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CERTIFICATE # 4821.01

BACL
Bay Area Compliance Labs Corp.

FCC PART 15.247
TEST REPORT

For

Xstar Smart Power Co.,Limited

9B, Cheong Tai Commercil Building, 66 Wing Lok Street, Sheung Wan, Hong Kong

FCC ID: 2ARIR-1824A

Report Type:	**Product Type:**
Original Report	PRATI

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Reviewed By: Simon Wang
RF Engineer

Simon wang

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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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

The *Xstar Smart Power Co.,Limited's* product, model number: *X19 (FCC ID: 2ARIR-1824A)* or model number: *X20* or the "EUT" in this report was a *PRATI,* which was measured approximately: 12.3 cm (L) * 5.2 cm (W) * 1.5 cm (H) for X19 and 11.2 cm (L) * 4.8 cm (W) * 1.5 cm (H) for X20, rated with input voltage: DC 3.7 V from battery or DC 5.0V from adapter.

Adapter Information:
Input: AC 100-240V, 50/60Hz, 150mA
Output: DC 5.0V, 500mA

Notes: This series products model: X20 and X19 are electrically identical, the difference between them is model name, screen size, product shell size, model name and capacity of battery, GSM antenna due to marketing purpose. Model X19 was selected for fully testing, the detailed information can be referred to the declaration letter which was stated and guaranteed by the applicant.

**All measurement and test data in this report was gathered from production sample serial number: 1801469-1 & 1801469-2 (Assigned by BACL, Shenzhen). The EUT supplied by the applicant was received on 2018-09-12.*

Objective

This test report is prepared on behalf of *Xstar Smart Power Co.,Limited* 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 15B JBP and Part 22H /24E PCE submissions with FCC ID: 2ARIR-1824A.

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℃
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

No exercise software was made to the EUT tested.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

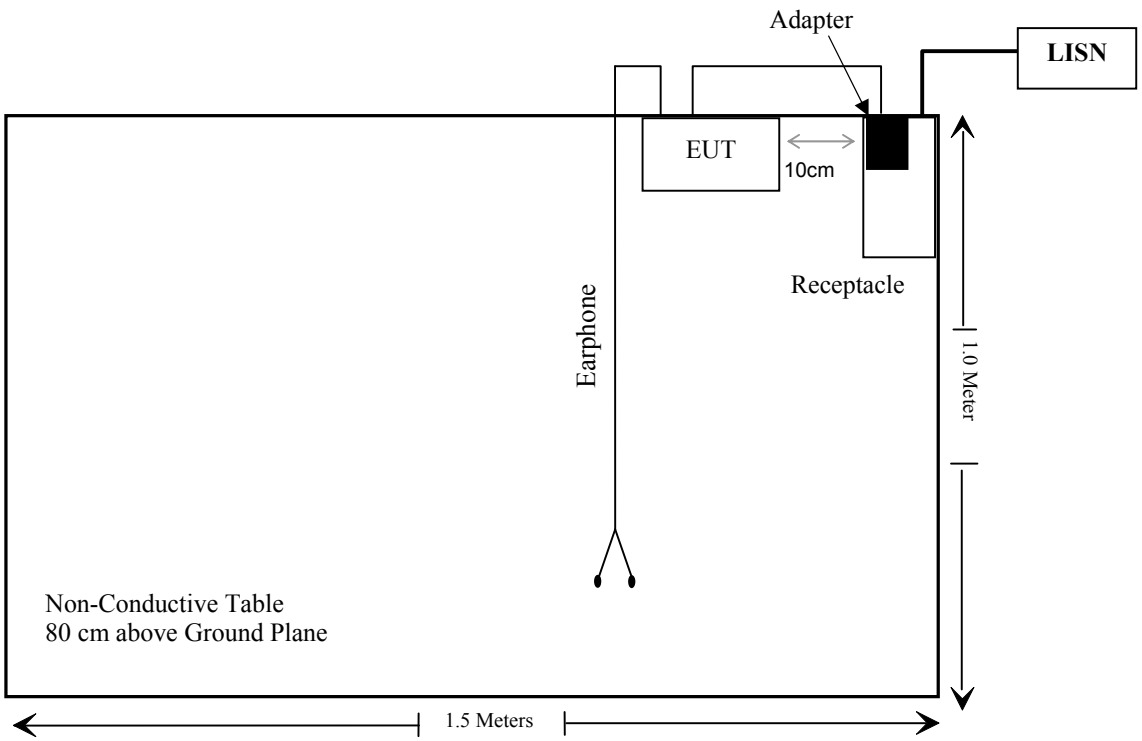
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cable	1.0	EUT	Adapter

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (1)& §2.1093	RF Exposure	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
Unknown	Conducted Emission Cable	78652	UF A210B-1-0720-504504	2018-05-12	2018-11-12
Radiated Emission Test					
A.H.System	Horn Antenna	SAS-200/571	135	2018-08-18	2021-08-17
Rohde & Schwarz	Signal Analyzer	FSEM	845987/005	2018-06-23	2019-06-23
COM-POWER	Pre-amplifier	PA-122	181919	2018-08-01	2019-02-01
Sonoma Instrument	Amplifier	310N	186238	2018-05-12	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	Notch Filter	BSF2402-2480MN-0898-001	99632	2018-05-21	2018-11-21
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	P-Series Power Meter	N1912A	MY5000448	2018-01-02	2019-01-02
Agilent	Wideband Power Sensor	N1921A	MY54210016	2018-01-02	2019-01-02
WEINSCHEL	10dB Attenuator	5324	AU 3842	Each Time	
Rohde & Schwarz	SPECTRUM ANALYZER	FSU26	200120	2017-12-24	2018-12-24
Ducommun technologies	RF Cable	RG-214	3	Each Time	

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

FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

For worst case:

Frequency (MHz)	Maximum Tune-up power		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
	(dBm)	(mW)				
2480	6.5	4.5	5	1.4	3.0	**Yes**

Result: No Standalone SAR test is required

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 internal antenna arrangement, which was permanently attached and the antenna gain is 0.8 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

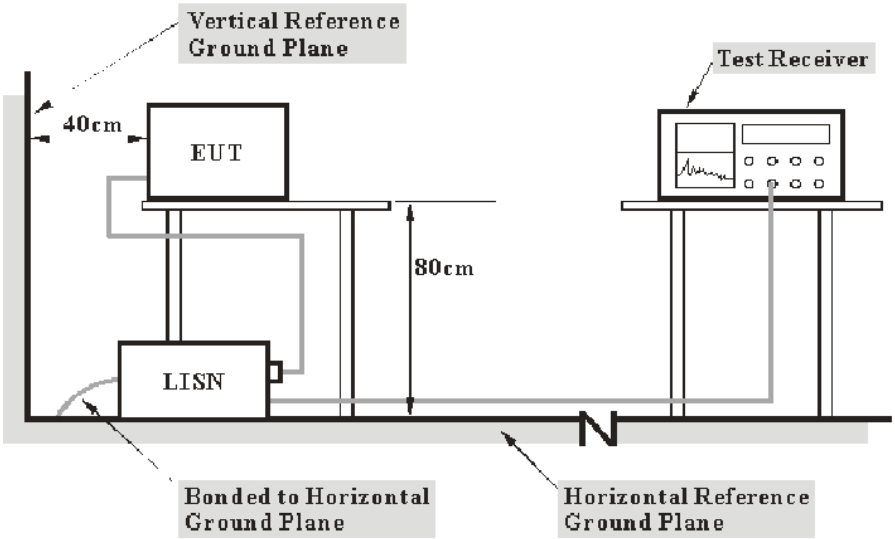
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



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

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

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

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

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

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

Test Procedure

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

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

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

Corrected Factor & Margin Calculation

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

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

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

Margin = Limit – Corrected Amplitude

Test Results Summary

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

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

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

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

Test Data

Environmental Conditions

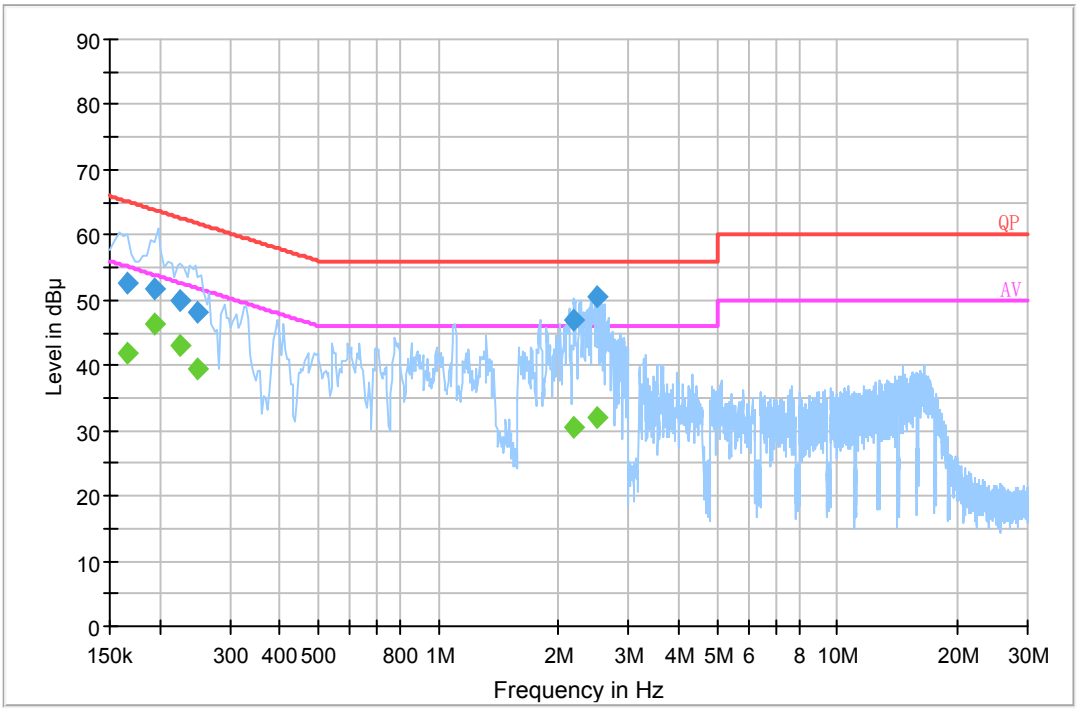
Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Nancy Wang on 2018-10-27.

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

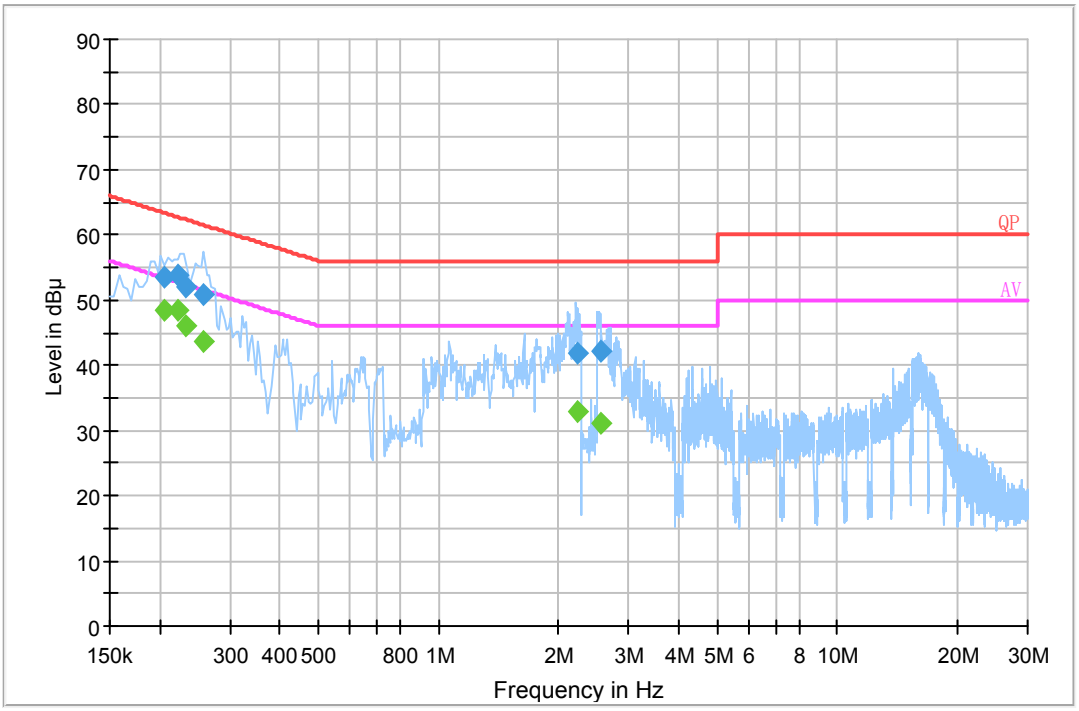
Model X19:

AC 120V/60 Hz, Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.165500	52.6	19.8	65.2	12.6	QP
0.193500	51.6	19.8	63.9	12.3	QP
0.225500	49.9	19.7	62.6	12.7	QP
0.249500	48.0	19.7	61.8	13.8	QP
2.177270	46.8	19.9	56.0	9.2	QP
2.492410	50.6	19.9	56.0	5.4	QP
0.165500	42.0	19.8	55.2	13.2	Ave.
0.193500	46.3	19.8	53.9	7.6	Ave.
0.225500	43.1	19.7	52.6	9.5	Ave.
0.249500	39.4	19.7	51.8	12.4	Ave.
2.177270	30.4	19.9	46.0	15.6	Ave.
2.492410	32.0	19.9	46.0	14.0	Ave.

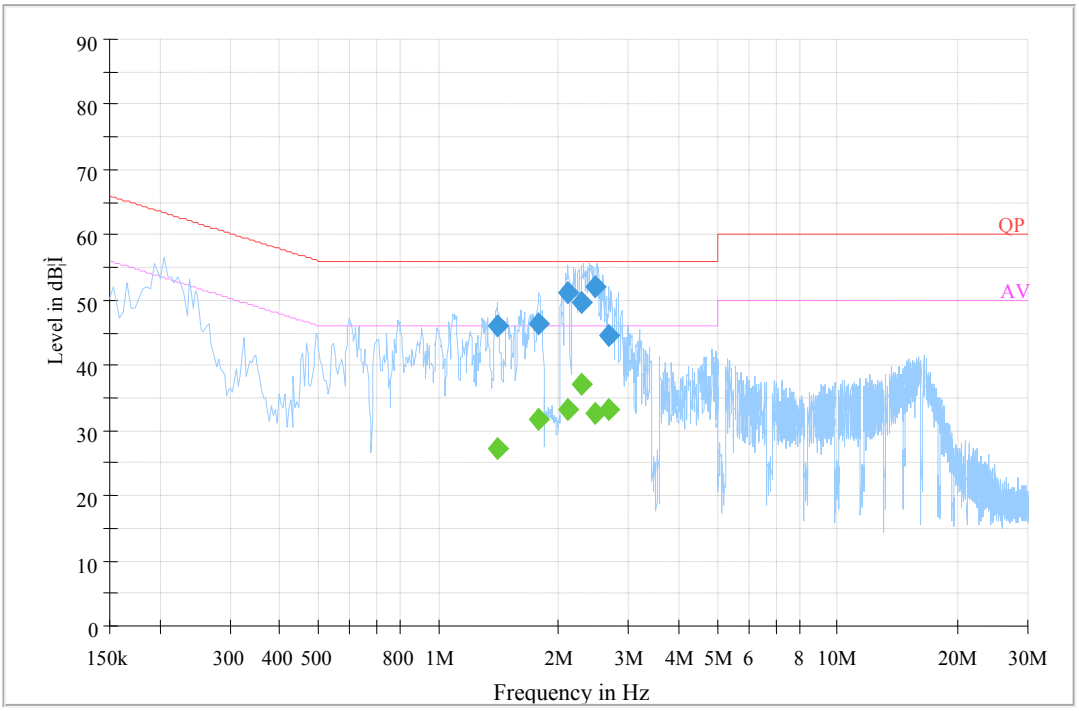
AC 120V/60 Hz, Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.206500	53.4	19.7	63.3	9.9	QP
0.221500	53.8	19.7	62.8	9.0	QP
0.233500	52.0	19.7	62.3	10.3	QP
0.257500	50.9	19.7	61.5	10.6	QP
2.236730	42.0	19.9	56.0	14.0	QP
2.539930	42.2	19.9	56.0	13.8	QP
0.206500	48.4	19.7	53.3	4.9	Ave.
0.221500	48.3	19.7	52.8	4.5	Ave.
0.233500	46.0	19.7	52.3	6.3	Ave.
0.257500	43.7	19.7	51.5	7.8	Ave.
2.236730	32.9	19.9	46.0	13.1	Ave.
2.539930	31.1	19.9	46.0	14.9	Ave.

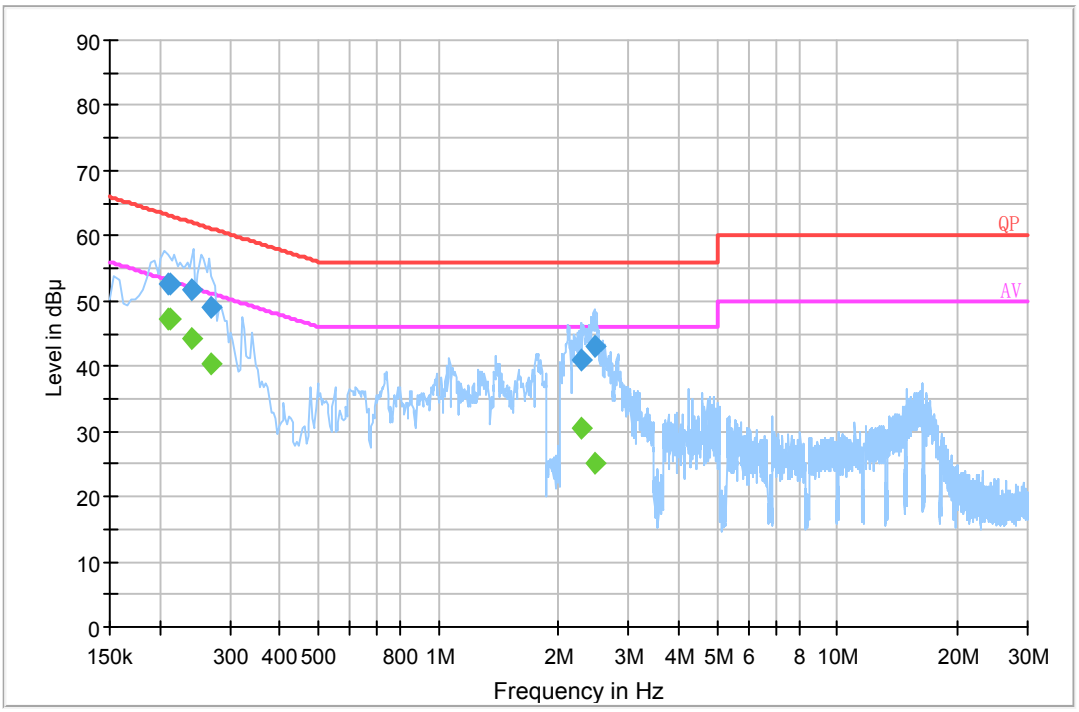
Model X20:

AC 120V/60 Hz, Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
1.412850	46.1	19.8	56.0	9.9	QP
1.787210	46.4	19.9	56.0	9.6	QP
2.114290	51.3	19.9	56.0	4.7	QP
2.283470	49.5	19.9	56.0	6.5	QP
2.480710	52.2	19.9	56.0	3.8	QP
2.677770	44.7	19.9	56.0	11.3	QP
1.412850	27.1	19.8	46.0	18.9	Ave.
1.787210	31.6	19.9	46.0	14.4	Ave.
2.114290	33.1	19.9	46.0	12.9	Ave.
2.283470	37.2	19.9	46.0	8.8	Ave.
2.480710	32.5	19.9	46.0	13.5	Ave.
2.677770	33.3	19.9	46.0	12.7	Ave.

AC 120V/60 Hz, Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.210500	52.6	19.7	63.2	10.6	QP
0.213500	52.7	19.7	63.1	10.4	QP
0.241500	51.9	19.7	62.0	10.1	QP
0.270500	49.0	19.7	61.1	12.1	QP
2.275890	40.9	19.9	56.0	15.1	QP
2.473130	43.0	19.9	56.0	13.0	QP
0.210500	47.2	19.7	53.2	6.0	Ave.
0.213500	47.4	19.7	53.1	5.7	Ave.
0.241500	44.2	19.7	52.0	7.8	Ave.
0.270500	40.4	19.7	51.1	10.7	Ave.
2.275890	30.4	19.9	46.0	15.6	Ave.
2.473130	25.0	19.9	46.0	21.0	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

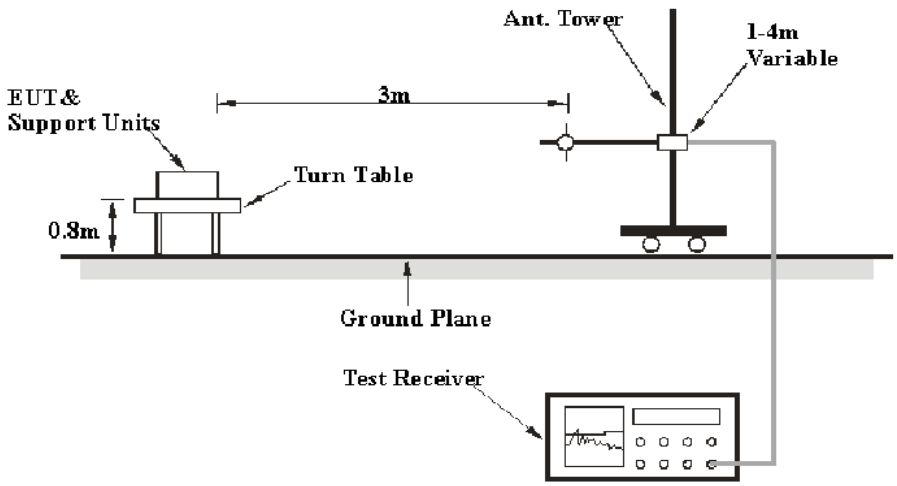
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

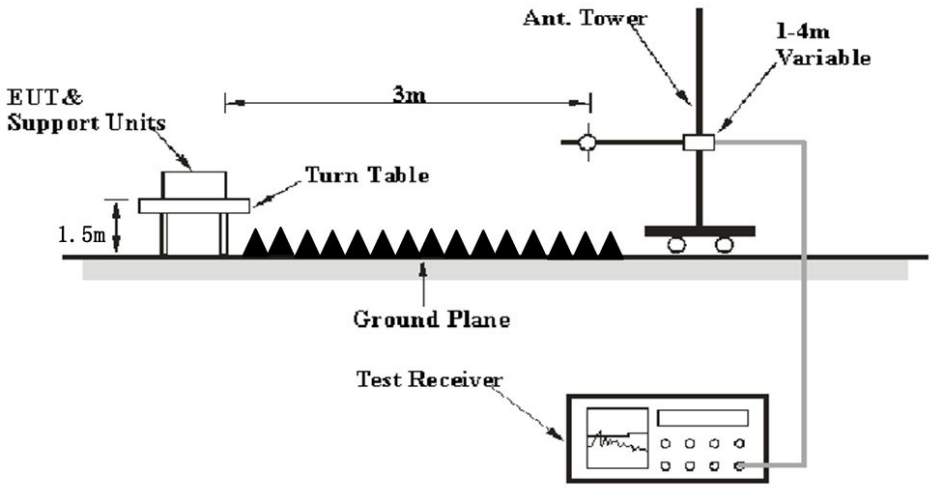
FCC §15.205; §15.209; §15.247(d)

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 or Peak detection modes 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

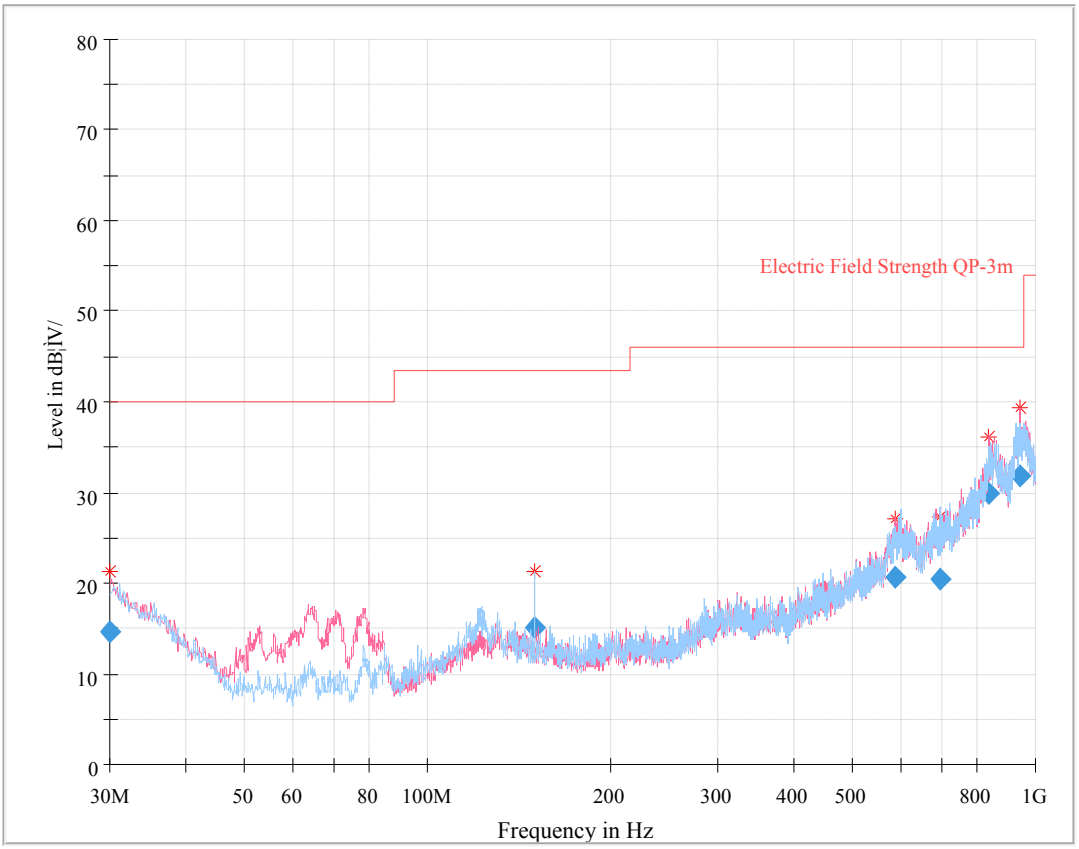
Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Nancy Wang from 2018-10-24 to 2018-10-27.

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

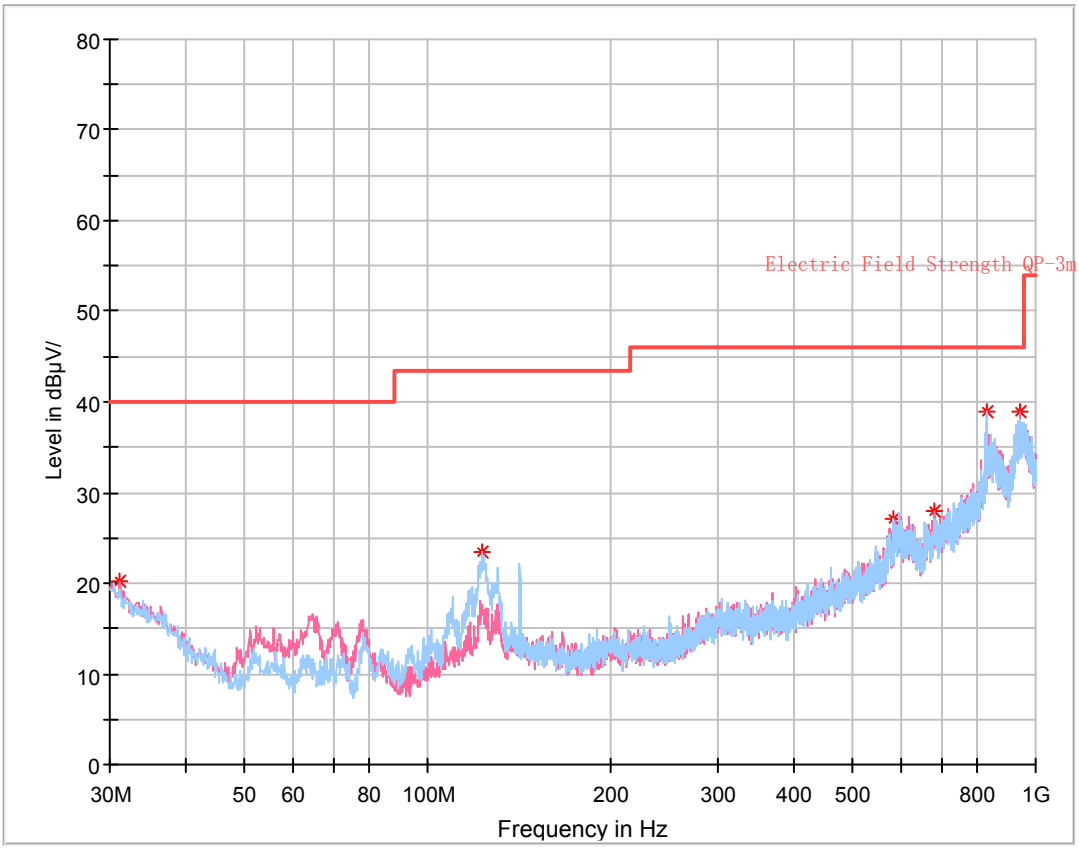
30 MHz~1 GHz: *(the worst case is GFSK Mode, High channel)*

Model X19:



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
30.018327	14.66	176.0	V	148.0	-7.6	40.00	25.34
150.038625	14.62	178.0	H	82.0	-14.2	43.50	28.88
587.026500	20.71	290.0	V	46.0	-2.6	46.00	25.29
698.735750	20.50	288.0	H	280.0	-1.3	46.00	25.50
838.878000	29.88	318.0	V	78.0	5.8	46.00	16.12
940.748750	31.78	262.0	V	19.0	8.9	46.00	14.22

Model X20:



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
584.476250	27.17	102.0	H	0.0	-2.8	46.00	18.83
829.643750	38.88	300.0	H	55.0	4.9	46.00	7.12
122.877500	23.41	300.0	H	263.0	-14.1	43.50	20.09
939.860000	38.92	102.0	V	321.0	8.8	46.00	7.08
682.567500	28.06	202.0	V	111.0	-2.0	46.00	17.94
31.212500	20.18	300.0	V	123.0	-8.4	40.00	19.82

Note: PK detection data compliance with QP detection limit.

1 GHz - 25 GHz:

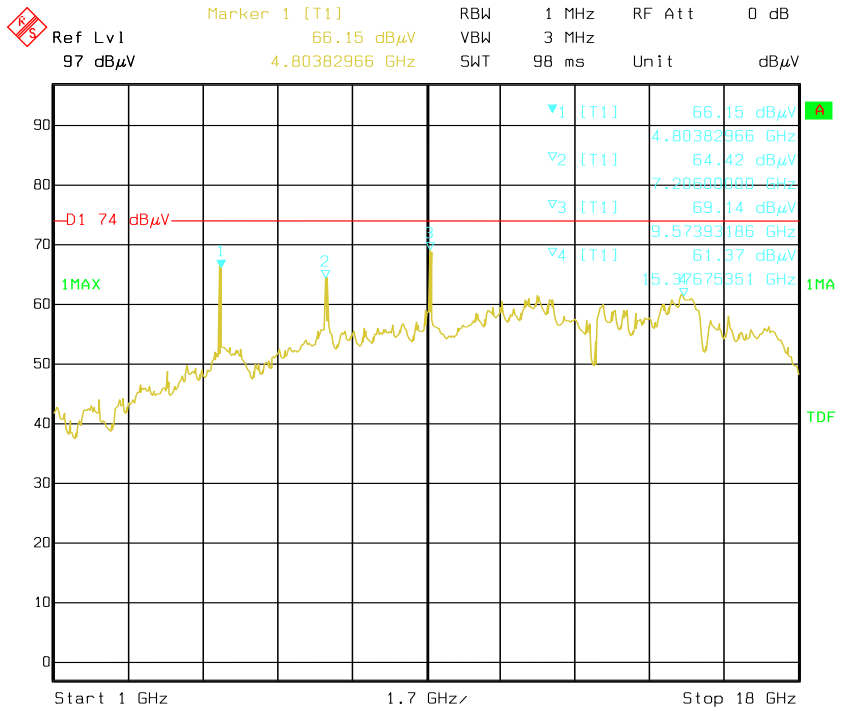
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2402.00	65.00	PK	216	1.2	H	33.00	98.00	/	/
2402.00	54.24	Ave.	216	1.2	H	33.00	87.24	/	/
2402.00	64.25	PK	336	1.9	V	33.00	97.25	/	/
2402.00	53.63	Ave.	336	1.9	V	33.00	86.63	/	/
2389.00	27.45	PK	161	2.1	H	33.00	60.45	74	13.55
2389.00	13.36	Ave.	161	2.1	H	33.00	46.36	54	7.64
2483.60	27.52	PK	72	1.2	H	33.20	60.72	74	13.28
2483.60	13.28	Ave.	72	1.2	H	33.20	46.48	54	7.52
4804.00	58.25	PK	231	1.6	H	7.88	66.13	74	7.87
4804.00	45.55	Ave.	231	2.2	H	7.88	53.43	54	0.57
7206.00	49.62	PK	115	2.1	H	15.88	65.50	78.0	12.50
9608.00	51.36	PK	294	2.1	H	18.96	70.32	78.0	7.68
Middle Channel (2441 MHz)									
2441.00	65.81	PK	285	2.4	H	33.10	98.91	/	/
2441.00	55.14	Ave.	285	2.4	H	33.10	88.24	/	/
2441.00	63.14	PK	348	2.1	V	33.10	96.24	/	/
2441.00	53.95	Ave.	348	2.1	V	33.10	87.05	/	/
4882.00	56.80	PK	293	1.8	H	9.21	66.01	74	7.99
4882.00	44.50	Ave.	293	1.8	H	9.21	53.71	54	0.29
7323.00	47.56	PK	138	1.4	H	14.71	62.27	74	11.73
7323.00	37.87	Ave.	138	1.4	H	14.71	52.58	54	1.42
9764.00	51.95	PK	99	2.4	H	18.40	70.35	78.91	8.56

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)				
High Channel (2480 MHz)									
2480.00	66.09	PK	117	1.7	H	33.20	99.29	/	/
2480.00	55.34	Ave.	117	1.7	H	33.20	88.54	/	/
2480.00	65.50	PK	313	2.1	V	33.20	98.70	/	/
2480.00	55.11	Ave.	313	2.1	V	33.20	88.31	/	/
2389.00	27.35	PK	192	2.2	H	33.00	60.35	74	13.65
2389.00	13.24	Ave.	192	2.2	H	33.00	46.24	54	7.76
2483.60	35.84	PK	120	2.3	H	33.20	69.04	74	4.96
2483.60	15.96	Ave.	120	2.3	H	33.20	49.16	54	4.84
4960.00	55.41	PK	57	1.4	H	9.07	64.48	74	9.52
4960.00	43.47	Ave.	57	1.4	H	9.07	52.54	54	1.46
7440.00	48.23	PK	338	1.5	H	14.79	63.02	74	10.98
7440.00	37.18	Ave.	338	1.5	H	14.79	51.97	54	2.03
9920.00	49.90	PK	19	1.7	H	19.32	69.22	79.29	10.07

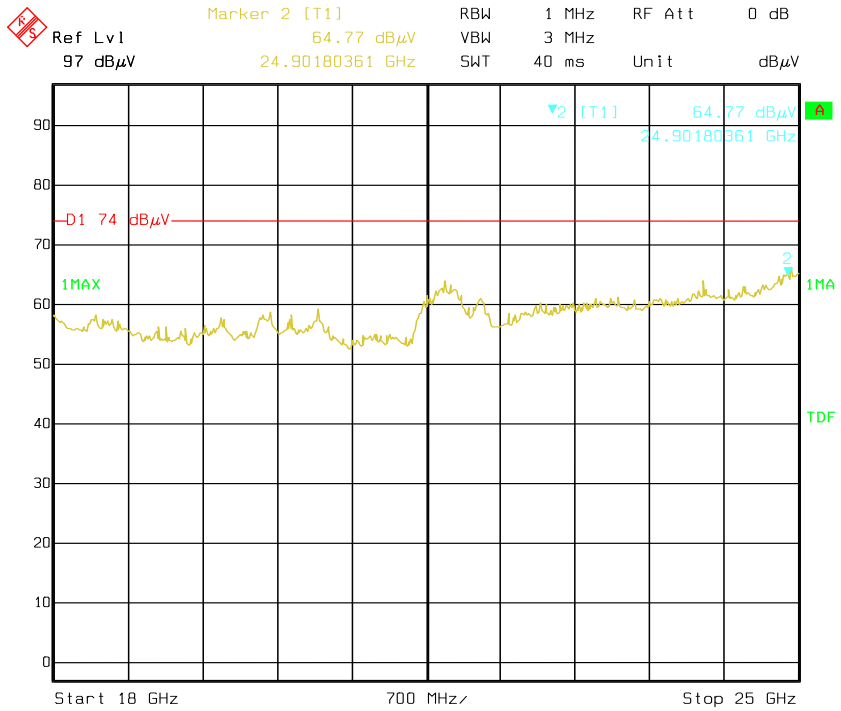
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB to the limit was not recorded.
And for the pre-scan is performed with the 2400-2483.5MHz band filter.

Pre-scan with Low channel Peak

Horizontal

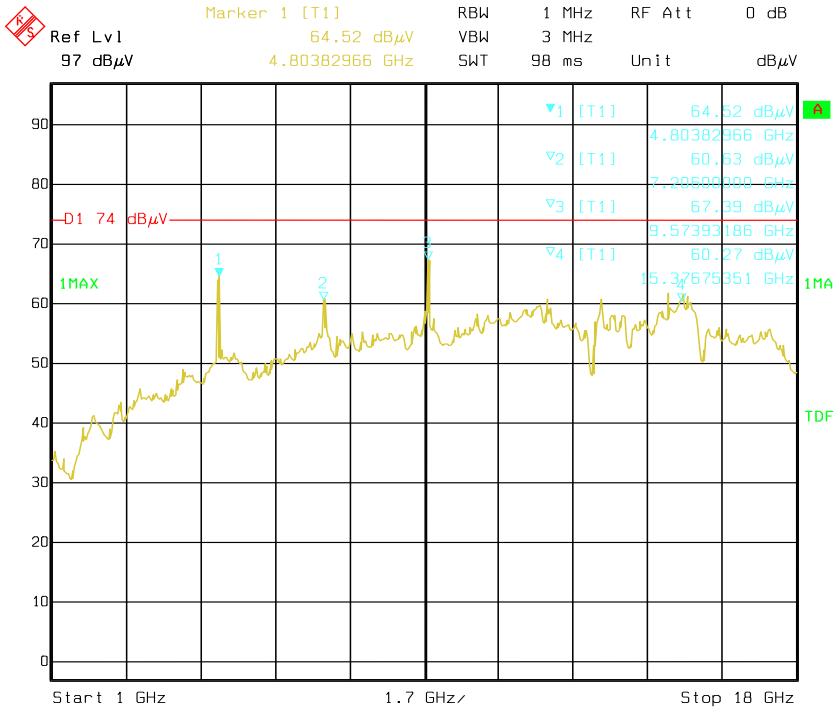


Date: 24.OCT.2018 18:41:11

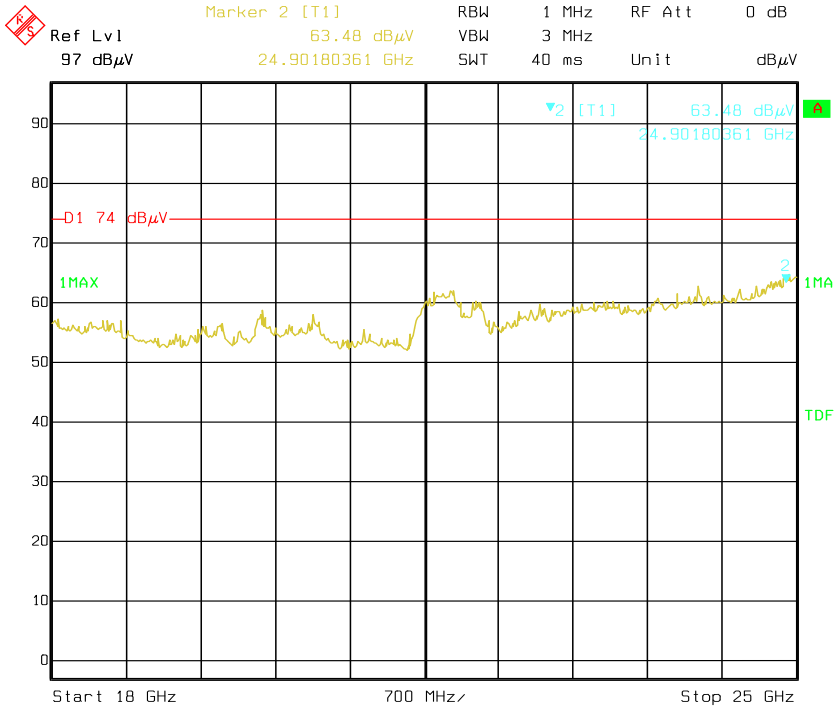


Date: 27.OCT.2018 18:48:09

Vertical

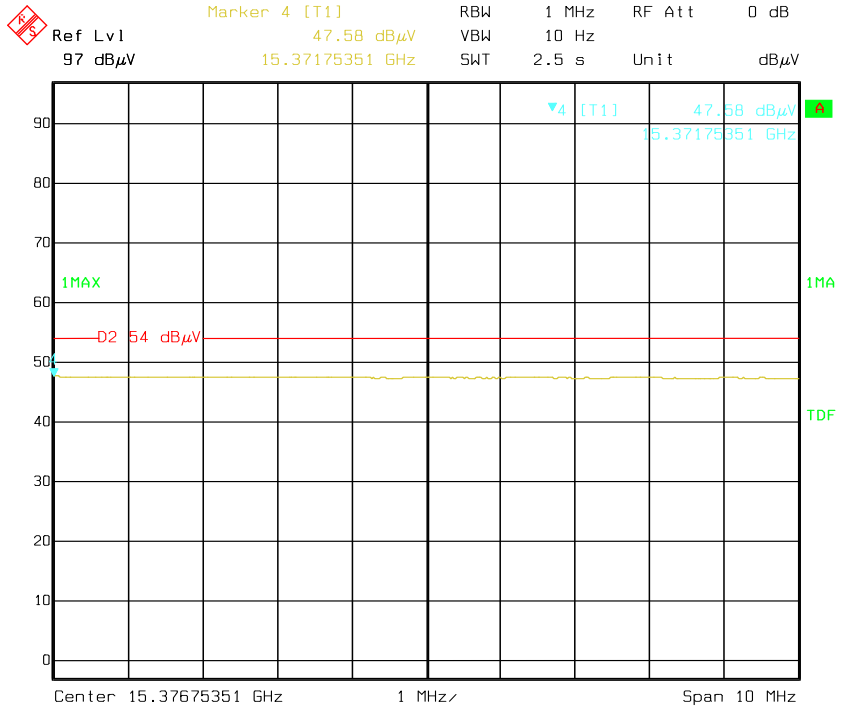


Date: 24.OCT.2018 18:43:42

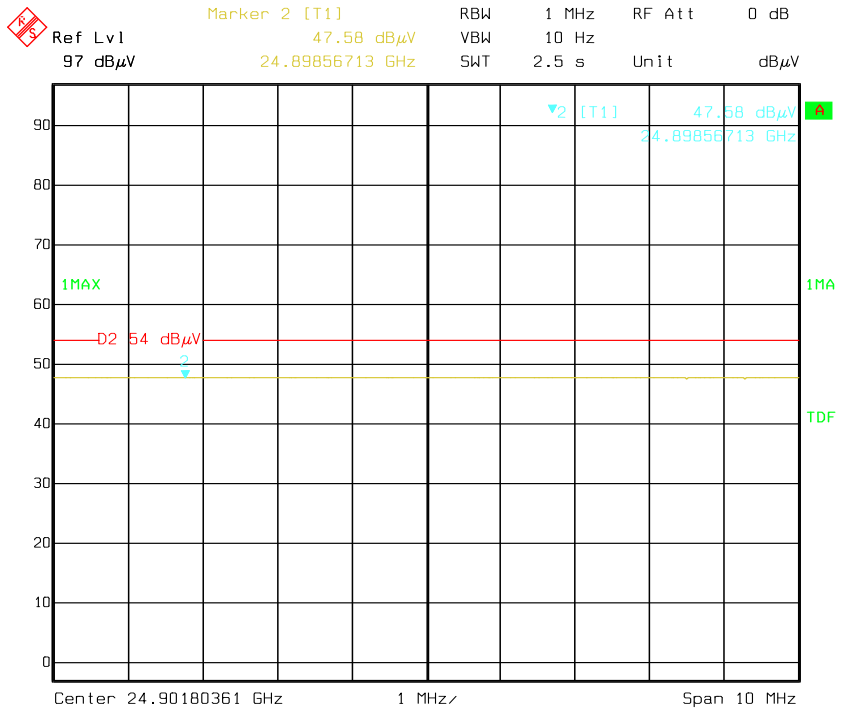


Date: 27.OCT.2018 18:50:11

Pre-scan for Average
Horizontal

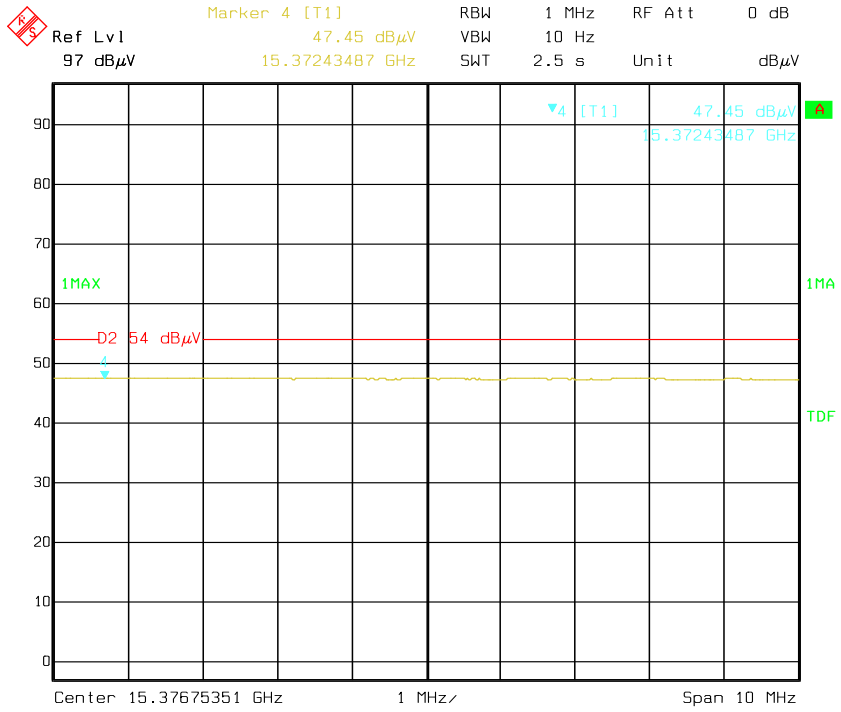


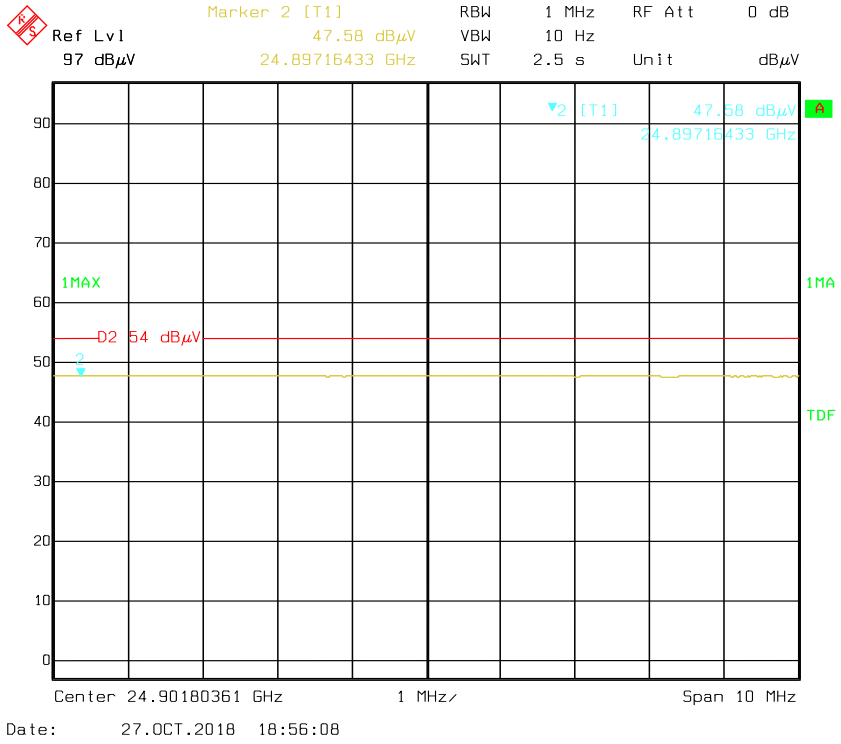
Date: 24.OCT.2018 18:46:09



Date: 27.OCT.2018 18:53:06

Vertical


Marker 4 [T1]
47.45 dBμV
15.3724343487 GHz
RBW 1 MHz
VBW 10 Hz
SWT 2.5 s
RF Att 0 dB
Unit dBμV
Ref Lvl
97 dBμV
▼4 [T1] 47.45 dBμV
15.37243487 GHz
A
1MAX
1MA
D2 54 dBμV
TDF
Center 15.37675351 GHz
1 MHz/
Span 10 MHz
Date: 24.OCT.2018 18:48:09


Marker 2 [T1]
47.58 dBμV
24.89716433 GHz
RBW 1 MHz
VBW 10 Hz
SWT 2.5 s
RF Att 0 dB
Unit dBμV
Ref Lvl
97 dBμV
▼2 [T1] 47.58 dBμV
24.89716433 GHz
A
1MAX
1MA
D2 54 dBμV
TDF
Center 24.90180361 GHz
1 MHz/
Span 10 MHz
Date: 27.OCT.2018 18:56:08

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:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Nancy Wang on 2018-09-25.

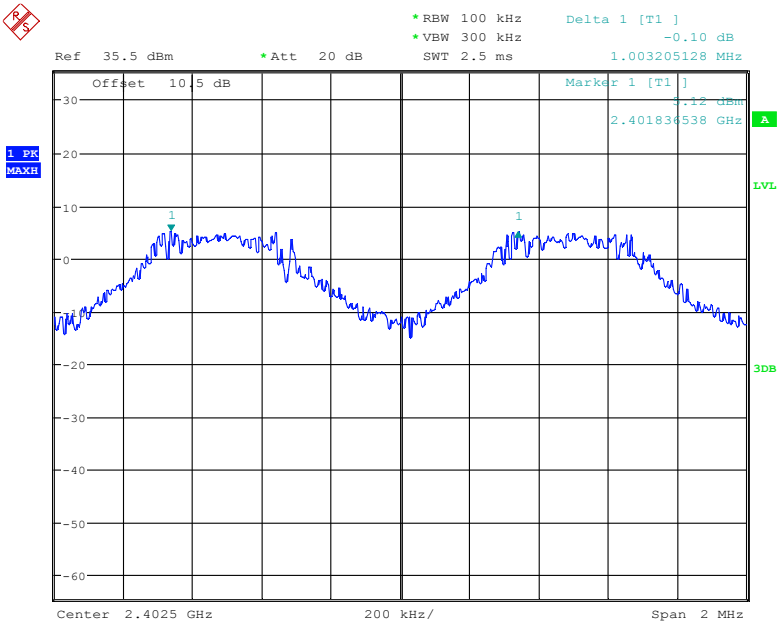
EUT operation mode: Transmitting

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	1.003	0.937	0.625	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.000	0.947	0.631	> two-thirds of the 20 dB bandwidth	Compliance
High	1.003	0.942	0.628	> two-thirds of the 20 dB bandwidth	Compliance
EDR(π/4-DQPSK)					
Low	1.003	1.260	0.840	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.000	1.264	0.843	> two-thirds of the 20 dB bandwidth	Compliance
High	1.003	1.255	0.837	> two-thirds of the 20 dB bandwidth	Compliance
EDR(8-DPSK)					
Low	1.010	1.274	0.849	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.000	1.279	0.853	> two-thirds of the 20 dB bandwidth	Compliance
High	1.010	1.269	0.846	> two-thirds of the 20 dB bandwidth	Compliance

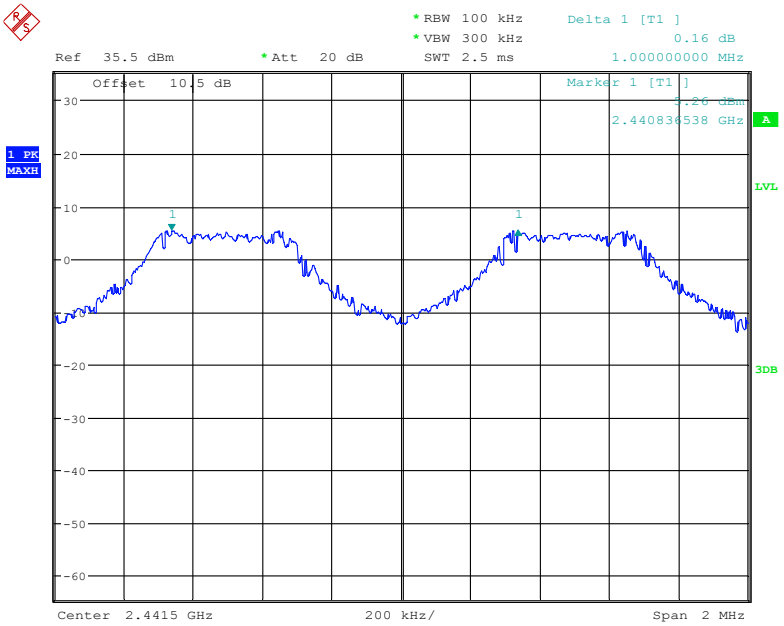
Please refer to the following plots.

BDR (GFSK): Low Channel



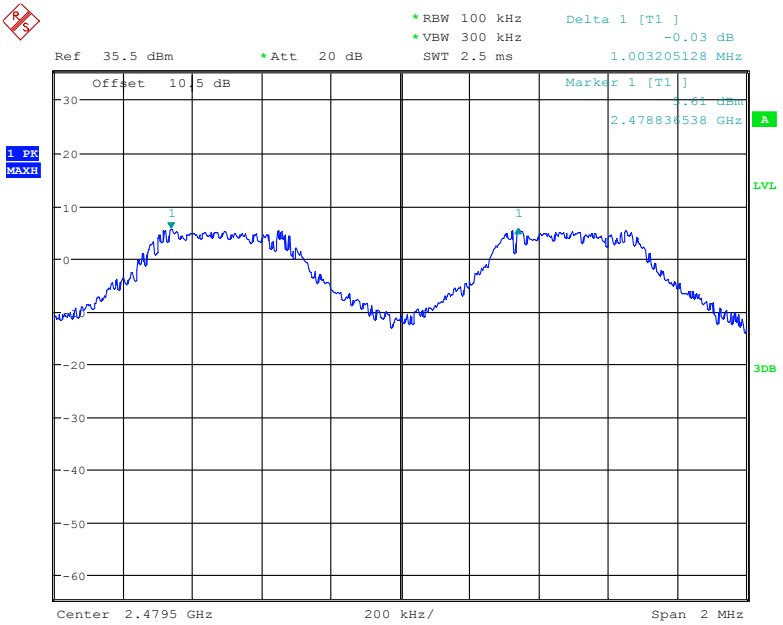
Date: 25.SEP.2018 10:44:44

BDR (GFSK): Middle Channel



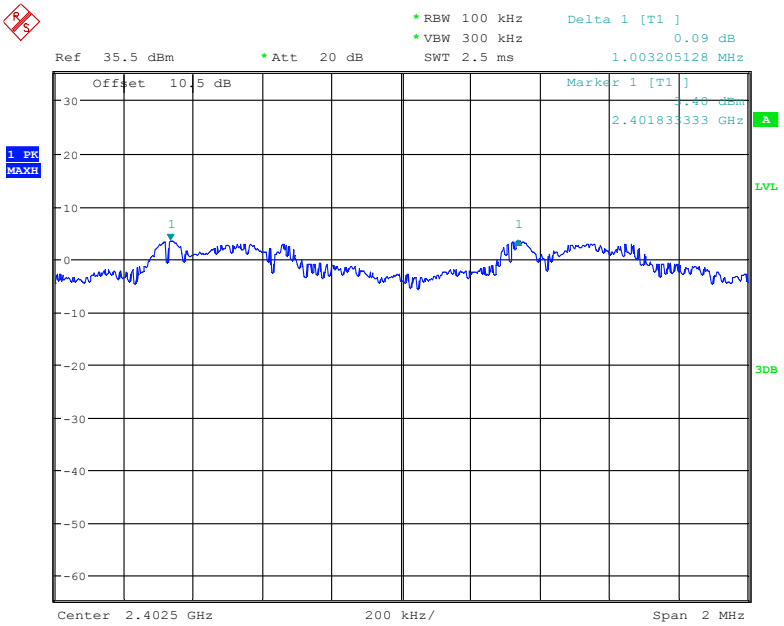
Date: 25.SEP.2018 10:47:35

BDR (GFSK): High Channel



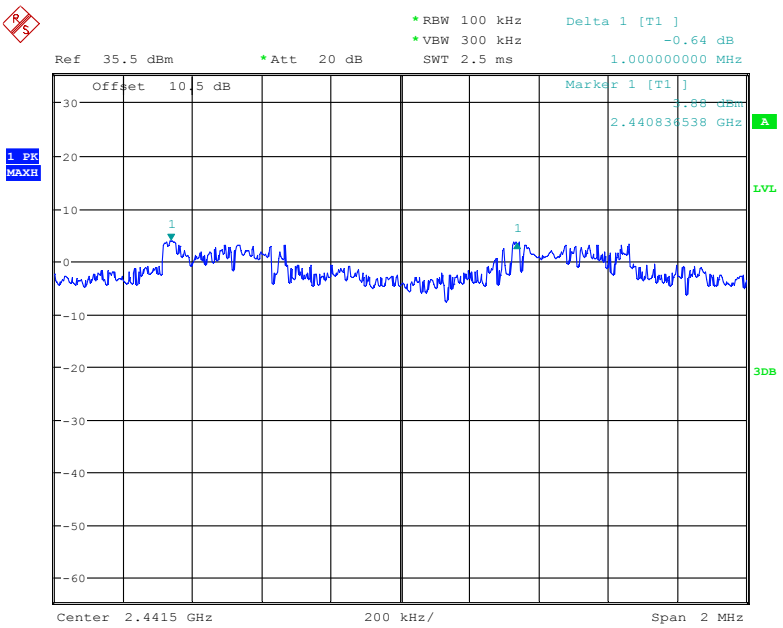
Date: 25.SEP.2018 10:50:06

EDR (π/4-DQPSK): Low Channel



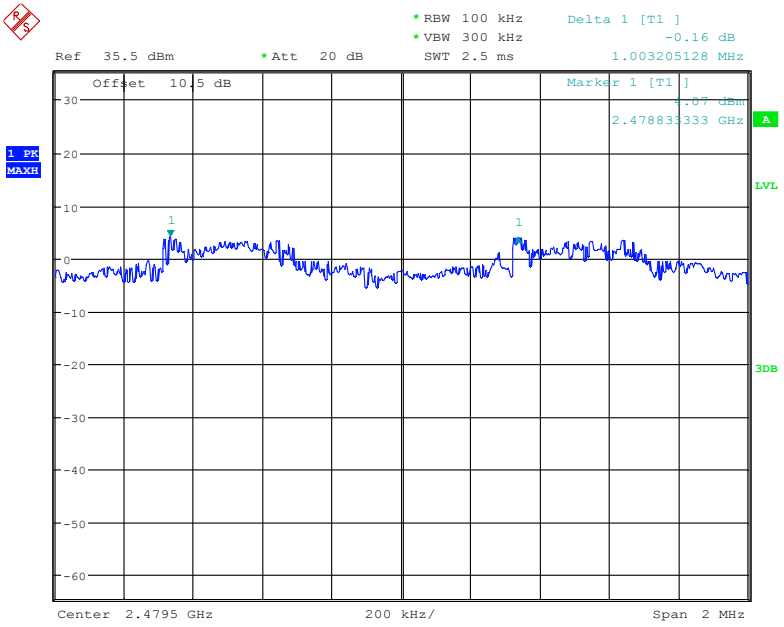
Date: 25.SEP.2018 10:54:08

EDR (π/4-DQPSK): Middle Channel



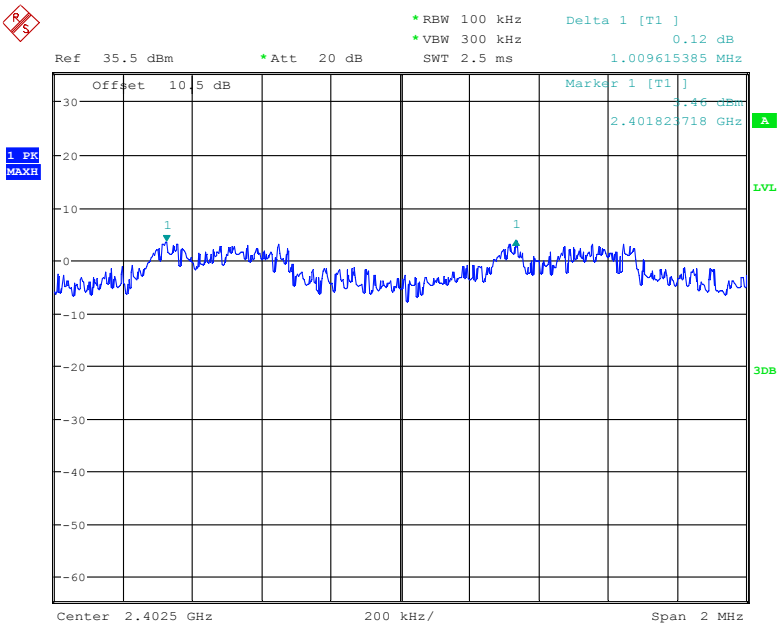
Date: 25.SEP.2018 10:55:39

EDR (π/4-DQPSK): High Channel



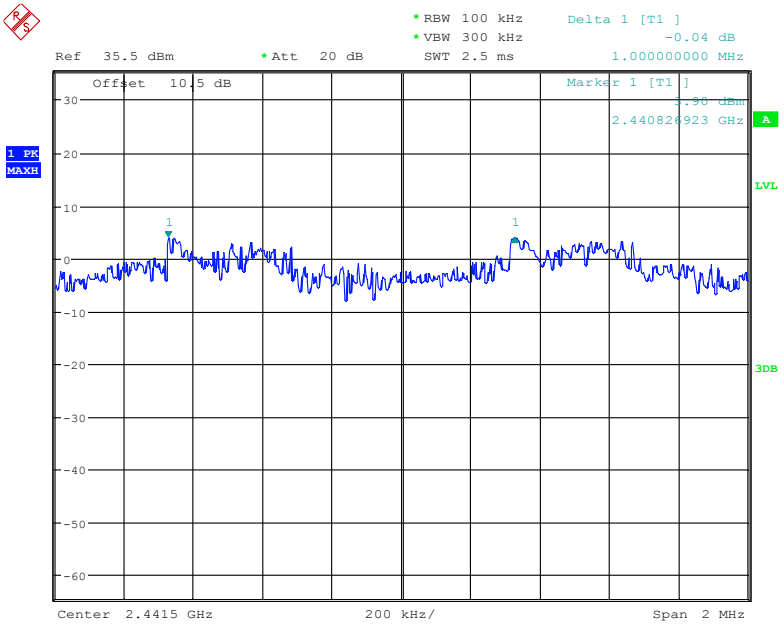
Date: 25.SEP.2018 10:58:26

EDR (8-DPSK): Low Channel



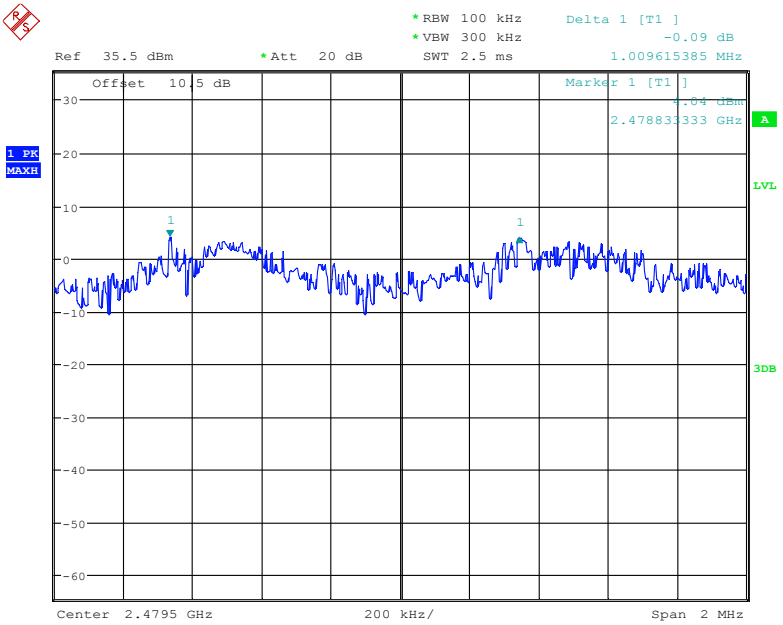
Date: 25.SEP.2018 11:01:50

EDR (8-DPSK): Middle Channel



Date: 25.SEP.2018 11:05:00

EDR (8-DPSK): High Channel



Date: 25.SEP.2018 11:06:01

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:	56 %
ATM Pressure:	101.0 kPa

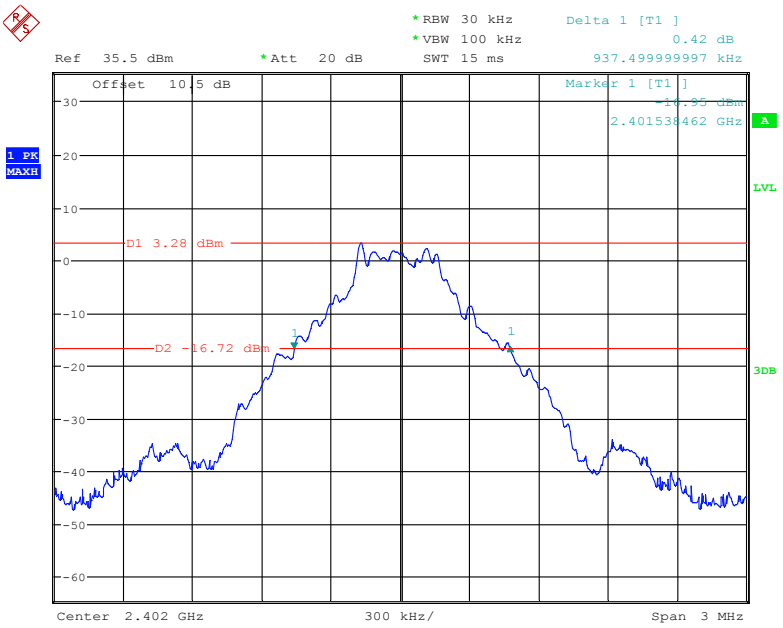
The testing was performed by Nancy Wang on 2018-09-25.

EUT operation mode: Transmitting

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

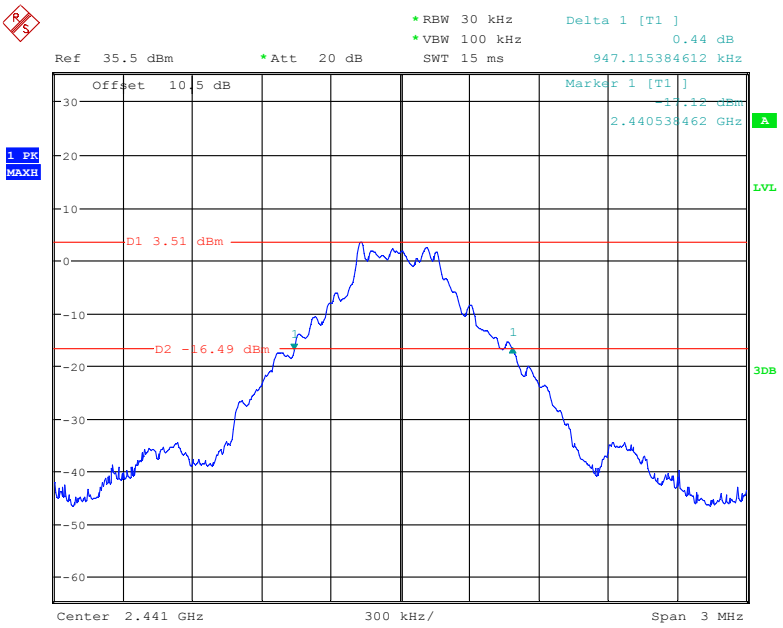
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.937
	Middle	2441	0.947
	High	2480	0.942
EDR (π/4-DQPSK)	Low	2402	1.260
	Middle	2441	1.264
	High	2480	1.255
EDR (8-DPSK)	Low	2402	1.274
	Middle	2441	1.279
	High	2480	1.269

BDR (GFSK): Low Channel



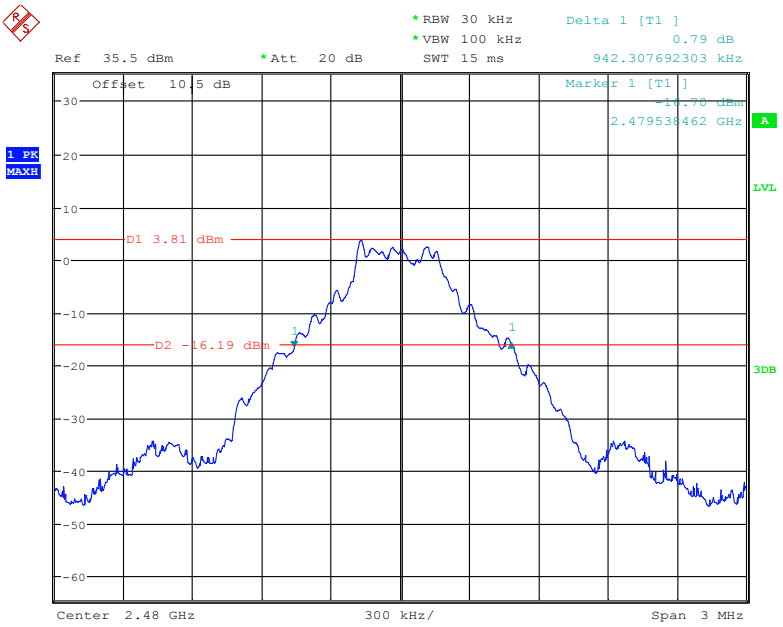
Date: 25.SEP.2018 10:07:09

BDR (GFSK): Middle Channel



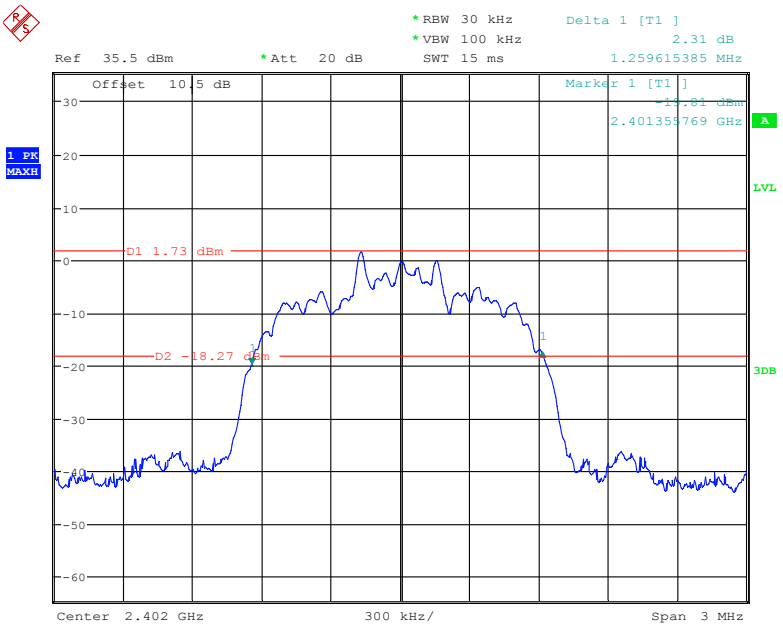
Date: 25.SEP.2018 10:08:21

BDR (GFSK): High Channel



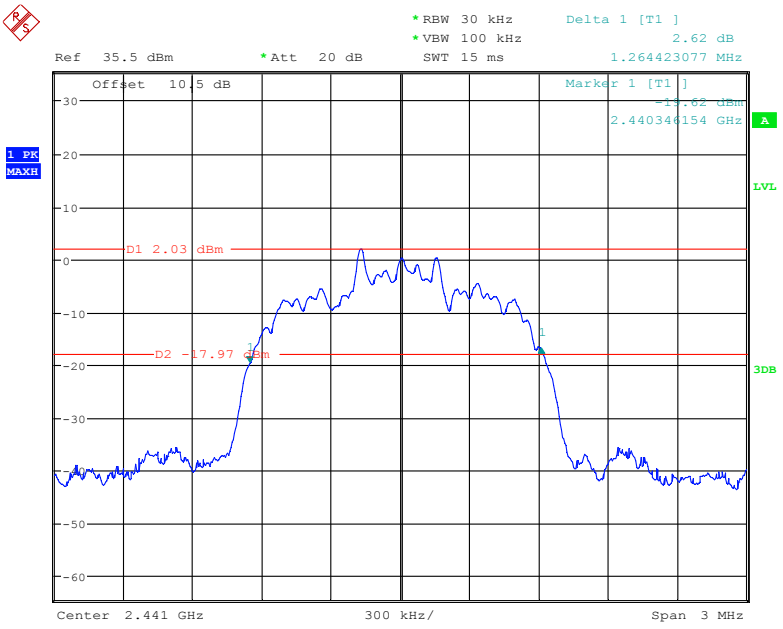
Date: 25.SEP.2018 10:09:49

EDR (π/4-DQPSK): Low Channel



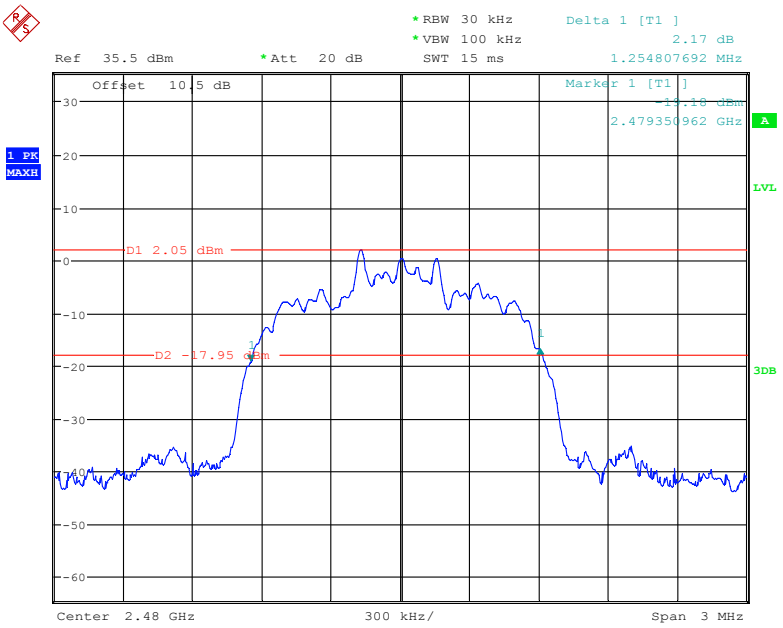
Date: 25.SEP.2018 10:06:02

EDR (π/4-DQPSK): Middle Channel



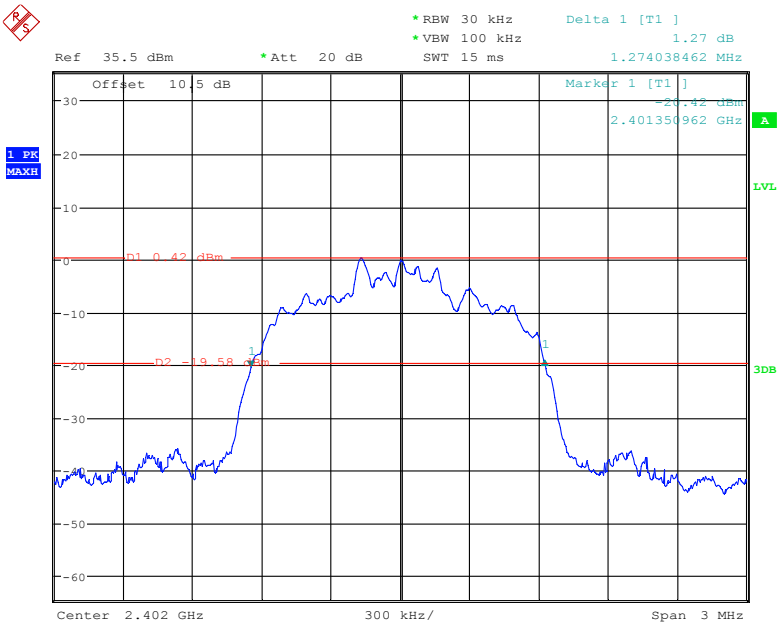
Date: 25.SEP.2018 10:05:07

EDR (π/4-DQPSK): High Channel



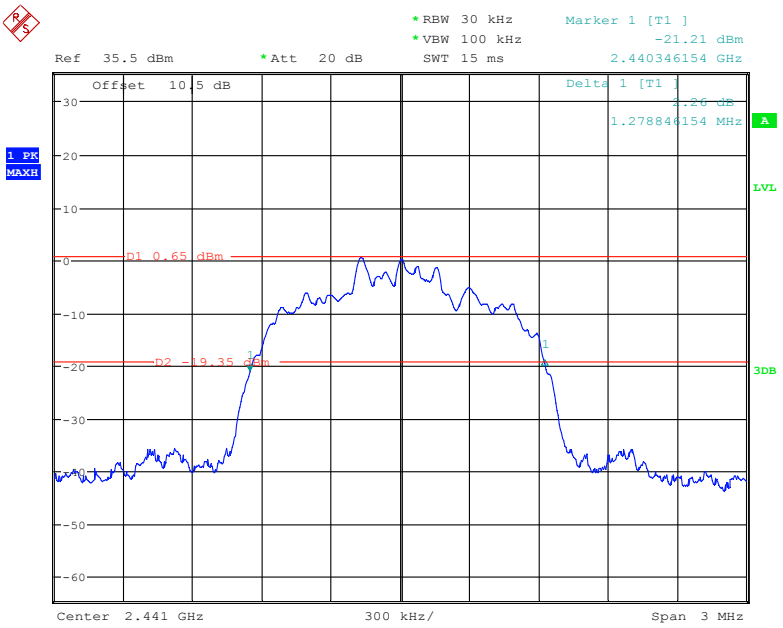
Date: 25.SEP.2018 10:03:54

EDR (8-DPSK): Low Channel



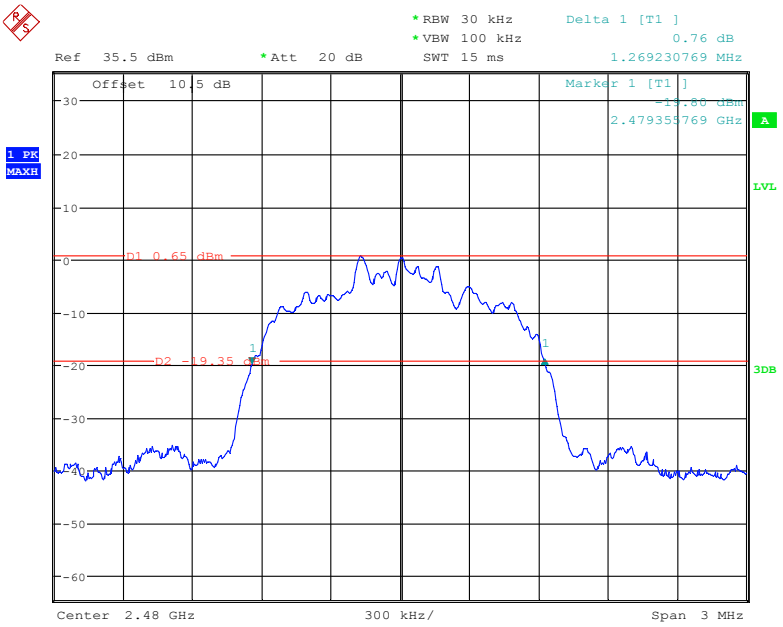
Date: 25.SEP.2018 09:55:56

EDR (8-DPSK): Middle Channel



Date: 25.SEP.2018 09:57:29

EDR (8-DPSK): High Channel



Date: 25.SEP.2018 10:02:59

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:	56 %
ATM Pressure:	101.0 kPa

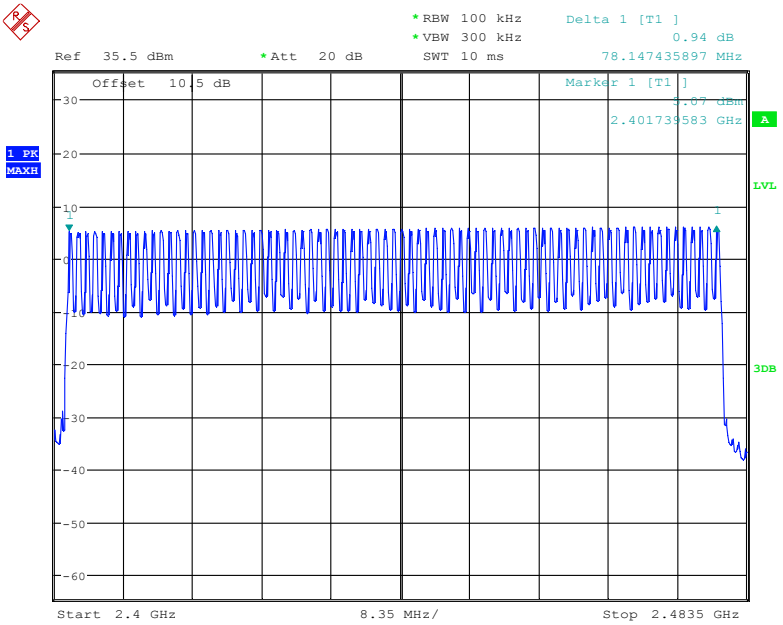
The testing was performed by Nancy Wang on 2018-09-25.

EUT operation mode: Transmitting

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

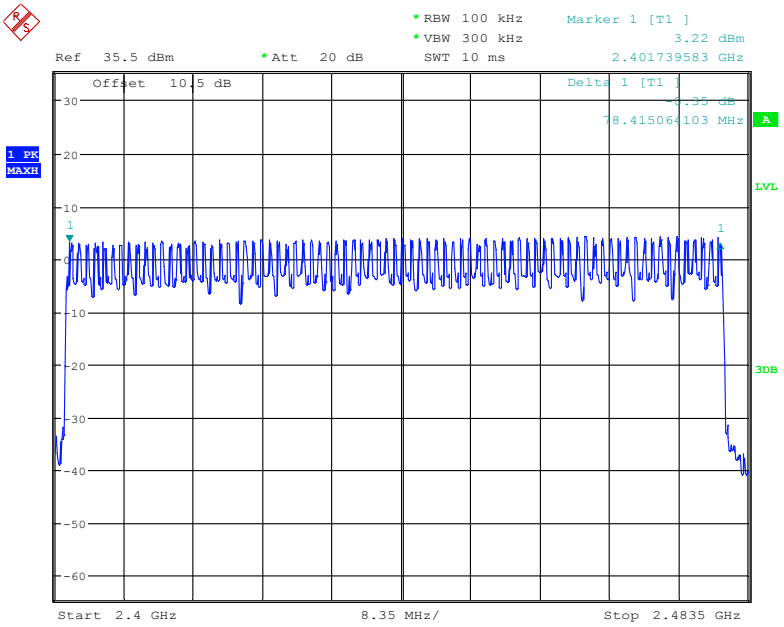
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	⩾15
EDR (π/4-DQPSK)	2400-2483.5	79	⩾15
EDR (8-DPSK)	2400-2483.5	79	⩾15

BDR (GFSK): Number of Hopping Channels



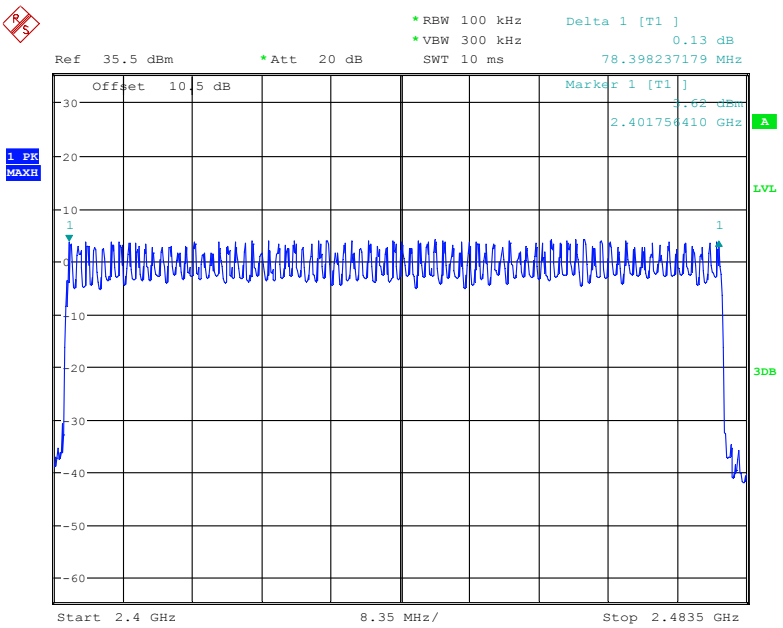
Date: 25.SEP.2018 13:06:13

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



Date: 25.SEP.2018 11:56:33

EDR (8-DPSK): Number of Hopping Channels



Date: 25.SEP.2018 11:10:51

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

Applicable Standard

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

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.
Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test or each variation in transmit time.
Repeat the measurement using a longer sweep time to determine the number of hops over the period pecified in the requirements. The sweep time shall be equal to, or less than, the period specified in the equirements. Determine the number of hops over the sweep time and calculate the total number of hops in he period specified in the requirements, using the following equation:
(Number of hops in the period specified in the requirements) =
(number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)
The average time of occupancy is calculated from the transmit time per hop multiplied by the number of ops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.
The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

Test Data

Environmental Conditions

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

The testing was performed by Nancy Wang on 2018-09-25.

EUT operation mode: Transmitting

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

Mode		Pulse Time (ms)	Hopping Number	Period Time (s)	Total of Dwell (s)	Limit (s)	Result
BDR (GFSK)	DH 1	0.391	300	31.6	0.117	0.4	Pass
	DH 3	1.673	150	31.6	0.251	0.4	Pass
	DH 5	2.936	130	31.6	0.382	0.4	Pass
EDR (π/4-DQPSK)	2DH 1	0.402	300	31.6	0.121	0.4	Pass
	2DH 3	1.673	140	31.6	0.234	0.4	Pass
	2DH 5	2.909	60	31.6	0.175	0.4	Pass
EDR (8-DPSK)	3DH 1	0.410	310	31.6	0.127	0.4	Pass
	3DH 3	1.663	140	31.6	0.233	0.4	Pass
	3DH 5	2.925	100	31.6	0.293	0.4	Pass

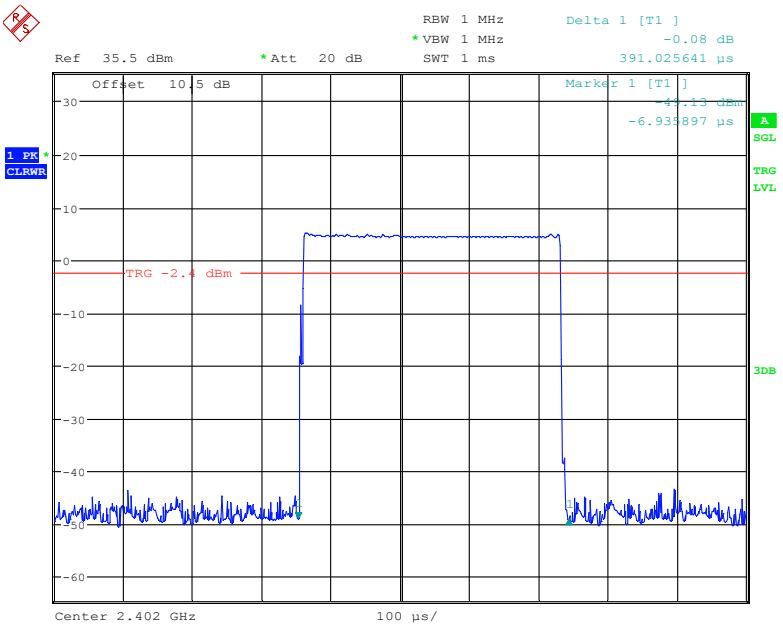
Note 1: A period time=0.4*79=31.6(s), Total of Dwell=Pluse Time*Hopping Number

Note 2: Hopping Number= Hopping Number in 3.16s*10

Note 3: Hopping Number in 3.16s = Total of highest signals in 3.16s.(Second high signals were other channel)

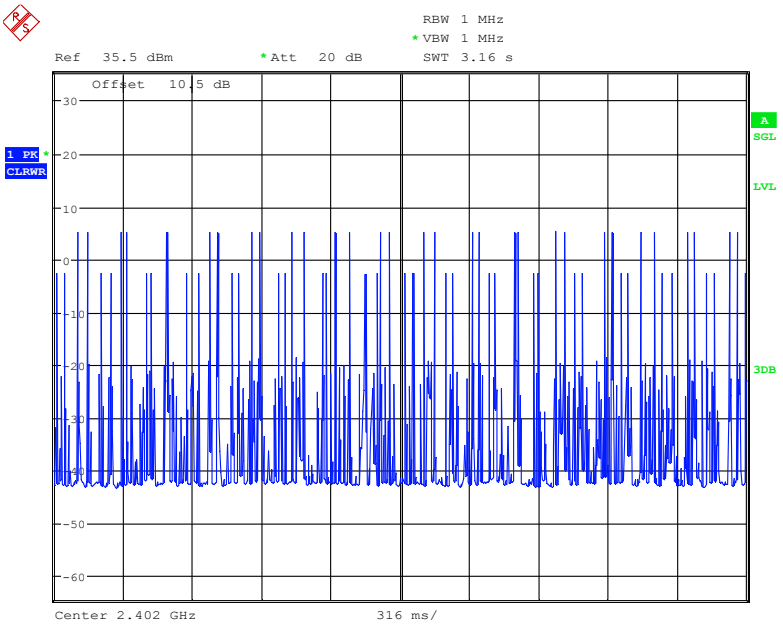
BDR (GFSK):

Pulse time, DH1



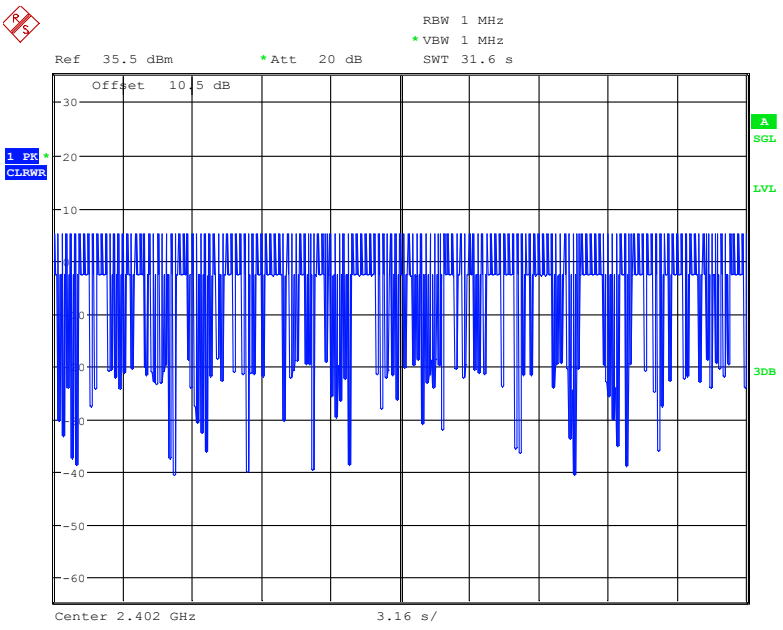
Date: 25.SEP.2018 13:08:21

Hopping number in 3.16S, DH1



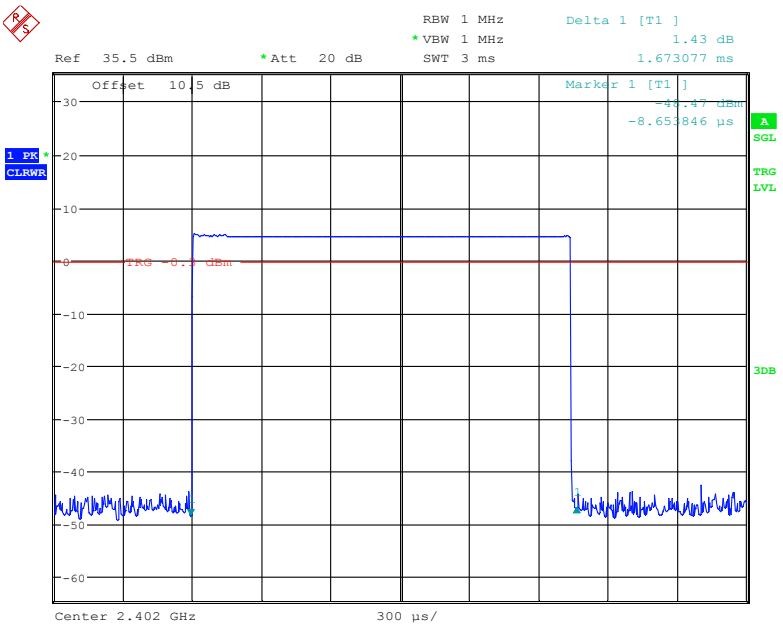
Date: 25.SEP.2018 13:10:32

Hopping number in 31.6S, DH1



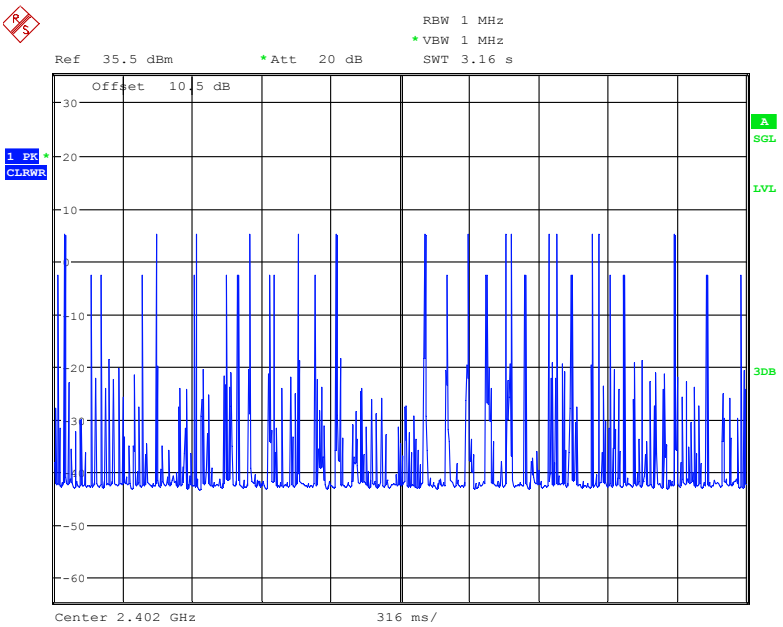
Date: 25.SEP.2018 13:10:14

Pulse time, DH3



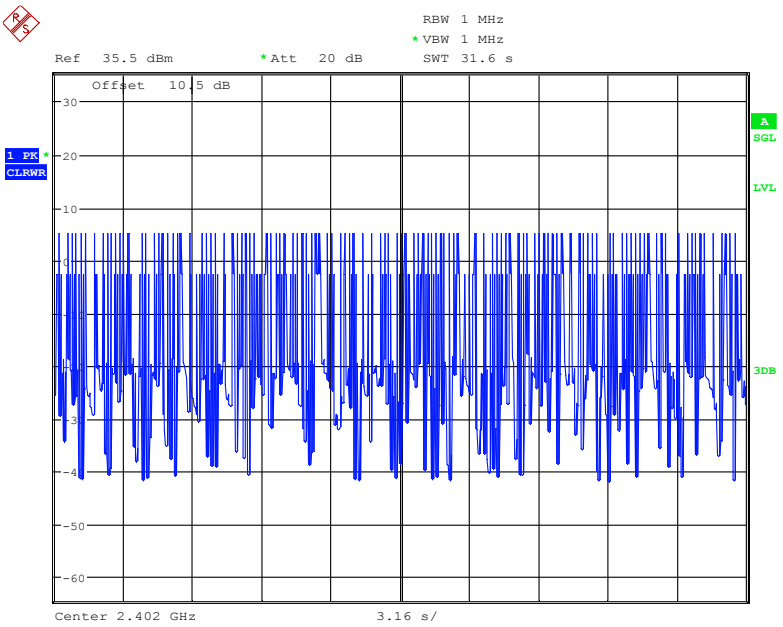
Date: 25.SEP.2018 13:17:40

Hopping number in 3.16S, DH3



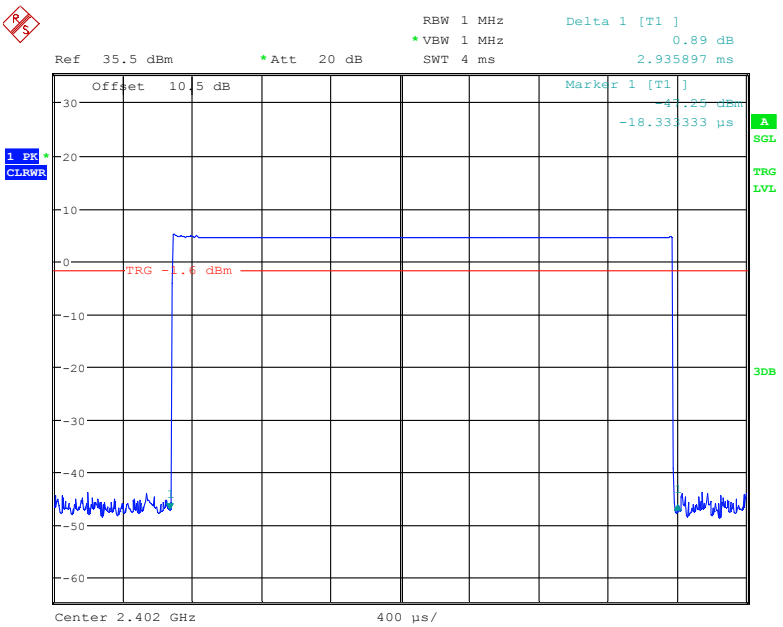
Date: 25.SEP.2018 13:16:41

Hopping number in 31.6S, DH3



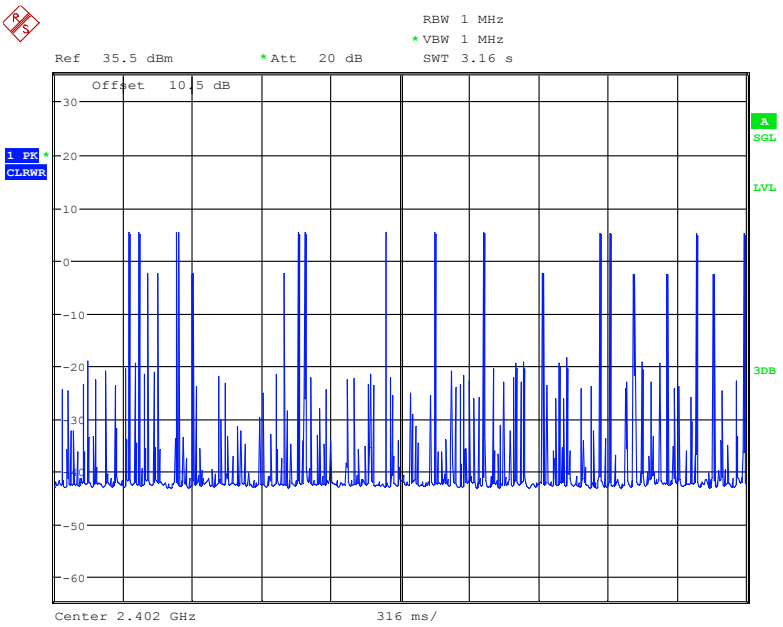
Date: 25.SEP.2018 13:16:19

Pulse time, DH5



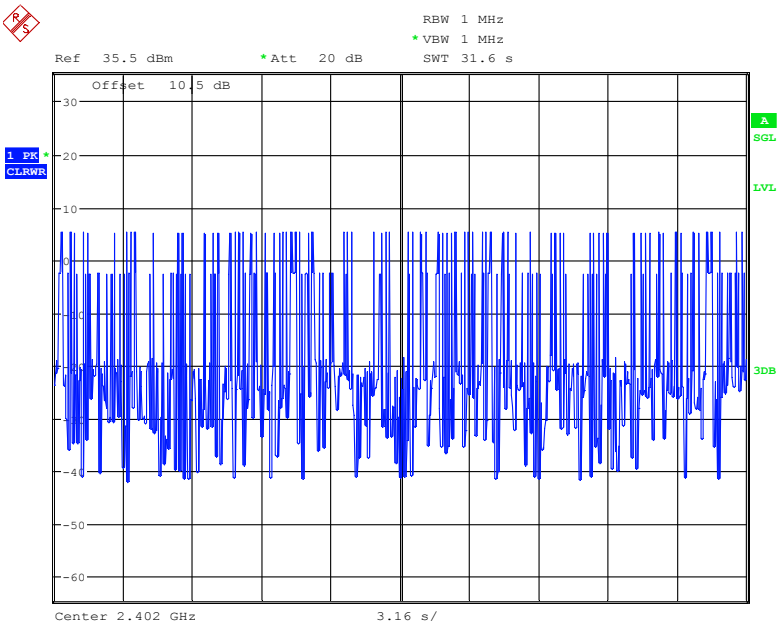
Date: 25.SEP.2018 13:24:15

Hopping number in 3.16S, DH5



Date: 25.SEP.2018 13:25:37

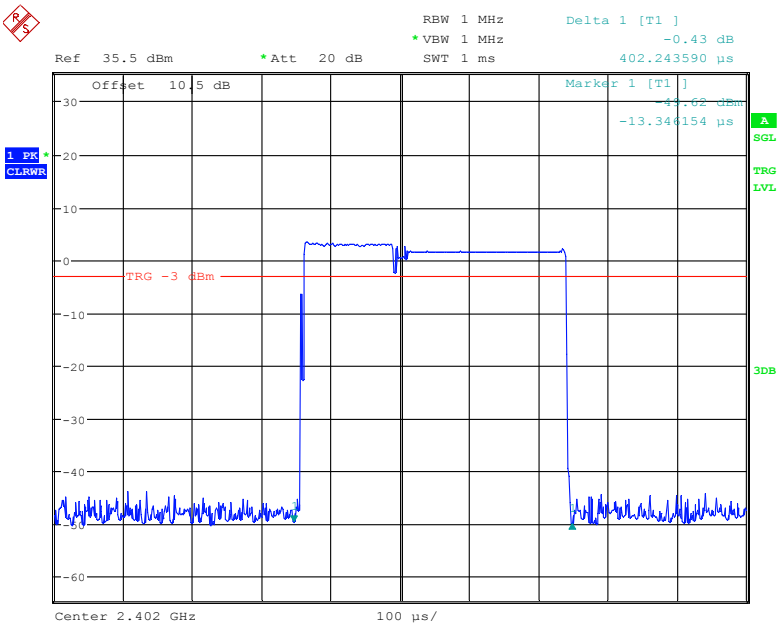
Hopping number in 31.6S, DH5



Date: 25.SEP.2018 13:25:18

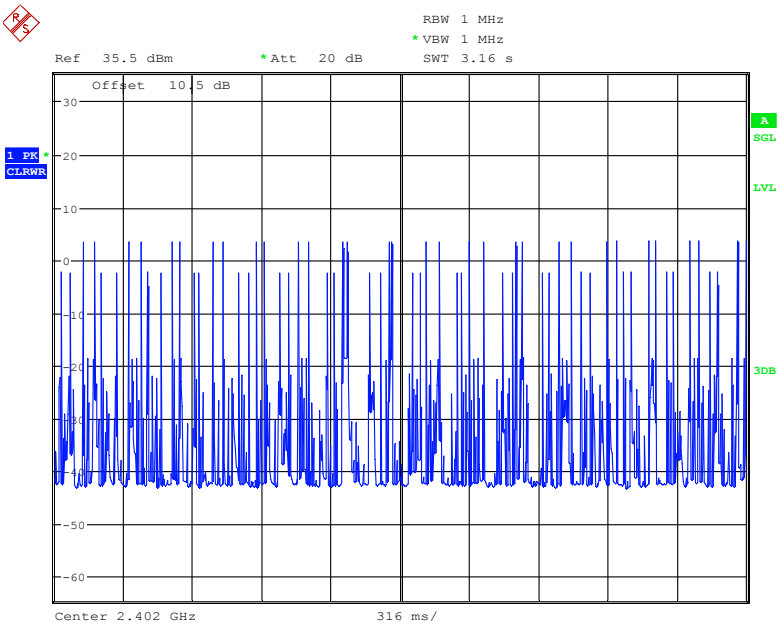
EDR (π/4-DQPSK):

Pulse time, 2DH1



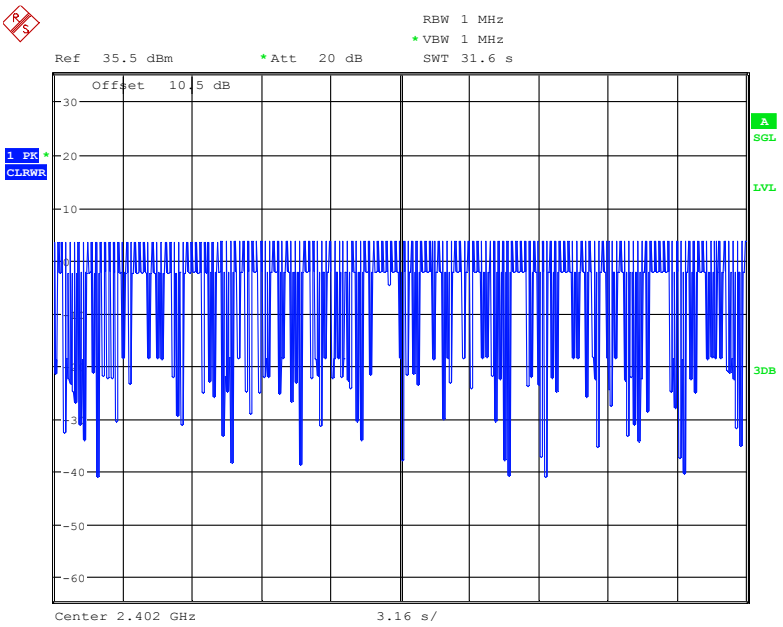
Date: 25.SEP.2018 13:12:45

Hopping number in 3.16S, 2DH1



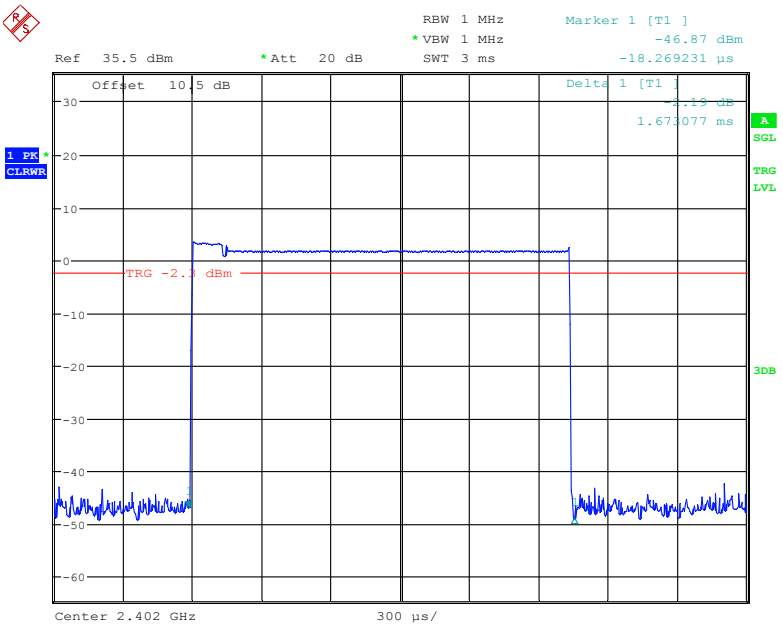
Date: 25.SEP.2018 13:11:17

Hopping number in 31.6S, 2DH1



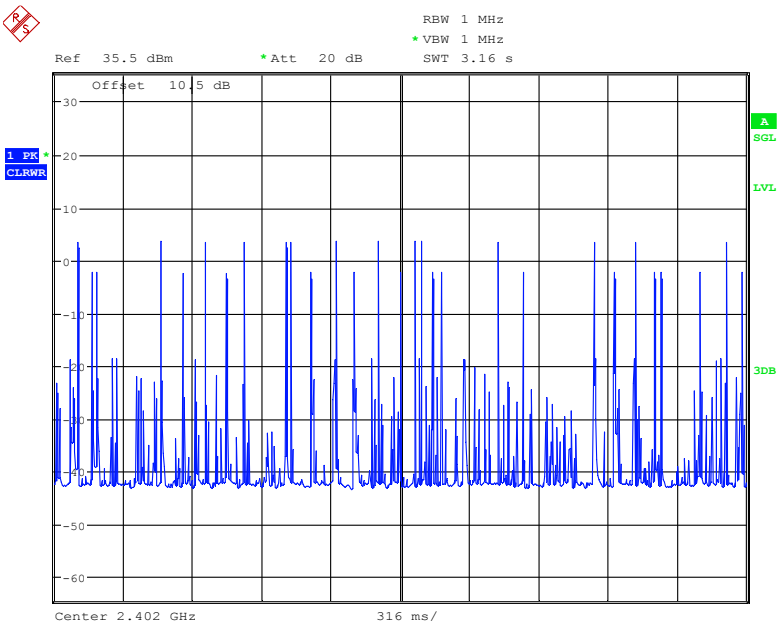
Date: 25.SEP.2018 13:12:02

Pulse time, 2DH3



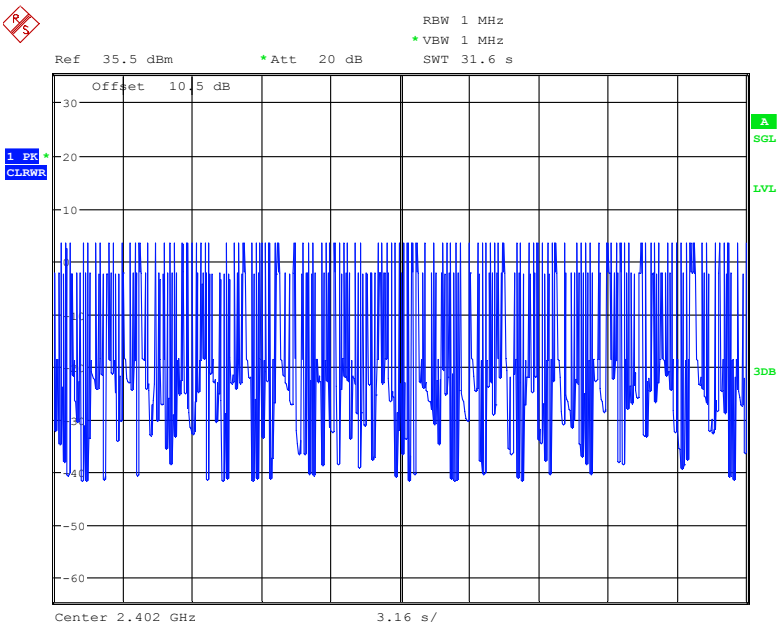
Date: 25.SEP.2018 13:19:01

Hopping number in 3.16S, 2DH3



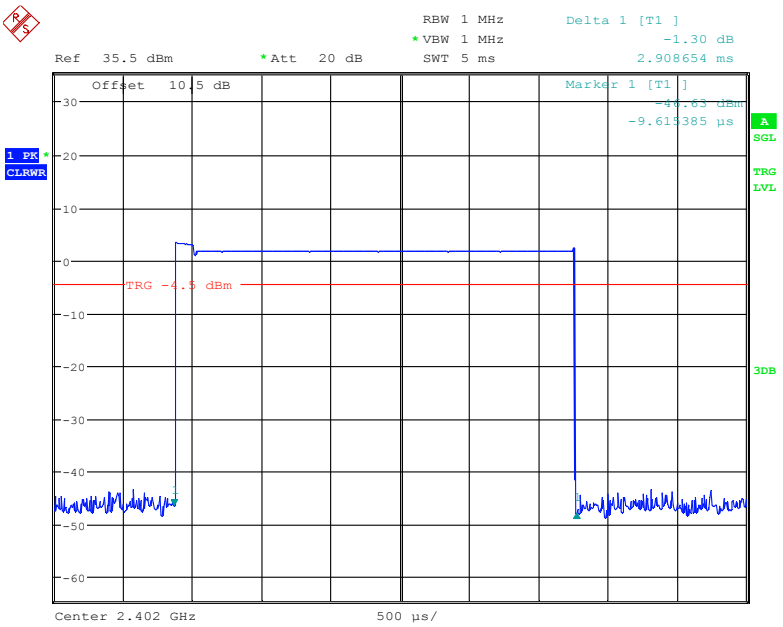
Date: 25.SEP.2018 13:20:39

Hopping number in 31.6S, 2DH3



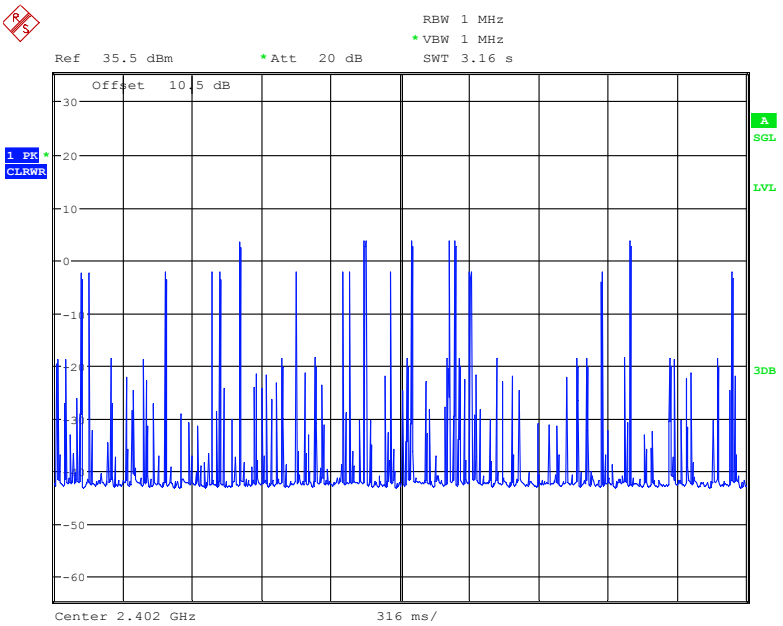
Date: 25.SEP.2018 13:20:23

Pulse time, 2DH5



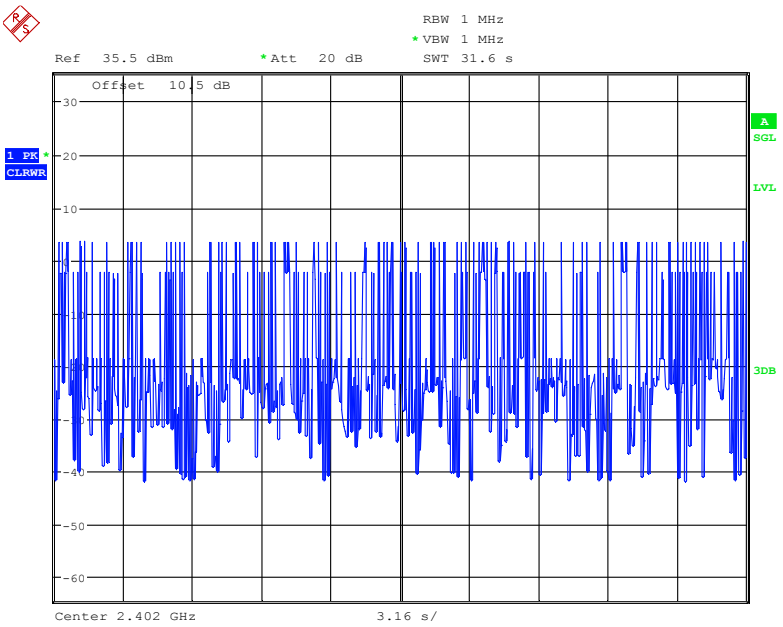
Date: 25.SEP.2018 13:27:55

Hopping number in 3.16S, 2DH5



Date: 25.SEP.2018 13:26:00

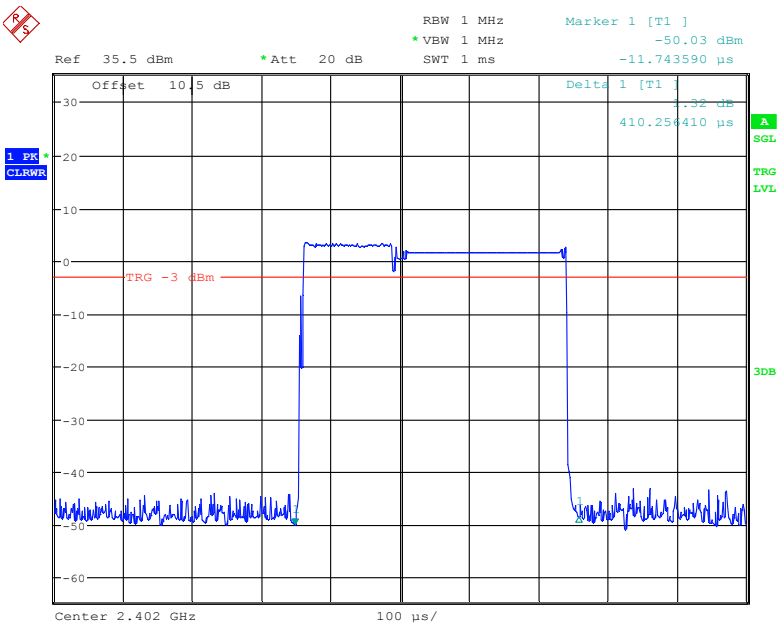
Hopping number in 31.6S, 2DH5



Date: 25.SEP.2018 13:26:46

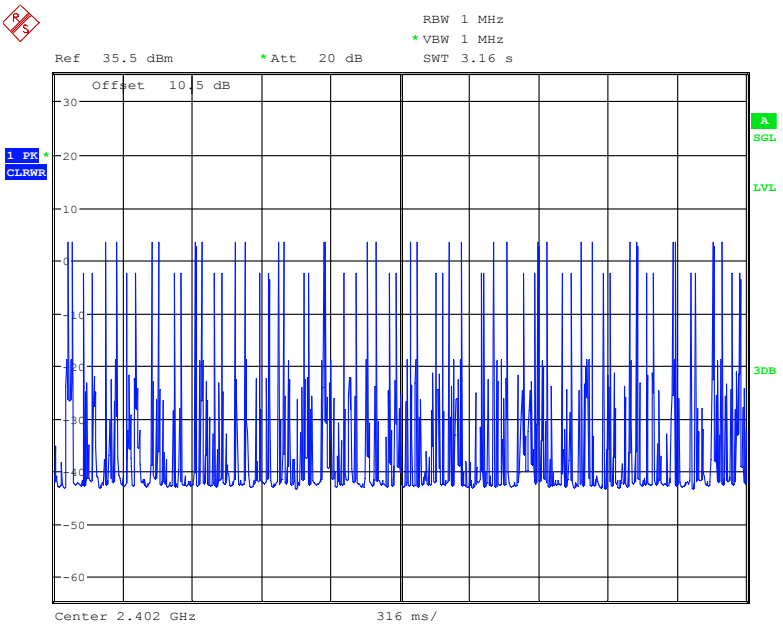
EDR (8-DPSK):

Pulse time, 3DH1



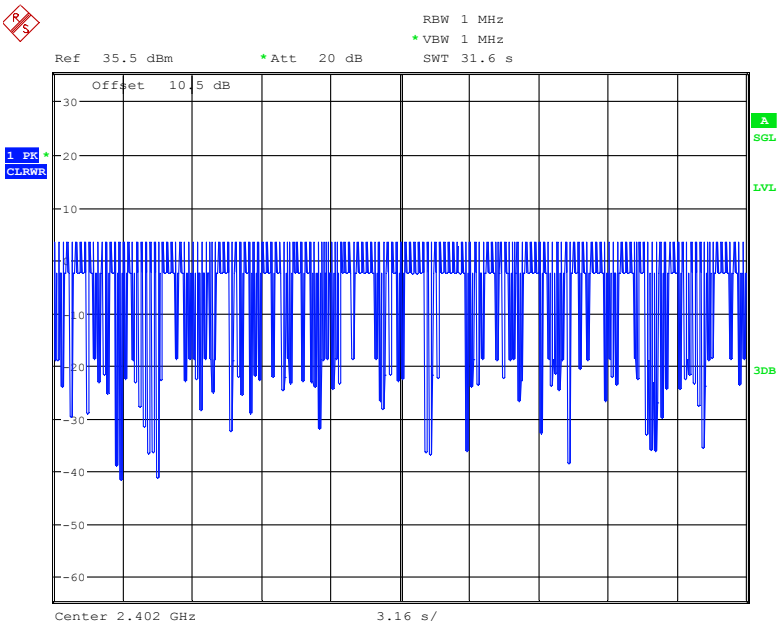
Date: 25.SEP.2018 13:13:36

Hopping number in 3.16S, 3DH1



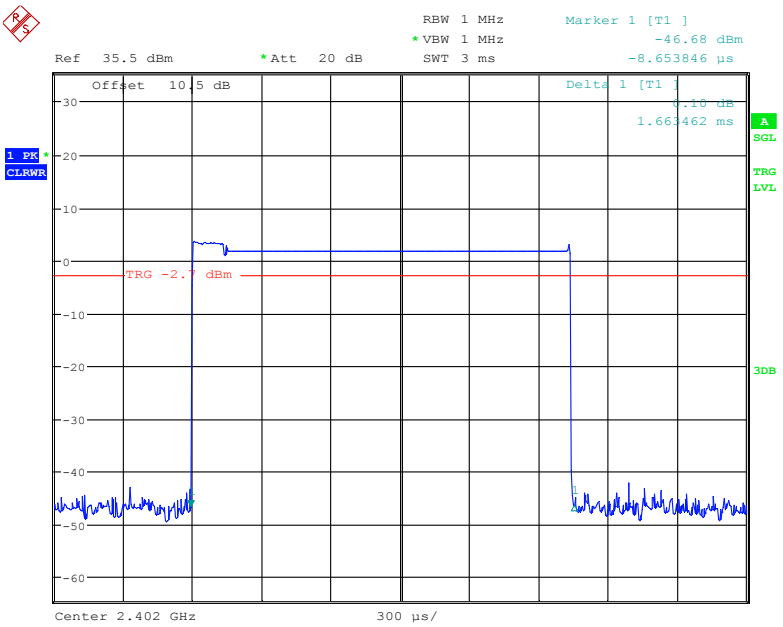
Date: 25.SEP.2018 13:15:09

Hopping number in 31.6S, 3DH1



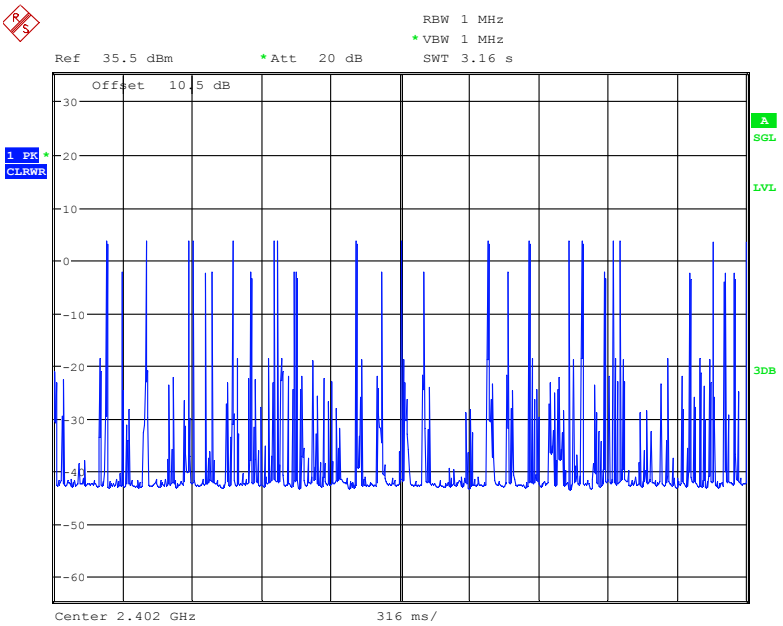
Date: 25.SEP.2018 13:14:50

Pulse time, 3DH3



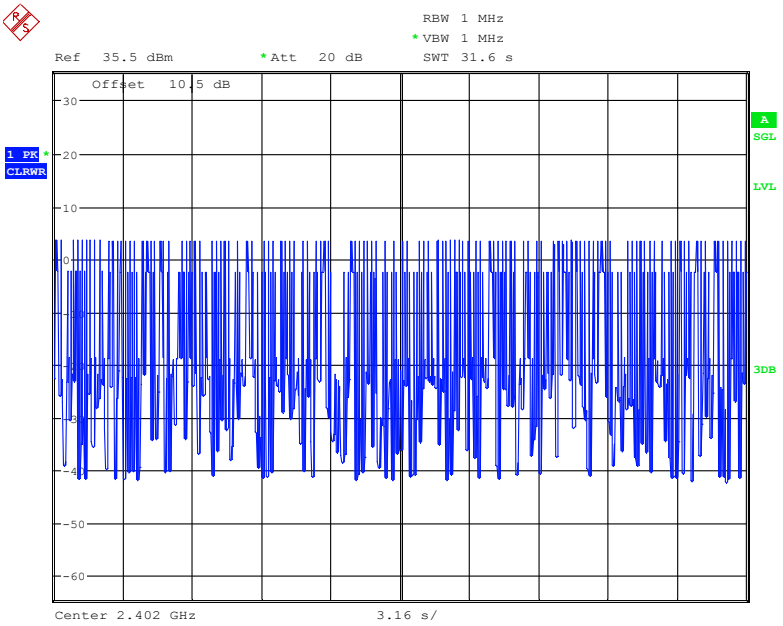
Date: 25.SEP.2018 13:22:56

Hopping number in 3.16S, 3DH3



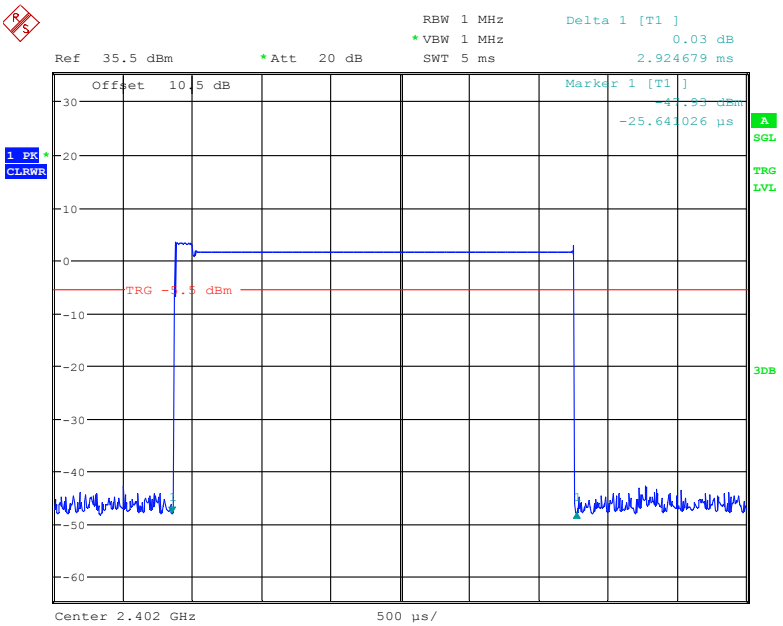
Date: 25.SEP.2018 13:21:29

Hopping number in 31.6S, 3DH3



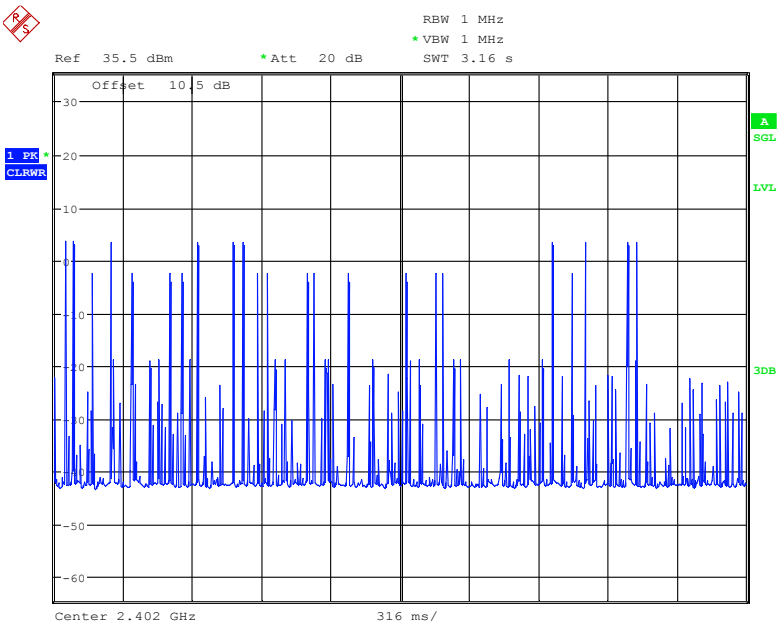
Date: 25.SEP.2018 13:22:17

Pulse time, 3DH5



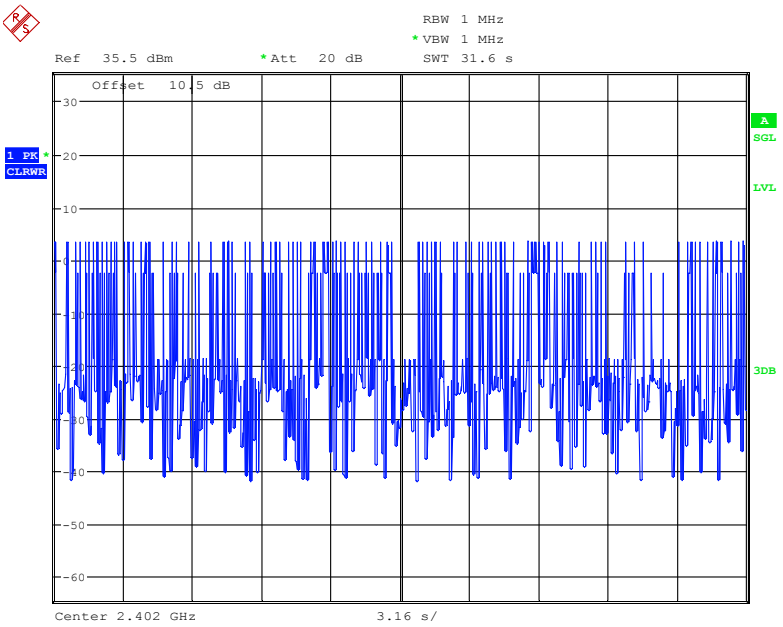
Date: 25.SEP.2018 13:30:44

Hopping number in 3.16S, 3DH5



Date: 25.SEP.2018 13:30:10

Hopping number in 31.6S, 3DH5



Date: 25.SEP.2018 13:29:18

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

Applicable Standard

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

Test Procedure

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

Test Data

Environmental Conditions

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

The testing was performed by Nancy Wang on 2018-09-25.

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	5.67	3.69	125
	Middle	2441	5.99	3.97	125
	High	2480	6.14	4.11	125
EDR (π/4-DQPSK)	Low	2402	4.41	2.76	125
	Middle	2441	4.46	2.79	125
	High	2480	4.83	3.04	125
EDR (8-DPSK)	Low	2402	4.84	3.05	125
	Middle	2441	5.21	3.32	125
	High	2480	5.40	3.47	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:	56 %
ATM Pressure:	101.0 kPa

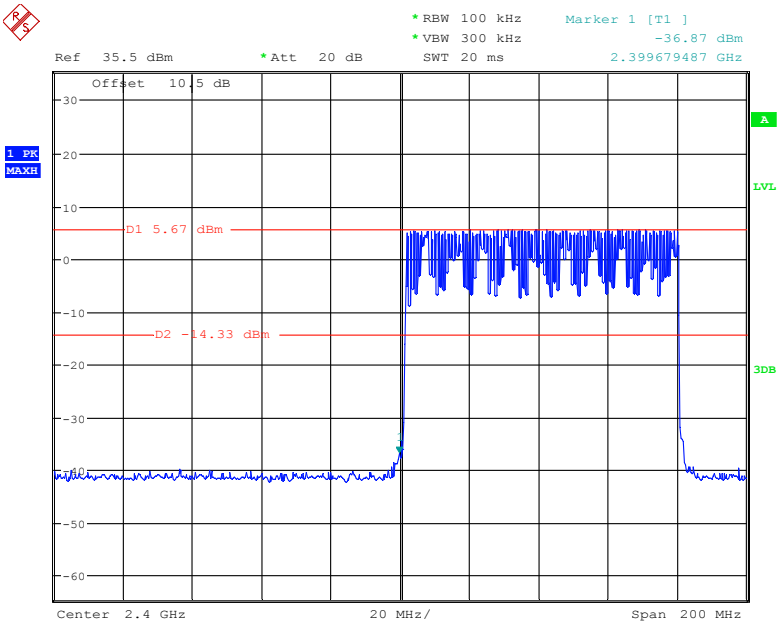
The testing was performed by Nancy Wang on 2018-09-25.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following plots.

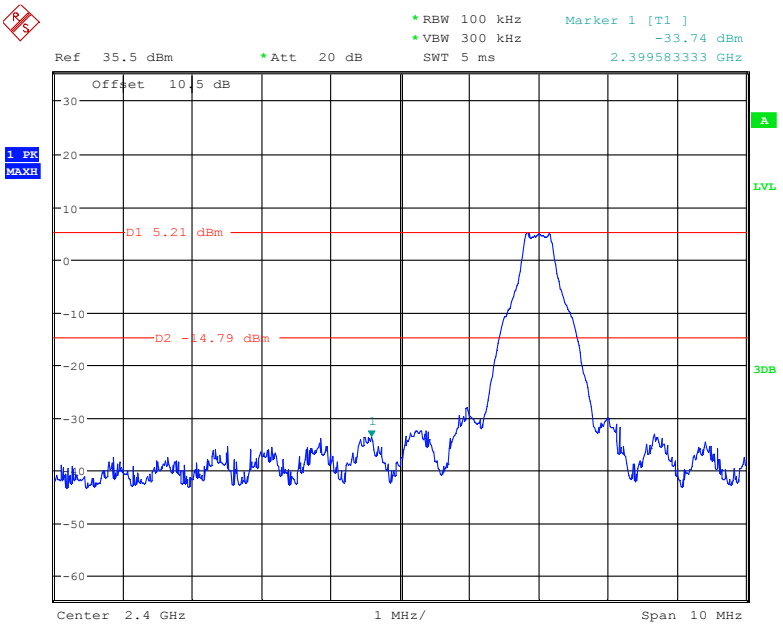
BDR (GFSK): Band Edge-Left Side

Hopping



Date: 25.SEP.2018 10:23:08

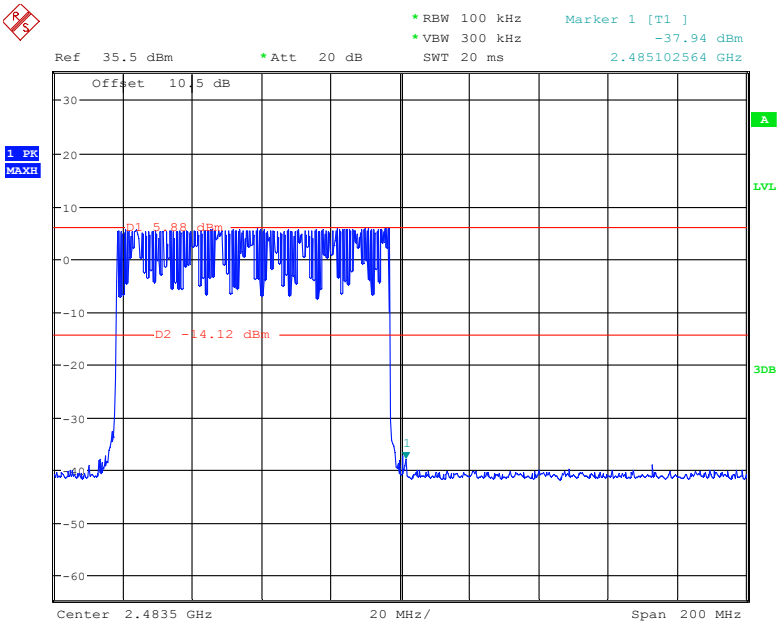
Single



Date: 25.SEP.2018 10:11:28

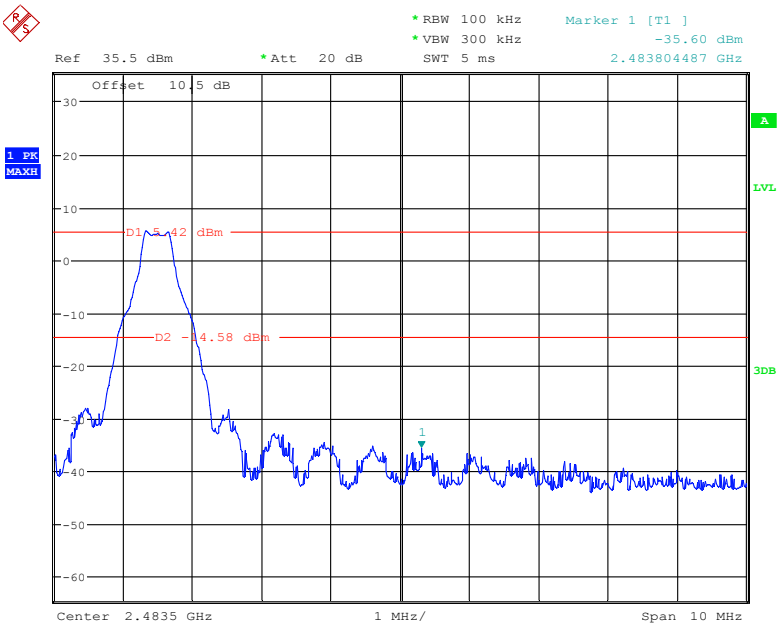
BDR (GFSK): Band Edge-Right Side

Hopping



Date: 25.SEP.2018 10:19:18

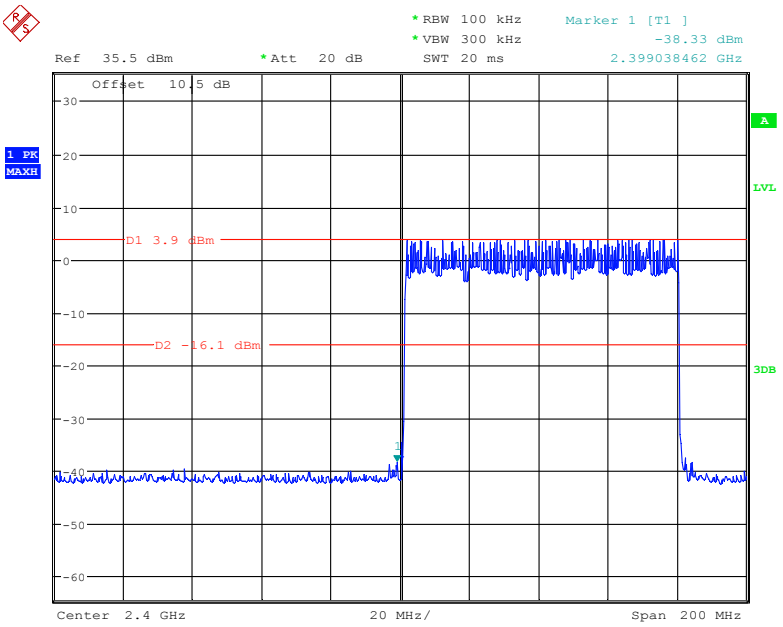
Single



Date: 25.SEP.2018 10:12:26

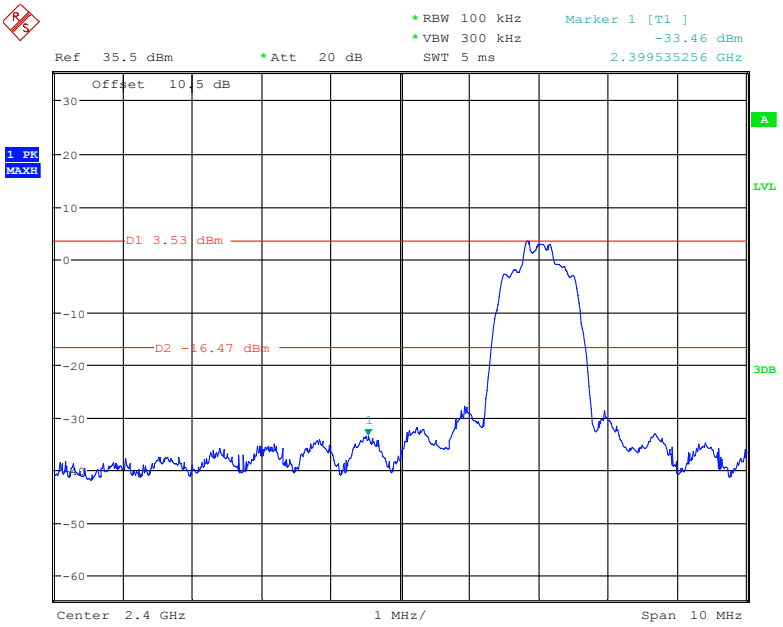
EDR (π/4-DQPSK): Band Edge-Left Side

Hopping



Date: 25.SEP.2018 10:25:18

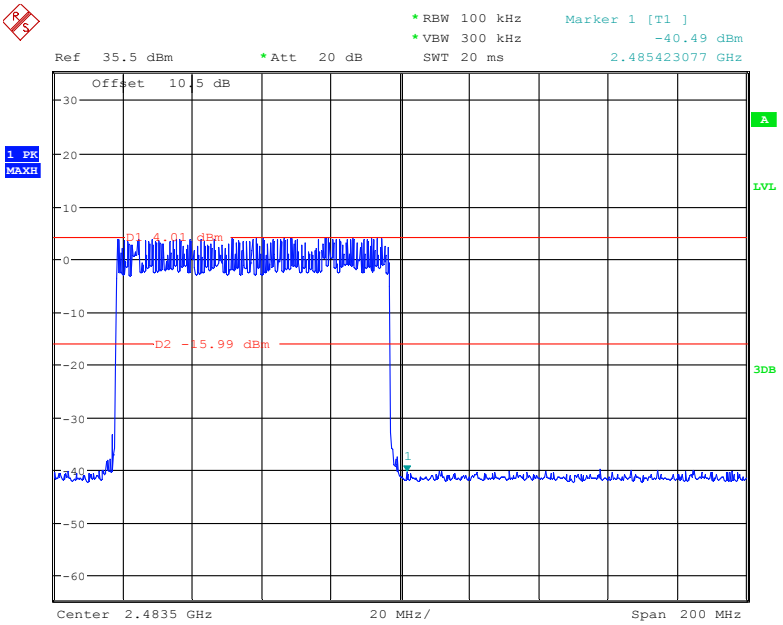
Single



Date: 25.SEP.2018 10:41:59

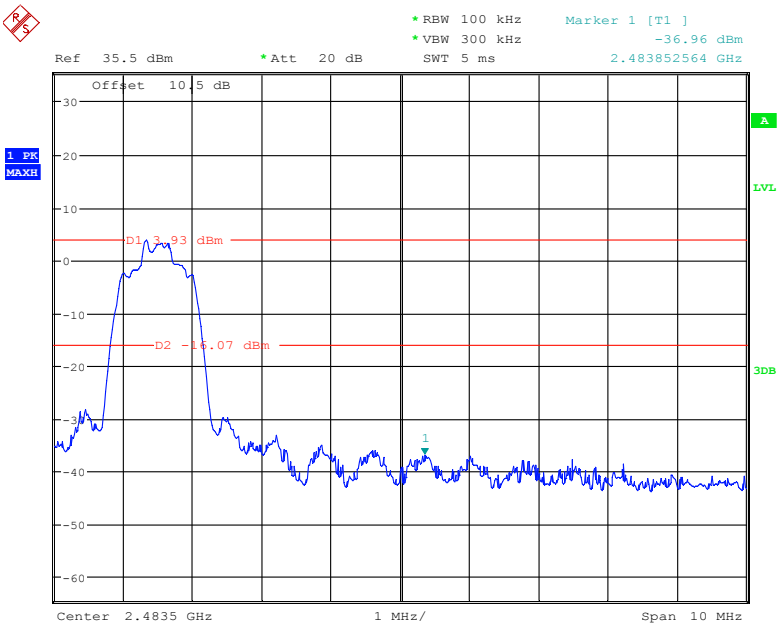
EDR (π/4-DQPSK): Band Edge-Right Side

Hopping



Date: 25.SEP.2018 10:27:57

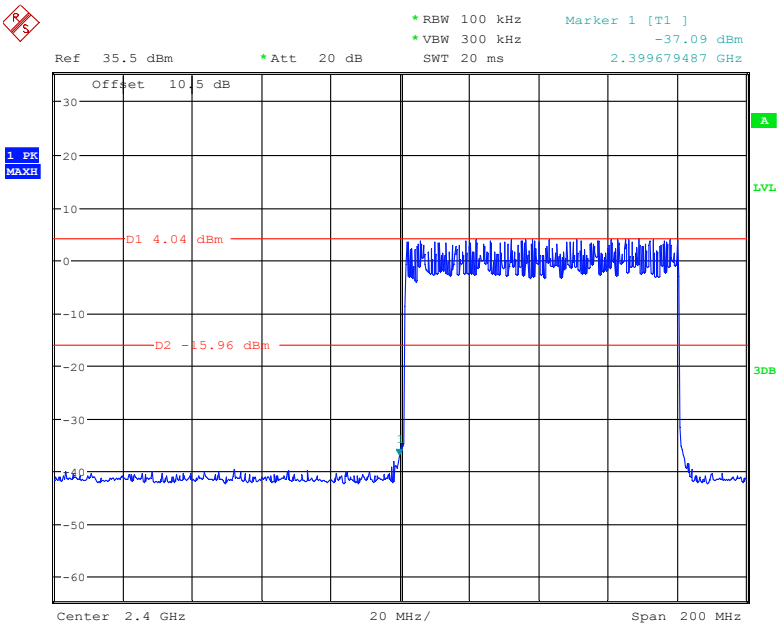
Single



Date: 25.SEP.2018 10:37:27

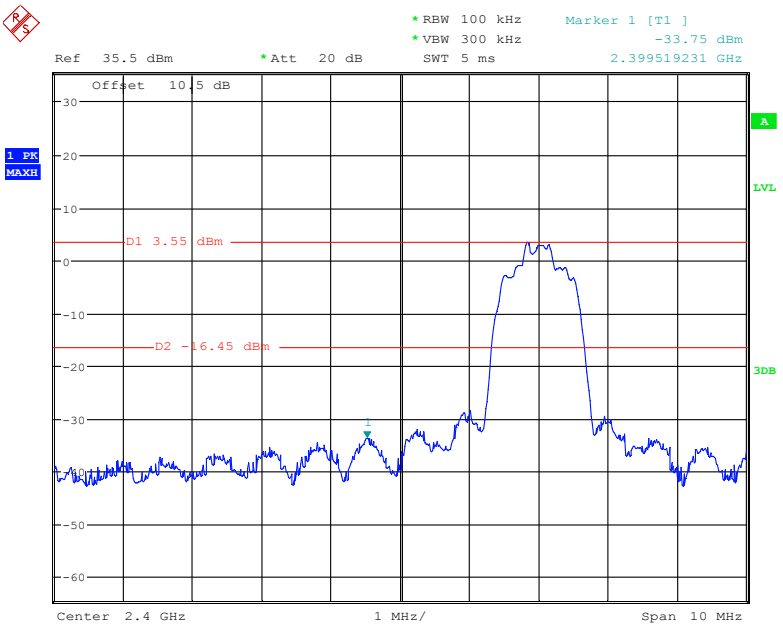
EDR (8DPSK): Band Edge-Left Side

Hopping



Date: 25.SEP.2018 10:33:22

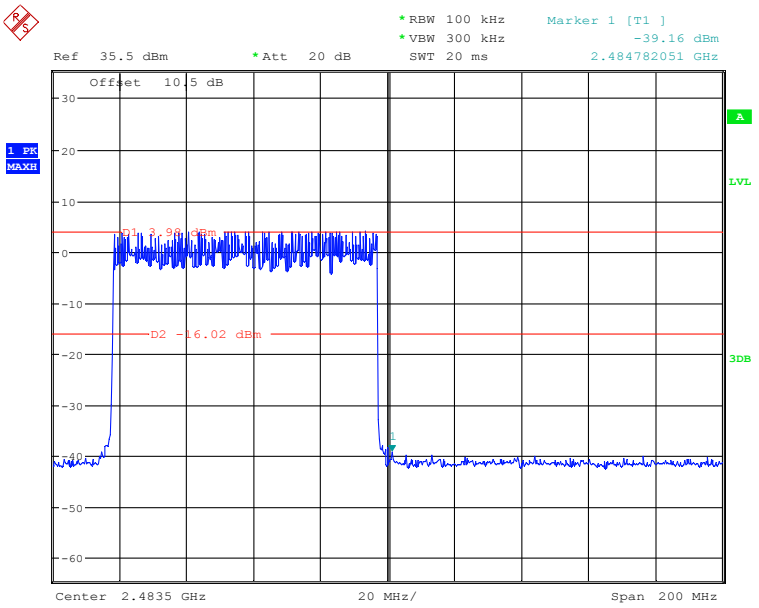
Single



Date: 25.SEP.2018 10:35:26

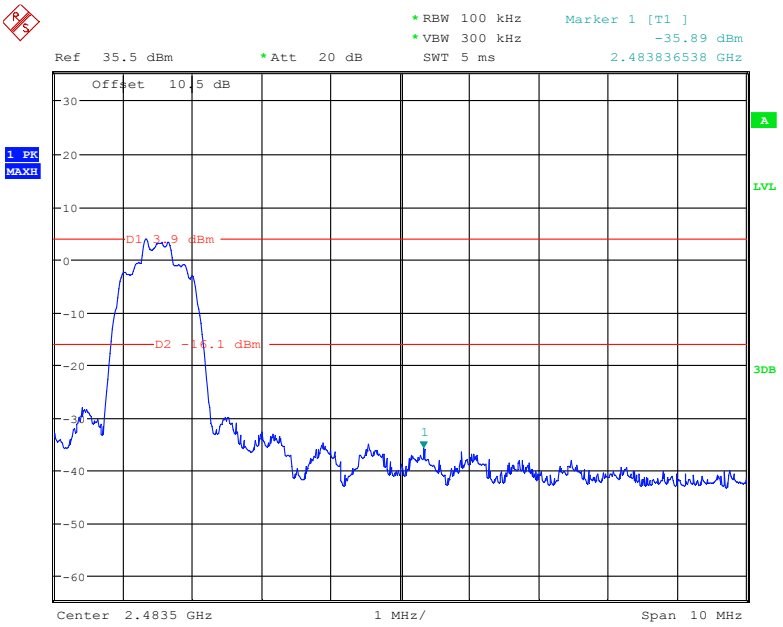
EDR (8DPSK): Band Edge-Right Side

Hopping



Date: 25.SEP.2018 10:30:34

Single



Date: 25.SEP.2018 10:36:36

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