

## FCC TEST REPORT

For

Nanjing University 5D Technology Co., Ltd.


MUDO Bluetooth Speaker

Test Model: MUDO-1.0

Prepared for	: Nanjing University 5D Technology Co., Ltd.
Address	: F6, Bulding No.4, No.18, East Jialingjiang Street, Jianye District, Nanjing, Jiangsu, China
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Date of receipt of test sample	: August 11, 2016
Number of tested samples	: 1
Sample number	: Prototype
Date of Test	: August 11, 2016~August 30, 2016
Date of Report	: August 30, 2016

**FCC TEST REPORT****FCC CFR 47 PART 15 C(15.247): 2015****Report Reference No. .... : LCS1608302684E****Date of Issue ..... : August 30, 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..... : Nanjing University 5D Technology Co., Ltd.****Address ..... : F6, Bulding No.4, No.18, East Jialingjiang Street, Jianye  
District, Nanjing, Jiangsu, 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****Shenzhen LCS Compliance Testing Laboratory Ltd. All rights reserved.**

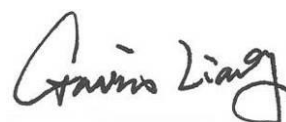
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**Test Item Description. .... : MUDO Bluetooth Speaker****Trade Mark ..... : ****Test Model ..... : MUDO-1.0****Ratings ..... : DC 3.7V by battery (4000mAh)  
Recharge Voltage: 5V $\overline{\text{---}}$ , 2A****Result ..... : Positive****Compiled by:**

Ada Liang/ File administrators

**Supervised by:**

Glin Lu/ Technique principal

**Approved by:**

Gavin Liang/ Manager

## FCC -- TEST REPORT

<b>Test Report No. : LCS1608302684E</b>	<u>August 30, 2016</u> Date of issue
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Test Model.....	: MUDO-1.0
EUT.....	: MUDO Bluetooth Speaker
<b>Applicant.....</b>	<b>: Nanjing University 5D Technology Co., Ltd.</b>
Address.....	: F6, Bulding No.4, No.18, East Jialingjiang Street, Jianye District, Nanjing, Jiangsu, China
Telephone.....	: /
Fax.....	: /
<b>Manufacturer.....</b>	<b>: Nanjing University 5D Technology Co., Ltd.</b>
Address.....	: F6, Bulding No.4, No.18, East Jialingjiang Street, Jianye District, Nanjing, Jiangsu, China
Telephone.....	: /
Fax.....	: /
<b>Factory.....</b>	<b>: Nanjing University 5D Technology Co., Ltd.</b>
Address.....	: F6, Bulding No.4, No.18, East Jialingjiang Street, Jianye District, Nanjing, Jiangsu, China
Telephone.....	: /
Fax.....	: /

<b>Test Result</b>	<b>Positive</b>
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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	2016-08-30	Initial Issue	Gavin Liang

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# 1. GENERAL INFORMATION

## 1.1. Description of Device (EUT)

EUT	: MUDO Bluetooth Speaker
Test Model	: MUDO-1.0
Power Supply	: DC 3.7V by battery (4000mAh) Recharge Voltage: 5V $\overline{\text{---}}$ , 2A
Hardware Version	: V1.0
Software Version	: V1.0
Frequency Range	: 2402.00-2480.00MHz
Channel Spacing	: 1MHz for Bluetooth V3.0 (DSS) 2MHz for Bluetooth V4.0 (DTS)
Channel Number	: 79 channels for Bluetooth V3.0 (Channel Frequency=2402+1(K-1), K=1, 2, 3.....79) (DSS) 40 channels for Bluetooth V4.0 (Channel Frequency=2402+2(K-1), K=1, 2, 3.....40) (DTS)
Modulation Type	: GFSK, Pi/4-DQPSK, 8-DPSK for Bluetooth V3.0 (DSS) GFSK for Bluetooth V4.0 (DTS)
Bluetooth Version	: This report is only for V4.0 BLE part. For V3.0 part, please see another separate report.
Antenna Description	: Internal Antenna, 0dBi(Max.)

### Additional models No.

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Remark: 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
Charge Interface	1	1.0m
AUX 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

## 1.5. List Of Measuring Equipments

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Cal Date	Due Date
EMC Receiver	R&S	ESCS 30	100174	9kHz – 2.75GHz	2016/06/18	2017/06/17
Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	9kHz~40GHz	2016/07/16	2017/07/15
LISN	MESS Tec	NNB-2/16Z	99079	9KHz-30MHz	2016/06/18	2017/06/17
LISN (Support Unit)	EMCO	3819/2NM	9703-1839	9KHz-30MHz	2016/06/18	2017/06/17
RF Cable-CON	UTIFLEX	3102-26886-4	CB049	9KHz-30MHz	2016/06/18	2017/06/17
ISN	SCHAFFNER	ISN ST08	21653	9KHz-30MHz	2016/06/18	2017/06/17
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	30M-18GHz	2016/06/18	2017/06/17
Amplifier	SCHAFFNER	COA9231A	18667	9kHz-2GHz	2016/04/18	2017/04/17
Amplifier	Agilent	8449B	3008A02120	1GHz-26.5GHz	2016/04/18	2017/04/17
Amplifier	MITEQ	AMF-6F-260400	9121372	26.5GHz-40GHz	2016/04/18	2017/04/17
Loop Antenna	R&S	HFH2-Z2	860004/001	9k-30MHz	2016/04/18	2017/04/17
By-log Antenna	SCHWARZBECK	VULB9163	9163-470	30MHz-1GHz	2016/04/18	2017/04/17
Horn Antenna	EMCO	3115	6741	1GHz-18GHz	2016/04/18	2017/04/17
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170154	15GHz-40GHz	2016/04/18	2017/04/17
RF Cable-R03m	Jye Bao	RG142	CB021	30MHz-1GHz	2016/06/18	2017/06/17
RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	1GHz-40GHz	2016/06/18	2017/06/17
Power Meter	R&S	NRVS	100444	DC-40GHz	2016/06/18	2017/06/17
Power Sensor	R&S	NRV-Z51	100458	DC-30GHz	2016/06/18	2017/06/17
Power Sensor	R&S	NRV-Z32	10057	30MHz-6GHz	2016/06/18	2017/06/17
AC Power Source	HPC	HPA-500E	HPA-9100024	AC 0~300V	2016/06/18	2017/06/17
DC power Source	GW	GPC-6030D	C671845	DC 1V-60V	2016/06/18	2017/06/17
Temp. and Humidity Chamber	Giant Force	GTH-225-20-S	MAB0103-00	N/A	2016/06/18	2017/06/17
RF CABLE-1m	JYE Bao	RG142	CB034-1m	20MHz-7GHz	2016/06/18	2017/06/17
RF CABLE-2m	JYE Bao	RG142	CB035-2m	20MHz-1GHz	2016/06/18	2017/06/17
Signal Generator	R&S	SMR40	10016	10MHz~40GHz	2015/07/16	2016/07/15
Universal Radio Communication Tester	R&S	CMU200	112012	N/A	2015/10/27	2016/10/26
Wideband Radio Communication Tester	R&S	CMW500	1201.0002K50	N/A	2015/11/19	2016/11/18
MXG Vector Signal Generator	Agilent	N5182A	MY47071151	250KHz~6GHz	2015/10/27	2016/10/26
MXG Vector Signal Generator	Agilent	E4438C	MY42081396	250KHz~6GHz	2015/10/27	2016/10/26
PSG Analog Signal Generator	Agilent	N8257D	MY46520521	250KHz~20GHz	2015/11/19	2016/11/18
MXA Signal Analyzer	Agilent	N9020A	MY50510140	10Hz~26.5GHz	2015/10/27	2016/10/26
DC Power Supply	Agilent	E3642A	/	0-8V,5A/0-20V,2.5A	2016/05/20	2017/05/19
RF Control Unit	Tonscend	JS0806-1	/	/	2015/11/19	2016/11/18
LTE Test Software	Tonscend	JS1120-1	/	Version: 2.5.7.0	N/A	N/A
X-series USB Peak and Aver	Agilent	U2021XA	MY54080022	/	2015/10/27	2016/10/26
4 Ch.Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	MY54080016	/	2015/10/27	2016/10/26
Test Software	Ascentest	AT890-SW	20141230	Version: 20160630	N/A	N/A
Splitter/Combiner(Qty: 2)	Mini-Circuits	ZAPD-50W 4.2-6.0 GHz	NN256400424	/	2015/10/27	2016/10/26
Splitter/Combine(Qty: 2)	MCLI	PS3-7	4463/4464	/	2015/10/27	2016/10/26
ATT (Qty: 1)	Mini-Circuits	VAT-30+	30912	/	2015/10/27	2016/10/26



## 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. The EUT was set to transmit at 100% duty cycle. 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
	2440	1
	2480	1
For Conducted Emission		
Test Mode	TX Mode	
For Radiated Emission		
Test Mode	TX Mode	

Worst-case mode and channel used for 150kHz-30 MHz power line conducted emissions was the mode and channel with the highest output power, that was determined to be TX-Low Channel(2402MHz, GFSK).

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-Low Channel(2402MHz, GFSK).

\*\*\*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

All measurements contained in this report were conducted with ANSI C63.10: 2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen LCS Compliance Testing Laboratory Ltd..

### 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 FCC's request, Test Procedure KDB558074 D01 DTS Meas Guidance v03r05 is required to be used for this kind of FCC 15.247 digital modulation device.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 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

### **3. SYSTEM TEST CONFIGURATION**

#### **3.1. Justification**

The system was configured for testing in a continuous transmit 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.

## 4. SUMMARY OF TEST RESULTS

Applied Standard: FCC Part 15 Subpart C		
FCC Rules	Description of Test	Result
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(e)	Power Spectral Density	Compliant
§15.247(a)(2)	6dB Bandwidth	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

## 5. TEST RESULT

### 5.1. Maximum Conducted Output Power Measurement

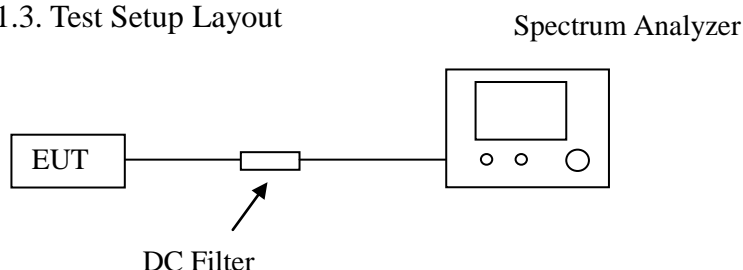
#### 5.1.1. Standard Applicable

According to § 15.247(b)(3), For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850MHz bands: 1 Watt.

#### 5.1.2. Test Procedures

The transmitter output (antenna port) was connected to the Spectrum Analyzer.

#### 5.1.3. Test Setup Layout



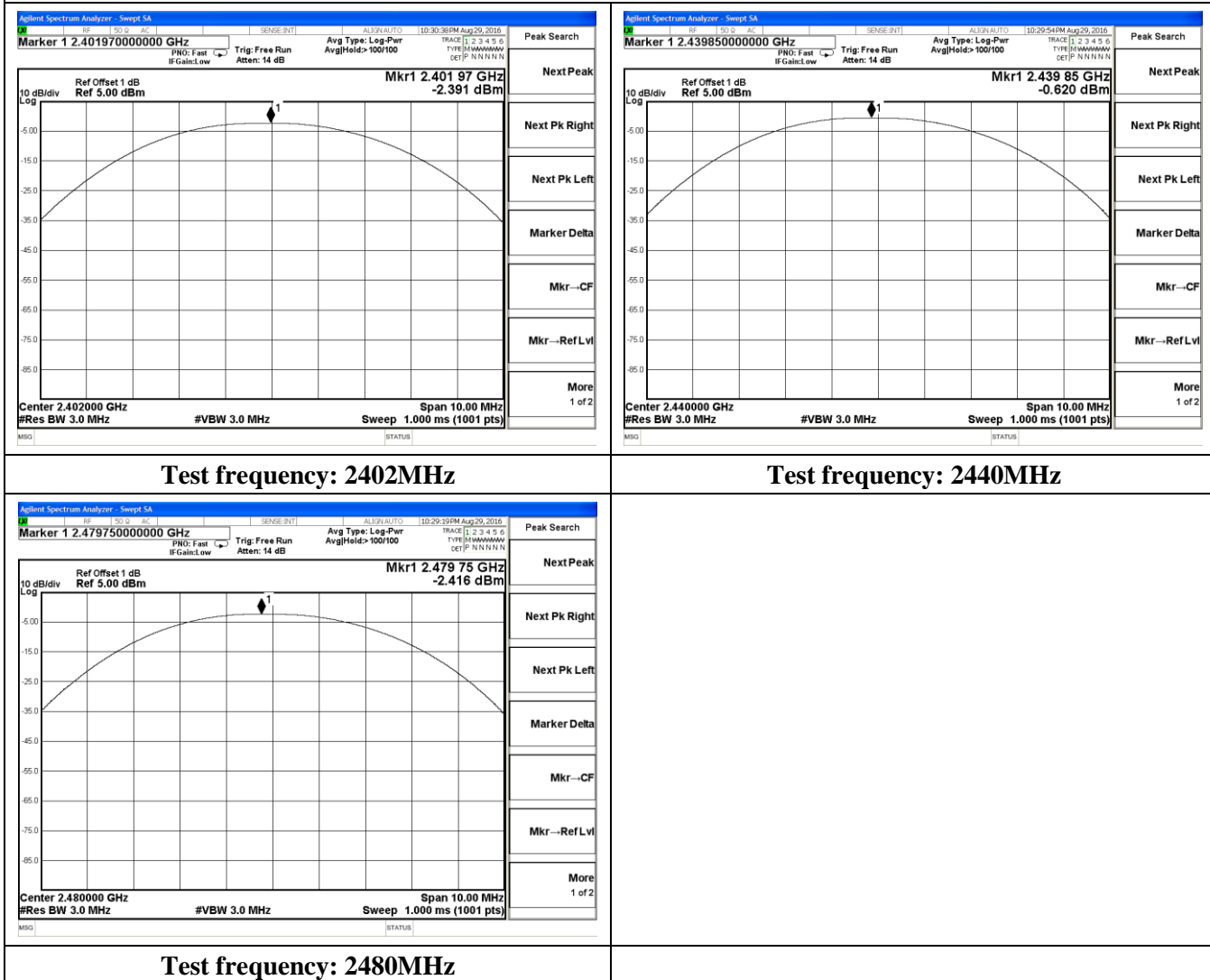
#### 5.1.4. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

#### 5.1.5. Test Result of Maximum Conducted Output Power

Modulation	Frequency (MHz)	Output Power (dBm)	Output Power (mW)	Limit (mW)	Result
GFSK	2402	-2.391	0.58	1000	Pass
	2440	-0.620	0.87	1000	Pass
	2480	-2.416	0.57	1000	Pass

## Test Plots Of Maximum Conducted Output Power Measurement



## 5.2. Power Spectral Density Measurement

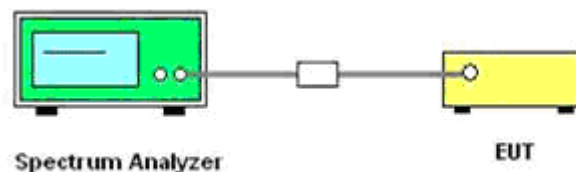
### 5.2.1. Standard Applicable

According to §15.247(e): For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 5.2.2. Test Procedures

- 1) The transmitter was connected directly to a Spectrum Analyzer through a directional couple.
- 2) The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.
- 3) Set the RBW = 3 kHz.
- 4) Set the VBW  $\geq 3 \times \text{RBW}$
- 5) Set the span to 1.5 times the DTS channel bandwidth.
- 6) Detector = peak.
- 7) Sweep time = auto couple.
- 8) Trace mode = max hold.
- 9) Allow trace to fully stabilize.
- 10) Use the peak marker function to determine the maximum power level in any 3 kHz band segment within the fundamental EBW.

### 5.2.3. Test Setup Layout



### 5.2.4. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

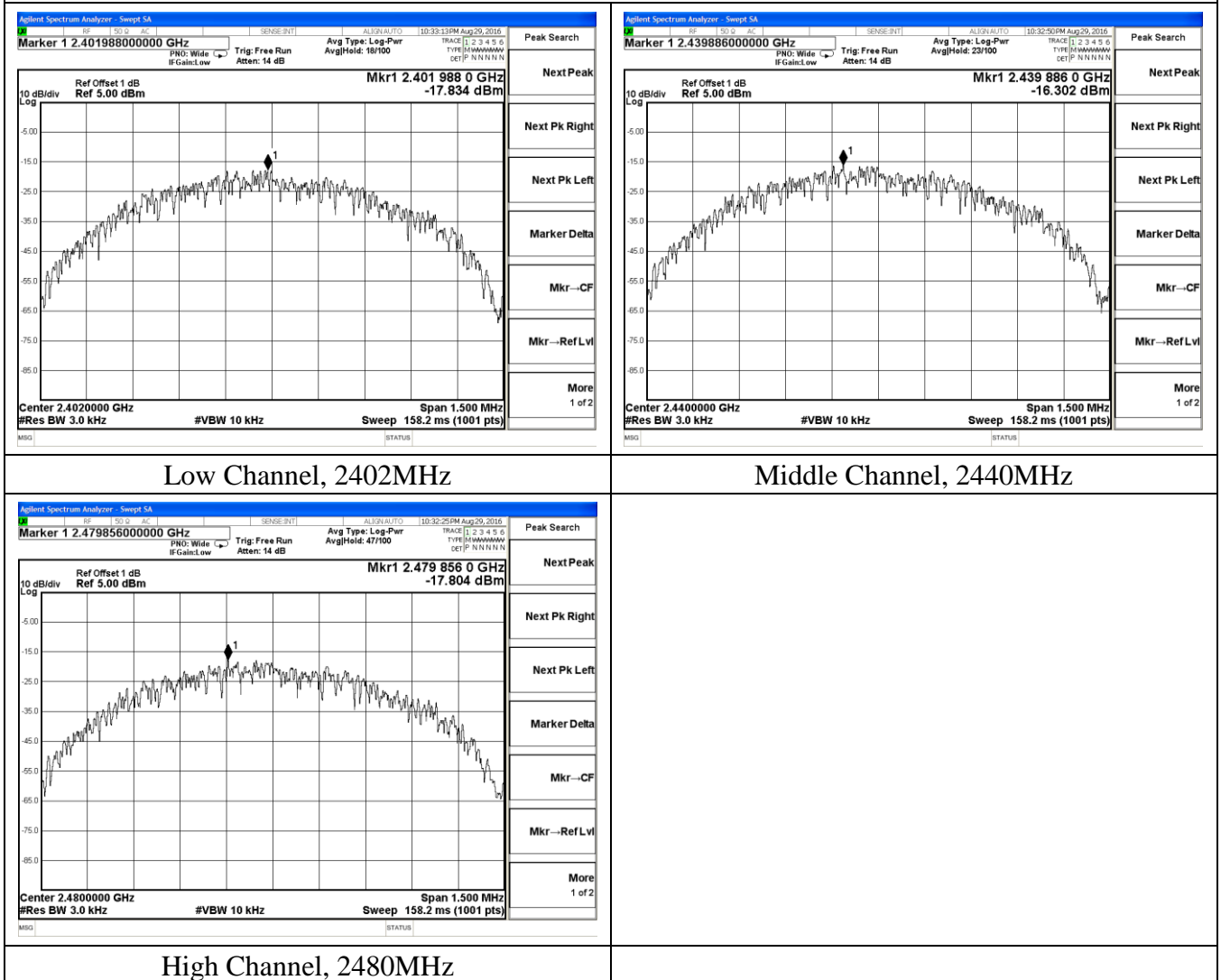


## 5.2.5. Test Result of Power Spectral Density

Modulation	Frequency (MHz)	Reading Level (dBm/3KHz)	Max. Limit (dBm/3KHz)	Result
GFSK	2402	-17.834	8	Pass
	2440	-16.302	8	Pass
	2480	-17.804	8	Pass

The test data refer to the following page.

## Test Plots Of Power Spectral Density Measurement



### 5.3. 6 dB Spectrum Bandwidth Measurement

#### 5.3.1. Standard Applicable

According to §15.247(a)(2): Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

#### 5.3.2. Instruments Setting

The following table is the setting of the Spectrum Analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> RBW
Detector	Peak
Trace	Max Hold
Sweep Time	100ms

#### 5.3.3. Test Procedures

1) The transmitter output (antenna port) was connected to the spectrum analyser in peak hold mode.

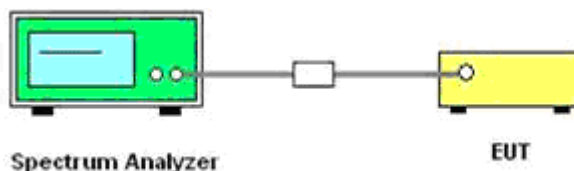
2) Set RBW/VBW = 100KHz/300KHz (for 6dB bandwidth measurement)

Set RBW = 1%~5% OBW; VBW  $\geq 3$ \*RBW (for occupied bandwidth measurement)

3) Measured the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

4) Measured the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20dB relative to the maximum level measured in the fundamental emission.

#### 5.3.4. Test Setup Layout



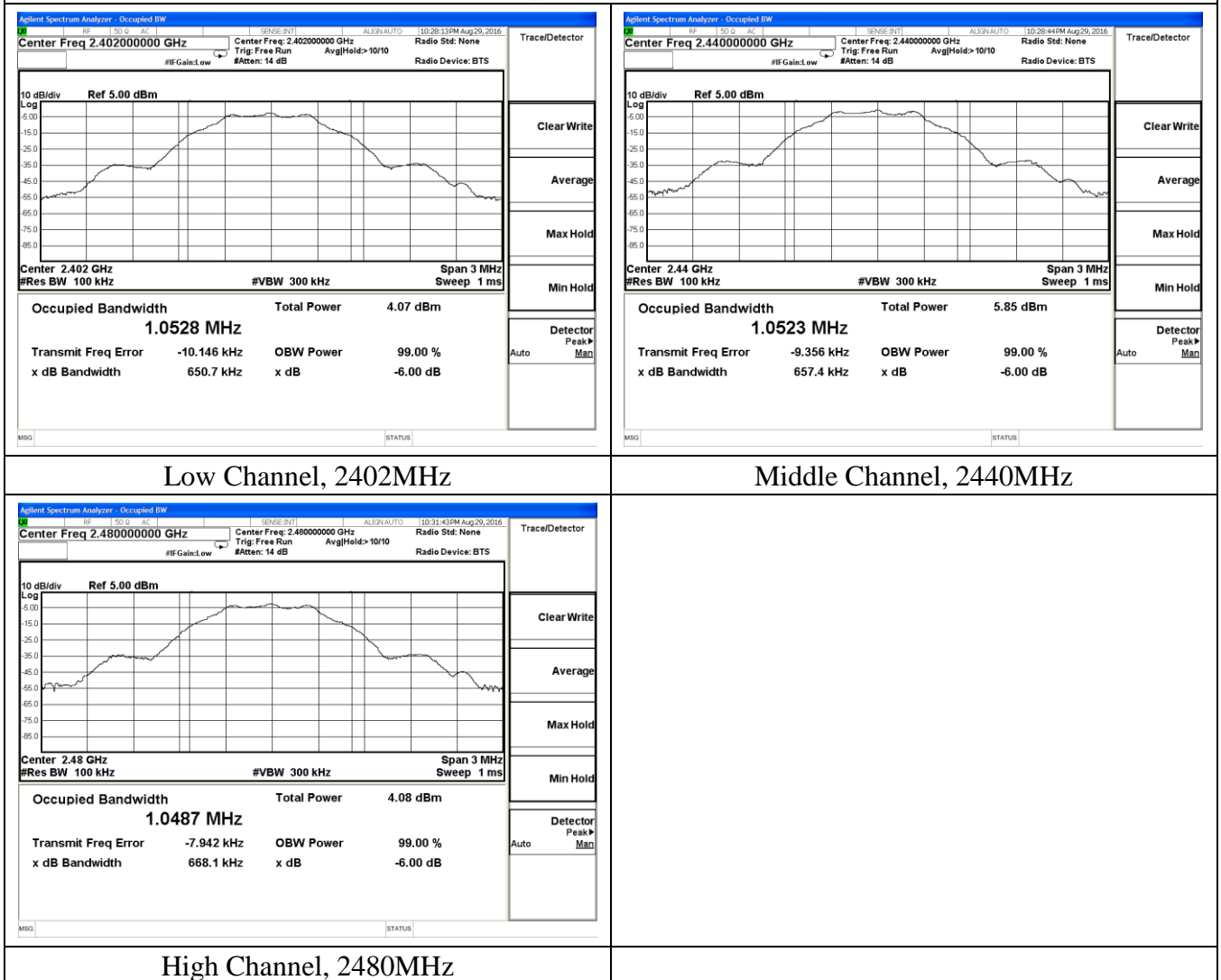
#### 5.3.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

## 5.3.6. Test Result of Spectrum Bandwidth

Modulation	Frequency (MHz)	6dB Bandwidth (KHz)	Min. Limit (KHz)	Result
GFSK	2402	650.7	500	Complies
	2440	657.4	500	Complies
	2480	668.1	500	Complies

## Test Plots Of 6 dB Spectrum Bandwidth Measurement



## 5.4. Radiated Emissions Measurement

### 5.4.1. 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

### 5.4.2. 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 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RB 100kHz for QP

#### 5.4.3. 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.

## 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 ( $\pm 45^\circ$ ) 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 ( $\pm 45^\circ$ ) 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:**

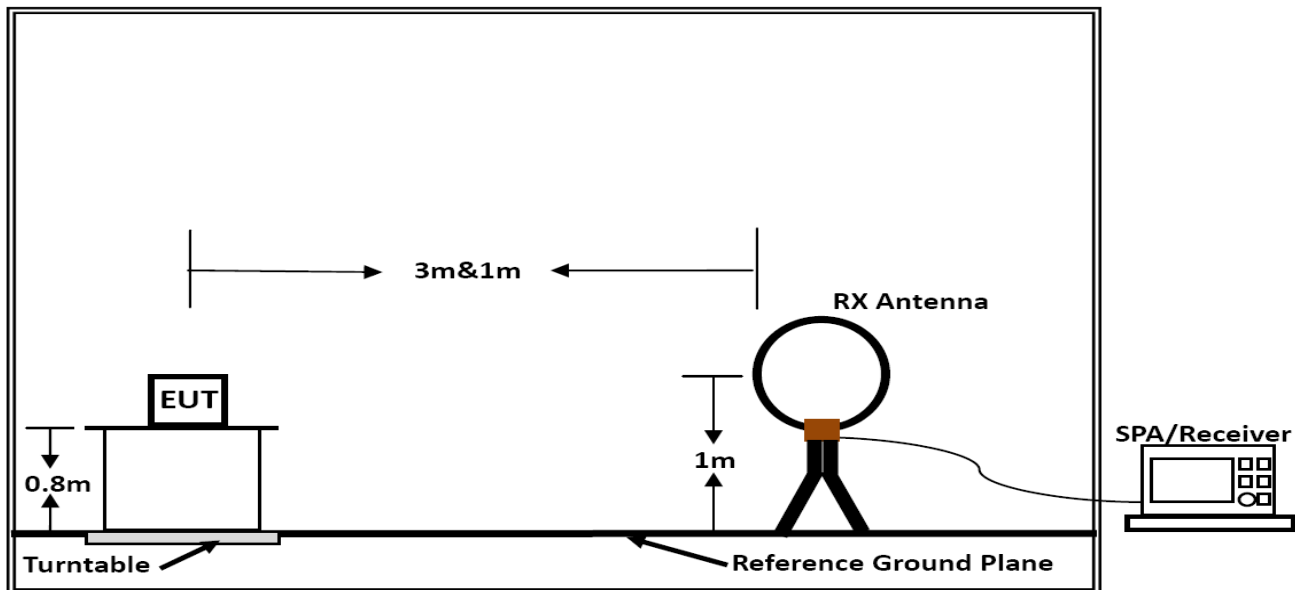
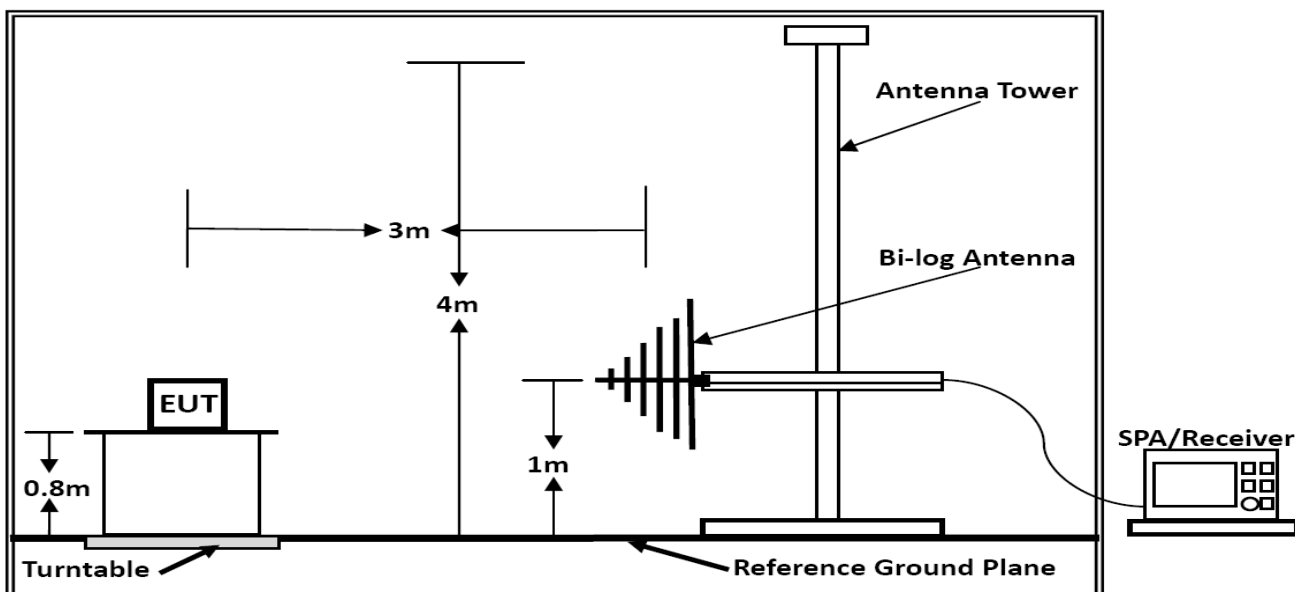
- The antenna is moved spherical over the EUT in different polarisations of the antenna.

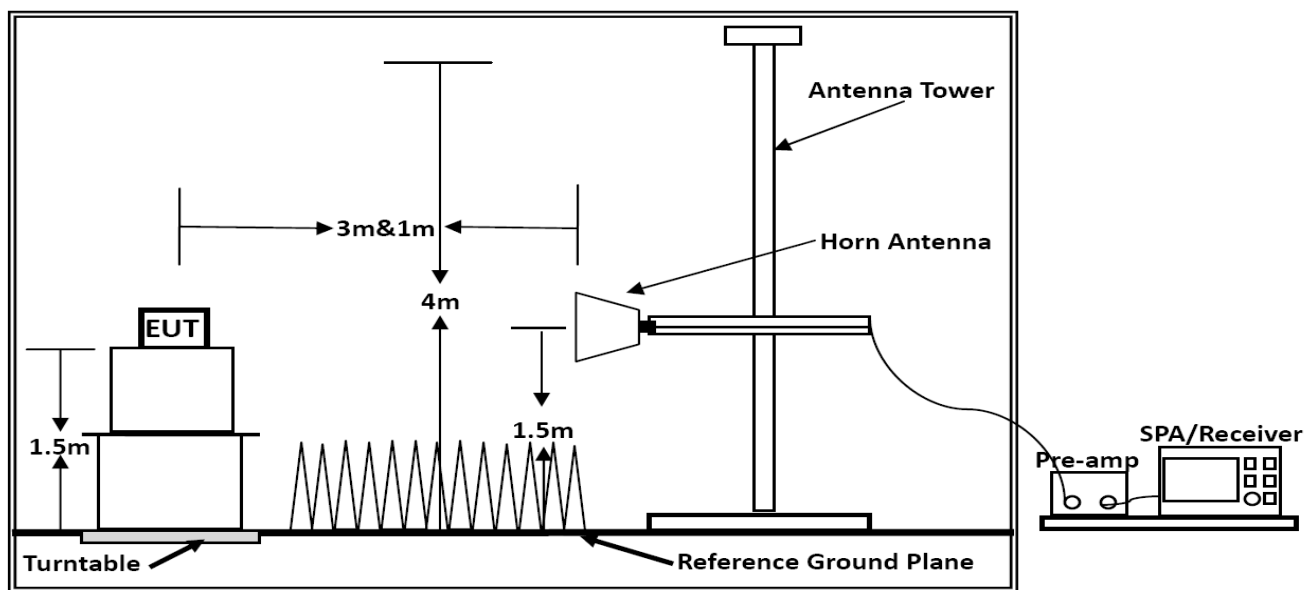
##### **Final measurement:**

- 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.



## 5.4.4. Test Setup Layout

**Below 30MHz****Below 1GHz**



**Above 1GHz**

#### 5.4.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

## 5.4.6. Results of Radiated Emissions (9kHz~30MHz)

Temperature	25°C	Humidity	60%
Test Engineer	Kyle Yin	Configurations	BLE V4.0

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

Note:

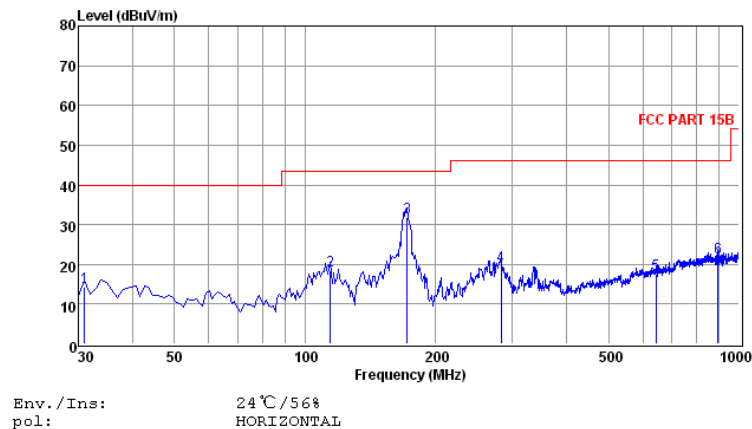
The radiated emissions from 9kHz to 30MHz are at least 20dB below the official limit and no need to report.

Distance extrapolation factor =  $40 \log (\text{specific distance} / \text{test distance})$  (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor.

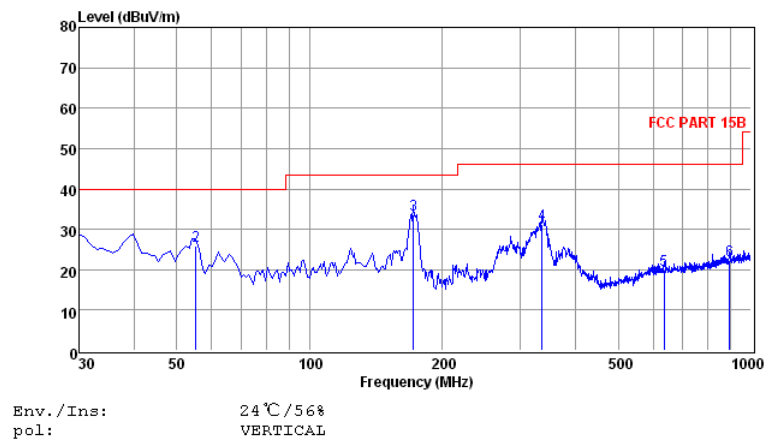
## 5.4.7. Results of Radiated Emissions (30MHz~1GHz)

Temperature	25°C	Humidity	60%
Test Engineer	Kyle Yin	Configurations	TX-Low Channel



	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBm	dB	dB/m	dBm	dBm	dB	
1	30.97	1.45	0.39	12.32	14.16	40.00	-25.84	QP
2	114.39	6.34	0.65	11.47	18.46	43.50	-25.04	QP
3	171.62	21.97	0.91	9.09	31.97	43.50	-11.53	QP
4	283.17	5.77	1.06	12.73	19.56	46.00	-26.44	QP
5	644.01	-2.75	1.74	18.61	17.60	46.00	-28.40	QP
6	895.24	-1.15	1.84	21.04	21.73	46.00	-24.27	QP

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



	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBm	dB	dB/m	dBm	dBm	dB	
1	30.00	14.21	0.39	12.33	26.93	40.00	-13.07	QP
2	55.22	12.28	0.46	13.01	25.75	40.00	-14.25	QP
3	171.62	23.62	0.91	9.09	33.62	43.50	-9.88	QP
4	336.52	16.09	1.09	13.98	31.16	46.00	-14.84	QP
5	635.28	-0.42	1.71	18.58	19.87	46.00	-26.13	QP
6	894.27	-0.47	1.84	21.03	22.40	46.00	-23.60	QP

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

Note:

Pre-scan all mode and recorded the worst case results in this report (TX-Low Channel(2402MHz)).

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

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

## 5.4.8. Results for Radiated Emissions (Above 1GHz)

**TX Mode**

## Channel 1

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.
4804.14	47.34	33.06	35.04	3.94	49.30	74	-24.70	Peak	Horizontal
4804.17	38.65	33.06	35.04	3.94	40.61	54	-13.39	Average	Horizontal
4804.14	52.81	33.06	35.04	3.94	54.77	74	-19.23	Peak	Vertical
4804.17	35.33	33.06	35.04	3.94	37.29	54	-16.71	Average	Vertical

## Channel 20

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.
4880.22	51.19	33.16	35.15	3.96	53.16	74	-20.84	Peak	Horizontal
4880.25	38.25	33.16	35.15	3.96	40.22	54	-13.78	Average	Horizontal
4880.22	52.38	33.16	35.15	3.96	54.35	74	-19.65	Peak	Vertical
4880.25	37.97	33.16	35.15	3.96	39.94	54	-14.06	Average	Vertical

## Channel 40

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.
4960.31	52.73	33.26	35.14	3.98	54.83	74	-19.17	Peak	Horizontal
4960.34	39.63	33.26	35.14	3.98	41.73	54	-12.27	Average	Horizontal
4960.31	51.94	33.26	35.14	3.98	54.04	74	-19.96	Peak	Vertical
4960.34	37.62	33.26	35.14	3.98	39.72	54	-14.28	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. Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

## 5.4.9. Results of Band Edges Test (Radiated)

## TX Mode

## Tx-2402

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.
2378.37	47.10	32.89	35.16	3.51	48.34	74	-25.66	Peak	Horizontal
2378.40	35.59	32.89	35.16	3.51	36.83	54	-17.17	Average	Horizontal
2390.00	53.28	32.92	35.16	3.54	54.58	74	-19.42	Peak	Horizontal
2389.97	37.91	32.92	35.16	3.54	39.21	54	-14.79	Average	Horizontal
2378.37	48.64	32.89	35.16	3.51	49.88	74	-24.12	Peak	Vertical
2378.40	31.86	32.89	35.16	3.51	33.11	54	-20.89	Average	Vertical
2390.00	49.24	32.92	35.16	3.54	50.54	74	-23.46	Peak	Vertical
2389.97	35.44	32.92	35.16	3.54	36.74	54	-17.26	Average	Vertical

## Tx-2480

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.
2483.50	47.90	33.06	35.18	3.60	49.38	74	-24.62	Peak	Horizontal
2483.51	34.79	33.08	35.18	3.60	36.29	54	-17.71	Average	Horizontal
2488.73	44.16	33.08	35.18	3.62	45.68	74	-28.32	Peak	Horizontal
2488.76	35.22	33.08	35.18	3.62	36.74	54	-17.26	Average	Horizontal
2483.50	45.52	33.06	35.18	3.60	47.00	74	-27.00	Peak	Vertical
2483.51	35.49	33.08	35.18	3.60	36.99	54	-17.01	Average	Vertical
2488.73	46.02	33.08	35.18	3.62	47.54	74	-26.46	Peak	Vertical
2488.76	35.28	33.08	35.18	3.62	36.80	54	-17.20	Average	Vertical

## 5.5. Conducted Spurious Emissions and Band Edges Test

### 5.5.1. Standard Applicable

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. Instruments Setting

The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Detector	Peak
Attenuation	Auto
RB / VB (Emission in restricted band)	100KHz/300KHz
RB / VB (Emission in non-restricted band)	100KHz/300KHz

### 5.5.3. Test Procedures

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz

The spectrum from 9kHz to 26.5GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

### 5.5.4. Test Setup Layout

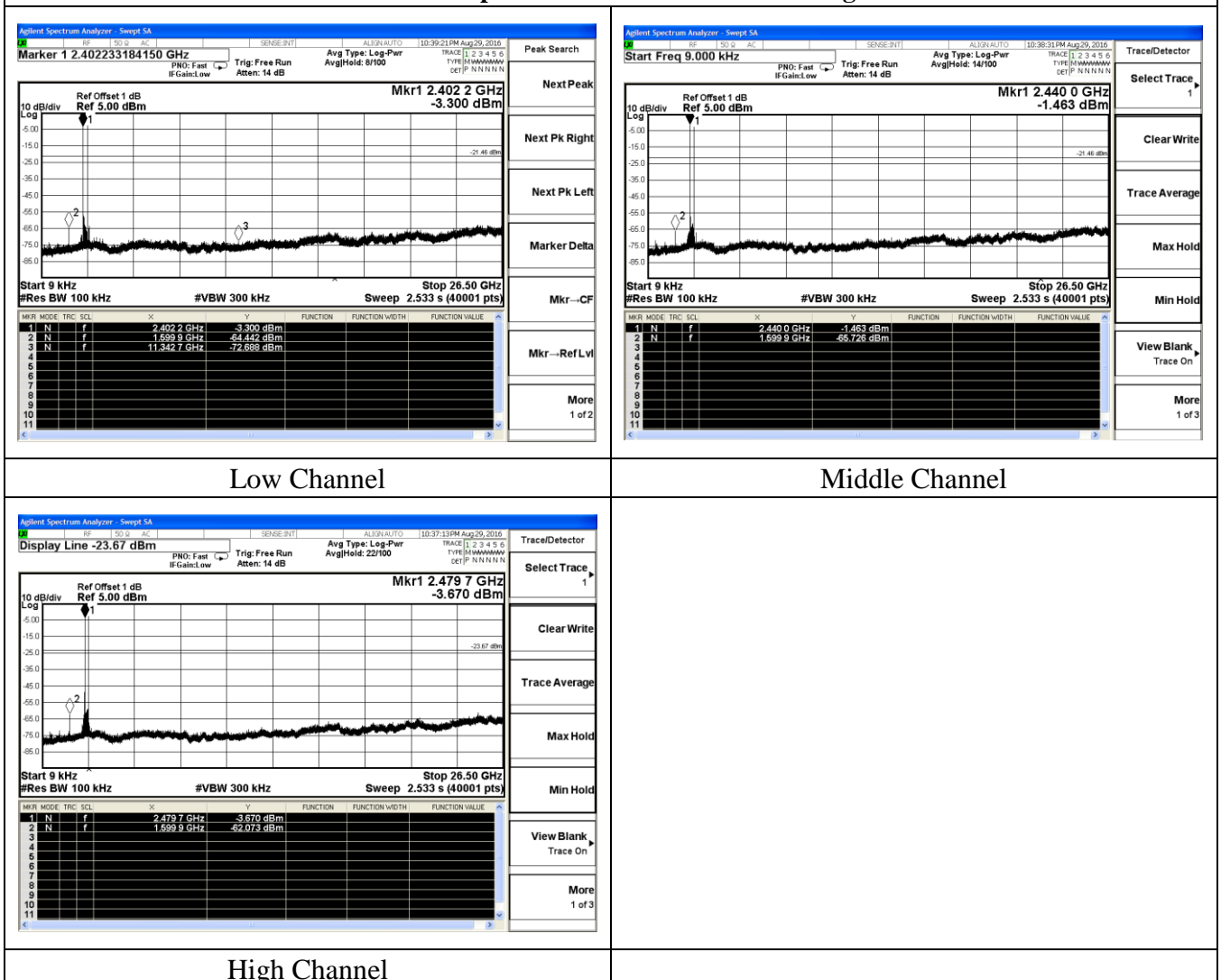
This test setup layout is the same as that shown in section 5.3.4.

### 5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

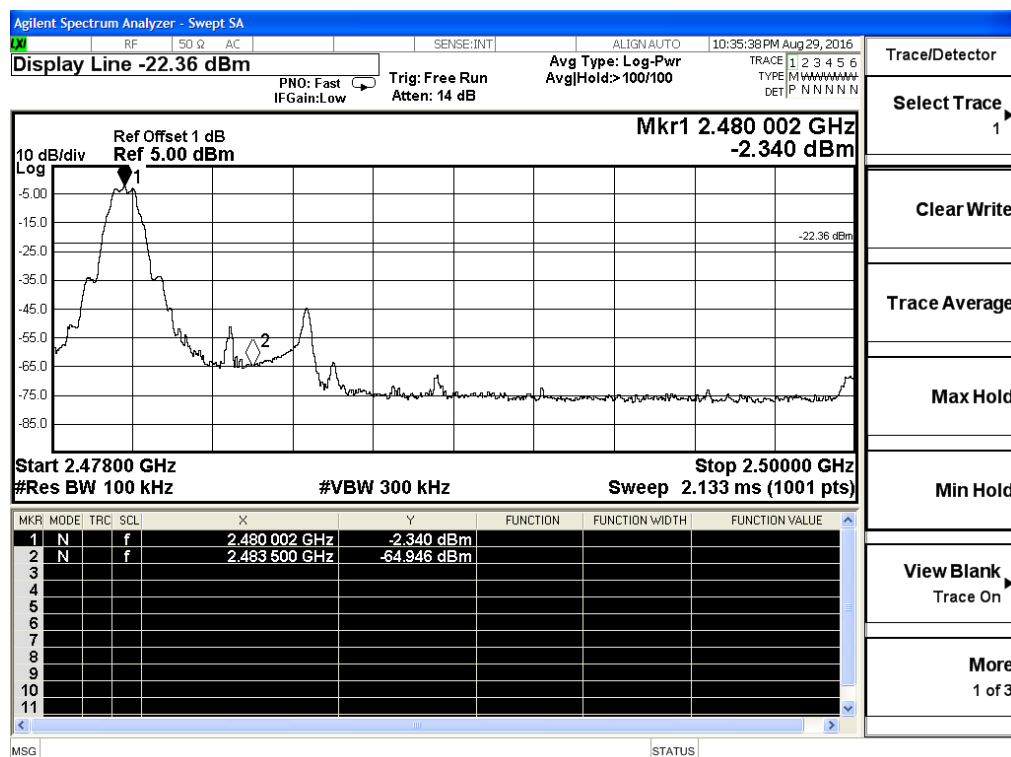
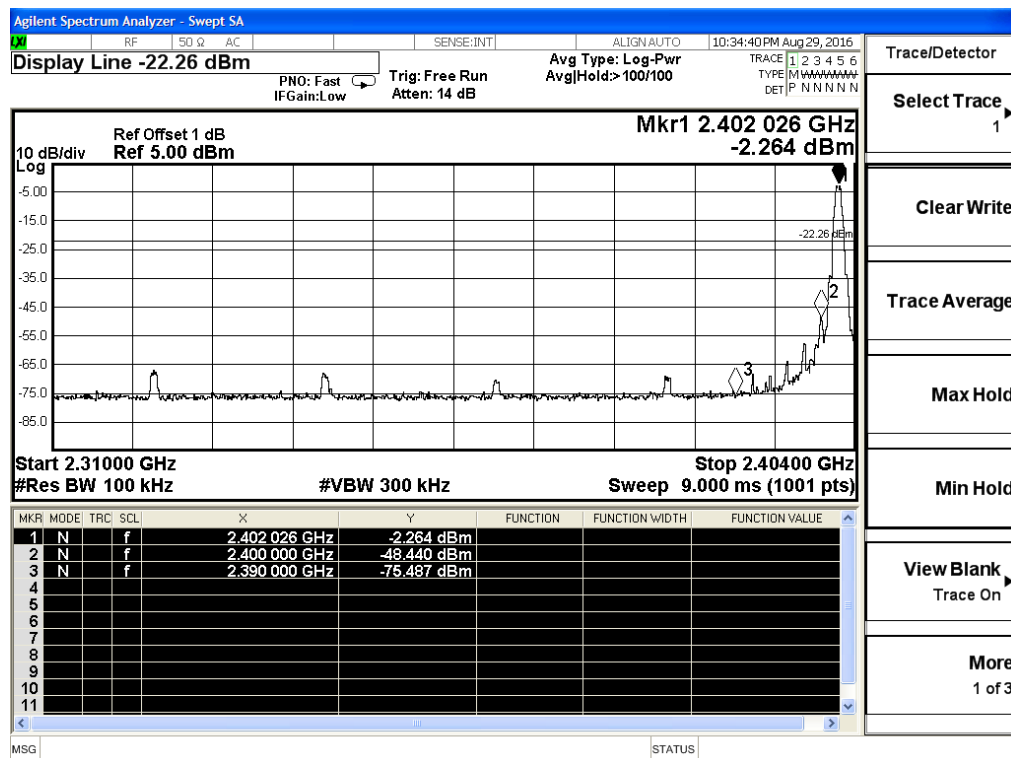
## 5.5.6. Test Results of Conducted Spurious Emissions

## Test Plots Of Conducted Spurious Emissions and Band Edges Measurement





## 5.5.7. Test Results of Band Edges Test



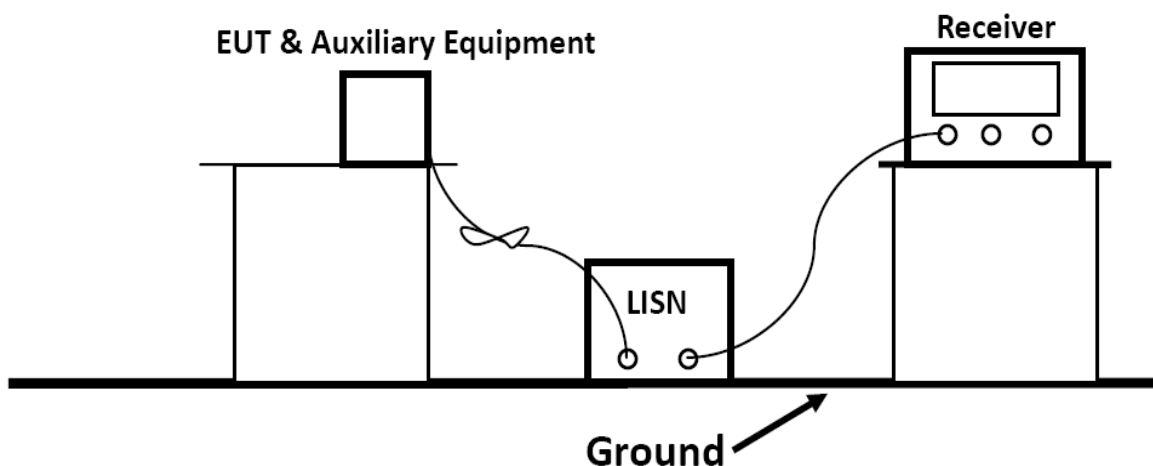
## 5.6. Power line conducted emissions

### 5.6.1 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 is 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

### 5.6.2 Block Diagram of Test Setup

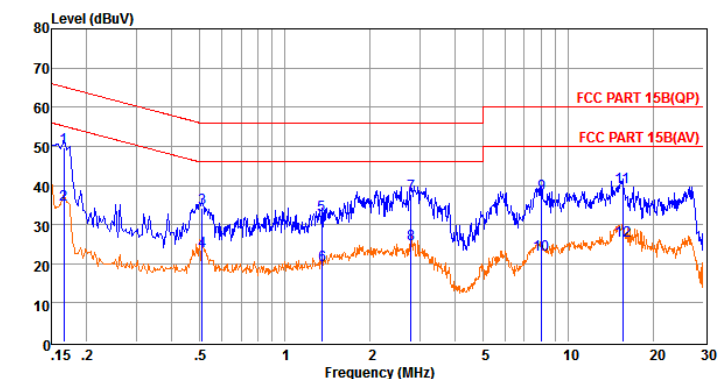


### 5.6.3 Test Results

PASS.

The test data please refer to following page.

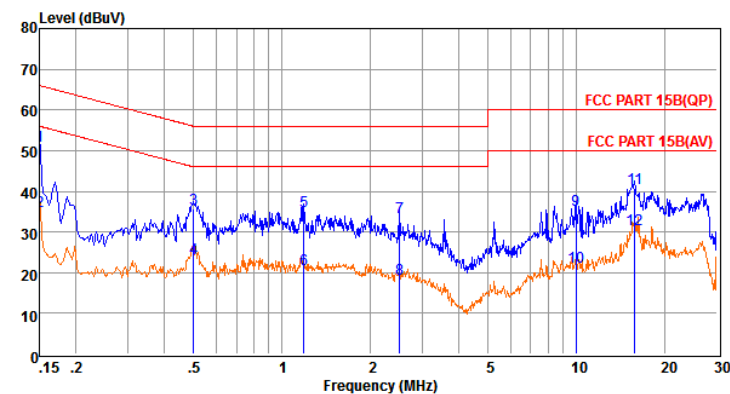
Temperature	25°C	Humidity	60%
Test Engineer	Kyle Yin	Configurations	TX-Low Channel



Env. Ins: 24\*/56%  
Pol: LINE

Freq	Reading	LisnFac	CabLos	Atten_Fac	Measured	Limit	Over	Remark
MHz	dBuV	dB	dB	dB	dBuV	dBuV	dB	
1 0.16589	30.13	9.59	0.02	10.00	49.74	65.16	-15.42	QP
2 0.16599	15.35	9.59	0.02	10.00	34.96	55.16	-20.20	Average
3 0.51007	14.61	9.62	0.04	10.00	34.27	56.00	-21.73	QP
4 0.51017	3.57	9.62	0.04	10.00	23.23	46.00	-22.77	Average
5 1.35213	12.64	9.63	0.05	10.00	32.32	56.00	-23.68	QP
6 1.35313	-0.19	9.63	0.05	10.00	19.49	46.00	-26.51	Average
7 2.77945	18.17	9.64	0.05	10.00	37.86	56.00	-18.14	QP
8 2.78045	5.17	9.64	0.05	10.00	24.86	46.00	-21.14	Average
9 8.06243	17.96	9.68	0.07	10.00	37.71	60.00	-22.29	QP
10 8.06343	2.56	9.68	0.07	10.00	22.31	50.00	-27.69	Average
1115.55226	19.74	9.72	0.10	10.00	39.56	60.00	-20.44	QP
1215.55326	6.17	9.72	0.10	10.00	25.99	50.00	-24.01	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%  
Pol: NEUTRAL

Freq	Reading	LisnFac	CabLos	Atten_Fac	Measured	Limit	Over	Remark
MHz	dBuV	dB	dB	dB	dBuV	dBuV	dB	
1 0.15000	31.36	9.70	0.02	10.00	51.08	66.00	-14.92	QP
2 0.15010	15.47	9.70	0.02	10.00	35.19	55.99	-20.80	Average
3 0.50203	15.89	9.62	0.04	10.00	35.55	56.00	-20.45	QP
4 0.50213	3.86	9.62	0.04	10.00	23.52	46.00	-22.48	Average
5 1.18439	15.33	9.63	0.05	10.00	35.01	56.00	-20.99	QP
6 1.18539	1.03	9.63	0.05	10.00	20.71	46.00	-25.29	Average
7 2.51327	13.97	9.64	0.05	10.00	33.66	56.00	-22.34	QP
8 2.51427	-1.26	9.64	0.05	10.00	18.43	46.00	-27.57	Average
9 9.96568	15.48	9.72	0.08	10.00	35.28	60.00	-24.72	QP
10 9.96668	1.66	9.72	0.08	10.00	21.46	50.00	-28.54	Average
1115.80144	20.79	9.75	0.10	10.00	40.64	60.00	-19.36	QP
1215.80244	10.69	9.75	0.10	10.00	30.54	50.00	-19.46	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 mode and recorded the worst case results in this report (BLE (High Channel)).

## 5.7. Antenna Requirements

### 5.7.1. 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.

### 5.7.2. Antenna Connected Construction

#### 5.7.2.1. 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.

#### 5.7.2.2. Antenna Connector Construction

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

### 5.7.3. Results: Compliance.

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