

# FCC Part 15 EMI TEST REPORT

of

E.U.T. : ZIGBEE MODULE

Model No. : ZBM-220

FCC ID. : XBTZBM-220

for

APPLICANT : United Integrated Services CO., LTD.

ADDRESS : 5F No 3 Lane 7 Paokao Road Hsintien 23144  
Taipei Hsien ,Taiwan

Test Performed by

**ELECTRONICS TESTING CENTER, TAIWAN**

NO. 34. LIN 5, DINGFU VIL., LINKOU DIST.,

NEW TAIPEI CITY, TAIWAN, 24442, R.O.C

Tel : (02)26023052 Fax : (02)26010910

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Report Number : 13-01-RBF-035

# TEST REPORT CERTIFICATION

Applicant : United Integrated Services CO., LTD.  
 5F No 3 Lane 7 Paokao Road Hsintien 23144 Taipei Hsien ,Taiwan

Manufacturer : United Integrated Services CO., LTD.  
 5F No 3 Lane 7 Paokao Road Hsintien 23144 Taipei Hsien ,Taiwan

## Description of EUT

- a) Type of EUT : ZIGBEE MODULE  
 b) Trade Name : UIS  
 c) Model No. : ZBM-220  
 d) Power Supply : DC 3V

Regulation Applied : FCC Rules and Regulations Part 15 Subpart C

I HEREBY CERTIFY THAT: The data shown in this report were made in accordance with the procedures given in ANSI C63.4, and the energy emitted by the device was founded to be within the limits applicable. I assume full responsibility for accuracy and completeness of these data.

Note: 1. The result of the testing report relate only to the item tested.  
 2. The testing report shall not be reproduced expect in full, without the written approval of ETC.

## Summary of Tests

Test	Results
Radiated Emission	<b>Pass</b>
Conducted Emission	<b>Pass</b>
Emission Bandwidth	<b>Pass</b>
Output Power	<b>Pass</b>
100 kHz Bandwidth of Band Edges	<b>Pass</b>
Power Density	<b>Pass</b>
Out-of-Band Conducted Emission	<b>Pass</b>

Date Test Item Received : *Jan. 26, 2013*

Date Test Campaign Completed : *Feb. 06, 2013*

Date of Issue : *May 17, 2013*

Test Engineer :

A handwritten signature in blue ink that reads "Vincent Chang". The signature is written on a light yellow rectangular background.

( Vincent Chang, Engineer )

Approve & Authorized :

A handwritten signature in blue ink that reads "S. S. Liou". The signature is written on a light yellow rectangular background.

S. S. Liou, Section Manager  
EMC Dept. II of ELECTRONICS  
TESTING CENTER, TAIWAN

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# 1 GENERAL INFORMATION

## 1.1 Product Description

- a) Type of EUT : ZIGBEE MODULE
- b) Trade Name : UIS
- c) Model No. : ZBM-220
- d) Power Supply : DC 3V

## 1.2 Characteristics of Device

Frequency band	: 2405MHz~2480MHz
Number of channels	: 16 channels
Channel spacing	: 5MHz
Transmitter antenna source	: Printed Antenna

## 1.3 Test Methodology

Both conducted and radiated emissions were performed according to the procedures illustrated in ANSI C63.4 (2003). Other required measurements were illustrated in separate sections of this test report for details. For RF test the measurement procedure was referred to FCC KDB 558074 D01 DTS Meas Guidance v02.

Test Frequency:

Channel Low:2405MHz

Channel Middle:2440MHz

Channel High:2480MHz

## 1.4 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the roof top of Building at NO. 34. LIN 5, DINGFU VIL., LINKOU DIST., NEW TAIPEI CITY, TAIWAN, 24442, R.O.C.

This site has been fully described in a report submitted to your office, and accepted in a letter dated Jan. 11, 2011.

## 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

Except for Class A digital devices, for equipment that 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 150kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50 $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

Frequency MHz	Quasi Peak dB $\mu$ V	Average dB $\mu$ V
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

### (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 $\mu$ V/m	Radiated $\mu$ V/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 device, according to §15.209(a), the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the above table.

### (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**

According to 15.247(b), The maximum peak conducted output power of the intentional radiator shall not exceed the following:

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

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### **(6) 100 kHz Bandwidth of Frequency Band Edges Requirement**

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, 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)).

#### **(7) Power Density Requirement**

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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

## 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	4.5-5.15
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	3360-4400	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 Justification

For both radiated and conducted emissions below 1 GHz, the system was configured for testing in a typical fashion as a customer would normally use it. The peripherals other than EUT were connected in normally standing by situation. Measurement was performed under the condition that a computer program was exercised to simulate data communication of EUT, and the transmission rate was set to maximum allowed by EUT. Three highest emissions were verified with varying placement of the cables connected to EUT to maximize the emission from EUT.

For conducted and radiated spurious emissions, whichever RF channel is operated, the digital circuits function identically. As the reason, measurement of radiated emissions from digital circuits is only performed with channel 1 by transmitting mode.

#### 3.2 Devices for Tested System

Device	Manufacture	Model / FCC ID	Cable Description
ZIGBEE MODULE *	United Integrated Services CO., LTD.	ZBM-220 / XBTZBM-220XXX	0.5m Unshielded USB Cable
Notebook PC	DELL	PP25L	1.8mUnshielded AC Power Cord

Remark “\*” means equipment under test.

## 4 RADIATED EMISSION MEASUREMENT

### 4.1 Applicable Standard

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 digitally modulated intentional radiators, and the out band emission shall be comply with §15.247 (d).

### 4.2 Measurement Procedure

1. Setup the configuration per figure 1 and 2 for frequencies measured below and above 1 GHz respectively.
2. For emission frequencies measured below 1 GHz, a pre-scan is performed in a shielded chamber to determine the accurate frequencies of higher emissions will be checked on a open test site. As the same purpose, for emission frequencies measured above 1 GHz, a pre-scan also 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 100 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.
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 placement of cables associated with EUT to obtain the worse case and record the result.

Figure 1 : Frequencies measured below 1 GHz configuration

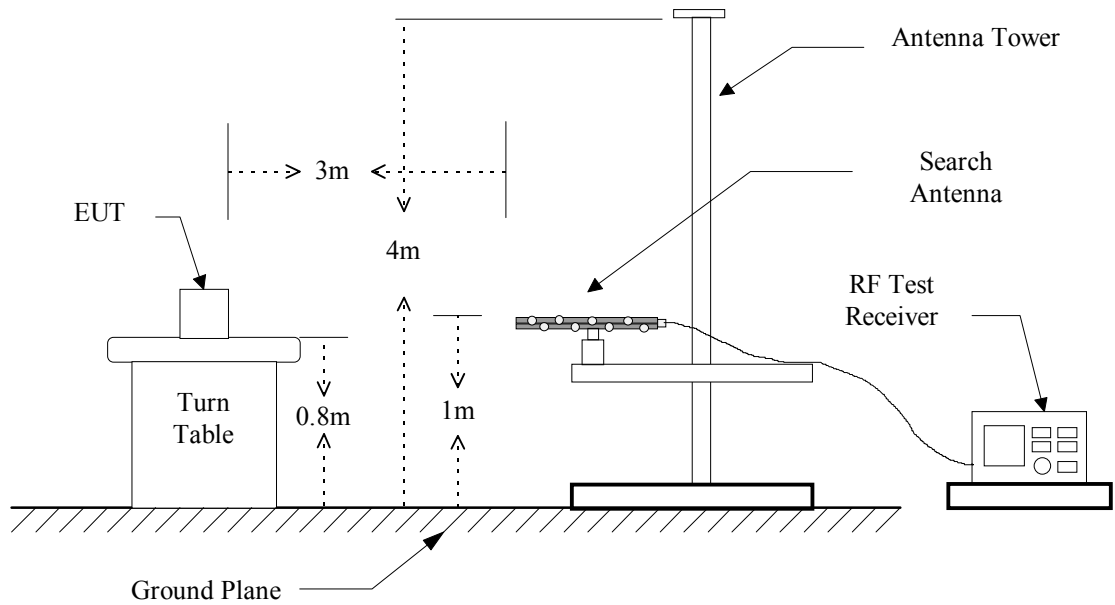
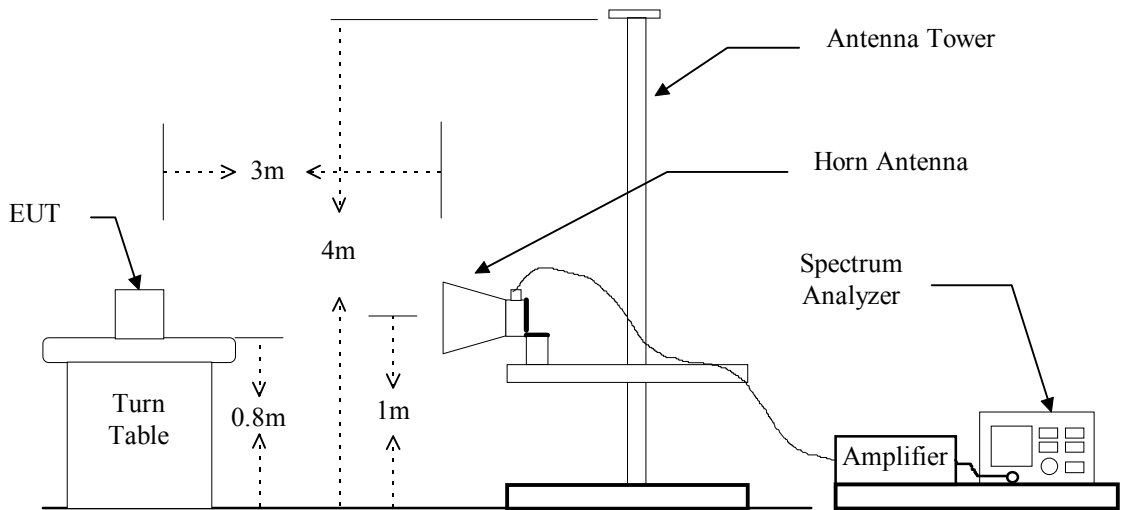


Figure 2 : Frequencies measured above 1 GHz configuration



### 4.3 Measuring Instrument

The following instrument are used for radiated emissions measurement:

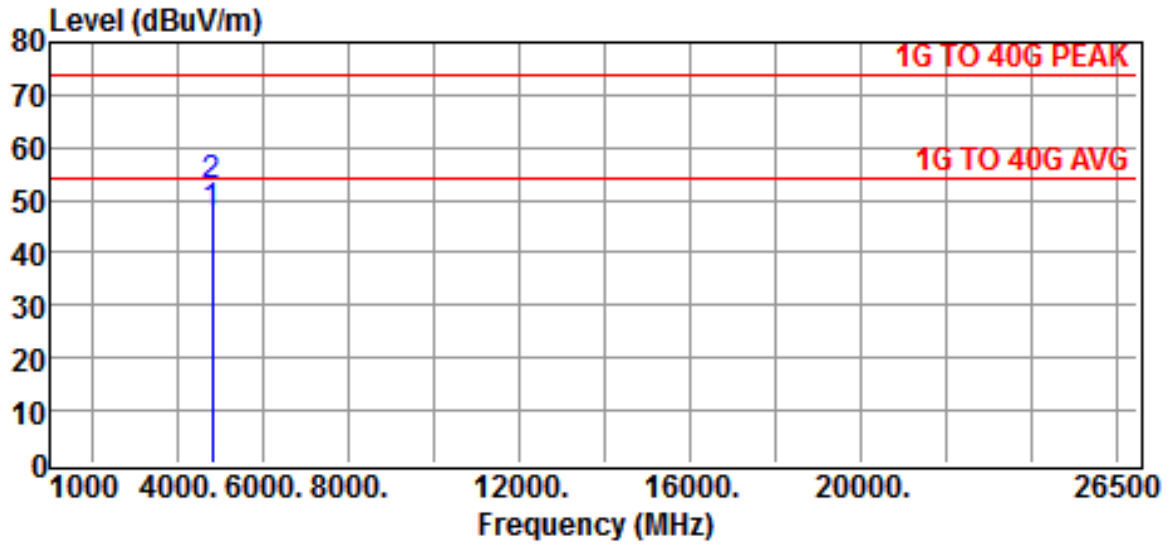
Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Test Receiver	Rohde & Schwarz	ESVS30	2012/05/07	2013/05/07
EMI Test Receiver	Rohde & Schwarz	ESL	2012/07/30	2013/07/30
Bi-Log Antenna	ETC	MCTD 2756	2013/01/17	2014/01/17
Log-periodic Antenna	EMCO	3146	2012/10/17	2013/10/17
Double Ridged Guide Horn Antenna	EMCO	3116	2012/10/26	2013/10/29
Biconical Antenna	EMCO	3110	2012/10/17	2013/10/17
Double Ridged Antenna	EMCO	3115	2012/05/18	2013/05/18
Amplifier	HP	8449B	2011/12/28	2012/12/27
Amplifier	HP	83051A	2012/05/16	2013/05/16
Amplifier	HP	8447D	2012/05/16	2013/05/16
Spectrum	Rohde & Schwarz	FSP40	2012/09/20	2013/09/20

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	N/A
	Spectrum Analyzer	Peak	100 kHz	100 kHz
Above 1000	Spectrum Analyzer	Peak	1 MHz	1 MHz
	Spectrum Analyzer	Average	1 MHz	10 Hz

### 4.4 Radiated Emission Data

#### 4.4.1 RF Portion



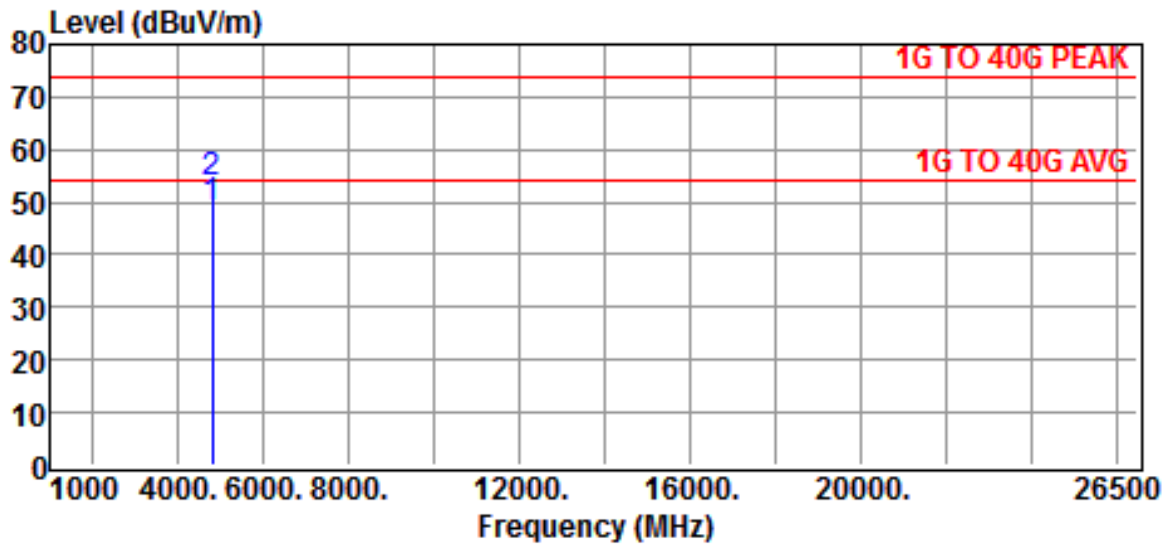
Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:HORIZONTAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH Low		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
4810.0000	46.1	1.3	47.4	54.0	-6.6	Average
4810.0000	51.4	1.3	52.7	74.0	-21.3	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit - Result



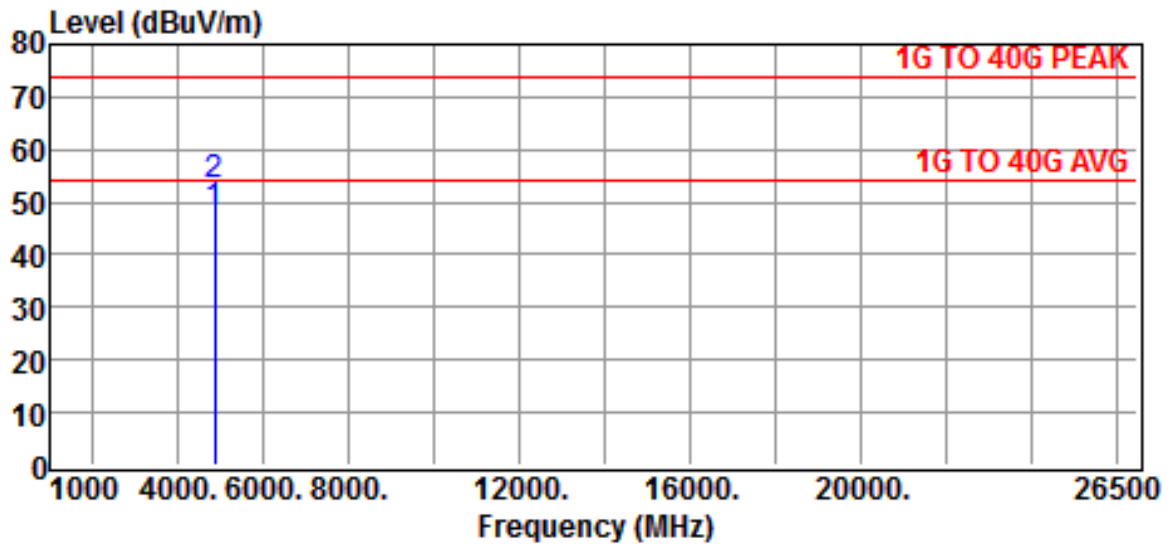


Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:VERTICAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH Low		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
4810.0000	47.4	1.3	48.7	54.0	-5.3	Average
4810.0000	52.5	1.3	53.8	74.0	-20.2	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit - Result

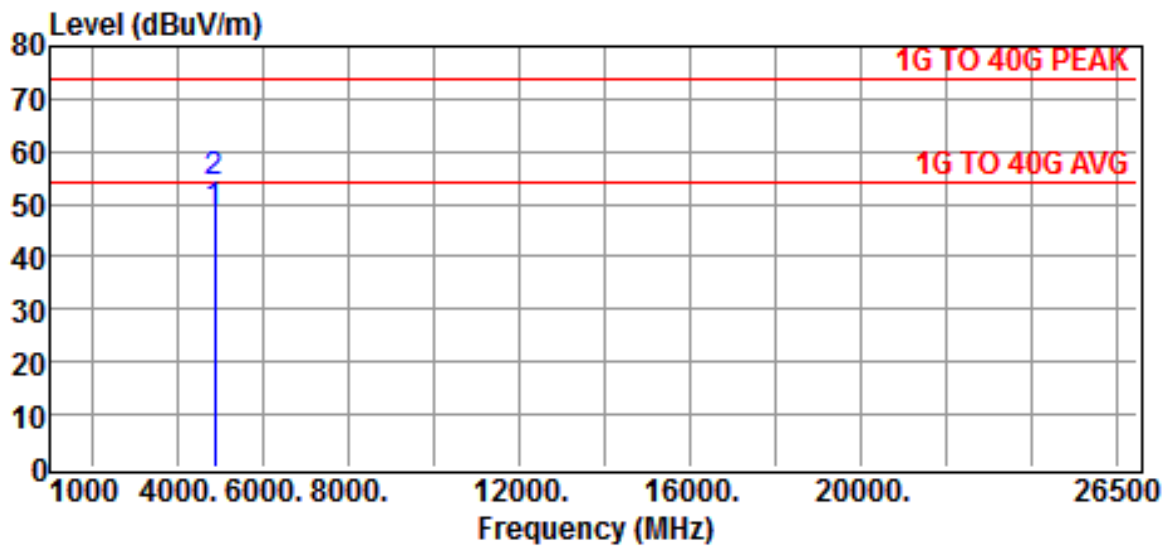


Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:HORIZONTAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH Mid		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
4880.0000	46.3	1.4	47.7	54.0	-6.3	Average
4880.0000	51.9	1.4	53.3	74.0	-20.7	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit - Result

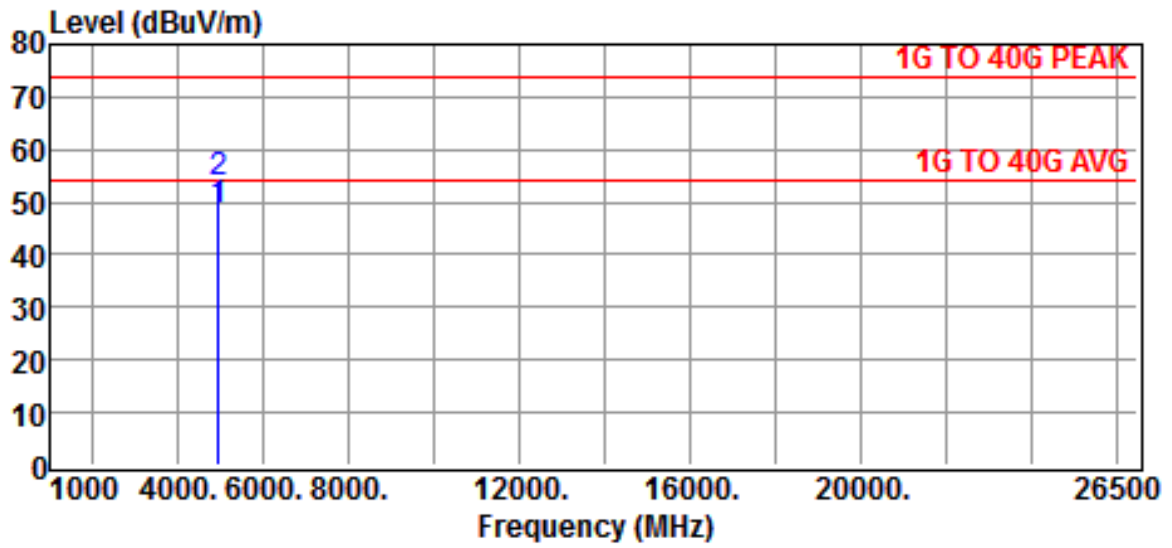


Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:VERTICAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH Mid		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
4880.0000	47.1	1.4	48.5	54.0	-5.5	Average
4880.0000	52.6	1.4	54.0	74.0	-20.0	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit - Result

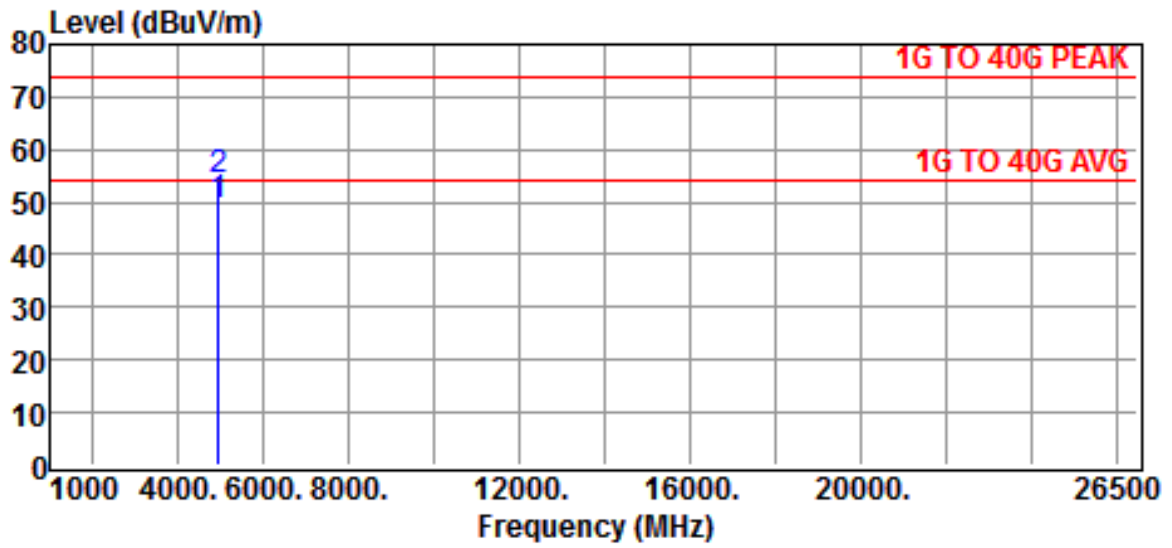


Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:HORIZONTAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH High		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
4960.0000	46.9	1.6	48.5	54.0	-5.5	Average
4960.0000	51.9	1.6	53.5	74.0	-20.5	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit - Result



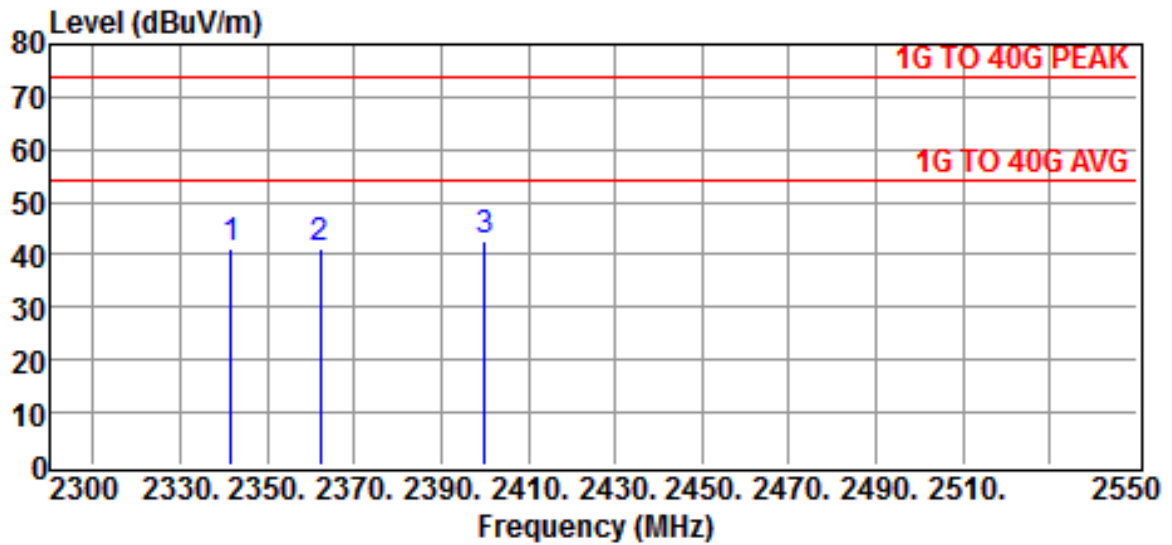
Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:VERTICAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH High		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
4960.0000	47.9	1.6	49.5	54.0	-4.5	Average
4960.0000	52.7	1.6	54.3	74.0	-19.7	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit - Result

**4.4.2 Radiated Emission of Restricted bands**

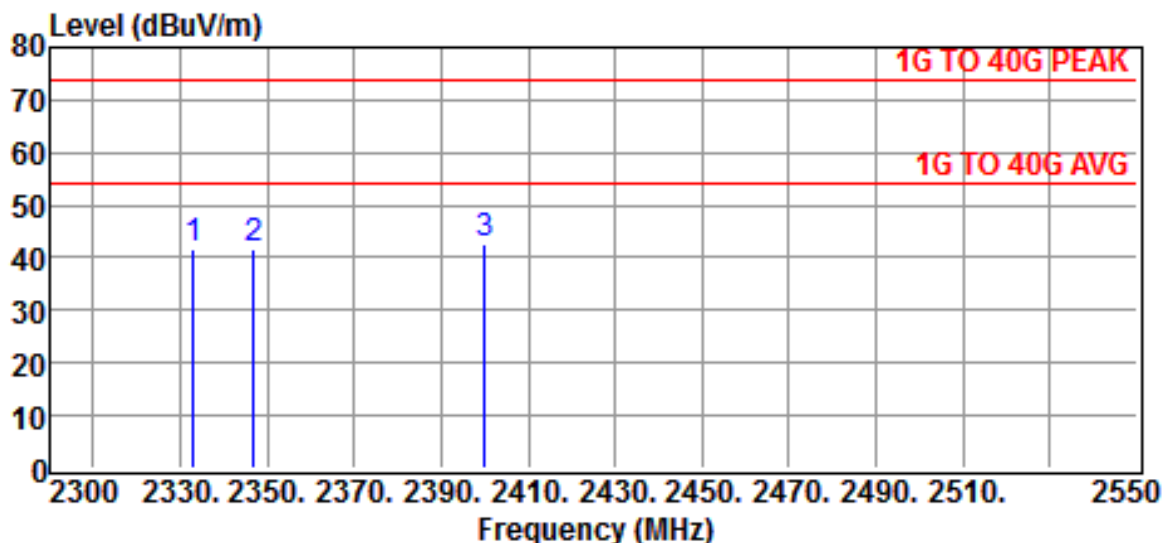


Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:HORIZONTAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH Low - Restricted Bands		
Test Mode	:		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
2341.7500	47.1	-5.9	41.2	74.0	-32.8	Peak
2362.2500	47.2	-5.9	41.3	74.0	-32.7	Peak
2400.0000	48.3	-5.8	42.5	74.0	-31.5	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit – Result
5. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.

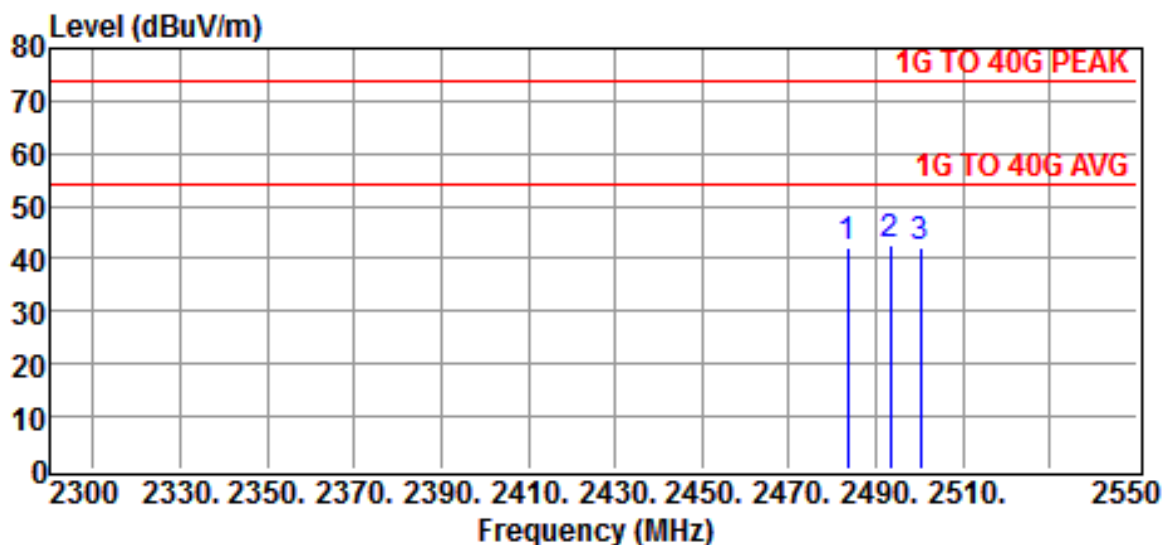


Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:VERTICAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH Low - Restricted Bands		
Test Mode	:		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
2333.0000	47.6	-6.0	41.6	74.0	-32.4	Peak
2347.0000	47.5	-5.9	41.6	74.0	-32.4	Peak
2400.0000	48.3	-5.8	42.5	74.0	-31.5	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit – Result
5. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.



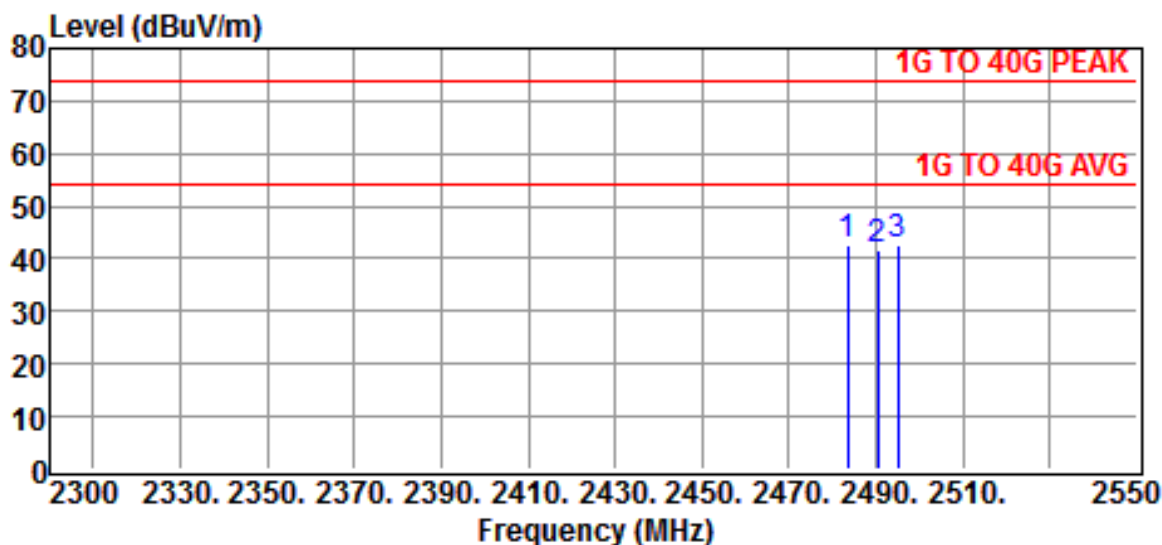
Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:HORIZONTAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH High - Restricted Bands		
Test Mode	:		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
2483.5000	47.5	-5.4	42.1	74.0	-31.9	Peak
2493.2500	47.9	-5.4	42.5	74.0	-31.5	Peak
2500.2500	47.5	-5.4	42.1	74.0	-31.9	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit – Result
5. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.





Site	:CHAMBER #2	Date	:2013-02-06
Limit	:1G TO 40G PEAK	Ant. Pol.	:VERTICAL
EUT	: ZIGBEE MODULE	Temp.	:20°C
Power Rating	:DC 3V	Humi.	:65%
Model	: ZBM-220	Engineer.	:VC
Test Mode	: CH High - Restricted Bands		
Test Mode	:		

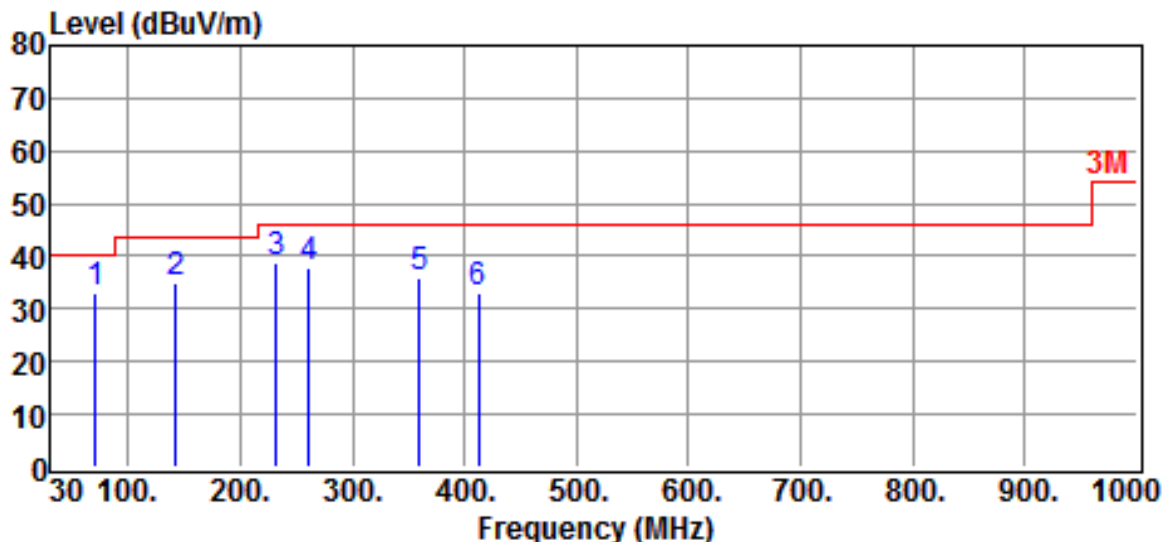
Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
2483.5000	47.9	-5.4	42.5	74.0	-31.5	Peak
2490.5000	47.2	-5.4	41.8	74.0	-32.2	Peak
2495.0000	48.0	-5.4	42.6	74.0	-31.4	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit – Result
5. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.

### 4.4.3 Other Emission

a) Emission frequencies below 1 GHz



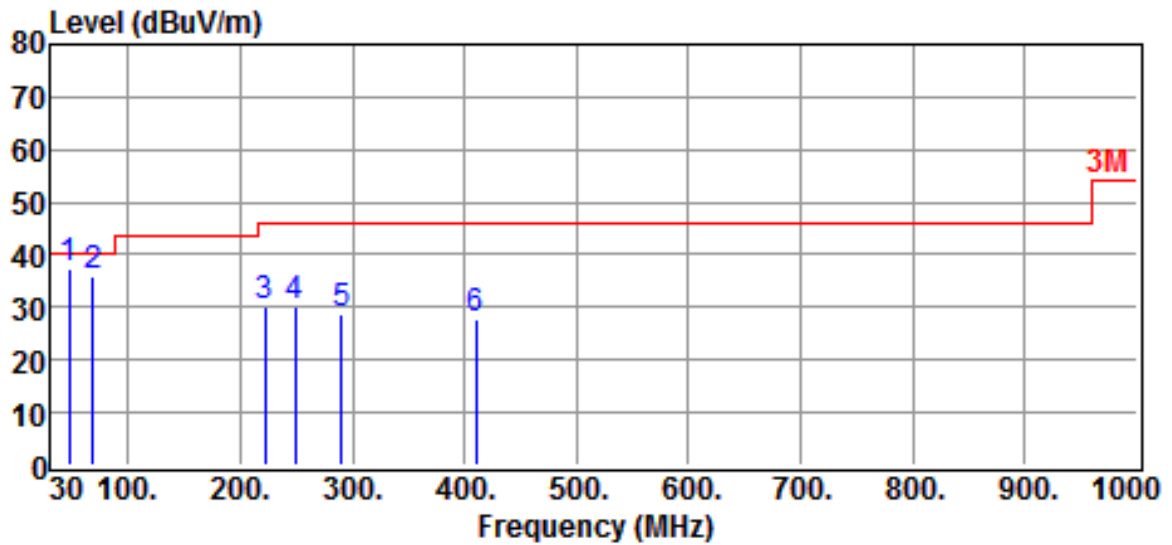
Site	: OPEN SITE	Date	: 2013-02-06
Limit	: 3M	Ant. Pol.	: HORIZONTAL
EUT	: ZIGBEE MODULE	Temp.	: 20°C
Power Rating	: DC 3V	Humi.	: 65%
Model	: ZBM-220	Engineer.	: VC
Test Mode	: CH High (Worst case)		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
70.7400	22.8	10.4	33.2	40.0	-6.8	QP
142.5200	21.1	14.1	35.2	43.5	-8.3	QP
231.7600	20.0	18.9	38.9	46.0	-7.1	QP
260.8600	16.5	21.1	37.6	46.0	-8.4	QP
359.8000	17.8	18.0	35.8	46.0	-10.2	QP
412.1800	13.8	19.4	33.2	46.0	-12.8	QP

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
4. The margin value=Limit - Result

Test Date : Feb. 06, 2013    Temperature : 20 °C    Humidity : 65 %



Site	: OPEN SITE	Date	: 2013-02-06
Limit	: 3M	Ant. Pol.	: VERTICAL
EUT	: ZIGBEE MODULE	Temp.	: 20°C
Power Rating	: DC 3V	Humi.	: 65%
Model	: ZBM-220	Engineer.	: VC
Test Mode	: CH High (Worst case)		

Freq MHz	Reading dBuV	Correction Factor dB	Result dBuV/m	Limits dBuV/m	Over limit dB	Detector
47.4600	24.9	12.3	37.2	40.0	-2.8	QP
68.8000	25.6	10.5	36.1	40.0	-3.9	QP
222.0600	11.8	18.6	30.4	46.0	-15.6	QP
249.2200	10.1	20.0	30.1	46.0	-15.9	QP
289.9600	5.3	23.6	28.9	46.0	-17.1	QP
410.2400	8.5	19.4	27.9	46.0	-18.1	QP

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss
3. The expanded uncertainty of the radiated emission tests is 3.53 dB.
- 4.. The margin value=Limit - Result

## 4.5 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:

$$\mathbf{Result = Reading + Corrected Factor}$$

where

$$\text{Corrected Factor} = \text{Antenna FACTOR} + \text{Cable Loss} + \text{High Pass Filter Loss} - \text{Amplifier Gain}$$

## 4.6 Photos of Radiation Measuring Setup



## 5 CONDUCTED EMISSION MEASUREMENT

### 5.1 Standard Applicable

According to §15.207(a), except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that 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 150kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

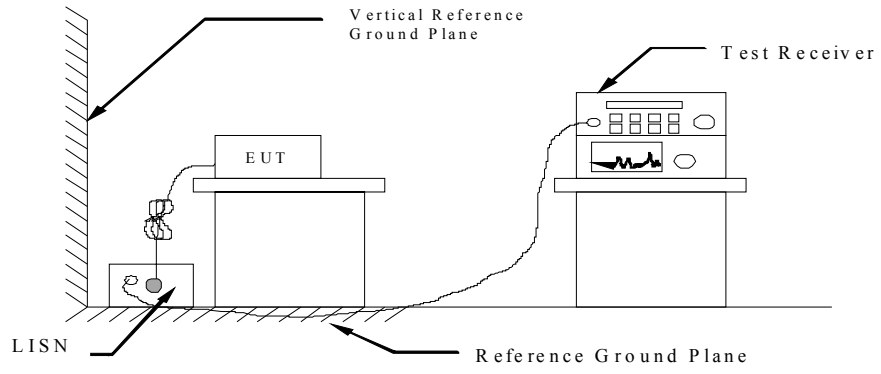
Frequency MHz	Quasi Peak dB $\mu$ V	Average dB $\mu$ V
0.15 - 0.5	66-56*	56-46*
0.5 - 5.0	56	46
5.0 - 30.0	60	50

\* Decreases with the logarithm of the frequency

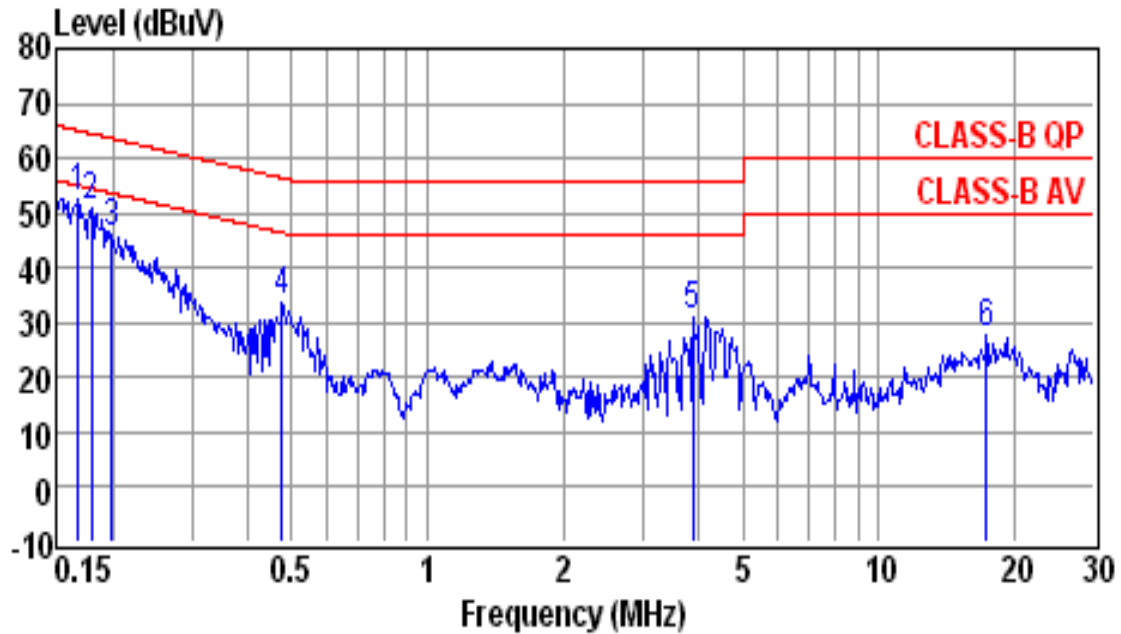
### 5.2 Measurement Procedure

1. Setup the configuration per figure 5.
2. 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.
3. Record the 6 or 8 highest emissions relative to the limit.
4. Measure each frequency obtained from step 3 by a test receiver set on quasi peak detector function, and then records 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.
5. Confirm the highest three emissions with variation of the EUT cable configuration and record the final data.
6. Repeat all above procedures on measuring each operation mode of EUT.

Figure 5: Conducted emissions measurement configuration



### 5.3 Conducted Emission Data



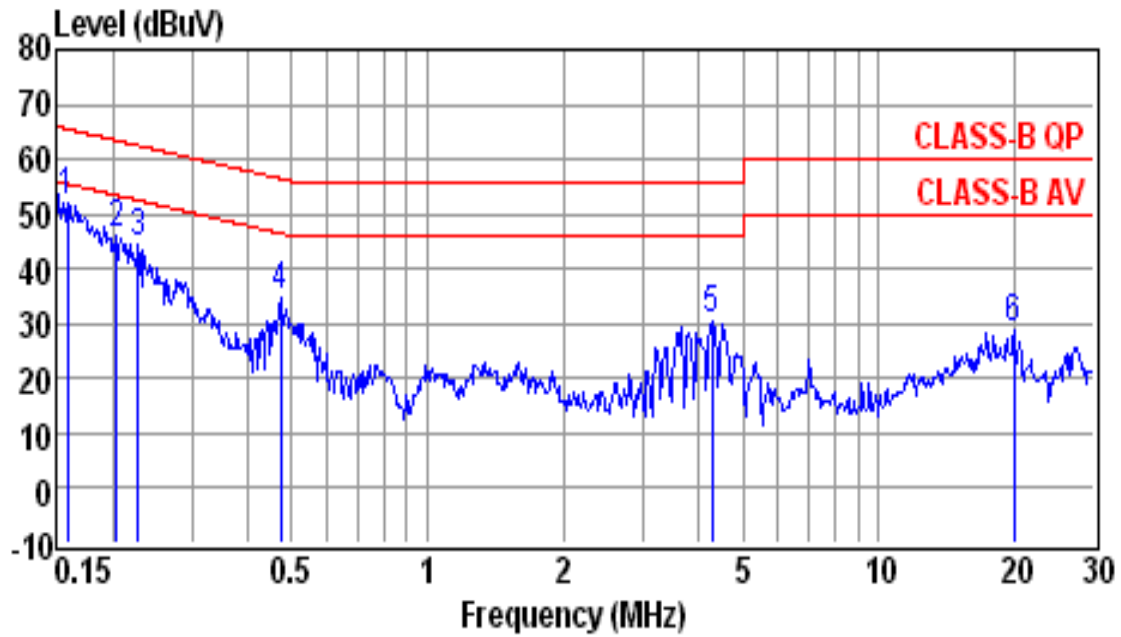
Site : conducted #1 Date : 05-17-2013  
 Condition : CLASS-B QP LISN : NEUTRAL  
 Tem / Hum : 25 °C / 65% Test Mode : CH High (Worst case)  
 EUT : ZIGBEE MODULE Power Rating :  
 Memo : Memo :

Freq (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV)	Limit Line (dBuV)	Over Limit (dB)	Remark
0.1677	42.1	10.3	52.4	65.1	-12.7	QP
0.1796	40.4	10.3	50.7	64.5	-13.8	QP
0.1997	35.7	10.3	46.0	63.6	-17.6	QP
0.4761	23.3	10.3	33.6	56.4	-22.8	QP
3.8810	20.6	10.5	31.1	56.0	-24.9	QP
17.3830	17.0	10.8	27.8	60.0	-32.2	QP

Note :

1. Result = Reading + Factor
2. Factor = LISN Factor + Cable Loss





Site : conducted #1 Date : 05-17-2013  
 Condition : CLASS-B QP LISN : LINE  
 Tem / Hum : 25 °C / 65% Test Mode : CH High (Worst case)  
 EUT : ZIGBEE MODULE Power Rating :  
 Memo : Memo :

Freq (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV)	Limit Line (dBuV)	Over Limit (dB)	Remark
0.1590	41.6	10.3	51.9	65.5	-13.6	QP
0.2040	35.5	10.3	45.8	63.4	-17.6	QP
0.2280	34.0	10.3	44.3	62.5	-18.2	QP
0.4711	24.7	10.3	35.0	56.5	-21.5	QP
4.2690	19.9	10.5	30.4	56.0	-25.6	QP
19.9500	17.6	11.1	28.7	60.0	-31.3	QP

Note :

1. Result = Reading + Factor
2. Factor = LISN Factor + Cable Loss

## 5.4 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:

$$\mathbf{RESULT = READING + LISN FACTOR}$$

Assume a receiver reading of 22.5 dB  $\mu$  V is obtained, and LISN Factor is 0.1 dB, then the total of disturbance voltage is 22.6 dB  $\mu$  V.

$$\text{RESULT} = 22.5 + 0.1 = 22.6 \text{ dB } \mu \text{ V}$$

$$\begin{aligned} \text{Level in } \mu \text{ V} &= \text{Common Antilogarithm}[(22.6 \text{ dB } \mu \text{ V})/20] \\ &= 13.48 \mu \text{ V} \end{aligned}$$

## 5.5 Conducted Measurement Equipment

The following test equipments are used during the conducted test.

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
EMI Test Receiver	Rohde & Schwarz	ESCI	2012/07/16	2013/07/16
LISN	EMCO	3825/2	2012/11/02	2013/11/02
LISN	Rohde & Schwarz	ESH2-Z5	2012/08/23	2013/08/23

## 5.6 Photos of Conduction Measuring Setup



## **6 ANTENNA REQUIREMENT**

### **6.1 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.

### **6.2 Antenna Construction and Directional Gain**

Please see photos submitted in Exhibit.

The printed antenna was embedded in the EUT. No consideration of replacement. The antenna gain is 2dBi. No need to reduce the peak output power.

## 7 EMISSION BANDWIDTH MEASUREMENT

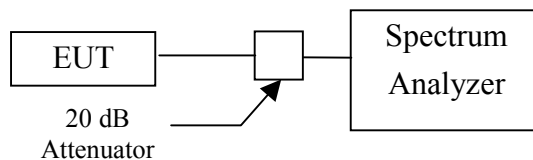
### 7.1 Standard Applicable

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.

### 7.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. 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. The settings of spectrum analyzer is as followings.
  - 1) Set resolution bandwidth (RBW) = 1-5% or DTS BW, not to exceed 100 kHz.
  - 2) Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
  - 3) Detector = Peak.
  - 4) Trace mode = max hold.
  - 5) Sweep = auto couple.
  - 6) Allow the trace to stabilize.
  - 7) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.
3. Repeat above procedures until all frequencies measured were complete.

Figure 4: Emission bandwidth measurement configuration.



### 7.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2012/12/07	2013/12/07

## 7.4 Measurement Data

Test Date : Feb. 06, 2013      Temperature : 20 °C      Humidity : 65 %

- a) Channel Low: 6 dB Emission Bandwidth is 1.48 MHz
- b) Channel Mid: 6 dB Emission Bandwidth is 1.46 MHz
- c) Channel High: 6 dB Emission Bandwidth is 1.48 MHz

*Note : The expanded uncertainty: frequency  $\times 1.65 \times 10^{-6}$  ( $1 \text{ GHz} < f \leq 18 \text{ GHz}$ ).*

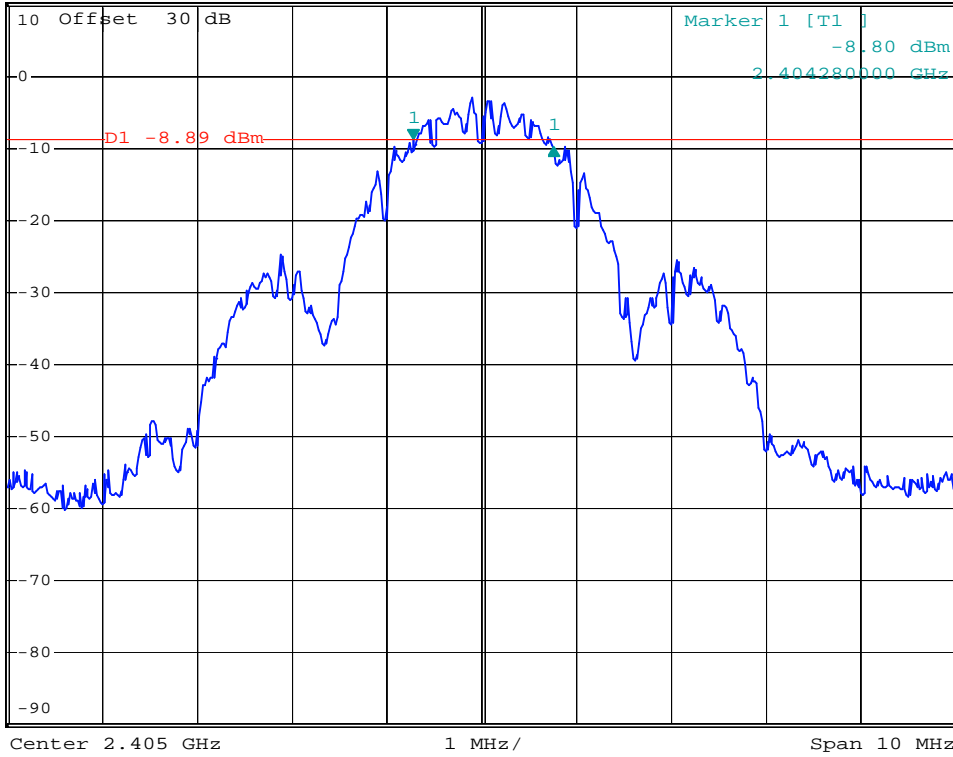


\*RBW 30 kHz Delta 1 [T1 ]  
VBW 100 kHz -1.07 dB  
SWT 15 ms 1.480000000 MHz

Ref 10 dBm

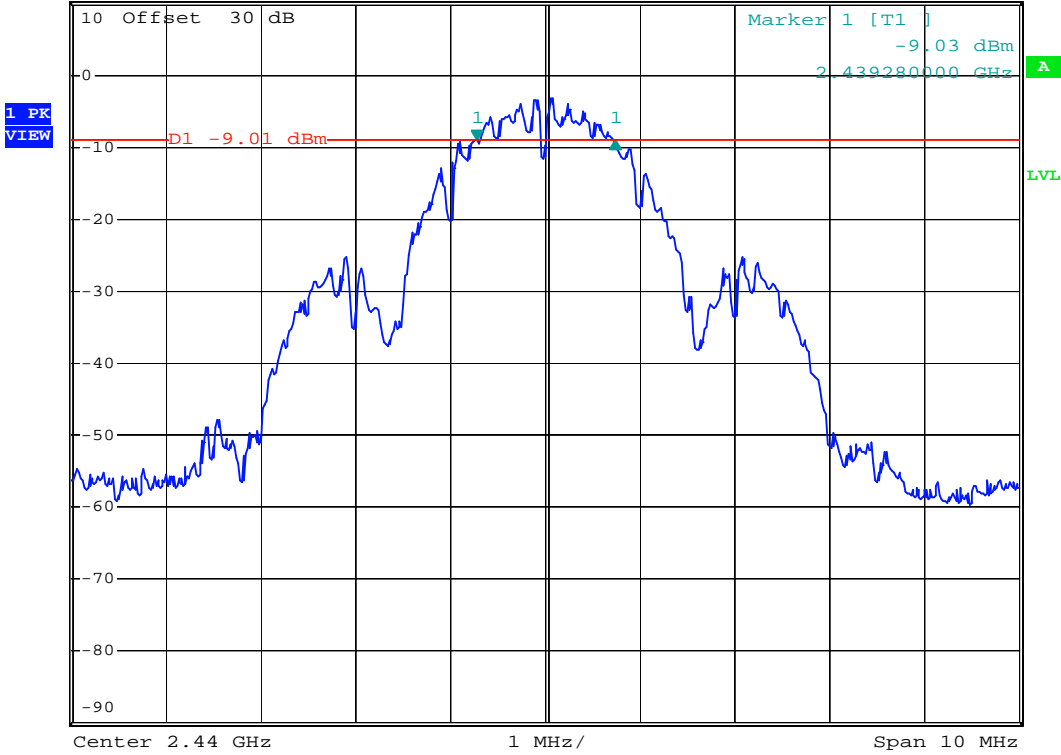
Att 10 dB

PK  
VIEW

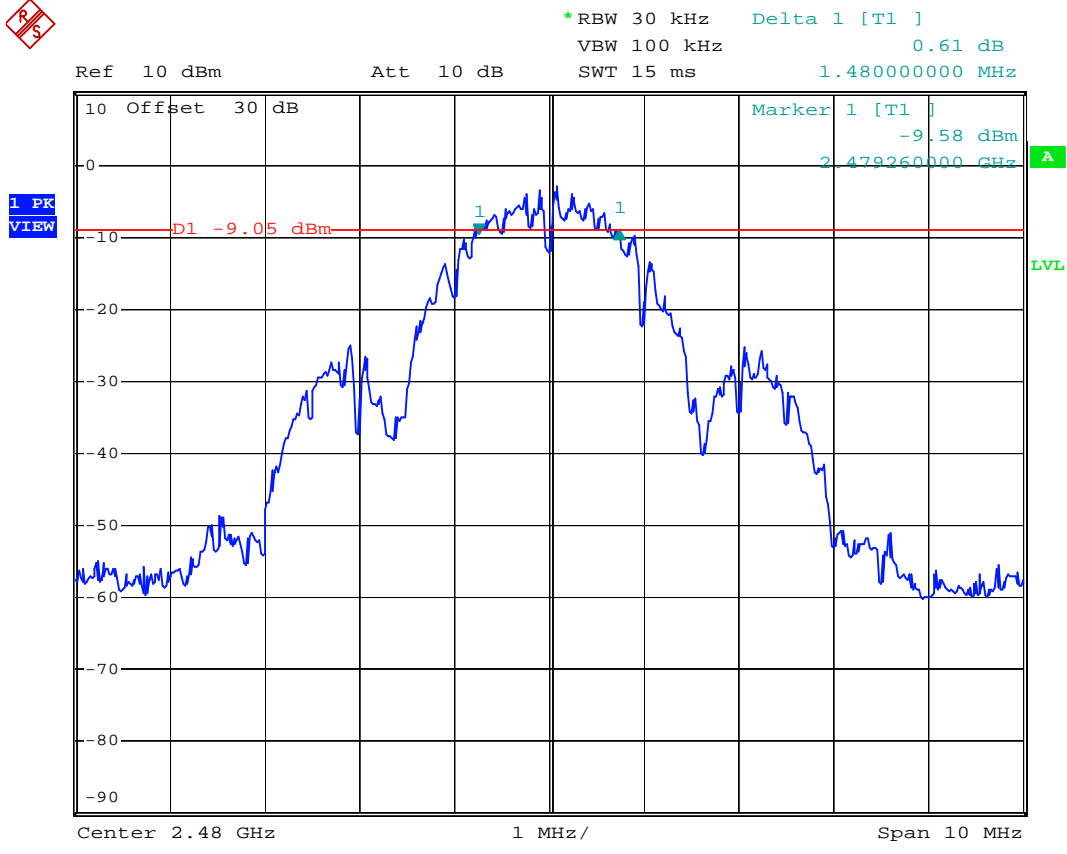




Ref 10 dBm Att 10 dB \*RBW 30 kHz Delta 1 [T1 ]  
VBW 100 kHz 0.06 dB  
SWT 15 ms 1.460000000 MHz







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## 8 OUTPUT POWER MEASUREMENT

### 8.1 Standard Applicable

According to 15.247(b), The maximum peak conducted output power of the intentional radiator shall not exceed the following:

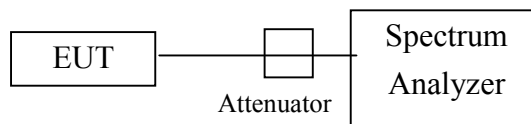
(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 8.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 5 without connection to measurement instrument. 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.
3. The settings of spectrum analyzer is as followings.
  - 1) Set the RBW = maximum available (at least 1 MHz).
  - 2) Set the VBW = 3 x RBW or maximum available setting (must be  $\geq$  RBW).
  - 3) Set the span to fully encompass the DTS bandwidth.
  - 4) Detector = peak.
  - 5) Sweep time = auto couple.
  - 6) Trace mode = max hold.
  - 7) Allow trace to fully stabilize.
  - 8) Use the spectrum analyzer's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges.
4. Repeat above procedures until all frequencies measured were complete.

Figure 5: Output power and measurement configuration.



### 8.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2012/12/07	2013/12/07

## 8.4 Measurement Data

Test Date : Feb. 06, 2013      Temperature : 20 °C      Humidity : 65 %

- a) Channel Low: Output Peak Power is 3.44 dBm **2.208** mW
- b) Channel Mid: Output Peak Power is 3.16 dBm **2.070** mW
- c) Channel High: Output Peak Power is 2.49 dBm **1.774** mW

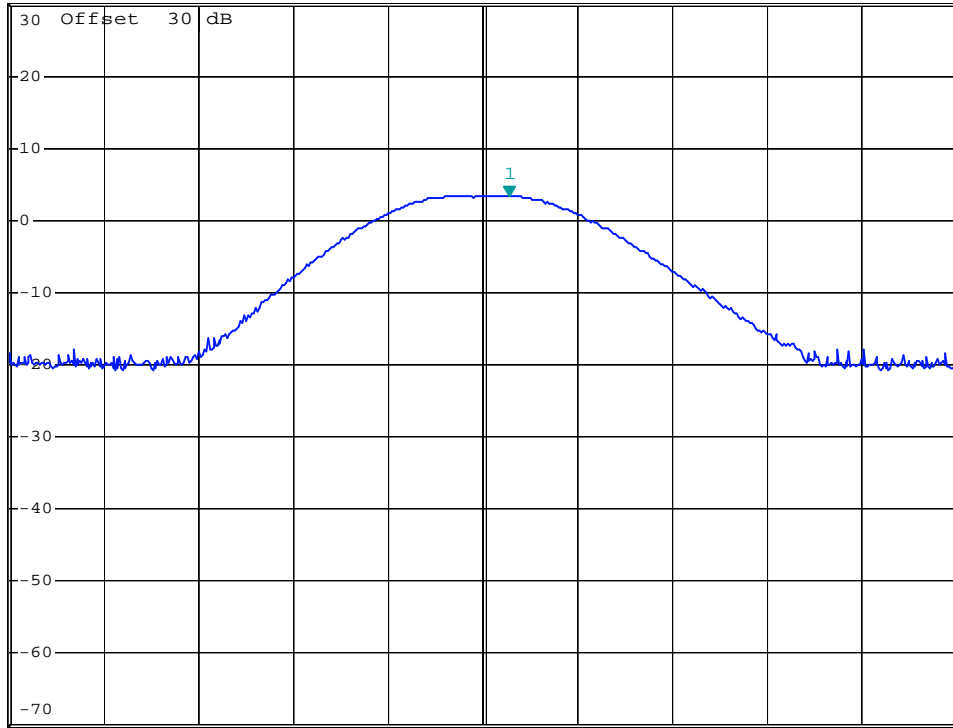


\*RBW 3 MHz    Marker 1 [T1 ]  
VBW 10 MHz                    3.44 dBm  
SWT 2.5 ms                    2.405560000 GHz

Ref 30 dBm

Att 30 dB

1 PK  
VIEW



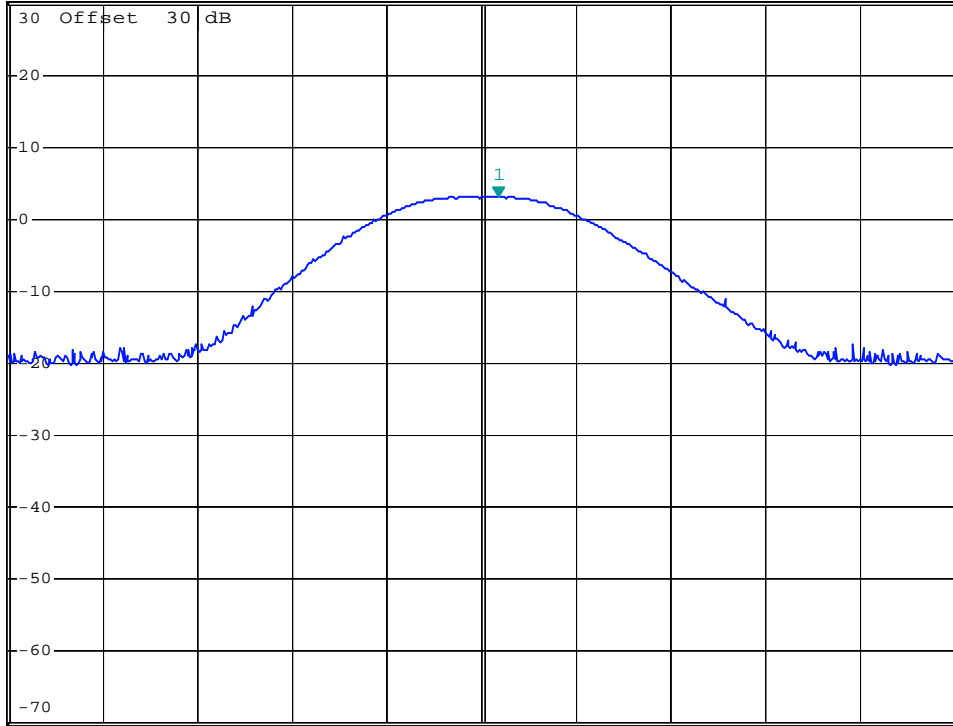


\*RBW 3 MHz      Marker 1 [T1 ]  
VBW 10 MHz      3.16 dBm  
SWT 2.5 ms      2.440360000 GHz

Ref 30 dBm

Att 30 dB

1 PK  
VIEW



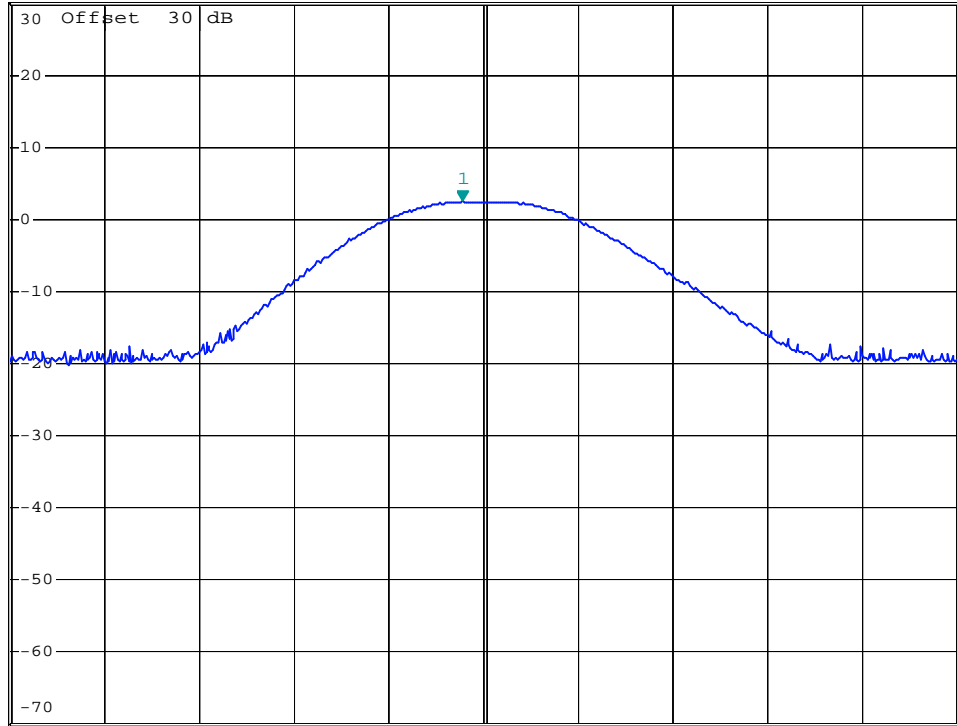


\*RBW 3 MHz      Marker 1 [T1 ]  
VBW 10 MHz      2.49 dBm  
SWT 2.5 ms      2.479560000 GHz

Ref 30 dBm

Att 30 dB

1 PK  
VIEW



Center 2.48 GHz

2 MHz/

Span 20 MHz

## 9 100 kHz BANDWIDTH OF BAND EDGES MEASUREMENT

### 9.1 Standard Applicable

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, 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)).

### 9.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 5 without connection to measurement instrument. 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.
3. Set both RBW of spectrum analyzer to 100kHz and VBW to  $\geq 300$ kHz with a convenient frequency span including 100kHz bandwidth from band edge.
4. 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.
5. Repeat above procedures until all measured frequencies were complete.

### 9.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2012/12/07	2013/12/07

## 9.4 Measurement Data

Test Date : Feb. 06, 2013      Temperature : 20 °C      Humidity : 65 %

- a) Lower Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.
- b) Upper Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.

***Note : The expanded uncertainty: 2dB.***



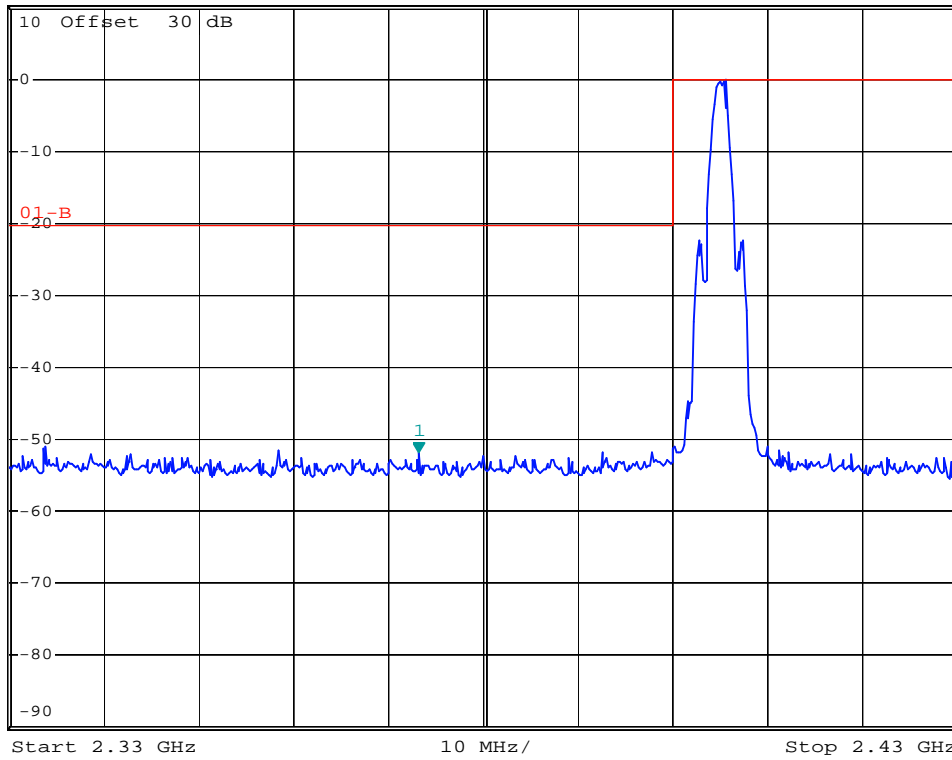


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -51.77 dBm  
SWT 10 ms 2.373200000 GHz

Ref 10 dBm

Att 10 dB

1 PK  
VIEW





## 10 POWER DENSITY MEASUREMENT

### 10.1 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

### 10.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. 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.
3. Following the procedures below.
  - 1) Set analyzer center frequency to DTS channel center frequency.
  - 2) Set the span to 1.5 times the DTS channel bandwidth.
  - 3) Set the RBW  $\geq$  3 kHz.
  - 4) Set the VBW  $\geq$  3 x RBW.
  - 5) Detector = peak.
  - 6) Sweep time = auto couple.
  - 7) Trace mode = max hold.
  - 8) Allow trace to fully stabilize.
  - 9) Use the peak marker function to determine the maximum amplitude level.
  - 10) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
4. Repeat above procedures until all measured frequencies were complete.

### 10.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2012/12/07	2013/12/07

## 10.4 Measurement Data

Test Date : Feb. 06, 2013      Temperature : 20 °C      Humidity : 65 %

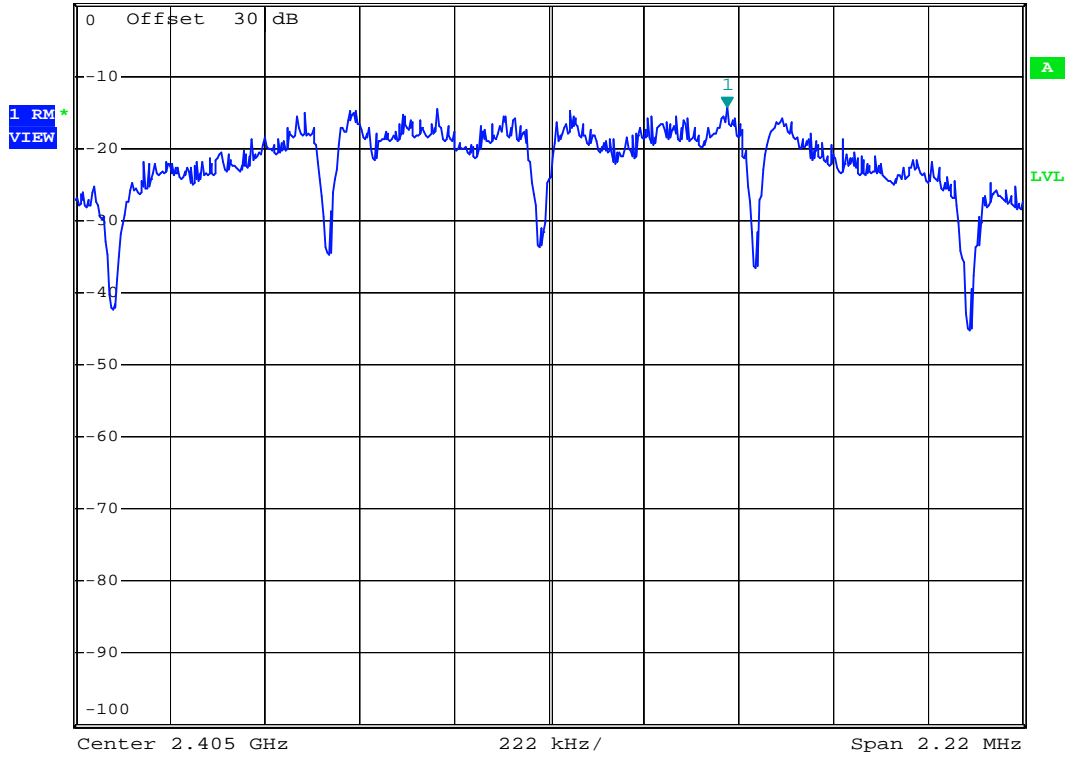
### Maximun Power Density (MPD) Test Result

- a) Channel Low: MPD is -14.23 dBm = 0.038 mW
- b) Channel Mid: MPD is -14.66 dBm = 0.034 mW
- c) Channel High: MPD is -13.91 dBm = 0.041 mW

*Note : The expanded uncertainty: 2dB.*



\*RBW 3 kHz      Marker 1 [T1 ]  
\*VBW 10 kHz      -14.23 dBm  
Ref 0 dBm      Att 10 dB      SWT 250 ms      2.405417360 GHz

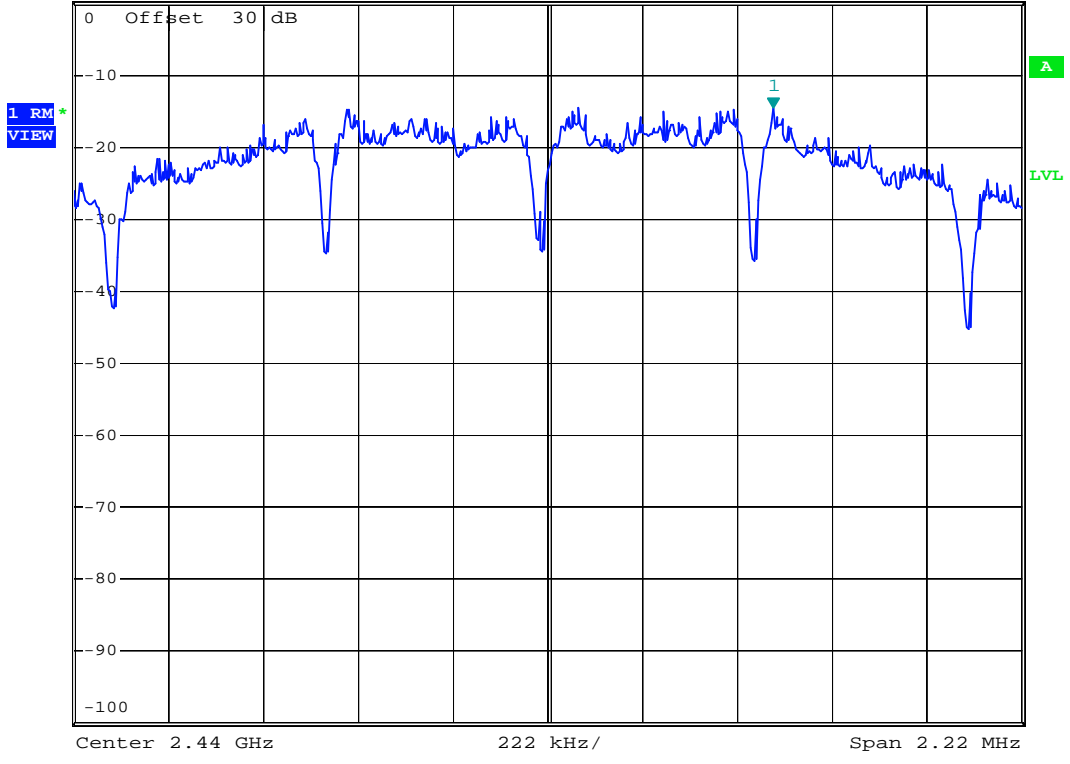


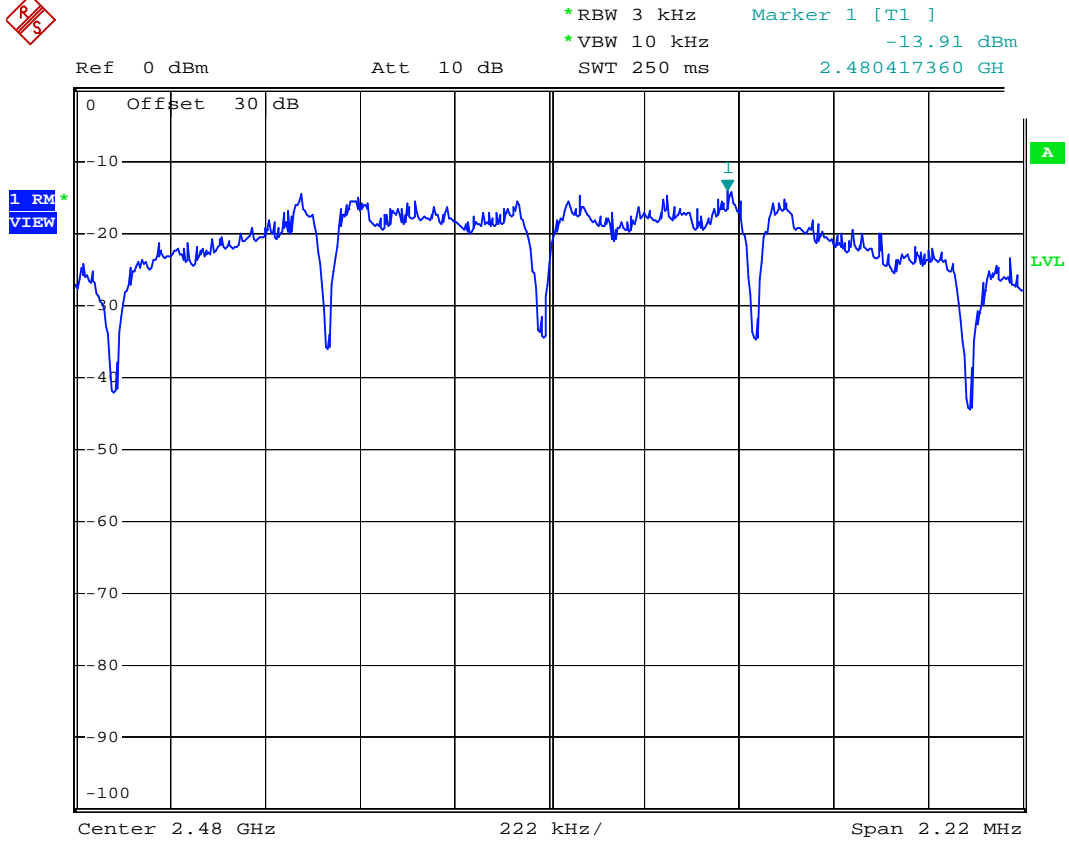


\*RBW 3 kHz      Marker 1 [T1 ]  
\*VBW 10 kHz      -14.66 dBm  
SWT 250 ms      2.440528360 GHz

Ref 0 dBm

Att 10 dB





## 11 OUT-OF-BAND CONDUCTED EMISSION MEASUREMENT

### 11.1 Standard Applicable

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, 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)).

### 11.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. 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.
3. Use the following spectrum analyzer settings:
  - 1) Set start frequency to DTS channel edge frequency.
  - 2) Set stop frequency so as to encompass the spectrum to be examined.
  - 3) Set RBW = 100 kHz.
  - 4) Set VBW  $\geq$  300 kHz.
  - 5) Detector = peak.
  - 6) Trace Mode = max hold.
  - 7) Sweep = auto couple.
  - 8) Allow the trace to stabilize (this may take some time, depending on the extent of the span).
  - 9) Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.
4. Repeat above procedures until all measured frequencies were complete.

### 11.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2012/12/07	2013/12/07



## 11.4 Measurement Data

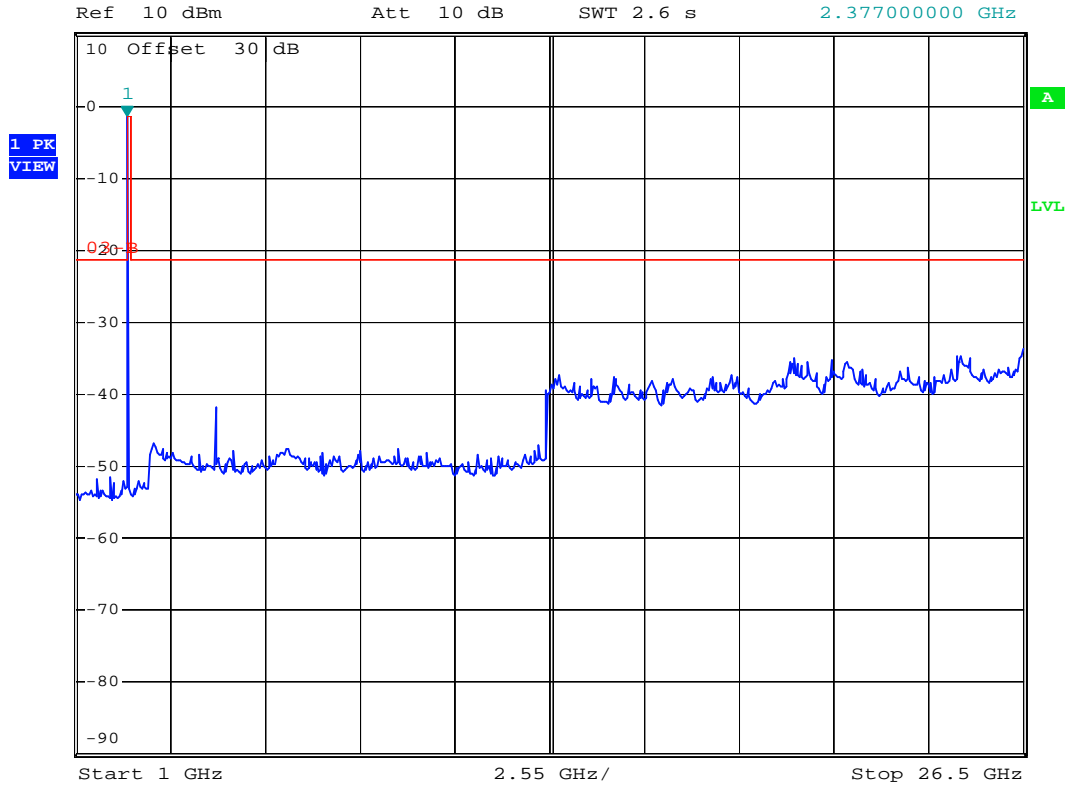
Test Date : Feb. 06, 2013      Temperature : 20 °C      Humidity : 65 %

<b>Test Mode</b>	<b>Result</b>
<b>Channel Low</b>	1 GHz to 26.5 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.
<b>Channel Middle</b>	1 GHz to 26.5 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.
<b>Channel High</b>	1 GHz to 26.5 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

*Note : The expanded uncertainty: 2dB.*



\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -1.44 dBm  
SWT 2.6 s 2.377000000 GHz



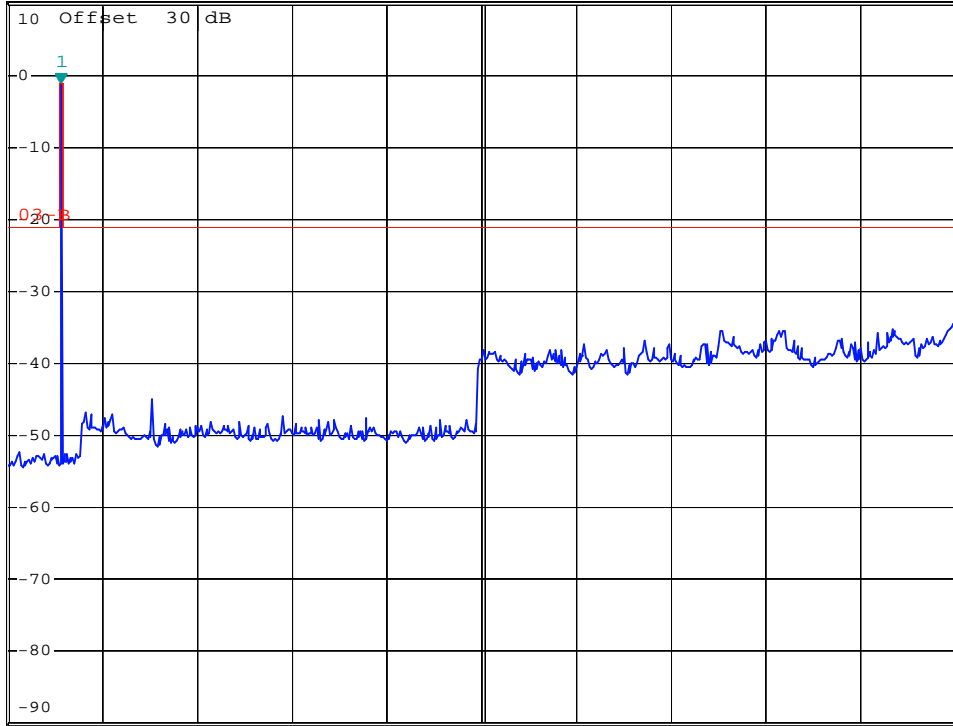


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -1.08 dBm  
SWT 2.6 s 2.428000000 GHz

Ref 10 dBm

Att 10 dB

1 PK  
VIEW

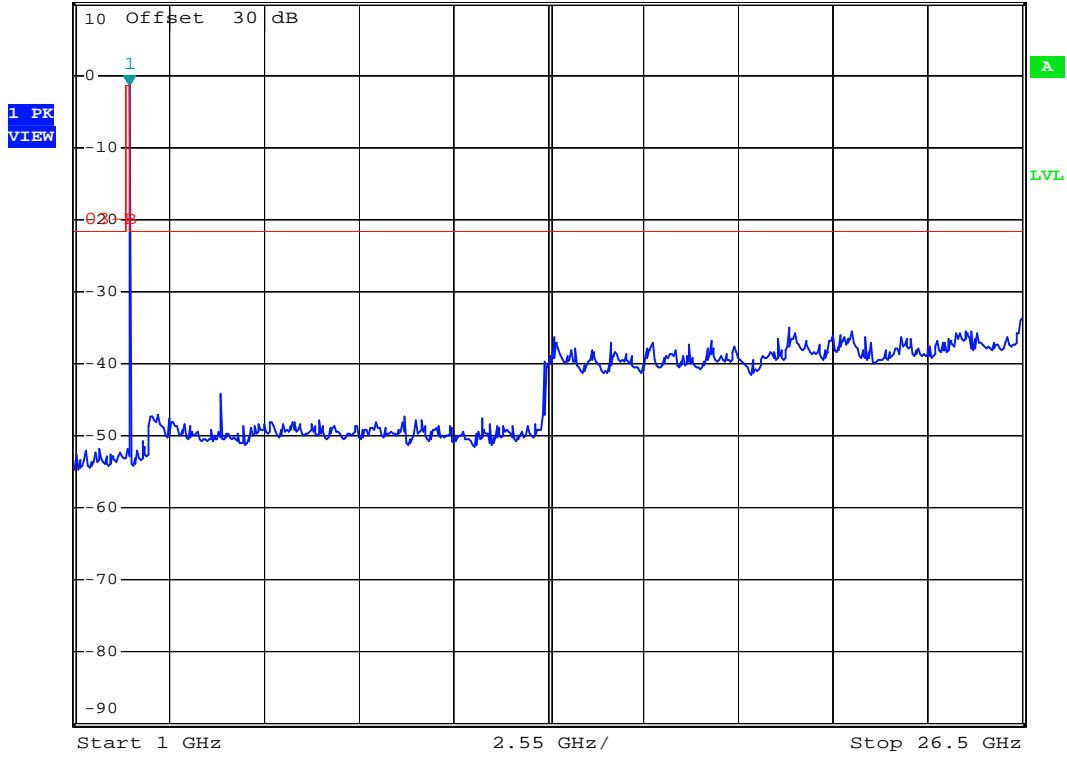




\*RBW 100 kHz Marker 1 [T1 ]  
VEW 300 kHz -1.50 dBm  
SWT 2.6 s 2.479000000 GHz

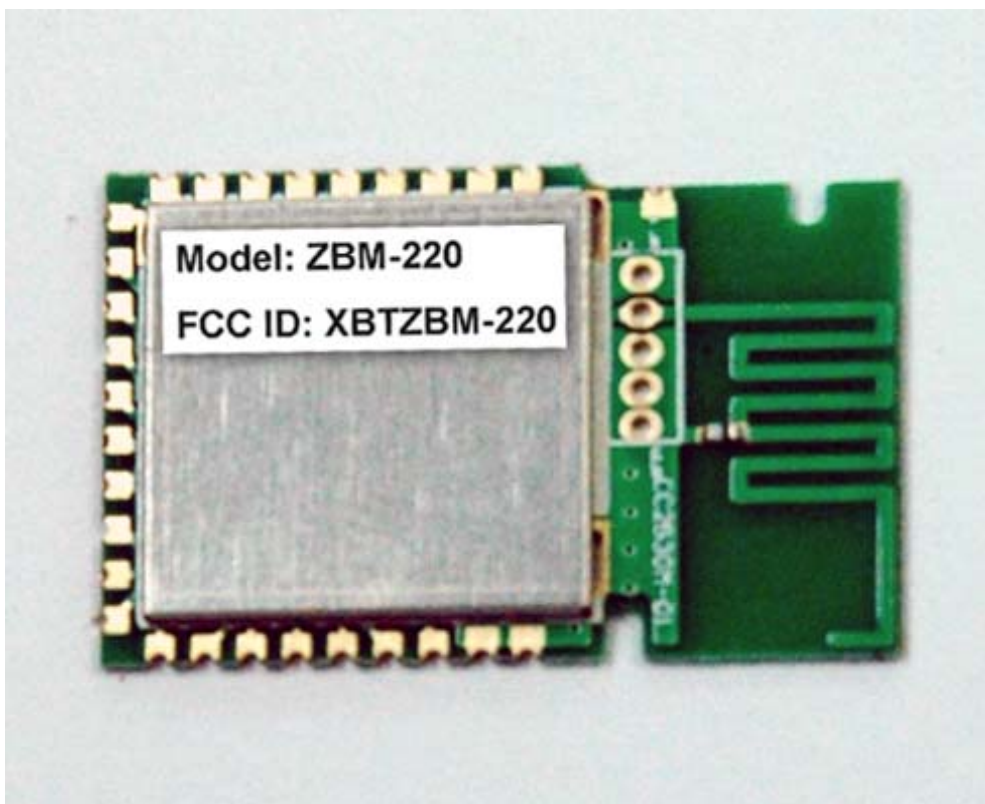
Ref 10 dBm

Att 10 dB

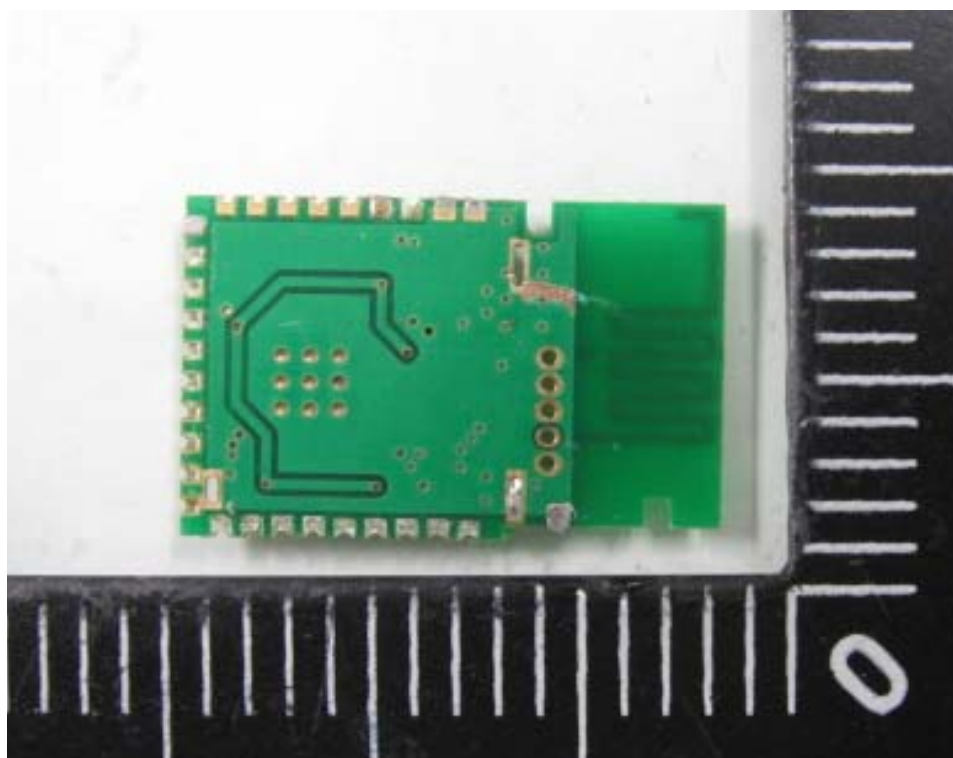


## CONSTRUCTION PHOTOS OF EUT

1.

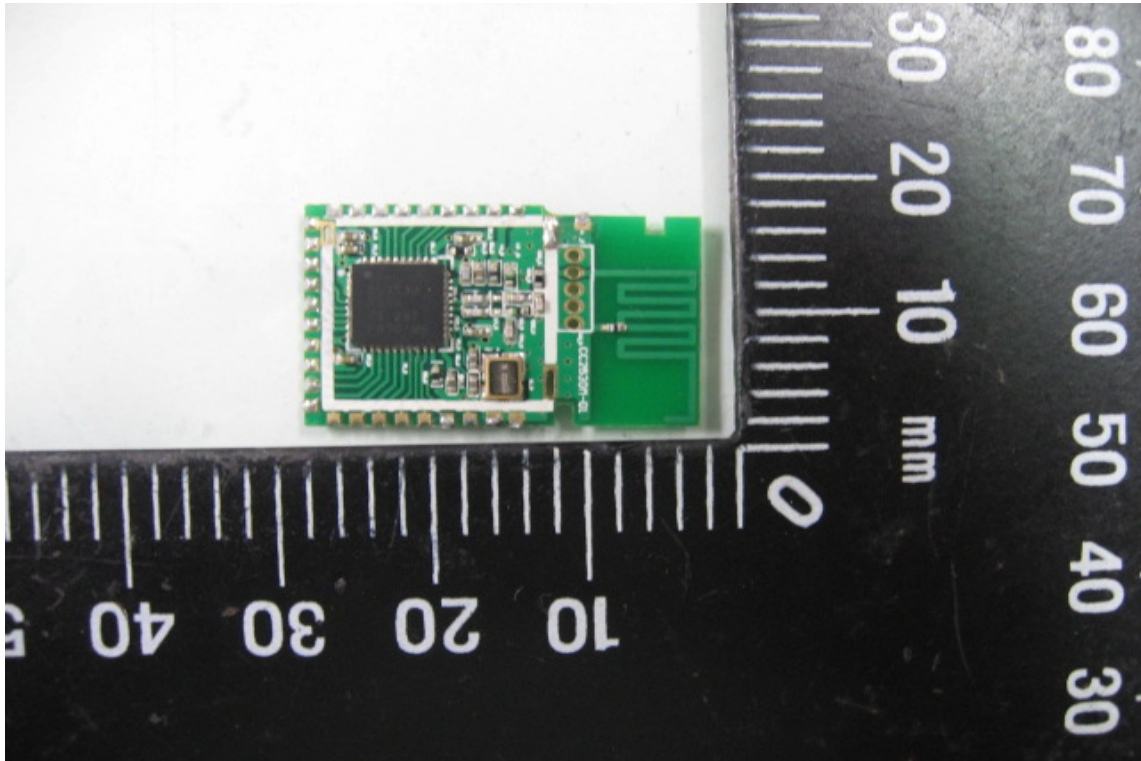


2.



### CONSTRUCTION PHOTOS OF EUT

3.



4.

