RADIO TEST REPORT

FCC ID:2AAUI-GDIEXPLR

IC: 11210A-GDIEXPLR

Product: ECOXPLORER

Trade Name: ECOXGEAR

Model Name: GDI-EXPLR100

Serial Model: GDI-EXPLR101, GDI-EXPLR102, GDI-EXPLR103, GDI-EXPLR104,GDI-EXPLR105, GDI-EXPLR106, GDI-EXPLR107, GDI-EXPLR108, GDI-EXPLR109, GDI-EXPLR110, GDI-EXPLR111, GDI-EXPLR112, GDI-EXPLR113, GDI-EXPLR114, GDI-EXPLR115, GDI-EXPLR116, GDI-EXPLR117, GDI-EXPLR118, GDI-EXPLR119, GDI-EXPLR120

Report No.: UNIA2018110217FR-01

Prepared for

Grace Digital Inc.

10531 4S Commons Drive #166 Suite #430 San Diego,CA 92127,United States

Prepared by

Shenzhen United Testing Technology Co., Ltd.

2F, Annex Bldg, Jiahuangyuan Tech Park, #365 Baotian 1 Rd, Tiegang Community, XixiangStr, Bao'an District, Shenzhen, China

TEST RESULTCERTIFICATION

Applicant's name	:	Grace Digital Inc
Address	:	10531 4S Commons Drive #166 Suite #430 San Diego,CA 92127,United States
Manufacture's Name	:	NEO Telecom Corporation
Address	:	7F, 674-24, Anyang Dong, Manan Gu, Anyang City, Kyunggi Do South Korea

Product description

Product name	:	ECOXPLORER
Trade Mark	:	ECOXGEAR
Model and/or type reference	:	GDI-EXPLR100, GDI-EXPLR101, GDI-EXPLR102, GDI-EXPLR103, GDI-EXPLR104,GDI-EXPLR105, GDI-EXPLR106, GDI-EXPLR107, GDI-EXPLR108, GDI-EXPLR109, GDI-EXPLR110, GDI-EXPLR111, GDI-EXPLR112, GDI-EXPLR113, GDI-EXPLR114, GDI-EXPLR115, GDI-EXPLR116, GDI-EXPLR117, GDI-EXPLR118, GDI-EXPLR119, GDI-EXPLR120
Standards	:	FCC Rules and Regulations Part 15 Subpart C Section 15.247 ANSI C63.10: 2013 RSS-247-Issue 2 RSS-Gen Issue 5

This device described above has been tested by Shenzhen United Testing Technology Co., Ltd., 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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Date of Test	:	Oct. 30, 2018
Date (s) of performance of tests	:	Oct. 30, 2018--Nov.09 2018
Date of Issue	:	Nov.09, 2018
Test Result	:	Pass

Prepared by: Kaln.Yang

Kaln.yang/Editor

Reviewer: Sherwin Qian

Sherwin Qian/Supervisor

Approved & Authorized Signer: Liuze

Liuze/Manager

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1 TEST SUMMARY

1.1 Environment conditions

During the measurement the environment condition were within the listed ranges：

Normal temperature	25℃
Relative humidity	55%
Air pressure	101KPa

1.2 SUMMARY of TEST RESULTS

FCC Part 15.207 RSS-Gen 8.8	AC Power Conducted Emission	PASS
FCC Part 15.205/ 15.209 RSS-Gen 8.9	Radiated Emissions	PASS
FCC Part 15.247(d) RSS-Gen 8.10	Band Edge Compliance of RF Emission	PASS
FCC Part 15.247(b) RSS 247 5.4 (d)	Maximum Conducted Output Power	PASS
FCC Part 15.247(a)(1)(i) RSS 247 5.1 (1) RSS-Gen 4.6	20dB Bandwidth& 99% Bandwidth	PASS
FCC Part 15.247(d) RSS 247 5.5	Spurious RF Conducted Emission	PASS
FCC Part 15.247(g)(h) RSS 247 5.1 (1)	Pseudorandom Frequency Hopping Sequence	PASS
FCC Part 15.247(a)(1)(iii)	Number of hopping frequency& Time of Occupancy	PASS
FCC Part 15.247(a)(1)	Frequency Separation	PASS
FCC Part 15.203/15.247 (b) RSS-Gen.6.7	Antenna Requirement	PASS

1.3 TEST FACILITY

Test Firm : Shenzhen United Testing Technology Co.,Ltd.

Address :2F, Annex Bldg, JiahuangyuanTech Park, #365 Baotian 1 Rd,TiegangCommunity, XixiangStr, Bao'an District, Shenzhen,China

The testing quality ability of our laboratory meet with "Quality Law of People's Republic of China" Clause 19.The testing quality system of our laboratory meets with ISO/IEC-17025 requirements, which is approved by CNAS. This approval result is accepted by MRA of APLAC.

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

CNAS-LAB Code: L6494

The EMC Laboratory has been assessed and in compliance with CNAS-CL01 accreditation criteria for testing Laboratories (identical to ISO/IEC 17025:2017 General Requirements) for the Competence of testing Laboratories.

Designation Number: CN1227

Test Firm Registration Number: 674885

The 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.

1.4 MEASUREMENT UNCERTAINTY

Measurement Uncertainty

Conducted Emission Expanded Uncertainty	=	2.23dB, k=2
Radiated emission expanded uncertainty(9kHz-30MHz)	=	3.08dB, k=2
Radiated emission expanded uncertainty(30MHz-1000MHz)	=	4.42dB, k=2
Radiated emission expanded uncertainty(Above 1GHz)	=	4.06dB, k=2

2 GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

Equipment	ECOXPLORER
Trade Mark	ECOXGEAR
Model Name	GDI-EXPLR100
Serial No.	GDI-EXPLR101, GDI-EXPLR102, GDI-EXPLR103, GDI-EXPLR104,GDI-EXPLR105, GDI-EXPLR106, GDI-EXPLR107, GDI-EXPLR108, GDI-EXPLR109, GDI-EXPLR110, GDI-EXPLR111, GDI-EXPLR112, GDI-EXPLR113, GDI-EXPLR114, GDI-EXPLR115, GDI-EXPLR116, GDI-EXPLR117, GDI-EXPLR118, GDI-EXPLR119, GDI-EXPLR120
Model Difference	All models have the same functionality, software and electronics, only the color, front frame shape and model names may differ. Test sample model:GDI-EXPLR100
FCC ID	2AAUI-GDIEXPLR
IC	11210A -GDIEXPLR
Antenna Type	PCB Antenna
Antenna Gain	0.0 dBi
Frequency Range	2402MHz - 2480MHz
Number of Channels	79
Modulation Type	GFSK, π /4DQPSK, 8DPSK
Battery	DC 12.0V / 3ah/20HR
PowerSource	DC 12.0V from battery charged by adapter
Adapter Model	GA160015

2.2 CARRIER FREQUENCY OF CHANNELS

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

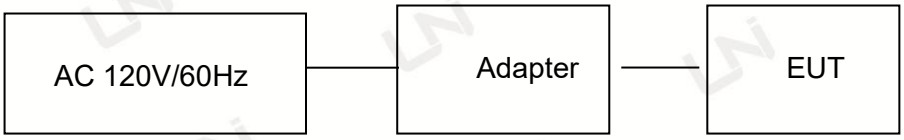
2.3 OPARATION OF EUT DURING TESTING

Operating Mode
The mode is used: Transmitting mode

Low Channel	2402MHz
Middle Channel	2441MHz
High Channel	2480MHz

2.4 DESCRIPTION OF TEST SETUP

Operation of EUT during Conducted testing:



AC/DC adapter
MODEL:GA160015
INPUT:100-240~,50/60Hz, 1.0A
OUTPUT: 16.0V ⎓ 1.5A ⊖-⊂-⊕

Operation of EUT during Radiation and Above1GHz Radiation testing:

2.5 MEASUREMENT INSTRUMENTS LIST

Item	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
CONDUCTED EMISSIONS TEST					
1	AMN	Schwarzbeck	NNLK8121	8121370	2019.09.09
2	AMN	ETS	3810/2	00020199	2019.09.09
3	EMI TEST RECEIVER	Rohde&Schwarz	ESCI	101210	2019.09.09
4	AAN	TESEQ	T8-Cat6	38888	2019.09.09
RADIATED EMISSION TEST					
1	Horn Antenna	Sunol	DRH-118	A101415	2019.09.29
2	BicoNILog Antenna	Sunol	JB1 Antenna	A090215	2019.09.29
3	PREAMP	HP	8449B	3008A00160	2019.09.09
4	PREAMP	HP	8447D	2944A07999	2019.09.09
5	EMI TEST RECEIVER	Rohde&Schwarz	ESR3	101891	2019.09.09
6	VECTOR Signal Generator	Rohde&Schwarz	SMU200A	101521	2019.09.28
7	Signal Generator	Agilent	E4421B	MY4335105	2019.09.28
8	MXA Signal Analyzer	Agilent	N9020A	MY50510140	2019.09.28
9	MXA Signal Analyzer	Agilent	N9020A	MY51110104	2019.09.09
10	ANT Tower&Turn table Controller	Champro	EM 1000	60764	2019.09.28
11	Anechoic Chamber	Taihe Maorui	9m*6m*6m	966A0001	2019.09.09
12	Shielding Room	Taihe Maorui	6.4m*4m*3m	643A0001	2019.09.09
13	RF Power sensor	DARE	RPR3006W	15I00041SNO88	2019.03.14
14	RF Power sensor	DARE	RPR3006W	15I00041SNO89	2019.03.14
15	RF power divider	Anritsu	K241B	992289	2019.09.28
16	Wideband radio communication tester	Rohde&Schwarz	CMW500	154987	2019.09.28
17	Biconical antenna	Schwarzbeck	VHA 9103	91032360	2019.09.08
18	Biconical antenna	Schwarzbeck	VHA 9103	91032361	2019.09.08
19	Broadband Hybrid Antennas	Schwarzbeck	VULB9163	VULB9163#958	2019.09.08
20	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1680	2019.01.12
21	Active Receive Loop Antenna	Schwarzbeck	FMZB 1919B	00023	2019.11.02
22	Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170651	2019.03.14
23	Microwave Broadband Preamplifier	Schwarzbeck	BBV 9721	100472	2019.10.24
24	Active Loop Antenna	Com-Power	AL-130R	10160009	2019.05.10
25	Power Meter	KEYSIGHT	N1911A	MY50520168	2019.05.10

Note: The calibration interval was one year

3 TEST CONDITIONS AND RESULTS

3.1 CONDUCTED EMISSIONS TEST

Limit

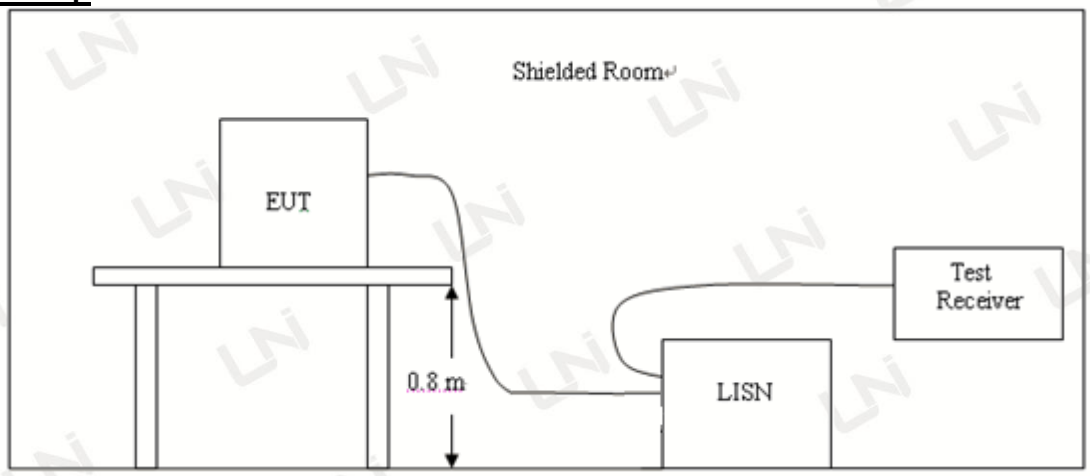
According to FCC CFR Title 47 Part 15 Subpart C Section 15.207 and RSS Gen 8.8, AC Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus as below:

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

* Decreasing linearly with the logarithm of the frequency

For intentional device, according to §15.207(a) Line Conducted Emission Limit is same as above table.

Test Setup



Test Procedure

1,The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. A wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10.

2, Support equipment, if needed, was placed as per ANSI C63.10.

3, All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.

4, If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC 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.

Test Result

---PASS---

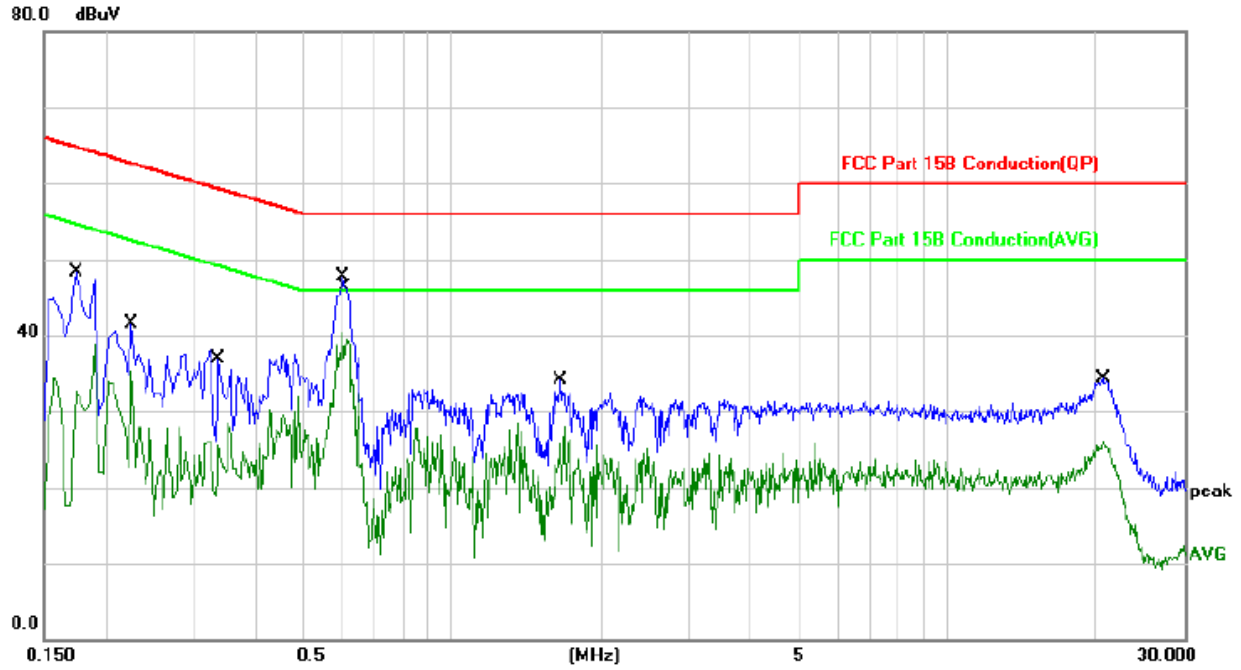
Remark:

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:.

Please refer to test data as follows:

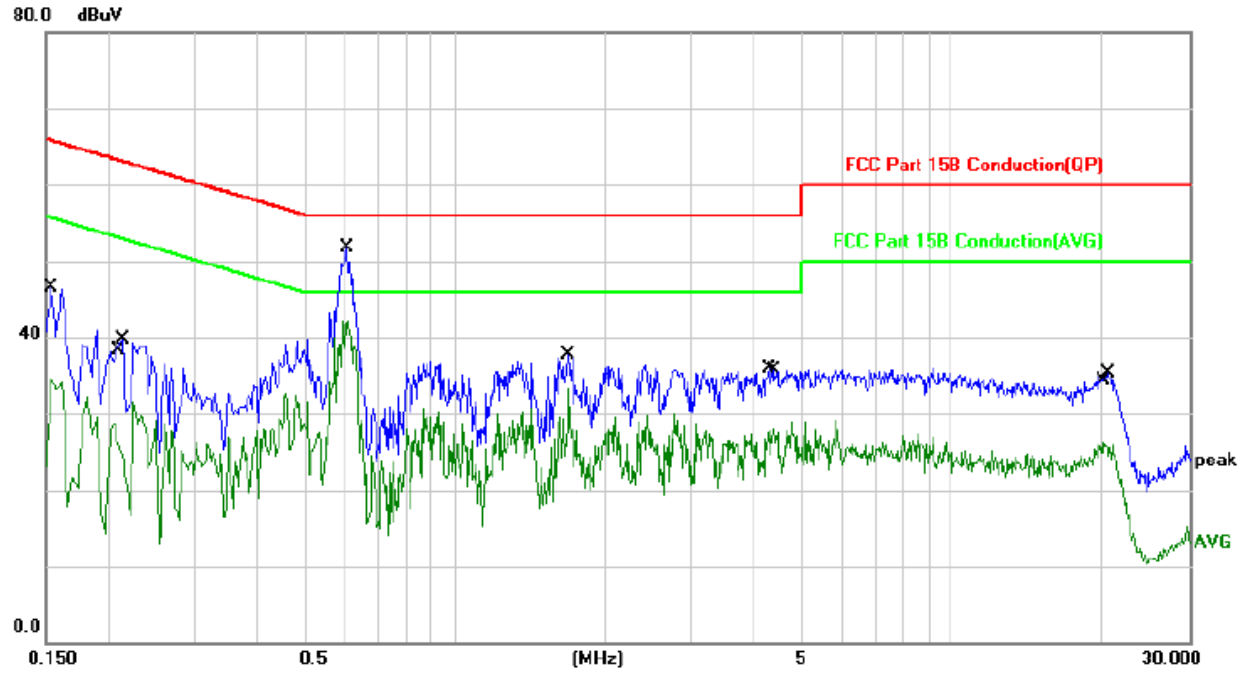
Temperature:	25℃	Relative Humidity:	48%
Test Date:	Nov.05, 2018	Pressure:	1030hPa
Test Voltage:	AC 120V 60Hz	Polarization:	

Line	L



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1740	48.04	0.19	48.23	64.76	-16.53	QP	
2		0.1740	32.43	0.19	32.62	54.76	-22.14	AVG	
3		0.2260	41.27	0.20	41.47	62.59	-21.12	QP	
4		0.2260	35.08	0.20	35.28	52.59	-17.31	AVG	
5		0.3379	36.67	0.32	36.99	59.25	-22.26	QP	
6		0.3379	25.22	0.32	25.54	49.25	-23.71	AVG	
7		0.6020	47.33	0.33	47.66	56.00	-8.34	QP	
8	*	0.6140	39.07	0.33	39.40	46.00	-6.60	AVG	
9		1.6540	33.99	0.20	34.19	56.00	-21.81	QP	
10		20.5340	34.50	-0.12	34.38	60.00	-25.62	QP	
11		20.5340	26.25	-0.12	26.13	50.00	-23.87	AVG	

Line	N



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1539	46.39	0.17	46.56	65.78	-19.22	QP	
2		0.1539	34.26	0.17	34.43	55.78	-21.35	AVG	
3		0.2060	28.55	0.19	28.74	53.36	-24.62	AVG	
4		0.2140	39.58	0.20	39.78	63.04	-23.26	QP	
5		0.6060	51.33	0.33	51.66	56.00	-4.34	QP	
6	*	0.6100	41.82	0.33	42.15	46.00	-3.85	AVG	
7		1.6940	37.41	0.20	37.61	56.00	-18.39	QP	
8		1.6940	33.16	0.20	33.36	46.00	-12.64	AVG	
9		4.2900	35.84	-0.02	35.82	56.00	-20.18	QP	
10		4.3980	28.15	-0.01	28.14	46.00	-17.86	AVG	
11		20.1259	26.31	-0.11	26.20	50.00	-23.80	AVG	
12		20.5540	35.39	-0.12	35.27	60.00	-24.73	QP	

3.2 RADIATED EMISSION TEST

Limit

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.

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)

Except when the requirements applicable to a given device state otherwise, emissions from licence‑exempt transmitters shall comply with the field strength limits shown in table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission

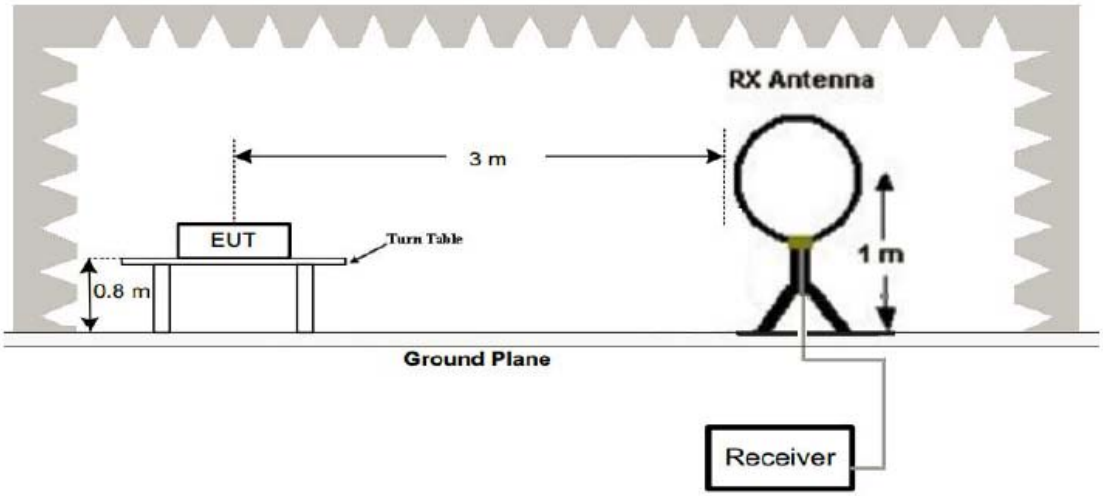
Unwanted emissions that fall into restricted bands shall comply with the limits specified in RSS-Gen; and Unwanted emissions that do not fall within the restricted frequency bands shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Radiated emission limits

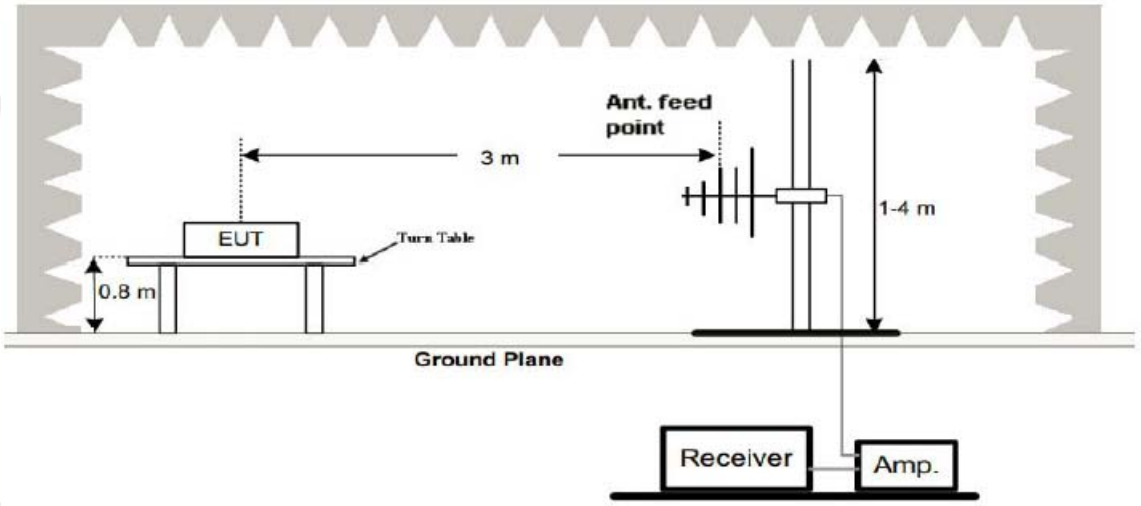
Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(30/3)	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

Test Setup

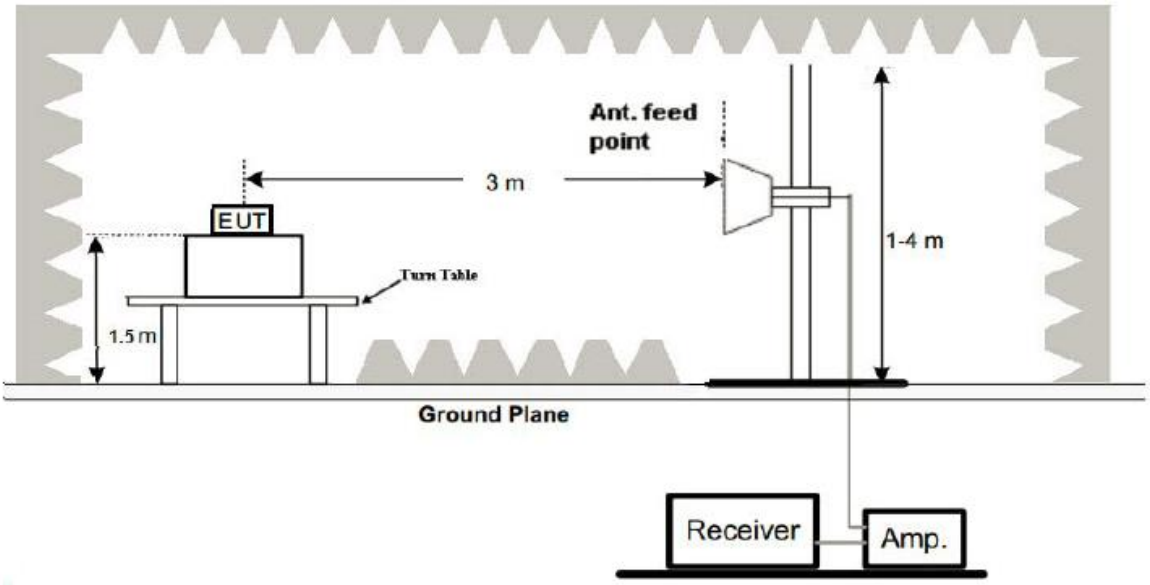
1. Radiated Emission Test-Up Frequency Below 30MHz



2. Radiated Emission Test-Up Frequency 30MHz~1GHz



3. Radiated Emission Test-Up Frequency Above 1GHz



Test Procedure

1. Below 1GHz measurement the EUT is placed on a turntable which is 0.8m above ground plane, and above 1GHz measurement EUT was placed on a low permittivity and low loss tangent turn table which is 1.5m above ground plane.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
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	Bilog Antenna	3
1GHz-18GHz	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

TEST RESULTS

---PASS---

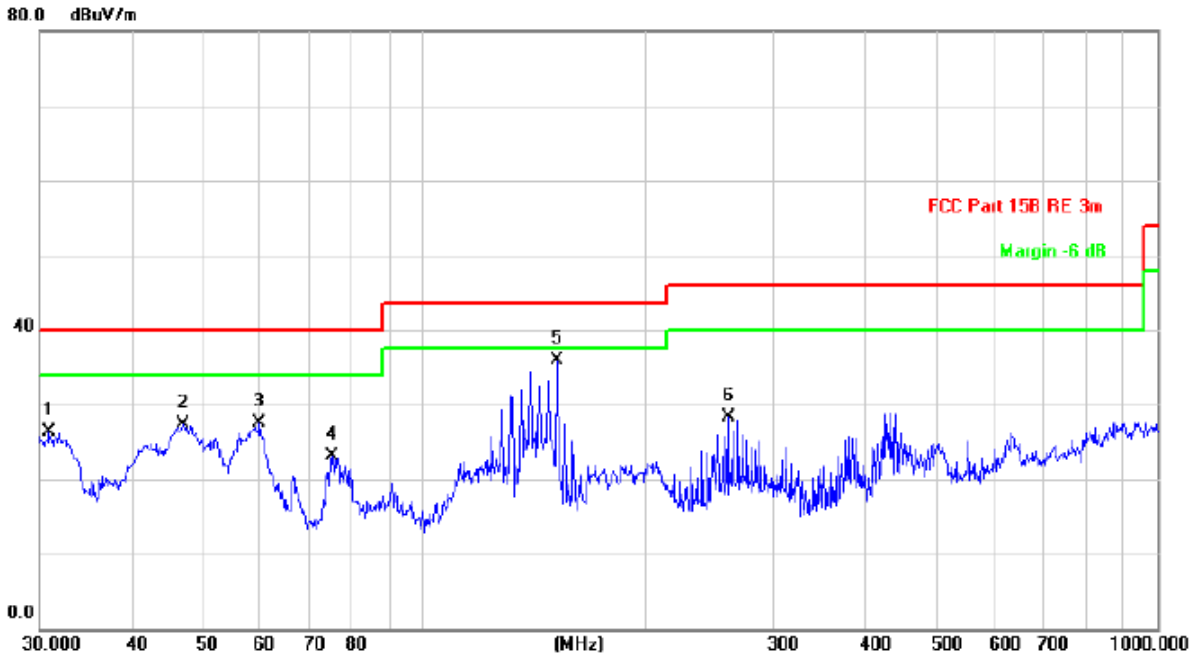
Remark:
1. All the test modes completed for test. Only the worst mode was reported.
2. By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that “Z axis” position was the worst, and test data recorded in this report.
3. Radiated emission test from 9KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9KHz to 30MHz and not recorded in this report.

Below 1GHz Test Results:

Note: For test below 1GHz 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:

Temperature:	25℃	Relative Humidity:	48%
Test Date:	Nov.05, 2018	Pressure:	1030hPa
Test Voltage:	AC 120V 60Hz	Polarization:	Horizontal/Vertical

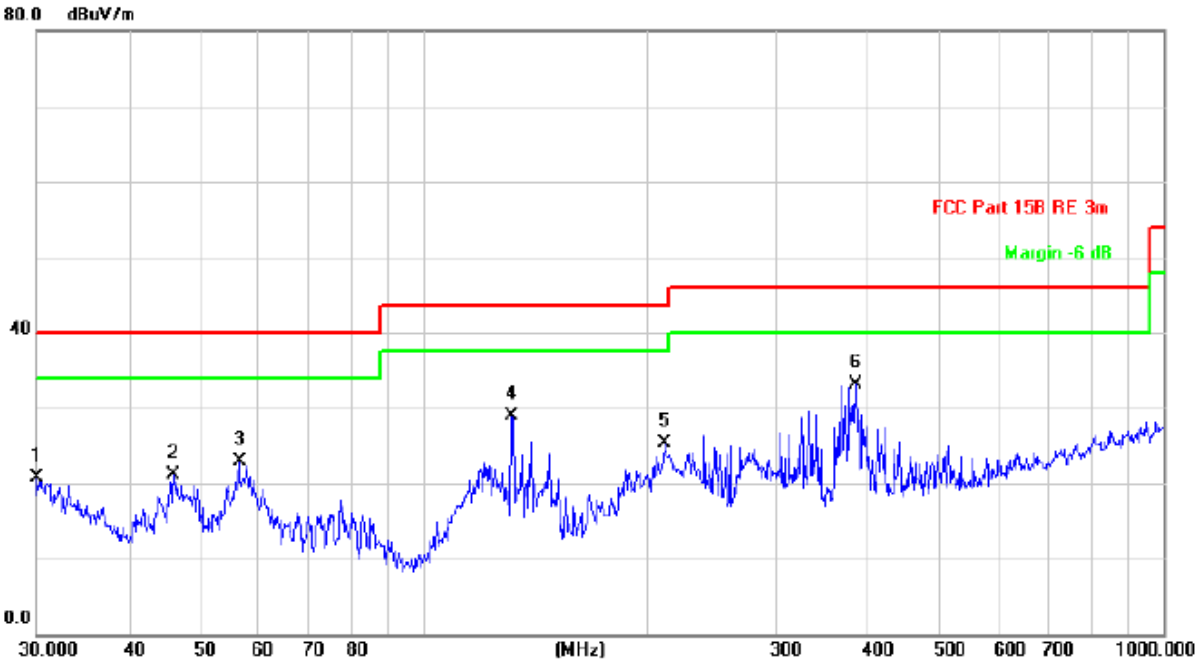
Polarization:	Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		30.9619	32.03	-5.71	26.32	40.00	-13.68	QP			
2		47.1599	44.45	-17.21	27.24	40.00	-12.76	QP			
3		59.8588	46.77	-19.17	27.60	40.00	-12.40	QP			
4		75.1822	42.13	-19.00	23.13	40.00	-16.87	QP			
5	*	152.1297	48.65	-12.79	35.86	43.50	-7.64	QP			
6		260.1444	40.40	-12.13	28.27	46.00	-17.73	QP			

Remark: Absolute Level= Reading Level+ Factor, Margin= Absolute Level – Limit
Factor=Ant. Factor + Cable Loss – Pre-amplifier

Polarization:	Vertical



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		30.0000	24.12	-3.50	20.62	40.00	-19.38	QP			
2		46.0162	36.98	-15.84	21.14	40.00	-18.86	QP			
3		56.3947	41.77	-18.88	22.89	40.00	-17.11	QP			
4		131.7576	41.71	-12.71	29.00	43.50	-14.50	QP			
5		212.2694	39.72	-14.46	25.26	43.50	-18.24	QP			
6	*	383.9318	42.11	-9.08	33.03	46.00	-12.97	QP			

Remark: Absolute Level= Reading Level+ Factor, Margin= Absolute Level – Limit
Factor=Ant. Factor + Cable Loss – Pre-amplifier

Remark：

(1) Measuring frequencies from 9 kHz to the 1 GHz, Radiated emission test from 9kHz to 30MHz was verified, and no any emission was found except system noise floor.

(2) * denotes emission frequency which appearing within the Restricted Bands specified in provision of 15.205, then the general radiated emission limits in 15.209 apply.

(3) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz.

Above 1 GHz Test Results:

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

GFSK: CH Low (2402MHz) Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.00	58.56	-3.43	54.92	74	19.08	PK
4804.00	45.28	-3.43	41.64	54	12.36	AV
5740.00	56.99	-2.34	54.65	74	19.35	PK
5740.00	44.61	-2.34	42.27	54	11.73	AV
7206.00	55.09	-0.75	54.14	74	19.86	PK
7206.00	41.65	-0.75	40.70	54	13.30	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin= Absolute Level – Limit						

GFSK: CH Low (2402MHz) Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804.00	57.03	-3.43	53.39	74	20.61	PK
4804.00	43.40	-3.43	39.76	54	14.24	AV
5740.00	57.01	-2.34	54.67	74	19.33	PK
5740.00	44.33	-2.34	41.99	54	12.01	AV
7206.00	55.37	-0.75	54.42	74	19.58	PK
7206.00	42.63	-0.75	41.68	54	12.32	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin= Absolute Level – Limit						

GFSK: CH Middle (2441MHz) Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.00	57.41	-3.51	53.90	74	20.10	PK
4882.00	43.97	-3.51	40.46	54	13.54	AV
5369.50	56.63	-2.41	54.22	74	19.78	PK
5369.50	44.62	-2.41	42.21	54	11.79	AV
7323.00	54.50	-0.82	53.68	74	20.32	PK
7323.00	40.85	-0.82	40.03	54	13.97	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin= Absolute Level – Limit						

GFSK: CH Middle (2441MHz) Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882.00	57.17	-3.51	53.66	74	20.34	PK
4882.00	43.80	-3.51	40.29	54	13.71	AV
5369.50	57.17	-2.41	54.76	74	19.24	PK
5369.50	45.81	-2.41	43.40	54	10.60	AV
7323.00	54.92	-0.82	54.10	74	19.90	PK
7323.00	42.38	-0.82	41.56	54	12.44	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin= Absolute Level – Limit						

GFSK: CH High (2480MHz) Horizontal:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.00	57.34	-3.43	53.91	74	20.09	PK
4960.00	45.56	-3.43	42.13	54	11.87	AV
5758.50	55.95	-2.33	53.62	74	20.38	PK
5758.50	44.89	-2.33	42.56	54	11.44	AV
7440.00	54.58	-0.75	53.83	74	20.17	PK
7440.00	40.51	-0.75	39.76	54	14.24	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin= Absolute Level – Limit						

GFSK: CH High (2480MHz) Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960.00	56.97	-3.43	53.54	74	20.46	PK
4960.00	45.64	-3.43	42.21	54	11.79	AV
5758.50	57.42	-2.33	55.09	74	18.91	PK
5758.50	44.45	-2.33	42.12	54	11.88	AV
7440.00	54.72	-0.75	53.97	74	20.03	PK
7440.00	42.11	-0.75	41.36	54	12.64	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Margin= Absolute Level – Limit						

Remark：
(1) Measuring frequencies from 1 GHz to the 25 GHz.
(2) Data of measurement within this frequency range shown “--- ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
(3) When the test results of Peak Detected below the limits of Average Detected, the Average Detected is not need completed. For example: Top Channel at Fundamental 73.16dBuV/m(PK Value) <93.98(AV Limit), at harmonic 53.20 dBuV/m(PK Value) <54 dBuV/m(AV Limit), the Average Detected not need to completed.
(4) All modes of operation were investigated and the worst-case emissions are reported.

3.3 BAND EDGE

Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

The band edge compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW to 100KHz and VBM to 300KHz to measure the peak field strength and set RBW to 1MHz and VBW to 10Hz to measure the average radiated field strength.The conducted RF band edge was measured by using a spectrum analyzer. Set span wide enough to capture the highest in-band emission and the emission at the band edge. Set RBW to 100 kHz and VBW to 300 kHz, to measure the conducted peak band edge.

Test Result

---PASS---

Radiated Band Edge Test:

Operation Mode: GFSK TX CH Low (2402MHz)

Horizontal (Worst case):

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2335.00	52.99	-5.78	47.21	74	26.79	PK
2335.00	/	/	/	54	/	AV
2390.00	56.10	-5.84	50.26	74	23.74	PK
2390.00	/	/	/	54	/	AV
2400.00	57.08	-5.84	51.24	74	22.76	PK
2400.00	/	/	/	54	/	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2335.00	54.03	-5.78	48.25	74	25.75	PK
2335.00	/	/	/	54	/	AV
2390.00	56.43	-5.84	50.59	74	23.41	PK
2390.00	/	/	/	54	/	AV
2400.00	57.52	-5.84	51.68	74	22.32	PK
2400.00	/	/	/	54	/	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Operation Mode: GFSK TX CH High (2480MHz)

Horizontal (Worst case):

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2483.50	55.88	-5.65	50.23	74	23.77	PK
2483.50	/	/	/	54	/	AV
2489.00	54.21	-5.65	48.56	74	25.44	PK
2489.00	/	/	/	54	/	AV
2500.00	51.92	-5.72	46.20	74	27.80	PK
2500.00	/	/	/	54	/	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Reading Result (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2483.50	57.21	-5.65	51.56	74	22.44	PK
2483.50	/	/	/	54	/	AV
2489.00	55.17	-5.65	49.52	74	24.48	PK
2489.00	/	/	/	54	/	AV
2500.00	52.83	-5.72	47.11	74	26.89	PK
2500.00	/	/	/	54	/	AV
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

3.4 CONDUCTED OUTPUT POWER

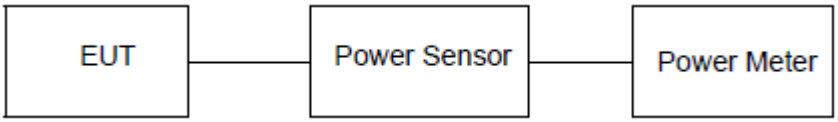
Limit

The Maximum Peak Output Power Measurement is 30dBm.

Test Procedure

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

Test Configuration



Test Result

Type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK	00	2.750	20.97	Pass
	39	2.463		
	78	2.435		
π/4DQPSK	00	2.735	20.97	Pass
	39	2.035		
	78	2.065		
8DPSK	00	2.671	20.97	Pass
	39	2.516		
	78	2.529		

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

3.5 OCCUPIED BANDWIDTH MEASUREMENT

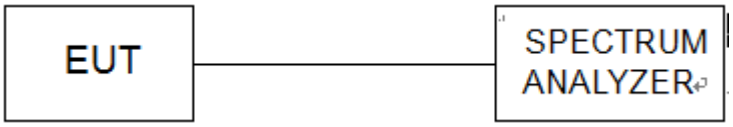
Limit

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



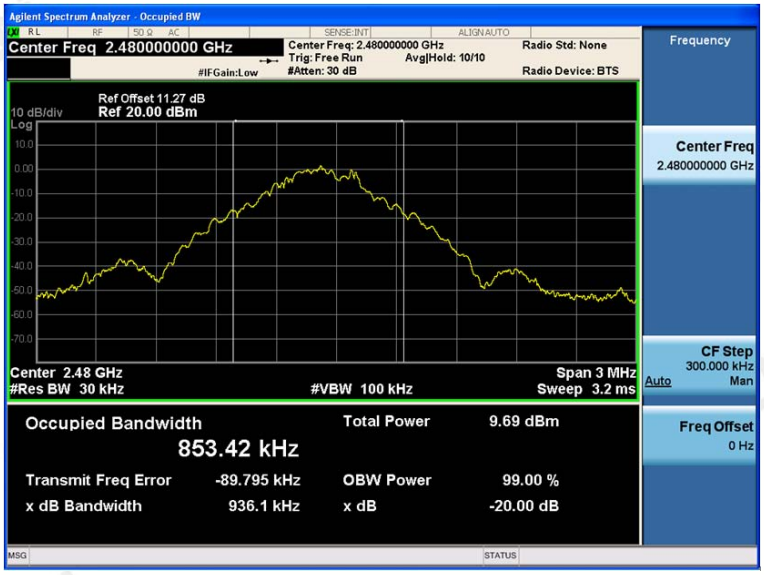
Test Result

---PASS---

Modulation	Channel	20dB bandwidth (MHz)	99% OBW (MHz)	Result
GFSK	CH00	0.9393	0.87111	Pass
	CH39	0.9388	0.85350	
	CH78	0.9361	0.85342	
π/4DQPSK	CH00	1.255	1.1675	
	CH39	1.225	1.1652	
	CH78	1.228	1.1642	
8DPSK	CH00	1.263	1.1545	
	CH39	1.261	1.1583	
	CH78	1.254	1.1614	

GFSK Modulation
CH00

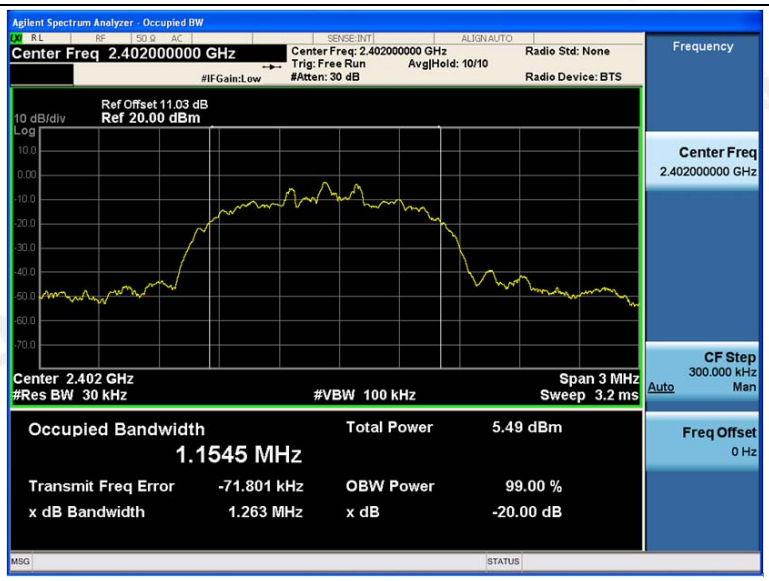
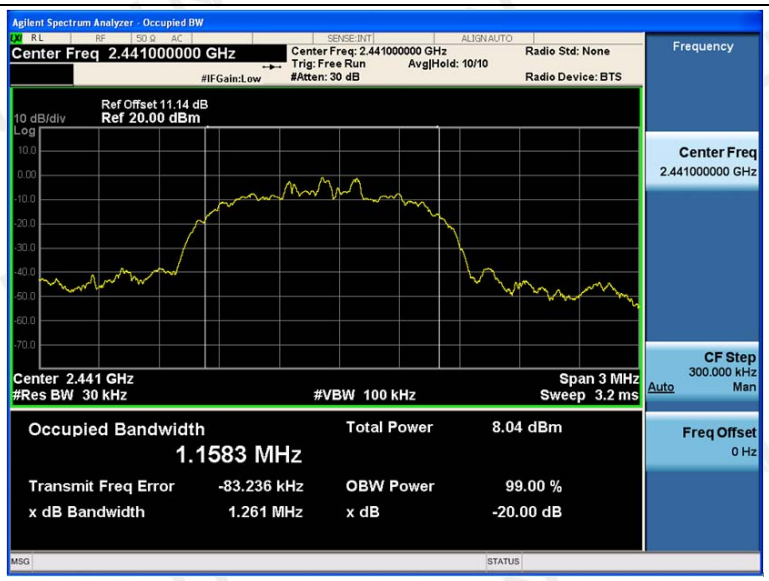
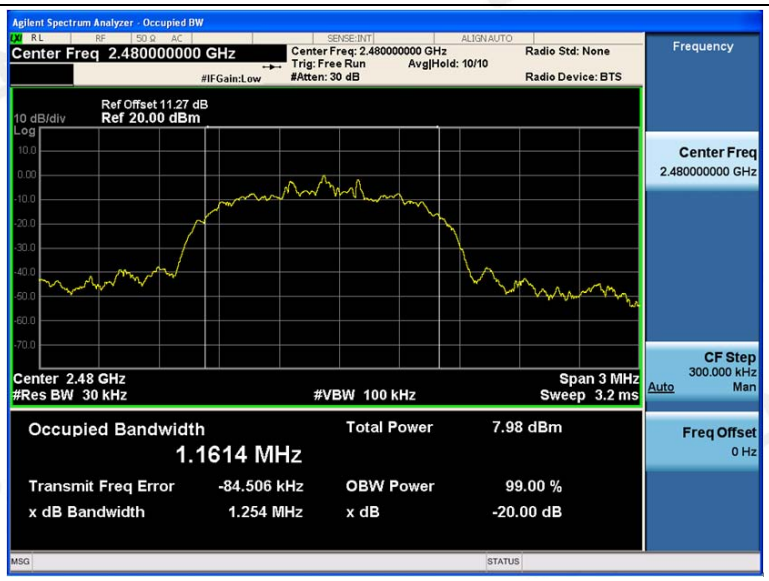
CH39

CH78


π/4DQPSK Modulation
CH00

CH39

CH78


8DPSK Modulation
CH00

CH39

CH78


3.6 Frequency Separation

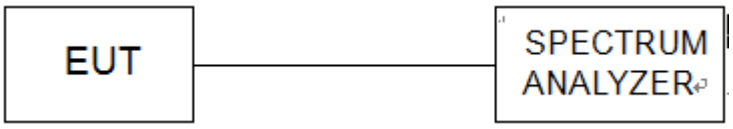
LIMIT

According to 15.247(a)(1),frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the 2/3*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

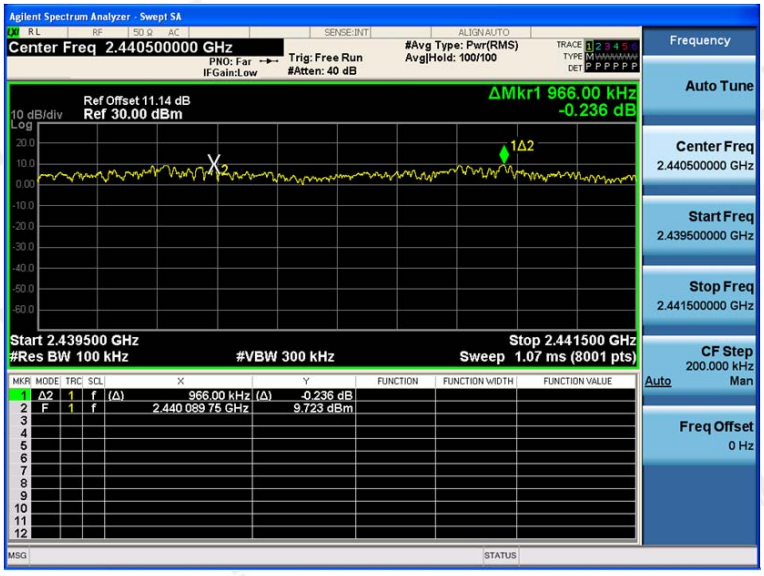
Modulation	Channel	Channel Separation (MHz)	Limit(MHz)	Result
GFSK	CH38	0.955	25KHz or 2/3*20dB bandwidth	Pass
	CH39			
π/4DQPSK	CH38	0.966	25KHz or 2/3*20dB bandwidth	Pass
	CH39			
8DPSK	CH38	0.852	25KHz or 2/3*20dB bandwidth	Pass
	CH39			

Note:

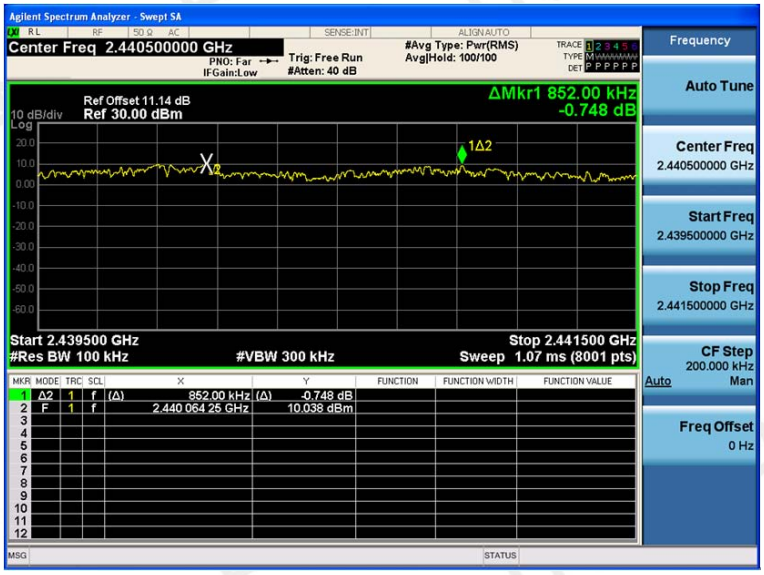
We have tested all mode at high, middle and low channel, and recorded worst case at middle

GFSK Modulation

π/4DQPSKModulation



8DPSKModulation



3.7 Number of hopping frequency

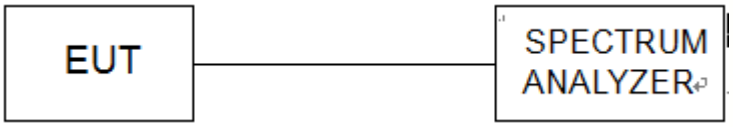
Limit

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

Test Procedure

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

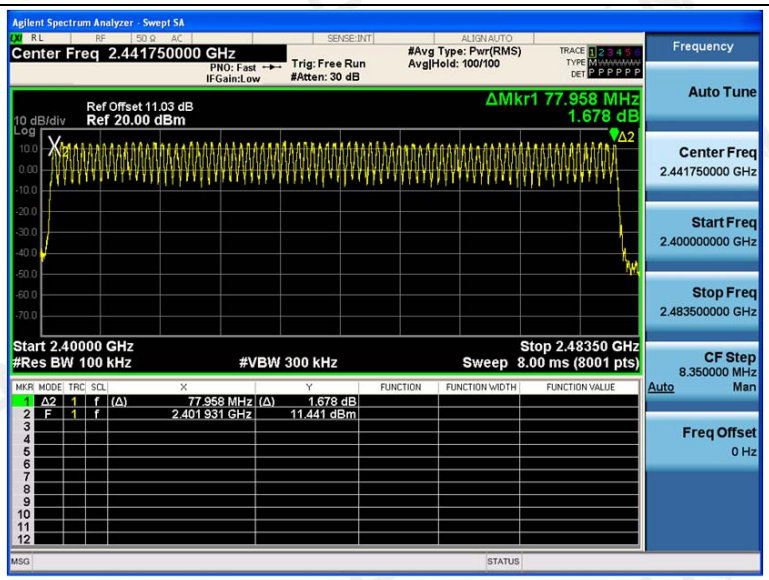
Test Configuration

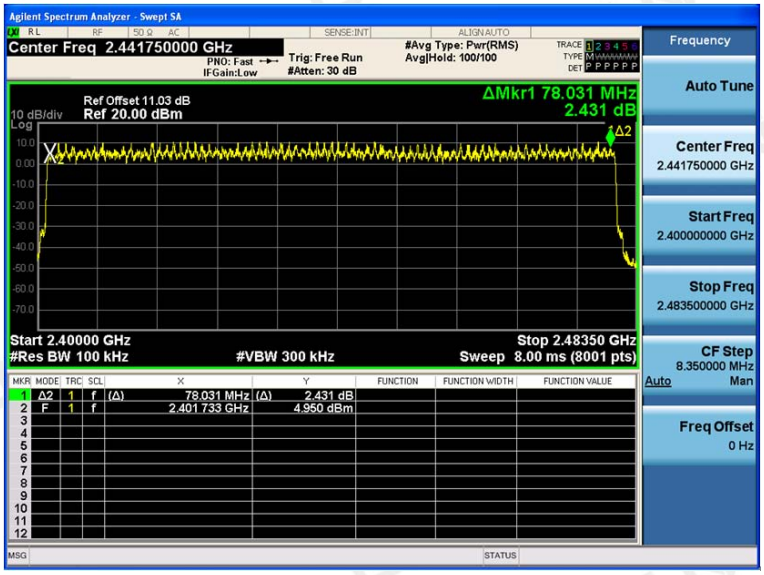
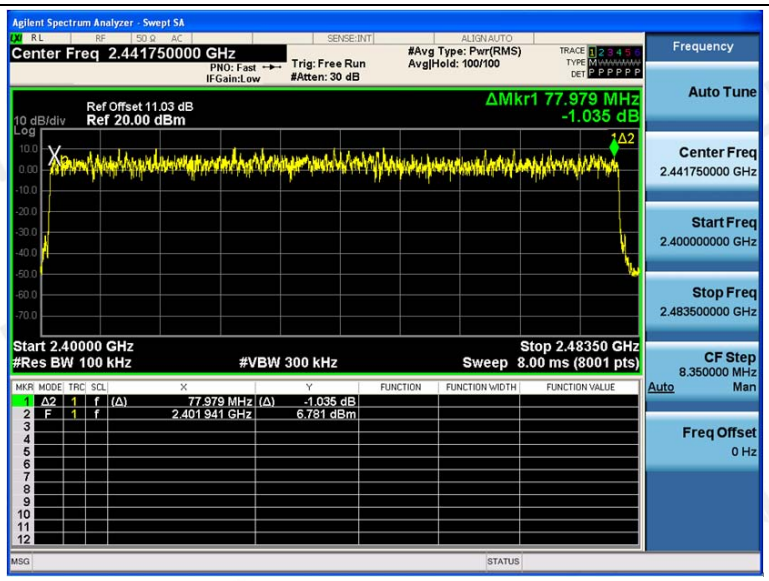


Test Results

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

GFSK



π/4DQPSK

8DPSK


3.8 Time of Occupancy (Dwell Time)

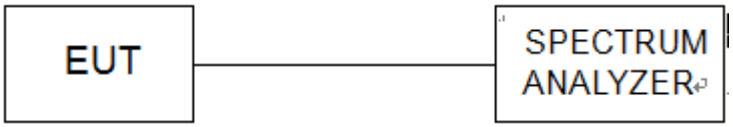
Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test Procedure

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

Test Configuration



Test Results

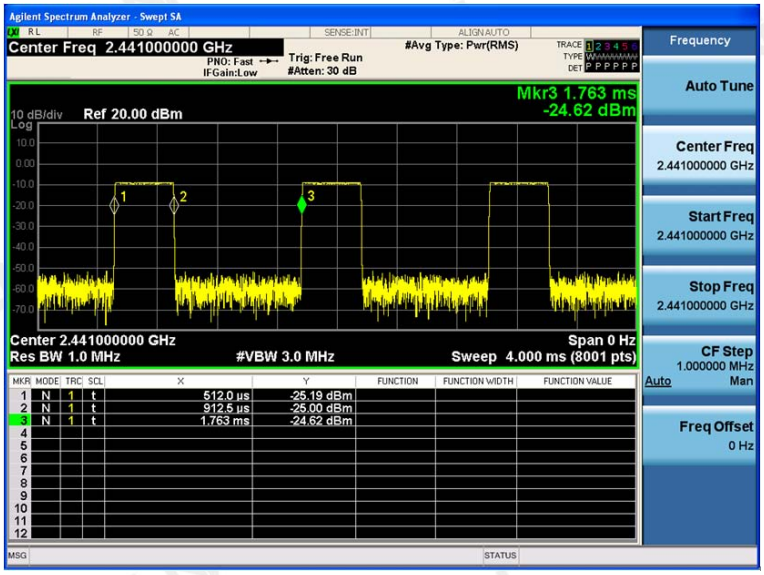
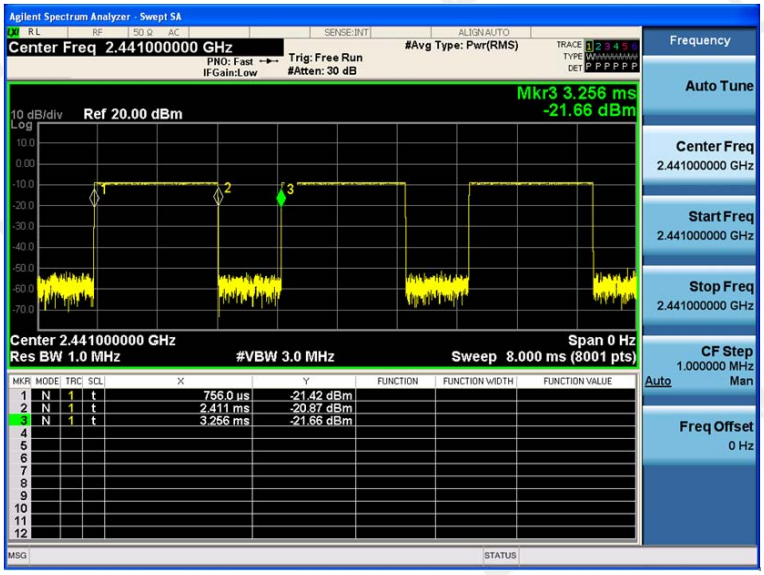
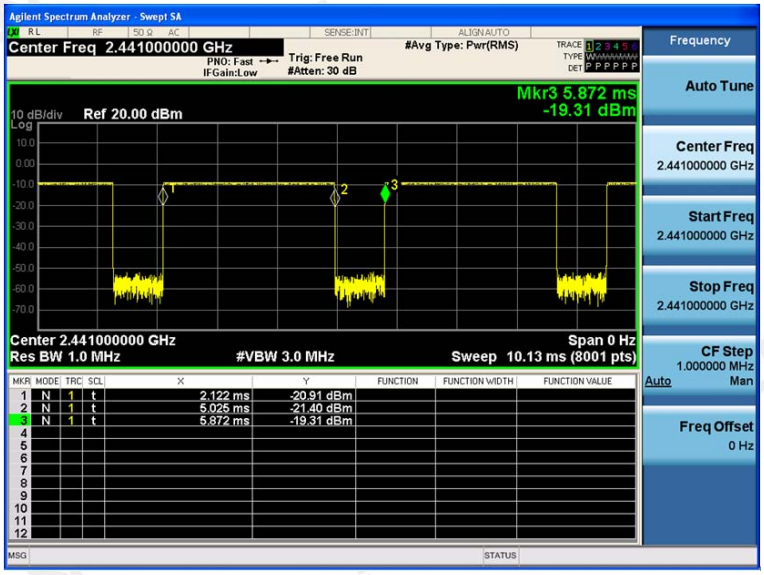
Modulation	Packet	Pulse time (ms)	Dwell time (ms)	Limit (s)	Result
GFSK	DH1	0.401	0.128	0.40	Pass
	DH3	1.655	0.265		
	DH5	2.904	0.310		
π/4DQPSK	2-DH1	0.413	0.132	0.40	Pass
	2-DH3	1.664	0.266		
	2-DH5	2.911	0.311		
8DPSK	3-DH1	0.413	0.132	0.40	Pass
	3-DH3	1.662	0.266		
	3-DH5	2.913	0.311		

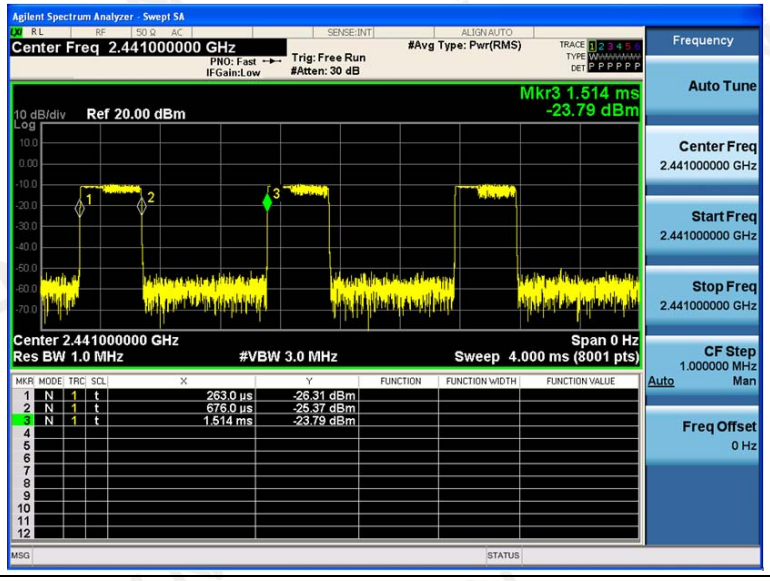
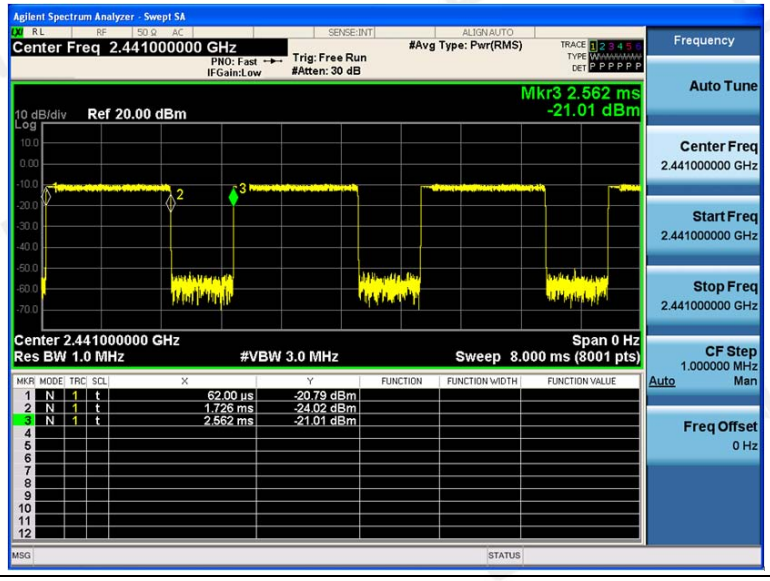
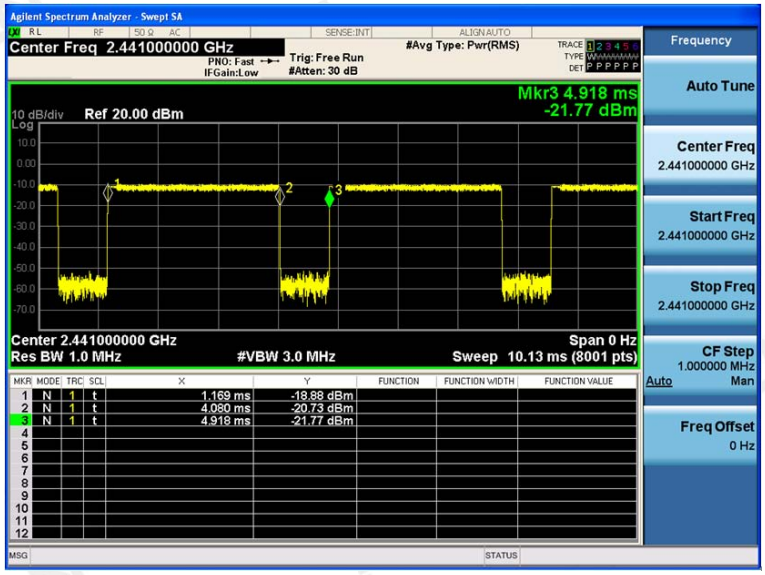
Note:

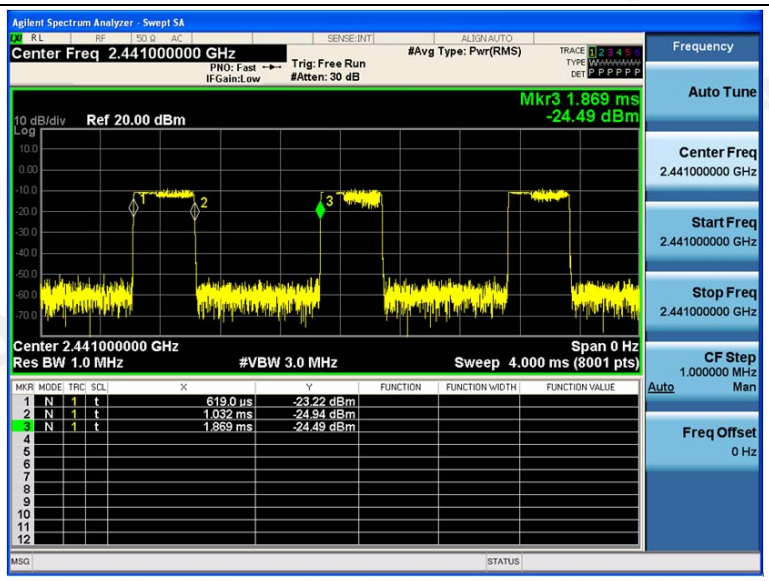
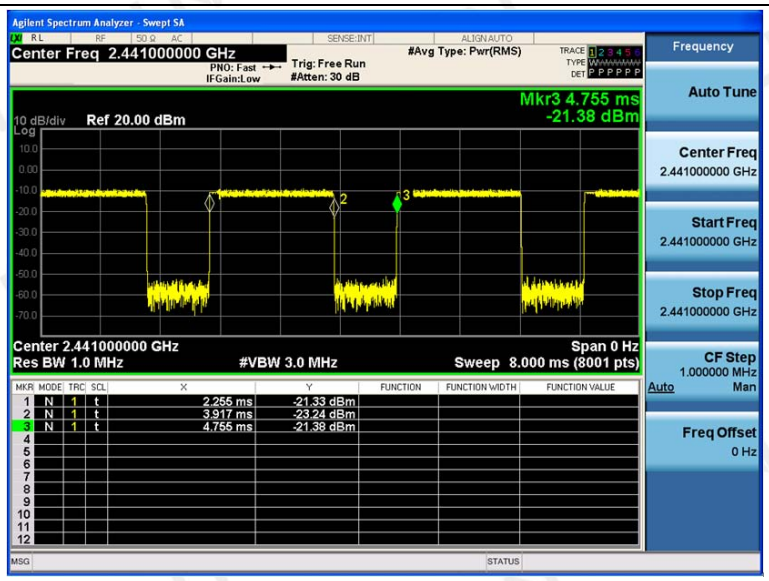
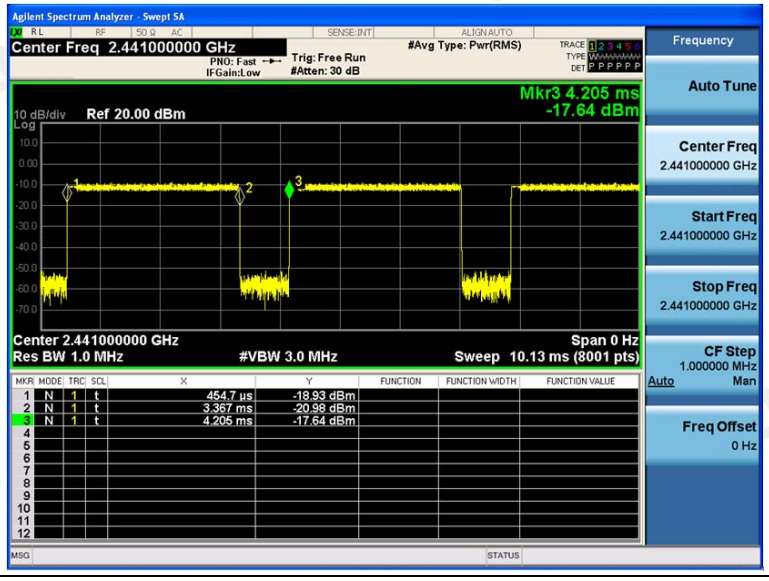
1. We have tested all mode at high,middle and low channel,and recoreded worst case at middle channel.
2. Dwell time=Pulse time (ms) × (1600 ÷ 2 ÷ 79) ×31.6 Second for DH1, 2-DH1, 3-DH1

   Dwell time=Pulse time (ms) × (1600 ÷ 4 ÷ 79) ×31.6 Second for DH3, 2-DH3, 3-DH3

   Dwell time=Pulse time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 Second for DH5, 2-DH5, 3-DH5

GFSK
DH1

DH3

DH5


π/4DQPSK
2-DH1

2-DH3

2-DH5


8DPSK
3-DH1

3-DH3

3-DH5


3.9 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 desiredpower, 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.

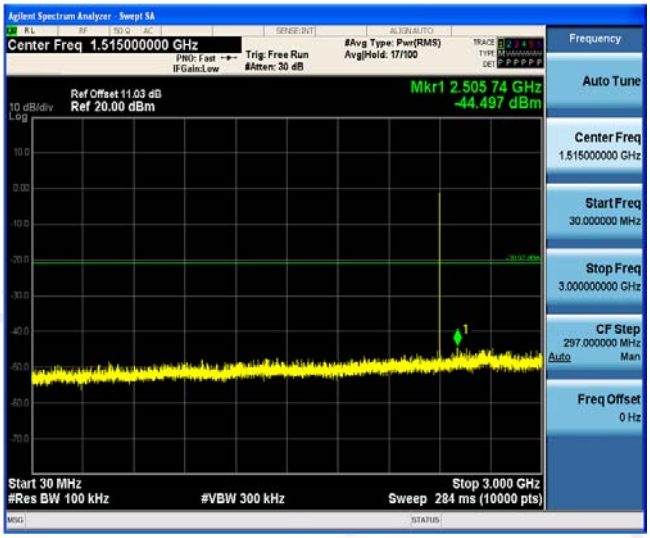
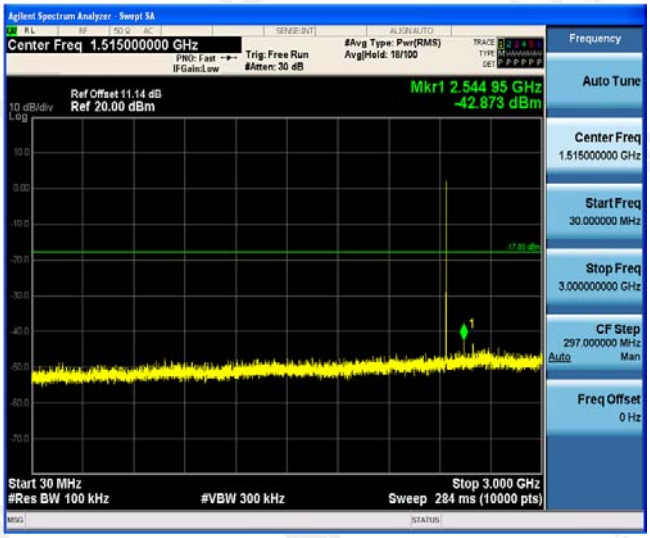
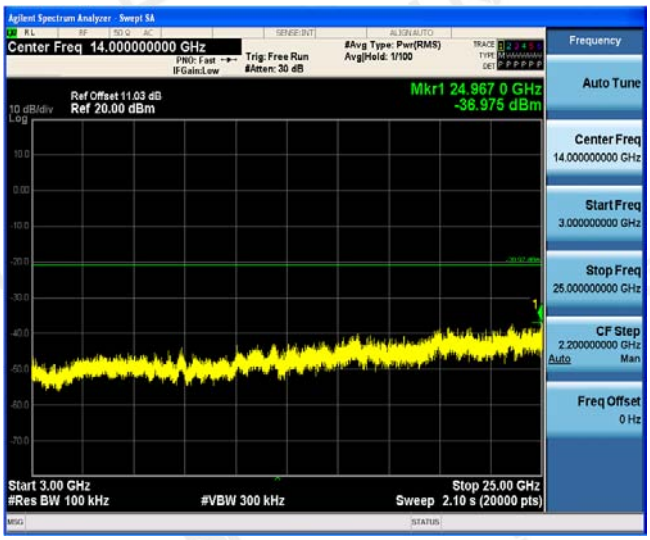
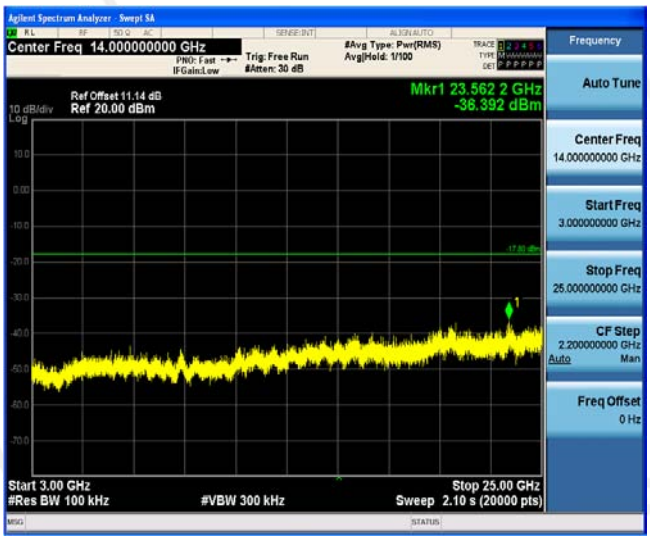
Test Procedure

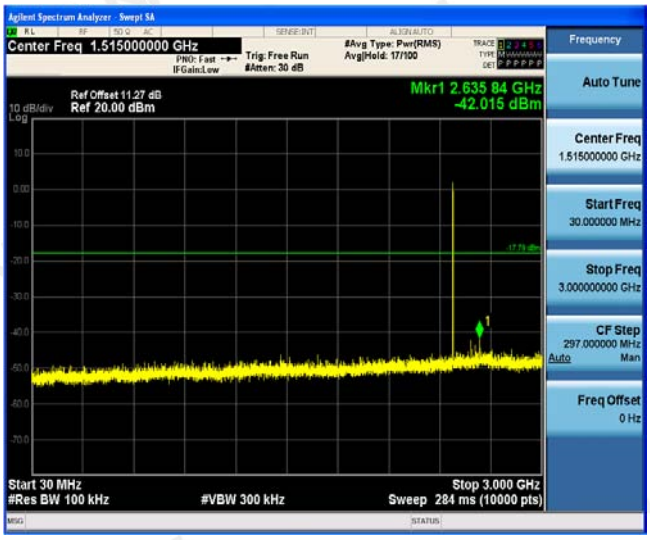
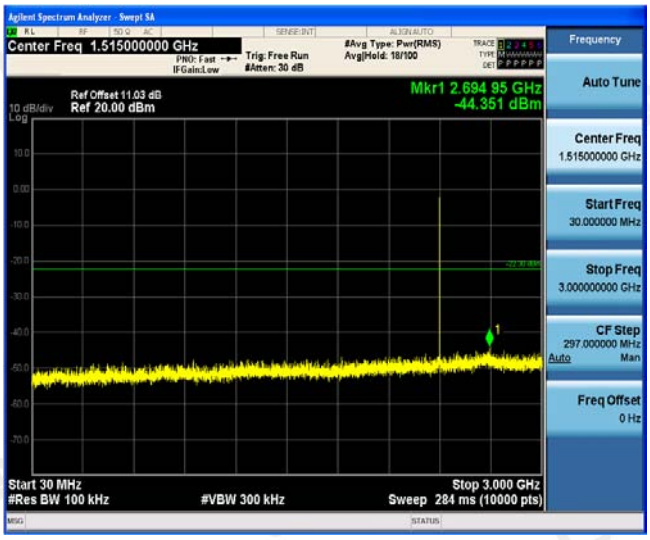
Connect the transmitter output to spectrumanalyzer using a low loss RF cable, and set the spectrumanalyzer to RBW=100 kHz, VBW= 300 kHz, peak detector , and max hold. Measurements utilizing these setting are made of the in-band reference level, bandedge and out-of-band emissions.

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.

GFSK CH00	*GFSK CH39*
	
30MHz-3GHz	30MHz-3GHz
	
3GHz-25GHz	3GHz-25GHz

GFSK CH78	π/4DQPSK CH00
	
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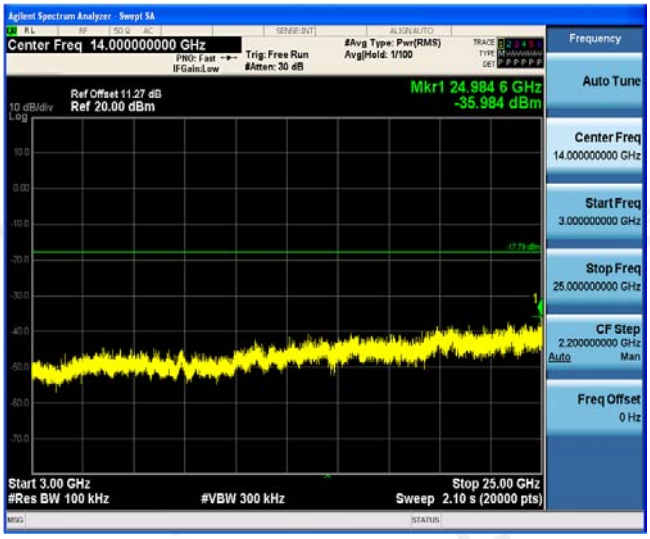
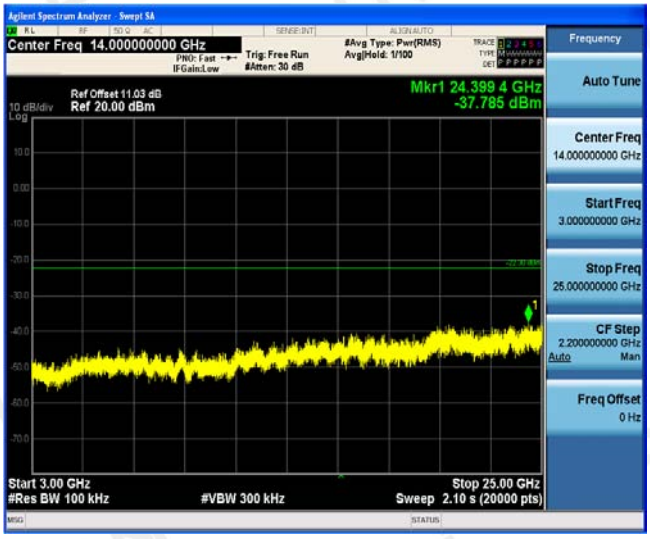
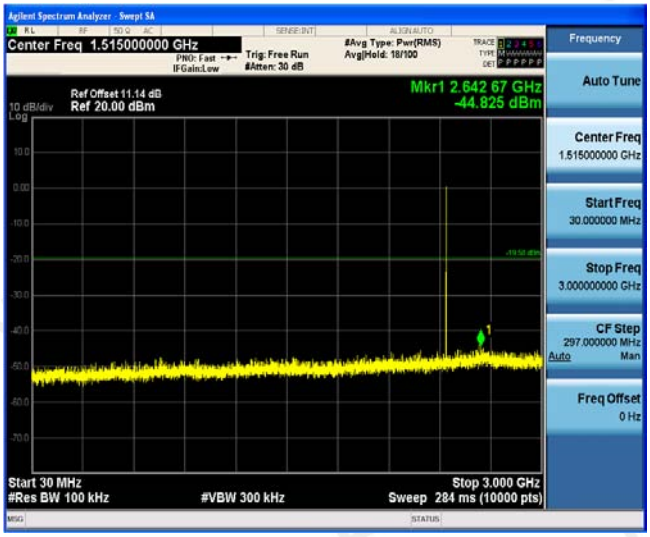
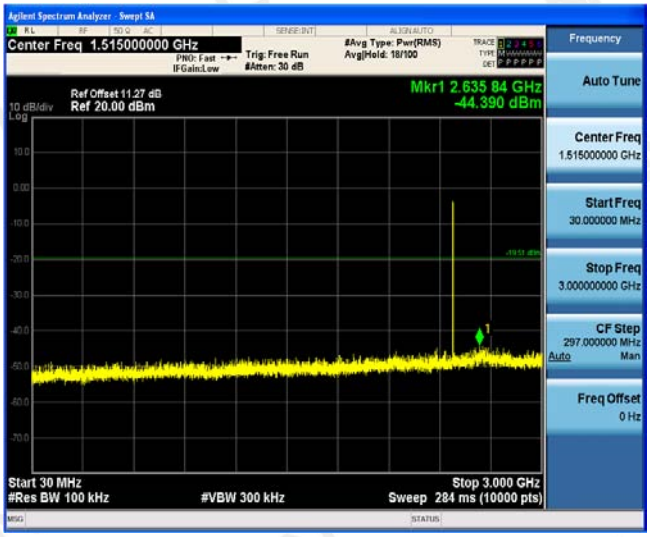
	
3GHz-25GHz	3GHz-25GHz

π/4DQPSK CH39	π/4DQPSK CH78
	
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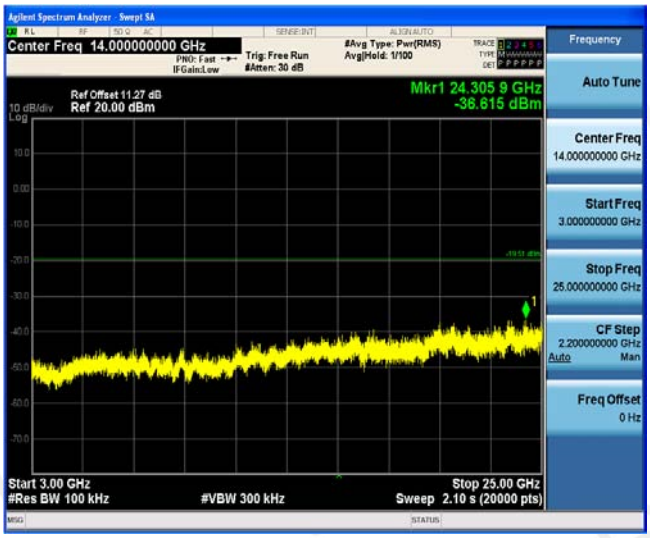
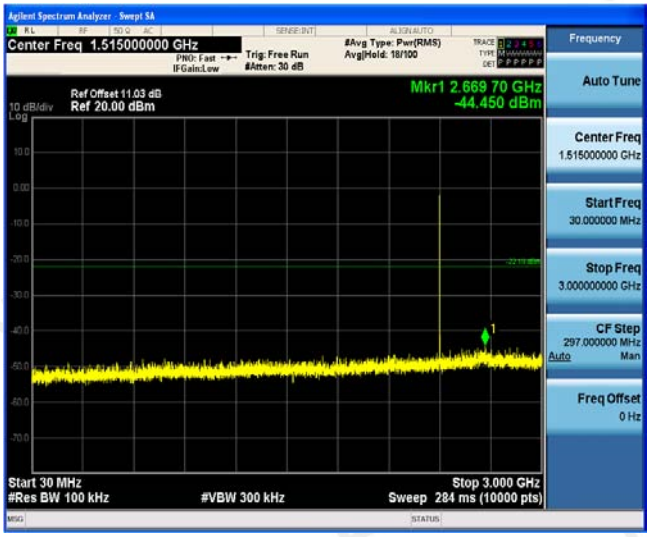
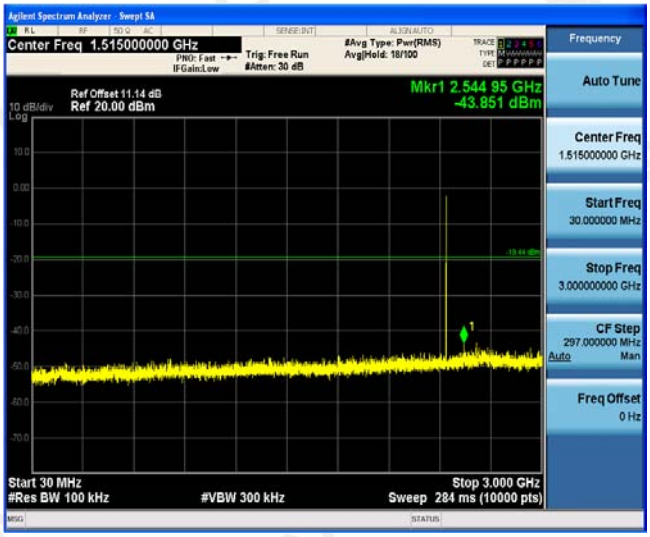
	
3GHz-25GHz	3GHz-25GHz

8DPSK CH00	8DPSK CH39
	
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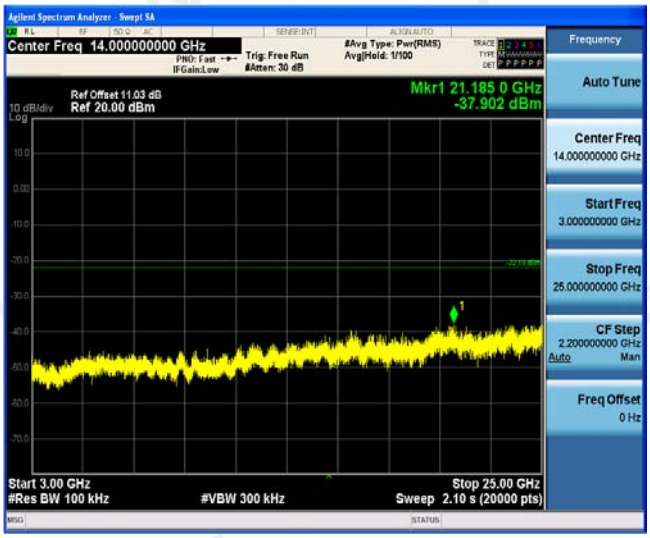
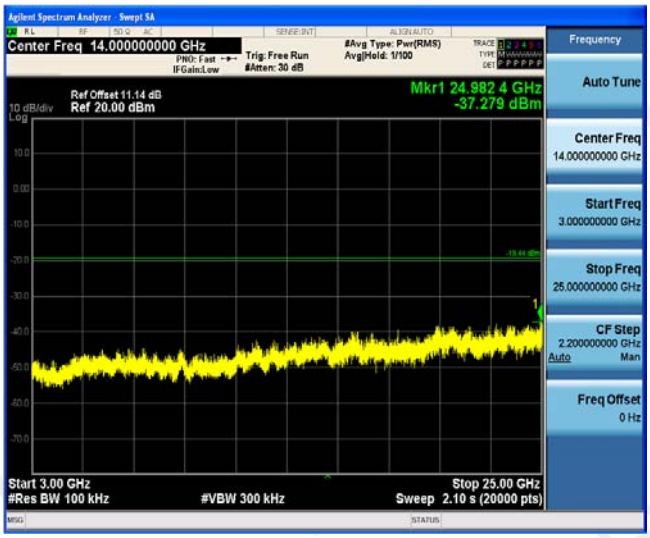
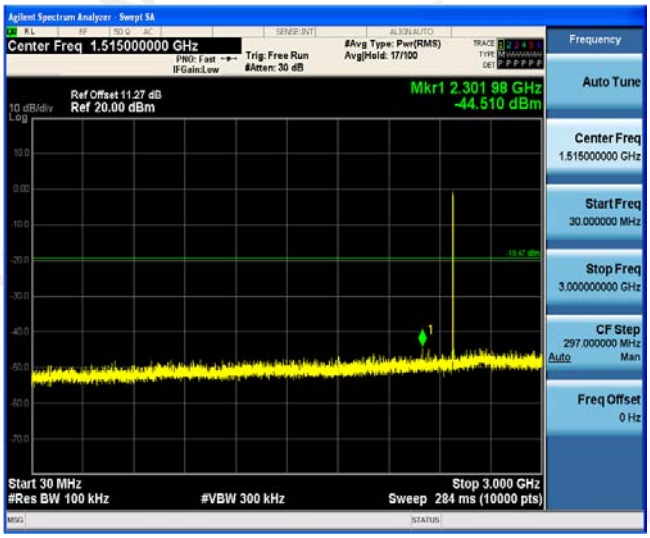
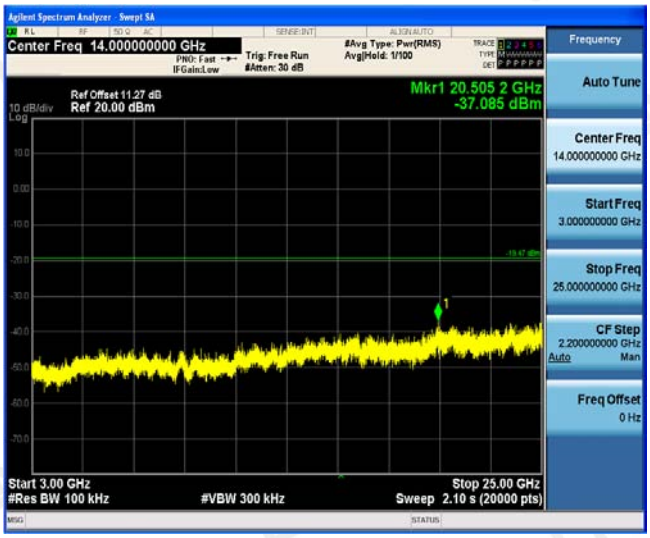
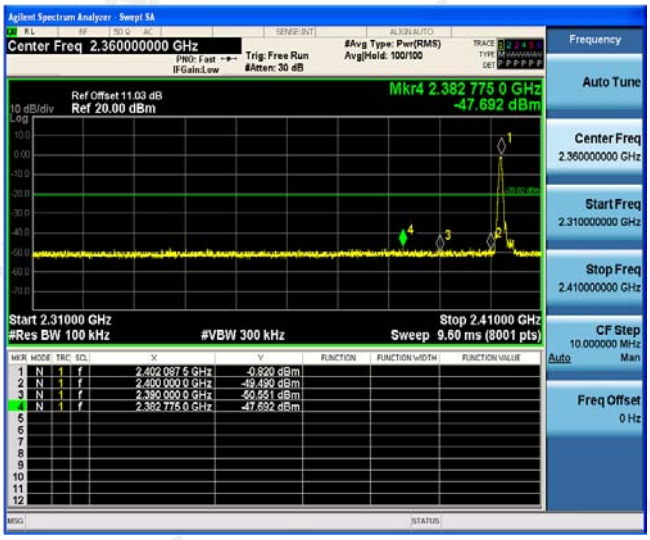
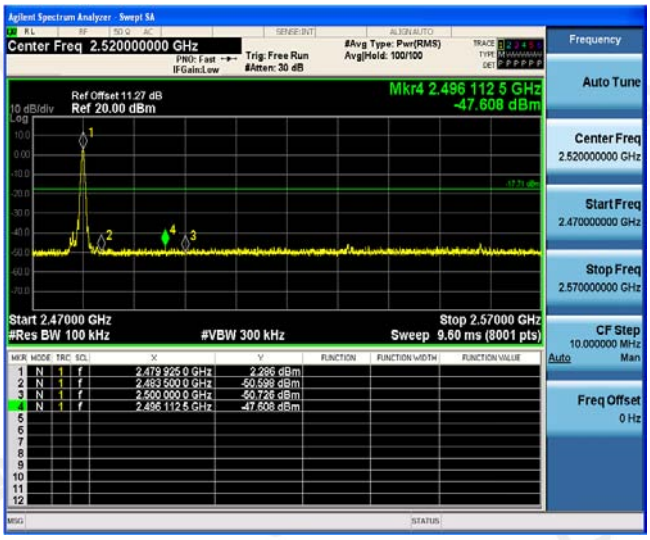
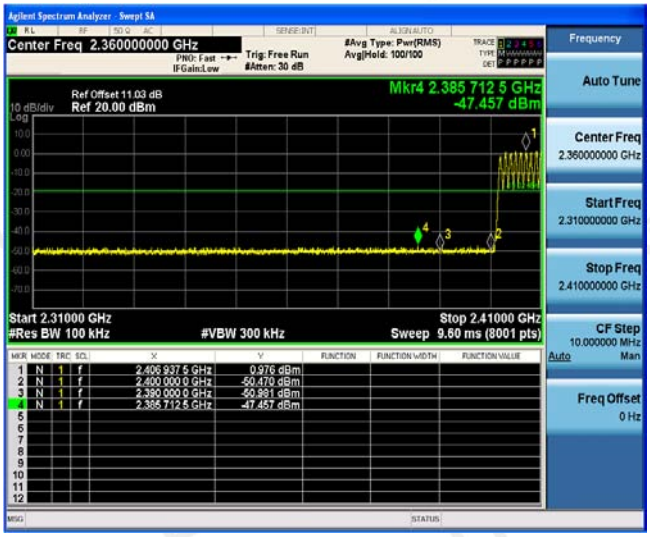
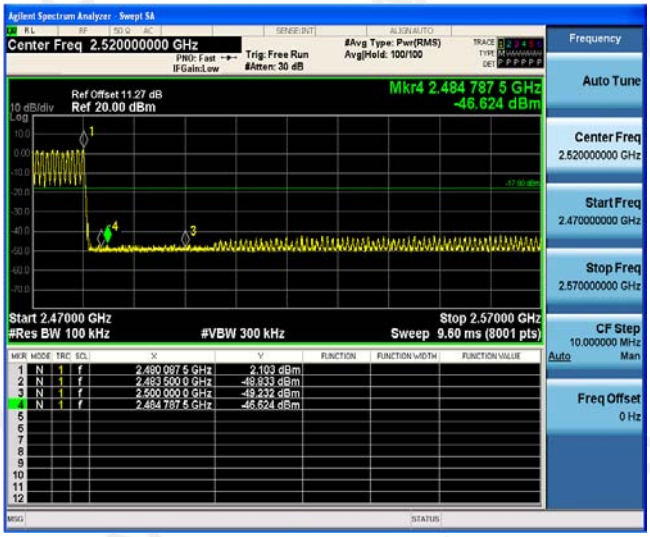
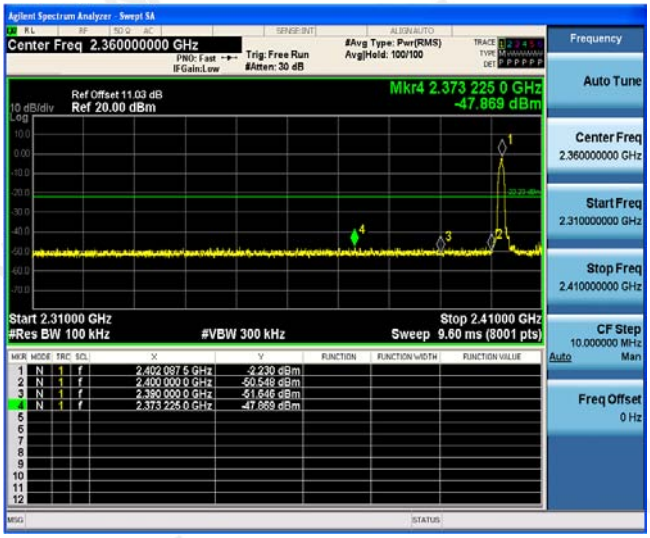
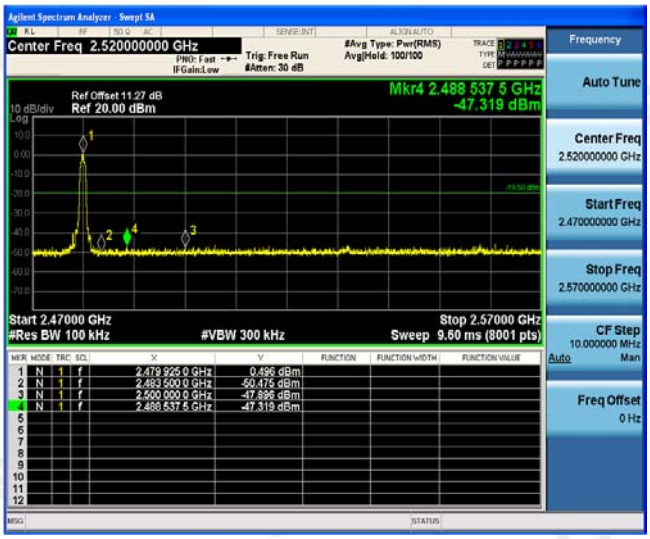
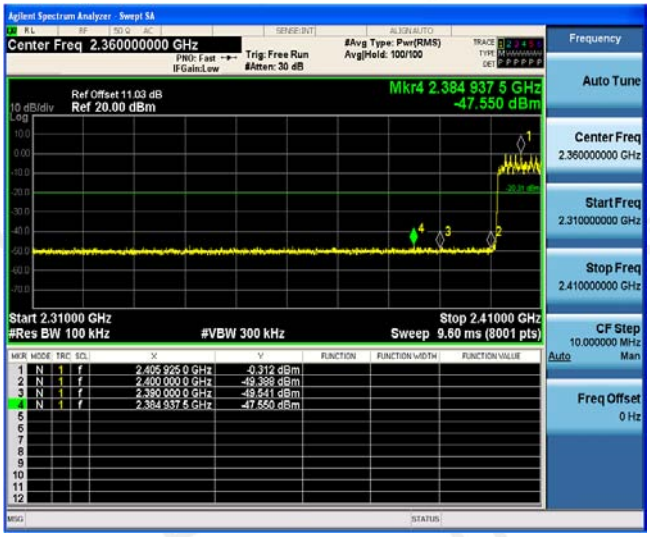
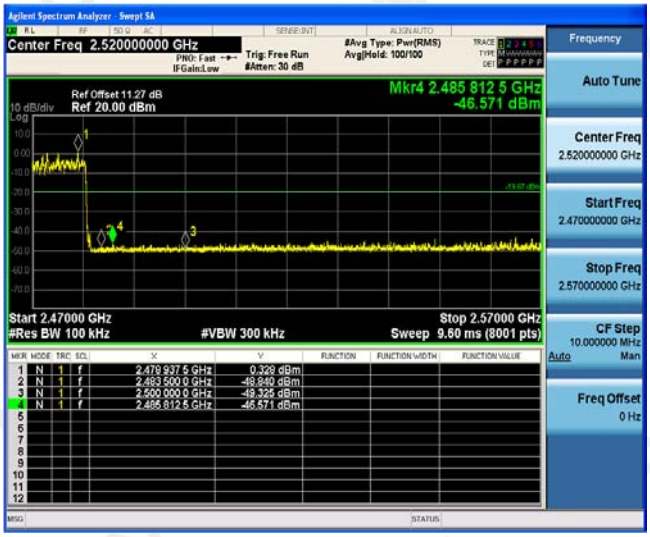
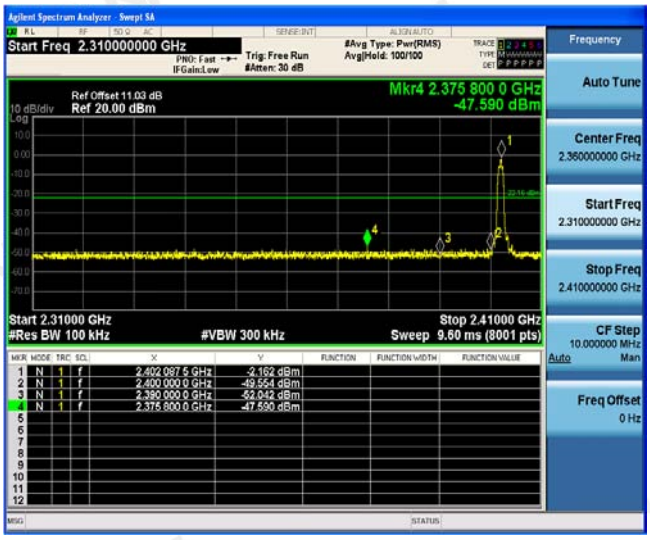
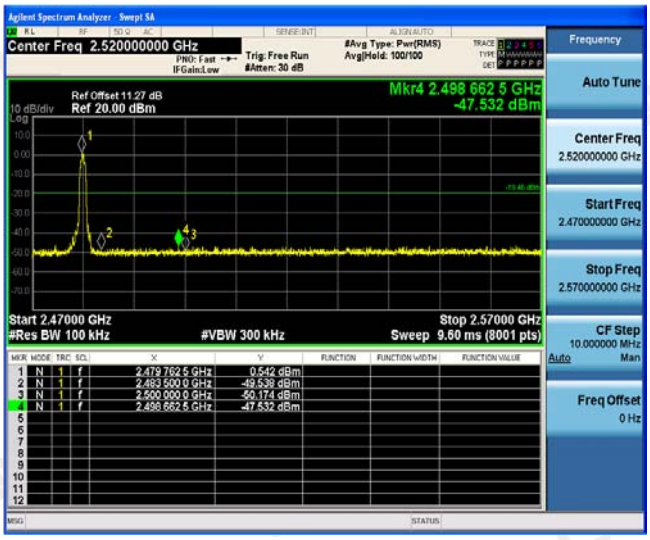
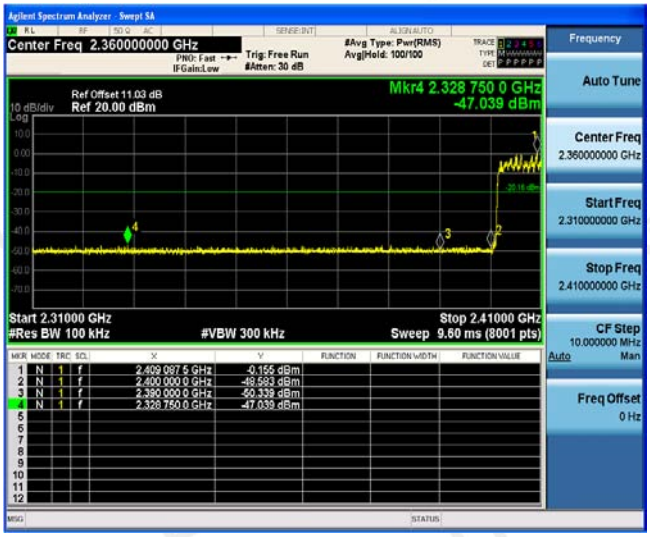
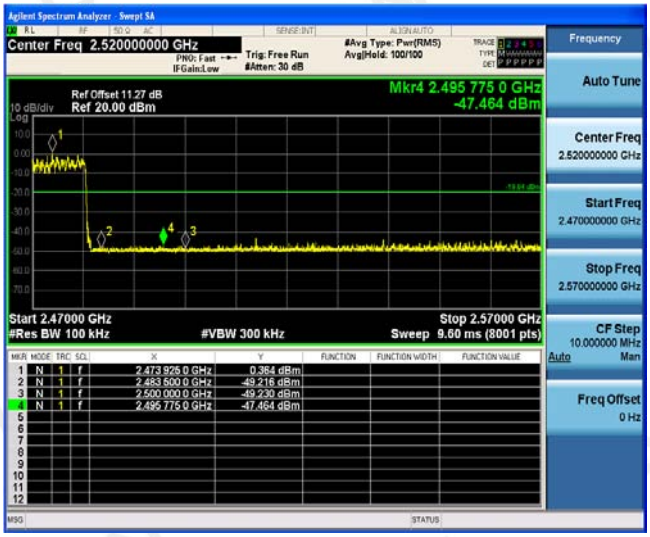
	
3GHz-25GHz	3GHz-25GHz

8DPSK CH78	
	
30MHz-3GHz	3GHz-25GHz

Conducted Band Edge Test:

GFSK	
	
Left Band edge hoping off	RightBand edge hoping off
	
Left Band edge hoping on	RightBand edge hoping on

π/4DQPSK	
	
Left Band edge hoping off	RightBand edge hoping off
	
Left Band edge hoping on	RightBand edge hoping on

8DPSK	
	
Left Band edge hoping off	RightBand edge hoping off
	
Left Band edge hoping on	RightBand edge hoping on

3.10 Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

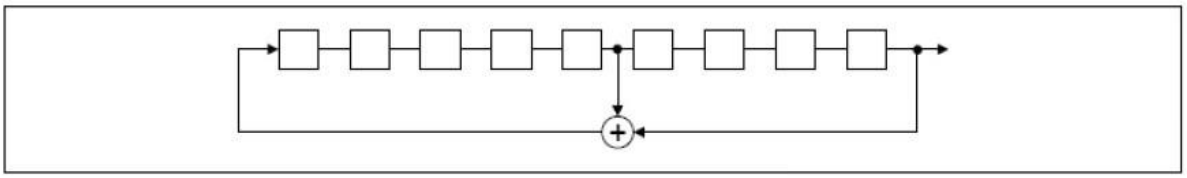
For 47 CFR Part 15C section 15.247 (g) (h) requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hop-ping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence Requirement

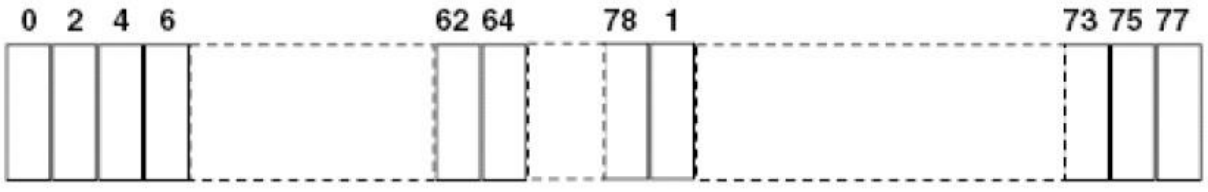
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the firststage. The sequence begins with the first one of 9 consecutive ones, forexample: the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

- Number of shift register stages:9
- Length of pseudo-random sequence:29-1=511 bits
- Longest sequence of zeros:8(non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of pseudorandom frequency hopping sequence as follows:



Each frequency used equally on the average by each transmitter.

According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift frequencies in synchronization with the transmitted signals.

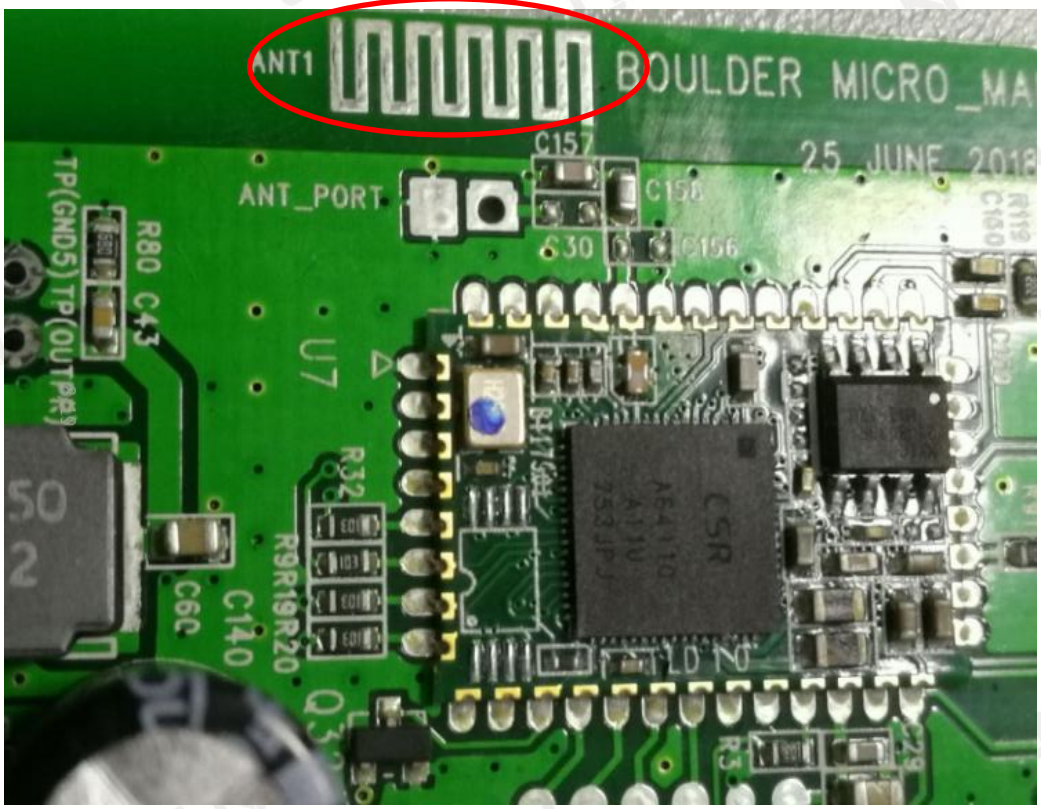
Compliance for section 15.247(g)
According to Bluetooth Core Specification, the Bluetooth system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.
Compliance for section 15.247(h)
According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels. According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

3.11 ANTENNA REQUIREMENT

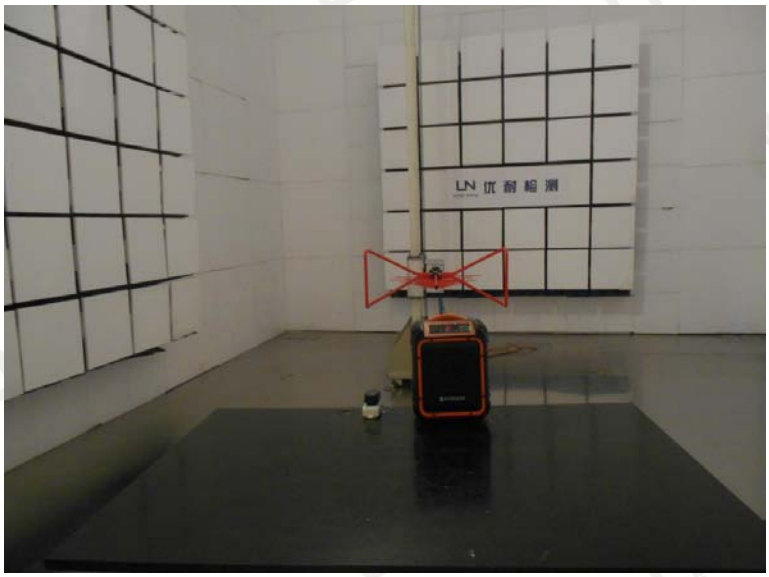
Standard Applicable:
For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

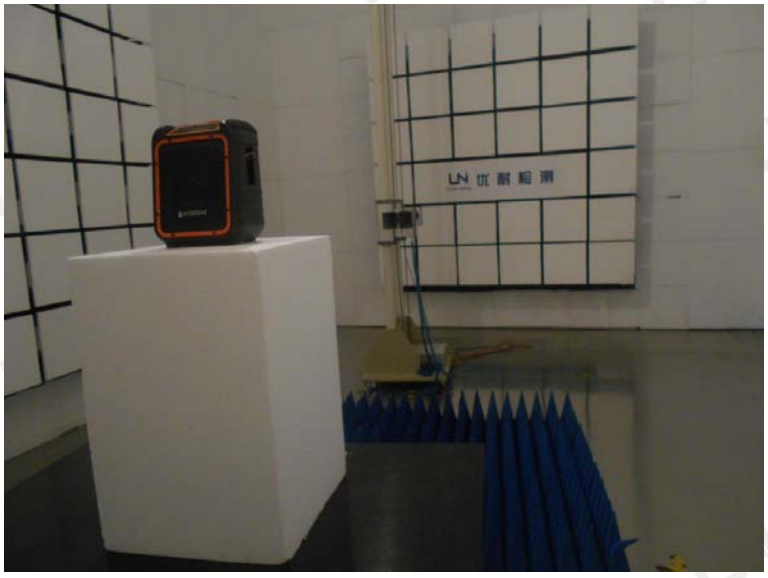
Antenna Connected Construction
The antenna used in this product is anIntegral Antenna, the directional gains of antenna used for transmitting is 0.0dBi.

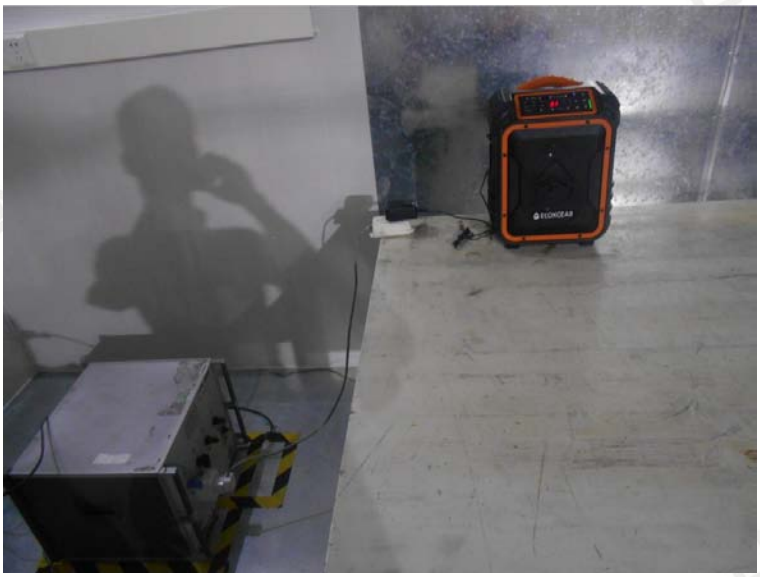
ANTENNA



4 PHOTOGRAPH OF TEST

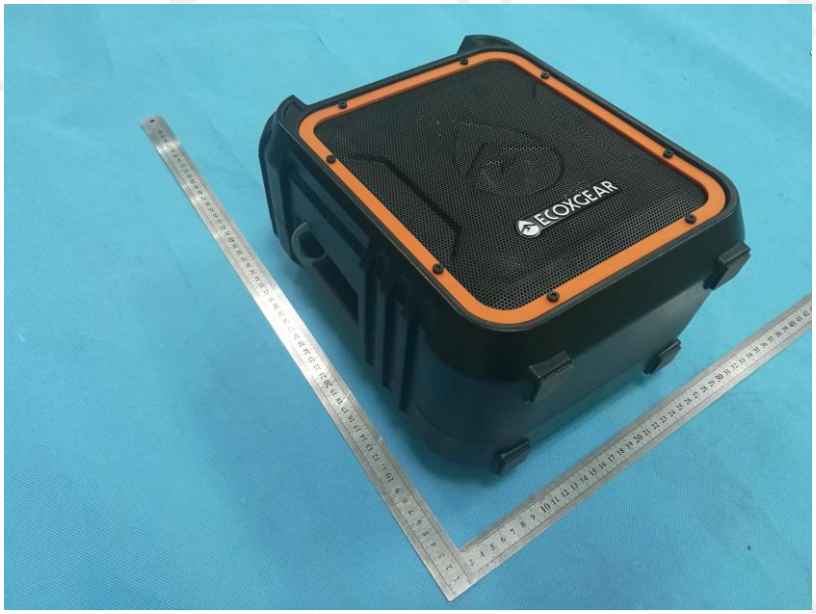






5 PHOTOGRAPH OF EUT

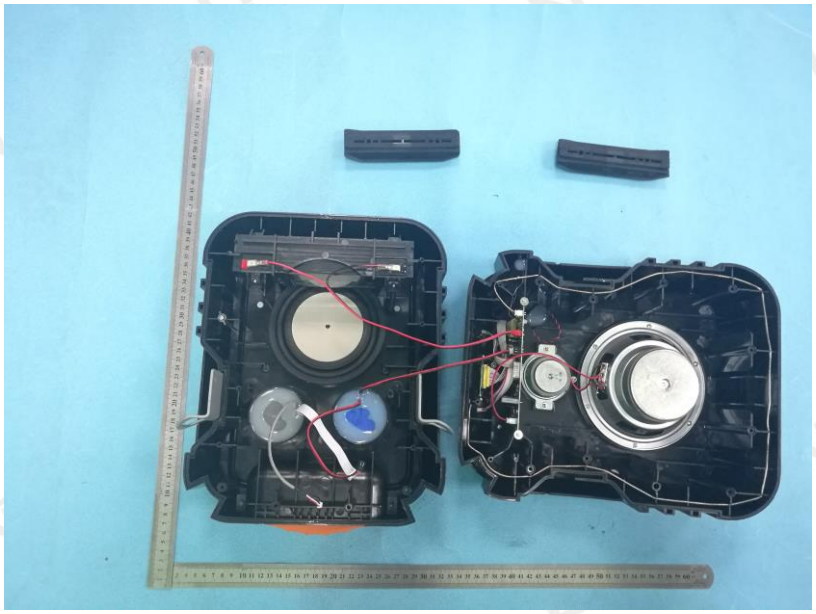
External photos

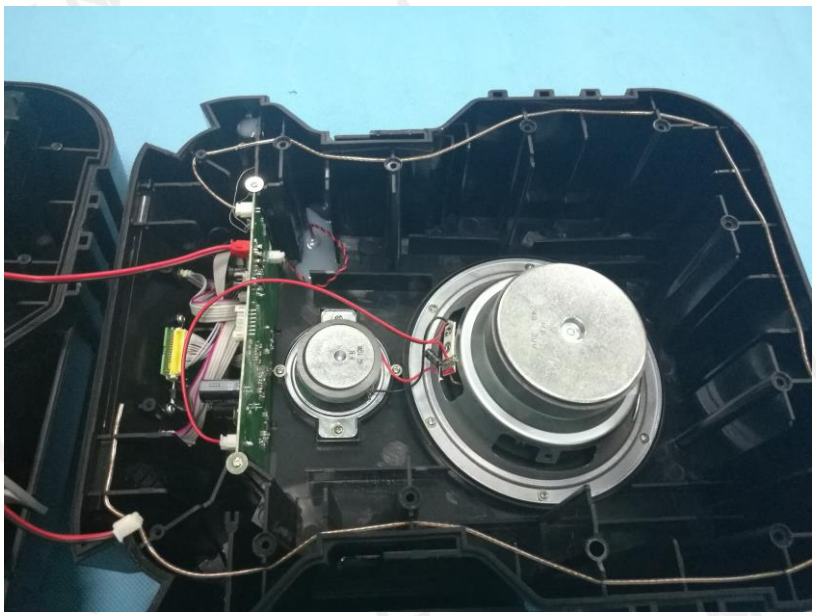


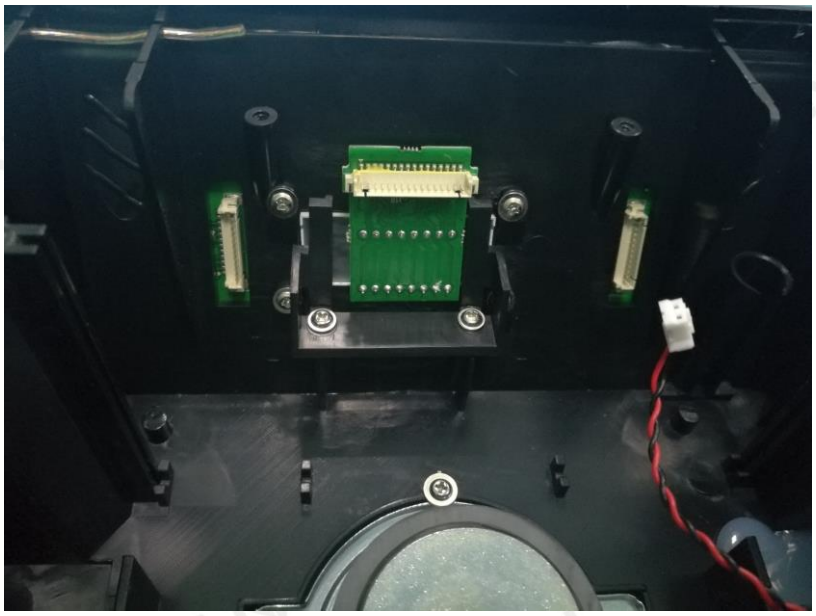

VOLUME
SOURCE
P6
P5
P4
P3
P2
P1
MIC VOLUME
RADIO

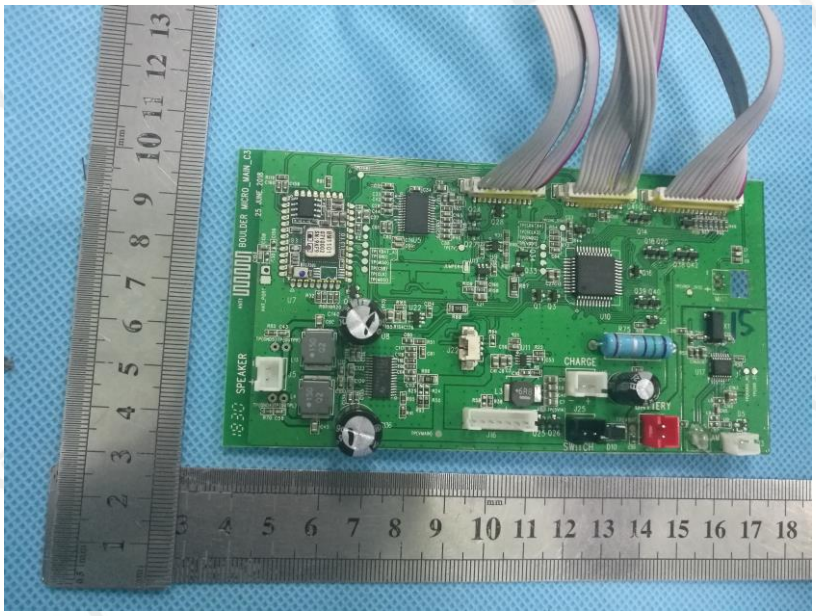

SUNLIGHT ELECTRONIC
AC/DC ADAPTER
MODEL : GA160015
INPUT : 100-240V~, 50/60Hz, 1.0A
OUTPUT : 16.0V 1.5A
LISTED
I.T.E POWER SUPPLY
E359407
4ZX4
MADE IN CHINA

Internal Photos

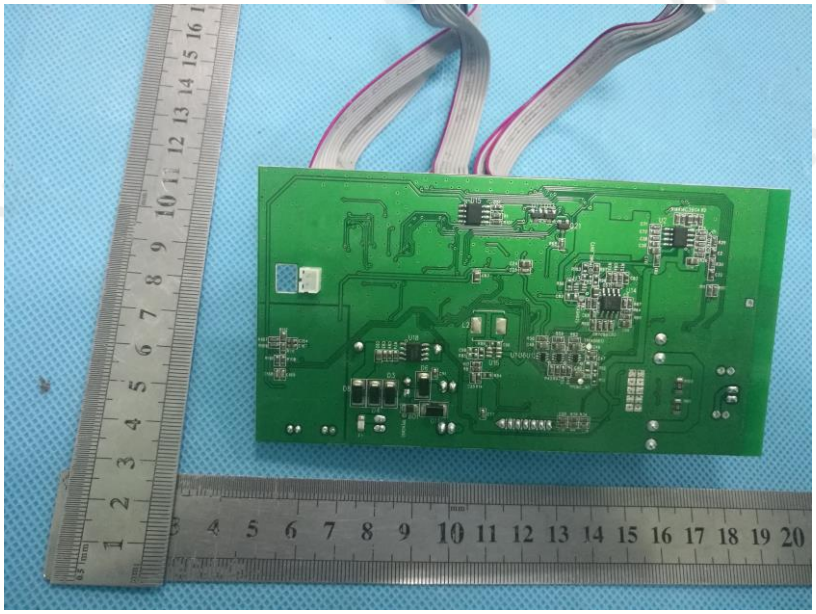


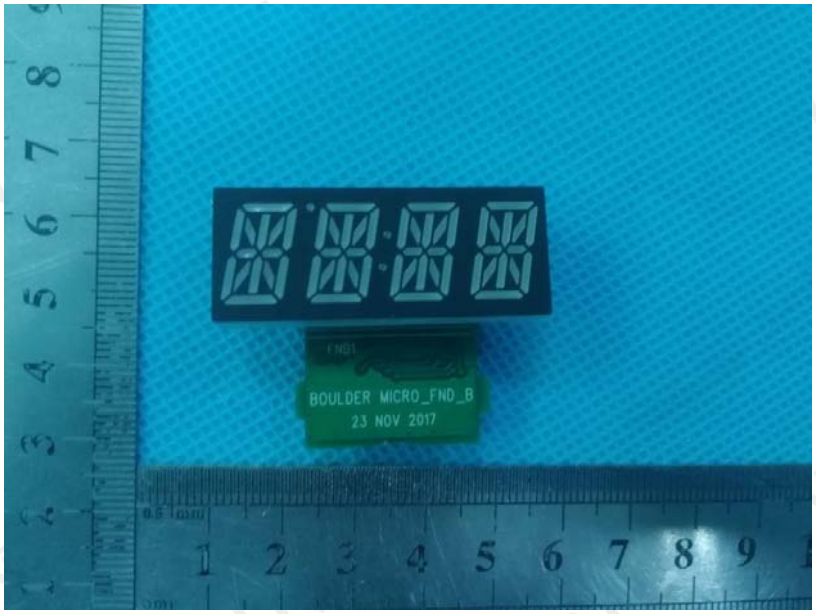


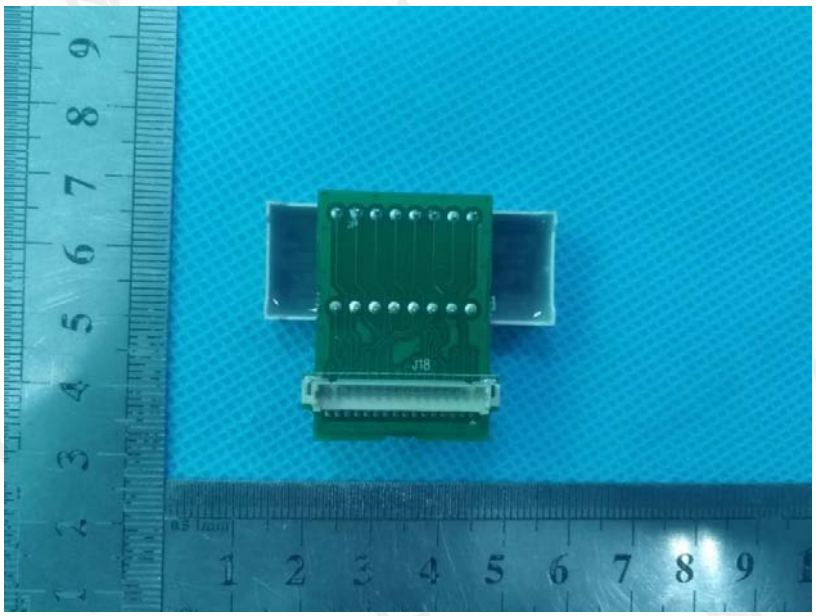


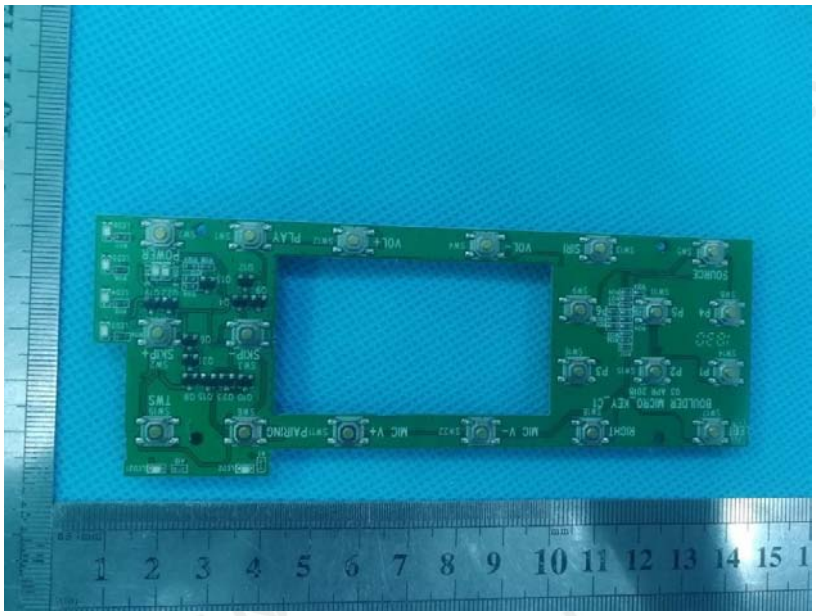

SPEAKER
CHARGE

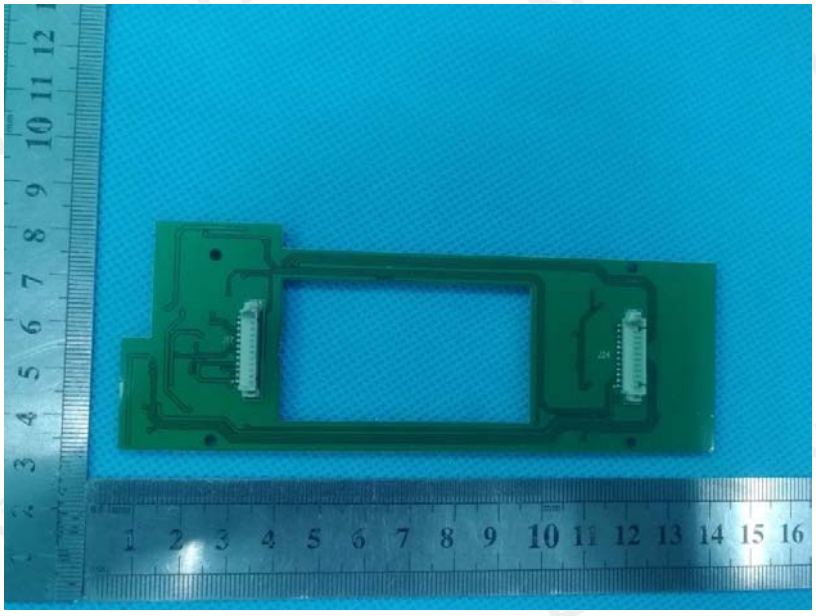

ANT1
BOULDER MICRO_MA
25 JUNE 201
ANT_PORT
C157
C158
C156
U7
Q2
Q32
C60
C140
R32
R80
C43




BOULDER MICRO_FND_B
23 NOV 2017







**********End of Report**********