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Report No.: GTI20140326F-2

Page 1 of 62

# TEST REPORT

**Product Name** .....: PROJECTOR PAD P70

**Trademark** .....: AIPTEK

**Model/Type reference** .....: P70

**Listed Model(s)** .....: /

**FCC ID**.....: 2AB5H-P70001

**Test Standards** .....: **FCC Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz**

**Applicant** .....: AIPTEK International Inc.

**Address of applicant** .....: 2F, No.58, Park Avenue 2nd Rd., Science-Based Industrial Park, Hsinchu 30844, Taiwan, R.O.C.

**Date of Receipt** .....: Dec.03, 2014

**Date of Test Date**.....: Feb.11, 2015 - Mar.10, 2015

**Data of issue.** .....: Mar.11, 2015

<b>Test result</b>	<b>Pass *</b>
--------------------	---------------

\* In the configuration tested, the EUT complied with the standards specified above

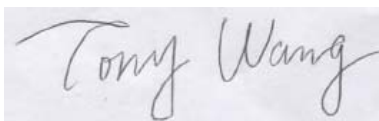
GENERAL DESCRIPTION OF EUT	
Equipment:	PROJECTOR PAD P70
Model Name:	P70
Manufacturer:	AIPTEK International Inc.
Manufacturer Address:	2F, No.58, Park Avenue 2nd Rd., Science-Based Industrial Park, Hsinchu 30844, Taiwan, R.O.C.
Power Rating:	DC 3.7V from battery or DC 5.0V form    Input: 100-240V~ 50/60Hz 0.45A Max    adapter Output: 5V---2.5A

Compiled By:



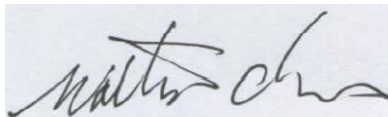
(Allen Wang)

Reviewed By:



(Tony Wang)

Approved By:



(Walter Chen)

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## 1. SUMMARY

### 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 C63.10-2009](#): American National Standard for Testing Unlicensed Wireless Devices

### 1.2. Test Description

FCC PART 15 15.247		
FCC Part 15.207	AC Power Conducted Emission	PASS
FCC Part 15.247(a)(1)(i)	20dB Bandwidth	PASS
FCC Part 15.247(d)	Spurious RF Conducted Emission	PASS
FCC Part 15.247(b)	Maximum Peak Output Power	PASS
FCC Part 15.247(b)	Pseudorandom Frequency Hopping Sequence	PASS
FCC Part 15.247(a)(1)(iii)	Number of hopping frequency& Time of Occupancy	PASS
FCC Part 15.247(a)(1)	Frequency Separation	PASS
FCC Part 15.109/15.205/15.209	Radiated Emissions	PASS
FCC Part 15.247(d)	Band Edge Compliance of RF Emission	PASS
FCC Part 15.203/15.247 (b)	Antenna Requirement	PASS

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

## 1.3. Test Facility

### 1.3.1 Address of the test laboratory

#### Shenzhen General Testing & Inspection Technology Co., Ltd.

Add: 1F, 2 Block, Jiaquan Building, Guanlan High-tech Park Baoan District, Shenzhen, Guangdong, China

### 1.3.2 Laboratory accreditation

The test facility is recognized, certified, or accredited by the following organizations:

#### IC Registration No.: 9783A

The 3m alternate test site of Shenzhen GTI Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration NO.: 9783A on Aug, 2011.

#### FCC-Registration No.: 214666

Shenzhen GTI Technology 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. Registration 214666, Sep 19, 2011

## 1.4. Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements and is documented in the Shenzhen General Testing & Inspection Technology Co., Ltd quality system acc. to DIN EN 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.

Hereafter the best measurement capability for General Testing & Inspection laboratory is reported:

Test Items	Measurement Uncertainty	Notes
Transmitter power conducted	0.57 dB	(1)
Transmitter power Radiated	2.20 dB	(1)
Conducted spurious emission 9KHz-40 GHz	1.60 dB	(1)
Radiated spurious emission 9KHz-40 GHz	2.20 dB	(1)
Conducted Emission 9KHz-30MHz	3.39 dB	(1)
Radiated Emission 30~1000MHz	4.24 dB	(1)
Radiated Emission 1~18GHz	5.16 dB	(1)
Radiated Emission 18-40GHz	5.54 dB	(1)
Occupied Bandwidth	-----	(1)

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

## 2. GENERAL INFORMATION

### 2.1. 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

### 2.2. General Description of EUT

Product Name:	PROJECTOR PAD P70
Model/Type reference:	P70
Power supply:	DC 3.7V from battery
Adapter information:	Model: APS-A01205025WZ-G Input: 100-240VAC, 50/60Hz, 0.45A Output: 5V---2.5A
Hardware version:	RV2.1
Software version:	Android 4.4.4
<b>Bluetooth 2.1</b>	
Version:	Supported BT2.1
Modulation:	GFSK, $\pi/4$ DQPSK, 8DPSK
Operation frequency:	2402MHz~2480MHz
Channel number:	79
Channel separation:	1MHz
Antenna type:	FPC Antenna
Antenna gain:	0 dBi

Note: For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

## 2.3. Description of Test Modes

The Applicant provides communication tools software to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing .There are 79 channels provided to the EUT. Channel 00/39/78 was selected to test.

### Operation Frequency :

Channel	Frequency (MHz)
<b>00</b>	<b>2402</b>
2	2403
:	:
38	2440
<b>39</b>	<b>2441</b>
40	2442
:	:
77	2479
<b>78</b>	<b>2480</b>

## 2.4. Measurement Instruments List

Maximum Peak Output Power / Band Edge Compliance of RF Emission / Spurious RF Conducted Emission /Hoping Require/ 20dB bandwidth					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	Spectrum Analyzer	Rohde & Schwarz	FSU	100105	Jan 07,2016

Conducted Emission					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	LISN	R&S	ENV216	101112	Jan. 07, 2016
2	LISN	R&S	ENV216	101113	Jan. 07, 2016
3	EMI Test Receiver	R&S	ESCI	100920	Jan. 07, 2016
4	Cable	Schwarzbeck	Cable001	--	Jan. 07, 2016

Radiated Emission					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	EMI Test Receiver	R&S	ESCI	100967	Jan 07,2016
2	High pass filter	micro-tranics	HPM50111	34202	Jan 07,2016
3	Log-Bicon Antenna	Schwarzbeck	CBL6141A	4180	Jan. 10,2016
4	Ultra-Broadband Antenna	ShwarzBeck	BBHA9170	25841	Jan. 10,2016
5	Loop Antenna	LAPLAC	RF300	9138	Jan. 10,2016
6	Spectrum Analyzer	Rohde & Schwarz	FSU	100105	Jan 07,2016
7	Horn Antenna	Schwarzbeck	BBHA 9120D	648	Jan. 10,2016

8	Pre-Amplifier	HP	8447D	1937A03050	Jan. 07,2016
9	Pre-Amplifier	EMCI	EMC05183 5	980075	Jan. 07,2016
10	Antenna Mast	UC	UC3000	N/A	N/A
11	Turn Table	UC	UC3000	N/A	N/A
12	Cable	Schwarzbeck	Cable002	--	Jan. 07,2016
13	Cable	Schwarzbeck	Cable003	--	Jan. 07,2016

Note: 1. The Cal. Interval was one year.

2. The cable loss has calculated in test result which connection between each test instruments.



### 3. TEST CONDITIONS AND RESULTS

#### 3.1. Conducted Emission (AC Main)

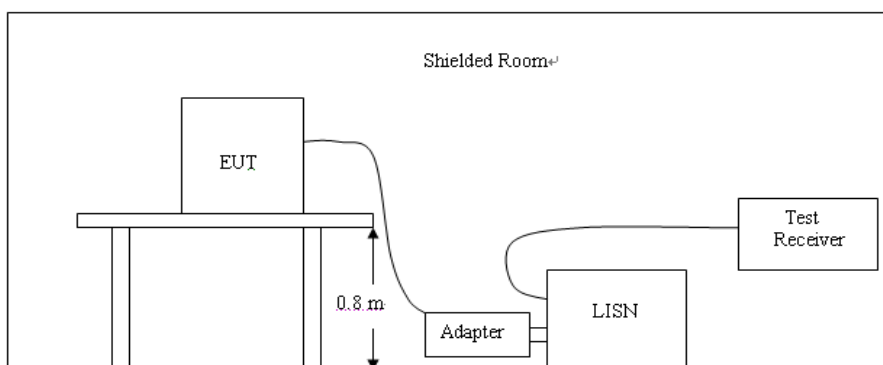
##### LIMIT

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 equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system; a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2009.
2. Support equipment, if needed, was placed as per ANSI C63.10-2009
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2009
4. The EUT received DC5V power from the adapter, the adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5. All support equipments received AC power from a second LISN, if any.
6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8. During the above scans, the emissions were maximized by cable manipulation.

## TEST RESULTS

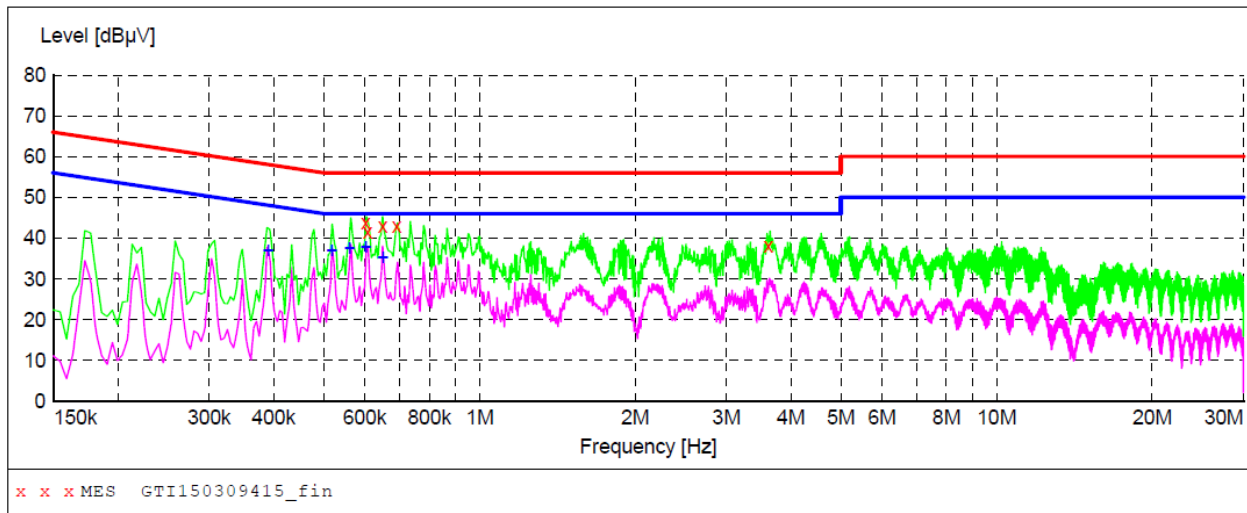
**Note:** We tested all modes and recorded the worst case at GFSK mode.

LINE

L

### SCAN TABLE: "Voltage (9K-30M) FIN1"

Short Description: 150K-30M Voltage



### MEASUREMENT RESULT: "GTI150309415\_fin"

03/09/2015 1:48PM

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.602000	43.70	9.9	56	12.3	QP	L1	GND
0.608000	41.60	9.9	56	14.4	QP	L1	GND
0.650000	42.80	10.0	56	13.2	QP	L1	GND
0.692000	43.00	10.0	56	13.0	QP	L1	GND
3.620000	38.00	10.5	56	18.0	QP	L1	GND

### MEASUREMENT RESULT: "GTI150309415\_fin2"

03/09/2015 1:48PM

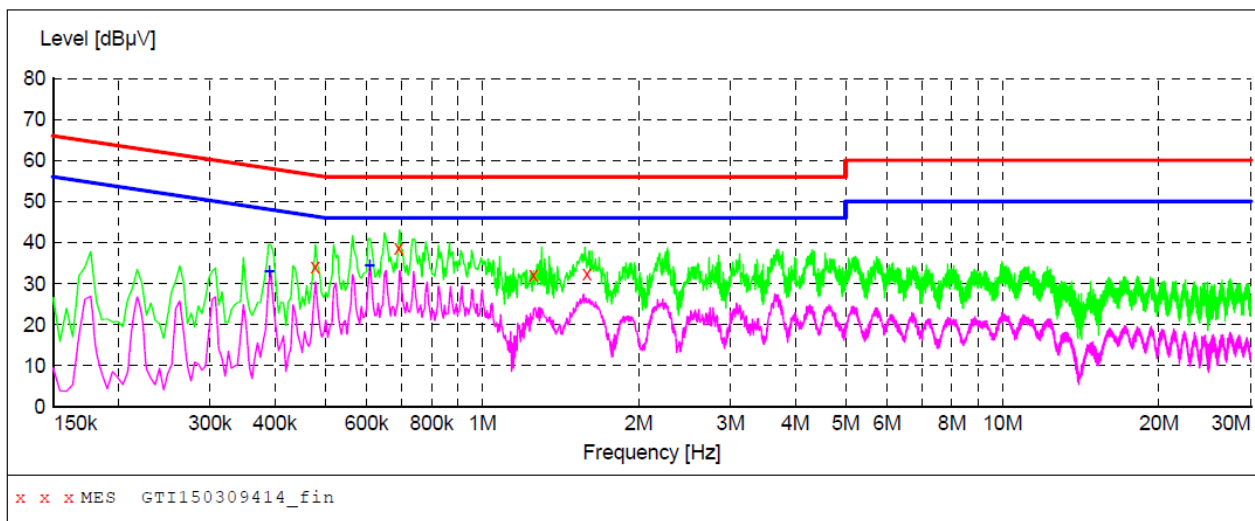
Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.390000	37.00	9.9	48	11.1	AV	L1	GND
0.518000	37.00	9.9	46	9.0	AV	L1	GND
0.560000	37.50	9.9	46	8.5	AV	L1	GND
0.602000	37.90	9.9	46	8.1	AV	L1	GND
0.650000	35.20	10.0	46	10.8	AV	L1	GND

LINE

N

**SCAN TABLE: "Voltage (9K-30M)FIN1"**

Short Description: 150K-30M Voltage


**MEASUREMENT RESULT: "GTI150309414\_fin"**

03/09/2015 1:45PM

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.478000	34.10	9.9	56	22.3	QP	N	GND
0.692000	38.70	10.0	56	17.3	QP	N	GND
1.256000	32.00	10.2	56	24.0	QP	N	GND
1.592000	32.50	10.3	56	23.5	QP	N	GND

**MEASUREMENT RESULT: "GTI150309414\_fin2"**

03/09/2015 1:45PM

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.390000	33.00	9.9	48	15.1	AV	N	GND
0.608000	34.40	9.9	46	11.6	AV	N	GND

## 3.2. Radiated Emission

### Limit

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

The frequency spectrum above 1 GHz for Transmitter was investigated. All emission not reported are much lower than the prescribed limits. Set the RBW=1MHz, VBW=3MHz for Peak Detector while the RBW=1MHz, VBW=10Hz for Average Detector, Readings are both peak and average values. The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

Frequency (MHz)	Distance (Meters)	Radiated (dBuV/m)	Radiated (μV/m)
0.009-0.49	3	$20\log(2400/F(\text{KHz}))+40\log(300/3)$	$2400/F(\text{KHz})$
0.49-1.705	3	$20\log(24000/F(\text{KHz}))+40\log(30/3)$	$24000/F(\text{KHz})$
1.705-30	3	$20\log(30)+40\log(30/3)$	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

### Test Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0°C to 360°C to acquire the highest emissions from EUT
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.

### Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

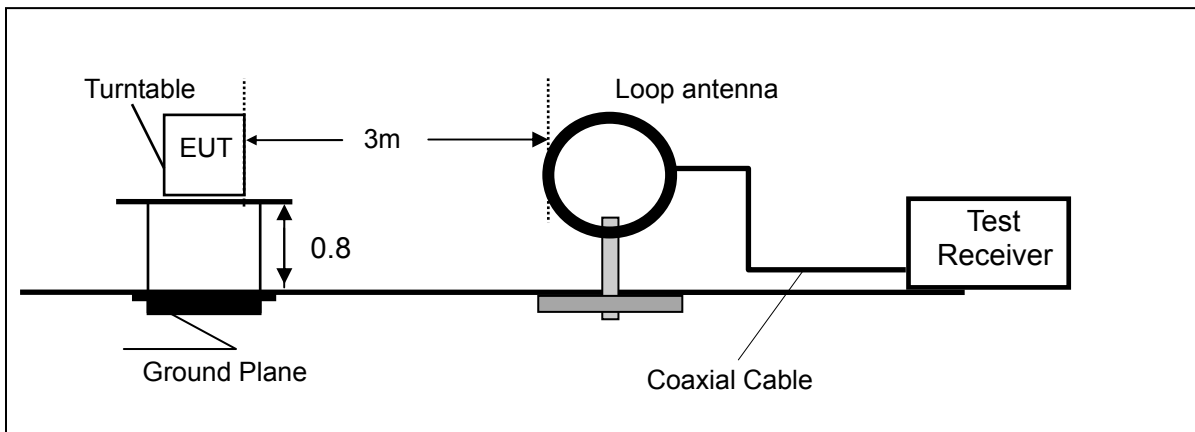
For example

Frequency (MHz)	FS (dBμV/m)	RA (dBμV/m)	AF (dB)	CL (dB)	AG (dB)	Transd (dB)
150.00	40	58.1	12.2	1.6	31.90	-18.1

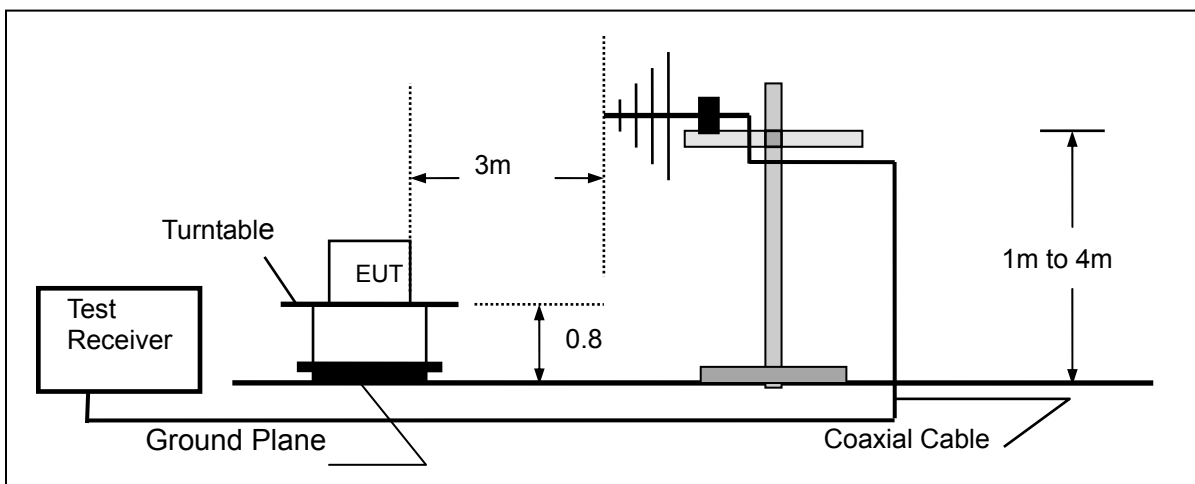
$$\text{Transd} = \text{AF} + \text{CL} - \text{AG}$$

## Test Configuration

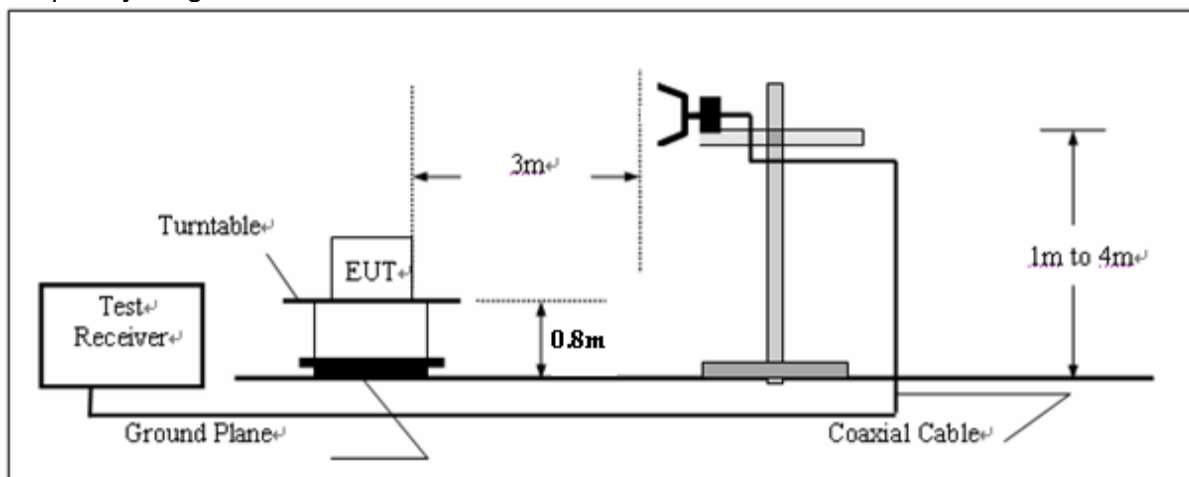
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



## Test Results

Remark: We measured Radiated Emission at GFSK,  $\pi/4$  DQPSK and 8DPSK mode from 9 KHz to 25GHz and recorded worst case at GFSK mode.

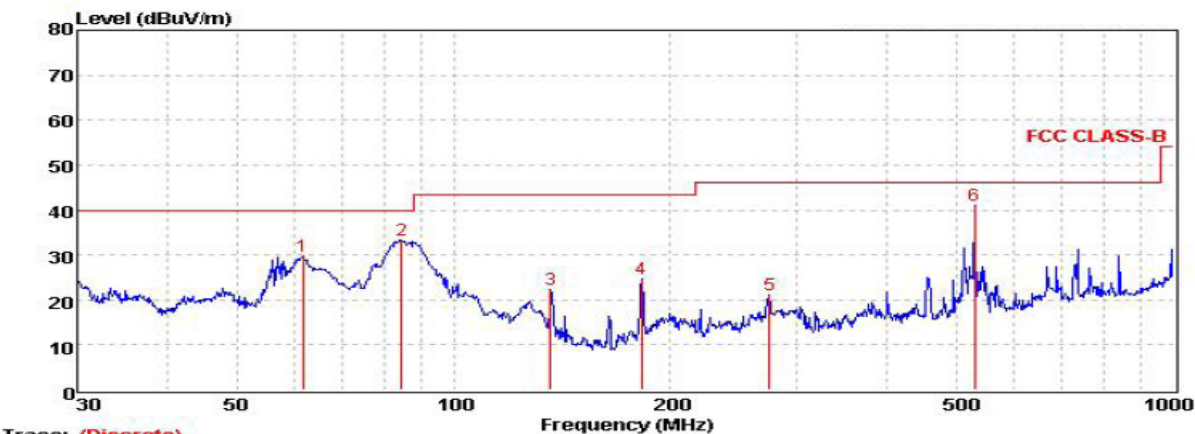
### For 9 KHz-30MHz

Frequency (MHz)	Corrected Reading (dBuV/m)@3m	FCC Limit (dBuV/m) @3m	Margin (dB)	Detector	Result
0.41	65.36	96.48	31.24	QP	PASS
1.26	55.14	64.38	10.12	QP	PASS
15.87	50.32	69.54	19.91	QP	PASS
25.36	54.36	69.54	15.67	QP	PASS

### For 30MHz-1GHz

#### Horizontal

Data: 6

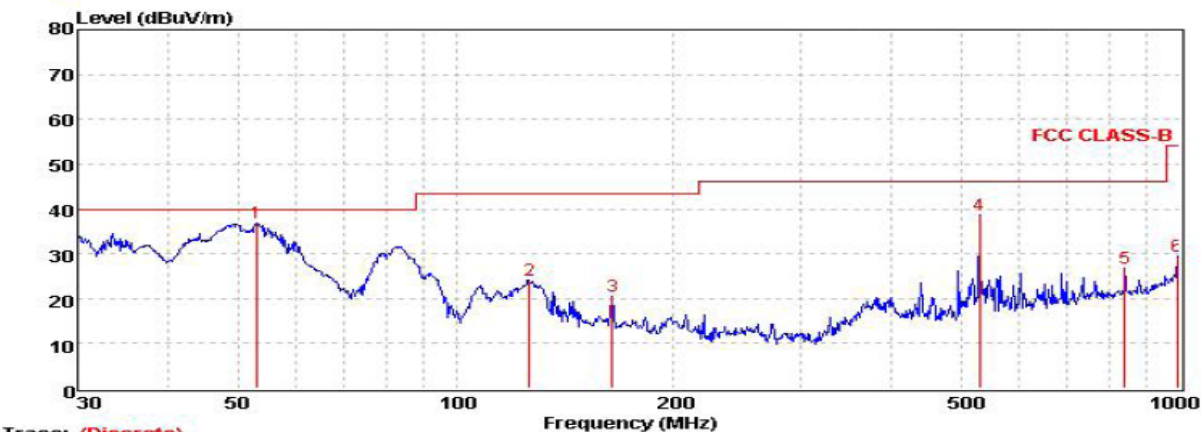


Trace: (Discrete)

Mark	Frequency MHz	Level dBuV/m	Factor dB/m	Reading dBuV	Limit dBuV/m	Margin dB	Polarization	Detector
1	61.78	29.70	-20.06	49.76	40.00	10.30	HORIZONTAL	Peak
2	84.70	33.24	-21.09	54.33	40.00	6.76	HORIZONTAL	Peak
3	136.46	22.37	-18.90	41.27	43.50	21.13	HORIZONTAL	Peak
4	182.56	24.77	-19.61	44.38	43.50	18.73	HORIZONTAL	Peak
5	274.19	21.15	-17.46	38.61	46.00	24.85	HORIZONTAL	Peak
6	528.25	41.12	-11.14	52.26	46.00	4.88	HORIZONTAL	Peak

#### Vertical

Data: 5



Trace: (Discrete)

Mark	Frequency MHz	Level dBuV/m	Factor dB/m	Reading dBuV	Limit dBuV/m	Margin dB	Polarization	Detector
1	52.95	36.74	-16.55	53.29	40.00	3.26	VERTICAL	Peak
2	126.33	24.14	-18.75	42.89	43.50	19.36	VERTICAL	Peak
3	164.33	20.39	-20.59	40.98	43.50	23.11	VERTICAL	Peak
4	528.25	38.60	-11.14	49.74	46.00	7.40	VERTICAL	Peak
5	839.18	26.73	-7.11	33.84	46.00	19.27	VERTICAL	Peak
6	993.01	29.55	-3.29	32.84	54.00	24.45	VERTICAL	Peak





## For 1GHz to 25GHz

## GFSK Mode (above 1GHz)

Frequency(MHz):				2402			Polarity:			HORIZONTAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
1	4804.00	55.65	PK	74.00	18.35	1.00 H	125	53.75	31.42	6.98	36.5	1.90
1	4804.00	39.45	AV	54.00	14.55	1.00 H	125	37.55	31.42	6.98	36.5	1.90
2	7206.00	48.14	PK	74.00	25.86	1.00 H	110	37.54	37.03	8.87	35.3	10.60
2	7206.00	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2402			Polarity:			VERTICAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
1	4804.00	54.98	PK	74.00	19.02	1.00 V	125	53.08	31.42	6.98	36.5	1.90
1	4804.00	39.45	AV	54.00	14.55	1.00 V	125	37.55	31.42	6.98	36.5	1.90
2	7206.00	47.87	PK	74.00	26.13	1.00 V	19	37.27	37.03	8.87	35.3	10.60
2	7206.00	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2440			Polarity:			HORIZONTAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
1	4882.00	55.84	PK	74.00	18.16	1.00 H	0	53.78	30.98	7.58	36.5	2.06
1	4882.00	40.12	AV	54.00	13.88	1.00 H	0	38.06	30.98	7.58	36.5	2.06
2	7323.00	46.45	PK	74.00	27.55	1.00 H	180	35.53	37.66	8.56	35.3	10.92
2	7323.00	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2440			Polarity:			VERTICAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
1	4882.00	56.65	PK	74.00	17.35	1.00 V	35	54.59	30.98	7.58	36.5	2.06
1	4882.00	39.51	AV	54.00	14.49	1.00 V	35	37.45	30.98	7.58	36.5	2.06
2	7323.00	47.35	PK	74.00	26.65	1.00 V	120	36.43	37.66	8.56	35.3	10.92
2	7323.00	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2480			Polarity:			HORIZONTAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
1	4960.00	54.36	PK	74.00	19.64	1.00 H	115	51.29	31.47	7.80	36.2	3.07
1	4960.00	41.25	AV	54.00	12.75	1.00 H	115	38.18	31.47	7.80	36.2	3.07
2	7340.00	48.14	PK	74.00	25.86	1.00 H	137	36.40	38.32	8.72	35.3	11.74
2	7340.00	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2480			Polarity:			VERTICAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
1	4960.00	55.74	PK	74.00	18.26	1.00 V	90	52.67	31.47	7.80	-36.2	3.07
1	4960.00	39.26	AV	54.00	14.74	1.00 V	90	36.19	31.47	7.80	-36.2	3.07
2	7340.00	47.36	PK	74.00	26.64	1.00 V	145	35.62	38.32	8.72	-35.3	11.74
2	7340.00	--	AV	--	--	--	--	--	--	--	--	--

REMARKS:

1. Emission level (dBUV/m) = Raw Value (dBUV) + Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB) - Pre-amplifier Factor
3. Margin value = Limit value - Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.



### 3.3. Maximum Peak Output Power

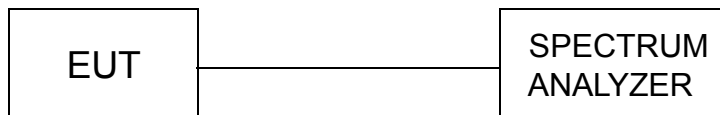
#### Limit

The Maximum Peak Output Power Measurement is 30dBm.

#### Test Procedure

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum.

#### Test Configuration



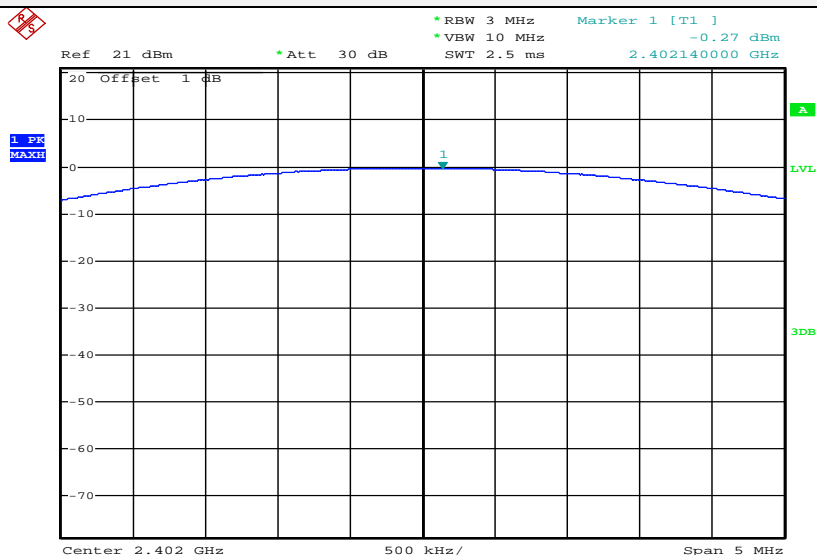
#### Test Results

Type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK	00	-0.27	30.00	Pass
	39	-0.09		
	78	-0.39		
$\pi/4$ DQPSK	00	-1.65	30.00	Pass
	39	-1.28		
	78	-1.46		
8DPSK	00	-1.48	30.00	Pass
	39	-1.19		
	78	-1.37		

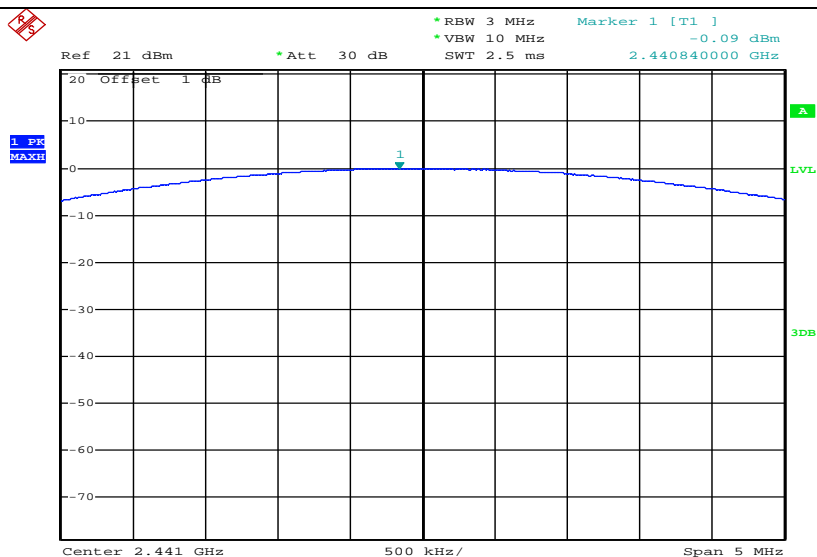
Note: 1.The test results including the cable lose.

Test plot as follows:

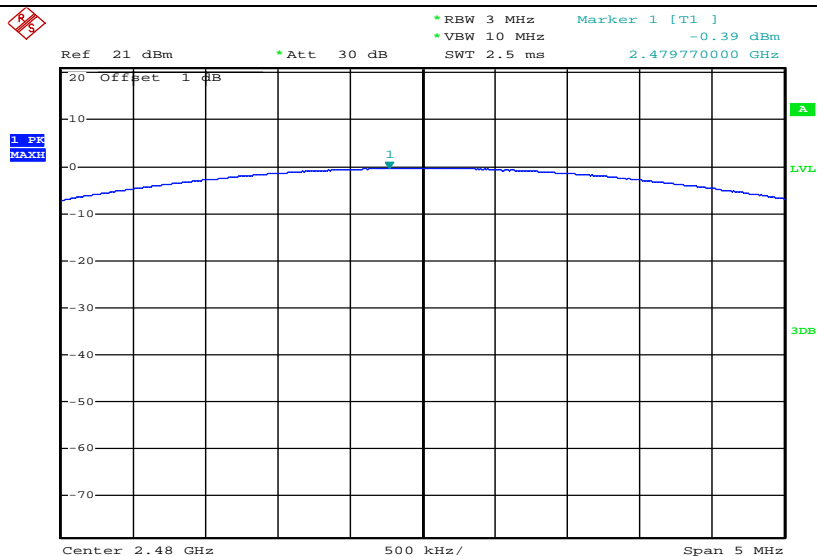
### GFSK Modulation



### CH00

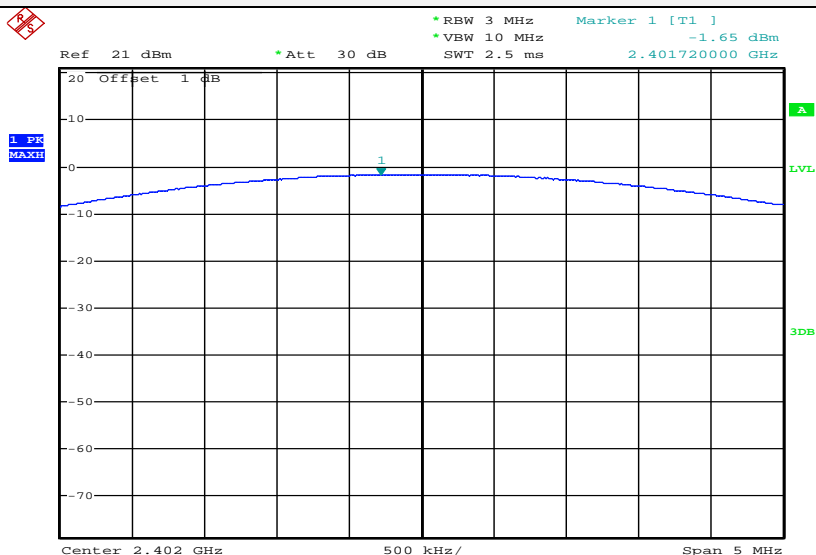


### CH39

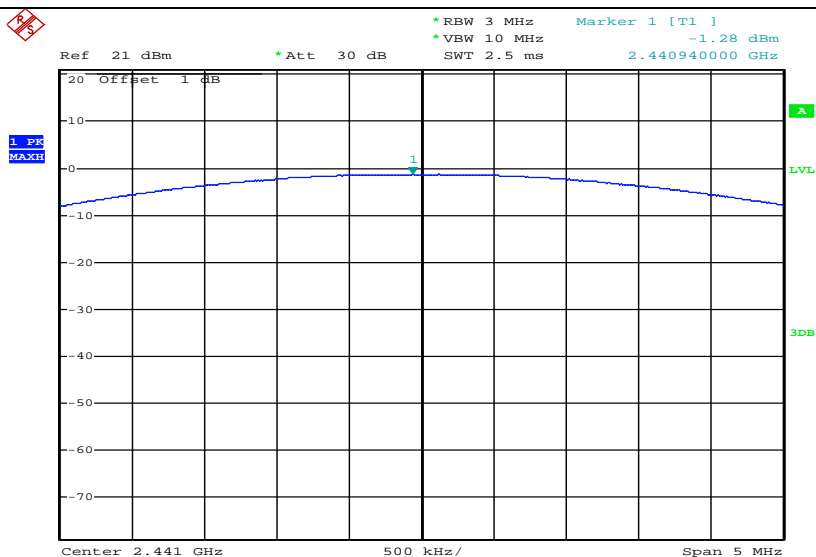


### CH78

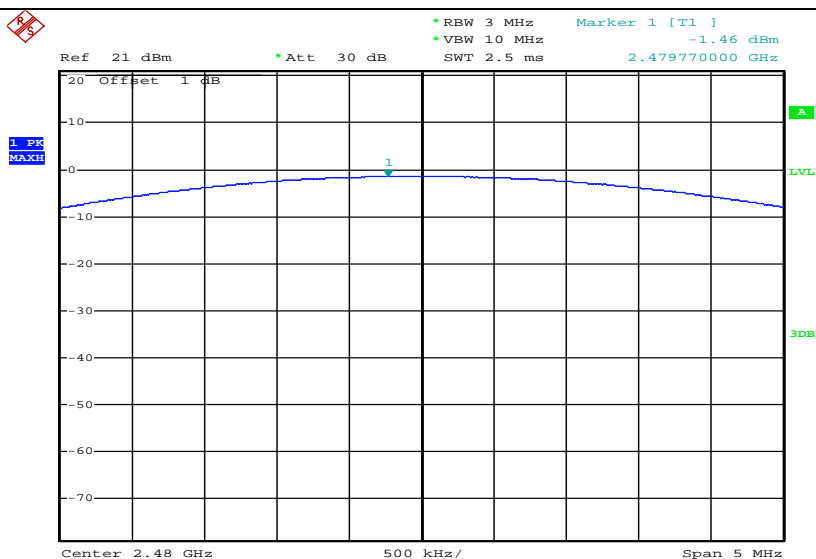
### $\pi/4$ DQPSK Modulation



### CH00

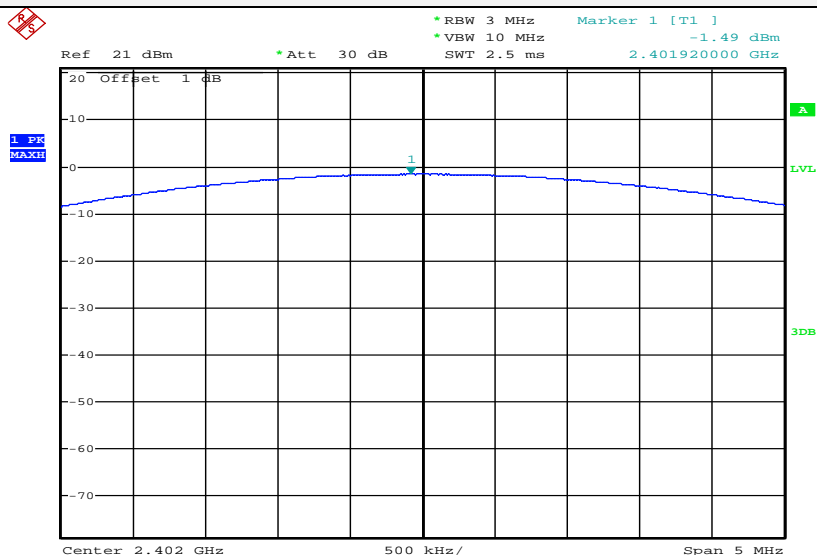


### CH39

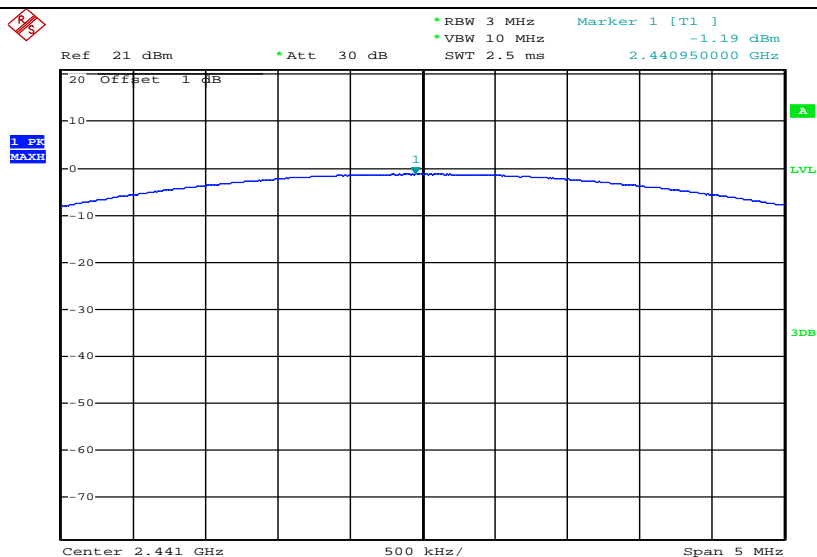


### CH78

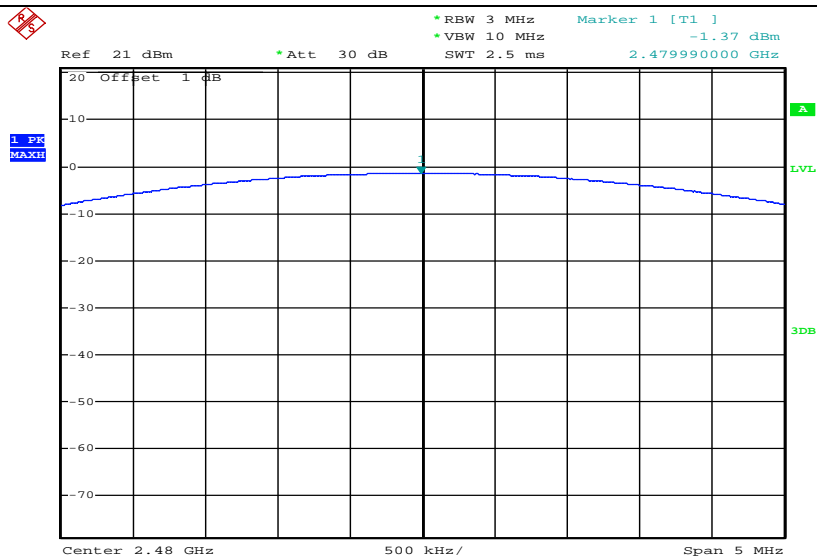
### 8DPSK Modulation



### CH00



### CH39



### CH78

### 3.4. 20dB Bandwidth

#### Limit

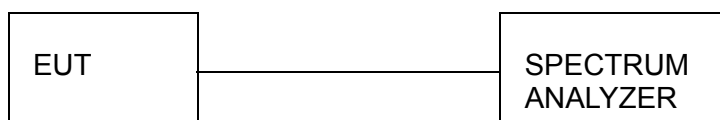
For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwidth.

#### Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30 KHz RBW and 100 KHz VBW.

The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

#### Test Configuration

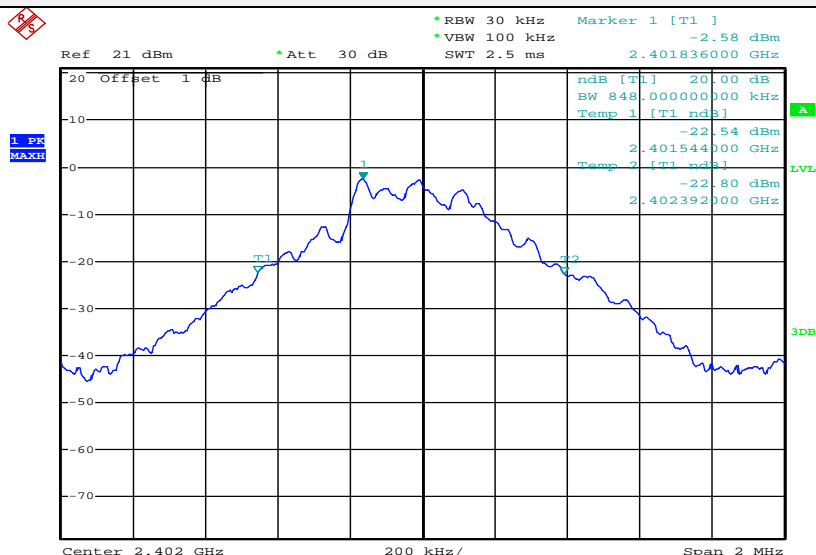


#### Test Results

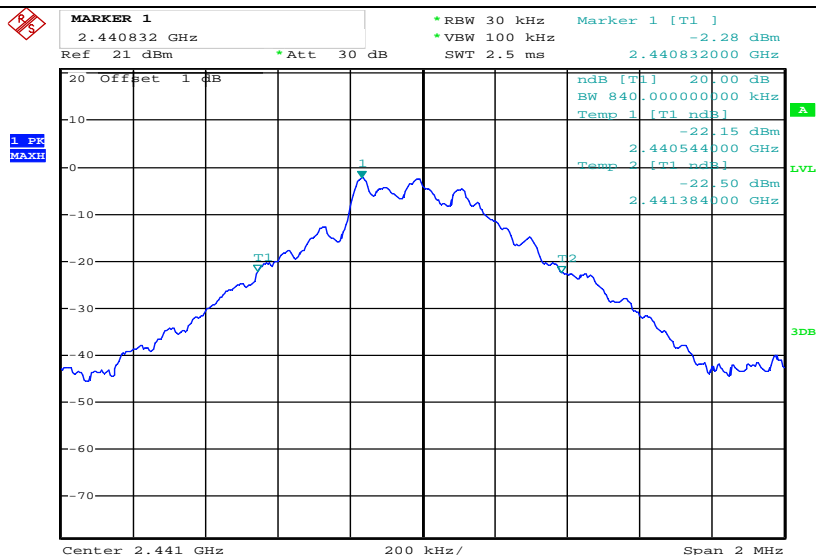
Modulation	Channel	20dB bandwidth (MHz)	Result
GFSK	CH00	0.848	Pass
	CH39	0.840	
	CH78	0.844	
$\pi/4$ DQPSK	CH00	1.244	
	CH39	1.220	
	CH78	1.220	
8DPSK	CH00	1.208	
	CH39	1.212	
	CH78	1.216	

Test plot as follows:

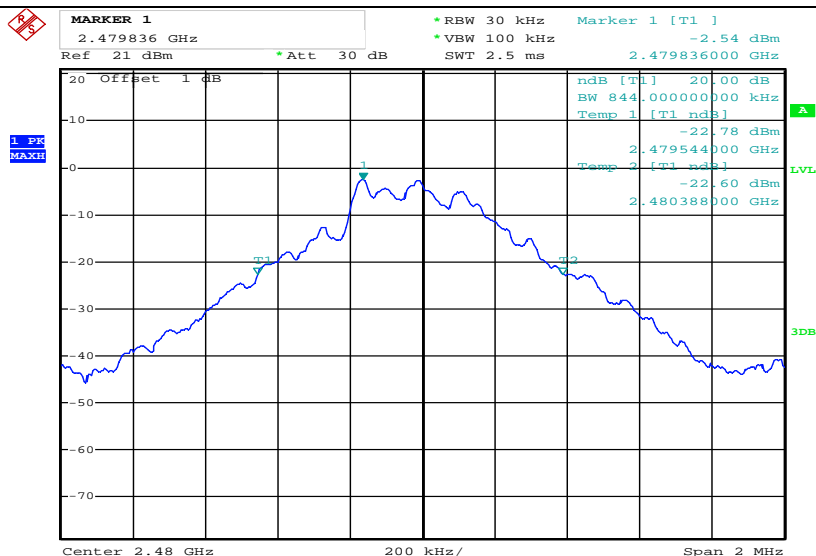
### GFSK Modulation



### CH00

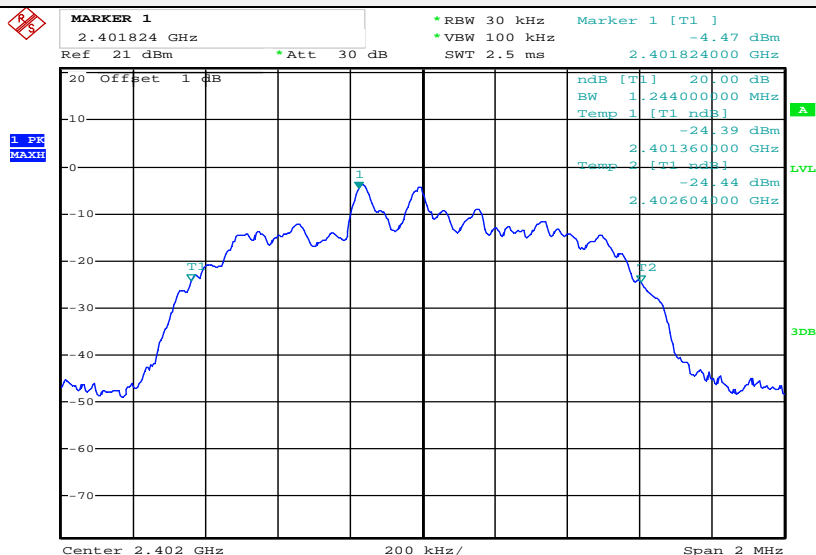


### CH39

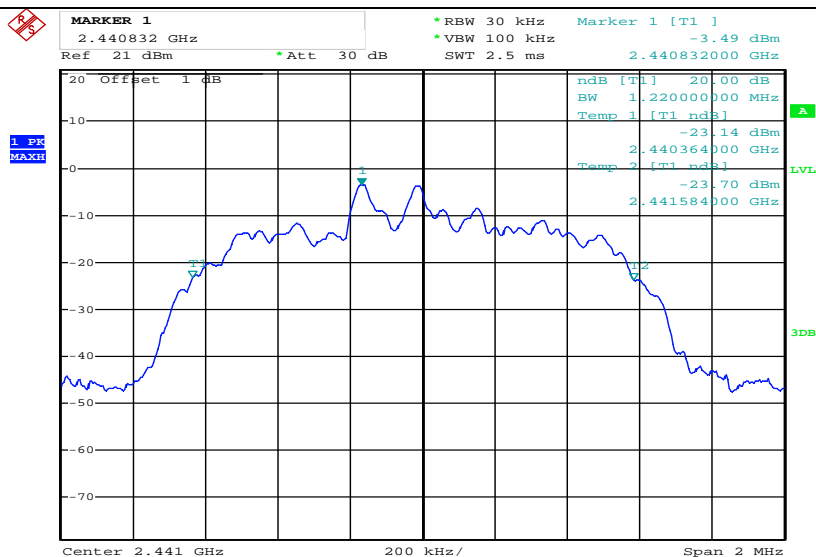


### CH78

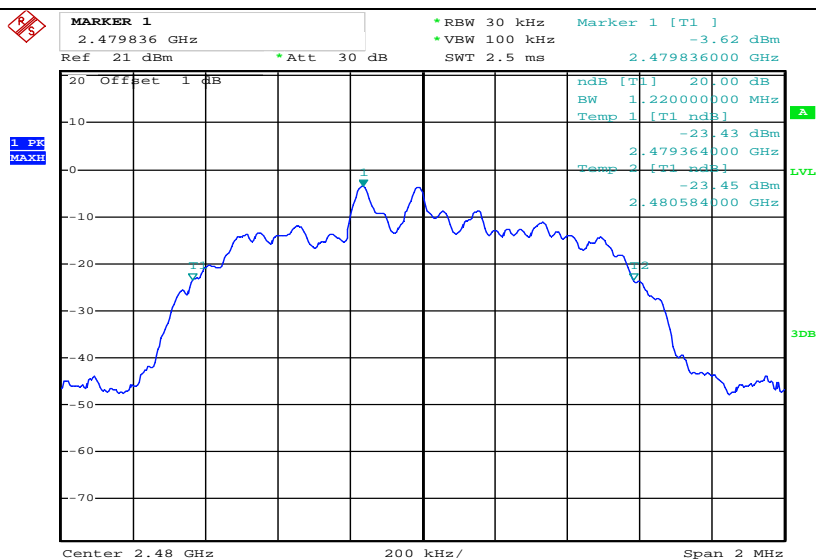
### $\pi/4$ DQPSK Modulation



### CH00



### CH39



### CH78





### 3.5. Band Edge

#### **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)).

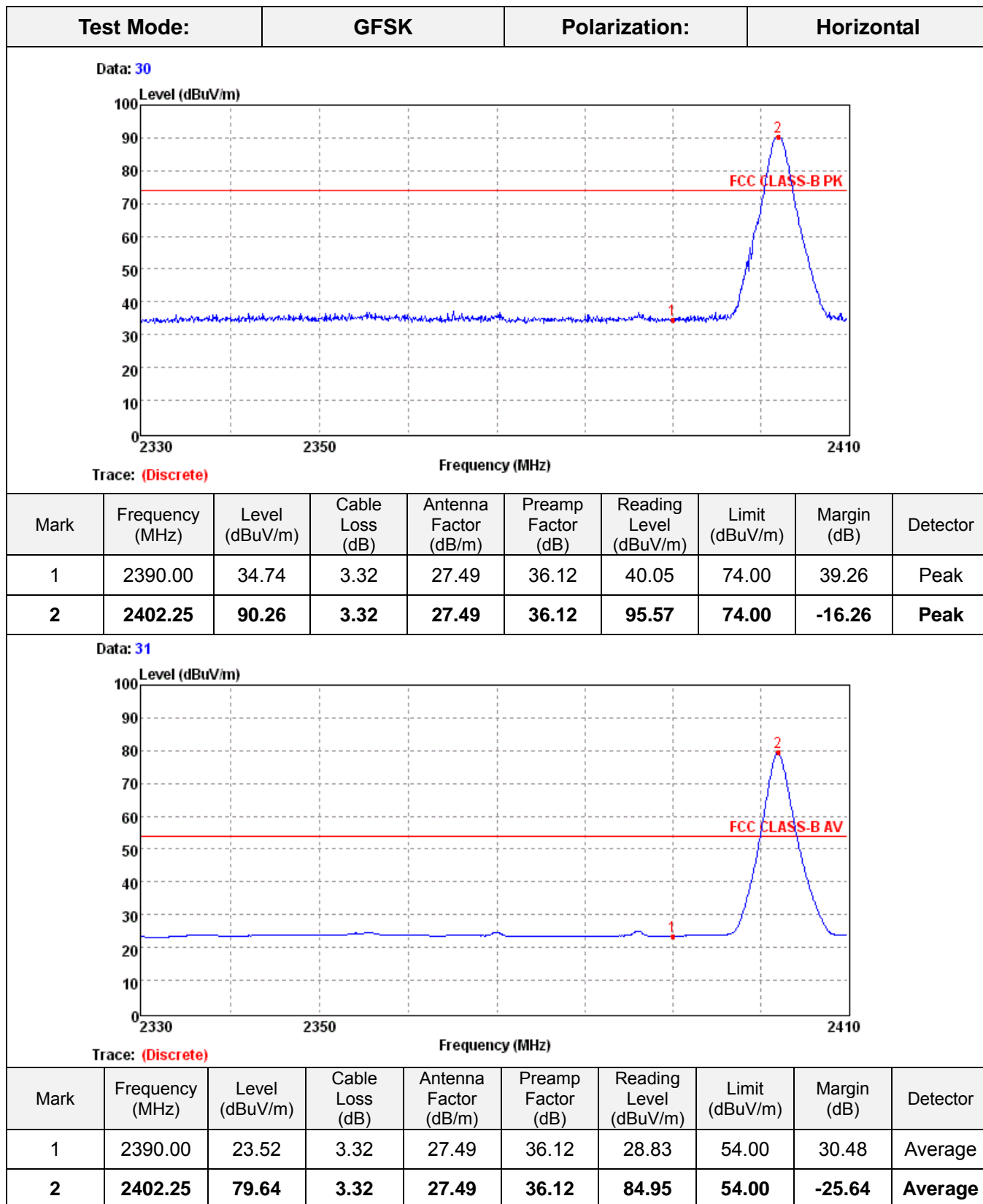
#### **Test Procedure**

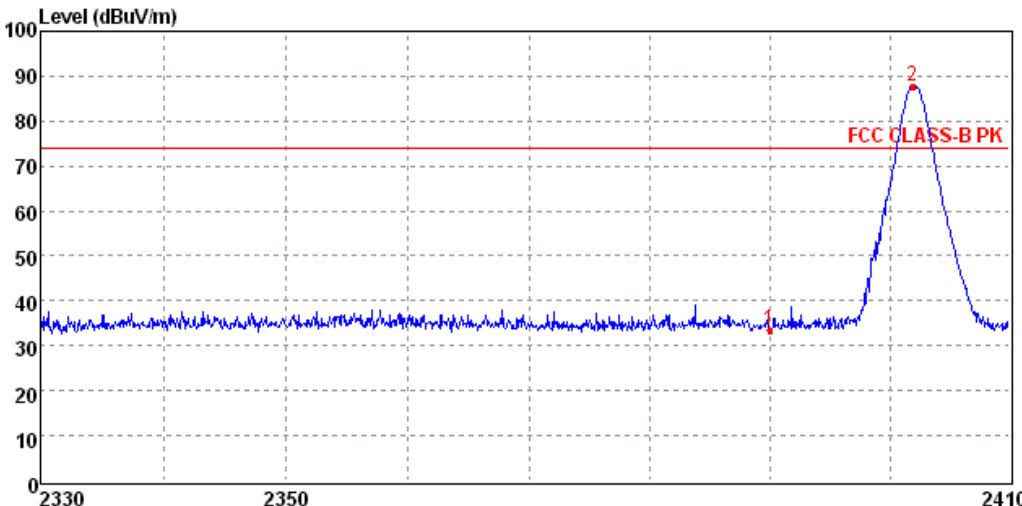
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to an EMI test receiver, then turn on the EUT and make it operate in 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 both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge, for Radiated emissions restricted band RBW=1MHz, VBW=3MHz.
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.

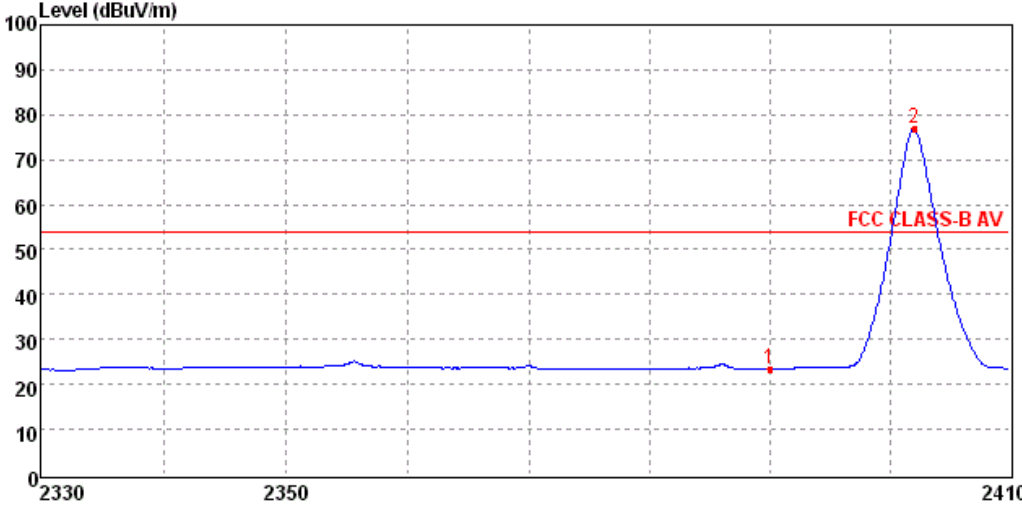
#### **TEST RESULTS**

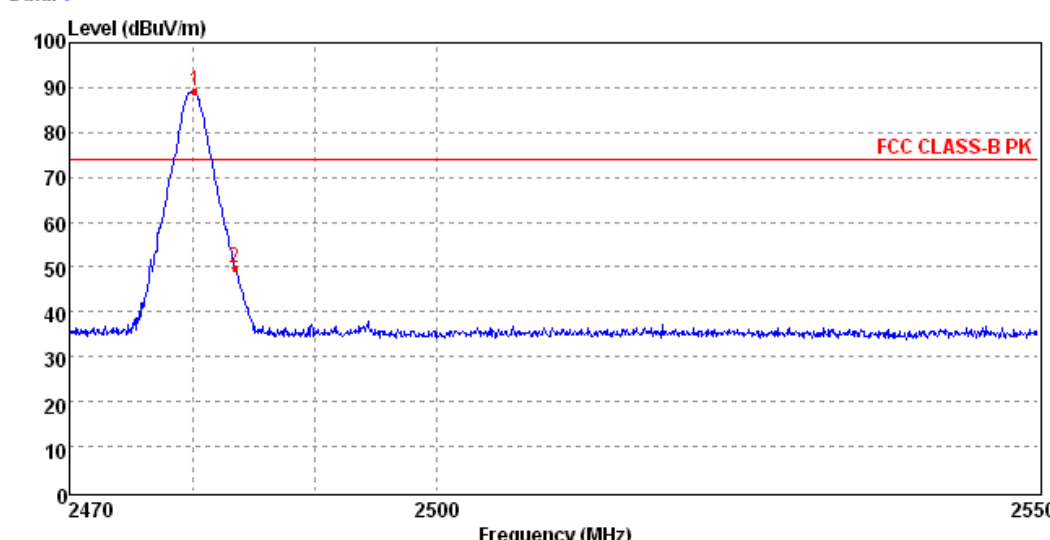
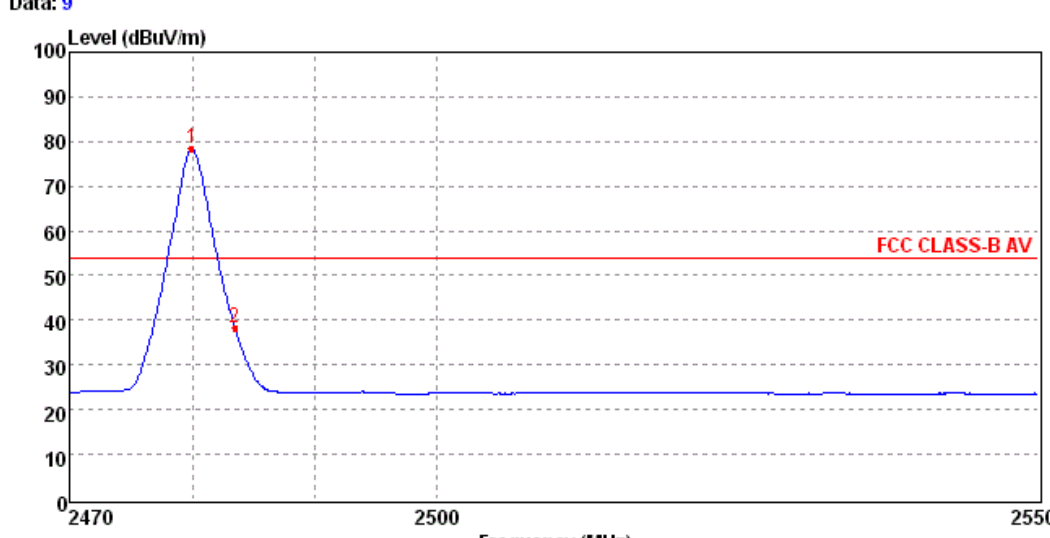
Remark: we measured all conditions (DH1, DH3, DH5) and recorded worst case at DH1

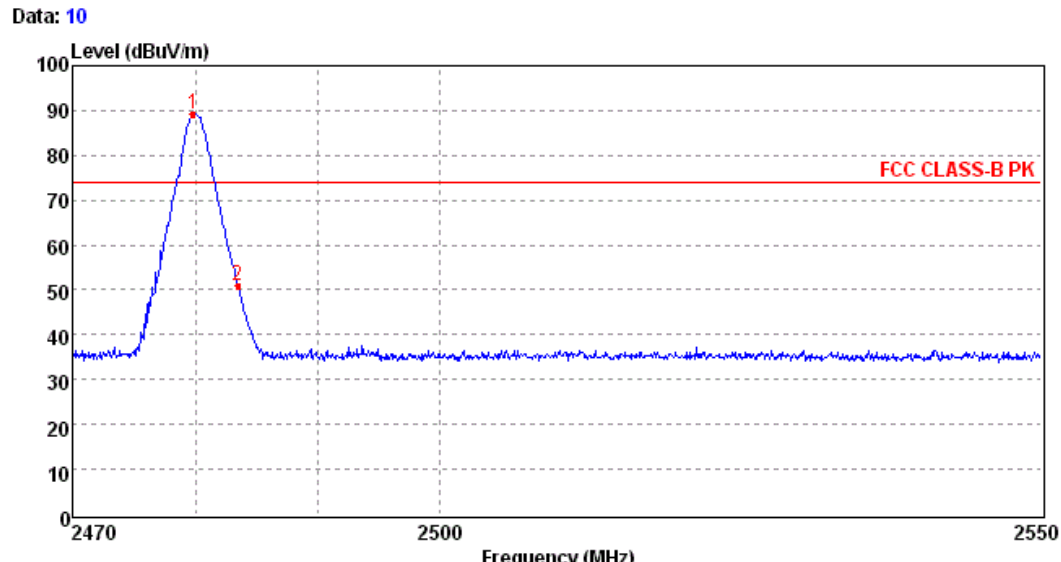
# A. Radiated Bandedge Measurement

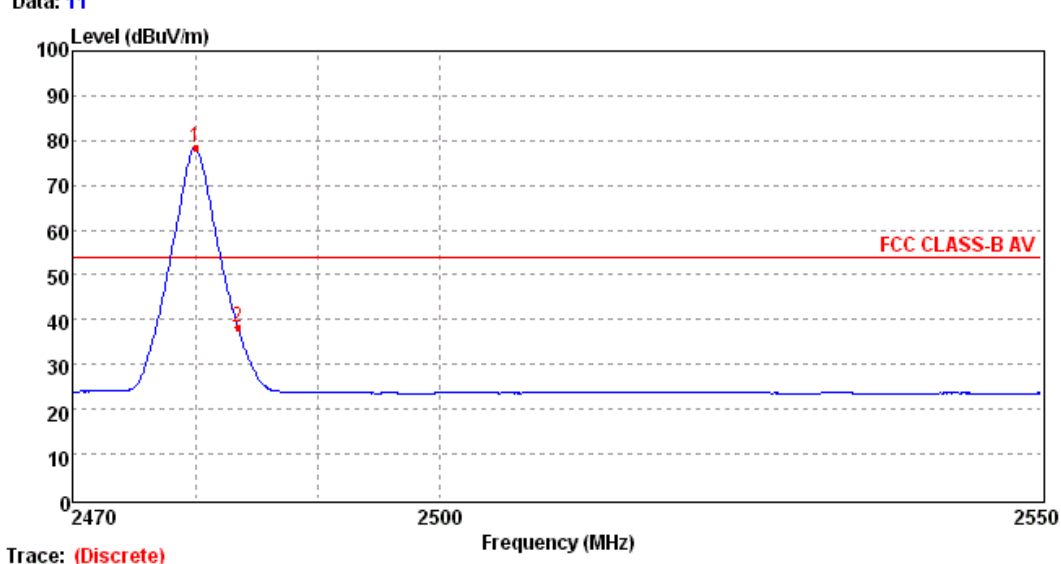


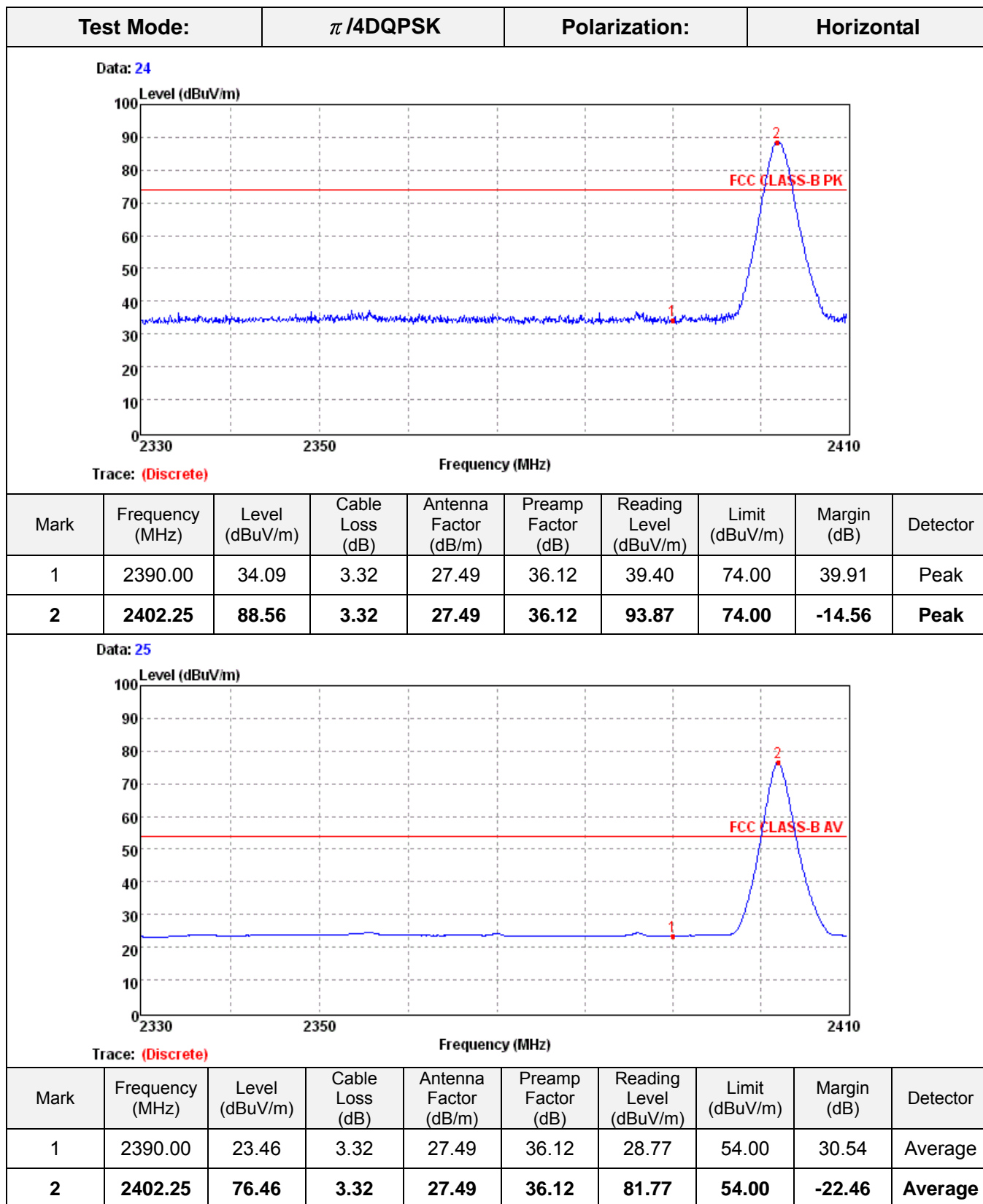
Test Mode:		GFSK			Polarization:		Vertical		
Data: 28									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.00	33.44	3.32	27.49	36.12	38.75	74.00	40.56	Peak
2	2402.25	87.64	3.32	27.49	36.12	92.95	74.00	-13.64	Peak

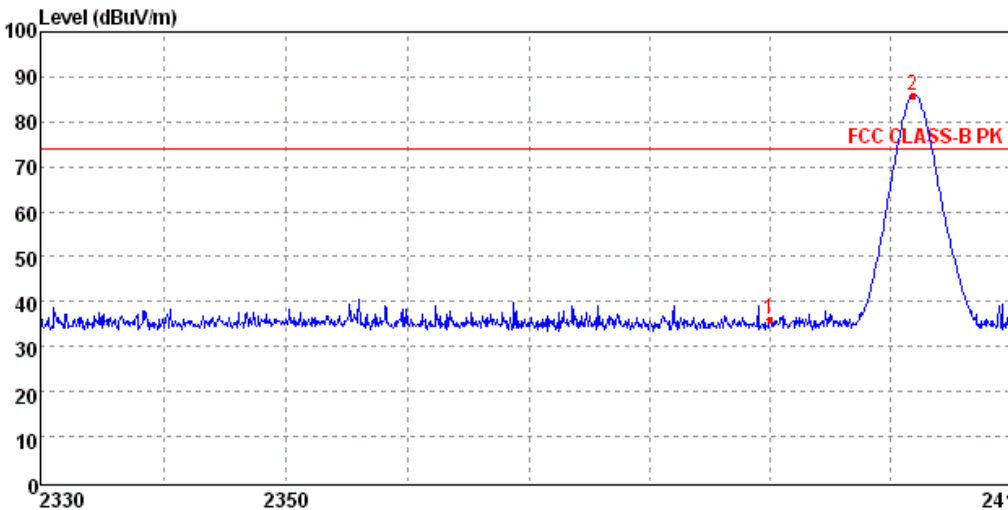
Data: 29									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.00	23.49	3.32	27.49	36.12	28.80	54.00	30.51	Average
2	2402.25	77.00	3.32	27.49	36.12	82.31	54.00	-23.00	Average

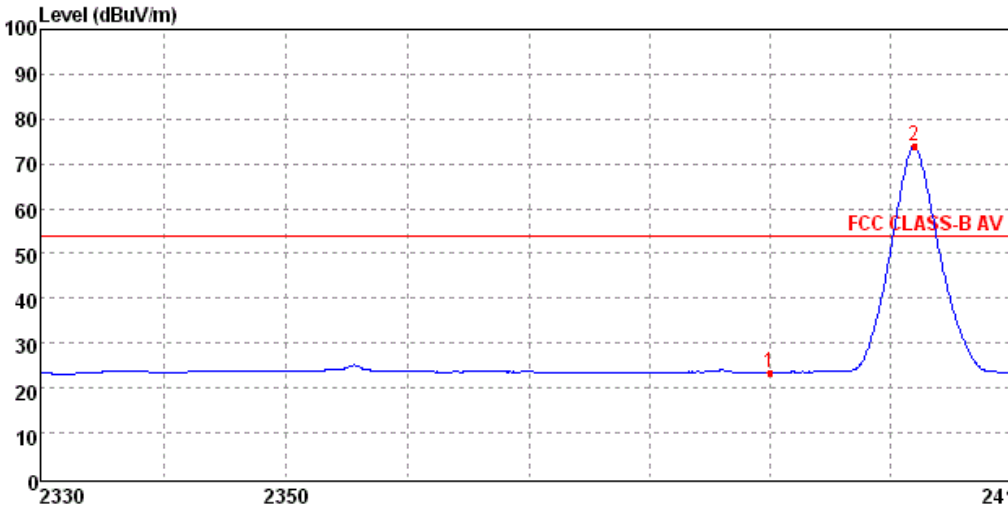
Test Mode:		GFSK			Polarization:		Horizontal		
Data: 8									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBUV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector
1	2480.10	89.05	3.88	27.45	36.55	94.27	74.00	-15.05	Peak
2	2483.50	49.86	3.88	27.45	36.55	55.08	74.00	24.14	Peak
Data: 9									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBUV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector
1	2480.10	78.44	3.88	27.45	36.55	83.66	54.00	-24.44	Average
2	2483.50	38.17	3.88	27.45	36.55	43.39	54.00	15.83	Average

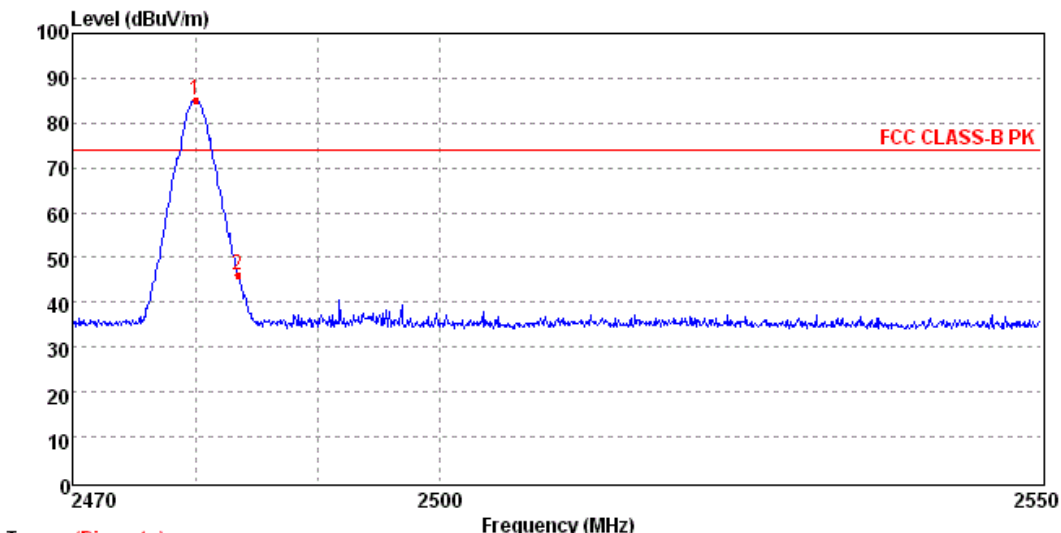
Test Mode:		GFSK		Polarization:		Vertical			
Data: 10									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2479.83	89.14	3.88	27.45	36.55	94.36	74.00	-15.14	Peak
2	2483.50	50.80	3.88	27.45	36.55	56.02	74.00	23.20	Peak

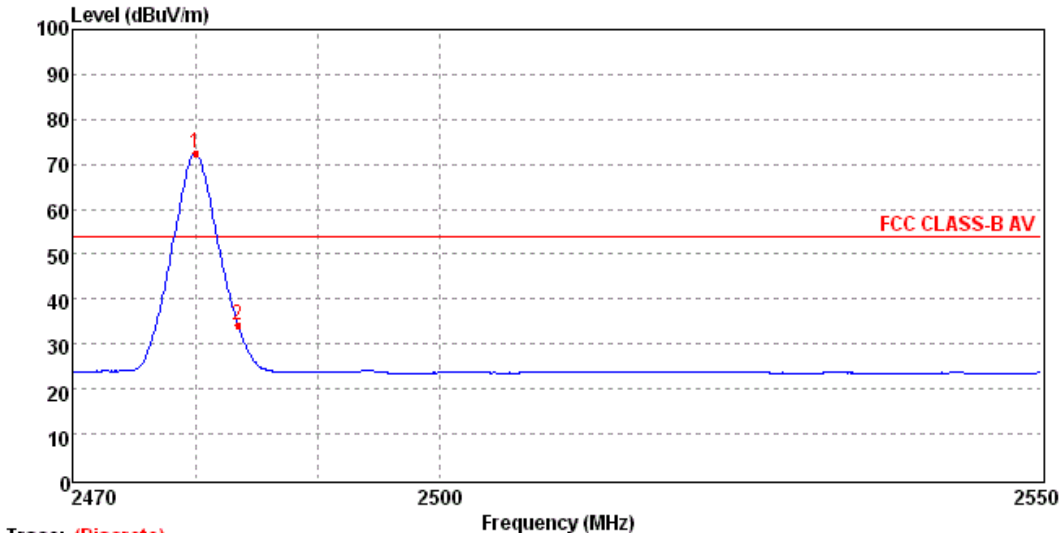
Data: 11									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2480.01	78.41	3.88	27.45	36.55	83.63	54.00	-24.41	Average
2	2483.50	38.15	3.88	27.45	36.55	43.37	54.00	15.85	Average



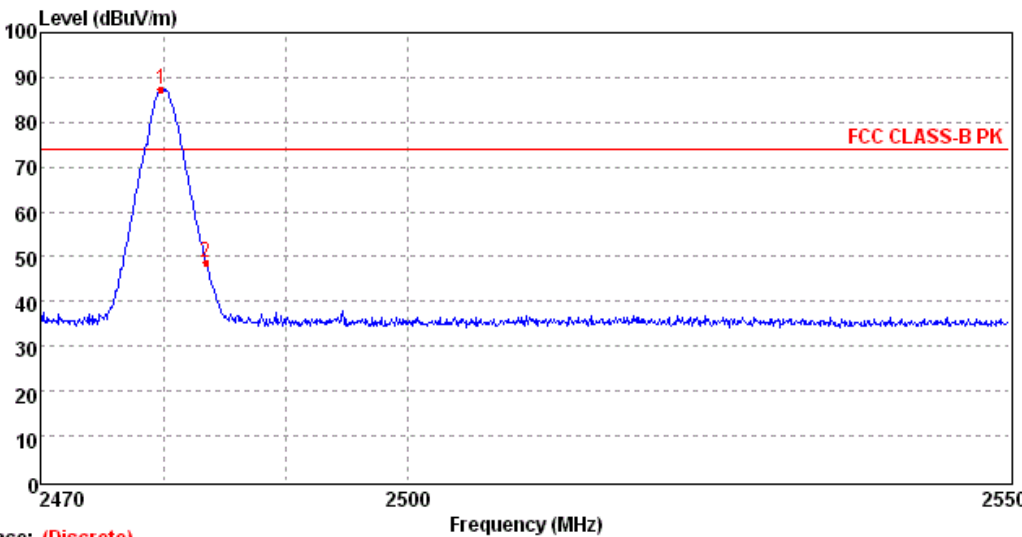
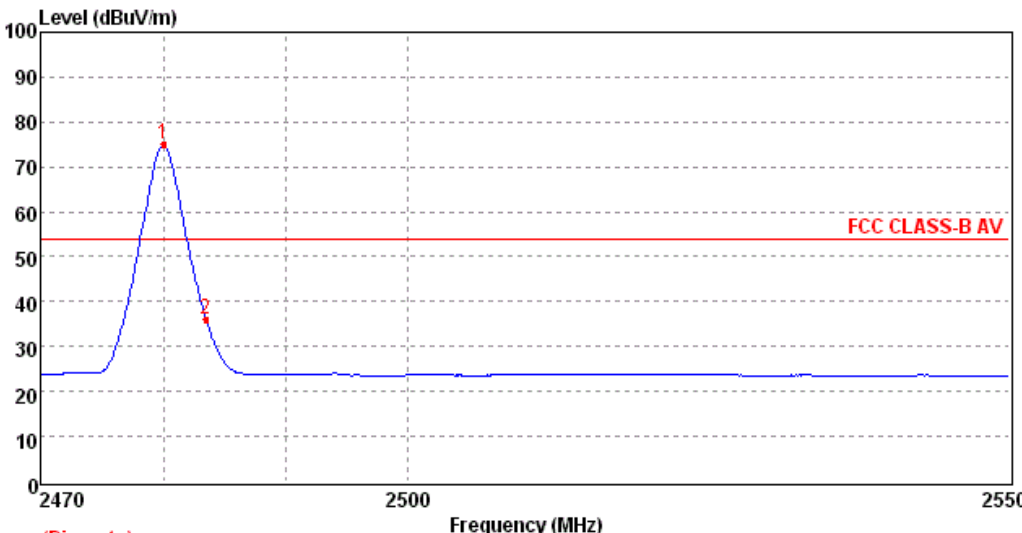
Test Mode:		$\pi$ /4DQPSK			Polarization:		Vertical		
Data: 26									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.00	36.10	3.32	27.49	36.12	41.41	74.00	37.90	Peak
2	2402.25	85.96	3.32	27.49	36.12	91.27	74.00	-11.96	Peak

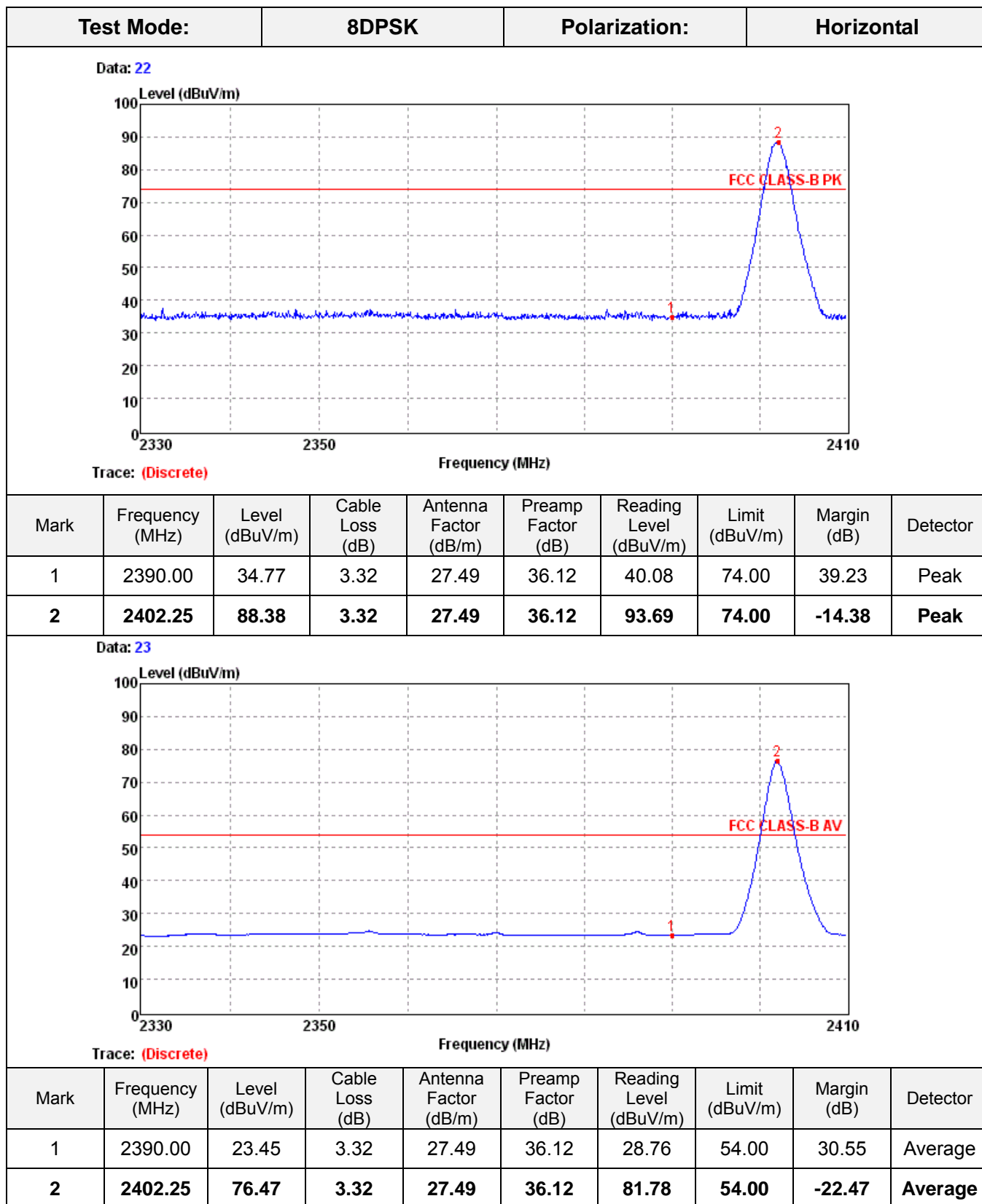
Data: 27									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.00	23.48	3.32	27.49	36.12	28.79	54.00	30.52	Average
2	2402.25	73.86	3.32	27.49	36.12	79.17	54.00	-19.86	Average

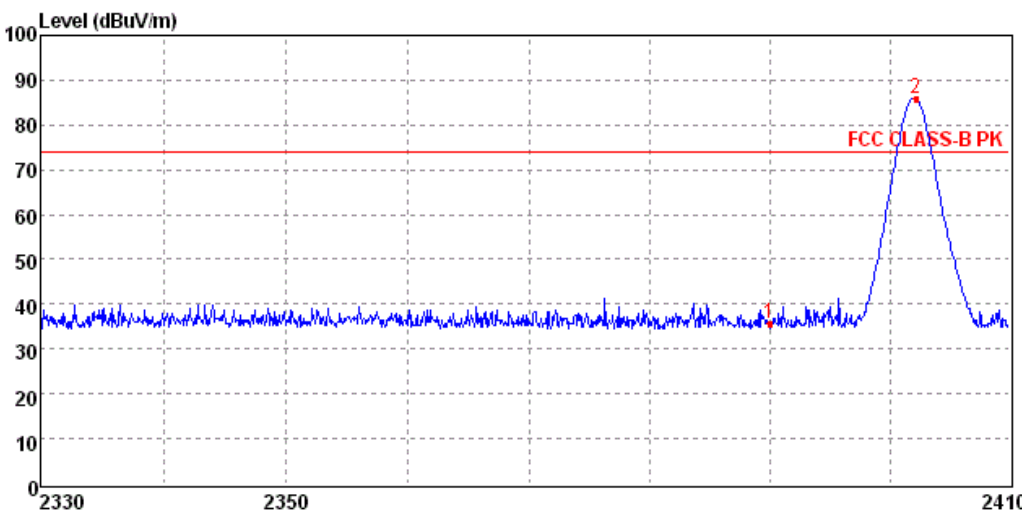
Test Mode:		$\pi$ /4DQPSK			Polarization:		Horizontal		
Data: 14									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preampl Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2480.10	85.20	3.88	27.45	36.55	90.42	74.00	-11.20	Peak
2	2483.50	45.94	3.88	27.45	36.55	51.16	74.00	28.06	Peak

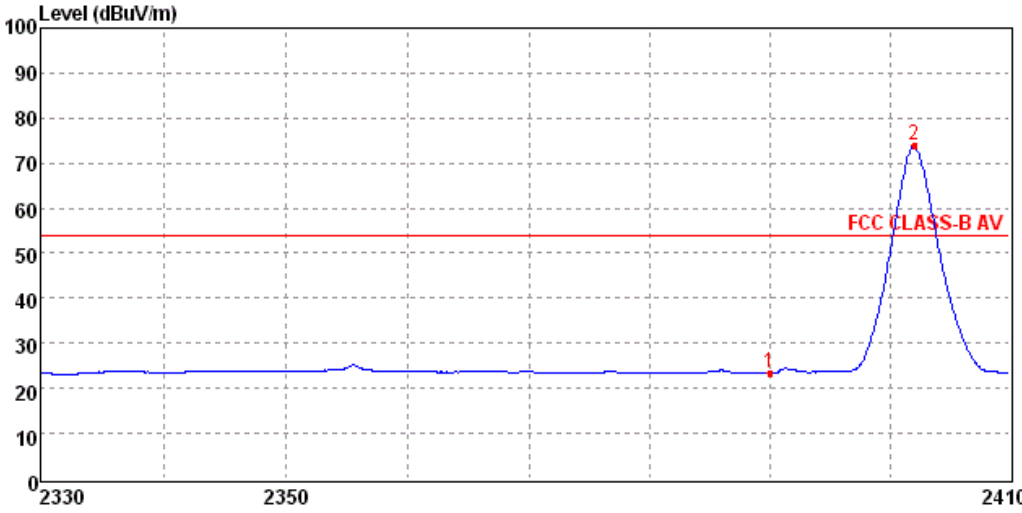
Data: 15									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preampl Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2480.02	72.56	3.88	27.45	36.55	77.78	54.00	-18.56	Average
2	2483.50	34.25	3.88	27.45	36.55	39.47	54.00	19.75	Average

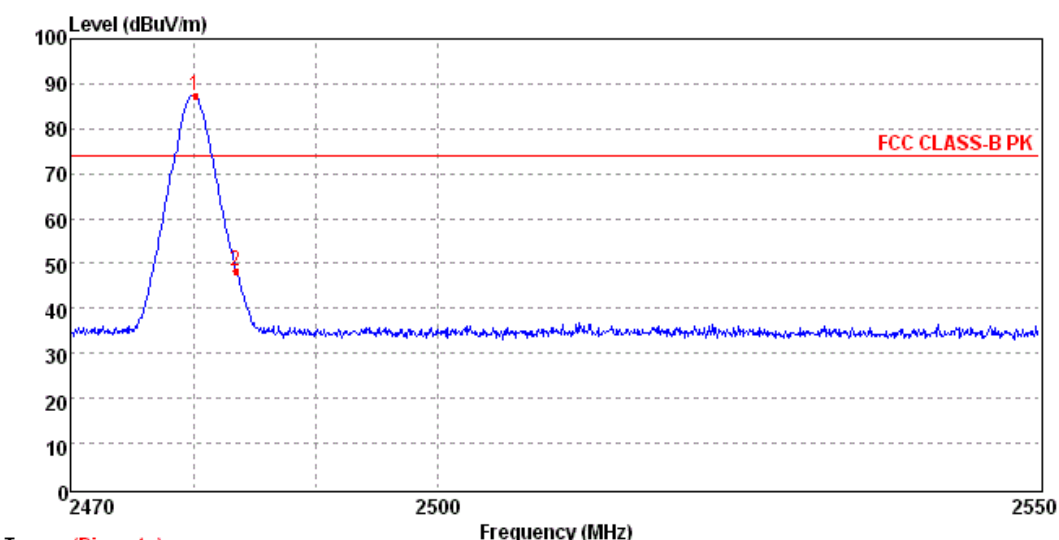


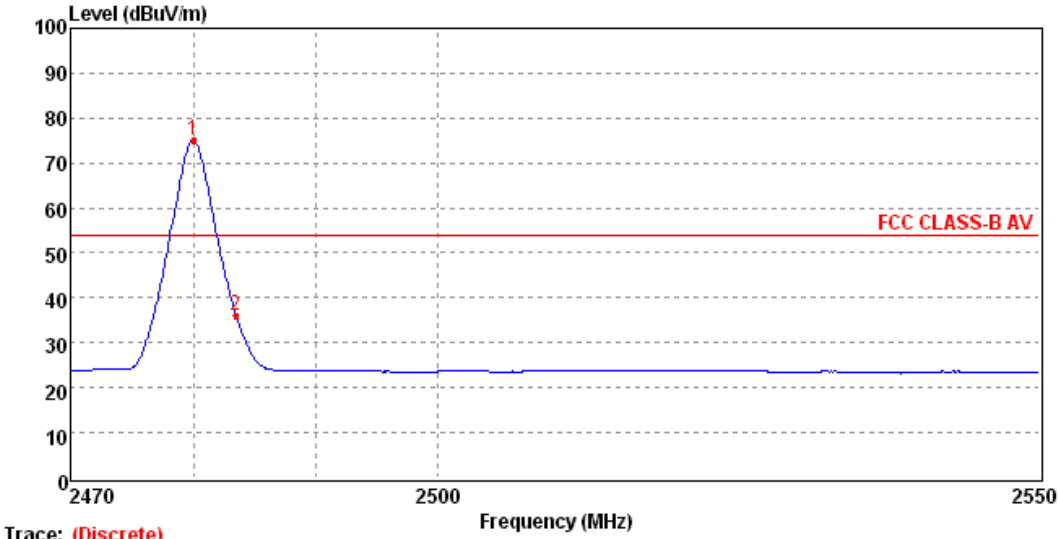
Test Mode:		$\pi$ /4DQPSK			Polarization:		Vertical		
Data: 12									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBUV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preampl Factor (dB)	Reading Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector
1	2479.83	87.34	3.88	27.45	36.55	92.56	74.00	-13.34	Peak
2	2483.50	48.64	3.88	27.45	36.55	53.86	74.00	25.36	Peak
Data: 13									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBUV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preampl Factor (dB)	Reading Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector
1	2480.01	74.91	3.88	27.45	36.55	80.13	54.00	-20.91	Average
2	2483.50	36.14	3.88	27.45	36.55	41.36	54.00	17.86	Average

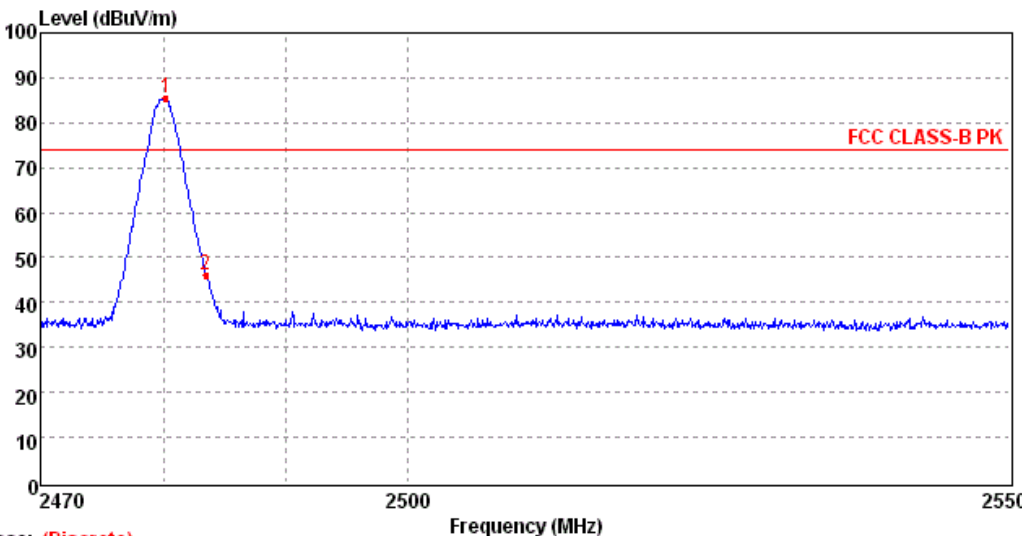
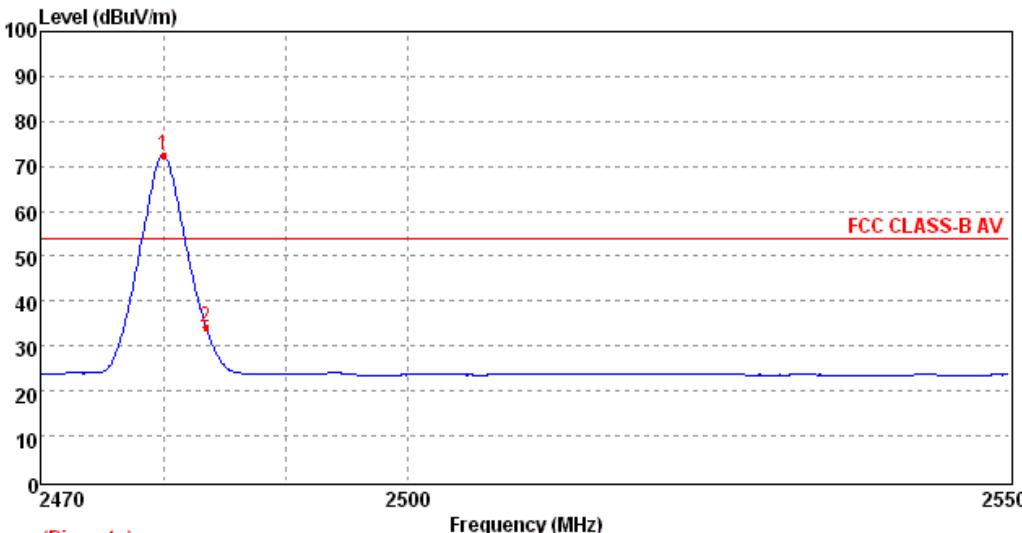


Test Mode:		8DPSK				Polarization:		Vertical	
Data: 20									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preampl Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.00	35.55	3.32	27.49	36.12	40.86	74.00	38.45	Peak
2	2402.25	85.91	3.32	27.49	36.12	91.22	74.00	-11.91	Peak

Data: 21									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preampl Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.00	23.49	3.32	27.49	36.12	28.80	54.00	30.51	Average
2	2402.25	73.85	3.32	27.49	36.12	79.16	54.00	-19.85	Average

Test Mode:		8DPSK			Polarization:		Horizontal		
Data: 16									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2480.10	87.31	3.88	27.45	36.55	92.53	74.00	-13.31	Peak
2	2483.50	48.39	3.88	27.45	36.55	53.61	74.00	25.61	Peak

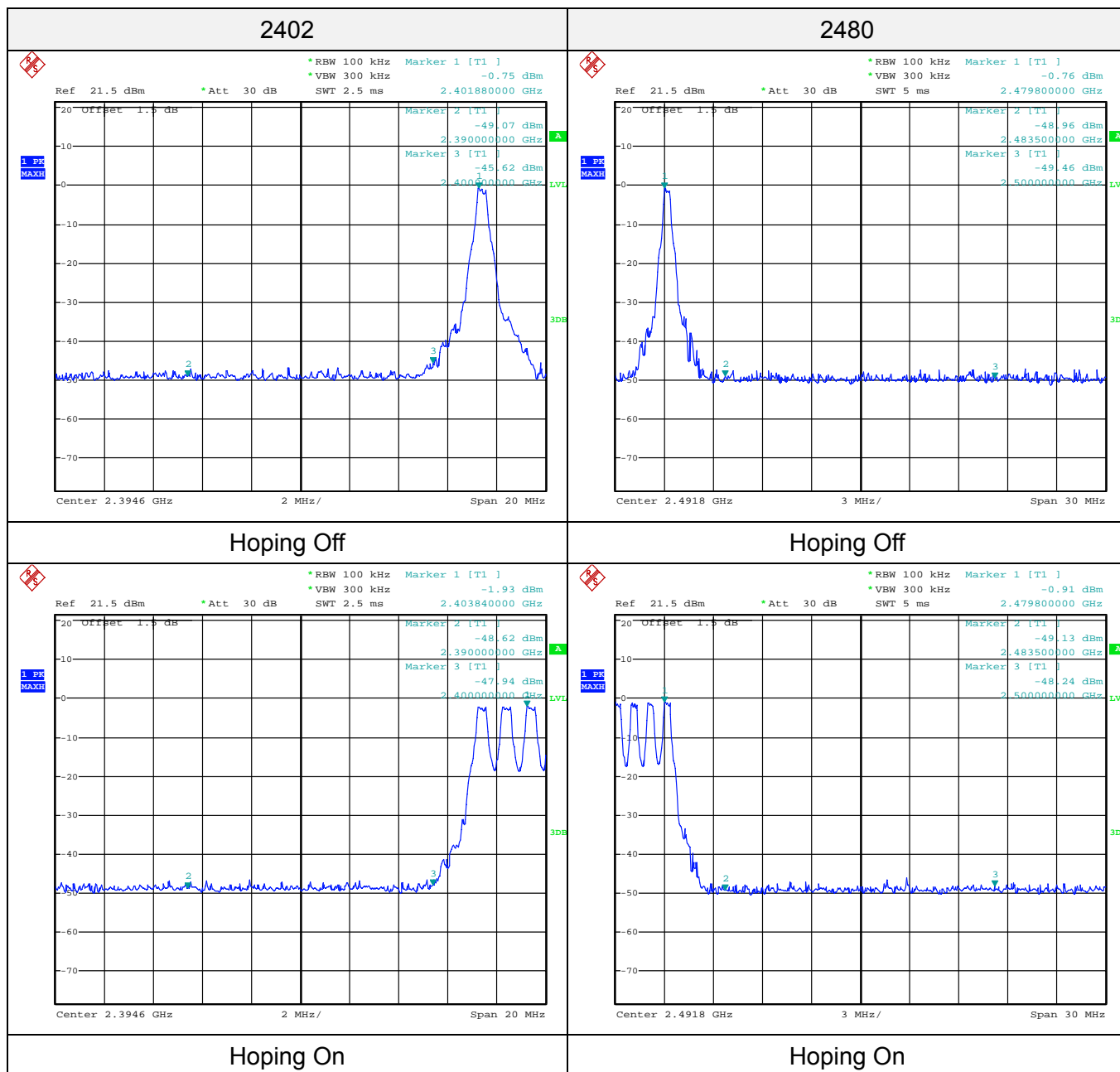
Data: 17									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2480.02	75.13	3.88	27.45	36.55	80.35	54.00	-21.13	Average
2	2483.50	36.20	3.88	27.45	36.55	41.42	54.00	17.80	Average

Test Mode:		8DPSK			Polarization:		Vertical		
Data: 18									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2480.26	85.48	3.88	27.45	36.55	90.70	74.00	-11.48	Peak
2	2483.50	46.11	3.88	27.45	36.55	51.33	74.00	27.89	Peak
Data: 19									
									
Trace: (Discrete)									
Mark	Frequency (MHz)	Level (dBuV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Reading Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2480.02	72.62	3.88	27.45	36.55	77.84	54.00	-18.62	Average
2	2483.50	34.23	3.88	27.45	36.55	39.45	54.00	19.77	Average

## B. Conducted Bandedge Measurement

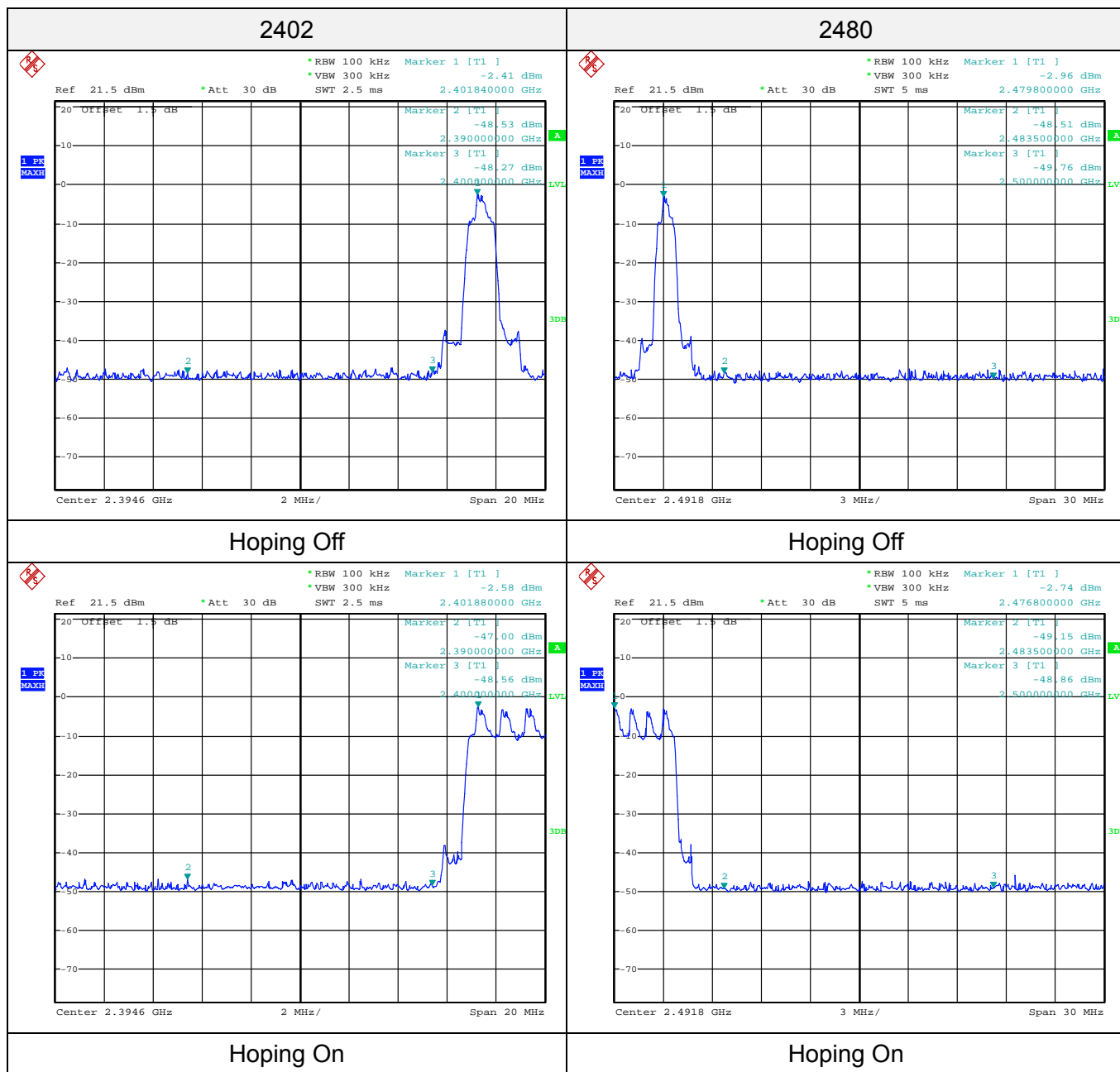
### GFSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hopping Mode	Limit (dBc)	Verdict
2400.00	44.87	OFF	20	PASS
2400.00	48.20	ON	20	PASS
2483.50	46.01	OFF	20	PASS
2483.50	48.22	ON	20	PASS



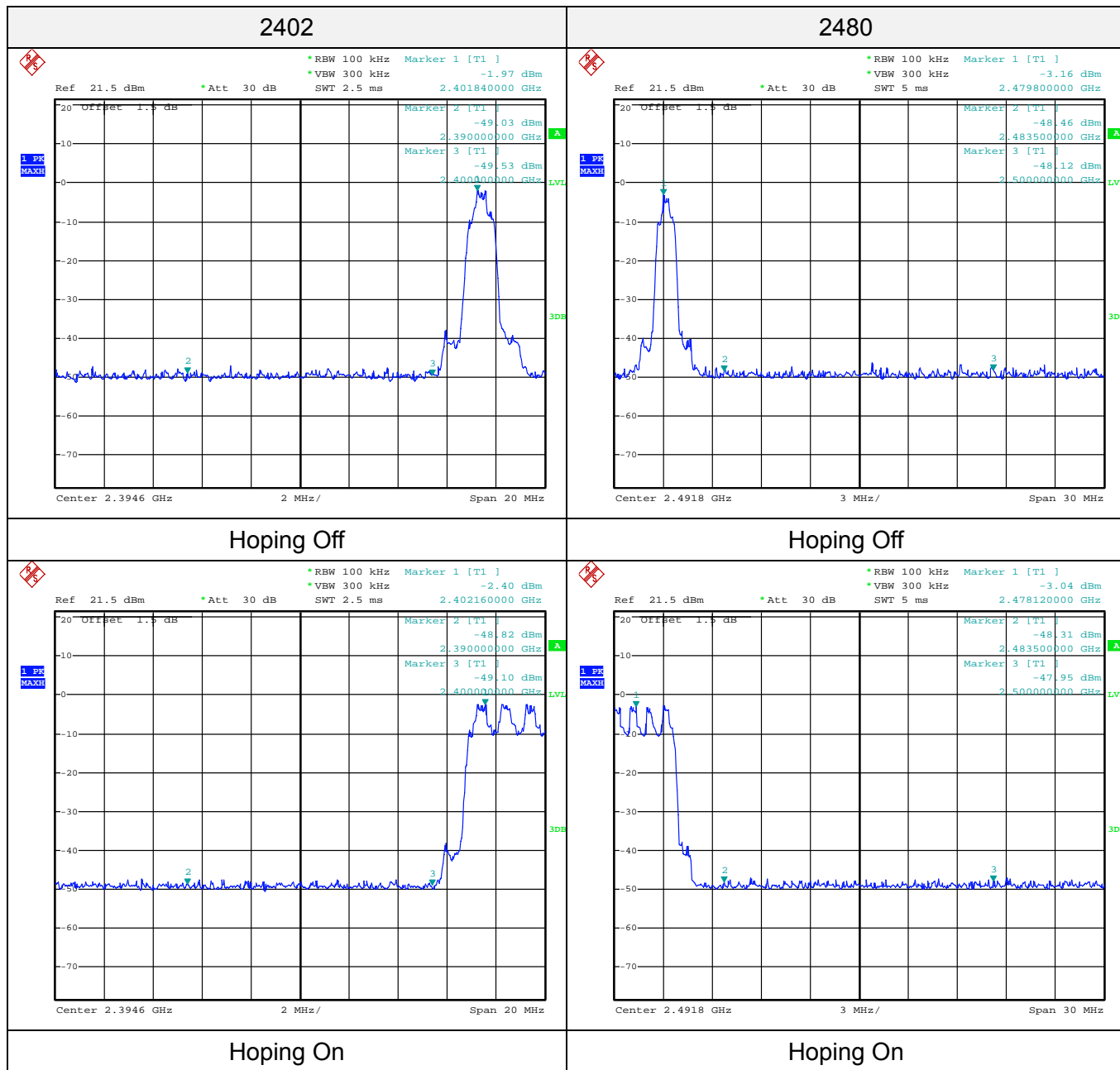
$\pi/4$ DQPSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hopping Mode	Limit (dBc)	Verdict
2400.00	45.86	OFF	20	PASS
2400.00	45.98	ON	20	PASS
2483.50	46.80	OFF	20	PASS
2483.50	46.12	ON	20	PASS



### 8DPSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hopping Mode	Limit (dBc)	Verdict
2400.00	47.56	OFF	20	PASS
2400.00	46.70	ON	20	PASS
2483.50	45.30	OFF	20	PASS
2483.50	45.27	ON	20	PASS





### 3.6. Frequency Separation

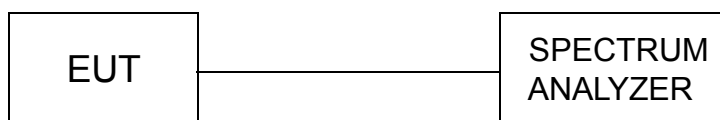
#### LIMIT

According to 15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the  $2/3 \times 20\text{dB}$  bandwidth of the hopping channel, whichever is greater.

#### TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 KHz RBW and 300 KHz VBW.

#### TEST CONFIGURATION



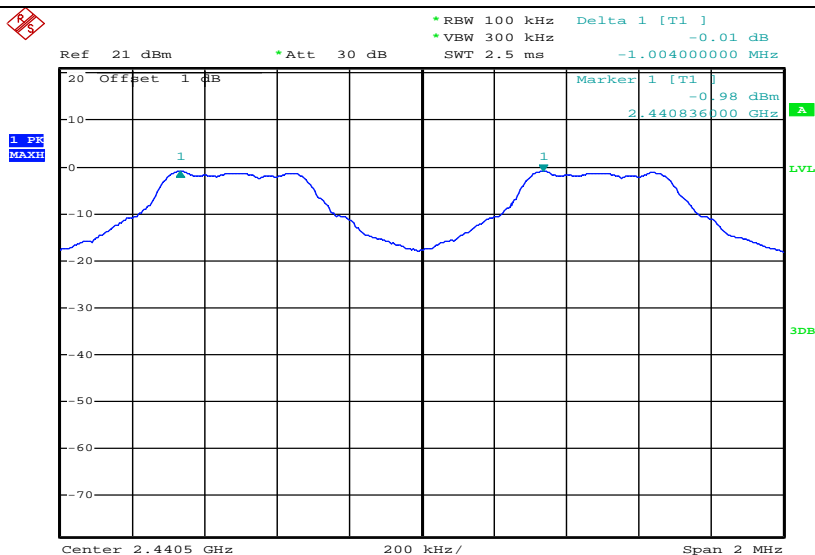
#### TEST RESULTS

Modulation	Channel	Channel Separation (MHz)	Limit(MHz)	Result
GFSK	CH39	1.004	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			
$\pi/4$ DQPSK	CH39	1.004	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			
8DPSK	CH39	1.004	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			

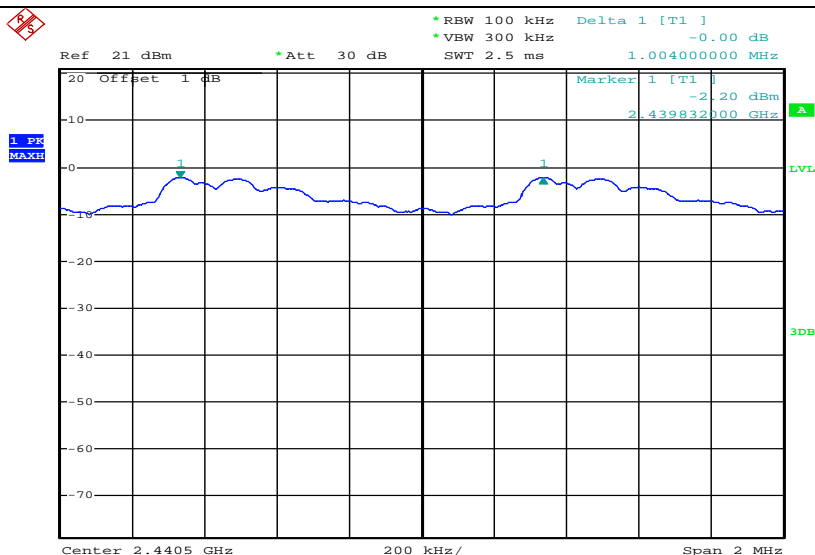
Note:

We have tested all mode at high, middle and low channel, and recorded worst case at middle

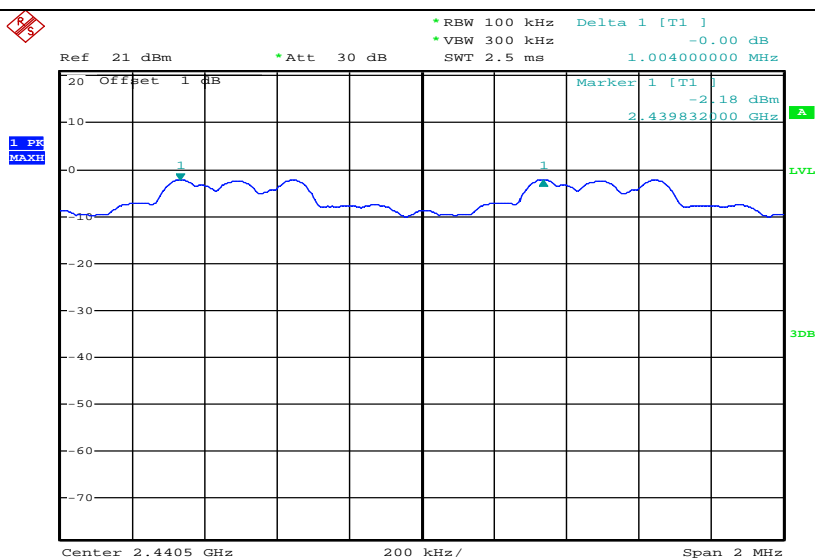
#### Test plot as follows:



### GFSK



### 8DPSK



### $\pi/4$ DQPSK

### 3.7. Number of hopping frequency

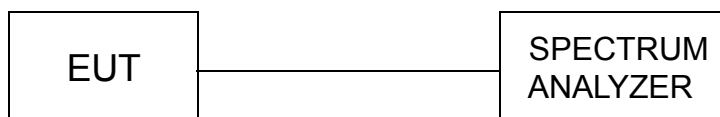
#### Limit

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

#### Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 2400MHz to 2483.5MHz with 100 KHz RBW and 300 KHz VBW.

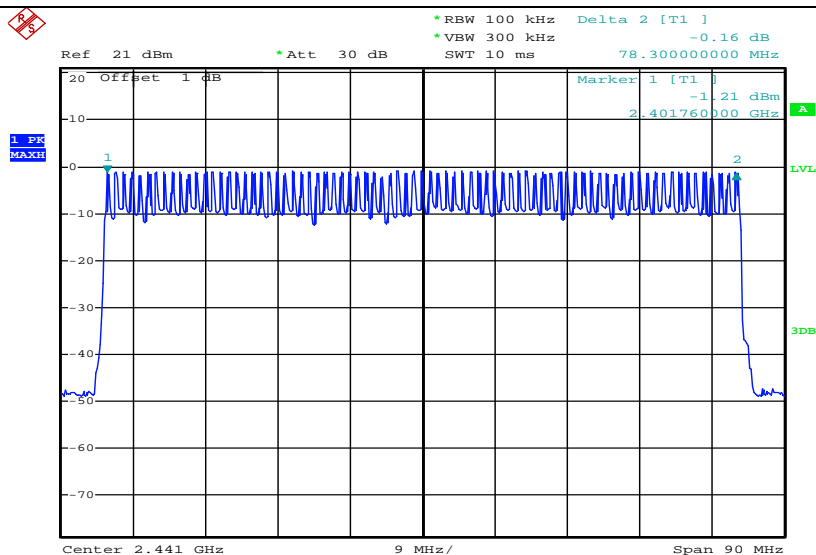
#### Test Configuration



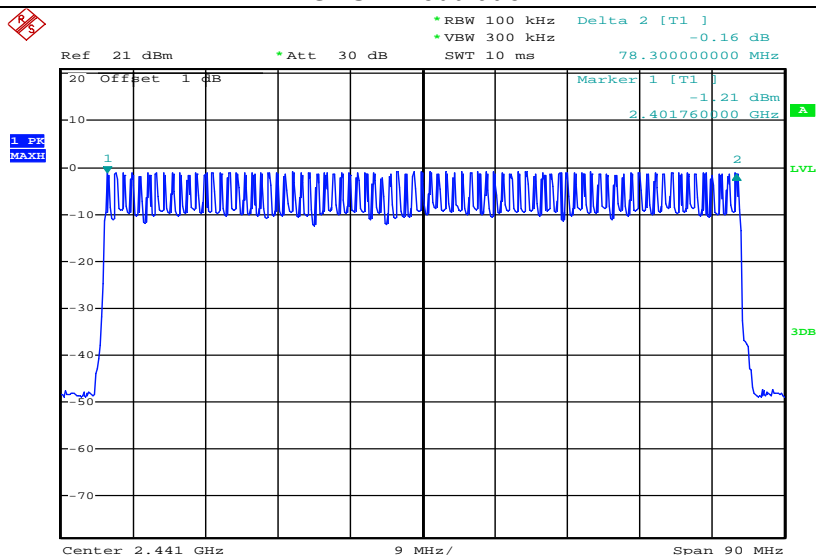
#### Test Results

Modulation	Number of Hopping Channel	Limit	Result
GFSK	79	≥15	Pass
π/4DQPSK	79		
8DPSK	79		

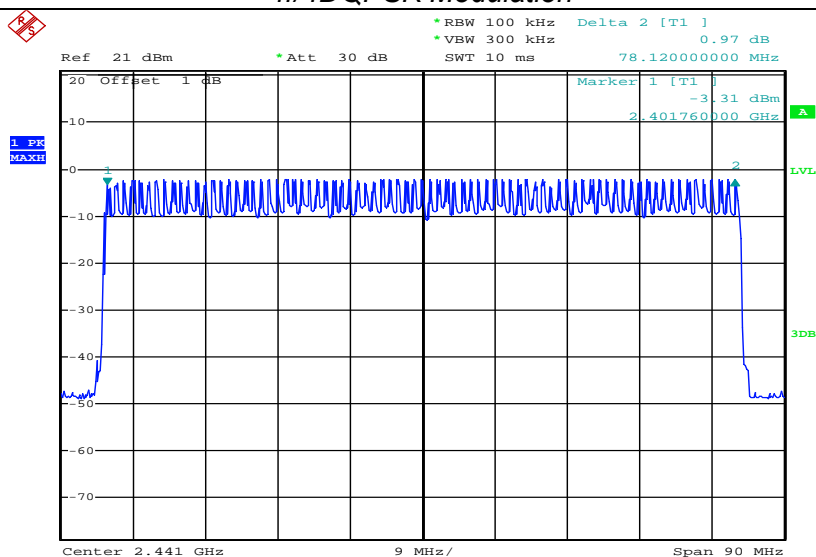
#### Test plot as follows:



### GFSK Modulation



### $\pi/4$ DQPSK Modulation



### 8DPSK Modulation

### 3.8. Time of Occupancy (Dwell Time)

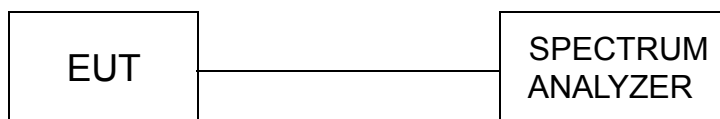
#### Limit

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 Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with 1MHz RBW and 3MHz VBW, Span 0Hz.

#### Test Configuration



#### Test Results

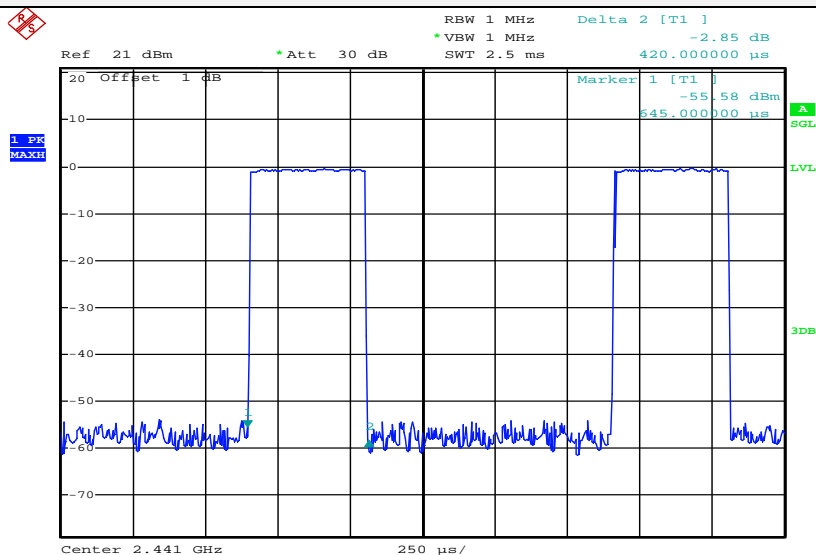
Modulation	Packet	Dwell time (second)	Limit (second)	Result
GFSK	DH1	0.134	0.40	Pass
	DH3	0.270		
	DH5	0.315		
$\pi/4$ DQPSK	2-DH1	0.139	0.40	Pass
	2-DH3	0.270		
	2-DH5	0.315		
8DPSK	3-DH1	0.138	0.40	Pass
	3-DH3	0.270		
	3-DH5	0.315		

Note:

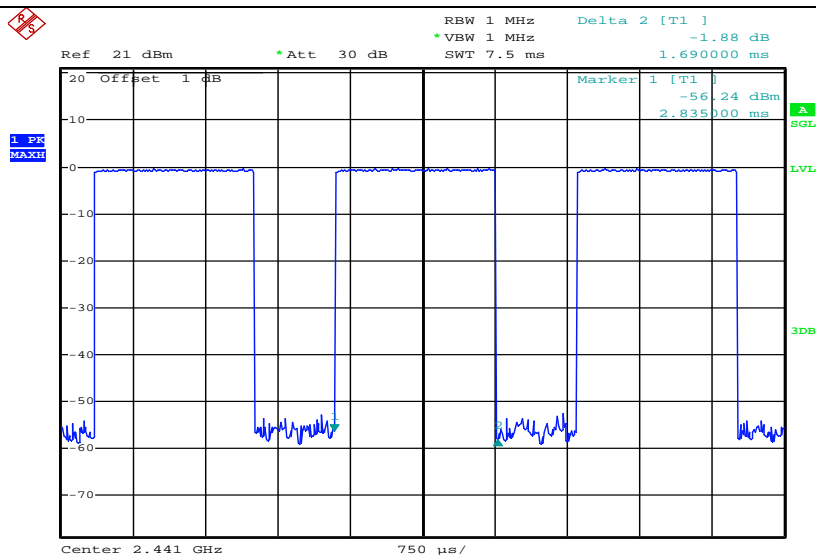
- We have tested all mode at high,middle and low channel,and recoreded worst case at middle channel.
- $\text{Dwell time} = \text{Pulse time (ms)} \times (1600 \div 2 \div 79) \times 31.6$  Second for DH1, 2-DH1, 3-DH1  
 $\text{Dwell time} = \text{Pulse time (ms)} \times (1600 \div 4 \div 79) \times 31.6$  Second for DH3, 2-DH3, 3-DH3  
 $\text{Dwell time} = \text{Pulse time (ms)} \times (1600 \div 6 \div 79) \times 31.6$  Second for DH5, 2-DH5, 3-DH5

#### Test plot as follows:

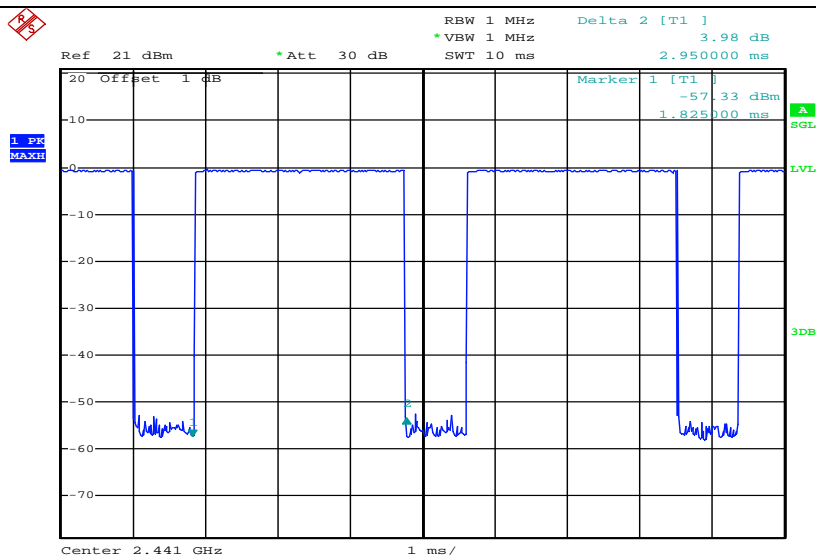
### FSK Modulation



### DH1

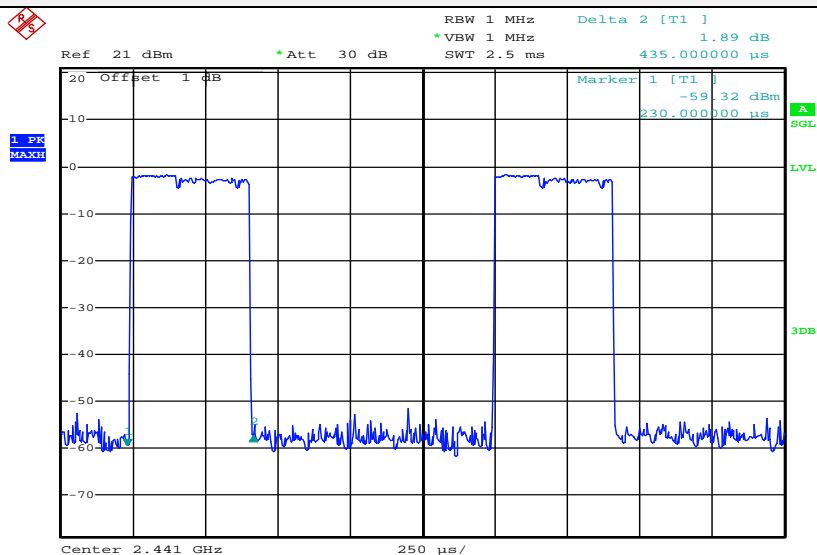


### DH3

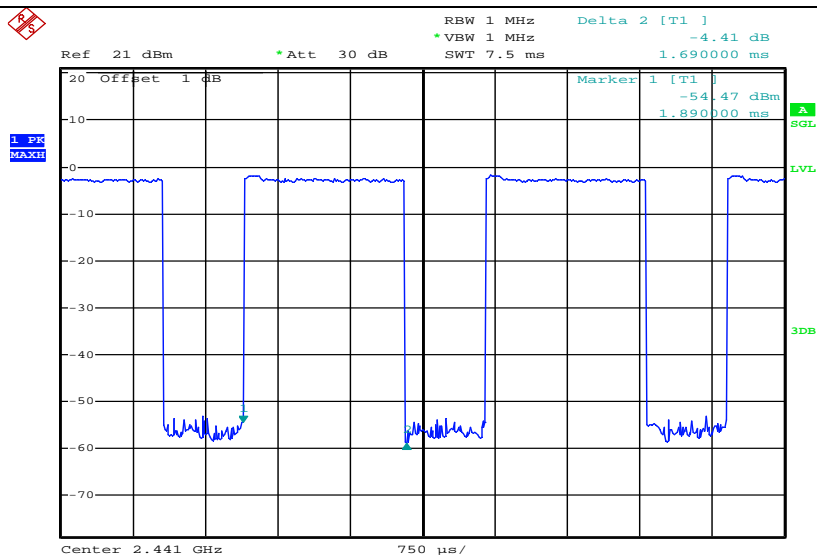


### DH5

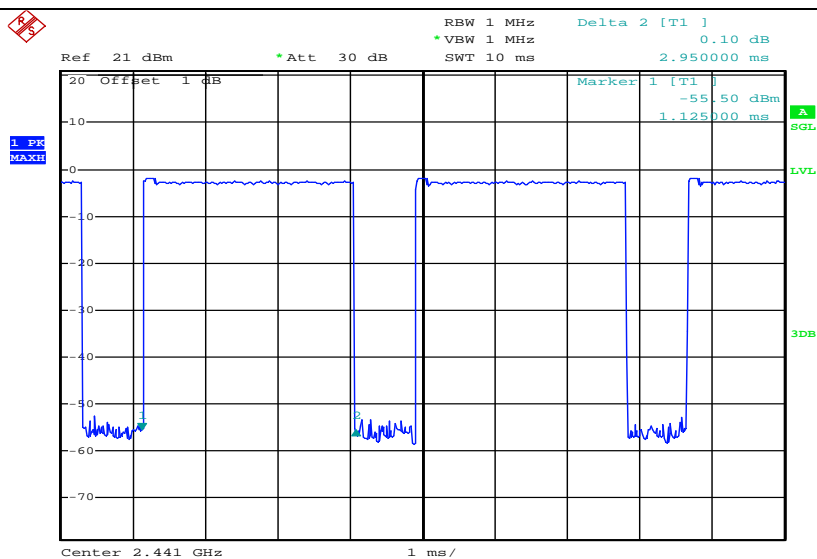
### $\pi/4$ DQPSK Modulation



### 2-DH1

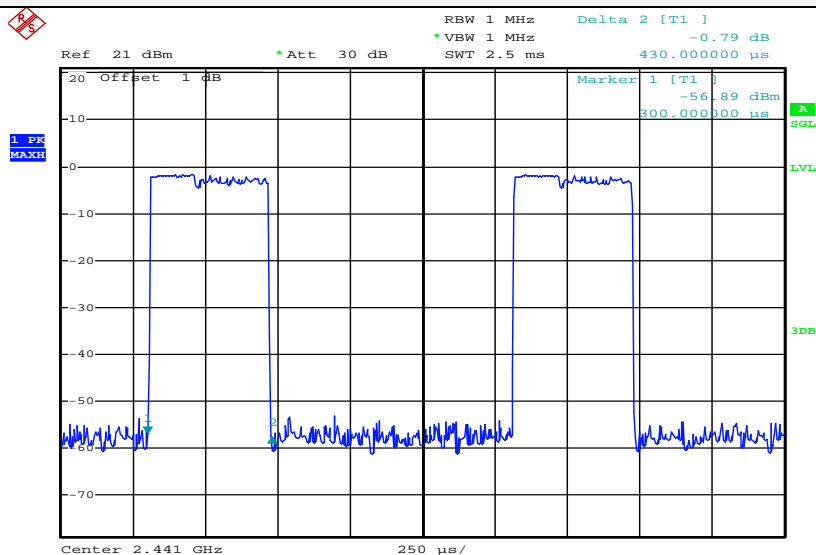


### 2-DH3

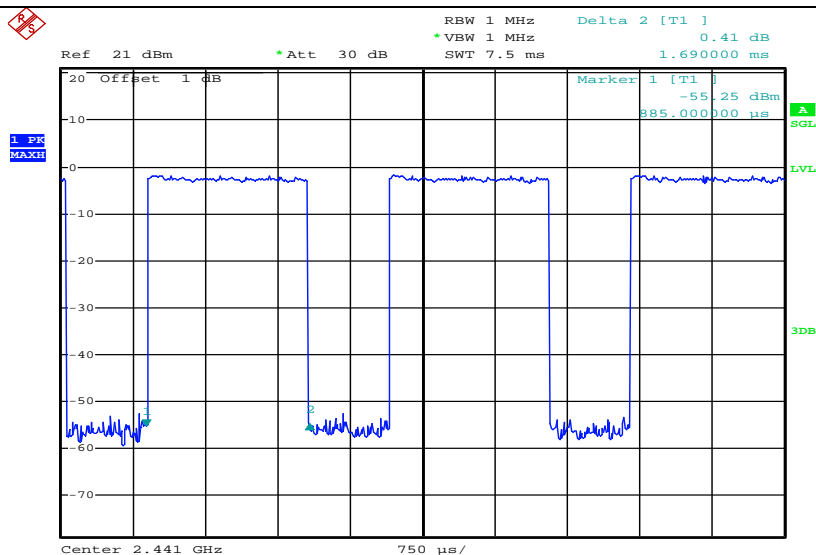


### 2-DH5

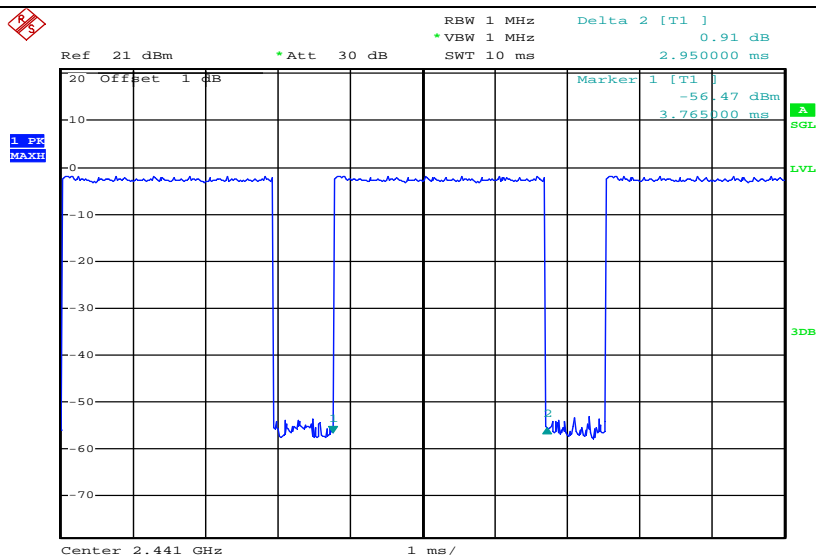
## 8DPSK Modulation



## 3-DH1



## 3-DH3



## 3-DH5



### 3.9. Spurious RF Conducted Emission

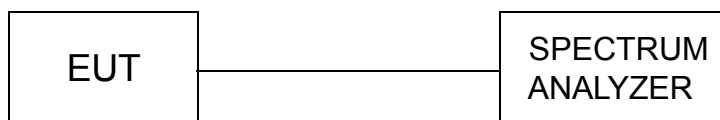
#### Limit

1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

#### Test Procedure

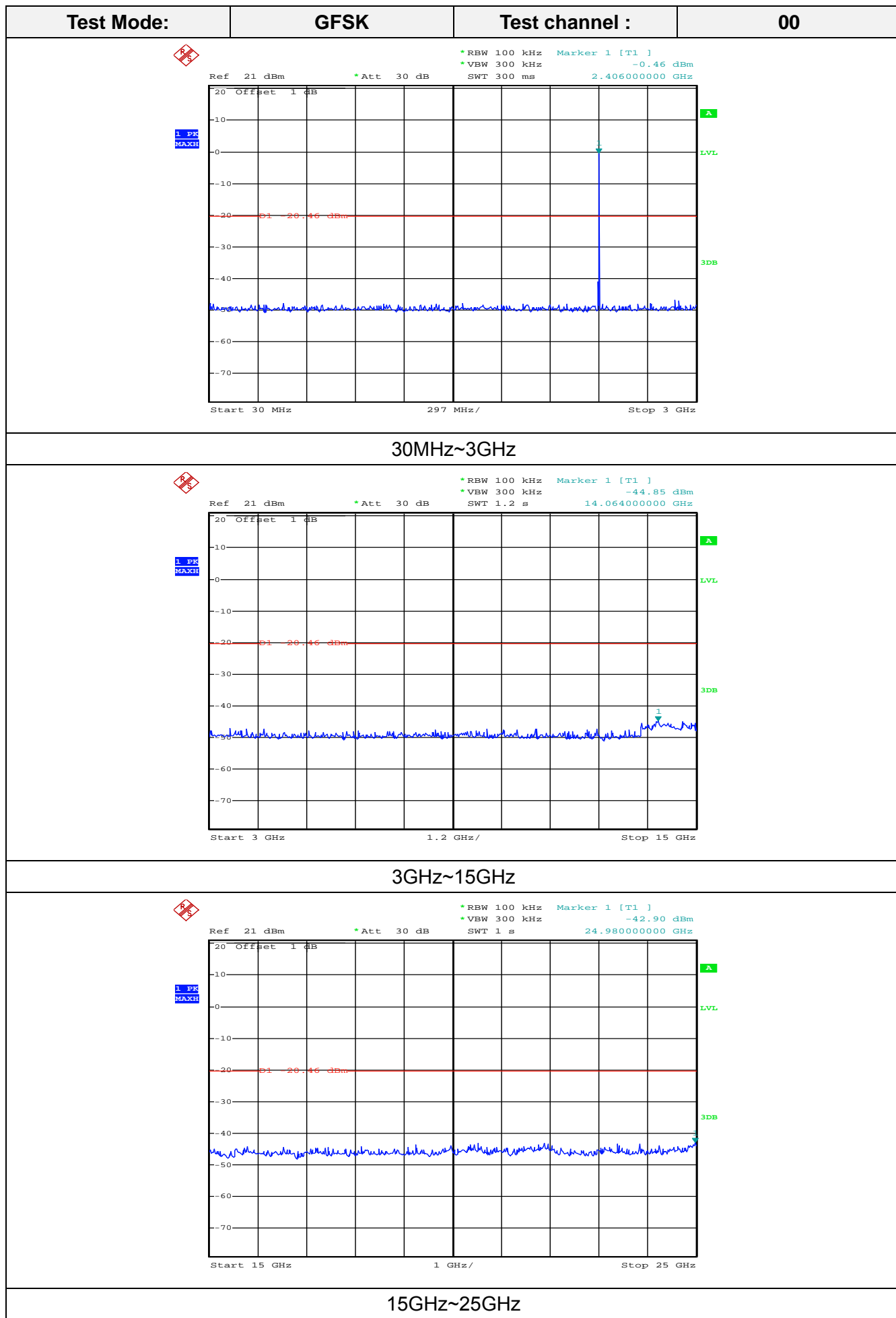
The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10-2009 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW=100 kHz and VBM= 300 KHz to measure the peak field strength, and measurement frequency range from 30MHz to 26.5GHz.

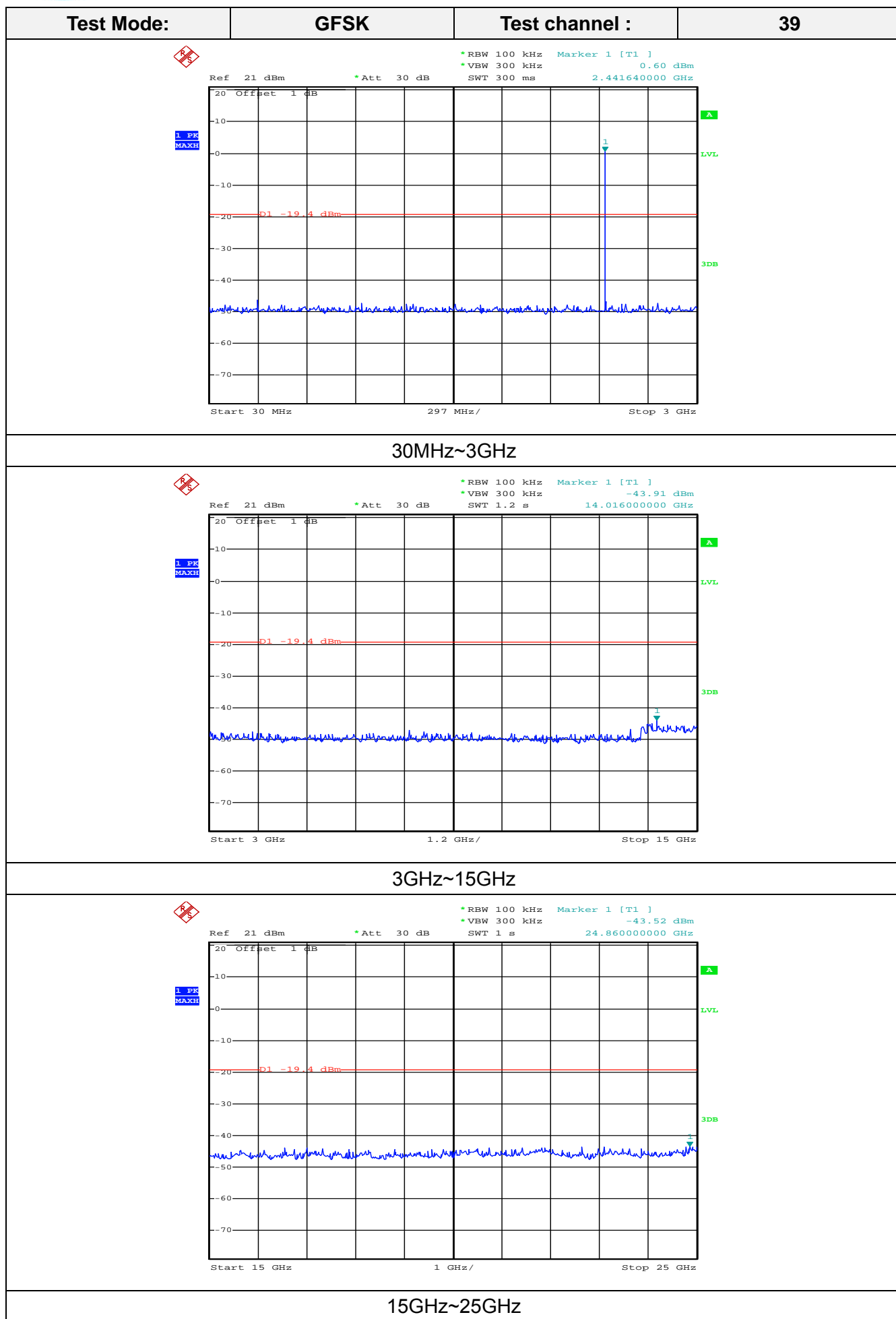
#### Test Configuration

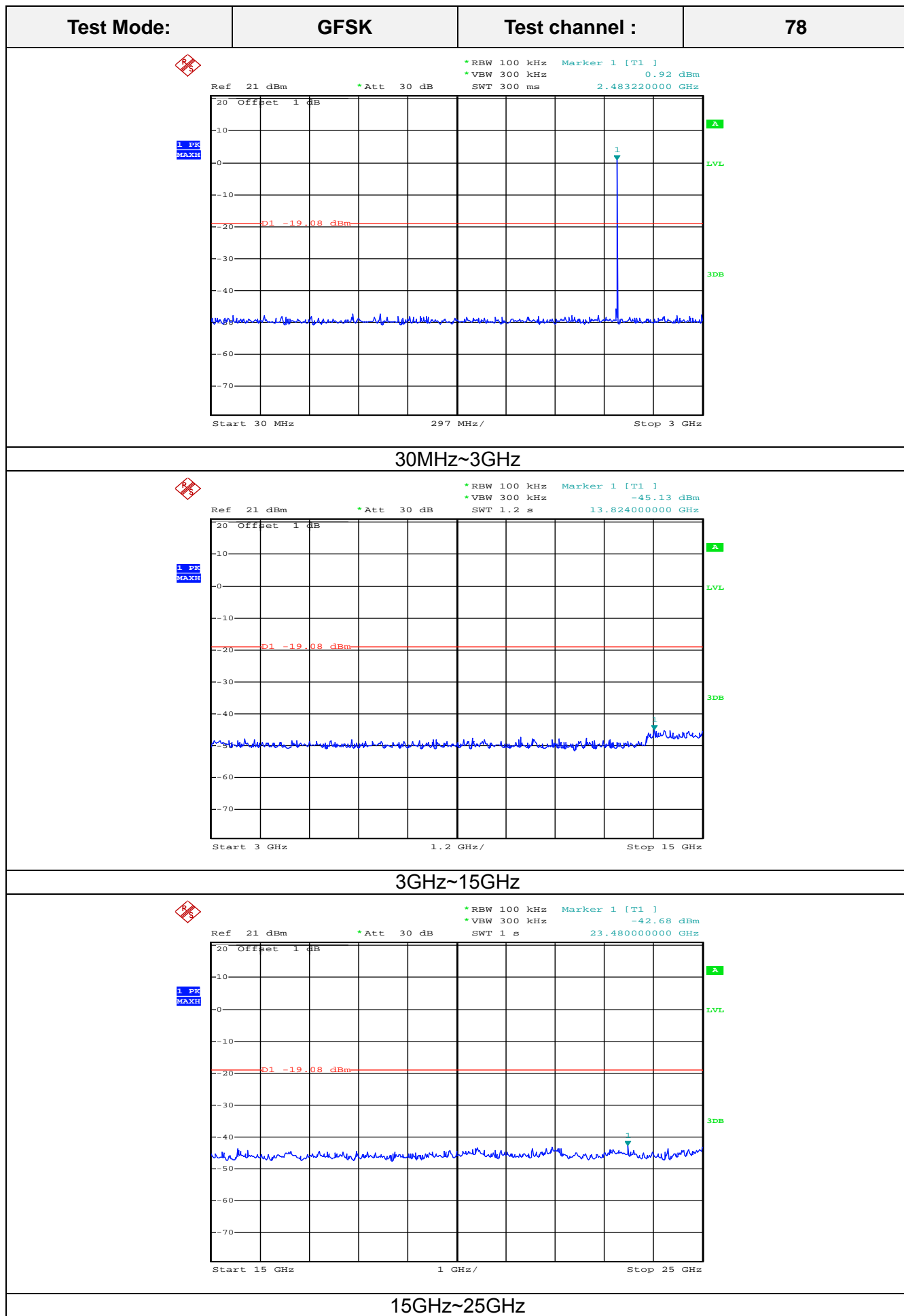


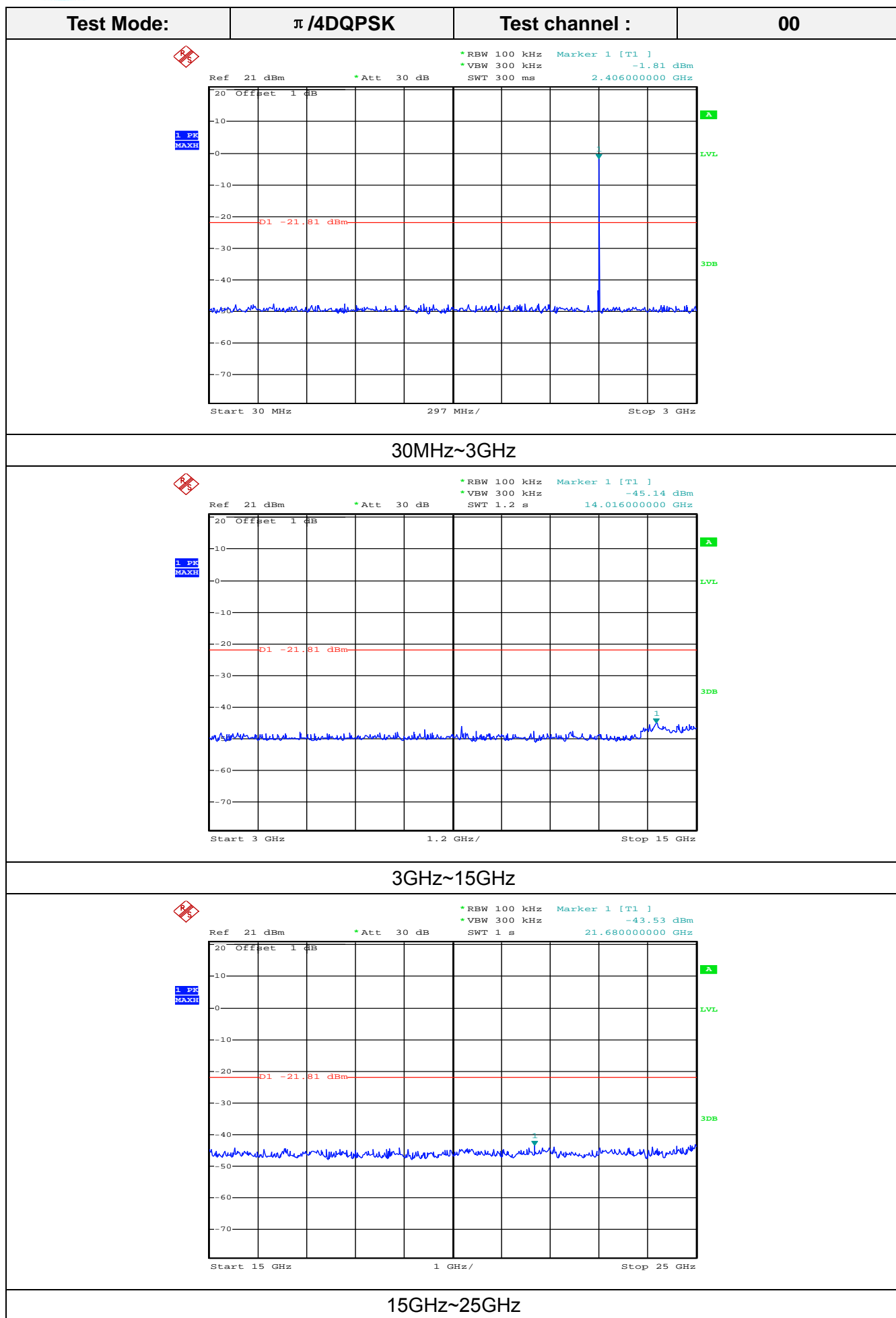
#### Test Results

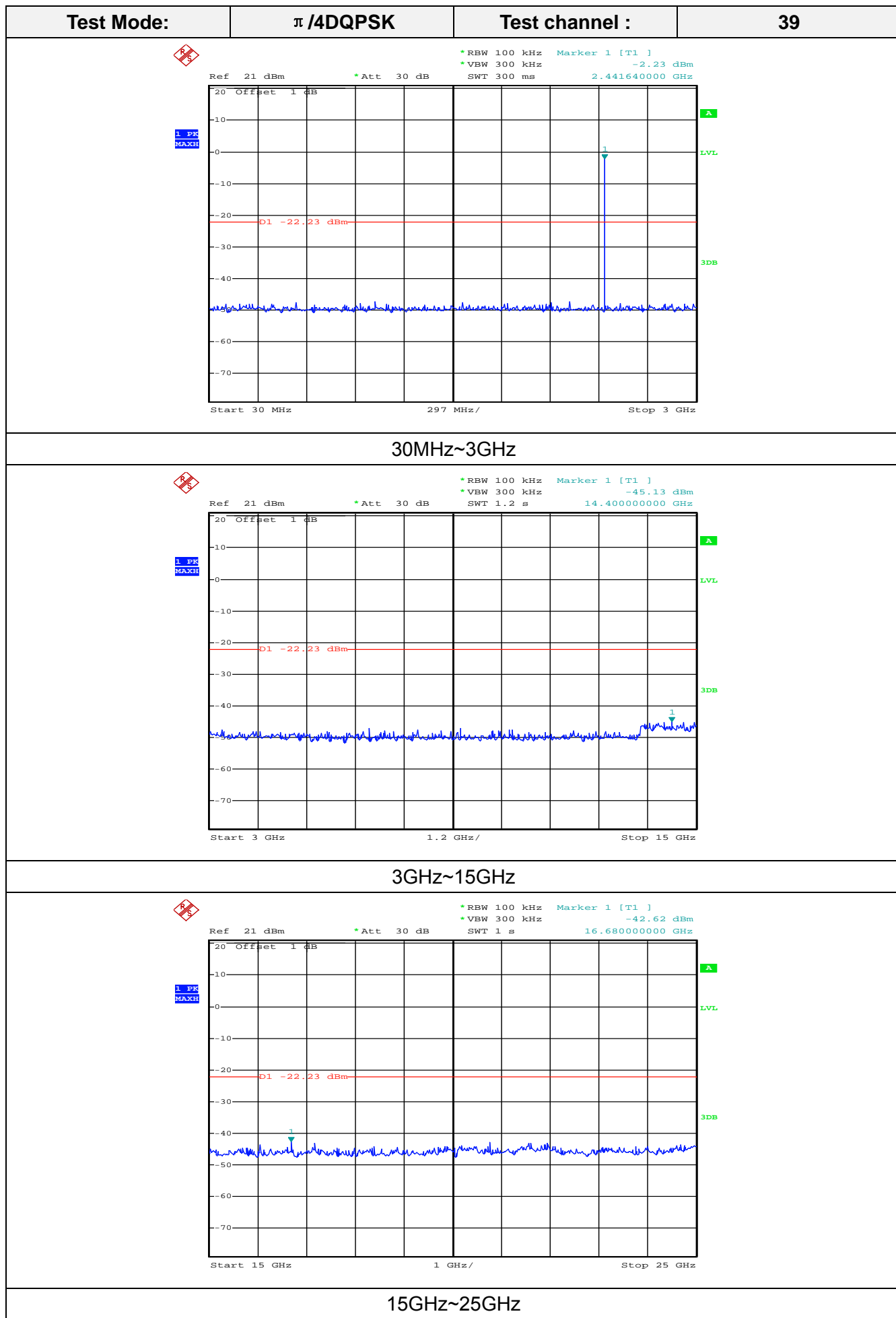
Remark: We measured all conditions (DH1, DH3, DH5) and recorded worst case at DH1

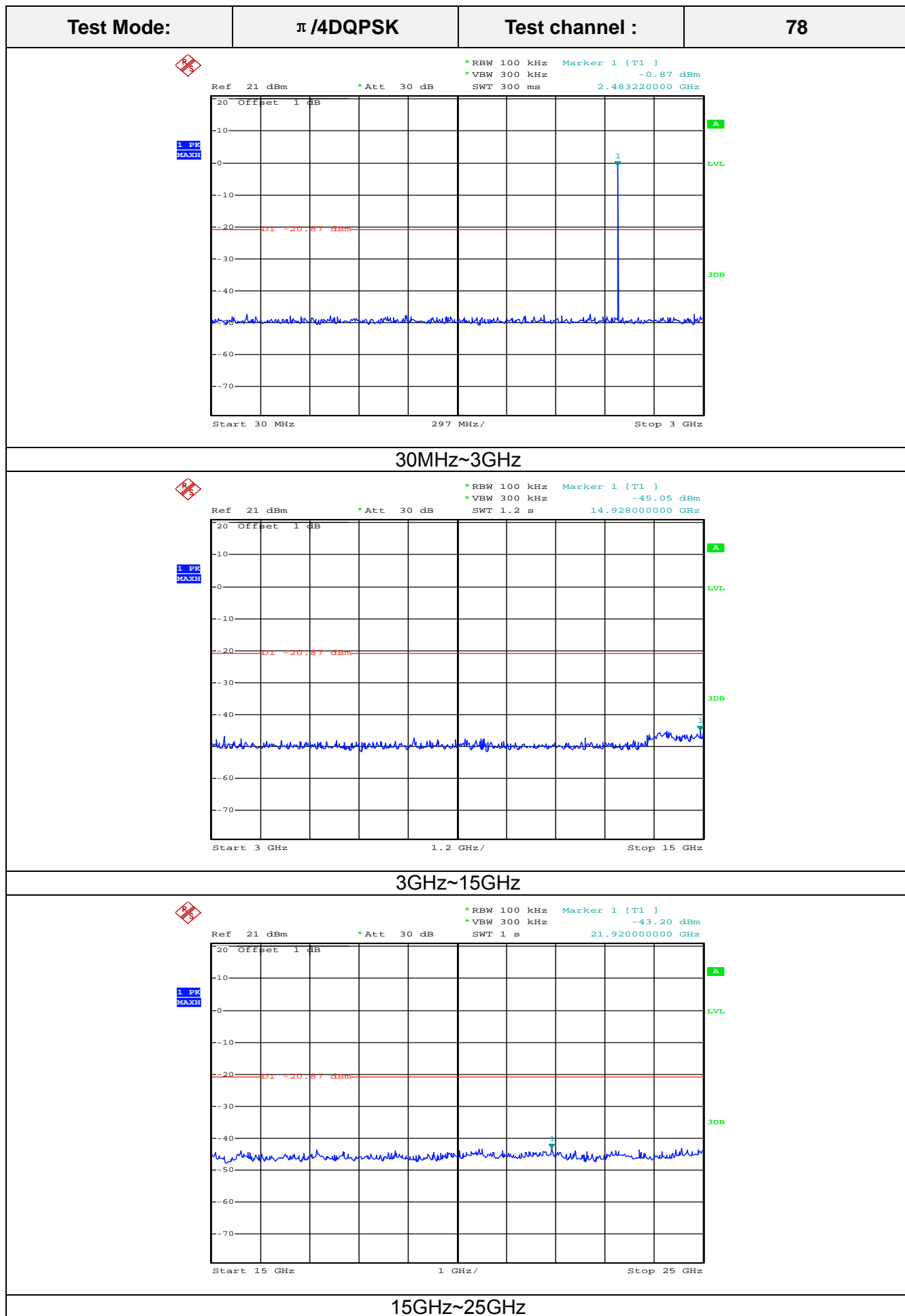


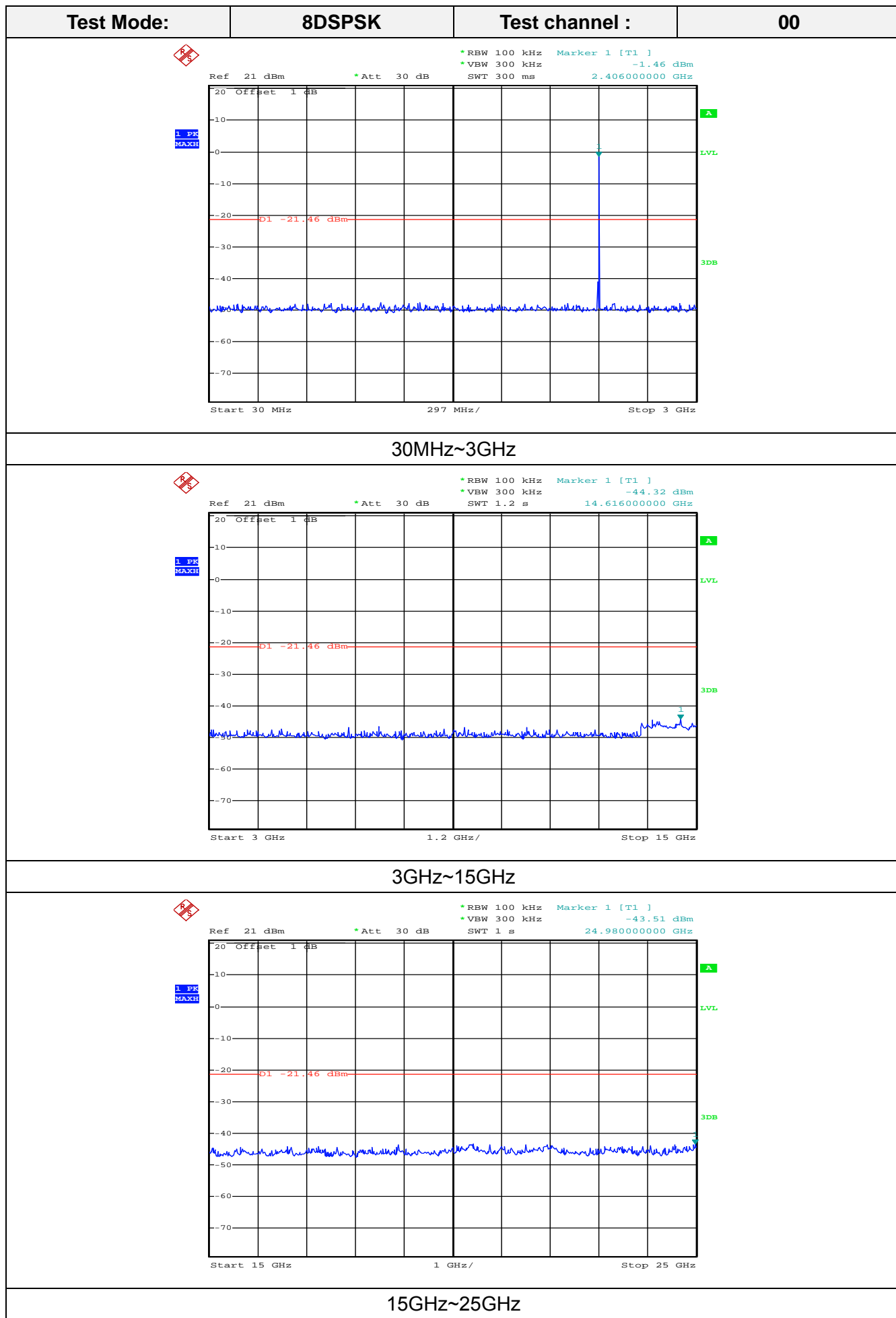




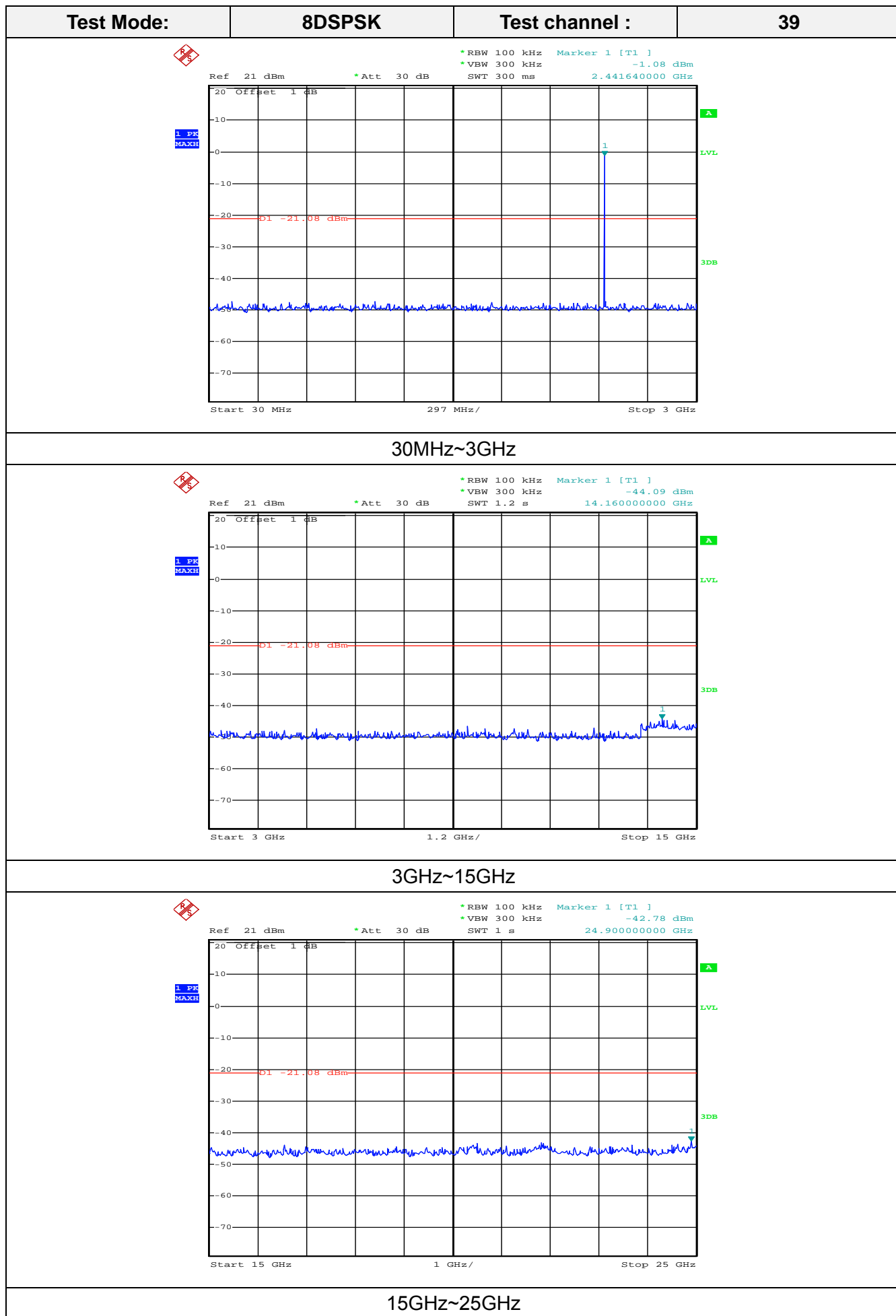


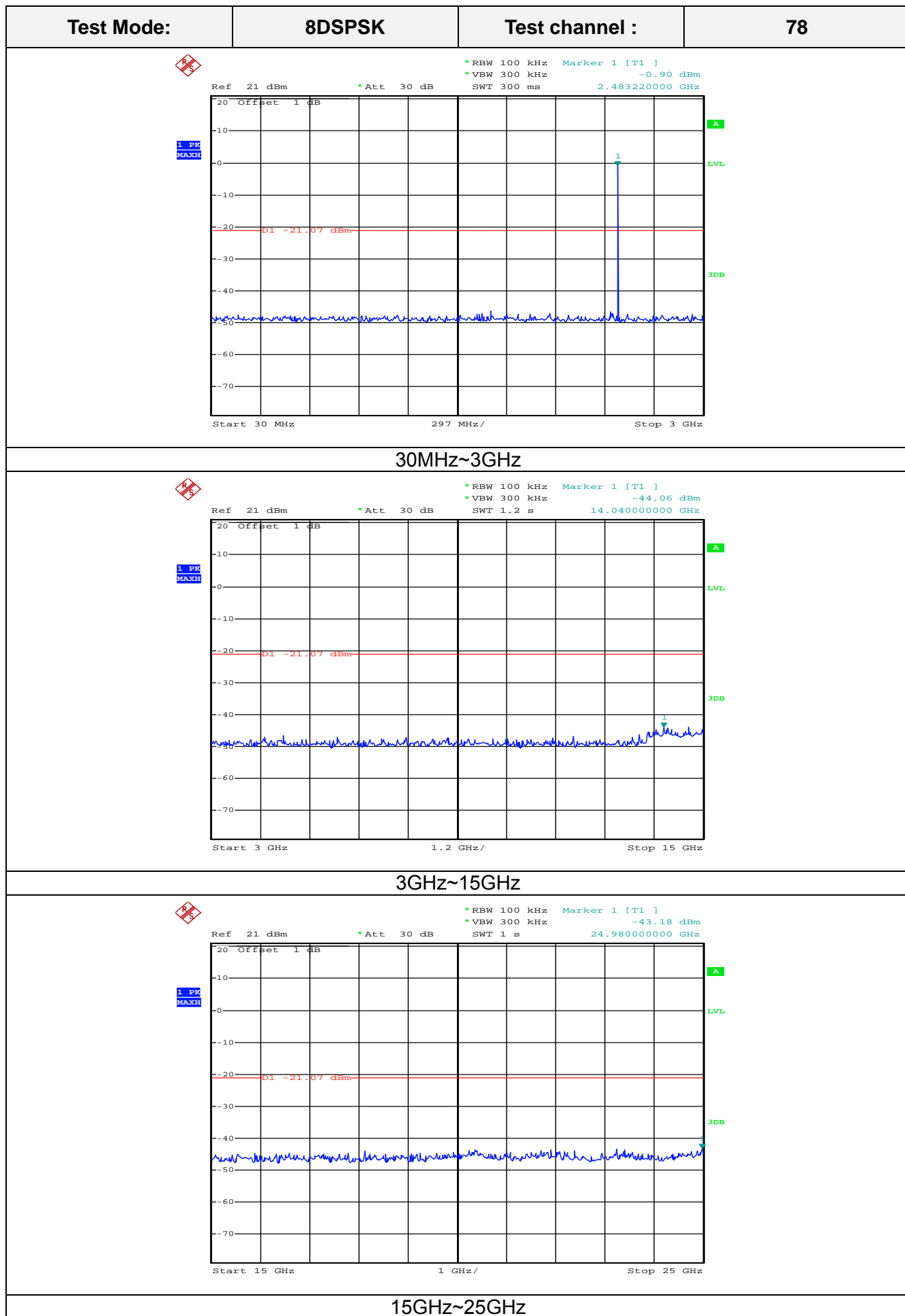












### 3.10. Pseudorandom Frequency Hopping Sequence

#### TEST APPLICABLE

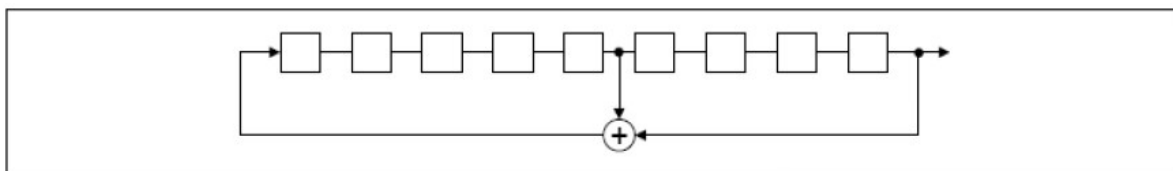
##### **For 47 CFR Part 15C section 15.247 (a) (1) requirement:**

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping 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 hop-ping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

#### **EUT Pseudorandom Frequency Hopping Sequence Requirement**

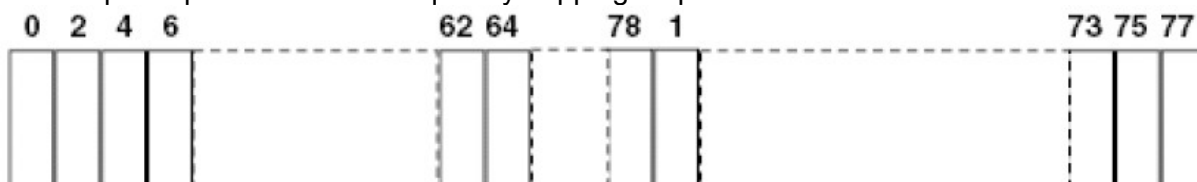
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive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

- Number of shift register stages:9
- Length of pseudo-random sequence:29-1=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.

### 3.11. Antenna Requirement

#### Standard Applicable

For intentional device, according to FCC 47 CFR 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.

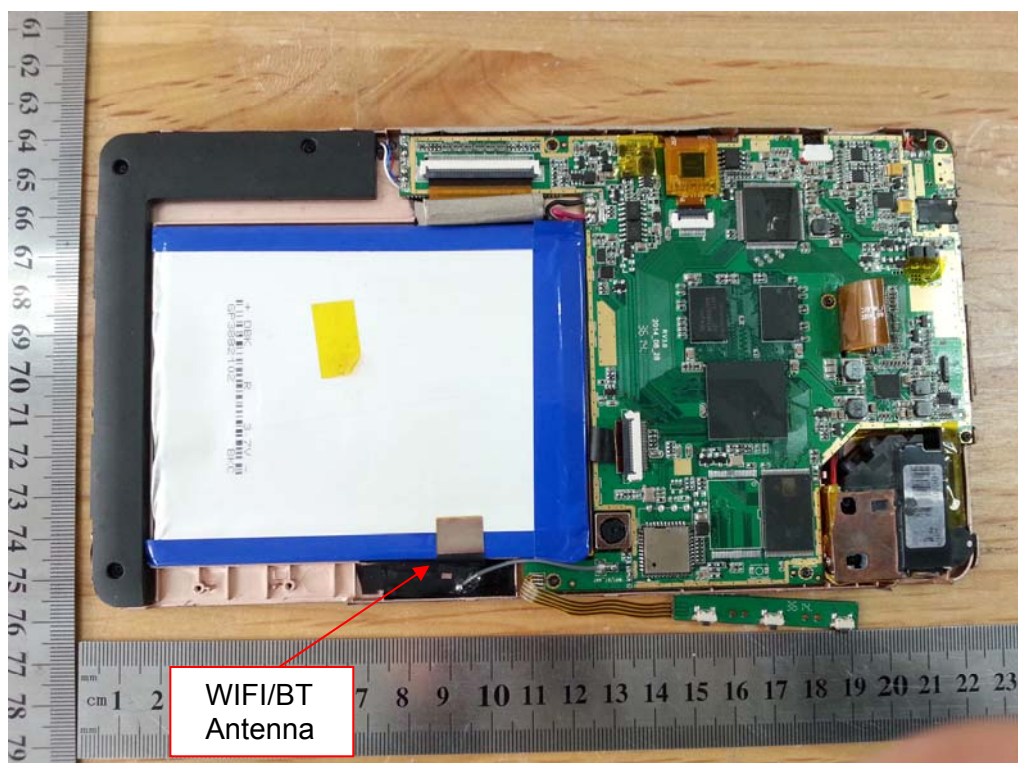
And according to FCC 47 CFR Section 15.247 (c), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

#### **Refer to statement below for compliance**

The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

#### Antenna Connected Construction

The antenna is a FPC antenna; the maximum gain of the antenna is 0dBi



## 4. EUT TEST PHOTO

Radiated Emission (30MHz-1GHz)



Radiated Emission (1GHz-25GHz)



Conducted Emission



## 5. PHOTOGRAPHS OF EUT CONSTRUCTIONAL

Please reference to the test report No.: GTI20140326F-1

\*\*\*\*\*THE END\*\*\*\*\*