ACCREDITED
TESTING LABORATORY
CERTIFICATE # 4821.01

BACL
Bay Area Compliance Labs Corp.

FCC PART 15.247
TEST REPORT

For

Thundercomm Technology Co., Ltd

4F, Taixiang Building, 1A Longxiang Rd, Haidian Dist, Beijing, China

FCC ID: 2AOHHTURBOXSOMD845

Report Type:	**Product Type:**
Original Report	Thundersoft TurboX D845 SOM

Report Number: RSZ181105003-00B

Report Date: 2019-01-17

Reviewed By: Rocky Kang
RF Engineer

Prepared By: Bay Area Compliance Laboratories Corp. (Shenzhen)
6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China
Tel: +86-755-33320018
Fax: +86-755-33320008
www.baclcorp.com.cn

Note: This report must not be used by the customer to claim product certification, approval, or endorsement by A2LA* or any agency of the Federal Government. * This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*".

TABLE OF CONTENTS

GENERAL INFORMATION **4**
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) 4
OBJECTIVE 4
RELATED SUBMITTAL(S)/GRANT(S) 4
TEST METHODOLOGY 4
MEASUREMENT UNCERTAINTY 4
TEST FACILITY 5
SYSTEM TEST CONFIGURATION **6**
DESCRIPTION OF TEST CONFIGURATION 6
EUT EXERCISE SOFTWARE 6
SPECIAL ACCESSORIES 6
EQUIPMENT MODIFICATIONS 6
SUPPORT EQUIPMENT LIST AND DETAILS 6
EXTERNAL I/O CABLE 6
BLOCK DIAGRAM OF TEST SETUP 7
SUMMARY OF TEST RESULTS **8**
TEST EQUIPMENT LIST **9**
FCC §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE) **11**
APPLICABLE STANDARD 11
RESULT 11
FCC §15.203 – ANTENNA REQUIREMENT **12**
APPLICABLE STANDARD 12
ANTENNA CONNECTOR CONSTRUCTION 12
FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS **13**
APPLICABLE STANDARD 13
EUT SETUP 13
EMI TEST RECEIVER SETUP 13
TEST PROCEDURE 13
CORRECTED FACTOR & MARGIN CALCULATION 14
TEST RESULTS SUMMARY 14
TEST DATA 14
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS **17**
APPLICABLE STANDARD 17
EUT SETUP 17
EMI TEST RECEIVER & SPECTRUM ANALYZER 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 **26**
APPLICABLE STANDARD 26
TEST PROCEDURE 26
TEST DATA 26

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH 33
APPLICABLE STANDARD 33
TEST PROCEDURE 33
TEST DATA 33
FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST 39
APPLICABLE STANDARD 39
TEST PROCEDURE 39
TEST DATA 39
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME) 42
APPLICABLE STANDARD 42
TEST PROCEDURE 42
TEST DATA 42
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT 58
APPLICABLE STANDARD 58
TEST PROCEDURE 58
TEST DATA 58
FCC §15.247(d) - BAND EDGES TESTING 59
APPLICABLE STANDARD 59
TEST PROCEDURE 59
TEST DATA 59

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

The *Thundercomm Technology Co., Ltd's* product, model number: TurboX-D845-SOM (FC*C ID: 2AOHHTURBOXSOMD845)* or the "EUT" in this report was a *Thundersoft TurboX D845 SOM,* which was measured approximately: 60.0 mm (L) *37.0 mm (W), rated with input voltage: DC 3.8 V.

**All measurement and test data in this report was gathered from production sample serial number: 181105003(Assigned by BACL, shenzhen).The EUT supplied by the applicant was received on 2018-11-05*

Objective

This test report is prepared on behalf of *Thundercomm 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)

Part 15.247 DTS and Part 15.407 NII submissions with FCC ID: 2AOHHTURBOXSOMD845.

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.

For Radiated Emissions testing, please refer to DA 00-705 Released March 30, 2000, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

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

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF Output Power with Power meter		±0.5dB
RF conducted test with spectrum		±1.5dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±3℃
Humidity		±6%
Supply voltages		±0.4%

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

"QRCT" software was made to the EUT tested, and the power level is 7.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

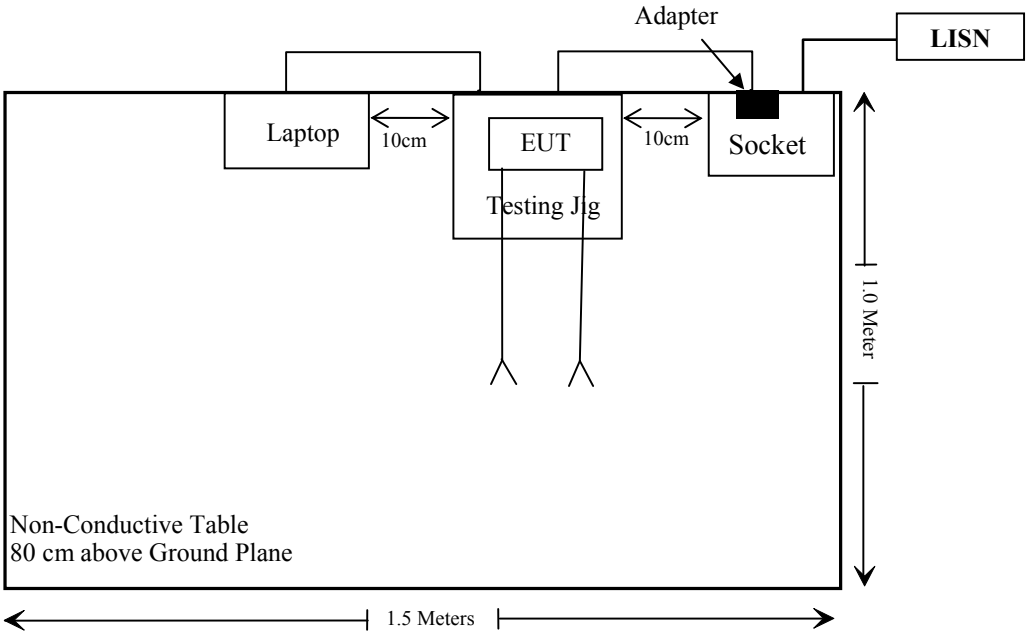
Manufacturer	Description	Model	Serial Number
Thundersoft	Testing Jig	N/A	N/A
STH	Adapter	P24120200	N/A
BULL	Socket	GN-415K	5503290068073
Compaq	Laptop	CQ45	CND9524JMW
N/A	Antenna 0	N/A	N/A
N/A	Antenna 1	N/A	N/A

External I/O Cable

Cable Description	Length (m)	From/Port	To
Unshielded un-detachable AC cable	1.2	Socket	LISN
Unshielded un-detachable DC cable	1.4	Adapter	Testing Jig
Unshielded detachable USB cable	1.4	Testing Jig	Laptop

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §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
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	100176	2018-07-11	2019-07-11
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2018-12-21	2019-12-21
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2018-11-12	2019-11-12
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Un-known	Conducted Emission Cable	78652	UF A210B-1-0720-504504	2018-11-12	2019-11-12
Radiated Emission Test					
A.H. System	Horn Antenna	SAS-200/571	135	2018-09-01	2021-08-31
Rohde & Schwarz	Signal Analyzer	FSEM	845987/005	2018-06-23	2019-06-23
COM-POWER	Pre-amplifier	PA-122	181919	2018-11-12	2019-11-12
Sonoma instrument	Amplifier	310N	186238	2018-11-12	2019-11-12
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017-12-22	2020-12-21
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2018-01-11	2019-01-11
Ducommun technologies	RF Cable	UFA147A-2362-100100	MFR64639 231029-003	2018-07-11	2021-07-10
Ducommun technologies	RF Cable	104PEA	218124002	2018-11-12	2019-11-12
Ducommun technologies	RF Cable	RG-214	1	2018-11-19	2019-05-21
Ducommun technologies	RF Cable	RG-214	2	2018-11-12	2019-11-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-04	2017-12-29	2020-12-28
Heatsink Required	Amplifier	QLW-18405536-J0	15964001002	2018-11-12	2019-11-12
Sinoscite	Band Reject Filter	BSF2402-2480MN-0898-001	99632	2018-11-12	2019-11-12
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Agilent	USB wideband power meter	U2021XA	MY54250003	2018-06-23	2019-06-23
WEINSCHEL	10dB Attenuator	5324	AU 3842	Each Time	
Rohde & Schwarz	Spectrum Analyzer	FSU26	200120	2017-12-24	2018-12-24
Ducommun technologies	RF Cable	RG-214	3	Each Time	

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) 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) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

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

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm2)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
	(dBi)	(numeric)	(dBm)	(mW)			
2402-2480	4	2.51	2	1.58	20	0.001	1

Note: To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliance

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

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

Antenna Connector Construction

The EUT has one FPC antenna arrangement, which was permanently attached and the antenna gain is 4.0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

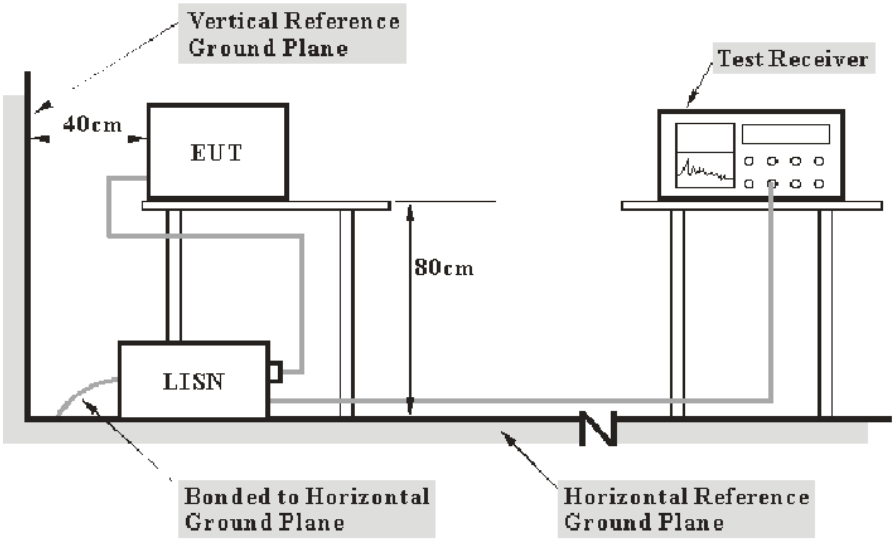
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



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

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

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

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

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

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

Test Procedure

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

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

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

Corrected Factor & Margin Calculation

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

Correction Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

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

Margin = Limit – Corrected Amplitude

Test Results Summary

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

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

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

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

Test Data

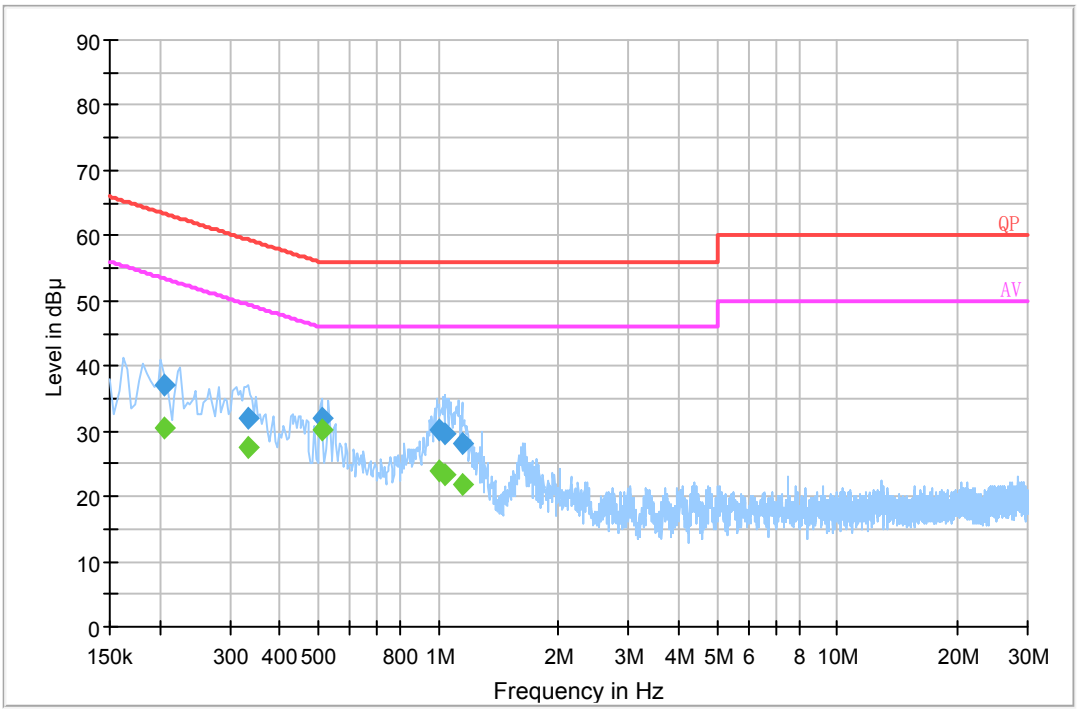
Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2019-01-09.

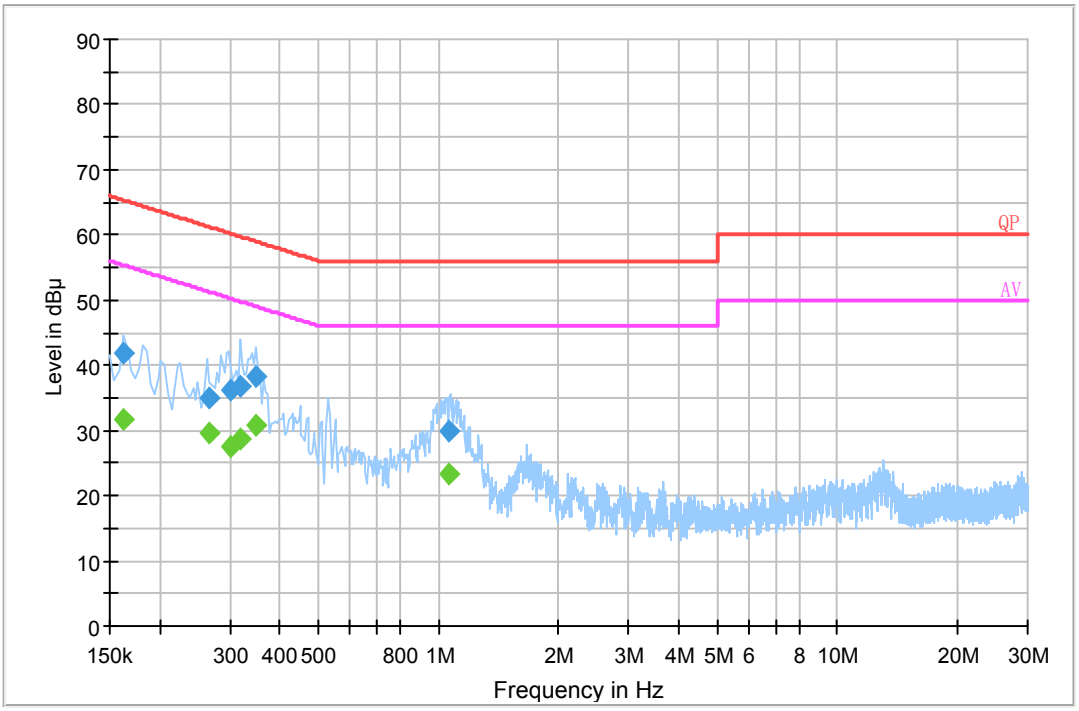
EUT operation mode: Transmitting (the worst case is GFSK Mode, High channel)

AC 120V/60 Hz, Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.206500	37.1	19.7	63.3	26.2	QP
0.332990	31.9	19.7	59.4	27.5	QP
0.510350	32.1	19.8	56.0	23.9	QP
0.999090	30.1	19.8	56.0	25.9	QP
1.042430	29.7	19.8	56.0	26.3	QP
1.152810	28.2	19.8	56.0	27.8	QP
0.206500	30.4	19.7	53.3	22.9	Ave.
0.332990	27.4	19.7	49.4	22.0	Ave.
0.510350	30.3	19.8	46.0	15.7	Ave.
0.999090	24.0	19.8	46.0	22.0	Ave.
1.042430	23.2	19.8	46.0	22.8	Ave.
1.152810	21.9	19.8	46.0	24.1	Ave.

AC 120V/60 Hz, Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.161500	41.8	19.7	65.4	23.6	QP
0.265500	35.1	19.7	61.3	26.2	QP
0.302500	36.1	19.8	60.2	24.1	QP
0.317230	36.8	19.8	59.8	23.0	QP
0.348690	38.2	19.7	59.0	20.8	QP
1.057950	29.9	19.8	56.0	26.1	QP
0.161500	31.8	19.7	55.4	23.6	Ave.
0.265500	29.5	19.7	51.3	21.8	Ave.
0.302500	27.5	19.8	50.2	22.7	Ave.
0.317230	28.7	19.8	49.8	21.1	Ave.
0.348690	30.9	19.7	49.0	18.1	Ave.
1.057950	23.3	19.8	46.0	22.7	Ave.

Note:
1) Correction Factor =LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
2) Corrected Amplitude = Reading + Correction Factor
3) Margin = Limit – Corrected Amplitude

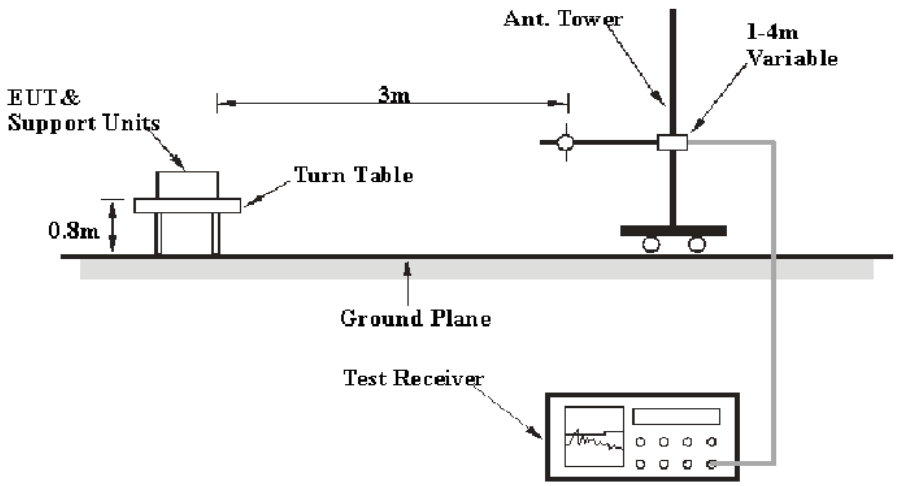
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

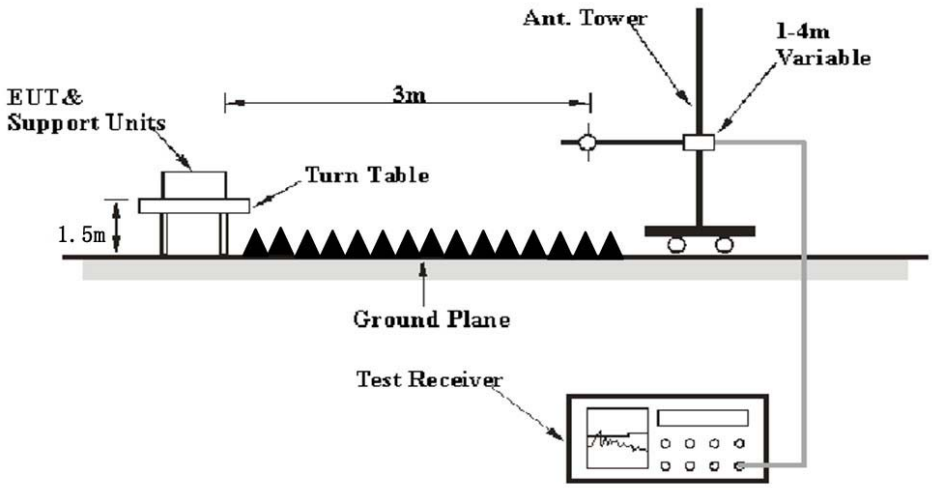
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



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

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, according to the DA 00-705 Released March 30, 2000, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Average

Test Procedure

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

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

Corrected Amplitude & Margin Calculation

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

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

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

Margin = Limit – Corrected Amplitude

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

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

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

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

Test Data

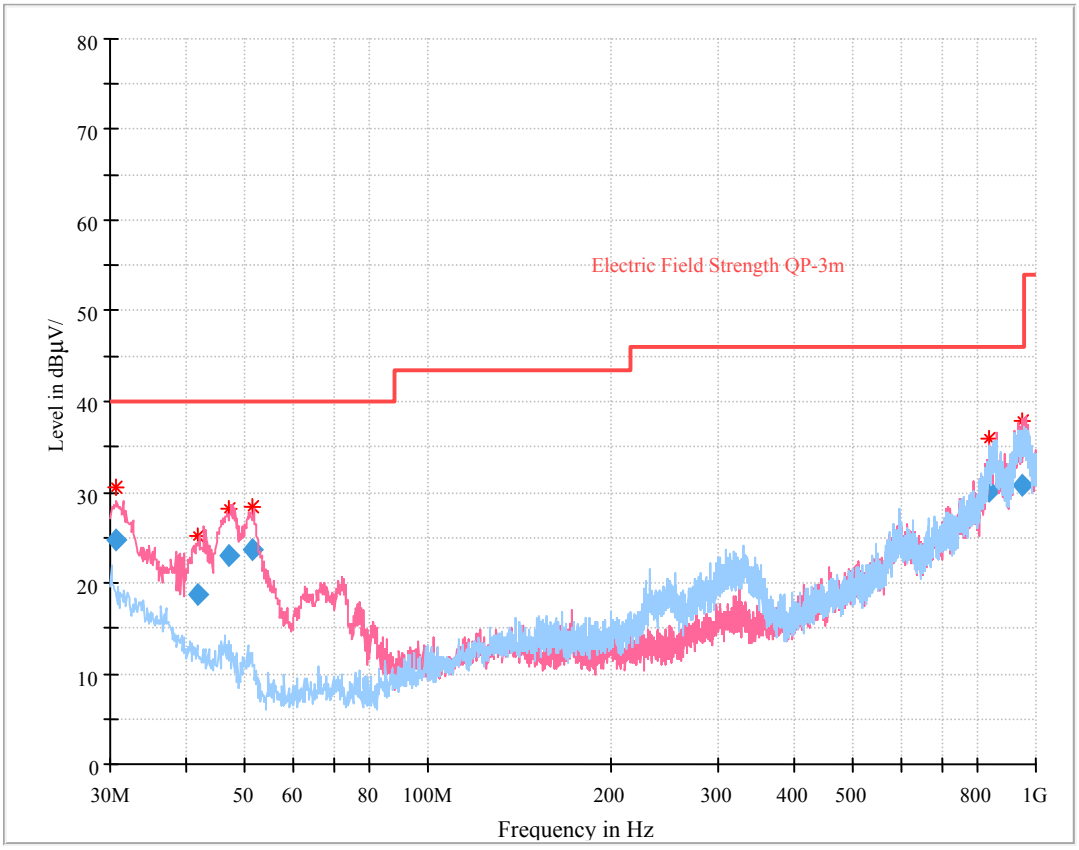
Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	54 %
ATM Pressure:	101.0 kPa

The testing was performed by Kiki Kong on 2018-12-06.

EUT operation mode: Transmitting (*Scan with GFSK, π/4-DQPSK, 8DPSK mode, the worst case is GFSK Mode*)

30 MHz~1 GHz: *(the worst case is GFSK Mode, High channel)*



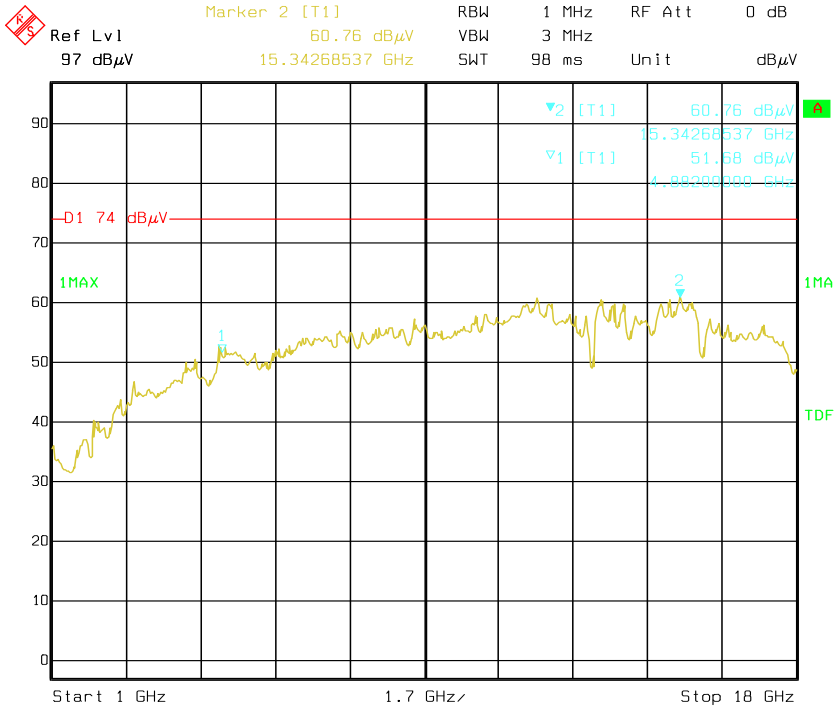
Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
30.731750	24.67	107.0	V	266.0	-8.1	40.00	15.33
41.860000	18.72	109.0	V	257.0	-15.1	40.00	21.28
47.193750	23.05	107.0	V	206.0	-18.3	40.00	16.95
51.411250	23.67	107.0	V	236.0	-19.7	40.00	16.33
837.796500	30.04	150.0	H	266.0	5.7	46.00	15.96
947.381750	30.86	194.0	V	300.0	9.7	46.00	15.14

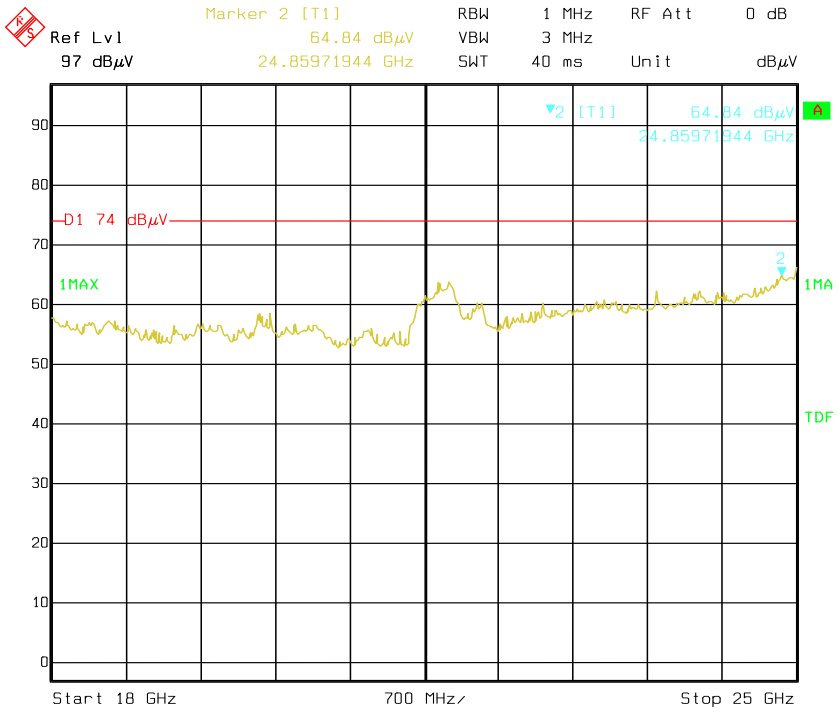
1 GHz - 25 GHz:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2389.43	27.64	PK	304	2.3	V	33.00	60.64	74	13.36
2389.43	13.82	Ave.	304	2.3	V	33.00	46.82	54	7.18
2484.49	27.03	PK	134	1.1	V	33.20	60.23	74	13.77
2484.49	13.26	Ave.	134	1.1	V	33.20	46.46	54	7.54
4804.00	44.52	PK	255	1.5	V	7.88	52.40	74	21.60
4804.00	28.13	Ave.	255	1.5	V	7.88	36.01	54	17.99
Middle Channel (2441 MHz)									
4882.00	44.62	PK	138	2.0	V	9.21	53.83	74	20.17
4882.00	29.21	Ave.	138	2.0	V	9.21	38.42	54	15.58
High Channel (2480 MHz)									
2389.69	27.30	PK	135	2.0	V	33.00	60.30	74	13.70
2389.69	13.69	Ave.	135	2.0	V	33.00	46.69	54	7.31
2483.50	28.53	PK	262	1.0	V	33.20	61.73	74	12.27
2483.50	19.41	Ave.	262	1.0	V	33.20	52.61	54	1.39
4960.00	44.28	PK	142	1.0	V	9.07	53.35	74	20.65
4960.00	28.64	Ave.	142	1.0	V	9.07	37.71	54	16.29

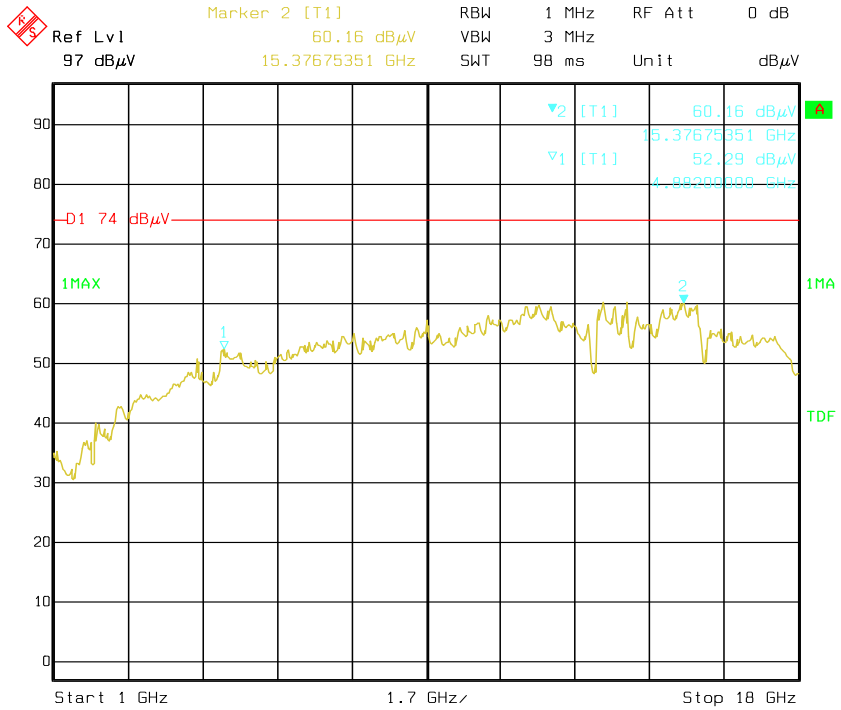
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB to the limit was not recorded.
And for the pre-scan is performed with the 2400-2483.5MHz band filter.

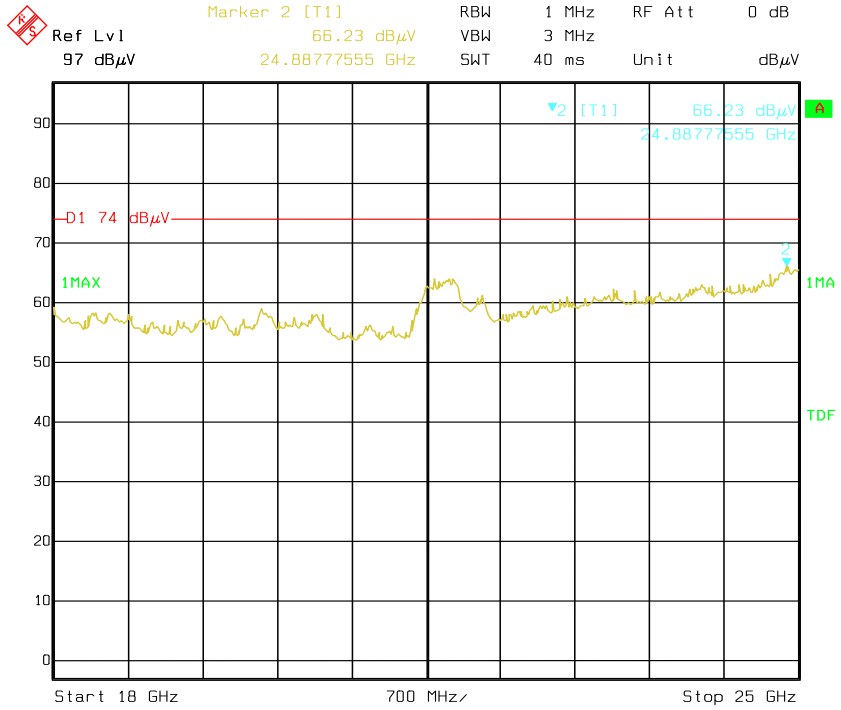
Pre-scan with middle channel Peak
Horizontal



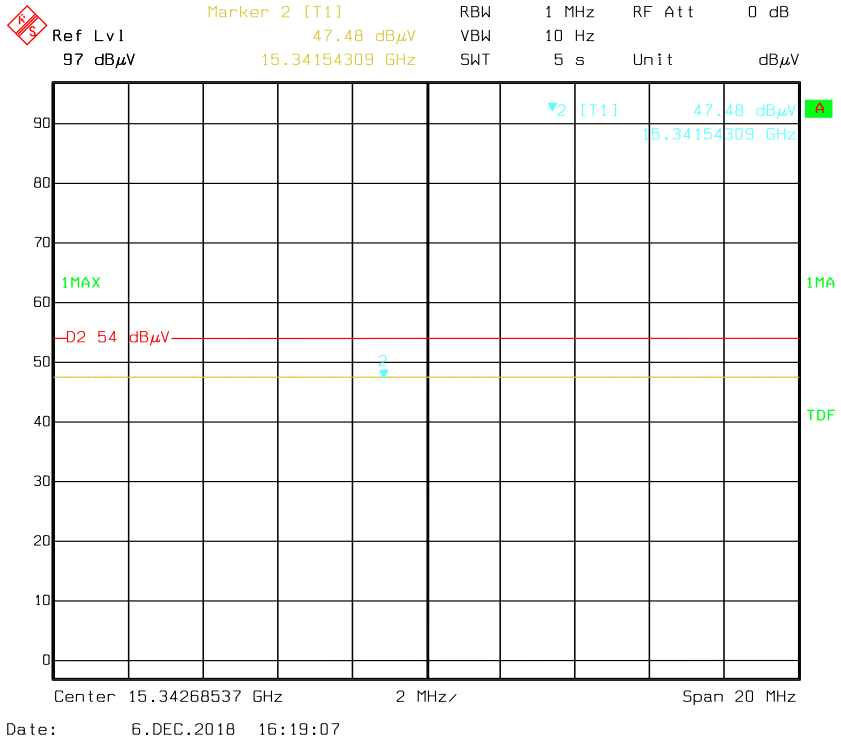


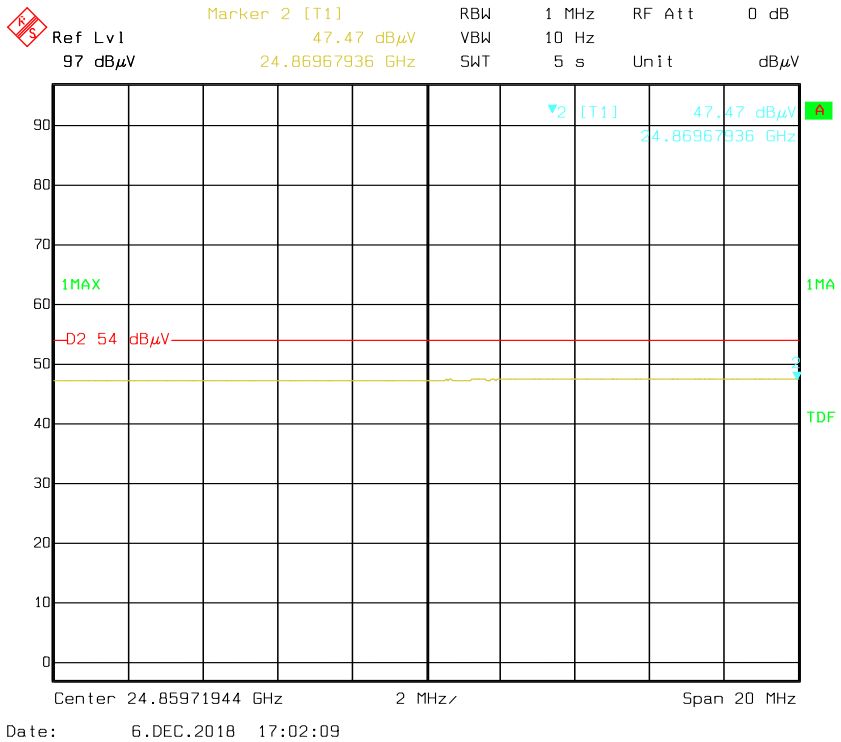
Vertical


Marker 2 [T1]
60.16 dBµV
15.37675351 GHz
RBW 1 MHz
VBW 3 MHz
SWT 98 ms
RF Att 0 dB
Unit dBµV
Ref Lvl
97 dBµV
▼2 [T1] 60.16 dBµV
15.37675351 GHz
▽1 [T1] 52.29 dBµV
4.88200000 GHz
D1 74 dBµV
1MAX
1MA
TDF
Start 1 GHz
1.7 GHz/
Stop 18 GHz
Date: 6.DEC.2018 16:21:46

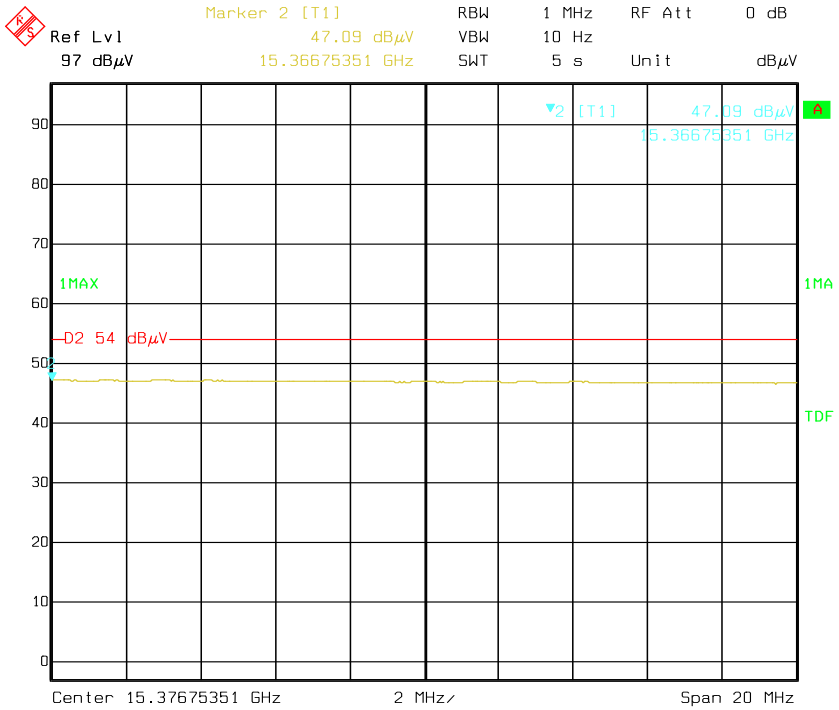

Marker 2 [T1]
66.23 dBµV
24.88777555 GHz
RBW 1 MHz
VBW 3 MHz
SWT 40 ms
RF Att 0 dB
Unit dBµV
Ref Lvl
97 dBµV
▼2 [T1] 66.23 dBµV
24.88777555 GHz
D1 74 dBµV
1MAX
1MA
TDF
Start 18 GHz
700 MHz/
Stop 25 GHz
Date: 6.DEC.2018 16:55:33

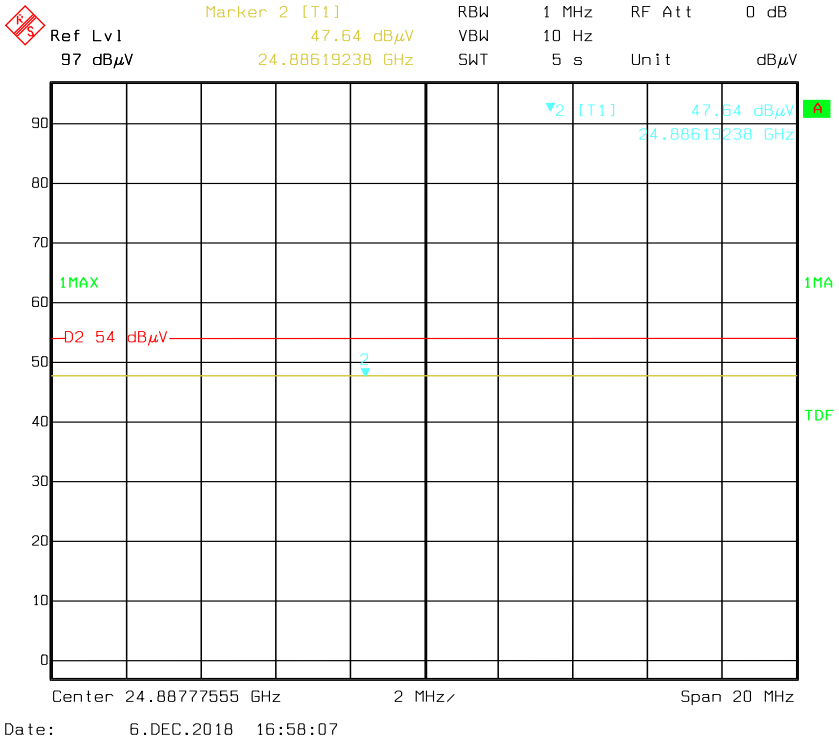
Pre-scan for Average
Horizontal





Vertical


Marker 2 [T1]
47.09 dBµV
15.36675351 GHz
RBW 1 MHz
VBW 10 Hz
SWT 5 s
RF Att 0 dB
Unit dBµV
Ref Lvl
97 dBµV
▼2 [T1] 47.09 dBµV
15.36675351 GHz
1MAX
1MA
D2 54 dBµV
TDF
Center 15.37675351 GHz
2 MHz/
Span 20 MHz
Date: 6.DEC.2018 16:24:06


Marker 2 [T1]
47.64 dBµV
24.88619238 GHz
RBW 1 MHz
VBW 10 Hz
SWT 5 s
RF Att 0 dB
Unit dBµV
Ref Lvl
97 dBµV
▼2 [T1] 47.64 dBµV
24.88619238 GHz
1MAX
1MA
D2 54 dBµV
TDF
Center 24.88777555 GHz
2 MHz/
Span 20 MHz
Date: 6.DEC.2018 16:58:07

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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	54 %
ATM Pressure:	101.0 kPa

The testing was performed by Kiki Kong on 2018-12-07.

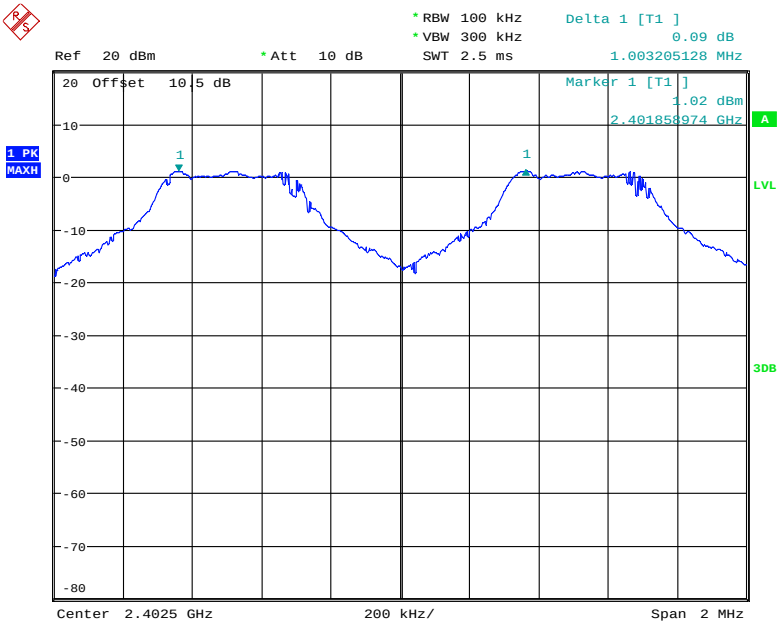
EUT operation mode: Transmitting

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

Channel	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit	Result
BDR(GFSK)					
Low	1.003	0.96	0.640	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.003	0.96	0.640	> two-thirds of the 20 dB bandwidth	Compliance
High	1.000	0.96	0.640	> two-thirds of the 20 dB bandwidth	Compliance
EDR(π/4-DQPSK)					
Low	1.000	1.36	0.907	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.003	1.36	0.907	> two-thirds of the 20 dB bandwidth	Compliance
High	1.006	1.36	0.907	> two-thirds of the 20 dB bandwidth	Compliance
EDR(8DPSK)					
Low	1.003	1.35	0.900	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.003	1.35	0.900	> two-thirds of the 20 dB bandwidth	Compliance
High	1.003	1.35	0.900	> two-thirds of the 20 dB bandwidth	Compliance

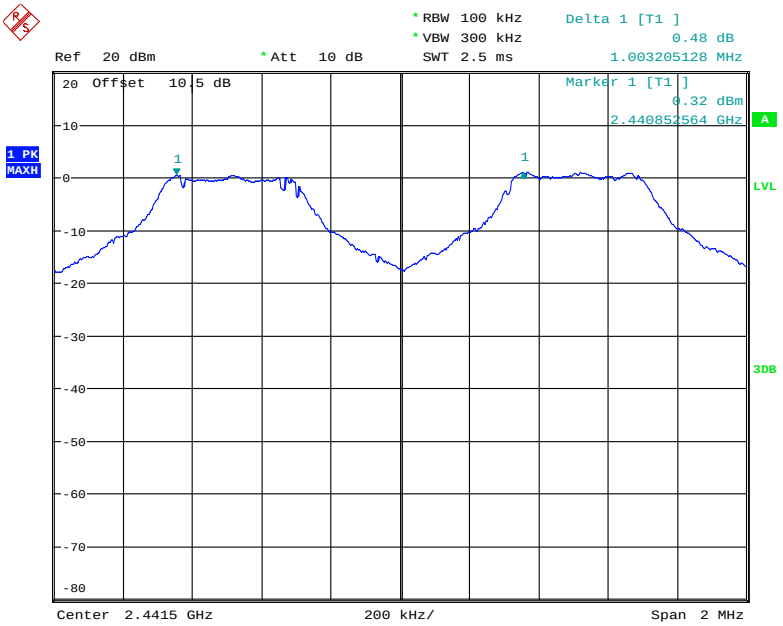
Please refer to the following plots.

BDR (GFSK): Low Channel



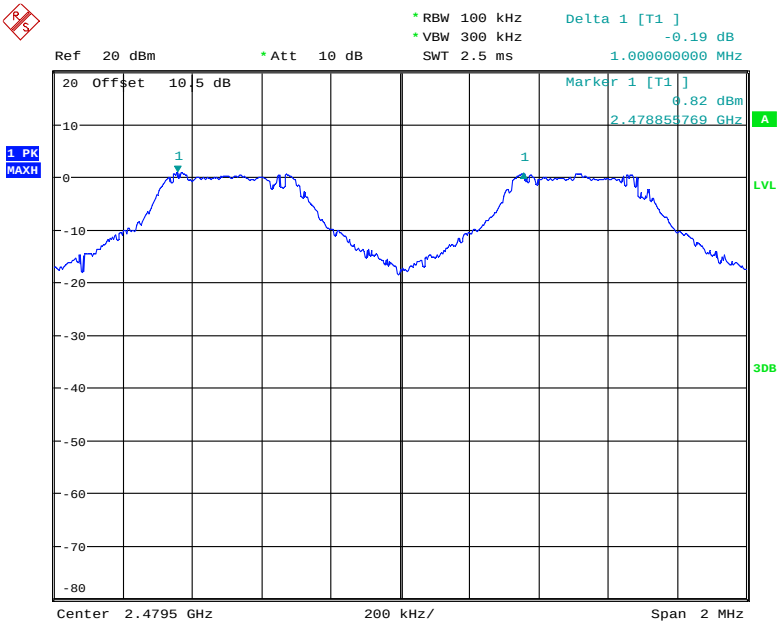
Date: 7.DEC.2018 10:31:52

BDR (GFSK): Middle Channel



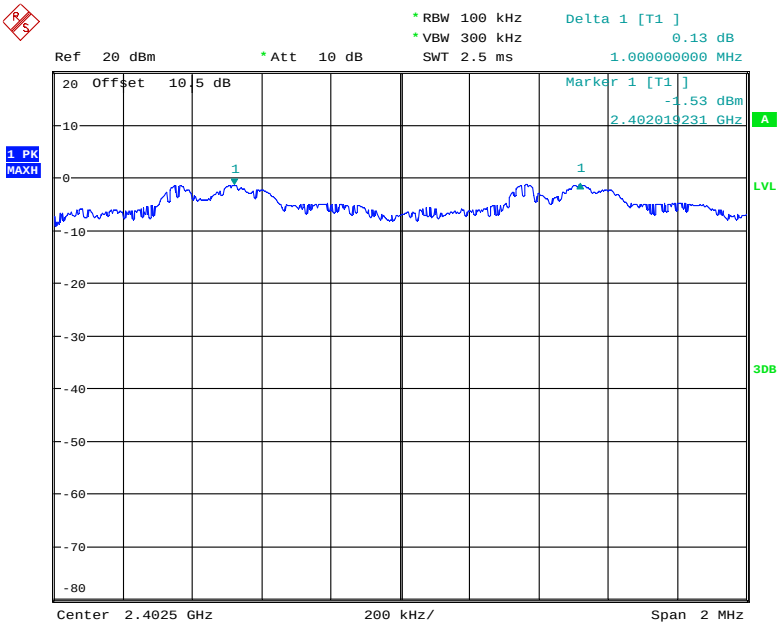
Date: 7.DEC.2018 10:40:52

BDR (GFSK): High Channel



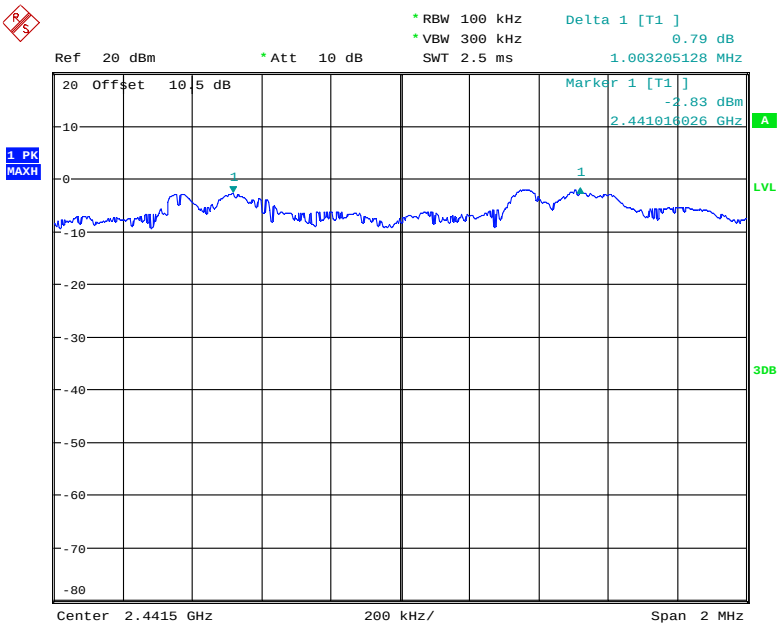
Date: 7.DEC.2018 10:44:18

EDR (π/4-DQPSK): Low Channel



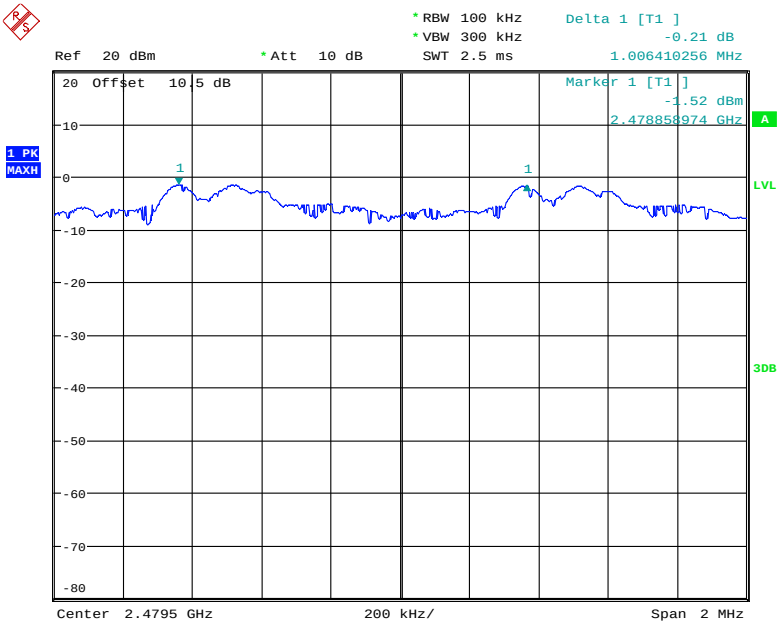
Date: 7.DEC.2018 10:57:56

EDR (π/4-DQPSK): Middle Channel



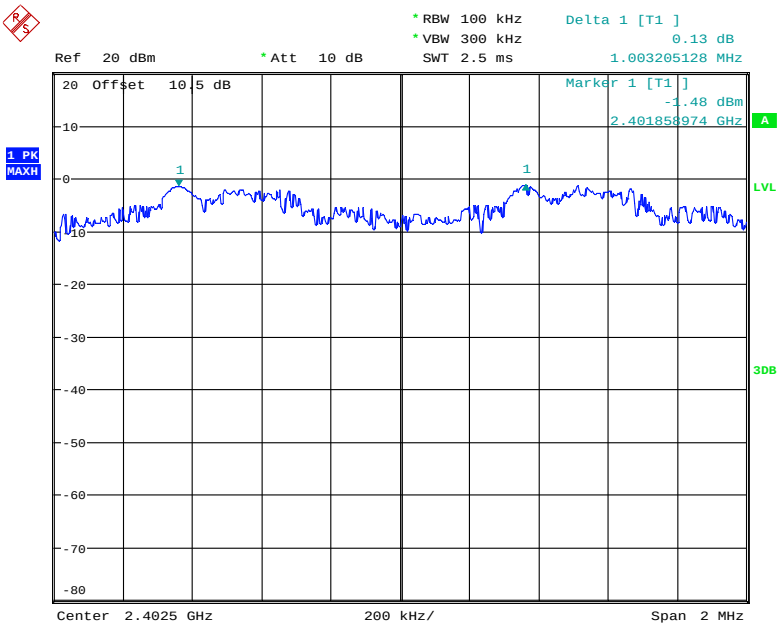
Date: 7.DEC.2018 10:53:42

EDR (π/4-DQPSK): High Channel



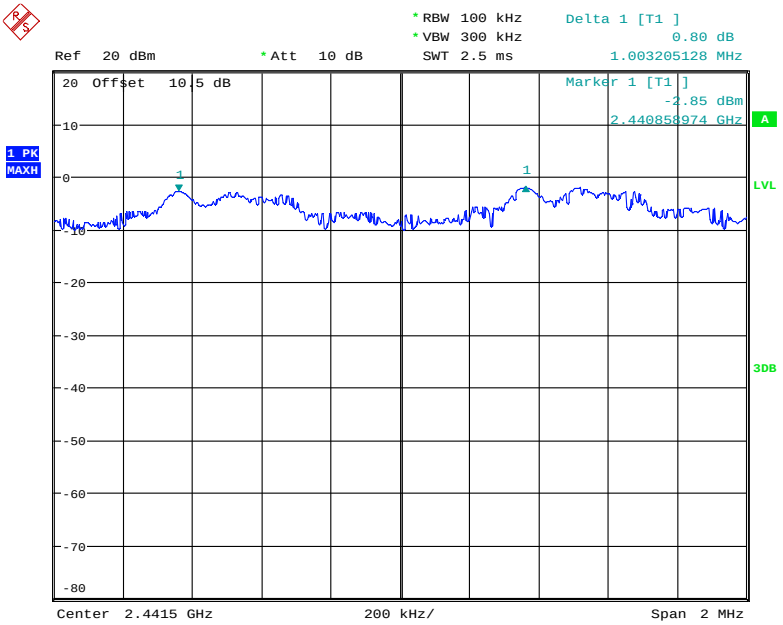
Date: 7.DEC.2018 10:49:24

EDR (8DPSK): Low Channel



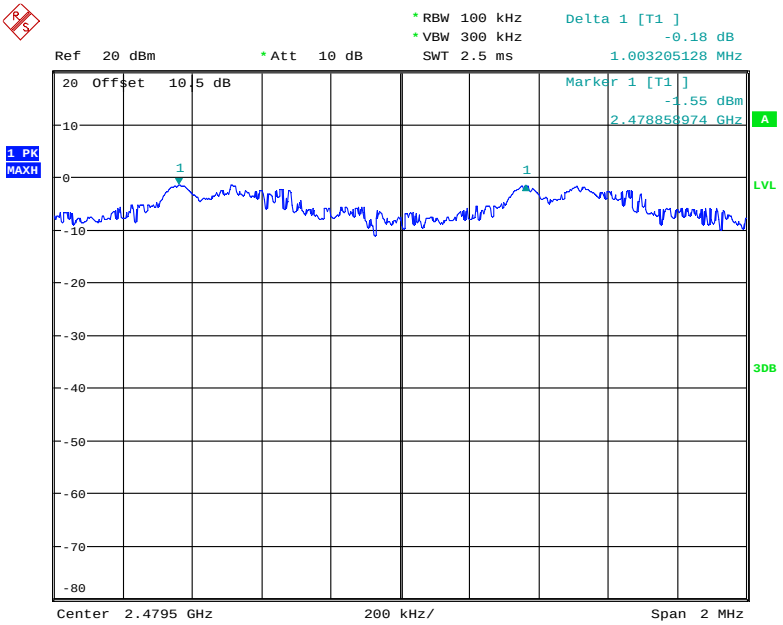
Date: 7.DEC.2018 11:00:39

EDR (8DPSK): Middle Channel



Date: 7.DEC.2018 11:03:35

EDR (8DPSK): High Channel



Date: 7.DEC.2018 11:06:21

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH

Applicable Standard

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

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

Test Data

Environmental Conditions

Temperature:	24~25 ℃
Relative Humidity:	54~56 %
ATM Pressure:	100.9~101.0 kPa

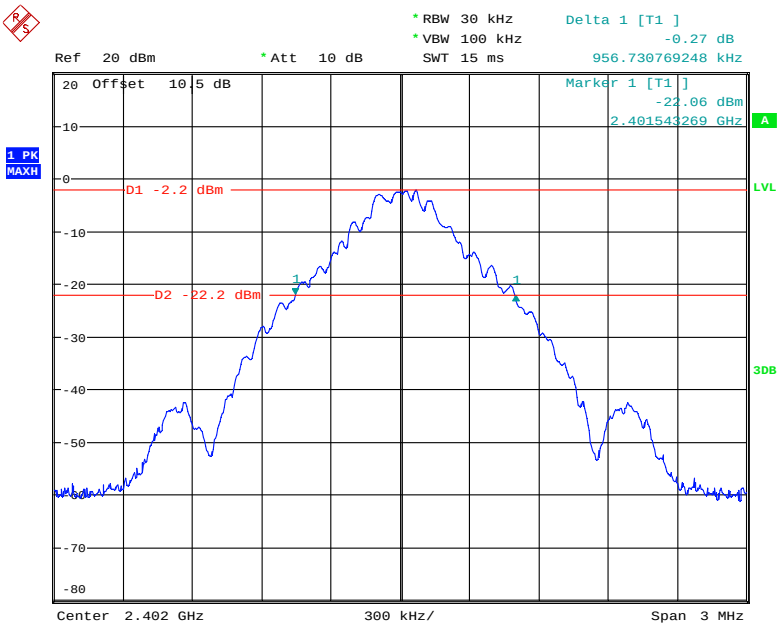
The testing was performed by Kiki Kong on 2018-12-07 and 2018-12-15.

EUT operation mode: Transmitting

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

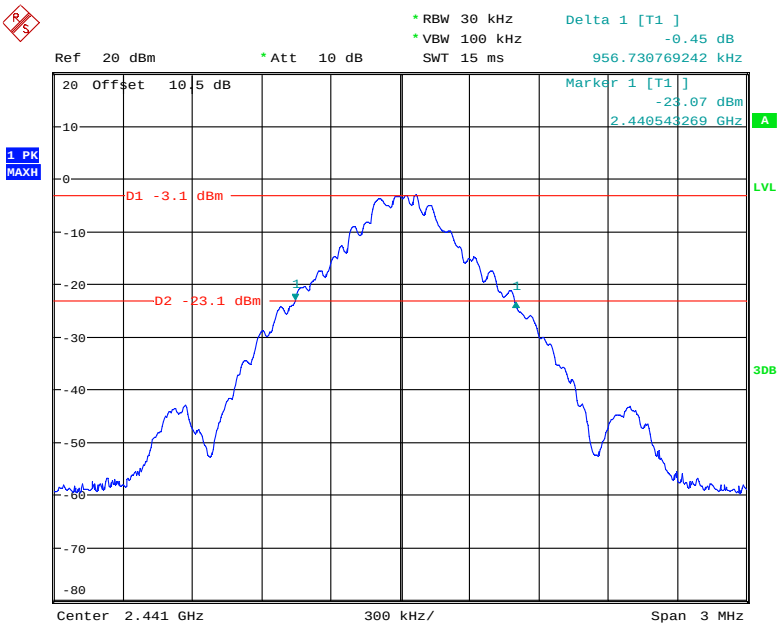
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.96
	Middle	2441	0.96
	High	2480	0.96
EDR (π/4-DQPSK)	Low	2402	1.36
	Middle	2441	1.36
	High	2480	1.36
EDR (8DPSK)	Low	2402	1.35
	Middle	2441	1.35
	High	2480	1.35

BDR (GFSK): Low Channel



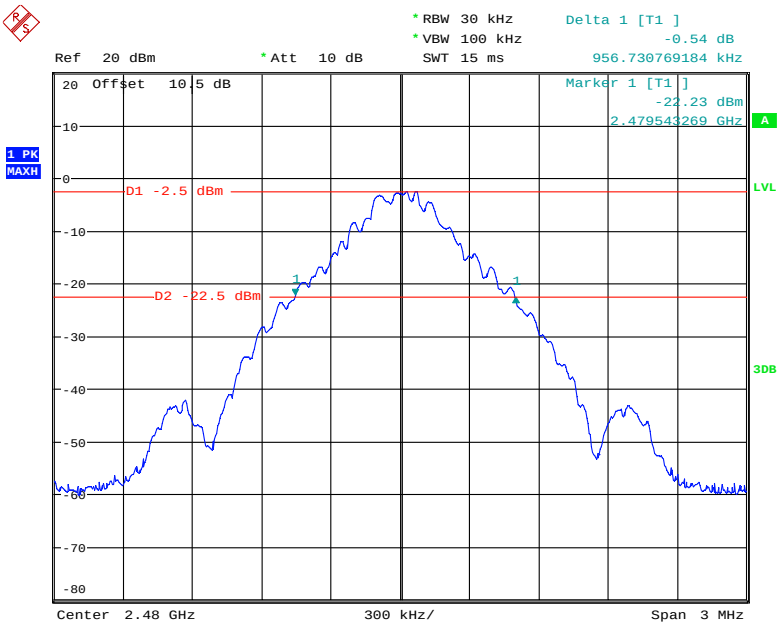
Date: 7.DEC.2018 10:26:41

BDR (GFSK): Middle Channel



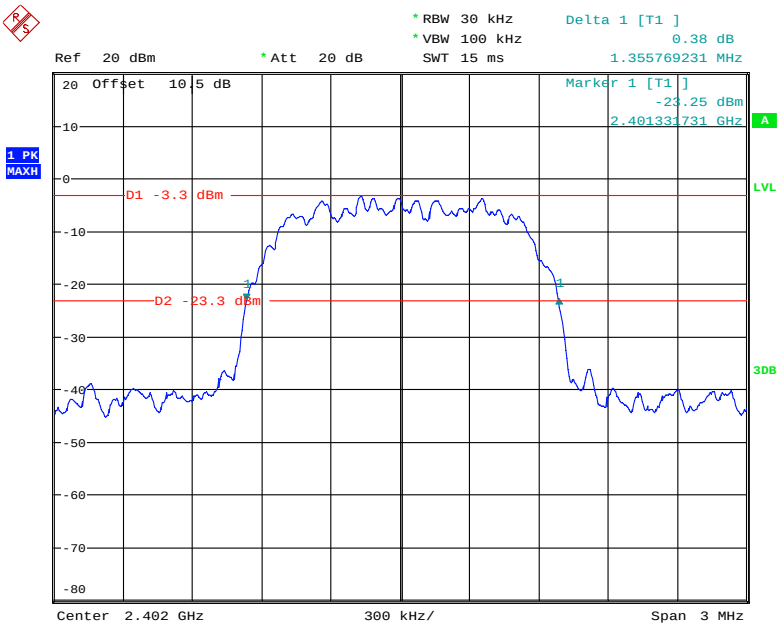
Date: 7.DEC.2018 10:25:39

BDR (GFSK): High Channel



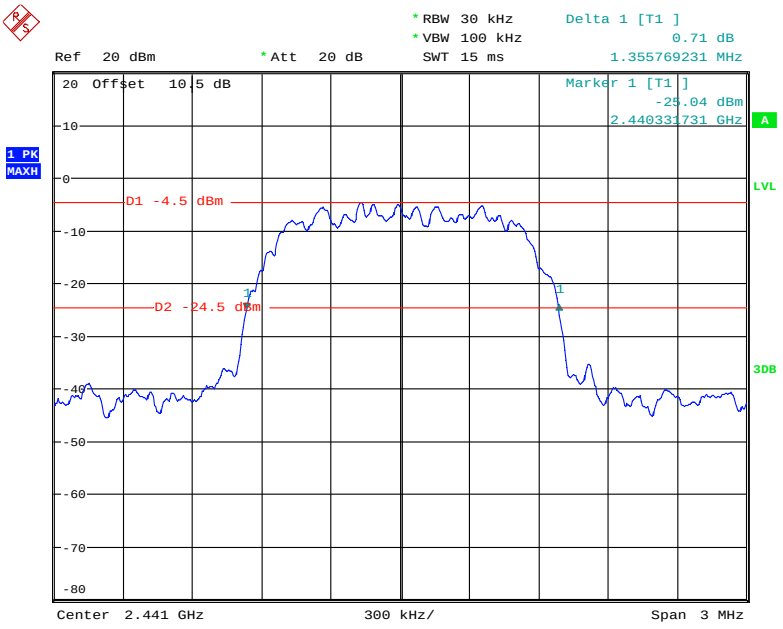
Date: 7.DEC.2018 10:23:49

EDR (π/4-DQPSK): Low Channel



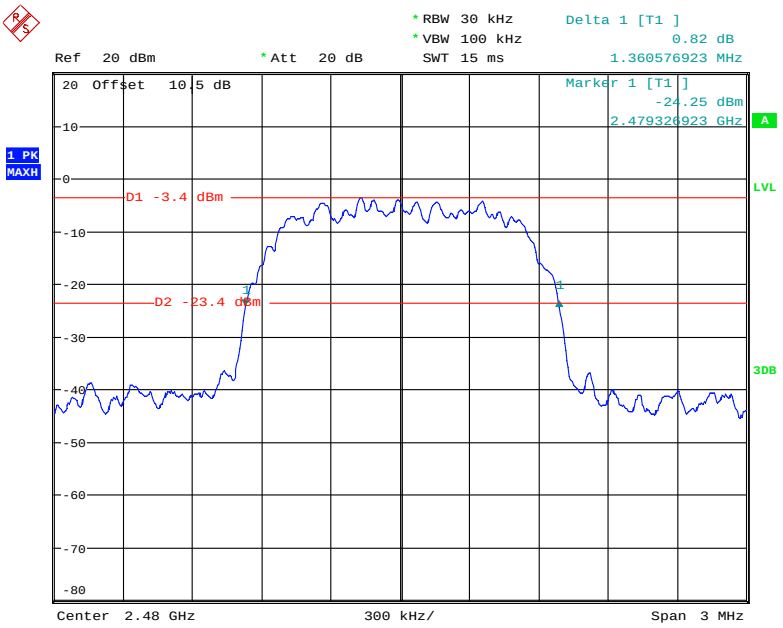
Date: 15.DEC.2018 16:55:22

EDR (π/4-DQPSK): Middle Channel



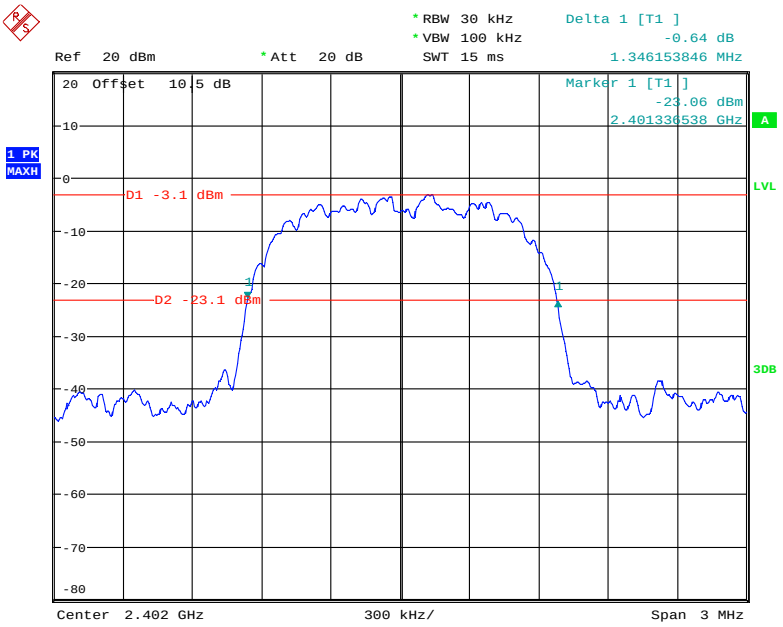
Date: 15.DEC.2018 16:56:34

EDR (π/4-DQPSK): High Channel



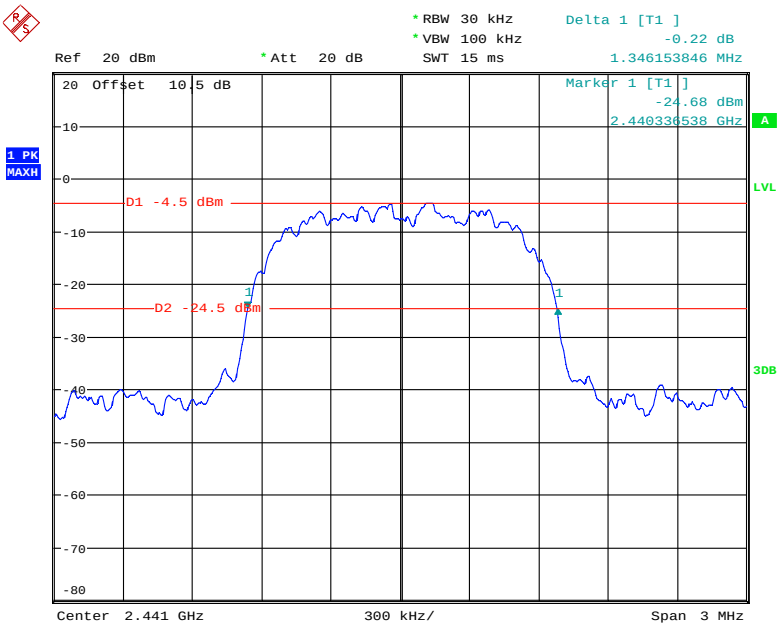
Date: 15.DEC.2018 16:57:33

EDR (8DPSK): Low Channel



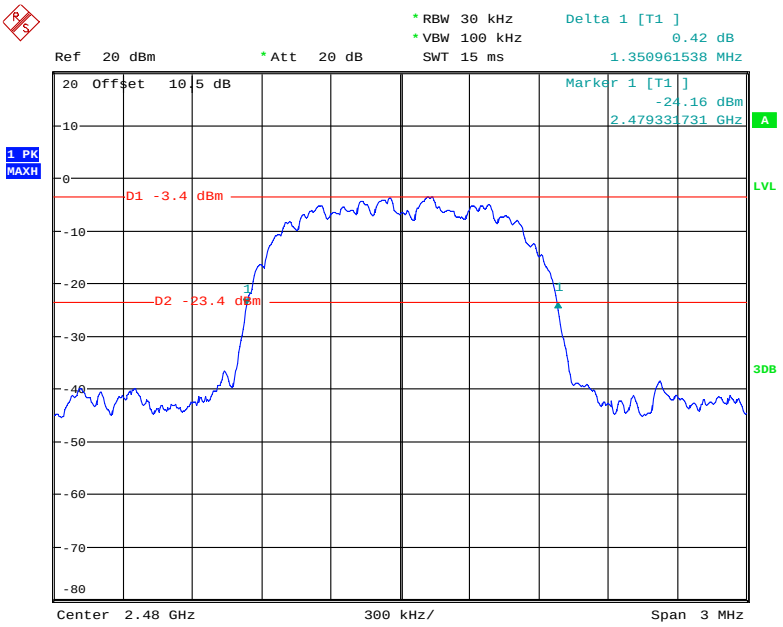
Date: 15.DEC.2018 17:01:24

EDR (8DPSK): Middle Channel



Date: 15.DEC.2018 17:00:25

EDR (8DPSK): High Channel



Date: 15.DEC.2018 16:58:37

FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

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

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	54 %
ATM Pressure:	101.0 kPa

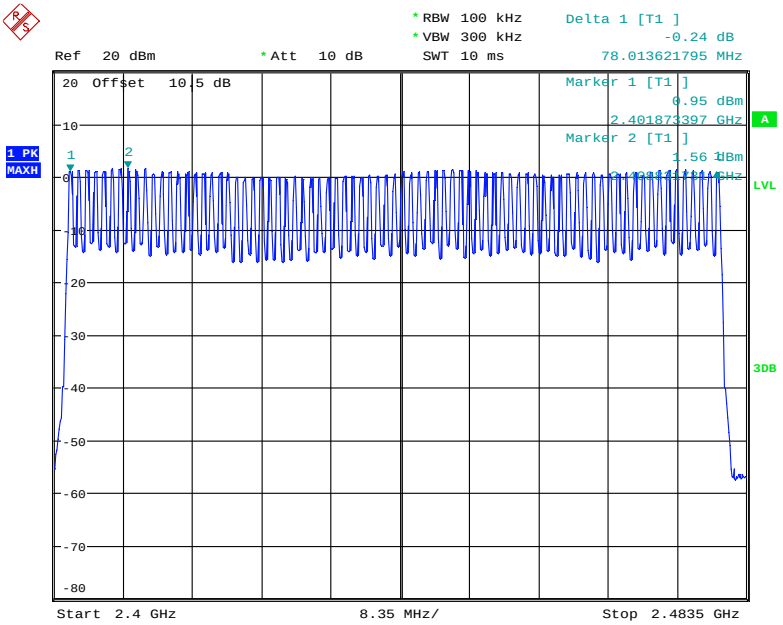
The testing was performed by Kiki Kong on 2018-12-07.

EUT operation mode: Transmitting

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

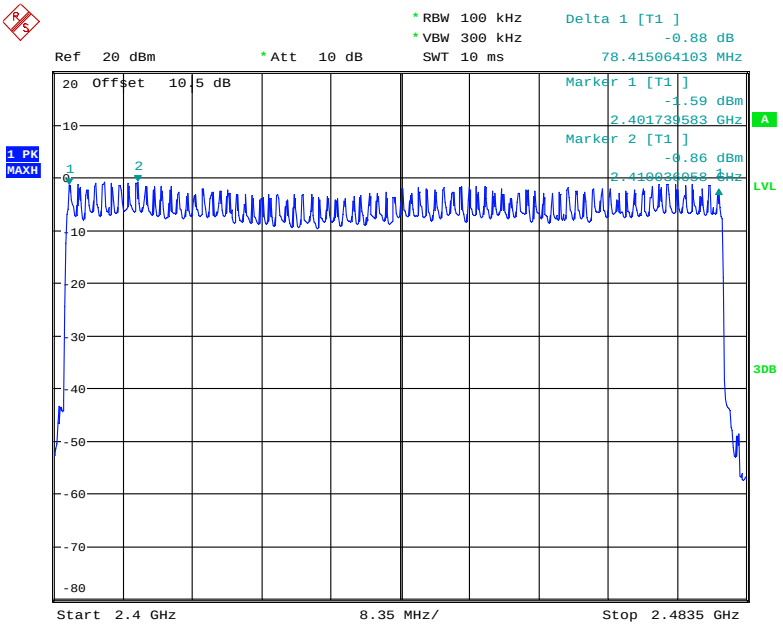
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	⩾15
EDR (π/4-DQPSK)	2400-2483.5	79	⩾15
EDR (8DPSK)	2400-2483.5	79	⩾15

BDR (GFSK): Number of Hopping Channels



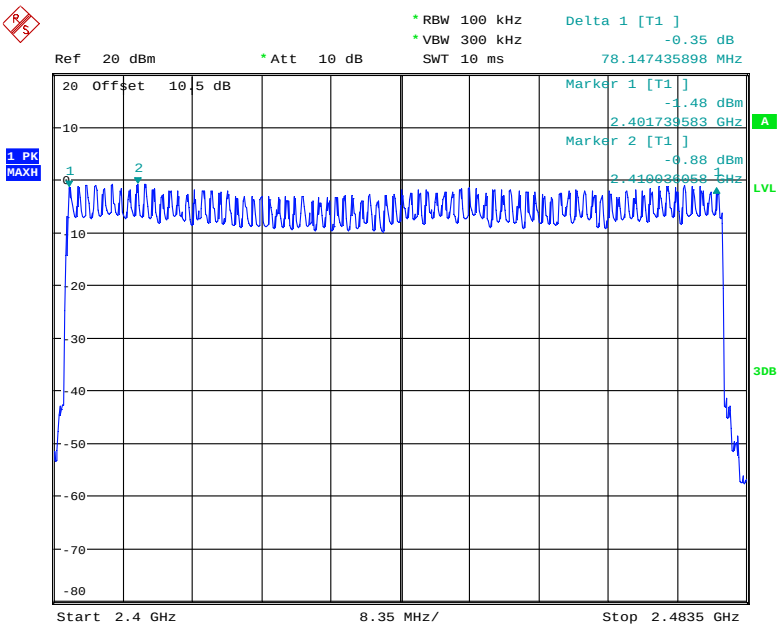
Date: 7.DEC.2018 11:39:11

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



Date: 7.DEC.2018 11:33:09

EDR (8DPSK): Number of Hopping Channels



Date: 7.DEC.2018 11:28:24

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. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	54 %
ATM Pressure:	101.0 kPa

The testing was performed by Kiki Kong on 2018-12-07.

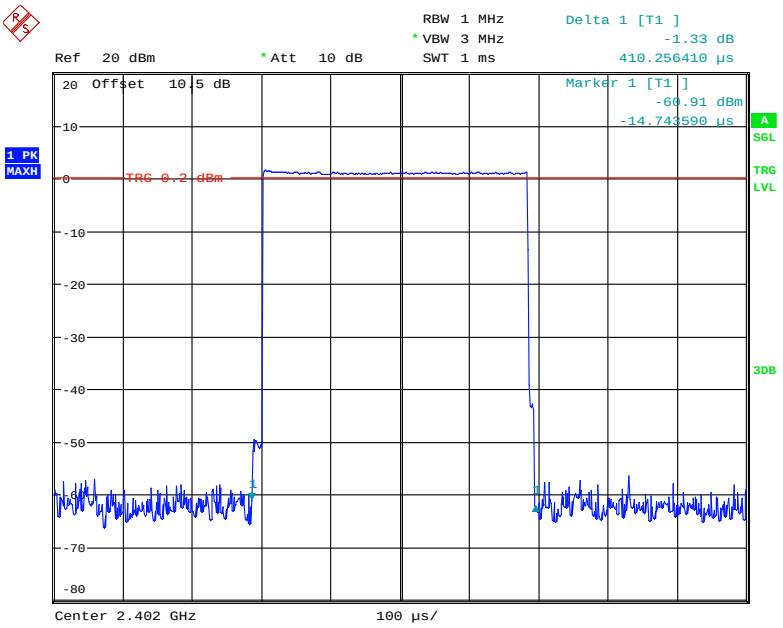
EUT operation mode: Transmitting

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

Mode		Channel	Pulse Width (ms)	Dwell Time (S)	Limit (S)	Result
BDR (GFSK)	DH 1	Low	0.41	0.131	0.4	Pass
		Middle	0.41	0.131	0.4	Pass
		High	0.41	0.131	0.4	Pass
		Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	DH 3	Low	1.68	0.269	0.4	Pass
		Middle	1.68	0.269	0.4	Pass
		High	1.68	0.269	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	DH 5	Low	2.93	0.313	0.4	Pass
		Middle	2.93	0.313	0.4	Pass
		High	2.93	0.313	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (π/4-DQPSK)	2DH 1	Low	0.42	0.134	0.4	Pass
		Middle	0.42	0.134	0.4	Pass
		High	0.42	0.134	0.4	Pass
		Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	2DH 3	Low	1.68	0.269	0.4	Pass
		Middle	1.68	0.269	0.4	Pass
		High	1.68	0.269	0.4	Pass
		Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	2DH 5	Low	2.93	0.313	0.4	Pass
		Middle	2.93	0.313	0.4	Pass
		High	2.93	0.313	0.4	Pass
		Note:2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (8DPSK)	3DH 1	Low	0.42	0.134	0.4	Pass
		Middle	0.42	0.134	0.4	Pass
		High	0.42	0.134	0.4	Pass
		Note: 3DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	3DH 3	Low	1.68	0.269	0.4	Pass
		Middle	1.68	0.269	0.4	Pass
		High	1.68	0.269	0.4	Pass
		Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	3DH 5	Low	2.93	0.313	0.4	Pass
		Middle	2.93	0.313	0.4	Pass
		High	2.93	0.313	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				

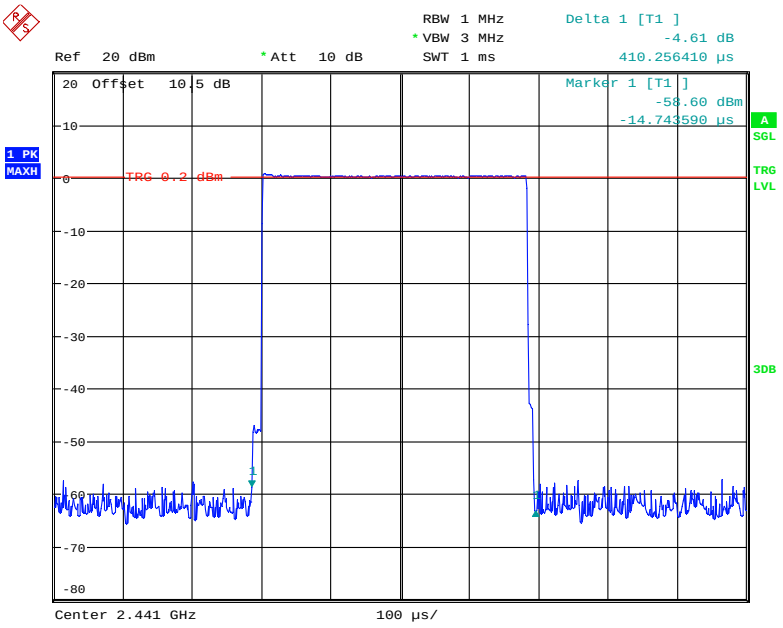
BDR (GFSK):

Pulse time, Low Channel, DH1



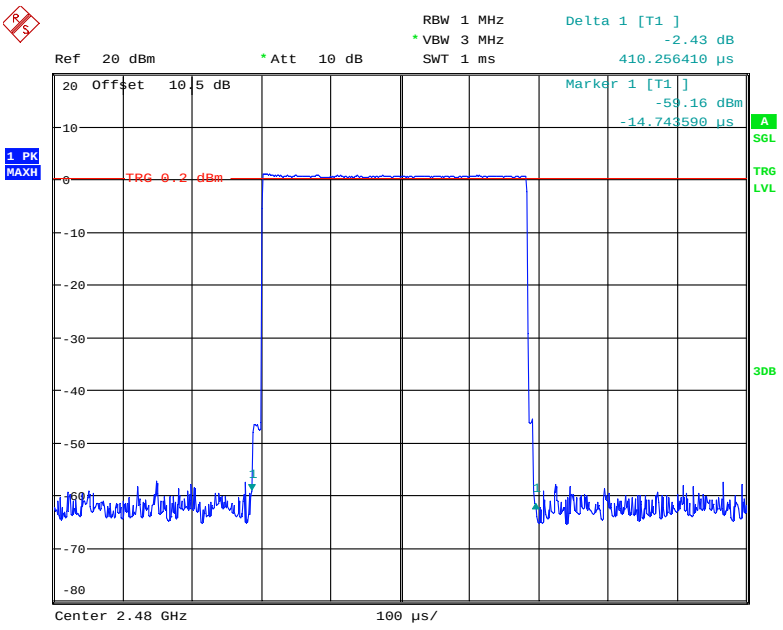
Date: 7.DEC.2018 11:40:58

Pulse time, Middle Channel, DH1



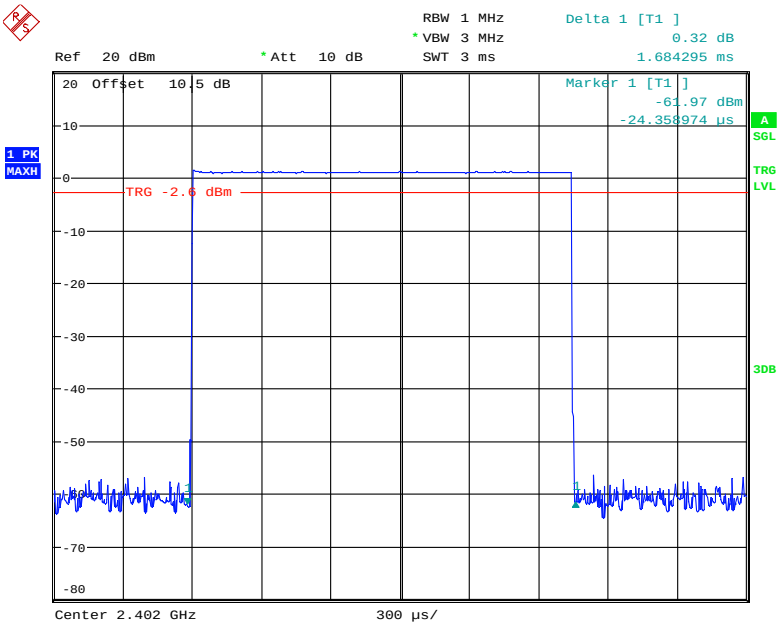
Date: 7.DEC.2018 11:41:26

Pulse time, High Channel, DH1



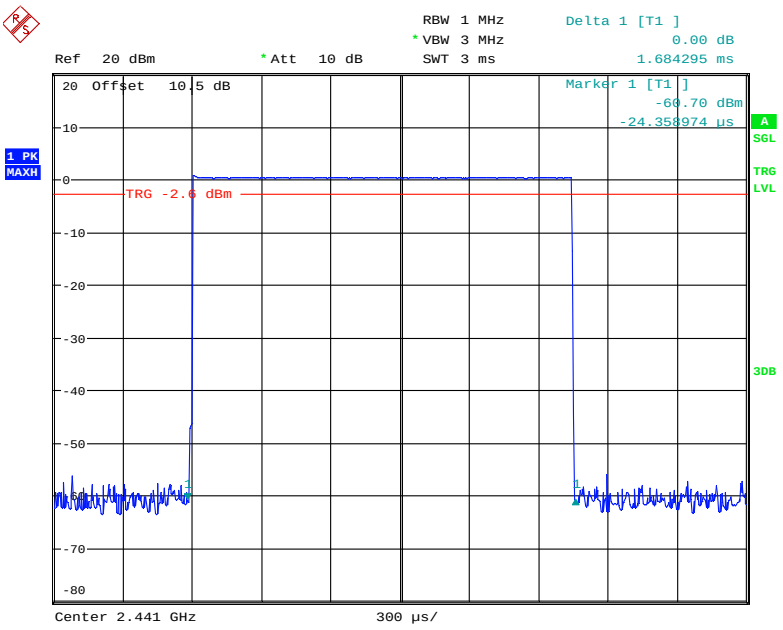
Date: 7.DEC.2018 11:41:37

Pulse time, Low Channel, DH3



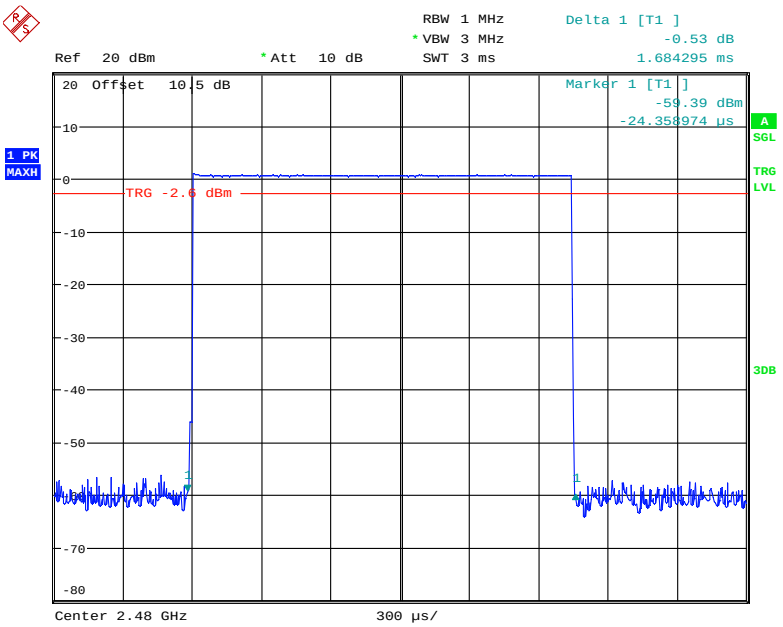
Date: 7.DEC.2018 11:48:03

Pulse time, Middle Channel, DH3



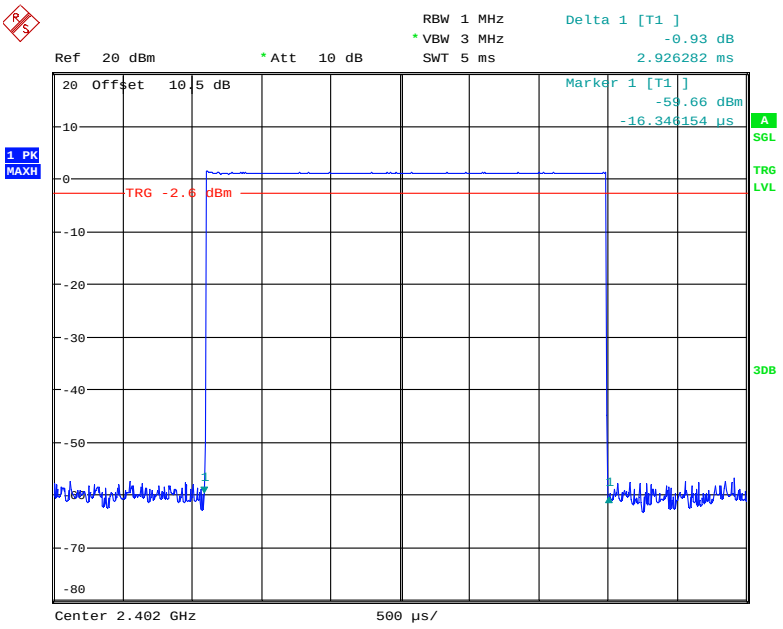
Date: 7.DEC.2018 11:47:51

Pulse time, High Channel, DH3



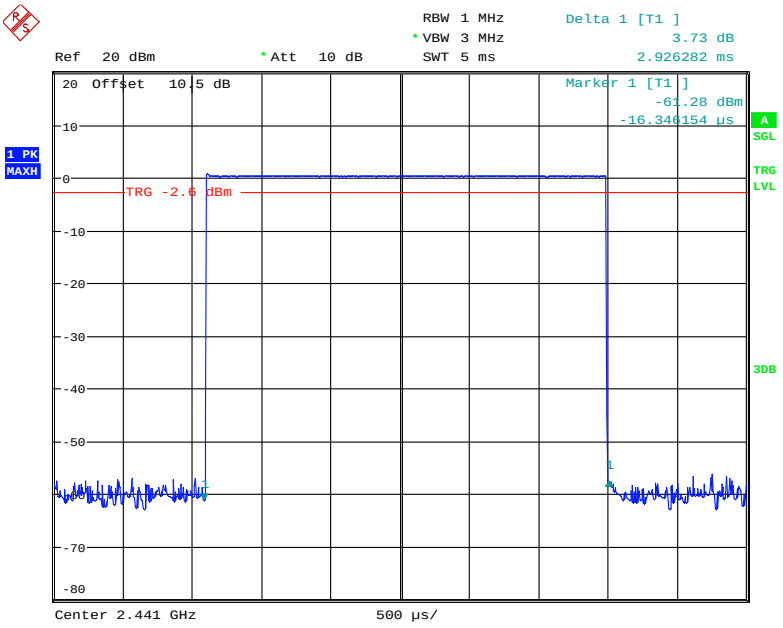
Date: 7.DEC.2018 11:47:38

Pulse time, Low Channel, DH5



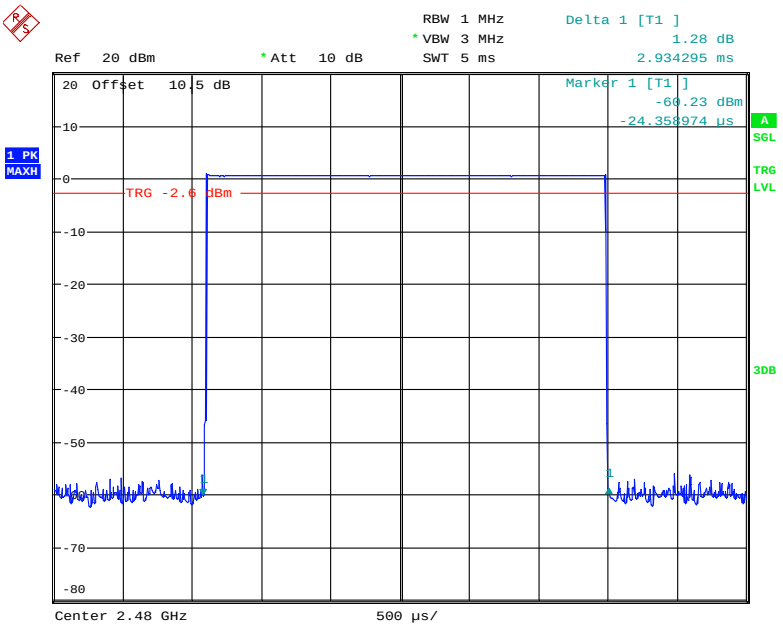
Date: 7.DEC.2018 11:51:09

Pulse time, Middle Channel, DH5



Date: 7.DEC.2018 11:51:40

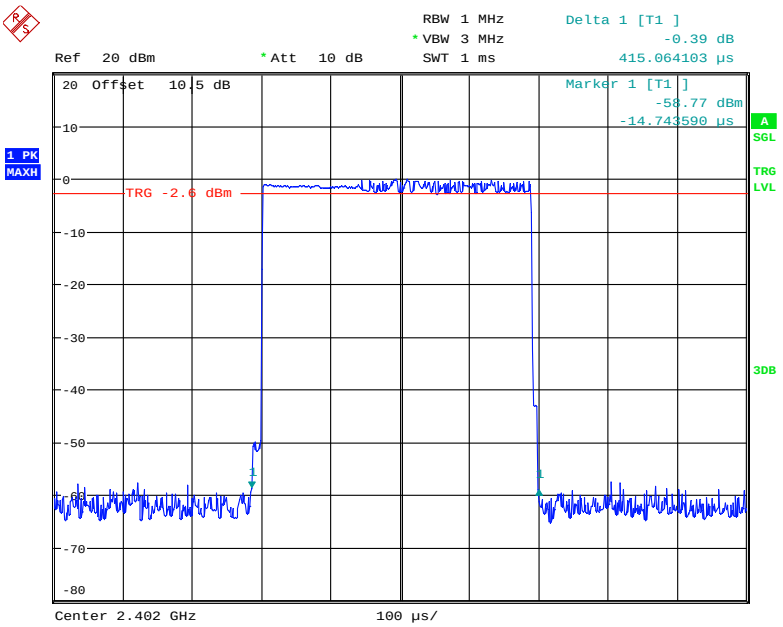
Pulse time, High Channel, DH5



Date: 7.DEC.2018 11:52:03

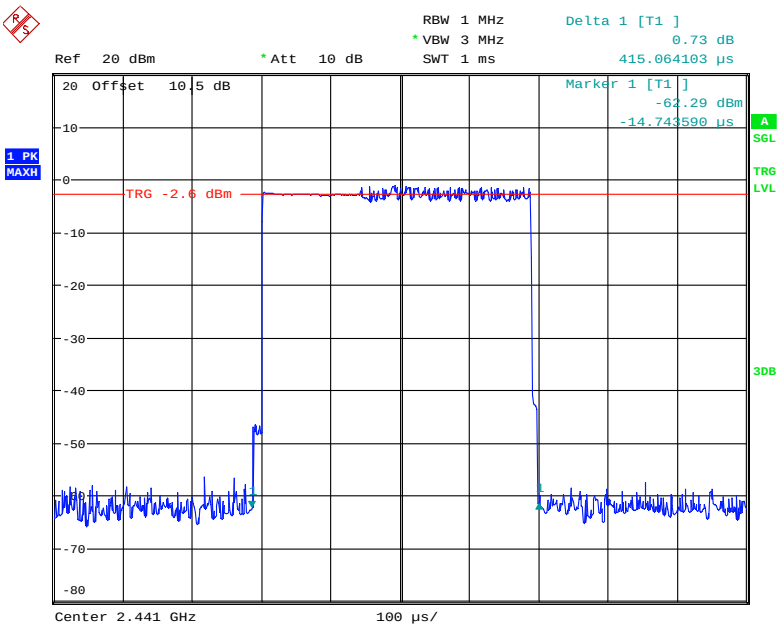
EDR (π/4-DQPSK):

Pulse time, Low Channel, 2DH1



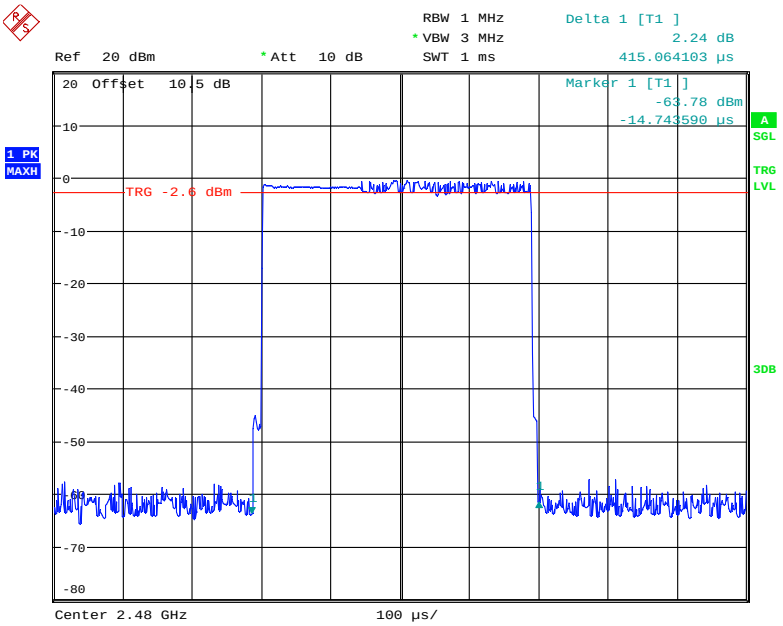
Date: 7.DEC.2018 11:43:16

Pulse time, Middle Channel, 2DH1



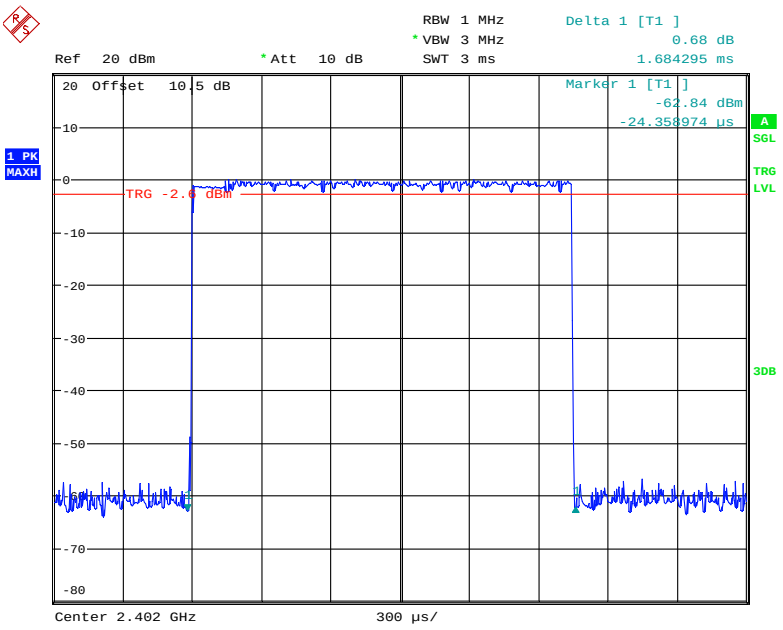
Date: 7.DEC.2018 11:43:05

Pulse time, High Channel, 2DH1



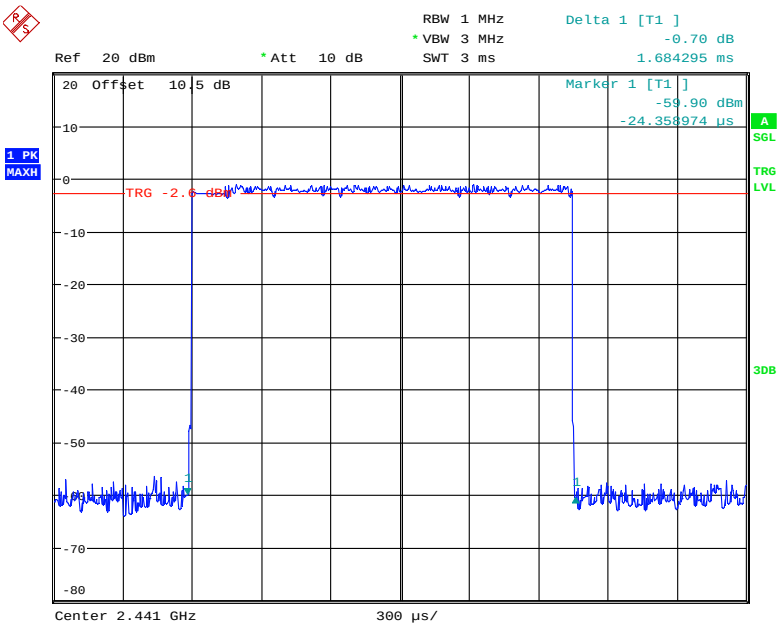
Date: 7.DEC.2018 11:42:53

Pulse time, Low Channel, 2DH3



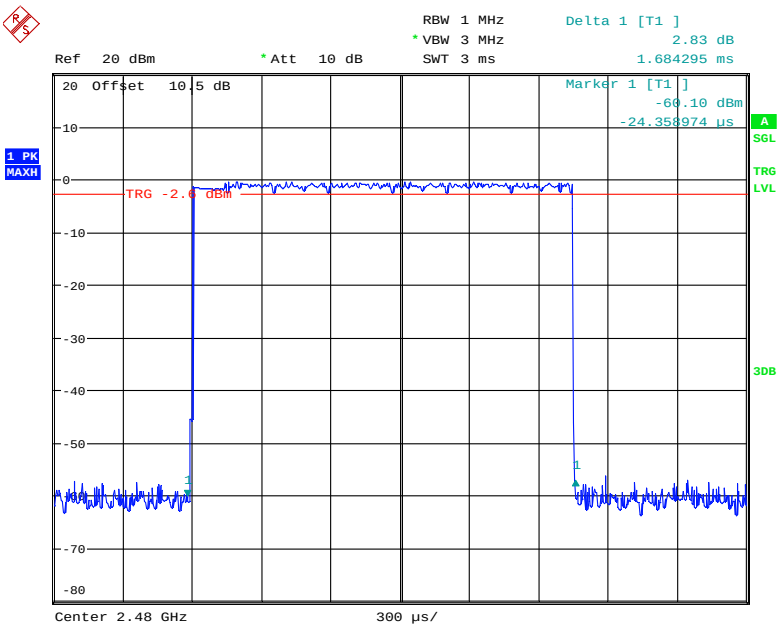
Date: 7.DEC.2018 11:46:49

Pulse time, Middle Channel, 2DH3



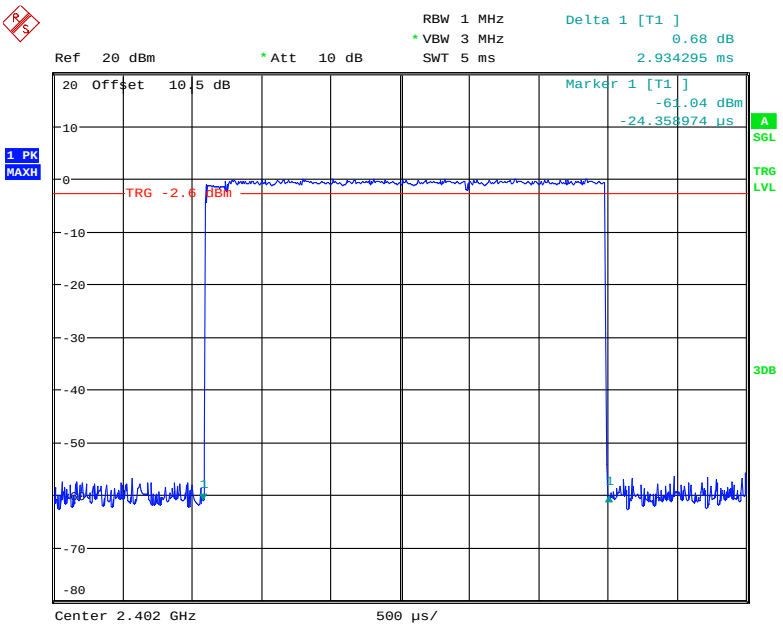
Date: 7.DEC.2018 11:47:01

Pulse time, High Channel, 2DH3



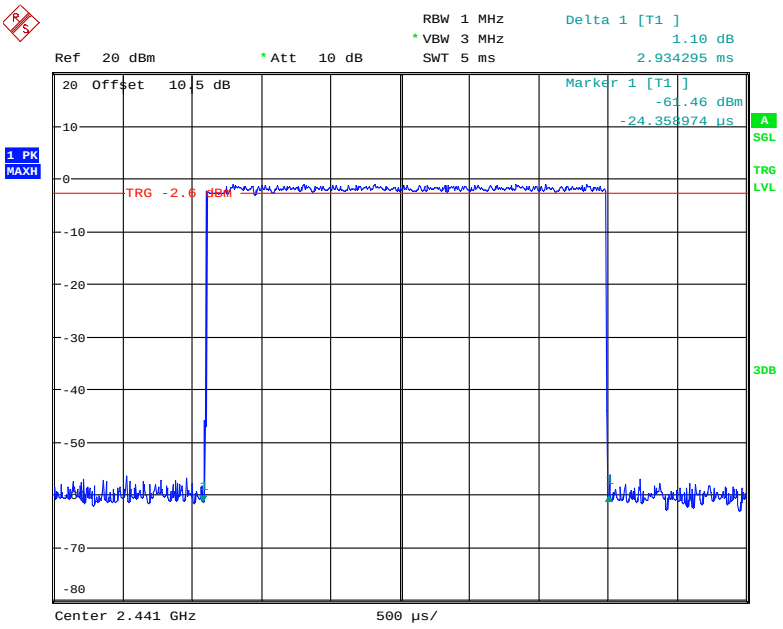
Date: 7.DEC.2018 11:47:13

Pulse time, Low Channel, 2DH5



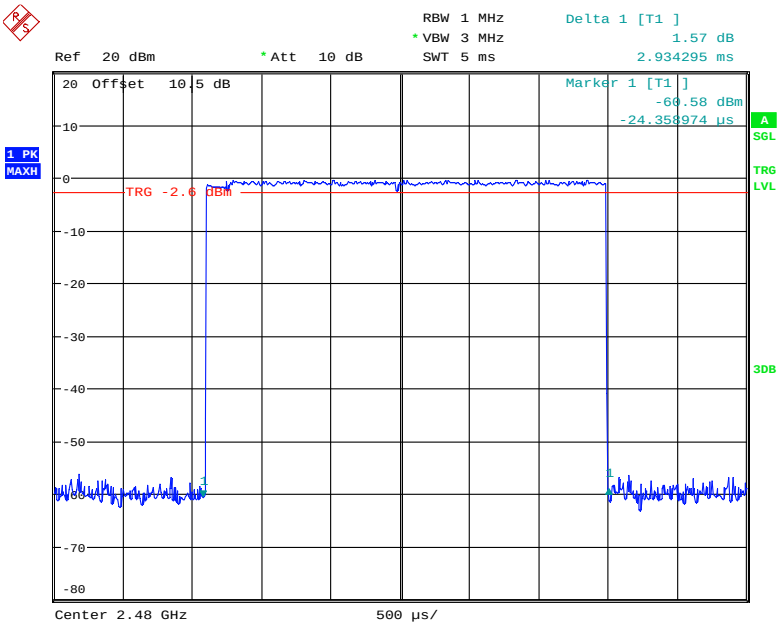
Date: 7.DEC.2018 11:52:50

Pulse time, Middle Channel, 2DH5



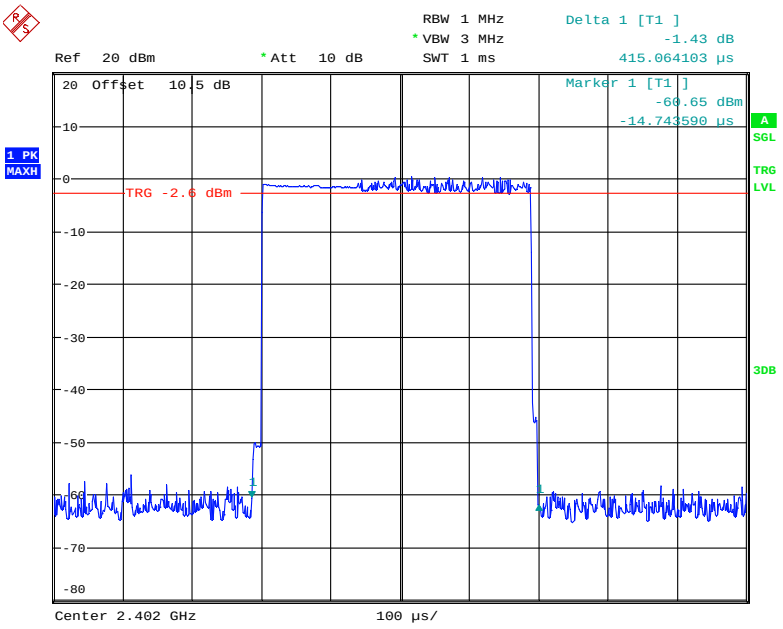
Date: 7.DEC.2018 11:52:40

Pulse time, High Channel, 2DH5



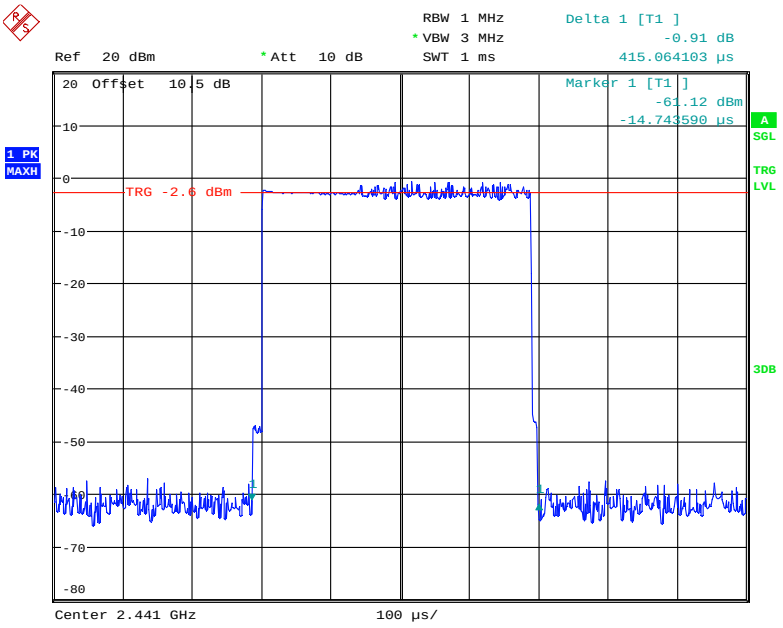
Date: 7.DEC.2018 11:52:28

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



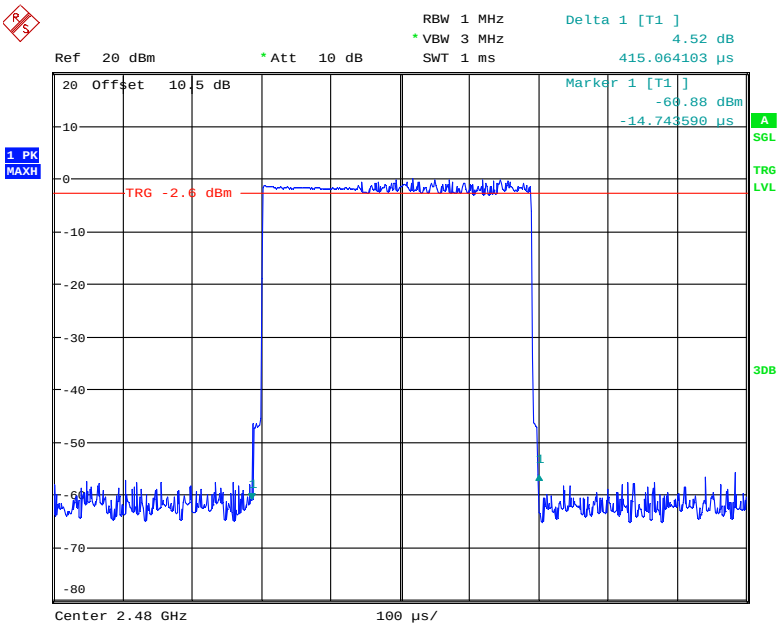
Date: 7.DEC.2018 11:43:39

Pulse time, Middle Channel, 3DH1



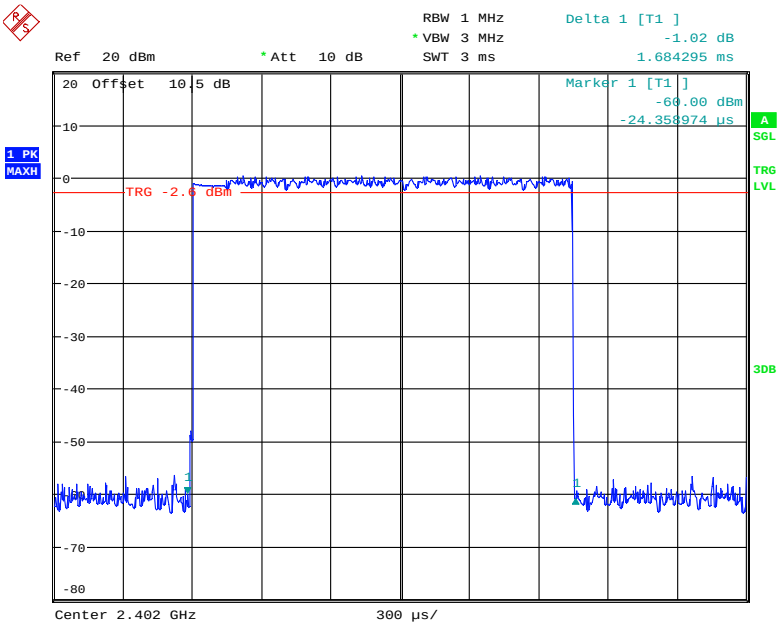
Date: 7.DEC.2018 11:43:56

Pulse time, High Channel, 3DH1



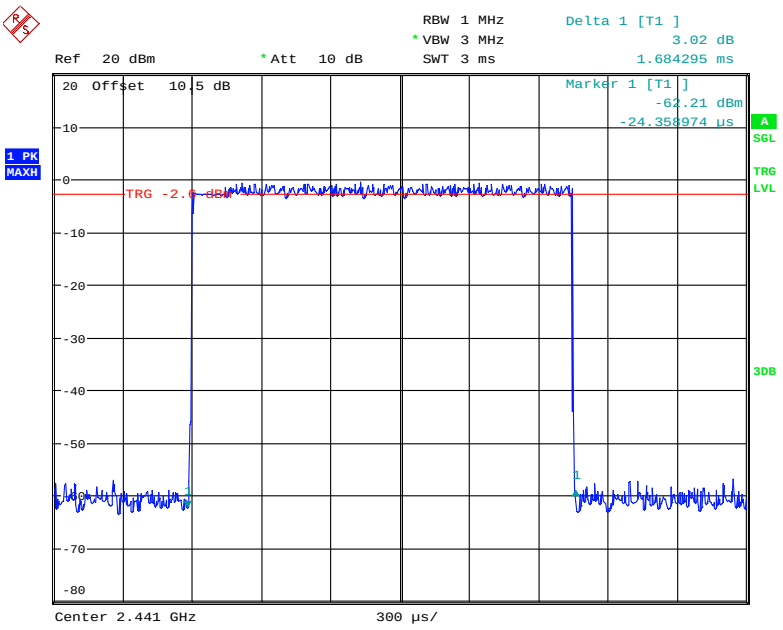
Date: 7.DEC.2018 11:44:09

Pulse time, Low Channel, 3DH3



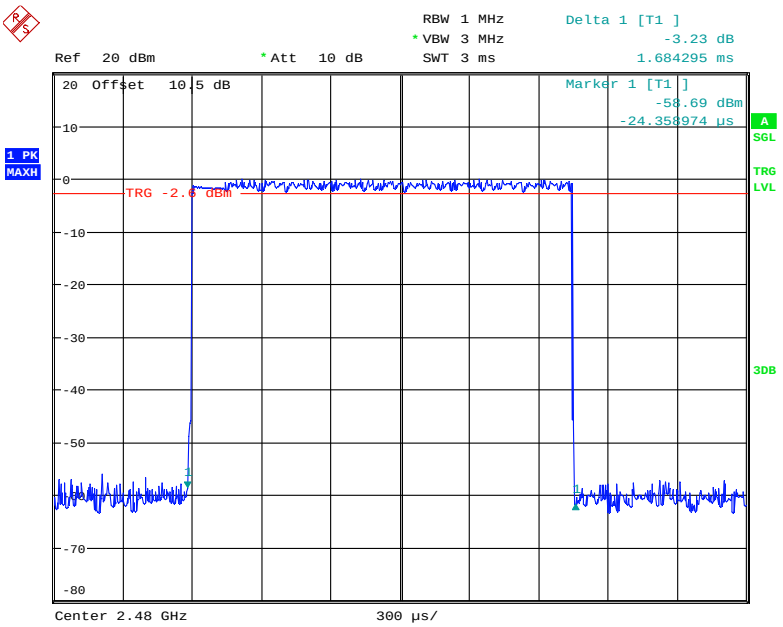
Date: 7.DEC.2018 11:46:25

Pulse time, Middle Channel, 3DH3



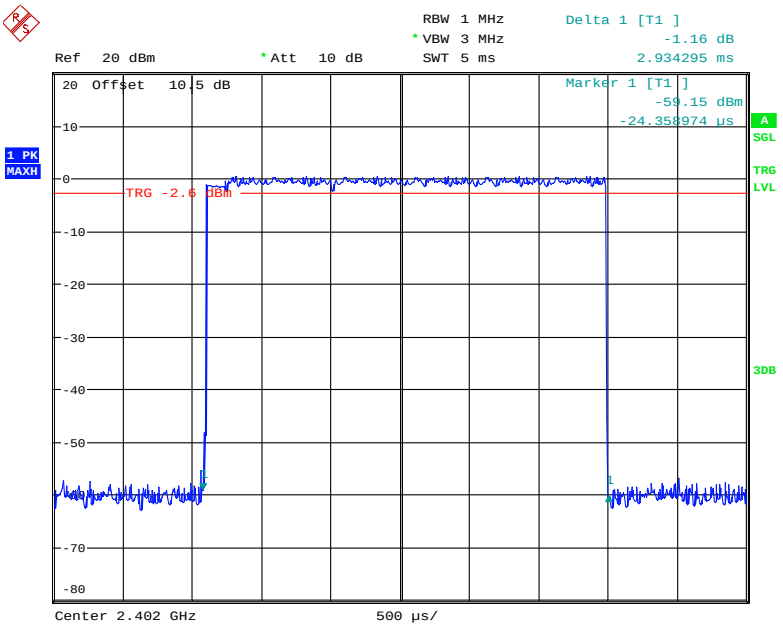
Date: 7.DEC.2018 11:46:11

Pulse time, High Channel, 3DH3



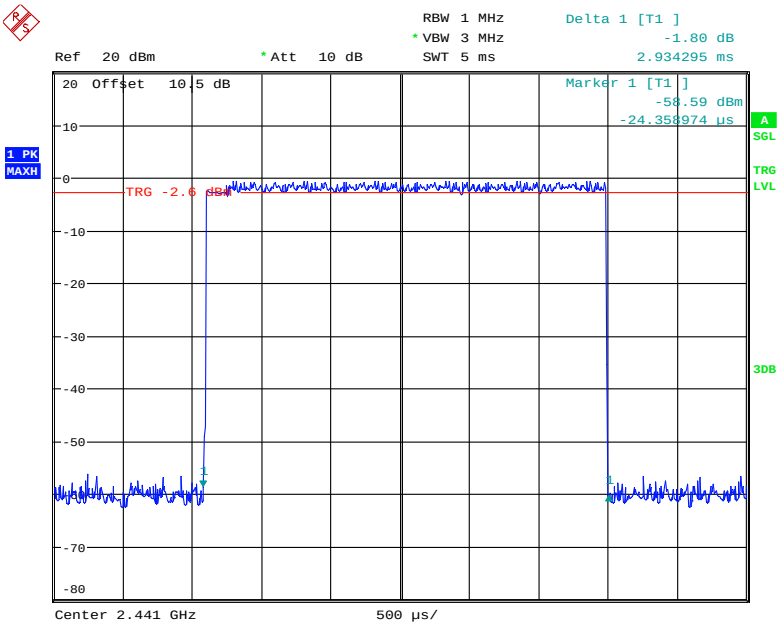
Date: 7.DEC.2018 11:45:45

Pulse time, Low Channel, 3DH5



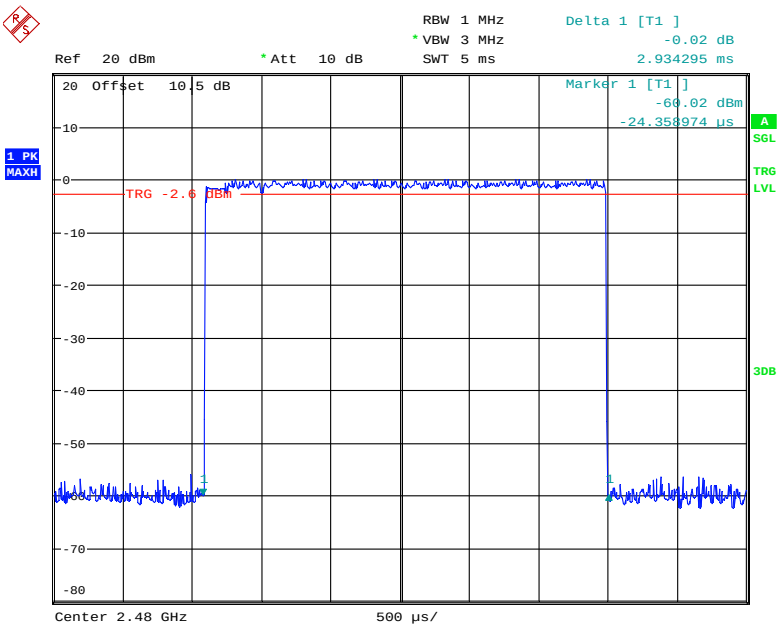
Date: 7.DEC.2018 11:53:19

Pulse time, Middle Channel, 3DH5



Date: 7.DEC.2018 11:53:32

Pulse time, High Channel, 3DH5



Date: 7.DEC.2018 11:53:44

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

Applicable Standard

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

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Kiki Kong on 2018-12-14.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table.

Mode	Channel	Frequency (MHz)	Peak Output Power		Limit (mW)
			(dBm)	(mW)	
BDR (GFSK)	Low	2402	0.72	1.180	125
	Middle	2441	-0.16	0.964	125
	High	2480	0.41	1.099	125
	Max.power	2409	1.44	1.393	125
EDR (π/4-DQPSK)	Low	2402	-0.01	0.998	125
	Middle	2441	-1.08	0.780	125
	High	2480	-0.24	0.946	125
	Max.power	2410	0.86	1.219	125
EDR (8DPSK)	Low	2402	0.39	1.094	125
	Middle	2441	-0.65	0.861	125
	High	2480	0.08	1.019	125
	Max.power	2410	1.21	1.321	125

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

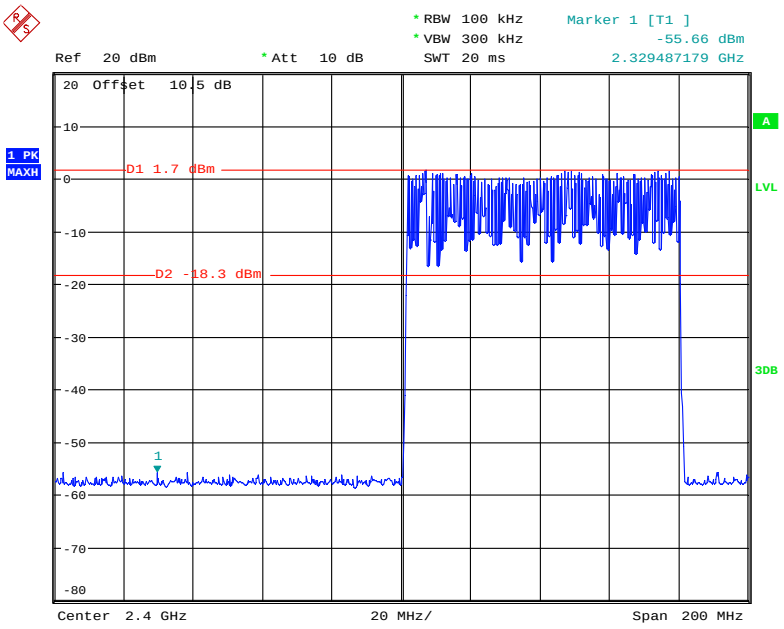
Temperature:	24 ℃
Relative Humidity:	54 %
ATM Pressure:	101.0 kPa

The testing was performed by Kiki Kong on 2018-12-07.

EUT operation mode: Transmitting

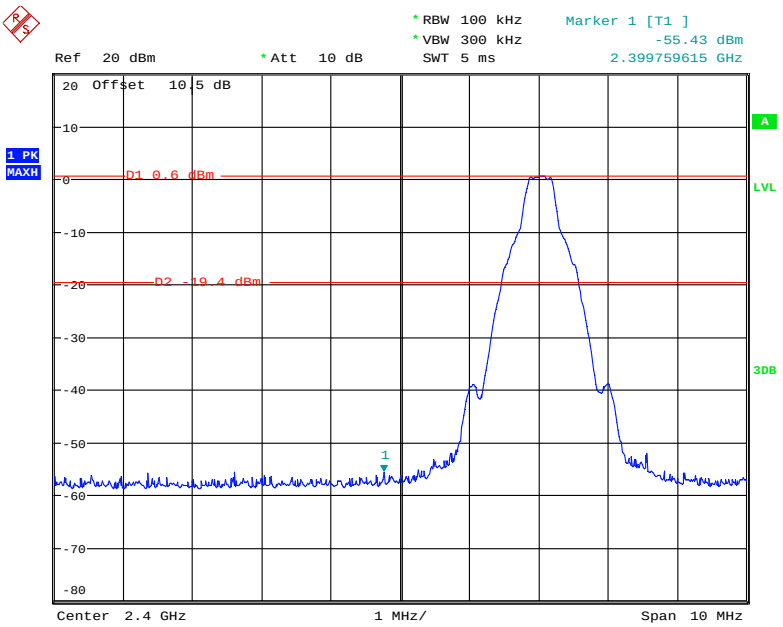
Test Result: Compliance. Please refer to following plots.

BDR (GFSK): Band Edge-Left Side Hopping



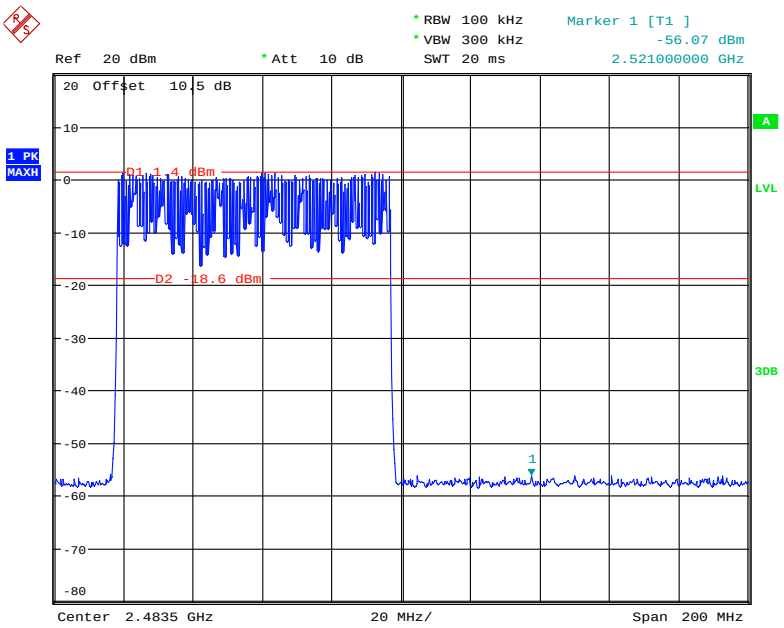
Date: 7.DEC.2018 11:11:00

Single



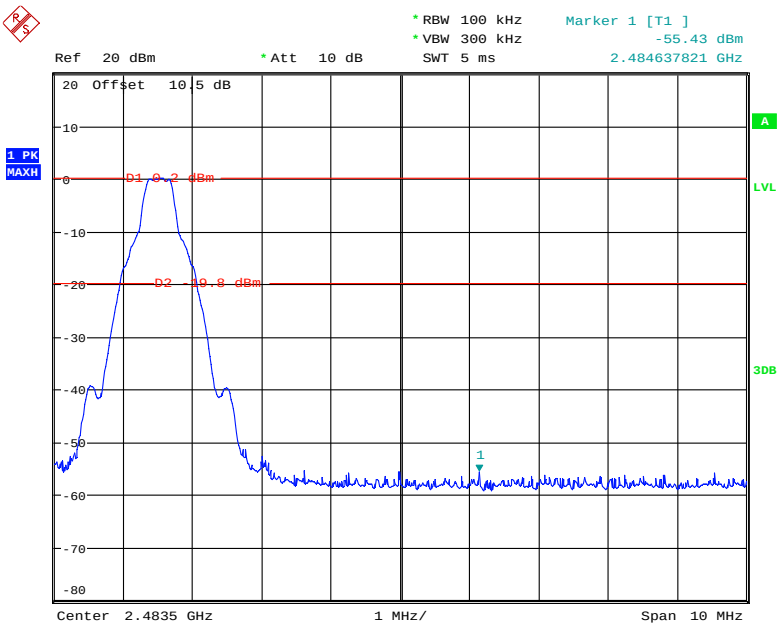
Date: 7.DEC.2018 11:09:24

BDR (GFSK): Band Edge-Right Side Hopping



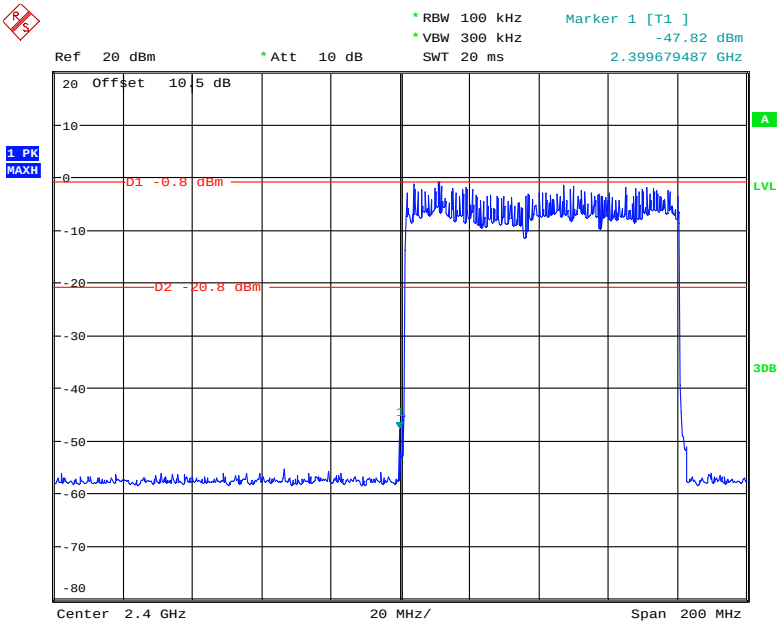
Date: 7.DEC.2018 11:12:09

Single



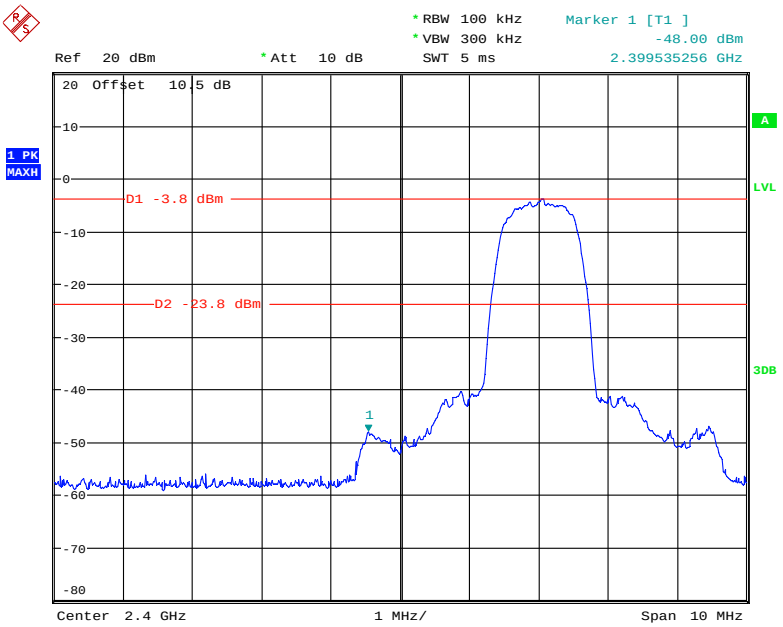
Date: 7.DEC.2018 11:12:54

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



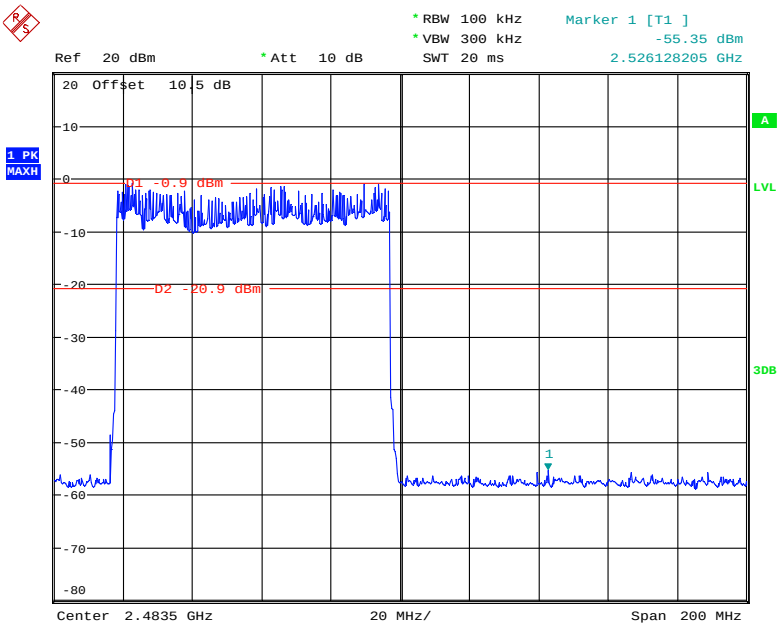
Date: 7.DEC.2018 11:16:09

Single



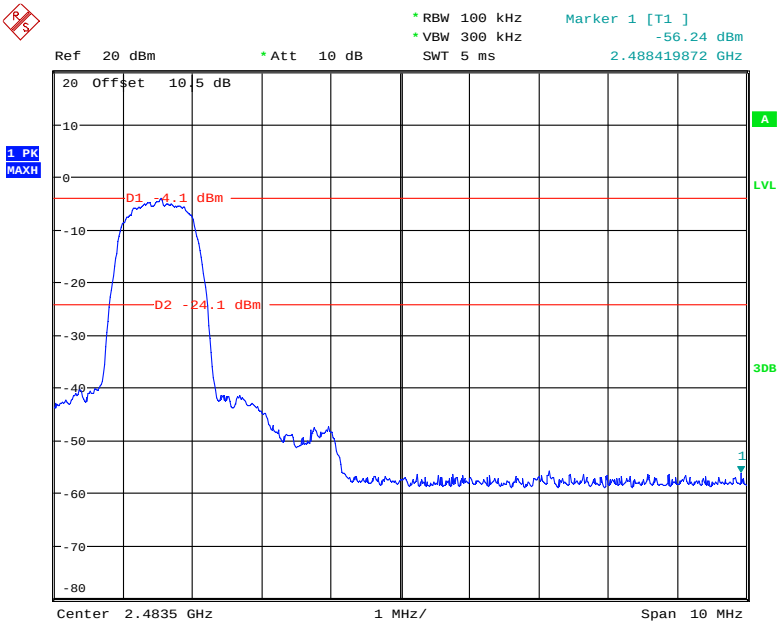
Date: 7.DEC.2018 11:16:59

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



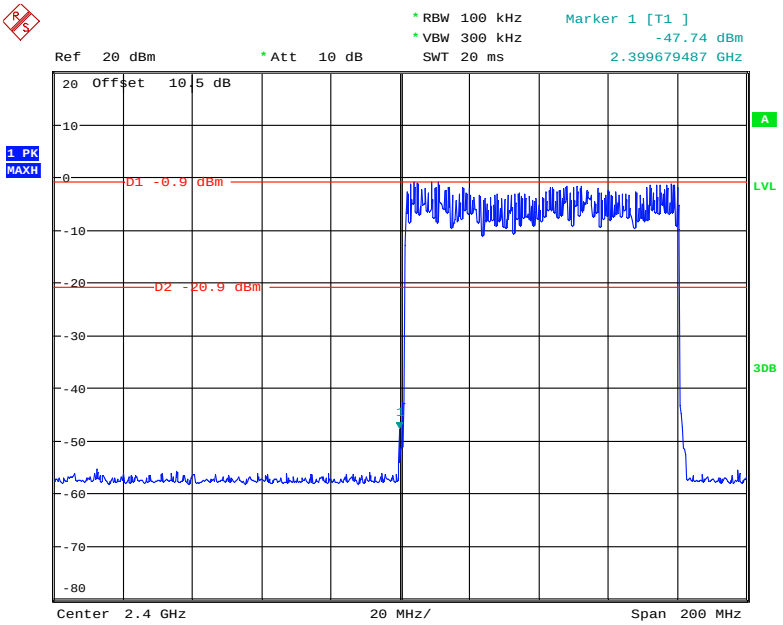
Date: 7.DEC.2018 11:15:06

Single



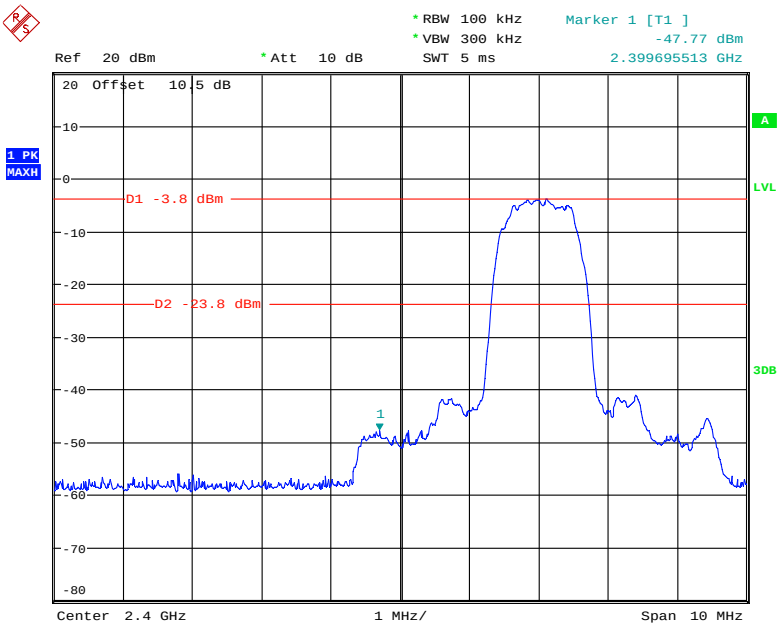
Date: 7.DEC.2018 11:13:55

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



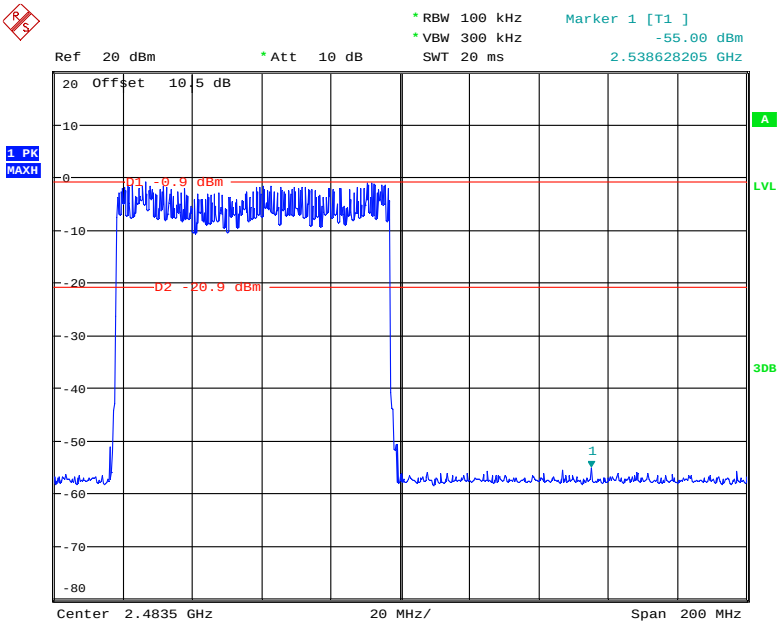
Date: 7.DEC.2018 11:19:56

Single



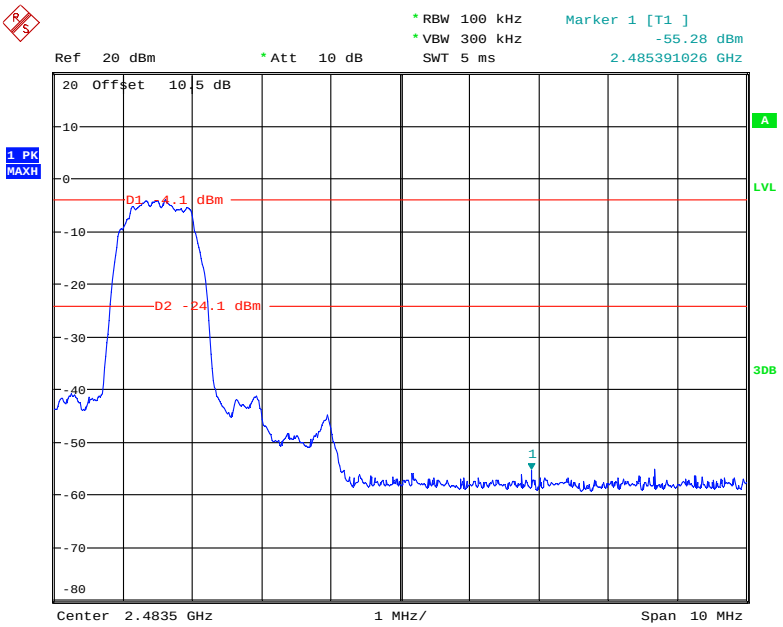
Date: 7.DEC.2018 11:17:47

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



Date: 7.DEC.2018 11:21:29

Single



Date: 7.DEC.2018 11:22:10

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