FCC PART 15.247
TEST REPORT

For

Cubic Transportation Systems, Inc.

5650 Kearny Mesa Road, San Diego, California 92111, United States

FCC ID: LVC312B

Report Type:	**Product Type:**
Original Report	5300-10009

Report Number:	RSZ181011003-00A
Report Date:	2019-04-19
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

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The information marked # is provided by the applicant, the laboratory is not responsible for its authenticity.

TABLE OF CONTENTS

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

The *Cubic Transportation Systems, Inc.'s* product, model number: *5300-10009-1 (FCC ID: LVC312B)* or the "EUT" in this report was a *5300-10009,* which was measured approximately: 125.0 mm (L) * 33.6 mm (W) * 205.0 mm (H), rated with input voltage: DC 3.7 V or DC 12-24V.

Notes: This series products model: 5300-10009-3 and 5300-10009-1are electrically identical. Model 5300-10009-1 was selected for fully testing, the detailed information can be referred to the declaration letter.

**All measurement and test data in this report was gathered from production sample serial number: 181011003. (Assigned by BACL, Shenzhen). The EUT supplied by the applicant was received on 2018-10-11.*

Objective

This test report is prepared on behalf of *Cubic Transportation Systems, Inc.* 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, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

FCC Part 15.247 DTS and Part 15.225 DXX submissions with FCC ID: LVC312B.

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 KDB 558074 D01 15.247 Meas Guidance v05r02.

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		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±1℃
Humidity		±6%
Supply voltages		±0.4%

Note: 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. (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

“blue test.exe” exercise software was used.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

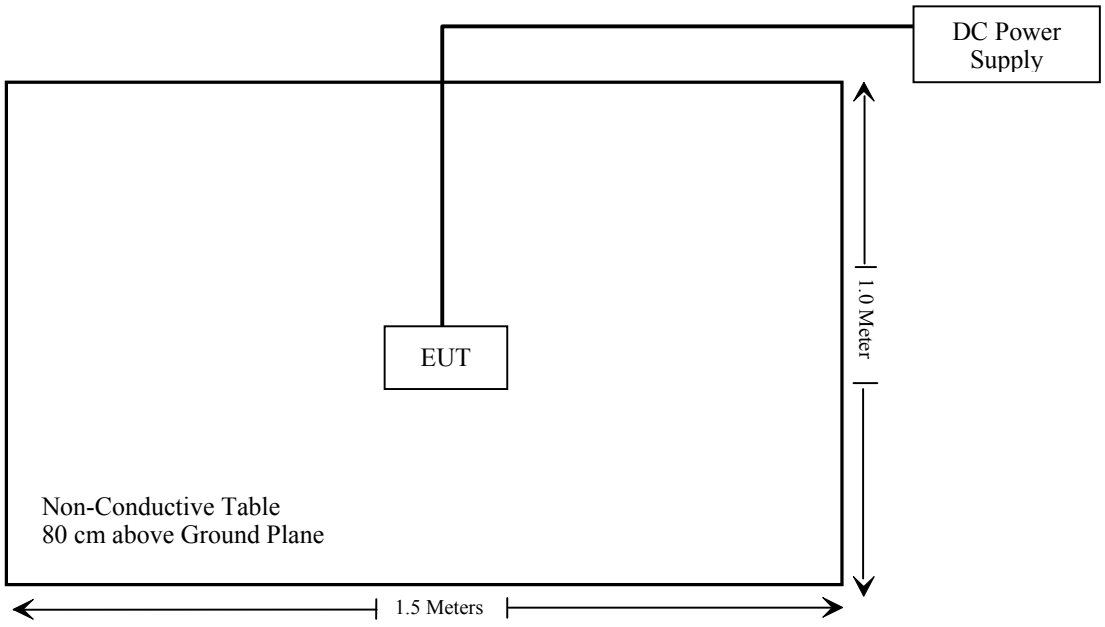
Manufacturer	Description	Model	Serial Number
Pro instrument	DC Power Supply	pps3300	N/A

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding detachable DC Cable	1.2	EUT	DC Power Supply

Block Diagram of Test Setup

For Radiated Emissions:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (1)& §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Not Applicable
§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

Not Applicable: EUT power by battery and used on vehicle.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
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	2018-05-22	2018-11-22
Sonoma instrument	Amplifier	310N	186238	2017-11-12	2018-11-12
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	2018-08-01	2019-02-01
Ducommun technologies	RF Cable	104PEA	218124002	2018-05-21	2018-11-21
Ducommun technologies	RF Cable	RG-214	1	2018-05-21	2018-11-19
Ducommun technologies	RF Cable	RG-214	2	2018-05-22	2018-11-22
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-04	2017-12-29	2020-12-28
Heatsink Required	Amplifier	QLW-18405536-J0	15964001002	2018-08-01	2019-02-01
Sinoscite	Band Reject Filter	BSF2402-2480MN-0898-001	99632	2018-05-21	2018-11-21
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
RF Conducted Test					
Agilent	USB wideband power meter	U2021XA	MY54250003	2018-06-23	2019-06-23
WEINSCHEL	3dB Attenuator	6231	666	Each Time	
Rohde & Schwarz	Spectrum Analyzer	FSU26	200120	2017-12-24	2018-12-24
Rohde & Schwarz	Spectrum Analyzer	FSU26	200120	2018-12-24	2019-12-24
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) & §1.1307 (b) (1) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 1.1307 (b)(1), 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		Max Tune-up Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
	(dBi)	(numeric)	(dBm)	(mW)			
GSM850 (824-849MHz)	1.6	1.4	24.5	281.8	20	0.079	0.55
PCS1900 (1850-1910)	1.6	1.4	20.5	112.2	20	0.031	1.00
WCDMA850 (824-849MHz)	1.6	1.4	23.5	223.9	20	0.062	0.55
WCDMA1900 (1850-1910)	1.6	1.4	24.0	251.2	20	0.070	1.00
Wi-Fi (2412-2462)	2.6	1.8	19.0	79.4	20	0.028	1.00
Bluetooth (2402-2480)	0.5	1.1	6.5	4.5	20	0.001	1.00

Note 1: The Tune-up power and antenna gain were declared by the applicant.
Note 2: Please refer to the report of FCC ID: UDV-1009092010008 for the max tune-up power.
Note 3: The Wi-Fi and Bluetooth have its own module, so they can transmit at the same time.

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.079/0.55 + 0.028/1 + 0.001/1 = 0.173 < 1.0$$

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 ceramic chip antenna arrangement, which was permanently attached and the antenna gain is 0.5 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliance.

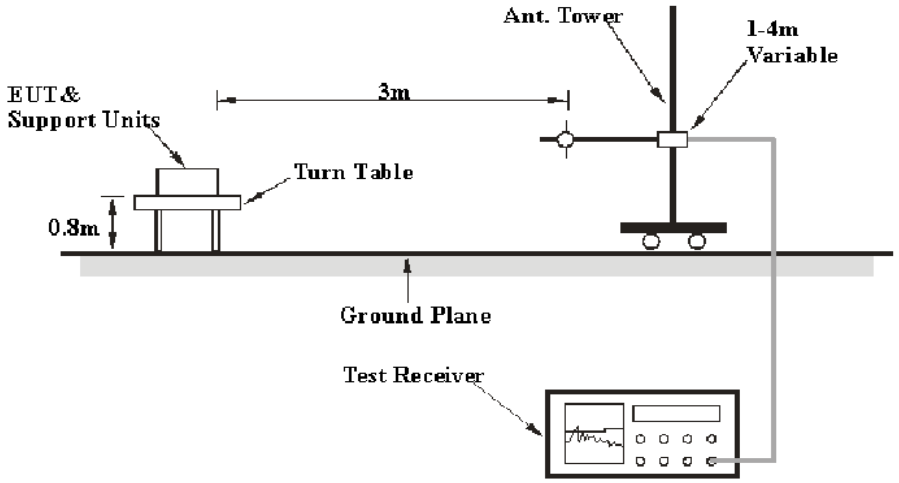
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

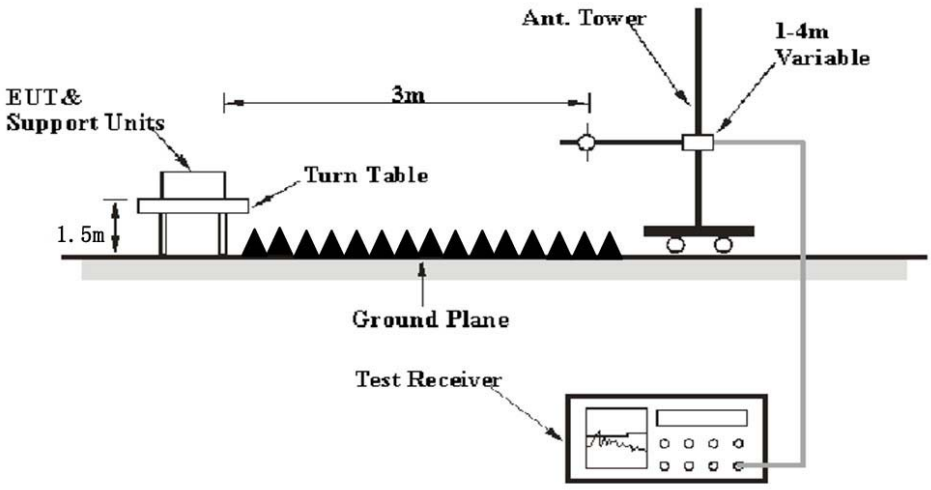
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



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

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

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

Frequency Range	RBW	Video B/W	IF B/W	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

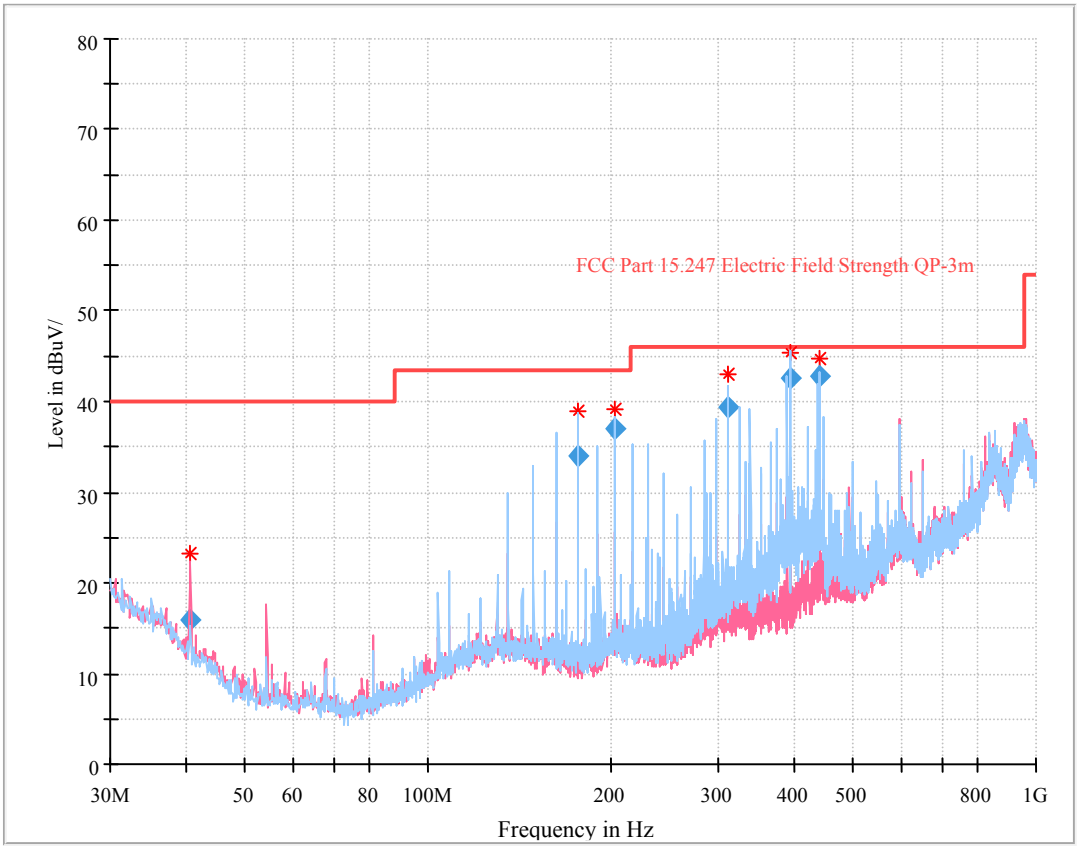
Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-10-26.

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)*



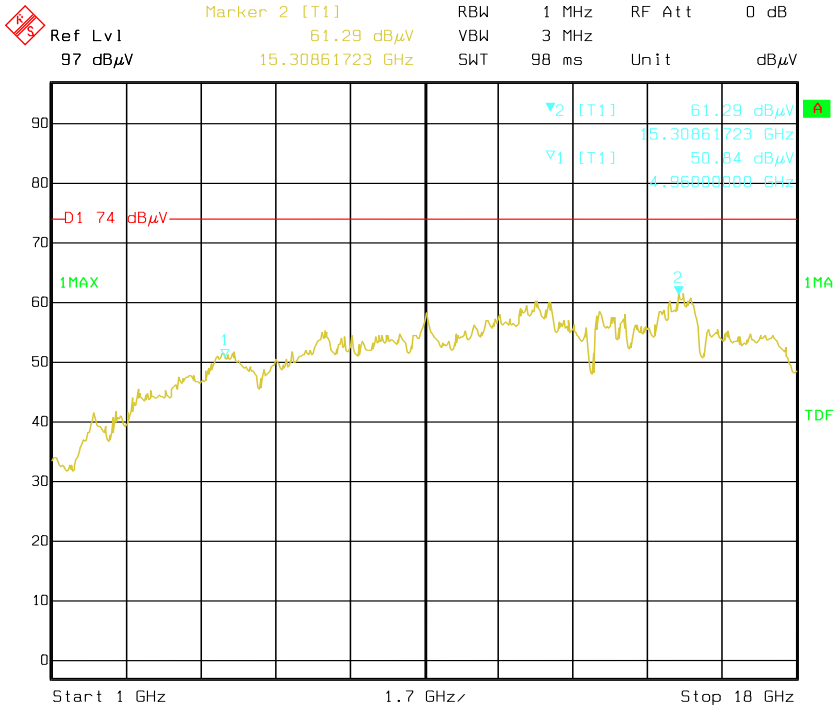
Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
40.687250	15.94	337.0	V	227.0	-14.2	40.00	24.06
176.281000	34.71	229.0	H	85.0	-15.1	43.50	8.79
203.406375	37.81	160.0	H	63.0	-13.8	43.50	5.69
311.906000	39.43	157.0	H	31.0	-10.7	46.00	6.57
395.188875	42.48	108.0	H	271.0	-10.4	46.00	3.52
442.004250	42.82	108.0	H	76.0	-8.6	46.00	3.18

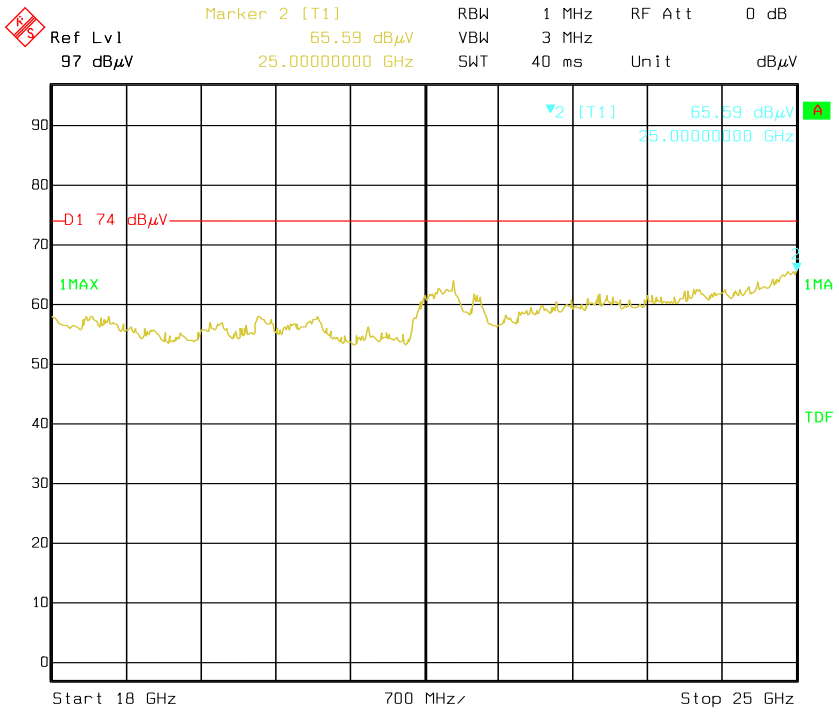
1 GHz - 25 GHz:

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)									
2402.00	63.23	PK	196	2.2	H	33.00	96.23	/	/
2402.00	50.03	Ave.	196	2.2	H	33.00	83.03	/	/
2402.00	58.37	PK	142	2.3	V	33.00	91.37	/	/
2402.00	45.29	Ave.	142	2.3	V	33.00	78.29	/	/
2399.00	27.15	PK	191	1.0	H	33.00	60.15	74	13.85
2399.00	13.27	Ave.	191	1.0	H	33.00	46.27	54	7.73
2483.50	27.49	PK	145	1.3	H	33.20	60.69	74	13.31
2483.50	13.38	Ave.	145	1.3	H	33.20	46.58	54	7.42
4804.00	42.97	PK	23	2.0	H	7.88	50.85	74	23.15
4804.00	29.75	Ave.	23	2.0	H	7.88	37.63	54	16.37
Middle Channel (2441 MHz)									
2441.00	65.03	PK	178	1.3	H	33.10	98.13	/	/
2441.00	54.74	Ave.	178	1.3	H	33.10	87.84	/	/
2441.00	59.23	PK	97	2.4	V	33.10	92.33	/	/
2441.00	47.25	Ave.	97	2.4	V	33.10	80.35	/	/
4882.00	42.20	PK	57	1.5	H	9.21	51.41	74	22.59
4882.00	28.13	Ave.	57	1.5	H	9.21	37.34	54	16.66
High Channel (2480 MHz)									
2480.00	67.92	PK	115	1.9	H	33.20	101.12	/	/
2480.00	56.28	Ave.	115	1.9	H	33.20	89.48	/	/
2480.00	60.18	PK	340	1.9	V	33.20	93.38	/	/
2480.00	48.77	Ave.	340	1.9	V	33.20	81.97	/	/
2399.00	27.44	PK	332	1.8	H	33.00	60.44	74	13.56
2399.00	13.26	Ave.	332	1.8	H	33.00	46.26	54	7.74
2483.50	32.22	PK	130	1.3	H	33.20	65.42	74	8.58
2483.50	14.97	Ave.	130	1.3	H	33.20	48.17	54	5.83
4960.00	43.27	PK	135	1.1	H	9.07	52.34	74	21.66
4960.00	29.79	Ave.	135	1.1	H	9.07	38.86	54	15.14

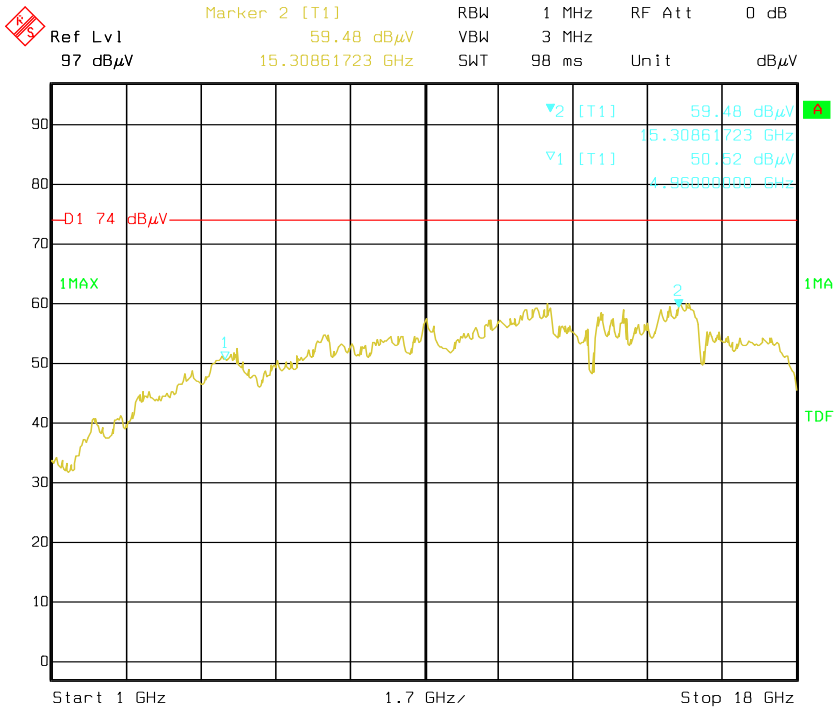
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB to the limit was not recorded.
And for the pre-scan is performed with the 2400-2483.5MHz band filter.

Pre-scan with High channel Peak
Horizontal





Vertical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97 dBµV
59.48 dBµV
15.30861723 GHz
RBW 1 MHz
VBW 3 MHz
SWT 98 ms
RF Att 0 dB
Unit dBµV
▼2 [T1] 59.48 dBµV
15.30861723 GHz
▽1 [T1] 50.52 dBµV
4.95000000 GHz
D1 74 dBµV
1MAX
1MA
TDF
A
Start 1 GHz
1.7 GHz/
Stop 18 GHz
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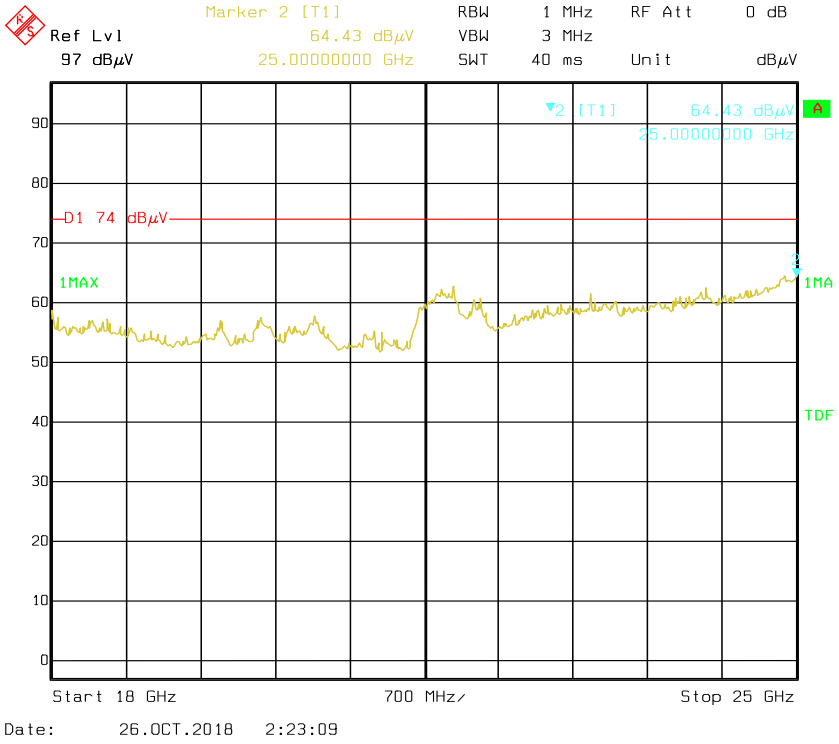
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64.43 dBµV
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RBW 1 MHz
VBW 3 MHz
SWT 40 ms
RF Att 0 dB
Unit dBµV
▼2 [T1] 64.43 dBµV
25.00000000 GHz
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1MA
TDF
A
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700 MHz/
Stop 25 GHz
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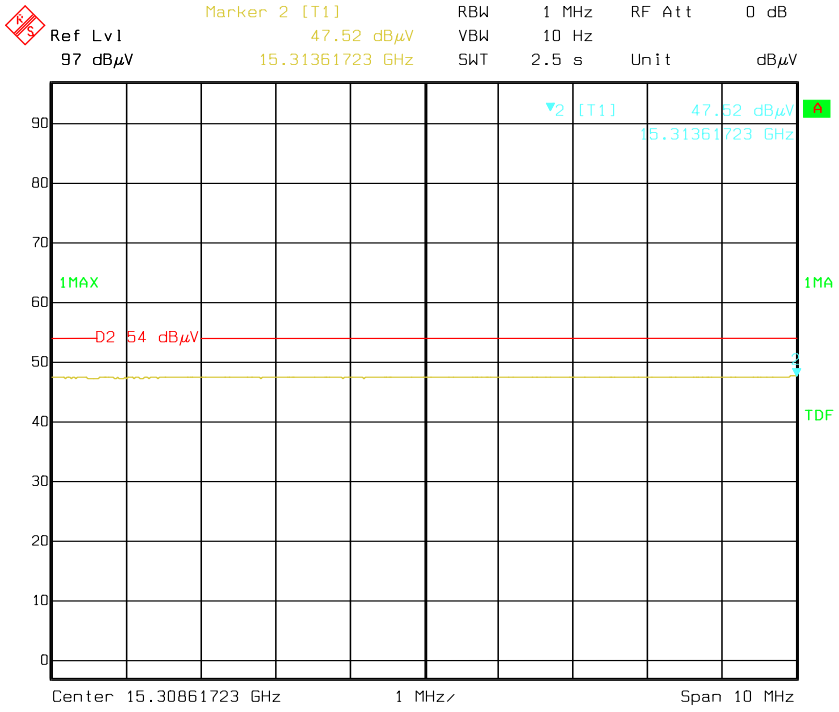
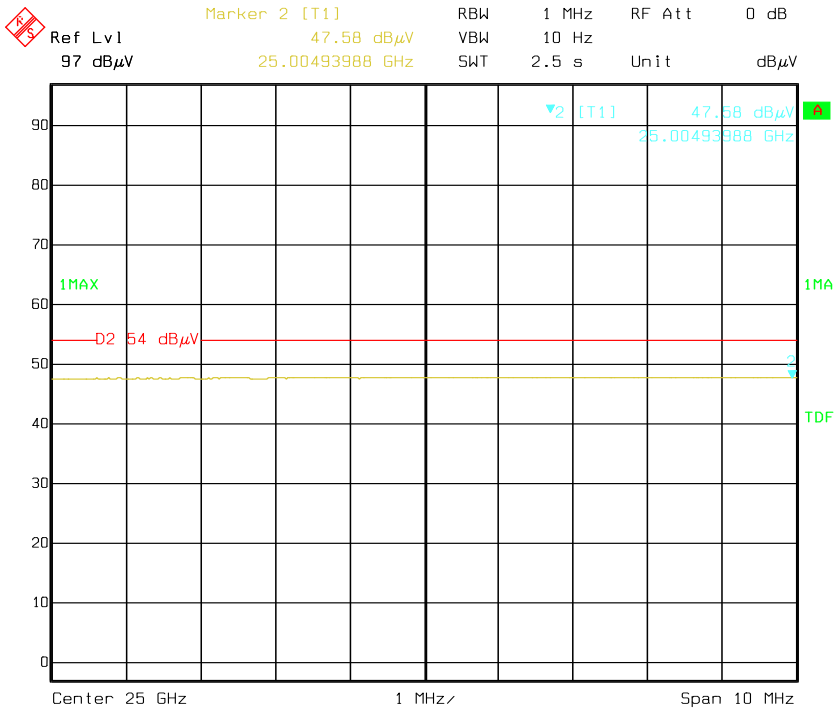
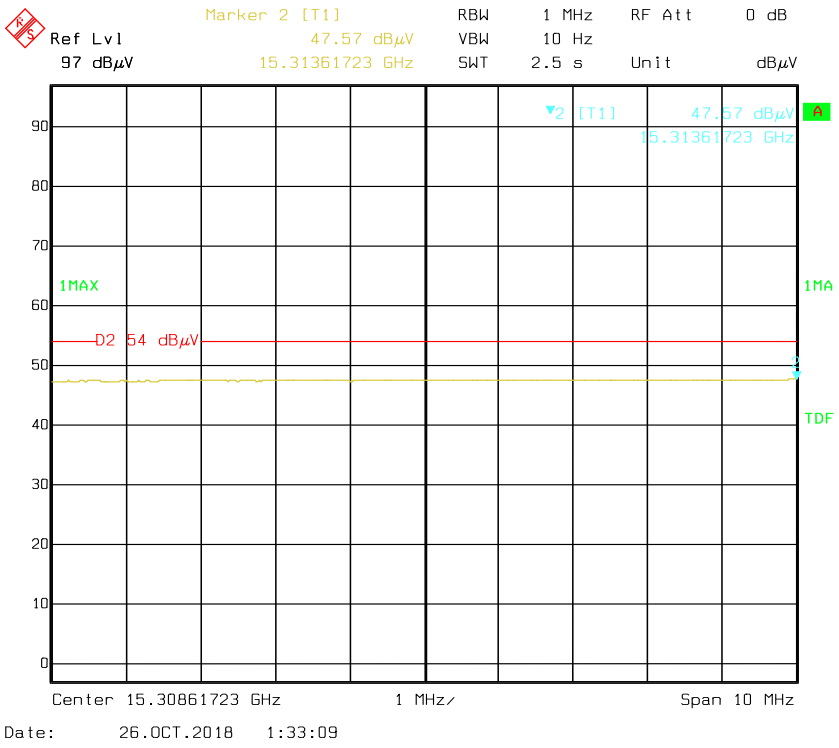
Pre-scan for Average
Horizontal





Vertical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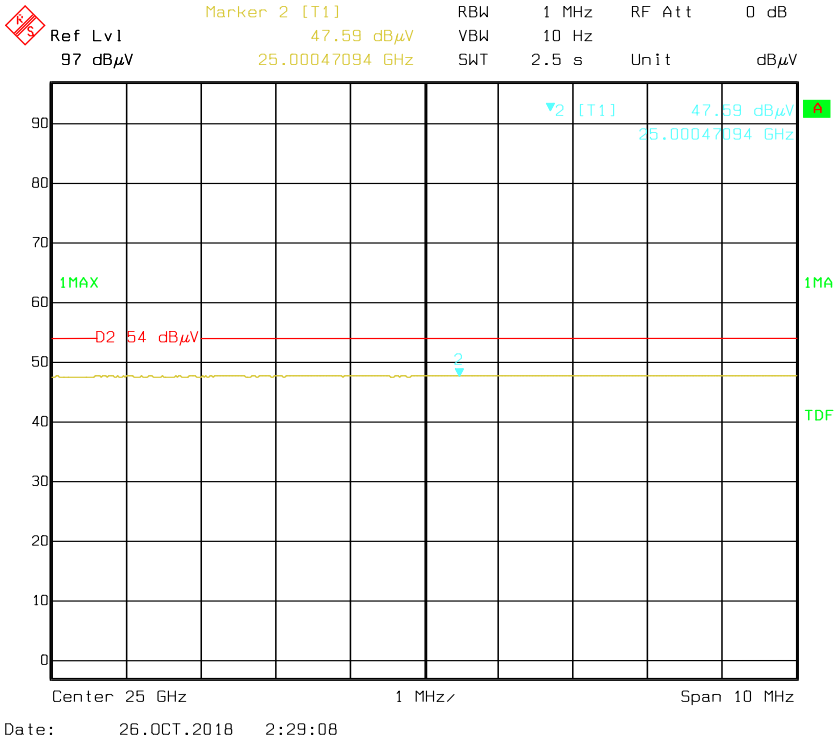
97 dBµV
47.57 dBµV
15.31361723 GHz
RBW 1 MHz
VBW 10 Hz
SWT 2.5 s
RF Att 0 dB
Unit dBµV
▼2 [T1]
47.57 dBµV
15.31361723 GHz
A
1MAX
1MA
D2 54 dBµV
TDF
Center 15.30861723 GHz
1 MHz/
Span 10 MHz
Date: 26.OCT.2018 1:33:09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RBW 1 MHz
VBW 10 Hz
SWT 2.5 s
RF Att 0 dB
Unit dBµV
▼2 [T1]
47.59 dBµV
25.00047094 GHz
A
1MAX
1MA
D2 54 dBµV
TDF
Center 25 GHz
1 MHz/
Span 10 MHz
Date: 26.OCT.2018 2:29:08

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:	25 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-10-25.

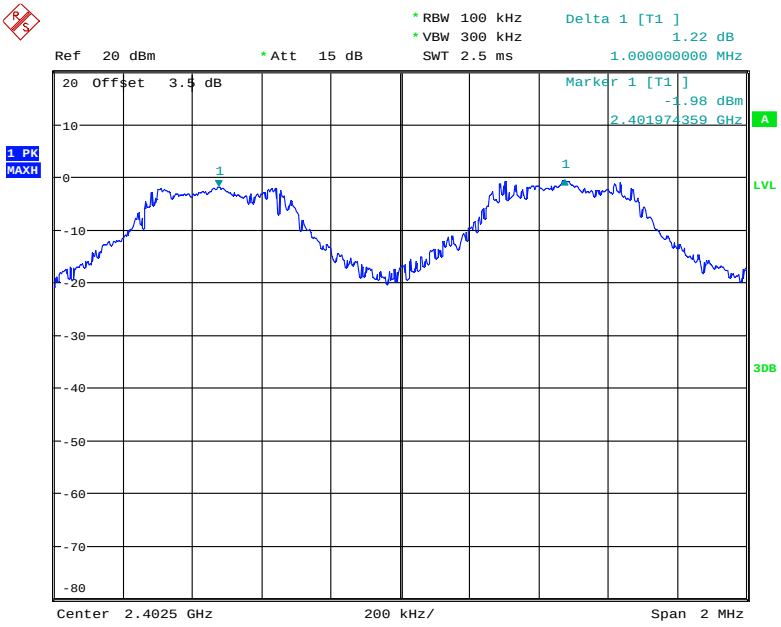
EUT operation mode: Transmitting

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	1.000	0.933	0.622	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.022	0.899	0.599	> two-thirds of the 20 dB bandwidth	Compliance
High	1.000	0.899	0.599	> two-thirds of the 20 dB bandwidth	Compliance
EDR(π/4-DQPSK)					
Low	1.000	1.250	0.833	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.006	1.255	0.837	> two-thirds of the 20 dB bandwidth	Compliance
High	1.026	1.260	0.840	> two-thirds of the 20 dB bandwidth	Compliance
EDR(8DPSK)					
Low	1.006	1.236	0.824	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.003	1.255	0.837	> two-thirds of the 20 dB bandwidth	Compliance
High	1.006	1.250	0.833	> two-thirds of the 20 dB bandwidth	Compliance

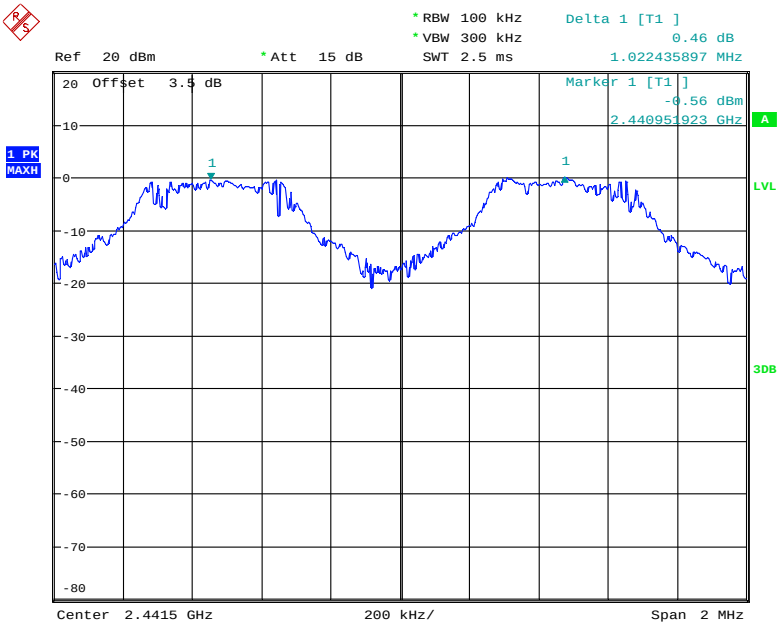
Please refer to the following plots.

BDR (GFSK): Low Channel



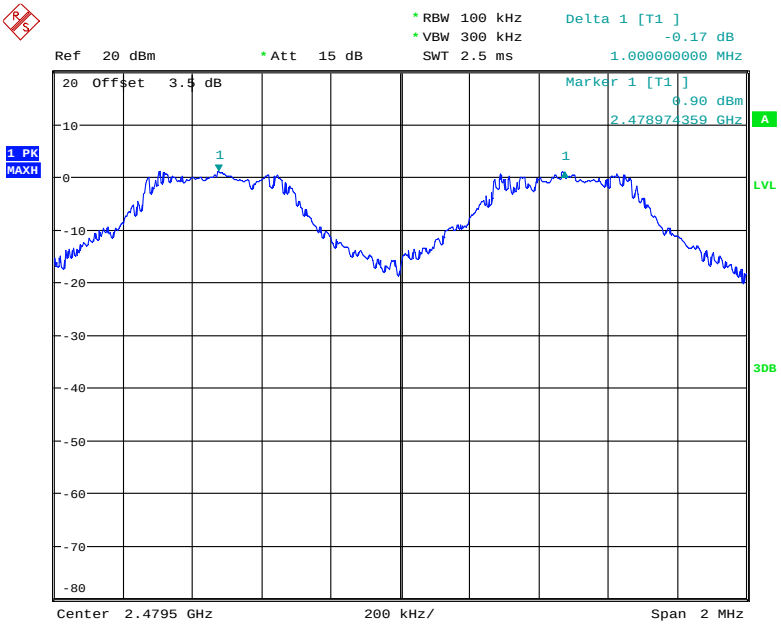
Date: 25.OCT.2018 20:48:14

BDR (GFSK): Middle Channel



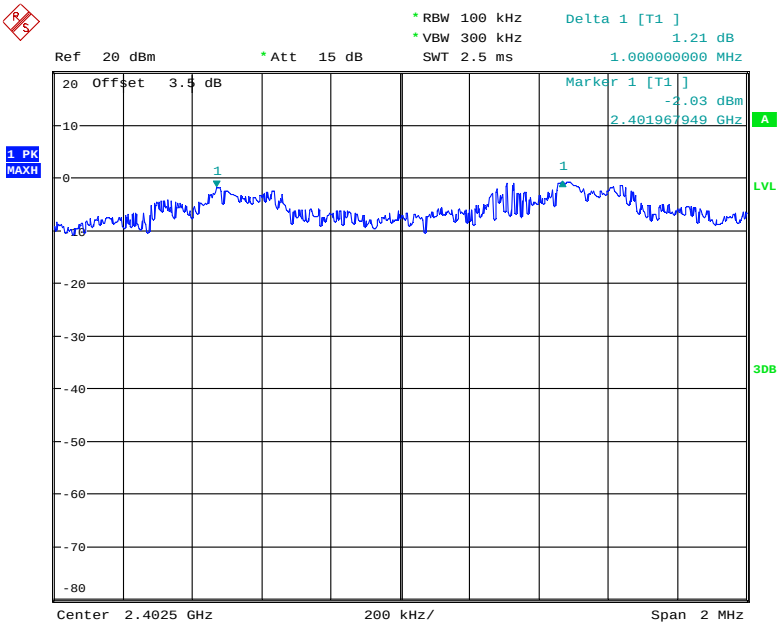
Date: 25.OCT.2018 20:50:05

BDR (GFSK): High Channel



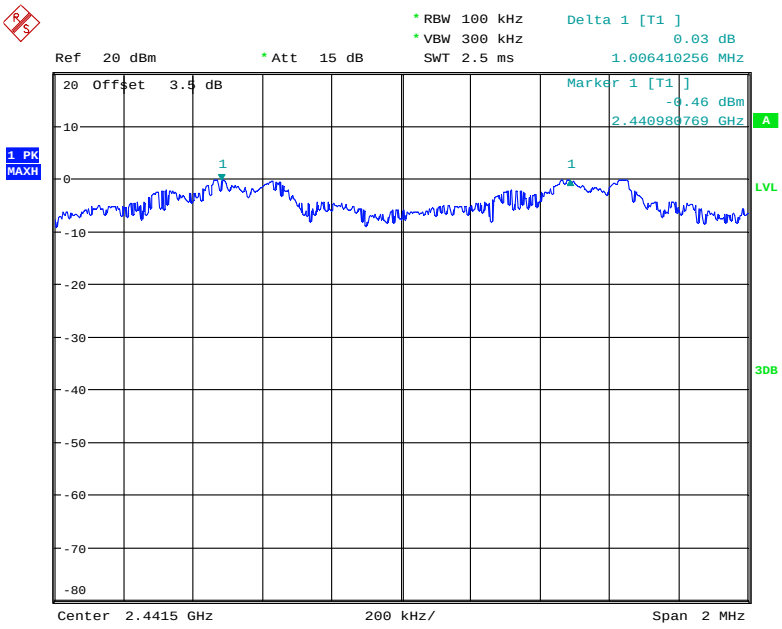
Date: 25.OCT.2018 20:52:14

EDR (π/4-DQPSK): Low Channel



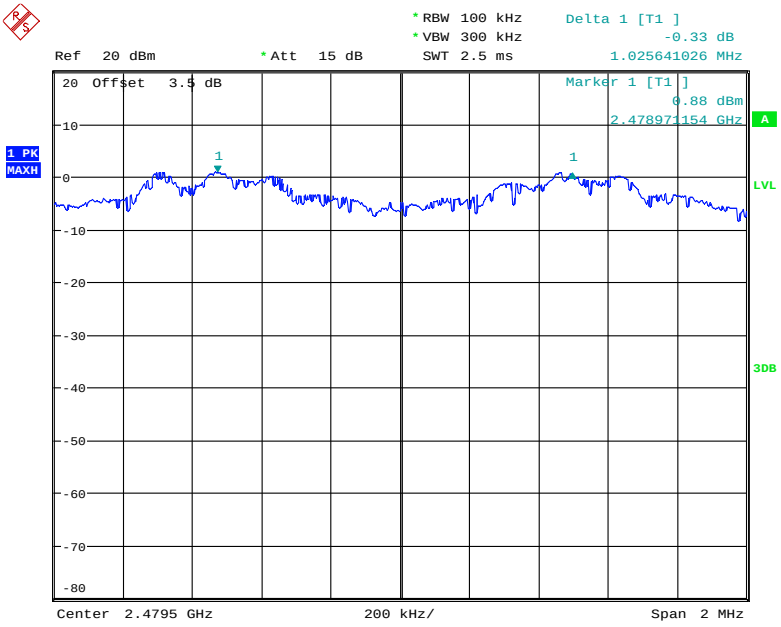
Date: 25.OCT.2018 21:02:08

EDR (π/4-DQPSK): Middle Channel



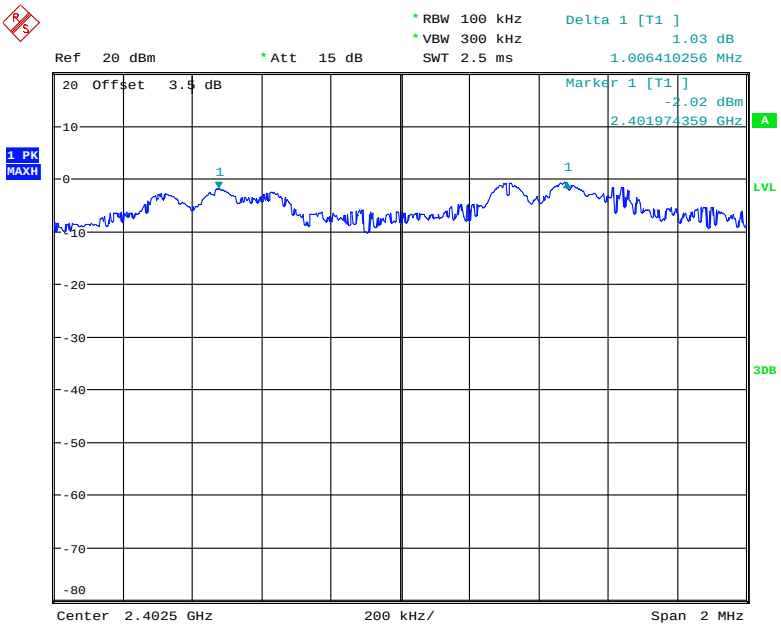
Date: 25.OCT.2018 20:59:57

EDR (π/4-DQPSK): High Channel



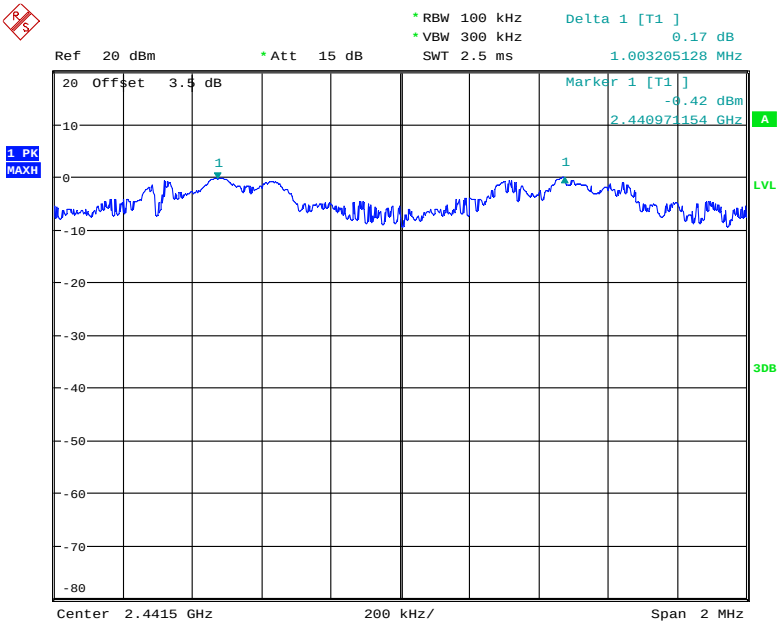
Date: 25.OCT.2018 20:56:40

EDR (8DPSK): Low Channel



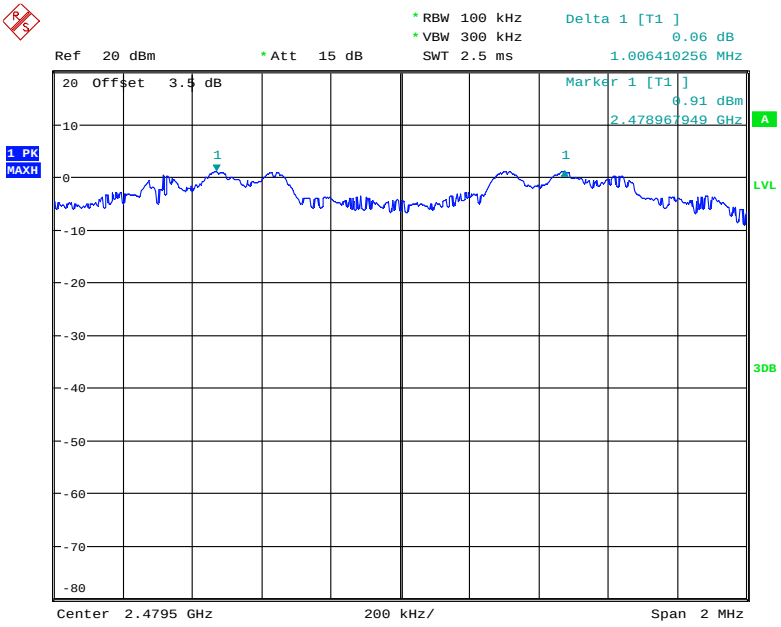
Date: 25.OCT.2018 21:06:21

EDR (8DPSK): Middle Channel



Date: 25.OCT.2018 21:09:42

EDR (8DPSK): High Channel



Date: 25.OCT.2018 21:15:09

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:	25 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

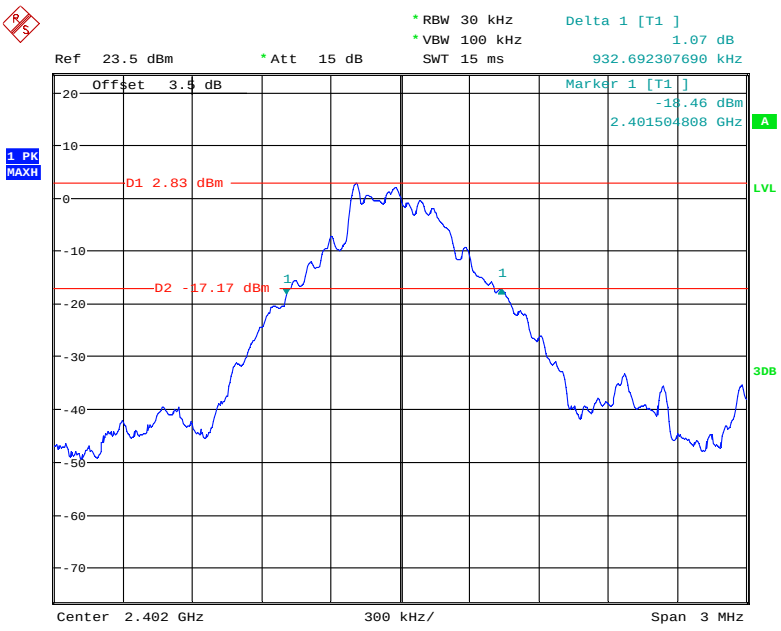
The testing was performed by Tracy Hu on 2018-10-24.

EUT operation mode: Transmitting

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

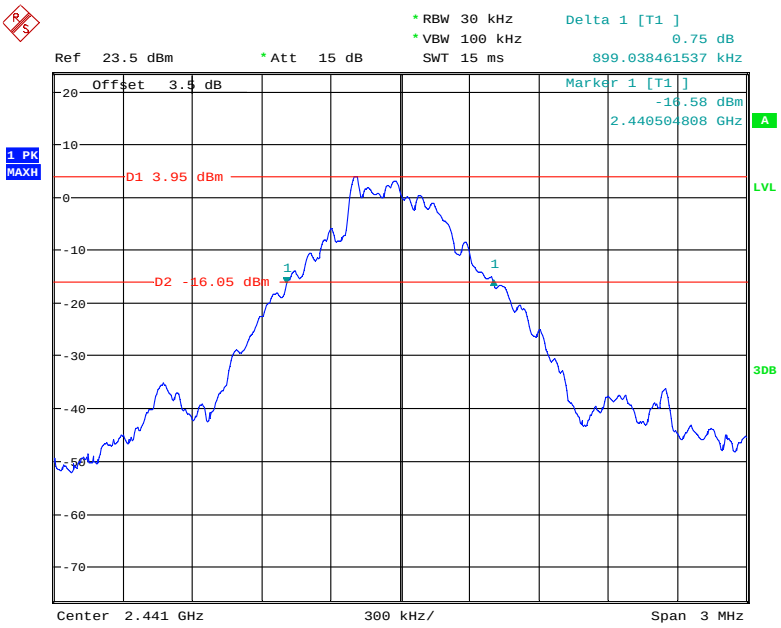
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.933
	Middle	2441	0.899
	High	2480	0.899
EDR (π/4-DQPSK)	Low	2402	1.250
	Middle	2441	1.255
	High	2480	1.260
EDR (8DPSK)	Low	2402	1.236
	Middle	2441	1.255
	High	2480	1.250

BDR (GFSK): Low Channel



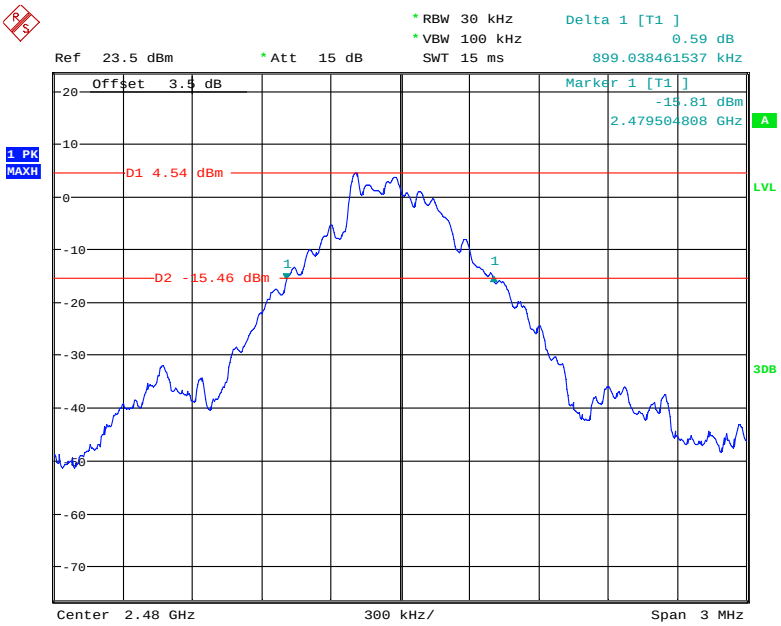
Date: 24.OCT.2018 16:59:52

BDR (GFSK): Middle Channel



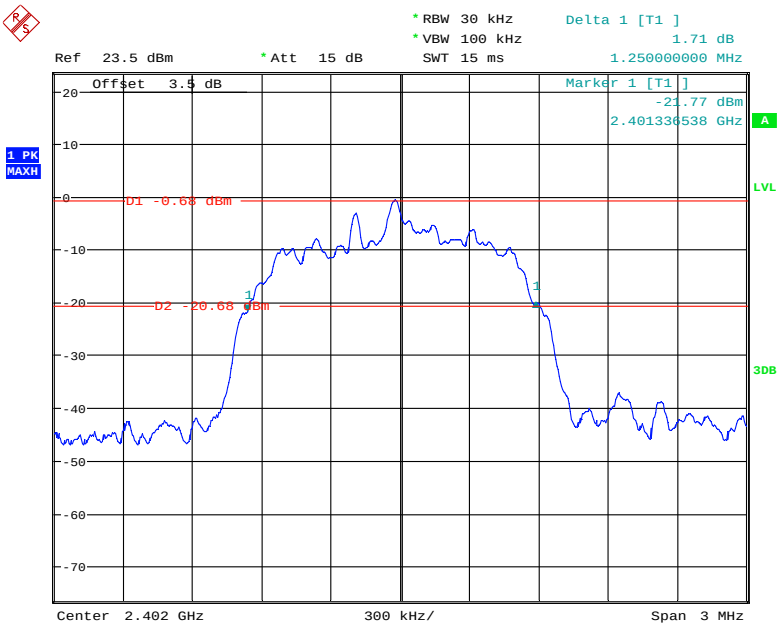
Date: 24.OCT.2018 17:02:17

BDR (GFSK): High Channel



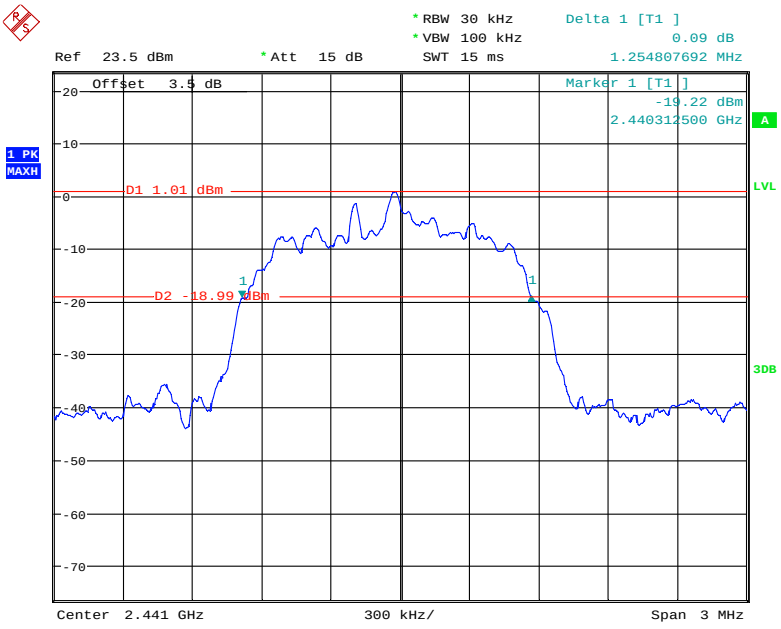
Date: 24.OCT.2018 17:03:18

EDR (π/4-DQPSK): Low Channel



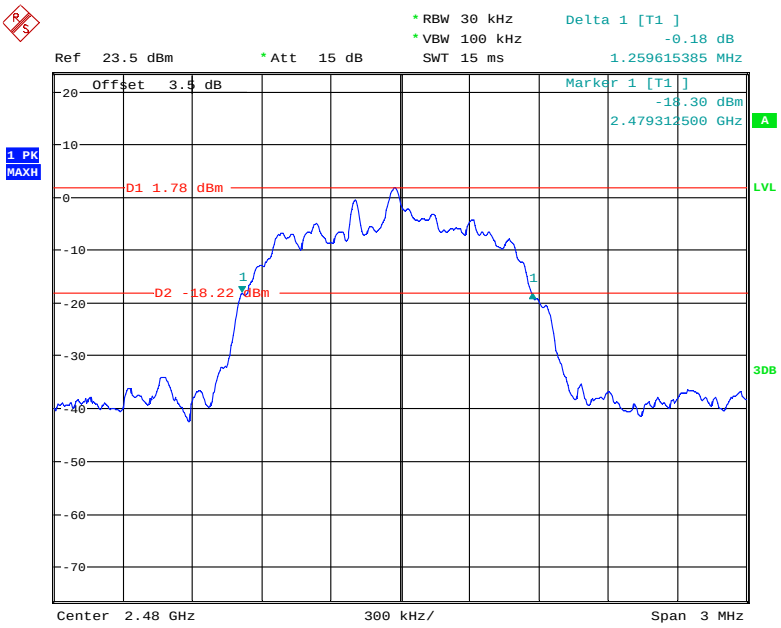
Date: 24.OCT.2018 17:07:35

EDR (π/4-DQPSK): Middle Channel



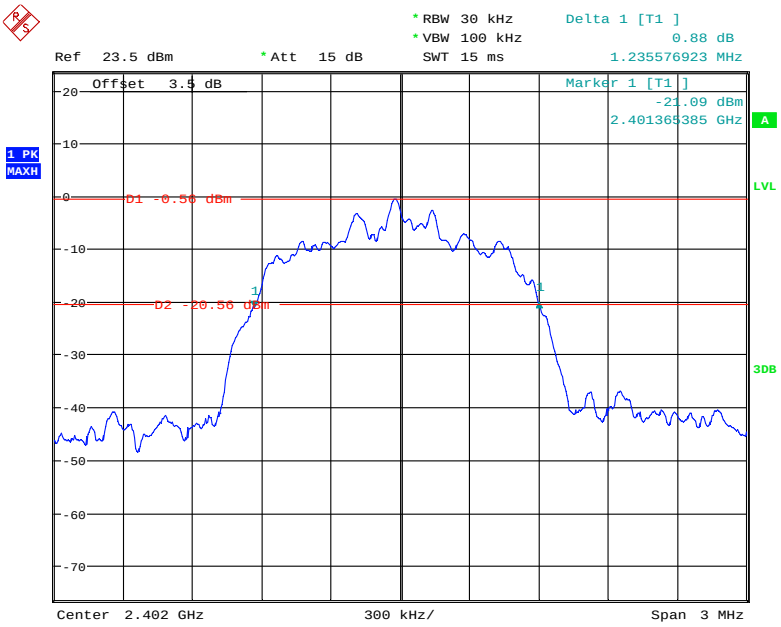
Date: 24.OCT.2018 17:06:30

EDR (π/4-DQPSK): High Channel



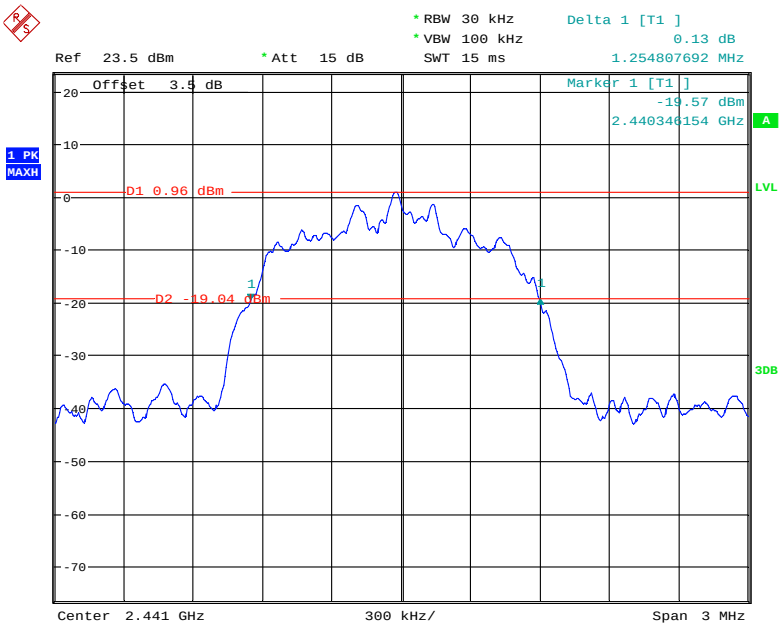
Date: 24.OCT.2018 17:05:06

EDR (8DPSK): Low Channel



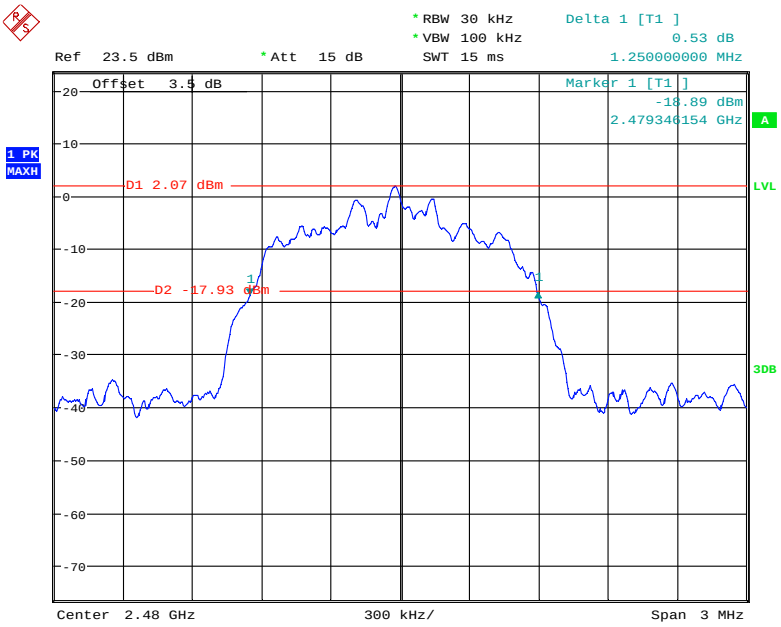
Date: 24.OCT.2018 16:58:24

EDR (8DPSK): Middle Channel



Date: 24.OCT.2018 16:57:18

EDR (8DPSK): High Channel



Date: 24.OCT.2018 16:55:06

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:	25 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

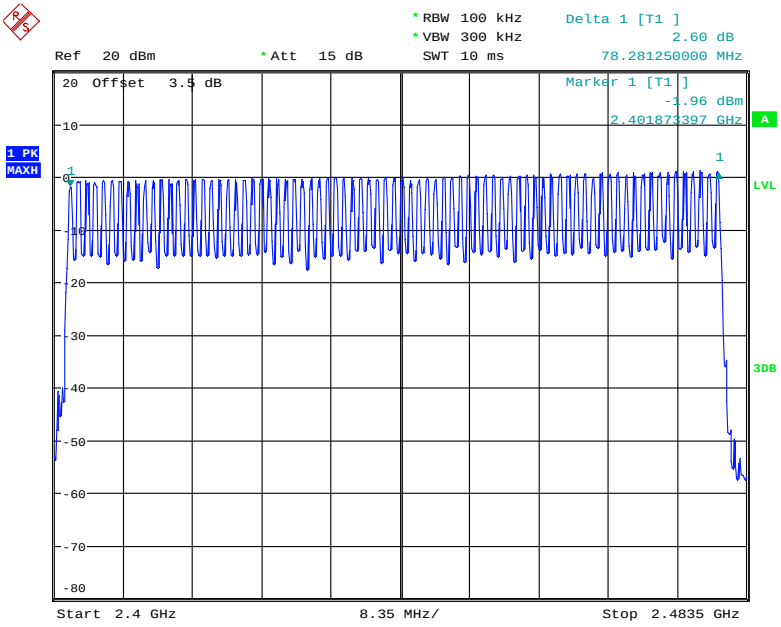
The testing was performed by Tracy Hu on 2018-10-25.

EUT operation mode: Transmitting

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

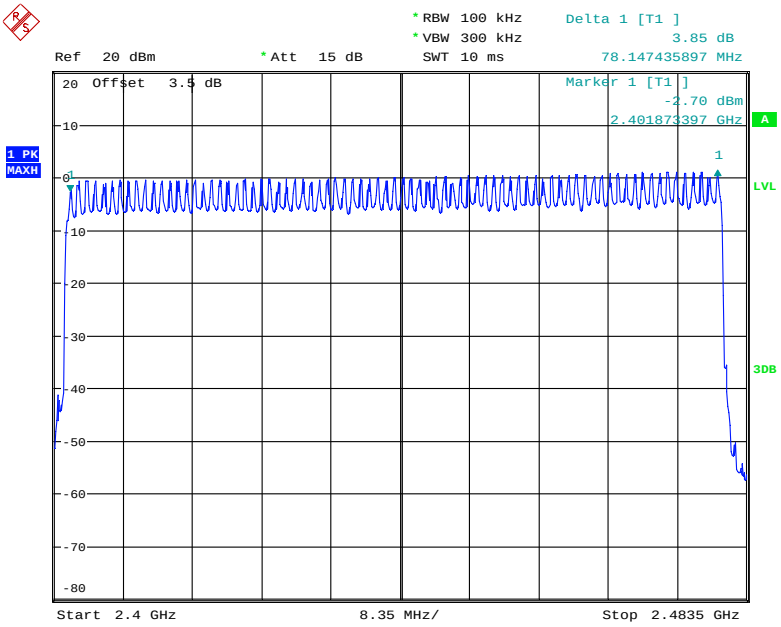
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥15
EDR (π/4-DQPSK)	2400-2483.5	79	≥15
EDR (8DPSK)	2400-2483.5	79	≥15

BDR (GFSK): Number of Hopping Channels



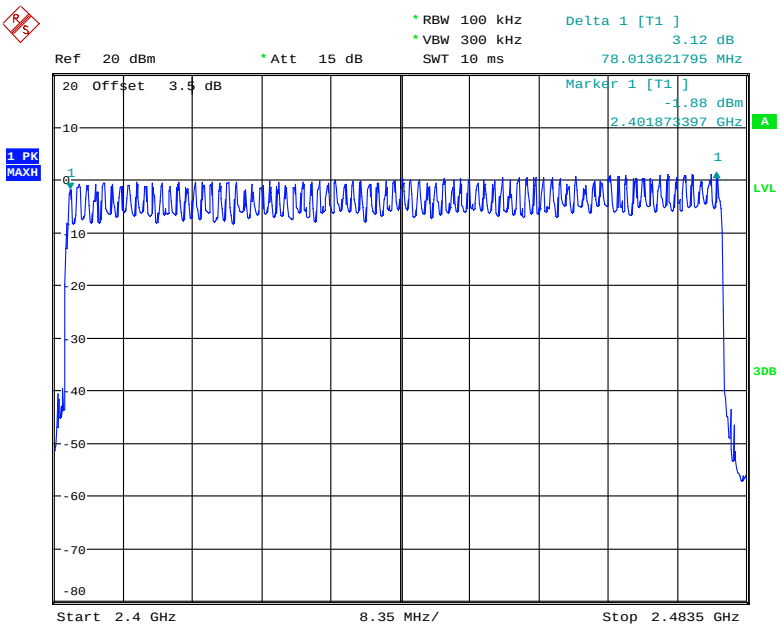
Date: 25.OCT.2018 20:45:37

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



Date: 25.OCT.2018 20:39:39

EDR (8DPSK): Number of Hopping Channels



Date: 25.OCT.2018 20:31:38

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:	25 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Simon Wang on 2019-04-18.

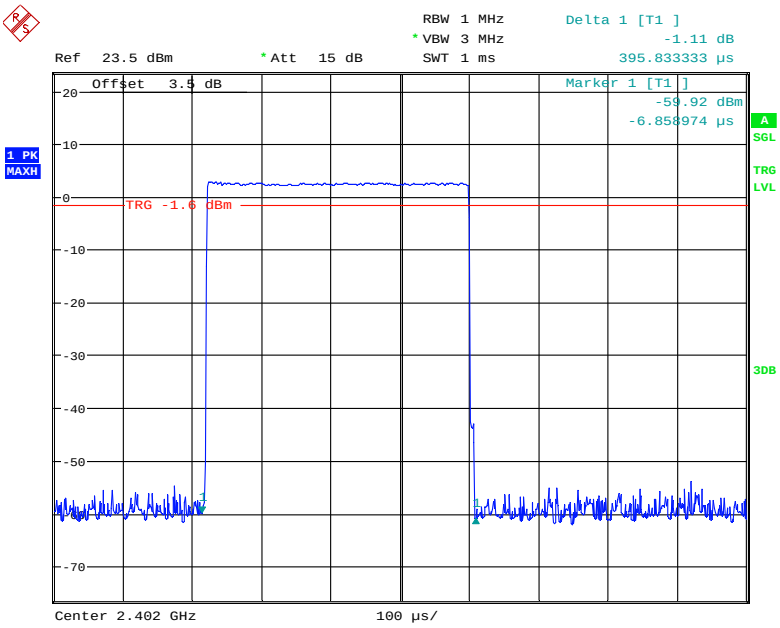
EUT operation mode: Transmitting

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	0.396	0.127	0.4	Pass
		Middle	0.396	0.127	0.4	Pass
		High	0.396	0.127	0.4	Pass
		Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	DH 3	Low	1.661	0.266	0.4	Pass
		Middle	1.661	0.266	0.4	Pass
		High	1.661	0.266	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	DH 5	Low	2.916	0.311	0.4	Pass
		Middle	2.916	0.311	0.4	Pass
		High	2.916	0.311	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (π/4-DQPSK)	2DH 1	Low	0.401	0.128	0.4	Pass
		Middle	0.401	0.128	0.4	Pass
		High	0.401	0.128	0.4	Pass
		Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	2DH 3	Low	1.661	0.266	0.4	Pass
		Middle	1.661	0.266	0.4	Pass
		High	1.661	0.266	0.4	Pass
		Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	2DH 5	Low	2.916	0.311	0.4	Pass
		Middle	2.916	0.311	0.4	Pass
		High	2.916	0.311	0.4	Pass
		Note:2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (8DPSK)	3DH 1	Low	0.401	0.128	0.4	Pass
		Middle	0.401	0.128	0.4	Pass
		High	0.401	0.128	0.4	Pass
		Note: 3DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	3DH 3	Low	1.661	0.266	0.4	Pass
		Middle	1.661	0.266	0.4	Pass
		High	1.661	0.266	0.4	Pass
		Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	3DH 5	Low	2.916	0.311	0.4	Pass
		Middle	2.916	0.311	0.4	Pass
		High	2.916	0.311	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				

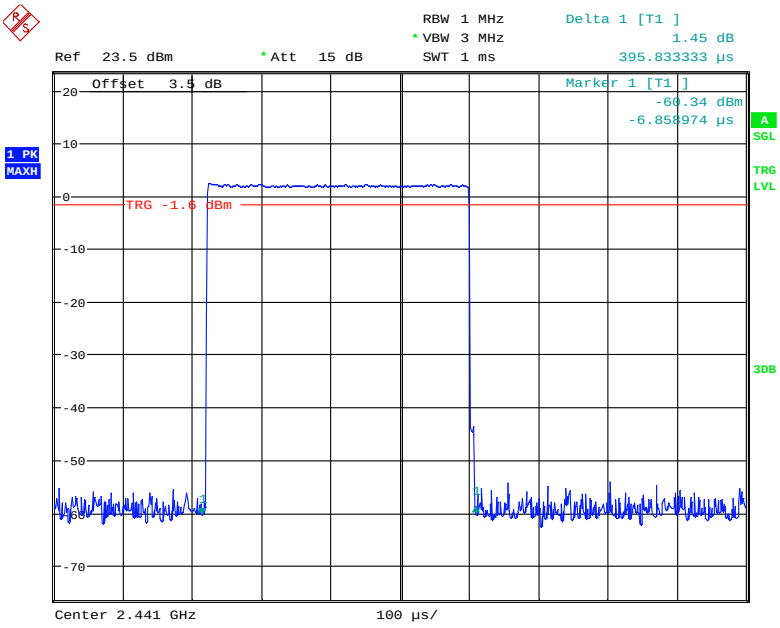
BDR (GFSK):

Pulse time, Low Channel, DH1



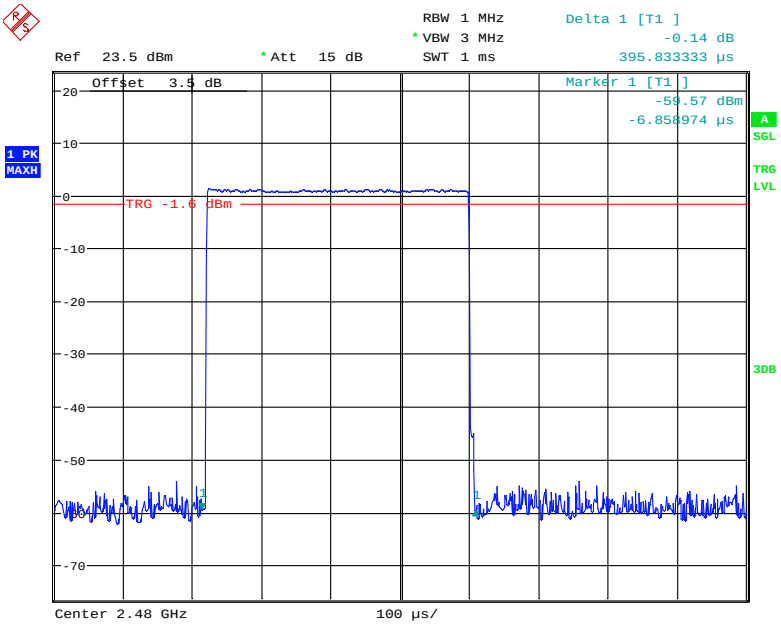
Date: 18.APR.2019 18:28:48

Pulse time, Middle Channel, DH1



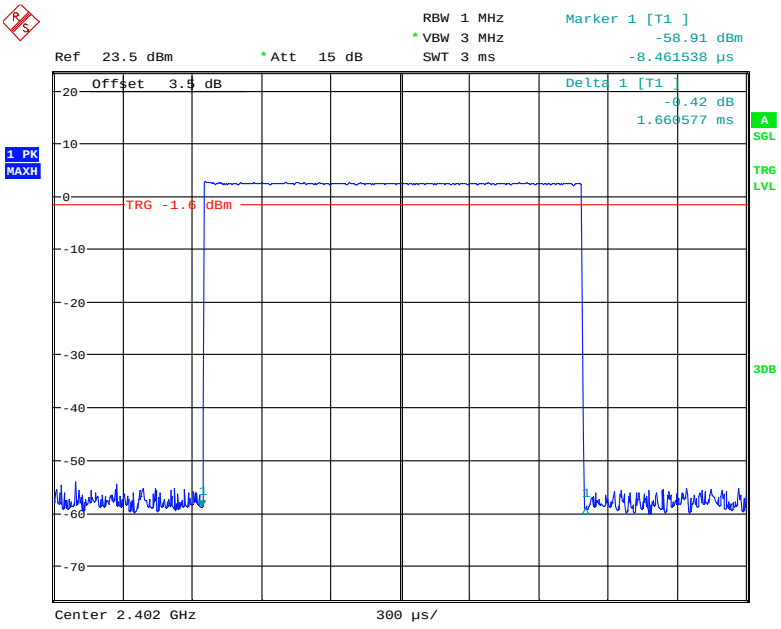
Date: 18.APR.2019 18:29:33

Pulse time, High Channel, DH1



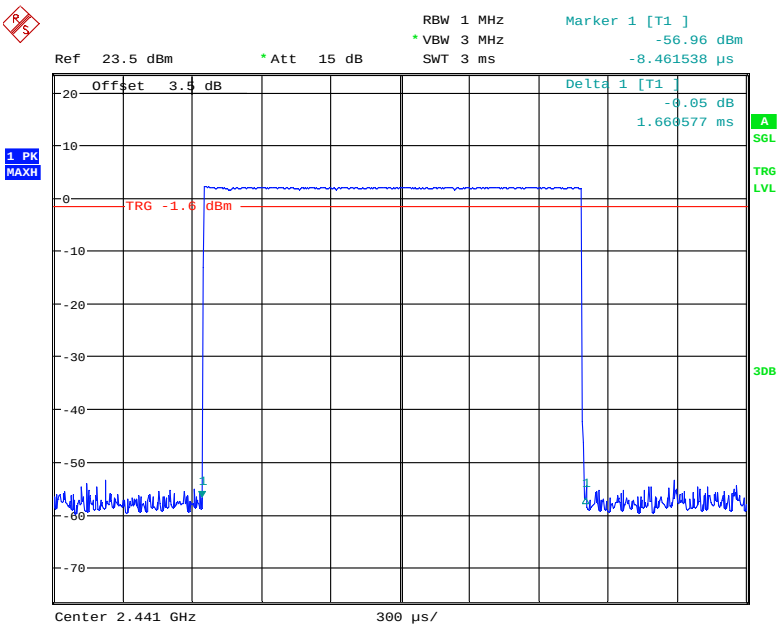
Date: 18.APR.2019 18:30:03

Pulse time, Low Channel, DH3



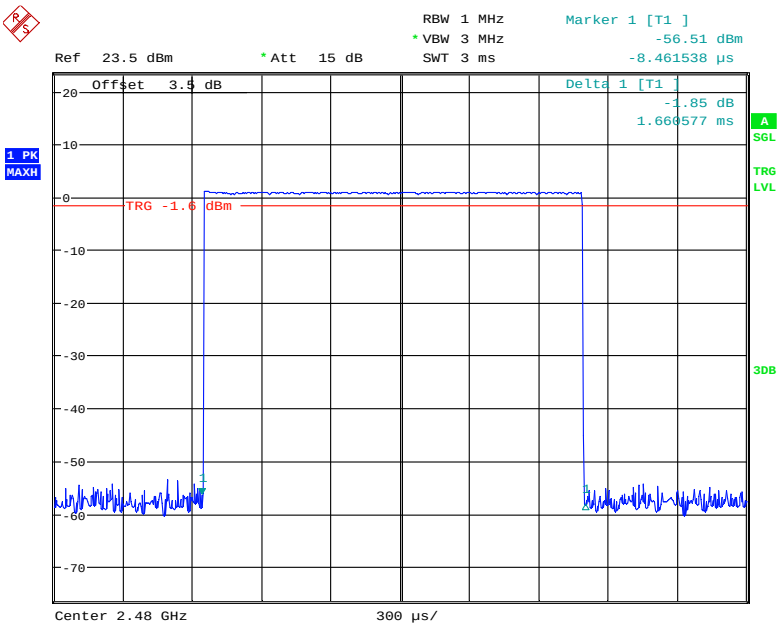
Date: 18.APR.2019 18:39:38

Pulse time, Middle Channel, DH3



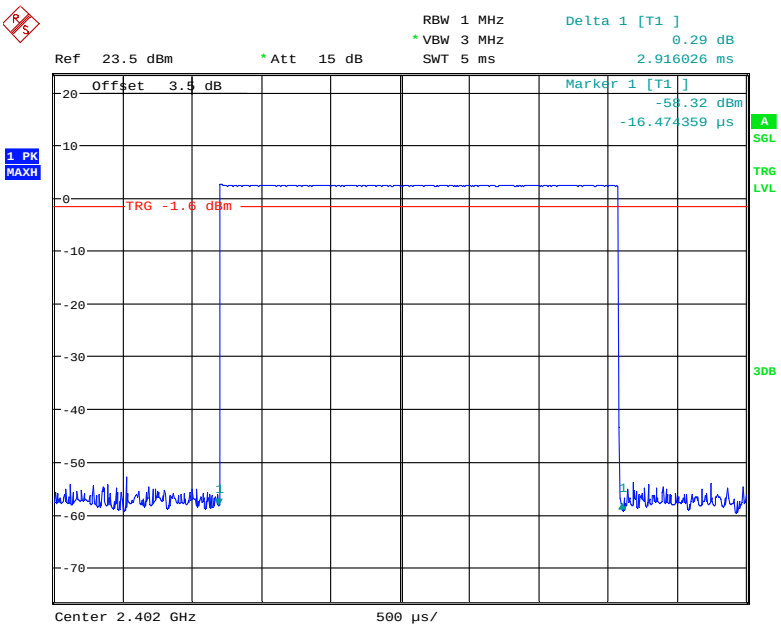
Date: 18.APR.2019 18:39:30

Pulse time, High Channel, DH3



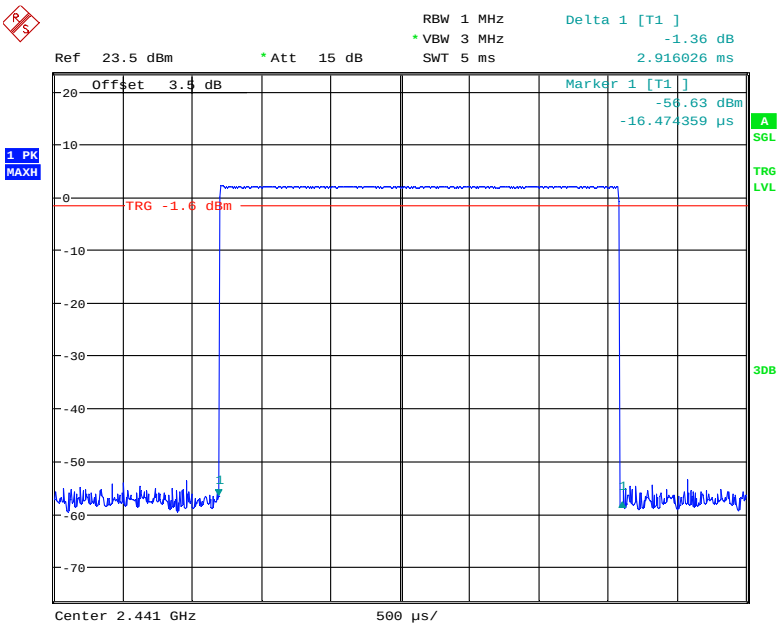
Date: 18.APR.2019 18:39:19

Pulse time, Low Channel, DH5



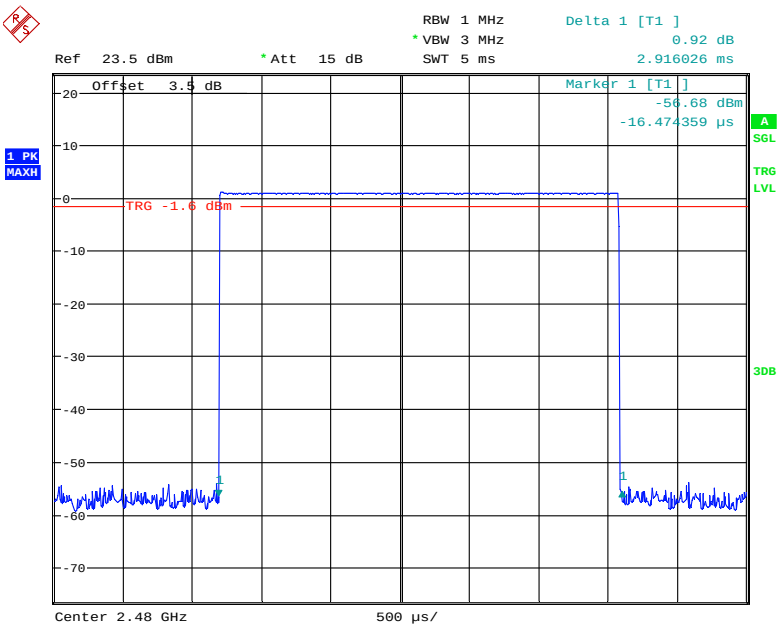
Date: 18.APR.2019 18:40:25

Pulse time, Middle Channel, DH5



Date: 18.APR.2019 18:40:35

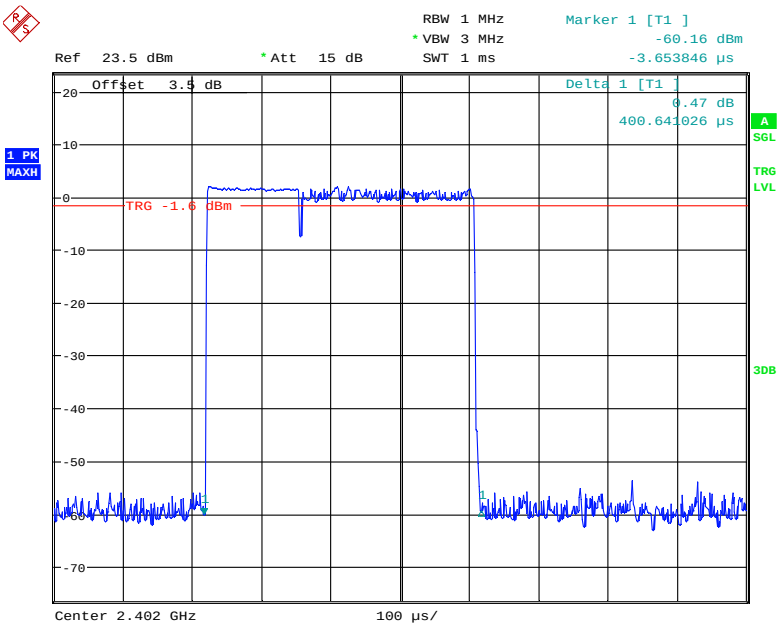
Pulse time, High Channel, DH5



Date: 18.APR.2019 18:40:49

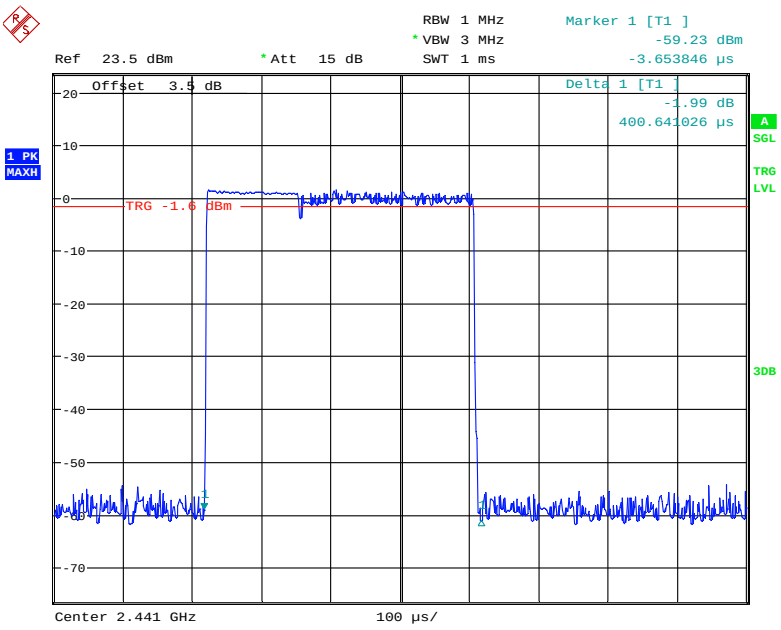
EDR (π/4-DQPSK):

Pulse time, Low Channel, 2DH1



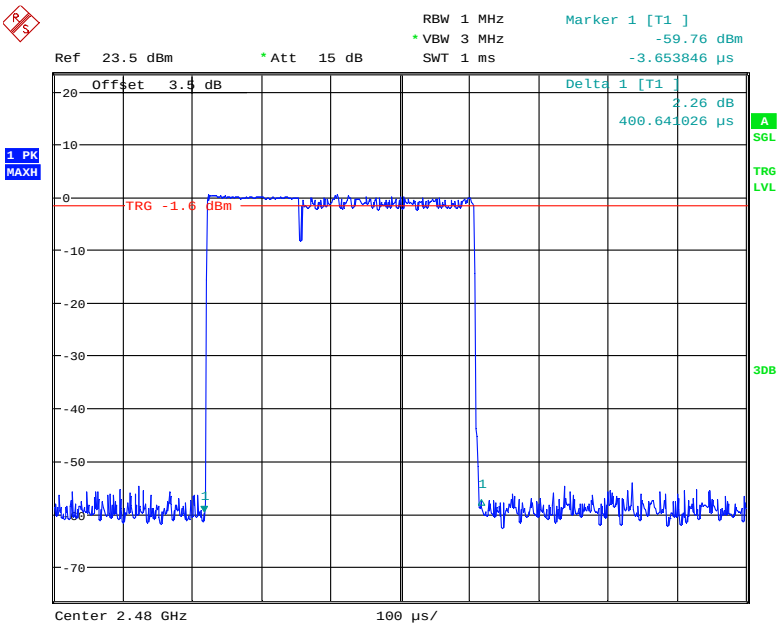
Date: 18.APR.2019 18:34:49

Pulse time, Middle Channel, 2DH1



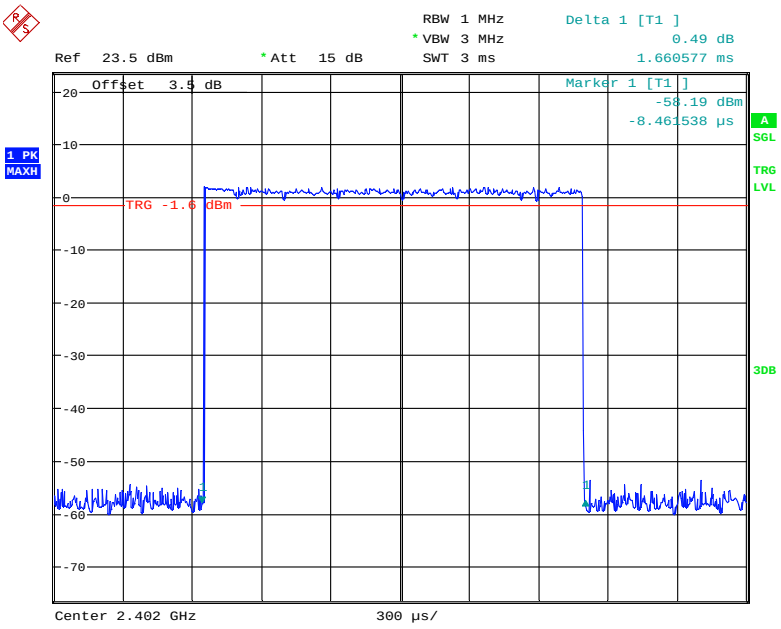
Date: 18.APR.2019 18:34:40

Pulse time, High Channel, 2DH1



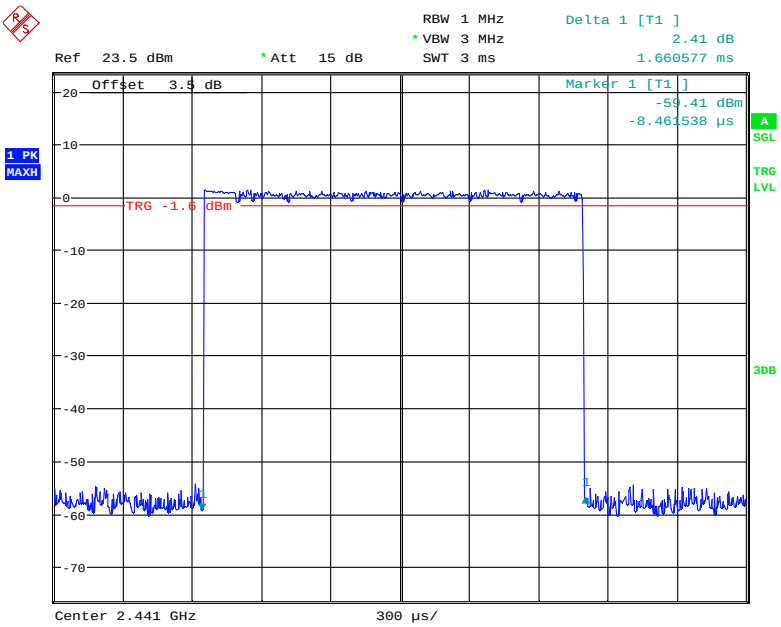
Date: 18.APR.2019 18:34:20

Pulse time, Low Channel, 2DH3



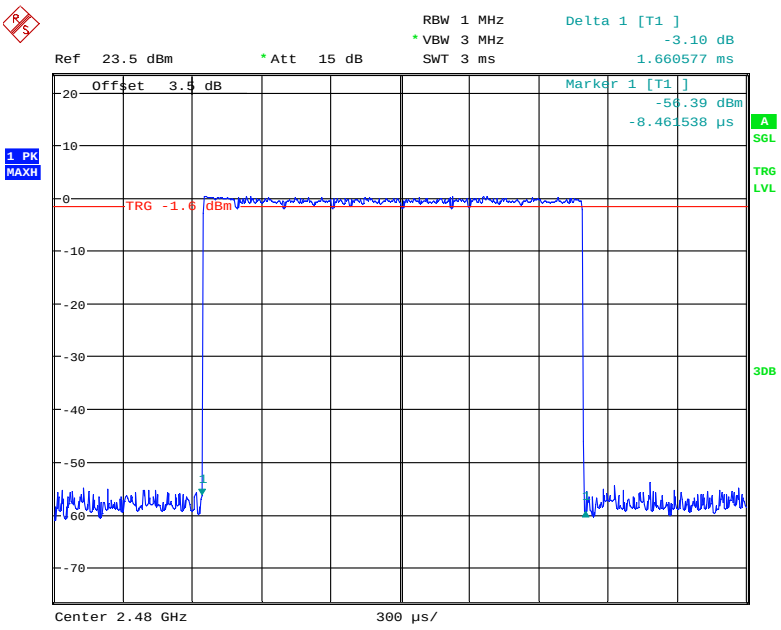
Date: 18.APR.2019 18:38:15

Pulse time, Middle Channel, 2DH3



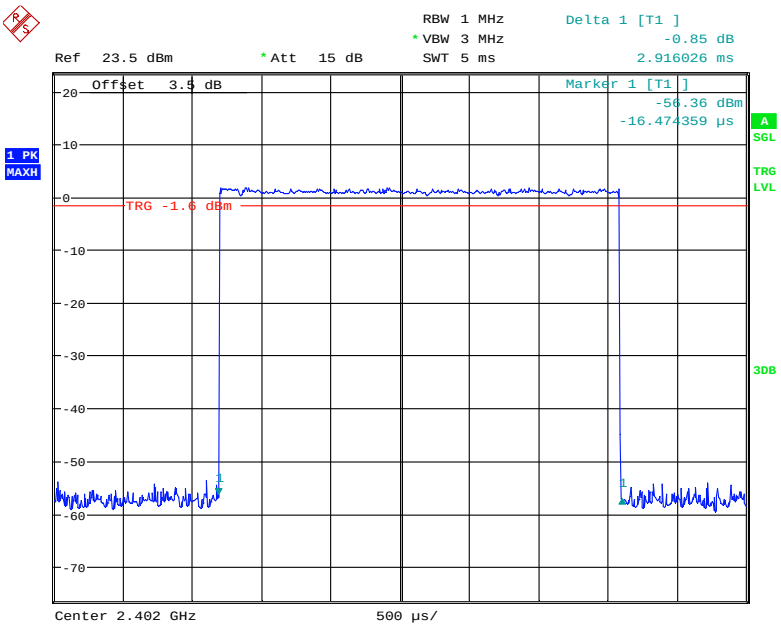
Date: 18.APR.2019 18:38:25

Pulse time, High Channel, 2DH3



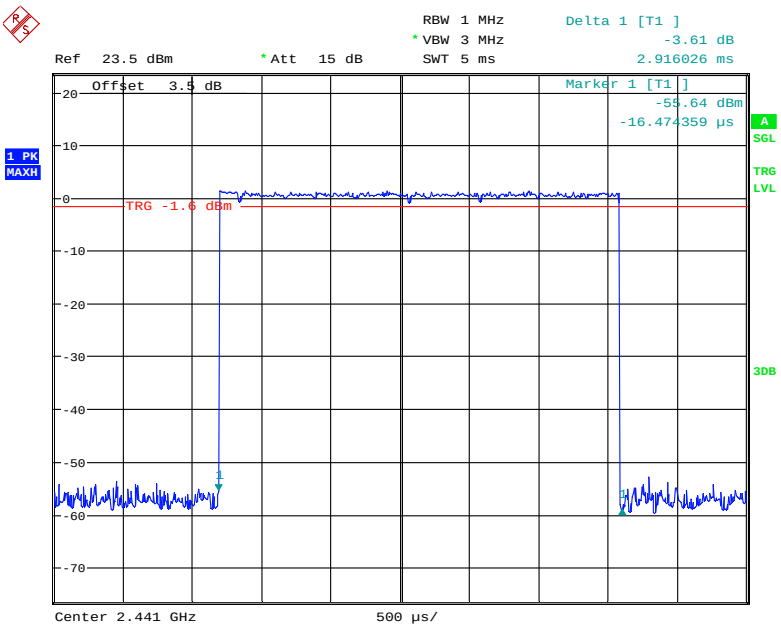
Date: 18.APR.2019 18:38:35

Pulse time, Low Channel, 2DH5



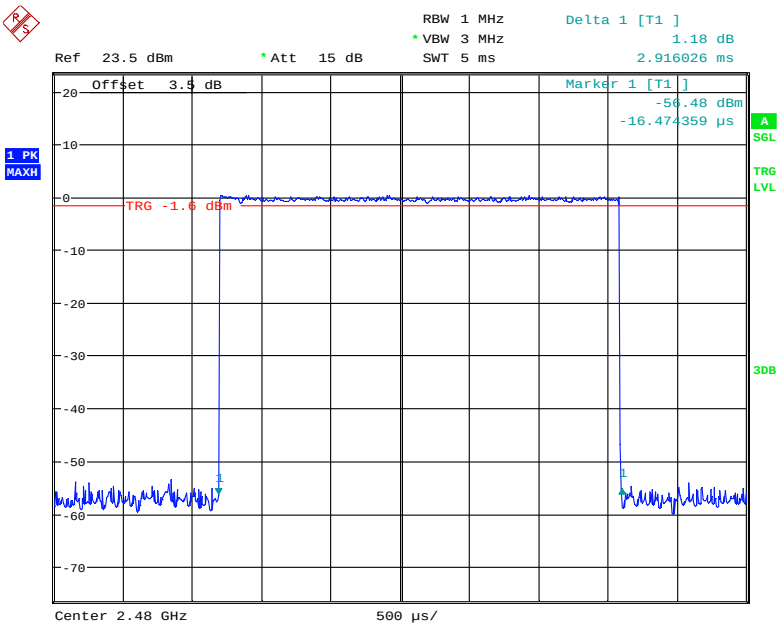
Date: 18.APR.2019 18:41:46

Pulse time, Middle Channel, 2DH5



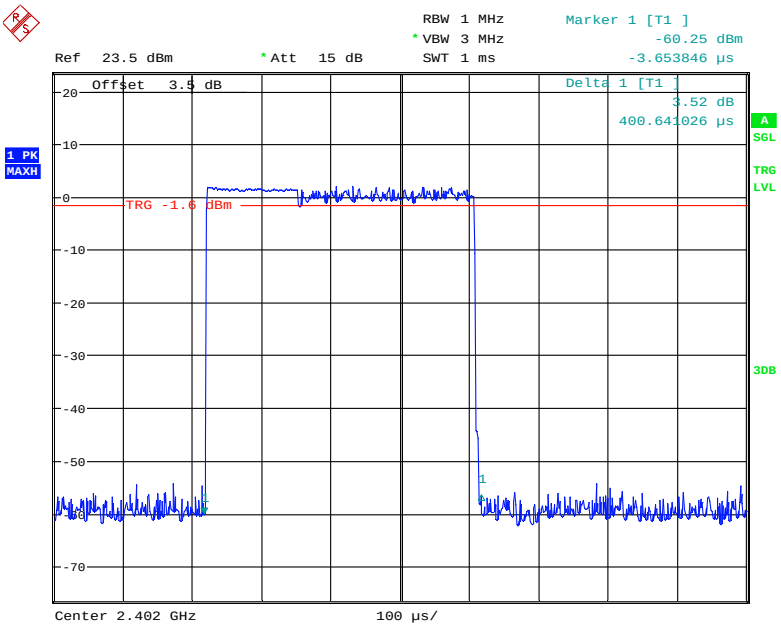
Date: 18.APR.2019 18:41:32

Pulse time, High Channel, 2DH5



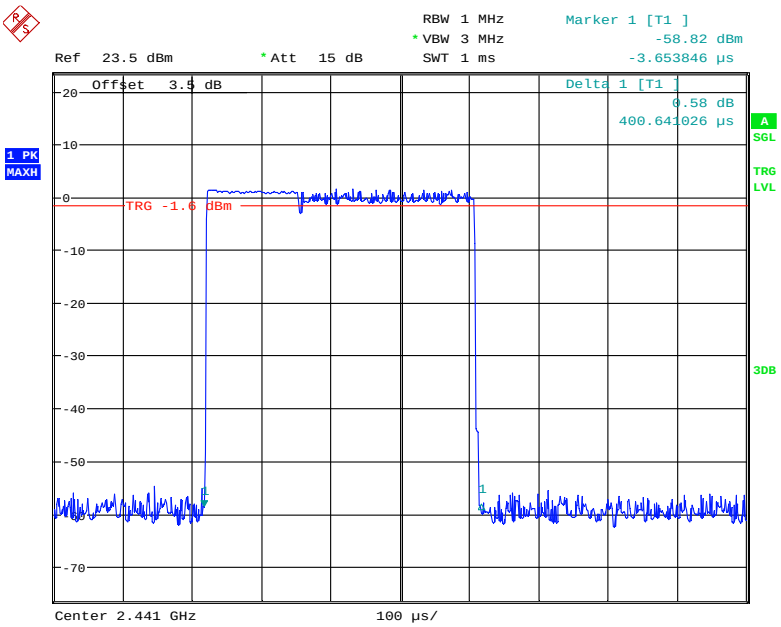
Date: 18.APR.2019 18:41:23

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



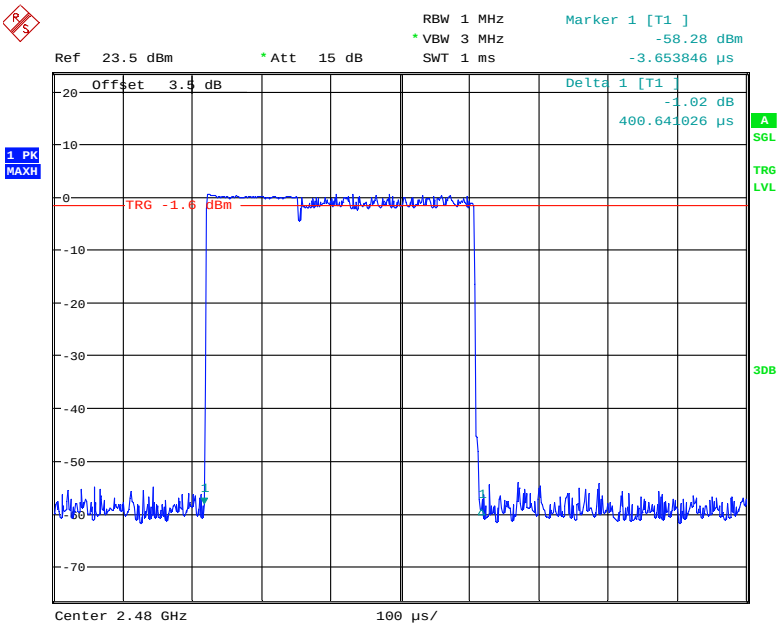
Date: 18.APR.2019 18:35:22

Pulse time, Middle Channel, 3DH1



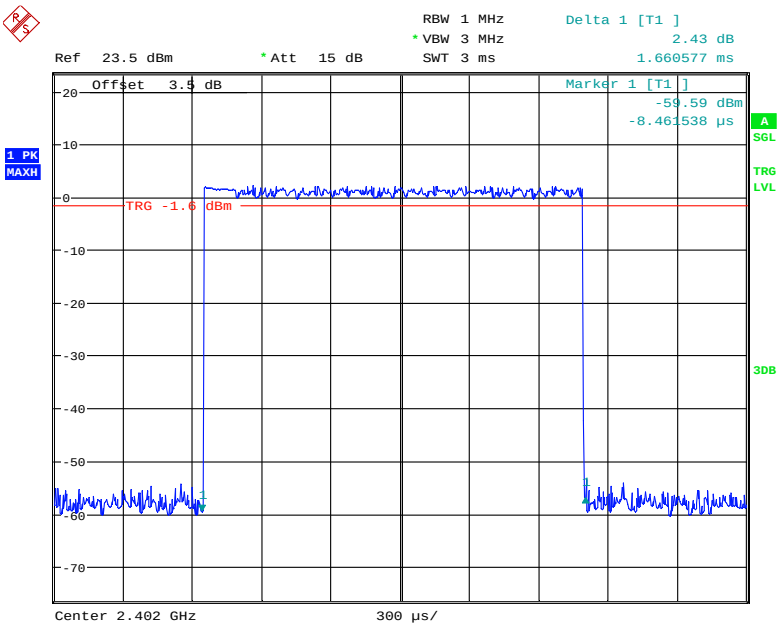
Date: 18.APR.2019 18:35:33

Pulse time, High Channel, 3DH1



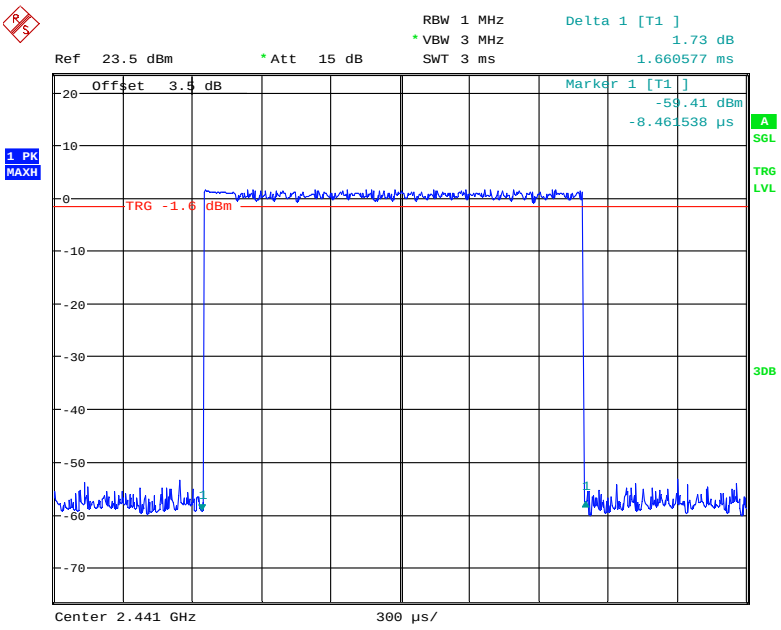
Date: 18.APR.2019 18:35:47

Pulse time, Low Channel, 3DH3



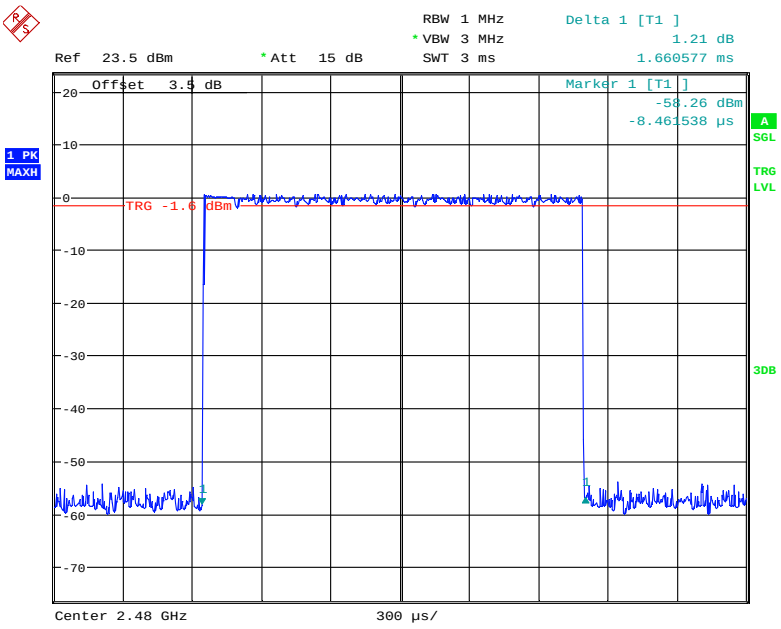
Date: 18.APR.2019 18:37:36

Pulse time, Middle Channel, 3DH3



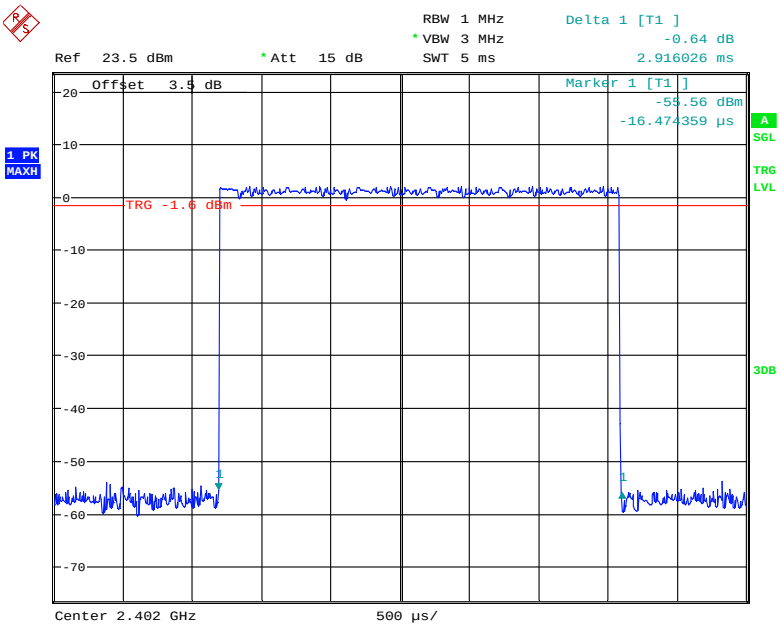
Date: 18.APR.2019 18:37:25

Pulse time, High Channel, 3DH3



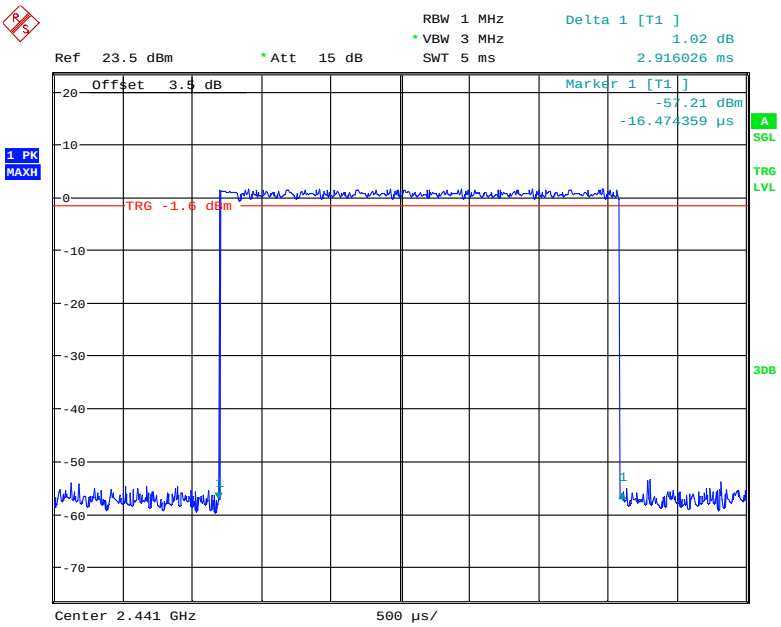
Date: 18.APR.2019 18:37:12

Pulse time, Low Channel, 3DH5



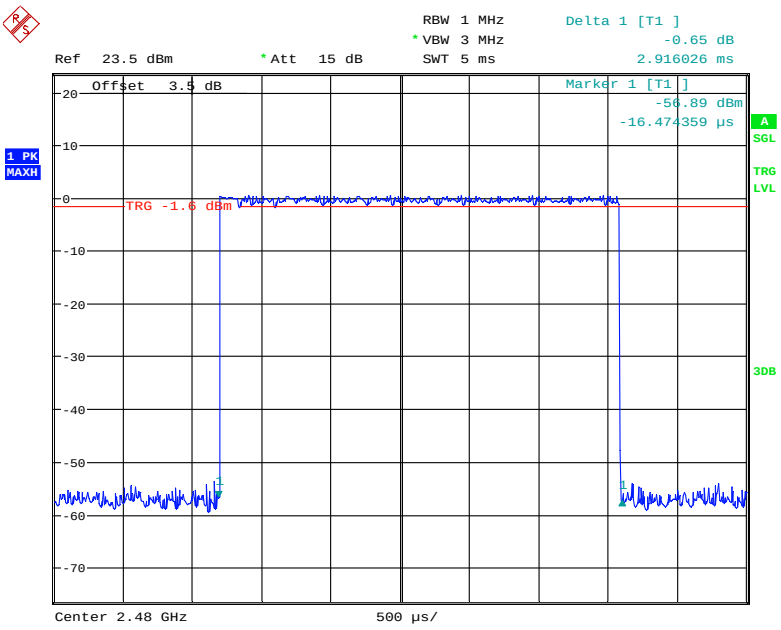
Date: 18.APR.2019 18:42:02

Pulse time, Middle Channel, 3DH5



Date: 18.APR.2019 18:42:13

Pulse time, High Channel, 3DH5



Date: 18.APR.2019 18:42:22

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:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-10-24.

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	4.80	3.02	125
	Middle	2441	5.78	3.78	125
	High	2480	6.31	4.28	125
EDR (π/4-DQPSK)	Low	2402	2.83	1.92	125
	Middle	2441	4.10	2.57	125
	High	2480	4.95	3.13	125
EDR (8DPSK)	Low	2402	3.18	2.08	125
	Middle	2441	4.42	2.77	125
	High	2480	5.25	3.35	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

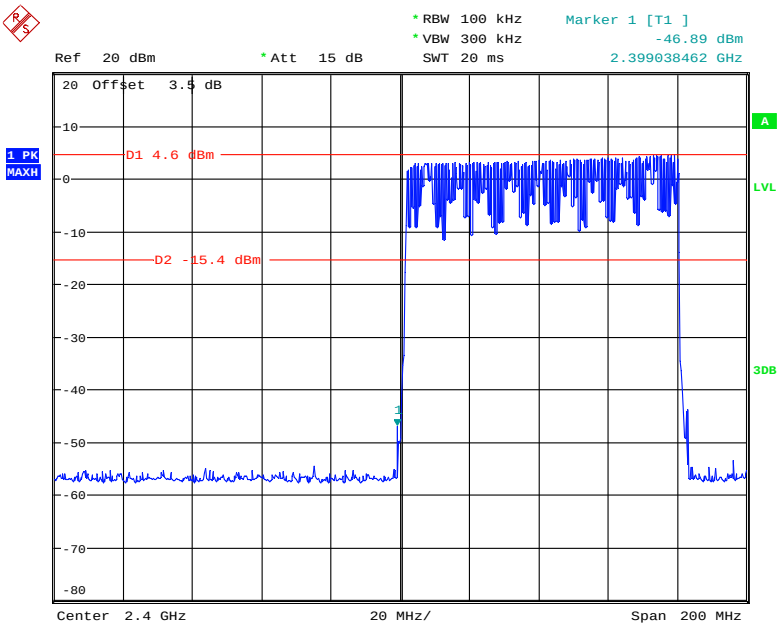
Temperature:	25 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-10-25.

EUT operation mode: Transmitting

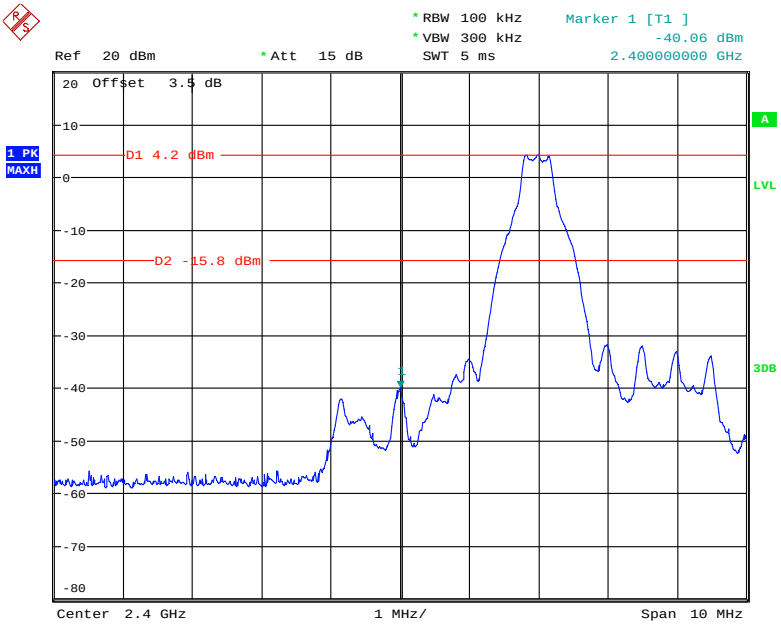
Test Result: Compliance. Please refer to following plots.

BDR (GFSK): Band Edge-Left Side Hopping



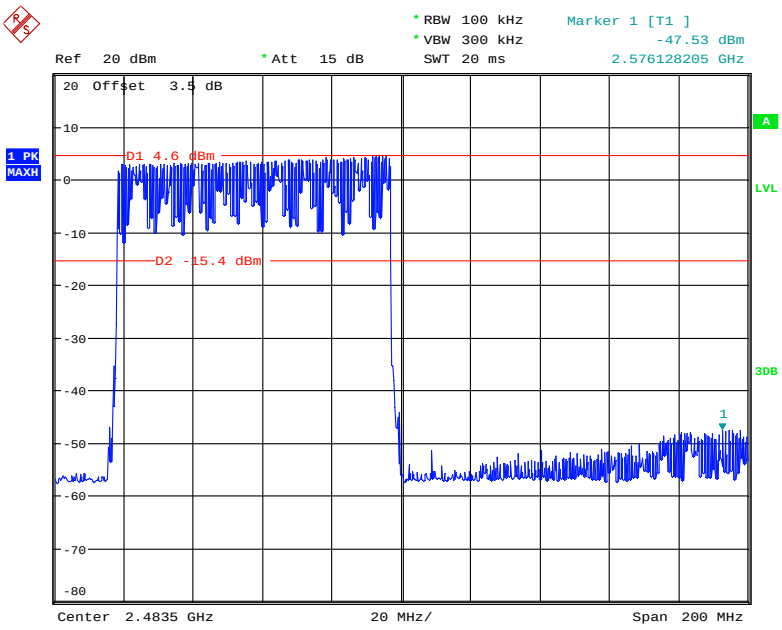
Date: 25.OCT.2018 20:15:47

Single



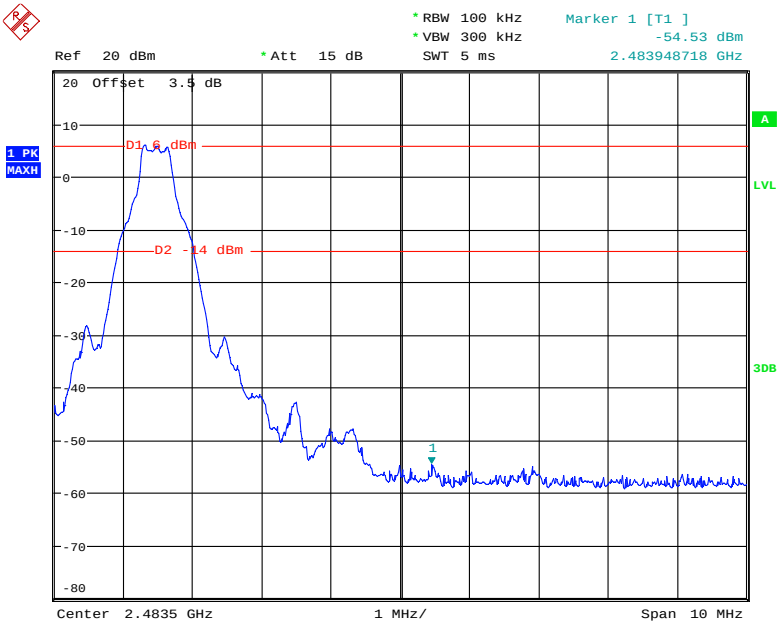
Date: 25.OCT.2018 19:56:17

BDR (GFSK): Band Edge-Right Side Hopping



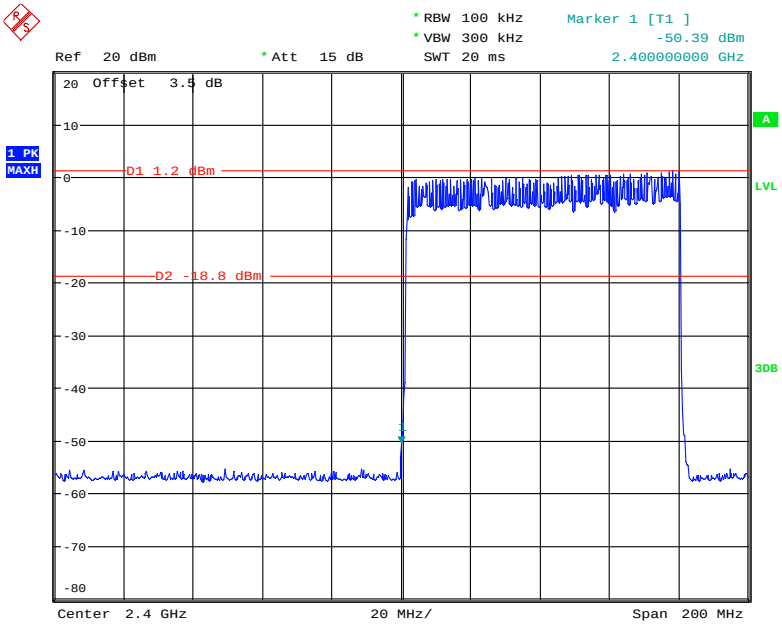
Date: 25.OCT.2018 20:12:27

Single



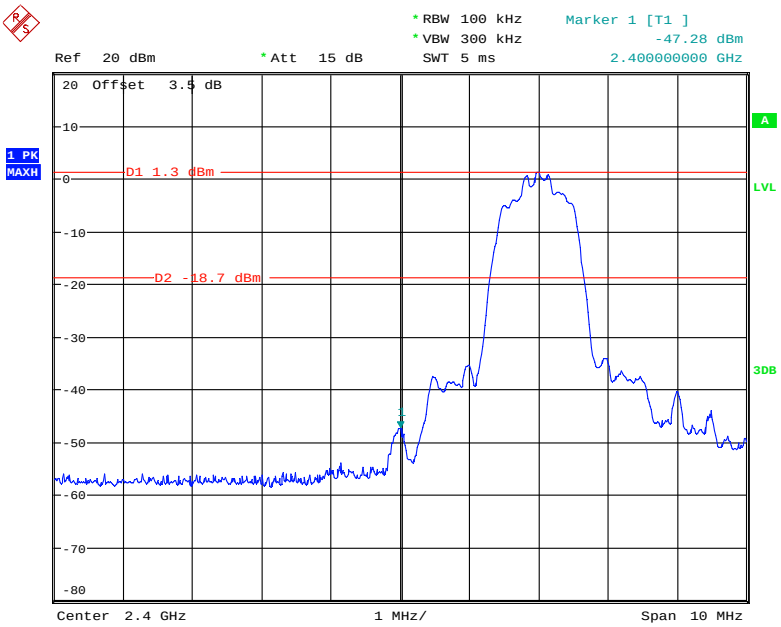
Date: 25.OCT.2018 19:57:39

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



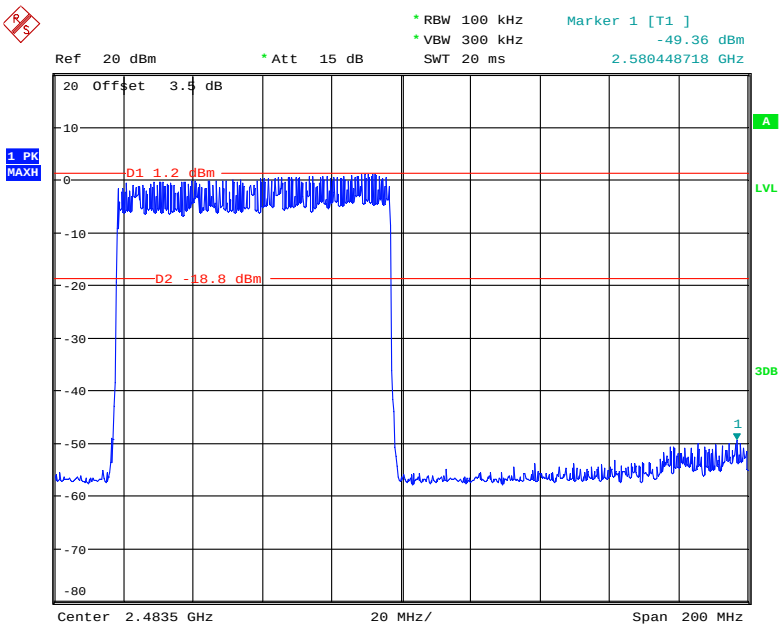
Date: 25.OCT.2018 20:18:55

Single



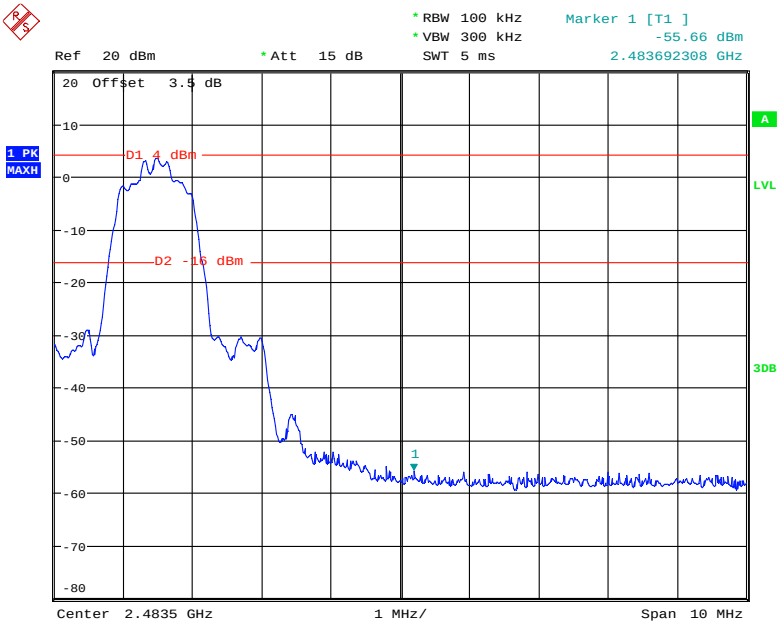
Date: 25.OCT.2018 20:01:54

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



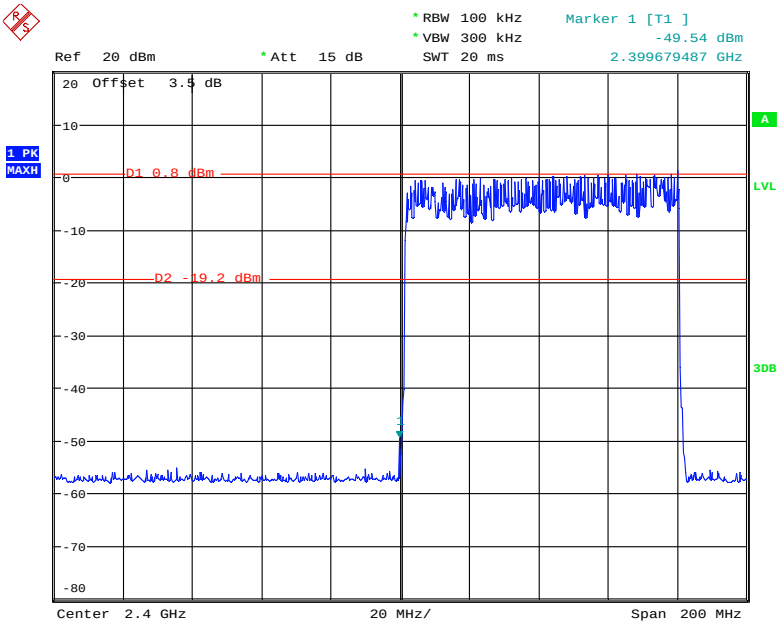
Date: 25.OCT.2018 20:21:44

Single



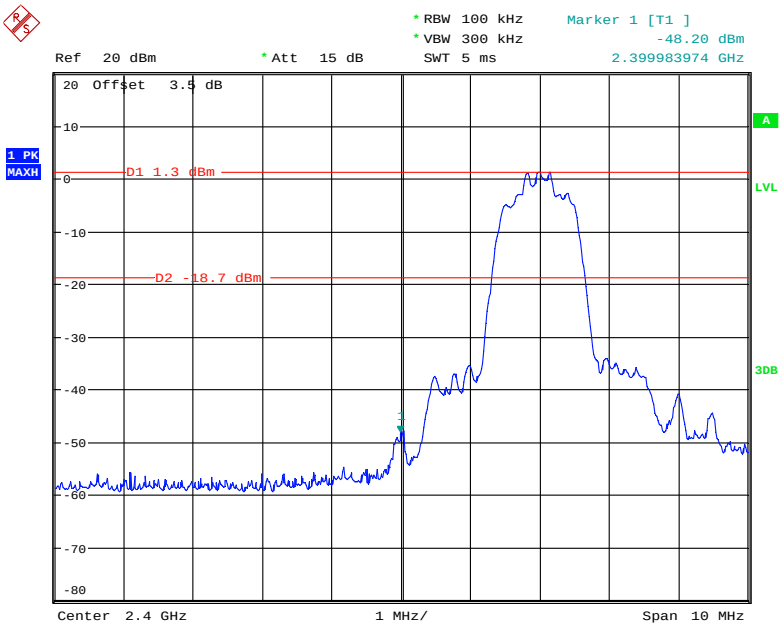
Date: 25.OCT.2018 19:59:27

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



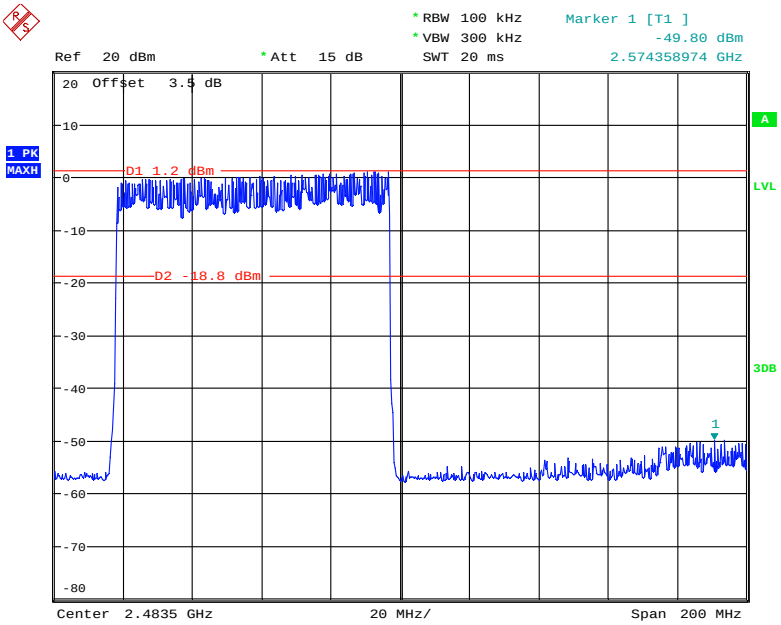
Date: 25.OCT.2018 20:26:11

Single



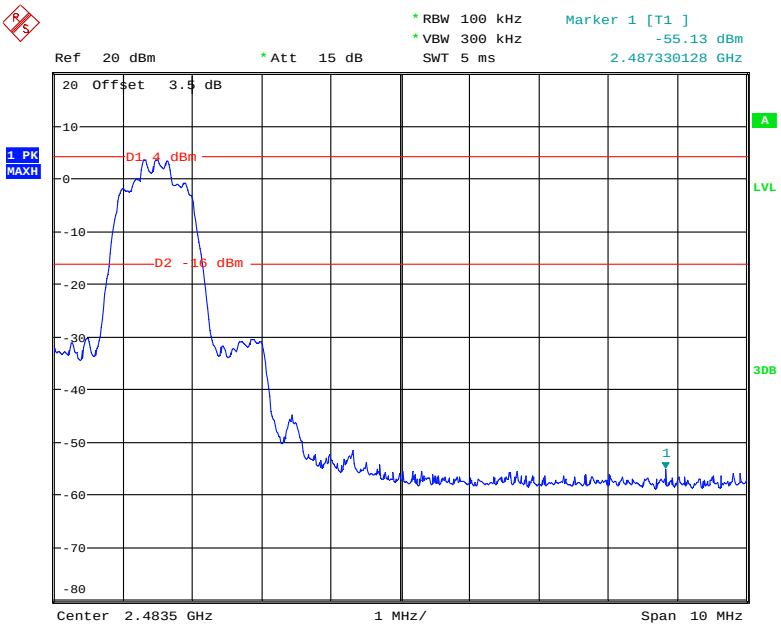
Date: 25.OCT.2018 20:04:00

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



Date: 25.OCT.2018 20:24:24

Single



Date: 25.OCT.2018 20:05:22

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