FCC TEST REPORT

FOR

Dongguan Haoyinliang Electronics Co.Ltd

2.4G Wireless Transmitter

Model No.: h-RF801

Additional Model No.: /

Prepared for	:	Dongguan Haoyinliang Electronics Co.Ltd
Address	:	No.46, Xinan Avenue, Ludong Community, Humen Town, Dongguan City, Guangdong Province, China
Prepared by	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
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Date of receipt of test sample	:	Jul 03, 2017
Number of tested samples	:	1
Serial number	:	Prototype
Date of Test	:	Jul 03, 2017~Jul 12, 2017
Date of Report	:	Jul 12, 2017

FCC TEST REPORT

FCC CFR 47 PART 15 C(15.247)

Report Reference No. ..... :		**LCS170803007AE**
Date of Issue ..... :		Jul 12, 2017
Testing Laboratory Name ..... :		**Shenzhen LCS Compliance Testing Laboratory Ltd.**
Address ..... :		1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China
Testing Location/ Procedure..... :		Full application of Harmonised standards ■ Partial application of Harmonised standards □ Other standard testing method □
Applicant's Name..... :		**Dongguan Haoyinliang Electronics Co.Ltd**
Address ..... :		No.46, Xinan Avenue, Ludong Community, Humen Town, Dongguan City, Guangdong Province, China
Test Specification		
Standard..... :		FCC CFR 47 PART 15 C(15.247)
Test Report Form No. ..... :		LCSEMC-1.0
TRF Originator ..... :		Shenzhen LCS Compliance Testing Laboratory Ltd.
Master TRF ..... :		Dated 2011-03

Test Item Description. ..... :		**2.4G Wireless Transmitter**
Trade Mark..... :		invons
Model/ Type reference..... :		h-RF801
Ratings ..... :		Adapter input:100~240VAC, 50/60Hz, 260mA Adapter output:5VDC, 0.5A
Result ..... :		**Positive**

Compiled by:	**Supervised by:**	**Approved by:**
Calvin Weng		
Calvin Weng/ Administrators	Glin Lu/ Technique principal	Gavin Liang/ Manager

FCC -- TEST REPORT

Test Report No. : LCS170803007AE	Jul 12, 2017 Date of issue

EUT.....	: 2.4G Wireless Transmitter
Type / Model.....	: h-RF801
Applicant.....	**: Dongguan Haoyinliang Electronics Co.Ltd**
Address.....	: No.46, Xinan Avenue, Ludong Community, Humen Town, Dongguan City, Guangdong Province, China
Telephone.....	:
Fax.....	:
Manufacturer.....	**: Dongguan Haoyinliang Electronics Co.Ltd**
Address.....	: No.46, Xinan Avenue, Ludong Community, Humen Town, Dongguan City, Guangdong Province, China
Telephone.....	:
Fax.....	:
Factory.....	: **Dongguan Haoyinliang Electronics Co.Ltd**
Address.....	: No.46, Xinan Avenue, Ludong Community, Humen Town, Dongguan City, Guangdong Province, China
Telephone.....	:
Fax.....	:

Test Result	**Positive**

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.

Revision History

Revision	Issue Date	Revisions	Revised By
000	Jul 12, 2017	Initial Issue	Gavin Liang

TABLE OF CONTENTS

1. GENERAL INFORMATION

1.1 Description of Device (EUT)

EUT	:	2.4G Wireless Transmitter
Test Model	:	h-RF801
List Model(s)	:	/
Model Declaration	:	/
Hardware Version	:	/
Software Version	:	/
Power Supply	:	Adapter input:100~240VAC, 50/60Hz, 260mA Adapter output:5VDC, 0.5A
2.4G FHSS	:	
Operating Frequency	:	2.402-2.480GHz
Channel Number	:	31 channels(refer to setion 1.7 for channel information)
Channel Spacing	:	1MHz(min), 4MHz(max)
Modulation Type	:	GFSK
Antenna Description	:	Integral Antenna, 0dBi(Max.)

1.2. Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	Certificate
ShenZhen TEKA Technology Co.,Lt	Power Adapter	RHD10W050050	---	FCC VoC

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
USB	1	2m, unshielded cable
Earphone	1	N/A

1.4. Description of Test Facility

CNAS Registration Number is L4595.
FCC Registration Number is 899208.
Industry Canada Registration Number is 9642A-1.
ESMD Registration Number is ARCB0108.
UL Registration Number is 100571-492.
TUV SUD Registration Number is SCN1081.
TUV RH Registration Number is UA 50296516-001

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.

1.5. 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 LCS 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.

1.6. Measurement Uncertainty

Test Item		Frequency Range	Uncertainty	Note
Radiation Uncertainty	:	9KHz~30MHz	±3.10dB	(1)
		30MHz~200MHz	±2.96dB	(1)
		200MHz~1000MHz	±3.10dB	(1)
		1GHz~26.5GHz	±3.80dB	(1)
		26.5GHz~40GHz	±3.90dB	(1)
Conduction Uncertainty	:	150kHz~30MHz	±1.63dB	(1)
Power disturbance	:	30MHz~300MHz	±1.60dB	(1)

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

1.7 Description of Test Modes

Bluetooth operates in the unlicensed ISM Band at 2.4GHz. With basic data rate feature, the data rates can be up to 1 Mb/s by modulating the RF carrier using GFSK techniques. The EUT works in the X-axis, Y-axis, Z-axis. The following operating modes were applied for the related test items. All test modes were tested, only the result of the worst case was recorded in the report.

Mode of Operations	Frequency Range (MHz)	Data Rate (Mbps)
GFSK	2402	1
	2441	1
	2480	1
For Conducted Emission		
Test Mode	TX Mode	
For Radiated Emission		
Test Mode	TX Mode	

Worst-case mode and channel used for 150 KHz-30 MHz power line conducted emissions was the mode and channel with the highest output power that was determined to be TX (1Mbps).

Worst-case mode and channel used for 9kHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be TX(1Mbps-Middle Channel).

AC conducted emission pre-test at both at AC 120V/60Hz and AC 240V/50Hz modes, recorded worst case;

frequency & channel list:

Channel	Frequency(MHz)	Channel	Frequency(MHz)
1	**2402**	17	2442
2	2403	18	2443
3	2404	19	2444
4	2405	20	2446
5	2407	21	2448
6	2409	22	2450
7	2411	23	2454
8	2415	24	2458
9	2419	25	2462
10	2423	26	2466
11	2427	27	2470
12	2431	28	2474
13	2435	29	2478
14	2439	30	2479
15	2440	**31**	**2480**
16	**2441**		

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2013, FCC CFR PART 15C 15.207, 15.209, 15.247 and DA 00-705.

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

The EUT was operated in the normal operating mode for Hopping Numbers and Dwell Time test and a continuous transmits mode for other tests.

According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209, 15.247 under the FCC Rules Part 15 Subpart C.

2.3 General Test Procedures

2.3.1 Conducted Emissions

The EUT is directly placed on the ground. According to the requirements in Section 6.2.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

2.3.2 Radiated Emissions

The EUT is placed on a turntable, which is directly placed on the ground. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10-2013.

2.4. Test Sample

The application provides 2 samples to meet requirement;

Sample Number	Description
Sample 1	Engineer sample –Conducted measurement
Sample 2	Engineer sample –Radiated measurement

3. SYSTEM TEST CONFIGURATION

3.1 Justification

The system was configured for testing in a continuous transmits condition.

3.2 EUT Exercise Software

The sample will be controlled by dialing RF test tool to enter RF test mode to control sample change channel, modulation and so on;

3.3 Special Accessories

Manufacturer	Description	Model	Serial Number	Certificate
Lenovo	PC	B470	--	DOC
Lenovo	AC/DC ADAPTER	ADP-90DDB	--	DOC

3.4 Block Diagram/Schematics

Please refer to the related document.

3.5 Equipment Modifications

Shenzhen LCS Compliance Testing Laboratory Ltd. has not done any modification on the EUT.

3.6 Test Setup

Please refer to the test setup photo.

4. SUMMARY OF TEST RESULTS

Applied Standard: FCC Part 15 Subpart C			
FCC Rules	**Description of Test**	**Test Sample**	**Result**
§15.247(b)(1)	Maximum Conducted Output Power	Sample 1	Compliant
§15.247(c)	Frequency Separation And 20 dB Bandwidth	Sample 1	Compliant
§15.247(a)(1)(ii)	Number Of Hopping Frequency	Sample 1	Compliant
§15.247(a)(1)(iii)	Time Of Occupancy (Dwell Time)	Sample 1	Compliant
§15.209, §15.247(d)	Conducted Spurious Emissions	Sample 1	Compliant
§15.209, §15.247(d)	Radiated Spurious Emissions	Sample 2	Compliant
§15.205	Emissions at Restricted Band	Sample 2	Compliant
§15.207(a)	Conducted Emissions	Sample 1	Compliant
§15.203	Antenna Requirements	Sample 1 Sample 2	Compliant
§15.247(i)§2.1093	RF Exposure	N/A	Compliant

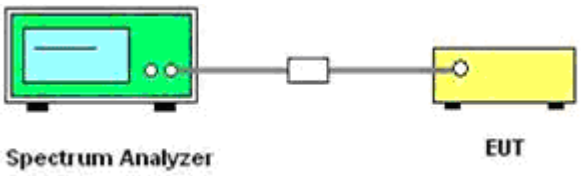
5. SUMMARY OF TEST EQUIPMENT

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
1	Power Sensor	R&S	NRV-Z51	100458	2017-06-18	2018-06-17
2	Power Sensor	R&S	NRV-Z32	10057	2017-06-18	2018-06-17
3	Power Meter	R&S	NRVS	100444	2017-06-18	2018-06-17
4	DC Filter	MPE	23872C	N/A	2017-06-18	2018-06-17
5	RF Cable	Harbour Industries	1452	N/A	2017-06-18	2018-06-17
6	SMA Connector	Harbour Industries	9625	N/A	2017-06-18	2018-06-17
7	Spectrum Analyzer	Agilent	N9020A	MY50510140	2016-10-27	2017-10-26
8	Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	2017-06-16	2018-06-15
9	RF Cable	Hubersuhne	Sucoflex104	FP2RX2	2017-06-18	2018-06-17
10	3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	2017-06-18	2018-06-17
11	Amplifier	SCHAFFNER	COA9231A	18667	2017-04-18	2018-04-17
12	Amplifier	Agilent	8449B	3008A02120	2017-04-18	2018-04-17
13	Amplifier	MITEQ	AMF-6F-260400	9121372	2017-04-18	2018-04-17
14	Loop Antenna	R&S	HFH2-Z2	860004/001	2017-04-18	2018-04-17
15	By-log Antenna	SCHWARZBECK	VULB9163	9163-470	2017-04-18	2018-04-17
16	Horn Antenna	EMCO	3115	6741	2017-04-18	2018-04-17
17	Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170154	2017-04-18	2018-04-17
18	RF Cable-R03m	Jye Bao	RG142	CB021	2017-06-18	2018-06-17
19	RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	2017-06-18	2018-06-17
20	EMI Test Receiver	R&S	ESCI	101142	2017-06-18	2018-06-17
21	Artificial Mains	R&S	ENV216	101288	2017-06-18	2018-06-17
22	EMI Test Software	AUDIX	E3	N/A	2017-06-18	2018-06-17

6. ANTENNA PORT MEASUREMENT

6.1 Peak Power

6.1.1 Block Diagram of Test Setup



6.1.2 Limit

According to §15.247(b)(1), For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping system in the 2400–2483.5 MHz band: 0.125 watts.

6.1.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW ≥ RBW

Sweep = auto

Detector function = peak

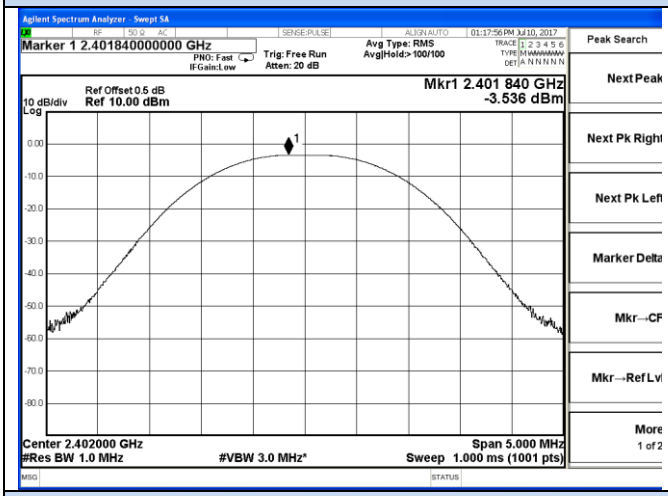
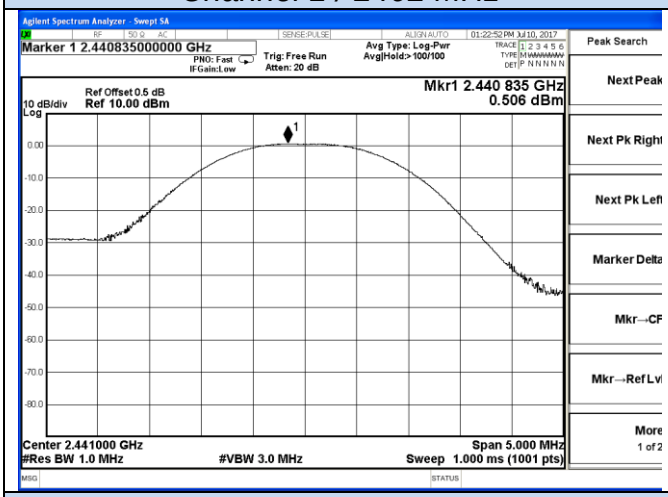
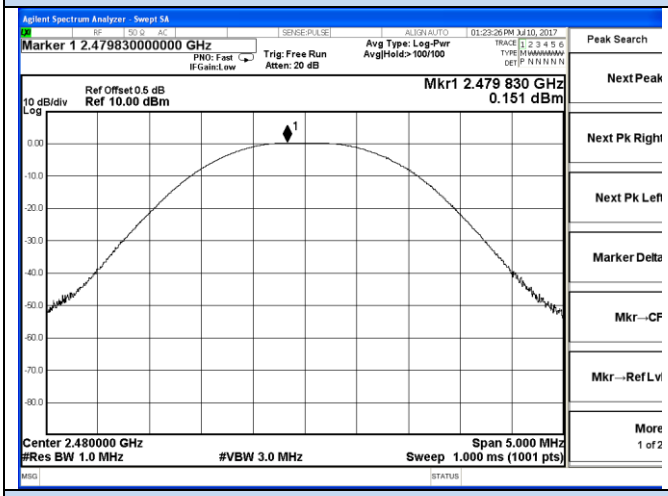
Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power

6.1.4 Test Results

Test Mode	Channel	Frequency (MHz)	Measured Maximum Power (dBm)	Limits (dBm)	Verdict
GFSK	1	2402	-3.536	30.00	PASS
	16	2441	0.506		
	31	2480	0.151		

Remark:
1. Test results including cable loss;

Peak Output Power	
GFSK	
	
Channel 1 / 2402 MHz	
	
Channel 16 / 2441 MHz	
	
Channel 31 / 2480 MHz	

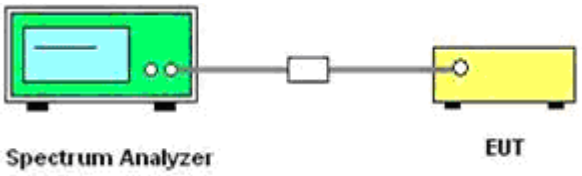
6.2 Frequency Separation and 20 dB Bandwidth

6.2.1 Limit

§ 15.247(a) (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

According to §15.247(c) or A8.1(a), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, 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 in15.209(a).

6.2.2 Block Diagram of Test Setup



6.2.3 Test Procedure

Frequency separation test procedure：

1). Place the EUT on the table and set it in transmitting mode.

2). Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.

3). Set center frequency of Spectrum Analyzer = middle of hopping channel.

4). Set the Spectrum Analyzer as RBW = 100 KHz, VBW = 300 KHz, Span = wide enough to capture the peaks of two adjacent channels, Sweep = auto.

5). Max hold, mark 2 peaks of hopping channel and record the 2 peaks frequency.

20dB bandwidth test procedure：

1). Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel.

2). RBW = 30 KHz, VBW = 100 KHz.

3). Detector function = peak.

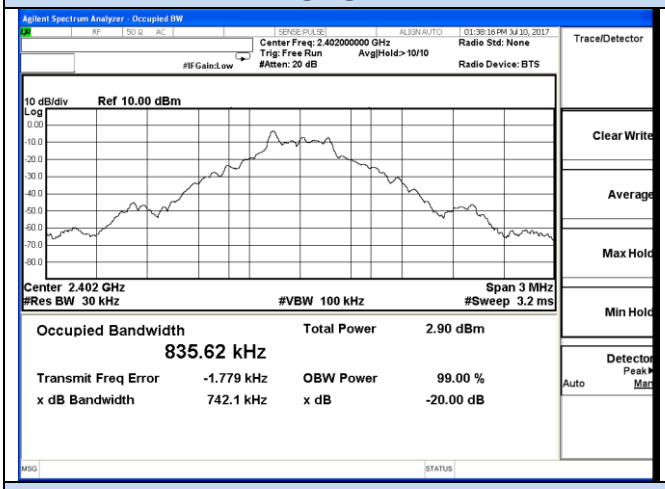
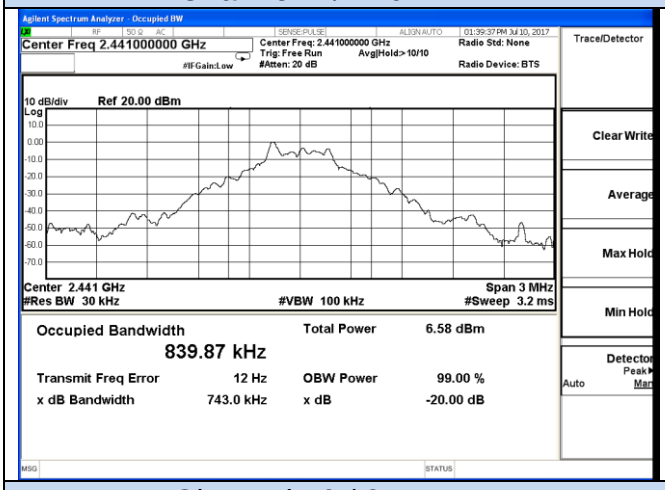
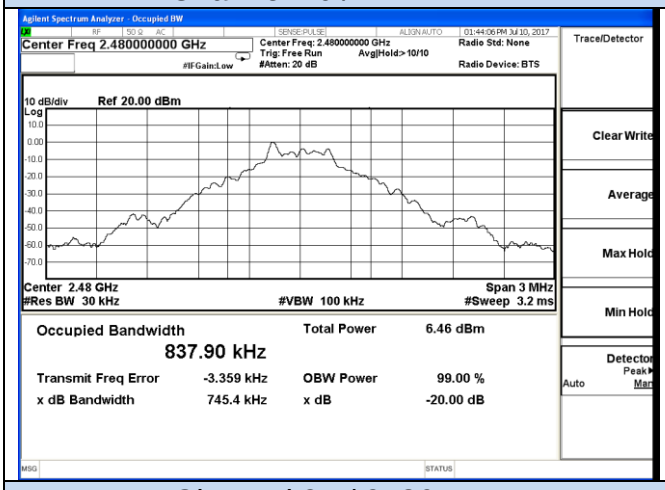
4). Trace = max hold.

6.2.4 Test Results

6.2.4.1 20dB Bandwidth

Test Mode	Channel	Frequency (MHz)	Measured Bandwidth (KHz)		Limits (KHz)	Verdict
			99%	20dB		
GFSK	1	2402	835.62	742.1	No Limits	PASS
	16	2441	839.87	743.0		
	31	2480	837.90	745.4		

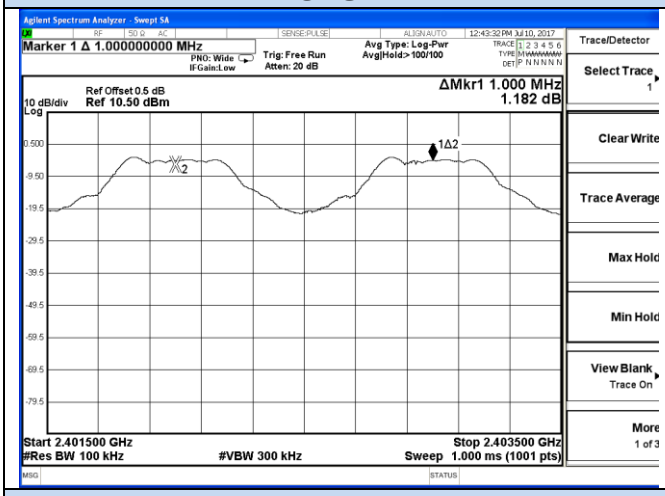
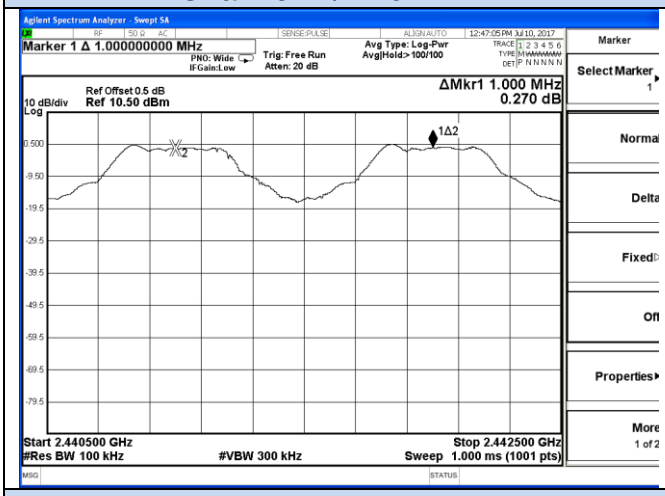
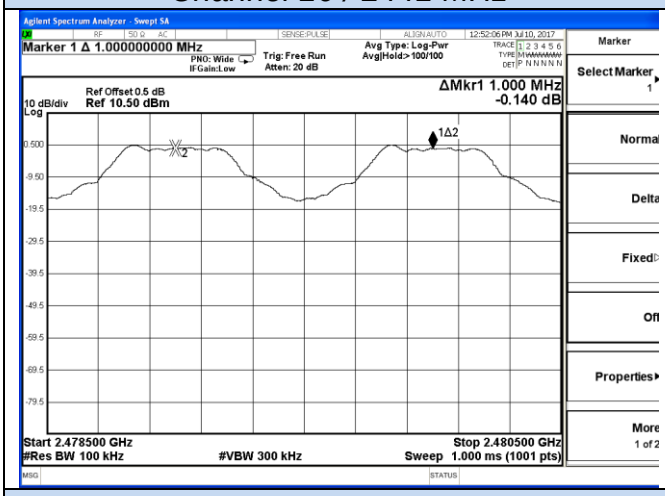
Remark:
1. *Test results including cable loss;*
2. *Please refer following test plots;*

20dB Bandwidth and 99% Bandwidth	
GFSK	
	
Channel 1 / 2402 MHz	
	
Channel 16 / 2441 MHz	
	
Channel 31 / 2480 MHz	

6.2.4.2 Frequency Separation

The Measurement Result With 1Mbps For GFSK Modulation				
Channel	20dB Bandwidth (KHz)	Channel Separation (MHz)	Limit (KHz)	Result
Low	742.1	1.000	≥742.1	Pass
Middle	743.0	1.000	≥743.0	Pass
High	745.4	1.000	≥745.4	Pass

Remark:
1. *Test results including cable loss;*
2. *Please refer to following plots;*

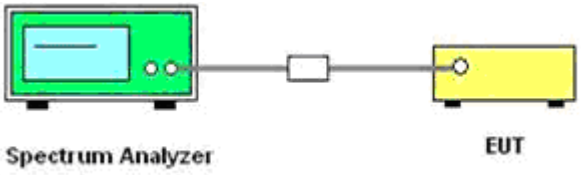
Frequency Separation	
GFSK	
	
Channel 1 / 2402 MHz	
	
Channel 16 / 2441 MHz	
	
Channel 31 / 2480 MHz	

6.3 Number of Hopping Frequency

6.3.1 Limit

According to §15.247(a)(1)(ii) or A8.1 (d), Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

6.3.2 Block Diagram of Test Setup



6.3.3 Test Procedure

1). Place the EUT on the table and set it in transmitting mode.

2). Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.

3). Set Spectrum Analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.

4). Set the Spectrum Analyzer as RBW = 1 MHz, VBW=1MHz.

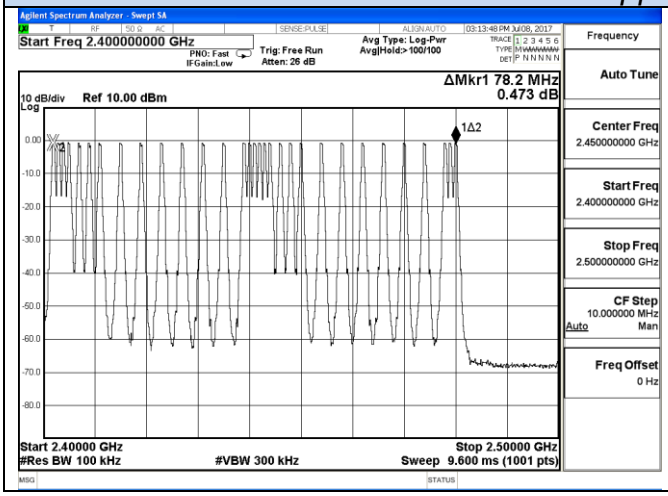
5). Max hold, view and count how many channel in the band.

6.3.4 Test Results

Test Mode	Measurement Result (No. of Channels)	Limit (No. of Channels)	Result
GFSK	31	≥15	PASS

Remark:
1. *Test results including cable loss;*
2. *Please refer following test plots;*

Number of Hopping Frequency

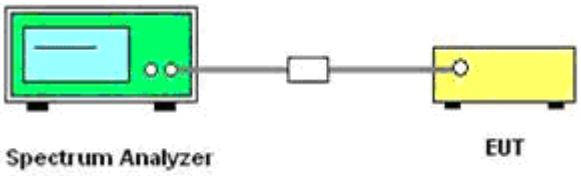


6.4 Time of Occupancy (Dwell Time)

6.4.1 Limit

According to §15.247(a)(1)(iii) or A8.1 (d), Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands. The average time of occupancy on any channels shall not greater than 0.4 s within a period 0.4 s multiplied by the number of hopping channels employed.

6.4.2 Block Diagram of Test Setup



6.4.3 Test Procedure

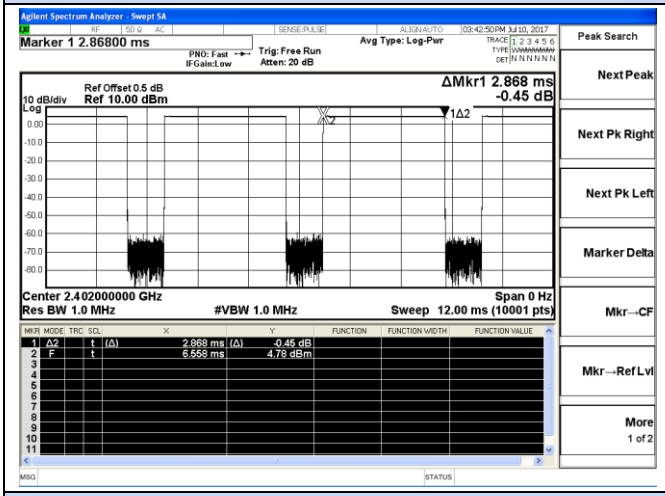
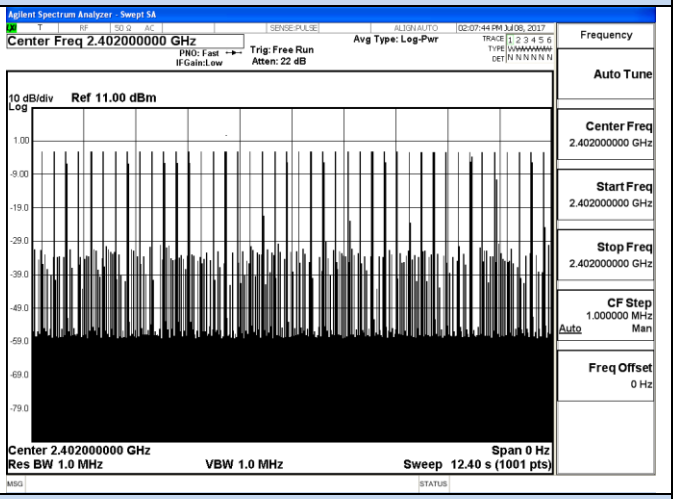
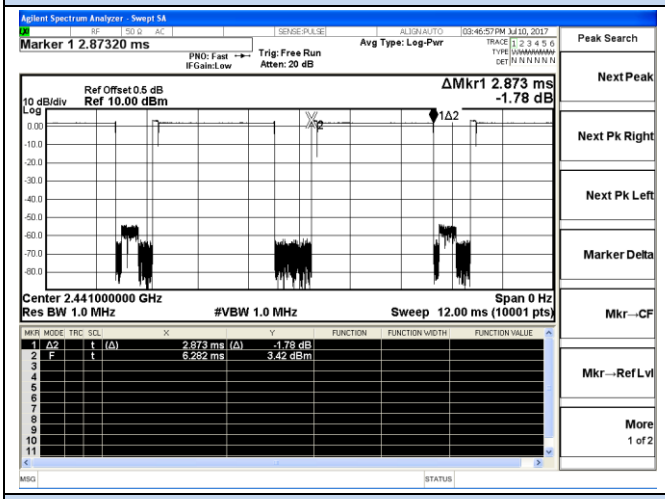
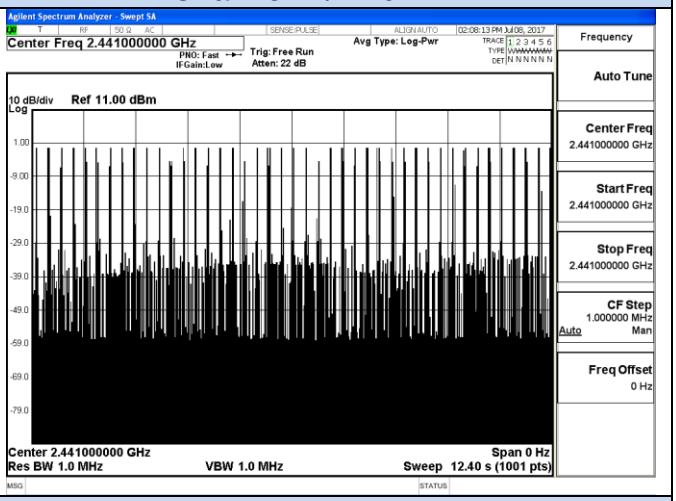
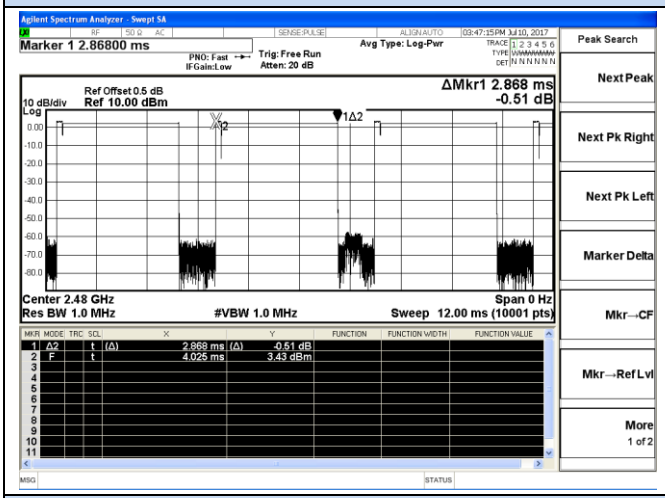
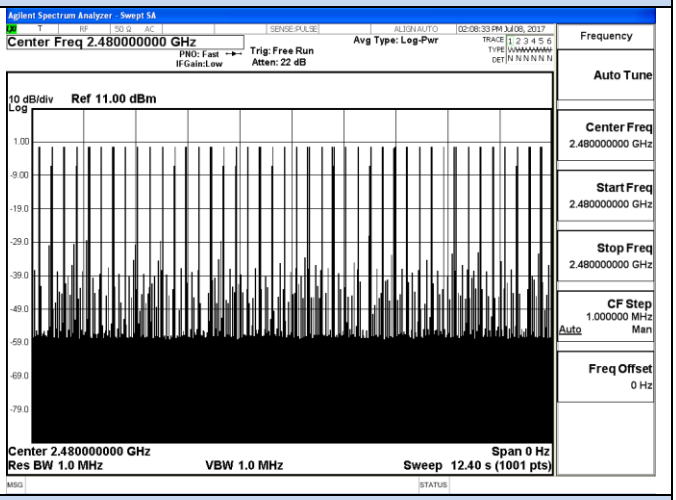
1). Place the EUT on the table and set it in transmitting mode.
2). Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.
3). Set center frequency of Spectrum Analyzer = operating frequency.
4). Set the Spectrum Analyzer as RBW, VBW=1MHz, Span = 0Hz, Sweep = auto.
5). Repeat above procedures until all frequency measured was complete.

6.4.4 Test Results

The Dwell Time=Burst Width*Total Hops. The detailed calculations are showed as follows:
The duration for dwell time calculation: 0.4[s]*hopping number=0.4[s]*31[ch]=12.4[s];
The burst width [ms/hop/ch], which is directly measured, refers to the duration on one channel hop.
The total hops for all channels are directly measured;

Mode	Frequency (MHz)	Pulse Width (ms)	Pulse Number	Dwell Time (S)	Limit (S)	Verdict
GFSK	2402	2.868	42	0.121	0.4	PASS
						PASS
						PASS
GFSK	2441	2.873	43	0.124	0.4	PASS
						PASS
						PASS
GFSK	2480	2.868	42	0.121	0.4	PASS
						PASS
						PASS

Remark:
1. *Test results including cable loss;*
2. *Please refer to following plots;*
3. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*
4. *Dwell Time Calculate formula:*
   Dwell time=Single Pulse length (ms) × total channel number
5. *Measured at low, middle and high channel, recorded worst at middle channel;*

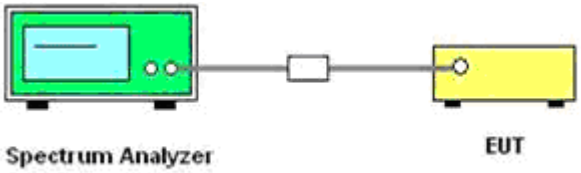
Dwell time	
GFSK	GFSK
	
Channel 1 / 2402 MHz	Channel 1 / 2402 MHz
	
Channel 16 / 2441 MHz	Channel 16 / 2441 MHz
	
Channel 31 / 2480 MHz	Channel 31 / 2480 MHz

6.5 Conducted Spurious Emissions and Band Edges Test

6.5.1 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 conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

6.5.2 Block Diagram of Test Setup



6.5.3 Test Procedure

Conducted RF measurements of the transmitter output were made to confirm that the EUT antenna port conducted emissions meet the specified limit and to identify any spurious signals that require further investigation or measurements on the radiated emissions site.
The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to 100 KHz. The video bandwidth is set to 300 KHz.
Measurements are made over the 9 KHz to 26.5GHz range with the transmitter set to the lowest, middle, and highest channels

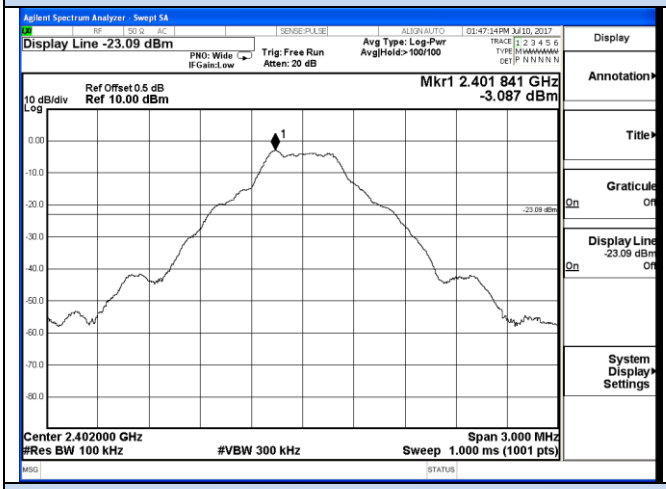
6.5.4 Test Results of Conducted Spurious Emissions

Test Mode	Channel	Frequency (MHz)	Spurious RF Conducted Emission (dBc)	Limits (dBc)	Verdict
GFSK	1	2402	<-20	-20	PASS
	16	2441	<-20		
	31	2480	<-20		

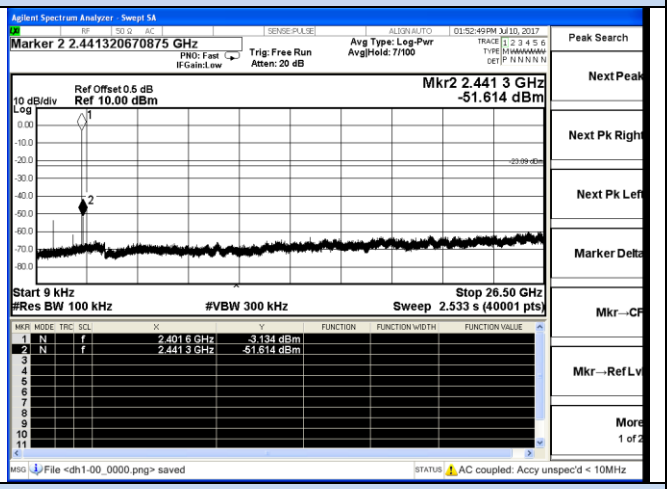
Remark:
1. *Test results including cable loss;*
2. *Please refer to following plots;*

RF Conducted Spurious Emissions

GFSK – Channel 1 / 2402 MHz

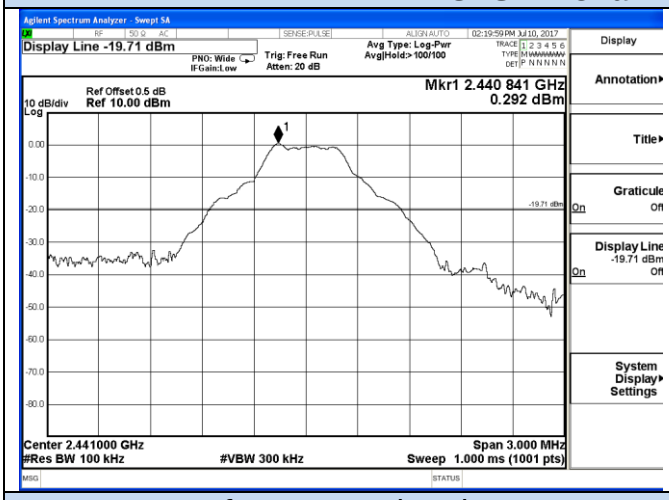


Reference Peak Value

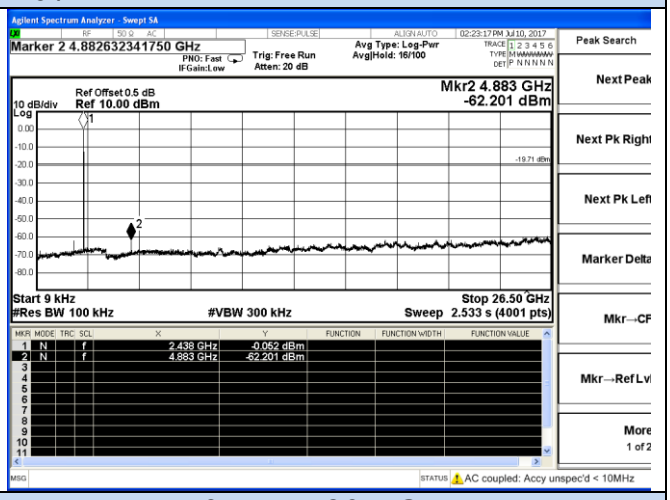


9 KHz – 26.5 GHz

GFSK – Channel 16 / 2441 MHz

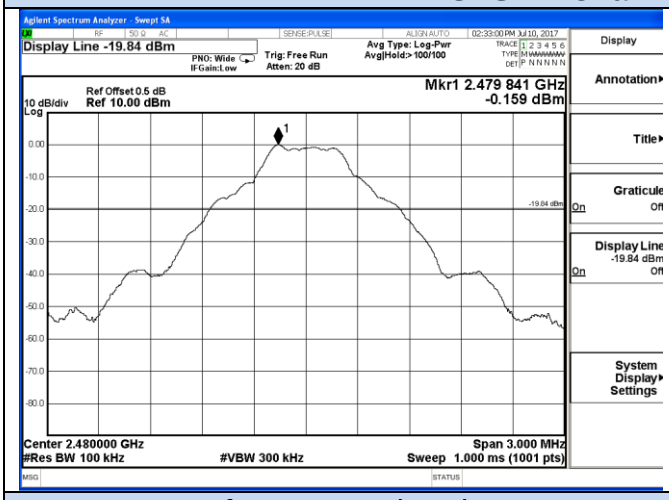


Reference Peak Value

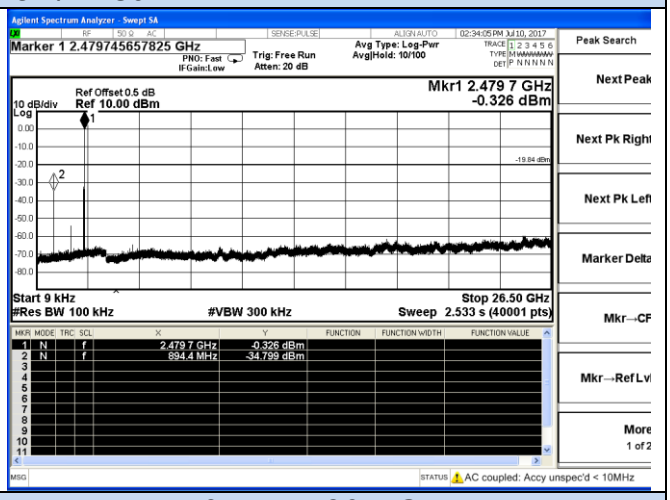


9 KHz – 26.5 GHz

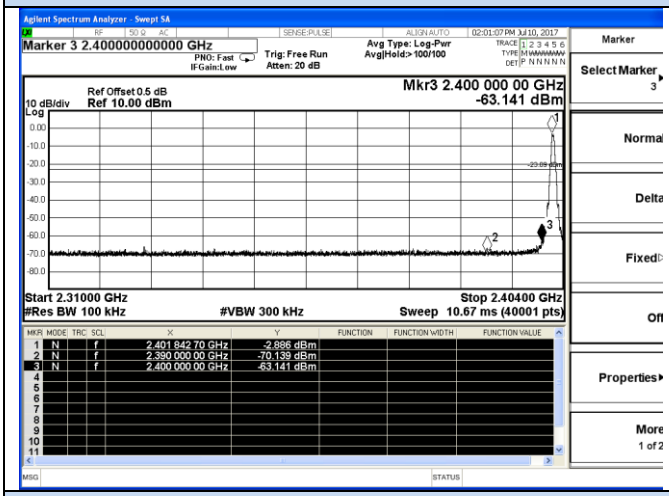
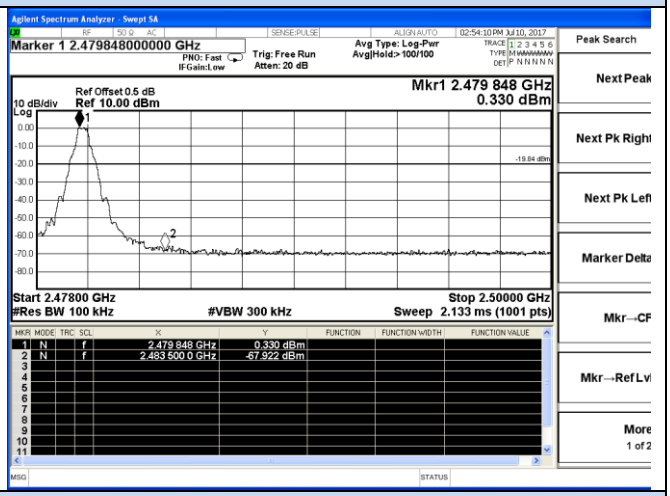
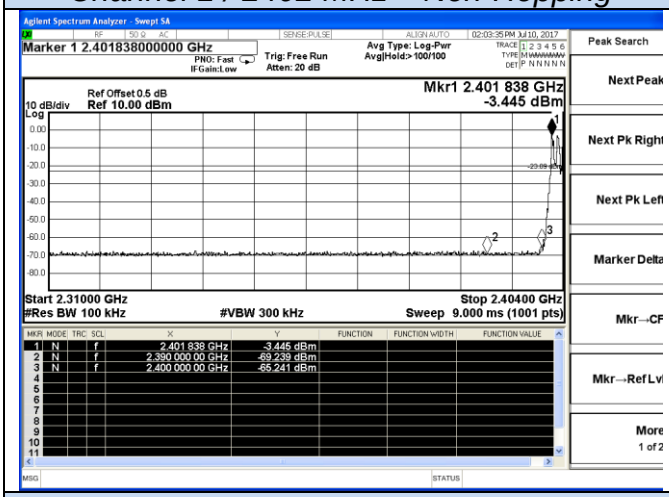
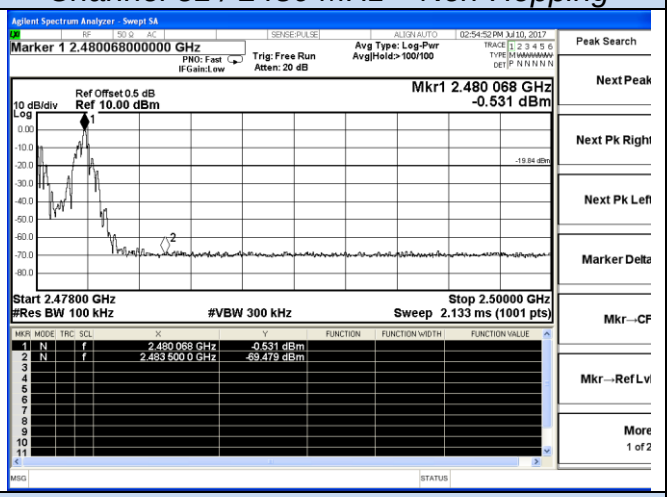
GFSK – Channel 31 / 2480 MHz



Reference Peak Value

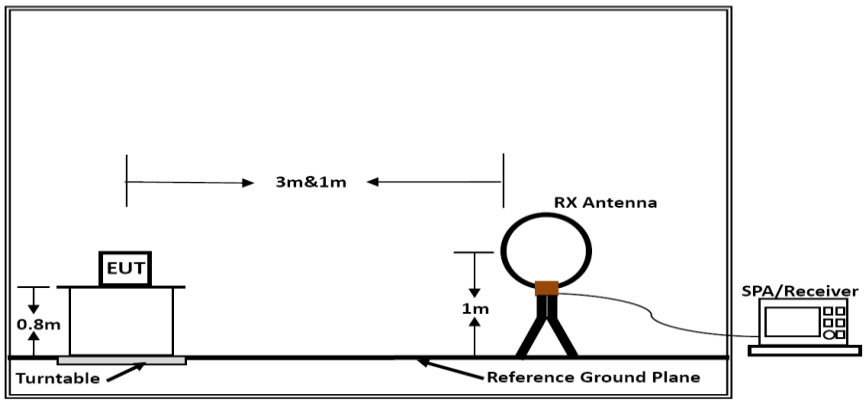


9 KHz – 26.5 GHz

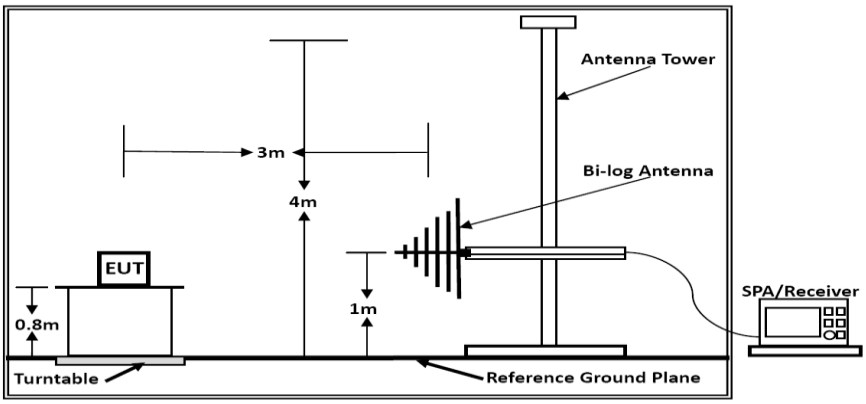
Band-edge for RF conducted emissions	
GFSK	GFSK
	
Channel 1 / 2402 MHz – Non-Hopping	Channel 31 / 2480 MHz – Non-Hopping
	
Channel 1 / 2402 MHz – Hopping	Channel 31 / 2480 MHz – Hopping

7. RADIATED MEASUREMENT

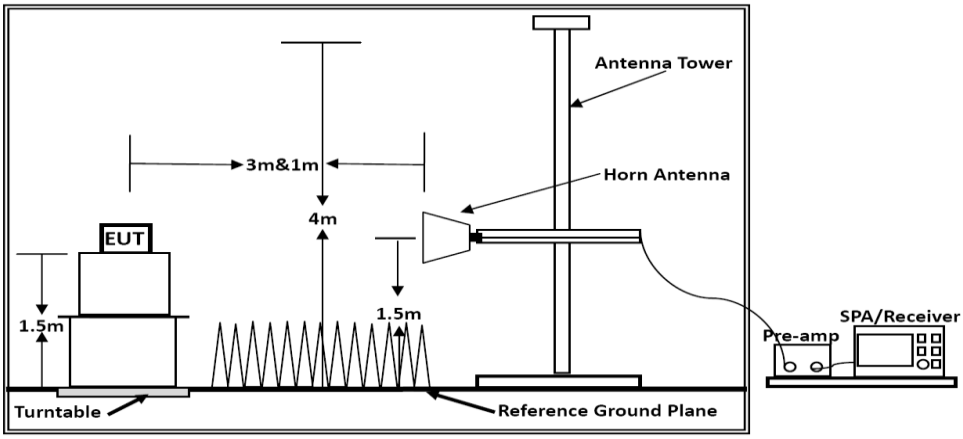
7.1 Block Diagram of Test Setup



Below 30MHz



Below 1GHz



Above 1GHz

Above 18 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m.

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1.5m]) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

7.2 Restricted Band Emission Limit

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
\1\ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293.	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(\2\)
13.36-13.41			

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

\2\ Above 38.6

According to §15.247 (d): 20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

7.3 Instruments Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10^{th} carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP

7.4 Test Procedures

1) Sequence of testing 9 kHz to 30 MHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 0.8 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

2) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) Sequence of testing above 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

Premeasurement:

--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

Final measurement:

--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

7.5 EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

7.6 Test Results

Radiated Emissions (9 KHz~30MHz)

Temperature	25℃	Humidity	60%
Test Engineer	Chaz Liu	Configurations	GFSK

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Over Limit (dBuV)	Remark
-	-	-	-	See Note

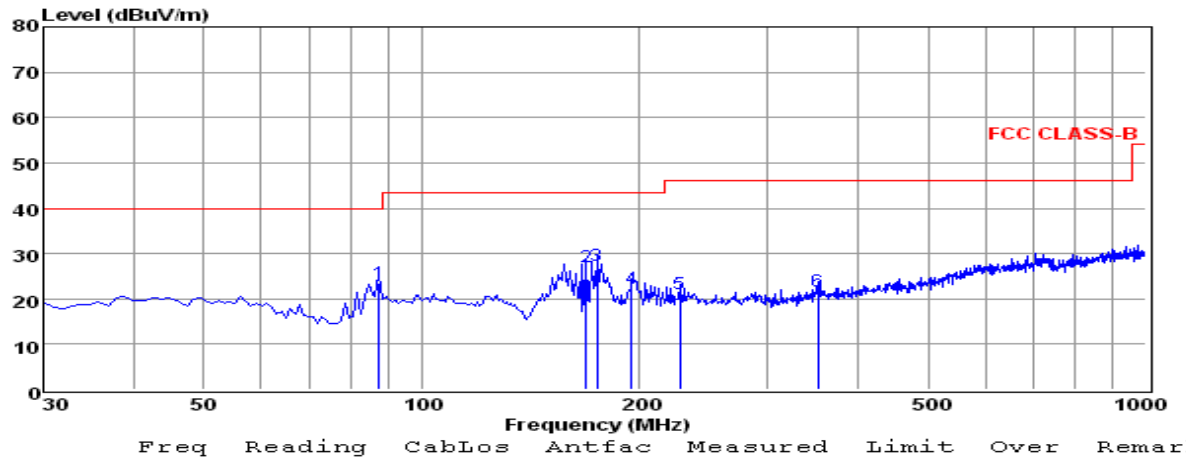
Note:
The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.
Distance extrapolation factor = 40 log (specific distance / test distance) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor.

PASS.

Pre-scan all modes and recorded the worst case results in this report (TX-Middle Channel (1Mbps)). The test data please refer to following page.

Below 1GHz (Middle Channel)

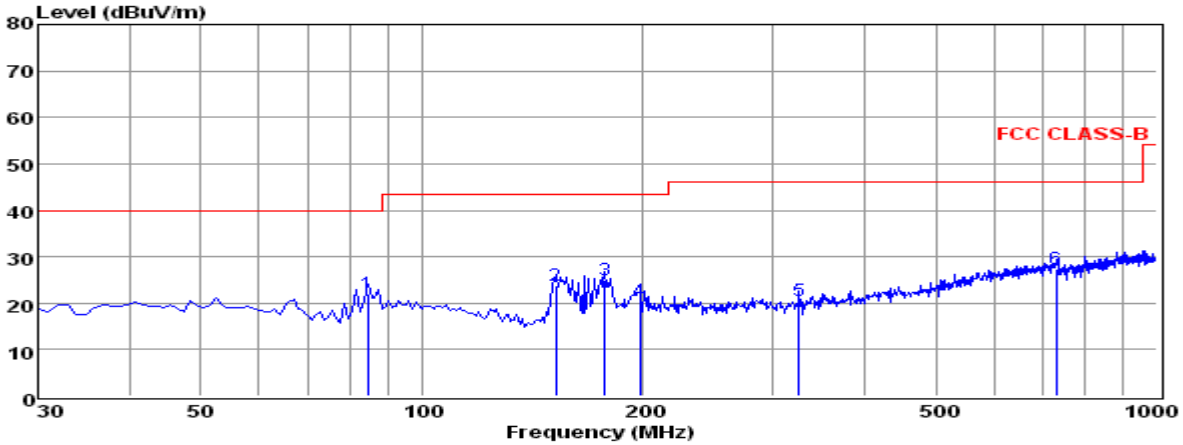
Vertical:



	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	87.23	11.86	0.47	11.02	23.35	40.00	-16.65	QP
2	168.71	17.25	0.80	8.93	26.98	43.50	-16.52	QP
3	174.53	17.40	0.73	9.29	27.42	43.50	-16.08	QP
4	194.90	10.81	0.96	10.56	22.33	43.50	-21.17	QP
5	226.91	8.66	0.89	11.51	21.06	46.00	-24.94	QP
6	352.04	6.23	1.15	14.31	21.69	46.00	-24.31	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Horizontal:



	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	84.32	11.47	0.54	10.07	22.08	40.00	-17.92	QP
2	152.22	14.68	0.73	8.35	23.76	43.50	-19.74	QP
3	177.44	14.49	0.89	9.50	24.88	43.50	-18.62	QP
4	197.81	9.18	0.84	10.57	20.59	43.50	-22.91	QP
5	325.85	5.96	1.04	13.56	20.56	46.00	-25.44	QP
6	729.37	6.53	1.70	19.18	27.41	46.00	-18.59	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Above 1GHz

Note: Only recorded the worst test result.

Channel 1 / 2402 MHz:

Freq. MHz	Reading dBuV	Ant. Fac dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4804.00	46.81	33.06	35.04	3.94	48.77	74.00	-25.23	Peak	Horizontal
4804.00	32.02	33.06	35.04	3.94	33.98	54.00	-20.02	Average	Horizontal
4804.00	48.97	33.06	35.04	3.94	50.93	74.00	-23.07	Peak	Vertical
4804.00	33.86	33.06	35.04	3.94	35.82	54.00	-18.18	Average	Vertical

Channel 16 / 2441 MHz:

Freq. MHz	Reading dBuV	Ant. Fac dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4882.00	48.00	33.16	35.15	3.96	49.97	74.00	-24.03	Peak	Horizontal
4882.00	33.42	33.16	35.15	3.96	35.39	54.00	-18.61	Average	Horizontal
4882.00	50.14	33.16	35.15	3.96	52.11	74.00	-21.89	Peak	Vertical
4882.00	34.18	33.16	35.15	3.96	36.15	54.00	-17.85	Average	Vertical

Channel 31 / 2480 MHz:

Freq. MHz	Reading dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab. Los dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4960.00	50.02	33.26	35.14	3.98	52.12	74.00	-21.88	Peak	Horizontal
4960.00	31.21	33.26	35.14	3.98	33.31	54.00	-20.69	Average	Horizontal
4960.00	51.54	33.26	35.14	3.98	53.64	74.00	-20.36	Peak	Vertical
4960.00	33.13	33.26	35.14	3.98	35.23	54.00	-18.77	Average	Vertical

Notes:

1). Measuring frequencies from 9 KHz - 10th harmonic (ex. 26GHz), No emission found between lowest internal used/generated frequency to 30 MHz.

2). Radiated emissions measured in frequency range from 9 KHz - 10th harmonic (ex. 26GHz) were made with an instrument using Peak detector mode.

3). 18~25GHz at least have 20dB margin. No recording in the test report.

8. POWER LINE CONDUCTED EMISSIONS

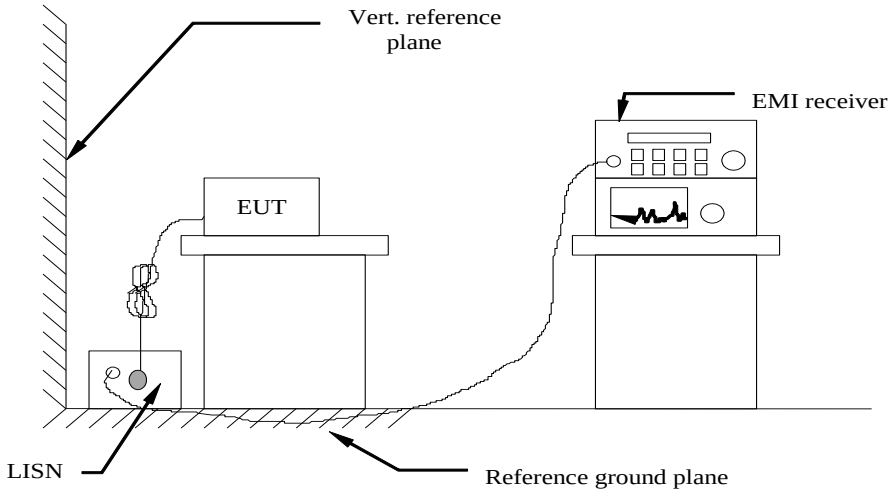
8.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

8.2 Block Diagram of Test Setup



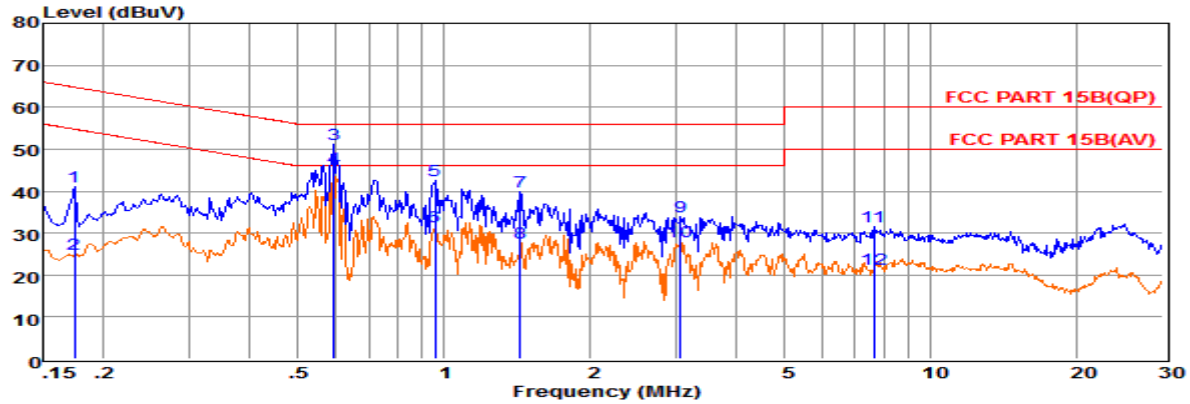
8.3 Test Results

PASS.

The test data please refer to following page.

AC Conducted Emission of power adapter @ AC 240V/50Hz @ GFSK (worst case)

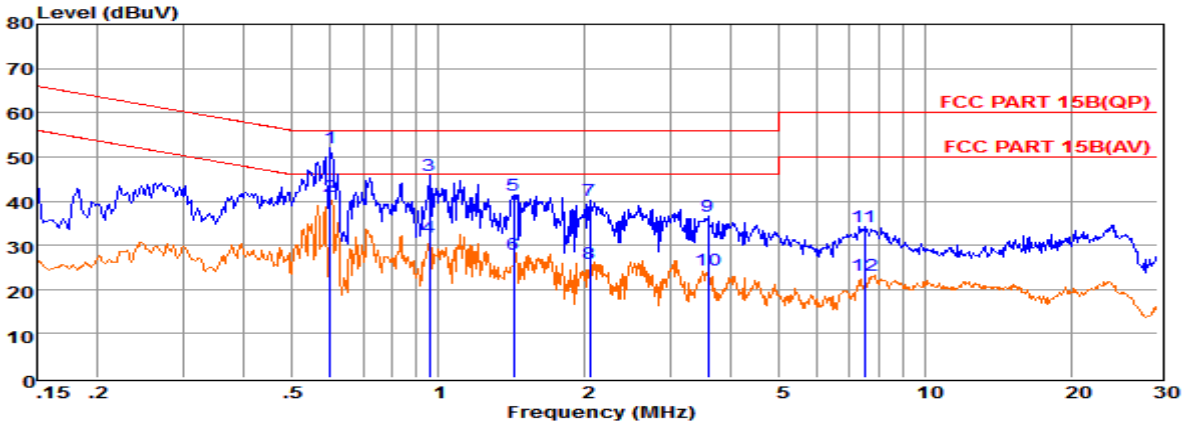
Line:



	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.17	21.47	9.60	0.02	10.00	41.09	64.77	-23.68	QP
2	0.17	5.27	9.60	0.02	10.00	24.89	64.76	-39.87	Average
3	0.59	31.54	9.63	0.04	10.00	51.21	56.00	-4.79	QP
4	0.59	25.94	9.63	0.04	10.00	45.61	56.00	-10.39	Average
5	0.96	22.76	9.63	0.05	10.00	42.44	56.00	-13.56	QP
6	0.96	11.73	9.63	0.05	10.00	31.41	56.00	-24.59	Average
7	1.43	20.19	9.64	0.05	10.00	39.88	56.00	-16.12	QP
8	1.43	8.00	9.64	0.05	10.00	27.69	56.00	-28.31	Average
9	3.06	14.32	9.64	0.06	10.00	34.02	56.00	-21.98	QP
10	3.06	8.32	9.64	0.06	10.00	28.02	56.00	-27.98	Average
11	7.65	11.87	9.68	0.07	10.00	31.62	60.00	-28.38	Average
12	7.65	1.67	9.68	0.07	10.00	21.42	60.00	-38.58	QP

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

Neutral:



	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.60	32.24	9.63	0.04	10.00	51.91	56.00	-4.09	QP
2	0.60	21.32	9.63	0.04	10.00	40.99	56.00	-15.01	Average
3	0.96	26.11	9.63	0.05	10.00	45.79	56.00	-10.21	QP
4	0.96	12.15	9.63	0.05	10.00	31.83	56.00	-24.17	Average
5	1.43	21.78	9.63	0.05	10.00	41.46	56.00	-14.54	QP
6	1.43	8.22	9.63	0.05	10.00	27.90	56.00	-28.10	Average
7	2.04	20.41	9.63	0.05	10.00	40.09	56.00	-15.91	QP
8	2.05	6.13	9.63	0.05	10.00	25.81	56.00	-30.19	Average
9	3.58	16.72	9.65	0.06	10.00	36.43	56.00	-19.57	QP
10	3.59	4.61	9.65	0.06	10.00	24.32	56.00	-31.68	Average
11	7.49	14.30	9.70	0.07	10.00	34.07	60.00	-25.93	QP
12	7.49	3.37	9.70	0.07	10.00	23.14	60.00	-36.86	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

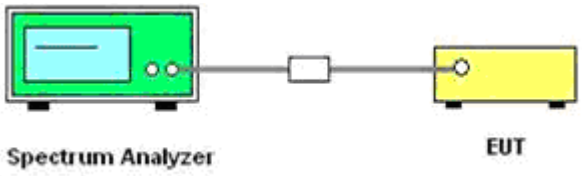
****Note: Pre-scan all modes and recorded the worst case results in this report;*

9. RESTRICT-BAND BAND-EDGE MEASUREMENTS FOR RADIATED EMISSIONS

9.1 Standard Applicable

Per the requirement of ANSI C63.10:2013 §6.10.5, Restricted-band band-edge tests shall be performed as radiated measurements, however, §12.7.2 that allowed a converted method from conducted measurement function, for conducted measurements above 1000 MHz, EIRP shall be computed as specified in §12.7.4.2, and then field strength shall be computed as follows:
1) E[dBuV/m] = EIRP[dBm] − 20 log (d[m]) + 104.77, where E is field strength and d is distance at which the field strength limit is specified in the applicable requirements.
2) E[dBuV/m] = EIRP[dBm] + 95.2, for d = 3 m.
Then the radiated field strength E can be calculated as
E=EIRP[dBm] + 95.2

9.2 Block Diagram of Test Setup



9.3 Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of Spectrum Analyzer.

9.4. Test Procedures

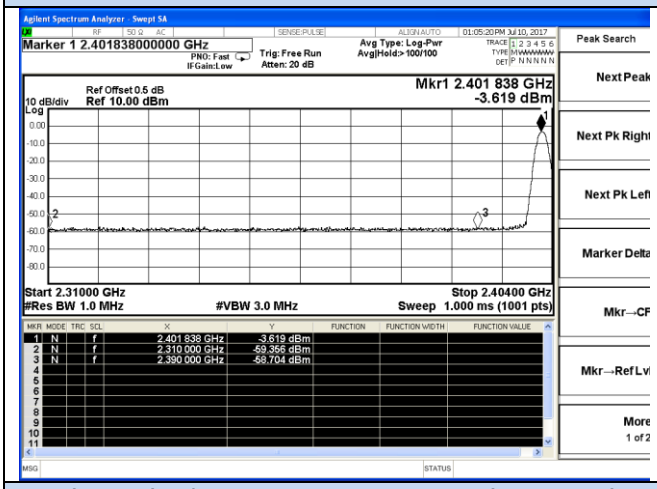
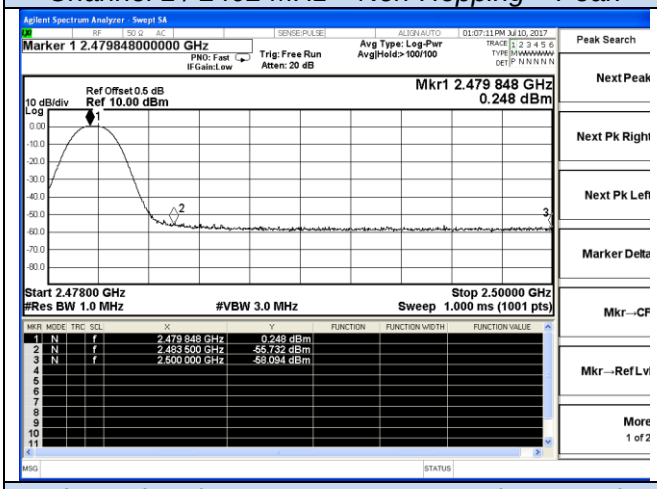
1. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
2. Repeat above procedures until all measured frequencies were complete.
3. Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
4. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)
5. Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
6. For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
7. Compare the resultant electric field strength level to the applicable regulatory limit.
8. Perform radiated spurious emission test duress until all measured frequencies were complete.
9. Spectrum analyzer setup:
   Resolution bandwidth: 1MHz
   Video bandwidth: 3 × RBW
   Detector: Peak and average above 1 GHz

9.5. Test Results

GFSK – Non-Hopping							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-59.356	2.00	0.00	37.844	Peak	74.00	PASS
2390.000	-58.704	2.00	0.00	38.496	Peak	74.00	PASS
2483.500	-55.732	2.00	0.00	41.468	Peak	74.00	PASS
2500.000	-58.094	2.00	0.00	39.106	Peak	74.00	PASS

Remark:

1. *Measured at Hopping and Non-Hopping mode, recorded worst at Non-Hopping mode.*
2. *The other emission levels were very low against the limit.*
3. *If all peak measurement results satisfy the average limit, then average measurements are not required..*
4. *Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=330KHz/Sweep time=Auto/Detector=Peak;*
5. *Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.*
6. *Please refer to following test plots;*

Restrict-BandBand-edge measurements for radiated emissions	
GFSK	
	
Channel 1 / 2402 MHz – Non-Hopping – Peak	
	
Channel 31 / 2480 MHz – Non-Hopping – Peak	

10. ANTENNA REQUIREMENT

10.1 Standard Applicable

According to antenna requirement of §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be re-placed by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

10.2 Antenna Connected Construction

10.2.1. Standard Applicable

According to § 15.203 & RSS-Gen, 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.

10.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting is 0dBi, and the antenna is an integral antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

10.2.3. Results: Compliance.

Measurement

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.
Conducted power refers ANSI C63.10:2013 Output power test procedure for FHSS devices.
Radiated power refers to ANSI C63.10:2013 Radiated emissions tests.

Measurement parameters

Measurement parameter	
Detector:	Peak
Sweep Time:	Auto
Resolution bandwidth:	1MHz
Video bandwidth:	3MHz
Trace-Mode:	Max hold

Note: The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module. For FHSS devices, the GFSK mode is used;

Limits

FCC	ISED
Antenna Gain	
6 dBi	

Tnom	Vnom	Lowest Channel 2402 MHz	Middle Channel 2441 MHz	Highest Channel 2480 MHz
Conducted power [dBm] Measured with GFSK modulation		-3.536	0.506	0.151
Radiated power [dBm] Measured with GFSK modulation		-3.834	0.228	-0.225
Gain [dBi] Calculated		-0.298	-0.278	-0.376
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

11. TEST SETUP PHOTOGRAPHS OF EUT

Please refer to separated files for Test Setup Photos of the EUT.

12. EXTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for External Photos of the EUT.

13. INTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for Internal Photos of the EUT.

----------THE END OF REPORT----------