

# FCC Part 15

# EMI TEST REPORT

## of

E.U.T. : 2.4GHz Wireless IR Color CCD  
Camera

Model : KW2421

FCC ID : TJI-KW2421

for

APPLICANT : Kingwave Technology Co. Ltd.

ADDRESS : 18F-3, No. 186, Jian-Yi Road, Chung-Ho City,  
Taipei Hsien, Taiwan

Test Performed by

## **ELECTRONICS TESTING CENTER, TAIWAN**

NO.34, LIN 5, DINGFU TSUEN, LINKOU SHIANG  
TAIPEI COUNTY, TAIWAN, 24442, R.O.C.

Tel:(02)26023052      Fax:(02)26010910  
<http://www/etc.org.tw> ; e-mail : [emc@etc.org.tw](mailto:emc@etc.org.tw)

Report Number : 11-05-RBF-166-04

# TEST REPORT CERTIFICATION

Applicant : Kingwave Technology Co. Ltd.  
18F-3, No. 186, Jian-Yi Road, Chung-Ho City, Taipei Hsien, Taiwan

Manufacture : Kingwave Technology Co. Ltd.  
18F-3, No. 186, Jian-Yi Road, Chung-Ho City, Taipei Hsien, Taiwan

Description of Device :  
a) Type of EUT : 2.4GHz Wireless IR Color CCD Camera  
b) Trade Name : KINGWAVE  
c) Model No. : KW2421  
d) Power Supply : DC 12V

Regulation Applied : FCC Rules and Regulations Part 15 Subpart C (2009)

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.

Date Test Item Received : *May. 25, 2011*  
Date Test Campaign Completed : *Jun. 28, 2011*  
Date of Issue : *Jun. 30, 2011*

Test Engineer : *Falcon Shi*  
( Falcon Shi, Engineer )

Check By : *Charles Wang*  
( Charles Wang, Supervisor )

Approve & Authorized : *Will Yau*  
Will Yauo, Manager  
EMC Dept. II of ELECTRONICS  
TESTING CENTER, TAIWAN

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## 1 GENERAL INFORMATION

### 1.1 Product Description

- a) Type of EUT : 2.4GHz Wireless IR Color CCD Camera
- b) Trade Name : KINGWAVE
- c) Model No. : KW2421
- d) Power Supply : DC 12V

### 1.2 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.

### 1.3 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 TSUEN, LINKOU SHIANG TAIPEI COUNTY, TAIWAN, 24442, R.O.C.

This site has been fully described in a report submitted to your office, and accepted in a letter dated Aug. 05, 2008.

## 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 or 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 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

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 $\mu$ 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) Hopping Channel Separation**

According to 15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

**(5) Number of Hopping frequencies used**

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

**(6) Hopping Channel Bandwidth**

According to 15.247(a)(1)(ii), for frequency hopping system operating in the 5725-5850 MHz band, the maximum 20dB bandwidth of the hopping channel is 1MHz.

**(7) Dwell Time of each frequency**

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2400-2483.5 band, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

**(8) Output Power Requirement**

According to 15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt.

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

**(9) 100 kHz Bandwidth of Frequency Band Edges Requirement**

According to 15.247(c), 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.

**(10) Out-of-Band Conducted Emission Requirement**

According to 15.247(c), 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.

**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, 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. Three highest emissions were verified with varying placement of the transmitting antenna connected to EUT (if applicable) to maximize the emission from EUT.

For conducted and radiated emissions, whichever RF channel is operated, the digital circuits' function identically. As the reason, measurement of emissions from digital circuits is performed with the highest, middle and the lowest channel by transmitting mode.

### 3.2 Devices for Tested System

Device	Manufacture	Model / FCC ID.	Description
2.4GHz Wireless IR Color CCD Camera *	Kingwave Technology Co. Ltd.	KW2421 / TJI-KW2421	----

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 direct sequence spread spectrum, and the out band emission shall be comply with §15.247 (c)

### 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

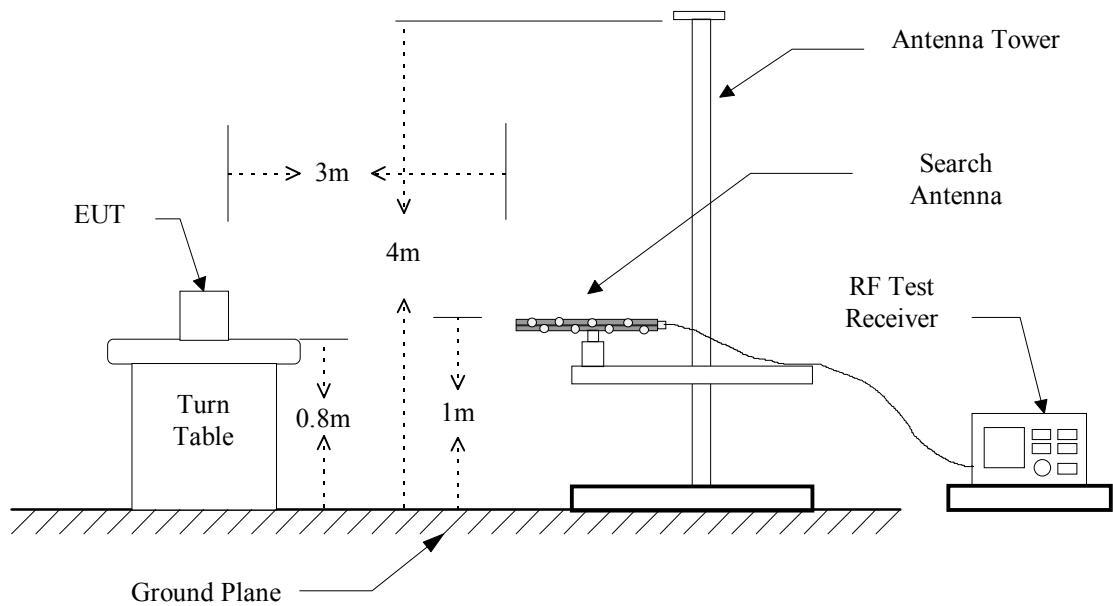
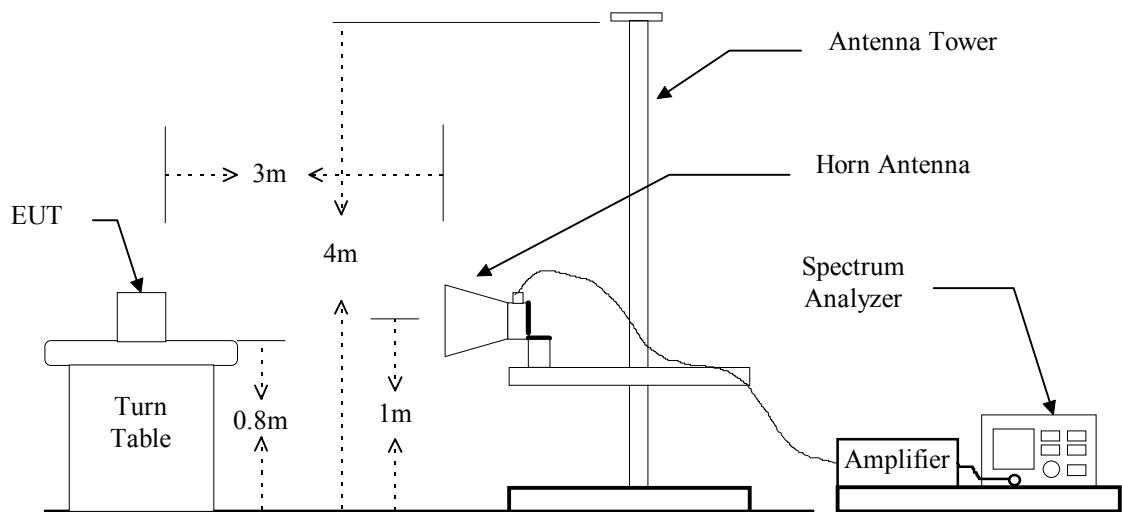


Figure 2 : Frequencies measured above 1 GHz configuration



### 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	2011/05/13	2012/05/12
Spectrum	Advantest	R3162	2011/03/03	2012/03/01
Bi-Log Antenna	Schaffner	CBL 6111	2010/05/20	2012/05/19
Log-periodic Antenna	EMCO	3146	2010/10/11	2011/10/10
Biconical Antenna	EMCO	3110B	2010/10/11	2011/10/10
Double Ridged Antenna	EMCO	3115	2011/05/10	2012/05/09
Amplifier	HP	8449B	2010/12/29	2011/12/28
Amplifier	HP	83051A	2011/05/12	2012/05/11
Amplifier	HP	8447D	2011/05/09	2012/05/08
Spectrum	Rohde & Schwarz	FSP40	2010/09/17	2011/09/16

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 Tx Portion

#### A. Channel Low

Operation Mode : Transmitting

Fundamental Frequency : 2403.000 MHz

Test Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

Frequency (MHz)	Reading (dBuV)				Factor (dB)	Result @3m (dBuV/m)		Limit @3m (dBuV/m)		Margin (dB)	Table Deg. (Deg.)	Ant. High (m)
	H		V			Peak	Ave	Peak	Ave			
4806.220	46.6	---	49.4	---	0.9	50.3	---	74.0	54.0	-3.7	276	1.50
7209.440	---	---	---	---	5.7	---	---	74.0	54.0	---	---	---
9612.660	---	---	---	---	7.2	---	---	74.0	54.0	---	---	---
12015.880	---	---	---	---	9.2	---	---	74.0	54.0	---	---	---
14419.100	---	---	---	---	11.6	---	---	74.0	54.0	---	---	---
16822.320	---	---	---	---	11.8	---	---	74.0	54.0	---	---	---
19225.540	---	---	---	---	8.9	---	---	74.0	54.0	---	---	---
21628.760	---	---	---	---	9.8	---	---	74.0	54.0	---	---	---
24031.980	---	---	---	---	10.3	---	---	74.0	54.0	---	---	---

Operation Mode : Receiving

Fundamental Frequency : Local Frequency : 2403.000 MHz

Test Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

Frequency (MHz)	Reading (dBuV)				Factor (dB)	Result @3m (dBuV/m)		Limit @3m (dBuV/m)		Margin (dB)	Table Deg. (Deg.)	Ant. High (m)
	H		V			Peak	Ave	Peak	Ave			
* 2403.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 4806.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 7209.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 9612.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 12015.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---

Note :

1. Item of margin shown in above table refer to average limit.
2. It is considered that the results of average comply with average limit when measuring data with a peak function detector meet the average limit. Mark “\*\*\*” means that Peak result is meet average limit.
3. Remark “---” means that the emissions level is too low to be measured.
4. Remark “\*” means the local oscillator frequency and its harmonics.
5. Item “Margin” referred to Average limit while there is only peak result.
6. The expanded uncertainty of the radiated emission tests is 3.53 dB.

**B. Channel Middle**Operation Mode : TransmittingFundamental Frequency : 2439.000 MHzTest Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

Frequency (MHz)	Reading (dBuV)				Factor (dB) Corr.	Result @3m (dBuV/m)		Limit @3m (dBuV/m)		Margin (dB)	Table Deg. (Deg.)	Ant. High (m)
	H		V			Peak	Ave	Peak	Ave			
4876.170	45.9	---	. 48.3	---	1.1	49.4	---	74.0	54.0	-4.6	209	1.40
7313.340	---	---	---	---	5.9	---	---	74.0	54.0	---	---	---
9750.510	---	---	---	---	7.3	---	---	74.0	54.0	---	---	---
12187.680	---	---	---	---	9.3	---	---	74.0	54.0	---	---	---
14624.850	---	---	---	---	11.6	---	---	74.0	54.0	---	---	---
17062.020	---	---	---	---	13.1	---	---	74.0	54.0	---	---	---
19499.190	---	---	---	---	8.5	---	---	74.0	54.0	---	---	---
21936.360	---	---	---	---	9.9	---	---	74.0	54.0	---	---	---
24373.530	---	---	---	---	10.7	---	---	74.0	54.0	---	---	---

Operation Mode : ReceivingFundamental Frequency : Local Frequency : 2439.000 MHzTest Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

Frequency (MHz)	Reading (dBuV)				Factor (dB) Corr.	Result @3m (dBuV/m)		Limit @3m (dBuV/m)		Margin (dB)	Table Deg. (Deg.)	Ant. High (m)
	H		V			Peak	Ave	Peak	Ave			
* 2439.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 4878.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 7317.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 9756.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 12196.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---

Note :

1. Item of margin shown in above table refer to average limit.
2. It is considered that the results of average comply with average limit when measuring data with a peak function detector meet the average limit. Mark “\*\*\*” means that Peak result is meet average limit.
3. Remark “---” means that the emissions level is too low to be measured.
4. Remark “\*” means the local oscillator frequency and its harmonics.
5. Item “Margin” referred to Average limit while there is only peak result.
6. The expanded uncertainty of the radiated emission tests is 3.53 dB.

**C. Channel High**Operation Mode : TransmittingFundamental Frequency : 2478.000 MHzTest Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

Frequency (MHz)	Reading (dBuV)				Factor (dB) Corr.	Result @3m (dBuV/m)		Limit @3m (dBuV/m)		Margin (dB)	Table Deg. (Deg.)	Ant. High (m)
	H		V			Peak	Ave	Peak	Ave			
4953.520	45.5	---	46.6	---	1.4	48.0	---	74.0	54.0	-6.0	209	1.30
7429.040	---	---	---	---	6.1	---	---	74.0	54.0	---	---	---
9904.560	---	---	---	---	7.4	---	---	74.0	54.0	---	---	---
12380.080	---	---	---	---	9.4	---	---	74.0	54.0	---	---	---
14855.600	---	---	---	---	11.5	---	---	74.0	54.0	---	---	---
17331.120	---	---	---	---	15.0	---	---	74.0	54.0	---	---	---
19806.640	---	---	---	---	8.6	---	---	74.0	54.0	---	---	---
22282.160	---	---	---	---	10.1	---	---	74.0	54.0	---	---	---
24757.680	---	---	---	---	11.0	---	---	74.0	54.0	---	---	---

Operation Mode : ReceivingFundamental Frequency : Local Frequency : 2478.000 MHzTest Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

Frequency (MHz)	Reading (dBuV)				Factor (dB) Corr.	Result @3m (dBuV/m)		Limit @3m (dBuV/m)		Margin (dB)	Table Deg. (Deg.)	Ant. High (m)
	H		V			Peak	Ave	Peak	Ave			
* 2478.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 4956.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 7434.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 9911.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---
* 12390.000	---	---	---	---	---	---	---	74.0	54.0	---	---	---

Note :

1. Item of margin shown in above table refer to average limit.
2. It is considered that the results of average comply with average limit when measuring data with a peak function detector meet the average limit. Mark “\*\*\*” means that Peak result is meet average limit.
3. Remark “---” means that the emissions level is too low to be measured.
4. Remark “\*” means the local oscillator frequency and its harmonics.
5. Item “Margin” referred to Average limit while there is only peak result.
6. The expanded uncertainty of the radiated emission tests is 3.53 dB.

#### 4.4.2 Radiated Emissions in Restricted Bands

Operation Mode : Transmitting

Test Date : Mar. 30, 2011 Temperature : 21 °C Humidity : 63 %

**Operation Mode :CH Low Restricted Frequency band : 2310MHz-2390MHz**

Frequency (MHz)	Reading (dBuV)				Factor (dB) Corr.	Result @3m (dBuV/m)		Limit @3m (dBuV/m)		Margin (dB)	Table Deg. (Deg.)	Ant. High (m)
	H		V			Peak	Ave	Peak	Ave			
2379.415	57.2	---	58.7	---	-6.5	52.2	---	74.0	54.0	-1.8	213	1.40
2381.242	57.3	---	59.2	---	-6.5	52.7	---	74.0	54.0	-1.3	253	1.50

**Operation Mode : CH Hiigh Restricted Frequency band : 2483.5MHz-2500MHz**

Frequency (MHz)	Reading (dBuV)				Factor (dB) Corr.	Result @3m (dBuV/m)		Limit @3m (dBuV/m)		Margin (dB)	Table Deg. (Deg.)	Ant. High (m)
	H		V			Peak	Ave	Peak	Ave			
2483.676	62.1	41.3	70.9	41.6	-6.1	64.8	35.5	74.0	54.0	-9.2	211	1.50
2484.843	61.0	41.2	69.6	41.5	-6.1	63.5	35.4	74.0	54.0	-10.5	257	1.40

*Note :*

1. Item of margin shown in above table refer to average limit.
2. It is considered that the results of average comply with average limit when measuring data with a peak function detector meet the average limit. Mark “\*\*\*” means that Peak result is meet average limit.
3. Remark “---” means that the emissions level is too low to be measured.
4. Item “Margin” referred to Average limit while there is only peak result.
5. The expanded uncertainty of the radiated emission tests is 3.53 dB.

#### 4.4.3 Other Emissions

##### a) Emission frequencies below 1 GHz

Operation Mode : Transmitter

Test Date : Jun. 28, 2011      Temperature : 25 °C      Humidity : 63 %

Frequency (MHz)	Ant-Pol H/V	Meter Reading (dBuV)	Corrected Factor (dB)	Result @3m (dBuV/m)	Limit @3m (dBuV/m)	Margin (dB)	Table Degree (Deg.)	Ant. High (m)
119.100	V	21.9	12.8	34.7	43.5	-8.8	305	1.0
132.060	V	23.7	13.6	37.3	43.5	-6.2	69	1.0
143.940	V	23.2	14.3	37.5	43.5	-6.0	127	1.0
150.690	V	22.2	14.6	36.8	43.5	-6.7	23	1.1
155.820	H	21.7	14.6	36.3	43.5	-7.2	138	1..2
177.960	V	21.1	16.1	37.2	43.5	-6.3	216	1.2

Note :

1. Remark “---” means that the emissions level is too low to be measured.
2. The expanded uncertainty of the radiated emission tests is 3.53 dB.

##### b) Emission frequencies above 1 GHz

Radiated emission frequencies above 1 GHz to 25 GHz were too low to be measured with a pre-amplifier of 35 dB.

## 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:

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

where 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

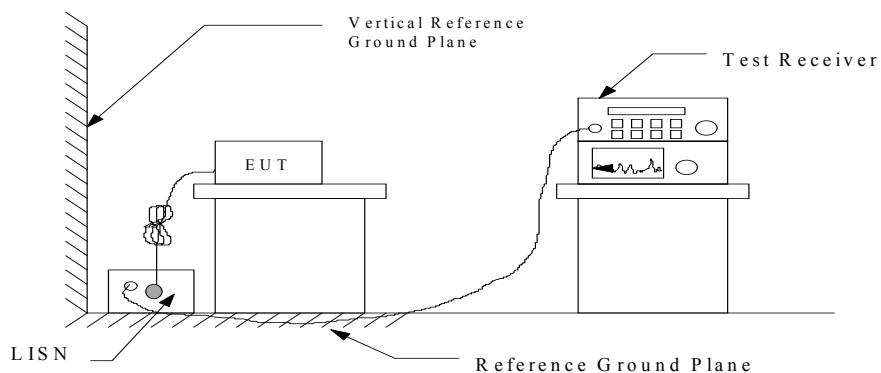
### 5.1 Standard Applicable

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

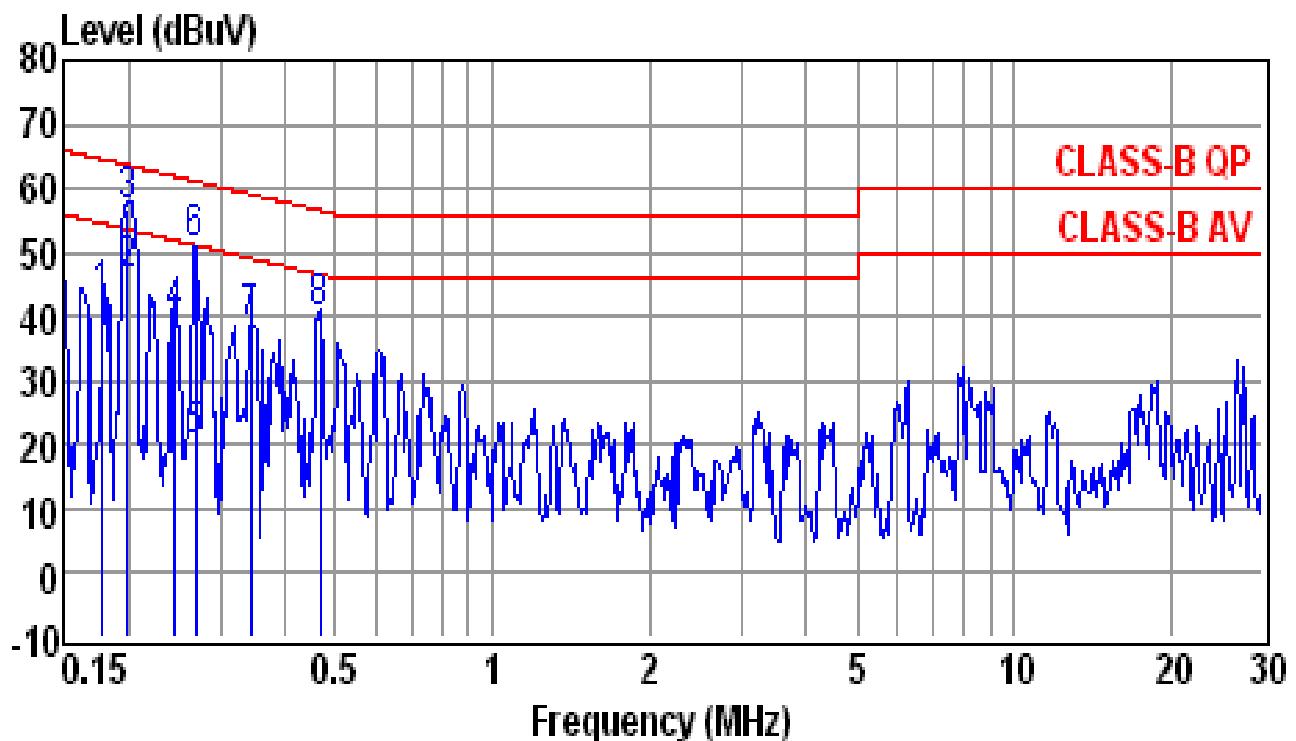
### 5.2 Measurement Procedure

1. Setup the configuration per figure 3.
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 3 : Conducted emissions measurement configuration



### 5.3 Conducted Emission Data

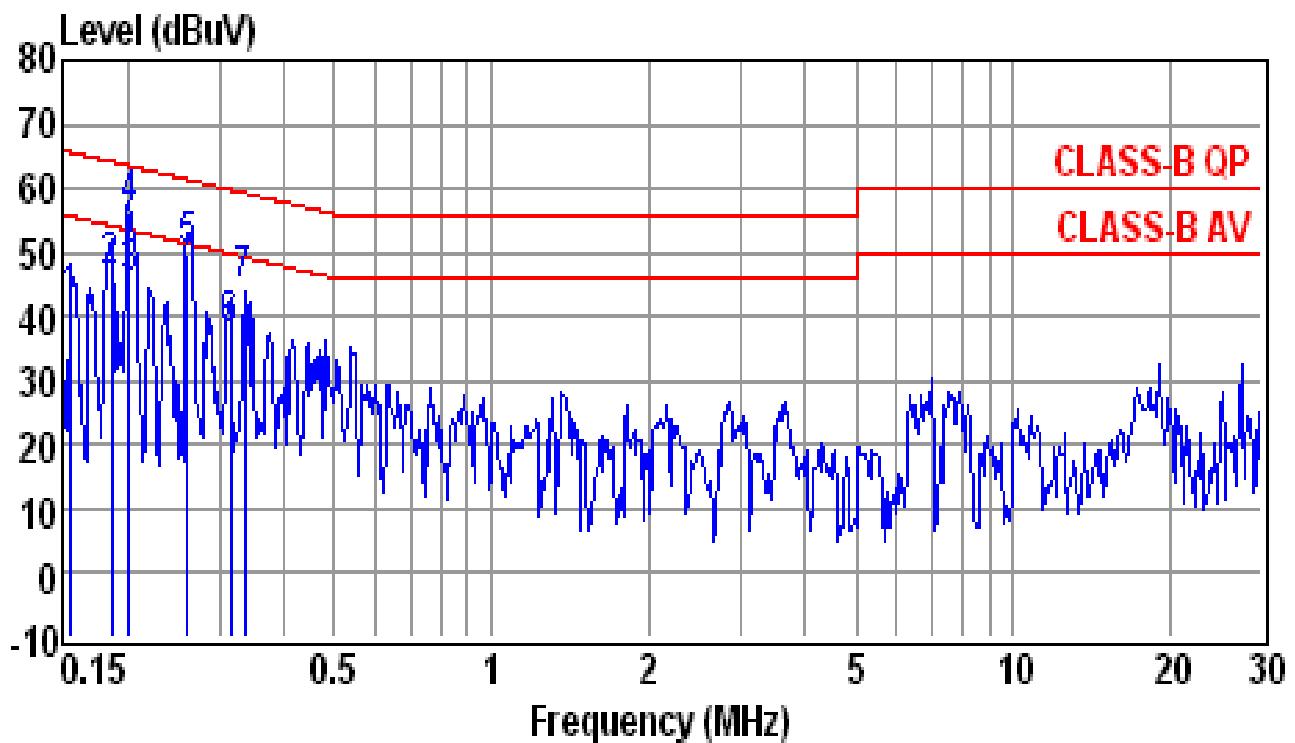


Site	: conducted #1	Date	: 06-27-2011
Condition	: CLASS-B QP	LISN	: NEUTRAL
Tem / Hum	: 24 °C / 50%	Test Mode	: OPERATION
EUT	: 2421	Power Rating	:
Memo	:	Memo	:

Freq (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV)	Limit Line (dBuV)	Over Limit (dB)	Remark
0.1787	41.93	0.24	42.17	64.55	-22.38	QP
0.1997	45.62	0.24	45.86	53.62	-7.76	Average
0.1997	56.75	0.24	56.99	63.62	-6.63	QP
0.2455	39.22	0.24	39.46	61.91	-22.45	QP
0.2687	19.90	0.24	20.14	51.16	-31.02	Average
0.2687	50.41	0.24	50.65	61.16	-10.51	QP
0.3428	38.49	0.26	38.75	59.13	-20.38	QP
0.4661	39.72	0.27	39.99	56.58	-16.59	QP

Note :

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



Site	: conducted #1	Date	: 06-27-2011
Condition	: CLASS-B QP	LISN	: LINE
Tem / Hum	: 24 °C / 50%	Test Mode	: OPERATION
EUT	: 2421	Power Rating	:
Memo	:	Memo	:

Freq (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV)	Limit Line (dBuV)	Over Limit (dB)	Remark
0.1565	41.70	0.23	41.93	65.65	-23.72	QP
0.1864	46.23	0.24	46.47	64.20	-17.73	QP
0.2018	45.29	0.24	45.53	53.54	-8.01	Average
0.2018	56.24	0.24	56.48	63.54	-7.06	QP
0.2616	49.83	0.24	50.07	61.38	-11.31	QP
0.3150	37.08	0.25	37.33	59.84	-22.51	QP
0.3356	44.27	0.26	44.53	59.31	-14.78	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:

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

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.

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

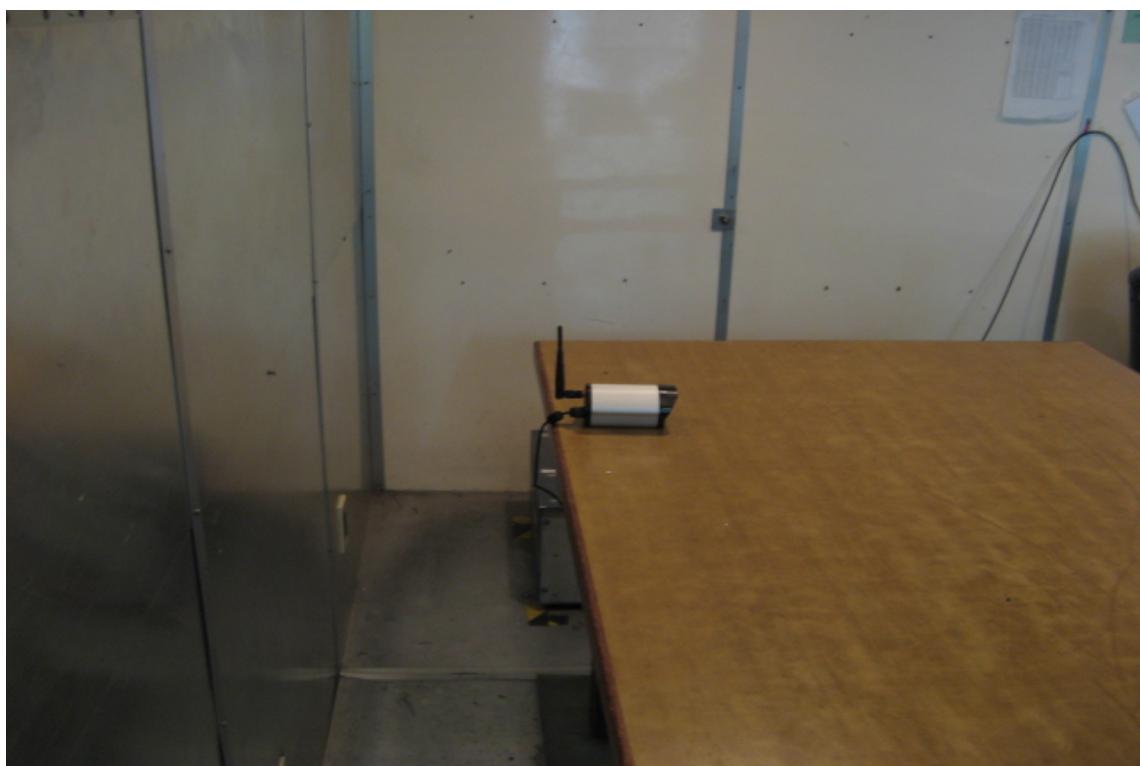
$$\begin{aligned} \text{Level in } \mu \text{ V} &= \text{Common Antilogarithm}[(22.6 \text{ dB } \mu \text{ V})/20] \\ &= 13.48 \text{ } \mu \text{ V} \end{aligned}$$

## 5.5 Conducted Measurement Equipment

The following test equipment are used during the conducted test .

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
EMI Test Receiver	Rohde & Schwarz	ESCI	2011/02/03	2012/02/02
LISN	EMCO	3625/2	2011/03/01	2012/02/08
LISN	Rohde & Schwarz	ESH2-Z5	2010/08/10	2011/08/09

## 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.

### **6.2 Antenna Construction**

The antenna is an omni-directional antenna with a reversed SMA connector.  
Please see antenna specifications submitted in Exhibit.

## 7 HOPPING CHANNEL SEPARATION

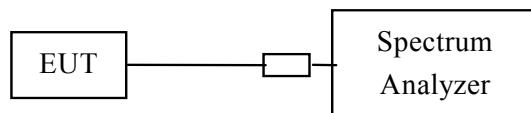
### 7.1 Standard Applicable

According to 15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

### 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. The EUT must have its hopping function enabled. Then set it to any one convenient frequency within its operating range.
3. Use the following spectrum analyzer settings:
  - Span = wide enough to capture the peaks of two adjacent channels
  - Resolution (or IF) Bandwidth (RBW)  $\geq$  1% of the span
  - Video (or Average) Bandwidth (VBW)  $\geq$  RBW
  - Sweep = auto
  - Detector function = peak
  - Trace = max hold
4. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

Figure 4 : Measurement configuration.



### 7.3 Measurement Equipment

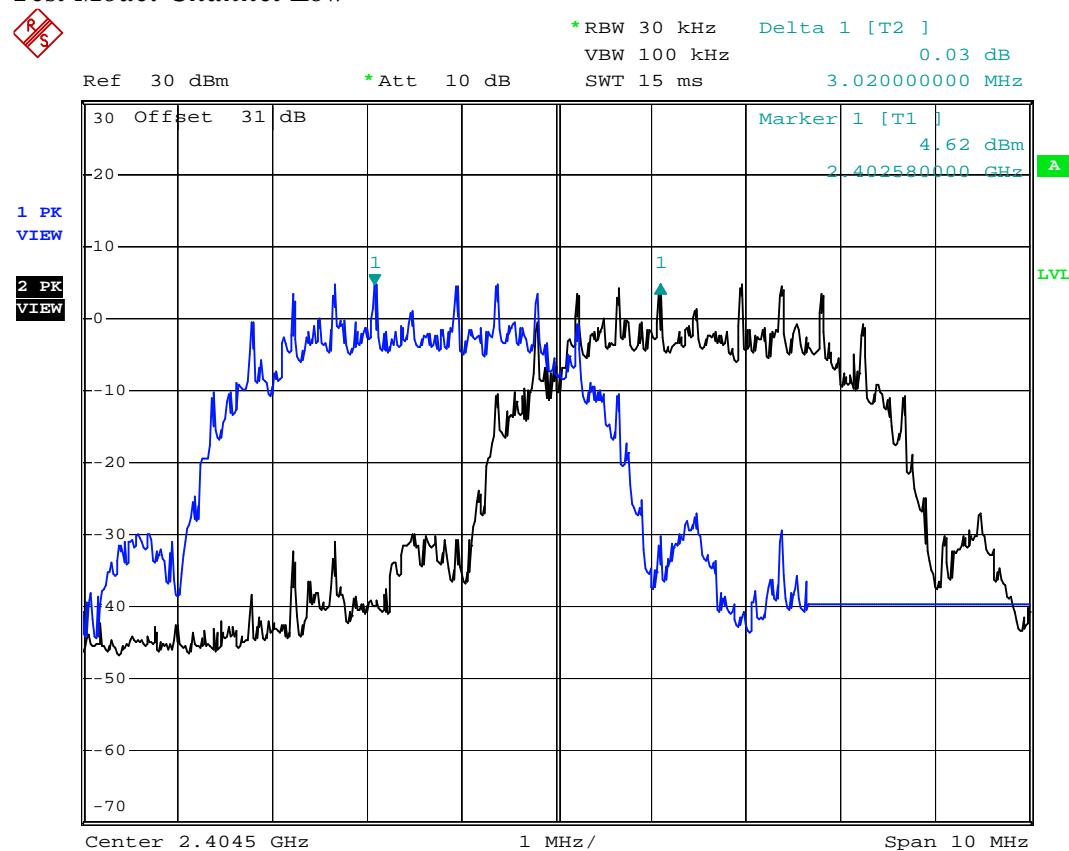
Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2010/09/17	2011/09/16
Attenuator	Weinschel Engineering	1	N/A	N/A

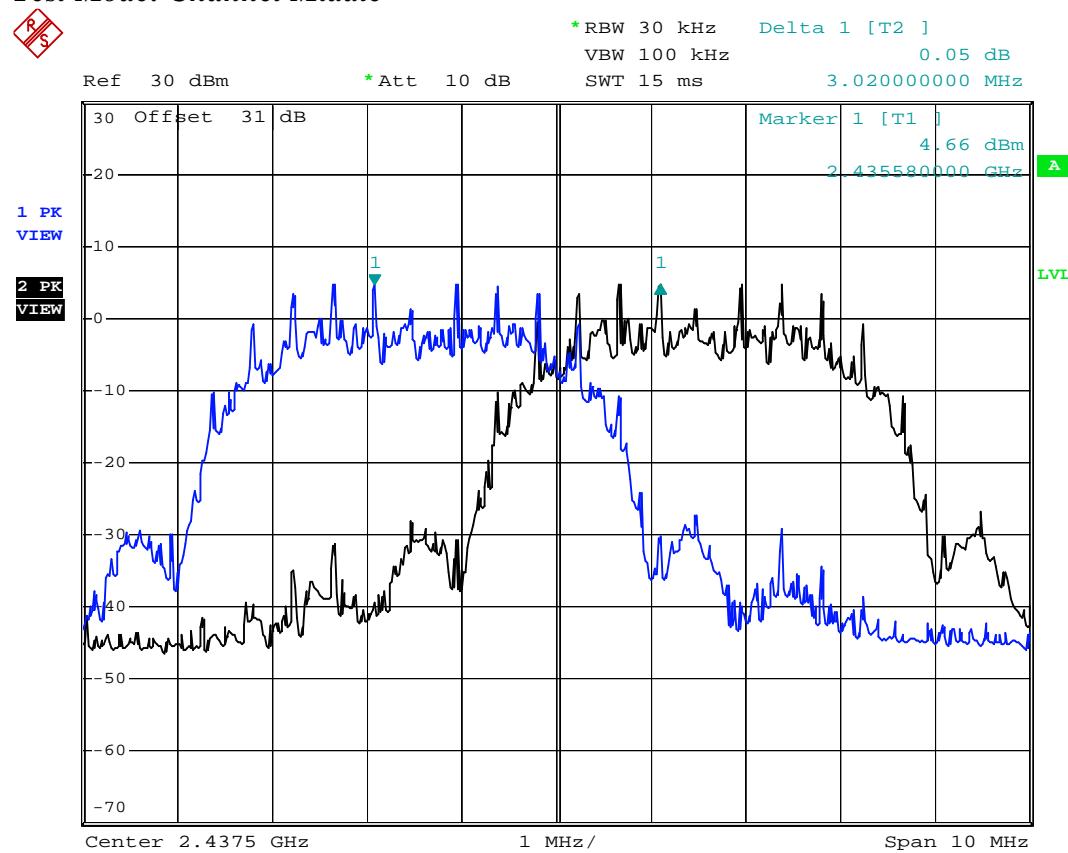
### 7.4 Measurement Data

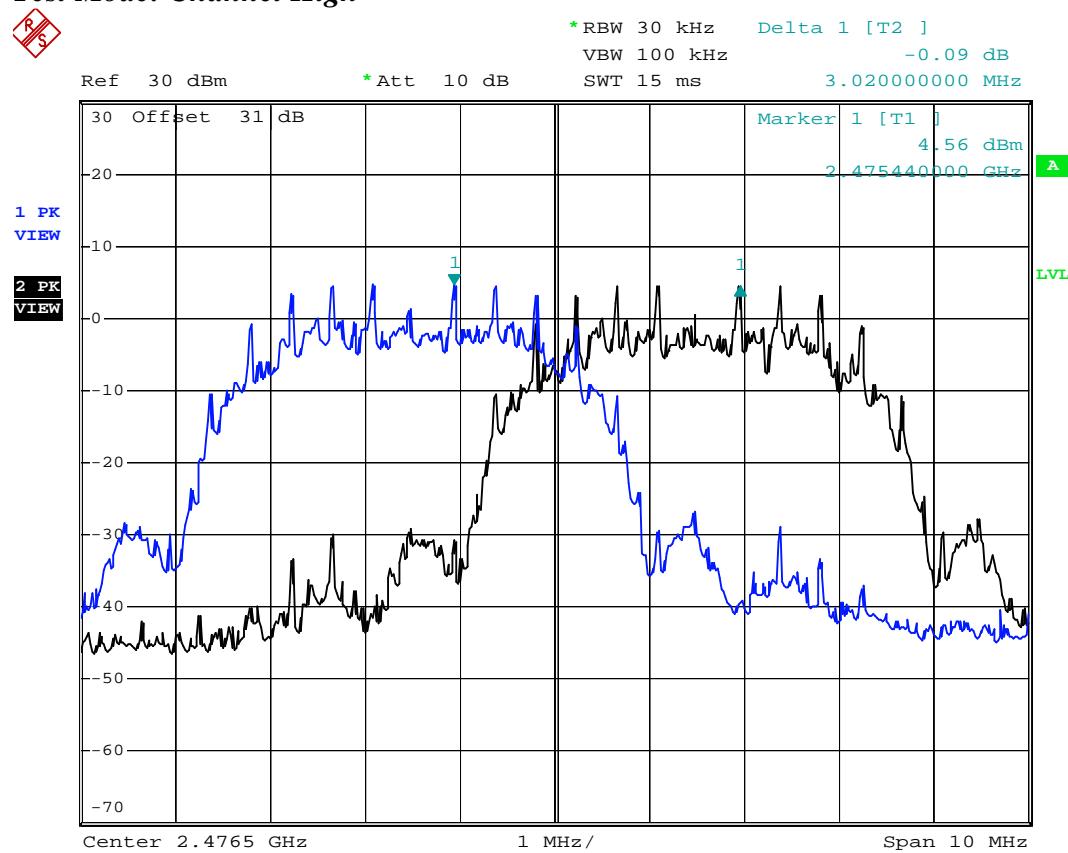
Test Date : Jun. 28, 2011      Temperature : 25 °C      Humidity : 63 %

- a) Channel Low : Adjacent Hopping Channel Separation is 3020 kHz
- b) Channel Middle : Adjacent Hopping Channel Separation is 3020 kHz
- c) Channel High : Adjacent Hopping Channel Separation is 3020 kHz

*Note : The expanded uncertainty of the hopping channel separation tests is 2dB.*

**Test Mode: Channel Low**

**Test Mode: Channel Middle**

**Test Mode: Channel High**

## 8 NUMBER OF HOPPING FREQUENCY USED

### 8.1 Standard Applicable

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

### 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 4 without connection to measurement instrument.  
Turn on the EUT and connect it to measurement instrument. The EUT must have its hopping function enabled.
3. Use the following spectrum analyzer settings:  
Span = the frequency band of operation  
RBW  $\geq$  1% of the span  
VBW  $\geq$  RBW  
Sweep = auto  
Detector function = peak  
Trace = max hold
4. Allow the trace to stabilize. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

### 8.3 Measurement Equipment

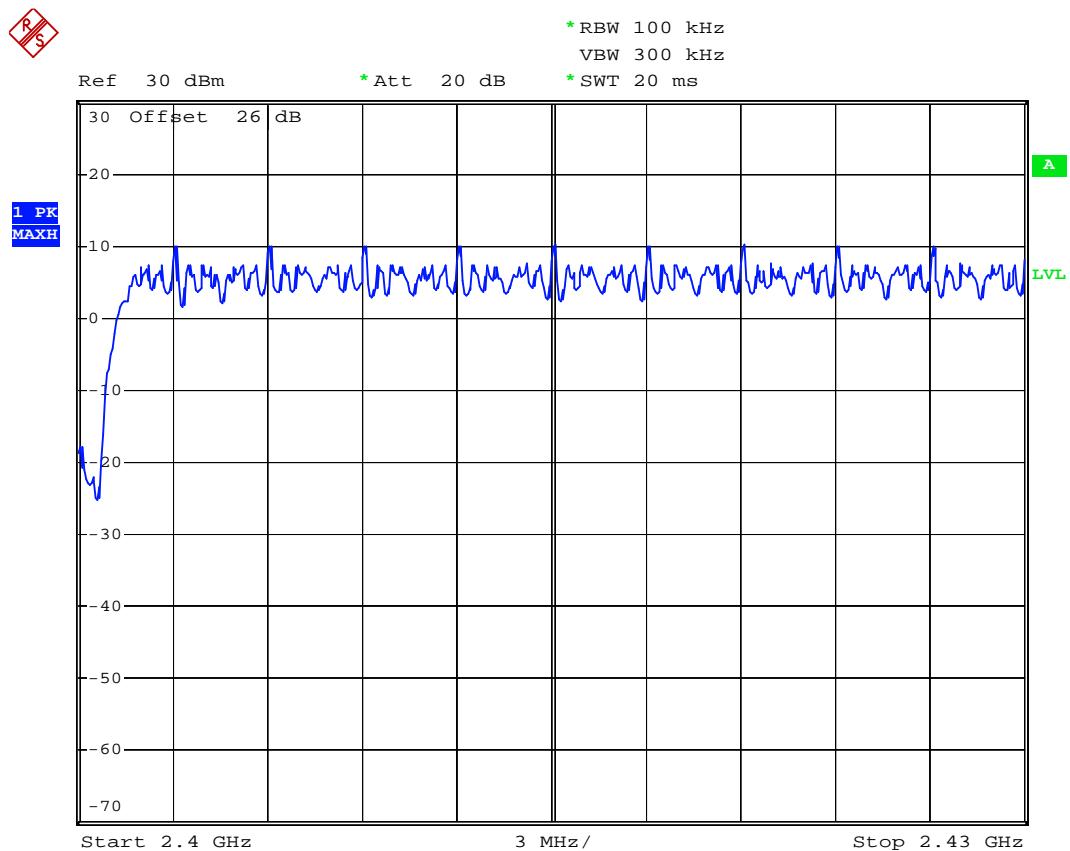
Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2010/09/17	2011/09/16
Attenuator	Weinschel Engineering	1	N/A	N/A

## 8.4 Measurement Data

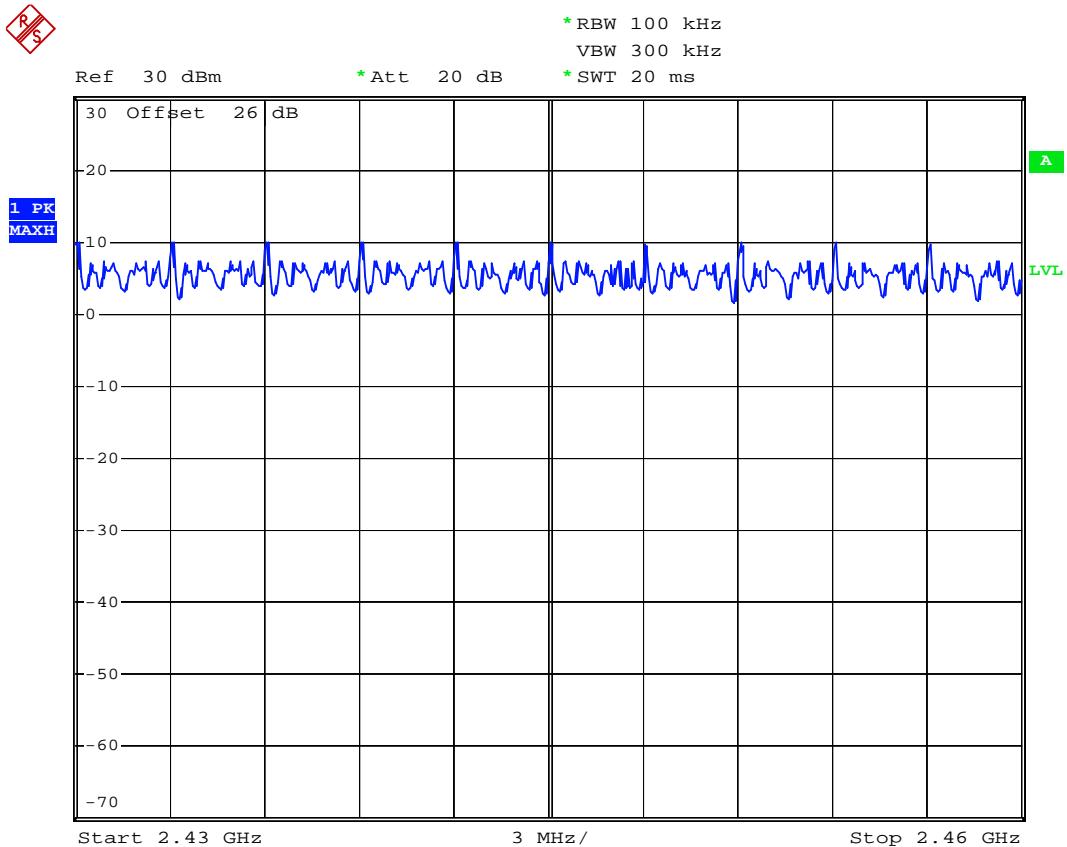
Test Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

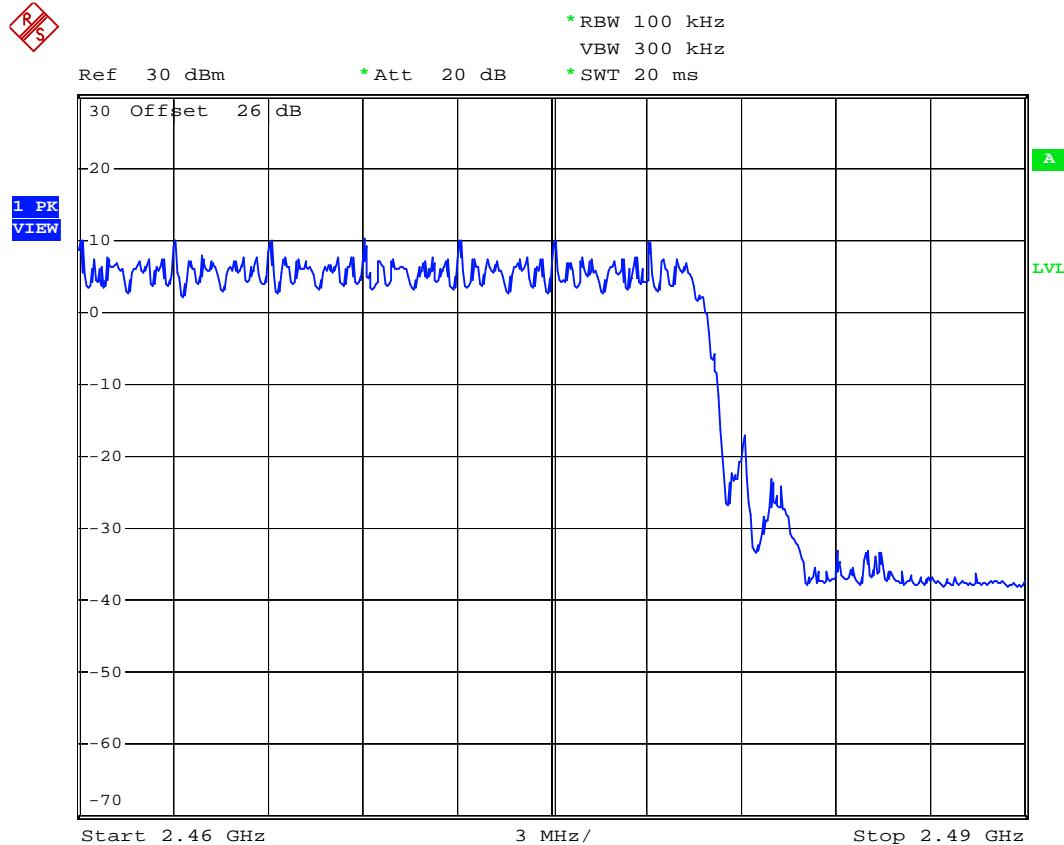
There are 26 hopping frequencies used.

*Note : The expanded uncertainty of umber of hopping frequency used tests is 2dB.*



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## 9 CHANNEL BANDWIDTH

### 9.1 Standard Applicable

According to 15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

### 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 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.
3. Use the following spectrum analyzer settings:  
Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel  
RBW  $\geq$  1% of the 20 dB bandwidth  
VBW  $\geq$  RBW  
Sweep = auto  
Detector function = peak  
Trace = max hold
4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

### 9.3 Measurement Equipment

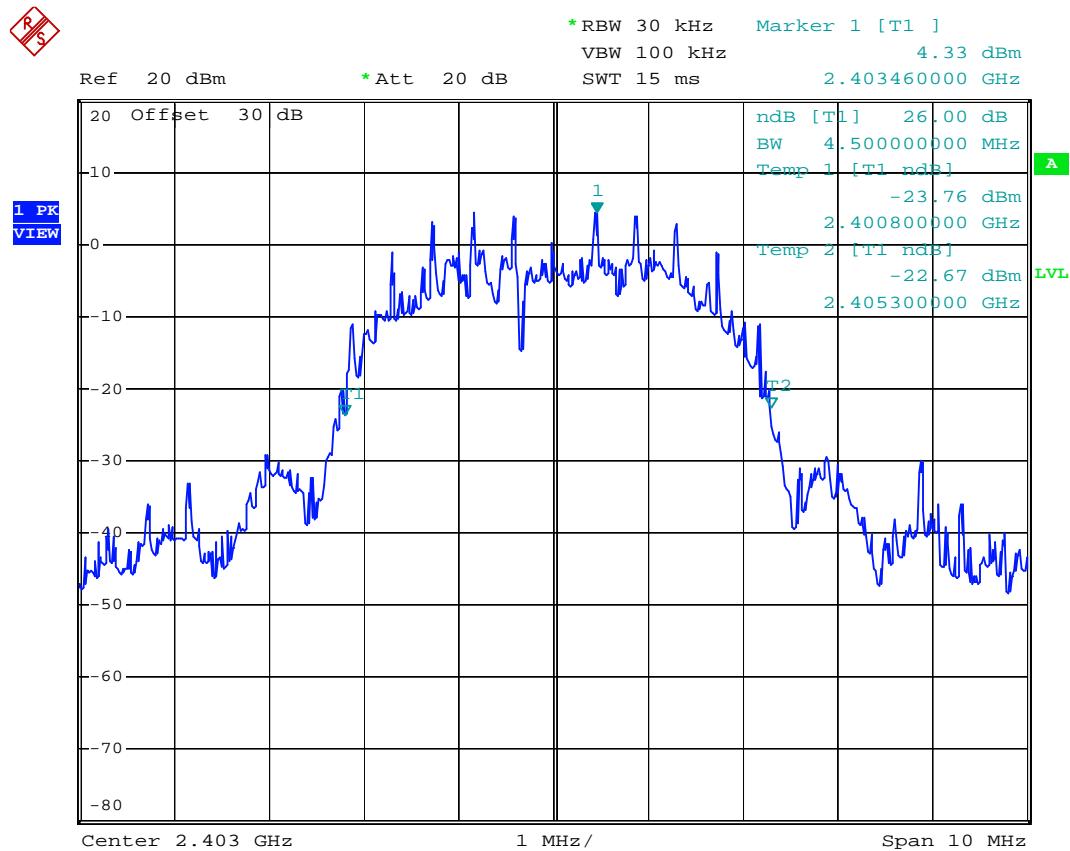
Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2010/09/17	2011/09/16
Attenuator	Weinschel Engineering	1	N/A	N/A

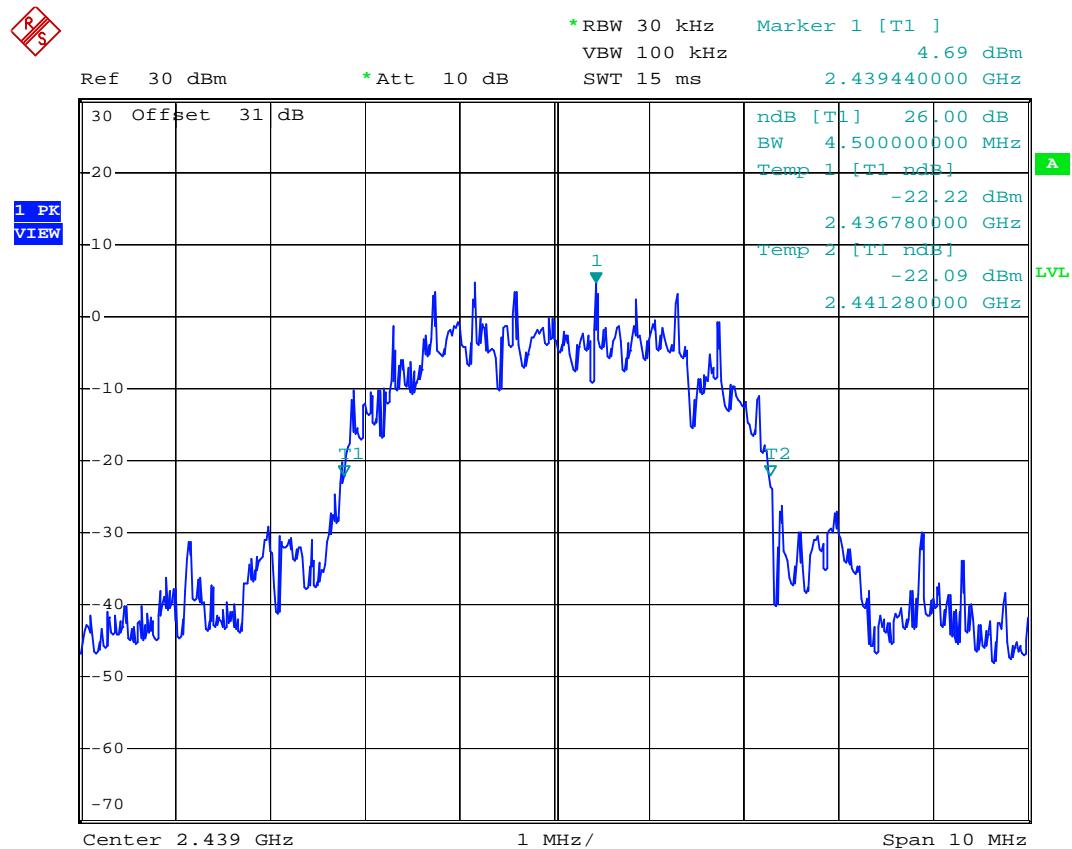
### 9.4 Measurement Data

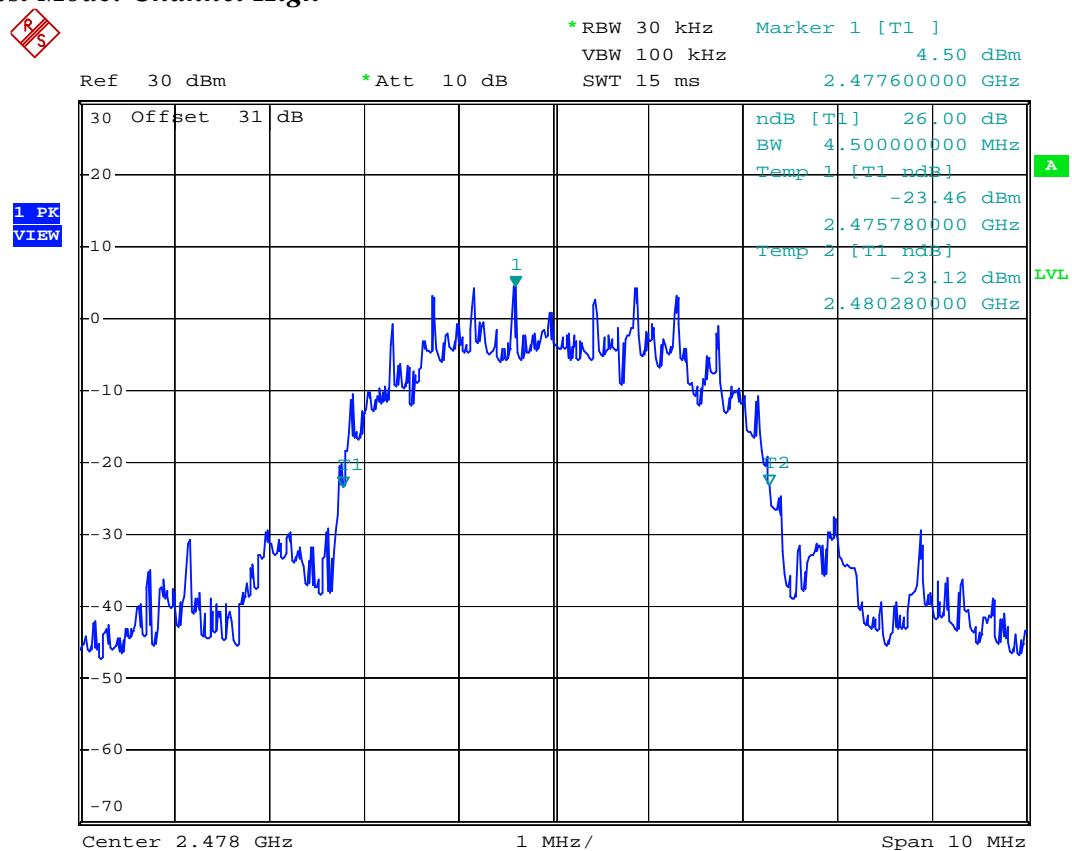
Test Date : Jun. 28, 2011      Temperature : 25 °C      Humidity : 63 %

- a) Channel Low : Channel Bandwidth is 4.500 MHz
- b) Channel Middle : Channel Bandwidth is 4.500 MHz
- c) Channel High : Channel Bandwidth is 4.500 MHz

*Note : The expanded uncertainty of channel bandwidth tests is 2dB.*

**Test Mode: Channel Low**

**Test Mode: Channel Middle**

**Test Mode: Channel High**

## 10 DWELL TIME ON EACH CHANNEL

### 10.1 Standard Applicable

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2400-2483.5 band, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

### 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 it to measurement instrument. The EUT must have its hopping function enabled.
3. Use the following spectrum analyzer settings:  
Span = zero span, centered on a hopping channel  
RBW = 1 MHz  
VBW  $\geq$  RBW  
Sweep = as necessary to capture the entire dwell time per hopping channel  
Detector function = peak  
Trace = max hold
4. Use the marker-delta function to determine the dwell time. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

### 10.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2010/09/17	2011/09/16
Attenuator	Weinschel Engineering	1	N/A	N/A

## 10.4 Measurement Data

Test Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

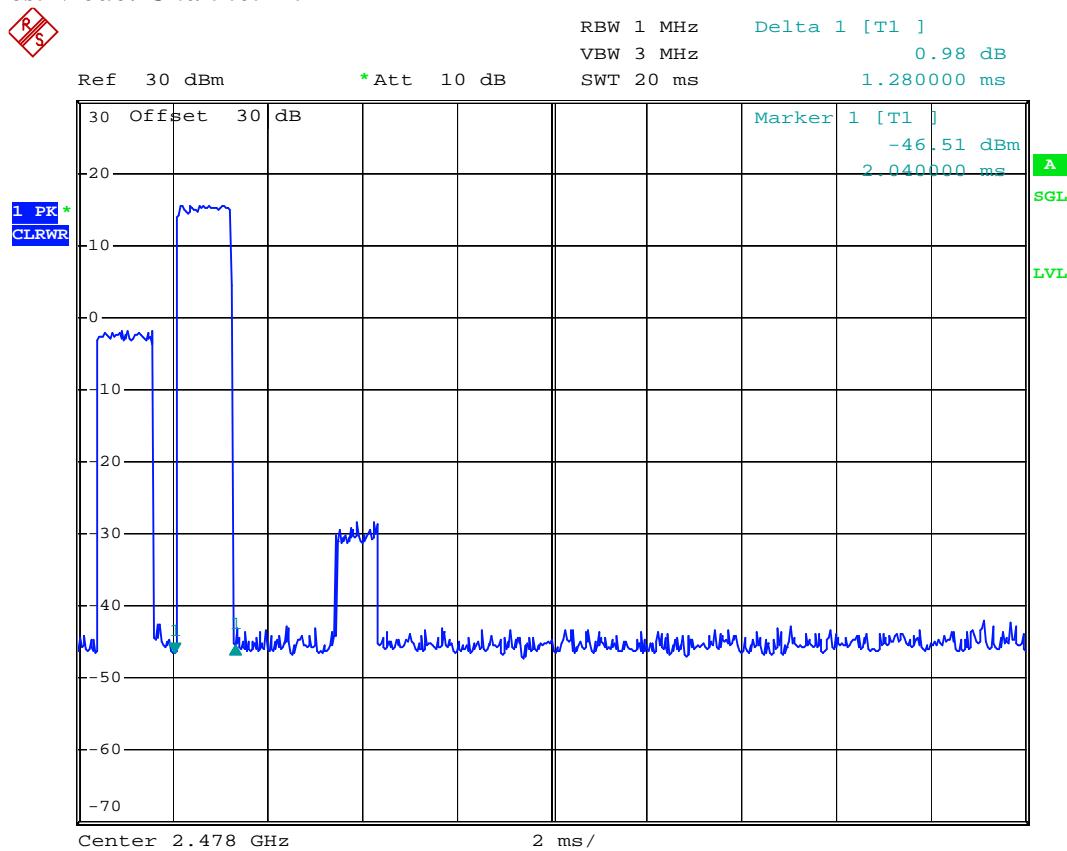
**Period = 0.4(seconds) x 26(channels) = 10.4 seconds**

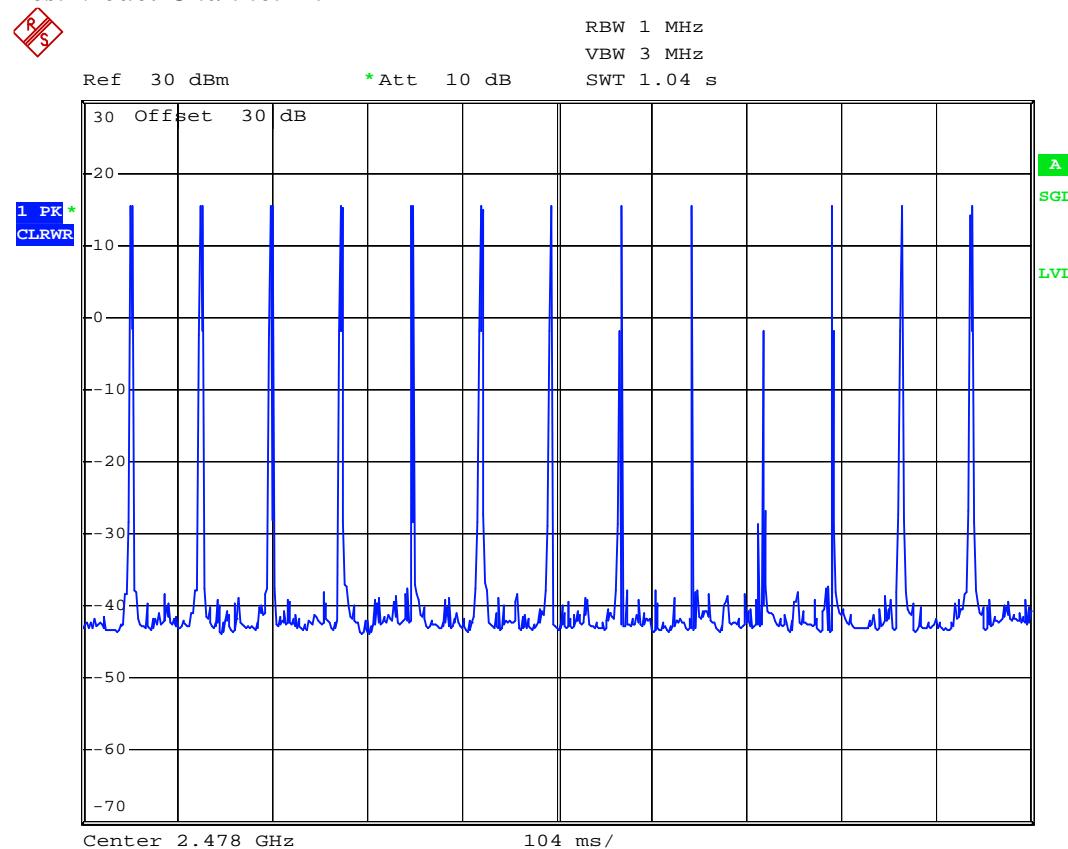
a) Channel Hi :

The maximum time of occupancy = 1.28 ms x 12 x 10 = 153.600 ms

The maximum time of occupancy for a particular channel is 153.600ms in any 10.4 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

*Note : The expanded uncertainty of dwell time on each channel tests is 2dB.*

**Test Mode: Channel Hi**

**Test Mode: Channel Hi**

## 11 OUTPUT POWER MEASUREMENT

### 11.1 Standard Applicable

According to 15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt.

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

### 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:  
 Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel  
 RBW > the 20 dB bandwidth of the emission being measured  
 $VBW \geq RBW$   
 Sweep = auto  
 Detector function = peak  
 Trace = max hold
4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all frequencies measured were complete.

### 11.3 Measurement Equipment

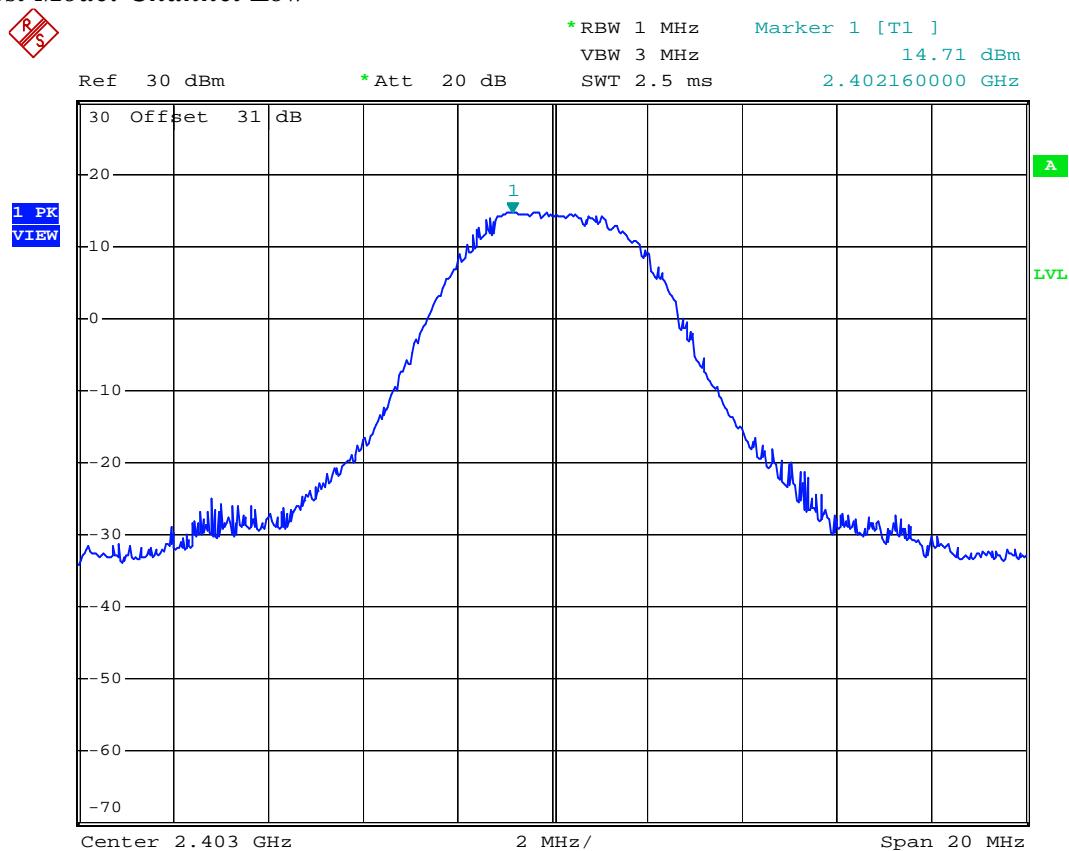
Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2010/09/17	2011/09/16
Attenuator	Weinschel Engineering	1	N/A	N/A

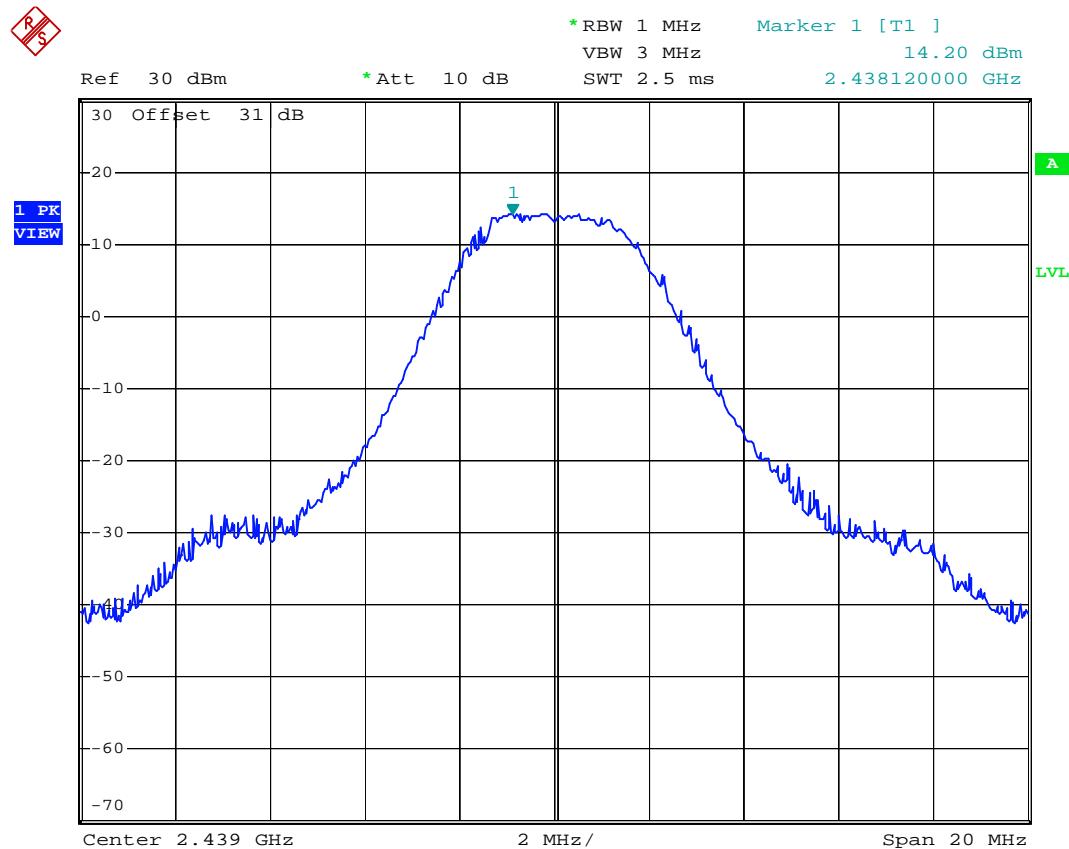
## 11.4 Measurement Data

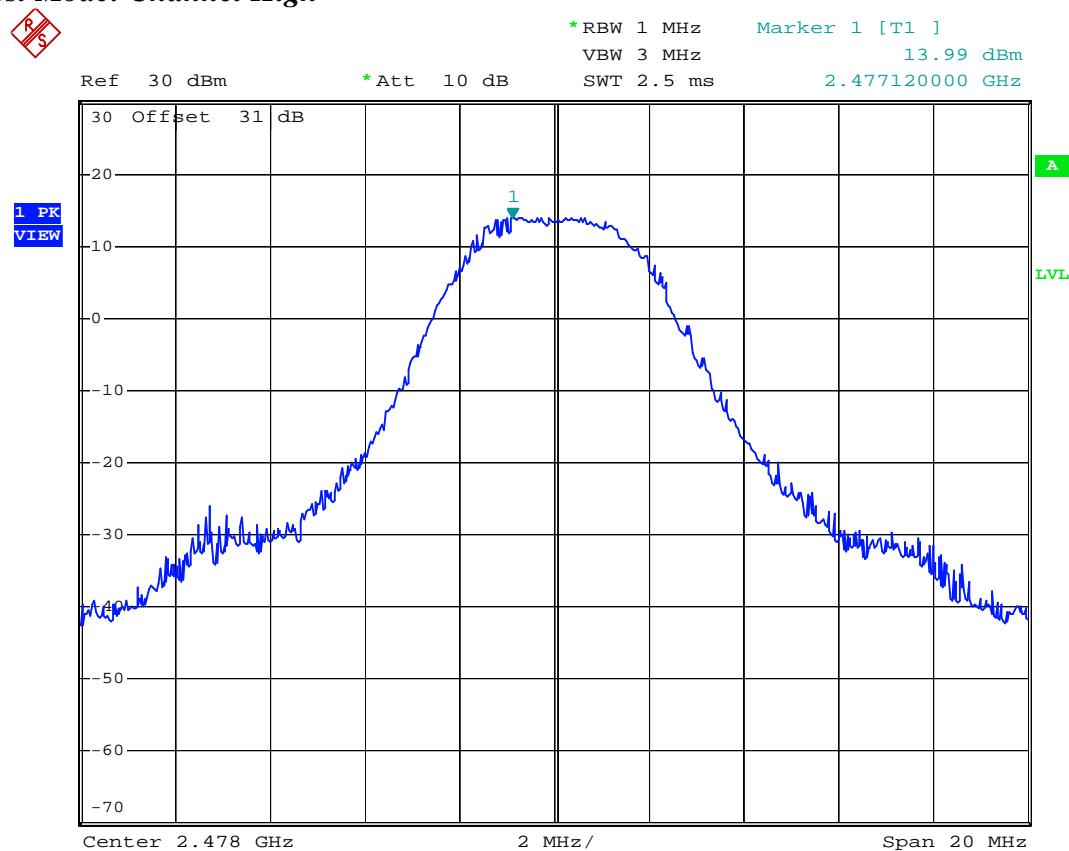
Test Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

- a) Channel Low : Output Peak Power is 14.71 dBm = **29.580** mW
- b) Channel Middle : Output Peak Power is 14.2 dBm = **26.303** mW
- c) Channel High : Output Peak Power is 13.99 dBm = **25.061** mW

*Note : The expanded uncertainty of output power measurement tests is 2dB.*

**Test Mode: Channel Low**

**Test Mode: Channel Middle**

**Test Mode: Channel High**

## 12 100 kHz BANDWIDTH OF BAND EDGES MEASUREMENT

### 12.1 Standard Applicable

According to 15.247(c), 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.

### 12.2 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:
  - Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
  - RBW  $\geq$  1% of the span
  - VBW  $\geq$  RBW
  - Sweep = auto
  - Detector function = peak
  - Trace = max hold
4. Allow the trace to stabilize. Set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all measured frequencies were complete.

### 12.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2010/09/17	2011/09/16
Attenuator	Weinschel Engineering	1	N/A	N/A

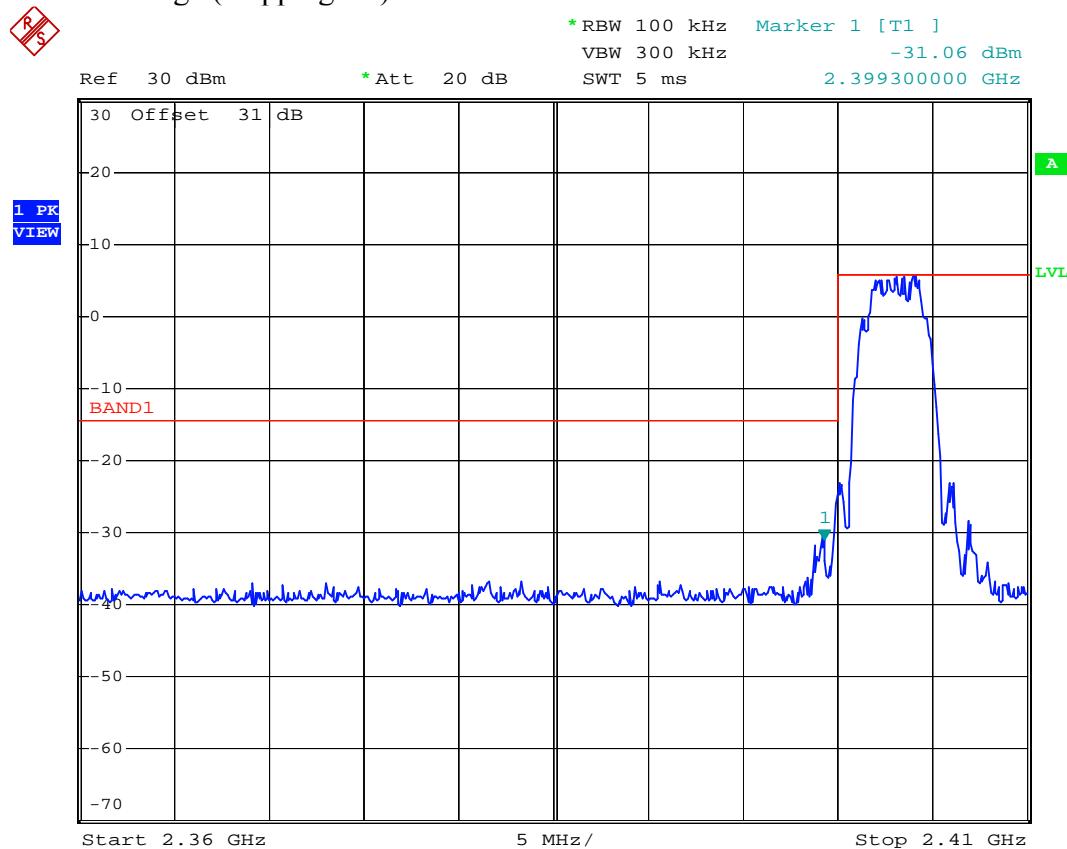
## 12.4 Measurement Data

Test Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

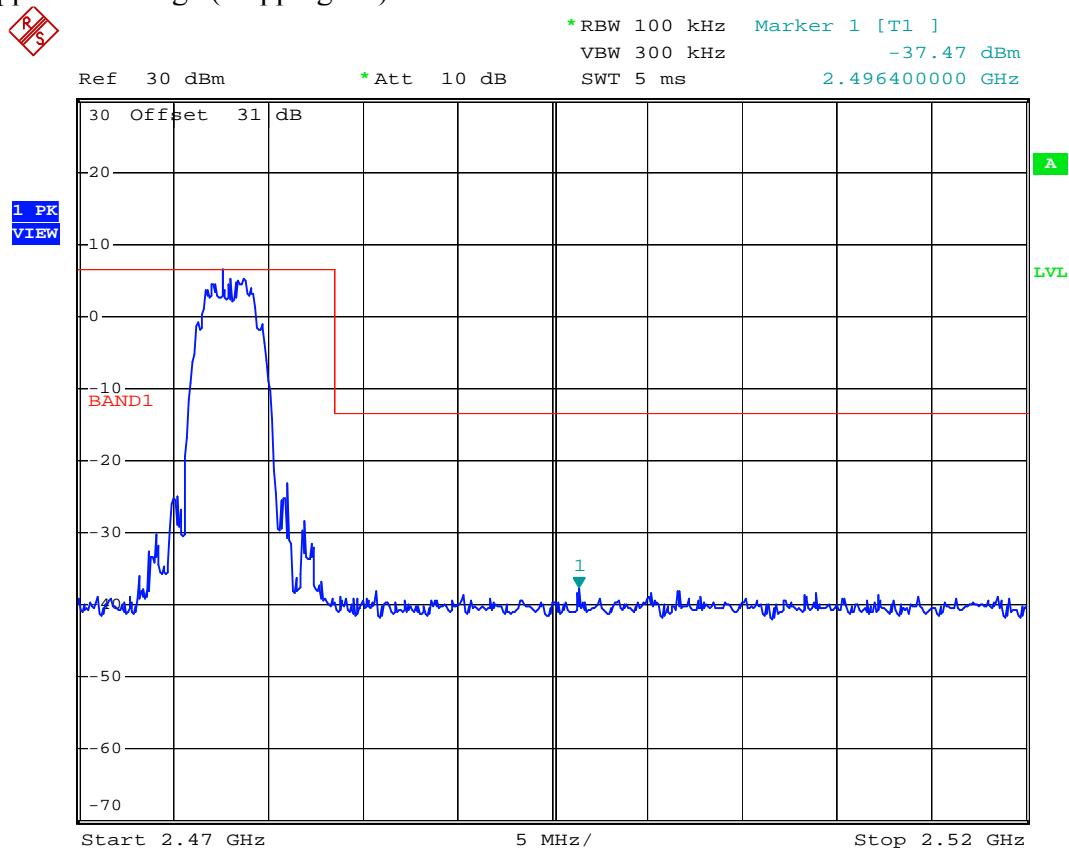
- a) Lower Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.
- b) Upper Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.

*Note : The expanded uncertainty of the 100 KHz bandwidth of band edges tests is 1000Hz.*

## Lower Band Edge (Hopping off)



## Upper Band Edge (Hopping off)



## 13 CONDUCTED SPURIOUS EMISSION MEASUREMENT

### 13.1 Standard Applicable

According to 15.247(c), 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.

### 13.2 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:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold.

4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all measured frequencies were complete.

### 13.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2010/09/17	2011/09/16
Attenuator	Weinschel Engineering	1	N/A	N/A

### 13.4 Measurement Data

Test Date : Jun. 28, 2011 Temperature : 25 °C Humidity : 63 %

#### Mode : Low Channel

- a) 1 GHz to 3 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.
- b) 3 GHz to 25 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

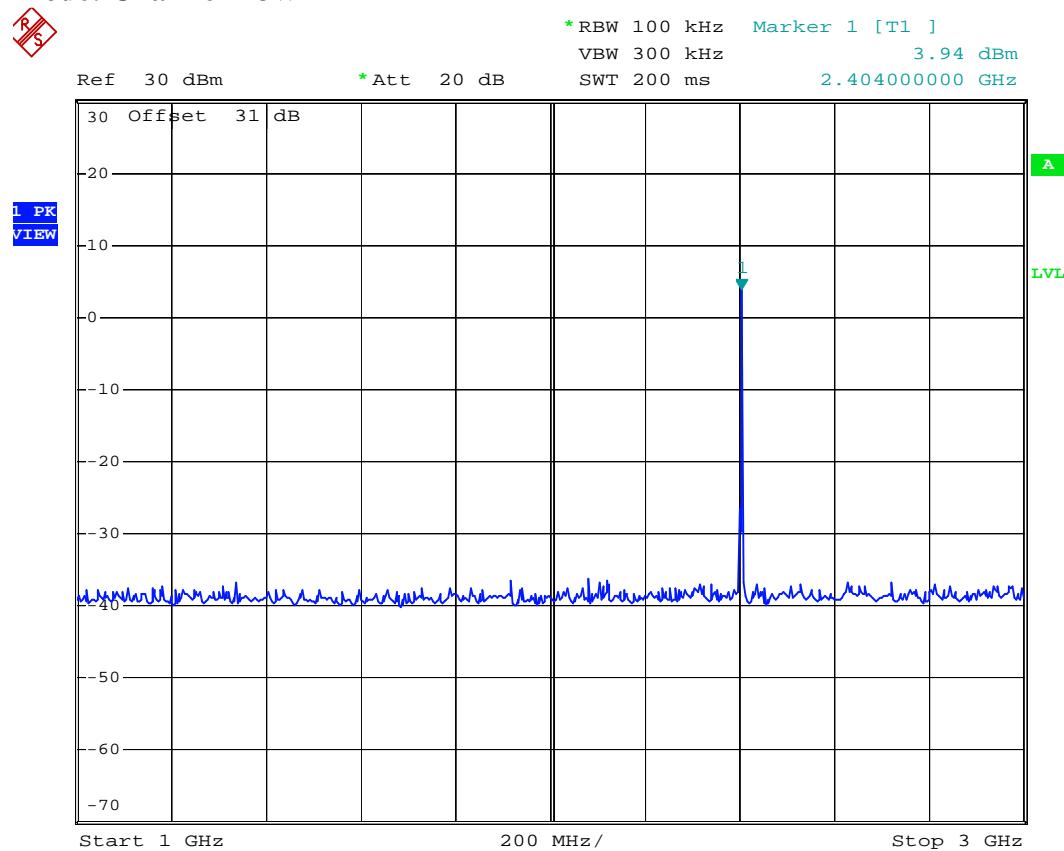
#### Mode : Mid Channel

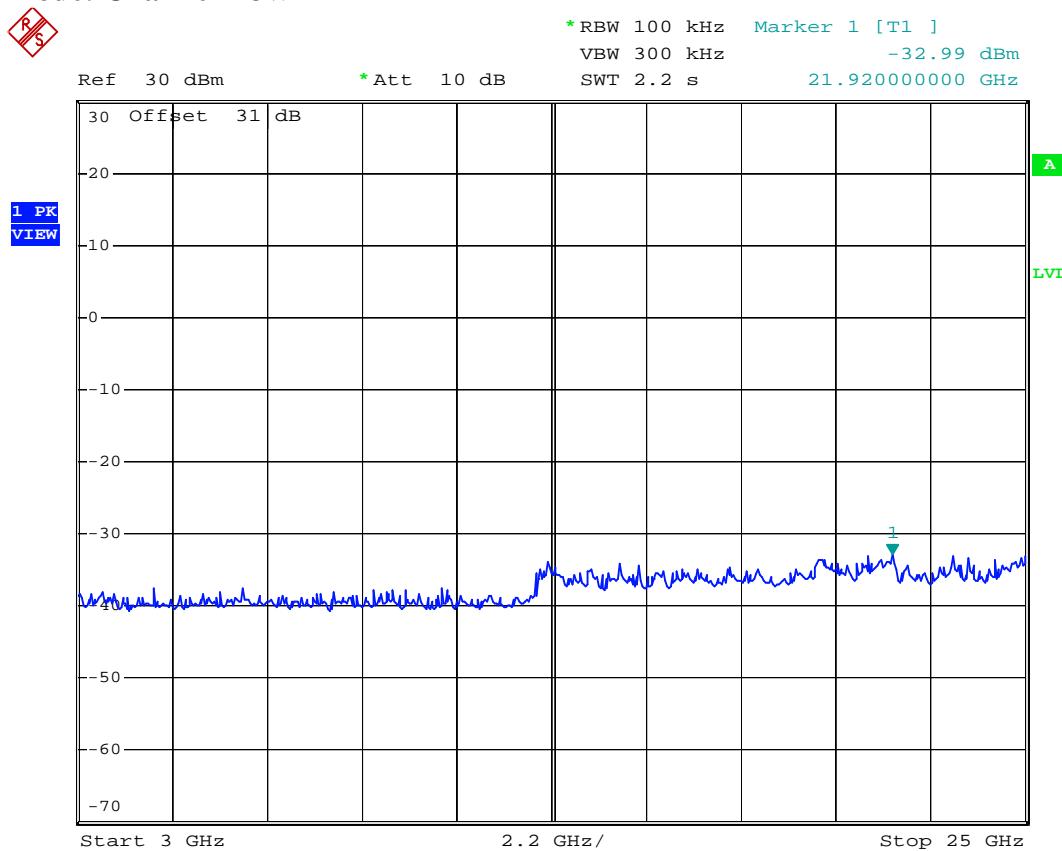
- a) 1 GHz to 3 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.
- b) 3 GHz to 25 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

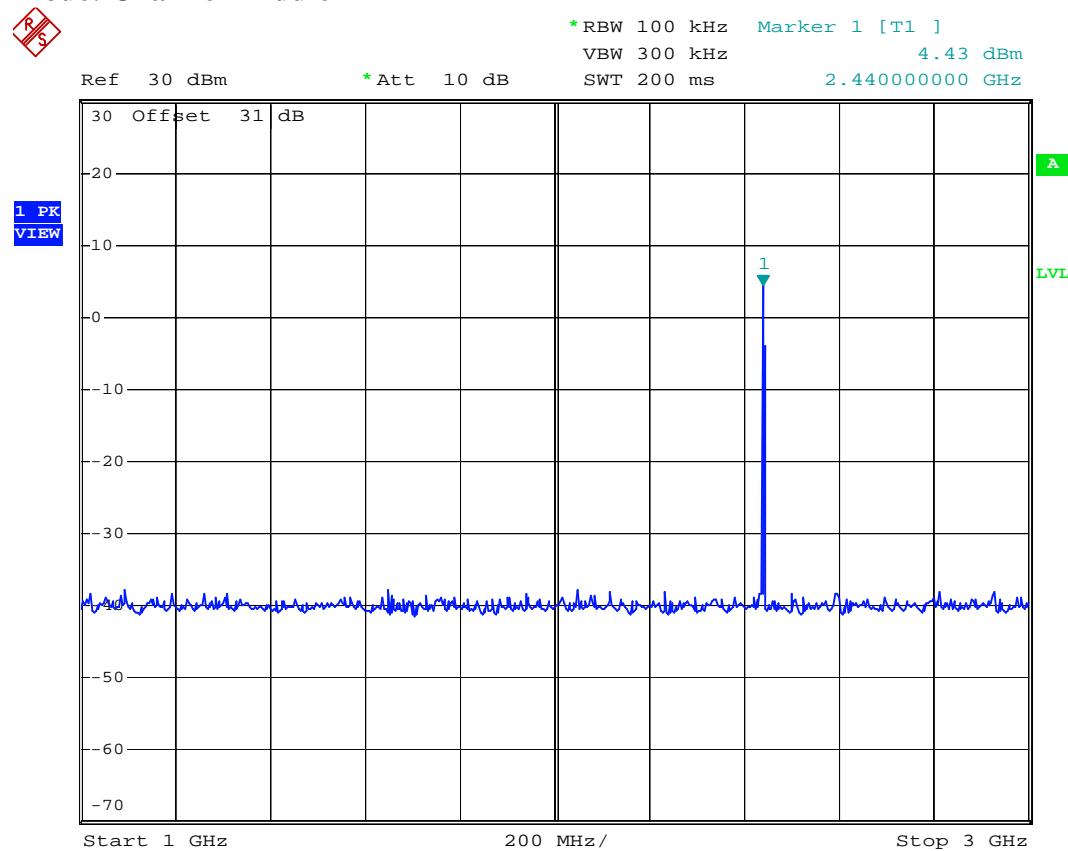
#### Mode : Hi Channel

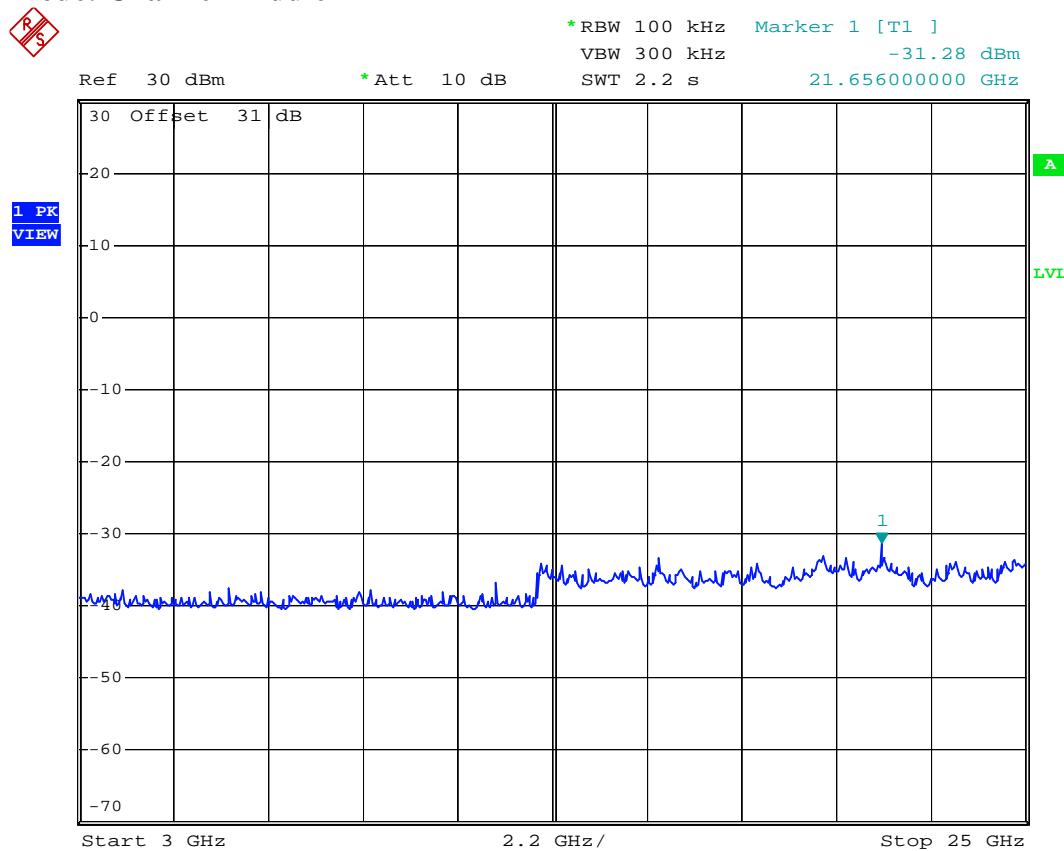
- a) 1 GHz to 3 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.
- b) 3 GHz to 25 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

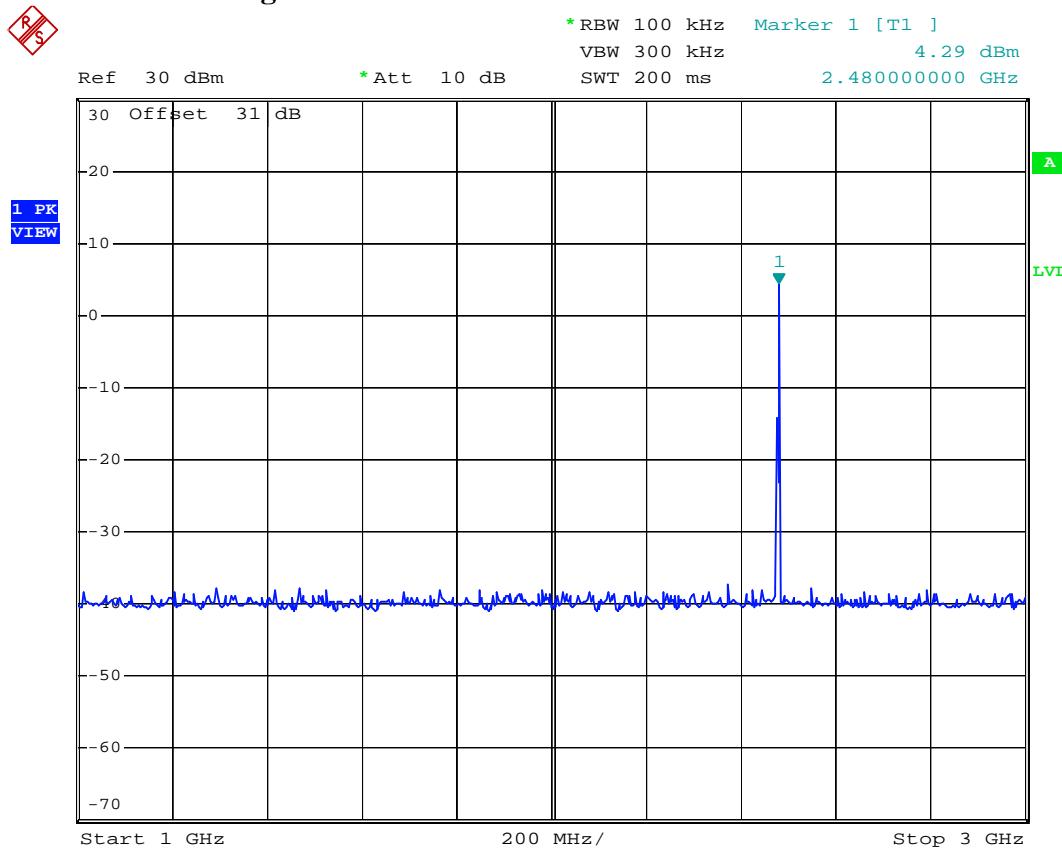
***Note : The expanded uncertainty of the out-of-band conducted emission tests is 2dB.***

**Mode: Channel Low**

**Mode: Channel Low**

**Mode: Channel Middle**

**Mode: Channel Middle**

**Mode: Channel High**

**Mode: Channel High**