



# FCC RADIO TEST REPORT

**FCC ID** : PPD-QCNFA435  
**Equipment** : Single Stream 802.11a/b/g/n/ac + BT 4.1 M.2 Type Card  
**Brand Name** : Qualcomm Atheros  
**Model Name** : QCNFA435  
**Applicant** : Qualcomm Atheros, Inc.  
1700 Technology Drive, San Jose, CA 95110  
**Manufacturer** : Qualcomm Atheros, Inc.  
1700 Technology Drive, San Jose, CA 95110  
**Standard** : FCC Part 15 Subpart C §15.247

The product was received on Mar. 20, 2018 and testing was started from Mar. 20, 2018 and completed on Apr. 30, 2018. 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 report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

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

Reviewed by: Jones Tsai

**SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory**  
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)



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## History of this test report



## Summary of Test Result

| Report Clause  | Ref Std. Clause       | Test Items   | Result (PASS/FAIL) | Remark                                    |
|--|-----------------------|--|--------------------|---|
| 3.1  | 15.247(b)(1)          | Peak Output Power                                  | Pass               | -   |
| 3.2  | 15.247(d)             | Radiated Band Edges and Radiated Spurious Emission | Pass               | Under limit<br>12.33 dB at<br>934.200 MHz |
| 3.3  | 15.203 &<br>15.247(b) | Antenna Requirement                                | Pass               | -   |
| <b>Remark:</b> The reported TX power in EMC report is per actual shipping power setting and measured in this unit. This has considered the actual shipping power during the measurement. |                       |  |                    |   |

Reviewed by: Joseph Lin

Report Producer: Maggie Chiang



## 1 General Description

### 1.1 Product Feature of Equipment Under Test

Bluetooth, Wi-Fi 2.4GHz 802.11b/g/n/ac, and Wi-Fi 5GHz 802.11a/n/ac.

| Product Specification subjective to this standard |   |
|---|---|
| Sample 1  | EUT with Portable Computer (HONGBO Antenna) |
| Sample 2  | EUT with Portable Computer (ACON Antenna)   |

**Remark:** All the tests were performed with Sample 1.

The product was installed into Portable Computer (Brand Name: DELL, Model Name: P88G, P88G001) during test, and the antenna information was recorded in the following table.

| Antenna Information |             |                        |                 |              |                         |
|---------------------|-------------|------------------------|-----------------|--------------|-------------------------|
| Manufacturer        | HONGBO      |                        | Manufacturer    | ACON         |                         |
| Model Name          | 260-26161   |                        | Model Name      | ANF6Y-200019 |                         |
| Ant. Type           | PIFA        |                        | Ant. Type       | PIFA         |                         |
| Peak Gain (dBi)     | 2.4GHz WLAN | Main:0.89<br>Aux:-2.1  | Peak Gain (dBi) | 2.4GHz WLAN  | Main:-0.02<br>Aux:-2.43 |
|                     | 5GHz WLAN   | Main:1.39<br>Aux:-1.59 |                 | 5GHz WLAN    | Main:-1.86<br>Aux:-2.26 |

### 1.2 Modification of EUT

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

### 1.3 Testing Location

Sportun Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

|                    |   |           |
|--------------------|---|-----------|
| Test Site          | SPORTON INTERNATIONAL INC.  |           |
| Test Site Location | No.52, Huaya 1st Rd., Guishan Dist.,<br>Taoyuan City, Taiwan (R.O.C.)<br>TEL: +886-3-327-3456<br>FAX: +886-3-328-4978 |           |
| Test Site No.      | <b>Sportun Site No.</b>   |           |
|                    | TH05-HY   | 03CH07-HY |

**Note:** The test site complies with ANSI C63.4 2014 requirement.



## 1.4 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:** All test items were verified and recorded according to the standards and without any deviation during the test.



## 2 Test Configuration of Equipment Under Test

### 2.1 Carrier Frequency Channel

| Frequency Band  | Channel | Freq.<br>(MHz) | Channel | Freq.<br>(MHz) | Channel | Freq.<br>(MHz) |
|-----------------|---------|----------------|---------|----------------|---------|----------------|
| 2400-2483.5 MHz | 0       | 2402           | 27      | 2429           | 54      | 2456           |
|                 | 1       | 2403           | 28      | 2430           | 55      | 2457           |
|                 | 2       | 2404           | 29      | 2431           | 56      | 2458           |
|                 | 3       | 2405           | 30      | 2432           | 57      | 2459           |
|                 | 4       | 2406           | 31      | 2433           | 58      | 2460           |
|                 | 5       | 2407           | 32      | 2434           | 59      | 2461           |
|                 | 6       | 2408           | 33      | 2435           | 60      | 2462           |
|                 | 7       | 2409           | 34      | 2436           | 61      | 2463           |
|                 | 8       | 2410           | 35      | 2437           | 62      | 2464           |
|                 | 9       | 2411           | 36      | 2438           | 63      | 2465           |
|                 | 10      | 2412           | 37      | 2439           | 64      | 2466           |
|                 | 11      | 2413           | 38      | 2440           | 65      | 2467           |
|                 | 12      | 2414           | 39      | 2441           | 66      | 2468           |
|                 | 13      | 2415           | 40      | 2442           | 67      | 2469           |
|                 | 14      | 2416           | 41      | 2443           | 68      | 2470           |
|                 | 15      | 2417           | 42      | 2444           | 69      | 2471           |
|                 | 16      | 2418           | 43      | 2445           | 70      | 2472           |
|                 | 17      | 2419           | 44      | 2446           | 71      | 2473           |
|                 | 18      | 2420           | 45      | 2447           | 72      | 2474           |
|                 | 19      | 2421           | 46      | 2448           | 73      | 2475           |
|                 | 20      | 2422           | 47      | 2449           | 74      | 2476           |
|                 | 21      | 2423           | 48      | 2450           | 75      | 2477           |
|                 | 22      | 2424           | 49      | 2451           | 76      | 2478           |
|                 | 23      | 2425           | 50      | 2452           | 77      | 2479           |
|                 | 24      | 2426           | 51      | 2453           | 78      | 2480           |
|                 | 25      | 2427           | 52      | 2454           | -       | -              |
|                 | 26      | 2428           | 53      | 2455           | -       | -              |

## 2.2 Test Mode

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 emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). The worst mode of radiated spurious emissions is Bluetooth 1Mbps mode, and recorded in this report.

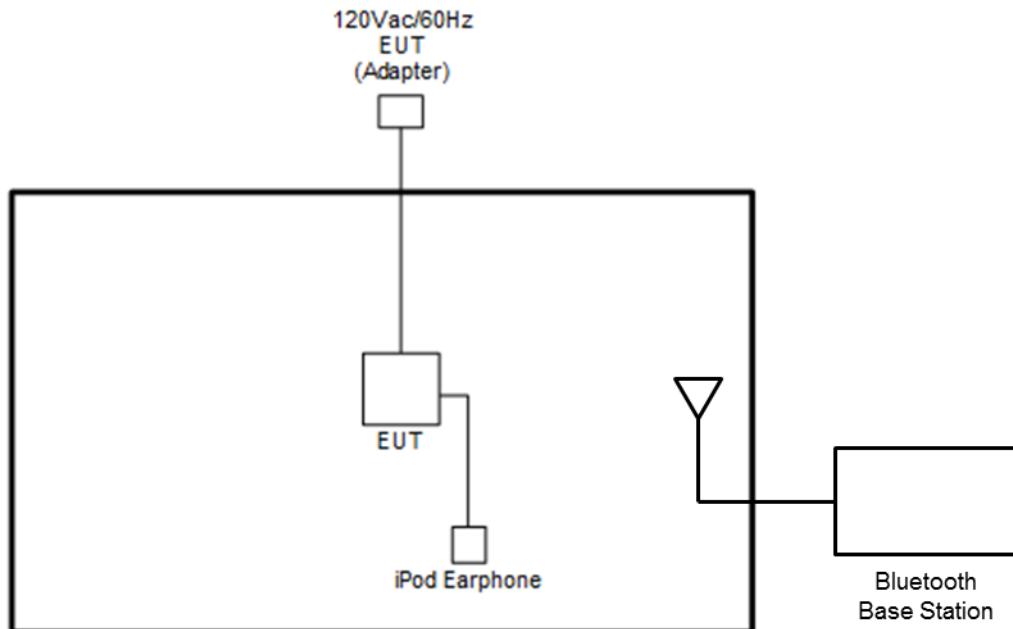
The following summary table is showing all test modes to demonstrate in compliance with the standard.

| Summary table of Test Cases |                         |
|-----------------------------|-------------------------|
| Radiated Test Cases         | Bluetooth BR 1Mbps GFSK |
|                             | Mode 1: CH00_2402 MHz   |
|                             | Mode 2: CH39_2441 MHz   |
|                             | Mode 3: CH78_2480 MHz   |

**Remark:**

1. For radiated test cases, the worst mode data rate 1Mbps was reported only since the highest RF output power in the preliminary tests.
2. The Radiated Spurious Emission test has only performed the test cases which chosen from module supplier

## 2.3 Connection Diagram of Test System





## 2.4 Support Unit used in test configuration and system

| Item | Equipment              | Trade Name | Model Name | FCC ID       | Data Cable        | Power Cord        |
|------|------------------------|------------|------------|--------------|-------------------|-------------------|
| 1.   | Bluetooth Base Station | R&S        | CBT32      | N/A          | N/A               | Unshielded, 1.8 m |
| 2.   | iPod Earphone          | Apple      | N/A        | Verification | Unshielded, 1.0 m | N/A               |

## 2.5 EUT Operation Test Setup

The RF test items, utility “QRCT” was installed in Portable Computer which was programmed in order to make the EUT get into the engineering modes to contact with base station to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

### 3 Test Result

#### 3.1 Output Power Measurement

##### 3.1.1 Limit of Output Power

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, 2Mbps, 3Mbps and AFH modes are 0.125 watts.

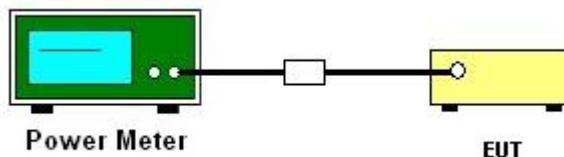
##### 3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

##### 3.1.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.5.
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

Please refer to Appendix A.

##### 3.1.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.



## 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 limits as below.

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

### 3.2.2 Measuring Instruments

See list of measuring equipment of this test report.



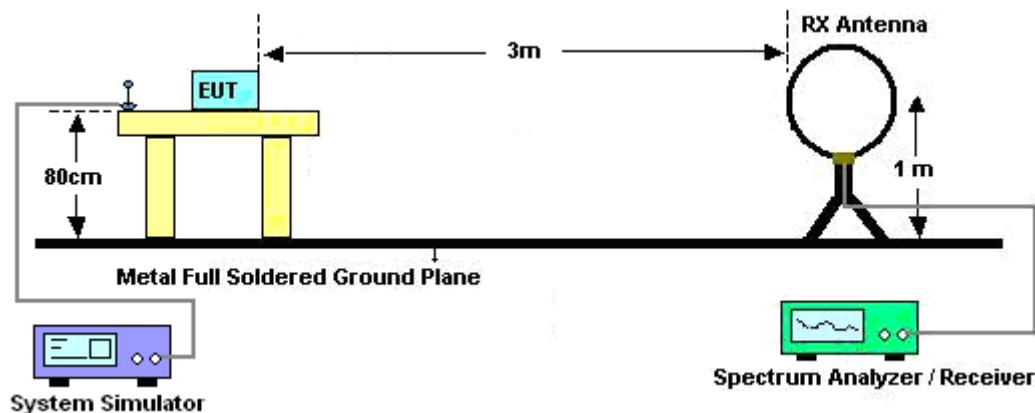
### 3.2.3 Test Procedures

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  $f < 1$  GHz, RBW=1MHz for  $f > 1$  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 =  $N_1 \cdot L_1 + N_2 \cdot L_2 + \dots + N_{n-1} \cdot L_{n-1} + N_n \cdot L_n$   
Where  $N_1$  is number of type 1 pulses,  $L_1$  is length of type 1 pulses, etc.  
Average Emission Level = Peak Emission Level +  $20 \cdot \log(\text{Duty cycle})$
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
7. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
8. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

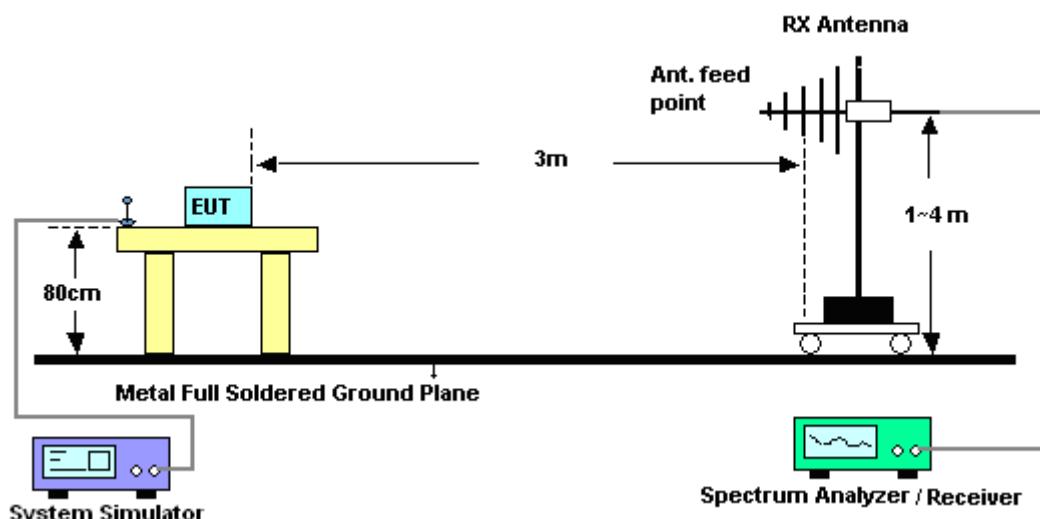
Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.79dB) derived from  $20 \log(\text{dwell time}/100\text{ms})$ . This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

### 3.2.4 Test Setup

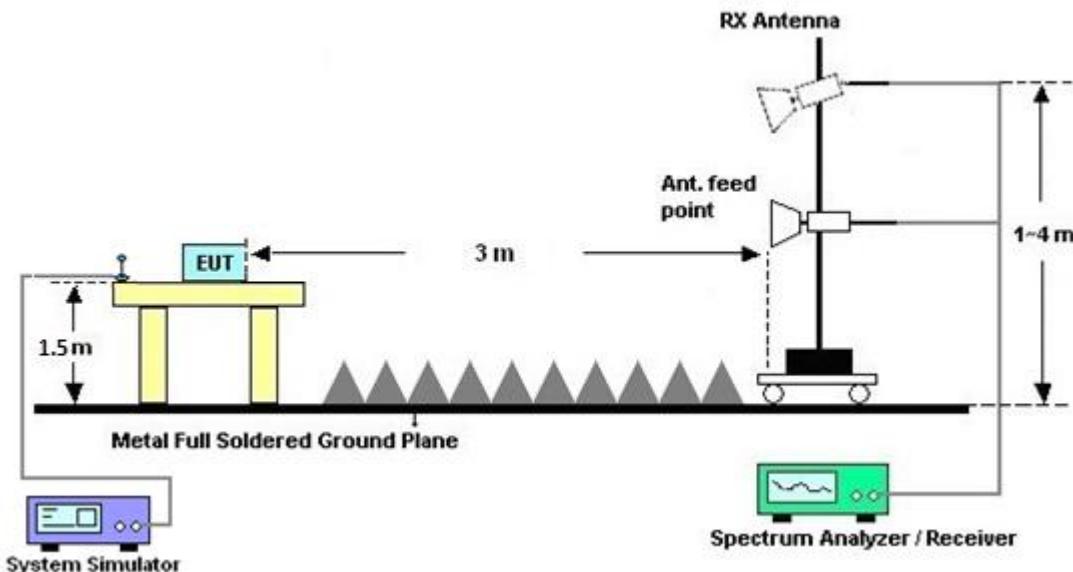
For radiated emissions below 30MHz



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 was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

### 3.2.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B and C.

### 3.2.7 Duty Cycle

Please refer to Appendix D.

### 3.2.8 Test Result of Radiated Spurious Emission (30MHz ~ 10<sup>th</sup> Harmonic)

Please refer to Appendix B and C.



### **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 rule.

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

An embedded-in antenna design 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  | N/A                           | Dec. 20, 2017    | Mar. 20, 2018               | Dec. 19, 2018 | Conducted (TH05-HY)   |
| Power Sensor              | Agilent         | E9327A                    | US40441548  | 50MHz~18GHz                   | Dec. 20, 2017    | Mar. 20, 2018               | Dec. 19, 2018 | Conducted (TH05-HY)   |
| Spectrum Analyzer         | Rohde & Schwarz | FSP40                     | 100055      | 9kHz~40GHz                    | Jun. 20, 2017    | Mar. 20, 2018               | Jun. 19, 2018 | Conducted (TH05-HY)   |
| BT Base Station (Measure) | Rohde & Schwarz | CBT                       | 101136      | BT 3.0                        | Sep. 20, 2017    | Mar. 20, 2018               | Sep. 19, 2018 | Conducted (TH05-HY)   |
| Bilog Antenna             | TESEQ           | CBL 6111D&00800 N1D01N-06 | 35419&03    | 30MHz to 1GHz                 | Dec. 18, 2017    | Mar. 31, 2018~Apr. 04, 2018 | Dec. 17, 2018 | Radiation (03CH07-HY) |
| Double Ridge Horn Antenna | ESCO            | 3117                      | 00075962    | 1GHz ~ 18GHz                  | Aug. 23, 2017    | Mar. 31, 2018~Apr. 04, 2018 | Aug. 22, 2018 | Radiation (03CH07-HY) |
| Loop Antenna              | Rohde & Schwarz | HFH2-Z2                   | 100315      | 9 kHz~30 MHz                  | Nov. 10, 2017    | Mar. 31, 2018~Apr. 04, 2018 | Nov. 09, 2018 | Radiation (03CH07-HY) |
| Preamplifier              | MITEQ           | AMF-7D-0010 1800-30-10P   | 1590075     | 1GHz ~ 18GHz                  | Apr. 25, 2017    | Mar. 31, 2018~Apr. 04, 2018 | Apr. 24, 2018 | Radiation (03CH07-HY) |
| Preamplifier              | Agilent         | 8449B                     | 3008A02362  | 1GHz~ 26.5GHz                 | Oct. 30, 2017    | Mar. 31, 2018~Apr. 04, 2018 | Oct. 29, 2018 | Radiation (03CH07-HY) |
| Spectrum Analyzer         | Agilent         | N9010A                    | MY53470118  | 10Hz~44GHz                    | Apr. 17, 2017    | Mar. 31, 2018~Apr. 04, 2018 | Apr. 16, 2018 | Radiation (03CH07-HY) |
| Antenna Mast              | Max-Full        | MFA520BS                  | N/A         | 1m~4m                         | N/A              | Mar. 31, 2018~Apr. 04, 2018 | N/A           | Radiation (03CH07-HY) |
| Turn Table                | ChainTek        | Chaintek 3000             | N/A         | 0~360 Degree                  | N/A              | Mar. 31, 2018~Apr. 04, 2018 | N/A           | Radiation (03CH07-HY) |
| Amplifier                 | MITEQ           | TTA1840-35-HG             | 1871923     | 18GHz~40GHz, VSWR : 2.5:1 max | Jul. 18, 2017    | Mar. 31, 2018~Apr. 04, 2018 | Jul. 17, 2018 | Radiation (03CH07-HY) |
| EMI Test Receiver         | Agilent         | N9038A (MXE)              | MY53290053  | 20Hz to 26.5GHz               | Jan. 16, 2018    | Mar. 31, 2018~Apr. 04, 2018 | Jan. 15, 2019 | Radiation (03CH07-HY) |
| Amplifier                 | SONOMA          | 310N                      | 187231      | 9kHz~1GHz                     | Jan. 08, 2018    | Mar. 31, 2018~Apr. 04, 2018 | Jan. 07, 2019 | Radiation (03CH07-HY) |
| SHF-EHF Horn Antenna      | SCHWARZBECK     | BBHA 9170                 | BBHA9170584 | 18GHz- 40GHz                  | Nov. 27, 2017    | Mar. 31, 2018~Apr. 04, 2018 | Nov. 26, 2018 | Radiation (03CH07-HY) |
| Test Software             | Audix           | E3 6.2009-8-24            | N/A         | N/A                           | N/A              | Mar. 31, 2018~Apr. 04, 2018 | N/A           | Radiation (03CH07-HY) |



## 5 Uncertainty of Evaluation

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

|   |     |
|---|-----|
| Measuring Uncertainty for a Level of Confidence<br>of 95% ( $U = 2U_{C(y)}$ ) | 5.7 |
|---|-----|

### Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

|   |     |
|---|-----|
| Measuring Uncertainty for a Level of Confidence<br>of 95% ( $U = 2U_{C(y)}$ ) | 5.5 |
|---|-----|

### Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

|   |     |
|---|-----|
| Measuring Uncertainty for a Level of Confidence<br>of 95% ( $U = 2U_{C(y)}$ ) | 5.2 |
|---|-----|

## Appendix A. Test Result of Conducted Test Items

|                |           |                    |       |    |
|----------------|-----------|--------------------|-------|----|
| Test Engineer: | Ethan Lin | Temperature:       | 21-25 | °C |
| Test Date:     | 2018/3/20 | Relative Humidity: | 51-54 | %  |

| <b><u>TEST RESULTS DATA</u></b> |     |     |                     |                      |
|---------------------------------|-----|-----|---------------------|----------------------|
| <b><u>Peak Power Table</u></b>  |     |     |                     |                      |
| DH                              | CH. | NTX | Peak Power<br>(dBm) | Power Limit<br>(dBm) |
| DH1                             | 0   | 1   | 5.58                | 20.97                |
|                                 | 39  | 1   | <b>5.85</b>         | 20.97                |
|                                 | 78  | 1   | 5.82                | 20.97                |
| 2DH1                            | 0   | 1   | <b>5.48</b>         | 20.97                |
|                                 | 39  | 1   | 4.60                | 20.97                |
|                                 | 78  | 1   | 4.61                | 20.97                |
| 3DH1                            | 0   | 1   | 4.68                | 20.97                |
|                                 | 39  | 1   | <b>5.07</b>         | 20.97                |
|                                 | 78  | 1   | 4.81                | 20.97                |

| <b><u>TEST RESULTS DATA</u></b>   |     |     |                        |                     |
|-----------------------------------|-----|-----|------------------------|---------------------|
| <b><u>Average Power Table</u></b> |     |     |                        |                     |
| <b><u>(Reporting Only)</u></b>    |     |     |                        |                     |
| DH                                | CH. | NTX | Average Power<br>(dBm) | Duty Factor<br>(dB) |
| DH1                               | 0   | 1   | 4.72                   | 5.15                |
|                                   | 39  | 1   | <b>4.98</b>            | 5.15                |
|                                   | 78  | 1   | 4.72                   | 5.15                |
| 2DH1                              | 0   | 1   | 1.49                   | 5.10                |
|                                   | 39  | 1   | <b>1.71</b>            | 5.10                |
|                                   | 78  | 1   | 1.49                   | 5.10                |
| 3DH1                              | 0   | 1   | 1.51                   | 5.10                |
|                                   | 39  | 1   | <b>1.71</b>            | 5.10                |
|                                   | 78  | 1   | 1.50                   | 5.10                |



## Appendix B. Radiated Spurious Emission

|                 |  |                     |  |         |  |
|-----------------|--|---------------------|--|---------|--|
| Test Engineer : | Jesse Wang, Stan Hsieh, and Lance Chiang | Temperature :       |  | 22~24°C |  |
|                 |  | Relative Humidity : |  | 51~53%  |  |

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

| BT                     | Note | Frequency | Level            | Over   | Limit            | Read           | Antenna  | Path   | Preamp | Ant    | Table   | Peak  | Pol.  |
|------------------------|------|-----------|------------------|--------|------------------|----------------|----------|--------|--------|--------|---------|-------|-------|
|                        |      |           |                  | Limit  | Line             | Level          | Factor   | Loss   | Factor | Pos    | Pos     | Avg.  |       |
|                        |      | ( MHz )   | ( dB $\mu$ V/m ) | ( dB ) | ( dB $\mu$ V/m ) | ( dB $\mu$ V ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| BT<br>CH00<br>2402MHz  |      | 2389.8    | 47.39            | -26.61 | 74               | 43.05          | 31.95    | 7.44   | 35.05  | 370    | 114     | P     | H     |
|                        |      | 2389.8    | 22.6             | -31.4  | 54               | -              | -        | -      | -      | -      | -       | A     | H     |
|                        | *    | 2402      | 99.07            | -      | -                | 94.73          | 31.95    | 7.44   | 35.05  | 370    | 114     | P     | H     |
|                        | *    | 2402      | 74.28            | -      | -                | -              | -        | -      | -      | -      | -       | A     | H     |
|                        |      |           |                  |        |                  |                |          |        |        |        |         |       | H     |
|                        |      |           |                  |        |                  |                |          |        |        |        |         |       | H     |
|                        |      | 2389.17   | 49.49            | -24.51 | 74               | 45.14          | 31.95    | 7.44   | 35.04  | 280    | 199     | P     | V     |
|                        |      | 2389.17   | 24.7             | -29.3  | 54               | -              | -        | -      | -      | -      | -       | A     | V     |
|                        | *    | 2402      | 105.5            | -      | -                | 101.16         | 31.95    | 7.44   | 35.05  | 280    | 199     | P     | V     |
|                        | *    | 2402      | 80.71            | -      | -                | -              | -        | -      | -      | -      | -       | A     | V     |
| BT<br>CH 39<br>2441MHz |      |           |                  |        |                  |                |          |        |        |        |         |       | V     |
|                        |      | 2388.26   | 45.36            | -28.64 | 74               | 41.01          | 31.95    | 7.44   | 35.04  | 357    | 111     | P     | H     |
|                        |      | 2388.26   | 20.57            | -33.43 | 54               | -              | -        | -      | -      | -      | -       | A     | H     |
|                        | *    | 2441      | 98.31            | -      | -                | 93.79          | 32.08    | 7.5    | 35.06  | 357    | 111     | P     | H     |
|                        | *    | 2441      | 73.52            | -      | -                | -              | -        | -      | -      | -      | -       | A     | H     |
|                        |      | 2493      | 46.35            | -27.65 | 74               | 41.67          | 32.2     | 7.56   | 35.08  | 357    | 111     | P     | H     |
|                        |      | 2493      | 21.56            | -32.44 | 54               | -              | -        | -      | -      | -      | -       | A     | H     |
|                        |      | 2371.6    | 46.25            | -27.75 | 74               | 42             | 31.91    | 7.38   | 35.04  | 272    | 202     | P     | V     |
|                        |      | 2371.6    | 21.46            | -32.54 | 54               | -              | -        | -      | -      | -      | -       | A     | V     |
|                        | *    | 2441      | 105.43           | -      | -                | 100.91         | 32.08    | 7.5    | 35.06  | 272    | 202     | P     | V     |
|                        | *    | 2441      | 80.64            | -      | -                | -              | -        | -      | -      | -      | -       | A     | V     |
|                        |      | 2495.03   | 46.99            | -27.01 | 74               | 42.31          | 32.2     | 7.56   | 35.08  | 272    | 202     | P     | V     |
|                        |      | 2495.03   | 22.2             | -31.8  | 54               | -              | -        | -      | -      | -      | -       | A     | V     |



| BT<br>CH 78<br>2480MHz | *   | 2480    | 96.87  | -      | -  | 92.22 | 32.16 | 7.56 | 35.07 | 344 | 114 | P | H |
|------------------------|---|---------|--------|--------|----|-------|-------|------|-------|-----|-----|---|---|
|                        | *   | 2480    | 72.08  | -      | -  | -     | -     | -    | -     | -   | -   |   | H |
|                        |   | 2483.64 | 50.11  | -23.89 | 74 | 45.46 | 32.16 | 7.56 | 35.07 | 344 | 114 | P | H |
|                        |   | 2483.64 | 25.32  | -28.68 | 54 | -     | -     | -    | -     | -   | -   |   | H |
|                        |   |         |        |        |    |       |       |      |       |     |     |   | H |
|                        |   |         |        |        |    |       |       |      |       |     |     |   | H |
|                        | *   | 2480    | 104.28 | -      | -  | 99.63 | 32.16 | 7.56 | 35.07 | 295 | 195 | P | V |
|                        | *   | 2480    | 79.49  | -      | -  | -     | -     | -    | -     | -   | -   |   | V |
|                        |   | 2483.52 | 56.58  | -17.42 | 74 | 51.93 | 32.16 | 7.56 | 35.07 | 295 | 195 | P | V |
|                        |   | 2483.52 | 31.79  | -22.21 | 54 | -     | -     | -    | -     | -   | -   |   | 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>( dB $\mu$ V/m ) | Over<br>Limit<br>( dB ) | Limit<br>Line<br>( dB $\mu$ V/m ) | Read<br>Level<br>( dB $\mu$ V ) | Antenna<br>Factor<br>( dB/m ) | Path<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 |   | 4804                 | 42.27                     | -31.73                  | 74                                | 56.35                           | 34.24                         | 11.08                  | 59.4                       | 100                  | 0                       | P                     | H             |
|                        |   | 4804                 | 17.48                     | -36.52                  | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | H             |
|                        |   |                      |                           |                         |                                   |                                 |                               |                        |                            |                      |                         |                       | H             |
|                        |   |                      |                           |                         |                                   |                                 |                               |                        |                            |                      |                         |                       | H             |
|                        |   | 4804                 | 43.54                     | -30.46                  | 74                                | 57.62                           | 34.24                         | 11.08                  | 59.4                       | 100                  | 0                       | P                     | V             |
|                        |   | 4804                 | 18.75                     | -35.25                  | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | V             |
|                        |   |                      |                           |                         |                                   |                                 |                               |                        |                            |                      |                         |                       | V             |
|                        |   |                      |                           |                         |                                   |                                 |                               |                        |                            |                      |                         |                       | V             |
| BT<br>CH 39<br>2441MHz |   | 4882                 | 41.46                     | -32.54                  | 74                                | 55.37                           | 34.22                         | 11.16                  | 59.29                      | 100                  | 0                       | P                     | H             |
|                        |   | 4882                 | 16.67                     | -37.33                  | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | H             |
|                        |   | 7323                 | 41.82                     | -32.18                  | 74                                | 50.57                           | 35.7                          | 13.61                  | 58.06                      | 100                  | 0                       | P                     | H             |
|                        |   | 7323                 | 17.03                     | -36.97                  | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | H             |
|                        |   | 4882                 | 43.6                      | -30.4                   | 74                                | 57.51                           | 34.22                         | 11.16                  | 59.29                      | 100                  | 0                       | P                     | V             |
|                        |   | 4882                 | 18.81                     | -35.19                  | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | V             |
|                        |   | 7323                 | 41.16                     | -32.84                  | 74                                | 49.91                           | 35.7                          | 13.61                  | 58.06                      | 100                  | 0                       | P                     | V             |
|                        |   | 7323                 | 16.37                     | -37.63                  | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | V             |
| BT<br>CH 78<br>2480MHz |   | 4960                 | 41.82                     | -32.18                  | 74                                | 55.51                           | 34.21                         | 11.26                  | 59.16                      | 100                  | 0                       | P                     | H             |
|                        |   | 4960                 | 17.03                     | -36.97                  | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | H             |
|                        |   | 7440                 | 41.6                      | -32.4                   | 74                                | 50.42                           | 35.63                         | 13.71                  | 58.16                      | 100                  | 0                       | P                     | H             |
|                        |   | 7440                 | 16.81                     | -37.19                  | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | H             |
|                        |   | 4960                 | 44.99                     | -29.01                  | 74                                | 58.68                           | 34.21                         | 11.26                  | 59.16                      | 100                  | 0                       | P                     | V             |
|                        |   | 4960                 | 20.2                      | -33.8                   | 54                                | -                               | -                             | -                      | -                          | -                    | -                       | A                     | V             |
|                        |   | 7440                 | 40.69                     | -33.31                  | 74                                | 49.51                           | 35.63                         | 13.71                  | 58.16                      | 100                  | 0                       | P                     | V             |
|                        |   | 7440                 | 15.9                      | -38.1                   | 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)

**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 or Average</b>   |
| H/V | <b>Horizontal or Vertical</b>  |



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

| BT                     | Note | Frequency | Level            | Over   | Limit            | Read           | Antenna  | Path   | Preamp | Ant    | Table   | Peak  | Pol.  |
|------------------------|------|-----------|------------------|--------|------------------|----------------|----------|--------|--------|--------|---------|-------|-------|
|                        |      |           | Limit            | Line   | Level            | Factor         | Loss     | Factor | Pos    | Pos    | Avg.    |       |       |
|                        |      | ( MHz )   | ( dB $\mu$ V/m ) | ( dB ) | ( dB $\mu$ V/m ) | ( dB $\mu$ V ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| BT<br>CH 00<br>2402MHz |      | 2390      | 55.45            | -18.55 | 74               | 54.51          | 32.22    | 4.58   | 35.86  | 103    | 308     | P     | H     |
|                        |      | 2390      | 43.54            | -10.46 | 54               | 42.6           | 32.22    | 4.58   | 35.86  | 103    | 308     | A     | H     |

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)

2. Level(dB $\mu$ V/m) =

Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dB $\mu$ V) - Preamp Factor(dB)

3. Over Limit(dB) = Level(dB $\mu$ V/m) – Limit Line(dB $\mu$ V/m)

#### For Peak Limit @ 2390MHz:

1. Level(dB $\mu$ V/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dB $\mu$ V) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dB $\mu$ V) – 35.86 (dB)

= 55.45 (dB $\mu$ V/m)

2. Over Limit(dB)

= Level(dB $\mu$ V/m) – Limit Line(dB $\mu$ V/m)

= 55.45(dB $\mu$ V/m) – 74(dB $\mu$ V/m)

= -18.55(dB)

#### For Average Limit @ 2390MHz:

1. Level(dB $\mu$ V/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dB $\mu$ V) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dB $\mu$ V) – 35.86 (dB)

= 43.54 (dB $\mu$ V/m)

2. Over Limit(dB)

= Level(dB $\mu$ V/m) – Limit Line(dB $\mu$ V/m)

= 43.54(dB $\mu$ V/m) – 54(dB $\mu$ V/m)

= -10.46(dB)

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

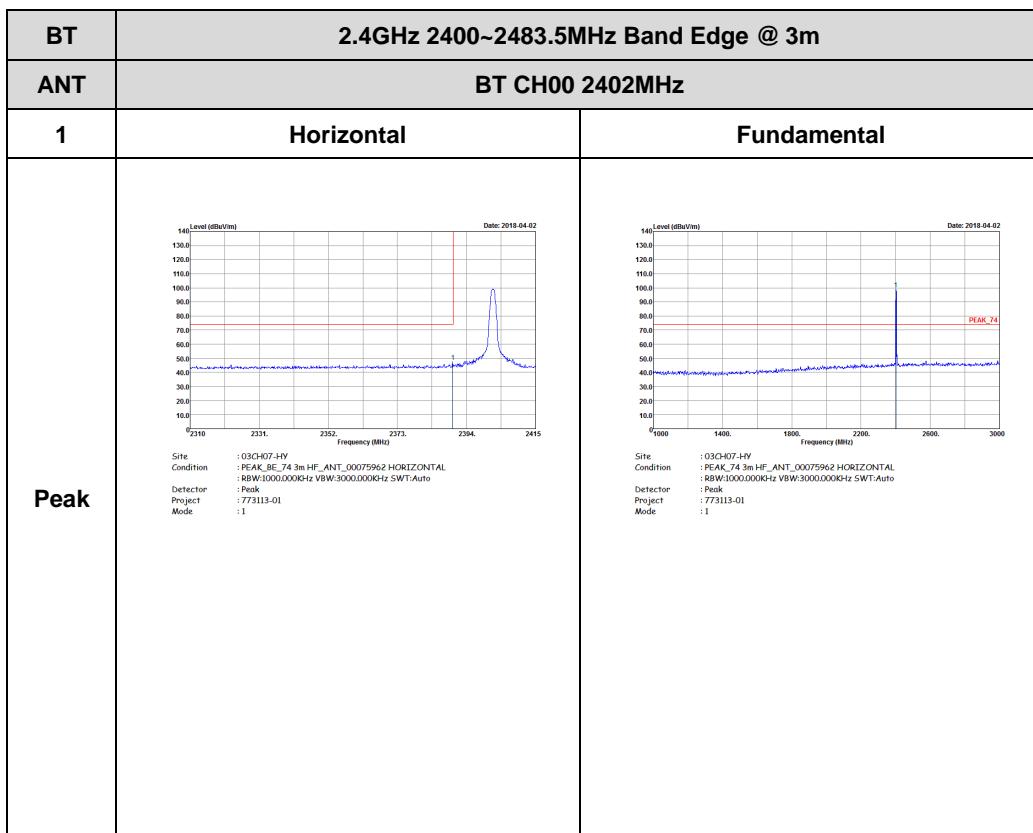


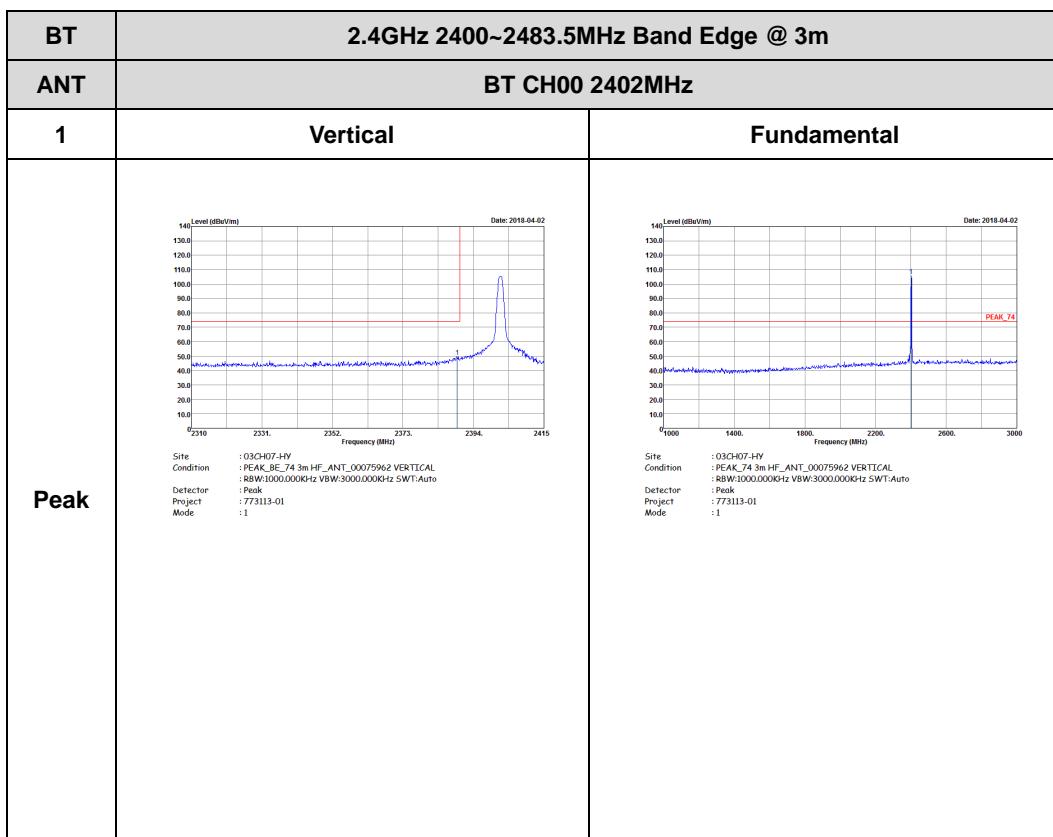
## Appendix C. Radiated Spurious Emission Plots

|                        |  |                            |         |
|------------------------|--|----------------------------|---------|
| <b>Test Engineer :</b> | Jesse Wang, Stan Hsieh, and Lance Chiang | <b>Temperature :</b>       | 22~24°C |
|                        |  | <b>Relative Humidity :</b> | 51~53%  |

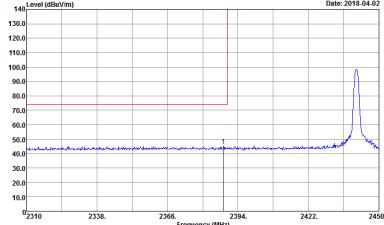
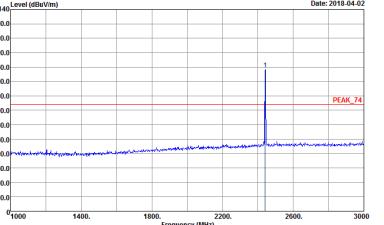
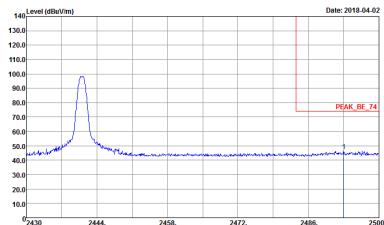
### 2.4GHz 2400~2483.5MHz

#### BT (Band Edge @ 3m)

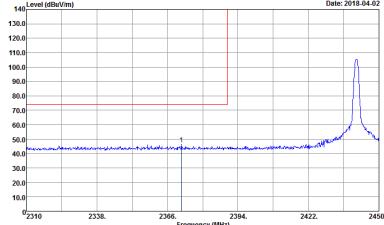
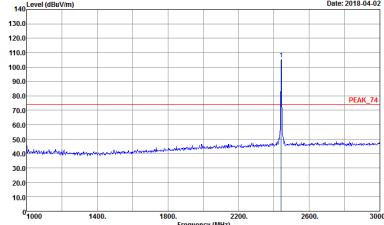
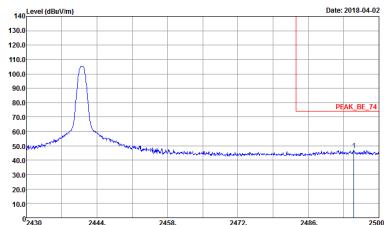


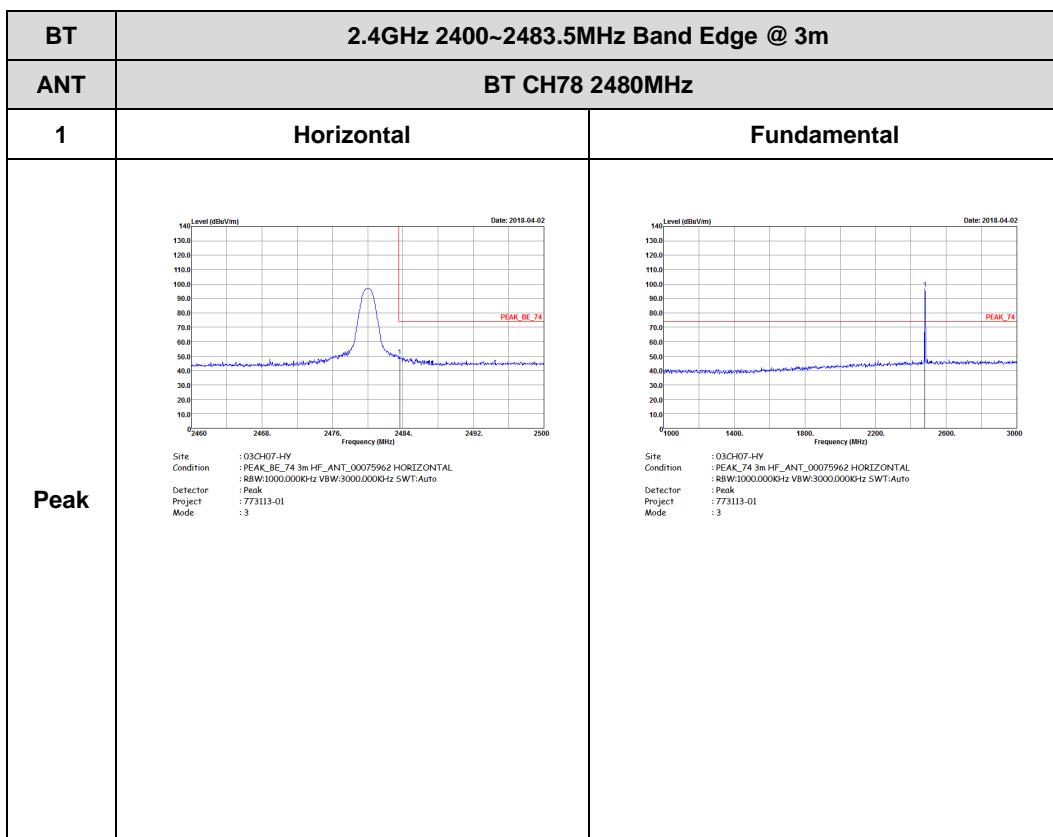


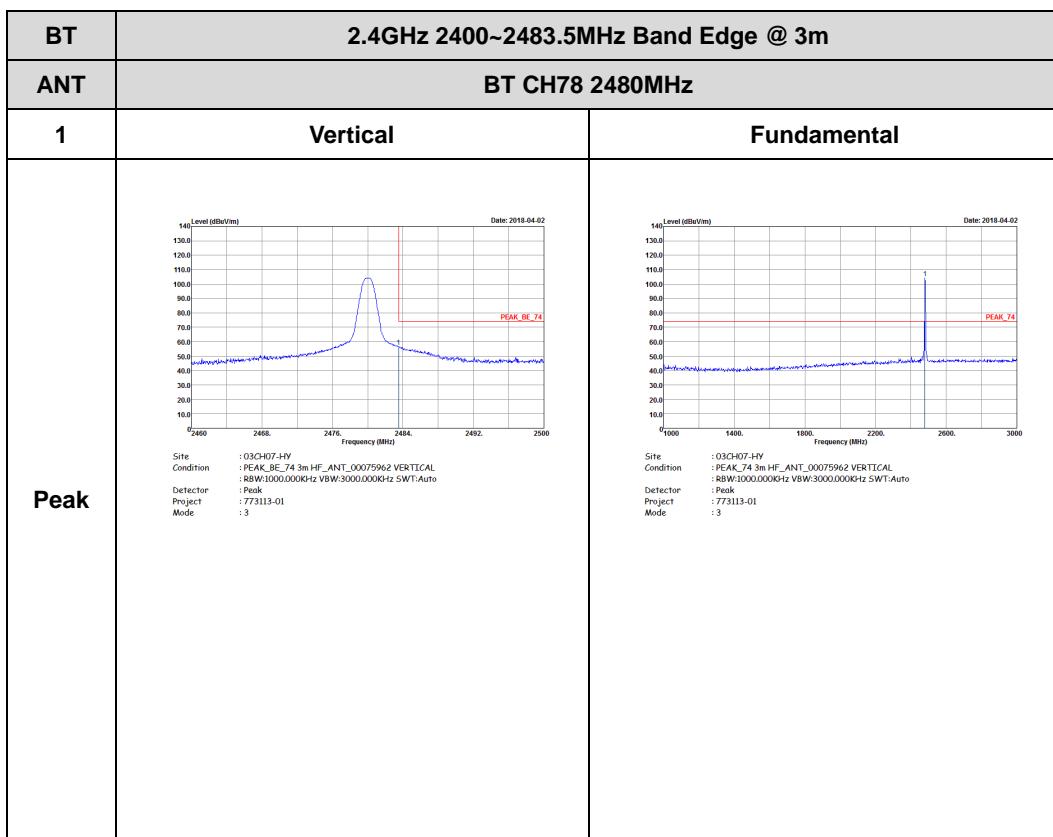


|             |   |   |
|-------------|---|---|
| <b>BT</b>   | <b>2.4GHz 2400~2483.5MHz Band Edge @ 3m</b>   |   |
| <b>ANT</b>  | <b>BT CH39 2441MHz</b>  |   |
| <b>1</b>    | <b>Horizontal</b>   | <b>Fundamental</b>  |
| <b>Peak</b> |  <p>Site : 03CH07-HY<br/>Condition : PEAK_BE_74 3m HF,_ANT_00075962 HORIZONTAL<br/>Detector : R8W:1000.000KHz VBW:3000.000KHz SWT:Auto<br/>Project : Peak<br/>Mode : 773113-01<br/>: 2</p>   |  <p>Site : 03CH07-HY<br/>Condition : PEAK_74 3m HF,_ANT_00075962 HORIZONTAL<br/>Detector : R8W:1000.000KHz VBW:3000.000KHz SWT:Auto<br/>Project : Peak<br/>Mode : 773113-01<br/>: 2</p> |
| <b>Peak</b> |  <p>Site : 03CH07-HY<br/>Condition : PEAK_BE_74 3m HF,_ANT_00075962 HORIZONTAL<br/>Detector : R8W:1000.000KHz VBW:3000.000KHz SWT:Auto<br/>Project : Peak<br/>Mode : 773113-01<br/>: 2</p> | <b>Left blank</b>   |



|             |   |   |
|-------------|---|---|
| <b>BT</b>   | <b>2.4GHz 2400~2483.5MHz Band Edge @ 3m</b>   |   |
| <b>ANT</b>  | <b>BT CH39 2441MHz</b>  |   |
| <b>1</b>    | <b>Vertical</b>   | <b>Fundamental</b>  |
| <b>Peak</b> | <br>Site : 03CH07-HY<br>Condition : PEAK_BE_74 3m HF_, ANT_00075962 VERTICAL<br>Detector : R8W:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Project : 773113-01<br>Mode : 2   | <br>Site : 03CH07-HY<br>Condition : PEAK_74 3m HF_, ANT_00075962 VERTICAL<br>Detector : R8W:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Project : 773113-01<br>Mode : 2 |
| <b>Peak</b> | <br>Site : 03CH07-HY<br>Condition : PEAK_BE_74 3m HF_, ANT_00075962 VERTICAL<br>Detector : R8W:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Project : 773113-01<br>Mode : 2 | <b>Left blank</b>   |

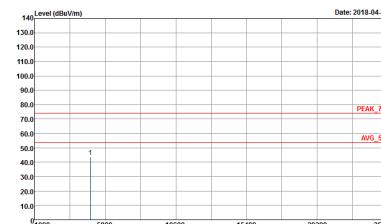


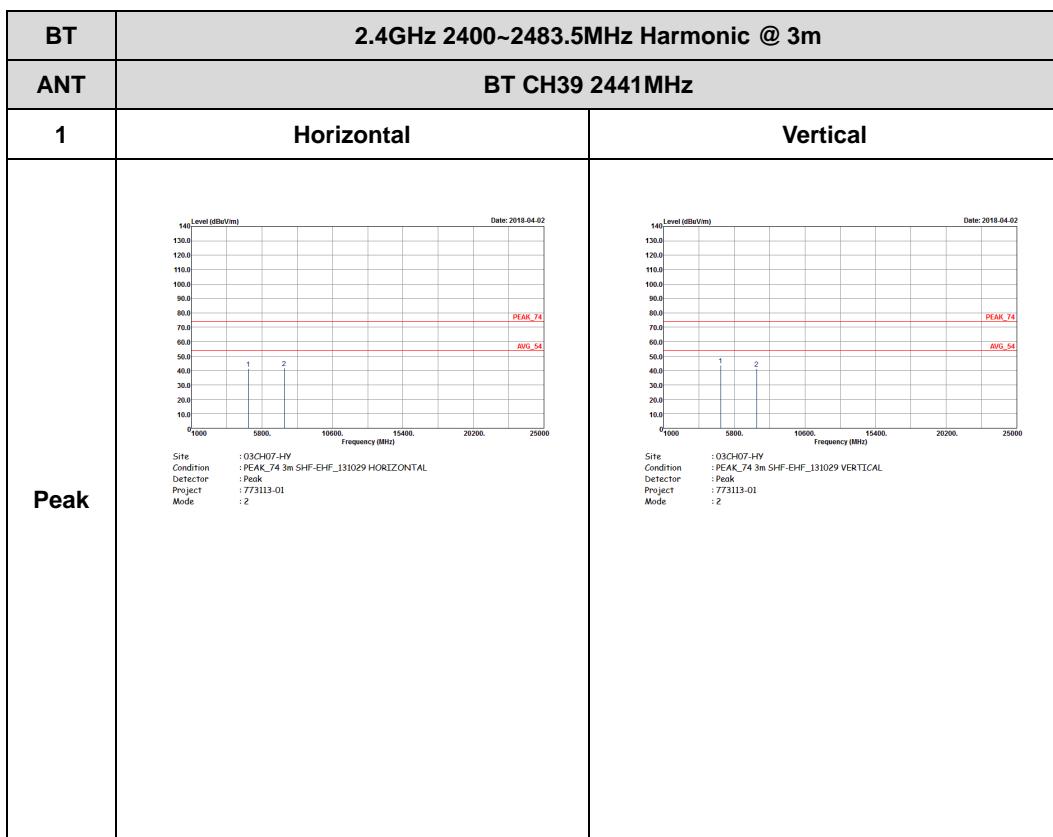


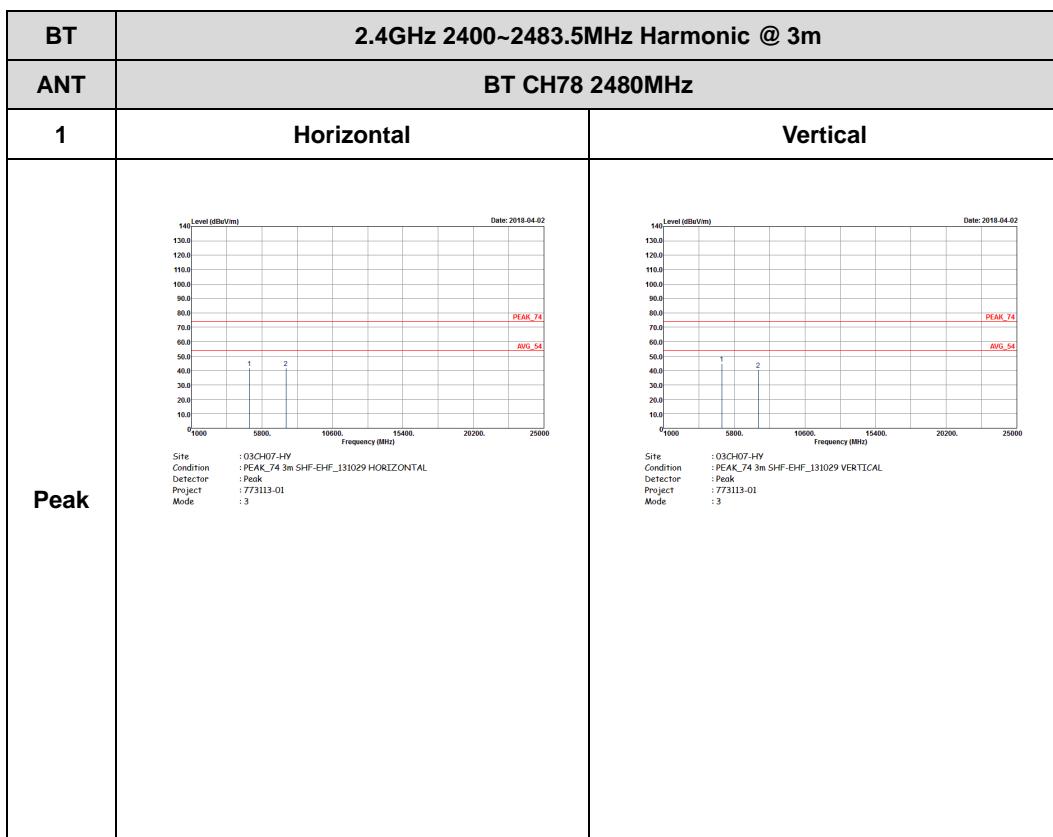


## 2.4GHz 2400~2483.5MHz

## BT (Harmonic @ 3m)

|      |   |  |
|------|---|--|
| BT   | 2.4GHz 2400~2483.5MHz Harmonic @ 3m   |  |
| ANT  | BT CH00 2402MHz   |  |
| 1    | Horizontal  | Vertical   |
| Peak |  <p>Site : 03C-K07-1/P<br/>Condition : PEAK_74 3m SHF-EHF_131029 HORIZONTAL<br/>Detector : Peak<br/>Project : 773113-01<br/>Mode : 1</p> |  <p>Site : 03C-K07-1/P<br/>Condition : PEAK_74 3m SHF-EHF_131029 VERTICAL<br/>Detector : Peak<br/>Project : 773113-01<br/>Mode : 1</p> |

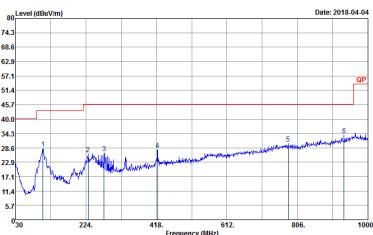
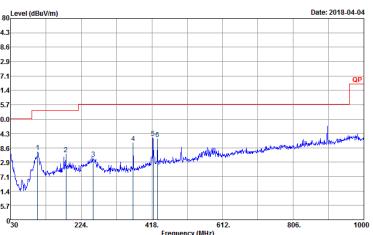






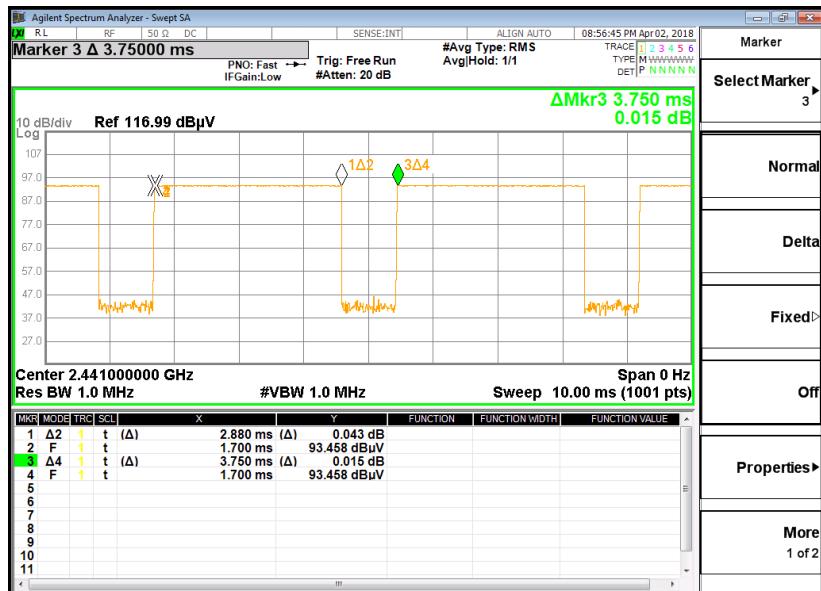
## Emission below 1GHz

## 2.4GHz BT (LF)

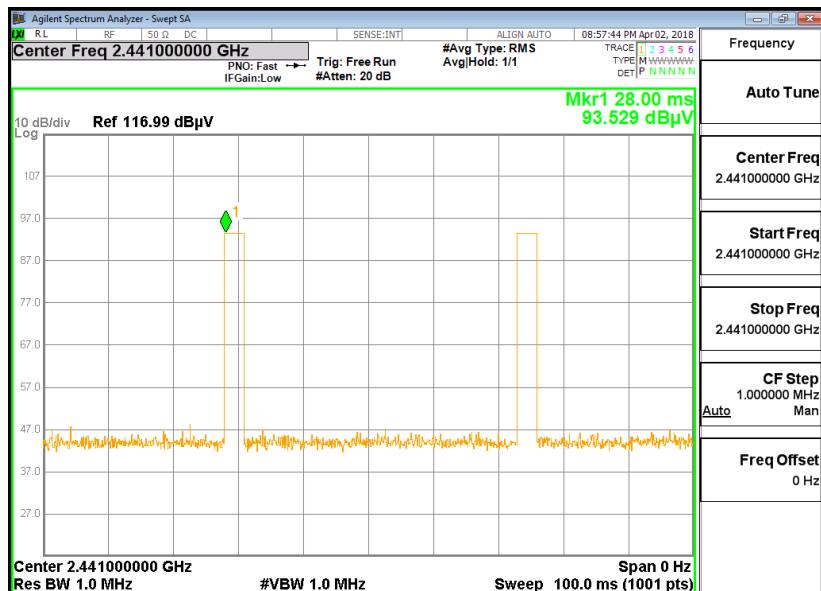
| BT           | 2.4GHz 2400~2483.5MHz  |   |
|--------------|--|---|
| ANT          | BT LF  |   |
| 1            | Horizontal   | Vertical  |
| QP /<br>Peak |  <p>Site : 030107-H/P<br/>Condition : QP 3m LF-ANT-35419(6) HORIZONTAL<br/>Detector : Peak<br/>Project : 773113-01<br/>Mode : 4</p> |  <p>Site : 030107-H/P<br/>Condition : QP 3m LF-ANT-35419(6) VERTICAL<br/>Detector : Peak<br/>Project : 773113-01<br/>Mode : 4</p> |

## Appendix D. Duty Cycle Plots

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



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



#### Note:

1. Worst case Duty cycle = on time/100 milliseconds =  $2 * 2.88 / 100 = 5.76 \%$
2. Worst case Duty cycle correction factor =  $20 * \log(\text{Duty cycle}) = -24.79 \text{ dB}$
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

$$2.88 \text{ ms} \times 20 \text{ channels} = 57.6 \text{ ms}$$

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:

$$2.88 \text{ ms} \times 2 = 5.76 \text{ ms}$$

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

$$20 \times \log(5.76 \text{ ms}/100\text{ms}) = -24.79 \text{ dB}$$