



Shenzhen Huatongwei International Inspection Co., Ltd.

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# TEST REPORT

Report No.....: CHTEW19090136 Report Verification:



Project No.....: SHT1909007613EW

FCC ID .....: 2ACCU-SLAR0919

Applicant's name .....: PreSonus Audio Electronics, Inc.

Address.....: 18011 Grand Bay Court Baton Rouge, LA 70809, USA

Manufacturer.....: PreSonus Audio Electronics, Inc.

Address.....: 18011 Grand Bay Court Baton Rouge, LA 70809, USA

Test item description .....: MIXER

Trade Mark.....: PreSonus

Model/Type reference .....: STUDIO LIVE AR16c

Listed Model(s) .....: STUDIO LIVE AR12c, STUDIO LIVE AR8c

Standard .....: FCC CFR Title 47 Part 15 Subpart C Section 15.247

Date of receipt of test sample.....: Sep.09, 2019

Date of testing.....: Sep.09, 2019- Sep.19, 2019

Date of issue.....: Sep.20, 2019

Result.....: PASS

Compiled by

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(Position+Printed name+Signature): Project Engineer Kiki Kong

Approved by

(Position+Printed name+Signature): RF Manager Hans Hu

Testing Laboratory Name.....: Shenzhen Huatongwei International Inspection Co., Ltd.

Address.....: 1/F, Bldg 3, Hongfa Hi-tech Industrial Park, Genyu Road, Tianliao, Gongming, Shenzhen, China

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*The test report merely correspond to the test sample.*

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## 1. **TEST STANDARDS AND REPORT VERSION**

### 1.1. Test Standards

The tests were performed according to following standards:

[FCC Rules Part 15.247](#): Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

[ANSI C63.10-2013](#): American National Standard for Testing Unlicensed Wireless Devices

[KDB 558074 D01 15.247 Meas Guidance v05r02](#): Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of The FCC Rules

### 1.2. Report version

Revision No.	Date of issue	Description
N/A	2019-09-20	Original

## 2. TEST DESCRIPTION

Test Item	Section in CFR 47	Result	Test Engineer
Antenna Requirement	15.203/15.247 (c)	PASS	Bruce Wong
AC Power Line Conducted Emissions	15.207	PASS	Kang Yang
Conducted Peak Output Power	15.247 (b)(1)	PASS	Bruce Wong
20 dB Bandwidth	15.247 (a)(1)	PASS	Bruce Wong
Carrier Frequencies Separation	15.247 (a)(1)	PASS	Bruce Wong
Hopping Channel Number	15.247 (a)(1)	PASS	Bruce Wong
Dwell Time	15.247 (a)(1)	PASS	Bruce Wong
Pseudorandom Frequency Hopping Sequence	15.247(b)(4)	PASS	Bruce Wong
Restricted band	15.247(d)/15.205	PASS	Kang Yang
Radiated Emissions	15.247(d)/15.209	PASS	Kang Yang

Note: The measurement uncertainty is not included in the test result.

### 3. **SUMMARY**

#### 3.1. Client Information

Applicant:	PreSonus Audio Electronics, Inc.
Address:	18011 Grand Bay Court Baton Rouge, LA 70809, USA
Manufacturer:	PreSonus Audio Electronics, Inc.
Address:	18011 Grand Bay Court Baton Rouge, LA 70809, USA

#### 3.2. Product Description

Name of EUT:	MIXER
Trade Mark:	PreSonus
Model No.:	STUDIOLIVE AR16c
Listed Model(s):	STUDIOLIVE AR12c, STUDIOLIVE AR8c
Power supply:	AC 100-240V
Hardware version:	V3.0
Software version:	V3.0
<b>Bluetooth</b>	
Version:	Supported BT5.0+EDR
Modulation:	GFSK, π/4DQPSK, 8DPSK
Operation frequency:	2402MHz~2480MHz
Channel number:	79
Channel separation:	1MHz
Antenna type:	PCB Antenna
Antenna gain:	2.00dBi

### 3.3. Operation state

➤ **Test frequency list**

According to section 15.31(m), regards to the operating frequency range over 10 MHz, must select three channel which were tested. the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test, please see the above gray bottom.

Channel	Frequency (MHz)
00	2402
01	2403
:	:
39	2441
:	:
77	2479
78	2480

➤ **TEST MODE**

For RF test items:
The engineering test program was provided and enabled to make EUT continuous transmit
For AC power line conducted emissions:
The EUT was set to connect with the Bluetooth instrument under large package sizes transmission.
For Radiated suprious emissions test item:
The engineering test program was provided and enabled to make EUT continuous transmit. The EUT in each of three orthogonal axis emissions had been tested ,but only the worst case (X axis) data recorded in the report.

### 3.4. EUT configuration

**The following peripheral devices and interface cables were connected during the measurement:**

- - supplied by the manufacturer
- - supplied by the lab

	/	Manufacturer:	/
	/	Model No.:	/
	/	Manufacturer:	/
	/	Model No.:	/

### 3.5. Modifications

No modifications were implemented to meet testing criteria.

## 4. **TEST ENVIRONMENT**

### 4.1. Address of the test laboratory

Laboratory: Shenzhen Huatongwei International Inspection Co., Ltd.  
Address: 1/F, Bldg 3, Hongfa Hi-tech Industrial Park, Genyu Road, Tianliao, Gongming, Shenzhen, China

### 4.2. Test Facility

#### **CNAS-Lab Code: L1225**

Shenzhen Huatongwei International Inspection Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories.

#### **A2LA-Lab Cert. No.: 3902.01**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

#### **FCC-Registration No.: 762235**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files.

#### **IC-Registration No.:5377A**

Two 3m Alternate Test Site of Shenzhen Huatongwei International Inspection Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No.: 5377A.

#### **ACA**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory can also perform testing for the Australian C-Tick mark as a result of our A2LA accreditation.

### 4.3. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15~35°C
Relative Humidity:	30~60 %
Air Pressure:	950~1050mba

### 4.4. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors in calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report according to TR-100028-01 "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2" and is documented in the Shenzhen Huatongwei International Inspection Co., Ltd. quality system according to ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Here after the best measurement capability for Shenzhen Huatongwei International Inspection Co., Ltd. is reported:

Test Items	Measurement Uncertainty	Notes
Transmitter power conducted	0.51 dB	(1)
Conducted spurious emissions 9kHz~40GHz	0.51 dB	(1)
Conducted Disturbance 150kHz~30MHz	3.02 dB	(1)
Radiated Emissions below 1GHz	4.90 dB	(1)
Radiated Emissions above 1GHz	4.96 dB	(1)
Occupied Bandwidth	70 Hz	(1)

- (1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=1.96

## 4.5. Equipments Used during the Test

● Conducted Emission						
Used	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date (YY-MM-DD)	Next Cal. Date (YY-MM-DD)
●	Shielded Room	Albatross projects	N/A	N/A	2018/09/28	2023/09/27
●	EMI Test Receiver	R&S	ESCI	101247	2018/10/27	2019/10/26
●	Artificial Mains	SCHWARZBECK	NNLK 8121	573	2018/10/27	2019/10/26
●	Pulse Limiter	R&S	ESH3-Z2	100499	2018/10/27	2019/10/26
●	RF Connection Cable	HUBER+SUHNER	EF400	N/A	2018/11/15	2019/11/14
●	Test Software	R&S	ES-K1	N/A	N/A	N/A
○	Single Balanced Telecom Pair ISN	FCC	FCC-TLISN-T2-02	20371	2018/10/28	2019/10/27
○	Two Balanced Telecom Pairs ISN	FCC	FCC-TLISN-T4-02	20373	2018/10/28	2019/10/27
○	Four Balanced Telecom Pairs ISN	FCC	FCC-TLISN-T8-02	20375	2018/10/28	2019/10/27
○	V-Network	R&S	ESH3-Z6	100211	2018/10/27	2019/10/26
○	V-Network	R&S	ESH3-Z6	100210	2018/10/27	2019/10/26
○	2-Line V-Network	R&S	ESH3-Z5	100049	2018/10/27	2019/10/26

● Radiated Emission-6th test site						
Used	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date (YY-MM-DD)	Next Cal. Date (YY-MM-DD)
●	Semi-Anechoic Chamber	Albatross projects	SAC-3m-02	N/A	2018/09/30	2021/09/29
●	EMI Test Receiver	R&S	ESCI	100900	2018/10/28	2019/10/27
●	Loop Antenna	R&S	HFH2-Z2	100020	2017/11/20	2020/11/19
●	Ultra-Broadband Antenna	SCHWARZBECK	VULB9163	546	2017/04/05	2020/04/04
●	Pre-Amplifier	SCHWARZBECK	BBV 9742	N/A	2018/11/15	2019/11/14
●	RF Connection Cable	HUBER+SUHNER	N/A	N/A	2018/09/28	2019/09/27
●	RF Connection Cable	HUBER+SUHNER	SUCOFLEX104	501184/4	2018/09/28	2019/09/27
●	Test Software	R&S	ES-K1	N/A	N/A	N/A
●	Turntable	Maturo Germany	TT2.0-1T	N/A	N/A	N/A
●	Antenna Mast	Maturo Germany	CAM-4.0-P-12	N/A	N/A	N/A

● Radiated emission-7th test site						
Used	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date (YY-MM-DD)	Next Cal. Date (YY-MM-DD)
●	Semi-Anechoic Chamber	Albatross projects	SAC-3m-01	N/A	2018/09/30	2021/09/29
●	Spectrum Analyzer	R&S	FSP40	100597	2018/10/27	2019/10/26
●	Horn Antenna	SCHWARZBECK	9120D	1011	2017/03/27	2020/03/26
●	Pre-amplifier	BONN	BLWA0160-2M	1811887	2018/11/14	2019/11/13
●	Pre-amplifier	CD	PAP-0102	12004	2018/11/14	2019/11/13
●	Broadband Pre-amplifier	SCHWARZBECK	BBV 9718	9718-248	2019/04/26	2020/04/25
●	RF Connection Cable	HUBER+SUHNER	RE-7-FH	N/A	2018/11/15	2019/11/14
●	RF Connection Cable	HUBER+SUHNER	RE-7-FL	N/A	2018/11/15	2019/11/14
●	Test Software	Audix	E3	N/A	N/A	N/A

●	Turntable	Maturo Germany	TT2.0-1T	N/A	N/A	N/A
●	Antenna Mast	Maturo Germany	CAM-4.0-P-12	N/A	N/A	N/A

**● RF Conducted Method**

Used	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date (YY-MM-DD)	Next Cal. Date (YY-MM-DD)
●	Signal and spectrum Analyzer	R&S	FSV40	100048	2018/10/28	2019/10/27
●	Spectrum Analyzer	Agilent	N9020A	MY50510187	2018/09/29	2019/09/28
○	Radio communication tester	R&S	CMW500	137688-Lv	2018/09/29	2019/09/28
○	Test software	Tonscend	JS1120-1(LTE)	N/A	N/A	N/A
○	Test software	Tonscend	JS1120-2(WIFI)	N/A	N/A	N/A
○	Test software	Tonscend	JS1120-3(WCDMA)	N/A	N/A	N/A
○	Test software	Tonscend	JS1120-4(GSM)	N/A	N/A	N/A

## 5. TEST CONDITIONS AND RESULTS

### 5.1. Antenna requirement

#### Requirement

##### FCC CFR Title 47 Part 15 Subpart C Section 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, 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.

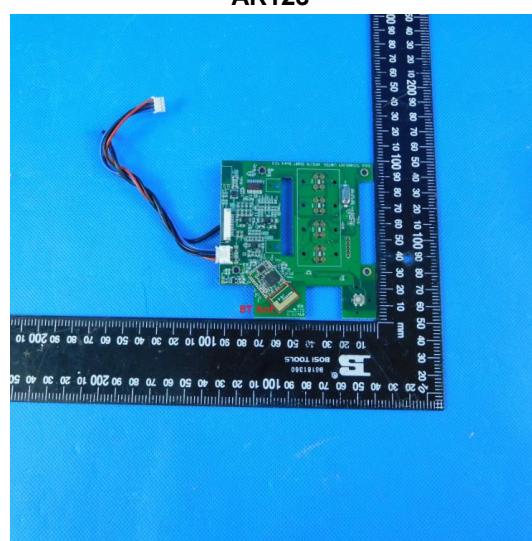
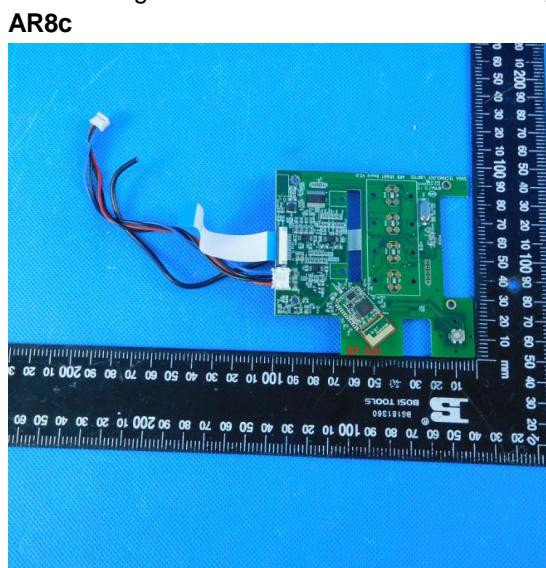
##### FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1)(i):

- (i) Systems operating in the 2400~2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

#### Test Result:

Passed       Not Applicable

The directional gain of the antenna less than 6 dBi, please refer to the below antenna photo.



## 5.2. Conducted Emissions (AC Main)

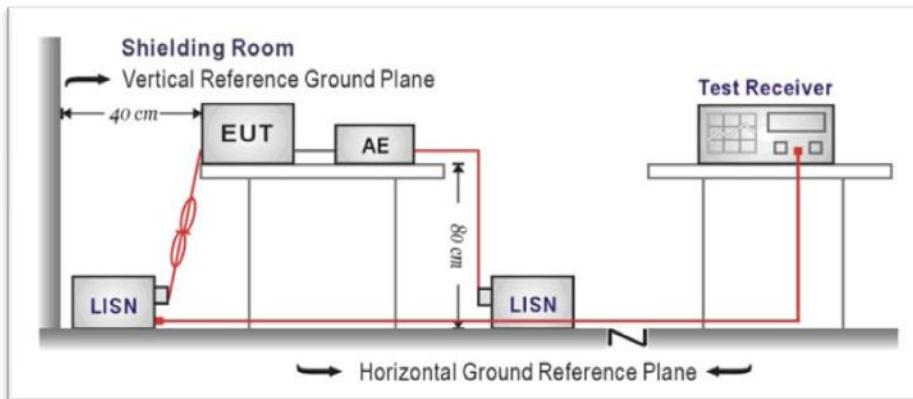
### LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.207

Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

\* Decreases with the logarithm of the frequency.

### TEST CONFIGURATION



### TEST PROCEDURE

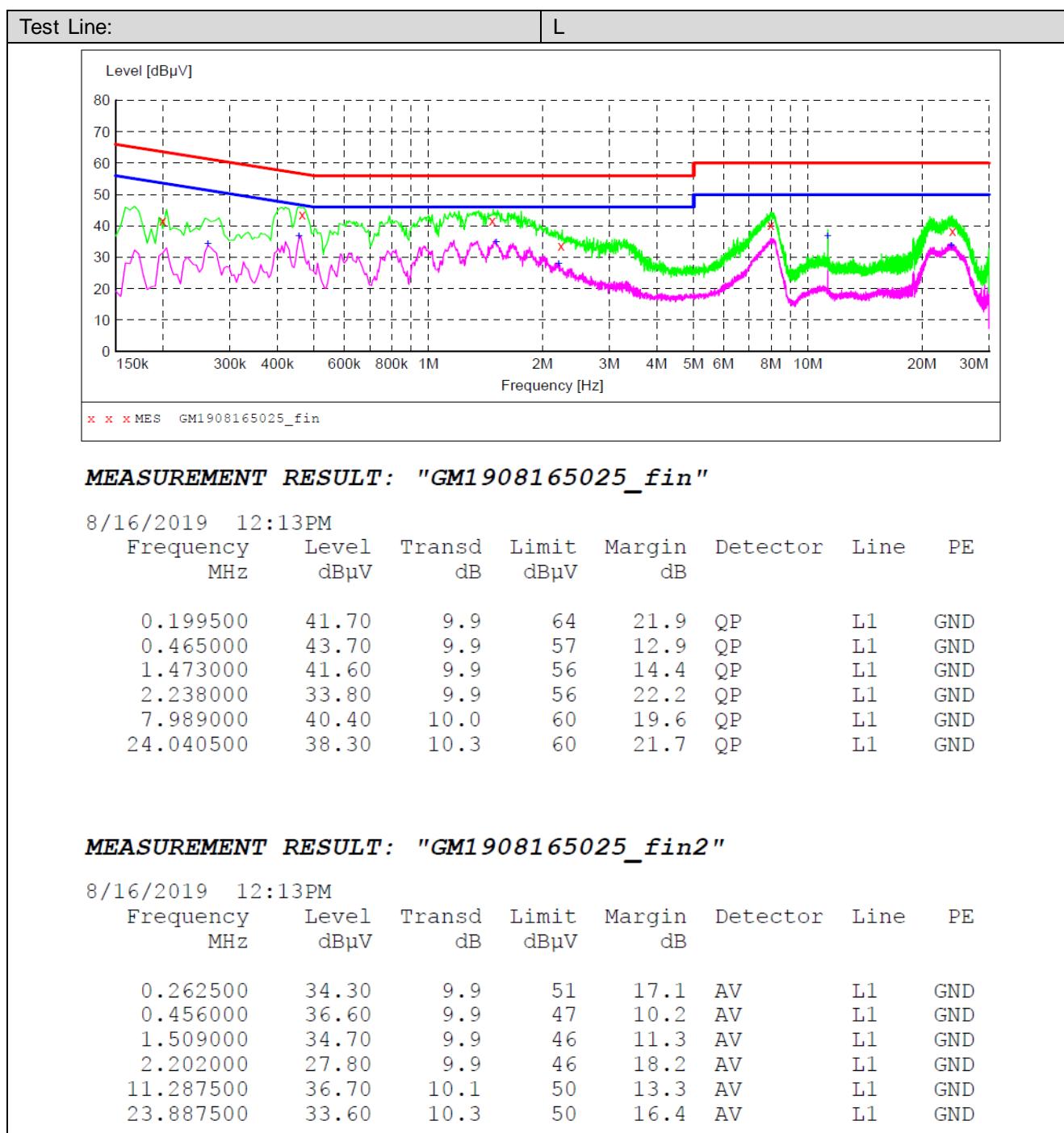
1. The EUT was setup according to ANSI C63.10:2013 requirements.
2. The EUT was placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above the conducting ground plane. The vertical conducting plane was located 40 cm to the rear of the EUT. All other surfaces of EUT were at least 80 cm from any other grounded conducting surface.
3. The EUT and simulators are connected to the main power through a line impedances stabilization network (LISN). The LISN provides a 50 ohm /50uH coupling impedance for the measuring equipment.
4. The peripheral devices are also connected to the main power through a LISN. (Please refer to the block diagram of the test setup and photographs)
5. Each current-carrying conductor of the EUT power cord, except the ground (safety) conductor, was individually connected through a LISN to the input power source.
6. The excess length of the power cord between the EUT and the LISN receptacle were folded back and forth at the center of the lead to form a bundle not exceeding 40 cm in length.
7. Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9 kHz.
8. During the above scans, the emissions were maximized by cable manipulation.

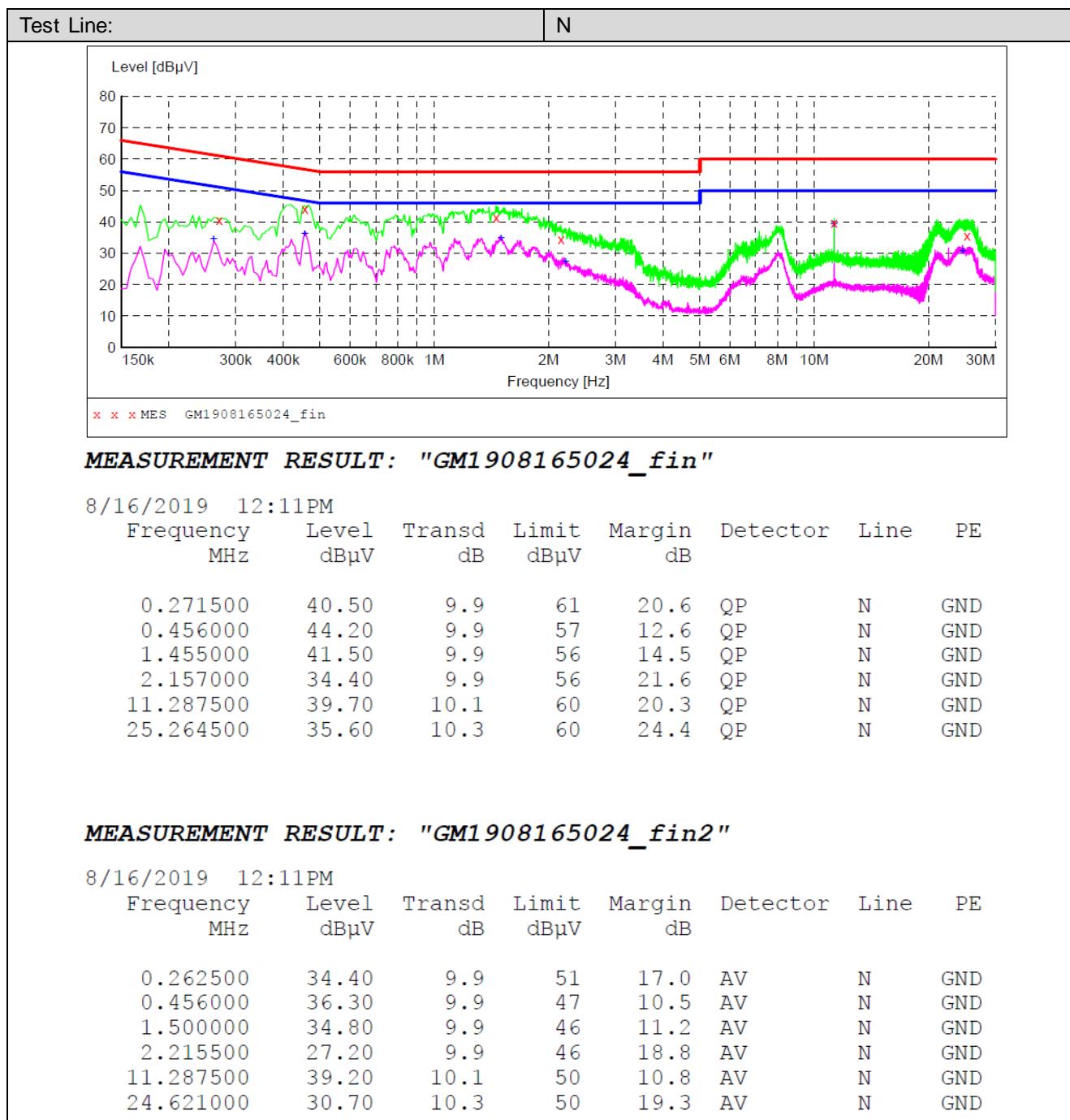
### TEST RESULTS

Passed       Not Applicable

Note:

- 1) Transd= Cable loss + Pulse Limiter Factor + Artificial Mains Factor
- 2) Margin= Limit - Level
- 3) The worst case is model: STUDIOOLIVE AR16c





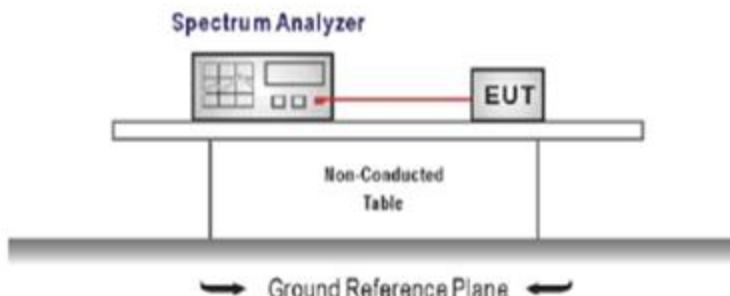
### 5.3. Conducted Peak Output Power

#### LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 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.  
For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

#### TEST CONFIGURATION



#### TEST PROCEDURE

1. The transmitter output was connected to the spectrum analyzer through an attenuator, the pathloss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:  
Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel  
 $RBW \geq$  the 20 dB bandwidth of the emission being measured,  $VBW \geq RBW$   
Sweep = auto, Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

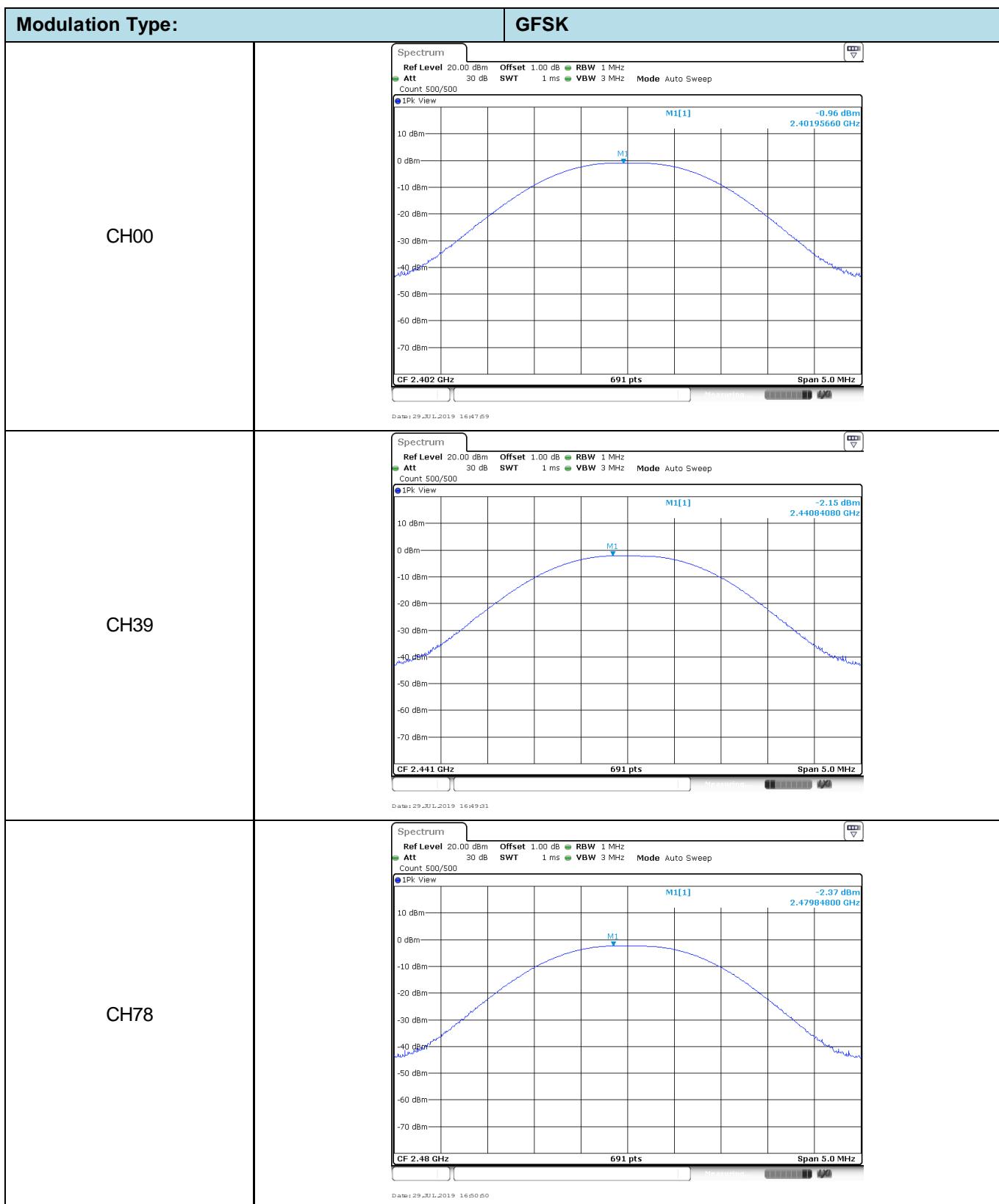
#### TEST MODE:

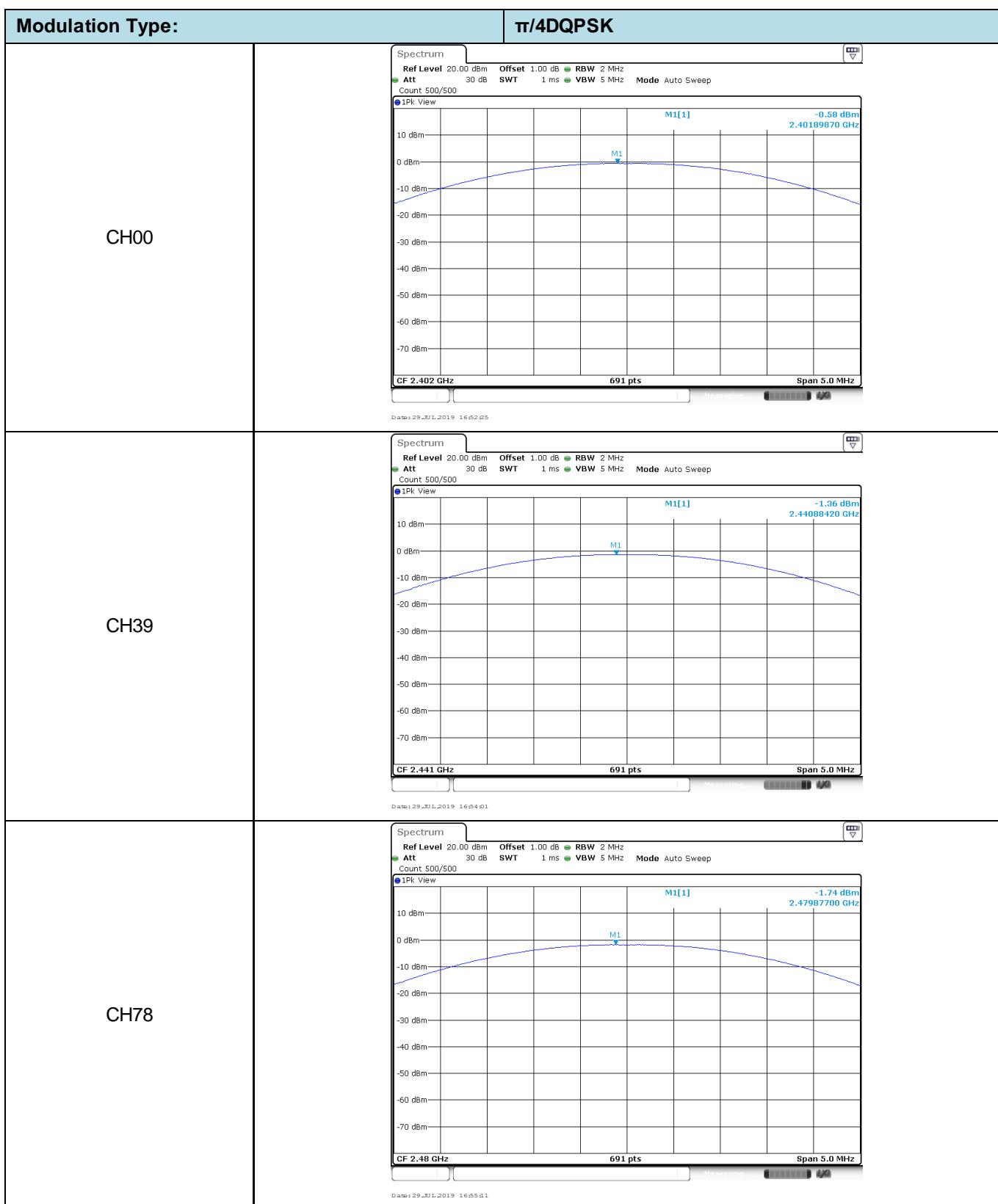
Please refer to the clause 3.3

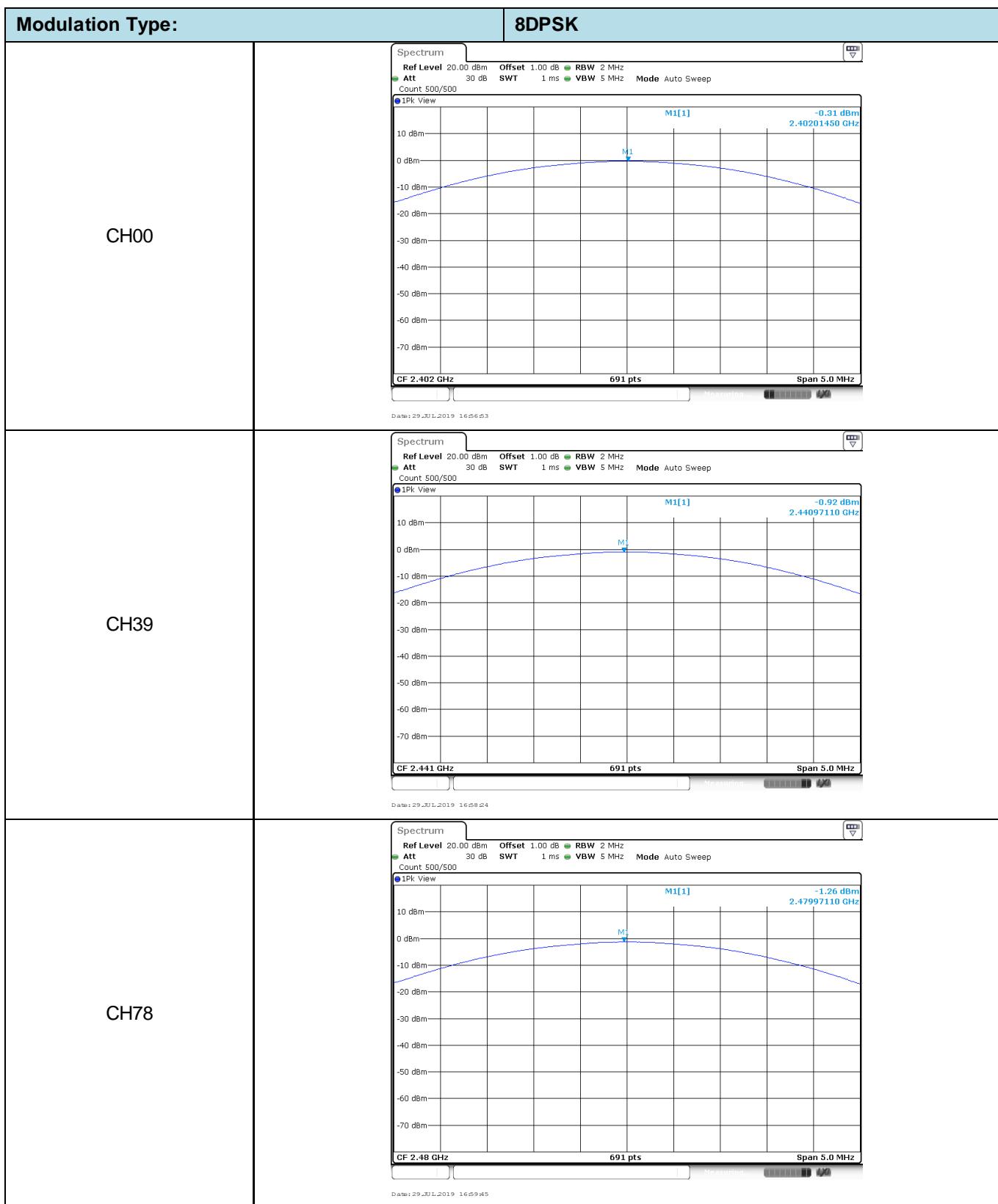
#### TEST RESULTS

Passed       Not Applicable

Modulation type	Channel	Peak Output power (dBm)	Average Output power (dBm)	Limit (dBm)	Result
GFSK	00	-0.96	-0.99	$\leq 30.00$	Pass
	39	-2.15	-2.19		
	78	-2.37	-2.42		
$\pi/4$ DQPSK	00	-0.58	-1.03	$\leq 21.00$	Pass
	39	-1.36	-1.55		
	78	-1.74	-1.92		
8DPSK	00	-0.31	-1.39	$\leq 21.00$	Pass
	39	-0.92	-1.56		
	78	-1.26	-2.08		





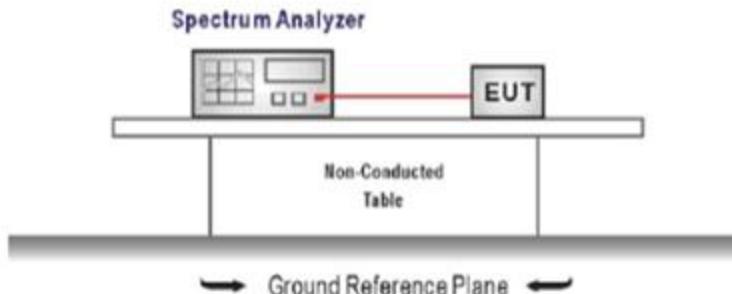


## 5.4. 20 dB Bandwidth

### LIMIT

N/A

### TEST CONFIGURATION



### TEST PROCEDURE

1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:  
Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel  
RBW  $\geq$  1% of the 20 dB bandwidth, VBW  $\geq$  RBW  
Sweep = auto, Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

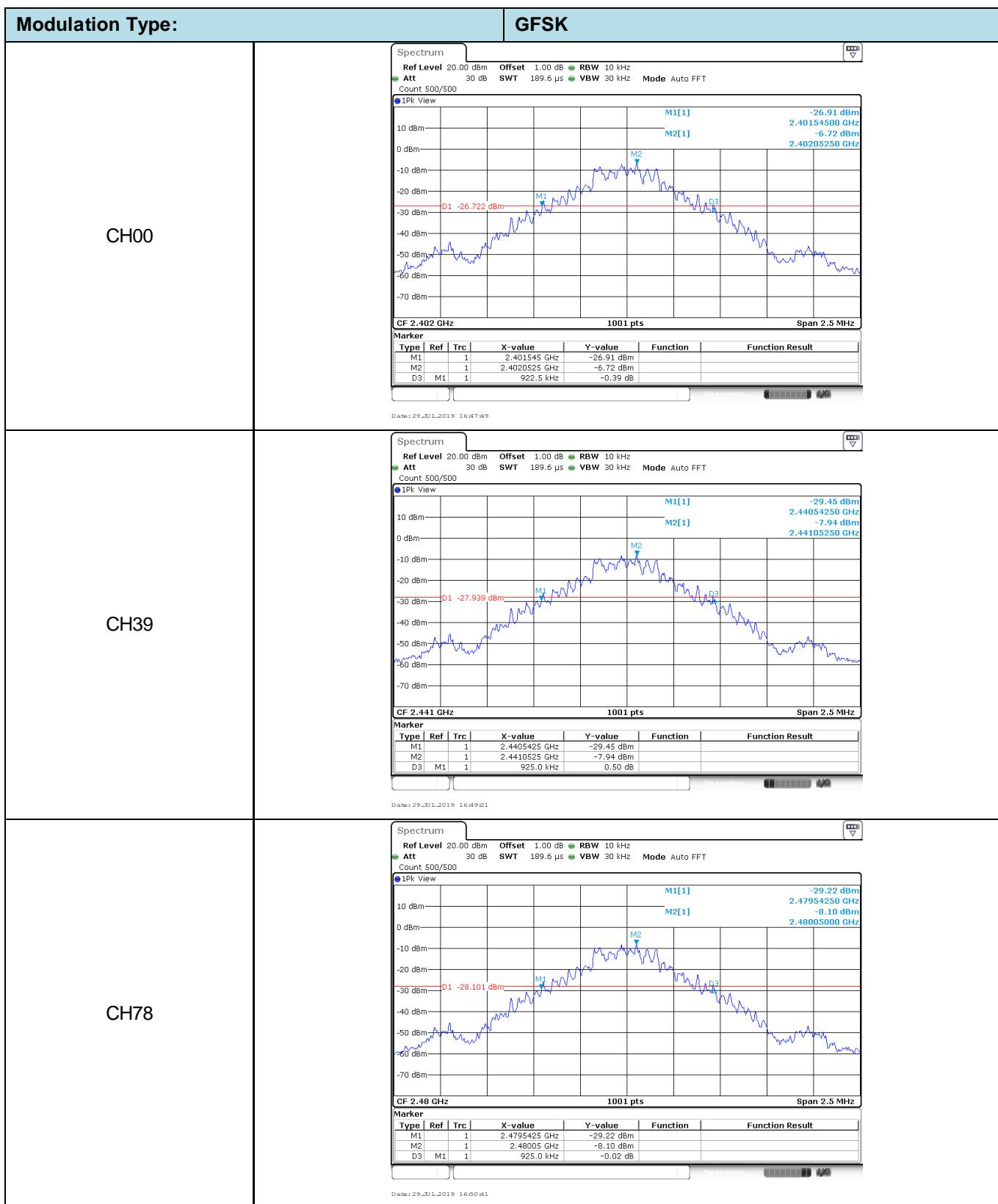
### TEST MODE:

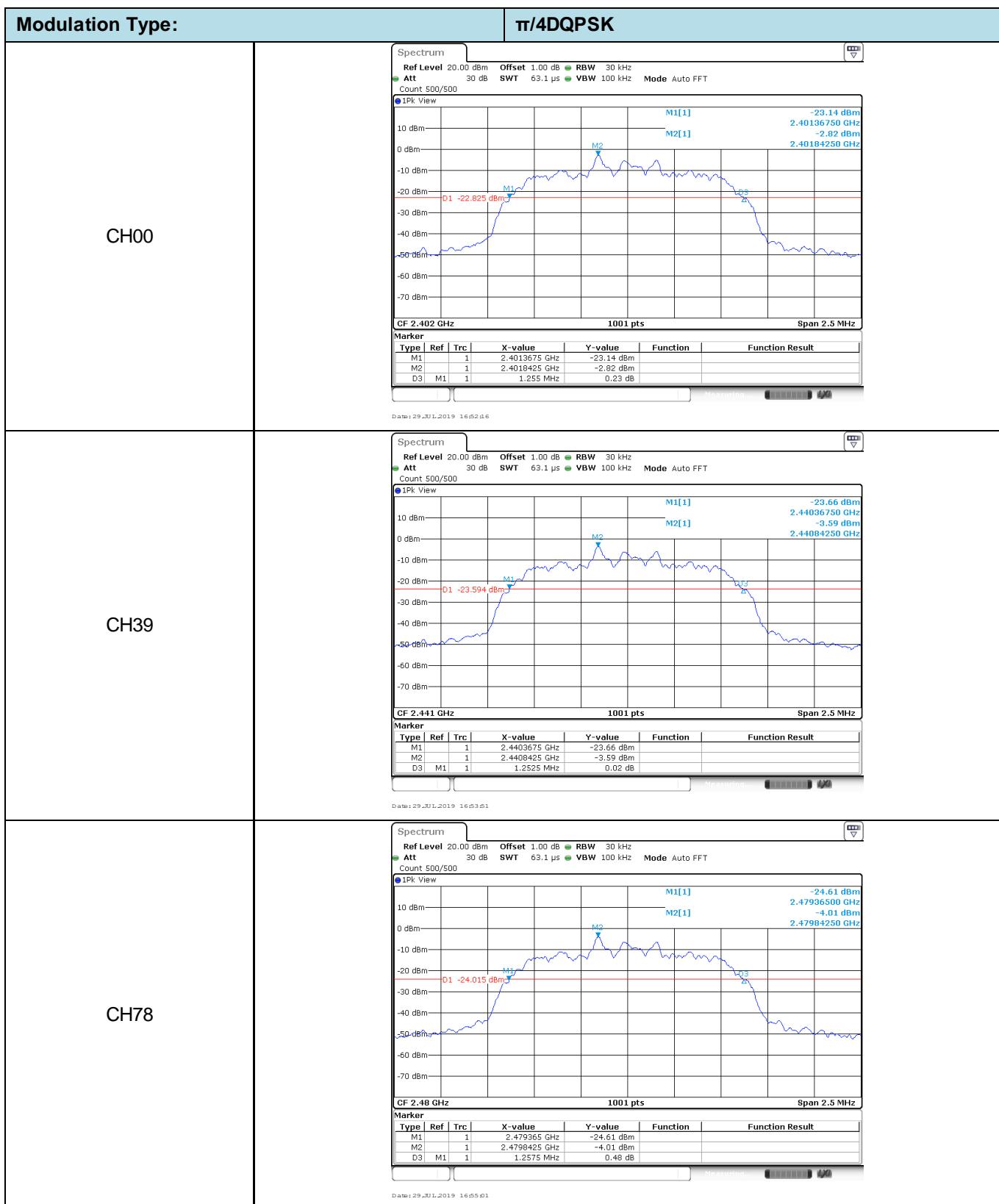
Please refer to the clause 3.3

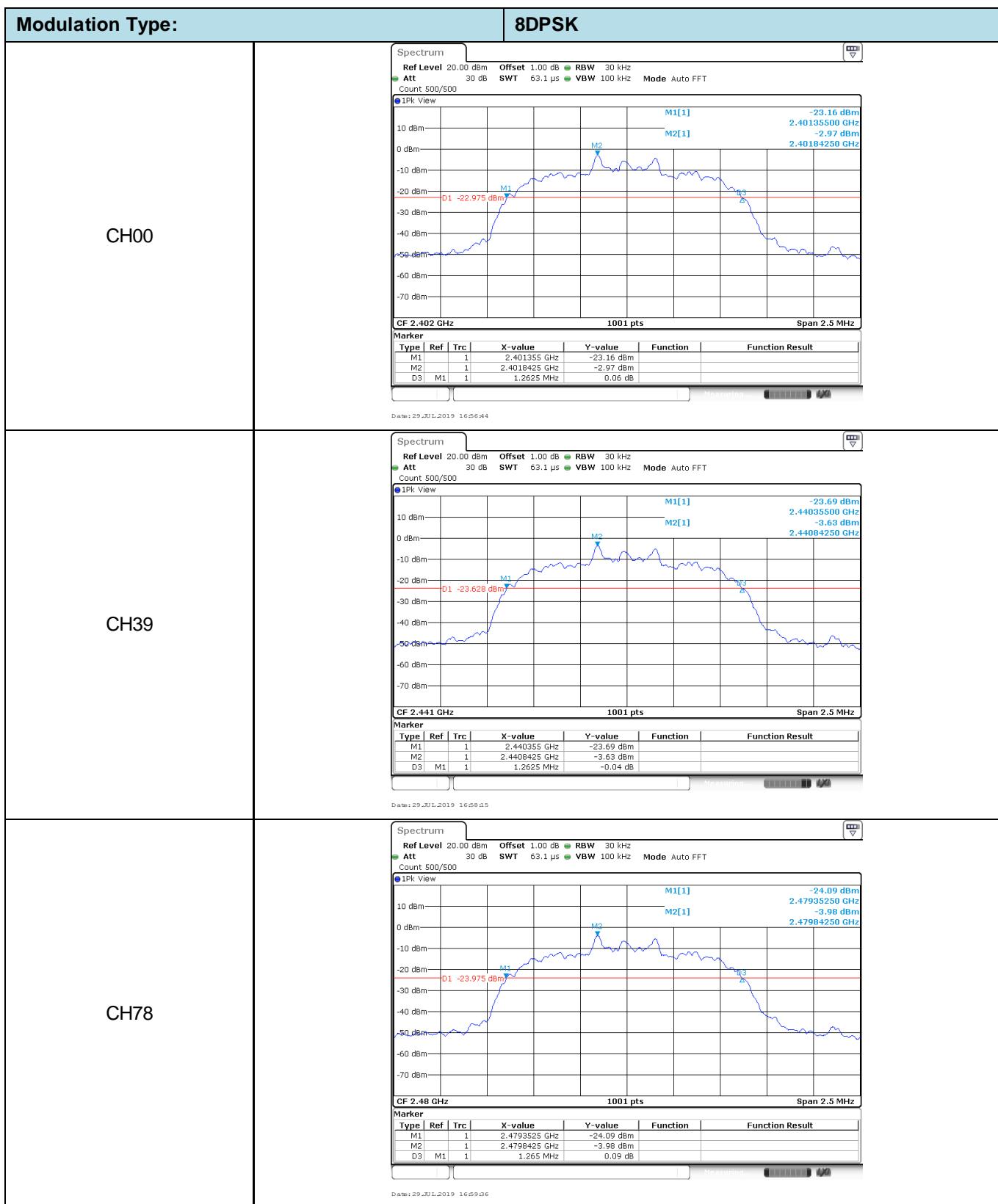
### TEST RESULTS

Passed       Not Applicable

Modulation type	Channel	20 dB Bandwidth (MHz)	Limit (MHz)	Result
GFSK	00	0.92	-	Pass
	39	0.93		
	78	0.93		
$\pi/4$ DQPSK	00	1.25	-	Pass
	39	1.25		
	78	1.26		
8DPSK	00	1.26	-	Pass
	39	1.26		
	78	1.26		







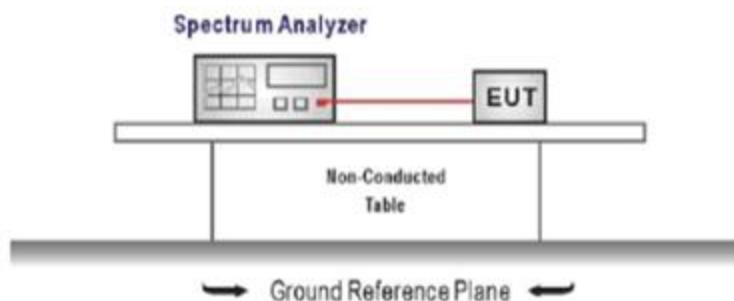
## 5.5. Carrier Frequencies Separation

### LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):

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

### TEST CONFIGURATION



### TEST PROCEDURE

1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:  
Span = wide enough to capture the peaks of two adjacent channels  
RBW  $\geq$  1% of the span, VBW  $\geq$  RBW  
Sweep = auto, Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

### TEST MODE:

Please refer to the clause 3.3

### TEST RESULTS

Passed       Not Applicable

Modulation type	Channel	Carrier Frequencies Separation (MHz)	Limit (MHz) *	Result
GFSK	39	1.00	$\geq$ 0.93	Pass
$\pi/4$ DQPSK	39	1.00	$\geq$ 0.84	Pass
8DPSK	39	1.00	$\geq$ 0.84	Pass

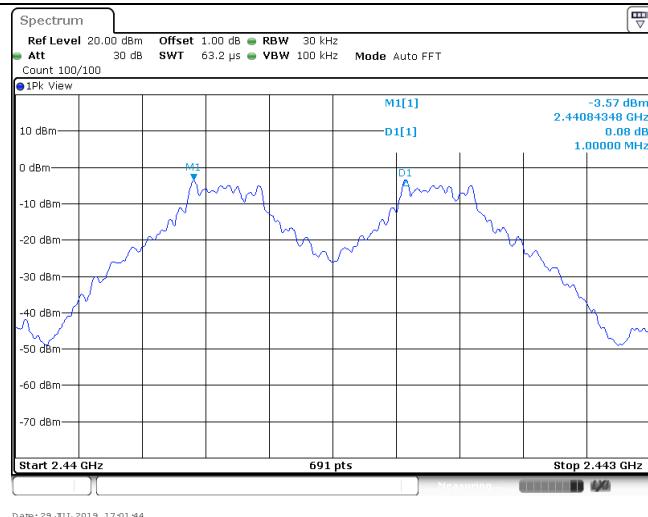
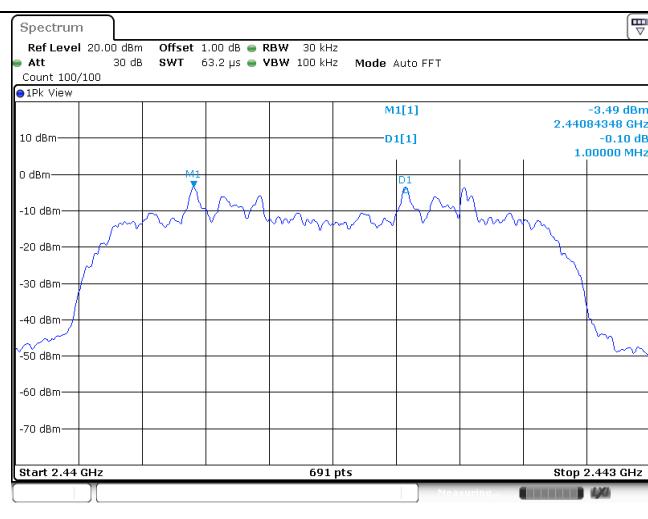
Note:

\*: GFSK limit = The maximum 20 dB Bandwidth for GFSK modulation on the section 5.4.

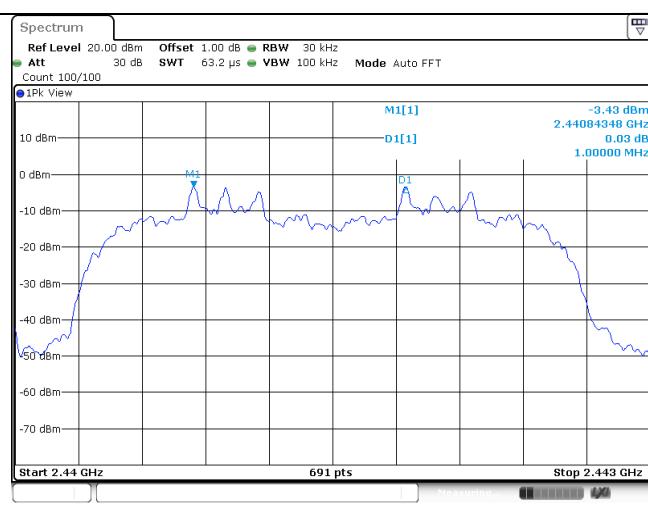
$\pi/4$ DQPSK limit =  $2/3 *$  The maximum 20 dB Bandwidth for  $\pi/4$ DQPSK modulation on the section 5.4.

8DPSK limit =  $2/3 *$  The maximum 20 dB Bandwidth for 8DPSK modulation on the section 5.4

GFSK

 $\pi/4$ DQPSK

8DPSK

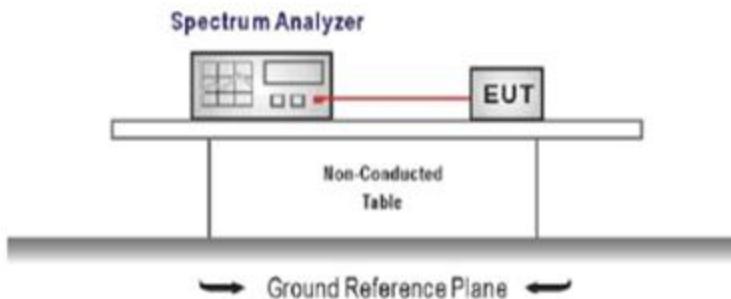


## 5.6. Hopping Channel Number

### LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):Frequency hopping systems in the 2400–2483.5 MHz band shall use at least **15** channels.

### TEST CONFIGURATION



### TEST PROCEDURE

1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:  
Span = the frequency band of operation  
RBW  $\geq$  1% of the span, VBW  $\geq$  RBW  
Sweep = auto, Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

### TEST MODE:

Please refer to the clause 3.3

### TEST RESULTS

Passed       Not Applicable

Modulation type	Channel number	Limit	Result
GFSK	79	$\geq 15.00$	Pass
$\pi/4$ DQPSK	79		
8DPSK	79		

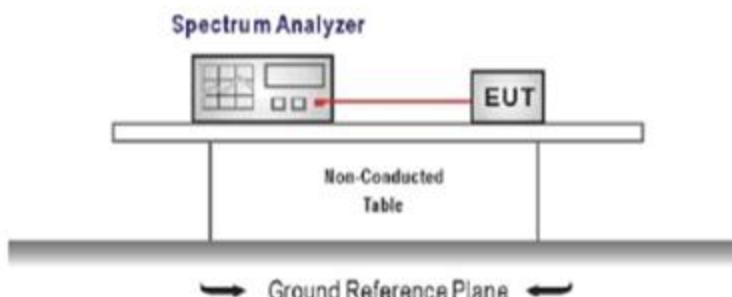


## 5.7. Dwell Time

### LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):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.

### TEST CONFIGURATION



### TEST PROCEDURE

1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:  
Span = zero span, centered on a hopping channel, RBW= 1 MHz, VBW  $\geq$  RBW  
Sweep = as necessary to capture the entire dwell time per hopping channel,  
Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

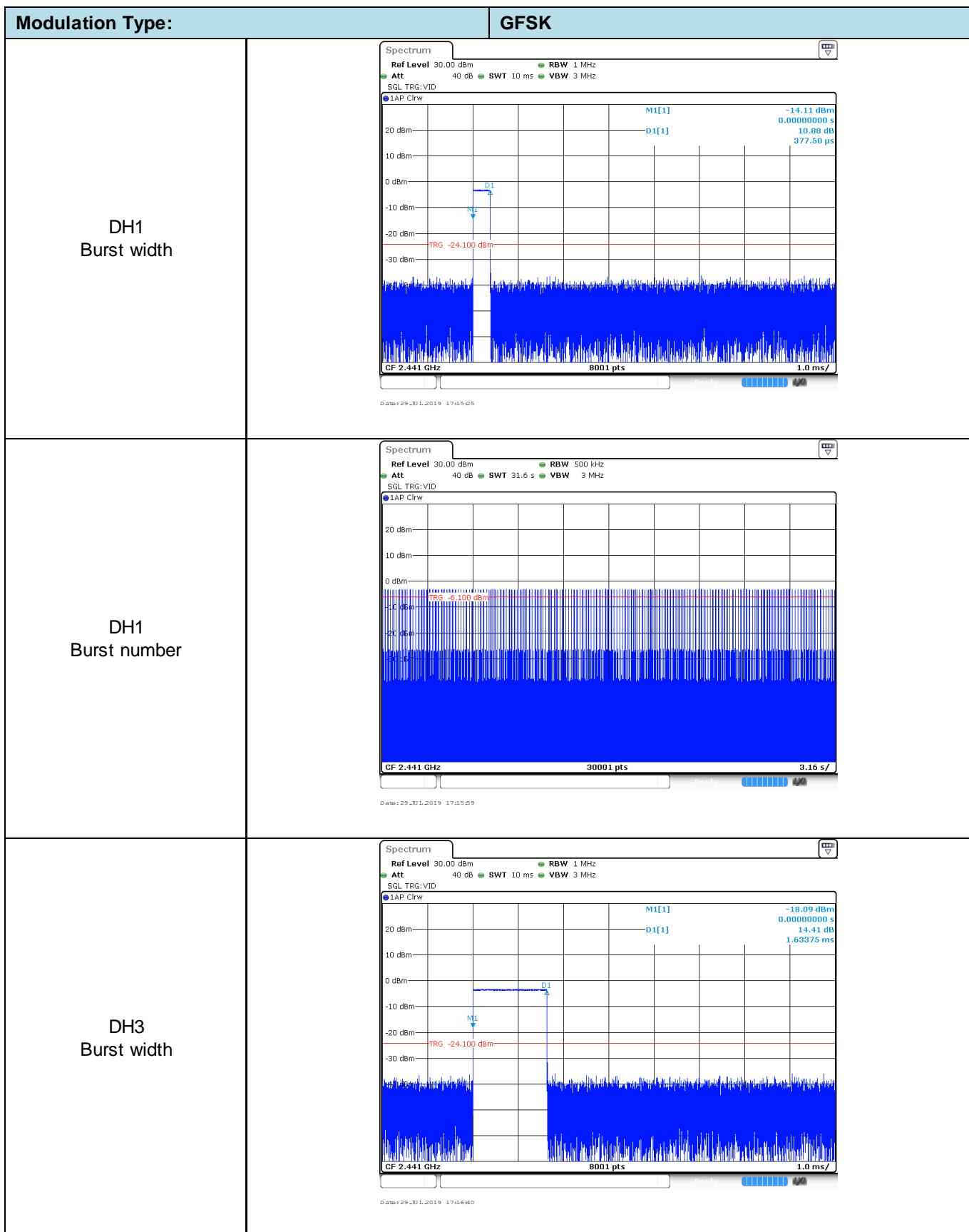
### TEST MODE:

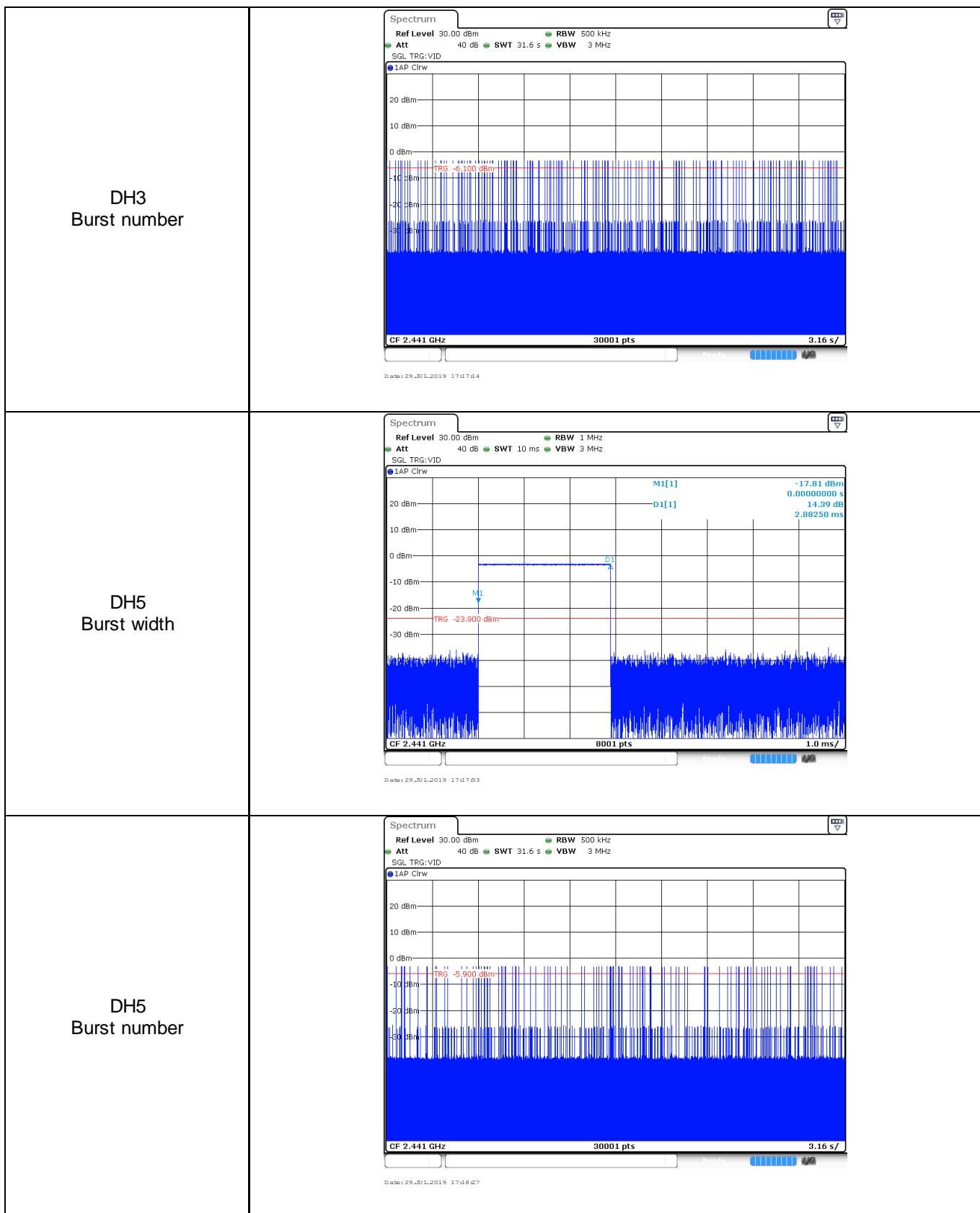
Please refer to the clause 3.3

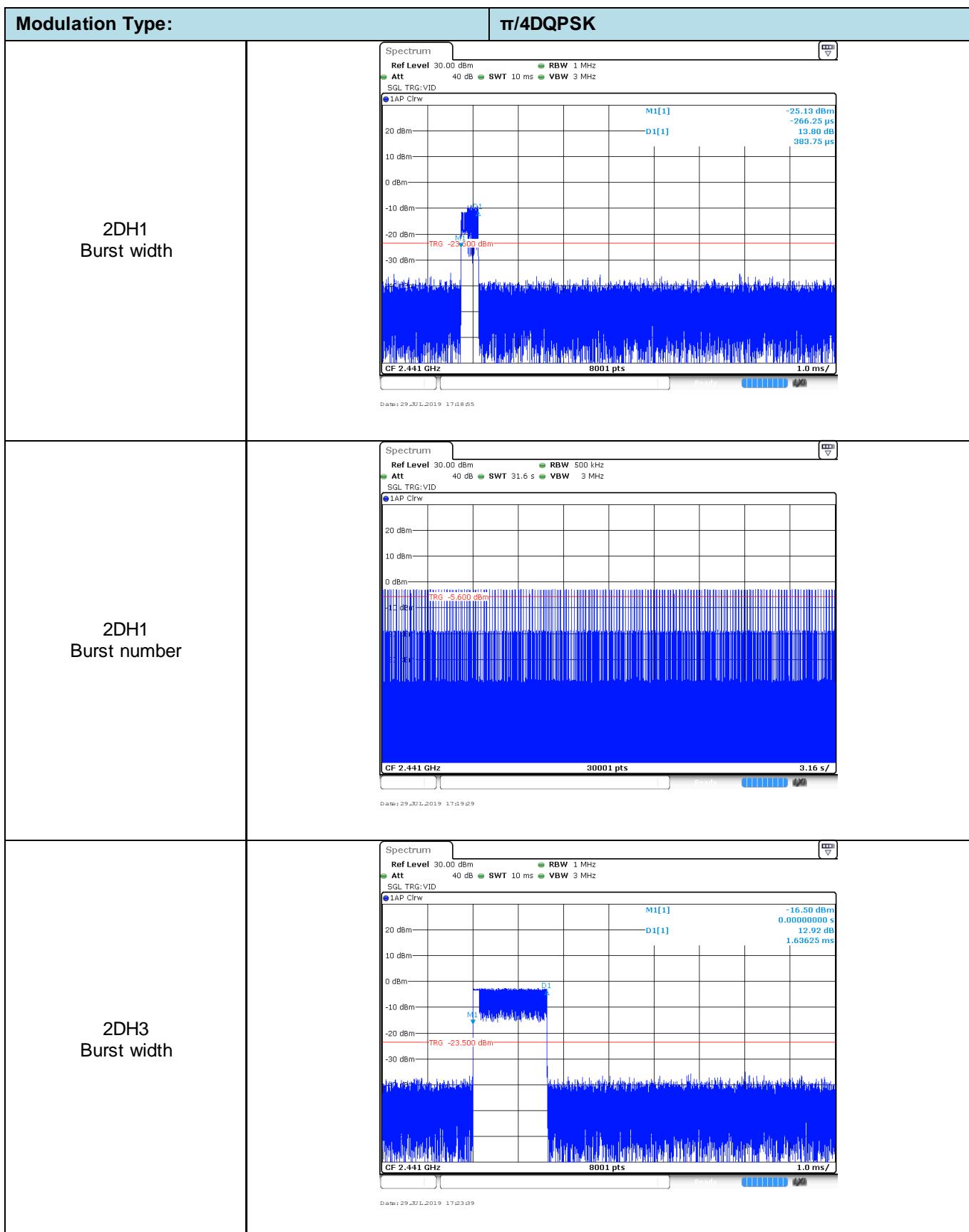
### TEST RESULTS

Passed       Not Applicable

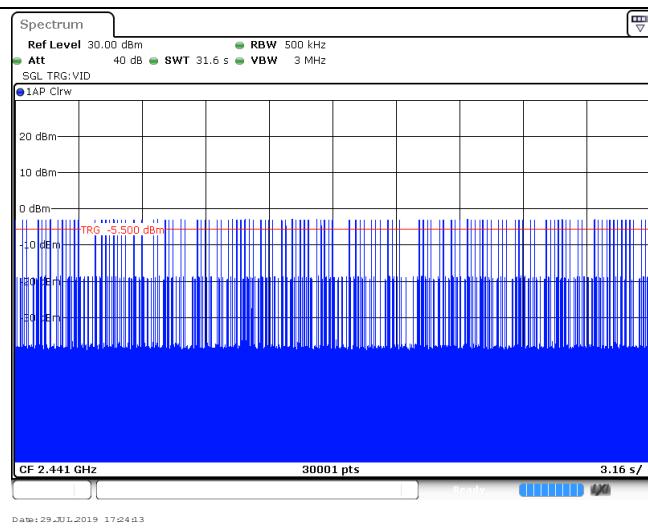
Modulation type	Channel	Burst Width [ms/hop/ch]	Total Hops[hop*ch]	Dwell time (Second)	Limit (Second)	Result
GFSK	DH1	0.38	321.00	0.12	$\leq 0.40$	Pass
	DH3	1.63	161.00	0.26		
	DH5	2.88	112.00	0.32		
$\pi/4$ DQPSK	2DH1	0.38	321.00	0.12	$\leq 0.40$	Pass
	2DH3	1.64	155.00	0.25		
	2DH5	2.89	96.00	0.28		
8DPSK	3DH1	0.38	319.00	0.12	$\leq 0.40$	Pass
	3DH3	1.63	164.00	0.27		
	3DH5	2.89	103.00	0.30		



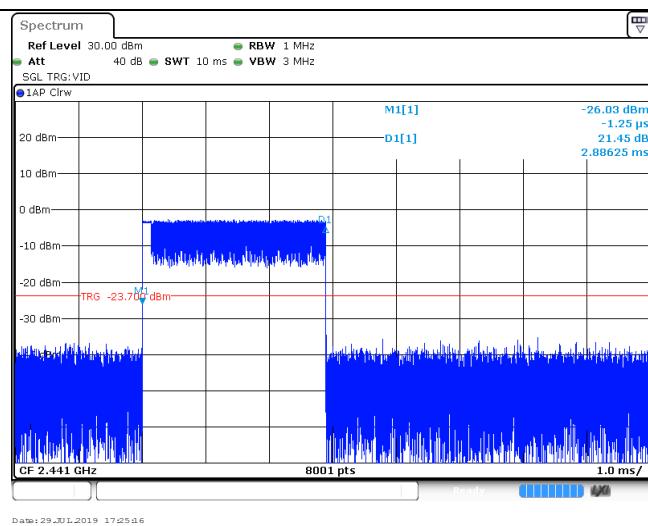




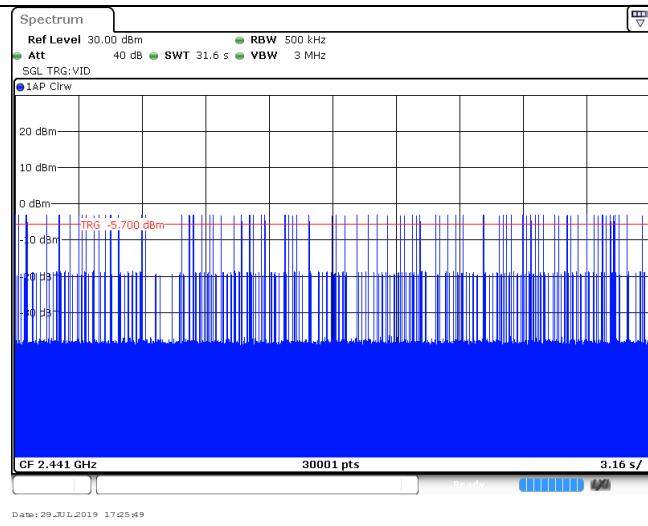
2DH3  
Burst number

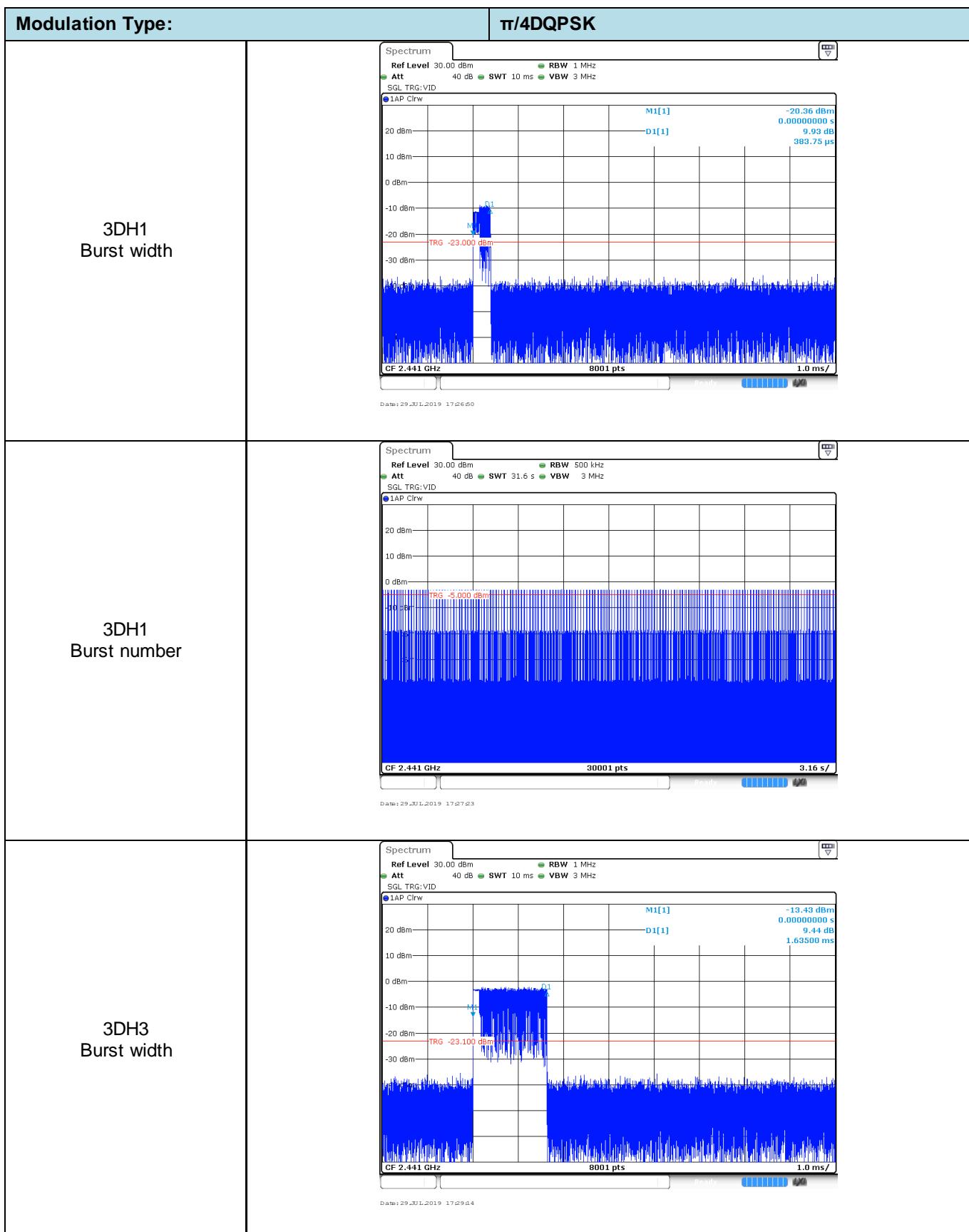


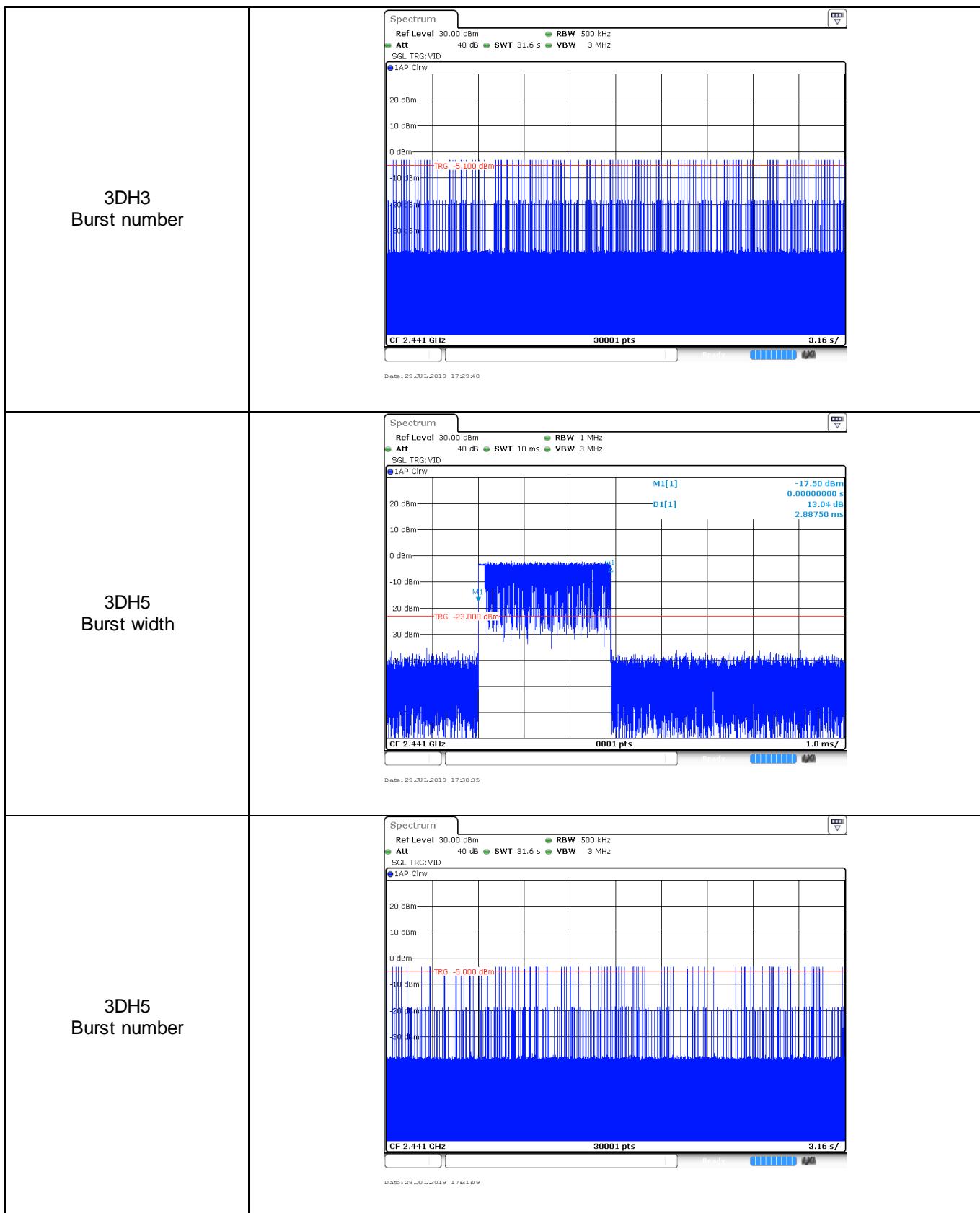
2DH5  
Burst width



2DH5  
Burst number







## 5.8. Pseudorandom Frequency Hopping Sequence

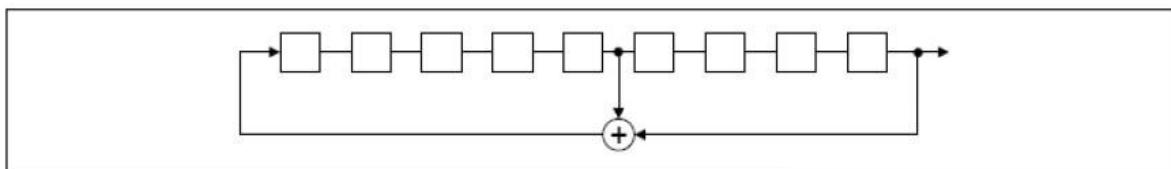
### LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):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 RESULTS

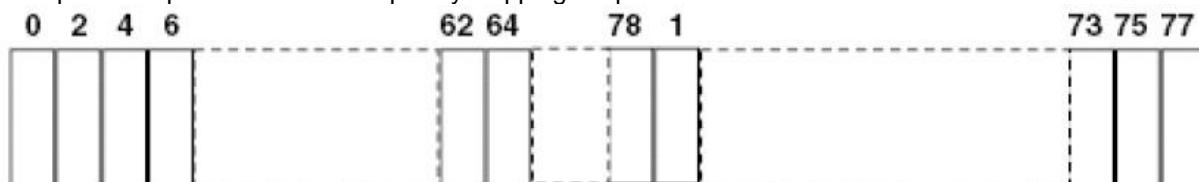
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence:  $2^9 - 1 = 511$  bits
- Longest sequence of zeros: 8 (non-inverted signal)



*Linear Feedback Shift Register for Generation of the PRBS sequence*

An example of pseudorandom frequency hopping sequence as follows:



Each frequency used equally one the average by each transmitter.

The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

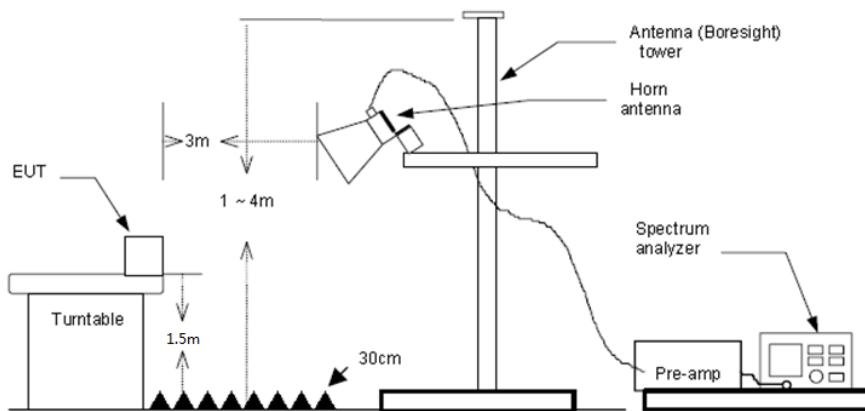
## 5.9. Restricted band (radiated)

### LIMIT

#### FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d):

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, Radiated Emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the Radiated Emissions limits specified in §15.209(a) (see §15.205(c)).

### TEST CONFIGURATION



### TEST PROCEDURE

1. The EUT was setup and tested according to ANSI C63.10:2013 for compliance to FCC 47CFR 15.247 requirements.
2. The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level.
3. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.
4. The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10:2013 on radiated measurement.
5. The receiver set as follow:  
RBW=1 MHz, VBW=3 MHz Peak detector for Peak value  
RBW=1 MHz, VBW=10 Hz Peak detector for Average value.

### TEST MODE:

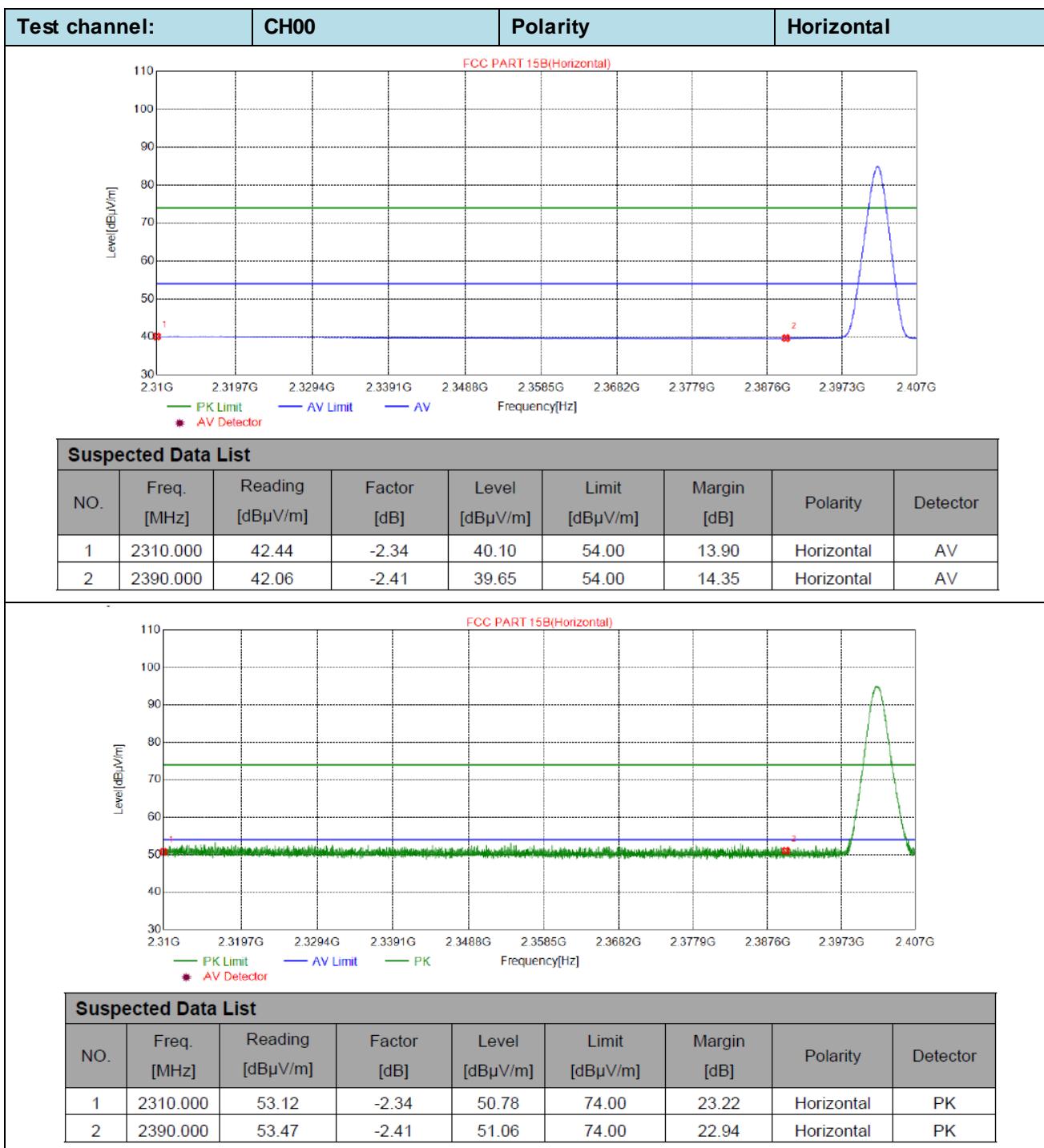
Please refer to the clause 3.3

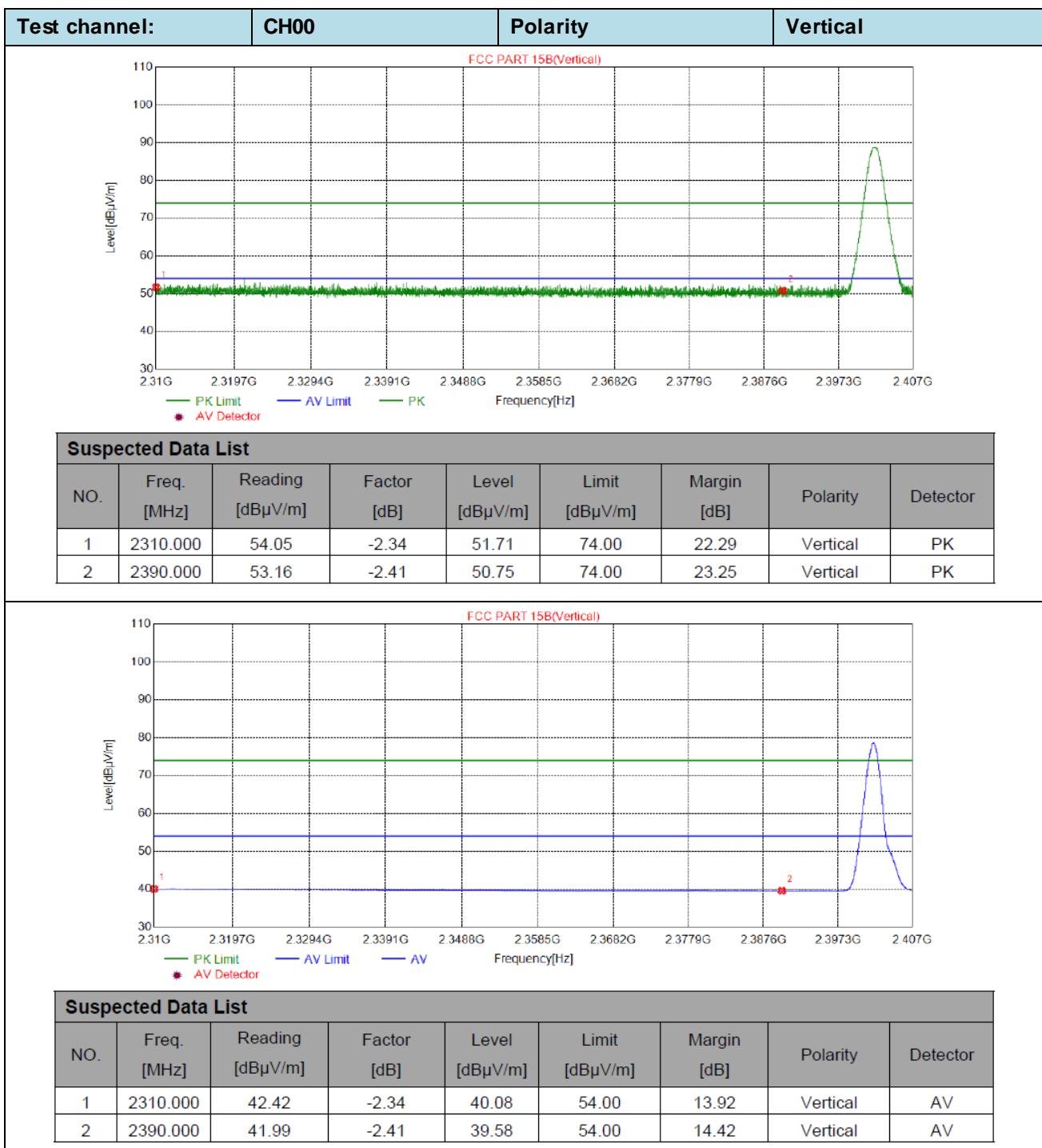
### TEST RESULTS

Passed       Not Applicable

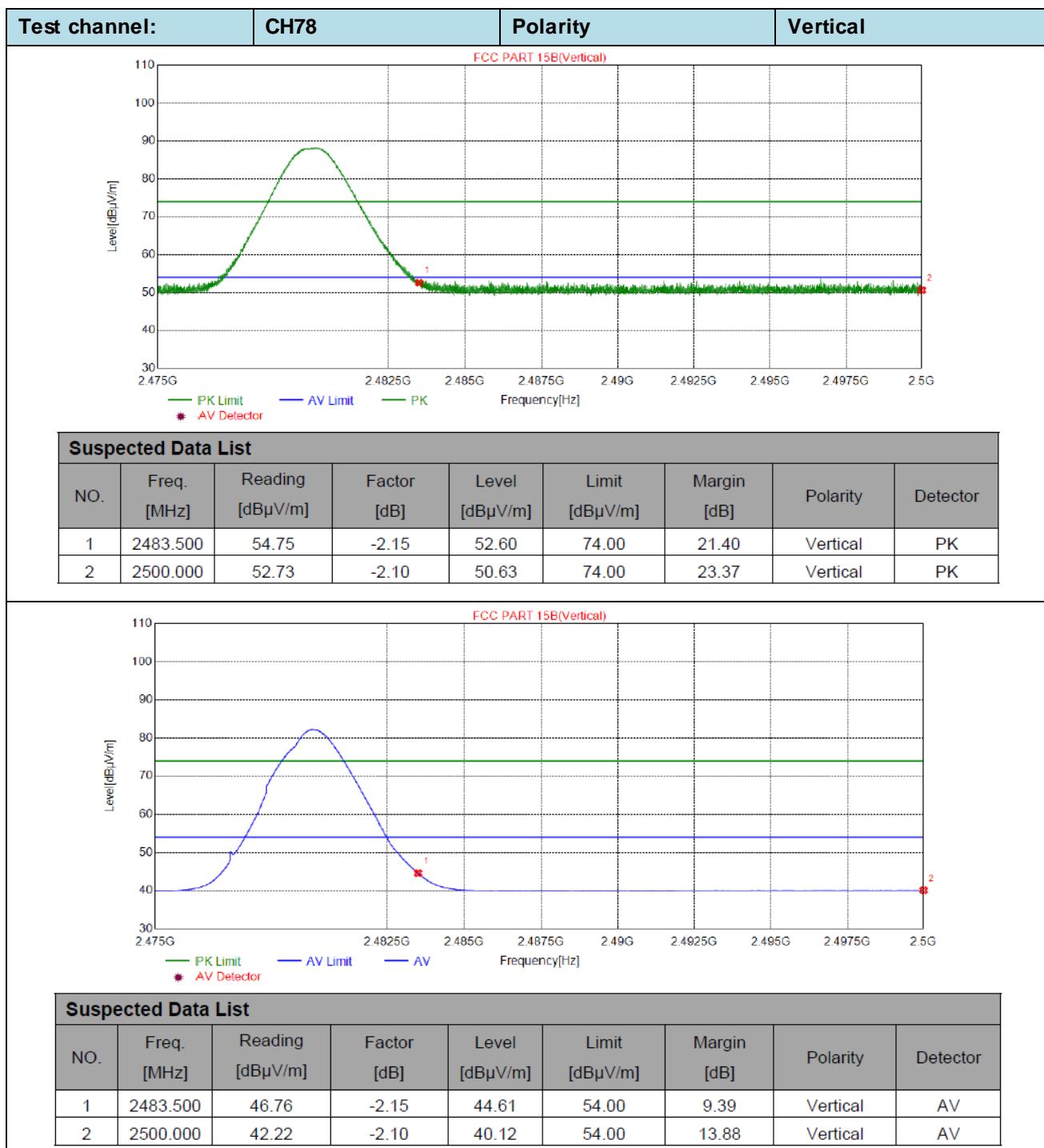
#### Note:

- 1) Final level= Read level + Factor
- 2) Have pre-scan all modulation mode, found the GFSK modulation which it was worst case, so only the worst case's data on the test report.
- 3) The peak level is lower than average limit(54 dBuV/m), this data is the too weak instrument of signal is unable to test.





Test channel:	CH78	Polarity	Horizontal					
<b>FCC PART 15B(Horizontal)</b>								
<b>Suspected Data List</b>								
NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Polarity	Detector
1	2483.500	48.79	-2.15	46.64	54.00	7.36	Horizontal	AV
2	2500.000	42.25	-2.10	40.15	54.00	13.85	Horizontal	AV
<b>FCC PART 15B(Horizontal)</b>								
<b>Suspected Data List</b>								
NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Polarity	Detector
1	2483.500	59.05	-2.15	56.90	74.00	17.10	Horizontal	PK
2	2500.000	52.44	-2.10	50.34	74.00	23.66	Horizontal	PK

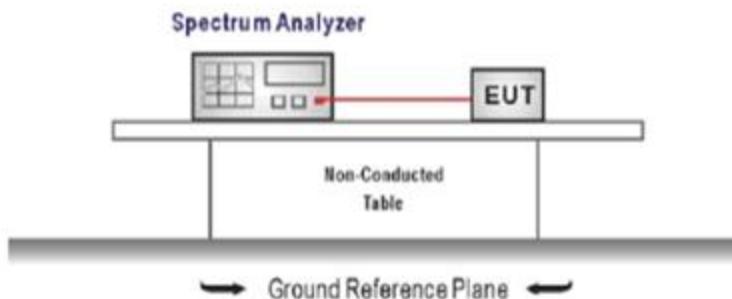


## 5.10. Band edge and Spurious Emissions (conducted)

### LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

### TEST CONFIGURATION



### TEST PROCEDURE

1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:  
RBW = 100 kHz, VBW  $\geq$  RBW, scan up through 10<sup>th</sup> harmonic.  
Sweep = auto, Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

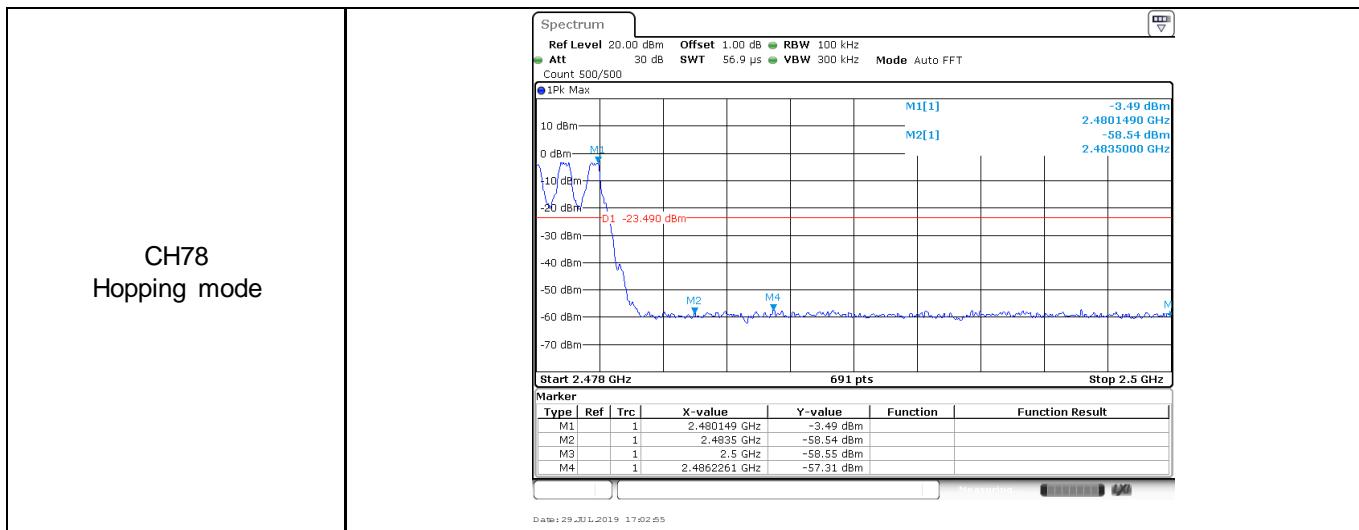
### TEST MODE:

Please refer to the clause 3.3

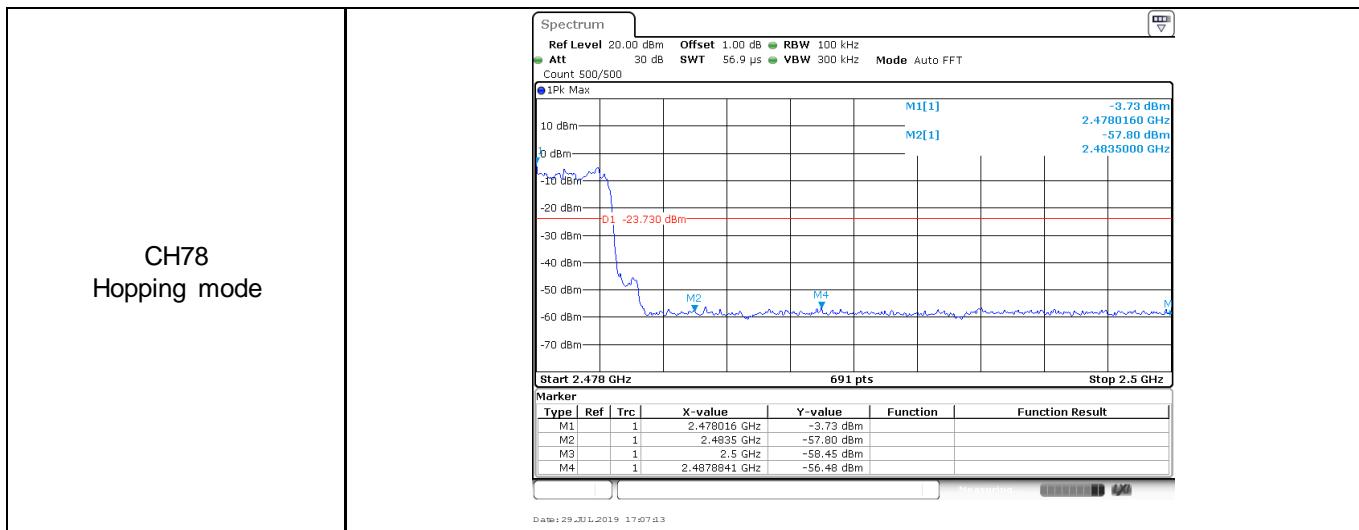
### TEST RESULTS

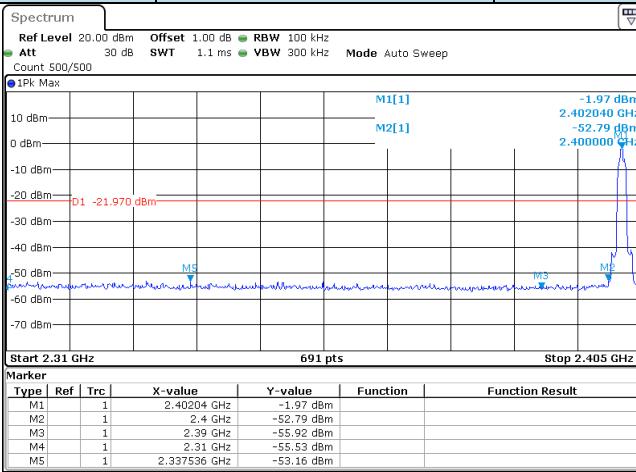
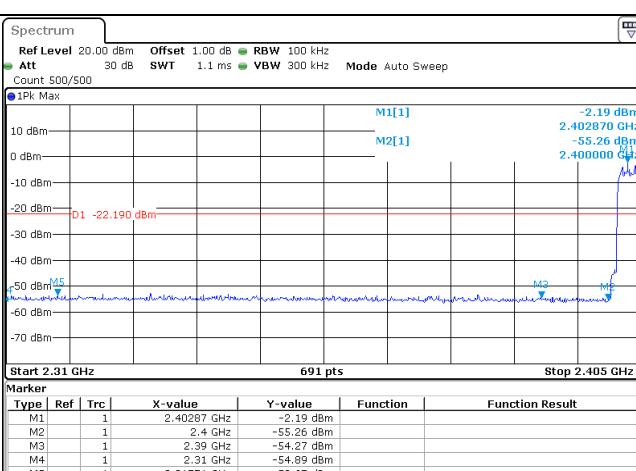
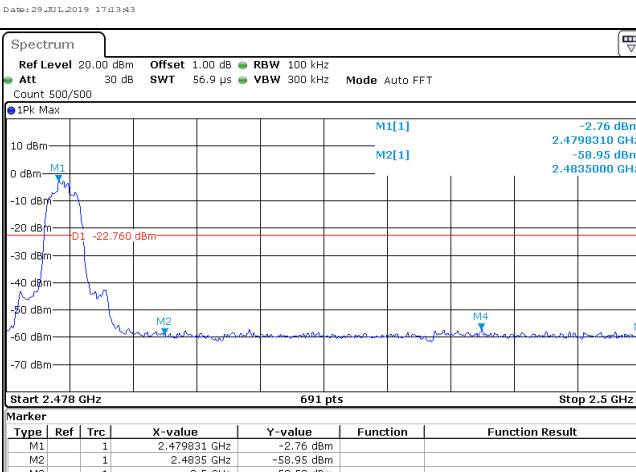
Passed       Not Applicable

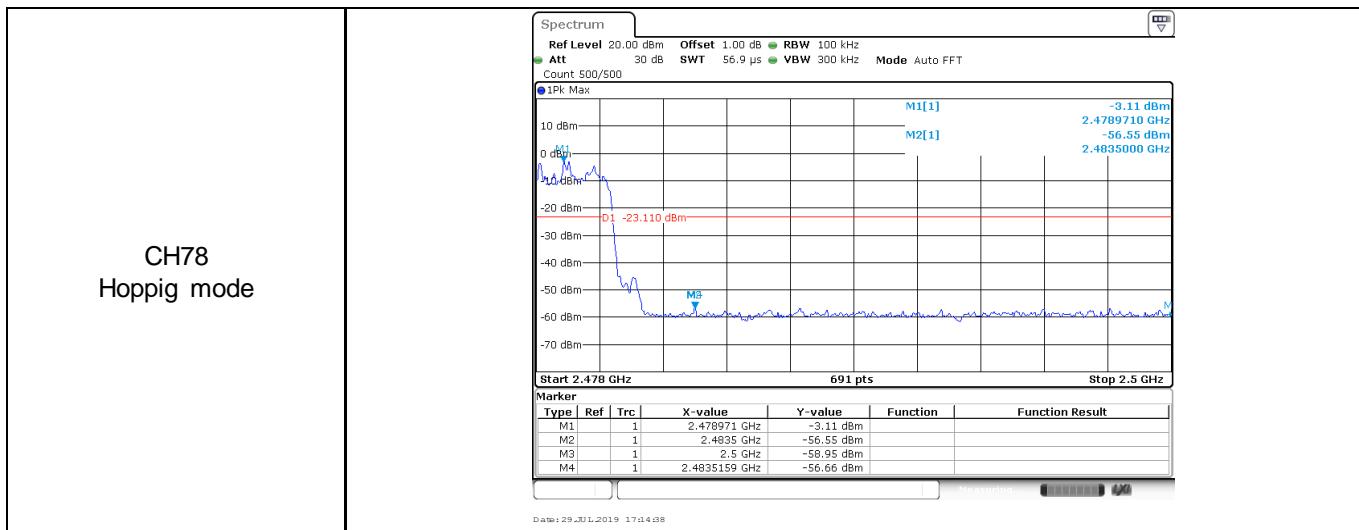
Test Item:	Band edge	Modulation type:	GFSK
CH00 No hopping mode			
CH00 Hopping mode			
CH78 No hopping mode			

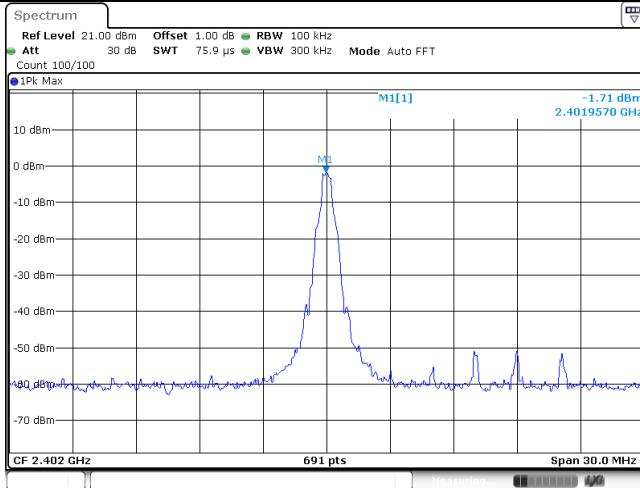
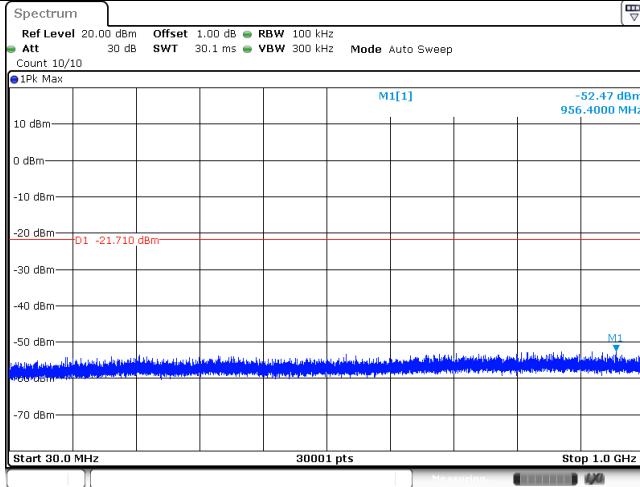
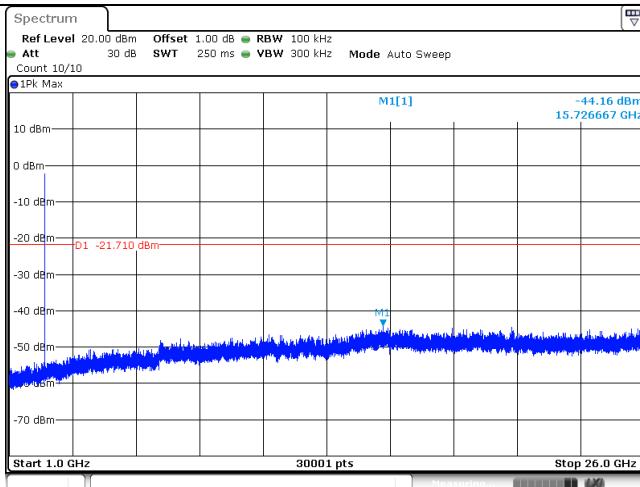


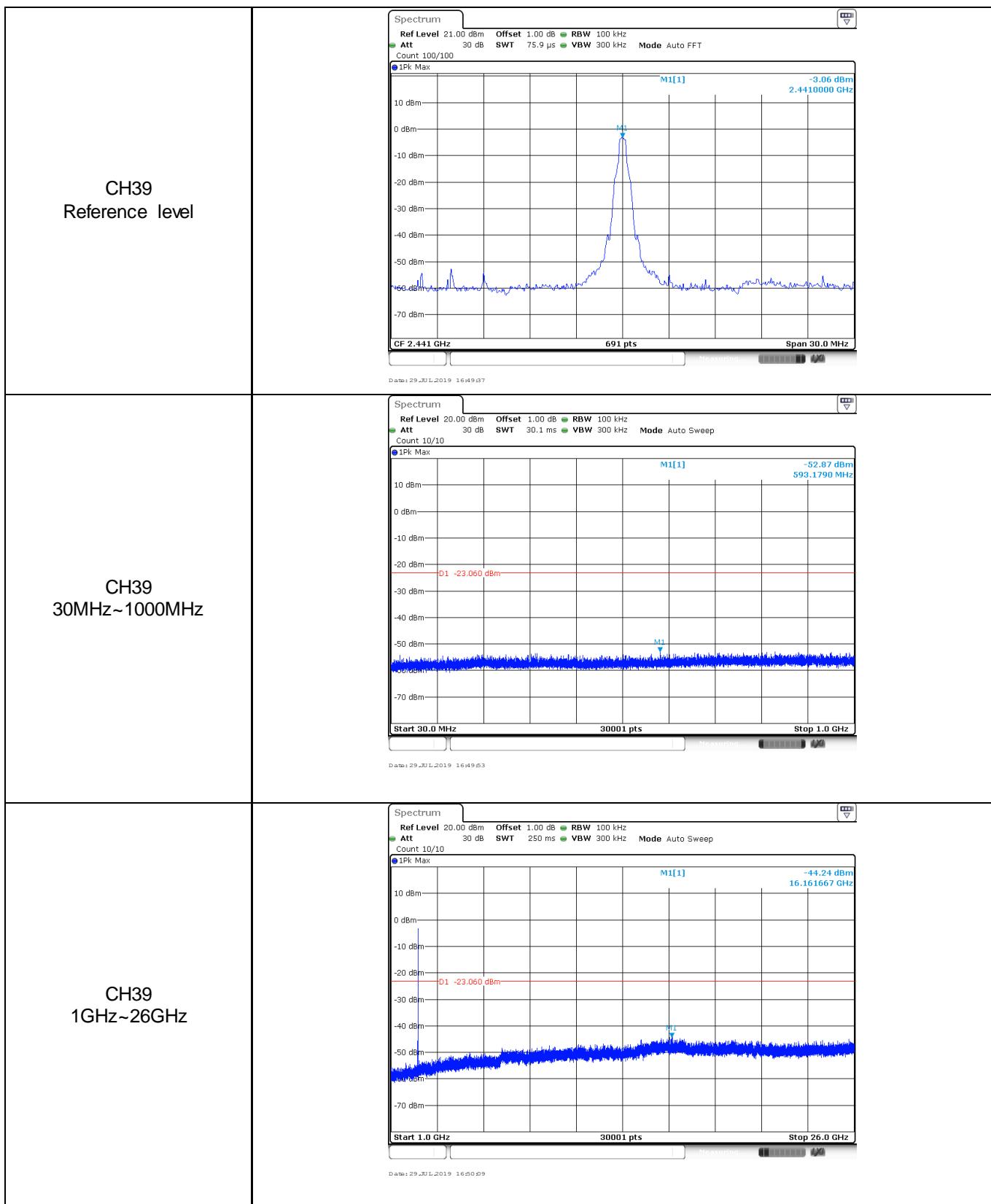
Test Item:	Band edge	Modulation type:	$\pi/4$ DQPSK																																										
CH00 No hopping mode			<p>Spectrum</p> <p>Ref Level 20.00 dBm Offset 1.00 dB RBW 100 kHz  Att 30 dB SWT 1.1 ms VBW 300 kHz Mode Auto Sweep  Count 500/500</p> <p>1Pk Max</p> <p>M1[1] -1.85 dBm 2.40204 GHz  M2[1] -53.57 dBm 2.400000 GHz  M3 -54.93 dBm 2.31 GHz</p> <p>Start 2.31 GHz 691 pts Stop 2.405 GHz</p> <p>Marker</p> <table border="1"> <thead> <tr> <th>Type</th><th>Ref</th><th>Trc</th><th>X-value</th><th>Y-value</th><th>Function</th><th>Function Result</th></tr> </thead> <tbody> <tr> <td>M1</td><td>1</td><td></td><td>2.40204 GHz</td><td>-1.85 dBm</td><td></td><td></td></tr> <tr> <td>M2</td><td>1</td><td></td><td>2.4 GHz</td><td>-53.57 dBm</td><td></td><td></td></tr> <tr> <td>M3</td><td>1</td><td></td><td>2.39 GHz</td><td>-55.73 dBm</td><td></td><td></td></tr> <tr> <td>M4</td><td>1</td><td></td><td>2.31 GHz</td><td>-54.93 dBm</td><td></td><td></td></tr> <tr> <td>M5</td><td>1</td><td></td><td>2.399906 GHz</td><td>-53.26 dBm</td><td></td><td></td></tr> </tbody> </table> <p>Date: 29.JUL.2019 16:52:29</p>	Type	Ref	Trc	X-value	Y-value	Function	Function Result	M1	1		2.40204 GHz	-1.85 dBm			M2	1		2.4 GHz	-53.57 dBm			M3	1		2.39 GHz	-55.73 dBm			M4	1		2.31 GHz	-54.93 dBm			M5	1		2.399906 GHz	-53.26 dBm		
Type	Ref	Trc	X-value	Y-value	Function	Function Result																																							
M1	1		2.40204 GHz	-1.85 dBm																																									
M2	1		2.4 GHz	-53.57 dBm																																									
M3	1		2.39 GHz	-55.73 dBm																																									
M4	1		2.31 GHz	-54.93 dBm																																									
M5	1		2.399906 GHz	-53.26 dBm																																									
CH00 Hopping mode			<p>Spectrum</p> <p>Ref Level 20.00 dBm Offset 1.00 dB RBW 100 kHz  Att 30 dB SWT 1.1 ms VBW 300 kHz Mode Auto Sweep  Count 500/500</p> <p>1Pk Max</p> <p>M1[1] -2.20 dBm 2.402870 GHz  M2[1] -54.76 dBm 2.400000 GHz  M3 -54.89 dBm 2.31 GHz</p> <p>Start 2.31 GHz 691 pts Stop 2.405 GHz</p> <p>Marker</p> <table border="1"> <thead> <tr> <th>Type</th><th>Ref</th><th>Trc</th><th>X-value</th><th>Y-value</th><th>Function</th><th>Function Result</th></tr> </thead> <tbody> <tr> <td>M1</td><td>1</td><td></td><td>2.402870 GHz</td><td>-2.20 dBm</td><td></td><td></td></tr> <tr> <td>M2</td><td>1</td><td></td><td>2.4 GHz</td><td>-54.76 dBm</td><td></td><td></td></tr> <tr> <td>M3</td><td>1</td><td></td><td>2.39 GHz</td><td>-54.20 dBm</td><td></td><td></td></tr> <tr> <td>M4</td><td>1</td><td></td><td>2.31 GHz</td><td>-54.89 dBm</td><td></td><td></td></tr> <tr> <td>M5</td><td>1</td><td></td><td>2.326935 GHz</td><td>-53.02 dBm</td><td></td><td></td></tr> </tbody> </table> <p>Date: 29.JUL.2019 17:06:15</p>	Type	Ref	Trc	X-value	Y-value	Function	Function Result	M1	1		2.402870 GHz	-2.20 dBm			M2	1		2.4 GHz	-54.76 dBm			M3	1		2.39 GHz	-54.20 dBm			M4	1		2.31 GHz	-54.89 dBm			M5	1		2.326935 GHz	-53.02 dBm		
Type	Ref	Trc	X-value	Y-value	Function	Function Result																																							
M1	1		2.402870 GHz	-2.20 dBm																																									
M2	1		2.4 GHz	-54.76 dBm																																									
M3	1		2.39 GHz	-54.20 dBm																																									
M4	1		2.31 GHz	-54.89 dBm																																									
M5	1		2.326935 GHz	-53.02 dBm																																									
CH78 No hopping mode			<p>Spectrum</p> <p>Ref Level 20.00 dBm Offset 1.00 dB RBW 100 kHz  Att 30 dB SWT 56.9 <math>\mu</math>s VBW 300 kHz Mode Auto FFT  Count 500/500</p> <p>1Pk Max</p> <p>M1[1] -2.75 dBm 2.479831 GHz  M2[1] -59.56 dBm 2.4835000 GHz</p> <p>Start 2.478 GHz 691 pts Stop 2.5 GHz</p> <p>Marker</p> <table border="1"> <thead> <tr> <th>Type</th><th>Ref</th><th>Trc</th><th>X-value</th><th>Y-value</th><th>Function</th><th>Function Result</th></tr> </thead> <tbody> <tr> <td>M1</td><td>1</td><td></td><td>2.479831 GHz</td><td>-2.75 dBm</td><td></td><td></td></tr> <tr> <td>M2</td><td>1</td><td></td><td>2.4835 GHz</td><td>-59.56 dBm</td><td></td><td></td></tr> <tr> <td>M3</td><td>1</td><td></td><td>2.5 GHz</td><td>-60.02 dBm</td><td></td><td></td></tr> <tr> <td>M4</td><td>1</td><td></td><td>2.4874377 GHz</td><td>-57.36 dBm</td><td></td><td></td></tr> </tbody> </table> <p>Date: 29.JUL.2019 16:55:24</p>	Type	Ref	Trc	X-value	Y-value	Function	Function Result	M1	1		2.479831 GHz	-2.75 dBm			M2	1		2.4835 GHz	-59.56 dBm			M3	1		2.5 GHz	-60.02 dBm			M4	1		2.4874377 GHz	-57.36 dBm									
Type	Ref	Trc	X-value	Y-value	Function	Function Result																																							
M1	1		2.479831 GHz	-2.75 dBm																																									
M2	1		2.4835 GHz	-59.56 dBm																																									
M3	1		2.5 GHz	-60.02 dBm																																									
M4	1		2.4874377 GHz	-57.36 dBm																																									



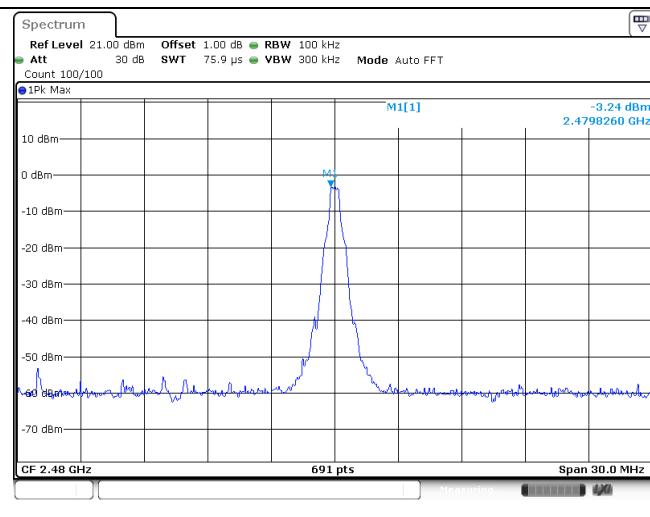
Test Item:	Band edge	Modulation type:	8DPSK
CH00 No hopping mode			
CH00 Hopping mode			
CH78 No hopping mode			



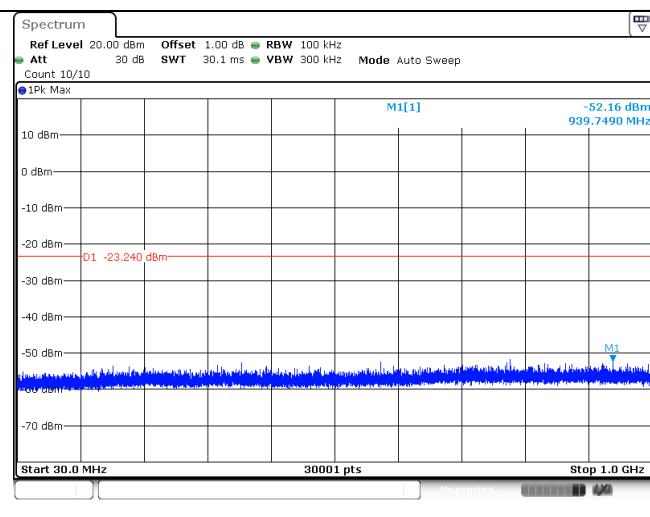
Test Item:	SE	Modulation type:	GFSK
CH00 Reference level			
CH00 30MHz~1000MHz			
CH00 1GHz~26GHz			



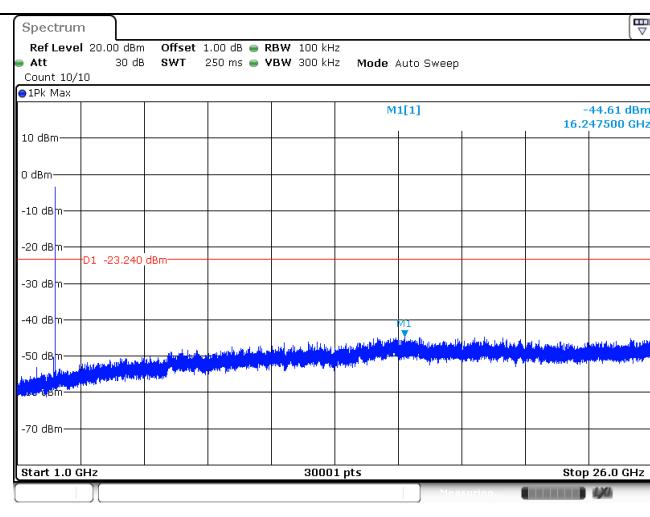
CH78  
Reference level

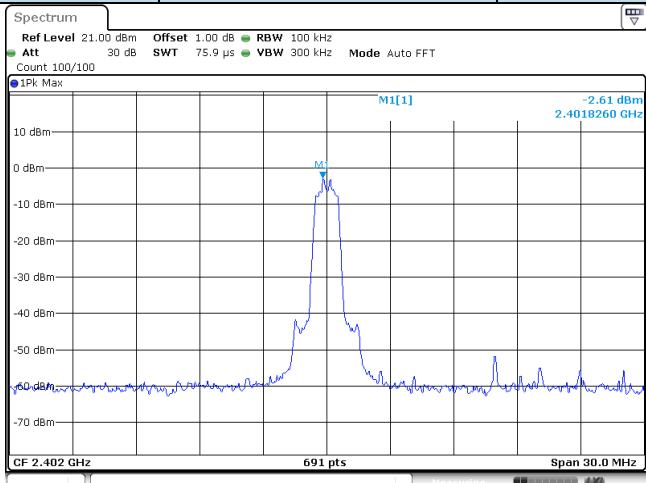
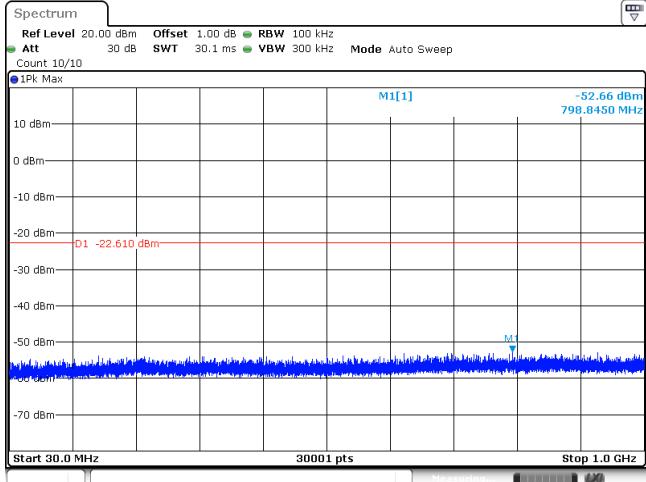
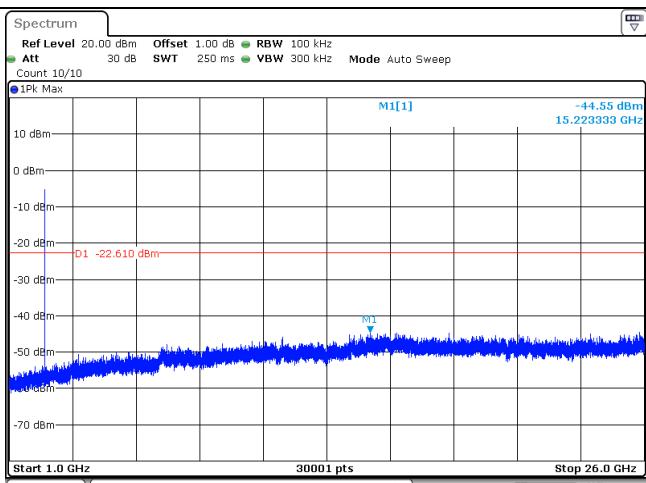


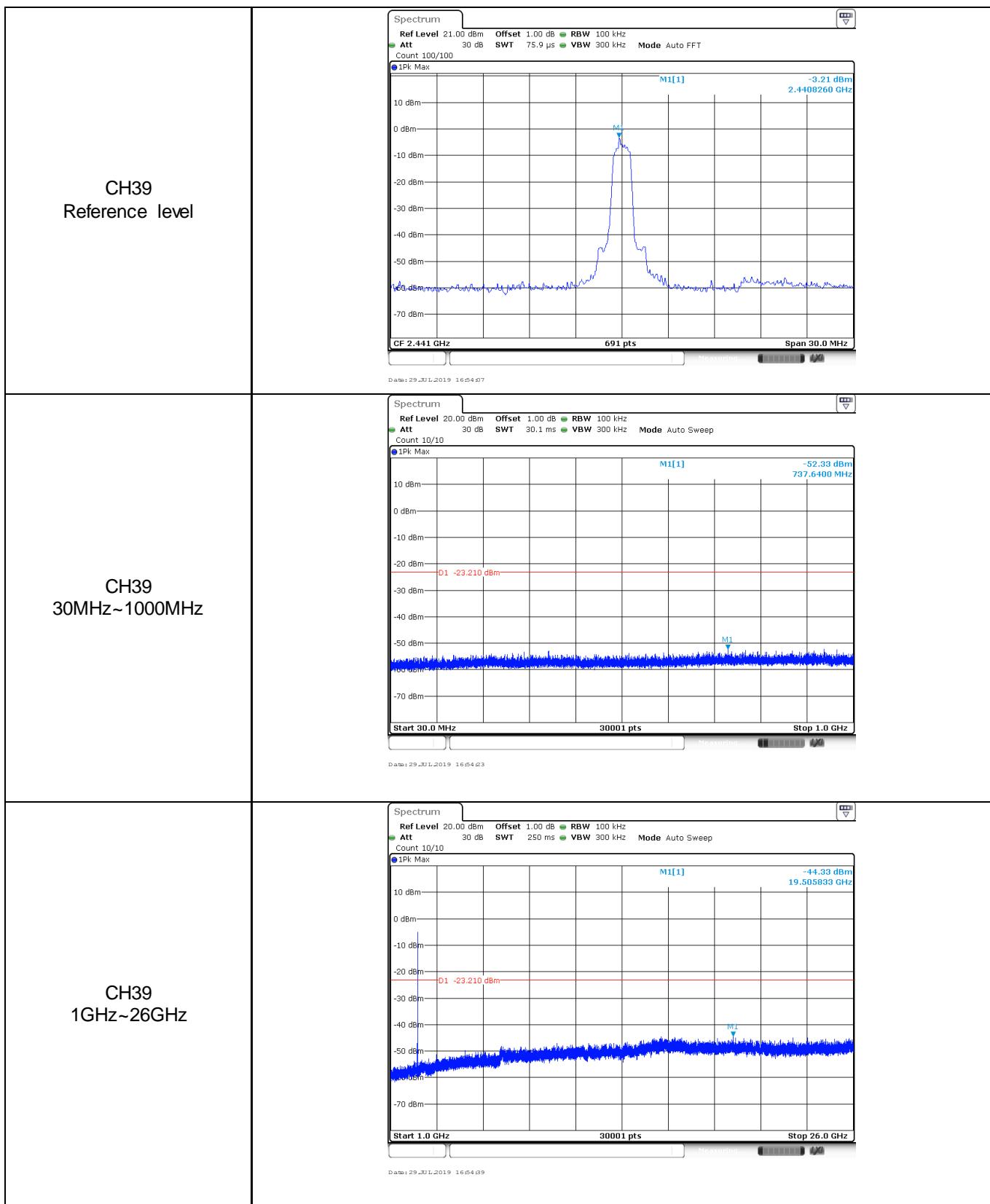
CH78  
30MHz~1000MHz

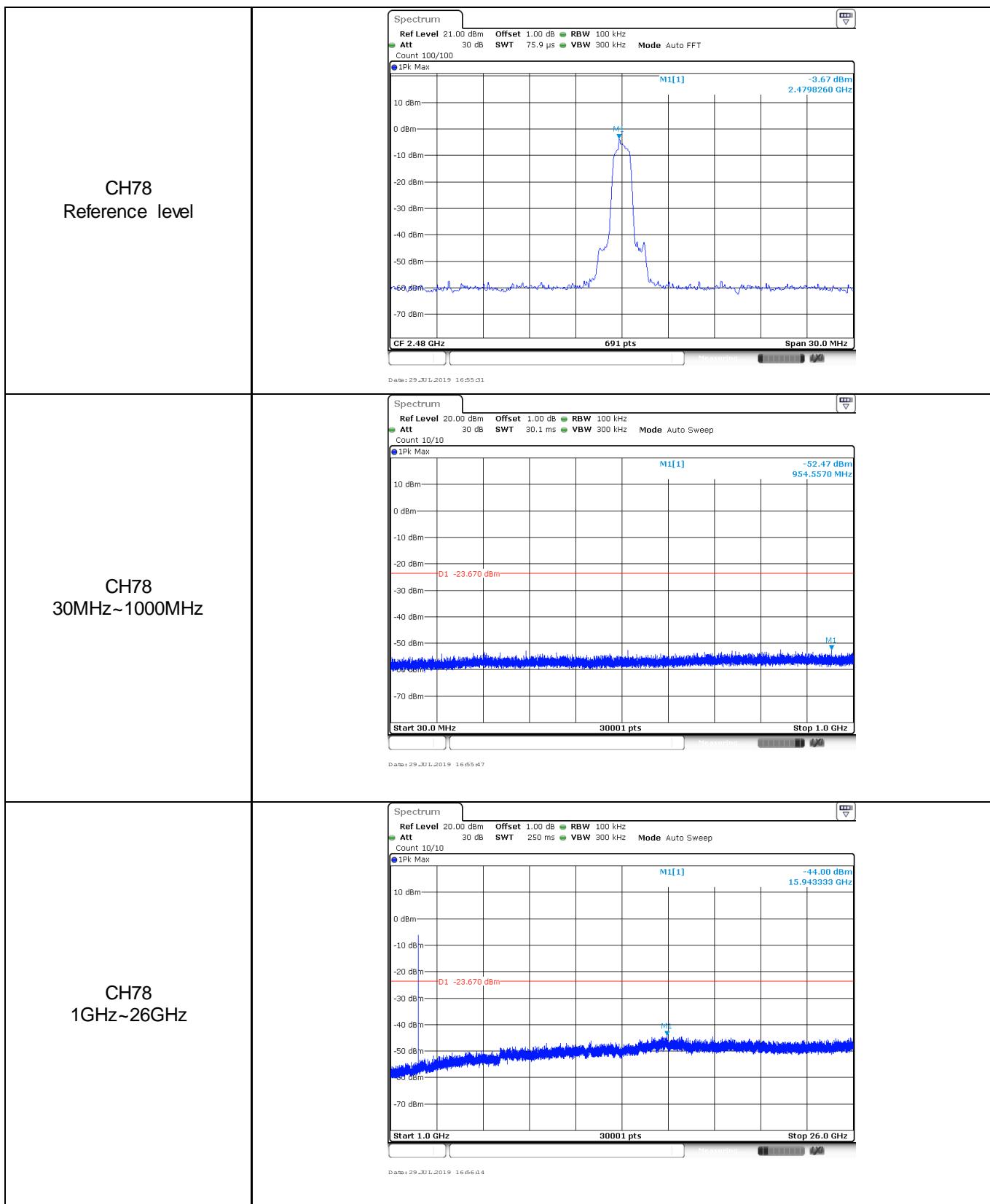


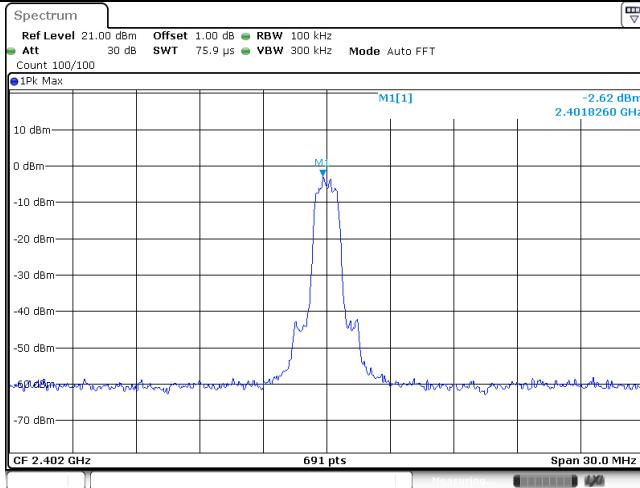
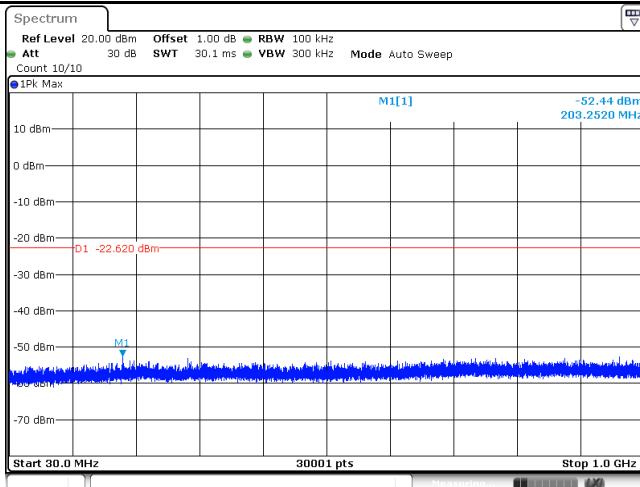
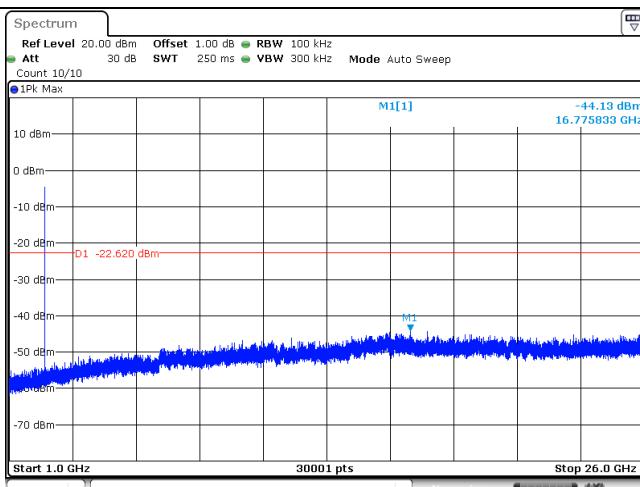
CH78  
1GHz~26GHz

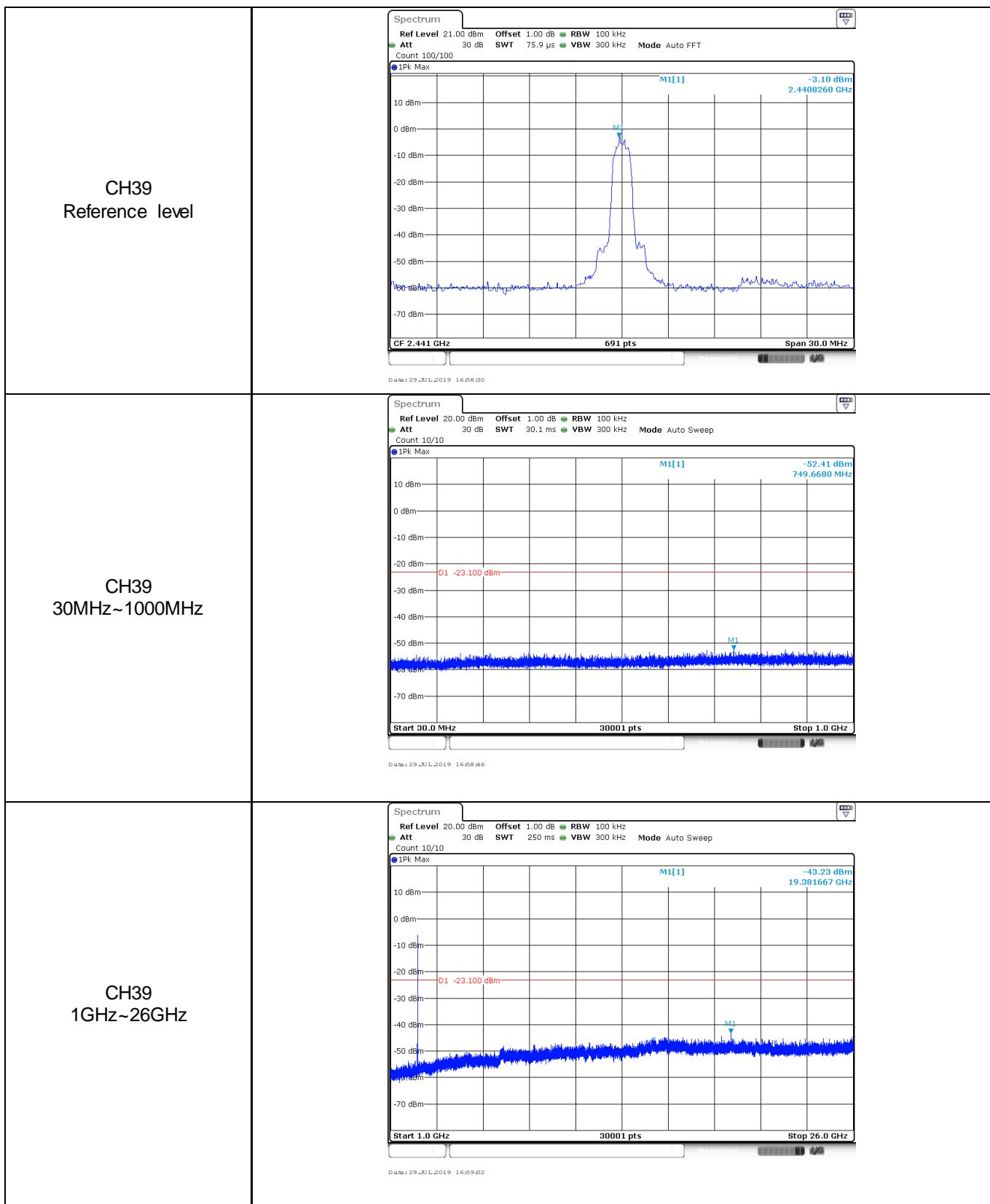


Test Item:	SE	Modulation type:	$\pi/4$ DQPSK
CH00 Reference level			 <p>Spectrum</p> <p>Ref Level 21.00 dBm Offset 1.00 dB RBW 100 kHz</p> <p>Att 30 dB SWT 75.9 μs VBW 300 kHz Mode Auto FFT</p> <p>Count 100/1000</p> <p>1Pk Max</p> <p>M1[1] -2.61 dBm 2.4018260 GHz</p> <p>CF 2.402 GHz 691 pts Span 30.0 MHz</p> <p>Date: 29 JUL 2019 16:52:46</p>
CH00 30MHz~1000MHz			 <p>Spectrum</p> <p>Ref Level 20.00 dBm Offset 1.00 dB RBW 100 kHz</p> <p>Att 30 dB SWT 30.1 ms VBW 300 kHz Mode Auto Sweep</p> <p>Count 10/10</p> <p>1Pk Max</p> <p>M1[1] -52.66 dBm 798.0450 MHz</p> <p>D1 -22.610 dBm</p> <p>Start 30.0 MHz 30001 pts Stop 1.0 GHz</p> <p>Date: 29 JUL 2019 16:53:02</p>
CH00 1GHz~26GHz			 <p>Spectrum</p> <p>Ref Level 20.00 dBm Offset 1.00 dB RBW 100 kHz</p> <p>Att 30 dB SWT 250 ms VBW 300 kHz Mode Auto Sweep</p> <p>Count 10/10</p> <p>1Pk Max</p> <p>M1[1] -44.55 dBm 15.223333 GHz</p> <p>D1 -22.610 dBm</p> <p>Start 1.0 GHz 30001 pts Stop 26.0 GHz</p> <p>Date: 29 JUL 2019 16:53:19</p>

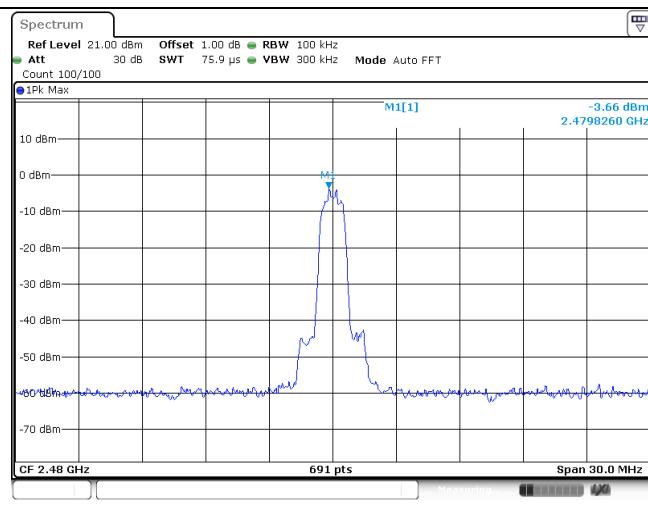




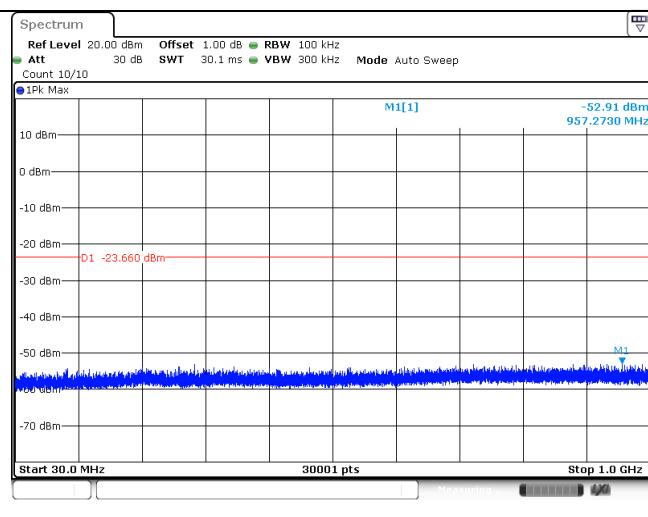
Test Item:	SE	Modulation type:	8DPSK
CH00 Reference level			
CH00 30MHz~1000MHz			
CH00 1GHz~26GHz			



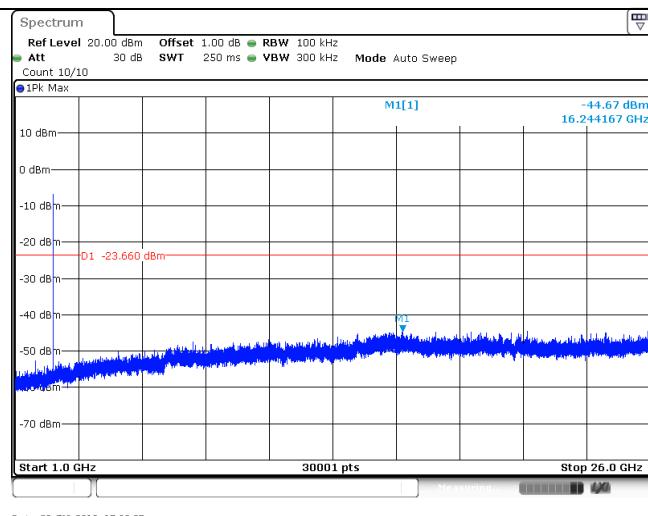
CH78  
Reference level



CH78  
30MHz~1000MHz



CH78  
1GHz~26GHz



## 5.11. Spurious Emissions (radiated)

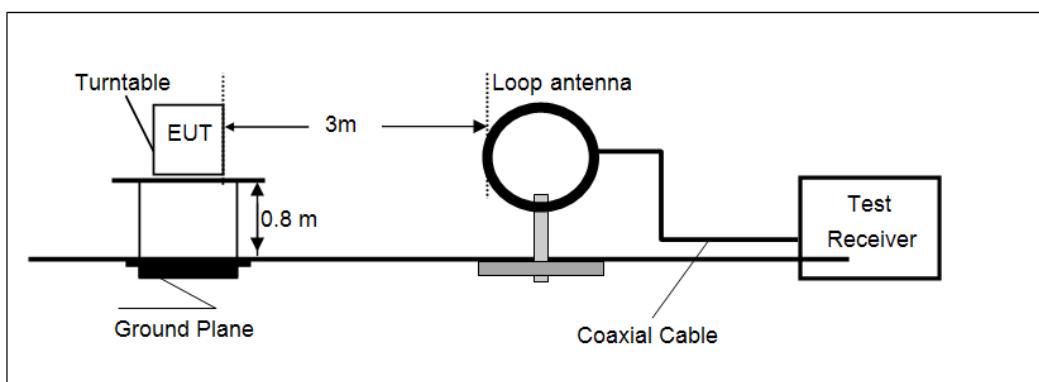
### LIMIT

#### FCC CFR Title 47 Part 15 Subpart C Section 15.209

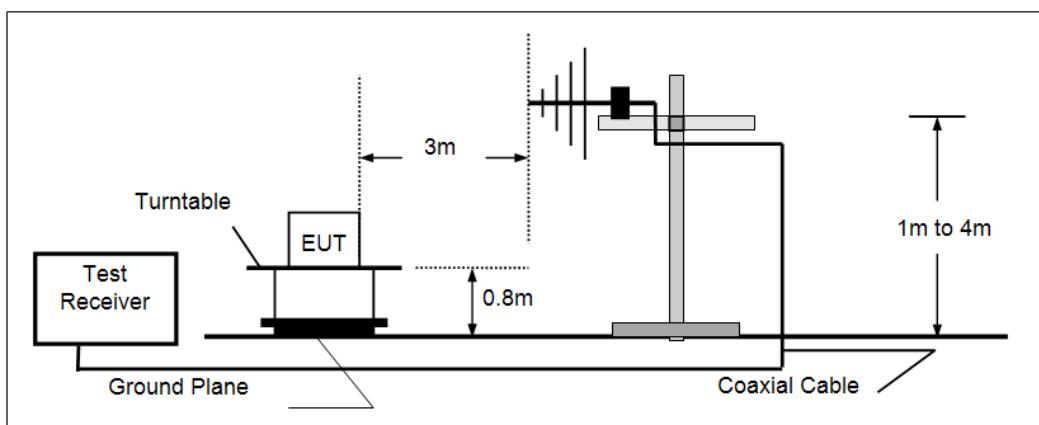
Frequency	Limit (dB <sub>UV</sub> /m @3m)	Value
30 MHz ~ 88 MHz	40.00	Quasi-peak
88 MHz ~ 216 MHz	43.50	Quasi-peak
216 MHz ~ 960 MHz	46.00	Quasi-peak
960 MHz ~ 1 GHz	54.00	Quasi-peak
Above 1 GHz	54.00	Average
	74.00	Peak

### TEST CONFIGURATION

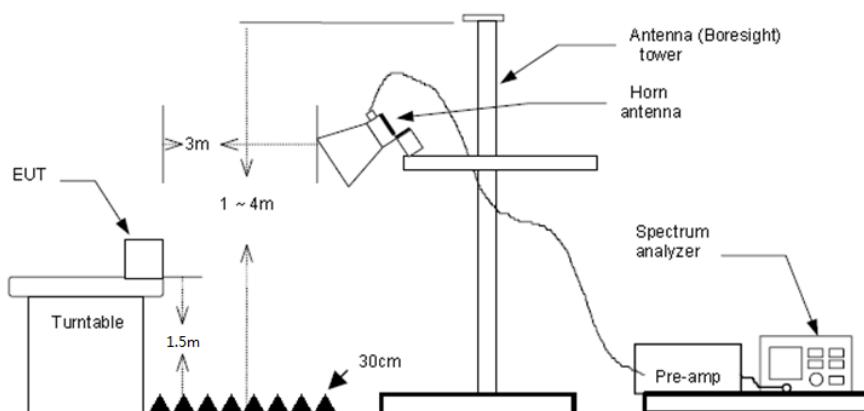
- Below 30 MHz



- 30 MHz ~1000 MHz



- Above 1 GHz



### TEST PROCEDURE

1. The EUT was tested according to ANSI C63.10:2013.
2. The EUT is placed on a turn table with 0.8 meter above ground for below 1GHz, 1.5 meter above ground for above 1GHz.
3. The EUT was set 3 meters from the receiving antenna, which was mounted on the top of a variable height antenna tower.
4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
5. Set to the maximum power setting and enable the EUT transmit continuously.
6. Use the following spectrum analyzer settings
  - (1) Span shall wide enough to fully capture the emission being measured;
  - (2) Below 1 GHz:  
RBW=120 kHz, VBW=300 kHz, Sweep=auto, Detector function=peak, Trace=max hold;  
If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
  - (3) From 1 GHz to 10<sup>th</sup> harmonic:  
RBW=1 MHz, VBW=3 MHz Peak detector for Peak value  
RBW=1 MHz, VBW=10 Hz Peak detector for Average value.

### TEST MODE:

Please refer to the clause 3.3

### TEST RESULTS

Passed       Not Applicable

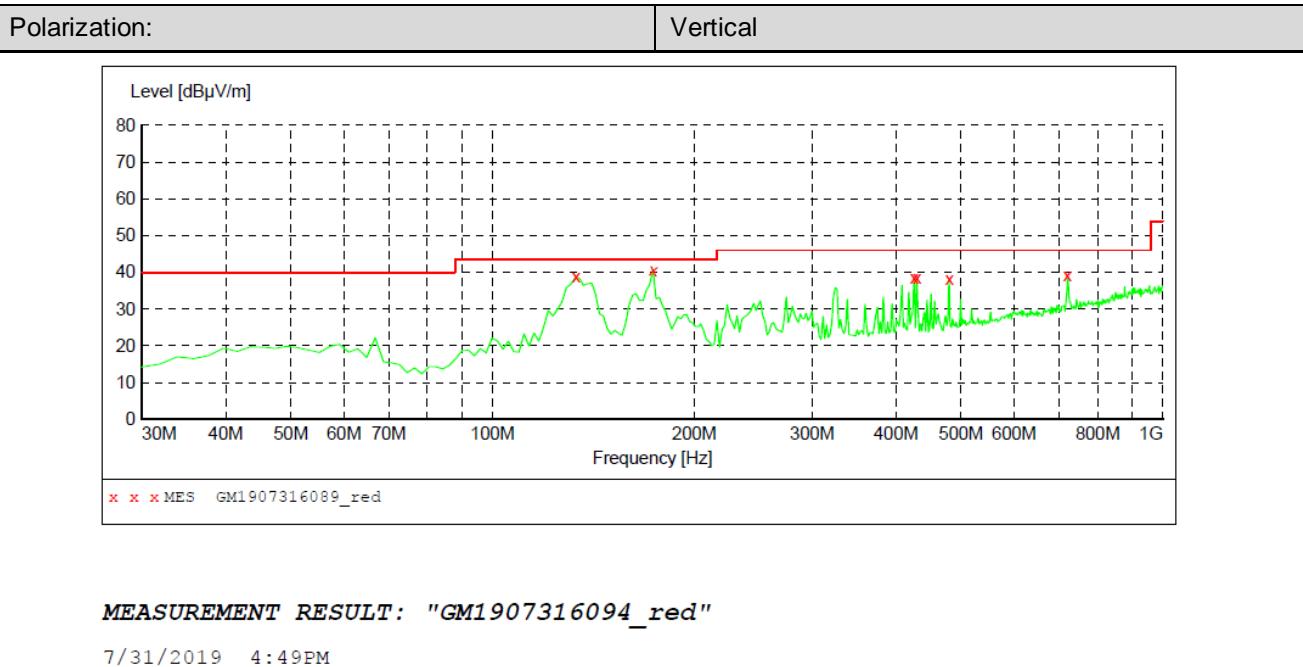
#### Note:

- 1) Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor
- 2) The emission levels of other frequencies are very lower than the limit and not show in test report.
- 3) Below 1 GHz, Have pre-scan all modulation mode, found the GFSK modulation High channel which it was worst case, so only the worst case's data on the test report.
- 4) Above 1 GHz, Have pre-scan all modulation mode, found the GFSK modulation which it was worst case, so only the worst case's data on the test report
- 5) The peak level is lower than average limit(54 dBuV/m), this data is the too weak instrument of signal is unable to test.
- 6) The worst case is model: STUDIO LIVE AR16c

#### ➤ 9 kHz ~ 30 MHz

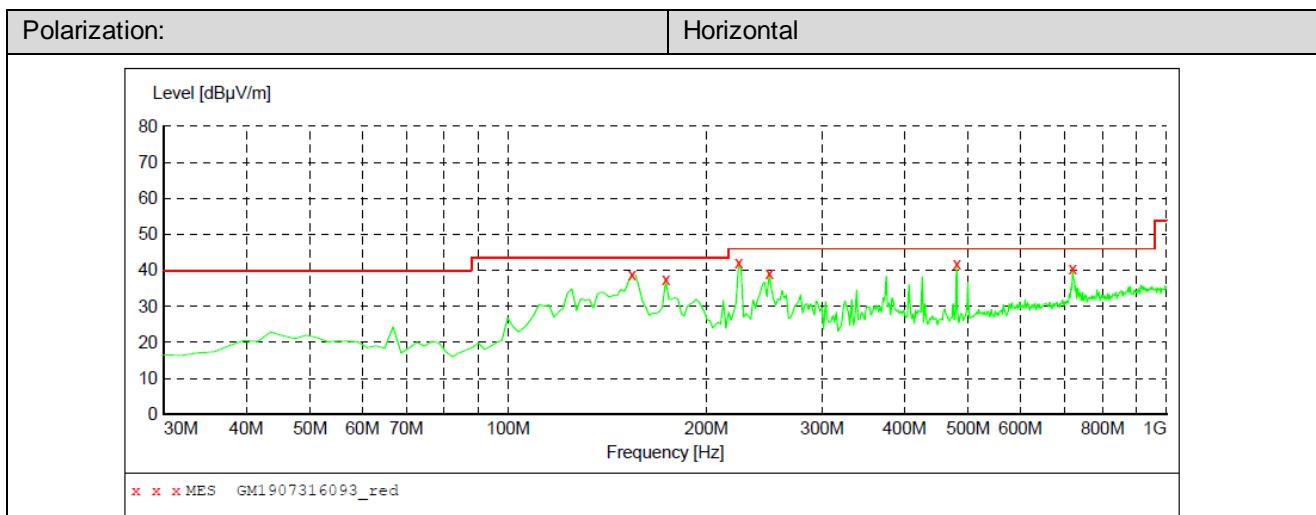
The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

## &gt; 30 MHz ~ 1 GHz

**MEASUREMENT RESULT: "GM1907316094\_red"**

7/31/2019 4:49PM

Frequency MHz	Level dB $\mu$ V/m	Transd dB	Limit dB $\mu$ V/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
134.760000	38.90	-9.8	43.5	4.6	QP	300.0	360.00	VERTICAL
173.560000	40.30	-9.0	43.5	3.2	QP	100.0	7.00	VERTICAL
425.760000	37.90	0.1	46.0	8.1	QP	100.0	346.00	VERTICAL
429.640000	38.00	0.1	46.0	8.0	QP	100.0	38.00	VERTICAL
480.080000	37.40	1.2	46.0	8.6	QP	100.0	358.00	VERTICAL
720.640000	38.50	6.6	46.0	7.5	QP	100.0	249.00	VERTICAL

**MEASUREMENT RESULT: "GM1907316093\_red"**

7/31/2019 5:18PM

Frequency MHz	Level dB $\mu$ V/m	Transd dB	Limit dB $\mu$ V/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
154.160000	38.90	-9.9	43.5	4.6	QP	100.0	75.00	HORIZONTAL
173.560000	37.40	-9.0	43.5	6.1	QP	300.0	67.00	HORIZONTAL
224.000000	42.00	-5.8	46.0	4.0	QP	100.0	116.00	HORIZONTAL
249.220000	39.00	-4.6	46.0	7.0	QP	100.0	156.00	HORIZONTAL
480.080000	41.70	1.2	46.0	4.3	QP	100.0	317.00	HORIZONTAL
720.640000	40.60	6.6	46.0	5.4	QP	100.0	169.00	HORIZONTAL

## &gt; 1 GHz ~ 25 GHz

Test channel				CH00			
Freq. [MHz]	Reading [dB $\mu$ V/m]	Factor [dB]	Level [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]	Polarity	Detector
1188.000	37.19	-5.96	31.23	74.00	42.77	Horizontal	PK
2991.625	43.17	-0.07	43.10	74.00	30.90	Horizontal	PK
3985.968	37.48	2.97	40.45	74.00	33.55	Horizontal	PK
6250.781	33.31	10.94	44.25	74.00	29.75	Horizontal	PK
Freq. [MHz]	Reading [dB $\mu$ V/m]	Factor [dB]	Level [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]	Polarity	Detector
1242.343	36.74	-5.72	31.02	74.00	42.98	Vertical	PK
2987.218	47.24	-0.05	47.19	74.00	26.81	Vertical	PK
3985.968	37.48	2.97	40.45	74.00	33.55	Vertical	PK
5310.781	35.95	8.47	44.42	74.00	29.58	Vertical	PK

Test channel				CH39			
Freq. [MHz]	Reading [dB $\mu$ V/m]	Factor [dB]	Level [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]	Polarity	Detector
1133.656	37.96	-6.53	31.43	74.00	42.57	Horizontal	PK
2994.562	40.38	-0.09	40.29	74.00	33.71	Horizontal	PK
4171.031	33.93	3.65	37.58	74.00	36.42	Horizontal	PK
5047.875	32.60	8.30	40.90	74.00	33.10	Horizontal	PK
Freq. [MHz]	Reading [dB $\mu$ V/m]	Factor [dB]	Level [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]	Polarity	Detector
1270.250	36.89	-5.65	31.24	74.00	42.76	Vertical	PK
3000.437	39.38	-0.12	39.26	74.00	34.74	Vertical	PK
3993.312	35.70	3.00	38.70	74.00	35.30	Vertical	PK
4983.250	38.04	7.74	45.78	74.00	28.22	Vertical	PK

Test channel				CH78			
Freq. [MHz]	Reading [dB $\mu$ V/m]	Factor [dB]	Level [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]	Polarity	Detector
1254.093	37.01	-5.69	31.32	74.00	42.68	Horizontal	PK
2987.218	38.43	-0.05	38.38	74.00	35.62	Horizontal	PK
3598.218	35.00	1.44	36.44	74.00	37.56	Horizontal	PK
5097.812	32.63	8.78	41.41	74.00	32.59	Horizontal	PK
Freq. [MHz]	Reading [dB $\mu$ V/m]	Factor [dB]	Level [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]	Polarity	Detector
1220.312	36.88	-5.78	31.10	74.00	42.90	Vertical	PK
2988.687	43.86	-0.05	43.81	74.00	30.19	Vertical	PK
3994.781	38.71	3.00	41.71	74.00	32.29	Vertical	PK
4984.718	38.08	7.75	45.83	74.00	28.17	Vertical	PK

## Remark:

- Final Level =Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor
- The peak level is lower than average limit(54 dB $\mu$ V/m),this data is the too weak instrument of signal is unable to test.
- The emission levels of other frequencies are very lower than the limit and not show in test report.

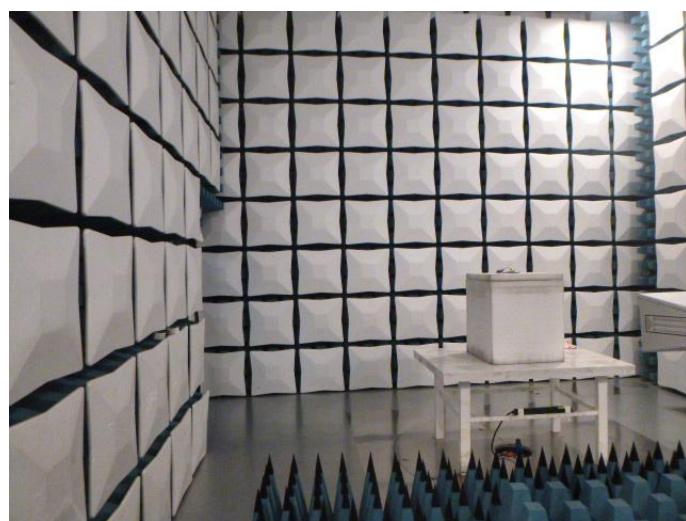
## 6. TEST SETUP PHOTOS

Conducted Emissions (AC Mains)



Radiated Emissions



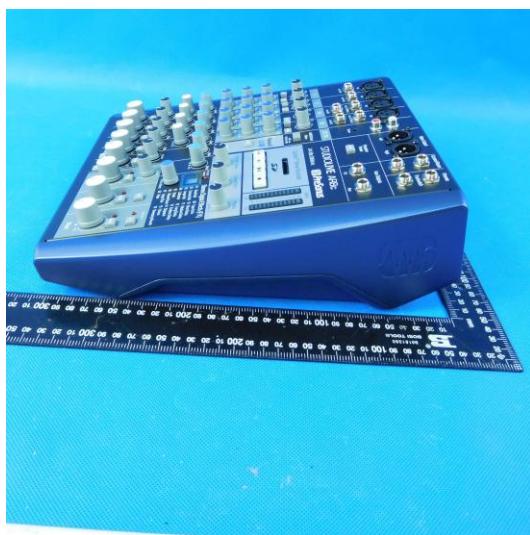
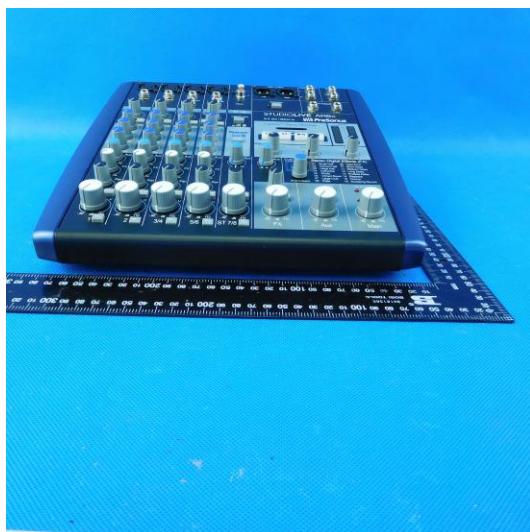


## 7. EXTERANAL AND INTERNAL PHOTOS

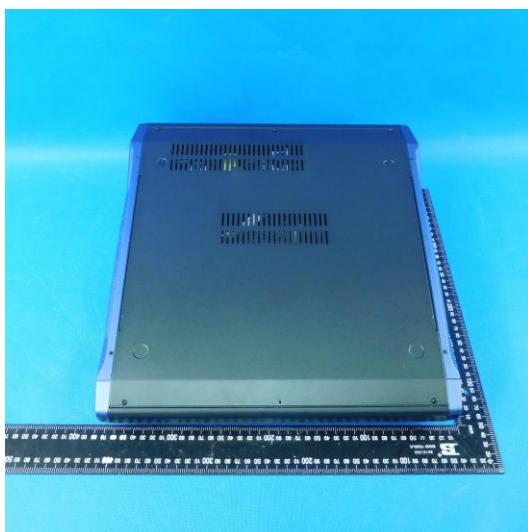
### External Photos

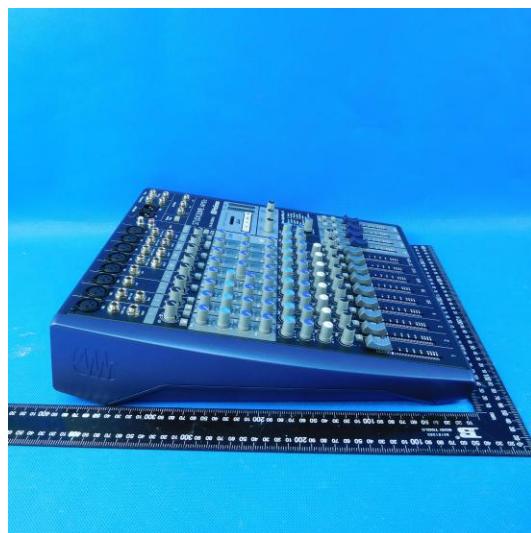
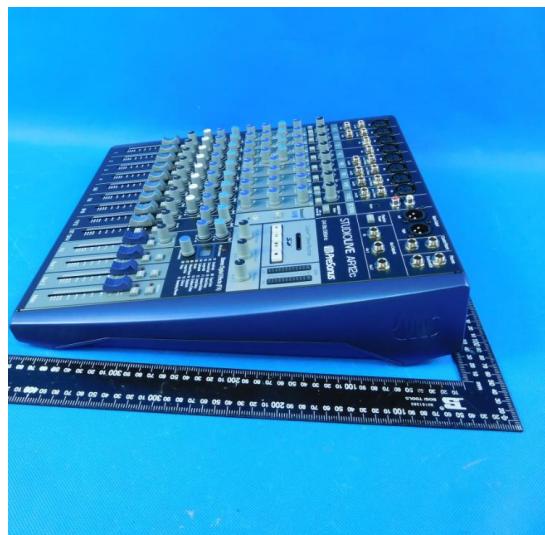
AR8c

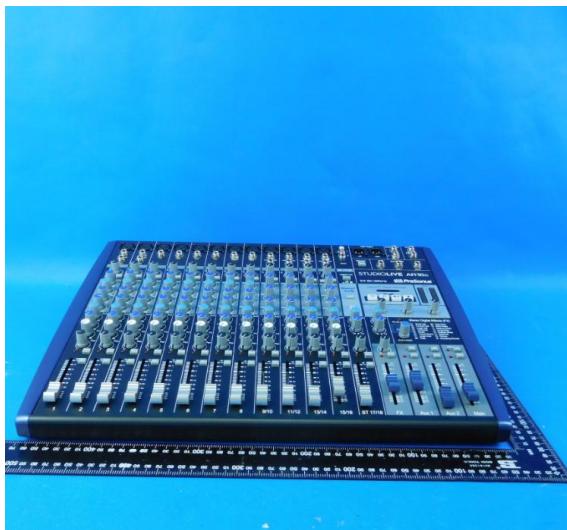
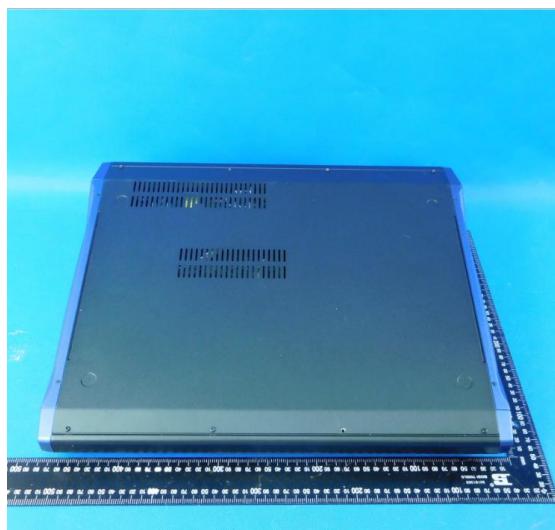


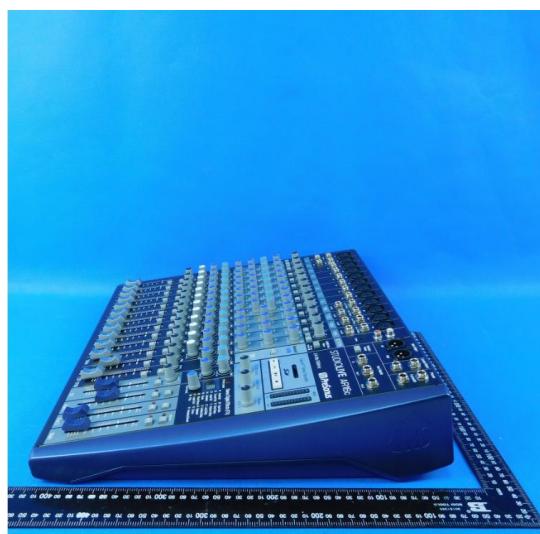


**AR12c**



**AR16c**





**Internal Photos****AR8c**