FCC Part 15C Test Report

FCC ID: 2AGQF-WT-SPECTRA

Product Name:	Spectra Controller
Trademark:	N/A
Model Name :	Spectra, Spectra Controller
Prepared For : **Address :**	Wavetec FZCO Light Industrial Unit #, Dubai Silicon Oasis, P.O. Box 341133 Dubai, United Arab Emirates
Prepared By : **Address :**	Shenzhen BCTC Testing Co., Ltd. BCTC Building & 1-2F, East of B Building, Pengzhou Industrial, Fuyuan 1st Road, Qiaotou Community, Fuyong Street, Bao'an District, Shenzhen, China
Test Date:	Mar. 27, 2019 to May 14, 2019
Date of Report :	Jun. 19, 2019
Report No.:	BCTC-LH190300165E

TEST RESULT CERTIFICATION

Applicant's name............. :	Wavetec FZCO
Address .... :	Light Industrial Unit #, Dubai Silicon Oasis, P.O. Box 341133 Dubai, United Arab Emirates
Manufacture's Name........ :	Wavetec FZCO
Address .... :	Light Industrial Unit #, Dubai Silicon Oasis, P.O. Box 341133 Dubai, United Arab Emirates
Product description	
Product name .... :	Spectra Controller
Trademark .... :	N/A
Model and/or type reference .... :	Spectra, Spectra Controller
Standards .... :	FCC Part15.247 ANSI C63.10:2013 KDB 558074 D01

This device described above has been tested by BCTC, and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

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Prepared by(Engineer):	Cai Fang Zhong	Cai Fang Zhong
Reviewer(Supervisor):	Eric Yang	Eric Yang
Approved(Manager):	Zero Zhou	Zero Zhou

倍测检测 BCTC APPROVED SHENZHEN BCTC TESTING CO., LTD

Table of Contents

(Note: N/A means not applicable)

1. TEST SUMMARY

Test procedures according to the technical standards:

FCC Part15 (15.247) , Subpart C			
Standard Section	Test Item	Judgment	Remark
15.205(a) 15.209 15.247(d)	Radiated Spurious Emissions	PASS	
15.247(d)	Conducted Spurious emissions	PASS	
15.247(d) 15.205(a)	Band edge	PASS	
15.207	Conducted Emission	PASS	
15.247(a)	20dB Bandwidth	PASS	
15.247(b)	Maximum Peak Output Power	PASS	
15.247(a)	Frequency Separation	PASS	
15.247(a)	Number of Hopping Frequency	PASS	
15.247(a)	Dwell time	PASS	
15.203	Antenna Requirement	PASS	
15.247(g), (h)	Frequency Hopping System	PASS	
Note: (1)” N/A” denotes test is not applicable in this Test Report			

2. TEST FACILITY

Shenzhen BCTC Testing Co., Ltd.
Add. : BCTC Building & 1-2F, East of B Building, Pengzhou Industrial, Fuyuan 1st Road, Qiaotou Community, Fuyong Street, Bao'an District, Shenzhen, China
FCC Test Firm Registration Number: 712850
Test site MRA number: CN1212
IC Registered No.: 23583

3. MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement y ± U，where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2，providing a level of confidence of approximately 95 %。

No.	Item	Uncertainty
1	3m camber Radiated spurious emission(30MHz-1GHz)	U=4.3dB
2	3m chamber Radiated spurious emission(1GHz-18GHz)	U=4.5dB
3	3m chamber Radiated spurious emission(18GHz-40GHz)	U=3.34dB
4	Conducted Adjacent channel power	U=1.38dB
5	Conducted output power uncertainty Above 1G	U=1.576dB
6	Conducted output power uncertainty below 1G	U=1.28dB
7	humidity uncertainty	U=5.3%
8	Temperature uncertainty	U=0.59℃

4. GENERAL INFORMATION

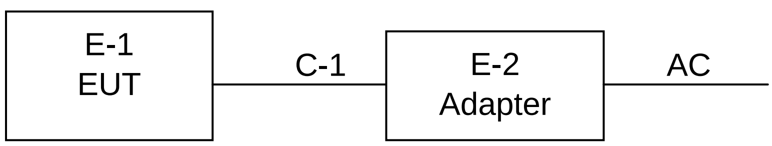
4.1 GENERAL DESCRIPTION OF EUT

<table>
<tr><td>Equipment</td><td>Spectra Controller</td></tr>
<tr><td>Trade Name</td><td>N/A</td></tr>
<tr><td>Model Name</td><td>Spectra, Spectra Controller</td></tr>
<tr><td>Model Difference</td><td>The product is different for model number and outlook color.</td></tr>
<tr><td>Product Description</td><td>The EUT is a Spectra Controller
<table>
<tr><td>Operation Frequency:</td><td>2402-2480 MHz</td></tr>
<tr><td>Modulation Type:</td><td>GFSK, Pi/4DQPSK, 8DPSK</td></tr>
<tr><td>Number Of Channel</td><td>79CH</td></tr>
<tr><td>Antenna Designation:</td><td>Internal antenna</td></tr>
<tr><td>Antenna Gain</td><td>0dBi</td></tr>
</table>
Based on the application, features, or specification exhibited in User's Manual, the EUT is considered as an ITE/Computing Device. More details of EUT technical specification, please refer to the User's Manual.</td></tr>
<tr><td>Channel List</td><td>Please refer to the Note 2.</td></tr>
<tr><td>Ratings</td><td>DC 12V From adapter</td></tr>
<tr><td>Adapter</td><td>Model No.: GST40A12
Input: AC100-240V~50/60Hz, 1.0A
Output: DC 12V, 3.3A</td></tr>
<tr><td>Connecting I/O Port(s)</td><td>Please refer to the User's Manual</td></tr>
</table>

4.2 Test Setup Configuration

See test photographs attached in *EUT TEST SETUP PHOTOGRAPHS* for the actual

Conducted Emission / Radiated Spurious Emission Test



4.3 Support Equipment

No.	Device Type	Brand	Model	Series No.	Data Cable
E-1	Spectra Controller	N/A	Spectra , Spectra Controller	N/A	EUT
E-2	Adapter	N/A	GST40A12	N/A	Auxiliary

Item	Shielded Type	Ferrite Core	Length	Note
C-1	NO	NO	1.0M	DC cable unshielded

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

4.4 Channel List

CH	Frequency (MHz)	CH	Frequency (MHz)	CH	Frequency (MHz)	CH	Frequency (MHz)
0	2402	1	2403	2	2404	3	2405
4	2406	5	2407	6	2408	7	2409
8	2410	9	2411	10	2412	11	2413
12	2414	13	2415	14	2416	15	2417
16	2418	17	2419	18	2420	19	2421
20	2422	21	2423	22	2424	23	2425
24	2426	25	2427	26	2428	27	2429
28	2430	29	2431	30	2432	31	2433
32	2434	33	2435	34	2436	35	2437
36	2438	37	2439	38	2440	39	2441
40	2442	41	2443	42	2444	43	2445
44	2446	45	2447	46	2448	47	2449
48	2450	49	2451	50	2452	51	2453
52	2454	53	2455	54	2456	55	2457
56	2458	57	2459	58	2460	59	2461
60	2462	61	2463	62	2464	63	2465
64	2466	65	2467	66	2468	67	2469
68	2470	69	2471	70	2472	71	2473
72	2474	73	2475	74	2476	75	2477
76	2478	77	2479	78	2480	79	/

4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

The EUT is Continue Transmitting.

The software is installed in operation system, named “RFTestTool.apk” ,Version 1.0.

Test Mode	Test mode	Low channel	Middle channel	High channel
1	Transmitting(GFSK)	2402MHz	2441MHz	2480MHz
2	Transmitting(Pi/4DQPSK)	2402MHz	2441MHz	2480MHz
3	Transmitting(8DPSK)	2402MHz	2441MHz	2480MHz
4	Transmitting(Link)			

5. TEST FACILITY AND TEST INSTRUMENT USED

5.1 Test Facility

All measurement facilities used to collect the measurement data are located at BCTC Building & 1-2F, East of B Building, Pengzhou Industrial, Fuyuan 1st Road, Qiaotou Community, Fuyong Street, Bao'an District, Shenzhen, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

5.2 Test Instrument Used

RF conduction and RadiationTest equipment

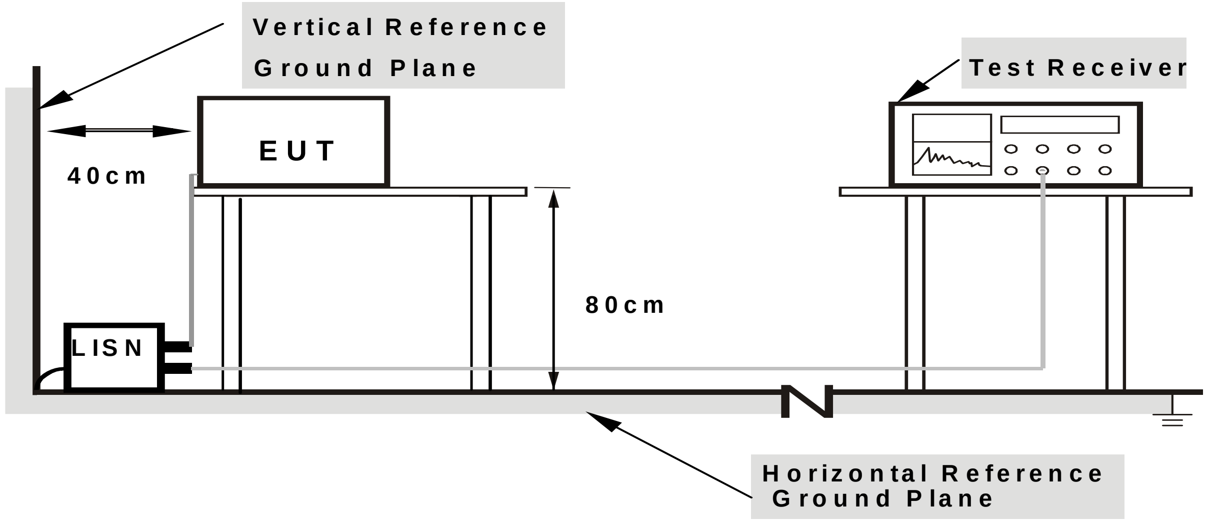
Item	Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
1	Spectrum Analyzer (9kHz-26.5GHz)	Agilent	E4407B	MY45109572	2018.06.20	2019.06.20
2	Test Receiver (9kHz-7GHz)	R&S	ESR7	101154	2018.06.20	2019.06.20
3	Bilog Antenna (30MHz-3GHz)	SCHWARZBECK	VULB9163	VULB9163-942	2018.06.23	2019.06.23
4	Horn Antenna (1GHz-18GHz)	SCHWARZBECK	BBHA9120D	1541	2018.06.23	2021.06.22
5	Horn Antenna (18GHz-40GHz)	SCHWARZBECK	BBHA9170	822	2018.08.06	2019.08.06
6	Amplifier (9KHz-6GHz)	SCHWARZBECK	BBV9744	9744-0037	2018.06.20	2019.06.20
7	Amplifier (0.5GHz-18GHz)	SCHWARZBECK	BBV9718	9718-309	2018.06.20	2019.06.20
8	Amplifier (18GHz-40GHz)	MITEQ	TTA1840-35-HG	2034381	2018.08.06	2019.08.06
9	Loop Antenna (9KHz-30MHz)	SCHWARZBECK	FMZB1519B	014	2018.06.23	2019.06.23
10	RF cables1 (9kHz-30MHz)	Huber+Suhnar	9kHz-30MHz	B1702988-0008	2019.02.12	2020.02.12
11	RF cables2 (30MHz-1GHz)	Huber+Suhnar	30MHz-1GHz	1486150	2019.03.27	2020.03.27
12	RF cables3 (1GHz-40GHz)	Huber+Suhnar	1GHz-40GHz	1607106	2018.06.19	2019.06.19
13	Power Metter	Keysight	E4419	\	2018.06.15	2019.06.15
14	Power Sensor (AV)	Keysight	E9 300A	\	2018.06.15	2019.06.15
15	Signal Analyzer 20kHz-26.5GHz	KEYSIGHT	N9020A	MY49100060	2018.08.14	2019.08.13
16	Test Receiver 9kHz-40GHz	R&S	FSP40	100550	2018.06.13	2019.06.12
17	D.C. Power Supply	LongWei	TPR-6405D	\	\	\
18	Software	Frad	EZ-EMC	FA-03A2 RE	\	\

Conduction Test equipment

Item	Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
1	Test Receiver	R&S	ESR3	102075	2018.06.20	2019.06.20
2	LISN	SCHWARZBECK	NSLK8127	8127739	2018.06.19	2019.06.19
3	LISN	R&S	ENV216	101375	2018.06.20	2019.06.20
4	RF cables	Huber+Suhnar	9kHz-30MHz	B1702988-0008	2019.02.12	2020.02.12
5	Software	Frad	EZ-EMC	EMC-CON 3A1	\	\

6. CONDUCTED EMISSIONS

6.1 Block Diagram Of Test Setup



Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

6.2 Limit

FREQUENCY (MHz)	Limit (dBuV)		Standard
	Quasi-peak	Average	
0.15 -0.5	66 - 56 *	56 - 46 *	FCC
0.50 -5.0	56.00	46.00	FCC
5.0 -30.0	60.00	50.00	FCC

6.3 Test procedure

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

a. The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.

b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.

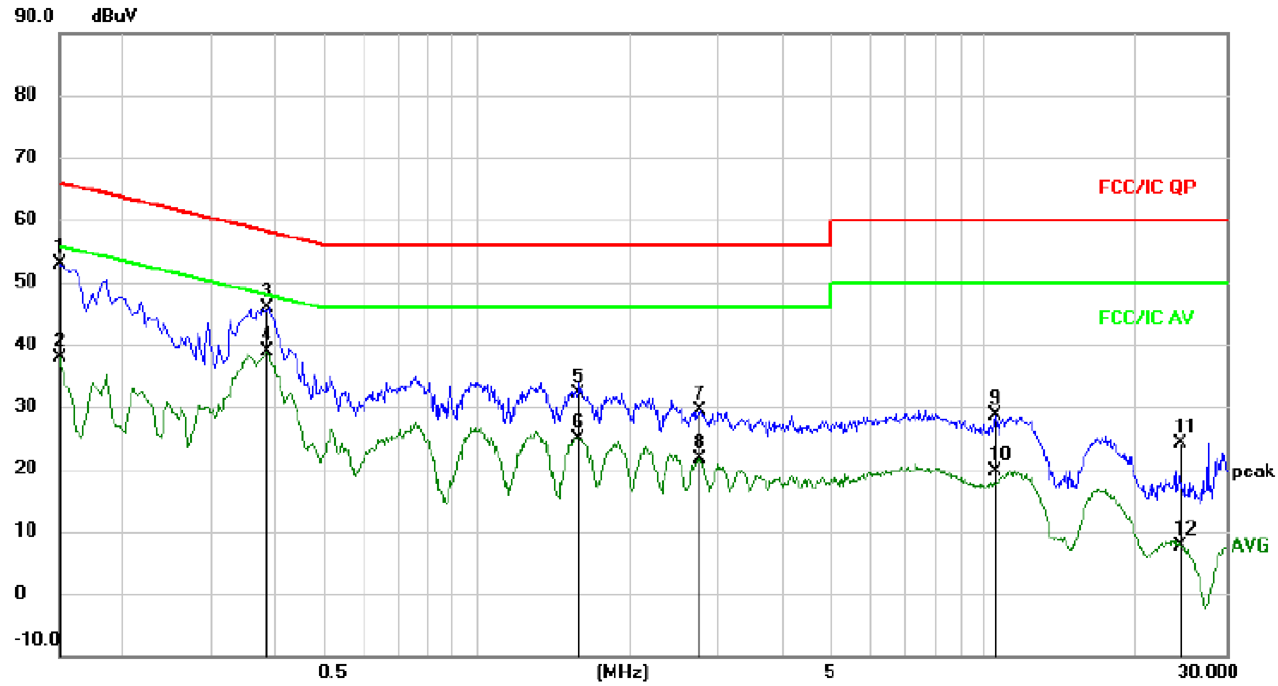
c. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

d. LISN at least 80 cm from nearest part of EUT chassis.

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

6.4 Test Result

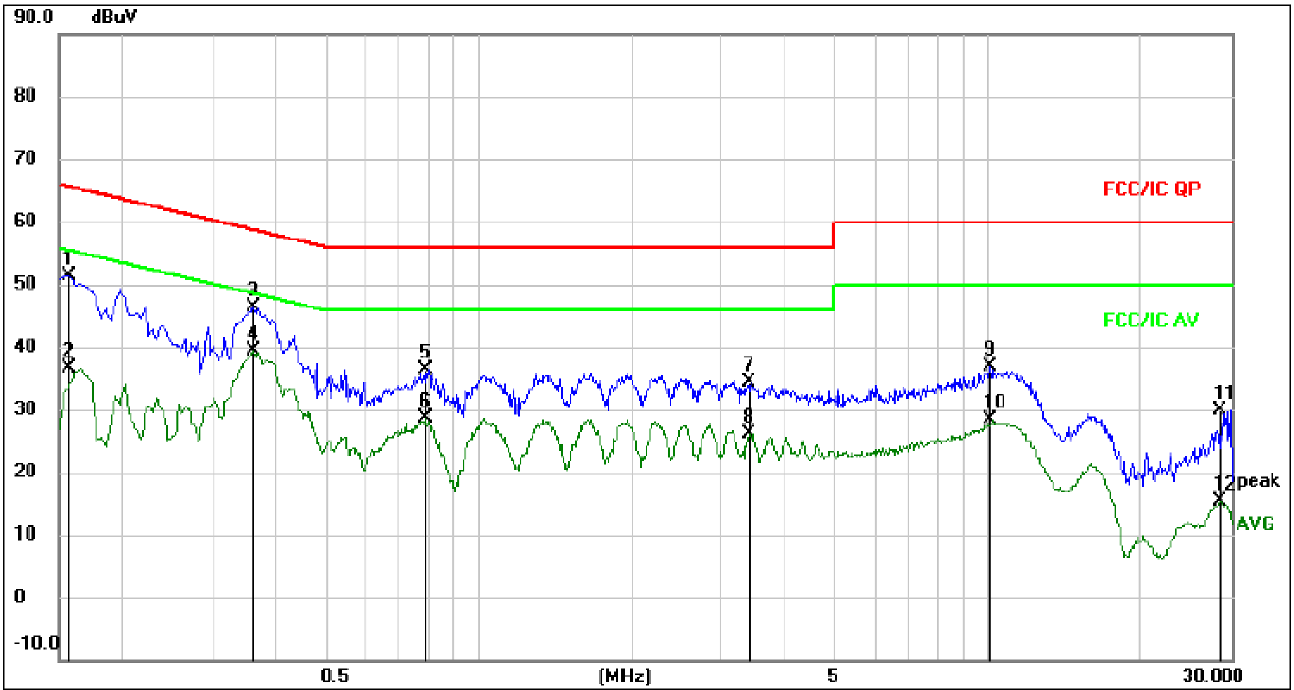
Temperature：	26℃	Relative Humidity：	54%
Pressure：	101kPa	Phase：	L
Test Voltage：	AC 120V/60Hz	Test Mode：	Mode 4



Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	Detector	Comment
		MHz	dBuV		dBuV	dBuV	dB	Detector	Comment
1		0.1500	43.26	9.52	52.78	66.00	-13.22	QP	
2		0.1500	28.29	9.52	37.81	56.00	-18.19	AVG	
3		0.3860	36.41	9.51	45.92	58.15	-12.23	QP	
4	*	0.3860	29.31	9.51	38.82	48.15	-9.33	AVG	
5		1.5859	22.44	9.58	32.02	56.00	-23.98	QP	
6		1.5859	15.40	9.58	24.98	46.00	-21.02	AVG	
7		2.7580	19.78	9.64	29.42	56.00	-26.58	QP	
8		2.7580	11.98	9.64	21.62	46.00	-24.38	AVG	
9		10.5500	18.91	9.69	28.60	60.00	-31.40	QP	
10		10.5500	9.91	9.69	19.60	50.00	-30.40	AVG	
11		24.4860	14.27	9.75	24.02	60.00	-35.98	QP	
12		24.4860	-2.04	9.75	7.71	50.00	-42.29	AVG	

Temperature：	26℃	Relative Humidity:	54%
Pressure：	101kPa	Phase :	N
Test Voltage ：	AC 120V/60Hz	Test Mode：	Mode 4



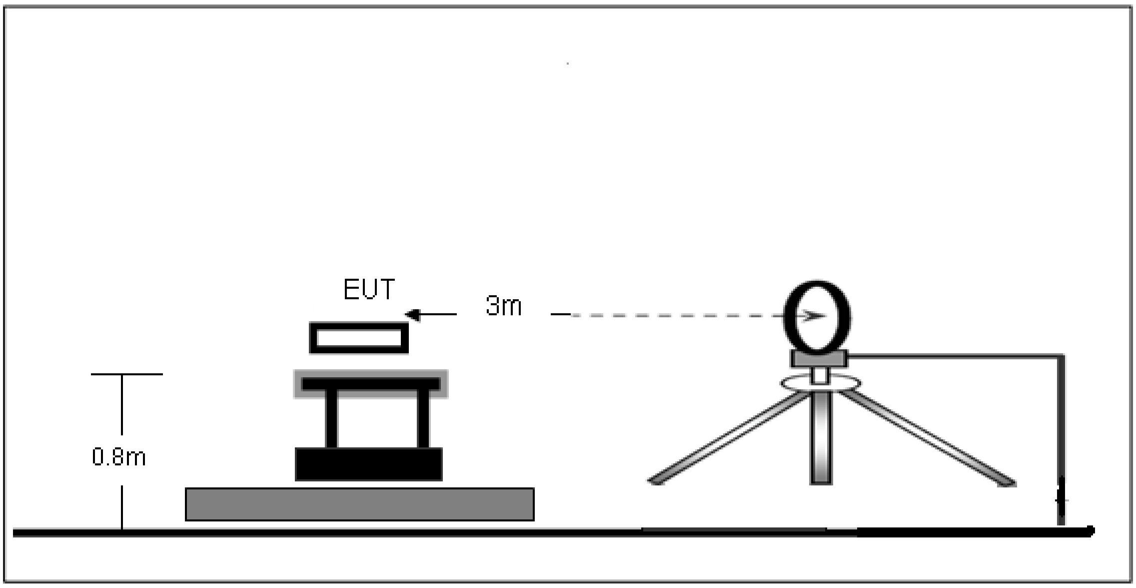
Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	Detector	Comment
		MHz	dBuV		dBuV	dBuV	dB		
1		0.1580	41.85	9.51	51.36	65.57	-14.21	QP	
2		0.1580	27.06	9.51	36.57	55.57	-19.00	AVG	
3		0.3620	36.75	9.53	46.28	58.68	-12.40	QP	
4	*	0.3620	29.75	9.53	39.28	48.68	-9.40	AVG	
5		0.7860	26.63	9.63	36.26	56.00	-19.74	QP	
6		0.7860	18.93	9.63	28.56	46.00	-17.44	AVG	
7		3.3980	24.71	9.69	34.40	56.00	-21.60	QP	
8		3.3980	16.51	9.69	26.20	46.00	-19.80	AVG	
9		10.1100	27.07	9.69	36.76	60.00	-23.24	QP	
10		10.1100	18.70	9.69	28.39	50.00	-21.61	AVG	
11		28.5900	20.13	9.71	29.84	60.00	-30.16	QP	
12		28.5900	5.79	9.71	15.50	50.00	-34.50	AVG	

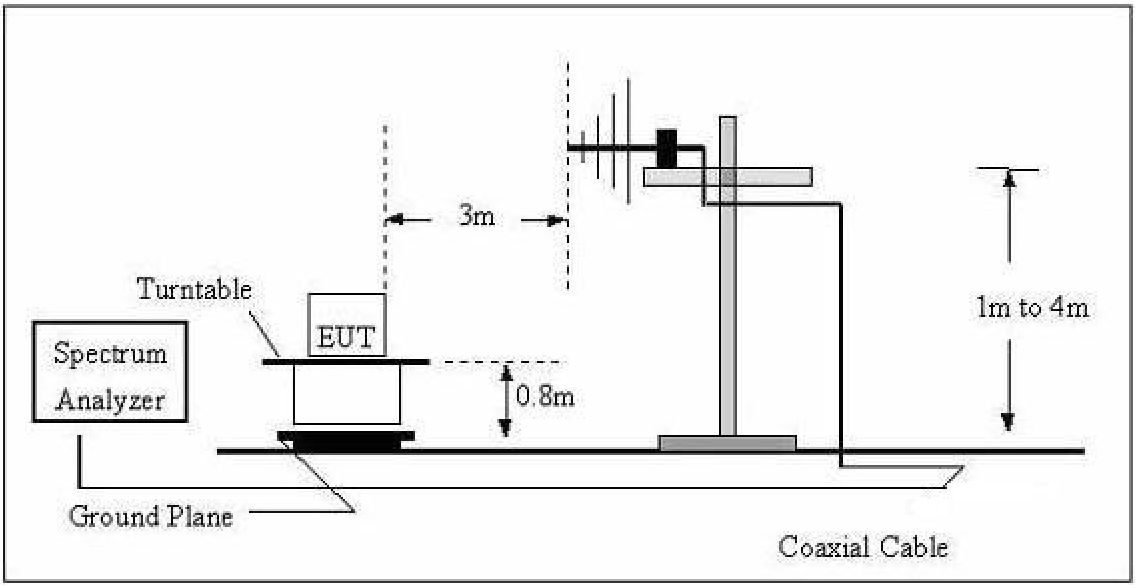
7. RADIATED EMISSIONS

7.1 Block Diagram Of Test Setup

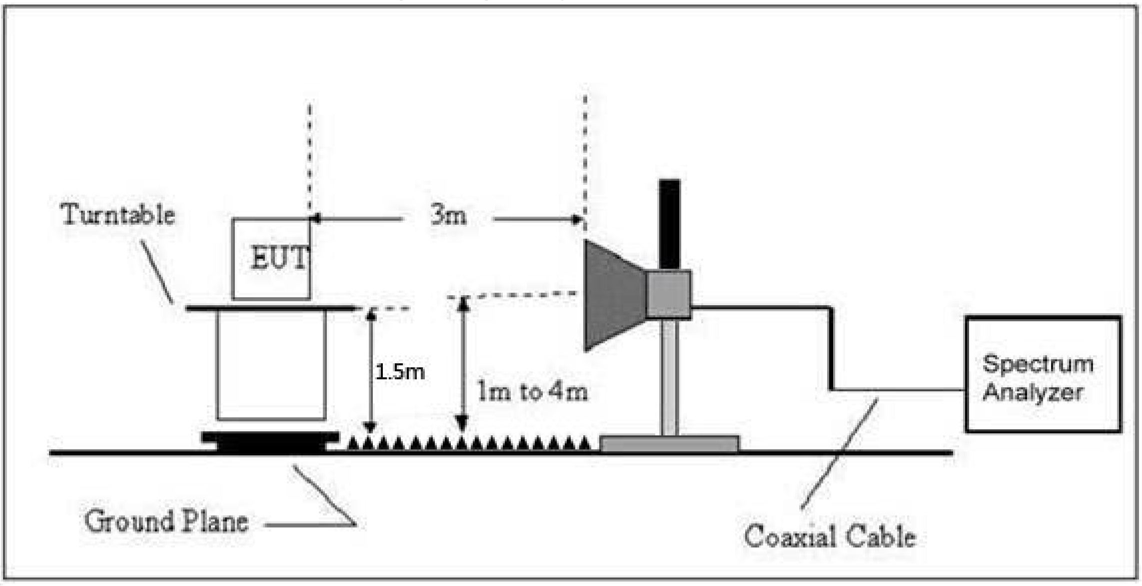
（A）Radiated Emission Test-Up Frequency Below 30MHz



（B）Radiated Emission Test-Up Frequency 30MHz~1GHz



（C）Radiated Emission Test-Up Frequency Above 1GHz



7.2 Limit

20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequency	Field Strength	Distance	Field Strength Limit at 3m Distance	
(MHz)	uV/m	(m)	uV/m	dBuV/m
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	$20\log^{(2400/F(kHz))}$ + 80
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	$20\log^{(24000/F(kHz))}$ + 40
1.705 ~ 30	30	30	100 * 30	$20\log^{(30)}$ + 40
30 ~ 88	100	3	100	$20\log^{(100)}$
88 ~ 216	150	3	150	$20\log^{(150)}$
216 ~ 960	200	3	200	$20\log^{(200)}$
Above 960	500	3	500	$20\log^{(500)}$

7.3 Test procedure

Receiver Parameter	Setting
Attenuation	Auto
9kHz~150kHz	RBW 200Hz for QP
150kHz~30MHz	RBW 9kHz for QP
30MHz~1000MHz	RBW 120kHz for QP

Spectrum Parameter	Setting
1-25GHz	RBW 1 MHz /VBW 1 MHz for Peak, RBW 1 MHz / VBW 10Hz for Average

Below 1GHz test procedure as below:

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. 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.

d. 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 (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Above 1GHz test procedure as below:

g. Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 metre to 1.5 metre(Above 18GHz the distance is 1 meter and table is 1.5 metre).

h. Test the EUT in the lowest channel ,the middle channel ,the Highest channel.

Note:

Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

7.4 Test Result

Between 9KHz – 30MHz

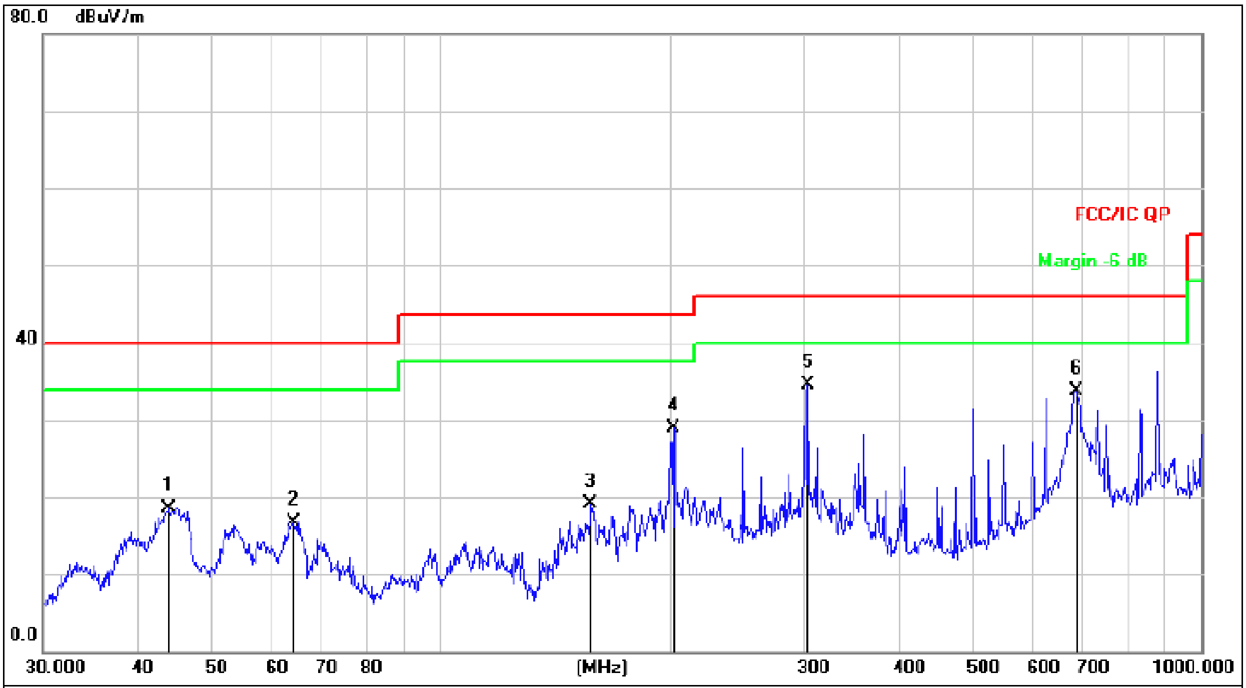
Temperature：	26℃	Relative Humidity：	54%
Pressure：	101 kPa	Test Voltage ：	AC 120V/60Hz
Test Mode ：	Mode 4	Polarization :	--

Freq.	Reading	Limit	Margin	State
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F
--	--	--	--	PASS
--	--	--	--	PASS

Note:
The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Distance extrapolation factor =40 log (specific distance/test distance)(dB);
Limit line = specific limits(dBuv) + distance extrapolation factor.
Test all the modes and only worst case was reported.

Between 30MHz – 1GHz

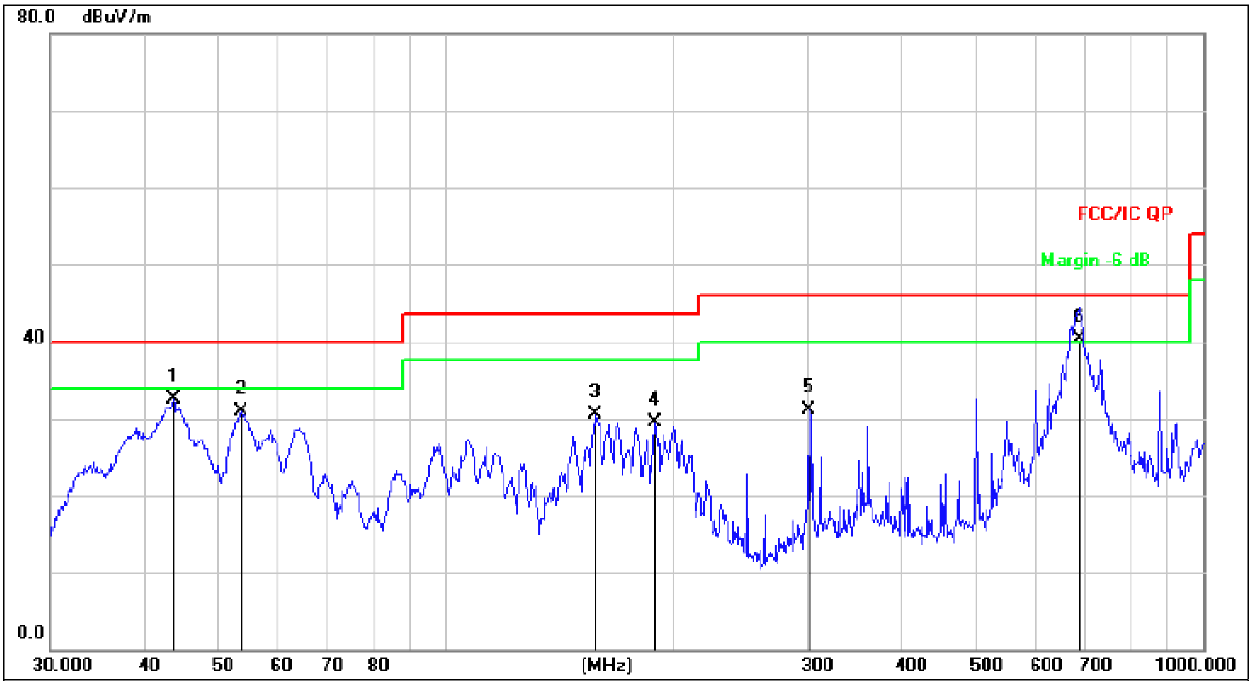
Temperature：	26℃	Relative Humidtity：	54%
Pressure：	101kPa	Test Voltage ：	AC 120V/60Hz
Test Mode ：	Mode 4	Polarization :	Horizontal



Remark:
Factor = Antenna Factor + Cable Loss – Pre-amplifier.

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1		43.9658	32.76	-14.18	18.58	40.00	-21.42	QP
2		63.9828	33.12	-16.39	16.73	40.00	-23.27	QP
3		157.5588	38.14	-19.05	19.09	43.50	-24.41	QP
4		202.8104	45.23	-16.26	28.97	43.50	-14.53	QP
5	*	304.6099	47.93	-13.49	34.44	46.00	-11.56	QP
6		684.7454	39.88	-6.10	33.78	46.00	-12.22	QP

Temperature:	26℃	Relative Humidtity:	54%
Pressure:	101kPa	Test Voltage :	AC 120V/60Hz
Test Mode :	Mode 4	Polarization :	Vertical



Remark:
Factor = Antenna Factor + Cable Loss – Pre-amplifier.

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1		43.6584	46.76	-14.23	32.53	40.00	-7.47	QP
2		53.6932	45.53	-14.56	30.97	40.00	-9.03	QP
3		157.5588	49.60	-19.05	30.55	43.50	-12.95	QP
4		188.4125	46.78	-17.24	29.54	43.50	-13.96	QP
5		301.4224	44.54	-13.46	31.08	46.00	-14.92	QP
6	*	684.7983	46.37	-6.10	40.27	46.00	-5.73	QP

Remark:
Test all the modes and only worst case was reported.

Between 1-25GHz

Polar (H/V)	Frequency	Meter Reading	Pre-amplifier	Cable Loss	Antenna Factor	Emission Level	Limits	Margin	Detector Type
	(MHz)	(dBuV)	(dB)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	
GFSK Low Channel:2402MHz									
V	4804.00	60.98	39.55	7.77	25.66	54.86	74.00	-19.14	Pk
V	4804.00	48.73	39.55	7.77	25.66	42.61	54.00	-11.39	AV
V	7206.00	56.34	38.33	7.3	24.55	49.86	74.00	-24.14	Pk
V	7206.00	44.42	38.33	7.3	24.55	37.94	54.00	-16.06	AV
V	15453.36	52.30	35.23	6.6	26.59	50.26	74.00	-23.74	Pk
H	4804.00	61.23	39.55	7.77	25.66	55.11	74.00	-18.89	Pk
H	4804.00	45.62	39.55	7.77	25.66	39.50	54.00	-14.50	AV
H	7206.00	59.01	38.33	7.3	23.55	51.53	74.00	-22.47	Pk
H	7206.00	48.80	38.33	7.3	23.22	40.99	54.00	-13.01	AV
H	15450.09	51.58	35.45	6.6	27.88	50.61	74.00	-23.39	Pk

Polar (H/V)	Frequency	Meter Reading	Pre-amplifier	Cable Loss	Antenna Factor	Emission Level	Limits	Margin	Detector Type
	(MHz)	(dBuV)	(dB)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	
GFSK Middle Channel:2441MHz									
V	4882.00	61.60	38.89	7.57	25.45	55.73	74.00	-18.27	Pk
V	4882.00	48.70	38.89	7.57	25.45	42.83	54.00	-11.17	AV
V	7323.00	55.09	38.78	7.35	24.78	48.44	74.00	-25.56	Pk
V	7323.00	45.68	38.78	7.35	24.78	39.03	54.00	-14.97	AV
V	15454.70	51.49	35.89	6.42	26.47	48.49	74.00	-25.51	Pk
H	4882.00	61.14	38.89	7.57	25.45	55.27	74.00	-18.73	Pk
H	4882.00	46.59	38.89	7.57	25.45	40.72	54.00	-13.28	AV
H	7323.00	59.06	38.78	7.35	24.78	52.41	74.00	-21.59	Pk
H	7323.00	48.06	38.78	7.35	24.78	41.41	54.00	-12.59	AV
H	15453.96	50.87	36.68	6.42	26.65	47.26	74.00	-26.74	Pk

Polar (H/V)	Frequency	Meter Reading	Pre-amplifier	Cable Loss	Antenna Factor	Emission Level	Limits	Margin	Detector Type
	(MHz)	(dBuV)	(dB)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	
GFSK High Channel:2480MHz									
V	4960.00	61.01	38.75	7.46	25.45	55.17	74.00	-18.83	Pk
V	4960.00	47.60	38.75	7.46	25.45	41.76	54.00	-12.24	AV
V	7440.00	53.93	38.65	7.22	24.78	47.28	74.00	-26.72	Pk
V	7440.00	45.48	38.65	7.22	24.78	38.83	54.00	-15.17	AV
V	15457.71	53.02	35.58	6.35	26.47	50.26	74.00	-23.74	Pk
H	4960.00	60.34	38.75	7.46	25.45	54.50	74.00	-19.50	Pk
H	4960.00	48.15	38.75	7.46	25.45	42.31	54.00	-11.69	AV
H	7440.00	59.67	38.65	7.22	24.78	53.02	74.00	-20.98	Pk
H	7440.00	47.32	38.65	7.22	24.78	40.67	54.00	-13.33	AV
H	15457.01	50.80	36.42	6.32	26.65	47.35	74.00	-26.65	Pk

Remark:

1. Emission Level = Meter Reading + Antenna Factor + Cable Loss – Pre-amplifier,
   Margin= Emission Level - Limit
2. If peak below the average limit, the average emission was no test.
3. The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
4. All the Modulation are test, the worst mode is GFSK, the data recording in the report.

7.5 RADIATED Band EMISSION MEASUREMENT

Test Requirement:

FCC Part15 C Section 15.209 and 15.205

LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

FREQUENCY (MHz)	Limit (dBuV/m) (at 3M)	
	PEAK	AVERAGE
Above 1000	74	54

Notes:

(1) The limit for radiated test was performed according to FCC PART 15C.

(2) The tighter limit applies at the band edges.

(3) Emission level (dBuV/m)=20log Emission level (uV/m).

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	2300MHz
Stop Frequency	2520
RB / VB (emission in restricted band)	1 MHz / 1 MHz for Peak, 1 MHz / 10Hz for Average

TEST PROCEDURE

Above 1GHz test procedure as below:

a. 1. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. 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.

d. 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 rota table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. Test the EUT in the lowest channel,the Highest channel

Note:

Both horizontal and vertical antenna polarities were tested

and performed pretest to three orthogonal axis. The worst case emissions were reported

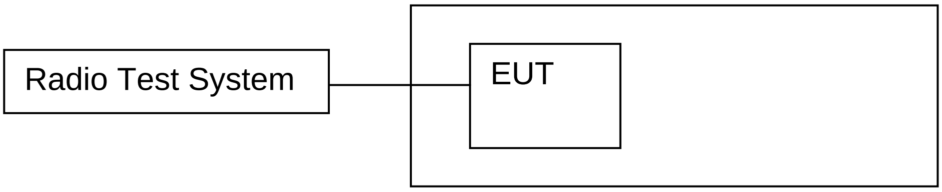
TEST RESULT

	Polar (H/V)	Frequency (MHz)	Meter Reading (dBuV)	Pre-amplifier (dB)	Cable Loss (dB)	Antenna Factor (dB/m)	Emission evel (dBuV/m)	Limits (dBuV/m)		Result
							PK	PK	AV	
GFSK	Low Channel 2402MHz									
	H	2390.00	56.69	38.06	7.42	20.15	46.20	74.00	54.00	PASS
	H	2400.00	60.12	38.06	7.42	20.15	49.63	74.00	54.00	PASS
	V	2390.00	56.78	38.06	7.42	20.15	46.29	74.00	54.00	PASS
	V	2400.00	57.10	38.06	7.42	20.15	46.61	74.00	54.00	PASS
	High Channel 2480MHz									
	H	2483.50	54.02	38.17	7.45	20.54	43.84	74.00	54.00	PASS
	H	2485.50	59.07	38.17	7.45	20.54	48.89	74.00	54.00	PASS
	V	2483.50	61.77	38.2	7.45	20.54	51.56	74.00	54.00	PASS
	V	2485.50	59.10	38.2	7.45	20.54	48.89	74.00	54.00	PASS
Pi/4DQPSK	Low Channel 2402MHz									
	H	2390.00	55.97	38.06	7.42	20.15	45.48	74.00	54.00	PASS
	H	2400.00	59.33	38.06	7.42	20.15	48.84	74.00	54.00	PASS
	V	2390.00	61.71	38.06	7.42	20.15	51.22	74.00	54.00	PASS
	V	2400.00	59.41	38.06	7.42	20.15	48.92	74.00	54.00	PASS
	High Channel 2480MHz									
	H	2483.50	56.67	38.17	7.45	20.54	46.49	74.00	54.00	PASS
	H	2485.50	57.54	38.17	7.45	20.54	47.36	74.00	54.00	PASS
	V	2483.50	59.65	38.2	7.45	20.54	49.44	74.00	54.00	PASS
	V	2485.50	58.70	38.2	7.45	20.54	48.49	74.00	54.00	PASS
8DPSK	Low Channel 2402MHz									
	H	2390.00	55.57	38.06	7.42	20.15	45.08	74.00	54.00	PASS
	H	2400.00	60.28	38.06	7.42	20.15	49.79	74.00	54.00	PASS
	V	2390.00	62.01	38.06	7.42	20.15	51.52	74.00	54.00	PASS
	V	2400.00	59.00	38.06	7.42	20.15	48.51	74.00	54.00	PASS
	High Channel 2480MHz									
	H	2483.50	55.89	38.17	7.45	20.54	45.71	74.00	54.00	PASS
	H	2485.50	59.48	38.17	7.45	20.54	49.30	74.00	54.00	PASS
	V	2483.50	61.01	38.2	7.45	20.54	50.80	74.00	54.00	PASS
	V	2485.50	57.20	38.2	7.45	20.54	46.99	74.00	54.00	PASS

Remark:
1. Emission Level = Meter Reading + Antenna Factor + Cable Loss – Pre-amplifier, Margin= Emission Level - Limit
2. If the PK measured levels comply with average limit, then the average level were deemed to comply with average limit.

8. CONDUCTED EMISSION

8.1 Block Diagram Of Test Setup



8.2 Limit

Regulation 15.247 (d),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)).

8.3 Test procedure

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

2. Set the spectrum analyzer:

Blow 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

Detector function = peak, Trace = max hold

Above 30MHz:

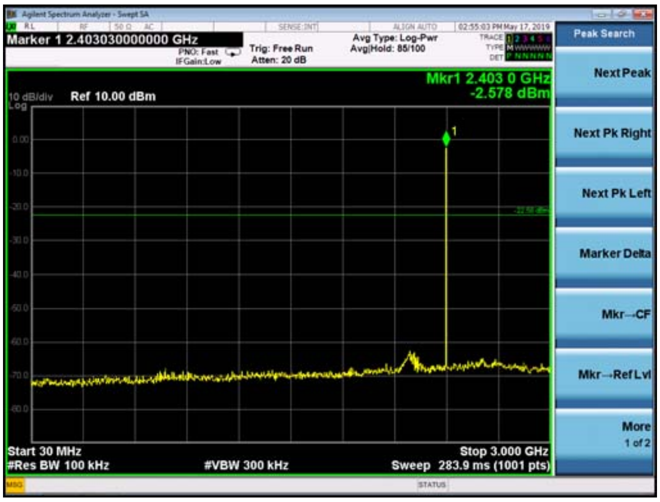
RBW = 100KHz, VBW = 300KHz, Sweep = auto

Detector function = peak, Trace = max hold

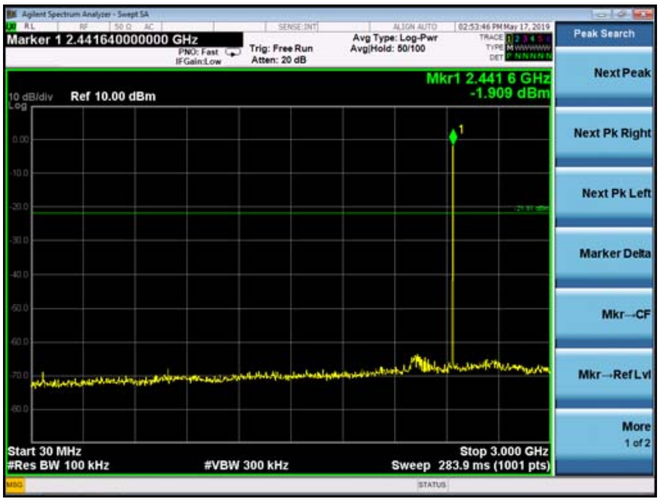
8.4 Test Result

30MHz – 25GHz

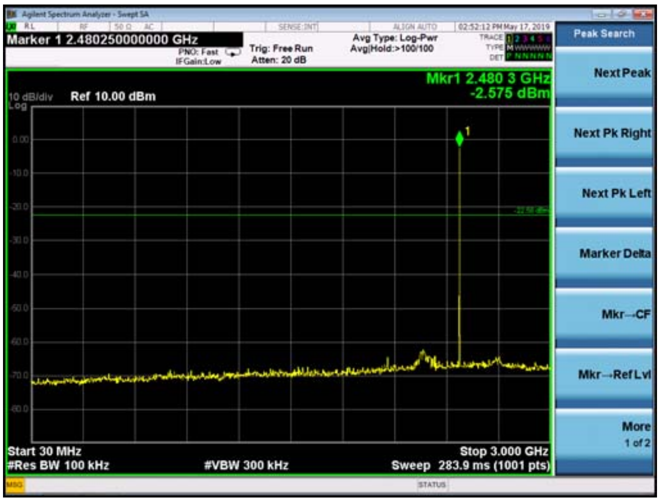
GFSK Low Channel



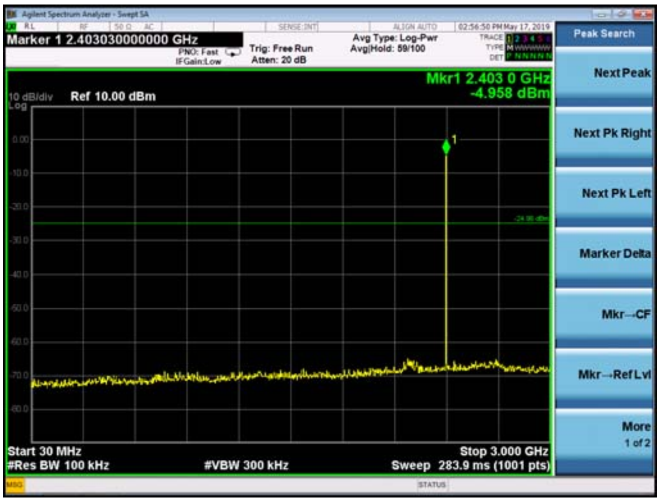
GFSK Middle Channel



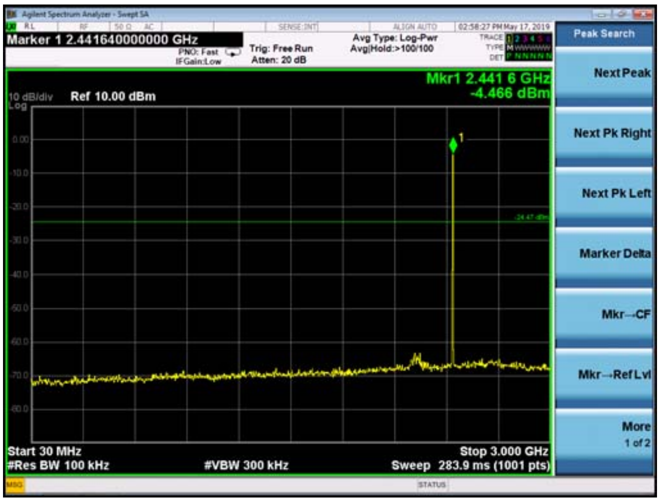
GFSK High Channel



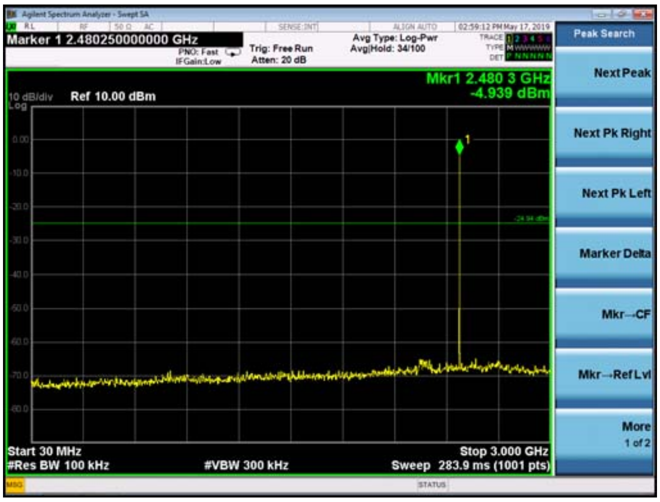
Pi/4 DQPSK Low Channel



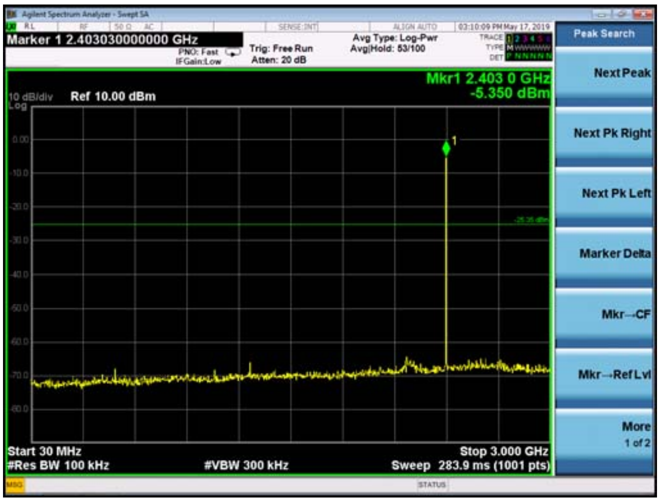
Pi/4 DQPSK Middle Channel



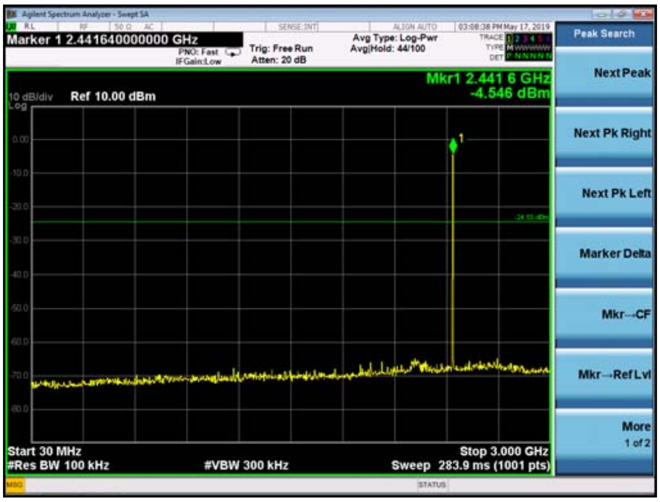
Pi/4 DQPSK High Channel



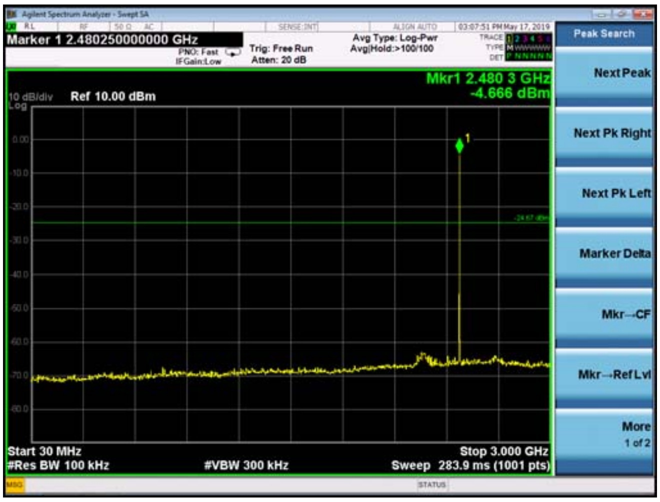
8DPSK Low Channel



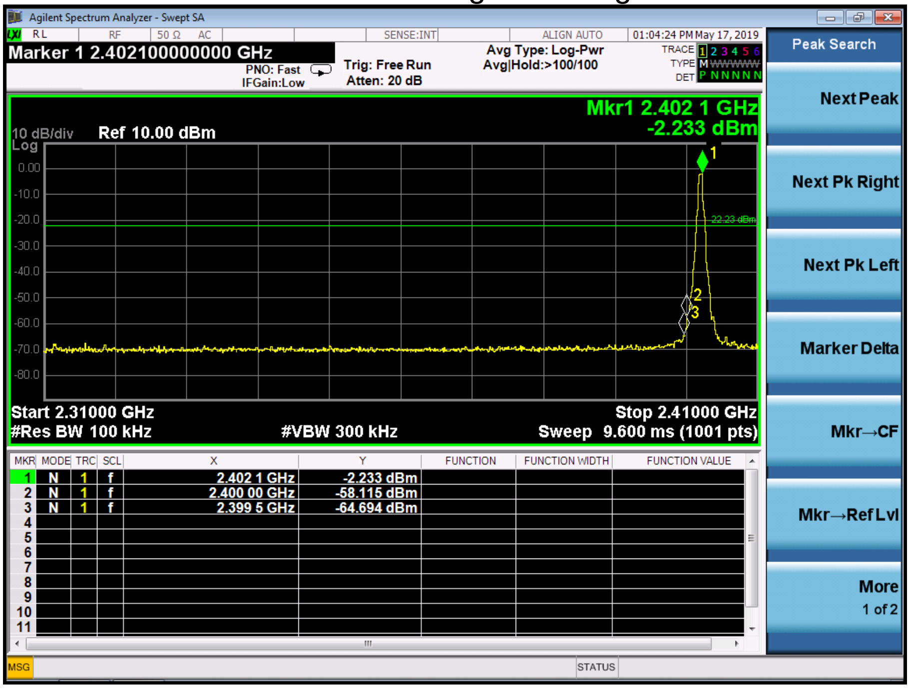
8DPSK Middle Channel



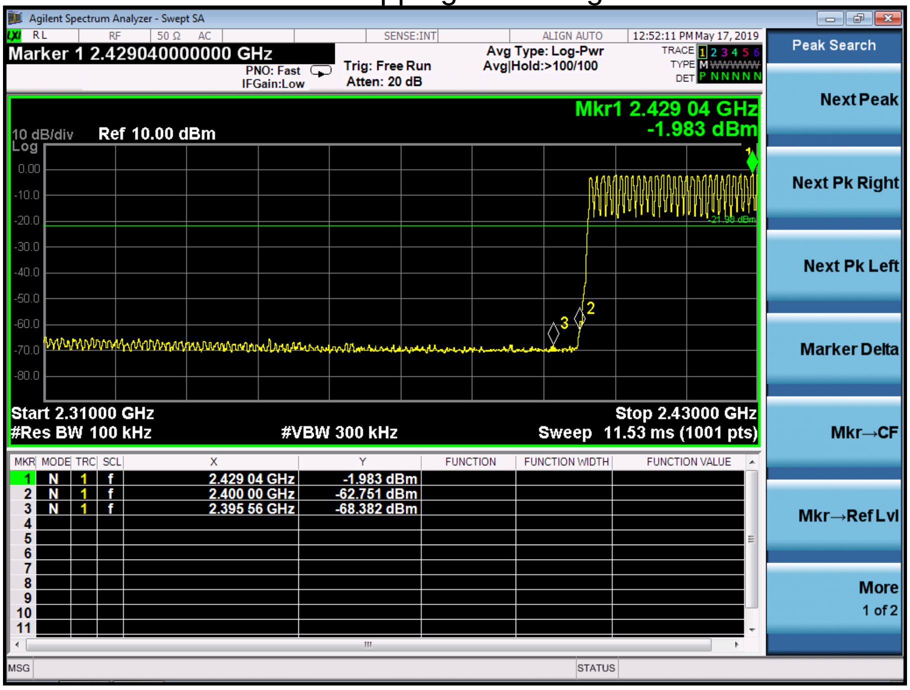
8DPSK High Channel



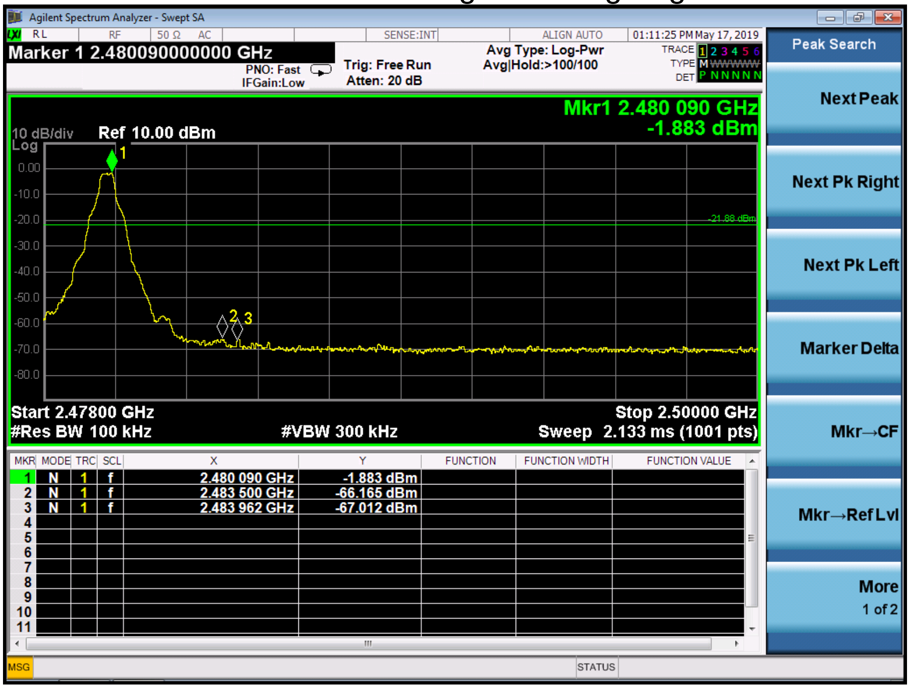
GFSK Transmitting Band edge-left side



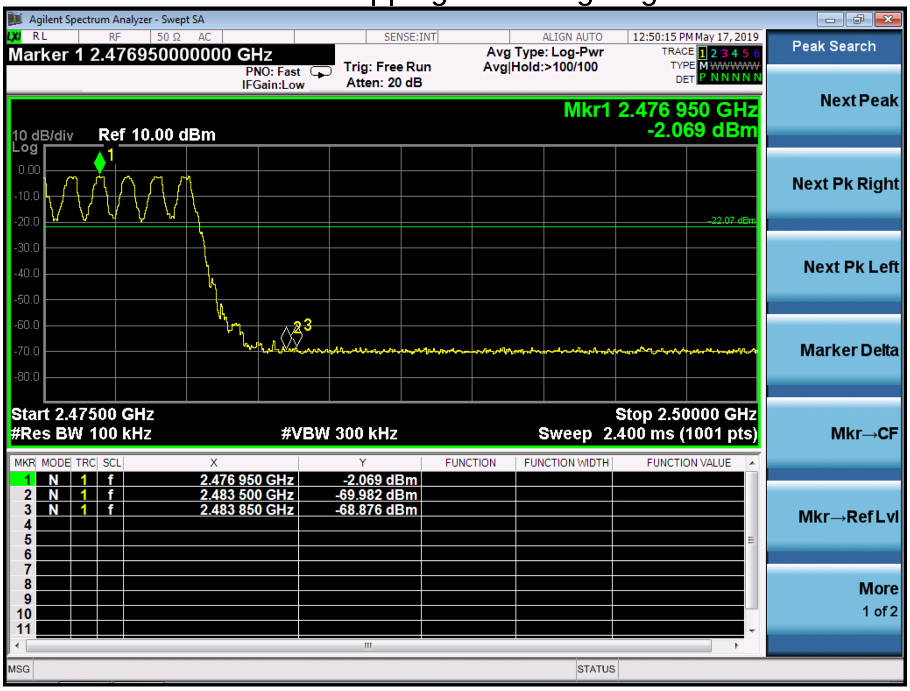
GFSK Hopping Band edge-left side



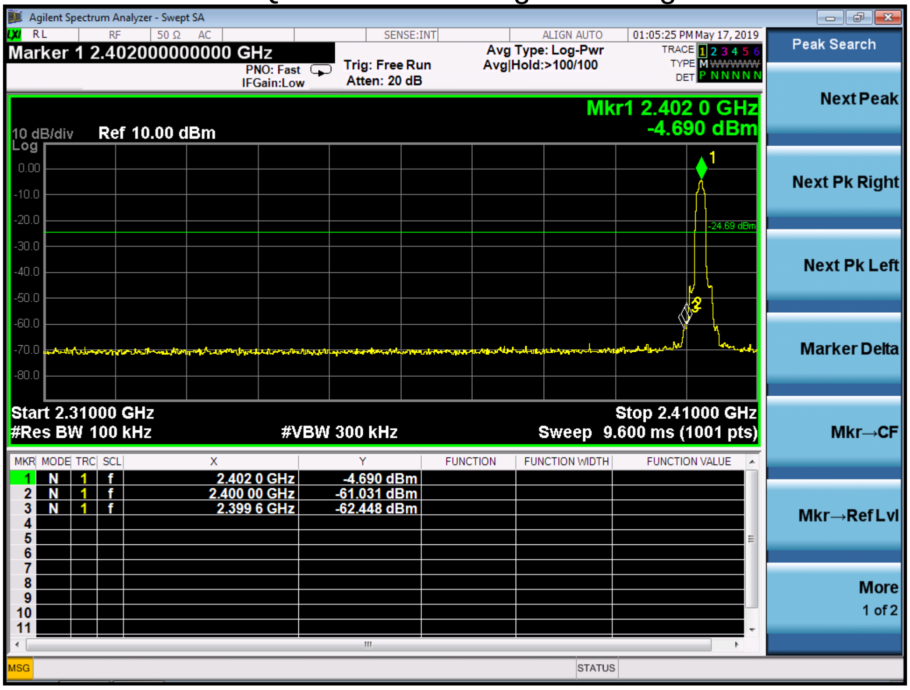
GFSK Transmitting Band edge-right side



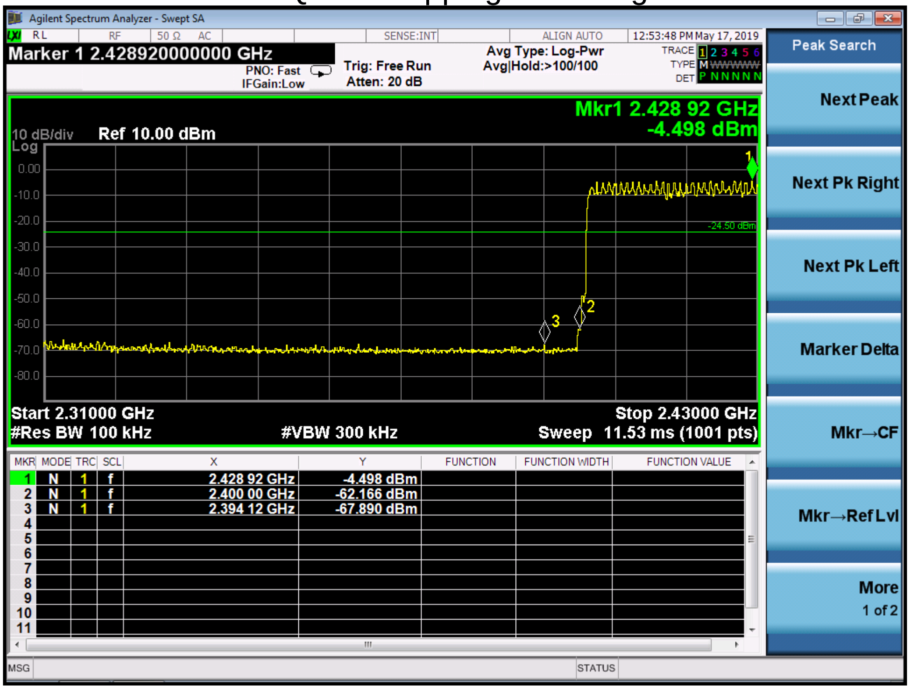
GFSK Hopping Band edge-right side



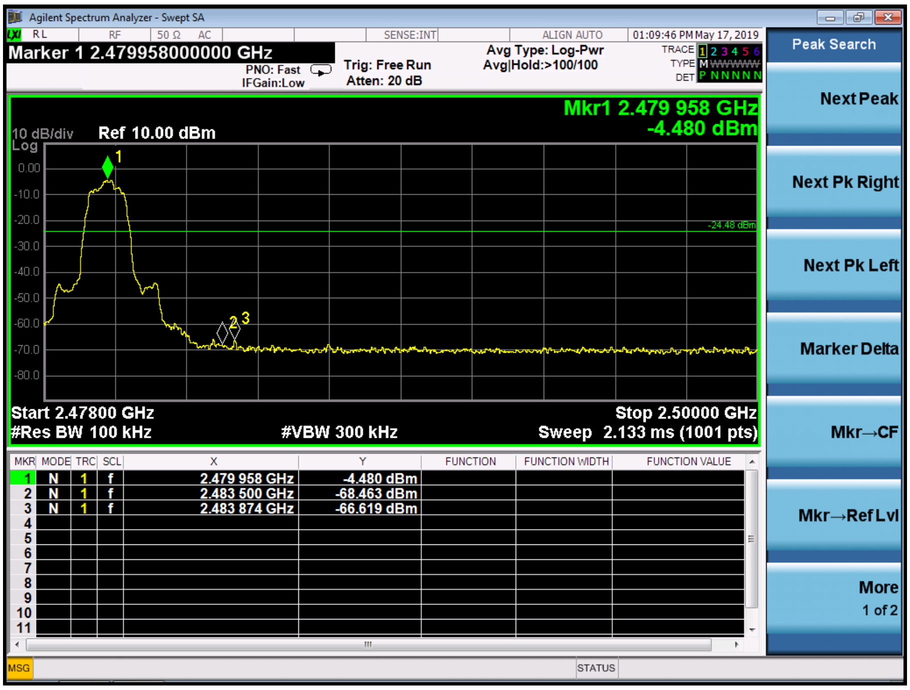
Pi/4 DQPSK Transmitting Band edge-left side



Pi/4 DQPSK Hopping Band edge-left side

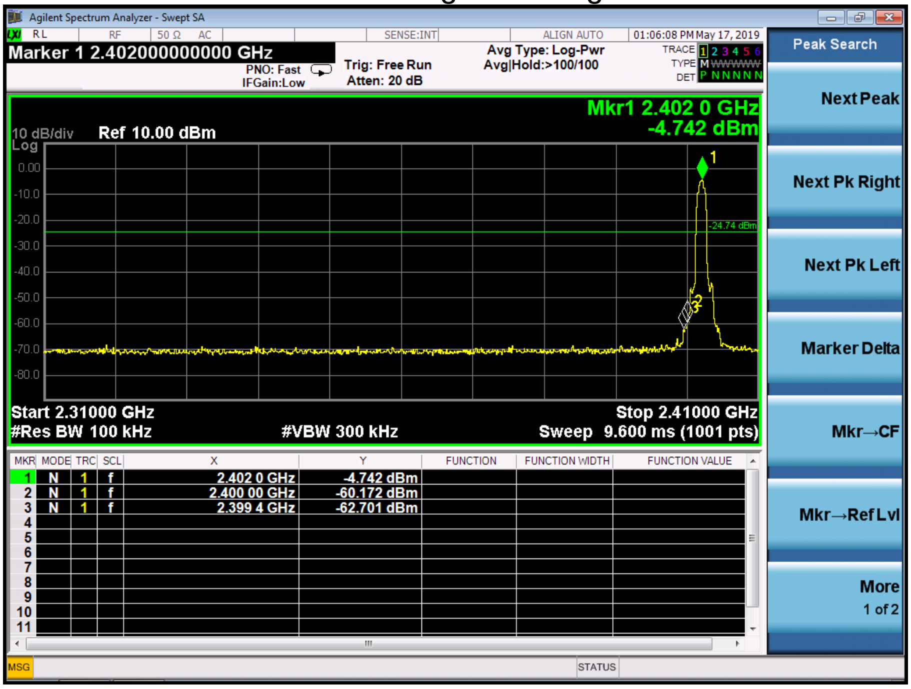


Pi/4 DQPSK Transmitting Band edge-right side

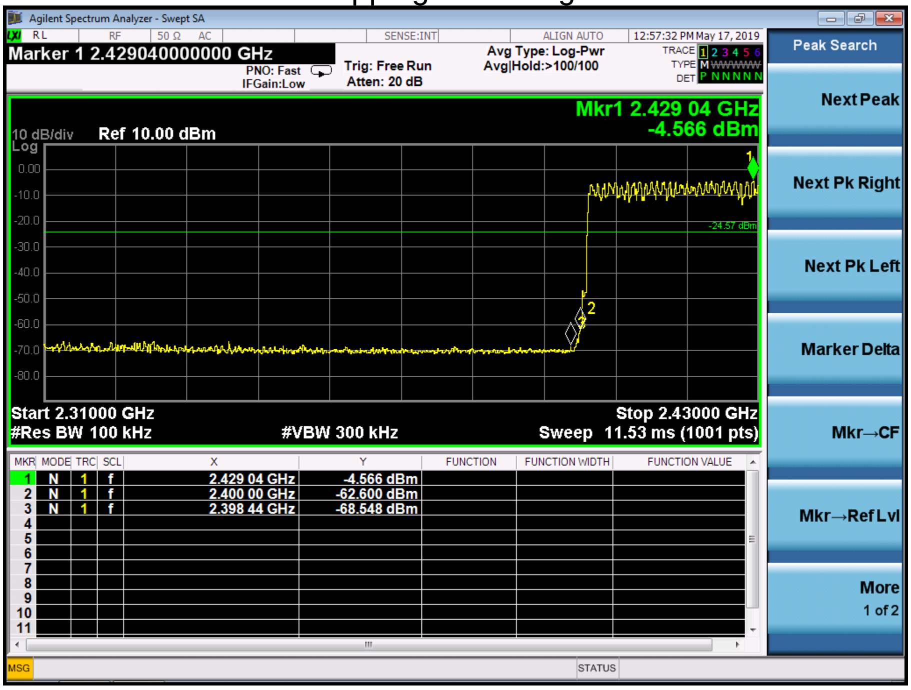


Pi/4 DQPSK Hopping Band edge-right side

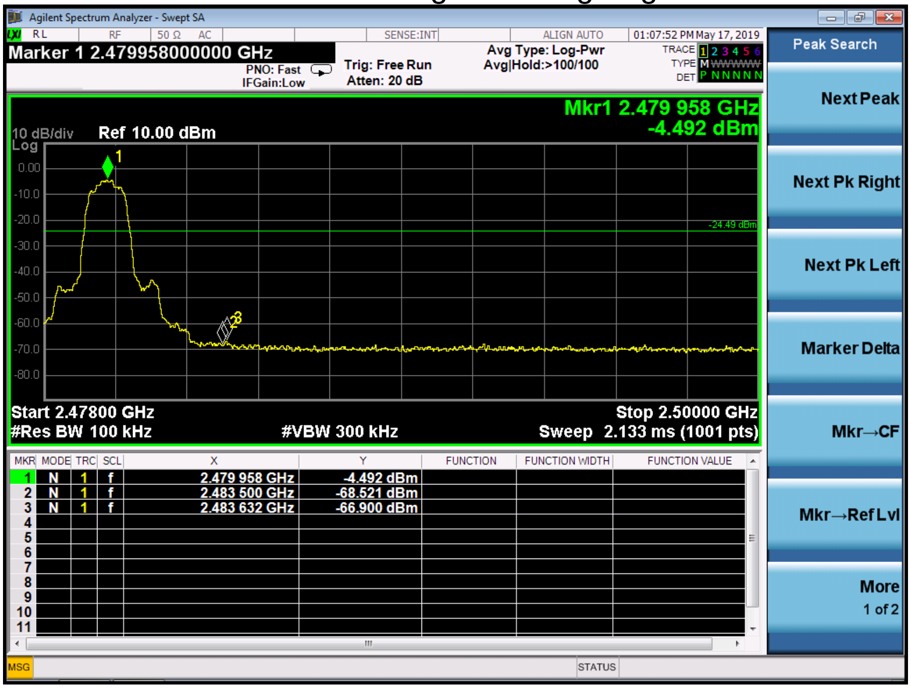
8DPSK Transmitting Band edge-left side



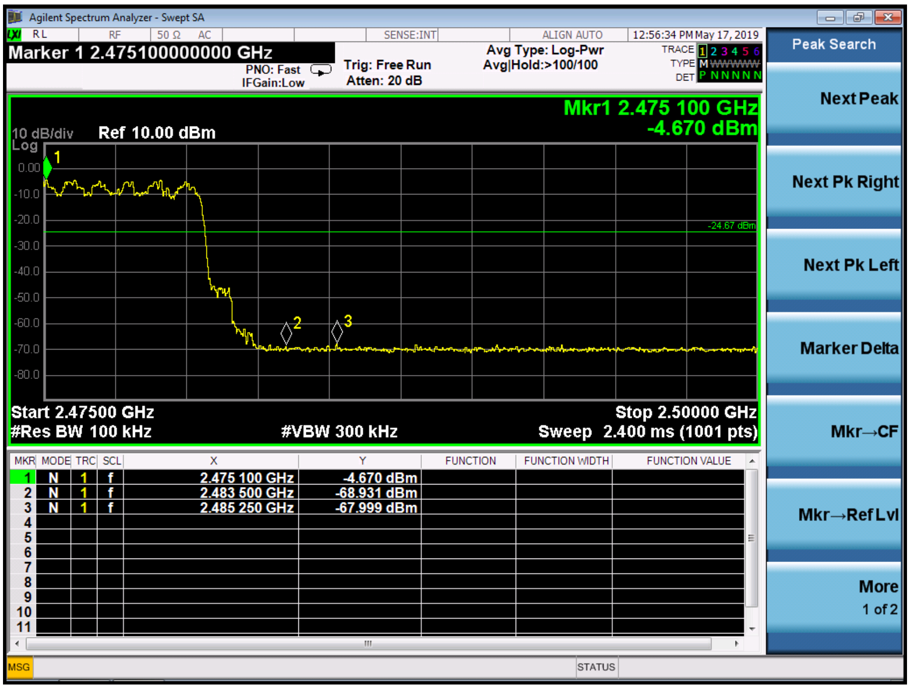
8DPSK Hopping Band edge-left side



8DPSK Transmitting Band edge-right side

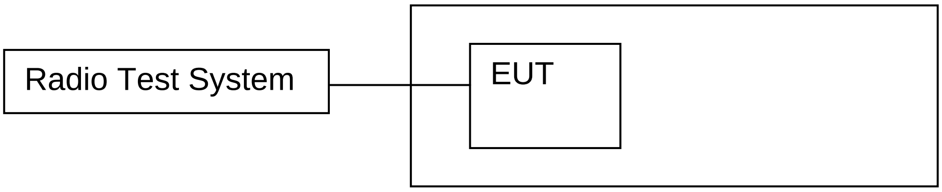


8DPSK Hopping Band edge-right side



9. 20 DB BANDWIDTH

9.1 Block Diagram Of Test Setup



9.2 Limit

N/A

9.3 Test procedure

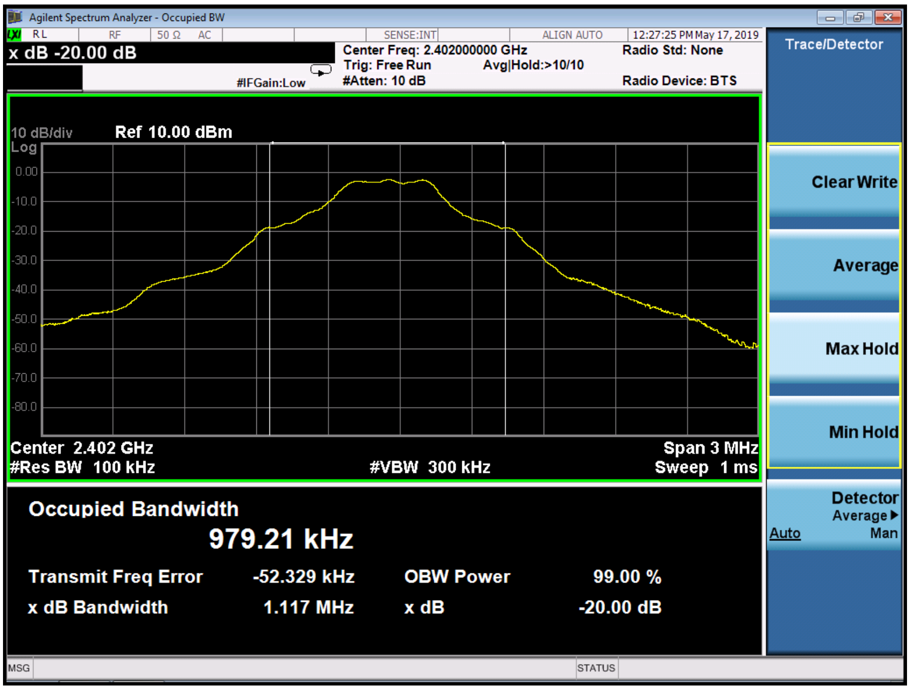
1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

9.4 Test Result

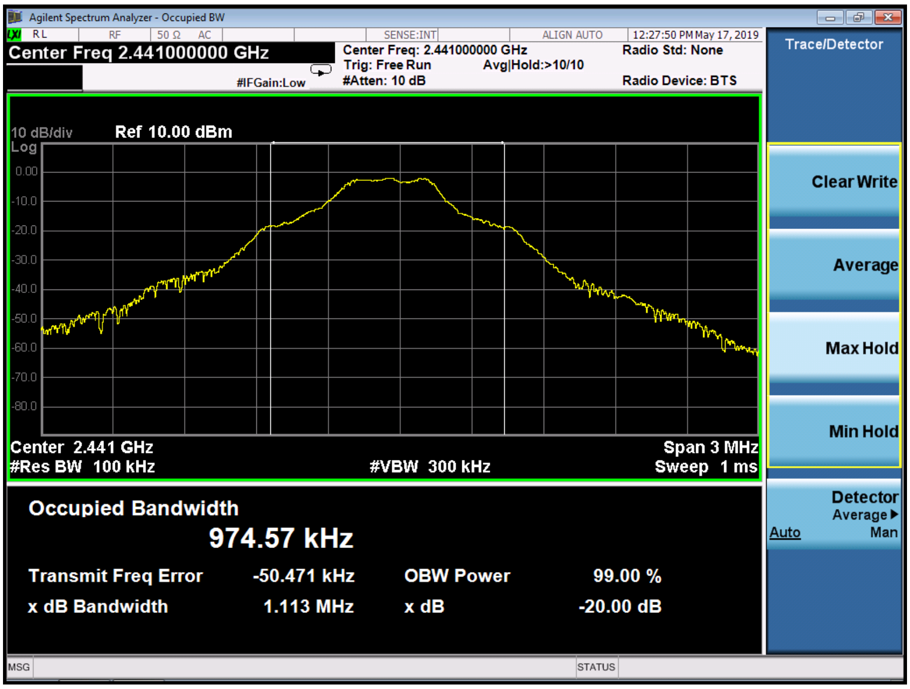
Modulation	Test Channel	Bandwidth(MHz)
GFSK	Low	1.177
GFSK	Middle	1.113
GFSK	High	1.113
Pi/4 DQPSK	Low	1.401
Pi/4 DQPSK	Middle	1.403
Pi/4 DQPSK	High	1.404
8DPSK	Low	1.372
8DPSK	Middle	1.371
8DPSK	High	1.366

Test plots

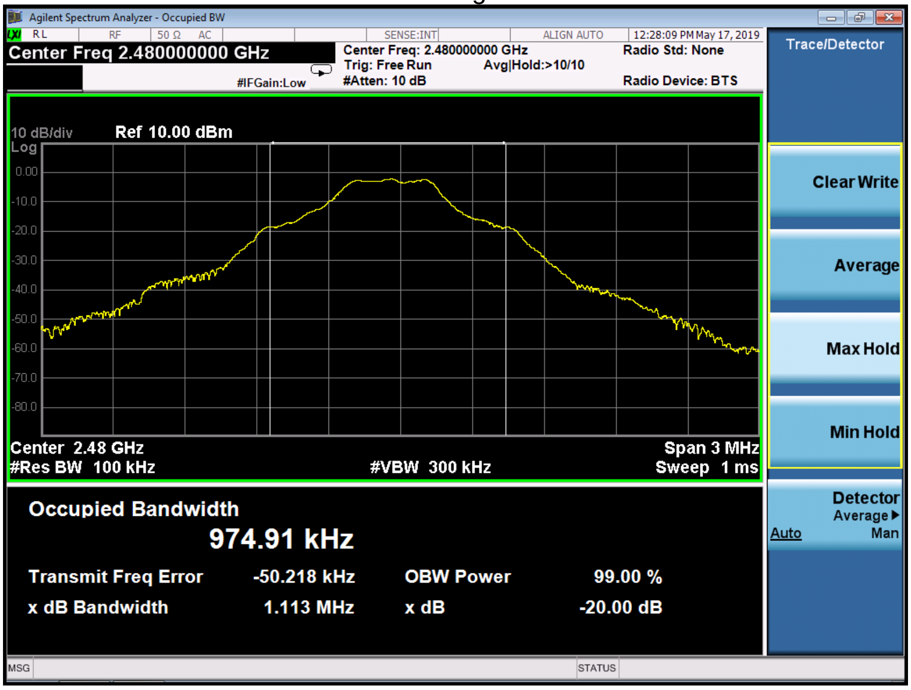
GFSK Low Channel



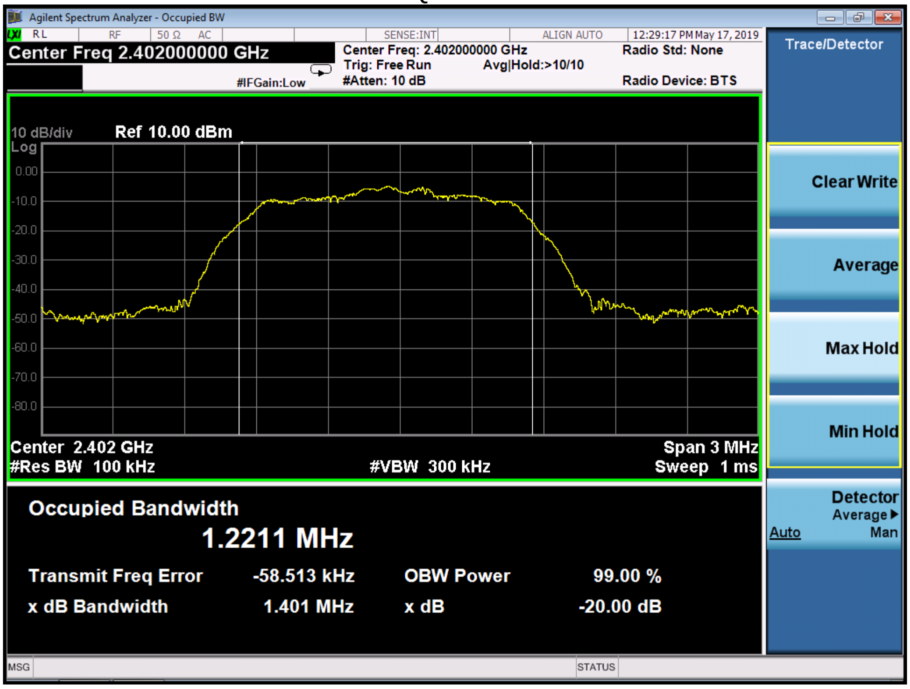
GFSK Middle Channel



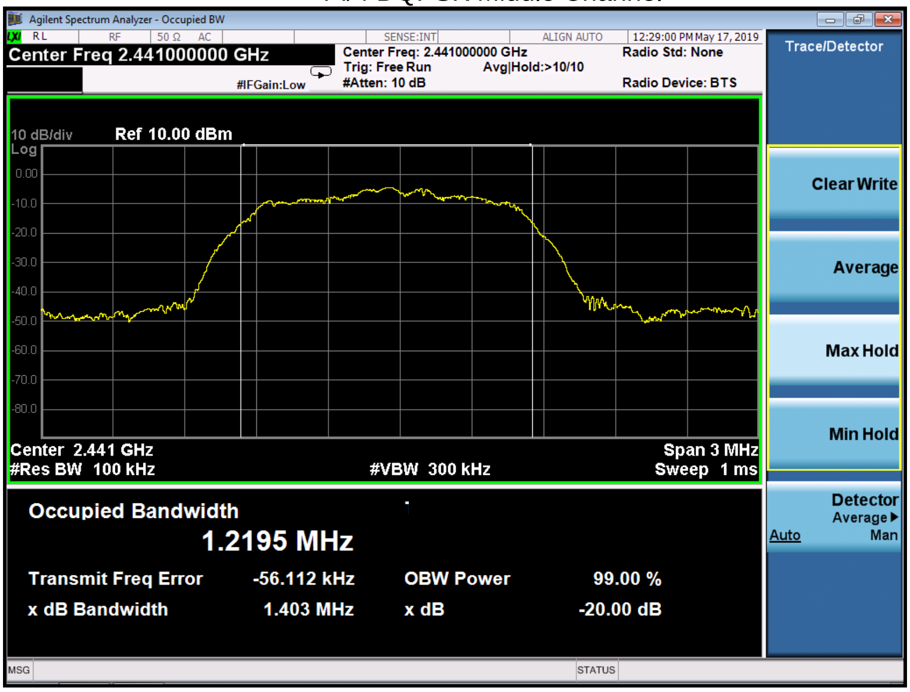
GFSK High Channel



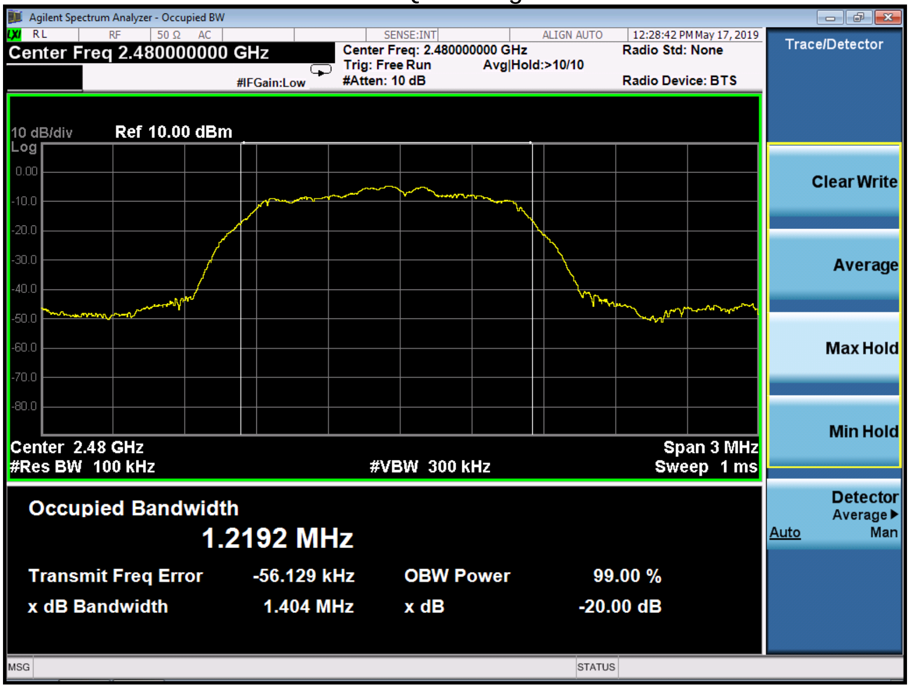
Pi/4 DQPSK Low Channel



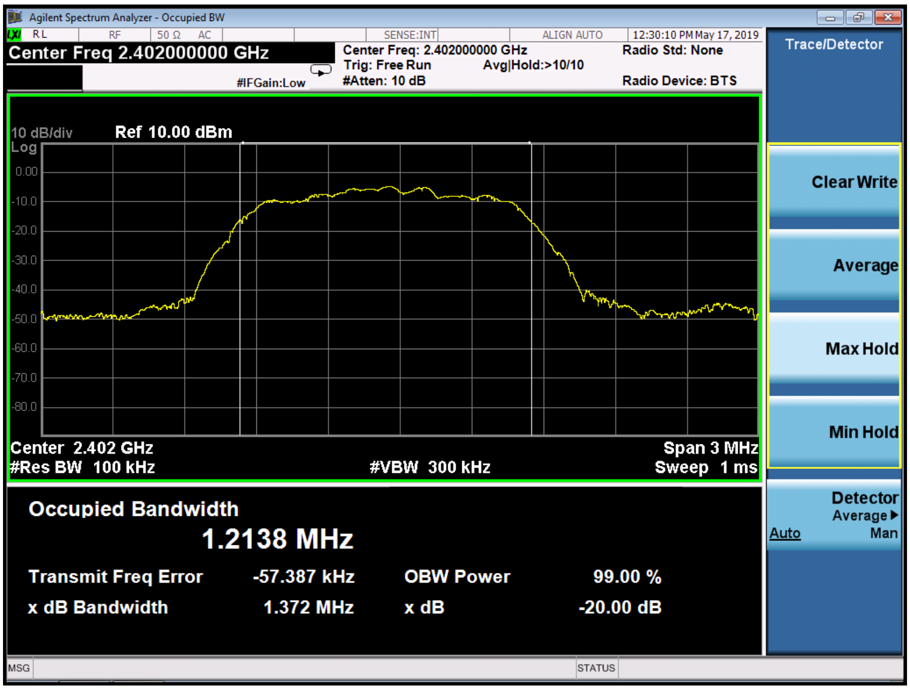
Pi/4 DQPSK Middle Channel



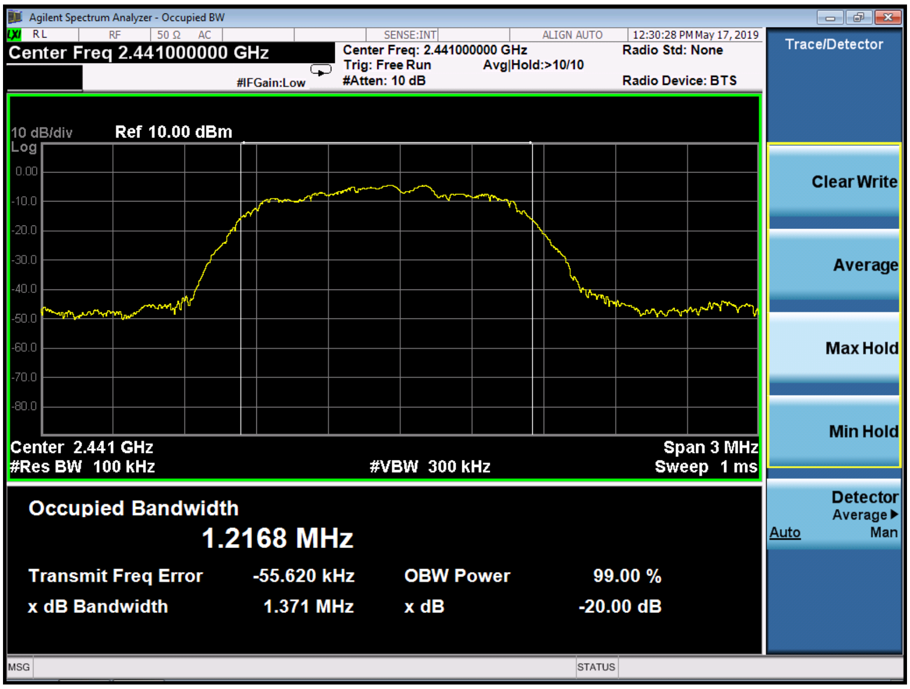
Pi/4 DQPSK High Channel



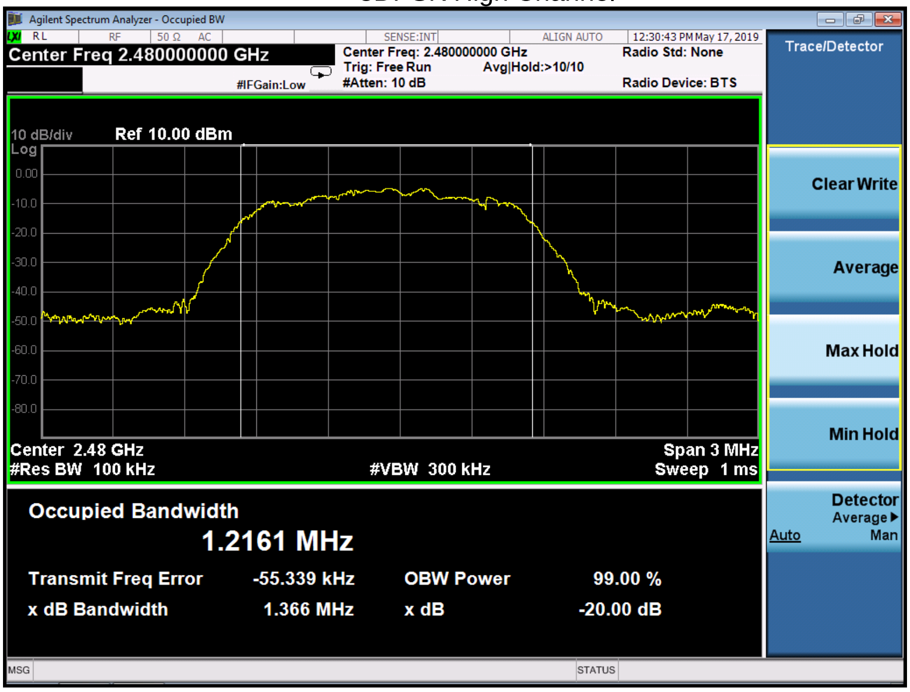
8DPSK Low Channel



8DPSK Middle Channel

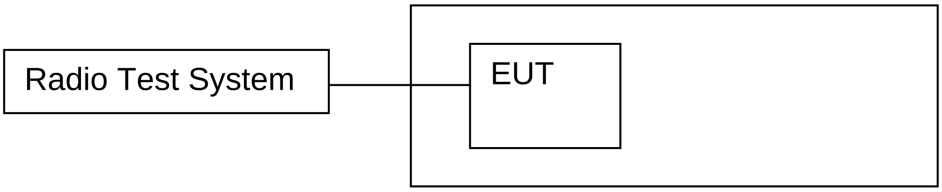


8DPSK High Channel



10. MAXIMUM PEAK OUTPUT POWER

10.1 Block Diagram Of Test Setup



10.2 Limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

10.3 Test procedure

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

2. Set the spectrum analyzer: RBW = 3MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.

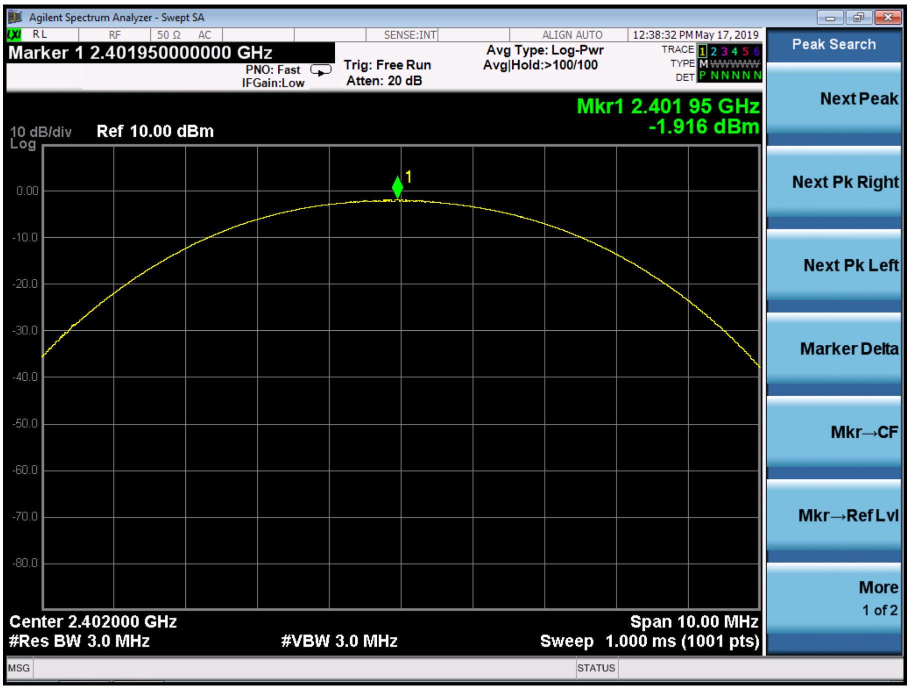
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

10.4 Test Result

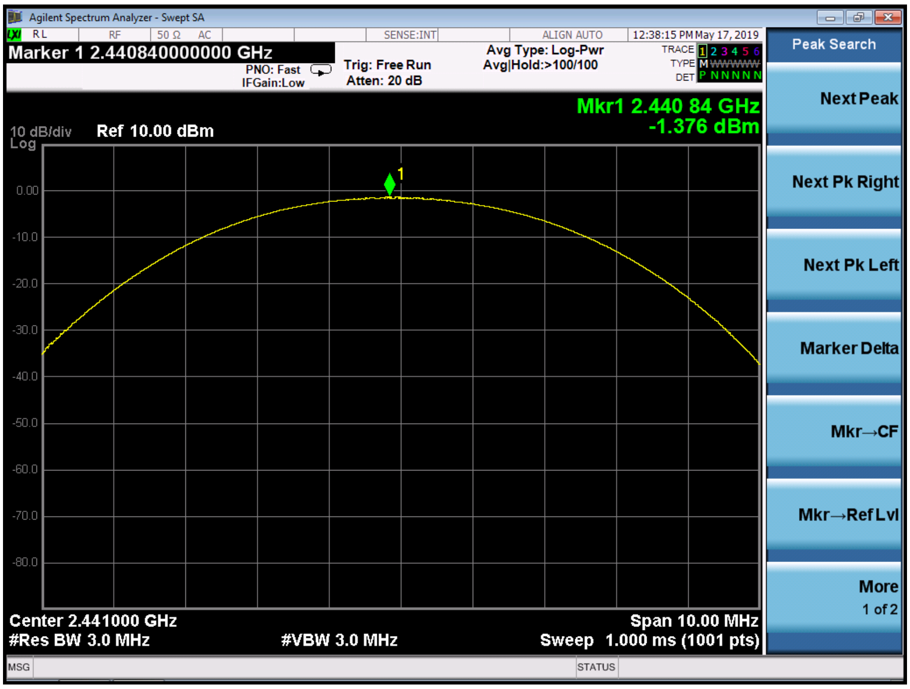
Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Low	-1.92	21
GFSK	Middle	-1.38	21
GFSK	High	-1.55	21
Pi/4 DQPSK	Low	-2.32	21
Pi/4 DQPSK	Middle	-1.80	21
Pi/4 DQPSK	High	-2.03	21
8DPSK	Low	-1.84	21
8DPSK	Middle	-1.35	21
8DPSK	High	-1.52	21

Test plots

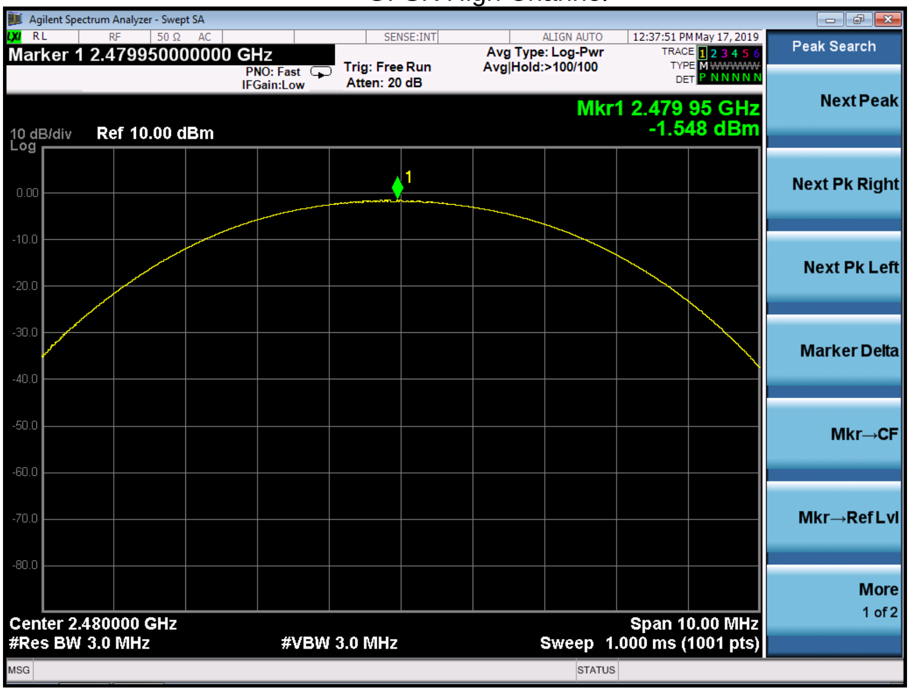
GFSK Low Channel



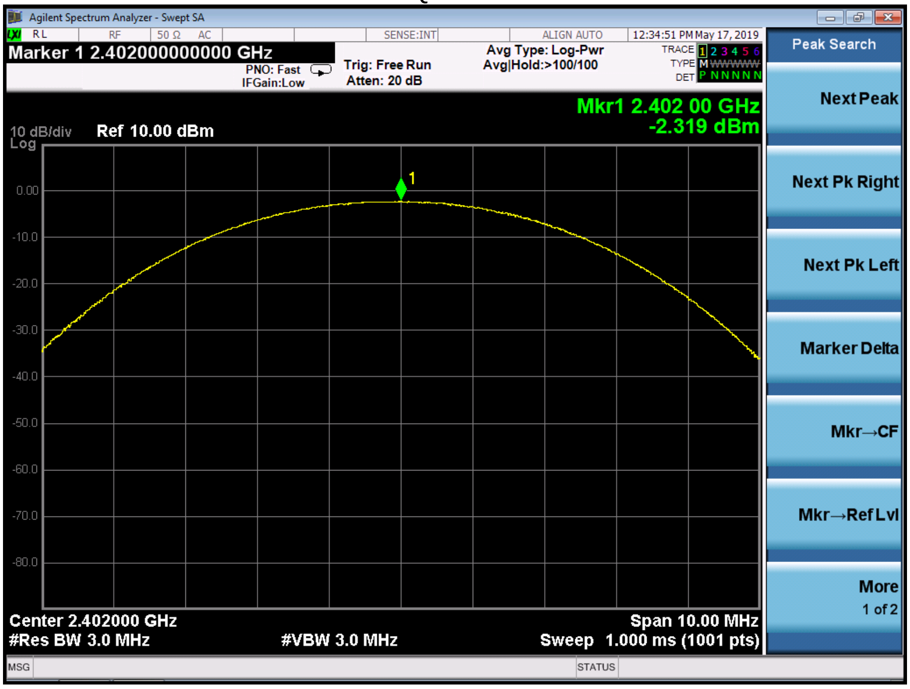
GFSK Middle Channel



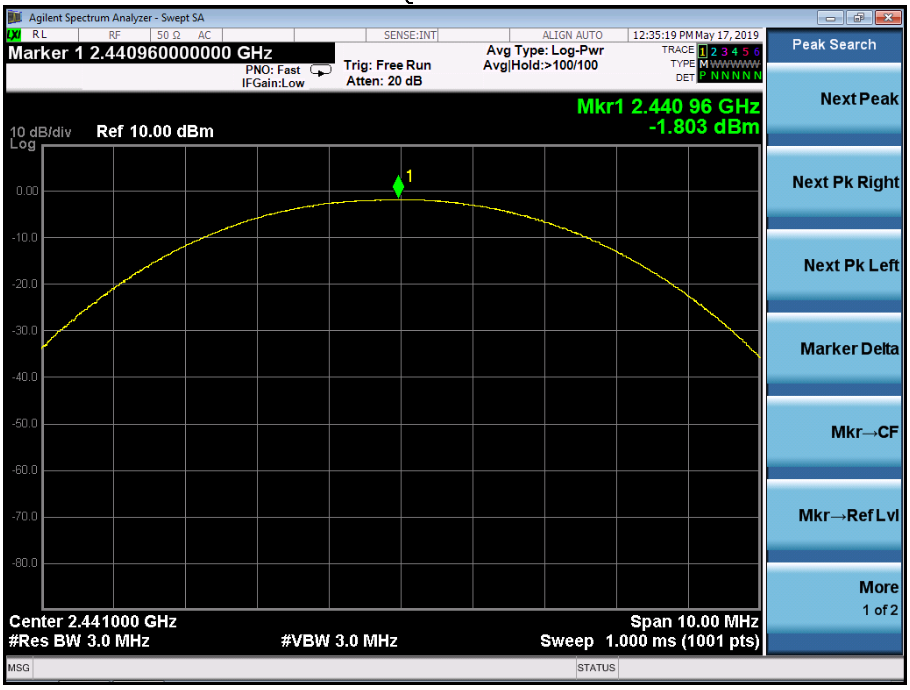
GFSK High Channel



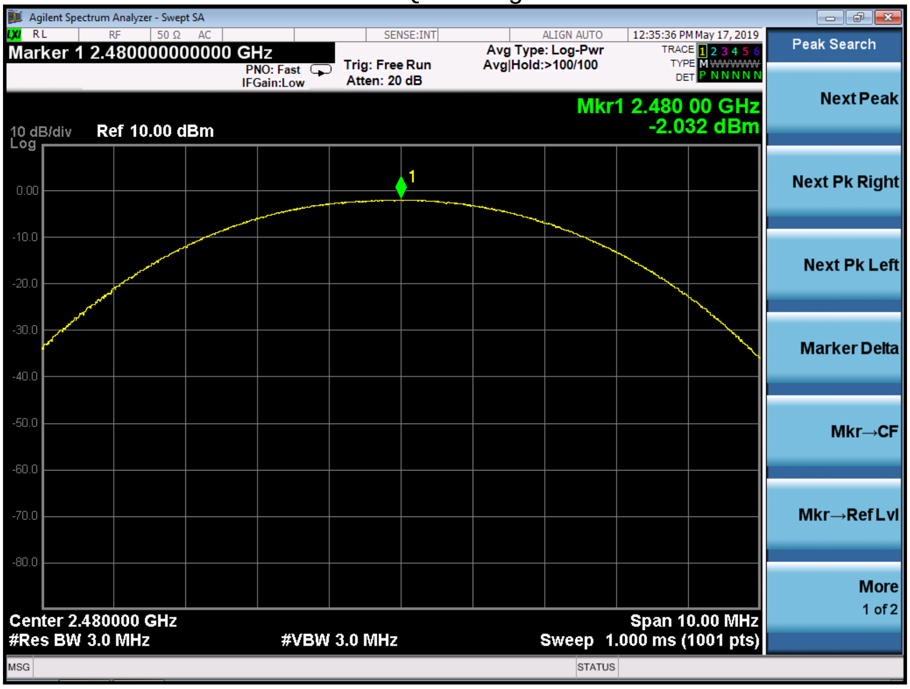
Pi/4 DQPSK Low Channel



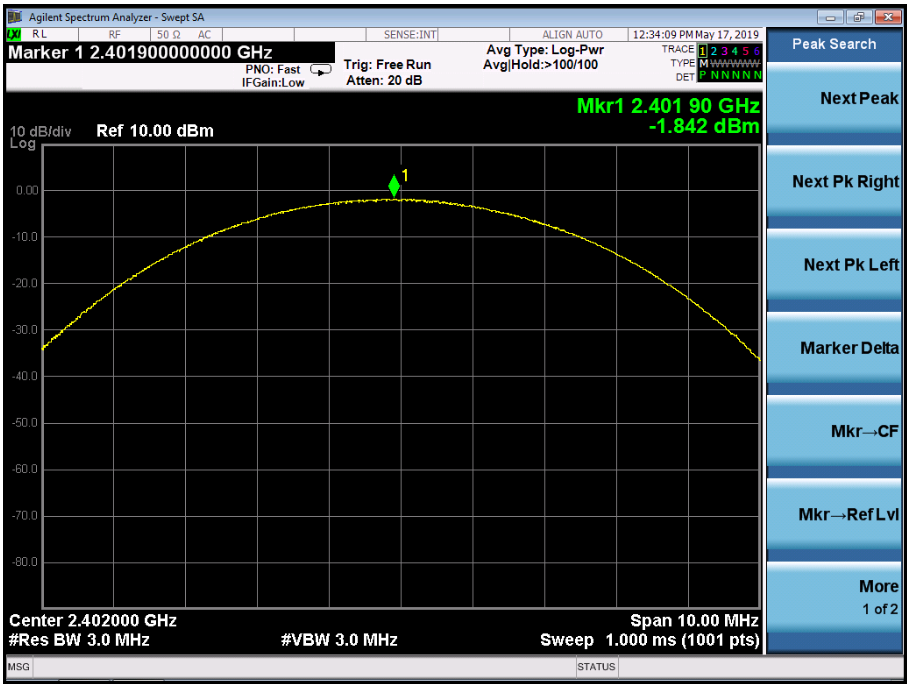
Pi/4 DQPSK Middle Channel



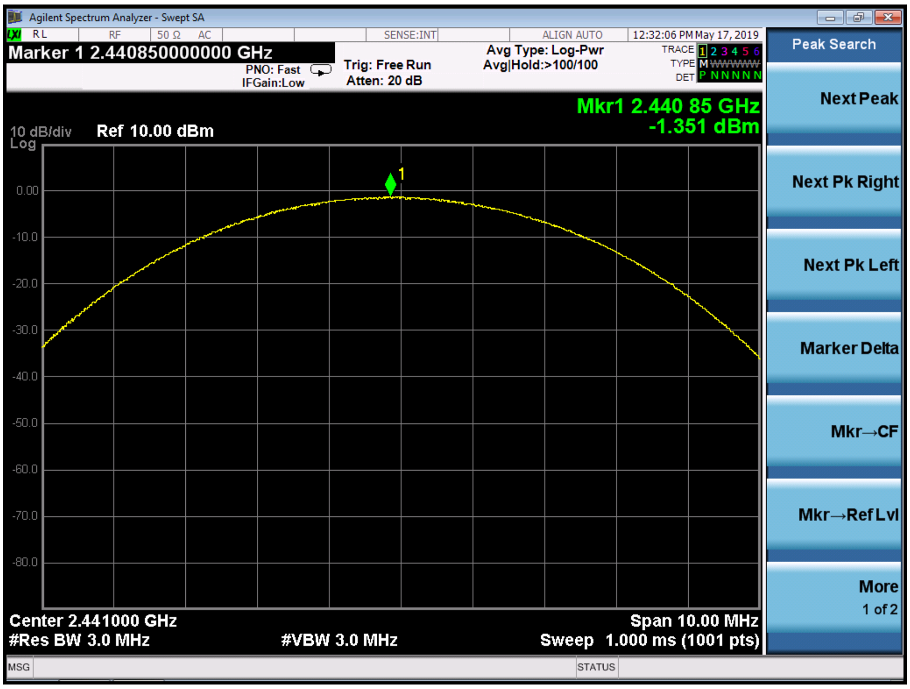
Pi/4 DQPSK High Channel



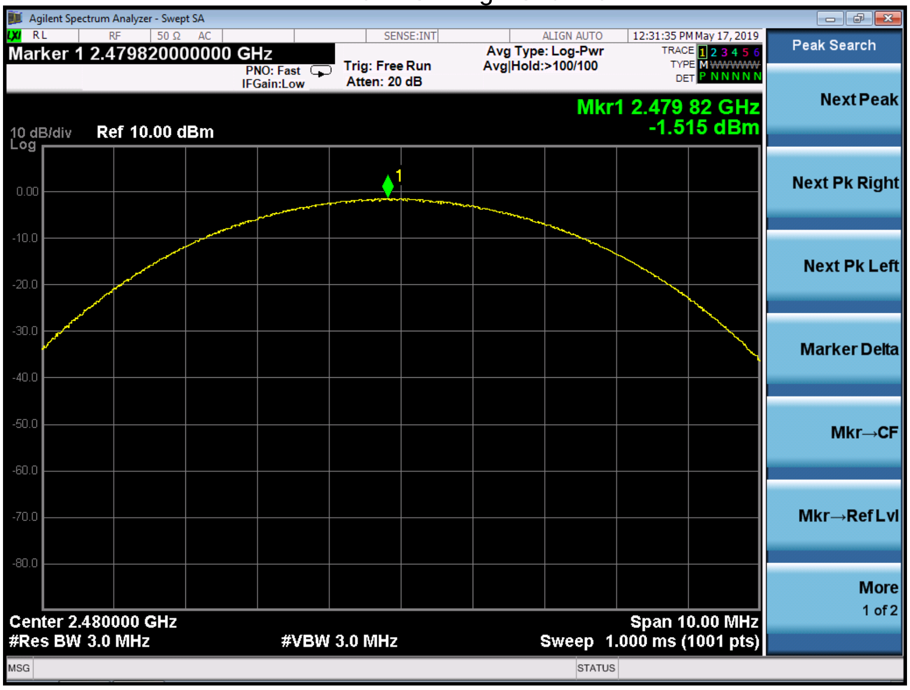
8DPSK Low Channel



8DPSK Middle Channel

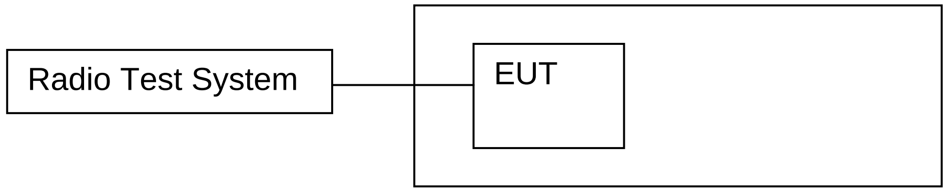


8DPSK High Channel



11. HOPPING CHANNEL SEPARATION

11.1 Block Diagram Of Test Setup



11.2 Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125W.

11.3 Test procedure

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

2. Set the spectrum analyzer: RBW = 30kHz. VBW = 100kHz , Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

11.4 Test Result

Modulation	Test Channel	Separation (MHz)	Limit(MHz)	Result
GFSK	Low	0.990	0.785	PASS
GFSK	Middle	0.992	0.742	PASS
GFSK	High	1.000	0.742	PASS
Pi/4 DQPSK	Low	0.996	0.934	PASS
Pi/4 DQPSK	Middle	0.992	0.935	PASS
Pi/4 DQPSK	High	1.004	0.936	PASS
8DPSK	Low	0.998	0.915	PASS
8DPSK	Middle	1.004	0.914	PASS
8DPSK	High	1.004	0.911	PASS

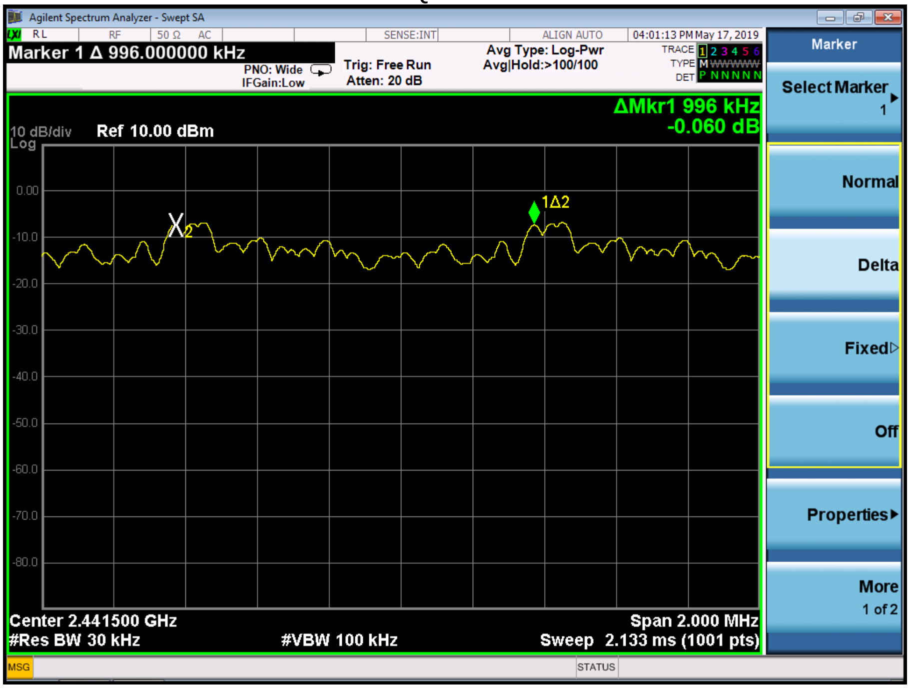
Test plots

GFSK Low Channel

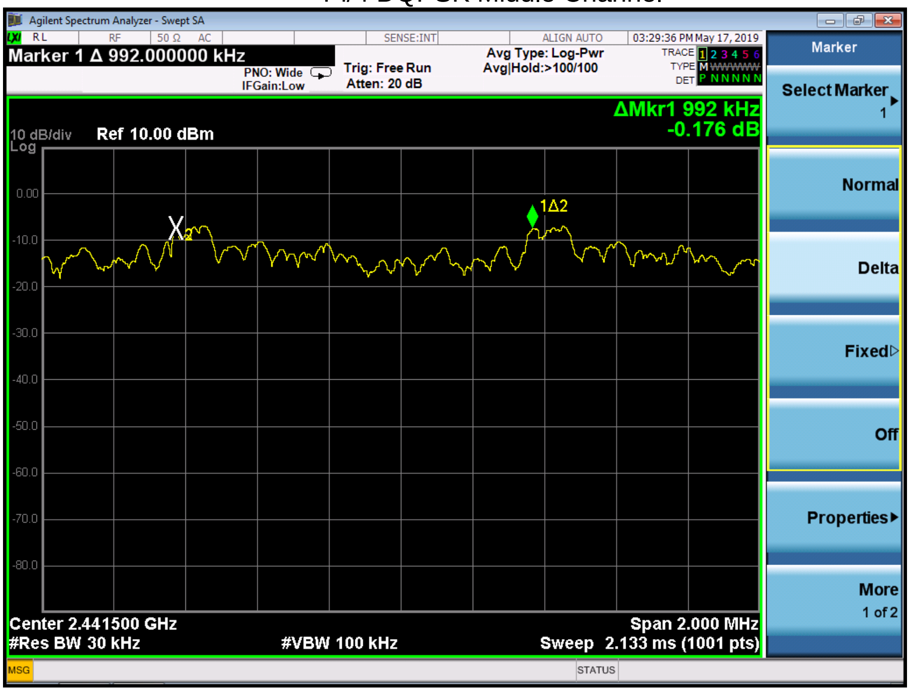
GFSK Middle Channel

GFSK High Channel

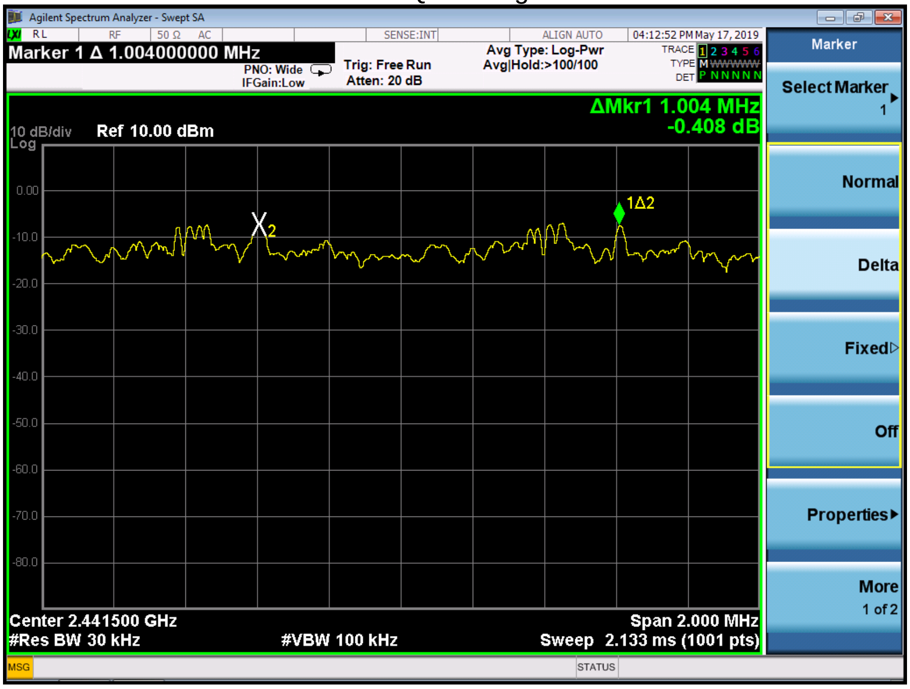
Pi/4 DQPSK Low Channel



Pi/4 DQPSK Middle Channel



Pi/4 DQPSK High Channel



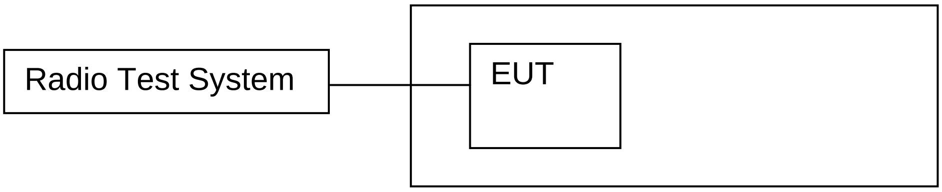
8DPSK Low Channel

8DPSK Middle Channel

8DPSK High Channel

12. NUMBER OF HOPPING FREQUENCY

12.1 Block Diagram Of Test Setup



12.2 Limit

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

12.3 Test procedure

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

2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

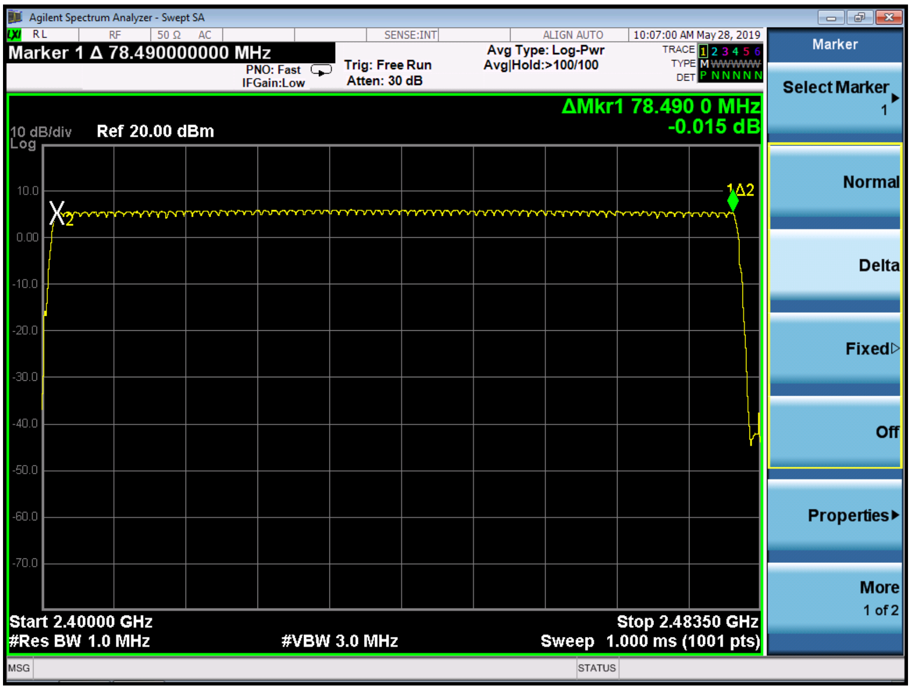
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.

4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

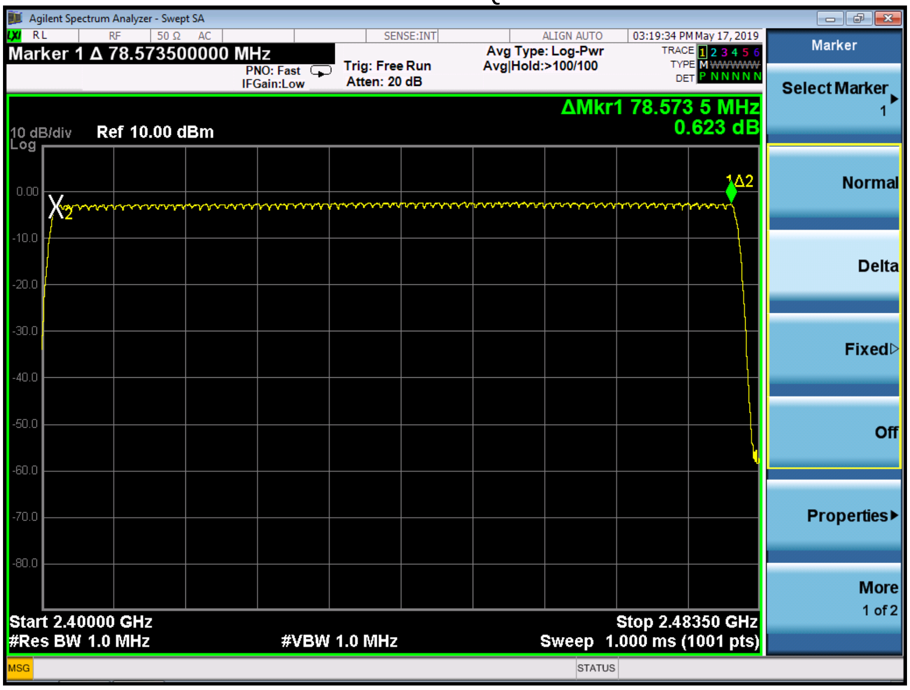
12.4 Test Result

Modulation	Hopping No	Limit	Result
GFSK	79	15	PASS
Pi/4 DQPSK	79	15	PASS
8DPSK	79	15	PASS

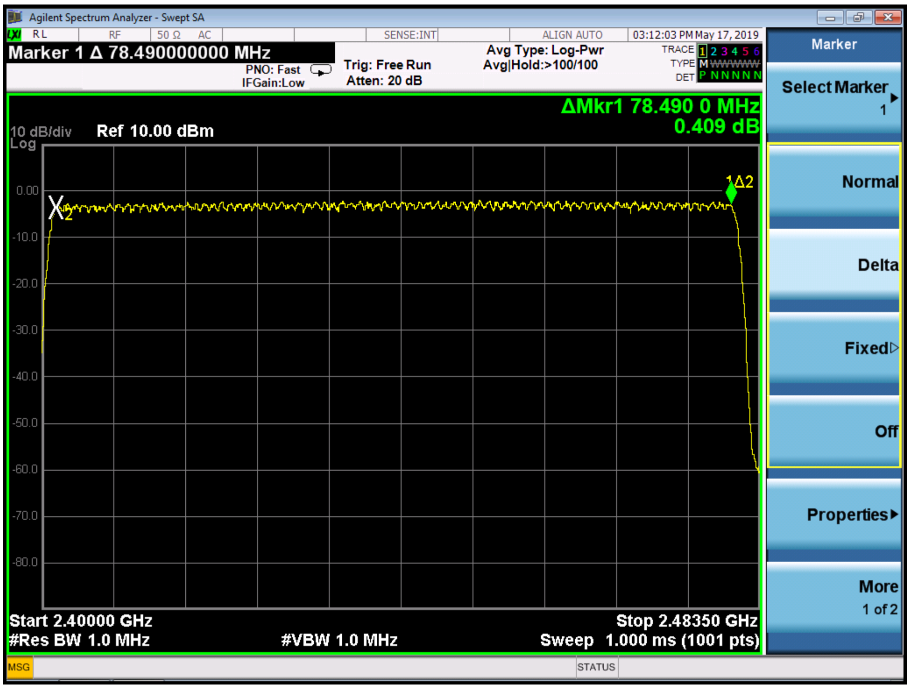
Test Plots:
79 Channels in total
GFSK



Pi/4 DQPSK

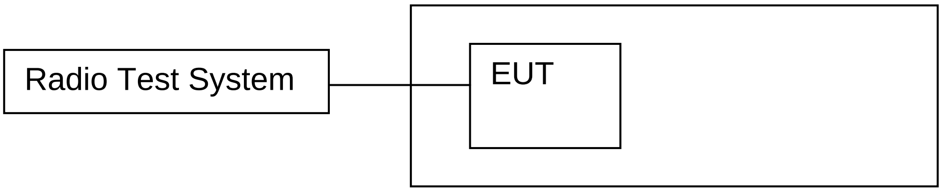


8DPSK



13. DWELL TIME

13.1 Block Diagram Of Test Setup



13.2 Limit

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

13.3 Test procedure

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

2. Set spectrum analyzer span = 0. Centred on a hopping channel;

3. Set RBW = 1MHz and VBW = 3MHz.Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.

4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

13.4 Test Result

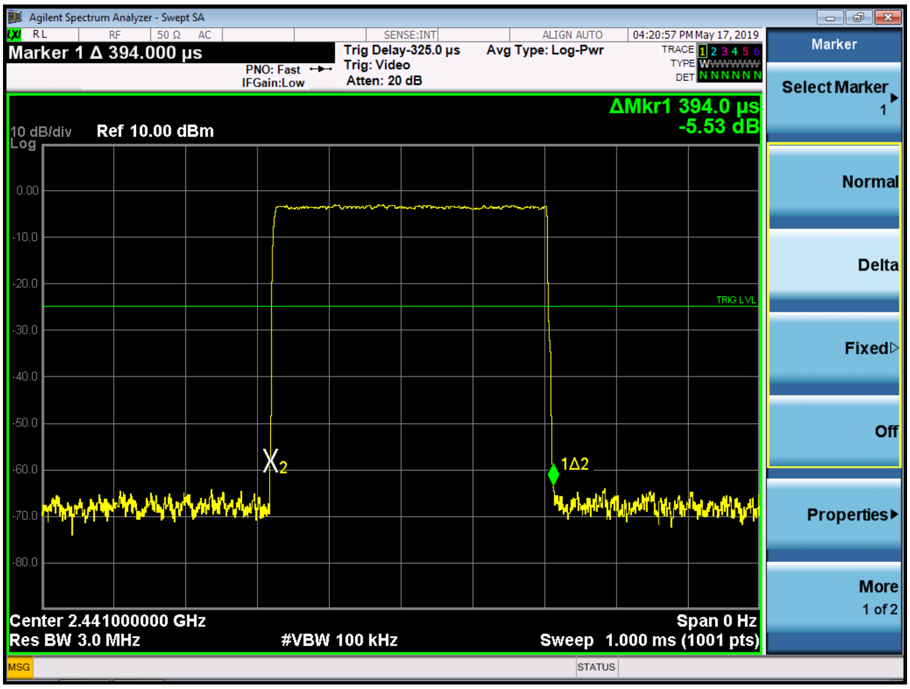
DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).
DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).
DH1 Packet permit maximum 1600 / 79 /2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

DH5:1600/79/6*0.4*79*(MkrDelta)/1000
DH3:1600/79/4*0.4*79*(MkrDelta)/1000
DH1:1600/79/2*0.4*79*(MkrDelta)/1000
Remark: Mkr Delta is once pulse time.

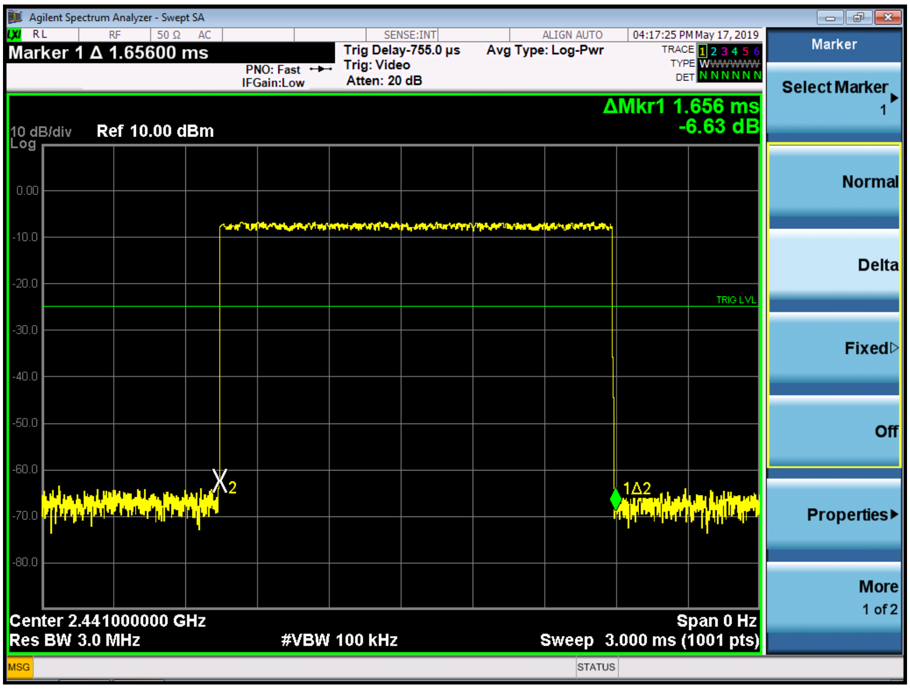
Modulation	Channel Data	Packet	pulse time(ms)	Dwell Time(s)	Limits(s)
GFSK	Middle	DH1	0.394	0.126	0.4
		DH3	1.656	0.265	0.4
		DH5	2.898	0.309	0.4
Pi/4DQPSK	Middle	DH1	0.403	0.129	0.4
		DH3	1.659	0.265	0.4
		DH5	2.910	0.310	0.4
8DPSK	Middle	DH1	0.400	0.128	0.4
		DH3	1.674	0.268	0.4
		DH5	2.916	0.311	0.4

Test Plots

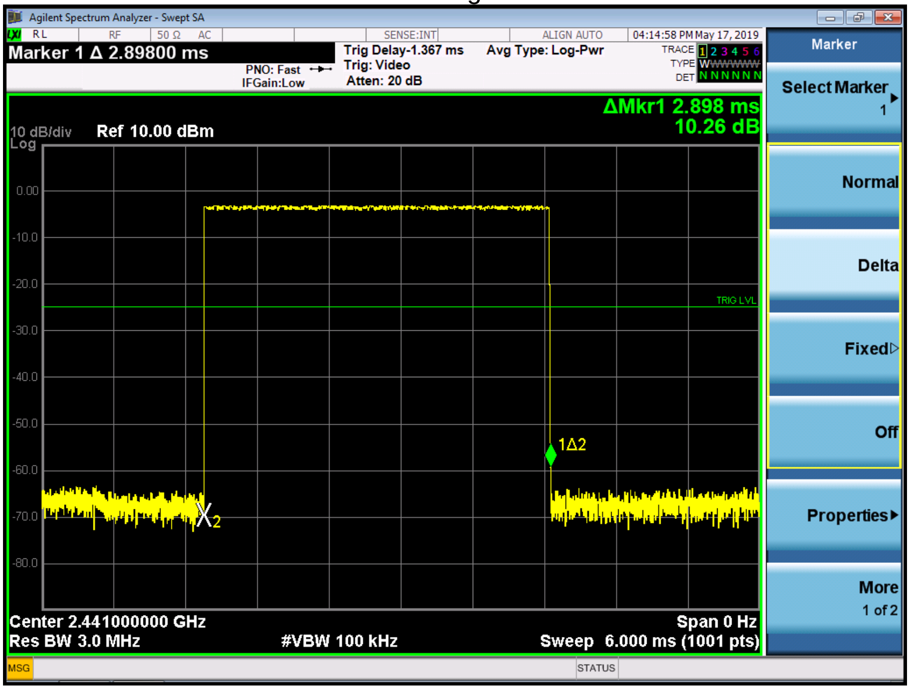
GFSK DH1 Middle Channel



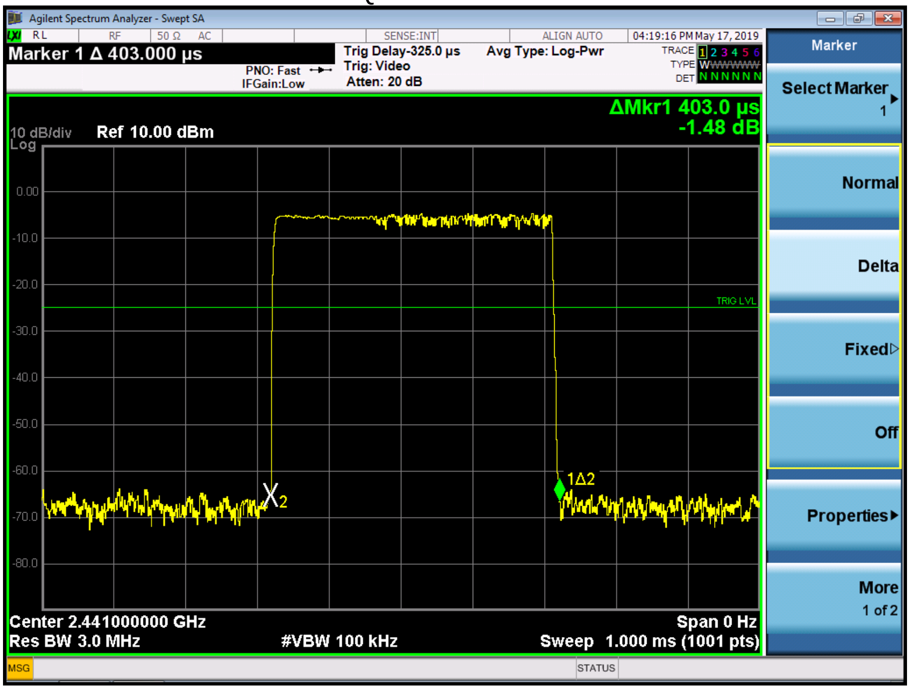
GFSK DH3 Middle Channel



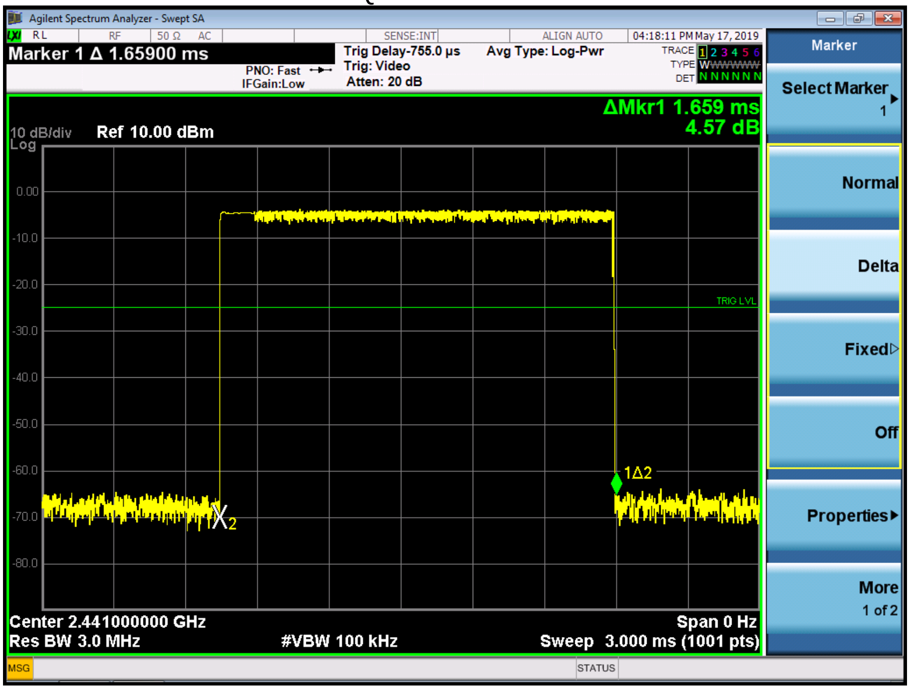
GFSK DH5 High Middle Channel



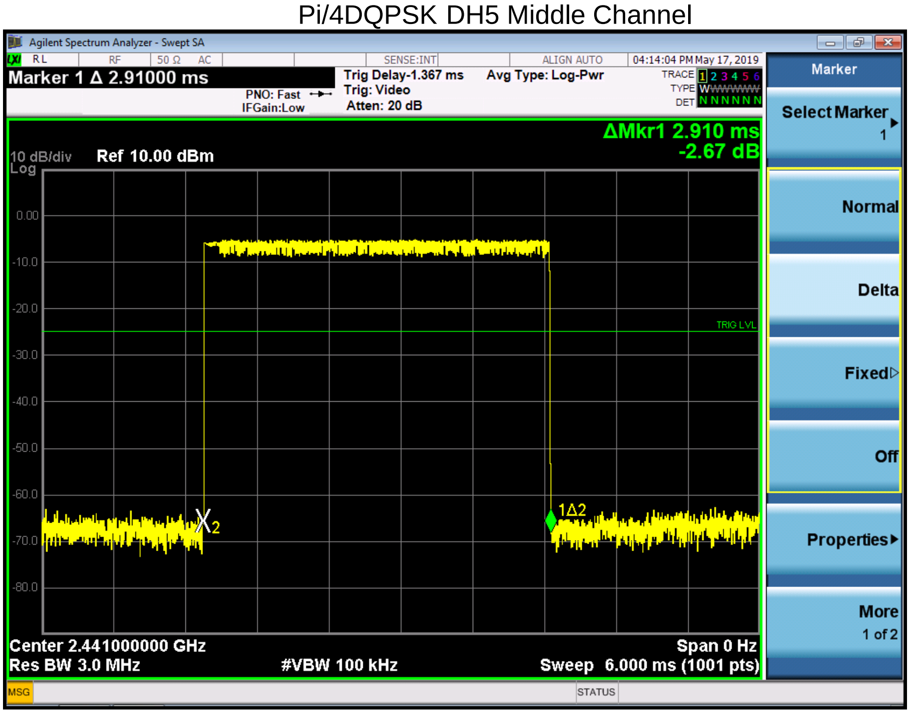
Pi/4DQPSK DH1 Middle Channel



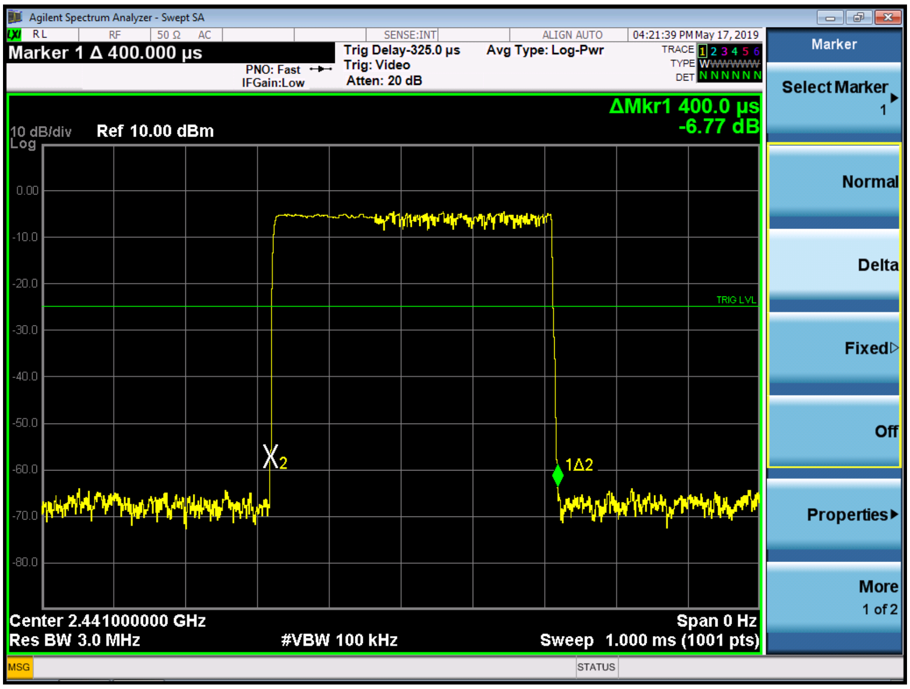
Pi/4DQPSK DH3 Middle Channel



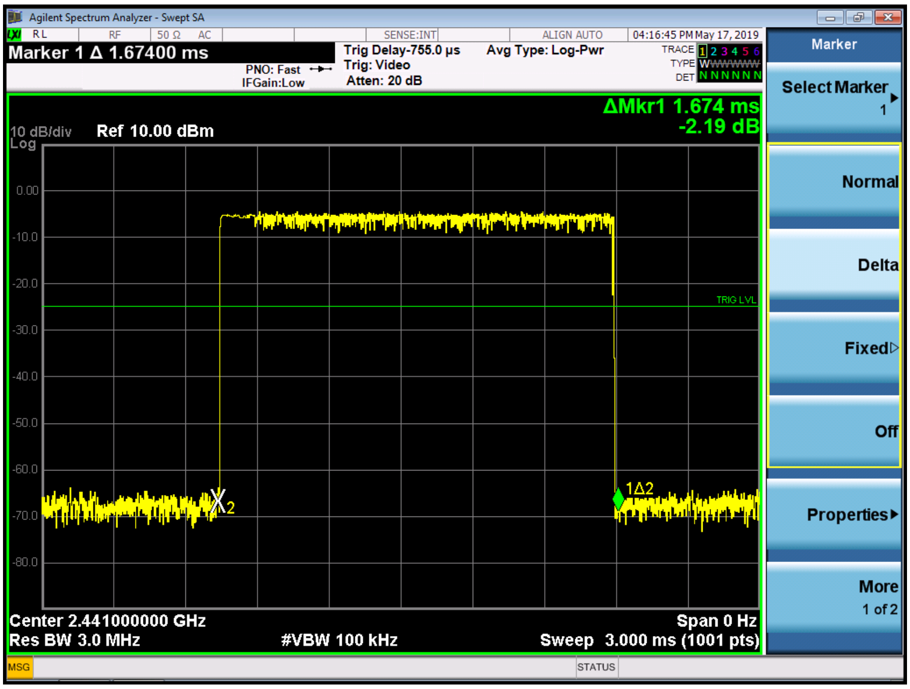
Pi/4DQPSK DH5 Middle Channel



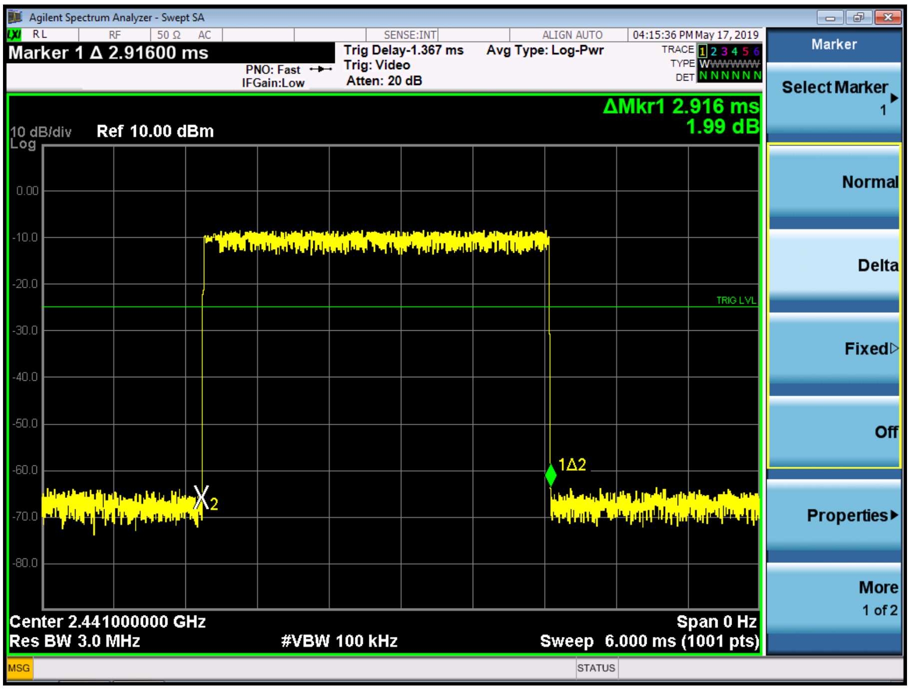
8DPSK DH1 Middle Channel



8DPSK DH3 Middle Channel

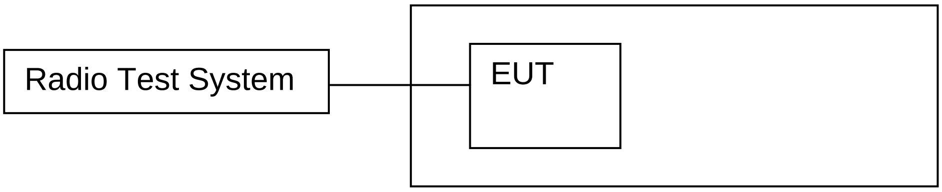


8DPSK DH5 Middle Channel



14. FREQUENCY HOPPING SYSTEM REQUIREMENTS

15.1 Block Diagram Of Test Setup



15.2 Limit

According to FCC Part 15.247(a)(1), The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

15.3 Test procedure

This transmitter device is frequency hopping device, and complies with FCC part 15.247 rule.

This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centred from 2402 to 2480 MHz) in the range 2,400-2,483.5 MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the

Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

This device was tested with an bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements for DA 00-705 and FCC Part 15.247 rule.

15.4 Test Result

Pseudorandom Frequency Hopping Sequence Table as below:
Channel: 06, 25, 40, 56, 40, 56, 72, 09, 01, 09, 33, 41, 33, 41, 65, 72, 53, 68, 06, 22, 04, 20, 36, 54, 36, 46, 76, 78, 68, 76, 22, 29, 10, 26, 42, 58, 44, 60, 76, 13, 03, 11, 35, 43, 37, 45, 64, 71, 55, 71, 08, 23, 08, 24, 40, 56, 40, 48, 72, 01, 71, 01, 25, 33, 12, 28, 44, 60, 45, 58, 74, 12, 07, 15, 31, 40 etc.

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

15. ANTENNA REQUIREMENT

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

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.

The EUT antenna is Internal antenna, It comply with the standard requirement.

16. EUT PHOTOGRAPHS

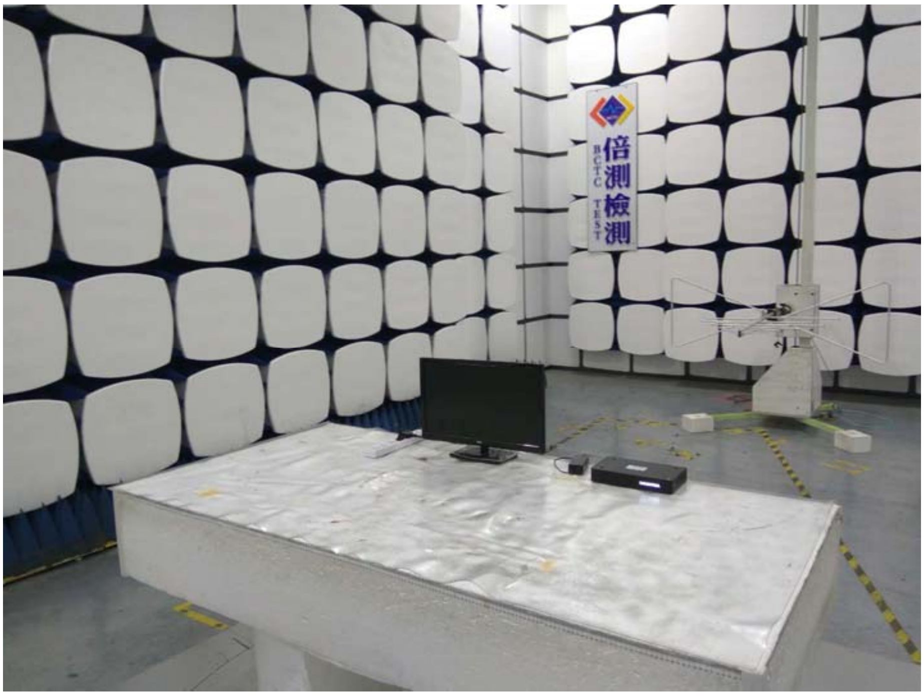
EUT Photo 1

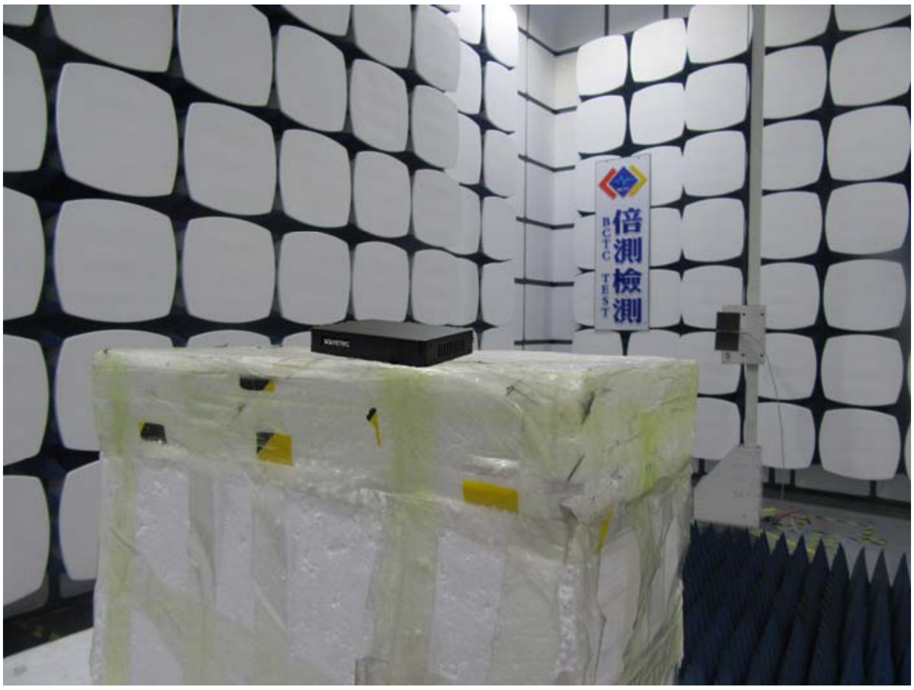
EUT Photo 2

EUT Photo 3

17. EUT TEST SETUP PHOTOGRAPHS

Spurious emissions





Conducted emissions

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