

Report No.: FR811724A



# FCC RADIO TEST REPORT

FCC ID : UDX-60053020

Equipment : LTE & Wi-Fi Router

**Brand Name: CISCO** 

Model Name: Z3C-HW-NA

Applicant : Cisco Systems, Inc.

170 West Tasman Drive, San Jose, CA 95134

Standard : FCC Part 15 Subpart C §15.247

The product was received on Jan. 17, 2018 and testing was started from May 08, 2018 and completed on May 25, 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 report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERTIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Approved by: Jones Tsai

SPORTON INTERTIONAL 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

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| Report No. | Version | Description             | Issued Date   |
|------------|---------|-------------------------|---------------|
| FR811724A  | 01      | Initial issue of report | Jul. 27, 2018 |
|            |         |                         |               |
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## **Summary of Test Result**

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| Report<br>Clause | Ref Std.<br>Clause    | Test Items                                      | Result<br>(PASS/FAIL) | Remark                                  |
|------------------|-----------------------|---|-----------------------|---|
| 3.1              | 15.247(a)(2)          | 6dB Bandwidth                                   | Pass                  | -                                       |
| 3.1              | 2.1049                | 99% Occupied Bandwidth                          | Reporting only        | -                                       |
| 3.2              | 15.247(b)(3)          | Peak Output Power Pass                          |                       | -                                       |
| 3.3              | 15.247(e)             | Power Spectral Density Pass                     |                       | -                                       |
| 3.4              | 15.247(d)             | Conducted Band Edges and Spurious Emission Pass |                       | -                                       |
| 3.5              | 15.247(d)             | Radiated Band Edges and Spurious Emission Pass  |                       | Under limit<br>4.15 dB at<br>86.970 MHz |
| 3.6              | 15.207                | AC Conducted Emission Pass                      |                       | Under limit<br>14.84 dB at<br>3.973 MHz |
| 3.7              | 15.203 &<br>15.247(b) | Antenna Requirement                             |                       |   |

Reviewed by: Joseph Lin Report Producer: Yuping Lin

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## 1 General Description

## 1.1 Product Feature of Equipment Under Test

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

| Product Specification subjective to this standard |                                    |  |  |  |  |
|---|------------------------------------|--|--|--|--|
|   | WWAN: PIFA Antenna                 |  |  |  |  |
|   | WLAN                               |  |  |  |  |
| Antenna Type                                      | <ant. 1="">: PIFA Antenna</ant.>   |  |  |  |  |
|   | <ant. 2="">: Dipole Antenna</ant.> |  |  |  |  |
|   | Bluetooth: PIFA Antenna            |  |  |  |  |

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#### 1.2 Modification of EUT

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

## 1.3 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 and TW0007 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.      | Sporton   | Site No. |  |  |  |  |
| rest site No.      | TH05-HY   | CO05-HY  |  |  |  |  |

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

| Test Site          | SPORTON INTERNATIONAL INC.  |
|--------------------|---|
| Test Site Location | No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist.,<br>Taoyuan City, Taiwan (R.O.C.)<br>TEL: +886-3-327-0868<br>FAX: +886-3-327-0855 |
| Test Site No.      | Sporton Site No. 03CH12-HY  |

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

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## 1.4 Applicable Standards

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

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- FCC Part 15 Subpart C §15.247
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- 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. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

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#### **Test Configuration of Equipment Under Test** 2

## 2.1 Carrier Frequency Channel

| Frequency Band  | Channel             | Freq.<br>(MHz) | Channel | Freq.<br>(MHz) |
|-----------------|---------------------|----------------|---------|----------------|
|                 | 0                   | 2402           | 21      | 2444           |
|                 | 1                   | 2404           | 22      | 2446           |
|                 | 2                   | 2406           | 23      | 2448           |
|                 | 3                   | 2408           | 24      | 2450           |
|                 | 4                   | 2410           | 25      | 2452           |
|                 | 5                   | 2412           | 26      | 2454           |
|                 | 6                   | 2414           | 27      | 2456           |
|                 | 7                   | 2416           | 28      | 2458           |
|                 | 8                   | 2418           | 29      | 2460           |
|                 | 9<br>10<br>11<br>12 | 2420           | 30      | 2462           |
| 2400-2483.5 MHz |                     | 2422           | 31      | 2464           |
|                 |                     | 2424           | 32      | 2466           |
|                 |                     | 2426           | 33      | 2468           |
|                 | 13                  | 2428           | 34      | 2470           |
|                 | 14                  | 2430           | 35      | 2472           |
|                 | 15                  | 2432           | 36      | 2474           |
|                 | 16                  | 2434           | 37      | 2476           |
|                 | 17                  | 2436           | 38      | 2478           |
|                 | 18                  | 2438           | 39      | 2480           |
|                 | 19                  | 2440           | -       | -              |
|                 | 20                  | 2442           | -       | -              |

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#### 2.2 Test Mode

a. 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: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report.

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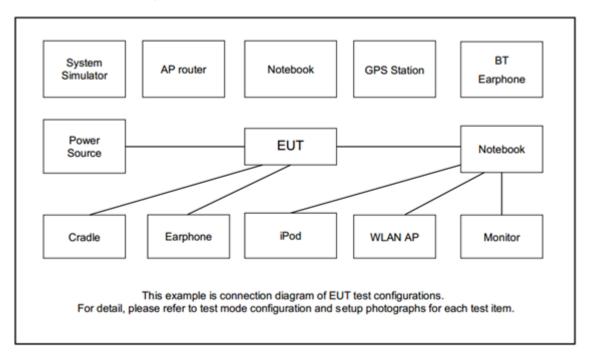
b. AC power line Conducted Emission was tested under maximum output power.

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   |  |  |  |  |
| rest item                   | Bluetooth – LE / GFSK  |  |  |  |  |
| Conducted                   | Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps   |  |  |  |  |
|                             | Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps   |  |  |  |  |
| Test Cases                  | Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps   |  |  |  |  |
| Radiated                    | Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps   |  |  |  |  |
|                             | Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps   |  |  |  |  |
| Test Cases                  | Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps   |  |  |  |  |
| AC                          | Made 4: W/I AN /2 4CHz) Link - Plueteeth - LE Link - P.L.45 /LAN\ Link - LISP Link |  |  |  |  |
| Conducted                   | Mode 1: WLAN (2.4GHz) Link + Bluetooth - LE Link + RJ-45 (LAN) Link + USB Link     |  |  |  |  |
| Emission                    | + Adapter + Connects to the MR33 via RJ-45   |  |  |  |  |

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## 2.3 Connection Diagram of Test System



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## 2.4 Support Unit used in test configuration and system

| Item | Equipment        | Trade Name | Model Name     | FCC ID                                       | Data Cable | Power Cord   |
|------|------------------|------------|----------------|--|------------|--|
| 1.   | Notebook         | DELL       | Latitude E6320 | FCC DoC/<br>Contains FCC ID:<br>QDS-BRCM1054 | N/A        | AC I/P:<br>Unshielded, 1.2 m<br>DC O/P:<br>Shielded, 1.8 m |
| 2.   | Notebook         | DELL       | Latitude E3340 | FCC DoC/<br>Contains FCC ID:<br>PD97260NGU   | N/A        | AC I/P:<br>Unshielded, 1.2 m<br>DC O/P:<br>Shielded, 1.8 m |
| 3.   | Mobile Phone     | Apple      | Apple 6S Plus  | N/A  | N/A        | N/A  |
| 4.   | Cloud-Managed    | cisco      | MR33           | N/A  | N/A        | N/A  |
| 5.   | USB Flash Device | Kingston   | DTGE9          | N/A  | N/A        | N/A  |

## 2.5 EUT Operation Test Setup

The RF test items, utility "CMD" was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

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## 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.

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#### 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.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).  
= 
$$4.2 + 10 = 14.2$$
 (dB)

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#### 3 Test Result

#### 3.1 6dB and 99% Bandwidth Measurement

#### 3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

#### 3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

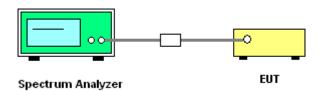
#### 3.1.3 Test Procedures

- 1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
- 2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.

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- 3. Set to the maximum power setting and enable the EUT transmit continuously.
- 4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
- 5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 30kHz and set the Video bandwidth (VBW) = 100kHz.
- 6. Measure and record the results in the test report.

#### 3.1.4 Test Setup

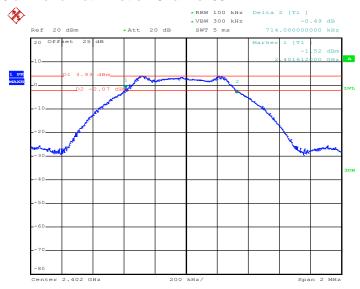


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#### 3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

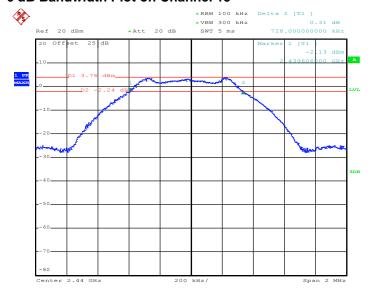
#### 6 dB Bandwidth Plot on Channel 00



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Date: 11.MAY.2018 03:05:32

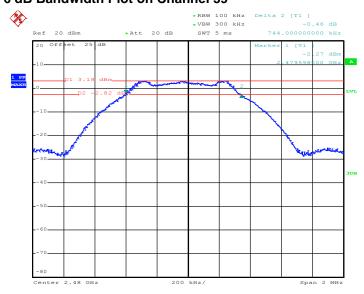
#### 6 dB Bandwidth Plot on Channel 19



Date: 11.MAY.2018 03:44:23

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#### 6 dB Bandwidth Plot on Channel 39



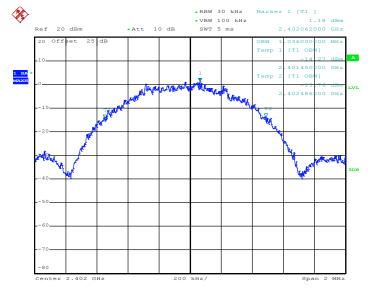
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Date: 11.MAY.2018 03:52:00

### 3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

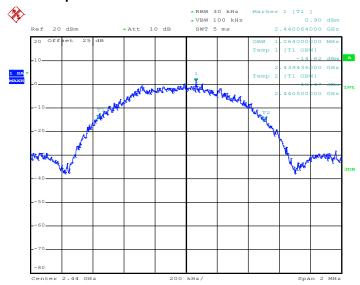
#### 99% Bandwidth Plot on Channel 00



Date: 11.MAY.2018 03:40:42

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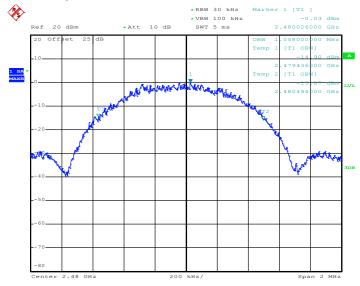
#### 99% Occupied Bandwidth Plot on Channel 19



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#### 99% Occupied Bandwidth Plot on Channel 39



Date: 11.MAY.2018 04:07:27

Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

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### 3.2 Output Power Measurement

#### 3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

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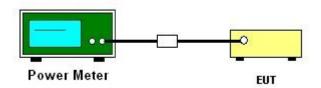
#### 3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

#### 3.2.3 Test Procedures

- For Peak Power, the testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04 section 9.1.3 PKPM1 Peak power meter method.
- 2. For Average Power, the testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04 section 9.2.3.2 Method AVGPM-G.
- 3. The RF output of EUT was connected to the power meter by RF cable and attenuator.
- 4. The path loss was compensated to the results for each measurement.
- 5. Set to the maximum power setting and enable the EUT transmit continuously.
- 6. Measure the conducted output power and record the results in the test report.

#### 3.2.4 Test Setup



#### 3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

#### 3.2.6 Test Result of Average Output Power (Reporting Olny)

Please refer to Appendix A.

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## 3.3 Power Spectral Density Measurement

#### 3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

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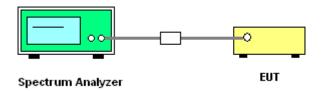
#### 3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

#### 3.3.3 Test Procedures

- The testing follows Measurement Procedure 10.2 Method PKPSD of FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- 2. The RF output of EUT was connected to the spectrum analyzer 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. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
- 5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
- 6. Measure and record the results in the test report.
- 7. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

#### 3.3.4 Test Setup



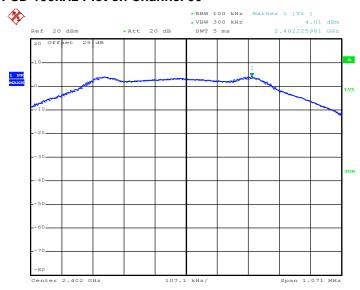
#### 3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

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## 3.3.6 Test Result of Power Spectral Density Plots (100kHz)

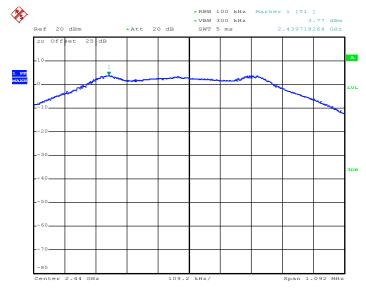
#### PSD 100kHz Plot on Channel 00



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Date: 11.MAY.2018 03:35:51

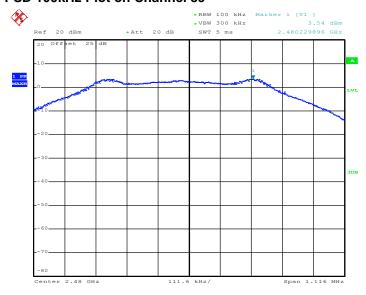
#### PSD 100kHz Plot on Channel 19



Date: 11.MAY.2018 03:47:49

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#### PSD 100kHz Plot on Channel 39

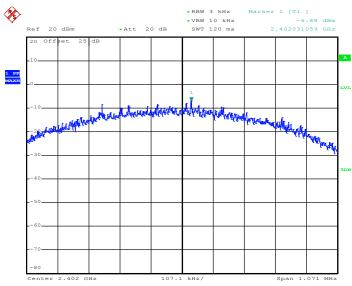


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Date: 11.MAY.2018 03:53:16

## 3.3.7 Test Result of Power Spectral Density Plots (3kHz)

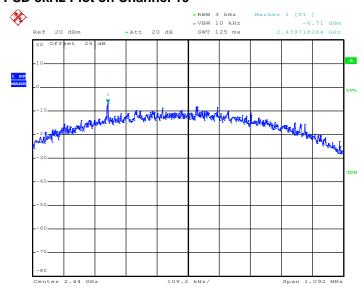
#### **PSD 3kHz Plot on Channel 00**



Date: 11.MAY.2018 03:33:17

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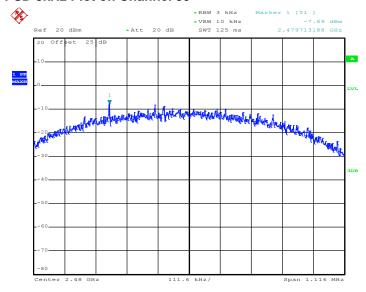
#### **PSD 3kHz Plot on Channel 19**



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Date: 11.MAY.2018 03:47:13

#### **PSD 3kHz Plot on Channel 39**



Date: 11.MAY.2018 03:52:51

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## 3.4 Conducted Band Edges and Spurious Emission Measurement

#### 3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

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#### 3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

#### 3.4.3 Test Procedure

- 1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- 2. The RF output of EUT was connected to the spectrum analyzer 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. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
- 5. Measure and record the results in the test report.
- 6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

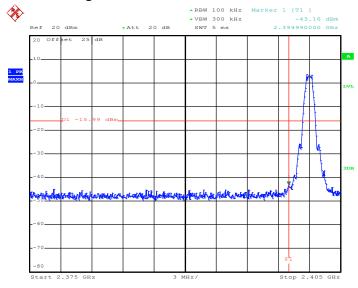
#### 3.4.4 Test Setup



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## 3.4.5 Test Result of Conducted Band Edges Plots

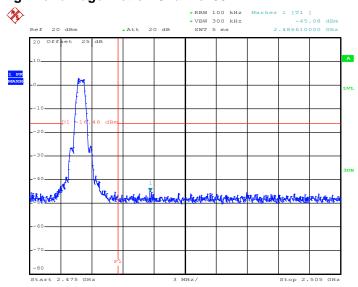
#### Low Band Edge Plot on Channel 00



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Date: 11.MAY.2018 03:36:52

#### **High Band Edge Plot on Channel 39**



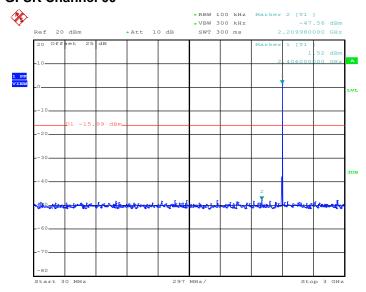
Date: 11.MAY.2018 03:55:28

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### 3.4.6 Test Result of Conducted Spurious Emission Plots

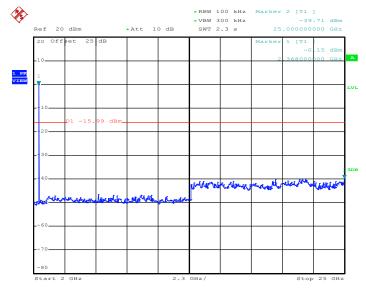
# Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 00

Report No.: FR811724A



Date: 11.MAY.2018 03:39:03

# Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 00

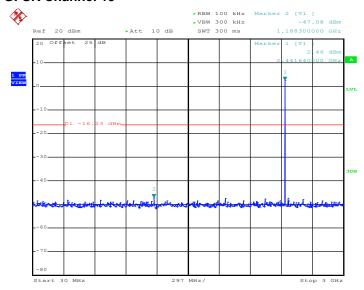


Date: 11.MAY.2018 03:39:35

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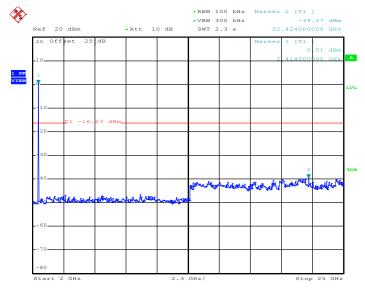
# Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 19

Report No.: FR811724A



Date: 11.MAY.2018 03:48:41

# Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 19

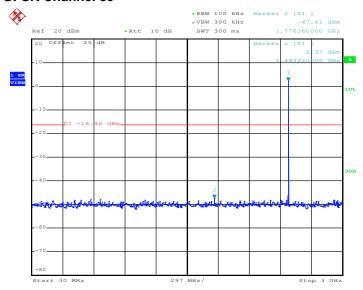


Date: 11.MAY.2018 03:49:08

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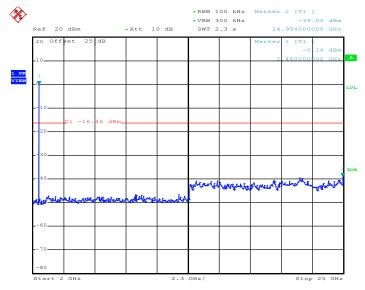
# Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 39

Report No.: FR811724A



Date: 11.MAY.2018 03:56:07

# Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 39



Date: 11.MAY.2018 03:56:23

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## 3.5 Radiated Band Edges and Spurious Emission Measurement

#### 3.5.1 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. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

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| Frequency     | Field Strength     | Measurement Distance |  |  |
|---------------|--------------------|----------------------|--|--|
| (MHz)         | (microvolts/meter) | (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                    |  |  |

#### 3.5.2 Measuring Instruments

See list of measuring equipment of this test report.

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#### 3.5.3 Test Procedures

- 1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- 2. 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.

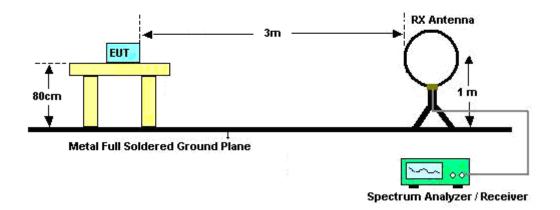
Report No.: FR811724A

- 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.
- 4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
- 5. Corrected Reading: Antenna Factor + Cable Loss + Read Level Preamp Factor = Level
- 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.
- 7. 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.
- 8. 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; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
  - (3) Set RBW = 1 MHz, VBW= 3MHz for  $f \ge 1$  GHz for peak measurement. For average measurement:
    - VBW = 10 Hz, when duty cycle is no less than 98 percent.
    - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

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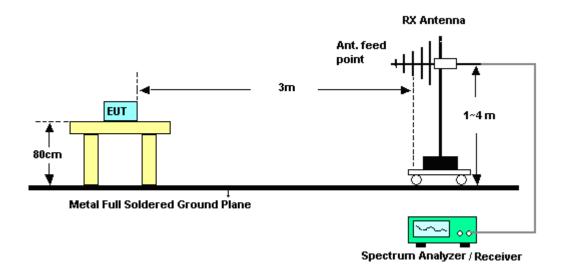
## 3.5.4 Test Setup

#### For radiated emissions below 30MHz



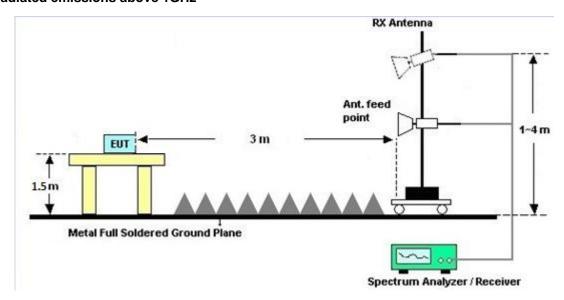
Report No.: FR811724A

#### For radiated emissions from 30MHz to 1GHz



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#### For radiated emissions above 1GHz



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#### 3.5.5 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.

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

Please refer to Appendix C and D.

#### 3.5.7 Duty Cycle

Please refer to Appendix E.

#### 3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix C and D.

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#### 3.6 AC Conducted Emission Measurement

#### 3.6.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

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| Eroquency of emission (MHz) | Conducted limit (dBμV) |           |  |  |  |
|-----------------------------|------------------------|-----------|--|--|--|
| Frequency of emission (MHz) | Quasi-peak             | Average   |  |  |  |
| 0.15-0.5                    | 66 to 56*              | 56 to 46* |  |  |  |
| 0.5-5                       | 56                     | 46        |  |  |  |
| 5-30                        | 60                     | 50        |  |  |  |

<sup>\*</sup>Decreases with the logarithm of the frequency.

#### 3.6.2 Measuring Instruments

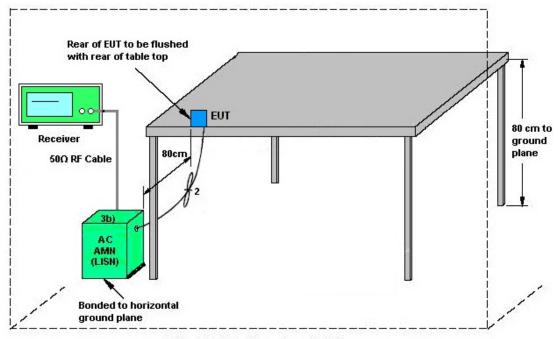
See list of measuring equipment of this test report.

#### 3.6.3 Test Procedures

- The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
- 2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
- 3. All the support units are connecting to the other LISN.
- 4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
- 5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
- 6. Both sides of AC line were checked for maximum conducted interference.
- 7. The frequency range from 150 kHz to 30 MHz was searched.
- 8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

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## 3.6.4 Test Setup



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AMN = Artificial mains network (LISN)

AE = Associated equipment

EUT = Equipment under test

ISN = Impedance stabilization network

#### 3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

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## 3.7 Antenna Requirements

#### 3.7.1 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.

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#### 3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

#### 3.7.3 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.

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## 4 List of Measuring Equipment

| Instrument               | Manufacturer          | Model No.                           | Serial No.     | Characteristics                    | Calibration<br>Date | Test Date                     | Due Date      | Remark                   |
|--------------------------|-----------------------|-------------------------------------|----------------|------------------------------------|---------------------|-------------------------------|---------------|--------------------------|
| Power Meter              | Agilent               | E4416A                              | GB412923<br>44 | N/A                                | Dec. 20, 2017       | May 11, 2018                  | Dec. 19, 2018 | Conducted<br>(TH05-HY)   |
| Power Sensor             | Agilent               | E9327A                              | US404415<br>48 | 50MHz~18GHz                        | Dec. 20, 2017       | May 11, 2018                  | Dec. 19, 2018 | Conducted<br>(TH05-HY)   |
| Spectrum<br>Analyzer     | Rohde &<br>Schwarz    | FSP30                               | 101067         | 9kHz ~ 30GHz                       | Nov. 13, 2017       | May 11, 2018                  | Nov. 12, 2018 | Conducted<br>(TH05-HY)   |
| Switch Box & RF<br>Cable | Burgeon               | ETF-058                             | EC130048<br>4  | N/A                                | Mar. 01, 2018       | May 11, 2018                  | Feb. 28, 2019 | Conducted<br>(TH05-HY)   |
| AC Power Source          | ChainTek              | APC-1000W                           | N/A            | N/A                                | N/A                 | May 25, 2018                  | N/A           | Conduction<br>(CO05-HY)  |
| EMI Test Receiver        | Rohde &<br>Schwarz    | ESR3                                | 102388         | 3.6GHz                             | Dec. 08, 2017       | May 25, 2018                  | Dec. 07, 2018 | Conduction<br>(CO05-HY)  |
| LISN                     | Rohde &<br>Schwarz    | ENV216                              | 100080         | 9kHz~30MHz                         | Nov. 30, 2017       | May 25, 2018                  | Nov. 29, 2018 | Conduction<br>(CO05-HY)  |
| Software                 | Rohde &<br>Schwarz    | EMC32<br>V10.30                     | N/A            | N/A                                | N/A                 | May 25, 2018                  | N/A           | Conduction<br>(CO05-HY)  |
| LF Cable                 | HUBER +<br>SUHNER     | RG-214/U                            | LF01           | N/A                                | Jan. 03, 2018       | May 25, 2018                  | Jan. 02, 2019 | Conduction<br>(CO05-HY)  |
| Pulse Limiter            | Rohde &<br>Schwarz    | ESH3-Z2                             | 100851         | N/A                                | Jan. 03, 2018       | May 25, 2018                  | Jan. 02, 2019 | Conduction<br>(CO05-HY)  |
| Amplifier                | MITEQ                 | TTA1840-35-<br>HG                   | 1871923        | 18GHz~40GHz,<br>VSWR: 2.5:1<br>max | Jul. 18, 2017       | May 08, 2018~<br>May 12, 2018 | Jul. 17, 2018 | Radiation<br>(03CH12-HY) |
| Spectrum<br>Analyzer     | Keysight              | N9010A                              | MY542004<br>85 | 10Hz ~ 44GHz                       | Oct. 31, 2017       | May 08, 2018~<br>May 12, 2018 | Oct. 30, 2018 | Radiation<br>(03CH12-HY) |
| Bilog Antenna            | TESEQ                 | CBL6111D&0<br>0802N1D01N-<br>06     | 47020&06       | 30MHz~1GHz                         | Nov. 20, 2017       | May 08, 2018~<br>May 12, 2018 | Nov. 19, 2018 | Radiation<br>(03CH12-HY) |
| Loop Antenna             | Rohde &<br>Schwarz    | HFH2-Z2                             | 100488         | 9 kHz~30 MHz                       | Nov. 23, 2017       | May 08, 2018~<br>May 12, 2018 | Nov. 22, 2018 | Radiation<br>(03CH12-HY) |
| EMI Test Receiver        | Rohde &<br>Schwarz    | ESU26                               | 100390         | 20Hz~26.5GHz                       | Dec. 25, 2017       | May 08, 2018~<br>May 12, 2018 | Dec. 24, 2018 | Radiation<br>(03CH12-HY) |
| Horn Antenna             | SCHWARZBE<br>CK       | BBHA 9120D                          | 9120D-132<br>8 | 1GHz ~ 18GHz                       | Oct. 20, 2017       | May 08, 2018~<br>May 12, 2018 | Oct. 19, 2018 | Radiation<br>(03CH12-HY) |
| Amplifier                | Sonoma-Instru<br>ment | 310 N                               | 187282         | 9KHz~1GHz                          | Jan. 19, 2018       | May 08, 2018~<br>May 12, 2018 | Jan. 18, 2020 | Radiation<br>(03CH12-HY) |
| Preamplifier             | Keysight              | 83017A                              | MY532701<br>48 | 1GHz~26.5GHz                       | Jan. 15, 2018       | May 08, 2018~<br>May 12, 2018 | Jan. 14, 2019 | Radiation<br>(03CH12-HY) |
| Filter                   | Wainwright            | WHKX12-270<br>0-3000-18000<br>-60ST | SN2            | 3 GHz Highpass                     | Jul. 17, 2017       | May 08, 2018~<br>May 12, 2018 | Jul. 16, 2018 | Radiation<br>(03CH12-HY) |
| Filter                   | Wainwright            | WLKS1200-1<br>2SS                   | SN2            | 1.2G Low Pass                      | Jul. 17, 2017       | May 08, 2018~<br>May 12, 2018 | Jul. 16, 2018 | Radiation<br>(03CH12-HY) |
| Attenuator               | Fairview<br>Microwave | SA18S5W-10                          | n/a            | 10db                               | Jul. 17, 2017       | May 08, 2018~<br>May 12, 2018 | Jul. 16, 2018 | Radiation<br>(03CH12-HY) |
| Antenna Mast             | EMEC                  | AM-BS-4500-<br>B                    | N/A            | 1m~4m                              | N/A                 | May 08, 2018~<br>May 12, 2018 | N/A           | Radiation<br>(03CH12-HY) |

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| Instrument              | Manufacturer      | Model No.                  | Serial No.      | Characteristics | Calibration<br>Date | Test Date                     | Due Date      | Remark                   |
|-------------------------|-------------------|----------------------------|-----------------|-----------------|---------------------|-------------------------------|---------------|--------------------------|
| Turn Table              | EMEC              | TT2000                     | N/A             | 0~360 Degree    | N/A                 | May 08, 2018~<br>May 12, 2018 | N/A           | Radiation<br>(03CH12-HY) |
| SHF-EHF Horn<br>Antenna | SCHWARZBE<br>CK   | BBHA 9170                  | BBHA9170<br>584 | 18GHz ~ 40GHz   | Nov. 27, 2017       | May 08, 2018~<br>May 12, 2018 | Nov. 26, 2018 | Radiation<br>(03CH12-HY) |
| Preamplifier            | MITEQ             | AMF-7D-0010<br>1800-30-10P | 1590074         | 1GHz~18GHz      | May 22, 2017        | May 08, 2018~<br>May 12, 2018 | May 21, 2018  | Radiation<br>(03CH12-HY) |
| Software                | Audix             | E3<br>6.2009-8-24          | RK-00098<br>9   | N/A             | N/A                 | May 08, 2018~<br>May 12, 2018 | N/A           | Radiation<br>(03CH12-HY) |
| RF Cable                | HUBER +<br>SUHNER | SUCOFLEX<br>126E           | 0058/126E       | 30M-18G         | Mar. 14, 2018       | May 08, 2018~<br>May 12, 2018 | Mar. 13, 2019 | Radiation<br>(03CH12-HY) |
| RF Cable                | HUBER +<br>SUHNER | SUCOFLEX<br>104            | MY15539/<br>4   | 30M-18G         | Mar. 14, 2018       | May 08, 2018~<br>May 12, 2018 | Mar. 13, 2019 | Radiation<br>(03CH12-HY) |
| RF Cable                | HUBER +<br>SUHNER | SUCOFLEX<br>104            | MY36979/<br>4   | 30M-18G         | Mar. 14, 2018       | May 08, 2018~<br>May 12, 2018 | Mar. 13, 2019 | Radiation<br>(03CH12-HY) |
| RF Cable                | HUBER +<br>SUHNER | SUCOFLEX<br>102            | 505134/2        | 30M~40GHz       | Oct. 17, 2017       | May 08, 2018~<br>May 12, 2018 | Oct. 16, 2018 | Radiation<br>(03CH12-HY) |
| RF Cable                | HUBER +<br>SUHNER | SUCOFLEX<br>102            | 800740/2        | 30M~40GHz       | Oct. 17, 2017       | May 08, 2018~<br>May 12, 2018 | Oct. 16, 2018 | Radiation<br>(03CH12-HY) |

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## 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)) | 2.7 |
|---|-----|
| 01 93 % (0 = 20C(y))  |     |

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

| Measuring Uncertainty for a Level of Confidence | EA  |
|---|-----|
| of 95% (U = 2Uc(y))                             | 5.1 |

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

| Measuring Uncertainty for a Level of Confidence | F 2 |
|---|-----|
| of 95% (U = 2Uc(y))                             | 5.2 |

#### <u>Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)</u>

| Measuring Uncertainty for a Level of Confidence |     |
|---|-----|
| of 95% (U = 2Uc(y))                             | 4.7 |

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### Appendix A. Test Result of Conducted Test Items

| Test Engineer: | Shiming Liu | Temperature:       | 21~25 | °C |
|----------------|-------------|--------------------|-------|----|
| Test Date:     | 2018/5/11   | Relative Humidity: | 51~54 | %  |

#### TEST RESULTS DATA 6dB and 99% Occupied Bandwidth

|   | Mod. | Data<br>Rate | NTX | CH. | Freq.<br>(MHz) | 99%<br>Occupied<br>BW<br>(MHz) | 6dB BW<br>(MHz) | 6dB BW<br>Limit<br>(MHz) | Pass/Fail |
|---|------|--------------|-----|-----|----------------|--------------------------------|-----------------|--------------------------|-----------|
| Ī | BLE  | 1Mbps        | 1   | 0   | 2402           | 1.036                          | 0.714           | 0.50                     | Pass      |
| Ī | BLE  | 1Mbps        | 1   | 19  | 2440           | 1.064                          | 0.728           | 0.50                     | Pass      |
|   | BLE  | 1Mbps        | 1   | 39  | 2480           | 1.058                          | 0.744           | 0.50                     | Pass      |

## TEST RESULTS DATA

|  | Peal | k P | ower | Table |
|--|------|-----|------|-------|
|--|------|-----|------|-------|

| Mod. | Data<br>Rate | N⊤x | CH. | Freq.<br>(MHz) | Peak<br>Conducted<br>Power<br>(dBm) | Conducted<br>Power<br>Limit<br>(dBm) | DG<br>(dBi) | EIRP<br>Power<br>(dBm) | EIRP<br>Power<br>Limit<br>(dBm) | Pass<br>/Fail |
|------|--------------|-----|-----|----------------|-------------------------------------|--------------------------------------|-------------|------------------------|---------------------------------|---------------|
| BLE  | 1Mbps        | 1   | 0   | 2402           | 4.65                                | 30.00                                | 0.36        | 5.01                   | 36.00                           | Pass          |
| BLE  | 1Mbps        | 1   | 19  | 2440           | 4.38                                | 30.00                                | 0.36        | 4.74                   | 36.00                           | Pass          |
| BLE  | 1Mbps        | 1   | 39  | 2480           | 4.23                                | 30.00                                | 0.36        | 4.59                   | 36.00                           | Pass          |

# TEST RESULTS DATA Average Power Table

(Reporting Only)

| Мо | od. | Data<br>Rate | N⊤× | CH. | Freq.<br>(MHz) | Duty<br>Factor<br>(dB) | Average<br>Conducted<br>Power<br>(dBm) |
|----|-----|--------------|-----|-----|----------------|------------------------|--|
| BL | E.  | 1Mbps        | 1   | 0   | 2402           | 0.00                   | 4.30                                   |
| BL | E.  | 1Mbps        | 1   | 19  | 2440           | 0.00                   | 4.04                                   |
| BL | E.  | 1Mbps        | 1   | 39  | 2480           | 0.00                   | 3.87                                   |

## TEST RESULTS DATA

Peak Power Density

| Mod. | Data<br>Rate | N⊤x | СН. | Freq.<br>(MHz) | Peak PSD<br>(dBm<br>/100kHz) | Peak PSD<br>(dBm<br>/3kHz) | DG<br>(dBi) | Peak PSD<br>Limit<br>(dBm<br>/3kHz) | Pass/Fail |
|------|--------------|-----|-----|----------------|------------------------------|----------------------------|-------------|-------------------------------------|-----------|
| BLE  | 1Mbps        | 1   | 0   | 2402           | 4.01                         | -6.88                      | 0.36        | 8.00                                | Pass      |
| BLE  | 1Mbps        | 1   | 19  | 2440           | 3.77                         | -6.71                      | 0.36        | 8.00                                | Pass      |
| BLE  | 1Mbps        | 1   | 39  | 2480           | 3.54                         | -7.69                      | 0.36        | 8.00                                | Pass      |

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 20dBc limit.

## **Appendix B. AC Conducted Emission Test Results**

| Toot Engineer   | Arthur Haigh | Temperature :       | <b>25~26</b> ℃ |
|-----------------|--------------|---------------------|----------------|
| Test Engineer : | Althur Hsien | Relative Humidity : | 64~66%         |

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### **EUT Information**

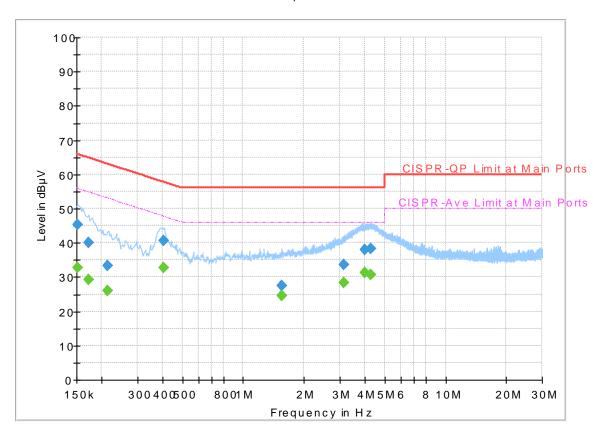
 Report NO :
 811724

 Test Mode :
 Mode 1

 Test Voltage :
 120Vac/60Hz

Phase: Line

#### Full Spectrum



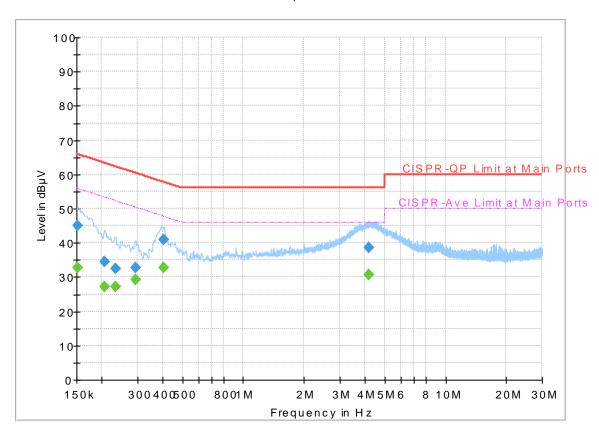
### Final\_Result

| Frequency | QuasiPeak | CAverage | Limit  | Margin | Line | Filter | Corr. |
|-----------|-----------|----------|--------|--------|------|--------|-------|
| (MHz)     | (dBµV)    | (dBµV)   | (dBµV) | (dB)   |      |        | (dB)  |
| 0.152250  |           | 32.66    | 55.88  | 23.22  | L1   | OFF    | 19.5  |
| 0.152250  | 45.19     | -        | 65.88  | 20.69  | L1   | OFF    | 19.5  |
| 0.172500  |           | 29.20    | 54.84  | 25.64  | L1   | OFF    | 19.5  |
| 0.172500  | 40.09     | -        | 64.84  | 24.75  | L1   | OFF    | 19.5  |
| 0.213000  |           | 26.08    | 53.09  | 27.01  | L1   | OFF    | 19.5  |
| 0.213000  | 33.22     |          | 63.09  | 29.87  | L1   | OFF    | 19.5  |
| 0.402000  |           | 32.70    | 47.81  | 15.11  | L1   | OFF    | 19.5  |
| 0.402000  | 40.57     | -        | 57.81  | 17.24  | L1   | OFF    | 19.5  |
| 1.551750  |           | 24.54    | 46.00  | 21.46  | L1   | OFF    | 19.6  |
| 1.551750  | 27.37     | -        | 56.00  | 28.63  | L1   | OFF    | 19.6  |
| 3.151500  |           | 28.28    | 46.00  | 17.72  | L1   | OFF    | 19.6  |
| 3.151500  | 33.71     |          | 56.00  | 22.29  | L1   | OFF    | 19.6  |
| 3.972750  |           | 31.16    | 46.00  | 14.84  | L1   | OFF    | 19.6  |
| 3.972750  | 38.06     |          | 56.00  | 17.94  | L1   | OFF    | 19.6  |
| 4.269750  |           | 30.69    | 46.00  | 15.31  | L1   | OFF    | 19.6  |
| 4.269750  | 38.39     |          | 56.00  | 17.61  | L1   | OFF    | 19.6  |

### **EUT Information**

Report NO: 811724
Test Mode: Mode 1
Test Voltage: 120Vac/60Hz
Phase: Neutral

Full Spectrum



### **Final Result**

| Frequency | QuasiPeak | CAverage | Limit  | Margin | Line | Filter | Corr. |
|-----------|-----------|----------|--------|--------|------|--------|-------|
| (MHz)     | (dBµV)    | (dBµV)   | (dBµV) | (dB)   |      |        | (dB)  |
| 0.152250  |           | 32.66    | 55.88  | 23.22  | N    | OFF    | 19.5  |
| 0.152250  | 44.97     |          | 65.88  | 20.91  | N    | OFF    | 19.5  |
| 0.206250  | -         | 27.24    | 53.36  | 26.12  | N    | OFF    | 19.5  |
| 0.206250  | 34.43     | -        | 63.36  | 28.93  | N    | OFF    | 19.5  |
| 0.233250  |           | 27.13    | 52.33  | 25.20  | N    | OFF    | 19.5  |
| 0.233250  | 32.55     |          | 62.33  | 29.78  | N    | OFF    | 19.5  |
| 0.294000  |           | 29.15    | 50.41  | 21.26  | N    | OFF    | 19.5  |
| 0.294000  | 32.87     |          | 60.41  | 27.54  | N    | OFF    | 19.5  |
| 0.402000  |           | 32.74    | 47.81  | 15.07  | N    | OFF    | 19.5  |
| 0.402000  | 40.82     |          | 57.81  | 16.99  | N    | OFF    | 19.5  |
| 4.182000  | -         | 30.80    | 46.00  | 15.20  | N    | OFF    | 19.6  |
| 4.182000  | 38.63     |          | 56.00  | 17.37  | N    | OFF    | 19.6  |

# Appendix C. Radiated Spurious Emission

| Test Engineer : | Watt Tseng, Karl Hou and Nick Yu | Temperature :       | 21~23°C |
|-----------------|----------------------------------|---------------------|---------|
| rest Engineer.  |                                  | Relative Humidity : | 59~62%  |

Report No. : FR811724A

### 2.4GHz 2400~2483.5MHz

### BLE (Band Edge @ 3m)

| BLE          | Note | Frequency | Level      | Over   | Limit      | Read                | Antenna  | Path   | Preamp | Ant  | Table   | Peak  | Pol. |
|--------------|------|-----------|------------|--------|------------|---------------------|----------|--------|--------|------|---------|-------|------|
|              |      |           |            | Limit  | Line       | Level               | Factor   | Loss   | Factor | Pos  | Pos     | Avg.  |      |
|              |      | (MHz)     | ( dBµV/m ) | ( dB ) | ( dBµV/m ) | (dB <sub>µ</sub> V) | ( dB/m ) | ( dB ) | ( dB ) | (cm) | ( deg ) | (P/A) |      |
|              |      | 2342.655  | 53.42      | -20.58 | 74         | 43.94               | 27.03    | 14.03  | 31.58  | 152  | 133     | Р     | Н    |
|              |      | 2388.96   | 41.19      | -12.81 | 54         | 31.56               | 27.15    | 14.06  | 31.58  | 152  | 133     | Α     | Н    |
|              | *    | 2402      | 94.74      | -      | -          | 85.09               | 27.15    | 14.07  | 31.57  | 152  | 133     | Р     | Н    |
|              | *    | 2402      | 93.8       | -      | -          | 84.15               | 27.15    | 14.07  | 31.57  | 152  | 133     | Α     | Н    |
| BLE          |      |           |            |        |            |                     |          |        |        |      |         |       | Н    |
| CH 00        |      |           |            |        |            |                     |          |        |        |      |         |       | Н    |
| 2402MHz      |      | 2386.65   | 53.53      | -20.47 | 74         | 43.9                | 27.15    | 14.06  | 31.58  | 102  | 9       | Р     | V    |
| 2402111112   |      | 2385.285  | 41.21      | -12.79 | 54         | 31.62               | 27.11    | 14.06  | 31.58  | 102  | 9       | Α     | V    |
|              | *    | 2402      | 91.51      | -      | -          | 81.86               | 27.15    | 14.07  | 31.57  | 102  | 9       | Р     | V    |
|              | *    | 2402      | 90.55      | -      | -          | 80.9                | 27.15    | 14.07  | 31.57  | 102  | 9       | Α     | V    |
|              |      |           |            |        |            |                     |          |        |        |      |         |       | V    |
|              |      |           |            |        |            |                     |          |        |        |      |         |       | V    |
|              |      | 2331.56   | 53.78      | -20.22 | 74         | 44.37               | 26.99    | 14.01  | 31.59  | 104  | 219     | Р     | Н    |
|              |      | 2389.38   | 41.19      | -12.81 | 54         | 31.56               | 27.15    | 14.06  | 31.58  | 104  | 219     | Α     | Н    |
|              | *    | 2440      | 99.2       | -      | -          | 89.39               | 27.28    | 14.1   | 31.57  | 104  | 219     | Р     | Н    |
|              | *    | 2440      | 98.19      | ı      | -          | 88.38               | 27.28    | 14.1   | 31.57  | 104  | 219     | Α     | Н    |
| DI E         |      | 2491.11   | 53.9       | -20.1  | 74         | 43.92               | 27.4     | 14.14  | 31.56  | 104  | 219     | Р     | Н    |
| BLE<br>CH 19 |      | 2496.08   | 41.43      | -12.57 | 54         | 31.44               | 27.4     | 14.14  | 31.55  | 104  | 219     | Α     | Н    |
| 2440MHz      |      | 2362.36   | 53.88      | -20.12 | 74         | 44.35               | 27.07    | 14.04  | 31.58  | 100  | 10      | Р     | V    |
| 277VIII 12   |      | 2384.62   | 41.16      | -12.84 | 54         | 31.57               | 27.11    | 14.06  | 31.58  | 100  | 10      | Α     | V    |
|              | *    | 2440      | 94.11      | 1      | -          | 84.3                | 27.28    | 14.1   | 31.57  | 100  | 10      | Р     | V    |
|              | *    | 2440      | 93.1       | -      | -          | 83.29               | 27.28    | 14.1   | 31.57  | 100  | 10      | Α     | V    |
|              |      | 2495.24   | 53.56      | -20.44 | 74         | 43.57               | 27.4     | 14.14  | 31.55  | 100  | 10      | Р     | V    |
|              |      | 2499.93   | 41.6       | -12.4  | 54         | 31.61               | 27.4     | 14.14  | 31.55  | 100  | 10      | Α     | V    |

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### FCC RADIO TEST REPORT

|         | * | 2480    | 101.69 | -      | -  | 91.77 | 27.36 | 14.12 | 31.56 | 117 | 227 | Р | Н |
|---------|---|---------|--------|--------|----|-------|-------|-------|-------|-----|-----|---|---|
|         | * | 2480    | 100.74 | -      | -  | 90.82 | 27.36 | 14.12 | 31.56 | 117 | 227 | Α | Н |
|         |   | 2483.6  | 55.01  | -18.99 | 74 | 45.07 | 27.36 | 14.14 | 31.56 | 117 | 227 | Р | Н |
|         |   | 2483.52 | 43.57  | -10.43 | 54 | 33.63 | 27.36 | 14.14 | 31.56 | 117 | 227 | Α | Н |
| BLE     |   |         |        |        |    |       |       |       |       |     |     |   | Н |
| CH 39   |   |         |        |        |    |       |       |       |       |     |     |   | Н |
| 2480MHz | * | 2480    | 95.37  | -      | -  | 85.45 | 27.36 | 14.12 | 31.56 | 100 | 10  | Р | V |
|         | * | 2480    | 94.47  | -      | -  | 84.55 | 27.36 | 14.12 | 31.56 | 100 | 10  | Α | V |
|         |   | 2498.88 | 54.07  | -19.93 | 74 | 44.08 | 27.4  | 14.14 | 31.55 | 100 | 10  | Р | V |
|         |   | 2483.52 | 42.02  | -11.98 | 54 | 32.08 | 27.36 | 14.14 | 31.56 | 100 | 10  | Α | V |
|         |   |         |        |        |    |       |       |       |       |     |     |   | V |
|         |   |         |        |        |    |       |       |       |       |     |     |   | V |

Report No. : FR811724A

#### Remark

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<sup>1.</sup> No other spurious found.

<sup>2.</sup> All results are PASS against Peak and Average limit line.

#### 2.4GHz 2400~2483.5MHz

Report No.: FR811724A

### BLE (Harmonic @ 3m)

| BLE              | Note | Frequency | Level      | Over   | Limit      | Read                | Antenna  | Path   | Preamp | Ant    | Table   | Peak | Pol |
|------------------|------|-----------|------------|--------|------------|---------------------|----------|--------|--------|--------|---------|------|-----|
|                  |      | ,         | ļ<br>      | Limit  | Line       | Level               | Factor   | Loss   | Factor | Pos    |         | Avg. |     |
|                  |      | (MHz)     | ( dBµV/m ) |        | ( dBµV/m ) | (dB <sub>µ</sub> V) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) |      |     |
|                  |      | 4804      | 37.84      | -36.16 | 74         | 56.4                | 31.32    | 6.7    | 56.58  | 100    | 0       | Р    | Н   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | Н   |
| BLE              |      |           |            |        |            |                     |          |        |        |        |         |      | Н   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | Н   |
| CH 00            |      | 4804      | 39.59      | -34.41 | 74         | 58.15               | 31.32    | 6.7    | 56.58  | 100    | 0       | Р    | V   |
| 2402MHz          |      |           |            |        |            |                     |          |        |        |        |         |      | V   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | V   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | V   |
|                  |      | 4880      | 37.26      | -36.74 | 74         | 55.62               | 31.46    | 6.73   | 56.55  | 100    | 0       | Р    | Н   |
|                  |      | 7320      | 43.85      | -30.15 | 74         | 55.86               | 36.15    | 8.06   | 56.22  | 100    | 0       | Р    | Н   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | Н   |
| BLE              |      |           |            |        |            |                     |          |        |        |        |         |      | Н   |
| CH 19<br>2440MHz |      | 4880      | 38.75      | -35.25 | 74         | 57.11               | 31.46    | 6.73   | 56.55  | 100    | 0       | Р    | V   |
| 244UIVITI2       |      | 7320      | 43.75      | -30.25 | 74         | 55.76               | 36.15    | 8.06   | 56.22  | 100    | 0       | Р    | V   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | V   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | V   |
|                  |      | 4960      | 37.65      | -36.35 | 74         | 55.79               | 31.63    | 6.75   | 56.52  | 100    | 0       | Р    | Н   |
|                  |      | 7440      | 44.07      | -29.93 | 74         | 55.6                | 36.47    | 8.07   | 56.07  | 100    | 0       | Р    | Н   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | Н   |
| BLE              |      |           |            |        |            |                     |          |        |        |        |         |      | Н   |
| CH 39            |      | 4960      | 37.6       | -36.4  | 74         | 55.74               | 31.63    | 6.75   | 56.52  | 100    | 0       | Р    | V   |
| 2480MHz          |      | 7440      | 43.57      | -30.43 | 74         | 55.1                | 36.47    | 8.07   | 56.07  | 100    | 0       | Р    | V   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | V   |
|                  |      |           |            |        |            |                     |          |        |        |        |         |      | V   |

# Remark 2.

- 1. No other spurious found.
- 2. All results are PASS against Peak and Average limit line.

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### Emission below 1GHz 2.4GHz BLE (LF)

Report No. : FR811724A

| BLE           | Note | Frequency | Level      | Over   | Limit      | Read   | Antenna  | Path | Preamp | Ant    | Table   | Peak  | Pol. |
|---------------|------|-----------|------------|--------|------------|--------|----------|------|--------|--------|---------|-------|------|
|               |      |           |            | Limit  | Line       | Level  | Factor   | Loss | Factor | Pos    | Pos     | Avg.  |      |
|               |      | (MHz)     | ( dBµV/m ) | (dB)   | ( dBµV/m ) | (dBµV) | ( dB/m ) | (dB) | (dB)   | ( cm ) | ( deg ) | (P/A) | (H/V |
|               |      | 85.89     | 25.04      | -14.96 | 40         | 40.16  | 14.5     | 0.82 | 30.44  | -      | -       | Р     | Н    |
|               |      | 209.28    | 29.3       | -14.2  | 43.5       | 41.99  | 16.28    | 1.33 | 30.3   | 100    | 0       | Р     | Н    |
|               |      | 296.49    | 25.86      | -20.14 | 46         | 34.85  | 19.67    | 1.49 | 30.15  | -      | -       | Р     | Н    |
|               |      | 315.4     | 26.49      | -19.51 | 46         | 34.93  | 20.16    | 1.52 | 30.12  | -      | -       | Р     | Н    |
|               |      | 715.1     | 30.14      | -15.86 | 46         | 30.45  | 26.92    | 2.26 | 29.49  | -      | -       | Р     | Н    |
|               |      | 981.8     | 33.31      | -20.69 | 54         | 29.48  | 29.97    | 2.76 | 28.9   | -      | -       | Р     | Н    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | Н    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | Н    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | Н    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | Н    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | Н    |
| 2.4GHz<br>BLE |      |           |            |        |            |        |          |      |        |        |         |       | Н    |
| LF            |      | 37.29     | 35.28      | -4.72  | 40         | 43.56  | 21.56    | 0.46 | 30.3   | -      | -       | Р     | V    |
| LF            |      | 86.97     | 35.85      | -4.15  | 40         | 50.87  | 14.6     | 0.82 | 30.44  | 100    | 0       | Р     | V    |
|               |      | 209.82    | 22.87      | -20.63 | 43.5       | 35.56  | 16.28    | 1.33 | 30.3   | -      | -       | Р     | V    |
|               |      | 522.6     | 27.07      | -18.93 | 46         | 30.32  | 24.58    | 1.92 | 29.75  | -      | -       | Р     | V    |
|               |      | 812.4     | 31.78      | -14.22 | 46         | 30.36  | 28.25    | 2.44 | 29.27  | -      | -       | Р     | V    |
|               |      | 993       | 33.19      | -20.81 | 54         | 29.36  | 29.93    | 2.77 | 28.87  | -      | -       | Р     | V    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | V    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | V    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | V    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | V    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | V    |
|               |      |           |            |        |            |        |          |      |        |        |         |       | V    |

Remark

1. No other spurious found.

2. All results are PASS against limit line.

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### Note symbol

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| *   | Fundamental Frequency 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 | Peak or Average   |
| H/V | Horizontal or Vertical  |

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

Report No.: FR811724A

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

- 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(dBµV/m)
- = Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBµV) 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(dBµV/m)
- = Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) 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".

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# **Appendix D. Radiated Spurious Emission Plots**

| Test Engineer : | Watt Tseng, Karl Hou and Nick Yu | Temperature :       | 21~23°C |
|-----------------|----------------------------------|---------------------|---------|
|                 |                                  | Relative Humidity : | 59~62%  |

Report No. : FR811724A

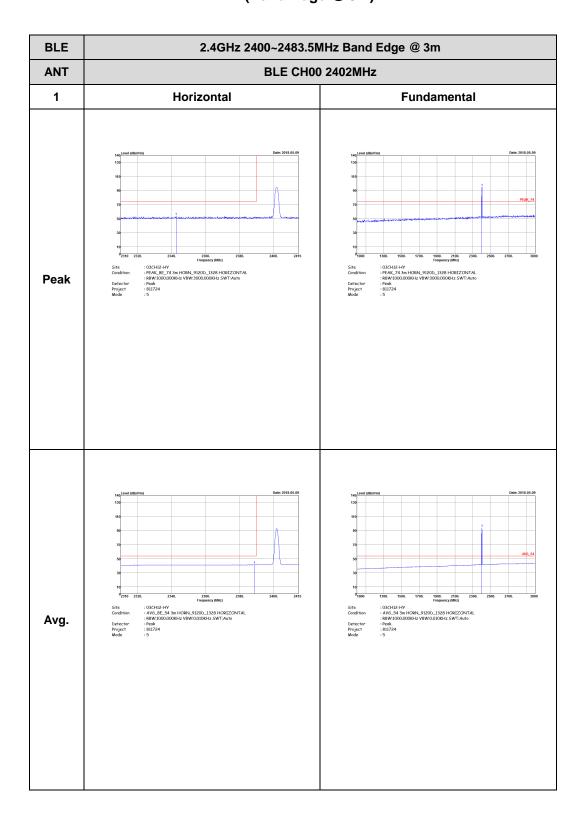
### **Note symbol**

| -L | Low channel location  |
|----|-----------------------|
| -R | High channel location |

TEL: 886-3-327-3456 Page Number: D1 of D13

### 2.4GHz 2400~2483.5MHz BLE (Band Edge @ 3m)

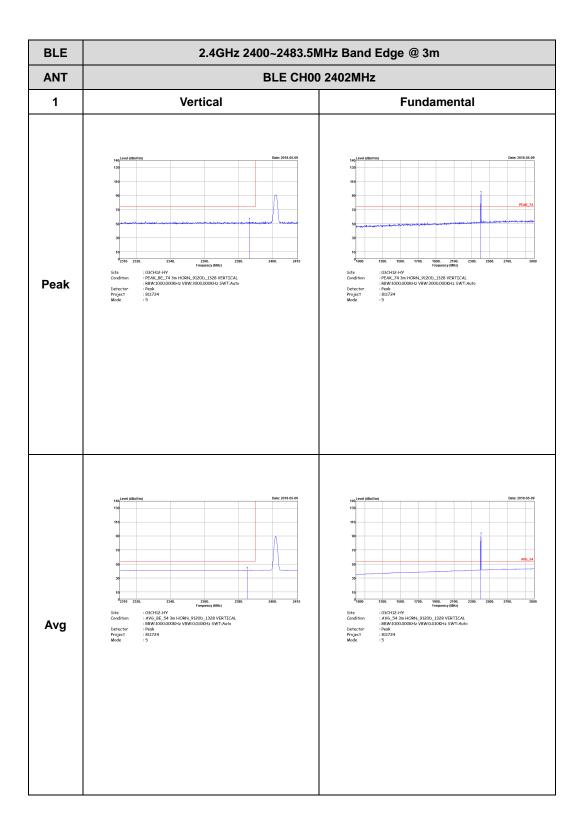
Report No.: FR811724A



TEL: 886-3-327-3456 Page Number: D2 of D13



ADIO TEST REPORT Report No. : FR811724A



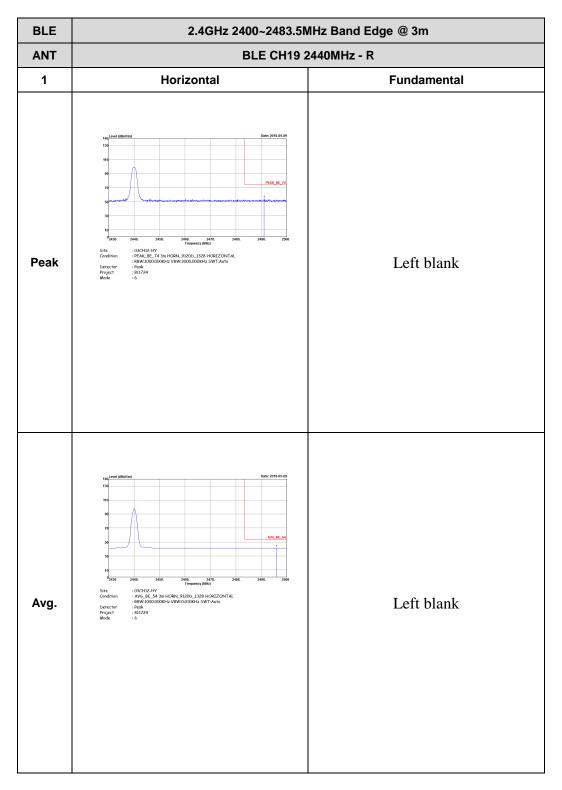
TEL: 886-3-327-3456 Page Number: D3 of D13



BLE 2.4GHz 2400~2483.5MHz Band Edge @ 3m **ANT** BLE CH19 2440MHz - L 1 Horizontal **Fundamental** Peak : 03CH12-HY
: AV6\_54 3m HORN\_9120b\_1328 HORIZONTAL
:RBW:1000.000KHz VBW:0.010KHz SWT:Auto
:Peok
:811724
:6 Avg.

Report No. : FR811724A

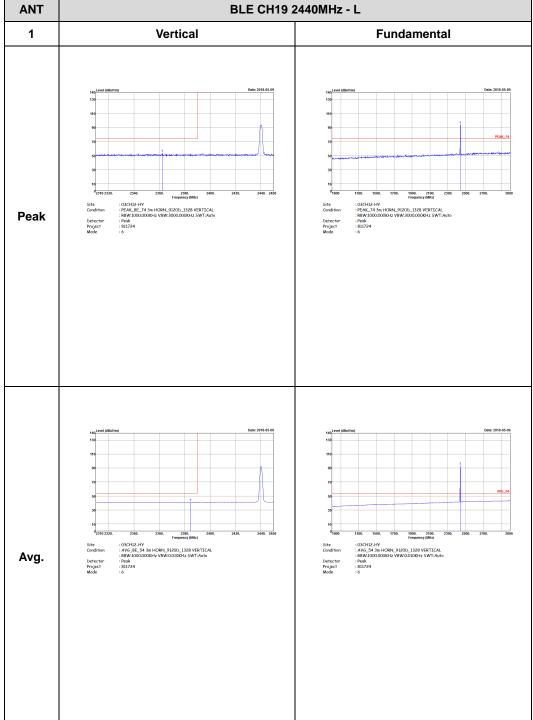
TEL: 886-3-327-3456 Page Number : D4 of D13



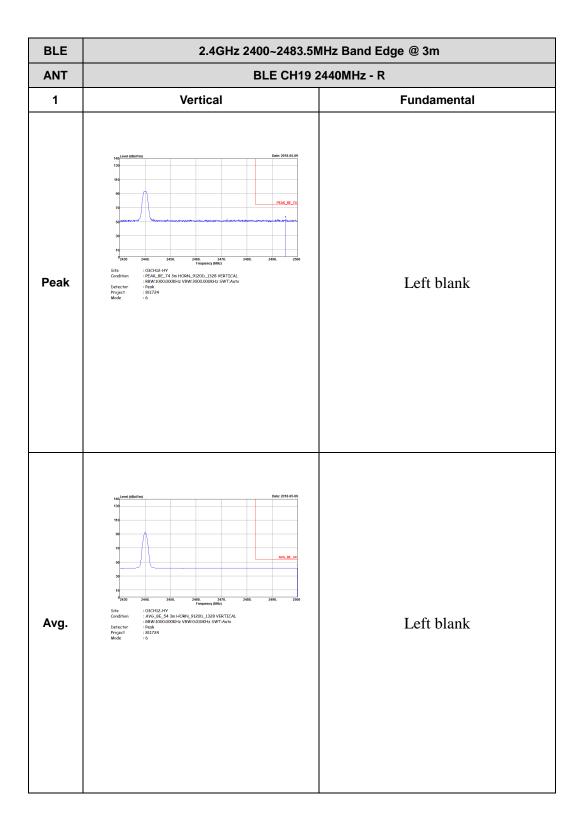
: D5 of D13 TEL: 886-3-327-3456 Page Number



Report No. : FR811724A **BLE** 2.4GHz 2400~2483.5MHz Band Edge @ 3m ANT BLE CH19 2440MHz - L 1 Vertical **Fundamental** 

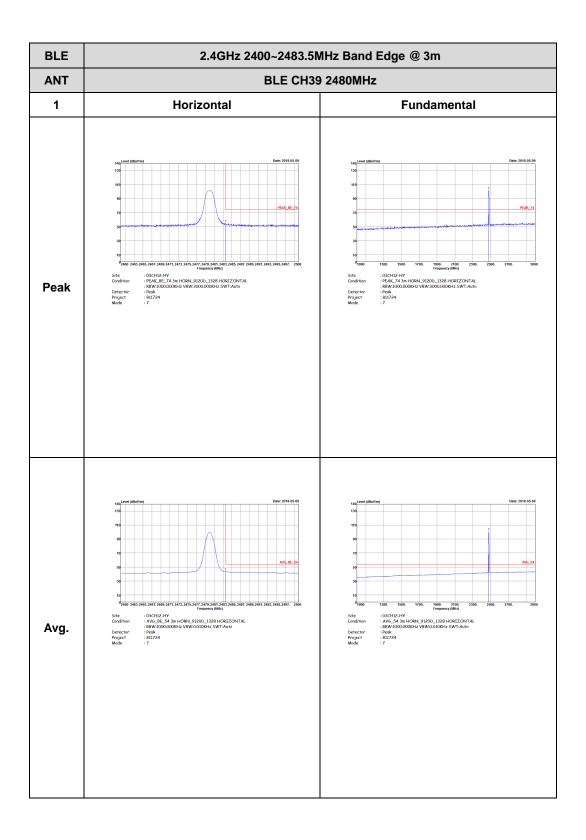


TEL: 886-3-327-3456 Page Number : D6 of D13



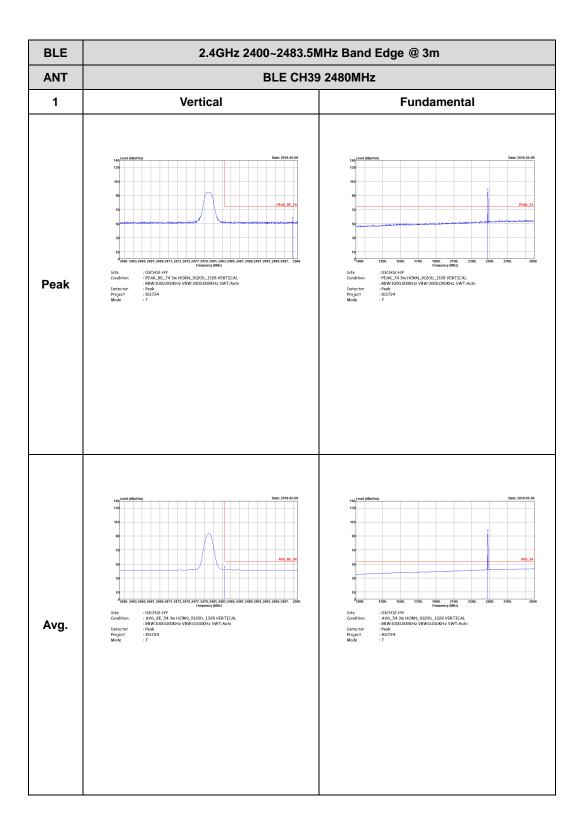
: D7 of D13 TEL: 886-3-327-3456 Page Number





TEL: 886-3-327-3456 Page Number : D8 of D13

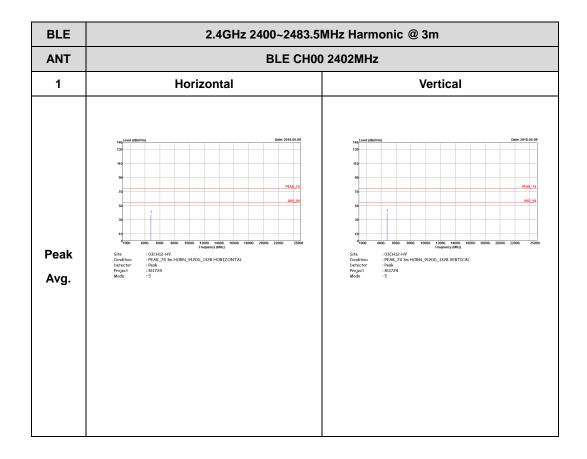




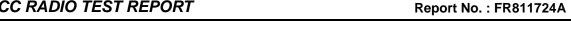
TEL: 886-3-327-3456 Page Number : D9 of D13

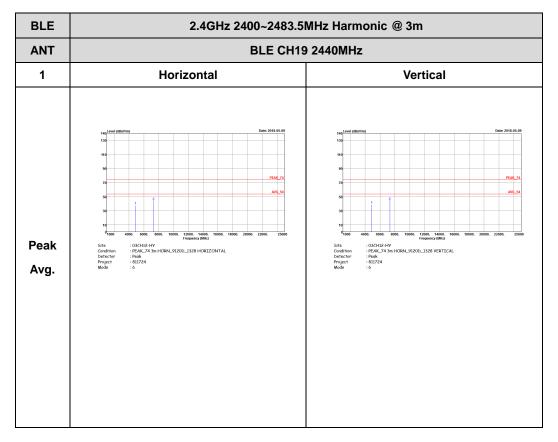
### 2.4GHz 2400~2483.5MHz BLE (Harmonic @ 3m)

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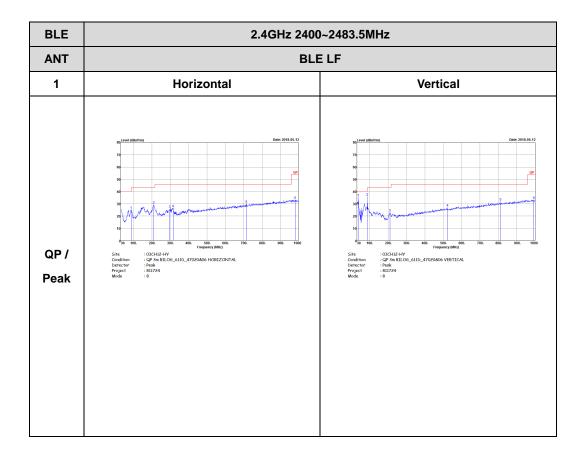
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### Emission below 1GHz 2.4GHz BLE (LF)

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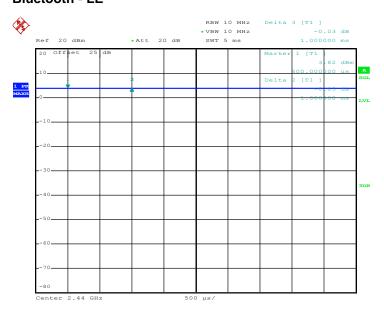


## Appendix E. Duty Cycle Plots

| Band          | Duty<br>Cycle(%) | T(us) | 1/T(kHz) | VBW<br>Setting | Duty<br>Factor(dB) |
|---------------|------------------|-------|----------|----------------|--------------------|
| Bluetooth -LE | 100.00           | -     | -        | 10Hz           | 0.00               |

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#### Bluetooth - LE



Date: 11.MAY.2018 03:01:01

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