



# FCC RF Co-location Test Report

APPLICANT : Nest Labs Inc.  
EQUIPMENT : Outdoor Security Camera  
MODEL NAME : Nest Cam IQ  
MODEL NUMBER : A0055  
FCC ID : ZQANC41  
STANDARD : FCC Part 15 Subpart E §15.407  
CLASSIFICATION : (NII) Unlicensed National Information Infrastructure

The product was completed on Jul. 27, 2017. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

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

Reviewed by: Joseph Lin / Supervisor

Approved by: Jones Tsai / Manager



**SPORTON INTERNATIONAL INC.**

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## REVISION HISTORY

| REPORT NO.   | VERSION | DESCRIPTION                                                | ISSUED DATE   |
|--------------|---------|------------------------------------------------------------|---------------|
| FR6N0107-01F | Rev. 01 | Initial issue of report                                    | Aug. 29, 2017 |
| FR6N0107-01F | Rev. 02 | Revising connection diagram of test system in section 2.3. | Sep. 05, 2017 |
|              |         |                                                            |               |
|              |         |                                                            |               |
|              |         |                                                            |               |
|              |         |                                                            |               |
|              |         |                                                            |               |
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|              |         |                                                            |               |
|              |         |                                                            |               |
|              |         |                                                            |               |
|              |         |                                                            |               |



## SUMMARY OF TEST RESULT

| Report Section | FCC Rule           | Description         | Limit                                          | Result |
|----------------|--------------------|---------------------|------------------------------------------------|--------|
| 3.1            | 15.407(b)          | Unwanted Emissions  | $\leq -17, -27$ dBm (depend on band)&15.209(a) | Pass   |
| 3.2            | 15.203 & 15.407(a) | Antenna Requirement | N/A                                            | Pass   |



# 1 General Description

## 1.1 Applicant

**Nest Labs Inc.**

3400 Hillview Ave. Palo Alto, CA 94304 USA

## 1.2 Product Feature of Equipment Under Test

Bluetooth-LE, Wi-Fi 2.4GHz 802.11b/g/n/ac, and Wi-Fi 5GHz 802.11a/n/ac, 15.4

| Product Specification subjective to this standard |                                                                  |
|---------------------------------------------------|------------------------------------------------------------------|
| Antenna Type                                      | WLAN: IFA Antenna<br>Bluetooth: IFA Antenna<br>15.4: IFA Antenna |

## 1.3 Modification of EUT

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

## 1.4 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW0007 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

|                    |                                                                                                                                        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| 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.                                                                                                                       |
|                    | 03CH11-HY                                                                                                                              |

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

## 1.5 Applicable Standards

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

- ♦ FCC Part 15 Subpart E
- ♦ FCC KDB 789033 D02 General UNII Test Procedures New Rules v01r04
- ♦ FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- ♦ 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

- 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: 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 four orthogonal panels, X, Y, Z, Back. The worst cases (Back plane) were recorded in this report.

### 2.1 Carrier Frequency and Channel

| 2400-2483.5 MHz<br>15.4 |             | 2400-2483.5 MHz<br>Bluetooth LE |             |
|-------------------------|-------------|---------------------------------|-------------|
| Channel                 | Freq. (MHz) | Channel                         | Freq. (MHz) |
| 18                      | 2440        | 00                              | 2402        |

| 2400-2483.5 MHz<br>802.11g |             | 5250-5350 MHz<br>Band 2 (U-NII-2A) |             |
|----------------------------|-------------|------------------------------------|-------------|
| Channel                    | Freq. (MHz) | Channel                            | Freq. (MHz) |
| 06                         | 2437        | 64                                 | 5320        |

### 2.2 Test Mode

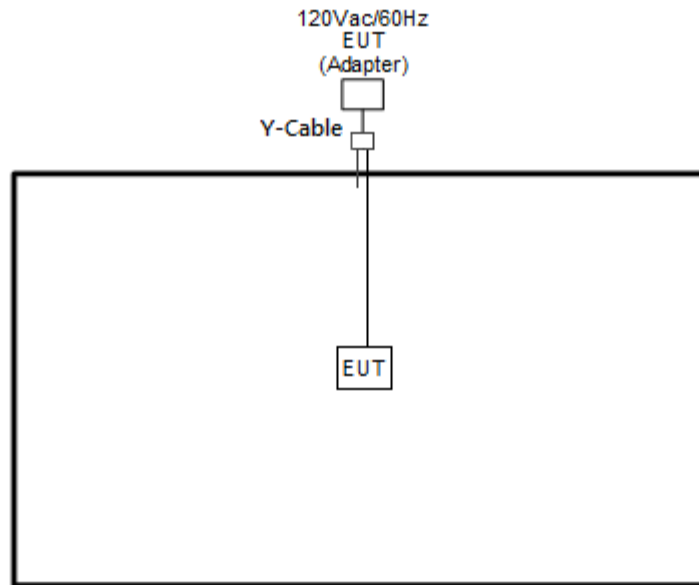
Final test mode of conducted test items and radiated spurious emissions are considering the modulation and worse data rates as below table.

<Co-Location>

| Modulation          | Data Rate         |
|---------------------|-------------------|
| Bluetooth LE + 15.4 | 1 Mbps + 250 kbps |
| 802.11g + 15.4      | 6 Mbps + 250 kbps |
| 802.11a + 15.4      | MCS0 + 250 kbps   |

## 2.3 Connection Diagram of Test System

<Co-Location Tx Mode>



## 2.4 EUT Operation Test Setup

The RF test items, programmed RF utility, “CMD” installed in the notebook make the EUT provide functions like channel selection and power level for continuous transmitting and receiving signals.

### 3 Test Result

#### 3.1 Unwanted Emissions Measurement

##### 3.1.1 Limit of Unwanted Emissions

(1) Unwanted spurious emissions fallen in restricted bands shall comply with the general field strength limits as below table,

| 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                                |

**Note:** The following formula is used to convert the EIRP to field strength.

$$E = \frac{1000000\sqrt{30P}}{3} \text{ } \mu\text{V/m, where P is the eirp (Watts)}$$

| EIRP (dBm) | Field Strength at 3m (dBμV/m) |
|------------|-------------------------------|
| - 27       | 68.3                          |

(2) KDB789033 D02 v01r04 G)2)c)

- (i) Sections 15.407(b)(1) to (b)(3) specify the unwanted emission limits for the U-NII-1 and U-NII-2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz.<sup>3</sup>
- (ii) Section 15.407(b)(4) specifies the unwanted emission limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b)(4)(i). The emission limits are in terms of a Peak detector. An alternative to the band emissions mask is specified in Section 15.407(b)(4)(ii). The alternative limits are based on the highest antenna gain specified in the filing. There are also marketing and importation restrictions for the devices using the alternative limit.<sup>4</sup>

**Note 3:** An out-of-band emission that complies with both the average and peak limits of Section 15.209 is not required to satisfy the -27 dBm/MHz peak emission limit.

**Note 4:** Only devices with antenna gains of 10 dBi or less may be approved using the emission limits specified in Section 15.247(d) till March 2, 2018; all other devices operating in this band must use the mask specified in Section 15.407(b)(4)(i).

### 3.1.2 Measuring Instruments

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

### 3.1.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v01r04. Section G) Unwanted emissions measurement.
  - (1) Procedure for Unwanted Emissions Measurements Below 1000MHz
    - RBW = 120 kHz
    - VBW = 300 kHz
    - Detector = Peak
    - Trace mode = max hold



(2) Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz

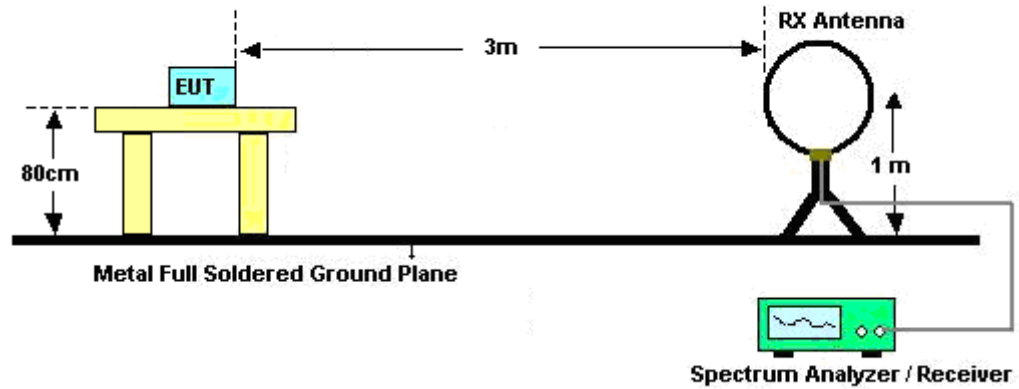
- RBW = 1 MHz
- VBW  $\geq$  3 MHz
- Detector = Peak
- Sweep time = auto
- Trace mode = max hold

(3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz

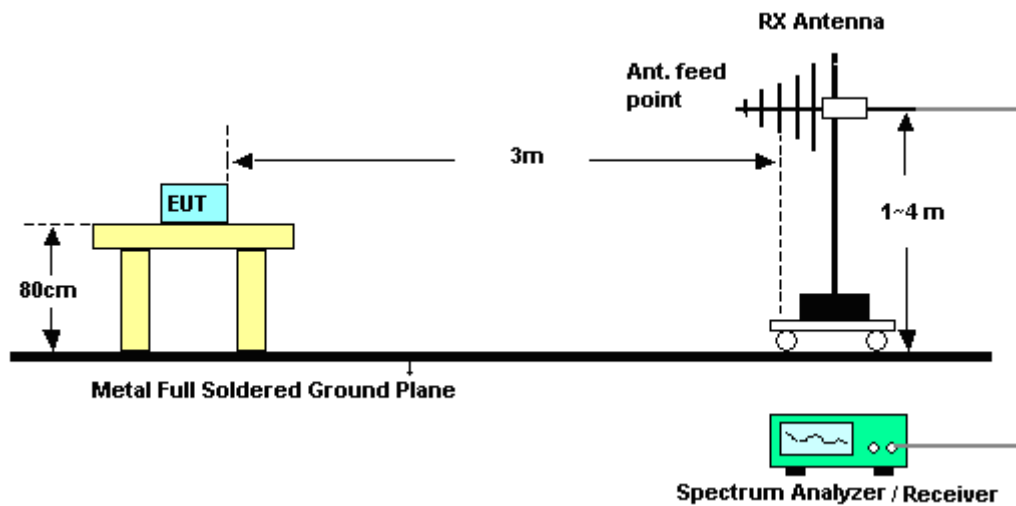
- RBW = 1 MHz
  - VBW = 10 Hz, when duty cycle is no less than 98 percent.
  - VBW  $\geq$  1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
2. 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.
  3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
  4. The antenna is a broadband antenna and its height is adjusted between one meter and four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
  5. For each suspected emission, the EUT was arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
  6. 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.

### 3.1.4 Test Setup

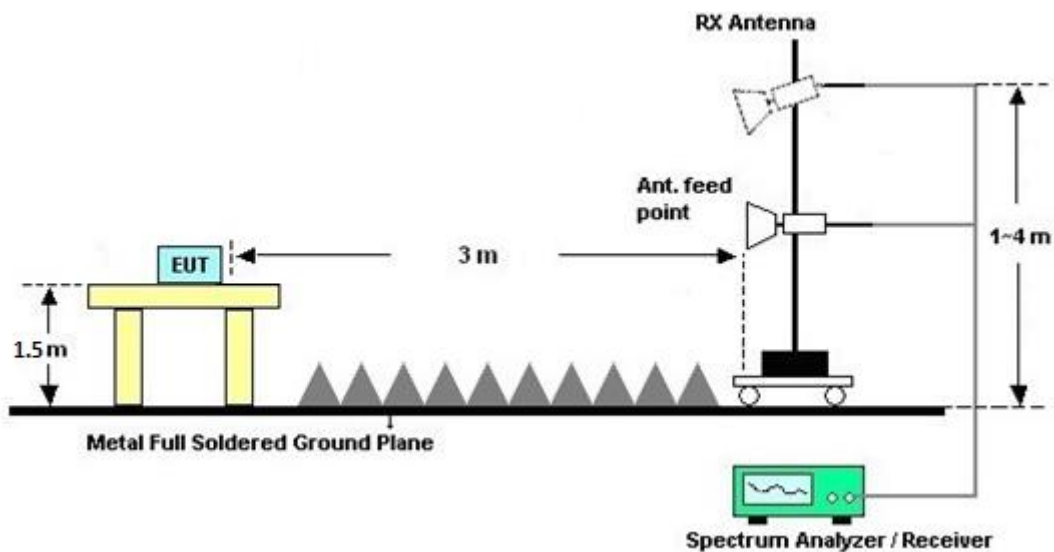
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



### 3.1.5 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.

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

Please refer to Appendix A and B.

### 3.1.7 Duty Cycle

Please refer to Appendix C.

### 3.1.8 Test Result of Radiated Spurious Emissions (30MHz ~ 10th Harmonic)

Please refer to Appendix A and B.



## **3.2 Antenna Requirements**

### **3.2.1 Standard Applicable**

If transmitting antenna directional gain is greater than 6 dBi, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### **3.2.2 Antenna Anti-Replacement Construction**

An embedded-in antenna design is used.

### **3.2.3 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                |
|----------------------|-----------------|-------------------------|----------------|-----------------|------------------|-------------------------------|---------------|-----------------------|
| Spectrum Analyzer    | Keysight        | N9010A                  | MY54200486     | 10Hz ~ 44GHz    | Oct. 12, 2016    | Jul. 14, 2017 ~ Jul. 25, 2017 | Oct. 11, 2017 | Radiation (03CH11-HY) |
| EMI Test Receiver    | Agilent         | N9038A(MXE)             | MY53290053     | 20Hz to 26.5GHz | Jan. 12, 2017    | Jul. 14, 2017 ~ Jul. 25, 2017 | Jan. 11, 2018 | Radiation (03CH11-HY) |
| Loop Antenna         | Rohde & Schwarz | HFH2-Z2                 | 100488         | 9 kHz~30 MHz    | Oct. 20, 2016    | Jul. 14, 2017 ~ Jul. 25, 2017 | Oct. 19, 2018 | Radiation (03CH11-HY) |
| Bilog Antenna        | TESEQ           | CBL 6111D&N-6-06        | 35414&AT-N0602 | 30MHz~1GHz      | Oct. 15, 2016    | Jul. 14, 2017 ~ Jul. 25, 2017 | Oct. 14, 2017 | Radiation (03CH11-HY) |
| Horn Antenna         | SCHWARZBECK     | BBHA 9120 D             | 9120D-1326     | 1GHz ~ 18GHz    | Oct. 07, 2016    | Jul. 14, 2017 ~ Jul. 25, 2017 | Oct. 06, 2017 | Radiation (03CH11-HY) |
| SHF-EHF Horn Antenna | SCHWARZBECK     | BBHA 9170               | BBHA9170584    | 18GHz- 40GHz    | Nov. 08, 2016    | Jul. 14, 2017 ~ Jul. 25, 2017 | Nov. 07, 2017 | Radiation (03CH11-HY) |
| Amplifier            | SONOMA          | 310N                    | 187312         | 9kHz~1GHz       | Nov. 10, 2016    | Jul. 14, 2017 ~ Jul. 25, 2017 | Nov. 09, 2017 | Radiation (03CH11-HY) |
| Preamplifier         | Keysight        | 83017A                  | MY53270080     | 1GHz~26.5GHz    | Nov. 10, 2016    | Jul. 14, 2017 ~ Jul. 25, 2017 | Nov. 09, 2017 | Radiation (03CH11-HY) |
| Preamplifier         | MITEQ           | AMF-7D-0010 1800-30-10P | 1902247        | 1GHz~18GHz      | Jun. 23, 2017    | Jul. 14, 2017 ~ Jul. 25, 2017 | Jun. 22, 2018 | Radiation (03CH11-HY) |
| Preamplifier         | MITEQ           | TTA1840-35-HG           | 1887435        | 18GHz~40GHz     | Oct. 13, 2016    | Jul. 14, 2017 ~ Jul. 25, 2017 | Oct. 12, 2017 | Radiation (03CH11-HY) |
| Antenna Mast         | EMEC            | AM-BS-4500-B            | N/A            | 1~4m            | N/A              | Jul. 14, 2017 ~ Jul. 25, 2017 | N/A           | Radiation (03CH11-HY) |
| Turn Table           | EMEC            | TT 2000                 | N/A            | 0~360 Degree    | N/A              | Jul. 14, 2017 ~ Jul. 25, 2017 | N/A           | Radiation (03CH11-HY) |



## 5 Uncertainty of Evaluation

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

|                                                                            |      |
|----------------------------------------------------------------------------|------|
| Measuring Uncertainty for a Level of Confidence<br>of 95% ( $U = 2Uc(y)$ ) | 5.20 |
|----------------------------------------------------------------------------|------|

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

|                                                                            |      |
|----------------------------------------------------------------------------|------|
| Measuring Uncertainty for a Level of Confidence<br>of 95% ( $U = 2Uc(y)$ ) | 5.50 |
|----------------------------------------------------------------------------|------|

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

|                                                                            |      |
|----------------------------------------------------------------------------|------|
| Measuring Uncertainty for a Level of Confidence<br>of 95% ( $U = 2Uc(y)$ ) | 5.20 |
|----------------------------------------------------------------------------|------|



## Appendix A. Radiated Spurious Emission

|                 |                                 |                     |         |
|-----------------|---------------------------------|---------------------|---------|
| Test Engineer : | J.C. Liang, Jacky Huang, Ken Wu | Temperature :       | 20~24°C |
|                 |                                 | Relative Humidity : | 50~54%  |

### Co-location

#### WIFI 802.11g CDD and 15.4 (Harmonic @ 3m)

|                                                              | Note                                                                                        | Frequency | Level      | Over   | Limit      | Read     | Antenna  | Cable  | 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 ) |
| 802.11g<br>CH06<br>2437MHz<br>and<br>15.4<br>CH18<br>2440MHz |                                                                                             | 4874      | 47.71      | -26.29 | 74         | 68.88    | 31.71    | 9.56   | 62.87  | 100    | 0       | P       | H       |
|                                                              |                                                                                             | 7311      | 43.52      | -30.48 | 74         | 57.01    | 37.43    | 11.31  | 62.69  | 100    | 0       | P       | H       |
|                                                              |                                                                                             | 4874      | 48.71      | -25.29 | 74         | 70.31    | 31.71    | 9.56   | 62.87  | 100    | 0       | P       | V       |
|                                                              |                                                                                             | 7311      | 44.52      | -29.48 | 74         | 58.47    | 37.43    | 11.31  | 62.69  | 100    | 0       | P       | V       |
| Remark                                                       | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. |           |            |        |            |          |          |        |        |        |         |         |         |



## WIFI 802.11a CDD and 15.4 (Harmonic @ 3m)

|                                                              | Note                                                                                        | Frequency<br>( MHz ) | Level<br>( dBμV/m ) | Over<br>Limit<br>( dB ) | Limit<br>Line<br>( dBμV/m ) | Read<br>Level<br>( dBμV ) | Antenna<br>Factor<br>( dB/m ) | Cable<br>Loss<br>( dB ) | Preamp<br>Factor<br>( dB ) | Ant<br>Pos<br>( cm ) | Table<br>Pos<br>( deg ) | Peak<br>Avg.<br>( P/A ) | Pol.<br>( H/V ) |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------|---------------------|-------------------------|-----------------------------|---------------------------|-------------------------------|-------------------------|----------------------------|----------------------|-------------------------|-------------------------|-----------------|
| 802.11a<br>CH64<br>5320MHz<br>and<br>15.4<br>CH18<br>2440MHz |                                                                                             | 4880                 | 57.04               | -16.96                  | 74                          | 49.39                     | 31.71                         | 9.01                    | 33.07                      | 100                  | 254                     | P                       | H               |
|                                                              |                                                                                             | 4880                 | 48.02               | -5.98                   | 54                          | 40.37                     | 31.71                         | 9.01                    | 33.07                      | 100                  | 254                     | A                       | H               |
|                                                              |                                                                                             | 10640                | 53.11               | -20.89                  | 74                          | 63.29                     | 38.77                         | 14.82                   | 64.07                      | 100                  | 243                     | P                       | H               |
|                                                              |                                                                                             | 10640                | 43.73               | -10.27                  | 54                          | 53.91                     | 38.77                         | 14.82                   | 64.07                      | 100                  | 243                     | A                       | H               |
|                                                              |                                                                                             | 15960                | 48.72               | -25.28                  | 74                          | 54.87                     | 36.02                         | 18.3                    | 60.73                      | 100                  | 0                       | P                       | H               |
|                                                              |                                                                                             | 4880                 | 57.67               | -16.33                  | 74                          | 50.02                     | 31.71                         | 9.01                    | 33.07                      | 102                  | 286                     | P                       | V               |
|                                                              |                                                                                             | 4880                 | 49.91               | -4.09                   | 54                          | 42.26                     | 31.71                         | 9.01                    | 33.07                      | 102                  | 286                     | A                       | V               |
|                                                              |                                                                                             | 10640                | 49.49               | -24.51                  | 74                          | 59.97                     | 38.77                         | 14.82                   | 64.07                      | 100                  | 0                       | P                       | V               |
|                                                              |                                                                                             | 15960                | 47.74               | -26.26                  | 74                          | 53.89                     | 36.02                         | 18.3                    | 60.73                      | 100                  | 0                       | P                       | V               |
| Remark                                                       | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. |                      |                     |                         |                             |                           |                               |                         |                            |                      |                         |                         |                 |



## BLE and 15.4 (Harmonic @ 3m)

|                                                          | Note                                                                                        | Frequency<br>( MHz ) | Level<br>( dBμV/m ) | Over<br>Limit<br>( dB ) | Limit<br>Line<br>( dBμV/m ) | Read<br>Level<br>( dBμV ) | Antenna<br>Factor<br>( dB/m ) | Cable<br>Loss<br>( dB ) | Preamp<br>Factor<br>( dB ) | Ant<br>Pos<br>( cm ) | Table<br>Pos<br>( deg ) | Peak<br>Avg.<br>( P/A ) | Pol.<br>( H/V ) |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------|---------------------|-------------------------|-----------------------------|---------------------------|-------------------------------|-------------------------|----------------------------|----------------------|-------------------------|-------------------------|-----------------|
| BLE<br>CH00<br>2402MHz<br>and<br>15.4<br>CH18<br>2440MHz |                                                                                             | 4804                 | 52.43               | -21.57                  | 74                          | 73.82                     | 31.6                          | 9.6                     | 63.02                      | 100                  | 270                     | P                       | H               |
|                                                          |                                                                                             | 4804                 | 50.02               | -3.98                   | 54                          | 71.41                     | 31.6                          | 9.6                     | 63.02                      | 100                  | 270                     | A                       | H               |
|                                                          |                                                                                             | 4880                 | 44.38               | -29.62                  | 74                          | 65.55                     | 31.71                         | 9.56                    | 62.87                      | 100                  | 0                       | P                       | H               |
|                                                          |                                                                                             | 7320                 | 45.3                | -28.7                   | 74                          | 58.72                     | 37.51                         | 11.31                   | 62.7                       | 100                  | 0                       | P                       | H               |
|                                                          |                                                                                             | 4804                 | 48.47               | -25.53                  | 74                          | 70.29                     | 31.6                          | 9.6                     | 63.02                      | 100                  | 0                       | P                       | V               |
|                                                          |                                                                                             | 4880                 | 48.35               | -25.65                  | 74                          | 69.95                     | 31.71                         | 9.56                    | 62.87                      | 100                  | 0                       | P                       | V               |
|                                                          |                                                                                             | 7320                 | 43.56               | -30.44                  | 74                          | 57.44                     | 37.51                         | 11.31                   | 62.7                       | 100                  | 0                       | P                       | V               |
| Remark                                                   | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. |                      |                     |                         |                             |                           |                               |                         |                            |                      |                         |                         |                 |



## Emission below 1GHz

## WIFI 802.11g CDD and 15.4 (LF @ 3m)

|                                                              | Note                                        | Frequency | Level      | Over   | Limit      | Read   | Antenna  | Cable  | 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) |
| 802.11g<br>CH06<br>2437MHz<br>and<br>15.4<br>CH18<br>2440MHz |                                             | 30        | 22.41      | -17.59 | 40         | 29.7   | 24.36    | 0.82   | 32.5   | -      | -       | P     | H     |
|                                                              |                                             | 129.09    | 29.79      | -13.71 | 43.5       | 43.07  | 17.61    | 1.51   | 32.45  | -      | -       | P     | H     |
|                                                              |                                             | 149.07    | 31.05      | -12.45 | 43.5       | 44.72  | 17.08    | 1.61   | 32.44  | 100    | 85      | P     | H     |
|                                                              |                                             | 399.4     | 26.92      | -19.08 | 46         | 34.77  | 21.86    | 2.56   | 32.33  | -      | -       | P     | H     |
|                                                              |                                             | 749.4     | 30.87      | -15.13 | 46         | 31.5   | 28.13    | 3.44   | 32.33  | -      | -       | P     | H     |
|                                                              |                                             | 955.2     | 33.27      | -12.73 | 46         | 29.33  | 31.02    | 3.9    | 31.15  | -      | -       | P     | H     |
|                                                              |                                             | 32.16     | 26.92      | -13.08 | 40         | 35.24  | 23.33    | 0.82   | 32.49  | -      | -       | P     | V     |
|                                                              |                                             | 41.07     | 26.66      | -13.34 | 40         | 39.49  | 18.83    | 0.82   | 32.49  | -      | -       | P     | V     |
|                                                              |                                             | 59.43     | 24.51      | -15.49 | 40         | 44.15  | 11.81    | 1.02   | 32.49  | -      | -       | P     | V     |
|                                                              |                                             | 442.1     | 27.95      | -18.05 | 46         | 34.49  | 23.07    | 2.7    | 32.35  | -      | -       | P     | V     |
|                                                              |                                             | 718.6     | 29.27      | -16.73 | 46         | 30.99  | 27.16    | 3.4    | 32.41  | -      | -       | P     | V     |
|                                                              |                                             | 944       | 33.44      | -12.56 | 46         | 30.18  | 30.53    | 3.82   | 31.26  | 100    | 0       | P     | V     |
| Remark                                                       | 1. No other spurious found.                 |           |            |        |            |        |          |        |        |        |         |       |       |
|                                                              | 2. All results are PASS against limit line. |           |            |        |            |        |          |        |        |        |         |       |       |



## WIFI 802.11a CDD and 15.4 (LF @ 3m)

| WIFI<br>Ant.<br>1+2                                          | Note                                                                       | Frequency<br>( MHz ) | Level<br>( dBμV/m ) | Over<br>Limit<br>( dB ) | Limit<br>Line<br>( dBμV/m ) | Read<br>Level<br>(dBμV) | Antenna<br>Factor<br>( dB/m ) | Cable<br>Loss<br>( dB ) | Preamp<br>Factor<br>( dB ) | Ant<br>Pos<br>( cm ) | Table<br>Pos<br>( deg ) | Peak<br>Avg.<br>(P/A) | Pol.<br>(H/V) |
|--------------------------------------------------------------|----------------------------------------------------------------------------|----------------------|---------------------|-------------------------|-----------------------------|-------------------------|-------------------------------|-------------------------|----------------------------|----------------------|-------------------------|-----------------------|---------------|
| 802.11a<br>CH64<br>5320MHz<br>and<br>15.4<br>CH18<br>2440MHz |                                                                            | 125.58               | 29.29               | -14.21                  | 43.5                        | 42.65                   | 17.54                         | 1.51                    | 32.46                      | -                    | -                       | P                     | H             |
|                                                              |                                                                            | 149.07               | 31.06               | -12.44                  | 43.5                        | 44.73                   | 17.08                         | 1.61                    | 32.44                      | -                    | -                       | P                     | H             |
|                                                              |                                                                            | 195.78               | 26.43               | -17.07                  | 43.5                        | 42.2                    | 14.86                         | 1.69                    | 32.39                      | -                    | -                       | P                     | H             |
|                                                              |                                                                            | 359.5                | 27.94               | -18.06                  | 46                          | 37.13                   | 20.64                         | 2.48                    | 32.35                      | -                    | -                       | P                     | H             |
|                                                              |                                                                            | 633.9                | 28.82               | -17.18                  | 46                          | 31.61                   | 26.42                         | 3.15                    | 32.46                      | -                    | -                       | P                     | H             |
|                                                              |                                                                            | 950.3                | 33.72               | -12.28                  | 46                          | 30.11                   | 30.82                         | 3.82                    | 31.2                       | 100                  | 0                       | P                     | H             |
|                                                              |                                                                            | 34.32                | 26.43               | -13.57                  | 40                          | 35.79                   | 22.3                          | 0.82                    | 32.49                      | -                    | -                       | P                     | V             |
|                                                              |                                                                            | 41.34                | 26.18               | -13.82                  | 40                          | 39.56                   | 18.28                         | 0.82                    | 32.49                      | -                    | -                       | P                     | V             |
|                                                              |                                                                            | 59.16                | 26.66               | -13.34                  | 40                          | 46.3                    | 11.81                         | 1.02                    | 32.49                      | -                    | -                       | P                     | V             |
|                                                              |                                                                            | 444.9                | 26.81               | -19.19                  | 46                          | 33.3                    | 23.12                         | 2.7                     | 32.35                      | -                    | -                       | P                     | V             |
|                                                              |                                                                            | 614.3                | 29.44               | -16.56                  | 46                          | 32.78                   | 25.94                         | 3.09                    | 32.46                      | -                    | -                       | P                     | V             |
|                                                              |                                                                            | 930                  | 34.09               | -11.91                  | 46                          | 31.5                    | 29.98                         | 3.82                    | 31.38                      | 100                  | 0                       | P                     | V             |
| Remark                                                       | 1. No other spurious found.<br>2. All results are PASS against limit line. |                      |                     |                         |                             |                         |                               |                         |                            |                      |                         |                       |               |



## BLE and 15.4 (LF @ 3m)

| WIFI<br>Ant.<br>1+2                                      | Note                                                                       | Frequency<br>( MHz ) | Level<br>( dBμV/m ) | Over<br>Limit<br>( dB ) | Limit<br>Line<br>( dBμV/m ) | Read<br>Level<br>(dBμV) | Antenna<br>Factor<br>( dB/m ) | Cable<br>Loss<br>( dB ) | Preamp<br>Factor<br>( dB ) | Ant<br>Pos<br>( cm ) | Table<br>Pos<br>( deg ) | Peak<br>Avg.<br>(P/A) | Pol.<br>(H/V) |
|----------------------------------------------------------|----------------------------------------------------------------------------|----------------------|---------------------|-------------------------|-----------------------------|-------------------------|-------------------------------|-------------------------|----------------------------|----------------------|-------------------------|-----------------------|---------------|
| BLE<br>CH00<br>2402MHz<br>and<br>15.4<br>CH18<br>2440MHz |                                                                            | 31.62                | 21.42               | -18.58                  | 40                          | 29.74                   | 23.33                         | 0.82                    | 32.49                      | -                    | -                       | P                     | H             |
|                                                          |                                                                            | 131.25               | 24.87               | -18.63                  | 43.5                        | 38.16                   | 17.6                          | 1.51                    | 32.45                      | -                    | -                       | P                     | H             |
|                                                          |                                                                            | 150.42               | 21.05               | -22.45                  | 43.5                        | 34.74                   | 17.05                         | 1.61                    | 32.43                      | -                    | -                       | P                     | H             |
|                                                          |                                                                            | 512.8                | 24.91               | -21.09                  | 46                          | 30.23                   | 24.1                          | 2.91                    | 32.39                      | -                    | -                       | P                     | H             |
|                                                          |                                                                            | 784.4                | 30.62               | -15.38                  | 46                          | 30.89                   | 28.32                         | 3.49                    | 32.23                      | -                    | -                       | P                     | H             |
|                                                          |                                                                            | 948.2                | 33.54               | -12.46                  | 46                          | 30.04                   | 30.73                         | 3.82                    | 31.22                      | 100                  | 0                       | P                     | H             |
|                                                          |                                                                            | 38.37                | 29.87               | -10.13                  | 40                          | 41.68                   | 19.85                         | 0.82                    | 32.49                      | 100                  | 184                     | P                     | V             |
|                                                          |                                                                            | 61.05                | 26.26               | -13.74                  | 40                          | 45.98                   | 11.73                         | 1.02                    | 32.49                      | -                    | -                       | P                     | V             |
|                                                          |                                                                            | 66.99                | 23.29               | -16.71                  | 40                          | 42.72                   | 12.03                         | 1.02                    | 32.49                      | -                    | -                       | P                     | V             |
|                                                          |                                                                            | 447                  | 25.04               | -20.96                  | 46                          | 31.49                   | 23.16                         | 2.7                     | 32.35                      | -                    | -                       | P                     | V             |
|                                                          |                                                                            | 682.2                | 28.68               | -17.32                  | 46                          | 31.2                    | 26.56                         | 3.27                    | 32.47                      | -                    | -                       | P                     | V             |
|                                                          |                                                                            | 957.3                | 33.36               | -12.64                  | 46                          | 29.33                   | 31.1                          | 3.9                     | 31.14                      | -                    | -                       | P                     | V             |
| Remark                                                   | 1. No other spurious found.<br>2. All results are PASS against limit line. |                      |                     |                         |                             |                         |                               |                         |                            |                      |                         |                       |               |



**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>P</b> eak or <b>A</b> verage                                                                                                                          |
| H/V | <b>H</b> orizontal or <b>V</b> ertical                                                                                                                   |



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

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

1. Level(dBμV/m) =

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

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

**For Peak Limit @ 2390MHz:**

1. Level(dBμV/m)

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

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

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

**For Average Limit @ 2390MHz:**

1. Level(dBμV/m)

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

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

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

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

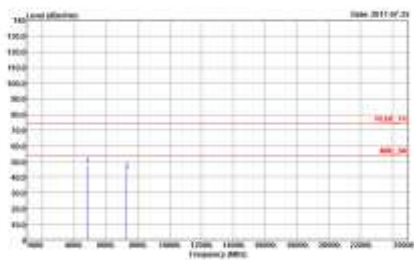
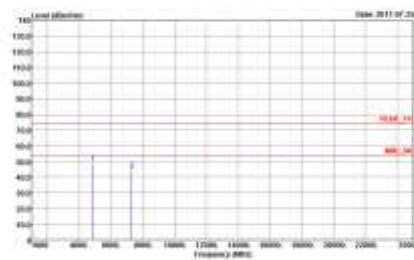


## Appendix B. Radiated Spurious Emission Plots

|                 |                                 |                     |         |
|-----------------|---------------------------------|---------------------|---------|
| Test Engineer : | J.C. Liang, Jacky Huang, Ken Wu | Temperature :       | 20~24°C |
|                 |                                 | Relative Humidity : | 50~54%  |

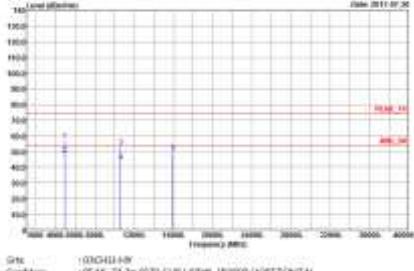
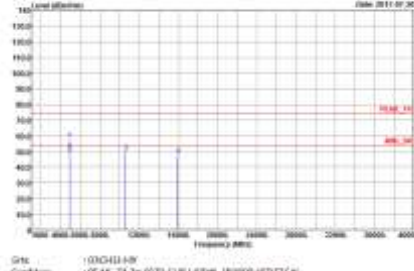
### Co-location Mode

#### WIFI 802.11g CDD and 15.4 (Harmonic @ 3m)

|              | Co-location mode Harmonic @ 3m                                                                                                                                           |                                                                                                                                                                         |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | 802.11g CH06 2437MHz and 15.4 CH18 2440MHz                                                                                                                               |                                                                                                                                                                         |
|              | Horizontal                                                                                                                                                               | Vertical                                                                                                                                                                |
| Peak<br>Avg. |  <p>Grid: 100CH06-07<br/>Condition: 1. PEAK: 78.3mV RMS SLP-HARM 150000 HORIZONTAL</p> |  <p>Grid: 100CH06-07<br/>Condition: 1. PEAK: 78.3mV RMS SLP-HARM 150000 VERTICAL</p> |

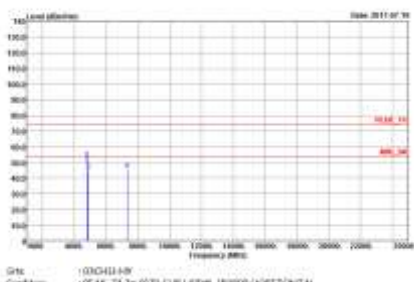
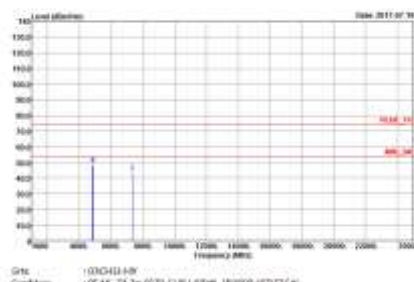


WIFI 802.11a CDD and 15.4 (Harmonic @ 3m)

|              | Co-location mode Harmonic @ 3m                                                                                                                                         |                                                                                                                                                                       |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | WIFI 802.11a CH64 5320MHz and 15.4 CH18 2440MHz                                                                                                                        |                                                                                                                                                                       |
|              | Horizontal                                                                                                                                                             | Vertical                                                                                                                                                              |
| Peak<br>Avg. |  <p>SPK<br/>Condition : 100CH414-01<br/>:PEAK: 74.3m 9070.54P-1-010009 HORIZONTAL</p> |  <p>SPK<br/>Condition : 100CH414-01<br/>:PEAK: 74.3m 9070.54P-1-010009 VERTICAL</p> |

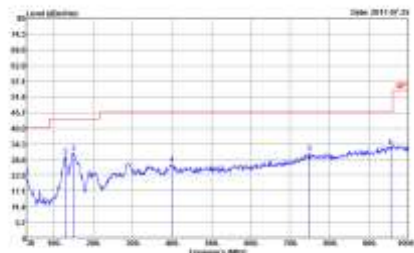
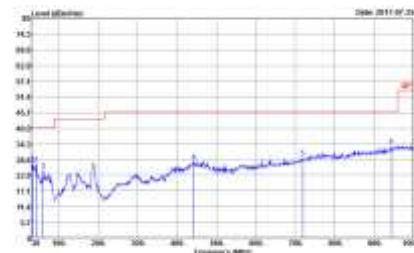


BLE and 15.4 (Harmonic @ 3m)

|              | Co-location mode Harmonic @ 3m                                                                                                                                         |                                                                                                                                                                       |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | BLE CH00 2402MHz and 15.4 CH18 2440MHz                                                                                                                                 |                                                                                                                                                                       |
|              | Horizontal                                                                                                                                                             | Vertical                                                                                                                                                              |
| Peak<br>Avg. |  <p>File: 107CH00-HR<br/>Condition: :PEAK: 74.3m 9070.54P-HR000 150000 HORIZONTAL</p> |  <p>File: 107CH00-HR<br/>Condition: :PEAK: 74.3m 9070.54P-HR000 150000 VERTICAL</p> |

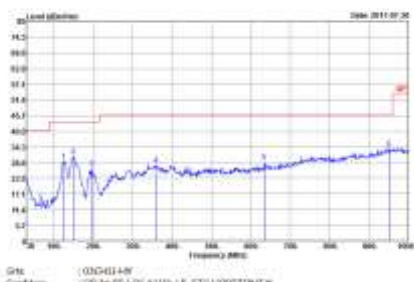
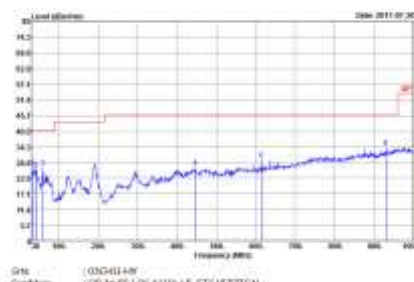


Emission below 1GHz  
WIFI 802.11g CDD and 15.4 (LF)

|              | Co-location mode                                                                                                                                           |                                                                                                                                                           |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | 802.11g CH06 2437MHz and 15.4 CH18 2440MHz LF                                                                                                              |                                                                                                                                                           |
|              | Horizontal                                                                                                                                                 | Vertical                                                                                                                                                  |
| QP /<br>Peak |  <p>File: 03CH18-4M<br/>Condition: QP 15.4 LF-63333-LF ETC HORIZONTAL</p> |  <p>File: 03CH18-4M<br/>Condition: QP 15.4 LF-63333-LF ETC VERTICAL</p> |

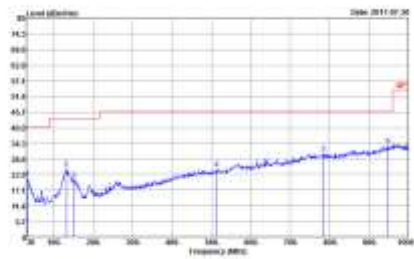
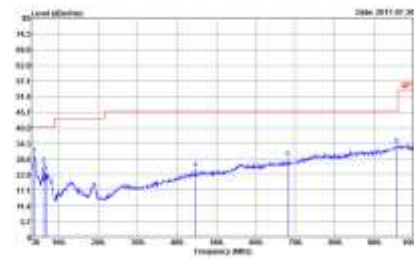


WIFI 802.11a CDD and 15.4 (LF)

|              | Co-location mode                                                                                       |                                                                                                         |
|--------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
|              | WIFI 802.11a CH64 5320MHz and 15.4 CH18 2440MHz LF                                                     |                                                                                                         |
|              | Horizontal                                                                                             | Vertical                                                                                                |
| QP /<br>Peak |  <p>QP /<br/>Peak</p> |  <p>QP /<br/>Peak</p> |



BLE and 15.4 (LF)

|              | Co-location mode                                                                                                                                                 |                                                                                                                                                                 |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | BLE CH00 2402MHz and 15.4 CH18 2440MHz LF                                                                                                                        |                                                                                                                                                                 |
|              | Horizontal                                                                                                                                                       | Vertical                                                                                                                                                        |
| QP /<br>Peak |  <p>File : 03CH014-0F<br/>Condition : TQP 3s BE-LOG S1113-LF ETC HORIZONTAL</p> |  <p>File : 03CH014-0F<br/>Condition : TQP 3s BE-LOG S1113-LF ETC VERTICAL</p> |

## Appendix C. Duty Cycle Plots

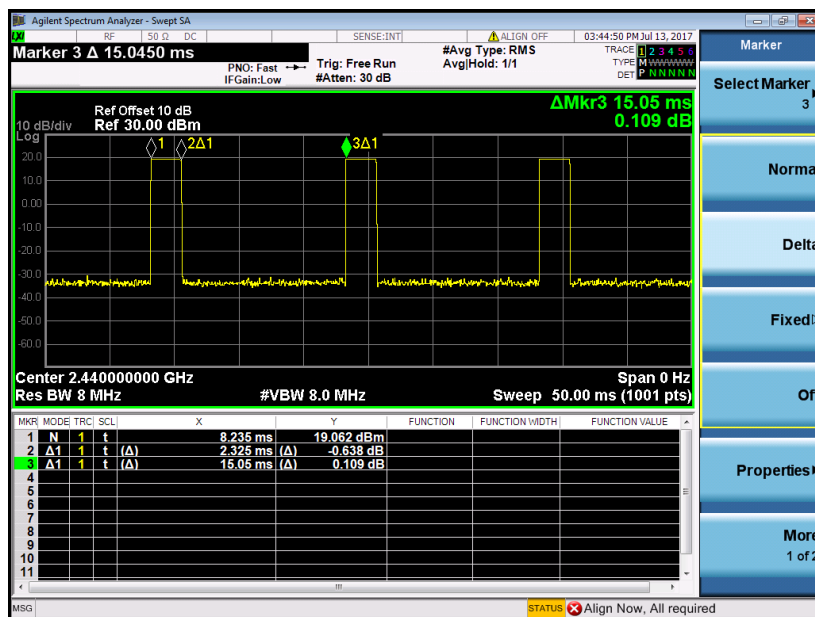
| Band          | Duty Cycle(%) | T(us) | 1/T(kHz) | VBW Setting |
|---------------|---------------|-------|----------|-------------|
| 15.4          | 15.45         | 2325  | 0.43     | 1kHz        |
| Bluetooth -LE | 62.18         | 388   | 2.58     | 3kHz        |

### <CDD Modes>

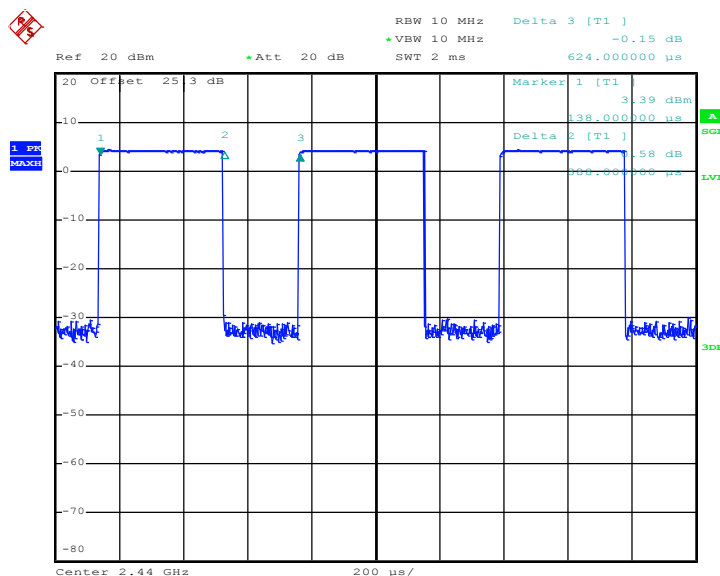
| Band               | Duty Cycle(%) | T(us) | 1/T(kHz) | VBW Setting |
|--------------------|---------------|-------|----------|-------------|
| 802.11g for Ant. 1 | 99.05         | -     | -        | 10Hz        |
| 802.11g for Ant. 2 | 98.57         | -     | -        | 10Hz        |
| 802.11a for Ant. 1 | 99.05         | -     | -        | 10Hz        |
| 802.11a for Ant. 2 | 98.81         | -     | -        | 10Hz        |

For the co-location mode, the larger VBW will apply.

## 15.4



## Bluetooth - LE

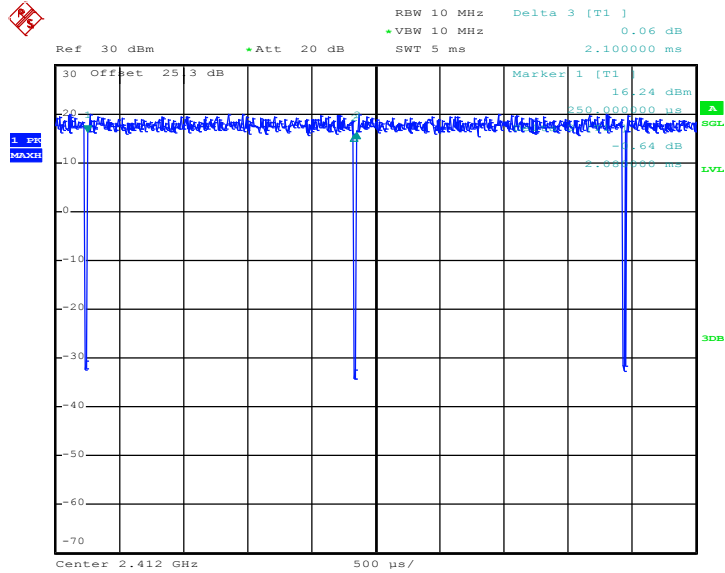


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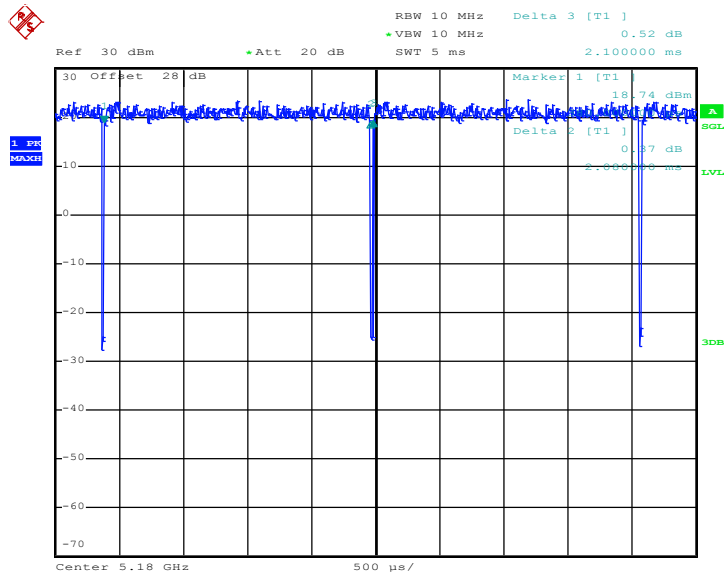
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802.11g



Date: 4.JUL.2017 23:20:58

802.11a

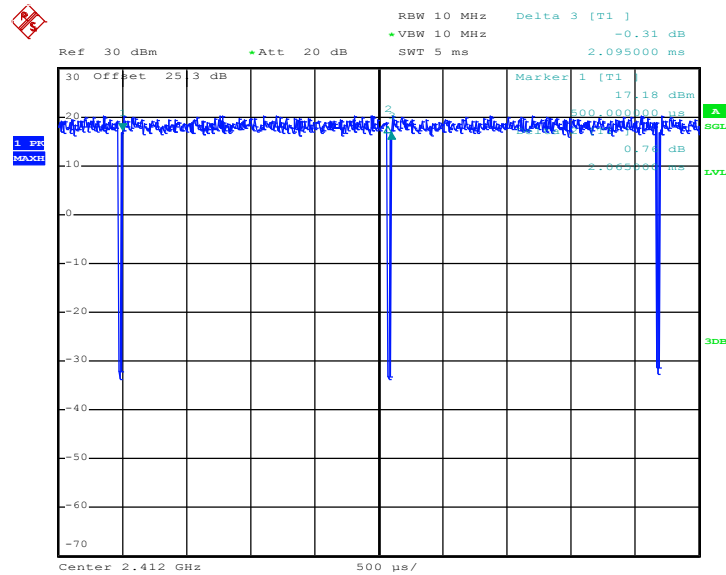


Date: 5.JUL.2017 01:09:23



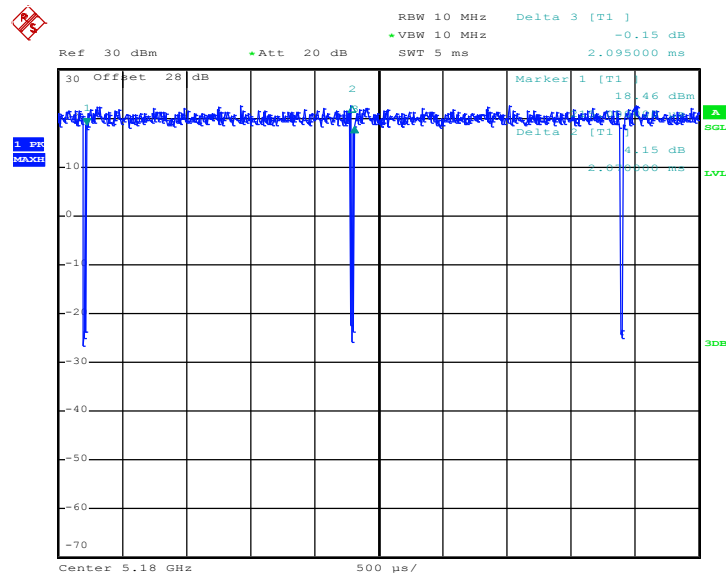
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802.11g



Date: 4.JUL.2017 23:21:25

802.11a



Date: 5.JUL.2017 01:09:52