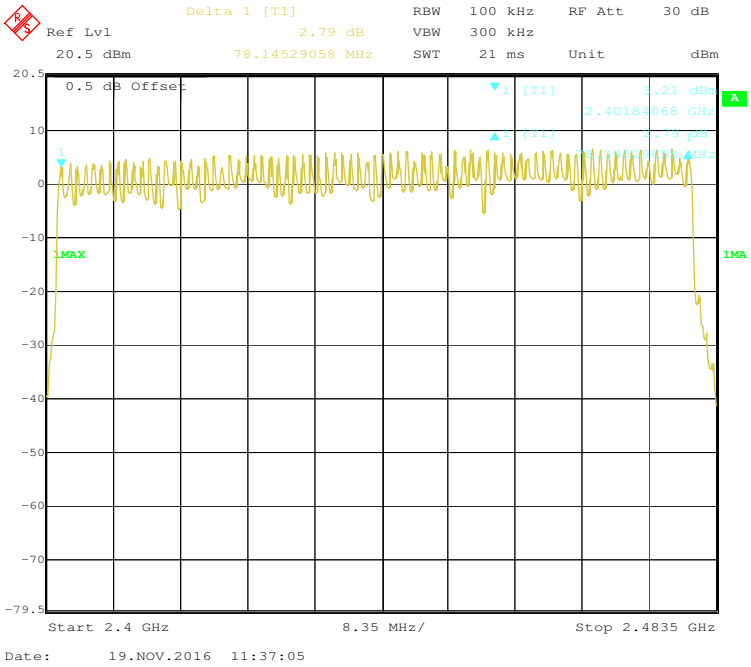
BDR (GFSK): Number of Hopping Channels



EDR (π/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

Temperature:	24.5 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Peter Jiang on 2016-11-19 to 2016-11-23.

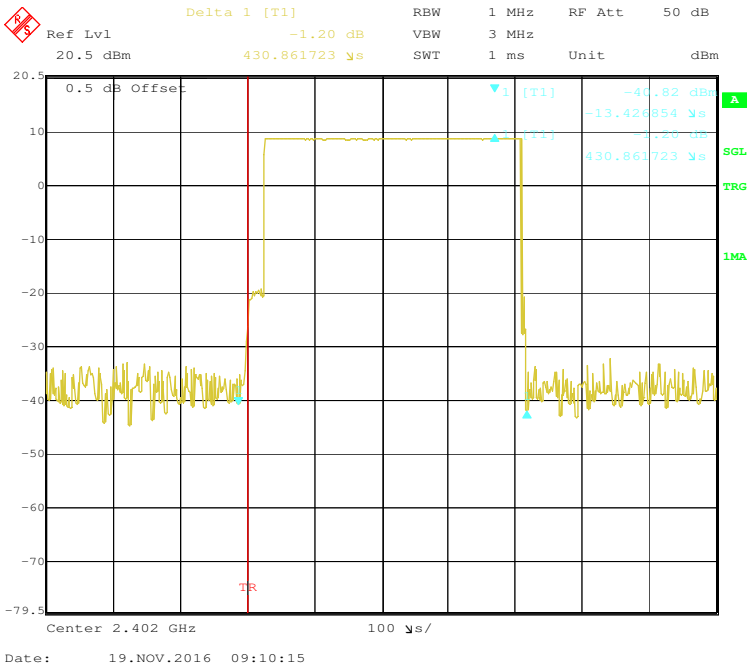
EUT operation mode: Transmitting

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

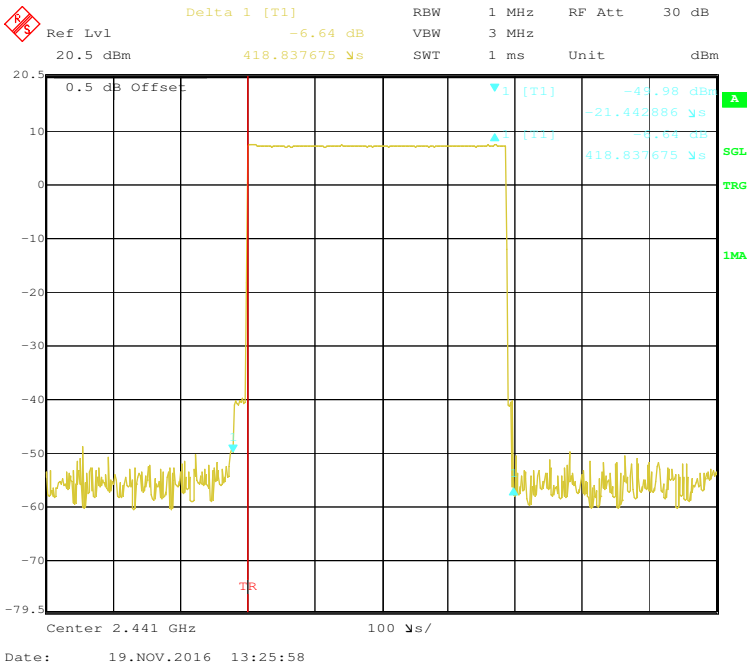
Mode		Channel	Pulse Width (ms)	Dwell Time (S)	Limit (S)	Result
BDR (GFSK)	DH 1	Low	0.431	0.138	0.4	Pass
		Middle	0.419	0.134	0.4	Pass
		High	0.425	0.136	0.4	Pass
		Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	DH 3	Low	1.695	0.271	0.4	Pass
		Middle	1.689	0.270	0.4	Pass
		High	1.695	0.271	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	DH 5	Low	2.972	0.317	0.4	Pass
		Middle	2.972	0.317	0.4	Pass
		High	2.950	0.315	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (π/4-DQPSK)	2DH 1	Low	0.425	0.136	0.4	Pass
		Middle	0.425	0.136	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	1.689	0.270	0.4	Pass
		Middle	1.702	0.272	0.4	Pass
		High	1.689	0.270	0.4	Pass
		Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	2DH 5	Low	2.942	0.314	0.4	Pass
		Middle	2.950	0.315	0.4	Pass
		High	2.950	0.315	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	0.435	0.139	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	1.710	0.274	0.4	Pass
		Middle	1.689	0.270	0.4	Pass
		High	1.695	0.271	0.4	Pass
		Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	3DH 5	Low	2.942	0.314	0.4	Pass
		Middle	2.950	0.315	0.4	Pass
		High	2.950	0.315	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				

BDR (GFSK):

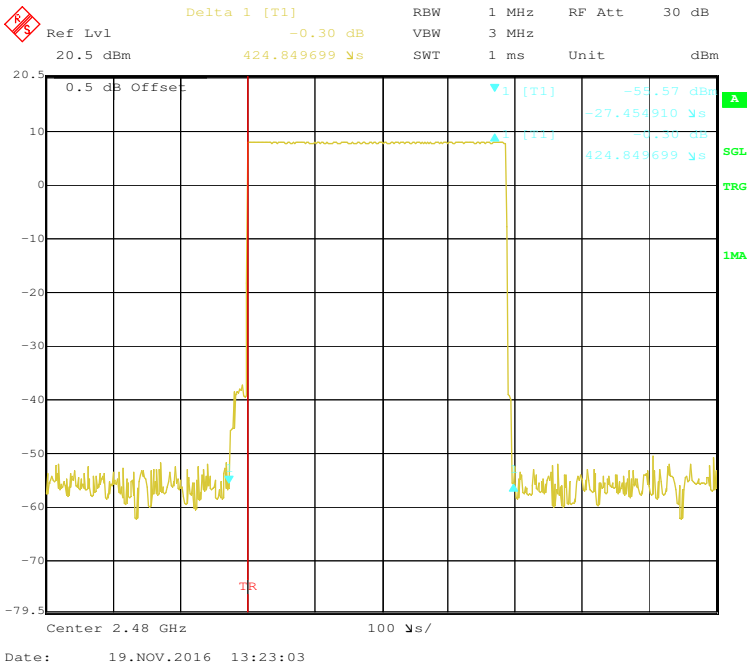
Pulse time, Low Channel, DH1



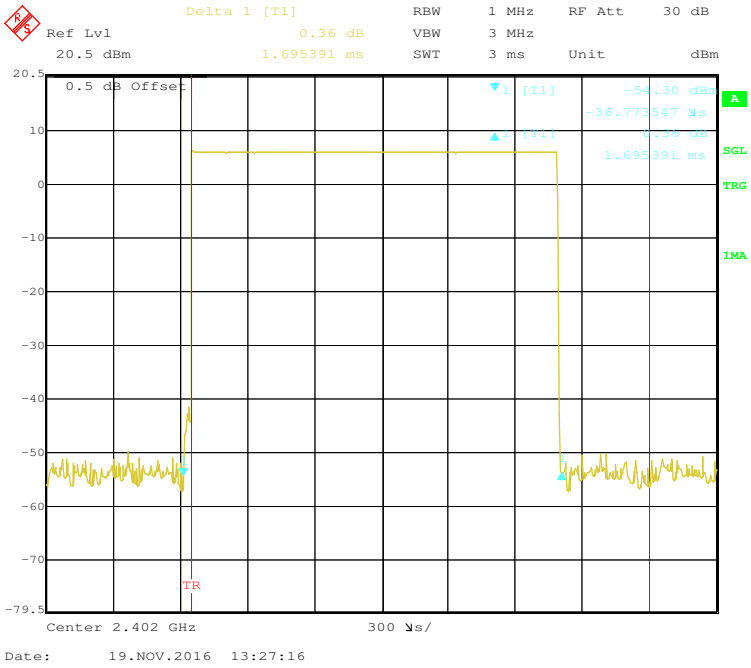
Pulse time, Middle Channel, DH1



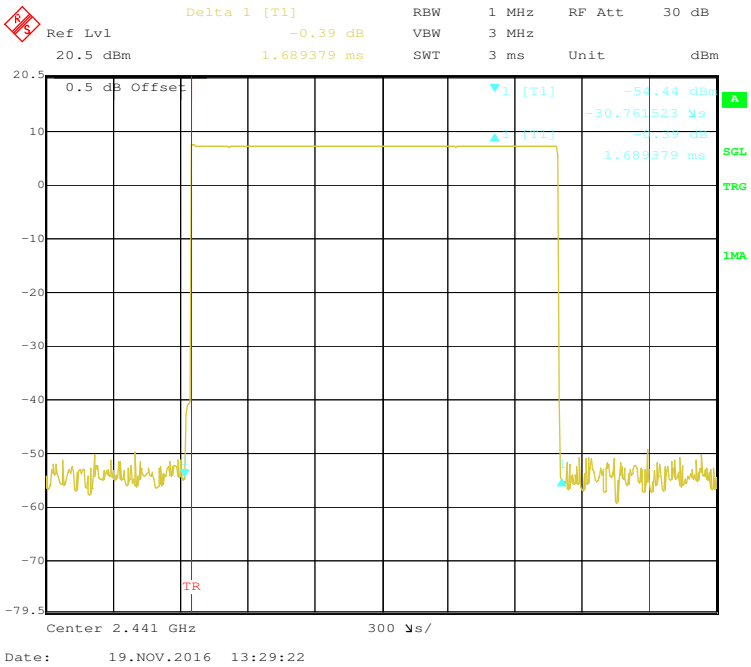
Pulse time, High Channel, DH1



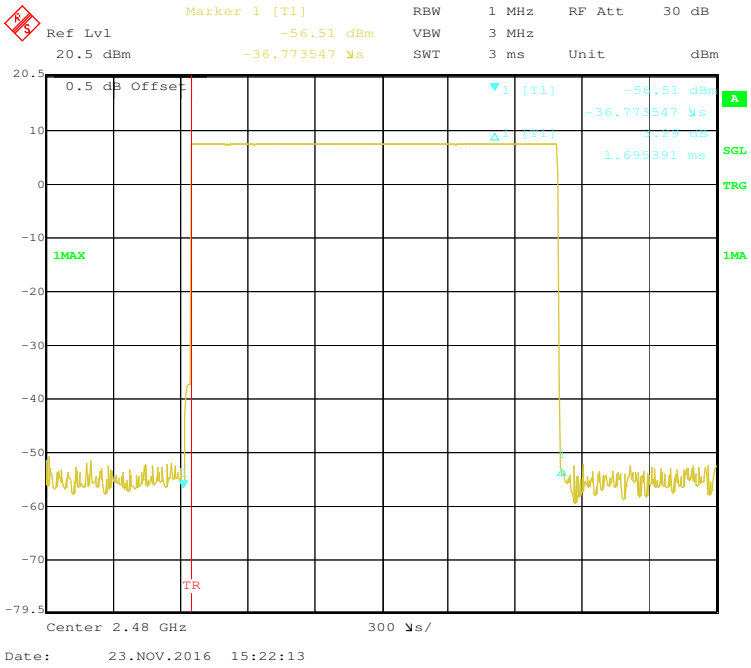
Pulse time, Low Channel, DH3



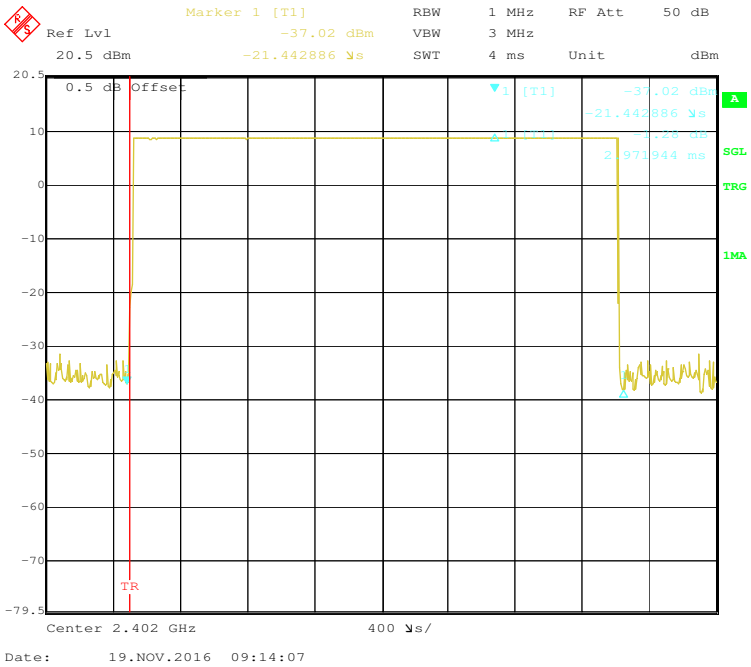
Pulse time, Middle Channel, DH3



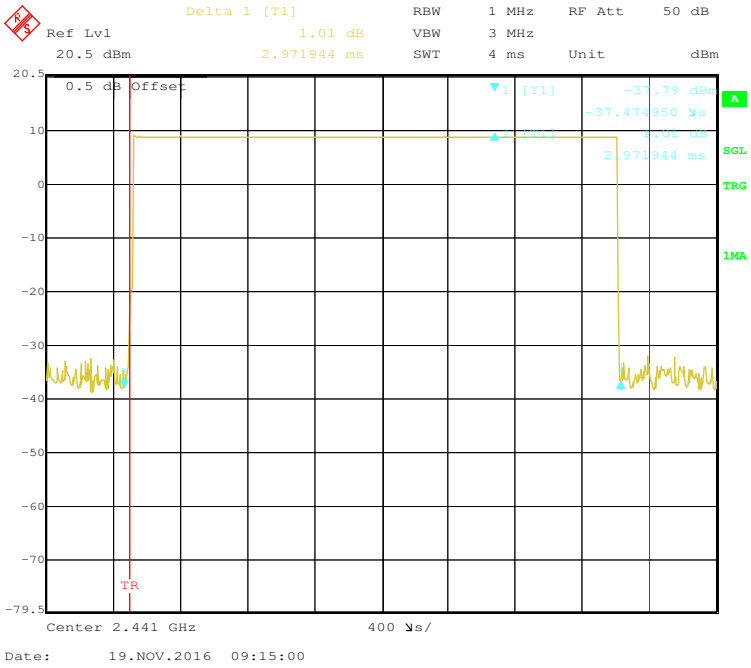
Pulse time, High Channel, DH3



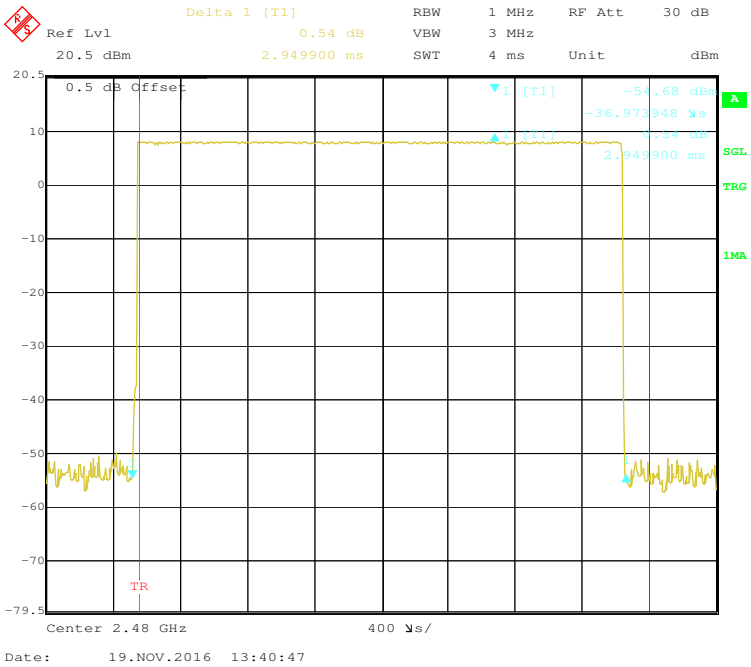
Pulse time, Low Channel, DH5



Pulse time, Middle Channel, DH5

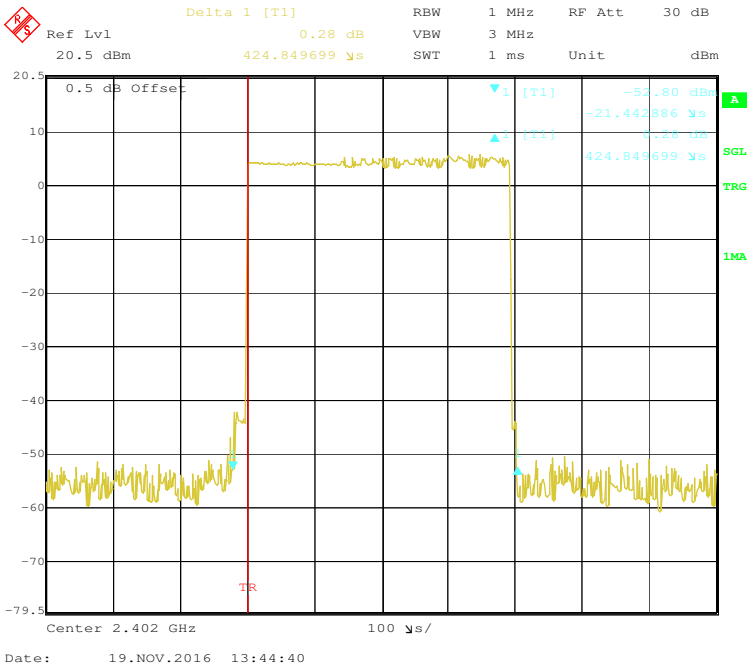


Pulse time, High Channel, DH5

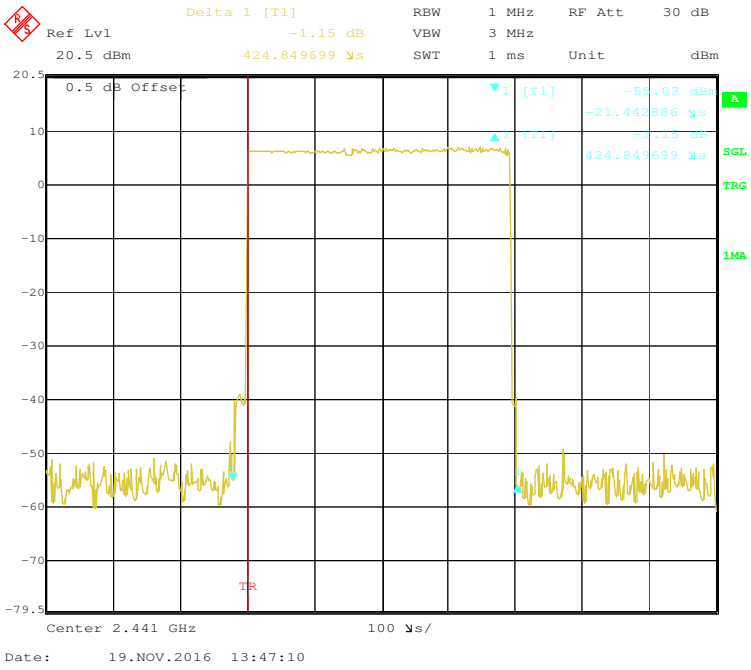


EDR (π/4-DQPSK):

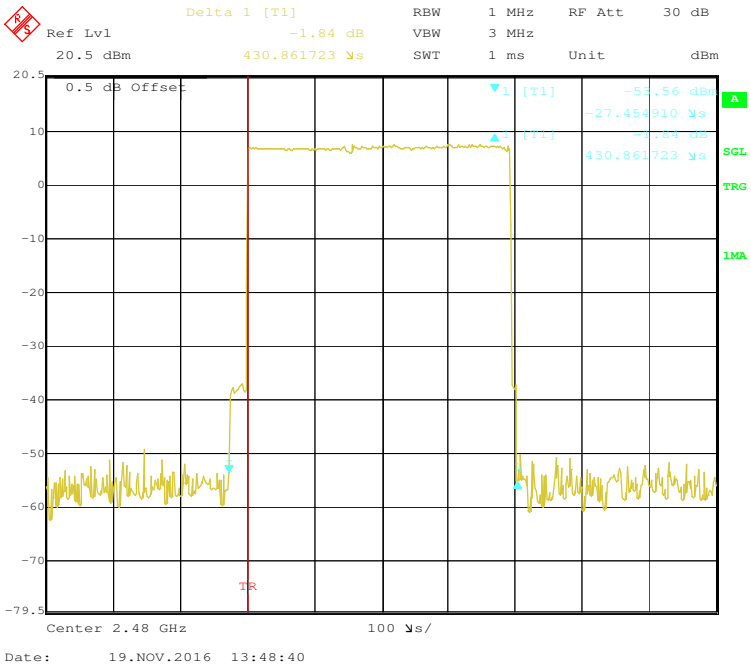
Pulse time, Low Channel, 2DH1



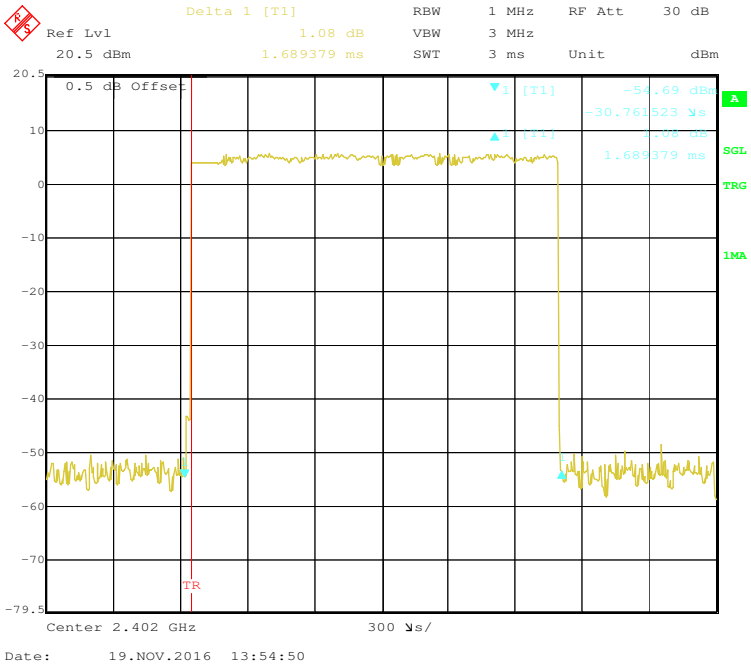
Pulse time, Middle Channel, 2DH1



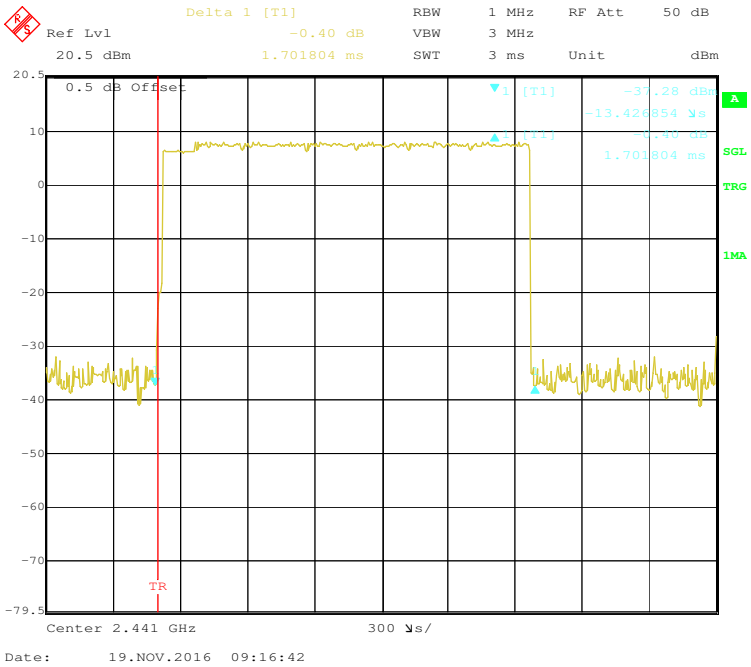
Pulse time, High Channel, 2DH1



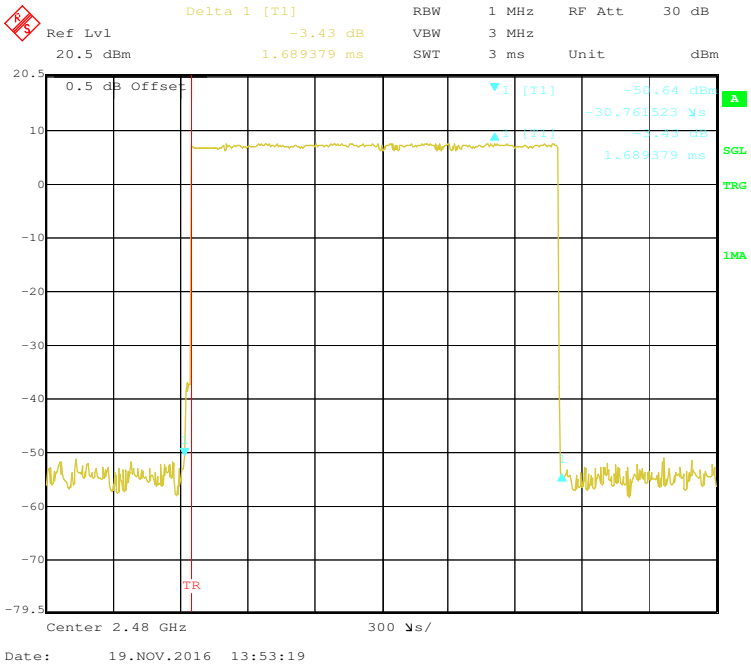
Pulse time, Low Channel, 2DH3



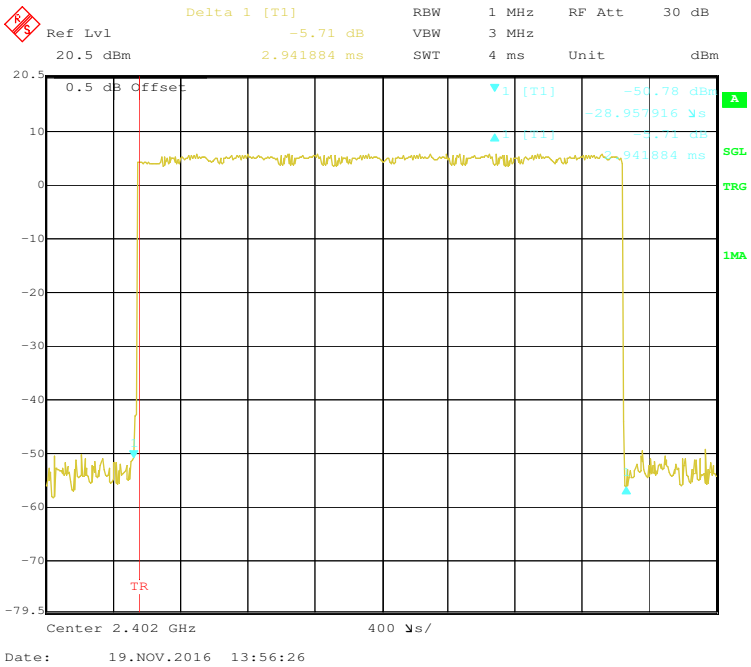
Pulse time, Middle Channel, 2DH3



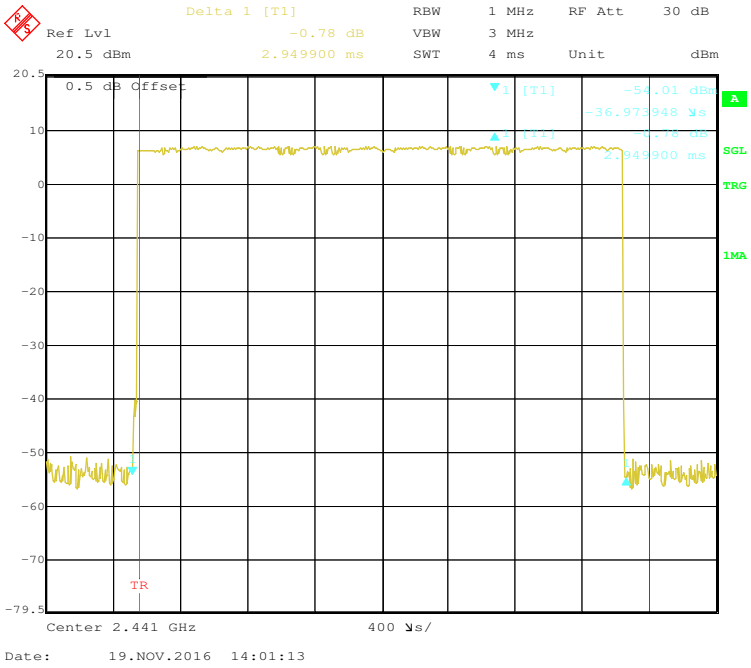
Pulse time, High Channel, 2DH3



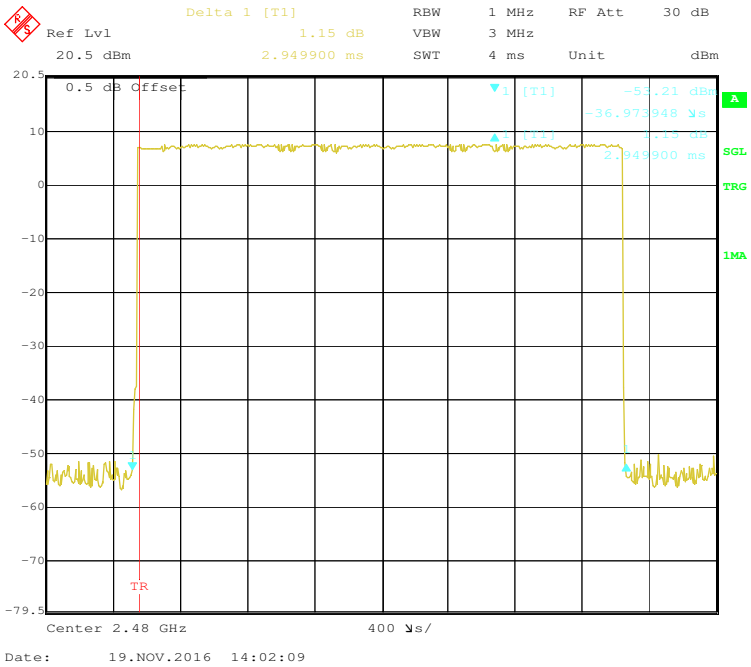
Pulse time, Low Channel, 2DH5



Pulse time, Middle Channel, 2DH5

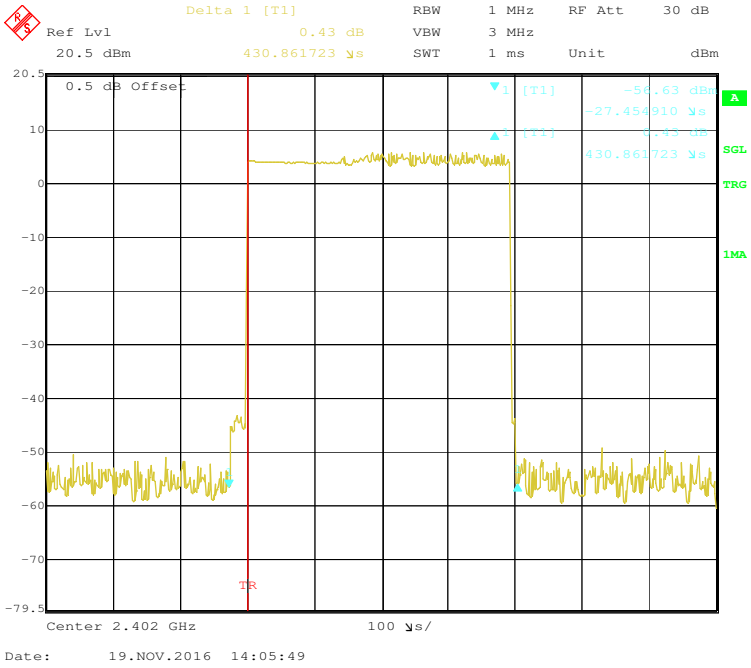


Pulse time, High Channel, 2DH5

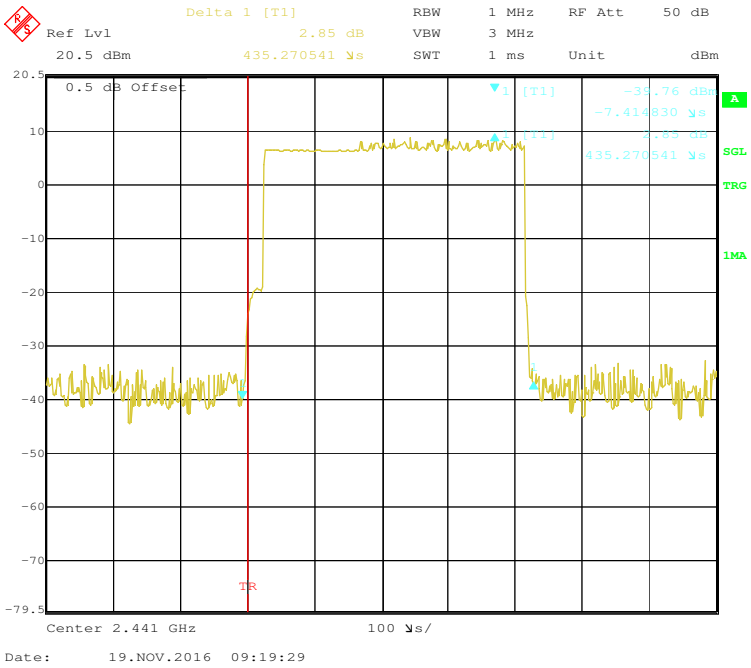


EDR (8DPSK):

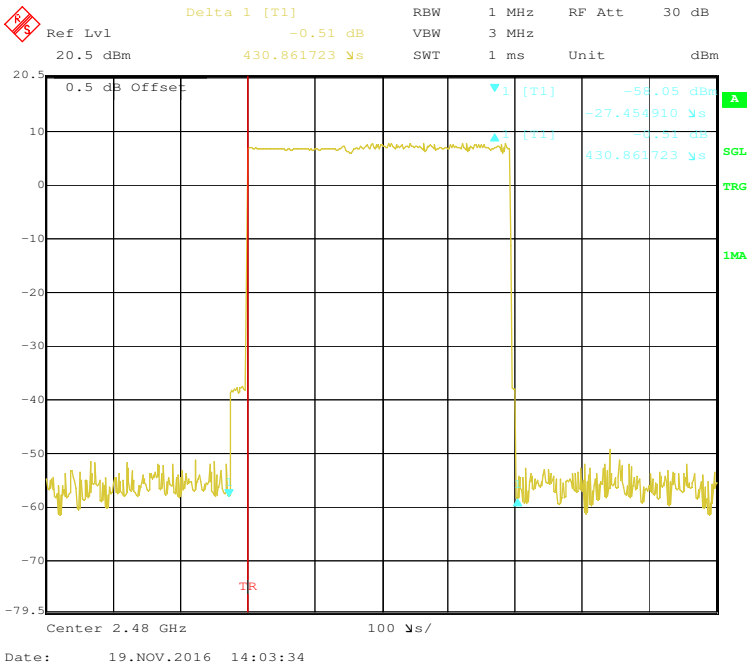
Pulse time, Low Channel, 3DH1



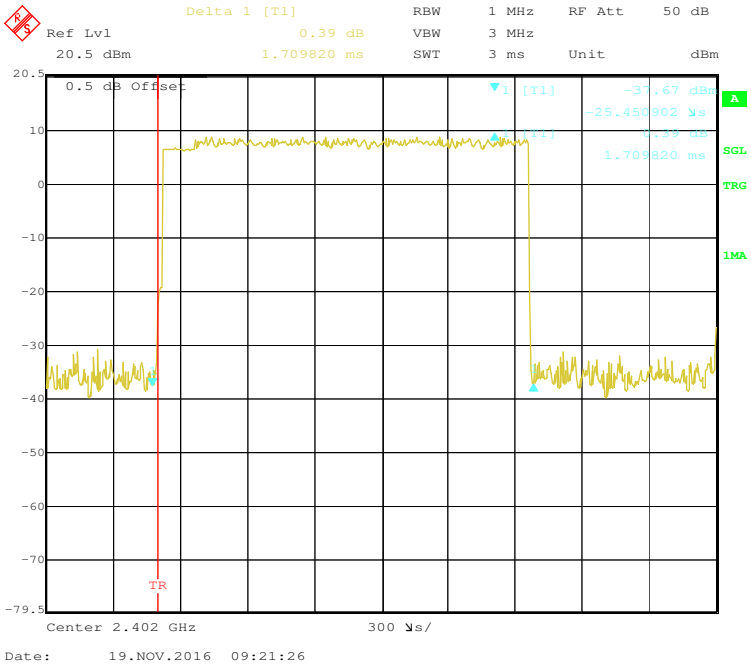
Pulse time, Middle Channel, 3DH1



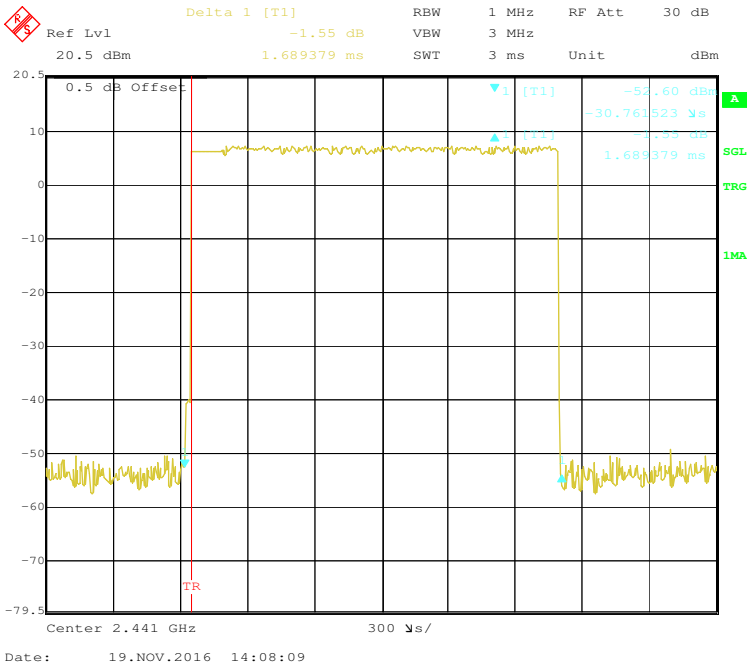
Pulse time, High Channel, 3DH1



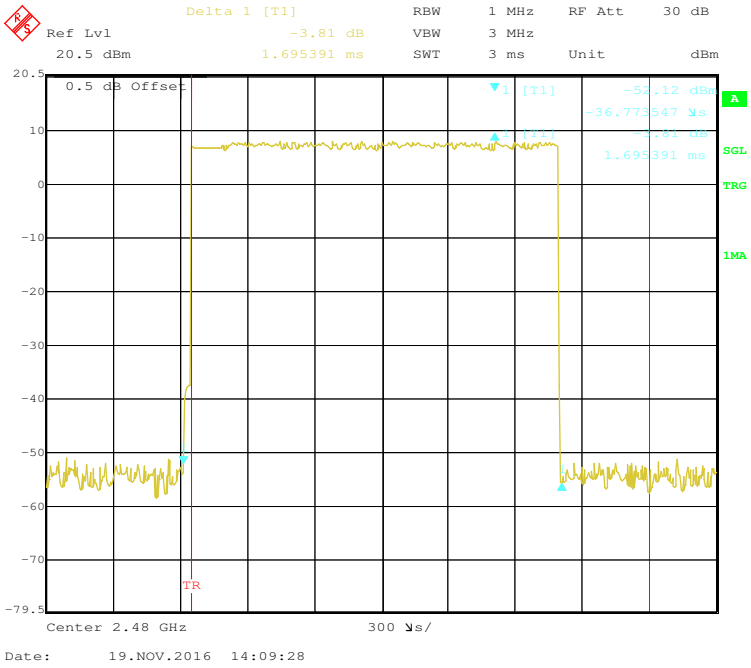
Pulse time, Low Channel, 3DH3



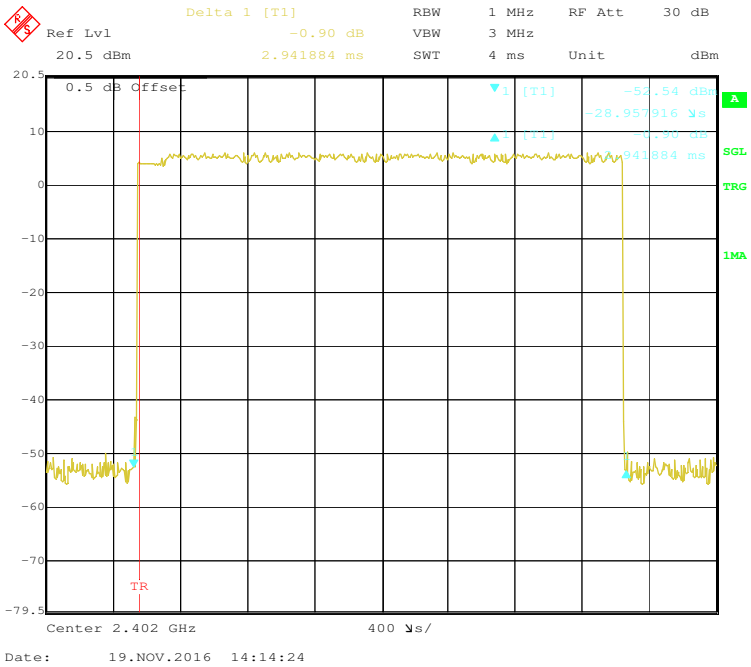
Pulse time, Middle Channel, 3DH3



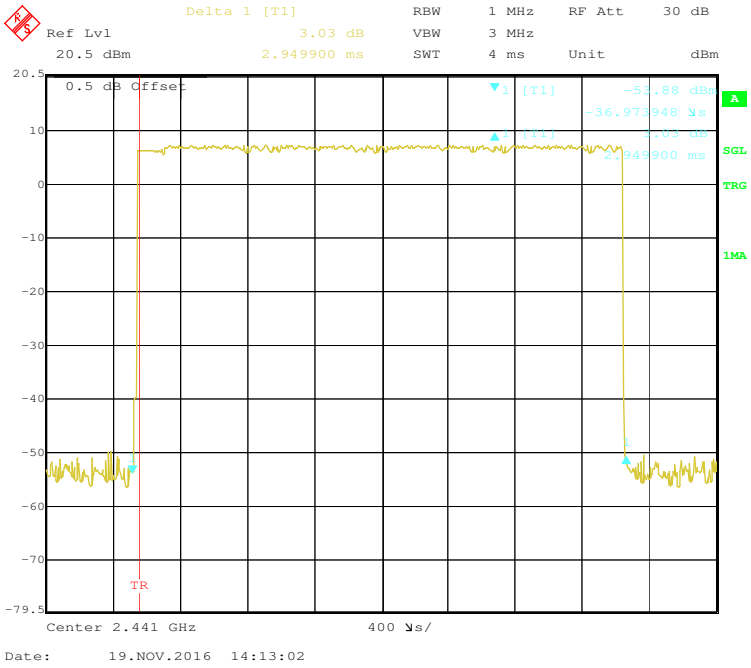
Pulse time, High Channel, 3DH3



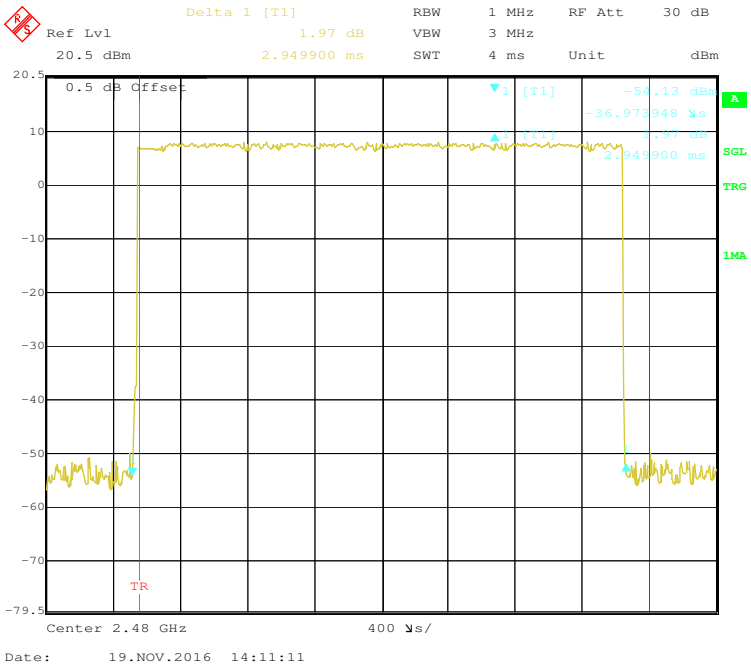
Pulse time, Low Channel, 3DH5



Pulse time, Middle Channel, 3DH5



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:	24 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

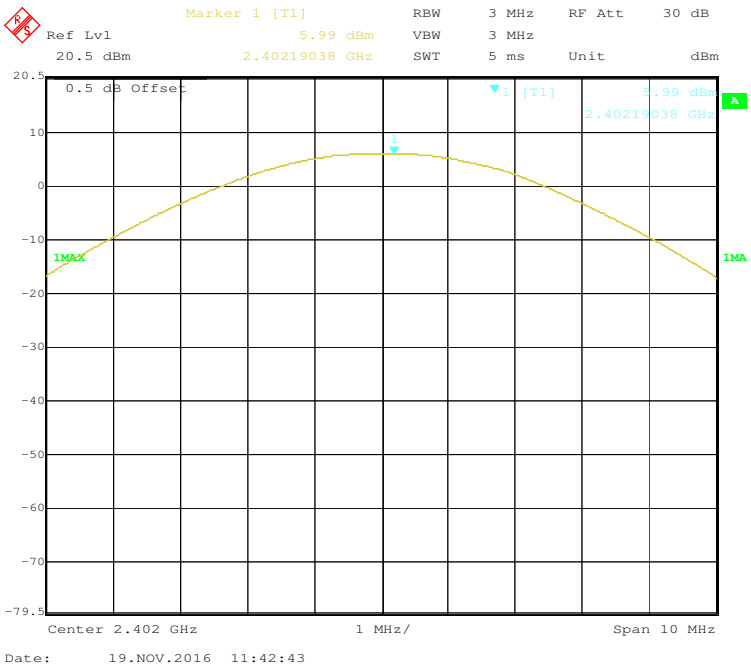
The testing was performed by Peter Jiang on 2016-11-19.

EUT operation mode: Transmitting

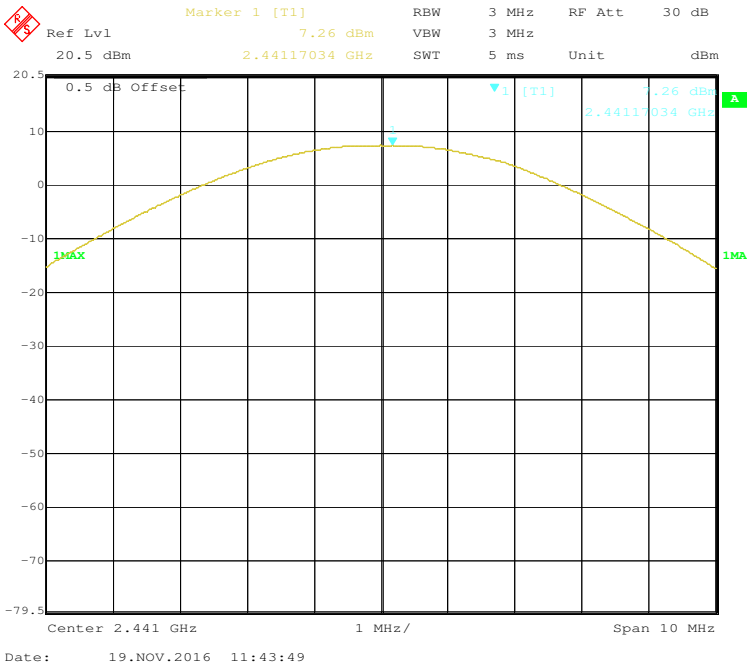
Test Result: Compliance. Please refer to following tables and plots

Mode	Channel	Frequency (MHz)	Output Power		Limit (mW)
			(dBm)	(mW)	
BDR (GFSK)	Low	2402	5.99	3.97	1000
	Middle	2441	7.26	5.32	1000
	High	2480	7.84	6.08	1000
EDR (π/4-DQPSK)	Low	2402	5.91	3.90	1000
	Middle	2441	7.22	5.27	1000
	High	2480	7.84	6.08	1000
EDR (8DPSK)	Low	2402	6.35	4.32	1000
	Middle	2441	7.51	5.64	1000
	High	2480	8.15	6.53	1000

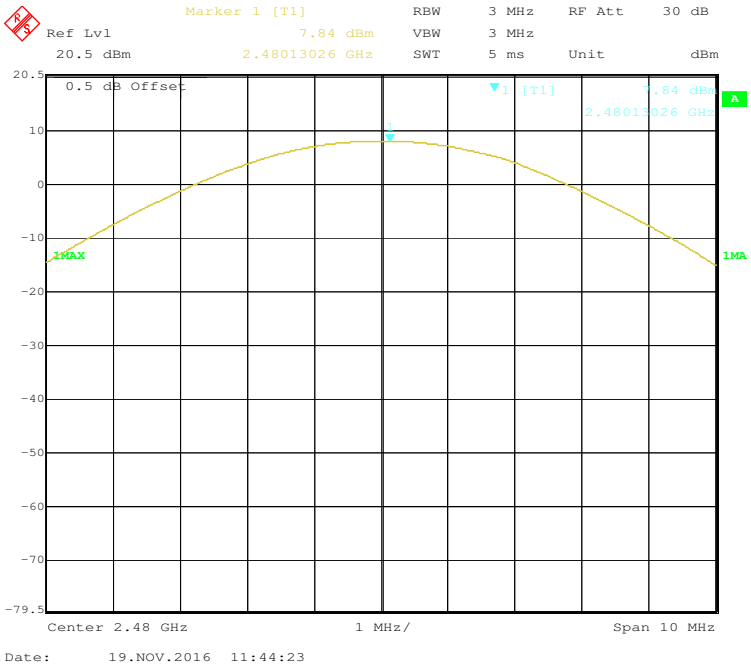
BDR (GFSK): Low Channel



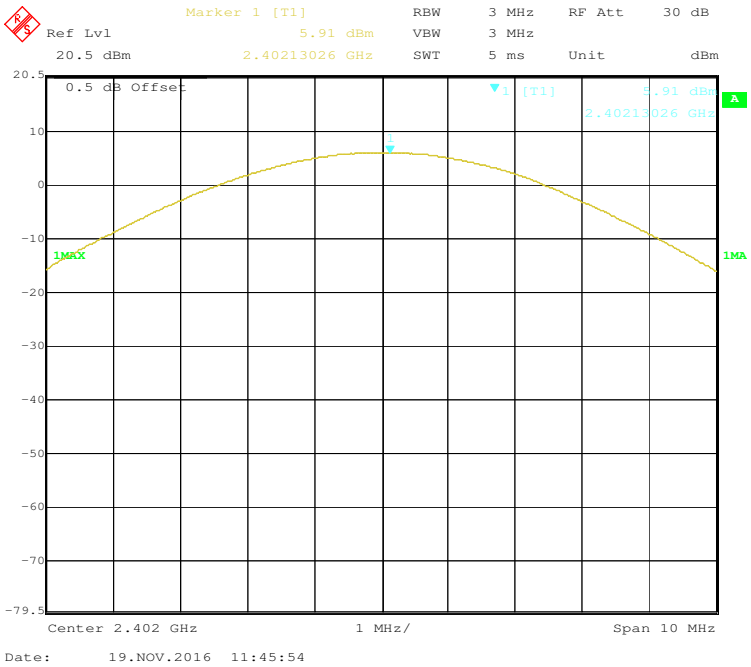
BDR (GFSK): Middle Channel



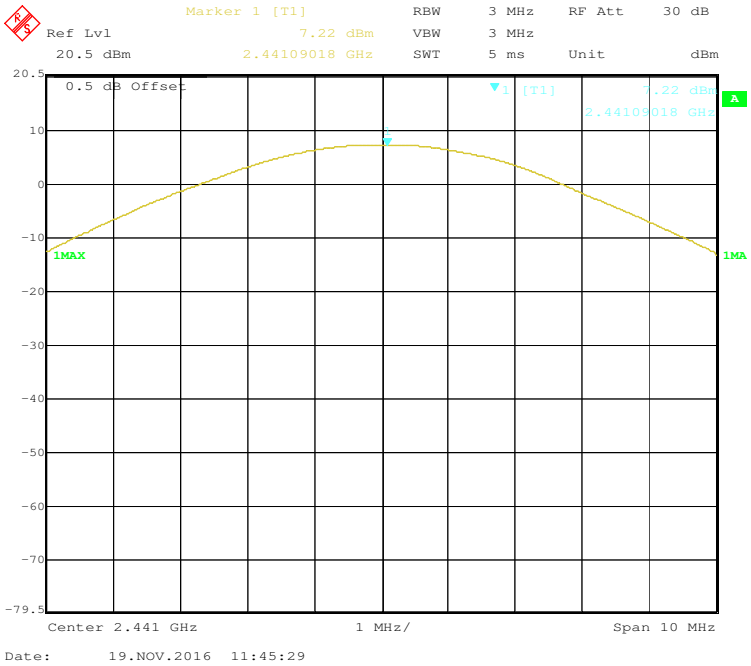
BDR (GFSK): High Channel



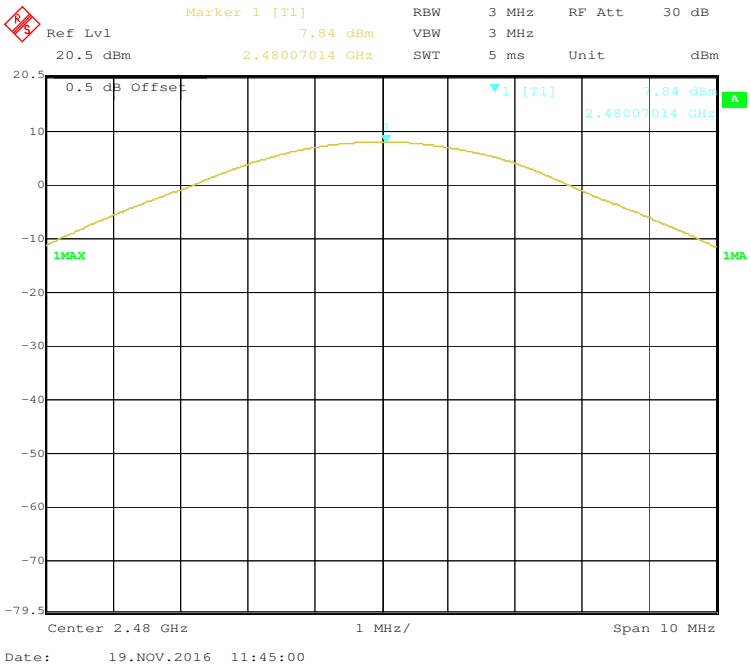
EDR (π/4-DQPSK): Low Channel



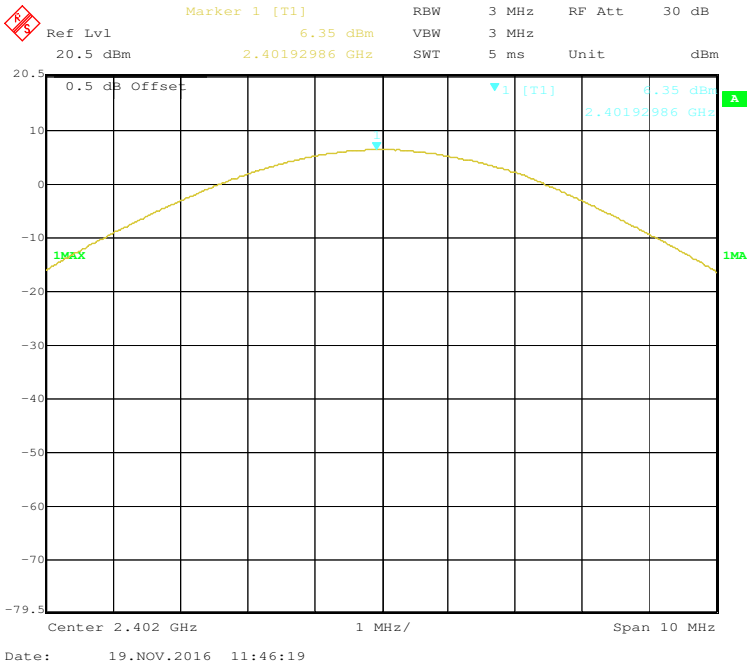
EDR (π/4-DQPSK): Middle Channel



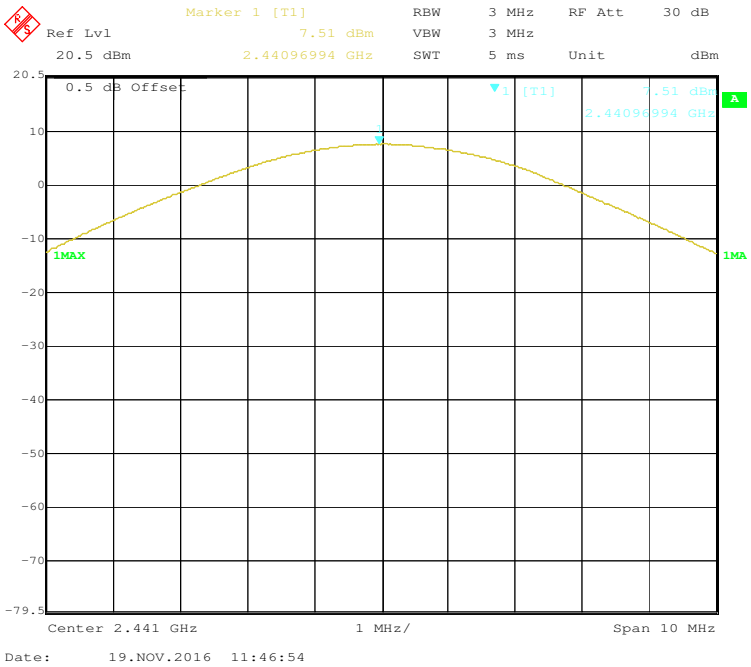
EDR (π/4-DQPSK): High Channel



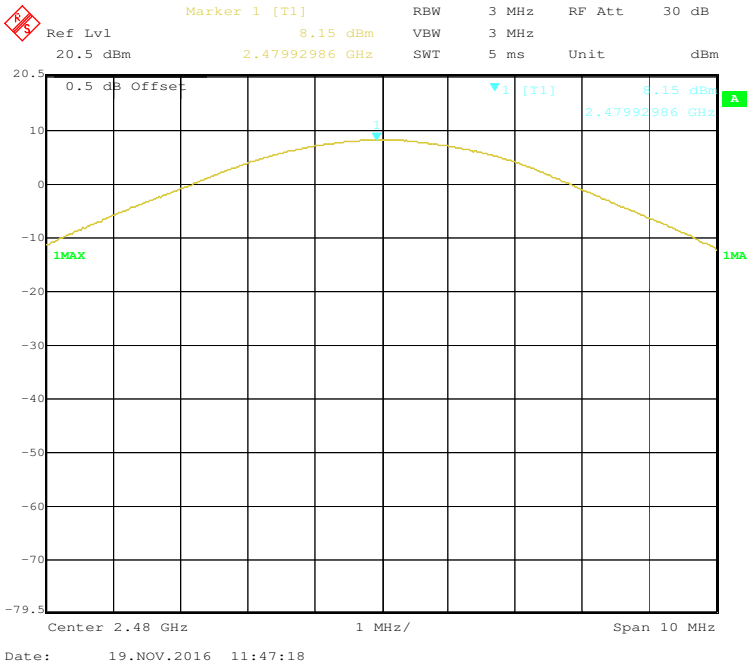
EDR (8DPSK): Low Channel



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

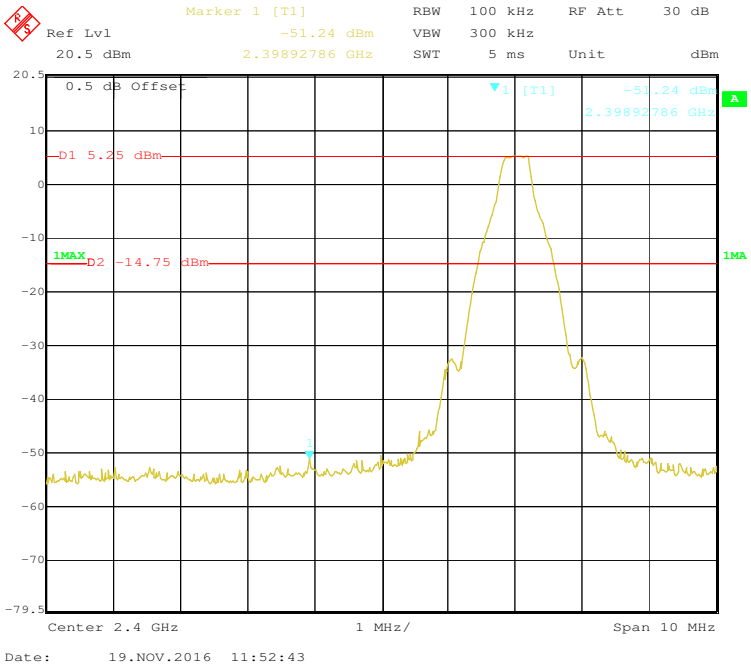
Temperature:	23.8℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Peter Jiang on 2016-11-19.

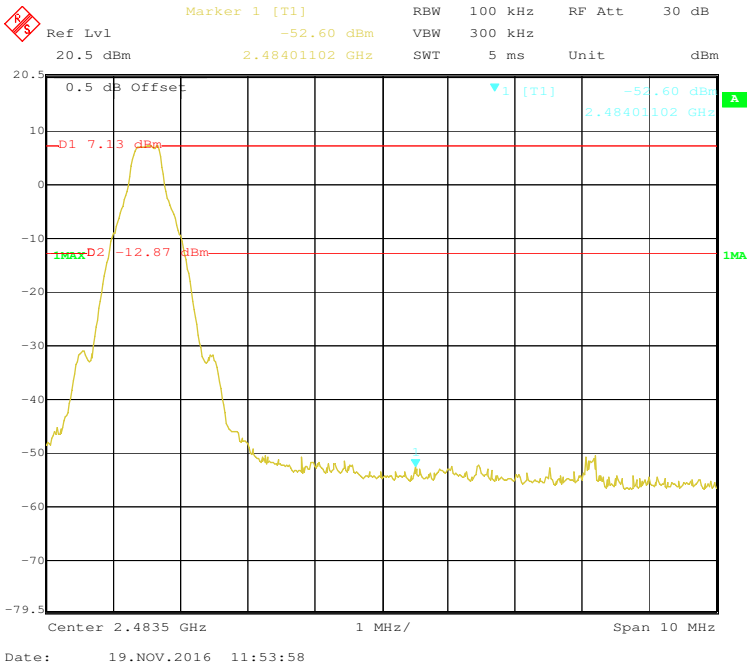
EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following plots.

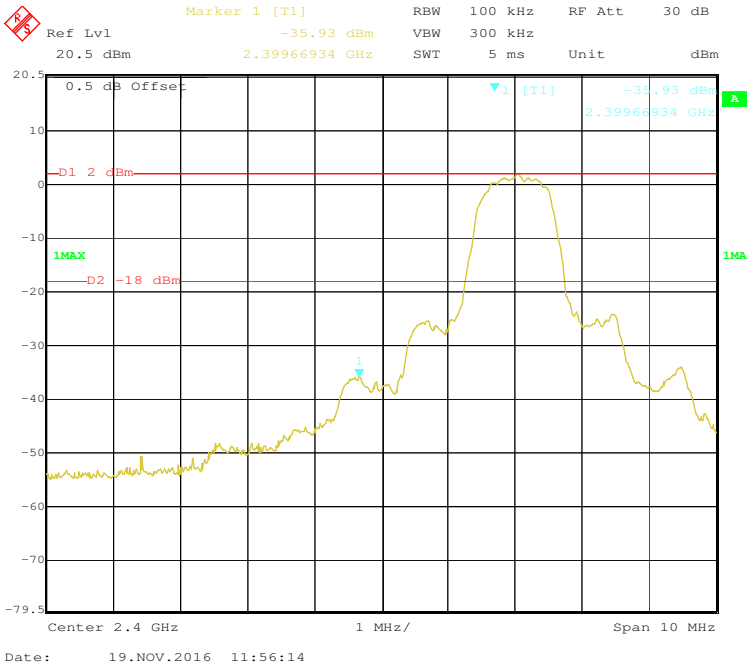
BDR (GFSK): Band Edge-Left Side



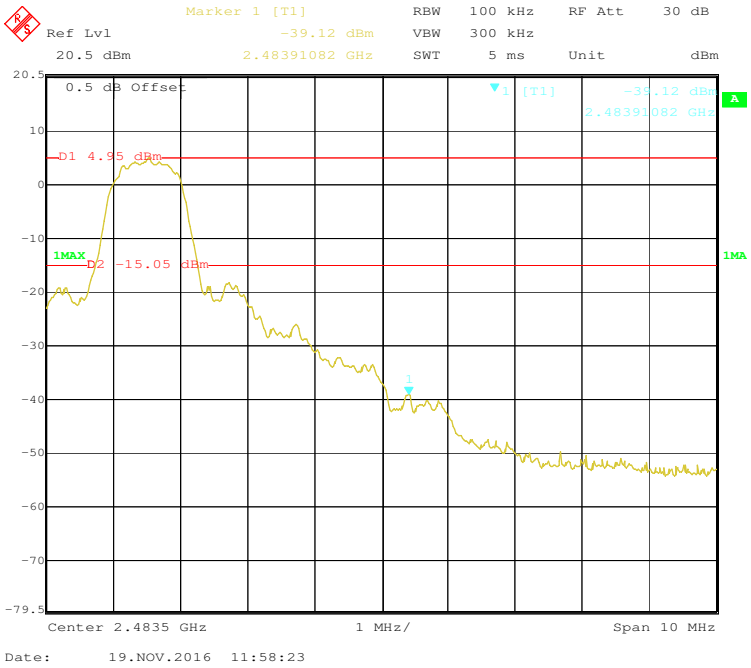
BDR (GFSK): Band Edge-Right Side



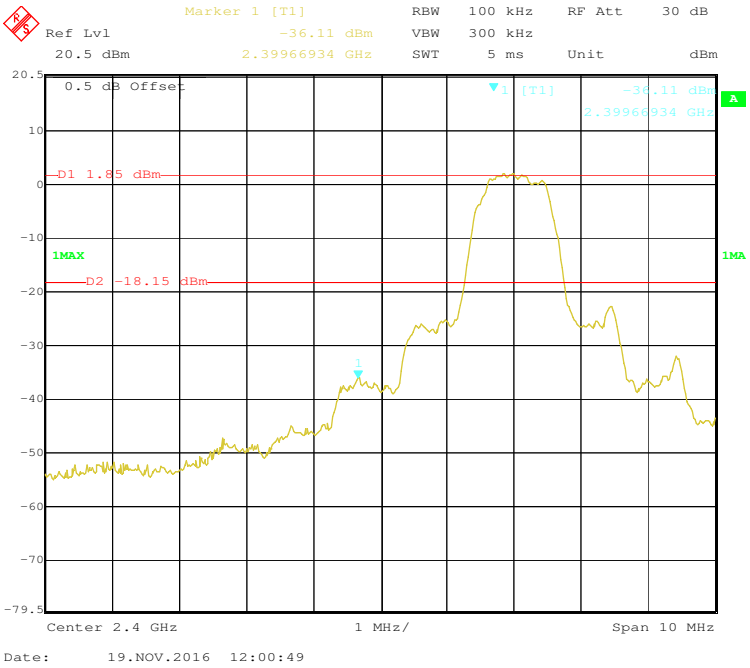
EDR (π/4-DQPSK): Band Edge-Left Side



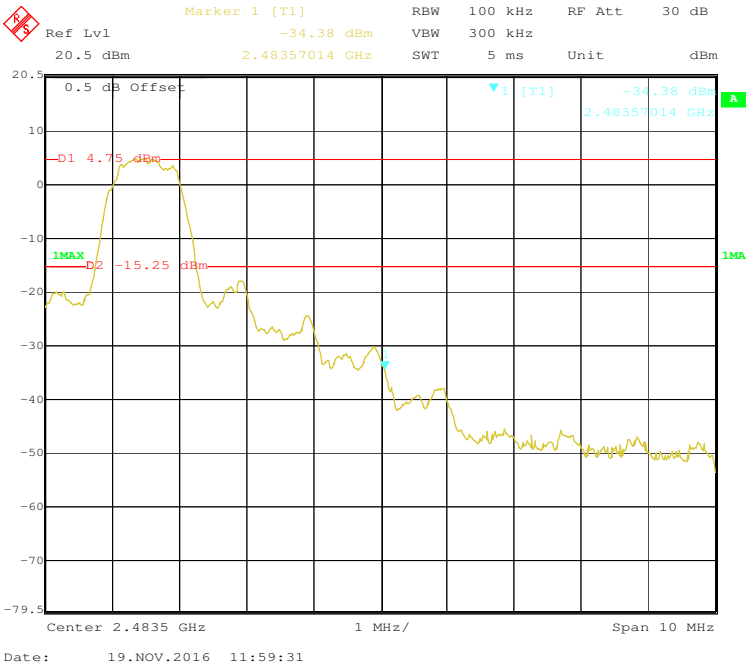
EDR (π/4-DQPSK): Band Edge-Right Side



EDR (8DPSK): Band Edge-Left Side



BDR (8DPSK): Band Edge-Right Side



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