

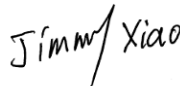
FCC PART 15.247 TEST REPORT

For

Apex Drone (Shenzhen) Co.,Ltd.

A.Floor 4,A001 Building,Zhi Ji Industrial Park, No.92 KuiChong Street,LongGang
district,ShenZhen,China

FCC ID: 2AQT5-GD-136

Report Type: Original Report	Product Type: SMTALY Smart Neck Massager
Report Number: RSZ200409810-00A	
Report Date: 2020-05-15	
Jimmy Xiao 	
Reviewed By: RF Engineer	
Prepared By: Bay Area Compliance Laboratories Corp. (Shenzhen) 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China Tel: +86-755-33320018 Fax: +86-755-33320008 www.baclcorp.com.cn	

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	SMTALY Smart Neck Massager
Tested Model	GD-136
Multiple Model	M3
Model Different	Please refer to the DOS
Frequency Range	Bluetooth: 2402~2480MHz
Maximum conducted peak output power	2.37dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK
Antenna Specification	-0.48dBi
Voltage Range	DC 3.7 V from battery
Date of Test	2020/04/23~2020/05/04
Sample serial number	RSZ200409810-RF-S1 (Assigned by BACL, Shenzhen)
Received date	2020/04/09
Sample/EUT Status	Good condition

Objective

This test report is prepared on behalf of *Apex Drone (Shenzhen) 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 Part15.247 DTS Submittal(s)/Grant(s) with FCC ID: 2AQT5-GD-136.

Test Methodology

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

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

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

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF Output Power with Power meter		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±1 °C
Humidity		±6%
Supply voltages		±0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

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

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

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

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

FCC-assist Software was used, and the power level is 10.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

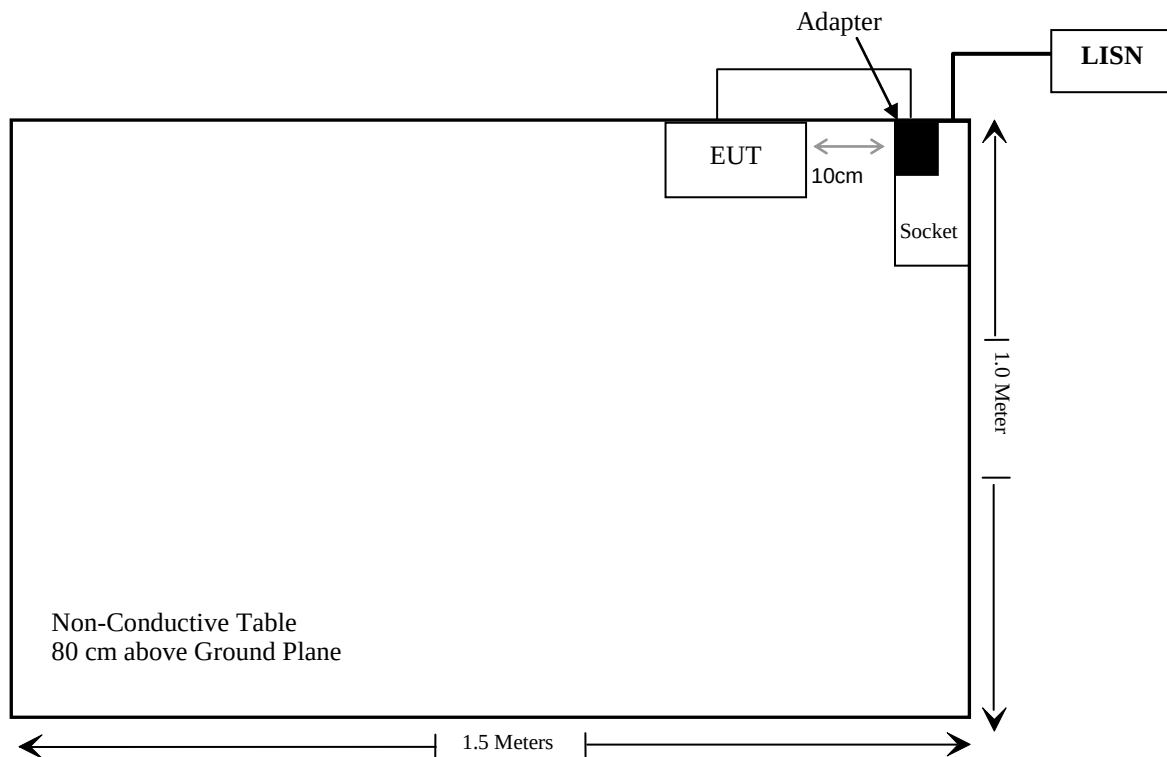
Manufacturer	Description	Model	Serial Number
BLU	Adapter	EU-01-004	5503290068073

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cable	0.5	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	ESCI	101120	2019/7/9	2020/7/8
Rohde & Schwarz	LISN	ENV216	101613	2020/1/22	2021/1/21
Rohde & Schwarz	Transient Limitor	ESH3Z2	DE25985	2019/11/29	2020/11/28
Unknown	CE Cable	CE Cable	UF A210B-1-0720-504504	2019/11/29	2020/11/28
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2019/7/9	2020/7/8
Sonoma instrument	Pre-amplifier	310 N	186238	2020/4/20	2021/4/20
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017/12/22	2020/12/21
Unknown	Cable 2	RF Cable 2	F-03-EM197	2019/11/29	2020/11/28
Unknown	Cable	Chamber Cable 1	F-03-EM236	2019/11/29	2020/11/28
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2019/7/22	2020/07/21
COM-POWER	Pre-amplifier	PA-122	181919	2019/11/29	2020/11/28
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2019/11/29	2020/11/28
Sunol Sciences	Horn Antenna	DRH-118	A052604	2017/12/22	2020/12/21
Insulted Wire Inc.	RF Cable	SPS-2503-3150	02222010	2019/11/29	2020/11/28
Unknown	RF Cable	W1101-EQ1 OUT	F-19-EM005	2019/11/29	2020/11/28
SNSD	Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2020/4/20	2021/4/20
Ducommun Technologies	Horn antenna	ARH-4223-02	1007726-02 1304	2017/12/6	2020/12/5

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Unknown	RF Cable	Unknown	2301 276	2019/11/29	2020/11/28
Agilent	USB wideband power meter	U2021XA	MY54250003	2019/7/10	2020/7/9
Rohde & Schwarz	Spectrum Analyzer	FSU26	200120	2020/3/1	2021/2/28
WEINSCHL	3dB Attenuator	6231	666	2019/11/29	2020/11/28

*** 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:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot$

$[\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

1. $f(\text{GHz})$ 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	2.5	1.78	5	0.6	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 PCB antenna arrangement, which was permanently attached and the antenna gain is -0.48dBi, fulfill the requirement of this section. Please refer to the EUT photos.

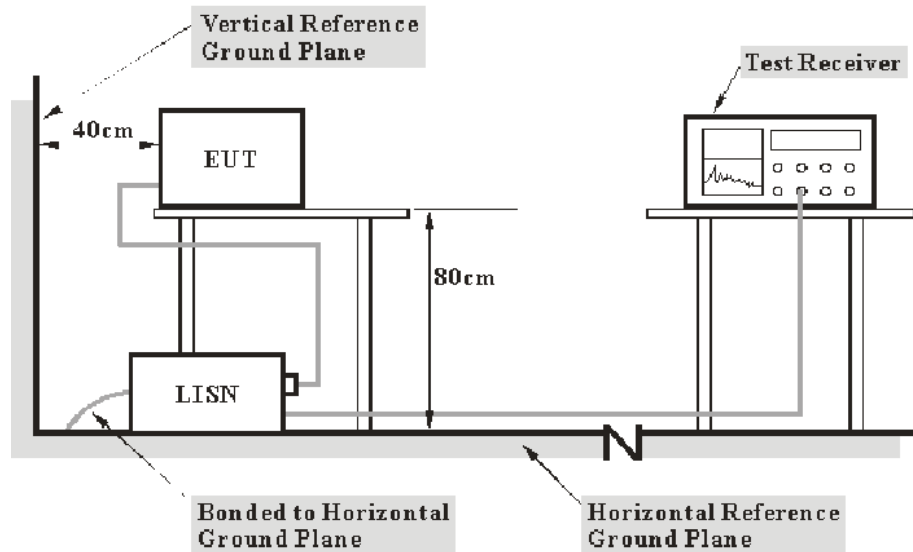
Result: Compliance.

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.

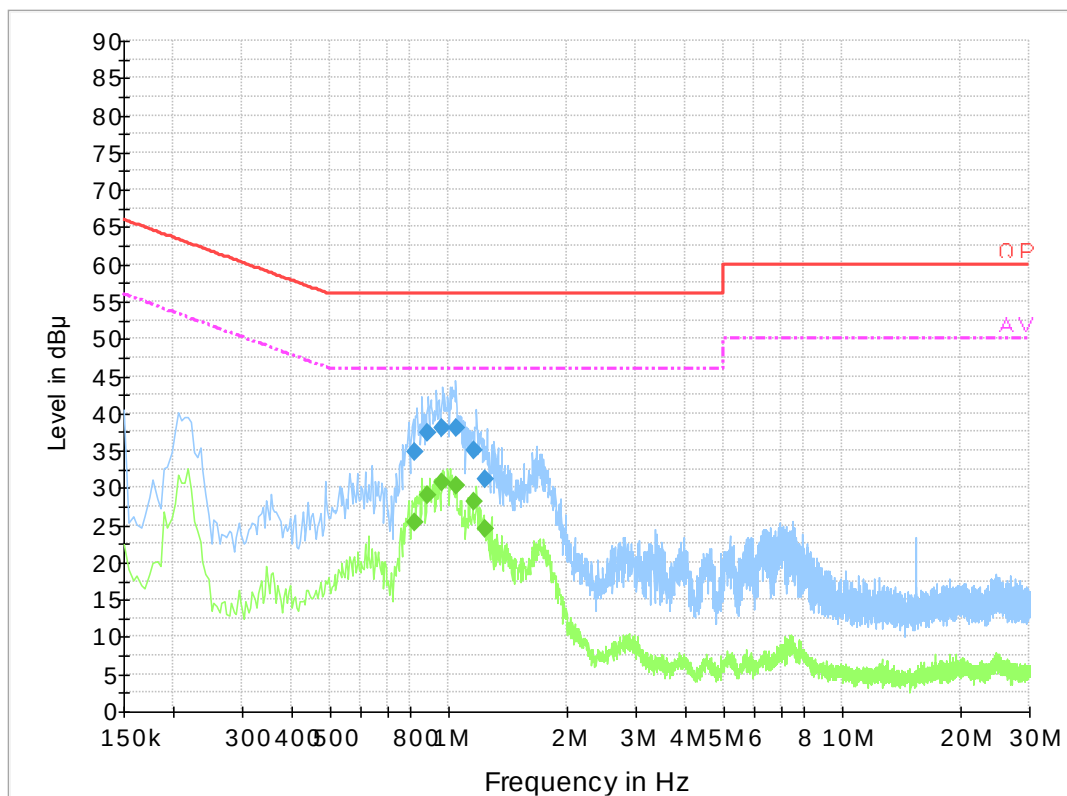
Test Data

Environmental Conditions

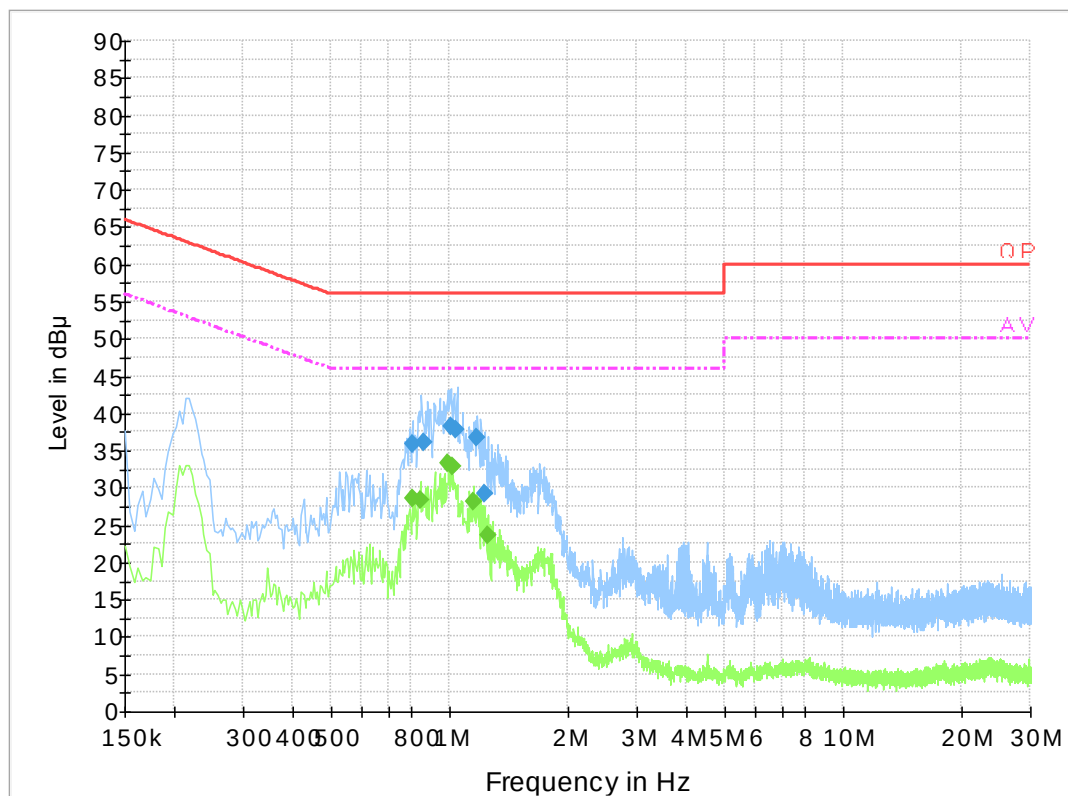
Temperature:	25 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2020-04-23.

EUT operation mode: Charging

AC 120V/60 Hz, Line

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.825790	34.7	19.8	56.0	21.3	QP
0.888650	37.3	19.8	56.0	18.7	QP
0.967450	38.0	19.9	56.0	18.0	QP
1.050310	38.0	19.9	56.0	18.0	QP
1.164330	35.1	19.8	56.0	20.9	QP
1.247190	31.1	19.8	56.0	24.9	QP
0.825790	25.4	19.8	46.0	20.6	Ave.
0.888650	29.0	19.8	46.0	17.0	Ave.
0.967450	30.7	19.9	46.0	15.3	Ave.
1.050310	30.3	19.9	46.0	15.7	Ave.
1.164330	28.2	19.8	46.0	17.8	Ave.
1.247190	24.6	19.8	46.0	21.4	Ave.

AC 120V/60 Hz, Neutral

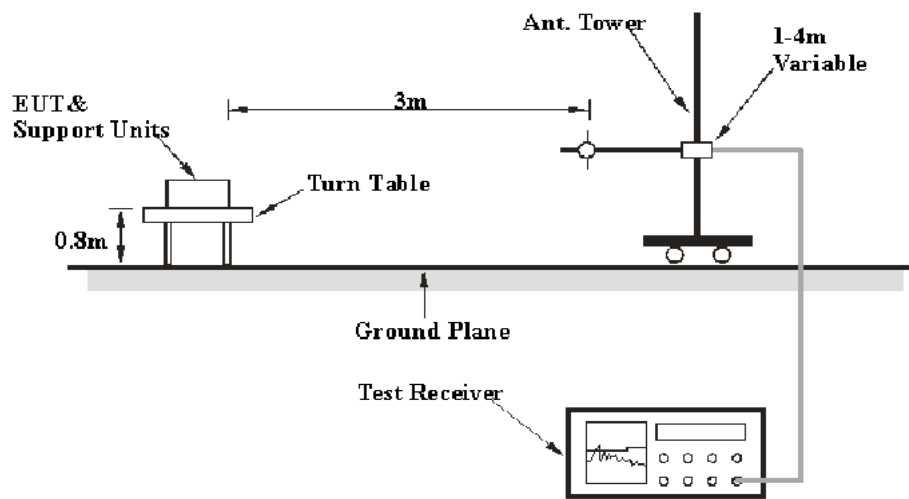
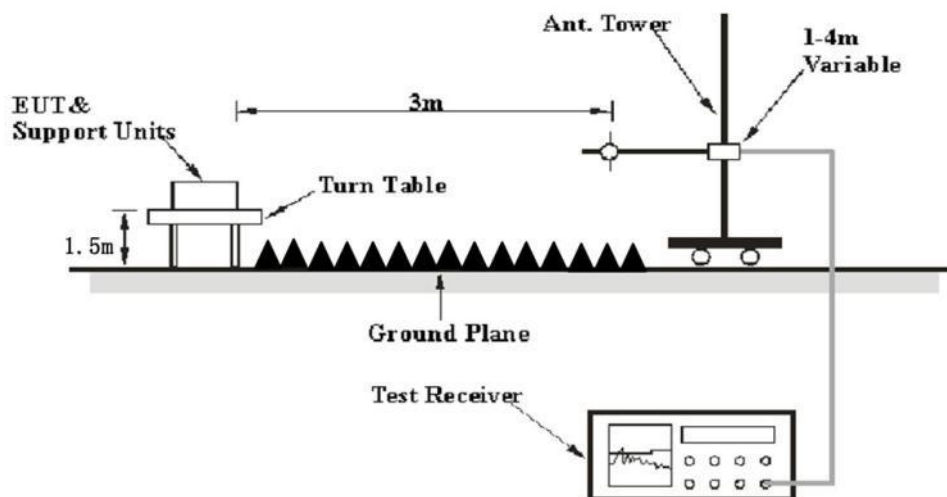
Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.805910	35.9	19.8	56.0	20.1	QP
0.862750	36.0	19.8	56.0	20.0	QP
1.010850	38.2	19.8	56.0	17.8	QP
1.046250	37.9	19.8	56.0	18.1	QP
1.176330	36.6	19.8	56.0	19.4	QP
1.235190	29.3	19.8	56.0	26.7	QP
0.806000	28.5	19.8	46.0	17.5	Ave.
0.846000	28.3	19.8	46.0	17.7	Ave.
0.998000	33.3	19.8	46.0	12.7	Ave.
1.022000	32.8	19.8	46.0	13.2	Ave.
1.154000	28.1	19.8	46.0	17.9	Ave.
1.254000	23.7	19.8	46.0	22.3	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, according to the DA 00-705 Released March 30, 2000, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

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

Test Procedure

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

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

Corrected Amplitude & Margin Calculation

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

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

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.

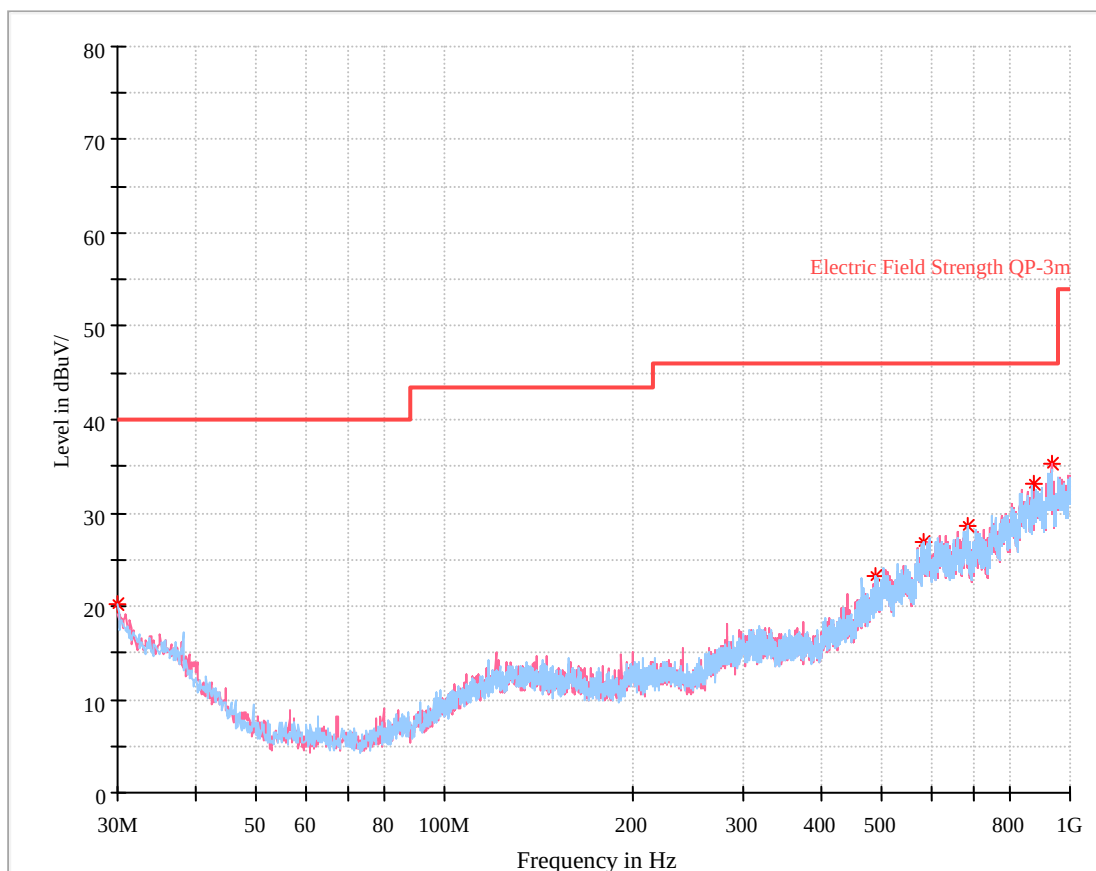
Test Data

Environmental Conditions

Temperature:	23 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Holland Yang on 2020-04-24 for below 1GHz and by Charlie Cha on 2020-05-04 for above 1GHz.

EUT operation mode: Transmitting (the worst case is $\pi/4$ -DQPSK Mode middle channel)



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
30.000000	20.30	390.0	H	345.0	-7.6	40.00	19.70
489.295000	23.23	390.0	H	240.0	-5.8	46.00	22.77
583.385000	26.93	305.0	H	242.0	-2.4	46.00	19.07
685.841250	28.53	105.0	H	295.0	-1.3	46.00	17.47
872.930000	33.20	105.0	V	52.0	3.6	46.00	14.06
932.342500	35.18	390.0	V	103.0	4.8	46.00	10.82

1 GHz - 25 GHz: (Scan with GFSK, $\pi/4$ -DQPSK mode, the worst case is $\pi/4$ -DPSK Mode)

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)									
2331.21	28.62	PK	348	2.4	H	31.64	60.26	74	13.74
2331.21	13.54	Ave.	348	2.4	H	31.64	45.18	54	8.82
2488.49	28.81	PK	154	1.2	H	32.13	60.94	74	13.06
2488.49	13.64	Ave.	154	1.2	H	32.13	45.77	54	8.23
4804.00	48.38	PK	232	1.7	H	6.28	54.66	74	19.34
4804.00	33.24	Ave.	232	1.7	H	6.28	39.52	54	14.48
Middle Channel (2441 MHz)									
4882.00	49.11	PK	353	1.6	H	6.76	55.87	74	18.13
4882.00	33.84	Ave.	353	1.6	H	6.76	40.60	54	13.40
High Channel (2480 MHz)									
2356.65	28.68	PK	350	2.4	H	31.77	60.45	74	13.55
2356.65	13.58	Ave.	350	2.4	H	31.77	45.35	54	8.65
2489.76	28.86	PK	56	2.4	H	32.13	60.99	74	13.01
2489.76	13.69	Ave.	56	2.4	H	32.13	45.82	54	8.18
4960.00	49.95	PK	346	1.3	H	6.80	56.75	74	17.25
4960.00	34.05	Ave.	346	1.3	H	6.80	40.85	54	13.15

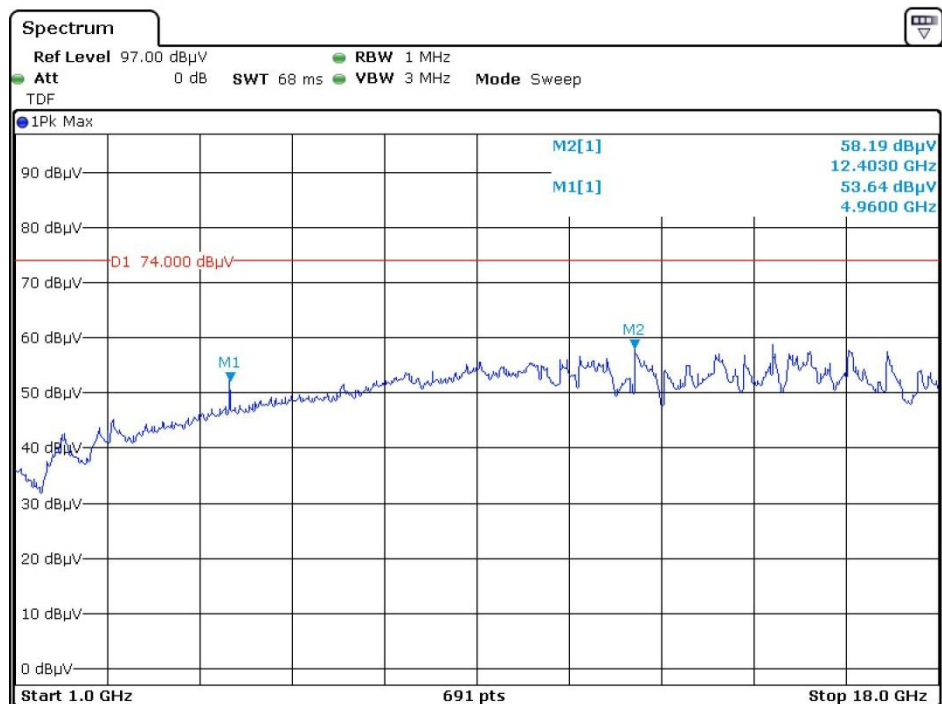
Note:

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

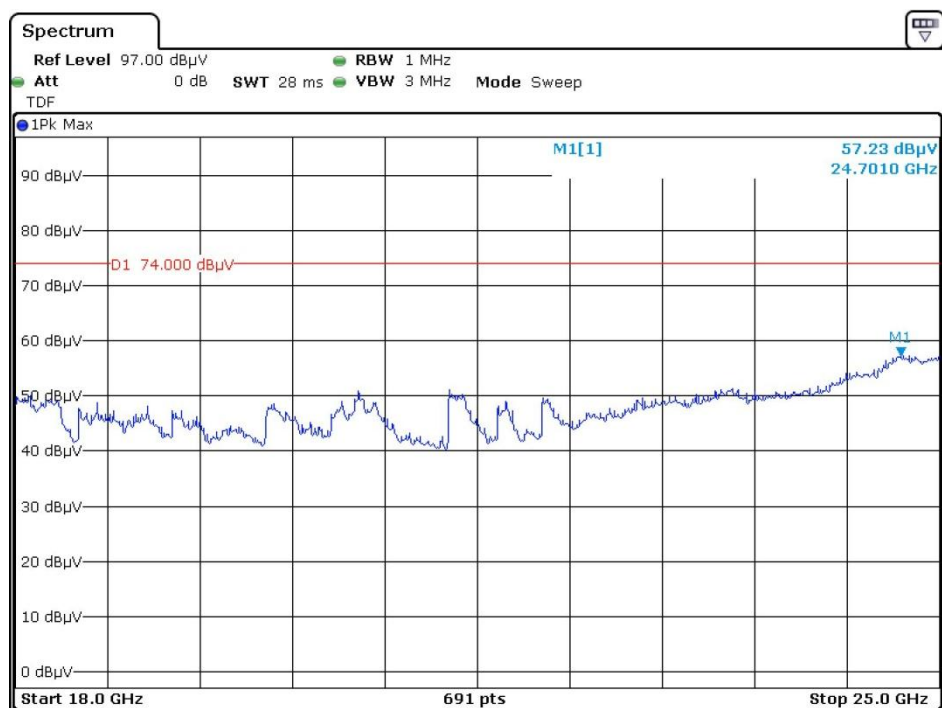
Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

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

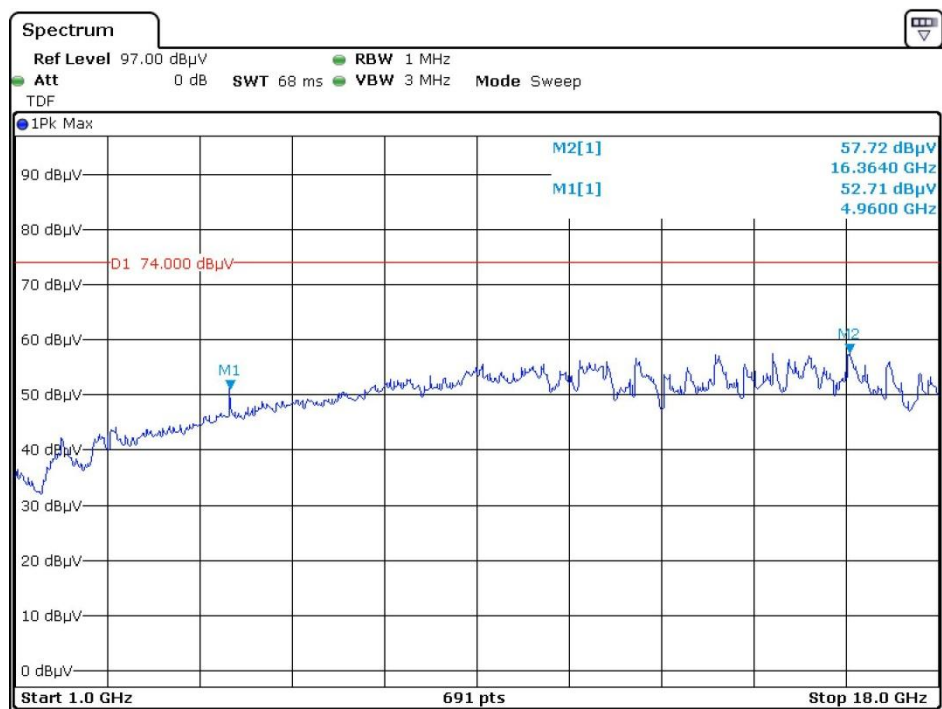
**Pre-scan with high channel Peak
Horizontal**

Date: 4.MAY.2020 17:02:08

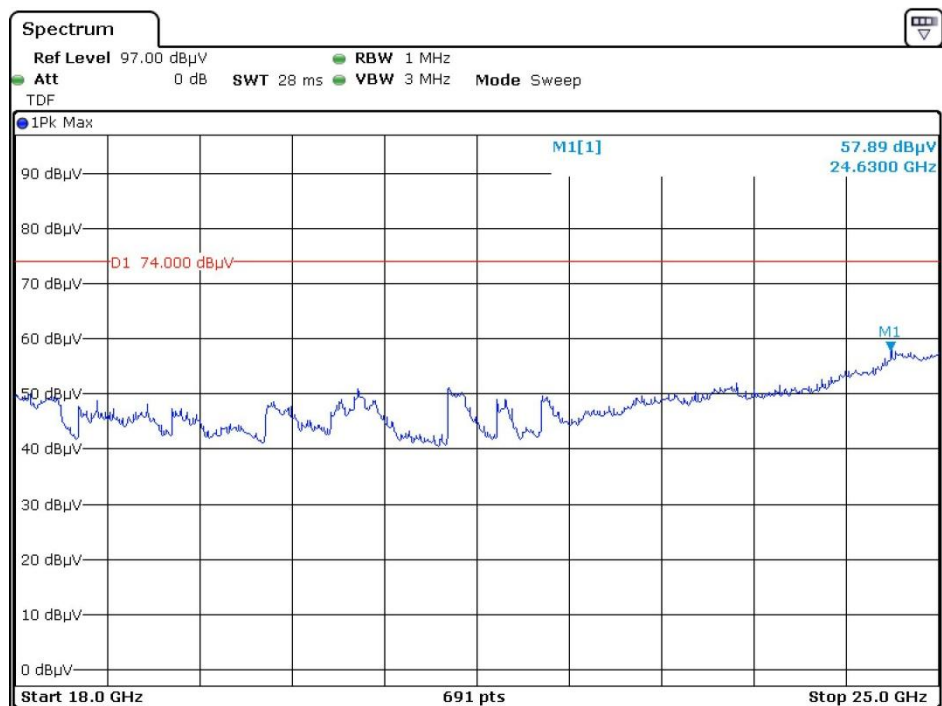


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Vertical

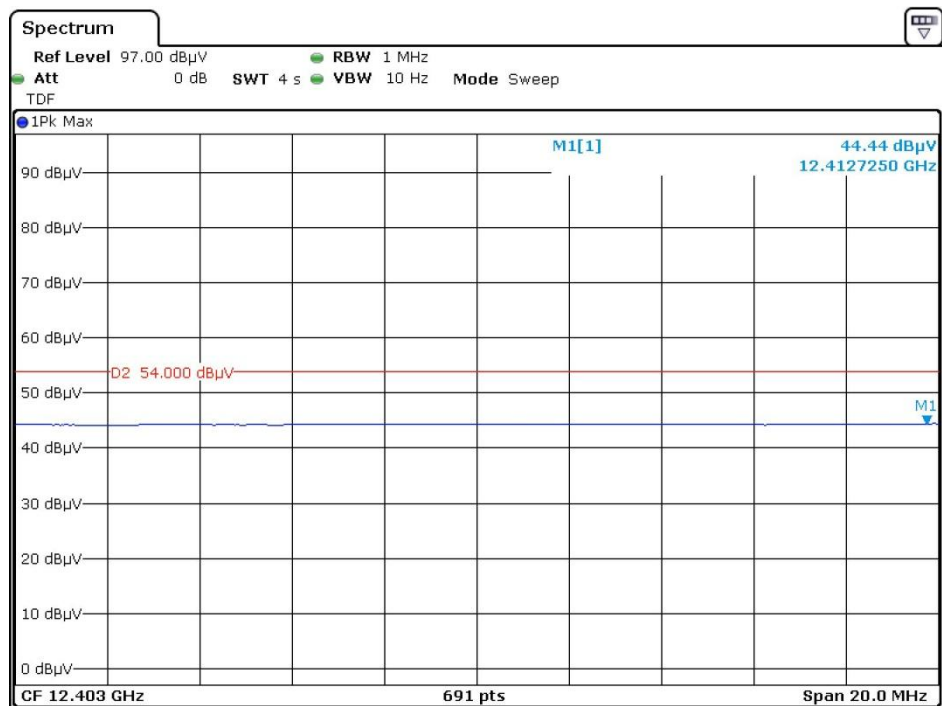


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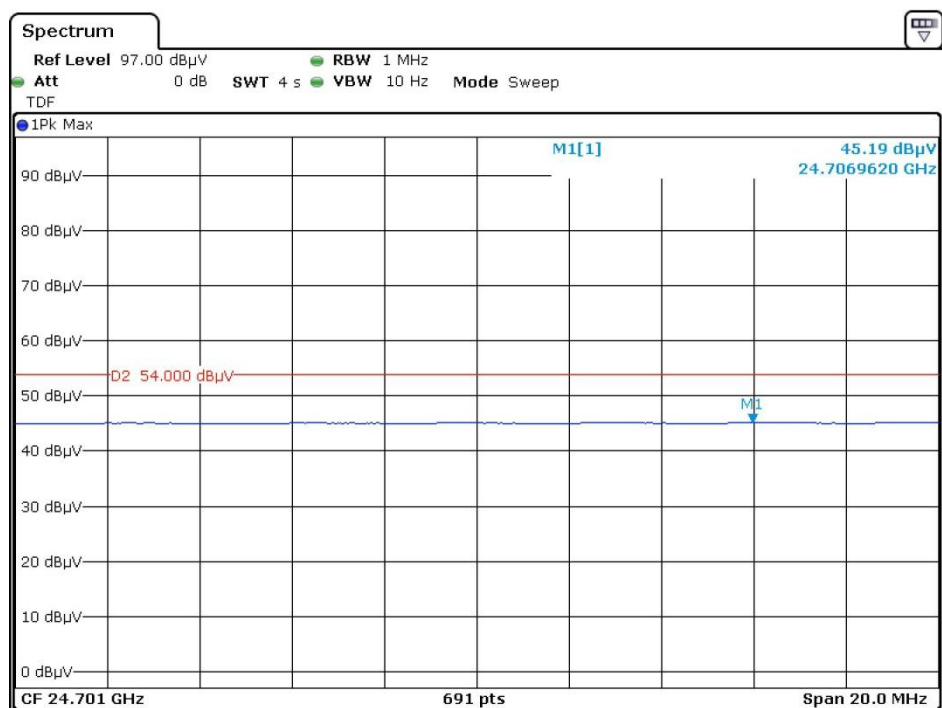


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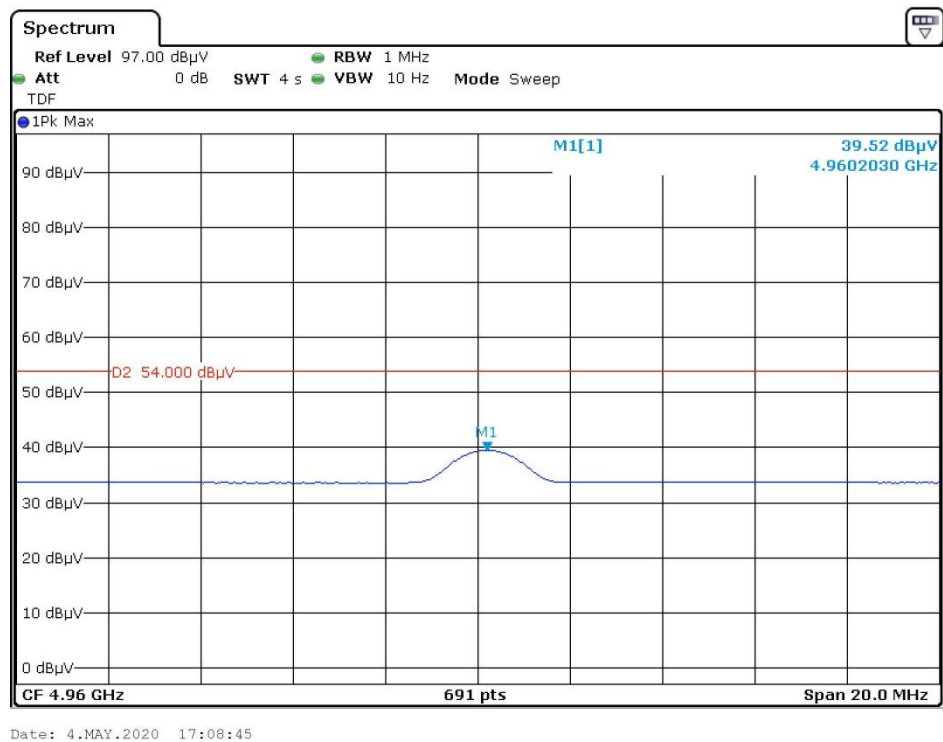
Pre-scan for Average Horizontal



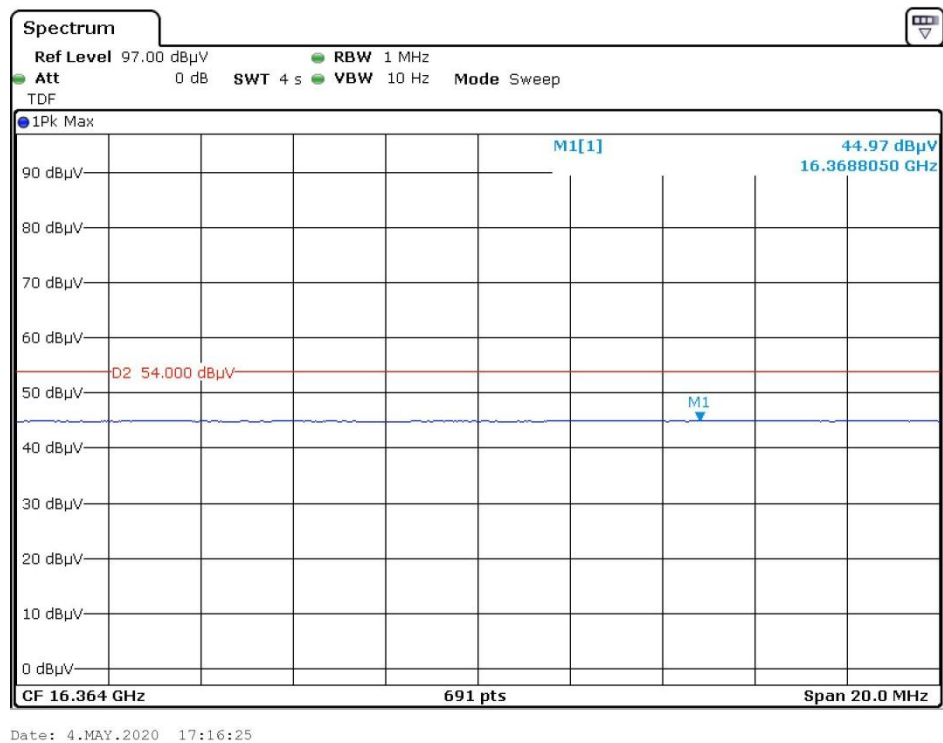
Date: 4.MAY.2020 17:05:50

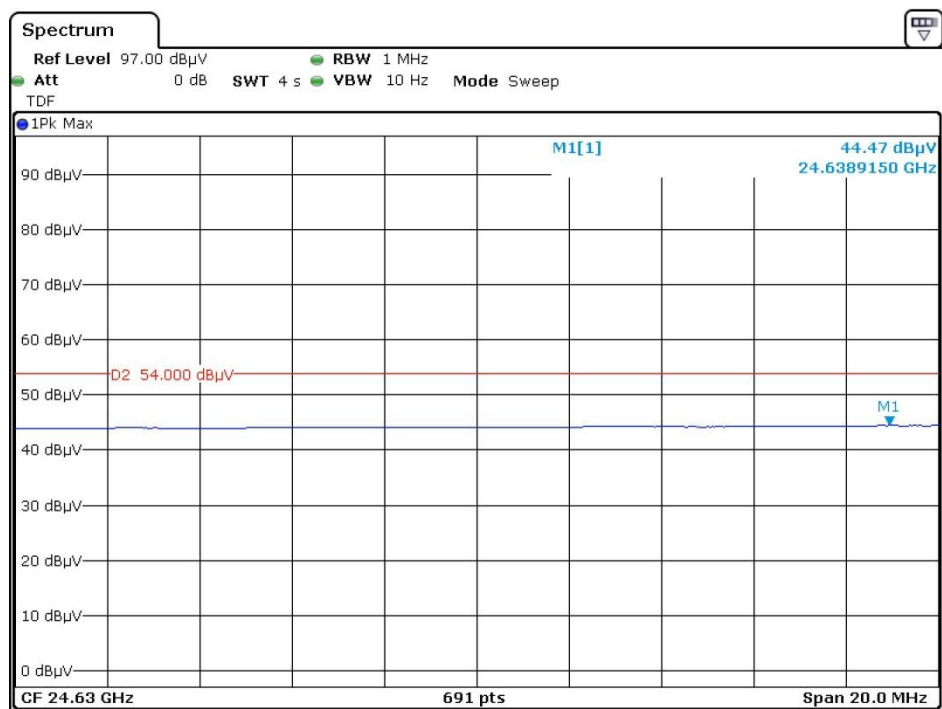


Date: 4.MAY.2020 18:07:07

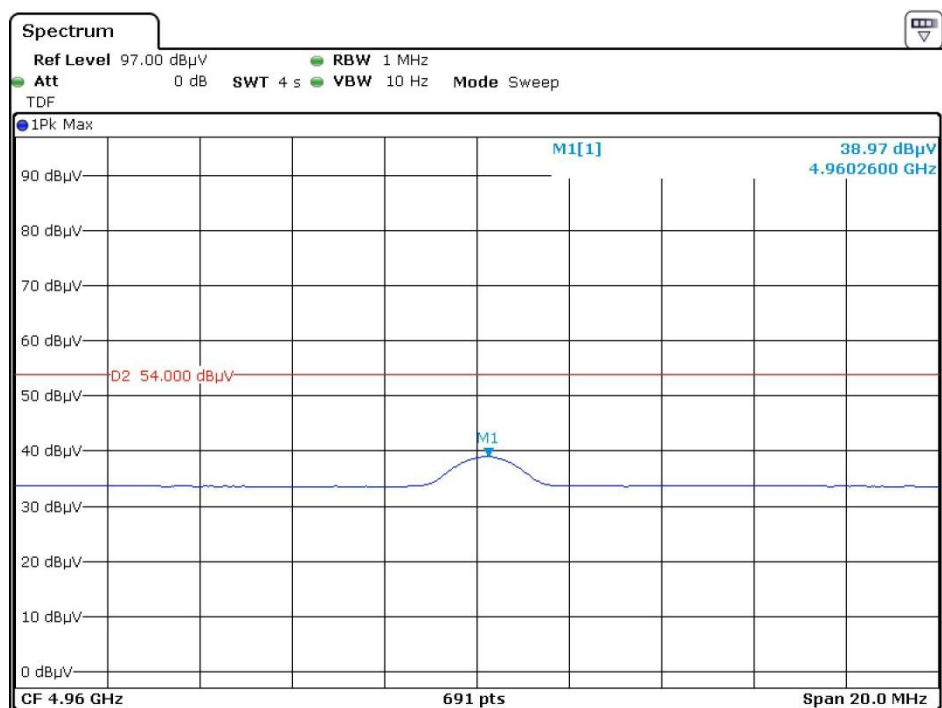


Vertical





Date: 4.MAY.2020 18:15:54



Date: 4.MAY.2020 17:20:22

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. 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 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by George Zhong on 2020-04-23.

EUT operation mode: Transmitting

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

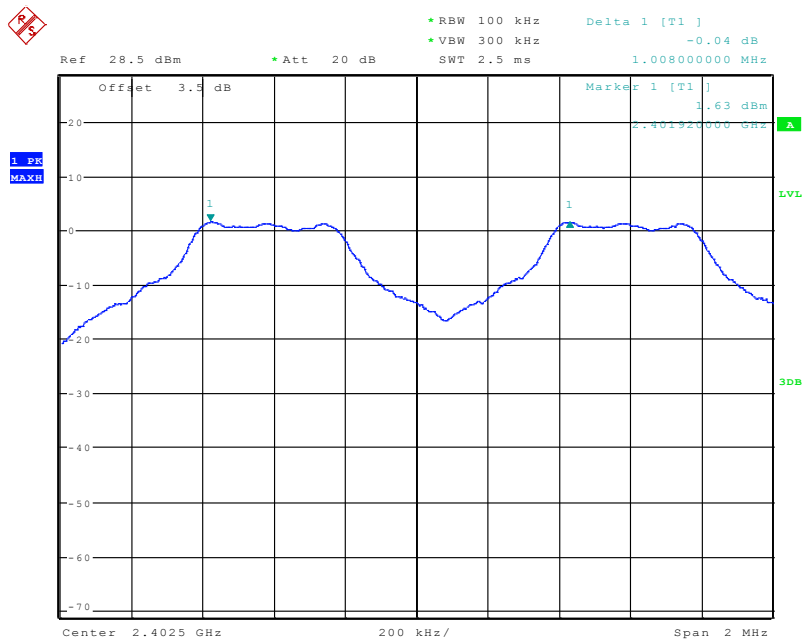
Channel	Channel Separation(MHZ)	20dBc BW (MHZ)	Two-thirds of the 20 dB bandwidth (MHZ)	Channel Separation limit	Result
BR MODE(GFSK)					
Low	1.008	0.931	0.621	>Two-thirds of the 20 dB bandwidth	PASS
Middle	1.000	0.934	0.623	>Two-thirds of the 20 dB bandwidth	PASS
High	1.000	0.932	0.621	>Two-thirds of the 20 dB bandwidth	PASS
EDR MODE($\pi/4$ -DQPSK)					
Low	1.004	1.287	0.858	>Two-thirds of the 20 dB bandwidth	PASS
Middle	0.996	1.294	0.863	>Two-thirds of the 20 dB bandwidth	PASS
High	1.000	1.296	0.864	>Two-thirds of the 20 dB bandwidth	PASS

Note: The limit= (2/3)*20dB bandwidth

Please refer to the following plots:

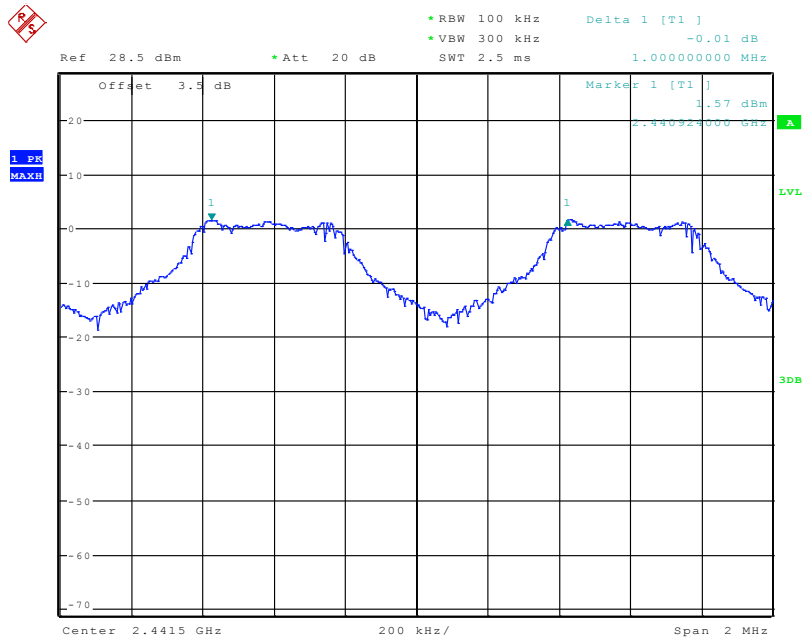
BDR (GFSK)

Low Channel



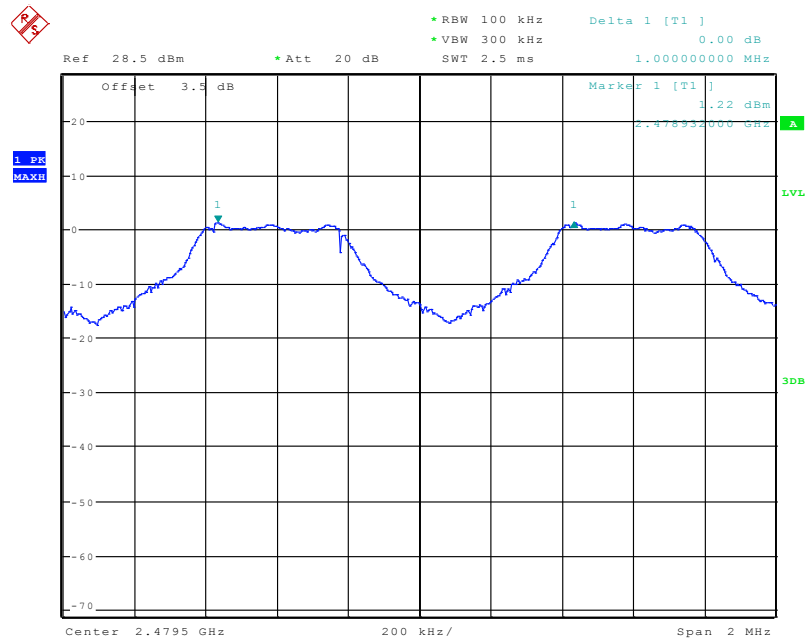
Date: 23.APR.2020 23:03:26

Middle Channel



Date: 23.APR.2020 23:05:51

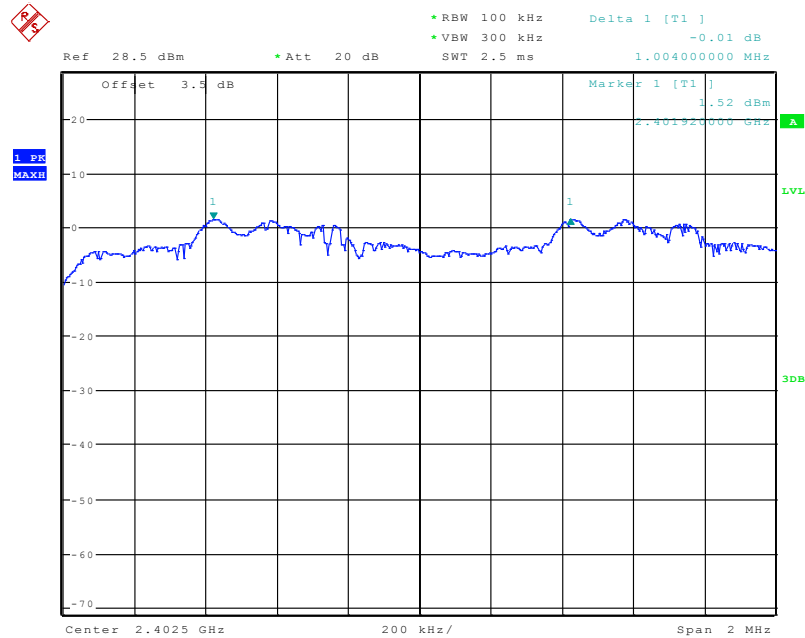
High Channel



Date: 23.APR.2020 23:09:48

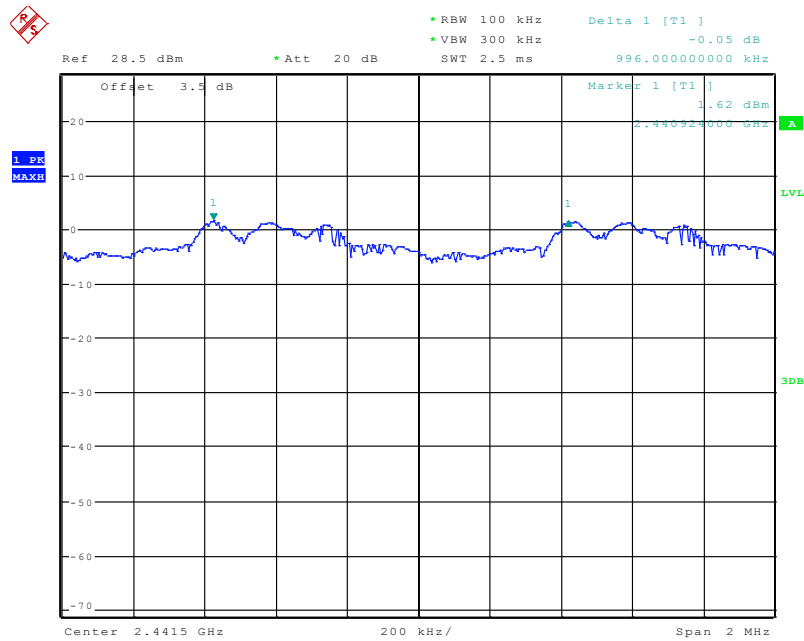
EDR ($\pi/4$ -DQPSK)

Low Channel



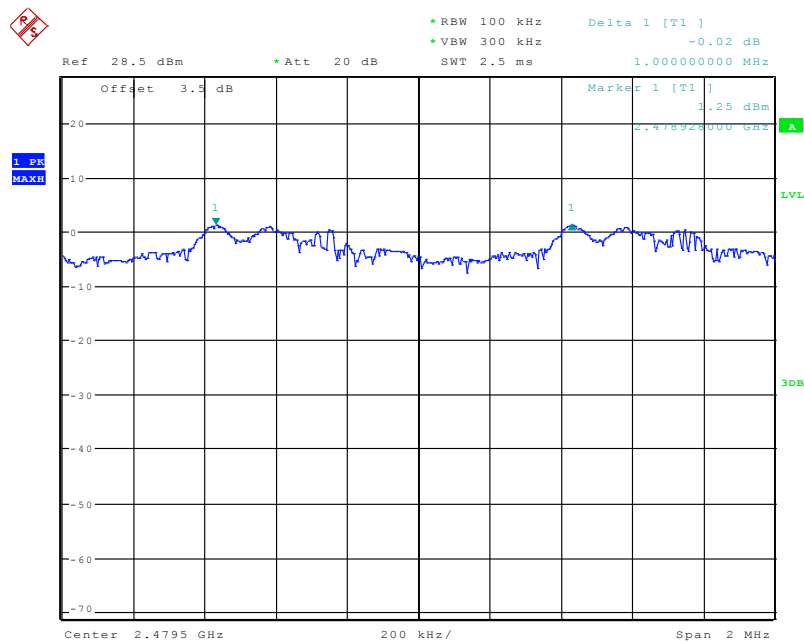
Date: 23.APR.2020 23:23:41

Middle Channel



Date: 23.APR.2020 23:19:55

High Channel



Date: 23.APR.2020 23:15:46

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

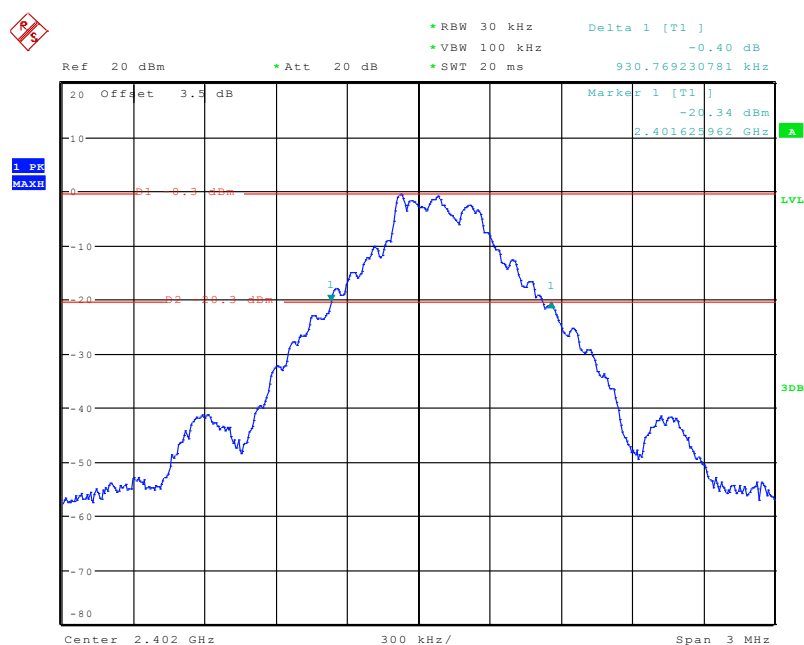
Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by George Zhong on 2020-04-23.

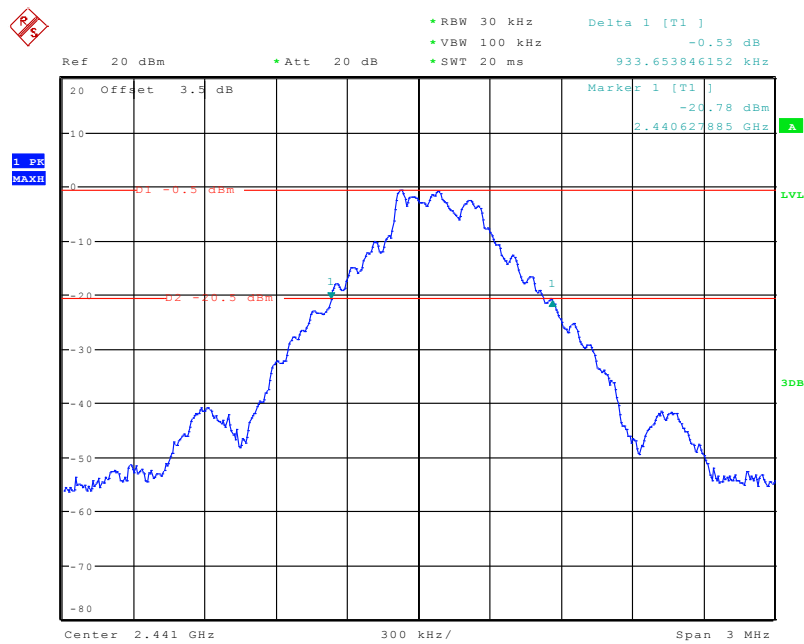
EUT operation mode: Transmitting

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

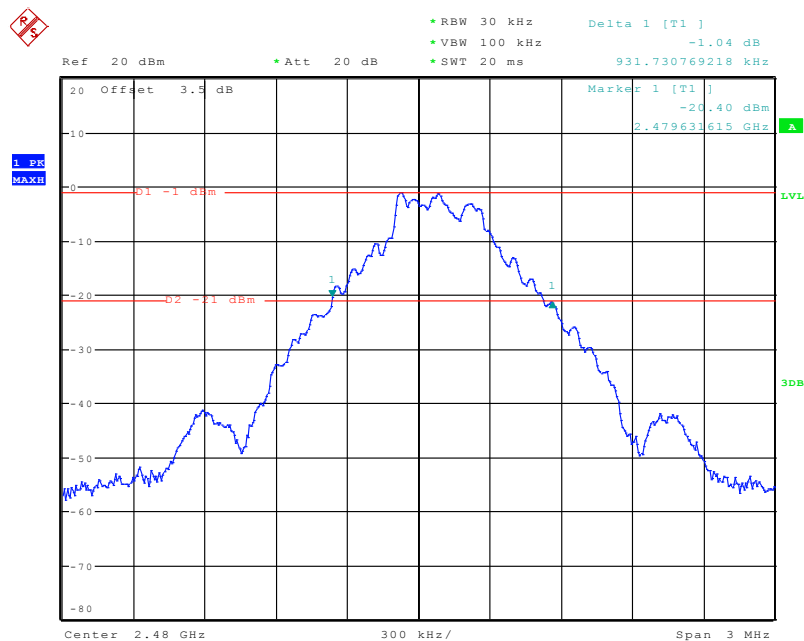
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.931
	Middle	2441	0.934
	High	2480	0.932
EDR ($\pi/4$-DQPSK)	Low	2402	1.287
	Middle	2441	1.294
	High	2480	1.296

BDR (GFSK): Low Channel

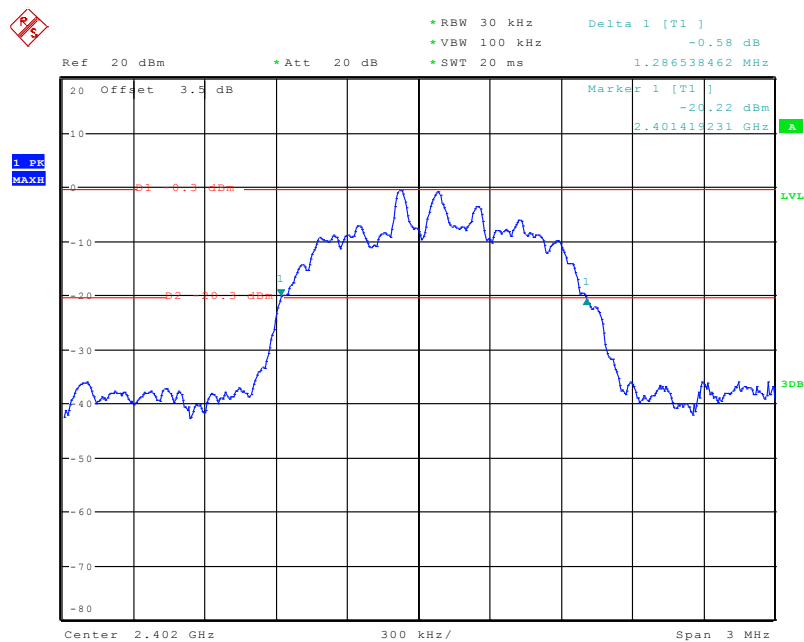
Date: 23.APR.2020 21:26:38

BDR (GFSK): Middle Channel

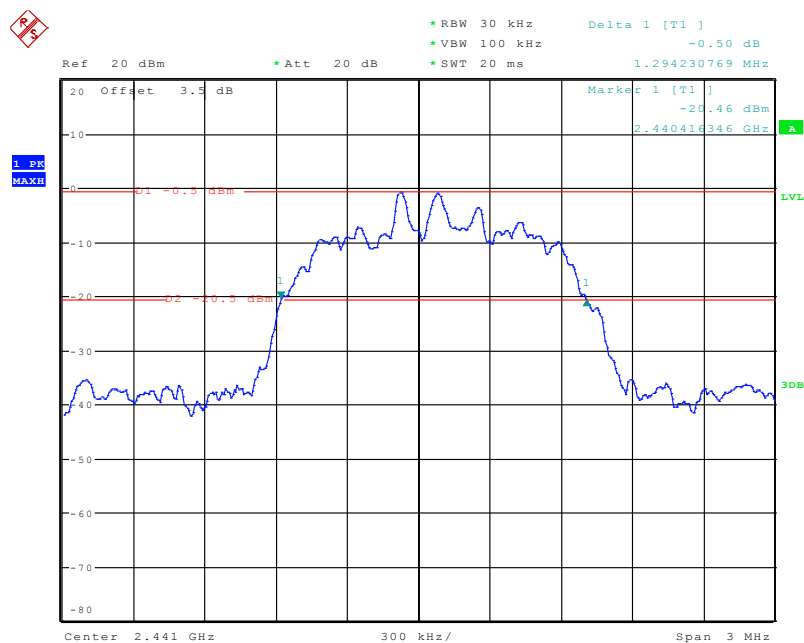
Date: 23.APR.2020 21:23:29

BDR (GFSK): High Channel

Date: 23.APR.2020 21:22:29

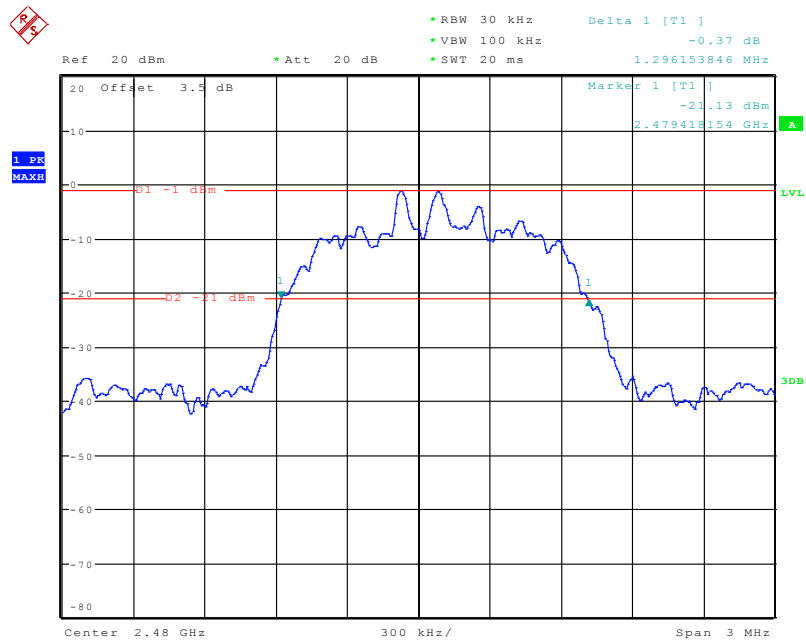
EDR ($\pi/4$ -DQPSK): Low Channel

Date: 23.APR.2020 21:25:34

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

Date: 23.APR.2020 21:24:18

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



Date: 23.APR.2020 21:21:44

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:	55 %
ATM Pressure:	101.0 kPa

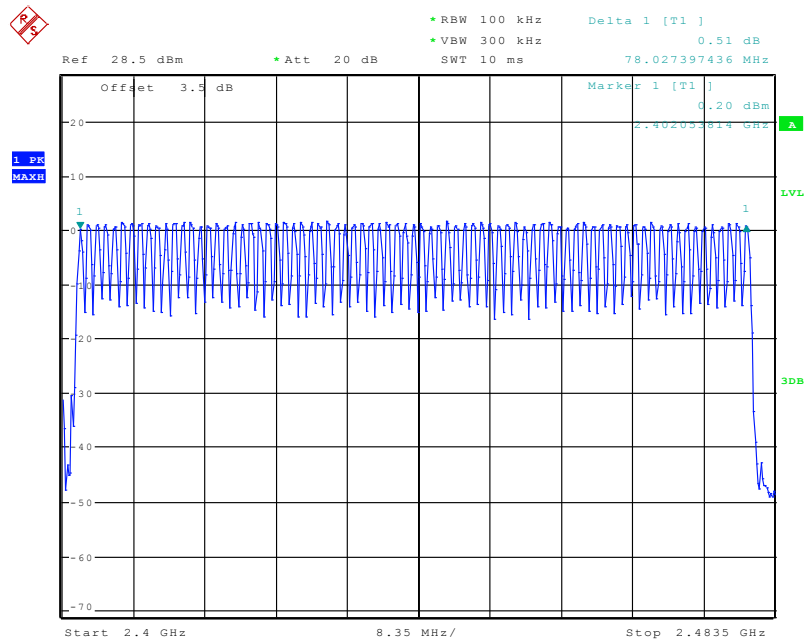
The testing was performed by George Zhong on 2020-04-23.

EUT operation mode: Transmitting

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

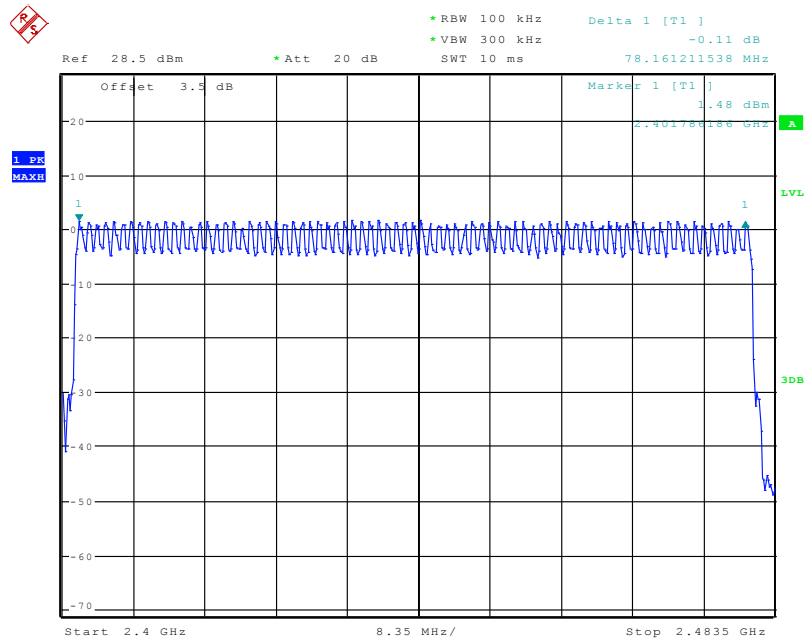
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥15
EDR (π/4-DQPSK)	2400-2483.5	79	≥15

BDR (GFSK): Number of Hopping Channels



Date: 23.APR.2020 23:30:46

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



Date: 23.APR.2020 23:28:43

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

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

Test Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW $\geq 3 \times$ 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:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by George Zhong on 2020-04-23.

EUT operation mode: Transmitting

BDR Mode (GFSK)

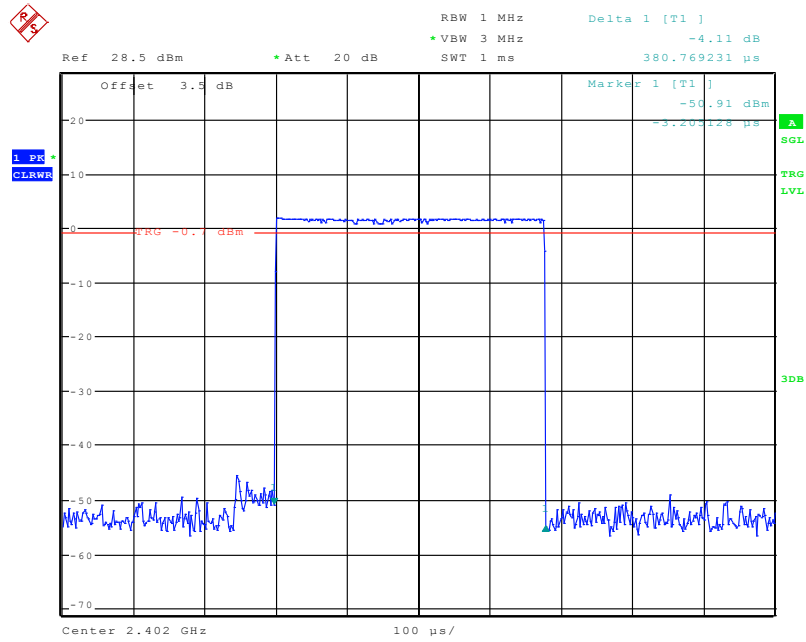
Mode	Channel	Pulse Width (ms)	Dwell Time (s)	Limit (s)	Result
DH 1	Low	0.381	0.122	0.4	Pass
	Middle	0.381	0.122	0.4	Pass
	High	0.381	0.122	0.4	Pass
	Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6s				
DH 3	Low	1.654	0.265	0.4	Pass
	Middle	1.654	0.265	0.4	Pass
	High	1.654	0.265	0.4	Pass
	Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6s				
DH 5	Low	2.914	0.311	0.4	Pass
	Middle	2.914	0.311	0.4	Pass
	High	2.914	0.311	0.4	Pass
	Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6s				

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

Mode	Channel	Pulse Width (ms)	Dwell Time (s)	Limit (s)	Result
DH 1	Low	0.392	0.125	0.4	Pass
	Middle	0.392	0.125	0.4	Pass
	High	0.392	0.125	0.4	Pass
	Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6s				
DH 3	Low	1.654	0.265	0.4	Pass
	Middle	1.654	0.265	0.4	Pass
	High	1.654	0.265	0.4	Pass
	Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6s				
DH 5	Low	2.914	0.311	0.4	Pass
	Middle	2.914	0.311	0.4	Pass
	High	2.914	0.311	0.4	Pass
	Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6s				

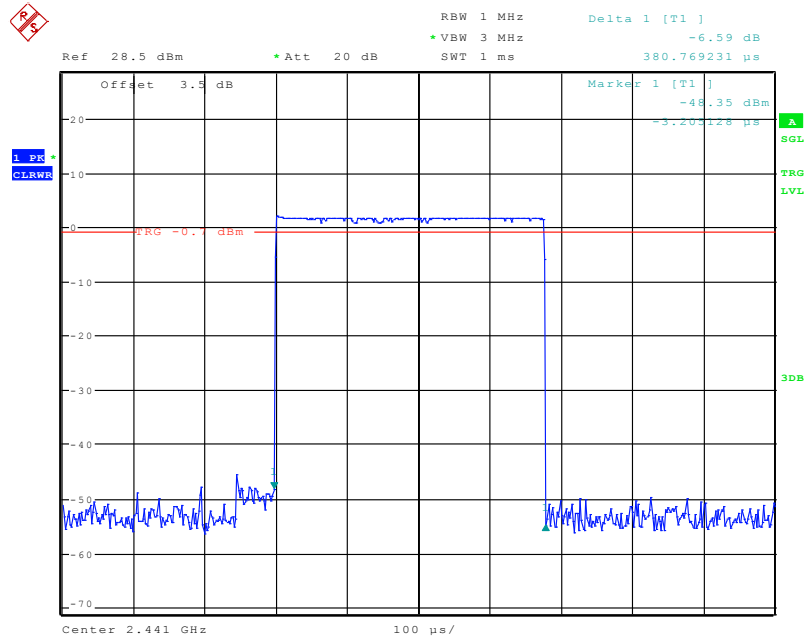
BDR (GFSK):

Pulse time, DH1,Low Channel



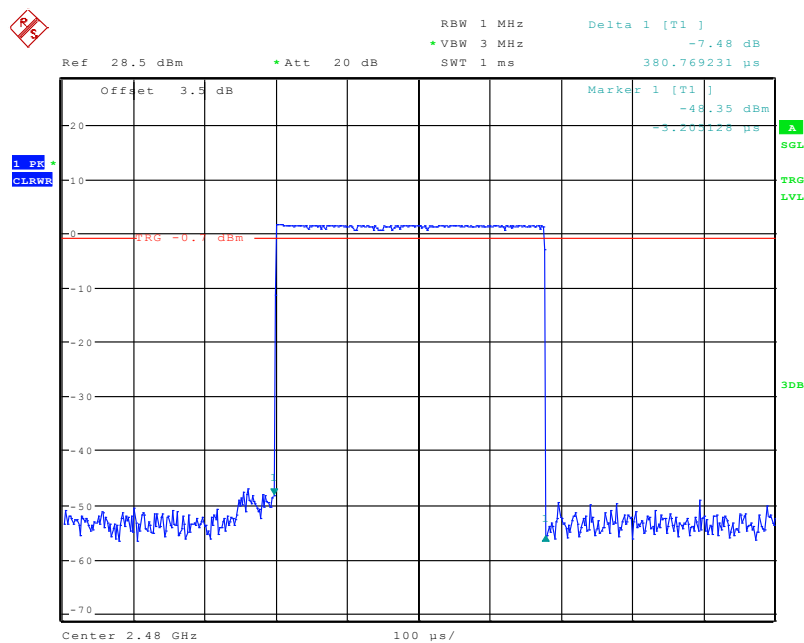
Date: 23.APR.2020 23:33:13

Pulse time, DH1,Middle Channel



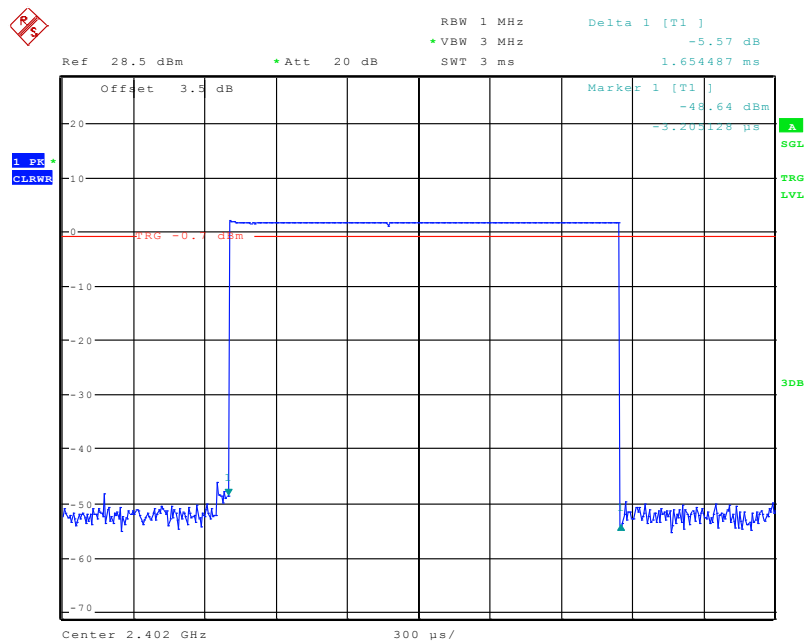
Date: 23.APR.2020 23:33:34

Pulse time, DH1,High Channel



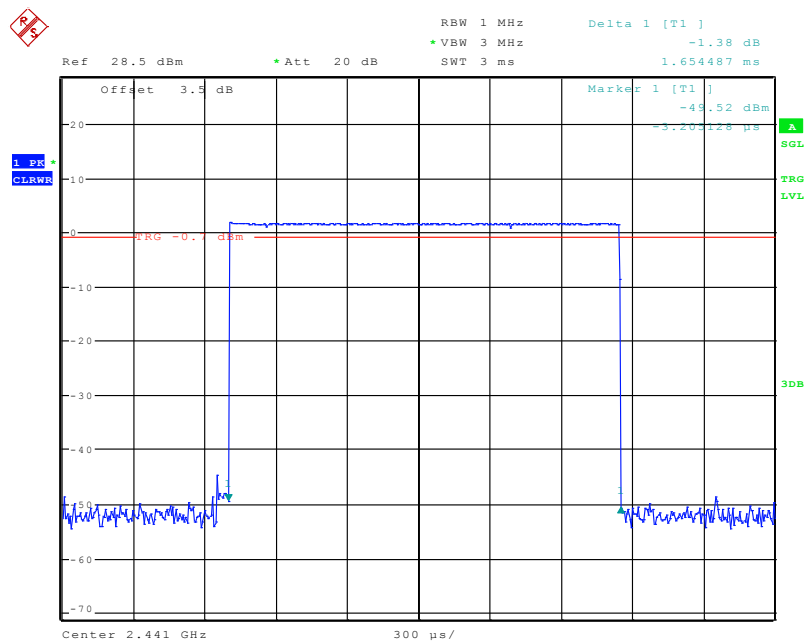
Date: 23.APR.2020 23:33:43

Pulse time, DH3,Low Channel



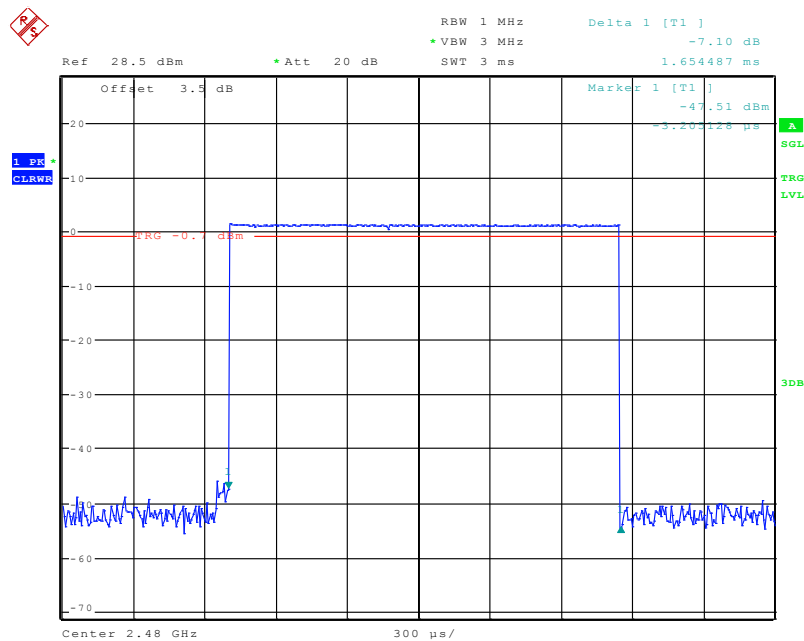
Date: 23.APR.2020 23:35:32

Pulse time, DH3,Middle Channel



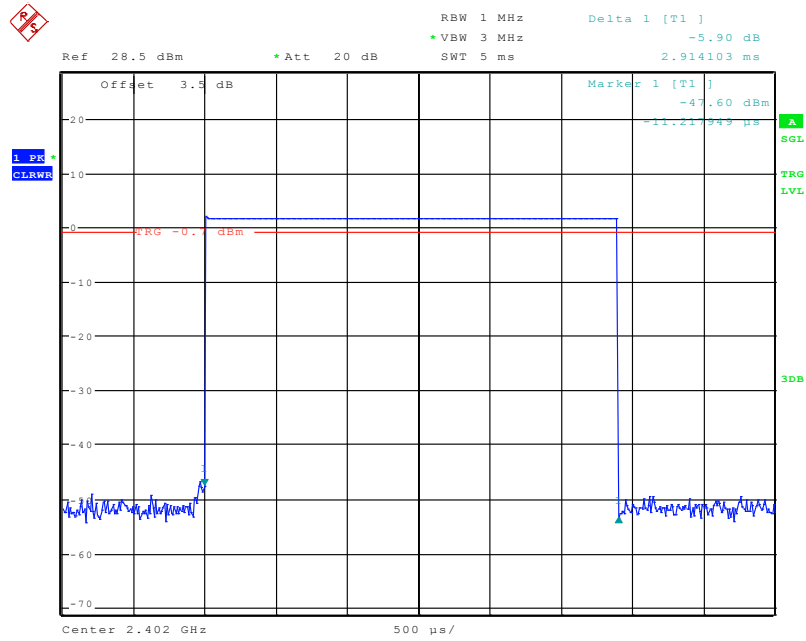
Date: 23.APR.2020 23:35:52

Pulse time, DH3,High Channel



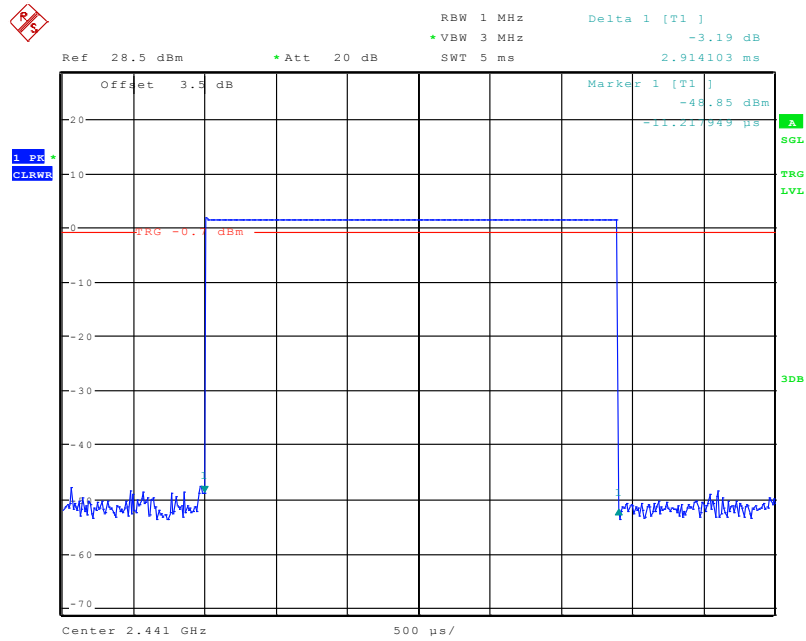
Date: 23.APR.2020 23:36:04

Pulse time, DH5, Low Channel

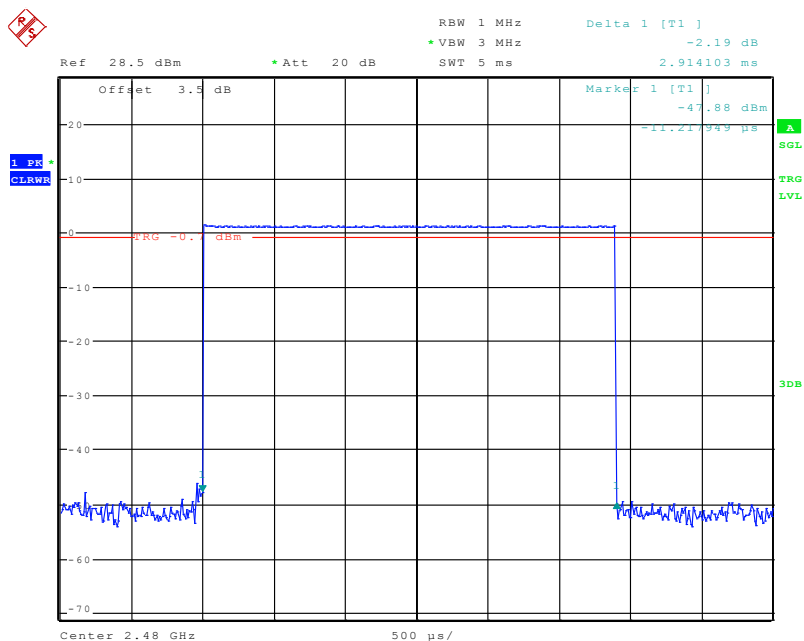


Date: 23.APR.2020 23:38:53

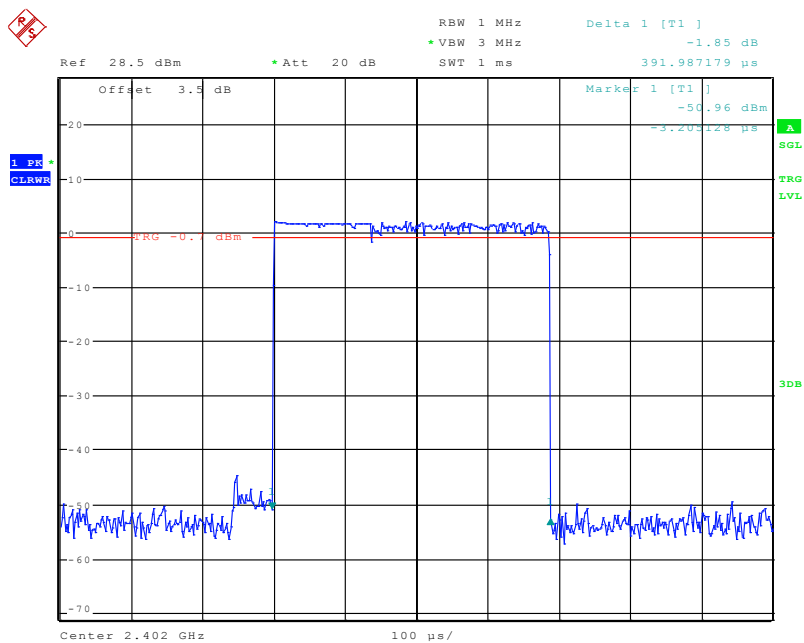
Pulse time, DH5, Middle Channel



Date: 23.APR.2020 23:39:06

Pulse time, DH5, High Channel

Date: 23.APR.2020 23:39:21

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

Date: 23.APR.2020 23:34:48

RBW 1 MHz
VBW 3 MHz
SWT 1 ms
Delta 1 [T1]
-6.10 dB
391.987179 μ s

Ref 28.5 dBm
Att 20 dB

Offset 3.5 dB
Marker 1 [T1]
-48.57 dBm
3.202128 μ s

1 dB
CLRWR

ARG -0.0 dBm

Center 2.441 GHz
100 μ s/

Date: 23.APR.2020 23:34:38

RBW 1 MHz
VBW 3 MHz
SWT 1 ms
Delta 1 [T1]
-3.60 dB
391.987179 μ s

Ref 28.5 dBm
Att 20 dB

Offset 3.5 dB

Marker 1 [T1]
-50.51 dBm
-3.205128 μ s

1 ps
CLRWR

ARG -0.0 dBm

Center 2.48 GHz
100 ps/

Date: 23.APR.2020 23:34:27

RBW 1 MHz
Delta 1 [T1]
-5.89 dB
+ VBW 3 MHz
SWT 3 ms
1.654487 ms

Ref 28.5 dBm
+ Att 20 dB

Offset 3.5 dB
Marker 1 [T1]
-48.15 dBm
-3.205128 MHz

1 dB
CLAWR

28.5 dBm

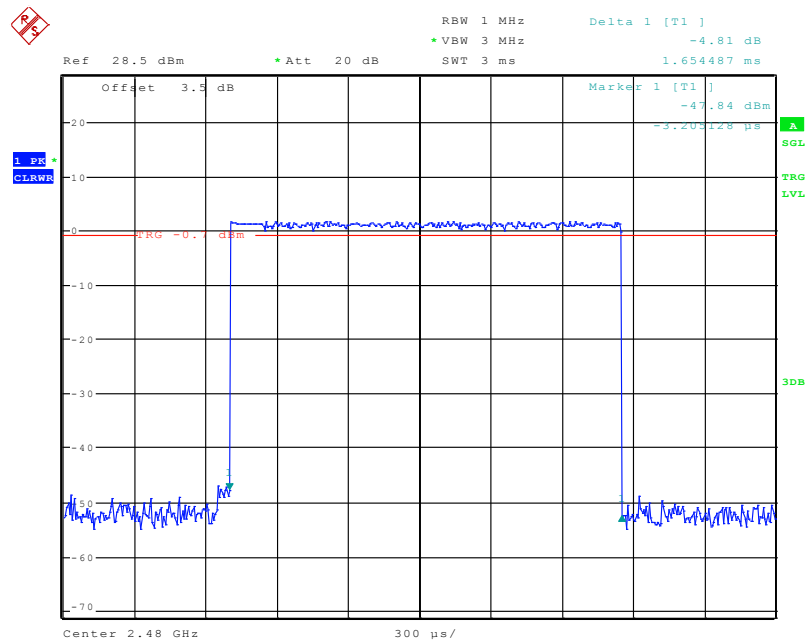
Center 2.402 GHz
300 us/

Date: 23.APR.2020 23:37:18

The screenshot displays a Spectrum Analyzer interface. At the top, a red box with a white 'R' is visible. The main display area shows a blue signal trace on a grid. The y-axis is labeled 'dBm' and ranges from -70 to -20. The x-axis is labeled 'Center 2.441 GHz' and '300 ps/'. A sharp drop in the signal is visible, reaching approximately -55 dBm. A red horizontal line is drawn at -48.83 dBm. A green marker is placed at the bottom of the signal drop, with a value of -48.83 dBm. The text 'Marker 1 [T1]' is displayed in the top right corner. The text 'Delta 1 [T1]' is displayed in the top right corner. The text 'Ref 28.5 dBm' is displayed in the top left corner. The text 'Att 20 dB' is displayed in the top left corner. The text 'RBW 1 MHz' is displayed in the top left corner. The text 'VBW 3 MHz' is displayed in the top left corner. The text 'SWT 3 ms' is displayed in the top left corner. The text '1.654487 ms' is displayed in the top left corner. The text 'TRG = U. dBm' is displayed in the top left corner. The text '1. dB' is displayed in the top left corner. The text 'CLAW' is displayed in the top left corner. The text 'A' is displayed in the top left corner. The text 'SQL' is displayed in the top left corner. The text 'TRG' is displayed in the top left corner. The text 'LVL' is displayed in the top left corner. The text '3DB' is displayed in the top left corner.

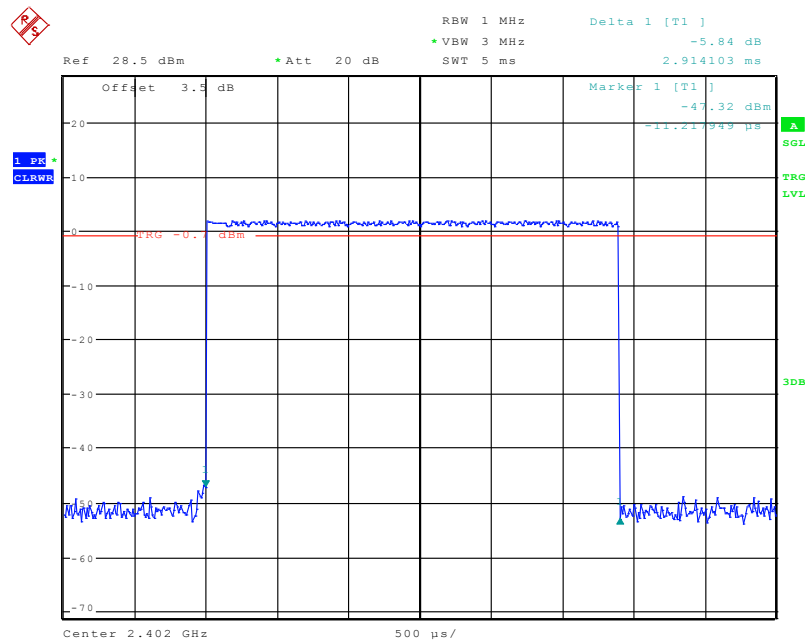
Date: 23.APR.2020 23:36:49

Pulse time, 2DH3,High Channel



Date: 23.APR.2020 23:36:21

Pulse time, 2DH5,Low Channel



Date: 23.APR.2020 23:40:02

RBW 1 MHz
VBW 3 MHz
SWT 5 ms
Delta 1 [T1]
-3.63 dB
-2.914103 ms

Ref 28.5 dBm
Att 20 dB

Offset 3.5 dB
Marker 1 [T1]
-48.13 dBm
-11.21449 ps

1 PR
CLRWR

ARG -0.0 dBm

Center 2.441 GHz
500 ps/

Date: 23.APR.2020 23:39:49

RBW 1 MHz
 • VBW 3 MHz
 • Att 20 dB
 Delta 1 [T1]
 -5.40 dB
 2.914103 ms

Ref 28.5 dBm

Offset 3.5 dB

Marker 1 [T1]
 -48.30 dBm
 -11.21343 ps

1 PR
 CLRWR

SRG -0.1 dBm

Center 2.48 GHz

500 ps/

Date: 23.APR.2020 23:39:37

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:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by George Zhong on 2020-04-23.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table.

Mode	Channel	Frequency (MHz)	Reading power (dBm)	Limit (dBm)
GFSK	Low	2402	2.20	30
	Middle	2441	2.05	30
	High	2480	1.61	30
$\pi/4$ -DQPSK	Low	2402	2.34	30
	Middle	2441	2.37	30
	High	2480	1.84	30

Note: The data above was tested in conducted mode.

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

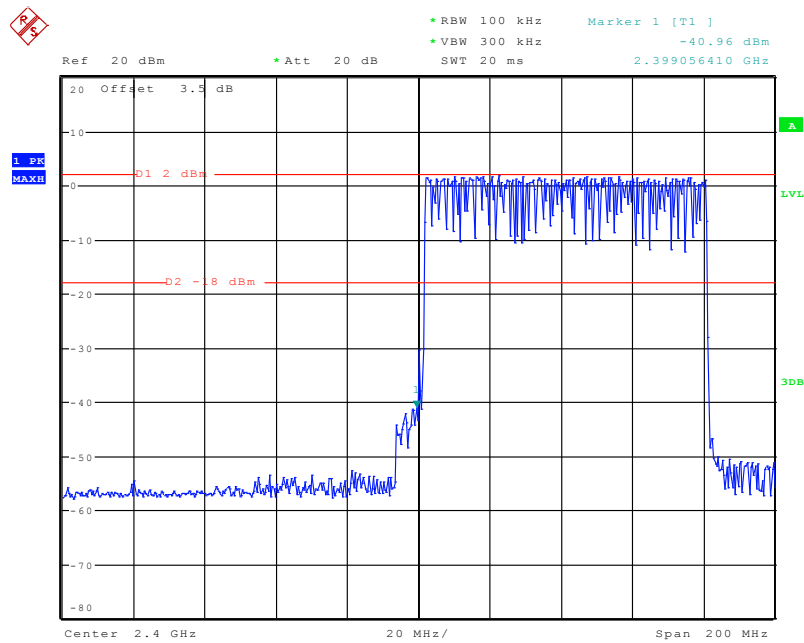
Environmental Conditions

Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

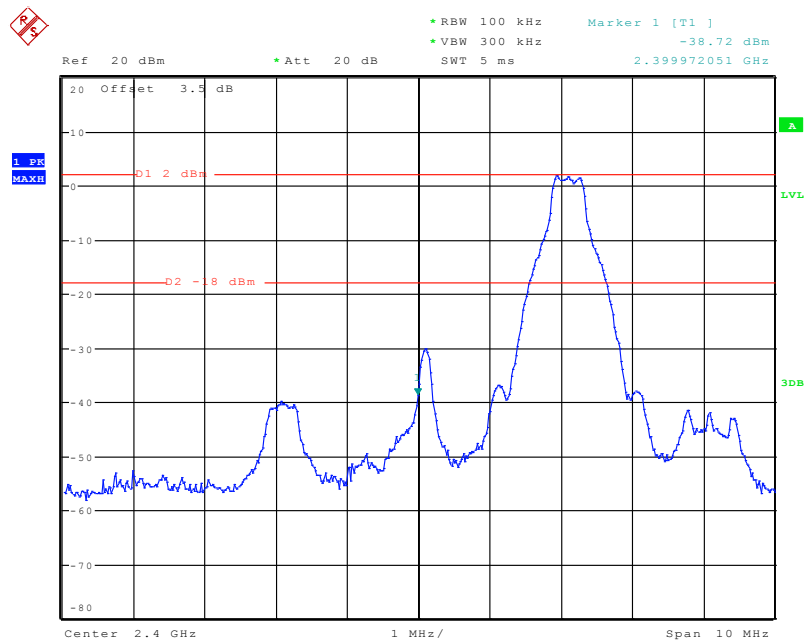
The testing was performed by George Zhong on 2020-04-23.

EUT operation mode: Transmitting

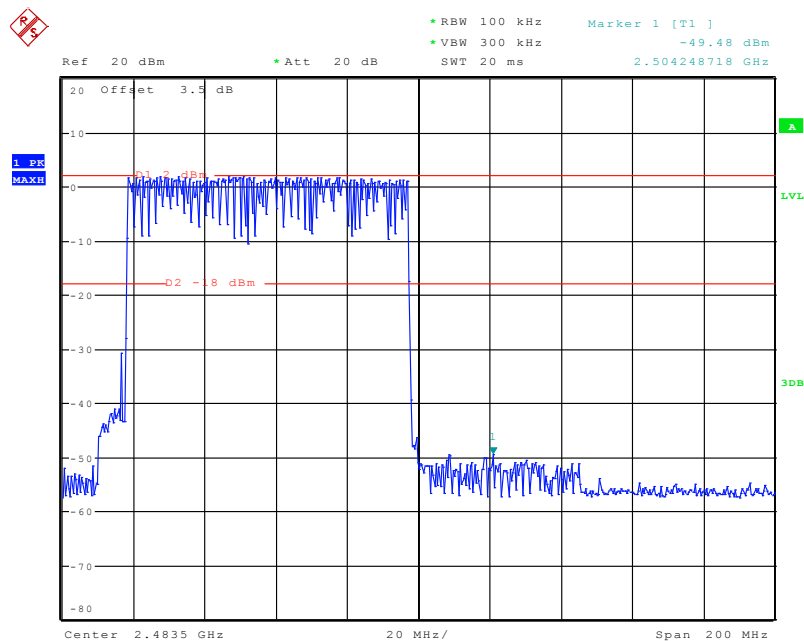
Test Result: Compliance. Please refer to following plots.

BDR (GFSK): Band Edge-Left Side**Hopping**

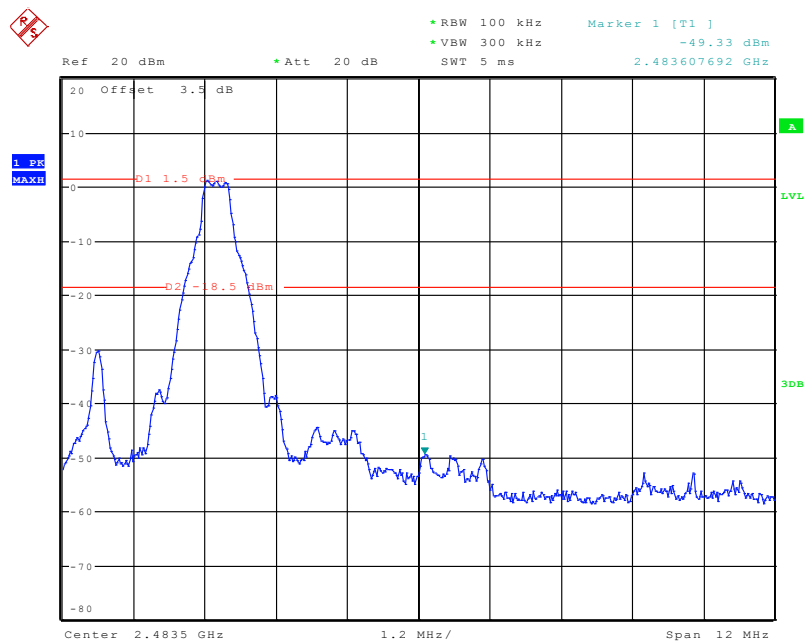
Date: 23.APR.2020 22:45:45

Single

Date: 23.APR.2020 22:35:10

BDR (GFSK): Band Edge-Right Side**Hopping**

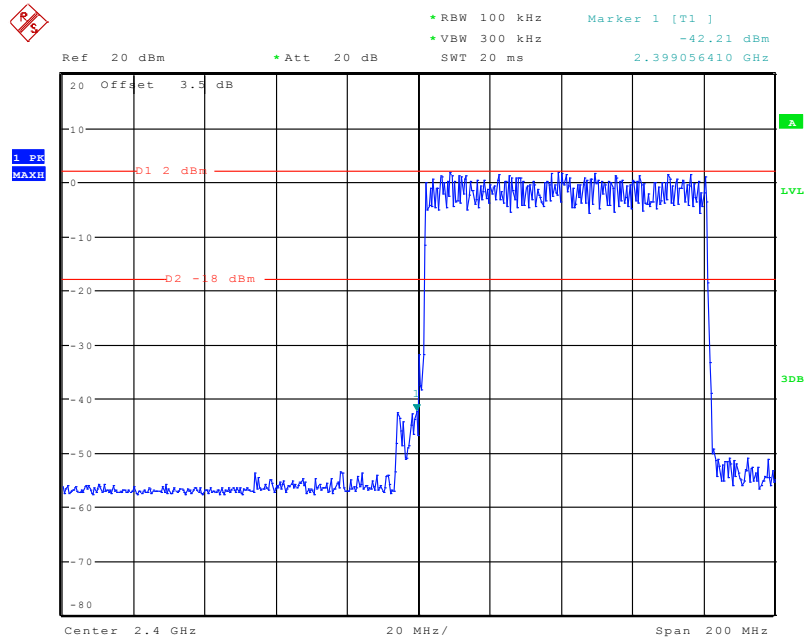
Date: 23.APR.2020 22:40:44

Single

Date: 23.APR.2020 22:38:03

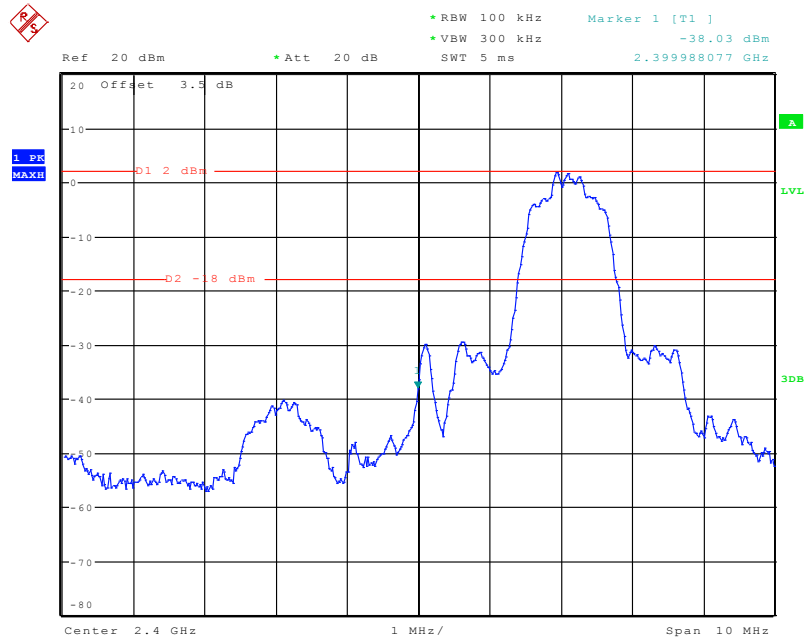
EDR ($\pi/4$ -DQPSK): Band Edge-Left Side

Hopping



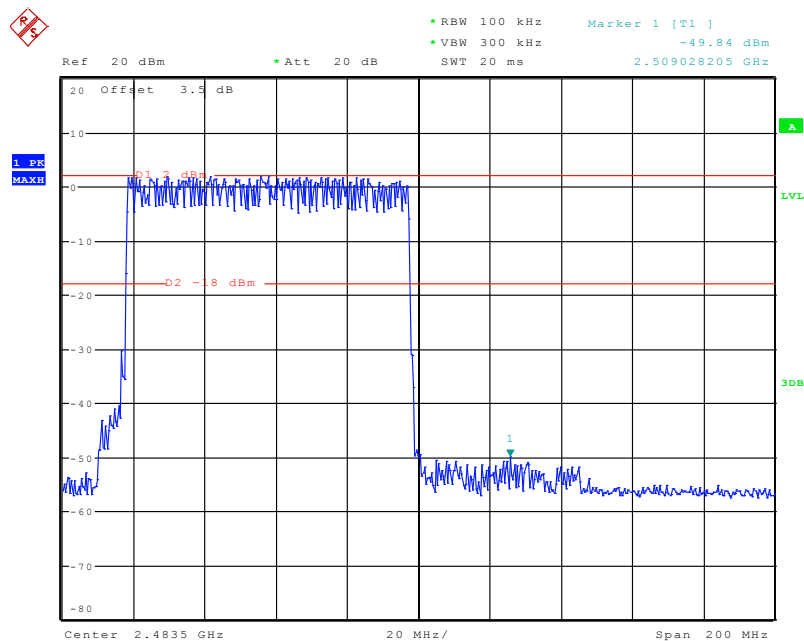
Date: 23.APR.2020 22:44:19

Single



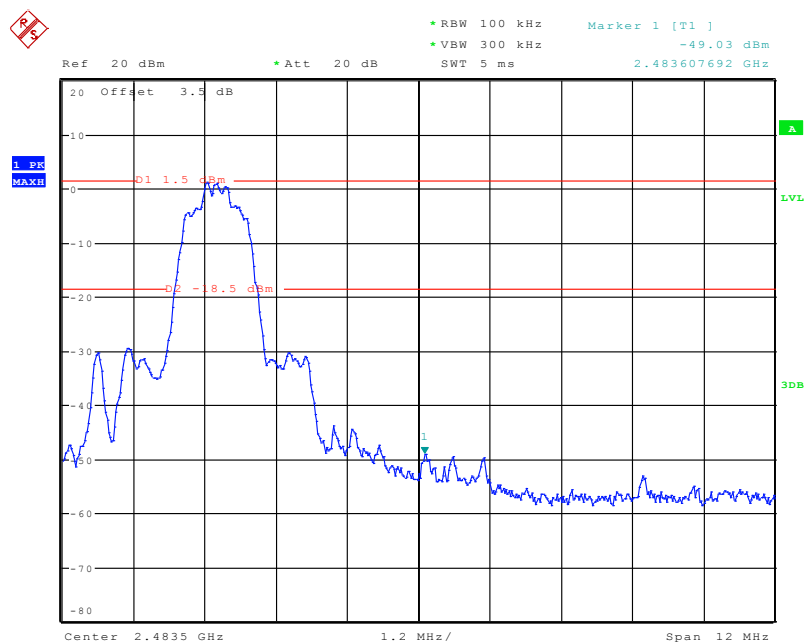
Date: 23.APR.2020 22:36:31

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



Date: 23.APR.2020 22:43:10

Single



Date: 23.APR.2020 22:37:20

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