

## Electromagnetic Emission

### FCC MEASUREMENT REPORT

#### CERTIFICATION OF COMPLIANCE

#### FCC Part 15 Certification Measurement

**PRODUCT** : RF DATA MODEM  
**MODEL/Serial No.** : HWC-W100 / Proto type  
**Multi model** : NONE  
**FCC ID** : W4BHW-C-W100  
**APPLICANT** : HYUNDAI ELEVATOR CO., LTD.  
San 136-1, Ami-ri, Bubal-eup, Ichon-shi, Kyonggi-do, Korea  
Attn.: Lee Kang Hyuk / General Manager  
**MANUFACTURER** : ARTWARE CO., LTD.  
806 AceTechno Tower 1st, 197-17 Guro3-dong, Guro-gu, Seoul, Korea  
**TYPE OF MODULATION** : O-QPSK  
**SPREAD SPECTRUM** : DSSS  
**FREQUENCY CHANNEL** : 2 405 MHz to 2 480 MHz and Channel Spacing 5 MHz(16 Channels)  
**PROTOCOL** : IEEE 802.15.4  
**ANTENNA TYPE** : Dipole Antenna  
**ANTENNA GAIN** : 1.53 dBi  
**RULE PART(S)** : FCC Part 15 Subpart B and Subpart C  
**FCC PROCEDURE** : ANSI C63.4-2003  
**TEST REPORT No.** : ETLE090130.02  
**DATES OF TEST** : January 31 - February 10, 2009  
**REPORT ISSUE DATE** : March 10, 2009  
**TEST LABORATORY** : ETL Inc. (FCC Designation Number : KR0022)

The RF DATA MODEM, Model HWC-W100 has been tested in accordance with the measurement procedures specified in ANSI C63.4-2003 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 Subpart C section 15.247

I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.



Hyung Seok, Lee / Chief Engineer

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## FCC MEASUREMENT REPORT

**Scope** – *Measurement and determination of electromagnetic emission(EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

### General Information

<b>Applicant Name</b>	: HYUNDAI ELEVATOR CO., LTD.
<b>Address</b>	: San 136-1, Ami-ri, Bubal-eup, Ichon-shi, Kyonggi-do, Korea
<b>Attention</b>	: Lee Kang Hyuk / General Manager

- **EUT Type** : RF DATA MODEM
- **Model Number** : HWC-W100
- **S/N** : Proto type
- **Freq. Range** : 2 405 MHz – 2 480 MHz
- **Number of Channels** : 16
- **Modulation Technique** : O-QPSK
- **Frequency Channel** : 2 405 MHz to 2 480 MHz and Channel Spacing 5 MHz (16 Channels)
- **Protocol** : IEEE 802.15.4
- **Antenna Type** : Dipole Antenna
- **ANTENNA GAIN** : 1.53 dBi
- **FCC Rule Part(s)** : FCC Part 15 Subpart B and C
- **Test Procedure** : ANSI C63.4-2003
- **FCC Classification** : DSS: Part 15 Spread Spectrum Transmitter  
JBP: Part 15 Class B Computing Device Peripheral
- **Place of Tests** : ETL Inc. Testing Lab.  
Radiated Emission test;  
#499-1, Sagot-ri, Seosin-myeon, Hwaseong-si,  
Gyeonggi-do, 445-882, Korea  
  
Conducted Emission test;  
ETL Inc. Testing Lab.  
371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea

## 1. INTRODUCTION

The measurement test for radiated and conducted emission test was conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.4-2003 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with FCC Rules according to the ANSI C63.4-2003 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003) was used in determining radiated and conducted emissions from the HYUNDAI ELEVATOR CO., LTD. Model: HWC-W100

## 2. PRODUCT INFORMATION

### 2.1 Equipment Description

The Equipment Under Test (EUT) is RF DATA MODEM

### 2.2 General Specification

#### \* Specification

Operating Frequency	2 405 MHz ~ 2 480 MHz	
Transmit Power	10 mW less	
Occupied Bandwidth	3 MHz and less	
Spread Spectrum	DSSS(Direct Sequence SS)	
Modulation	O-QPSK	
DS-SS	32-chip PN code	2MChips/s chips rate
Communication Method	Half duplex	
RF Data Rate	250Kbps	
Data Format	@@	
Channel Spacing	5MHz	
RF Channels	16 Channels	
Frequency Stability	±10 ppm	
Transmit Spurious	-40 dBm	
Receiver Sensitivity	High sensitivity -94 dBm	
Supply Voltage	Normal DC 24 V	
Operating Temperature	-30 ~ 80°C	

#### \* Frequency and channels

NET ID	Frequency	NET ID	Frequency
0	2,405 MHz	8	2,445 MHz
1	2,410 MHz	9	2,450 MHz
2	2,415 MHz	10	2,455 MHz
3	2,420 MHz	11	2,460 MHz
4	2,425 MHz	12	2,465 MHz
5	2,430 MHz	13	2,470 MHz
6	2,435 MHz	14	2,475 MHz
7	2,440 MHz	15	2,480 MHz

## 3. DESCRIPTION OF TESTS

### 3.1 Radiated Emission Measurement

Radiated emission measurements were made in accordance with § 13 in ANSI C63.4-2003 "Measurement of Intentional radiators". The measurements were performed over the frequency range of 30 MHz to 40 GHz using antenna as the input transducer to a Spectrum analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak, Quasi-peak, Average" within a bandwidth of 120 kHz and above 1GHz is 1 MHz.

Preliminary measurements were made at 3 m using broadband antennas, and spectrum analyzer to determine the frequency producing the maximum emission in shielded room. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 GHz using Log-Bicon antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used. Final measurements were made open site at 3 m. The test equipment was placed on a wooden turn-table. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined by manual. The detector function was set to CISPR Quasi-peak mode and the bandwidth of the receiver was set to 120 kHz or 1 MHz depending on the frequency or type of signal. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0.8 m high nonmetallic 1m x 1.5 m table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 m to 4 m and stopped at the azimuth or height producing the maximum emission.

Varying the mode of operating frequencies of the EUT maximized each emission. The system was tested in all the three orthogonal planes and changing the polarity of the antenna. The worst-case emissions are recorded in the data tables. If necessary, the radiated emission measurement could be performed at a closer distance to ensure higher accuracy and the results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per section 15.31(f).

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

## 3.2 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section § 13 in ANSI C63.4-2003 "measurement of intentional radiators" The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a  $50 \Omega$  / 50  $\mu$ H LISN as the input transducer to a Spectrum Analyzer or a Test Receiver. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 9 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1 m x 1.5 m x 0.8 m wooden table which is placed 0,4 m away from the vertical wall and 1,5 m away from the side wall of the chamber room. Two LISN are bonded to the shielded room. The EUT is powered from the LISN and the support equipment is powered from the other LISN. Power to the LISNs are filtered by a noise cut power line filters. All electrical cables are shielded by braided tinned steel tubing with inner  $\phi$  1.2 cm. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. Non-inductive bundling to a 1 m length shortened all interconnecting cables more than 1 m. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the EMI Test Receiver to determine the frequency producing the maximum emission from the EUT. The frequency producing the maximum level was reexamined using to set Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the spectrum analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission.

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

### 3.3 FCC Part 15.205 Restricted Bands of Operations

(a) Except as shown in paragraph (d) of this section, 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
<sup>1</sup> 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	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	( <sup>2</sup> )
13.36 - 13.41			

<sup>1</sup>Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

<sup>2</sup> Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

## **4. TEST CONDITION**

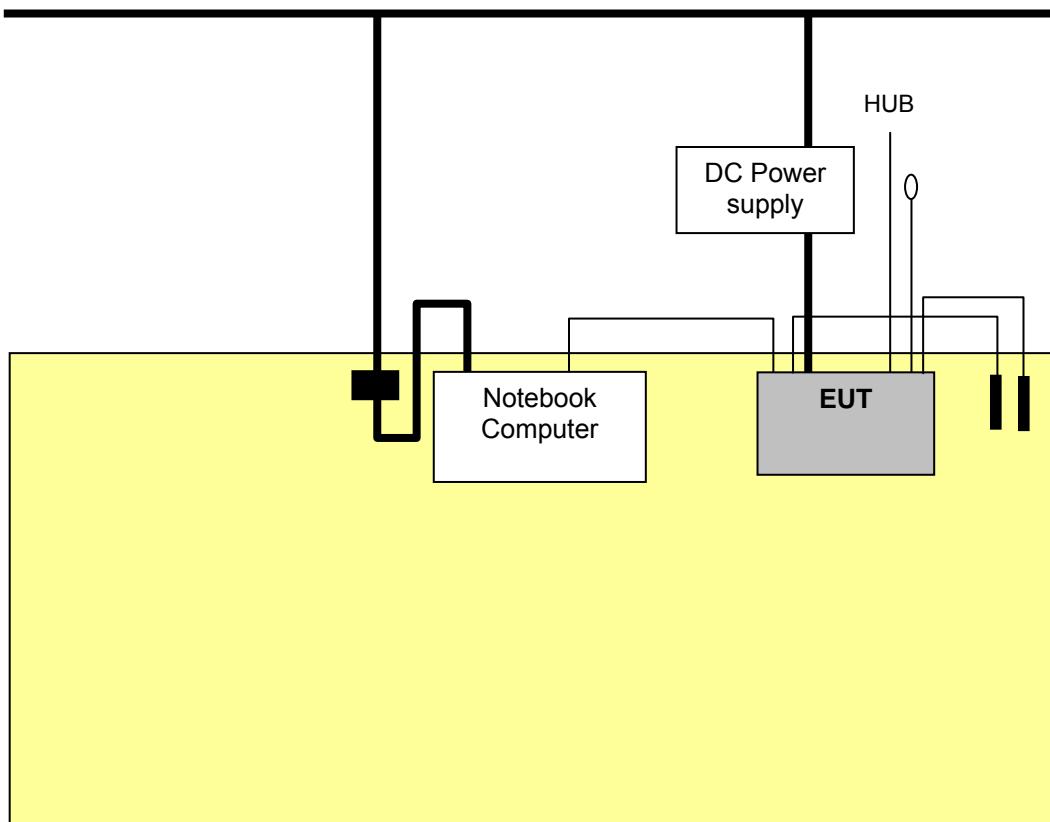
### **4.1 Test Configuration**

The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the following conditions and configurations were used.

### **4.2 Description of Test modes**

The EUT operated under Tx, Rx and standby mode during all the tests.

### **4.3 The setup drawing(s)**



- : Data Line
- : Termination
- : Power Line
- : Adapter

## 5. TEST RESULTS

### 5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

Applied Standard : 47 CFR Part 15, Subpart B and C			
FCC Rule	Measurement Required	Limit	Result
15.247(a)(2)	6 dB Bandwidth	> 500 kHz	Pass
15.247(b)(3)	Maximum Peak Output Power	< 1 W	Pass
15.247(d)	Bandwidth of Frequency Band Edges	More than 20 dBc	Pass
15.247(e)	Power Spectral Density	8 dBm	Pass
15.109, 209(a)	Spurious Emissions	Various	Pass
15.107, 207	Conducted Emissions	Various	Pass
15.247(i) 1.1307(b)(1)	RF Exposure	< 20 cm	Pass

The data collected shows that the **HYUNDAI ELEVATOR CO., LTD. / RF DATA MODEM / HWC-W100** complied with technical requirements of above rules part 15.107, 15.109, 15.209 and 15.247 Limits.

The equipment is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified during testing.

## 5.2 6 dB Bandwidth

EUT	RF DATA MODEM / HWC-W100
Limit apply to	FCC Part 15.247(a)(2)
Test Date	January 31, 2009
Operating Condition	RF transmitting continuously during the tested.
Result	Pass

### Limit

The maximum 6 dB bandwidth shall be at least 500 kHz

### Test Data

Frequency(MHz)	6 dB Bandwidth (MHz)	Limit
2 405	1.63	> 500 kHz
2 440	1.59	
2 480	1.59	

### NOTES:

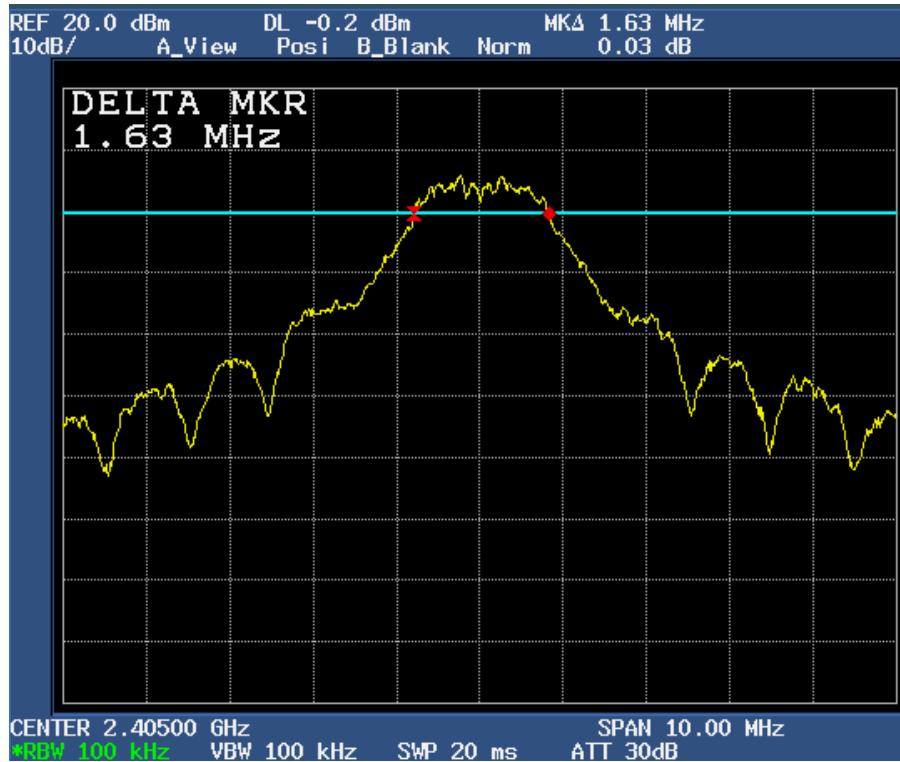
1. Measure frequency separation of relevant channel using spectrum analyzer.
2. RBW 100 kHz, VBW 100 kHz, span 10 MHz, Sweep time Auto.
3. Please see the measured plot in next page.



Test Engineer: Kug Kyoung, Yoon

**Plots of 6 dB Bandwidth**

[2 405MHz]



[2 440 MHz]



[2 480 MHz]



## 5.3 Maximum peak conducted output power

EUT	RF DATA MODEM / HWC-W100
Limit apply to	FCC Part 15.247(b)(3)
Test Date	February 02, 2009
Operating Condition	RF transmitting continuously during the tested.
Result	Pass

### Limit

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

- For systems using digital modulation operating in the 2 400 MHz - 2 483.5 MHz band: 1 W(30 dBm)

### Test Data

Frequency(MHz)	Output Power (dBm)	Limit
2 405	8.88	> 30 dBm(1W)
2 440	8.47	
2 480	8.05	

### NOTES:

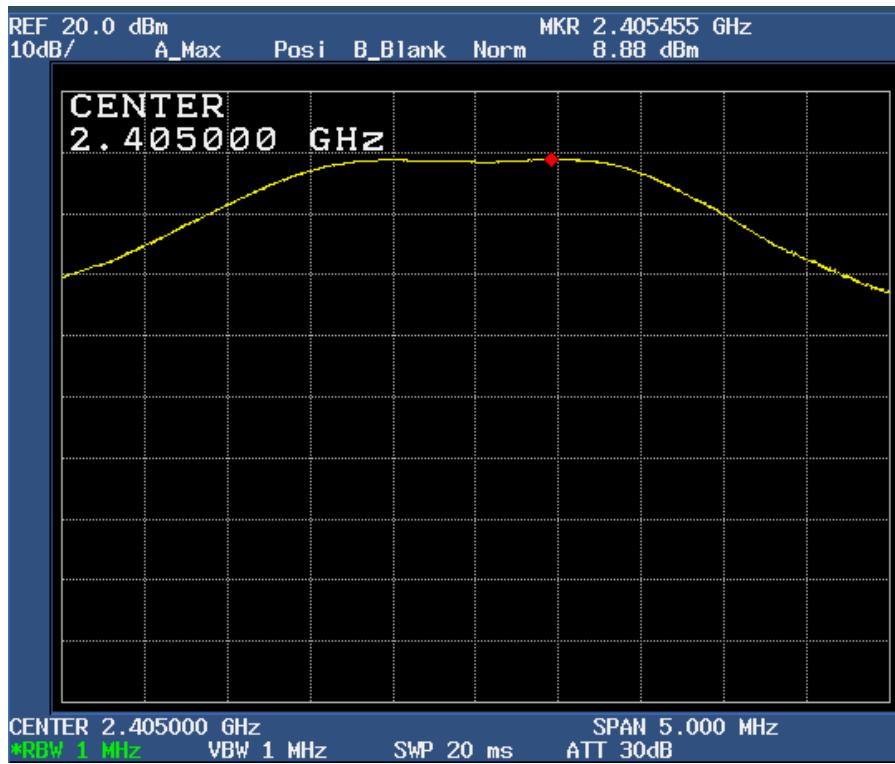
1. Measure conducted maximum peak output of relevant channel using spectrum analyzer
2. RBW 1 MHz, VBW 1 MHz
3. Maximum peak power is DIV/Main antenna summed across



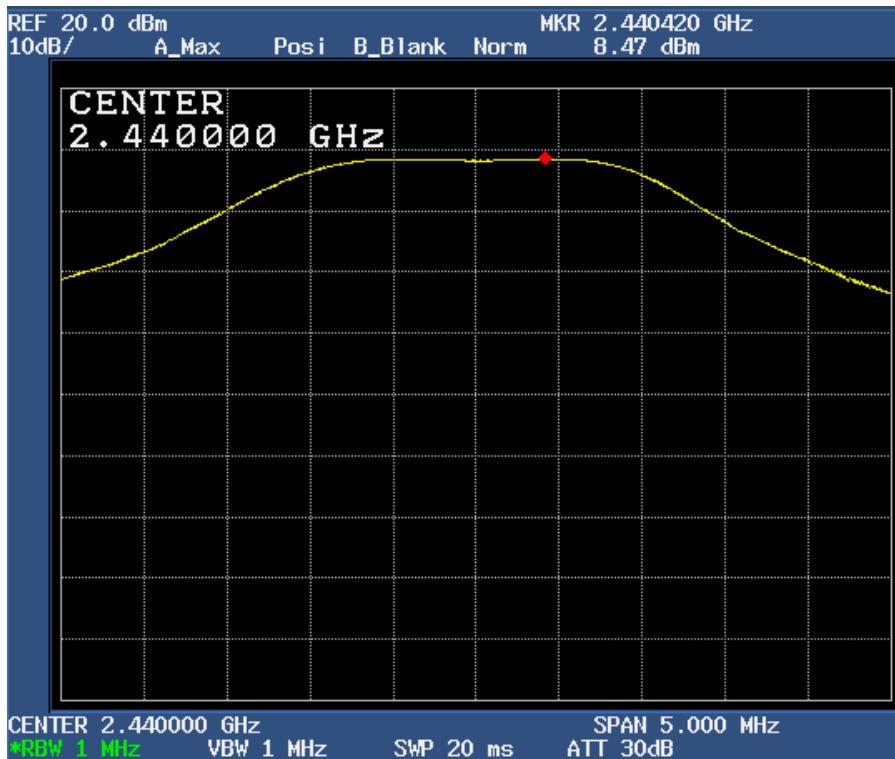
Test Engineer: Kug Kyoung, Yoon

**Plots of Maximum Peak Output Power**

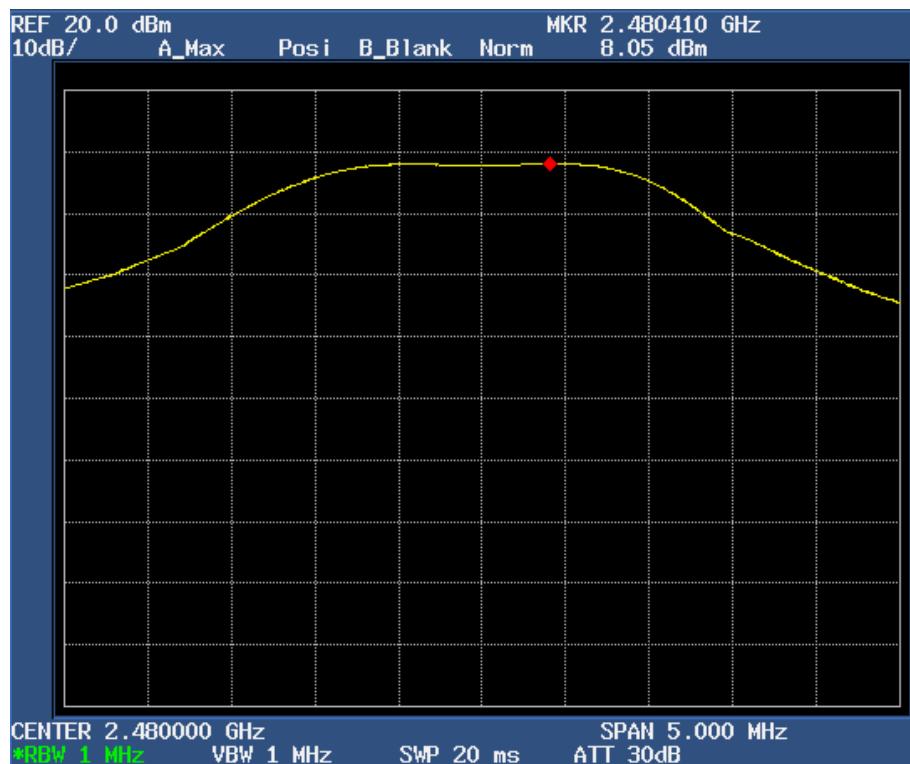
[2 405 MHz]



[2 440 MHz]



[2 480 MHz]



## 5.4 Bandwidth of Frequency Band Edges

EUT	RF DATA MODEM / HWC-W100
Limit apply to	FCC Part 15.247(d)
Test Date	February 04, 2009
Operating Condition	RF transmitting continuously during the tested.
Result	Pass

### Limit

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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

### Test Results

- Refer to see the measured plot in next page.

### NOTES:

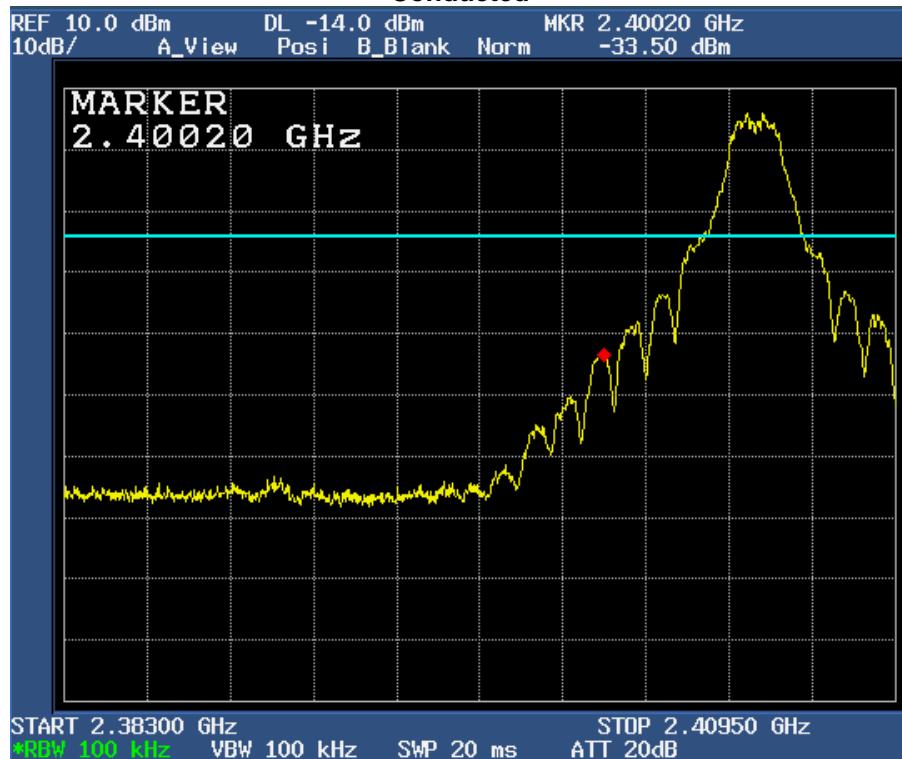
1. The test was performed to make a direct field strength measurement at the band edge frequencies.



Test Engineer: Kug Kyoung, Yoon

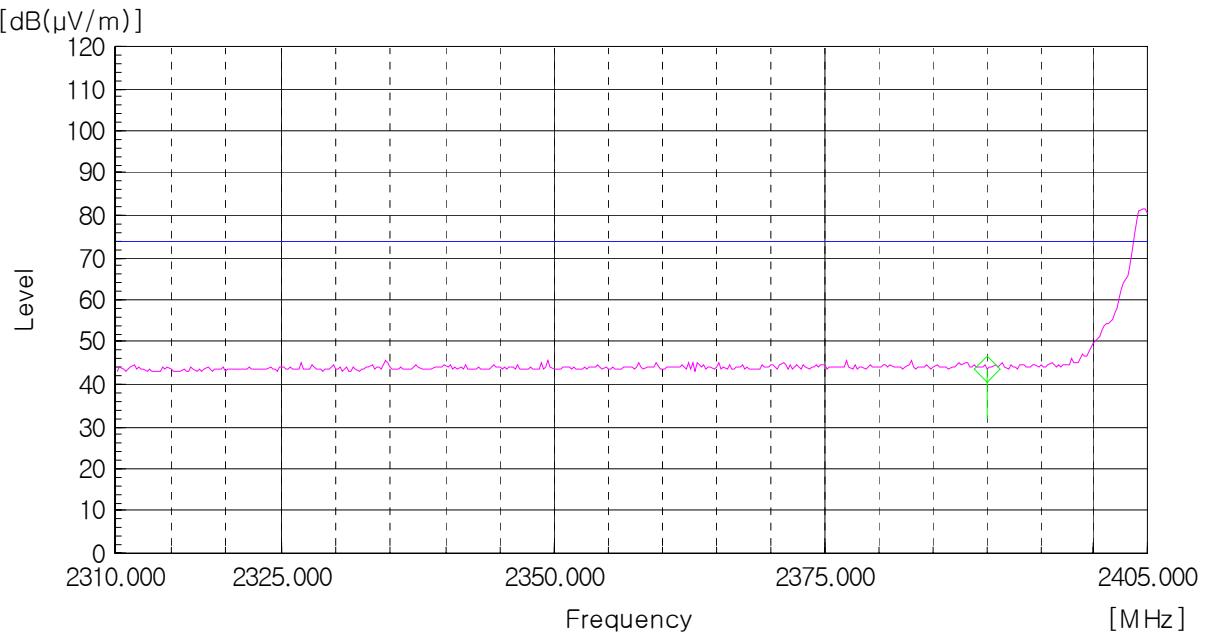
#### 5.4.1 Bandwidth of Frequency Band Edges

Conducted

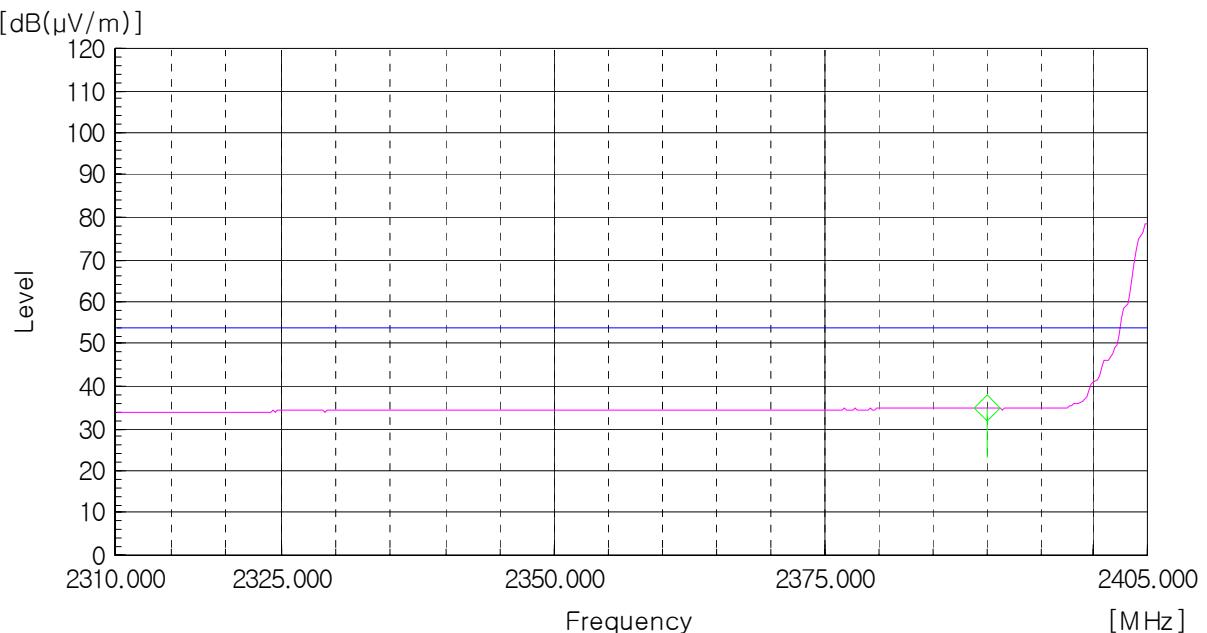


**Radiated**

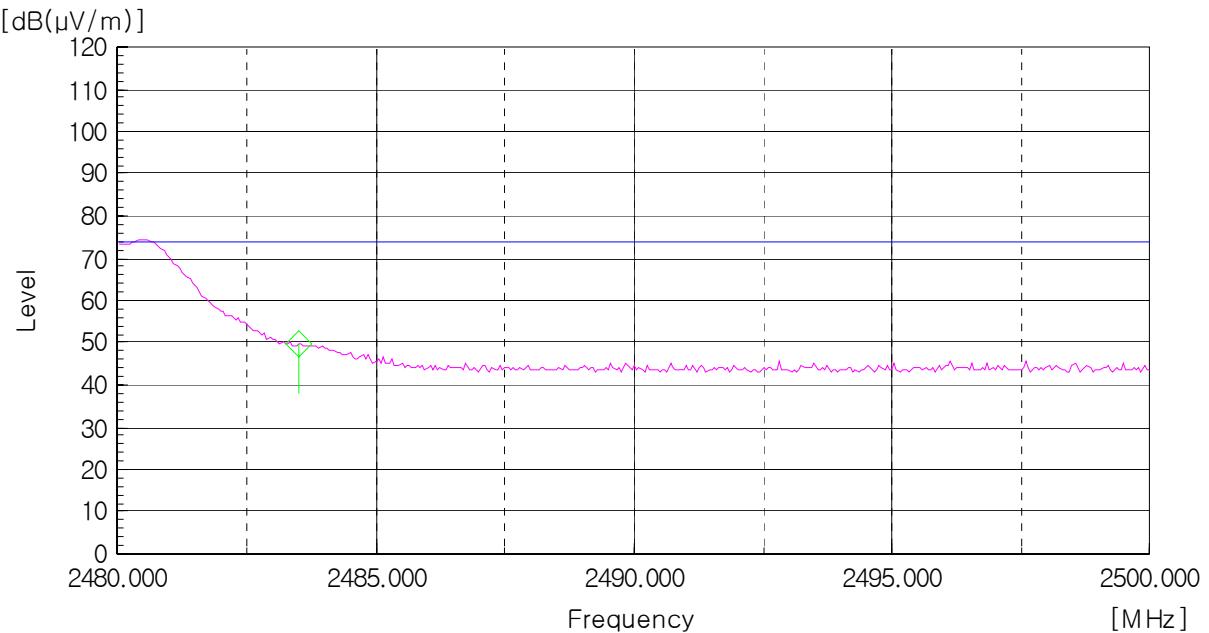
Peak Detector: RBW: 1MHz, VBW: 1MHz (2310 MHz – 2390 MHz)



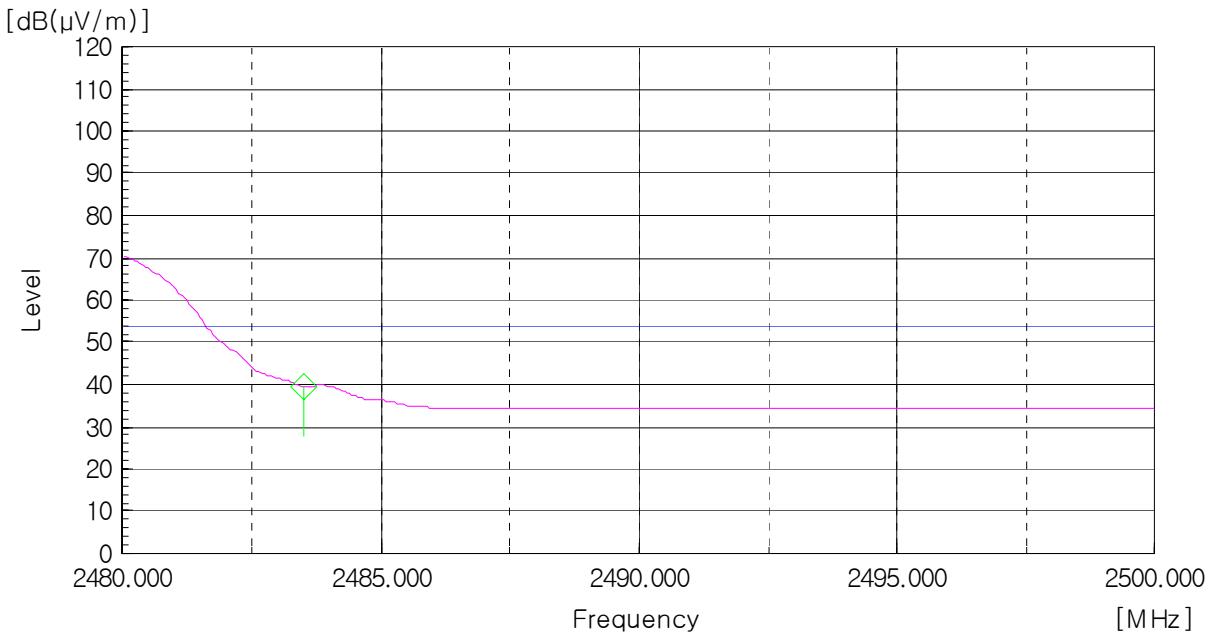
AV Detector: RBW: 1MHz, VBW: 10Hz (2310 MHz – 2390 MHz)



Peak Detector: RBW: 1MHz, VBW: 1MHz (2483.5 MHz – 2500 MHz)



Peak Detector: RBW: 1MHz, VBW: 10Hz (2483.5 MHz – 2500 MHz)



## 5.5 Power Spectral Density

EUT	RF DATA MODEM/ HWC-W100
Limit apply to	FCC Part 15.247(e)
Test Date	February 05, 2009
Operating Condition	RF transmitting continuously during the tested.
Result	Pass

### Limit

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

### Test Data

802.11b mode

Channel	Frequency (MHz)	PSD (dBm)	Limit
Low	2 405	-5.45	8 dBm
Mid	2 440	-6.38	
High	2 480	-7.69	

### NOTES:

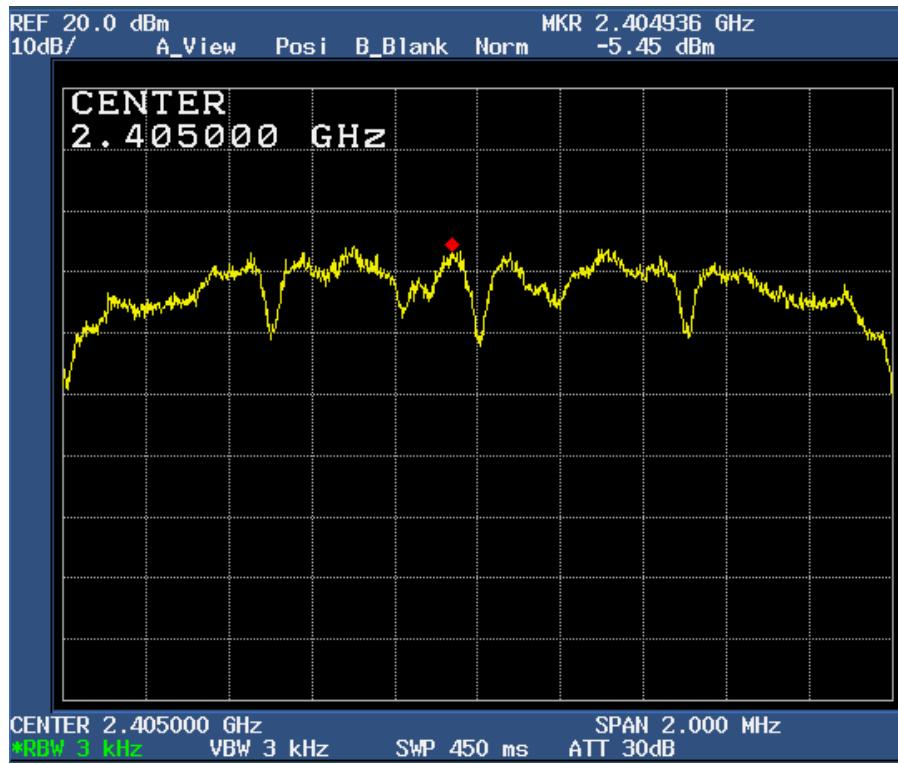
1. Measure power spectral density of relevant channel using spectrum analyzer.
2. RBW 3 kHz, VBW 3 kHz, span 2 MHz, Sweep time Auto.
3. Please see the measured plot in next page.



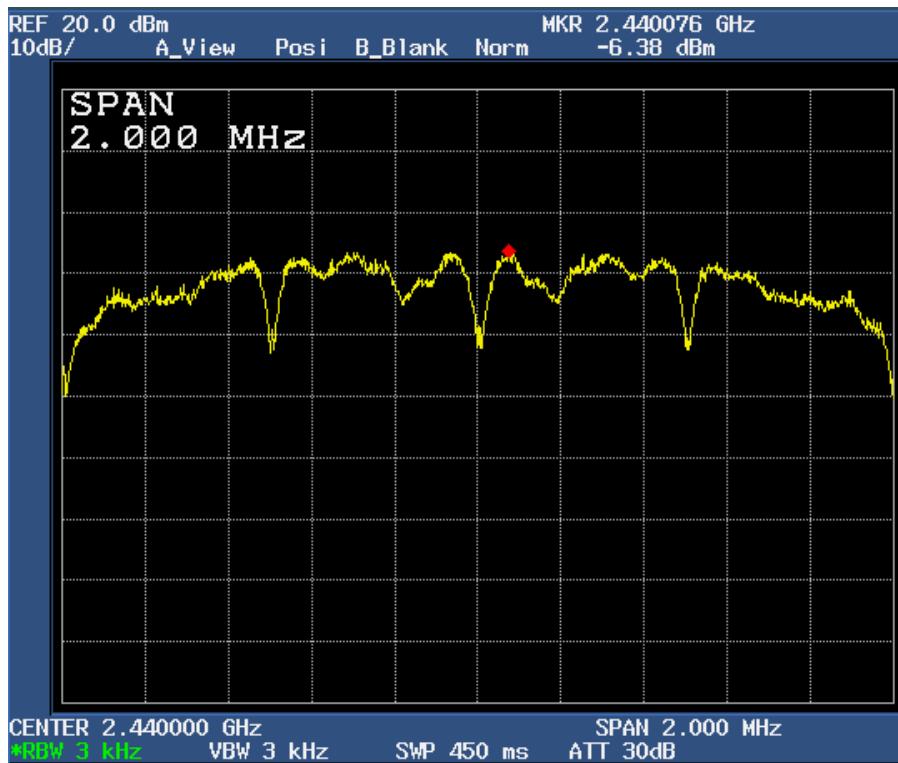
Test Engineer: Kug Kyoung, Yoon

**Power Spectral Density**

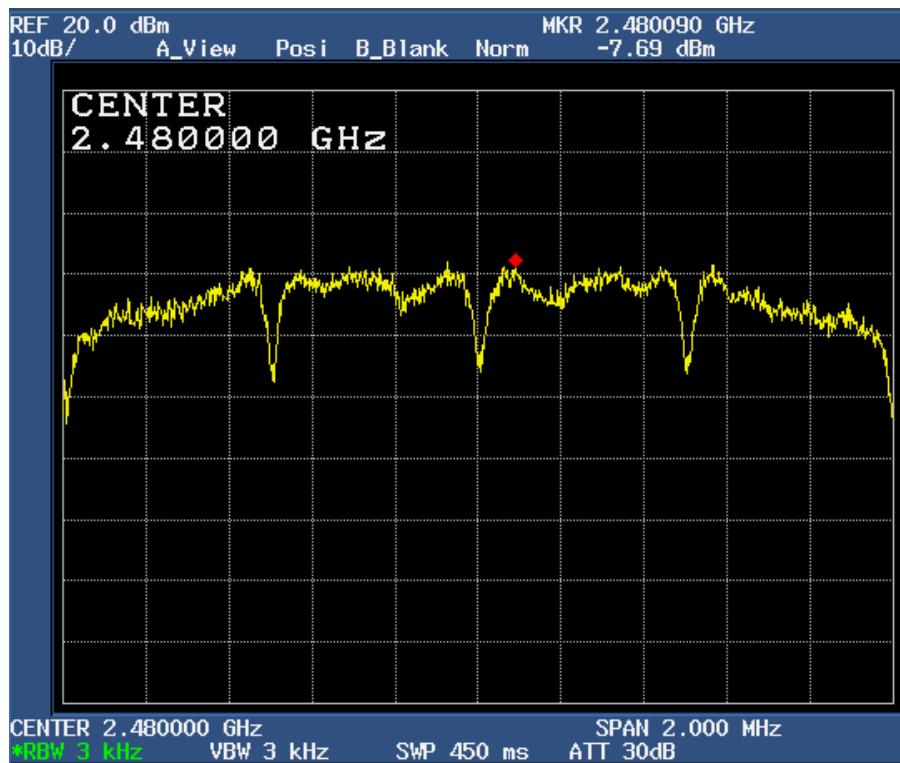
[CH Low]



[CH Mid]



[CH High]



## 5.6 Spurious Emissions

### 5.6.1 Radiated Emissions

EUT	RF DATA MODEM/ HWC-W100
Limit apply to	FCC Part 15.109, 209
Test Date	February 06, 2009
Operating Condition	Low CH, Middle CH, High CH Transmission
Result	Pass

#### Limit

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequencies (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	Field Strength (dB $\mu\text{V}/\text{m}$ )	Measurement Distance (m)
30 – 88	100*	40	3
88 – 216	150*	43.5	3
216 – 960	200*	46	3
Above 960	500	54	3

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

#### Test Results

- Refer to see the measured plot in next page.



Test Engineer: Kug Kyoung, Yoon

## Radiated Emissions Test data

### - Below 1 GHz

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical. Detector mode: CISPR Quasi – Peak mode (6 dB Bandwidth: 120 kHz)

Frequency [MHz]	Reading [dB $\mu$ V]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]
34.77	23.49	V	11.22	0.89	35.60	40.00	4.40
50.45	20.79	V	12.21	1.20	34.20	40.00	5.80
66.13	23.87	V	10.27	1.36	35.50	40.00	4.50
128.85	16.22	V	11.79	2.29	30.30	43.50	13.20
274.75	16.86	H	11.69	3.45	32.00	46.00	14.00
300.25	15.83	H	12.47	3.70	32.00	46.00	14.00
351.25	14.75	H	13.64	4.11	32.50	46.00	13.50
400.75	18.94	H	14.56	4.60	38.10	46.00	7.90
500.25	20.75	H	16.65	5.40	42.80	46.00	3.20

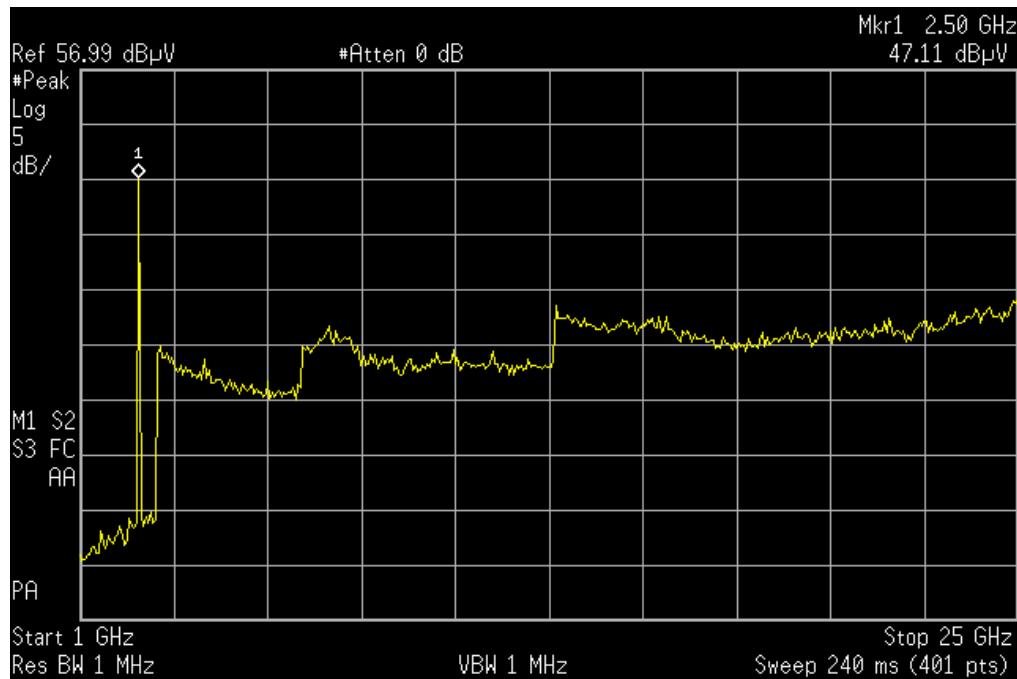
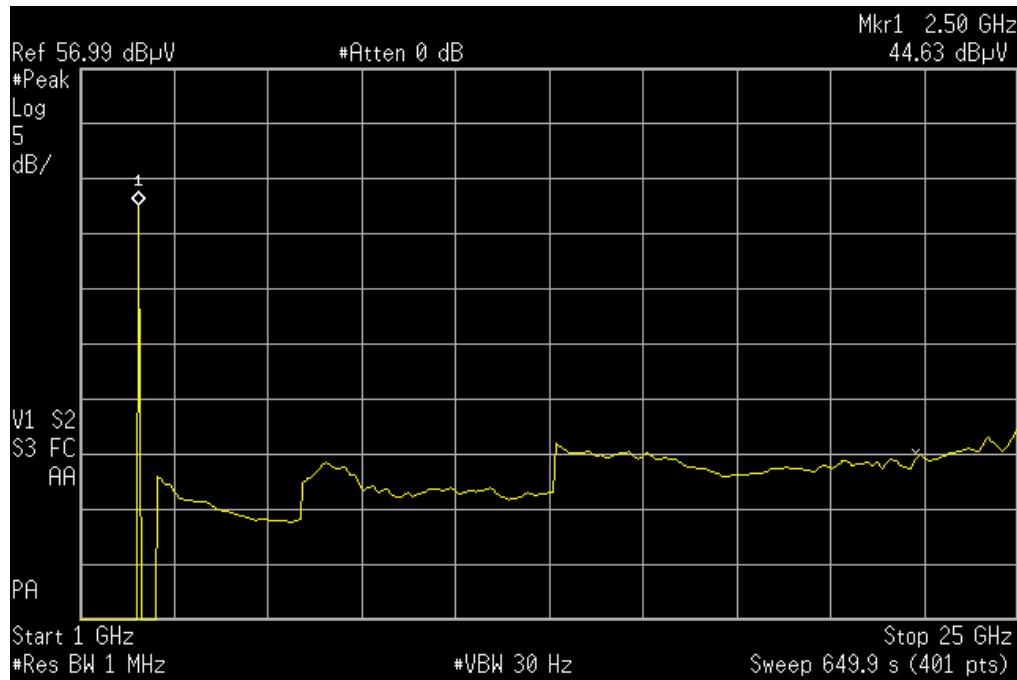
### NOTES:

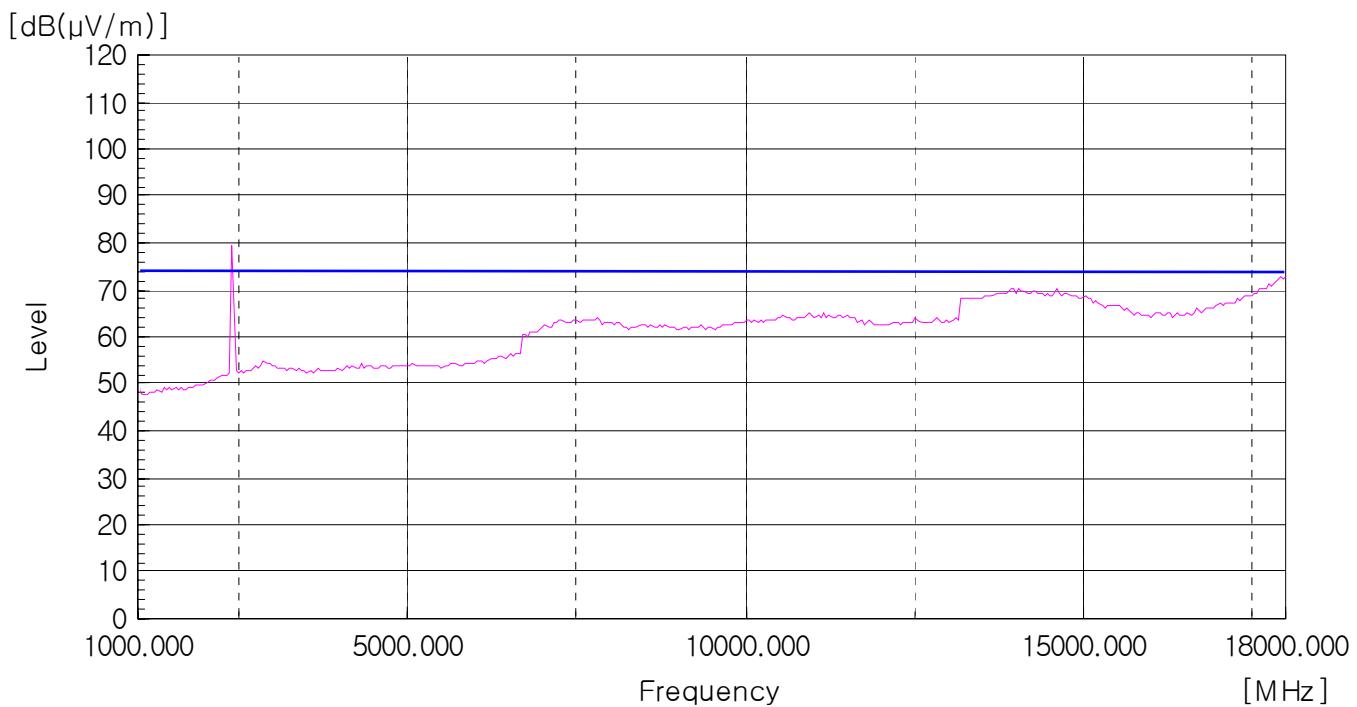
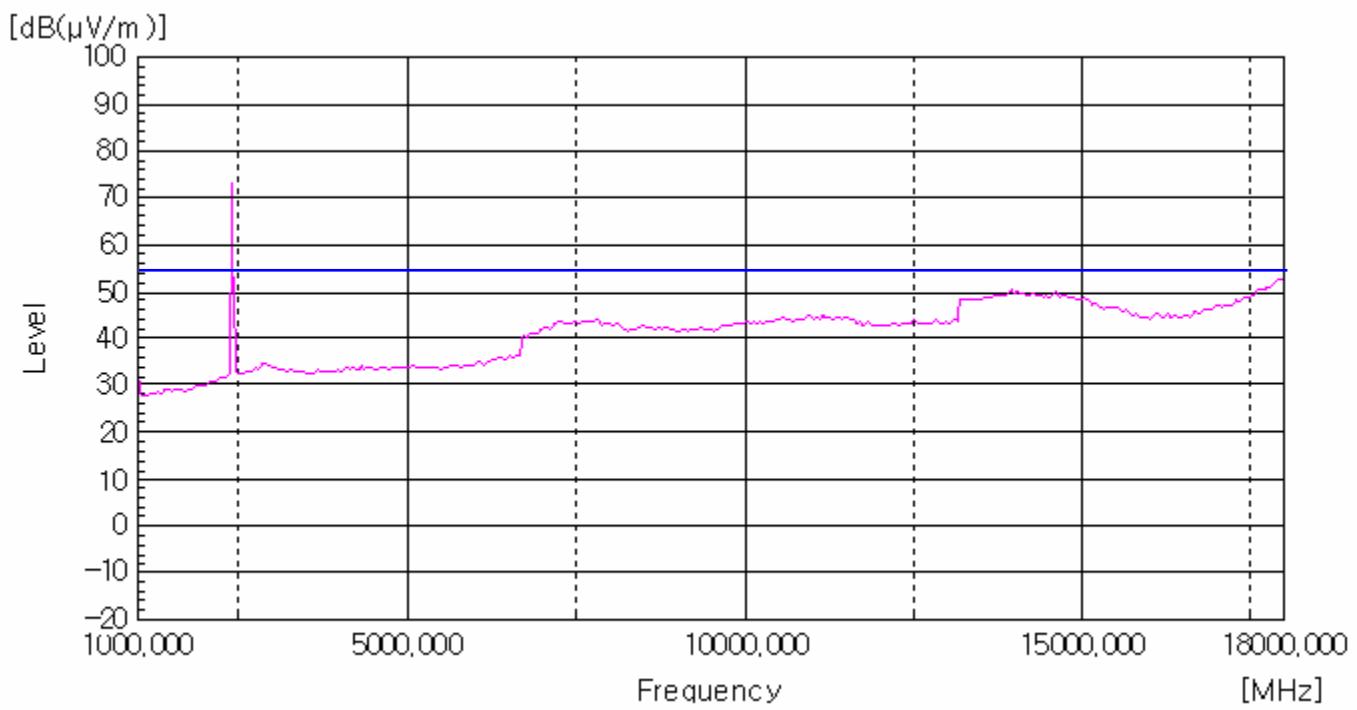
1. \* H : Horizontal polarization , \*\* V : Vertical polarization
2. Result = Reading + Antenna factor + Cable loss
3. Margin value = Limit - Result
4. The measurement was performed for the frequency range above 30 MHz according to FCC Part 15.209.

**- Above 1 GHz**

- Operating mode: Tx, Rx / CH: Low, Mid, High

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.

**Pre Scan Data Peak Detector****Pre Scan Data AV Detector**

**Final data Peak****Final data AV**



# FCC TEST REPORT

## 1. Low CH

Detector mode: Peak mode

Frequency [MHz]	Reading [dB $\mu$ N]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ N]	Preamp [dB]	Result [dB $\mu$ N/m]	Limit [dB $\mu$ N/m]	Margin [dB]
-	-	-	-	-	-	-	74.00	-
-	-	-	-	-	-	-	74.00	-

Detector mode: Average mode

Frequency [MHz]	Reading [dB $\mu$ N]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ N]	Preamp [dB]	Result [dB $\mu$ N/m]	Limit [dB $\mu$ N/m]	Margin [dB]
-	-	-	-	-	-	-	54.00	-
-	-	-	-	-	-	-	54.00	-

## 2. Middle CH

Detector mode: Peak mode

Frequency [MHz]	Reading [dB $\mu$ N]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ N]	Preamp [dB]	Result [dB $\mu$ N/m]	Limit [dB $\mu$ N/m]	Margin [dB]
-	-	-	-	-	-	-	74.00	-
-	-	-	-	-	-	-	74.00	-

Detector mode: Average mode

Frequency [MHz]	Reading [dB $\mu$ N]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ N]	Preamp [dB]	Result [dB $\mu$ N/m]	Limit [dB $\mu$ N/m]	Margin [dB]
-	-	-	-	-	-	-	54.00	-
-	-	-	-	-	-	-	54.00	-

## 3. High CH

Detector mode: Peak mode

Frequency [MHz]	Reading [dB $\mu$ N]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ N]	Preamp [dB]	Result [dB $\mu$ N/m]	Limit [dB $\mu$ N/m]	Margin [dB]
-	-	-	-	-	-	-	74.00	-
-	-	-	-	-	-	-	74.00	-



# FCC TEST REPORT

Detector mode: Average mode

Frequency [MHz]	Reading [dB $\mu$ N]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ N]	Preamp [dB]	Result [dB $\mu$ N/m]	Limit [dB $\mu$ N/m]	Margin [dB]
-	-	-	-	-	-	-	54.00	-
-	-	-	-	-	-	-	54.00	-

**Result: All emissions below noise floor of 20 dB $\mu$ N/m**

NOTES:

1. \* H : Horizontal polarization , \*\* V : Vertical polarization
2. Result = Reading + Antenna factor + Cable loss - Preamp
3. Margin value = Limit - Result
4. Measuring frequencies from 1 GHz to the 10<sup>th</sup> harmonic of highest fundamental frequency.
5. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded(ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
6. Spectrum setting:
  - a. Peak Setting 1 GHz to 10<sup>th</sup> harmonics of fundamental, RBW = 1 MHz, VBW = 1 MHz, Sweep = Auto
  - b. AV Setting 1 GHz to 10<sup>th</sup> harmonics of fundamental, RBW = 1 MHz, VBW = 30 Hz, Sweep = Auto
7. Considered that's already beyond the background noise floor.

## 5.6.2 Conducted Measurement

EUT	RF DATA MODEM / HWC-W100
Limit apply to	FCC Part 15.247(d)
Test Date	February 07, 2009
Operating Condition	RF transmitting continuously during the tested.
Result	Pass

### Limit

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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

### Test Results

- Refer to see the measured plot in next page.

### NOTES:

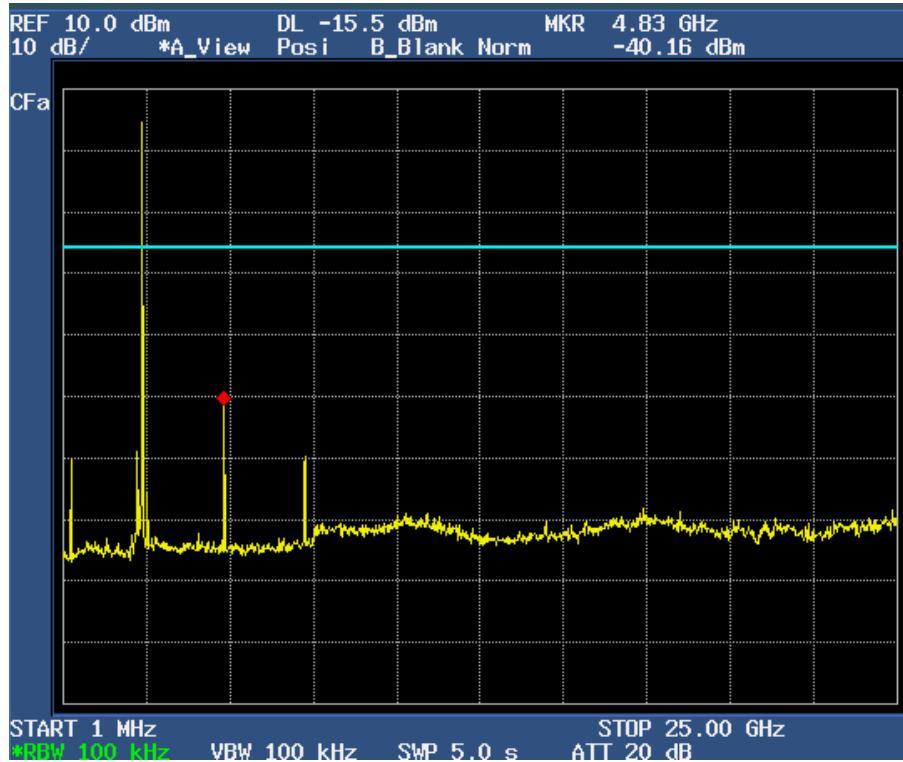
1. Measure conducted measurement channel using spectrum analyzer.
2. RBW 100 kHz, VBW 100 kHz, Frequency range 30 MHz to 25 GHz.



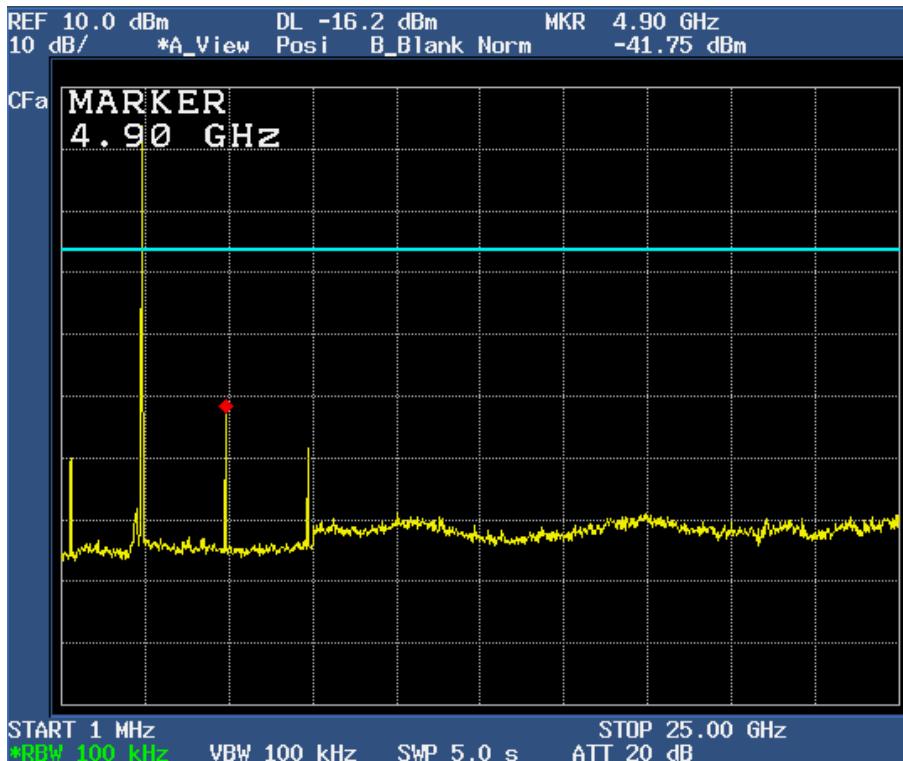
Test Engineer: Kug Kyoung, Yoon

**Spurious Emissions (Conducted Measurement)**

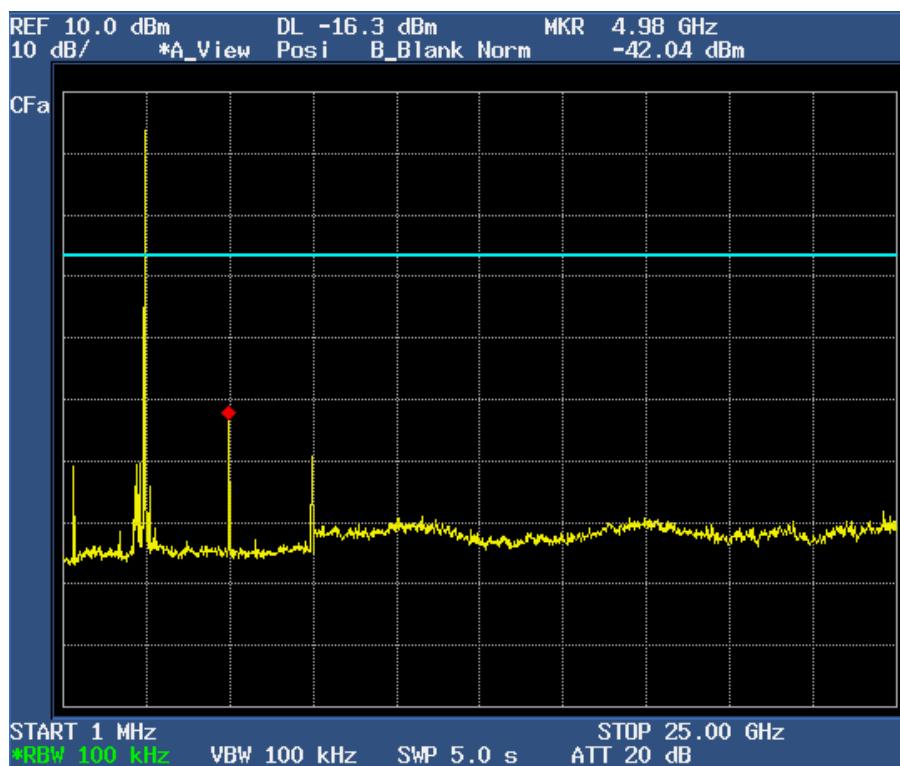
[CH Low]



[CH Mid]



[CH High]



## 5.7 Conducted Emissions Measurement

EUT	RF DATA MODEM/ HWC-W100		
Limit apply to	FCC Part 15.107, 207		
Test Date	February 10, 2009		
Operating Condition	RF transmitting continuously during the tested.		
Result	Passed		

### 5.7.1 Conducted Emission Test Data

The following table shows the highest levels of conducted emissions on both polarizations of hot and neutral line.  
Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 9 kHz)

Frequency [MHz]	Result [dB $\mu$ V]		Phase (*L/**N)	Limit [dB $\mu$ V]		Margin [dB]	
	Quasi-peak	Average		Quasi-peak	Average	Quasi-peak	Average
0.159	54.70	51.80	N	65.50	55.50	10.80	3.70
0.321	47.10	46.10	N	59.70	49.70	12.60	3.60
0.480	41.10	38.60	N	56.30	46.30	15.20	7.70
0.637	35.00	31.20	H	56.00	46.00	21.00	14.80
0.962	39.30	36.90	N	56.00	46.00	16.70	9.10
1.125	36.60	32.90	H	56.00	46.00	19.40	13.10
2.406	33.30	25.40	N	56.00	46.00	22.70	20.60
5.789	31.60	24.60	H	60.00	50.00	28.40	25.40
21.661	37.70	35.80	H	60.00	50.00	22.30	14.20

#### NOTES:

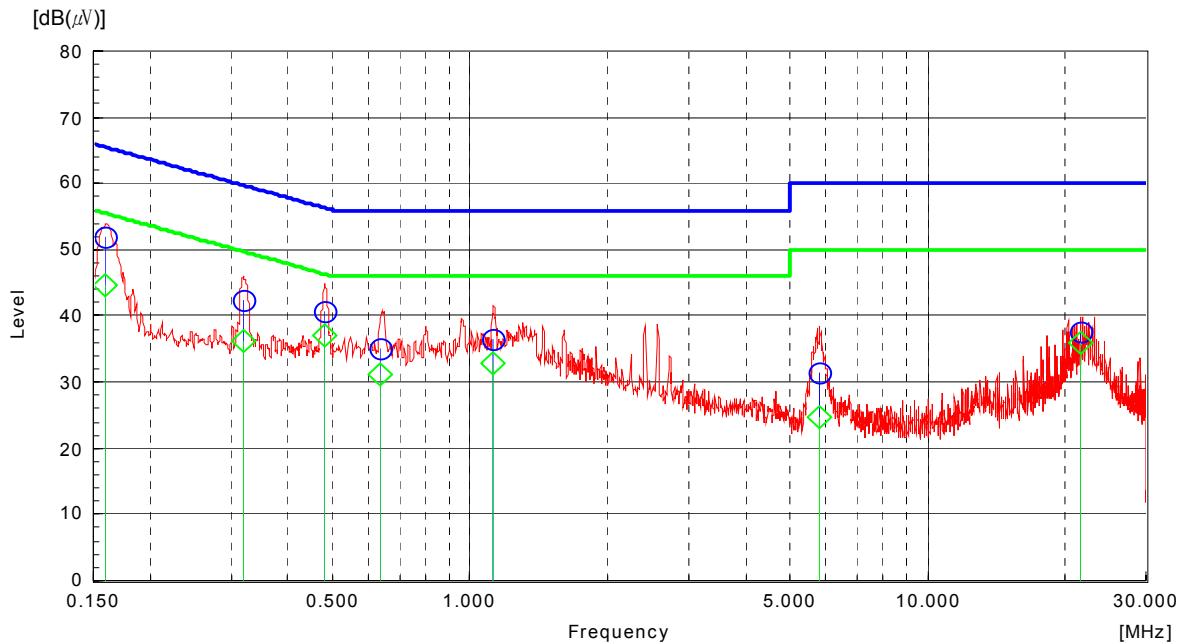
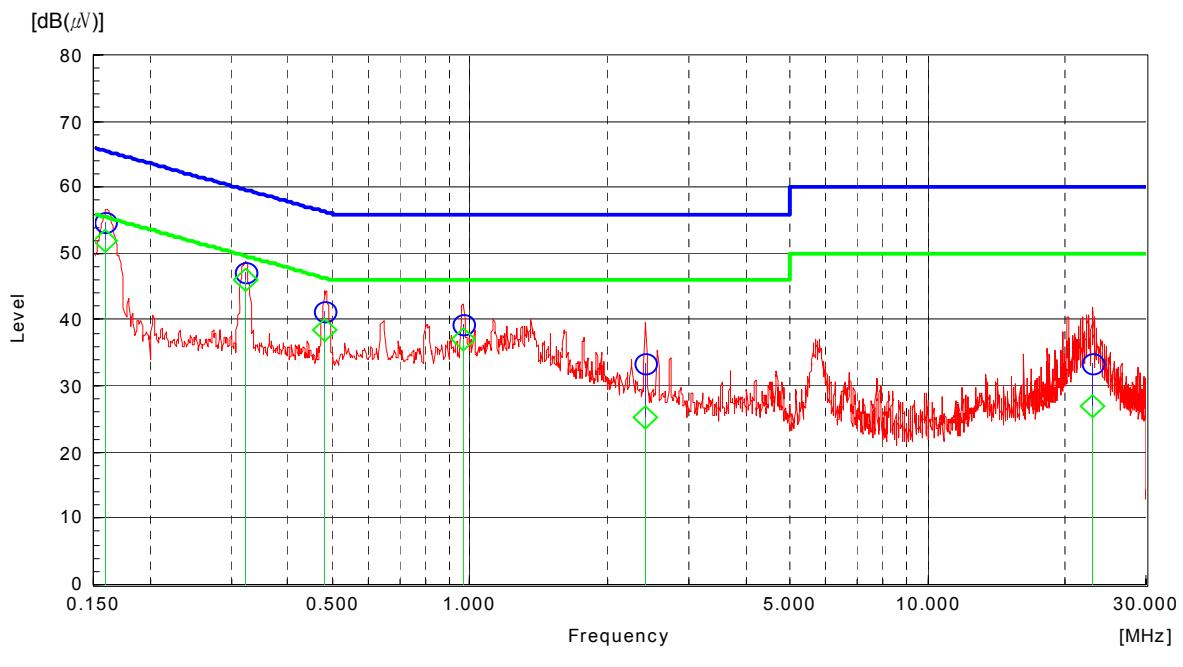
1. \* H : HOT Line , \*\*N : Neutral Line
2. Margin value = Limit – Result
3. Measurement were performed at the AC Power Inlet in the frequency band of 150 kHz ~ 30 MHz according to the FCC Part 15 Class B.



Test Engineer: Kug Kyoung, Yoon

**Line: HOT Line**

Limit :   
— Quasi-Peak  
— Average

**Line: Neutral Line**

Quasi-peak



Average



## 5.8 Radio Frequency Exposure

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

### Limit

#### Limits for general population/Uncontrolled exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
0.3-1.34	614	1.63	(100)	30
1.34-30	824/f	2.19/f	(180/f <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100 000	--	--	1.0	30

f = frequency in MHz

\*Plane-wave equivalent power density

### MPE Prediction

Predication of MPE limit at a given distance.

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density (in appropriate units, e.g. mW/cm<sup>2</sup>)

P = power input to the antenna (in appropriate units, e.g., mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Maximum peak output power at antenna input : 8.88 dBm (7.73 mW)

Prediction distance : 20 cm

Predication frequency : 2 405 MHz

Antenna gain(Max) : 2.0 dBi (1.42 numeric)

Power density at predication frequency at 20 cm : 0.00218 mW/cm<sup>2</sup>

MPE Limit for : 1.0 mW/cm<sup>2</sup>

### Test Result

The power density level at 20 cm is **0.00218 mW/cm<sup>2</sup>**

## 6. SAMPLE CALCULATION

### Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor.  
The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF$$

Where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

$$dB(\mu V) = 20 \log_{10} (uV) : \text{Equation}$$

Example : @ 500.25 MHz

Class B Limit	= 46.00 dBuV/m
Reading	= 20.75dBuV
Antenna Factor + Cable Loss	= $16.65 + 5.40 = 22.05$ dBuV/m
Total	= 42.80 dBuV/m
Margin	= $46.00 - 42.80 = 3.20$ dB
	= 3.20 dB below Limit

## 7. List of test equipments used for measurements

Test Equipment		Model	Mfg.	Serial No.	Cal. Due Date
<input checked="" type="checkbox"/>	Spectrum Analyzer	R3273	Advantest	95090411	09.06.24
<input checked="" type="checkbox"/>	EMI TEST Receiver	ESVS10	R&S	835165/001	09.04.04
<input checked="" type="checkbox"/>	EMI TEST Receiver	ESPI3	R&S	100478	09.10.02
<input checked="" type="checkbox"/>	LISN	3825/2	EMCO	9208-1995	09.10.01
<input checked="" type="checkbox"/>	LISN	3816-2	EMCO	1002	09.10.01
<input checked="" type="checkbox"/>	Turn-Table	MFT-120S	Max-Full Antenna Corp	-	N/A
<input checked="" type="checkbox"/>	Antenna Master	MFA-440E	Max-Full Antenna Corp	-	N/A
<input checked="" type="checkbox"/>	LogBicon Antenna	VULB9160	Schwarzbeck	3082	10.01.25
<input checked="" type="checkbox"/>	Broad band Horn antenna	BBHA 9120D	Schwarzbeck	227	09.03.15
<input checked="" type="checkbox"/>	Preamplifier	8447D	H.P	3307A02865	09.10.02