



# SPORTON International Inc.

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## FCC RADIO TEST REPORT

Applicant's company	Ubiquiti Networks, Inc.
Applicant Address	2580 Orchard Parkway San Jose, CA 95131
FCC ID	SWX-UAPACHD
Manufacturer's company	Ubiquiti Networks, Inc.
Manufacturer Address	2580 Orchard Parkway San Jose, CA 95131

Product Name	UniFi Access Point
Brand Name	UBIQUITI
Model Name	UAP-AC-SHD, UAP-AC-HD
Test Rule	47 CFR FCC Part 15 Subpart C § 15.247
Test Freq. Range	2402 ~ 2480MHz
Received Date	Jun. 17, 2016
Final Test Date	Nov. 08, 2016
Submission Type	Original Equipment

### Statement

**Test result included is only for the Bluetooth LE of the product.**

The test result in this report refers exclusively to the presented test model / sample.

Without written approval of SPORTON International Inc., the test report shall not be reproduced except in full.

The measurements and test results shown in this test report were made in accordance with the procedures and found in compliance with the limit given in **ANSI C63.10-2013, 47 CFR FCC Part 15 Subpart C** and **KDB558074 D01 v03r05**.

The test equipment used to perform the test is calibrated and traceable to NML/ROC.





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### History of This Test Report

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR661623-02AD	Rev. 01	Initial issue of report	Nov. 09, 2016
FR661623-02AD	Rev. 02	Adding a Model Name: UAP-AC-SHD	Nov. 14, 2016



## 1. VERIFICATION OF COMPLIANCE

Product Name : UniFi Access Point  
Brand Name : UBIQUITI  
Model No. : UAP-AC-SHD, UAP-AC-HD  
Applicant : Ubiquiti Networks, Inc.  
Test Rule Part(s) : 47 CFR FCC Part 15 Subpart C § 15.247

Sporton International as requested by the applicant to evaluate the EMC performance of the product sample received on Jun. 17, 2016 would like to declare that the tested sample has been evaluated and found to be in compliance with the tested rule parts. The data recorded as well as the test configuration specified is true and accurate for showing the sample's EMC nature.

A handwritten signature in blue ink, appearing to read 'Sam Chen', is written over a horizontal line.

Sam Chen

SPORTON INTERNATIONAL INC.

## 2. SUMMARY OF THE TEST RESULT

Applied Standard: 47 CFR FCC Part 15 Subpart C			
Part	Rule Section	Description of Test	Result
4.1	15.207	AC Power Line Conducted Emissions	Complies
4.2	15.247(b)(3)	Maximum Conducted Output Power	Complies
4.3	15.247(e)	Power Spectral Density	Complies
4.4	15.247(a)(2)	6dB Spectrum Bandwidth	Complies
4.5	15.247(d)	Radiated Emissions	Complies
4.6	15.247(d)	Band Edge Emissions	Complies
4.7	15.203	Antenna Requirements	Complies

### 3. GENERAL INFORMATION

#### 3.1. Product Details

Items	Description
Power Type	From PoE
Modulation	DSSS
Data Rate (Mbps)	GFSK: 1
Frequency Range	2402 ~ 2480MHz
Channel Number	40 (37 hopping + 3 advertising channel)
Channel Bandwidth (99%)	1.05 MHz
Maximum Conducted Output Power	-0.13 dBm
Carrier Frequencies	Please refer to section 3.4
Antenna	Please refer to section 3.3

#### 3.2. Accessories

Support Unit	Brand	Model	Rating
PoE	UBIQUITI	GP-H480-050G	Input: 100-240V~50/60Hz, MAX 0.75A(0.75A) Output: 48V, 0.5A(0.5A)
<b>Others</b>			
Power cable*1, Non-shielded, 0.6m			

### 3.3. Table for Filed Antenna

#### For 2.4GHz WLAN function

Ant.	Brand	Model Name	Antenna Type	Connector	TX/RX Gain (dBi)
1	-	-	PIFA Antenna	N/A	3
2	-	-	PIFA Antenna	N/A	3

#### For 5GHz WLAN function

Ant.	Brand	Model Name	Antenna Type	Connector	TX/RX Gain (dBi)
3	-	-	PIFA Antenna	N/A	4
4	-	-	PIFA Antenna	N/A	4

#### For Bluetooth function

Ant.	Brand	Model Name	Antenna Type	Connector	TX/RX Gain (dBi)
5	-	-	PIFA Antenna	N/A	1

#### For RX function

Ant.	Brand	Model Name	Antenna Type	Connector	RX Gain (dBi)	
					2.4GHz	5GHz
6	-	-	PIFA Antenna	N/A	1	2

Note: The EUT has six antennas.

#### For 2.4GHz WLAN function

##### IEEE 802.11b/g/n/ac mode (4TX/4RX):

Chain 1 and Chain 2 connect to Ant. 1.

Chain 3 and Chain 4 connect to Ant. 2.

Chain 1, Chain 2, Chain 3 and Chain 4 can be used as transmitting/receiving antenna.

Chain 1, Chain 2, Chain 3 and Chain 4 could transmit/receive simultaneously.

#### For 5GHz WLAN function

IEEE 802.11a/n/ac mode (4TX/4RX): The module has four chains.

Chain 1 and Chain 2 connect to Ant. 3.

Chain 3 and Chain 4 connect to Ant. 4.

Chain 1, Chain 2, Chain 3 and Chain 4 can be used as transmitting/receiving antenna.

Chain 1, Chain 2, Chain 3 and Chain 4 could transmit/receive simultaneously.

#### For Bluetooth function: The module has one chain only.

Chain 1 connects to Ant. 5.

Chain 1 can be used as transmitting/receiving antenna.

Chain 1 could transmit/receive simultaneously.

#### For RX function: The module has one chain only.

Chain 1 connects to Ant. 6.

Only Chain 1 can be used as receiving antenna.

### 3.4. Table for Carrier Frequencies

Frequency Band	Channel No.	Frequency	Channel No.	Frequency
2400~2483.5MHz	0	2402 MHz	20	2442 MHz
	1	2404 MHz	:	:
	2	2406 MHz	37	2476 MHz
	:	:	38	2478 MHz
	18	2438 MHz	39	2480 MHz
	19	2440 MHz	-	-



### 3.5. Table for Test Modes

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate shown in the table below is the worst-case rate with respect to the specific test item. The following table is a list of the test modes shown in this test report.

Test Items	Mode	Data Rate	Channel	Chain
AC Power Line Conducted Emissions	CTX	-	-	-
Maximum Conducted Output Power Power Spectral Density	GFSK	1 Mbps	0/20/39	1
6dB Spectrum Bandwidth	GFSK	1 Mbps	0/20/39	1
Radiated Emissions 9kHz~1GHz	CTX	-	-	-
Radiated Emissions 1GHz~10 <sup>th</sup> Harmonic	GFSK	1 Mbps	0/20/39	1
Band Edge Emissions	GFSK	1 Mbps	0/20/39	1

Note: The EUT supports P to M and P to P operating mode. After evaluating, the P to M is the worst operating mode. And it was tested and recorded in the report.

The following test modes were performed for all tests:

#### For Conducted Emission test:

Mode 1. CTX - 2.4GHz

Mode 2. CTX - 5GHz

Mode 3. CTX - Bluetooth

Mode 1 generated the worst test result, so it was recorded in this report.

#### For Radiated Emission test (Below 1GHz):

Mode 1. CTX - 5GHz at Z-axis

Mode 2. CTX - 5GHz at Y-axis

Mode 2 has been evaluated to be the worst case among Mode 1~2, thus measurement for Mode 3 ~ 4 will follow this same test mode.

Mode 3. CTX - 2.4GHz at Y-axis

Mode 4. CTX - Bluetooth at Y-axis

Mode 2 generated the worst test result, so it was recorded in this report.

#### For Radiated Emission test (Above 1GHz):

The EUT can be placed in Y-axis and Z-axis. After evaluating, The worst case was found at Y-axis, so it's recorded in this report.

Mode 1. CTX at Y-axis

#### For Co-location MPE Test:

The EUT could be applied with 2.4GHz WLAN function, 5GHz WLAN function and Bluetooth function; therefore Co-location Maximum Permissible Exposure (Please refer to FA661623-02) tests are added for simultaneously transmit between 2.4GHz WLAN function, 5GHz WLAN function and Bluetooth function.

### 3.6. Table for Testing Locations

Test Site Location				
Address:	No.8, Lane 724, Bo-ai St., Jhubei City, Hsinchu County 302, Taiwan, R.O.C.			
TEL:	886-3-656-9065			
FAX:	886-3-656-9085			
Test Site No.	Site Category	Location	FCC Designation No.	IC File No.
03CH01-CB	SAC	Hsin Chu	TW0006	IC 4086D
CO02-CB	Conduction	Hsin Chu	TW0006	IC 4086D
TH01-CB	OVEN Room	Hsin Chu	-	-

Open Area Test Site (OATS); Semi Anechoic Chamber (SAC).

### 3.7. Table for Multiple Listing

The model names as below

Brand Name	Model Name	2.4GHz/5GHz WLAN function	2.4GHz/5GHz RX function	Bluetooth function
UBIQUITI	UAP-AC-SHD	○	○	○
	UAP-AC-HD	○	X	X

Note: The Model UAP-AC-SHD was selected to test and recorded in the report.

### 3.8. Table for Supporting Units

For Test Site No: CO02-CB

Support Unit	Brand	Model	FCC ID
NB	DELL	E6430	DoC

For Test Site No: 03CH01-CB

Support Unit	Brand	Model	FCC ID
NB	DELL	E4300	DoC

For Test Site No: TH01-CB

Support Unit	Brand	Model	FCC ID
NB	DELL	E4300	DoC

### 3.9. Table for Parameters of Test Software Setting

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

#### Power Parameters:

Test Software Version	Telnet		
Frequency	2402 MHz	2442 MHz	2480 MHz
Power Parameters	Default	Default	Default

### 3.10. EUT Operation during Test

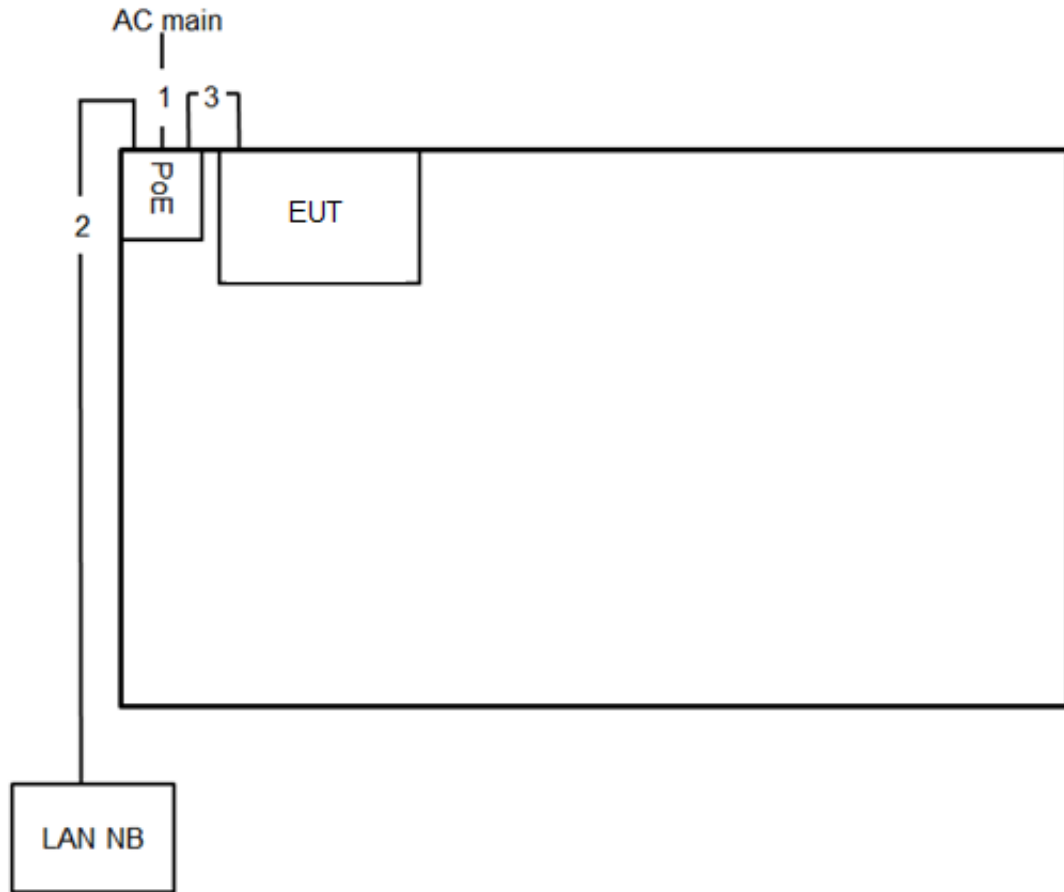
The EUT was programmed to be in continuously transmitting mode.

### 3.11. Duty Cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle (%)	Duty Factor (dB)	1/T Minimum VBW (kHz)
GFSK	0.408	0.624	65.38%	1.85	2.45

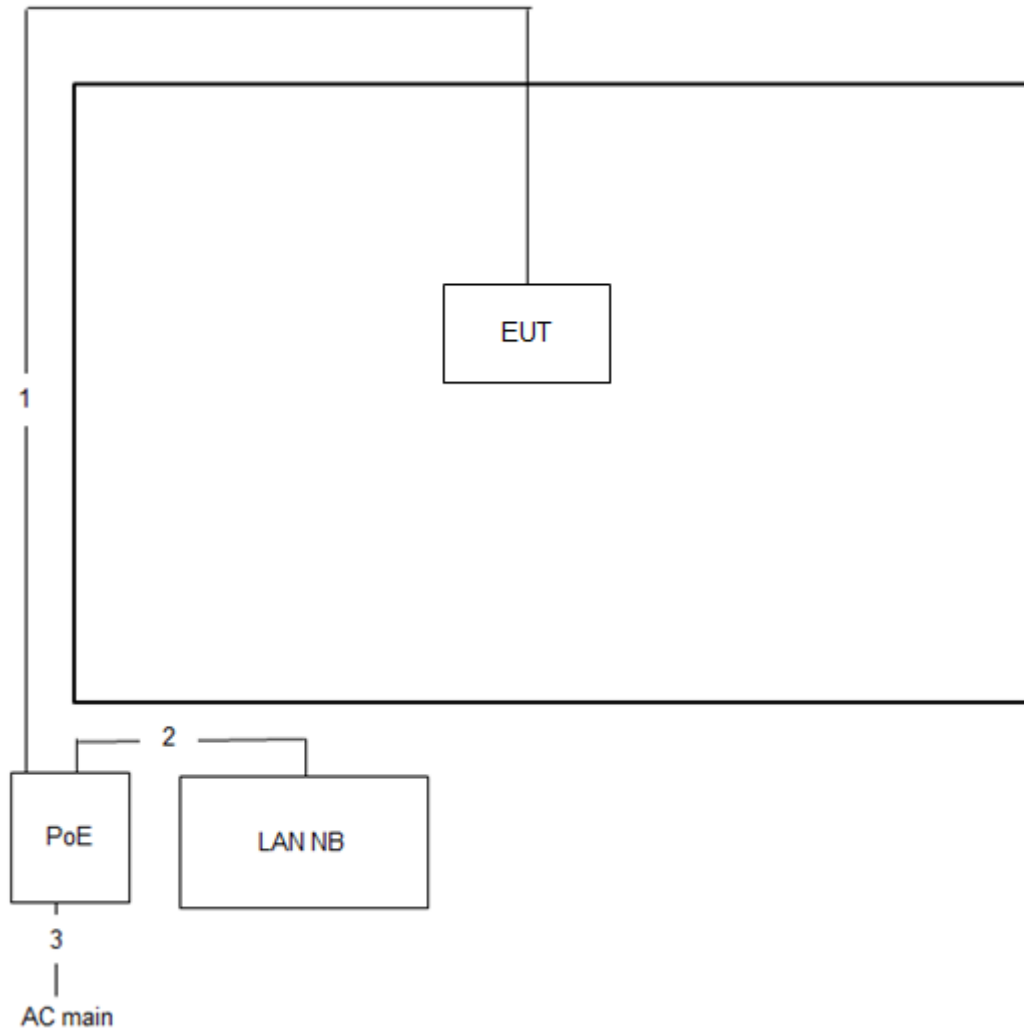
### 3.12. Test Configurations

#### 3.12.1. AC Power Line Conduction Emissions Test Configuration



Item	Connection	Shielded	Length
1	Power cable	No	0.6m
2	RJ-45 cable	No	10m
3	RJ-45 cable	No	1m

### 3.12.2. Radiation Emissions Test Configuration



Item	Connection	Shielded	Length
1	RJ-45 cable	No	10m
2	RJ-45 cable	No	1.5m
3	Power cable	No	0.6m

## 4. TEST RESULT

### 4.1. AC Power Line Conducted Emissions Measurement

#### 4.1.1. Limit

For this product which is designed to be connected to the 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 below limits table.

Frequency (MHz)	QP Limit (dBuV)	AV Limit (dBuV)
0.15~0.5	66~56	56~46
0.5~5	56	46
5~30	60	50

#### 4.1.2. Measuring Instruments and Setting

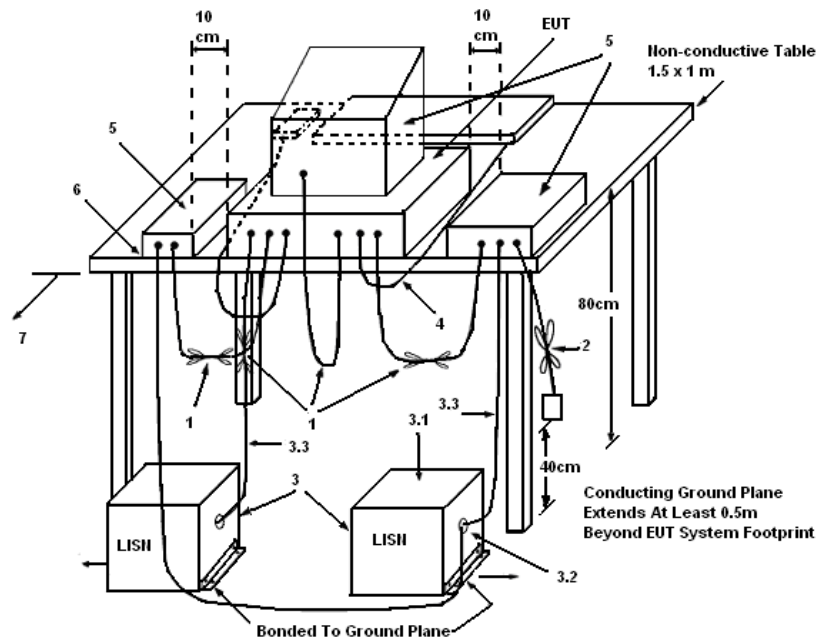
Please refer to section 5 of equipments list in this report. The following table is the setting of the receiver.

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

#### 4.1.3. Test Procedures

1. Configure the EUT according to ANSI C63.10. The EUT or host of EUT has to be placed 0.4 meter far from the conducting wall of the shielding room and at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT or host of EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connected to the other LISNs. The LISN should provide 50uH/50ohms coupling impedance.
4. The frequency range from 150 kHz to 30 MHz was searched.
5. Set the test-receiver system to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. The measurement has to be done between each power line and ground at the power terminal.

#### 4.1.4. Test Setup Layout



#### LEGEND:

- (1) Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
- (2) I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
- (3) EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50  $\Omega$ . LISN can be placed on top of, or immediately beneath, reference ground plane.
  - (3.1) All other equipment powered from additional LISN(s).
  - (3.2) Multiple outlet strip can be used for multiple power cords of non-EUT equipment.
  - (3.3) LISN at least 80 cm from nearest part of EUT chassis.
- (4) Cables of hand-operated devices, such as keyboards, mice, etc., shall be placed as for normal use.
- (5) Non-EUT components of EUT system being tested.
- (6) Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop.
- (7) Rear of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane.

#### 4.1.5. Test Deviation

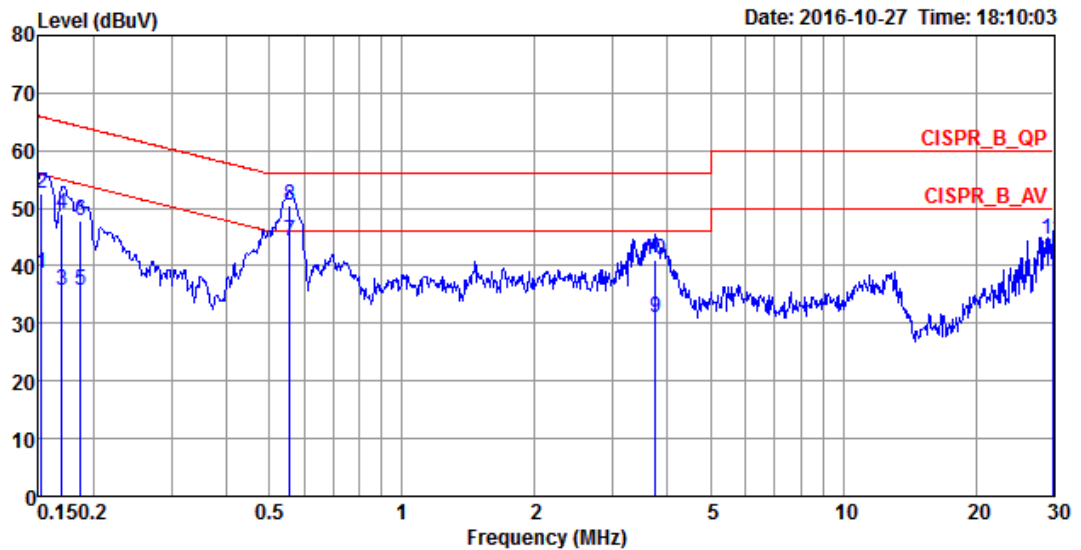
There is no deviation with the original standard.

#### 4.1.6. EUT Operation during Test

The EUT was placed on the test table and programmed in normal function.

4.1.7. Results of AC Power Line Conducted Emissions Measurement

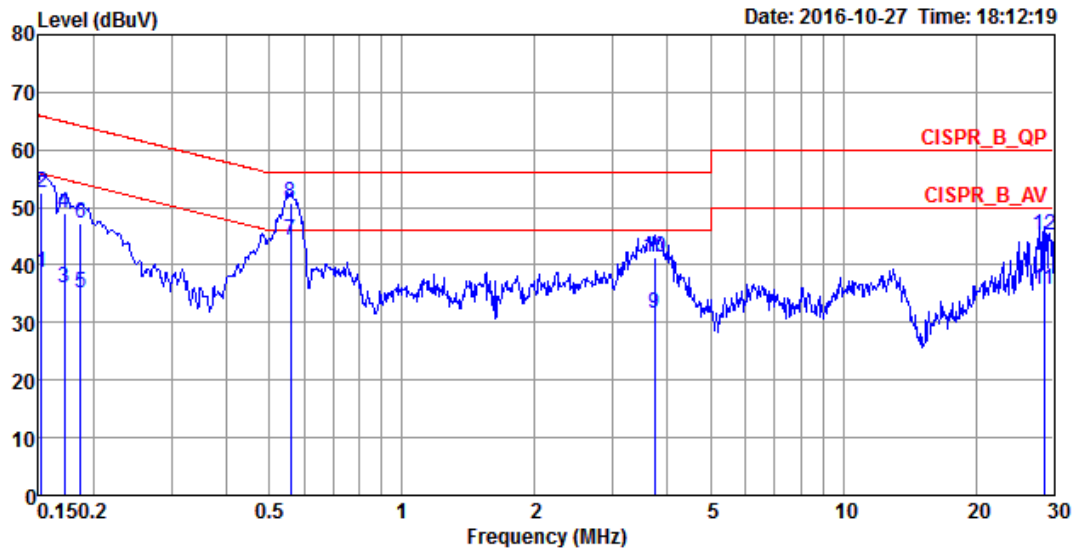
Temperature	22°C	Humidity	52%
Test Engineer	Ryo Fan/Edison Lin	Phase	Line
Configuration	CTX	Test Mode	Mode 1



	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark	Pol/Phase
	MHz	dBuV	dB	dBuV	dBuV	dB	dB		
1	0.1524	38.78	-17.09	55.87	28.66	9.96	0.16	Average	LINE
2	0.1524	52.53	-13.34	65.87	42.41	9.96	0.16	QP	LINE
3	0.1694	35.72	-19.27	54.99	25.60	9.96	0.16	Average	LINE
4	0.1694	48.87	-16.12	64.99	38.75	9.96	0.16	QP	LINE
5	0.1864	35.63	-18.57	54.20	25.50	9.95	0.18	Average	LINE
6	0.1864	47.71	-16.49	64.20	37.58	9.95	0.18	QP	LINE
7	0.5552	44.20	-1.80	46.00	33.98	10.02	0.20	Average	LINE
8	0.5552	50.62	-5.38	56.00	40.40	10.02	0.20	QP	LINE
9	3.7594	30.93	-15.07	46.00	20.50	10.11	0.32	Average	LINE
10	3.7594	41.05	-14.95	56.00	30.62	10.11	0.32	QP	LINE
11	29.8956	40.92	-9.08	50.00	29.97	10.35	0.60	Average	LINE
12	29.8956	44.47	-15.53	60.00	33.52	10.35	0.60	QP	LINE



Temperature	22°C	Humidity	52%
Test Engineer	Ryo Fan/Edison Lin	Phase	Neutral
Configuration	CTX	Test Mode	Mode 1



	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark	Pol/Phase
	MHz	dBuV	dB	dBuV	dBuV	dB	dB		
1	0.1524	38.56	-17.31	55.87	28.44	9.96	0.16	Average	NEUTRAL
2	0.1524	52.64	-13.23	65.87	42.52	9.96	0.16	QP	NEUTRAL
3	0.1712	36.10	-18.80	54.90	25.98	9.96	0.16	Average	NEUTRAL
4	0.1712	49.01	-15.89	64.90	38.89	9.96	0.16	QP	NEUTRAL
5	0.1864	35.27	-18.93	54.20	25.13	9.96	0.18	Average	NEUTRAL
6	0.1864	47.19	-17.01	64.20	37.05	9.96	0.18	QP	NEUTRAL
7	0.5581	44.23	-1.77	46.00	34.06	9.97	0.20	Average	NEUTRAL
8	0.5581	50.78	-5.22	56.00	40.61	9.97	0.20	QP	NEUTRAL
9	3.7395	31.64	-14.36	46.00	21.30	10.02	0.32	Average	NEUTRAL
10	3.7395	41.40	-14.60	56.00	31.06	10.02	0.32	QP	NEUTRAL
11	28.5122	35.76	-14.24	50.00	24.85	10.34	0.57	Average	NEUTRAL
12	28.5122	45.14	-14.86	60.00	34.23	10.34	0.57	QP	NEUTRAL

Note: Level = Read Level + LISN Factor + Cable Loss.

## 4.2. Maximum Conducted Output Power Measurement

### 4.2.1. Limit

The limit for output power is 30dBm.

### 4.2.2. Measuring Instruments and Setting

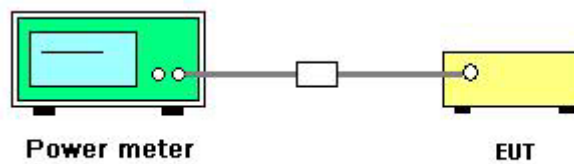
Please refer to section 5 of equipments list in this report. The following table is the setting of the power meter.

Power Meter Parameter	Setting
Bandwidth	50MHz bandwidth is greater than the EUT emission bandwidth
Detector	Average

### 4.2.3. Test Procedures

1. Test procedures refer KDB558074 D01 v03r05 section 9.2.3.2.
2. This procedure provides an alternative for determining the RMS output power using a broadband RF average power meter with a thermocouple detector.

### 4.2.4. Test Setup Layout



### 4.2.5. Test Deviation

There is no deviation with the original standard.

### 4.2.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

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

<b>Temperature</b>	20°C	<b>Humidity</b>	56%
<b>Test Engineer</b>	Gary Chu	<b>Configurations</b>	GFSK
<b>Test Date</b>	Oct. 19, 2016~Nov. 07, 2016		

Channel	Frequency	Conducted Power (dBm)	Max. Limit (dBm)	Result
0	2402 MHz	-1.01	30.00	Complies
20	2442 MHz	-1.34	30.00	Complies
39	2480 MHz	-0.13	30.00	Complies

### 4.3. Power Spectral Density Measurement

#### 4.3.1. Limit

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.

#### 4.3.2. Measuring Instruments and Setting

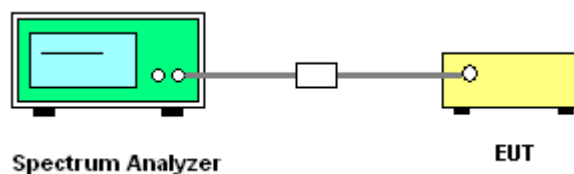
Please refer to section 5 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	5-30 % greater than the DTS channel bandwidth.
RBW	$3 \text{ kHz} \leq \text{RBW} \leq 100\text{kHz}$
VBW	$\geq 3 \times \text{RBW}$
Detector	Peak
Trace	Max Hold
Sweep Time	Auto couple

#### 4.3.3. Test Procedures

1. Test was performed in accordance with KDB558074 D01 v03r05 for Performing Compliance Measurements on Digital Transmission Systems (DTS) - section 10.2 Method PKPSD (peak PSD).
2. Use this procedure when the maximum conducted output power in the fundamental emission is used to demonstrate compliance. The EUT must be configured to transmit continuously at full power over the measurement duration.
3. Ensure that the number of measurement points in the sweep  $\geq 2 \times \text{span/RBW}$  (use of a greater number of measurement points than this minimum requirement is recommended).
4. Use the peak marker function to determine the maximum level in any 3 kHz band segment within the fundamental EBW.
5. The resulting PSD level must be  $\leq 8 \text{ dBm}$ .

#### 4.3.4. Test Setup Layout



#### **4.3.5. Test Deviation**

There is no deviation with the original standard.

#### **4.3.6. EUT Operation during Test**

The EUT was programmed to be in continuously transmitting mode.

#### 4.3.7. Test Result of Power Spectral Density

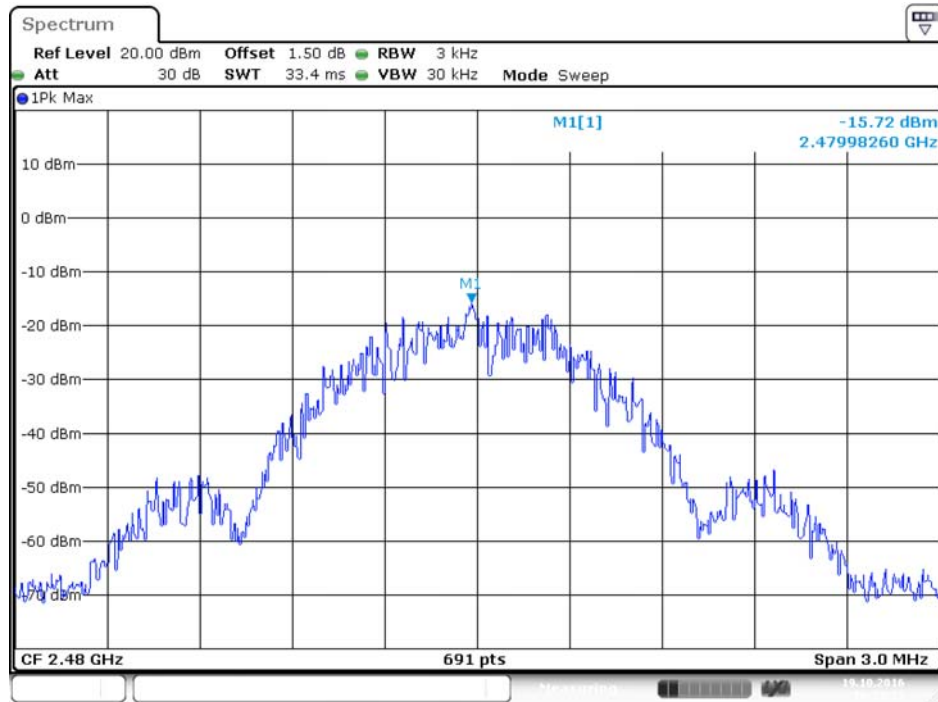
<b>Temperature</b>	20°C	<b>Humidity</b>	56%
<b>Test Engineer</b>	Gary Chu	<b>Configurations</b>	GFSK

Channel	Frequency	Power Density (dBm/3kHz)	Power Density Limit (dBm/3kHz)	Result
		Chain 1		
0	2402 MHz	-15.88	8.00	Complies
20	2442 MHz	-17.29	8.00	Complies
39	2480 MHz	-15.72	8.00	Complies

Note: All the test values were listed in the report.

For plots, only the channel with worse result was shown.

### Power Density Plot on Configuration Bluetooth / 2480 MHz



Date: 19.OCT.2016 10:23:21

## 4.4. 6dB Spectrum Bandwidth Measurement

### 4.4.1. Limit

For digital modulation systems, the minimum 6dB bandwidth shall be at least 500 kHz.

### 4.4.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of the spectrum analyzer.

6dB Spectrum Bandwidth	
Spectrum Parameters	Setting
Attenuation	Auto
Span Frequency	> 6dB Bandwidth
RBW	100kHz
VBW	$\geq 3 \times \text{RBW}$
Detector	Peak
Trace	Max Hold
Sweep Time	Auto
99% Occupied Bandwidth	
Spectrum Parameters	Setting
Span	1.5 times to 5.0 times the OBW
RBW	1 % to 5 % of the OBW
VBW	$\geq 3 \times \text{RBW}$
Detector	Peak
Trace	Max Hold

### 4.4.3. Test Procedures

For Radiated 6dB Bandwidth Measurement:

1. The transmitter was radiated to the spectrum analyzer in peak hold mode.
2. Test was performed in accordance with KDB558074 D01 v03r05 for Performing Compliance Measurements on Digital Transmission Systems (DTS) - section 8.0 DTS bandwidth = > 8.1 Option 1.
3. Measured the spectrum width with power higher than 6dB below carrier.

### 4.4.4. Test Setup Layout

For Radiated 6dB Bandwidth Measurement:

This test setup layout is the same as that shown in section 4.5.4.



#### 4.4.5. Test Deviation

There is no deviation with the original standard.

#### 4.4.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

#### 4.4.7. Test Result of 6dB Spectrum Bandwidth

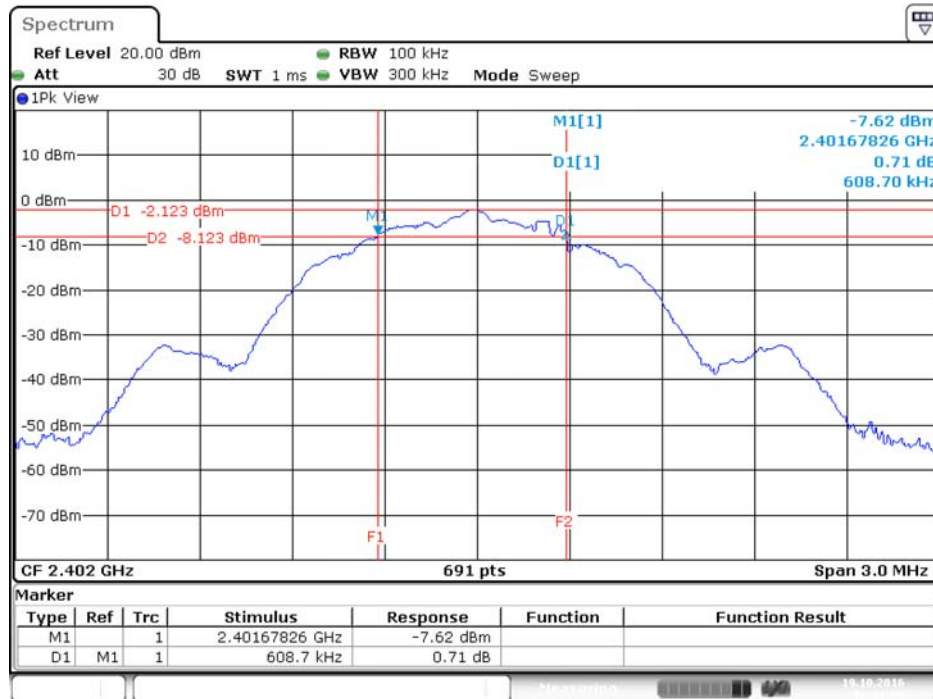
<b>Temperature</b>	20°C	<b>Humidity</b>	56%
<b>Test Engineer</b>	Gary Chu	<b>Configurations</b>	GFSK

Channel	Frequency	6dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	Min. Limit (kHz)	Test Result
0	2402 MHz	0.609	1.054	500	Complies
20	2442 MHz	0.639	1.007	500	Complies
39	2480 MHz	0.643	1.033	500	Complies

Note: All the test values were listed in the report.

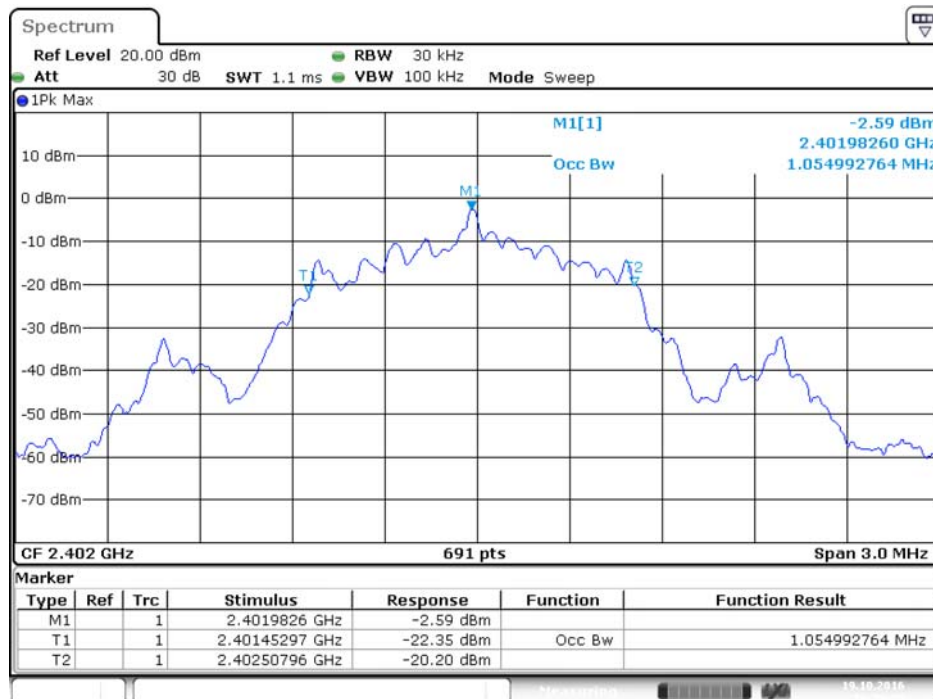
For plots, only the channel with worse result was shown.

### 6 dB Bandwidth Plot on Configuration Bluetooth / 2402Hz



Date: 19.OCT.2016 10:32:34

### 99% Occupied Bandwidth Plot on Configuration Bluetooth / 2402Hz



Date: 19.OCT.2016 10:29:53

## 4.5. Radiated Emissions Measurement

### 4.5.1. Limit

30dBc 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 (micorvolts/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

### 4.5.2. Measuring Instruments and Setting

Please refer to section 5 of equipments 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	10th carrier harmonic
RBW / VBW (Emission in restricted band)	1 MHz / 3MHz for Peak, 1 MHz / 1/T for Average
RBW / VBW (Emission in non-restricted band)	100kHz / 300kHz for peak

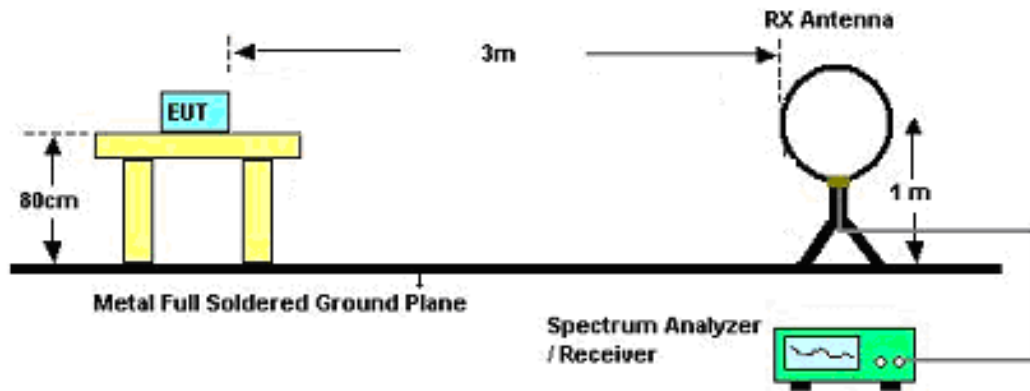
Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RBW 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RBW 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RBW 120kHz for QP

#### 4.5.3. Test Procedures

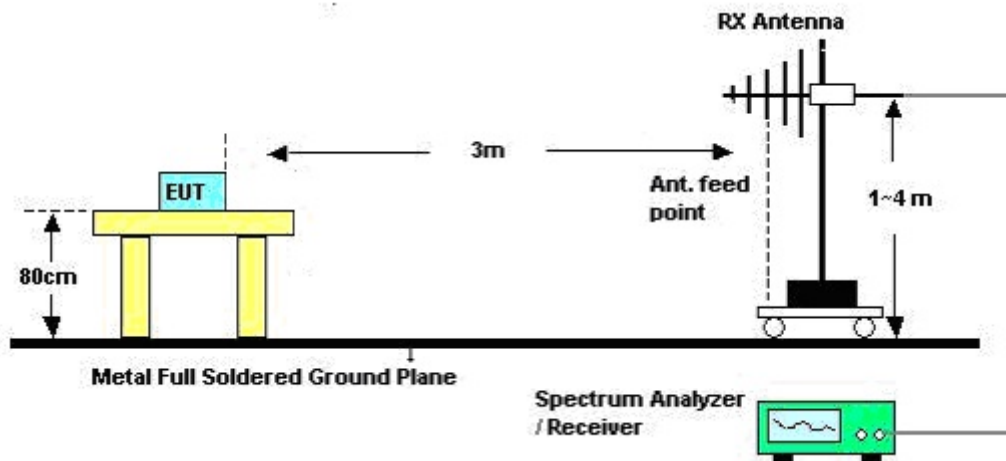
1. Configure the EUT according to ANSI C63.10. The EUT was placed on the top of the turntable 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 1m & 3m far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
6. For emissions above 1GHz, use 1MHz VBW and 3MHz RBW for peak reading. Then 1MHz RBW and 1/T VBW for average reading in spectrum analyzer.
7. If the emissions level of the EUT in peak mode was 3 dB lower than the average limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
8. For testing above 1GHz, the emissions level of the EUT in peak mode was lower than average limit (that means the emissions level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
9. In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be QP measured by receiver. High – Low scan is not required in this case.

#### 4.5.4. Test Setup Layout

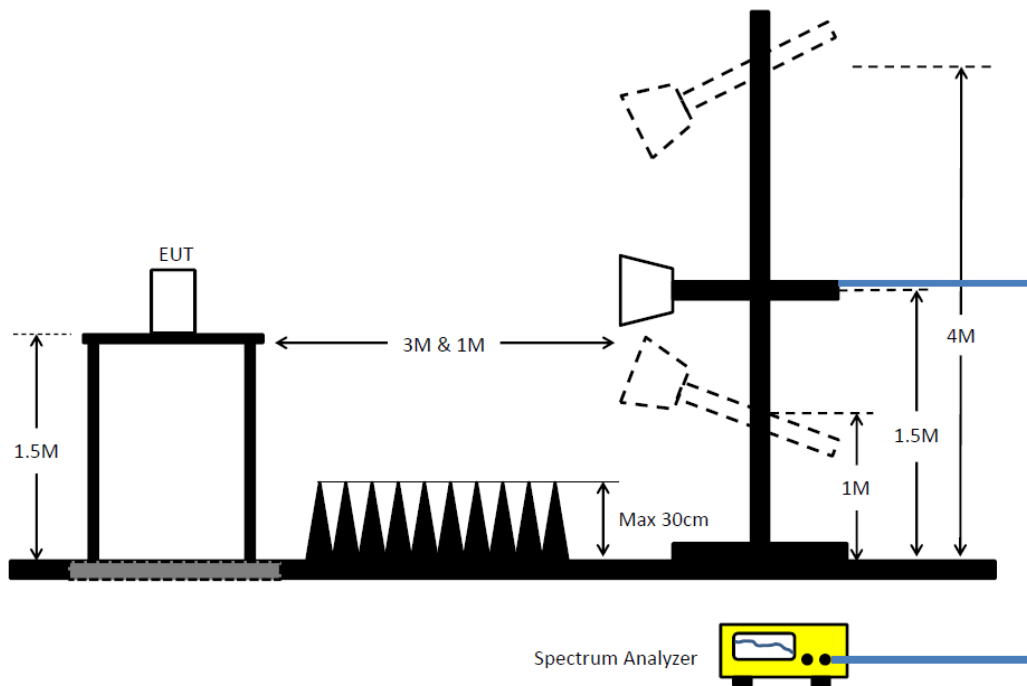
For Radiated Emissions: 9kHz ~30MHz



For Radiated Emissions: 30MHz~1GHz



**For Radiated Emissions: Above 1GHz**



**4.5.5. Test Deviation**

There is no deviation with the original standard.

**4.5.6. EUT Operation during Test**

The EUT was programmed to be in continuously transmitting mode.

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

<b>Temperature</b>	22°C	<b>Humidity</b>	54%
<b>Test Engineer</b>	Brian Sun	<b>Configurations</b>	CTX
<b>Test Date</b>	Nov. 04, 2016	<b>Test Mode</b>	Mode 2

<b>Freq. (MHz)</b>	<b>Level (dBuV)</b>	<b>Over Limit (dB)</b>	<b>Limit Line (dBuV)</b>	<b>Remark</b>
-	-	-	-	See Note

Note:

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

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

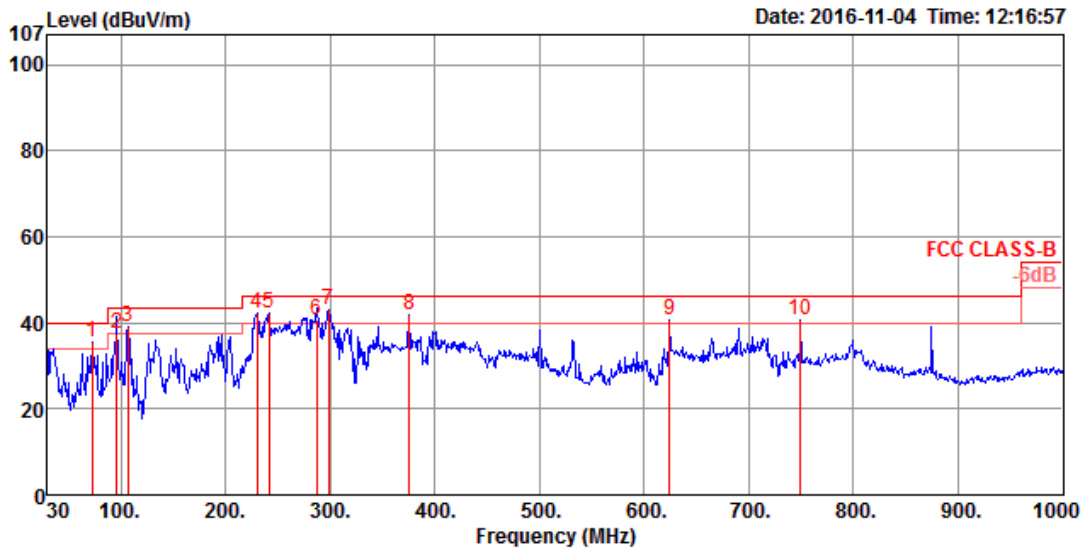
Limit line = specific limits (dBuV) + distance extrapolation factor.



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

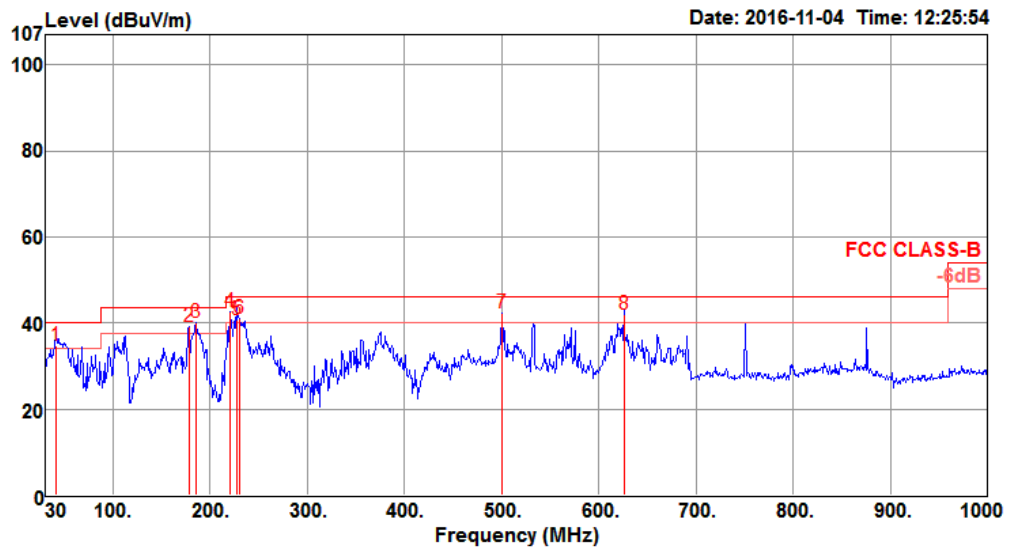
Temperature	22°C	Humidity	54%
Test Engineer	Brian Sun	Configurations	CTX
Test Mode	Mode 2		

Horizontal



	Freq	Level	Limit	Over	Read	CableAntenna	Preamp	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	Line	Limit	Level	Loss	Factor	Factor	cm	deg	
1 @	72.68	35.36	40.00	-4.64	53.74	0.75	12.71	31.84	200	258 Peak	HORIZONTAL
2	95.96	37.48	43.50	-6.02	52.16	0.87	16.30	31.85	200	322 QP	HORIZONTAL
3 @	106.63	39.01	43.50	-4.49	52.19	0.87	17.81	31.86	200	331 Peak	HORIZONTAL
4 @	229.82	42.40	46.00	-3.60	56.17	1.21	17.00	31.98	125	74 Peak	HORIZONTAL
5 @	241.46	42.40	46.00	-3.60	55.00	1.23	18.12	31.95	150	235 Peak	HORIZONTAL
6 @	287.05	40.49	46.00	-5.51	51.82	1.34	19.37	32.04	125	236 QP	HORIZONTAL
7 @	298.69	42.95	46.00	-3.05	54.03	1.37	19.56	32.01	125	260 Peak	HORIZONTAL
8 @	375.32	41.75	46.00	-4.25	50.64	1.50	21.73	32.12	100	98 Peak	HORIZONTAL
9 @	624.61	40.74	46.00	-5.26	46.06	1.97	25.16	32.45	125	125 Peak	HORIZONTAL
10 @	749.74	40.68	46.00	-5.32	45.07	2.19	26.00	32.58	150	241 Peak	HORIZONTAL

**Vertical**



	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg	
1	41.64	34.86	40.00	-5.14	47.26	0.56	18.71	31.67	100	229 QP	VERTICAL
2	178.41	39.19	43.50	-4.31	54.53	1.06	15.54	31.94	100	132 Peak	VERTICAL
3	185.20	40.17	43.50	-3.33	55.60	1.08	15.45	31.96	100	147 Peak	VERTICAL
4	220.12	42.51	46.00	-3.49	56.98	1.18	16.30	31.95	200	310 Peak	VERTICAL
5	226.91	40.75	46.00	-5.25	54.74	1.20	16.78	31.97	200	270 QP	VERTICAL
6	229.82	41.04	46.00	-4.96	54.81	1.21	17.00	31.98	200	181 Peak	VERTICAL
7	500.45	42.30	46.00	-3.70	49.13	1.76	23.73	32.32	100	144 Peak	VERTICAL
8	625.58	41.99	46.00	-4.01	47.31	1.97	25.16	32.45	100	40 QP	VERTICAL

**Note:**

The amplitude of spurious emissions that are attenuated by more than 20dB below the permissible value has no need to be reported.

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

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

#### 4.5.9. Results for Radiated Emissions (1GHz~10<sup>th</sup> Harmonic)

<b>Temperature</b>	22°C	<b>Humidity</b>	54%
<b>Test Engineer</b>	Brian Sun	<b>Configurations</b>	Channel 0
<b>Test Date</b>	Oct. 18, 2016		

##### *Horizontal*

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	4795.92	47.39	74.00	-26.61	41.19	7.01	34.09	34.90	161	208	Peak	HORIZONTAL
2	4813.24	35.09	54.00	-18.91	28.78	7.04	34.17	34.90	161	208	Average	HORIZONTAL

##### *Vertical*

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	4794.00	34.37	54.00	-19.63	28.17	7.01	34.09	34.90	148	318	Average	VERTICAL
2	4794.00	44.09	74.00	-29.91	37.89	7.01	34.09	34.90	148	318	Peak	VERTICAL



<b>Temperature</b>	22°C	<b>Humidity</b>	54%
<b>Test Engineer</b>	Brian Sun	<b>Configurations</b>	Channel 20
<b>Test Date</b>	Oct. 18, 2016		

**Horizontal**

	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	4874.04	35.74	54.00	-18.26	29.12	7.18	34.34	34.90	154	299	Average	HORIZONTAL
2	4888.56	47.93	74.00	-26.07	41.24	7.21	34.38	34.90	154	299	Peak	HORIZONTAL

**Vertical**

	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	4874.40	35.67	54.00	-18.33	29.05	7.18	34.34	34.90	149	106	Average	VERTICAL
2	4880.00	48.22	74.00	-25.78	41.60	7.18	34.34	34.90	149	106	Peak	VERTICAL



<b>Temperature</b>	22°C	<b>Humidity</b>	54%
<b>Test Engineer</b>	Brian Sun	<b>Configurations</b>	Channel 39
<b>Test Date</b>	Oct. 17, 2016		

**Horizontal**

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	4959.47	49.02	74.00	-24.98	41.96	7.38	34.58	34.90	129	236	Peak	HORIZONTAL
2	4959.88	35.61	54.00	-18.39	28.55	7.38	34.58	34.90	129	236	Average	HORIZONTAL

**Vertical**

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	4960.11	35.84	54.00	-18.16	28.78	7.38	34.58	34.90	166	59	Average	VERTICAL
2	4960.37	49.23	74.00	-24.77	42.17	7.38	34.58	34.90	166	59	Peak	VERTICAL

**Note:**

The amplitude of spurious emissions that are attenuated by more than 20dB below the permissible value has no need to be reported.

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

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

## 4.6. Emissions Measurement

### 4.6.1. Limit

30dBc 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 (micorvolts/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

### 4.6.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	100 MHz
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 1/T for Average
RBW / VBW (30dBc in any 100 kHz bandwidth emission)	100 kHz / 300 kHz for Peak

### 4.6.3. Test Procedures

#### For Radiated band edges Measurement:

The test procedure is the same as section 4.5.3.

#### For Radiated Out of Band Emission Measurement:

Test was performed in accordance with KDB558074 D01 v03r05 for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 11.0 Unwanted Emissions into Non-Restricted Frequency Bands Measurement Procedure.

#### **4.6.4. Test Setup Layout**

For Radiated band edges Measurement:

This test setup layout is the same as that shown in section 4.5.4.

For Radiated Out of Band Emission Measurement:

This test setup layout is the same as that shown in section 4.5.4.

#### **4.6.5. Test Deviation**

There is no deviation with the original standard.

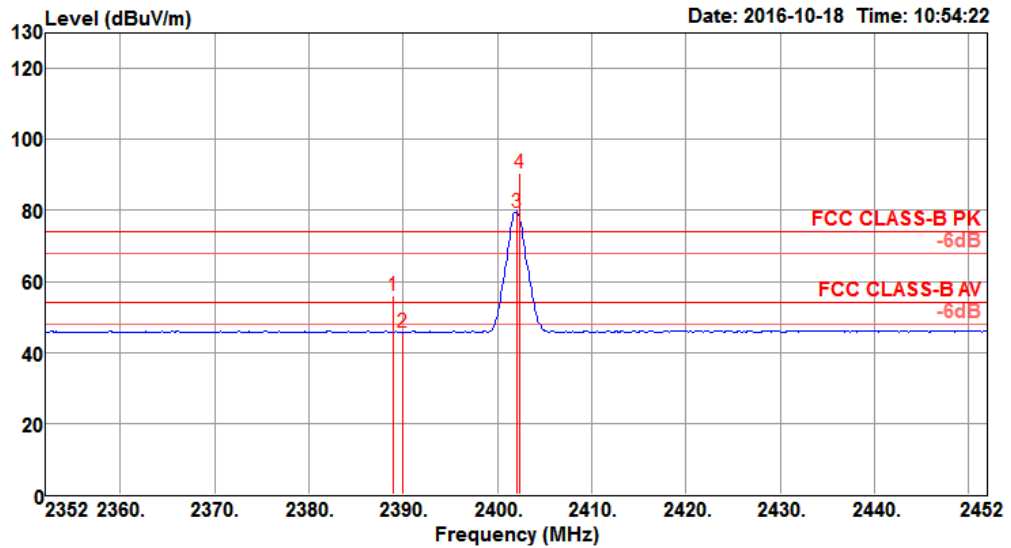
#### **4.6.6. EUT Operation during Test**

The EUT was programmed to be in continuously transmitting mode.

4.6.7. Test Result of Band Edge and Fundamental Emissions

Temperature	22°C	Humidity	54%
Test Engineer	Brian Sun	Configurations	Channel 0, 20, 39

Channel 0

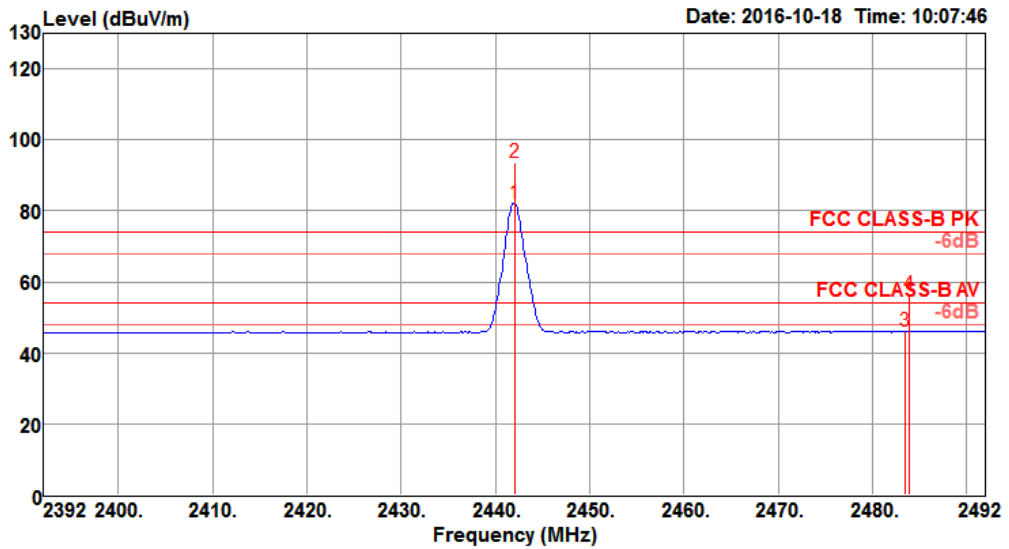


	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	2389.00	56.02	74.00	-17.98	22.76	4.69	28.57	0.00	183	42	Peak	HORIZONTAL
2	2390.00	45.68	54.00	-8.32	12.42	4.69	28.57	0.00	183	42	Average	HORIZONTAL
3 @	2402.00	79.52			46.21	4.71	28.60	0.00	183	42	Average	HORIZONTAL
4 @	2402.40	90.40			57.09	4.71	28.60	0.00	183	42	Peak	HORIZONTAL

Item 3, 4 are the fundamental frequency at 2402 MHz.



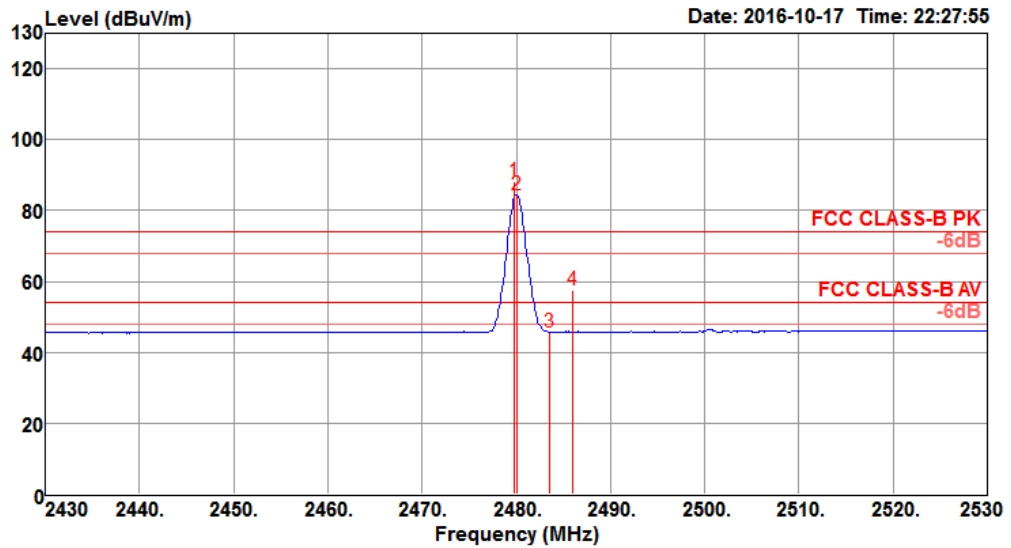
Channel 20



	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg	
1 @	2442.00	82.12			48.69	4.74	28.69	0.00	180	38 Average	HORIZONTAL
2 @	2442.00	93.56			60.13	4.74	28.69	0.00	180	38 Peak	HORIZONTAL
3	2483.50	45.99	54.00	-8.01	12.44	4.78	28.77	0.00	180	38 Average	HORIZONTAL
4	2483.90	56.28	74.00	-17.72	22.73	4.78	28.77	0.00	180	38 Peak	HORIZONTAL

Item 1, 2 are the fundamental frequency at 2442 MHz.

Channel 39



	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Po1/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1 @	2479.80	88.24			54.53	4.95	28.76	0.00	263	62	Peak	HORIZONTAL
2 @	2480.00	84.38			50.67	4.95	28.76	0.00	263	62	Average	HORIZONTAL
3	2483.50	45.74	54.00	-8.26	12.02	4.95	28.77	0.00	263	62	Average	HORIZONTAL
4	2486.00	57.48	74.00	-16.52	23.76	4.95	28.77	0.00	263	62	Peak	HORIZONTAL

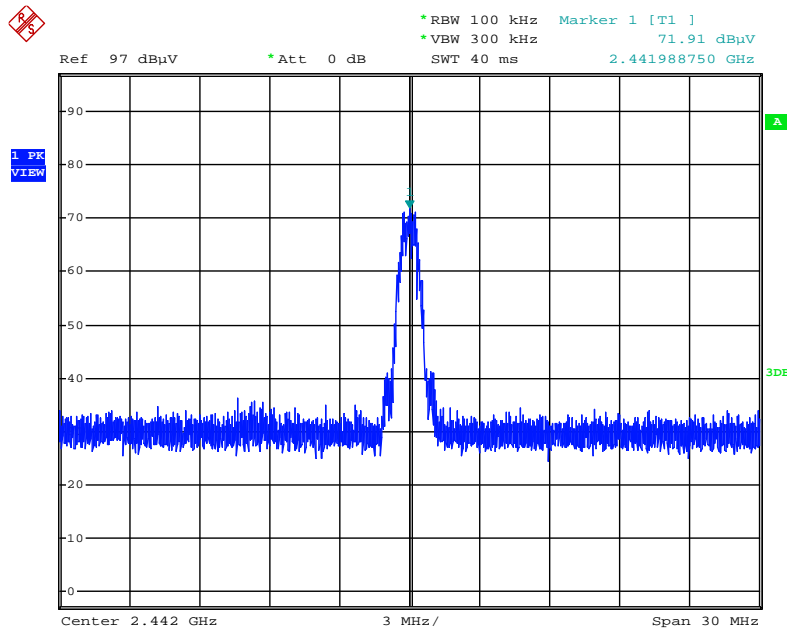
Item 1, 2 are the fundamental frequency at 2480 MHz.

Note:

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

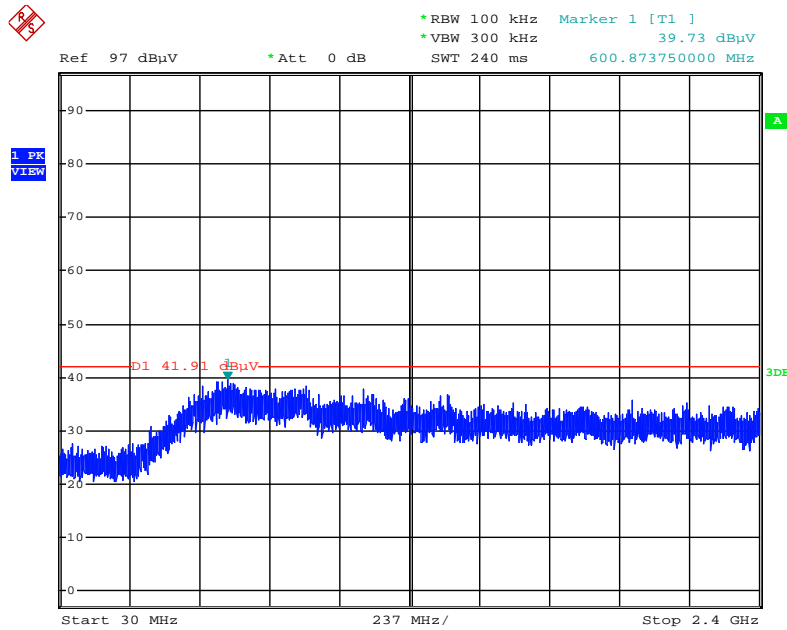
Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

**For Emission not in Restricted Band**  
**Plot on Configuration / Reference Level**



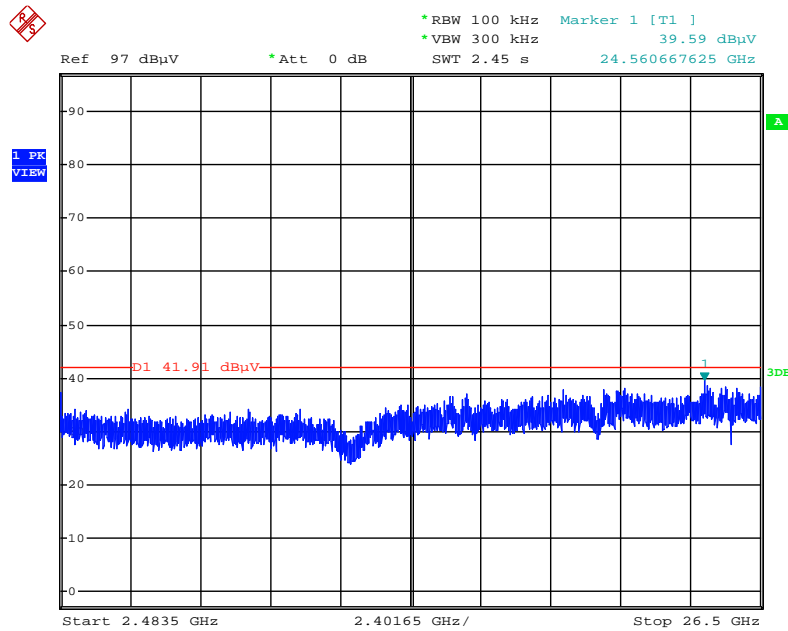
Date: 8.NOV.2016 18:00:36

**Plot on Configuration For Bluetooth 4.0 / Channel 0 / 30MHz~2400MHz (down 30dBc)**



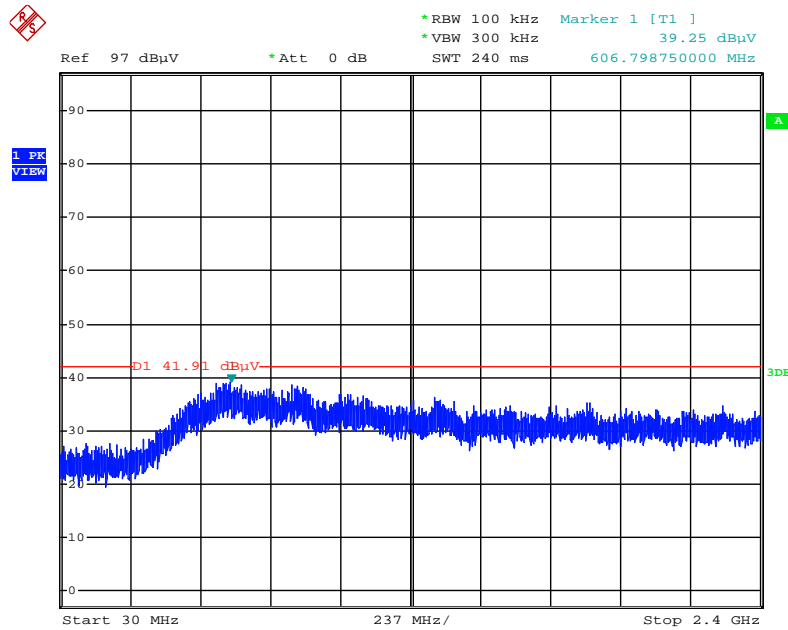
Date: 8.NOV.2016 18:02:06

**Plot on Configuration For Bluetooth 4.0 / Channel 0 / 2483.5MHz~26500MHz (down 30dBc)**



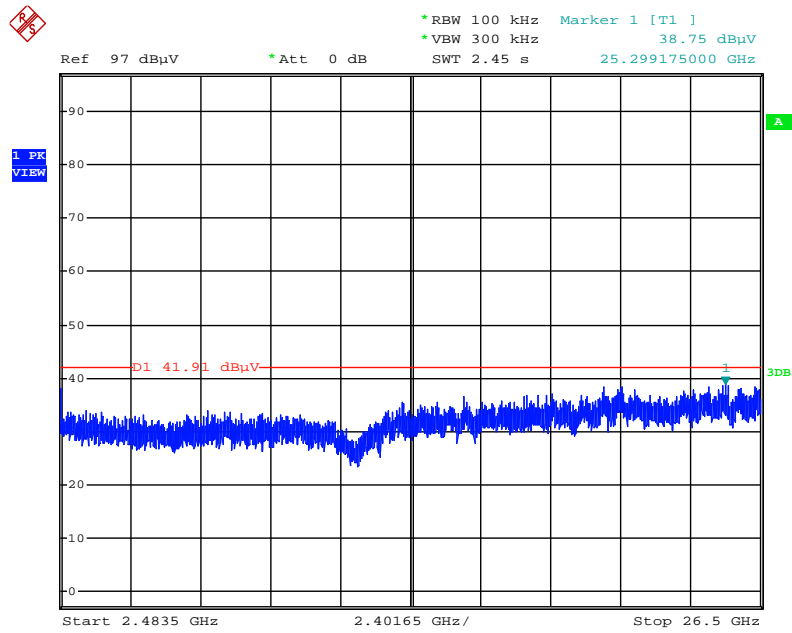
Date: 8.NOV.2016 18:02:58

**Plot on Configuration For Bluetooth 4.0 / Channel 39 / 30MHz~2400MHz (down 30dBc)**



Date: 8.NOV.2016 18:10:29

Plot on Configuration For Bluetooth 4.0 / Channel 39 / 2483.5MHz~26500MHz (down 30dBc)



Date: 8.NOV.2016 18:09:29

## 4.7. Antenna Requirements

### 4.7.1. Limit

Except for special regulations, the Low-power Radio-frequency Devices must not be equipped with any jacket for installing an antenna with extension cable. 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 the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

### 4.7.2. Antenna Connector Construction

Please refer to section 3.3 in this test report; antenna connector complied with the requirements.

## 5. LIST OF MEASURING EQUIPMENTS

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark
LISN	Schwarzbeck	NSLK 8127	8127650	9kHz ~ 30MHz	Nov. 16, 2015	Conduction (CO02-CB)
LISN	Schwarzbeck	NSLK 8127	8127478	9kHz ~ 30MHz	Nov. 13, 2015	Conduction (CO02-CB)
EMI Receiver	Agilent	N9038A	MY52260140	9kHz ~ 8.4GHz	Jan. 18, 2016	Conduction (CO02-CB)
COND Cable	Woken	Cable	01	0.15MHz ~ 30MHz	Dec. 01, 2015	Conduction (CO02-CB)
Software	Audix	E3	6.120210n	-	N.C.R.	Conduction (CO02-CB)
Pulse Limiter	Schwarzbeck	VTSD 9561F	9561-F073	9kHz ~ 30MHz	Sep. 29, 2016	Conduction (CO02-CB)
Loop Antenna	Teseq	HLA 6120	24155	9kHz - 30 MHz	Mar. 16, 2016*	Radiation (03CH01-CB)
BILOG ANTENNA	TESEQ	CBL6112D	37880	20MHz ~ 2GHz	Aug. 30, 2016	Radiation (03CH01-CB)
Horn Antenna	EMCO	3115	9610-4976	1GHz ~ 18GHz	Apr. 25, 2016	Radiation (03CH01-CB)
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170252	15GHz ~ 40GHz	Jul. 25, 2016	Radiation (03CH01-CB)
Pre-Amplifier	Agilent	8447D	2944A10991	0.1MHz ~ 1.3GHz	Mar. 15, 2016	Radiation (03CH01-CB)
Pre-Amplifier	Agilent	8449B	3008A02310	1GHz ~ 26.5GHz	Jan. 18, 2016	Radiation (03CH01-CB)
Spectrum Analyzer	R&S	FSP-40	100019	9kHz ~ 40GHz	Apr. 21, 2016	Radiation (03CH01-CB)
EMI Test	R&S	ESCS	100355	9kHz ~ 2.75GHz	May 16, 2016	Radiation (03CH01-CB)
RF Cable-low	Woken	Low Cable-1	N/A	30 MHz ~ 1 GHz	Oct. 24, 2016	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-16	N/A	1 GHz ~ 18 GHz	Nov. 02, 2015	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-16	N/A	1 GHz ~ 18 GHz	Oct. 24, 2016	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-17	N/A	1 GHz ~ 18 GHz	Nov. 02, 2015	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-17	N/A	1 GHz ~ 18 GHz	Oct. 24, 2016	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-40G-1	N/A	18GHz ~ 40 GHz	Nov. 02, 2015	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-40G-1	N/A	18GHz ~ 40 GHz	Oct. 24, 2016	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-40G-2	N/A	18GHz ~ 40 GHz	Nov. 02, 2015	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-40G-2	N/A	18GHz ~ 40 GHz	Oct. 24, 2016	Radiation (03CH01-CB)
Test Software	Audix	E3	6.2009-10-7	N/A	N/A	Radiation (03CH01-CB)

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark
Spectrum analyzer	R&S	FSV40	100979	9kHz~40GHz	Dec. 09, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-6	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-6	1 GHz – 26.5 GHz	Oct. 24, 2016	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-7	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-7	1 GHz – 26.5 GHz	Oct. 24, 2016	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-8	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-8	1 GHz – 26.5 GHz	Oct. 24, 2016	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-9	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-9	1 GHz – 26.5 GHz	Oct. 24, 2016	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-10	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-10	1 GHz – 26.5 GHz	Oct. 24, 2016	Conducted (TH01-CB)
Power Sensor	Agilent	E9327A	US40442088	50MHz~18GHz	Dec. 09, 2015	Conducted (TH01-CB)

Note: Calibration Interval of instruments listed above is one year.

“\*” Calibration Interval of instruments listed above is two years.

N.C.R. means Non-Calibration required.



## 6. MEASUREMENT UNCERTAINTY

Test Items	Uncertainty	Remark
Conducted Emission (150kHz ~ 30MHz)	3.2 dB	Confidence levels of 95%
Radiated Emission (30MHz ~ 1,000MHz)	3.6 dB	Confidence levels of 95%
Radiated Emission (1GHz ~ 18GHz)	3.7 dB	Confidence levels of 95%
Radiated Emission (18GHz ~ 40GHz)	3.5 dB	Confidence levels of 95%
Conducted Emission	1.7 dB	Confidence levels of 95%