



Shenzhen GTI Technology Co., Ltd.

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

Tel: +86-755-27559792

Fax: +86-755-86116468

Report No.: GTI20150566F-2

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TEST REPORT

Product Name: IEEE 802.11b/g/n WLAN BT Combo USB Module

Trademark: LB-LINK

Model/Type reference: BL-R8723BT1

Listed Model(s): /

FCC ID.....: S8J-R8723BT1

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

Applicant: Shenzhen Bilian Electronic Co., Ltd.

Address of applicant: Building B1, Zhongxing Industrial Zone, Juling,
Jutang Community, Guanlan street, Bao'an, Shenzhen,
China

Date of Receipt: Oct. 12, 2015

Date of Test Date.....: Oct. 12, 2015 - Nov. 03, 2015

Data of issue.: Nov. 03, 2015

Test result	Pass *
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* In the configuration tested, the EUT complied with the standards specified above

GENERAL DESCRIPTION OF EUT	
Equipment:	IEEE 802.11b/g/n WLAN BT Combo USB Module
Model Name:	BL-R8723BT1
Manufacturer:	Shenzhen Bilian Electronic Co., Ltd.
Manufacturer Address:	Building B1, Zhongxing Industrial Zone, Juling, Jutang Community, Guanlan street, Bao'an, Shenzhen, China
Power Rating:	DC 5.0V form PC

Compiled By: Thomas Morgan
(Thomas Morgan)

Reviewed By: Tony Wang
(Tony Wang)

Approved By: Walter Chen
(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 C63.10:2013](#): American National Standard for Testing Unlicensed Wireless Devices

[ANSI C63.4:2014](#): American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

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 15.205/15.209	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:	IEEE 802.11b/g/n WLAN BT Combo USB Module
Model/Type reference:	BL-R8723BT1
Power supply:	DC 5V from PC
Hardware version:	V1.0
Software version:	05/06/2014,1014.0.1128.2011
Bluetooth 3.0	
Version:	Supported BT3.0
Modulation:	GFSK, $\pi/4$ DQPSK, 8DPSK
Operation frequency:	2402MHz~2480MHz
Channel number:	79
Channel separation:	1MHz
Antenna type:	External Antenna
Antenna gain:	5.0dBi

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.

Peripherals Devices:

OUTSIDE SUPPORT EQUIPMENT						
No.	Equipment	Model	Serial No.	Manufacture	Trade name	Remark
1.	PC Note	1717-A31	L3-M1102	Lenovo	IBM	FCC DOC
2.	AC adapter	PA-1650-161	Qzp1158	Lenovo	Lenovo	Input: AC 100-240V,50-60Hz Output: DC 20V, 3.25A

Note: All the above equipment /cable were placed in worse case position to maximize emission signals during emission test.

Operation Frequency :

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

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.	Calibrate 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	AK9515E	33156	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 Below 1GHz	Schwarzbeck	AK9515E	33155	Jan. 07,2016
13	Cable Above 1GHz	Hubersuhner	SUCOFLEX1 02	DA1580	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)

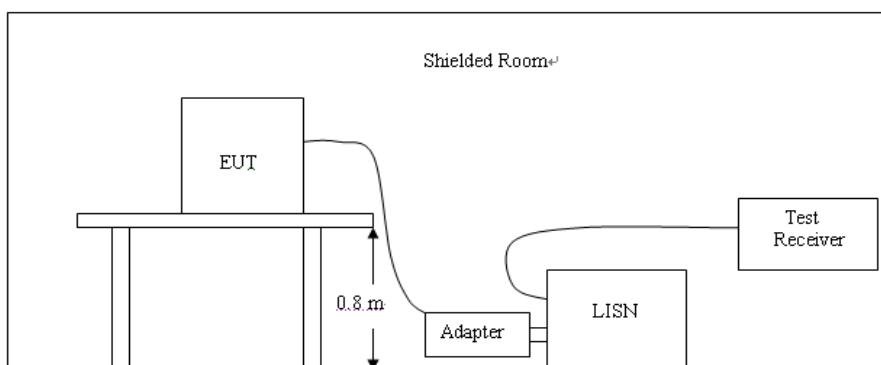
LIMIT

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

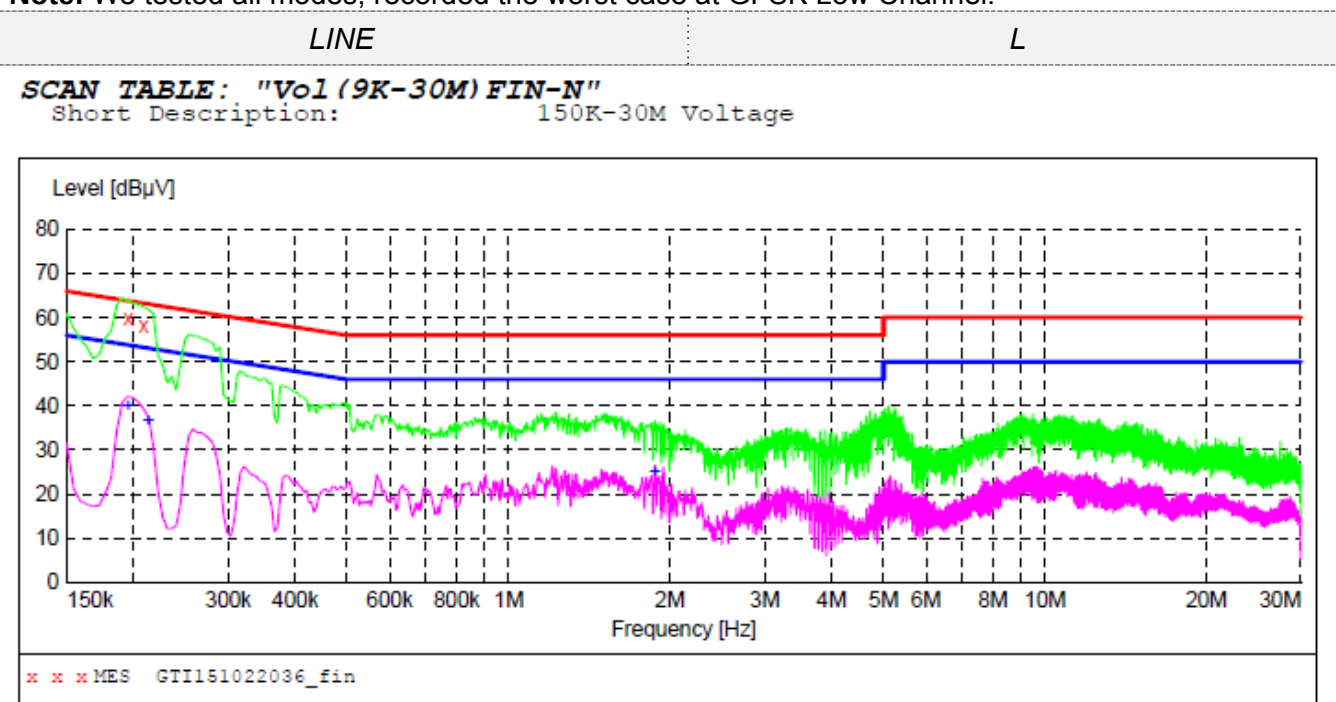


TEST PROCEDURE

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 C63.10:2013.
2. Support equipment, if needed, was placed as per ANSI C63.10:2013
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10:2013
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, recorded the worst case at GFSK Low Channel.



MEASUREMENT RESULT: "GTI151022036_fin"

10/22/2015 9:45AM

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.195000	59.70	9.5	64	4.1	QP	L1	GND
0.208500	58.00	9.5	63	5.3	QP	L1	GND

MEASUREMENT RESULT: "GTI151022036_fin2"

10/22/2015 9:45AM

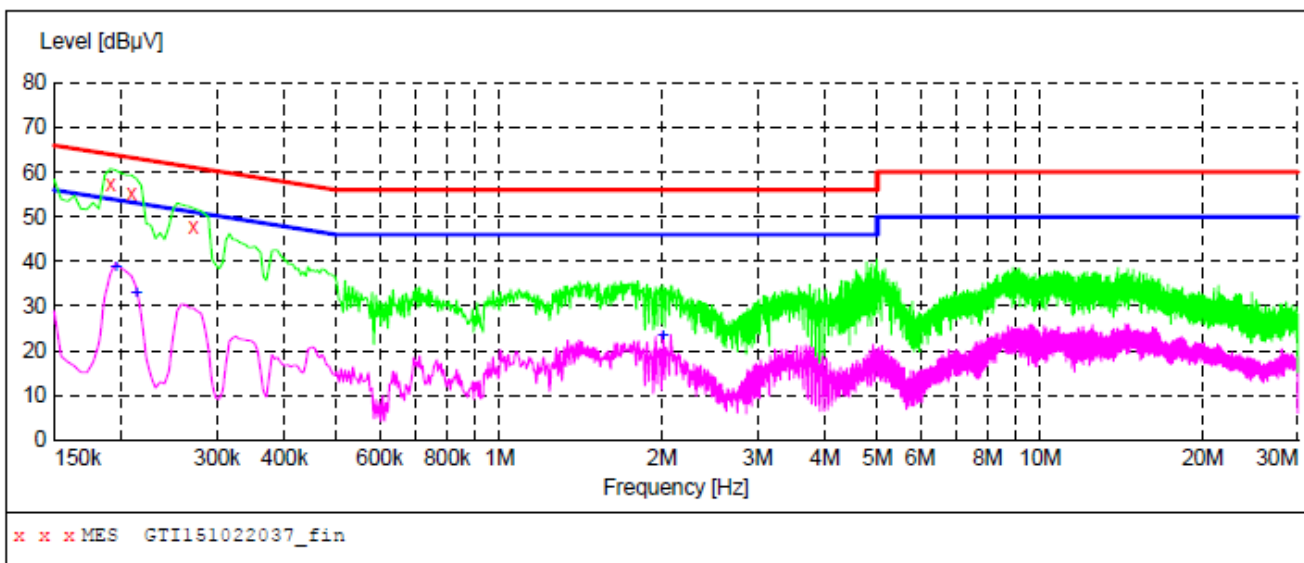
Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.195000	39.90	9.5	54	13.9	AV	L1	GND
0.213000	36.40	9.5	53	16.7	AV	L1	GND
1.872500	24.90	10.0	46	21.1	AV	L1	GND

LINE

N

SCAN TABLE: "Vol (9K-30M) FIN-N"

Short Description: 150K-30M Voltage


MEASUREMENT RESULT: "GTI151022037_fin"

10/22/2015 9:49AM

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.190500	57.40	9.5	64	6.6	QP	N	GND
0.208500	55.40	9.5	63	7.9	QP	N	GND
0.271500	47.90	9.5	61	13.2	QP	N	GND

MEASUREMENT RESULT: "GTI151022037_fin2"

10/22/2015 9:49AM

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.195000	38.70	9.5	54	15.1	AV	N	GND
0.213000	32.90	9.5	53	20.2	AV	N	GND
2.007500	23.40	10.0	46	22.6	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. RBW=1MHz, VBW=3MHz for peak values, RBW=1MHz, VBW=10Hz for Average values, used peak detector. 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° to 360° 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

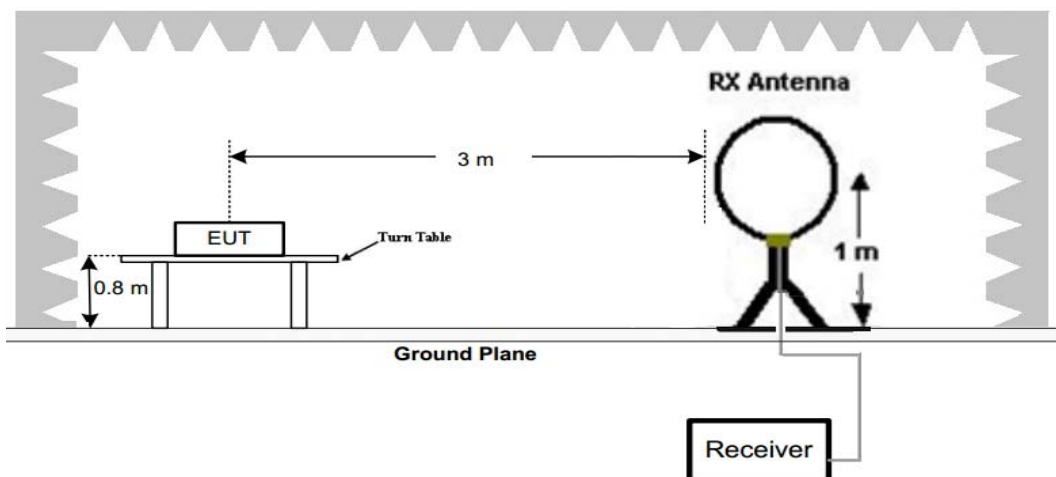
Frequency (MHz)	FS (dBμV/m)	RA (dBμV/m)	AF (dB)	CL (dB)	AG (dB)	Transd (dB)
150.00	40	58.1	12.2	1.6	31.90	-18.1

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

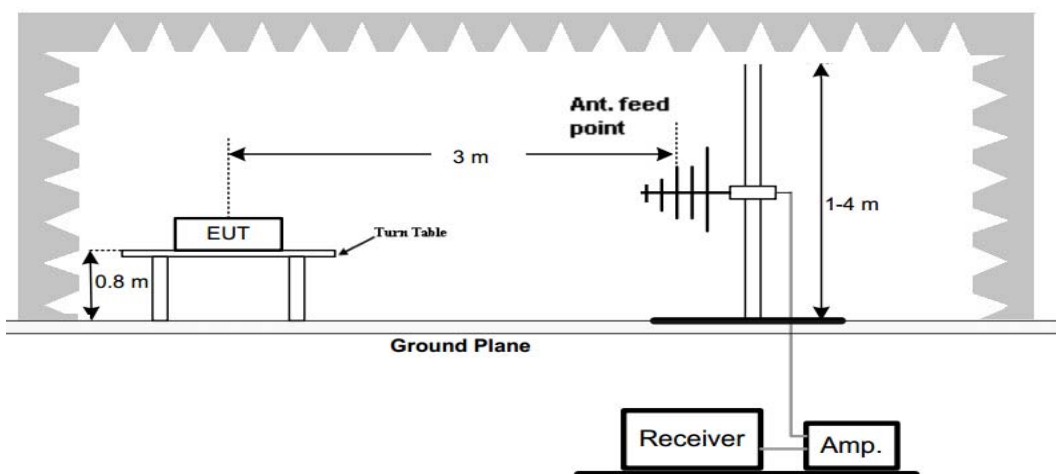
Test Configuration

For the actual test configuration, please refer to the related Item –EUT Test Photos.

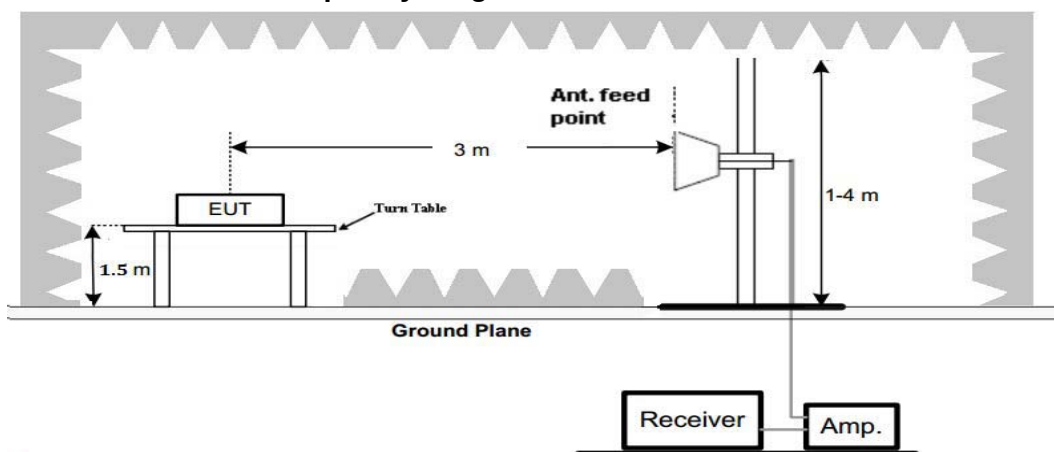
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



Test Results

Remark:

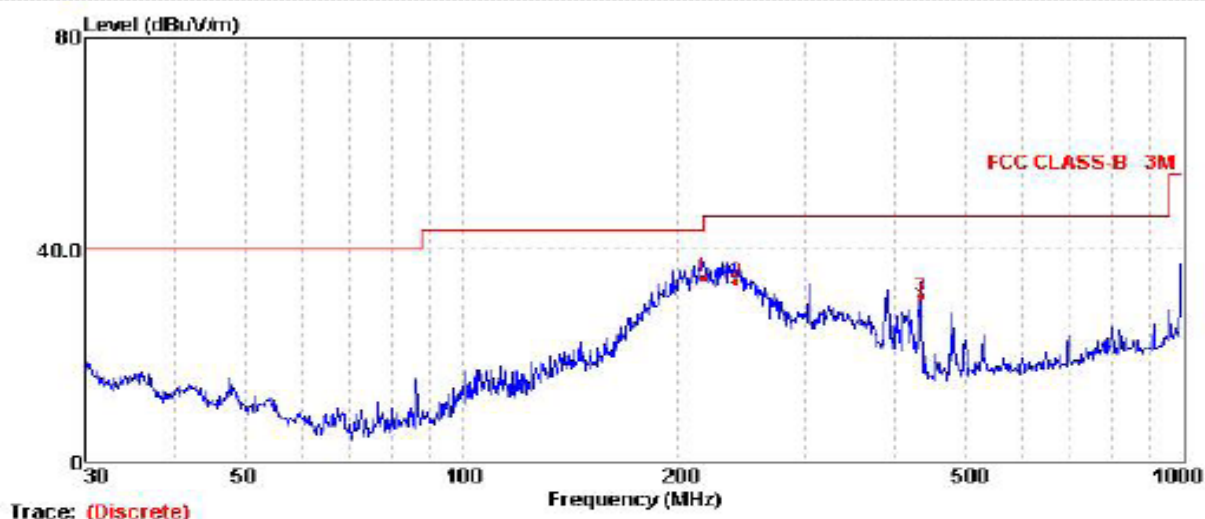
1. We measured Radiated Emission at GFSK, $\pi/4$ DQPSK and 8DPSK mode from 9 KHz to 25GHz and recorded worst case at GFSK mode.
2. By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that “Z axis” position was the worst, and test data recorded in this report.

For 9 KHz-30MHz

Frequency (MHz)	Corrected Reading (dBuV/m)@3m	FCC Limit (dBuV/m) @3m	Margin (dB)	Detector	Result
0.36	48.57	96.48	47.91	Peak	PASS
1.25	51.42	65.67	14.25	QP	PASS
13.68	31.06	69.54	38.48	QP	PASS
26.54	48.27	69.54	21.27	QP	PASS

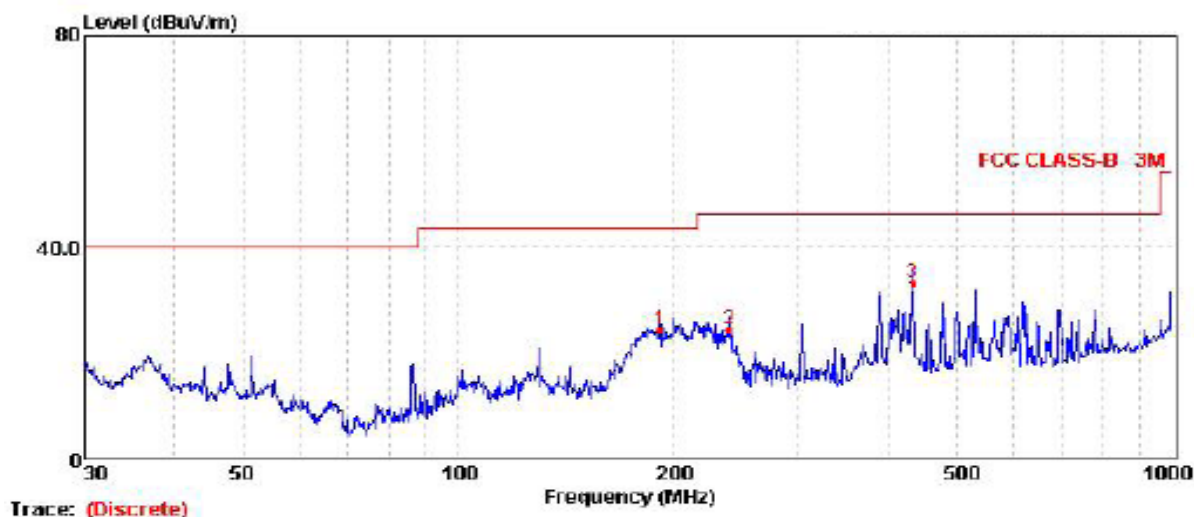
For 30MHz-1GHz

Horizontal



Mark	Frequency MHz	Level dBuV/m	Factor dB/m	Reading dBuV	Limit dBuV/m	Margin dB	Polarization	Detector
1	216.02	34.63	-17.77	52.40	46.00	11.37	HORIZONTAL	QP
2	239.99	33.55	-17.65	51.20	46.00	12.45	HORIZONTAL	QP
3	432.55	30.84	-12.67	43.51	46.00	15.16	HORIZONTAL	QP

Vertical



Mark	Frequency MHz	Level dBuV/m	Factor dB/m	Reading dBuV	Limit dBuV/m	Margin dB	Polarization	Detector
1	191.75	24.06	-18.64	42.70	43.50	19.44	VERTICAL	QP
2	239.99	24.15	-17.65	41.80	46.00	21.85	VERTICAL	QP
3	432.55	32.94	-12.67	45.61	46.00	13.06	VERTICAL	QP



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	46.16	PK	74.00	27.84	1.00	95	44.26	31.42	6.98	36.5	1.90
1	4804	35.10	AV	54.00	18.90	1.00	95	33.20	31.42	6.98	36.5	1.90
2	7206	39.81	PK	74.00	34.19	1.00	95	29.21	37.03	8.87	35.3	10.60
2	7206	--	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	44.03	PK	74.00	29.97	1.00	215	42.13	31.42	6.98	36.5	1.90
1	4804	33.05	AV	54.00	20.95	1.00	215	31.15	31.42	6.98	36.5	1.90
2	7206	39.02	PK	74.00	34.98	1.00	215	28.42	37.03	8.87	35.3	10.60
2	7206	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2441			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	46.71	PK	74.00	27.29	1.00	81	44.65	30.98	7.58	36.5	2.06
1	4882	34.56	AV	54.00	19.44	1.00	81	32.50	30.98	7.58	36.5	2.06
2	7323	40.65	PK	74.00	33.35	1.00	81	29.73	37.66	8.56	35.3	10.92
2	7323	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2441			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	46.57	PK	74.00	27.43	1.00	221	44.51	30.98	7.58	36.5	2.06
1	4882	35.31	AV	54.00	18.69	1.00	221	33.25	30.98	7.58	36.5	2.06
2	7323	39.62	PK	74.00	34.38	1.00	221	28.70	37.66	8.56	35.3	10.92
2	7323	--	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	45.54	PK	74.00	28.46	1.00	66	42.47	31.47	7.80	36.2	3.07
1	4960	34.51	AV	54.00	19.49	1.00	66	31.44	31.47	7.80	36.2	3.07
2	7340	38.40	PK	74.00	35.60	1.00	66	26.66	38.32	8.72	35.3	11.74
2	7340	--	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	44.58	PK	74.00	29.42	1.00	210	41.51	31.47	7.80	-36.2	3.07
1	4960	34.61	AV	54.00	19.39	1.00	210	31.54	31.47	7.80	-36.2	3.07
2	7340	37.46	PK	74.00	36.54	1.00	210	25.72	38.32	8.72	-35.3	11.74
2	7340	--	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

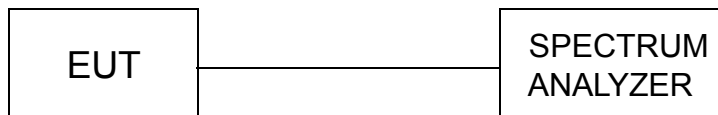
Limit

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



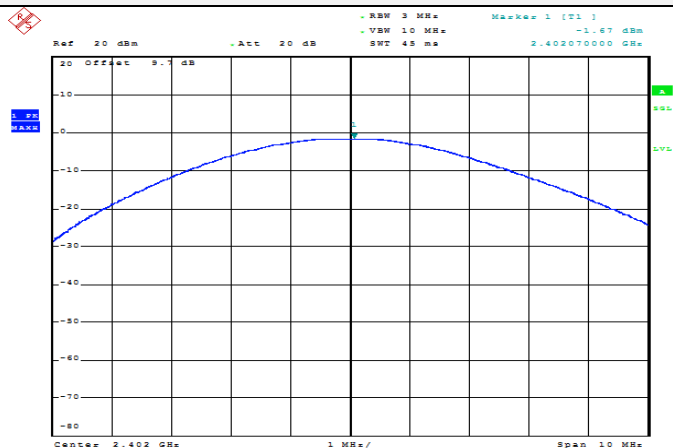
Test Results

Type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK	00	-1.670	30.00	Pass
	39	-0.400		
	78	-2.430		
$\pi/4$ DQPSK	00	-0.450	30.00	Pass
	39	1.190		
	78	-0.950		
8DPSK	00	-0.280	30.00	Pass
	39	1.340		
	78	-0.690		

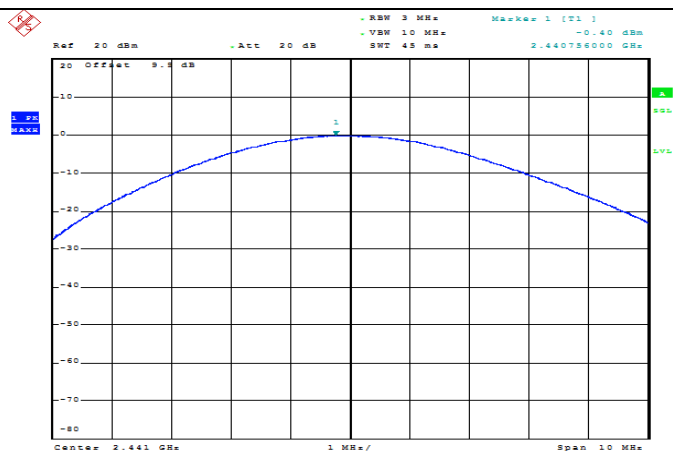
Note: 1.The test results including the cable lose.

Test plot as follows:

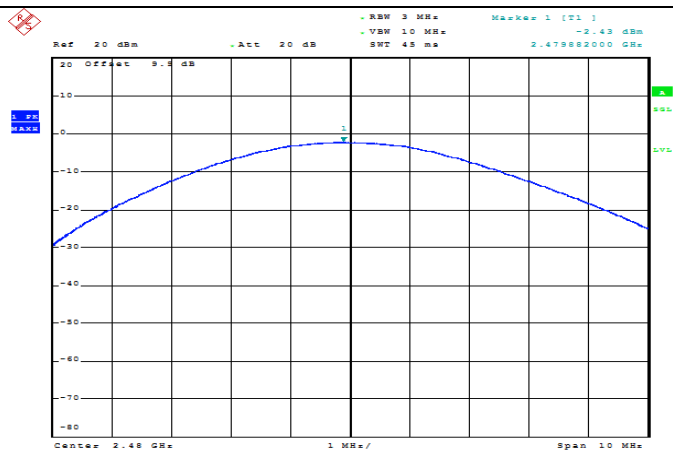
GFSK Modulation



CH00

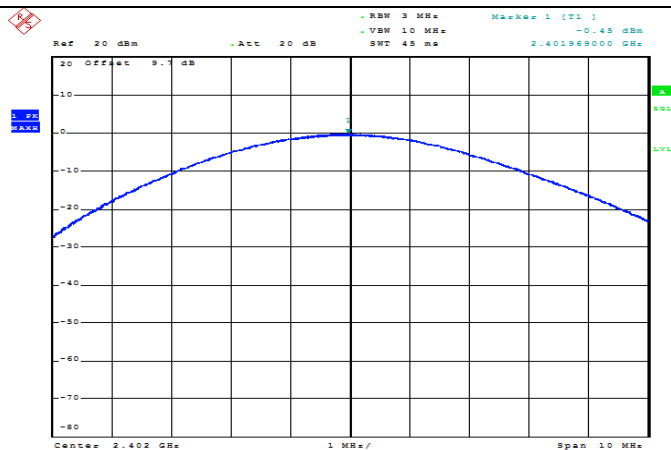


CH39

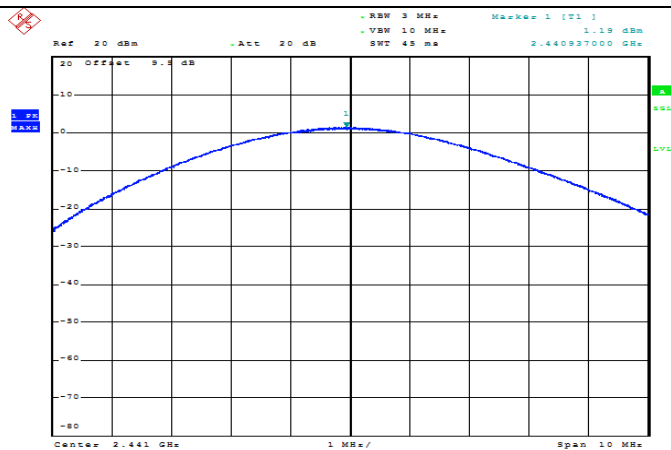


CH78

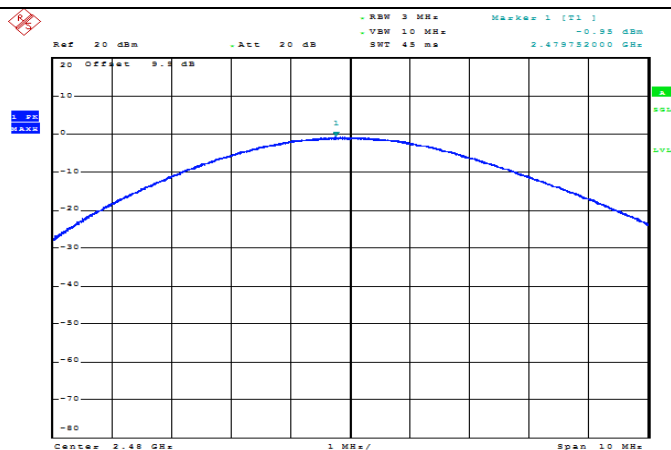
$\pi/4$ DQPSK Modulation



CH00



CH39



CH78

8DPSK Modulation



3.4. 20dB Bandwidth

Limit

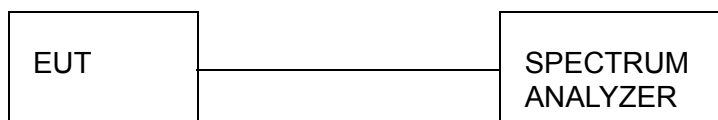
For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwidth.

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

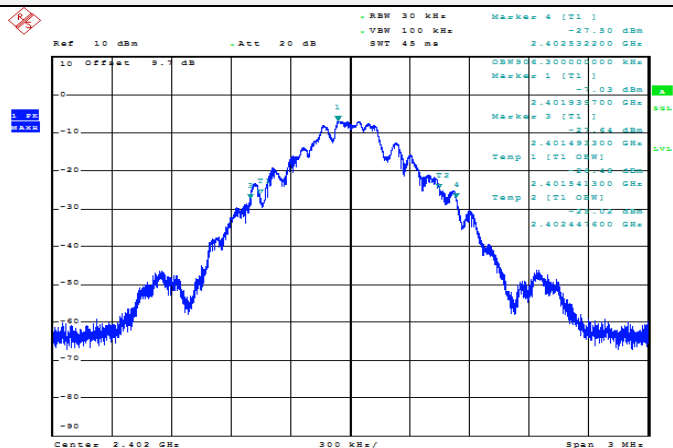


Test Results

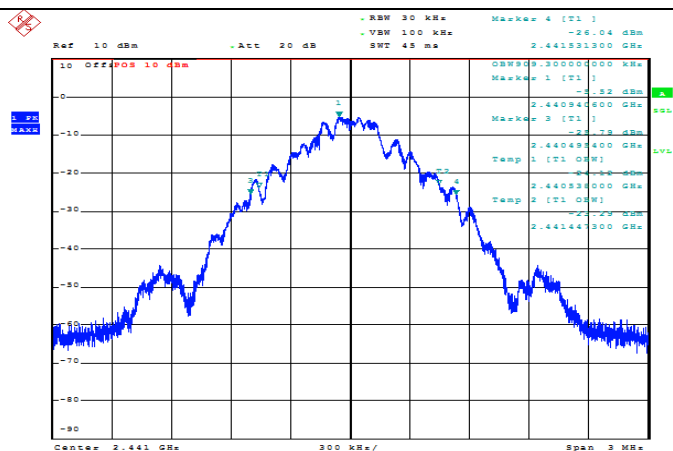
Modulation	Channel	20dB bandwidth (MHz)	99% OBW(MHz)	Result
GFSK	CH00	1.039	0.906	Pass
	CH39	1.036	0.909	
	CH78	1.038	0.909	
$\pi/4$ DQPSK	CH00	1.354	1.193	
	CH39	1.354	1.193	
	CH78	1.353	1.193	
8DPSK	CH00	1.293	1.169	
	CH39	1.291	1.173	
	CH78	1.294	1.172	

Test plot as follows:

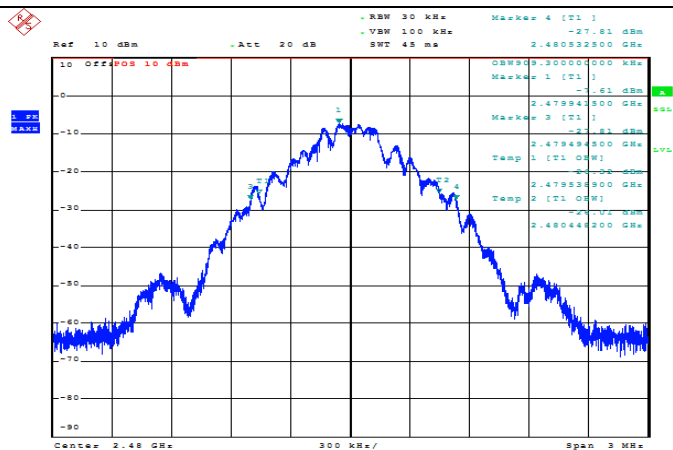
GFSK Modulation



CH00

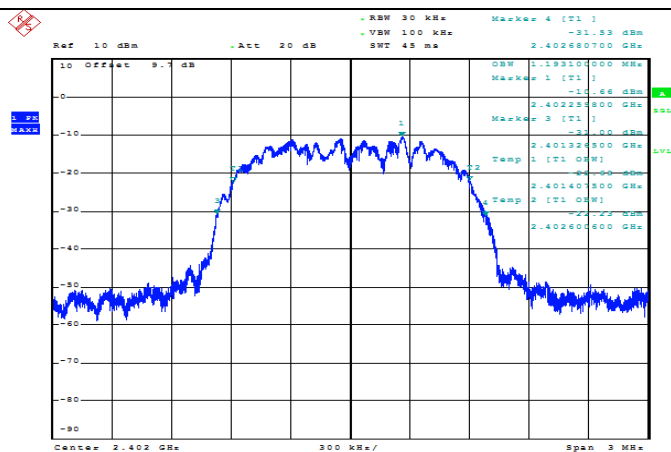


CH39

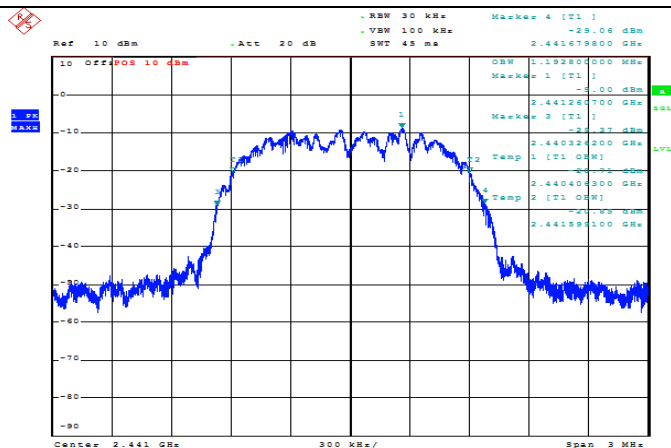


CH78

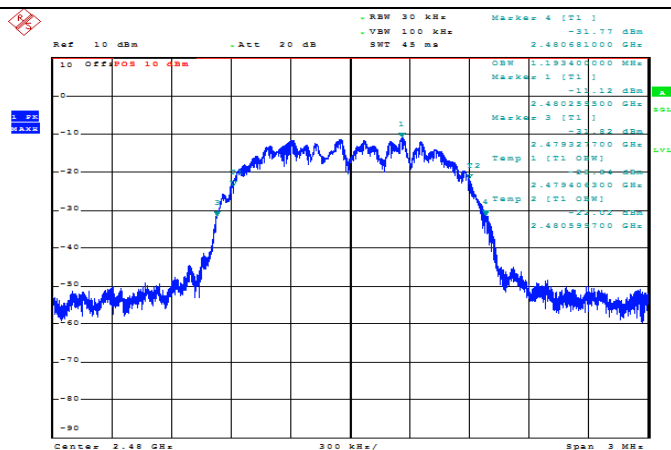
$\pi/4$ DQPSK Modulation



CH00

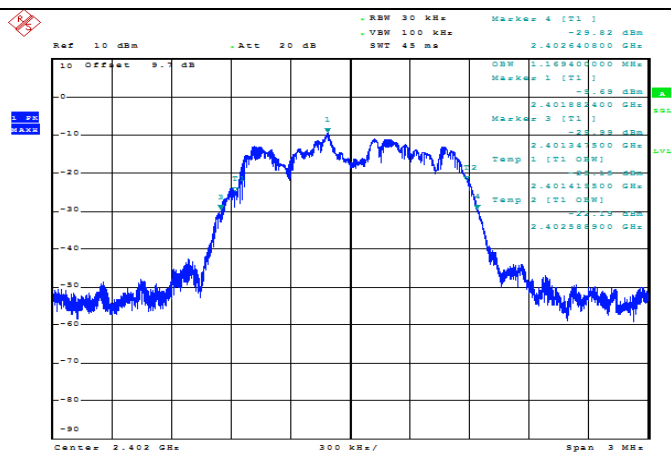


CH39

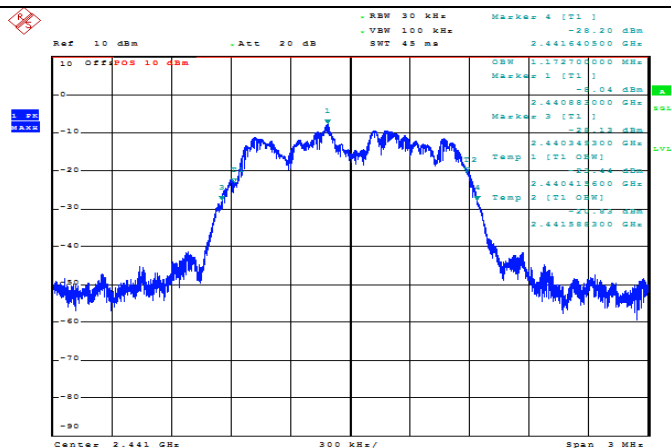


CH78

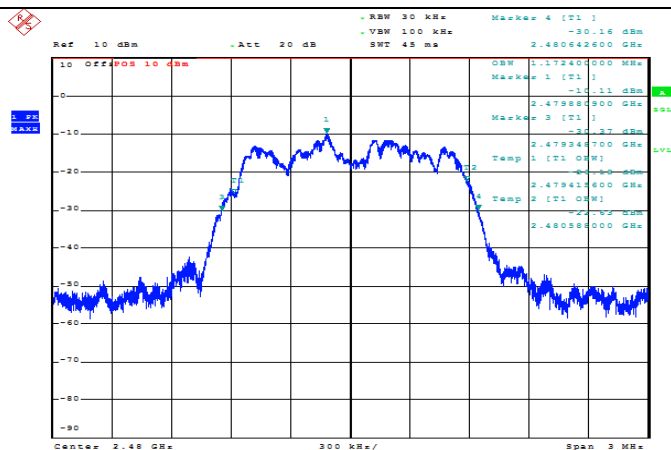
8DPSK Modulation



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

Test Procedure tor conducted method

1. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a spectrum analyzer
2. 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 spectrum analyzer RBW =100 kHz and VBW=300 kHz
4. Use spectrum analyzer Maxhold function to allow trace to fully stabilize
5. Marker the highest point which fall into restricted frequency bands
6. Repeat above procedures until all measured frequencies were complete.

Test Procedure tor radiated method

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel
7. Test the EUT in the lowest channel, the highest channel
8. The radiation measurements are performed in X, Y, Z axis positioning. And found the X axis positioning which it is worse case, only the test worst case mode is recorded in the report.
9. Repeat above procedures until all frequencies measured was complete.

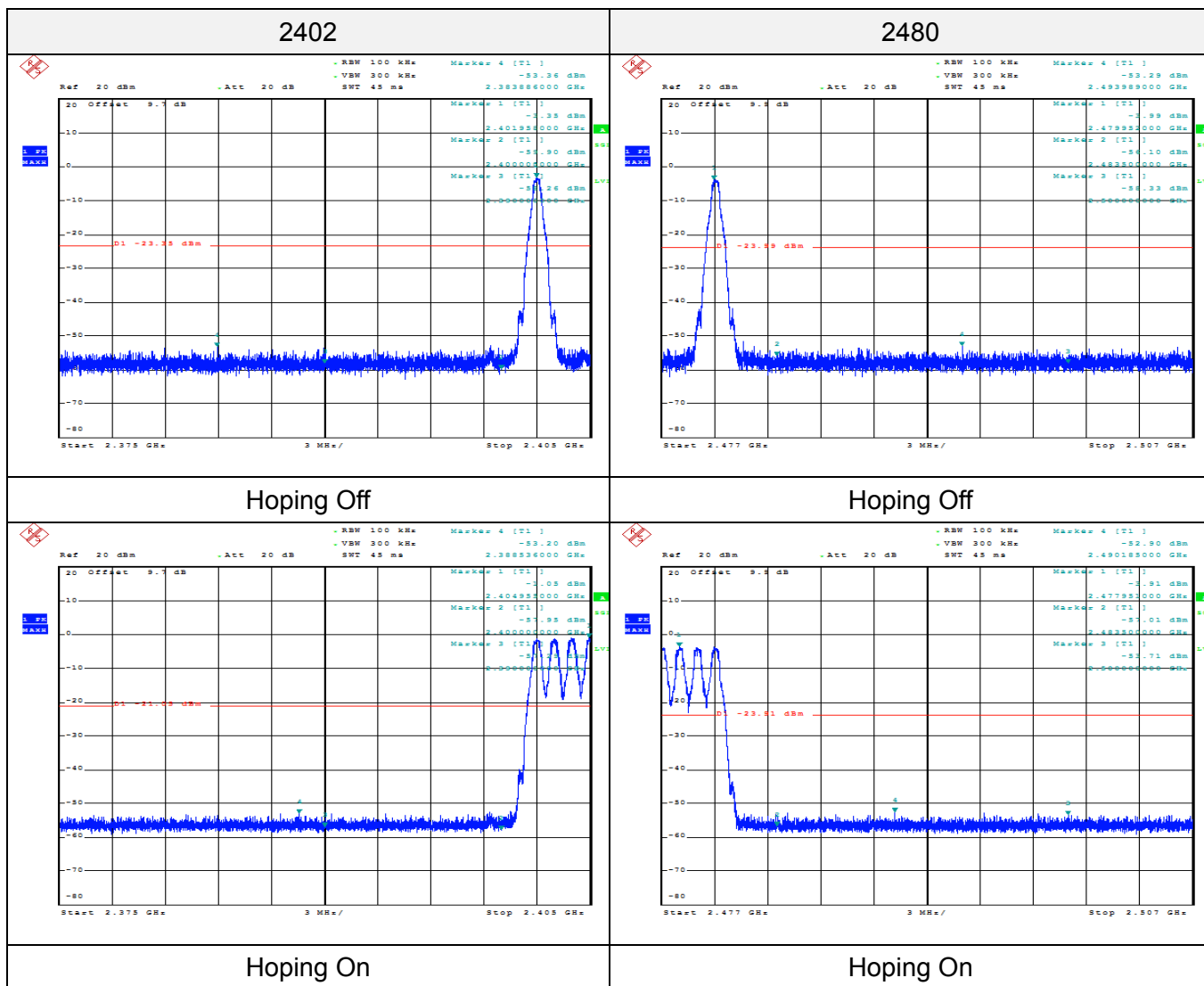
TEST RESULTS

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

A. Conducted Bandedge Measurement

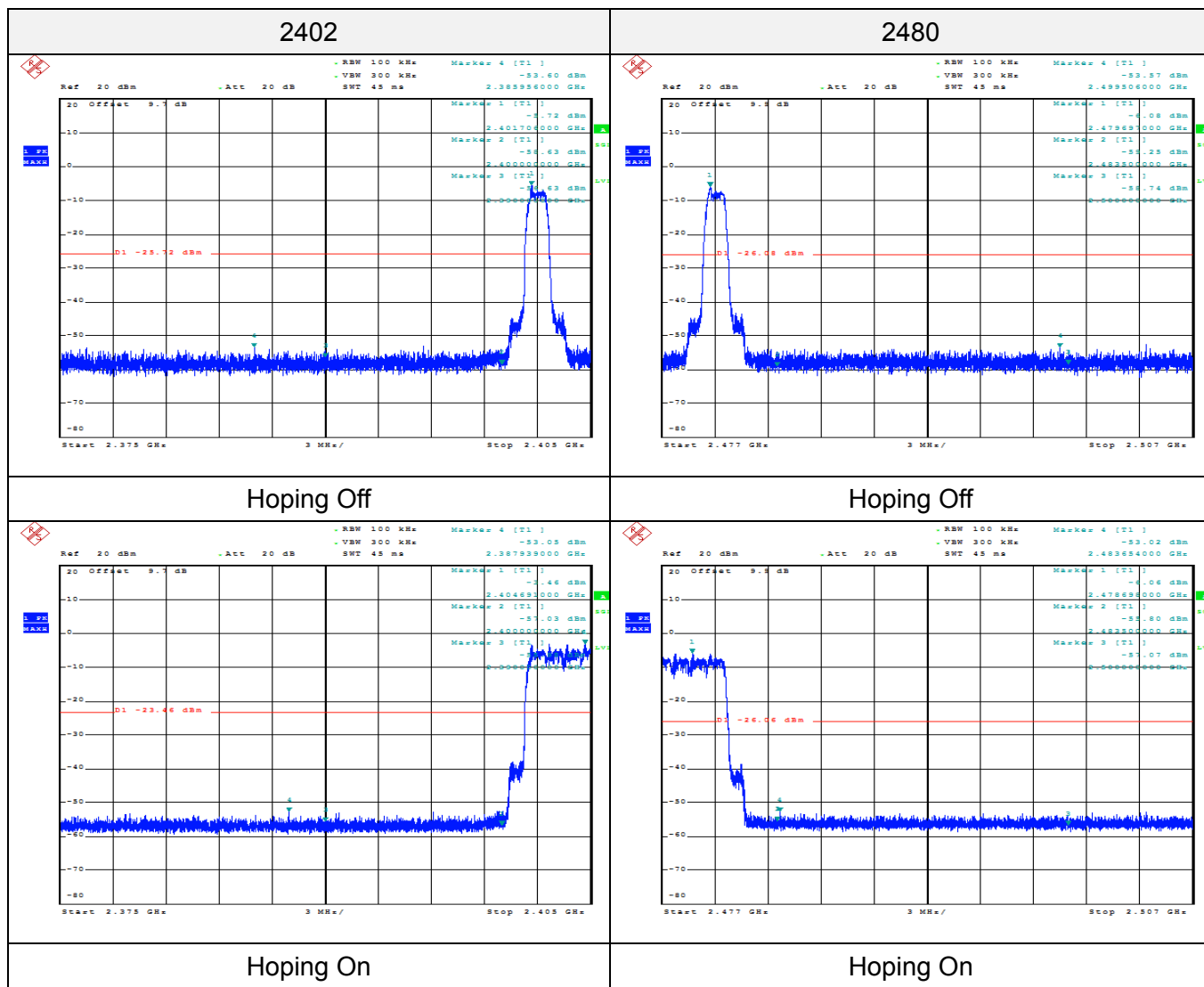
GFSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hopping Mode	Limit (dBc)	Verdict
2383.886	50.012	OFF	20	PASS
2388.536	52.155	ON	20	PASS
2493.989	49.295	OFF	20	PASS
2490.185	48.989	ON	20	PASS



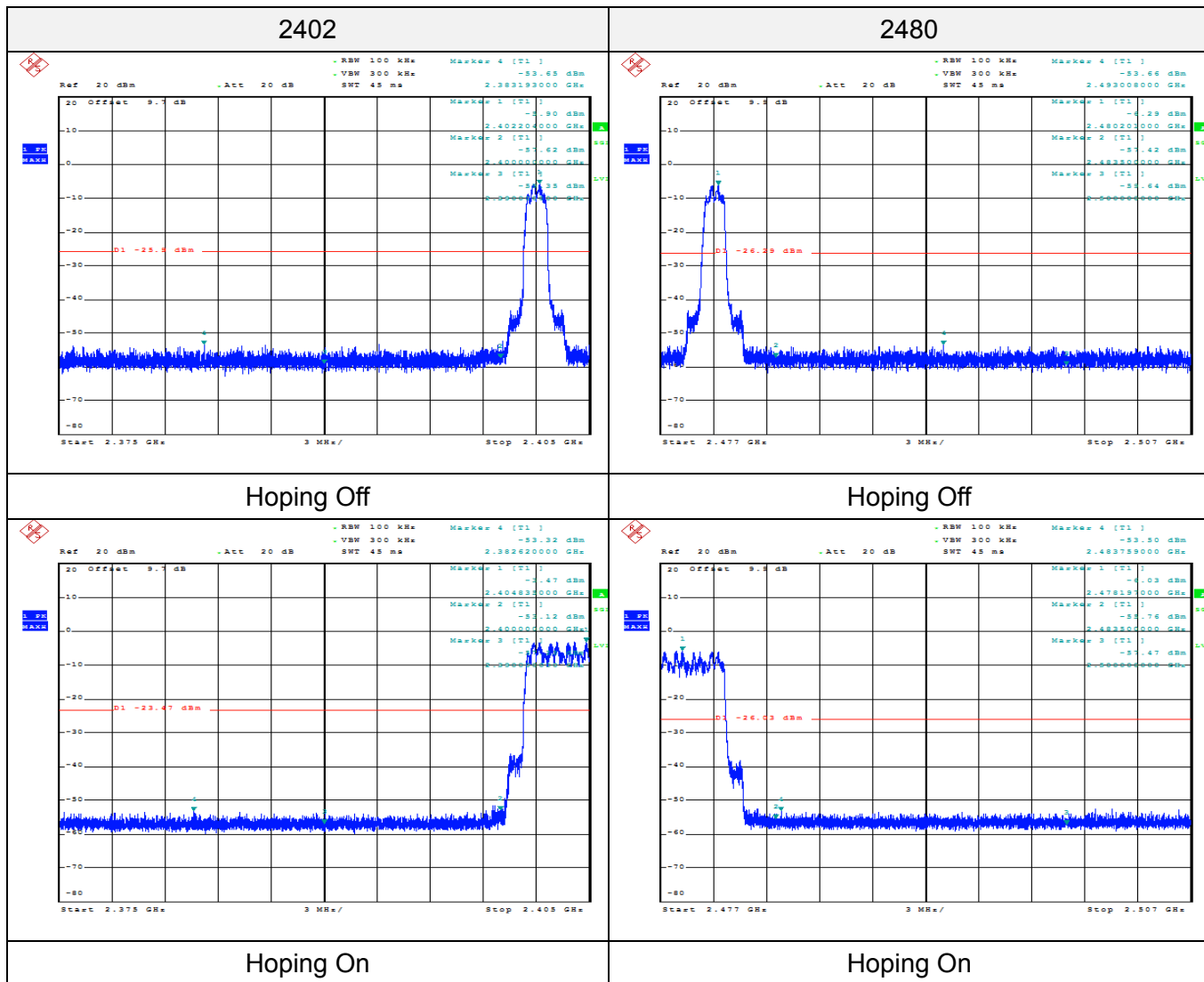
$\pi/4$ DQPSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hopping Mode	Limit (dBc)	Verdict
2385.956	47.877	OFF	20	PASS
2387.939	49.586	ON	20	PASS
2499.506	47.491	OFF	20	PASS
2483.654	46.962	ON	20	PASS



8DPSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hopping Mode	Limit (dBc)	Verdict
2383.193	47.750	OFF	20	PASS
2382.620	49.854	ON	20	PASS
2493.008	47.369	OFF	20	PASS
2483.759	47.466	ON	20	PASS



A. Radiated measurements

GFSK

Frequency(MHz):			2402			Polarity:			HORIZONTAL		
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)
2390	51.22	PK	74.00	22.78	1.00	90	56.53	27.49	3.32	36.12	-5.31
2390	38.37	AV	54.00	15.63	1.00	90	43.68	27.49	3.32	36.12	-5.31
Frequency(MHz):			2402			Polarity:			VERTICAL		
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)
2390	51.10	PK	74.00	22.90	1.00	220	56.41	27.49	3.32	36.12	-5.31
2390	37.97	AV	54.00	16.03	1.00	220	43.28	27.49	3.32	36.12	-5.31
Frequency(MHz):			2480			Polarity:			HORIZONTAL		
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)
2483.5	49.31	PK	74.00	24.69	1.00	98	55.03	27.45	3.38	36.55	-5.72
2483.5	39.00	AV	54.00	15.00	1.00	98	44.72	27.45	3.38	36.55	-5.72
Frequency(MHz):			2480			Polarity:			VERTICAL		
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)
2483.5	50.73	PK	74.00	23.27	1.00	205	56.45	27.45	3.38	36.55	-5.72
2483.5	37.07	AV	54.00	16.93	1.00	205	42.79	27.45	3.38	36.55	-5.72

3.6. Frequency Separation

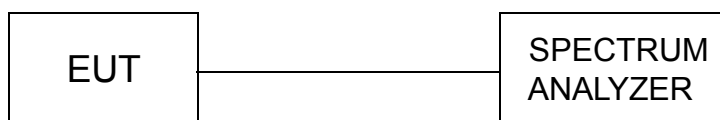
LIMIT

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 30 KHz RBW and 100KHz VBW.

TEST CONFIGURATION



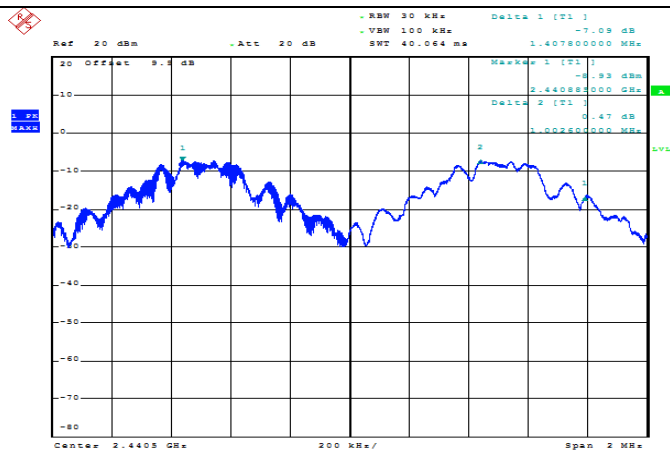
TEST RESULTS

Modulation	Channel	Channel Separation (MHz)	Limit(MHz)	Result
GFSK	CH39	1.003	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			
$\pi/4$ DQPSK	CH39	1.002	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			
8DPSK	CH39	0.998	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			

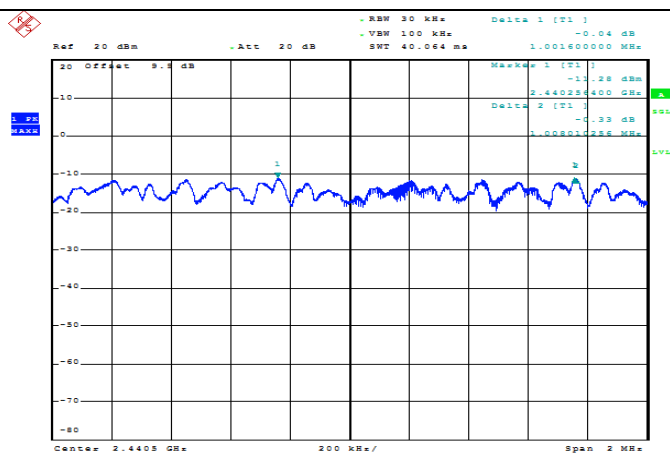
Note:

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

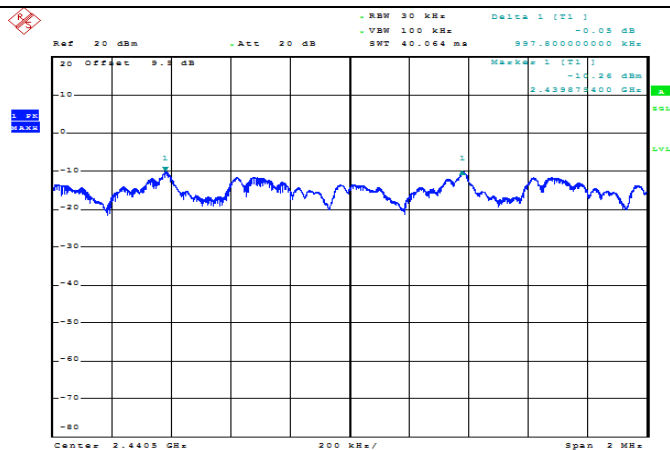
Test plot as follows:



GFSK



8DPSK



$\pi/4$ DQPSK

3.7. Number of hopping frequency

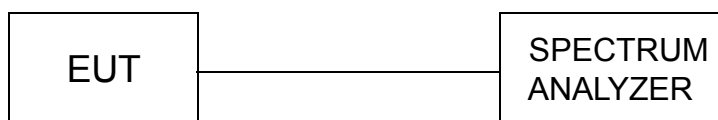
Limit

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.

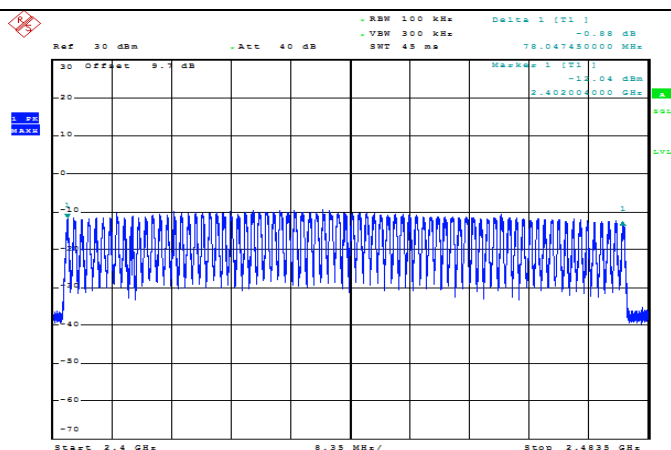
Test Configuration



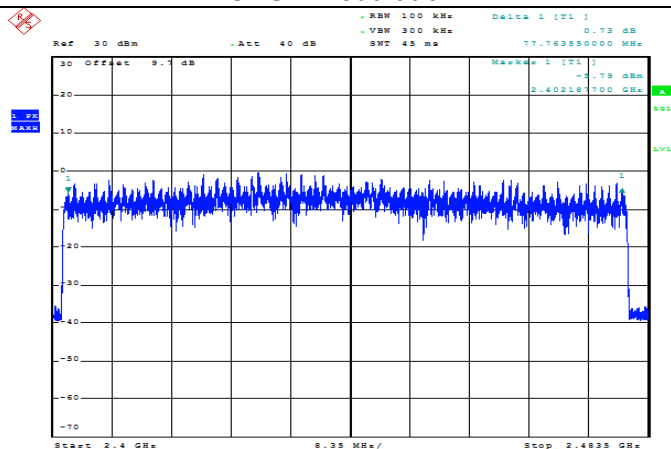
Test Results

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

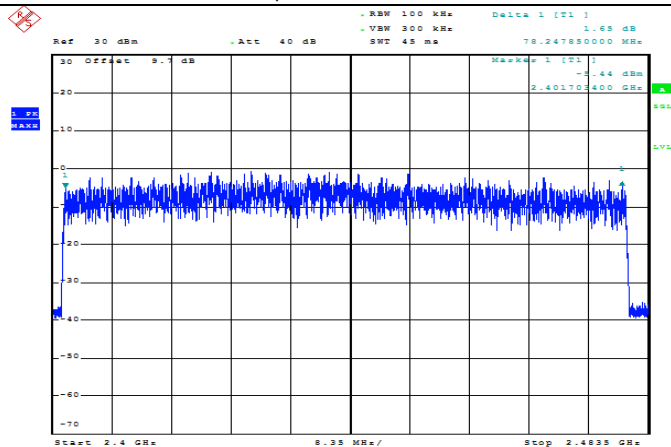
Test plot as follows:



GFSK Modulation



$\pi/4$ DQPSK Modulation



8DPSK Modulation

3.8. Time of Occupancy (Dwell Time)

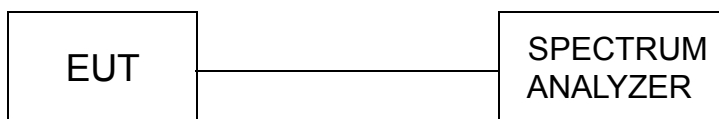
Limit

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

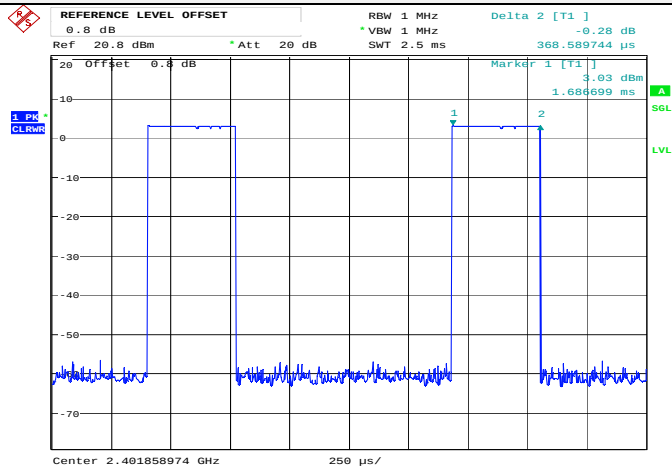
Modulation	Packet	Pulse time (ms)	Dwell time (s)	Limit (s)	Result
GFSK	DH1	0.369	0.118	0.40	Pass
	DH3	1.670	0.267		
	DH5	2.818	0.301		
$\pi/4$ DQPSK	2-DH1	0.393	0.126	0.40	Pass
	2-DH3	1.682	0.269		
	2-DH5	2.081	0.222		
8DPSK	3-DH1	0.389	0.124	0.40	Pass
	3-DH3	1.670	0.267		
	3-DH5	2.834	0.302		

Note:

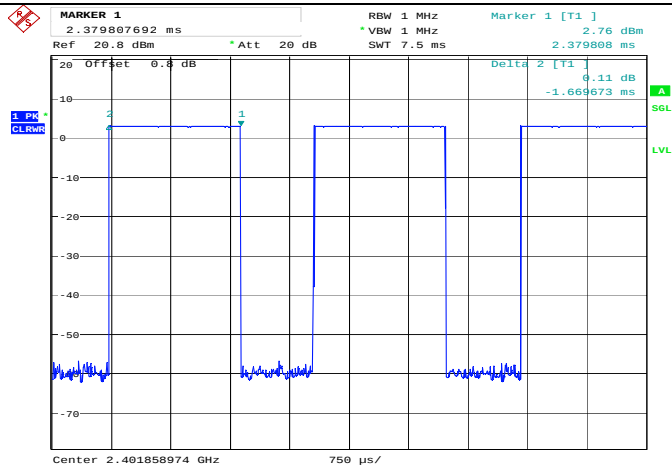
- We have tested all mode at high,middle and low channel,and recoreded worst case at middle channel.
- $\text{Dwell time} = \text{Pulse time (ms)} \times (1600 \div 2 \div 79) \times 31.6$ Second for DH1, 2-DH1, 3-DH1
 $\text{Dwell time} = \text{Pulse time (ms)} \times (1600 \div 4 \div 79) \times 31.6$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

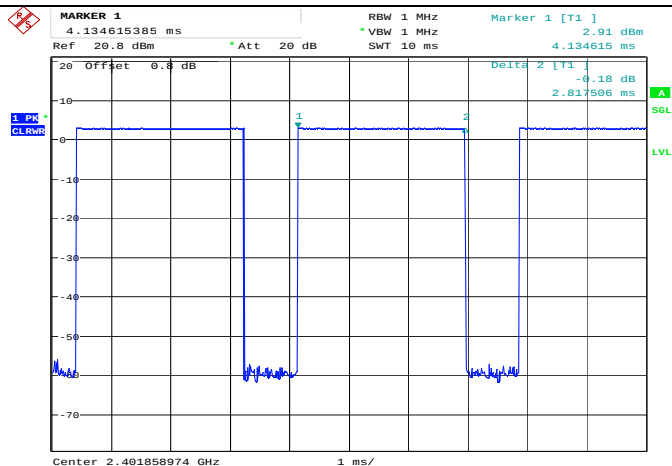
GFSK Modulation



DH1

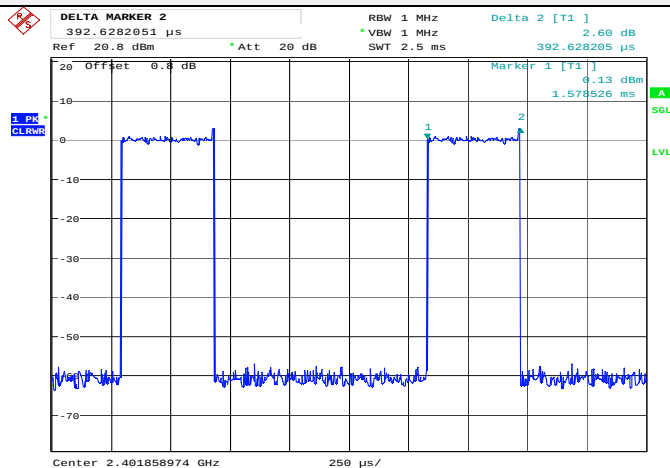


DH3

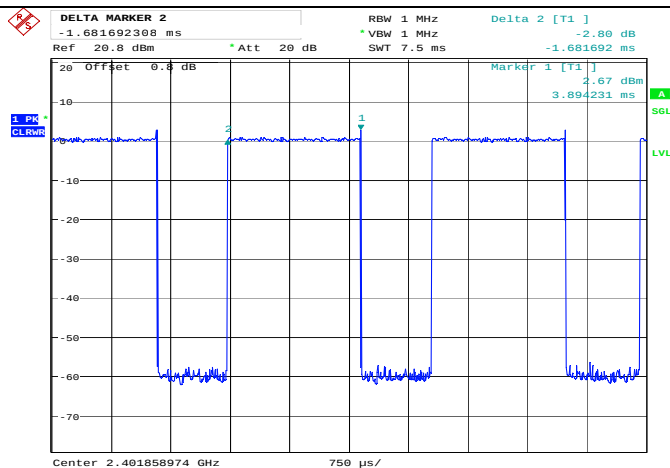


DH5

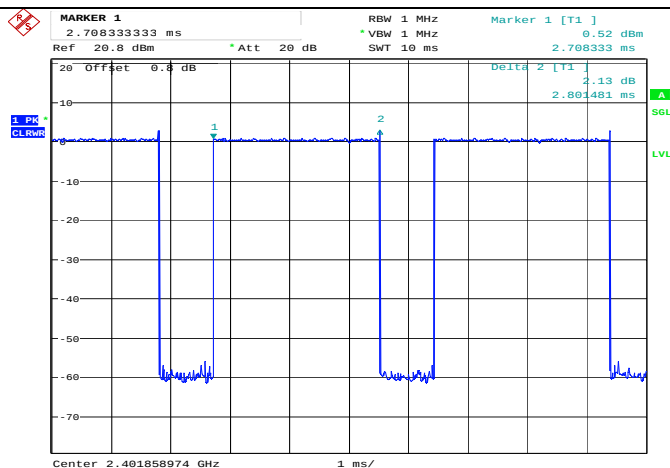
$\pi/4$ DQPSK Modulation



2DH1

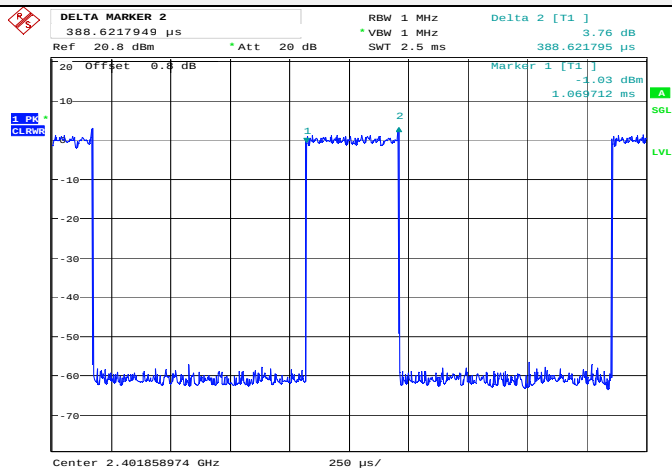


2DH3

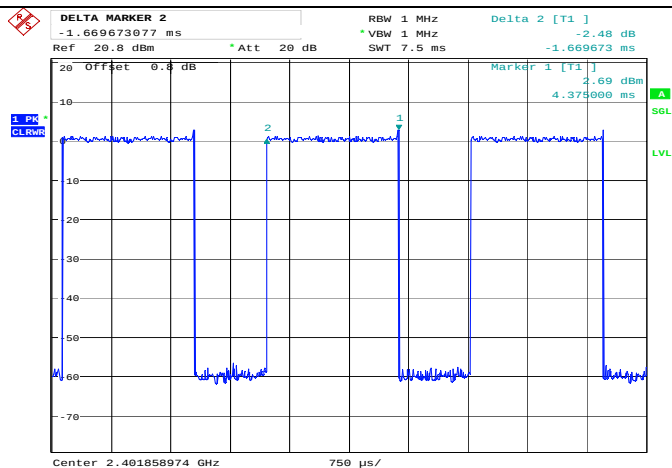


2DH5

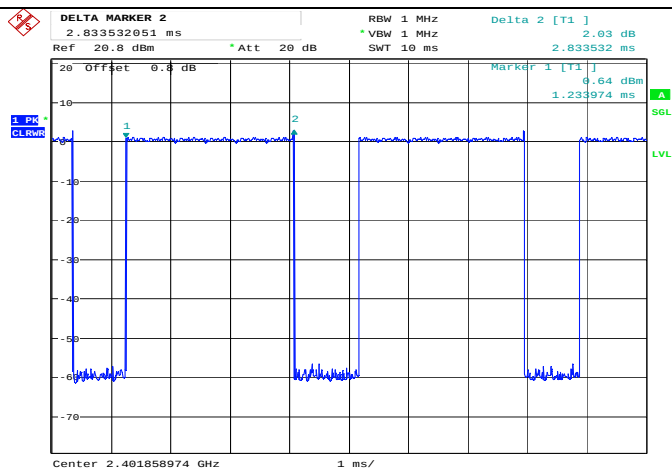
8DPSK Modulation



3DH1



3DH3



3DH5

3.9. Spurious RF Conducted Emission

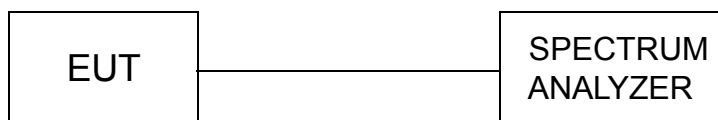
Limit

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

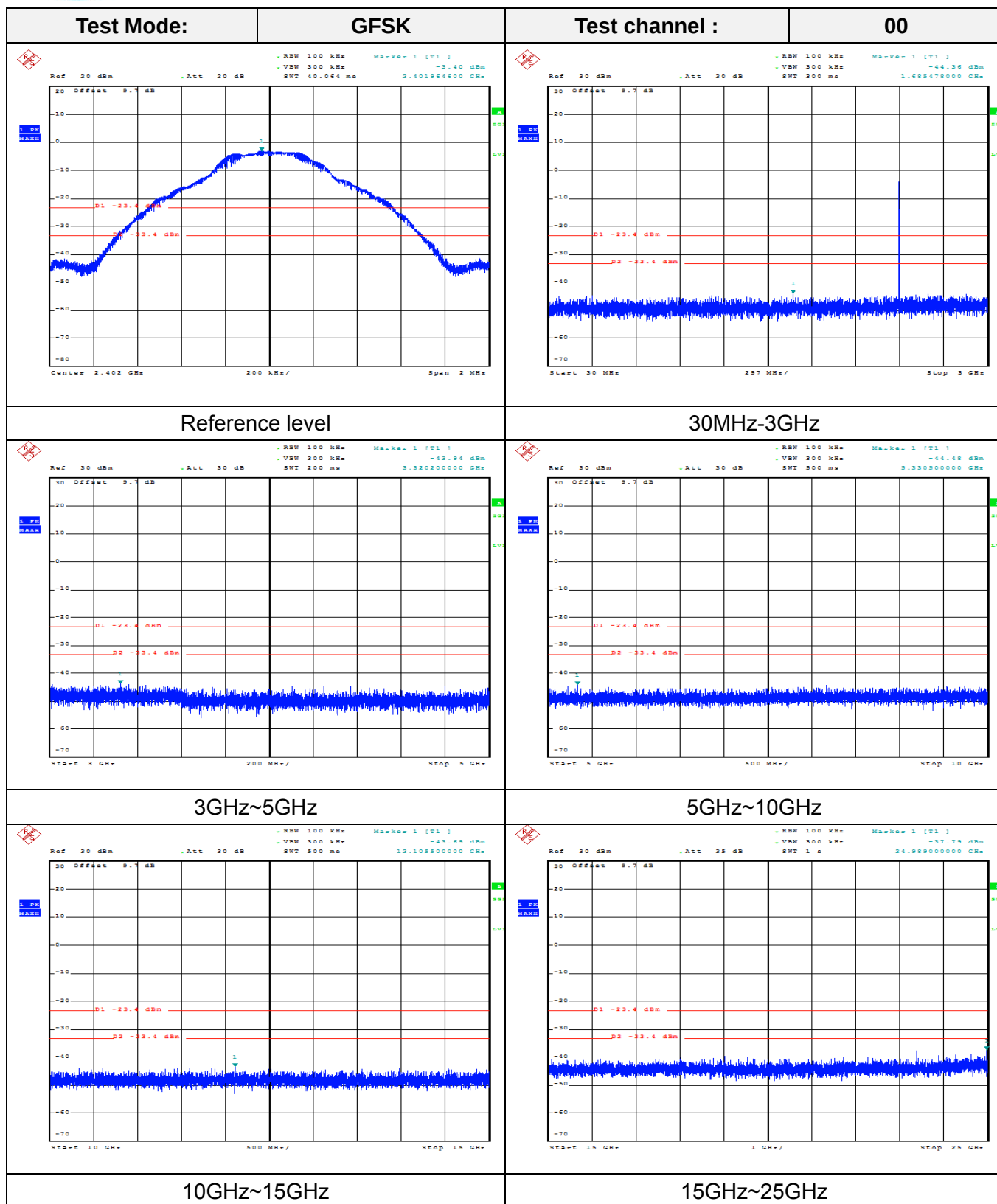
The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10:2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting 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.

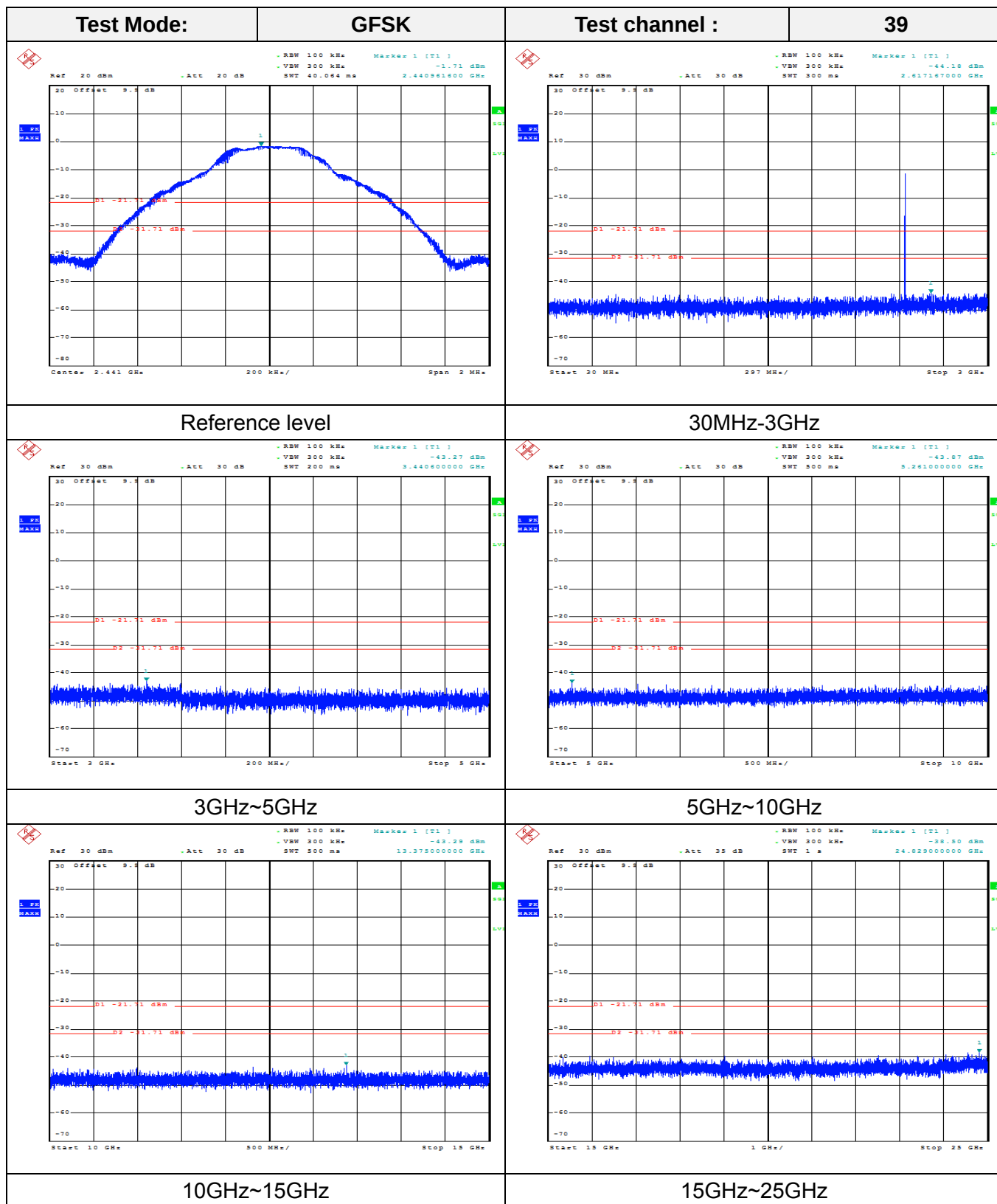
Test Configuration

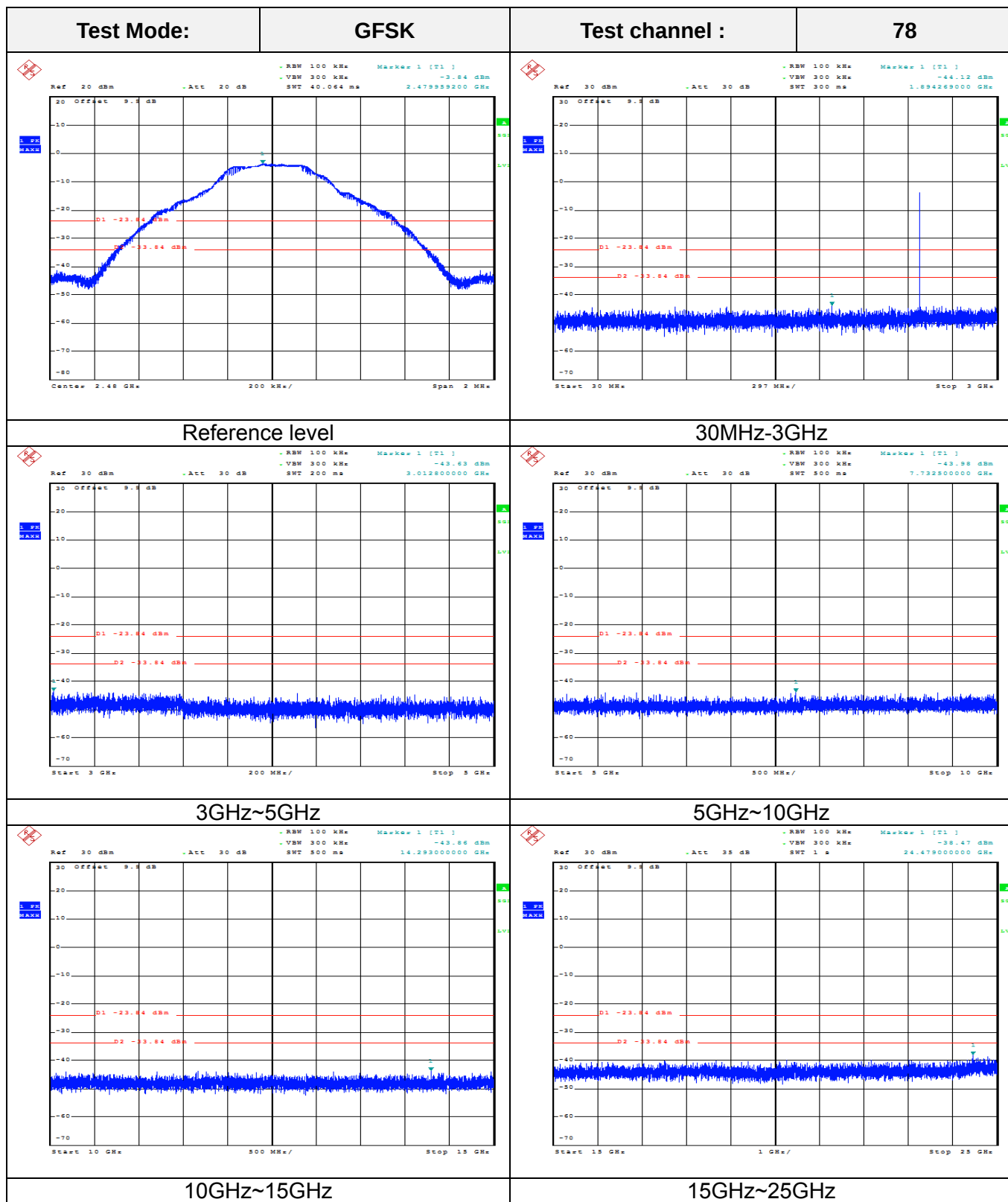


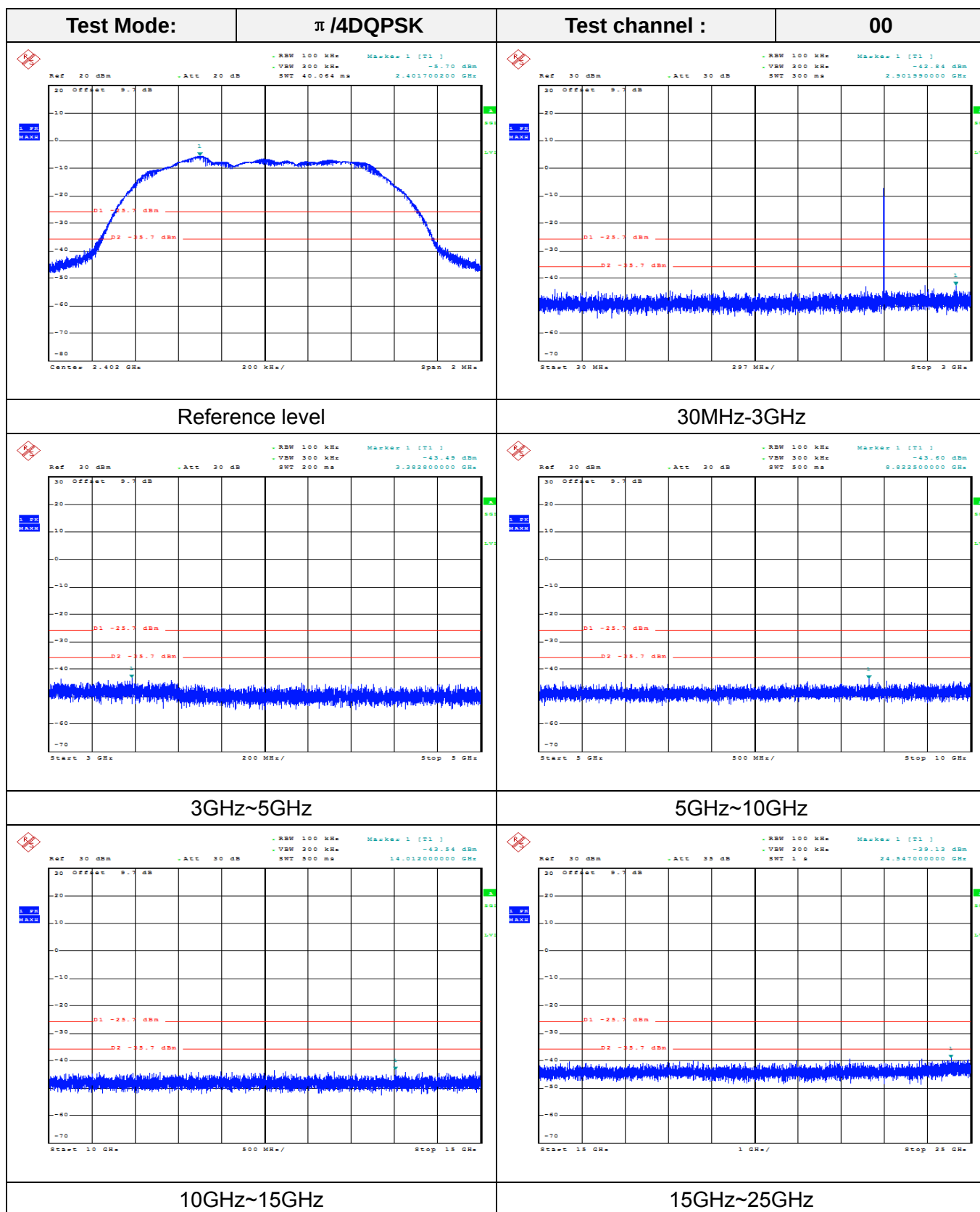
Test Results

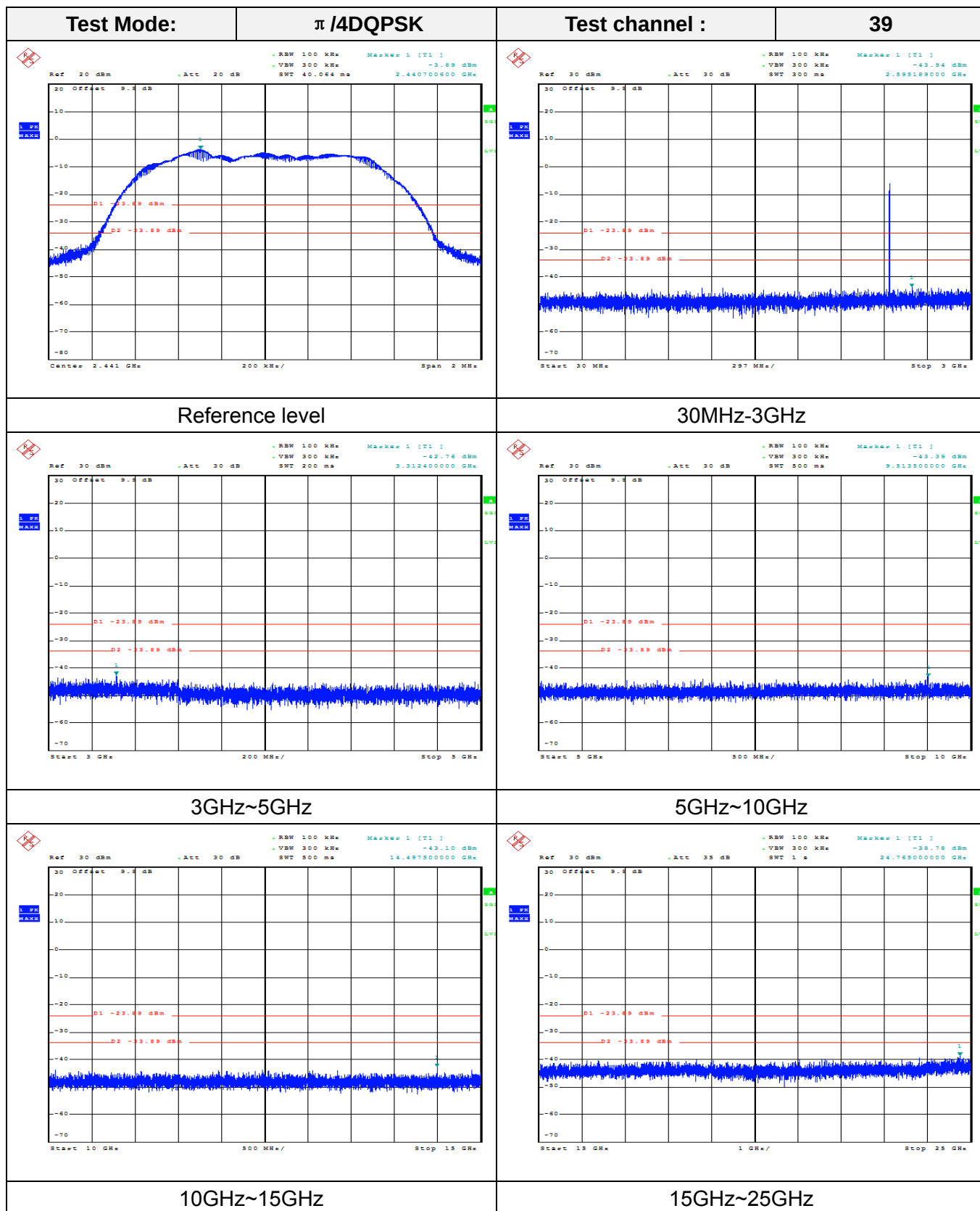
Remark: We measured all conditions (DH1, DH3, DH5) and recorded worst case at DH5

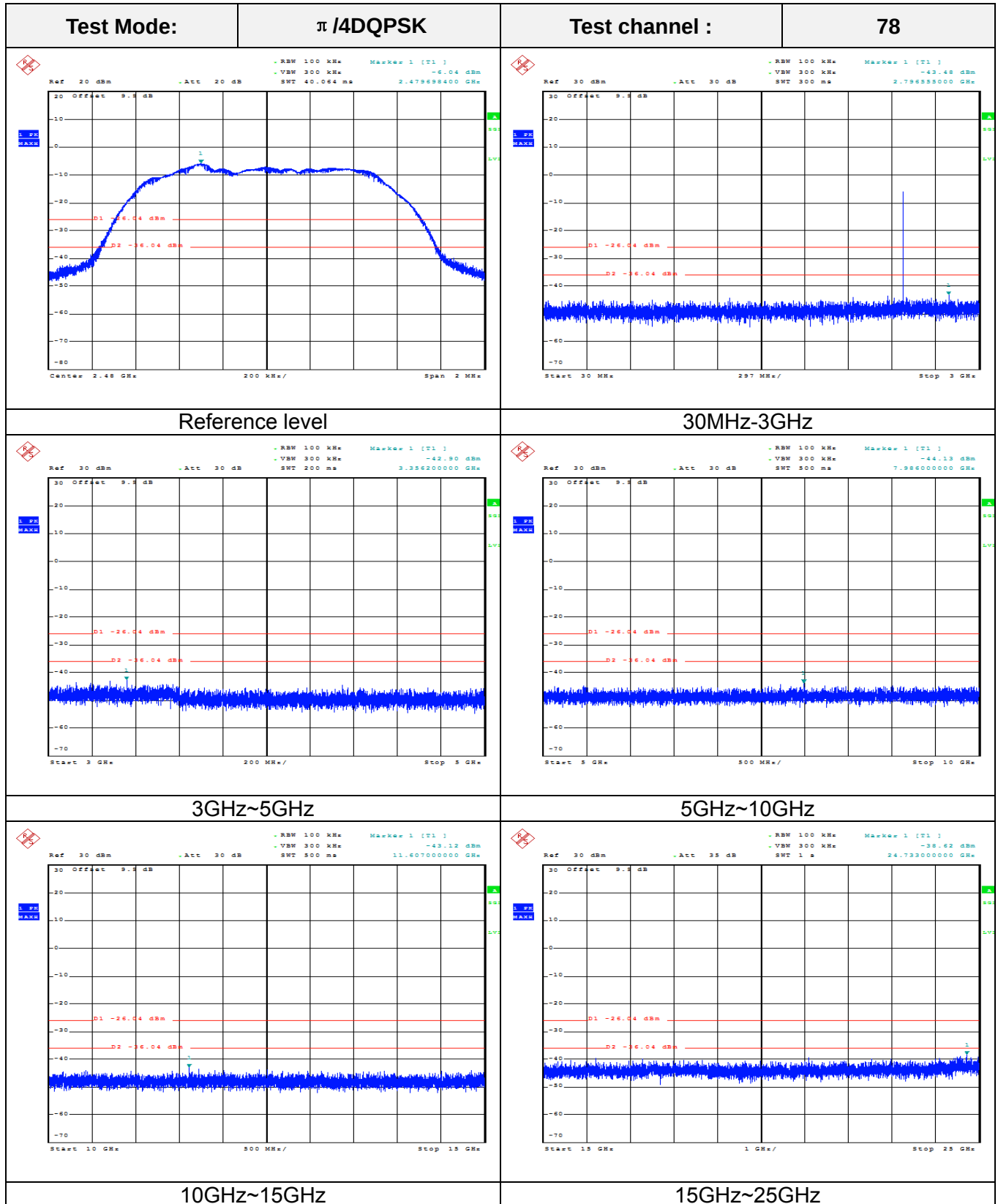


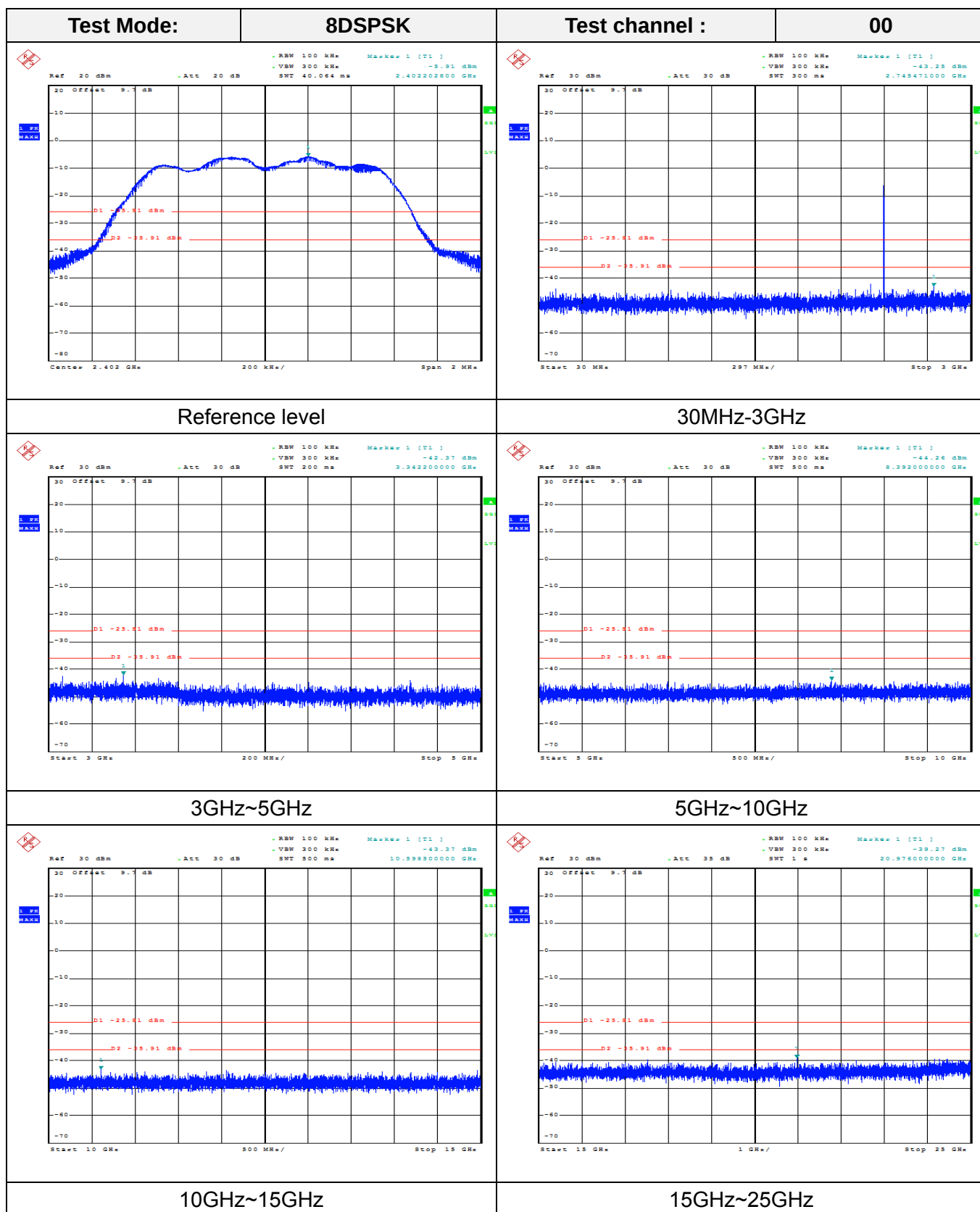


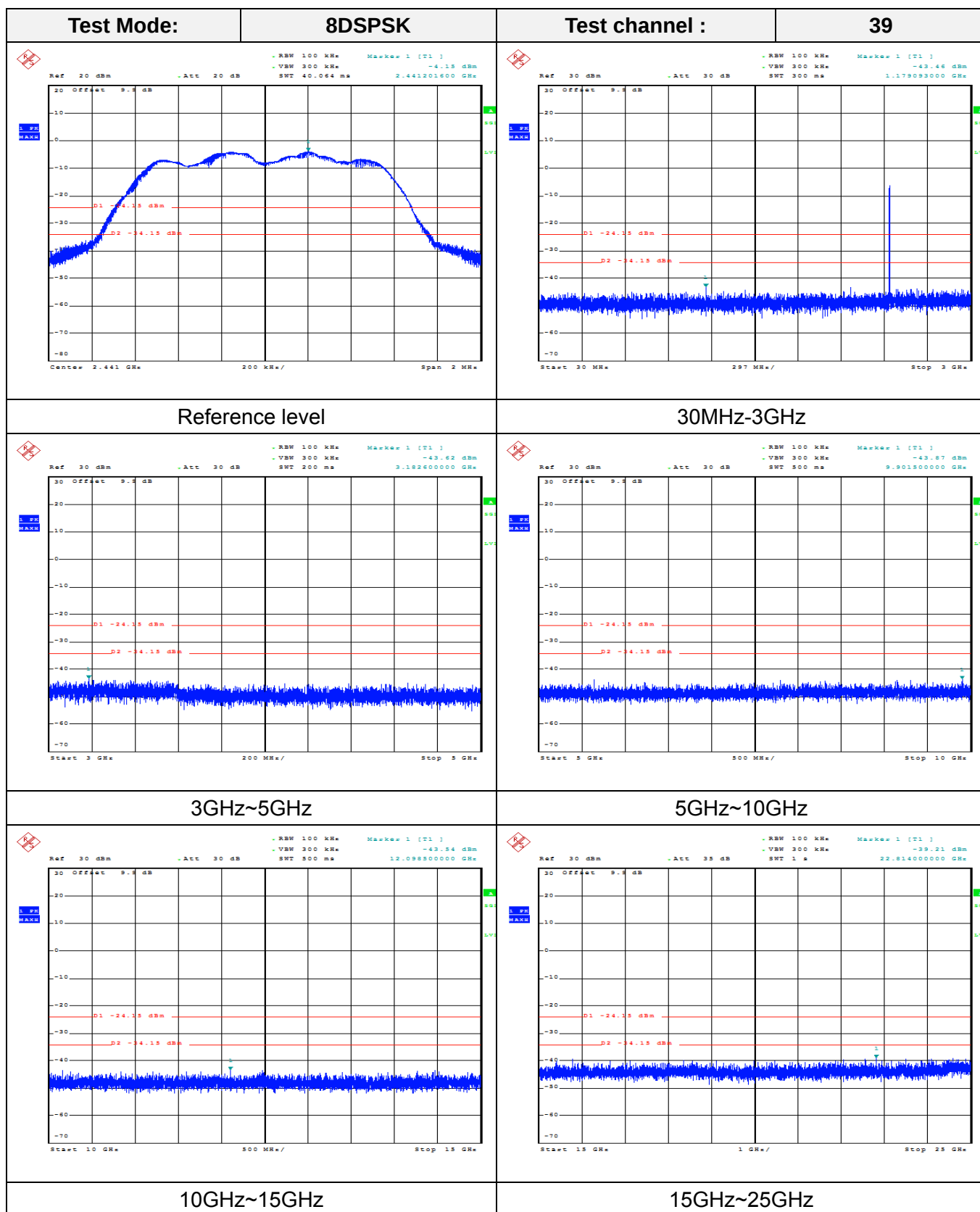


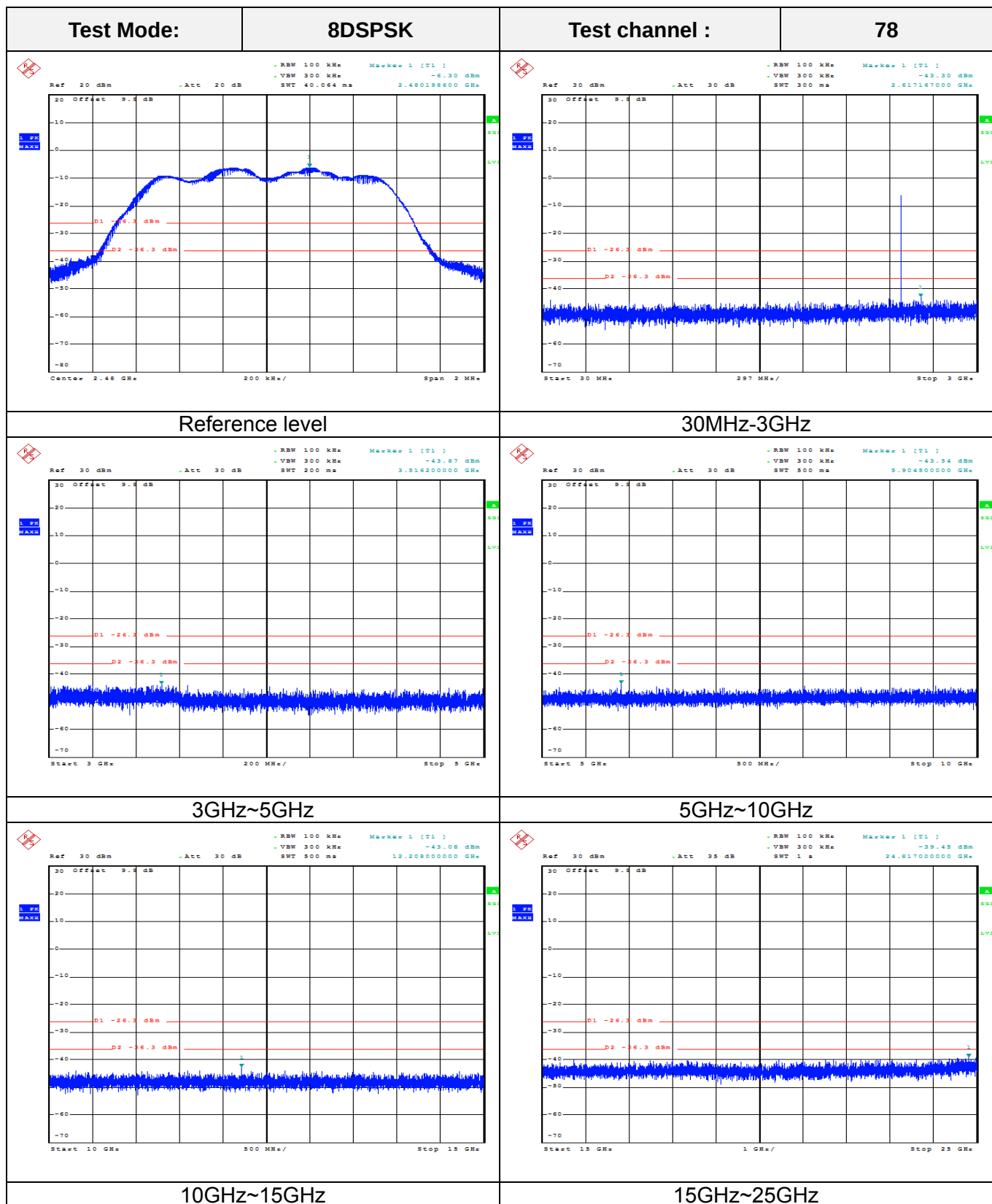












3.10. Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

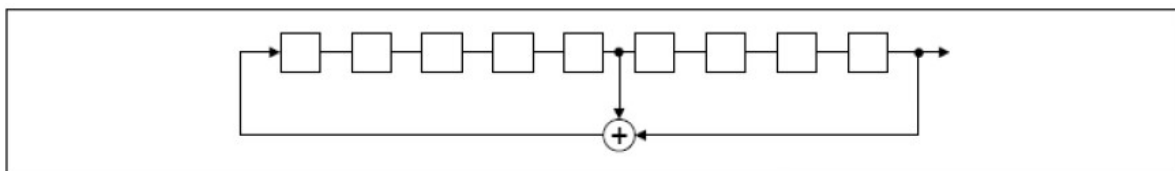
For 47 CFR Part 15C section 15.247 (a) (1) requirement:

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

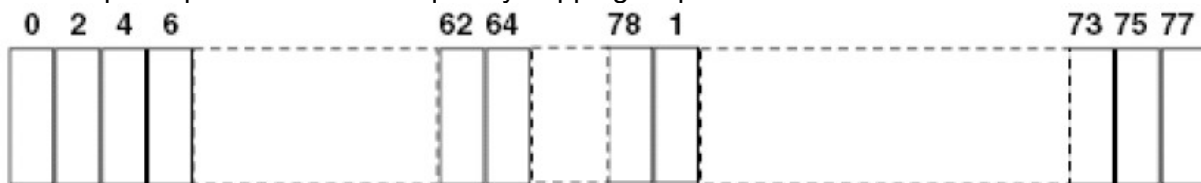
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: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

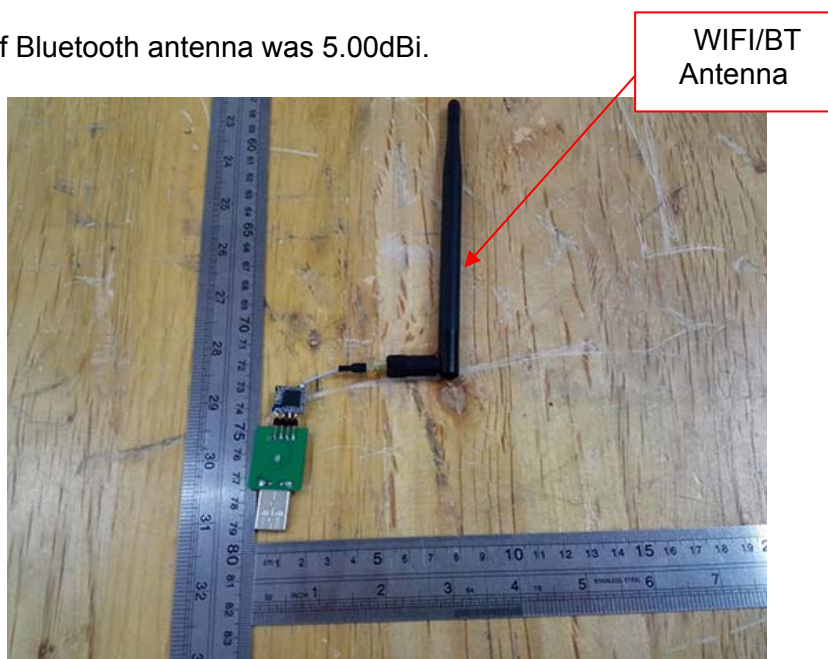
And according to FCC 47 CFR Section 15.247 (c), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

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.

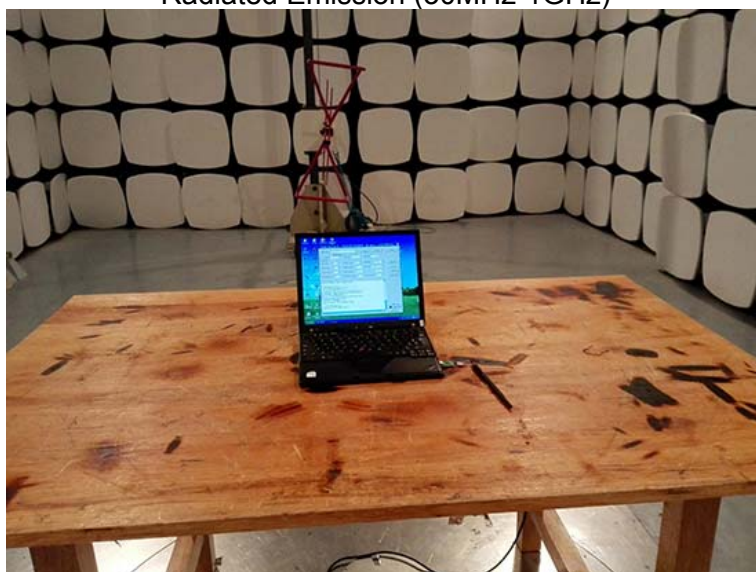
Antenna Connected Construction

The maximum gain of Bluetooth antenna was 5.00dBi.

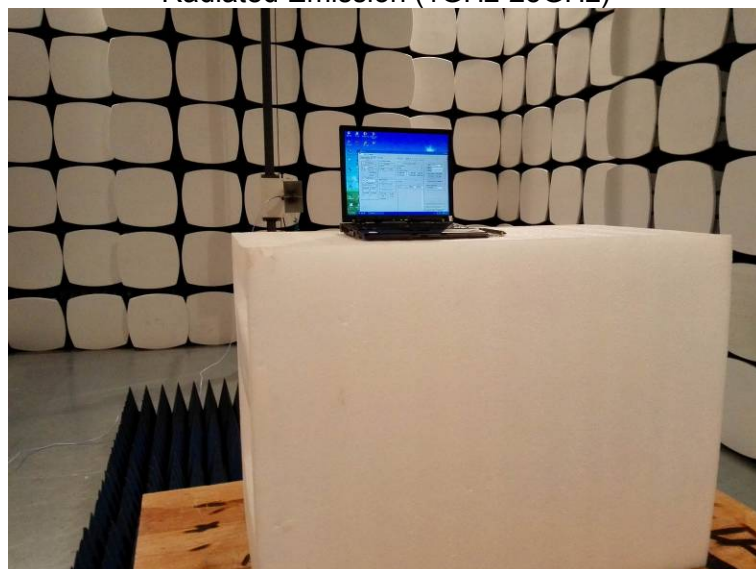


4. EUT TEST PHOTO

Radiated Emission (30MHz-1GHz)



Radiated Emission (1GHz-25GHz)



Conducted Emission





5. PHOTOGRAPHS OF EUT CONSTRUCTIONAL

Please reference to the test report No.: GTI20150566F-1

*****THE END*****