# FCC CO-LOCATION RADIO TEST REPORT

| | | |
|---|---|---|
| **FCC ID** | : | **A4RGGH2X** |
| **Equipment** | : | **Phone** |
| **Model Name** | : | **GGH2X, GC15S** |
| **Applicant** | : | **Google LLC<br>1600 Amphitheatre Parkway,<br>Mountain View, CA 94043 USA** |
| **Standard** | : | **FCC Part 15 Subpart E §15.407** |

**The product was received on Feb. 05, 2024 and testing was performed from Mar. 15, 2024 to Mar. 18, 2024. We, Sporton International Inc. Wensan Laboratory, 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 from Sporton International Inc. Wensan Laboratory, the test report shall not be reproduced except in full.**

Louis Wu

**Approved by: Louis Wu**

***Sporton International Inc. Wensan Laboratory***
*No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)*

# Table of Contents

# History of this test report

| Report No. | Version | Description | Issue Date |
|---|---|---|---|
| FR3D2001I | 01 | Initial issue of report | May 10, 2024 |
| FR3D2001I | 02 | Revise Antenna information<br>This report is an updated version, replacing the report issued on May 10, 2024. | May 28, 2024 |
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# Summary of Test Result

| Report Clause | Ref Std. Clause | Test Items | Result (PASS/FAIL) | Remark |
|---|---|---|---|---|
| 3.1 | 15.247(d)<br>15.407(b) | Unwanted Emissions | Pass | 6.47 dB under the limit at 4960.00 MHz |
| 3.2 | 15.203 | Antenna Requirement | Pass | - |

**Conformity Assessment Condition:**

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section “Measurement Uncertainty”.

**Disclaimer:**

1. The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.
2. The GGH2X and GC15S are 100% identical in Hardware / Software to each other, and only have different model names for marketing segmentation. The test sample are all model GGH2X.

**Reviewed by: William Chen**

**Report Producer: Ming Chen**

# 1 General Description

## 1.1 Product Feature of Equipment Under Test

| Product Feature |
|---|
| **General Specs**<br>GSM/WCDMA/LTE/5G NR, Bluetooth, BLE, BLE channel sounding, Thread, Wi-Fi 802.11be, UWB, NFC, WPC Rx, NTN and GNSS<br><br>**Antenna Type**<br>WLAN:<br>**<Ant. 3>:** IFA Antenna<br>**<Ant. 4>:** ILA Antenna<br>Bluetooth:<br>**<Ant. 3>:** IFA Antenna<br>**<Ant. 4>:** ILA Antenna |

| EUT Information List | |
|---|---|
| **S/N** | **Performed Test Item** |
| 41251FDKD0007K<br>41251FDKD0007Y | Radiated Spurious Emission |

| Antenna information (Open Mode) | | |
|---|---|---|
| **2400 MHz ~ 2483.5 MHz** | Peak Gain (dBi) | <Ant. 3>: -3.3<br><Ant. 4>: -3.5 |
| **5150 MHz ~ 5250 MHz** | Peak Gain (dBi) | <Ant. 3>: -2.9<br><Ant. 4>: -4.1 |
| **5925 MHz ~ 6425 MHz** | Peak Gain (dBi) | <Ant. 3>: -6.6<br><Ant. 4>: -3.3 |

| Antenna information (Close Mode) | | |
|---|---|---|
| **2400 MHz ~ 2483.5 MHz** | Peak Gain (dBi) | <Ant. 3>: -4.3<br><Ant. 4>: -1.1 |
| **5150 MHz ~ 5250 MHz** | Peak Gain (dBi) | <Ant. 3>: -5.9<br><Ant. 4>: -3.6 |
| **5925 MHz ~ 6425 MHz** | Peak Gain (dBi) | <Ant. 3>: -7.6<br><Ant. 4>: -3.4 |

**Remark:** The EUT's information above is declared by manufacturer. Please refer to Disclaimer in report summary.

## 1.2 Modification of EUT

No modifications made to the EUT during the testing.

## 1.3 Testing Location

| | |
|---|---|
| **Test Site** | Sporton International Inc. Wensan Laboratory |
| **Test Site Location** | No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist.,<br>Taoyuan City 333010, Taiwan (R.O.C.)<br>TEL: +886-3-327-0868<br>FAX: +886-3-327-0855 |
| **Test Site No.** | **Sporton Site No.** |
| | 03CH16-HY |

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

FCC designation No.: TW3786

## 1.4 Applicable Standards

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

- FCC Part 15 Subpart E
- FCC Part 15 Subpart C §15.247
- FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- FCC KDB 414788 D01 Radiated Test Site v01r01.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ANSI C63.10-2013

**Remark:**

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.

# 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, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT (Open and Close) and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape) and accessory (Adapter or Earphone), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures. find X plane close with Adapter as worst plane.

## 2.1 Carrier Frequency and Channel

| 2400-2483.5 MHz | | | |
|---|---|---|---|
| Bluetooth – LE 1Mbps | | 802.11g | |
| Channel | Channel | Channel | Freq. (MHz) |
| 39 | 2480 | 06 | 2437 |

| 5150-5250 MHz | | 5925-6425 MHz | |
|---|---|---|---|
| 802.11a | | 802.11a | |
| Channel | Freq. (MHz) | Channel | Freq. (MHz) |
| 36 | 5180 | 01 | 5955 |

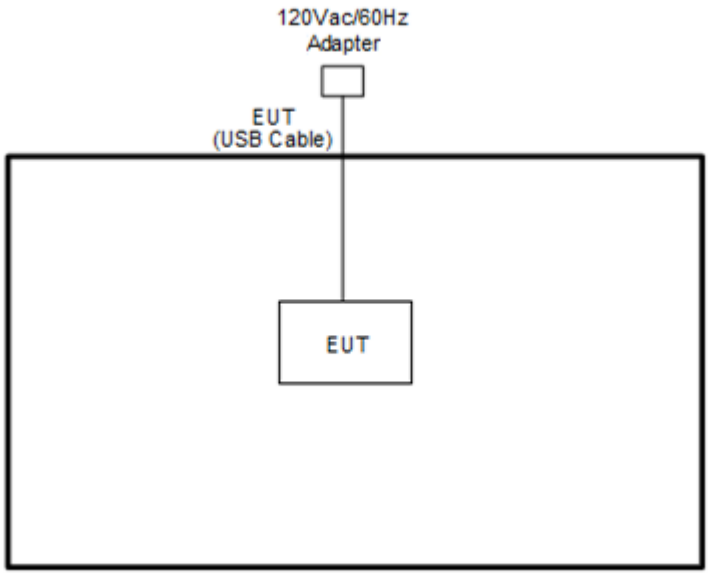
**<Co-Location>**

| Modulation | Data Rate | Worst Plane |
|---|---|---|
| 2.4GHz 802.11g for MIMO <Ant. 3+4> + 5GHz 802.11a for MIMO <Ant. 3+4> | 6 Mbps + 6 Mbps | X Plane open with Adapter |
| 2.4GHz 802.11g for MIMO <Ant. 3+4> + 6GHz 802.11a for MIMO <Ant. 3+4> | 6 Mbps + 6 Mbps | X Plane close with Adapter |
| Bluetooth – LE for <Ant. 3> + 5GHz 802.11a for MIMO <Ant. 3+4> | GFSK + 6 Mbps | X Plane open with Adapter |

**Remark:**

1. For Radiated Test Cases, the tests were performed with USB Cable 2.
2. During the preliminary test, both charging modes (Adapter mode and WPC Rx mode) were verified. It is determined that the adaptor mode is the worst case for official test.

## 2.2 Connection Diagram of Test System




## 2.3 Support Unit used in test configuration and system

| Item | Equipment | Brand Name | Model Name | FCC ID | Data Cable | Power Cord |
|---|---|---|---|---|---|---|
| 1. | Adapter | Chicony | G9BR1 | N/A | N/A | N/A |

## 2.4 EUT Operation Test Setup

The RF test items, utility “RF Compliance 1.2_11-29-23” 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.

# 3 Test Result

## 3.1 Unwanted Emissions Measurement

This section is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement.

### 3.1.1 Limit of Unwanted Emissions

**<For 2402 MHz ~ 2480 MHz>**

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 is measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB.

**<For 5150 MHz ~ 5250 MHz>**

For transmitters operating in the 5150-5250 MHz band: all emissions outside of the 5150-5350 MHz band shall not exceed an EIRP of –27dBm/MHz.

**<For 5925 MHz ~ 6425 MHz>**

For transmitters operating within the 5.925-7.125 GHz band: Any emissions outside of the 5.925-7.125 GHz band must not exceed an e.i.r.p. of −27 dBm/MHz.

| EIRP (dBm) | Field Strength at 3m (dBμV/m) |
|---|---|
| - 27 (RMS) | 68.3 |
| - 7 (Peak) | 88.3 |

According 987594 D02 U-NII 6GHz EMC Measurement v01 section G:
Unwanted emissions outside of restricted bands are measured with a RMS detector.
In addition, 15.35(b) applies where the peak emissions must be limited to no more than 20 dB above the average limit

Unwanted spurious emissions fallen in restricted bands shall comply with the general field strength limits as below table:

| Frequency (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 - 960 | 200 | 3 |
| Above 960 | 500 | 3 |

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

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

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

(2) KDB789033 D02 v02r01 G)2)c)

(i) Sections 15.407(b)(1-3) specifies the unwanted emissions limit 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.

(ii) Section 15.407(b)(4) specifies the unwanted emissions limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b)(4)(i). The emission limits are based on the use of a peak detector.

### 3.1.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

### 3.1.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01. Section G) Unwanted emissions measurement.

   (1) Procedure for Unwanted Emissions Measurements Below 1000 MHz

   - 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 ≥ 3 MHz
   - Detector = Peak
   - Sweep time = auto
   - Trace mode = max hold

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

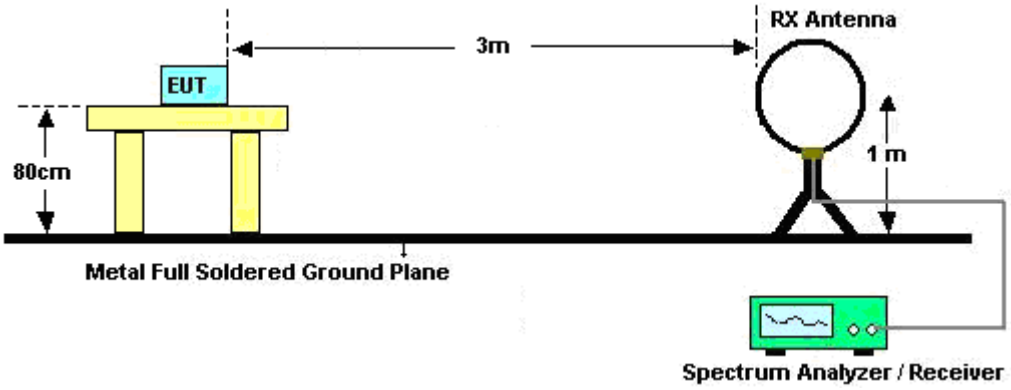
   - RBW = 1 MHz
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

2. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
3. The EUT is set 3 meters away from the receiving antenna which is 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 is 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. Radiated testing below 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as "-".

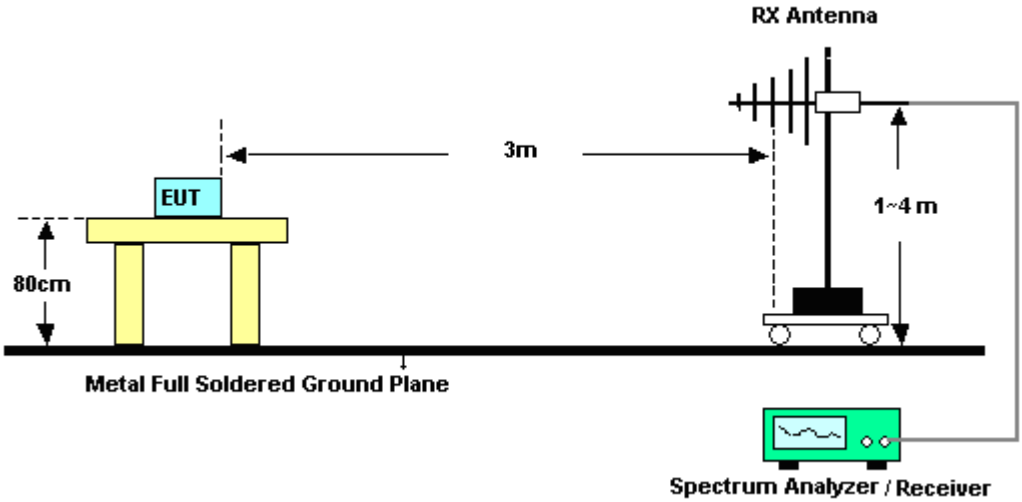
7. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as "-".

### 3.1.4 Test Setup

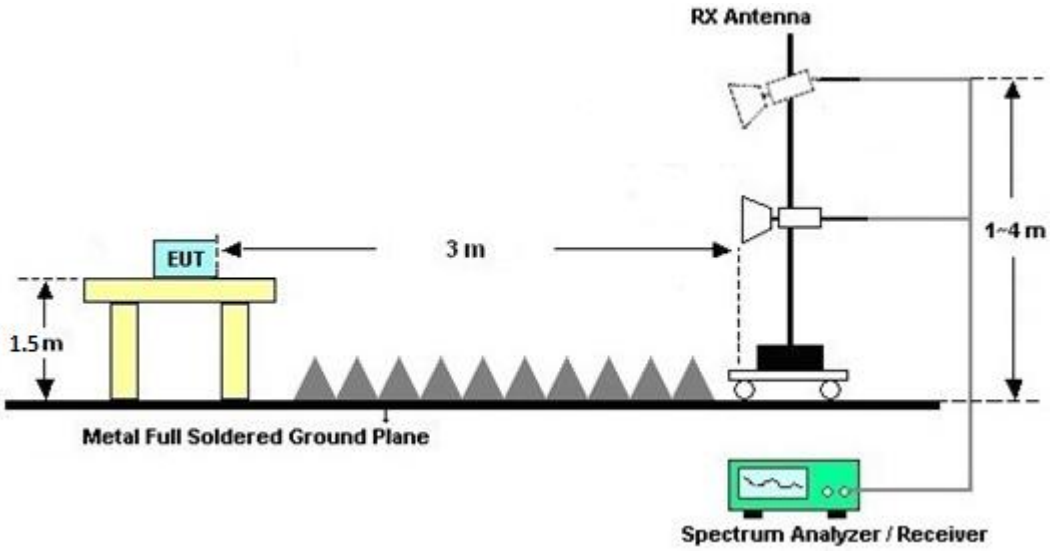
**For radiated emissions below 30MHz**



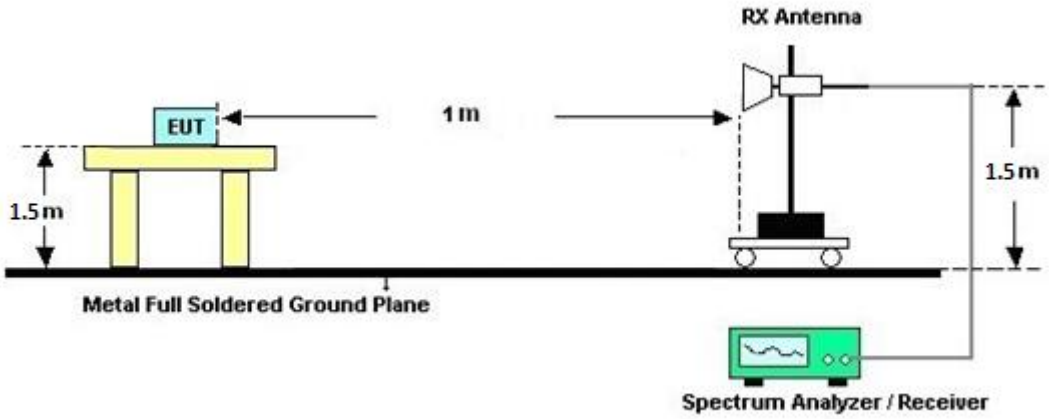

**For radiated emissions from 30MHz to 1GHz**



**For radiated test from 1GHz to 18GHz**




**For radiated test above 18GHz**




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

The low frequency, which starts from 9 kHz to 30 MHz, is pre-scanned and the result which is 20 dB lower than the limit line is not reported.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, 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

The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

### 3.2.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

# 4 List of Measuring Equipment

| Instrument | Brand Name | Model No. | Serial No. | Characteristics | Calibration Date | Test Date | Due Date | Remark |
|---|---|---|---|---|---|---|---|---|
| Loop Antenna | Rohde & Schwarz | HFH2-Z2 | 100488 | 9 kHz~30 MHz | Sep. 12, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Sep. 11, 2024 | Radiation (03CH16-HY) |
| SHF-EHF Horn Antenna | SCHWARZBECK | BBHA9170 | 00993 | 18GHz-40GHz | Nov. 24, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Nov. 23, 2024 | Radiation (03CH16-HY) |
| Bilog Antenna | TESEQ | CBL 6111D & 00802N1D01N-06 | 47020 & 06 | 30MHz to 1GHz | Oct. 07, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Oct. 06, 2024 | Radiation (03CH16-HY) |
| Horn Antenna | SCHWARZBECK | BBHA 9120 D | 9120D-1522 | 1G~18GHz | Mar. 23, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Mar. 22, 2024 | Radiation (03CH16-HY) |
| Amplifier | SONOMA | 310N | 371607 | 9kHz~1GHz | Jul. 03, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Jul. 02, 2024 | Radiation (03CH16-HY) |
| Preamplifier | Keysight | 83017A | MY53270264 | 1GHz~26.5GHz | Dec. 07, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Dec. 06, 2024 | Radiation (03CH16-HY) |
| Preamplifier | EMEC | EM1G18G | 060812 | 1GHz~18GHz | Dec. 25, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Dec. 24, 2024 | Radiation (03CH16-HY) |
| Preamplifier | EMEC | EM18G40G | 060801 | 18GHz~40GHz | Jun. 27, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Jun. 26, 2024 | Radiation (03CH16-HY) |
| Filter | Wainwright | WLK4-1000-1530-8000-40SS | SN17 | 1.53GHz Low Pass Filter | Jan. 15, 2024 | Mar. 15, 2024~ Mar. 18, 2024 | Jan. 14, 2025 | Radiation (03CH16-HY) |
| Filter | Wainwright | WHKX12-2700-3000-18000-60ST | SN3 | 3GHz High Pass Filter | Jun. 29, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Jun. 28, 2024 | Radiation (03CH16-HY) |
| Filter | Wainwright | WHKX8-5872.5-6750-18000-40ST | SN27 | 6.75GHz High Pass Filter | Nov. 13, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Nov. 12, 2024 | Radiation (03CH16-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102 | 803951/2 | 9K~30M | Mar. 06, 2024 | Mar. 15, 2024~ Mar. 18, 2024 | Mar. 05, 2025 | Radiation (03CH16-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102/SUCOFLEX 104 | EC-A5-300-5757,805935/4,802434/4 | 30MHz~18GHz | Aug. 08, 2023 | Mar. 15, 2024~ Mar. 18, 2024 | Aug. 07, 2024 | Radiation (03CH16-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102 | 804011/2,804012/2 | 18-40GHz | Jan. 02, 2024 | Mar. 15, 2024~ Mar. 18, 2024 | Jan. 01, 2025 | Radiation (03CH16-HY) |
| Software | Audix | E3 6.2009-8-24 | RK-001136 | N/A | N/A | Mar. 15, 2024~ Mar. 18, 2024 | N/A | Radiation (03CH16-HY) |
| Controller | ChainTek | 3000-1 | N/A | Control Turn table & Ant Mast | N/A | Mar. 15, 2024~ Mar. 18, 2024 | N/A | Radiation (03CH16-HY) |
| Antenna Mast | ChainTek | MBS-520-1 | N/A | 1m~4m | N/A | Mar. 15, 2024~ Mar. 18, 2024 | N/A | Radiation (03CH16-HY) |
| Turn Table | ChainTek | T-200-S-1 | N/A | 0~360 Degree | N/A | Mar. 15, 2024~ Mar. 18, 2024 | N/A | Radiation (03CH16-HY) |

# 5 Measurement Uncertainty

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

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **6.5 dB** |

**Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)**

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **4.5 dB** |

**Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)**

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **4.5dB** |

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

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **5.5 dB** |

# Appendix A. Radiated Spurious Emission

| | | | |
|---|---|---|---|
| **Test Engineer :** | Bill Chang, Gary Guo and Steven Wu | **Temperature :** | 18.2~20.2°C |
| | | **Relative Humidity :** | 54.2~56.1% |

**WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (5GHz) 802.11a_Tx_CH36**

**2.4GHz 2400~2483.5MHz**

**WIFI 802.11g (Harmonic @ 3m)**

| WIFI Ant. | Note | Frequency | Level | Margin | Limit Line | Read Level | Antenna Factor | Path Loss | Preamp Factor | Ant Pos | Table Pos | Peak Avg. | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3+4 | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| | * | 2437 | 115.12 | 41.12 | 74 | 99.46 | 27.6 | 17.96 | 29.9 | - | - | P | H |
| | | 4874 | 56.88 | -17.12 | 74 | 42.37 | 32.65 | 11.3 | 29.44 | 302 | 158 | P | H |
| | | 4874 | 47.17 | -6.83 | 54 | 32.66 | 32.65 | 11.3 | 29.44 | 302 | 158 | A | H |
| | * | 5180 | 107.23 | 39.03 | 68.2 | 91.78 | 33 | 11.84 | 29.39 | - | - | P | H |
| | | 7311 | 45.54 | -28.46 | 74 | 59.85 | 36.88 | 14.26 | 65.45 | - | - | P | H |
| | | 10360 | 46.24 | -21.96 | 68.2 | 57.51 | 38.7 | 16.56 | 66.53 | - | - | P | H |
| | | 15540 | 46.88 | -27.12 | 74 | 55.32 | 37.54 | 20.36 | 66.34 | - | - | P | H |
| 802.11g | | | | | | | | | | | | | H |
| CH 06 | | | | | | | | | | | | | H |
| 2437MHz | | | | | | | | | | | | | H |
| + | * | 2437 | 109.13 | 35.13 | 74 | 93.47 | 27.6 | 17.96 | 29.9 | | | P | V |
| 802.11a | | 4874 | 55.71 | -18.29 | 74 | 41.2 | 32.65 | 11.3 | 29.44 | 198 | 213 | P | V |
| CH 36 | | 4874 | 46.22 | -7.78 | 54 | 31.71 | 32.65 | 11.3 | 29.44 | 198 | 213 | A | V |
| 5180MHz | * | 5180 | 105.93 | 37.73 | 68.2 | 90.48 | 33 | 11.84 | 29.39 | - | - | P | V |
| | | 7311 | 46.58 | -27.42 | 74 | 60.89 | 36.88 | 14.26 | 65.45 | - | - | P | V |
| | | 10360 | 46.41 | -21.79 | 68.2 | 57.68 | 38.7 | 16.56 | 66.53 | - | - | P | V |
| | | 15540 | 52.11 | -21.89 | 74 | 60.55 | 37.54 | 20.36 | 66.34 | 100 | 58 | P | V |
| | | 15540 | 41.37 | -12.63 | 54 | 49.81 | 37.54 | 20.36 | 66.34 | 100 | 58 | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

**Remark**

1. No other spurious found.
2. All results are PASS against Peak and Average limit line.
3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.

## BLE(1M)_Tx_CH39 + WLAN (5GHz) 802.11a_Tx_CH36

## (Harmonic @ 3m)

| WIFI | Note | Frequency | Level | Margin | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ant. | | | | | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| 3+4 | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| BLE CH 39 2480MHz + 802.11a CH 36 5180MHz | | 2480 | 113.02 | 39.02 | 74 | 97.23 | 27.7 | 17.98 | 29.89 | 400 | 0 | P | H |
| | | 4960 | 57.62 | -16.38 | 74 | 42.62 | 32.88 | 11.54 | 29.42 | 153 | 251 | P | H |
| | | 4960 | 47.53 | -6.47 | 54 | 32.53 | 32.88 | 11.54 | 29.42 | 153 | 251 | A | H |
| | | 5180 | 106.81 | 38.61 | 68.2 | 91.36 | 33 | 11.84 | 29.39 | - | - | P | H |
| | | 7440 | 43.81 | -30.19 | 74 | 58.41 | 36.44 | 14.43 | 65.47 | - | - | P | H |
| | | 10360 | 47.19 | -21.01 | 68.2 | 58.46 | 38.7 | 16.56 | 66.53 | - | - | P | H |
| | | 15540 | 46.47 | -27.53 | 74 | 54.91 | 37.54 | 20.36 | 66.34 | - | - | P | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | * | 2480 | 110.09 | 36.09 | 74 | 94.3 | 27.7 | 17.98 | 29.89 | 100 | 0 | P | V |
| | | 4960 | 57.18 | -16.82 | 74 | 42.18 | 32.88 | 11.54 | 29.42 | 104 | 310 | P | V |
| | | 4960 | 47.24 | -6.76 | 54 | 32.24 | 32.88 | 11.54 | 29.42 | 104 | 310 | A | V |
| | * | 5180 | 105.15 | 36.95 | 68.2 | 89.7 | 33 | 11.84 | 29.39 | - | - | P | V |
| | | 7440 | 44.19 | -29.81 | 74 | 58.79 | 36.44 | 14.43 | 65.47 | - | - | P | V |
| | | 10360 | 46.58 | -21.62 | 68.2 | 57.85 | 38.7 | 16.56 | 66.53 | - | - | P | V |
| | | 15540 | 46.74 | -27.26 | 74 | 55.18 | 37.54 | 20.36 | 66.34 | - | - | P | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

**Remark**

1. No other spurious found.
2. All results are PASS against Peak and Average limit line.
3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.

**WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (6GHz) 802.11a_Tx_CH01**

**(Harmonic @ 3m)**

| WIFI Ant. | Note | Frequency | Level | Margin | Limit Line | Read Level | Antenna Factor | Path Loss | Preamp Factor | Ant Pos | Table Pos | Peak Avg. | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3+4 | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| | * | 2437 | 114.49 | 40.49 | 74 | 98.83 | 27.6 | 17.96 | 29.9 | 400 | 0 | P | H |
| | | 4872 | 56.12 | -17.88 | 74 | 41.62 | 32.64 | 11.3 | 29.44 | 382 | 131 | P | H |
| | | 4872 | 46.25 | -7.75 | 54 | 31.75 | 32.64 | 11.3 | 29.44 | 382 | 131 | A | H |
| | * | 5955 | 111.74 | 43.54 | 68.2 | 94.14 | 34.18 | 12.86 | 29.44 | - | - | P | H |
| | | 7311 | 45.48 | -28.52 | 74 | 59.79 | 36.88 | 14.26 | 65.45 | - | - | P | H |
| | | 11910 | 47.42 | -26.58 | 74 | 56.87 | 38.72 | 17.81 | 65.98 | - | - | P | H |
| | | 17865 | 51.21 | -22.79 | 74 | 52.76 | 41.31 | 22.24 | 65.1 | 156 | 79 | P | H |
| | | 17865 | 40.34 | -13.66 | 54 | 41.89 | 41.31 | 22.24 | 65.1 | 156 | 79 | A | H |
| 802.11g | | | | | | | | | | | | | H |
| CH 06 | | | | | | | | | | | | | H |
| 2437MHz | | | | | | | | | | | | | H |
| + | | | | | | | | | | | | | H |
| 802.11a | * | 2437 | 110.33 | 36.33 | 74 | 94.67 | 27.6 | 17.96 | 29.9 | 100 | 0 | P | V |
| CH 01 | | 4874 | 57.03 | -16.97 | 74 | 42.52 | 32.65 | 11.3 | 29.44 | 213 | 62 | P | V |
| 5955MHz | | 4874 | 46.89 | -7.11 | 54 | 32.38 | 32.65 | 11.3 | 29.44 | 213 | 62 | A | V |
| | * | 5955 | 107.67 | 39.47 | 68.2 | 90.07 | 34.18 | 12.86 | 29.44 | - | - | P | V |
| | | 7311 | 45.86 | -28.14 | 74 | 60.17 | 36.88 | 14.26 | 65.45 | - | - | P | V |
| | | 11910 | 47.25 | -26.75 | 74 | 56.7 | 38.72 | 17.81 | 65.98 | - | - | P | V |
| | | 17865 | 50.46 | -23.54 | 74 | 52.01 | 41.31 | 22.24 | 65.1 | 100 | 176 | P | V |
| | | 17865 | 40.76 | -13.24 | 54 | 42.31 | 41.31 | 22.24 | 65.1 | 100 | 176 | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

**Remark**

1. No other spurious found.
2. All results are PASS against Peak and Average limit line.
3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.

**Emission below 1GHz**

**BLE(1M)_Tx_CH39 + WLAN (5GHz) 802.11a_Tx_CH36**

**(LF @ 3m)**

| WIFI Ant. | Note | Frequency | Level | Margin | Limit Line | Read Level | Antenna Factor | Path Loss | Preamp Factor | Ant Pos | Table Pos | Peak Avg. | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3+4 | | ( MHz ) | ( dBµV/m ) | ( dB ) | ( dBµV/m ) | ( dBµV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| | | 31.35 | 22.58 | -17.42 | 40 | 30.41 | 23.86 | 0.76 | 32.45 | - | - | P | H |
| | | 95.61 | 36.33 | -7.17 | 43.5 | 51.98 | 15.38 | 1.39 | 32.42 | - | - | P | H |
| | | 289.2 | 23.54 | -22.46 | 46 | 34.3 | 19.09 | 2.56 | 32.41 | - | - | P | H |
| | | 514.2 | 25.31 | -20.69 | 46 | 30.74 | 23.92 | 3.31 | 32.66 | - | - | P | H |
| | | 621.3 | 28.68 | -17.32 | 46 | 31.53 | 26.04 | 3.82 | 32.71 | - | - | P | H |
| | | 896.4 | 34.54 | -11.46 | 46 | 32.97 | 28.92 | 4.6 | 31.95 | - | - | P | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| BLE | | | | | | | | | | | | | H |
| CH 39 | | | | | | | | | | | | | H |
| 2480MHz | | | | | | | | | | | | | H |
| + | | | | | | | | | | | | | H |
| 802.11a | | 87.78 | 27.85 | -12.15 | 40 | 44.46 | 14.5 | 1.29 | 32.4 | - | - | P | V |
| CH 36 | | 93.72 | 36.45 | -7.05 | 43.5 | 52.43 | 15.07 | 1.36 | 32.41 | - | - | P | V |
| 5180MHz | | 289.47 | 20.3 | -25.7 | 46 | 31.06 | 19.09 | 2.56 | 32.41 | - | - | P | V |
| LF | | 499.5 | 25.1 | -20.9 | 46 | 30.64 | 23.92 | 3.25 | 32.71 | - | - | P | V |
| | | 702.5 | 28.67 | -17.33 | 46 | 30.7 | 26.56 | 4.16 | 32.75 | - | - | P | V |
| | | 953.1 | 34.76 | -11.24 | 46 | 30.59 | 30.79 | 4.87 | 31.49 | - | - | P | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

**Remark**

1. No other spurious found.
2. All results are PASS against Peak and Average limit line.
3. The emission position marked as "-" means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only.

**Note symbol**

| | |
|---|---|
| * | **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 **Margin** line. |
| P/A | **P**eak or **A**verage |
| H/V | **H**orizontal or **V**ertical |

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

| BT | Note | Frequency | Level | Margin | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 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) |
| BT CH 00 2402MHz | | 2390 | 55.45 | -18.55 | 74 | 54.51 | 32.22 | 4.58 | 35.86 | 103 | 308 | P | H |
| | | 2390 | 43.54 | -10.46 | 54 | 42.6 | 32.22 | 4.58 | 35.86 | 103 | 308 | A | H |

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =

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

3. Margin (dB) = Level(dBμV/m) – Limit Line(dBμV/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(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Margin (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) + Path 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. Margin (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”.**

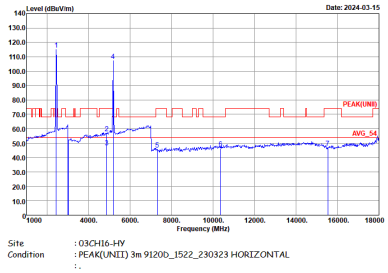
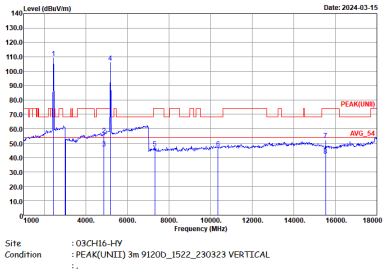
# Appendix B. Radiated Spurious Emission Plots

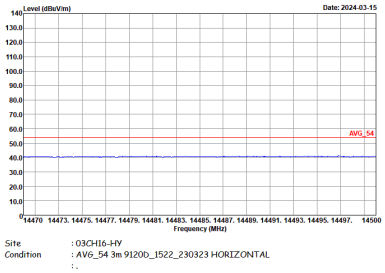
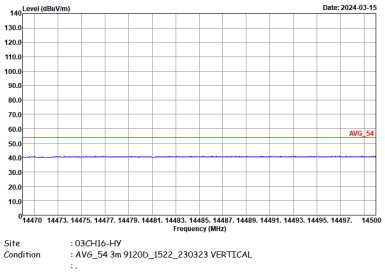
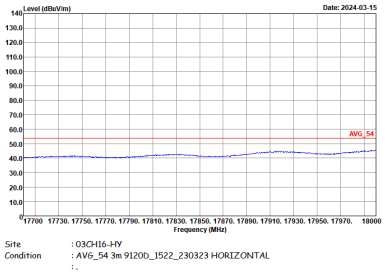
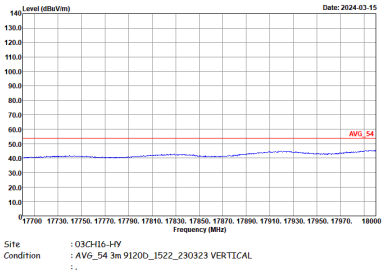
| | | | |
|---|---|---|---|
| **Test Engineer :** | Bill Chang, Gary Guo and Steven Wu | **Temperature :** | 18.2~20.2°C |
| | | **Relative Humidity :** | 54.2~56.1% |

**WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (5GHz) 802.11a_Tx_CH36**

**2.4GHz 2400~2483.5MHz**

**WIFI 802.11g (Harmonic @ 3m)**

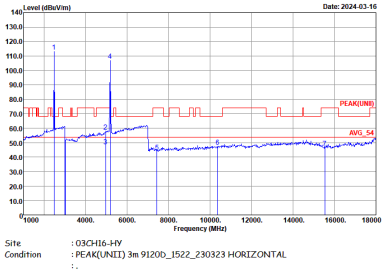
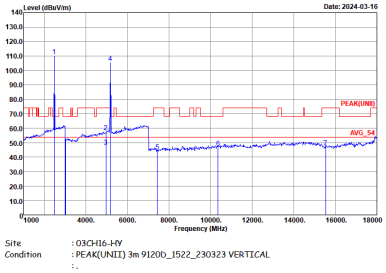
| **WIFI** | **11g_Tx_Ch06 + 11a_Tx_Ch36 Harmonic @ 3m** | |
|---|---|---|
| **ANT** | **11g_Tx_Ch06 + 11a_Tx_Ch36** | |
| **3+4** | **Horizontal** | **Vertical** |
| **Peak**<br>**Avg.** |  |  |

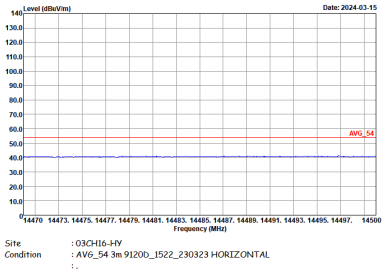
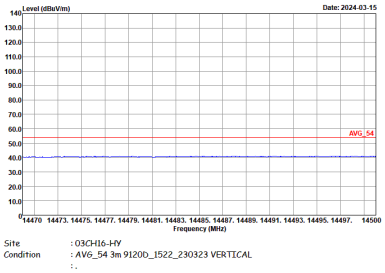
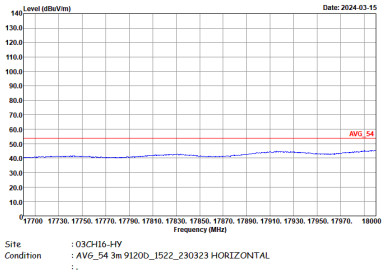
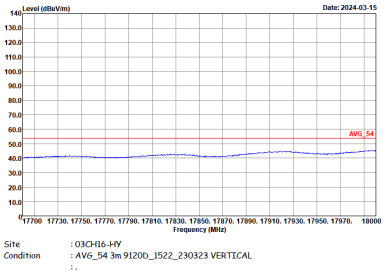
| WIFI | 11g_Tx_Ch06 + 11a_Tx_Ch36 Harmonic @ 3m | |
|---|---|---|
| ANT | 11g_Tx_Ch06 + 11a_Tx_Ch36 | |
| 3+4 | Horizontal | Vertical |
| 14.47G ~14.5G Avg. |  |  |
| 17.7G ~18G Avg |  |  |

## Band 1 - 5150~5250MHz

## BLE(1M)_Tx_CH39 + WLAN (5GHz) 802.11a_Tx_CH36

## (Harmonic @ 3m)

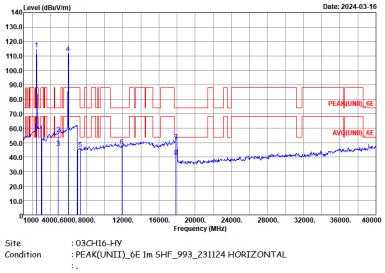
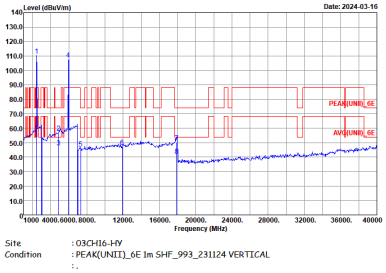
| | Band 1 5150~5250MHz Harmonic @ 3m | |
|---|---|---|
| | BLE_Tx_Ch39 +11a_Tx_Ch36 | |
| | Horizontal | Vertical |
| Peak<br>Avg. |  |  |

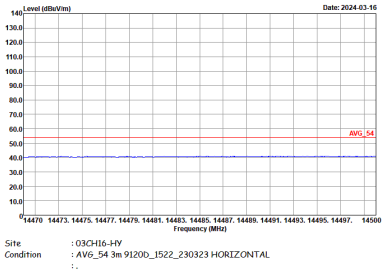
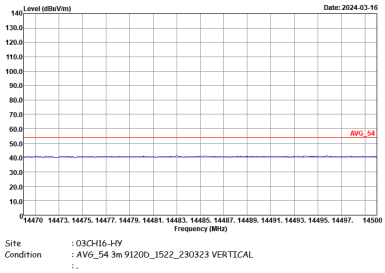
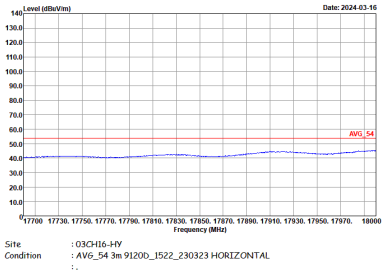
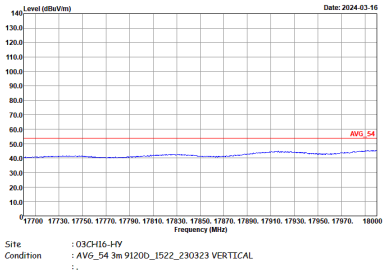
| | Band 1 5150~5250MHz Harmonic @ 3m | |
|---|---|---|
| | BLE_Tx_Ch39 +11a_Tx_Ch36 | |
| | Horizontal | Vertical |
| 14.47G ~14.5G Avg. |  |  |
| 17.7G ~18G Avg |  |  |

## Band 5 - 5925~6425MHz

## WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (6GHz) 802.11a_Tx_CH01

## (Harmonic @ 3m)

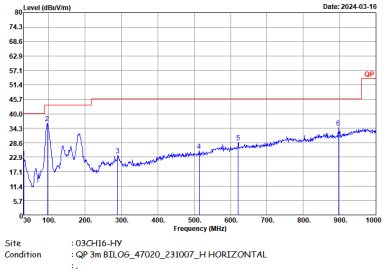
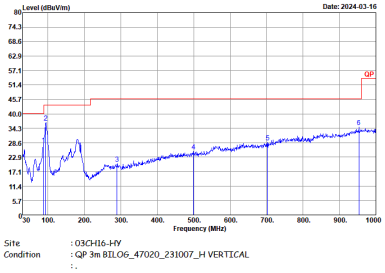
| WIFI | Band 5 5925~6425MHz Harmonic @ 3m | |
|---|---|---|
| ANT | 11g_Tx_Ch06 + 11a_Tx_Ch01 | |
| 3+4 | Horizontal | Vertical |
| Peak<br>Avg. |  |  |

| WIFI | Band 5 5925~6425MHz Harmonic @ 3m | |
|---|---|---|
| ANT | 11g_Tx_Ch06 + 11a_Tx_Ch01 | |
| 3+4 | Horizontal | Vertical |
| 14.47G ~14.5G Avg. |  |  |
| 17.7G ~18G Avg |  |  |

## Emission below 1GHz

## BLE(1M)_Tx_CH39 + WLAN (5GHz) 802.11a_Tx_CH36

## (LF)

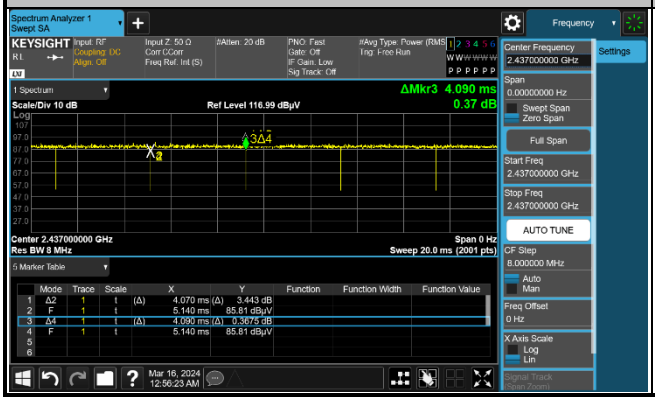
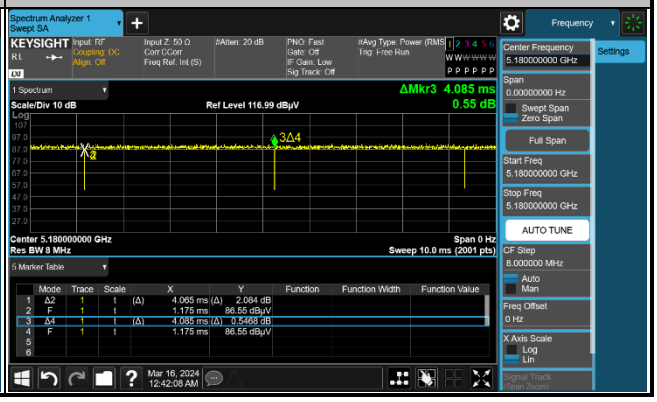
| | 2.4GHz 2400~2483.5MHz | |
|---|---|---|
| | BLE_Tx_Ch39 +11a_Tx_Ch36 | |
| | Horizontal | Vertical |
| QP / Peak |  |  |

# Appendix C. Duty Cycle Plots

**<Mode 1>**

| Antenna | Band | Duty Cycle(%) | T(us) | 1/T(kHz) | VBW Setting |
|---|---|---|---|---|---|
| 3+4 | 2.4GHz 802.11g | 99.51 | - | - | 10Hz |
| 3+4 | 5GHz 802.11a | 99.51 | - | - | 10Hz |

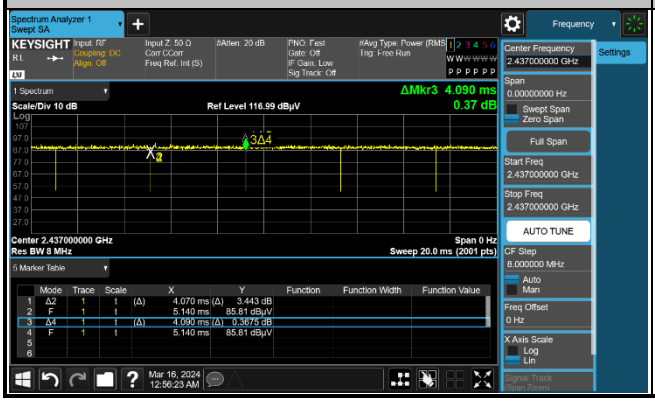
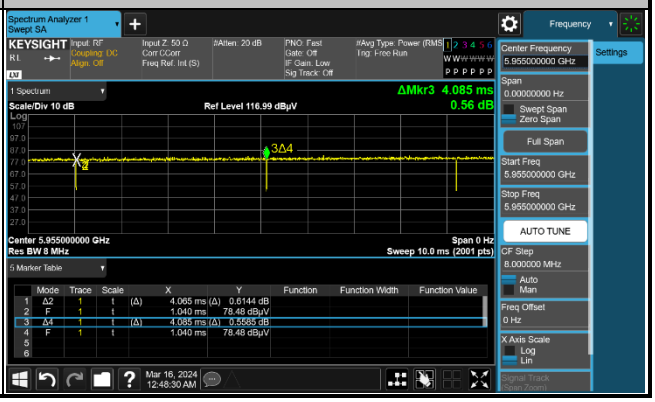
**MIMO <Ant. 3+4>**

| 2.4GHz 802.11g | 5GHz 802.11a |
|---|---|
|  |  |

**<Mode 2>**

| Antenna | Band | Duty Cycle(%) | T(us) | 1/T(kHz) | VBW Setting |
|---|---|---|---|---|---|
| 3+4 | 2.4GHz 802.11g | 99.51 | - | - | 10Hz |
| 3+4 | 6GHz 802.11a | 99.51 | - | - | 10Hz |

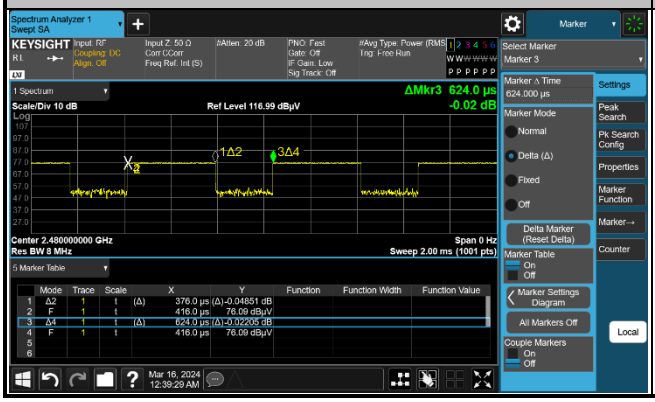
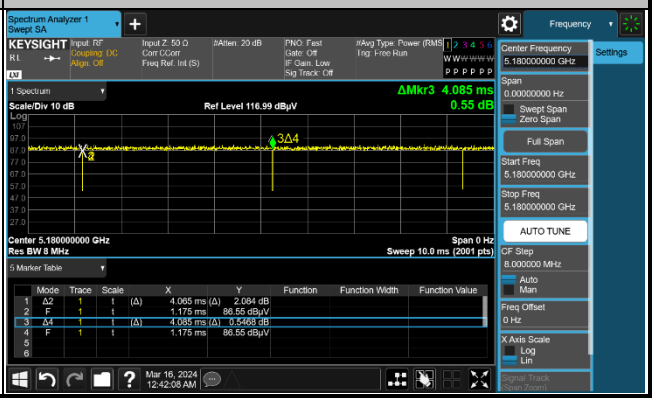
**MIMO <Ant. 3+4>**

| 2.4GHz 802.11g | 6GHz 802.11a |
|---|---|
|  |  |

**<Mode 3>**

| Antenna | Band | Duty Cycle(%) | T(us) | 1/T(kHz) | VBW Setting |
|---|---|---|---|---|---|
| 3 | Bluetooth - LE for 1Mbps | 60.26 | 376 | 2.66 | 2.7KHz |
| 3+4 | 5GHz 802.11a | 99.51 | - | - | 10Hz |

**<Ant. 3>** **MIMO <Ant. 3+4>**

| Bluetooth - LE for 1Mbps | 5GHz 802.11a |
|---|---|
|  |  |



———THE END———