



FCC PART 15.247  
TEST REPORT

For

**Shenzhen Ground Enterprises Co., Ltd**

Room607, Building F, MingYueHuaDu, Gonghe Industrial Rd, Xixiang, Bao An District,  
Shenzhen, 518102, China

**FCC ID: 2AMD8SP-005**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Bluetooth Shower Speaker
<b>Report Number:</b> RSZ181226830-00	
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## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

The *Shenzhen Ground Enterprises Co., Ltd's* product, model number: *SP-005 (FCC ID: 2AMD8SP-005; UPC Number: 813561025838, 813561025821, 813561025845, 813561025852; SKU Number: AC-AWS20-MBB, AC-AWS20-MRSE, AC-AWS20-MGM, AC-AWS20-MCG)* or the "EUT" in this report was a *Bluetooth Shower Speaker*, which was measured approximately: 8.5 cm (L) \* 8.5 cm (W) \* 5.0 cm (H), rated with input voltage: DC 3.7 V from battery.

*Notes: This series products model: AC-AWS20-MBB, AC-AWS20, AS-WSP20-FLW, AS-WSP20-GR08, AS-WSP20-CAB, AS-WSP20-GR01, AS-WSP20-ZB06, AS-WSP20-01, AS-WSP20-04, AS-WSP20-SNK, AS-WSP20-ANC, AS-WSP20-08, AS-WSP20-03, AS-WSP20-06, AS-WSP20-LNKs, AS-WSP20-SQU, AS-WSP20-ZB04, AS-WSP20-MRM, AS-WSP20-BTS, AC-AWS20-MB, AC-AWS20-MRG, AC-AWS20-MBL, AC-AWS20-MCR, AC-AWS20-MGM, AC-AWS20-MRSE, AC-AWS20-MCG, AS-WSP20-AVC, AS-WSP20-FLR, AS-WSP20-GLX, AC-AWS20-PD4-BL, AC-AWS20-PD4-GC, AC-AWS20-PD4-PA, AC-AWS20-PD4-CT, AC-AWS20-SD4-08, AC-AWS20-SD4-01, AC-AWS20-SD4-06, AC-AWS20-SD4-03, AC-AWS20-PD5-SK, AC-AWS20-PD5-SP, AC-AWS20-PD5-LF, AC-AWS20-PD5-FL, AC-AWS20-SD5-QZ, AC-AWS20-SD5-01, AC-AWS20-SD5-06, AC-AWS20-SD5-03, AC-AWS20-SD5-09 and SP-005 are electrically identical. Model SP-005 was selected for fully testing, the detailed information can be referred to the declaration letter.*

*\*All measurement and test data in this report was gathered from production sample serial number: 181226830. (Assigned by BACL, Shenzhen). The EUT supplied by the applicant was received on 2018-12-26.*

### Objective

This test report is prepared on behalf of *Shenzhen Ground Enterprises 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)

No Related Submittal(s)/Grant(s).

### Test Methodology

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

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

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

**Measurement Uncertainty**

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

**Test Facility**

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

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

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

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

The system was configured for testing in an engineering mode.

### EUT Exercise Software

“FCCAssist\_2.4” exercise software was used, power level is 10.

### Special Accessories

No special accessory.

### Equipment Modifications

No modification was made to the EUT tested.

### Support Equipment List and Details

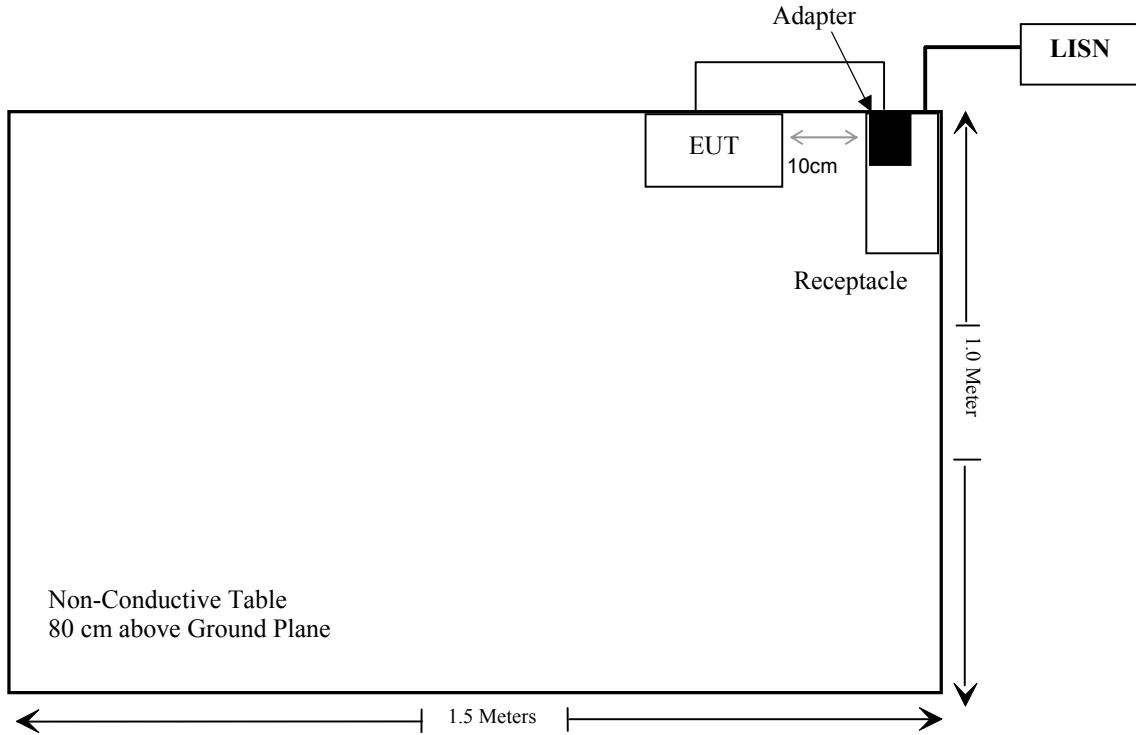
Manufacturer	Description	Model	Serial Number
N/A	Adapter	XSTAR-01	N/A

### 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**

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

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
<b>RF Conducted Test</b>					
Agilent	USB wideband power meter	U2021XA	MY54250003	2018-06-23	2019-06-23
WEINSCHL	3dB Attenuator	6231	666	Each Time	
Rohde Schwarz	EMI Test Receiver	ESR	1316.3003K03 -101746-zn	2018-07-11	2019-07-11
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:

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

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	-2	0.63	5	0.2	3.0	Yes

**Result: No Standalone SAR test is required**

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## **FCC §15.203 – ANTENNA REQUIREMENT**

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### **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 -0.68 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:

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

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

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

## Test Results Summary

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

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

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

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

## Test Data

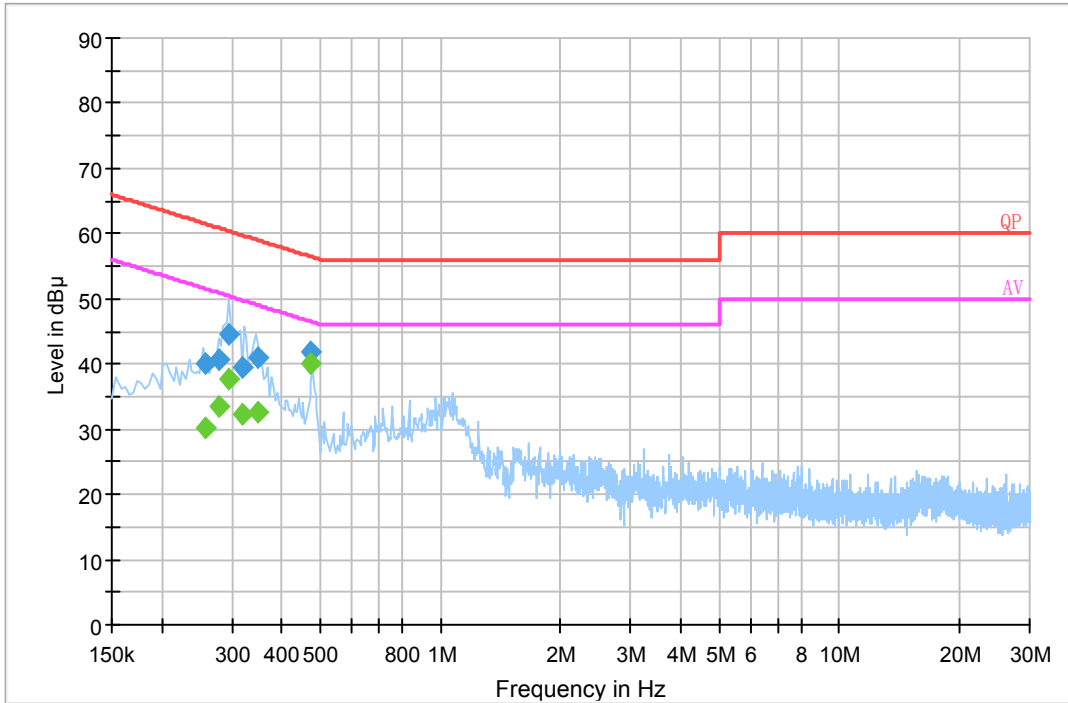
### Environmental Conditions

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Moon Tan on 2019-01-07.*

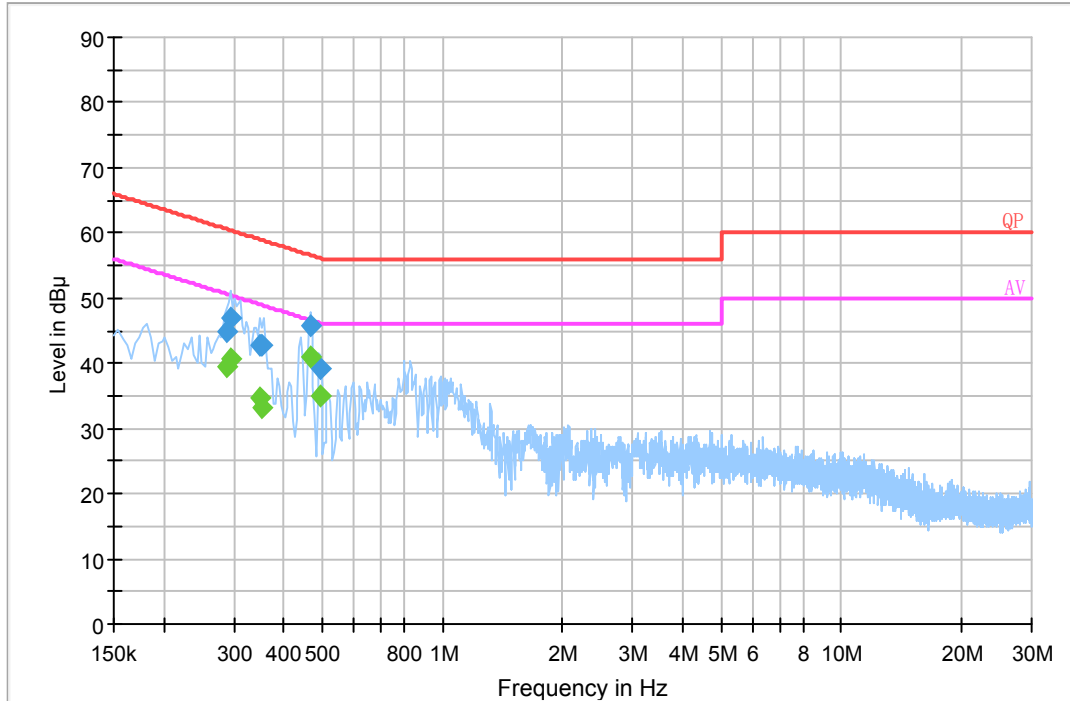
*EUT operation mode: Transmitting & charging (the worst case is  $\pi/4$ -DQPSK Mode, High channel)*

**AC 120V/60 Hz, Line**



Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.257500	40.1	19.7	61.5	21.4	QP
0.277500	40.7	19.8	60.9	20.2	QP
0.293500	44.7	19.8	60.4	15.7	QP
0.317170	39.5	19.8	59.8	20.3	QP
0.348690	41.1	19.7	59.0	17.9	QP
0.470830	41.7	19.8	56.5	14.8	QP
0.257500	30.3	19.7	51.5	21.2	Ave.
0.277500	33.3	19.8	50.9	17.6	Ave.
0.293500	37.8	19.8	50.4	12.6	Ave.
0.317170	32.4	19.8	49.8	17.4	Ave.
0.348690	32.6	19.7	49.0	16.4	Ave.
0.470830	40.0	19.8	46.5	6.5	Ave.

**AC 120V/60 Hz, Neutral**



Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.286500	45.0	19.8	60.6	15.6	QP
0.293500	47.0	19.8	60.4	13.4	QP
0.348750	42.7	19.7	59.0	16.3	QP
0.352630	42.8	19.7	58.9	16.1	QP
0.467010	45.8	19.8	56.6	10.8	QP
0.494650	39.2	19.8	56.1	16.9	QP
0.286500	39.4	19.8	50.6	11.2	Ave.
0.293500	40.6	19.8	50.4	9.8	Ave.
0.348750	34.7	19.7	49.0	14.3	Ave.
0.352630	33.3	19.7	48.9	15.6	Ave.
0.467010	41.0	19.8	46.6	5.6	Ave.
0.494650	34.9	19.8	46.1	11.2	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



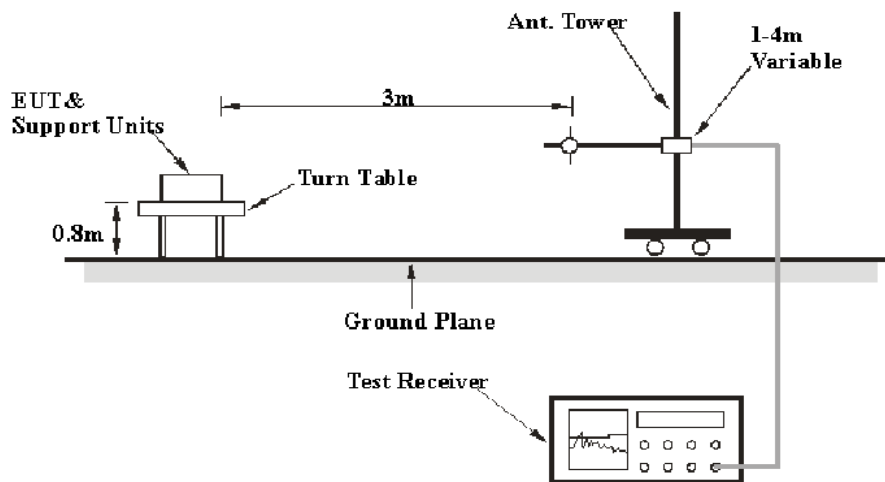
**FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS**

**Applicable Standard**

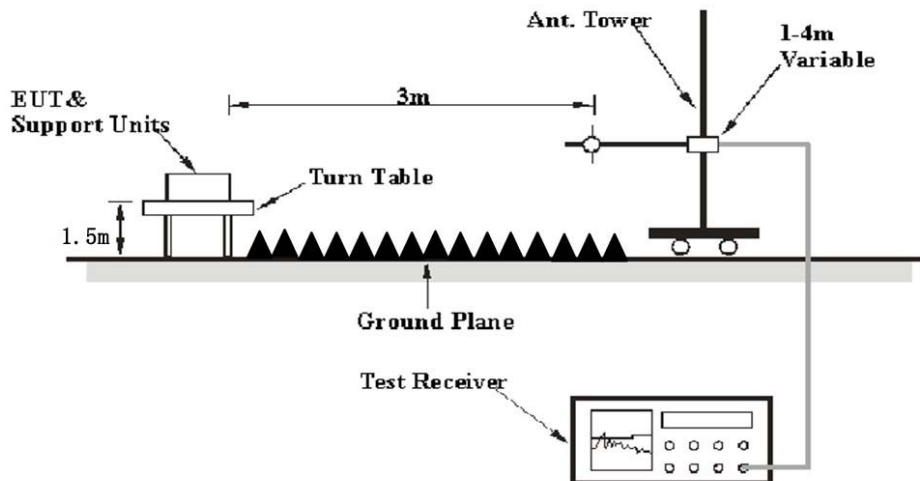
FCC §15.205; §15.209; §15.247(d)

**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.

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

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

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

**Test Data**

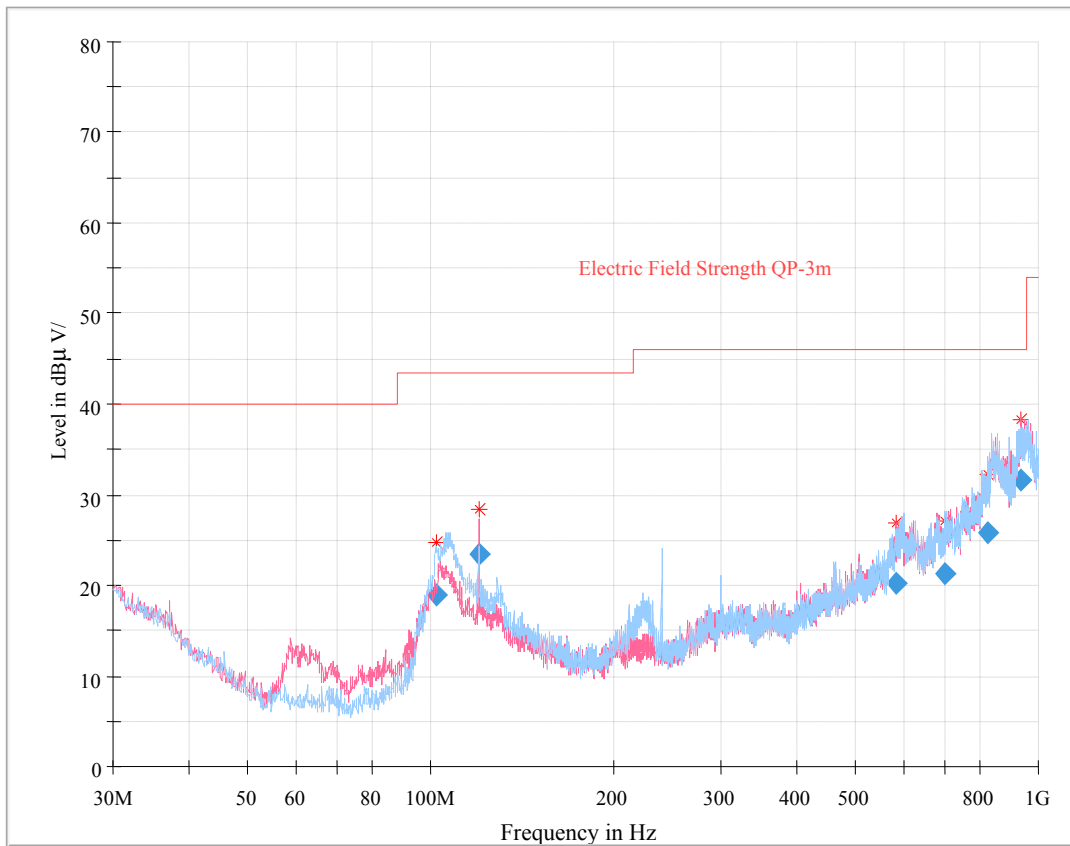
**Environmental Conditions**

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Moon Tan on 2019-01-07.*

*EUT operation mode: Transmitting (Scan with GFSK,  $\pi/4$ -DQPSK mode, the worst case is  $\pi/4$ -DQPSK Mode)*

**30 MHz~1 GHz:** (the worst case is  $\pi/4$ -DQPSK, High channel)



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
102.518875	18.93	262.0	H	289.0	-16.8	43.50	24.57
119.994000	23.37	107.0	V	331.0	-14.3	43.50	20.13
582.746750	20.24	304.0	V	94.0	-2.9	46.00	25.76
703.584625	21.22	316.0	H	303.0	-1.1	46.00	24.78
825.937000	25.82	339.0	V	200.0	4.5	46.00	20.18
937.520375	31.68	258.0	V	186.0	8.5	46.00	14.32

**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)				
<b>Low Channel (2402 MHz)</b>									
2387.94	28.14	PK	155	1.7	H	33.00	61.14	74	12.86
2387.94	14.16	Ave.	155	1.7	H	33.00	47.16	54	6.84
2484.15	27.21	PK	283	1.8	H	33.20	60.41	74	13.59
2484.15	13.42	Ave.	283	1.8	H	33.20	46.62	54	7.38
4804.00	52.52	PK	279	2.2	H	7.88	60.40	74	13.60
4804.00	39.35	Ave.	279	2.2	H	7.88	47.23	54	6.77
<b>Middle Channel (2441 MHz)</b>									
4882.00	50.65	PK	67	1.4	H	9.21	59.86	74	14.14
4882.00	38.14	Ave.	67	1.4	H	9.21	47.35	54	6.65
<b>High Channel (2480 MHz)</b>									
2384.71	28.74	PK	53	1.7	H	33.00	61.74	74	12.26
2384.71	14.36	Ave.	53	1.7	H	33.00	47.36	54	6.64
2484.38	27.24	PK	227	2.0	H	33.20	60.44	74	13.56
2484.38	13.62	Ave.	227	2.0	H	33.20	46.82	54	7.18
4960.00	51.56	PK	249	1.3	H	9.07	60.63	74	13.37
4960.00	39.29	Ave.	249	1.3	H	9.07	48.36	54	5.64

Note:

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

Corrected Amplitude = Corrected Factor + Reading

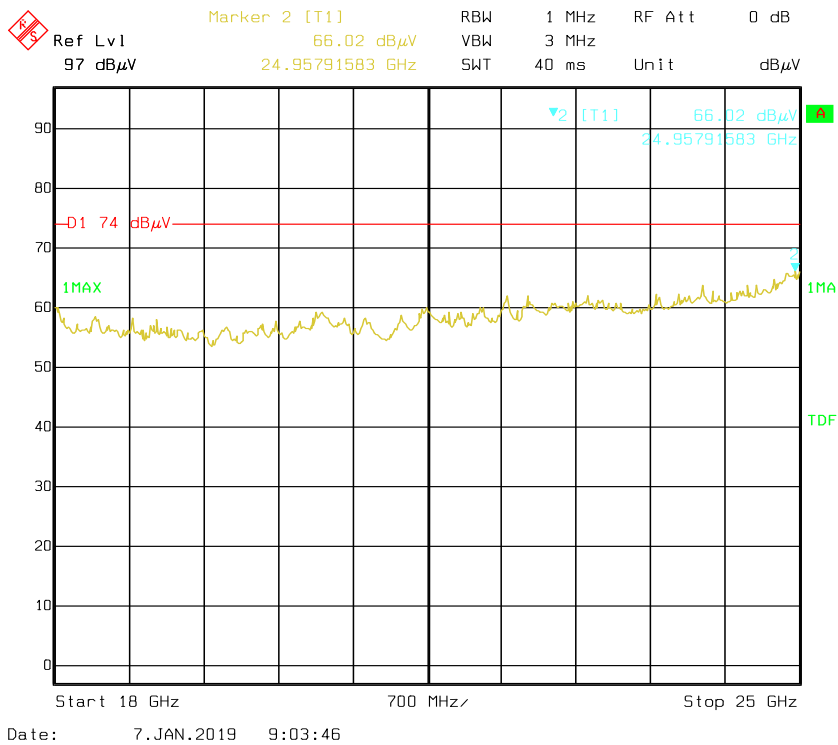
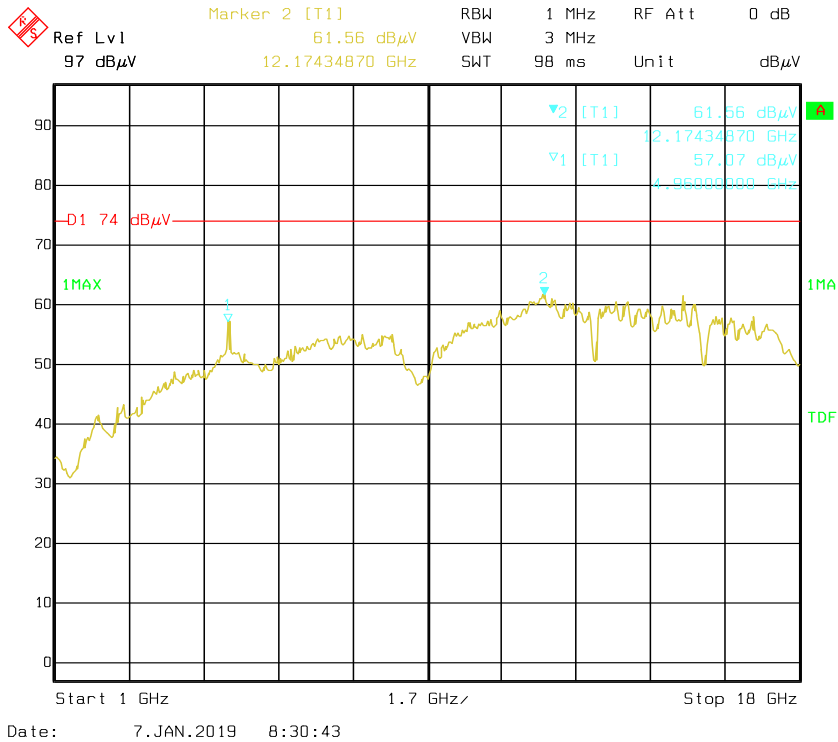
Margin = Limit - Corrected. Amplitude

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

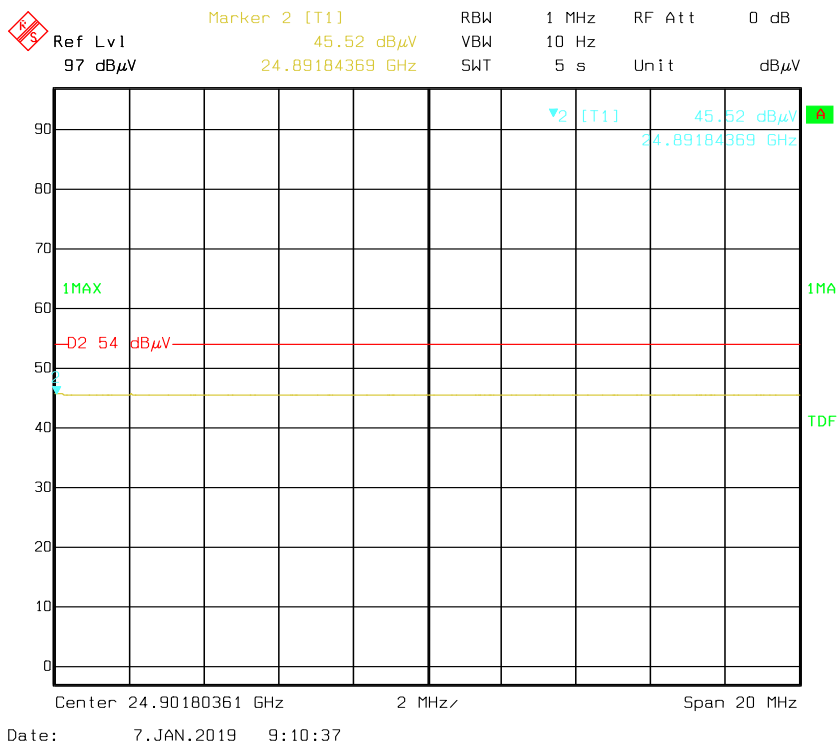
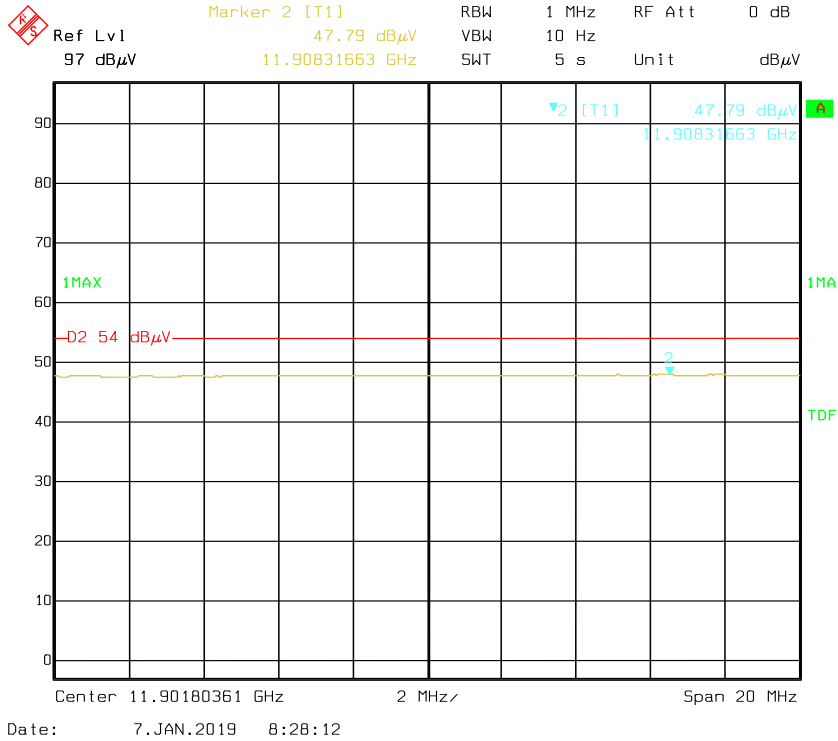
And for the pre-scan is performed with the 2400-2483.5MHz band filter.



Vertical

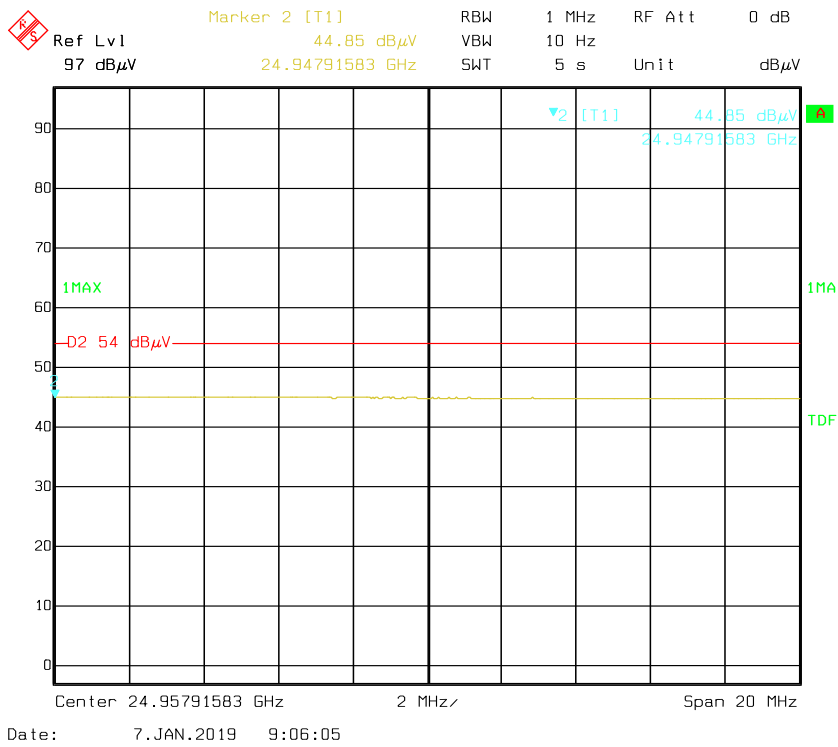
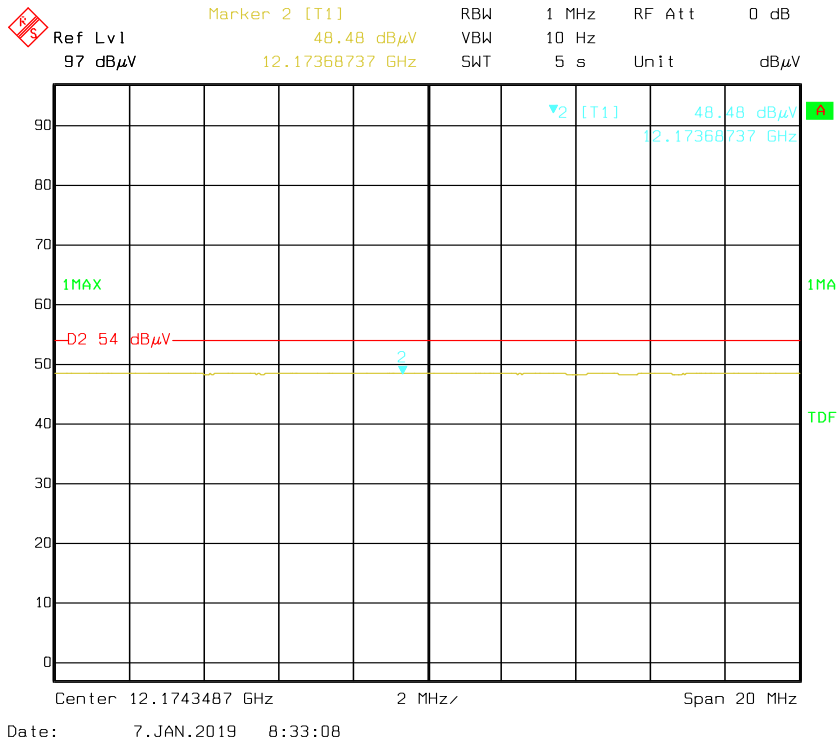


**Pre-scan for Average Horizontal**





### Vertical



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

### **Applicable Standard**

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

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Moon Tan on 2019-01-02.*

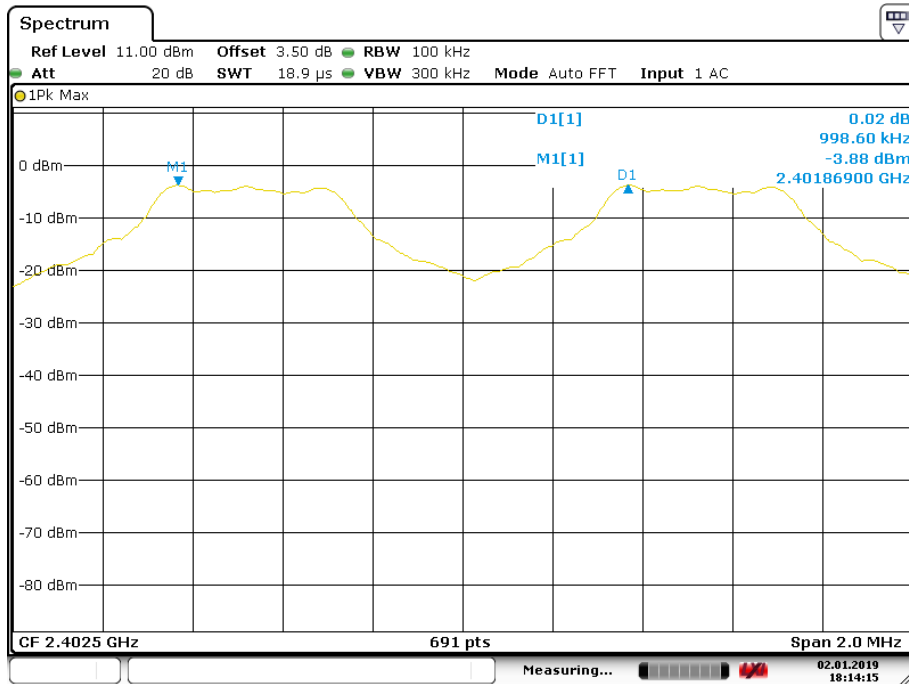
*EUT operation mode: Transmitting*

*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
<b>BDR(GFSK)</b>					
Low	0.999	0.881	0.587	> two-thirds of the 20 dB bandwidth	Compliance
Middle	0.999	0.881	0.587	> two-thirds of the 20 dB bandwidth	Compliance
High	0.999	0.881	0.587	> two-thirds of the 20 dB bandwidth	Compliance
<b>EDR(<math>\pi/4</math>-DQPSK)</b>					
Low	1.001	1.224	0.816	> two-thirds of the 20 dB bandwidth	Compliance
Middle	0.999	1.224	0.816	> two-thirds of the 20 dB bandwidth	Compliance
High	1.001	1.224	0.816	> two-thirds of the 20 dB bandwidth	Compliance

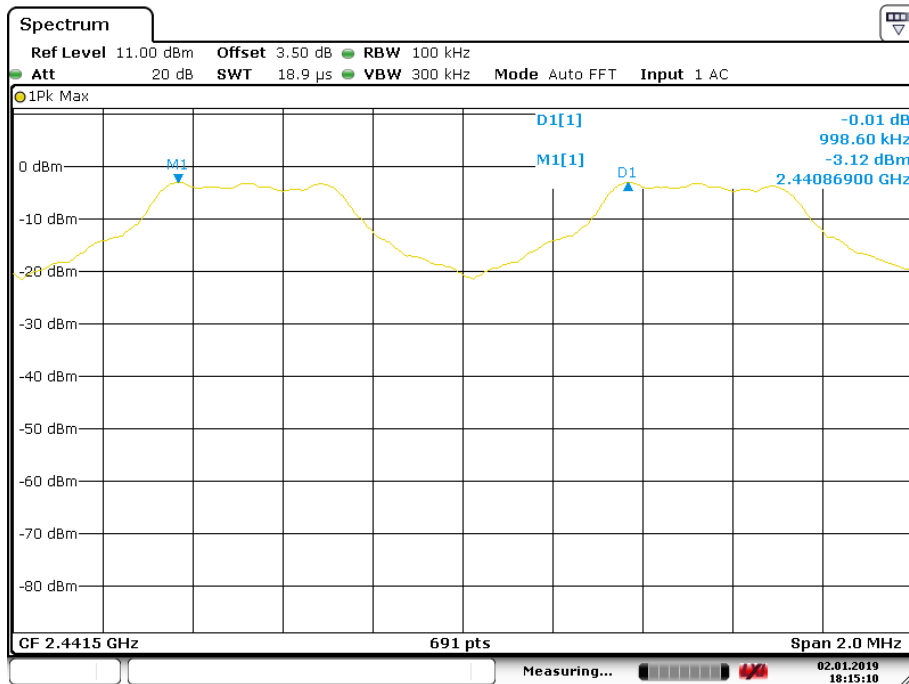
Please refer to the following plots.

**BDR (GFSK): Low Channel**



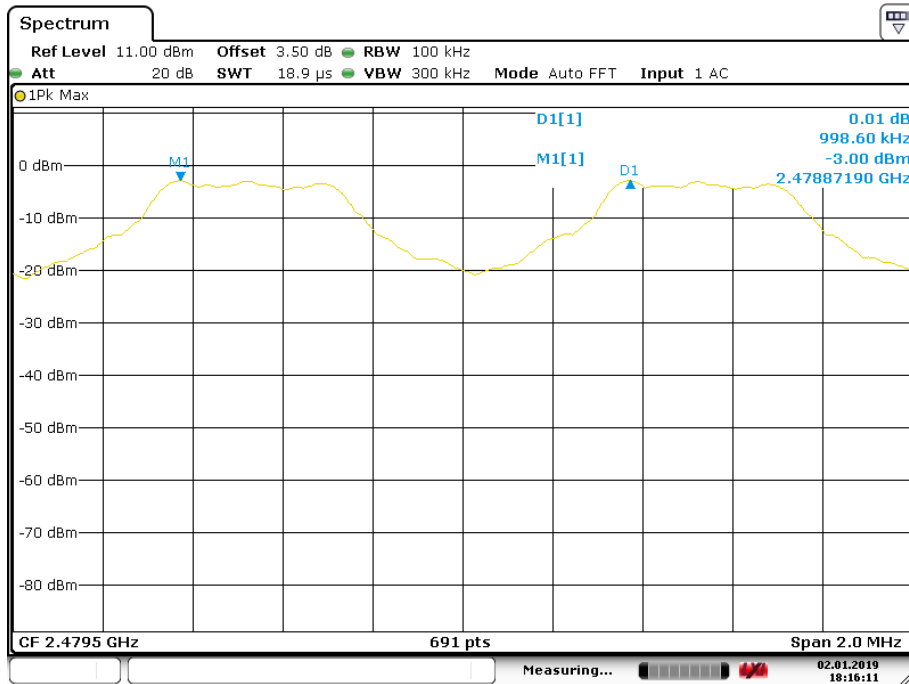
Date: 2.JAN.2019 18:14:15

**BDR (GFSK): Middle Channel**



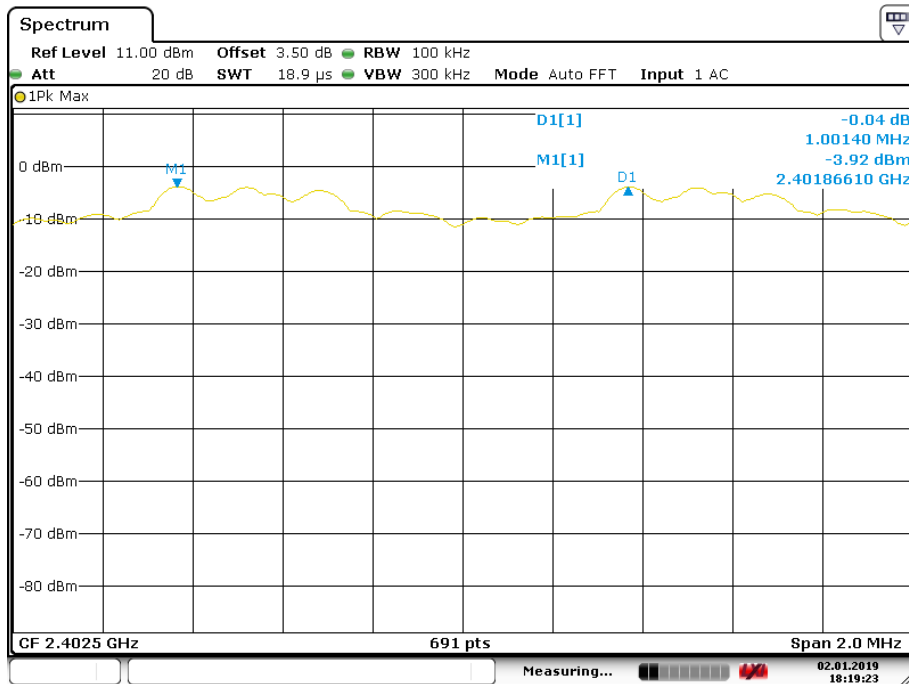
Date: 2.JAN.2019 18:15:10

**BDR (GFSK): High Channel**



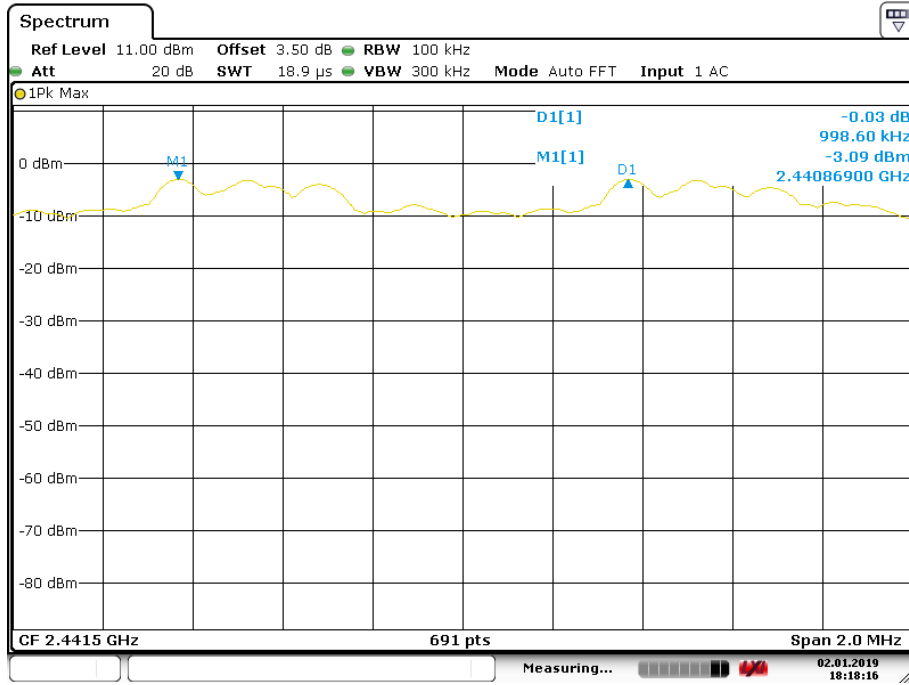
Date: 2.JAN.2019 18:16:12

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



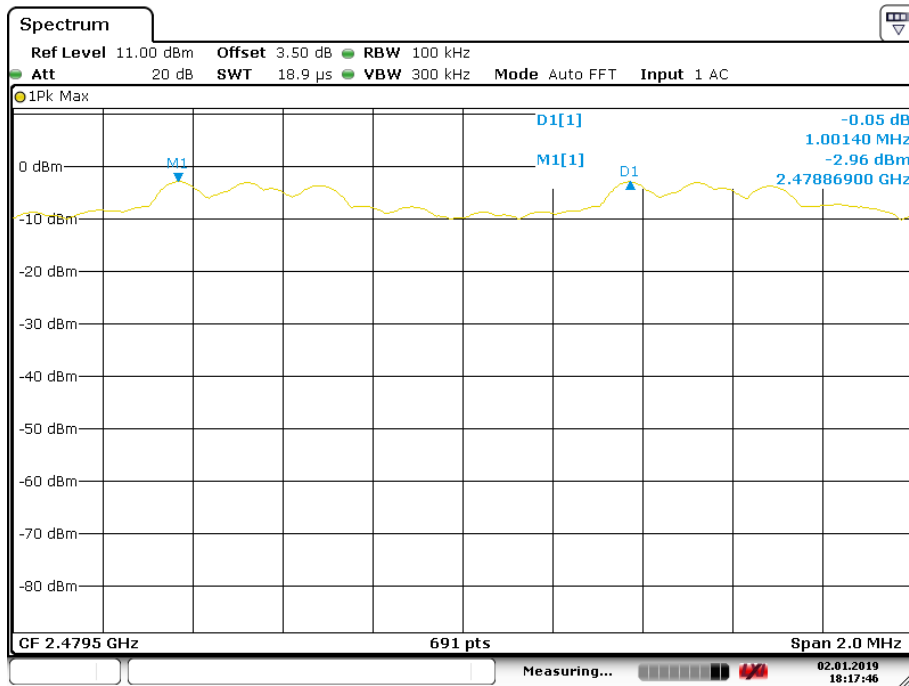
Date: 2.JAN.2019 18:19:24

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



Date: 2.JAN.2019 18:18:16

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



Date: 2.JAN.2019 18:17:46

## **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**

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

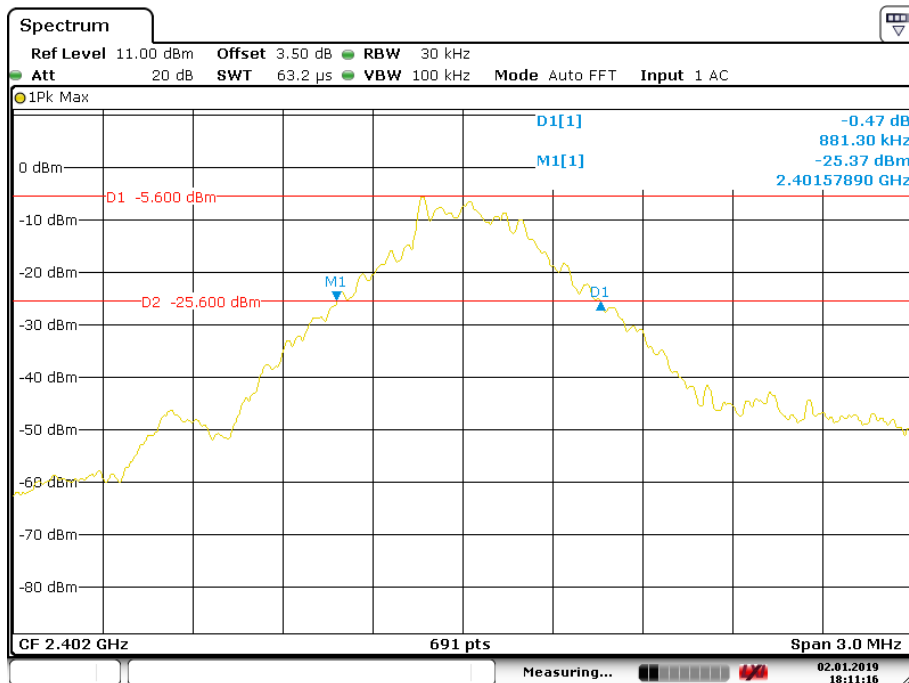
*The testing was performed by Moon Tan on 2019-01-02.*

*EUT operation mode: Transmitting*

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

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
<b>BDR (GFSK)</b>	Low	2402	0.881
	Middle	2441	0.881
	High	2480	0.881
<b>EDR (<math>\pi/4</math>-DQPSK)</b>	Low	2402	1.224
	Middle	2441	1.224
	High	2480	1.224

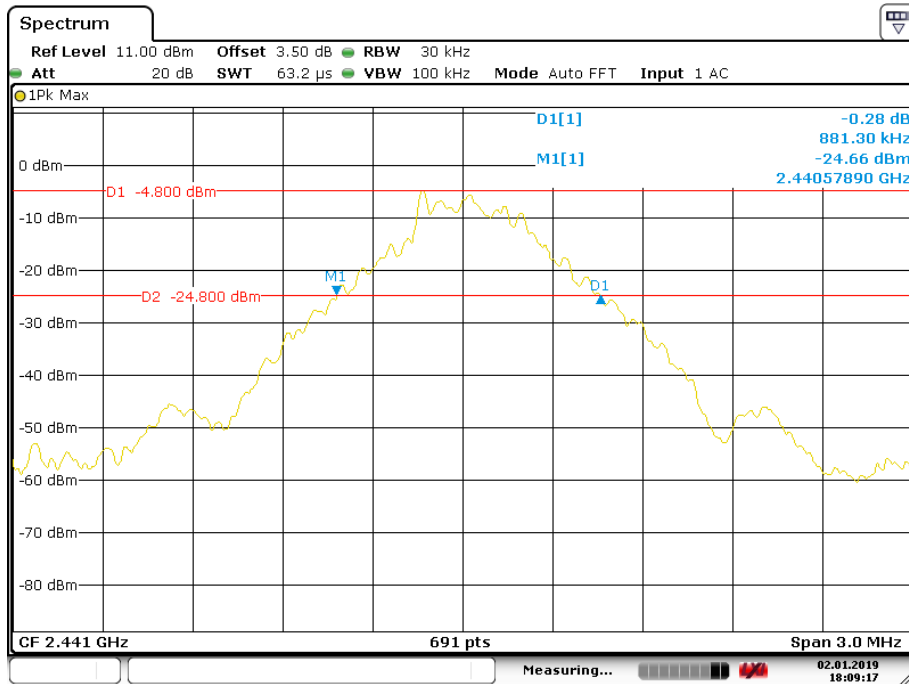
**BDR (GFSK): Low Channel**



Date: 2.JAN.2019 18:11:16

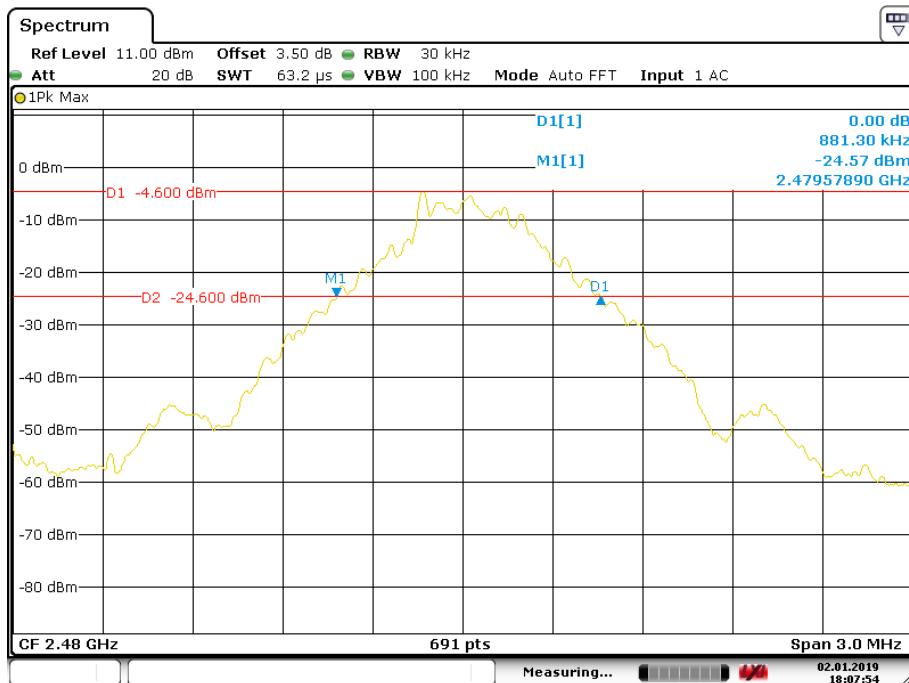


**BDR (GFSK): Middle Channel**



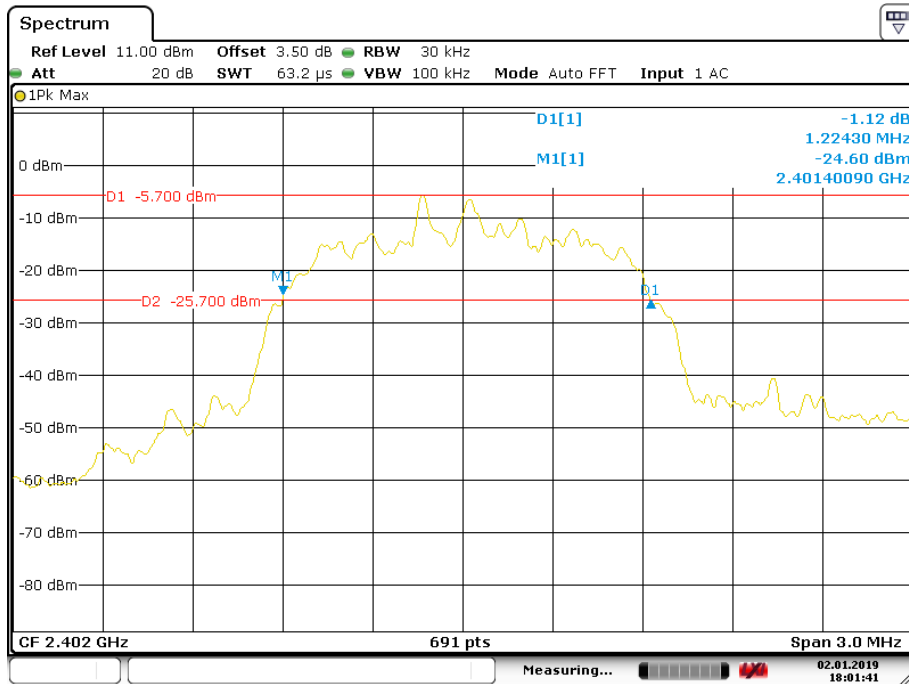
Date: 2.JAN.2019 18:09:17

**BDR (GFSK): High Channel**



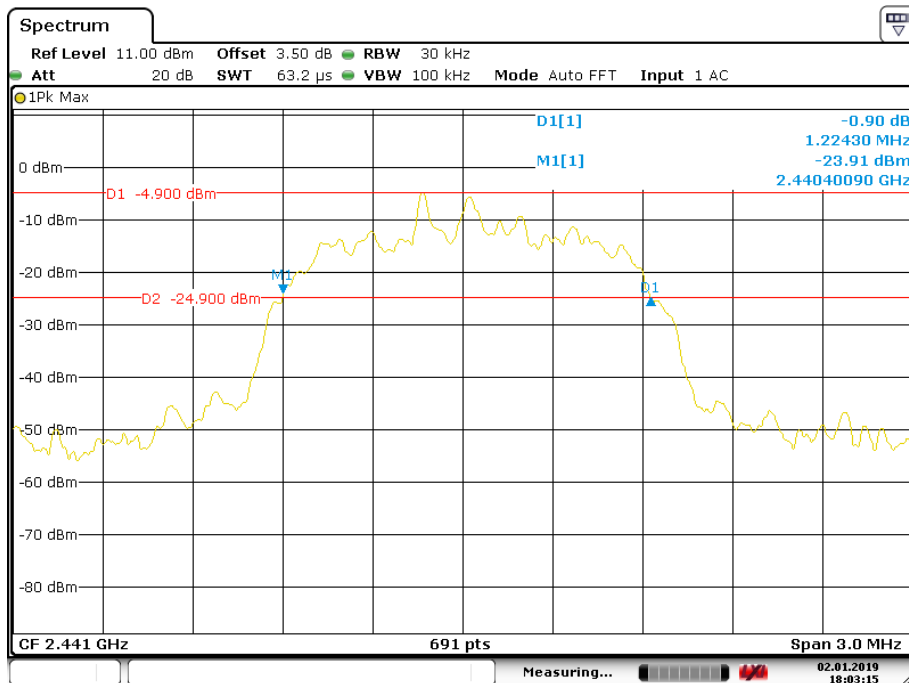
Date: 2.JAN.2019 18:07:54

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



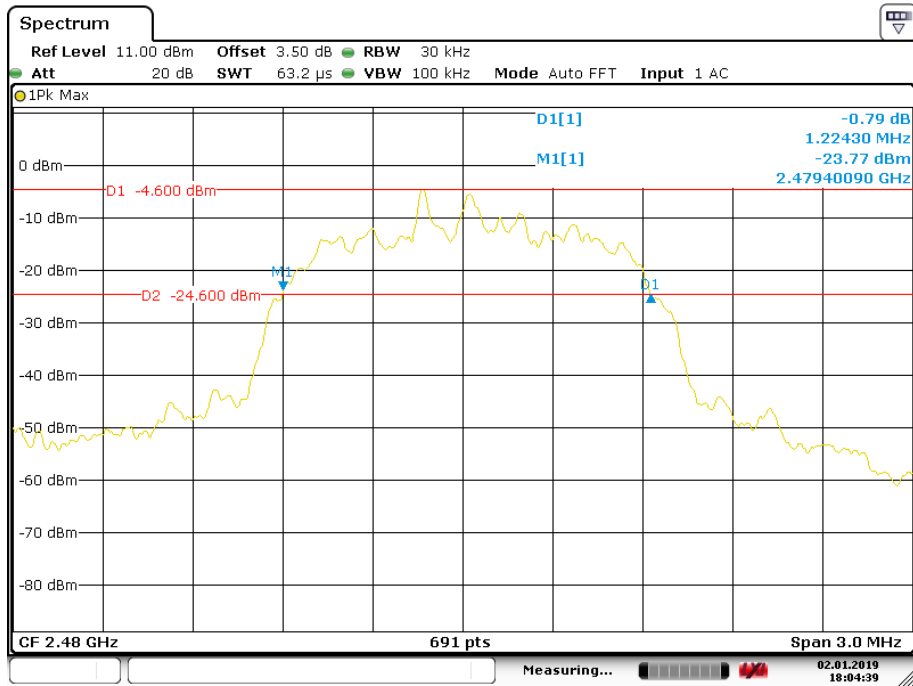
Date: 2.JAN.2019 18:01:41

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



Date: 2.JAN.2019 18:03:15

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



Date: 2.JAN.2019 18:04:39

## **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**

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

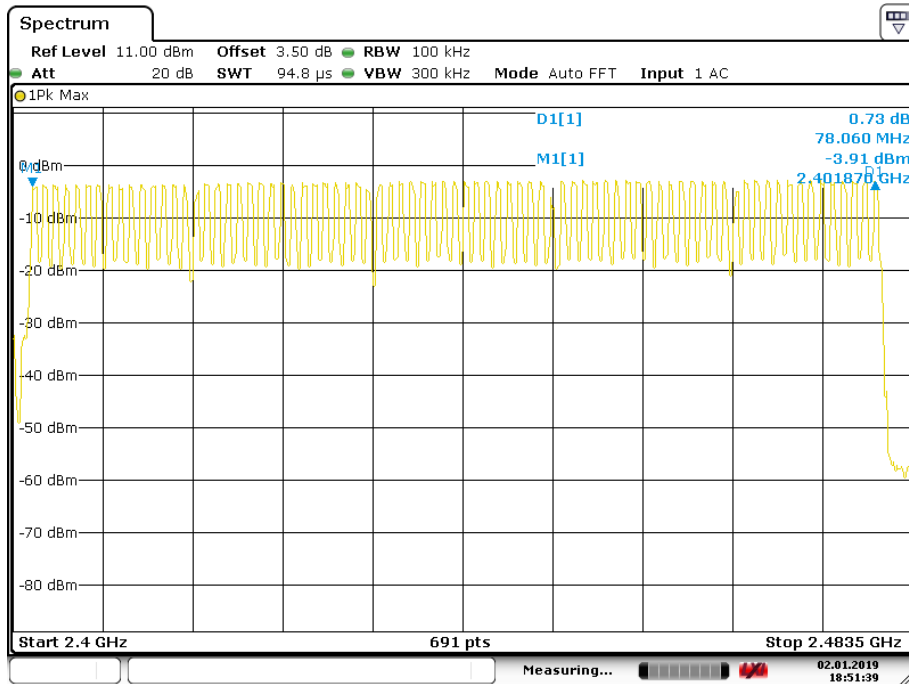
*The testing was performed by Moon Tan on 2019-01-02.*

*EUT operation mode: Transmitting*

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

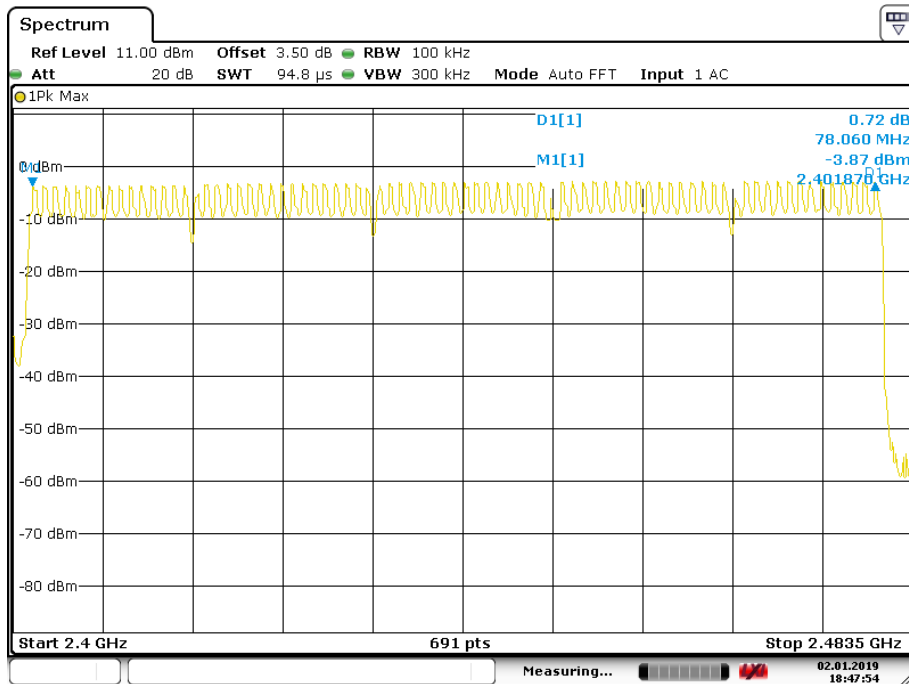
<b>Mode</b>	<b>Frequency Range (MHz)</b>	<b>Number of Hopping Channel (CH)</b>	<b>Limit (CH)</b>
BDR (GFSK)	2400-2483.5	79	≥15
EDR (π/4-DQPSK)	2400-2483.5	79	≥15

### BDR (GFSK): Number of Hopping Channels



Date: 2.JAN.2019 18:51:39

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



Date: 2.JAN.2019 18:47:54

**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**

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

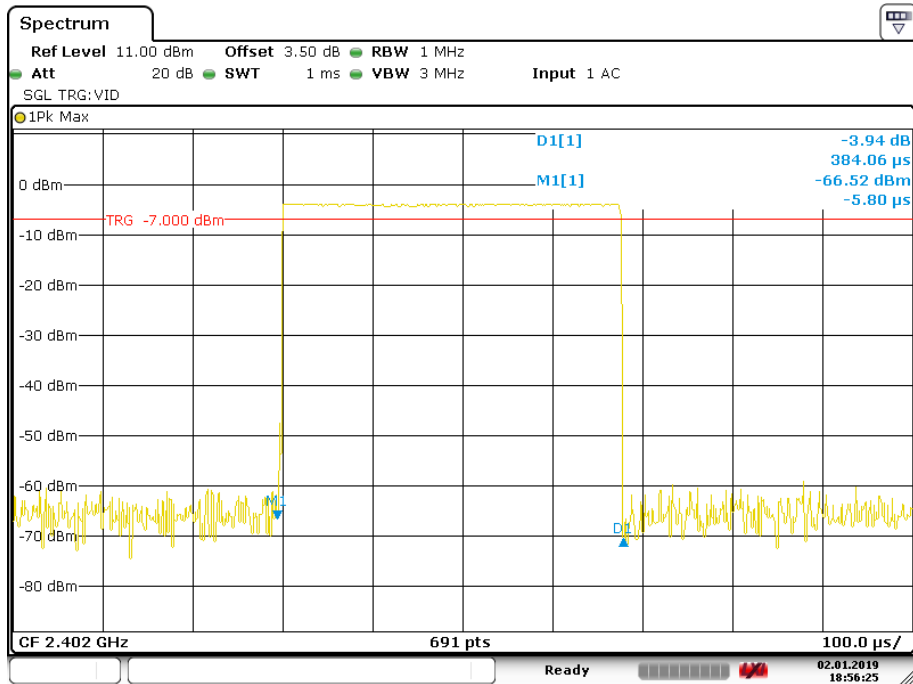
*The testing was performed by Moon Tan on 2019-01-02.*

*EUT operation mode: Transmitting*

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

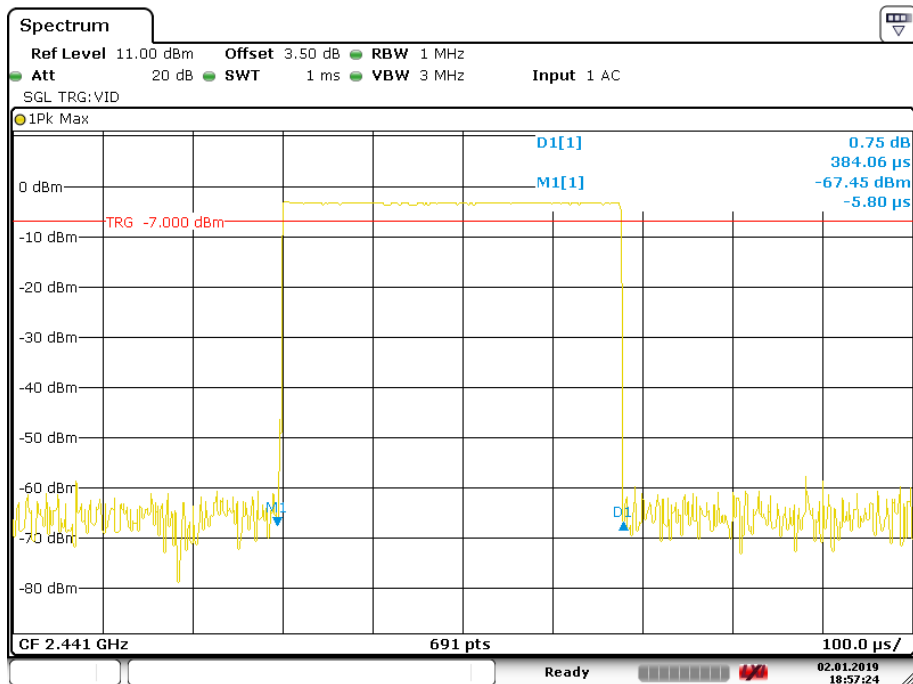
Mode		Channel	Pulse Width (ms)	Dwell Time (S)	Limit (S)	Result	
BDR (GFSK)	DH 1	Low	0.384	0.123	0.4	Pass	
		Middle	0.384	0.123	0.4	Pass	
		High	0.384	0.123	0.4	Pass	
	Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S						
	DH 3	Low	1.655	0.265	0.4	Pass	
		Middle	1.655	0.265	0.4	Pass	
		High	1.655	0.265	0.4	Pass	
	Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S						
	DH 5	Low	2.901	0.309	0.4	Pass	
		Middle	2.901	0.309	0.4	Pass	
		High	2.901	0.309	0.4	Pass	
	Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S						
	EDR ( $\pi/4$ -DQPSK)	2DH 1	Low	0.394	0.126	0.4	Pass
Middle			0.394	0.126	0.4	Pass	
High			0.394	0.126	0.4	Pass	
Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S							
2DH 3		Low	1.655	0.265	0.4	Pass	
		Middle	1.655	0.265	0.4	Pass	
		High	1.655	0.265	0.4	Pass	
Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S							
2DH 5		Low	2.901	0.309	0.4	Pass	
		Middle	2.901	0.309	0.4	Pass	
		High	2.901	0.309	0.4	Pass	
Note:2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S							

**BDR (GFSK):**  
**Pulse time, Low Channel, DH1**



Date: 2.JAN.2019 18:56:25

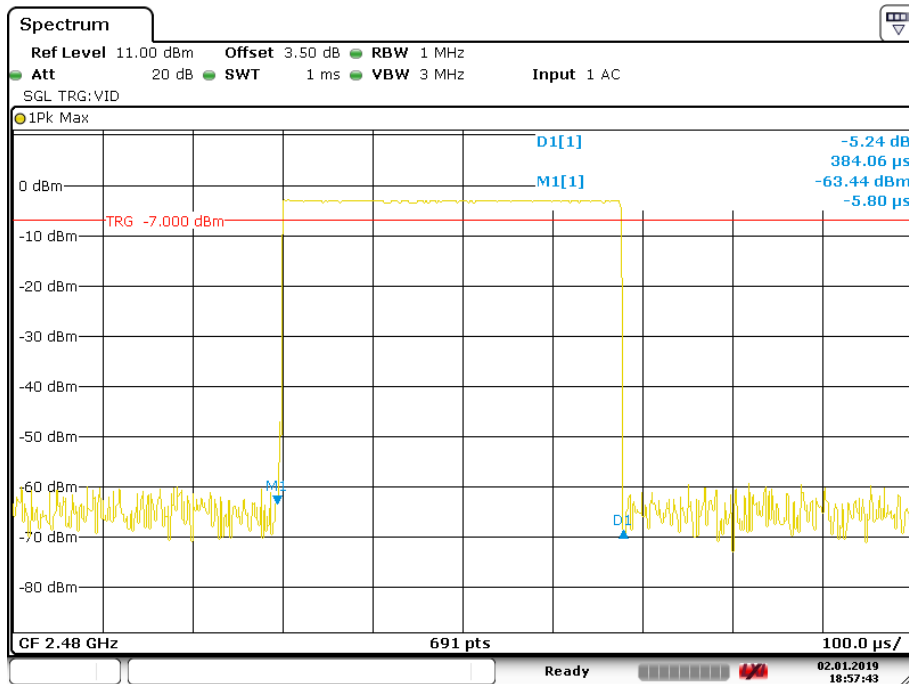
**Pulse time, Middle Channel, DH1**



Date: 2.JAN.2019 18:57:24

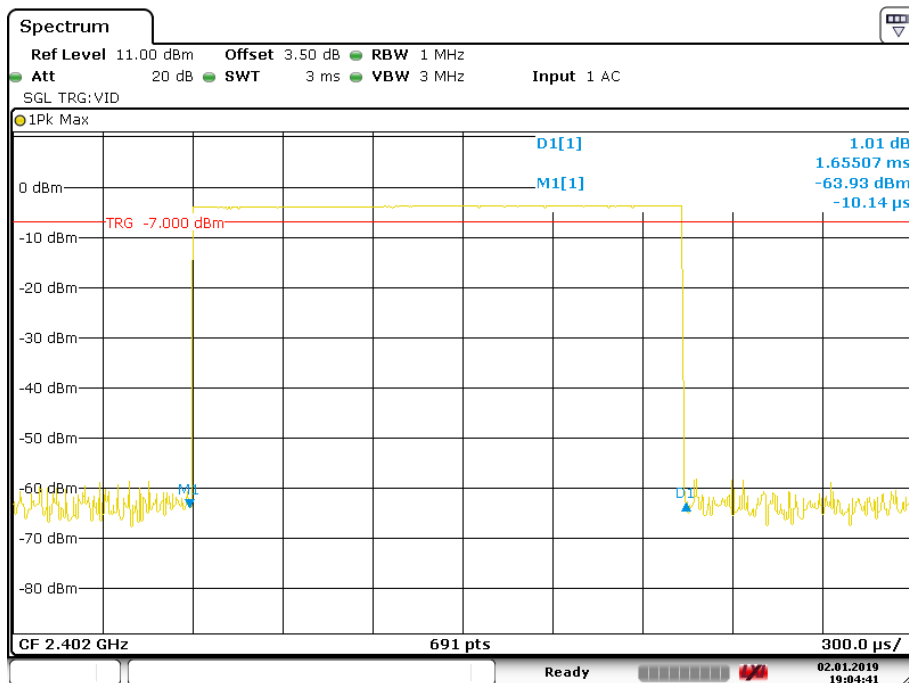


### Pulse time, High Channel, DH1



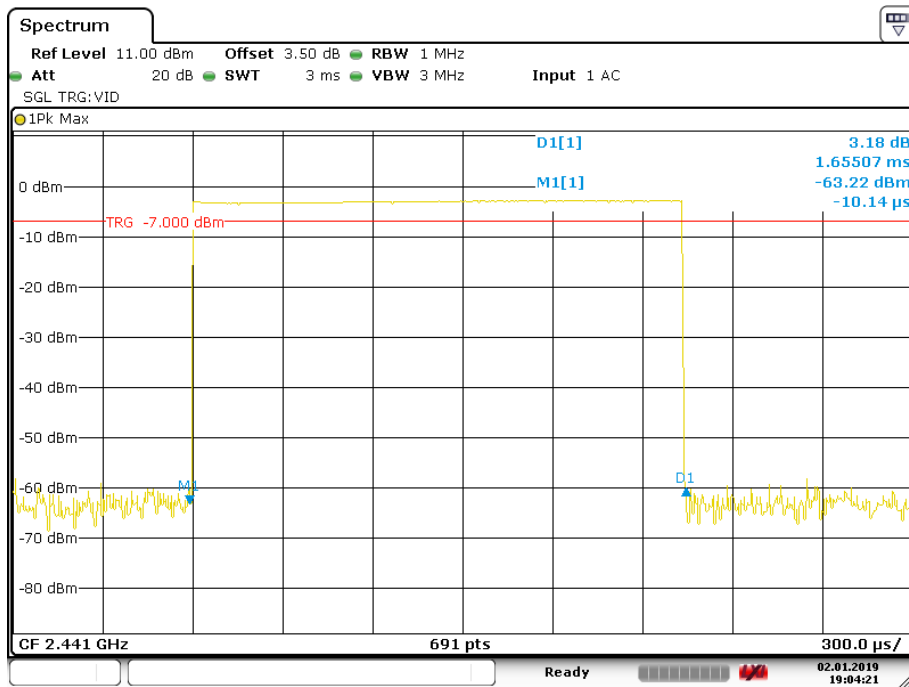
Date: 2.JAN.2019 18:57:44

### Pulse time, Low Channel, DH3



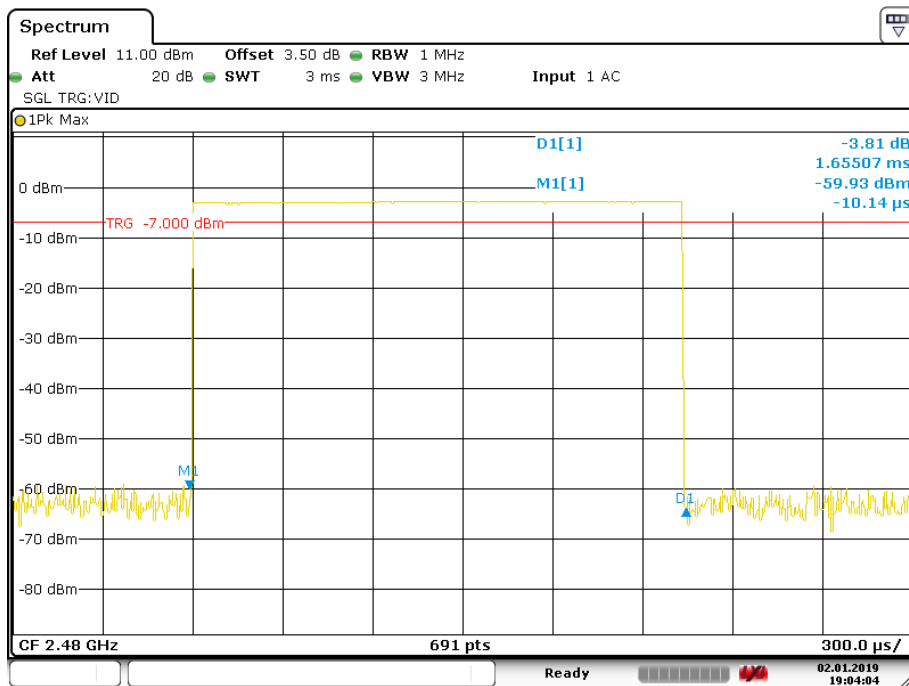
Date: 2.JAN.2019 19:04:42

### Pulse time, Middle Channel, DH3



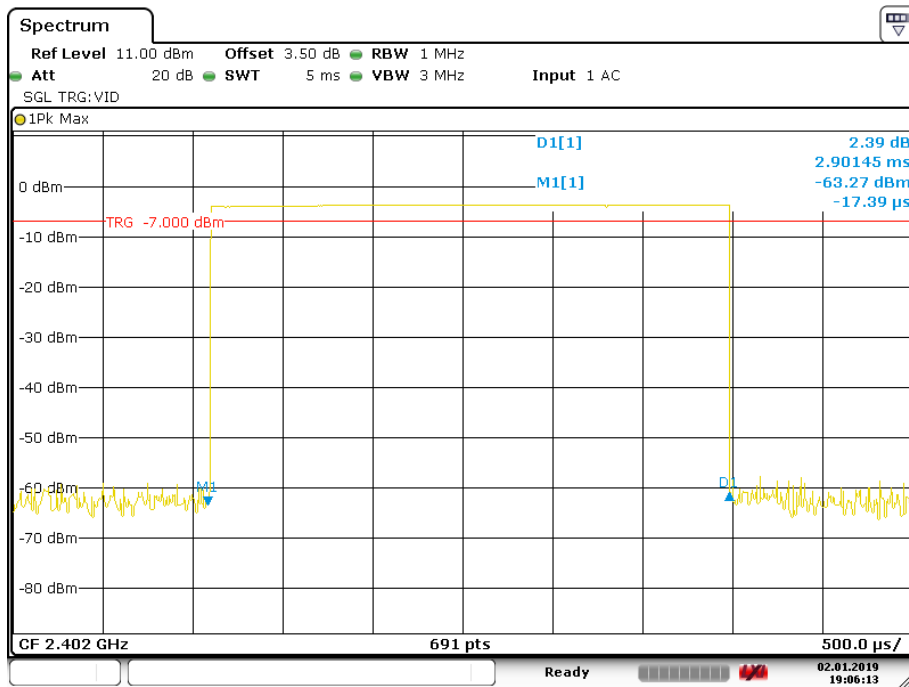
Date: 2.JAN.2019 19:04:22

### Pulse time, High Channel, DH3



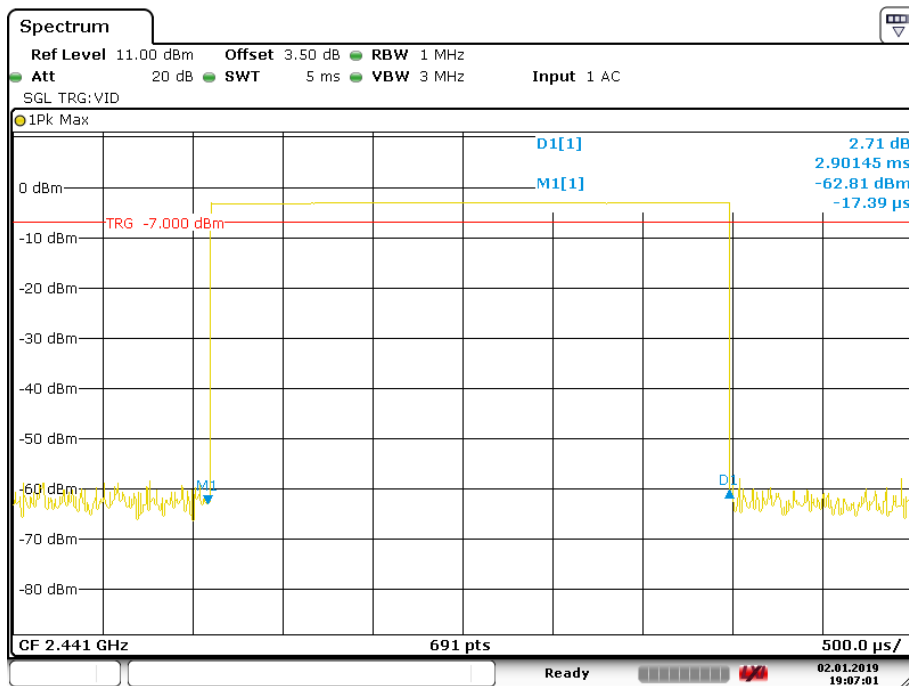
Date: 2.JAN.2019 19:04:04

Pulse time, Low Channel, DH5



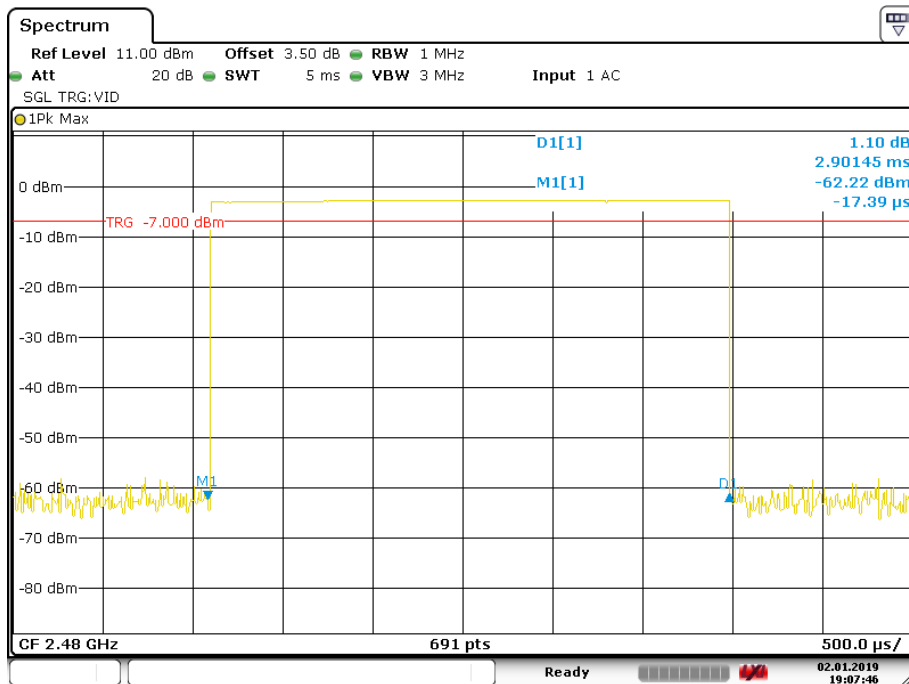
Date: 2.JAN.2019 19:06:13

Pulse time, Middle Channel, DH5



Date: 2.JAN.2019 19:07:02

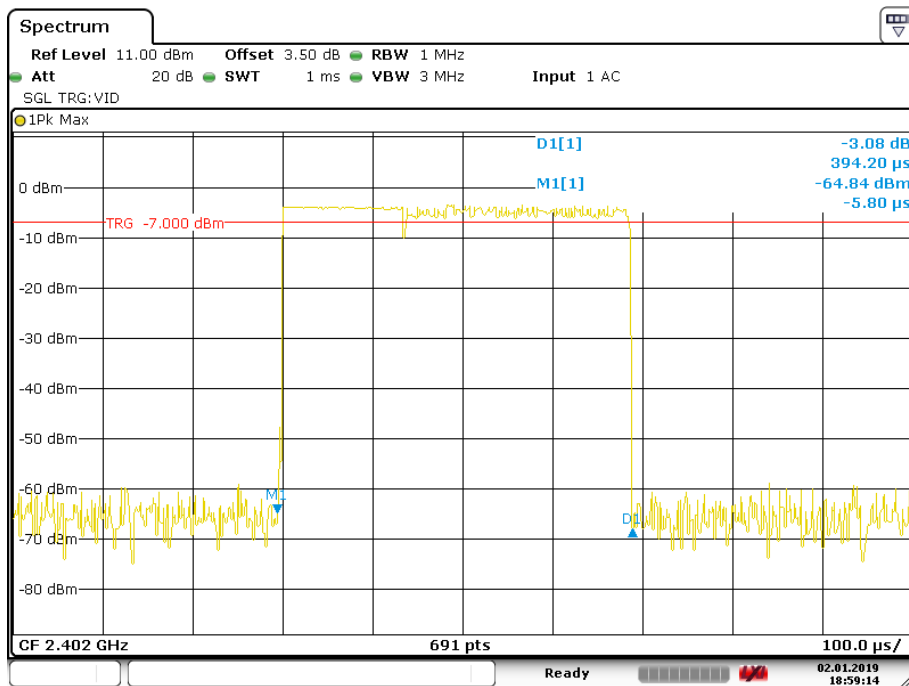
### Pulse time, High Channel, DH5



Date: 2.JAN.2019 19:07:47

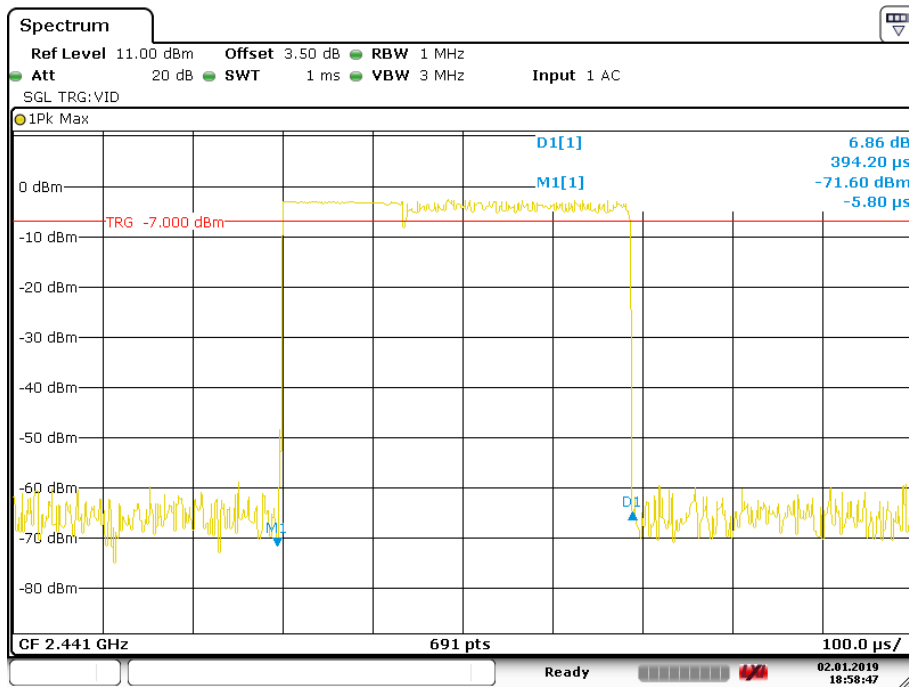
### EDR ( $\pi/4$ -DQPSK):

### Pulse time, Low Channel, 2DH1



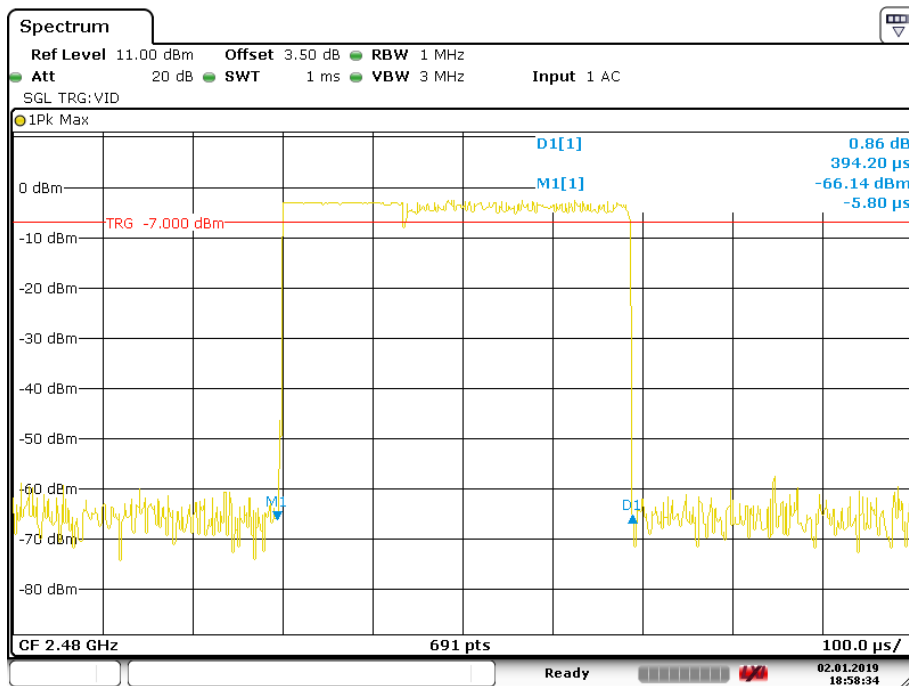
Date: 2.JAN.2019 18:59:15

### Pulse time, Middle Channel, 2DH1



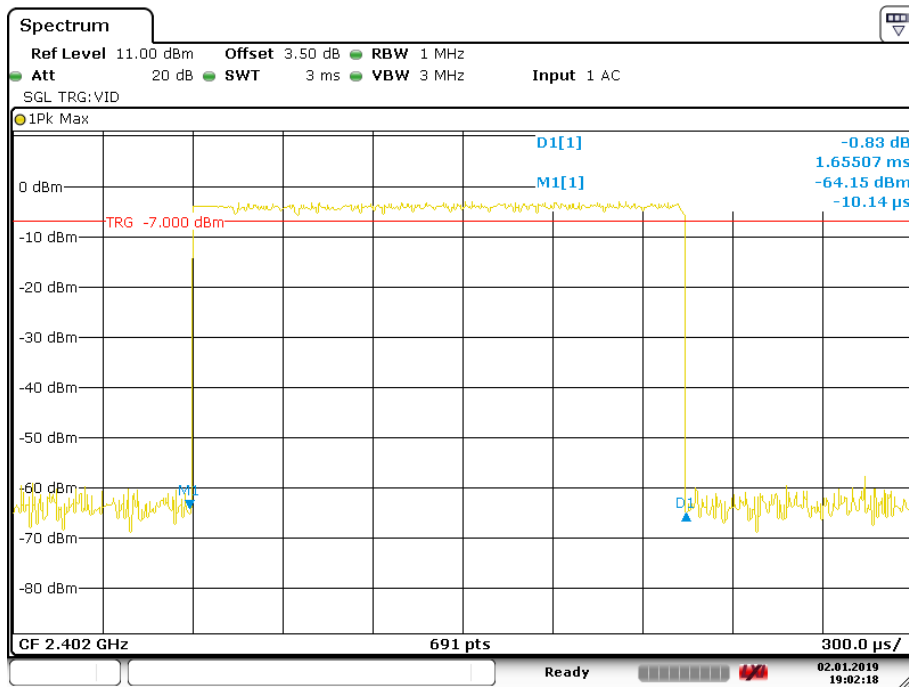
Date: 2.JAN.2019 18:58:48

### Pulse time, High Channel, 2DH1



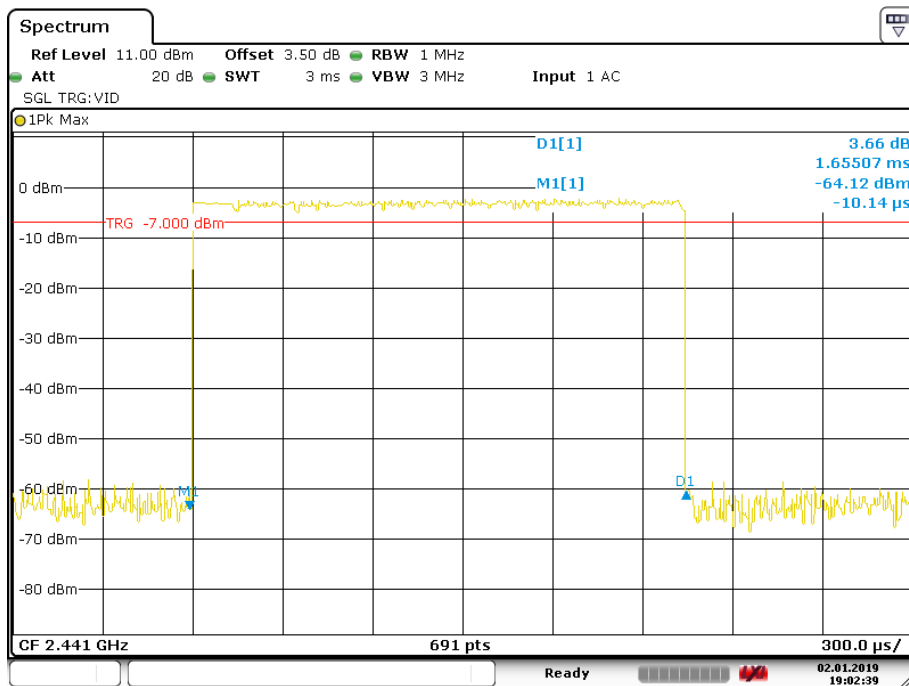
Date: 2.JAN.2019 18:58:34

Pulse time, Low Channel, 2DH3



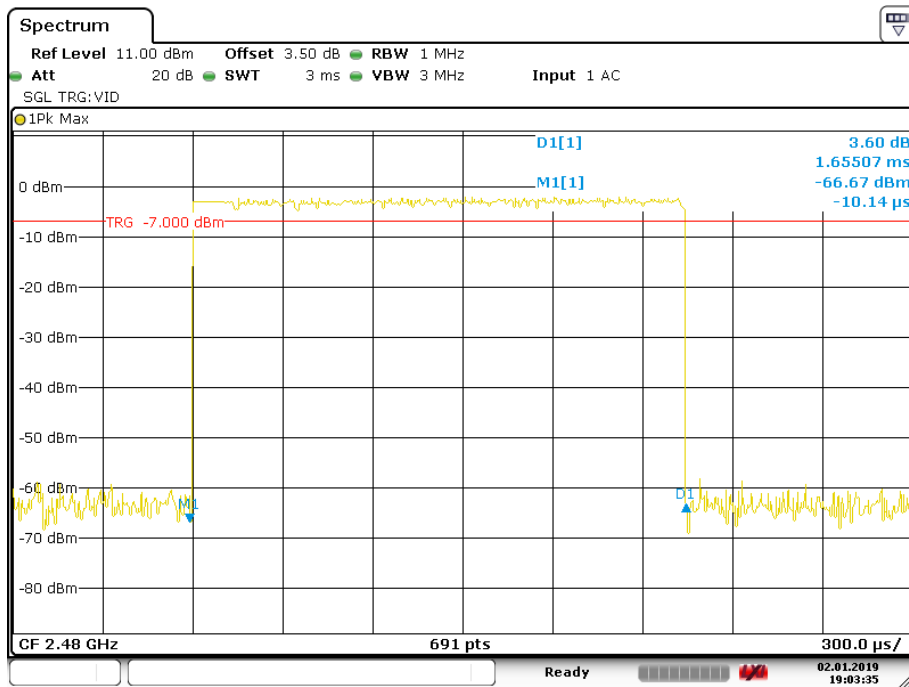
Date: 2.JAN.2019 19:02:19

Pulse time, Middle Channel, 2DH3



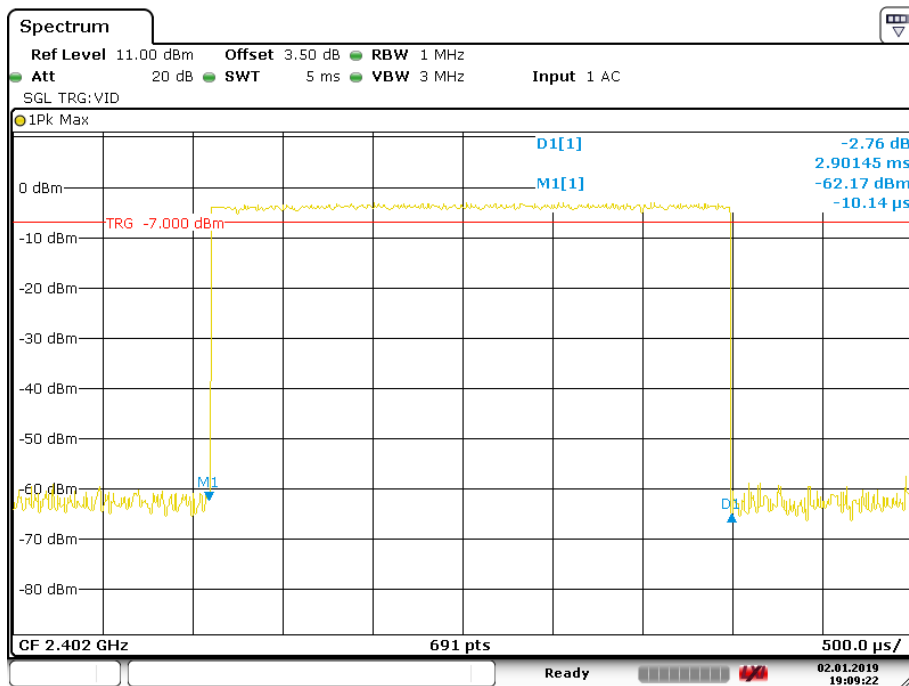
Date: 2.JAN.2019 19:02:39

### Pulse time, High Channel, 2DH3



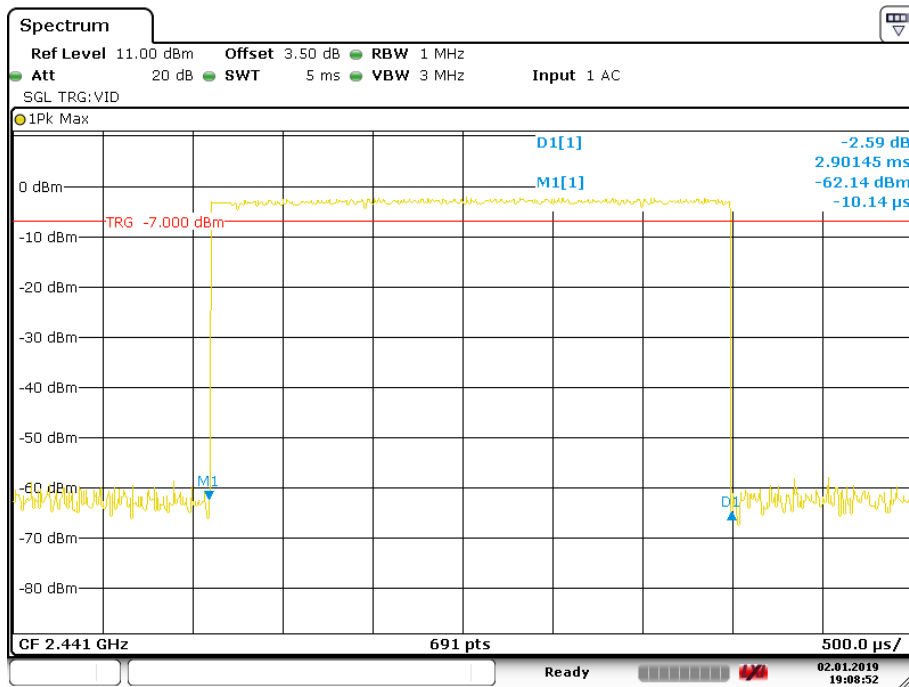
Date: 2.JAN.2019 19:03:35

### Pulse time, Low Channel, 2DH5



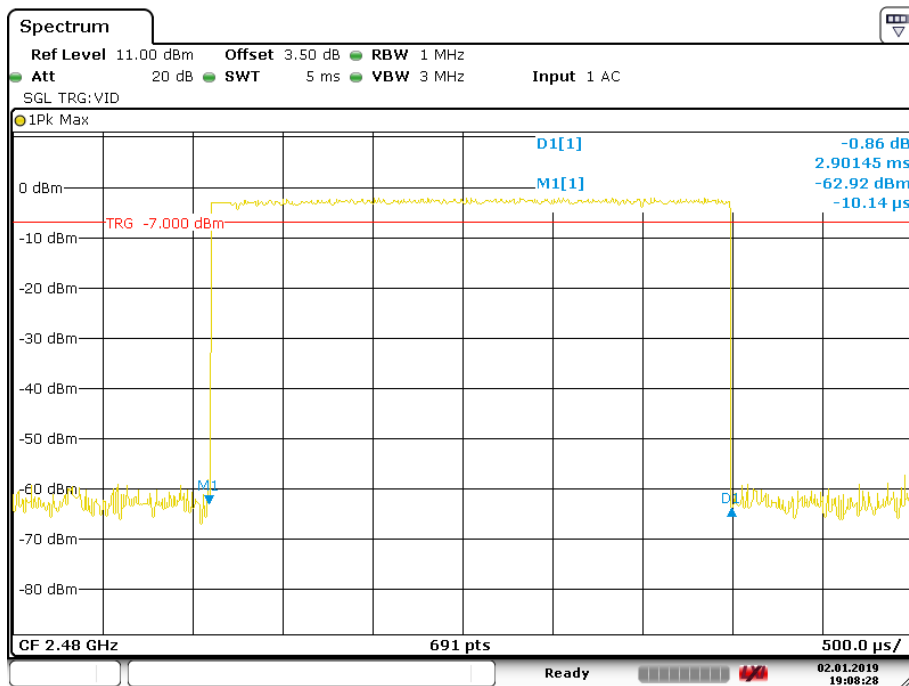
Date: 2.JAN.2019 19:09:22

Pulse time, Middle Channel, 2DH5



Date: 2.JAN.2019 19:08:53

Pulse time, High Channel, 2DH5



Date: 2.JAN.2019 19:08:29



## 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

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Moon Tan on 2019-01-02.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table.*

Mode	Channel	Frequency (MHz)	Peak Output Power		Limit (mW)
			(dBm)	(mW)	
<b>BDR (GFSK)</b>	Low	2402	-3.92	0.406	125
	Middle	2441	-3.20	0.479	125
	High	2480	-2.94	0.508	125
<b>EDR (<math>\pi/4</math>-DQPSK)</b>	Low	2402	-3.05	0.495	125
	Middle	2441	-2.34	0.583	125
	High	2480	-2.28	0.592	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

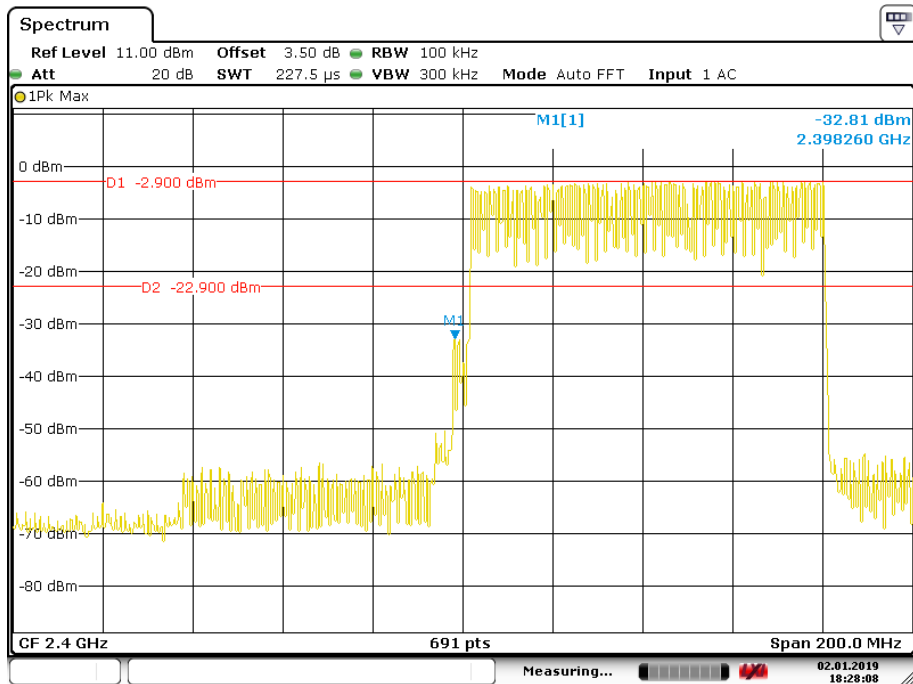
<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Moon Tan on 2019-01-02.*

*EUT operation mode: Transmitting*

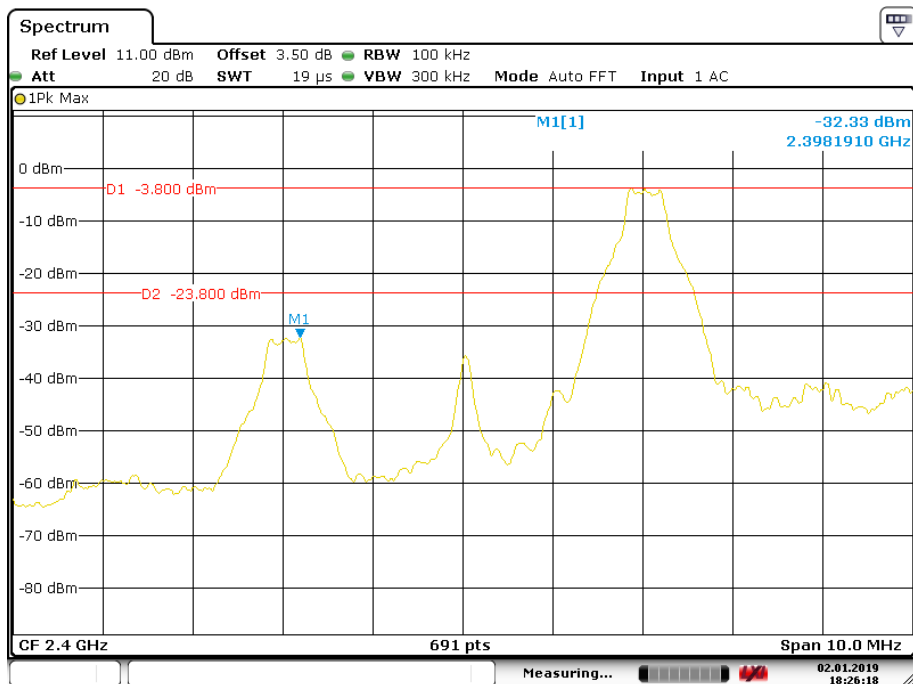
*Test Result: Compliance. Please refer to following plots.*

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



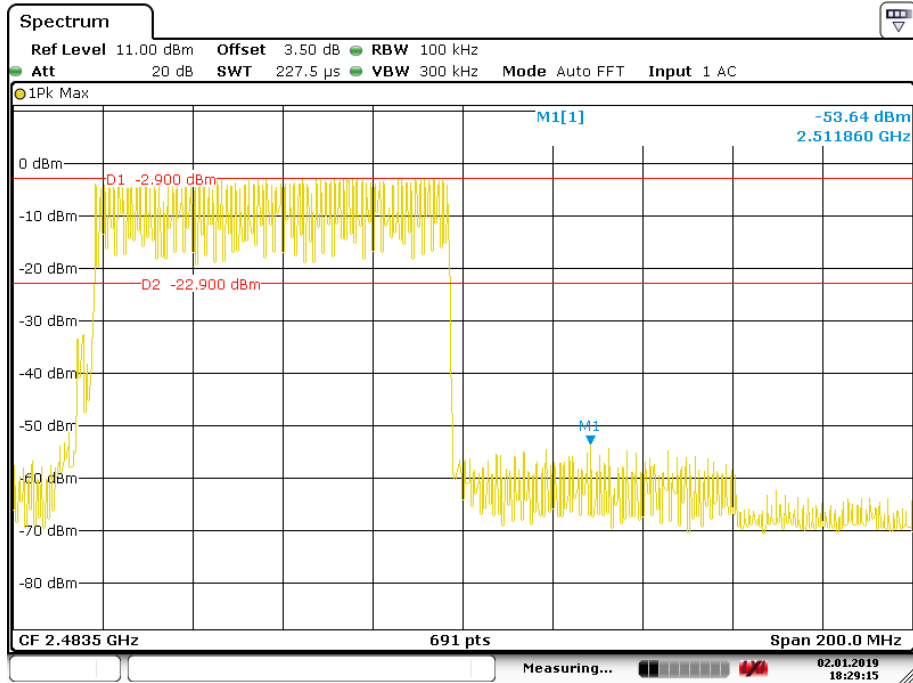
Date: 2.JAN.2019 18:28:09

### Single

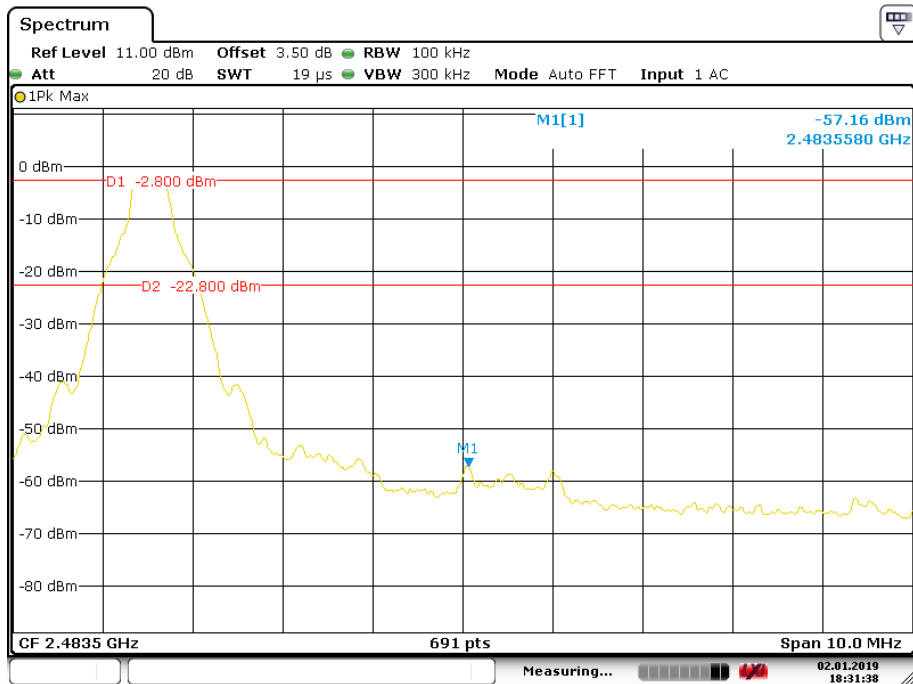


Date: 2.JAN.2019 18:26:19

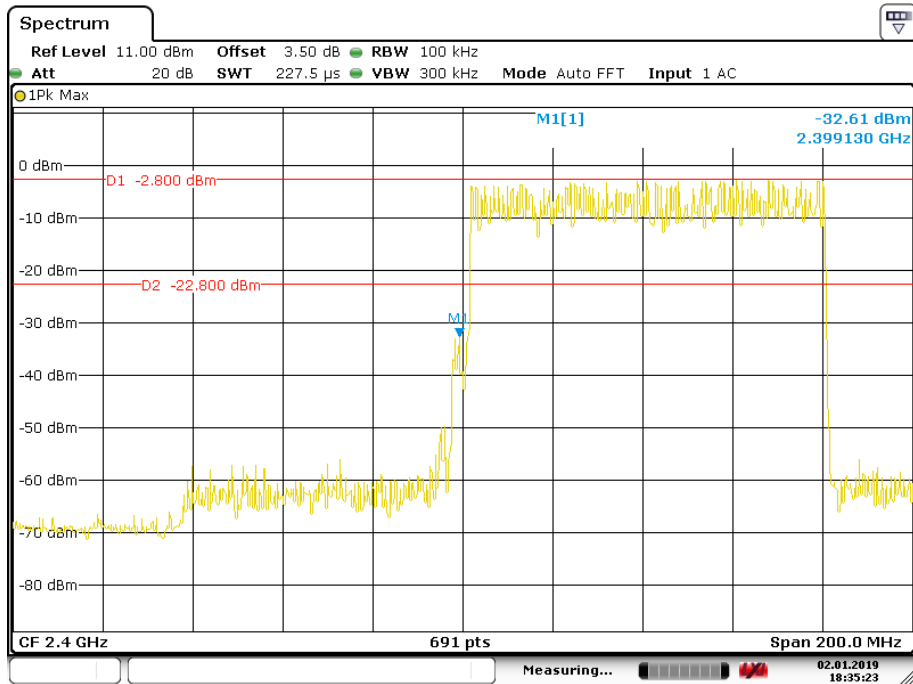
### BDR (GFSK): Band Edge-Right Side Hopping



### Single

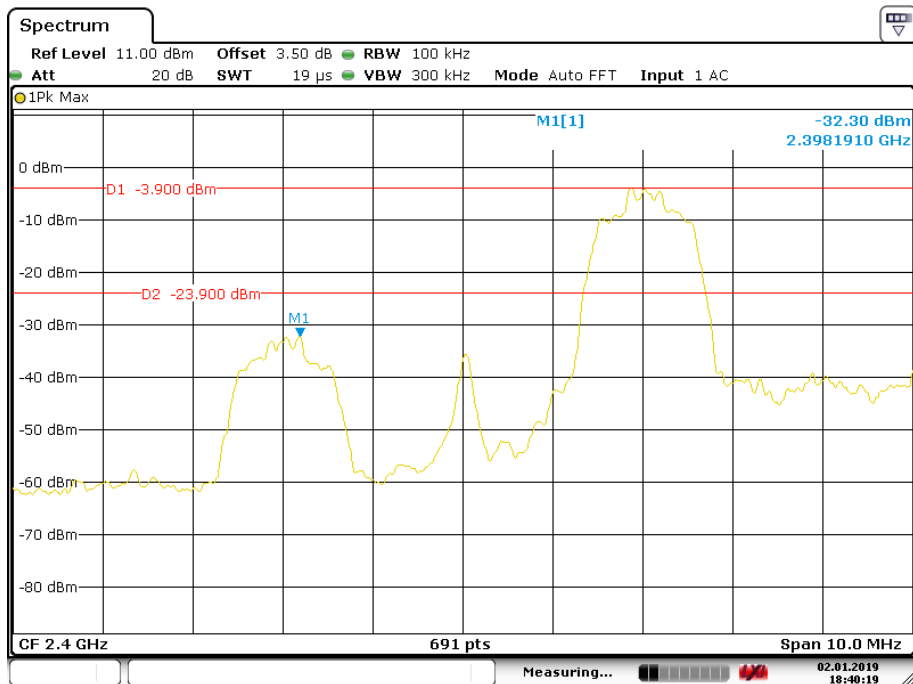


### EDR ( $\pi/4$ -DQPSK): Band Edge-Left Side Hopping



Date: 2.JAN.2019 18:35:23

### Single



Date: 2.JAN.2019 18:40:20

