CONFORMANCE TEST REPORT
FOR
FCC 47 CFR, Part 15 Subpart C

Report No.: 14-08-MAS-077-02

Client:	Lightspeed Technologies Inc.
Product:	Topcat
Model:	TCA
FCC ID:	ORV-LSTCA
Manufacturer/supplier:	REOR ELECTRONICS CO., LTD.
Date test item received:	2014/08/04
Date test campaign completed:	2014/09/11
Date of issue:	2014/09/11

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Total number of pages of this test report: 49 pages
Total number of pages of photos: External photos 3 pages
Internal photos 4 pages
Setup photos 3 pages

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Client	: Lightspeed Technologies Inc.
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Manufacturer	: REOR ELECTRONICS CO., LTD.
Address	: 5F., No. 122, Ciaohe Rd., Jhonghe Dist., New Taipei City 23558, Taiwan.
EUT	: Topcat
Trade name	: LIGHTSPEED
Model No.	: TCA
Power Source	: Adapter : DSA-60PFB-24 Input: 100-240VAC, 50/60Hz, 1.5A Output: +24V ⎓ 2.5A
Regulations applied	: FCC 47 CFR, Part 15 Subpart C

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1 GENERAL INFORMATION

1.1 Product Description

a) Type of EUT : Topcat
b) Trade Name : LIGHTSPEED
c) Model No. : TCA
d) FCC ID : ORV-LSTCA

1.2 Characteristics of Device

The EUT is Topcat device. It conforms to the IEEE 802.15.4 ZigBee protocal and operates in the unlicensed ISM Band at 2.4 GHz.

Topcat all-in-one design provides high intelligibility of the teacher's voice, full-range sound for multimedia, and even distribution throughout the classroom.
Fully integrated in-ceiling solution provides clear, full audio for media rich classrooms. Our unique exciter technology combined with a wireless media connector decreases the installation cost without sacrificing audio quality and sound distribution.

1.3 Test Methodology

All testing were performed according to the procedures in ANSI C63.10 (2009) and FCC CFR 47 Part 2 and Part 15 and KDB 558074 D01 v03r02.

1.4 Test Facility

The semi-anechoic chamber and conducted measurement facility used to collect the radiated and conducted data are located inside the Building at No.8, Lane 29, Wen-ming Road, Lo-shan Tsun, Kweishan Hsiang, Taoyuan, Taiwan, R.O.C.
This site has been accreditation as a FCC filing site.

1.5 Test Summary

Requirement	FCC Paragraph #	Test Pass
Antenna Requirement	15.203	☒
Conducted Emission	15.207	☒
Emission Bandwidth	15.247 (a)(2)	☒
Output Power Requirement	15.247 (b)	☒
Power Density Requirement	15.247 (e)	☒
Spurious Emissions	15.247 (d)	☒
Radiated Emission	15.247 (d)	☒

Note: The test setup and measurement method for conductive output power measurements shown in this test report is different to the "Peak Output Power" test. Certain measurement uncertainty of peak power may be expected with the use of different power detection method or measuring equipment. Therefore, the conductive output power measurement results provided in this test report may be different to the specification of the device under test.

2 PROVISIONS APPLICABLE

2.1 Definition

Unintentional radiator:
A device that intentionally generates and radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction.

Class A Digital Device:
A digital device which is marketed for use in commercial or business environment; exclusive of a device which is market for use by the general public, or which is intended to be used in the home.

Class B Digital Device :
A digital device which is marketed for use in a residential environment notwithstanding use in a commercial, business of industrial environment. Example of such devices that are marketed for the general public.

Note : A manufacturer may also qualify a device intended to be marketed in a commercial, business, or industrial environment as a Class B digital device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B Digital Device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B Digital Device, Regardless of its intended use.

Intentional radiator:
A device that intentionally generates and emits radio frequency energy by radiation or induction.

2.2 Requirement for Compliance

(1) Conducted Emission Requirement

For unintentional device, according to §15.107(a) Line Conducted Emission Limits is as following:

Frequency MHz	Quasi Peak dB μV	Average dB μV
0.15 - 0.5	66-56*	56-46*
0.5 - 5.0	56	46
5.0 - 30.0	60	50

*Decreases with the logarithm of the frequency.

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

(2) Radiated Emission Requirement

For unintentional device, according to §15.109(a), except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency MHz	Distance Meters	Radiated dB μV/m	Radiated μV/m
30 - 88	3	40.0	100
88 - 216	3	43.5	150
216 - 960	3	46.0	200
above 960	3	54.0	500

For intentional radiator device, according to §15.209(a), the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table::

Frequency (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

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

(3) Antenna Requirement

For intentional device, according to §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.

(4) Bandwidth Requirement

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

(5) Output Power Requirement

For systems using digital modulation , according to 15.247(b), the maximum peak output power of the intentional radiator shall not exceed 1 Watt. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(6) Spurious Emissions Measurement

According to 15.247 (d) , in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

(7) Power Density Requirement

According to 15.247 (e) , for digitally modulated systems, the peak 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..

2.3 Restricted Bands of Operation

Only spurious emissions are permitted in any of the frequency bands listed below :

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42-16.423	399.9-410	4.5-5.25
0.495 - 0.505 **	16.69475 - 16.69525	608-614	5.35-5.46
2.1735 - 2.1905	16.80425 - 16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475 - 156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

** : Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz

2.4 Labeling Requirement

The device shall bear the following statement in a conspicuous location on the device :

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.5 User Information

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual.

The Federal Communications Commission Radio Frequency Interference Statement includes the following paragraph.

This equipment has been tested and found to comply with the limits for a Class B Digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

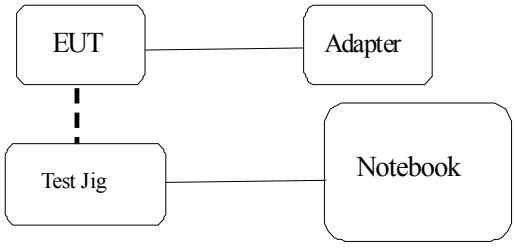
-- Consult the dealer or an experienced radio / TV technician for help.

3. SYSTEM TEST CONFIGURATION

3.1 Devices for Tested System

Device	Manufacture	Model No.	Cable Description
* Topcat	REOR ELECTRONICS CO., LTD.	TCA	----
Notebook	HP	6570b	2.5m*1, Unshielded Power Line/Adapter 1.0m*1 Unshielded Signal Line(USB Cable)
Test Jig	N/A	N/A	0.2m*1 Unshielded Signal Line

Remark: 1. "*" means equipment under test.



A HP notebook performs the control test mode. The notebook removes away after the control command is ready.

2.

Test Software:	SmartRF studio7.link (T1)
Power Level:	4.5dBm for Ch Low, Mid, High

3.2 Dscription of Test modes

There are three channels have been tested as following:

Channel	Frequency (MHz)
Low = 1	2405
Middle = 8	2440
High = 16	2480

3.2.2 Test Mode Description

3.2.2.1 Modulation Type

Test Mode	Modulation	Note
A	IEEE 802.15.4 ZigBee	-

3.2.2.2 Test Mode and Worse Case Determination

Item	Test Item	Test Mode	Test Frequency (MHz)
1	Conducted Emission	A	-
2	Emission Bandwidth	A	L，M，H
3	Output Power Requirement	A	L，M，H
4	Power Density Requirement	A	L，M，H
5	Spurious Emissions	A	L，M，H
6	Radiated Emission	A	L，M，H
6.1	Radiated Emission (below 1GHz)	A	M (Worse Case)
6.2	Radiated Emission (above 1GHz)	A	L，M，H

note: The worse case is chosen by channel middle which emission has no difference with others'.

4 CONDUCTED EMISSION MEASUREMENT

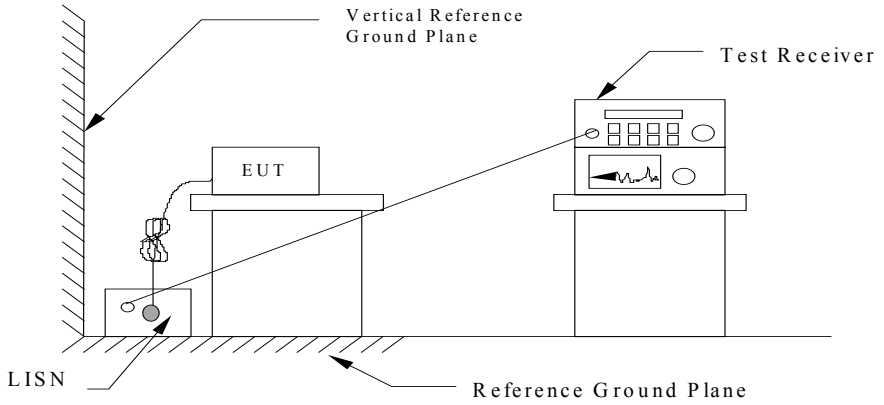
4.1 Standard Applicable

For unintentional and intentional device, Line Conducted Emission Limits are in accordance to §15.107(a) and §15.207(a) respectively. Both Limits are identical specification.

4.2 Measurement Procedure

1. The testing follows FCC KDB 558074 D01 v03r02.
2. Setup the configuration per figure 1.
3. A preliminary scan with a spectrum monitor is performed to identify the frequency of emission that has the highest amplitude relative to the limit by operating the EUT in selected modes of operation, typical cable positions, and with a typical system configuration.
4. Record the 6 highest emissions relative to the limit.
5. Measure each frequency obtained from step 3 by a test receiver set on quasi peak detector function, and then record the accuracy frequency and emission level. If all emissions measured in the specified band are attenuated more than 20 dB from the limit, this step would be ignored, and the peak detector function would be used.
6. Confirm the highest three emissions with variation of the EUT cable configuration and record the final data.
7. Repeat all above procedures on measuring each operation mode of EUT.

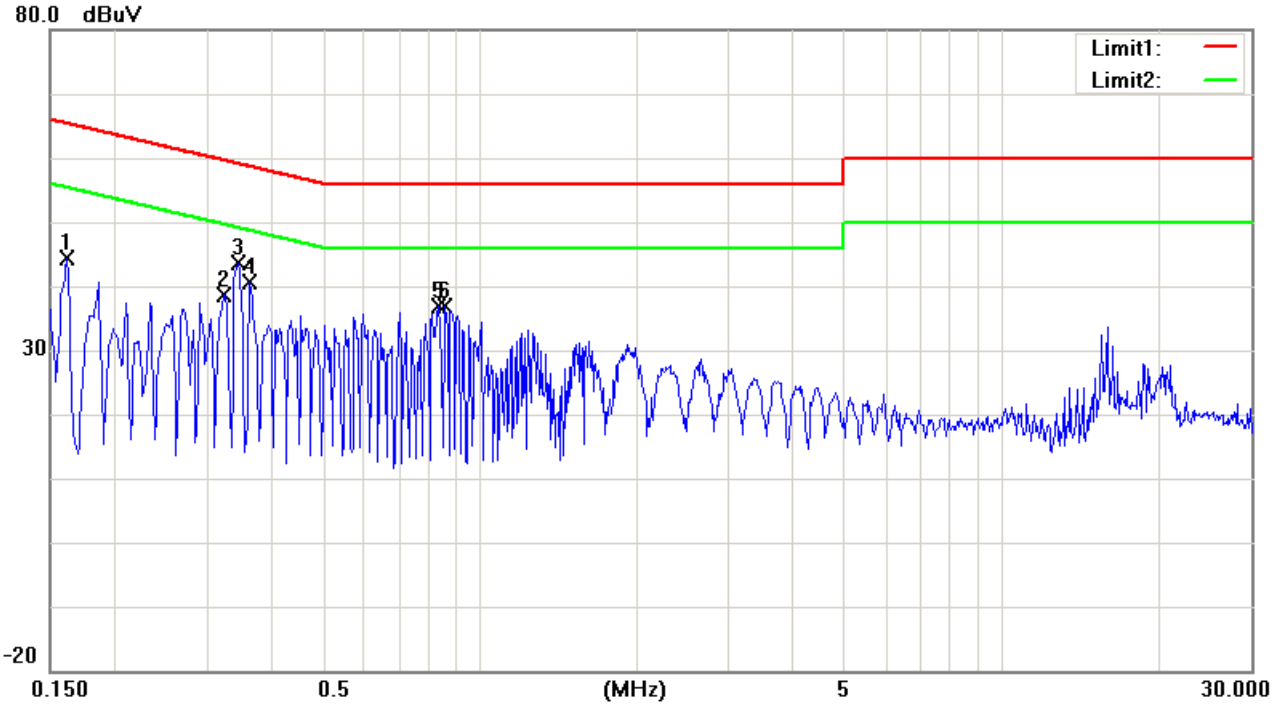
Figure 1 : Conducted emissions measurement configuration



4.3 Conducted Emission Data

File: topcat-fpce **Data:** #5 **Date:** 2014/8/4 **Temperature:** 23 ℃

Time: AM 09:10:56 **Humidity:** 60 %



Condition: **Phase:** L1

EUT:

Model:

Test Mode:

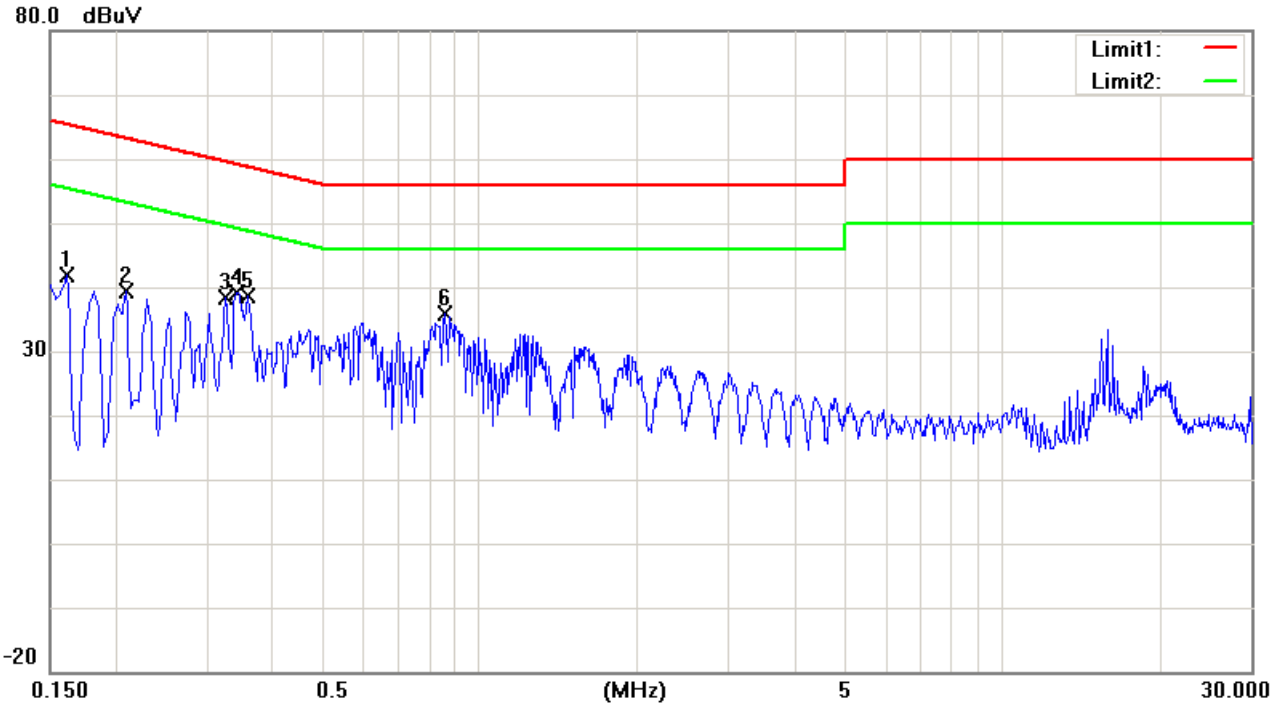
Note:

No.	Frequency	Reading	Detector	Corrected	Result	Limit	Margin
	(MHz)	(dBuV)		dB	(dBuV)	(dBuV)	(dB)
1	0.1620	34.71	peak	9.62	44.33	65.36	-21.03
2	0.3220	29.05	peak	9.62	38.67	59.66	-20.99
3	0.3460	33.95	peak	9.62	43.57	59.06	-15.49
4	0.3620	31.09	peak	9.63	40.72	58.68	-17.96
5	0.8340	27.13	peak	9.65	36.78	56.00	-19.22
6	0.8580	27.14	peak	9.65	36.79	56.00	-19.21

Note: 1. Place of measurement: EMC LAB. of the ETC.
2. "***" means the value was too low to be measured.
3. If the data table appeared symbol of "----" means the Q.P. value is under the limit of AVG. so, the AVG. value doesn't need to be measured.
4. "#" means the noise was too low, so record the peak value.
5. The estimated measurement uncertainty of the result measurement is ±2.5dB.

File: topcat-fpce **Data:** #2 **Date:** 2014/8/4 **Temperature:** 23 ℃

Time: AM 09:06:32 **Humidity:** 60 %



Condition: **Phase:** N

EUT:

Model:

Test Mode:

Note:

No.	Frequency	Reading	Detector	Corrected	Result	Limit	Margin
	(MHz)	(dBuV)		dB	(dBuV)	(dBuV)	(dB)
1	0.1620	32.34	peak	9.60	41.94	65.36	-23.42
2	0.2100	29.82	peak	9.60	39.42	63.21	-23.79
3	0.3260	28.69	peak	9.60	38.29	59.55	-21.26
4	0.3420	29.56	peak	9.60	39.16	59.15	-19.99
5	0.3580	28.99	peak	9.61	38.60	58.77	-20.17
6	0.8540	26.13	peak	9.63	35.76	56.00	-20.24

Note: 1. Place of measurement: EMC LAB. of the ETC.
2. "***" means the value was too low to be measured.
3. If the data table appeared symbol of "----" means the Q.P. value is under the limit of AVG. so, the AVG. value doesn't need to be measured.
4. "#" means the noise was too low, so record the peak value.
5. The estimated measurement uncertainty of the result measurement is ±2.5dB.

4.4 Result Data Calculation

The result data is calculated by adding the LISN Factor to the measured reading. The basic equation with a sample calculation is as follows:

RESULT = READING + LISN FACTOR (Included Cable Loss)

4.5 Conducted Measurement EquiPMent

The following test equiPMent are used during the conducted test.

Equipment	Manufacturer	Model No.
EMI Test Receiver	R&S	ESCI
V-LISN	R&S	ENV216
V-LISN	R&S	ENV216

5 ANTENNA REQUIREMENT

5.1 Standard Applicable

For intentional device, according to §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.

And according to §15.247 (b), if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2 Antenna Construction and Directional Gain

The antennas is a Inverted-F antenna.

Antenna Type	monopole
Peak Antenna Gain	-2 dBi

The directional gain of antenna doesn't greater than 6 dBi, the power won't be reduced.

6 EMISSION BANDWIDTH MEASUREMENT

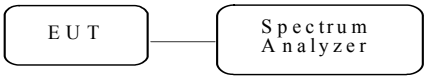
6.1 Standard Applicable

According to 15.247(a)(2), system using digital modulation techniques, the minimum 6dB bandwidth shall be at least 500 kHz.

6.2 Measurement Procedure

1. The testing follows FCC KDB 558074 D01 v03r02.
2. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
3. Position the EUT as shown in figure 2. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
4. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
5. Repeat above procedures until all frequencies measured were complete.

Figure 2: Emission bandwidth measurement configuration.



6.3 Measurement Equipment

Equipment	Manufacturer	Model No.
Spectrum Analyzer	Agilent	E4446A

6.4 Measurement Data

Test Date: Aug. 18, 2014 Temperature: 22℃ Humidity: 60%

Channel	6dB Bandwidth (MHz)	FCC Limit (kHz)	Chart
L	1.6333	500	Page 21
M	1.6333	500	Page 22
H	1.6333	500	Page 23

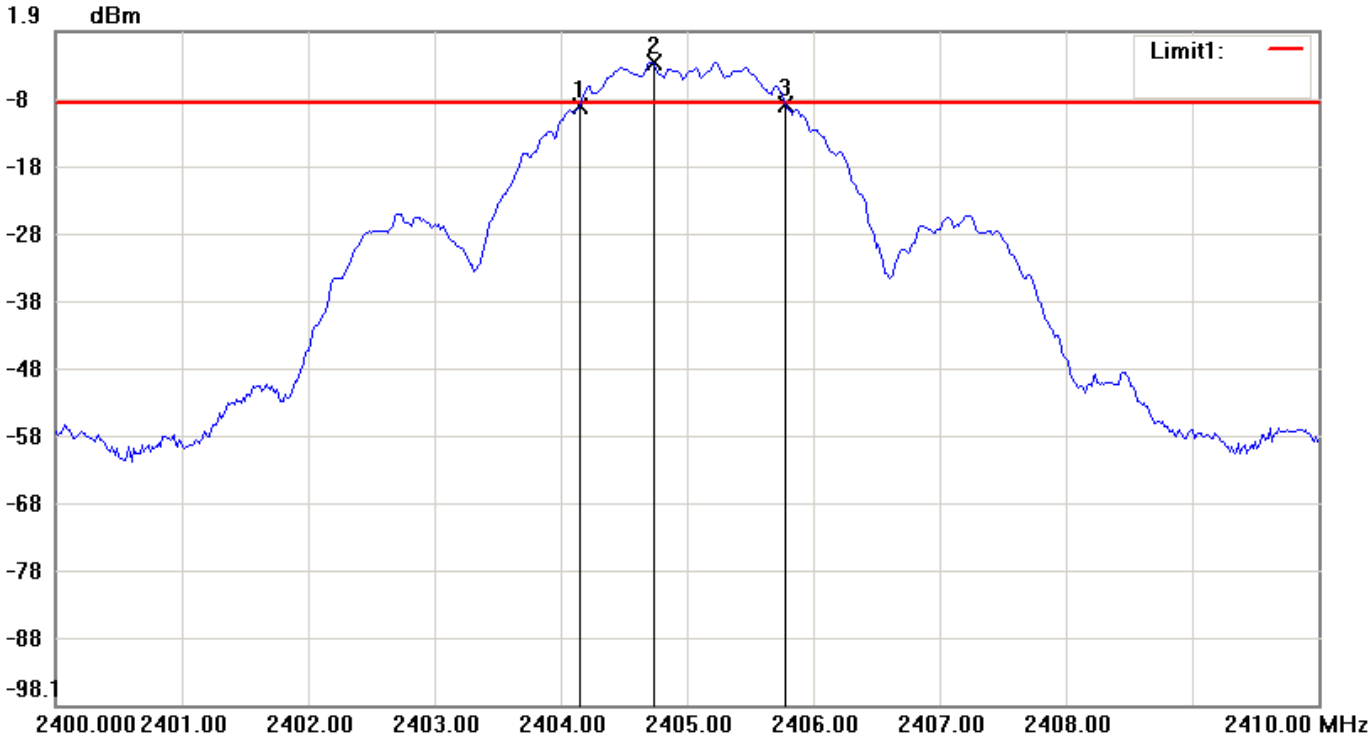
Note:

1. Please refer to page 21 to page 23 for chart

2. The estimated measurement uncertainty of the result measurement is 8.25×10^{-7} (1GHz≦f ≦18GHz)

File: **RM1049_a5-3-6-test** **Data:** **#1** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 04:30:45** **Humidity:** **60 %**



Condition: **-8.72dBm** **RF Conducted**

EUT: **Sweep Time: 500ms** **Att.: 10dB**

Model: **RBW: 100 KHz** **VBW: 300 KHz**

Test Mode:

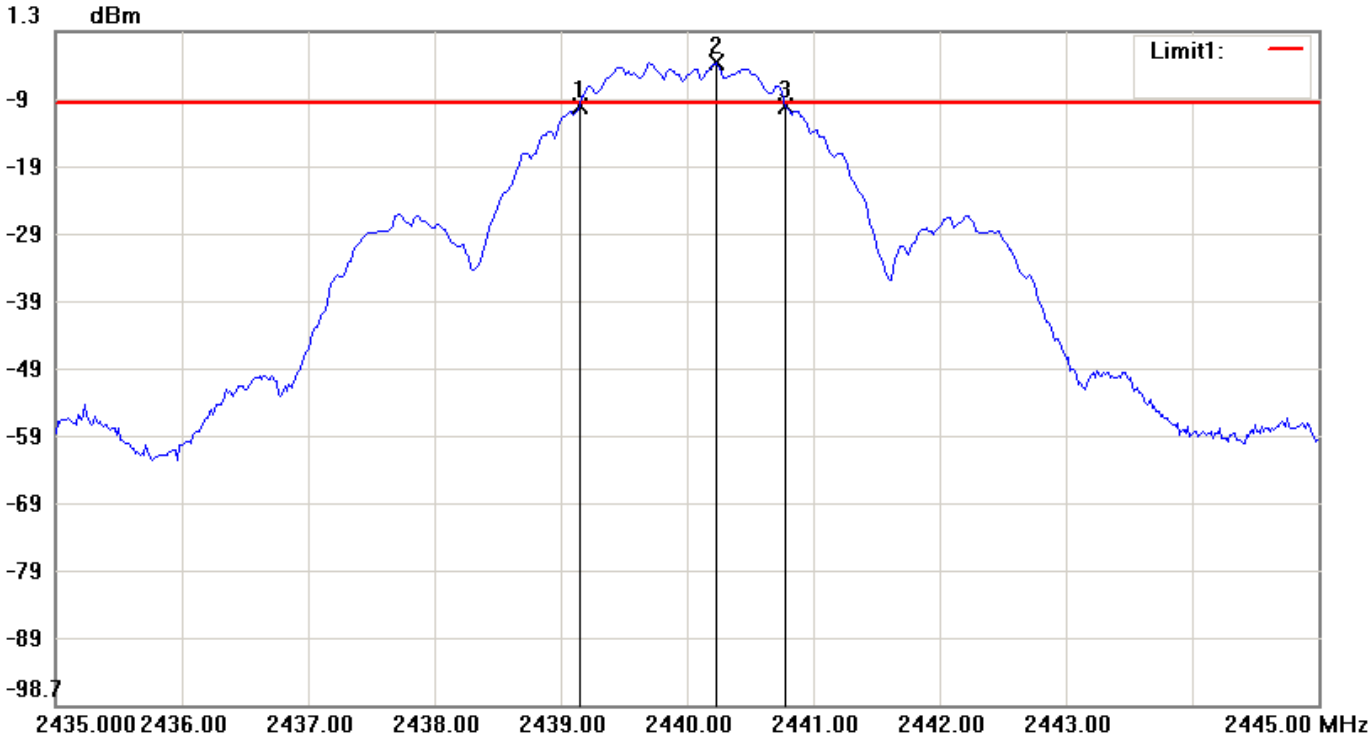
Note: **Channel L-6dB EBW**

No.	Frequency(MHz)	Level(dBm)
1	2404.15000	-9.26
2	2404.71670	-2.72
3	2405.78330	-8.97

No.		△Frequency(MHz)	△Level(dB)
1	mk3-mk1	1.6333	0.29

File: **RM1049_a5-3-6-test** **Data:** **#15** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 05:17:19** **Humidity:** **60 %**



Condition: **-9.44dBm** **RF Conducted**

EUT: **Sweep Time: 500ms** **Att.: 10dB**

Model: **RBW: 100 KHz** **VBW: 300 KHz**

Test Mode:

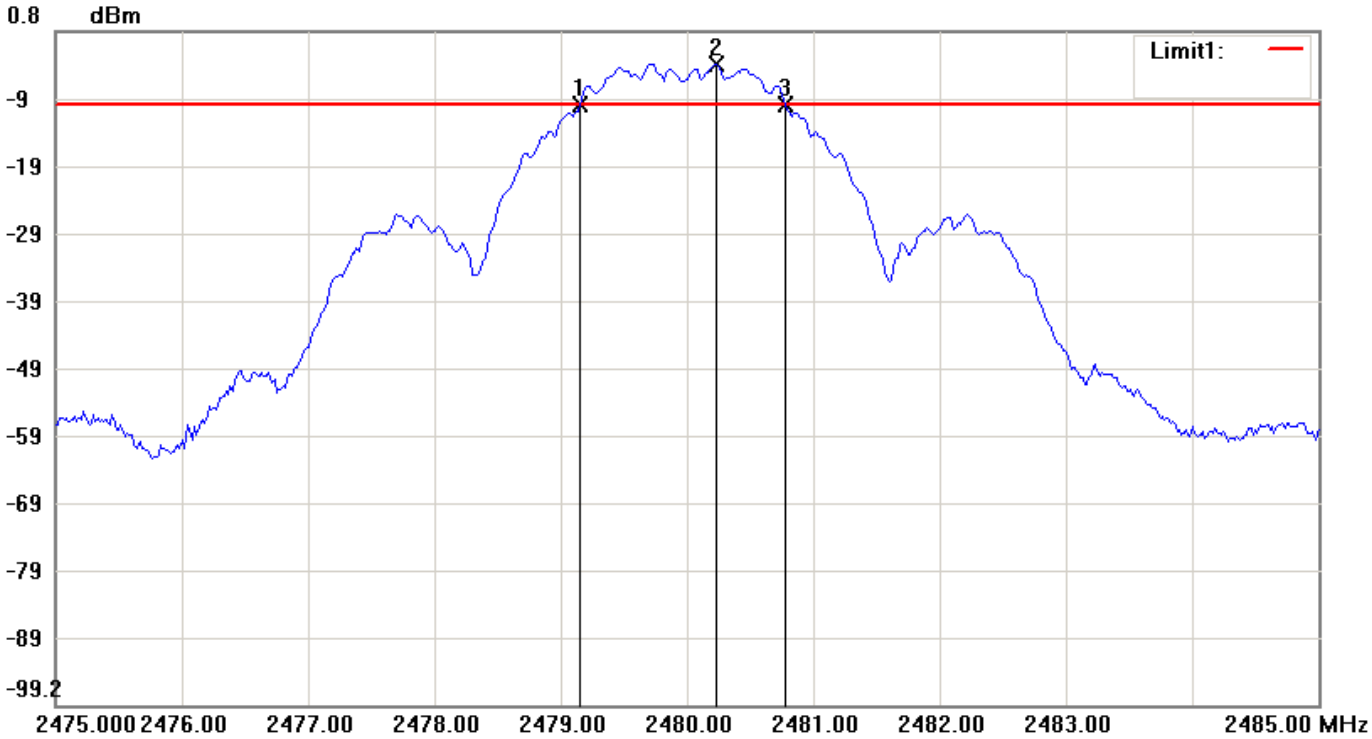
Note: **Channel M-6dB EBW**

No.	Frequency(MHz)	Level(dBm)
1	2439.15000	-9.89
2	2440.23330	-3.44
3	2440.78330	-9.94

No.		△Frequency(MHz)	△Level(dB)
1	mk3-mk1	1.6333	-0.05

File: **RM1049_a5-3-6-test** **Data:** **#10** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 04:50:01** **Humidity:** **60 %**



Condition: **-10.01dBm**

EUT:

Model:

Test Mode:

Note: **Channel H-6dB EBW**

RF Conducted

Sweep Time: 500ms **Att.: 10dB**

RBW: 100 KHz **VBW: 300 KHz**

No.	Frequency(MHz)	Level(dBm)
1	2479.15000	-10.17
2	2480.21670	-4.01
3	2480.78330	-10.07

No.		△Frequency(MHz)	△Level(dB)
1	mk3-mk1	1.6333	0.1

7 OUTPUT POWER MEASUREMENT

7.1 Standard Applicable

For direct sequence system, according to 15.247(b), the maximum peak output power of the transmitter shall not exceed 1 Watt. If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

7.2 Measurement Procedure

1. The testing follows FCC KDB 558074 D01 v03r02.
2. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
3. Position the EUT as shown in figure 2. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range.
4. Measure the highest value appearing on power meter and record the level to calculate result data.
5. Repeat above procedures until all frequencies measured were complete.

7.3 Measurement Equipment

Equipment	Manufacturer	Model No.
Power Meter	Agilent	N1912A
Wideband Power Sensor	Agilent	N1922A

7.4 Measurement Data

Test Date: Aug. 18, 2014 Temperature: 22℃ Humidity: 60%

Channel	Maximum Peak Output Power (dBm)	FCC Limit (dBm)	Chart
L	1.43	30.0	-
M	0.79	30.0	-
H	0.19	30.0	-

Note:

The estimated measurement uncertainty of the result measurement is ±1.5dB(1GHz≦f≦18GHz)

8 POWER DENSITY MEASUREMENT

8.1 Standard Applicable

According to 15.247(e), for direct sequence systems, the transmitted power density averaged over any 1 second interval shall not be greater than 8 dBm in any 3 kHz bandwidth within these bands.

8.2 Measurement Procedure

1. The testing follows FCC KDB 558074 D01 v03r02.
2. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
3. Position the EUT as shown in figure 1. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set EUT to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
4. Adjust the center frequency of spectrum analyzer on highest level appearing on spectral display within a 300 kHz frequency span.
5. Set the spectrum analyzer on a 3 kHz resolution bandwidth and 10 kHz video bandwidth as well as max. hold function, then record the measurement result.
6. Repeat above procedures until all measured frequencies were complete.

8.3 Measurement Equipment

Equipment	Manufacturer	Model No.
Spectrum Analyzer	Agilent	E4446A

8.4 Measurement Data

Test Date: Aug. 18, 2014 Temperature: 22℃ Humidity: 60%

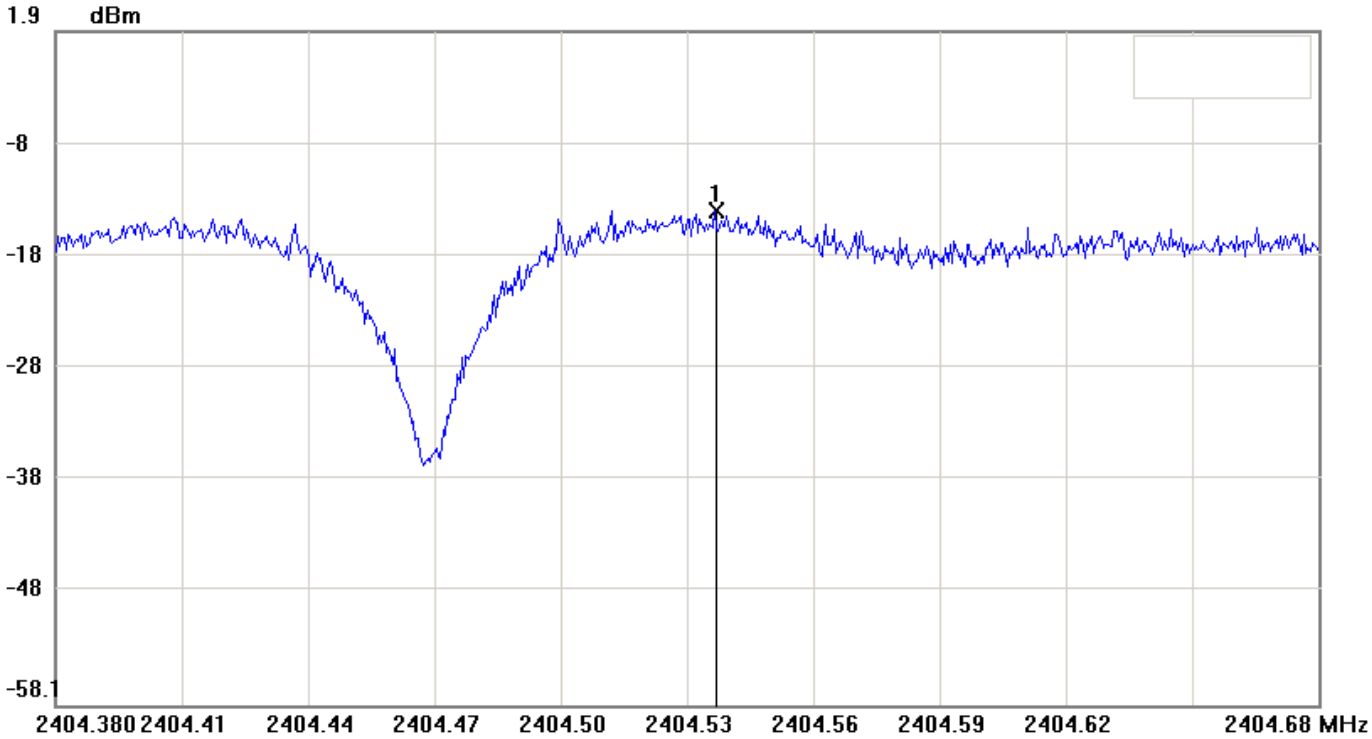
Channel	Peak Power Spectral Density (dBm)	FCC Limit (dBm)	Chart
L	-14.11	8	Page 28
M	-14.83	8	Page 29
H	-15.61	8	Page 30

Note:

1. *Please refer to page 28 to page 30 for chart*
2. *The estimated measurement uncertainty of the result measurement is ±1.5dB(1GHz≦f≦ 18GHz)*

File: **RM1049_a5-3-6-test** **Data:** **#4** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 04:35:17** **Humidity:** **60 %**



Condition: **RF Conducted**

EUT: **Sweep Time: 100000ms Att.: 10dB**

Model: **RBW: 3 KHz VBW: 10 KHz**

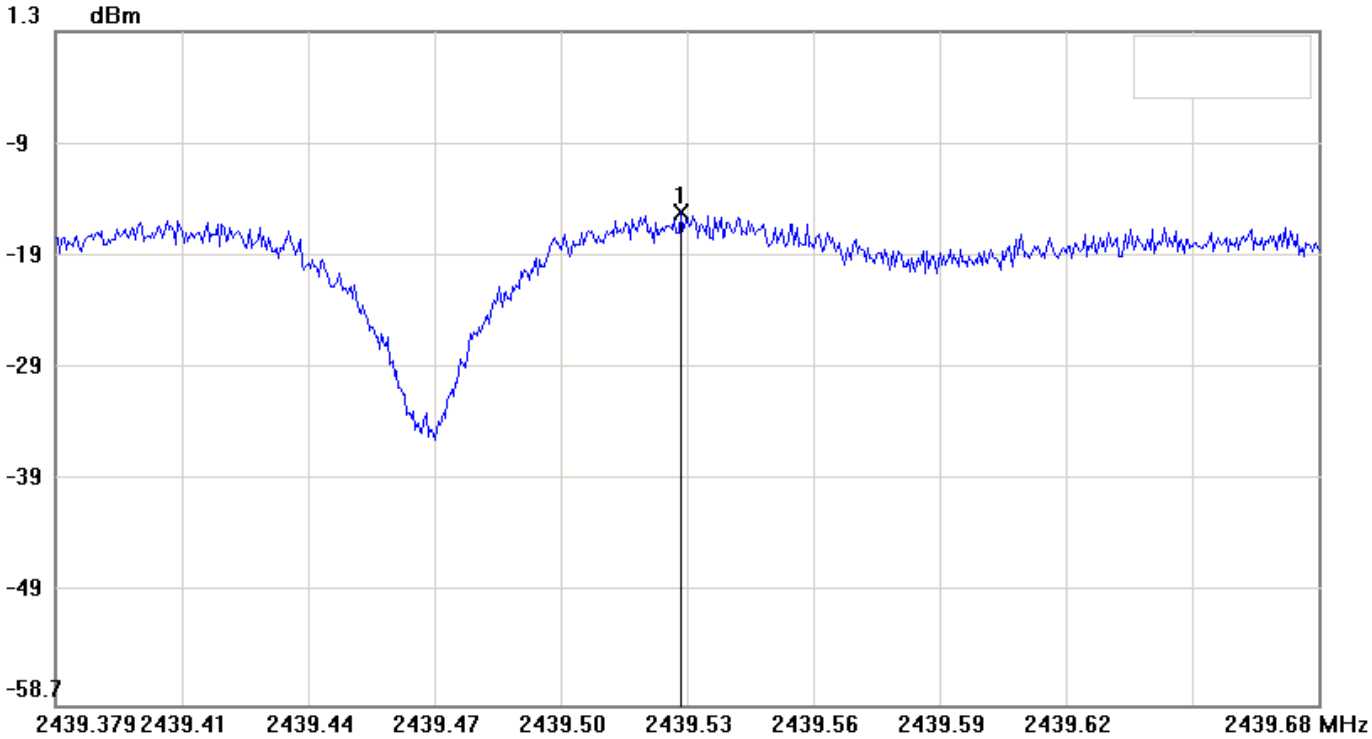
Test Mode:

Note: **Channel L-Power Density (PK)**

No.	Frequency(MHz)	Level(dBm)
1	2404.53620	-14.11

File: **RM1049_a5-3-6-test** **Data:** **#18** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 05:21:47** **Humidity:** **60 %**



Condition: **RF Conducted**

EUT: **Sweep Time: 100000ms Att.: 10dB**

Model: **RBW: 3 KHz VBW: 10 KHz**

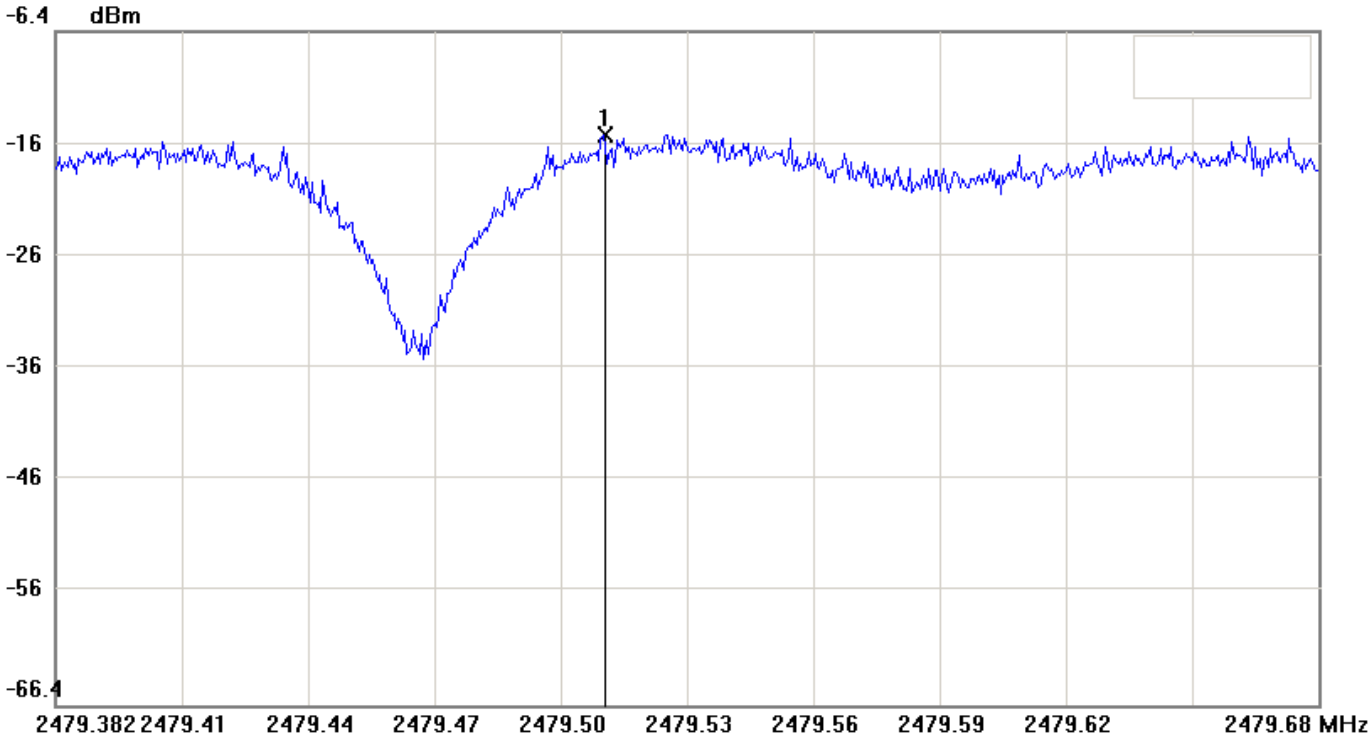
Test Mode:

Note: **Channel M-Power Density (PK)**

No.	Frequency(MHz)	Level(dBm)
1	2439.52780	-14.83

File: **RM1049_a5-3-6-test** **Data:** **#13** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 04:54:51** **Humidity:** **60 %**



Condition: **RF Conducted**

EUT: **Sweep Time: 100000ms Att.: 10dB**

Model: **RBW: 3 KHz VBW: 10 KHz**

Test Mode:

Note: **Channel H-Power Density (PK)**

No.	Frequency(MHz)	Level(dBm)
1	2479.51180	-15.61

9 SPURIOUS EMISSION - RF CONDUCTED MEASUREMENT

9.1 Standard Applicable

According to 12.247 (d) , in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

9.2 Measurement Procedure

1. The testing follows FCC KDB 558074 D01 v03r02.
2. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
3. Position the EUT as shown in figure 1. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
4. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge.
5. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
6. Repeat above procedures until all measured frequencies were complete.

9.3 Measurement Equipment

Equipment	Manufacturer	Model No.
Spectrum Analyzer	Agilent	E4446A

9.4 Measurement Data

Test Date: Aug. 18, 2014 Temperature: 22℃ Humidity: 60%

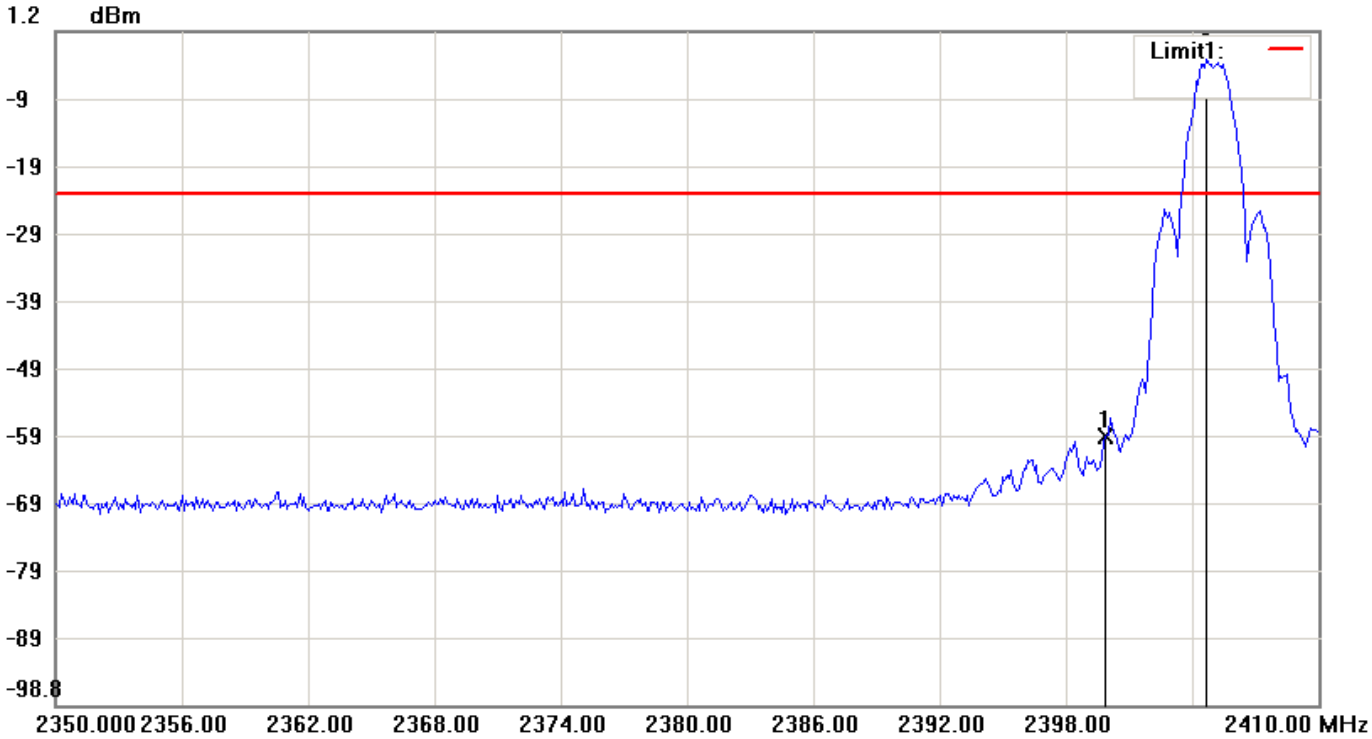
Channel	Frequency(MHz)	Chart
L	2405	Page 33, Page 35
M	2440	Page 36
H	2480	Page 34, Page 37

Frequency Band: 2400 MHz ~ 2483.5 MHz
All out-of –band conducted emissions were more than 20dB below the carrier.

Note: 1. Please refer to page 33 to page 37 for chart
2. An external attenuator is used as part of the test system for these measurements, the attenuation introduced by the external attenuator has not been explicitly compensated in the measured power level as it is irrelevant to these specific measurement results.

File: **RM1049_a5-3-6-test** **Data:** **#5** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 04:35:55** **Humidity:** **60 %**



Condition: **-22.79dBm** **RF Conducted**

EUT: **Sweep Time: 500ms** **Att.: 10dB**

Model: **RBW: 100 KHz** **VBW: 300 KHz**

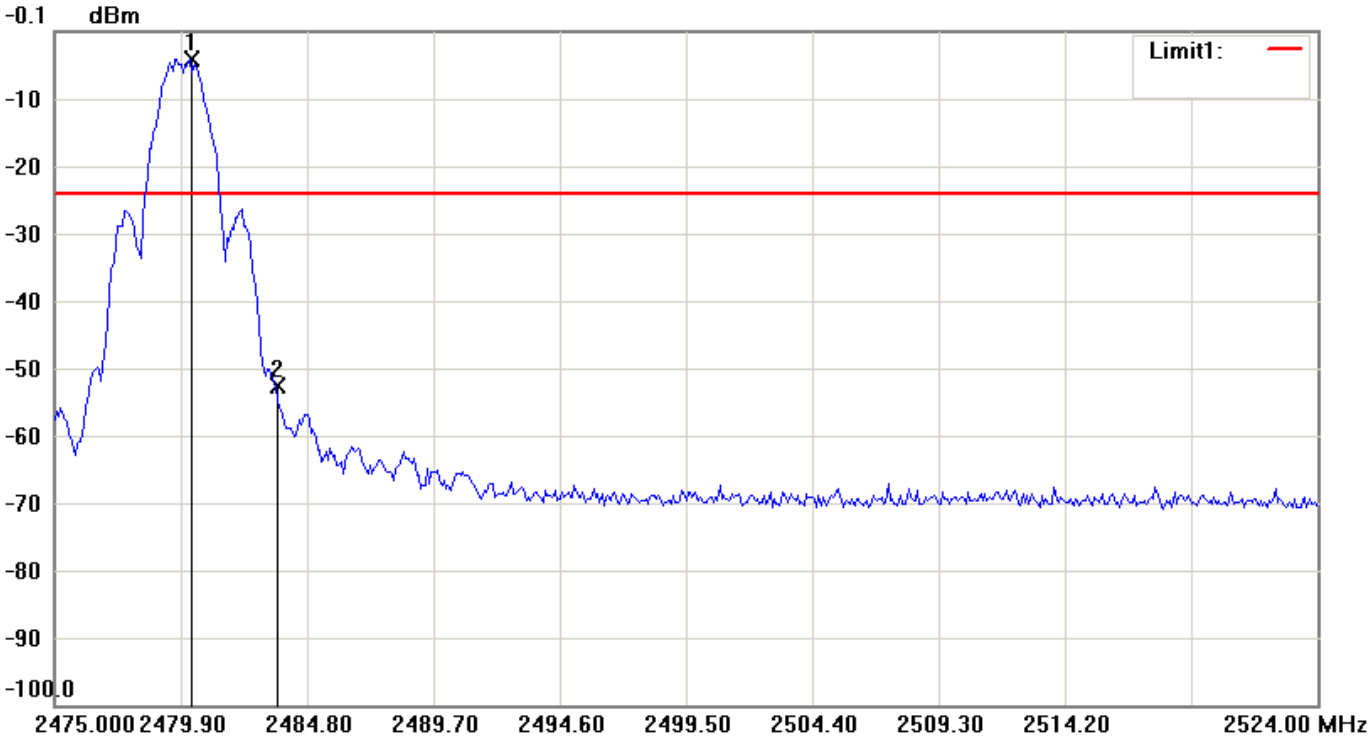
Test Mode:

Note: **Channel L-Bandedge**

No.	Frequency(MHz)	Level(dBm)
1	2399.90000	-58.99
2	2404.70000	-2.79

File: **RM1049_a5-3-6-test** **Data:** **#14** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 04:55:29** **Humidity:** **60 %**



Condition: **-24.28dBm**

EUT:

Model:

Test Mode:

Note: **Channel H-Bandedge**

RF Conducted

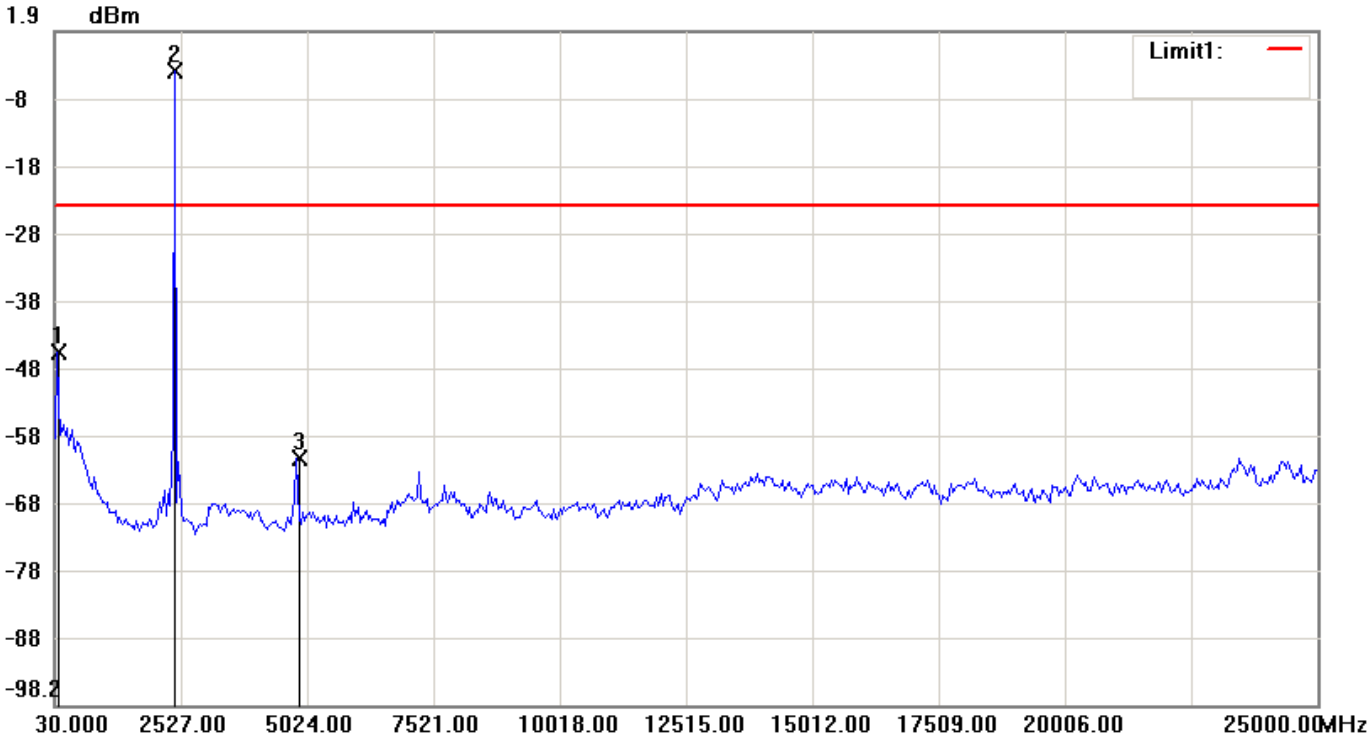
Sweep Time: 500ms **Att.: 10dB**

RBW: 100 KHz **VBW: 300 KHz**

No.	Frequency(MHz)	Level(dBm)
1	2480.22670	-4.28
2	2483.57500	-52.61

File: **RM1049_a5-3-6-test** **Data:** **#2** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 04:31:38** **Humidity:** **60 %**



Condition: **-23.94dBm** **RF Conducted**

EUT: **Sweep Time: 2386.4ms** **Att.: 10dB**

Model: **RBW: 100 KHz** **VBW: 300 KHz**

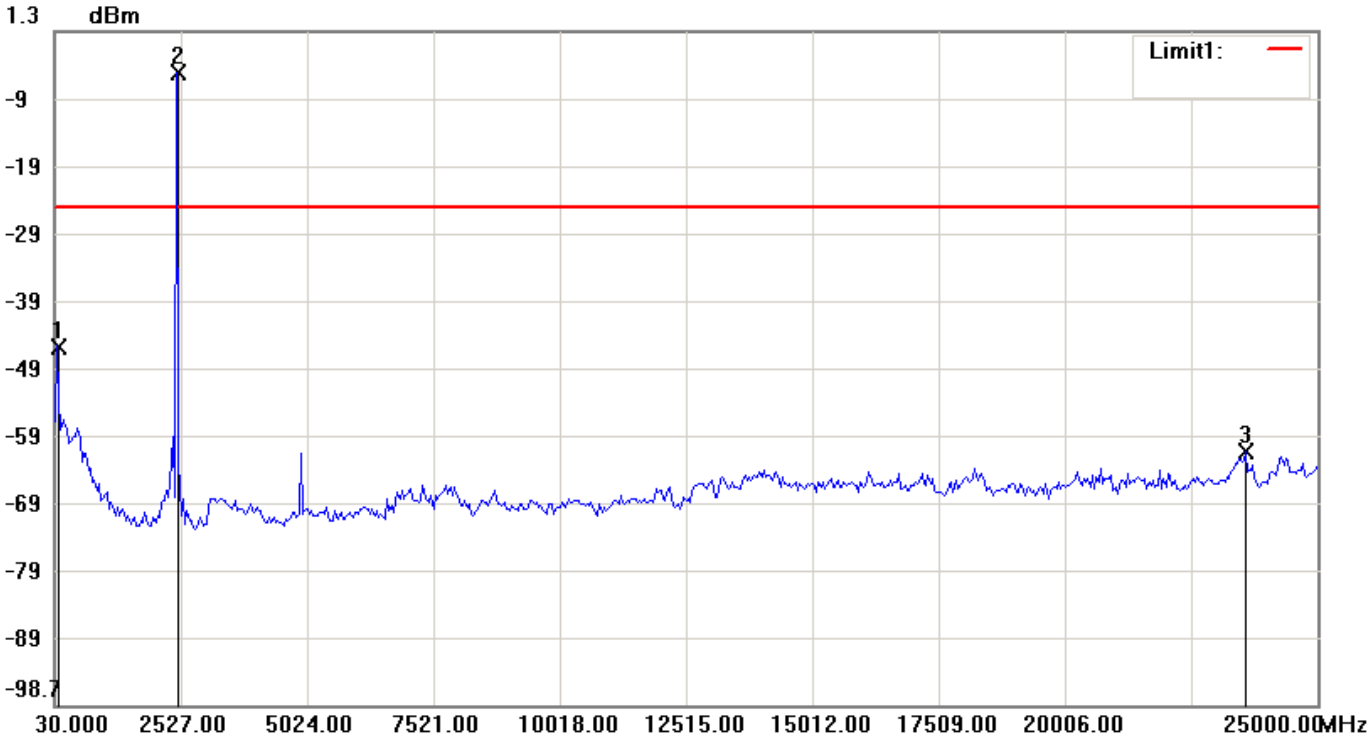
Test Mode:

Note: **Channel L-Conducted Spurious**

No.	Frequency(MHz)	Level(dBm)
1	71.6167	-45.71
2	2402.15000	-3.94
3	4815.91670	-61.49

File: **RM1049_a5-3-6-test** **Data:** **#16** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 05:18:11** **Humidity:** **60 %**



Condition: **-24.89dBm** **RF Conducted**

EUT: **Sweep Time: 2386.4ms** **Att.: 10dB**

Model: **RBW: 100 KHz** **VBW: 300 KHz**

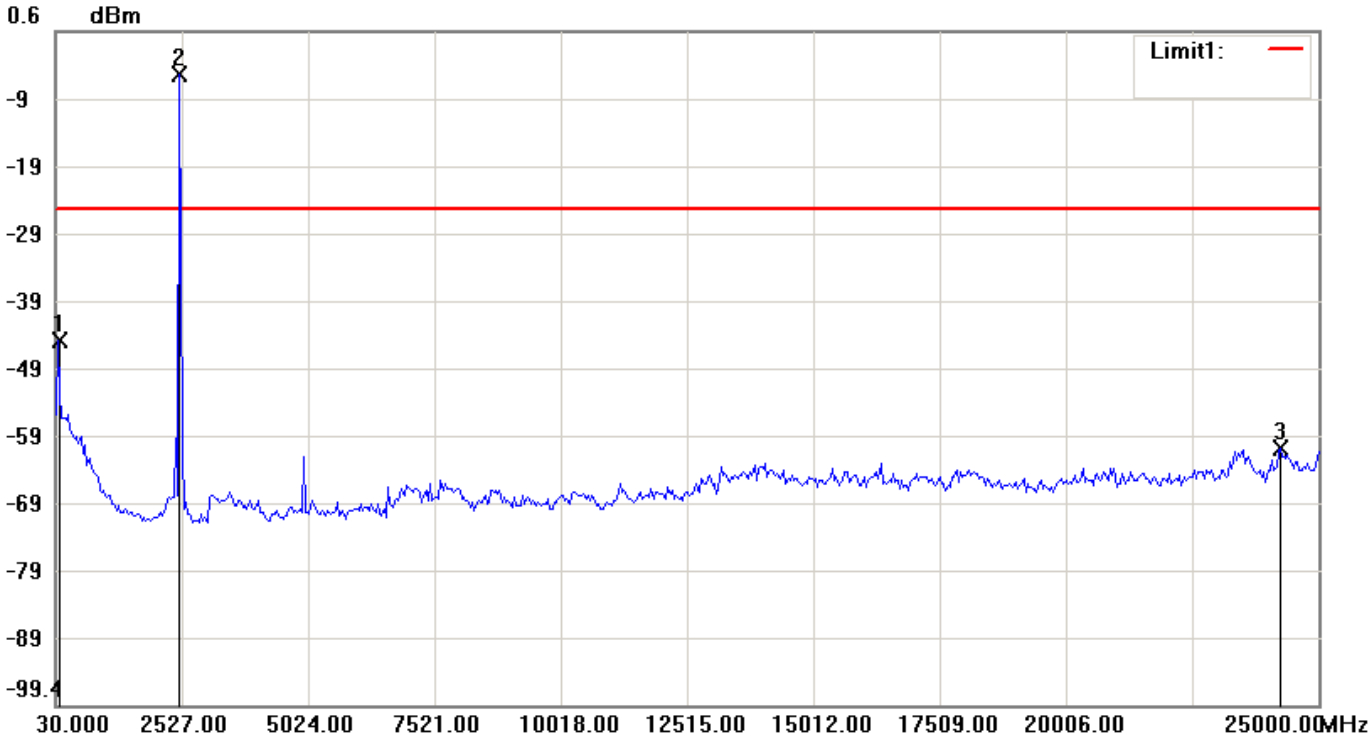
Test Mode:

Note: **Channel M-Conducted Spurious**

No.	Frequency(MHz)	Level(dBm)
1	71.6167	-45.49
2	2443.76670	-4.89
3	23585.03330	-61.18

File: **RM1049_a5-3-6-test** **Data:** **#11** **Date:** **2014/8/18** **Temperature:** **22 ℃**

Time: **PM 04:50:53** **Humidity:** **60 %**



Condition: **-25.86dBm** **RF Conducted**

EUT: **Sweep Time: 2386.4ms** **Att.: 10dB**

Model: **RBW: 100 KHz** **VBW: 300 KHz**

Test Mode:

Note: **Channel H-Conducted Spurious**

No.	Frequency(MHz)	Level(dBm)
1	71.6167	-45.31
2	2485.38330	-5.86
3	24250.90000	-61.13

10 RADIATED EMISSION MEASUREMENT

10.1 Standard Applicable

For unintentional radiator, the radiated emission shall comply with §15.109(a).

For intentional radiators, according to §15.247 (a), operation under this provision is limited to frequency hopping and direct sequence spread spectrum, and the out band emission shall be comply with §15.247 (d)

10.2 Measurement Procedure

The testing follows FCC KDB 558074 D01 v03r02.

A.Preliminary Measurement For Portable Devices.

For portable devices, the following procedure was performed to determine the maximum emission axis of EUT (X, Y and Z axis):

1. With the receiving antenna is H polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
2. With the receiving antennna is V polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
3. Compare the results derived from above two steps. The axis of maximum emission from EUT was determined and the configuration was used to perform the final measurement.
4. The position in which the maximum noise occurred was “X axis”. (Please see the test setup photos)

B. Final Measurement

1. Setup the configuration per figure 3 and 4 for frequencies measured below and above 1 GHz respectively.
2. For emission frequencies measured below 1 GHz, it is performed in a semi-anechoic chamber to determine the accurate frequencies of higher emissions. For emission frequencies measured above 1 GHz, a pre-scan be performed with a 1 meter measuring distance before final test.
3. For emission frequencies measured below and above 1 GHz, set the spectrum analyzer on a 120 kHz and 1 MHz resolution bandwidth respectively for each frequency measured in step 2.
4. The search antenna is to be raised and lowered over a range from 1 to 4 meters in horizontally polarized orientation. Position the highness when the highest value is indicated on spectrum analyzer, then change the orientation of EUT on test table over a range from 0 ° to 360 ° with a speed as slow as possible, and keep the azimuth that highest emission is indicated on the spectrum analyzer. Vary the antenna position again and record the highest value as a final reading. A RF test receiver is also used to confirm emissions measured.
   Note : A filter was used to avoid pre-amplifier saturated when measure TX operation mode.
5. Repeat step 4 until all frequencies need to be measured were complete.
6. Repeat step 5 with search antenna in vertical polarized orientations.
7. Check the three frequencies of highest emission with varying the datarate, placement of ANT. cables associated with EUT to obtain the worse case and record the result.
8. Investigate from the lowest frequency signal generated in the device up to the 10th harmonic.

Figure 3 : Frequencies measured below 1 GHz configuration

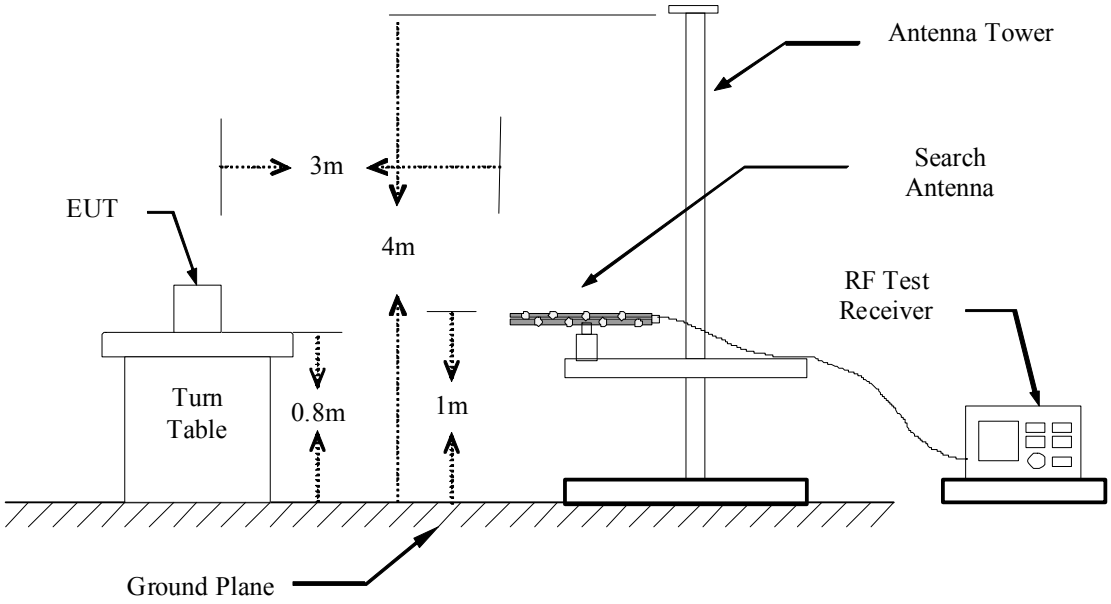
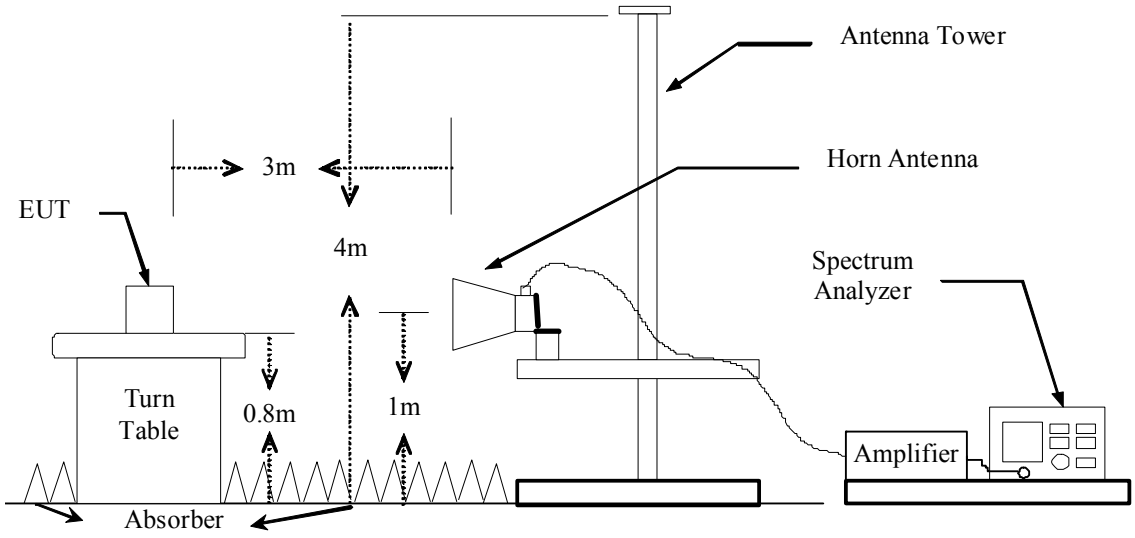


Figure 4 : Frequencies measured above 1 GHz configuration



10.3 Measuring Instrument

The following instrument are used for radiated emissions measurement :

Equipment	Manufacturer	Model No.
EMI Test Receiver	R&S	ESIB7
Spectrum Analyzer	Rohde & Schwarz	FSV 40
Horn Antenna	EMCO	3115
BiLog Antenna	ETC	MCTD2786
Horn Antenna	EMCO	3116
Preamplifier	Hewlett-Packard	8449B
Loop Antenna	EMCO	6512
PRE-Amplifier	EMCI	PA303N

Measuring instrument setup in measured frequency band when specified detector function is used :

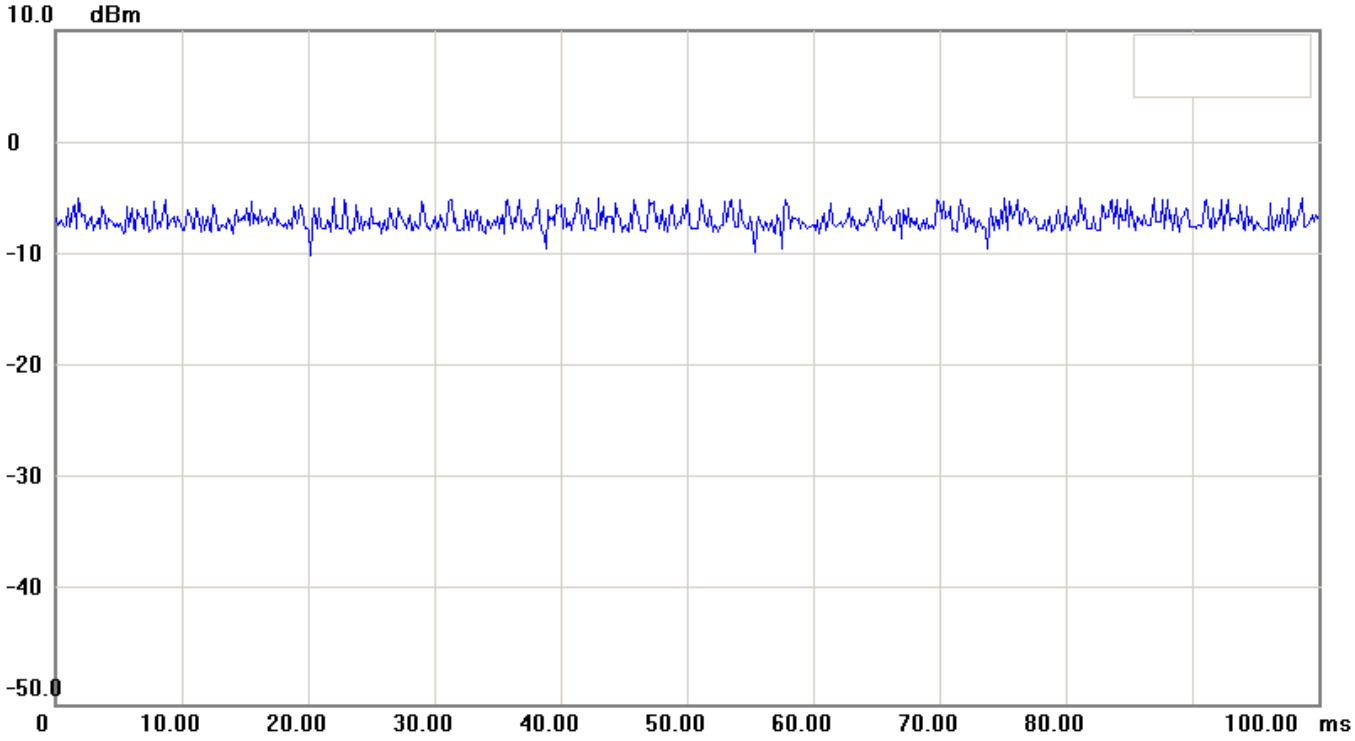
Frequency Band (MHz)	Instrument	Function	Resolution Bandwidth	Video Bandwidth
30 to 1000	RF Test Receiver	Quasi-Peak	120 kHz	300 kHz
	Spectrum Analyzer	Peak	120 kHz	300 kHz
Above 1000	Spectrum Analyzer	Peak	1 MHz	1 MHz
	Spectrum Analyzer	Average	1 MHz	VBW_avg (Note)

Note:For average measurement

Condition	VBW_avg
Duty cycle is no less than 98 percent	10 Hz
Duty cycle is less than 98 percent, T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation	$\geq \frac{1}{T}$
Current use	10Hz

File: topz **Data:** #1 **Date:** 2014/8/18 **Temperature:** 22 ℃

Time: PM 05:50:52 **Humidity:** 60 %



Condition: **RF Conducted**

EUT: **Sweep Time: 100ms Att.: 10dB**

Model: **RBW: 100 KHz VBW: 100 KHz**

Test Mode: **Channel M – Duty cycle**

Note: **100% duty**

10.4 Radiated Emission Data

10.4.1 Harmonic

10.4.1.1 Operation Mode: Tx

Test Date: Aug. 19, 2014 Temperature: 24℃ Humidity: 58%

a) Channel L

Fundamental Frequency: 2405 MHz

Frequency	Ant Pol	Reading (dBuV/m)@3m		Correct Factor	Result (dBuV/m)@3m		Limit (dBuV/m)@3m		Margin (worse)
(MHz)	H/V	Peak	AVG	(dB)	Peak	AVG	Peak	AVG	(dB)
4810.0000	H	---	---	-1.95	---	---	74.0	54.0	---
4810.0000	V	---	---	-1.95	---	---	74.0	54.0	---
7215.0000	H	---	---	1.11	---	---	74.0	54.0	---
7215.0000	V	---	---	1.11	---	---	74.0	54.0	---
9620.0000	H	---	---	2.58	---	---	74.0	54.0	---
9620.0000	V	---	---	2.58	---	---	74.0	54.0	---
12025.0000	H	---	---	4.90	---	---	74.0	54.0	---
12025.0000	V	---	---	4.90	---	---	74.0	54.0	---
14430.0000	H	---	---	9.81	---	---	74.0	54.0	---
14430.0000	V	---	---	9.81	---	---	74.0	54.0	---

Note :

1. Item of margin shown in above table refer to average limit.
2. Remark "---" means that the emissions level is too low to be measured.
3. If the peak result is under the average limit, that is deemed to meet the average limit.
4. If there is only peak result, item "Margin" referred to "peak result – average limit".
5. The radiation emissions have been measured to beyond the tenth harmonic of the fundamental frequency and show the significant frequencies, other means the value is too low to be detected.

b) Channel M

Fundamental Frequency: 2440 MHz

Frequency	Ant Pol	Reading (dBuV/m)@3m		Correct Factor	Result (dBuV/m)@3m		Limit (dBuV/m)@3m		Margin (worse)
(MHz)	H/V	Peak	AVG	(dB)	Peak	AVG	Peak	AVG	(dB)
4880.0000	H	---	---	-1.81	---	---	74.0	54.0	---
4880.0000	V	---	---	-1.81	---	---	74.0	54.0	---
7320.0000	H	---	---	1.35	---	---	74.0	54.0	---
7320.0000	V	---	---	1.35	---	---	74.0	54.0	---
9760.0000	H	---	---	2.73	---	---	74.0	54.0	---
9760.0000	V	---	---	2.73	---	---	74.0	54.0	---
12200.0000	H	---	---	5.02	---	---	74.0	54.0	---
12200.0000	V	---	---	5.02	---	---	74.0	54.0	---
14640.0000	H	---	---	8.90	---	---	74.0	54.0	---
14640.0000	V	---	---	8.90	---	---	74.0	54.0	---

Note :

1. Item of margin shown in above table refer to average limit.
2. Remark "---" means that the emissions level is too low to be measured.
3. If the peak result is under the average limit, that is deemed to meet the average limit.
4. If there is only peak result, item "Margin" referred to "peak result – average limit".
5. The radiation emissions have been measured to beyond the tenth harmonic of the fundamental frequency and show the significant frequencies, other means the value is too low to be detected.

c) Channel H

Fundamental Frequency: 2480 MHz

Frequency	Ant Pol	Reading (dBuV/m)@3m		Correct Factor	Result (dBuV/m)@3m		Limit (dBuV/m)@3m		Margin (worse)
(MHz)	H/V	Peak	AVG	(dB)	Peak	AVG	Peak	AVG	(dB)
4960.0000	H	---	---	-1.63	---	---	74.0	54.0	---
4960.0000	V	---	---	-1.63	---	---	74.0	54.0	---
7440.0000	H	---	---	1.64	---	---	74.0	54.0	---
7440.0000	V	---	---	1.64	---	---	74.0	54.0	---
9920.0000	H	---	---	2.90	---	---	74.0	54.0	---
9920.0000	V	---	---	2.90	---	---	74.0	54.0	---
12400.0000	H	---	---	5.16	---	---	74.0	54.0	---
12400.0000	V	---	---	5.16	---	---	74.0	54.0	---
14880.0000	H	---	---	7.53	---	---	74.0	54.0	---
14880.0000	V	---	---	7.53	---	---	74.0	54.0	---

Note :

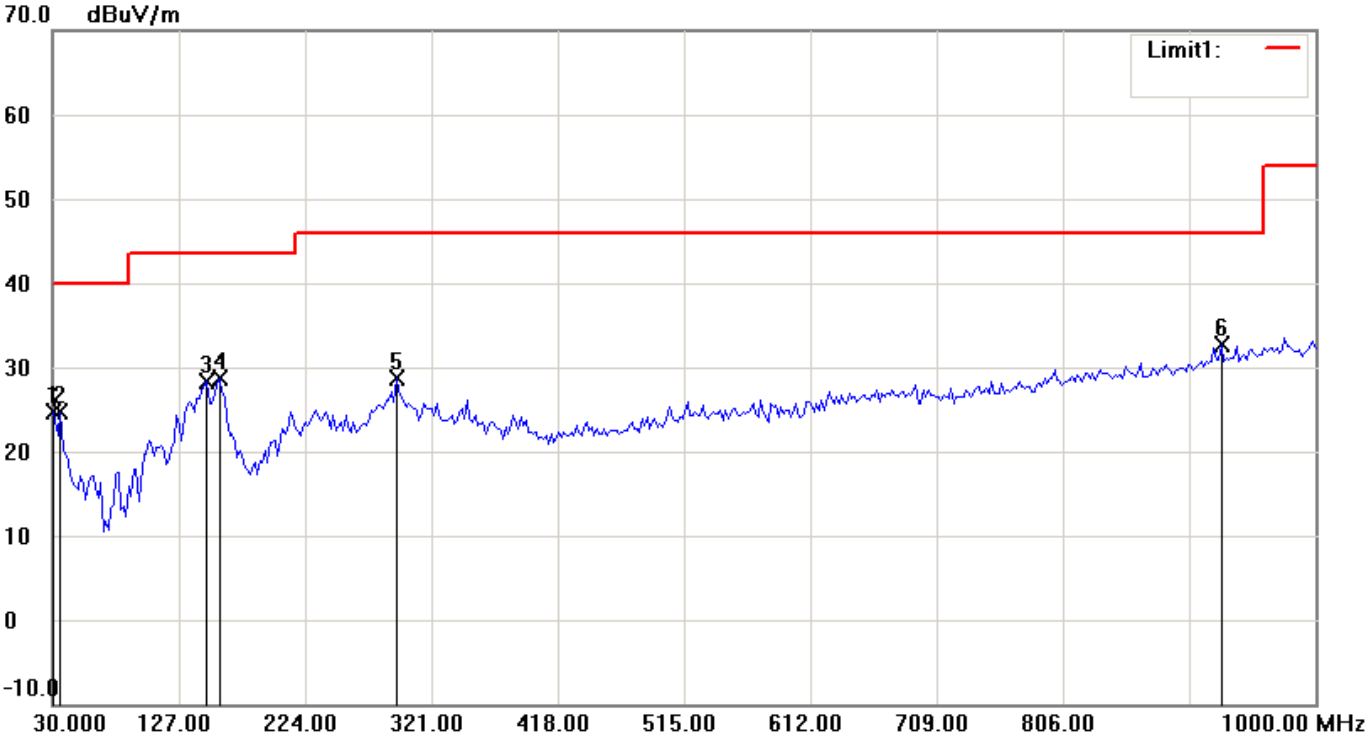
1. Item of margin shown in above table refer to average limit.
2. Remark "---" means that the emissions level is too low to be measured.
3. If the peak result is under the average limit, that is deemed to meet the average limit.
4. If there is only peak result, item "Margin" referred to "peak result – average limit".
5. The radiation emissions have been measured to beyond the tenth harmonic of the fundamental frequency and show the significant frequencies, other means the value is too low to be detected.

10.4.2 Spurious Emission

Operation Mode: Tx

10.4.2.1 30MHz to 1GHz

File: topz-f **Data:** #4 **Date:** 2014/8/19 **Time:** PM 03:53:48 **Temperature:** 24 ℃ **Humidity:** 58 %

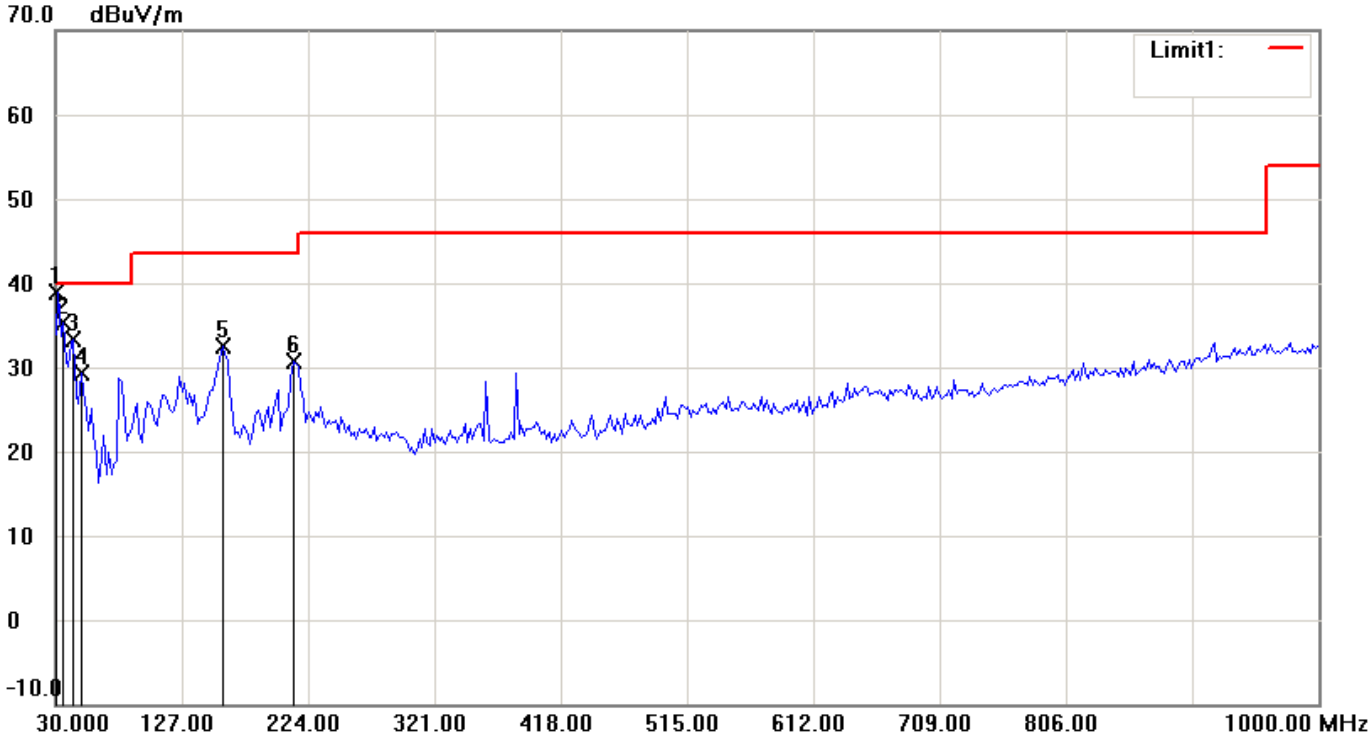


Condition: FCC_30-1000MHz **Polarization:** Horizontal
EUT: eutx **Distance:** 3m
Model:
Test Mode: zigbee
Note:

No.	Frequency (MHz)	Reading (dBuV/m)	Detector	Corrected dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
1	30.0000	4.29	peak	20.45	24.74	40.00	-15.26
2	35.8316	7.40	peak	17.33	24.73	40.00	-15.27
3	148.5772	14.13	peak	14.08	28.21	43.50	-15.29
4	158.2966	14.74	peak	13.90	28.64	43.50	-14.86
5	294.3686	10.83	peak	17.85	28.68	46.00	-17.32
6	928.0761	3.63	peak	29.01	32.64	46.00	-13.36

File: topz-f **Data:** #3 **Date:** 2014/8/19 **Temperature:** 24 ℃

Time: PM 03:52:21 **Humidity:** 58 %



Condition: FCC_30-1000MHz **Polarization:** Vertical

EUT: eutx **Distance:** 3m

Model:

Test Mode: zigbee

Note:

No.	Frequency (MHz)	Reading (dBuV/m)	Detector	Corrected dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
1	31.9438	19.58	QP	19.39	38.97	40.00	-1.03
2	35.8316	17.95	peak	17.33	35.28	40.00	-4.72
3	43.6071	19.86	peak	13.54	33.40	40.00	-6.60
4	49.4388	18.39	peak	10.84	29.23	40.00	-10.77
5	158.2966	18.52	peak	13.90	32.42	43.50	-11.08
6	212.7255	15.69	peak	14.92	30.61	43.50	-12.89

10.4.2.2 above 1GHz

10.4.2.2.1 Fundamental Frequency: 2405 MHz

Frequency	Ant Pol	Reading (dBuV/m)@3m		Correct Factor	Result (dBuV/m)@3m		Limit (dBuV/m)@3m		Margin (worse)
(MHz)	H/V	Peak	AVG	(dB)	Peak	AVG	Peak	AVG	(dB)
1199.6793	H	54.7	---	-13.33	41.4	---	74.0	54.0	-12.6
1240.0641	H	56.4	---	-13.15	43.3	---	74.0	54.0	-10.7

10.4.2.2.2 Fundamental Frequency: 2440 MHz

Frequency	Ant Pol	Reading (dBuV/m)@3m		Correct Factor	Result (dBuV/m)@3m		Limit (dBuV/m)@3m		Margin (worse)
(MHz)	H/V	Peak	AVG	(dB)	Peak	AVG	Peak	AVG	(dB)
1199.6793	H	53.8	---	-13.33	40.5	---	74.0	54.0	-13.5
1240.0641	H	55.5	---	-13.15	42.4	---	74.0	54.0	-11.6

10.4.2.2.3 Fundamental Frequency: 2480 MHz

Frequency	Ant Pol	Reading (dBuV/m)@3m		Correct Factor	Result (dBuV/m)@3m		Limit (dBuV/m)@3m		Margin (worse)
(MHz)	H/V	Peak	AVG	(dB)	Peak	AVG	Peak	AVG	(dB)
1199.6793	H	54.0	---	-13.33	40.7	---	74.0	54.0	-13.3
1240.0641	H	55.8	---	-13.15	42.7	---	74.0	54.0	-11.3
3851.1401	V	55.9	39.7	-3.18	52.7	36.5	74.0	54.0	-17.5

10.4.2.3 below 30MHz

Frequency	Reading (dBuV/m)	Duty	Factor	Result @3m (dBuV/m)			Limit @3m (dBuV/m)	
(MHz)	Peak	(dB)	(dB)	Peak	QP	AVG	Peak	AVG
Radiated emission frequencies from 9 kHz to 30 MHz were too low to be measured.								

Note:

1. Place of Measurement: Measuring site of the ETC.
2. Item of margin shown in above table refer to average limit.
3. Remark "---" means that the emissions level is too low to be measured.
4. If the peak result is under the average limit, that is deemed to meet the average limit.
5. If there is only peak result, item "Margin" referred to "peak result – average limit".
6. The radiation emissions have been measured to beyond the tenth harmonic of the fundamental frequency and show the significant frequencies, other means the value is too low to be detected.
7. The estimated measurement uncertainty of the result measurement is
   ±4.6dB (30MHz≦f<300MHz).
   ±4.4dB (300MHz≦f<1000MHz).
   ±4.1dB (1GHz≦f≦18GHz).
   ±4.4dB (18GHz<f≦40GHz).

10.4.3 Radiated Measurement at Bandedge with Fundamental Frequencies and co-location

Test Date: Aug. 19, 2014 Temperature: 24℃ Humidity: 58%

Operation Mode: Tx

Operation Channel	Test Frequency	Reading @3m (dBuV/m)				Factor	Result		Limit @3m		Margin (worse)	
		H		V			(dBuV/m)		(dBuV/m)		(dB)	
	(MHz)	Peak	Ave	Peak	Ave	(dB)	Peak	Ave	Peak	Ave	Peak	Ave
CH Low	2324.615	30.4	15.9	30.2	16.6	29.8	60.2	46.4	74	54	-13.9	-7.6
CH High	2483.526	30.5	17.3	32.4	20.0	29.8	62.2	49.8	74	54	-11.8	-4.2

Note :
1. Remark "---" means that the emissions level is too low to be measured.
2. The result is the highest value of radiated emission from restrict band of 2310 ~ 2390 MHz and 2483.5 ~ 2500 MHz.

10.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor, High Pass Filter Loss(if used) and Cable Loss, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation calculation is as follows:

Result = Reading + Corrected Factor

where
Corrected Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Amplifier Gain

11. EQUIPMENTS LIST FOR TESTING

Equipment	Manufacturer	Model No.	S/N	Calibration Date	Next Cal. Due
EMI Test Receiver	R&S	ESCI	13054418-001	07/03/2014	07/02/2015
V-LISN	R&S	ENV216	13057719-001	10/16/2013	10/15/2014
V-LISN	R&S	ENV216	13057719-002	12/12/2013	12/11/2014
Spectrum Analyzer	Agilent	E4446A	13052013-001	10/04/2013	10/03/2014
Power Meter	Agilent	N1922A	13053523-001	11/23/2013	11/22/2014
Peak Power Sensor	Agilent	N1912A	13050625-001	11/23/2013	11/22/2014
EMI Receiver	R&S	ESIB 7	13054414-001	07/20/2014	07/19/2015
Spectrum Analyzer	Rohde & Schwarz	FSV 40	13052017-001	01/20/2014	01/19/2015
Horn Antenna	EMCO	3115	13059201-001	07/22/2014	07/21/2015
BiLog Antenna	ETC	MCTD2786	BL09D01004	02/07/2014	02/06/2015
Hom Antenna	EMCO	3116	13059202-001	08/22/2014	08/21/2015
PRE-Amplifier	Agilent	8449B	13040709-001	11/26/2013	11/25/2014
Loop Antenna	EMCO	6512	13054104-001	07/01/2014	06/30/2017
PRE-Amplifier	EMCI	PA303N	13040720-001	07/03/2014	07/02/2015