

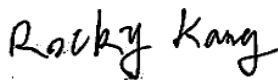
FCC PART 15.247 TEST REPORT

For

Thundercomm Technology Co., Ltd

4F, Taixiang Building, 1A Longxiang Rd Haidian Dist, Haidian Dist, Beijing, China, 100191

FCC ID: 2AOHHTURBOXSOMD820

Report Type: Original Report	Product Type: Thundersoft TurboX-D820-SoM
Report Number: RSZ180710003-00B	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

The *Thundercomm Technology Co., Ltd*'s product, model number: *TurboX-D820* (FCC ID: 2AOHHTURBOXSOMD820) or the "EUT" in this report was a *Thundersoft TurboX-D820-SoM*, which was measured approximately: 5.0 cm (L) * 3.6 cm (W) * 0.4 cm (H), rated with input voltage: DC 4.0V.

Notes: This series products model: TurboX and TurboX-D820 are electrically identical; the differences between them are the model number. Model TurboX-D820 was selected for fully testing, the detailed information can be referred to the declaration which was stated and guaranteed by the applicant.

** All measurement and test data in this report was gathered from production sample serial number: 180710003. (Assigned by BACL, Shenzhen). The EUT supplied by the applicant was received on 2018-07-10.*

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)

FCC Part 15.247 DTS and Part 15.407 NII submissions with FCC ID: 2AOHHTURBOXSOMD820.

Test Methodology

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

All emissions measurement was performed 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°C
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 used, and the power level was set at 9.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

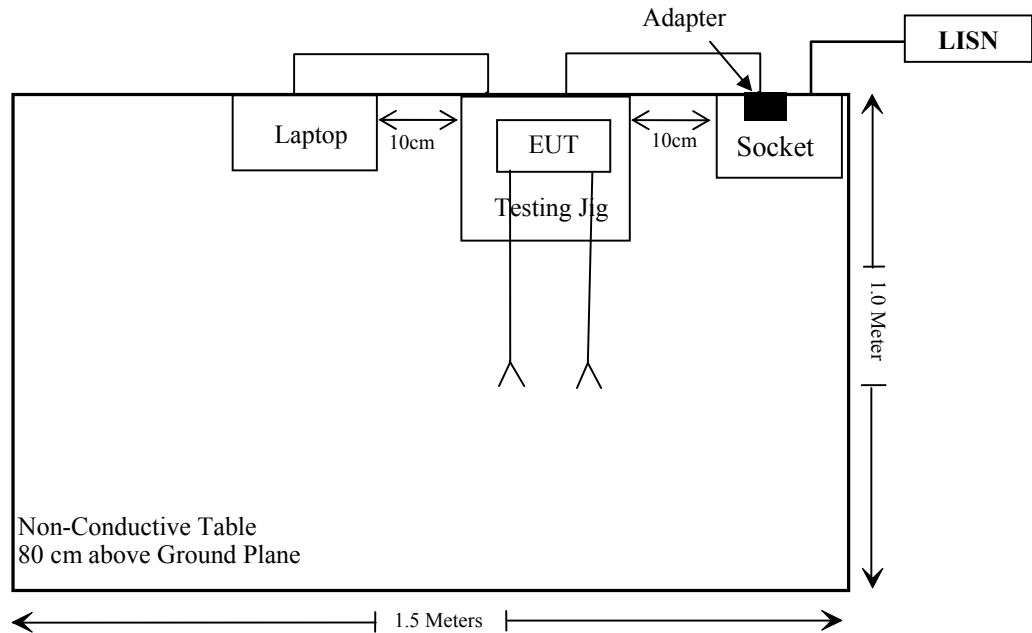
Manufacturer	Description	Model	Serial Number
Thundersoft	Testing Jig	N/A	N/A
STH	Adapter	P24120200	N/A
BULL	Socket	GN-415K	5503290068073
Compaq	Laptop	CQ45	CND9524JMW
N/A	Antenna 0	N/A	N/A
N/A	Antenna 1	N/A	N/A

External I/O Cable

Cable Description	Length (m)	From/Port	To
Unshielded un-detachable AC cable	1.2	Socket	mains
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	2017-12-21	2018-12-21
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2018-05-21	2018-11-19
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
N/A	Conducted Emission Cable	N/A	UF A210B-1-0720-504504	2018-05-12	2018-11-12
Radiated Emission Test					
A.H.System	Horn Antenna	SAS-200/571	135	2015-08-18	2018-08-17
Rohde & Schwarz	Signal Analyzer	FSEM	845987/005	2018-06-23	2019-06-23
Mini	Pre-amplifier	ZVA-183-S+	5969001149	2018-05-21	2019-05-21
HP	Amplifier	HP8447E	1937A01046	2018-05-21	2018-11-19
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
UTIFLEX MICRO-COAX	RF Cable	UFA147A-2362-100100	MFR64639 231029-003	2018-04-01	2018-10-01
Ducommun technologies	RF Cable	104PEA	218124002	2018-05-21	2018-11-19
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	2017-12-06	2020-12-05
Ducommun Technologies	Pre-amplifier	ALN-22093530-01	991373-01	2018-08-03	2019-08-03
Sinoscite	Notch Filter	BSF2402-2480MN-0898-001	N/A	2018-05-21	2019-05-21
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
WEINSCHTEL	3dB Attenuator	N/A	N/A	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		Turn up conducted power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
	(dBi)	(numeric)	(dBm)	(mW)			
2402-2480	5	3.16	9.5	11.22	20	0.007	1.0

Simultaneous transmitting consideration: (referring to the DTS &NII report, the highest MPE for 5G WiFi is $0.014\text{mW}/\text{cm}^2$, for 2.4G WiFi is $0.1\text{mW}/\text{cm}^2$)

The ratio= $\text{MPE}/\text{limit}_{\text{DSS}}+\text{MPE}/\text{limit}_{\text{NII}}=0.007+0.014=0.021 < 1.0$, simultaneous exposure is not required.

The ratio= $\text{MPE}/\text{limit}_{\text{DSS}}+\text{MPE}/\text{limit}_{\text{DTS}}=0.007+0.100=0.107 < 1.0$, simultaneous exposure is not required.

Note: 2.4GHz and 5GHz WiFi can't transmit simultaneously for this device.

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons, and the max available antenna gain is 5dBi.

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 two PCB antennas arrangement, which were connected to board with an unique connector and the antenna gain is 5 dBi, one for Bluetooth and wifi(antenna 0), the other for wifi only(antenna 1), fulfill the requirement of this section. Please refer to the EUT photos.

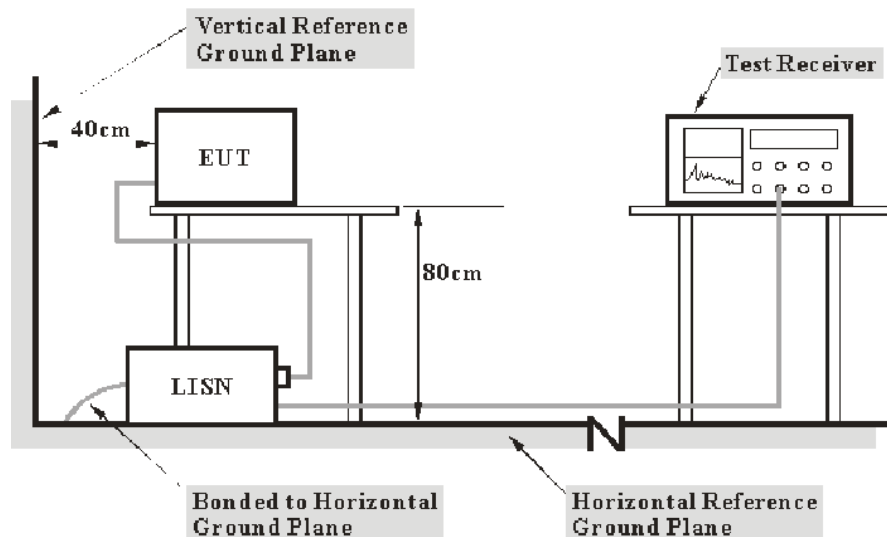
Result: Compliance.

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:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

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

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

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.

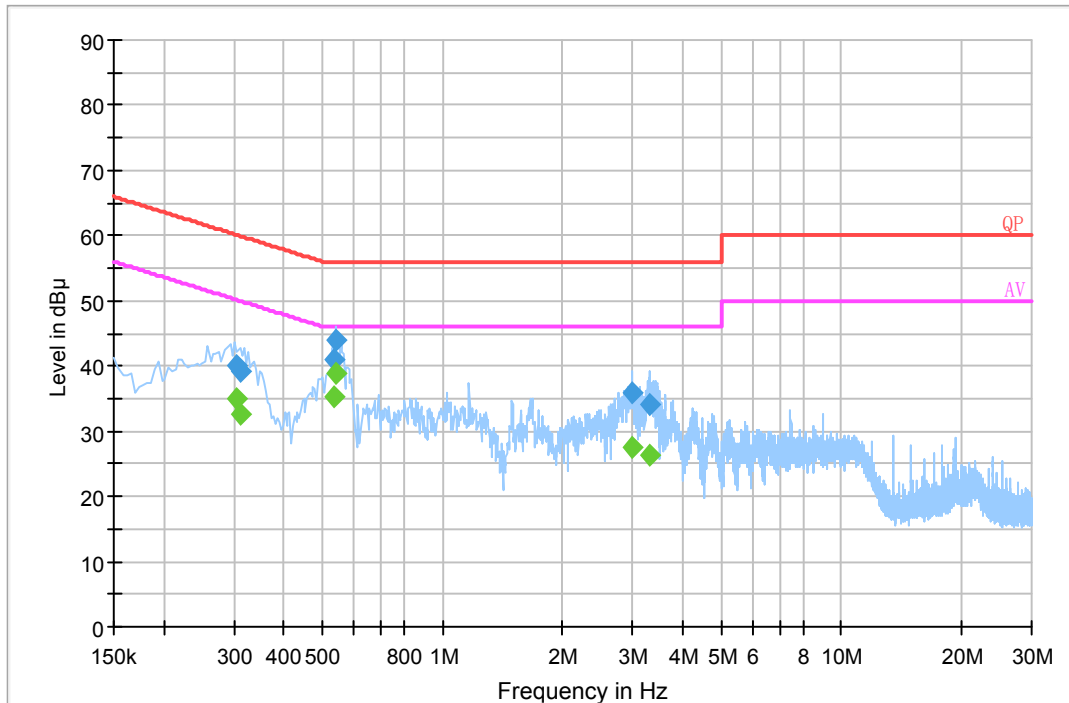
Test Data

Environmental Conditions

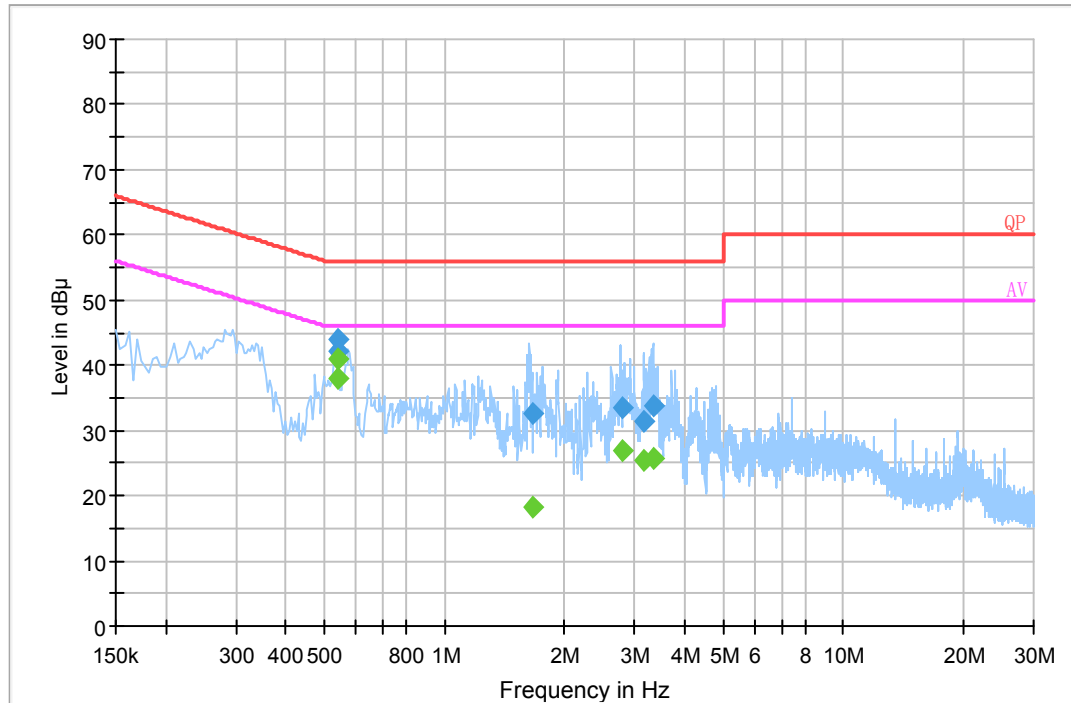
Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-08-15.

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)
0.305470	40.0	19.8	60.1	20.1	QP
0.313230	39.1	19.8	59.9	20.8	QP
0.533930	41.1	19.7	56.0	14.9	QP
0.537950	44.0	19.7	56.0	12	QP
2.985210	35.8	19.9	56.0	20.2	QP
3.324590	34.0	20.0	56.0	22	QP
0.305470	35.1	19.8	50.1	15	Ave.
0.313230	32.7	19.8	49.9	17.2	Ave.
0.533930	35.4	19.7	46.0	10.6	Ave.
0.537950	38.9	19.7	46.0	7.1	Ave.
2.985210	27.6	19.9	46.0	18.4	Ave.
3.324590	26.3	20.0	46.0	19.7	Ave.

AC 120V/60 Hz, Neutral

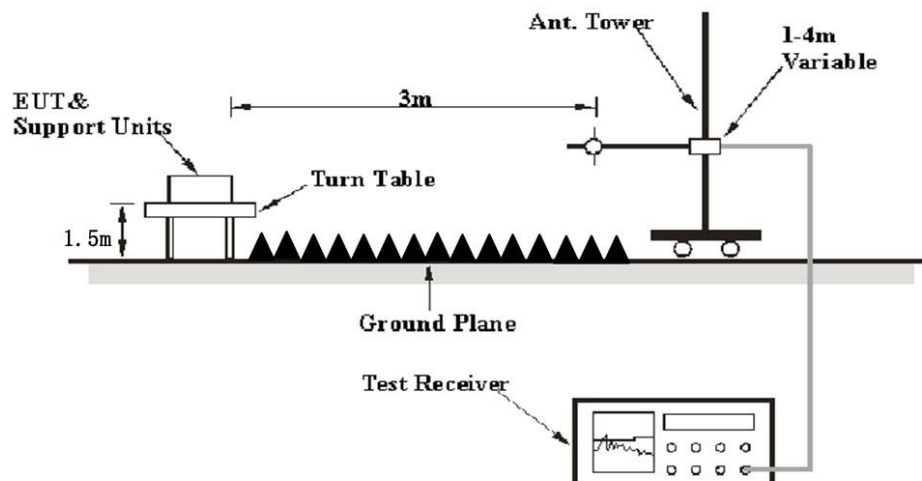
Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.537930	44.0	19.8	56.0	12.0	QP
0.537990	42.1	19.8	56.0	13.9	QP
1.658510	32.6	19.9	56.0	23.4	QP
2.792390	33.5	19.9	56.0	22.5	QP
3.178390	31.3	19.9	56.0	24.7	QP
3.356050	33.9	19.9	56.0	22.1	QP
0.537930	41.0	19.8	46.0	5.0	Ave.
0.537990	37.9	19.8	46.0	8.1	Ave.
1.658510	18.2	19.9	46.0	27.8	Ave.
2.792390	27.0	19.9	46.0	19.0	Ave.
3.178390	25.3	19.9	46.0	20.7	Ave.
3.356050	25.7	19.9	46.0	20.3	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, 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:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

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

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

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

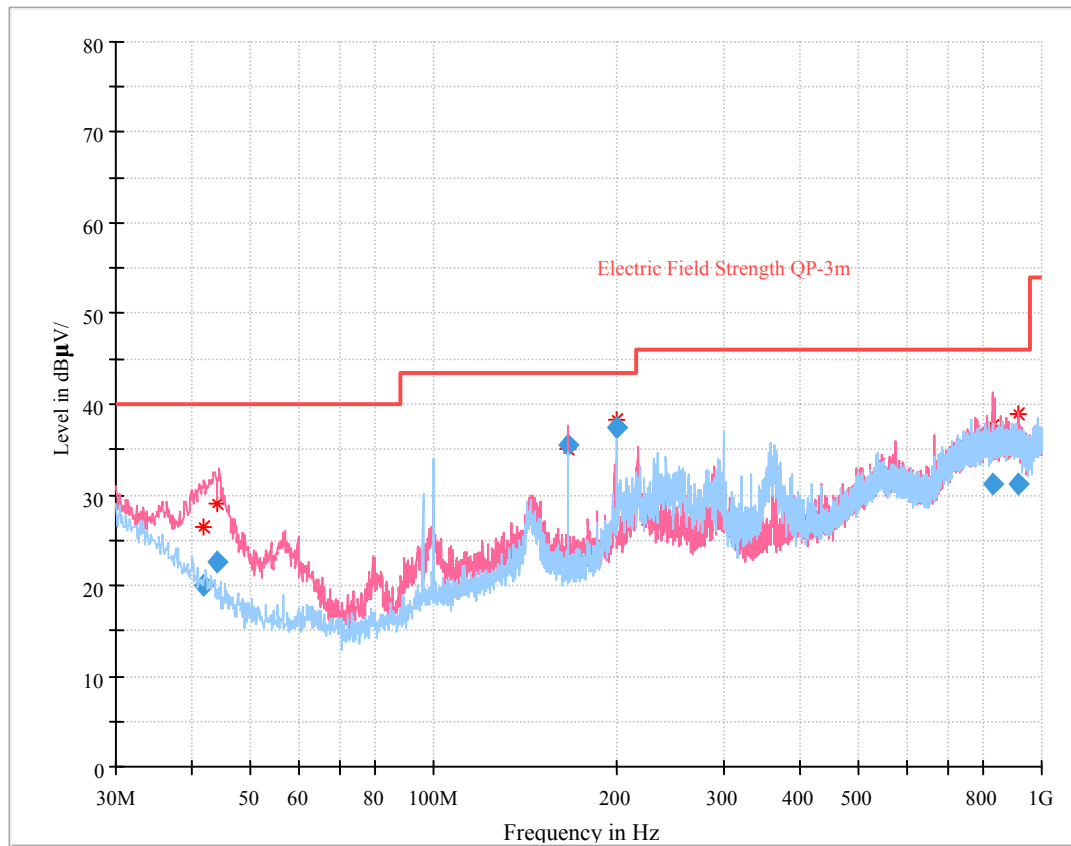
Test Data**Environmental Conditions**

Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-08-16.

EUT operation mode: Transmitting (Scan with GFSK, $\pi/4$ -DQPSK, 8-DPSK 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)
41.902750	19.91	107.0	V	227.0	-7.1	40.00	20.09
44.093500	22.53	119.0	V	180.0	-8.6	40.00	17.47
166.661750	35.41	100.0	V	116.0	-5.5	43.50	8.09
199.993375	37.44	182.0	H	77.0	-4.0	43.50	6.06
829.728125	31.22	400.0	V	261.0	9.4	46.00	14.78
914.965375	31.22	119.0	V	281.0	9.6	46.00	14.78

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	67.66	PK	9	1.1	H	33.92	101.58	/	/
2402.00	55.47	Ave.	9	1.1	H	33.92	89.39	/	/
2402.00	58.78	PK	167	1.1	V	33.92	92.70	/	/
2402.00	46.59	Ave.	167	1.1	V	33.92	80.51	/	/
2390.00	31.29	PK	294	1.2	H	33.92	65.21	74	8.79
2390.00	13.92	Ave.	294	1.2	H	33.92	47.84	54	6.16
2486.70	27.14	PK	209	1.3	H	34.08	61.22	74	12.78
2486.70	13.23	Ave.	209	1.3	H	34.08	47.31	54	6.69
4804.00	43.32	PK	4	1.9	H	5.84	49.16	74	24.84
4804.00	28.97	Ave.	4	1.9	H	5.84	34.81	54	19.19
Middle Channel (2441 MHz)									
2441.00	66.24	PK	228	1.8	H	33.92	100.16	/	/
2441.00	54.13	Ave.	228	1.8	H	33.92	88.05	/	/
2441.00	57.14	PK	151	1.9	V	33.92	91.06	/	/
2441.00	45.08	Ave.	151	1.9	V	33.92	79.00	/	/
4882.00	43.25	PK	243	2.2	H	6.21	49.46	74	24.54
4882.00	28.53	Ave.	243	2.2	H	6.21	34.74	54	19.26
High Channel (2480 MHz)									
2480.00	66.03	PK	288	1.9	H	34.08	100.11	/	/
2480.00	54.14	Ave.	288	1.9	H	34.08	88.22	/	/
2480.00	54.50	PK	21	2.3	V	34.08	88.58	/	/
2480.00	42.39	Ave.	21	2.3	V	34.08	76.47	/	/
2328.47	26.58	PK	43	1.3	H	33.83	60.41	74	13.59
2328.47	13.27	Ave.	43	1.3	H	33.83	47.10	54	6.90
2483.50	36.39	PK	198	2.2	H	34.08	70.47	74	3.53
2483.50	14.48	Ave.	198	2.2	H	34.08	48.56	54	5.44
4960.00	42.74	PK	68	1.4	H	7.82	50.56	74	23.44
4960.00	28.15	Ave.	68	1.6	H	7.82	35.97	54	18.03

Note:

Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

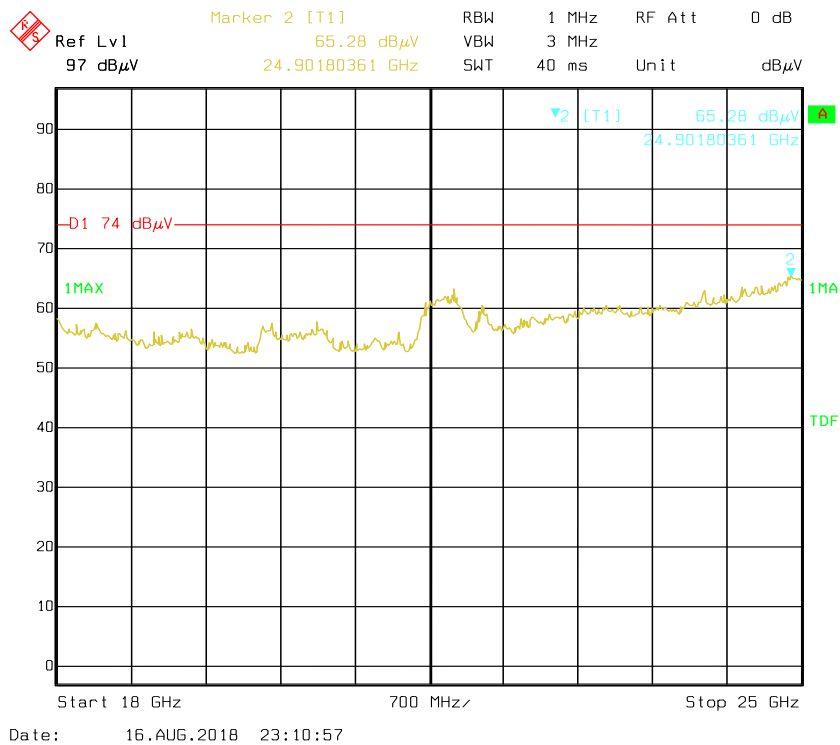
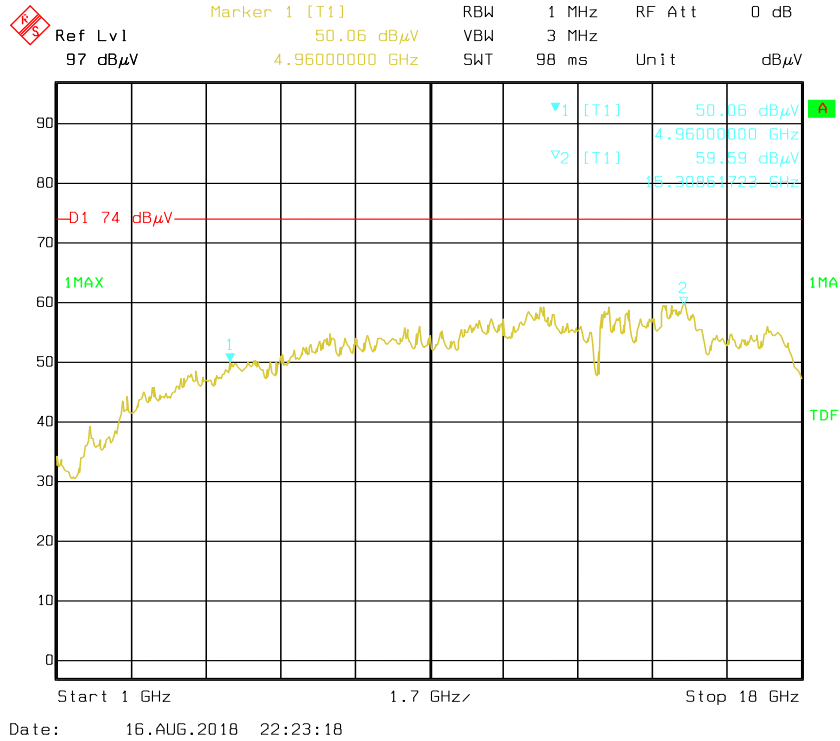
Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

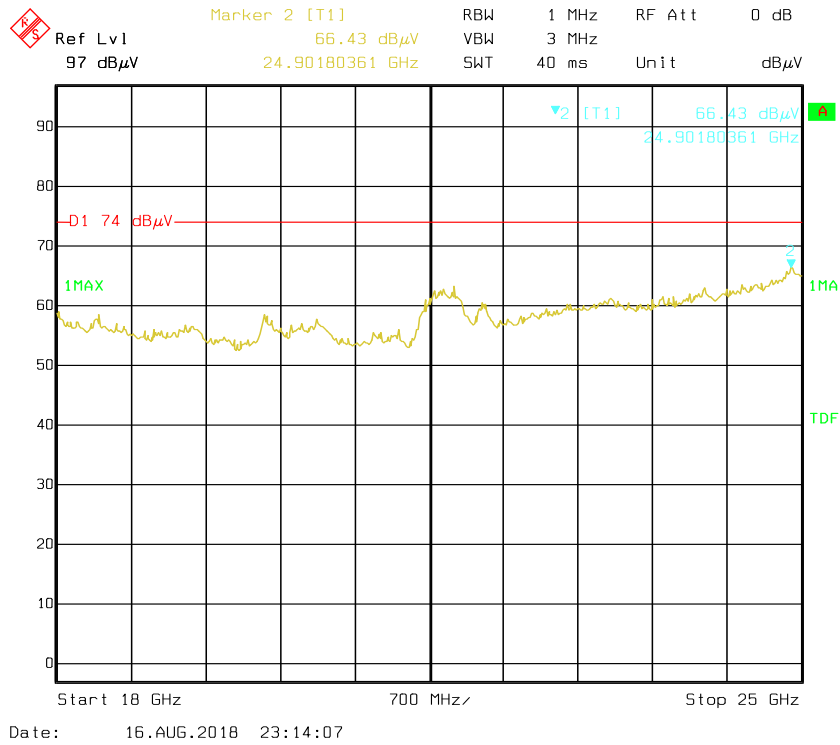
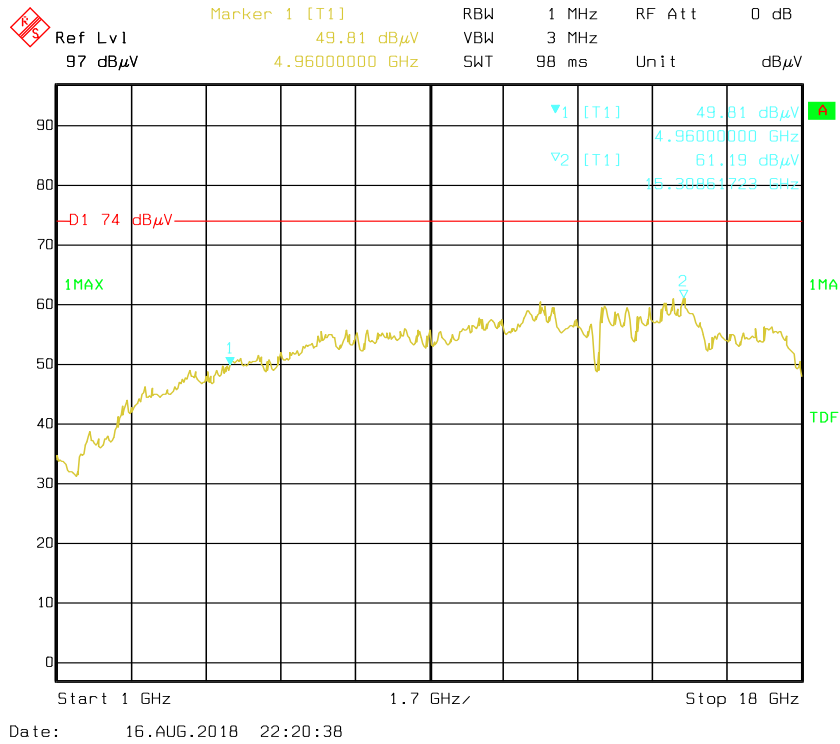
The other spurious emission which is 20dB to the limit was not recorded.

And for the pre-scan is performed with the 2400-2483.5MHz band filter.

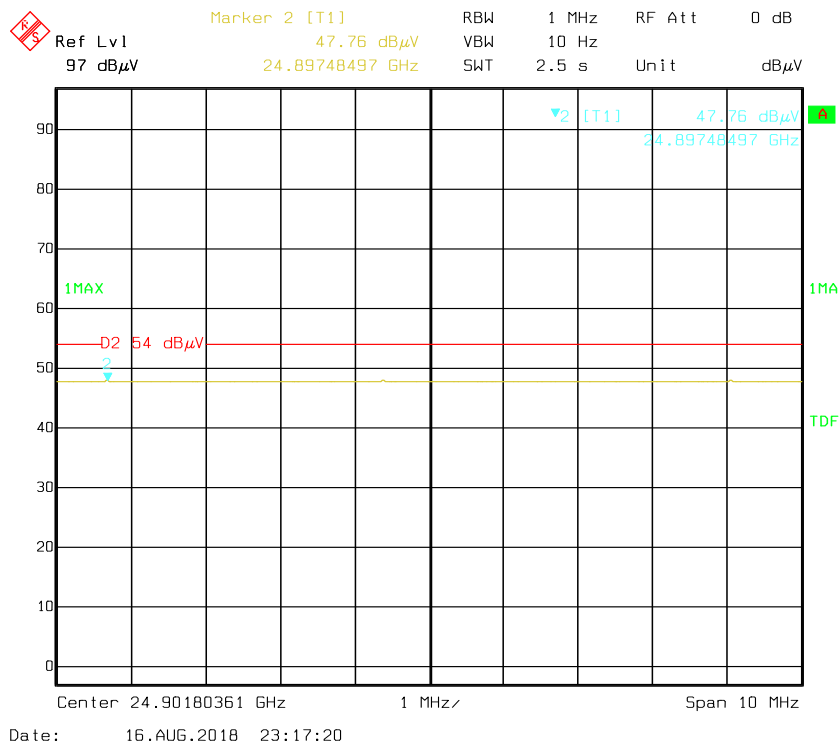
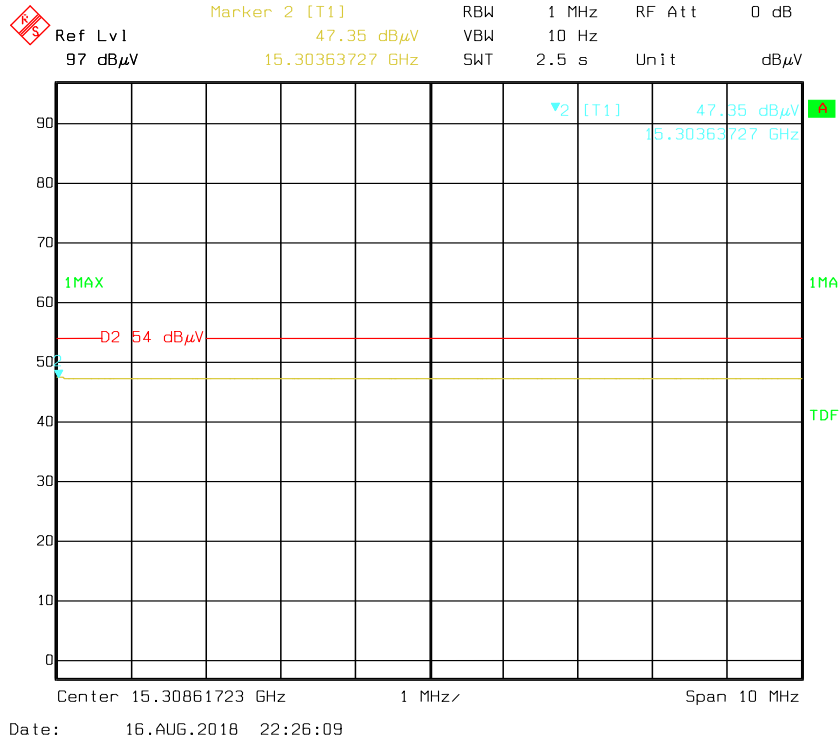
Pre-scan with High channel Peak Horizontal



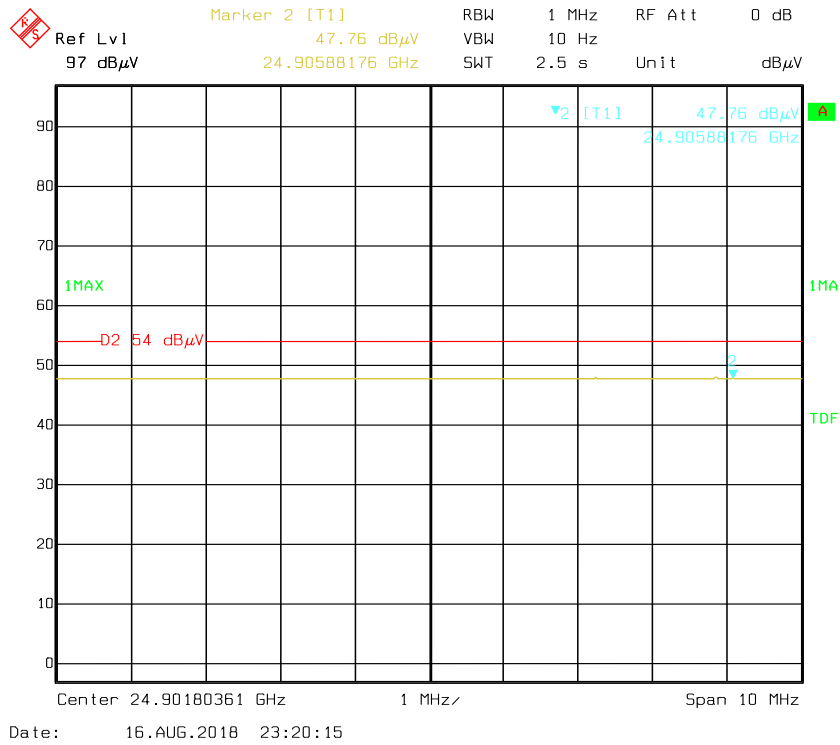
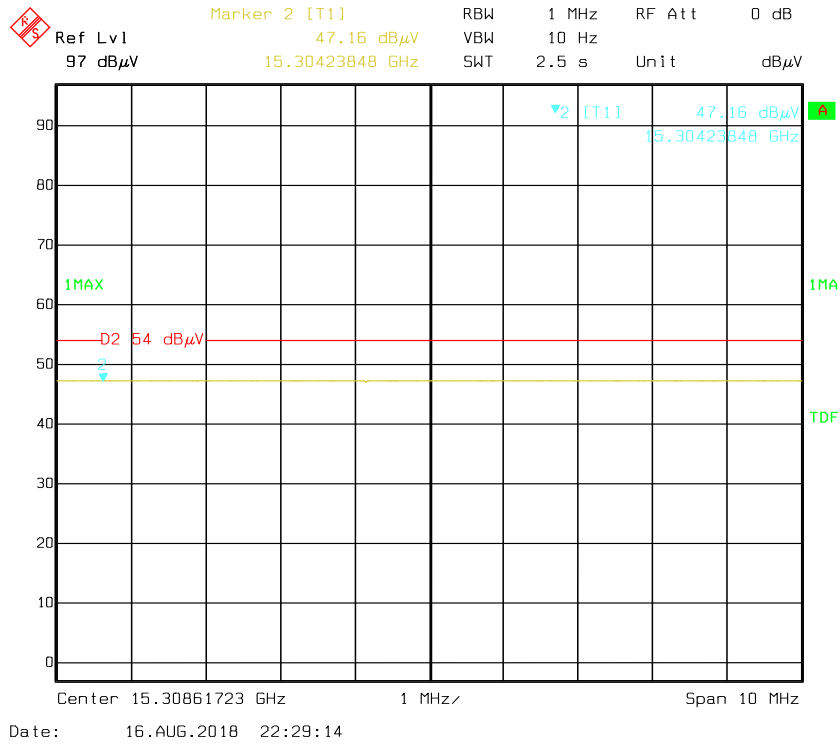
Vertical



Pre-scan for Average Horizontal



Vertical



FCC §15.247(a) (1)-CHANNEL SEPARATION TEST**Applicable Standard**

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

Test Procedure

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 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-07-17.

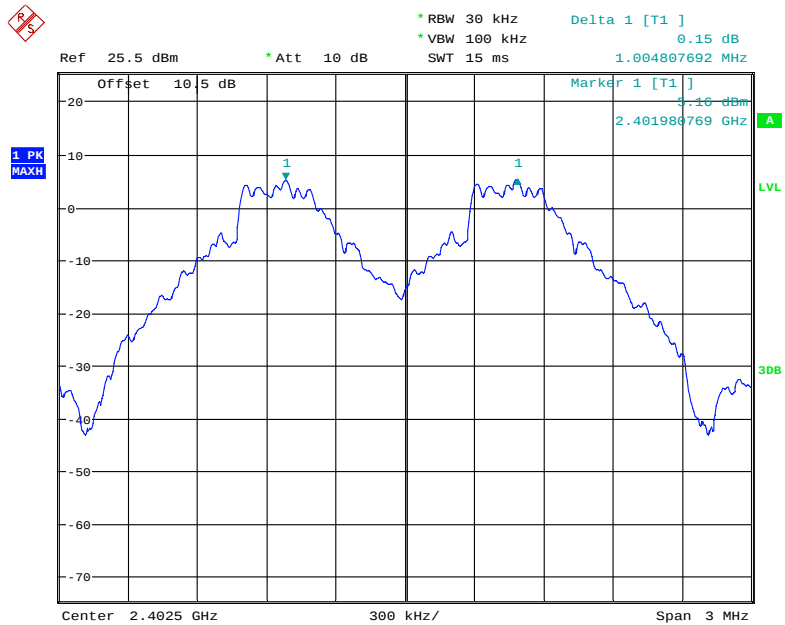
EUT operation mode: Transmitting

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

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	$\geq$ Limit (MHz)	Result
BDR (GFSK)	Low	2402	1.005	0.631	Pass
	Adjacent	2403			
	Middle	2441	1.005	0.628	Pass
	Adjacent	2442			
	High	2480	1.000	0.628	Pass
	Adjacent	2479			
EDR ($\pi/4$-DQPSK)	Low	2402	1.000	0.862	Pass
	Adjacent	2403			
	Middle	2441	1.000	0.846	Pass
	Adjacent	2442			
	High	2480	1.000	0.843	Pass
	Adjacent	2479			
EDR (8DPSK)	Low	2402	1.000	0.846	Pass
	Adjacent	2403			
	Middle	2441	1.000	0.837	Pass
	Adjacent	2442			
	High	2480	1.000	0.843	Pass
	Adjacent	2479			

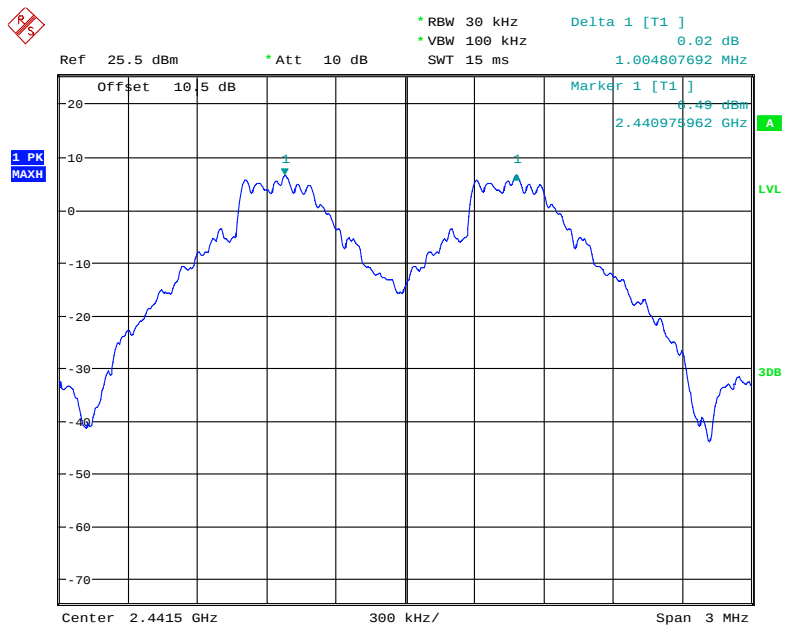
Note: Limit = 20 dB bandwidth *2/3

BDR (GFSK): Low Channel



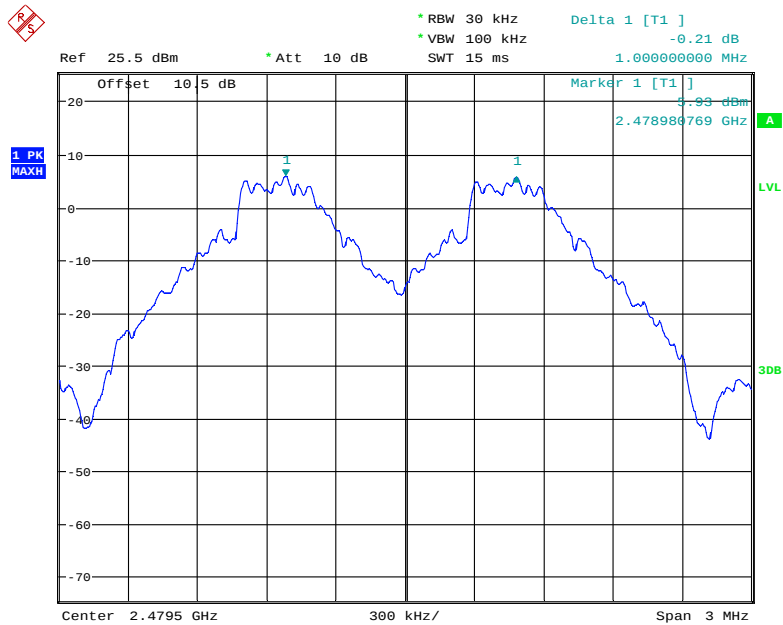
Date: 17.JUL.2018 22:21:57

BDR (GFSK): Middle Channel



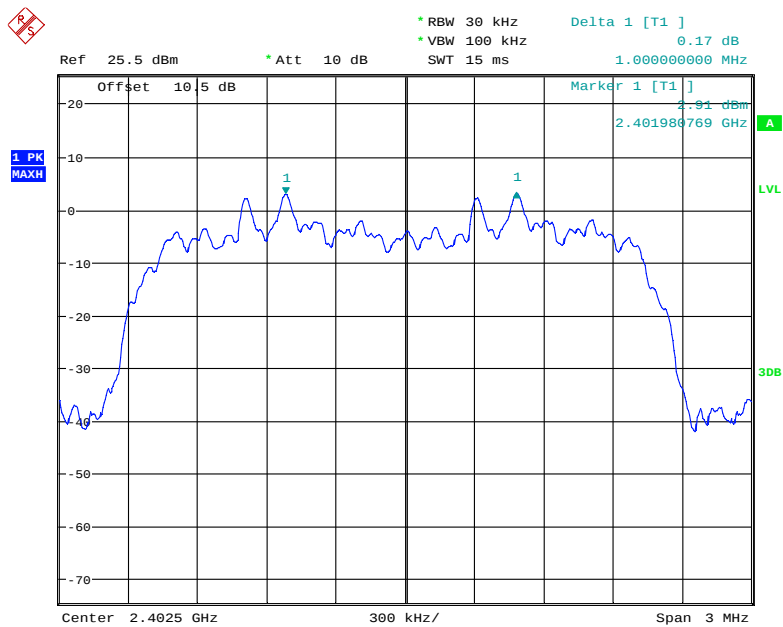
Date: 17.JUL.2018 22:23:03

BDR (GFSK): High Channel



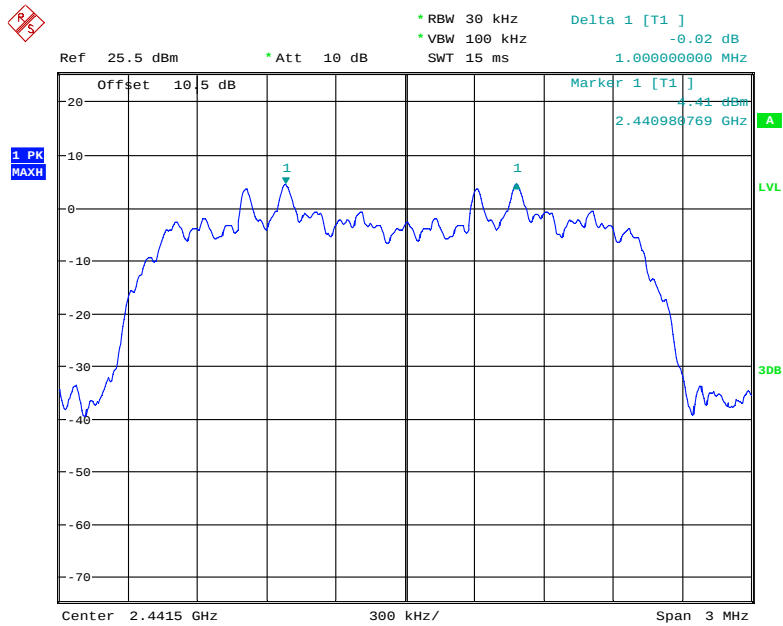
Date: 17.JUL.2018 22:24:10

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



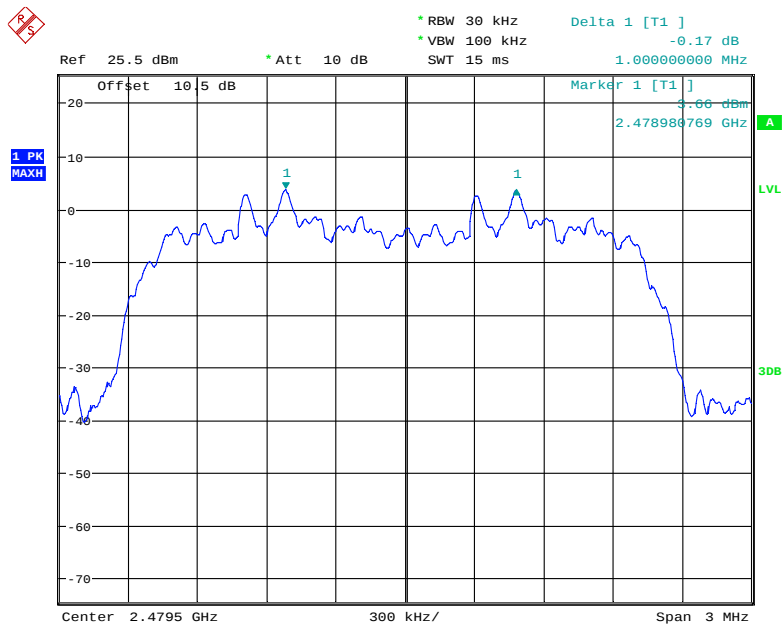
Date: 17.JUL.2018 22:25:05

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



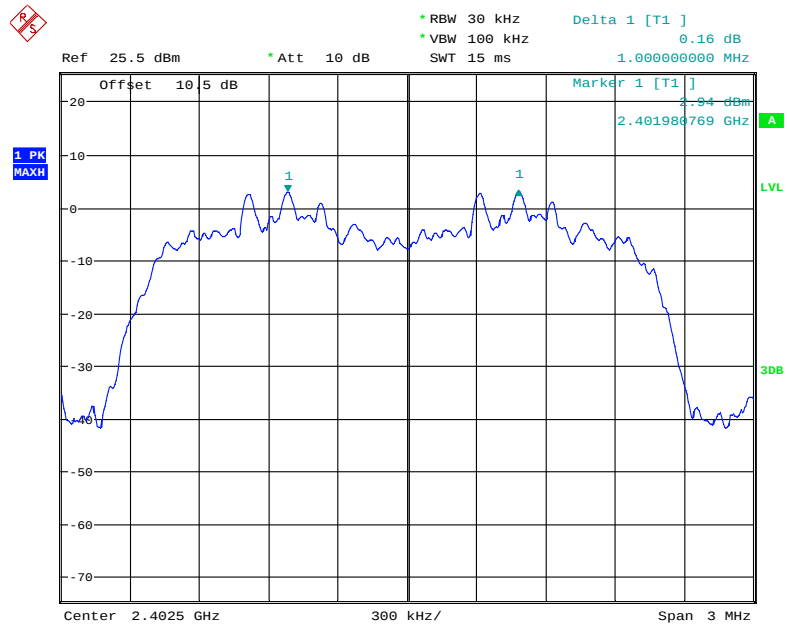
Date: 17.JUL.2018 22:26:01

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



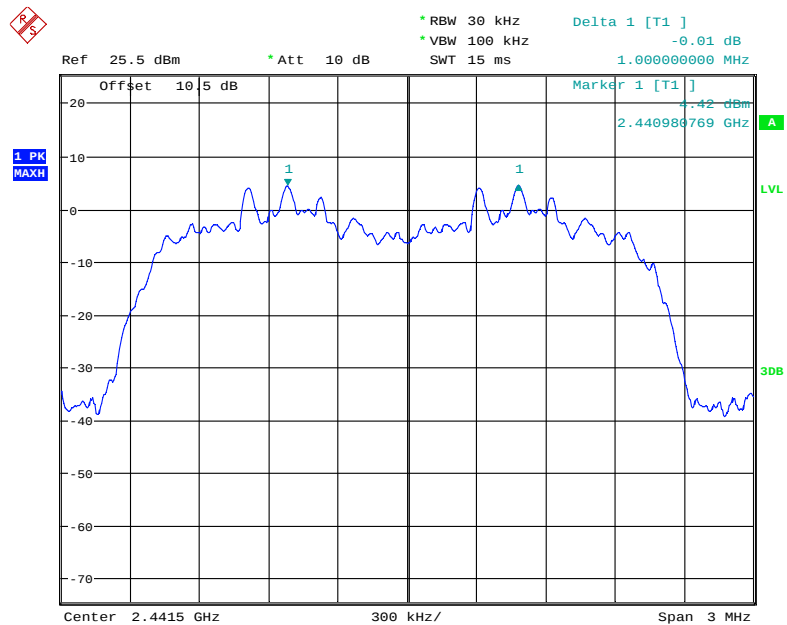
Date: 17.JUL.2018 22:27:08

EDR (8DPSK): Low Channel



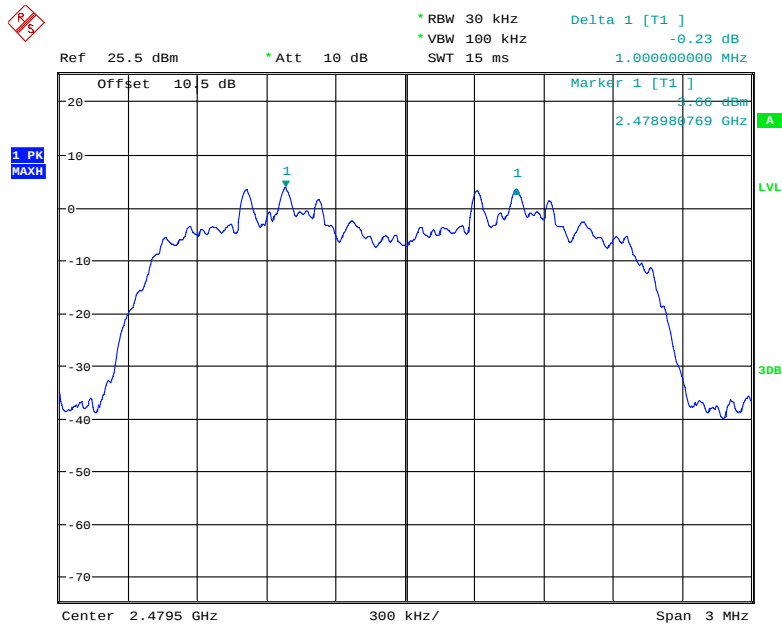
Date: 17.JUL.2018 22:28:22

EDR (8DPSK): Middle Channel



Date: 17.JUL.2018 22:29:28

EDR (8DPSK): High Channel



Date: 17.JUL.2018 22:31:00

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**

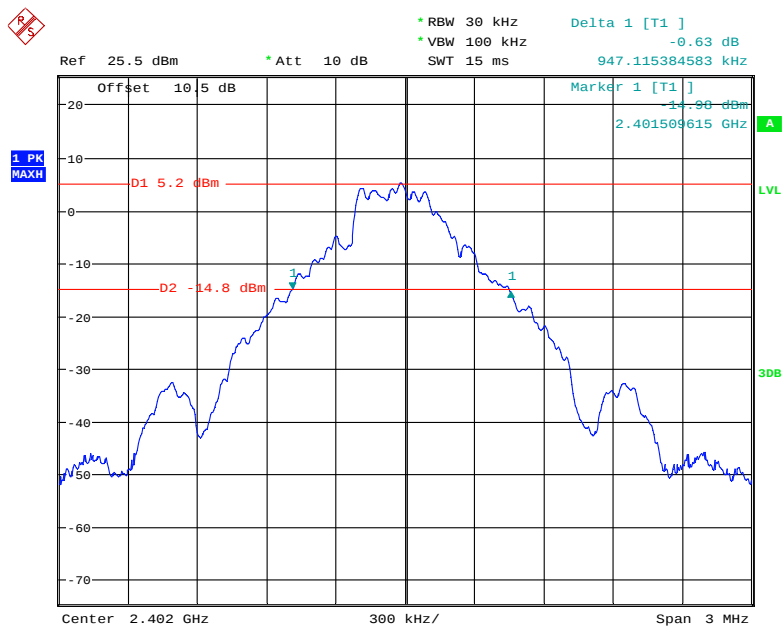
Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-07-17.

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	0.947
	Middle	2441	0.942
	High	2480	0.942
EDR ($\pi/4$-DQPSK)	Low	2402	1.293
	Middle	2441	1.269
	High	2480	1.264
EDR (8DPSK)	Low	2402	1.269
	Middle	2441	1.255
	High	2480	1.264

BDR (GFSK): Low Channel

Date: 17.JUL.2018 22:13:52

Ref 25.5 dBm Att 10 dB RBW 30 kHz VBW 100 kHz SWT 15 ms Delta 1 [T1] -0.23 dB 942.307692271 kHz

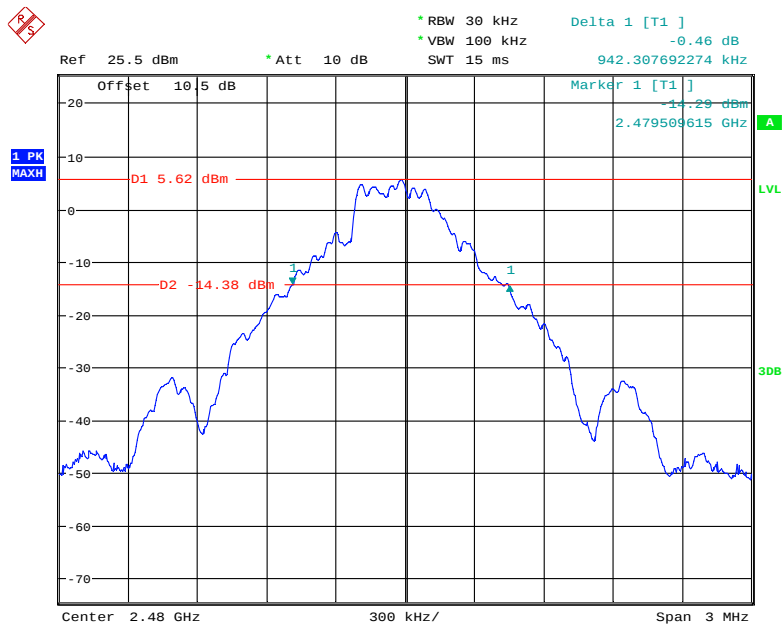
Offset 10 dB Marker 1 [T1] 2.44059615 GHz

1 PK MAXH

D1 6.51 dBm D2 -13.49 dBm

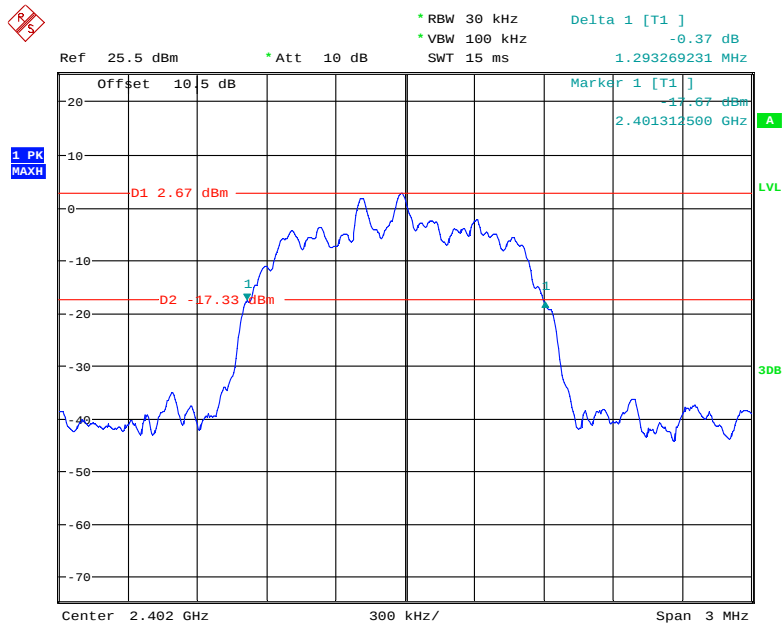
Center 2.441 GHz 300 kHz/ Span 3 MHz

BDR (GFSK): High Channel



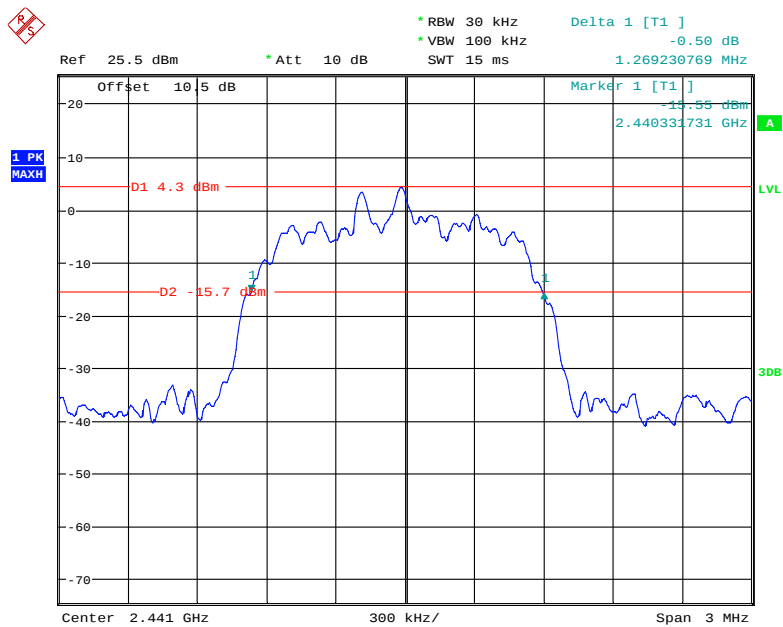
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EDR ($\pi/4$ -DQPSK): Low Channel



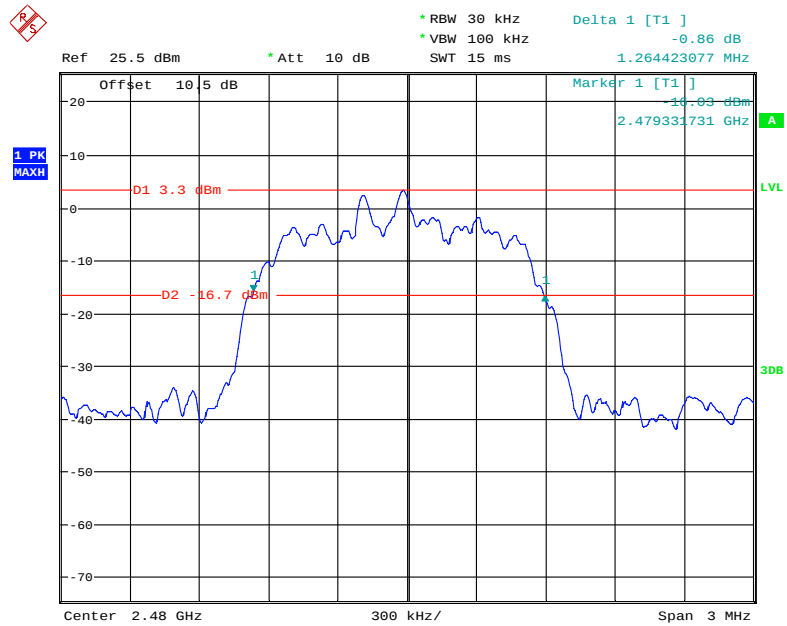
Date: 17.JUL.2018 22:07:47

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



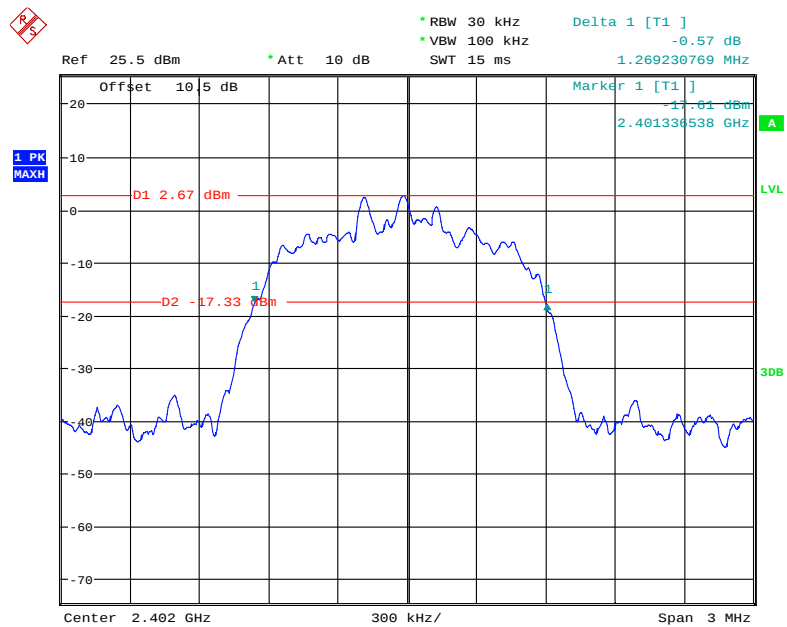
Date: 17.JUL.2018 22:09:32

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



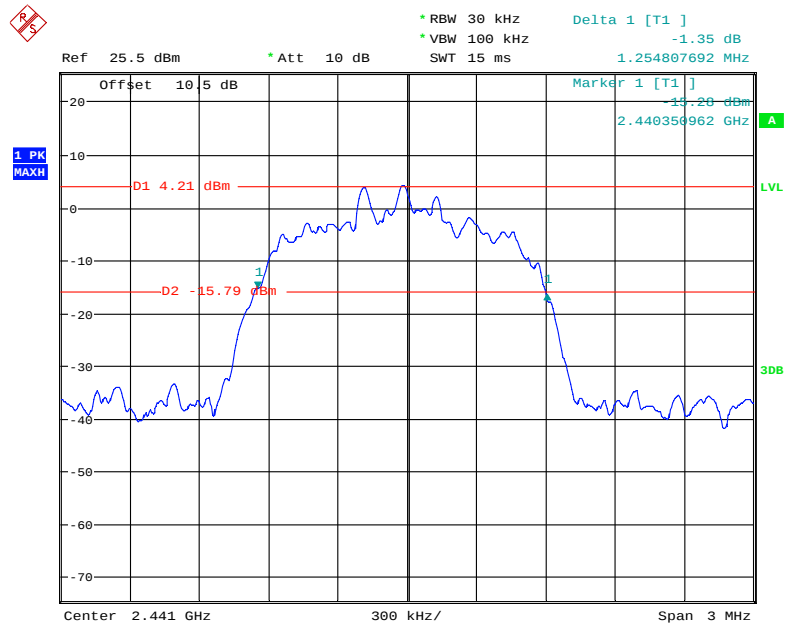
Date: 17.JUL.2018 22:11:02

EDR (8DPSK): Low Channel



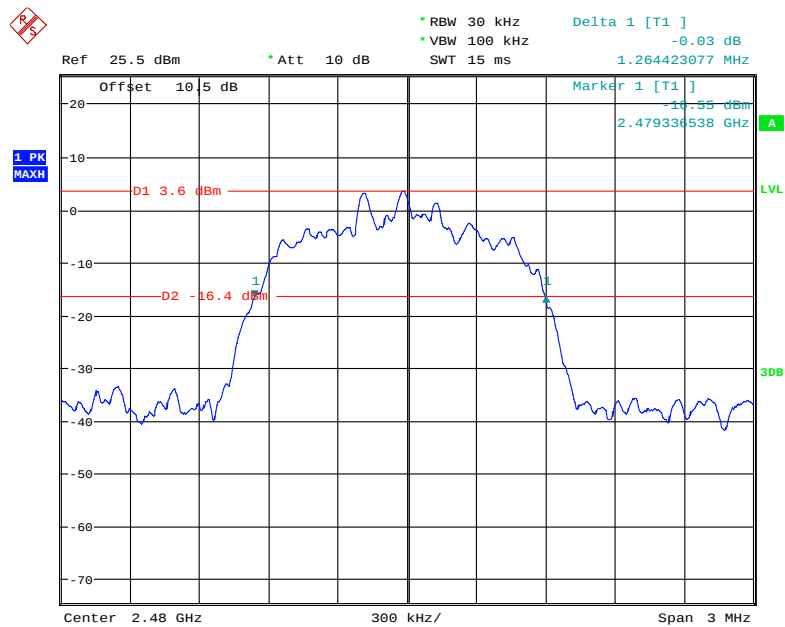
Date: 17.JUL.2018 22:06:23

EDR (8DPSK): Middle Channel



Date: 17.JUL.2018 22:05:18

EDR (8DPSK): High Channel



Date: 17.JUL.2018 21:58:17

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 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

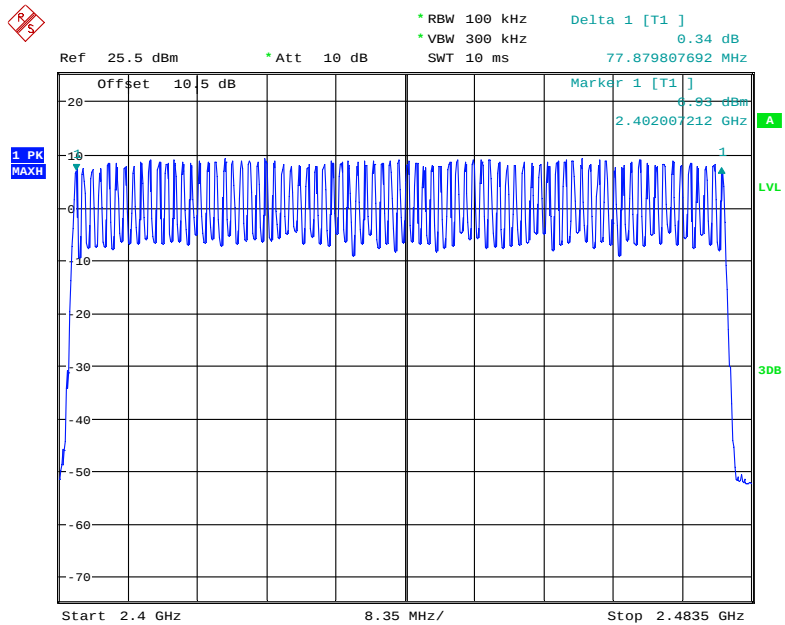
The testing was performed by Tracy Hu on 2018-07-17.

EUT operation mode: Transmitting

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

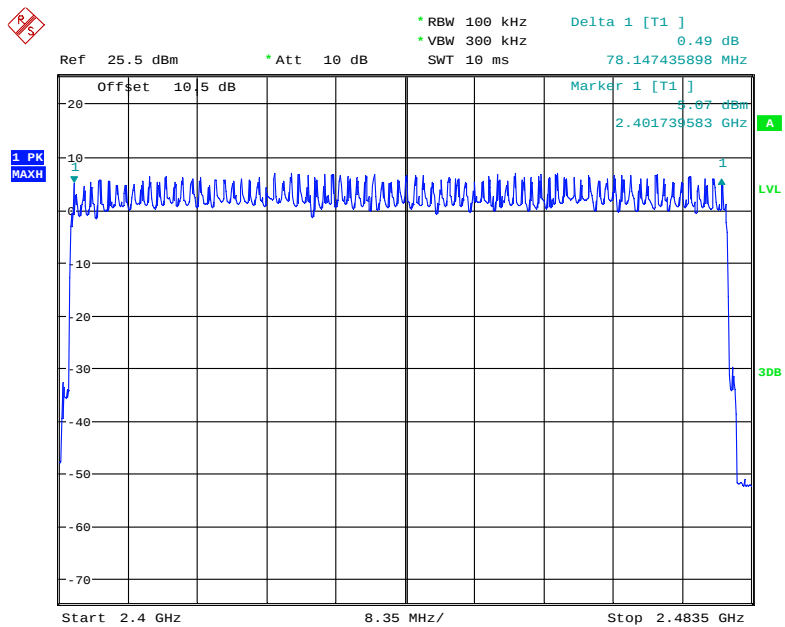
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥ 15
EDR ($\pi/4$ -DQPSK)	2400-2483.5	79	≥ 15
EDR (8DPSK)	2400-2483.5	79	≥ 15

BDR (GFSK): Number of Hopping Channels



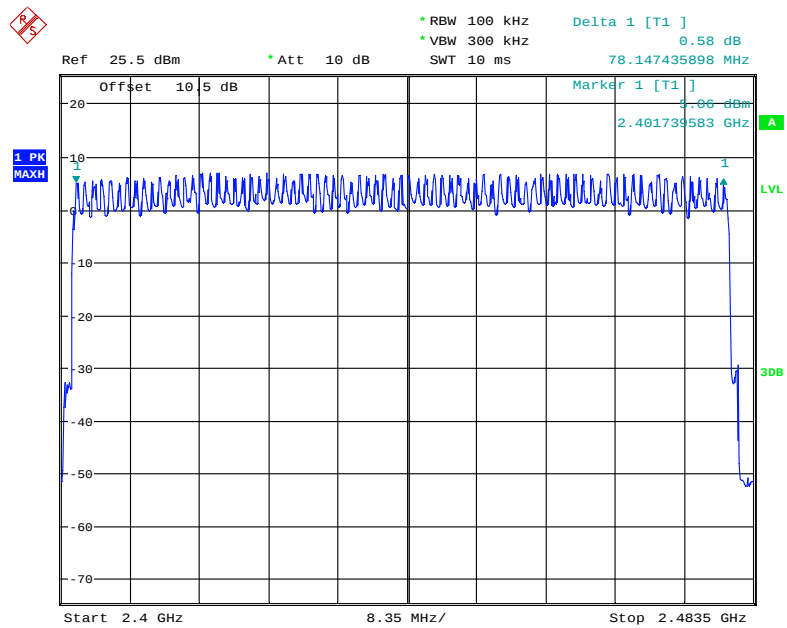
Date: 17.JUL.2018 22:51:26

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



Date: 17.JUL.2018 22:50:02

EDR (8DPSK): Number of Hopping Channels



Date: 17.JUL.2018 22:47:59

FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWEELL 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 $\geq 3 \times$ 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 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-07-17.

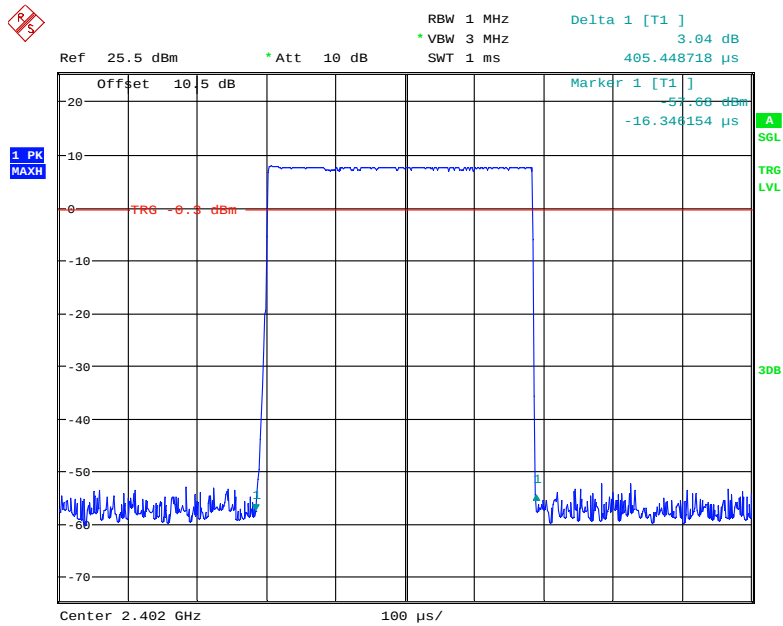
EUT operation mode: Transmitting

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	0.405	0.130	0.4	Pass
		Middle	0.405	0.130	0.4	Pass
		High	0.405	0.130	0.4	Pass
		Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	DH 3	Low	1.670	0.267	0.4	Pass
		Middle	1.670	0.267	0.4	Pass
		High	1.670	0.267	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	DH 5	Low	2.928	0.312	0.4	Pass
		Middle	2.928	0.312	0.4	Pass
		High	2.928	0.312	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR ($\pi/4$ -DQPSK)	2DH 1	Low	0.410	0.131	0.4	Pass
		Middle	0.410	0.131	0.4	Pass
		High	0.410	0.131	0.4	Pass
		Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	2DH 3	Low	1.670	0.267	0.4	Pass
		Middle	1.670	0.267	0.4	Pass
		High	1.670	0.267	0.4	Pass
		Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	2DH 5	Low	2.928	0.312	0.4	Pass
		Middle	2.928	0.312	0.4	Pass
		High	2.928	0.312	0.4	Pass
		Note: 2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (8DPSK)	3DH 1	Low	0.410	0.131	0.4	Pass
		Middle	0.410	0.131	0.4	Pass
		High	0.410	0.131	0.4	Pass
		Note: 3DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	3DH 3	Low	1.670	0.267	0.4	Pass
		Middle	1.670	0.267	0.4	Pass
		High	1.670	0.267	0.4	Pass
		Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	3DH 5	Low	2.928	0.312	0.4	Pass
		Middle	2.928	0.312	0.4	Pass
		High	2.928	0.312	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				

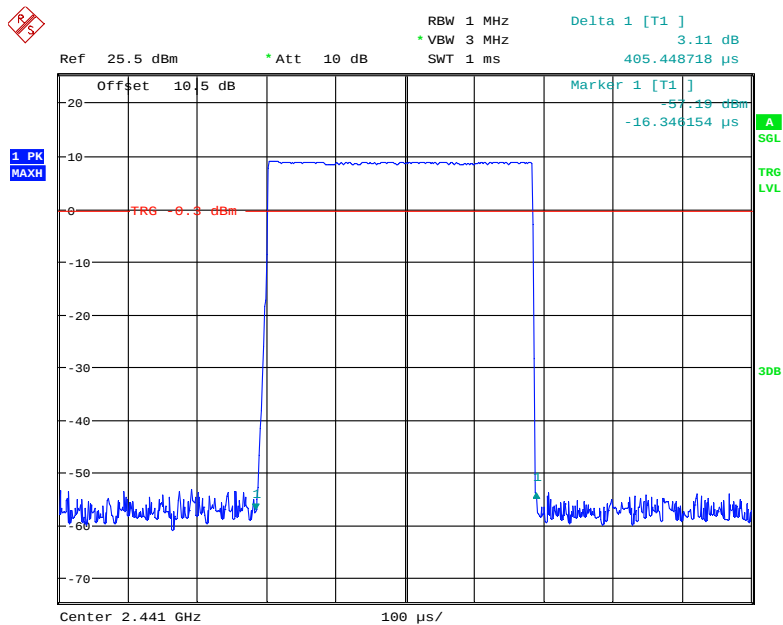
BDR (GFSK):

Pulse time, Low Channel, DH1



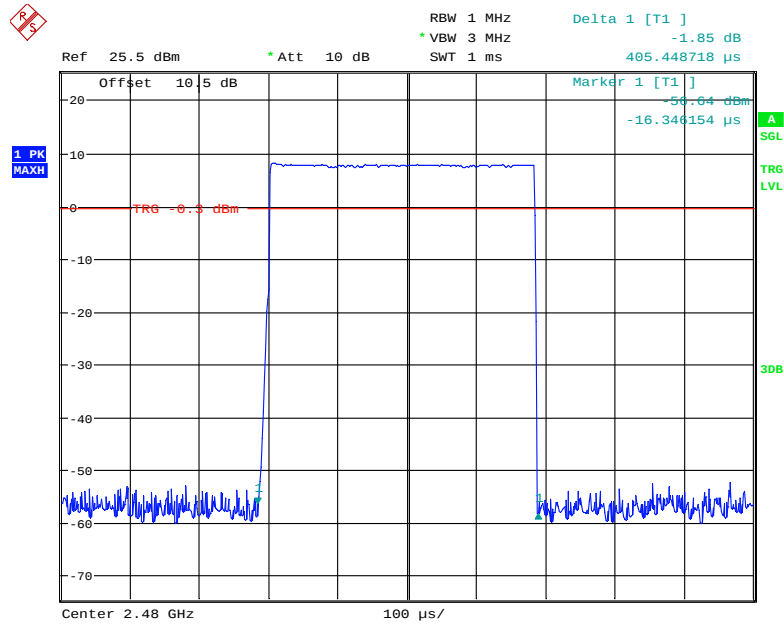
Date: 17.JUL.2018 22:53:25

Pulse time, Middle Channel, DH1



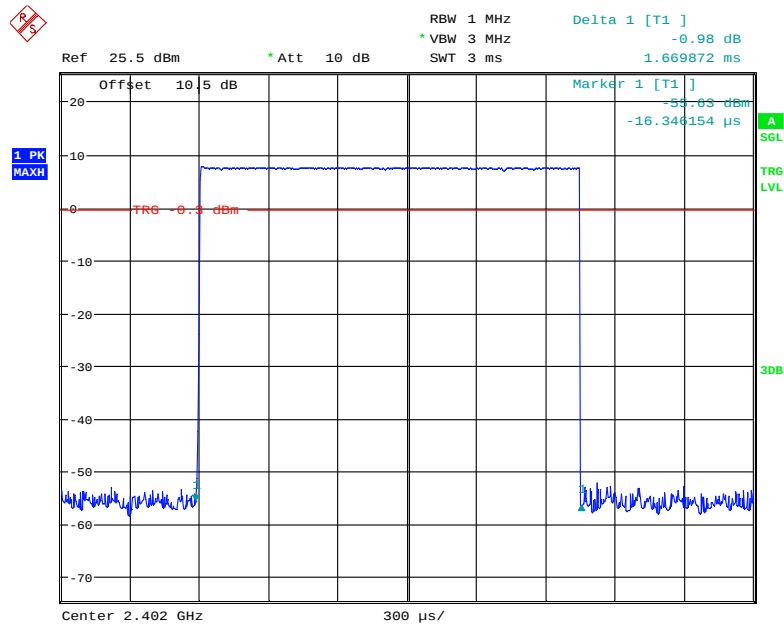
Date: 17.JUL.2018 22:53:55

Pulse time, High Channel, DH1



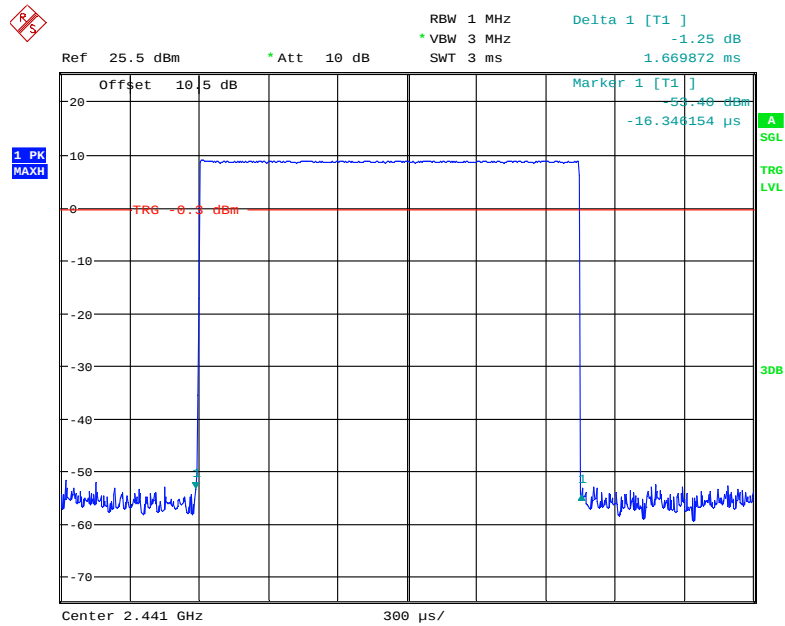
Date: 17.JUL.2018 22:54:07

Pulse time, Low Channel, DH3



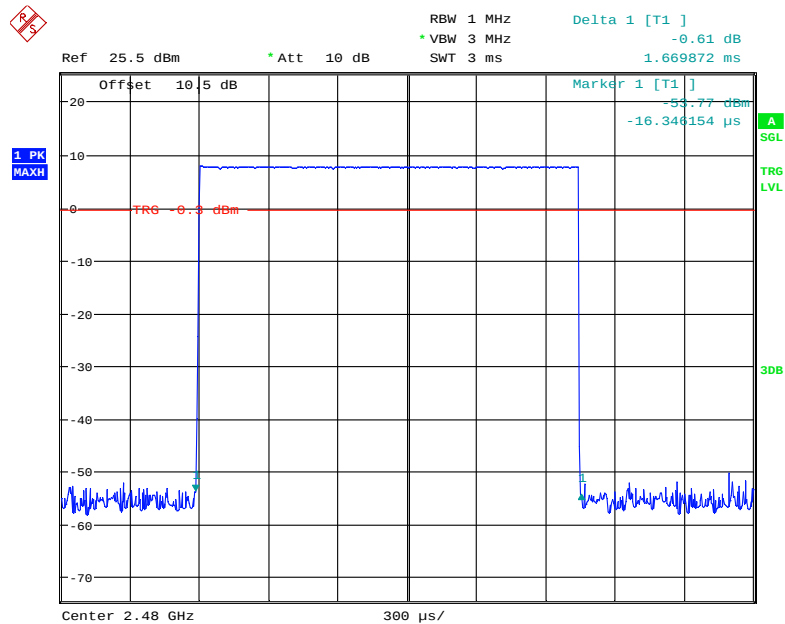
Date: 17.JUL.2018 22:58:40

Pulse time, Middle Channel, DH3



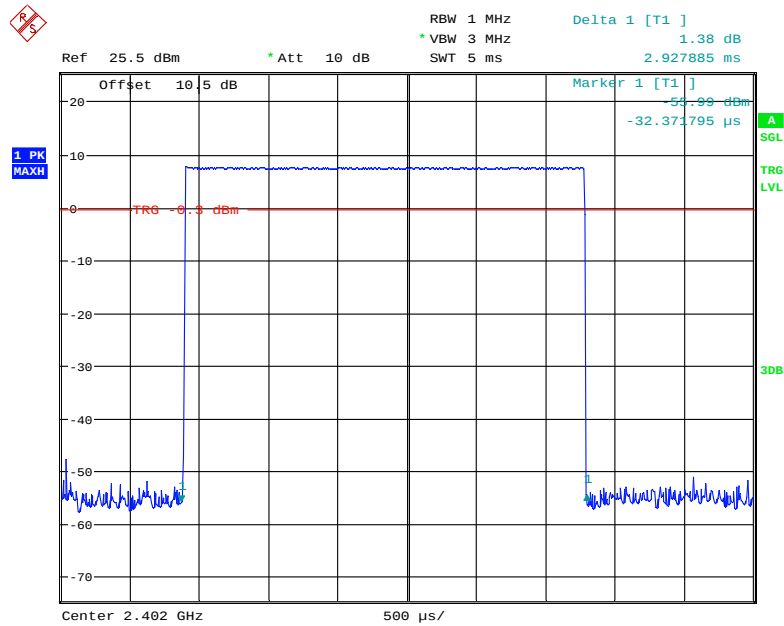
Date: 17.JUL.2018 22:59:03

Pulse time, High Channel, DH3



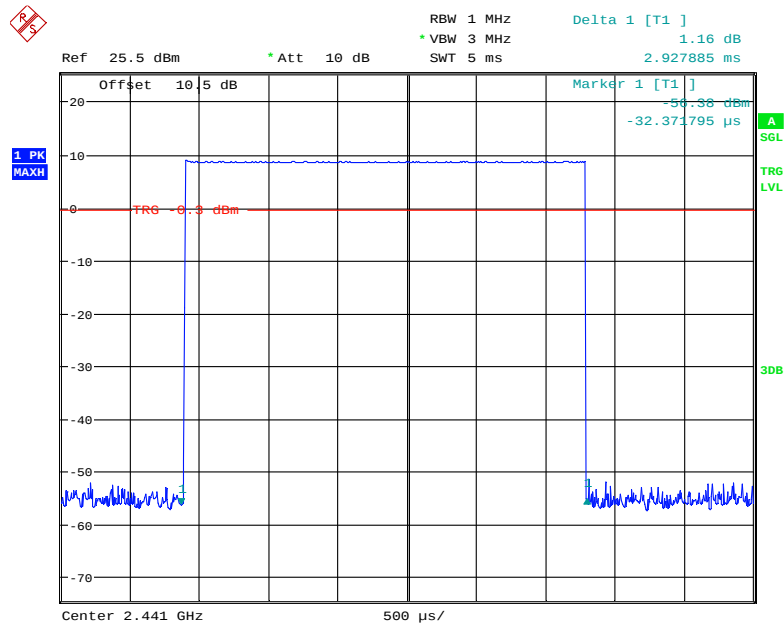
Date: 17.JUL.2018 22:59:16

Pulse time, Low Channel, DH5



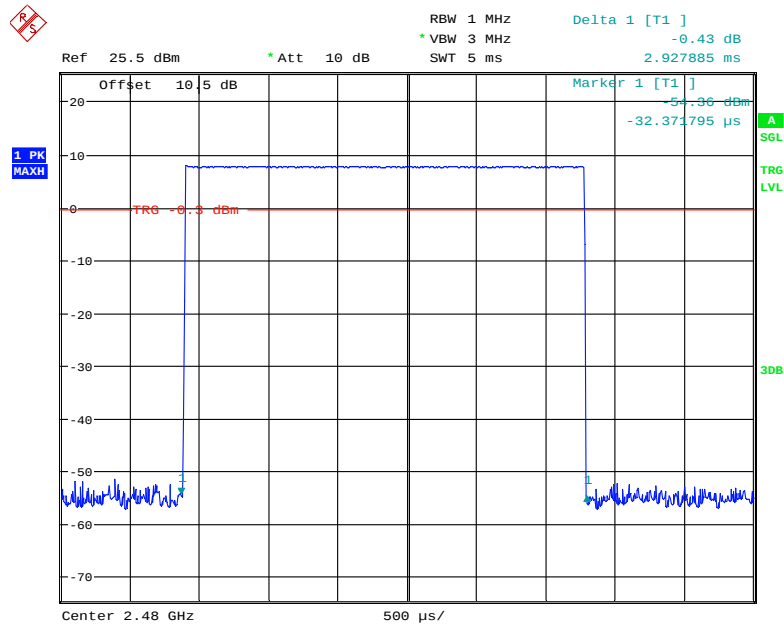
Date: 17.JUL.2018 23:02:12

Pulse time, Middle Channel, DH5



Date: 17.JUL.2018 23:02:44

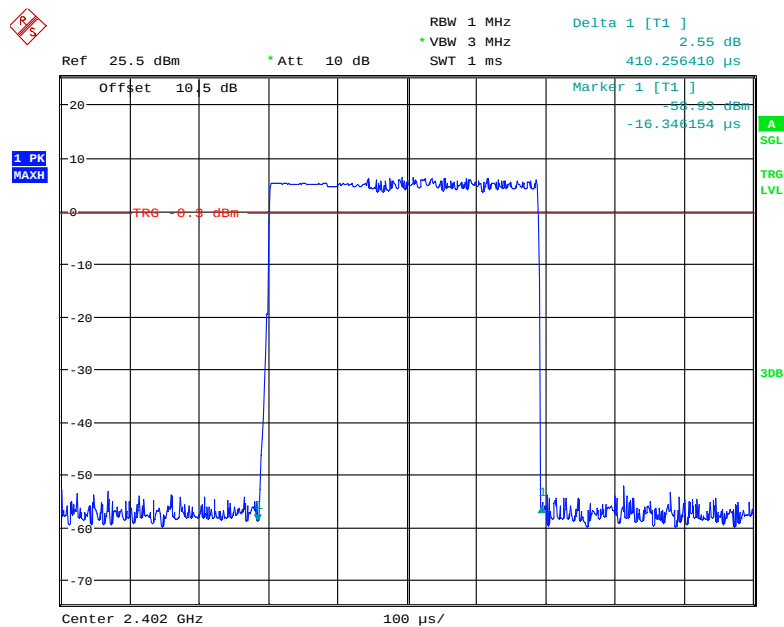
Pulse time, High Channel, DH5



Date: 17.JUL.2018 23:02:53

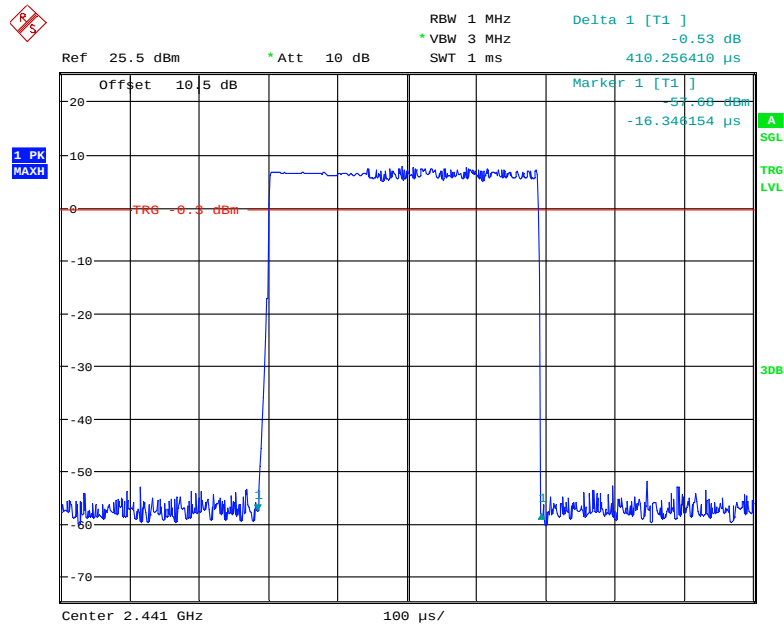
EDR ($\pi/4$ -DQPSK):

Pulse time, Low Channel, 2DH1



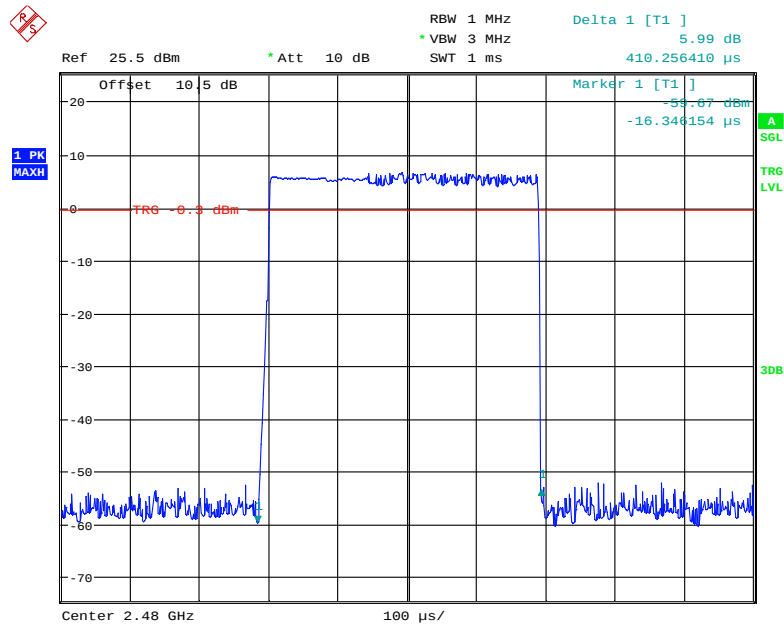
Date: 17.JUL.2018 22:55:13

Pulse time, Middle Channel, 2DH1



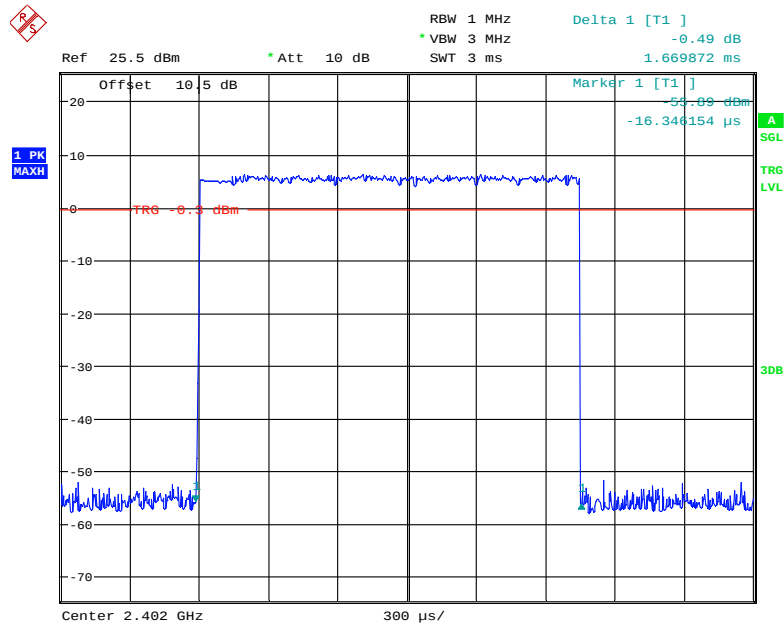
Date: 17.JUL.2018 22:55:31

Pulse time, High Channel, 2DH1



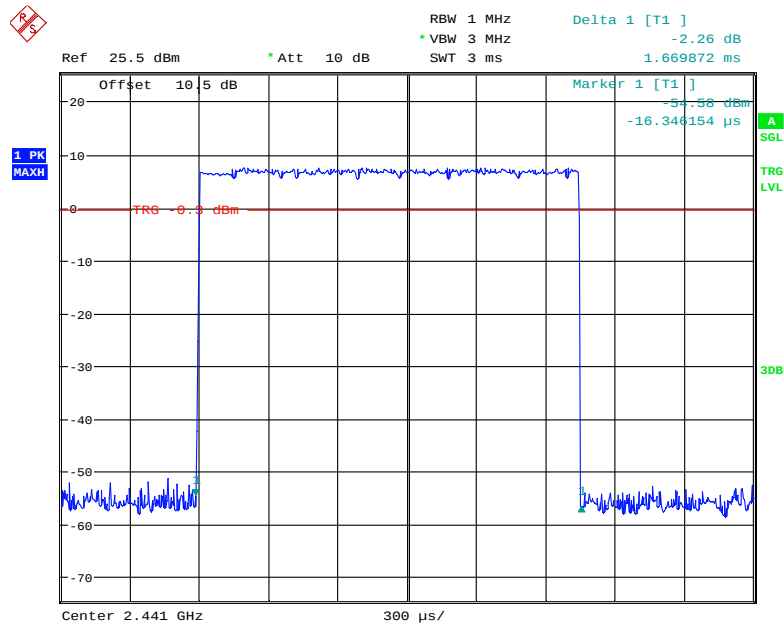
Date: 17.JUL.2018 22:55:44

Pulse time, Low Channel, 2DH3



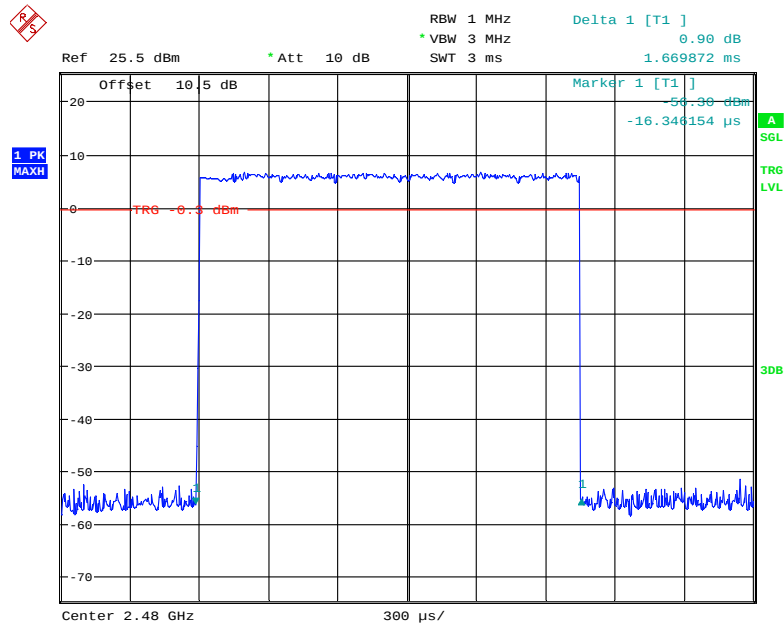
Date: 17.JUL.2018 22:59:55

Pulse time, Middle Channel, 2DH3



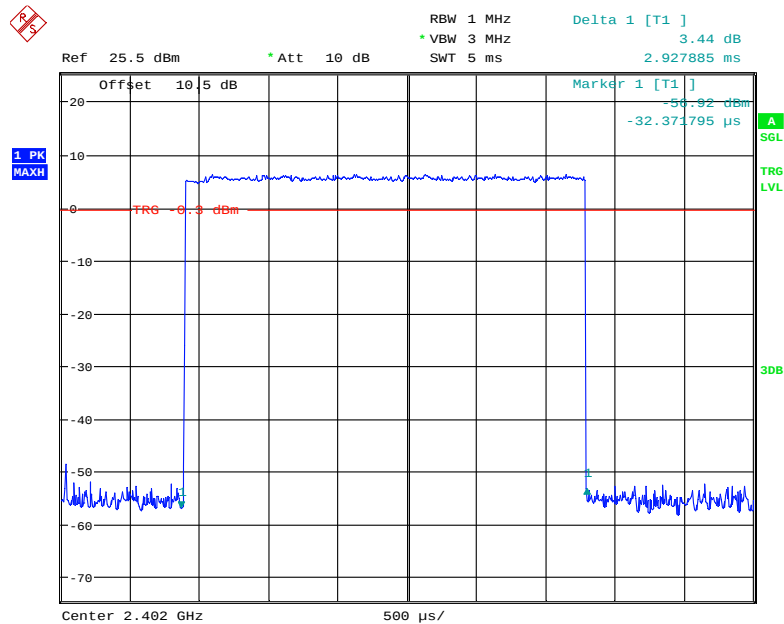
Date: 17.JUL.2018 23:00:10

Pulse time, High Channel, 2DH3



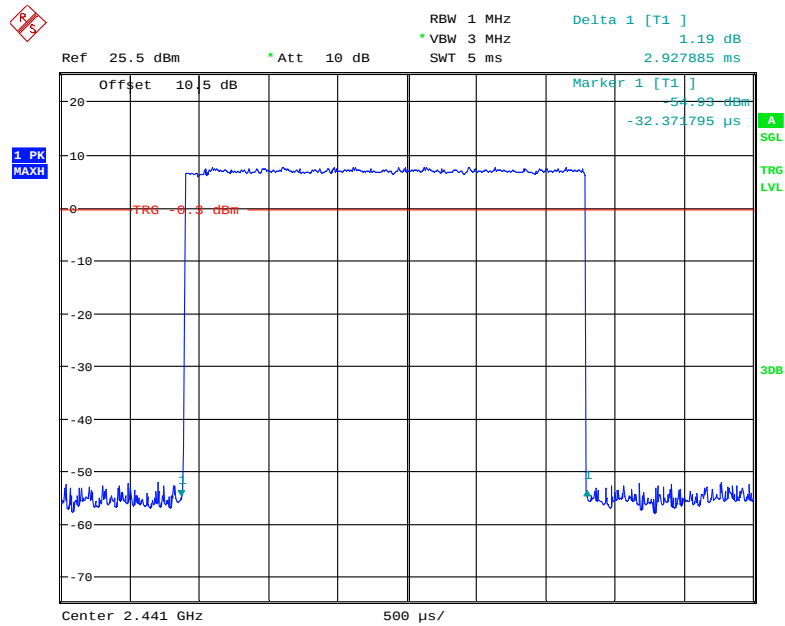
Date: 17.JUL.2018 23:00:27

Pulse time, Low Channel, 2DH5



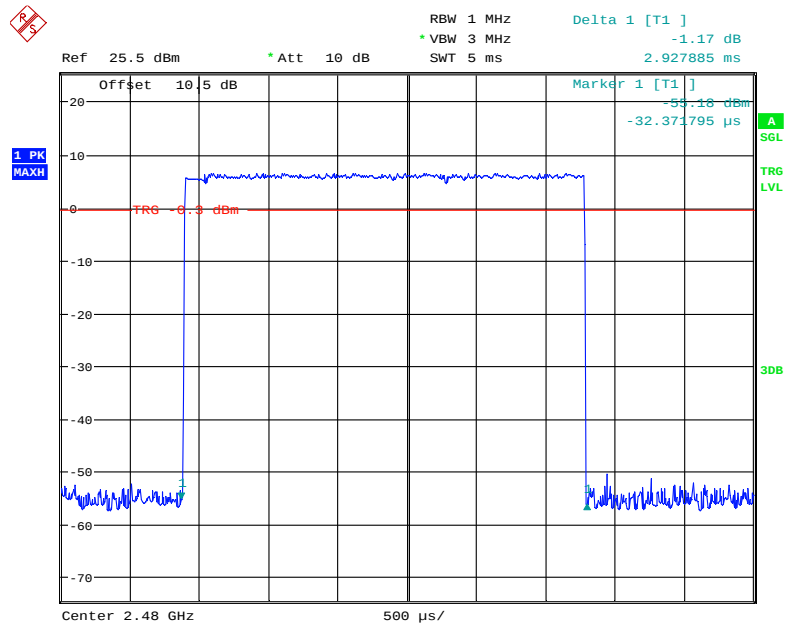
Date: 17.JUL.2018 23:04:23

Pulse time, Middle Channel, 2DH5



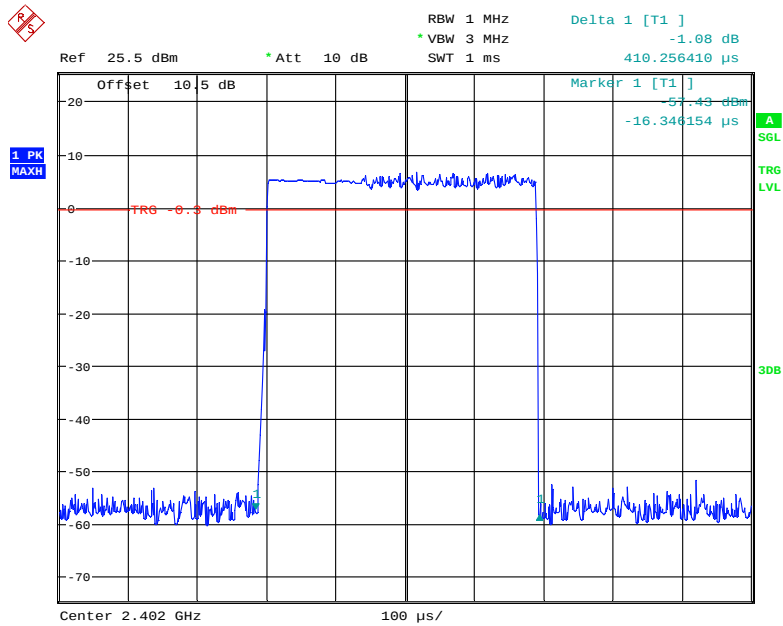
Date: 17.JUL.2018 23:04:40

Pulse time, High Channel, 2DH5



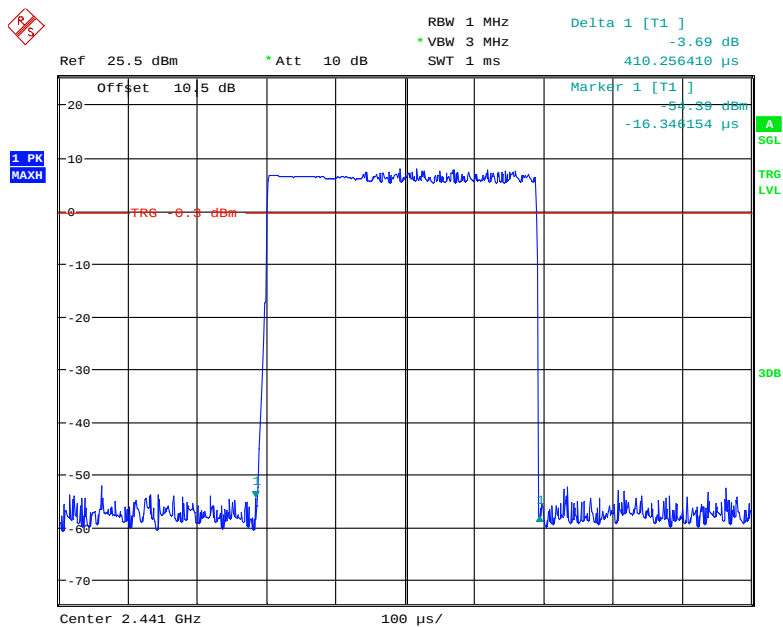
Date: 17.JUL.2018 23:04:51

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



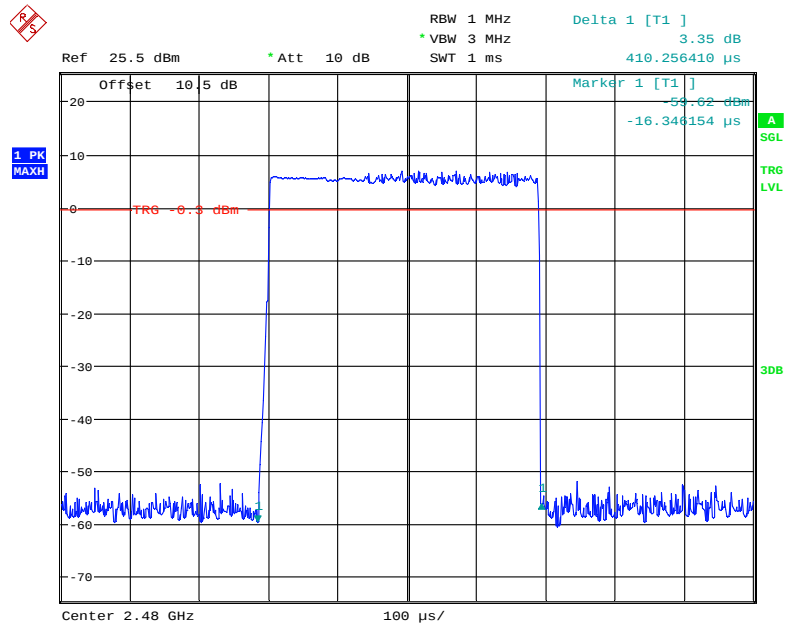
Date: 17.JUL.2018 22:57:13

Pulse time, Middle Channel, 3DH1



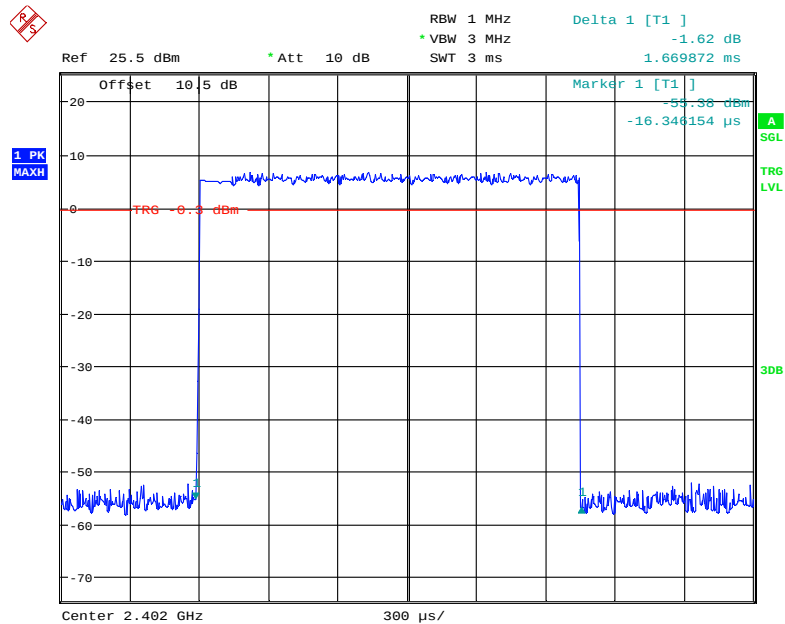
Date: 17.JUL.2018 22:57:29

Pulse time, High Channel, 3DH1



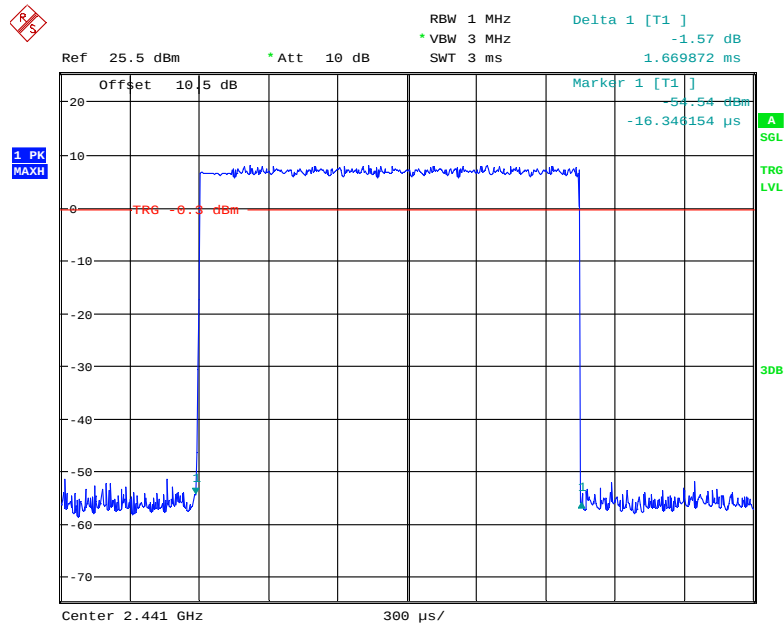
Date: 17.JUL.2018 22:57:41

Pulse time, Low Channel, 3DH3



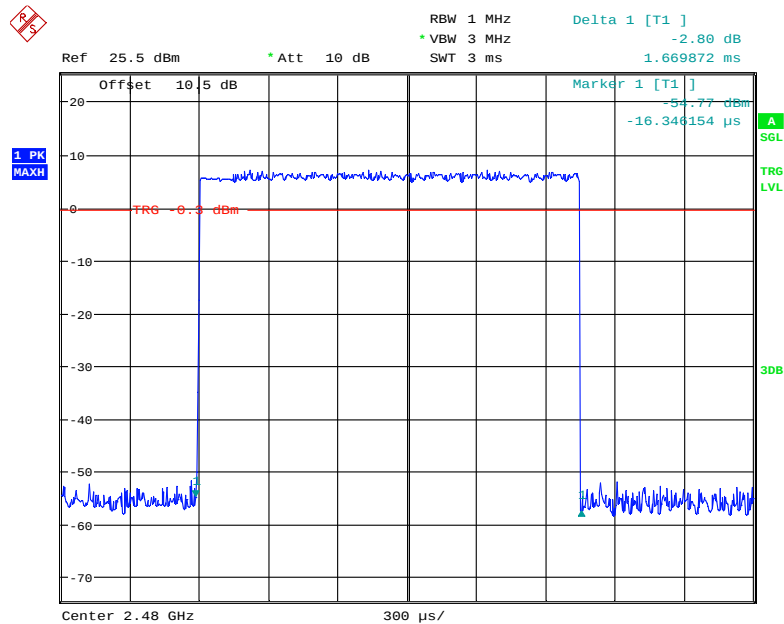
Date: 17.JUL.2018 23:00:57

Pulse time, Middle Channel, 3DH3



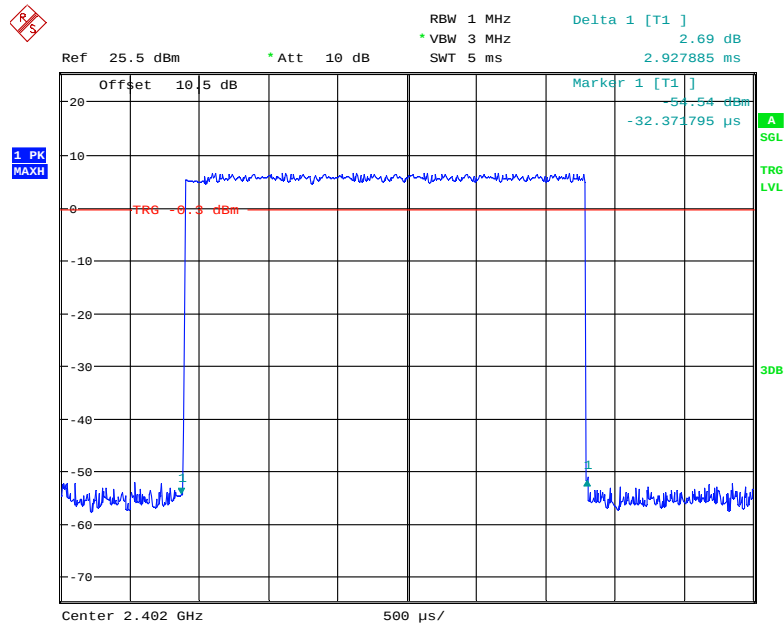
Date: 17.JUL.2018 23:01:17

Pulse time, High Channel, 3DH3



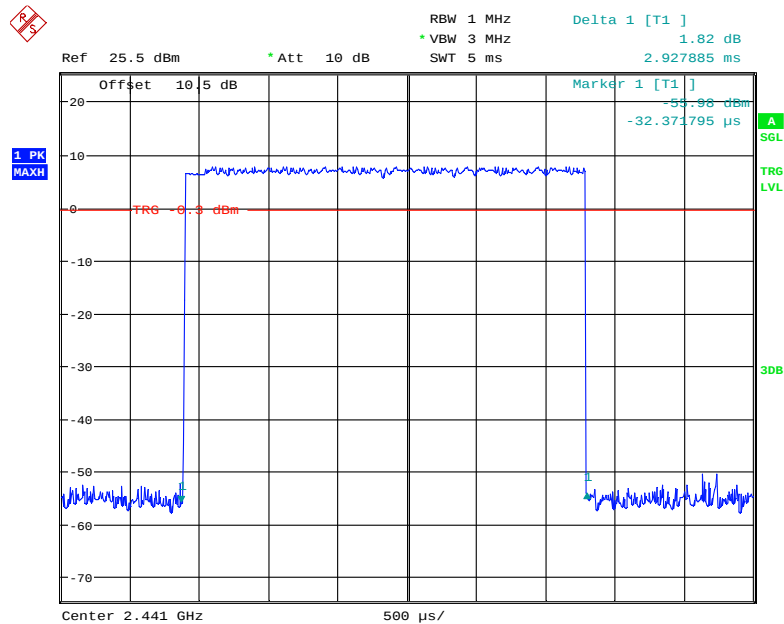
Date: 17.JUL.2018 23:01:30

Pulse time, Low Channel, 3DH5



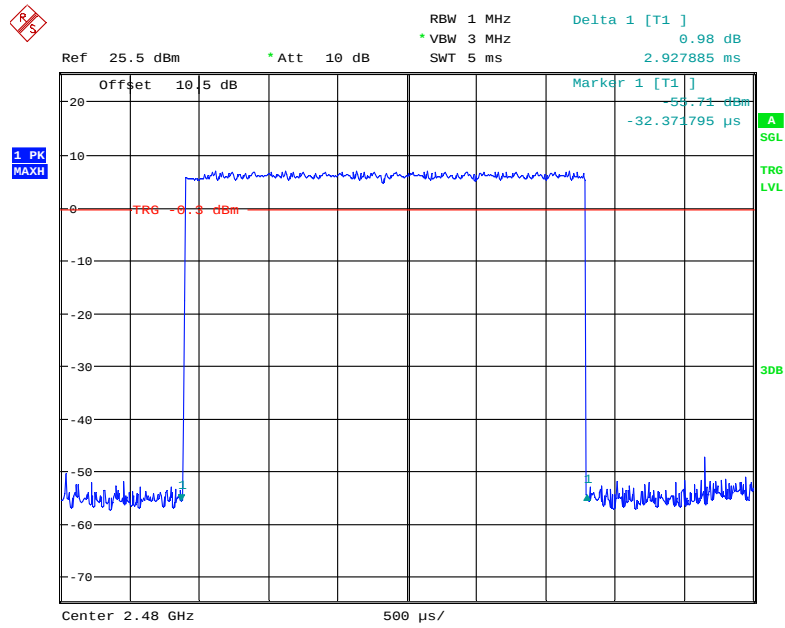
Date: 17.JUL.2018 23:05:40

Pulse time, Middle Channel, 3DH5



Date: 17.JUL.2018 23:05:28

Pulse time, High Channel, 3DH5



Date: 17.JUL.2018 23:05:09

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 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-07-17

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	7.86	6.11	125
	Middle	2441	9.11	8.15	125
	High	2480	8.20	6.61	125
EDR ($\pi/4$-DQPSK)	Low	2402	8.20	6.61	125
	Middle	2441	8.26	6.70	125
	High	2480	7.32	5.40	125
EDR (8DPSK)	Low	2402	7.24	5.30	125
	Middle	2441	7.24	5.30	125
	High	2480	7.63	5.79	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 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Tracy Hu on 2018-07-17.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following plots.

Ref 25.5 dBm * Att 10 dB

* RBW 100 kHz * VBW 300 kHz * Marker 1 [T1] -49.80 dBm
SWT 20 ms 2.345192308 GHz

Offset 10.5 dB

1 PK MAXH

D1 9.4 dBm

D2 -10.6 dBm

1

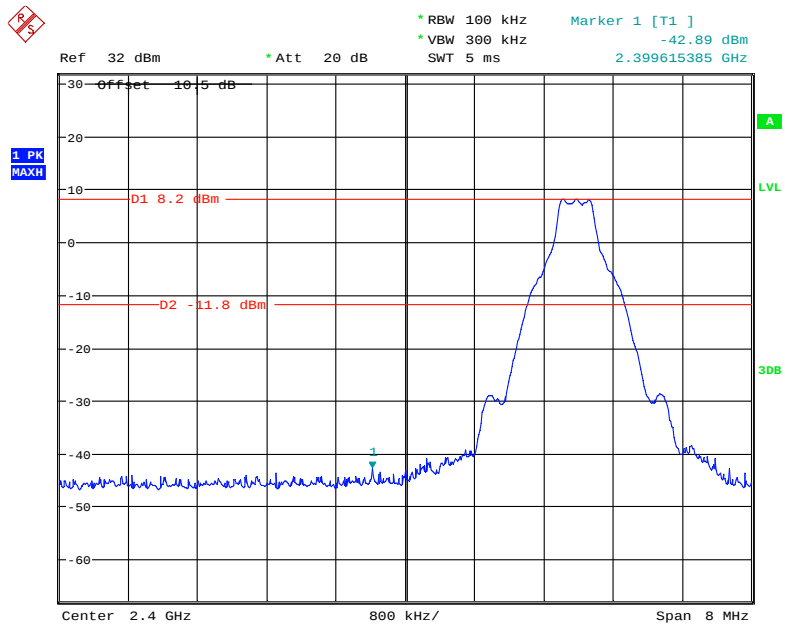
A

LVL

3DB

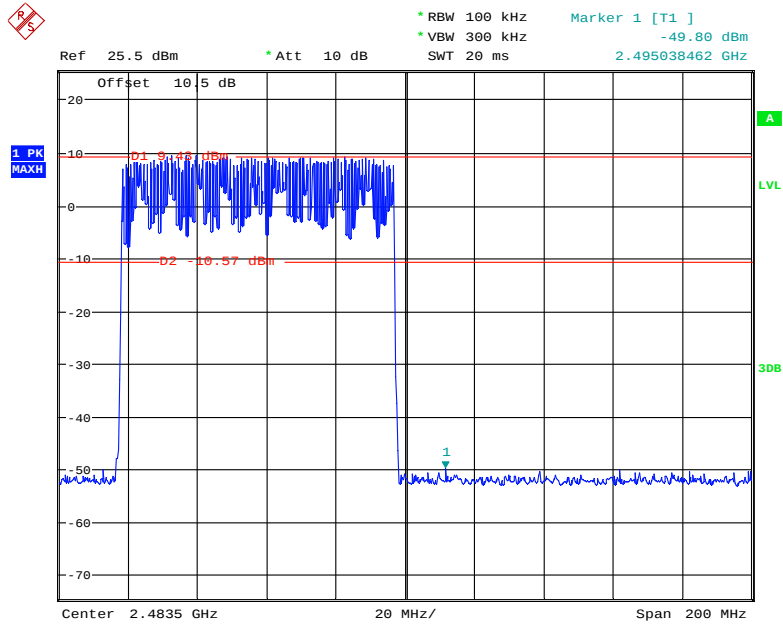
Center 2.4 GHz 20 MHz/ Span 200 MHz

Single



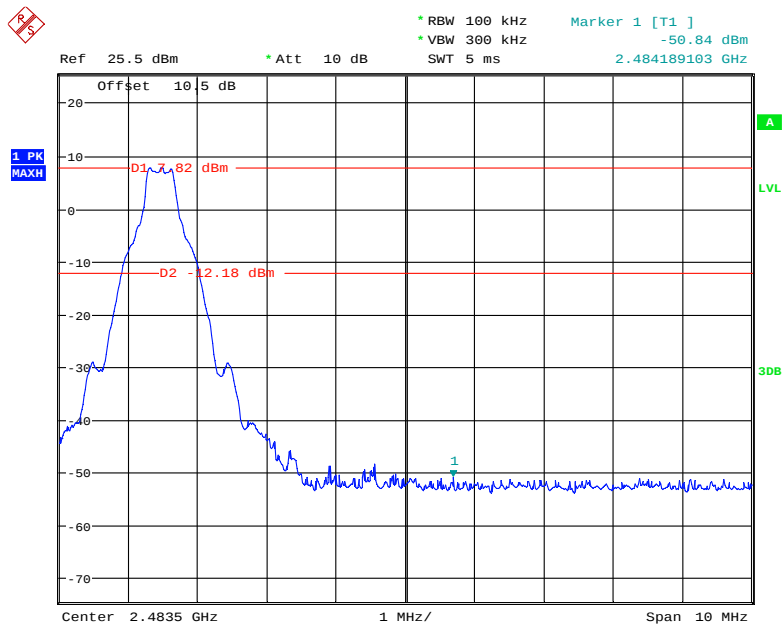
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BDR (GFSK): Band Edge-Right Side Hopping



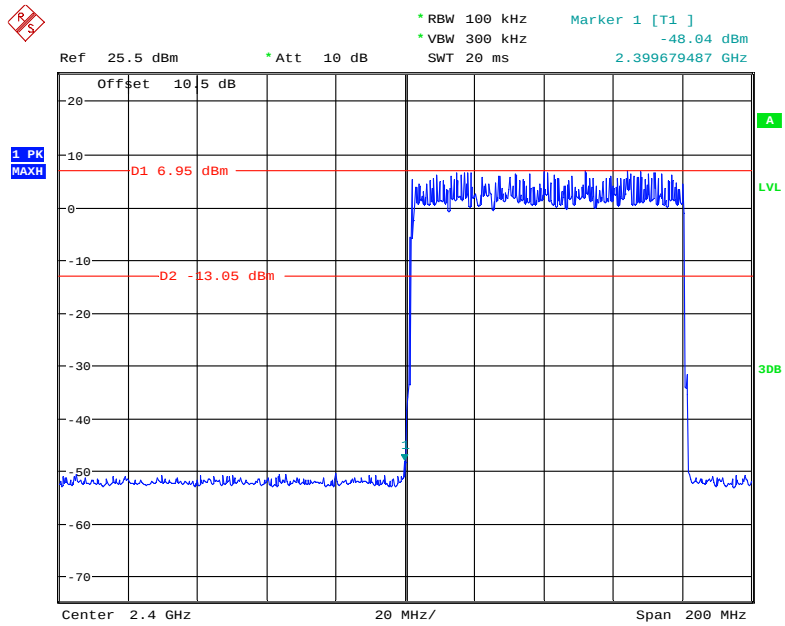
Date: 17.JUL.2018 22:39:02

Single



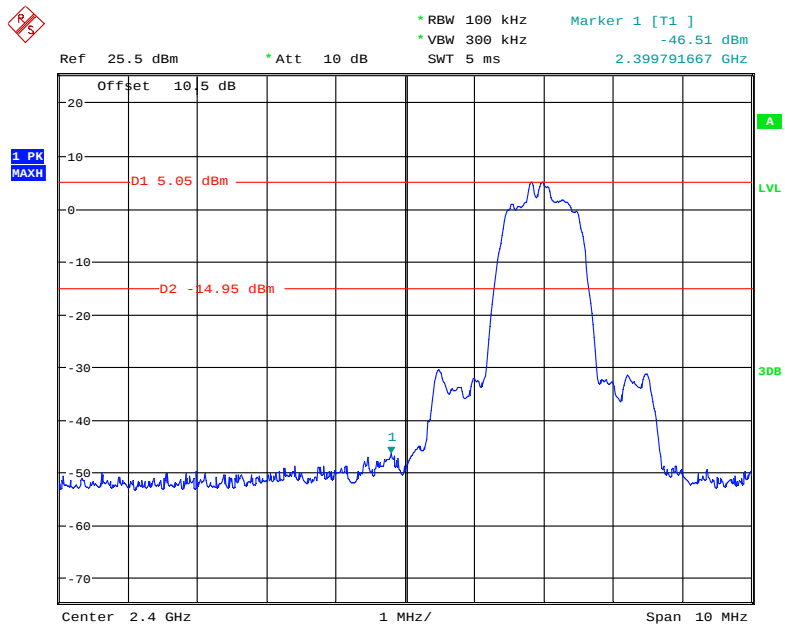
Date: 17.JUL.2018 22:35:41

EDR ($\pi/4$ -DQPSK): Band Edge-Left Side Hopping



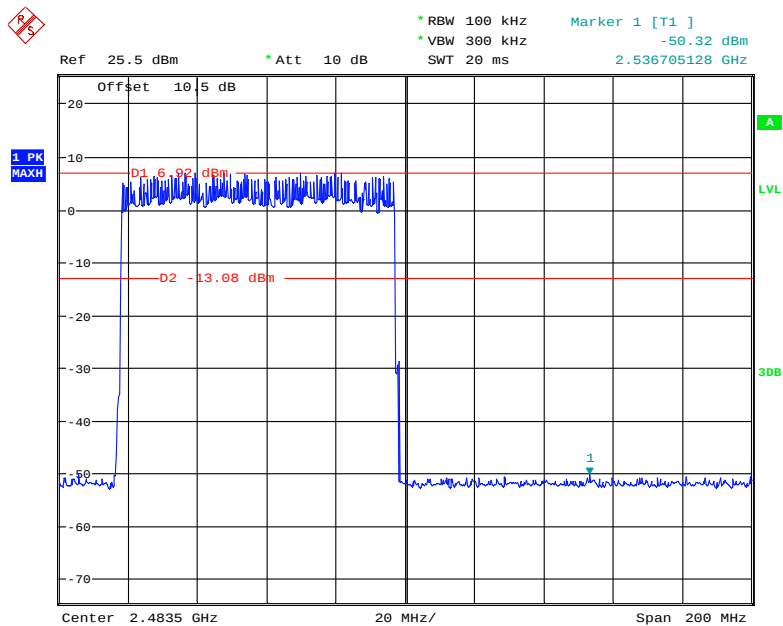
Date: 17.JUL.2018 22:41:53

Single



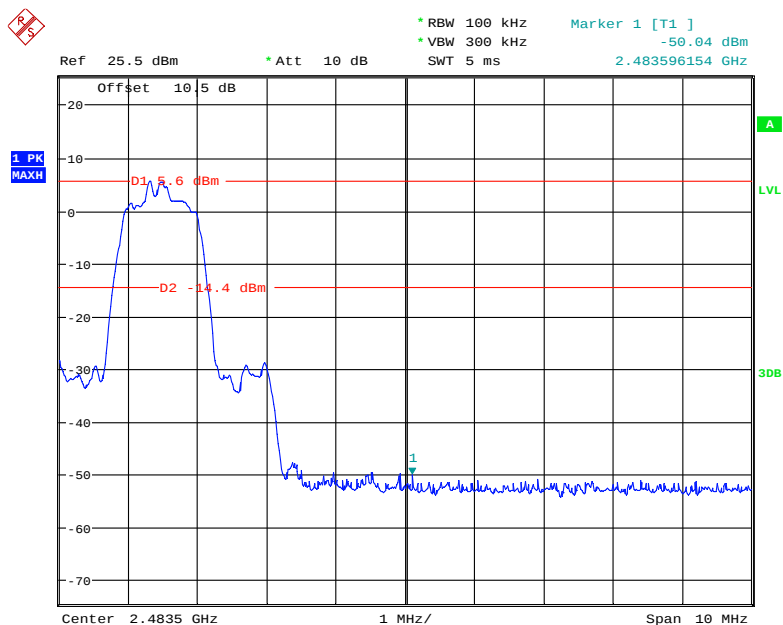
Date: 17.JUL.2018 22:34:04

EDR ($\pi/4$ -DQPSK): Band Edge-Right Side Hopping

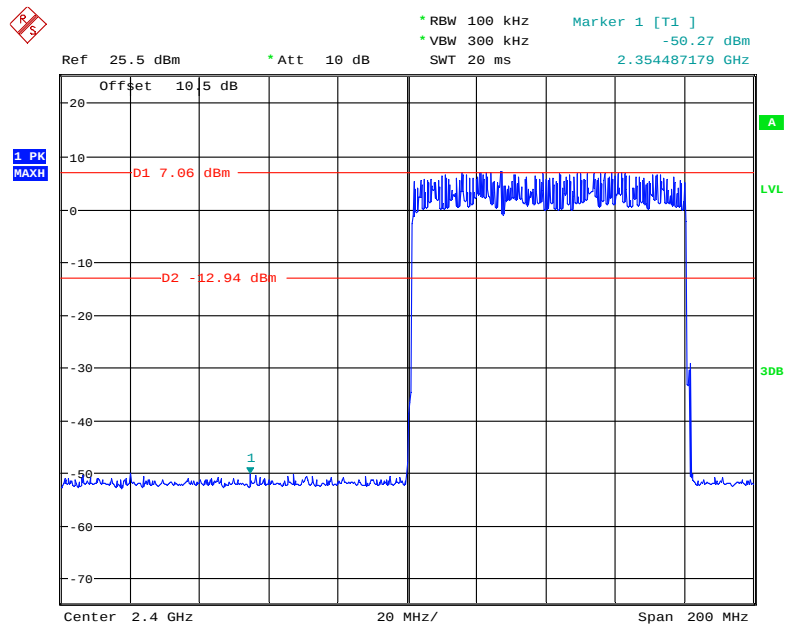


Date: 17.JUL.2018 22:40:42

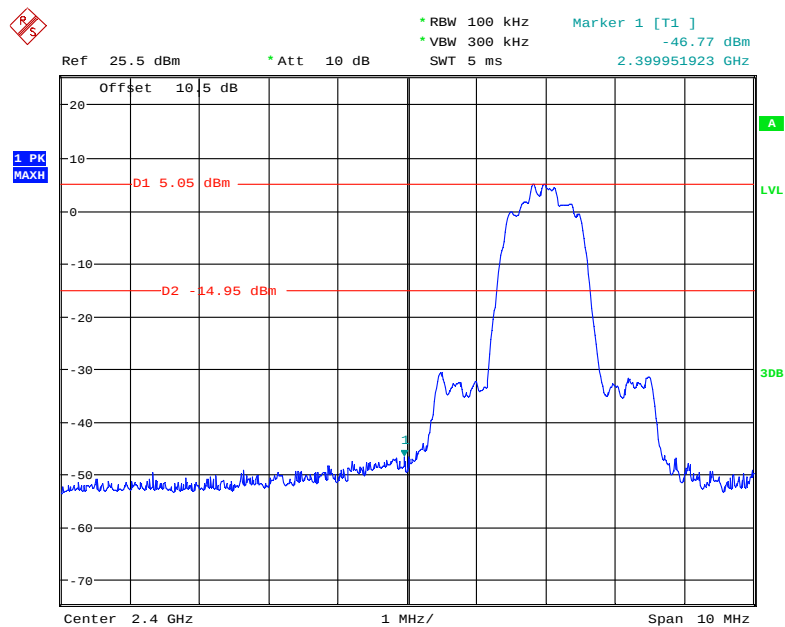
Single



Date: 17.JUL.2018 22:34:53

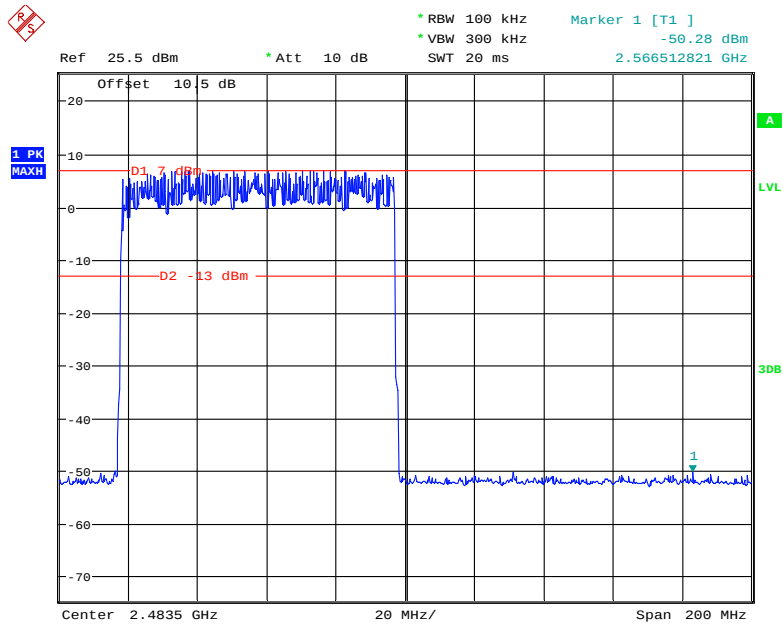
**EDR (8DPSK): Band Edge-Left Side
Hopping**

Date: 17.JUL.2018 22:43:41

Single

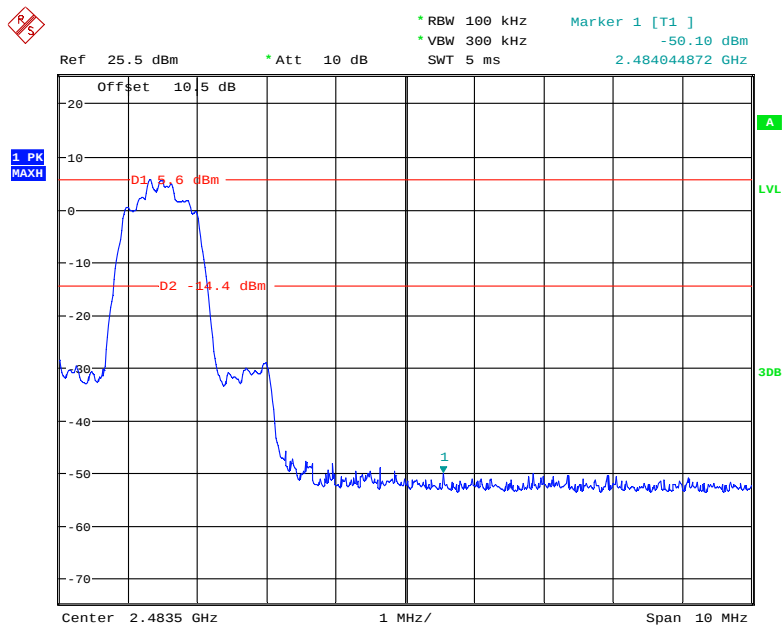
Date: 17.JUL.2018 22:33:13

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



Date: 17.JUL.2018 22:45:12

Single



Date: 17.JUL.2018 22:32:20

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