FCC TEST REPORT

FOR

Shenzhen KingBoard Technology Co., Ltd.

BLUETOOTH SPEAKER

Test Model No.: KTS-170A

Additional Model No.: Please refer to page 5.

Prepared for	:	Shenzhen KingBoard Technology Co., Ltd.
Address	:	Bldg. A, Dakanglong Industry Zone Dabuxiang, Guanlan, Shenzhen, China
Prepared by	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
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Date of receipt of test sample	:	March 29, 2016
Number of tested samples	:	1
Sample number	:	Prototype
Date of Test	:	March 29, 2016 - April 29, 2016
Date of Report	:	April 29, 2016

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FCC TEST REPORT

FCC CFR 47 PART 15 C(15.247): 2015

Report Reference No.	**:**	**LCS1603292449E**
Date of Issue.....	:	April 29, 2016
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	**:**	**Shenzhen KingBoard Technology Co., Ltd.**
Address.....	:	Bldg. A, Dakanglong Industry Zone Dabuxiang, Guanlan, Shenzhen, China
Test Specification		
Standard.....	:	FCC CFR 47 PART 15 C(15.247): 2015 / ANSI C63.10: 2013
Test Report Form No.....	:	LCSEMC-1.0
TRF Originator.....	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
Master TRF	:	Dated 2011-03

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Test Item Description.....	**:**	**BLUETOOTH SPEAKER**
Trade Mark.....	:	N/A
Test Model.....	:	KTS-170A
Ratings.....	:	DC 3.7 V Battery (300mAh) Recharge Voltage: 5V⎓, 300mA
Result	**:**	**Positive**

Compiled by:	Supervised by:	Approved by:
Dick Su/ File administrators	Glin Lu/ Technique principal	Gavin Liang/ Manager

FCC -- TEST REPORT

Test Report No. : LCS1603292449E	April 29, 2016 Date of issue

Test Model.....	: KTS-170A
EUT.....	: BLUETOOTH SPEAKER
Applicant.....	**: Shenzhen KingBoard Technology Co., Ltd.**
Address.....	: Bldg. A, Dakanglong Industry Zone Dabuxiang, Guanlan, Shenzhen, China
Telephone.....	: /
Fax.....	: /
Manufacturer.....	**: Shenzhen KingBoard Technology Co., Ltd.**
Address.....	: Bldg. A, Dakanglong Industry Zone Dabuxiang, Guanlan, Shenzhen, China
Telephone.....	: /
Fax.....	: /
Factory.....	: **Shenzhen KingBoard Technology Co., Ltd.**
Address.....	: Bldg. A, Dakanglong Industry Zone Dabuxiang, Guanlan, Shenzhen, 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
00	April 29, 2016	Initial Issue	Gavin Liang

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1. GENERAL INFORMATION

1.1 Description of Device (EUT)

EUT	:	BLUETOOTH SPEAKER
Test Model	:	KTS-170A
Hardware Version	:	V4
Software Version	:	V1.1
Power Supply	:	DC 3.7 V Battery (300mAh) Recharge Voltage: 5V⎓, 300mA
Frequency Range	:	2402.00-2480.00MHz
Channel Spacing	:	1MHz for Bluetooth V2.1+EDR
Channel Number	:	79 channels for Bluetooth V2.1+EDR
Modulation Type	:	GFSK, Pi/4-DQPSK, 8-DPSK for Bluetooth V2.1+EDR
Antenna Description	:	Internal Antenna, 0.5dBi (Max.)

Additional models No.			
BT-107	KTS-645	BT-139	KTS-21
BT-106	KTS-606	KTS-662	BT-120
KTS-634A	--	--	--
Remark: PCB board, structure and internal of these model(s) are the same, So no additional models were tested.			

1.2 Support equipment List

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

1.3 External I/O

I/O Port Description	Quantity	Cable
USB Port	1	N/A
A USB Port	1	N/A
TF Card Port	1	N/A
Audio Port	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.

VCCI Registration Number. is C-4260 and R-3804.

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.

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1.5 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Cal Date	Due Date
EMC Receiver	R&S	ESCS 30	100174	9kHz – 2.75GHz	June 18,2015	June 17,2016
Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	9kHz~40GHz	July 16,2015	July 15,2016
LISN	MESS Tec	NNB-2/16Z	99079	9KHz-30MHz	June 18,2015	June 17,2016
LISN (Support Unit)	EMCO	3819/2NM	9703-1839	9KHz-30MHz	June 18,2015	June 17,2016
RF Cable-CON	UTIFLEX	3102-26886-4	CB049	9KHz-30MHz	June 18,2015	June 17,2016
ISN	SCHAFFNER	ISN ST08	21653	9KHz-30MHz	June 18,2015	June 17,2016
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	30M-1GHz 3m	June 18,2015	June 17,2016
Amplifier	SCHAFFNER	COA9231A	18667	9kHz-2GHzz	June 18,2015	June 17,2016
Amplifier	Agilent	8449B	3008A02120	1GHz-26.5GHz	July 16,2015	July 15,2016
Amplifier	MITEQ	AMF-6F-260400	9121372	26.5GHz-40GHz	July 16,2015	July 15,2016
Spectrum Analyzer	Agilent	E4407B	MY41440292	9k-26.5GHz	July 16,2015	July 15,2016
MAX Signal Analyzer	Agilent	N9020A	MY50510140	20Hz~26.5GHz	Oct. 27,2015	Oct. 26,2016
Loop Antenna	R&S	HFH2-Z2	860004/001	9k-30MHz	June 18,2015	June 17,2016
By-log Antenna	SCHWARZBECK	VULB9163	9163-470	30MHz-1GHz	June 10,2015	June 09,2016
Horn Antenna	EMCO	3115	6741	1GHz-18GHz	June 10,2015	June 09,2016
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170154	15GHz-40GHz	June 10,2015	June 09,2016
RF Cable-R03m	Jye Bao	RG142	CB021	30MHz-1GHz	June 18,2015	June 17,2016
RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	1GHz-40GHz	June 18,2015	June 17,2016
Power Meter	R&S	NRVS	100444	DC-40GHz	June 18,2015	June 17,2016
Power Sensor	R&S	NRV-Z51	100458	DC-30GHz	June 18,2015	June 17,2016
Power Sensor	R&S	NRV-Z32	10057	30MHz-6GHz	June 18,2015	June 17,2016
RF CABLE-1m	JYE Bao	RG142	CB034-1m	20MHz-7GHz	June 18,2015	June 17,2016
RF CABLE-2m	JYE Bao	RG142	CB035-2m	20MHz-1GHz	June 18,2015	June 17,2016
Note: All equipment through GRGT EST calibration						

1.6 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.

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

1.8 Description of Test Modes

Bluetooth operates in the unlicensed ISM Band at 2.4GHz. With the introduction of the enhanced data rate (EDR) feature, the data rates can be up to 3 Mb/s. An increase in the peak data rate beyond the basic rate of 1 Mb/s is achieved by modulating the RF carrier using GFSK techniques, resulting in an increase of two to three times the number of bits per symbol. The 2 Mb/s EDR packets use a π/4-DQPSK modulation and the 3 Mb/s EDR packets use 8DPSK modulation. The following operating modes were applied for the related test items. For radiated measurement, the test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position. 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
π/4 DQPSK	2402	2
	2441	2
	2480	2
8-DPSK	2402	3
	2441	3
	2480	3
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-Hopping Mode).

Worst-case mode and channel used for 9kHz-1000 MHz radiated emissions was determined to be TX-Low Channel (2402MHz, 1Mbps).

***Note: Using a temporary antenna connector for the EUT when the conducted measurements are performed.

For pre-testing, when performed with LiPo Battery Charger, the input Voltage/Frequency AC 120V/60Hz and AC 240V/60Hz were used. Only recorded the worst case in this report.

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 engineering mode to fix the TX frequency that was for the purpose of the measurements.

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

According to the requirements in Section 6.2 of ANSI C63.10: 2013, AC power-line conducted emissions shall be 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 turn table and 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

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3. SYSTEM TEST CONFIGURATION

3.1 Justification

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

3.2 EUT Exercise Software

N/A.

3.3 Special Accessories

N/A.

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.

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4. SUMMARY OF TEST RESULTS

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

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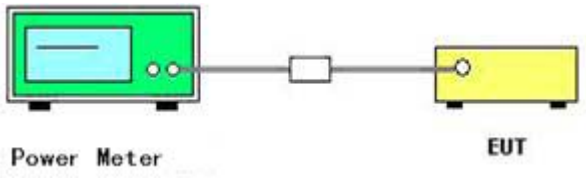
5. ANTENNA PORT MEASUREMENT

5.1 Maximum Conducted Output Power

5.1.1 Block Diagram of Test Setup



5.1.2 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: 1watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.1.3 Test Procedure

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the Hopping Frequency Device bandwidth and shall use a fast-responding diode detector.

5.1.4 Test Results

Channel	Frequency (MHz)	Output Power (dBm)	Output Power (mW)	Limit (mW)	Result
GFSK	2402	4.37	2.74	1000	Pass
	2441	3.67	2.33	1000	Pass
	2480	5.14	3.27	1000	Pass
π/4 DQPSK	2402	3.01	2.00	125	Pass
	2441	2.88	1.94	125	Pass
	2480	3.54	2.26	125	Pass
8-DPSK	2402	3.02	2.01	125	Pass
	2441	2.86	1.93	125	Pass
	2480	3.52	2.25	125	Pass

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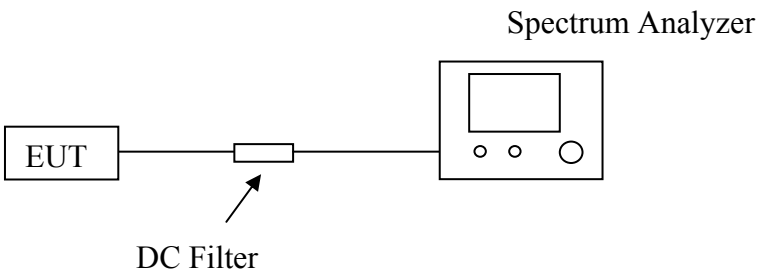
5.2 Frequency Separation and 20 dB Bandwidth

5.2.1 Limit

According to §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.

5.2.2 Block Diagram of Test Setup



5.2.3 Test Procedure

A. Place the EUT on the table and set it in transmitting mode.
B. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.
C. Set to the maximum power setting and enable the EUT transmit continuously.
D. For carrier frequency separation measurement, use the following spectrum analyzer settings:
   Span = wide enough to capture the peaks of two adjacent channels;
   RBW / VBW=100 KHz/ 300KHz; Sweep = auto; Detector function = peak;
   Trace = max hold.
E. For 20dB bandwidth measurement, use the following spectrum analyzer settings:
   Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel; RBW/VBW=30 KHz/ 100KHz; Sweep = auto; Detector function = peak;
   Trace = max hold.

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5.2.4 Test Results

The Measurement Result With 1Mbps For GFSK Modulation			
20dB Bandwidth Measurement			
Channel	**20dB Bandwidth (MHz)**		**Limit**
Low	0.831		Non-specified
Middle	0.832		Non-specified
High	0.832		Non-specified
Channel Separation Measurement			
Channel	**Channel Separation (MHz)**	**Limit (MHz)**	**Result**
Low	1.000	0.831	Pass
Middle	1.000	0.832	Pass
High	1.000	0.832	Pass

The Measurement Result With 2Mbps For π/4 DQPSK Modulation			
20dB Bandwidth Measurement			
Channel	**20dB Bandwidth (MHz)**		**Limit**
Low	1.117		Non-specified
Middle	1.117		Non-specified
High	1.115		Non-specified
Channel Separation Measurement			
Channel	**Channel Separation (MHz)**	**Limit (MHz)**	**Result**
Low	1.000	0.745	Pass
Middle	1.000	0.745	Pass
High	1.000	0.743	Pass

The Measurement Result With 3Mbps For 8-DPSK Modulation			
20dB Bandwidth Measurement			
Channel	**20dB Bandwidth (MHz)**		**Limit**
Low	1.116		Non-specified
Middle	1.162		Non-specified
High	1.116		Non-specified
Channel Separation Measurement			
Channel	**Channel Separation (MHz)**	**Limit (MHz)**	**Result**
Low	1.000	0.777	Pass
Middle	1.000	0.775	Pass
High	1.000	0.777	Pass

The test data refer to the following page.

For Frequency Separation Measurement, the Low, Mid and High channels were performed and only recorded the worst test plots for Low in this report.

Test Plot Of Frequency Separation (1Mbps)

Test Plot Of Frequency Separation (2Mbps)

Test Plot Of Frequency Separation (3Mbps)

Measurement of 20dB Bandwidth

Test frequency: 2402MHz(1Mbps)

Test frequency: 2402MHz(2Mbps)

Test frequency: 2441MHz(1Mbps)

Test frequency: 2441MHz(2Mbps)

Test frequency: 2480MHz(1Mbps)

Test frequency: 2480MHz(2Mbps)

Measurement of 20dB Bandwidth

Test frequency: 2402MHz(3Mbps)

Test frequency: 2441MHz(3Mbps)

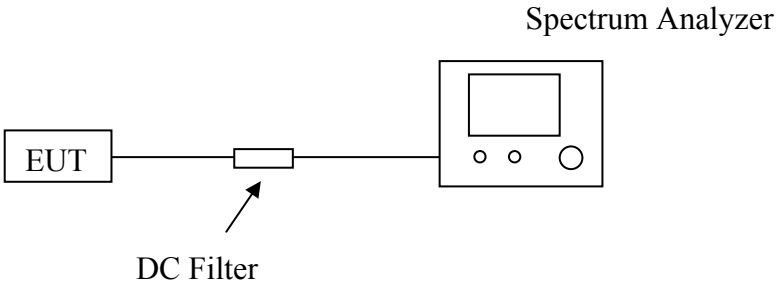
Test frequency: 2480MHz(3Mbps)

5.3 Number of Hopping Frequency

5.3.1 Limit

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

5.3.2 Block Diagram of Test Setup



5.3.3 Test Procedure

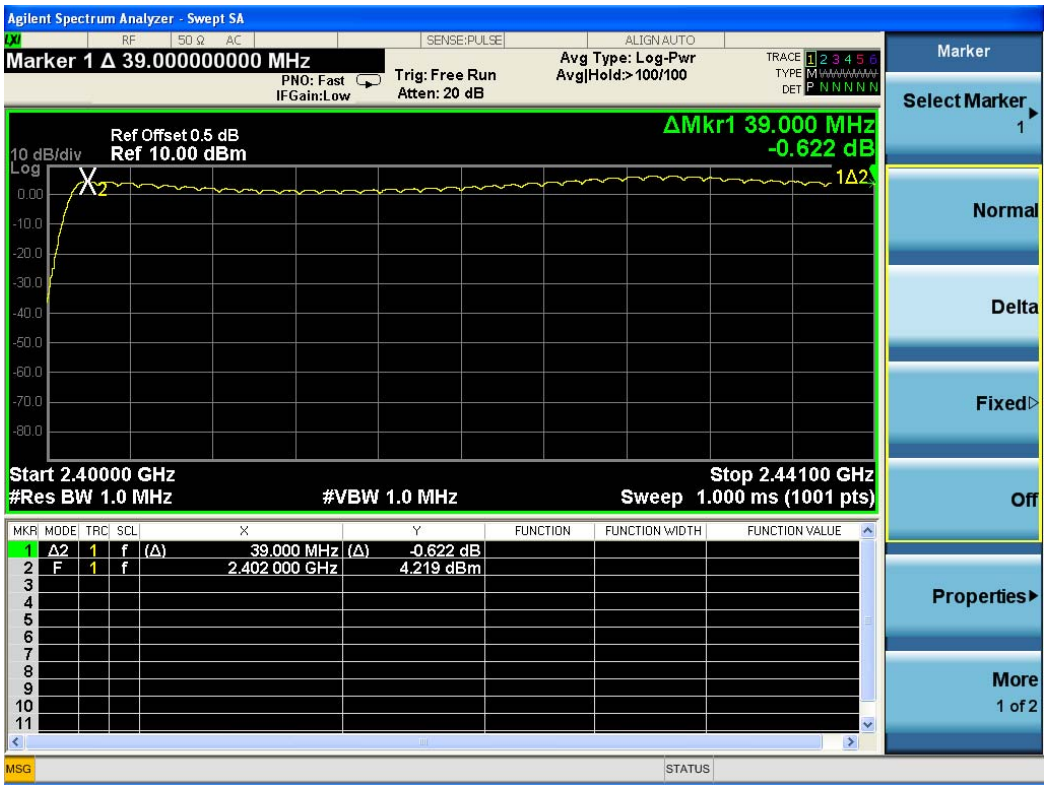
A. Place the EUT on the table and set it in transmitting mode.
B. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.
C. Set Spectrum Analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.
D. Set the Spectrum Analyzer as RBW, VBW=1MHz.
E. Max hold, view and count how many channel in the band.

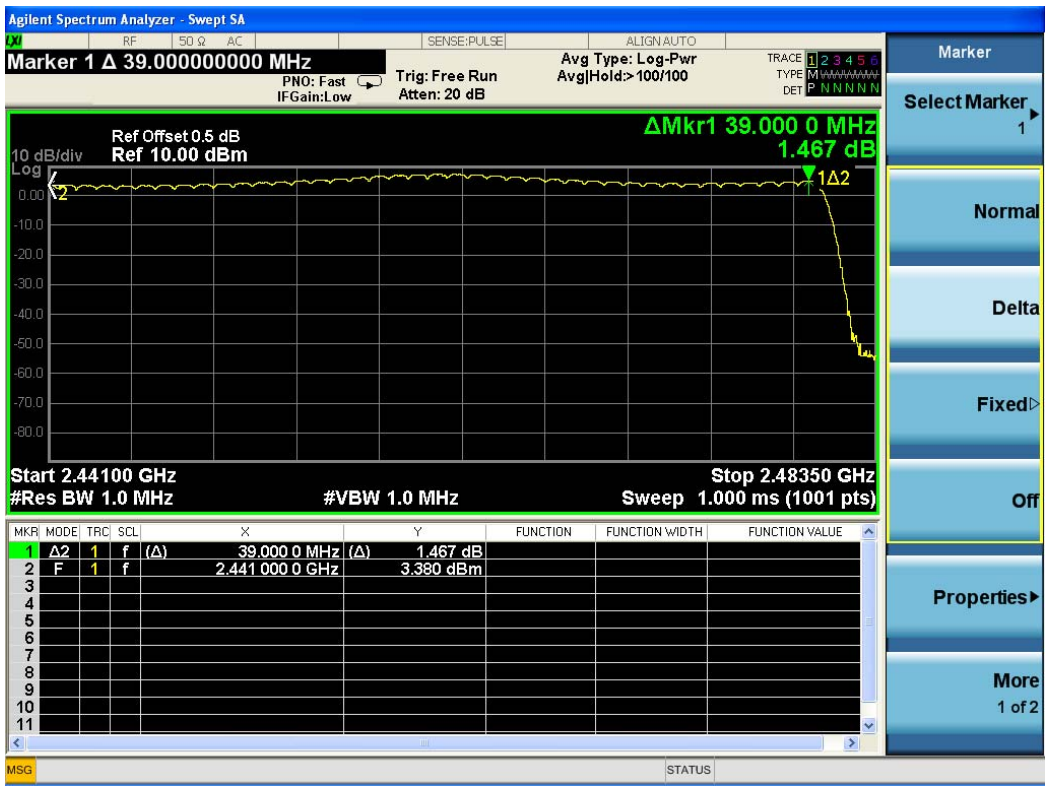
5.3.4 Test Results

Test Mode	Measurement Result (No. of Ch)	Limit (No. of Ch)	Result
Hopping(GFSK)	79	≥15	Pass
Hopping(π/4-DQPSK)	79	≥15	Pass
Hopping(8-DPSK)	79	≥15	Pass

The worst test data refer to the following page.

Test Plot for Number of Hopping Channel (GFSK)



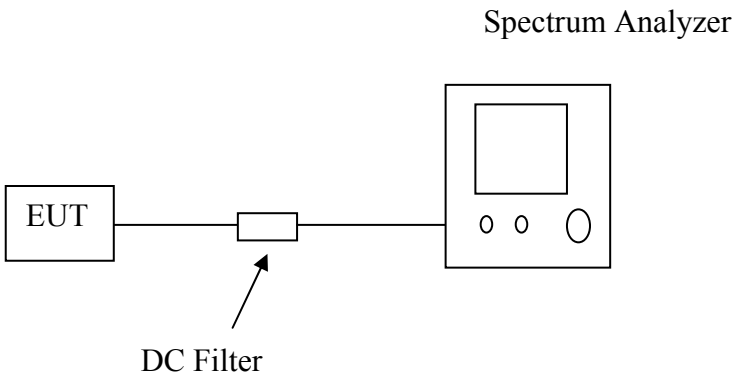


5.4 Time of Occupancy (Dwell Time)

5.4.1 Limit

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

5.4.2 Block Diagram of Test Setup



5.4.3 Test Procedure

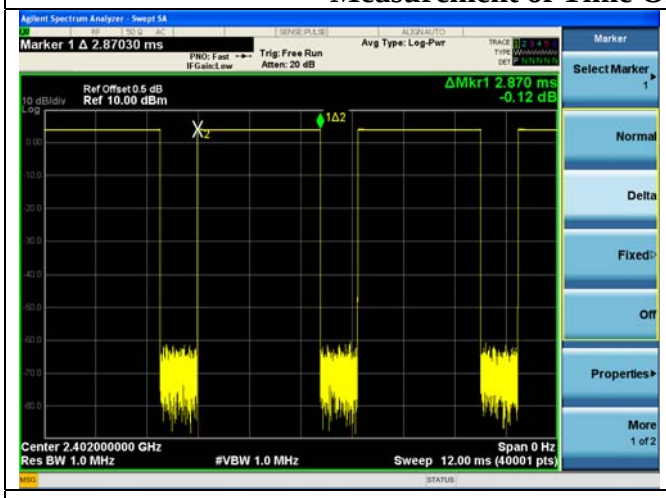
A. Place the EUT on the table and set it in transmitting mode.
B. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.
C. Set center frequency of Spectrum Analyzer = operating frequency.
D. Set the Spectrum Analyzer as RBW, VBW=1MHz, Span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

5.4.4 Test Results

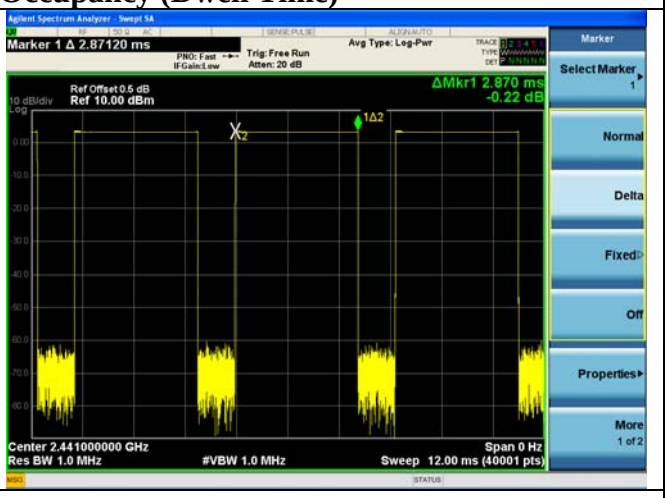
The Measurement Result With The Worst Case of 3Mbps For 8-DPSK Modulation				
Channel	**Time of Pulse for 3DH5 (ms)**	**Period Time (s)**	**Sweep Time (ms)**	**Limit (ms)**
Low	2.87	31.6	306.13	400
Middle	2.87	31.6	306.13	400
High	2.87	31.6	306.13	400

Calculation formula: Dwell Time (3DH5) =Burst Length (ms)*(1600/6)/79*31.6

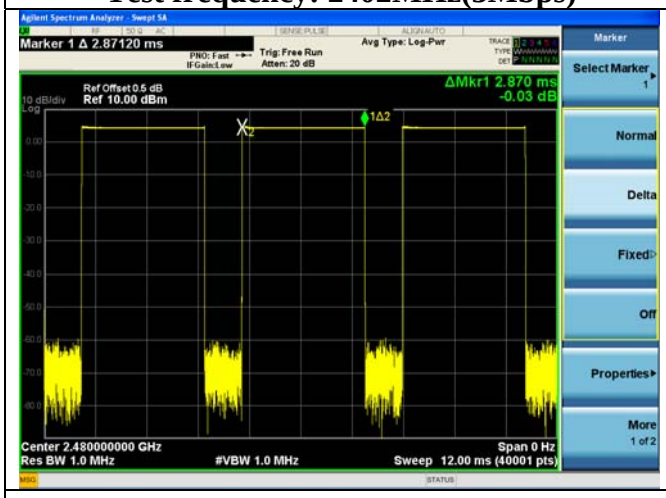
Measurement of Time Of Occupancy (Dwell Time)



Test frequency: 2402MHz(3Mbps)



Test frequency: 2441MHz(3Mbps)



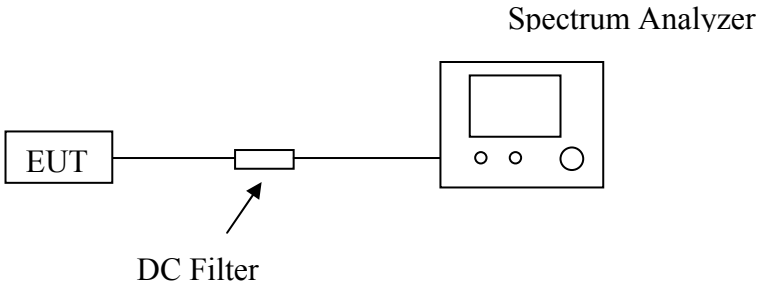
Test frequency: 2480MHz(3Mbps)

5.5 Conducted Spurious Emissions and Band Edges Test

5.5.1 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, 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)).

5.5.2 Block Diagram of Test Setup



5.5.3 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.

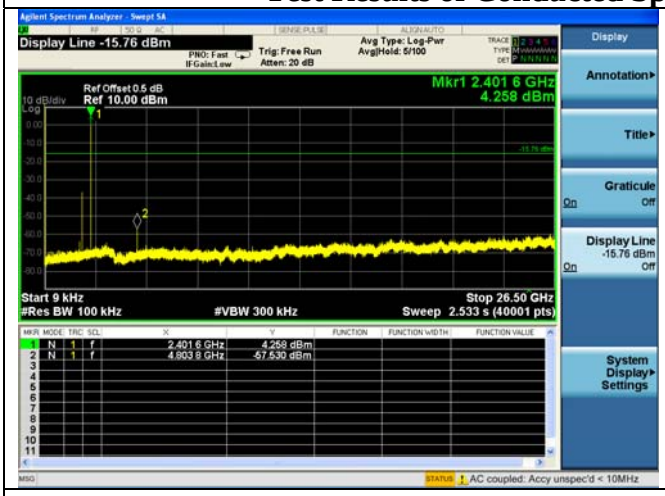
The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to 100 KHz. The video bandwidth is set to 300 KHz.

Measurements are made over the 9 kHz to 26.5GHz range with the transmitter set to the lowest, middle, and highest channels

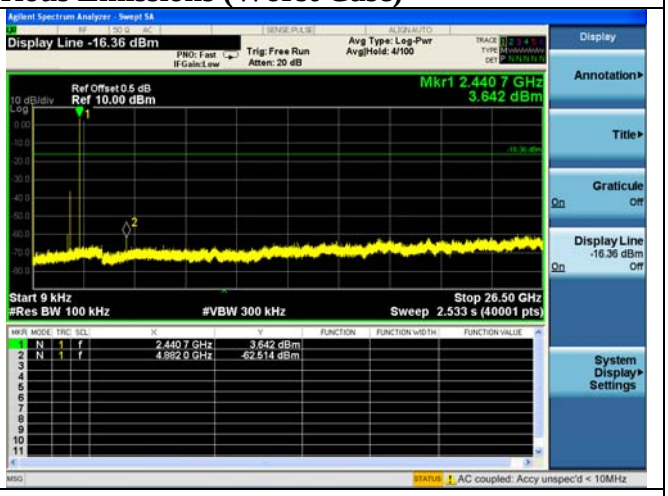
5.5.4 Test Results of Conducted Spurious Emissions

No non-compliance noted. Only record the worst test result (TX-GFSK) in this report. The test data refer to the following page.

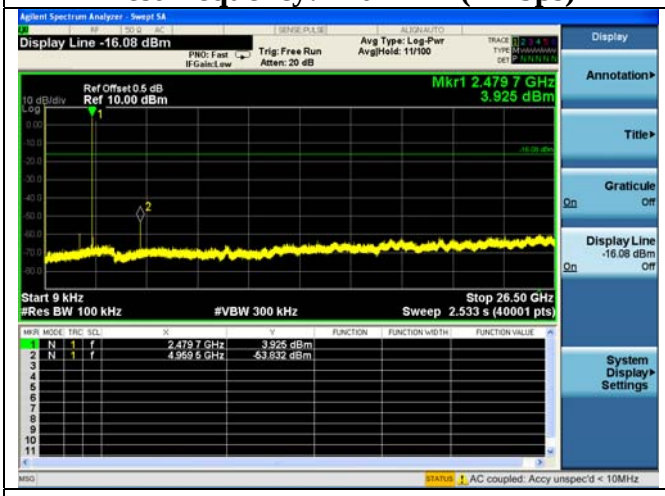
Test Results of Conducted Spurious Emissions (Worst Case)



Test frequency: 2402MHz(1Mbps)



Test frequency: 2441MHz(1Mbps)



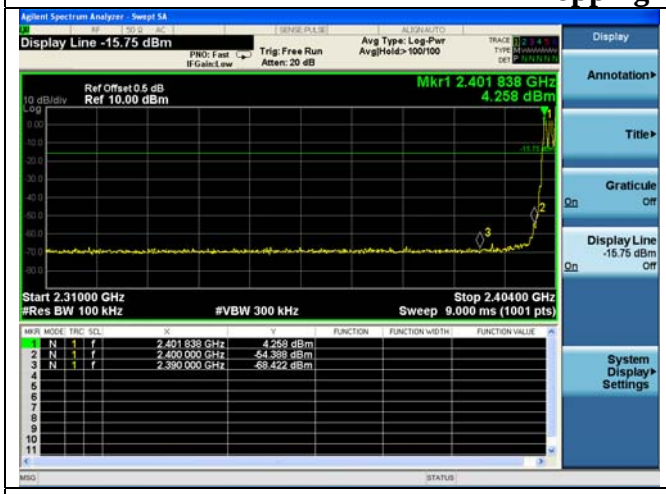
Test frequency: 2480MHz(1Mbps)

5.5.5 Test Results of Band Edges Test

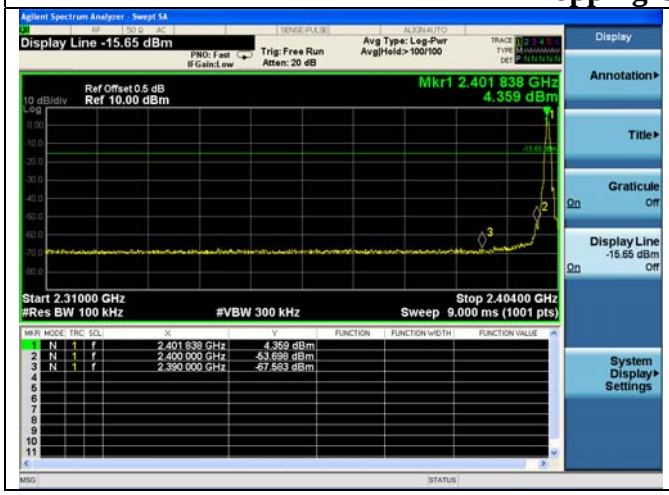
No non-compliance noted. Only record the worst test result in this report. The test data refer to the following page.

Test Results of Band Edges Test (Worst Case)

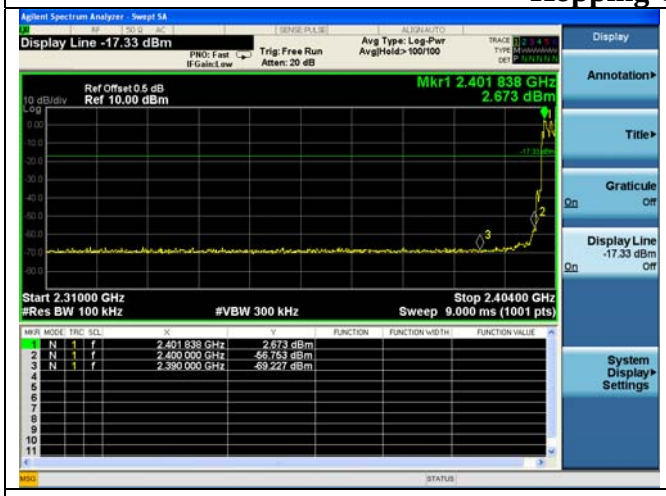
Hopping On (1Mbps)



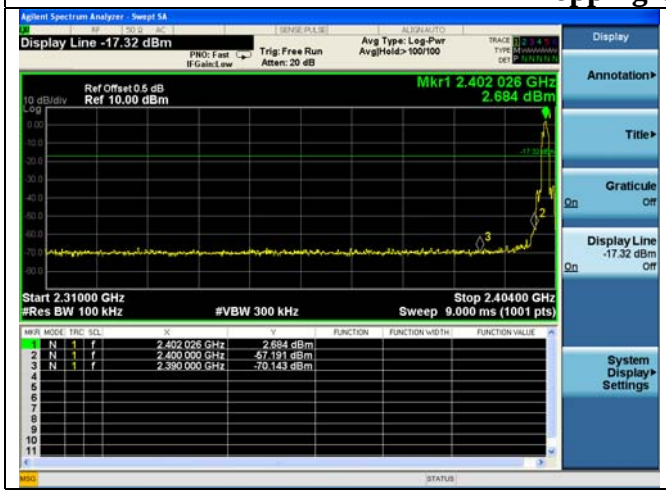
Hopping Off (1Mbps)



Hopping On (3Mbps)



Hopping Off (3Mbps)



6. RADIATED MEASUREMENT

6.1 Standard Applicable

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

6.2 Instruments Setting

The following table is the setting of spectrum analyzer and receiver.

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

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

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6.3 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.

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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.

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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.

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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.

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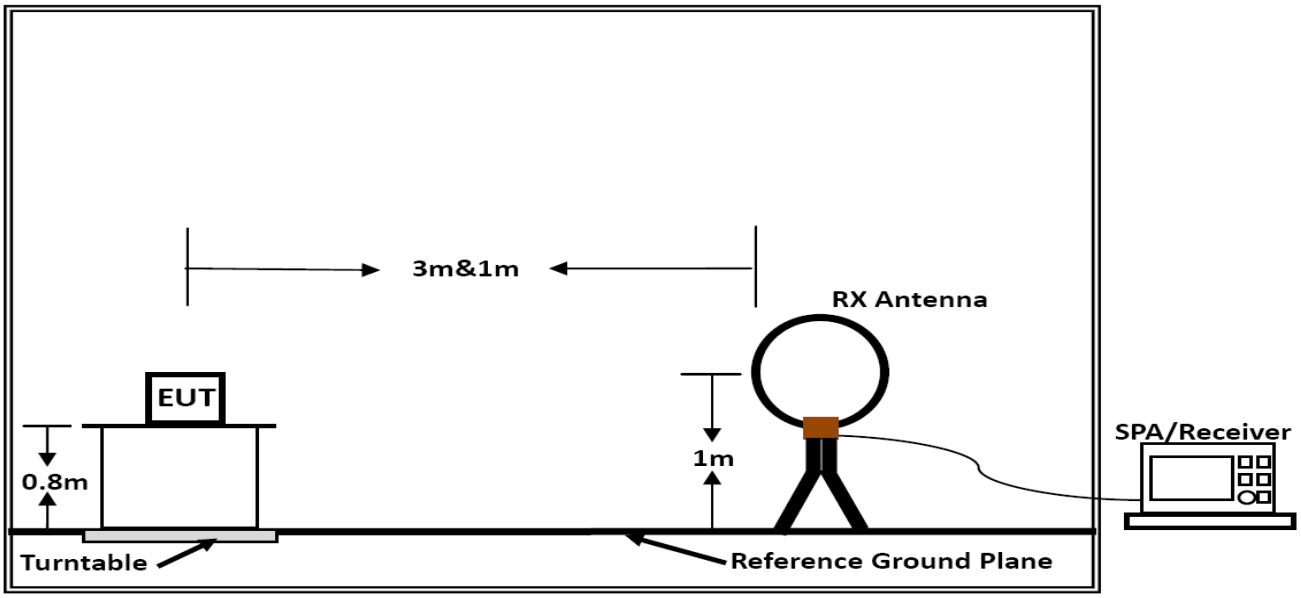
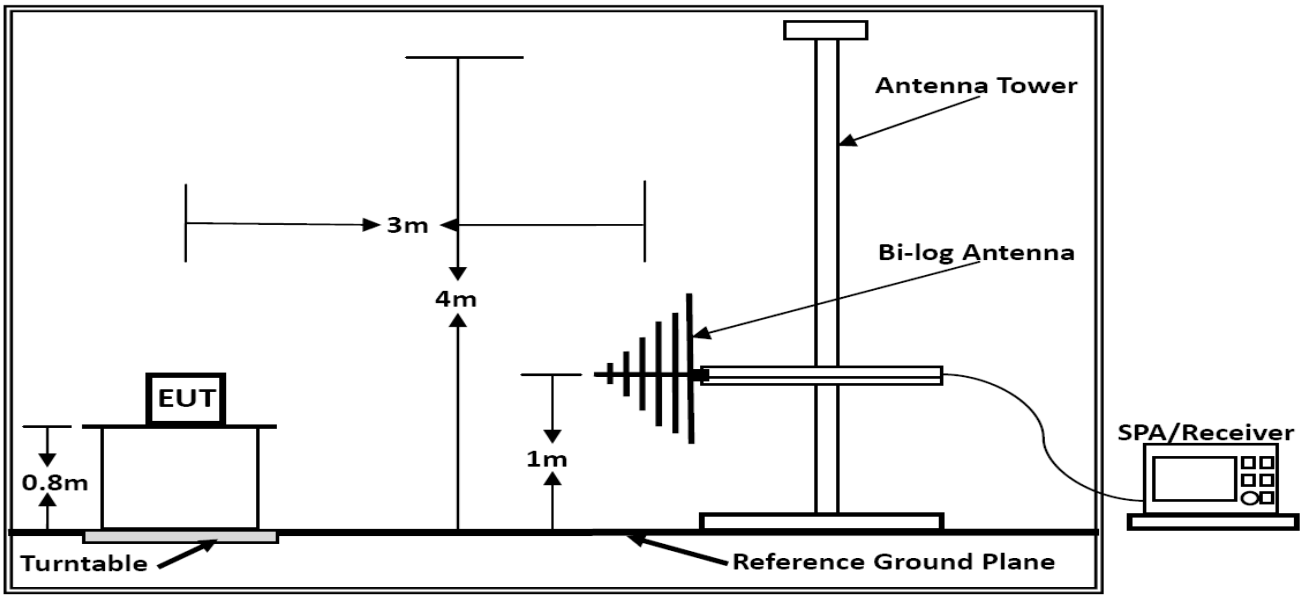
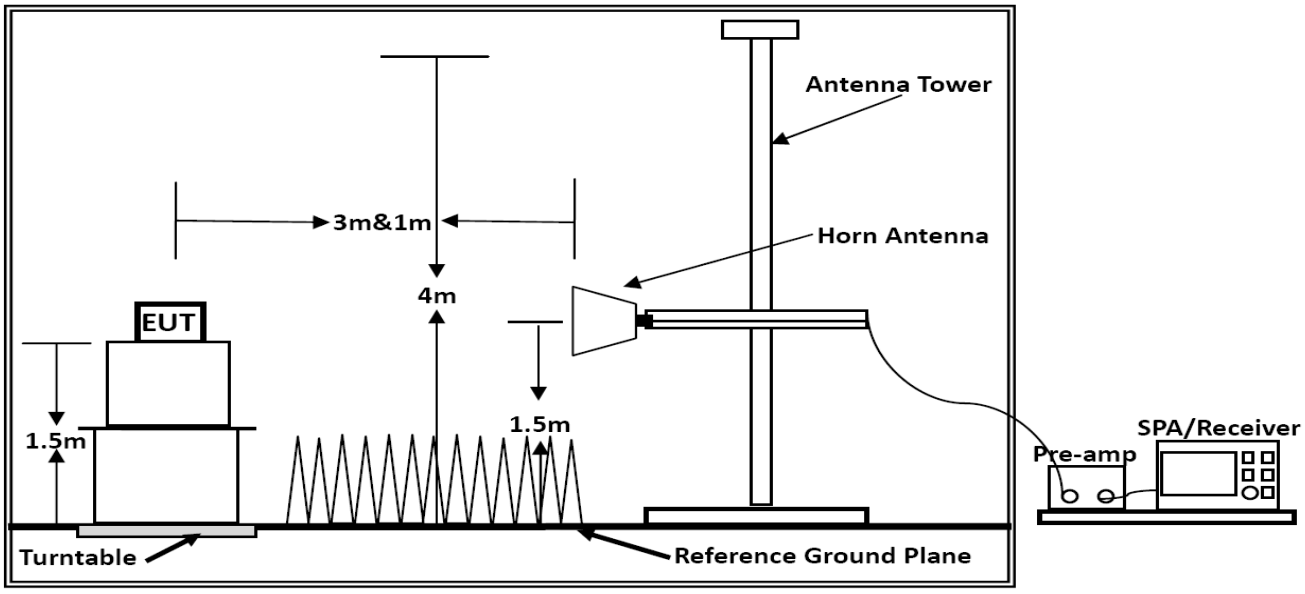
6.4 Test Setup Layout



Below 30MHz



Below 1GHz



Above 1GHz

6.5 EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

6.6 Results for Radiated Emissions

PASS.

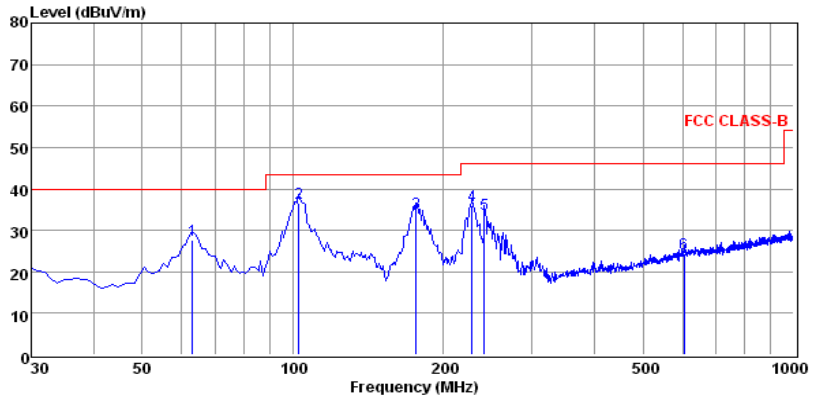
Only record the worst test result in this report.

The radiated emissions from 9 kHz to 30MHz are at least 20dB below the official limit and no need to report.

The test data please refer to following page:

Below 1GHz

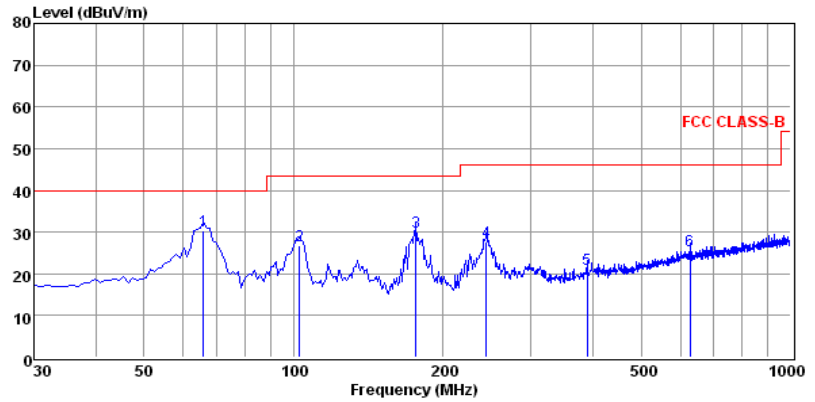
Temperature	25℃	Humidity	60%
Test Engineer	Chaz Liu	Configurations	TX-Low Channel(1Mbps)



Env. /Ins: 24℃/56%
pol: HORIZONTAL

	Freq MHz	Reading dBuV	CabLos dB	AntFac dB/m	PreFac dB	Measured dBuV/m	Limit dBuV/m	Over dB	Remark
1	62.98	15.70	0.48	11.51	0.00	27.69	40.00	-12.31	QP
2	102.75	23.04	0.60	12.91	0.00	36.55	43.50	-6.95	QP
3	176.47	24.06	0.73	9.43	0.00	34.22	43.50	-9.28	QP
4	227.88	23.38	0.93	11.55	0.00	35.86	46.00	-10.14	QP
5	241.46	20.83	1.01	12.09	0.00	33.93	46.00	-12.07	QP
6	604.24	4.39	1.55	18.47	0.00	24.41	46.00	-21.59	QP

Note: 1. All readings are Quasi-peak values.
2.Measured = Reading + Antenna Factor + Cable Loss - Amp Factor.
3.The emission levels that ate 20dB below the official limit are not reported.



Env. /Ins: 24℃/56%
pol: VERTICAL

	Freq MHz	Reading dBuV	CabLos dB	AntFac dB/m	PreFac dB	Measured dBuV/m	Limit dBuV/m	Over dB	Remark
1	65.89	19.49	0.52	10.34	0.00	30.35	40.00	-9.65	QP
2	102.75	13.33	0.60	12.91	0.00	26.84	43.50	-16.66	QP
3	176.47	19.95	0.73	9.43	0.00	30.11	43.50	-13.39	QP
4	244.37	14.75	0.90	12.08	0.00	27.73	46.00	-18.27	QP
5	389.87	5.19	1.17	14.82	0.00	21.18	46.00	-24.82	QP
6	627.52	5.29	1.63	18.55	0.00	25.47	46.00	-20.53	QP

Note: 1. All readings are Quasi-peak values.
2.Measured = Reading + Antenna Factor + Cable Loss - Amp Factor.
3.The emission levels that ate 20dB below the official limit are not reported.

****Note:*

Pre-scan all modes and recorded the worst case results in this report (TX-Low Channel (1Mbps)).
Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

Above 1GHz

The worst test result for GFSK, Tx-Low Channel:

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4804.19	44.03	33.06	35.04	3.94	45.99	74	-28.01	Peak	Horizontal
4804.19	33.01	33.06	35.04	3.94	34.97	54	-19.03	Average	Horizontal
4804.14	45.80	33.06	35.04	3.94	47.76	74	-26.24	Peak	Vertical
4804.20	35.29	33.06	35.04	3.94	37.25	54	-16.75	Average	Vertical

The worst test result for GFSK, Tx-Middle Channel:

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4882.21	45.18	33.16	35.15	3.96	47.15	74	-26.85	Peak	Horizontal
4882.20	33.79	33.16	35.15	3.96	35.76	54	-18.24	Average	Horizontal
4882.14	45.72	33.16	35.15	3.96	47.69	74	-26.31	Peak	Vertical
4882.24	34.75	33.16	35.15	3.96	36.72	54	-17.28	Average	Vertical

The worst test result for GFSK, Tx-High Channel:

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab.. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4960.31	41.65	33.26	35.14	3.98	43.75	74	-30.25	Peak	Horizontal
4960.38	33.74	33.26	35.14	3.98	35.84	54	-18.16	Average	Horizontal
4960.25	44.08	33.26	35.14	3.98	46.18	74	-27.82	Peak	Vertical
4960.36	35.75	33.26	35.14	3.98	37.85	54	-16.15	Average	Vertical

Notes:

1. *Measuring frequencies from 9k~10th harmonic (ex. 26GHz), No emission found between lowest internal used/generated frequency to 30MHz.*
2. *Radiated emissions measured in frequency range from 9k~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.*

6.7 Results for Band edge Testing (Radiated)

Note: Only recorded the worst test result.

Tx-2402, GFSK, Non-hopping

Freq. MHz	Reading Level dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
2376.39	42.20	32.89	35.16	3.51	43.44	74	-30.56	Peak	Horizontal
2376.42	32.11	32.90	35.16	3.51	33.36	54	-20.64	Average	Horizontal
2389.97	45.94	32.92	35.16	3.54	47.24	74	-26.76	Peak	Horizontal
2389.92	39.30	32.92	35.16	3.54	40.60	54	-13.40	Average	Horizontal
2376.48	43.68	32.89	35.16	3.51	44.92	74	-29.08	Peak	Vertical
2376.42	32.66	32.90	35.16	3.51	33.91	54	-20.09	Average	Vertical
2389.94	44.99	32.92	35.16	3.54	46.29	74	-27.71	Peak	Vertical
2390.03	36.76	32.92	35.16	3.54	38.06	54	-15.94	Average	Vertical

Tx-2480, GFSK, Non-hopping

Freq. MHz	Reading Level dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
2483.51	47.29	33.06	35.18	3.60	48.77	74	-25.23	Peak	Horizontal
2483.50	33.44	33.08	35.18	3.60	34.94	54	-19.06	Average	Horizontal
2488.74	45.12	33.08	35.18	3.62	46.64	74	-27.36	Peak	Horizontal
2488.76	35.55	33.08	35.18	3.62	37.07	54	-16.93	Average	Horizontal
2483.49	46.80	33.06	35.18	3.60	48.28	74	-25.72	Peak	Vertical
2483.58	36.79	33.08	35.18	3.60	38.29	54	-15.71	Average	Vertical
2488.74	44.71	33.08	35.18	3.62	46.23	74	-27.77	Peak	Vertical
2488.79	31.97	33.08	35.18	3.62	33.49	54	-20.51	Average	Vertical

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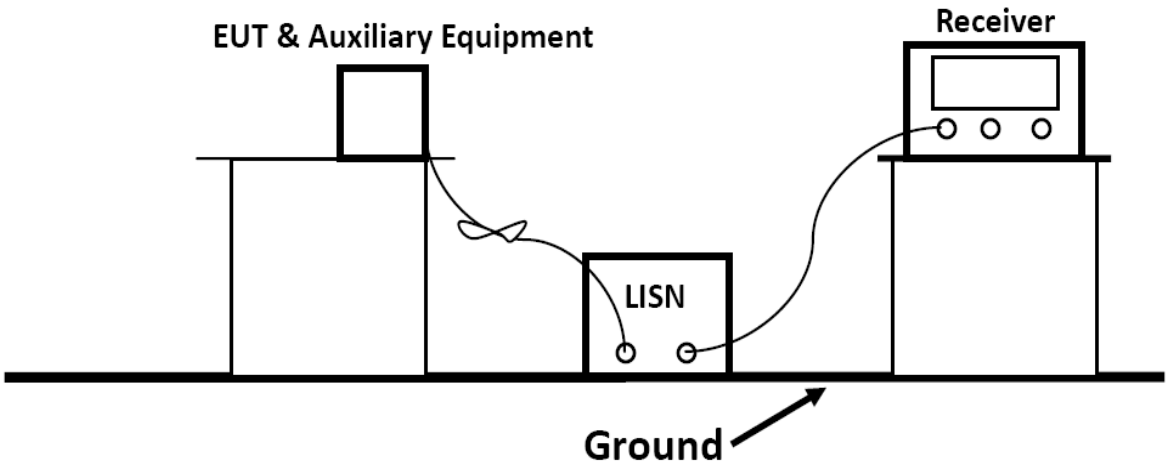
7. LINE CONDUCTED EMISSIONS

7.1 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 microvolt (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

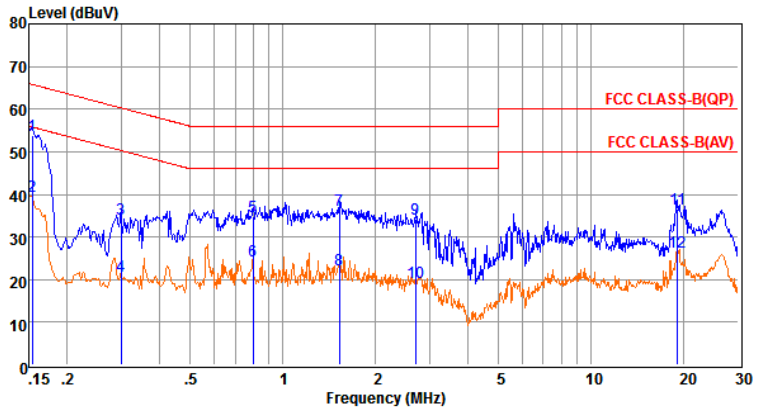
7.2 Block Diagram of Test Setup



7.3 Test Results

PASS.

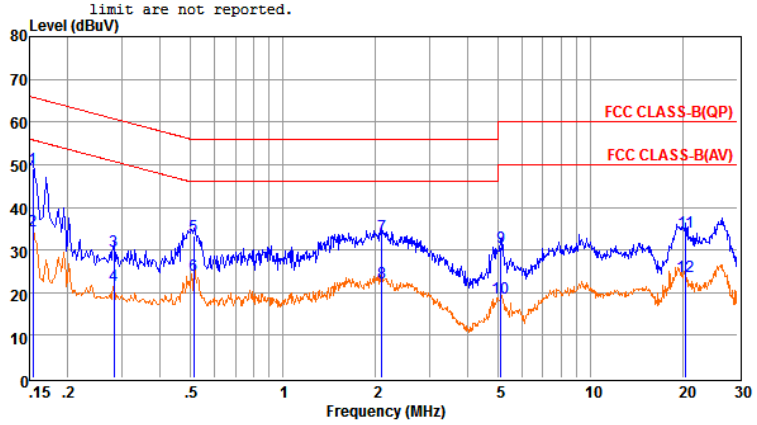
The test data please refer to following page.



Env. Ins: 24*/56%
Power Rating: AC 240V/60Hz
Pol: LINE

	Freq MHz	Reading dBuV	LisnFac dB	CabLos dB	Atten_Fac dB	Measured dBuV	Limit dBuV	Over dB	Remark
1	0.15403	34.24	9.58	0.02	10.00	53.84	65.78	-11.94	QP
2	0.15413	19.99	9.58	0.02	10.00	39.59	55.77	-16.18	Average
3	0.29869	14.64	9.63	0.03	10.00	34.30	60.28	-25.98	QP
4	0.29879	1.21	9.63	0.03	10.00	20.87	50.28	-29.41	Average
5	0.80023	15.08	9.64	0.04	10.00	34.76	56.00	-21.24	QP
6	0.80033	4.70	9.64	0.04	10.00	24.38	46.00	-21.62	Average
7	1.52736	16.55	9.64	0.05	10.00	36.24	56.00	-19.76	QP
8	1.52836	2.55	9.64	0.05	10.00	22.24	46.00	-23.76	Average
9	2.69248	14.37	9.64	0.05	10.00	34.06	56.00	-21.94	QP
10	2.69348	-0.30	9.64	0.05	10.00	19.39	46.00	-26.61	Average
11	19.12202	16.75	9.75	0.12	10.00	36.62	60.00	-23.38	QP
12	19.12302	6.48	9.75	0.12	10.00	26.35	50.00	-23.65	Average

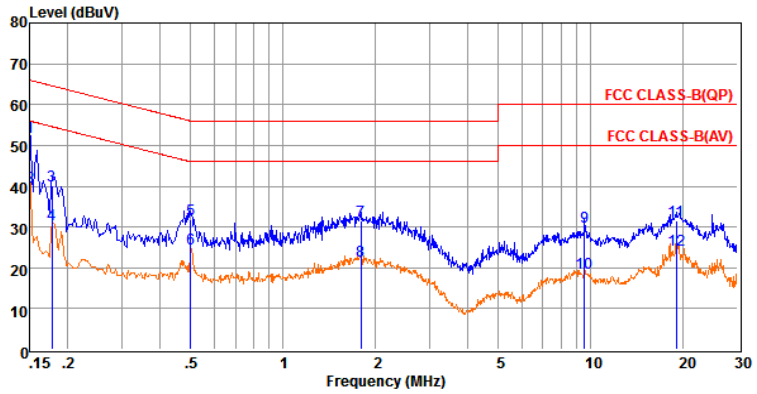
Remarks: 1. Measured = Reading + Lisn Factor +Cable Loss+Atten_Fac.
2. The emission levels that are 20dB below the official limit are not reported.



Env. Ins: 24*/56%
Power Rating: AC 240V/60Hz
Pol: NEUTRAL

	Freq MHz	Reading dBuV	LisnFac dB	CabLos dB	Atten_Fac dB	Measured dBuV	Limit dBuV	Over dB	Remark
1	0.15403	29.47	9.69	0.02	10.00	49.18	65.78	-16.60	QP
2	0.15413	14.83	9.69	0.02	10.00	34.54	55.77	-21.23	Average
3	0.28178	10.06	9.60	0.03	10.00	29.69	60.76	-31.07	QP
4	0.28188	1.96	9.60	0.03	10.00	21.59	50.76	-29.17	Average
5	0.51278	13.56	9.62	0.04	10.00	33.22	56.00	-22.78	QP
6	0.51288	4.29	9.62	0.04	10.00	23.95	46.00	-22.05	Average
7	2.09896	13.51	9.63	0.05	10.00	33.19	56.00	-22.81	QP
8	2.09996	2.76	9.63	0.05	10.00	22.44	46.00	-23.56	Average
9	5.11184	11.05	9.66	0.06	10.00	30.77	60.00	-29.23	QP
10	5.11284	-1.11	9.66	0.06	10.00	18.61	50.00	-31.39	Average
11	20.37727	14.26	9.87	0.12	10.00	34.25	60.00	-25.75	QP
12	20.37827	3.82	9.87	0.12	10.00	23.81	50.00	-26.19	Average

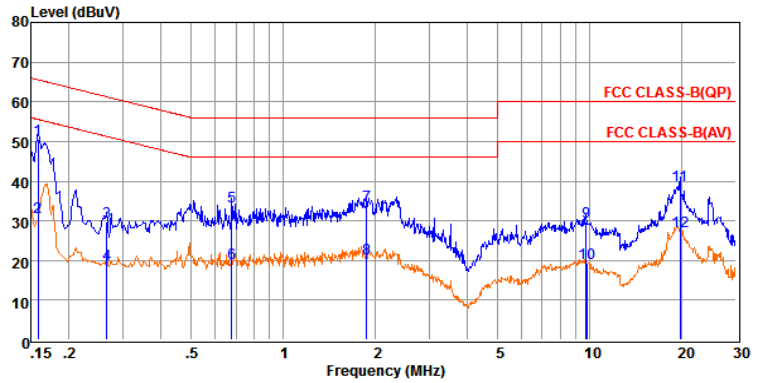
Remarks: 1. Measured = Reading + Lisn Factor +Cable Loss+Atten_Fac.
2. The emission levels that are 20dB below the official limit are not reported.



Env. Ins: 24*/56%
Power Rating: AC 120V/60Hz
Pol: LINE

	Freq MHz	Reading dBuV	LisnFac dB	CabLos dB	Atten_Fac dB	Measured dBuV	Limit dBuV	Over dB	Remark
1	0.15000	32.43	9.57	0.02	10.00	52.02	66.00	-13.98	QP
2	0.15010	20.16	9.57	0.02	10.00	39.75	55.99	-16.24	Average
3	0.17772	20.66	9.61	0.02	10.00	40.29	64.59	-24.30	QP
4	0.17782	10.98	9.61	0.02	10.00	30.61	54.59	-23.98	Average
5	0.50203	12.26	9.62	0.04	10.00	31.92	56.00	-24.08	QP
6	0.50213	4.93	9.62	0.04	10.00	24.59	46.00	-21.41	Average
7	1.79050	11.95	9.64	0.05	10.00	31.64	56.00	-24.36	QP
8	1.79150	1.96	9.64	0.05	10.00	21.65	46.00	-24.35	Average
9	9.55210	10.30	9.69	0.08	10.00	30.07	60.00	-29.93	QP
10	9.55310	-1.07	9.69	0.08	10.00	18.70	50.00	-31.30	Average
11	19.02097	11.74	9.75	0.12	10.00	31.61	60.00	-28.39	QP
12	19.02197	4.48	9.75	0.12	10.00	24.35	50.00	-25.65	Average

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



Env. Ins: 24*/56%
Power Rating: AC 120V/60Hz
Pol: NEUTRAL

	Freq MHz	Reading dBuV	LisnFac dB	CabLos dB	Atten_Fac dB	Measured dBuV	Limit dBuV	Over dB	Remark
1	0.15816	30.82	9.68	0.02	10.00	50.52	65.56	-15.04	QP
2	0.15826	11.11	9.68	0.02	10.00	30.81	55.55	-24.74	Average
3	0.26583	10.22	9.60	0.03	10.00	29.85	61.25	-31.40	QP
4	0.26593	-0.60	9.60	0.03	10.00	19.03	51.24	-32.21	Average
5	0.67902	14.00	9.63	0.04	10.00	33.67	56.00	-22.33	QP
6	0.67912	-0.34	9.63	0.04	10.00	19.33	46.00	-26.67	Average
7	1.86802	14.36	9.63	0.05	10.00	34.04	56.00	-21.96	QP
8	1.86902	0.92	9.63	0.05	10.00	20.60	46.00	-25.40	Average
9	9.75670	9.86	9.72	0.08	10.00	29.66	60.00	-30.34	QP
10	9.75770	-0.53	9.72	0.08	10.00	19.27	50.00	-30.73	Average
11	19.73967	19.07	9.88	0.12	10.00	39.07	60.00	-20.93	QP
12	19.74067	7.36	9.88	0.12	10.00	27.36	50.00	-22.64	Average

Remarks: 1. Measured = Reading + Lisn Factor +Cable Loss+Atten_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.

8. ANTENNA REQUIREMENT

8.1 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.

8.2 Antenna Connected Construction

8.2.1. 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.

8.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting is 0.5dBi, and the antenna is connected to PCB board and no consideration of replacement. Please see EUT photo for details.

8.2.3. 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 frequency-hopping spread-spectrum (FHSS) devices.

Radiated power refers to ANSI C63.10:2013 Radiated emissions tests.

Measurement parameters:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	3 MHz
Video bandwidth:	3 MHz
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 normal Bluetooth devices, the GFSK mode is used.

Limits:

FCC	IC
Antenna Gain	
6.0dBi	

Tnom	Vnom	lowest channel 2402 MHz	middle channel 2441 MHz	highest channel 2480 MHz
Conducted power [dBm] Measured with GFSK modulation		4.31	3.66	5.19
Radiated power [dBm] Measured with GFSK modulation		3.17	3.29	4.05
Gain [dBi] Calculated		-1.14	-0.37	-1.14
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

Result: -/-

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