

FCC PART 15.247 TEST REPORT

For

Shanghai Flydigi Electronics Technology Co., Ltd.

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FCC ID: 2AORE-CYBERFOX

Report Type: Original Report	Product Type: Flydigi Cyberfox Low Latency Wireless Earphone
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TABLE OF CONTENTS

GENERAL INFORMATION.....	4
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT)	4
OBJECTIVE	4
RELATED SUBMITTAL(S)/GRANT(S).....	4
TEST METHODOLOGY	5
MEASUREMENT UNCERTAINTY	5
TEST FACILITY	5
SYSTEM TEST CONFIGURATION.....	6
DESCRIPTION OF TEST CONFIGURATION	6
EUT EXERCISE SOFTWARE	6
SPECIAL ACCESSORIES.....	6
EQUIPMENT MODIFICATIONS	6
SUPPORT EQUIPMENT LIST AND DETAILS	7
EXTERNAL I/O CABLE.....	7
BLOCK DIAGRAM OF TEST SETUP	7
SUMMARY OF TEST RESULTS	9
TEST EQUIPMENT LIST	10
FCC§15.247 (I), §1.1310 &§2.1093 –RF EXPOSURE.....	11
MEASUREMENT RESULT	11
FCC §15.203 – ANTENNA REQUIREMENT	12
APPLICABLE STANDARD	12
ANTENNA CONNECTOR CONSTRUCTION	12
FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS	13
APPLICABLE STANDARD	13
EUT SETUP	13
EMI TEST RECEIVER SETUP.....	13
TEST PROCEDURE	13
CORRECTED FACTOR & OVER LIMIT CALCULATION.....	14
TEST RESULTS SUMMARY	14
TEST DATA	14
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS.....	17
APPLICABLE STANDARD	17
EUT SETUP	17
EMI TEST RECEIVER SETUP.....	18
TEST PROCEDURE	18
CORRECTED AMPLITUDE & MARGIN CALCULATION	18
TEST RESULTS SUMMARY	18
TEST DATA	19
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST	30
APPLICABLE STANDARD	30
TEST PROCEDURE	30
TEST DATA	30
FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH.....	36
APPLICABLE STANDARD	36
TEST PROCEDURE	36
TEST DATA	36

FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST	42
APPLICABLE STANDARD	42
TEST PROCEDURE	42
TEST DATA	42
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....	45
APPLICABLE STANDARD	45
TEST PROCEDURE	45
TEST DATA	45
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT	61
APPLICABLE STANDARD	61
TEST PROCEDURE	61
TEST DATA	61
FCC §15.247(d) - BAND EDGES TESTING	68
APPLICABLE STANDARD	68
TEST PROCEDURE	68
TEST DATA	68

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant:	Shanghai Flydigi Electronics Technology Co., Ltd.
Product Type:	Flydigi Cyberfox Low Latency Wireless Earphone
Tested Model:	FLYDIGI Cyberfox
Power Supply:	DC 3.8V from battery
RF Function:	Classic BT
Operating Band/Frequency:	2402-2480 MHz
Channel Number:	79
Channel Separation:	1MHz
Modulation Type:	GFSK, $\pi/4$ -DQPSK, 8-DPSK
Antenna Type:	Ceramics Antenna
Maximum Antenna Gain:	1.50dBi

**All measurement and test data in this report was gathered from production sample serial number: 20200217001. (Assigned by BACL, Kunshan). The EUT was received on 2020-02-17.*

Objective

This test report is prepared on behalf of *Shanghai Flydigi Electronics 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 Part 15.247 DTS submissions with FCC ID: 2AORE-CYBERFOX.

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 558074 D01 15.247 Meas Guidance v05r02.

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	5.65dB
Occupied Bandwidth		0.5kHz
Temperature		1.0°C
Humidity		6%

Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

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), the FCC designation No. CN1185 under the FCC KDB 974614 D01 and CAB identifier CN0004 under the ISED requirement. 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	...	...
...	...	...	...
...	...	78	2480
39	2441	/	/

EUT was tested with Channel 0, 39 and 78.

EUT Exercise Software

RF test software: Bluetest3

GFSK, $\pi/4$ -DQPSK, 8DPSK Power setting: Default.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

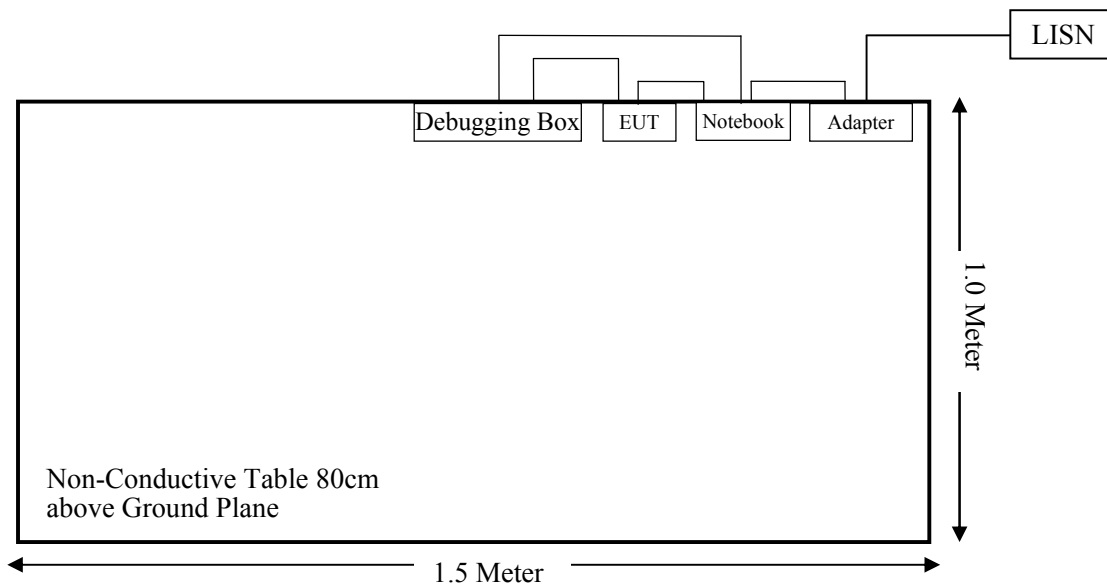
Manufacturer	Description	Model	Serial Number
DELL	Notebook	GX620	D65874152
DELL	Adapter	LA65NS0-00	DF263
Shanghai Flydigi Electronics Technology Co.,Ltd.	Debugging Box	/	/

External I/O Cable

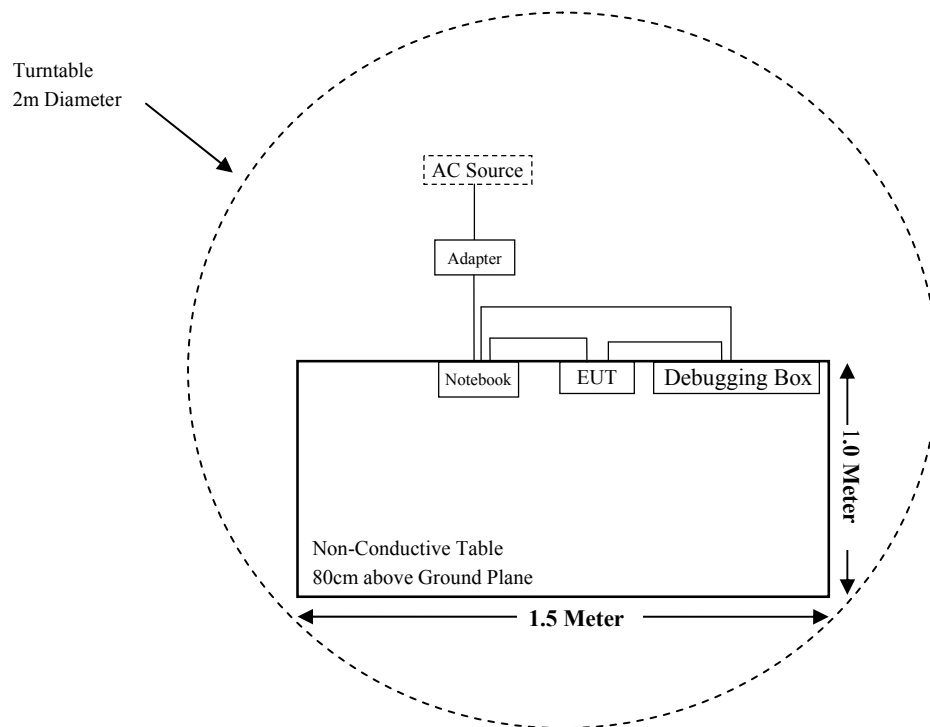
Cable Description	Length (m)	From Port	To
USB Cable	0.3	EUT	Debugging Box
USB Cable	1.2	Debugging Box	Notebook
USB Cable	1.0	EUT	Notebook
Power Cable	1.0	Adapter	AC Source

Block Diagram of Test Setup

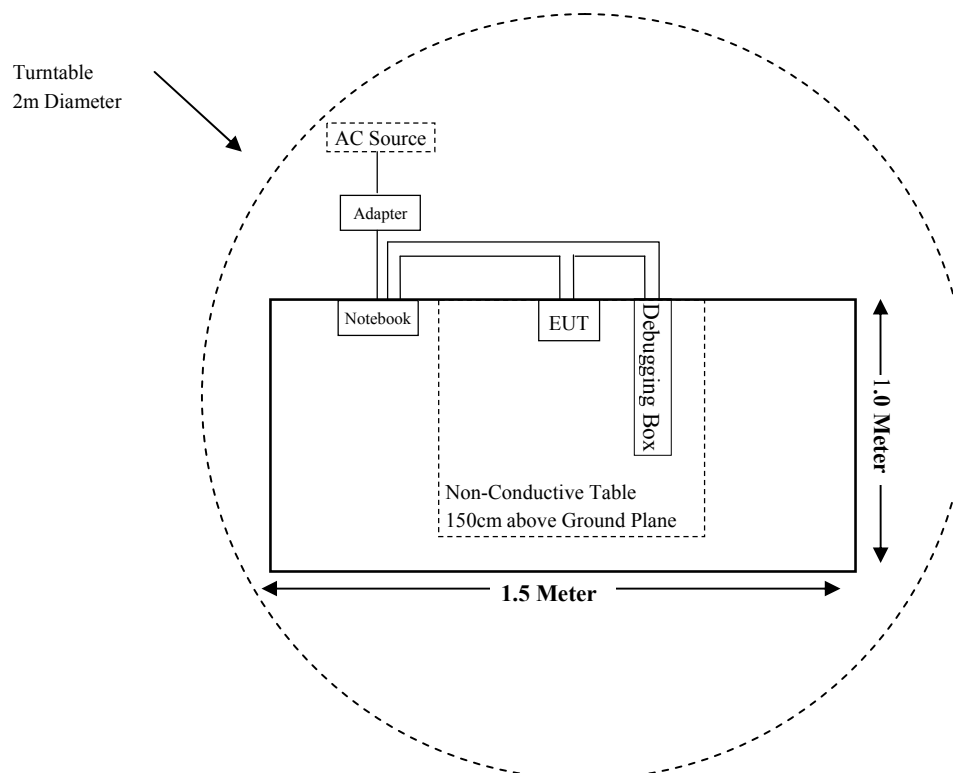
For Conducted Emissions:



For Radiated Emissions(Below 1GHz):



For Radiated Emissions(Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC§15.247 (i), §1.1310 &§2.1093	RF EXPOSURE	Compliant
§15.203	Antenna Requirement	Compliant
§15.207(a)	AC Line Conducted Emissions	Compliant
§15.205, §15.209 & §15.247(d)	Radiated Emissions & Restricted Bands Emissions	Compliant
§15.247(a)(1)	20 dB Emission Bandwidth	Compliant
§15.247(a)(1)	Channel Separation Test	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliant
§15.247(b)(1)	Peak Output Power Measurement	Compliant
§15.247(d)	Band edges	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test (Chamber 1#)					
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-102454-Qd	2019-06-25	2020-06-24
Sunol Sciences	Broadband Antenna	JB3	A040914-2	2020-01-09	2021-01-08
Sonoma Instrument	Pre-amplifier	310N	171205	2019-08-14	2020-08-13
Audix	Test Software	e3	V9	/	/
MICRO-COAX	Coaxial Cable	Cable-8	008	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2019-08-15	2020-08-14
Radiated Emission Test (Chamber 2#)					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2019-05-30	2020-05-29
ETS-LINDGREN	Horn Antenna	3115	6229	2019-01-11	2022-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2019-10-18	2022-10-17
A.H.Systems, inc	Amplifier	2641-1	491	2020-02-20	2021-02-19
SELECTOR	Amplifier	EM18G40G	060726	2019-03-22	2020-03-21
MICRO-TRONICS	Band Reject Filter	BRM50702	G024	2019-08-05	2020-08-04
Narda	Attenuator	10dB	010	2019-08-15	2020-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2019-08-15	2020-08-14
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2019-09-21	2020-09-20
Rohde & Schwarz	Signal Analyzer	FSV40	101116	2019-07-23	2020-07-22
Narda	Attenuator	10dB	010	2019-08-15	2020-08-14
Flydigi	RF Cable	Flydigi C01	C01	Each Time	N/A
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2019-07-11	2020-07-10
Audix	Test Software	e3	V9	--	--
Rohde & Schwarz	LISN	ENV216	3560655016	2019-11-30	2020-11-29
Rohde & Schwarz	Pulse limiter	ESH3-Z2	0357.8810.54	2019-08-10	2020-08-09
MICRO-COAX	Coaxial Cable	Cable-15	015	2019-08-15	2020-08-14

* **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 & §2.1093 –RF EXPOSURE

Applicable Standard

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

According to KDB447498 D01 General RF Exposure Guidance v06:

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

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

Measurement Result

Mode	Frequency Range (MHz)	Max Tune-up Conducted Power		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
		(dBm)	(mW)				
BT	2402-2480	6.50	4.47	5.0	1.4	3.0	Yes
BLE	2402-2480	9.00	7.94	5.0	2.5	3.0	Yes

Result: So the stand-alone SAR evaluation is not necessary.

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.

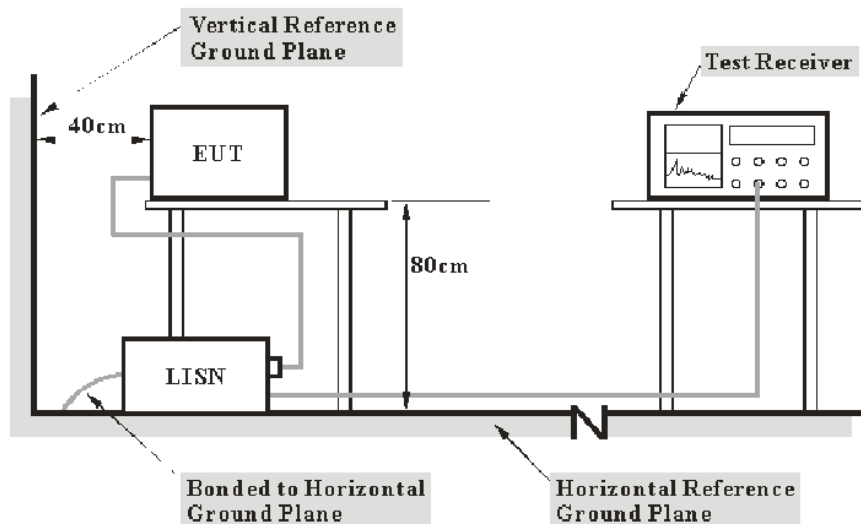
Antenna Connector Construction

The EUT has a ceramics antenna for Bluetooth and BLE and the antenna gain is 1.50 dBi, which was permanently attached; fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant.

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 & Over Limit Calculation

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

$$\text{Factor (dB)} = \text{LISN VDF (dB)} + \text{Cable Loss (dB)} + \text{Transient Limiter Attenuation (dB)}$$

The “**Over Limit**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of 7dB means the emission is 7 dB above the limit. The equation for over limit calculation is as follows:

$$\text{Over Limit (dB)} = \text{Read level (dB}\mu\text{V)} + \text{Factor (dB)} - \text{Limit (dB}\mu\text{V)}$$

Test Results Summary

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

Test Data

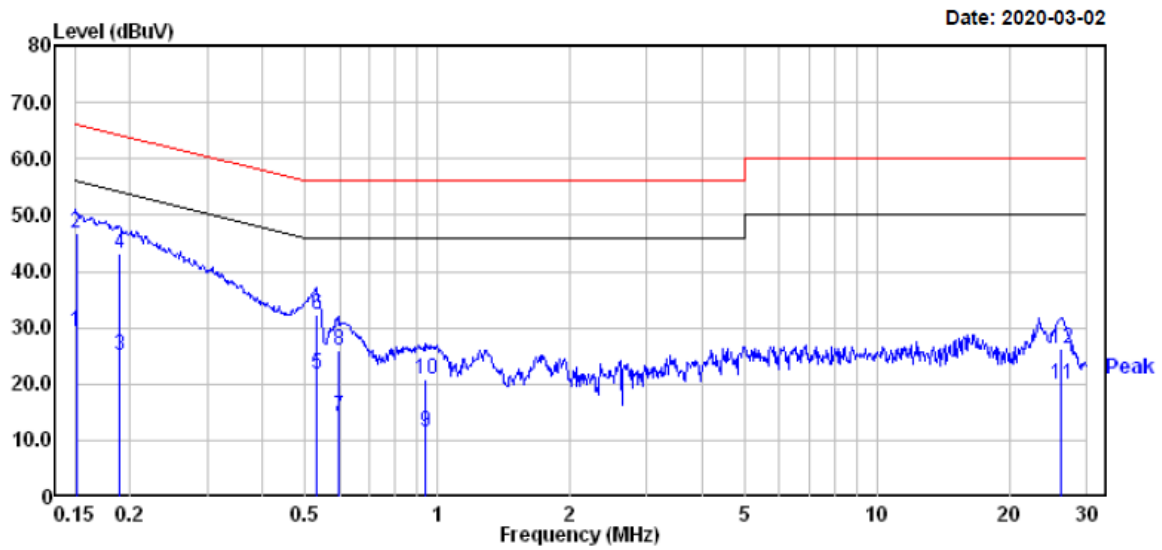
Environmental Conditions

Temperature:	23.2 °C
Relative Humidity:	50%
ATM Pressure:	101.1kPa

The testing was performed by Lee Li on 2020-03-02.

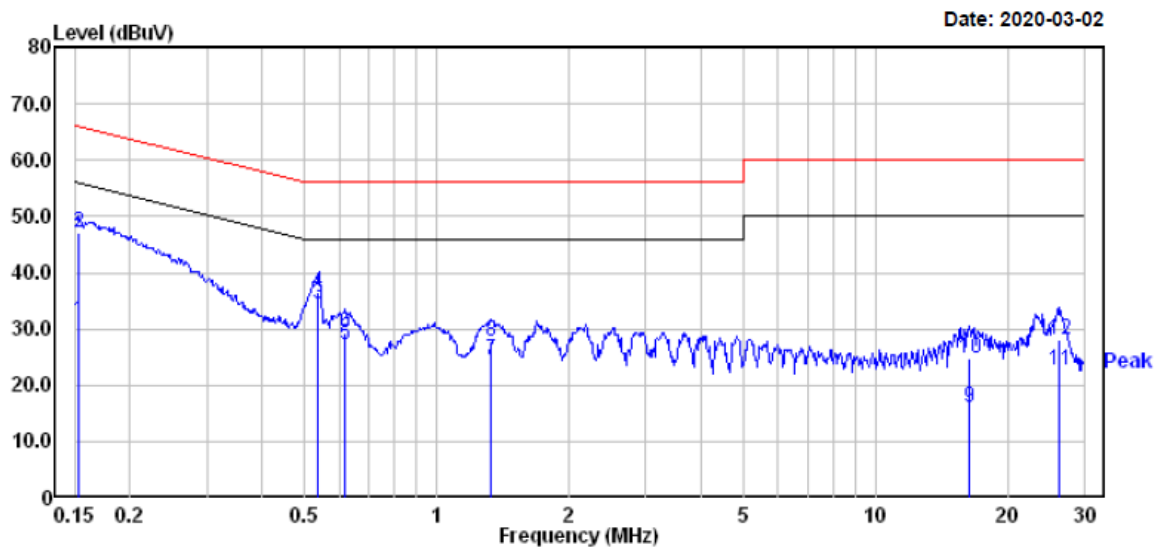
EUT operation mode: Transmitting in middle channel of 8DPSK (worst case)

AC 120V/60 Hz, Line



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.151	9.40	19.82	29.22	55.96	-26.74	Average
2	0.151	27.10	19.82	46.92	65.96	-19.04	QP
3	0.189	5.20	19.82	25.02	54.06	-29.04	Average
4	0.189	23.50	19.82	43.32	64.06	-20.74	QP
5	0.529	2.01	19.75	21.76	46.00	-24.24	Average
6	0.529	12.61	19.75	32.36	56.00	-23.64	QP
7	0.595	-5.70	19.75	14.05	46.00	-31.95	Average
8	0.595	6.10	19.75	25.85	56.00	-30.15	QP
9	0.938	-8.31	19.77	11.46	46.00	-34.54	Average
10	0.938	1.09	19.77	20.86	56.00	-35.14	QP
11	26.278	0.30	19.72	20.02	50.00	-29.98	Average
12	26.278	6.40	19.72	26.12	60.00	-33.88	QP

AC 120V/60 Hz, Neutral



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.152	11.70	19.82	31.52	55.87	-24.35	Average
2	0.152	27.40	19.82	47.22	65.87	-18.65	QP
3	0.535	14.81	19.75	34.56	46.00	-11.44	Average
4	0.535	16.91	19.75	36.66	56.00	-19.34	QP
5	0.621	7.30	19.75	27.05	46.00	-18.95	Average
6	0.621	9.60	19.75	29.35	56.00	-26.65	QP
7	1.324	4.51	19.82	24.33	46.00	-21.67	Average
8	1.324	7.91	19.82	27.73	56.00	-28.27	QP
9	16.398	-3.60	19.73	16.13	50.00	-33.87	Average
10	16.398	5.10	19.73	24.83	60.00	-35.17	QP
11	26.139	3.00	19.71	22.71	50.00	-27.29	Average
12	26.139	8.30	19.71	28.01	60.00	-31.99	QP

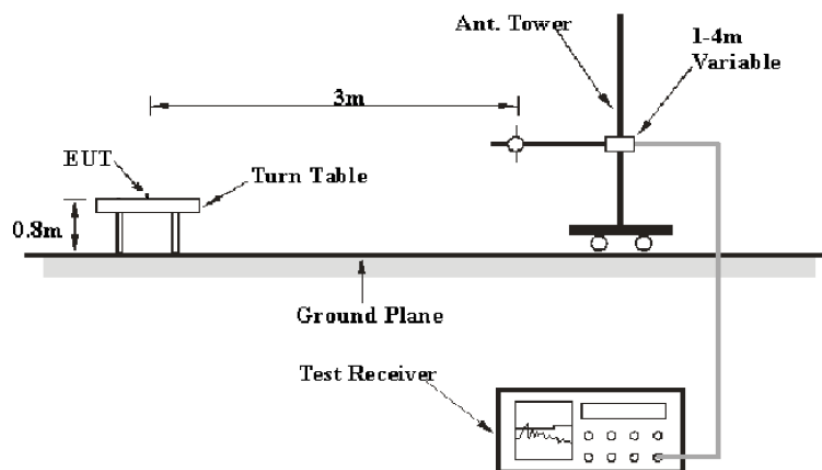
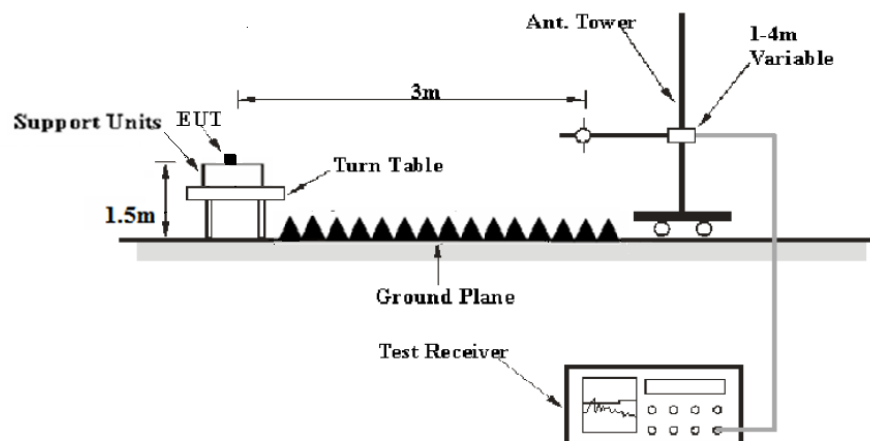
Note:

1) Factor (dB) = LISN VDF (dB) + Cable Loss (dB) + Transient Limiter Attenuation (dB)

2) Over Limit (dB) = Read level (dBuV) + Factor (dB) - Limit (dBuV)

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 Setup

The system was investigated from 30 MHz to 25 GHz.

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

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

Test Procedure

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

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

Corrected Amplitude & Margin Calculation

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

$$\text{Corrected Amplitude (dB}\mu\text{V/m)} = \text{Meter Reading (dB}\mu\text{V)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} - \text{Amplifier Gain (dB)}$$

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

$$\text{Margin (dB)} = \text{Limit (dB}\mu\text{V/m)} - \text{Corrected Amplitude (dB}\mu\text{V/m)}$$

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**

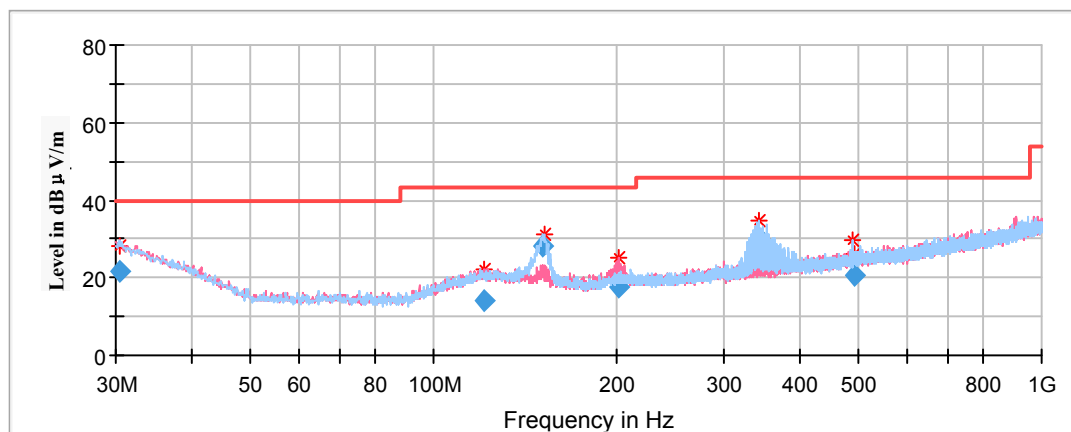
Temperature:	22.5~23.3 °C
Relative Humidity:	48~50 %
ATM Pressure:	101.2~101.3 kPa

The testing was performed by Lee Li from 2020-03-10 to 2020-03-16.

EUT operation mode: Transmitting

Spurious Emission Test:**30MHz-1GHz:**

Pre-Scan with GFSK, $\pi/4$ -DQPSK, 8DPSK modes of operation in the X,Y and Z axes of orientation, the worst case is the **middle channel of 8DPSK Mode in Z-axis of orientation** was recorded



Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	Quasi-peak (dBμV/m)	Height (cm)	Polar (H/V)				
30.56	21.73	100	H	181	-4.3	40.00	18.27
120.93	13.92	200	V	13	-11.2	43.50	29.58
151.21	27.97	200	H	0	-12.4	43.50	15.53
201.20	17.62	100	V	39	-12.3	43.50	25.88
342.00	30.19	100	H	114	-9.5	46.00	15.81
490.88	20.48	100	H	14	-6.4	46.00	25.52

1GHz-18GHz:

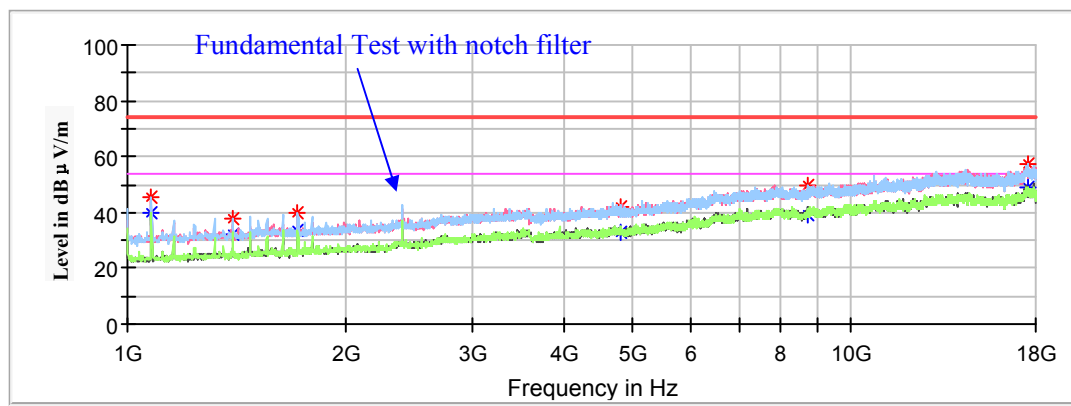
*Pre-Scan with GFSK, $\pi/4$ -DQPSK, 8DPSK modes of operation in the X,Y and Z axes of orientation, the worst case is the **middle channel of 8DPSK Mode in Z-axis of orientation** was recorded*

Note:

1. This test was performed with the 2.4-2.5 GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
 Corrected Amplitude (dB μ V/m) = Corrected Factor (dB/m) + Reading (dB μ V)
 Margin (dB) = Limit (dB μ V/m) – Corrected Amplitude (dB μ V/m)

Low Channel: 2402MHz

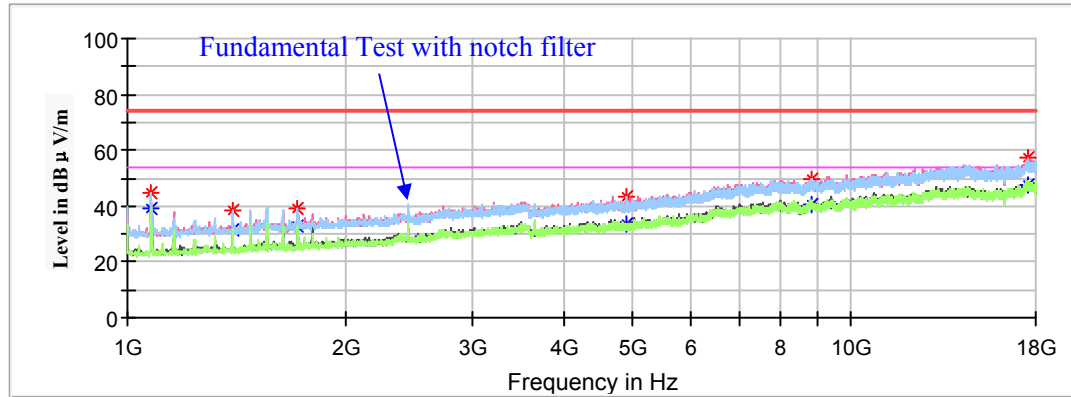
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dB μ V/m)	Margin (dB)
	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Height (cm)	Polar (H/V)				
1078.20	---	39.88	150	H	170	-12.2	54.00	14.12
1078.20	45.26	---	150	H	170	-12.2	74.00	28.74
1397.80	---	32.05	150	H	214	-10.5	54.00	21.95
1397.80	38.10	---	150	H	214	-10.5	74.00	35.90
1719.10	---	33.46	150	H	353	-9.2	54.00	20.54
1719.10	39.70	---	150	H	353	-9.2	74.00	34.30
4804.00	---	33.11	200	V	19	-0.6	54.00	20.89
4804.00	42.08	---	200	V	19	-0.6	74.00	31.92
8726.50	---	39.27	200	H	81	6.9	54.00	14.73
8726.50	49.71	---	200	H	81	6.9	74.00	24.29
17520.60	---	48.62	150	H	184	14.2	54.00	5.38
17520.60	57.30	---	150	H	184	14.2	74.00	16.70

Middle Channel: 2441MHz

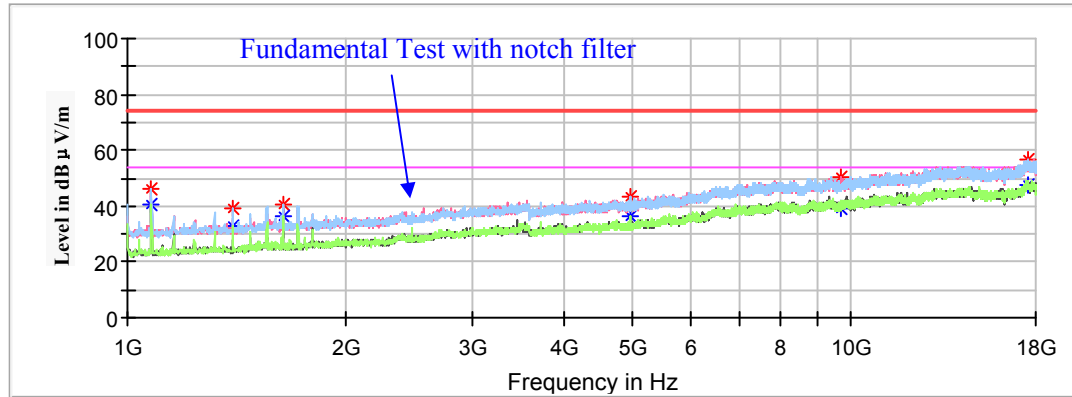
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1078.20	---	38.91	150	H	82	-12.2	54.00	15.09
1078.20	45.03	---	150	H	82	-12.2	74.00	28.97
1399.50	---	31.37	200	H	304	-10.5	54.00	22.63
1399.50	38.48	---	200	H	304	-10.5	74.00	35.52
1719.10	---	32.93	200	H	112	-9.2	54.00	21.07
1719.10	38.86	---	200	H	112	-9.2	74.00	35.14
4882.00	---	33.23	200	H	246	-0.4	54.00	20.77
4882.00	43.43	---	200	H	246	-0.4	74.00	30.57
8843.80	---	40.51	150	H	25	7.2	54.00	13.49
8843.80	49.99	---	150	H	25	7.2	74.00	24.01
17522.30	---	47.48	200	V	359	14.2	54.00	6.52
17522.30	57.25	---	200	V	359	14.2	74.00	16.75

High Channel: 2480MHz

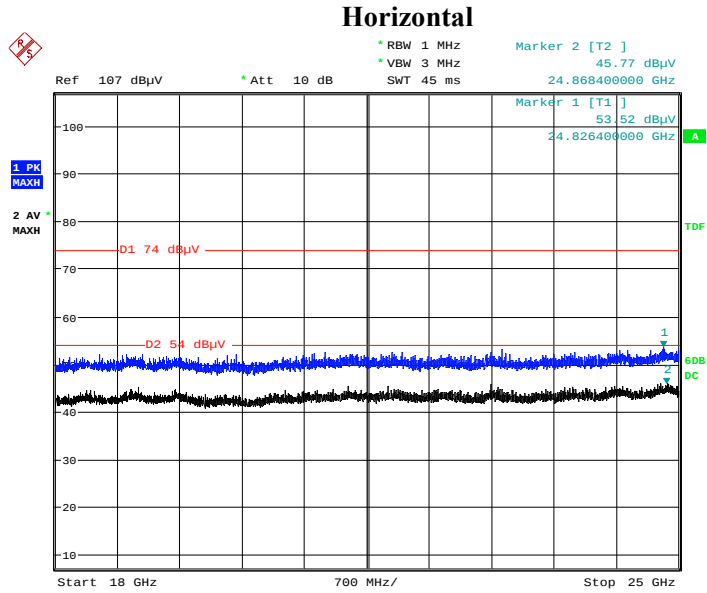
Full Spectrum



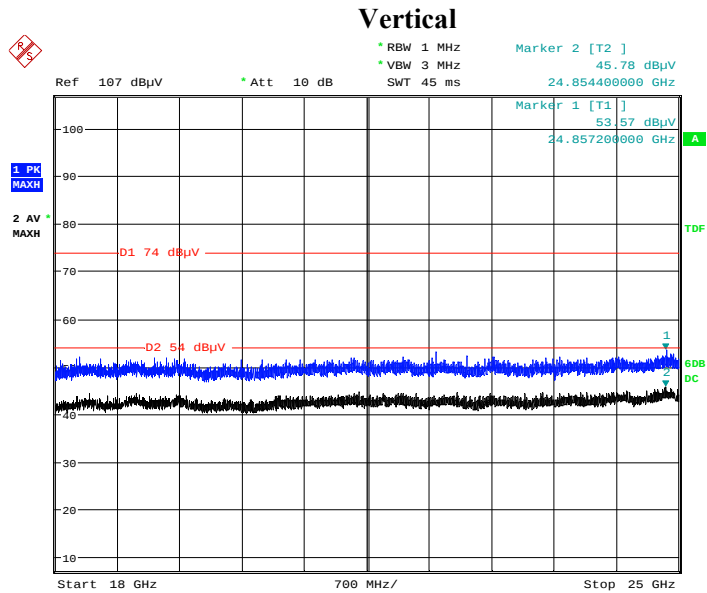
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1078.20	---	40.61	150	H	85	-12.2	54.00	13.39
1078.20	45.87	---	150	H	85	-12.2	74.00	28.13
1399.50	---	32.70	200	H	95	-10.5	54.00	21.30
1399.50	39.04	---	200	H	95	-10.5	74.00	34.96
1639.20	---	36.67	150	H	188	-9.5	54.00	17.33
1639.20	40.60	---	150	H	188	-9.5	74.00	33.40
4960.00	---	36.67	150	H	280	-0.3	54.00	17.33
4960.00	43.37	---	150	H	280	-0.3	74.00	30.63
9656.40	---	39.51	200	V	6	7.8	54.00	14.49
9656.40	50.11	---	200	V	6	7.8	74.00	23.89
17524.00	---	47.51	200	H	307	14.2	54.00	6.49
17524.00	56.97	---	150	H	307	14.2	74.00	17.03

18GHz-25GHz:

Pre-Scan with GFSK, $\pi/4$ -DQPSK, 8DPSK modes of operation in the X,Y and Z axes of orientation, the worst case is the **middle channel 8DPSK Mode in Z-axis of orientation** was recorded



Date: 16.MAR.2020 11:05:52



Date: 16.MAR.2020 11:20:03

Fundamental Test & Restricted Bands Emissions:

*Pre-Scan with GFSK, $\pi/4$ -DQPSK, 8DPSK modes of operation in the X,Y and Z axes of orientation, the worst case the **middle channel 8DPSK in Z-axis of orientation** was recorded*

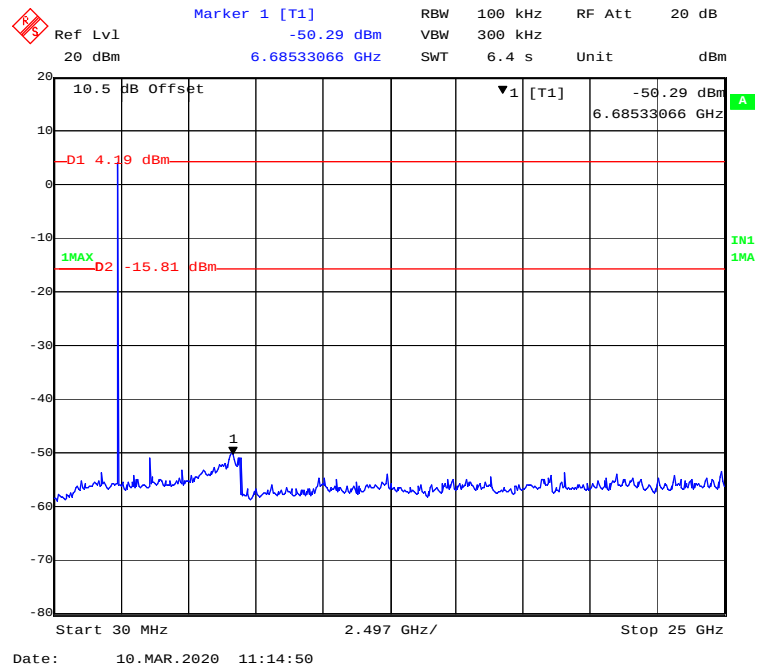
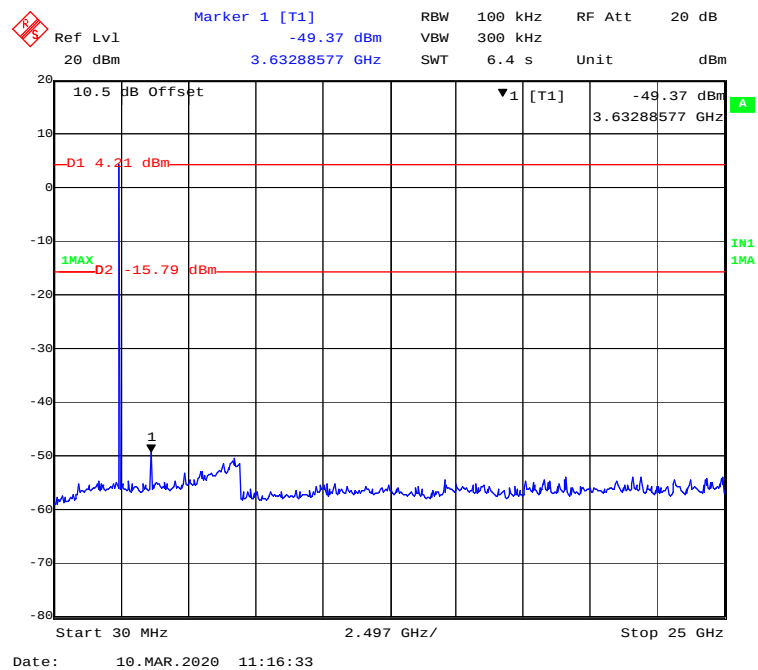
Note:

1. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)

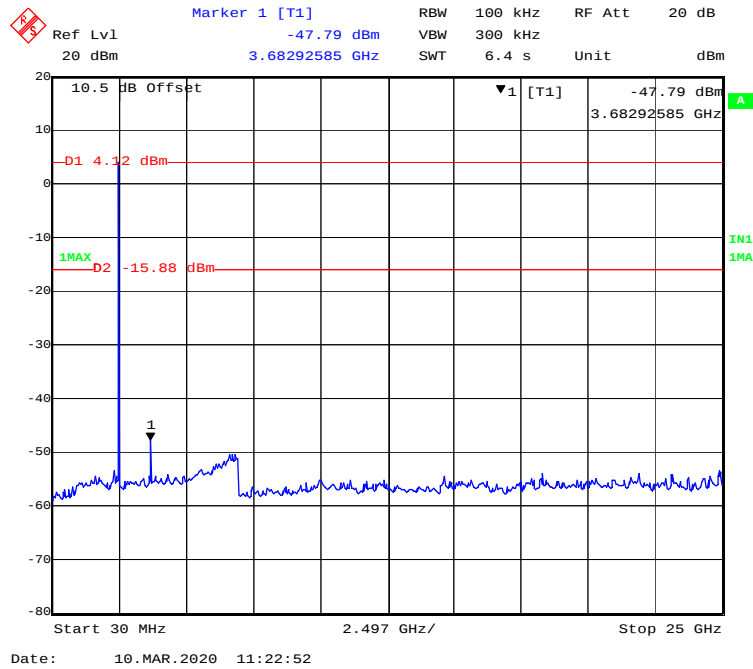
Corrected Amplitude (dB μ V/m) = Corrected Factor (dB/m) + Reading (dB μ V)

Margin (dB) = Limit (dB μ V/m) – Corrected Amplitude (dB μ V/m)

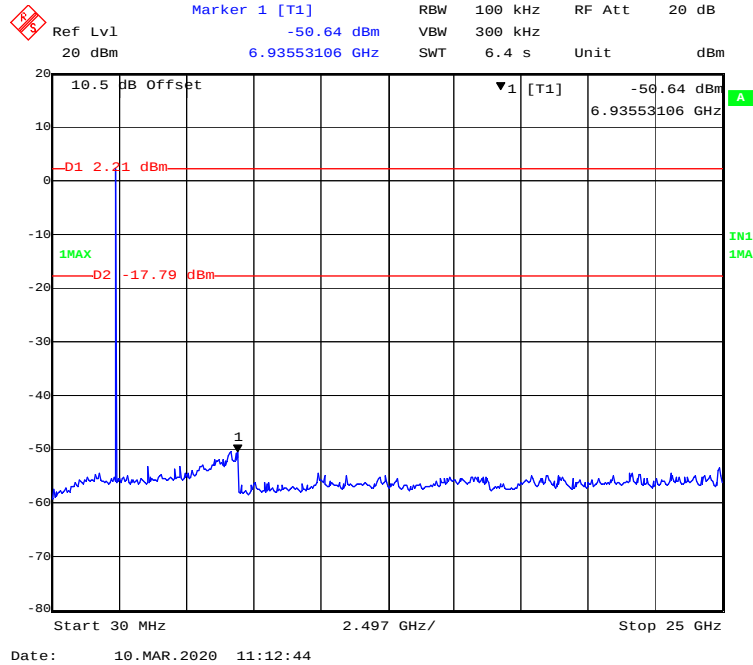
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
Low Channel: 2402MHz								
2390.00	---	41.60	200.0	V	185.0	2.8	54.00	12.40
2390.00	50.72	---	200.0	V	185.0	2.8	74.00	23.28
High Channel: 2480MHz								
2483.50	---	41.12	150.0	V	79.0	3.0	54.00	12.88
2483.50	51.08	---	150.0	V	79.0	3.0	74.00	22.92

Conducted Spurious Emissions at Antenna Port**BDR (GFSK): Low Channel****BDR (GFSK): Middle Channel**

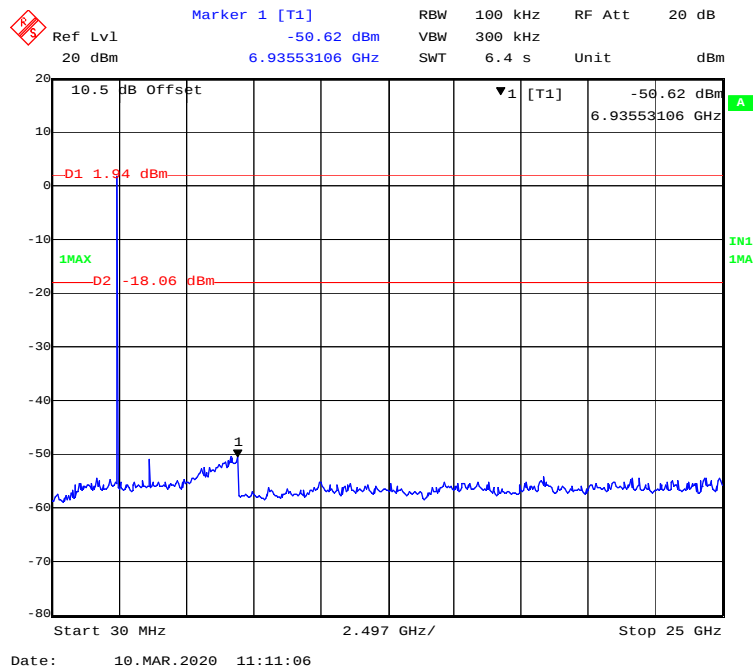
BDR (GFSK): High Channel



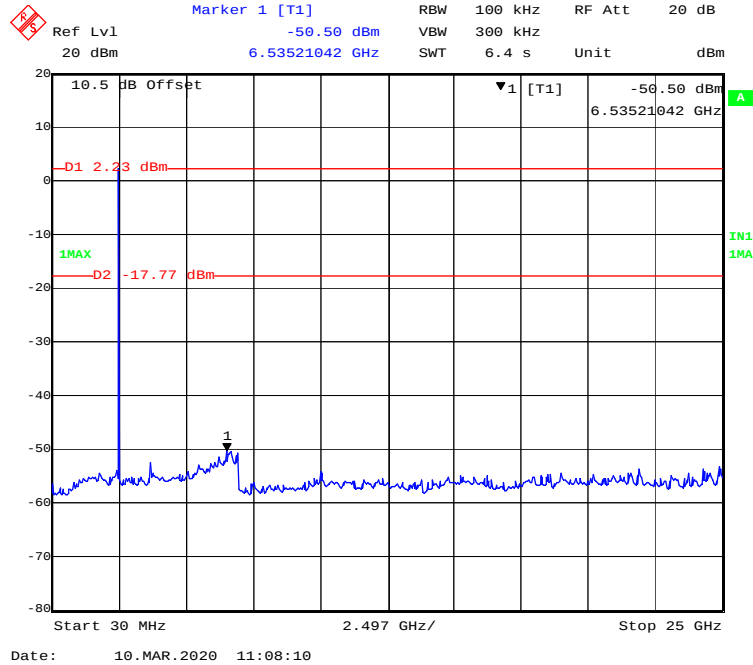
EDR ($\pi/4$ -DQPSK): Low Channel



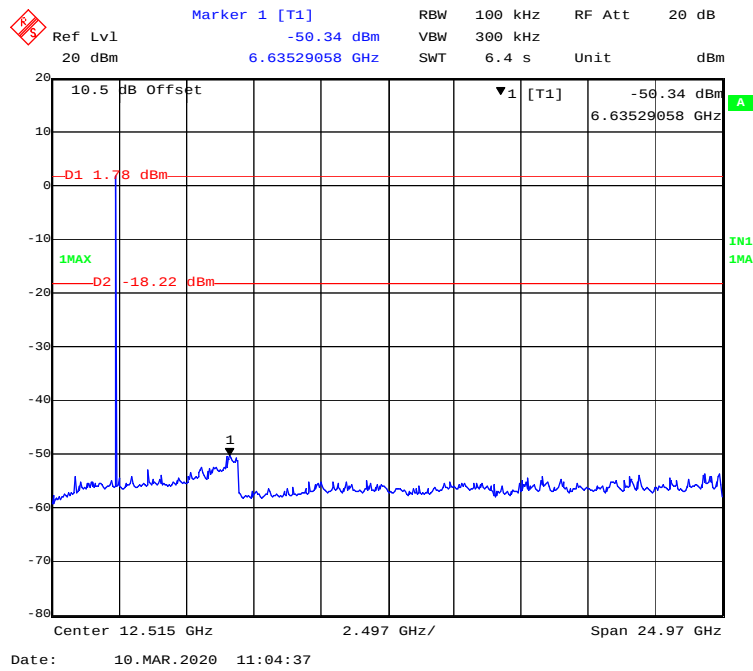
EDR ($\pi/4$ -DQPSK): Middle Channel



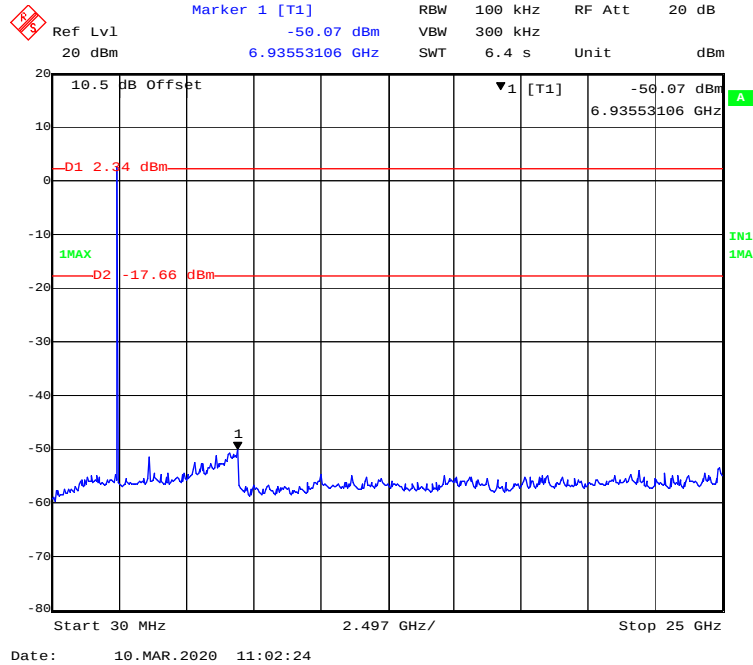
EDR ($\pi/4$ -DQPSK): High Channel



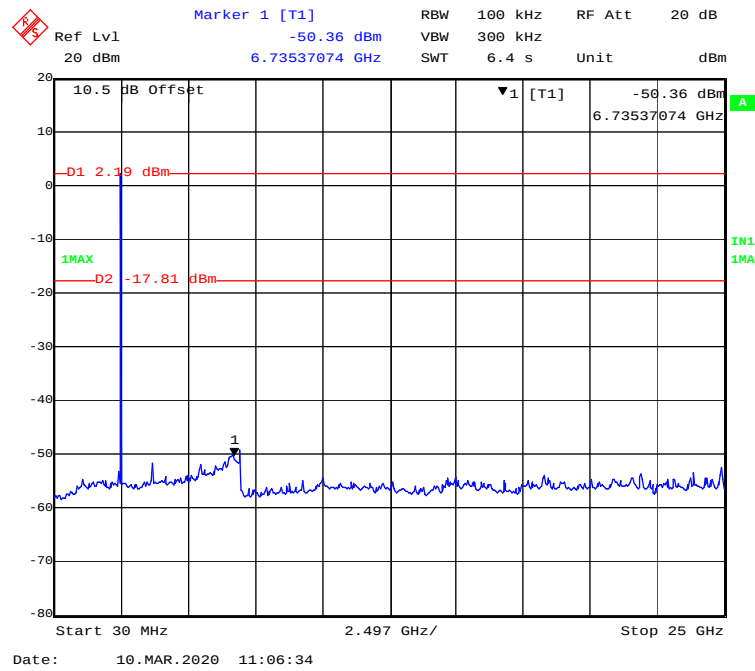
EDR (8DPSK): Low Channel



EDR (8DPSK): Middle Channel



EDR (8DPSK): High Channel



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

Applicable Standard

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

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- Span: Wide enough to capture the peaks of two adjacent channels.
- RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- Video (or average) bandwidth (VBW) $\geq$ RBW.
- Sweep: Auto.
- Detector function: Peak.
- Trace: Max hold.
- Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Test Data

Environmental Conditions

Temperature:	23.3 °C
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

The testing was performed by Lee Li on 2020-03-10.

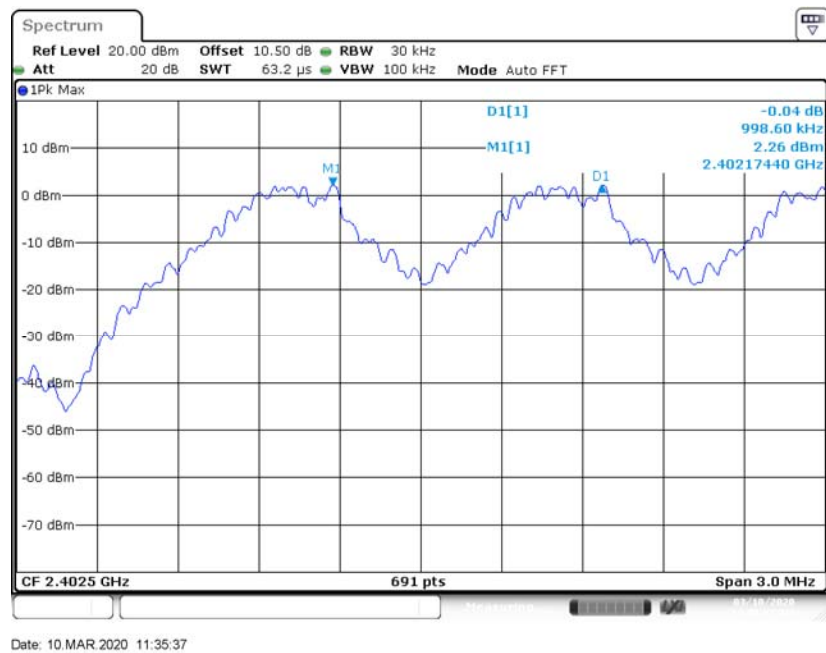
EUT operation mode: Transmitting

Test Result: Compliant.

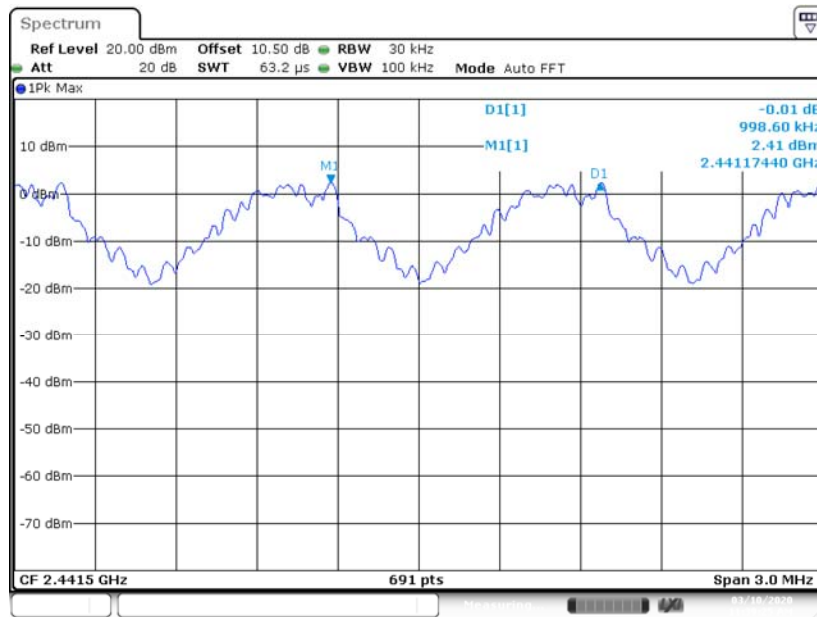
Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)	Result
BDR (GFSK)	Low	2402	0.999	0.956	Pass
	Adjacent	2403			
	Middle	2441	0.999	0.956	Pass
	Adjacent	2442			
	High	2480	0.999	0.956	Pass
	Adjacent	2479			
EDR ($\pi/4$ -DQPSK)	Low	2402	1.003	0.898	Pass
	Adjacent	2403			
	Middle	2441	1.003	0.898	Pass
	Adjacent	2442			
	High	2480	1.003	0.898	Pass
	Adjacent	2479			
EDR (8DPSK)	Low	2402	1.003	0.874	Pass
	Adjacent	2403			
	Middle	2441	1.003	0.870	Pass
	Adjacent	2442			
	High	2480	1.003	0.870	Pass
	Adjacent	2479			

Note: For BDR mode, Limit = 20 dB bandwidth, For BDR and EDR mode, Limit = 20 dB bandwidth*2/3

BDR (GFSK): Low Channel

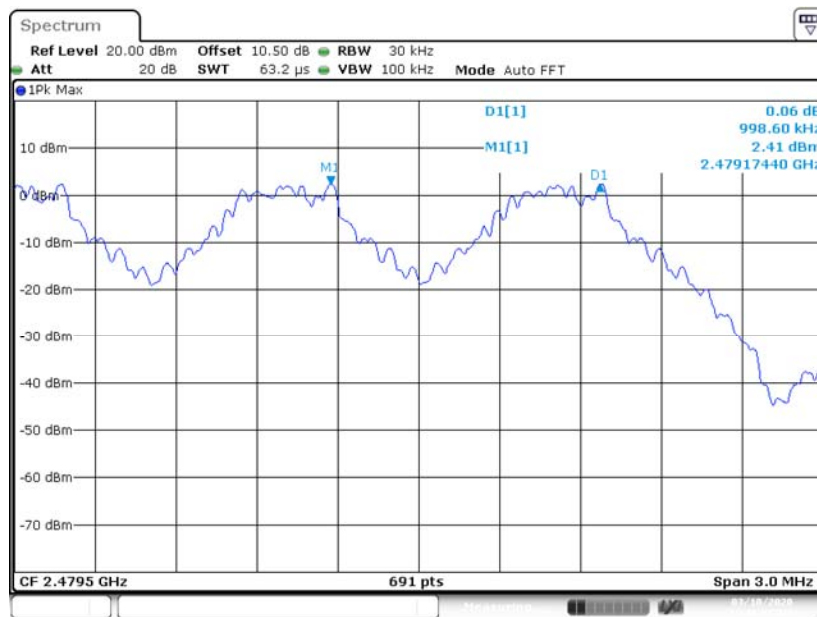


BDR (GFSK): Middle Channel

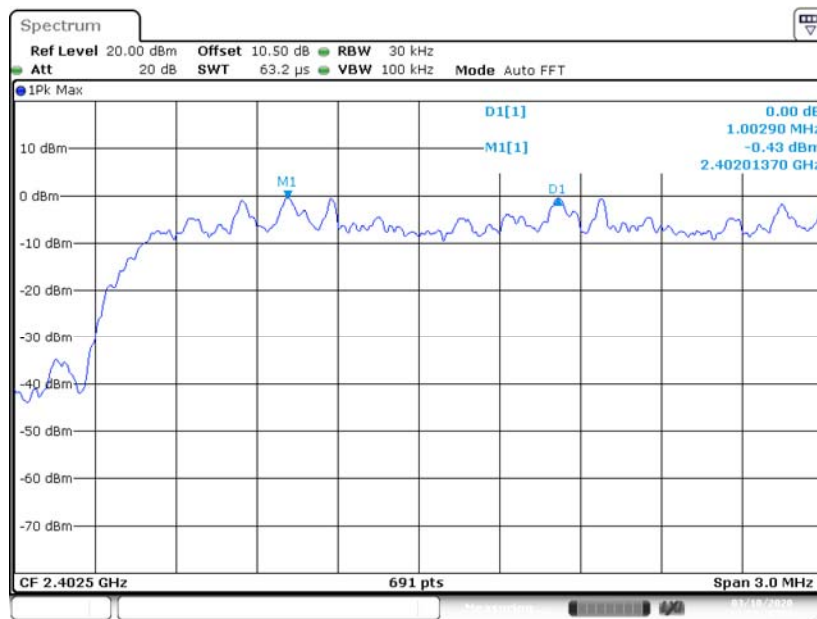


Date: 10. MAR. 2020 11:39:25

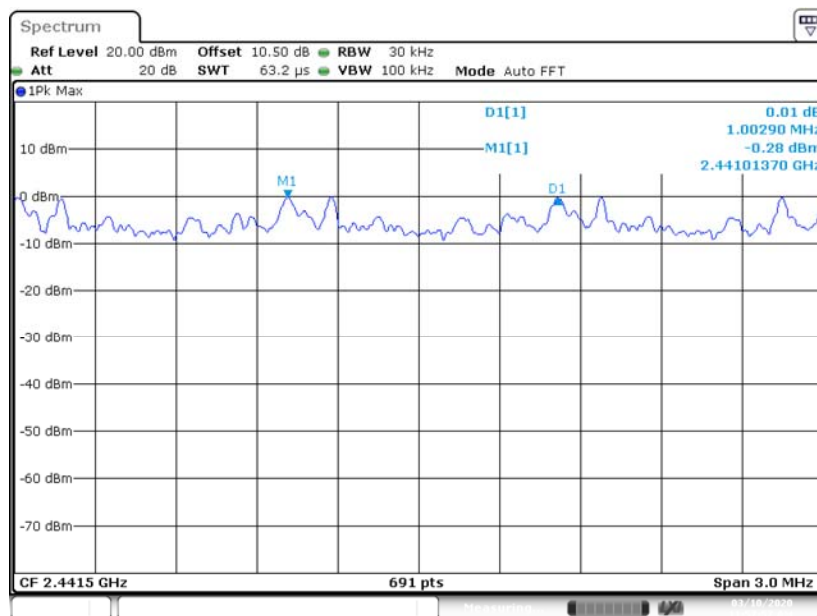
BDR (GFSK): High Channel



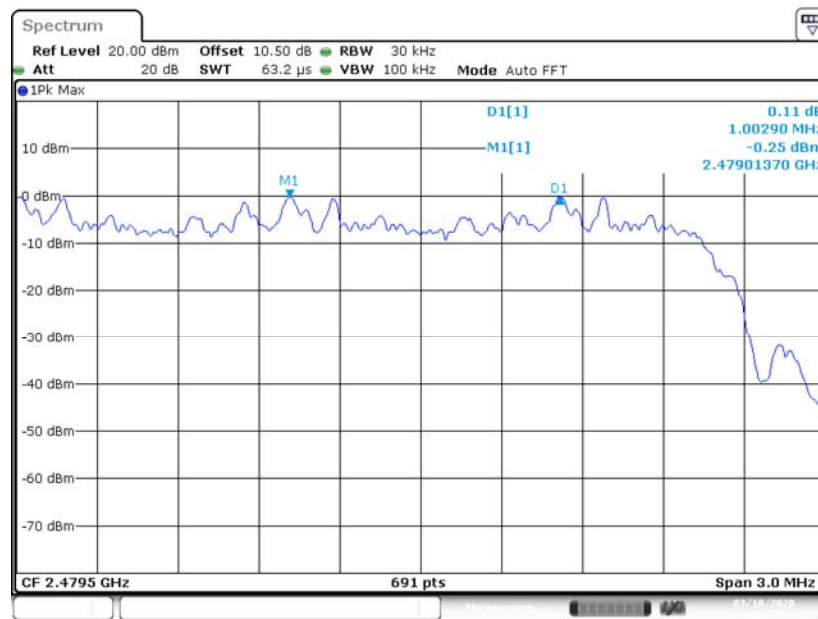
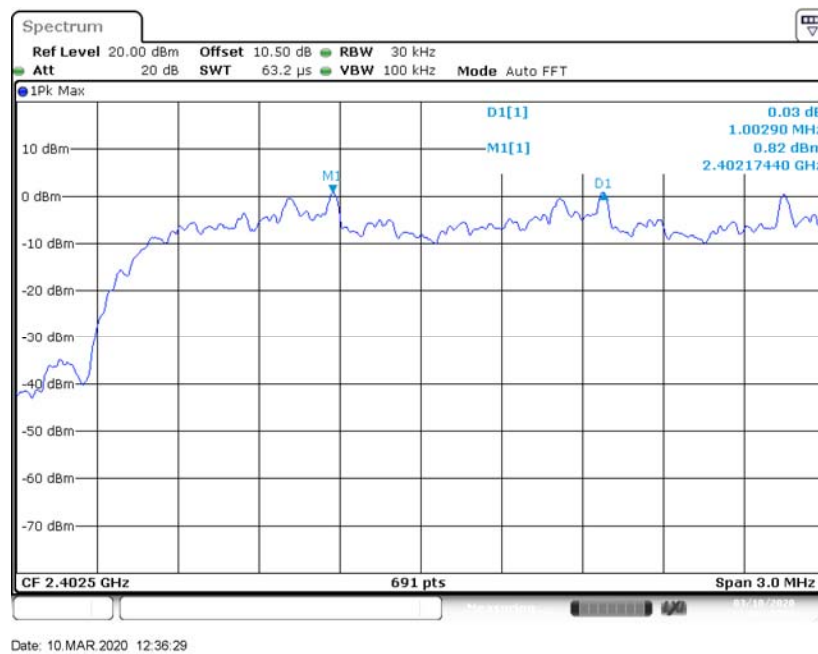
Date: 10. MAR. 2020 11:42:36

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

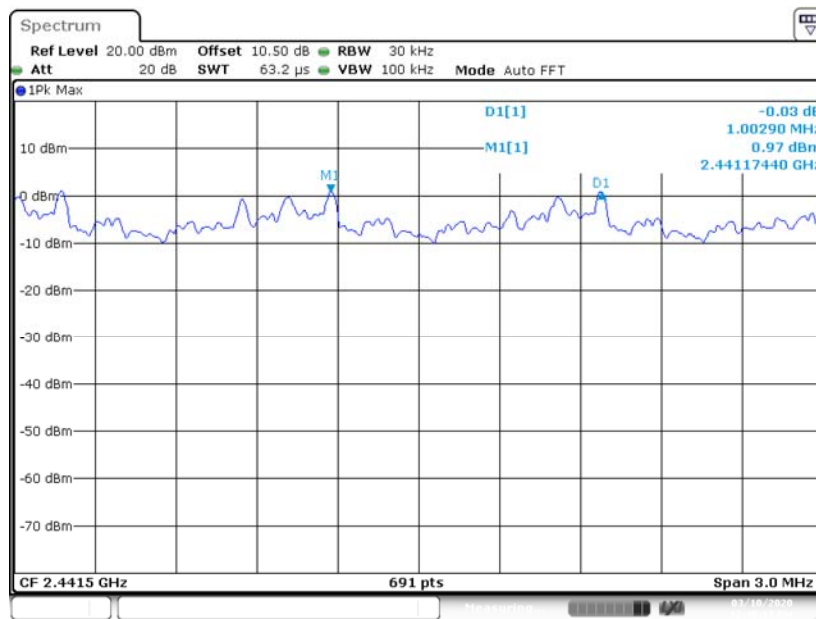
Date: 10.MAR.2020 12:27:26

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

Date: 10.MAR.2020 11:57:57

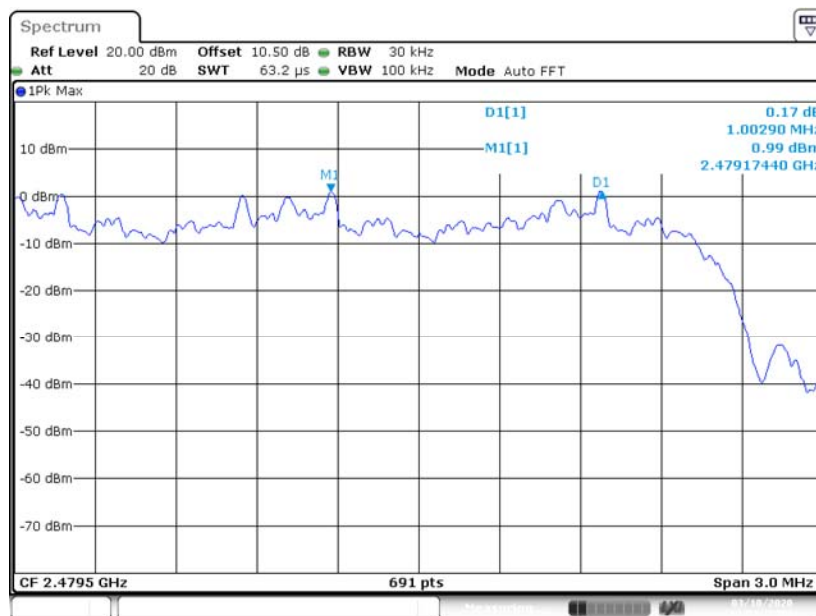
EDR ($\pi/4$ -DQPSK): High Channel**EDR (8DPSK): Low Channel**

EDR (8DPSK): Middle Channel



Date: 10.MAR.2020 12:48:11

EDR (8DPSK): High Channel



Date: 10.MAR.2020 12:52:28

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 °C
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

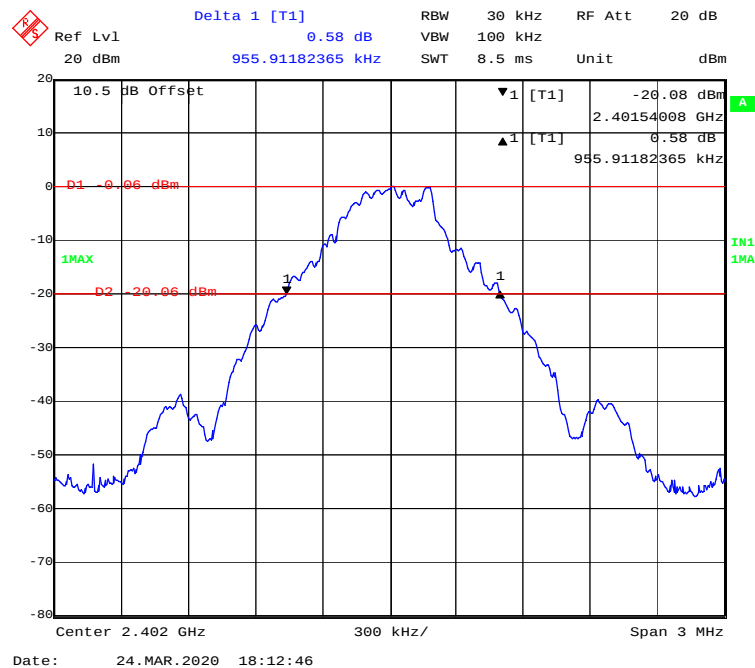
The testing was performed by Lee Li on 2020-03-24.

EUT operation mode: Transmitting

Test Result: Compliant.

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.956
	Middle	2441	0.956
	High	2480	0.956
EDR ($\pi/4$-DQPSK)	Low	2402	1.347
	Middle	2441	1.347
	High	2480	1.347
EDR (8DPSK)	Low	2402	1.311
	Middle	2441	1.305
	High	2480	1.305

BDR (GFSK): Low Channel



Delta 1 [T1]

Ref Lvl 20 dBm

RBW 30 kHz

VBW 100 kHz

SWT 8.5 ms

Unit dBm

10.5 dB Offset

▼ 1 [T1] -19.81 dBm

▲ 1 [T1] 0.52 dB

2.44054008 GHz

955.91182365 kHz

D1 0.31 dBm

1MAX

D2 -19.69 dBm

1

1

IN1 1MA

Center 2.441 GHz

300 kHz/

Span 3 MHz

Date: 24.MAR.2020 18:15:15

Delta 1 [T1] 0.49 dB

Ref Lvl 20 dBm

955.91182365 kHz

RBW 30 kHz

VBW 100 kHz

SWT 8.5 ms

Unit dBm

20 dB

10.5 dB Offset

▼1 [T1] -19.64 dBm

▲1 [T1] 0.49 dB

2.47954008 GHz

955.91182365 kHz

D1 0.36 dBm

D2 -19.64 dBm

1MAX

1

1

IN1 1MA

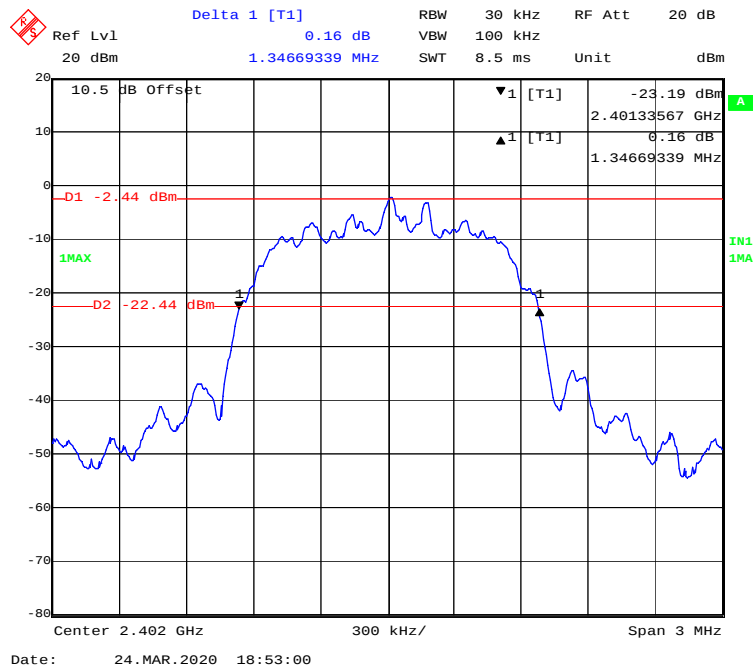
Center 2.48 GHz

300 kHz/

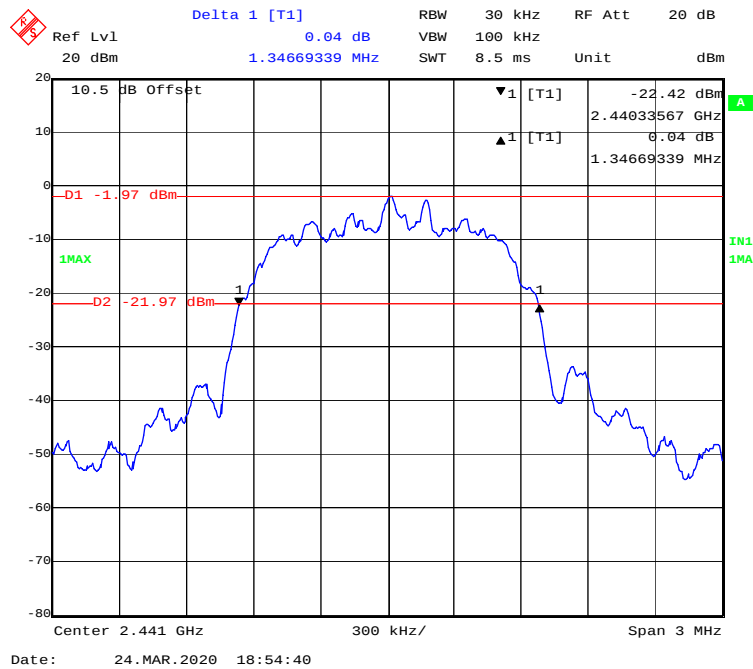
Span 3 MHz

Date: 24.MAR.2020 18:17:12

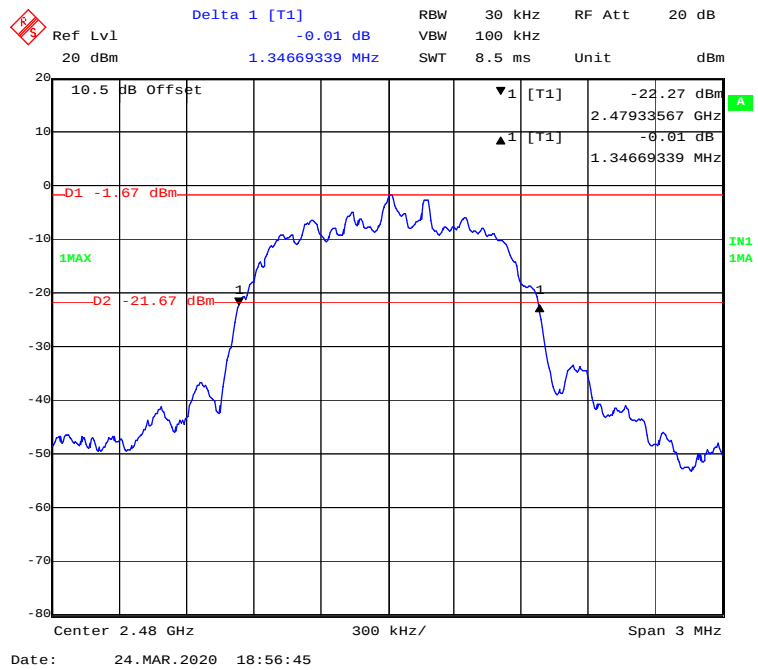
EDR ($\pi/4$ -DQPSK): Low Channel



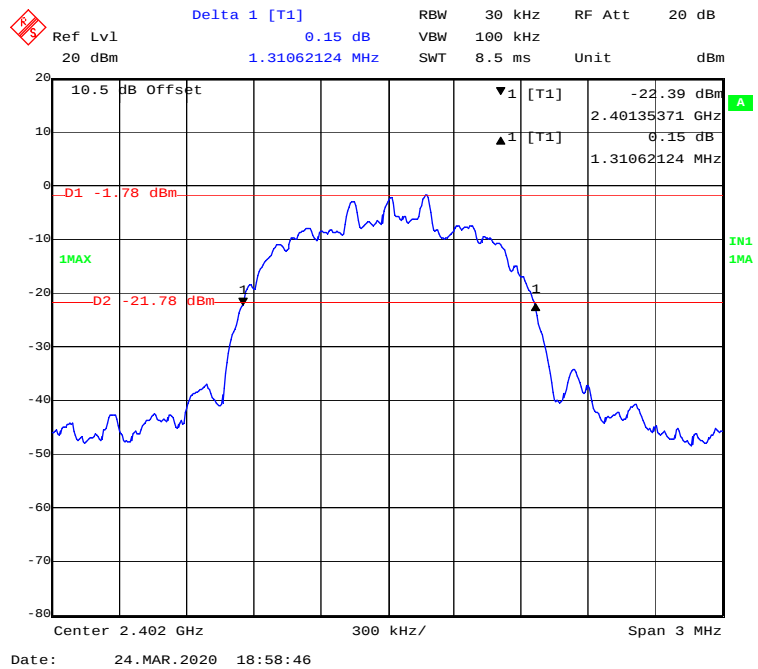
EDR($\pi/4$ -DQPSK): Middle Channel



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



EDR (8DPSK): Low Channel



Ref Lvl 20 dBm Delta 1 [T1] 0.65 dB RBW 30 kHz RF Att 20 dB
 20 dBm 1.30460922 MHz VBW 100 kHz SWT 8.5 ms Unit dBm

10.5 dB Offset

▼1 [T1] -22.06 dBm
 ▲1 [T1] 0.65 dB
 2.44035371 GHz
 1.30460922 MHz

D1 -1.31 dBm
 D2 -21.31 dBm

1MAX
 1

Center 2.441 GHz 300 kHz/ Span 3 MHz

Date: 24.MAR.2020 19:00:37

Delta 1 [T1] 0.59 dB

RBW 30 kHz VBW 100 kHz RF Att 20 dB

Ref Lvl 20 dBm Unit dBm

10.5 dB Offset

▼1 [T1] -21.61 dBm
2.47935371 GHz
▲1 [T1] 0.59 dB
1.30460922 MHz

-D1 -1.14 dBm

1MAX

-D2 -21.14 dBm

IN1 1MA

Center 2.48 GHz 300 kHz/ Span 3 MHz

Date: 24.MAR.2020 19:03:19

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

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- a. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
- b. RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- c. VBW $\geq$ RBW.
- d. Sweep: Auto.
- e. Detector function: Peak.
- f. Trace: Max hold.
- g. Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies.

Test Data**Environmental Conditions**

Temperature:	22.0~23.2 °C
Relative Humidity:	49~50 %
ATM Pressure:	101.1~101.3 kPa

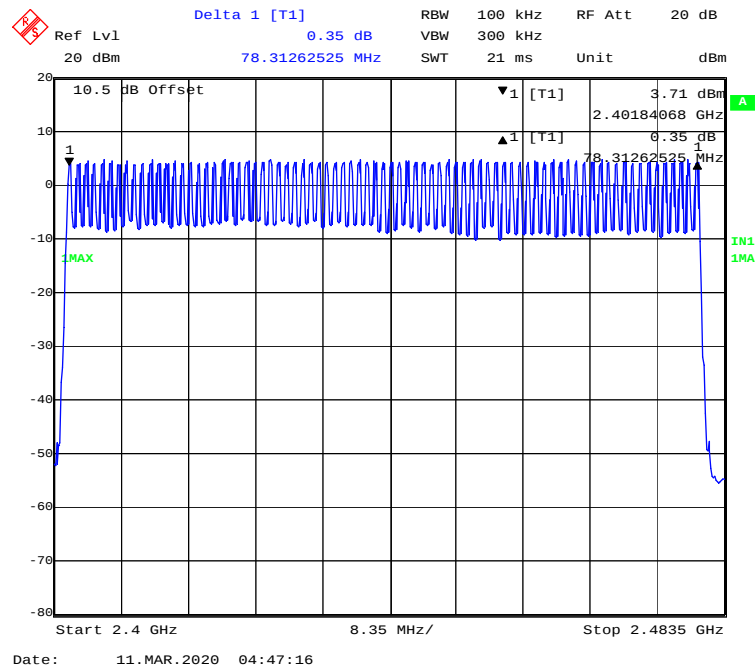
The testing was performed by Lee Li from 2020-03-10 to 2020-03-11.

EUT operation mode: Hopping

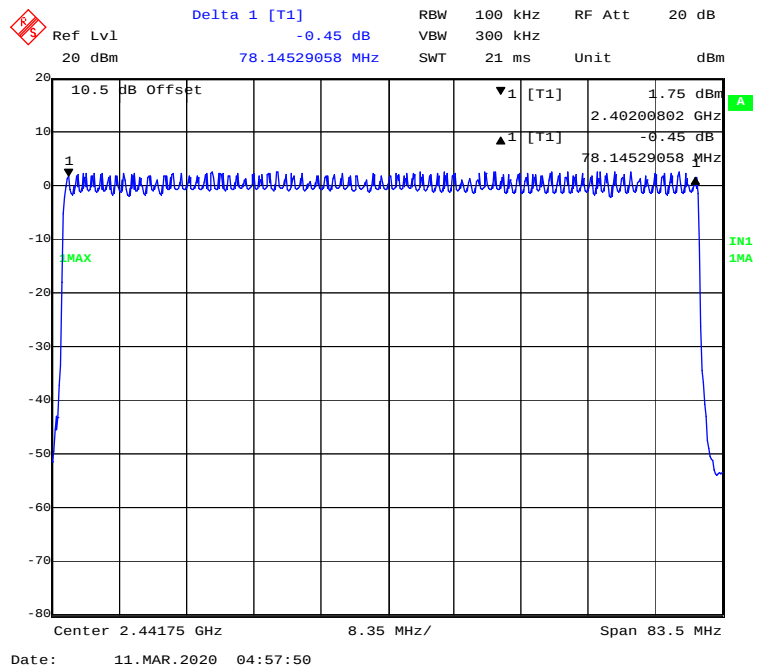
Test Result: Compliant.

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

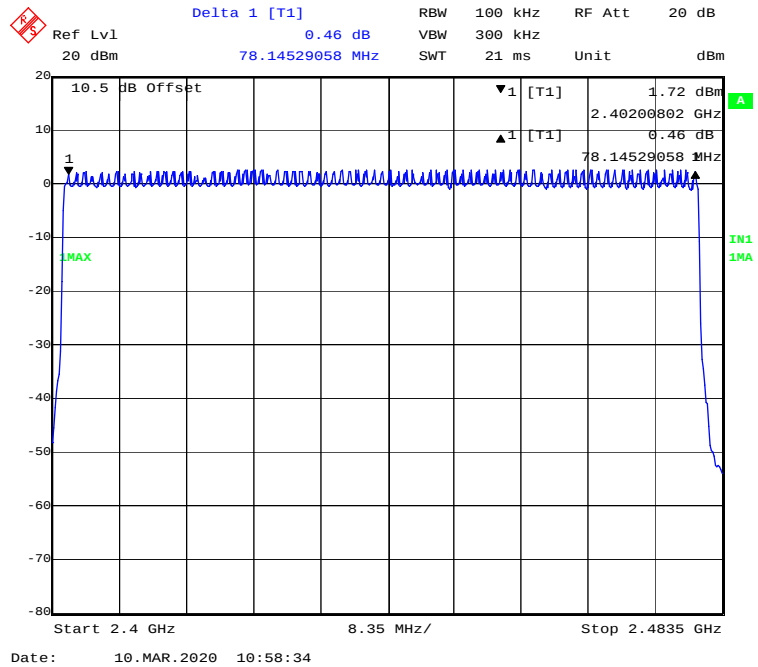
BDR (GFSK): Number of Hopping Channels



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



EDR (8DPSK): Number of Hopping Channels



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

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

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- a Span: Zero span, centered on a hopping channel.
- b RBW shall be $\leq$ channel spacing and where possible RBW should be set $\geq 1 / T$, where T is the expected dwell time per channel.
- c 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.
- d Detector function: Peak.
- e Trace: Max hold.

Test Data**Environmental Conditions**

Temperature:	22.0~23.3 °C
Relative Humidity:	49~50 %
ATM Pressure:	102.0~101.3 kPa

The testing was performed by Lee Li from 2020-03-10 to 2020-03-11.

EUT operation mode: Hopping

Mode		Channel	Pulse Width (ms)	Dwell Time (s)	Limit (s)	Result
BDR (GFSK)	DH1	Low	0.397	0.127	0.4	Pass
		Middle	0.399	0.128	0.4	Pass
		High	0.397	0.127	0.4	Pass
		Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	DH3	Low	1.668	0.267	0.4	Pass
		Middle	1.668	0.267	0.4	Pass
		High	1.668	0.267	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	DH5	Low	2.924	0.312	0.4	Pass
		Middle	2.934	0.313	0.4	Pass
		High	2.924	0.312	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR ($\pi/4$ -DQPSK)	2DH1	Low	0.411	0.132	0.4	Pass
		Middle	0.407	0.130	0.4	Pass
		High	0.409	0.131	0.4	Pass
		Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	2DH3	Low	1.665	0.266	0.4	Pass
		Middle	1.671	0.267	0.4	Pass
		High	1.671	0.267	0.4	Pass
		Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	2DH5	Low	2.939	0.313	0.4	Pass
		Middle	2.929	0.312	0.4	Pass
		High	2.939	0.313	0.4	Pass
		Note: 2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (8DPSK)	3DH1	Low	0.410	0.131	0.4	Pass
		Middle	0.410	0.131	0.4	Pass
		High	0.408	0.131	0.4	Pass
		Note:3 DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	3DH3	Low	1.675	0.268	0.4	Pass
		Middle	1.669	0.267	0.4	Pass
		High	1.669	0.267	0.4	Pass
		Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	3DH5	Low	2.946	0.314	0.4	Pass
		Middle	2.936	0.313	0.4	Pass
		High	2.946	0.314	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				

Delta 1 [T1] -0.49 dB
 RBW 500 kHz RF Att 20 dB
 VBW 2 MHz
 SWT 1 ms Unit dBm

Ref Lvl 20 dBm
 20 dBm

10.5 dB Offset

-59.93 dBm
 -10.821643 μs
 -0.49 dB
 396.793587 μs

Center 2.402 GHz 100 μs/

Date: 11.MAR.2020 04:42:53

Delta 1 [T1]

Ref Lvl 2.03 dB

20 dBm

398.797595 μ s

RBW 500 kHz

VBW 2 MHz

SWT 1 ms

RF Att 20 dB

Unit dBm

10.5 dB Offset

▼1 [T1] -63.72 dBm

▲1 [T1] 2.03 dB

-12.825651 μ s

398.797595 μ s

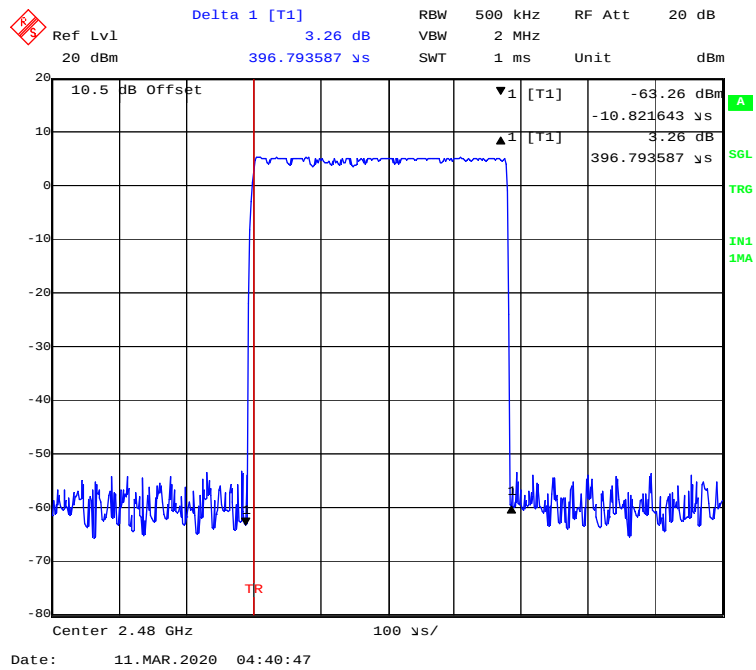
TR

Center 2.441 GHz

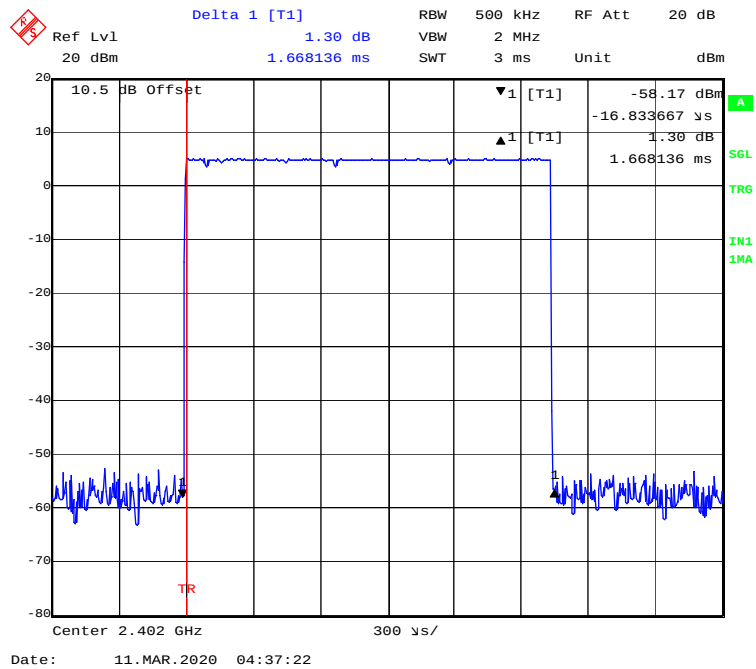
100 μ s/

Date: 11.MAR.2020 04:42:05

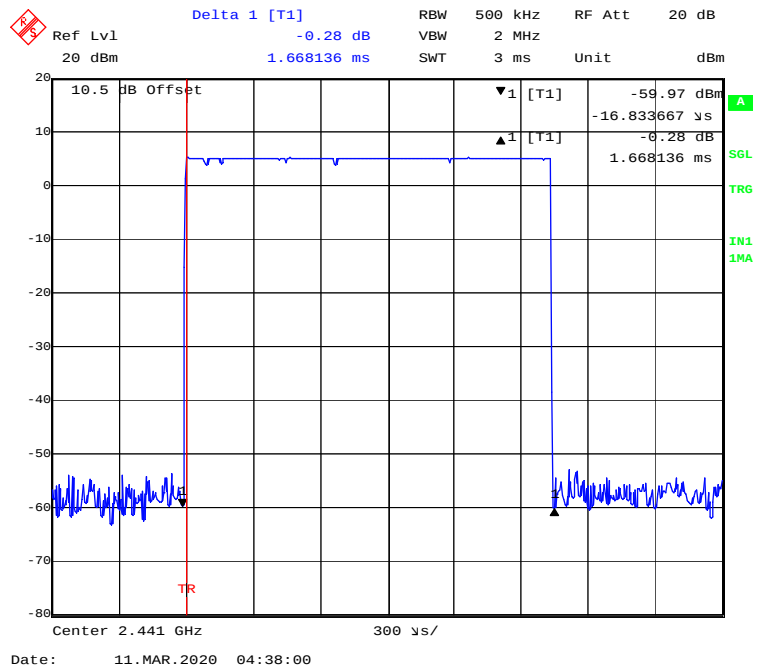
BDR (GFSK): Pulse time, High Channel, DH1



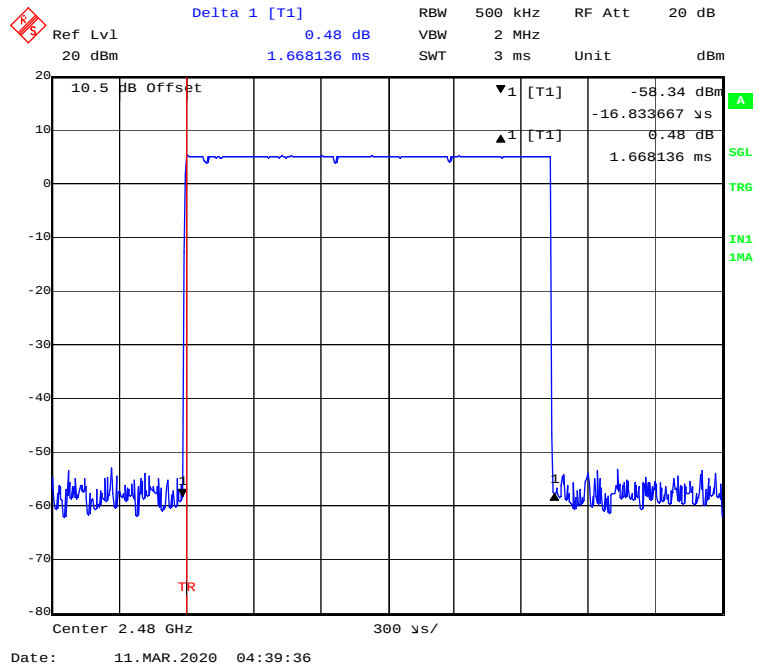
BDR (GFSK): Pulse time, Low Channel, DH3



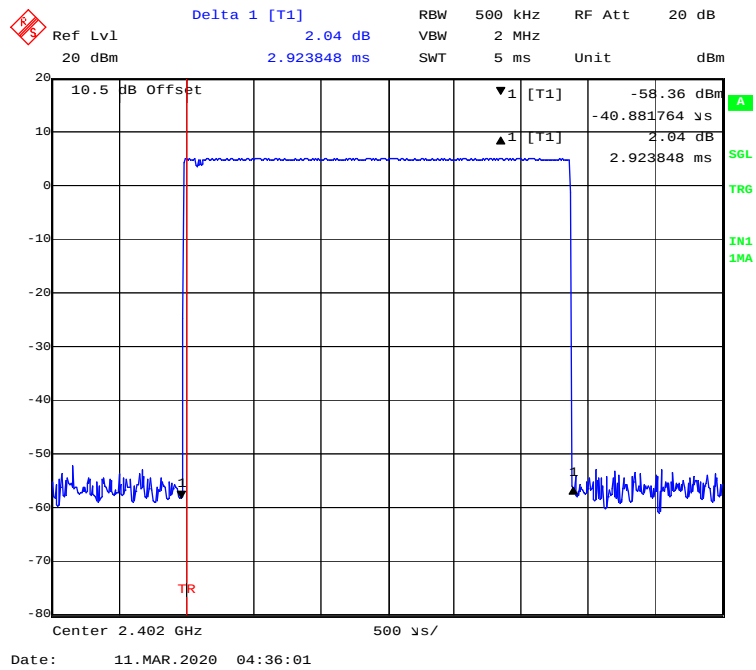
BDR (GFSK): Pulse time, Middle Channel, DH3



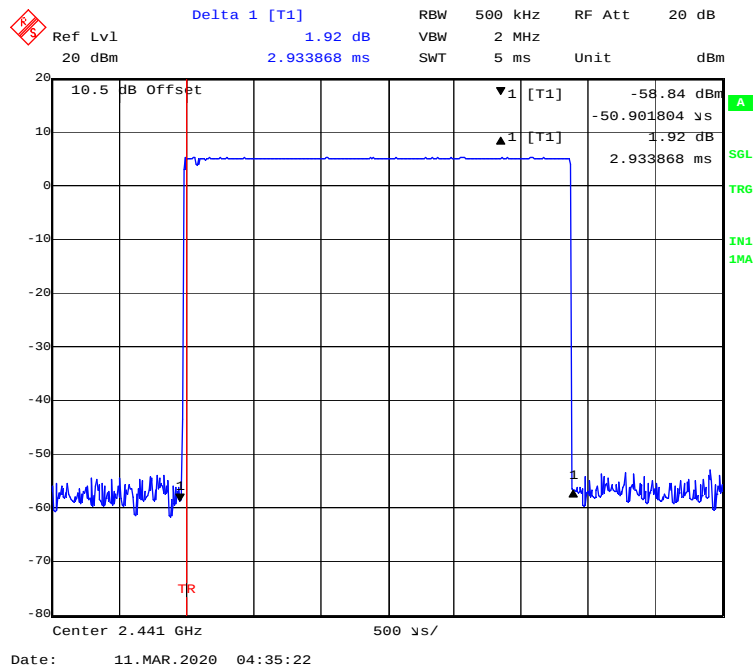
BDR (GFSK): Pulse time, High Channel, DH3

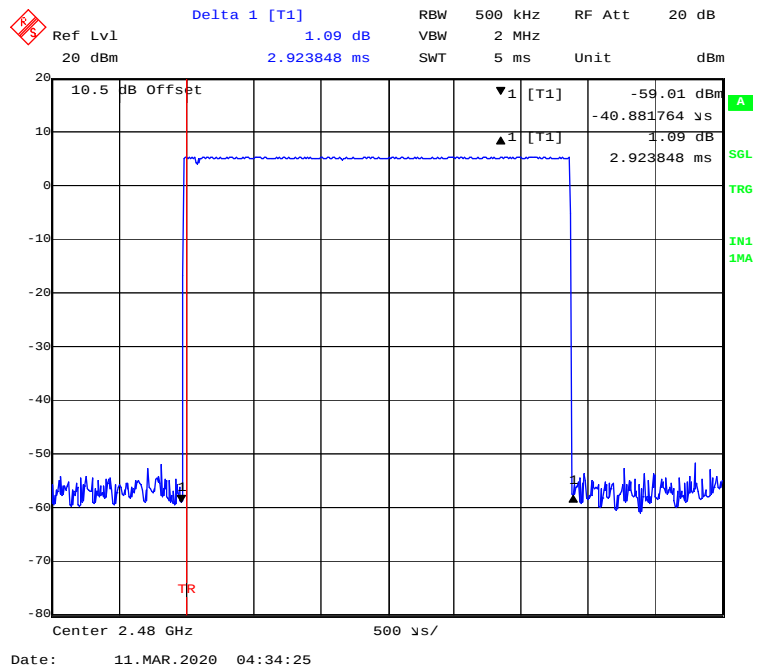
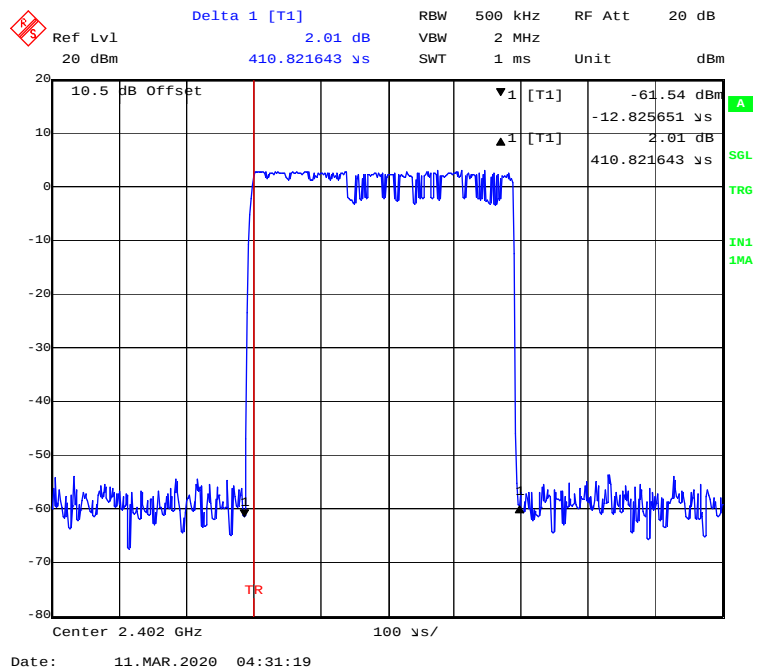


BDR (GFSK): Pulse time, Low Channel, DH5

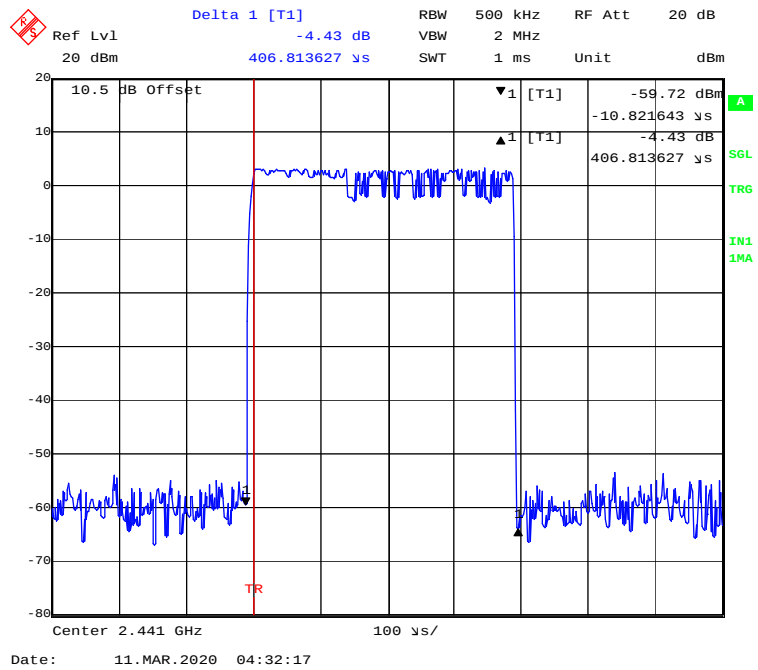


BDR (GFSK): Pulse time, Middle Channel, DH5

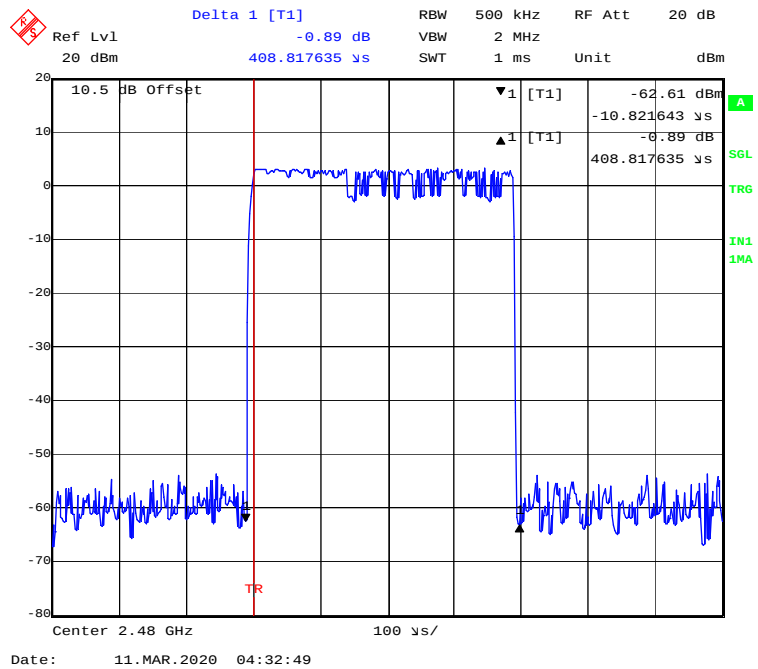


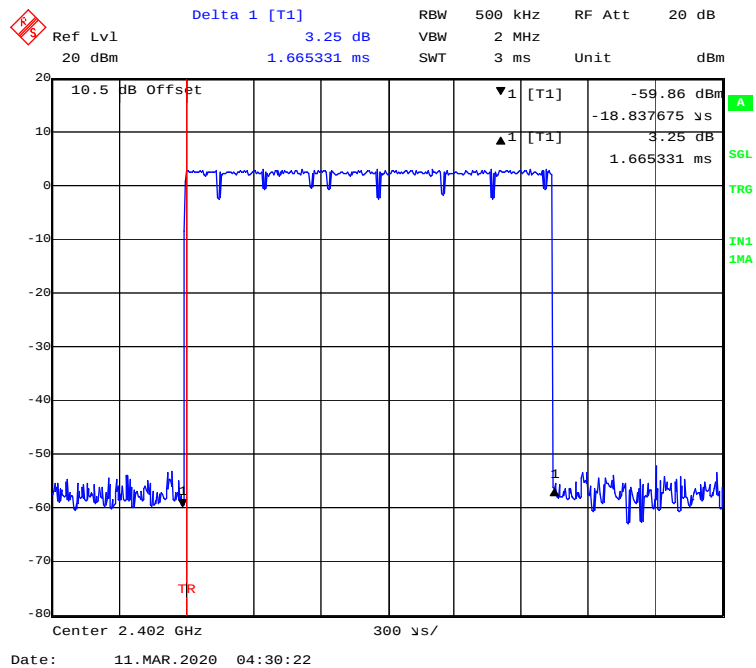
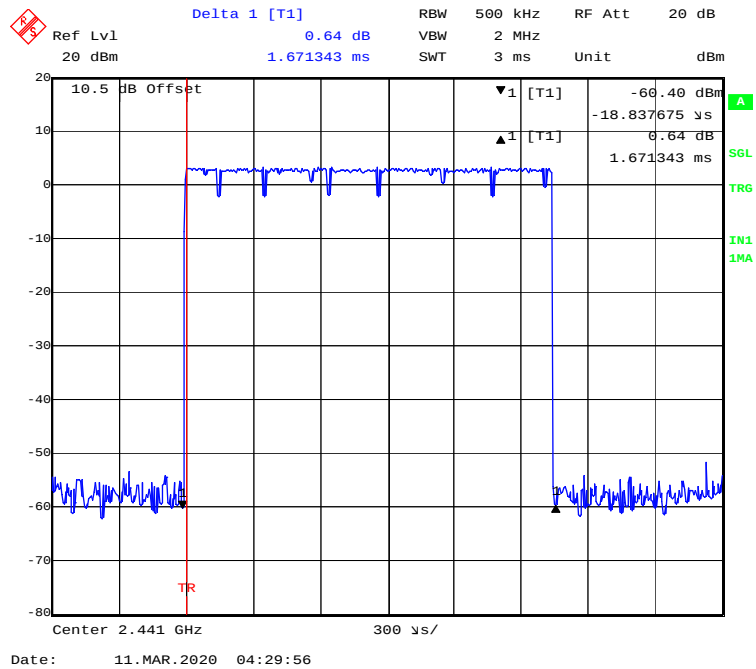
BDR (GFSK): Pulse time, High Channel, DH5**EDR ($\pi/4$ -DQPSK): Pulse time, Low Channel, 2DH1**

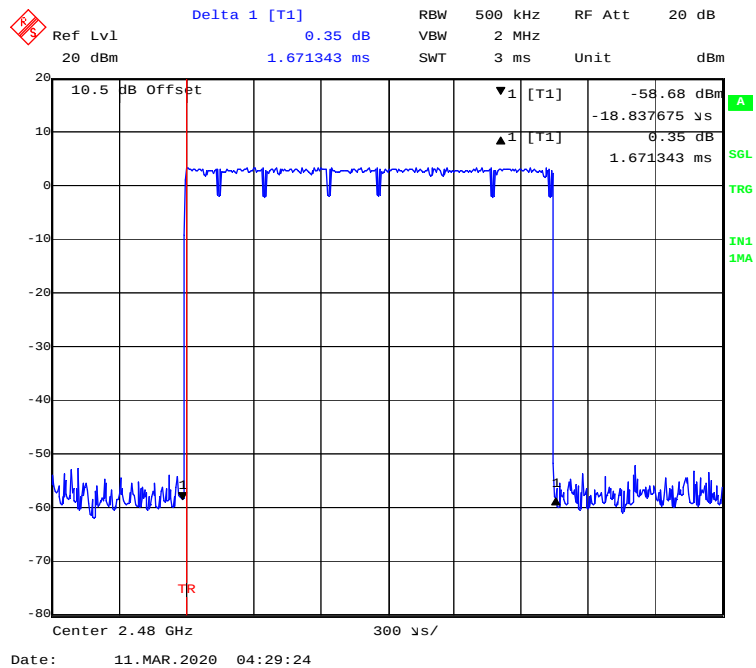
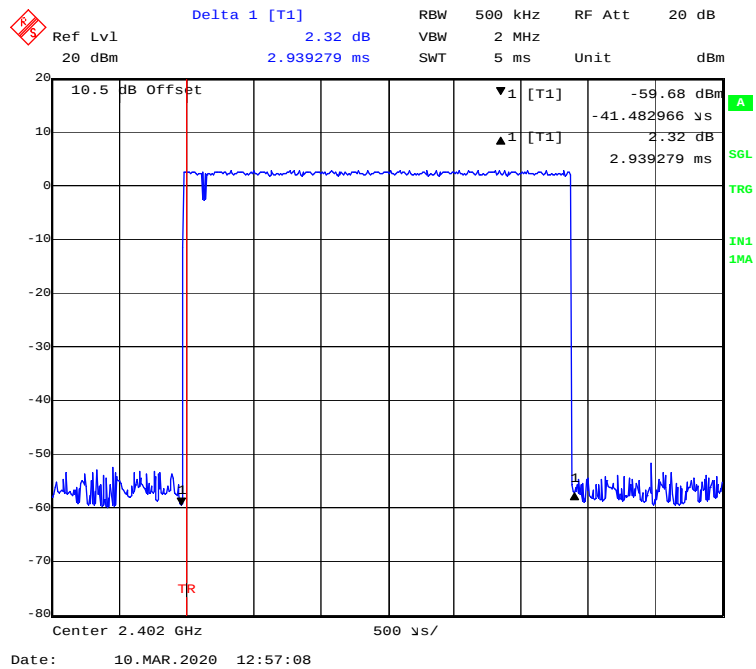
EDR ($\pi/4$ -DQPSK):Pulse time, Middle Channel, 2DH1



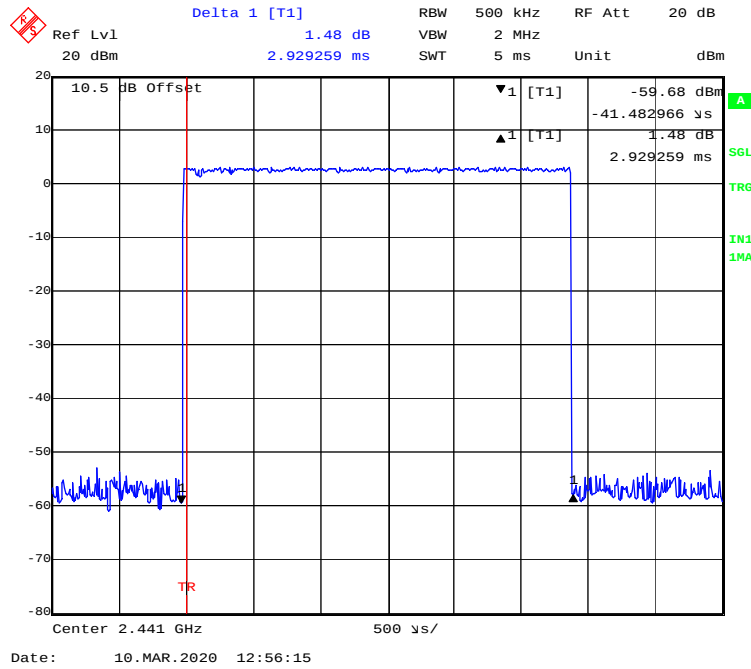
EDR ($\pi/4$ -DQPSK):Pulse time, High Channel, 2DH1



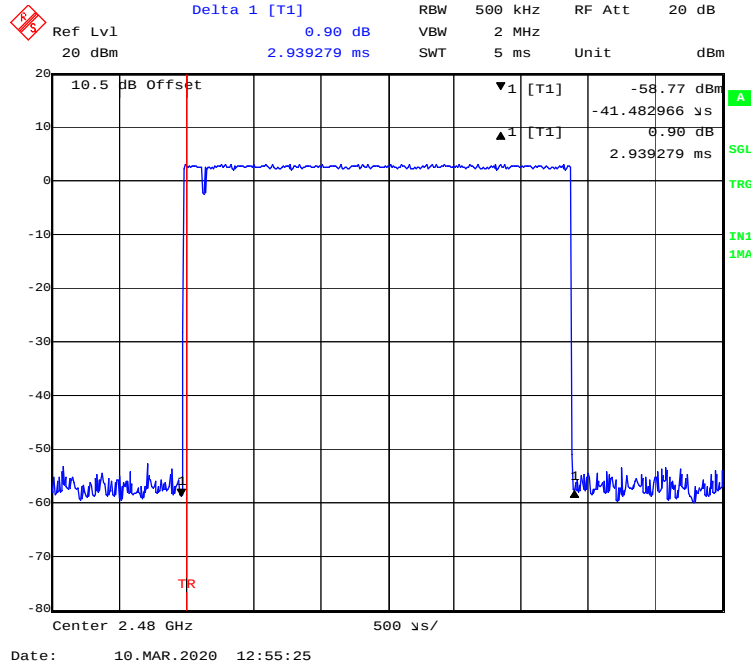
EDR ($\pi/4$ -DQPSK):Pulse time, Low Channel, 2DH3EDR ($\pi/4$ -DQPSK):Pulse time, Middle Channel, 2DH3

EDR ($\pi/4$ -DQPSK):Pulse time, High Channel, 2DH3**EDR ($\pi/4$ -DQPSK):Pulse time, Low Channel, 2DH5**

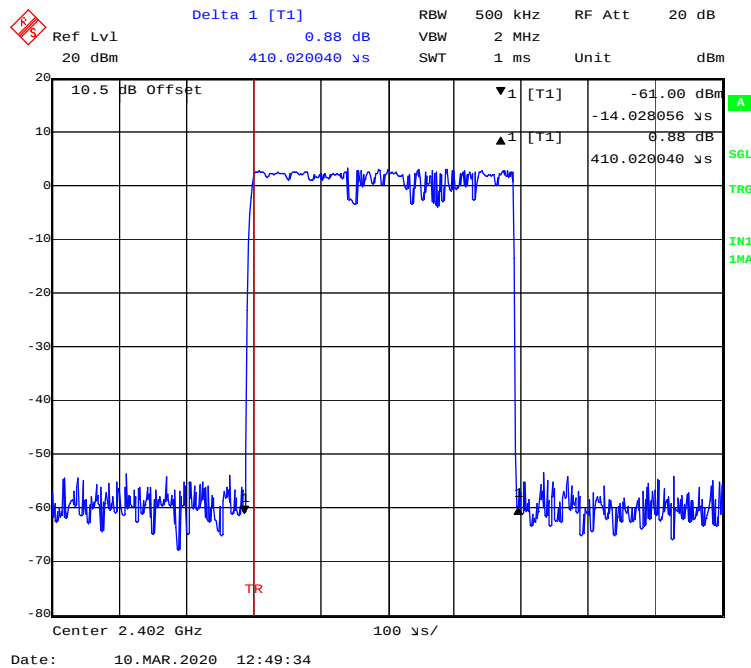
EDR ($\pi/4$ -DQPSK):Pulse time, Middle Channel, 2DH5



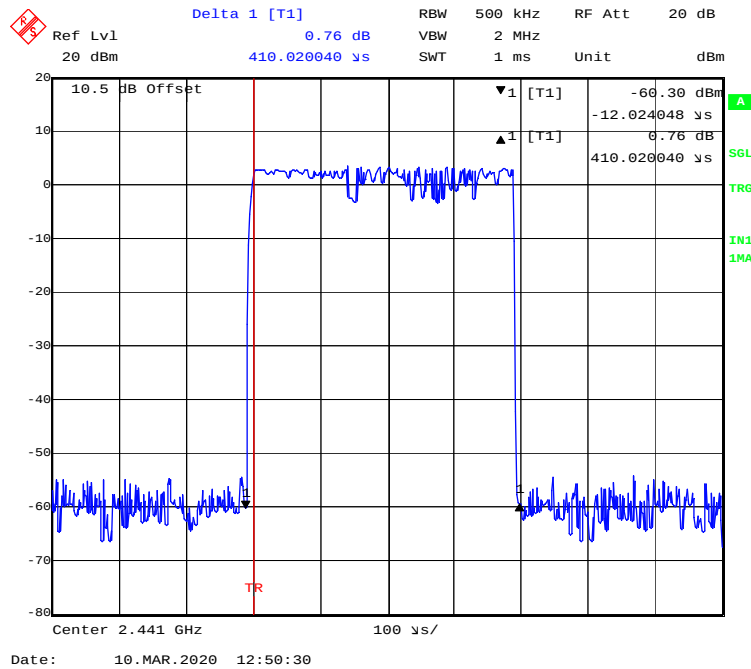
EDR ($\pi/4$ -DQPSK):Pulse time, High Channel, 2DH5

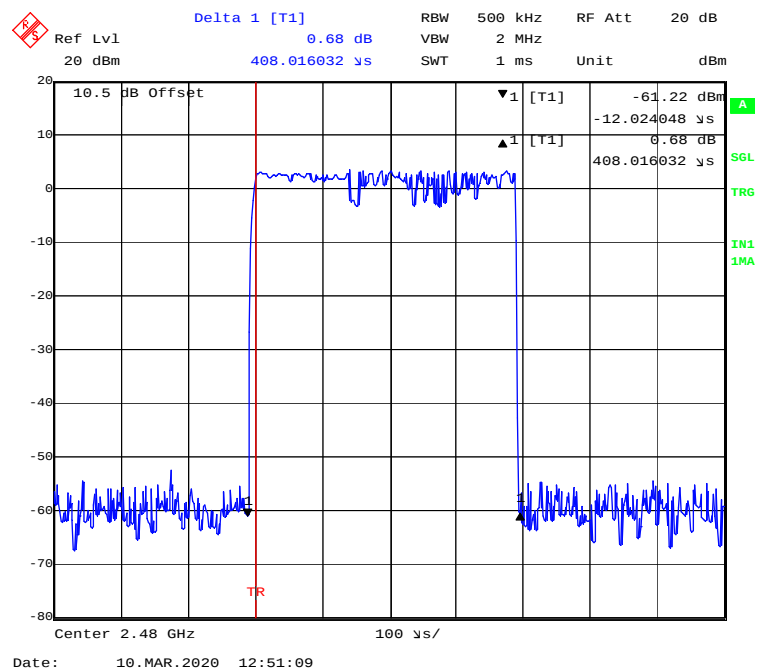
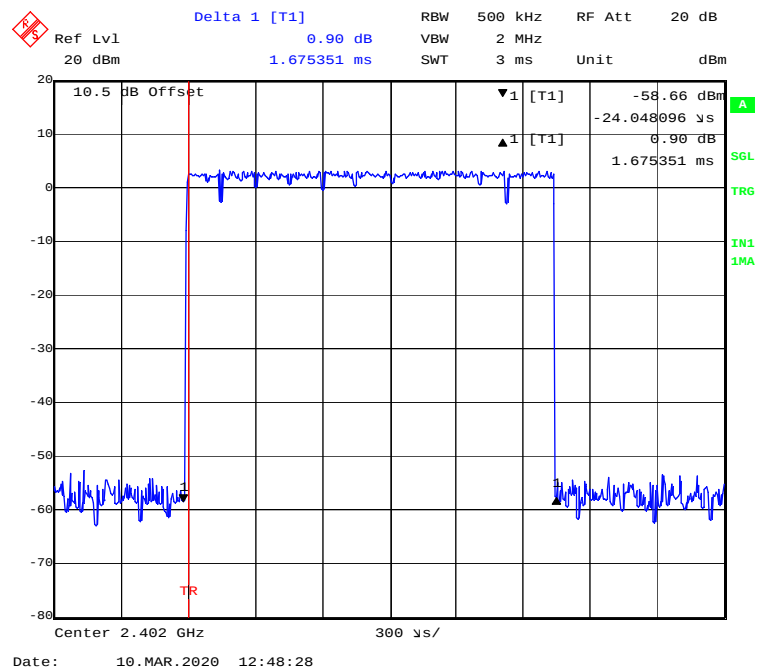


EDR (8DPSK): Pulse time, Low Channel, 3DH1

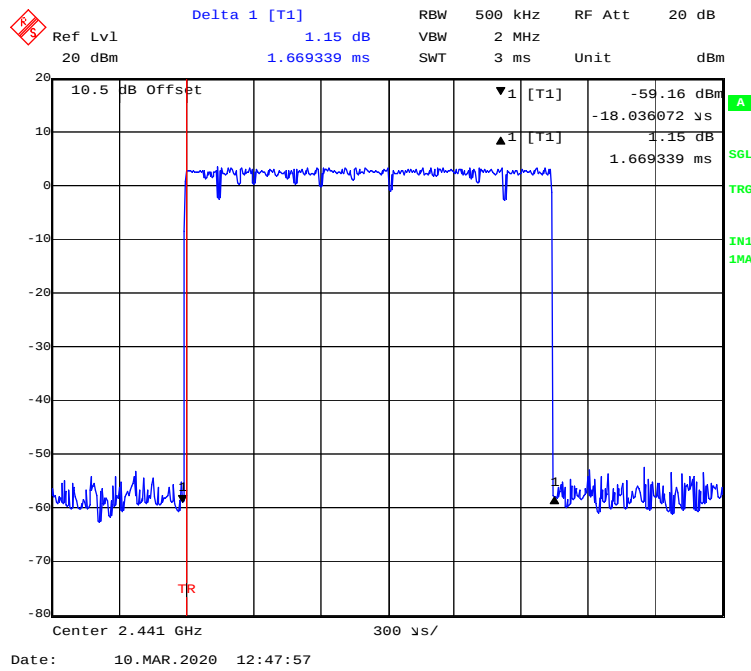


EDR (8DPSK): Pulse time, Middle Channel, 3DH1

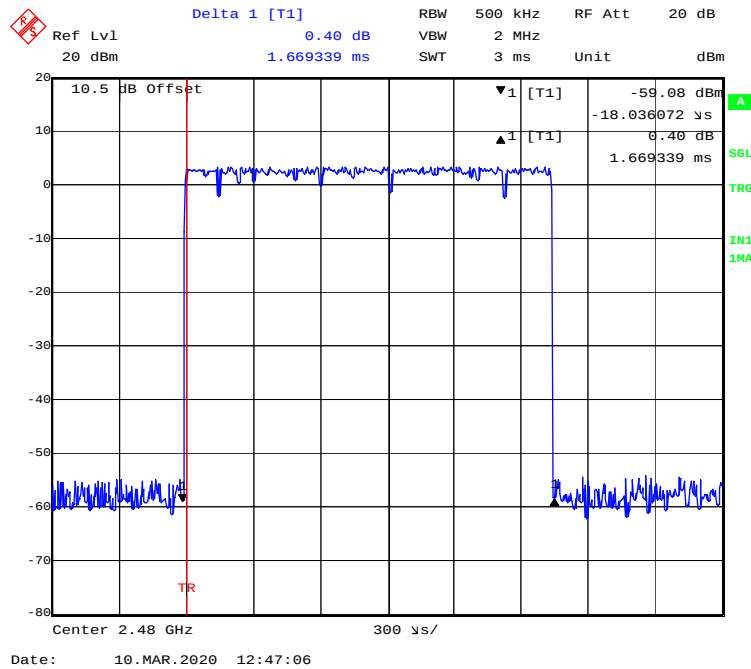


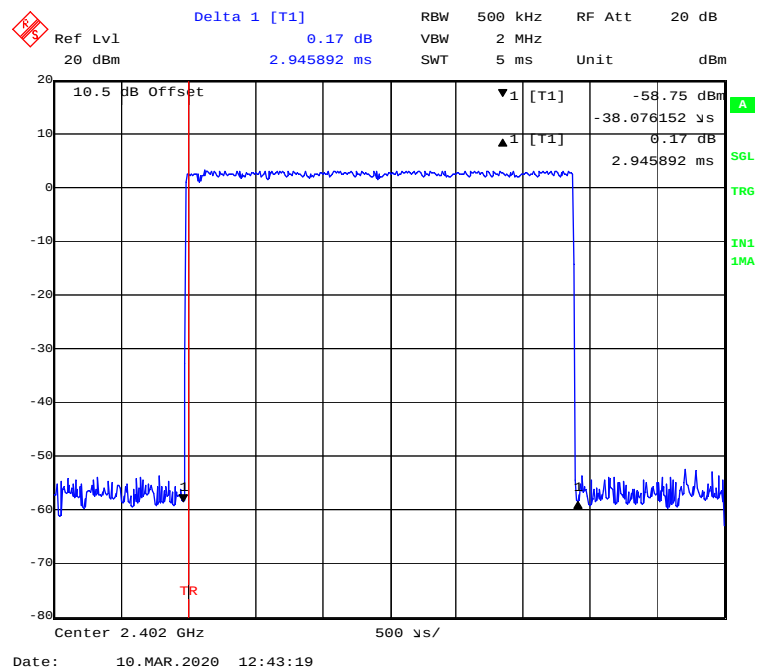
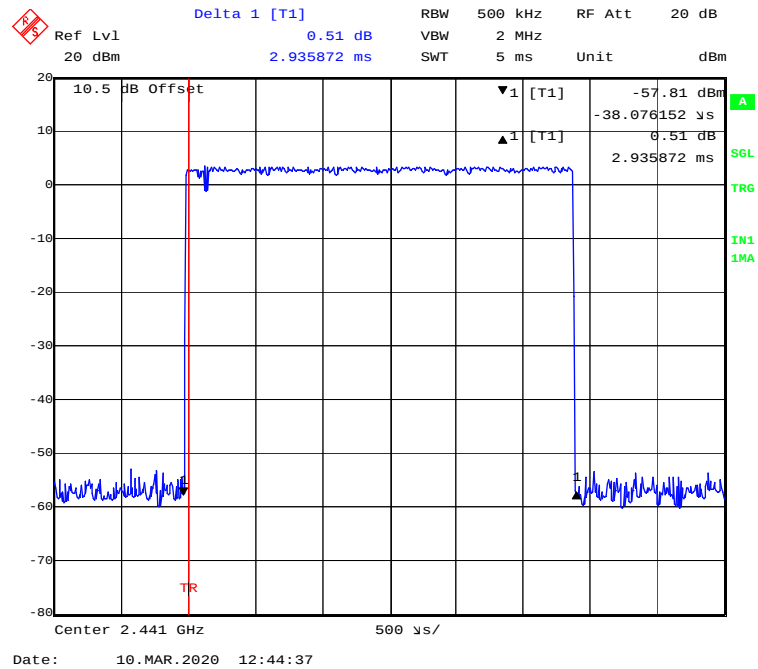
EDR (8DPSK): Pulse time, High Channel, 3DH1**EDR (8DPSK): Pulse time, Low Channel, 3DH3**

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

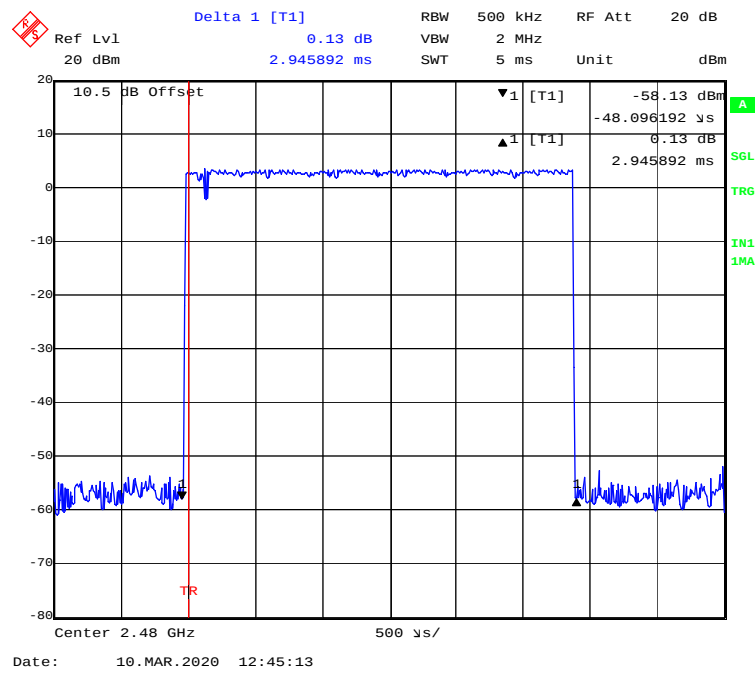


EDR (8DPSK): Pulse time, High Channel, 3DH3



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

EDR (8DPSK): 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

- a. Use the following spectrum analyzer settings:
 - 1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
 - 2) RBW > 20 dB bandwidth of the emission being measured.
 - 3) VBW $\geq$ RBW.
 - 4) Sweep: Auto.
 - 5) Detector function: Peak.
 - 6) Trace: Max hold.
- b. Allow trace to stabilize.
- c. Use the marker-to-peak function to set the marker to the peak of the emission.
- d. The indicated level is the peak output power, after any corrections for external attenuators and cables.
- e. A plot of the test results and setup description shall be included in the test report.

Test Data

Environmental Conditions

Temperature:	23.3 °C
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

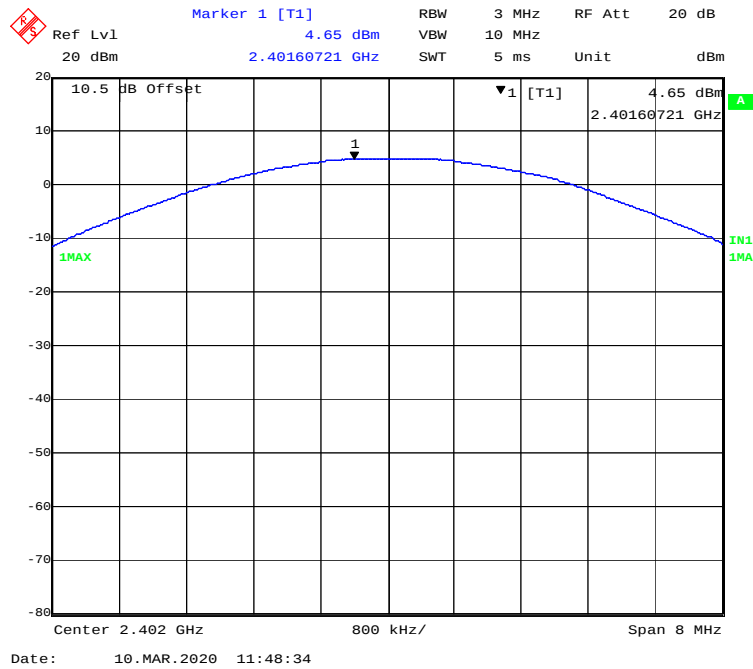
The testing was performed by Lee Li on 2020-03-10.

EUT operation mode: Transmitting

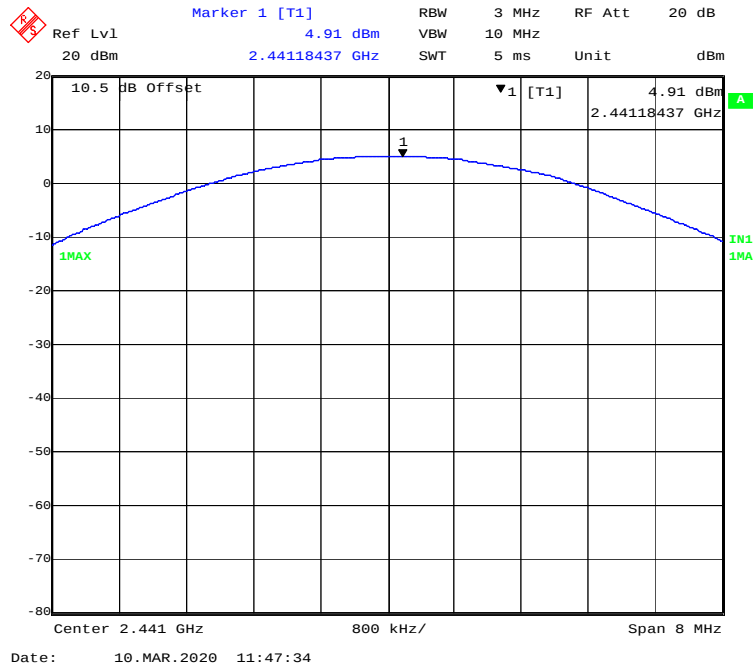
Test Result: Compliant.

Mode	Frequency (MHz)	Output Power		Limit (mW)
		(dBm)	(mW)	
BDR (GFSK)	2402	4.65	2.92	1000
	2441	4.91	3.10	1000
	2480	4.78	3.01	1000
EDR ($\pi/4$-DQPSK)	2402	4.91	3.10	125
	2441	4.91	3.10	125
	2480	4.91	3.10	125
EDR (8DPSK)	2402	5.52	3.56	125
	2441	5.52	3.56	125
	2480	5.52	3.56	125

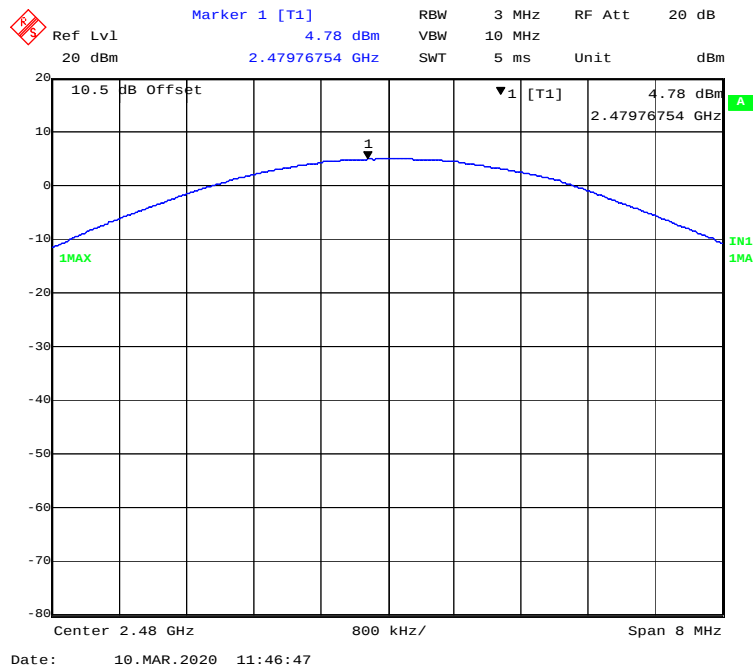
BDR (GFSK): 2402MHz



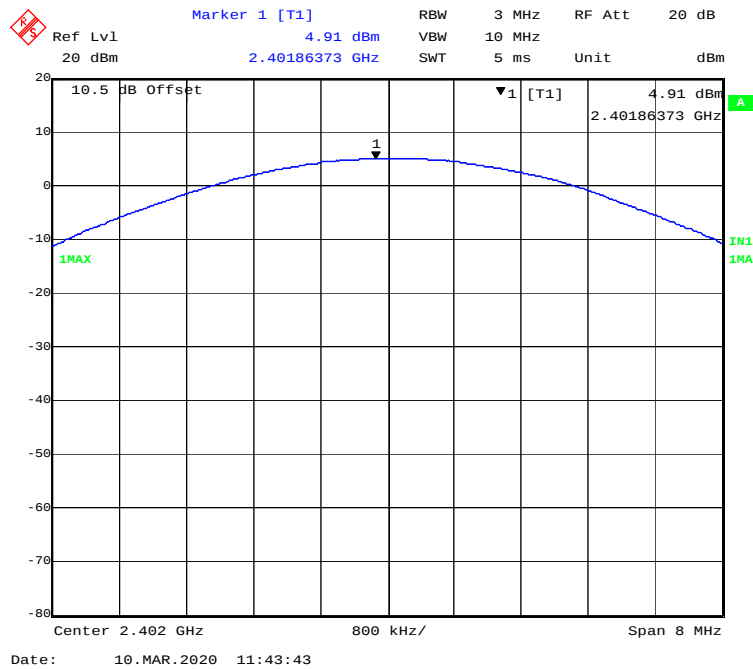
BDR (GFSK): 2441MHz



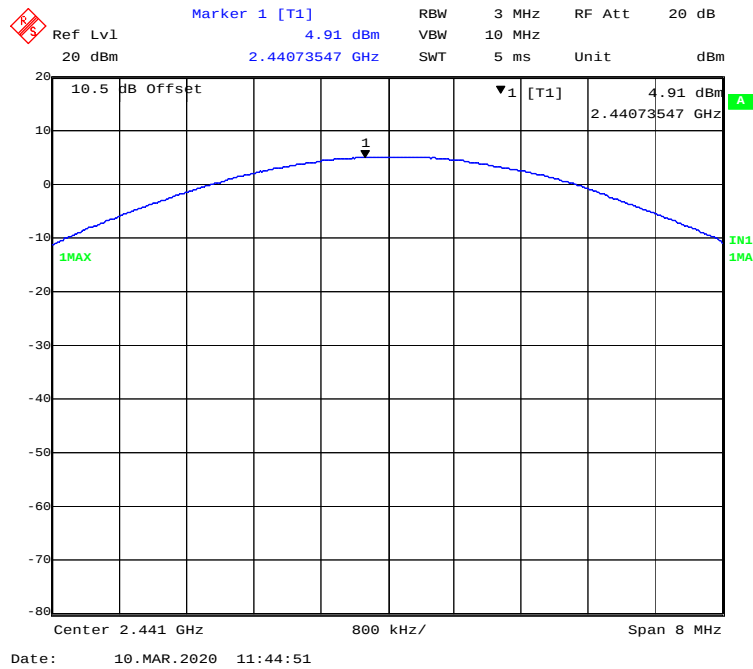
BDR (GFSK): 2480MHz



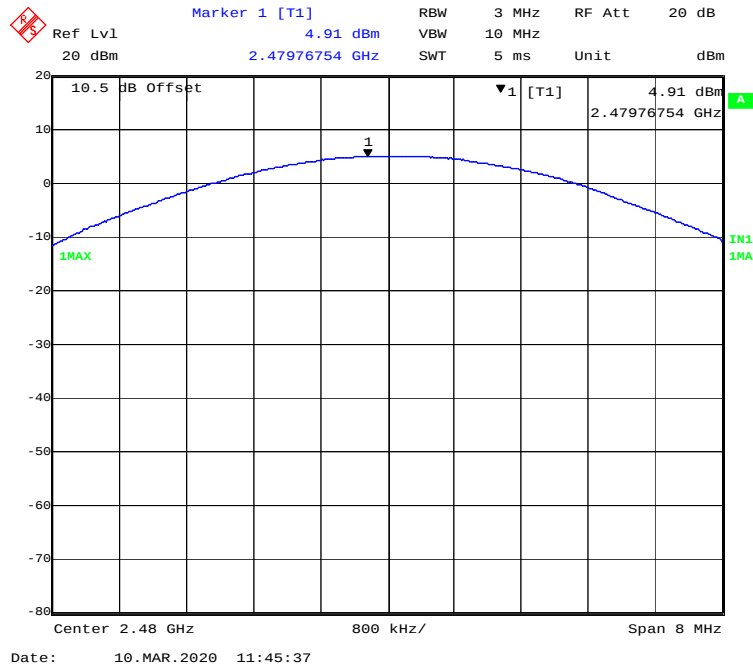
EDR($\pi/4$ -DQPSK): 2402MHz



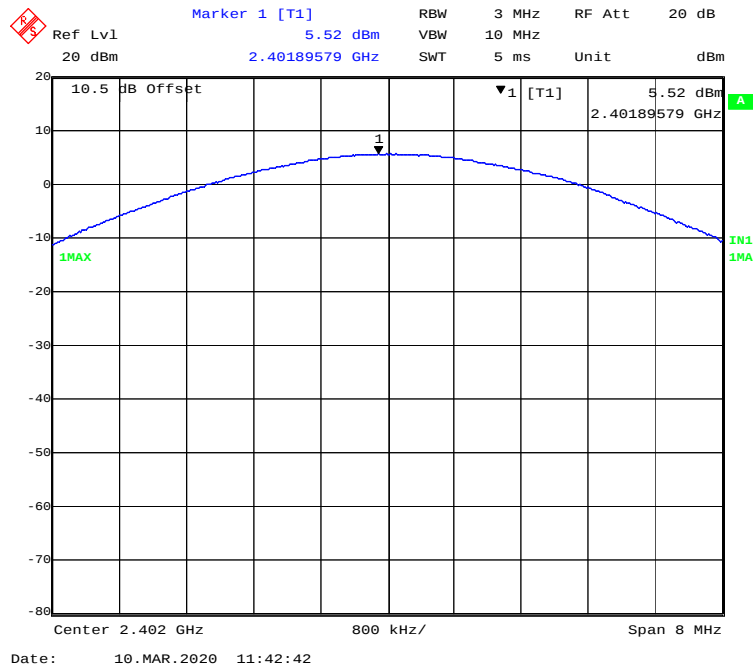
EDR($\pi/4$ -DQPSK): 2441MHz



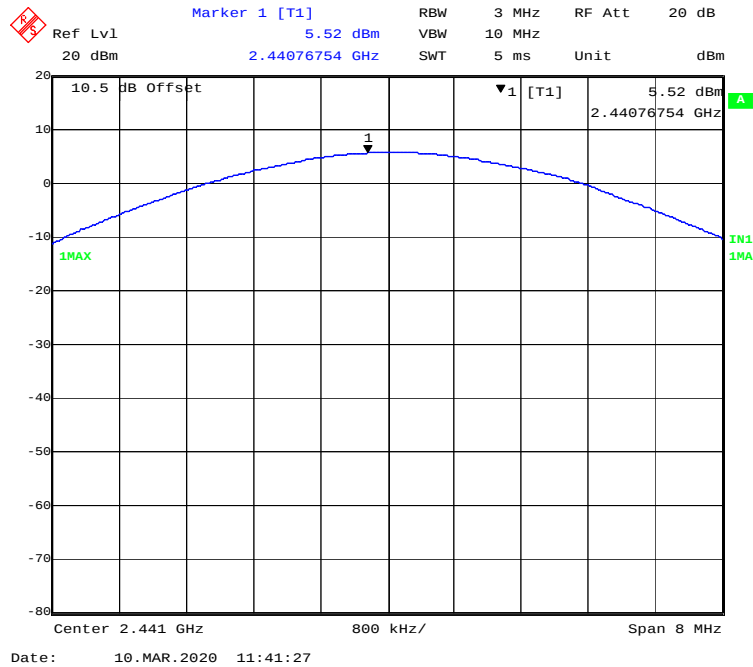
EDR($\pi/4$ -DQPSK): 2480MHz



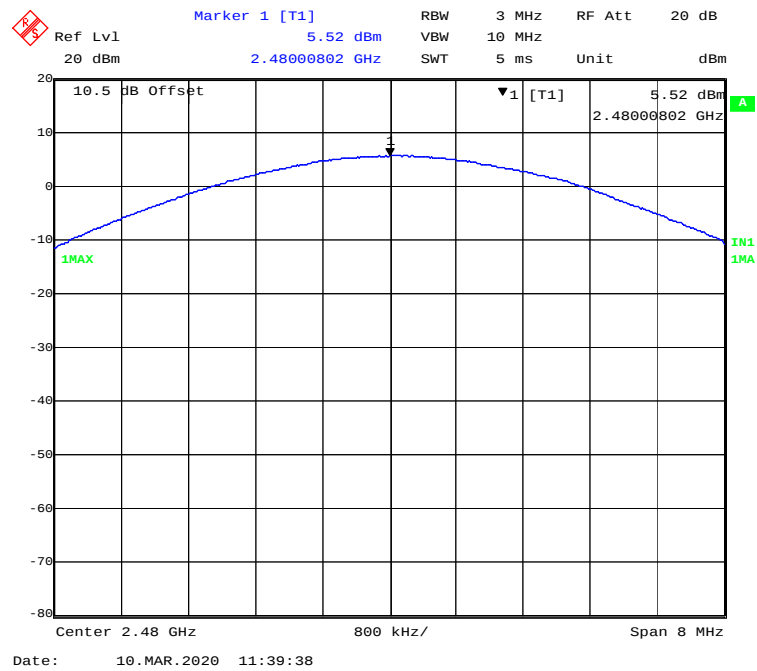
EDR(8DPSK): 2402MHz



EDR(8DPSK): 2441MHz



EDR(8DPSK): 2480MHz



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 °C
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

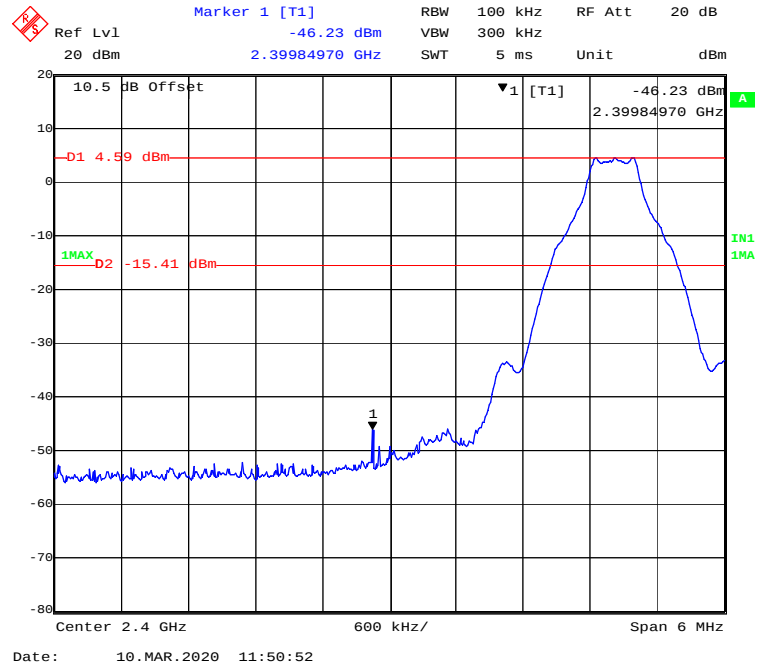
The testing was performed by Lee Li on 2020-03-10

EUT operation mode: Transmitting & Hopping

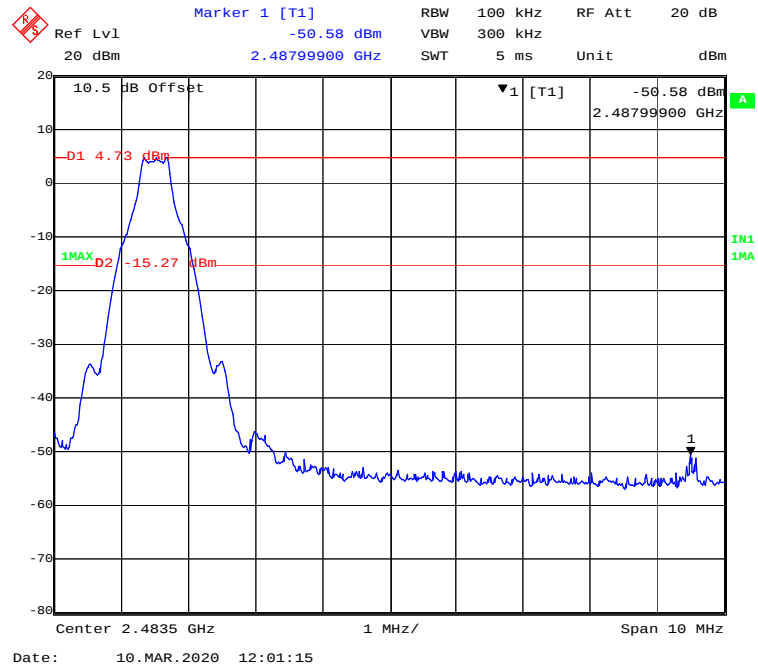
Test Result: Compliant.

Band Edge

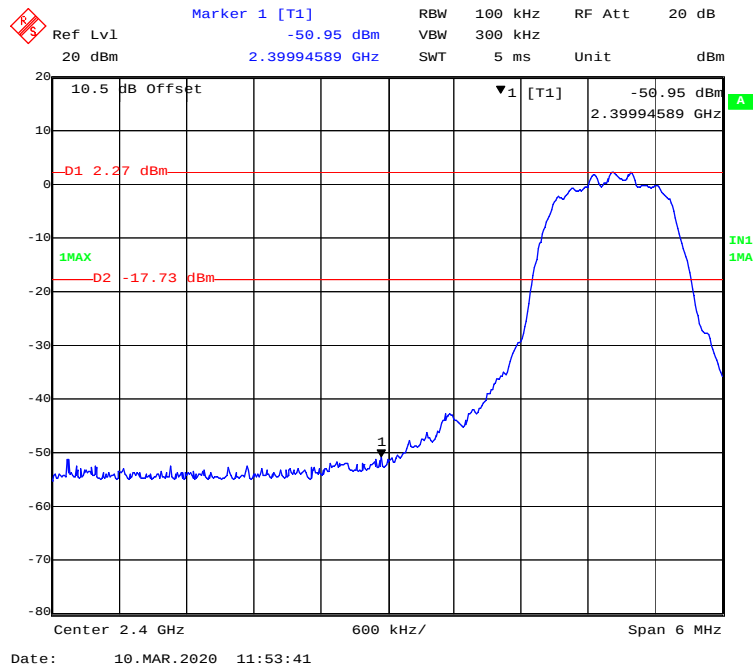
BDR (GFSK): Left Side - Transmitting



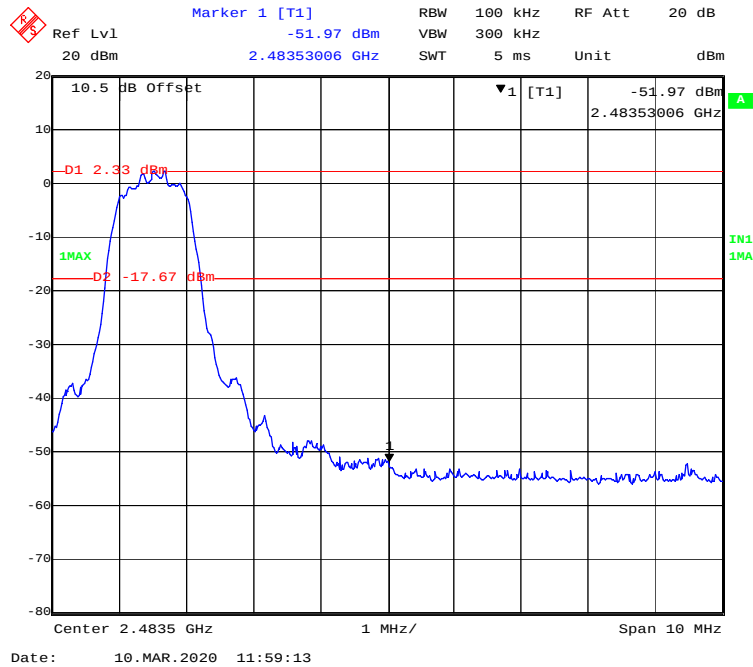
BDR (GFSK): Right Side - Transmitting



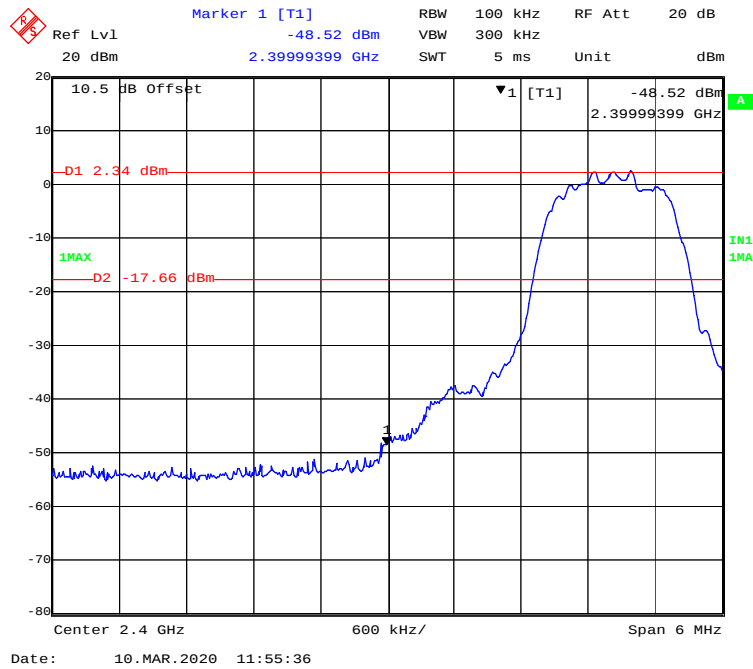
EDR ($\pi/4$ -DQPSK): Left Side - Transmitting



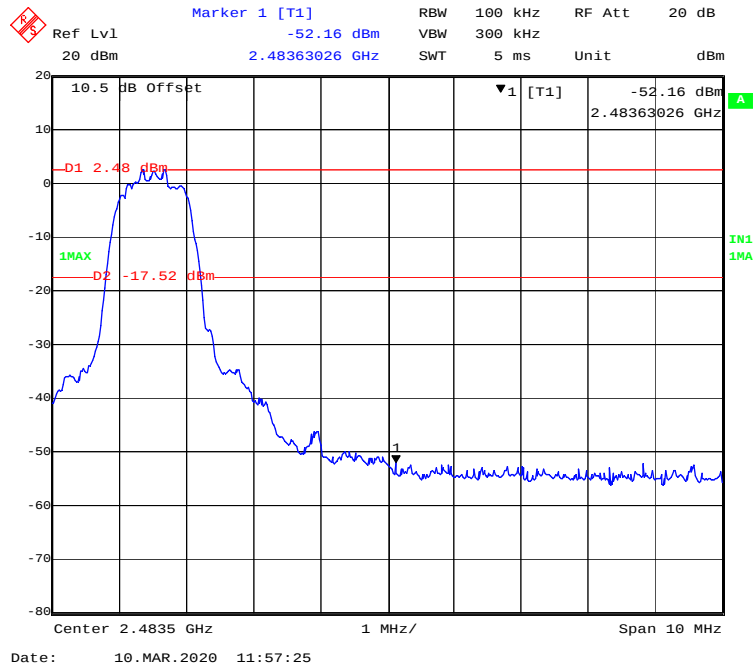
EDR ($\pi/4$ -DQPSK): Right Side - Transmitting



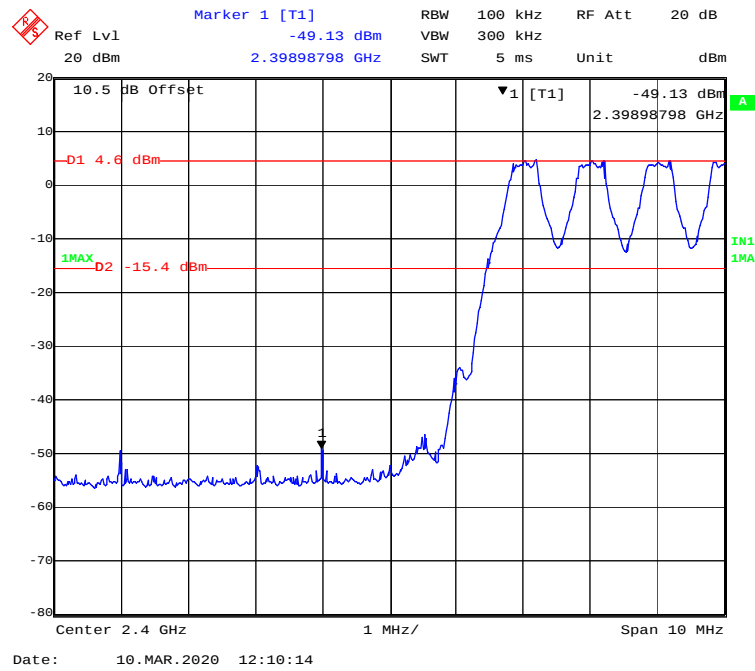
EDR (8DPSK): Left Side - Transmitting



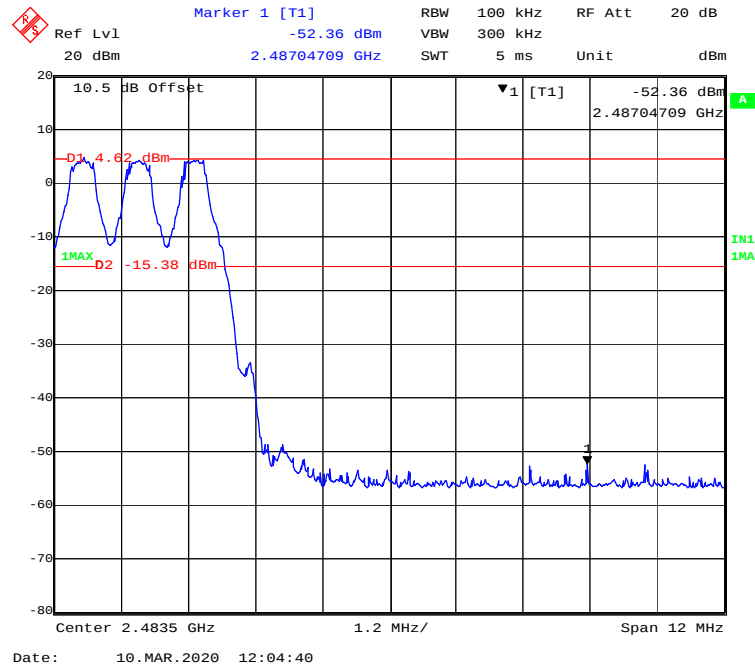
EDR (8DPSK): Right Side - Transmitting

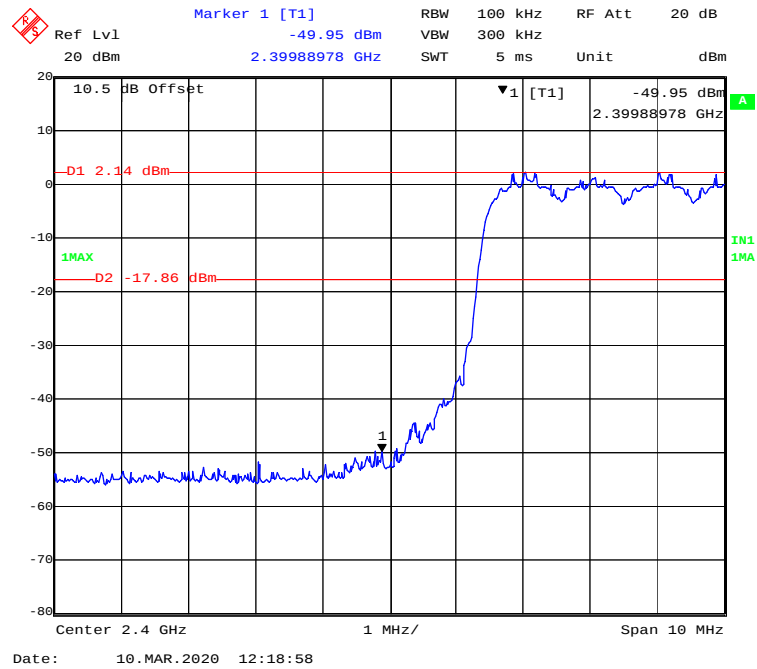
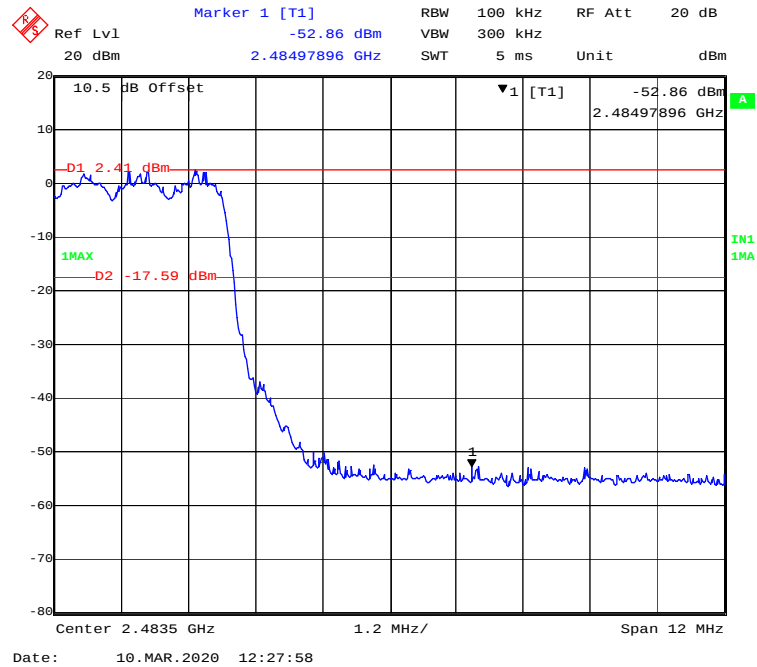


BDR (GFSK): Left Side - Hopping

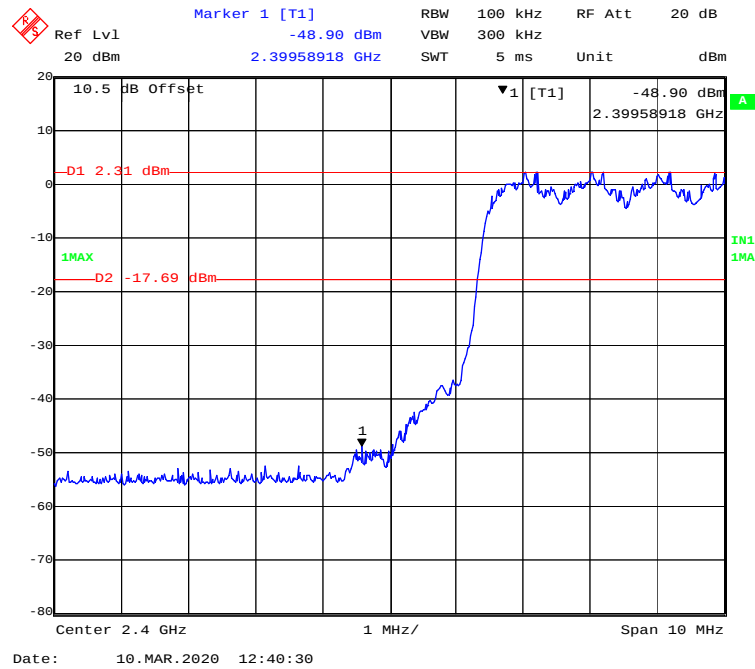


BDR (GFSK): Right Side- Hopping

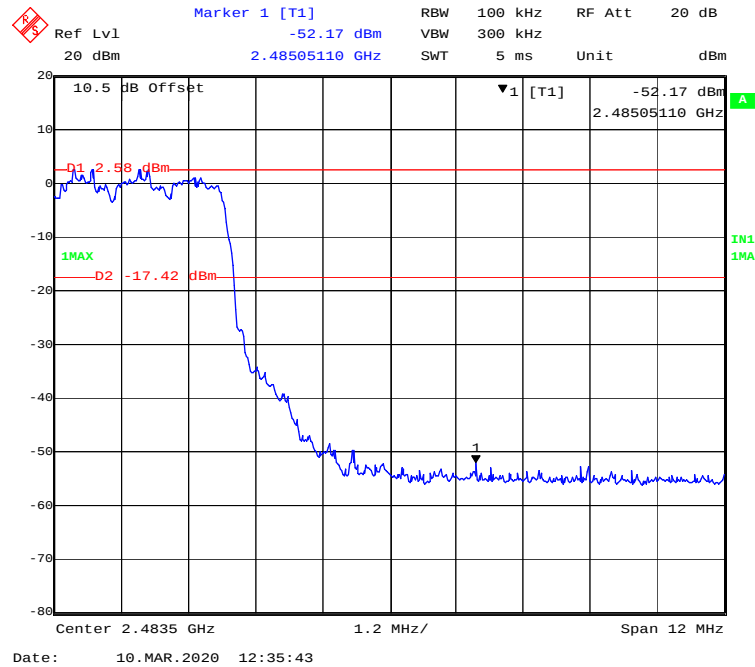


EDR ($\pi/4$ -DQPSK): Left Side- Hopping**EDR ($\pi/4$ -DQPSK): Right Side- Hopping**

EDR (8DPSK): Left Side- Hopping



EDR (8DPSK): Right Side- Hopping



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