ELEMENT WASHINGTON DC LLC
7185 Oakland Mills Road, Columbia, MD 21046 USA
Tel. 410.290.6652 / Fax 410.381.1520
http://www.element.com

# MEASUREMENT REPORT
## FCC PART 15.247 802.11b/g/n/ax/be

**Applicant Name:**
Microsoft Corporation
1 Microsoft Way
Redmond, WA 98052-8300
United States

**Date of Testing:**
1/2/2025 - 1/31-2025
**Test Report Issue Date:**
2/7/2025
**Test Site/Location:**
Element Lab., Columbia, MD, USA
**Test Report Serial No.:**
1M2503050023-09-R2.C3K

| | |
|---|---|
| **FCC ID:** | **C3K00002101** |
| **APPLICANT:** | **Microsoft Corporation** |

| | |
|---|---|
| **Application Type:** | Class II Permissive Change, Module Host Integration |
| **Host Model:** | 2109 |
| **EUT Type:** | Limited Modular Approval – Host Integration Computing Device |
| **Frequency Range:** | 2412 – 2462MHz |
| **Modulation Type:** | CCK, DSSS, OFDM, OFDMA |
| **FCC Classification:** | Digital Transmission System (DTS) |
| **FCC Rule Part(s):** | Part 15 Subpart C (15.247) |
| **Test Procedure(s):** | ANSI C63.10-2013, KDB 648474 D03 v01r04 |
| **Permissive Change(s):** | Please see change document |

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. Test results reported herein relate only to the item(s) tested.

This revised Test Report (S/N: 1M2503050023-09-R2.C3K) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

**RJ Ortanez**
**Executive Vice President**

ACCREDITED
CERT #2041.01

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# 1.0 INTRODUCTION

## 1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and\\or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

## 1.2 Element Test Location

Measurements were conducted at the Element laboratory(ies) indicated in Section 1.3 below. All measurement facilities are compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

## 1.3 Test Facility / Accreditations

**Measurements were performed at Element lab located in Columbia, MD 21046, U.S.A. ("MD")**

- Element Washington DC LLC is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.01 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- Element Washington DC LLC TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- Element Washington DC LLC facility is a registered (2451B) test laboratory with the site description on file with ISED.

- Element Washington DC LLC is a Recognized U.S. Certification Assessment Body (CAB # US0110) for ISED Canada as designated by NIST under the U.S. and Canada Mutual Recognition Agreements (MRAs).

# 2.0 PRODUCT INFORMATION

## 2.1 Equipment Description

The Equipment Under Test (EUT) is the **Microsoft Module (FCC ID: C3K00002101)** integrated into the **Portable Computing Device Model 2109**.

This host device (2109) contains a WLAN/BT transmitter module previously certified under **FCC ID: C3K00002101**. No changes have been made to the module and therefore all conducted testing performed on the original module remain applicable to this filing. This test report covers additional test cases for integrating the module transmitter into this host product.

**Test Device Serial No.:** 0F3K4CP24453Q6, 0F3K4CT24453Q6, 0F3K4CW24453Q6, 0F3K4CK24453Q6

## 2.2 Device Capabilities

This device contains the following capabilities:

Bluetooth (1x, EDR, LE), 802.11b/g/n/ac/ax/be WLAN, 802.11a/n/ac/ax/be UNII (5GHz and GHz), Wireless Power Transfer, NFC

| Ch. | Frequency (MHz) | Ch. | Frequency (MHz) |
|---|---|---|---|
| 1 | 2412 | 8 | 2447 |
| 2 | 2417 | 9 | 2452 |
| 3 | 2422 | 10 | 2457 |
| 4 | 2427 | 11 | 2462 |
| 5 | 2432 | 12 | 2467 |
| 6 | 2437 | 13 | 2472 |
| 7 | 2442 | | |

**Table 2-1. Frequency \ Channel Operations**

**Notes:**

1. The maximum achievable duty cycles for all modes were determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz, and detector = peak per the guidance of Section 6.0 b) of ANSI C63.10-2013 and KDB 558074 D01 v05r02. The RBW and VBW were both greater than 50\T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

| 802.11 Mode/Band | | MIMO (1+2) Duty Cycle [%] |
|---|---|---|
| 2.4GHz | b | 97.27 |
| | g | 99.01 |
| | n (HT20) | 99.41 |
| | ac (VHT20) | 99.54 |
| | ax (HE20) | 99.58 |
| | be (EHT20) | 99.62 |

**Table 2-2. Measured Duty Cycles**

2. The device employs MIMO technology. Below are the possible configurations.

| WiFi Configurations | | SISO | | SDM | | CDD | |
|---|---|---|---|---|---|---|---|
| | | ANT1 | ANT2 | ANT1 | ANT2 | ANT1 | ANT2 |
| 2.4GHz | 11b | ✓ | ✓ | × | × | ✓ | ✓ |
| | 11g | ✓ | ✓ | × | × | ✓ | ✓ |
| | 11n | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | 11ac | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | 11ax | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Table 2-3. Antenna / Technology Configuration**

✓= Support; × = NOT Support
**SISO** = Single Input Single Output
**SDM** = Spatial Diversity Multiplexing – MIMO function
**CDD** = Cyclic Delay Diversity - 2Tx Function

3. The device supports the following data rates (shown in Mbps):

| 802.11b | 802.11a/g | MCS Index | | Spatial Stream | OFDM (802.11n) | | OFDM (802.11ax) | | |
|---|---|---|---|---|---|---|---|---|---|
| 20MHz | 20MHz | | | | 20MHz | | 20MHz | | |
| | | HT | HE | | 0.8µs GI | 0.4µs GI | 0.8µs GI | 1.6µs GI | 3.2µs GI |
| 1 | 6 | 0 | 0 | 1 | 6.5 | 7.2 | 8.6 | 8.1 | 7.3 |
| 2 | 9 | 1 | 1 | 1 | 13 | 14.4 | 17.2 | 16.3 | 14.6 |
| 5.5 | 12 | 2 | 2 | 1 | 19.5 | 21.7 | 25.8 | 24.4 | 21.9 |
| 11 | 18 | 3 | 3 | 1 | 26 | 28.9 | 34.4 | 32.5 | 29.3 |
| | 24 | 4 | 4 | 1 | 39 | 43.3 | 51.6 | 48.8 | 43.9 |
| | 36 | 5 | 5 | 1 | 52 | 57.8 | 68.8 | 65 | 58.5 |
| | 48 | 6 | 6 | 1 | 58.5 | 65 | 77.4 | 73.1 | 65.8 |
| | 54 | 7 | 7 | 1 | 65 | 72.2 | 86 | 81.3 | 73.1 |
| | | | 8 | 1 | | ` | 103.2 | 97.5 | 87.8 |
| | | | 9 | 1 | | | 114.7 | 108.3 | 97.5 |
| | | | 10 | 1 | | | 129 | 121.9 | 109.7 |
| | | | 11 | 1 | ` | | 143.4 | 135.4 | 121.9 |
| 1 | 6 | 8 | 0 | 2 | 13 | 14.4 | 17.2 | 16.3 | 14.6 |
| 2 | 9 | 9 | 1 | 2 | 26 | 28.9 | 34.4 | 32.5 | 29.3 |
| 5.5 | 12 | 10 | 2 | 2 | 39 | 43.3 | 51.6 | 48.8 | 43.9 |
| 11 | 18 | 11 | 3 | 2 | 52 | 57.8 | 68.8 | 65 | 58.5 |
| | 24 | 12 | 4 | 2 | 78 | 86.7 | 103.2 | 97.5 | 87.8 |
| | 36 | 13 | 5 | 2 | 104 | 115.6 | 137.6 | 130 | 117 |
| | 48 | 14 | 6 | 2 | 117 | 130 | 154.9 | 146.3 | 131.6 |
| | 54 | 15 | 7 | 2 | 130 | 144.4 | 172.1 | 162.5 | 146.3 |
| | | | 8 | 2 | 156 | 173.3 | 206.5 | 195 | 175.5 |
| | | | 9 | 2 | N/A | N/A | 229.4 | 216.7 | 195 |
| | | | 10 | 2 | | | 258.1 | 243.8 | 219.4 |
| | | | 11 | 2 | | | 286.8 | 270.8 | 243.8 |

**Table 2-4. Supported Data Rates**

## 2.3 Test Configuration

ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 7.4 for AC line conducted emissions test setups, 7.2 and 7.3 for radiated emissions test setups.

## 2.4 Antenna Description

The following antenna gains were used for the testing.

| Frequency [GHz] | Antenna-1 Gain [dBi] | Antenna-2 Gain [dBi] | Measured Directional Gain [dBi] |
|---|---|---|---|
| 2.4 | 1.50 | 1.02 | 4.11 |

**Table 2-5. Antenna Peak Gain**

The antenna gains shown in this table were provided by the manufacturer.

## 2.5 Software and Firmware

The test was conducted with software\firmware version 1.0.4166.1200 installed on the EUT.

## 2.6 EMI Suppression Device(s) / Modifications

No EMI suppression device(s) were added and\or no modifications were made during testing.

# 3.0 DESCRIPTION OF TESTS

## 3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) was used in the measurement of the EUT.

**Deviation from measurement procedure…….....None**

## 3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 10'x16'x9' shielded enclosure. The shielded enclosure is manufactured by ETS Lindgren RF EnclosuresThe line-conducted facility is located inside a 7m x 3.66m x 2.7m shielded enclosure. The shielded enclosure is manufactured by AP Americas. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-5. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω\\50μH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is an ETS Lindgren Model LPRX-4X30 (100dB Attenuation, 14kHz-18GHz) and the two EMI\\RFI filters are ETS Lindgren Model LRW-2030-S1 (100dB Minimum Insertion Loss, 14kHz – 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference groundplane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Once the worst case emissions have been identified, the one EUT cable configuration\\arrangement and mode of operation that produced these emissions is used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

Line conducted emissions test results are shown in Section 7.4. The EMI Receiver mode of the Agilent MXE was used to perform AC line conducted emissions testing.

## 3.3 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. An 80cm tall test table made of Styrodur is placed on top of the turn table. For measurements above 1GHz, an additional Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33 depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 414788 D01 v01r01.

## 3.4 Environmental Conditions

The temperature is controlled within range of 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

# 4.0 ANTENNA REQUIREMENTS

**Excerpt from §15.203 of the FCC Rules\Regulations:**
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. 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 provisions of this section."

- The antennas of the EUT are **permanently attached.**
- There are no provisions for connections to an external antenna.

**Conclusion:**

The EUT unit complies with the requirement of §15.203.

# 5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the $U_{CISPR}$ measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

| Contribution | Expanded Uncertainty (±dB) |
|---|---|
| Conducted Bench Top Measurements | 1.13 |
| Line Conducted Disturbance | 3.09 |
| Radiated Disturbance (<1GHz) | 4.98 |
| Radiated Disturbance (>1GHz) | 5.07 |
| Radiated Disturbance (>18GHz) | 5.09 |

**Table 5-1. Measurement Uncertainty Budget – MD**

## 6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| - | WL25-1 | Conducted Cable Set (25GHz) | 4/2/2024 | Annual | 4/2/2025 | WL25-1 |
| - | MD 1M 18-40 | EMC Cable and Switch System | 4/3/2024 | Annual | 4/3/2025 | AP1-002 |
| - | AP1-002 | EMC Cable and Switch System | 4/4/2024 | Annual | 4/4/2025 | ETS-001 |
| - | ETS-001 | EMC Cable and Switch System | 4/5/2024 | Annual | 4/5/2025 | ETS-002 |
| - | ETS-002 | EMC Cable and Switch System | 4/6/2024 | Annual | 4/6/2025 | MD 1M 18-40 |
| ETS-Lindgren | 3116C | Horn Antenna (18-40GHz) | 2/27/2023 | Biennial | 2/27/2025 | 218893 |
| Rohde & Schwarz | TC-TA18 | Vivaldi Antenna | 2/23/2023 | Biennial | 2/23/2025 | 26040036 |
| Rohde & Schwarz | FSW26 | Spectrum Analyzer (26.5GHz) | 3/8/2024 | Annual | 3/8/2025 | 103187 |
| Rohde & Schwarz | ESU26 | EMI Test Receiver (26.5GHz) | 10/16/2024 | Annual | 10/16/2025 | 100342 |
| Rohde & Schwarz | ESU40 | EMI Test Receiver (40GHz) | 11/25/2024 | Annual | 11/25/2025 | 100348 |
| Pasternack | NMLC-2 | Line Condcuted Emissions Cable | 4/2/2024 | Annual | 4/2/2025 | NMLC-2 |
| Rohde & Schwarz | ENV216 | Two-Line V-Network | 1/31/2023 | Biennial | 1/31/2025 | 101379 |
| Sunol | JB6 | Bi-Log Antenna (20M-6GHz) | 3/2/2023 | Biennial | 3/2/2025 | A082816 |
| Sunol | JB5 | Bi-Log Antenna (20M-5GHz) | 9/11/2024 | Biennial | 9/11/2026 | A051107 |

**Table 6-1. Test Equipment Calibration Table – MD**

**Note:**

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

# 7.0 TEST RESULTS

## 7.1 Summary

Company Name: Microsoft Corporation

FCC ID: C3K00002101

FCC Classification: Digital Transmission System (DTS)

| FCC Part Section(s) | RSS Section(s) | Test Description | Test Limit | Test Condition | Test Result | Reference |
|---|---|---|---|---|---|---|
| 15.247(a)(2) | RSS-247 [5.2(a)] | 6dB Bandwidth | The minimum 6 dB bandwidth shall be at least 500 kHz. | CONDUCTED | PASS | See Original Filing for Module |
| 15.247(b)(3) | RSS-247 [5.4(b)] | Transmitter Output Power | shall not exceed 1 W | | PASS | See Original Filing for Module |
| N\A | RSS-247 [5.4(b)] | e.i.r.p. | shall not exceed 4 W | | PASS | See Original Filing for Module |
| 15.247(e) | RSS-247 [5.2(b)] | Transmitter Power Spectral Density | shall not be greater than 8 dBm in any 3 kHz band | | PASS | See Original Filing for Module |
| 15.247(d) | RSS-247 [5.5] | Band Edge / Out-of-Band Emissions | ≥ 20dBc | | PASS | See Original Filing for Module |
| 15.205 15.209 | RSS-Gen [8.9] | General Field Strength Limits (Restricted Bands and Radiated Emission Limits) | Emissions in restricted bands must meet the radiated limits detailed in 15.209 (RSS-Gen [8.9]) | RADIATED / CONDUCTED | PASS | Section 7.2, 7.3 |
| 15.207 | RSS-Gen [8.8] | AC Conducted Emissions 150kHz – 30MHz | < FCC 15.207 limits (RSS-Gen [8.8]) | LINE CONDUCTED | PASS | Section 7.4 |

**Table 7-1. Summary of Test Results**

**Notes:**

1) All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst-case emissions.
2) For band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is Element "Chamber Automation," Version 1.3.1.
3) The test data shown in this report follows the test plan prepared by the Grantee after consultation with FCC. Also, additional measurements are included based on worst-case findings from the filing of the original module report.

## 7.2 Emission Measurements

**Test Overview and Limit**

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst-case emissions are reported in this section.

***All out of band emissions appearing in a restricted band as specified in FCC §15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown FCC §15.209 and RSS-Gen (8.9).***

| Frequency | Field Strength [µV/m] | Measured Distance [Meters] |
|---|---|---|
| 0.009 – 0.490 MHz | 2400/F (kHz) | 300 |
| 0.490 – 1.705 MHz | 24000/F (kHz) | 30 |
| 1.705 – 30.00 MHz | 30 | 30 |
| 30.00 – 88.00 MHz | 100 | 3 |
| 88.00 – 216.0 MHz | 150 | 3 |
| 216.0 – 960.0 MHz | 200 | 3 |
| Above 960.0 MHz | 500 | 3 |

**Table 7-2. Radiated Limits**

**Test Procedures Used**

ANSI C63.10-2013 – Section 6.6.4.3, 11.12.2.2

**Test Settings – Above 1GHz**

**Average Field Strength Measurements**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = power average (RMS)
5. Number of measurement points = 1001 (Number of points must be ≥ 2 x span\\RBW)
6. Sweep time = auto
7. Trace (RMS) averaging was performed over at least 100 traces

### Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

## Test Settings – Below 1GHz

### Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

## Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

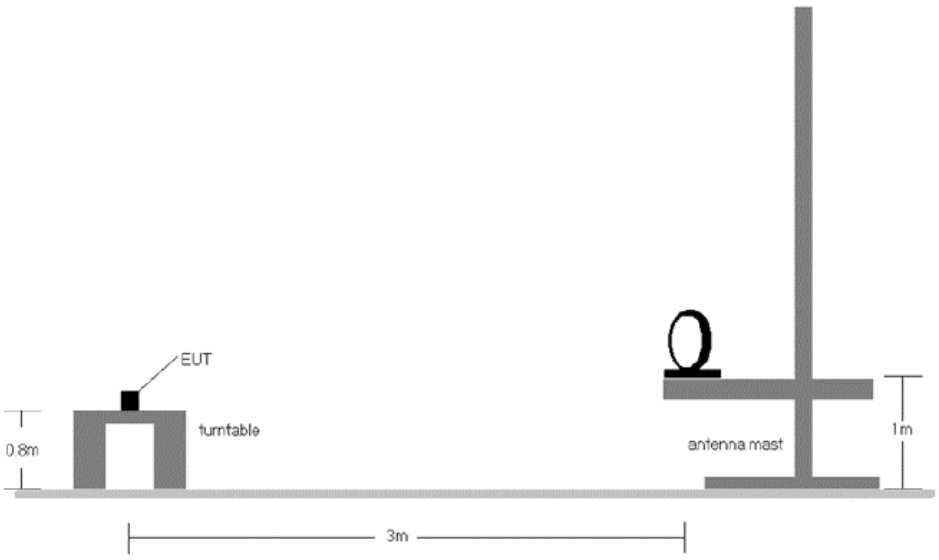



**Figure 7-1. Radiated Test Setup < 30MHz**

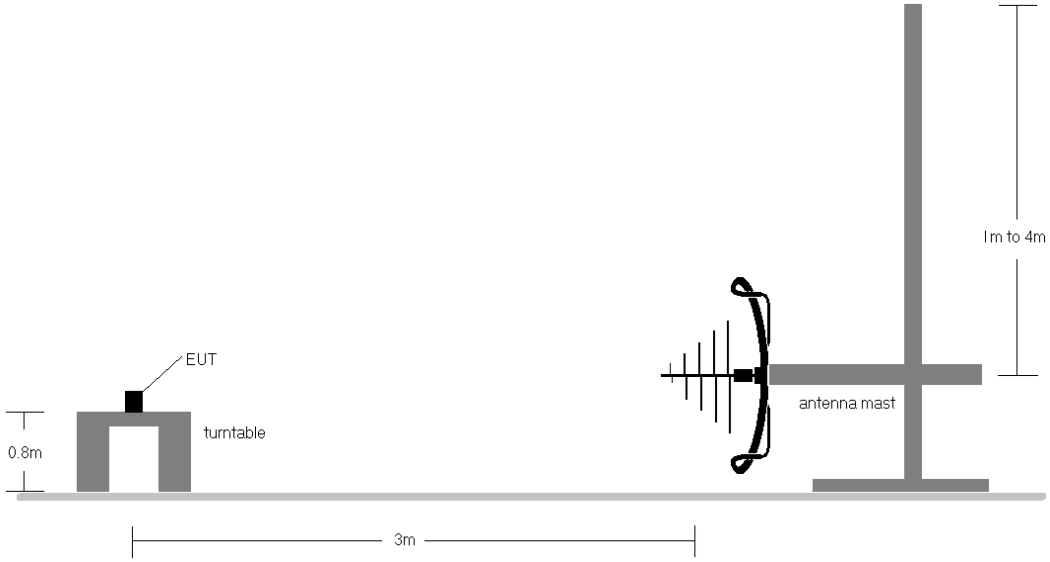



**Figure 7-2. Radiated Test Setup < 1GHz**

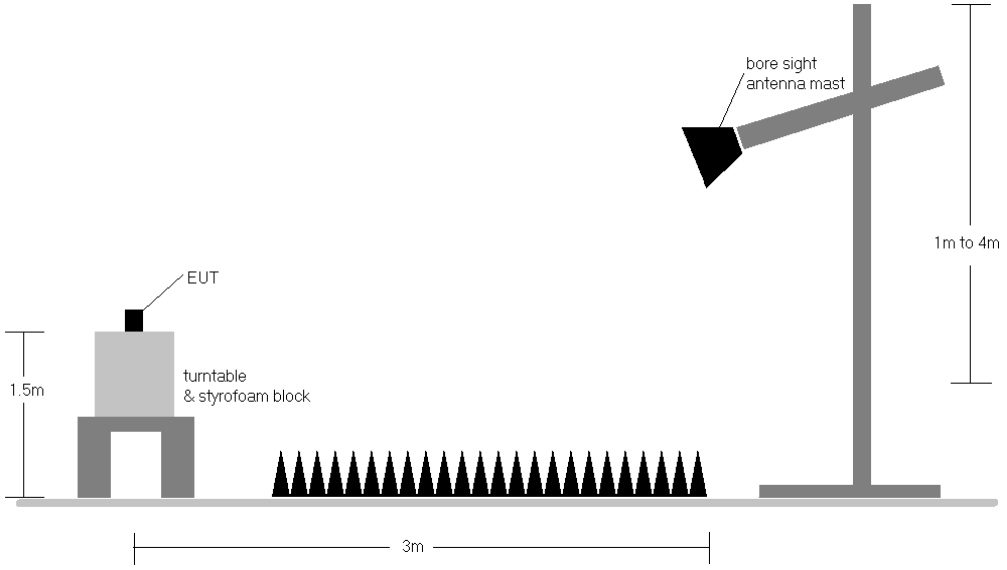



**Figure 7-3. Radiated Test Setup > 1GHz**


**Figure 7-4. Conducted Test Setup > 1GHz**

## Test Notes

1. The optional test procedures for antenna port conducted measurements of unwanted emissions per the guidance of ANSI C63.10-2013 Section 11.3 were not used to evaluate this device for compliance to radiated limits. All radiated spurious emissions levels were measured in a radiated test setup.
2. All emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limits shown in §15.209.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested with its standard battery.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
6. Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
7. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section.
8. The "-" shown in the following RSE tables are used to denote a noise floor measurement.
9. Emissions are investigated while operating on the center channel of the mode, band, and modulation that produced the worst-case results during the transmitter spurious emissions testing.
10. No spurious emissions were detected within 20dB of the limit below 30MHz.
11. The results recorded using the broadband antenna are known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
12. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. There were no emissions detected in the 30MHz – 1GHz frequency range, as shown in the subsequent plots.
13. Restricted Band Edge testing was performed using a conducted setup per C63.10 11.12.2.2.

## Sample Calculations

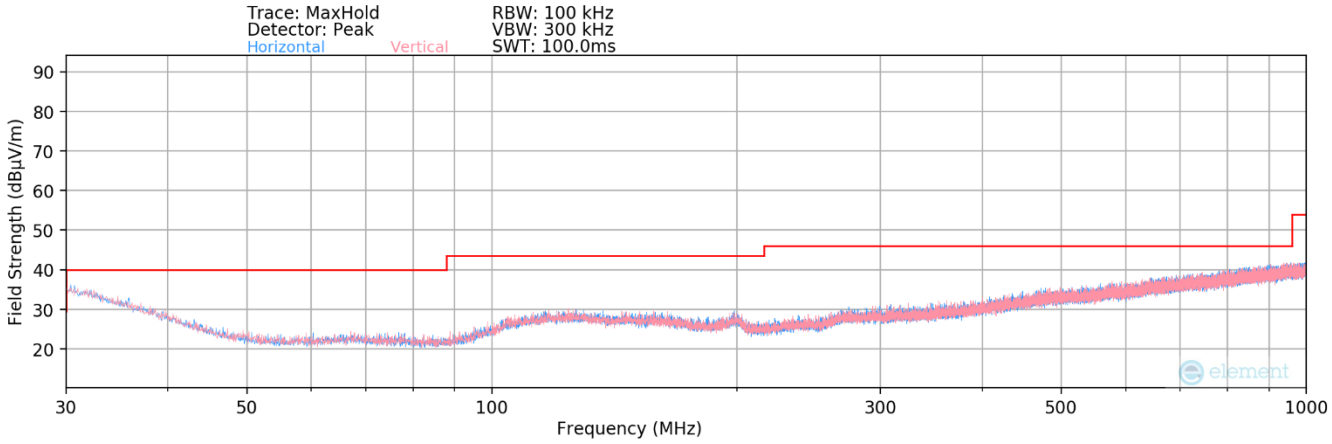
### Determining Spurious Emissions Levels

- Field Strength Level $_{[dB\mu V\backslash m]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB\backslash m]}$
- AFCL $_{[dB\backslash m]}$ = Antenna Factor $_{[dB\backslash m]}$ + Cable Loss $_{[dB]}$
- Margin $_{[dB]}$ = Field Strength Level $_{[dB\mu V\backslash m]}$ – Limit $_{[dB\mu V\backslash m]}$

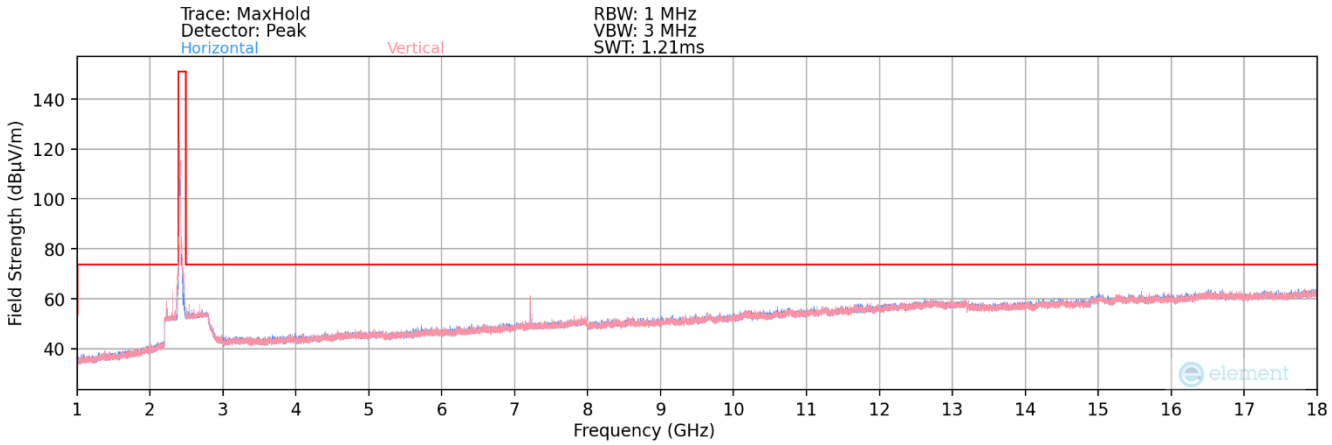
## Band Edge Field Strength Calculation

- Field Strength Level $_{[dB\mu V\backslash\backslash m]}$ = EIRP $_{[dBm]}$ - 20logd + 104.8

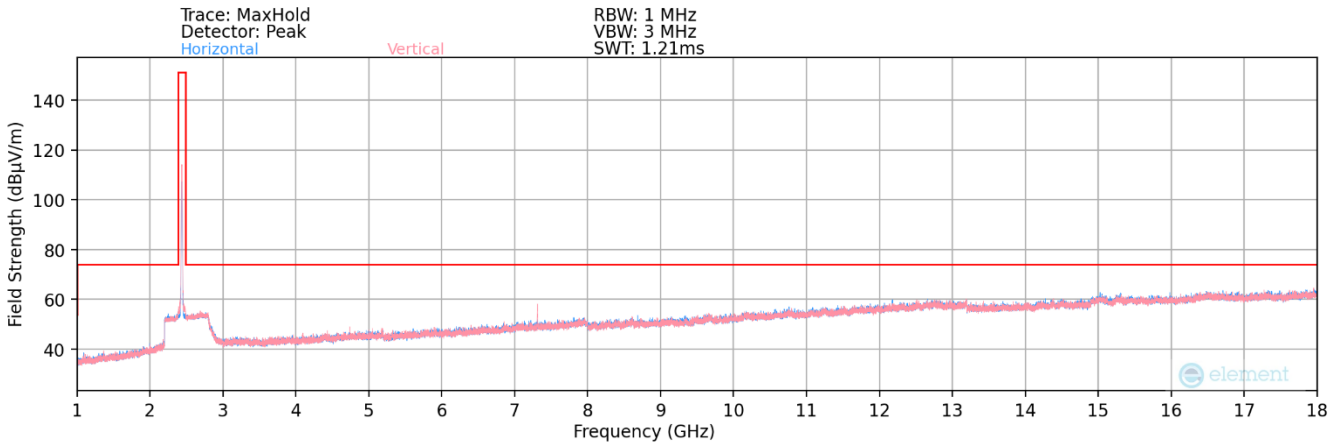
## 7.2.1 MIMO Radiated Spurious Emission Measurements



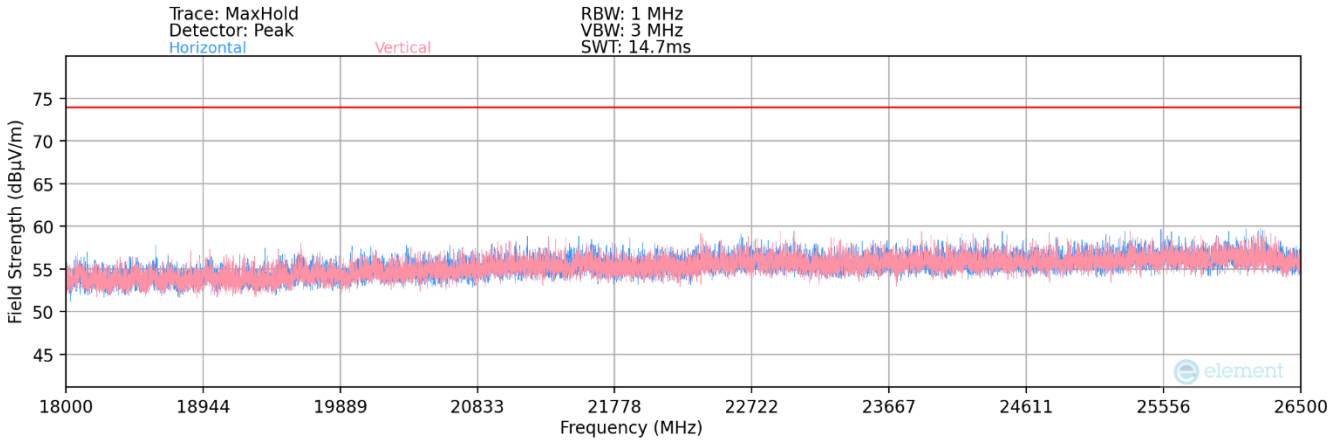

**Plot 7-1. Radiated Spurious Plot below 1GHz MIMO – 802.11b**




**Plot 7-2. Radiated Spurious Plot above 1GHz MIMO (802.11be 52T – Ch. 1)**




**Plot 7-3. Radiated Spurious Plot above 1GHz MIMO (802.11b – Ch. 6)**




**Plot 7-4. Radiated Spurious Plot above 18GHz MIMO 802.11b**

| | |
|---|---|
| Worst Case Mode: | 802.11b |
| Worst Case Transfer Rate: | 1 Mbps |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2437MHz |
| Channel: | 6 |

| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Distance Correction Factor [dB] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|---|
| 4874.00 | Avg | V | 110 | 157 | -77.17 | 9.64 | 0.00 | 39.47 | 53.98 | -14.51 |
| 4874.00 | Peak | V | 110 | 157 | -68.88 | 9.64 | 0.00 | 47.76 | 73.98 | -26.22 |
| 7311.00 | Avg | V | 125 | 142 | -74.91 | 15.19 | 0.00 | 47.28 | 53.98 | -6.70 |
| 7311.00 | Peak | V | 125 | 142 | -68.24 | 15.19 | 0.00 | 53.95 | 73.98 | -20.03 |
| 12185.00 | Avg | V | - | - | -85.77 | 23.05 | 0.00 | 44.28 | 53.98 | -9.70 |
| 12185.00 | Peak | V | - | - | -75.61 | 23.05 | 0.00 | 54.44 | 73.98 | -19.54 |

**Table 7-3. Radiated Measurements MIMO**

| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| 200.00 | Quasi-Peak | V | - | - | -71.05 | -13.60 | 21.63 | 43.52 | -21.89 |

**Table 7-4. Radiated Measurements MIMO below 1GHz**

| | |
|---|---|
| Worst Case Mode: | 802.11be |
| Worst Case Transfer Rate: | MCS0 |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2412MHz |
| Channel: | 1 |
| RU Index | 0 |

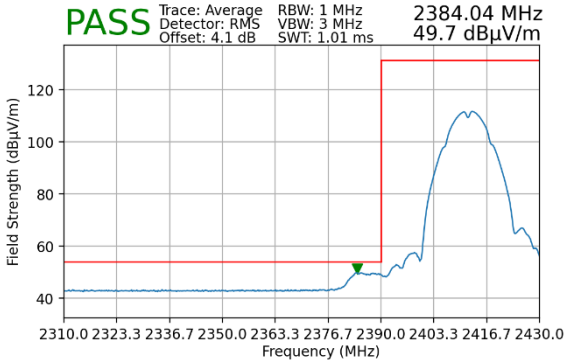
| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Distance Correction Factor [dB] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|---|
| 4824.00 | Avg | V | 119 | 148 | -74.23 | 9.19 | 0.00 | 41.96 | 53.98 | -12.02 |
| 4824.00 | Peak | V | 119 | 148 | -62.50 | 9.19 | 0.00 | 53.69 | 73.98 | -20.29 |
| 12060.00 | Avg | V | - | - | -85.19 | 22.22 | 0.00 | 44.03 | 53.98 | -9.95 |
| 12060.00 | Peak | V | - | - | -74.01 | 22.22 | 0.00 | 55.21 | 73.98 | -18.77 |

**Table 7-5. Radiated Measurements MIMO**

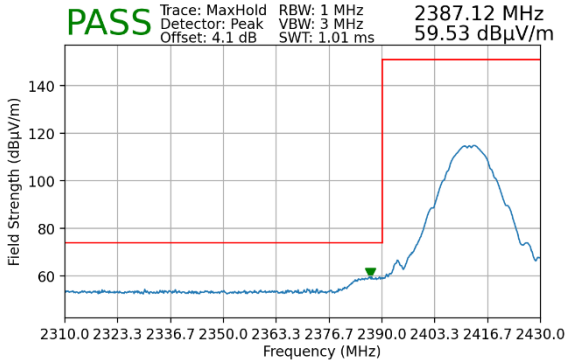
## 7.3 MIMO Restricted Band Edge Measurements

The restricted band edge measurements are measured with an EMI test receiver connected to the EUT while transmitting.

| | |
|---|---|
| Worst Case Mode: | 802.11b |
| Worst Case Transfer Rate: | 1Mbps |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2412MHz |
| Channel: | 1 |

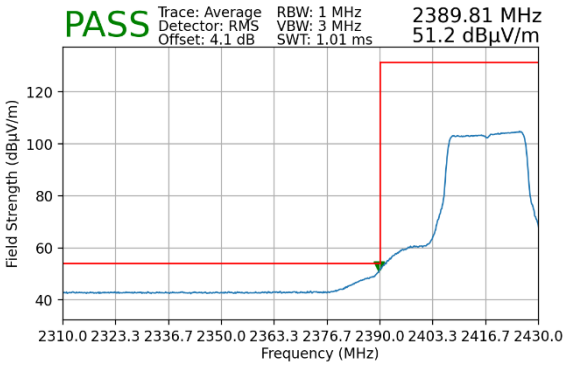



**Plot 7-5. Restricted Lower Band Edge Measurement MIMO (Average)**

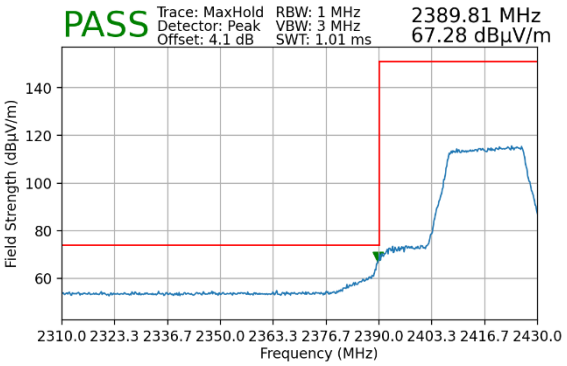



**Plot 7-6. Restricted Lower Band Edge Measurement MIMO (Peak)**

| | |
|---|---|
| Worst Case Mode: | 802.11be |
| Worst Case Transfer Rate: | MCS0 |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2417MHz |
| Channel: | 2 |

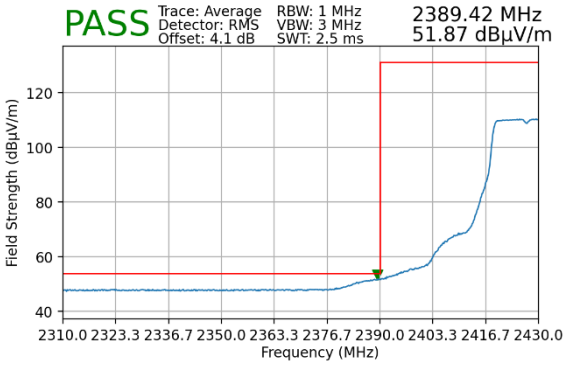



**Plot 7-7. Restricted Lower Band Edge Measurement MIMO (Average)**

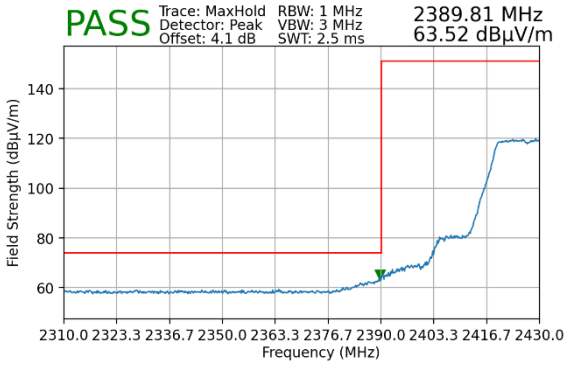



**Plot 7-8. Restricted Lower Band Edge Measurement MIMO (Peak)**

| | |
|---|---|
| Worst Case Mode: | 802.11g |
| Worst Case Transfer Rate: | 6Mbps |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2427MHz |
| Channel: | 4 |

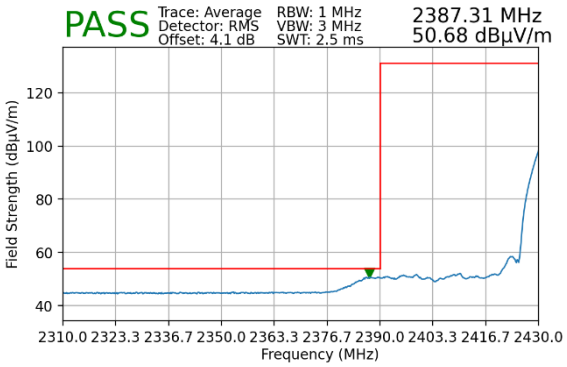



**Plot 7-9. Restricted Lower Band Edge Measurement MIMO (Average)**

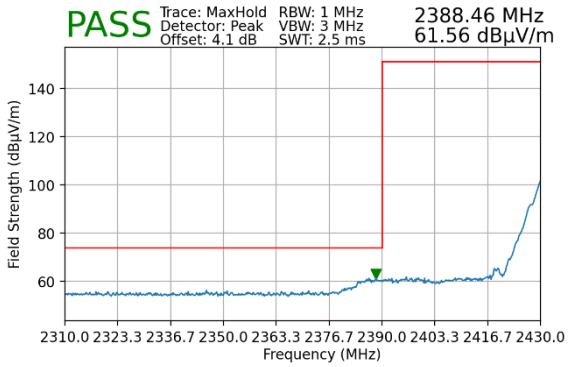



**Plot 7-10. Restricted Lower Band Edge Measurement MIMO (Peak)**

| | |
|---|---|
| Worst Case Mode: | 802.11b |
| Worst Case Transfer Rate: | 1Mbps |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2437MHz |
| Channel: | 6 |

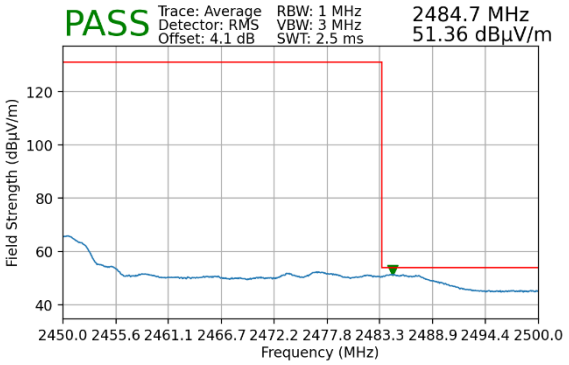



**Plot 7-11. Restricted Lower Band Edge Measurement MIMO (Average)**

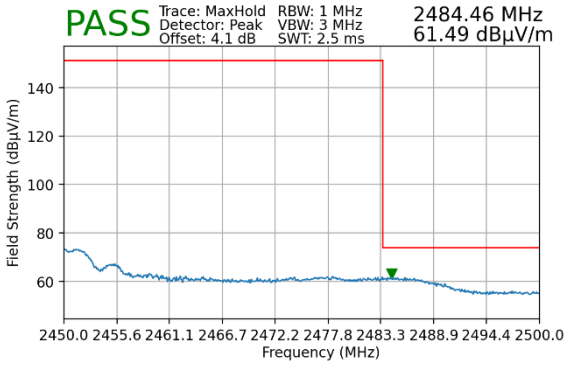



**Plot 7-12. Restricted Lower Band Edge Measurement MIMO (Peak)**

| | |
|---|---|
| Worst Case Mode: | 802.11b |
| Worst Case Transfer Rate: | 1Mbps |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2437MHz |
| Channel: | 6 |

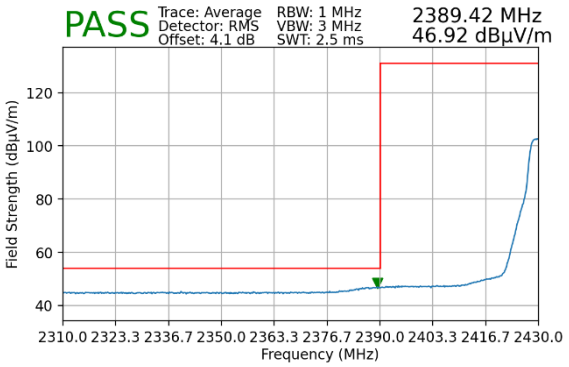



**Plot 7-13. Restricted Upper Band Edge Measurement MIMO (Average)**

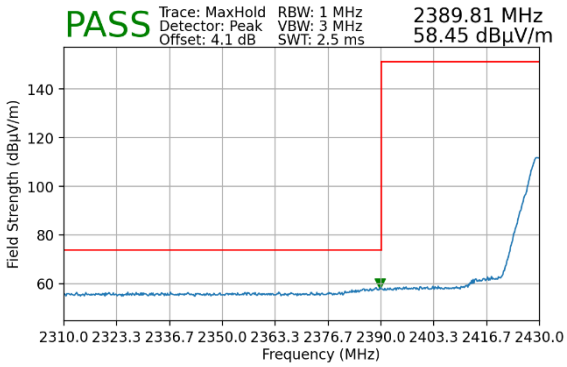



**Plot 7-14. Restricted Upper Band Edge Measurement MIMO (Peak)**

| | |
|---|---|
| Worst Case Mode: | 802.11n [40MHz] |
| Worst Case Transfer Rate: | MCS8 |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2437MHz |
| Channel: | 6 |

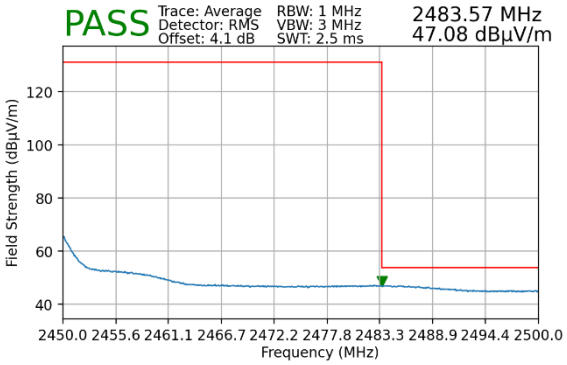



**Plot 7-15. Restricted Lower Band Edge Measurement MIMO (Average)**

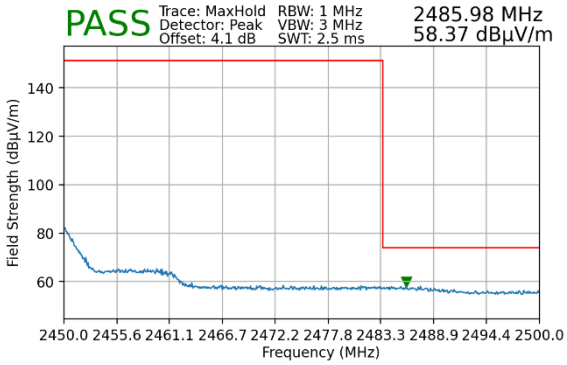



**Plot 7-16. Restricted Lower Band Edge Measurement MIMO (Peak)**

| | |
|---|---|
| Worst Case Mode: | 802.11n [40MHz] |
| Worst Case Transfer Rate: | MCS8 |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2437MHz |
| Channel: | 6 |

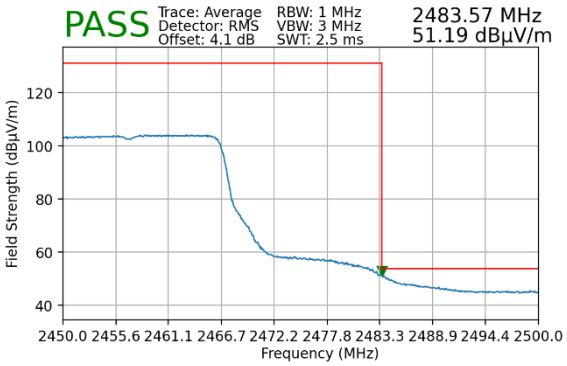



**Plot 7-17. Restricted Upper Band Edge Measurement MIMO (Average)**

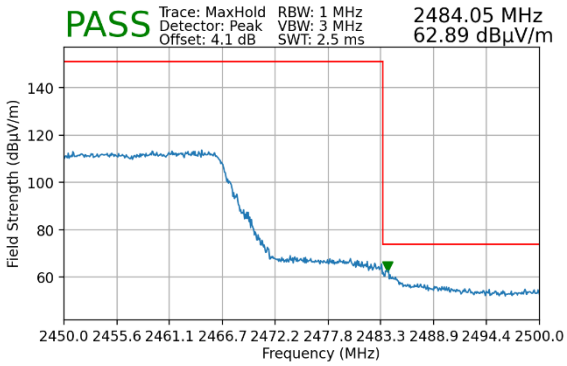



**Plot 7-18. Restricted Upper Band Edge Measurement MIMO (Peak)**

| | |
|---|---|
| Worst Case Mode: | 802.11be |
| Worst Case Transfer Rate: | MCS0 |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2457MHz |
| Channel: | 10 |




**Plot 7-19. Restricted Upper Band Edge Measurement MIMO (Average)**




**Plot 7-20. Restricted Upper Band Edge Measurement MIMO (Peak)**

## 7.4 Line-Conducted Test Data

**Test Overview and Limit**

All AC line conducted spurious emissions are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

***All conducted emissions must not exceed the limits shown in the table below per §15.207 and RSS-Gen (8.8).***

| 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 |

**Table 7-6. Conducted Limits**

*Decreases with the logarithm of the frequency.

**Test Procedures Used**

ANSI C63.10-2013, Section 6.2

**Test Settings**

**Quasi-Peak Field Strength Measurements**

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

**Average Field Strength Measurements**

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = RMS
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

## Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

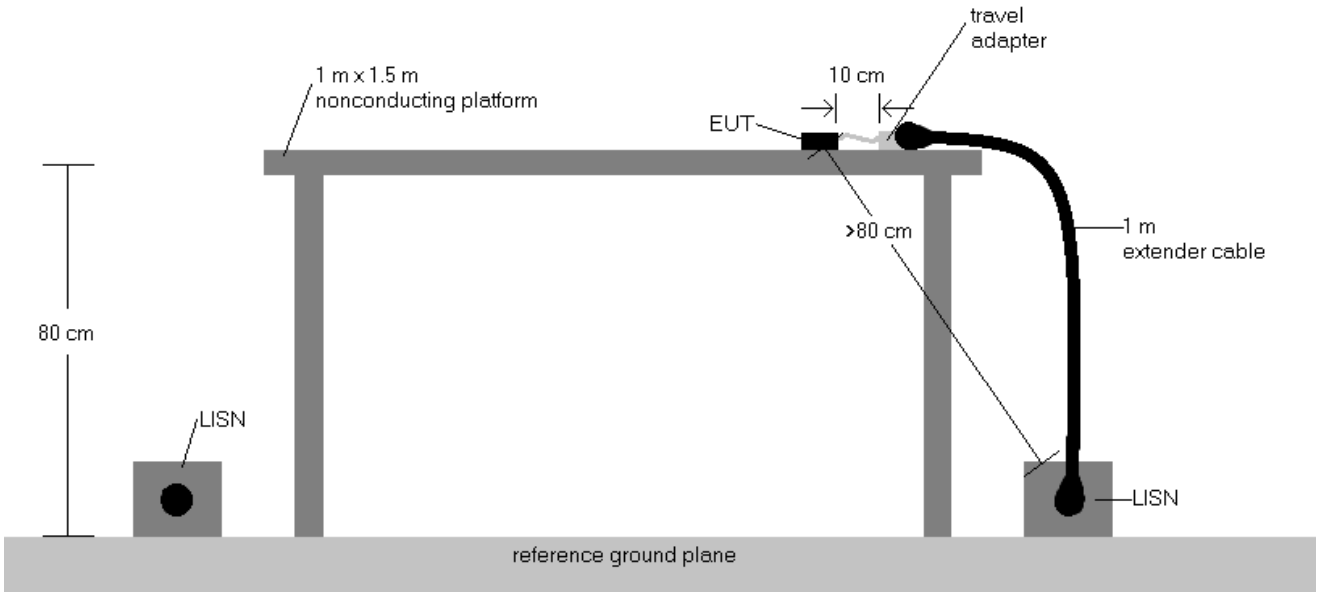
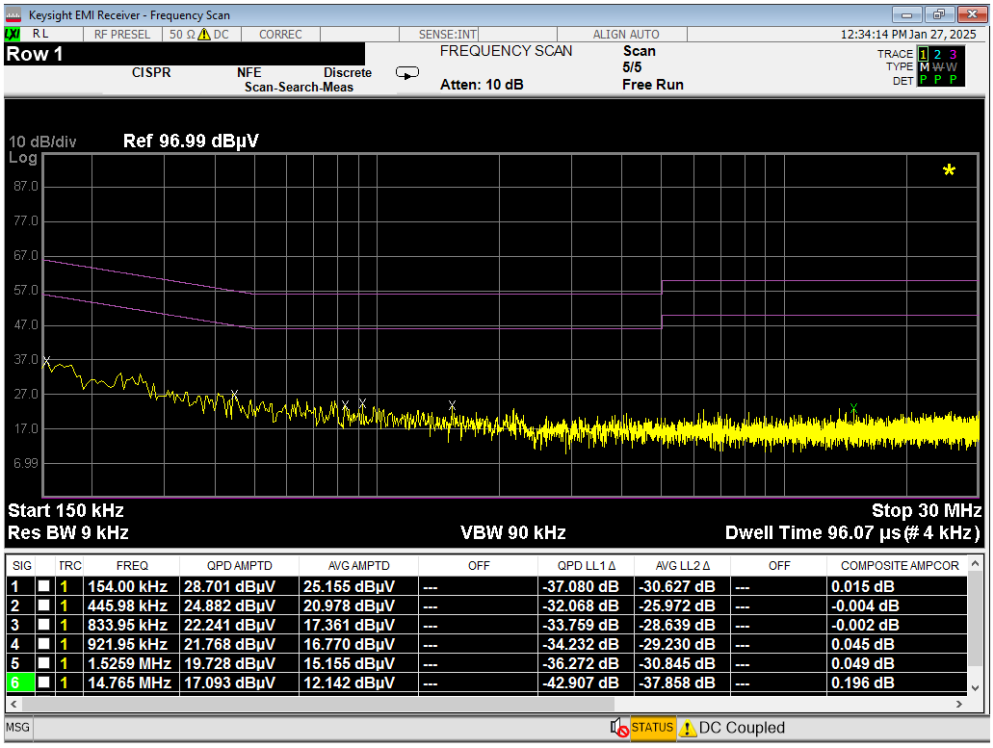



**Figure 7-5. Test Instrument & Measurement Setup**

## Test Notes

1. All modes of operation were investigated and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
2. The limit for an intentional radiator from 150kHz to 30MHz are specified in Part 15.207 and RSS-Gen(8.8).
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP\\AV Level (dBμV) = QP\\AV Analyzer\\Receiver Level (dBμV) + Corr. (dB)
5. Margin (dB) = QP\\AV Limit (dBμV) - QP\\AV Level (dBμV)
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.




**Plot 7-21. Line Conducted Plot with 802.11b – Ch.6 (L1)**

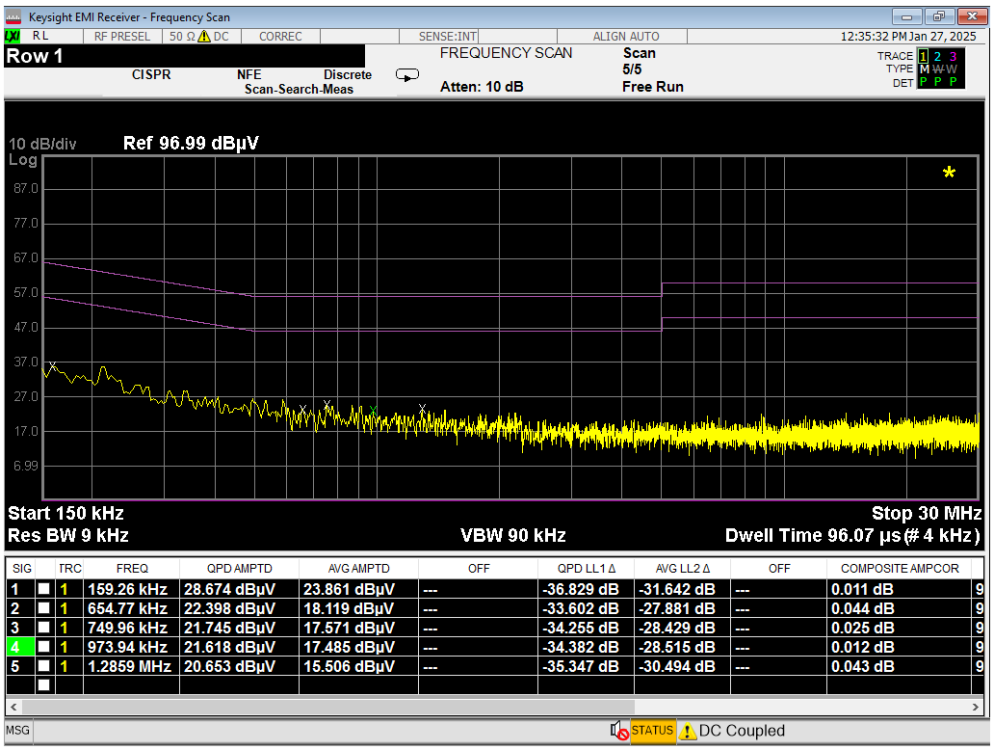



**Table 7-7. Line Conducted Data with 802.11b Ch.6 (N)**

# 8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Microsoft Portable Computing Device Model 2109 containing module FCC ID: C3K00002101** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.