



# Varient IC RF Test Report

**APPLICANT** : Texas Instruments Incorporated  
**EQUIPMENT** : WiFi and Bluetooth Module  
**BRAND NAME** : Texas Instruments  
**MODEL NAME** : WL18MODGB  
**IC** : 451I-WL18SBMOD  
**STANDARD** : IC RSS-247 issue 1

The product was received on Oct. 23, 2014 and testing was completed on Aug. 14, 2015. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

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Reviewed by: Joseph Lin / Supervisor

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Approved by: Jones Tsai / Manager



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IC : 451I-WL18SBMOD

Page Number : 1 of 22

Report Issued Date : Aug. 28, 2015

Report Version : Rev. 01

Report Template No.: BU5-CR247BT Version 1.0



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## REVISION HISTORY

| REPORT NO. | VERSION | DESCRIPTION  | ISSUED DATE   |
|------------|---------|--|---------------|
| CR4O2349A  | Rev. 01 | This is a variant report by adding 6 new antennas.<br>All the test cases were performed on original report which can be referred to Sporton Report Number CR3N2752-01ATX. Based on the original report, only the peak output power and conducted spurious emission and cabinet radiation were performed. | Aug. 28, 2015 |
|            |         |  |               |
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## SUMMARY OF TEST RESULT

| Report Section | IC Rule           | Description  | Limit                 | Result | Remark                                   |
|----------------|-------------------|--|-----------------------|--------|--|
| 3.1            | RSS-247<br>5.4(2) | Peak Output Power  | $\leq 125$ mW         | Pass   | -  |
| 3.2            | RSS-247<br>5.5    | Radiated Band Edges<br>and Radiated Spurious<br>Emission | 15.209(a) & 15.247(d) | Pass   | Under limit<br>9.23 dB at<br>216.840 MHz |
| 3.3            | N/A               | Antenna Requirement                                      | N/A                   | Pass   | -  |



# 1 General Description

## 1.1 Applicant

**Texas Instruments Incorporated**

12500 TI Boulevard, M/S 8751, Dallas, TX 75243, USA

## 1.2 Manufacturer

**Jorjin Technologies Inc**

17F, No.239, Sec. 1, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan

## 1.3 Product Feature of Equipment Under Test

| Product Feature                 |   |
|---------------------------------|---|
| Equipment                       | WiFi and Bluetooth Module                       |
| Brand Name                      | Texas Instruments                               |
| Model Name                      | WL18MODGB                                       |
| IC                              | 451I-WL18SBMOD                                  |
| EUT supports Radios application | WLAN 11b/g/n HT20/HT40<br>Bluetooth v4.0 EDR/LE |
| EUT Stage                       | Identical Prototype                             |

**Remark:** The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

## 1.4 Product Specification subjective to this standard

| Product Specification subjective to this standard |  |
|---|--|
| <b>Tx/Rx Frequency Range</b>                      | 2402 MHz ~ 2480 MHz  |
| <b>Number of Channels</b>                         | 79   |
| <b>Carrier Frequency of Each Channel</b>          | 2402+n*1 MHz; n=0~78   |
| <b>Maximum Output Power to Antenna</b>            | Bluetooth BR(1Mbps) : 11.90 dBm (0.0155 W)<br>Bluetooth EDR (2Mbps) : 9.78 dBm (0.0095 W)<br>Bluetooth EDR (3Mbps) : 9.85 dBm (0.0097 W) |
| <b>Type of Modulation</b>                         | Bluetooth BR (1Mbps) : GFSK<br>Bluetooth EDR (2Mbps) : $\pi/4$ -DQPSK<br>Bluetooth EDR (3Mbps) : 8-DPSK                                  |

| Antenna Information |              |               |
|---------------------|--------------|---------------|
| Antenna Type        | Brand        | 2.4GHz~2.5GHz |
| PCB                 | Ethertronics | -0.6          |
| Dipole              | LSR          | 2             |
| PCB                 | Laird        | 2             |
| Chip                | Pulse        | 3.2           |
| PIFA                | LSR          | 2             |

## 1.5 Modification of EUT

No modifications are made to the EUT during all test items.

## 1.6 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW1022 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

|                           |  |  |
|---------------------------|--|--|
| <b>Test Site</b>          | SPORTON INTERNATIONAL INC.   |  |
| <b>Test Site Location</b> | No. 52, Hwa Ya 1 <sup>st</sup> Rd., Hwa Ya Technology Park,<br>Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C.<br>TEL: +886-3-327-3456<br>FAX: +886-3-328-4978 |  |
| <b>Test Site No.</b>      | <b>Sporton Site No.</b>  |  |
|                           | TH05-HY  |  |

|                           |   |                            |
|---------------------------|---|----------------------------|
| <b>Test Site</b>          | SPORTON INTERNATIONAL INC.  |                            |
| <b>Test Site Location</b> | No. 58 , Aly. 75, Ln. 564, Wenhua 3rd Rd.,<br>Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C.<br>TEL: +886-3-327-0855 |                            |
| <b>Test Site No.</b>      | <b>Sporton Site No.</b>   | <b>IC Registration No.</b> |
|                           | 03CH10  | 4086H-1                    |

**Note:** The test site complies with ANSI C63.4 2009 requirement.

## 1.7 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ ANSI C63.10-2013

### Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. FCC permits the use of the 1.5 meter table as an alternative in C63.10-2013 through inquiry tracking number 961829.
3. This EUT has also been tested and complied with the requirements of ICES003, Subpart B, recorded in a separate test report.

## 2 Test Configuration of Equipment Under Test

### 2.1 Descriptions of Test Mode

Preliminary tests were performed in different data rates and recorded the RF output power in the following table:

| Channel | Frequency | Bluetooth RF Output Power |                |          |
|---------|-----------|---------------------------|----------------|----------|
|         |           | Data Rate / Modulation    |                |          |
|         |           | GFSK                      | $\pi$ /4-DQPSK | 8-DPSK   |
|         |           | 1Mbps                     | 2Mbps          | 3Mbps    |
| Ch00    | 2402MHz   | 11.90 dBm                 | 9.78 dBm       | 9.85 dBm |
| Ch39    | 2441MHz   | 11.37 dBm                 | 9.39 dBm       | 9.58 dBm |
| Ch78    | 2480MHz   | 11.50 dBm                 | 9.31 dBm       | 9.34 dBm |

**Remark:**

1. All the test data for each data rate were verified, but only the worst case was reported.
2. The data rate was set in 1Mbps for all the test items due to the highest RF output power.

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower).



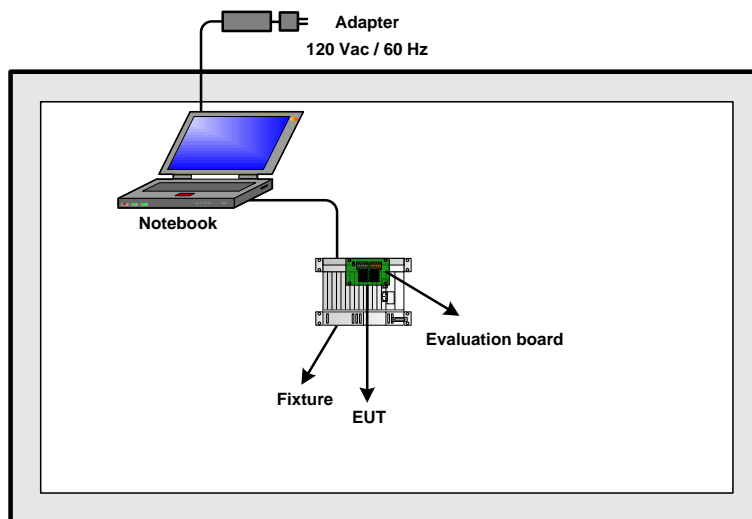
## 2.2 Test Mode

The following summary table is showing all test modes to demonstrate in compliance with the standard.

| Summary table of Test Cases   |                            |                                       |                               |
|---|----------------------------|---------------------------------------|-------------------------------|
| Test Item   | Data Rate / Modulation     |                                       |                               |
|   | Bluetooth BR 1Mbps<br>GFSK | Bluetooth EDR 2Mbps<br>$\pi/4$ -DQPSK | Bluetooth EDR 3Mbps<br>8-DPSK |
| Conducted<br>Test Cases   | Mode 1: CH00_2402 MHz      | Mode 4: CH00_2402 MHz                 | Mode 7: CH00_2402 MHz         |
|   | Mode 2: CH39_2441 MHz      | Mode 5: CH39_2441 MHz                 | Mode 8: CH39_2441 MHz         |
|   | Mode 3: CH78_2480 MHz      | Mode 6: CH78_2480 MHz                 | Mode 9: CH78_2480 MHz         |
| Radiated<br>Test Cases  | Bluetooth BR 1Mbps GFSK    |                                       |                               |
|   | Mode 1: CH00_2402 MHz      |                                       |                               |
|   | Mode 2: CH39_2441 MHz      |                                       |                               |
|   | Mode 3: CH78_2480 MHz      |                                       |                               |
| Remark:   |                            |                                       |                               |
| For radiated test cases, the worst mode data rate 1Mbps was reported only, because this data rate has the highest RF output power at preliminary tests, and the conducted spurious emissions and conducted band edge measurement for each data rate are no worse than 1Mbps, and no other significantly frequencies found in conducted spurious emission. |                            |                                       |                               |

## 2.3 Connection Diagram of Test System

<Bluetooth Tx Mode>



## 2.4 Support Unit used in test configuration and system

| Item | Equipment | Trade Name | Model Name                       | FCC ID                                      | Data Cable | Power Cord   |
|------|-----------|------------|----------------------------------|---|------------|--|
| 1.   | Notebook  | Lenovo     | E335 (with WiFi module TP00034A) | FCC DoC/<br>Contains FCC<br>ID:QDS-BRCM1058 | N/A        | AC I/P:<br>Unshielded, 1.2 m<br>DC O/P:<br>Shielded, 1.8 m |

## 2.5 EUT Operation Test Setup

For Bluetooth function, programmed RF utility, "HCI Tester" installed in the notebook make the EUT provide functions like channel selection and power level for continuous transmitting and receiving signals.



## 2.6 Measurement Results Explanation Example

**For all conducted test items:**

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

*Offset = RF cable loss + attenuator factor.*

Following shows an offset computation example with cable loss 4.2 dB and 10dB attenuator.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 4.2 + 10 = 14.2 \text{ (dB)}\end{aligned}$$

### 3 Test Result

#### 3.1 Peak Output Power Measurement

##### 3.1.1 Limit of Peak Output Power

Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts. The power limit for 1Mbps is 1watt, and for 2Mbps, 3Mbps and AFH are 0.125 watts.

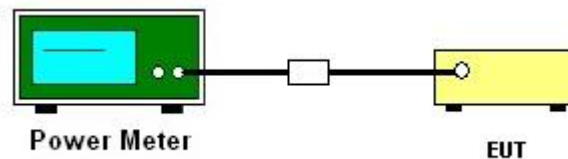
##### 3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

##### 3.1.3 Test Procedures

1. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power with cable loss and record the results in the test report.
5. Measure and record the results in the test report.

##### 3.1.4 Test Setup



### 3.1.5 Test Result of Peak Output Power

|                        |          |                            |           |
|------------------------|----------|----------------------------|-----------|
| <b>Test Mode :</b>     | 1Mbps    | <b>Temperature :</b>       | 24 - 26°C |
| <b>Test Engineer :</b> | Bill Kuo | <b>Relative Humidity :</b> | 48 – 51%  |

| Channel | Frequency<br>(MHz) | RF Power (dBm) |                      |           |
|---------|--------------------|----------------|----------------------|-----------|
|         |                    | GFSK           | Max. Limits<br>(dBm) | Pass/Fail |
|         |                    | 1 Mbps         |                      |           |
| 00      | 2402               | 11.90          | 20.97                | Pass      |
| 39      | 2441               | 11.37          | 20.97                | Pass      |
| 78      | 2480               | 11.50          | 20.97                | Pass      |

**Note:** For AFH mode using 20 hopping channels, the maximum output power limit is 20.97dBm.

|                        |          |                            |           |
|------------------------|----------|----------------------------|-----------|
| <b>Test Mode :</b>     | 2Mbps    | <b>Temperature :</b>       | 24 - 26°C |
| <b>Test Engineer :</b> | Bill Kuo | <b>Relative Humidity :</b> | 48 – 51%  |

| Channel | Frequency<br>(MHz) | RF Power (dBm) |                      |           |
|---------|--------------------|----------------|----------------------|-----------|
|         |                    | $\pi/4$ -DQPSK | Max. Limits<br>(dBm) | Pass/Fail |
|         |                    | 2 Mbps         |                      |           |
| 00      | 2402               | 9.78           | 20.97                | Pass      |
| 39      | 2441               | 9.39           | 20.97                | Pass      |
| 78      | 2480               | 9.31           | 20.97                | Pass      |

|                        |          |                            |           |
|------------------------|----------|----------------------------|-----------|
| <b>Test Mode :</b>     | 3Mbps    | <b>Temperature :</b>       | 24 - 26°C |
| <b>Test Engineer :</b> | Bill Kuo | <b>Relative Humidity :</b> | 48 – 51%  |

| Channel | Frequency<br>(MHz) | RF Power (dBm) |                      |           |
|---------|--------------------|----------------|----------------------|-----------|
|         |                    | 8-DPSK         | Max. Limits<br>(dBm) | Pass/Fail |
|         |                    | 3 Mbps         |                      |           |
| 00      | 2402               | 9.85           | 20.97                | Pass      |
| 39      | 2441               | 9.58           | 20.97                | Pass      |
| 78      | 2480               | 9.34           | 20.97                | Pass      |



## **3.2 Radiated Band Edges and Spurious Emission Measurement**

### **3.2.1 Limit of Radiated Band Edges and Spurious Emission**

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the FCC section 15.209 limits as below.

| <b>Frequency<br/>(MHz)</b> | <b>Field Strength<br/>(microvolts/meter)</b> | <b>Measurement Distance<br/>(meters)</b> |
|----------------------------|--|--|
| 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  |

### **3.2.2 Measuring Instruments**

The measuring equipment is listed in the section 4 of this test report.



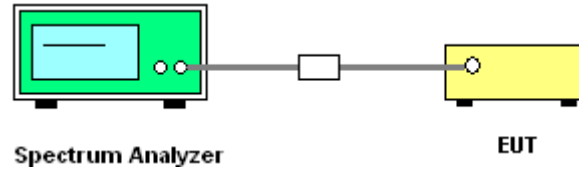
### 3.2.3 Test Procedures

1. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
4. Set to the maximum power setting and enable the EUT transmit continuously.
5. Use the following spectrum analyzer settings:
  - (1) Span shall wide enough to fully capture the emission being measured;
  - (2) Set RBW=100 kHz for  $f < 1 \text{ GHz}$ , RBW=1MHz for  $f > 1 \text{ GHz}$ ; VBW  $\geq$  RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
  - (3) For average measurement: use duty cycle correction factor method per 15.35(c).  
Duty cycle = On time/100 milliseconds  
On time =  $N_1 * L_1 + N_2 * L_2 + \dots + N_{n-1} * L_{n-1} + N_n * L_n$   
Where  $N_1$  is number of type 1 pulses,  $L_1$  is length of type 1 pulses, etc.  
Average Emission Level = Peak Emission Level +  $20 * \log(\text{Duty cycle})$
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level

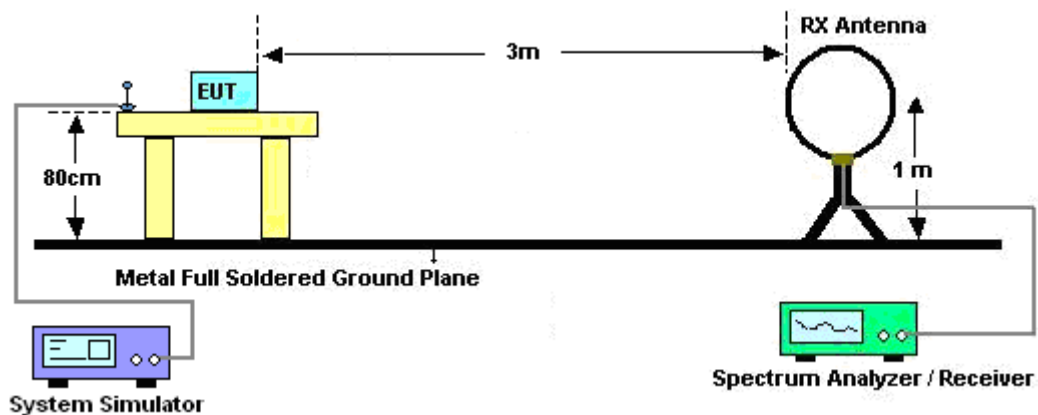
**Note:** The average levels were calculated from the peak level corrected with duty cycle correction factor (24.73dB) derived from  $20 \log (\text{dwell time}/100\text{ms})$ . This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

### 3.2.4 Test Setup

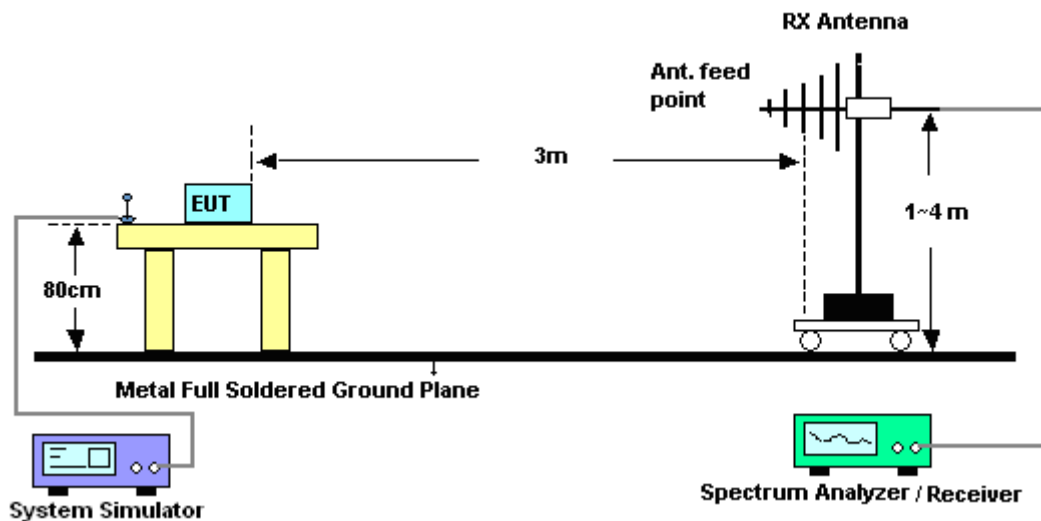
For Conducted Measurement Setup:



For radiated emissions below 30MHz

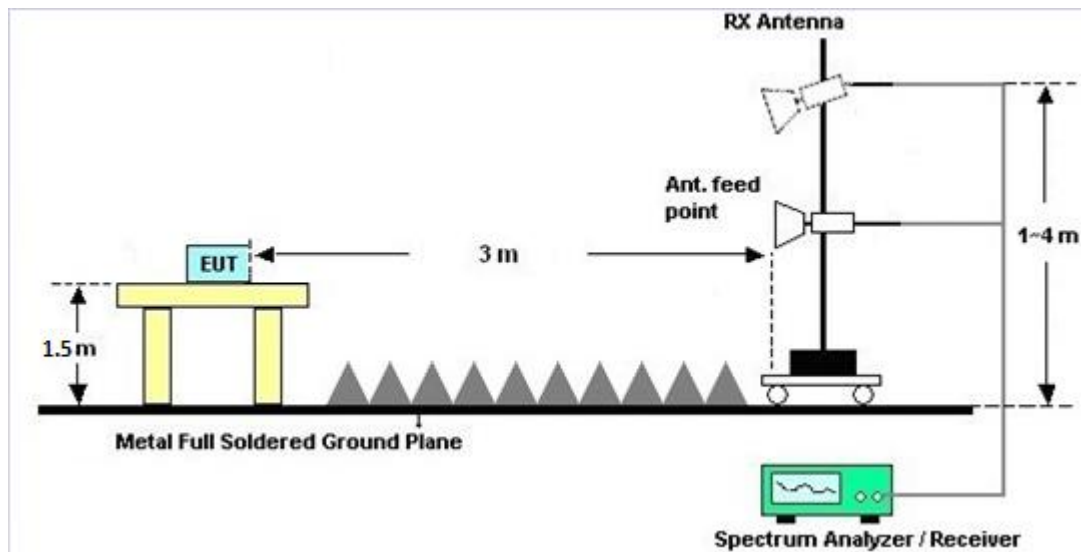


For radiated emissions from 30MHz to 1GHz





For radiated emissions above 1GHz



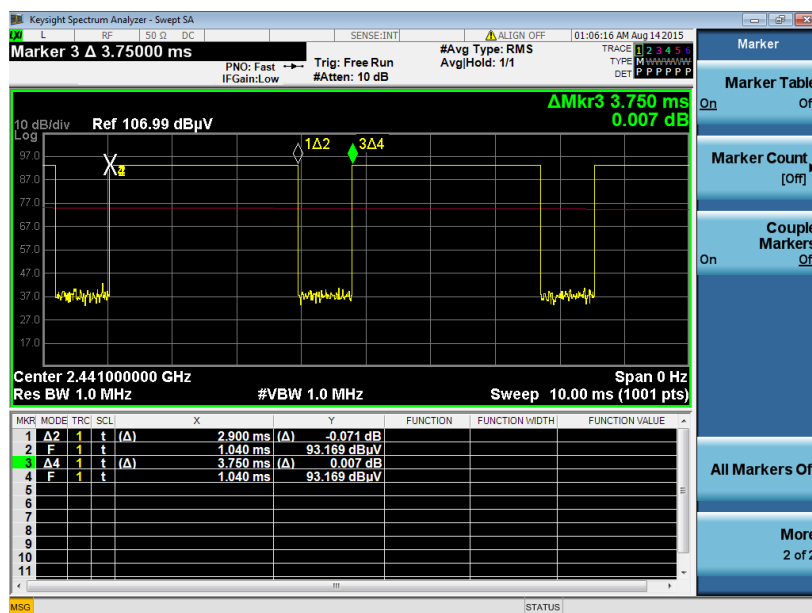
### 3.2.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

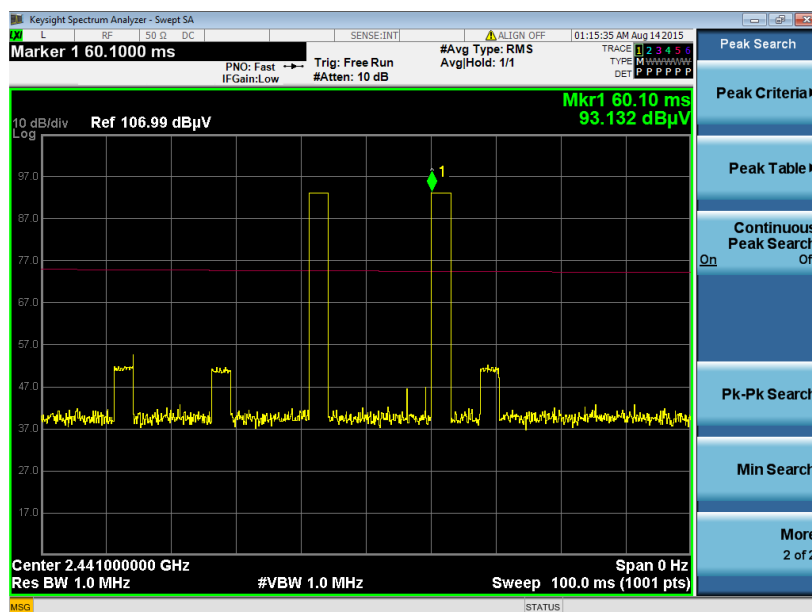


### 3.2.6 Duty cycle correction factor for average measurement

#### DH5 on time (One Pulse) Plot on Channel 39



#### DH5 on time (Count Pulses) Plot on Channel 39



#### Note:

1. Worst case Duty cycle = on time/100 milliseconds =  $2 * 2.90 / 100 = 5.80 \%$
2. Worst case Duty cycle correction factor =  $20 * \log(\text{Duty cycle}) = -24.73 \text{ dB}$
3. DH5 has the highest duty cycle worst case and is reported.

**Duty Cycle Correction Factor Consideration for AFH mode:**

Bluetooth normal hopping rate is 1600Hz and reduced to 800Hz in AFH mode; due to the reduced number of hopping frequencies, with the same packet configuration the dwell time in each channel frequency within 100msec period is longer in AFH mode than normal mode.

In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time DH5 packet is observed; the period to have DH5 packet completing one hopping sequence is

$$2.90\text{ ms} \times 20\text{ channels} = 58.0\text{ ms}$$

There cannot be 2 complete hopping sequences within 100ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period.  $[100\text{ms} / 57.6\text{ms}] = 2\text{ hops}$

Thus, the maximum possible ON time:

$$2.90\text{ ms} \times 2 = 5.80\text{ ms}$$

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

$$20 \times \log(5.80\text{ ms}/100\text{ms}) = -24.73\text{ dB}$$

**3.2.7 Test Result of Conducted Spurious at Band Edges in the Restricted Band**

Please refer to Appendix A.

**3.2.8 Test Result of Conducted Spurious Emission in the Restricted Band**

Please refer to Appendix A.

**3.2.9 Test Result of Cabinet Radiated Spurious at Band Edges**

Please refer to Appendix B.

**3.2.10 Test Result of Cabinet Radiated Spurious Emission (30MHz ~ 10<sup>th</sup> Harmonic)**

Please refer to Appendix B.



### **3.3 Antenna Requirements**

#### **3.3.1 Standard Applicable**

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

#### **3.3.2 Antenna Anti-Replacement Construction**

Non-standard antenna connector is used.

#### **3.3.3 Antenna Gain**

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.



## 4 List of Measuring Equipment

| Instrument               | Manufacturer    | Model No.           | Serial No.  | Characteristics               | Calibration Date | Test Date                       | Due Date      | Remark                   |
|--------------------------|-----------------|---------------------|-------------|-------------------------------|------------------|---------------------------------|---------------|--------------------------|
| Power Meter              | Agilent         | E4416A              | GB41292344  | 300MHz~40GHz                  | Jan. 14, 2015    | Aug.12, 2015~<br>Aug.13, 2015   | Jan. 13, 2016 | Conducted<br>(TH05-HY)   |
| Power Sensor             | Agilent         | E9327A              | US40441548  | 300MHz~40GHz                  | Jan. 14, 2015    | Aug.12,2015~<br>Aug.13,2015     | Jan. 13, 2016 | Conducted<br>(TH05-HY)   |
| Spectrum Analyzer        | Rohde & Schwarz | FSP40               | 100055      | 9kHz-40GHz                    | Jun. 18, 2015    | Aug.12, 2015~<br>Aug.13, 2015   | Jun. 17, 2016 | Conducted<br>(TH05-HY)   |
| BT Base Station(Measure) | Rohde & Schwarz | CBT                 | 101136      | BT 3.0 & 4.0                  | Sep. 24, 2014    | Aug.12, 2015~<br>Aug.13, 2015   | Sep. 23, 2015 | Conducted<br>(TH05-HY)   |
| Horn Antenna             | SCHWARZBECK     | BBHA 9170           | BBHA9170584 | 18GHz- 40GHz                  | Nov. 03, 2014    | Aug. 13, 2015~<br>Aug. 14, 2015 | Nov. 02, 2015 | Radiation<br>(03CH10-HY) |
| Loop Antenna             | TESEQ           | HLA 6120            | 31244       | 9kHz~30MHz                    | Feb. 02, 2015    | Aug. 13, 2015~<br>Aug. 14, 2015 | Feb. 01, 2016 | Radiation<br>(03CH10-HY) |
| Amplifier                | SONOMA          | 310N                | 187311      | 9kHz~1GHz                     | Nov. 24, 2014    | Aug. 13, 2015~<br>Aug. 14, 2015 | Nov. 23, 2015 | Radiation<br>(03CH10-HY) |
| Bilog Antenna            | TESEQ           | CBL 6111D           | 35413       | 30MHz~1GHz                    | Oct. 24, 2014    | Aug. 13, 2015~<br>Aug. 14, 2015 | Oct. 23, 2015 | Radiation<br>(03CH10-HY) |
| EMI Test Receiver        | Keysight        | N9038A              | MY54130085  | 20Hz ~ 8.4GHz                 | Nov. 05, 2014    | Aug. 13, 2015~<br>Aug. 14, 2015 | Nov. 04, 2015 | Radiation<br>(03CH10-HY) |
| Horn Antenna             | SCHWARZBECK     | BBHA 9120 D         | 9120D-1325  | 1GHz ~ 18GHz                  | Oct. 03, 2014    | Aug. 13, 2015~<br>Aug. 14, 2015 | Oct. 02, 2015 | Radiation<br>(03CH10-HY) |
| Preamplifier             | Keysight        | 83017A              | MY53270078  | 1GHz~26.5GHz                  | Nov. 20, 2014    | Aug. 13, 2015~<br>Aug. 14, 2015 | Nov. 19, 2015 | Radiation<br>(03CH10-HY) |
| Spectrum Analyzer        | Keysight        | N9010A              | MY54200485  | 10Hz ~ 44GHZ                  | Oct. 14, 2014    | Aug. 13, 2015~<br>Aug. 14, 2015 | Oct. 13, 2015 | Radiation<br>(03CH10-HY) |
| Controller               | EMEC            | EM 1000             | N/A         | Control Turn table & Ant Mast | N/A              | Aug. 13, 2015~<br>Aug. 14, 2015 | N/A           | Radiation<br>(03CH10-HY) |
| Antenna Mast             | EMEC            | AM-BS-4500-B        | N/A         | 1~4m                          | N/A              | Aug. 13, 2015~<br>Aug. 14, 2015 | N/A           | Radiation<br>(03CH10-HY) |
| Turn Table               | EMEC            | TT 2200             | N/A         | 0-360 degree                  | N/A              | Aug. 13, 2015~<br>Aug. 14, 2015 | N/A           | Radiation<br>(03CH10-HY) |
| Preamplifier             | MITEQ           | JS44-18004000-33-8P | 1840917     | 18GHz ~ 40GHz                 | Jun. 02, 2015    | Aug. 13, 2015~<br>Aug. 14, 2015 | Jun. 01, 2016 | Radiation<br>(03CH10-HY) |



## 5 Uncertainty of Evaluation

### Uncertainty of Conducted Emission Measurement (150 kHz ~ 30 MHz)

|   |      |
|---|------|
| Measuring Uncertainty for a Level of Confidence of 95% ( $U = 2Uc(y)$ ) | 2.26 |
|---|------|

### Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

|   |      |
|---|------|
| Measuring Uncertainty for a Level of Confidence of 95% ( $U = 2Uc(y)$ ) | 4.90 |
|---|------|



## Appendix A. Test Result of Conducted Spurious Emission

### Test Result of Conducted Spurious at Band Edges in the Restricted Band

| BT                    | Note | Frequency | Level      | Over   | Limit      | Read     | Antenna | Cable  | Grounding | Peak    |
|-----------------------|------|-----------|------------|--------|------------|----------|---------|--------|-----------|---------|
|                       |      |           |            | Limit  | Line       | Level    | Gain    | Loss   | Factor    | Avg     |
|                       |      | ( MHz )   | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dBi ) | ( dB ) | ( dB )    | ( P/A ) |
| BT<br>CH00<br>2402MHz |      | 2376.69   | -31.47     | -10.27 | -21.2      | -35.93   | 3.2     | 1.26   | 0         | P       |
|                       |      | 2376.69   | -59.21     | -18.01 | -41.2      | -        | -       | -      | 0         | A       |
|                       | *    | 2402.505  | -9.15      | -      | -          | -13.62   | 3.2     | 1.27   | 0         | P       |
|                       | *    | 2402.505  | -36.89     | -      | -          | -        | -       | -      | 0         | A       |
| BT<br>CH39<br>2441MHz |      | 2389.56   | -39.19     | -17.99 | -21.2      | -43.66   | 3.2     | 1.27   | 0         | P       |
|                       |      | 2389.56   | -66.93     | -25.73 | -41.2      | -        | -       | -      | 0         | A       |
|                       | *    | 2441.833  | -9.21      | -      | -          | -13.69   | 3.2     | 1.28   | 0         | P       |
|                       | *    | 2441.833  | -36.95     | -      | -          | -        | -       | -      | 0         | A       |
|                       |      | 2491.84   | -37.59     | -16.39 | -21.2      | -42.08   | 3.2     | 1.29   | 0         | P       |
|                       |      | 2491.84   | -65.33     | -24.13 | -41.2      | -        | -       | -      | 0         | A       |
| BT<br>CH78<br>2480MHz | *    | 2480.912  | -9.12      | -      | -          | -13.6    | 3.2     | 1.28   | 0         | P       |
|                       | *    | 2480.995  | -36.86     | -      | -          | -        | -       | -      | 0         | A       |
|                       |      | 2483.52   | -24.54     | -3.34  | -21.2      | -29.02   | 3.2     | 1.28   | 0         | P       |
|                       |      | 2483.52   | -52.28     | -11.08 | -41.2      | -        | -       | -      | 0         | A       |



## Test Result of Conducted Spurious Emission in the Restricted Band

| BT                    | Note | Frequency | Level      | Over   | Limit      | Read     | Antenna | Cable  | Grounding | Peak    |
|-----------------------|------|-----------|------------|--------|------------|----------|---------|--------|-----------|---------|
|                       |      | ( MHz )   | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dBi ) | ( dB ) | ( dB )    | ( P/A ) |
| BT<br>CH00<br>2402MHz |      | 32.91     | -67.44     | -12.24 | -55.2      | -75.51   | 3.2     | 0.17   | 4.7       | P       |
|                       |      | 168.71    | -79.72     | -28.02 | -51.7      | -87.92   | 3.2     | 0.3    | 4.7       | P       |
|                       |      | 444.19    | -79.3      | -30.1  | -49.2      | -87.64   | 3.2     | 0.44   | 4.7       | P       |
|                       |      | 627.52    | -80.38     | -31.18 | -49.2      | -88.81   | 3.2     | 0.53   | 4.7       | P       |
|                       |      | 800.18    | -66.17     | -16.97 | -49.2      | -74.64   | 3.2     | 0.57   | 4.7       | P       |
|                       |      | 948.59    | -80.66     | -31.46 | -49.2      | -89.19   | 3.2     | 0.63   | 4.7       | P       |
|                       |      | 4804      | -30.61     | -9.41  | -21.2      | -35.48   | 3.2     | 1.67   | 0         | P       |
|                       |      | 4804      | -58.35     | -17.15 | -41.2      | -        | -       | -      | 0         | A       |
|                       |      | 7206      | -49.06     | -27.86 | -21.2      | -54.14   | 3.2     | 1.88   | 0         | P       |
| BT<br>CH39<br>2441MHz |      | 45.52     | -76.35     | -21.15 | -55.2      | -84.44   | 3.2     | 0.19   | 4.7       | P       |
|                       |      | 72.68     | -77.68     | -22.48 | -55.2      | -85.79   | 3.2     | 0.21   | 4.7       | P       |
|                       |      | 318.09    | -80.46     | -31.26 | -49.2      | -88.74   | 3.2     | 0.38   | 4.7       | P       |
|                       |      | 558.65    | -79.74     | -30.54 | -49.2      | -88.13   | 3.2     | 0.49   | 4.7       | P       |
|                       |      | 703.18    | -72.38     | -23.18 | -49.2      | -80.83   | 3.2     | 0.55   | 4.7       | P       |
|                       |      | 813.76    | -51.07     | -1.87  | -49.2      | -59.56   | 3.2     | 0.59   | 4.7       | P       |
|                       |      | 4882      | -29.57     | -8.37  | -21.2      | -34.47   | 3.2     | 1.70   | 0         | P       |
|                       |      | 4882      | -57.31     | -16.11 | -41.2      | -        | -       | -      | 0         | A       |
|                       |      | 7323      | -53.87     | -32.67 | -21.2      | -59.04   | 3.2     | 1.97   | 0         | P       |
| BT<br>CH78<br>2480MHz |      | 45.52     | -75.81     | -20.61 | -55.2      | -83.9    | 3.2     | 0.19   | 4.7       | P       |
|                       |      | 140.58    | -79.43     | -27.73 | -51.7      | -87.6    | 3.2     | 0.27   | 4.7       | P       |
|                       |      | 438.37    | -80.21     | -31.01 | -49.2      | -88.55   | 3.2     | 0.44   | 4.7       | P       |
|                       |      | 552.83    | -79.89     | -30.69 | -49.2      | -88.28   | 3.2     | 0.49   | 4.7       | P       |
|                       |      | 703.18    | -73.03     | -23.83 | -49.2      | -81.48   | 3.2     | 0.55   | 4.7       | P       |
|                       |      | 827.34    | -49.91     | -0.71  | -49.2      | -58.4    | 3.2     | 0.59   | 4.7       | P       |
|                       |      | 4960      | -30.74     | -9.54  | -21.2      | -35.67   | 3.2     | 1.73   | 0         | P       |
|                       |      | 4960      | -58.48     | -17.28 | -41.2      | -        | -       | -      | 0         | A       |
|                       |      | 7440      | -48.68     | -27.48 | -21.2      | -53.95   | 3.2     | 2.07   | 0         | P       |





## Appendix B. Radiated Spurious Emission

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

| BT                     | Note | Frequency | Level      | Over Limit | Limit Line | Read Level | Antenna Factor | Cable Loss | Preamp Factor | Ant Pos | Table Pos | Peak Avg. | Pol.    |
|------------------------|------|-----------|------------|------------|------------|------------|----------------|------------|---------------|---------|-----------|-----------|---------|
|                        |      | ( MHz )   | ( dBμV/m ) | ( dB )     | ( dBμV/m ) | ( dBμV )   | ( dB/m )       | ( dB )     | ( dB )        | ( cm )  | ( deg )   | ( P/A )   | ( H/V ) |
| BT<br>CH00<br>2402MHz  |      | 2389.3    | 43.91      | -30.09     | 74         | 44.53      | 27.23          | 5.39       | 33.24         | 126     | 214       | P         | H       |
|                        |      | 2389.3    | 19.18      | -34.82     | 54         |            |                |            |               |         |           | A         | H       |
|                        | *    | 2401.91   | 95.24      | -          | -          | 95.84      | 27.23          | 5.39       | 33.22         | 126     | 214       | P         | H       |
|                        | *    | 2401.91   | 70.51      | -          | -          |            |                |            |               |         |           | A         | H       |
|                        |      |           |            |            |            |            |                |            |               |         |           |           | H       |
|                        |      |           |            |            |            |            |                |            |               |         |           |           | H       |
|                        |      | 2376.82   | 46         | -28        | 74         | 46.66      | 27.19          | 5.39       | 33.24         | 351     | 360       | P         | V       |
|                        |      | 2376.82   | 21.27      | -32.73     | 54         |            |                |            |               |         |           | A         | V       |
|                        | *    | 2402.17   | 91.93      | -          | -          | 92.53      | 27.23          | 5.39       | 33.22         | 351     | 360       | P         | V       |
|                        | *    | 2402.17   | 67.2       | -          | -          |            |                |            |               |         |           | A         | V       |
|                        |      |           |            |            |            |            |                |            |               |         |           |           | V       |
|                        |      |           |            |            |            |            |                |            |               |         |           |           | V       |
| BT<br>CH 39<br>2441MHz |      | 2389.23   | 43.74      | -30.26     | 74         | 44.36      | 27.23          | 5.39       | 33.24         | 139     | 210       | P         | H       |
|                        |      | 2389.23   | 19.01      | -34.99     | 54         |            |                |            |               |         |           | A         | H       |
|                        | *    | 2441.29   | 92.82      | -          | -          | 93.23      | 27.37          | 5.42       | 33.2          | 139     | 210       | P         | H       |
|                        | *    | 2441.29   | 68.09      | -          | -          |            |                |            |               |         |           | A         | H       |
|                        |      | 2484.99   | 43.2       | -30.8      | 74         | 43.46      | 27.46          | 5.46       | 33.18         | 139     | 210       | P         | H       |
|                        |      | 2484.99   | 18.47      | -35.53     | 54         |            |                |            |               |         |           | A         | H       |
|                        |      | 2355.6    | 42.76      | -31.24     | 74         | 43.54      | 27.14          | 5.33       | 33.25         | 336     | 328       | P         | V       |
|                        |      | 2355.6    | 18.03      | -35.97     | 54         |            |                |            |               |         |           | A         | V       |
|                        | *    | 2441.1    | 90.54      | -          | -          | 90.95      | 27.37          | 5.42       | 33.2          | 336     | 328       | P         | V       |
|                        | *    | 2441.1    | 65.81      | -          | -          |            |                |            |               |         |           | A         | V       |
|                        |      | 2488.98   | 42.54      | -31.46     | 74         | 42.76      | 27.5           | 5.46       | 33.18         | 336     | 328       | P         | V       |
|                        |      | 2488.98   | 17.81      | -36.19     | 54         |            |                |            |               |         |           | A         | V       |



|                        |   |         |       |        |    |       |       |      |       |     |     |   |   |
|------------------------|---|---------|-------|--------|----|-------|-------|------|-------|-----|-----|---|---|
| BT<br>CH 78<br>2480MHz | *   | 2479.98 | 91.4  | -      | -  | 91.68 | 27.46 | 5.44 | 33.18 | 107 | 212 | P | H |
|                        | *   | 2479.98 | 66.67 | -      | -  |       |       |      |       |     |     | A | H |
|                        |   | 2489.5  | 44.3  | -29.7  | 74 | 44.52 | 27.5  | 5.46 | 33.18 | 107 | 212 | P | H |
|                        |   | 2489.5  | 19.57 | -34.43 | 54 |       |       |      |       |     |     | A | H |
|                        |   |         |       |        |    |       |       |      |       |     |     |   | H |
|                        |   |         |       |        |    |       |       |      |       |     |     |   | H |
|                        | *   | 2479.91 | 88.74 | -      | -  | 89.02 | 27.46 | 5.44 | 33.18 | 366 | 326 | P | V |
|                        | *   | 2479.91 | 64.01 | -      | -  |       |       |      |       |     |     | A | V |
|                        |   | 2484.04 | 43.28 | -30.72 | 74 | 43.54 | 27.46 | 5.46 | 33.18 | 366 | 326 | P | V |
|                        |   | 2484.04 | 18.55 | -35.45 | 54 |       |       |      |       |     |     | A | V |
|                        |   |         |       |        |    |       |       |      |       |     |     |   | V |
|                        |   |         |       |        |    |       |       |      |       |     |     |   | V |
| Remark                 | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. |         |       |        |    |       |       |      |       |     |     |   |   |



## 2.4GHz 2400~2483.5MHz

## BT (Harmonic @ 3m)

| BT                     | Note  | Frequency<br>( MHz ) | Level<br>( dBμV/m ) | Over<br>Limit<br>( dB ) | Limit<br>Line<br>( dBμV/m ) | Read<br>Level<br>( dBμV ) | Antenna<br>Factor<br>( dB/m ) | Cable<br>Loss<br>( dB ) | Preamp<br>Factor<br>( dB ) | Ant<br>Pos<br>( cm ) | Table<br>Pos<br>( deg ) | Peak<br>Avg.<br>( P/A ) | Pol.<br>( H/V ) |
|------------------------|---|----------------------|---------------------|-------------------------|-----------------------------|---------------------------|-------------------------------|-------------------------|----------------------------|----------------------|-------------------------|-------------------------|-----------------|
| BT<br>CH 00<br>2402MHz |   | 4806                 | 61.05               | -12.95                  | 74                          | 82.69                     | 31.42                         | 7.58                    | 60.64                      | 100                  | 0                       | P                       | H               |
|                        |   | 4806                 | 36.32               | -17.68                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | H               |
|                        |   |                      |                     |                         |                             |                           |                               |                         |                            |                      |                         |                         | H               |
|                        |   |                      |                     |                         |                             |                           |                               |                         |                            |                      |                         |                         | H               |
|                        |   | 4806                 | 58.76               | -15.24                  | 74                          | 80.4                      | 31.42                         | 7.58                    | 60.64                      | 100                  | 0                       | P                       | V               |
|                        |   | 4806                 | 34.03               | -19.97                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | V               |
|                        |   |                      |                     |                         |                             |                           |                               |                         |                            |                      |                         |                         | V               |
|                        |   |                      |                     |                         |                             |                           |                               |                         |                            |                      |                         |                         | V               |
| BT<br>CH 39<br>2441MHz |   | 4884                 | 60.62               | -13.38                  | 74                          | 81.76                     | 31.56                         | 7.82                    | 60.52                      | 100                  | 0                       | P                       | H               |
|                        |   | 4884                 | 35.89               | -18.11                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | H               |
|                        |   | 7320                 | 45.08               | -28.92                  | 74                          | 60.35                     | 36.22                         | 9.49                    | 60.98                      | 100                  | 0                       | P                       | H               |
|                        |   | 7320                 | 20.35               | -33.65                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | H               |
|                        |   | 4884                 | 59.13               | -14.87                  | 74                          | 80.27                     | 31.56                         | 7.82                    | 60.52                      | 100                  | 0                       | P                       | V               |
|                        |   | 4884                 | 34.4                | -19.6                   | 54                          |                           |                               |                         |                            |                      |                         | A                       | V               |
|                        |   | 7320                 | 50.15               | -23.85                  | 74                          | 65.42                     | 36.22                         | 9.49                    | 60.98                      | 100                  | 0                       | P                       | V               |
|                        |   | 7320                 | 25.42               | -28.58                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | V               |
| BT<br>CH 78<br>2480MHz |   | 4962                 | 58.05               | -15.95                  | 74                          | 78.63                     | 31.73                         | 8.05                    | 60.36                      | 100                  | 0                       | P                       | H               |
|                        |   | 4962                 | 33.32               | -20.68                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | H               |
|                        |   | 7440                 | 46.14               | -27.86                  | 74                          | 61.38                     | 36.49                         | 9.61                    | 61.34                      | 100                  | 0                       | P                       | H               |
|                        |   | 7440                 | 21.41               | -32.59                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | H               |
|                        |   | 4962                 | 56.47               | -17.53                  | 74                          | 77.05                     | 31.73                         | 8.05                    | 60.36                      | 100                  | 0                       | P                       | V               |
|                        |   | 4962                 | 31.74               | -22.26                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | V               |
|                        |   | 7440                 | 47.65               | -26.35                  | 74                          | 62.89                     | 36.49                         | 9.61                    | 61.34                      | 100                  | 0                       | P                       | V               |
|                        |   | 7440                 | 22.92               | -31.08                  | 54                          |                           |                               |                         |                            |                      |                         | A                       | V               |
| Remark                 | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. |                      |                     |                         |                             |                           |                               |                         |                            |                      |                         |                         |                 |

### Emission below 1GHz

## 2.4GHz BT (LF)

[illegible]



**Note symbol**

|     |  |
|-----|--|
| *   | <b>Fundamental Frequency</b> which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency. |
| !   | Test result is <b>over limit</b> line.   |
| P/A | <b>Peak</b> or <b>Average</b>  |
| H/V | <b>Horizontal</b> or <b>Vertical</b>   |

A calculation example for radiated spurious emission is shown as below:

| WIFI    | Note | Frequency | Level      | Over   | Limit      | Read     | Antenna  | Cable  | Preamp | Ant    | Table   | Peak    | Pol.    |
|---------|------|-----------|------------|--------|------------|----------|----------|--------|--------|--------|---------|---------|---------|
| Ant.    |      |           |            | Limit  | Line       | Level    | Factor   | Loss   | Factor | Pos    | Pos     | Avg.    |         |
| 1+2     |      | ( MHz )   | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | ( P/A ) | ( H/V ) |
| 802.11b |      | 2390      | 55.45      | -18.55 | 74         | 54.51    | 32.22    | 4.58   | 35.86  | 103    | 308     | P       | H       |
| CH 01   |      |           |            |        |            |          |          |        |        |        |         |         |         |
| 2412MHz |      | 2390      | 43.54      | -10.46 | 54         | 42.6     | 32.22    | 4.58   | 35.86  | 103    | 308     | A       | H       |

1. Level(dBμV/m) =

Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

**For Peak Limit @ 2390MHz:**

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

**For Average Limit @ 2390MHz:**

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

**Both peak and average measured complies with the limit line, so test result is “PASS”.**

## Appendix C. Setup Photographs

### <Radiated Emission>

LF



HF

