FCC PART 15.247
TEST REPORT

For

Shenzhen MingZhan Information Technology Co., Ltd

8th floor, Huaqiang electronic world building 2-02, Shenzhen Huaqiang North Street, Futian District, Shenzhen, China

FCC ID: 2AN3WM5STACK-CORE

Report Type:	Product Type:
Original Report	WIFI & Bluetooth Development Board

Test Engineer:	Ada Yu
Report Number:	RSHA170928001-00A
Report Date:	2017-10-19
Reviewed By:	Oscar Ye RF Leader
Prepared By:	Bay Area Compliance Laboratories Corp. (Kunshan) No.248 Chenghu Road,Kunshan,Jiangsu province,China Tel: +86-0512-86175000 Fax: +86-0512-88934268 www.baclcorp.com.cn

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	Shenzhen MingZhan Information Technology Co., Ltd
Tested Model	M5Stack-CORE
Product Type	WIFI & Bluetooth Development Board
Dimension	54 mm(L)×54 mm(W)×12.6 mm(H)
Power Supply	DC 3.7V by battery and DC 5V from USB port

**All measurement and test data in this report was gathered from production sample serial number: 20170928001. (Assigned by the BACL. The EUT supplied by the applicant was received on 2017-09-28)*

Objective

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

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

Related Submittal(s)/Grant(s)

FCC Part15.247 DTS submission with FCC ID: 2AN3WM5STACK-CORE.

Test Methodology

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

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

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
	18GHz~40GHz	4.88dB
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.

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

SYSTEM TEST CONFIGURATION

Description of Test Configuration

Channel list for Bluetooth:

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

EUT was tested with Channel 0, 39 and 78.

EUT Exercise Software

RF Test Tool: SecureCRT

GFSK Power level: 6
π/4-DQPSK Power level: 6
8-DPSK Power level: 6

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

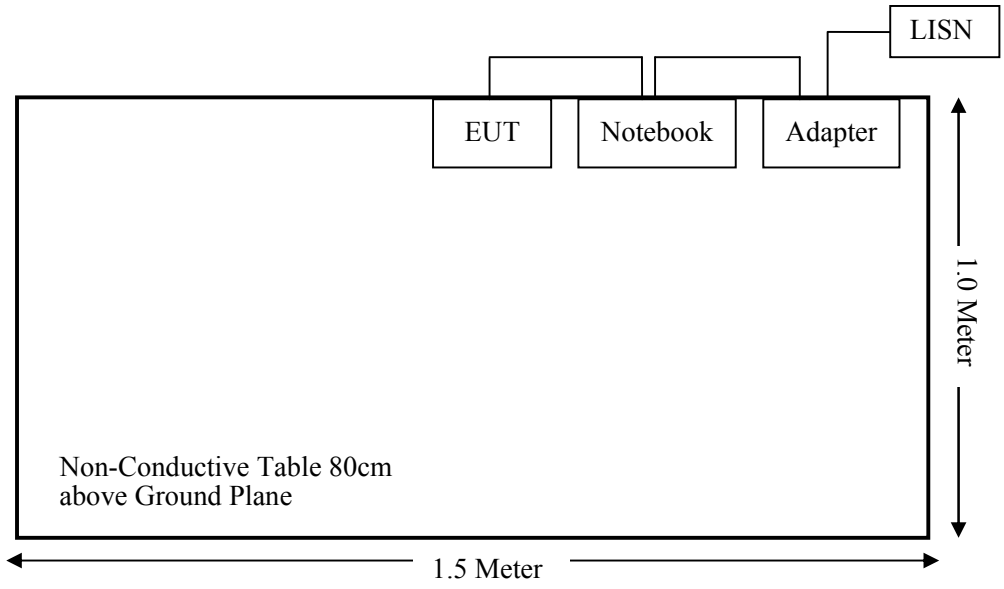
Manufacturer	Description	Model	Serial Number
DELL	Notebook	GX620	D65874152
DELL	Adapter	LA65NS0-00	DF263

External I/O Cable

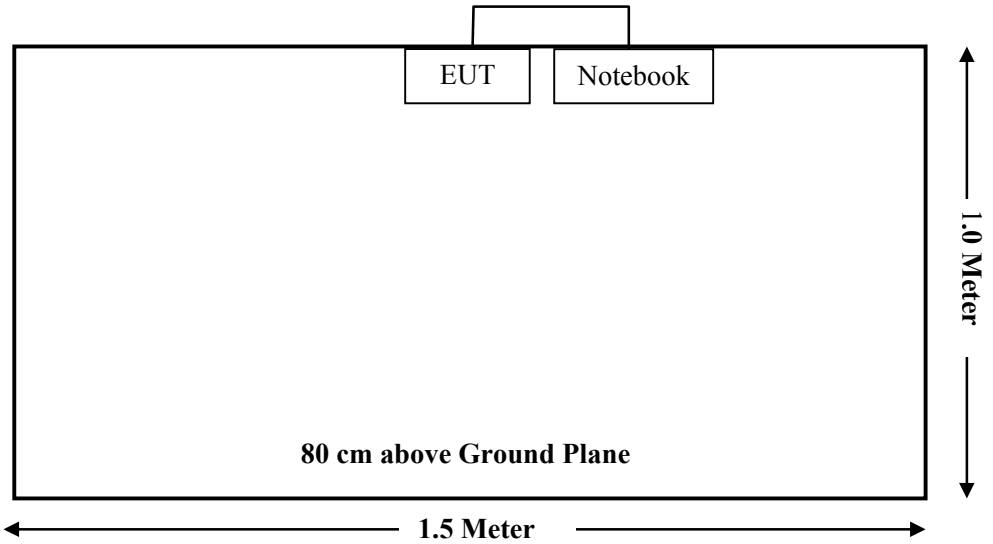
Cable Description	Length (m)	From Port	To
USB Cable	0.3	EUT	Notebook

Block Diagram of Test Setup

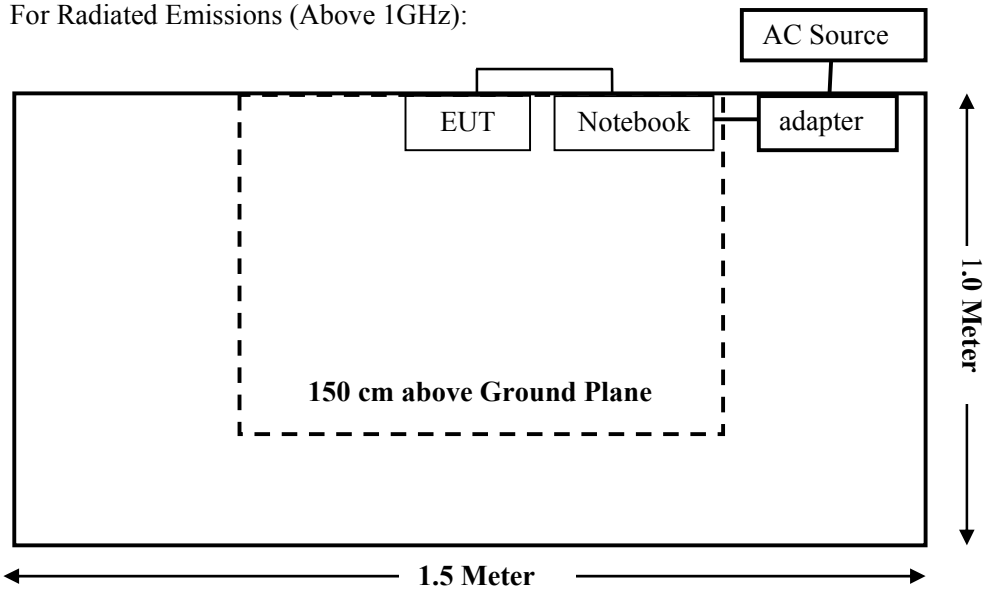
For Conducted Emissions:



For Radiated Emissions (Below 1GHz):



For Radiated Emissions (Above 1GHz):



SUMMARY OF TEST RESULTS

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

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test（Chamber 1#）					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Sunol Sciences	Broadband Antenna	JB3	A040914-2	2016-01-09	2019-01-08
Sonoma Instrunent	Pre-amplifier	310N	171205	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-8	008	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2017-08-15	2018-08-14
Radiated Emission Test（Chamber 2#）					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2017-08-27	2018-08-26
ETS-LINDGREN	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Narda	Pre-amplifier	AFS42-00101800	2001270	2016-12-12	2017-12-11
Heatsink Required	Amplifier	QLW-18405536-J0	15964001009	2016-12-12	2017-12-11
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2017-08-15	2018-08-14
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSV40	101116	2017-07-22	2018-07-21
Mingzhan	RF Cable	N/A	N/A	/	/
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Rohde & Schwarz	LISN	ESH3-Z5	862770/011	2017-10-10	2018-10-09
Rohde & Schwarz	LISN	ENV216	3560655016	2016-11-25	2017-11-24
BACL	BACL-EMC	V1.0	CE001	/	/
Narda	Attenuator/6dB	10690812-2	26850-6	2017-01-10	2018-01-09
MICRO-COAX	Coaxial Cable	Cable-15	015	2017-08-15	2018-08-14

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

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

Applicable Standard

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

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

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

f = frequency in MHz; * = Plane-wave equivalent power density;
According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:
Predication of MPE limit at a given distance
$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/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

Mode	Frequency Range	Antenna Gain		Target Output Power		Evaluation Distance	Power Density	MPE Limit
	(MHz)	(dBi)	(numeric)	(dBm)	(mW)	(cm)	(mW/cm^2)	(mW/cm^2)
BT(EDR)	2402-2480	2.00	1.58	6.50	4.47	20	0.0014	1
BLE	2402-2480	2.00	1.58	5.00	3.16	20	0.0010	1
802.11b	2412~2462	2.00	1.58	18.00	63.10	20	0.0199	1
802.11g		2.00	1.58	18.50	70.79	20	0.0223	1
802.11 n-HT20		2.00	1.58	18.50	70.79	20	0.0223	1
802.11 n-HT40	2422~2452	2.00	1.58	17.00	50.12	20	0.0158	1

Note:

1. For the above target output power are all declared by the manufacturer.
2. The EUT has the BT, 2.4GHz Wi-Fi functions, they can transmitting simultaneously. According to KDB 447498 D01 General RF Exposure Guidance v06 and test data, the *EDR mode for BT* and the *802.11g mode for 2.4G WIFI* are the worst case, their sum of MPE ratio is 0.024 which is less than 1.0,so the collocation exposure exclusion applies.

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 PIFA antenna arrangement for Bluetooth, which the antenna gain is 2 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

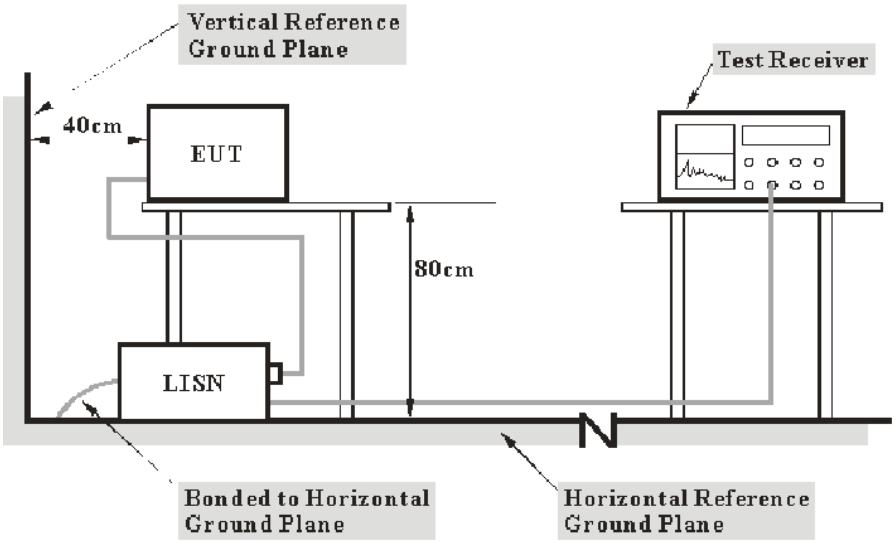
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

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

EMI Test Receiver Setup

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

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

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

Test Procedure

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

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

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

Corrected Factor & Margin Calculation

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

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 – Reading

Test Results Summary

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

Test Data

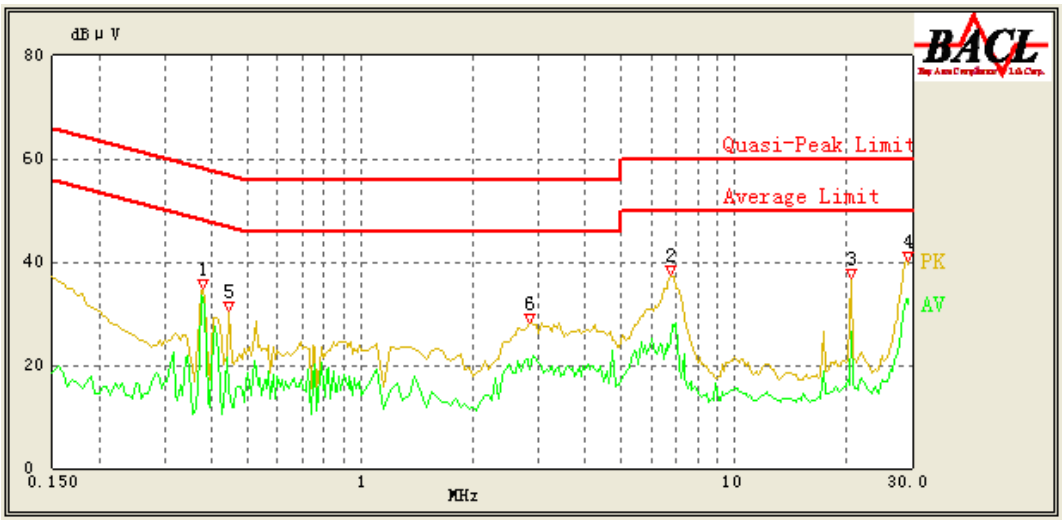
Environmental Conditions

Temperature:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-10-19.

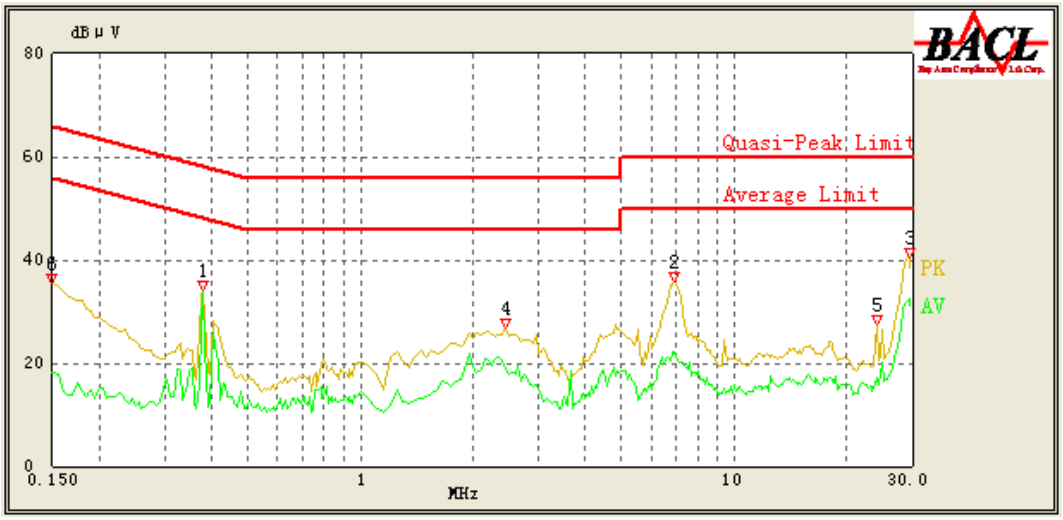
EUT operation mode: Transmitting in low channel of 8-DPSK (Worst case)

AC 120V/60 Hz, Line



Frequency (MHz)	Reading (dBµV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Correction (dB)	Limit (dBµV)	Margin (dB)	Comment
0.380	34.85	QP	9.000	L1	16.05	59.43	24.58	Compliance
0.380	33.04	AV	9.000	L1	16.05	49.43	16.39	Compliance
6.800	37.36	QP	9.000	L1	15.97	60.00	22.64	Compliance
6.750	24.38	AV	9.000	L1	15.96	50.00	25.62	Compliance
20.700	36.84	QP	9.000	L1	16.44	60.00	23.16	Compliance
20.600	26.44	AV	9.000	L1	16.44	50.00	23.56	Compliance
29.100	40.20	QP	9.000	L1	16.57	60.00	19.80	Compliance
29.100	32.67	AV	9.000	L1	16.57	50.00	17.33	Compliance
0.445	30.39	QP	9.000	L1	16.07	57.57	27.18	Compliance
0.445	15.09	AV	9.000	L1	16.07	47.57	32.48	Compliance
2.850	28.06	QP	9.000	L1	15.85	56.00	27.94	Compliance
2.850	19.11	AV	9.000	L1	15.85	46.00	26.89	Compliance

AC 120V/60 Hz, Neutral



Frequency (MHz)	Reading (dBµV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Correction (dB)	Limit (dBµV)	Margin (dB)	Comment
0.380	34.20	QP	9.000	N	16.09	59.43	25.23	Compliance
0.380	34.08	AV	9.000	N	16.09	49.43	15.35	Compliance
6.950	35.94	QP	9.000	N	15.92	60.00	24.06	Compliance
6.950	22.20	AV	9.000	N	15.92	50.00	27.80	Compliance
29.400	40.39	QP	9.000	N	16.33	60.00	19.61	Compliance
29.400	32.48	AV	9.000	N	16.33	50.00	17.52	Compliance
2.450	26.78	QP	9.000	N	15.90	56.00	29.22	Compliance
2.450	18.76	AV	9.000	N	15.90	46.00	27.24	Compliance
24.050	27.60	QP	9.000	N	16.22	60.00	32.40	Compliance
24.050	17.07	AV	9.000	N	16.22	50.00	32.93	Compliance
0.150	35.37	QP	9.000	N	16.06	66.00	30.63	Compliance
0.150	18.25	AV	9.000	N	16.06	56.00	37.75	Compliance

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

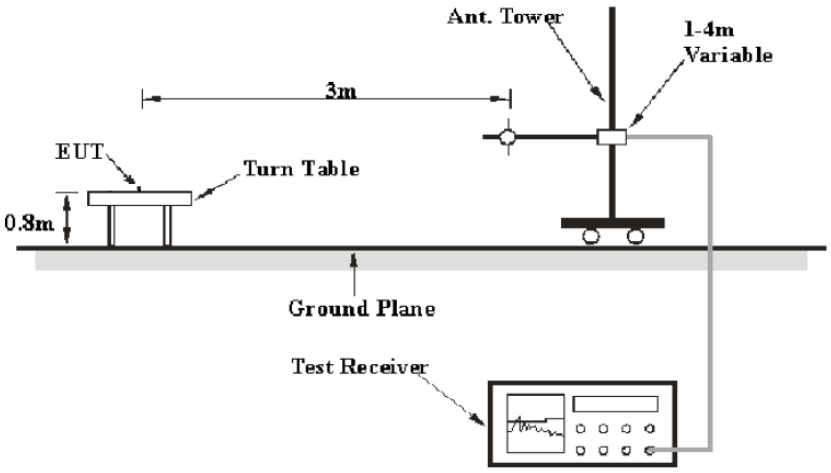
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

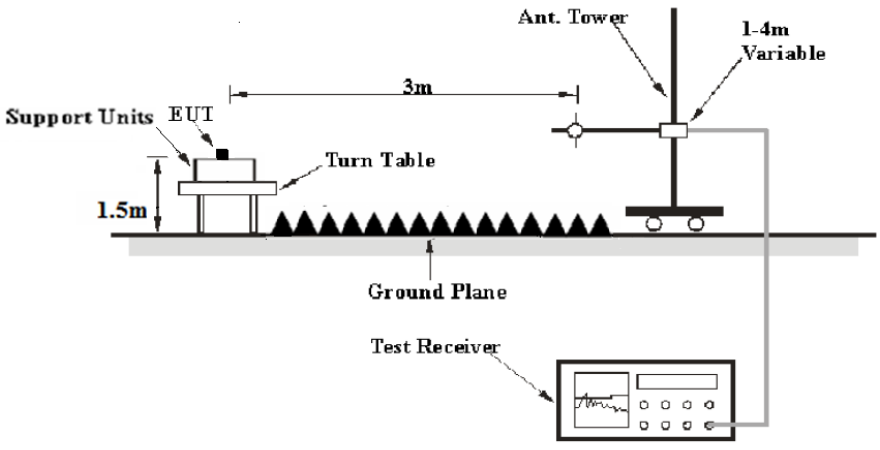
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



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

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

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

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

Frequency Range	Item	RBW	Video B/W	Detector
1GHz – 25GHz	PK Value	1MHz	3 MHz	PK
	AV Value	1MHz	10 Hz	PK

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 detection mode 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.

Test Data

Environmental Conditions

Temperature:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-10-16.

EUT operation mode: Transmitting

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

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	PK/QP /Ave.		Height (cm)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2402 MHz)									
175.69	32.18	QP	139	163	V	-13.90	18.28	43.5	25.22
2402.00	108.30	PK	354	196	V	-4.93	103.37	/	/
2402.00	98.01	Ave	354	196	V	-4.93	93.08	/	/
2402.00	103.91	PK	315	238	H	-4.93	98.98	/	/
2402.00	93.17	Ave	315	238	H	-4.93	88.24	/	/
2390.00	44.18	PK	206	130	V	-4.96	39.22	74	34.78
2390.00	29.17	Ave	206	130	V	-4.96	24.21	54	29.79
1795.83	45.68	PK	222	202	H	-6.86	38.82	74	35.18
1795.83	30.01	Ave	222	202	H	-6.86	23.15	54	30.85
1268.00	44.35	PK	234	176	V	-9.74	34.61	74	39.39
1268.00	30.21	Ave	234	176	V	-9.74	20.47	54	33.53
4804.00	45.76	PK	223	182	V	2.47	48.23	74	25.77
4804.00	34.78	Ave	223	182	V	2.47	37.25	54	16.75
7206.00	40.83	PK	275	226	V	9.79	50.62	74	23.38
7206.00	27.06	Ave	275	226	V	9.79	36.85	54	17.15

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	PK/QP /Ave.		Height (cm)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Middle Channel (2441 MHz)									
175.69	32.14	QP	15	233	V	-13.90	18.24	43.5	25.26
2441.00	107.36	PK	350	235	V	-4.82	102.54	/	/
2441.00	96.63	Ave	350	235	V	-4.82	91.81	/	/
2441.00	102.28	PK	349	149	H	-4.82	97.46	/	/
2441.00	91.79	Ave	349	149	H	-4.82	86.97	/	/
1334.00	45.56	PK	353	208	H	-9.26	36.30	74	37.70
1334.00	29.85	Ave	353	208	H	-9.26	20.59	54	33.41
3684.00	44.17	PK	164	150	H	-0.29	43.88	74	30.12
3684.00	30.19	Ave	164	150	H	-0.29	29.90	54	24.10
4882.00	47.88	PK	239	124	V	2.64	50.52	74	23.48
4882.00	35.94	Ave	239	124	V	2.64	38.58	54	15.42
6663.00	43.99	PK	117	126	H	8.66	52.65	74	21.35
6663.00	30.11	Ave	117	126	H	8.66	38.77	54	15.23
7323.00	40.52	PK	196	104	V	9.96	50.48	74	23.52
7323.00	26.97	Ave	196	104	V	9.96	36.93	54	17.07
High Channel (2480MHz)									
175.69	32.08	QP	348	113	V	-13.90	18.18	43.5	25.32
2480.00	107.01	PK	60	179	V	-4.72	102.29	/	/
2480.00	96.50	Ave	60	179	V	-4.72	91.78	/	/
2480.00	101.97	PK	40	237	H	-4.72	97.25	/	/
2480.00	91.41	Ave	40	237	H	-4.72	86.69	/	/
2483.50	45.39	PK	226	145	V	-4.71	40.68	74	33.32
2483.50	29.77	Ave	226	145	V	-4.71	25.06	54	28.94
2689.00	44.02	PK	150	183	H	-3.67	40.35	74	33.65
2689.00	30.10	Ave	150	183	H	-3.67	26.43	54	27.57
4960.00	51	PK	59	157	V	2.82	53.82	74	20.18
4960.00	40.68	Ave	59	157	V	2.82	43.50	54	10.50
6348.00	43.87	PK	163	247	H	7.49	51.36	74	22.64
6348.00	30.07	Ave	163	247	H	7.49	37.56	54	16.44
7440.00	41.54	PK	144	161	V	10.14	51.68	74	22.32
7440.00	27.86	Ave	144	161	V	10.14	38.00	54	16.00

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:	23.4 ℃
Relative Humidity:	49 %
ATM Pressure:	101.1 kPa

The testing was performed by Ada Yu on 2017-10-16.

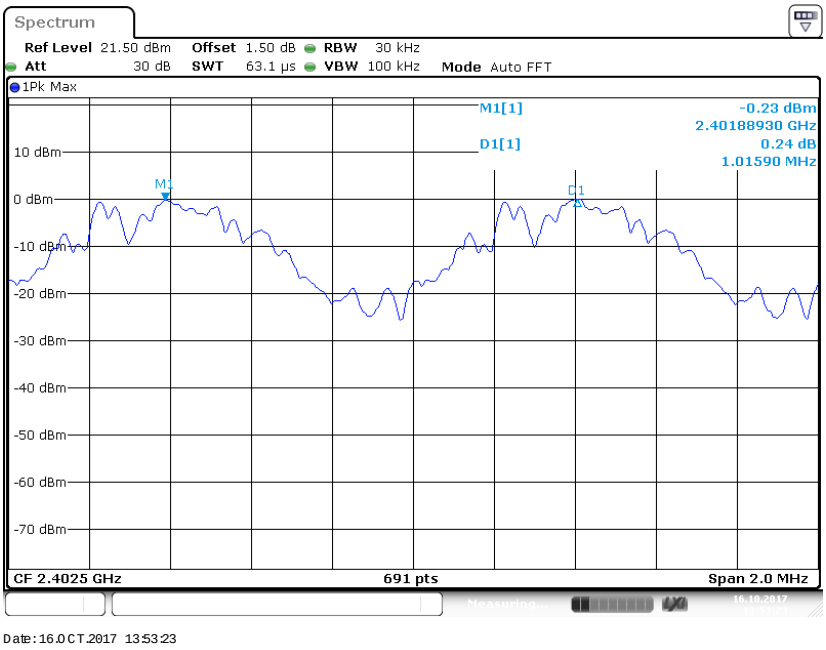
EUT operation mode: Hopping

Test Result: Compliance.

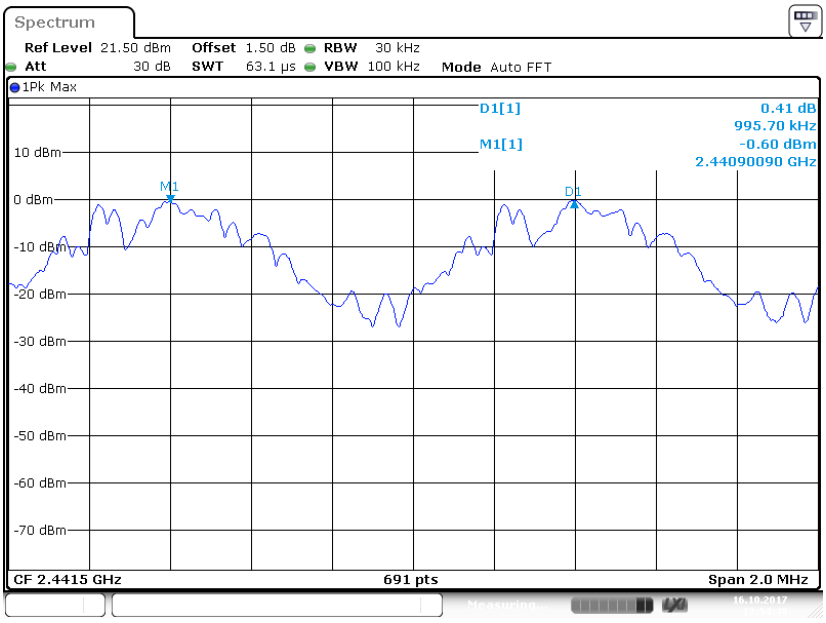
Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)	Result
BDR (GFSK)	Low	2402	1.016	0.446	Pass
	Adjacent	2403			
	Middle	2441	0.996	0.457	Pass
	Adjacent	2442			
	High	2480	1.004	0.449	Pass
	Adjacent	2479			
EDR (π/4-DQPSK)	Low	2402	1.007	0.863	Pass
	Adjacent	2403			
	Middle	2441	1.012	0.863	Pass
	Adjacent	2442			
	High	2480	0.999	0.865	Pass
	Adjacent	2479			
EDR (8-DPSK)	Low	2402	1.003	0.845	Pass
	Adjacent	2403			
	Middle	2441	0.99	0.848	Pass
	Adjacent	2442			
	High	2480	1.007	0.845	Pass
	Adjacent	2479			

Note: Limit = 20 dB bandwidth*2/3

BDR (GFSK): Low Channel

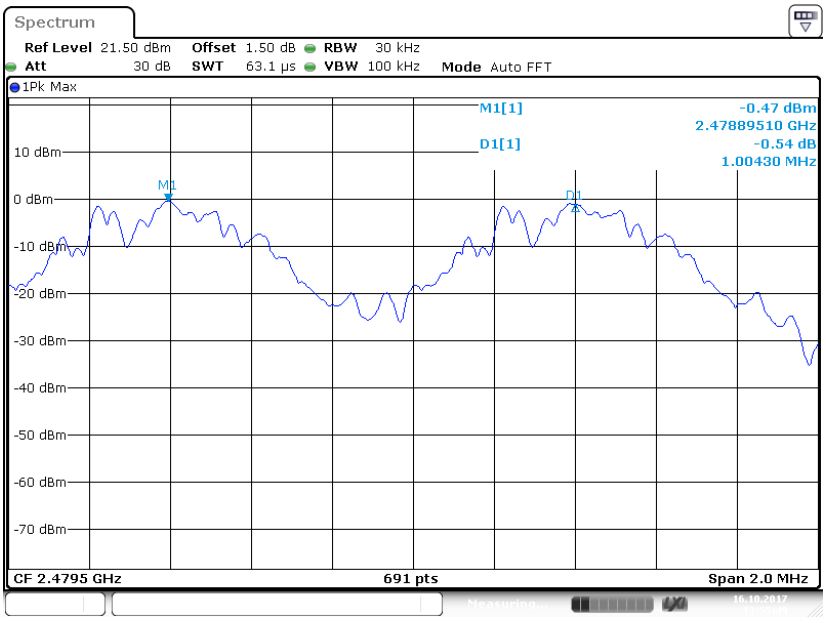


BDR (GFSK): Middle Channel



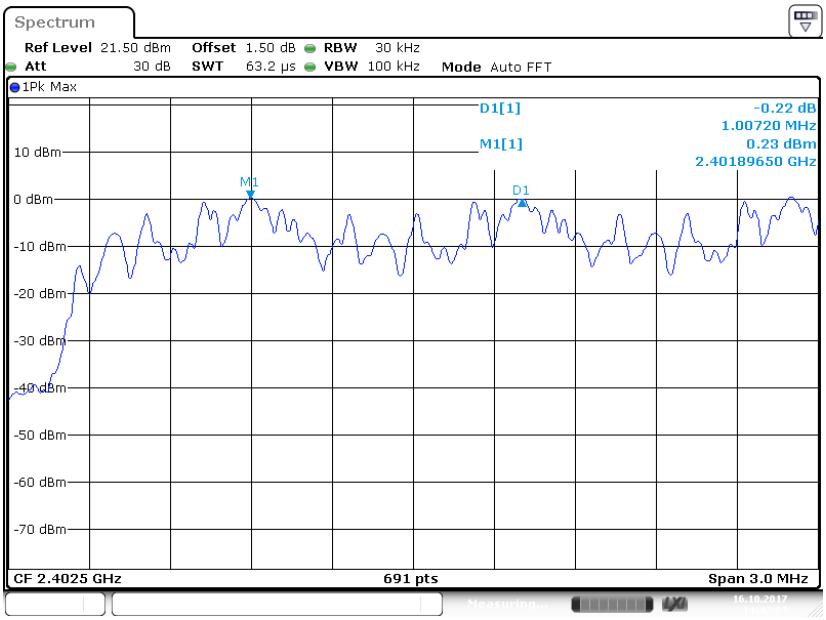
Date:16.OCT.2017 13:54:48

BDR (GFSK): High Channel



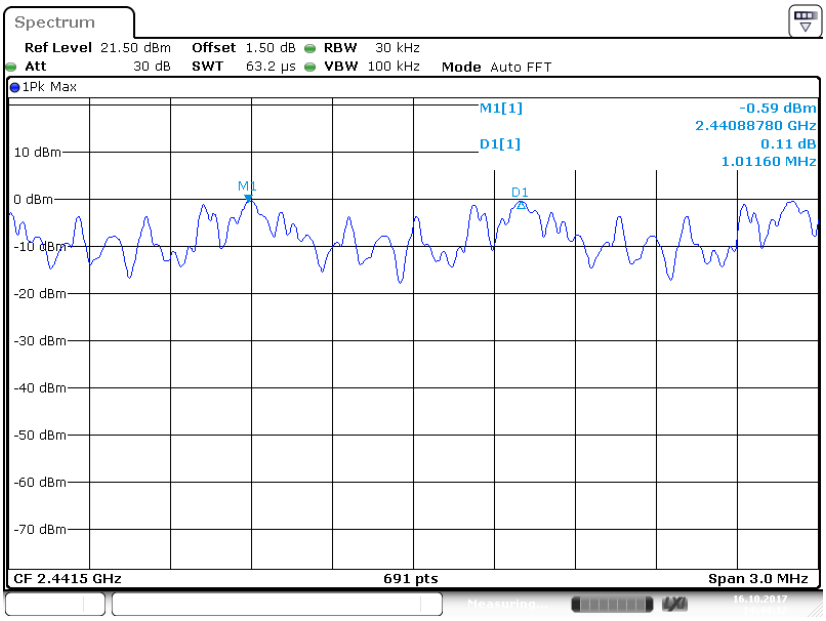
Date:16.OCT.2017 13:55:50

EDR (π/4-DQPSK): Low Channel



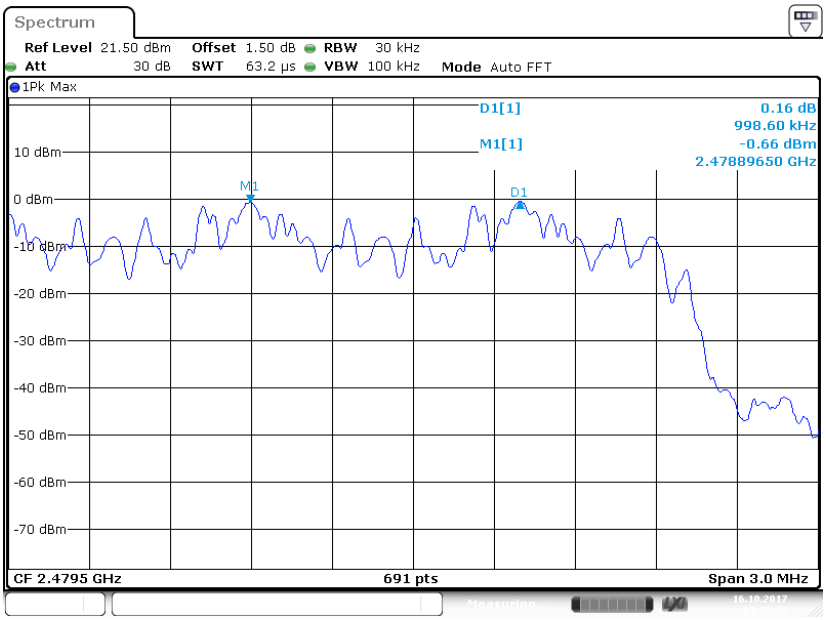
Date:16.OCT.2017 14:42:23

EDR (π/4-DQPSK): Middle Channel



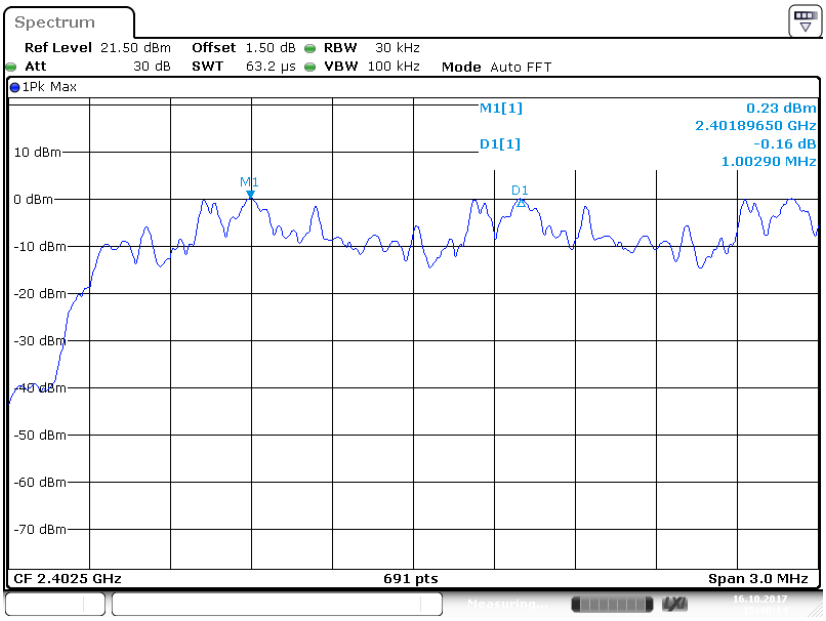
Date:16.OCT.2017 14:44:13

EDR (π/4-DQPSK): High Channel



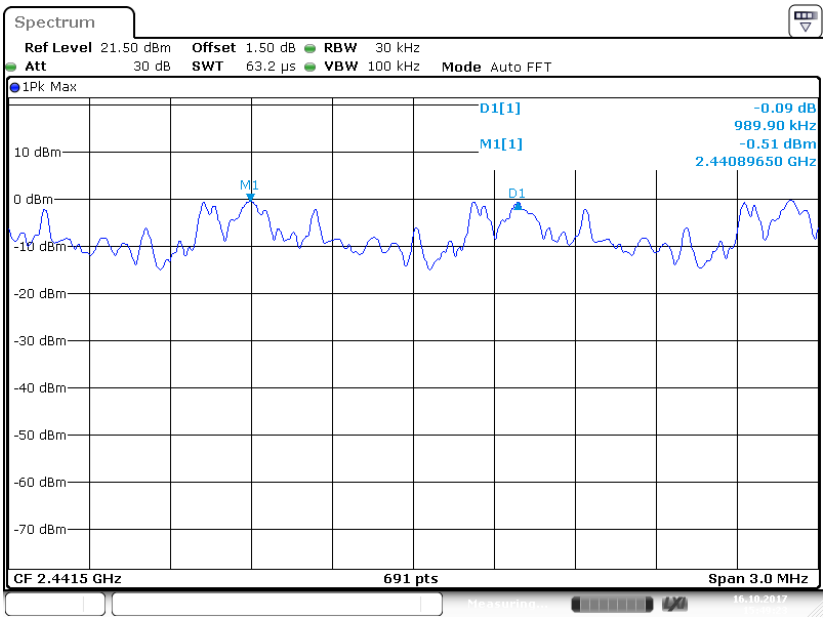
Date:16.OCT.2017 14:45:33

EDR (8-DPSK): Low Channel



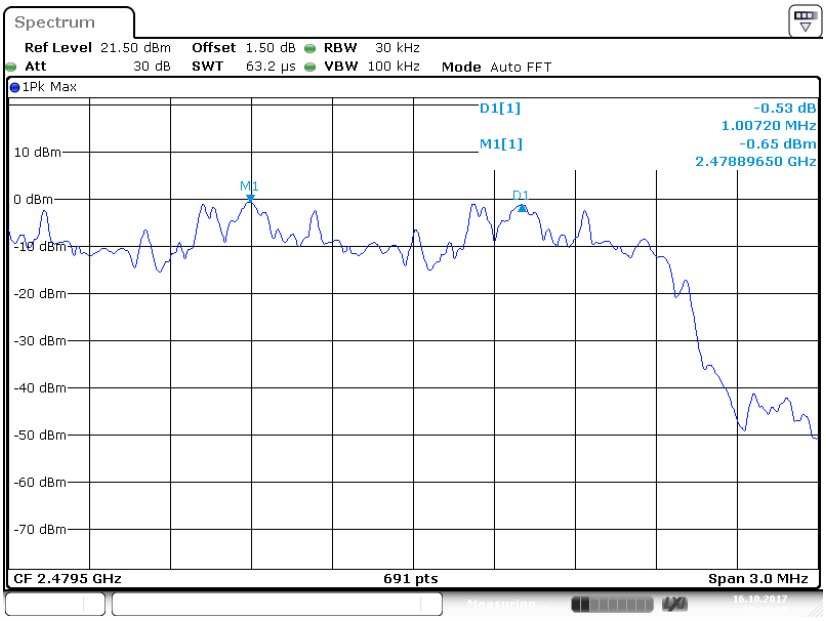
Date:16.OCT.2017 15:48:14

EDR (8-DPSK): Middle Channel



Date:16.OCT.2017 15:49:24

EDR (8-DPSK): High Channel



Date:16.OCT.2017 15:50:27

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:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

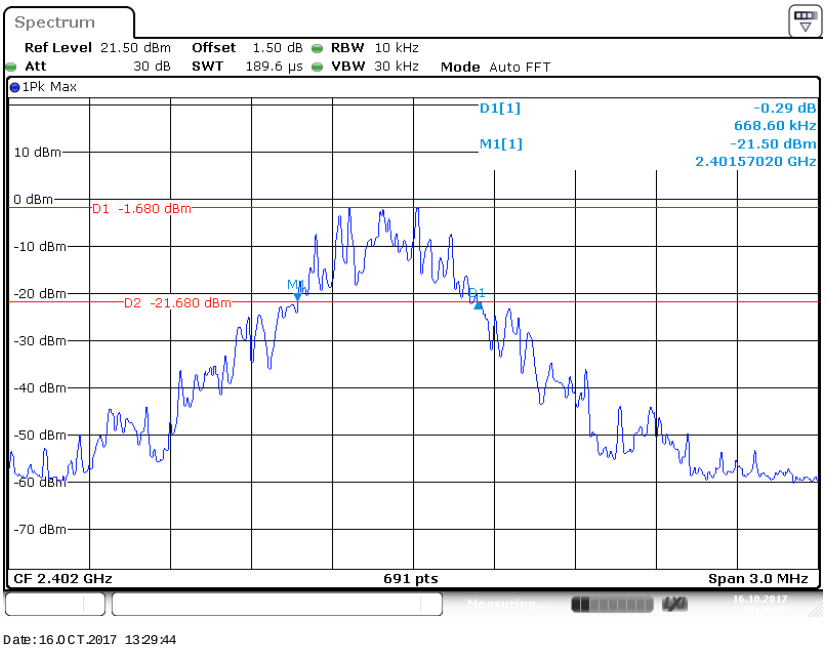
The testing was performed by Ada Yu on 2017-10-16.

EUT operation mode: Transmitting

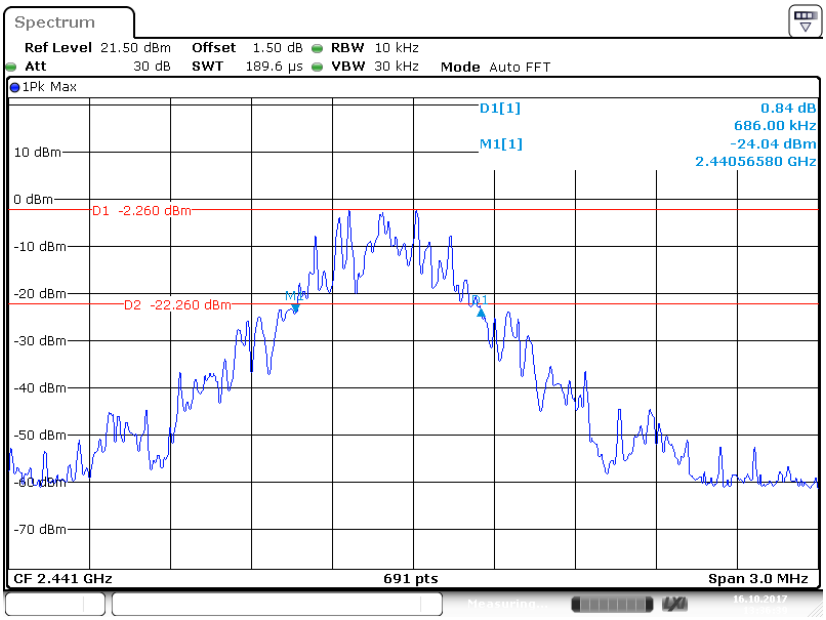
Test Result: Compliance.

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.669
	Middle	2441	0.686
	High	2480	0.673
EDR (π/4-DQPSK)	Low	2402	1.294
	Middle	2441	1.294
	High	2480	1.298
EDR (8-DPSK)	Low	2402	1.268
	Middle	2441	1.272
	High	2480	1.268

BDR (GFSK): Low Channel

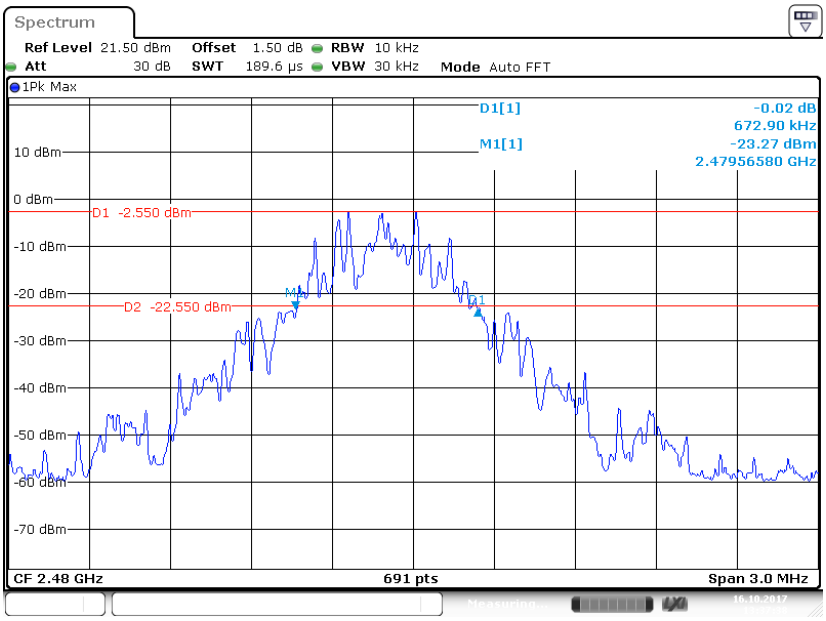


BDR (GFSK): Middle Channel



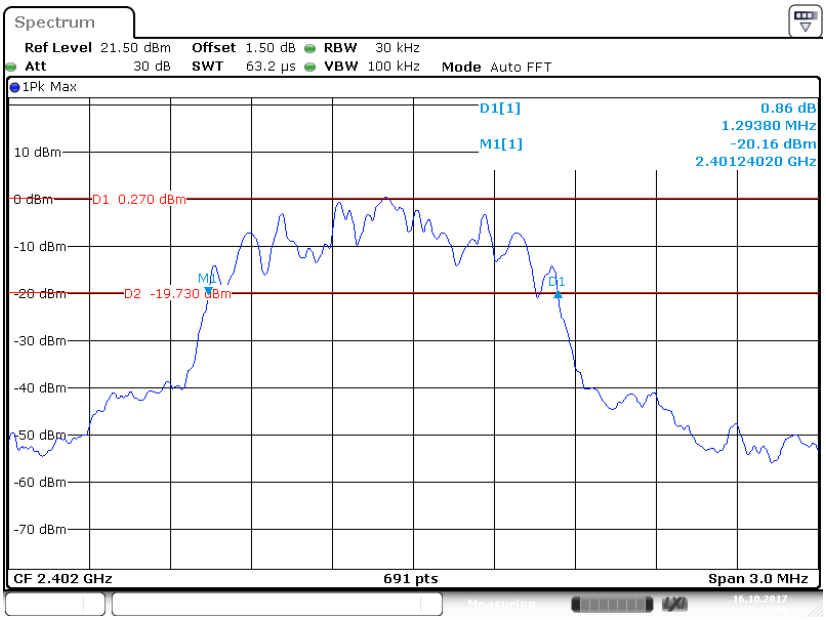
Date:16.OCT.2017 13:36:39

BDR (GFSK): High Channel



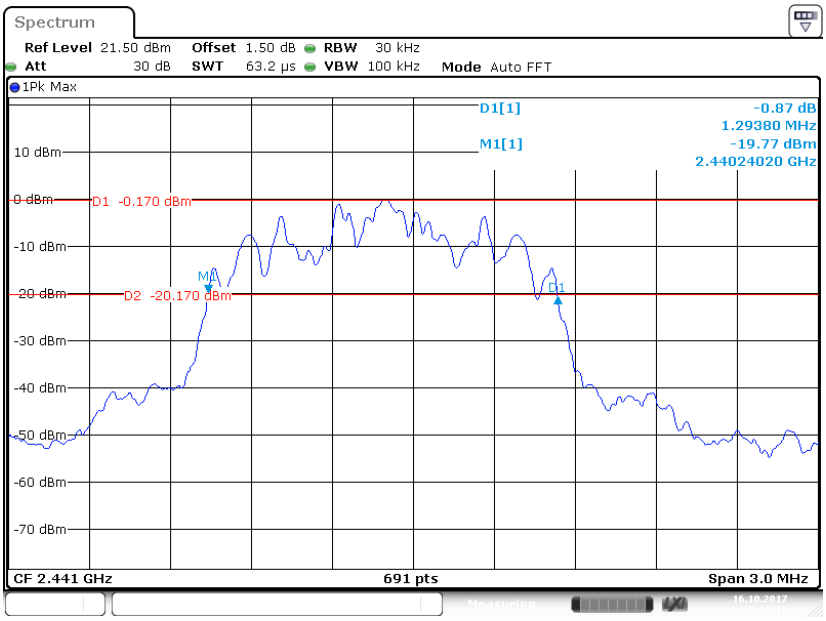
Date:16.OCT.2017 13:37:38

EDR (π/4-DQPSK): Low Channel



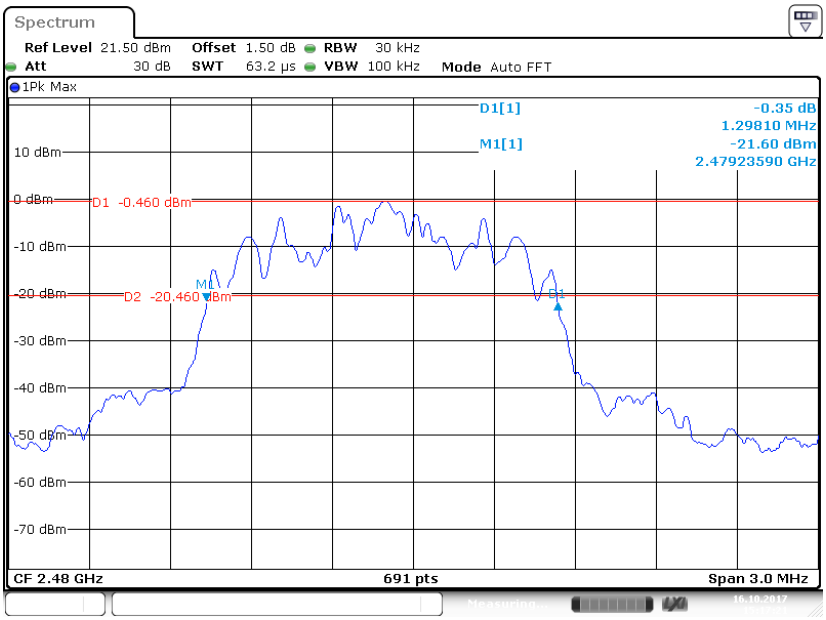
Date:16.OCT.2017 15:15:10

EDR(π/4-DQPSK): Middle Channel



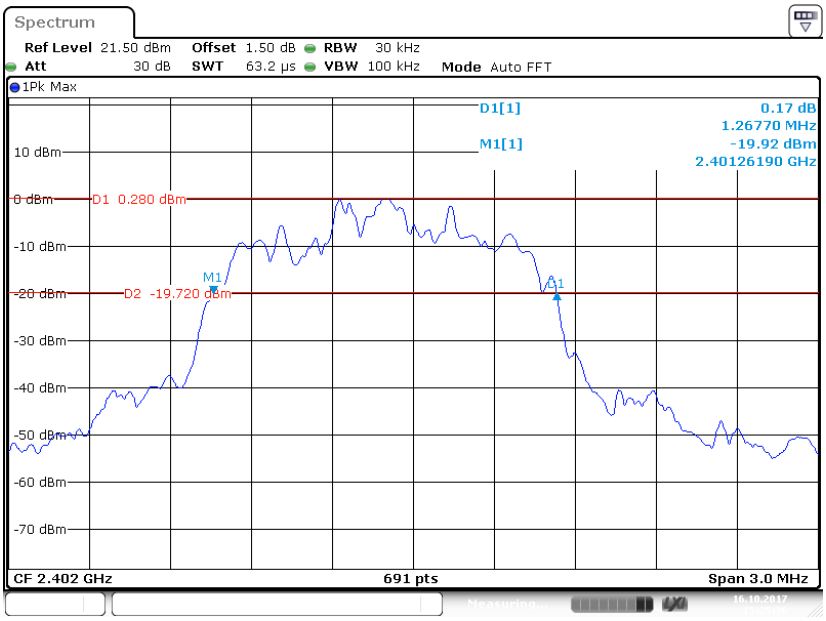
Date:16.OCT.2017 15:16:16

EDR (π/4-DQPSK): High Channel



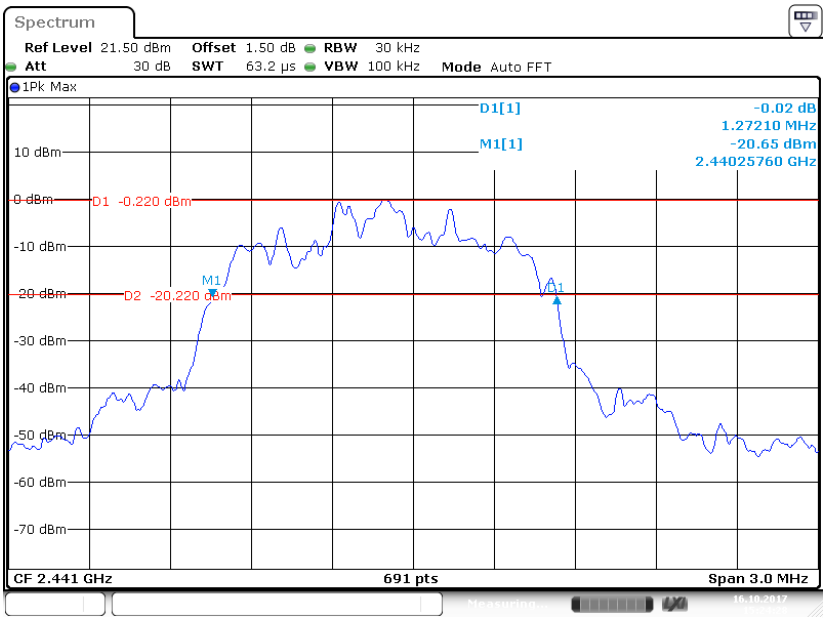
Date:16.OCT.2017 15:17:20

EDR (8-DPSK): Low Channel



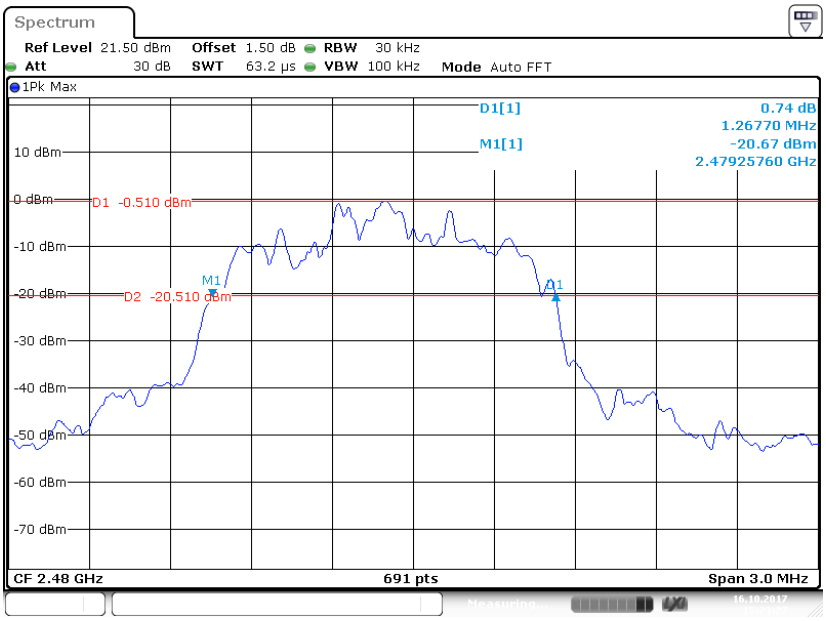
Date:16.OCT.2017 15:25:36

EDR (8-DPSK): Middle Channel



Date:16.OCT.2017 15:24:28

EDR (8-DPSK): High Channel



Date:16.OCT.2017 15:23:27

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:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

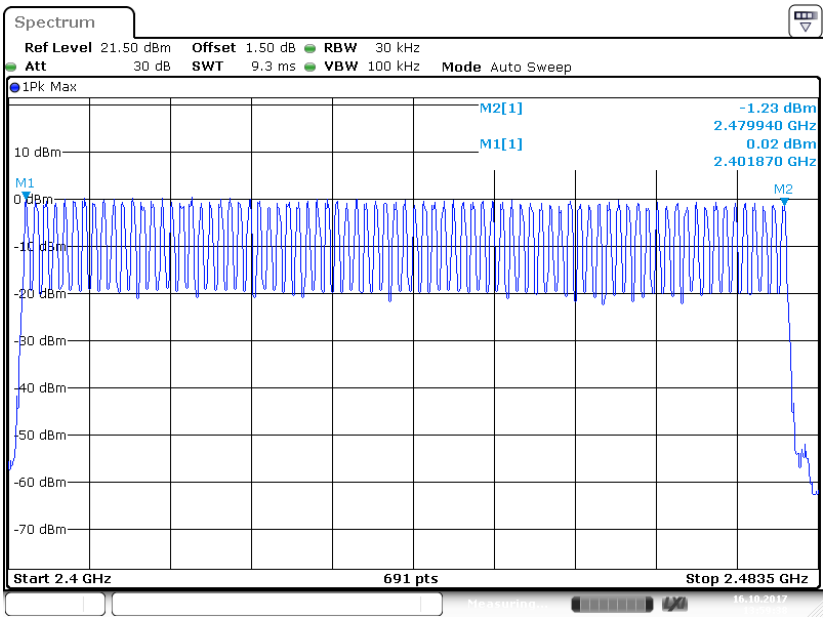
The testing was performed by Ada Yu on 2017-10-16.

EUT operation mode: Hopping

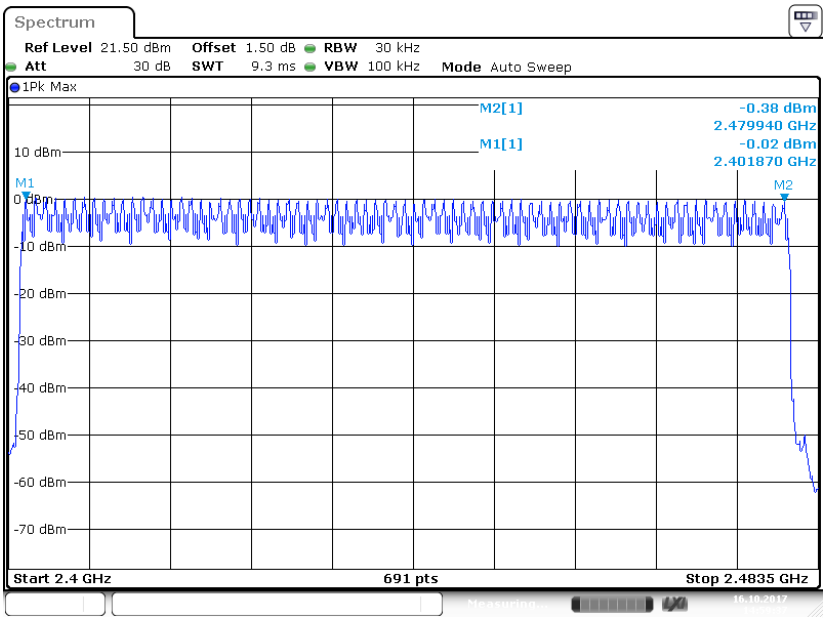
Test Result: Compliance.

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

BDR (GFSK): Number of Hopping Channels

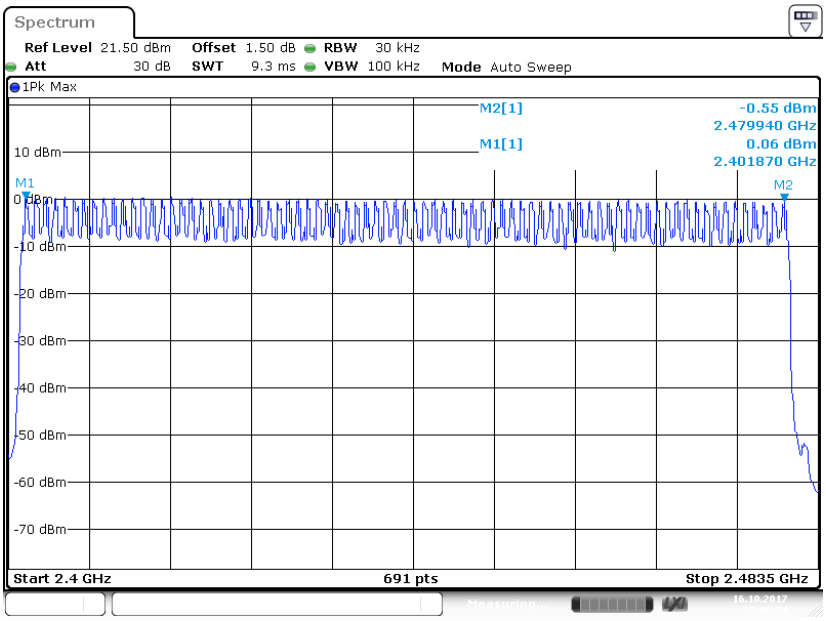


EDR (π/4-DQPSK): Number of Hopping Channels



Date:16.OCT.2017 14:59:38

EDR (8-DPSK): Number of Hopping Channels



Date:16.OCT.2017 15:46:34

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

Applicable Standard

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

Test Procedure

1 Span: Zero span, centered on a hopping channel.
2 RBW shall be ⩽ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
3 Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
4 Detector function: Peak.
5 Trace: Max hold.

Test Data

Environmental Conditions

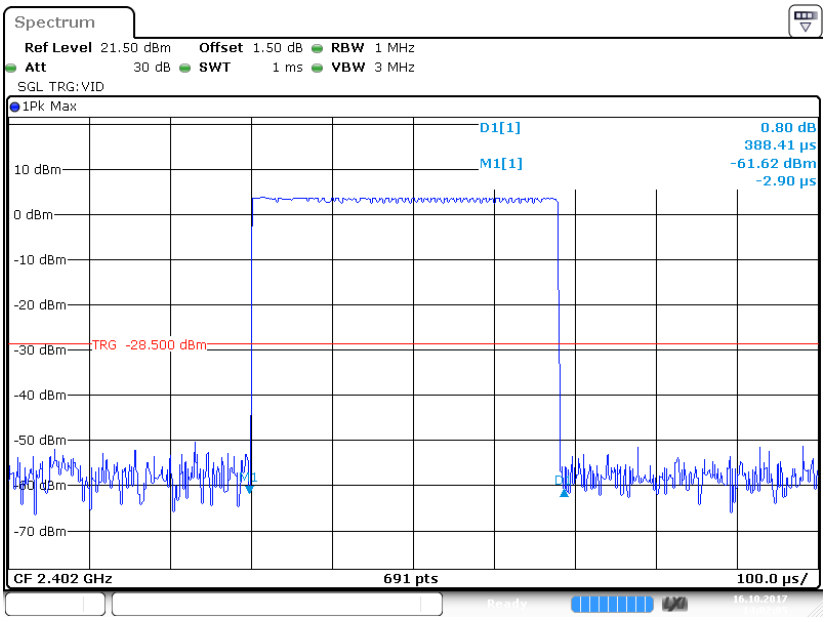
Temperature:	23.4 ℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

The testing was performed by Ada Yu on 2017-10-16.

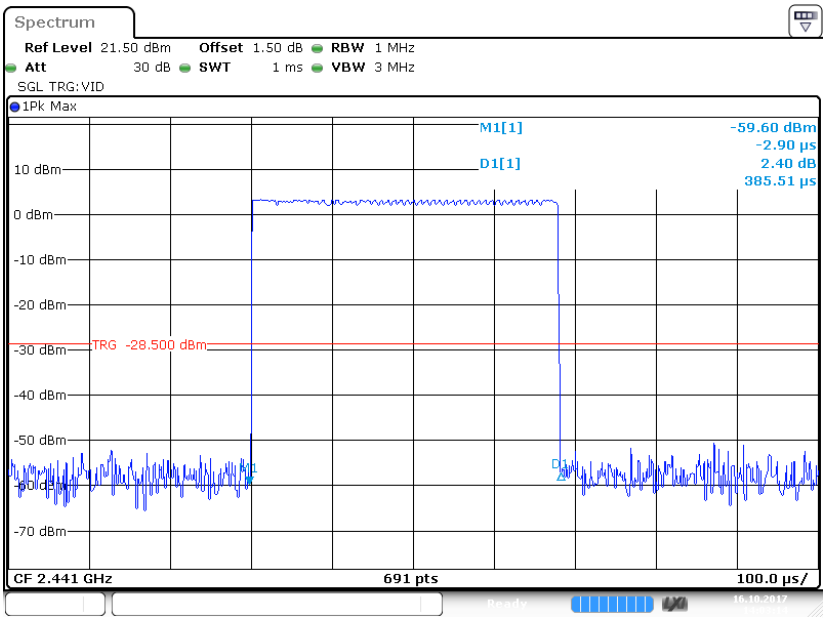
EUT operation mode: Hopping

Mode		Channel	Pulse Width (ms)	Dwell Time (s)	Limit (s)	Result
BDR (GFSK)	DH1	Low	0.388	0.124	0.4	Pass
		Middle	0.386	0.124	0.4	Pass
		High	0.388	0.124	0.4	Pass
		Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	DH3	Low	1.646	0.263	0.4	Pass
		Middle	1.649	0.264	0.4	Pass
		High	1.649	0.264	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	DH5	Low	2.898	0.309	0.4	Pass
		Middle	2.915	0.311	0.4	Pass
		High	2.909	0.310	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (π/4-DQPSK)	2DH1	Low	0.403	0.129	0.4	Pass
		Middle	0.404	0.129	0.4	Pass
		High	0.403	0.129	0.4	Pass
		Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	2DH3	Low	1.657	0.265	0.4	Pass
		Middle	1.678	0.268	0.4	Pass
		High	1.657	0.265	0.4	Pass
		Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	2DH5	Low	2.921	0.312	0.4	Pass
		Middle	2.909	0.310	0.4	Pass
		High	2.909	0.310	0.4	Pass
		Note: 2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (8-DPSK)	3DH1	Low	0.401	0.128	0.4	Pass
		Middle	0.404	0.129	0.4	Pass
		High	0.406	0.130	0.4	Pass
		Note:3 DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	3DH3	Low	1.666	0.267	0.4	Pass
		Middle	1.670	0.267	0.4	Pass
		High	1.659	0.265	0.4	Pass
		Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	3DH5	Low	2.911	0.311	0.4	Pass
		Middle	2.940	0.314	0.4	Pass
		High	2.922	0.312	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				

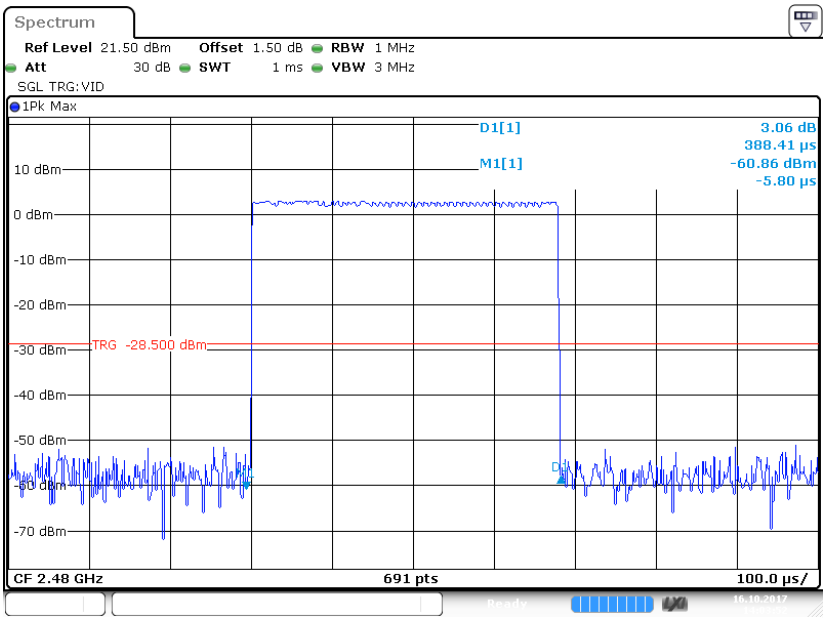
BDR (GFSK): Pulse time, Low Channel, DH1



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

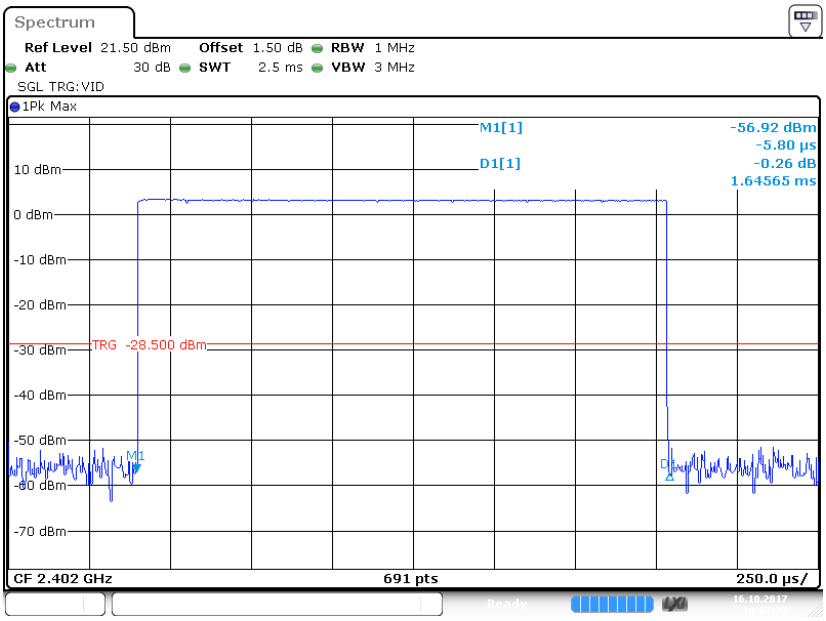


BDR (GFSK): Pulse time, High Channel, DH1



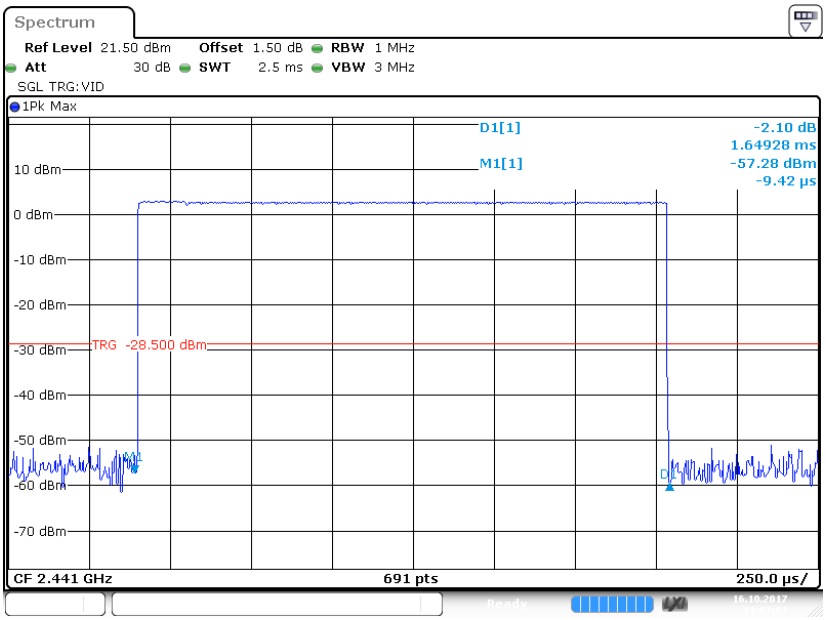
Date: 16.OCT.2017 14:03:53

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

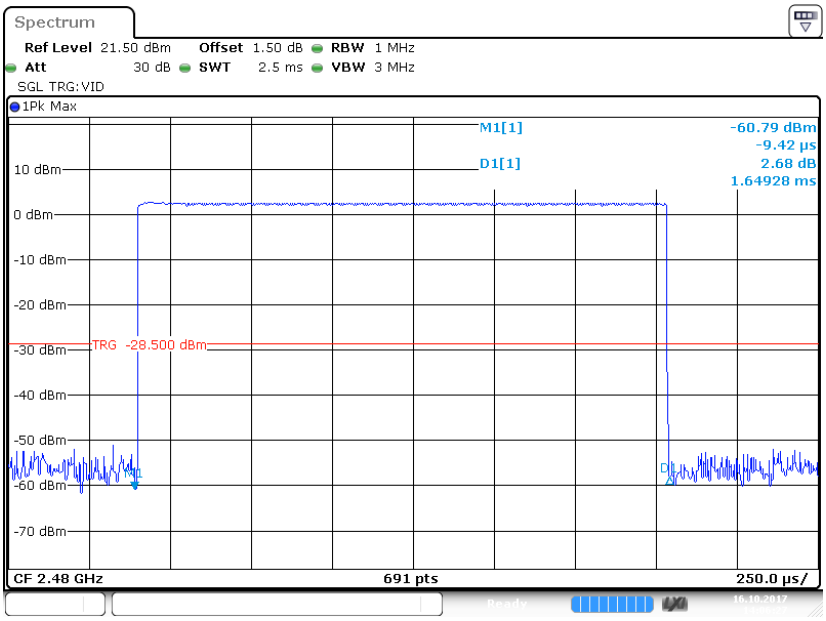


Date: 16.OCT.2017 14:07:32

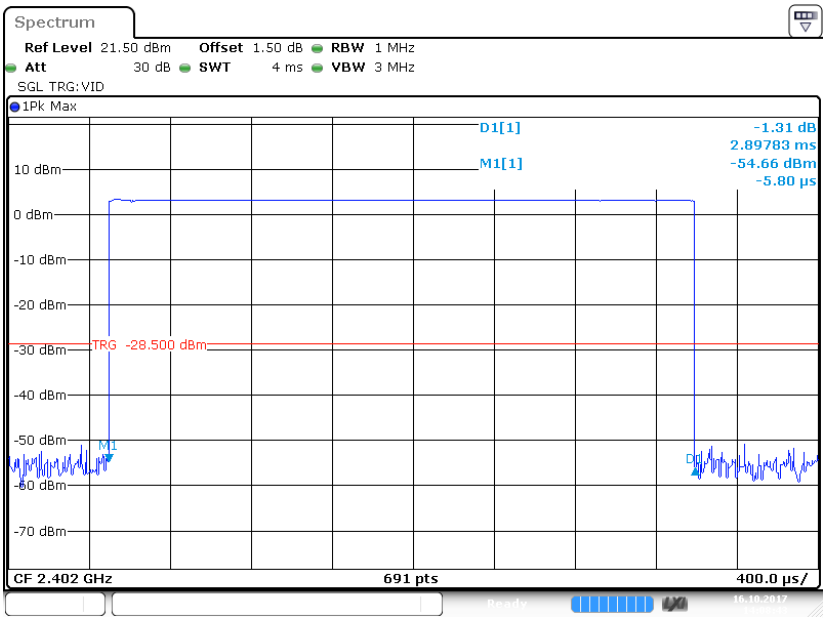
BDR (GFSK): Pulse time, Middle Channel, DH3



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

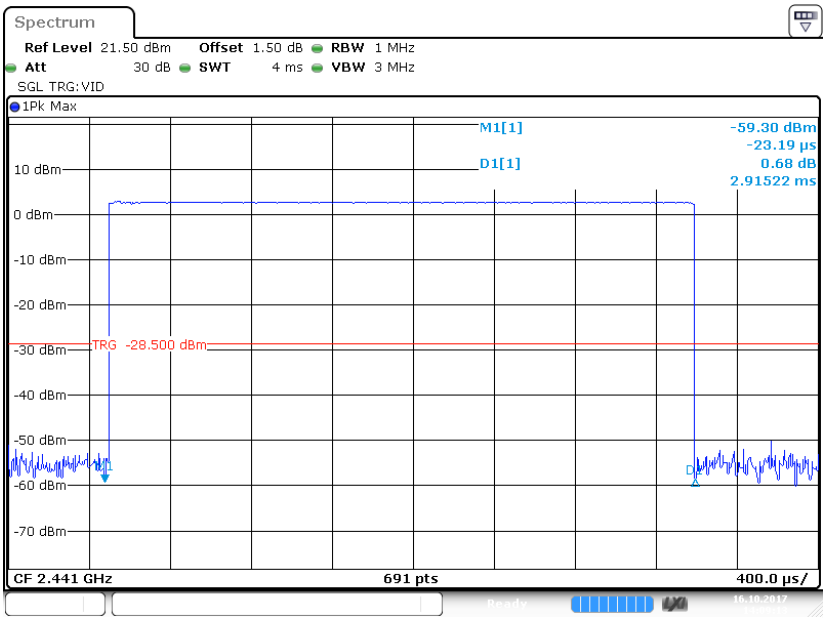


BDR (GFSK): Pulse time, Low Channel, DH5



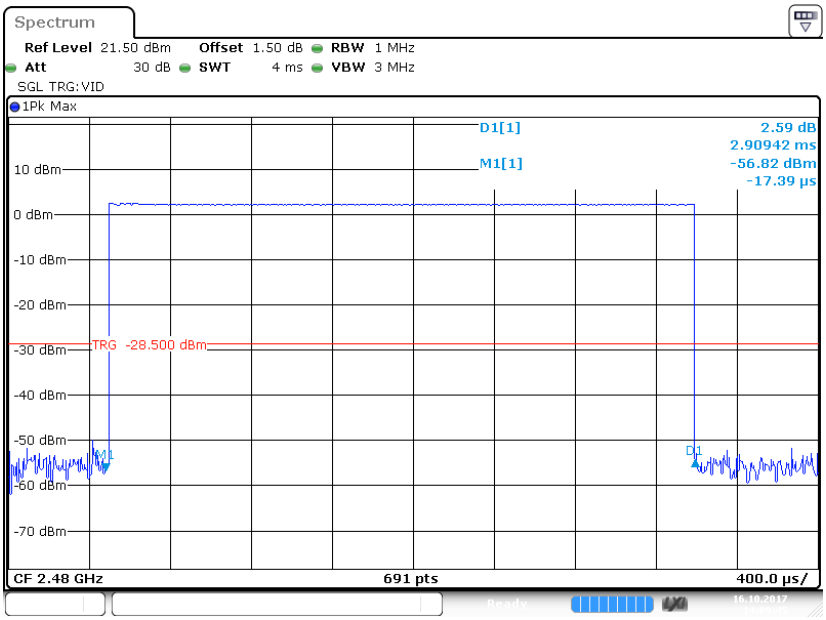
Date: 16.OCT.2017 14:08:43

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

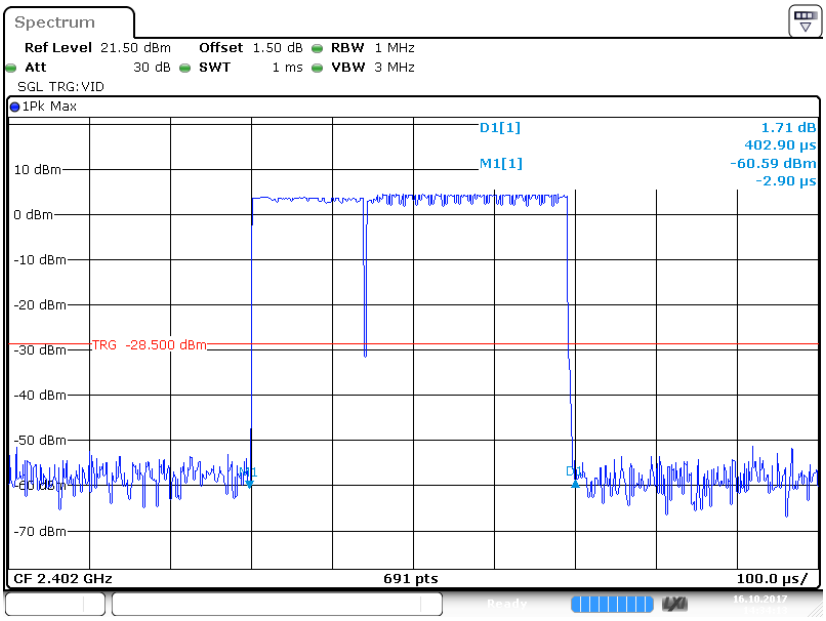


Date: 16.OCT.2017 14:09:14

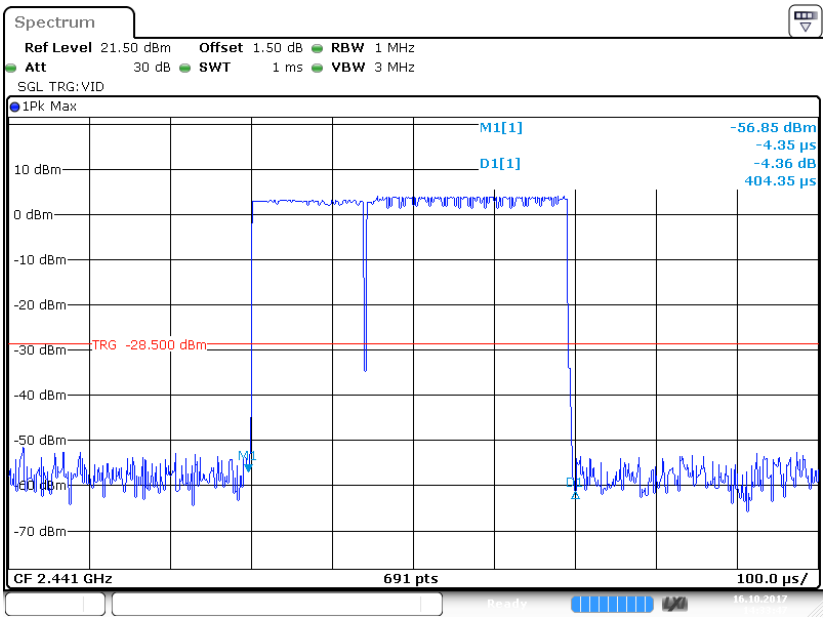
BDR (GFSK): Pulse time, High Channel, DH5



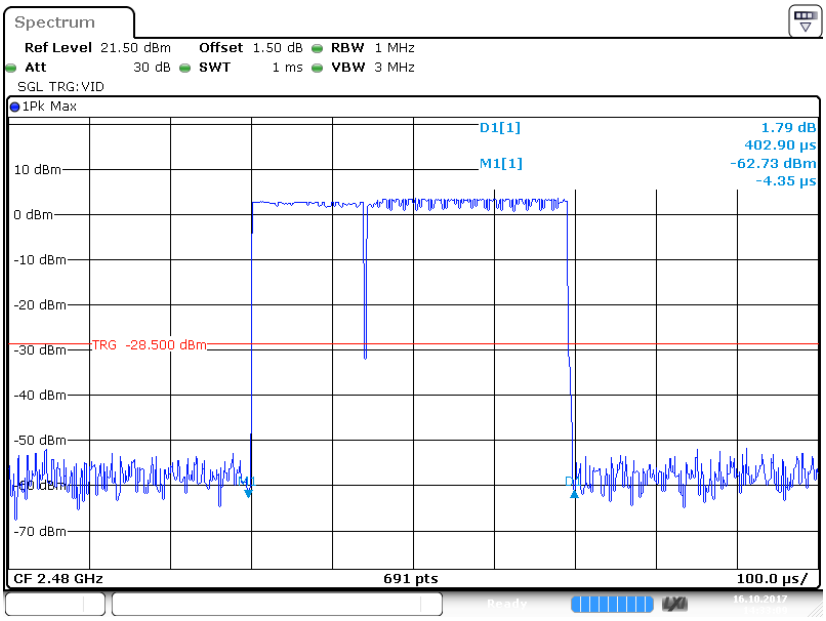
EDR (π/4-DQPSK): Pulse time, Low Channel, 2DH1



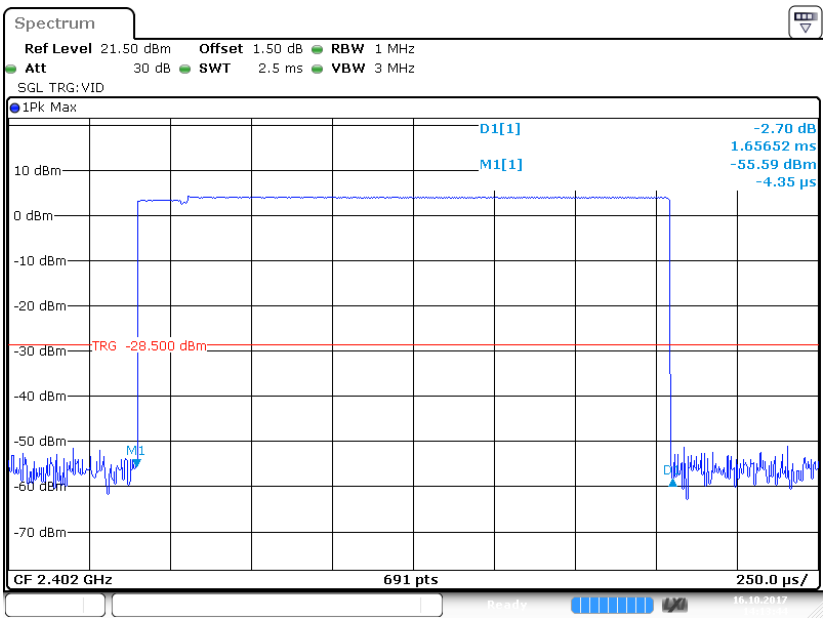
EDR (π/4-DQPSK):Pulse time, Middle Channel, 2DH1



EDR (π/4-DQPSK):Pulse time, High Channel, 2DH1

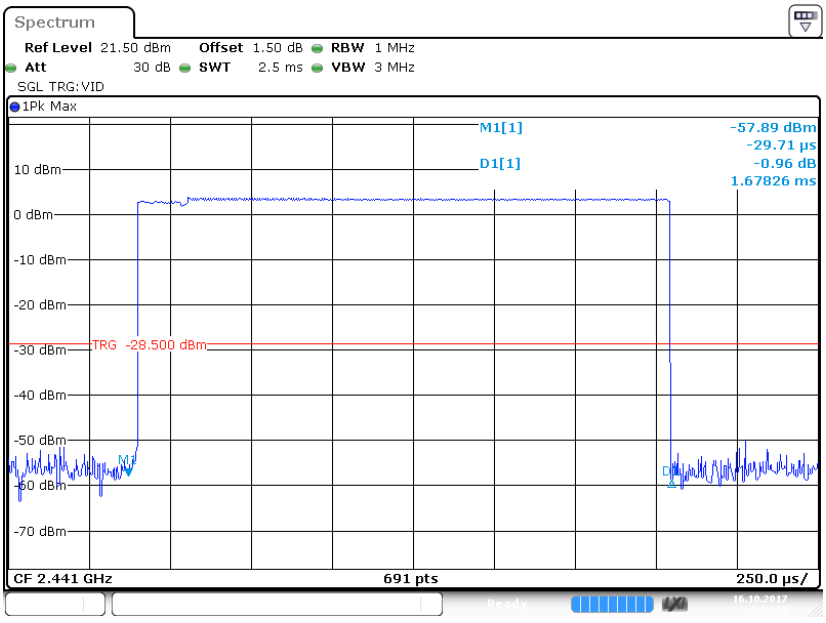


EDR (π/4-DQPSK):Pulse time, Low Channel, 2DH3



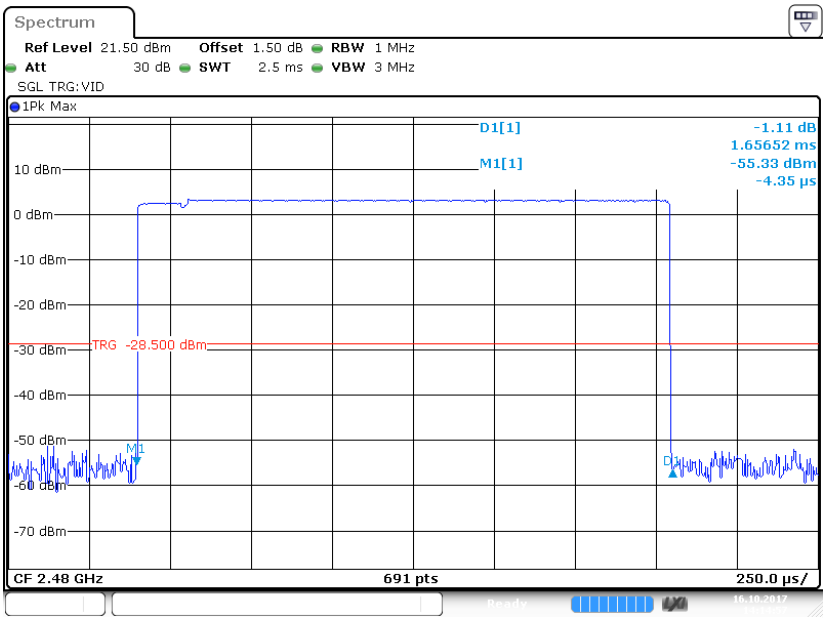
Date:16.OCT.2017 14:13:44

EDR (π/4-DQPSK):Pulse time, Middle Channel, 2DH3

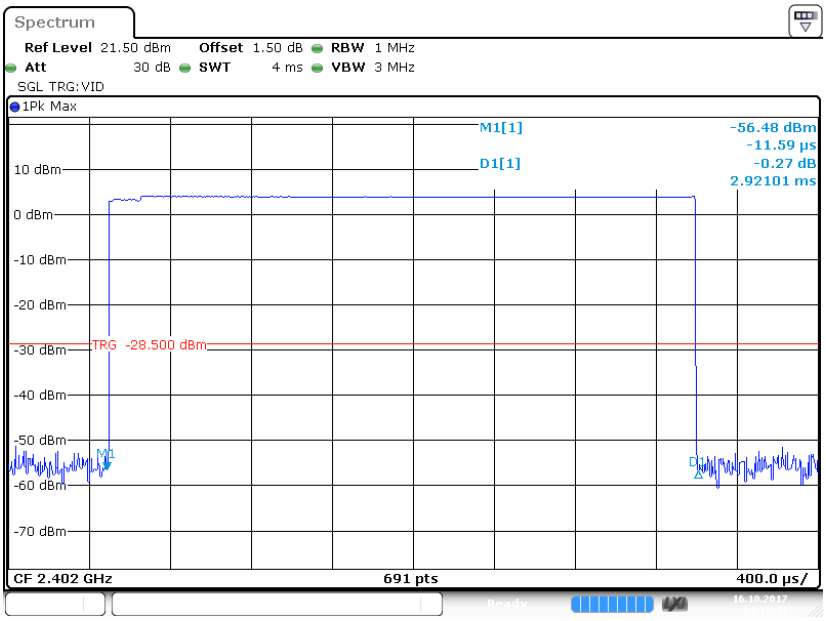


Date:16.OCT.2017 14:14:23

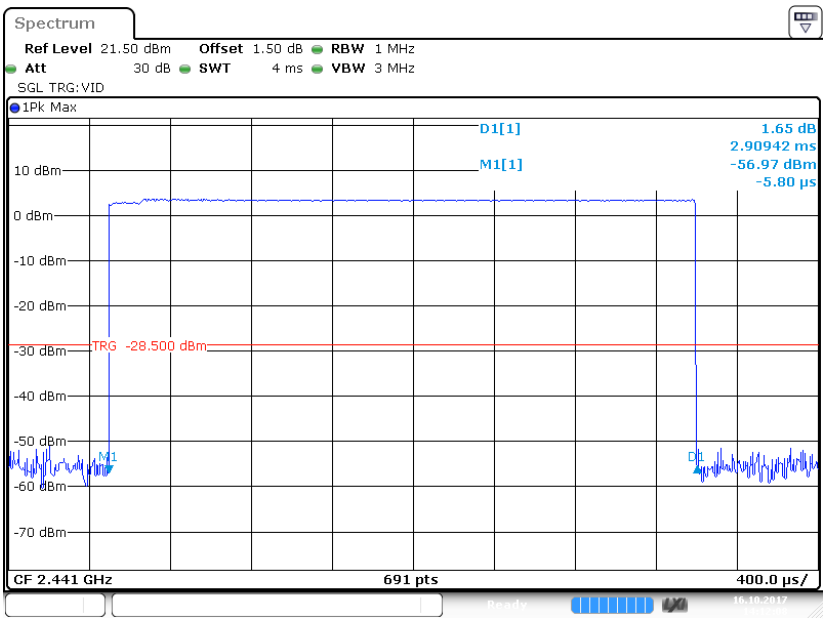
EDR (π/4-DQPSK):Pulse time, High Channel, 2DH3



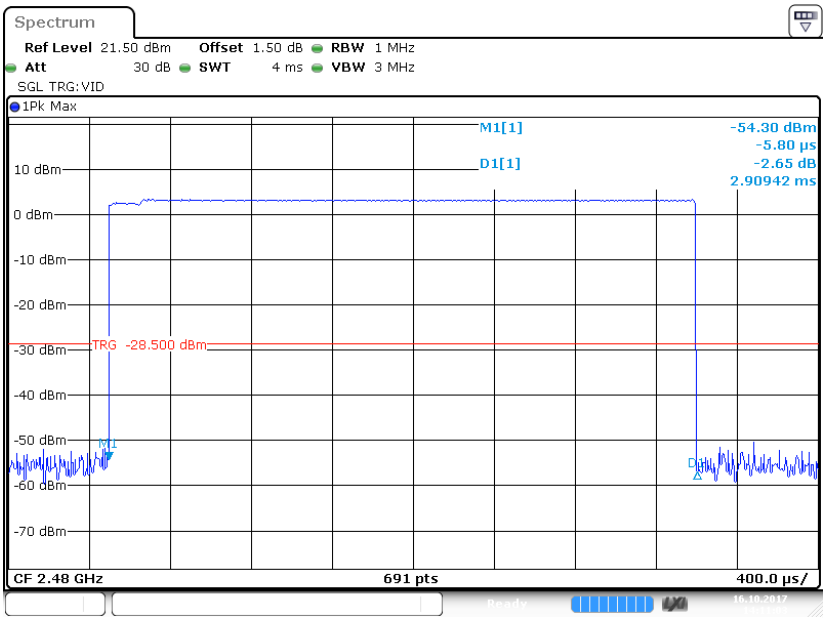
EDR (π/4-DQPSK):Pulse time, Low Channel, 2DH5



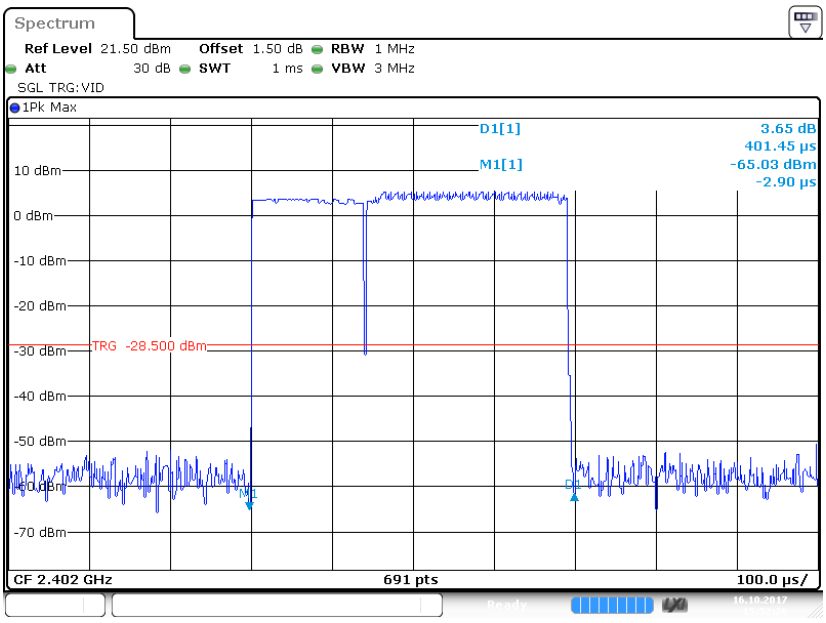
EDR (π/4-DQPSK):Pulse time, Middle Channel, 2DH5



EDR (π/4-DQPSK):Pulse time, High Channel, 2DH5

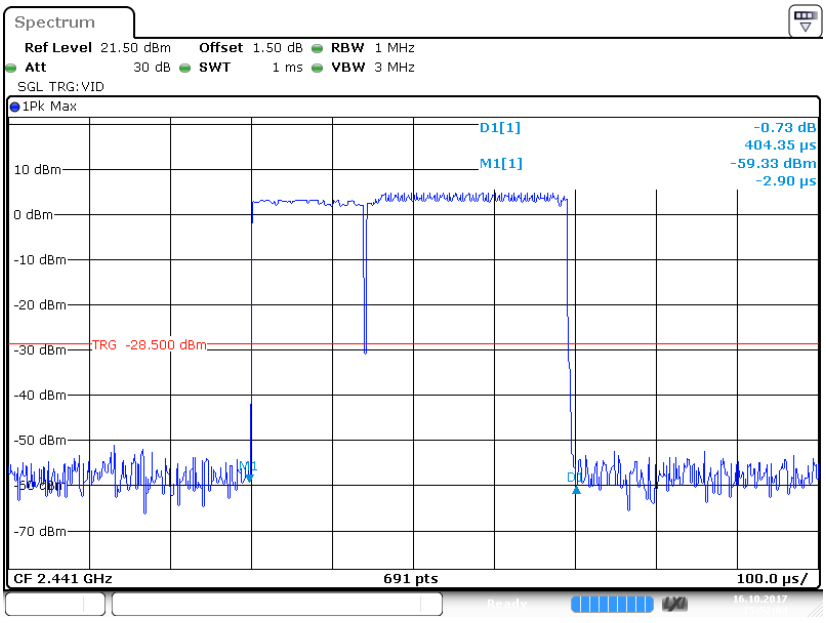


EDR (8-DPSK): Pulse time, Low Channel, 3DH1



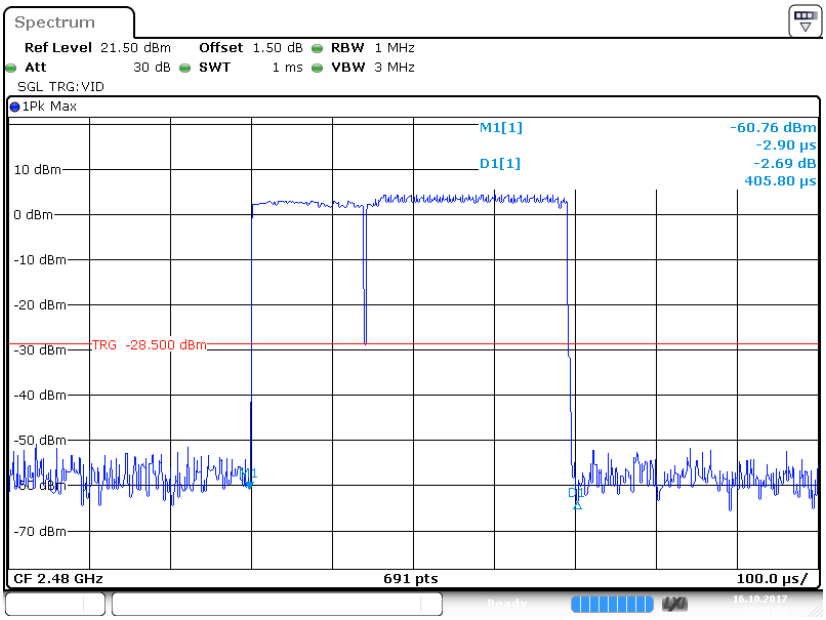
Date: 16.OCT.2017 15:52:26

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



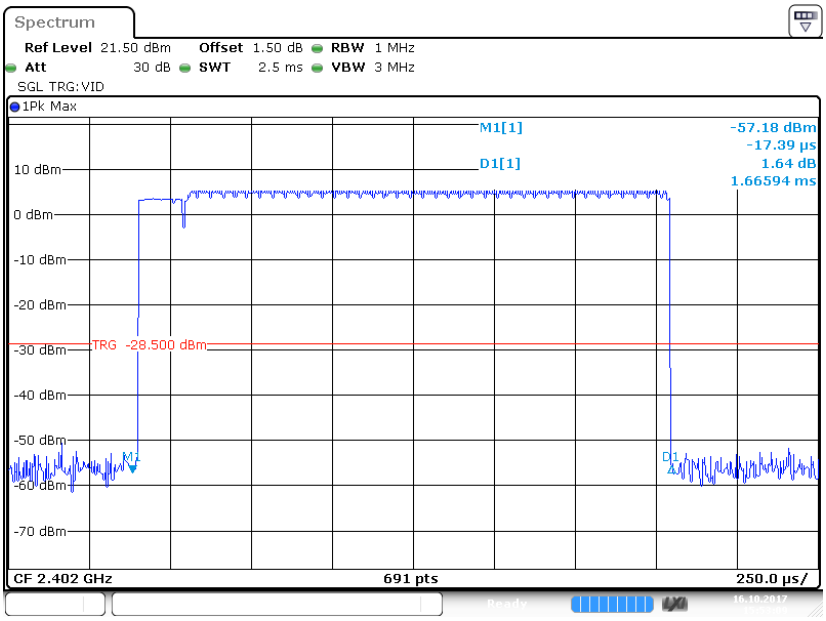
Date: 16.OCT.2017 15:52:03

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



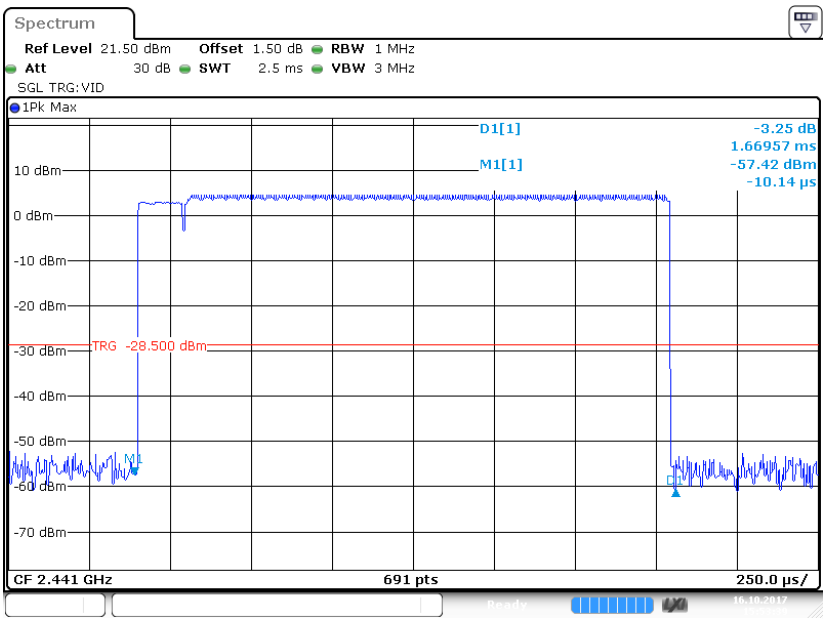
Date: 16.OCT.2017 15:51:24

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



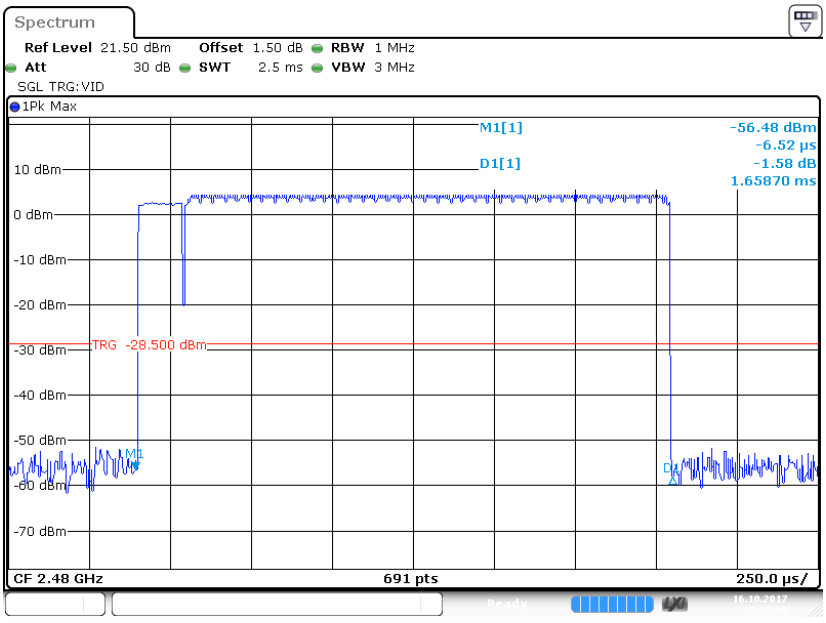
Date: 16.OCT.2017 15:53:09

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



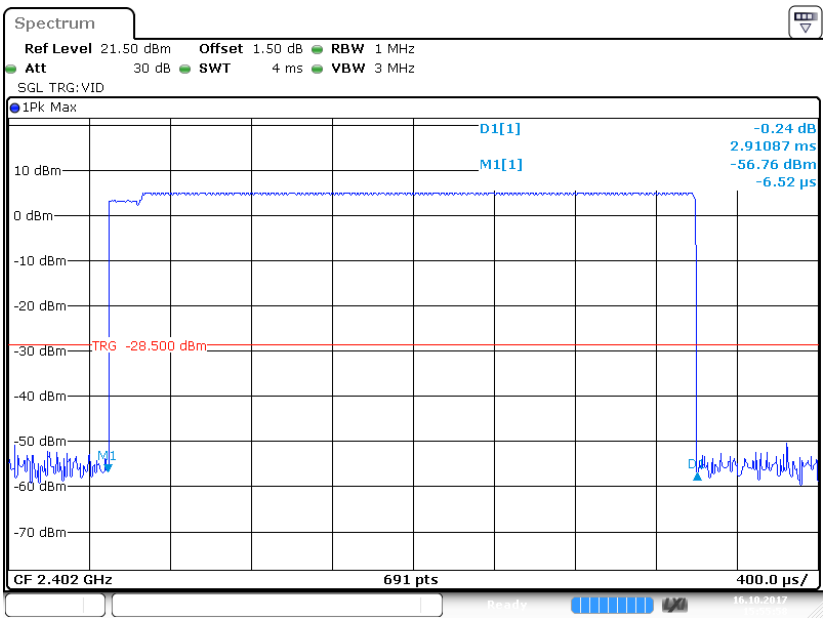
Date: 16.OCT.2017 15:53:39

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



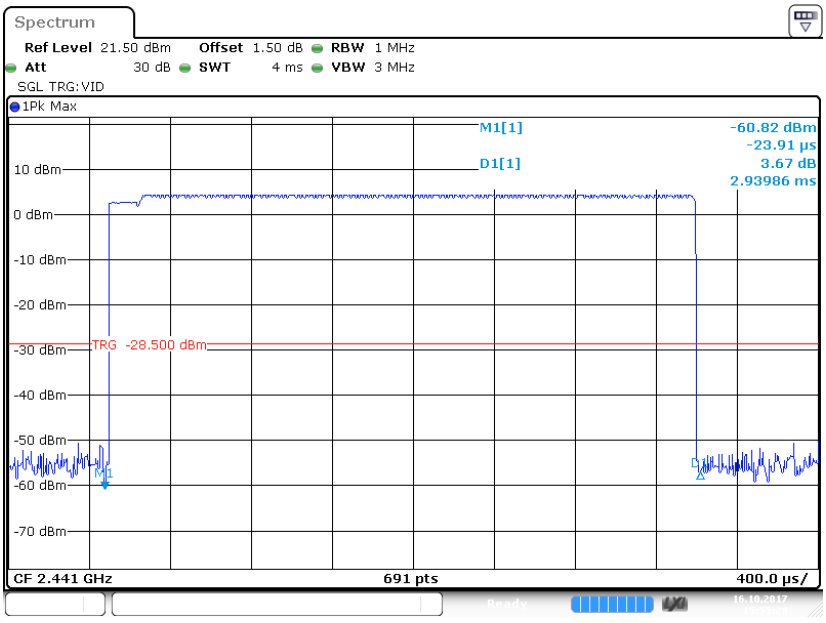
Date: 16.OCT.2017 15:54:06

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



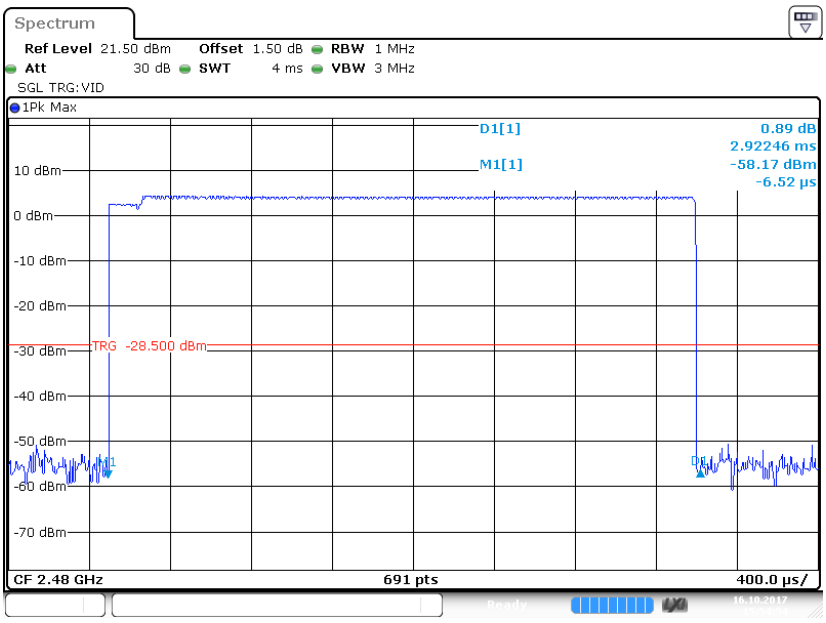
Date: 16.OCT.2017 15:55:58

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



Date: 16.OCT.2017 15:55:29

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



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

Applicable Standard

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

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

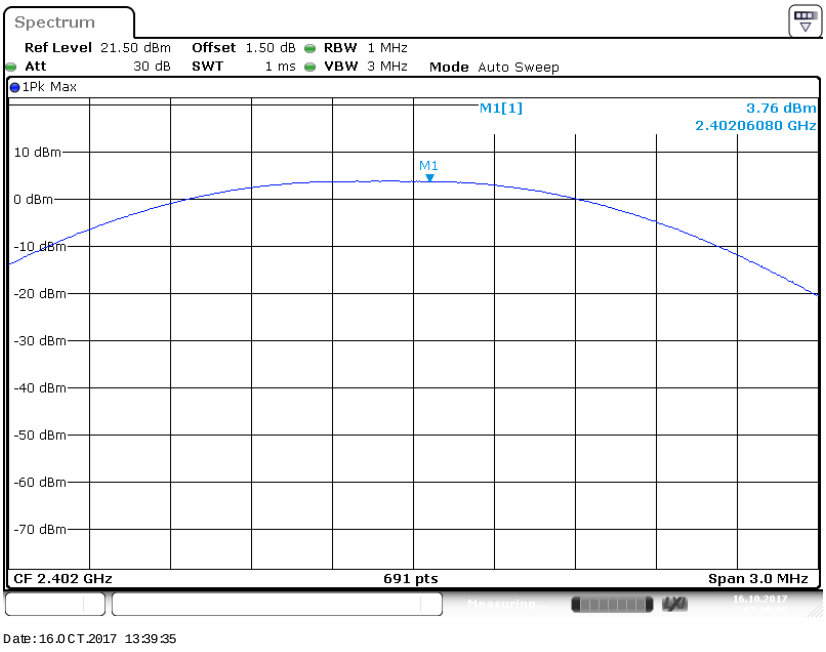
The testing was performed by Ada Yu on 2017-10-16.

EUT operation mode: Transmitting

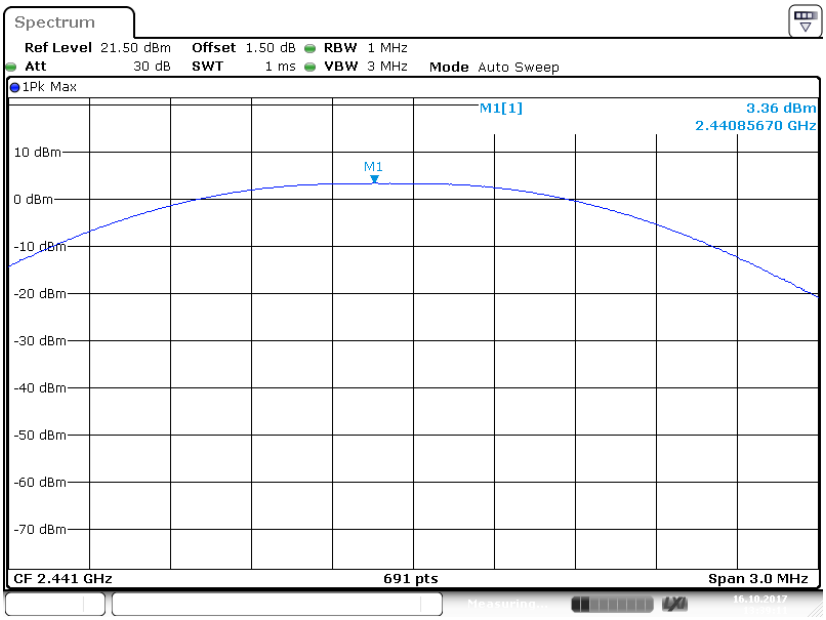
Test Result: Compliance.

Mode	Channel	Frequency (MHz)	Output Power		Limit (mW)
			(dBm)	(mW)	
BDR (GFSK)	Low	2402	3.76	2.38	1000
	Middle	2441	3.36	2.17	1000
	High	2480	3.05	2.02	1000
EDR (π/4-DQPSK)	Low	2402	5.92	3.91	1000
	Middle	2441	5.37	3.44	1000
	High	2480	5.08	3.22	1000
EDR (8-DPSK)	Low	2402	6.27	4.24	1000
	Middle	2441	5.73	3.74	1000
	High	2480	5.47	3.52	1000

BDR (GFSK): Low Channel

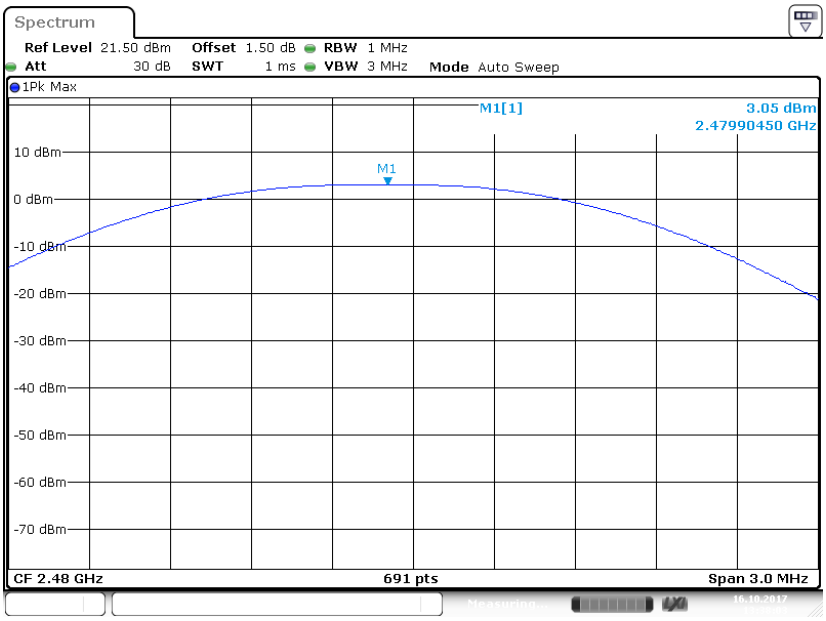


BDR (GFSK): Middle Channel



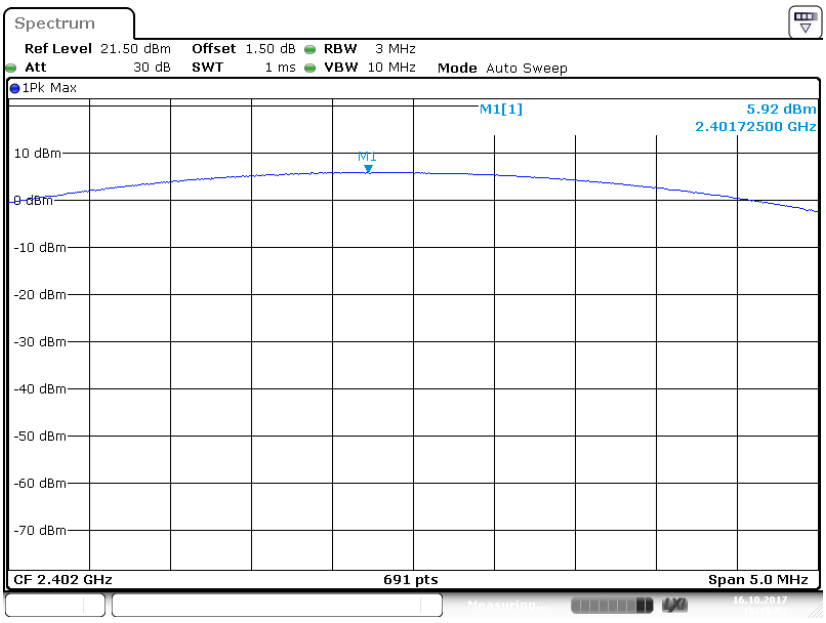
Date:16.OCT.2017 13:39:12

BDR (GFSK): High Channel



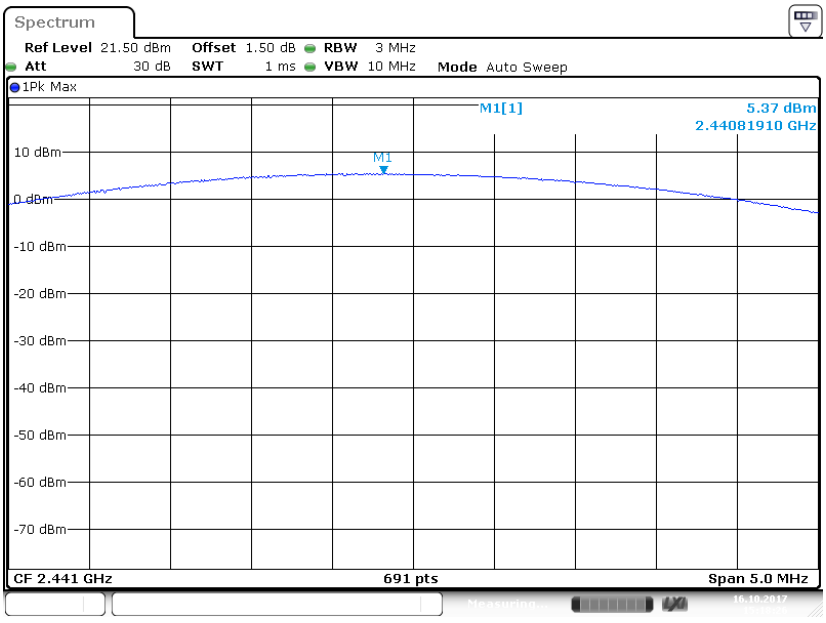
Date:16.OCT.2017 13:38:03

EDR(π/4-DQPSK): Low Channel



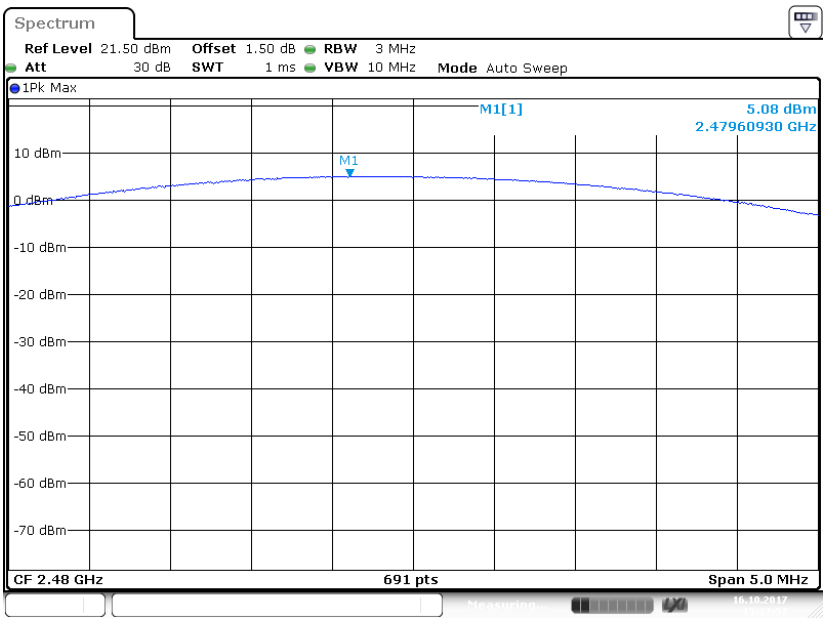
Date:16.OCT.2017 15:18:54

EDR(π/4-DQPSK): Middle Channel



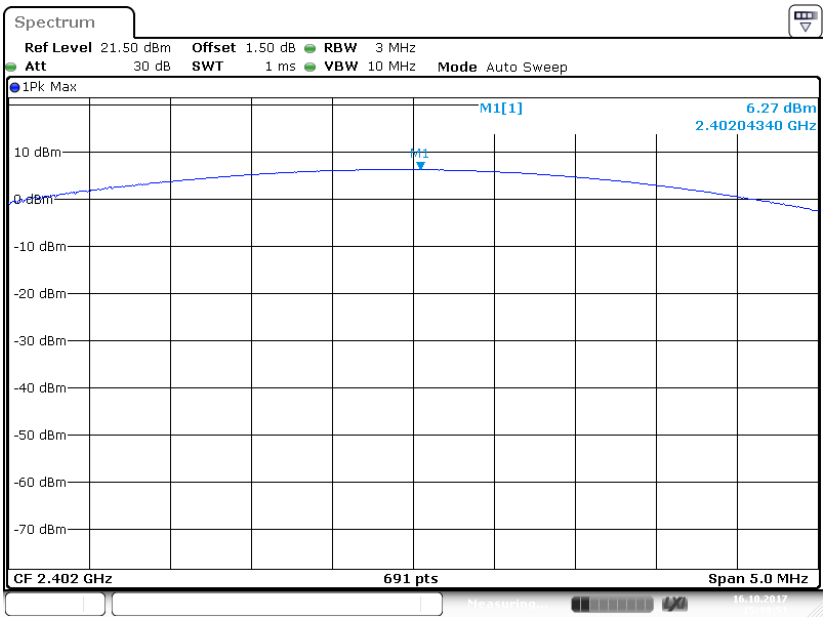
Date:16.OCT.2017 15:18:26

EDR(π/4-DQPSK): High Channel



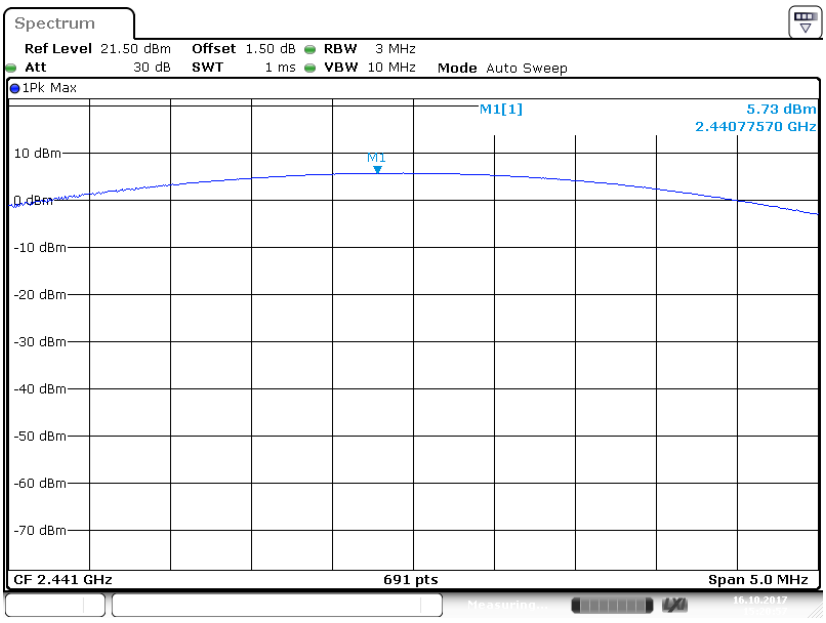
Date:16.OCT.2017 15:17:58

EDR(8-DPSK): Low Channel



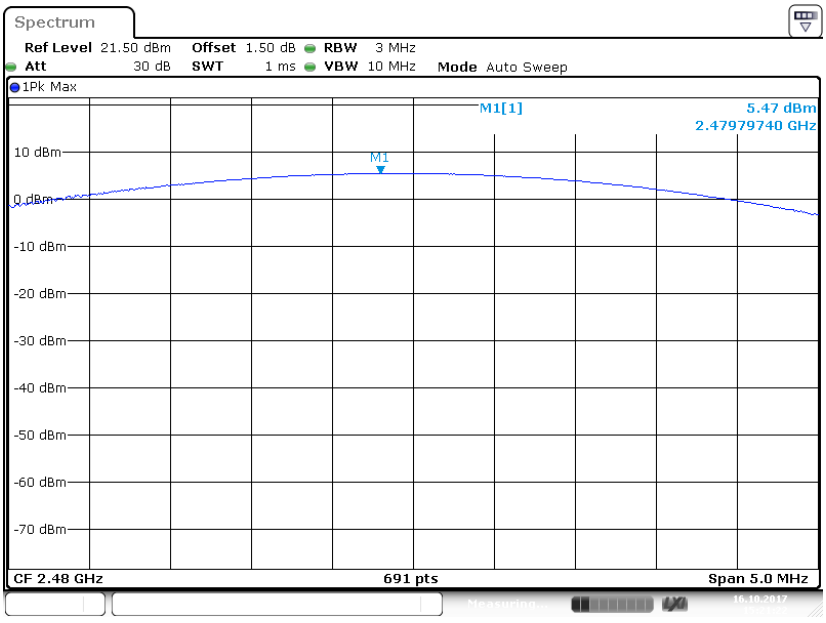
Date:16.OCT.2017 15:19:51

EDR(8-DPSK): Middle Channel



Date:16.OCT.2017 15:20:57

EDR(8-DPSK): High Channel



Date:16.OCT.2017 15:21:22

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:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

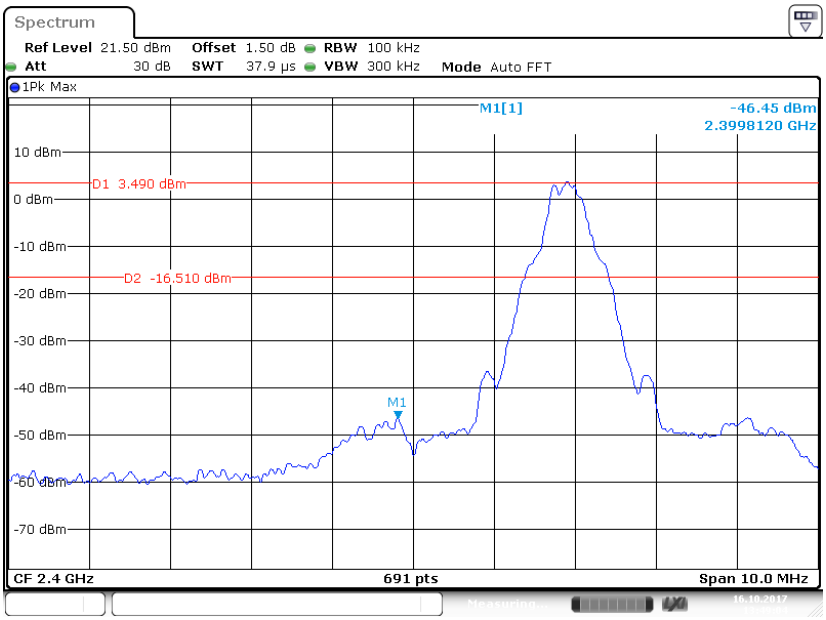
The testing was performed by Ada Yu on 2017-10-16.

EUT operation mode: Transmitting & Hopping

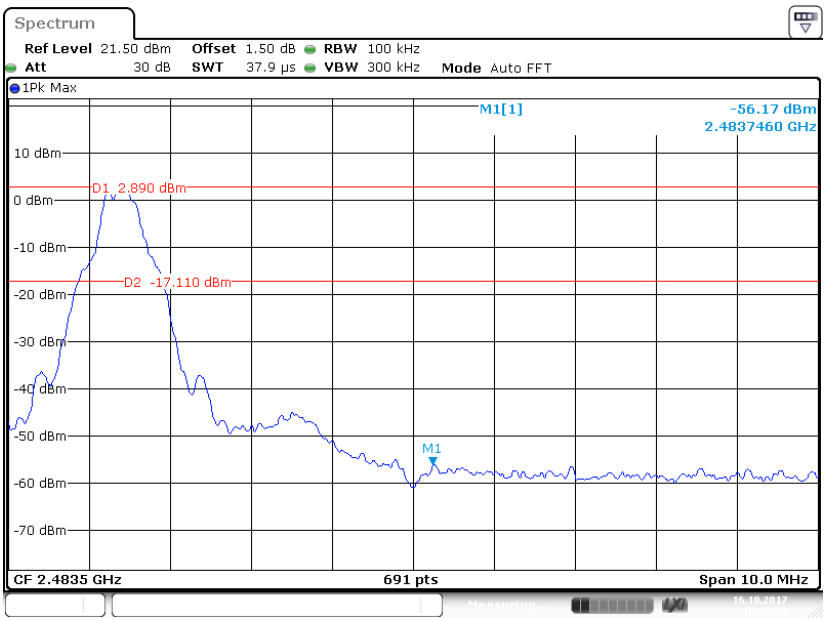
Test Result: Compliance.

Band Edge

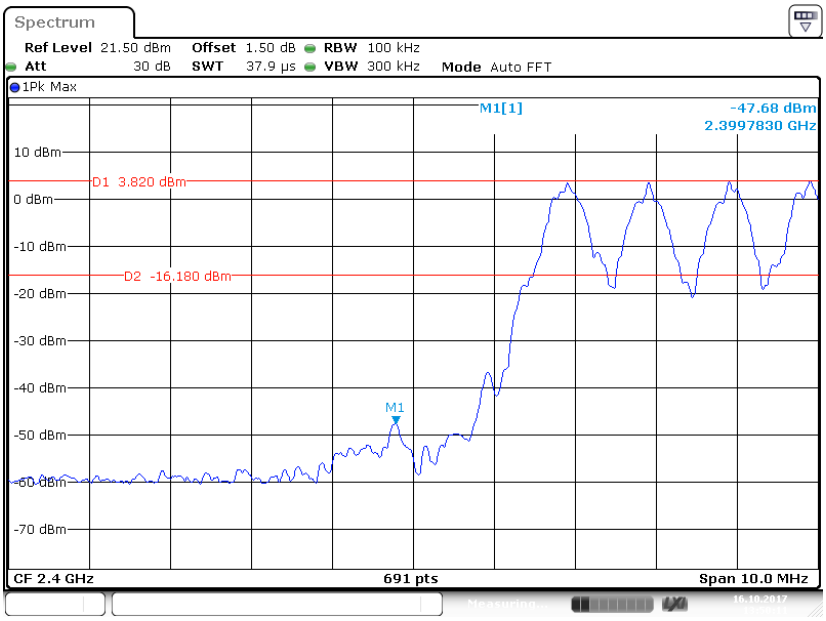
BDR (GFSK): Left Side



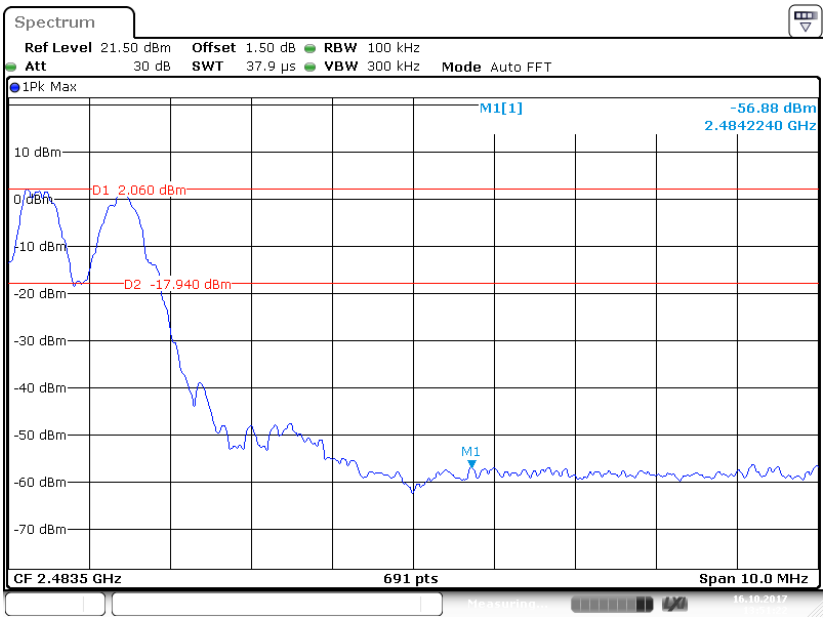
BDR (GFSK): Right Side



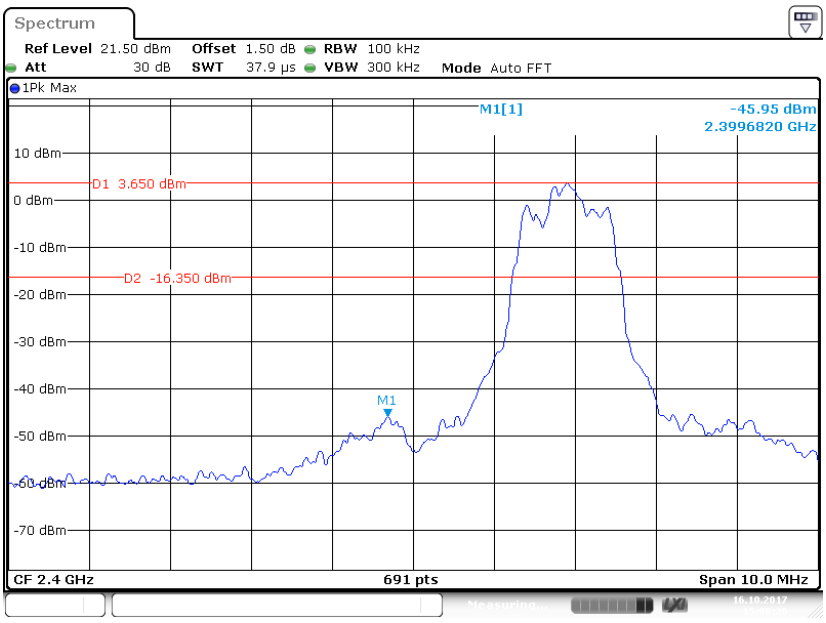
BDR (GFSK): Left Side-Hopping



BDR (GFSK): Right Side-Hopping

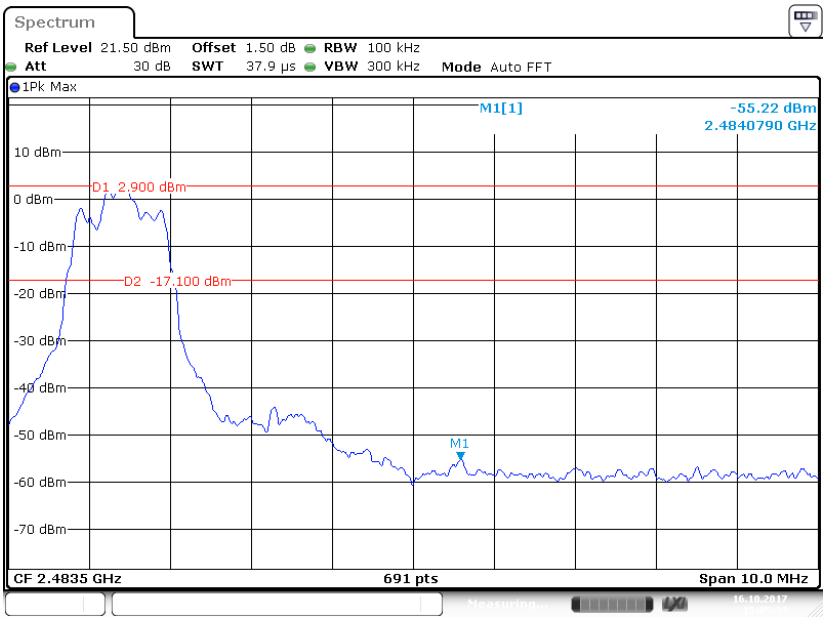


EDR (π/4-DQPSK): Left Side



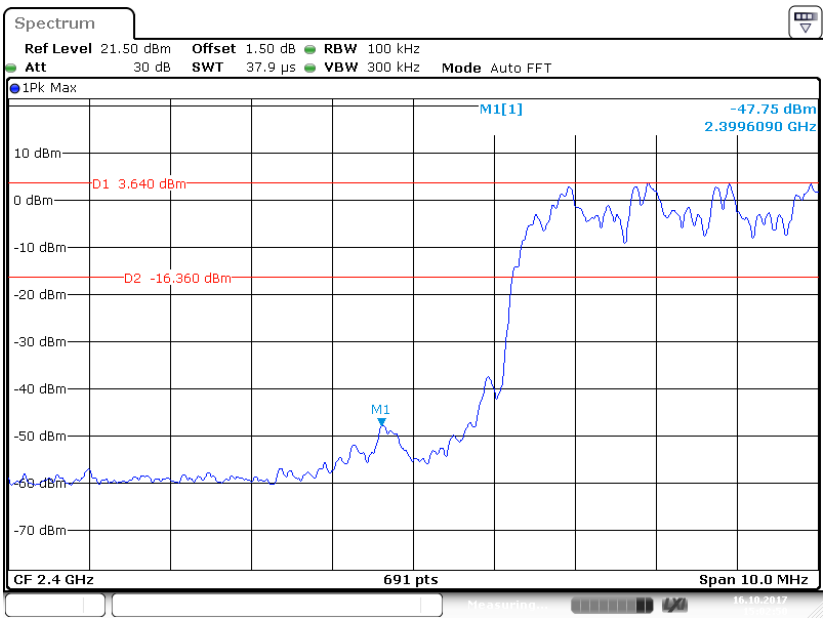
Date:16.OCT.2017 15:06:26

EDR (π/4-DQPSK): Right Side



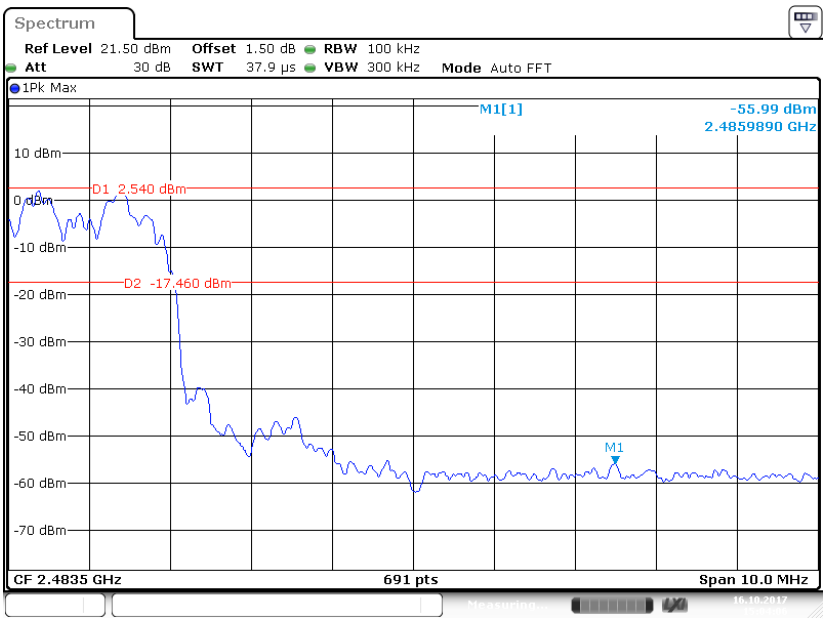
Date:16.OCT.2017 15:05:33

EDR (π/4-DQPSK): Left Side-Hopping



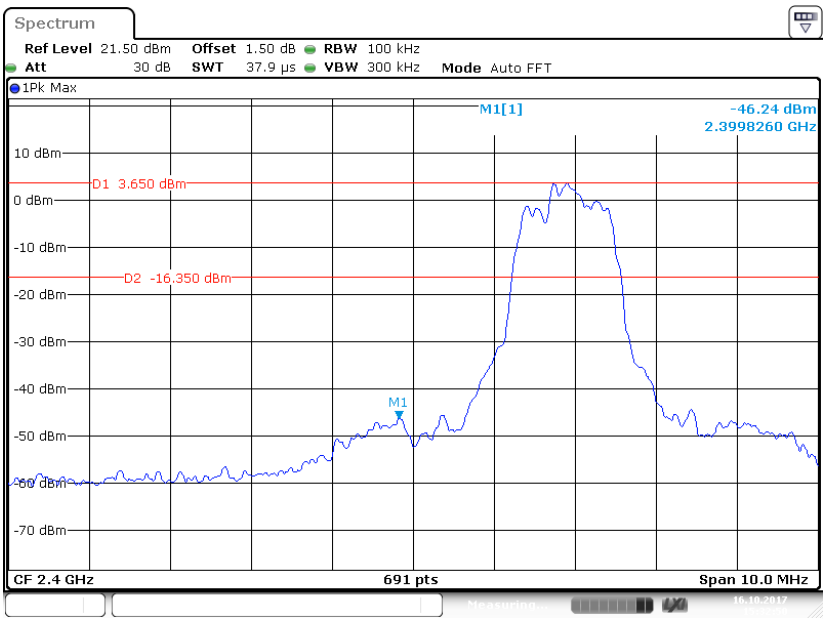
Date:16.OCT.2017 15:02:50

EDR (π/4-DQPSK): Right Side-Hopping



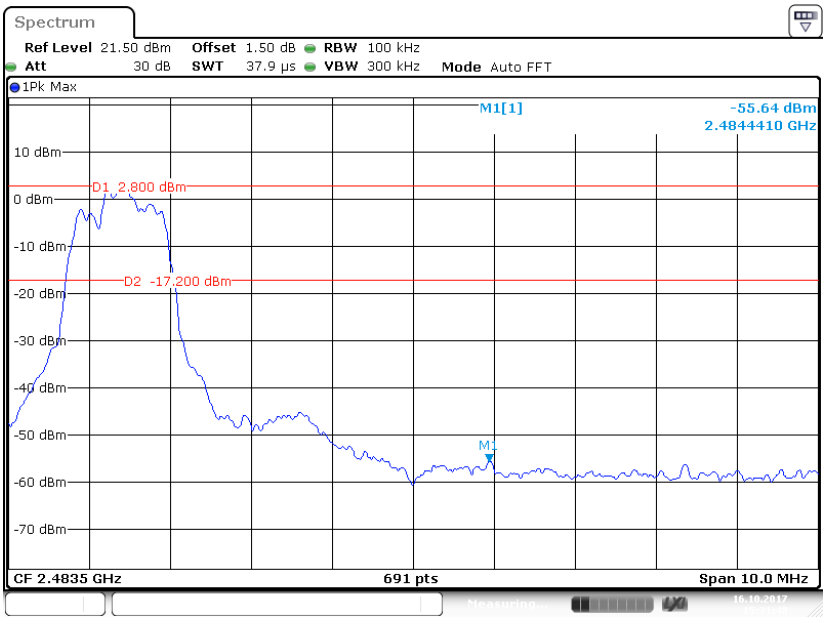
Date:16.OCT.2017 15:04:06

EDR (8-DPSK): Left Side



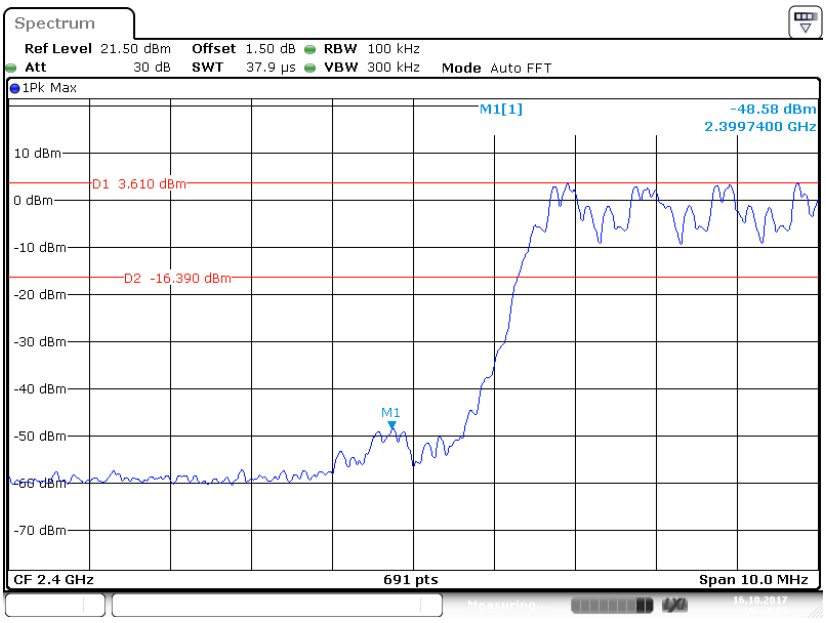
Date:16.OCT.2017 15:32:50

BDR (8-DPSK): Right Side



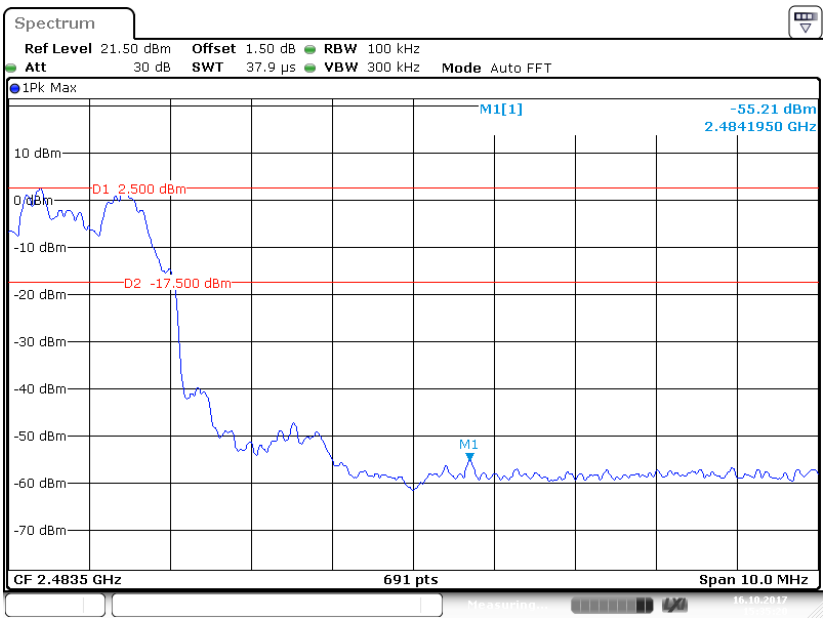
Date:16.OCT.2017 15:31:48

EDR (8-DPSK): Left Side-Hopping



Date:16.OCT.2017 15:34:05

BDR (8-DPSK): Right Side-Hopping



Date:16.OCT.2017 15:35:20

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