# FCC CO-LOCATION TEST REPORT

| | | |
|---|---|---|
| **FCC ID** | : | **UZ7MC330L** |
| **Equipment** | : | **Mobile Computer** |
| **Brand Name** | : | **Zebra** |
| **Model Name** | : | **MC330L** |
| **Applicant** | : | **Zebra Technologies Corporation<br>1 Zebra Plaza, Holtsville, NY 11742** |
| **Manufacturer** | : | **Zebra Technologies Corporation<br>1 Zebra Plaza, Holtsville, NY 11742** |
| **Standard** | : | **FCC Part 15 Subpart E §15.407** |

**The product was received on Aug. 12, 2019 and testing was started from Nov. 14, 2019 and completed on Nov. 14, 2019. We, SPORTON INTERNATIONAL INC. EMC & Wireless Communications 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 report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.**

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

Louis Wu

**Approved by: Louis Wu**

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

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# History of this test report

| Report No. | Version | Description | Issued Date |
|---|---|---|---|
| FR981244G | 01 | Initial issue of report | Dec. 02, 2019 |
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# Summary of Test Result

| Report Clause | Ref Std. Clause | Test Items | Result (PASS/FAIL) | Remark |
|---|---|---|---|---|
| 3.1 | 15.407(b) | Unwanted Emissions | Pass | Under limit 1.23 dB at 242483.500 MHz |
| 3.2 | 15.203<br>15.407(a) | Antenna Requirement | Pass | - |

| **Declaration of Conformity:** |
|---|
| The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers. |
| **Comments and Explanations:** |
| The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification. |

**Reviewed by: Wii Chang**

**Report Producer: Yimin Ho**

# 1 General Description

## 1.1 Product Feature of Equipment Under Test

| Product Feature | |
|---|---|
| **Equipment** | Mobile Computer |
| **Brand Name** | Zebra |
| **Model Name** | MC330L |
| **FCC ID** | UZ7MC330L |
| **EUT supports Radios application** | NFC<br>WLAN 11a/b/g/n HT20/HT40<br>WLAN 11ac VHT20/VHT40/VHT80<br>Bluetooth BR/EDR/LE |
| **HW Version** | DV |
| **SW Version_Gun** | Android Version 9 |
| **SW Version_Brick** | Android Version 9 |
| **SW Version_Rotate** | Android Version 9 |
| **FW Version_Gun** | Terminal Version: 02-11-08.00-PG-U00-PLT |
| **FW Version_Brick** | Terminal Version: 02-11-08.00-PG-U00-PLT |
| **FW Version_Rotate** | Terminal Version: 02-11-08.00-PG-U00-PLT |
| **MFD_Gun** | 01AUG19 |
| **MFD_Brick** | 02AUG19 |
| **MFD_Rotate** | 27JUL19 |
| **EUT Stage** | Identical Prototype |

**Remark:** The above EUT's information was declared by manufacturer.

| Specification of Accessories | | | | |
|---|---|---|---|---|
| **Adapter** | **Brand Name** | Zebra | **Part Number** | PWR-WUA5V12W0US |
| **U cable** | **Brand Name** | Symbol | **Model Name** | CBL-MC33-USBCHG-01 |
| **MC32 1X battery (Inventus)** | **Brand Name** | Symbol | **Model Number** | 82-000011-01 |
| **MC32 2X battery (Inventus)** | **Brand Name** | Symbol | **Model Number** | 82-000012-02 |
| **MC32 2X battery (TWS)** | **Brand Name** | Symbol | **Model Number** | 82-000012-02 |
| **MC33 1X battery (Inventus)** | **Brand Name** | ZEBRA | **Model Number** | BT-000338 |
| **MC33 2X battery (Inventus)** | **Brand Name** | ZEBRA | **Model Number** | BT-000337 |
| **MC33 2X battery (TWS)** | **Brand Name** | ZEBRA | **Model Number** | BT-000337A |
| **MC33 7000mA 2X (Inventus)** | **Brand Name** | ZEBRA | **Model Number** | BT-000375 |
| **Holster for MC3XXX Gun configuration** | **Brand Name** | Zebra | **Model Number** | SG-MC3021212-01R |
| **Rigid holster for MC3XXX Gun configuration** | **Brand Name** | Zebra | **Model Number** | SG-MC33-RDHLST-01 |
| **Holster for MC3XXXX Brick configuration** | **Brand Name** | Zebra | **Model Number** | 11-69293-01R |
| **Rigid holster for MC3XXX Brick configuration** | **Brand Name** | Zebra | **Model Number** | SG-MC33-RDHLST-01 |
| **Lanyard for MC3XXX Brick Configuration** | **Brand Name** | Zebra | **Model Number** | SG-MC33-LNYDB-01 |
| **Protective boot for MC3XXX straight shooter** | **Brand Name** | Zebra | **Model Number** | SG-MC33-RBTG-01 |
| **Protective boot for MC3XXX Turret Cup of Rotate configuration** | **Brand Name** | Zebra | **Model Number** | SG-MC33-RBTRT-01 |
| **Protective boot for MC3XXX Rotate configuration** | **Brand Name** | Zebra | **Model Number** | SG-MC33-RBTRD-01 |

**<Sample Information>**

| Organization / Function / Group | SKU1 | SKU2 | SKU3 | SKU4 | SKU5 |
|---|---|---|---|---|---|
| **Phase** | DV | DV | DV | DV | DV |
| **Configuration** | | | | | |
| **Form Factor** | Gun | Gun | Gun - Amazon | Gun China | Rotate |
| **Scanner** | SE965 | SE4850 new 20-4850-IM001R | SE4770 | SE4720 | SE965 |
| **Keypad** | Numeric (29Key) | Function Numeric (47Key) | AlphaNum (47Key) | Function Numeric (38Key) | Numeric (47Key) |
| **Tier** | Base | Base | Base | Base | Base |
| **NFC** | Yes | Yes | Yes | Yes | Yes |
| **Camera** | NA | NA | NA | NA | No |
| **Audio Jack (NA)** | NA | NA | NA | NA | No |
| **Back Hsg** | Gun 18D | Gun 18D | Gun 18D | Gun 18D | Rotate Head |
| **Screen Protector** | No | Yes | Yes | No | No |
| **RFID Tag** | Yes | Yes | Yes | Yes | No |
| **Hand strap** | No | Yes | Yes | No | No |
| **USB Charge cable in box** | No | No | No | Yes | No |
| **Wal wart adaptor** | No | No | No | Yes | No |
| **PCB** | Tripod | Tripod | Tripod | Tripod | Tripod |
| **DRAM/eMMIC** | 4/32 GB MLC | 4/32 GB MLC | 4/32 GB MLC | 4/16 GB MLC | 4/32 GB MLC |
| **DRAM/eMMC Mfr main source** | Hynix/Hynix | Hynix/Hynix | Hynix/Hynix | Hynix/Hynix | Hynix/Hynix |

| Organization / Function / Group | SKU6 | SKU7 | SKU8 | SKU9 | SKU10 |
|---|---|---|---|---|---|
| **Phase** | DV | DV | DV | DV | DV |
| **Configuration** | | | | | |
| **Form Factor** | Straight (S) | Straight (S) | Straight (S) China | Straight (L) | Straight(45) |
| **Scanner** | SE965 | SE4770 | SE4720 | SE4850 new 20-4850-IM001R | SE4770 |
| **Keypad** | AlphaNum (47Key) | Function Numeric (38Key) | Function Numeric (38Key) | Numeric (29Key) | Function Numeric (38Key) |
| **Tier** | Base + Camera | Base + Camera | Base | Base + Camera | Base + Camera |
| **NFC** | Yes | Yes | Yes | Yes | Yes |
| **Camera** | Yes | Yes | No | Yes | Yes |
| **Audio Jack (NA)** | No | No | No | No | No |
| **Back Hsg** | 22 Deg ST | 22 Deg ST | 22 Deg ST | 18 deg ST | 45 deg ST |
| **Screen Protector** | No | No | No | Yes | Yes |
| **RFID Tag** | No | No | No | No | No |
| **Hand strap** | Yes | No | No | No | Yes |
| **USB Charge cable in box** | No | No | Yes | No | No |
| **Wal wart adaptor** | No | No | Yes | No | No |
| **PCB** | Tripod | Tripod | Tripod | Tripod | Tripod |
| **DRAM/eMMIC** | 4/32 GB MLC | 4/32 GB MLC | 4/16 GB MLC | 4/32 GB MLC | 4/32 GB MLC |
| **DRAM/eMMC Mfr main source** | Hynix/Hynix | Hynix/Hynix | Hynix/Hynix | Hynix/Hynix | Hynix/Hynix |

## 1.2 Product Specification of Equipment Under Test

| Standards-related Product Specification | |
|---|---|
| **Tx/Rx Frequency Range** | 2400 MHz ~ 2483.5 MHz<br>5260 MHz ~ 5320 MHz |
| **Antenna Type / Gain** | **<2412 MHz ~ 2462 MHz>**<br>Ant. 1 : PIFA Antenna with gain 3.40 dBi<br>**<5250 MHz ~ 5350 MHz>**<br>Ant. 2 : PIFA Antenna with gain 4.41 dBi |
| **Type of Modulation** | 802.11n : OFDM (BPSK / QPSK / 16QAM / 64QAM)<br>802.11ac: OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM) |

## 1.3 Modification of EUT

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

## 1.4 Testing Location

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

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

FCC Designation No. TW0007

## 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 v02r01.
- FCC KDB 414788 D01 Radiated Test Site v01r01.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- ANSI C63.10-2013

**Remark:**

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

# 2 Test Configuration of Equipment Under Test

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 three orthogonal panels, X, Y, Z. The worst cases (Y plane) were recorded in this report.

## 2.1 Carrier Frequency and Channel

| 2400-2483.5 MHz<br>802.11n HT40 | | 5250-5350 MHz<br>802.11ac VHT40 | |
|---|---|---|---|
| **Channel** | **Freq. (MHz)** | **Channel** | **Freq. (MHz)** |
| 09 | 2452 | 62 | 5310 |

## 2.2 Test Mode

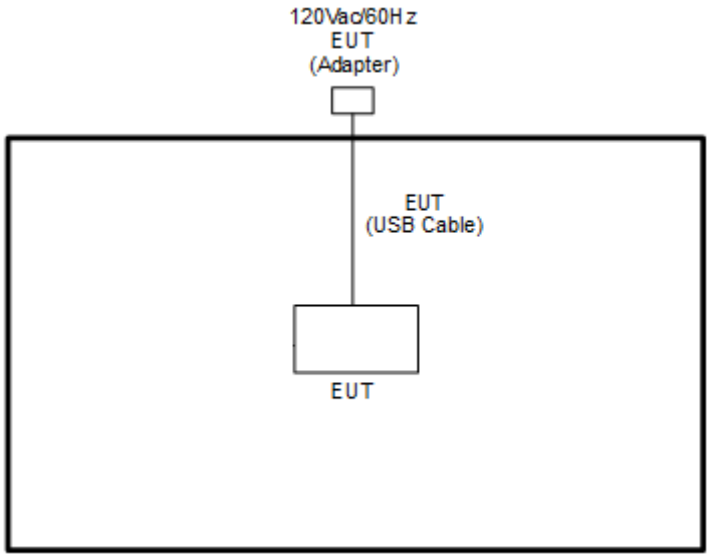
**Final test modes are considering the modulation and worse data rates as below table.**

**<Co-Location>**

| Modulation | Data Rate |
|---|---|
| **802.11n HT40 for Ant. 1 + 802.11ac VHT40 for Ant. 2** | **MCS0 + MCS0** |

**Remark:** All the tests were performed with MC33 2X battery (Inventus) and SKU 5.

## 2.3 Connection Diagram of Test System



## 2.4 Support Unit used in test configuration and system

| Item | Equipment | Trade Name | Model Name | FCC ID | Data Cable | Power Cord |
|---|---|---|---|---|---|---|
| 1. | Notebook | Lenovo | E330 | NA | N/A | AC I/P: Unshielded, 1.2m DC O/P: Shielded, 1.8m |

## 2.5 EUT Operation Test Setup

The RF test items, utility “QRCT v3.0.298.0” 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

(1) 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 |

(3) 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

See list of measuring equipment of 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 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 ≥ 3 MHz
   - Detector = Peak
   - Sweep time = auto
   - Trace mode = max hold

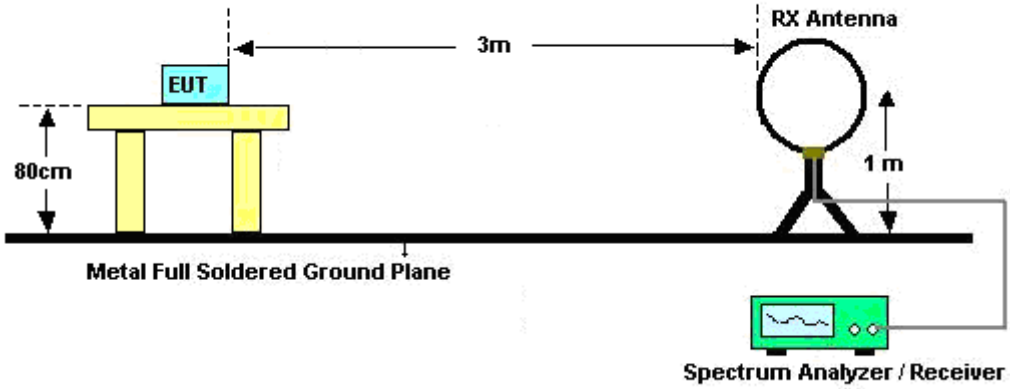
   (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz

   - RBW = 1 MHz
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 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.

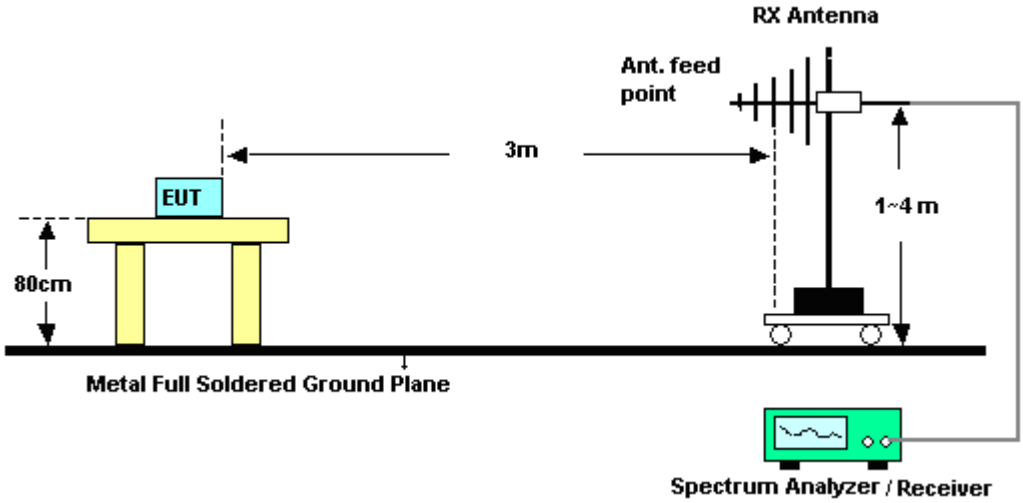
2. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
4. The antenna is a broadband 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

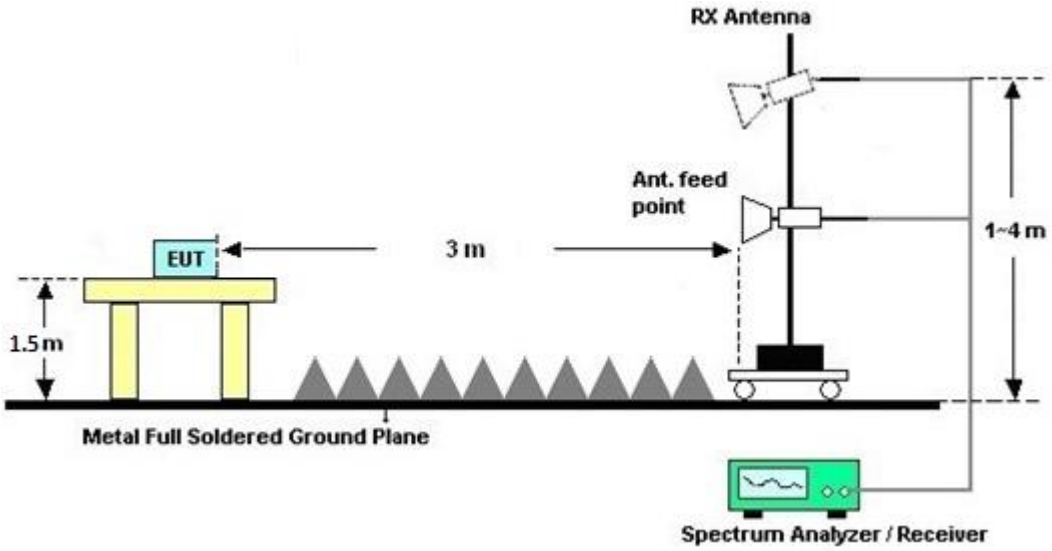
**For radiated emissions below 30MHz**




**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 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

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 |
|---|---|---|---|---|---|---|---|---|
| Loop Antenna | Rohde & Schwarz | HFH2-Z2 | 100488 | 9 kHz~30 MHz | Jan. 07, 2019 | Nov. 14, 2019 | Jan. 06, 2020 | Radiation (03CH12-HY) |
| Bilog Antenna | TESEQ | CBL 6111D&00800 N1D01N-06 | 37059&01 | 30MHz~1GHz | Oct. 12, 2019 | Nov. 14, 2019 | Oct. 11, 2020 | Radiation (03CH12-HY) |
| Horn Antenna | SCHWARZBECK | BBHA 9120D | 9120D-02037 | 1GHz ~ 18GHz | Oct. 28, 2019 | Nov. 14, 2019 | Oct. 27, 2020 | Radiation (03CH12-HY) |
| SHF-EHF Horn Antenna | SCHWARZBECK | BBHA 9170 | BBHA9170584 | 18GHz ~ 40GHz | Dec. 05, 2018 | Nov. 14, 2019 | Dec. 04, 2019 | Radiation (03CH12-HY) |
| Preamplifier | COM-POWER | PA-103 | 161075 | 10MHz~1GHz | Mar. 25, 2019 | Nov. 14, 2019 | Mar. 24, 2020 | Radiation (03CH12-HY) |
| Preamplifier | Agilent | 8449B | 3008A02375 | 1GHz~26.5GHz | May. 27, 2019 | Nov. 14, 2019 | May 26, 2020 | Radiation (03CH12-HY) |
| Preamplifier | MITEQ | AMF-7D-00101800-30-10P | 1590074 | 1GHz~18GHz | May. 20, 2019 | Nov. 14, 2019 | May 19, 2020 | Radiation (03CH12-HY) |
| Preamplifier | EMEC | EM18G40G | 060715 | 18GHz ~ 40GHz | Dec. 06, 2018 | Nov. 14, 2019 | Dec. 05, 2019 | Radiation (03CH12-HY) |
| EMI Test Receiver | Rohde & Schwarz | ESU26 | 100390 | 20Hz~26.5GHz | Dec. 26, 2018 | Nov. 14, 2019 | Dec. 25, 2019 | Radiation (03CH12-HY) |
| Spectrum Analyzer | Keysight | N9010A | MY553705 26 | 10Hz~44GHz | Mar. 19, 2019 | Nov. 14, 2019 | Mar. 18, 2020 | Radiation (03CH12-HY) |
| Filter | Wainwright | WLKS1200-12SS | SN1 | 1.2 GHz Lowpass | Mar. 22, 2019 | Nov. 14, 2019 | Mar. 21, 2020 | Radiation (03CH12-HY) |
| Filter | Wainwright | WHKX12-2700-3000-18000-60ST | SN2 | 3GHz High Pass | Jul. 15, 2019 | Nov. 14, 2019 | Jul. 14, 2020 | Radiation (03CH12-HY) |
| Filter | Woken | WHKX8-5272.5-6750-18000-40ST | SN2 | 6.75G Highpass | Mar. 19, 2019 | Nov. 14, 2019 | Mar. 18, 2020 | Radiation (03CH12-HY) |
| Notch Filter | Wainwright | WRCGV2400/2483-2390/2493-35/10SS | SN4 | 2.4G | Nov. 01, 2019 | Nov. 14, 2019 | Oct. 31, 2020 | Radiation (03CH12-HY) |
| Notch Filter | Wainwright | WRCJV12-5120-5150-5350-5380-40SS | SN6 | 5GBand1~2 | Jul. 03, 2018 | Nov. 14, 2019 | Jul. 02, 2020 | Radiation (03CH12-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 126E | 0058/126E | 30M-18G | Mar. 13, 2019 | Nov. 14, 2019 | Mar. 12, 2020 | Radiation (03CH12-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102 | 505134/2 | 30M~40GHz | Feb. 26, 2019 | Nov. 14, 2019 | Feb. 25, 2020 | Radiation (03CH12-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102 | 800740/2 | 30M~40GHz | Feb. 26, 2019 | Nov. 14, 2019 | Feb. 25, 2020 | Radiation (03CH12-HY) |
| Antenna Mast | EMEC | AM-BS-4500-B | N/A | 1m~4m | N/A | Nov. 14, 2019 | N/A | Radiation (03CH12-HY) |
| Turn Table | EMEC | TT2000 | N/A | 0~360 Degree | N/A | Nov. 14, 2019 | N/A | Radiation (03CH12-HY) |
| Software | Audix | E3 6.2009-8-24 | RK-000989 | N/A | N/A | Nov. 14, 2019 | N/A | Radiation (03CH12-HY) |

# 5 Uncertainty of Evaluation

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

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

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

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

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

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

# Appendix A. Radiated Spurious Emission

| Test Engineer : | Jack Cheng, Lance Chiang and Chuan Chu | Temperature : | 23.1~26.4°C |
|---|---|---|---|
| | | Relative Humidity : | 56~68% |

**2.4G 11n HT40_Tx_Ch09 + 5G 11ac(40)_Tx_Ch62**

**WIFI 802.11n HT40 (Band Edge @ 3m)**

| WIFI | Note | Frequency | Level | Over | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ant. | | | | Limit | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| 1 | | ( MHz ) | ( dBµV/m ) | ( dB ) | ( dBµV/m ) | ( dBµV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| 802.11n HT40 CH 09 2452MHz | | 2386.02 | 54.84 | -19.16 | 74 | 43.84 | 27.53 | 16.62 | 33.15 | 217 | 333 | P | H |
| | | 2310 | 46.32 | -7.68 | 54 | 35.01 | 27.84 | 16.53 | 33.06 | 217 | 333 | A | H |
| | * | 2452 | 93.02 | - | - | 82.17 | 27.4 | 16.68 | 33.23 | 217 | 333 | P | H |
| | * | 2452 | 85.28 | - | - | 74.43 | 27.4 | 16.68 | 33.23 | 217 | 333 | A | H |
| | | 2499.37 | 55.14 | -18.86 | 74 | 44.41 | 27.3 | 16.72 | 33.29 | 217 | 333 | P | H |
| | | 2484.67 | 46.23 | -7.77 | 54 | 35.46 | 27.33 | 16.71 | 33.27 | 217 | 333 | A | H |
| | | 2328.76 | 55.27 | -18.73 | 74 | 44.07 | 27.73 | 16.55 | 33.08 | 198 | 312 | P | V |
| | | 2389.38 | 46.07 | -7.93 | 54 | 35.08 | 27.52 | 16.63 | 33.16 | 198 | 312 | A | V |
| | * | 2452 | 105.88 | - | - | 95.03 | 27.4 | 16.68 | 33.23 | 198 | 312 | P | V |
| | * | 2452 | 97.97 | - | - | 87.12 | 27.4 | 16.68 | 33.23 | 198 | 312 | A | V |
| | | 2484.46 | 60.91 | -13.09 | 74 | 50.14 | 27.33 | 16.71 | 33.27 | 198 | 312 | P | V |
| | | 2483.5 | 52.77 | -1.23 | 54 | 42 | 27.33 | 16.71 | 33.27 | 198 | 312 | A | V |

**Remark**

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

**WIFI 802.11ac VHT40 (Band Edge @ 3m)**

| WIFI Ant. 2 | Note | Frequency ( MHz ) | Level ( dBµV/m ) | Over Limit ( dB ) | Limit Line ( dBµV/m ) | Read Level (dBµV) | Antenna Factor ( dB/m ) | Path Loss ( dB ) | Preamp Factor ( dB ) | Ant Pos ( cm ) | Table Pos ( deg ) | Peak Avg. (P/A) | Pol. (H/V) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11ac VHT40 CH 62 5310MHz | | 5087.38 | 50.46 | -23.54 | 74 | 42.24 | 31.95 | 9.74 | 33.47 | 208 | 355 | P | H |
| | | 5116.62 | 42.97 | -11.03 | 54 | 34.69 | 31.97 | 9.78 | 33.47 | 208 | 355 | A | H |
| | * | 5310 | 100.88 | - | - | 92.99 | 31.3 | 10.04 | 33.45 | 208 | 355 | P | H |
| | * | 5310 | 93.51 | - | - | 85.62 | 31.3 | 10.04 | 33.45 | 208 | 355 | A | H |
| | | 5368.08 | 50.86 | -23.14 | 74 | 42.82 | 31.37 | 10.11 | 33.44 | 208 | 355 | P | H |
| | | 5350.32 | 45.19 | -8.81 | 54 | 37.24 | 31.3 | 10.09 | 33.44 | 208 | 355 | A | H |
| | | 5109.82 | 51.57 | -22.43 | 74 | 43.29 | 31.98 | 9.77 | 33.47 | 400 | 20 | P | V |
| | | 5140.76 | 43 | -11 | 54 | 34.74 | 31.92 | 9.81 | 33.47 | 400 | 20 | A | V |
| | * | 5310 | 107.83 | - | - | 99.94 | 31.3 | 10.04 | 33.45 | 400 | 20 | P | V |
| | * | 5310 | 100.15 | - | - | 92.26 | 31.3 | 10.04 | 33.45 | 400 | 20 | A | V |
| | | 5355.12 | 56.55 | -17.45 | 74 | 48.58 | 31.32 | 10.09 | 33.44 | 400 | 20 | P | V |
| | | 5350.08 | 49.95 | -4.05 | 54 | 42 | 31.3 | 10.09 | 33.44 | 400 | 20 | A | V |
| **Remark** | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. | | | | | | | | | | | | |

**Co-location mode (Harmonic @ 3m)**

| Co-location | Note | Frequency ( MHz ) | Level ( dBμV/m ) | Over Limit ( dB ) | Limit Line ( dBμV/m ) | Read Level ( dBμV ) | Antenna Factor ( dB/m ) | Path Loss ( dB ) | Preamp Factor ( dB ) | Ant Pos ( cm ) | Table Pos ( deg ) | Peak Avg. (P/A) | Pol. (H/V) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-location mode | | 4904 | 51.75 | -22.25 | 74 | 44.42 | 31.22 | 9.6 | 33.49 | 100 | 331 | P | H |
| | | 4904 | 43.17 | -10.83 | 54 | 35.84 | 31.22 | 9.6 | 33.49 | 100 | 331 | A | H |
| | | 7356 | 45.26 | -28.74 | 74 | 59.53 | 36.28 | 13.02 | 63.57 | 100 | 0 | P | H |
| | | 10620 | 48.63 | -25.37 | 74 | 57.19 | 39.88 | 15.19 | 63.63 | 100 | 0 | P | H |
| | | 15930 | 43.71 | -30.29 | 74 | 49.99 | 37.06 | 18.73 | 62.07 | 100 | 0 | P | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 4904 | 51.58 | -22.42 | 74 | 44.25 | 31.22 | 9.6 | 33.49 | 100 | 276 | P | V |
| | | 4904 | 43.03 | -10.97 | 54 | 35.7 | 31.22 | 9.6 | 33.49 | 100 | 276 | A | V |
| | | 7356 | 44.1 | -29.9 | 74 | 58.37 | 36.28 | 13.02 | 63.57 | 100 | 0 | P | V |
| | | 10620 | 48.26 | -25.74 | 74 | 56.82 | 39.88 | 15.19 | 63.63 | 100 | 0 | P | V |
| | | 15930 | 43.4 | -30.6 | 74 | 49.68 | 37.06 | 18.73 | 62.07 | 100 | 0 | P | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| **Remark** | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. | | | | | | | | | | | | |

**Emission below 1GHz**

**Co-location mode (LF @ 3m)**

| Co-location | Note | Frequency | Level | Over | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Limit | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | (dBμV) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| Co-location mode | | 66.86 | 32.91 | -7.09 | 40 | 50.38 | 11.79 | 1.2 | 30.46 | - | - | P | H |
| | | 72.68 | 33.6 | -6.4 | 40 | 50.5 | 12.29 | 1.26 | 30.45 | 100 | 0 | P | H |
| | | 113.42 | 34.02 | -9.48 | 43.5 | 45.91 | 17.01 | 1.52 | 30.42 | - | - | P | H |
| | | 777.87 | 38.69 | -7.31 | 46 | 35.71 | 28.19 | 4.13 | 29.34 | - | - | P | H |
| | | 914.64 | 35.73 | -10.27 | 46 | 31.02 | 29.27 | 4.54 | 29.1 | - | - | P | H |
| | | 950.53 | 36.28 | -9.72 | 46 | 30 | 30.61 | 4.66 | 28.99 | - | - | P | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 42.61 | 34.64 | -5.36 | 40 | 46.02 | 18.02 | 0.96 | 30.36 | 100 | 353 | QP | V |
| | | 42.61 | 42.79 | 2.79 | 40 | 54.17 | 18.02 | 0.96 | 30.36 | 100 | 353 | P | V |
| | | 64.92 | 33.61 | -6.39 | 40 | 51.23 | 11.65 | 1.19 | 30.46 | - | - | P | V |
| | | 113.42 | 34.68 | -8.82 | 43.5 | 46.57 | 17.01 | 1.52 | 30.42 | - | - | P | V |
| | | 777.87 | 38.15 | -7.85 | 46 | 35.17 | 28.19 | 4.13 | 29.34 | - | - | P | V |
| | | 882.63 | 34.81 | -11.19 | 46 | 30.56 | 28.97 | 4.45 | 29.17 | - | - | P | V |
| | | 953.44 | 37.17 | -8.83 | 46 | 30.76 | 30.73 | 4.67 | 28.99 | - | - | P | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| **Remark** | 1. No other spurious found.<br>2. All results are PASS against limit line. | | | | | | | | | | | | |

**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 **over limit** 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:**

| WIFI | Note | Frequency | Level | Over | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ant. | | | | Limit | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| 0 | | ( MHz ) | ( dBµV/m ) | ( dB ) | ( dBµV/m ) | ( dBµV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| 802.11b CH 01 2412MHz | | 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. Over Limit(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. 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) + 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. 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

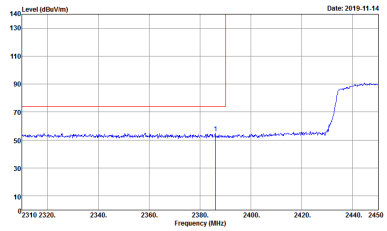
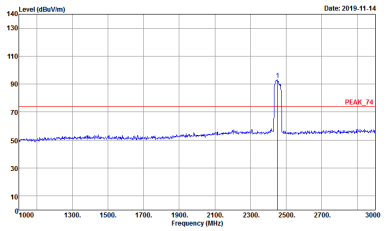
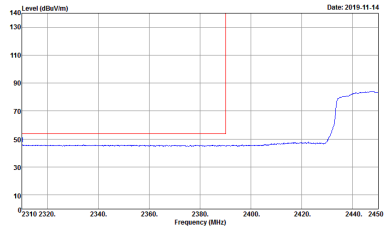
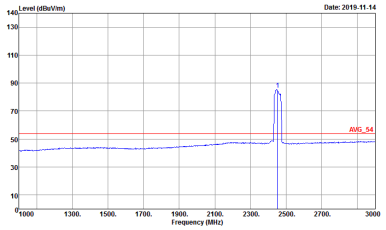
| | | | |
|---|---|---|---|
| **Test Engineer :** | Jack Cheng, Lance Chiang and Chuan Chu | **Temperature :** | 23.1~26.4°C |
| | | **Relative Humidity :** | 56~68% |

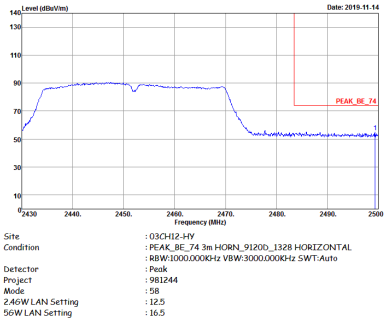
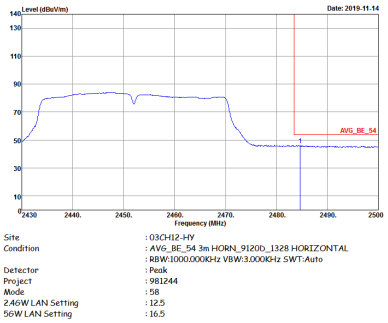
**Note symbol**

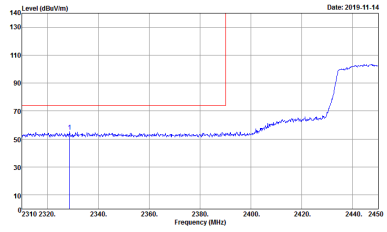
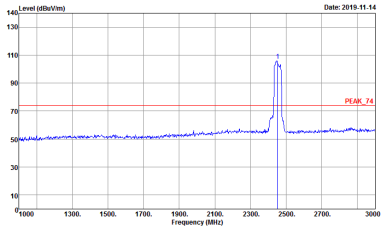
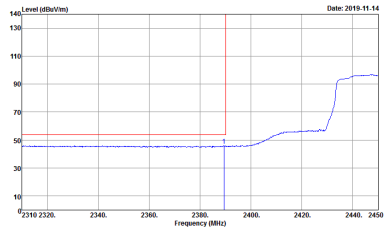
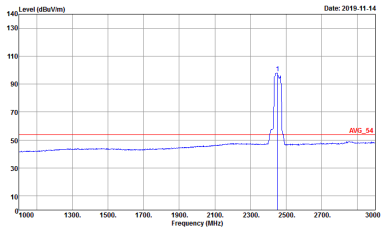
| | |
|---|---|
| -L | **Low channel location** |
| -R | **High channel location** |

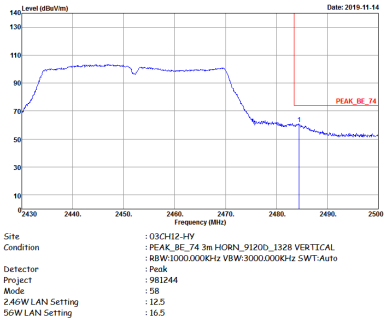
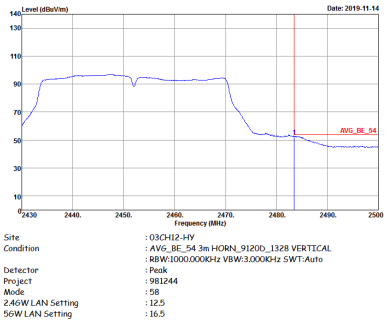
## 2.4G 11n HT40_Tx_Ch09 + 5G 11ac(40)_Tx_Ch62

## WIFI 802.11n HT40 (Band Edge @ 3m)

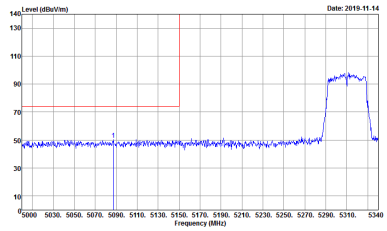
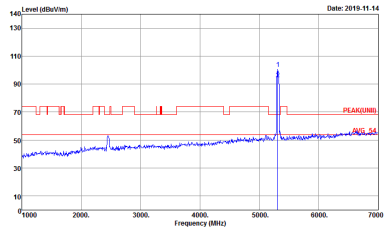
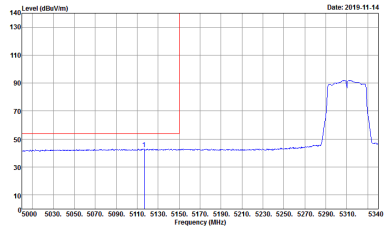
| WIFI | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | 802.11n HT40 CH09 2452MHz - L | |
| 1 | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH12-HY<br>Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 |  <br>Site : 03CH12-HY<br>Condition : PEAK_74 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 |
| Avg. |  <br>Site : 03CH12-HY<br>Condition : AVG_BE_54 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 |  <br>Site : 03CH12-HY<br>Condition : AVG_54 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 |

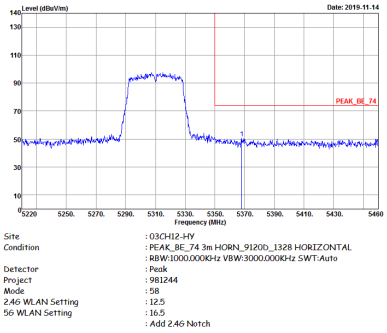
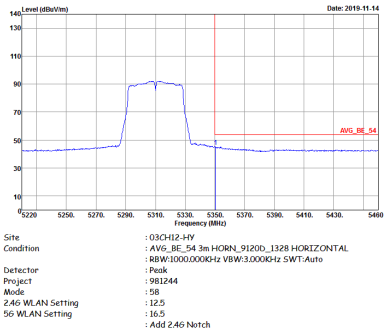
| WIFI | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | 802.11n HT40 CH09 2452MHz - R | |
| 1 | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH12-HY<br>Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 | Left blank |
| Avg. |  <br>Site : 03CH12-HY<br>Condition : AVG_BE_54 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 | Left blank |

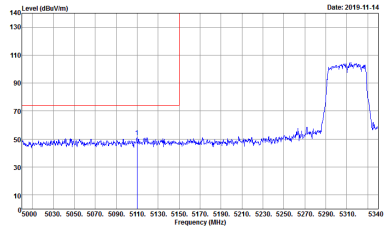
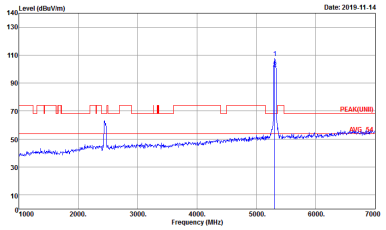
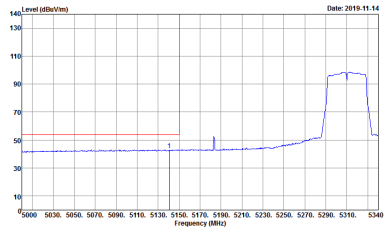
| WIFI | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | 802.11n HT40 CH09 2452MHz - L | |
| 1 | Vertical | Fundamental |
| Peak |  <br>Site : 03CH12-HY<br>Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 |  <br>Site : 03CH12-HY<br>Condition : PEAK_74 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 |
| Avg. |  <br>Site : 03CH12-HY<br>Condition : AVG_BE_54 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 |  <br>Site : 03CH12-HY<br>Condition : AVG_54 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4GW LAN Setting : 12.5<br>5GW LAN Setting : 16.5 |

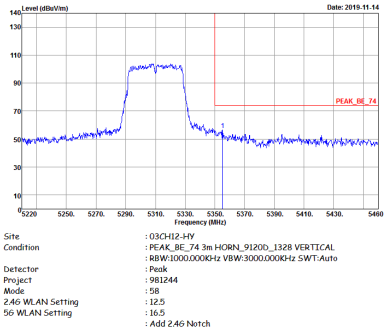
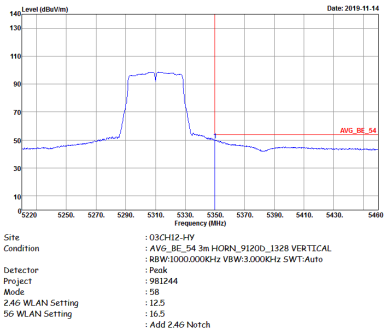
| WIFI | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | 802.11n HT40 CH09 2452MHz - R | |
| 1 | Vertical | Fundamental |
| Peak |  | Left blank |
| Avg. |  | Left blank |

## WIFI 802.11ac VHT40 (Band Edge @ 3m)

| WIFI | Band 2 5250~5350MHz Band Edge @ 3m | |
|---|---|---|
| ANT | 802.11ac VHT40 CH62 5310 - L | |
| 1 | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH12-HY<br>Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch |  <br>Site : 03CH12-HY<br>Condition : PEAK(UNII) 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch |
| Avg. |  <br>Site : 03CH12-HY<br>Condition : AVG_BE_54 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch | Left blank |

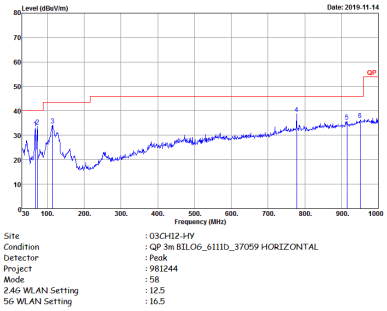
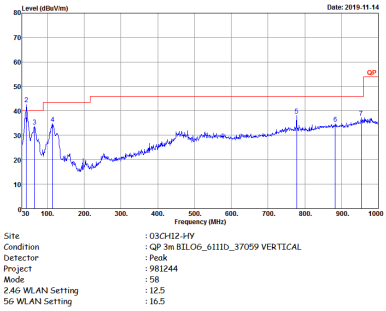
| WIFI | Band 2 5250~5350MHz Band Edge @ 3m | |
|---|---|---|
| ANT | 802.11ac VHT40 CH62 5310 - R | |
| 1 | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH12-HY<br>Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch | Left blank |
| Avg. |  <br>Site : 03CH12-HY<br>Condition : AVG_BE_54 3m HORN_9120D_1328 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch | Left blank |

| WIFI | Band 2 5250~5350MHz Band Edge @ 3m | |
|---|---|---|
| ANT | 802.11ac VHT40 CH62 5310 - L | |
| 1 | Vertical | Fundamental |
| Peak |  <br>Site : 03CH12-HY<br>Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch |  <br>Site : 03CH12-HY<br>Condition : PEAK(UNII) 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch |
| Avg. |  <br>Site : 03CH12-HY<br>Condition : AVG_BE_54 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch | Left blank |

| WIFI | Band 2 5250~5350MHz Band Edge @ 3m | |
|---|---|---|
| ANT | 802.11ac VHT40 CH62 5310 - R | |
| 1 | Vertical | Fundamental |
| Peak |  <br>Site : 03CH12-HY<br>Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch | Left blank |
| Avg. |  <br>Site : 03CH12-HY<br>Condition : AVG_BE_54 3m HORN_9120D_1328 VERTICAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto<br>Detector : Peak<br>Project : 981244<br>Mode : 58<br>2.4G WLAN Setting : 12.5<br>5G WLAN Setting : 16.5<br>: Add 2.4G Notch | Left blank |

## Emission below 1GHz

## Co-location mode (LF)

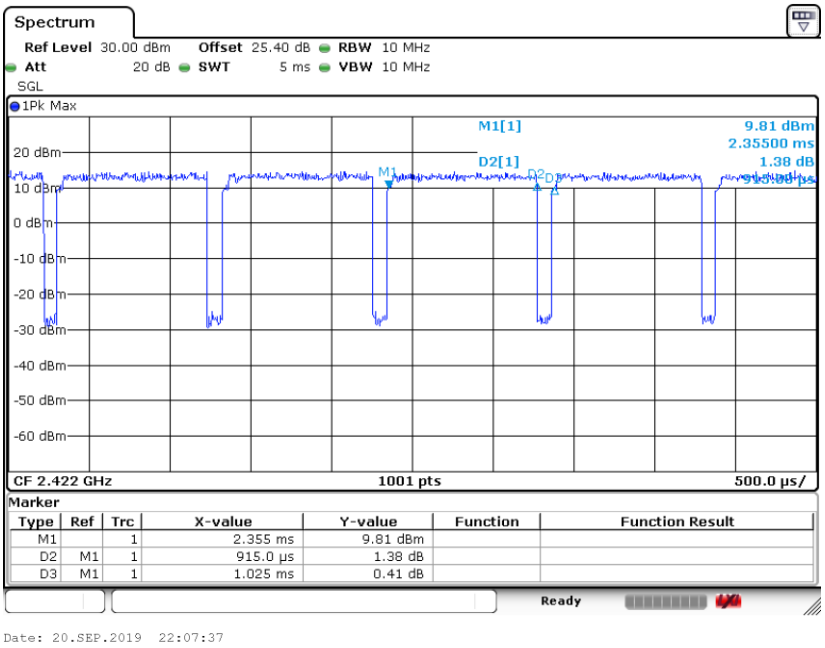
| | Co-location mode LF | |
|---|---|---|
| | Horizontal | Vertical |
| QP / Peak |  |  |

# Appendix C. Duty Cycle Plots

| Antenna | Band | Duty Cycle (%) | T(us) | 1/T(kHz) | VBW Setting | Duty Factor (dB) |
|---|---|---|---|---|---|---|
| 1 | 2.4GHz 802.11n HT40 | 89.27 | 915 | 1.09 | 3kHz | 0.49 |
| 2 | 5GHz 802.11ac VHT40 | 91.39 | 955 | 1.05 | 3kHz | 0.39 |

**<Ant. 1>**

**2.4GHz 802.11n HT40**



**<Ant. 2>**

**5GHz 802.11ac VHT40**