Shenzhen Global Test Service Co.,Ltd.
No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

FCC PART 15 SUBPART C TEST REPORT

FCC PART 15.247

Report Reference No.....:	**GTS20210308012-1-1**
FCC ID..... :	**2AY45TWS-SPARKS**
Compiled by (position+printed name+signature)..:	File administrators Jimmy Wang
Supervised by (position+printed name+signature)..:	Test Engineer Aaron Tan
Approved by (position+printed name+signature)..:	Manager Jason Hu
Date of issue.....:	Mar. 08, 2021
Representative Laboratory Name .:	**Shenzhen Global Test Service Co., Ltd.**
Address.....:	No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong
Applicant's name.....:	**Chengdu shuiyueyu technology Co.,Ltd.**
Address .....:	319th Qingpi Ave. Chengdu Strait Liang'an Technology Industry Kaifayuan, Wenjiang District, Chengdu, Sichuan
Test specification .....:	
Standard .....:	**FCC Part 15.247**

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Test item description .....:	**Sparks**
Trade Mark .....:	MOONDROP
Manufacturer .....:	**Chengdu shuiyueyu technology Co.,Ltd.**
Model/Type reference.....:	TWS-Sparks
Listed Models .....:	N/A
Modulation .....:	GFSK, Π/4DQPSK,8DPSK
Frequency.....	From 2402MHz to 2480MHz
Rating .....:	DC 3.60V from battery and DC 5V From External circuit
Result.....:	**PASS**

TEST REPORT

Test Report No. :	GTS20210308012-1-1	Mar. 08, 2021 Date of issue

Equipment under Test	:	Sparks
Model /Type	:	TWS-Sparks
Listed Models	:	N/A
Applicant	:	**Chengdu shuiyueyu technology Co.,Ltd.**
Address	:	319th Qingpi Ave. Chengdu Strait Liang‘an Technology Industry Kaifayuan, Wenjiang District, Chengdu, Sichuan
Manufacturer	:	**Chengdu shuiyueyu technology Co.,Ltd.**
Address	:	319th Qingpi Ave. Chengdu Strait Liang‘an Technology Industry Kaifayuan, Wenjiang District, Chengdu, Sichuan

Test Result:	**PASS**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

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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

SUMMARY

1.1 General Remarks

Date of receipt of test sample	:	Feb. 25, 2021
Testing commenced on	:	Feb. 25, 2021
Testing concluded on	:	Mar. 08, 2020

1.2 Product Description

Product Name:	Sparks
Model/Type reference:	TWS-Sparks
Power supply:	DC 3.60V from battery and DC 5V From External circuit
Adapter information (Auxiliary test suppied by test Lab）：	Mode:EP-TA20CBC Input:AC100-240V-50/60Hz，0.5A Output:DC 5V,2A
Testing sample ID：	GTS20210308012-1-1-1# (Engineer sample), GTS20210308012-1-1-2# (Normal sample)
Bluetooth :	
Supported Type:	Bluetooth BR/EDR
Modulation:	GFSK, π/4DQPSK, 8DPSK
Operation frequency:	2402MHz~2480MHz
Channel number:	79
Channel separation:	1MHz
Antenna type:	Chip Antenna
Antenna gain:	2.20dBi

1.3 Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	230V / 50 Hz	○	120V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

DC 3.60V from battery and DC 5V From external circuit

1.4 Short description of the Equipment under Test (EUT)

This is a Sparks.
For more details, refer to the user's manual of the EUT.

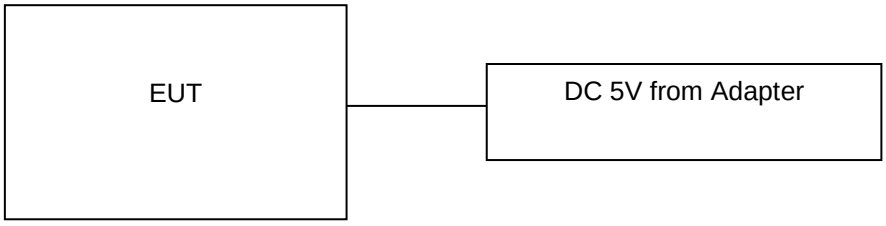
1.5 EUT operation mode

The Applicant provides communication tools software(Engineer mode) 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 and Channel 00/39/78 were selected to test.

Operation Frequency:

Channel	Frequency (MHz)
00	2402
01	2403
⋮	⋮
38	2440
39	2441
40	2442
⋮	⋮
77	2479
78	2480

1.6 Block Diagram of Test Setup



1.7 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for the device filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

1.8 Modifications

No modifications were implemented to meet testing criteria.

2 TEST ENVIRONMENT

2.1 Address of the test laboratory

Shenzhen Global Test Service Co.,Ltd.
No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

2.2 Test Facility

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

FCC-Registration No.: 165725

Shenzhen Global Test Service 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.

A2LA-Lab Cert. No.: 4758.01

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

CNAS-Lab Code: L8169

Shenzhen Global Test Service Co.,Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories. Date of Registration: Dec. 11, 2015. Valid time is until Dec. 10, 2024.

2.3 Environmental conditions

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

Temperature:	25 ° C
Humidity:	45 %
Atmospheric pressure:	950-1050mbar

AC Power Conducted Emission

Temperature:	25 ° C
Humidity:	46 %
Atmospheric pressure:	950-1050mbar

Conducted testing：

Temperature:	25 ° C
Humidity:	44 %
Atmospheric pressure:	950-1050mbar

2.4 Summary of measurement results

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Test result
§15.247(a)(1)	Carrier Frequency separation	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Middle	Compliant
§15.247(a)(1)	Number of Hopping channels	GFSK Π/4DQPSK 8DPSK	☒ Full	GFSK	☒ Full	Compliant
§15.247(a)(1)	Time of Occupancy (dwell time)	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Middle	Compliant
§15.247(a)(1)	Spectrumbandwidth of aFHSS system20dB bandwidth	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	Compliant
§15.247(b)(1)	Maximum outputpower	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	Compliant
§15.247(d)	Band edgecompliance conducted	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	Compliant
§15.205	Band edgecompliance radiated	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	Compliant
§15.247(d)	TX spuriousemissions conducted	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	Compliant
§15.247(d)	TX spuriousemissions radiated	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	Compliant
§15.209(a)	TX spurious Emissions radiated Below 1GHz	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Middle	Compliant
§15.107(a) §15.207	Conducted Emissions 9KHz-30 MHz	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Middle	Compliant

Remark:
1. The measurement uncertainty is not included in the test result.
2. We tested all test mode and recorded worst case in report

2.5 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors 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 Global Test Service 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 Shenzhen GTS laboratory is reported:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	4.10 dB	(1)
Radiated Emission	1~18GHz	4.32 dB	(1)
Radiated Emission	18-40GHz	5.54 dB	(1)
Conducted Disturbance	0.15~30MHz	3.12 dB	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

2.6 Equipments Used during the Test

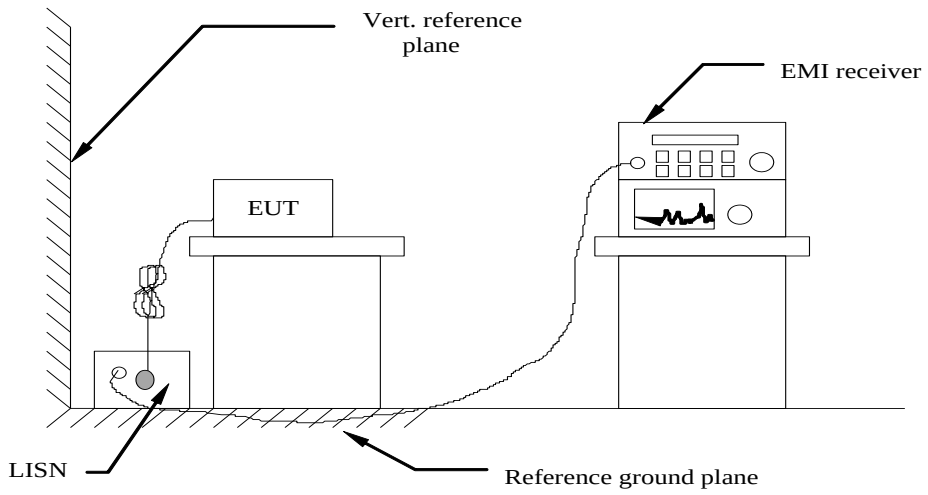
Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	3560.6550.08	2020/09/19	2021/09/18
LISN	R&S	ESH2-Z5	893606/008	2020/09/19	2021/09/18
EMI Test Receiver	R&S	ESPI3	101841-cd	2020/09/19	2021/09/18
EMI Test Receiver	R&S	ESCI7	101102	2020/09/19	2021/09/18
Spectrum Analyzer	Agilent	N9020A	MY48010425	2020/09/19	2021/09/18
Spectrum Analyzer	R&S	FSV40	100019	2020/09/19	2021/09/18
Vector Signal generator	Agilent	N5181A	MY49060502	2020/09/19	2021/09/18
Signal generator	Agilent	E4421B	3610AO1069	2020/09/19	2021/09/18
Climate Chamber	ESPEC	EL-10KA	A20120523	2020/09/19	2021/09/18
Controller	EM Electronics	Controller EM 1000	N/A	N/A	N/A
Horn Antenna	Schwarzbeck	BBHA 9120D	01622	2020/09/19	2021/09/18
Active Loop Antenna	Beijing Da Ze Technology Co.,Ltd.	ZN30900C	15006	2020/10/11	2021/10/10
Bilog Antenna	Schwarzbeck	VULB9163	000976	2020/05/26	2021/05/25
Broadband Horn Antenna	SCHWARZBECK	BBHA 9170	791	2020/09/19	2021/09/18
Amplifier	Schwarzbeck	BBV 9743	#202	2020/09/19	2021/09/18
Amplifier	Schwarzbeck	BBV9179	9719-025	2020/09/19	2021/09/18
Amplifier	EMCI	EMC051845B	980355	2020/09/19	2021/09/18
Temperature/Humidity Meter	Gangxing	CTH-608	02	2020/09/19	2021/09/18
High-Pass Filter	K&L	9SH10-2700/X12750-O/O	KL142031	2020/09/19	2021/09/18
High-Pass Filter	K&L	41H10-1375/U12750-O/O	KL142032	2020/09/19	2021/09/18
RF Cable(below 1GHz)	HUBER+SUHNER	RG214	RE01	2020/09/19	2021/09/18
RF Cable(above 1GHz)	HUBER+SUHNER	RG214	RE02	2020/09/19	2021/09/18
Data acquisition card	Agilent	U2531A	TW53323507	2020/09/19	2021/09/18
Power Sensor	Agilent	U2021XA	MY5365004	2020/09/19	2021/09/18
Test Control Unit	Tonscend	JS0806-1	178060067	2020/06/19	2021/06/18
Automated filter bank	Tonscend	JS0806-F	19F8060177	2020/06/19	2021/06/18
EMI Test Software	Tonscend	JS1120-1	Ver 2.6.8.0518	/	/
EMI Test Software	Tonscend	JS1120-3	Ver 2.5.77.0418	/	/
EMI Test Software	Tonscend	JS32-CE	Ver 2.5	/	/
EMI Test Software	Tonscend	JS32-RE	Ver 2.5.1.8	/	/

Note: The Cal.Interval was one year.

3 TEST CONDITIONS AND RESULTS

3.1 AC Power Conducted Emission

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 DC 12V power from adapter, the adapter received AC120V/60Hz and AC 240V/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.

AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following：

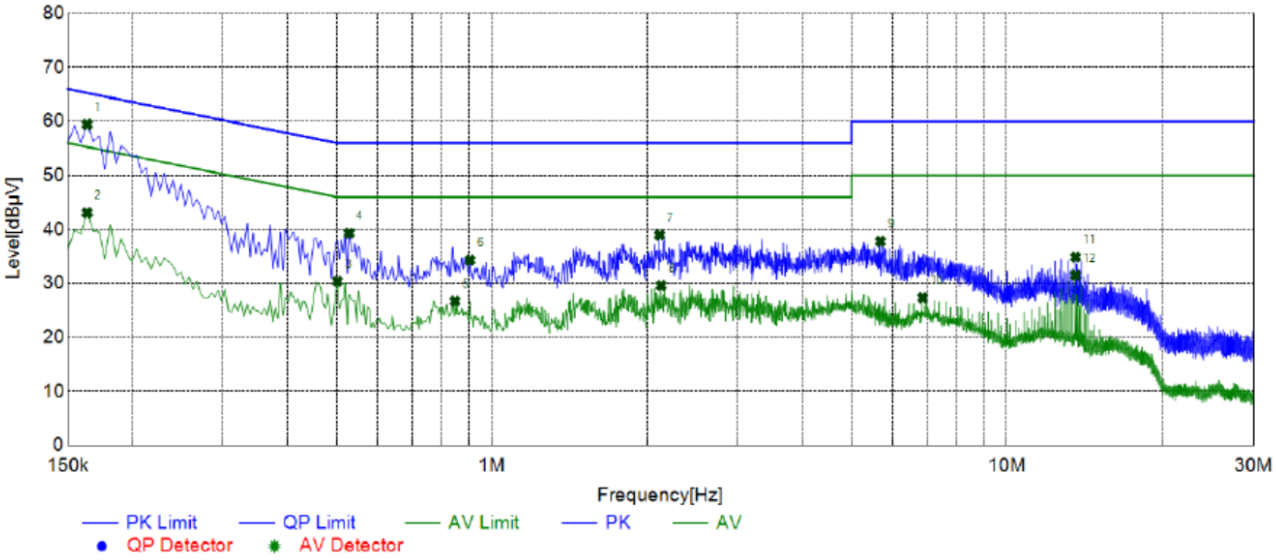
Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50
* Decreases with the logarithm of the frequency.		

TEST RESULTS

Remark:

1. All modes of GFSK, Pi/4 DQPSK and 8DPSK were test at Low, Middle, and High channel; only the worst result of GFSK Middle Channel was reported as below:
2. Both 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz power supply have been tested, only the worst result of 120 VAC, 60 Hz was reported as below:
3. Remark: Result=Reading value+Factor,and Margin=Limit- Result

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	L



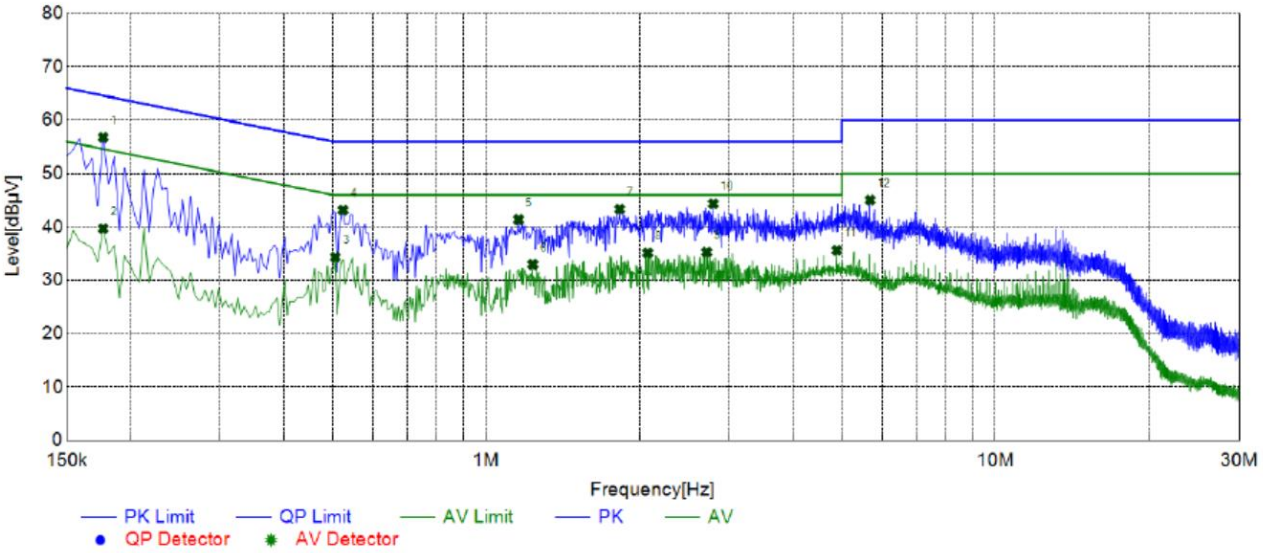
Suspected List

NO.	Frequency [MHz]	Reading [dBµV]	Factor [dB]	Result [dBµV]	Limit [dBµV]	Margin [dB]	Detector	Line	Remark
1	0.1635	49.41	10.05	59.46	65.28	5.82	Qp	L1	PASS
2	0.1635	33.03	10.05	43.08	55.28	12.20	AV	L1	PASS
3	0.5010	20.35	10.06	30.41	46.00	15.59	AV	L1	PASS
4	0.5280	29.23	10.06	39.29	56.00	16.71	Qp	L1	PASS
5	0.8475	16.69	10.07	26.76	46.00	19.24	AV	L1	PASS
6	0.9060	24.25	10.06	34.31	56.00	21.69	Qp	L1	PASS
7	2.1165	28.80	10.17	38.97	56.00	17.03	Qp	L1	PASS
8	2.1300	19.43	10.17	29.60	46.00	16.40	AV	L1	PASS
9	5.6805	27.25	10.53	37.78	60.00	22.22	Qp	L1	PASS
10	6.8640	16.77	10.59	27.36	50.00	22.64	AV	L1	PASS
11	13.5960	23.92	10.96	34.88	60.00	25.12	Qp	L1	PASS
12	13.5960	20.56	10.96	31.52	50.00	18.48	AV	L1	PASS

Note:1. Result (dBµV) = Reading (dBµV) + Factor (dB).

2. Factor (dB) = Cable loss (dB) + LISN Factor (dB).

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	N



Suspected List									
NO.	Frequency [MHz]	Reading [dBμV]	Factor [dB]	Result [dBμV]	Limit [dBμV]	Margin [dB]	Detector	Line	Remark
1	0.1770	46.74	10.05	56.79	64.63	7.84	Qp	N	PASS
2	0.1770	29.66	10.05	39.71	54.63	14.92	AV	N	PASS
3	0.5055	24.29	10.06	34.35	46.00	11.65	AV	N	PASS
4	0.5235	33.10	10.06	43.16	56.00	12.84	Qp	N	PASS
5	1.1580	31.30	10.09	41.39	56.00	14.61	Qp	N	PASS
6	1.2345	22.89	10.09	32.98	46.00	13.02	AV	N	PASS
7	1.8285	33.20	10.13	43.33	56.00	12.67	Qp	N	PASS
8	2.0760	24.99	10.17	35.16	46.00	10.84	AV	N	PASS
9	2.7105	25.05	10.25	35.30	46.00	10.70	AV	N	PASS
10	2.7915	34.11	10.26	44.37	56.00	11.63	Qp	N	PASS
11	4.8840	25.19	10.46	35.65	46.00	10.35	AV	N	PASS
12	5.6760	34.54	10.53	45.07	60.00	14.93	Qp	N	PASS

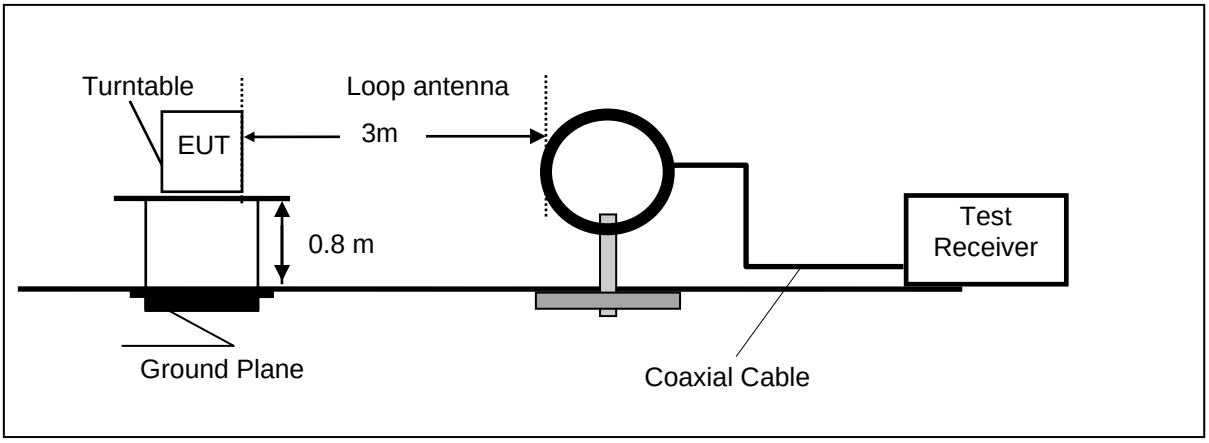
Note:1. Result (dBμV) = Reading (dBμV) + Factor (dB).

2. Factor (dB) = Cable loss (dB) + LISN Factor (dB).

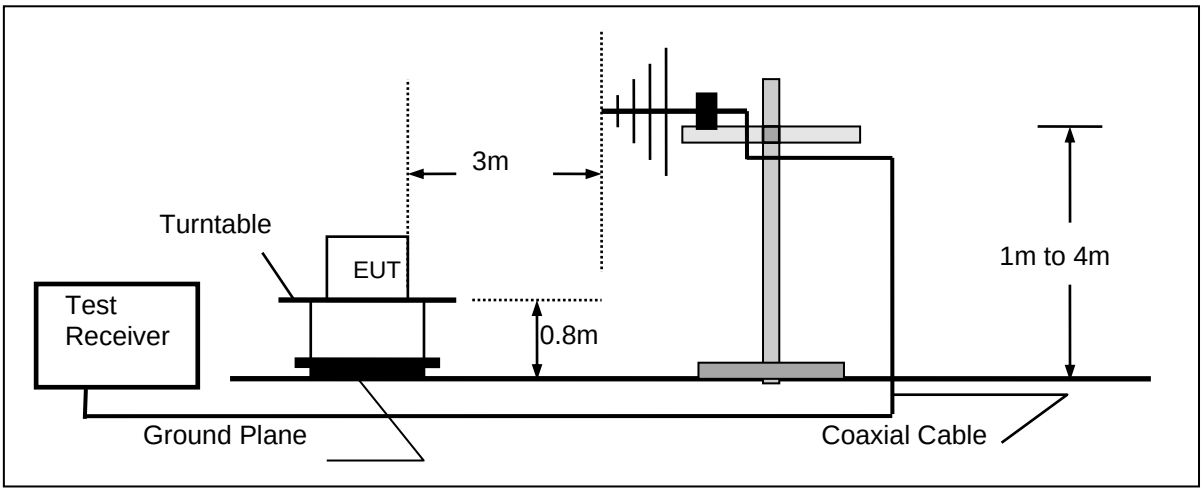
3.2 Radiated Emission

TEST CONFIGURATION

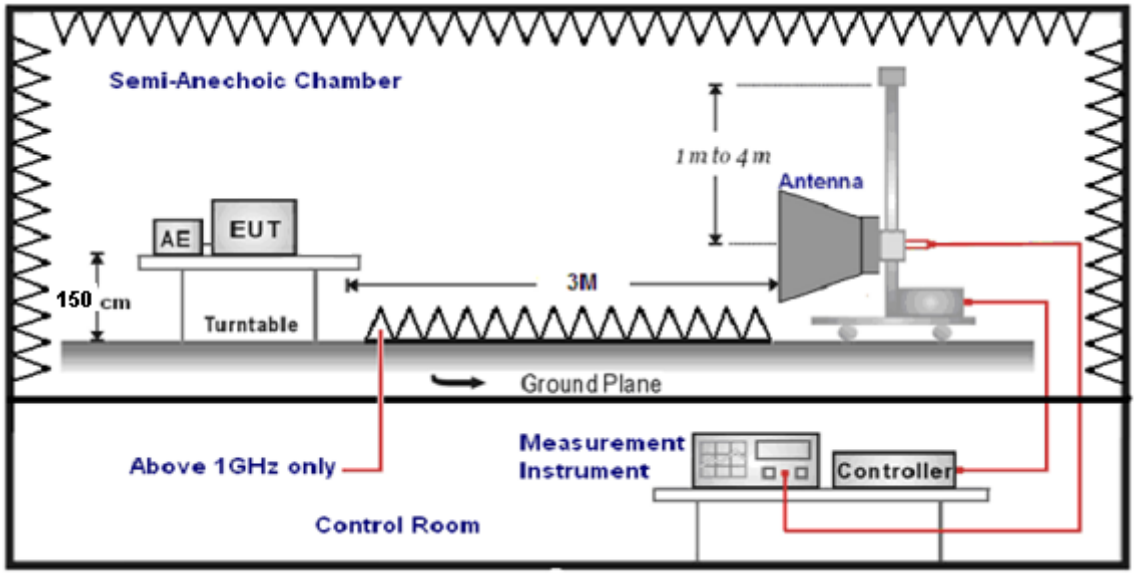
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz;the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 25GHz.
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.
5. Radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Ultra-Broadband Antenna	3
1GHz-18GHz	Double Ridged Horn Antenna	3
18GHz-25GHz	Horn Anternna	1

7. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz,Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

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	

Transd=AF +CL-AG

RADIATION 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 the100kHz bandwidth within the band that contains the highest level of desired power.

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 (dBμV/m)	Radiated (μV/m)
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(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

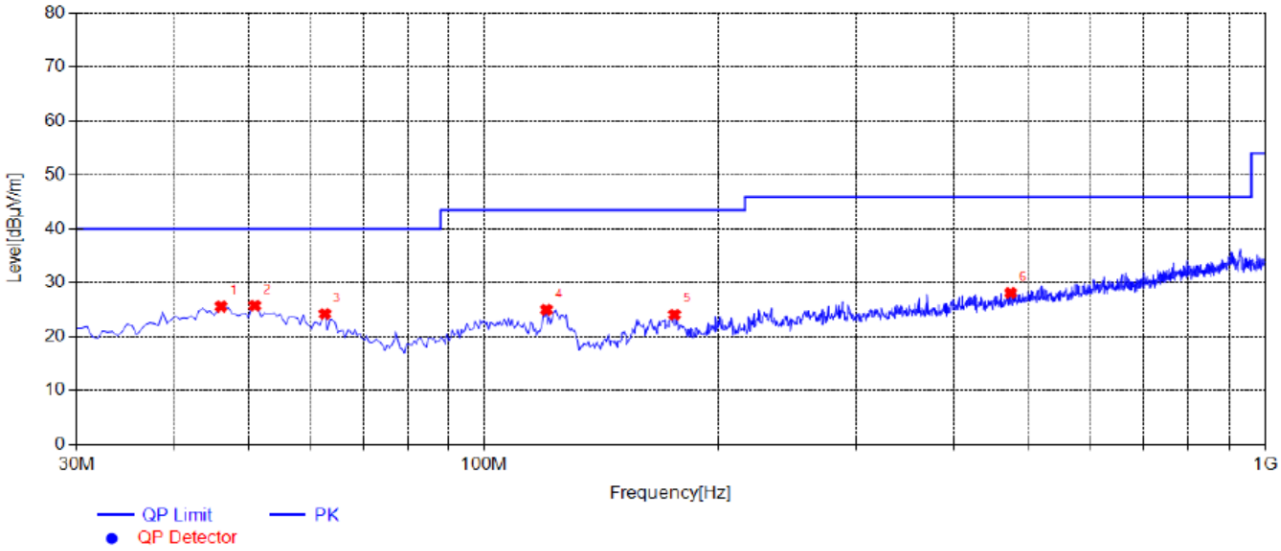
TEST RESULTS

Remark:

1. This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.
2. We measured Radiated Emission at GFSK,π/4 DQPSK and 8DPSK mode from 9 KHz to 25GHz and recorded worst case at GFSK DH5 mode.
3. For below 1GHz testing recorded worst at GFSK DH5 middle channel.
4. Radiated emission test from 9 KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9 KHz to 30MHz and not recorded in this report.

For 30MHz-1GHz

Horizontal



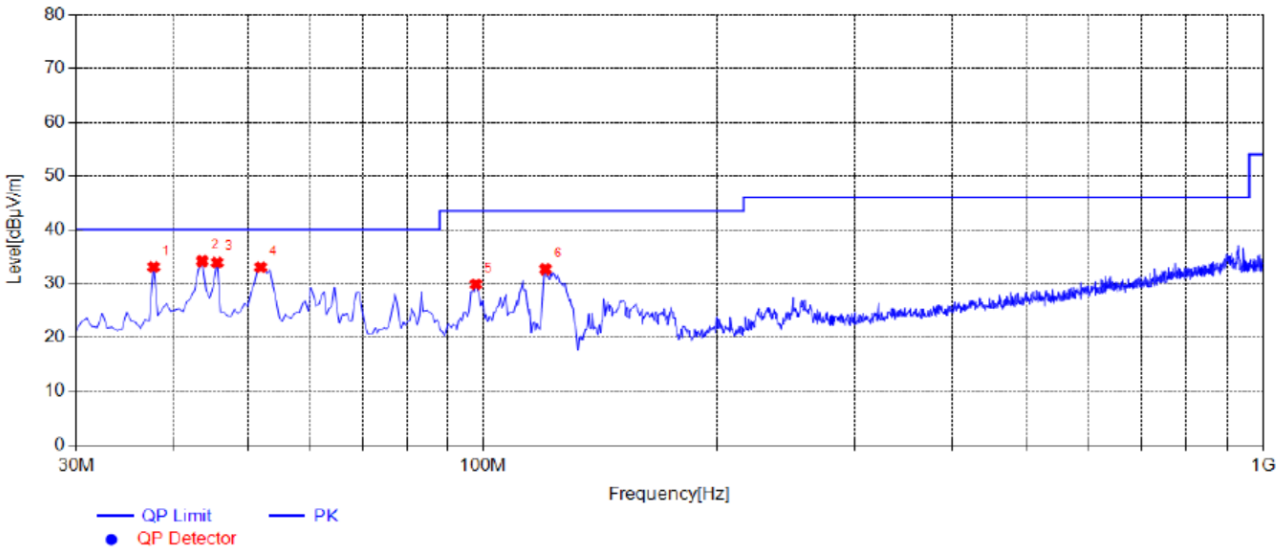
Suspected List

NO.	Frequency [MHz]	Reading [dBμV/m]	Factor [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity	Remark
1	46.0050	31.95	-6.37	25.58	40.00	14.42	100	177	PK	Horizonta	PASS
2	50.8550	32.42	-6.68	25.74	40.00	14.26	100	231	PK	Horizonta	PASS
3	62.4950	33.10	-8.90	24.20	40.00	15.80	100	155	PK	Horizonta	PASS
4	120.2100	35.99	-11.01	24.98	43.50	18.52	100	220	PK	Horizonta	PASS
5	175.5000	35.27	-11.21	24.06	43.50	19.44	100	93	PK	Horizonta	PASS
6	473.2900	32.17	-4.07	28.10	46.00	17.90	100	353	PK	Horizonta	PASS

Note:1. Result (dBμV/m) = Reading(dBμV/m) + Factor (dB) .

2. Factor (dB) = Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB).

Vertical



Suspected List

NO.	Frequency [MHz]	Reading [dBµV/m]	Factor [dB]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity	Remark
1	37.7600	41.19	-8.10	33.09	40.00	6.91	100	354	PK	Vertical	PASS
2	43.5800	40.71	-6.55	34.16	40.00	5.84	100	112	PK	Vertical	PASS
3	45.5200	40.35	-6.44	33.91	40.00	6.09	100	354	PK	Vertical	PASS
4	51.8250	39.65	-6.61	33.04	40.00	6.96	100	9	PK	Vertical	PASS
5	97.9000	38.52	-8.69	29.83	43.50	13.67	100	82	PK	Vertical	PASS
6	120.2100	43.69	-11.01	32.68	43.50	10.82	100	289	PK	Vertical	PASS

Note:1. Result (dBµV/m) = Reading(dBµV/m) + Factor (dB) .

2. Factor (dB) = Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB).

For 1GHz to 25GHz

Note: GFSK , Pi/4 DQPSK and 8DPSK all have been tested, only worse case GFSK is reported.

GFSK (above 1GHz)

Frequency(MHz):			2402		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	58.37	PK	74	15.63	56.47	31.42	6.98	36.5	1.9
4804.00	42.86	AV	54	11.14	40.96	31.42	6.98	36.5	1.9
7206.00	56.18	PK	74	17.82	45.58	37.03	8.87	35.3	10.6
7206.00	42.25	AV	54	11.75	31.65	37.03	8.87	35.3	10.6

Frequency(MHz):			2402		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	58.03	PK	74	15.97	56.13	31.42	6.98	36.5	1.9
4804.00	42.15	AV	54	11.85	40.25	31.42	6.98	36.5	1.9
7206.00	55.99	PK	74	18.01	45.39	37.03	8.87	35.3	10.6
7206.00	41.87	AV	54	12.13	31.27	37.03	8.87	35.3	10.6

Frequency(MHz):			2441		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4882.00	56.33	PK	74	17.67	54.27	30.98	7.58	36.5	2.06
4882.00	41.24	AV	54	12.76	39.18	30.98	7.58	36.5	2.06
7323.00	54.75	PK	74	19.25	43.83	37.66	8.56	35.3	10.92
7323.00	40.41	AV	54	13.59	29.49	37.66	8.56	35.3	10.92

Frequency(MHz):			2441		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4882.00	57.17	PK	74	16.83	55.11	30.98	7.58	36.5	2.06
4882.00	42.92	AV	54	11.08	40.86	30.98	7.58	36.5	2.06
7323.00	55.14	PK	74	18.86	44.22	37.66	8.56	35.3	10.92
7323.00	42.17	AV	54	11.83	31.25	37.66	8.56	35.3	10.92

Frequency(MHz):			2480		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4960.00	57.26	PK	74	16.74	54.19	31.47	7.8	36.2	3.07
4960.00	43.34	AV	54	10.66	40.27	31.47	7.8	36.2	3.07
7440.00	54.97	PK	74	19.03	43.23	38.32	8.72	35.3	11.74
7440.00	41.29	PK	54	12.71	29.55	38.32	8.72	35.3	11.74

Frequency(MHz):			2480		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4960.00	57.12	PK	74	16.88	54.05	31.47	7.8	36.2	3.07
4960.00	43.83	AV	54	10.17	40.76	31.47	7.8	36.2	3.07
7440.00	55.12	PK	74	18.88	43.38	38.32	8.72	35.3	11.74
7440.00	41.38	PK	54	12.62	29.64	38.32	8.72	35.3	11.74

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

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.

Results of Band Edges Test (Radiated)

Note: GFSK, Pi/4 DQPSK and 8DPSK all have been tested, only worse case GFSK is reported.

GFSK

Frequency(MHz):			**2402**		**Polarity:**		**HORIZONTAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2390.00	56.22	PK	74	17.78	61.63	27.49	3.32	36.22	-5.41
2390.00	41.88	AV	54	12.12	47.29	27.49	3.32	36.22	-5.41
Frequency(MHz):			**2402**		**Polarity:**		**VERTICAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2390.00	57.24	PK	74	16.76	62.65	27.49	3.32	36.22	-5.41
2390.00	41.94	AV	54	12.06	47.35	27.49	3.32	36.22	-5.41
Frequency(MHz):			**2480**		**Polarity:**		**HORIZONTAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2483.50	56.35	PK	74	17.65	61.86	27.45	3.38	36.34	-5.51
2483.50	38.76	AV	54	15.24	44.27	27.45	3.38	36.34	-5.51
Frequency(MHz):			**2480**		**Polarity:**		**VERTICAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2483.50	57.13	PK	74	16.87	62.64	27.45	3.38	36.34	-5.51
2483.50	39.77	AV	54	14.23	45.28	27.45	3.38	36.34	-5.51

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
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.

3.3 Maximum Peak Output Power

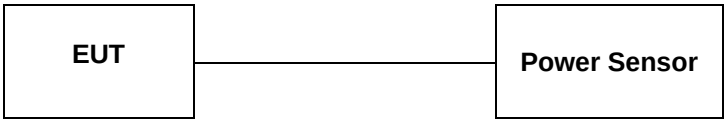
Limit

The Maximum Peak Output Power Measurement is 125mW (20.97).

Test Procedure

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

Test Configuration



Test Results

Type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK	00	3.13	20.97	Pass
	39	1.68		
	78	2.08		
π/4DQPSK	00	0.79	20.97	Pass
	39	-0.87		
	78	-0.7		
8DPSK	00	1.39	20.97	Pass
	39	-0.32		
	78	-0.04		

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

3.4 20dB Bandwidth

Limit

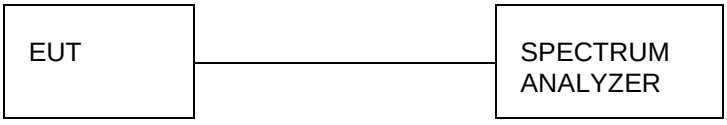
For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwidth.

Test Procedure

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

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

Test Configuration



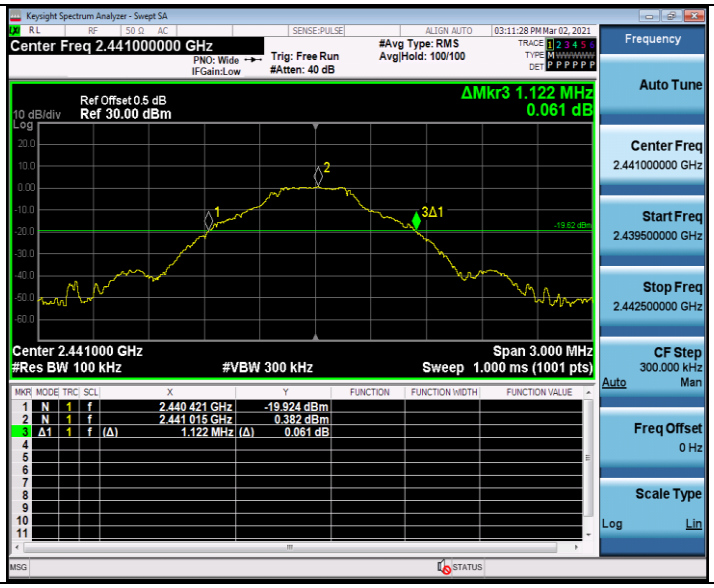
Test Results

Modulation	Channel	20dB bandwidth (MHz)	Result
GFSK	CH00	1.119	Pass
	CH39	1.122	
	CH78	1.110	
π/4DQPSK	CH00	1.389	
	CH39	1.377	
	CH78	1.386	
8DPSK	CH00	1.401	
	CH39	1.389	
	CH78	1.365	

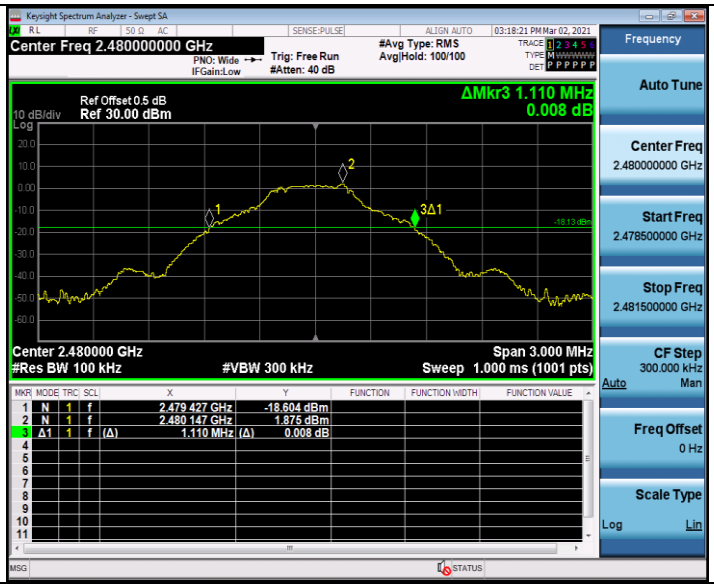
Test plot as follows:

GFSK Modulation

CH00

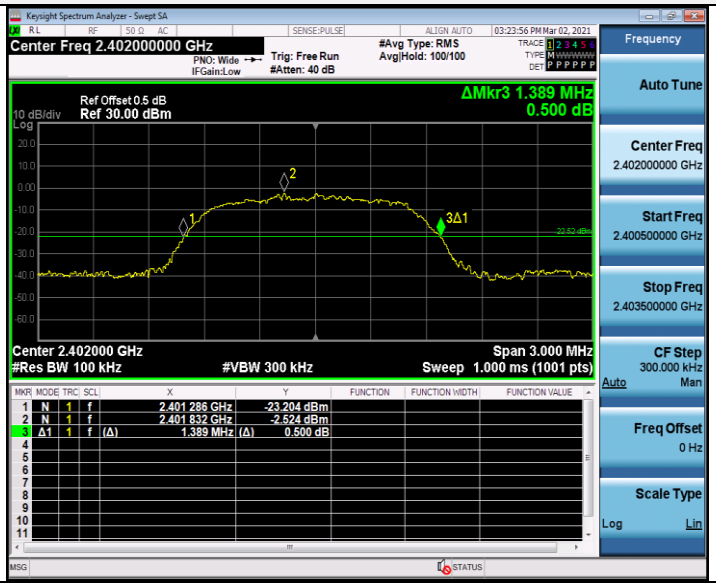


CH39

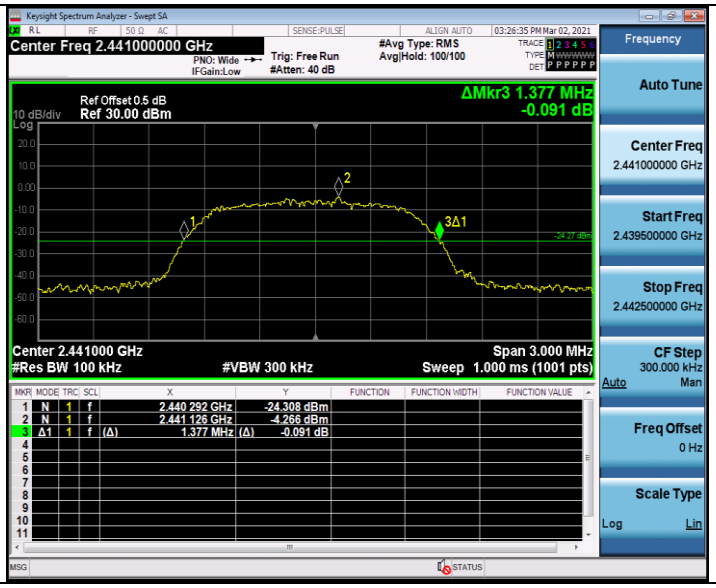


CH78

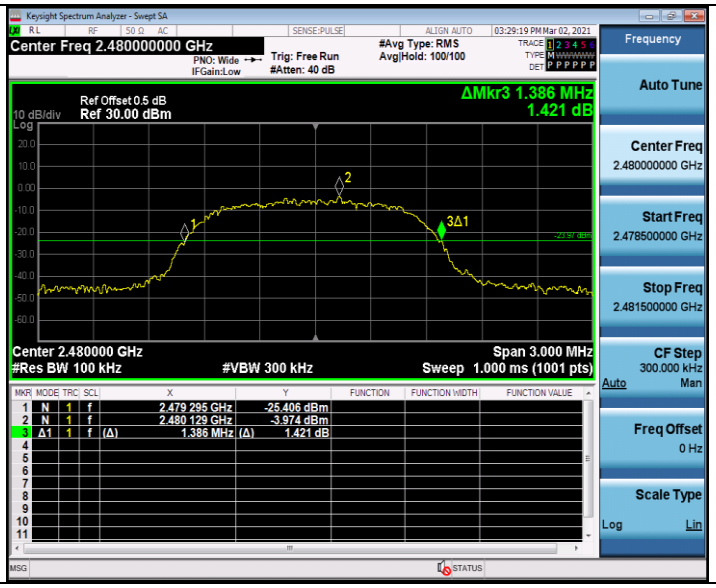
π/4DQPSK Modulation



CH00

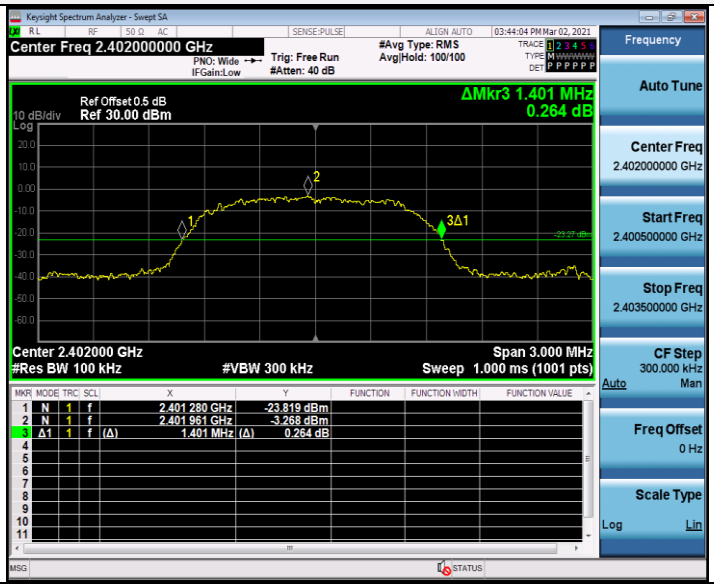


CH39

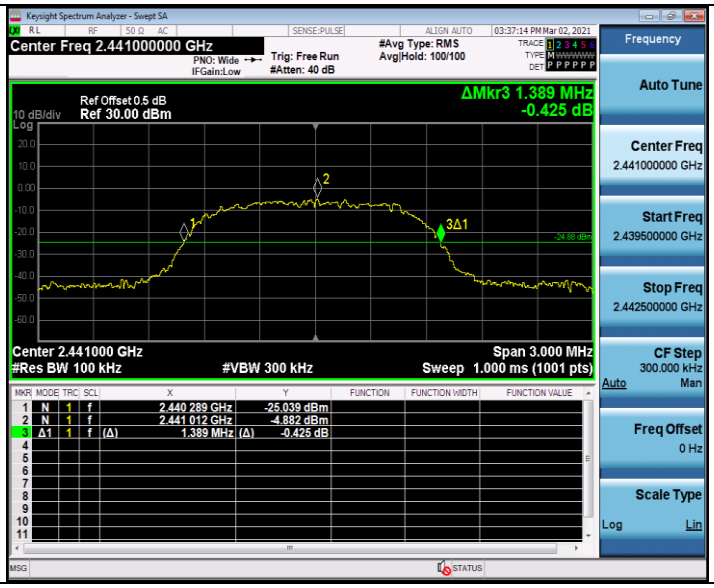


CH78

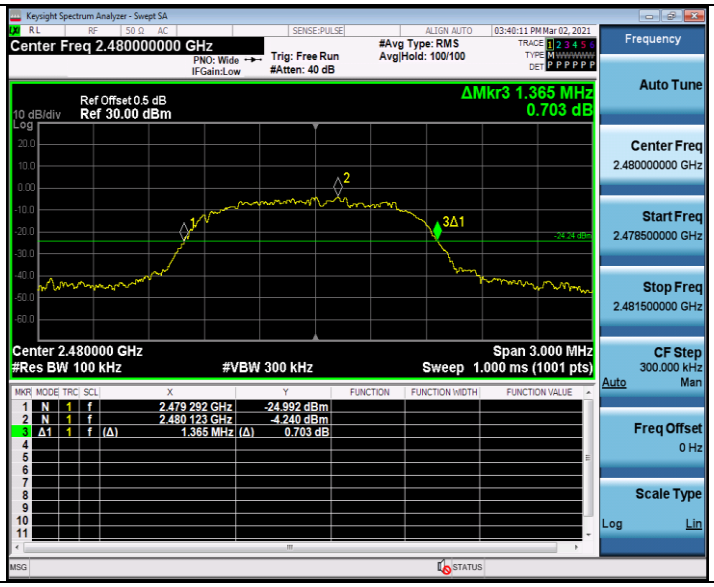
8DPSK Modulation



CH00



CH39



CH78

3.5 Frequency Separation

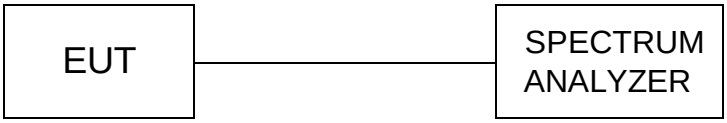
LIMIT

According to 15.247(a)(1),frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the 2/3*20dB 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 with100 KHz RBW and 300 KHz VBW.

TEST CONFIGURATION

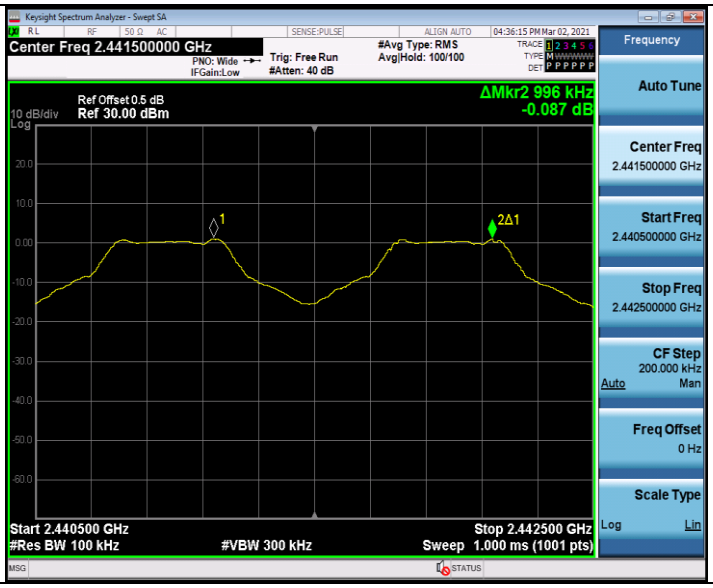


TEST RESULTS

Modulation	Channel	Channel Separation (MHz)	Limit(MHz)	Result
GFSK	CH38	0.996	25KHz or 2/3*20dB bandwidth	Pass
	CH39			
π/4DQPSK	CH38	1.006	25KHz or 2/3*20dB bandwidth	Pass
	CH39			
8DPSK	CH38	0.996	25KHz or 2/3*20dB bandwidth	Pass
	CH39			

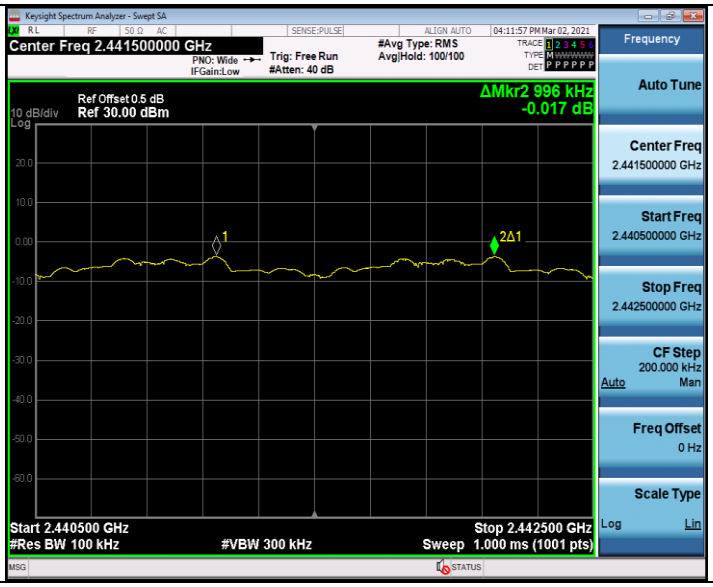
Note:
We have tested all mode at high, middle and low channel, and recorded worst case at middle

Test plot as follows:



GFSK

π/4DQPSK



8DPSK

3.6 Number of hopping frequency

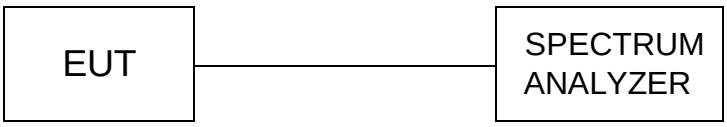
Limit

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

Test Procedure

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

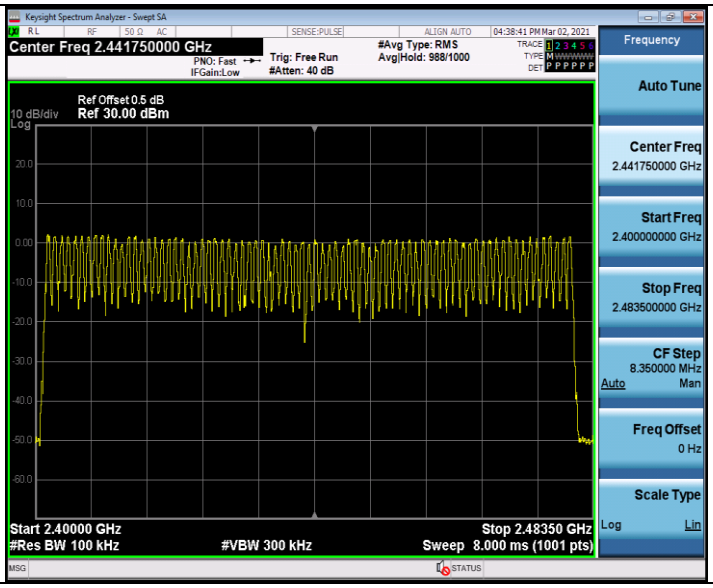
Test Configuration



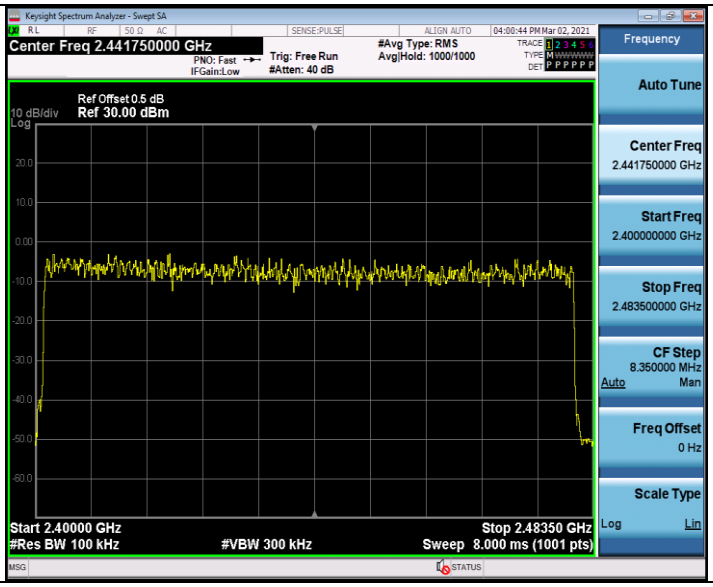
Test Results

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

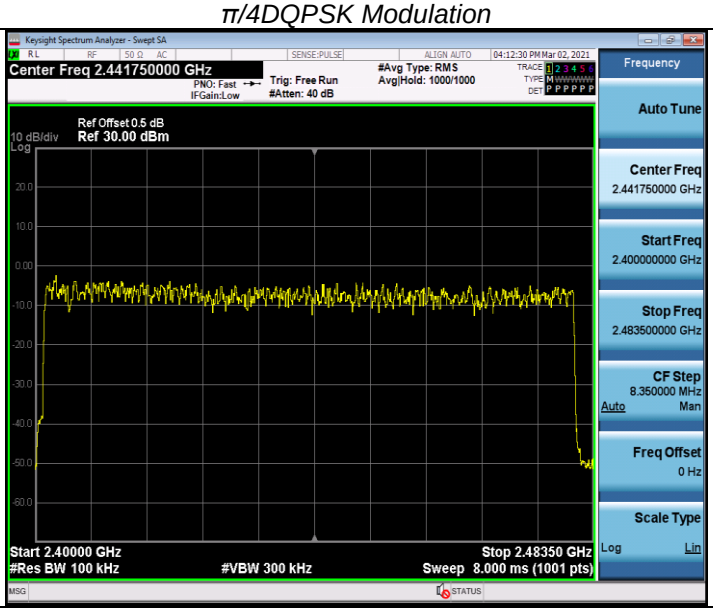
Test plot as follows:



GFSK Modulation



π/4DQPSK Modulation



8DPSK Modulation

3.7 Time of Occupancy (Dwell Time)

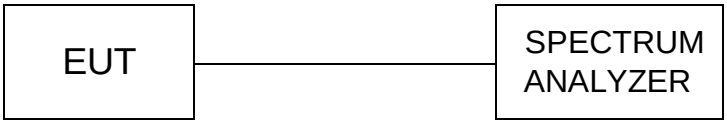
Limit

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 1MHz VBW, Span 0Hz.

Test Configuration



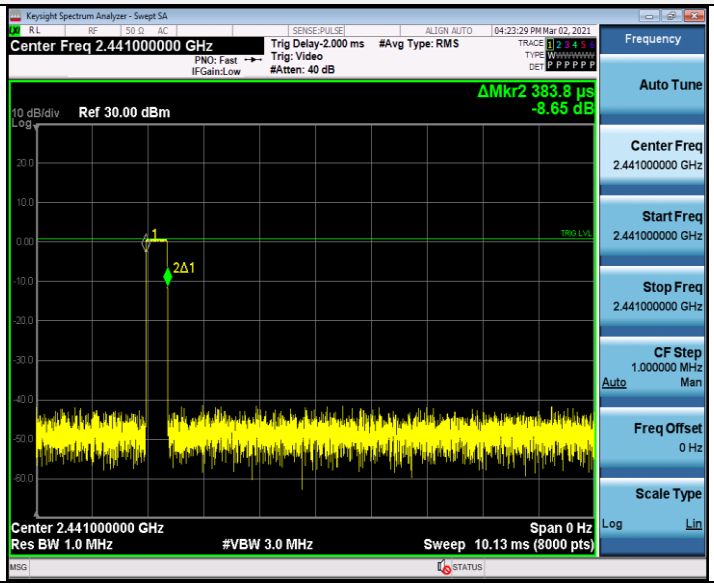
Test Results

Modulation	Packet	Burst time (ms)	Dwell time (s)	Limit (s)	Result
GFSK	DH1	0.384	0.123	0.40	Pass
	DH3	1.639	0.262		
	DH5	2.888	0.308		
π/4DQPSK	2-DH1	0.386	0.124	0.40	Pass
	2-DH3	1.638	0.262		
	2-DH5	2.885	0.308		
8DPSK	3-DH1	0.385	0.123	0.40	Pass
	3-DH3	1.637	0.262		
	3-DH5	2.888	0.308		

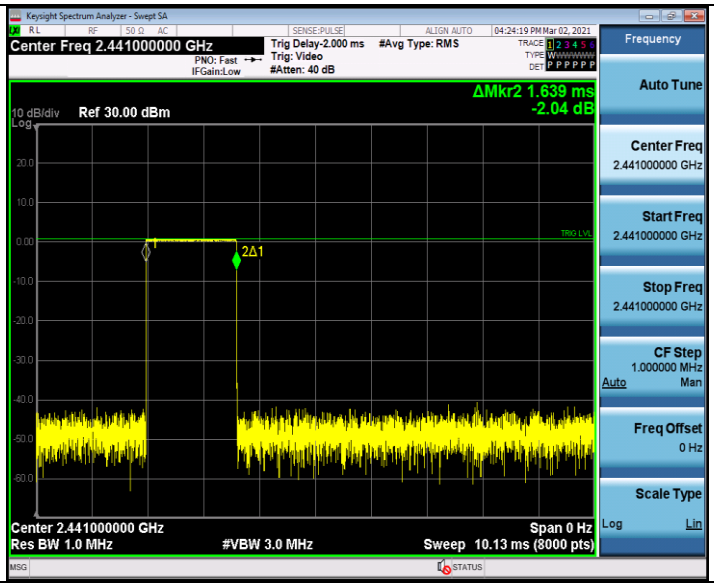
Note:We have tested all mode at high,middle and low channel,and recoreded worst case at middle channel.
Dwell time=Pulse time (ms) × (1600 ÷ 2 ÷ 79) ×31.6 Second for DH1, 2-DH1,
Dwell time=Pulse time (ms) × (1600 ÷ 4 ÷ 79) ×31.6 Second for DH3, 2-DH3,
Dwell time=Pulse time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 Second for DH5, 2-DH5,

Test plot as follows:

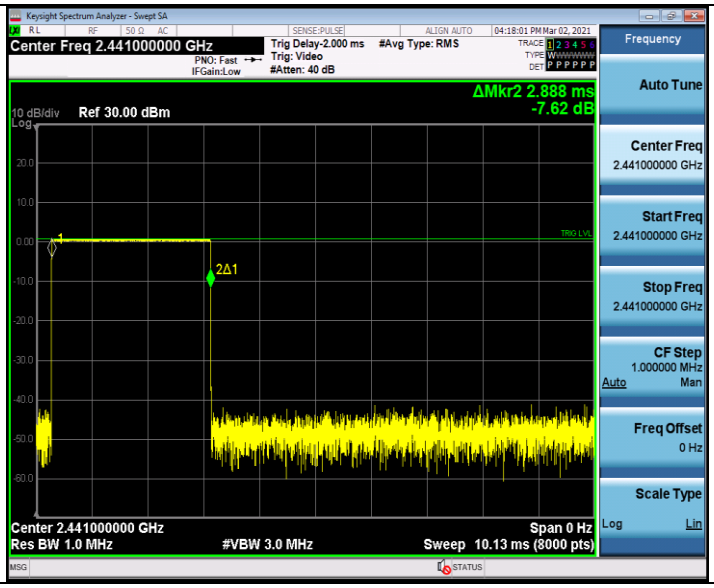
GFSK Modulation



DH1 burst time

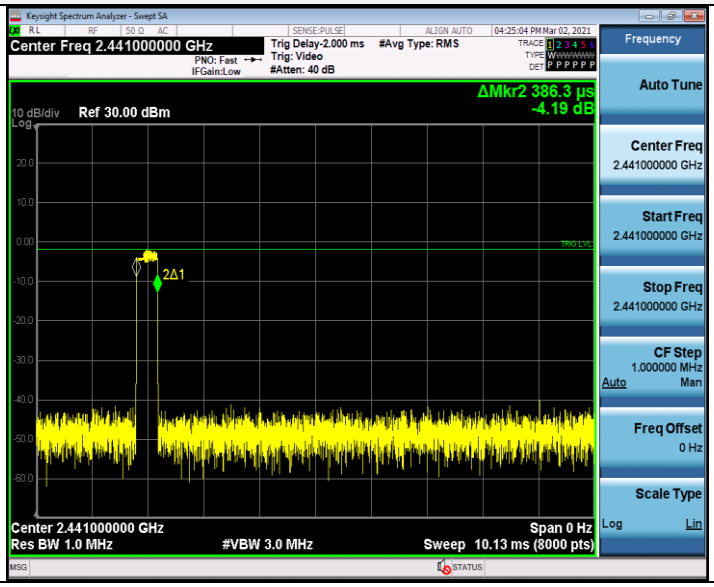


DH3 burst time



DH5 burst time

π/4DQPSK Modulation

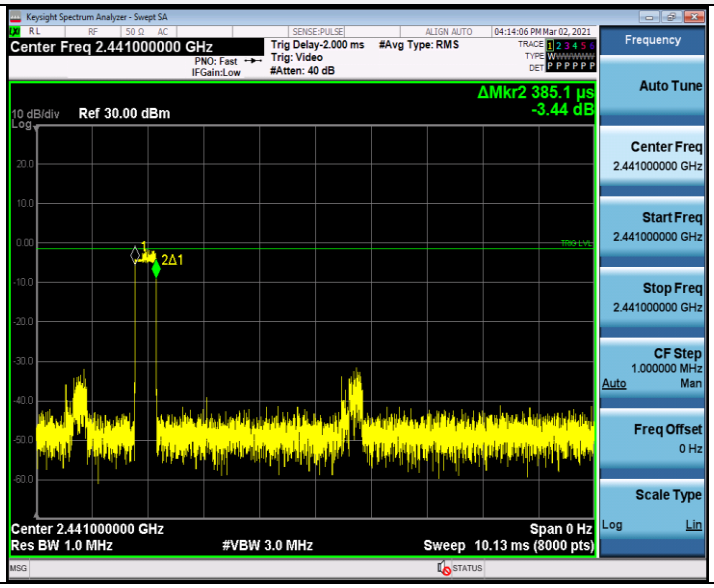


2-DH1 burst time

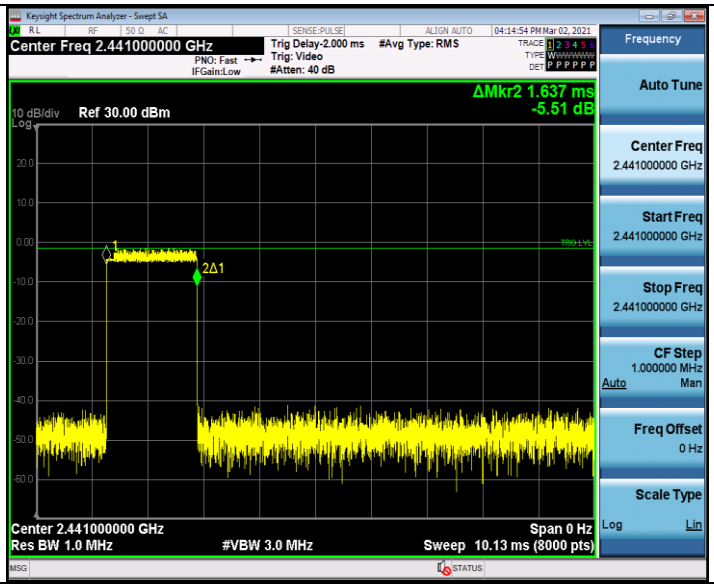
2-DH3 burst time

2-DH5 burst time

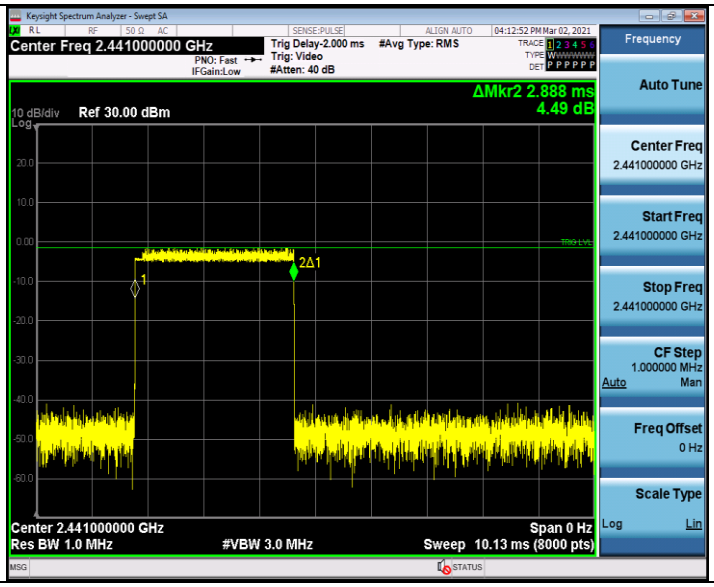
8DPSK Modulation



3-DH1 burst time



3-DH3 burst time



3-DH5 burst time

3.8 Out-of-band Emissions

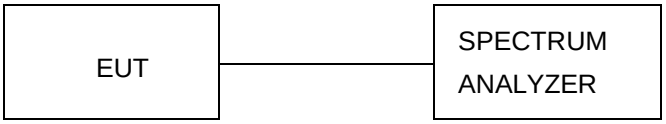
Limit

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 con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies 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.

Test Procedure

Connect the transmitter output to spectrum analyzer using a low loss RF cable, and set the spectrum analyzer to RBW=100 kHz, VBW= 300 kHz, peak detector , and max hold. Measurements utilizing these setting are made of the in-band reference level, bandedge and out-of-band emissions.

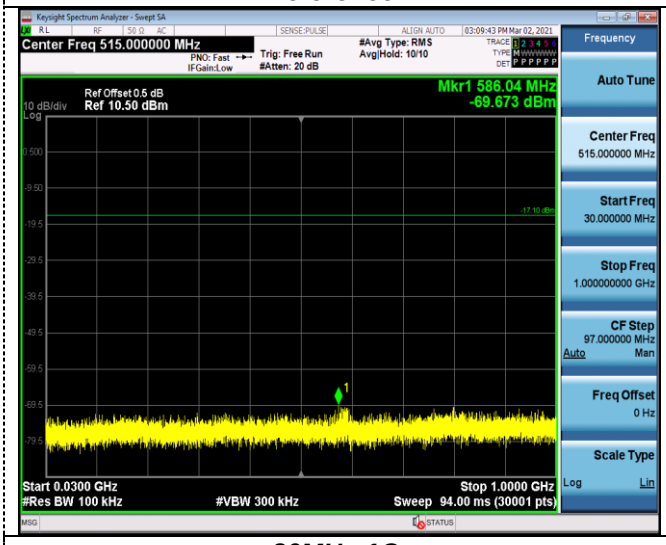
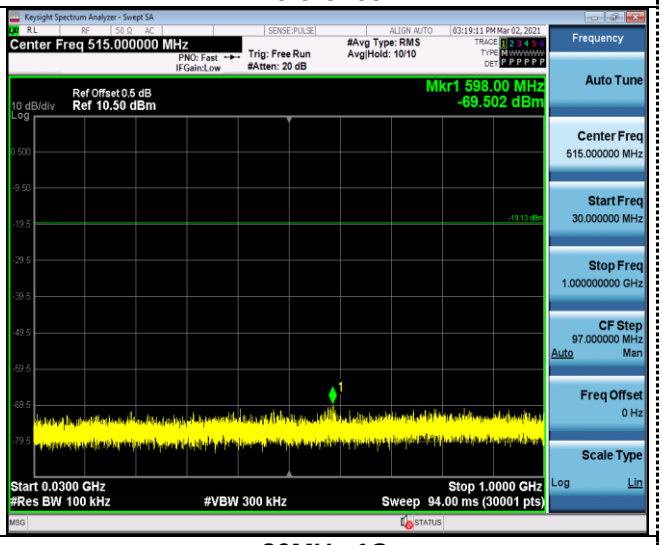
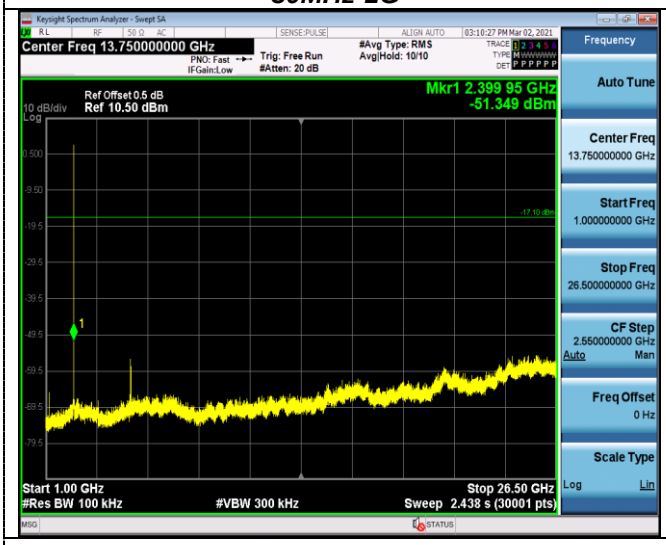
Test Configuration



Test Results

Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandage measurement data.
We measured all conditions (DH1, DH3, DH5) and recorded worst case at DH5

Test plot as follows:

GFSK(CH00)	GFSK(CH39)
reference	reference
	
30MHz-1G	30MHz-1G
	
1G-26.5G	1G-26.5G