

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.



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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

| | |
|-----------------------|--|
| Applicant Name | : HYUNDAI ELEVATOR CO., LTD. |
| Address | : San 136-1, Ami-ri, Bubal-eup, Ichon-shi, Kyonggi-do, Korea |
| Attention | : 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 laced 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 of 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 Ω / 50 μ 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 ϕ 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 |
| ¹ 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 | (²) |
| 13.36 - 13.41 | | | |

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

² 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

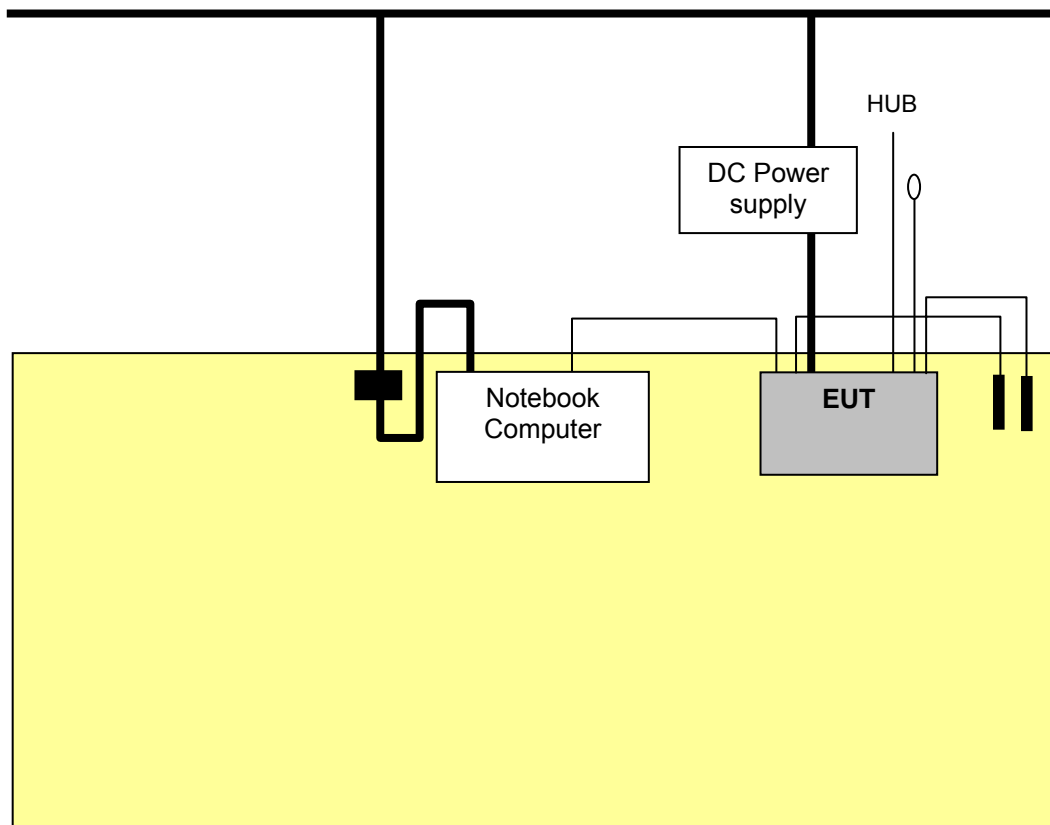
4.1 Test Configuration

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:

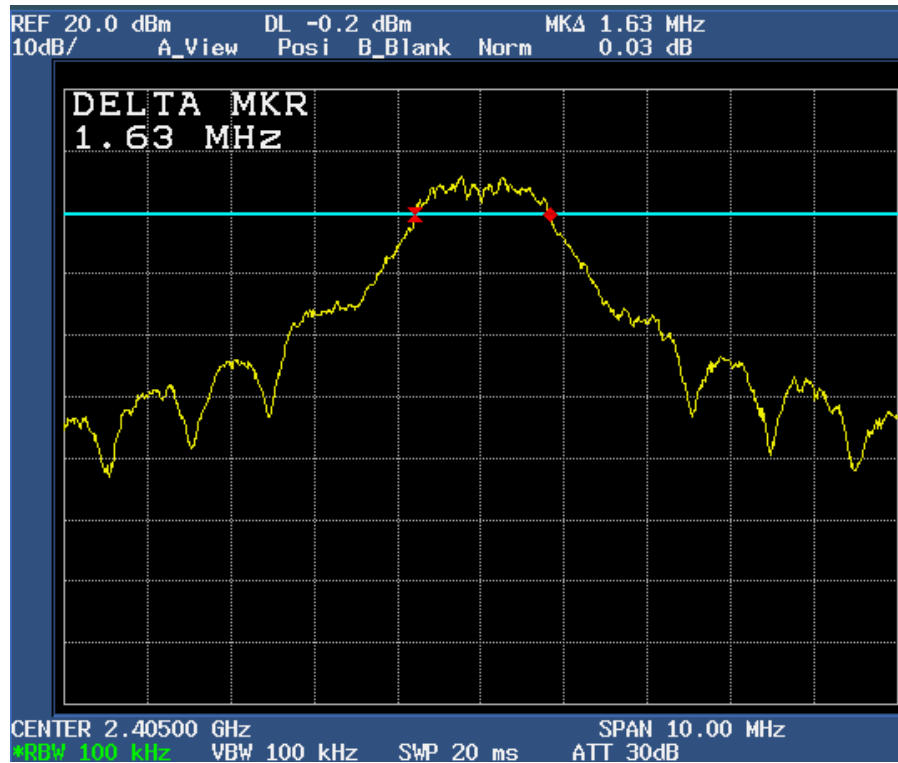
1. Measure frequency separation of relevant channel using spectrum analyzer.
2. RBW 100 kHz, VBW 100 kHz, span 10 MHz, Sweep time Auto.
3. Please see the measured plot in next page.



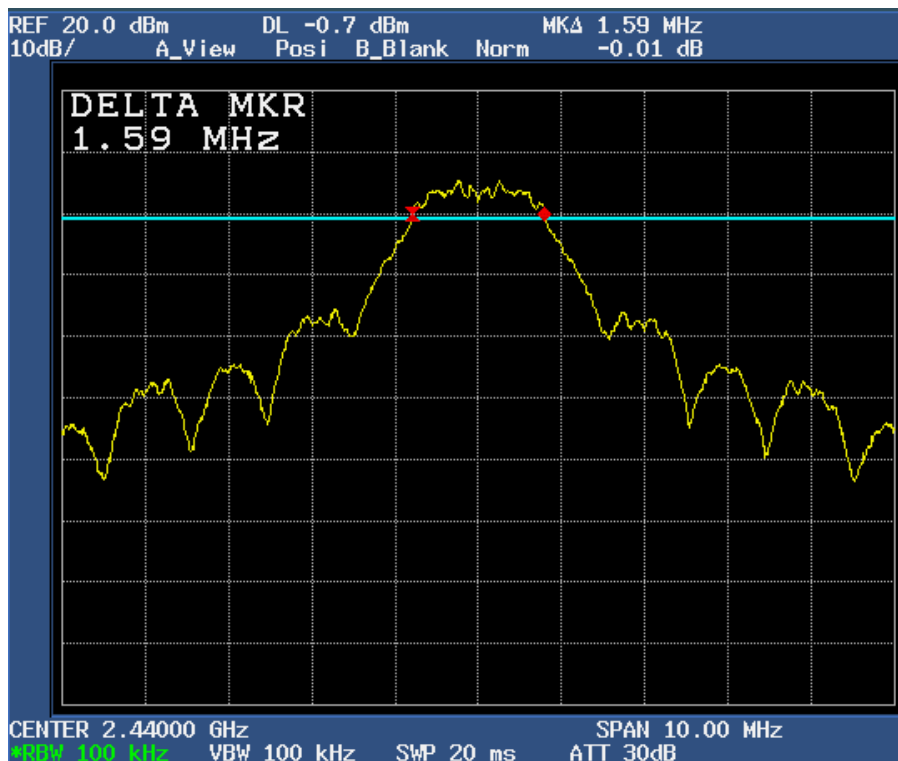
Test Engineer: Kug Kyoung, Yoon

Plots of 6 dB Bandwidth

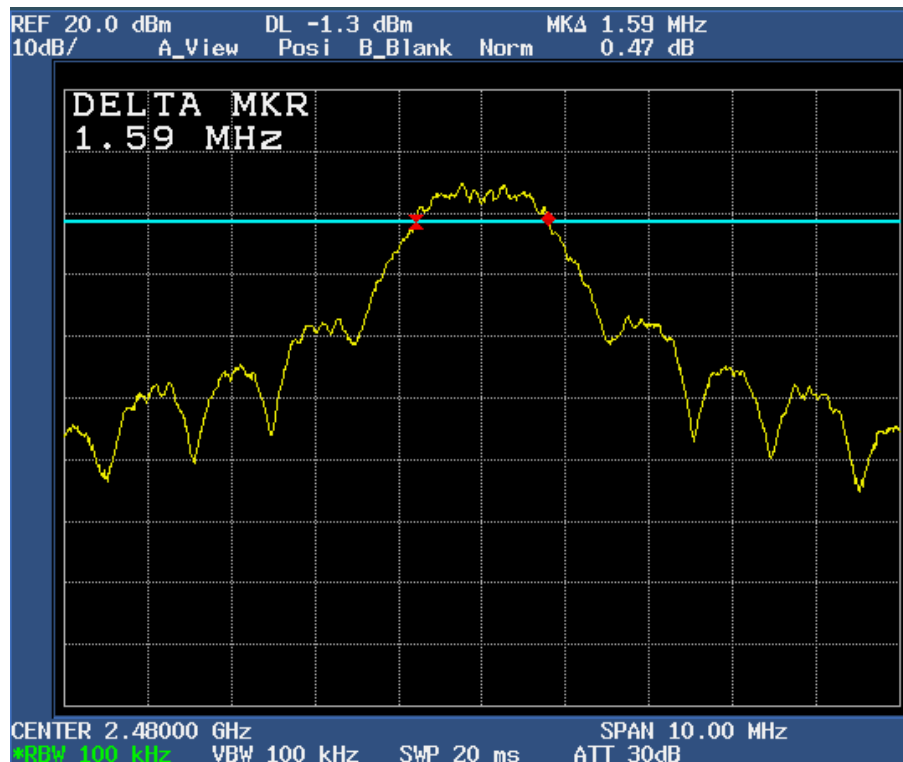
[2 405MHz]



[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:

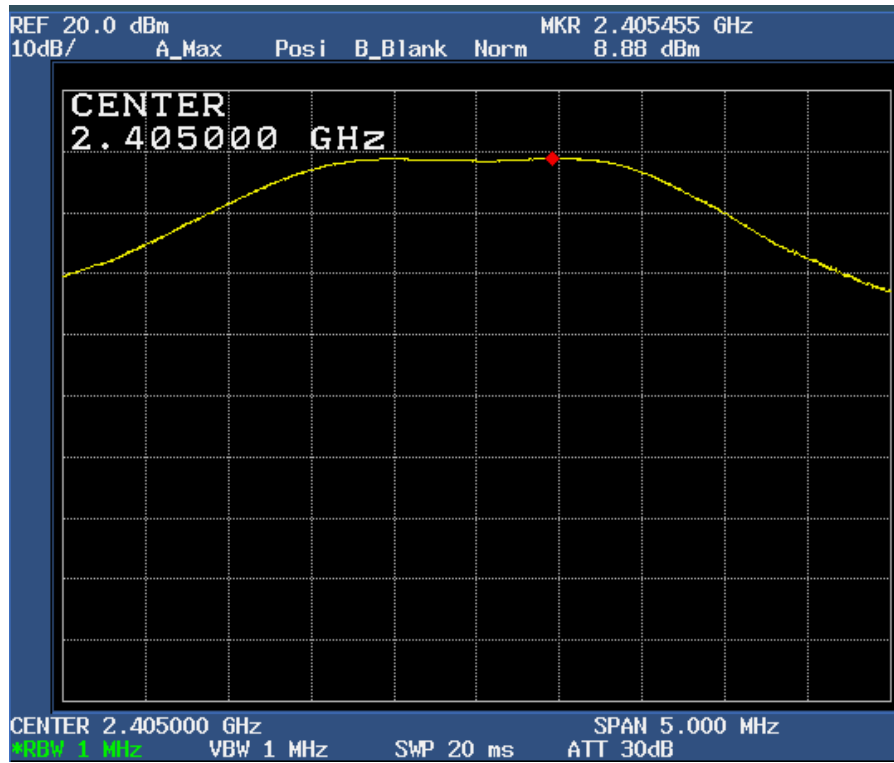
1. Measure conducted maximum peak output of relevant channel using spectrum analyzer
2. RBW 1 MHz, VBW 1 MHz
3. Maximum peak power is DIV/Main antenna summed across



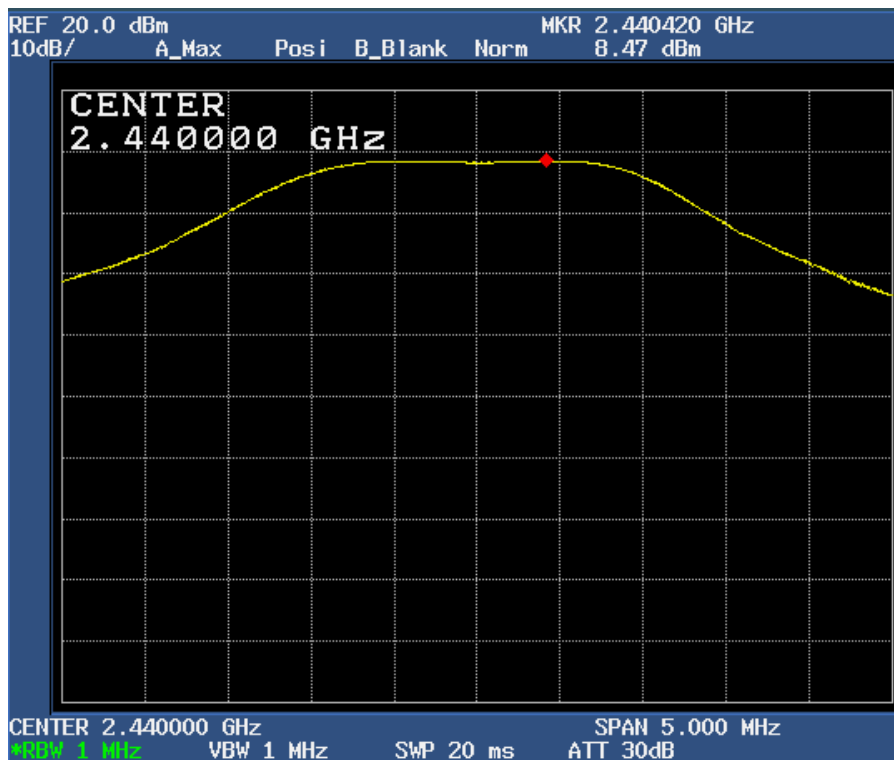
Test Engineer: Kug Kyoung, Yoon

Plots of Maximum Peak Output Power

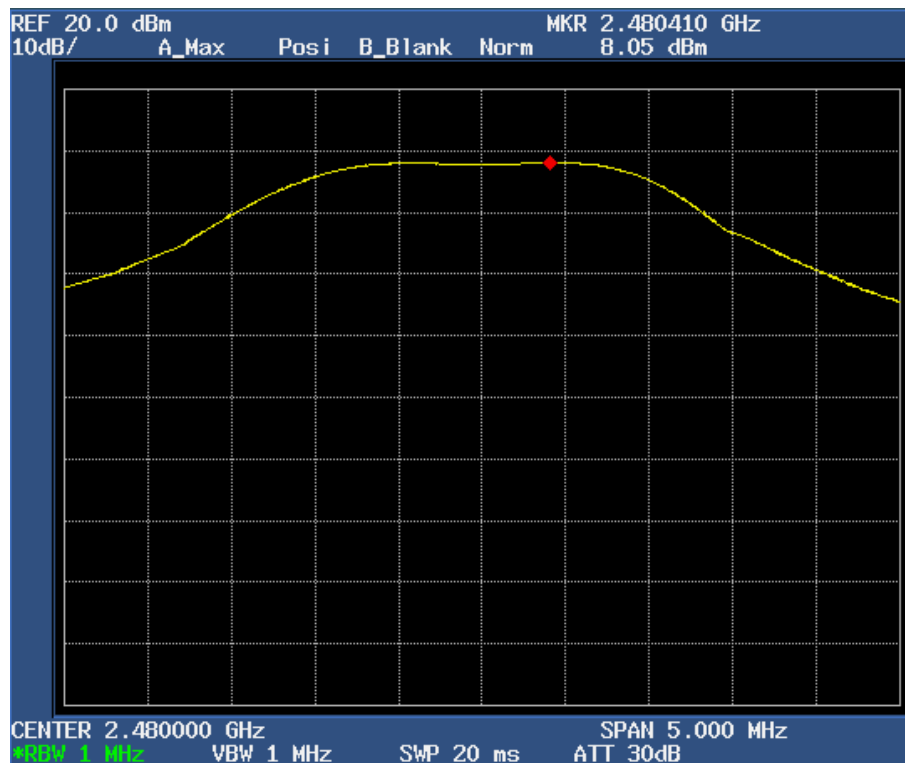
[2 405 MHz]



[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.

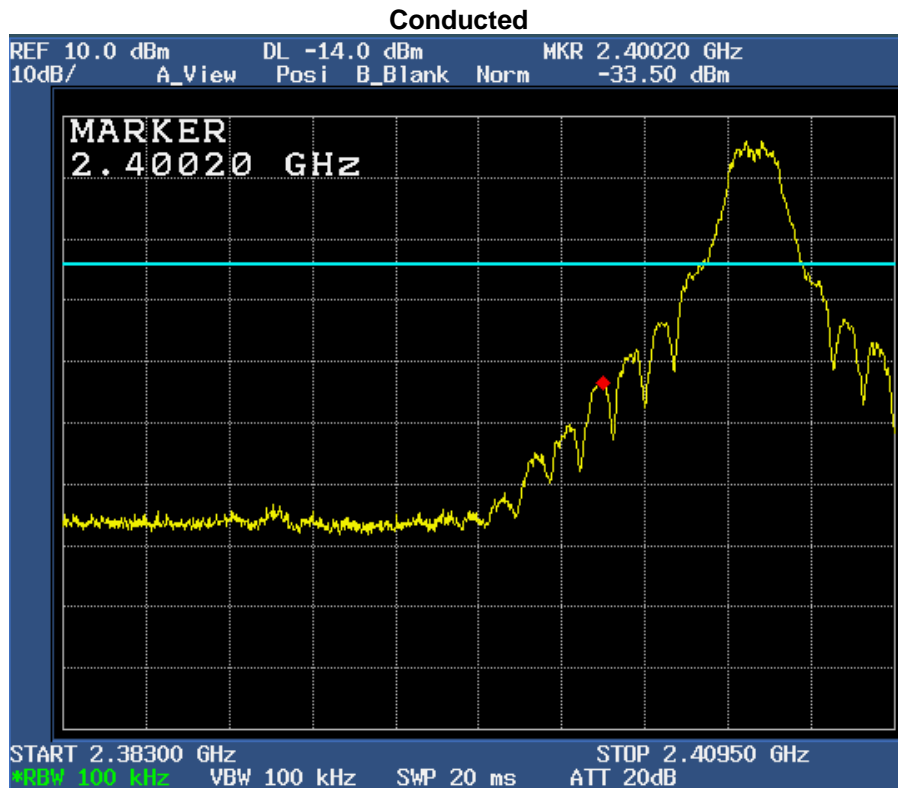
NOTES:

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



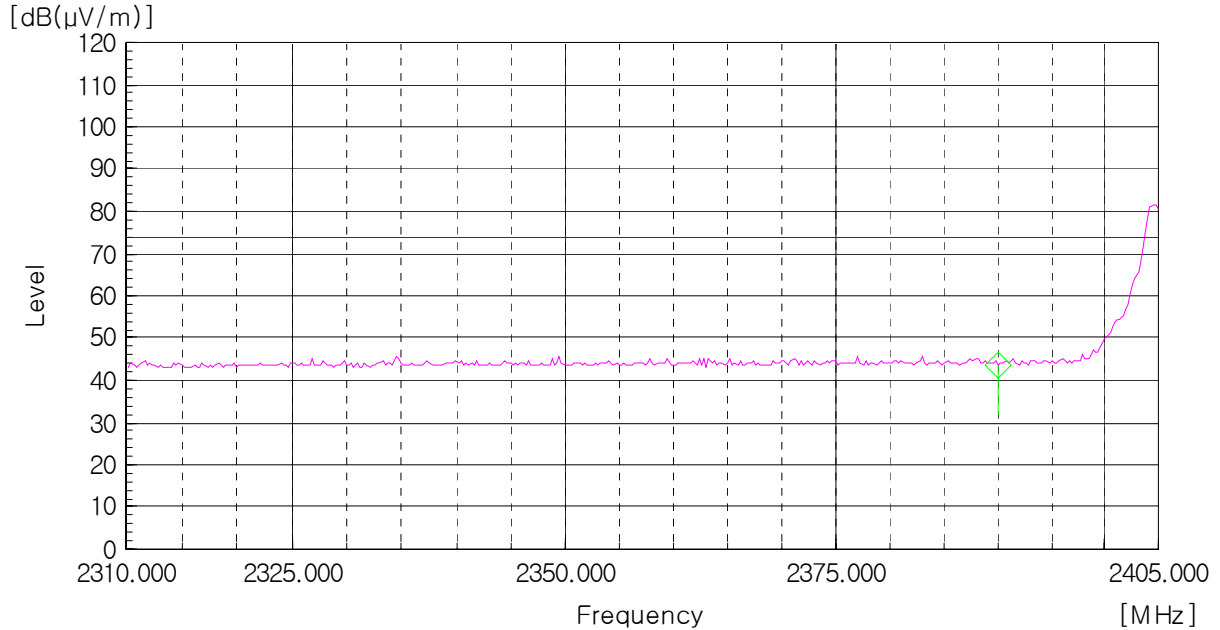
Test Engineer: Kug Kyoung, Yoon

5.4.1 Bandwidth of Frequency Band Edges

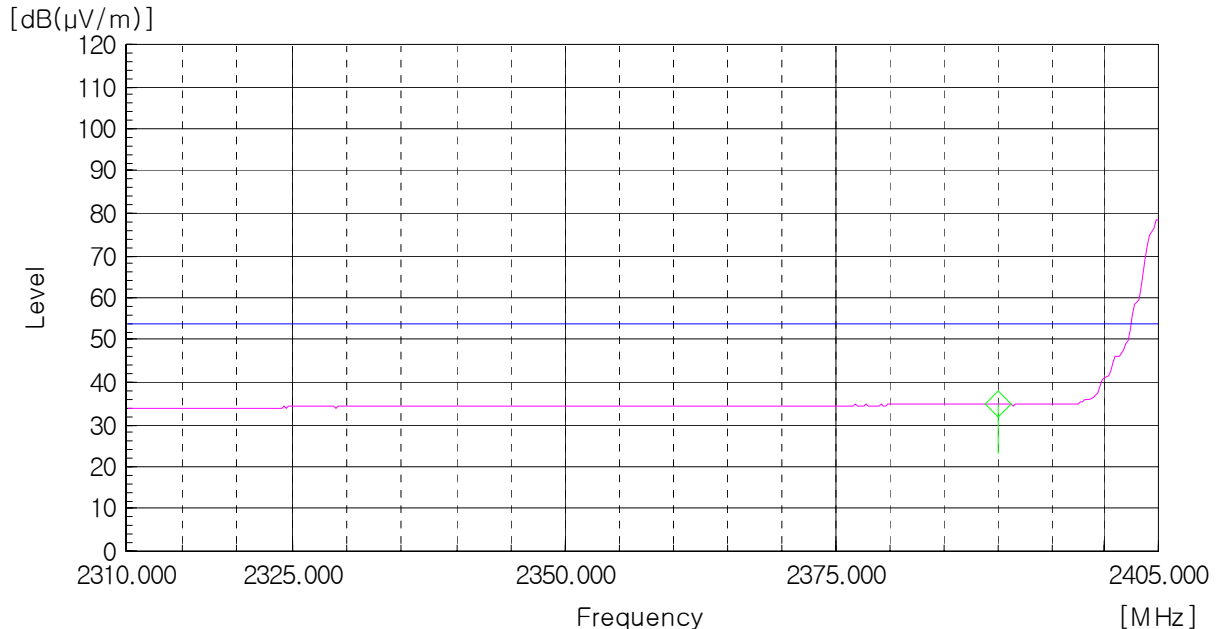


Radiated

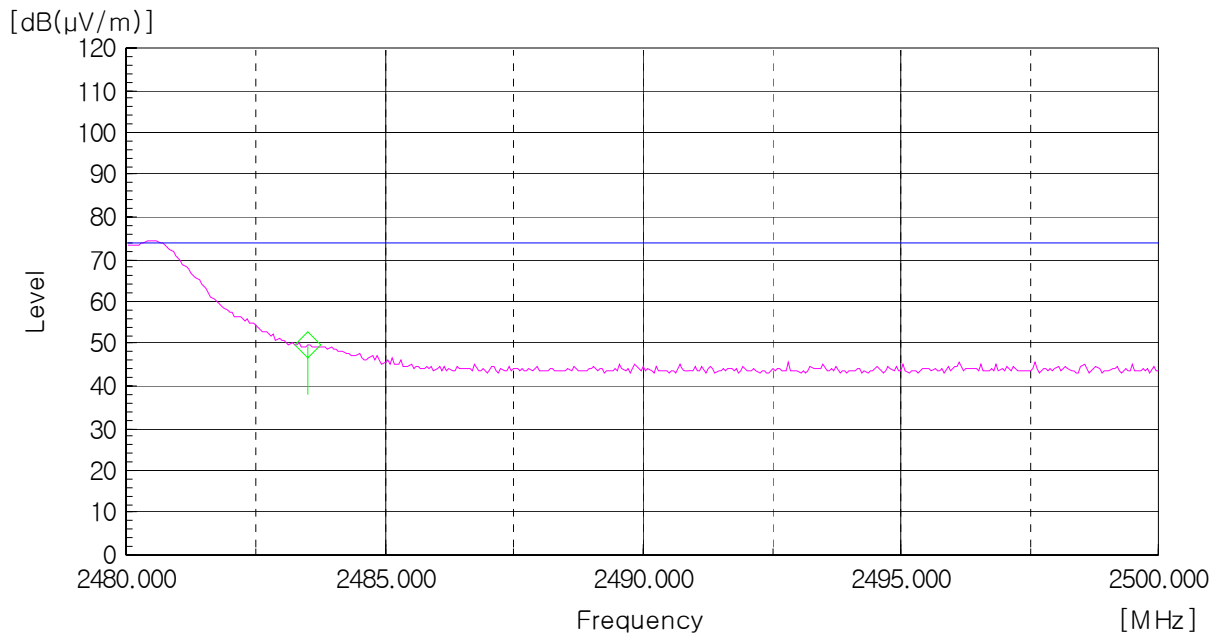
Peak Detector: RBW: 1MHz, VBW: 1MHz (2310 MHz – 2390 MHz)



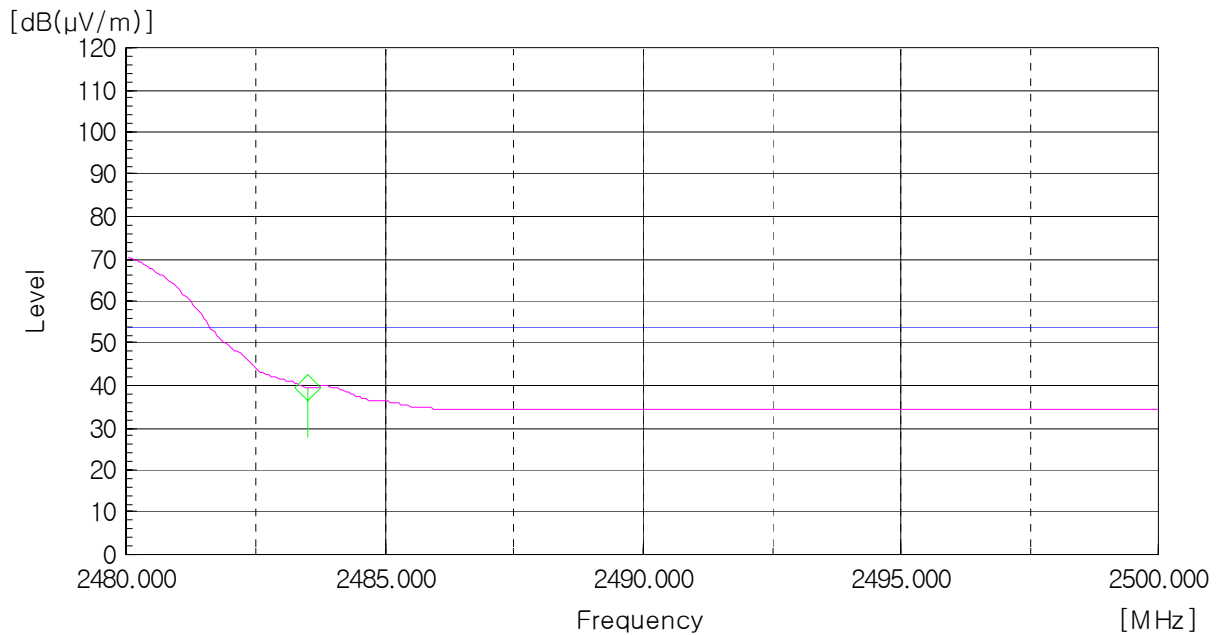
AV Detector: RBW: 1MHz, VBW: 10Hz (2310 MHz – 2390 MHz)



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:

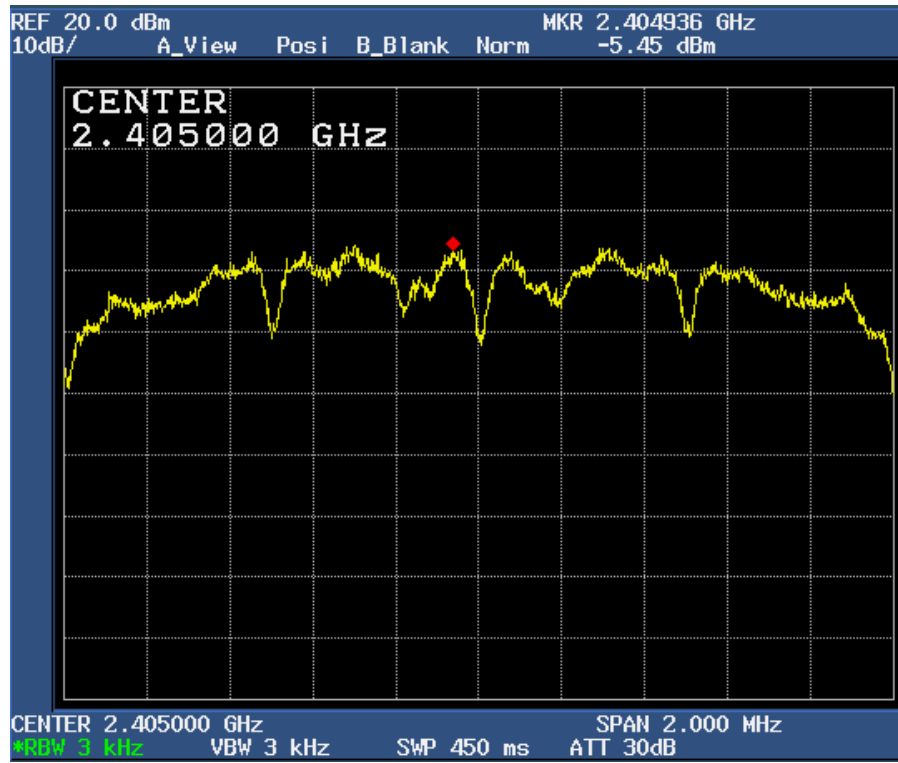
1. Measure power spectral density of relevant channel using spectrum analyzer.
2. RBW 3 kHz, VBW 3 kHz, span 2 MHz, Sweep time Auto.
3. Please see the measured plot in next page.



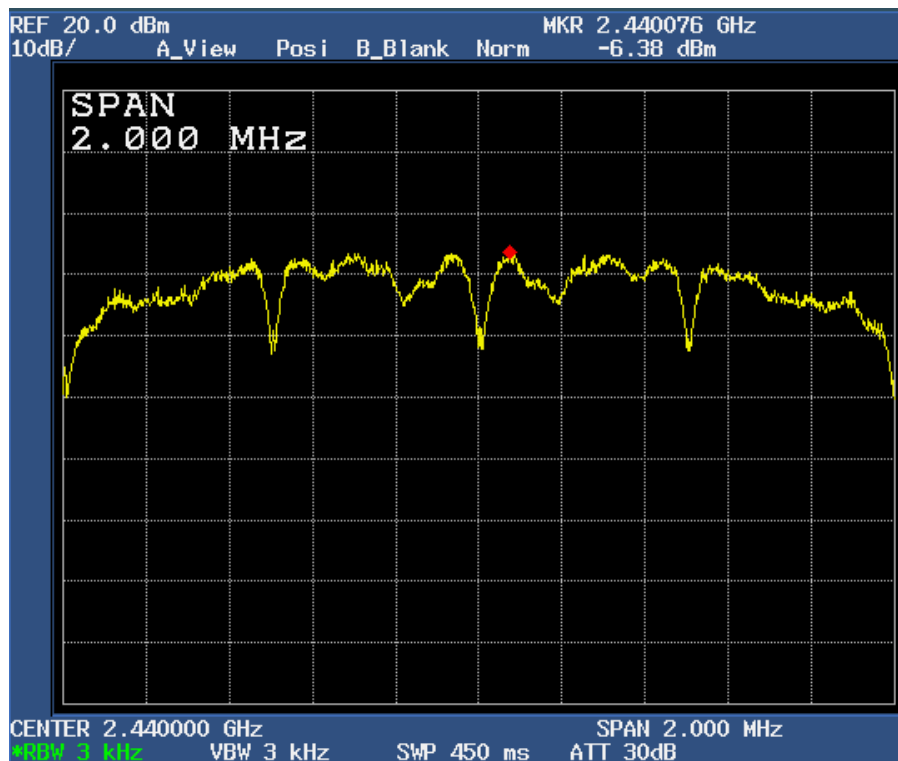
Test Engineer: Kug Kyoung, Yoon

Power Spectral Density

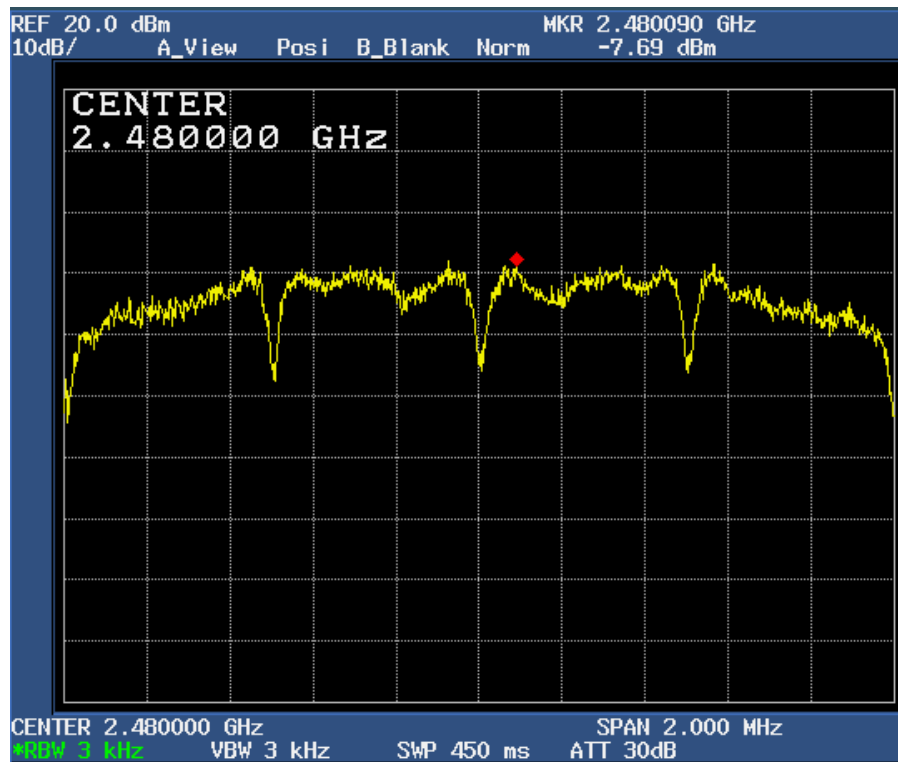
[CH Low]



[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 μ V] | Polarization (*H/**V) | Ant. Factor [dB/m] | Cable Loss [dB] | Result [dB μ V/m] | Limit [dB μ 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:

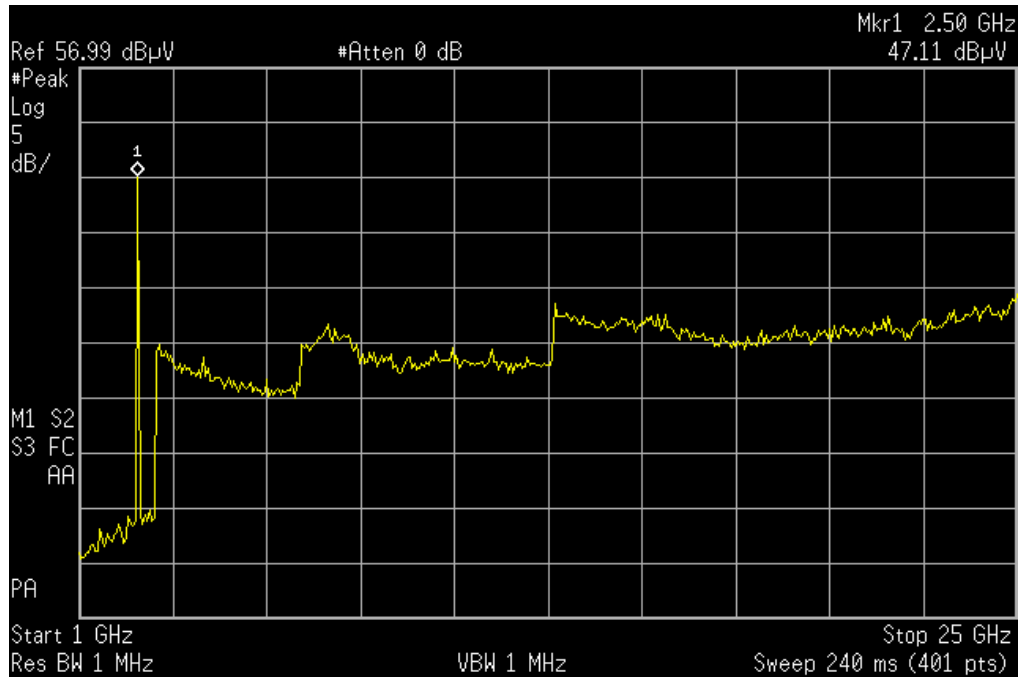
1. * H : Horizontal polarization , ** V : Vertical polarization
2. Result = Reading + Antenna factor + Cable loss
3. Margin value = Limit - Result
4. The measurement was performed for the frequency range above 30 MHz according to FCC Part 15.209.

- Above 1 GHz

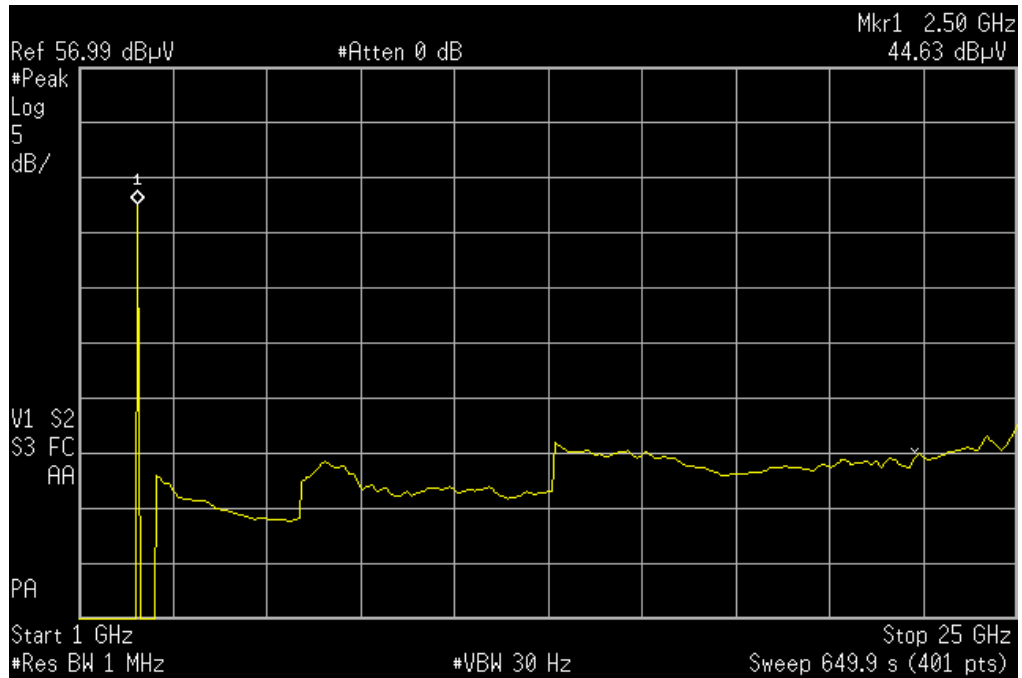
- Operating mode: Tx, Rx / CH: Low, Mid, High

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

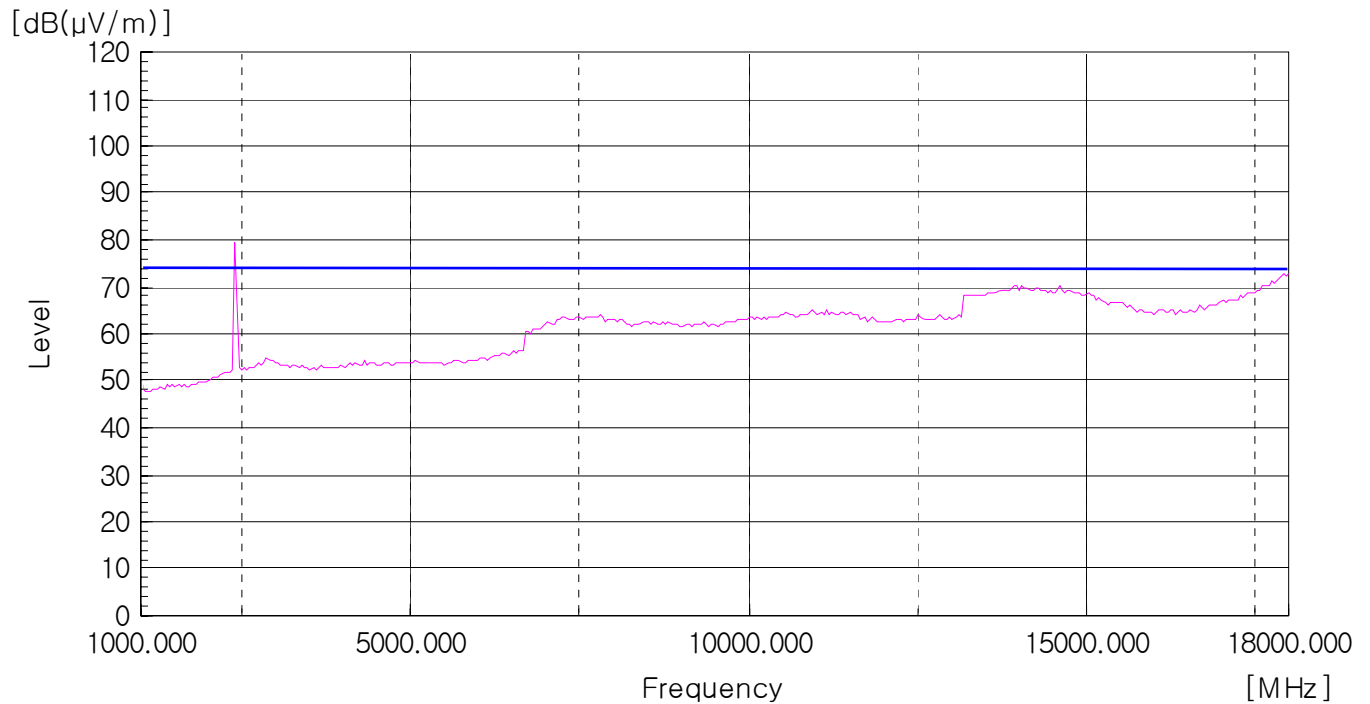
Pre Scan Data Peak Detector



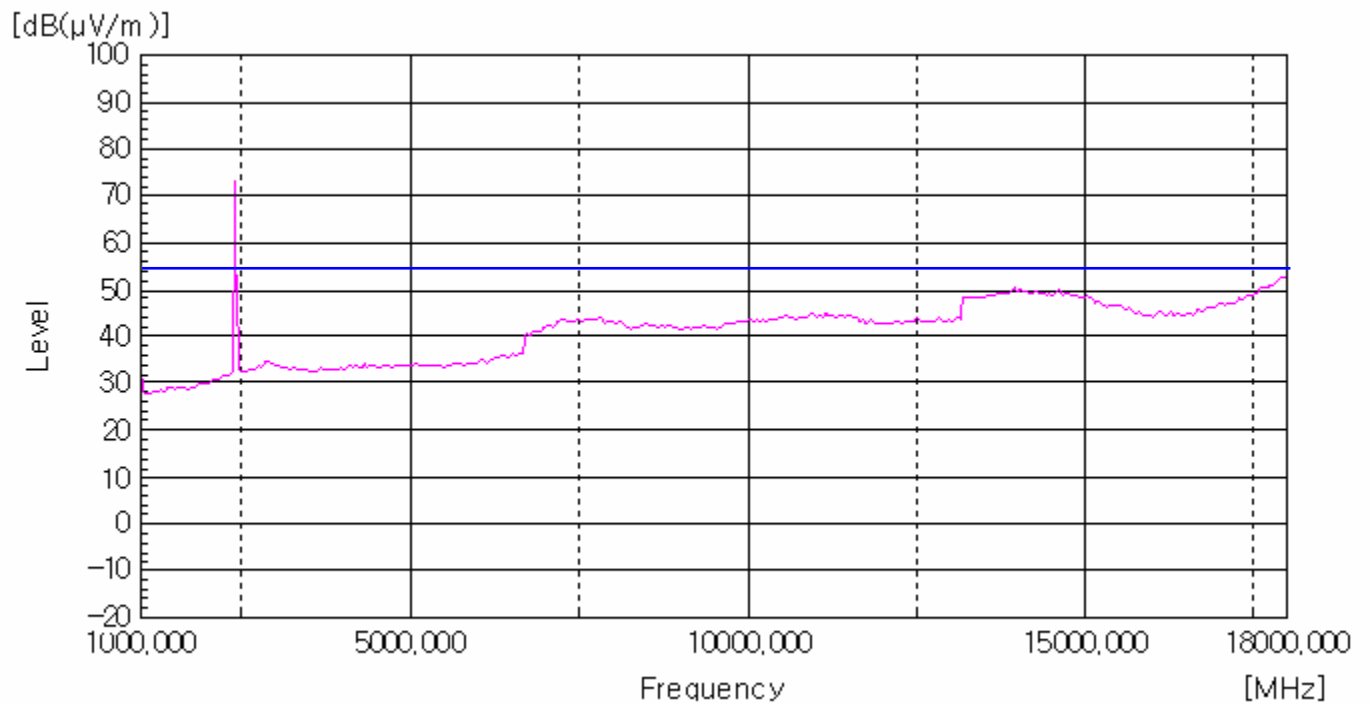
Pre Scan Data AV Detector



Final data Peak



Final data AV



1. Low CH

Detector mode: Peak mode

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

Detector mode: Average mode

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

2. Middle CH

Detector mode: Peak mode

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

Detector mode: Average mode

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

3. High CH

Detector mode: Peak mode

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

Detector mode: Average mode

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

Result: All emissions below noise floor of 20 dB μ V/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 10th 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 10th harmonics of fundamental, RBW = 1 MHz, VBW = 1 MHz, Sweep = Auto
 - b. AV Setting 1 GHz to 10th 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:

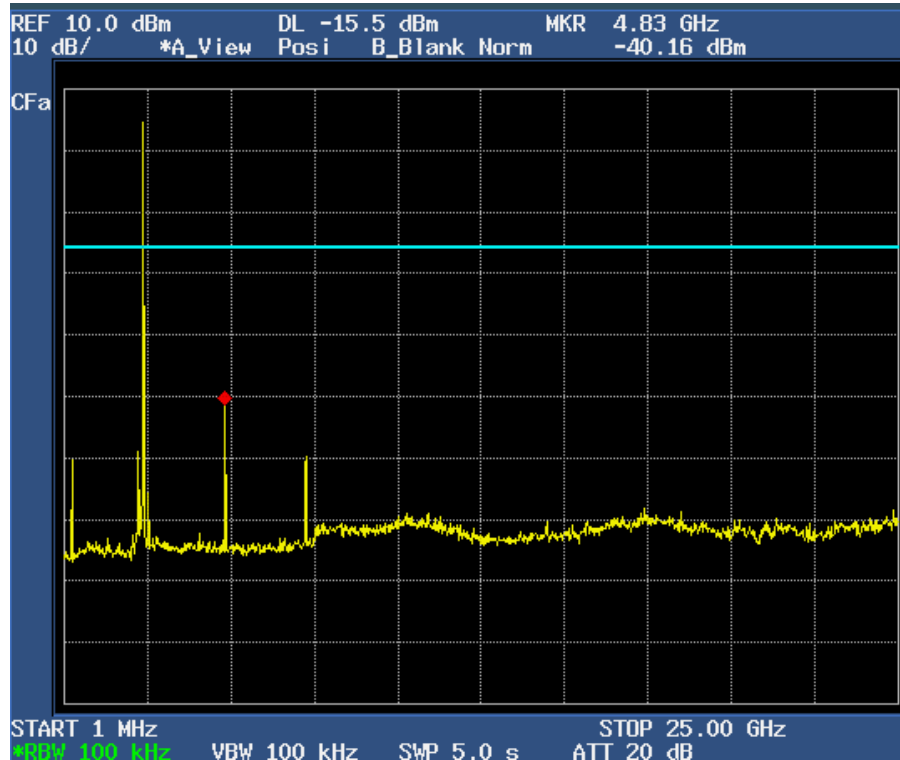
1. Measure conducted measurement channel using spectrum analyzer.
2. RBW 100 kHz, VBW 100 kHz, Frequency range 30 MHz to 25 GHz.



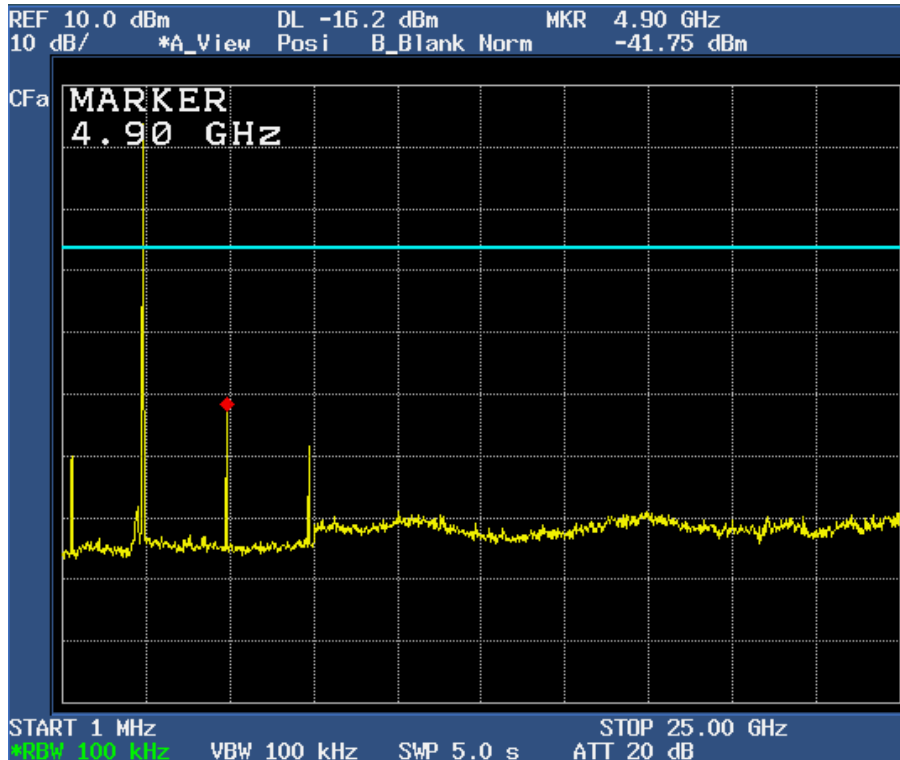
Test Engineer: Kug Kyoung, Yoon

Spurious Emissions (Conducted Measurement)

[CH Low]

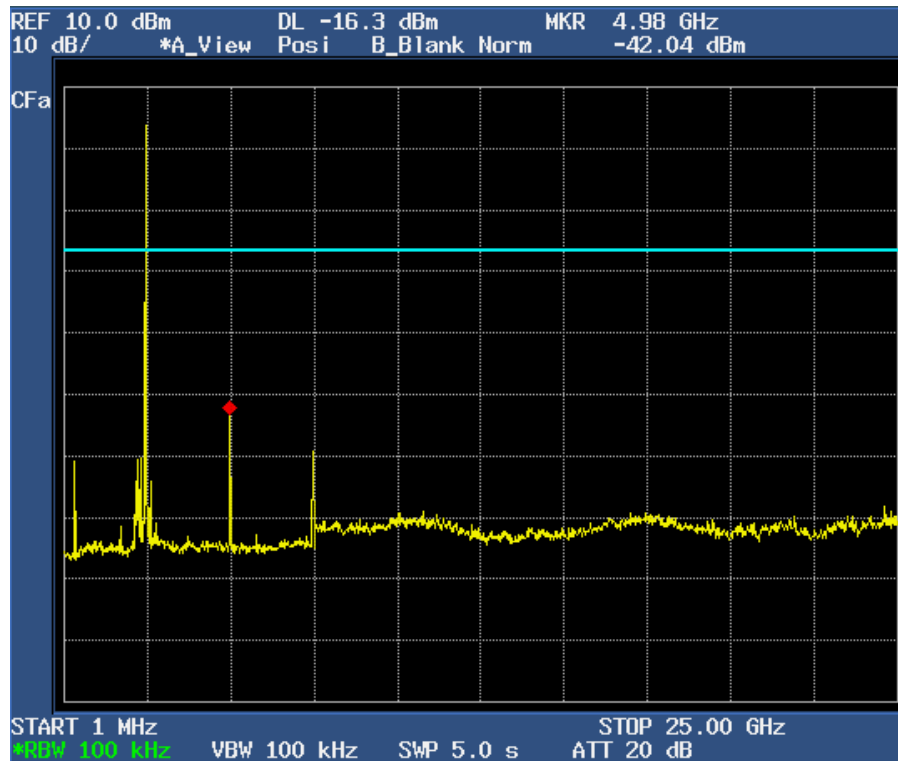


[CH Mid]



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[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 μ V] | | Phase (*L/**N) | Limit [dB μ 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:

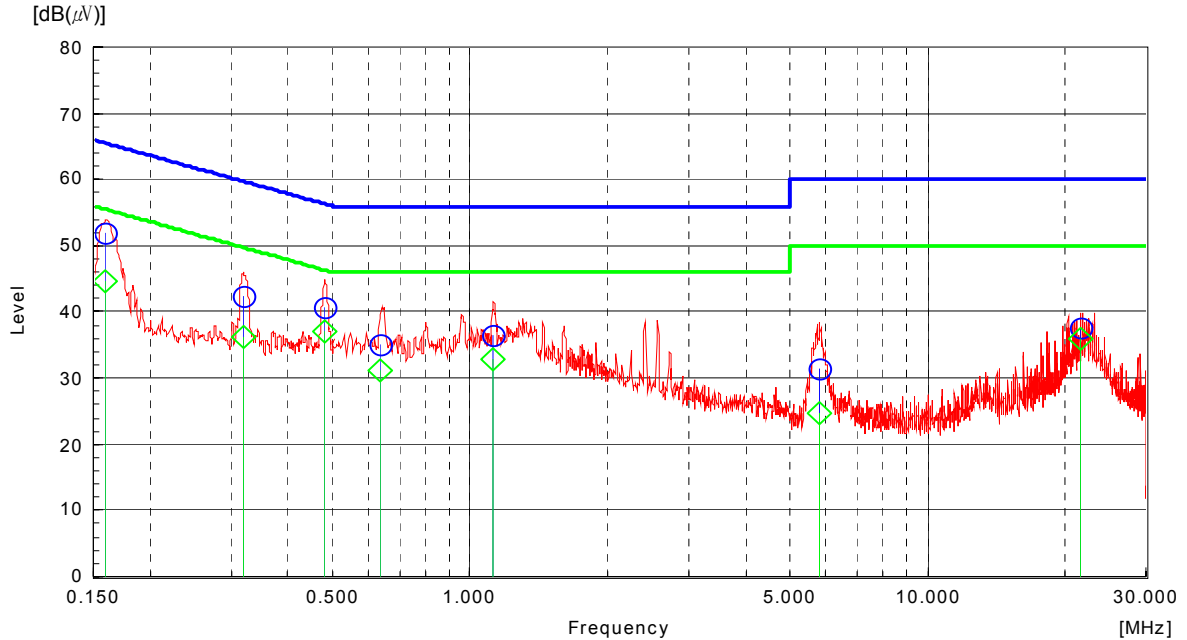
- * H : HOT Line , **N : Neutral Line
- Margin value = Limit – Result
- Measurement were performed at the AC Power Inlet in the frequency band of 150 kHz ~ 30 MHz according to the FCC Part 15 Class B.



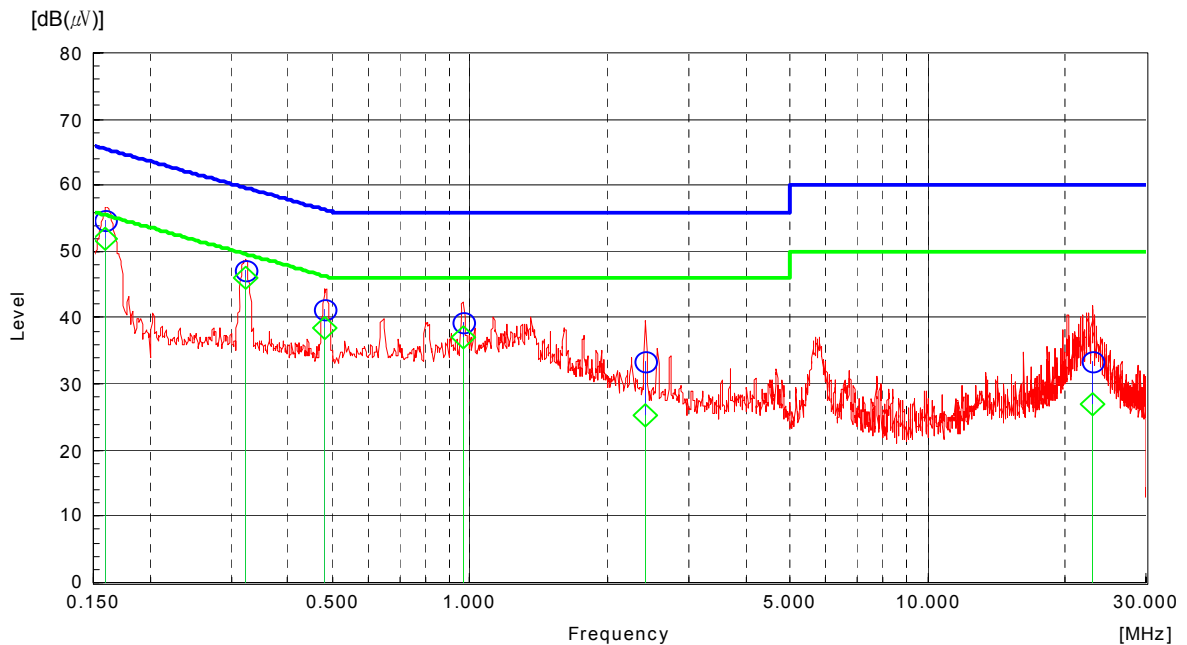
Test Engineer: Kug Kyoung, Yoon

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 ²) | Averaging Time E ² , H ² or S (minutes) |
|-----------------------|-----------------------------------|-----------------------------------|---|---|
| 0.3-1.34 | 614 | 1.63 | (100) | 30 |
| 1.34-30 | 824/f | 2.19/f | (180/f ²) | 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/cm²)
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 ² |
| MPE Limit for | : 1.0 mW/cm ² |

Test Result

The power density level at 20 cm is **0.00218 mW/cm²**

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

$$\text{Class B Limit} = 46.00 \text{ dBuV/m}$$

$$\text{Reading} = 20.75 \text{ dBuV}$$

$$\text{Antenna Factor + Cable Loss} = 16.65 + 5.40 = 22.05 \text{ dBuV/m}$$

$$\text{Total} = 42.80 \text{ dBuV/m}$$

$$\text{Margin} = 46.00 - 42.80 = 3.20 \text{ dB}$$

$$= 3.20 \text{ dB below Limit}$$

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 |