# RSE Cotransmission FCC Test Report

**FOR:**

Weathermatic

Model Name:

SLHUB-RF-5

Product Description:

Module receiving weather station data on a 15 or 60 minutes interval

FCC ID: OLPSLHUBRF900MZ

Applied Rules and Standards:
47 CFR Part 15.247 (DTS)

REPORT #: EMC_ASTRO-001-20001_15.247_DTS

DATE: 2020-04-08


**A2LA Accredited**

**IC recognized #**
**3462B-1**

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# 1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations.

No deviations were ascertained.

| Company | Description | Model # |
|---|---|---|
| Weathermatic | Module receiving weather station data on a 15 or 60 minutes interval | SLHUB-RF-5 |

| Section EMC | Name | Signature |
|---|---|---|
| Responsible for Testing Laboratory | Cindy Li (EMC Lab Manager) | Cindy Li Digitally signed by cindy.li@cetecom.com DN: CN=cindy.li@cetecom.com Reason: I am approving this document Location: Date: 2020-05-05 14:19:30 |

| Section EMC | Name | Signature |
|---|---|---|
| Responsible for the Report | Kris Lazarov (Senior EMC Engineer) | Kris Lazarov Digitally signed by Kris Lazarov Date: 2020.05.05 14:07:25 -07'00' |

# 2 Administrative Data

## 2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

| | |
|---|---|
| **Company Name:** | CETECOM Inc. |
| **Department:** | Compliance |
| **Street Address:** | 411 Dixon Landing Road |
| **City/Zip Code** | Milpitas, CA 95035 |
| **Country** | USA |
| **Telephone:** | +1 (408) 586 6200 |
| **Fax:** | +1 (408) 586 6299 |
| **EMC Lab Manager:** | Cindy Li |
| **Responsible Project Leader:** | Kris Lazarov |

## 2.2 Identification of the Client

| | |
|---|---|
| **Applicant Firm/Name:** | Weathermatic |
| **Street Address:** | 3301 W Kingsley Rd |
| **City/Zip Code** | Garland, TX 75041 |
| **Country** | USA |

## 2.3 Identification of the Manufacturer

| | |
|---|---|
| **Manufacturer's Name:** | Same as applicant |
| **Manufacturers Address:** | |
| **City/Zip Code** | |
| **Country** | |

# 3 Equipment Under Test (EUT)

## 3.1 EUT Specifications

| | |
|---|---|
| **Model No:** | SLHUB-RF-5 |
| **HW Version :** | FR |
| **SW Version :** | 0.21 |
| **FCC-ID :** | OLPSLHUBRF900MZ |
| **Product Description:** | Module receiving weather station data on a 15 or 60 minutes interval |
| **FHSS Radio Module:** | Weathermatic Model: SLHUBRF-5<br>FCC ID: OLPSLHUBRF900MZ |
| **Wi-Fi & Bluetooth Module:** | Espressif Systems Model: ESP32-WROOM-32D<br>FCC ID: 2AC7Z-ESPWROOM32D |
| **Modes of Operation:** | WLAN and FHSS<br>BTLE and FHSS |
| **Power Supply/ Rated Operating Voltage Range:** | Vmin: 20V dc/ Vnom: 24V dc / Vmax: 27.2V dc |
| **Operating Temperature Range** | -40 ºC to 85 ºC |
| **Sample Revision** | ☐Prototype Unit; ■Production Unit; ☐Pre-Production |

## 3.2 EUT Sample details

| EUT # | Serial Number | HW Version | SW Version | Notes/Comments |
|---|---|---|---|---|
| 1 | Engineering sample | FR | 0.21 | |

## 3.3 Accessory Equipment details

| AE # | Type | Model | Manufacturer | Serial Number |
|---|---|---|---|---|
| 1 | Irrigation C | SL1600 | Weathermatic | 0630160311 |

## 3.4 Test Sample Configuration

| EUT Set-up # | Combination of AE used for test set up | Comments |
|---|---|---|
| 1 | EUT#1 + AE#1 | |

### 3.5 Mode of Operation details

| Mode of Operation | Description of Operating modes | Additional Information |
|---|---|---|
| 1 | WLAN and FHSS | The WiFi module was operated in 802.11b mode on Low, Mid, and High channel simultaneously with the FHSS radio on middle channel. |
| 2 | BTLE and FHSS | The BT LE module was operated on Low, Mid, and High channel simultaneously with the FHSS radio on middle channel. |

### 3.6 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low, mid and high channels, and highest power. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

## 4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations.

This test report is to support a request for new equipment authorization under the FCC ID: OLPSLHUBRF900MZ

Testing procedures are based on 558074 D01 DTS Meas Guidance v04 – "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247" - April 5, 2017, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

## 5 Measurement Results Summary

| Test Specification | Test Case | Temperature and Voltage Conditions | Modes | Result |
|---|---|---|---|---|
| §15.247(d); §15.209 RSS-Gen 6.13 | TX Spurious emissions-Radiated | Nominal | WLAN and FHSS BTLE and FHSS | Complies |
| §15.207(a) RSS Gen 8.8 | AC Conducted Emissions | Nominal | WLAN and FHSS | Complies |

# 6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

Radiated measurement

| | |
|---|---|
| 9 kHz to 30 MHz | ±2.5 dB (Magnetic Loop Antenna) |
| 30 MHz to 1000 MHz | ±2.0 dB (Biconilog Antenna) |
| 1 GHz to 40 GHz | ±2.3 dB (Horn Antenna) |

Conducted measurement

| | |
|---|---|
| 150 kHz to 30 MHz | ±0.7 dB (LISN) |
| RF conducted measurement | ±0.5 dB |

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: http://physics.nist.gov/cuu/Uncertainty/typeb.html. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

## 6.1 Environmental Conditions During Testing:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25° C
- Relative humidity: 40-60%

## 6.2 Dates of Testing:

04/02/2020 - 04/03/2020

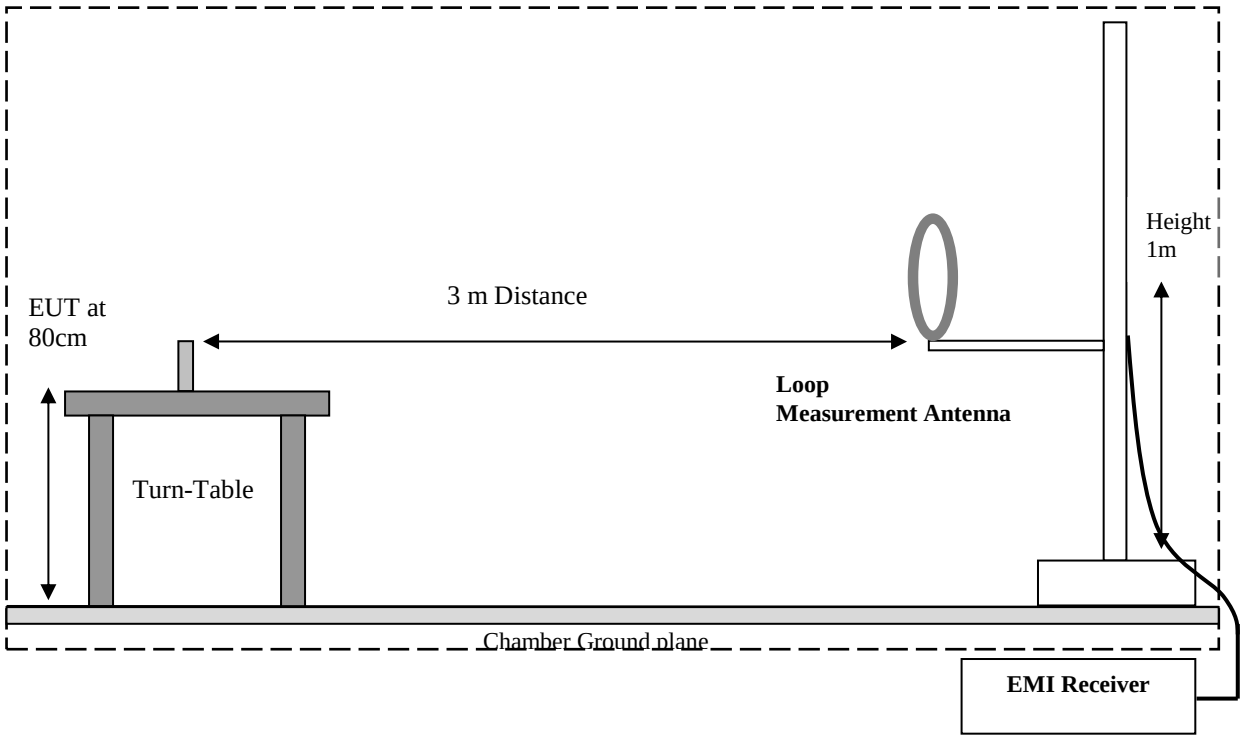
# 7 Measurement Procedures

## 7.1 Radiated Measurement

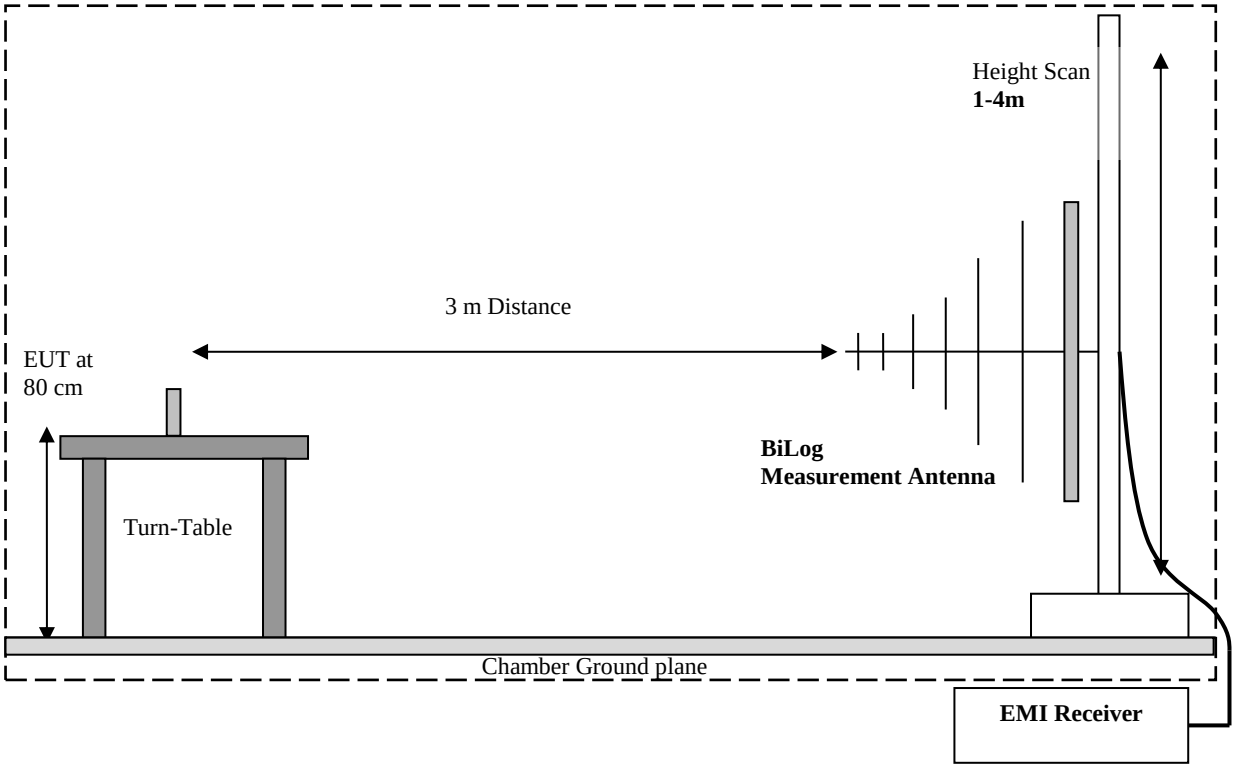
The radiated measurement is performed according to ANSI C63.10 (2013)

- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.

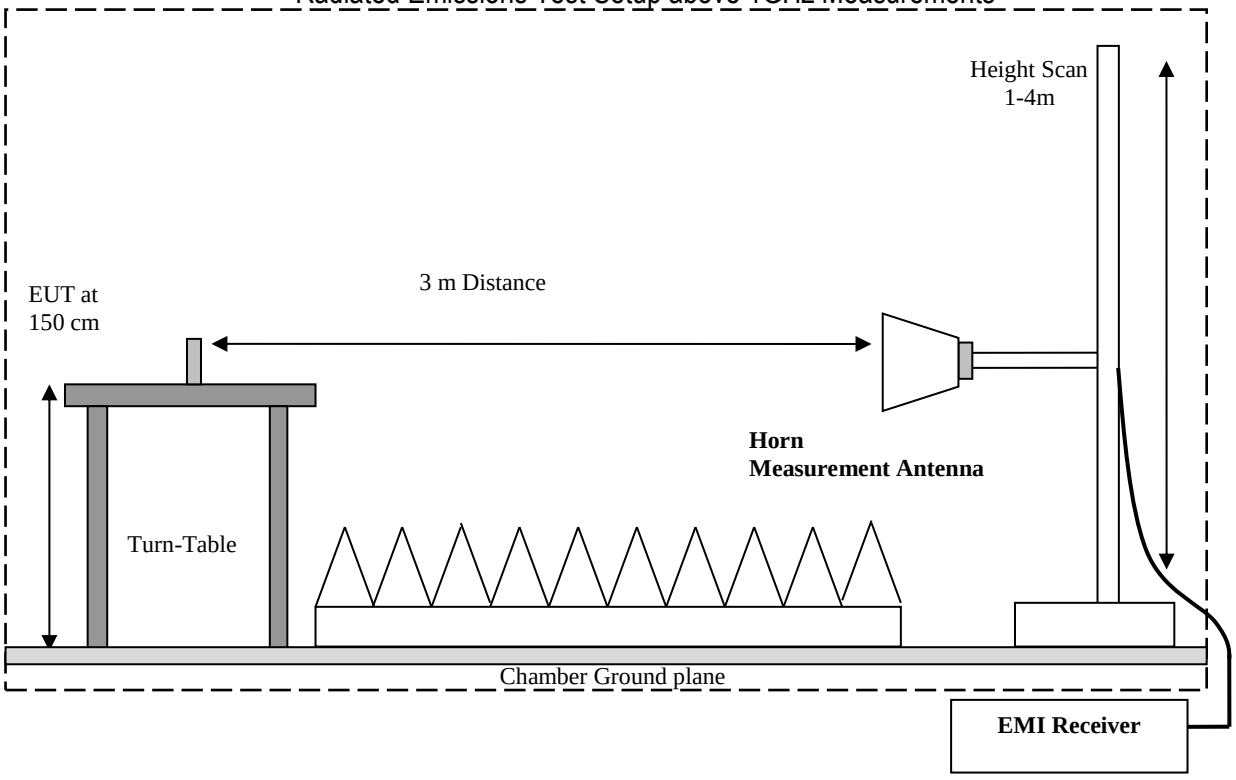
Radiated Emissions Test Setup below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements




Radiated Emissions Test Setup above 1GHz Measurements



### 7.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

1. Measured reading in dBµV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

FS (dBµV/m) = Measured Value on SA (dBµV)+ Cable Loss (dB)+ Antenna Factor (dB/m)

Example:

| Frequency (MHz) | Measured SA (dBµV) | Cable Loss (dB) | Antenna Factor Correction (dB) | Field Strength Result (dBµV/m) |
|---|---|---|---|---|
| 1000 | 80.5 | 3.5 | 14 | 98.0 |

# 8 Test Result Data

## 8.1 Radiated Transmitter Spurious Emissions and Restricted Bands

### 8.1.1 Measurement according to ANSI C63.10 (2013)

**Spectrum Analyzer Settings:**

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector: Peak

- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW= 120 KHz (<1GHz)

- Frequency > 1 GHz
- Detector = Peak / Average
- RBW = 1 MHz

- Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements.
- The highest (or worst-case) data rate shall be recorded for each measurement.
- For testing at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow: Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

### 8.1.2 Limits:

FCC §15.247

- In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

FCC §15.209

- Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency of emission (MHz) | Field strength (µV/m) | Measurement Distance (m) | Field strength @ 3m (dBµV/m) |
|---|---|---|---|
| 0.009–0.490 | 2400/F(kHz) / ------ | 300 | - |
| 0.490–1.705 | 24000/F(kHz) / ----- | 30 | - |
| 1.705–30.0 | 30 / (29.5) | 30 | - |
| 30–88 | 100 | 3 | 40 dBµV/m |
| 88–216 | 150 | 3 | 43.5 dBµV/m |
| 216–960 | 200 | 3 | 46 dBµV/m |
| Above 960 | 500 | 3 | 54 dBµV/m |

FCC §15.205

- Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090-0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| [1]0.495-0.505 | 16.69475-16.69525 | 608-614 | 5.35-5.46 |
| 2.1735-2.1905 | 16.80425-16.80475 | 960-1240 | 7.25-7.75 |
| 4.125-4.128 | 25.5-25.67 | 1300-1427 | 8.025-8.5 |
| 4.17725-4.17775 | 37.5-38.25 | 1435-1626.5 | 9.0-9.2 |
| 4.20725-4.20775 | 73-74.6 | 1645.5-1646.5 | 9.3-9.5 |
| 6.215-6.218 | 74.8-75.2 | 1660-1710 | 10.6-12.7 |
| 6.26775-6.26825 | 108-121.94 | 1718.8-1722.2 | 13.25-13.4 |
| 6.31175-6.31225 | 123-138 | 2200-2300 | 14.47-14.5 |
| 8.291-8.294 | 149.9-150.05 | 2310-2390 | 15.35-16.2 |
| 8.362-8.366 | 156.52475-156.52525 | 2483.5-2500 | 17.7-21.4 |
| 8.37625-8.38675 | 156.7-156.9 | 2690-2900 | 22.01-23.12 |
| 8.41425-8.41475 | 162.0125-167.17 | 3260-3267 | 23.6-24.0 |
| 12.29-12.293 | 167.72-173.2 | 3332-3339 | 31.2-31.8 |
| 12.51975-12.52025 | 240-285 | 3345.8-3358 | 36.43-36.5 |
| 12.57675-12.57725 | 322-335.4 | 3600-4400 | Above 38.6 |
| 13.36-13.41 | | | |

- Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
  *PEAK LIMIT= 74 dBµV/m
  *AVG. LIMIT= 54 dBµV/m

### 8.1.3 Test conditions and setup:

| Ambient Temperature | EUT Set-Up # | EUT operating mode | Power Input |
|---|---|---|---|
| 22° C | 1 | 1 and 2 | 120V / 60Hz |

DC correction was applied to the harmonics results for SLHUBRF-5 radio. The correction factor was derived from the Nemko test report # 10233152RUS2 published in FCC database.

Duty Cycle correction factor (dB) = 20 log (RFon ms / 100 ms) = 20 log (7.41 / 100) = -22.6 dB

### 8.1.4 Measurement result:

| EUT operating mode 1 WLAN and FHSS | | | | |
|---|---|---|---|---|
| **Plot #** | **Channel #** | **Scan Frequency** | **Limit** | **Result** |
| 1-3 | Low | 30 MHz – 18 GHz | See section 8.1.2 | Pass |
| 4-8 | Mid | 9 kHz – 26 GHz | See section 8.1.2 | Pass |
| 9-11 | High | 30 MHz – 18 GHz | See section 8.1.2 | Pass |

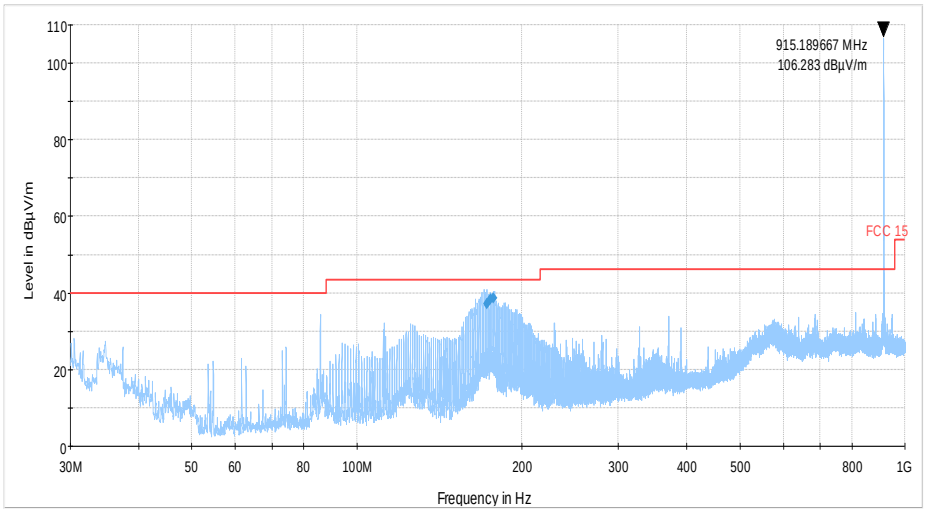
| EUT operating mode 2 BTLE and FHSS | | | | |
|---|---|---|---|---|
| **Plot #** | **Channel #** | **Scan Frequency** | **Limit** | **Result** |
| 12-14 | Low | 30 MHz – 18 GHz | See section 8.1.2 | Pass |
| 15-19 | Mid | 9 kHz – 26 GHz | See section 8.1.2 | Pass |
| 20-22 | High | 30 MHz – 18 GHz | See section 8.1.2 | Pass |

### 8.1.5 Measurement Plots:

**Plot #1 Radiated Emissions: 30 MHz – 1GHz**

**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN Low / FHSS Mid**

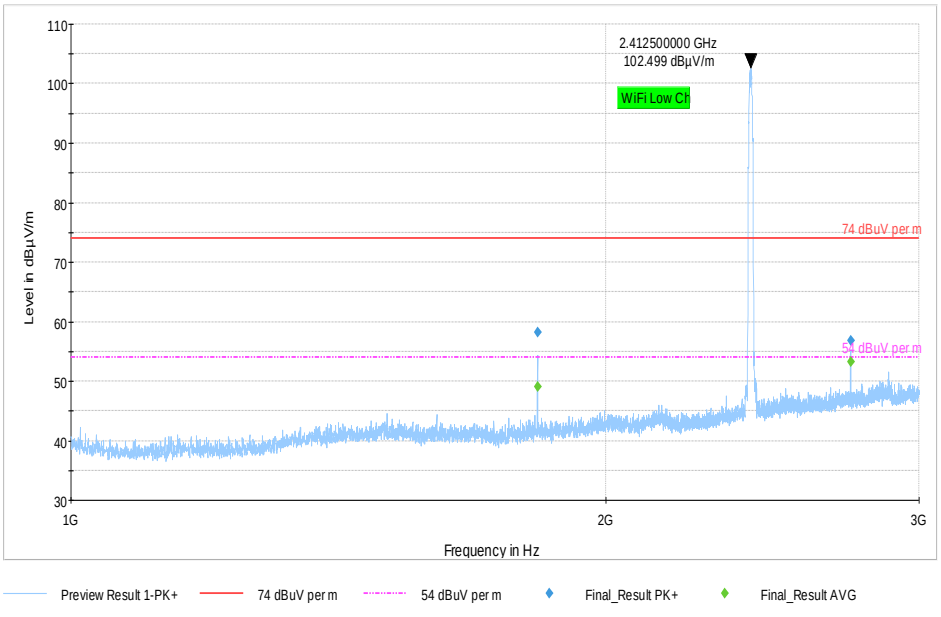
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|
| 172.734 | 37.17 | 43.52 | 6.35 | 200.0 | 120.000 | 266.0 | V | 153.0 |
| 175.118 | 38.30 | 43.52 | 5.22 | 200.0 | 120.000 | 281.0 | V | 203.0 |
| 177.458 | 38.74 | 43.52 | 4.78 | 200.0 | 120.000 | 154.0 | H | 94.0 |




**Plot # 2 Radiated Emissions: 1-3 GHz**

**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN Low / FHSS Mid**

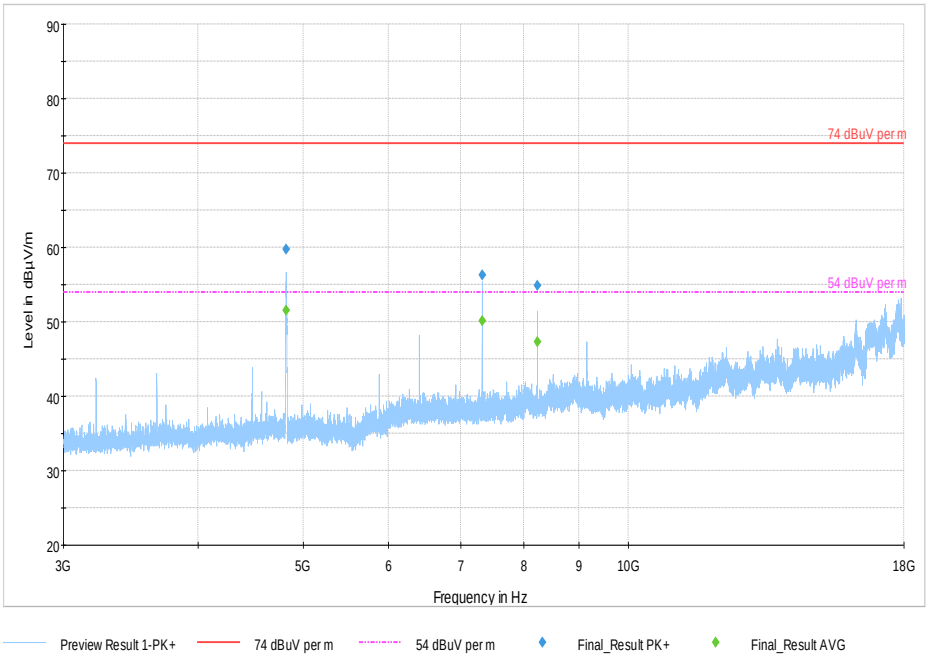
| Frequency (MHz) | MaxPeak (dBµV/m) | Average* (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 1830.579 | 58.20 | --- | 74.00 | 15.80 | 200.0 | 1000.000 | 161.0 | V | 259.0 |
| 1830.579 | --- | 35.6 | 54.00 | 18.4 | 200.0 | 1000.000 | 161.0 | V | 259.0 |
| 2745.466 | 56.78 | --- | 74.00 | 17.22 | 200.0 | 1000.000 | 160.0 | H | 50.0 |
| 2745.466 | --- | 34.18 | 54.00 | 19.82 | 200.0 | 1000.000 | 160.0 | H | 50.0 |



**Plot # 3 Radiated Emissions: 3-18 GHz**

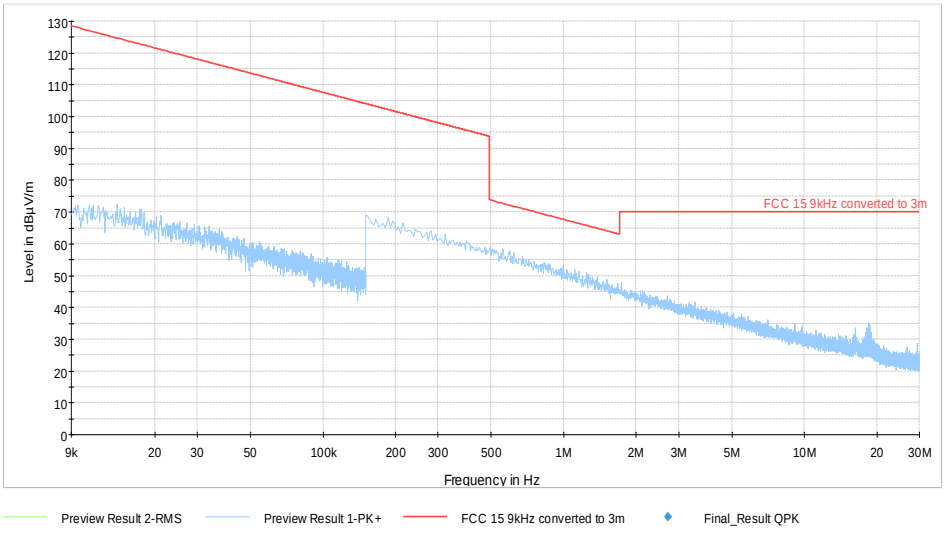
**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN Low / FHSS Mid**

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 4824.858 | --- | 51.60 | 54.00 | 2.40 | 200.0 | 1000.000 | 181.0 | V | 148.0 |
| 4824.858 | 59.75 | --- | 74.00 | 14.25 | 200.0 | 1000.000 | 181.0 | V | 148.0 |
| 7322.191 | 56.27 | --- | 74.00 | 17.73 | 200.0 | 1000.000 | 230.0 | H | 23.0 |
| 7322.191 | --- | 50.13 | 54.00 | 3.87 | 200.0 | 1000.000 | 230.0 | H | 23.0 |
| 8236.608 | 54.87 | --- | 74.00 | 19.13 | 200.0 | 1000.000 | 219.0 | H | 27.0 |
| 8236.608 | --- | 47.30 | 54.00 | 6.70 | 200.0 | 1000.000 | 219.0 | H | 27.0 |




**Plot # 4 Radiated Emissions: 9 KHz – 30 MHz**

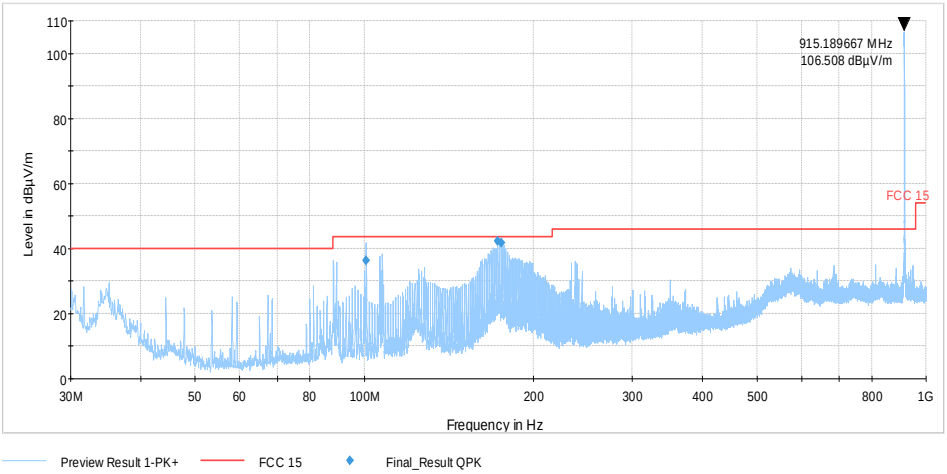
**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN Mid / FHSS Mid**



**Plot #5 Radiated Emissions: 30 MHz – 1GHz**

**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN Mid / FHSS Mid**

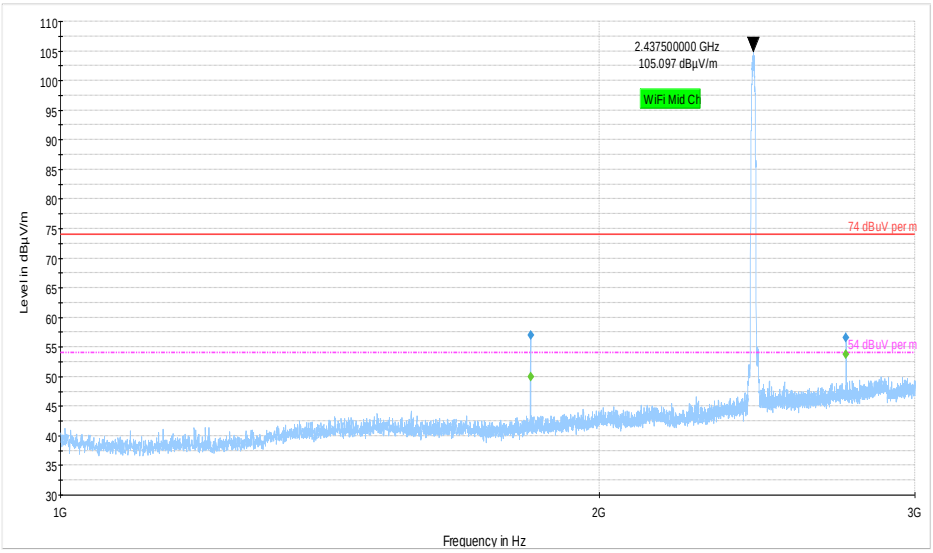
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|
| 100.785 | 36.35 | 43.52 | 7.17 | 200.0 | 120.000 | 151.0 | V | 193.0 |
| 172.863 | 42.25 | 43.52 | 1.27 | 200.0 | 120.000 | 191.0 | H | 92.0 |
| 175.191 | 41.76 | 43.52 | 1.76 | 200.0 | 120.000 | 209.0 | H | 86.0 |




**Plot #6 Radiated Emissions: 1-3 GHz**

**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN Mid / FHSS Mid**

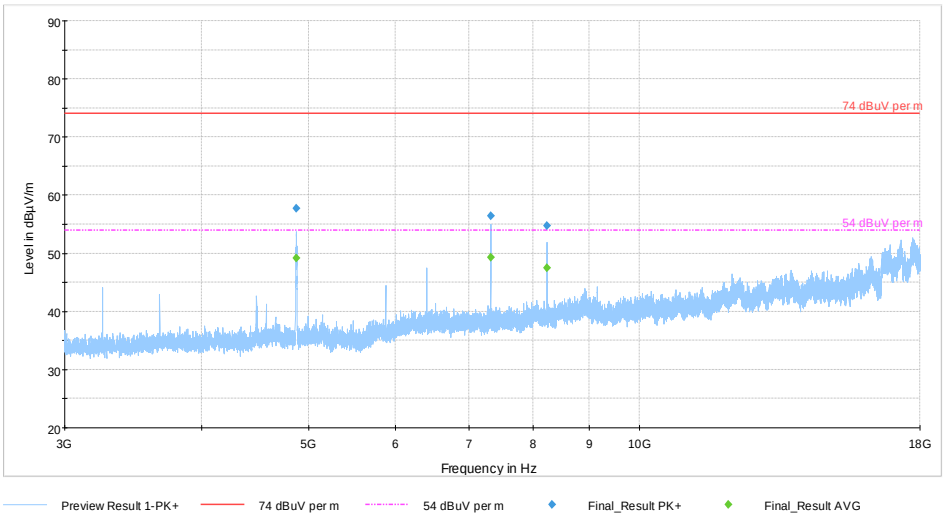
| Frequency (MHz) | MaxPeak (dBµV/m) | Average* (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 1830.561 | --- | 34.38 | 54.00 | 19.62 | 200.0 | 1000.000 | 155.0 | H | 33.0 |
| 1830.561 | 56.98 | --- | 74.00 | 17.02 | 200.0 | 1000.000 | 155.0 | H | 33.0 |
| 2745.826 | --- | 33.91 | 54.00 | 20.09 | 200.0 | 1000.000 | 155.0 | H | 51.0 |
| 2745.826 | 56.51 | --- | 74.00 | 17.49 | 200.0 | 1000.000 | 155.0 | H | 51.0 |



**Plot #7 Radiated Emissions: 3-18 GHz**

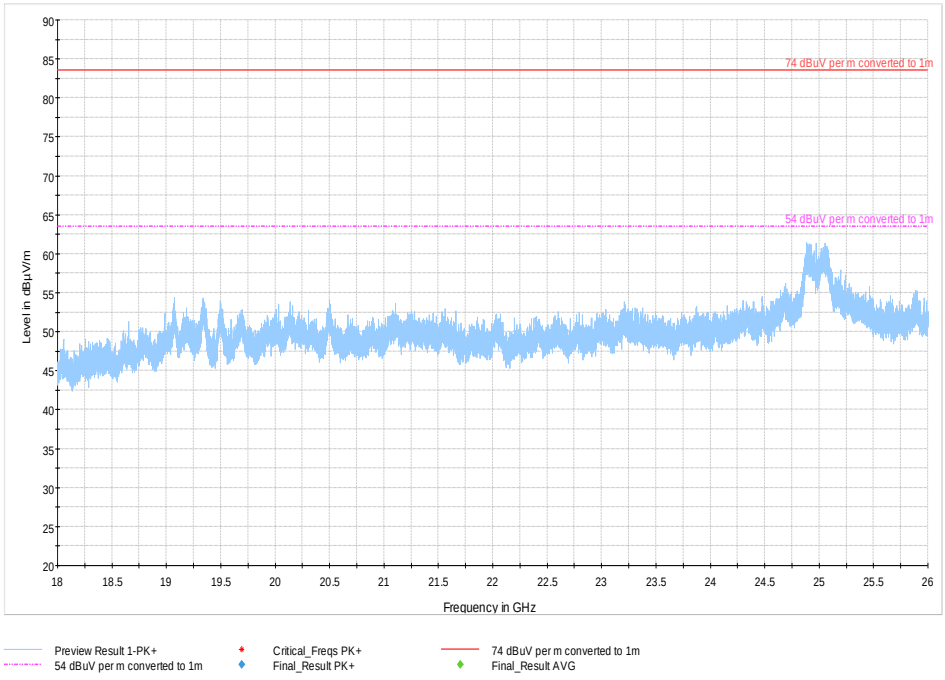
**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN Mid / FHSS Mid**

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 4874.992 | 57.76 | --- | 74.00 | 16.24 | 200.0 | 1000.000 | 212.0 | V | 156.0 |
| 4874.992 | --- | 49.16 | 54.00 | 4.84 | 200.0 | 1000.000 | 212.0 | V | 156.0 |
| 7321.440 | 56.42 | --- | 74.00 | 17.58 | 200.0 | 1000.000 | 140.0 | V | 248.0 |
| 7321.440 | --- | 49.35 | 54.00 | 4.65 | 200.0 | 1000.000 | 140.0 | V | 248.0 |
| 8237.584 | --- | 47.49 | 54.00 | 6.51 | 200.0 | 1000.000 | 190.0 | H | 26.0 |
| 8237.584 | 54.79 | --- | 74.00 | 19.21 | 200.0 | 1000.000 | 190.0 | H | 26.0 |




**Plot #8 Radiated Emissions: 18-26 GHz**

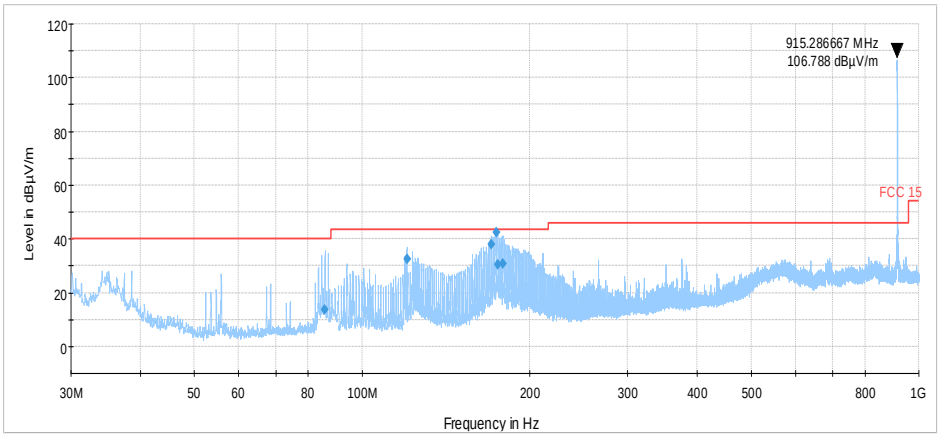
**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN Mid / FHSS Mid**



**Plot # 9 Radiated Emissions: 30 MHz – 1GHz**

**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN High / FHSS Mid**

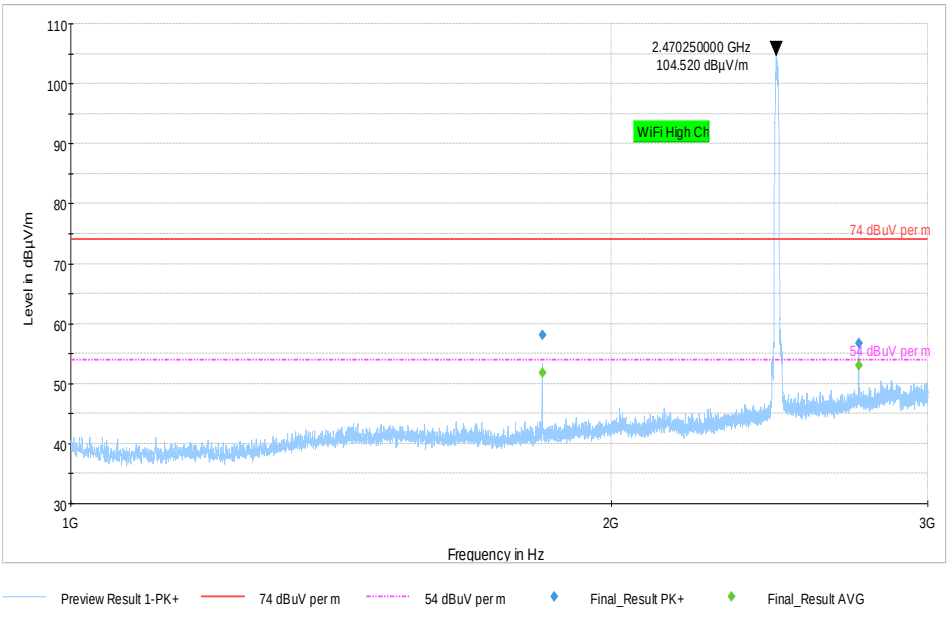
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|
| 85.757 | 13.80 | 40.00 | 26.20 | 200.0 | 120.000 | 315.0 | V | 255.0 |
| 120.395 | 32.60 | 43.52 | 10.93 | 200.0 | 120.000 | 166.0 | V | 200.0 |
| 170.726 | 37.88 | 43.52 | 5.64 | 200.0 | 120.000 | 174.0 | V | 18.0 |
| 174.207 | 42.52 | 43.52 | 1.00 | 200.0 | 120.000 | 192.0 | H | 84.0 |
| 175.510 | 30.62 | 43.52 | 12.90 | 200.0 | 120.000 | 186.0 | H | 73.0 |
| 178.963 | 30.71 | 43.52 | 12.81 | 200.0 | 120.000 | 180.0 | H | 100.0 |




**Plot #10 Radiated Emissions: 1-3 GHz**

**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN High / FHSS Mid**

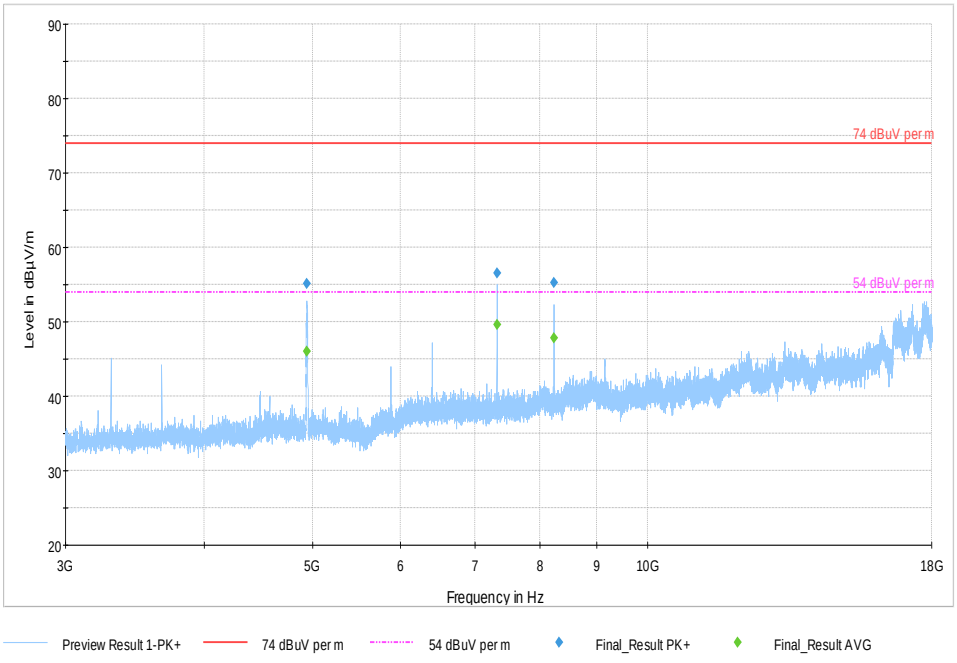
| Frequency (MHz) | MaxPeak (dBµV/m) | Average* (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 1830.526 | --- | 35.55 | 54.00 | 18.45 | 200.0 | 1000.000 | 140.0 | H | 41.0 |
| 1830.526 | 58.15 | --- | 74.00 | 15.85 | 200.0 | 1000.000 | 140.0 | H | 41.0 |
| 2745.449 | --- | 34.17 | 54.00 | 19.83 | 200.0 | 1000.000 | 151.0 | V | 110.0 |
| 2745.449 | 56.77 | --- | 74.00 | 17.23 | 200.0 | 1000.000 | 151.0 | V | 110.0 |



**Plot #11 Radiated Emissions: 3-18 GHz**

**Mode: WLAN 802.11/b and FHSS** | **Channel: WLAN High / FHSS Mid**

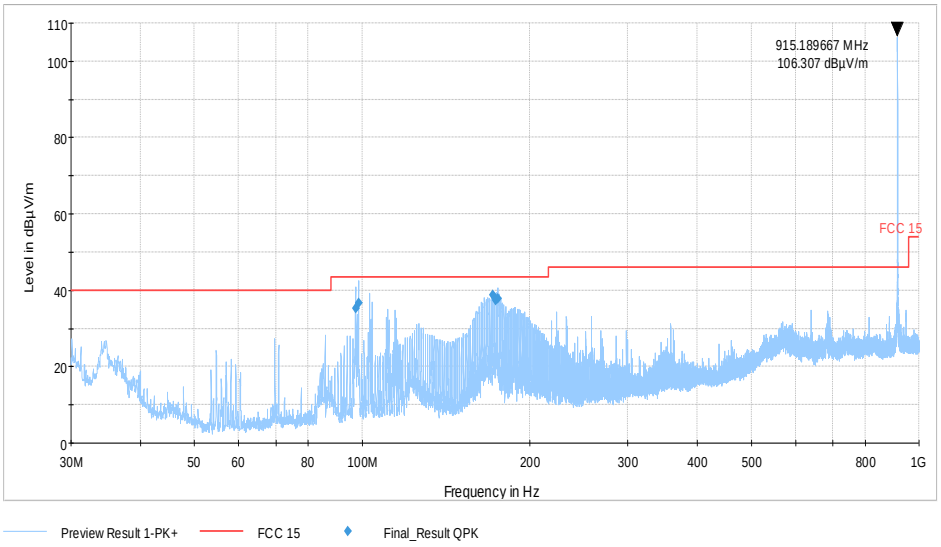
| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 4944.927 | 55.08 | --- | 74.00 | 18.92 | 200.0 | 1000.000 | 172.0 | H | 138.0 |
| 4944.927 | --- | 46.05 | 54.00 | 7.95 | 200.0 | 1000.000 | 172.0 | H | 138.0 |
| 7321.426 | 56.55 | --- | 74.00 | 17.45 | 200.0 | 1000.000 | 154.0 | V | 247.0 |
| 7321.426 | --- | 49.66 | 54.00 | 4.34 | 200.0 | 1000.000 | 154.0 | V | 247.0 |
| 8237.535 | --- | 47.88 | 54.00 | 6.12 | 200.0 | 1000.000 | 207.0 | H | 27.0 |
| 8237.535 | 55.22 | --- | 74.00 | 18.78 | 200.0 | 1000.000 | 207.0 | H | 27.0 |



**Plot #12 Radiated Emissions: 30 MHz – 1GHz**

**Mode: BTLE and FHSS** | **Channel: BTLE Low / FHSS Mid**

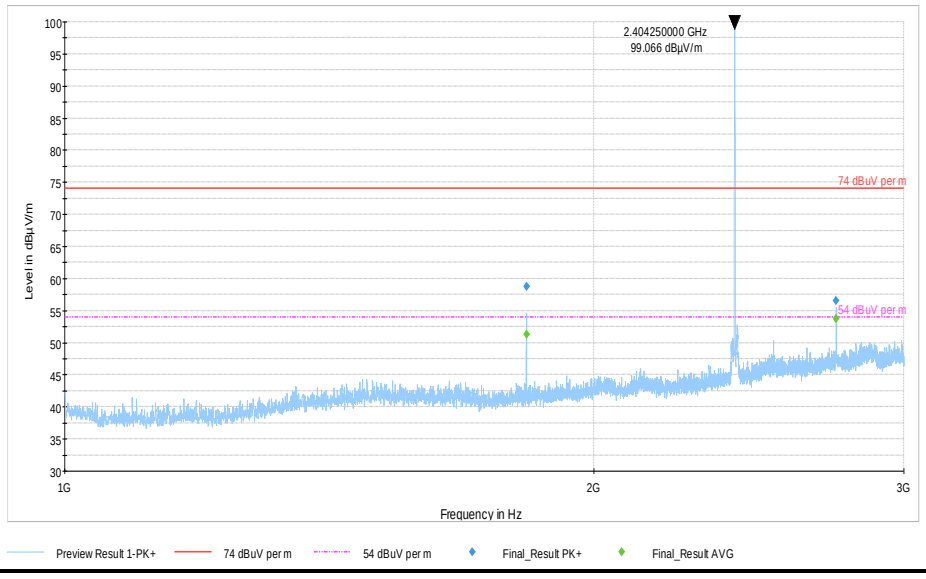
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|
| 97.295 | 35.30 | 43.52 | 8.22 | 200.0 | 120.000 | 140.0 | V | 258.0 |
| 98.532 | 36.68 | 43.52 | 6.84 | 200.0 | 120.000 | 153.0 | V | 50.0 |
| 171.646 | 38.84 | 43.52 | 4.68 | 200.0 | 120.000 | 198.0 | H | 57.0 |
| 173.977 | 37.27 | 43.52 | 6.25 | 200.0 | 120.000 | 236.0 | V | 192.0 |
| 175.102 | 37.93 | 43.52 | 5.60 | 200.0 | 120.000 | 214.0 | H | 108.0 |




**Plot # 13 Radiated Emissions: 1-3 GHz**

**Mode: BTLE and FHSS** | **Channel: BTLE Low / FHSS Mid**

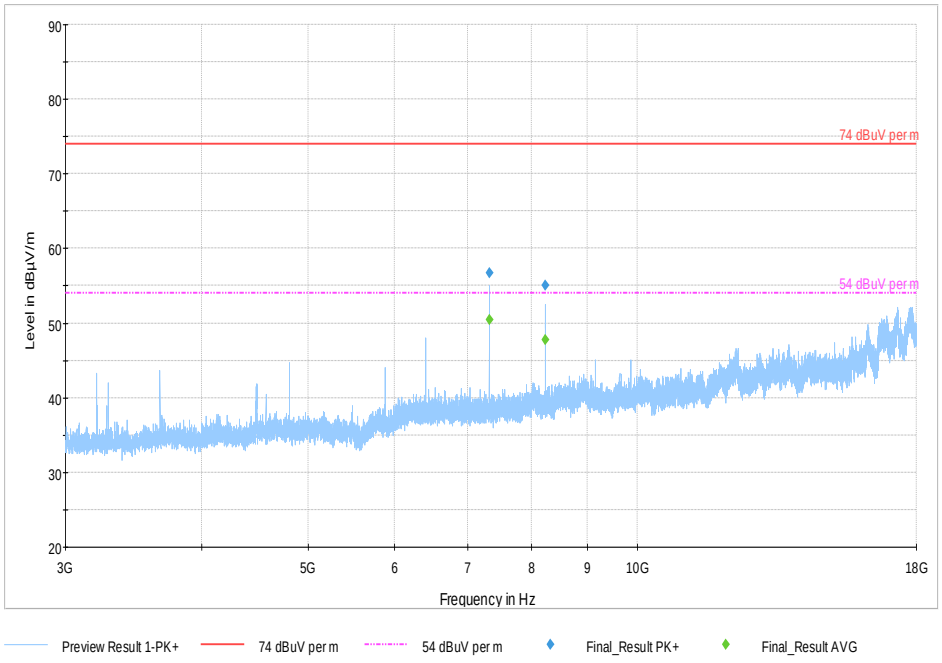
| Frequency (MHz) | MaxPeak (dBµV/m) | Average* (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 1830.627 | --- | 36.1 | 54.00 | 17.9 | 200.0 | 1000.000 | 140.0 | H | 46.0 |
| 1830.627 | 58.70 | --- | 74.00 | 15.30 | 200.0 | 1000.000 | 140.0 | H | 46.0 |
| 2745.575 | --- | 33.96 | 54.00 | 20.04 | 200.0 | 1000.000 | 181.0 | H | 71.0 |
| 2745.575 | 56.56 | --- | 74.00 | 17.44 | 200.0 | 1000.000 | 181.0 | H | 71.0 |



**Plot # 14 Radiated Emissions: 3-18 GHz**

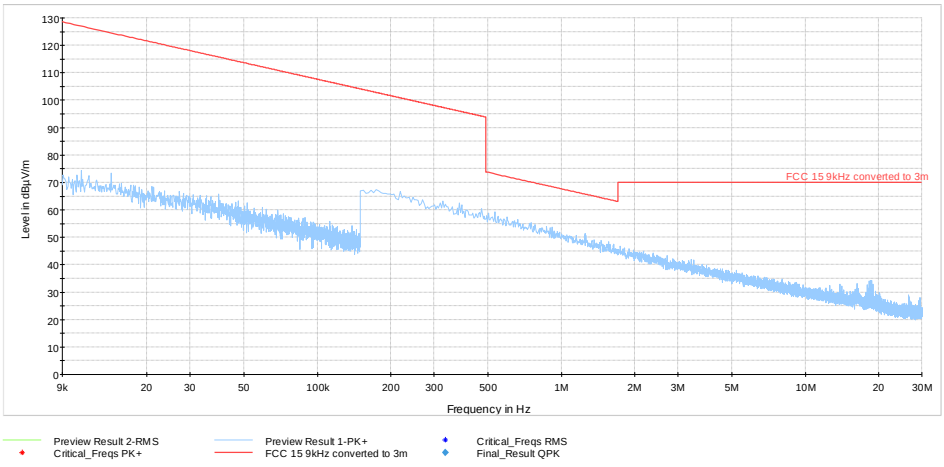
**Mode: BTLE and FHSS** | **Channel: BTLE Low / FHSS Mid**

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 7321.508 | --- | 50.45 | 54.00 | 3.55 | 200.0 | 1000.000 | 207.0 | H | 22.0 |
| 7321.508 | 56.74 | --- | 74.00 | 17.26 | 200.0 | 1000.000 | 207.0 | H | 22.0 |
| 8237.553 | --- | 47.71 | 54.00 | 6.29 | 200.0 | 1000.000 | 218.0 | H | 27.0 |
| 8237.553 | 55.06 | --- | 74.00 | 18.94 | 200.0 | 1000.000 | 218.0 | H | 27.0 |




**Plot # 15 Radiated Emissions: 9 KHz – 30 MHz**

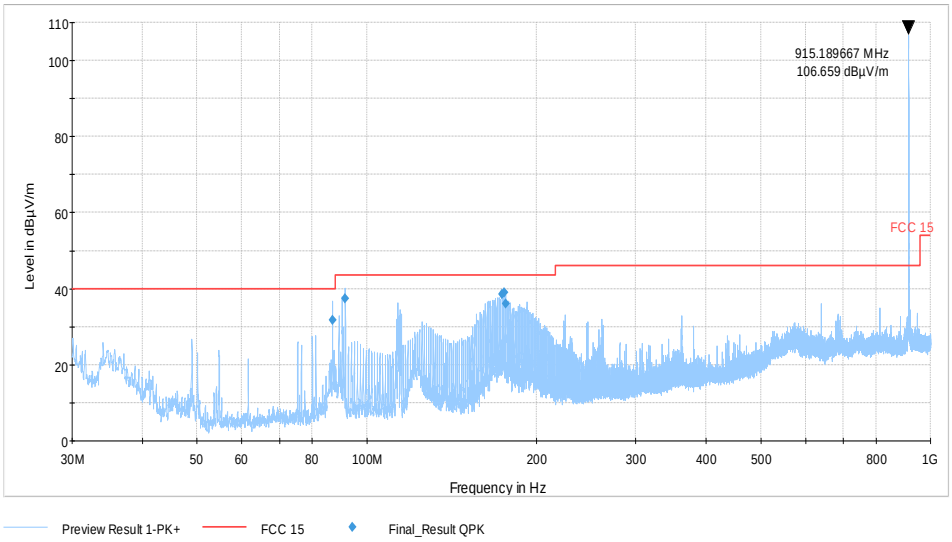
**Mode: BTLE and FHSS** | **Channel: BTLE Mid / FHSS Mid**



**Plot #16 Radiated Emissions: 30 MHz – 1GHz**

**Mode: BTLE and FHSS** | **Channel: BTLE Mid / FHSS Mid**

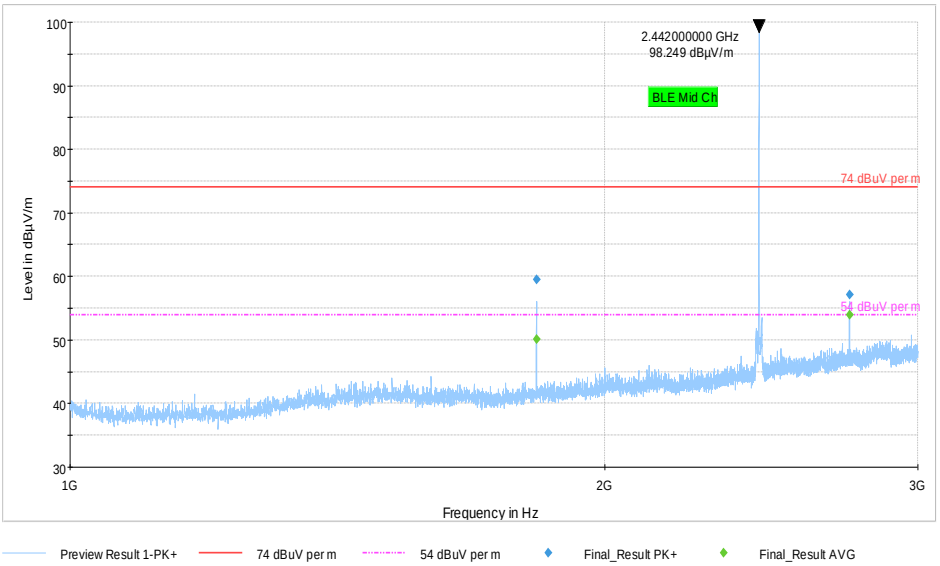
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|
| 86.963 | 31.70 | 40.00 | 8.30 | 200.0 | 120.000 | 154.0 | V | 44.0 |
| 91.598 | 37.48 | 43.52 | 6.05 | 200.0 | 120.000 | 154.0 | V | 306.0 |
| 173.902 | 38.62 | 43.52 | 4.90 | 200.0 | 120.000 | 191.0 | H | 71.0 |
| 175.066 | 39.10 | 43.52 | 4.42 | 200.0 | 120.000 | 193.0 | H | 104.0 |
| 176.232 | 36.14 | 43.52 | 7.38 | 200.0 | 120.000 | 231.0 | H | 72.0 |




**Plot #17 Radiated Emissions: 1-3 GHz**

**Mode: BTLE and FHSS** | **Channel: BTLE Mid / FHSS Mid**

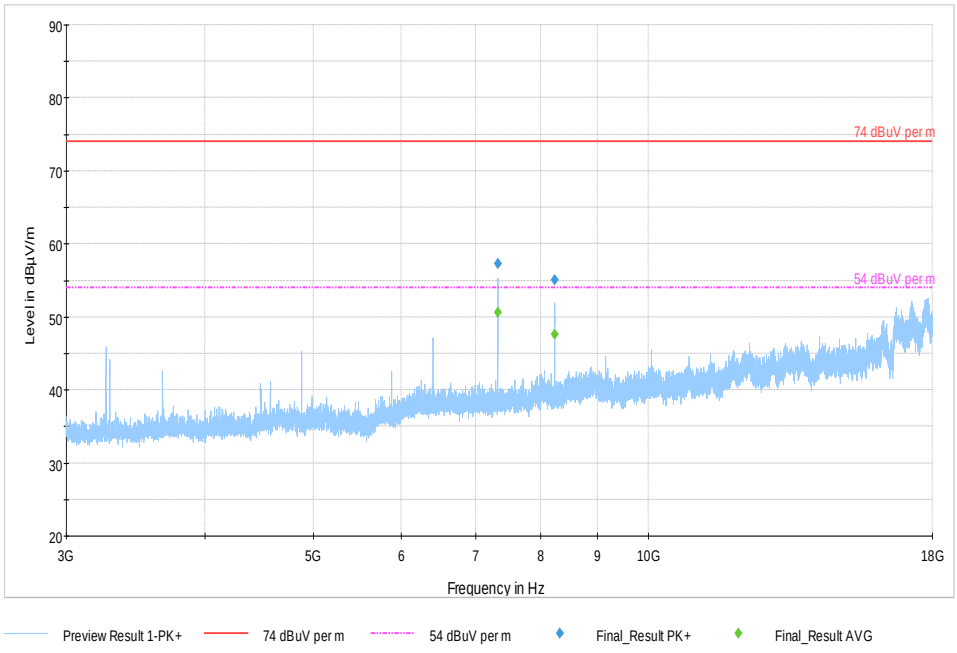
| Frequency (MHz) | MaxPeak (dBµV/m) | Average* (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 1830.679 | 59.45 | --- | 74.00 | 14.55 | 200.0 | 1000.000 | 164.0 | V | 250.0 |
| 1830.679 | --- | 36.85 | 54.00 | 17.15 | 200.0 | 1000.000 | 164.0 | V | 250.0 |
| 2745.852 | 57.08 | --- | 74.00 | 16.92 | 200.0 | 1000.000 | 283.0 | V | 111.0 |
| 2745.852 | --- | 34.48 | 54.00 | 19.52 | 200.0 | 1000.000 | 283.0 | V | 111.0 |



**Plot #18 Radiated Emissions: 3-18 GHz**

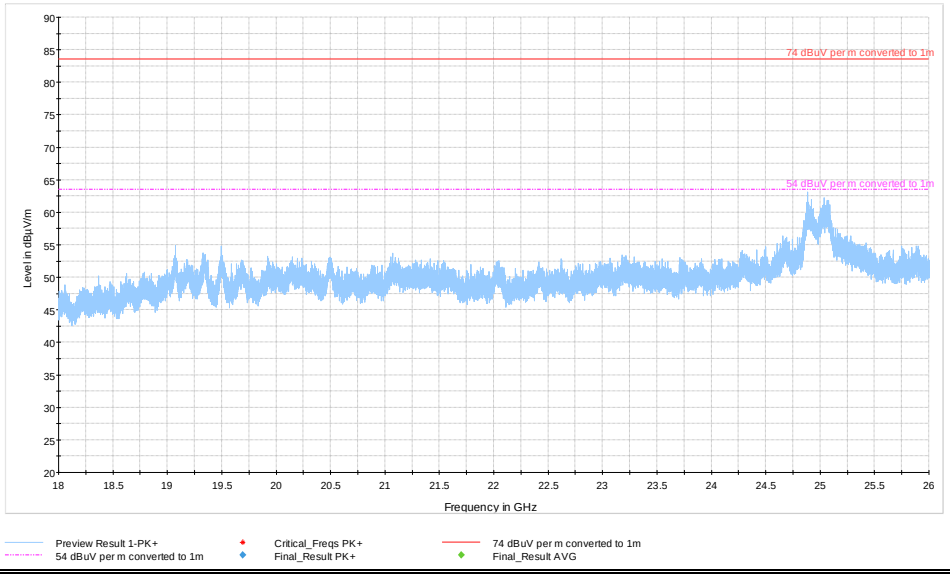
**Mode: BTLE and FHSS** | **Channel: BTLE Mid / FHSS Mid**

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 7321.412 | --- | 50.61 | 54.00 | 3.39 | 200.0 | 1000.000 | 190.0 | H | 20.0 |
| 7321.412 | 57.30 | --- | 74.00 | 16.70 | 200.0 | 1000.000 | 190.0 | H | 20.0 |
| 8236.618 | --- | 47.62 | 54.00 | 6.38 | 200.0 | 1000.000 | 218.0 | H | 29.0 |
| 8236.618 | 55.08 | --- | 74.00 | 18.92 | 200.0 | 1000.000 | 218.0 | H | 29.0 |




**Plot #19 Radiated Emissions: 18-26 GHz**

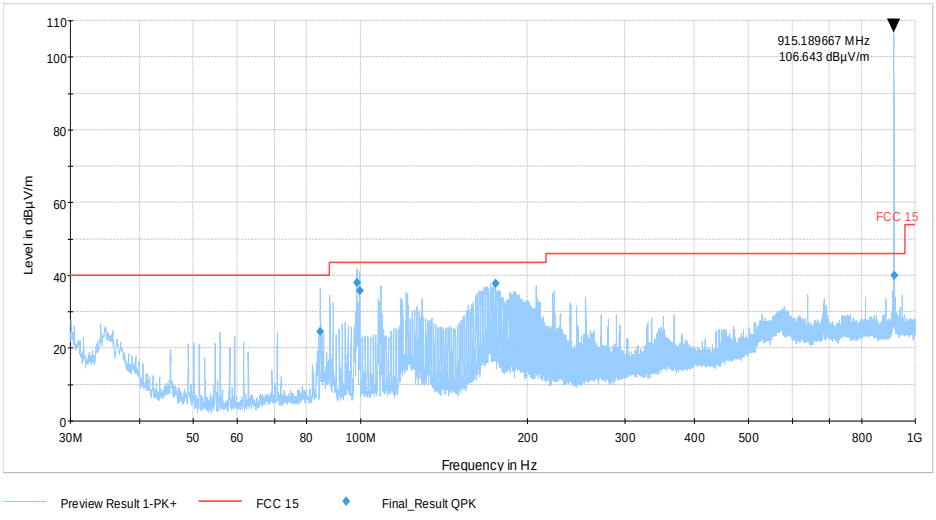
**Mode: BTLE and FHSS** | **Channel: BTLE Mid / FHSS Mid**



**Plot # 20 Radiated Emissions: 30 MHz – 1GHz**

**Mode: BTLE and FHSS** | **Channel: BTLE High / FHSS Mid**

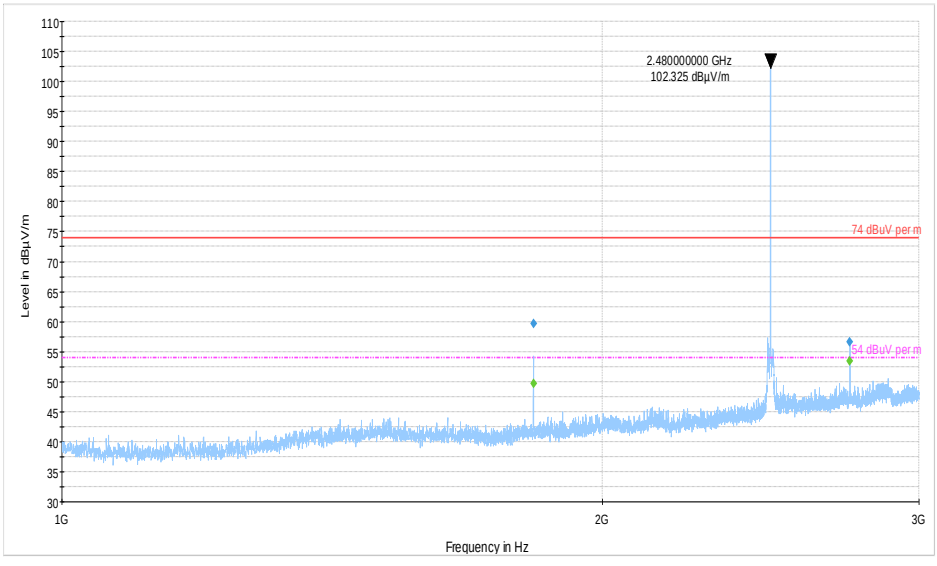
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|
| 84.614 | 24.57 | 40.00 | 15.43 | 200.0 | 120.000 | 260.0 | V | 168.0 |
| 98.521 | 38.03 | 43.52 | 5.49 | 200.0 | 120.000 | 152.0 | V | 42.0 |
| 99.664 | 35.84 | 43.52 | 7.69 | 200.0 | 120.000 | 163.0 | V | 281.0 |
| 175.073 | 37.70 | 43.52 | 5.82 | 200.0 | 120.000 | 153.0 | H | 82.0 |
| 916.566 | 40.03 | 46.02 | 5.99 | 200.0 | 120.000 | 157.0 | H | 157.0 |




**Plot #21 Radiated Emissions: 1-3 GHz**

**Mode: BTLE and FHSS** | **Channel: BTLE High / FHSS Mid**

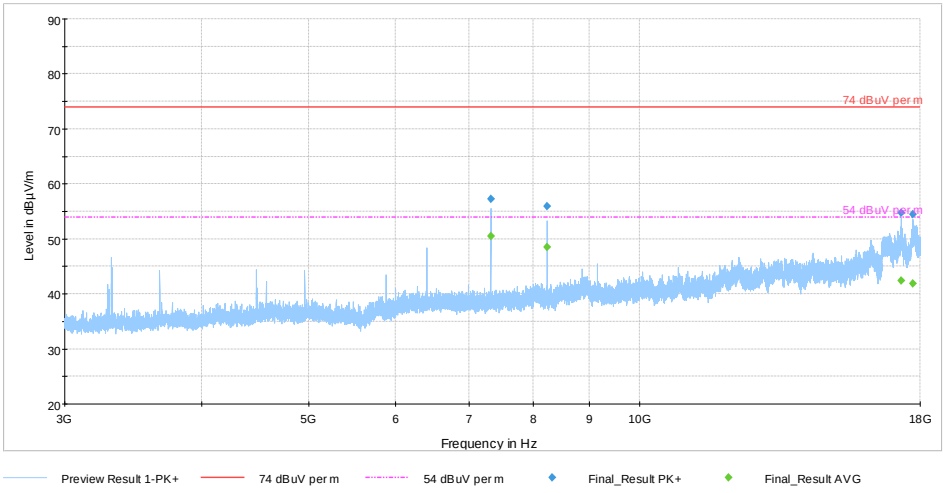
| Frequency (MHz) | MaxPeak (dBµV/m) | Average* (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 1830.533 | 59.74 | --- | 74.00 | 14.26 | 200.0 | 1000.000 | 140.0 | V | 240.0 |
| 1830.533 | --- | 37.14 | 54.00 | 16.86 | 200.0 | 1000.000 | 140.0 | V | 240.0 |
| 2745.546 | 56.58 | --- | 74.00 | 17.42 | 200.0 | 1000.000 | 186.0 | H | 73.0 |
| 2745.546 | --- | 33.98 | 54.00 | 20.02 | 200.0 | 1000.000 | 186.0 | H | 73.0 |



**Plot #22 Radiated Emissions: 3-18 GHz**

**Mode: BTLE and FHSS** | **Channel: BTLE High / FHSS Mid**

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|---|
| 7322.287 | --- | 50.47 | 54.00 | 3.53 | 200.0 | 1000.000 | 219.0 | V | 229.0 |
| 7322.287 | 57.24 | --- | 74.00 | 16.76 | 200.0 | 1000.000 | 219.0 | V | 229.0 |
| 8237.543 | --- | 48.50 | 54.00 | 5.50 | 200.0 | 1000.000 | 207.0 | H | 27.0 |
| 8237.543 | 55.98 | --- | 74.00 | 18.02 | 200.0 | 1000.000 | 207.0 | H | 27.0 |
| 17295.175 | --- | 42.47 | 54.00 | 11.53 | 200.0 | 1000.000 | 186.0 | H | 211.0 |
| 17295.175 | 54.77 | --- | 74.00 | 19.23 | 200.0 | 1000.000 | 186.0 | H | 211.0 |
| 17726.379 | --- | 41.92 | 54.00 | 12.08 | 200.0 | 1000.000 | 285.0 | H | 209.0 |
| 17726.379 | 54.48 | --- | 74.00 | 19.52 | 200.0 | 1000.000 | 285.0 | H | 209.0 |




* The Average result was calculated from the peak measurement and -22.6 dB DC correction factor

## 8.2 AC Power Line Conducted Emissions

### 8.2.1 Measurement according to ANSI C63.4

**Analyzer Settings:**

- RBW = 9 KHz (CISPR Bandwidth)
- Detector: Peak / Average for Pre-scan
- Quasi-Peak/Average for Final Measurements

### 8.2.2 Limits: §15.207

FCC §15.207(a)

- Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between frequency ranges.

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

*Decreases with the logarithm of the frequency.

### 8.2.3 Test conditions and setup:

| Ambient Temperature © | EUT Set-Up # | EUT operating mode | Power line (L1, L2, L3, N) | Power Input |
|---|---|---|---|---|
| 22° C | 1 | 1 | Line & Neutral | 120V / 60Hz |

### 8.2.4 Measurement Result:

| Plot # | Port | EUT Set-Up #: | EUT operating mode | Scan Frequency | Limit | Result |
|---|---|---|---|---|---|---|
| 1 | AC Mains | 1 | 1 | 150 kHz – 30 MHz | See section 8.2.2 | Pass |

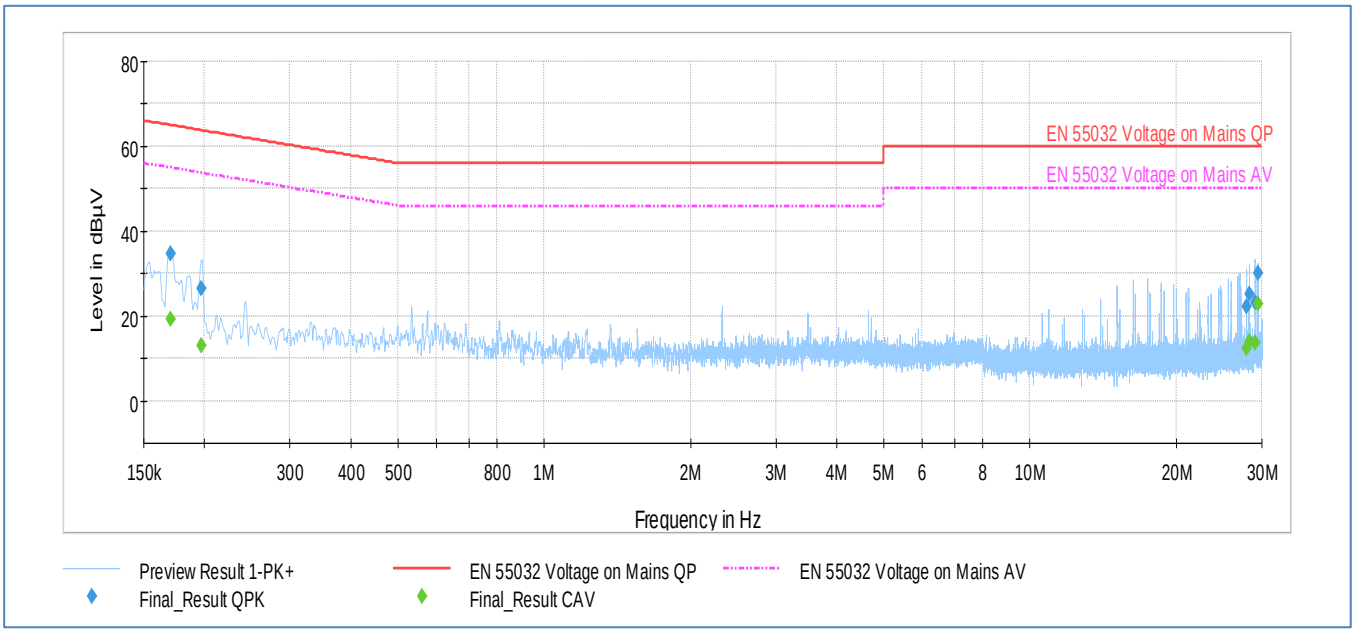
### 8.2.5 Measurement Plots:

**Plot # 1**

**Final Result**

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0.170 | 34.77 | --- | 64.95 | 30.17 | 500.0 | 9.000 | N | GND | 10.6 |
| 0.170 | --- | 19.08 | 54.95 | 35.87 | 500.0 | 9.000 | N | GND | 10.6 |
| 0.197 | 26.52 | --- | 63.74 | 37.23 | 500.0 | 9.000 | N | GND | 10.5 |
| 0.197 | --- | 13.04 | 53.74 | 40.70 | 500.0 | 9.000 | N | GND | 10.5 |
| 27.922 | 22.29 | --- | 60.00 | 37.71 | 500.0 | 9.000 | N | GND | 11.1 |
| 27.922 | --- | 12.30 | 50.00 | 37.70 | 500.0 | 9.000 | N | GND | 11.1 |
| 28.255 | 25.03 | --- | 60.00 | 34.97 | 500.0 | 9.000 | N | GND | 11.1 |
| 28.255 | --- | 14.00 | 50.00 | 36.00 | 500.0 | 9.000 | N | GND | 11.1 |
| 29.089 | --- | 13.56 | 50.00 | 36.44 | 500.0 | 9.000 | L1 | GND | 11.2 |
| 29.089 | 23.23 | --- | 60.00 | 36.77 | 500.0 | 9.000 | L1 | GND | 11.2 |
| 29.425 | --- | 22.81 | 50.00 | 27.19 | 500.0 | 9.000 | L1 | GND | 11.2 |
| 29.425 | 30.06 | --- | 60.00 | 29.94 | 500.0 | 9.000 | L1 | GND | 11.2 |

***Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.***



## 9 Test setup photos

Setup photos are included in supporting file name: “EMC_WEATH_022_20501_15.247_DTS_Setup_Photos.pdf”

## 10 Test Equipment And Ancillaries Used For Testing

| Equipment Name/Type | Manufacturer | Model | Serial # | Calibration Cycle | Last Calibration Date |
|---|---|---|---|---|---|
| EMI Receiver/Analyzer | Rohde&Schwarz | ESU 40 | 100251 | 3 Years | 07/16/2019 |
| Loop antenna | ETS Lindgren | 6507 | 161344 | 3 Years | 10/26/2017 |
| Biconlog Antenna | EMCO | 3142E | 166067 | 3 years | 06/27/2017 |
| Horn Antenna | EMCO | 3115 | 35114 | 3 years | 04/17/2019 |
| Horn Antenna | ETS Lindgren | Horn 3117-PA | 159547 | 3 years | 8/8/2017 |
| Horn Antenna | ETS Lindgren | Horn 3116 | 70497 | 3 years | 10/31/2017 |
| Compact Digital Barometer | Control Company | 35519-055 | 91119547 | 3 Years | 6/08/2017 |

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels. Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated “N/A” for cal status either do not specifically require calibration or is internally characterized before use.

## 11 History

| Date | Report Name | Changes to report | Report prepared by |
|---|---|---|---|
| 2020-04-08 | EMC_WEATH_022_20501_15.247_DTS | Initial Version | Kris Lazarov |
| | | | |

<<< The End >>>