# FCC TEST REPORT

| | |
|---|---|
| **CATEGORY:** | Mobile Module ( BlueTooth Part ) |
| **PRODUCT NAME:** | 802.11b + Bluetooth COMBO SIP |
| **FCC ID.:** | IXMWM-BB-AG-01 |
| **FILING TYPE:** | Certification |
| **BRAND NAME:** | USI |
| **MODEL NAME:** | WM-BB-AG-01 |
| **APPLICANT:** | **Universal Scientific Industrial Co., Ltd.**<br>135, Lane 351, Taiping, Sec.1, Tsao Yuen, Nan-Tou, Taiwan, R.O.C. |
| **MANUFACTURER:** | The same as Applicant. |
| **ISSUED BY:** | **SPORTON INTERNATIONAL INC.**<br>6F, No. 106, Sec. 1, Hsin Tai Wu Rd., His Chih, Taipei Hsien, Taiwan, R.O.C. |

## Statements:

The test result in this report refers exclusively to the presented test model / sample.

Without written approval of SPORTON International Inc., the test report shall not be reproduced except in full.

Certificate or Test Report could not be used by the applicant to claim the product endorsement by CNLA, NVLAP or any agency of U.S. government.

The test equipment used to perform the test are calibrated and traceable to NML/ROC or NIST/USA.

Dr. Alan Lane
Vice General Manager
Sporton International Inc.

Lab Code: 200079-0

# Table of Contents

# History of this test report

■ No additional attachment.

☐ Additional attachment were issued as following record:

| Attachment No. | Issue Date | Description |
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# 1. General Description of Equipment under Test

## 1.1. Applicant

**Universal Scientific Industrial Co., Ltd.**

135, Lane 351, Taiping, Sec.1, Tsao Yuen, Nan-Tou, Taiwan, R.O.C.

## 1.2. Manufacturer

The same as Applicant.

## 1.3. Basic Description of Equipment under Test

This product is a hybrid module includes wireless LAN of IEEE 802.11b and Bloutooth. The technical data has been listed on section below. And this module is specific to host equipment which is classified as mobile device.

## 1.4. Technical Features

| | |
|---|---|
| **Type of Modulation :** | FHSS |
| **Number of Channels :** | 79 |
| **Frequency Band :** | 2402MHz-2480MHz |
| **Carrier Frequencies :** | Please reference section 1.5 |
| **Bandwidth of Each Channel :** | 1MHz |
| **Output Power :** | GFSK : 2.46dBm (peak) |
| **Antenna Type / Class and Gain :** | Inverted-F Antenna (-0.1dBi ) |
| **Function Type :** | Transceiver |
| **Data Rate :** | 1 Mbps ( Max ) |
| **Power Rating (DC/AC , Voltage) :** | 3.3 VDC |
| **Temperature Range (Operating) :** | 0-55℃ |

## 1.5 Table for Carrier Frequencies

Note: The table below is the summary of the operating frequencies.

| Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---|---|---|---|---|---|
| 00 | 2402 MHz | 27 | 2429 MHz | 54 | 2456 MHz |
| 01 | 2403 MHz | 28 | 2430 MHz | 55 | 2457 MHz |
| 02 | 2404 MHz | 29 | 2431 MHz | 56 | 2458 MHz |
| 03 | 2405 MHz | 30 | 2432 MHz | 57 | 2459 MHz |
| 04 | 2406 MHz | 31 | 2433 MHz | 58 | 2460 MHz |
| 05 | 2407 MHz | 32 | 2434 MHz | 59 | 2461 MHz |
| 06 | 2408 MHz | 33 | 2435 MHz | 60 | 2462 MHz |
| 07 | 2409 MHz | 34 | 2436 MHz | 61 | 2463 MHz |
| 08 | 2410 MHz | 35 | 2437 MHz | 62 | 2464 MHz |
| 09 | 2411 MHz | 36 | 2438 MHz | 63 | 2465 MHz |
| 10 | 2412 MHz | 37 | 2439 MHz | 64 | 2466 MHz |
| 11 | 2413 MHz | 38 | 2440 MHz | 65 | 2467 MHz |
| 12 | 2414 MHz | 39 | 2441 MHz | 66 | 2468 MHz |
| 13 | 2415 MHz | 40 | 2442 MHz | 67 | 2469 MHz |
| 14 | 2416 MHz | 41 | 2443 MHz | 68 | 2470 MHz |
| 15 | 2417 MHz | 42 | 2444 MHz | 69 | 2471 MHz |
| 16 | 2418 MHz | 43 | 2445 MHz | 70 | 2472 MHz |
| 17 | 2419 MHz | 44 | 2446 MHz | 71 | 2473 MHz |
| 18 | 2420 MHz | 45 | 2447 MHz | 72 | 2474 MHz |
| 19 | 2421 MHz | 46 | 2448 MHz | 73 | 2475 MHz |
| 20 | 2422 MHz | 47 | 2449 MHz | 74 | 2476 MHz |
| 21 | 2423 MHz | 48 | 2450 MHz | 75 | 2477 MHz |
| 22 | 2424 MHz | 49 | 2451 MHz | 76 | 2478 MHz |
| 23 | 2425 MHz | 50 | 2452 MHz | 77 | 2479 MHz |
| 24 | 2426 MHz | 51 | 2453 MHz | 78 | 2480 MHz |
| 25 | 2427 MHz | 52 | 2454 MHz | | |
| 26 | 2428 MHz | 53 | 2455 MHz | | |

# 2. Test Configuration of the Equipment under Test

## 2.1. Description of the Test

a) This test report is only for the BlueTooth part of the product. It has been verified that the emission of the BlueTooth module is independent of the status of WLAN module

b) For 15.247(g), during data transmission, the carrier frequency is repeatly switched on 79 hopping frequencies, any 2 hopping frequencies will not be available on the spectrum simultaneously. So, this device can be taken as true frequeny hopping device.

c) For 15.247(h), the hopping sequence is determined by the address of piconet master. Each piconet master will have its unique address at any moment, so re-use of the hopping sequence is completely not possible. Within the piconet, one master can be communicated with many slaves via the same hopping sequency, but at any moment only one ( master or slave) can be "talk". It is determined by the master that who should be "listen" or "talk". Any slave who want to "talk" has to sent "inquery" to master first. So, 2 slaves (or one slave one master) is not possible to be on "talk" mode simultaneously.

d) The used peripherals as well as the configuration fulfill the requirements of ANSI C63.4:2001. The configuration is operated in a manner which tends to maximize its emission characteristics in a typical application.

e) The following modes were tested.

Mode 1: CH 00 (2402 MHz)
Mode 2: CH 39 (2441 MHz)
Mode 3: CH 78 (2480 MHz)

f) 3 meters measurement distance of OATS was used in this test.

## 2.2. Frequency Range Investigated

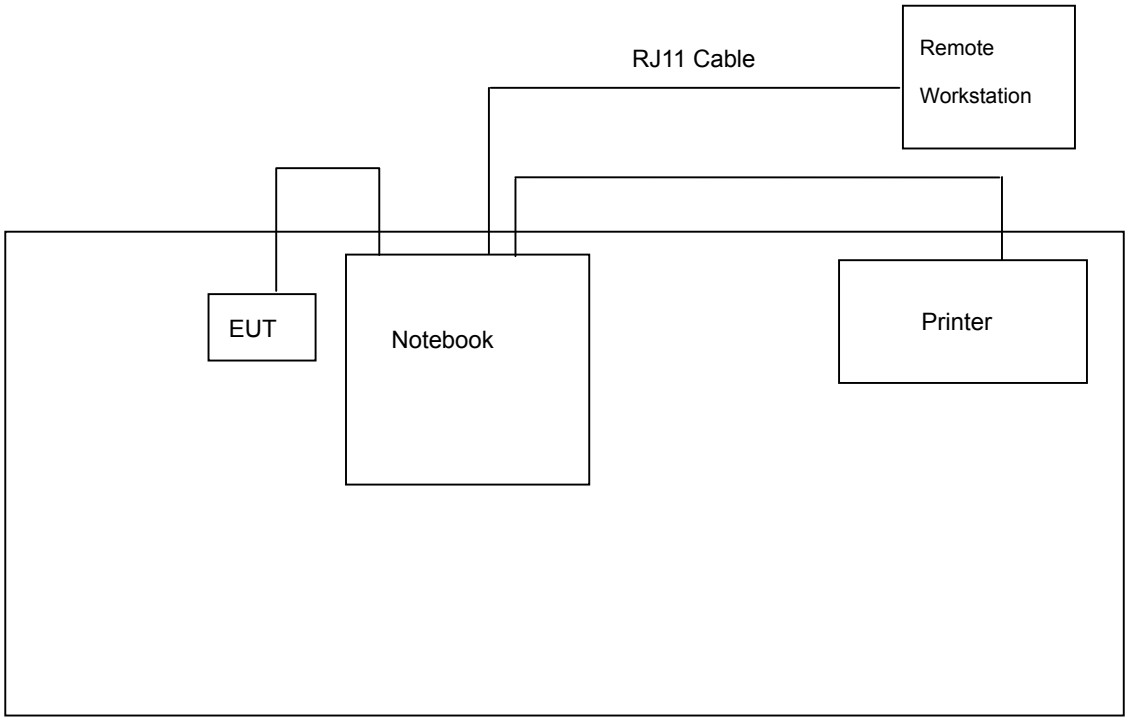
a) Conducted power line test: from 150 kHz to 30 MHz

b) Radiated emission test: from 30 MHz to 25000 MHz

## 2.3. Details of the Supporting Units

| Unit No | Device | Brand | FCC ID /DoC | Model No. | Power Supply | Power Cord | Data Cable |
|---|---|---|---|---|---|---|---|
| 1. | Notebook | IBM | DoC | 08N1180 | Switching | Non-Shielded | Shielded, 1.8m |
| 2. | Printer | HP | B94C2642X | DJ400 | Linear | Non-Shielded | Shielded, 1..35m |
| 3. | Modem | ACEEX | IFAXDM141 | DM141 | Linear | Non-Shielded | Shielded, 1.15m |

## 2.4. Connection Diagram of Test System




## 2.5. Test Software

There are 2 softwares may be used in the testing.

A) Channel & Power Controlling Software: This was provided by the manufacturer and is able to let the test engineer select the operating channel as well as the RF output power. The parameters for channel selection is trying to offer the test engineer the ability to fix the operating channel for testing, both normal data and continuously transmitting modes are allowed, and that for RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

B) “H” Pattern Generator: Except Access Point, the supporting equipment such as monitor or printer is always available. Under testing, these supporting equipment has to also under working condition. “H” Pattern Generator is able to continuously transmitting “H” character to those supporting equipments.

# 3. Test Location and Standards

## 3.1. Test Location

**Test Location :** Sporton Hwa Ya Testing Building

**Address :** No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.
Tel: +886 3 327 3456 Fax: +886 3 318 0055

**Test Site No. :** CO01-HY , 03CH03-HY

## 3.2. Test Conditions

| | |
|---|---|
| Normal Voltage | : 120V/60Hz |
| Extreme Voltage | : 138V and 102V |
| Normal Temperature | : 20 ℃ |
| Extreme Temperature | : -20 ℃ and 50 ℃ |

## 3.3. Test Standards

Here is the list of the standards followed in this test report.

**ANSI C63.4-2001**

**47 CFR Part 15 Subpart C ( Section 15.247 )**

## 3.4. DoC Statement

This EUT is also classified as a device of computer peripheral Class B which DoC has to be followed. It has been verified according to the rule of 47 CFR part 15 Subpart B, and found that all the requirements has been fulfilled.

# 4. Test Result and Details

## 4.1. Summary of the Test Results

| Applied Standard: 47 CFR Part 15 and Part 2 | | | |
|---|---|---|---|
| **Paragraph** | **FCC Rule** | **Description of Test** | **Result** |
| 5.1 | 15.247(a)(1) | Hopping Channel Bandwidth | Pass |
| 5.2 | 15.247(a)(iii) | Number of Hopping Frequency Used | Pass |
| 5.3 | 15.247(a)(1) | Hopping Channel Separation | Pass |
| 5.4 | 15.247(a)(iii) | Dwell Time of Each Frequency within a 31.6 Second Period | Pass |
| 5.5 | 15.247 (b)(1) | Maximum Peak Output Power | Pass |
| 5.6 | 15.247(c) | Band Edges of the Operation Frequency | Pass |
| 5.7 | 15.247(d) | Power Spectral Density | Pass |
| 5.8 | 15.107/15.207 | AC Power Line Conducted Emission | Pass |
| 5.9 | 15.209/15.247(c) | Spurious Radiated Emission | Pass |
| 5.10 | 15.203 | Antenna Requirement | Pass |
| 5.11 | 2.1091/2.1093 | Maximum Permissible Exposure for the EUT | Pass |

# 5. Test Result

## 5.1. Test of Hopping Channel Bandwidth

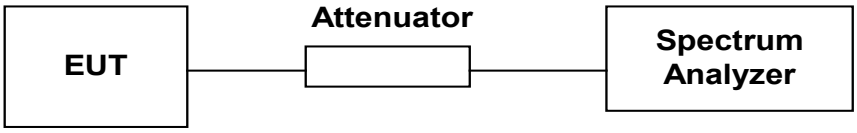
5.1.1. Measuring Instruments

Item 9 of the table on section 6.

5.1.2. Test Procedures

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. Set RBW of spectrum analyzer to 30KHz and VBW to 300KHz.
3. The Hopping Channel bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20 dB.

5.1.3. Test Setup Layout

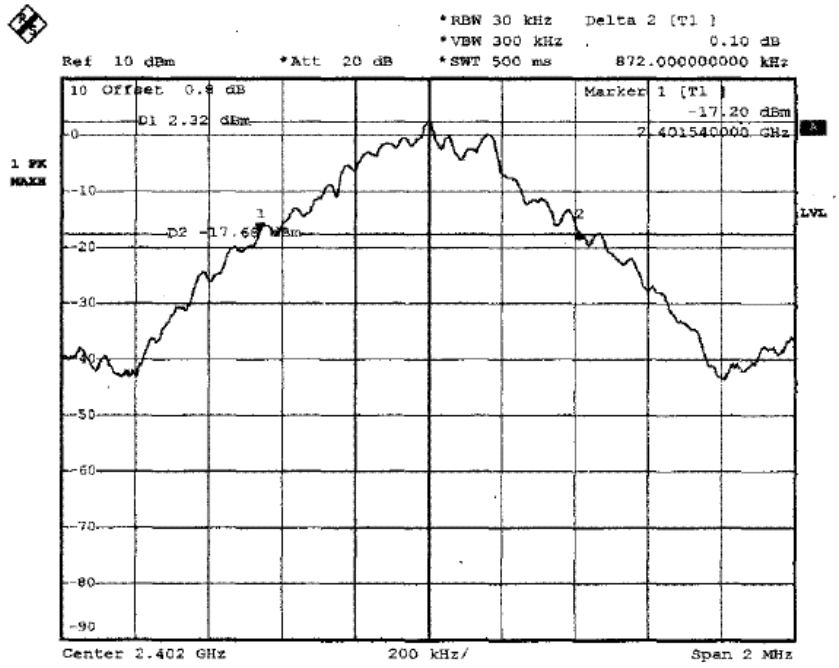



5.1.4. Test Result：See spectrum analyzer plots below

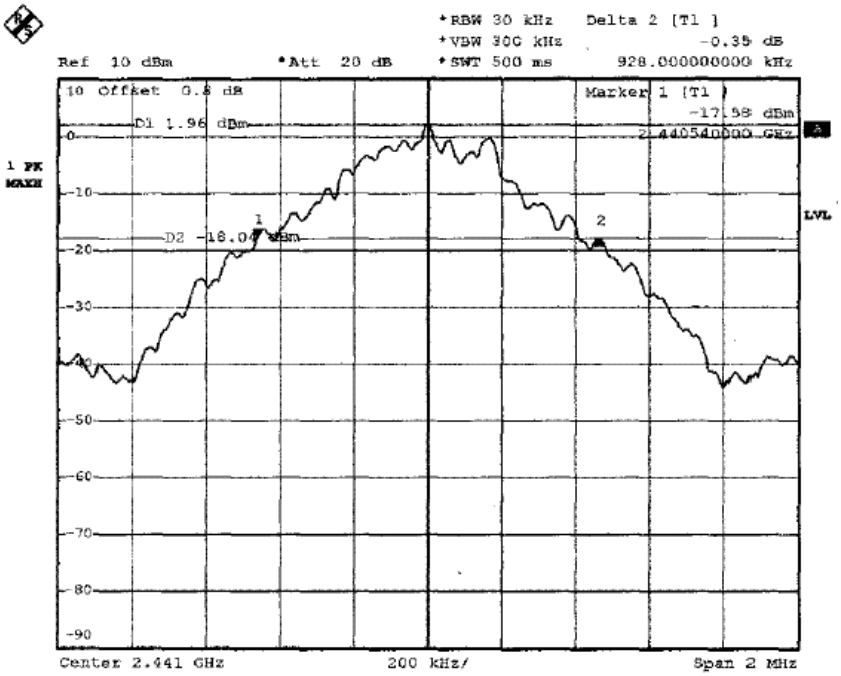
- Operating Mode: continuously transmitting
- Temperature: 26°C
- Relative Humidity: 67 %
- Duty cycle of the equipment during the test: 100%

| Channel | Frequency (MHz) | Hopping Channel Bandwidth (KHz) | Limits (KHz) |
|---|---|---|---|
| 00 | 2402 | 872.000 | 1.0 |
| 39 | 2441 | 928.000 | 1.0 |
| 78 | 2480 | 872.000 | 1.0 |

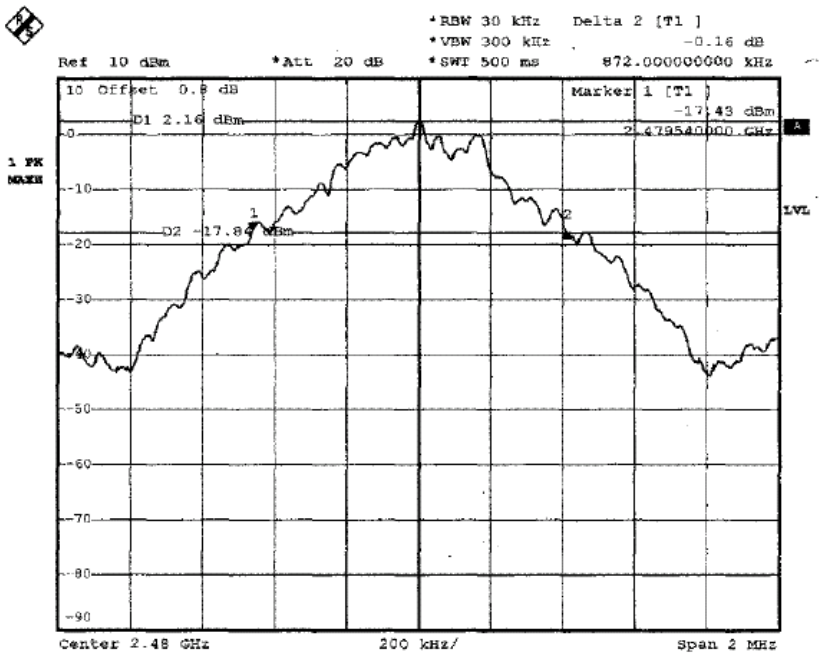
(Channel 00) :




(Channel 39) :



(Channel 78)：




5.1.5. Test Configuration（EUT Operating Condition）

The software provided by client enables the EUT under transmission condition continuously at lowest, middle and highest channel frequencies respectively.

## 5.2. Test of Number of Hopping Frequency

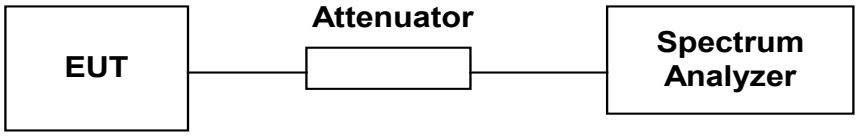
5.2.1. Measuring Instruments

Item 9 of the table on section 6.

5.2.2. Test Procedures

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. Set RBW of spectrum analyzer to 100KHz and VBW to 100KHz.
3. The number of hopping frequency used is defined total number of the channels available on the spectrum.

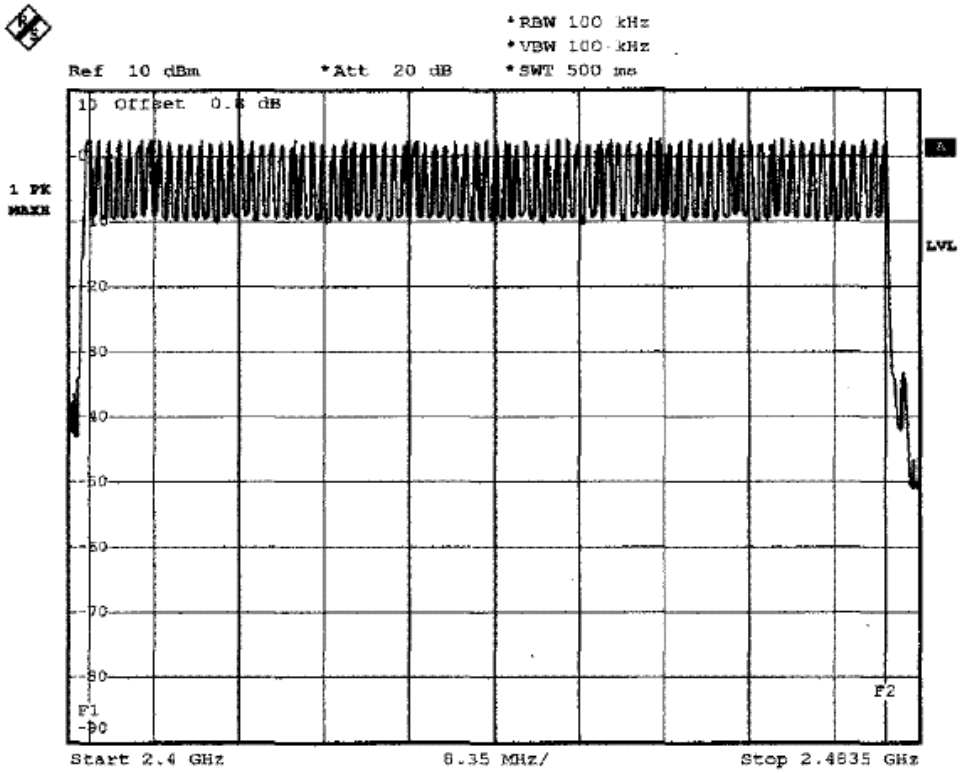
5.2.3. Test Setup Layout




5.2.4. Test Result：See spectrum analyzer plots below

- Operating Mode: normal hopping
- Temperature: 26°C
- Relative Humidity: 67 %
- Duty cycle of the equipment during the test: 100%

| Number of Hopping Frequency | Limit |
|---|---|
| 79 | 75 |




5.2.5. Test Configuration（EUT Operating Condition）

The software provided by client enables the EUT under continuous transmission condition. Hopping function is activated.

## 5.3. Test of Hopping Channel Separation

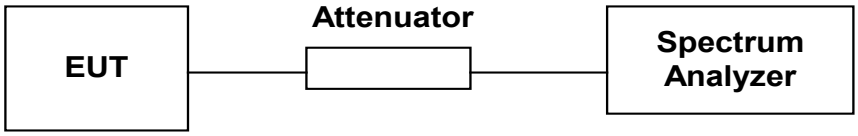
5.3.1. Measuring Instruments

Item 9 of the table on section 6.

5.3.2. Test Procedures

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. Set RBW of spectrum analyzer to 30KHz and VBW to 100KHz.
3. The Hopping Channel Separation is defined as the separation between 2 neighboring hopping frequencies.

5.3.3. Test Setup Layout



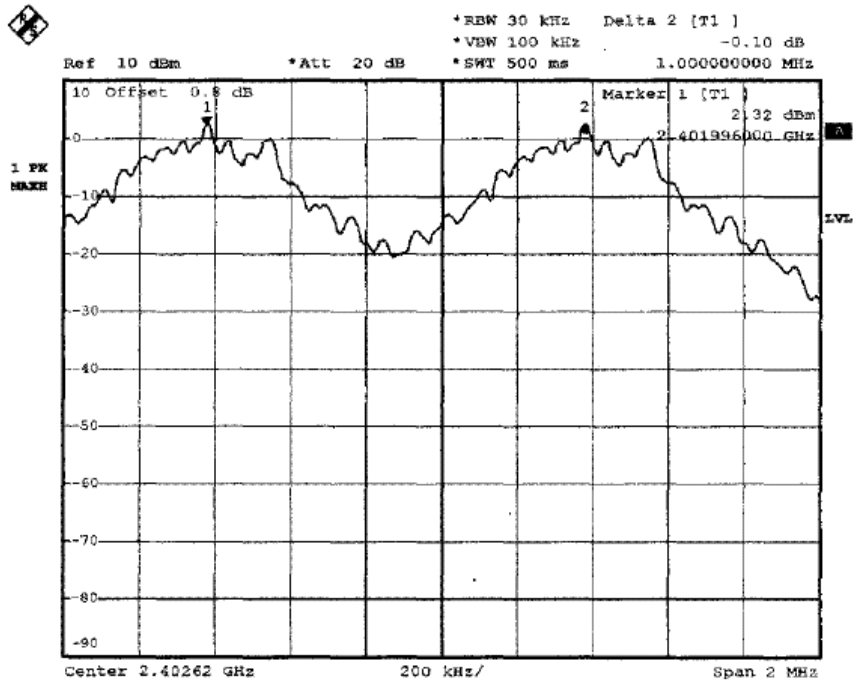

5.3.4. Test Result：The spectrum analyzer plots are attached as below

- Operating Mode: normal hopping
- Relative Humidity: 67 %
- Duty cycle of the equipment during the test: 100%

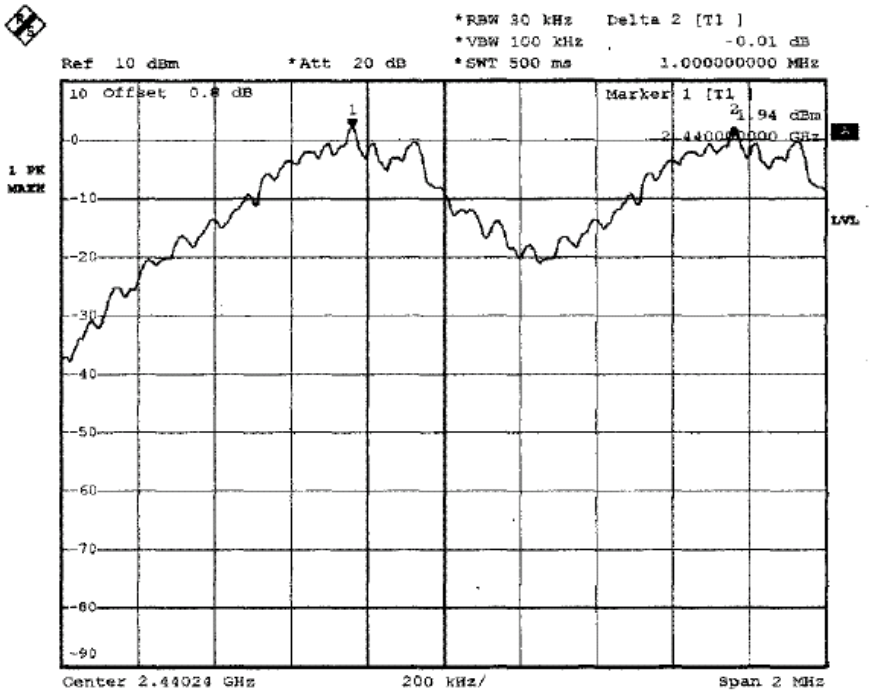
| Channel | Frequency ( MHz ) | Hopping Channel Separation ( KHz ) | Limits ( KHz ) |
|---|---|---|---|
| 00 | 2402 | 1000.0000 | 872.00 |
| 39 | 2441 | 1000.0000 | 928.00 |
| 78 | 2480 | 1000.0000 | 972.00 |

5.3.5. Note: The limit is the min of 25KHz or 20dB bandwidth , which is greater.

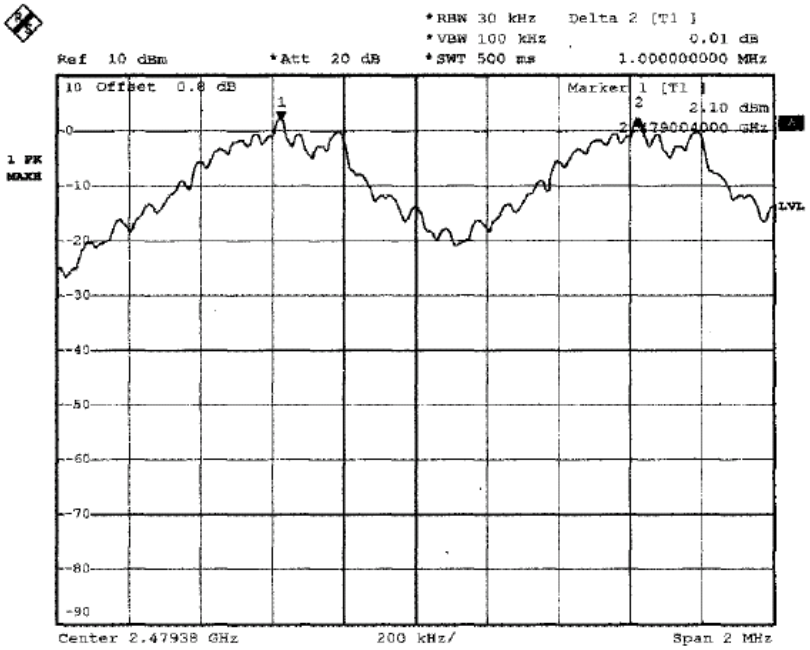
(Channel 00) :




(Channel 39) :



(Channel 78)：




5.3.6. Test Configuration（EUT Operating Condition）

The software provided by client enable the EUT under continuous transmission condition. Hopping function is activated.

## 5.4. Test of Dwell Time of Each Frequency within a 31.6 Seconds Period

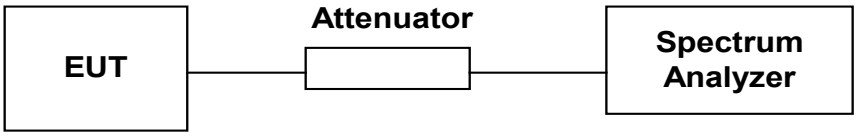
5.4.1. Measuring Instruments

Item 9 of the table on section 6.

5.4.2. Test Procedures

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. Set RBW of spectrum analyzer to 100kHz and VBW to 100kHz.
3. Set the center frequency on any frequency would be measure and set the frequency span to zero span.
4. Set the EUT for DH5 packet transmitting.
5. Measure the maximum time duration, t , of one single pulse.
6. DH5 Packet permit maximum 320 hops per second in 79 channels. So, the dwell time is the time duration of the pulse times 128 within 31.6 seconds.

5.4.3. Test Setup Layout

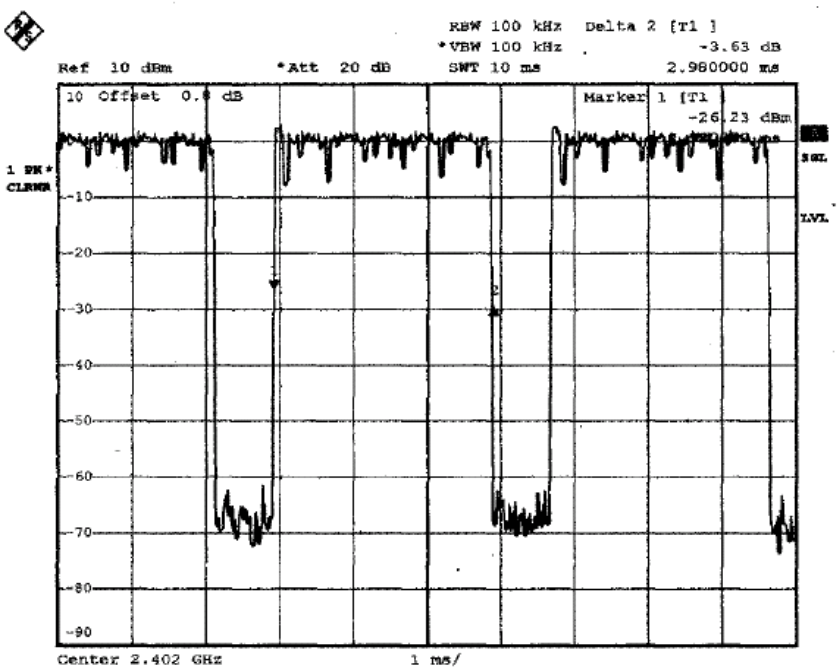



5.4.4. Test Result：See spectrum analyzer plots below

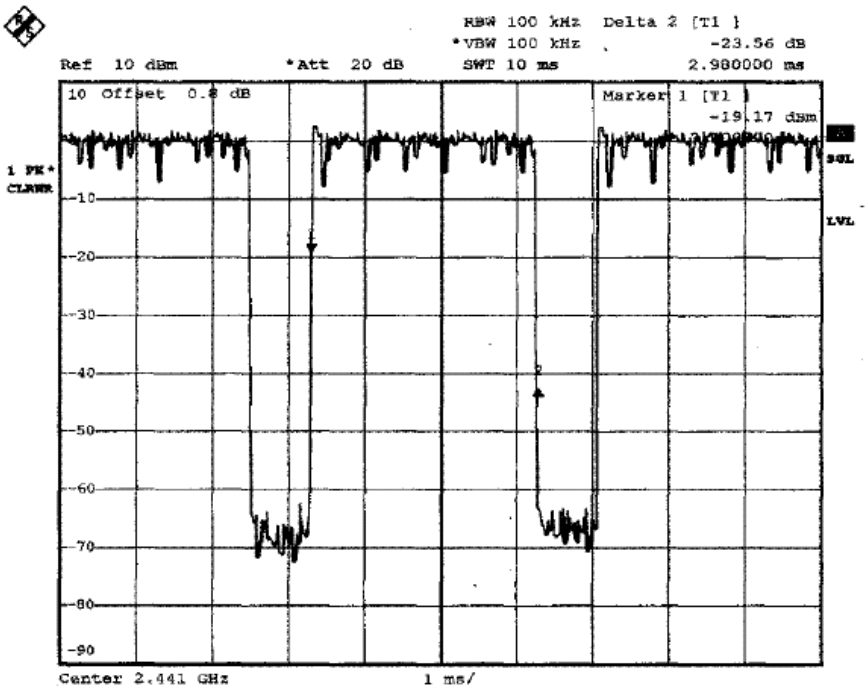
- Operating mode: normal hopping
- Temperature: 26°C
- Relative Humidity: 67 %
- Duty cycle of the equipment during the test : 100%

| Channel | Frequency (MHz) | Pulse Duration (ms) | Dwell Time (s) | Limits (s) |
|---|---|---|---|---|
| 00 | 2402 | 0.298 | 0.381 | 0.4 |
| 39 | 2441 | 0.298 | 0.381 | 0.4 |
| 78 | 2480 | 0.298 | 0.381 | 0.4 |

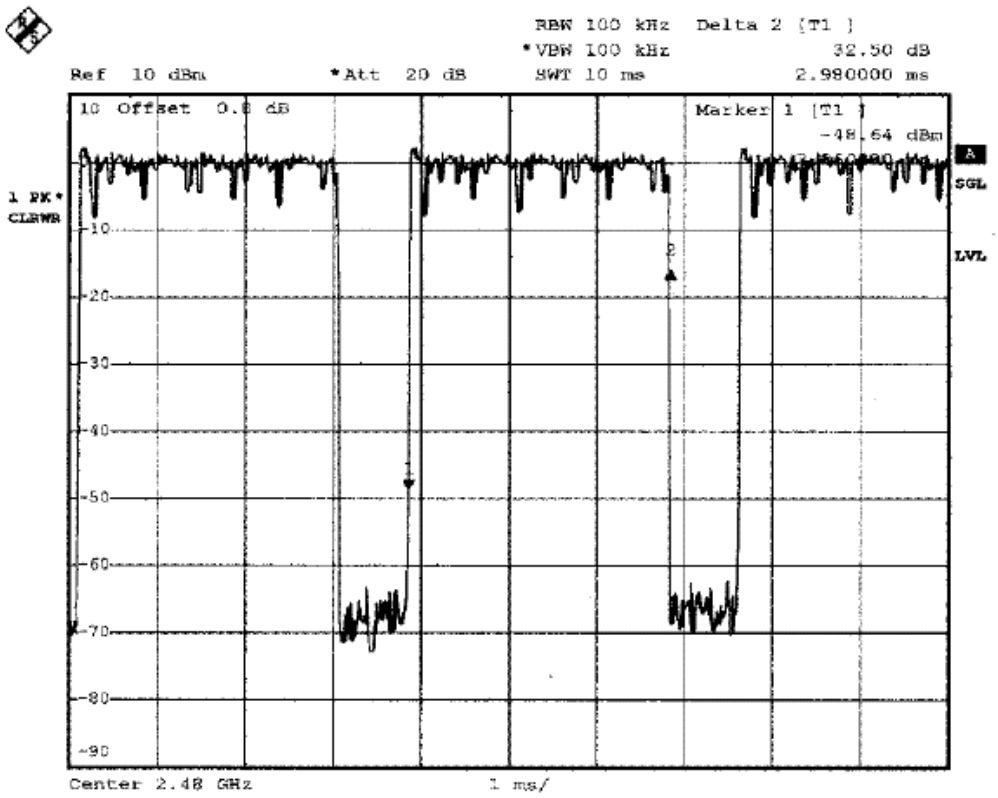
(Channel 00) :




(Channel 39) :



(Channel 78)：




5.4.5. Test Configuration（EUT Operating Condition）

Same as Section 5.3.5.

## 5.5. Test of Maximum Peak Output Power

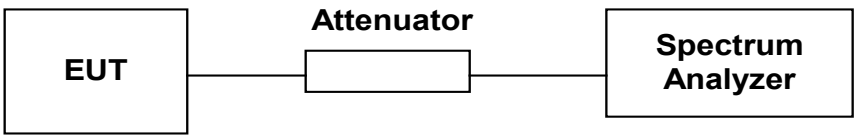
### 5.5.1. Measuring Instruments

Item 9 of the table on section 6.

### 5.5.2. Test Procedures

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. The center frequency of the spectrum analyzer was set to the fundamental frequency
3. Adjust RBW to 3MHz and VBW to 3MHz.

### 5.5.3. Test Setup Layout

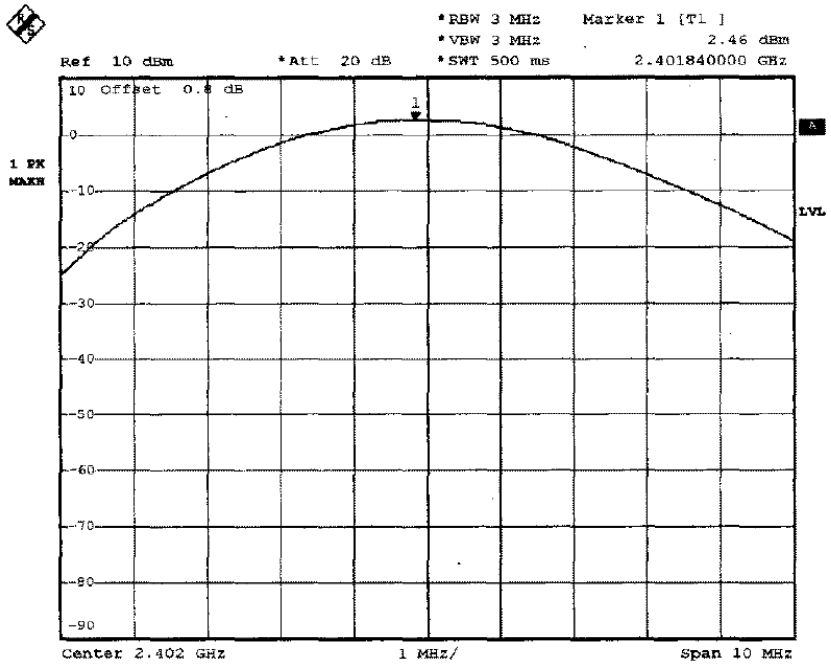


5.5.4. Test Result：See spectrum analyzer plots below

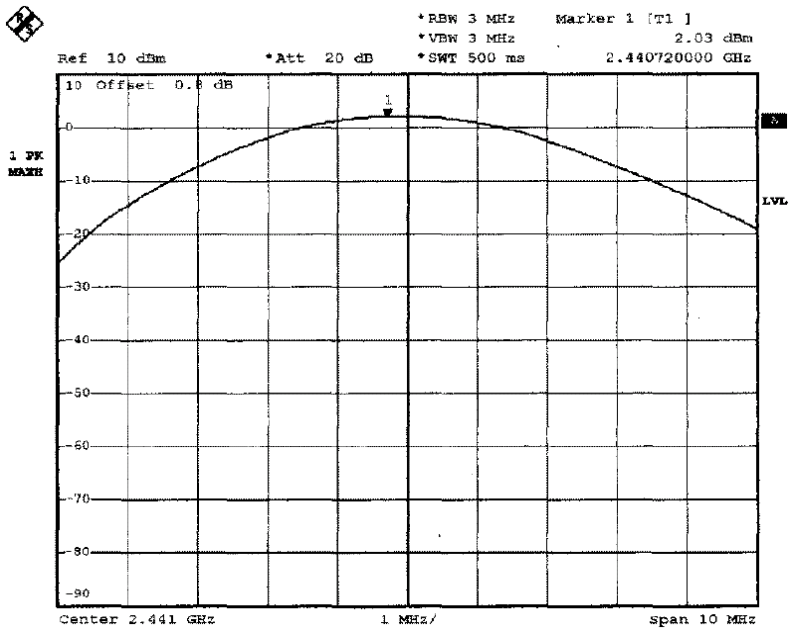
- Operating Mode: single channel continuous transmitting
- Temperature: 27°C
- Relative Humidity: 61 %
- Duty cycle of the equipment during the test : 100%

| Channel | Frequency (MHz) | Measured Output Power (dBm) | Measured Output Power (mWatt) | Limits (Watt/dBm ) |
|---|---|---|---|---|
| 00 | 2402 | 2.46 | 1.76 | 1W/30 dBm |
| 39 | 2441 | 2.03 | 1.59 | 1W/30 dBm |
| 78 | 2480 | 2.2 | 1.65 | 1W/30 dBm |

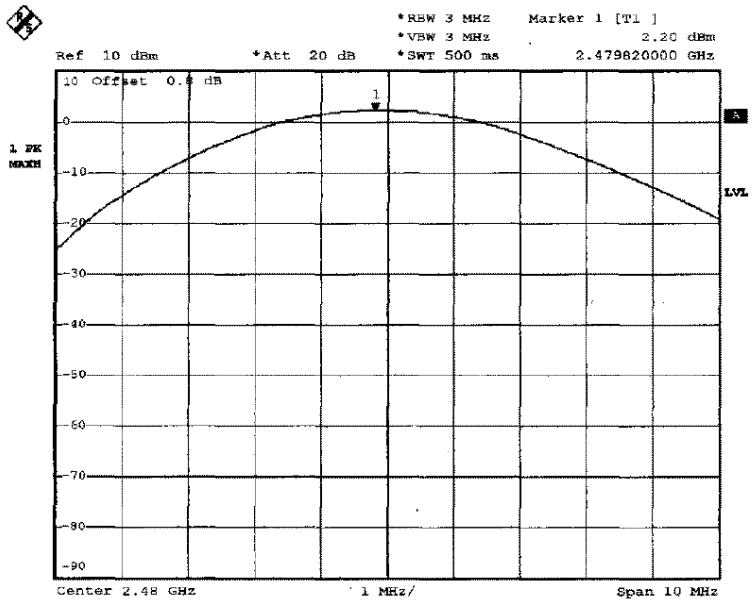
(Channel 00)：



(Channel 39)：




(Channel 78)：




5.5.5. Test Configuration（EUT Operating Condition）

5.5.6. Same as Section 5.4.5.

## 5.6. Test of Band Edges of the Operation Frequency

5.6.1. Measuring Instruments

Item 9 of the table on section 6.

5.6.2. Test Procedures

1. The transmitter output was connected to the spectrum analyzer via a low lose cable.
2. Set both RBW and VBW of spectrum analyzer to 100KHz with convenient frequency span including 100 KHz bandwidth from band edge.
3. The band edges emission was measured and recorded.

5.6.3. Test Result

Test Result in lower band (Channel 00)： PASS

Test Result in higher band(Channel 78)： PASS

5.6.4. Note on Band edge Emission

(A) Left Edge

The band edge emission plot shows 55.97dB delta between carrier maximum power and local maximum emission in the restricted band.

| CH 00 Carrier power strength (dB $\mu$ V/m) | Delta (dB) | The maximum field strength in restrict band (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
|---|---|---|---|---|
| 95.08 | 61.23 | 33.85 | 54.00 | 20.15 |

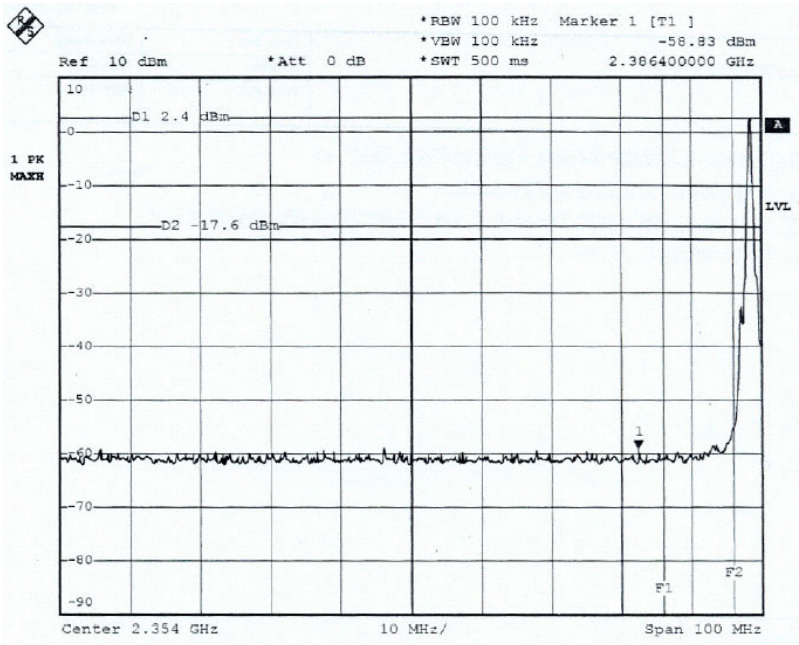
(B) Right Edge

The band edge emission plot shows 60.33dB delta between carrier maximum power and local maximum emission in the restricted band.

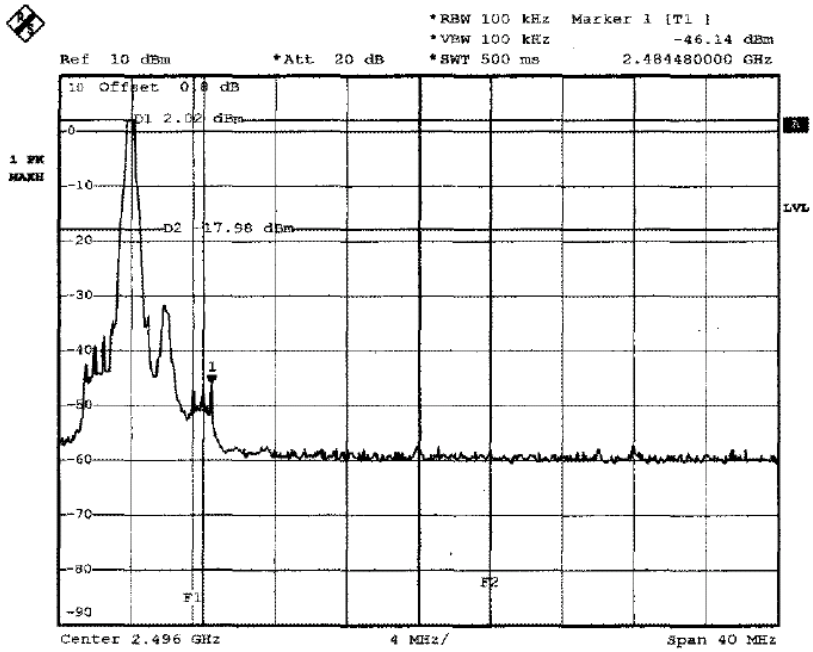
| CH 78 Carrier power strength (dB $\mu$ V/m) | Delta (dB) | The maximum field strength in restrict band (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
|---|---|---|---|---|
| 99.11 | 48.16 | 50.95 | 54.00 | 3.05 |

∗The maximum field strength in restricted band is the emission of carrier power strength subtract to the delta between carrier maximum power and local maximum emission in the restricted band.

(Channel 00)：




(Channel 78)：




Observation： All emissions in the 100kHz band edge are all lower than carrier by more than 20dB.

5.6.5. Test Configuration（EUT Operating Condition）

The software provided by client enables the EUT to stay in continuous transmission condition.
The hopping function is activated.

## 5.7. Power Spectral Density

The peak output power of this device is far lower than the limit of the peak power density, so there is no need to test this item.

## 5.8. Test of AC Power Line Conducted Emission

5.8.1. Measuring Instruments

Please reference item 1~7 in chapter 6 for the instruments used for testing.

5.8.2. Test Procedures

1. Configure the EUT according to ANSI C63.4.
2. The EUT has to be placed 0.4 meter far from the conducting wall of the shielding room and at least 80 centimeters from any other grounded conducting surface.
3. Connect EUT to the power mains through a line impedance stabilization network (LISN).
4. All the support units are connected to the other LISNs. The LISN should provides 50uH/50ohms coupling impedance.
5. The frequency range from 150 KHz to 30 MHz was searched.
6. Use the Channel & Power Controlling software to make the EUT working on selected channel and expected output power, then use the “H” Patter Generator software to make the supporting equipments stay on working condition.
7. Set the test-receiver system to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
8. The measurement has to be done between each power line and ground at the power terminal for each RF channel. Only one RF channel has to be investigated since this test is independent with the RF channel selection.

5.8.3. Test Result of Conducted Emission

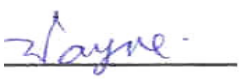
Testing Frequency Range: from 150KHz to 30 MHz
6dB Bandwidth : 9KHz
Test Mode : Mode 1
Temperature : 26°C
Relative Humidity : 61 %

## Line

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Remark |
|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | dB | |
| 1 | 0.159 | 46.32 | -19.20 | 65.52 | 46.18 | 0.10 | 0.04 | QP |
| 2 | 0.159 | 30.59 | -24.93 | 55.52 | 30.45 | 0.10 | 0.04 | Average |
| 3 | 0.170 | 27.54 | -27.42 | 54.96 | 27.41 | 0.10 | 0.03 | Average |
| 4 | 0.170 | 42.08 | -22.88 | 64.96 | 41.95 | 0.10 | 0.03 | QP |
| 5 | 0.235 | 33.09 | -19.18 | 52.27 | 32.98 | 0.10 | 0.01 | Average |
| 6 | 0.235 | 42.59 | -19.68 | 62.27 | 42.48 | 0.10 | 0.01 | QP |
| 7 | 0.357 | 38.22 | -20.58 | 58.80 | 38.12 | 0.10 | 0.00 | QP |
| 8 | 0.357 | 32.29 | -16.51 | 48.80 | 32.19 | 0.10 | 0.00 | Average |
| 9 | 1.180 | 27.68 | -18.32 | 46.00 | 27.56 | 0.10 | 0.02 | Average |
| 10 | 1.180 | 35.30 | -20.70 | 56.00 | 35.18 | 0.10 | 0.02 | QP |
| 11 | 1.540 | 27.70 | -18.30 | 46.00 | 27.57 | 0.10 | 0.03 | Average |
| 12 | 1.540 | 34.97 | -21.03 | 56.00 | 34.84 | 0.10 | 0.03 | QP |

## Neutral

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Remark |
|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | dB | |
| 1 | 0.161 | 29.75 | -25.65 | 55.40 | 29.61 | 0.10 | 0.04 | Average |
| 2 | 0.161 | 46.04 | -19.36 | 65.40 | 45.90 | 0.10 | 0.04 | QP |
| 3 | 0.168 | 45.17 | -19.89 | 65.06 | 45.04 | 0.10 | 0.03 | QP |
| 4 | 0.168 | 28.11 | -26.95 | 55.06 | 27.98 | 0.10 | 0.03 | Average |
| 5 | 0.209 | 37.40 | -25.84 | 63.24 | 37.29 | 0.10 | 0.01 | QP |
| 6 | 0.209 | 25.26 | -27.98 | 53.24 | 25.15 | 0.10 | 0.01 | Average |
| 7 | 0.236 | 32.42 | -19.82 | 52.24 | 32.31 | 0.10 | 0.01 | Average |
| 8 | 0.236 | 42.41 | -19.83 | 62.24 | 42.30 | 0.10 | 0.01 | QP |
| 9 | 0.360 | 37.21 | -21.53 | 58.74 | 37.11 | 0.10 | 0.00 | QP |
| 10 | 0.360 | 29.61 | -19.13 | 48.74 | 29.51 | 0.10 | 0.00 | Average |
| 11 | 1.170 | 35.15 | -20.85 | 56.00 | 35.03 | 0.10 | 0.02 | QP |
| 12 | 1.170 | 27.91 | -18.09 | 46.00 | 27.79 | 0.10 | 0.02 | Average |

Test Engineer : 

Wayne Hsu

5.8.4. Test Configuration（EUT Operating Condition）

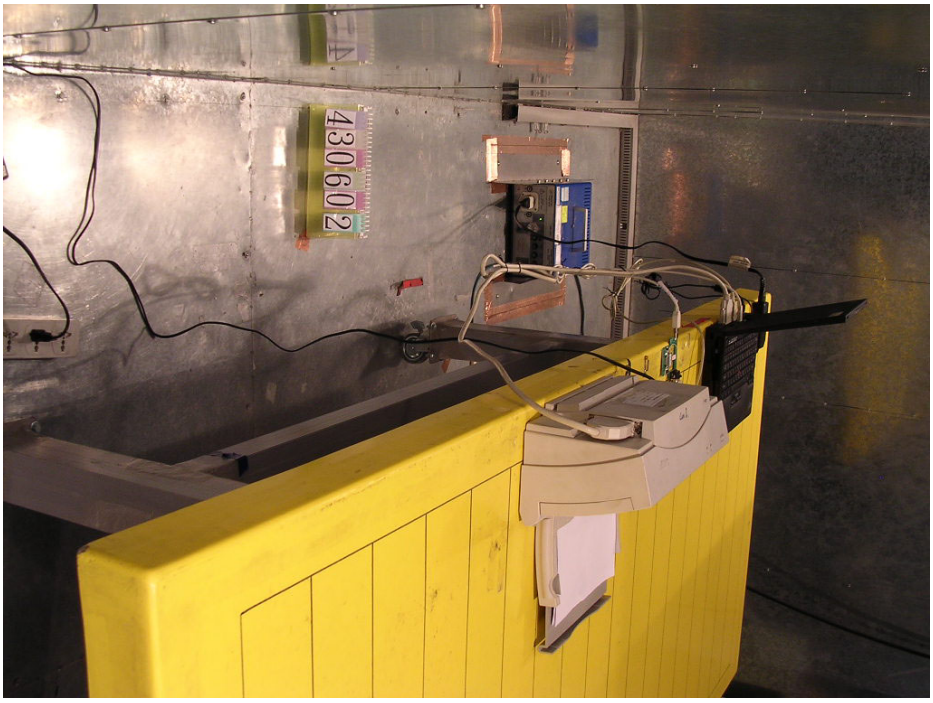
The software provided by client enables the EUT to stay in continuous transmission condition.
Hopping function is activated.

5.8.5. Photographs of Conducted Emission Test Configuration

- The photographs show the configuration that generates the maximum emission.

FRONT VIEW


REAR VIEW



## 5.9. Test of Spurious Radiated Emission

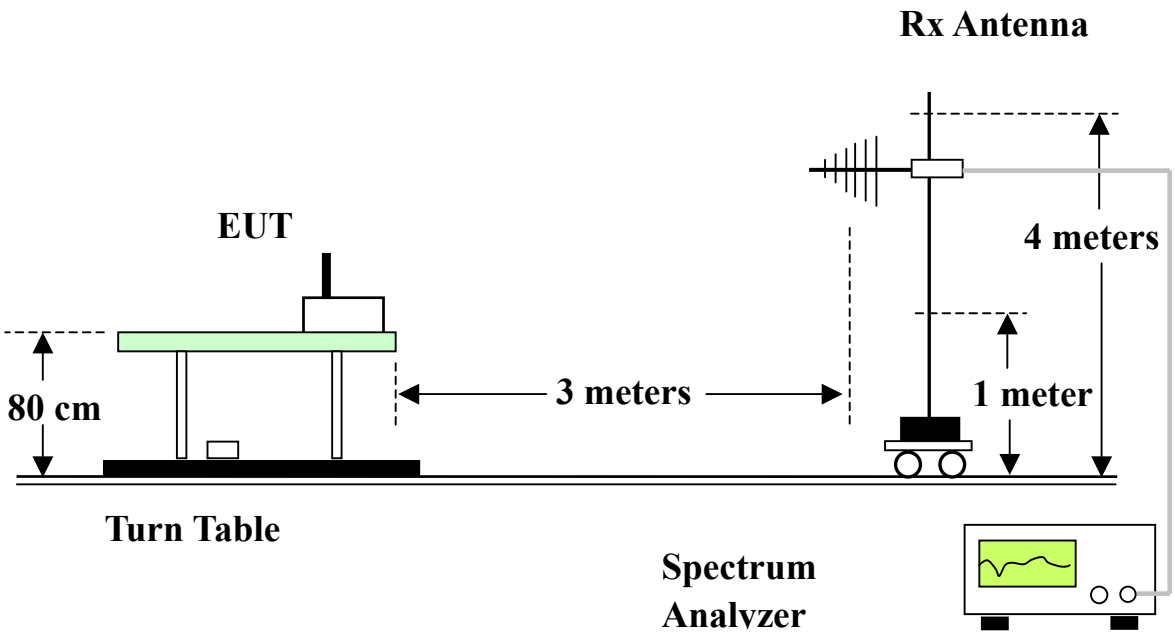
5.9.1. Measuring Instruments

Please reference item 8~19 in chapter 6 for the instruments used for testing.

5.9.2. Test Procedures

1. Configure the EUT according to ANSI C63.4.
2. The EUT was placed on the top of the turn table 0.8 meter above ground.
3. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turn table.
4. Power on the EUT and all the supporting units.
5. The turn table was rotated by 360 degrees to determine the position of the highest radiation.
6. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emission field strength of both horizontal and vertical polarization.
7. For each suspected emission, the antenna tower was scan (from 1 M to 4 M) and then the turn table was rotated (from 0 degree to 360 degrees) to find the maximum reading.
8. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
9. For emission above 1GHz, use 1MHz VBW & RBW for peak reading and 1MHz RBW & 300Hz VBW for average reading in spectrum analyzer.
10. If the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method and reported.
11. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB higher than average limit (that means the emission level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported. ( For peak measurement, RB=VB=1MHz, for average measurement, RB=1MHz, VB=10Hz)

5.9.3. Test Setup Layout



5.9.4. Test Results and Limit

***For spurious emission below 1GHz***

- RF LINK
- Test Distance : 3 M
- Temperature : 27 °C
- Relative Humidity : 62 %
- Emission level (dBuV/m) = 20 log Emission level (uV/m)
- Corrected Reading : Probe Factor + Cable Loss + Read Level - Preamp Factor = Level

**Horizontal**

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Preamp Factor | Remark | Ant Pos | Table Pos |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV/m | dB | dBuV/m | dBuV | dB | dB | dB | | cm | deg |
| 1 | 127.750 | 35.38 | -8.12 | 43.50 | 49.97 | 11.19 | 2.06 | 27.84 | QP | --- | --- |
| 2 | 132.510 | 37.03 | -6.47 | 43.50 | 51.35 | 11.46 | 2.05 | 27.83 | QP | 100 | 215 |
| 3 | 144.750 | 34.10 | -9.40 | 43.50 | 47.73 | 12.04 | 2.14 | 27.81 | QP | --- | --- |
| 1 | 400.000 | 37.66 | -8.34 | 46.00 | 46.20 | 15.79 | 3.47 | 27.80 | QP | --- | --- |
| 2 | 480.000 | 30.90 | -15.10 | 46.00 | 38.52 | 17.08 | 3.82 | 28.52 | QP | --- | --- |
| 3 | 665.600 | 31.92 | -14.08 | 46.00 | 36.90 | 19.10 | 4.65 | 28.73 | QP | --- | --- |

**Vertical**

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Preamp Factor | Remark | Ant Pos | Table Pos |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV/m | dB | dBuV/m | dBuV | dB | dB | dB | | cm | deg |
| 1 | 48.870 | 25.97 | -14.03 | 40.00 | 42.59 | 10.21 | 1.17 | 28.00 | QP | --- | --- |
| 2 | 133.190 | 34.34 | -9.16 | 43.50 | 48.65 | 11.49 | 2.03 | 27.83 | QP | --- | --- |
| 3 | 197.620 | 28.57 | -14.93 | 43.50 | 38.98 | 14.74 | 2.55 | 27.70 | QP | --- | --- |
| 1 | 311.200 | 35.97 | -10.03 | 46.00 | 46.33 | 13.86 | 3.14 | 27.36 | QP | --- | --- |
| 2 | 400.000 | 35.56 | -10.44 | 46.00 | 44.10 | 15.79 | 3.47 | 27.80 | QP | --- | --- |
| 3 | 665.600 | 32.90 | -13.10 | 46.00 | 37.88 | 19.10 | 4.65 | 28.73 | QP | --- | --- |

### *For spurious emission above 1GHz*

- Test Mode: Mode 1 ( 2402MHz)
- Test Distance : 3 M
- Temperature : 27 °C
- Relative Humidity : 62 %
- Emission level (dBuV/m) = 20 log Emission level (uV/m)
- Corrected Reading : Probe Factor + Cable Loss + Read Level - Preamp Factor = Level

**Horizontal**

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Preamp Factor | Remark | Ant Pos | Table Pos |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV/m | dB | dBuV/m | dBuV | dB | dB | dB | | cm | deg |
| 1 | 4806.000 | 53.83 | -20.17 | 74.00 | 60.73 | 33.03 | 2.41 | 42.34 | Peak | --- | --- |
| 2 | 4806.000 | 42.85 | -11.15 | 54.00 | 49.75 | 33.03 | 2.41 | 42.34 | Average | --- | --- |

**Vertical**

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Preamp Factor | Remark | Ant Pos | Table Pos |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV/m | dB | dBuV/m | dBuV | dB | dB | dB | | cm | deg |
| 1 | 4806.000 | 53.97 | -20.03 | 74.00 | 60.87 | 33.03 | 2.41 | 42.34 | Peak | --- | --- |
| 2 | 4806.000 | 45.01 | -8.99 | 54.00 | 51.91 | 33.03 | 2.41 | 42.34 | Average | 100 | 210 |

- Test Mode: Mode 2 (carrier 2441MHz)
- Test Distance : 3 M
- Temperature : 27 °C
- Relative Humidity : 62 %
- Emission level (dBuV/m) = 20 log Emission level (uV/m)
- Corrected Reading : Probe Factor + Cable Loss + Read Level - Preamp Factor = Level

**Horizontal**

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Preamp Factor | Remark | Ant Pos | Table Pos |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV/m | dB | dBuV/m | dBuV | dB | dB | dB | | cm | deg |
| 1 | 4884.000 | 53.36 | -20.64 | 74.00 | 60.11 | 33.19 | 2.51 | 42.45 | Peak | --- | --- |
| 2 | 4884.000 | 42.87 | -11.13 | 54.00 | 49.62 | 33.19 | 2.51 | 42.45 | Average | --- | --- |

**Vertical**

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Preamp Factor | Remark | Ant Pos | Table Pos |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV/m | dB | dBuV/m | dBuV | dB | dB | dB | | cm | deg |
| 1 | 4884.000 | 57.09 | -16.91 | 74.00 | 63.84 | 33.19 | 2.51 | 42.45 | Peak | --- | --- |
| 2 | 4884.000 | 45.30 | -8.70 | 54.00 | 52.05 | 33.19 | 2.51 | 42.45 | Average | 100 | 217 |

- Test Mode: Mode 3 (carrier 2480MHz)
- Test Distance : 3 M
- Temperature : 27 °C
- Relative Humidity : 62 %
- Emission level (dBuV/m) = 20 log Emission level (uV/m)
- Corrected Reading : Probe Factor + Cable Loss + Read Level - Preamp Factor = Level

**Horizontal**

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Preamp Factor | Remark | Ant Pos | Table Pos |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV/m | dB | dBuV/m | dBuV | dB | dB | dB | | cm | deg |
| 1 | 4964.000 | 53.46 | -20.54 | 74.00 | 60.21 | 33.35 | 2.46 | 42.56 | Peak | --- | --- |
| 2 | 4964.000 | 37.72 | -16.28 | 54.00 | 44.47 | 33.35 | 2.46 | 42.56 | Average | --- | --- |

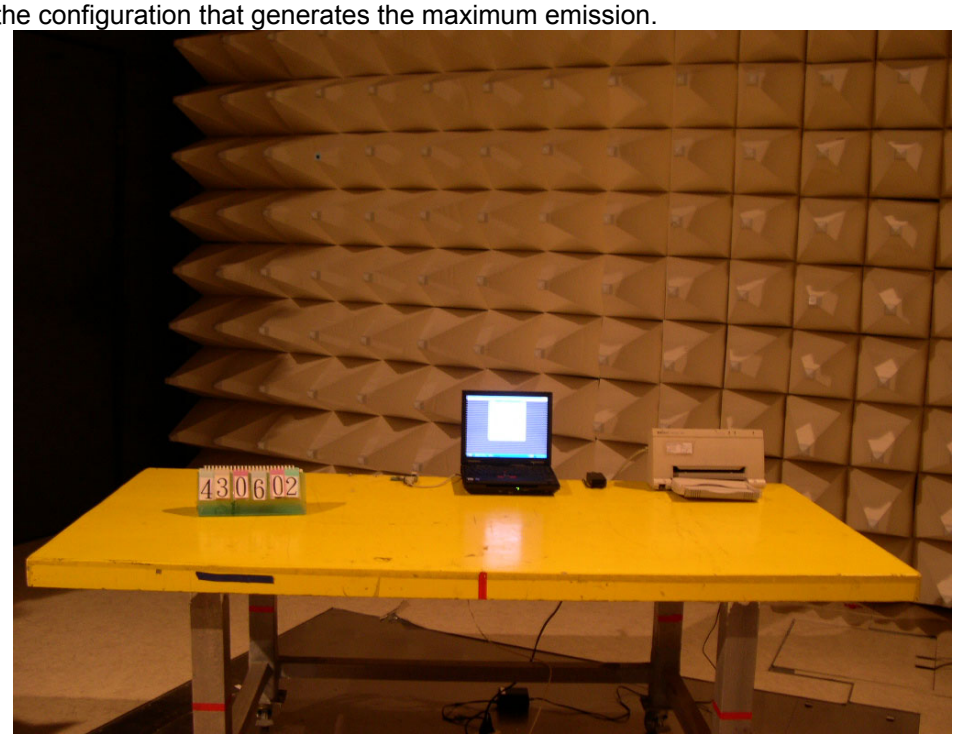
**Vertical**

| | Freq | Level | Over Limit | Limit Line | Read Level | Probe Factor | Cable Loss | Preamp Factor | Remark | Ant Pos | Table Pos |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV/m | dB | dBuV/m | dBuV | dB | dB | dB | | cm | deg |
| 1 | 4964.000 | 54.65 | -19.35 | 74.00 | 61.40 | 33.35 | 2.46 | 42.56 | Peak | 100 | 198 |
| 2 | 4964.000 | 38.74 | -15.26 | 54.00 | 45.49 | 33.35 | 2.46 | 42.56 | Average | --- | --- |

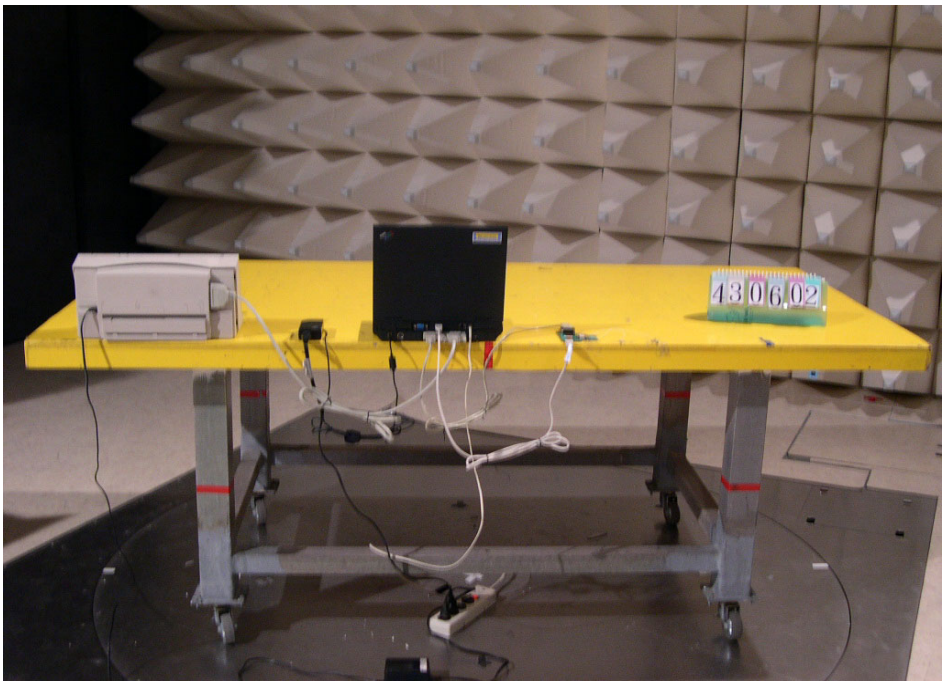
5.9.5. Photographs of Radiated Emission Test Configuration

- The photographs show the configuration that generates the maximum emission.

FRONT VIEW




REAR VIEW



## 5.10. Antenna Requirements

5.10.1. Standard Applicable

47 CFR Part15 Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

47 CFR Part15 Section 15.247 (b):

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

If the intentional radiator is used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

5.10.2. Antenna Connector Used in this Product

The maximum Gain antenna used in this product is external antenna with UFL antenna connector.

## 5.11. RF Exposure

5.11.1. Limit For Maximum Permissible Exposure (MPE)

This product can be classified as mobile device, so the 20cm separation distance warning is required.

In this section, the power density at 20cm location is calculated to examine if it is lower than the limit.

(A) Limits for Occupational / Controlled 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) |
|---|---|---|---|---|
| 0.3-3.0 | 614 | 1.63 | (100)* | 6 |
| 3.0-30 | 1842 / f | 4.89 / f | (900 / f)* | 6 |
| 30-300 | 61.4 | 0.163 | 1.0 | 6 |
| 300-1500 | | | F/300 | 6 |
| 1500-100,000 | | | 5 | 6 |

(B) 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)* | 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

5.11.2. MPE Calculation Method

$$E\ (V/m) = \frac{\sqrt{30 \times P \times G}}{d} \qquad \text{Power Density: } Pd\ (mW/cm^2) = \frac{E^2}{377}$$

**E** = Electric field (V/m)

**P** = Peak RF output power (mW)

**G** = EUT Antenna numeric gain (numeric)

**d** = Separation distance between radiator and human body (m)

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2}$$

From the peak EUT RF output power, the minimum mobile separation distance, d=20cm, as well as the gain of the used antenna, the RF power density can be obtained.

5.11.3. Calculated Result and Limit

| Channel No. | Antenna Gain (dBi) | Antenna Gain (numeric) | Peak Output Power (dBm) | Peak Output Power ( mW ) | Power Density (S) ($mW/cm^2$) | Limit of Power Density (S) ($mW/cm^2$) |
|---|---|---|---|---|---|---|
| Channel 00 | -0.1 | 0.98 | 2.4600 | 1.7620 | 0.0003 | 1 |
| Channel 39 | -0.1 | 0.98 | 2.0300 | 1.5959 | 0.0003 | 1 |
| Channel 78 | -0.1 | 0.98 | 2.2000 | 1.6596 | 0.0003 | 1 |

From the calculated result shown in above table, the power density is lower than limit at location 20cm far away.

# 6. List of Measuring Equipments Used

| Items | Instrument | Manufacturer | Model No. | Serial No. | Characteristics | Calibration Date | Remark |
|---|---|---|---|---|---|---|---|
| 1 | EMC Receiver | R&S | ESCS 30 | 100132 | 9 KHz – 2.75 GHz | Jun. 12, 2003 | Conduction (CO01-HY) |
| 2 | LISN | MessTec | NNB-2/16Z | 2001-008 | 9 KHz – 30 MHz | Apr. 30, 2003 | Conduction (CO01-HY) |
| 3 | LISN | MessTec | NNB-2/16Z | 2001-009 | 9 KHz – 30 MHz | Apr. 30, 2003 | Conduction (CO01-HY) |
| 4 | EMI Filter | LINDGREN | LRE-2060 | 1004 | < 450 Hz | N/A | Conduction (CO01-HY) |
| 5 | EMI Filter | LINDGREN | N6006 | 201052 | 0 ~ 60 Hz | N/A | Conduction (CO01-HY) |
| 6 | RF Cable-CON | Suhner | RG223/U | CB029 | 9KHz~30MHz | Dec. 24, 2003 | Conduction (CO01-HY) |
| 7 | 50 ohm BNC type | NOBLE | 50ohm | TM013 | 50 ohm | Apr. 24, 2003 | Conduction (CO01-HY) |
| 8 | 3m Semi Anechoic Chamber | SIDT FRANKONIA | SAC-3M | 03CH03-HY | 30MHz~1GHz 3m | Jun. 21, 2003 | Radiation (03CH03-HY) |
| 9 | Spectrum analyzer | R&S | FSP40 | 100004 | 9KHZ~40GHz | Aug. 23, 2003 | Radiation (03CH03-HY) |
| 10 | Amplifier | HP | 8447D | 2944A09072 | 100KHz – 1.3GHz | Nov. 05, 2003 | Radiation (03CH03-HY) |
| 11 | Biconical Antenna | SCHWARZBECK | VHBB 9124 | 301 | 30MHz –200MHz | Jul. 24, 2003 | Radiation (03CH03-HY) |
| 12 | Log Antenna | SCHWARZBECK | VUSLP 9111 | 221 | 200MHz -1GHz | Jul. 24, 2003 | Radiation (03CH03-HY) |
| 13 | RF Cable-R03m | Jye Bao | RG142 | CB021 | 30MHz~1GHz | Dec. 03, 2003 | Radiation (03CH03-HY) |
| 14 | Amplifier | MITEQ | AFS44 | 879981 | 100MHz~26.5GHz | Jul. 23, 2003 | Radiation (03CH03-HY) |
| 15 | Horn Antenna | COM-POWER | 3115 | 6741 | 1GHz – 18GHz | Apr. 08, 2003 | Radiation (03CH03-HY) |
| 16 | Turn Table | HD | DS 420 | 420/650/00 | 0 ~ 360 degree | N/A | Radiation (03CH03-HY) |
| 17 | Antenna Mast | HD | MA 240 | 240/560/00 | 1 m - 4 m | N/A | Radiation (03CH03-HY) |
| 18 | Horn Antenna | Schwarzbeck | BBHA9170 | 154 | 15GHz~40GHz | Jun. 02, 2003 | Radiation (03CH03-HY) |
| 19 | RF Cable-HIGH | Jye Bao | RG142 | CB030-HIGH | 1GHz~29.5GHz | Dec. 05, 2003 | Radiation (03CH03-HY) |

※ Calibration Interval of instruments listed above is one year.

| Items | Instrument | Manufacturer | Model No. | Serial No. | Characteristics | Calibration Date | Remark |
|---|---|---|---|---|---|---|---|
| 19 | Power meter | R&S | NRVS | 100444 | DC~40GHz | May 28, 2003 | Conducted |
| 20 | Power sensor | R&S | NRV-Z55 | 100049 | DC~40GHz | May 28, 2003 | Conducted |
| 21 | Power Sensor | R&S | NRV-Z32 | 100057 | 30MHz-6GHz | May 28, 2003 | Conducted |
| 22 | AC power source | HPC | HPA-500W | HPA-9100024 | AC 0~300V | May 27, 2003 | Conducted |
| 23 | Temp. and Humidity Chamber | KSON | THS-C3L | 612 | N/A | Oct. 01, 2003 | Conducted |
| 24 | Oscilloscope | Tektronix | TDS1012 | C038520 | 100MHz 2Ch. | Jan. 01, 2004 | Conducted |
| 25 | DC Detector | Narda | FSCM99899 | 4503A | 0.1MHZ~18GHz | Jan. 01, 2004 | Conducted |
| 26 | Signal Generator | R&S | SMR40 | 837900/23 | 1GHz~40GHz | Nov. 06, 2003 | Conducted |

※ Calibration Interval of instruments listed above is one year.