

# FCC TEST REPORT

**REPORT NO.:** RF961004A02

**MODEL NO.:** MOBTC9L, 41U5008,  
41U5009, 41U4973

**RECEIVED:** Oct. 4, 2007

**TESTED:** Oct. 8 ~ 15, 2007

**ISSUED:** Oct. 19, 2007

**APPLICANT:** PRIMAX ELECTRONICS LTD.

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R.O.C.

**ISSUED BY:** Advance Data Technology Corporation

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## 1. CERTIFICATION

**PRODUCT:** ThinkPad Bluetooth Laser Mouse  
**BRAND NAME:** lenovo, ThinkPad, PRIMAX  
**MODEL NO.:** MOBTC9L, 41U5008, 41U5009, 41U4973  
**APPLICANT:** PRIMAX ELECTRONICS LTD.  
**TESTED:** Oct. 8 ~ 15, 2007  
**TEST SAMPLE:** ENGINEERING SAMPLE  
**STANDARDS:** FCC Part 15, Subpart C (Section 15.247)  
ANSI C63.4-2003

The above equipment (model no.: MOBTC9L) has been tested by **Advance Data Technology Corporation**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

**PREPARED BY :** Celia Chen , **DATE:** Oct. 19, 2007  
( Celia Chen / Specialist )

**TECHNICAL**  
**ACCEPTANCE :** Jamison Chan , **DATE:** Oct. 19, 2007  
Responsible for RF ( Jamison Chan / Senior Engineer )

**APPROVED BY :** Ken Liu , **DATE:** Oct. 19, 2007  
( Ken Liu / Deputy Manager )

## 2. SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

| APPLIED STANDARD: FCC Part 15, Subpart C |   |        |  |
|--|---|--------|--|
| STANDARD SECTION                         | TEST TYPE AND LIMIT   | RESULT | REMARK   |
| 15.207                                   | AC Power Conducted Emission   | N/A    | Power supply is 3Vdc from batteries  |
| 15.247(a)(1)(iii)                        | Number of Hopping Frequency Used Spec.: At least 15 channels  | PASS   | Meet the requirement of limit.   |
| 15.247(a)(1)(iii)                        | Dwell Time on Each Channel Spec.: Max. 0.4 second within 31.6 second  | PASS   | Meet the requirement of limit.   |
| 15.247(a)(1)                             | 1. Hopping Channel Separation Spec.: Min. 25 kHz or 20 dB bandwidth, whichever is greater<br>2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System | PASS   | Meet the requirement of limit.   |
| 15.247(b)                                | Maximum Peak Output Power Spec.: max. 30dBm   | PASS   | Meet the requirement of limit.   |
| 15.247(d)                                | Transmitter Radiated Emissions Spec.: Table 15.209  | PASS   | Meet the requirement of limit. Minimum passing margin is -11.41 dB at 2483.500MHz. |
| 15.247(d)                                | Band Edge Measurement   | PASS   | Meet the requirement of limit.   |

## 2.1 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k=2$ .

| MEASUREMENT        | FREQUENCY    | UNCERTAINTY |
|--------------------|--------------|-------------|
| Radiated emissions | 30MHz ~ 1GHz | 3.75 dB     |
|                    | 1GHz ~ 40GHz | 2.89 dB     |

### 3. GENERAL INFORMATION

#### 3.1 GENERAL DESCRIPTION OF EUT

|                           |                                    |
|---------------------------|------------------------------------|
| <b>PRODUCT</b>            | ThinkPad Bluetooth Laser Mouse     |
| <b>MODEL NO.</b>          | MOBTC9L, 41U5008, 41U5009, 41U4973 |
| <b>FCC ID</b>             | EMJMMOBTC9L                        |
| <b>POWER SUPPLY</b>       | 3Vdc from batteries                |
| <b>MODULATION TYPE</b>    | GFSK                               |
| <b>RADIO TECHNOLOGY</b>   | FHSS                               |
| <b>TRANSFER RATE</b>      | 585.6Kbps                          |
| <b>FREQUENCY RANGE</b>    | 2402 MHz ~ 2480 MHz                |
| <b>NUMBER OF CHANNEL</b>  | 79                                 |
| <b>OUTPUT POWER</b>       | 1.321mW                            |
| <b>ANTENNA TYPE</b>       | Printed antenna with -3.66dBi gain |
| <b>DATA CABLE</b>         | N/A                                |
| <b>I/O PORTS</b>          | N/A                                |
| <b>ASSOCIATED DEVICES</b> | N/A                                |

#### NOTE:

1. The EUT is wireless mouse with Bluetooth technology.
2. The EUT has series models as follows:

| Brand Name                     | Model No. | Differentiation               |
|--------------------------------|-----------|-------------------------------|
| lenovo,<br>ThinkPad,<br>PRIMAX | MOBTC9L   | For marketing differentiation |
|                                | 41U5008   |                               |
|                                | 41U5009   |                               |
|                                | 41U4973   |                               |

During the test, model: **MOBTC9L** was selected as representative model for the test and its data was recorded in this report.

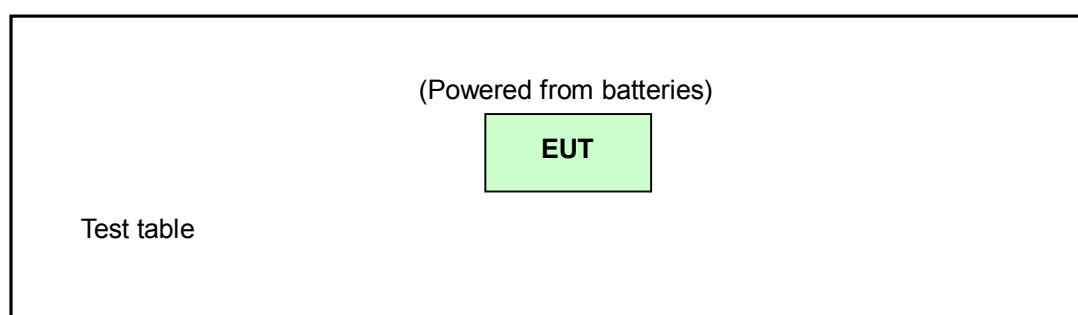
3. For more detailed features description, please refer to the manufacturer's specifications or User's Manual.

## 3.2 DESCRIPTION OF TEST MODES

79 channels are provided to this EUT:

| CHANNEL | FREQ.<br>(MHz) | CHANNEL | FREQ.<br>(MHz) | CHANNEL | FREQ.<br>(MHz) | CHANNEL | FREQ.<br>(MHz) |
|---------|----------------|---------|----------------|---------|----------------|---------|----------------|
| 0       | 2402           | 20      | 2422           | 40      | 2442           | 60      | 2462           |
| 1       | 2403           | 21      | 2423           | 41      | 2443           | 61      | 2463           |
| 2       | 2404           | 22      | 2424           | 42      | 2444           | 62      | 2464           |
| 3       | 2405           | 23      | 2425           | 43      | 2445           | 63      | 2465           |
| 4       | 2406           | 24      | 2426           | 44      | 2446           | 64      | 2466           |
| 5       | 2407           | 25      | 2427           | 45      | 2447           | 65      | 2467           |
| 6       | 2408           | 26      | 2428           | 46      | 2448           | 66      | 2468           |
| 7       | 2409           | 27      | 2429           | 47      | 2449           | 67      | 2469           |
| 8       | 2410           | 28      | 2430           | 48      | 2450           | 68      | 2470           |
| 9       | 2411           | 29      | 2431           | 49      | 2451           | 69      | 2471           |
| 10      | 2412           | 30      | 2432           | 50      | 2452           | 70      | 2472           |
| 11      | 2413           | 31      | 2433           | 51      | 2453           | 71      | 2473           |
| 12      | 2414           | 32      | 2434           | 52      | 2454           | 72      | 2474           |
| 13      | 2415           | 33      | 2435           | 53      | 2455           | 73      | 2475           |
| 14      | 2416           | 34      | 2436           | 54      | 2456           | 74      | 2476           |
| 15      | 2417           | 35      | 2437           | 55      | 2457           | 75      | 2477           |
| 16      | 2418           | 36      | 2438           | 56      | 2458           | 76      | 2478           |
| 17      | 2419           | 37      | 2439           | 57      | 2459           | 77      | 2479           |
| 18      | 2420           | 38      | 2440           | 58      | 2460           | 78      | 2480           |
| 19      | 2421           | 39      | 2441           | 59      | 2461           |         |                |

### 3.2.1 CONFIGURATION OF SYSTEM UNDER TEST





### 3.2.2 TEST MODE APPLICABILITY AND TESTED CHANNEL DETAIL

| EUT<br>CONFIGURE<br>MODE | Applicable to |       |       |    |      | Description |
|--------------------------|---------------|-------|-------|----|------|-------------|
|                          | PLC           | RE<1G | RE≥1G | BM | APCM |             |
| -                        | Note          | √     | √     | √  | √    | N/A         |

Where **PLC**: Power Line Conducted Emission      **RE<1G**: Radiated Emission below 1GHz  
**RE≥1G**: Radiated Emission above 1GHz      **BM**: Bandedge Measurement  
**APCM**: Antenna Port Conducted Measurement

Note: No need to concern of Conducted Emission due to the EUT is powered by battery.

#### RADIATED EMISSION TEST (BELOW 1 GHz):

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION TECHNOLOGY | MODULATION TYPE | PACKET TYPE |
|-------------------|----------------|-----------------------|-----------------|-------------|
| 0 to 78           | 0              | FHSS                  | GFSK            | DH3         |

#### RADIATED EMISSION TEST (ABOVE 1 GHz):

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION TECHNOLOGY | MODULATION TYPE | PACKET TYPE |
|-------------------|----------------|-----------------------|-----------------|-------------|
| 0 to 78           | 0, 39, 78      | FHSS                  | GFSK            | DH3         |

#### BANDEDGE MEASUREMENT:

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION TECHNOLOGY | MODULATION TYPE | PACKET TYPE |
|-------------------|----------------|-----------------------|-----------------|-------------|
| 0 to 78           | 0, 78          | FHSS                  | GFSK            | DH3         |

#### ANTENNA PORT CONDUCTED MEASUREMENT:

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION TECHNOLOGY | MODULATION TYPE | PACKET TYPE |
|-------------------|----------------|-----------------------|-----------------|-------------|
| 0 to 78           | 0, 39, 78      | FHSS                  | GFSK            | DH3         |

### **3.3.3 GENERAL DESCRIPTION OF APPLIED STANDARDS**

The EUT is a RF product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

**FCC Part 15, Subpart C (Section 15.247)**

**ANSI C63.4-2003**

All test items have been performed and recorded as per the above standards.

### **3.3.4 DESCRIPTION OF SUPPORT UNITS**

The EUT has been tested as an independent unit.

## 4. TEST TYPES AND RESULTS

### 4.1 CONDUCTED EMISSION MEASUREMENT

N/A

### 4.2 RADIATED EMISSION MEASUREMENT

#### 4.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT

Emissions radiated outside of the specified bands, shall be according to the general radiated limits in 15.209 as following:

| FREQUENCIES (MHz) | FIELD STRENGTH (microvolts/meter) | MEASUREMENT DISTANCE (meters) |
|-------------------|-----------------------------------|-------------------------------|
| 0.009 ~ 0.490     | 2400/F(kHz)                       | 300                           |
| 0.490 ~ 1.705     | 24000/F(kHz)                      | 30                            |
| 1.705 ~ 30.0      | 30                                | 30                            |
| 30 ~ 88           | 100                               | 3                             |
| 88 ~ 216          | 150                               | 3                             |
| 216 ~ 960         | 200                               | 3                             |
| Above 960         | 500                               | 3                             |

**NOTE:**

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

## 4.2.2 TEST INSTRUMENTS

| DESCRIPTION & MANUFACTURER        | MODEL NO.                | SERIAL NO.       | CALIBRATED UNTIL |
|-----------------------------------|--------------------------|------------------|------------------|
| HP Preamplifier                   | 8447D                    | 2432A03504       | May 09, 2008     |
| HP Preamplifier                   | 8449B                    | 3008A01201       | Oct. 01, 2008    |
| HP Preamplifier                   | 8449B                    | 3008A01292       | Aug. 05, 2008    |
| ROHDE & SCHWARZ TEST RECEIVER     | ESI7                     | 836697/012       | Oct. 24, 2007    |
| Schwarzbeck Antenna               | VULB 9168                | 137              | Sep. 13, 2008    |
| Schwarzbeck Antenna               | VHBA 9123                | 480              | Apr. 18, 2008    |
| EMCO Horn Antenna                 | 3115                     | 6714             | Oct. 24, 2007    |
| EMCO Horn Antenna                 | 3115                     | 9312-4192        | Apr. 19, 2008    |
| ADT. Turn Table                   | TT100                    | 0306             | NA               |
| ADT. Tower                        | AT100                    | 0306             | NA               |
| Software                          | ADT_Radiated_V<br>7.6.15 | NA               | NA               |
| SUHNER RF cable                   | SF104-26.5               | CABLE-CH6-17m-01 | Dec. 11, 2007    |
| ROHDE & SCHWARZ Spectrum Analyzer | FSP 40                   | 100036           | Mar. 13, 2008    |

- NOTE:**
1. The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to NML/ROC and NIST/USA.
  2. The horn antenna and HP preamplifier (model: 8449B) are used only for the measurement of emission frequency above 1GHz if tested.
  3. The test was performed in ADT Chamber No. 6.
  4. The Industry Canada Reference No. IC 3789-6.

### 4.2.3 TEST PROCEDURES

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. If the emission level of the EUT in peak mode was lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

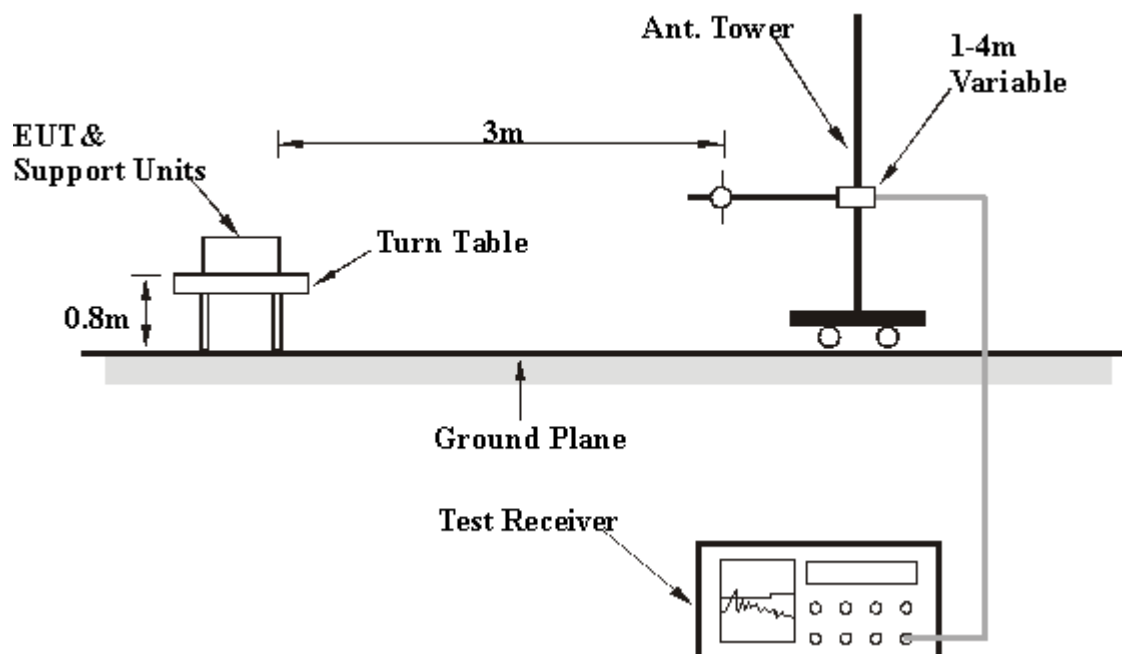
**NOTE:**

1. The resolution bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection at frequency below 1GHz.
2. The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 3MHz for Peak detection at frequency above 1GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz for Average detection (AV) at frequency above 1GHz.

### 4.2.4 DEVIATION FROM TEST STANDARD

No deviation

## 4.2.5 TEST SETUP



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

## 4.2.6 EUT OPERATING CONDITIONS

Set the EUT under transmission/receiving condition continuously at specific channel frequency.

## 4.2.7 TEST RESULTS

### RADIATED WORST CASE DATA: BELOW 1GHz

|                                 |                         |                          |               |
|---------------------------------|-------------------------|--------------------------|---------------|
| <b>MODULATION TYPE</b>          | GFSK                    | <b>CHANNEL</b>           | 0             |
| <b>INPUT POWER</b>              | 3Vdc                    | <b>FREQUENCY RANGE</b>   | Below 1000MHz |
| <b>ENVIRONMENTAL CONDITIONS</b> | 25deg. C, 70% RH, 992Pa | <b>DETECTOR FUNCTION</b> | Quasi-Peak    |
| <b>TESTED BY</b>                | Jamison Chan            |                          |               |

#### ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

| No. | Freq. (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|-----|-------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1   | 729.800     | 32.07 QP                | 46.00          | -13.93      | 1.59 H             | 187                  | 5.39             | 26.68                    |
| 2   | 776.453     | 31.02 QP                | 46.00          | -14.98      | 2.03 H             | 10                   | 3.28             | 27.74                    |
| 3   | 836.713     | 31.15 QP                | 46.00          | -14.85      | 2.22 H             | 148                  | 2.50             | 28.65                    |
| 4   | 858.096     | 31.93 QP                | 46.00          | -14.07      | 1.62 H             | 286                  | 3.06             | 28.87                    |
| 5   | 906.693     | 31.91 QP                | 46.00          | -14.09      | 1.95 H             | 172                  | 2.65             | 29.26                    |
| 6   | 918.357     | 31.89 QP                | 46.00          | -14.11      | 2.00 H             | 232                  | 2.55             | 29.34                    |

#### ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

| No. | Freq. (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|-----|-------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1   | 801.723     | 33.39 QP                | 46.00          | -12.61      | 1.00 V             | 328                  | 5.14             | 28.25                    |
| 2   | 832.826     | 32.47 QP                | 46.00          | -13.53      | 1.00 V             | 238                  | 3.86             | 28.61                    |
| 3   | 867.816     | 32.04 QP                | 46.00          | -13.96      | 1.10 V             | 70                   | 3.09             | 28.95                    |
| 4   | 889.198     | 32.42 QP                | 46.00          | -13.58      | 1.07 V             | 292                  | 3.30             | 29.12                    |
| 5   | 937.796     | 32.32 QP                | 46.00          | -13.68      | 1.14 V             | 211                  | 2.84             | 29.48                    |
| 6   | 957.234     | 32.94 QP                | 46.00          | -13.06      | 1.21 V             | 247                  | 3.23             | 29.71                    |

- REMARKS:**
1. Emission level(dBuV/m)=Raw Value(dBuV) + Correction Factor(dB/m)
  2. Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
  3. The other emission levels were very low against the limit.
  4. Margin value = Emission level – Limit value.

### RADIATED WORST CASE DATA: 1 ~ 25GHz

|                                 |                            |                          |                           |
|---------------------------------|----------------------------|--------------------------|---------------------------|
| <b>MODULATION TYPE</b>          | GFSK                       | <b>CHANNEL</b>           | 0                         |
| <b>INPUT POWER</b>              | 3Vdc                       | <b>FREQUENCY RANGE</b>   | 1 ~ 25GHz                 |
| <b>ENVIRONMENTAL CONDITIONS</b> | 25deg. C, 70% RH,<br>992Pa | <b>DETECTOR FUNCTION</b> | Peak (PK)<br>Average (AV) |
| <b>TESTED BY</b>                | Jamison Chan               |                          |                           |

#### ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

| No. | Freq. (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|-----|-------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1   | 1601.300    | 46.13 PK                | 74.00          | -27.87      | 1.00 H             | 88                   | 14.04            | 32.09                    |
| 2   | 1601.300    | 40.59 AV                | 54.00          | -13.41      | 1.00 H             | 88                   | 8.50             | 32.09                    |
| 3   | 2390.000    | 60.43 PK                | 74.00          | -13.57      | 1.01 H             | 207                  | 26.01            | 34.42                    |
| 4   | 2390.000    | 25.93 AV                | 54.00          | -28.07      | 1.01 H             | 207                  | -8.49            | 34.42                    |
| 5   | *2402.000   | 93.10 PK                |                |             | 1.01 H             | 207                  | 58.66            | 34.44                    |
| 6   | *2402.000   | 58.60 AV                |                |             | 1.01 H             | 207                  | 24.16            | 34.44                    |
| 7   | 4804.000    | 51.45 PK                | 74.00          | -22.55      | 1.00 H             | 333                  | 10.06            | 41.39                    |
| 8   | 4804.000    | 16.95 AV                | 54.00          | -37.05      | 1.00 H             | 333                  | -24.44           | 41.39                    |

#### ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

| No. | Freq. (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|-----|-------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1   | 1601.300    | 44.55 PK                | 74.00          | -29.45      | 1.56 V             | 6                    | 12.46            | 32.09                    |
| 2   | 1601.300    | 35.53 AV                | 54.00          | -18.47      | 1.56 V             | 6                    | 3.44             | 32.09                    |
| 3   | 2390.000    | 60.08 PK                | 74.00          | -13.92      | 1.51 V             | 34                   | 25.66            | 34.42                    |
| 4   | 2390.000    | 25.82 AV                | 54.00          | -28.18      | 1.51 V             | 34                   | -8.60            | 34.42                    |
| 5   | *2402.000   | 85.20 PK                |                |             | 1.51 V             | 34                   | 50.76            | 34.44                    |
| 6   | *2402.000   | 50.70 AV                |                |             | 1.51 V             | 34                   | 16.26            | 34.44                    |
| 7   | 4804.000    | 51.88 PK                | 74.00          | -22.12      | 1.36 V             | 65                   | 10.49            | 41.39                    |
| 8   | 4804.000    | 17.38 AV                | 54.00          | -36.62      | 1.36 V             | 65                   | -24.01           | 41.39                    |

- REMARKS:**
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
  2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
  3. The other emission levels were very low against the limit.
  4. Margin value = Emission level – Limit value.
  5. The DH3 packet was the worse case duty cycle for a transmit dwell time on a channel, based upon bluetooth theory the transmitter is on  $0.625 * 3$  per 247 ms per channel. Therefore, the duty cycle be equal to:  $20\log(1.875/100) = -34.5$  dB.
  6. Average value = peak reading +  $20\log(\text{duty cycle})$ .



|                                 |                         |                          |                           |
|---------------------------------|-------------------------|--------------------------|---------------------------|
| <b>MODULATION TYPE</b>          | GFSK                    | <b>CHANNEL</b>           | 39                        |
| <b>INPUT POWER</b>              | 3Vdc                    | <b>FREQUENCY RANGE</b>   | 1 ~ 25GHz                 |
| <b>ENVIRONMENTAL CONDITIONS</b> | 25deg. C, 70% RH, 992Pa | <b>DETECTOR FUNCTION</b> | Peak (PK)<br>Average (AV) |
| <b>TESTED BY</b>                | Jamison Chan            |                          |                           |

#### ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

| No. | Freq. (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|-----|-------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1   | 1627.300    | 46.17 PK                | 74.00          | -27.83      | 1.00 H             | 88                   | 13.99            | 32.19                    |
| 2   | 1627.300    | 37.40 AV                | 54.00          | -16.60      | 1.00 H             | 88                   | 5.22             | 32.19                    |
| 3   | *2441.000   | 95.84 PK                |                |             | 1.03 H             | 201                  | 61.32            | 34.52                    |
| 4   | *2441.000   | 61.34 AV                |                |             | 1.03 H             | 201                  | 26.82            | 34.52                    |
| 5   | 4882.000    | 53.42 PK                | 74.00          | -20.58      | 1.03 H             | 96                   | 11.83            | 41.60                    |
| 6   | 4882.000    | 18.92 AV                | 54.00          | -35.08      | 1.03 H             | 96                   | -22.67           | 41.60                    |

#### ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

| No. | Freq. (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|-----|-------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1   | 1627.300    | 45.03 PK                | 74.00          | -28.97      | 1.00 V             | 39                   | 12.85            | 32.19                    |
| 2   | 1627.300    | 36.45 AV                | 54.00          | -17.55      | 1.00 V             | 39                   | 4.27             | 32.19                    |
| 3   | *2441.000   | 86.68 PK                |                |             | 1.52 V             | 321                  | 52.16            | 34.52                    |
| 4   | *2441.000   | 52.18 AV                |                |             | 1.52 V             | 321                  | 17.66            | 34.52                    |
| 5   | 4882.000    | 52.67 PK                | 74.00          | -21.33      | 1.00 V             | 323                  | 11.08            | 41.60                    |
| 6   | 4882.000    | 18.17 AV                | 54.00          | -35.83      | 1.00 V             | 323                  | -23.42           | 41.60                    |

- REMARKS:**
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
  2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
  3. The other emission levels were very low against the limit.
  4. Margin value = Emission level – Limit value.
  5. The DH3 packet was the worse case duty cycle for a transmit dwell time on a channel, based upon bluetooth theory the transmitter is on 0.625 \* 3 per 247 ms per channel. Therefore, the duty cycle be equal to:  $20\log(1.875/100) = -34.5$  dB.
  6. Average value = peak reading +  $20\log(\text{duty cycle})$ .

|                                 |                            |                          |                           |
|---------------------------------|----------------------------|--------------------------|---------------------------|
| <b>MODULATION TYPE</b>          | GFSK                       | <b>CHANNEL</b>           | 78                        |
| <b>INPUT POWER</b>              | 3Vdc                       | <b>FREQUENCY RANGE</b>   | 1 ~ 25GHz                 |
| <b>ENVIRONMENTAL CONDITIONS</b> | 25deg. C, 70% RH,<br>992Pa | <b>DETECTOR FUNCTION</b> | Peak (PK)<br>Average (AV) |
| <b>TESTED BY</b>                | Jamison Chan               |                          |                           |

#### ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

| No. | Freq. (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|-----|-------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1   | 1653.300    | 47.30 PK                | 74.00          | -26.70      | 1.67 H             | 132                  | 15.01            | 32.29                    |
| 2   | 1653.300    | 40.79 AV                | 54.00          | -13.21      | 1.67 H             | 132                  | 8.50             | 32.29                    |
| 3   | *2480.000   | 95.55 PK                |                |             | 1.01 H             | 201                  | 60.95            | 34.60                    |
| 4   | *2480.000   | 61.05 AV                |                |             | 1.01 H             | 201                  | 26.45            | 34.60                    |
| 5   | 2483.500    | 62.37 PK                | 74.00          | -11.63      | 1.01 H             | 201                  | 27.76            | 34.61                    |
| 6   | 2483.500    | 27.87 AV                | 54.00          | -26.13      | 1.01 H             | 201                  | -6.74            | 34.61                    |
| 7   | 4960.000    | 54.58 PK                | 74.00          | -19.42      | 1.12 H             | 103                  | 12.79            | 41.80                    |
| 8   | 4960.000    | 20.08 AV                | 54.00          | -33.92      | 1.12 H             | 103                  | -21.71           | 41.80                    |

#### ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

| No. | Freq. (MHz)     | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB)   | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|-----|-----------------|-------------------------|----------------|---------------|--------------------|----------------------|------------------|--------------------------|
| 1   | 1653.300        | 45.07 PK                | 74.00          | -28.93        | 1.58 V             | 178                  | 12.78            | 32.29                    |
| 2   | 1653.300        | 36.25 AV                | 54.00          | -17.75        | 1.58 V             | 178                  | 3.96             | 32.29                    |
| 3   | *2480.000       | 87.94 PK                |                |               | 1.16 V             | 330                  | 53.34            | 34.60                    |
| 4   | *2480.000       | 53.44 AV                |                |               | 1.16 V             | 330                  | 18.84            | 34.60                    |
| 5   | <b>2483.500</b> | <b>62.59 PK</b>         | <b>74.00</b>   | <b>-11.41</b> | <b>1.16 V</b>      | <b>330</b>           | <b>27.98</b>     | <b>34.61</b>             |
| 6   | 2483.500        | 28.09 AV                | 54.00          | -25.91        | 1.16 V             | 330                  | -6.52            | 34.61                    |
| 7   | 4960.000        | 54.67 PK                | 74.00          | -19.33        | 1.56 V             | 69                   | 12.88            | 41.80                    |
| 8   | 4960.000        | 20.17 AV                | 54.00          | -33.83        | 1.56 V             | 69                   | -21.62           | 41.80                    |

- REMARKS:**
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
  2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
  3. The other emission levels were very low against the limit.
  4. Margin value = Emission level – Limit value.
  5. The DH3 packet was the worse case duty cycle for a transmit dwell time on a channel, based upon bluetooth theory the transmitter is on 0.625 \* 3 per 247 ms per channel. Therefore, the duty cycle be equal to:  $20\log(1.875/100) = -34.5$  dB.
  6. Average value = peak reading +  $20\log(\text{duty cycle})$ .

## 4.3 NUMBER OF HOPPING FREQUENCY USED

### 4.3.1 LIMIT OF HOPPING FREQUENCY USED

At least 15 channels frequencies, and should be equally spaced.

### 4.3.2 TEST INSTRUMENTS

| DESCRIPTION & MANUFACTURER | MODEL NO. | SERIAL NO. | CALIBRATED UNTIL |
|----------------------------|-----------|------------|------------------|
| SPECTRUM ANALYZER          | FSP 40    | 100036     | Mar. 13, 2008    |

**NOTE:** The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to NML/ROC and NIST/USA.

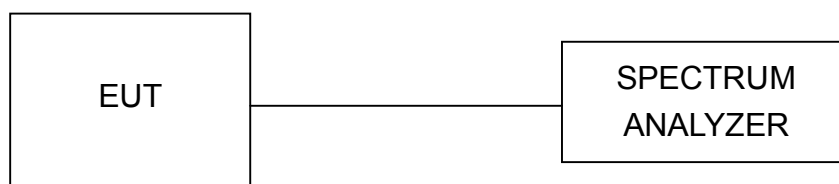
### 4.3.3 TEST PROCEDURES

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
- Set the SA on View mode and then plot the result on SA screen.
- Repeat above procedures until all frequencies measured were complete.

#### 4.3.4 DEVIATION FROM TEST STANDARD

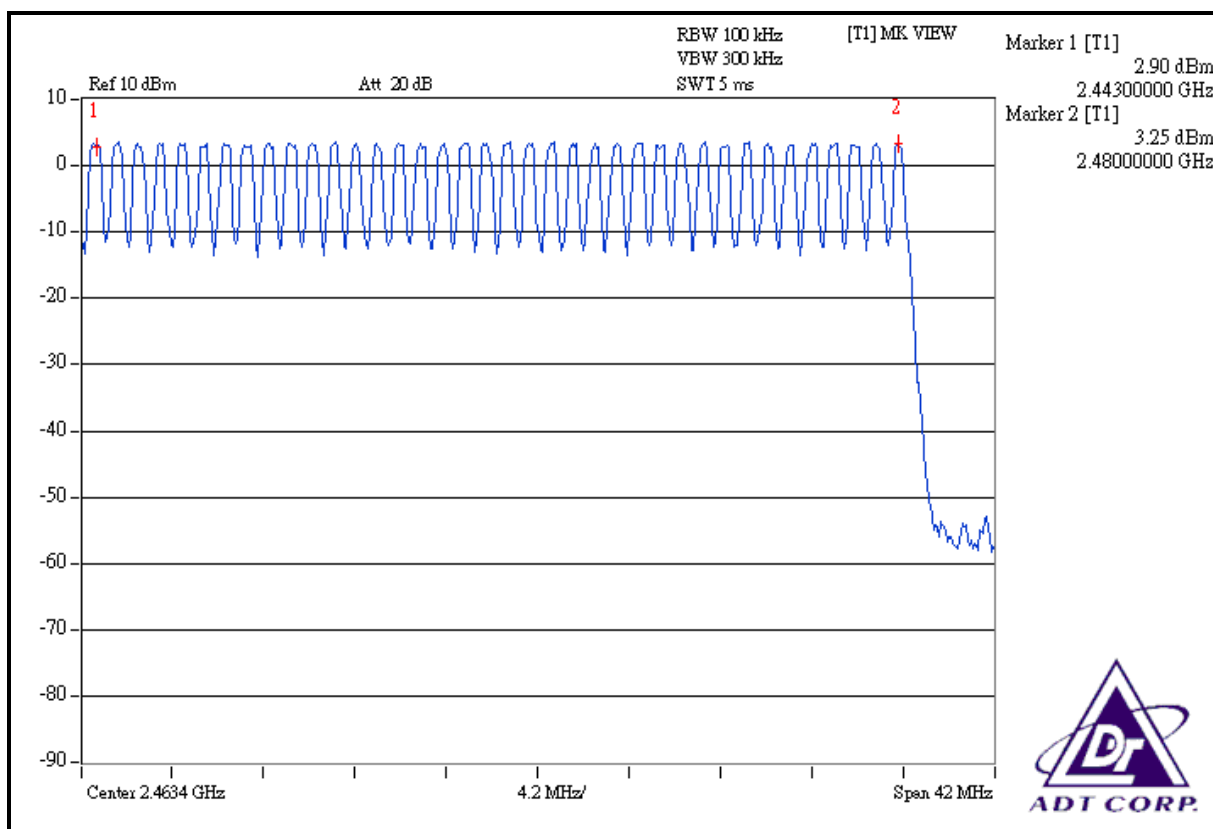
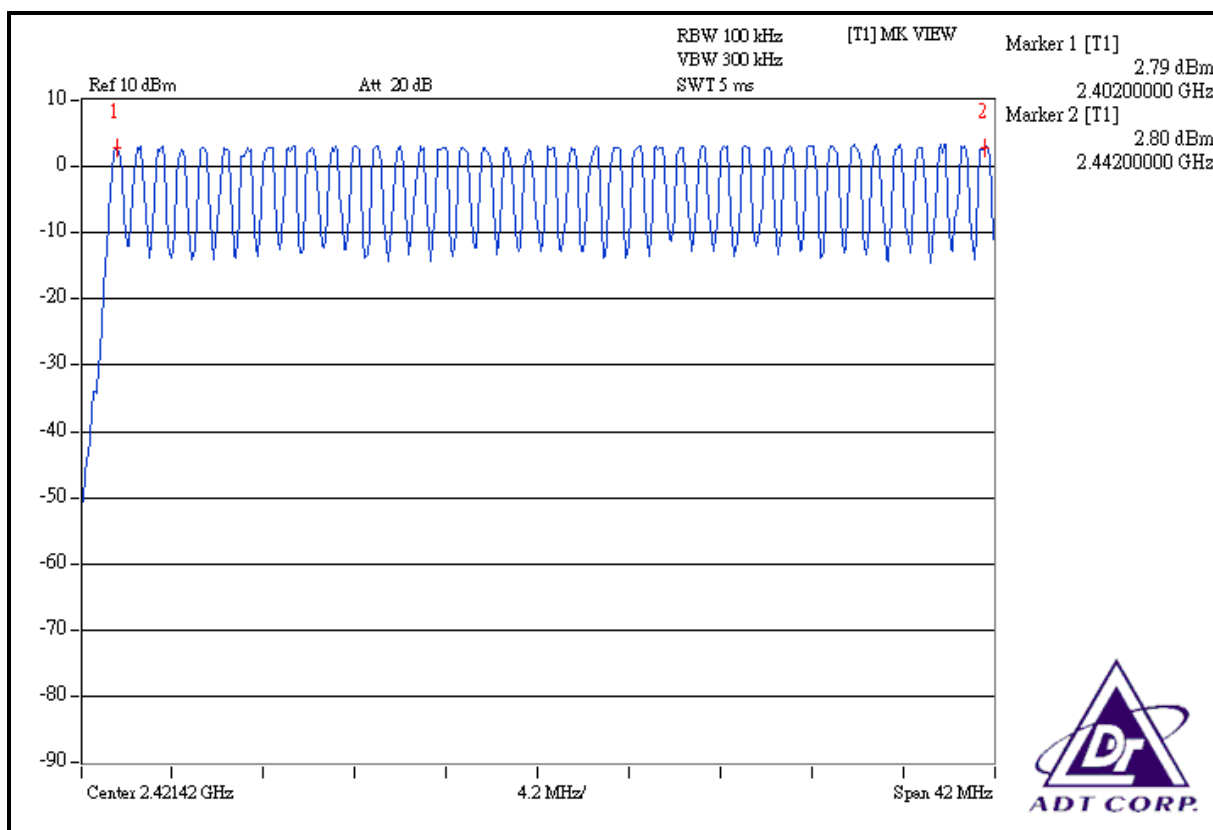
No deviation.

#### 4.3.5 TEST SETUP



#### 4.3.6 TEST RESULTS

There are 79 hopping frequencies in the hopping mode. Please refer to next two pages for the test result. On the plots, it shows that the hopping frequencies are equally spaced.



## 4.4 DWELL TIME ON EACH CHANNEL

### 4.4.1 LIMIT OF DWELL TIME USED

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

### 4.4.2 TEST INSTRUMENTS

| DESCRIPTION & MANUFACTURER | MODEL NO. | SERIAL NO. | CALIBRATED UNTIL |
|----------------------------|-----------|------------|------------------|
| SPECTRUM ANALYZER          | FSP 40    | 100036     | Mar. 13, 2008    |

**NOTES:** The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to NML/ROC and NIST/USA.

### 4.4.3 TEST PROCEDURES

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
- Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
- Repeat above procedures until all different time-slot modes have been completed.

### 4.4.4 DEVIATION FROM TEST STANDARD

No deviation.

#### 4.4.5 TEST SETUP

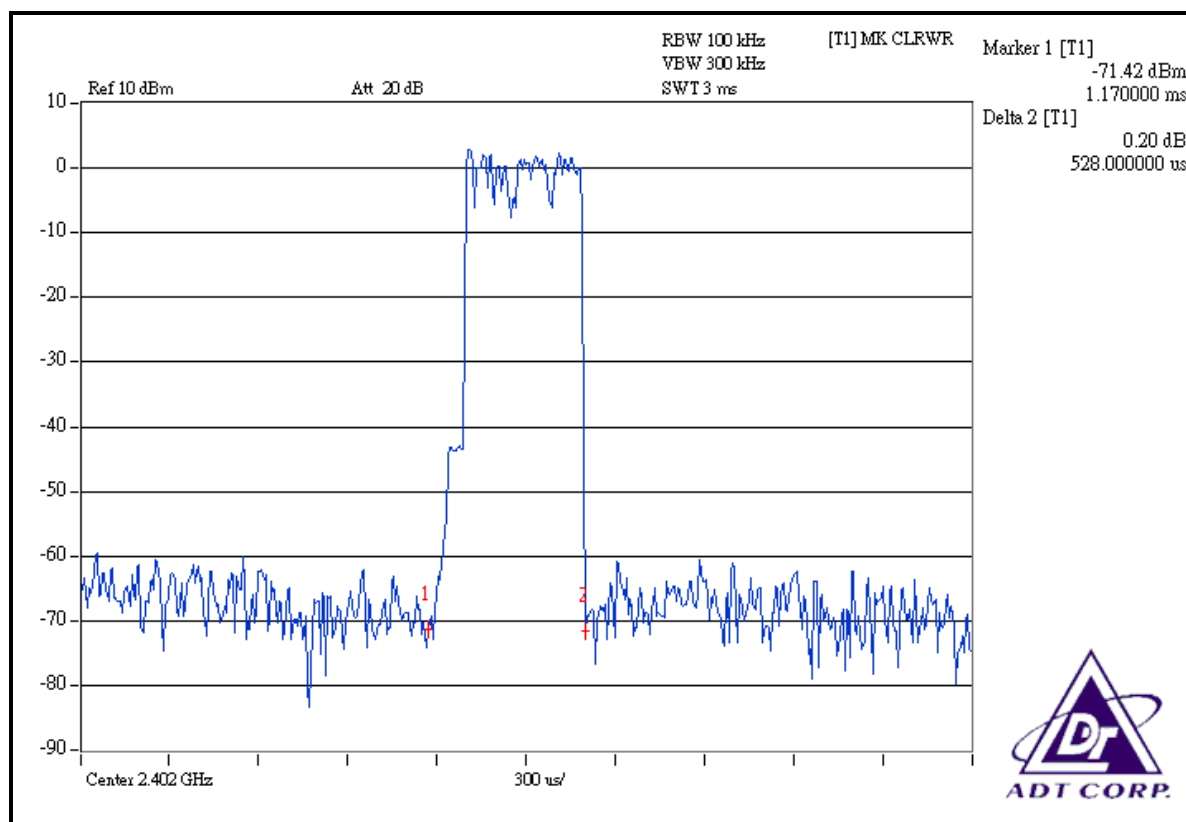
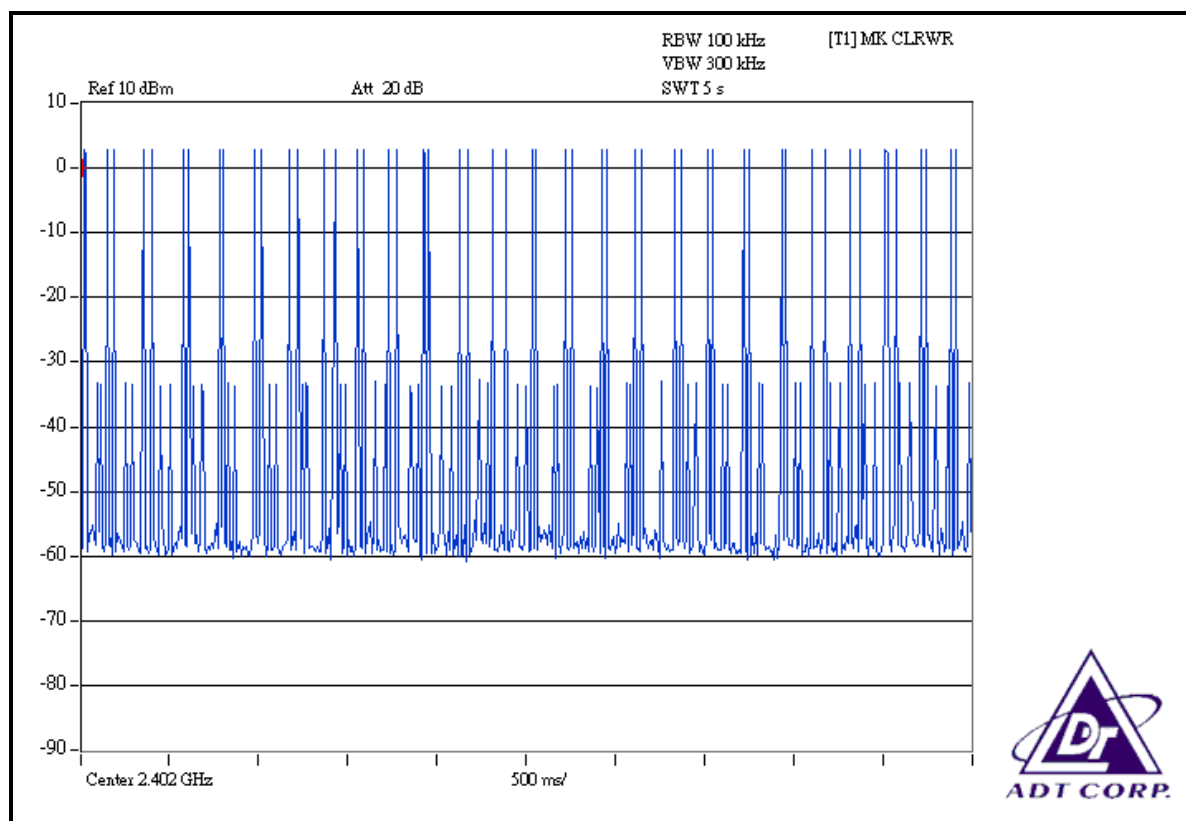


#### 4.4.6 TEST RESULTS

| Mode | Number of transmission in a 31.6 (79Hopping*0.4) | Length of transmission time (msec) | Result (msec) | Limit (msec) |
|------|--|------------------------------------|---------------|--------------|
| DH1  | 51 (times / 5 sec) *6.32=322.32 times            | 0.528                              | 170.185       | 400          |
| DH3  | 25 (times / 5 sec) *6.32=158.00 times            | 1.758                              | 277.764       | 400          |

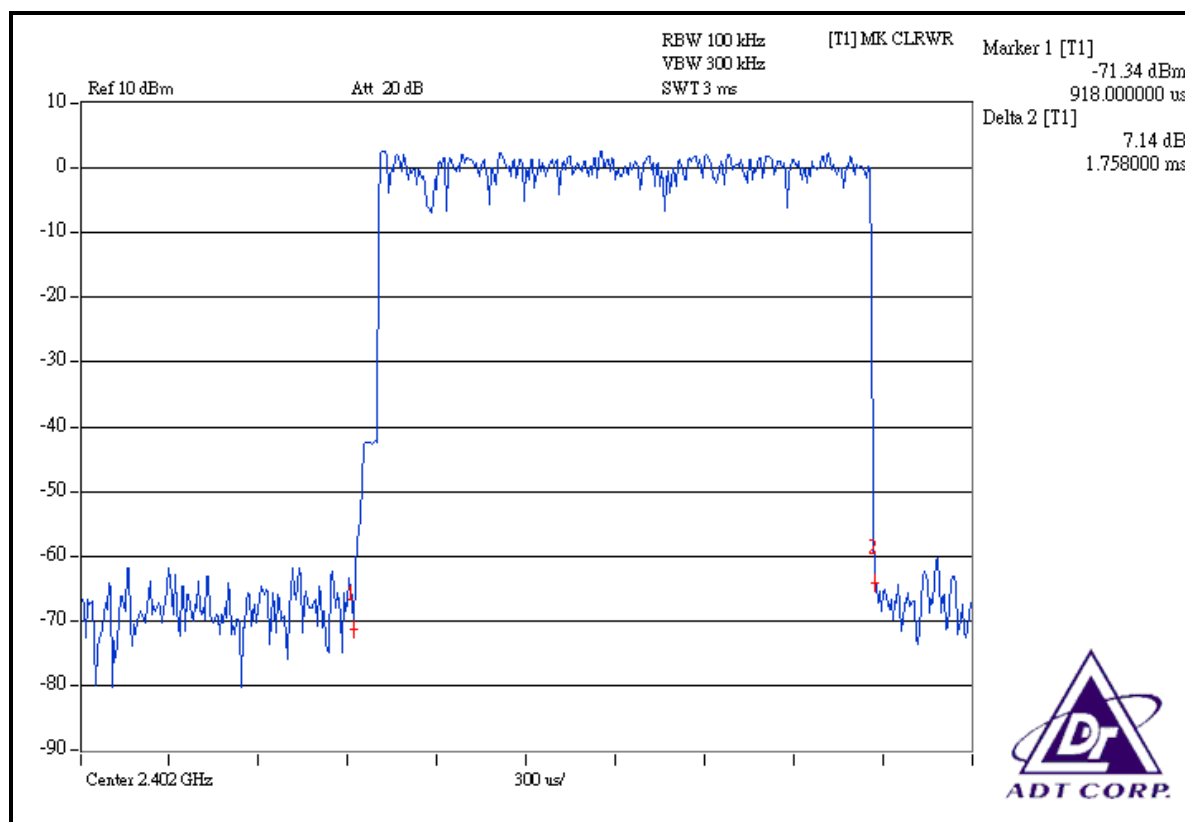
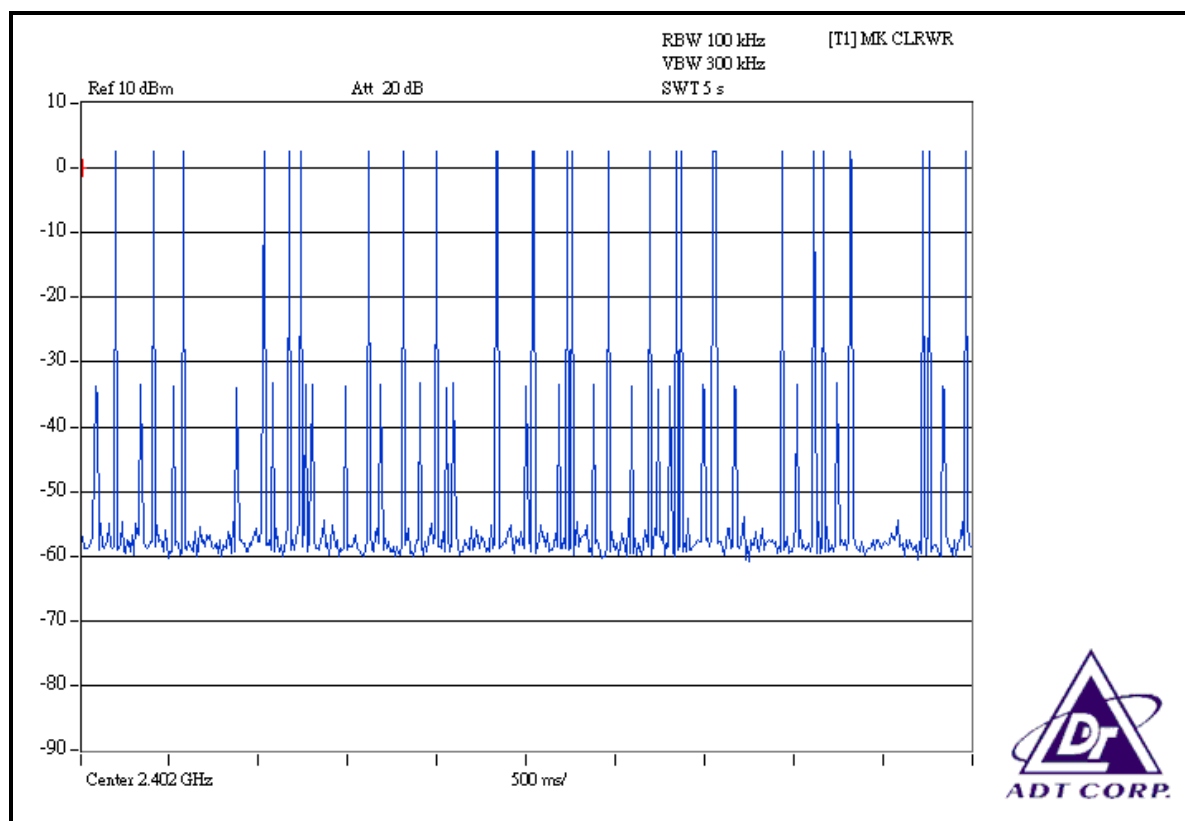
**NOTE:** Test plots of the transmitting time slot are shown on next 2 pages.

# DH1





### DH3



## 4.5 CHANNEL BANDWIDTH

### 4.5.1 LIMITS OF CHANNEL BANDWIDTH

For frequency hopping system operating in the 2400-2483.5MHz, If the 20dB bandwidth of hopping channel is greater than 25kHz, 20dB bandwidth of hopping channel shall be a minimum limit for the hopping channel separation.

### 4.5.2 TEST INSTRUMENTS

| DESCRIPTION & MANUFACTURER | MODEL NO. | SERIAL NO. | CALIBRATED UNTIL |
|----------------------------|-----------|------------|------------------|
| SPECTRUM ANALYZER          | FSP 40    | 100036     | Mar. 13, 2008    |

**NOTE:** The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to NML/ROC and NIST/USA.

### 4.5.3 TEST PROCEDURE

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
- Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
- Repeat above procedures until all frequencies measured were complete.

#### 4.5.4 DEVIATION FROM TEST STANDARD

No deviation.

#### 4.5.5 TEST SETUP



#### 4.5.6 EUT OPERATING CONDITION

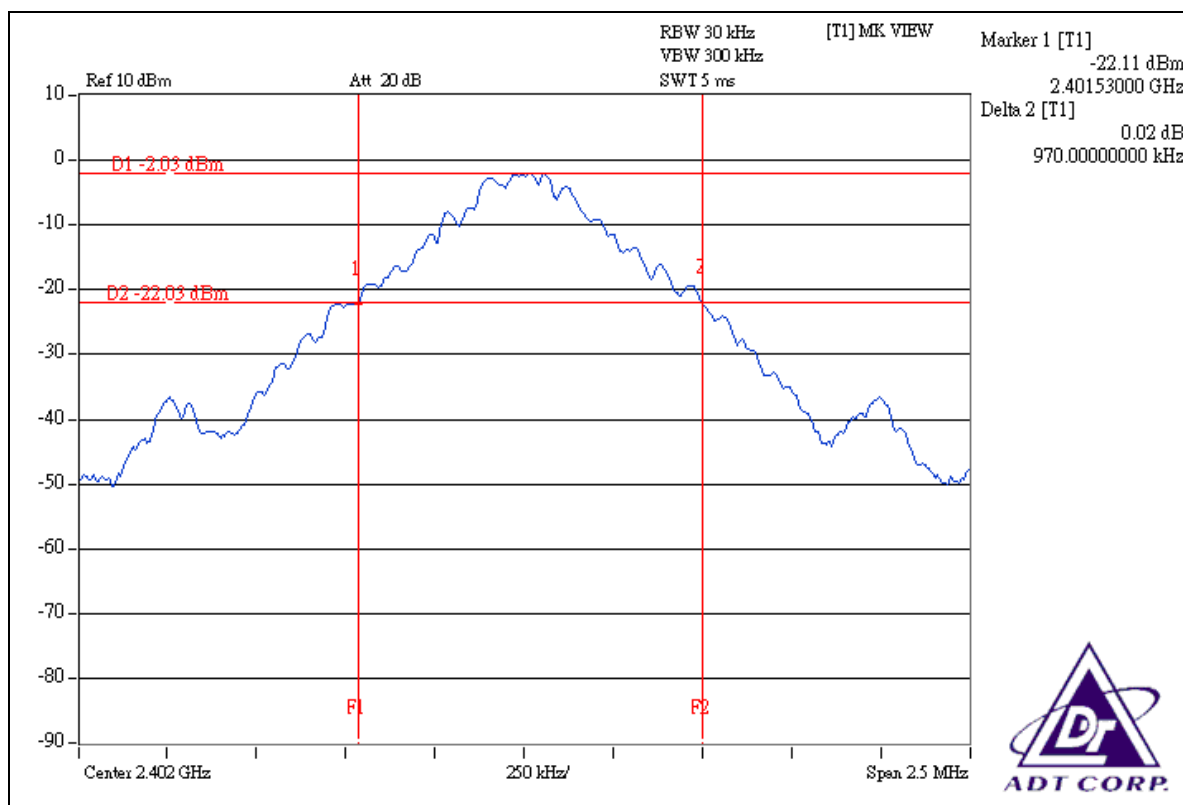
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

#### 4.5.7 TEST RESULTS

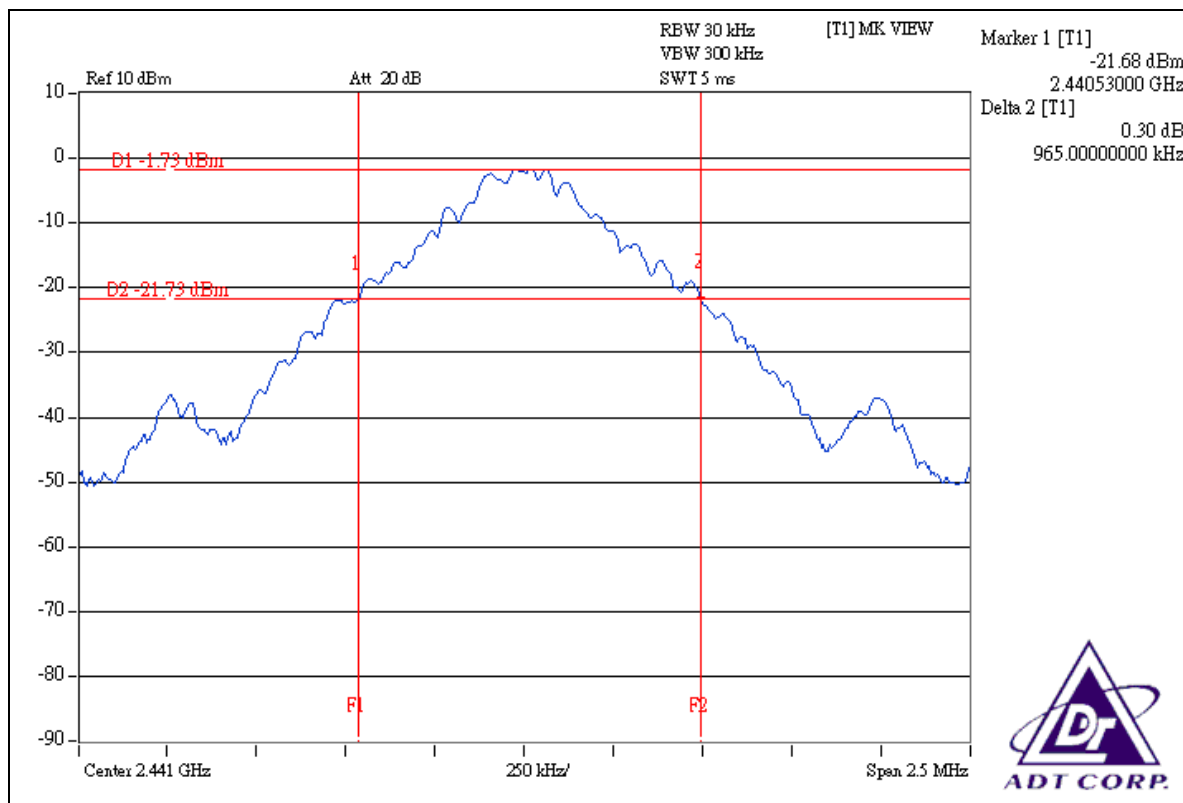
|                        |              |                                 |                           |
|------------------------|--------------|---------------------------------|---------------------------|
| <b>MODULATION TYPE</b> | GFSK         | <b>CHANNEL</b>                  | 0, 39, 78                 |
| <b>INPUT POWER</b>     | 3Vdc         | <b>ENVIRONMENTAL CONDITIONS</b> | 23 deg. C, 70%RH, 1007hPa |
| <b>TESTED BY</b>       | Jamison Chan |                                 |                           |

| <b>CHANNEL</b> | <b>CHANNEL FREQUENCY (MHz)</b> | <b>20dB BANDWIDTH (MHz)</b> |
|----------------|--------------------------------|-----------------------------|
| 0              | 2402                           | 0.970                       |
| 39             | 2441                           | 0.965                       |
| 78             | 2480                           | 0.965                       |

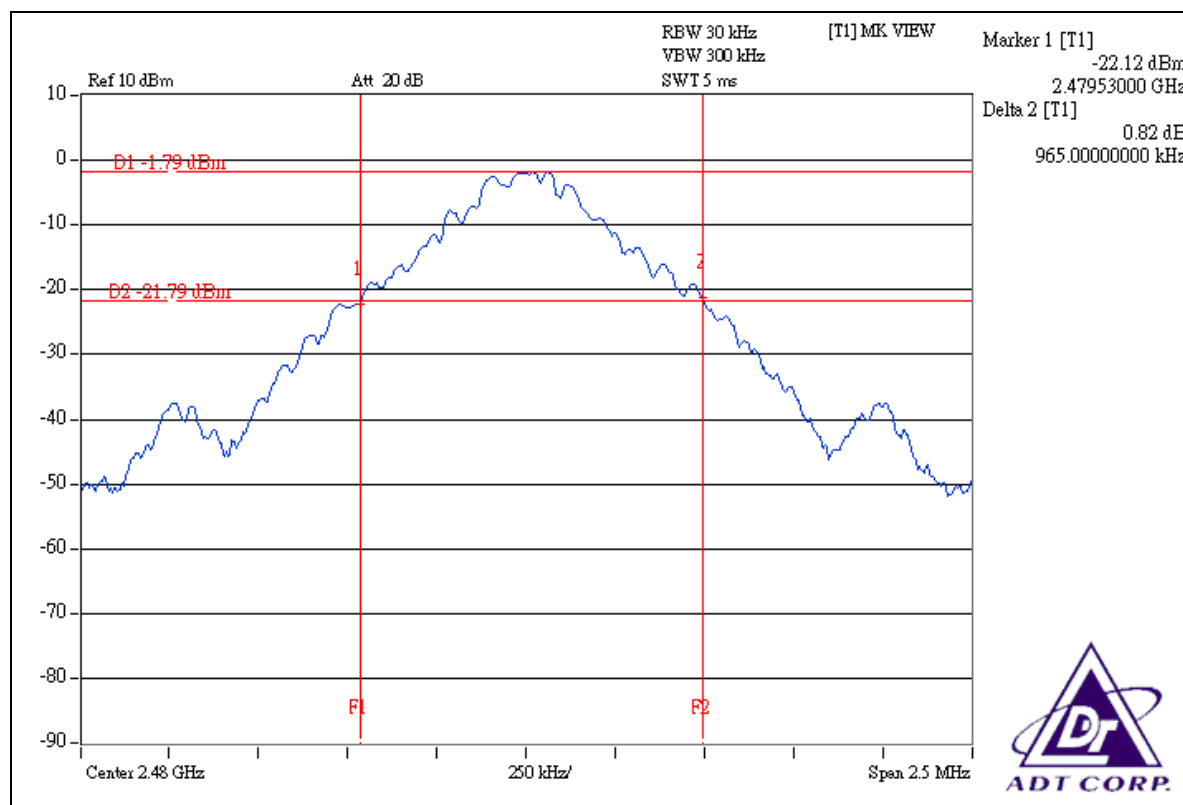
## CH 0



## CH 39



# CH 78



## 4.6 HOPPING CHANNEL SEPARATION

### 4.6.1 LIMIT OF HOPPING CHANNEL SEPARATION

At least 25kHz or 20dB hopping channel bandwidth (whichever is greater).

### 4.6.2 TEST INSTRUMENTS

| DESCRIPTION & MANUFACTURER | MODEL NO. | SERIAL NO. | CALIBRATED UNTIL |
|----------------------------|-----------|------------|------------------|
| SPECTRUM ANALYZER          | FSP 40    | 100036     | Mar. 13, 2008    |

**NOTES:** The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to NML/ROC and NIST/USA.

### 4.6.3 TEST PROCEDURES

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the MaxHold function record the separation of two adjacent channels.
4. Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

#### 4.6.4 DEVIATION FROM TEST STANDARD

No deviation.

#### 4.6.5 TEST SETUP



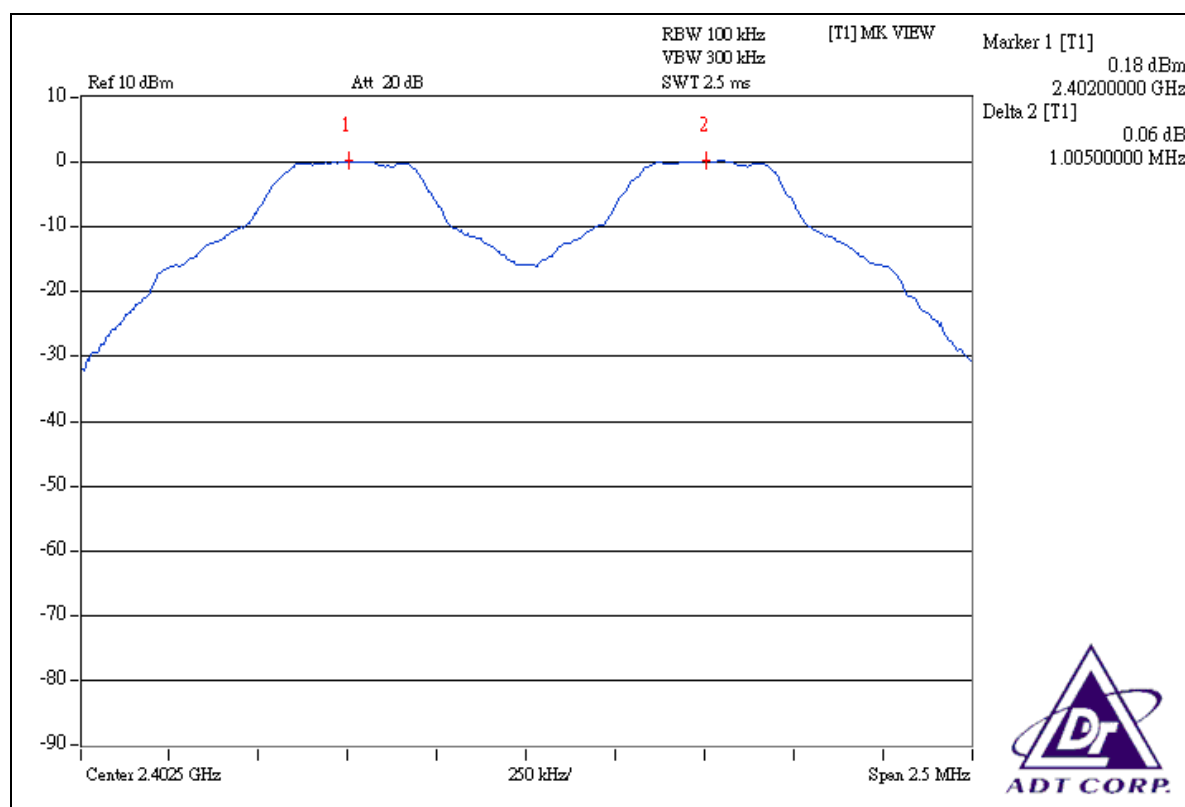
#### 4.6.6 TEST RESULTS

|                        |              |                                 |                           |
|------------------------|--------------|---------------------------------|---------------------------|
| <b>MODULATION TYPE</b> | GFSK         | <b>CHANNEL</b>                  | 0, 39, 78                 |
| <b>INPUT POWER</b>     | 3Vdc         | <b>ENVIRONMENTAL CONDITIONS</b> | 23 deg. C, 70%RH, 1007hPa |
| <b>TESTED BY</b>       | Jamison Chan |                                 |                           |

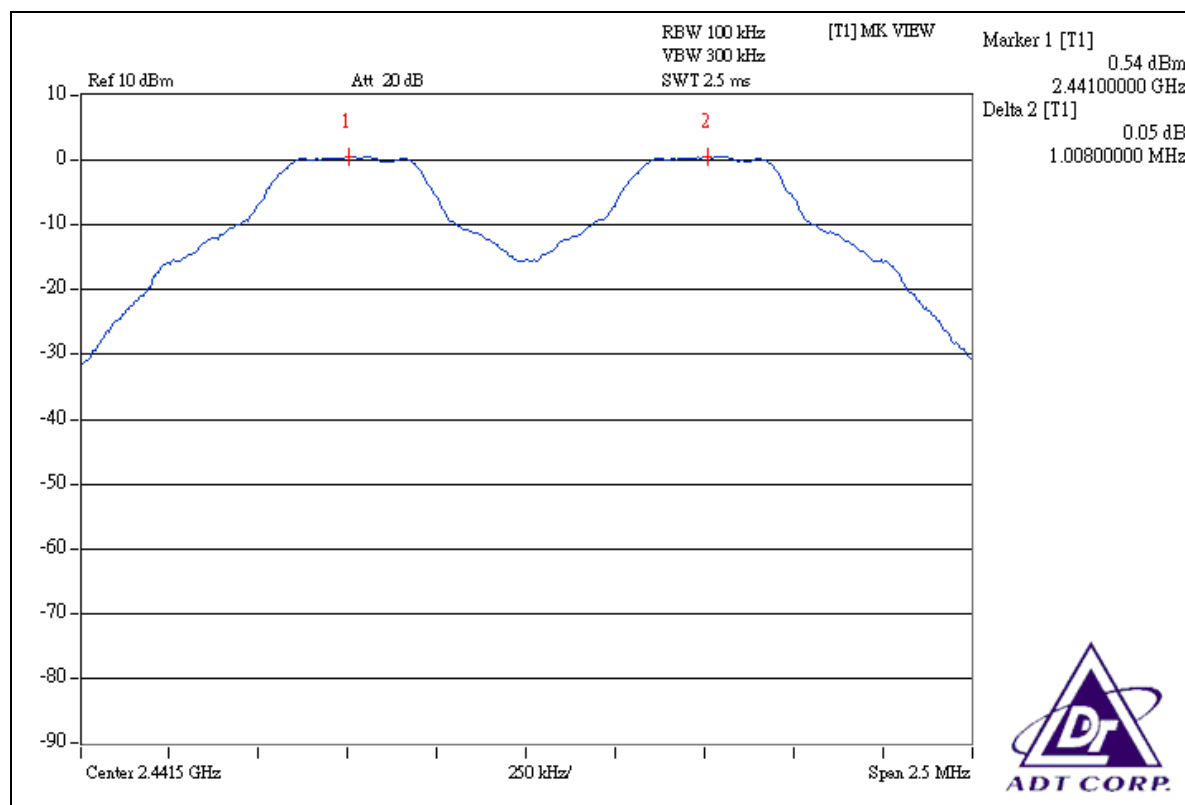
| CHANNEL | FREQUENCY (MHz) | ADJACENT CHANNEL SEPARATION (MHz) | MINIMUM LIMIT (MHz) | PASS / FAIL |
|---------|-----------------|-----------------------------------|---------------------|-------------|
| 0       | 2402            | 1.005                             | 0.970               | PASS        |
| 39      | 2441            | 1.008                             | 0.965               | PASS        |
| 78      | 2480            | 1.007                             | 0.965               | PASS        |

**NOTE:** The minimum limit is 20dB bandwidth. Test results please refer to next two pages.

# CH 0

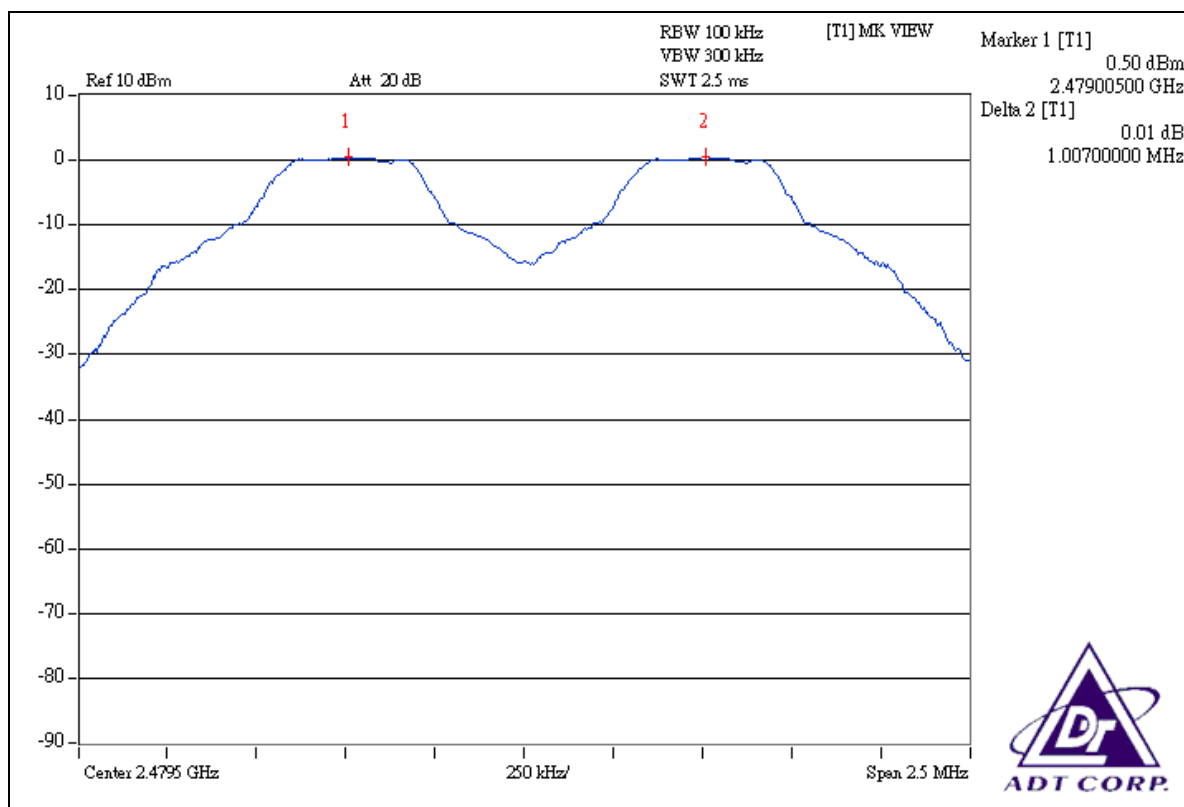


# CH 39





# CH 78



## 4.7 MAXIMUM PEAK OUTPUT POWER

### 4.7.1 LIMITS OF MAXIMUM PEAK OUTPUT POWER MEASUREMENT

The Maximum Peak Output Power Measurement is 30dBm.

### 4.7.2 TEST INSTRUMENTS

| DESCRIPTION & MANUFACTURER | MODEL NO. | SERIAL NO. | CALIBRATED UNTIL |
|----------------------------|-----------|------------|------------------|
| SPECTRUM ANALYZER          | FSP 40    | 100036     | Mar. 13, 2008    |

**NOTE:** The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.

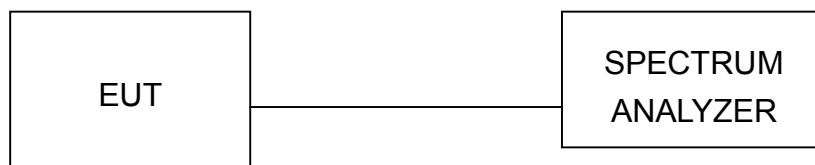
### 4.7.3 TEST PROCEDURES

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
- The center frequency of the spectrum analyzer is set to the fundamental frequency and using 3 MHz RBW and 10 MHz VBW.
- Measure the captured power within the band and recording the plot.
- Repeat above procedures until all frequencies required were complete.

### 4.7.4 DEVIATION FROM TEST STANDARD

No deviation

#### 4.7.5 TEST SETUP



For the actual test configuration, please refer to the related Item – Photographs of the Test Configuration.

#### 4.7.6 EUT OPERATING CONDITION

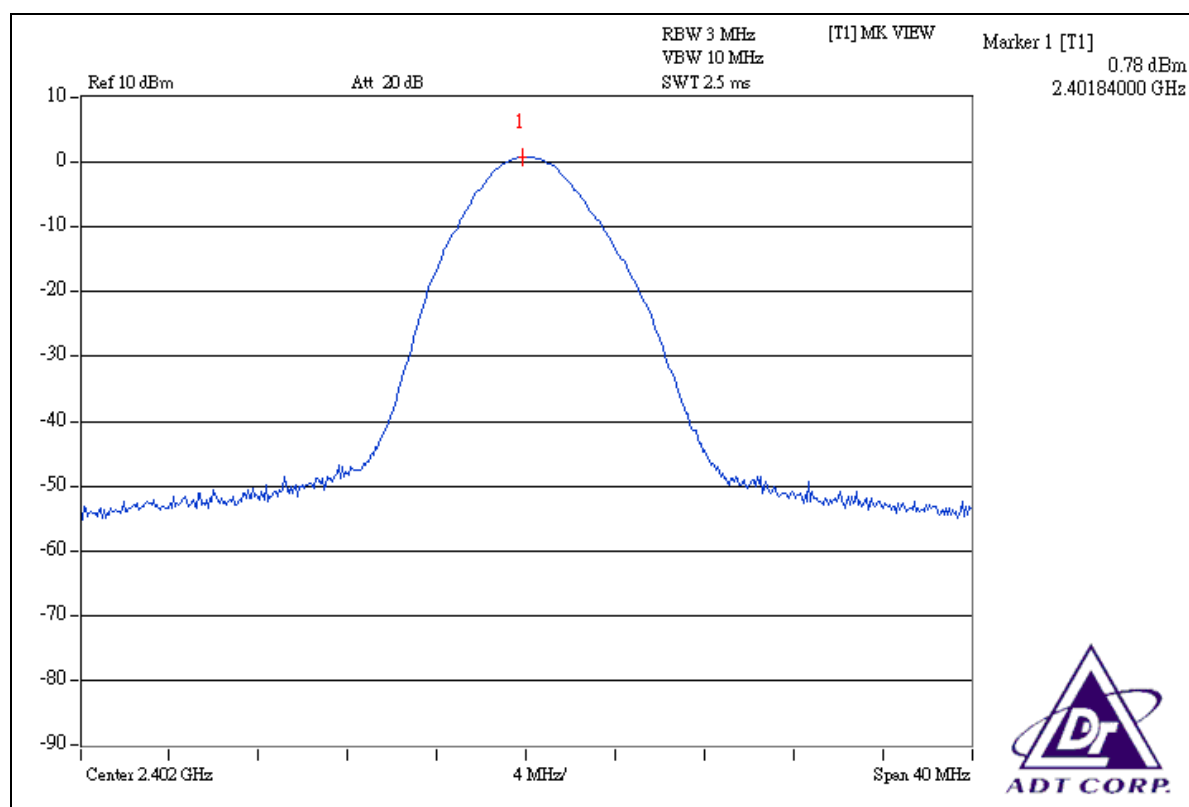
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

#### 4.7.7 TEST RESULTS

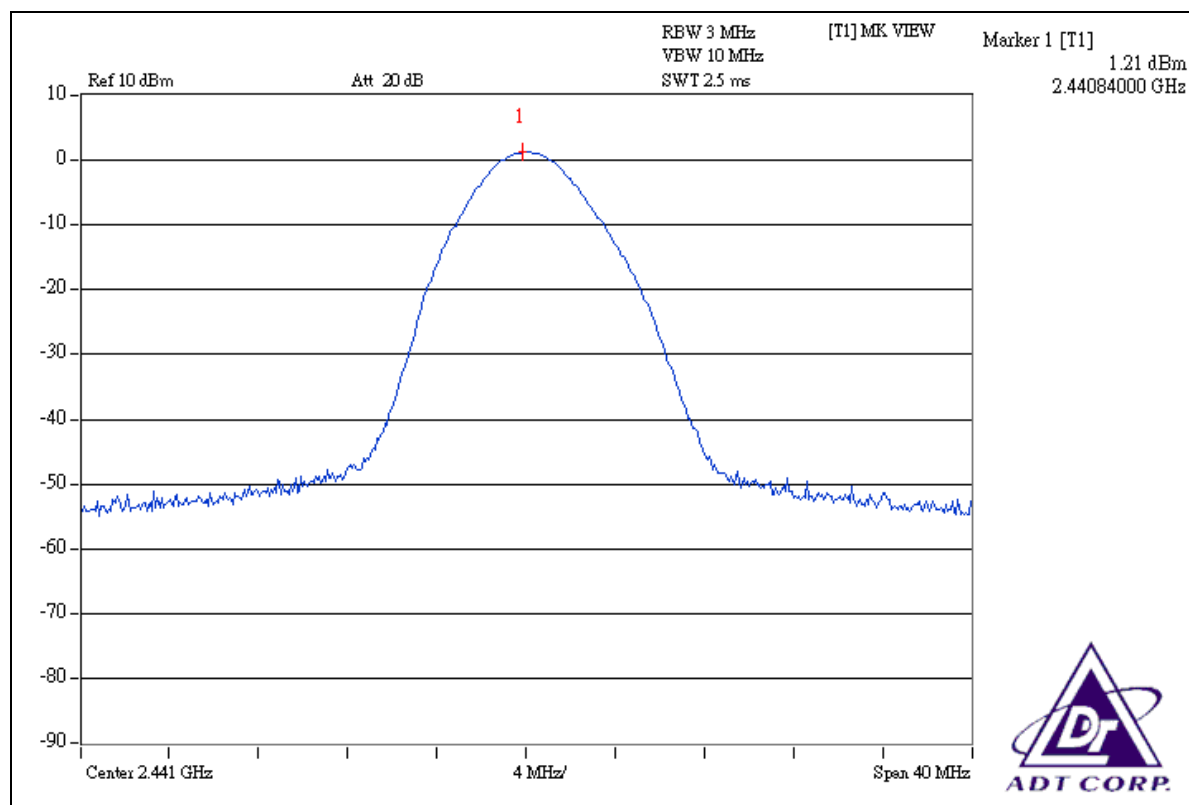
|                        |              |                                 |                           |
|------------------------|--------------|---------------------------------|---------------------------|
| <b>MODULATION TYPE</b> | GFSK         | <b>CHANNEL</b>                  | 0, 39, 78                 |
| <b>INPUT POWER</b>     | 3Vdc         | <b>ENVIRONMENTAL CONDITIONS</b> | 23 deg. C, 70%RH, 1007hPa |
| <b>TESTED BY</b>       | Jamison Chan |                                 |                           |

| CHANNEL | CHANNEL FREQUENCY (MHz) | PEAK POWER OUTPUT (mW) | PEAK POWER OUTPUT (dBm) | PEAK POWER LIMIT (dBm) | PASS/FAIL |
|---------|-------------------------|------------------------|-------------------------|------------------------|-----------|
| 0       | 2402                    | 1.197                  | 0.78                    | 30                     | PASS      |
| 39      | 2441                    | 1.321                  | 1.21                    | 30                     | PASS      |
| 78      | 2480                    | 1.312                  | 1.18                    | 30                     | PASS      |

## CH 0



## CH 39





## 4.8 BAND EDGES MEASUREMENT

### 4.8.1 LIMITS OF BAND EDGES MEASUREMENT

Below -20dB of the highest emission level of operating band (in 100KHz RBW).

### 4.8.2 TEST INSTRUMENTS

| DESCRIPTION & MANUFACTURER | MODEL NO. | SERIAL NO. | CALIBRATED UNTIL |
|----------------------------|-----------|------------|------------------|
| SPECTRUM ANALYZER          | FSP 40    | 100036     | Mar. 13, 2008    |

**NOTES:** The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to NML/ROC and NIST/USA.

### 4.8.3 TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer via a low loss cable. Set both RBW and VBW of spectrum analyzer to 100 kHz with suitable frequency span including 300 MHz bandwidth from band edge. The band edges was measured and recorded.

### 4.8.4 DEVIATION FROM TEST STANDARD

No deviation.

### 4.8.5 EUT OPERATING CONDITION

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

## 4.8.6 TEST RESULTS

The spectrum plots are attached on the following 4 images. D1 line indicates the highest level, D2 line indicates the 20dB offset below D1. It shows compliance with the requirement in part 15.247(d).

### NOTE 1:

The band edge emission plot on the next page shows 58.83dBc between carrier maximum power and local maximum emission in restrict band (2.3166GHz). The emission of carrier strength list in the test result of channel 0 at the item 4.2.7 is 93.10dBuV/m (Peak), so the maximum field strength in restrict band is  $93.10 - 58.83 = 34.27$  dBuV/m, which is under 74 dBuV/m limit.

Average value =  $34.27 - 34.50 = -0.23$  dBuV/m, which is under 54dBuV/m limit.

\*The DH3 packet was the worse case duty cycle for a transmit dwell time on a channel, based upon bluetooth theory the transmitter is on  $0.625 * 3$  per 247 ms per channel. Therefore, the duty cycle be equal to:  $20\log(1.875/100) = -34.5$  dB.

Average value = peak reading - 34.5.

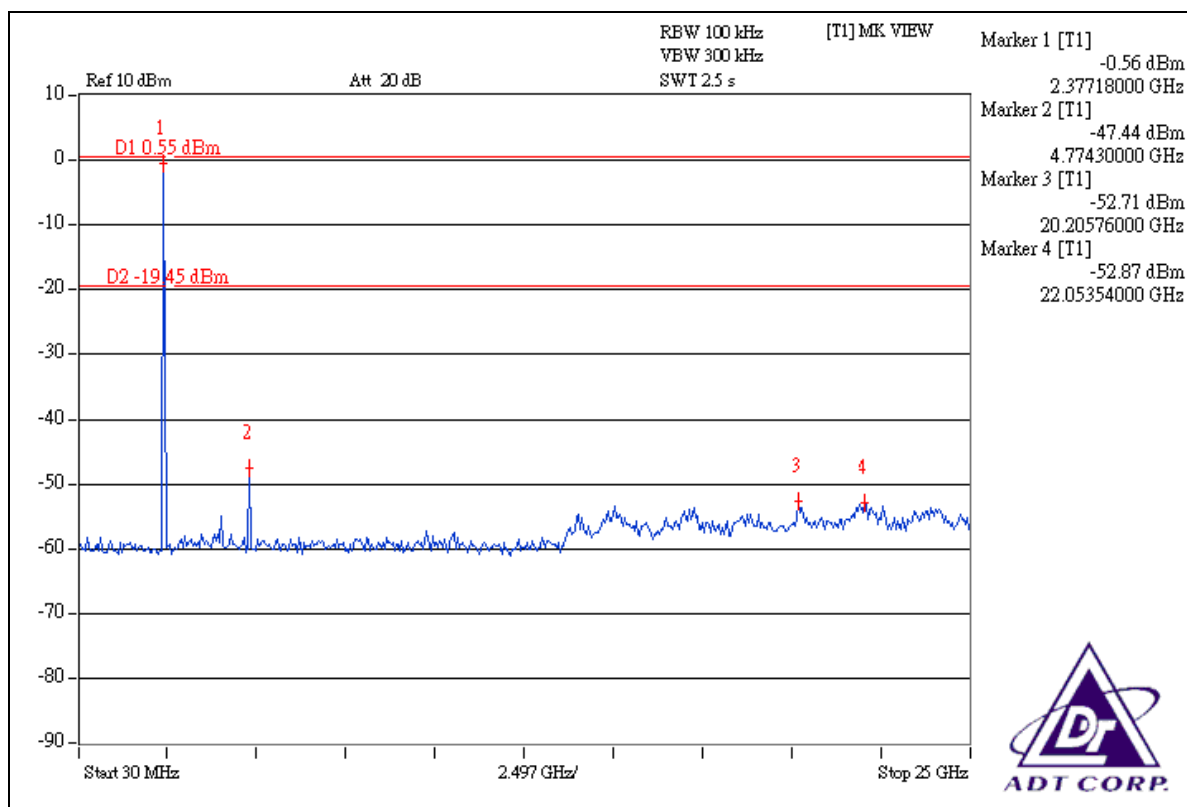
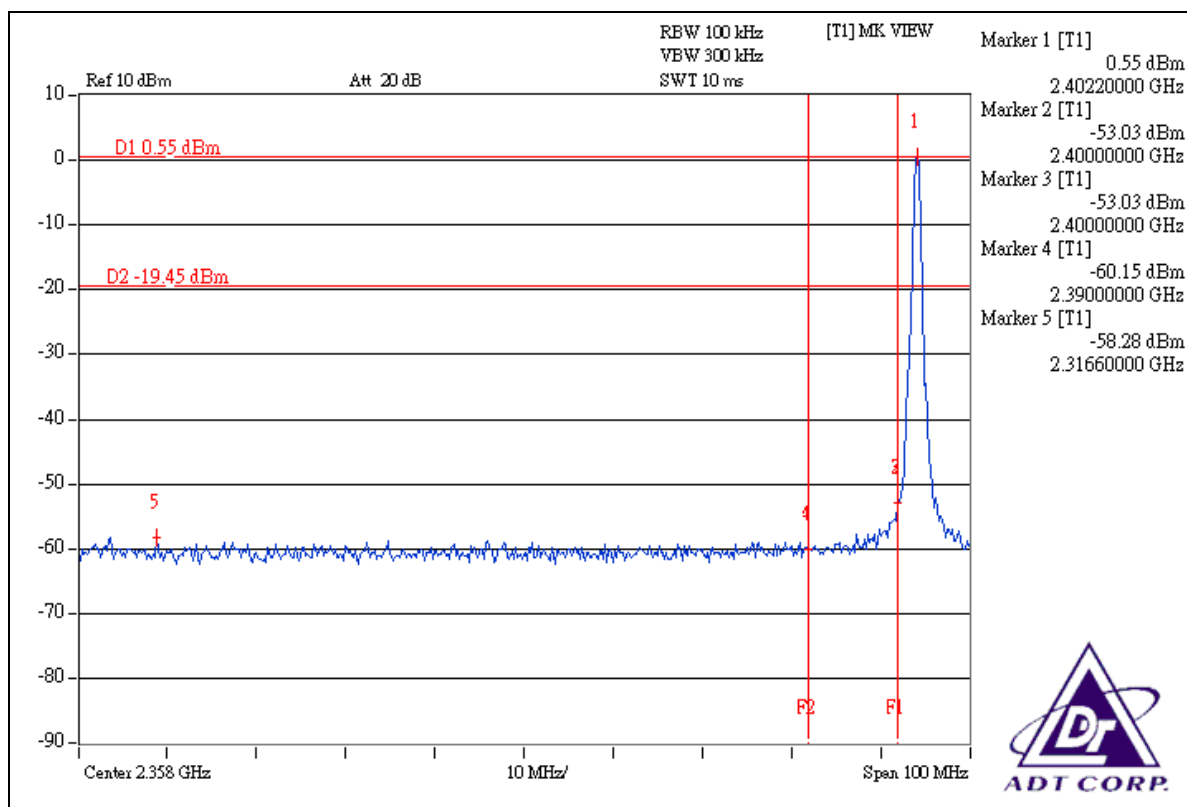
### NOTE 2:

The band edge emission plot on the next second page shows 57.74dBc between carrier maximum power and local maximum emission in restrict band (2.4848GHz). The emission of carrier strength list in the test result of channel 78 at the item 4.2.7 is 95.55dBuV/m (Peak), so the maximum field strength in restrict band is  $95.55 - 57.74 = 37.81$  dBuV/m, which is under 74 dBuV/m limit.

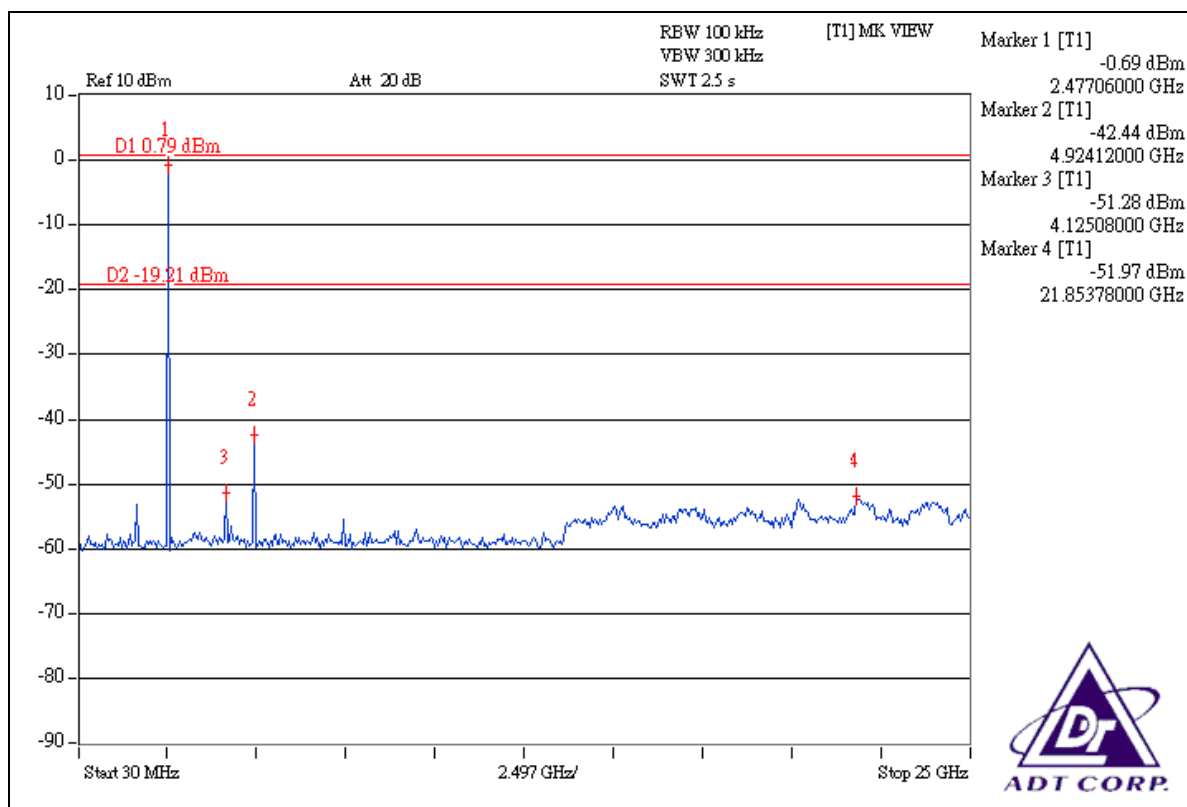
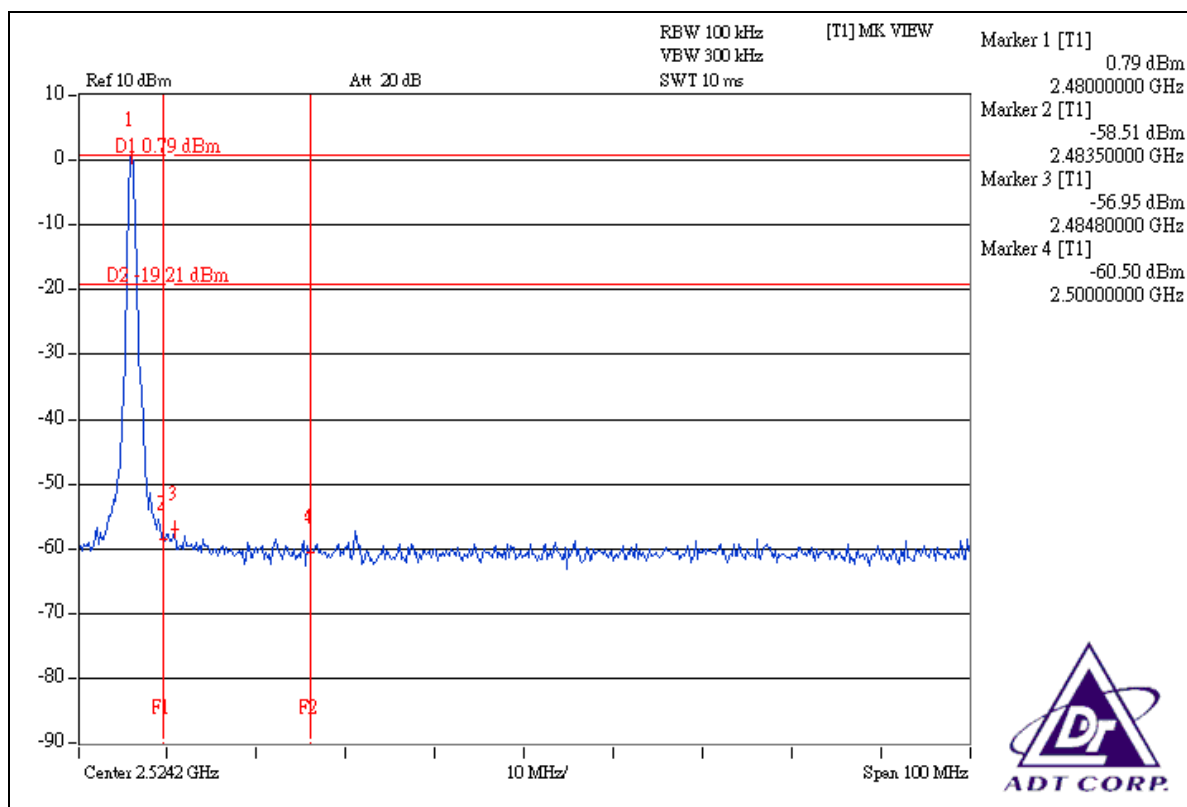
Average value =  $37.81 - 34.50 = 3.31$  dBuV/m, which is under 54dBuV/m limit.

\*The DH3 packet was the worse case duty cycle for a transmit dwell time on a channel, based upon bluetooth theory the transmitter is on  $0.625 * 3$  per 247 ms per channel. Therefore, the duty cycle be equal to:  $20\log(1.875/100) = -34.5$  dB.

Average value = peak reading - 34.5.







## **4.9 ANTENNA REQUIREMENT**

### **4.9.1 STANDARD APPLICABLE**

For intentional device, according to FCC 47 CFR 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.

And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### **4.9.2 ANTENNA CONNECTED CONSTRUCTION**

The antenna used in this product is Printed antenna without antenna connector. The maximum gain of this antenna is -3.66dBi.

## 5. PHOTOGRAPHS OF THE TEST CONFIGURATION

Please refer to the attached file (Test Setup Photo).

## 6. INFORMATION ON THE TESTING LABORATORIES

We, ADT Corp., were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

|                    |                       |
|--------------------|-----------------------|
| <b>USA</b>         | FCC, UL, A2LA         |
| <b>Germany</b>     | TUV Rheinland         |
| <b>Japan</b>       | VCCI                  |
| <b>Norway</b>      | NEMKO                 |
| <b>Canada</b>      | INDUSTRY CANADA , CSA |
| <b>R.O.C.</b>      | TAF, BSMI, NCC        |
| <b>Netherlands</b> | Telefication          |
| <b>Singapore</b>   | GOST-ASIA(MOU)        |
| <b>Russia</b>      | CERTIS(MOU)           |

Copies of accreditation certificates of our laboratories obtained from approval agencies can be downloaded from our web site:

[www.adt.com.tw/index.5/phtml](http://www.adt.com.tw/index.5/phtml). If you have any comments, please feel free to contact us at the following:

**Linko EMC/RF Lab:**  
Tel: 886-2-26052180  
Fax: 886-2-26051924

**Hsin Chu EMC/RF Lab:**  
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Fax: 886-3-5935342

**Hwa Ya EMC/RF/Safety Telecom Lab:**  
Tel: 886-3-3183232  
Fax: 886-3-3185050

**Web Site:** [www.adt.com.tw](http://www.adt.com.tw)

The address and road map of all our labs can be found in our web site also.

## **7. APPENDIX A – MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB**

No any modifications are made to the EUT by the lab during the test.