



# **ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR PCS PRIVATE LAND MOBILE LICENSED DATA TRANSCEIVER MODULE**

Test report file number : E053R-017

Applicant : Hoseo Telnet Co., Ltd.  
Address : 157-033, 680 Deungcheon3-Dong, Kangseo-Gu, Seoul Korea

Manufacturer : Hoseo Telnet Co., Ltd.  
Address : 157-033, 680 Deungcheon3-Dong, Kangseo-Gu, Seoul Korea

Type of Equipment : Telemetry Module

FCC ID. : R2SATM200

Model Name : ATM200

Serial number : None

Total page of Report : 30 pages (including this page)

Date of Incoming : March 11, 2005

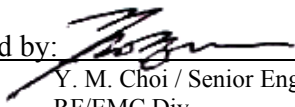
Date of issue : March 17, 2005

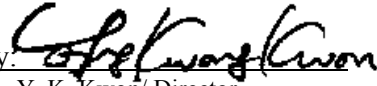
## **SUMMARY**

The equipment complies with the regulation; **FCC Part 24D and 90.**

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

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**1. VERIFICATION OF COMPLIANCE**

APPLICANT : Hoseo Telnet Co., Ltd.  
ADDRESS : 157-033, 680 Deungcheon3-Dong, Kangseo-Gu, Seoul Korea  
CONTACT PERSON : C. H. Kim / Marketing & Sales Director  
TELEPHONE NO : +82-2-2659-7345  
FCC ID : R2SATM200  
MODEL NO/NAME : ATM200  
SERIAL NUMBER : N/A  
DATE : March 17, 2005

|                                                         |                                                              |
|---------------------------------------------------------|--------------------------------------------------------------|
| DEVICE TYPE                                             | PCS Private Land Mobile Data Transceiver<br>Telemetry Module |
| THIS REPORT CONCERNS                                    | ORIGINAL GRANT                                               |
| MEASUREMENT PROCEDURES                                  | ANSI C63.4/2003                                              |
| TYPE OF EQUIPMENT TESTED                                | PRE-PRODUCTION                                               |
| KIND OF EQUIPMENT<br>AUTHORIZATION REQUESTED            | CERTIFICATION                                                |
| EQUIPMENT WILL BE OPERATED<br>UNDER FCC RULES PART(S)   | PART 24D and 90                                              |
| MODIFICATIONS ON THE EQUIPMENT<br>TO ACHIEVE COMPLIANCE | No                                                           |
| FINAL TEST WAS CONDUCTED ON                             | 3 METER(S) OPEN AREA TEST SITE                               |

- This device has shown compliance with the conducted emissions limits in 15.207 adopted under FCC 02-107 (ET Docket 98-80). The device may be marketed after July 11, 2005 and is not affected by the 15.37(j) transition provisions.
- The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.



## 2. TEST SUMMARY

### 2.1 Test items and results

| SECTION                              | TEST ITEMS                                               | RESULTS              |
|--------------------------------------|----------------------------------------------------------|----------------------|
| 2.1046, 24.132, 90.635               | RF Power Output at Antenna Terminals                     | Met the Limit / PASS |
| 2.1049, 24.131, 90.209(b), 90.210(j) | Occupied Bandwidth, Bandwidth Limitation, Emission Masks | Met the Limit / PASS |
| 2.1051, 24.133, 90.210(j)            | Spurious Emissions at Antenna Terminals                  | Met the Limit / PASS |
| 2.1053, 24.133, 90.210(j)            | Field strength of Spurious Radiation                     | Met the Limit / PASS |
| 2.1055(a)(1), 24.135, 90.213         | Frequency Stability with Temperature variation           | Met the Limit / PASS |
| 2.1055(d), 24.135, 90.213            | Frequency stability with primary voltage variation       | Met the Limit / PASS |
| 15.109(b)                            | Field strength of Spurious Radiation in Receiving Mode   | Met the Limit / PASS |
| 15.207 and 15.107                    | Conducted Limits                                         | Met the Limit / PASS |

### 2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

### 2.3 Related Submittal(s) / Grant(s)

Original submittal only

### 2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in section 2.1.

### 2.5 Test Methodology

Radiated testing was performed according to the procedures in ANSI C63.4/2003. Radiated testing was performed at a distance of 3 meters from EUT to the antenna.

### 2.6 Test Facility

The Electromagnetic compatibility measurement facilities are located on at 426-1 Daessangryung-Ri, Chowol-Myeon, Gwangju-Si, Gyeonggi-Do 464-080 Korea. Description details of test facilities were submitted to the Federal Communications Commission on January 18, 2002 (Registration Number: 92819 and 340658), accredited by KOLAS (Korea Laboratory Accreditation Scheme, No: 85) and approved by TUV, DNV, SEMKO and MIC (Ministry of Information and Communications in Korea) according to the requirement of ISO17025.

### 3. GENERAL INFORMATION

#### 3.1 Product Description

The Hoseo Telnet Co., Ltd., Model ATM200 (referred to as the EUT in this report) is a **Telemetry Module**, which will be installed into ReFlex Device. The interface between the module and Host device will be done by 14 pin connector. The product specification described herein was obtained from product data sheet or user's manual.

|                                             |                        |                                                             |
|---------------------------------------------|------------------------|-------------------------------------------------------------|
| DEVICE TYPE                                 |                        | PCS Private Land Mobile Data Transceiver                    |
| EMISSION DESIGNATOR                         |                        | 7K58F1D                                                     |
| OPERATING FREQUENCY                         | Transmitting Frequency | 896~902 MHz                                                 |
|                                             | Receiving Frequency.   | 929MHz~932MHz, and 935~942MHz                               |
| APPLICABLE FREQUENCY                        | PART 24                | 901~902 MHz                                                 |
|                                             | PART 90                | 896~901 MHz                                                 |
| OUTPUT POWER                                |                        | Up to 2W into Antenna                                       |
| MODULATION                                  |                        | 4 Level FSK                                                 |
| DATA TRANSFER RATE                          | Transmitter            | 1600 ~ 9600 bps                                             |
|                                             | Receiver               | 6400 bps                                                    |
| CHANNEL SPACING                             | Transmitter            | 12.5 kHz in 6.25kHz Steps                                   |
|                                             | Receiver               | 10 kHz and 12.5kHz                                          |
| USED CPU                                    |                        | uPD703017 (MASK ROM :128Kbyte, RAM :4Kbyte)                 |
| USED MEMORY                                 | EEPROM                 | 32 K bit                                                    |
|                                             | SRAM                   | 2 Kbytes                                                    |
| ANTENNA                                     | Transmitter            | Fixed Helical Antenna, Model No: HW-899H-MSMA               |
|                                             | Receiver               | Fixed Helical Antenna, Model No: HW-899H-MSMA               |
| ANTENNA GAIN                                |                        | 0 dBi                                                       |
| LIST OF EACH OSC. ORCRY. FREQ.(FREQ.>=1MHz) |                        | 14.7456, 16.8 MHz                                           |
| NUMBER OF LAYER                             |                        | 4 Layers                                                    |
| POWER REQUIREMENT                           |                        | DC 4.0V~10V                                                 |
| EXTERNAL CONNECTOR                          |                        | 2 X 7 Header Pin for Programming Down Loading and GPIO Port |

#### 3.2 Alternative type(s)/model(s); also covered by this test report.

No other model differences have been mentioned.



#### 4. EUT MODIFICATIONS

None

#### 5. SYSTEM TEST CONFIGURATION

##### 5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

| DEVICE TYPE   | MANUFACTURER           | MODEL/PART NUMBER | FCC ID    |
|---------------|------------------------|-------------------|-----------|
| ReFlex Module | Hoseo Telnet Co., Ltd. | ATM200            | R2SATM200 |
| Sub Board     | Hoseo Telnet Co., Ltd. | HS RM SUB VER 1.2 | N/A       |

##### 5.3 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

| Model     | Manufacturer                  | FCC ID    | Description            | Connected to |
|-----------|-------------------------------|-----------|------------------------|--------------|
| ATM200    | Hoseo Telnet Co., Ltd.        | R2SATM200 | Telemetry Module (EUT) | Power Supply |
| DRP-305DN | Digital Electronics Co., Ltd. | N/A       | DC Power Supply        | EUT          |

##### 5.4 Mode of operation during the test

The EUT was continuously transmitted with max power at 800, 1600, 6800 and 9600 bps and the worst data was recorded in this test report.

## 6. RF POWER OUTPUT at ANTENNA TERMINAL

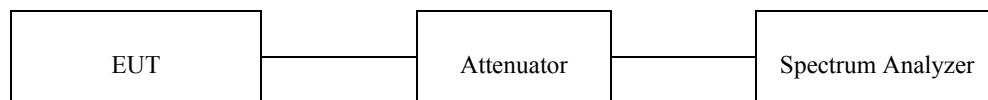
### 6.1 Operating environment

Temperature : 21°C

Relative humidity : 45 %

### 6.2 Test set-up

The RF output port of the EUT was connected to the input of the spectrum analyzer through sufficient attenuation. The resolution bandwidth was set to 2 MHz and video bandwidth of the spectrum analyzer was set at 3 MHz and the spectrum as recorded in the frequency band  $\pm 5$  MHz from the carrier frequency.



### 6.3 Test equipment used

|     | Model Number | Manufacturer        | Description              | Serial Number |
|-----|--------------|---------------------|--------------------------|---------------|
| ■ - | 8564E        | HP                  | Spectrum Analyzer        | 3650A00756    |
| ■ - | N/A          | HP                  | 30dB Attenuator Assembly | 2350A3133     |
| ■ - | DRP-305DN    | Digital Electronics | DC Power Supply          |               |

All test equipment used is calibrated on a regular basis.



## 6.4 Test data

- Test Date : March 15, 2005  
- Test Result : Pass

| CHANNEL | FREQUENCY<br>(MHz) | MEASURED<br>VLAUE (dBm) | LOSS<br>(dB) | TOTAL<br>(dBm) | RESULT<br>(W) |
|---------|--------------------|-------------------------|--------------|----------------|---------------|
| Low     | 896                | 31.83                   | 0.5          | 32.33          | 1.71          |
| High    | 902                | 31.83                   | 0.5          | 32.33          | 1.71          |

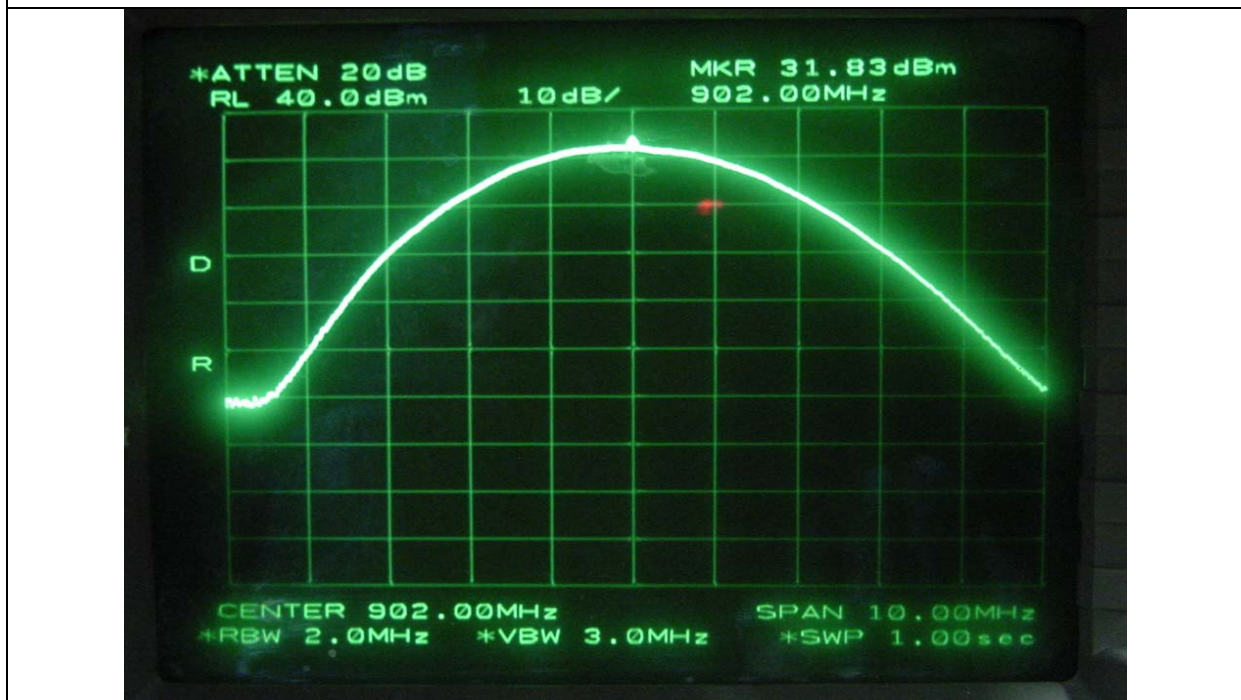
Remark: See next page for an overview sweep performed with peak detector and spectrum analyzer offset function was used for attenuator.

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Tested by: Ki-Hong, Nam / Test Engineer



Low Channel



High Channel

## 8. OCCUPIED BANDWIDTH, BANDWIDTH LIMITATION, EMISSION MASKS

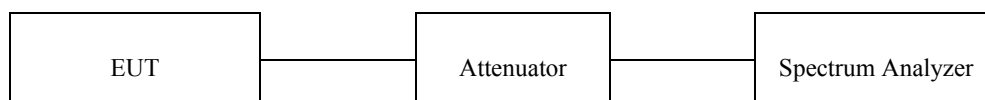
### 8.1 Operating environment

Temperature : 21°C

Relative humidity : 45 %

### 8.2 Test set-up

The RF output port of the EUT was connected to the input of the spectrum analyzer through sufficient attenuation. The resolution bandwidth and video bandwidth of the spectrum analyzer was set at 300 Hz for emission mask, 1 kHz for 99% occupied bandwidth and the spectrum was recorded in the frequency band  $\pm 25$  kHz from the carrier frequency.



### 8.3 Test equipment used

| Model Number | Manufacturer | Description              | Serial Number |
|--------------|--------------|--------------------------|---------------|
| ■ - 8564E    | HP           | Spectrum Analyzer        | 3650A00756    |
| ■ - N/A      | HP           | 30dB Attenuator Assembly | 2350A3133     |
| ■ - 3033B    | B&J TMI      | DC Power Supply          | 2056036       |

All test equipment used is calibrated on a regular basis.

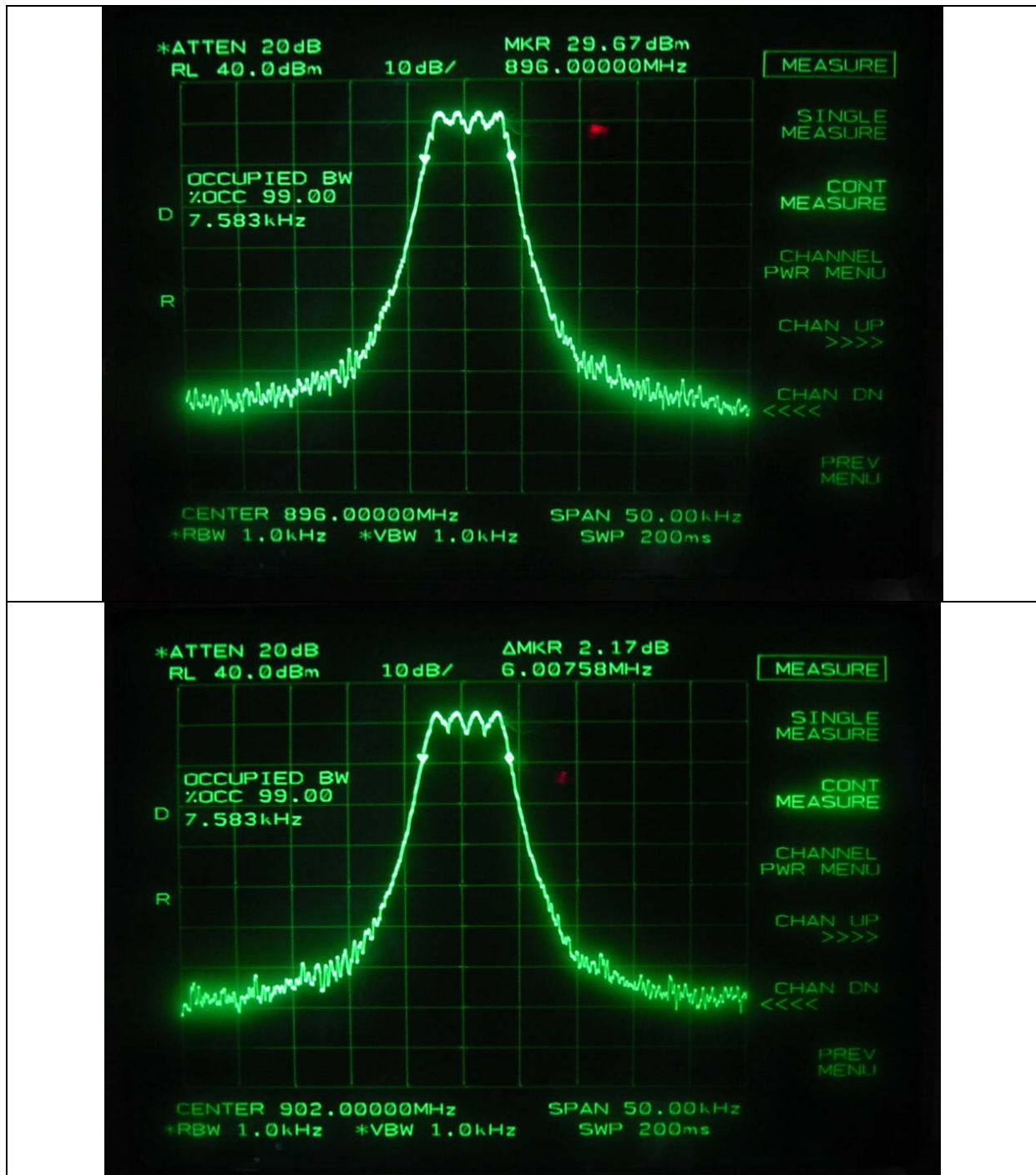


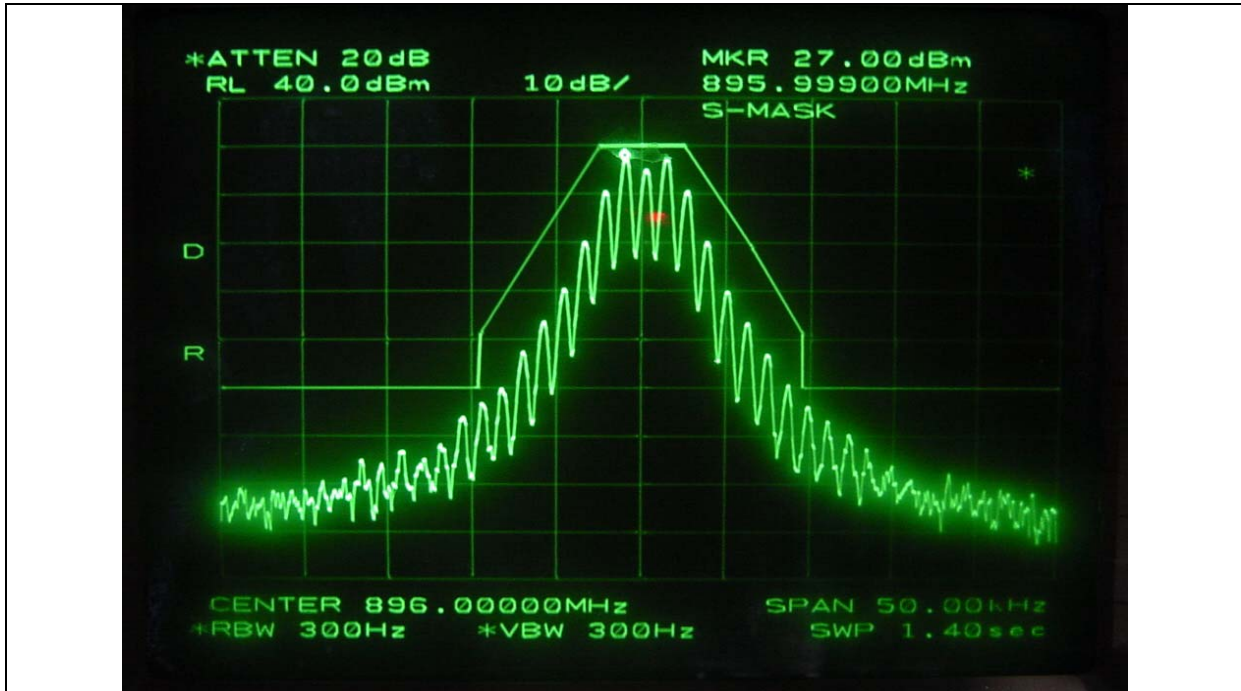
## 8.4 Test data

- Test Date : March 15, 2005  
- Test Result : Pass

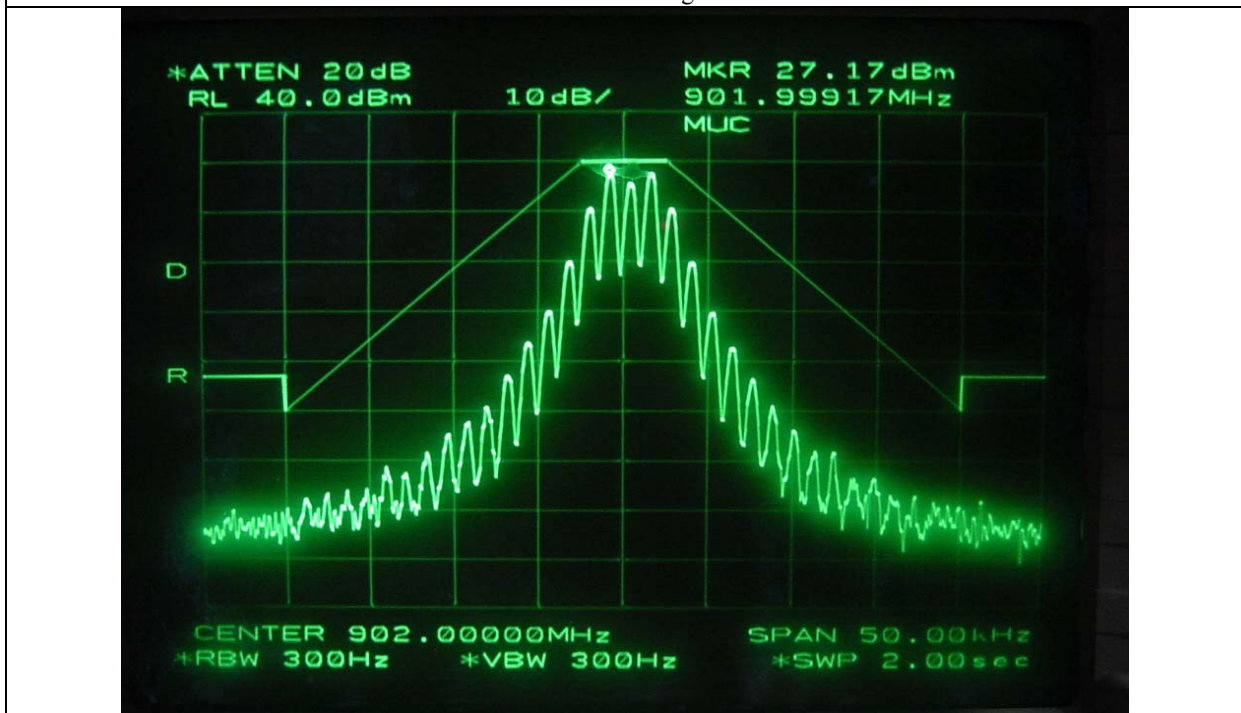
| CHANNEL | FREQUENCY(MHz) | MEASURED VLAUE (kHz) | LIMIT (kHz)          | MARGIN (kHz) |
|---------|----------------|----------------------|----------------------|--------------|
| Low     | 896            | 7.583                | 10.0 kHz for Part 24 | -2.417       |
| High    | 902            | 7.583                | 13.6 kHz for Part 90 |              |

Tested by: Ki-Hong, Nam / Test Engineer





Low Channel according to Part 90



High Channel according to Part 24D

## 9. SPURIOUS EMISSION AT ANTENNA TERMINAL

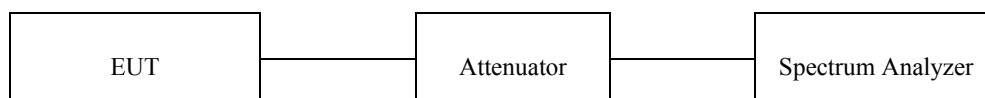
### 9.1 Operating environment

Temperature : 21°C

Relative humidity : 45 %

### 9.2 Test set-up for conducted measurement

The RF output port of the EUT was connected to the input of the spectrum analyzer through sufficient attenuation. The resolution bandwidth and video bandwidth of the spectrum analyzer was set at 100 kHz and sufficient scans were taken to show any out of band emissions up to 10 GHz.



### 9.3 Test equipment used

|     | Model Number | Manufacturer | Description              | Serial Number |
|-----|--------------|--------------|--------------------------|---------------|
| ■ - | 8564E        | HP           | Spectrum Analyzer        | 3650A00756    |
| ■ - | N/A          | HP           | 30dB Attenuator Assembly | 2350A3133     |
| ■ - | 3033B        | B&J TMI      | DC Power Supply          | 2056036       |

All test equipment used is calibrated on a regular basis.



## 9.4. Test data

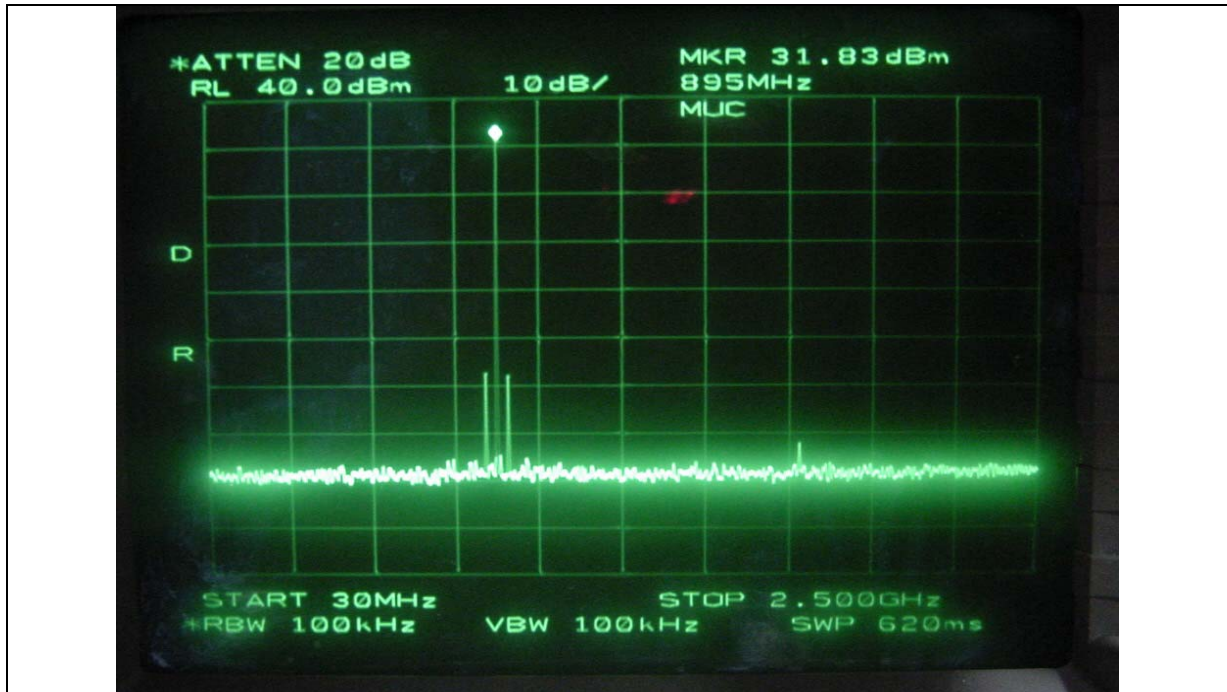
- Test Date : March 15, 2005
- Frequency range : 30 MHz ~ 10 GHz
- Result : PASSED BY -4.67 dB at Low Channel

| Carrier Freq.<br>(MHz) | Harmonic Freq.<br>(MHz) | Measured Value<br>(dBm) | Cable Loss<br>(dB) | TOTAL<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|------------------------|-------------------------|-------------------------|--------------------|----------------|----------------|----------------|
| 896.0                  | 862                     | -17.17                  | 0.5                | -16.67         | -13.0          | -5.67          |
|                        | 927                     | -17.67                  | 0.5                | -17.17         |                | -6.17          |
|                        | 1788                    | -32.17                  | 0.67               | -31.50         |                | -20.50         |
|                        | 2678                    | -39.67                  | 1.08               | -38.59         |                | -27.59         |
|                        | 5363                    | -38.17                  | 1.60               | -35.67         |                | -24.67         |
|                        | 6250                    | -40.00                  | 1.67               | -38.33         |                | -27.33         |
| 902.0                  | 870                     | -29.50                  | 0.50               | -29.00         | -12.0          | -18.00         |
|                        | 886                     | -23.50                  | 0.50               | -23.00         |                | -12.00         |
|                        | 919                     | -23.00                  | 0.50               | -22.50         |                | -11.50         |
|                        | 1800                    | -30.83                  | 0.67               | -30.16         |                | -19.16         |
|                        | 2700                    | -38.17                  | 1.08               | -37.09         |                | -26.09         |
|                        | 5400                    | -38.67                  | 1.60               | -37.07         |                | -26.07         |
|                        | 6300                    | -38.50                  | 1.67               | -36.83         |                | -25.83         |

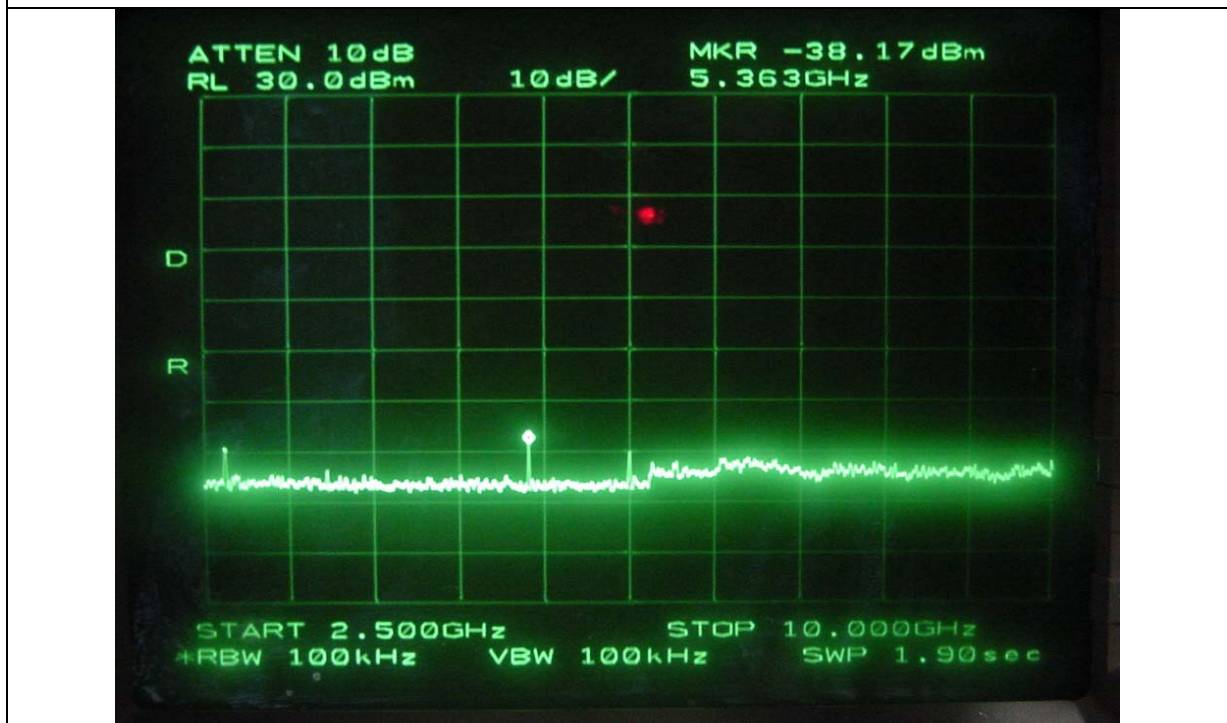
According to Part 24D, out of band emission shall be attenuated by  $43 + 10 \log (P)$  dBc, equates to -13.0dBm.

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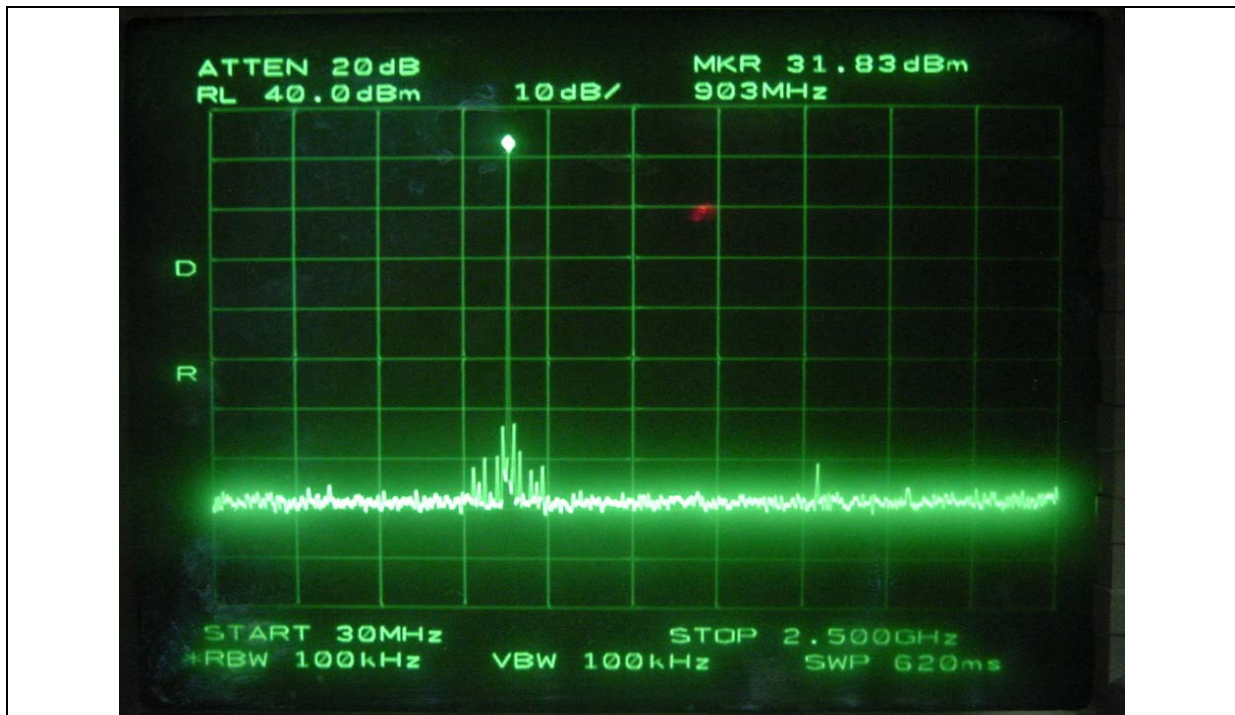
Tested by: Ki-Hong, Nam / Test Engineer



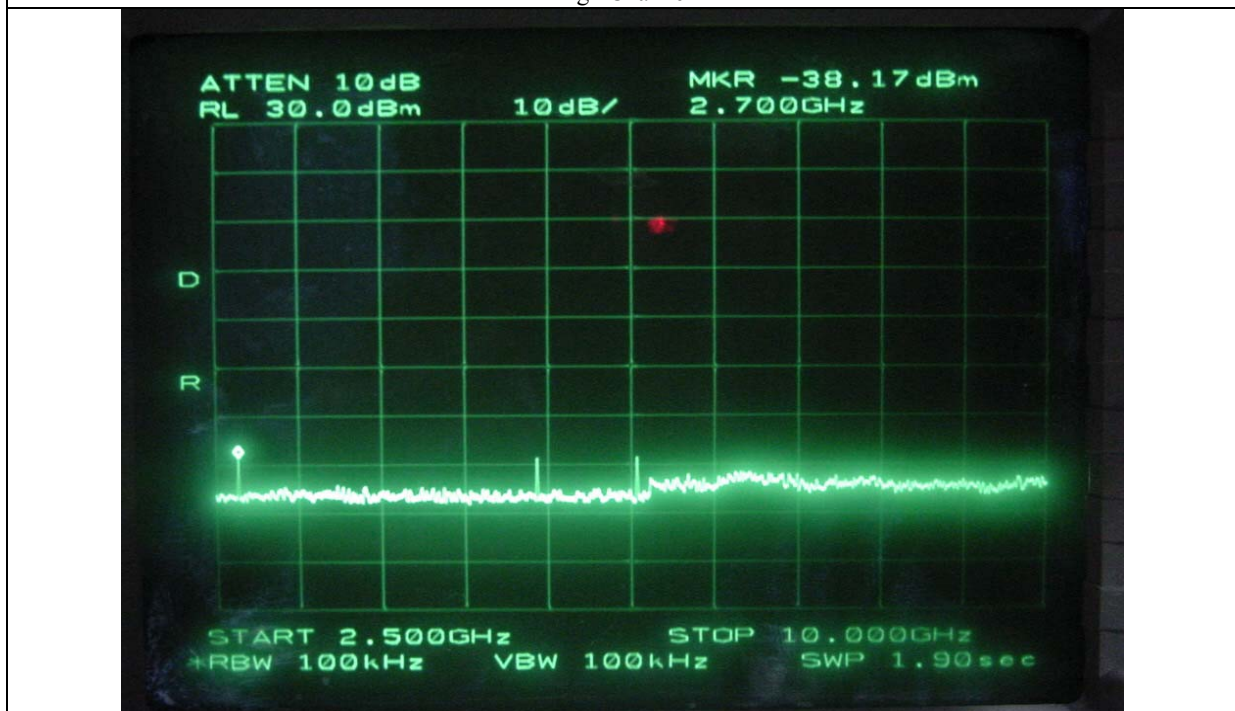
Low Channel



Low Channel



High Channel



High Channel

## 10 FIELD STRENGTH OF SPURIOUS RADIATION

### 10.1 Operating environment

Temperature : 14°C  
 Relative humidity : 48 %

### 10.2 Test set-up

The radiated emissions measurements were on the 3 meters, open-field test site. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

The frequency spectrum from 30MHz to up to 10<sup>th</sup> harmonic of the fundamental frequency was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 and 4.0 meters in order to determine the maximum emission levels. The test was performed by placing the EUT on 3-orthogonal axis. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

### 10.3 Test equipment used

| Model Number | Manufacturer    | Description            | Serial Number |
|--------------|-----------------|------------------------|---------------|
| ■ - ESVS10   | Rohde & Schwarz | EMI Test Receiver      | 827864/005    |
| ■ - 85650A   | Hewlett Packard | Quasi-Peak Adapter     | 3107A01542    |
| ■ - 8568B    | Hewlett-Packard | Spectrum Analyzer      | 3109A05456    |
| ■ - 85685A   | Hewlett-Packard | RF Preselector         | 3107A01264    |
| ■ - 8564E    | Hewlett-Packard | Spectrum Analyzer      | 3650A00756    |
| ■ - 8449B    | Hewlett-Packard | Preamplifier           | 3008A00833    |
| □ - 83051A   | Agilent         | Preamplifier           | 3950M00201    |
| ■ - BBHA9170 | Schwarzbeck     | Horn Antenna           | BBHA9170178   |
| □ - 8449B    | Hewlett-Packard | RF Amplifier           | 3008A00833    |
| □ - 8447F    | HP              | RF Amplifier           | 3113A04554    |
| ■ - 1070-1   | EMCO            | Antenna Master         | 9109-1624     |
| ■ - MA220    | HD              | Turn Table             | N/A           |
| ■ - HD240    | HD              | Antenna Mast           | N/A           |
| ■ - 3104C    | EMCO            | Biconical Antenna      | 9109-4441     |
| ■ - 3146     | EMCO            | Log Periodic Antenna   | 9109-3214     |
| ■ - YSE 500B | YoungShin Eng.  | Frequency Converter    | 950413001     |
| ■ - ETCR-10  | DaeHa           | Automatic Voltage Com. | N/A           |

All test equipment used is calibrated on a regular basis.

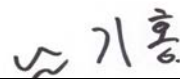
**10.4 Test data for Spurious & Harmonic Radiated Emission radiated emission**

- Test Date : March 16, 2005
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak Mode, 10Hz for Average Mode
- Frequency range : 1 GHz ~ 10 GHz
- Measurement distance : 3m
- Result : PASSED BY -14.03 dB at Low Channel

| Frequency (MHz)                              | Spectrum Reading (dBuV) | Generator Reading (dBm) | Ant. Gain (dBi) | Ant. Pol. (H/V) | Dipole Gain (dB) | Cable Loss (dB) | Total (dBm) | Limit (dBm) | Margin (dB) |
|----------------------------------------------|-------------------------|-------------------------|-----------------|-----------------|------------------|-----------------|-------------|-------------|-------------|
| <b>Test Data for Low Channel, 896.0 MHz</b>  |                         |                         |                 |                 |                  |                 |             |             |             |
| 896.0                                        | 107.50                  | 31.00                   |                 | H               | 0                | 0.84            | 30.16       |             |             |
| 896.0                                        | 104.33                  | 29.00                   |                 | V               | 0                | 0.84            | 28.16       |             |             |
| 1792.0                                       | 42.33                   | -38.00                  | 10.32           | H               | 2.15             | 1.17            | -31.00      | -13.0       | -20.00      |
| 1792.0                                       | 40.50                   | -40.10                  | 10.32           | V               | 2.15             | 1.17            | -33.10      | -13.0       | -22.10      |
| 2688.0                                       | 44.67                   | -33.50                  | 10.95           | H               | 2.15             | 1.33            | -26.03      | -13.0       | -15.03      |
| 2688.0                                       | 40.67                   | -39.30                  | 10.95           | V               | 2.15             | 1.33            | -31.83      | -13.0       | -20.83      |
| <b>Test Data for High Channel, 902.0 MHz</b> |                         |                         |                 |                 |                  |                 |             |             |             |
| 902.0                                        | 106.17                  | 30.50                   |                 | H               | 0                | 0.84            | 29.66       |             |             |
| 902.0                                        | 103.83                  | 28.00                   |                 | V               | 0                | 0.84            | 27.16       |             |             |
| 1804.0                                       | 41.83                   | -37.30                  | 10.35           | H               | 2.15             | 1.17            | -30.27      | -13.0       | -19.27      |
| 1804.0                                       | 37.83                   | -42.50                  | 10.35           | V               | 2.15             | 1.17            | -35.47      | -13.0       | -24.47      |
| 2706.0                                       | 44.33                   | -35.20                  | 10.97           | H               | 2.15             | 1.33            | -27.71      | -13.0       | -16.71      |
| 2706.0                                       | 37.00                   | -43.00                  | 10.97           | V               | 2.15             | 1.33            | 35.51       | -13.0       | -24.51      |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical,


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## 11. MAXIMUM PERMISSIBLE EXPOSURE

### 11.1 RF Exposure Calculation

According to the FCC rule 1.1310 table 1B, the limit for the maximum permissible RF exposure for an uncontrolled environment is  $1\text{mW}/\text{cm}^2$ .

The electric field generated for a  $1\text{mW}/\text{cm}^2$  exposure is calculated as follows:

$$E = \sqrt{(30 * P * G) / d}, \text{ and } S = E^2 / Z = E^2 / 3770, \text{ because } 1\text{mW} / \text{cm}^2 = 10\text{W} / \text{m}^2$$

Where

$S$  = Power density in  $\text{mW}/\text{cm}^2$ ,  $Z$  = Impedance of free space,  $377\Omega$

$E$  = Electric field strength in Volts/m,  $G$  = Numeric antenna gain, and  $d$  = distance in meter

Combining equations and rearranging the terms to express the distance as a function of the remaining variable

$$d = \sqrt{(30 * P * G) / (3770 * S)}$$

Changing to units of mW and cm, using  $P (\text{mW}) = P (\text{W}) / 1000$ ,  $d (\text{cm}) = 100 * d (\text{m})$

$$d = 0.282 * \sqrt{(P * G) / S}$$

Where

$d$  = distance in cm,  $P$  = Power in mW,  $G$  = Numeric antenna gain, and  $S$  = Power density in  $\text{mW}/\text{cm}^2$

### 11.2 Calculated MPE Safe Distance

According to above equation, the following result was obtained.

| Operating Mode | Peak Output Power |      | Antenna Gain | Calculated RF Exposure   |
|----------------|-------------------|------|--------------|--------------------------|
|                | (dBm)             | (mW) | dBi          | Separation Distance (cm) |
| Tx Mode        | 32.33             | 1710 | 0.0          | 11.66                    |

Following Caution on the manual will be described.

“CAUTION: Exposure to Radio Frequency Radiation.

Antenna shall be mounted in such a manner to minimize the potential for human contact during normal operation. The antenna should not be contacted during operation to avoid the possibility of exceeding the FCC radio frequency exposure limit.”

## 12. FREQUENCY STABILITY WITH TEMPERATURE VARIATION

### 12.1 Operating environment

Temperature : 21°C

Relative humidity : 45 %

### 12.2 Test set-up

The EUT was connected to an external DC power supply and the RF output port of the EUT was connected to a frequency counter via feed-through attenuators. The EUT was placed inside of the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

Turn EUT off and set chamber temperature to -30°C and then allow sufficient time (approximately 20 to 30 minutes after chamber reach the assigned temperature) for EUT to stabilize. Turn ON EUT and measure the EUT operating frequency and then turn off the EUT after the measurement.

Repeat above method emission measurements at +50°C and then record all measured frequencies on each temperature step.

### 12.3 Test equipment used

|     | Model Number | Manufacturer      | Description               | Serial Number |
|-----|--------------|-------------------|---------------------------|---------------|
| ■ - | 8564E        | HP                | Spectrum Analyzer         | 3650A00756    |
| ■ - | 53152A       | HP                | Frequency Counter         | US39270295    |
| ■ - | N/A          | HP                | 30 dB Attenuator Assembly | 2350A03133    |
| ■ - | 3033B        | B&J TMI           | DC Power Supply           | 2056036       |
| ■ - | EY-101       | Tabai ESPEC Corp. | Chamber                   | 5104390       |

All test equipment used is calibrated on a regular basis.



## 12.4 Test data

- Test Date : March 15, 2005  
- Operating Condition : 800/1600/6400/9200 bps was transmitted.  
- Result : PASSED BY -0.53PPM at 10°C on 896MHz

| Temperature (°C) | Center Freq. (Hz) | Measured Freq.(Hz) | Result (PPM) | Limit |
|------------------|-------------------|--------------------|--------------|-------|
| -30              | 896000000         | 896000171          | 0.1908482    | 1 PPM |
| -20              |                   | 896000190          | 0.2120536    |       |
| -10              |                   | 896000276          | 0.3080357    |       |
| 0                |                   | 896000396          | 0.4419643    |       |
| 10               |                   | 896000471          | 0.5256696    |       |
| 20               |                   | 896000198          | 0.2209821    |       |
| 30               |                   | 896000169          | 0.1886161    |       |
| 40               |                   | 896000029          | 0.0323661    |       |
| 50               |                   | 896000096          | 0.1071429    |       |
| -30              | 902000000         | 902000173          | 0.1917960    | 1 PPM |
| -20              |                   | 902000111          | 0.1230599    |       |
| -10              |                   | 902000292          | 0.3237251    |       |
| 0                |                   | 902000349          | 0.3869180    |       |
| 10               |                   | 902000428          | 0.4745001    |       |
| 20               |                   | 902000341          | 0.3780488    |       |
| 30               |                   | 902000136          | 0.1507761    |       |
| 40               |                   | 902000123          | 0.1363636    |       |
| 50               |                   | 902000083          | 0.0920177    |       |

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## 13. FREQUENCY STABILITY WITH VOLTAGE VARIATION

### 13.1 Operating environment

Temperature : 21°C

Relative humidity : 45 %

### 13.2 Test set-up

An external variable DC power supply was connected to the battery terminals of the EUT. The voltage of EUT set to 115% of the nominal value and was then decreased until the EUT light no longer illuminated; i.e., the battery end point. The output frequency was recorded for each battery voltage.

### 13.3 Test equipment used

| Model Number | Manufacturer | Description               | Serial Number |
|--------------|--------------|---------------------------|---------------|
| ■ - 8564E    | HP           | Spectrum Analyzer         | 3650A00756    |
| ■ - 53152A   | HP           | Frequency Counter         | US39270295    |
| ■ - N/A      | HP           | 30 dB Attenuator Assembly | 2350A03133    |
| ■ - 3033B    | B&J TMI      | DC Power Supply           | 2056036       |

All test equipment used is calibrated on a regular basis.



## 13.4 Test data

- Test Date : March 15, 2005
- Rated Supply Voltage : 4 ~ 10 Vdc
- Result : PASSED BY 0.29 PPM at 11.50Vdc on 896 MHz

| Voltage (Vdc) | Carrier Freq. (Hz) | Measured Freq. (Hz) | Result (PPM) | Limit |
|---------------|--------------------|---------------------|--------------|-------|
| 3.40          | 896000000          | 896000230           | 0.25669643   | 1 PPM |
| 11.50         |                    | 896000261           | 0.29129464   |       |
| 3.40          | 902000000          | 902000164           | 0.18181818   | 1 PPM |
| 11.50         |                    | 902000217           | 0.24057650   |       |

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## 14. FIELD STRENGTH OF SPURIOUS RADIATED EMISSION IN RECEIVING MODE

### 14.1 Operating environment

Temperature : 14°C

Relative humidity : 48 %

### 14.2 Test set-up

The radiated emissions measurements were on the 3 meters, open-field test site. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

The frequency spectrum from 30MHz to 1000MHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 and 4.0 meters in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

### 14.3 Test equipment used

| Model Number | Manufacturer    | Description            | Serial Number |
|--------------|-----------------|------------------------|---------------|
| ■ - ESVS10   | Rohde & Schwarz | EMI Test Receiver      | 827864/005    |
| ■ - 85650A   | Hewlett Packard | Quasi-Peak Adapter     | 3107A01542    |
| ■ - 8568B    | Hewlett-Packard | Spectrum Analyzer      | 3109A05456    |
| ■ - 85685A   | Hewlett-Packard | RF Preselector         | 3107A01264    |
| □ - 8449B    | Hewlett-Packard | RF Amplifier           | 3008A00833    |
| □ - 8447F    | HP              | RF Amplifier           | 3113A04554    |
| ■ - 1070-1   | EMCO            | Antenna Master         | 9109-1624     |
| ■ - MA220    | HD              | Turn Table             | N/A           |
| ■ - HD240    | HD              | Antenna Mast           | N/A           |
| ■ - 3104C    | EMCO            | Biconical Antenna      | 9109-4441     |
| ■ - 3146     | EMCO            | Log Periodic Antenna   | 9109-3214     |
| ■ - YSE 500B | YoungShin Eng.  | Frequency Converter    | 950413001     |
| ■ - ETCR-10  | DaeHa           | Automatic Voltage Com. | N/A           |

All test equipment used is calibrated on a regular basis.



## 14.4 Test data

- Test Date : March 16, 2005
- Resolution bandwidth : 120 kHz
- Frequency range : 30MHz ~ 2.0GHz
- Measurement distance : 3m
- Operating Condition : Receiving mode at Low and High Channel

| Frequency<br>(MHz)                                          | Reading<br>(dBuV) | Ant. Pol.<br>(H/V) | Ant. Factor<br>(dB/m) | Cable<br>Loss | Emission<br>Level(dBuV/m) | Limits<br>(dBuV/m) | Margin<br>(dB) |
|-------------------------------------------------------------|-------------------|--------------------|-----------------------|---------------|---------------------------|--------------------|----------------|
| 43.70                                                       | 12.50             | V                  | 12.88                 | 1.20          | 26.58                     | 40.00              | -13.42         |
| 43.78                                                       | 13.20             | V                  | 12.85                 | 1.20          | 27.25                     | 40.00              | -12.75         |
| 317.95                                                      | 21.40             | H                  | 13.96                 | 2.95          | 38.31                     | 46.02              | -7.71          |
| 318.09                                                      | 23.70             | H                  | 13.96                 | 2.95          | 40.61                     | 46.02              | -5.41          |
| 499.94                                                      | 13.30             | H                  | 17.21                 | 3.70          | 34.21                     | 46.02              | -11.81         |
| 529.88                                                      | 9.50              | H                  | 17.96                 | 3.82          | 31.28                     | 46.02              | -14.74         |
| 635.92                                                      | 12.40             | H                  | 19.10                 | 4.17          | 35.67                     | 46.02              | -10.35         |
| 923.49                                                      | 10.60             | H                  | 22.76                 | 5.22          | 38.58                     | 46.02              | -7.44          |
| It was not observed any emission from the EUT up to 2.0GHz. |                   |                    |                       |               |                           |                    |                |

Tabulated test data for Radiated Electromagnetic Field

Remark: "H": Horizontal, "V": Vertical

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## 15. CONDUCTED EMISSION TEST

### 15.1 Operating environment

Temperature : 20°C

Relative humidity : 43 %

### 15.2 Test set-up

The conducted emission measurements of power line were performed in a shielded room. The EUT was placed on a wooden table, 0.8 meters height above the floor. Power was fed to the EUT through a 50 ohm/ 50 microhenry Line Impedance Stabilization Network (LISN). The ground plane was electrically bonded to the shield room ground system and all power lines entering the shield room were filtered.

### 15.3 Test equipment used

| Model Number | Manufacturer        | Description            | Serial Number |
|--------------|---------------------|------------------------|---------------|
| ■ - ESHS10   | Rohde & Schwarz     | EMI Test Receiver      | 834467/007    |
| ■ - 3825/2   | EMCO                | AMN                    | 9109-1869     |
| ■ - N/A      | HanKook Shield room | Shield Room            | N/A           |
| ■ - YSE 500B | YoungShin Eng.      | Frequency Converter    | 950413001     |
| ■ - ETCR-10  | DaeHa               | Automatic Voltage Com. | N/A           |

All test equipment used is calibrated on a regular basis.

**15.4 Test data**

- Test Date : March 16, 2005
- Resolution bandwidth : 9 kHz
- Frequency range : 0.15MHz ~ 30MHz
- Result : PASSED BY -26.08 dB at 0.57 MHz with Peak Detector

| Frequency<br>(MHz) | Line | Quasi-Peak (dBuV) |                  |        | Margin<br>(dB) | Average (dBuV)    |        | Margin<br>(dB) |
|--------------------|------|-------------------|------------------|--------|----------------|-------------------|--------|----------------|
|                    |      | Emission<br>level | Detector<br>Mode | Limits |                | Emission<br>level | Limits |                |
| 0165               | H    | 37.62             | P                | 65.21  | -27.29         |                   |        |                |
| 0.22               | H    | 33.36             | P                | 62.82  | -29.46         |                   |        |                |
| 0.38               | H    | 28.97             | P                | 58.28  | -29.31         |                   |        |                |
| 0.51               | H    | 29.22             | P                | 56.00  | -26.78         |                   |        |                |
| 0.57               | H    | 29.92             | P                | 56.00  | -26.08         |                   |        |                |

Line Conducted Emissions Tabulated Data

Remark : "H": Hot Line, "N": Neutral line, "P": Peak detect.

Average mode was not recorded, because peak values were under the average limit.

Receiving mode was tested, but the result has margin more than 35 dB, so the data was not recorded.

See next page for an overview sweep performed with peak and average detector.

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