# Test Report 2024-158

## Version A
## Issued 11 Nov 2024

## Project: GCL-0647
## Model Identifier: A04999
## Primary Test Standard(s):
CFR 47, FCC Part 15.247
RSS-247 Issue 3


## Garmin Compliance Lab
**Garmin International**
**1200 E 151st Street**
**Olathe Kansas 66062 USA**


**Client-supplied Information**

| | |
|---|---|
| FCC ID: | IPH-04999 |
| IC ID: | 1792A-04999 |

ACCREDITED
CERTIFICATE #6162.01

**See section 6 of this report regarding the presence or absence of accreditation logos or marks on this cover page.**

## 1. Summary

The equipment or product described in section 5 of this report was tested at the Garmin Compliance Lab according to standards listed in section 6. This report focuses on the 2.4 GHz transceiver(s). The results are as follows.

| Parameter | Description | Key Performance Values | Result | Data starts at page |
|---|---|---|---|---|
| Radio Modulation | Summary of the kinds of communication this radio can achieve, as stated by the client. [RSS-GEN at Annex A item 10b] | Digitally modulated spread spectrum at rates as high as 72.2 Mbps. | Reported | N/A |
| Hopping Channels | The radio manages it use of channels appropriately. [15.247(a)(1); RSS-247 at 5.1] | N/A. The radios described in this report are not subjected to the Frequency Hopping rules. | N/A | N/A |
| DTS Bandwidth | The nature of the radio signal is broadband, being at least 500 kHz wide. [15.247(a)(2); RSS-247 at 5.2(a)] | The 6dB bandwidth is 512 kHz or greater. | PASS | 16 |
| Other Bandwidths | Regulatory agencies also require the reporting of signal bandwidths using alternate processes. [2.202; RSS-GEN at 6.7] | These values are reported but have no actual performance requirements. | Reported | 23 |
| Transmit Power | The peak transmit power presented to the antenna is no greater than 1 Watt or 30 dBm. The effective radiated power is limited to 4 Watts or 36 dBm EIRP. [15.247(b); RSS-247 at 5.4(d)] | The maximum transmit power is 18.9 dBm or 77.6 mW. | PASS | 30 |
| Antenna Gain | The radio should not focus too much energy in any direction. Unless additional rules are applied, the antenna gain is no greater than 6 dBi. [15.247(b)(4) and (c)] | NT. The client stated that the antenna gain was -0.35 dBi and will document antenna gain separately. | NT | NT |
| Unwanted Emissions (Conducted Spurious) | The radio should not provide too much radio energy to the antenna at frequencies beyond its intended frequency band. [15.247(d); RSS-247 at 5.5] | Emissions outside the band must be reduced at least 30 dB from in-band levels. The measured reduction was at least 42.5 dB. | PASS | 38 |
| Restricted Bands | The radio must not emit in certain designated restricted frequency bands above a set of limit values. [15.247(d) and 15.205; RSS-247 at 3.3] | Emissions in the restricted bands were at least 3.4 dB below the applicable limits. | PASS | 48 |

| | | | | |
|---|---|---|---|---|
| Power Spectral Density | The radio must not focus too much radio energy in a narrow frequency band. [15.247(e); RSS-247 at 5.2(b)] | The limit is 8 dBm in a 3 kHz band. The strongest emission level was -4.6 dBm in a band of at least 3 kHz. | PASS | 77 |
| Hybrid Systems | A radio that is both frequency hopping and digitally modulated should satisfy a combination of system rules. [15.247(f); RSS-247 at 5.3] | N/A. The radios described in this report are not subjected to the Hybrid System rules. | N/A | N/A |
| Frequency Hopping Rules | Frequency hopping systems have additional functional requirements. [15.247(g) and (h); RSS-247 at 5.1] | N/A. The radios described in this report are not subjected to the Frequency Hopping rules. | N/A | N/A |
| Radio Safety | The radio emissions must meet public health & safety guidelines related to human exposure. [15.247(i) and 1.1307; RSS-Gen at 3.4] | NT. Client will report radio energy safety results separately. | NT | NT |
| Unwanted Emissions (Radiated Spurious) | While transmitting, the radiated emissions must not be too strong. [15.209, RSS-Gen at 8.9] | Emissions other than the fundamental and harmonics must meet the 'Class B' limits. The measured emissions had at least 8.1 dB of margin. | PASS | 82 |
| Unwanted Emissions (Mains Conducted) | While transmitting, the emissions conducted into the power mains must not be too strong. [15.207, RSS-Gen at 8.8] | Emissions other than the fundamental and harmonics must meet the 'Class B' limits. The measured emissions had at least 18.8 dB of margin. | PASS | 119 |

**NT** (Not Tested) means the requirement may or may not be applicable, but the relevant measurement or test was not performed as part of this test project.

**N/A** (Not Applicable) means the lab judged that the test sample is exempt from the requirement.

**Table 1: Summary of results**

Report Organization

For convenience of the reader, this report is organized as follows:

1. Summary
2. Test Background
3. Report History and Approval
4. Test Sample Modifications and Special Conditions
5. Description of Equipment Tested
6. Test Standards Applied
7. Measurement Instrumentation Uncertainty
8. Selected Examples of Calculations
9. Environmental Conditions During Test
10. Immunity Performance Criteria
11. 3m RF Chamber Block Diagrams

Annex: Test records are provided for each type of test, following the order and page numbering stated in the summary table. Concluding notes appear on the final page of this report.

Due to confidentiality, certain material (such as test setup photographs) has been removed from this report and placed in GCL Test Report 2024-163. That report is treated as a part of this document by way of this reference.

## 2. Test Background

### 2.1 The Test Lab

The testing reported here was performed at the Garmin Compliance Lab, an organization within Garmin International, located at 1200 E 151st St, Olathe Kansas, USA. The contact telephone number is +1.913.397.8200.

### 2.2 The Client

The testing was performed on behalf of the Garmin design group, a separate organization located at 1200 E 151st St, Olathe Kansas, USA. Witnesses from the business group included: None.

### 2.3 Other Information

Test Sample received: 09 Aug 2024
Test Start Date: 28 Aug 2024
Test End Date: 04 Nov 2024

The data in this test report apply only to the specific samples tested.

Upon receipt all test samples were believed to be properly assembled and ready for testing.

## 3. Report History and Approval

This report was written by Andy Heier and initially issued on 11 Nov 2024 as Version A.

**Report Technical Review**:

David Arnett
Technical Lead EMC Engineer

**Report Approval:**

Shruti Kohli
Manager Test and Measurement (EMC, Reliability and Calibration)

## 4. Test Sample Modifications and Special Conditions

The following special conditions or usage attributes were judged during test to be necessary to achieve compliance with one or more of the standards listed in section 6 of this report:
None

The following modifications to the test sample(s) were made, and are judged necessary to achieve compliance with one or more of the standards listed in section 6 of this report:

Modification 1
Detailed Description: Sample E1's (s/n 8ME000064) firmware was updated from version 1.03 to 1.06.
Date applied: 25-Sep-2024 at 1pm
Reason for this modification: To fix the WiFi test page, correcting WiFi companion device connectivity and display packet-error-rate on the WiFi Rx test page.

The following tests were performed without this modification being present, and the presence or absence of the modification is judged by the lab and client to have no significant effect on these specific tests: Transmit Power, DTS Bandwidth, Occupied Bandwidth, Power Spectral Density, Conducted AC Mains Emissions, and Radiated Emissions.

## 5. Description of the Equipment Tested

### 5.1 Unique Identification

| | |
|---|---|
| Product Model | A04999 |
| Serial Numbers Tested | Initial Group: 8ME000064, 8ME000165<br>Updated Group: None for this report |

The product tested is a mobile device for collecting and sharing data with the user and nearby electronic devices.

The client delivered an initial group of test samples and affirmed that the test samples will be representative of production in all relevant aspects. However, prior to the start of testing the client identified design changes that would be needed in the 13.56 MHz NFC transceiver. The client stated that a second group of test samples would be provided with these design updates implemented. The client stated that the non-NFC transceivers in the initial group are representative of production and asked GCL to begin testing using those samples. This report may contain compliance data that was taken in non-NFC operating modes with samples from this initial group. The second group of NFC-updated samples was delivered to GCL on 04 November 2024. GCL only performed NFC-focused tests on samples from that updated group. The client affirmed that the test samples in this updated group will be representative of production in all relevant aspects.

### 5.2 Key Parameters

| | |
|---|---|
| EUT Input Power: | 5 Vdc |
| I/O Ports: | USB |
| Radio Transceivers: | IEEE 802.11 b/g/n, Bluetooth, Bluetooth Low Energy, ANT, NFC |
| Radio Receivers: | GPS L1, Galileo E1, BeiDou, GLONASS |
| Primary Functions: | Data collection and communication |
| Typical use: | Portable in multiple orientations |
| Highest internal frequency: | 2.484 GHz |
| Firmware Revision | 1.03, 1.06 (see section 4) |

## 5.3 Operating modes

During test, the EUT was operated in one or more of the following modes.

Mode 1: M1 (Bt Tx). Bluetooth, sometimes called Bluetooth Classic, radio is transmitting consistently on a selected channel sending data using the BR (Basic Rate of 1 Mbps), EDR2 (Extended Data Rate of 2 Mbps) or EDR3 (Extended Data Rate of 3 Mbps) modulation types.

Mode 2: M2 (Bt Lnk). Bluetooth Classic radio is paired to a companion device, transmitting and receiving data on various channels in accordance with the protocol, and maintaining the paired relationship.

Mode 3: M3 (Ble Tx). Bluetooth Low Energy radio transmitting consistently on a selected channel at 1 Mbps or 2 Mbps

Mode 4: M4 (Ble Lnk). Bluetooth Low Energy radio is paired to a companion device, transmitting and receiving data on various channels in accordance with the protocol, and maintaining the paired relationship.

Mode 5: M5 (ANT Tx). ANT radio transmitting consistently on a selected channel.

Mode 6: M6 (ANT Lnk). ANT radio is paired to a companion device, transmitting and receiving data in accordance with the protocol, and maintaining the paired relationship.

Mode 7: M7 (WiFi Tx). The IEEE 802.11 b/g/n radio was transmitting consistently on a selected channel, with a specified modulation type, and data rate.

Mode 8: M8 (WiFi Link). The IEEE 802.11 b/g/n radio is paired to a companion device, transmitting and receiving data on a selected channel in accordance with the protocol, and maintaining the paired relationship.

Mode 9: M9 (BtTx). The radio was set to receive 2.4 GHz signals but not transmit. In this situation, it was specifically looking for Bluetooth Classic signals which cover the 2.4 GHz band and represent a worst-case scenario.

Mode 10: M10 (RxWiFi). The IEEE 802.11 b/g/n radio was set to receive, but not transmit, on a selected channel, with a specified modulation type, and data rate.

Mode 12: M12 (NfcLnk). The NFC 13.56 MHz transceiver is in Card Emulation mode, and is actively linked to a companion NFC Reader.

Mode 13: M13 (GNSS). The Global Navigation Satellite System receiver is monitoring the GNSS bands, attempting to detect a constellation and determine location. Unless otherwise noted, the EUT was provided simulated GNSS signals representing one of more constellation types. In addition, the EUT may have been reporting signal levels and satellite data to an attached computer to monitor link health.

Mode 14: M14 (NfcIdle). The NFC 13.56 MHz transceiver is powered, but not actively linked to a companion device.

Mode 16: M12 (NfcTag). The NFC 13.56 MHz transceiver is in Card Reader mode, and is actively linked to a companion NFC Tag.

Mode 19: M19 (ML1). Multiple link, combining modes M4 & M6. The EUT is actively paired to both a BLE and an ANT companion device, used for Immunity tests.

Mode 20: M20 (ML2). Multiple link, combining modes M12 & M13. The EUT is actively linked to a NFC card reader and the specified satellite system, used for immunity tests.

## 5.4 EUT Arrangement

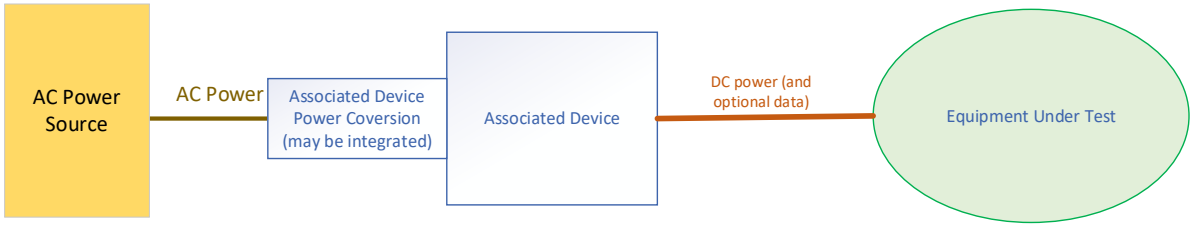
During test, the EUT components and associated support equipment were selected including the following arrangement sets.

Arrangement 1: A1 (Solo). The test sample operates from its battery and no external physical connections. No block diagram is needed for this arrangement.

Arrangement 2: A2 (Upwr). The test sample is attached to a Mains-powered device connected that provides dc power to the sample over a cable but no user data. See the block diagram in Figure 1.

Arrangement 3: A3 (Udata). The test sample is attached to a Mains-powered device connected that provides dc power to the sample and user data over a cable. See the block diagram in Figure 1.

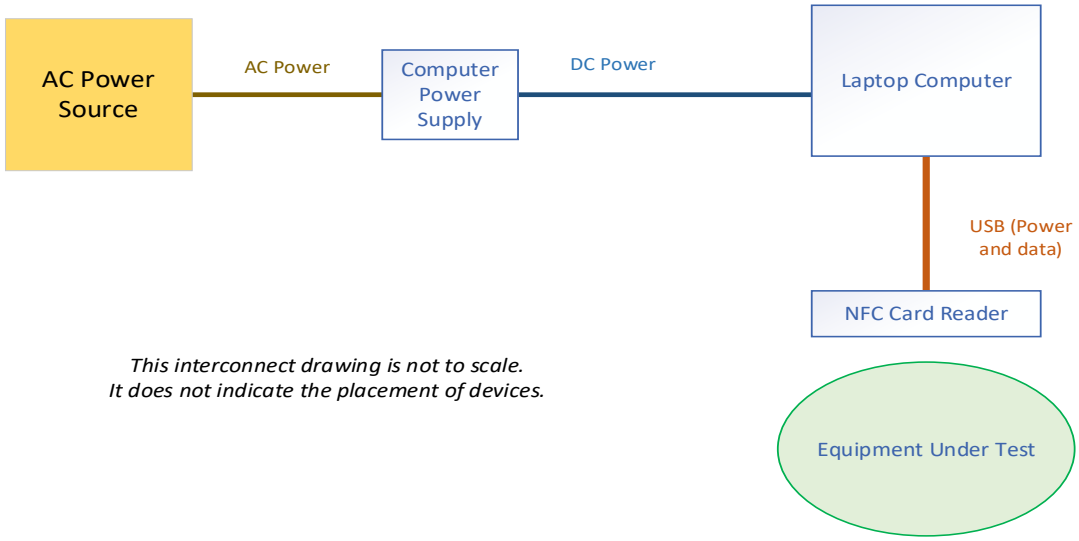
Arrangement 4: A4 (Udc). The test sample is attached to a Mains-powered device connected that provides dc power to the sample and may or may not provide user data. This arrangement is specified in the test plan to provide staff flexibility when the presence or absence of data on the cable is not pertinent. See the block diagram in Figure 1.




*This interconnect drawing is not to scale.*
*It does not indicate the placement of devices.*

**Figure 1: Block diagram of equipment arrangements A2, A3, A4**

Arrangement 6: A6 (NFCu). The test sample is powered via internal battery and actively linked to a NCR reader powered by a laptop PC.




*This interconnect drawing is not to scale.*
*It does not indicate the placement of devices.*

**Figure 2: Block diagram of equipment arrangement A6**

Arrangement 7: A7 (NFCu). The test sample is powered via internal battery and actively linked to a passive NFC tag.

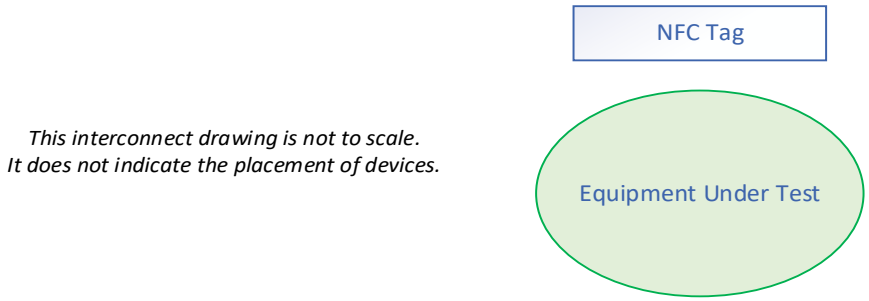



**Figure 2: Block diagram of equipment arrangement A7**

## 5.5 Associated Equipment (AE) used

| Description | Manufacturer | Model | Serial/Part Number |
|---|---|---|---|
| USB C power adaptor | Phihong (Garmin) | AQ27A-59CFA | 362-00118-00 |
| Tablet | Apple | iPad Pro 11 inch | DMPZ7582KD6L |
| Laptop | Dell | Latitude 5410 | 5VSPFB3 |
| Power Supply | Dell | HA65NM191 | 0BD-7TC0-A02 |
| Phone | Samsung | SM-G973U (S10) | RF8MC0W9XVR |
| NFC Card Reader | ACS | ACR1252U-M1 | RR554-118449 |
| NFC Tag | NXP | NTAG210µ | 04:11:CC:AA:8F:51:81 |
| Auxiliary Device | Garmin | A04999 | 3423419439 |
| Laptop | Dell | Inspiron | 7DCR5R3 |
| Wi-Fi Adaptor | Alpha network | AWUS036ACS | 21BP036AC8259 |
| Wi-Fi Adaptor | Alpha network | AWUS036ACS | 21BP036ACS2718 |
| BT Headphones | Garmin | DEZl Headset 200 | 16869214 |

**Table 2: List of associated equipment that may have been used during test**

## 5.6 Cables used

| Description | From | To | Length | EMC Treatment |
|---|---|---|---|---|
| USB C to custom cable | Power and/or Data source | EUT | 0.5m | None |

**Table 3: List of cables that may have been used during test**

## 6. Test Standards Applied

### 6.1. Accredited Standards

The following test or measurement standards were applied and are within the scope of the lab's accreditation. All results in this report that cite these standards are presented as Accredited results consistent with ISO/IEC 17025.

CFR 47, FCC Part 15, Subpart C
ANSI C63.10: 2020 and ANSI C63.10: 2020 +Cor 1: 2023
AS/NZS 4268: 2017
RSS-GEN Issue 5 Amd 2
RSS-247 Issue 3

### 6.2 Non-accredited Standards

The following test or measurement standards were applied and are either outside the scope of the lab's accreditation, or were performed in such a way that results are not presented as being fully accredited.

FCC Part 2.202
TRC-43 Issue 3

### 6.3 Variances

The following variances were applied to standards cited in this section.

Where different test standards cover the same test parameter or phenomenon, and the standards have compatible differences, the stricter of the requirements is typically applied. For example, a consolidated limit may be applied to emission tests selecting the strictest of the limits at each frequency. Likewise, if one standard requires a vertical antenna sweep with bore sighting and another does not, swept motion with bore sighting will typically be used as it is the more stringent requirement.

### 6.4 Laboratory Accreditation

The Garmin Compliance Lab, an organization within Garmin International, is registered with the US Federal Communication Commission as US1311. The lab is recognized by the Canada Department of Innovation, Science, and Economic Development (ISED) under CAB identifier US0233.

The Garmin Compliance Lab, an organization within Garmin International, is accredited by A2LA, Certificate No. 6162.01. The presence of the A2LA logo on the cover of this report indicates this is an accredited ISO/IEC 17025 test report. If the logo is absent, this report is not issued as an accredited report. Other marks and symbols adjacent to the A2LA logo are accreditation co-operations of which A2LA is a member under a mutual recognition agreement, and to which the Garmin Compliance Lab has been sublicensed.

## 7. Measurement Instrumentation Uncertainty

The lab has analyzed the sources of measurement instrumentation uncertainty. The analysis concludes that the actual measurement values cited in this report are accurate within the $U_{LAB}$ intervals shown below with approximately 95% statistical confidence. Where the report shows a judgment that a test sample passes a test against a published limit based on these measured values, that judgment has a statistical confidence of 97.5% or greater. Measurement Instrumentation Uncertainty is one component of over-all measurement uncertainty, and other uncertainty components are not considered as part of this analysis.

The primary benchmark for measurement instrumentation uncertainty (MIU) in an electromagnetic compatibility (EMC) test lab is the set of $U_{CISPR}$ values published in CISPR 16-4-2. In all cases where a $U_{CISPR}$ value is published by CISPR, the analysis shows that $U_{LAB}$ – this lab's estimated MIU – is better than the $U_{CISPR}$ benchmark.

The secondary benchmark for MIU in an EMC lab performing radio transceiver tests is a set of uncertainty limit values published in various ETSI standards. In this report, $U_{ETSI}$ is the most restrictive of the values found in the ETSI EN standards listed in section 5 of this report. The analysis principles are described in the ETSI TR documents listed there. In most cases $U_{LAB}$ is better than the $U_{ETSI}$ benchmark. Where $U_{LAB}$ exceeds the $U_{ETSI}$ benchmark cited here, that entry is preceded by an asterisk. When required by the ETSI EN standards, excess uncertainty will be added to the measurand before comparison to a limit. In an individual test report, staff may re-evaluate that excess uncertainty based on the uncertainty of the method used and the uncertainty limits of the actual ETSI EN standard being applied, and the revised uncertainty values will be shown in the test report.

Some measurement uncertainties analyzed and reported here are not addressed in CISPR 16-4-2 or the ETSI standards, as indicated by the entry 'None.'

| **Test Type** | | **$U_{LAB}$** | **$U_{CISPR}$** | **$U_{ETSI}$** |
|---|---|---|---|---|
| Conducted DC voltage | | 0.09% + 2 x LSDPV | None | 1% |
| Conducted AC voltage below 500 Hz | | 1.0% + 3 x LSDPV | None | 2% |
| Conducted Emissions, Mains Voltage | | 0.10% + 10 mV | None | None |
| Conducted Emissions, Mains Current | | 0.10% + 3 mA | None | None |
| Conducted Emissions, Mains Power | | 0.15% + 100 mW | None | None |
| Conducted Emissions, Power Mains, 9 kHz to 150 kHz | | 1.49 dB | 3.8 dB | None |
| Conducted Emissions, Power Mains, 150 kHz to 30 MHz | | 1.40 dB | 3.4 dB | None |
| Conducted Emissions, Cat 6 LCL, 150 kHz to 30 MHz | | 2.80dB | 5 dB | None |
| Conducted Emissions, Cat 5 LCL, 150 kHz to 30 MHz | | 3.21 dB | 5 dB | None |
| Conducted Emissions, Cat 3 LCL, 150 kHz to 30 MHz | | 4.24 dB | 5 dB | None |
| Radiated Emissions, below 30 MHz | | 0.88 dB | None | 6 dB |
| Radiated Emissions, 30 MHz to 1000 MHz | | 2.77 dB | 6.3 dB | 6 dB |
| Radiated Emissions, 1 GHz to 18 GHz | | 2.60 dB | 5.2 & 5.5 dB | 6 dB |
| Radiated Emissions, 18 GHz to 26.5 GHz | | 2.73 dB | None | 6 dB |
| *Radio Signal Frequency Accuracy | | *1.55 x 10^-7 | None | 1.0 x 10^-7 |
| Radio Signal Occupied Bandwidth | | 0.95% | None | 5% |
| Radio Power or Power Spectral Density | | 0.98 dB | None | 1 dB |
| Temperature | | 0.38 °C | None | 1 °C |
| Barometric Pressure | | 0.38 kPA | None | None |
| Relative Humidity | | 2.85% RH | None | ±5% RH |
| Signal Timing | The greater of these three... | 0.63 µsec<br>0.01% of value<br>0.5 x LSDPV | None | None |

***Note:*** *LSDPV stands for the Least Significant Digit Place Value reported. In the value 1470 msec, the least significant digit is the 7. It has a 10 msec place value. The LSDPV is thus 10 msec and the maximum error due to roundoff would be 5 msec. If the time value were reported as 147<u>0</u> msec, the underscore indicates that the 0 is a significant figure and the error due to roundoff would be 0.5 msec. All digits provided to the right of a decimal point radix are significant.*

## 8. Selected Example Calculations

Certain regulators require samples of the calculations that lead from the raw measurement to the final result for AC Mains conducted and unintended radiated emissions. The assumption is that the lab performs raw measurements, then adds, subtracts, multiplies, or divides based on transducer factors, amplifier gains, and losses in the signal transmission path. In this lab, our CISPR 16 Receiver does not work that way. The calibration factors and losses and gains are provided to the receiver as detailed data files. These factors are applied in the RF measurement path prior to the detector. But as a step in the lab measurement process, staff frequently verify that these factors are applied correctly. They make a measurement with the factors applied inside the receiver, then they disable the factors and remeasure the result manually adding in the various relevant factors.

The transmission loss is measured including the combined losses and gains of preamplifiers, cables, and any band-selective filters. In many cases above 1 GHz it is a negative value, indicating that the preamplifier gain is greater than these other losses.

Here are examples of these calculations. The data in these examples was not taken as part of this project:

### 8.1 AC Mains conducted emissions at 22 MHz

(Raw measurement) + (AMN factor) + (transmission loss) = Result

(7.145 dBµV) + (9.812 dB) + (0.216 dB) = 17.173 dBµV

### 8.2 Radiated Emissions at 630 MHz

(Raw measurement) + (Antenna factor) + (transmission loss) = Result

(2.25 dBµV) + (27.80 dB/m) + (2.89 dB) = 32.94 dBµV/m

### 8.3 Radiated Emissions at 2.7 GHz

(Raw measurement) + (Antenna factor) + (transmission loss) = Result

(43.72 dBµV) + (32.22 dB/m) + (-36.09 dB) = 39.85 dBµV/m

## 9. Environmental Conditions During Test

Environmental conditions in the test lab were monitored during the test period. Temperature and humidity are controlled by an air handling system. As information to the reader, the conditions were observed at the values or within the ranges noted below. For any tests where environmental conditions are critical to test results and require further constraints or details, the test records in the annex may provide more specific information.

| | |
|---|---|
| Temperature: | 19.7 to 20.9 °C |
| Relative Humidity: | 38.6% to 57.1% (non-condensing) |
| Barometric Pressure | 96.8 to 98.7 kPa |

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| Barometer | Traceable | 6453 | 240300703 | 9-Apr-2024 | 9-Apr-2027 |

**Table 4: Environmental monitoring device**

## 10. Immunity Performance Criteria

If this report includes immunity tests then results have been categorized as Performance Criteria A, B, C, or D. The standards that the lab applied will define the details for A, B, and C, as well as which criterion is required for each type of test. They will also define the electrical stresses that were applied during each test. In a very general sense the observed criteria noted in this report are as follows:

Criterion A. The stress applied did not alter product operation. This criterion is generally used for 'continuous' stresses that can be present for a long time in the places the product will be used, or that can appear often, even though they may come and go over time.

Criterion B. The stress applied altered product operation, but the product self-recovered so that the user would not have to try to figure out how to restore it to full operation. This criterion is generally used for 'transient' stresses that appear briefly and occasionally, but are usually not present in the places the product will be used.

Criterion C. The stress applied altered product operation, but the user could restore it to full operation, for example by power cycling the product. This criterion is generally used for 'transient' stresses that appear briefly and only rarely in the places the product will be used.

Criterion D. This is not an official criterion in the standards, because it would be a failure of the requirements. This indication in a test record means the product was affected in a way that the user might not be able to correct. The effect could include some degree of hardware damage, or it could include loss of program files or data files necessary for operation.

Repeatability is an issue in all EMC immunity work. When the product operation changes unexpectedly during a test, and the change would fail the requirements of the standard, this is an anomaly. The test operator needs to determine whether the anomaly was a result of the applied electrical stress. The investigation is done by repeating the section of the test where the anomaly occurred three times. If the same or a similar anomaly occurs in any of the three repeat trials, it is confirmed as a response to the stress. If not, the anomaly is judged unreproducible and is not considered when judging the A, B, or C observed performance. Since there is usually no ability to confirm a Criterion D anomaly, these are usually treated as Criterion D upon a single occurrence.

Tests that require Criterion B performance will be judged to Pass if criteria A or B is observed. Similarly, tests that require Criterion C performance will be judged to Pass if criteria A, B, or C is observed.

## 11. 3m RF Chamber Block Diagrams

The 3m chamber has three basic configurations which are shown in the figures below. These figures are not to scale.

Figure 1 shows a semi anechoic setup which is typically used for frequencies below 1 GHz. In this example, the antenna is mounted on a mast capable of 1-4 m elevation changes. If a preamplifier or RF filter is used, they are located at or just below floor level. The receiver is outside the chamber, typically in an adjacent separate shielded room.

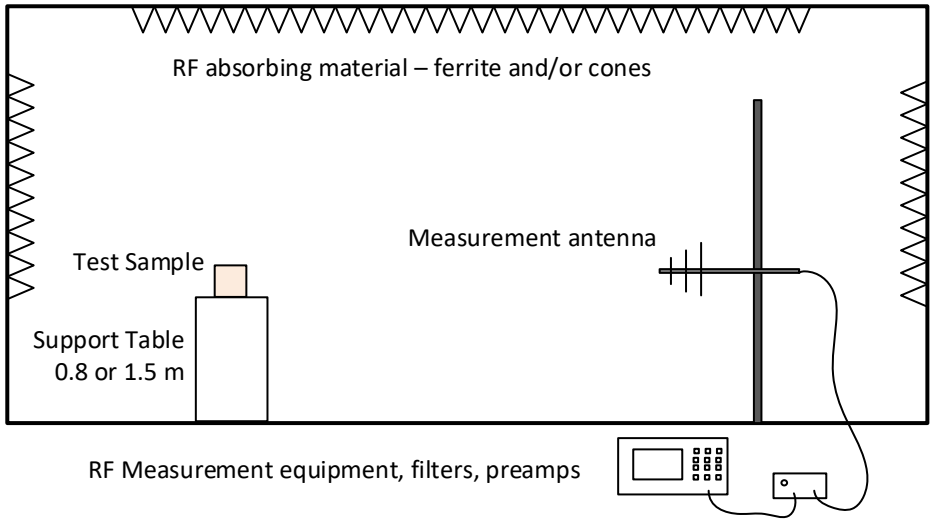



Figure 1: Typical configuration for measurements below 1 GHz

Figure 2 shows an FSOATS setup which is typically used for frequencies above 1 GHz but below an upper limit such as 14 or 18 GHz. In this example, the antenna is mounted on a mast capable of 1-4 m elevation changes and bore sighting. If a preamplifier or RF filter is used, they are located at or just below floor level. The receiver is outside the chamber, typically in an adjacent separate shielded room.

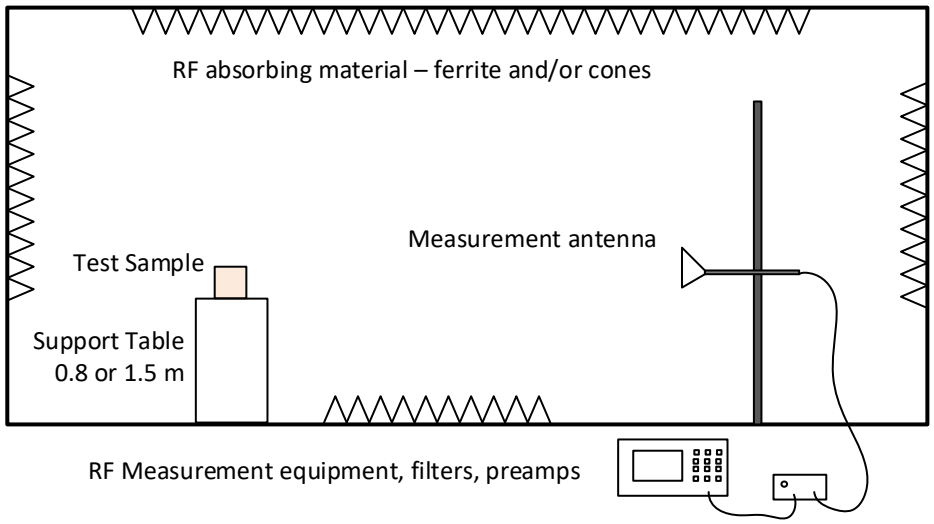



Figure 2: Typical configuration for measurements between 1 GHz and 14 GHz

Figure 3 shows an alternate FSOATS setup which is typically used for frequencies above 14 GHz. In this example, the antenna is mounted on a mast capable of 1-4 m elevation changes and bore sighting. A preamplifier is located on the mast just behind the antenna. The receiver is located in the chamber near floor level but outside the antenna beam. The receiver may be operated manually by an operator in the chamber and or remotely via an Ethernet connection.

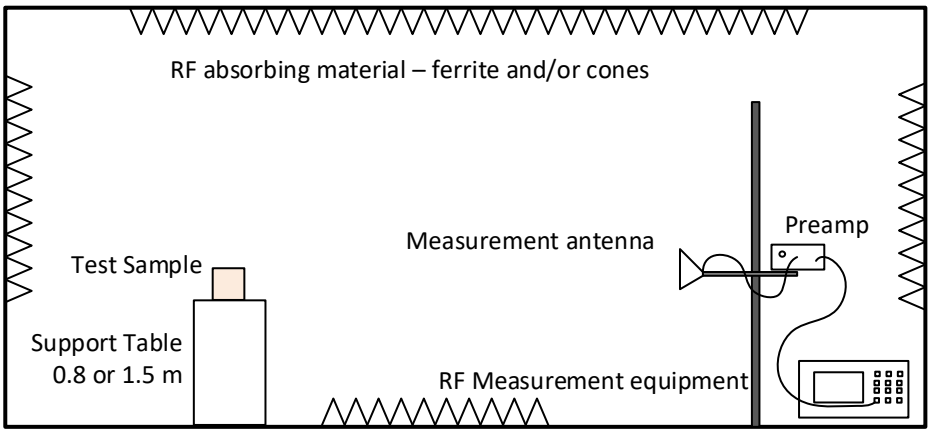



Figure 3: Typical configuration for measurements above 14 GHz

## ANNEX

The remainder of this report is an Annex containing individual test data records. These records are the basis for the judgments summarized in section 1 of this report. The Annex ends with a set of concluding notes regarding use of the report.

## Test Record
**Transmitter Bandwidth Tests**
**Test IDs TR05, TR06, TR07, TR08**
**Project GCL-0647**

| | |
|---|---|
| Test Date(s) | 05, 13 Sep 2024 |
| Test Personnel | Vladimir Tolstik supervised by Jim Solum, Jim Solum |
| Product Model | A04999 |
| Serial Number tested | 8ME000064 |
| Operating Mode | M1 (BtTx), M3 (BleTx), M5 (AntTx), M7 (WiFiTx) |
| Arrangement | A4 (Udc) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report). |
| Radio Protocol | Bluetooth Classic (Including EDR2 and EDR3), Bluetooth Low Energy (BLE), ANT, IEEE 802.11b/g/n |
| Radio Band | 2400 to 2483.5 MHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | **Vladimir Tolstik** |
| **Date of this record:** | **16 Sep 2024** |

Original record, Version A.

**Test Equipment Used**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| MXE Receiver 8.4 GHz | Keysight | N9038B | MY63460112 | 28-Feb-2024 | 1-Mar-2025 |

**Table TR05.1: List of test equipment used**

**Test Software Used:** Keysight PXE firmware A.37.02

**Test Method**

During this test the transmitter output is fed directly, or through RF attenuators, to the spectrum analyzer. The analyzer has a built-in capability to identify the minimum bandwidth that contains a specified portion of the total power observed, and also identify parameters such as the edge frequencies for that bandwidth and the center frequency error. The spectrum is scanned many times so that the varied effects of modulation are appropriately assessed. Since the focus is on the relative distribution of energy across a range of frequencies, the absolute amplitudes recorded during this test are not relevant and may not include cable losses or attenuation factors.

For BLE operating at 2 Mbps, the lowest operating frequency was 2404 MHz, and the highest operating frequency was 2478 MHz. For all other non-WiFi radios reported here, the lowest operating frequency was 2402 MHz, and the highest operating frequency was 2480 MHz.

**Test Setup**

This block diagram shows the test equipment setup.

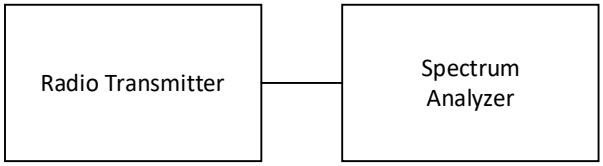



**Figure TR05.1: Test setup**

**Test Data**

The data for each test is summarized below, followed by the spectral data for each case highlighted in yellow.

The DTS Bandwidth is measured using a spectrum analyzer operating with a defined resolution bandwidth. The analysis finds the smallest continuous range of frequencies containing all emissions within 6 dB of the highest value. The requirement is that the DTS Bandwidth be greater than 500 kHz. As such the lowest measured bandwidth is worst case. All radios reported here are judged to have met this requirement.

| | 2402 (04) | 2440 | 2480 (78) |
|---|---|---|---|
| Bluetooth BR | **512.1** | **514.1** | **513.3** |
| Bluetooth EDR2 | **1074.0** | **1090.0** | **1075.0** |
| Bluetooth EDR3 | **1090.0** | **1036.0** | **1069.0** |
| BLE 1 Mbps | **760.9** | **766.8** | **766.7** |
| BLE 2 Mbps | **1132.0** | **1139.0** | **1128.0** |
| ANT | **513.4** | **513.2** | **512.5** |

**Table TR05.2: Summary of bandwidth data in kHz for Bluetooth, ANT and BLE modes**

| | Ch1 | Ch6 | Ch11 | Ch13 |
|---|---|---|---|---|
| B1 | 12.120 | 11.170 | 12.120 | 11.180 |
| B2 | NT | 11.440 | NT | NT |
| B5.5 | NT | 11.770 | NT | NT |
| B11 | NT | 11.580 | NT | NT |
| G6 | NT | 16.520 | NT | NT |
| G9 | NT | 16.530 | NT | NT |
| G12 | NT | 16.530 | NT | NT |
| G18 | NT | 16.530 | NT | NT |
| G24 | NT | 16.510 | NT | NT |
| G36 | NT | 16.560 | NT | NT |
| G48 | NT | 16.520 | NT | NT |
| G54 | 16.500 | 16.500 | 16.540 | 16.500 |
| NMCS0 | 17.780 | 17.730 | 17.750 | 17.760 |
| NMCS1 | NT | 17.780 | NT | NT |
| NMCS2 | NT | 17.790 | NT | NT |
| NMCS3 | NT | 17.800 | NT | NT |
| NMCS4 | NT | 17.770 | NT | NT |
| NMCS5 | NT | 17.770 | NT | NT |
| NMCS6 | NT | 17.750 | NT | NT |
| NMCS7 | NT | 17.760 | NT | NT |

**Table TR05.3: Summary of bandwidth data in MHz for IEEE 802.11 WiFi modes**

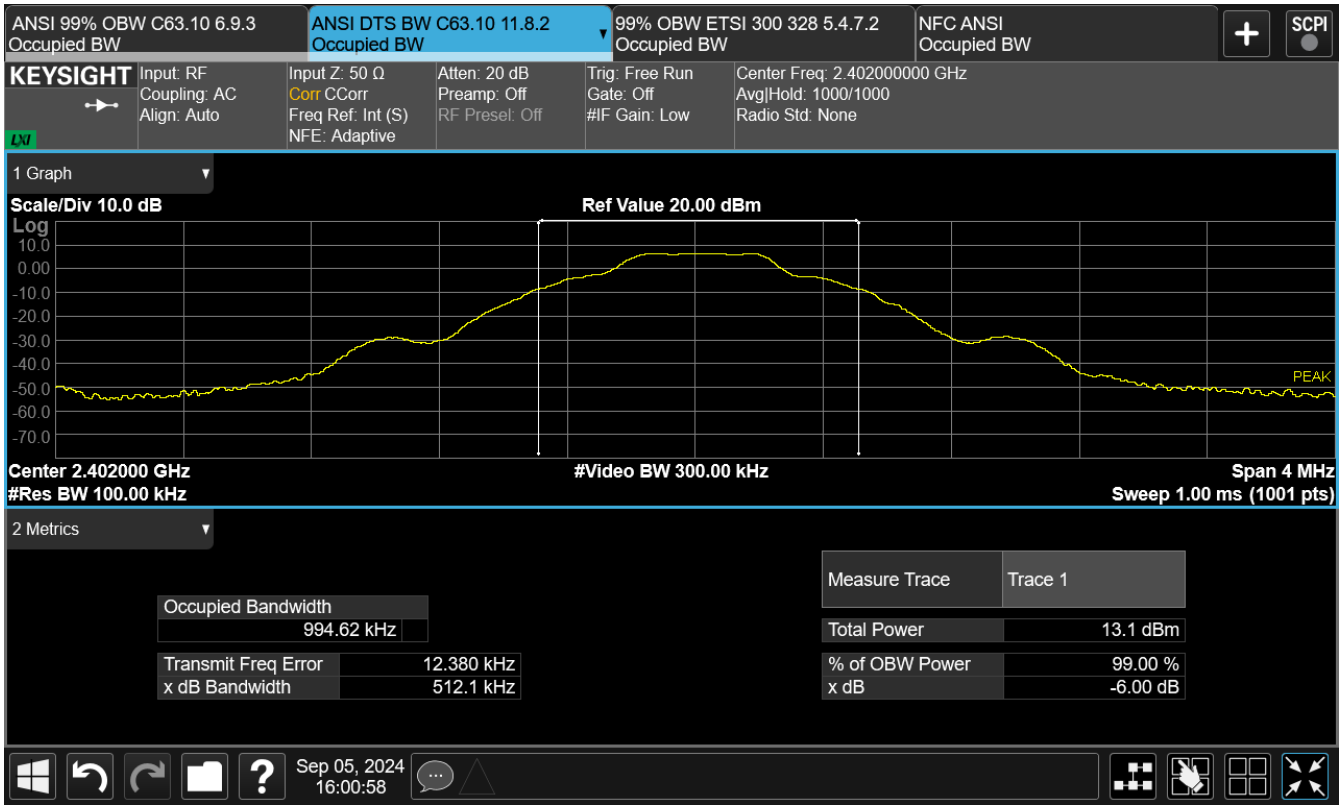



**Figure TR05.2: Bandwidth data for Bluetooth BR at channel 2402 MHz**

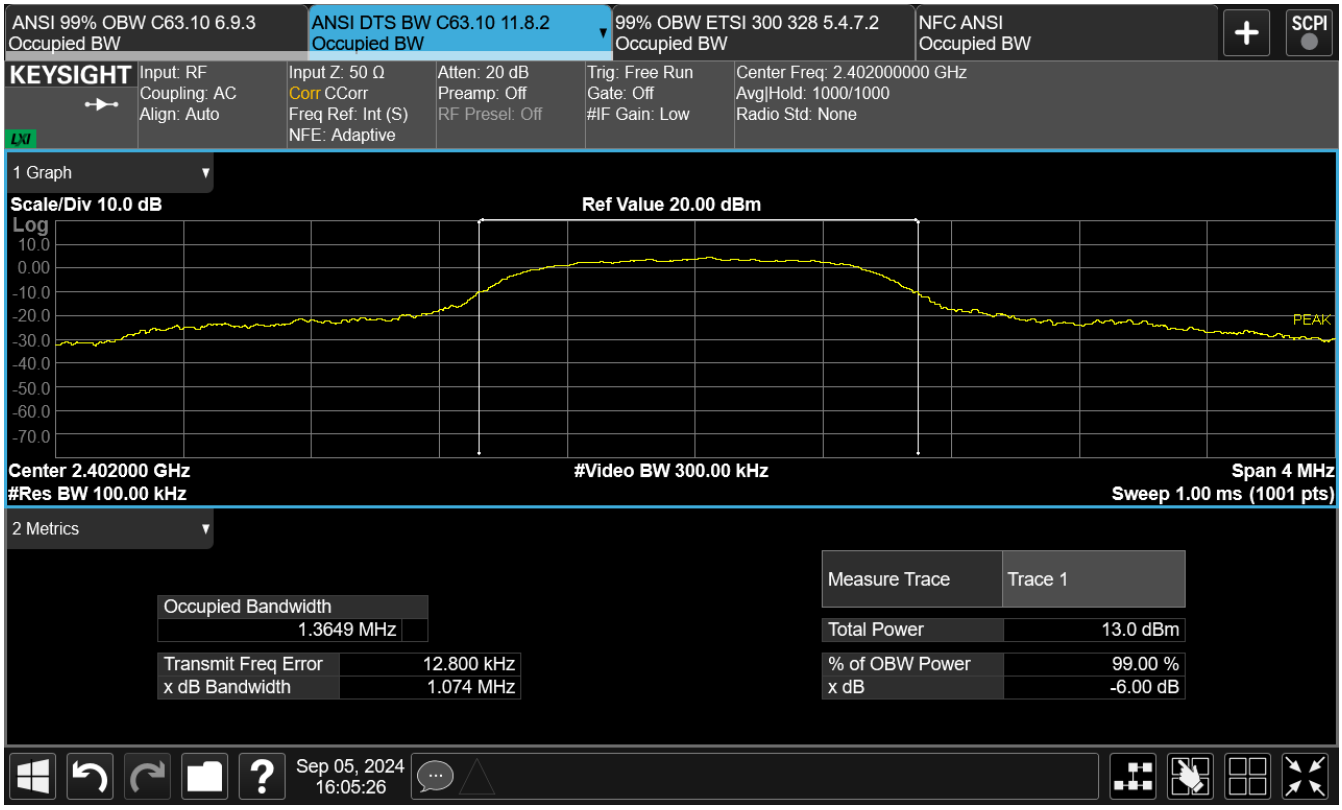



**Figure TR05.3: Bandwidth data for Bluetooth EDR2 at channel 2402 MHz**

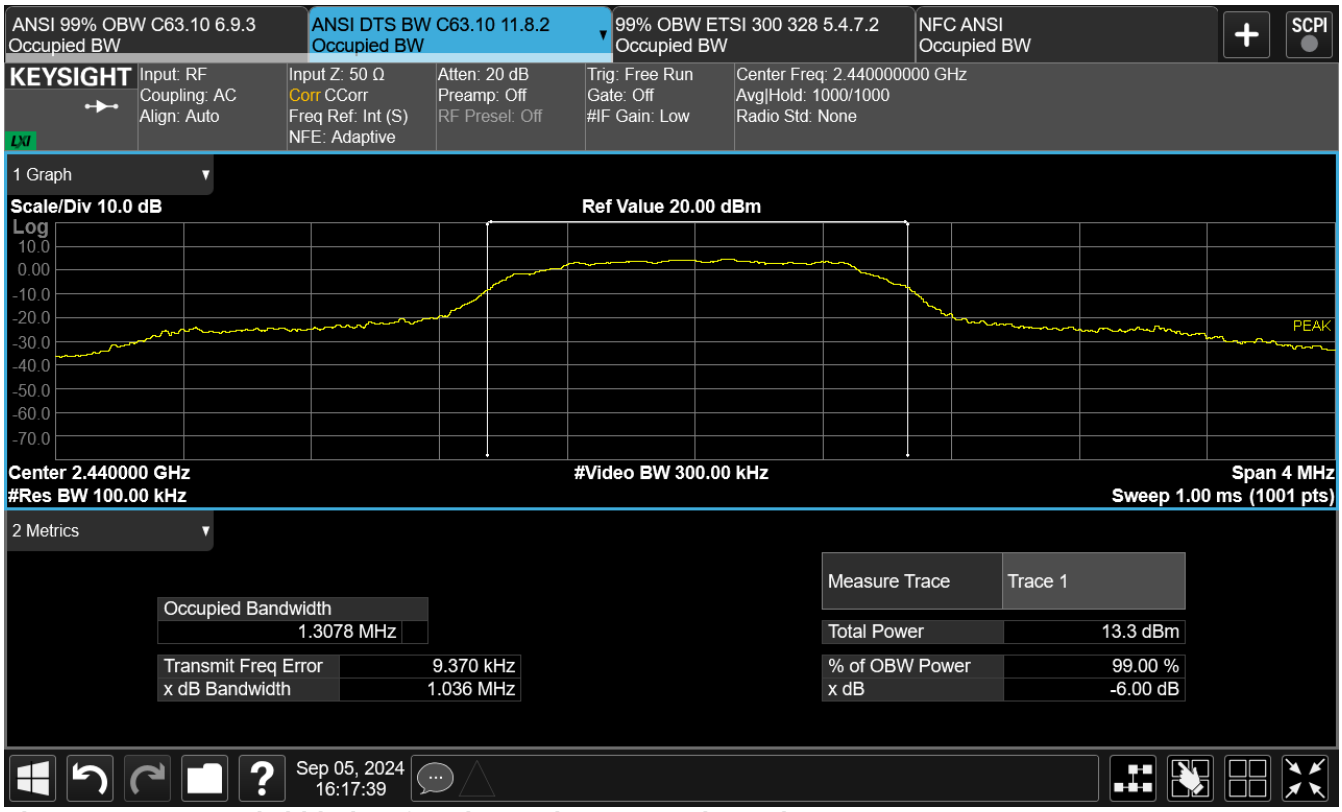



**Figure TR05.4: Bandwidth data for Bluetooth EDR3 at channel 2440 MHz**

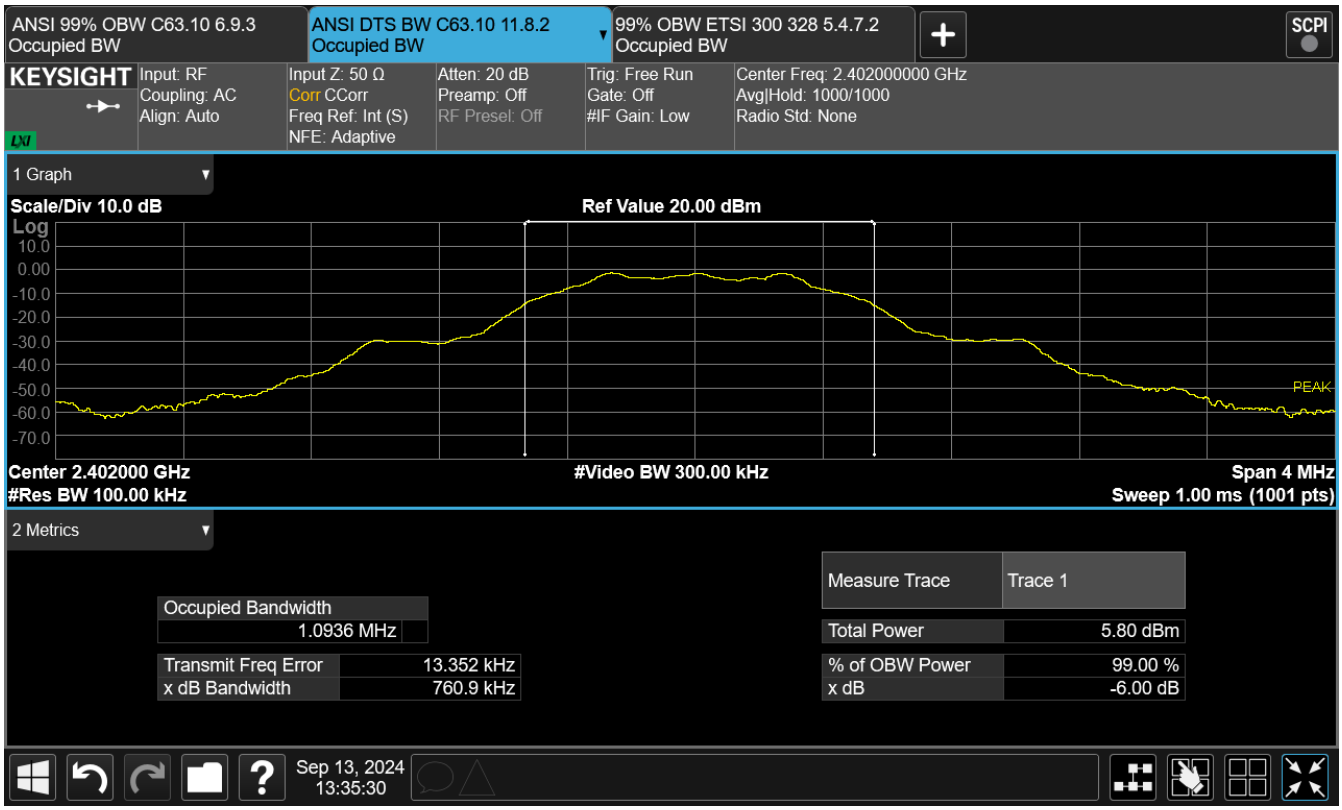



**Figure TR05.5: Bandwidth data for BLE1 at channel 2402 MHz**

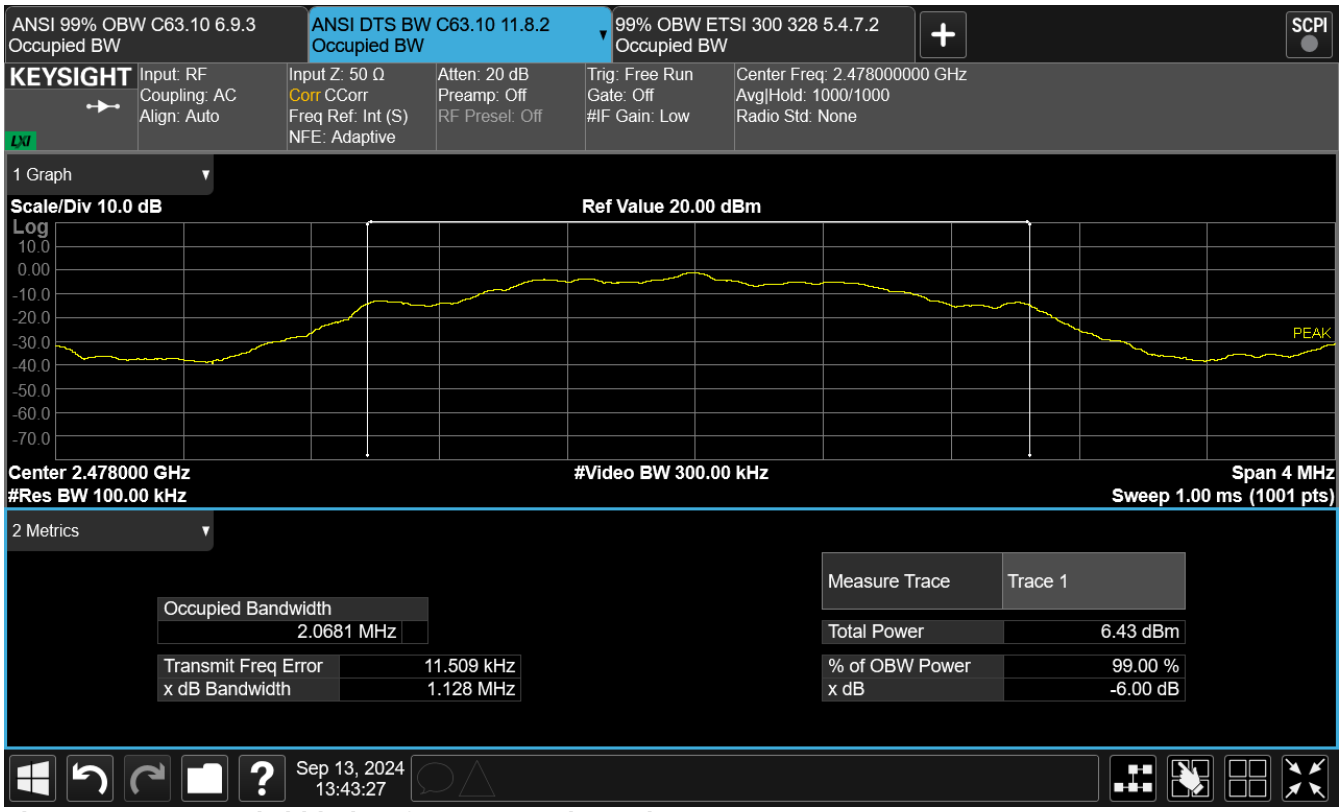



**Figure TR05.6: Bandwidth data for BLE2 at channel 2478 MHz**

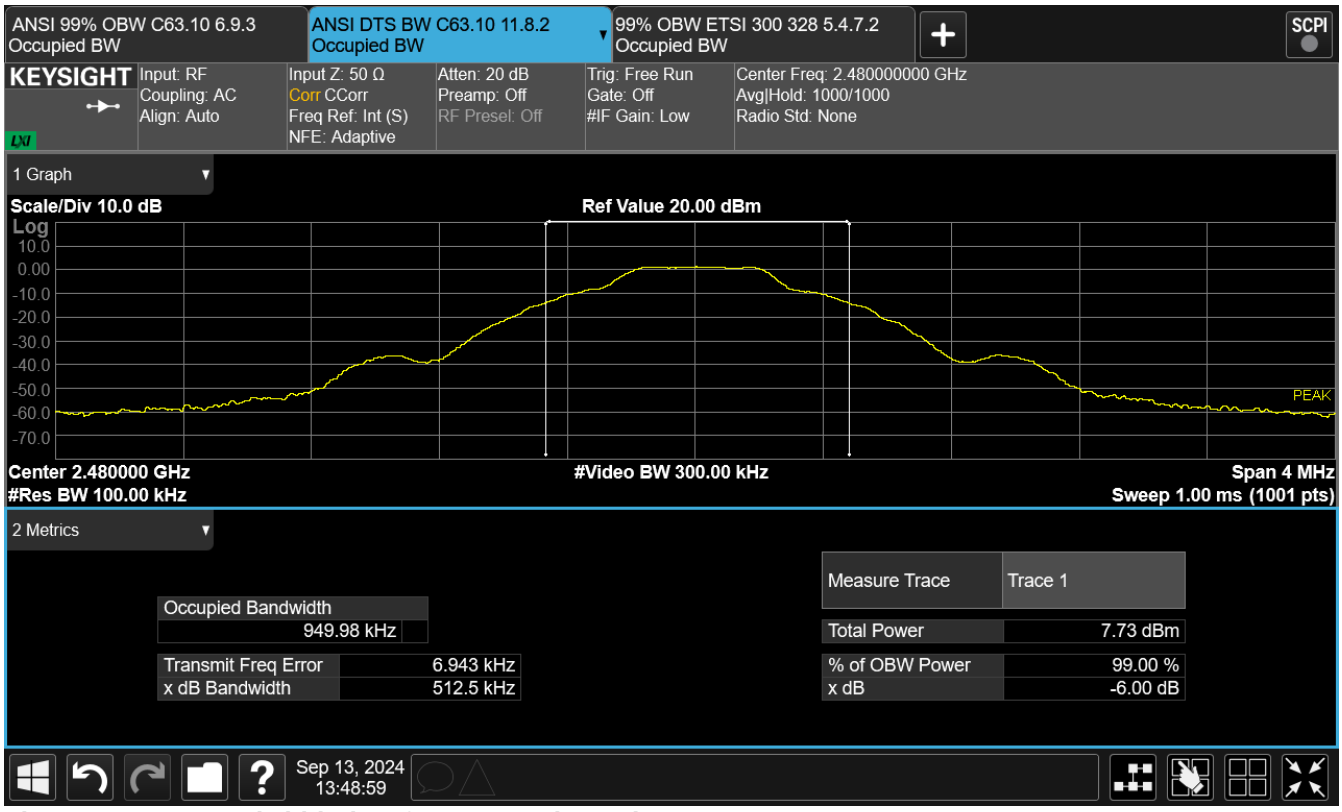



**Figure TR05.7: Bandwidth data for ANT at channel 2480 MHz**

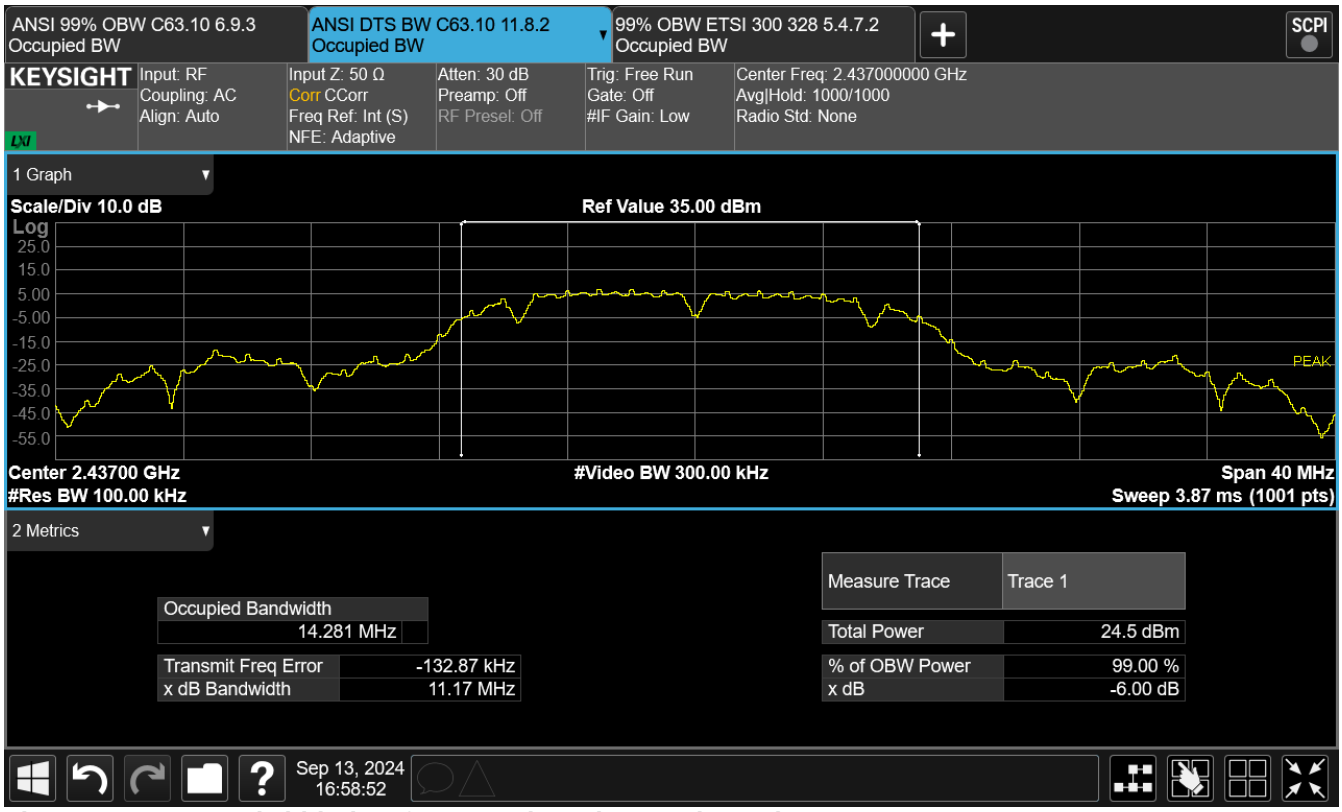



**Figure TR05.8: Bandwidth data for 802.11b 1 Mbps at channel 6**

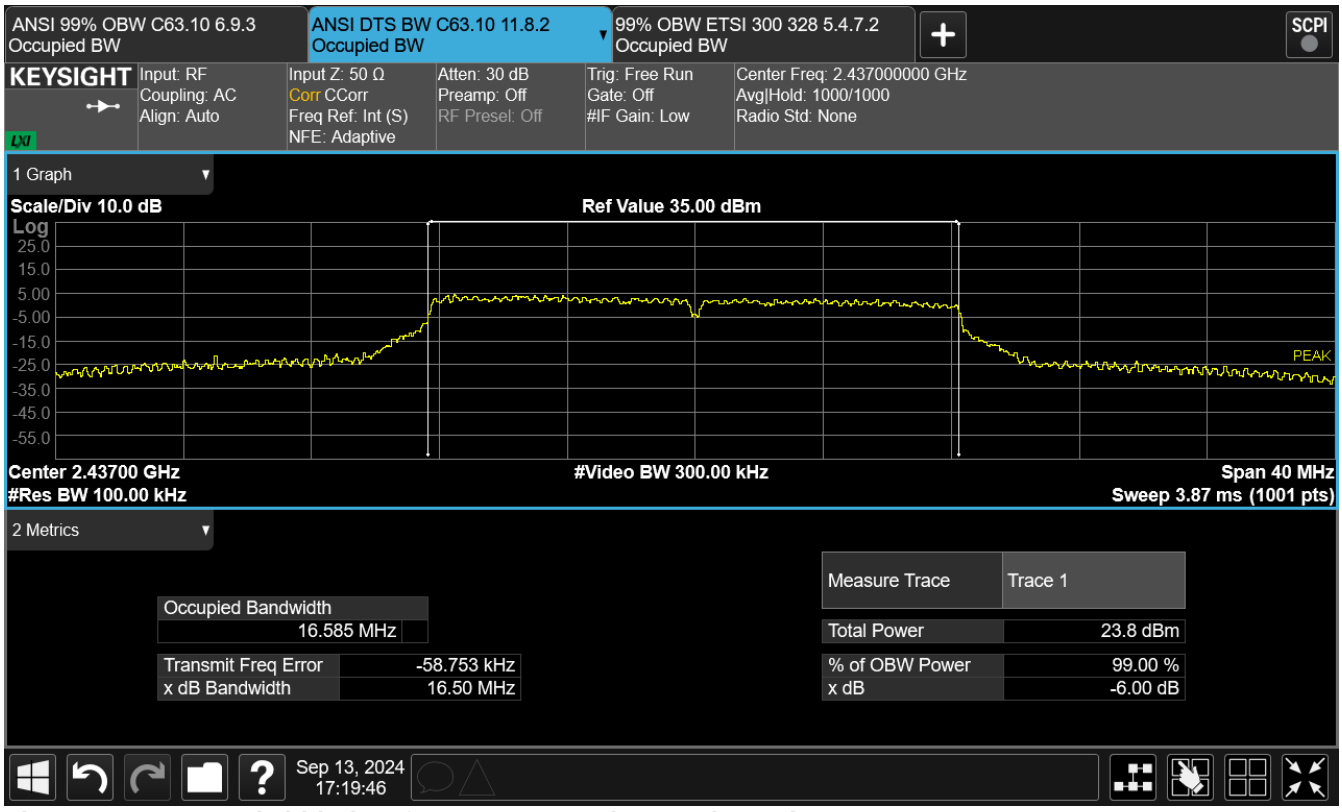



**Figure TR05.9: Bandwidth data for 802.11g 54 Mbps at channel 6**

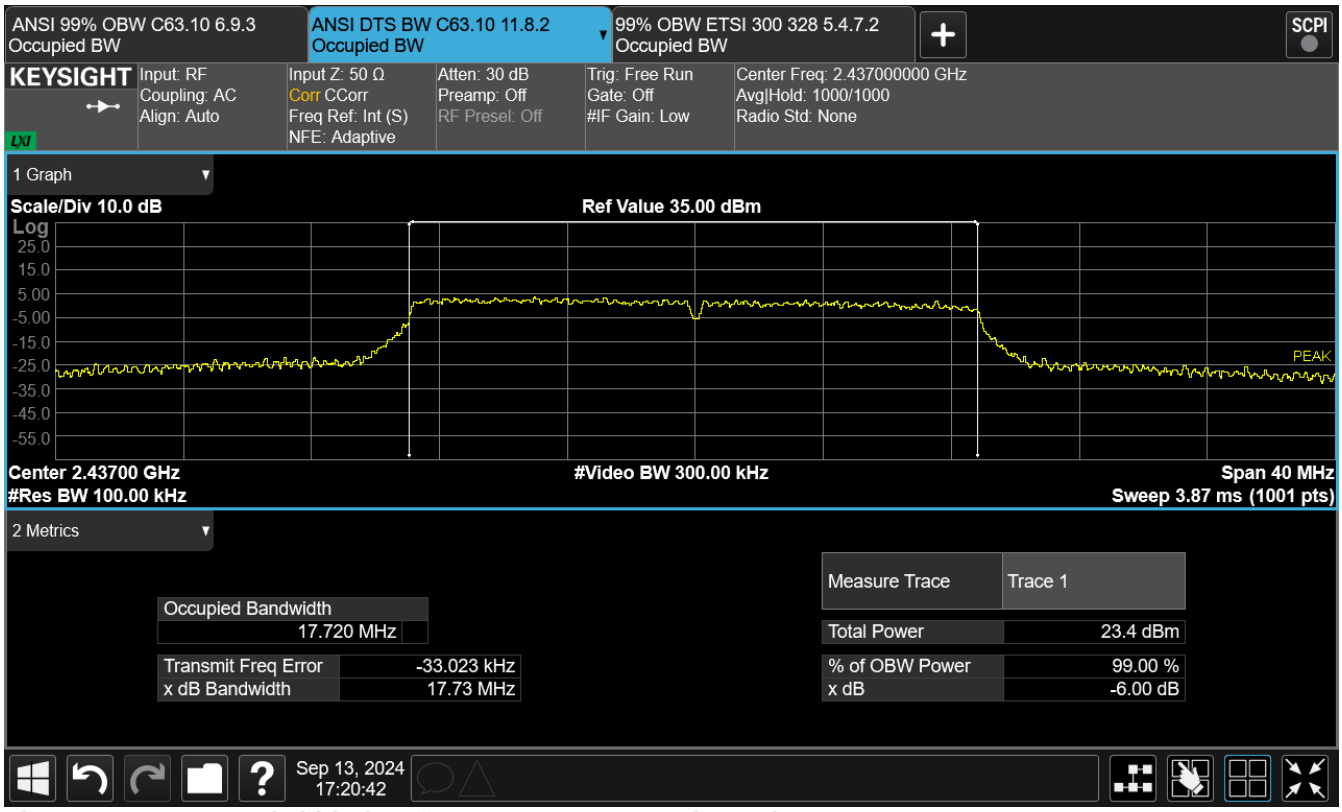



**Figure TR05.10: Bandwidth data for 802.11n MCS0 at channel 6**

**This line is the end of the test record.**

## Test Record
**Transmitter Bandwidth Tests**
**Test IDs TR09 – TR12**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 23 Sep 2024 |
| Test Personnel | Aditya Prakash |
| Product Model | A04999 |
| Serial Number tested | 8ME000064 |
| Operating Mode | M1 (BtTx), M3 (BleTx), M5 (AntTx), M7 (WiFiTx) |
| Arrangement | A4 (Udc) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 2.202, ANSI C63.10, TRC-43, RSS-GEN (as noted in Section 6 of the report). |
| Radio Protocol | Bluetooth Classic (Including EDR2 and EDR3), Bluetooth Low Energy (BLE), ANT, IEEE 802.11 b/g/n (WiFi) |
| Radio Band | 2400 to 2483.5 MHz |
| **Pass/Fail Judgment:** | **Reported** |
| **Test record created by:** | Aditya Prakash |
| **Date of this record:** | 23 Sep 2024 |

Original record, Version A.

**Test Equipment Used**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 44GHz | Keysight | N9048B | MY62220139 | 13-Mar-2024 | 15-Mar-2025 |

**Table TR09.1 Equipment Used**

**Software used:** Keysight PXE software A.37.02

**Background**
There are regulatory requirements to present two additional types of bandwidth analyses: 99% Occupied Bandwidth and Necessary Bandwidth. There are no limits or functional requirements around these data, beyond a reporting requirement. The contents of this test record are for information, and do not affect compliance of the devices that are the subject of this report.

For BLE operating at 2 Mbps, the lowest operating frequency was 2404 MHz, and the highest operating frequency was 2478 MHz. For all other Bluetooth, BLE, and ANT radios reported here, the lowest operating frequency was 2402 MHz, and the highest operating frequency was 2480 MHz.

**Test Setup**

This block diagram shows the test equipment setup.

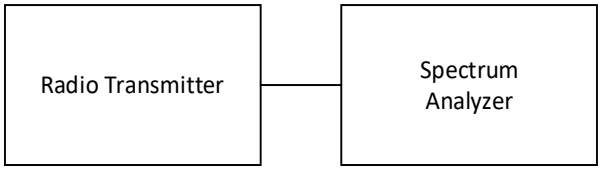



**Figure TR09.1: Test setup**

**Occupied Bandwidth, 99% Test Method**

During this test the transmitter output is fed directly, or through RF attenuators, to the spectrum analyzer. The analyzer has a built-in capability to identify the minimum bandwidth that contains a specified percentage of the total power observed. The spectrum is scanned hundreds of times so that the varied effects of modulation are appropriately assessed. Since the focus is on the relative distribution of energy across a range of frequencies, the absolute amplitudes recorded during this test are not relevant and may not include cable losses or attenuation factors.

**Occupied Bandwith, 99% Test Data**

The data for each type of bandwidth is summarized below, followed by the spectral data for the cases highlighted in yellow. The analysis threshold for this test was the bandwidth containing 99% of the observed power using the ANSI C63.10 method. The standards require testing a frequency near the bottom, middle, and top of the band. The measured bandwidth data are in bold font and have MHz as their units of measure.

| | 2402 (04) | 2440 | 2480 (78) |
|---|---|---|---|
| Bluetooth BR | **949.89** | **971.05** | **938.92** |
| Bluetooth EDR2 | **1279.50** | **1314.60** | **1279.20** |
| Bluetooth EDR3 | **1343.90** | **1294.20** | **1287.70** |
| BLE 1 Mbps | **1068.10** | **1071.10** | **1066.30** |
| BLE 2 Mbps | **2052.70** | **2050.10** | **2049.70** |
| ANT | **927.21** | **926.54** | **898.50** |

**Table TR09.2: Summary of 99% Occupied Bandwidth Data (in kHz) for Bluetooth, ANT and BLE modes**

| | Ch1 | Ch6 | Ch11 | Ch13 |
|---|---|---|---|---|
| B1 | 14.254 | 14.468 | 14.202 | 14.192 |
| B2 | | 14.375 | | |
| B5.5 | | 13.953 | | |
| B11 | | 14.074 | | |
| G6 | | 18.995 | | |
| G9 | 18.548 | 19.018 | 18.351 | 18.463 |
| G12 | | 17.973 | | |
| G18 | | 17.913 | | |
| G24 | | 17.861 | | |
| G36 | | 17.872 | | |
| G48 | | 17.847 | | |
| G54 | | 17.857 | | |
| NMCS0 | | 18.491 | | |
| NMCS1 | | 18.522 | | |
| NMCS2 | | 18.537 | | |
| NMCS3 | | 18.526 | | |
| NMCS4 | | 18.534 | | |
| NMCS5 | | 18.541 | | |
| NMCS6 | 18.932 | 19.768 | 18.835 | 18.888 |
| NMCS7 | | 18.482 | | |

**Table TR09.3: Summary of 99% Occupied Bandwidth Data (in MHz) for IEEE 802.11 WiFi modes**


**Figure TR09.1: Occupied bandwidth data for Bluetooth Classic EDR3 at low channel (2402 MHz)**

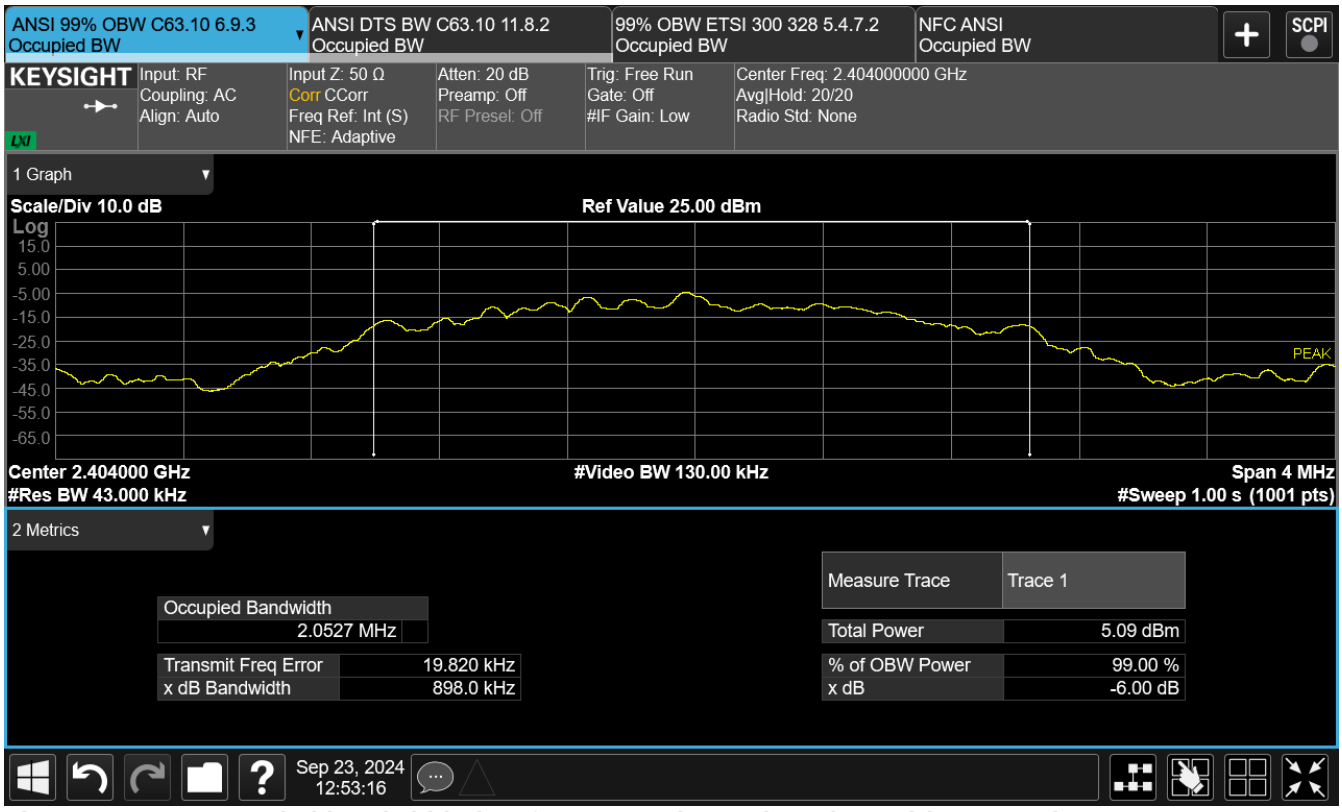



**Figure TR09.2: Occupied bandwidth data for BLE 2 Mbps at low channel (2404 MHz)**


**Figure TR09.3: Occupied bandwidth data for ANT at low channel (2402 MHz)**


**Figure TR09.4: Occupied bandwidth data for 802.11b 1 Mbps at channel 6**


**Figure TR09.5: Occupied bandwidth data for 802.11g 9 Mbps at channel 6**

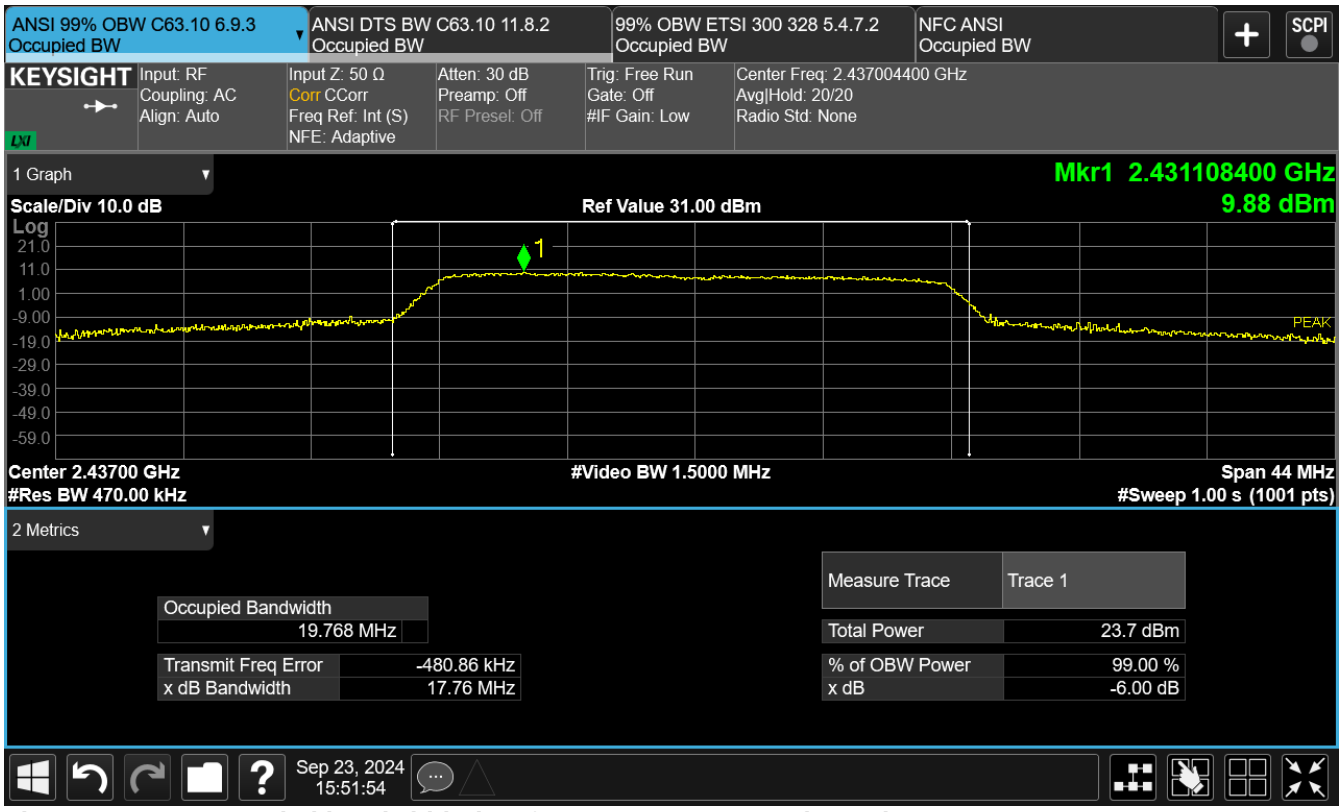



**Figure TR09.6: Occupied bandwidth data for 802.11n MCS6 at channel 6**

**Necessary Bandwidth Calculations**

The Necessary Bandwidth is a theoretical value based on the specifications for a communication protocol, rather than the hardware implementation and a subsequent lab measurement. The analysis methods in FCC Part 2.202 and TRC-43 are the same for NFC, Bluetooth, ANT, and IEEE 802.11b WiFi. However, they differ for IEEE 802.11g and 11n systems because the Canadian TRC-43 standard provides different analysis methods for Orthogonal Frequency Division Multiplexing systems (OFDM). The tables below will show the analysis for most of the radios signals as a combined approach, then separately analyze the results for IEEE 802.11g and n systems. The tables below may include radio protocols that are not part of the product being evaluated.

NFC (Near Field Communication) at 13.56 MHz uses continuous wave telegraphy without tone modulation. The bit rate 'B' in the FCC and TRC equations is split into two parts here. B is the baud rate. C is a coding factor. C=1 for Miller encoding where the transition speed is as high as the bit rate, or C=2 for Manchester encoding where the transition speed is as high as twice the bit rate). K is a factor set to 3 for non-fading circuits under the standards. The Necessary Bandwidth, $B_N$ is then:

$B_N = BCK$

| Radio Type | B (kbaud) | C | K | $B_N$ (kHz) |
|---|---|---|---|---|
| NFC A | 106 | 1 | 3 | 318.0 |
| NFC B | 212 | 2 | 3 | 1272.0 |
| NFC B | 424 | 2 | 3 | 2544.0 |

Table TR09.100: Necessary Bandwidth for NFC

The radio modulation schemes for Ant, for the various Bluetooth protocols, and for IEEE 802.11 b WiFi are a mix of Phase Shift Key (PSK) and Quadrature Amplitude Modulation (QAM) techniques. The Necessary Bandwidth calculations use the equations from 47CFR Part 2.202(g) table section 6. We have set the variable K=1, which leaves the equation for both PSK and QAM as:

$B_N = 2R / Log_2(S)$

where $B_N$ is the Necessary Bandwidth, R is the bit rate, and S is the number of signaling states.

| Radio Type | R Mbps | K | S | LogBase2 of (S) | $B_N$ (MHz) |
|---|---|---|---|---|---|
| ANT / ANT+ | 1 | 1 | 2 | 1 | 2 |

Table TR09.101: Necessary Bandwidth for ANT and ANT+ Radio Protocols (FCC and TRC-43)

| Radio Type | Sub-type | Method | R Mbps | K | S | LogBase2 of (S) | $B_N$ (MHz) |
|---|---|---|---|---|---|---|---|
| Bluetooth | BR | GFSK | 1 | 1 | 2 | 1 | 2 |
| | EDR2 | Pi/4 DPSK | 2 | 1 | 4 | 2 | 2 |
| | EDR3 | 8DPSK | 3 | 1 | 8 | 3 | 2 |
| BLE | 1Mbps | GFSK | 1 | 1 | 2 | 1 | 2 |
| | 2Mbps | DQPSK | 2 | 1 | 4 | 2 | 2 |

Table TR09.102: Necessary Bandwidth for Bluetooth Radio Protocols (FCC and TRC-43)

| Radio Type | Sub-type | R Mbps | K | S | LogBase2 of (S) | $B_N$ (MHz) |
|---|---|---|---|---|---|---|
| 802.11 b | 1 | 1 | 1 | 2 | 1 | 2 |
| | 2 | 2 | 1 | 4 | 2 | 2 |
| | 5.5 | 5.5 | 1 | 4 | 2 | 5.5 |
| | 11 | 11 | 1 | 4 | 2 | 11 |

Table TR09.103: Necessary Bandwidth for IEEE 802.11 b Radio Protocol (FCC and TRC-43)

| Radio Type | Sub-type | R Mbps | K | S | LogBase2 of (S) | $B_N$ (MHz) |
|---|---|---|---|---|---|---|
| 802.11 a/g | 6 | 6 | 1 | 2 | 1 | 12 |
| | 9 | 9 | 1 | 2 | 1 | 18 |
| | 12 | 12 | 1 | 4 | 2 | 12 |
| | 18 | 18 | 1 | 4 | 2 | 18 |
| | 24 | 24 | 1 | 16 | 4 | 12 |
| | 36 | 36 | 1 | 16 | 4 | 18 |
| | 48 | 48 | 1 | 64 | 6 | 16 |
| | 54 | 54 | 1 | 64 | 6 | 18 |
| 802.11 n/ac | MCS0 | 7.2 | 1 | 2 | 1 | 14.4 |
| | MCS1 | 14.4 | 1 | 4 | 2 | 14.4 |
| | MCS2 | 21.7 | 1 | 4 | 2 | 21.7 |
| | MCS3 | 28.9 | 1 | 16 | 4 | 14.5 |
| | MCS4 | 43.3 | 1 | 16 | 4 | 21.7 |
| | MCS5 | 57.8 | 1 | 64 | 6 | 19.3 |
| | MCS6 | 65 | 1 | 64 | 6 | 21.7 |
| | MCS7 | 72.2 | 1 | 64 | 6 | 24.1 |
| | MCS8 | 86.7 | 1 | 256 | 8 | 21.7 |

Table TR09.104: Necessary Bandwidth for IEEE 802.11 a, g, n, and ac 20 MHz Radio Protocols (FCC)

| Radio Type | Sub-type | R Mbps | K | S | LogBase2 of (S) | $B_N$ (MHz) |
|---|---|---|---|---|---|---|
| 802.11 n/ac | MCS0 | 15 | 1 | 2 | 1 | 30.0 |
| | MCS1 | 30 | 1 | 4 | 2 | 30.0 |
| | MCS2 | 45 | 1 | 4 | 2 | 45.0 |
| | MCS3 | 60 | 1 | 16 | 4 | 30.0 |
| | MCS4 | 90 | 1 | 16 | 4 | 45.0 |
| | MCS5 | 120 | 1 | 64 | 6 | 40.0 |
| | MCS6 | 135 | 1 | 64 | 6 | 45.0 |
| | MCS7 | 150 | 1 | 64 | 6 | 50.0 |
| | MCS8 | 180 | 1 | 256 | 8 | 45.0 |
| | MCS9 | 200 | 1 | 256 | 8 | 50.0 |

Table TR09.105: Necessary Bandwidth for IEEE 802.11 n and ac 40 MHz Radio Protocols (FCC)

As a note, the bit rate for IEEE 802.11 n or ac WiFi is calculated based on the IEEE standard's short guard interval of 400 nsec. If only the long guard interval of 800 nsec were implemented, the bit rates would decrease by a small amount.

The TRC-43 method for OFDM signals simply multiplies the number of subcarriers, K, and the subcarrier spacing, $N_S$. In both cases, Ns is 312.5 kHz. The count of subcarriers includes nulls. So for example, 802.11 n uses 4 pilot subcarriers, 52 data subcarriers, and one null suppressed subcarrier in the middle for 57 total subcarrier channels.

$$B_N = N_S * K$$

| Radio Type | Mode | Ns (MHz) | K | $B_N$ (MHz) |
|---|---|---|---|---|
| 802.11a/g | 20 MHz | 0.3125 | 53 | 16.6 |
| 802.11n/ac | 20 MHz | 0.3125 | 57 | 17.8 |
| 802.11n/ac | 40 MHz | 0.3125 | 117 | 36.6 |

Table TR09.106: Necessary Bandwidth for IEEE 802.11 a, g, n, and ac Radio Protocols (TRC-43)

**This line is the end of the test record.**

## Test Record
**Transmitter Power, Duty Cycle**
**Test IDs TR01, TR02, TR03**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 04, 19, 20 Sep 2024 |
| Test Personnel | Vladimir Tolstik supervised by Jim Solum and Majid Farah |
| Product Model | A04999 |
| Serial Number | 8ME000064 |
| Operating Mode | M1 (BtTx), M3 (BleTx), M5 (AntTx) |
| Arrangement | A4 (Udc) |
| Input Power | USB 5Vdc |
| Test Standards: | FCC Part 15, ANSI C63.10, ETSI EN 300 328, RSS-GEN, RSS-247 (as noted in Section 6 of the report). |
| Antenna Gain | -0.35 dBi, as reported by the client |
| Radio Protocol | Bluetooth, Bluetooth Low Energy, ANT |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | Vladimir Tolstik, Jim Solum |
| **Date of this record:** | 01 Nov 2024 |

Version B. Separated ANSI and ETSI WiFi data into separate test records. Original record, Version A dated 03 Oct 2024

**Test Equipment Used**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| RF Power Sensor | Rohde&Schwarz | NRP8S | 109124 | 18-Jul-2023 | 15-Jul-2025 |
| Thermometer | Thermco | ACCD370P | 210607316 | 21-Sep-2023 | 15-Sep-2025 |
| Thermal Chamber | Tenney | T2RC | 32774-02 | Calibration | Not Required |

Table TR01.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3; TimePowerAnalysisSpreadsheetV12a.xls

**Test Method**
The basic test standards provide options for the time evaluation test method. The following test methods were applied.

| | |
|---|---|
| ETSI EN 300 328: | 5.4.2.2.1.3 |
| ANSI C63.10: | 11.9.2.3.2 (Gated average power with broadband power meter) |

Under the ETSI standard, the parameters of duty cycle, transmitter timing, or medium utilization are typically not required for adaptive transceivers or transceivers emitting at 10 dBm EIRP or less, so those results will typically be omitted from the data set. Duty Cycle data will be included if it is relevant to test methods used for other standards such as Average Detector methods in the ANSI standards that apply duty cycle correction or certain kinds of analysis under the RF exposure standards.

**Transmit Power and Timing Data**
Each measurement is made conducted from the antenna port with the transmitter on a specified channel and in a selected transmission protocol. Where standards cited here apply harmonized test methods and different limits, the more strict limit has applied.

This test record will show results based on one or more of the following methods of analyzing the same set of raw power data vs. time. The ANSI peak power method looks for the highest power in the data record, with results in dBm units. The ANSI gated average power method determines the average power in the data record but only during times when the transmitter is keyed on, with results in dBm units. Under the US and Canadian rules a limit of 30 dBm is applied independent of which ANSI method is used. The ETSI 300 328 method looks at the individual transmission bursts within the data record and reports the power level from the burst with the for the highest average power. The ETSI result is presented in dBm EIRP units, and a 20 dBm EIRP limit is applied. The RF exposure analysis asks for the average power observed over the entire data record time, with results in linear power units such as milliwatts. RF exposure limits are not addressed in this test record. Many of the these standards also care about duty cycle, the portion of the time when the transmitter was actually transmitting. That is presented as a percentage, and no limit applies. All of these results are drawn from the same trace of Tx power data. The results are shown below.

ANSI Power

| Frequency | (MHz) | 2402 | 2404 | 2440 | 2478 | 2480 |
|---|---|---|---|---|---|---|
| Bluetooth | Basic | **7.34** | **NT** | **7.39** | **NT** | **7.96** |
| Bluetooth | EDR2 | **6.38** | **NT** | **6.49** | **NT** | **7.88** |
| Bluetooth | EDR3 | **6.37** | **NT** | **6.76** | **NT** | **7.86** |
| BT Low Energy | 1 Mbps | **-0.49** | **NT** | **-0.43** | **NT** | **-0.57** |
| BT Low Energy | 2 Mbps | **NT** | **-0.94** | **-0.88** | **-0.98** | **NT** |
| ANT | ---- | **1.65** | **NT** | **1.60** | **NT** | **1.74** |

Table TR01.2: Transmit Power, ANSI method, in dBm

The following figure shows the gate settings used for the BT Low Energy test case highlighted in yellow. Gate setting diagrams may not be included for radio modes where the duty cycle reported in Table TR01.6 below is greater than 98%, since ANSI C63.10 treats these as continuous transmissions.

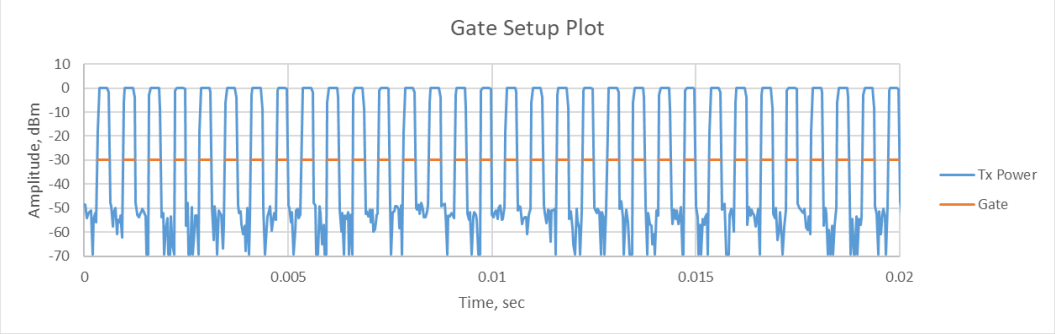



Figure TR01.1: Gate setting diagram for BLE Radio, 1 Mbps modulation, 2440 MHz

ETSI Power

| Frequency | (MHz) | 2402 | 2404 | 2440 | 2478 | 2480 |
|---|---|---|---|---|---|---|
| Bluetooth | Basic | **6.99** | **NT** | **7.03** | **NT** | **7.61** |
| Bluetooth | EDR2 | **6.03** | **NT** | **6.15** | **NT** | **7.53** |
| Bluetooth | EDR3 | **6.02** | **NT** | **6.41** | **NT** | **7.51** |
| BT Low Energy | 1 Mbps | **-0.45** | **NT** | **-0.38** | **NT** | **-0.53** |
| BT Low Energy | 2 Mbps | **NT** | **-1.07** | **-1.01** | **-1.11** | **NT** |
| ANT | ---- | **1.30** | **NT** | **1.25** | **NT** | **1.39** |

Table TR01.3: Transmit Power, ETSI method, in dBm EIRP

The ETSI method also requires that transmit power be verified for stability at the extremes of operating temperature. The Bluetooth Basic Rate transmitter was verified for power stability vs temperature on 2480 MHz.

| Tx Mode | Temp | Power | Limit | Result |
|---|---|---|---|---|
| Bluetooth | ˚C | dBm EIRP | dBm EIRP | |
| Basic Rate | 60 | 6.35 | 20 | Pass |
| Basic Rate | 20 | 7.93 | 20 | Pass |
| Basic Rate | -20 | 7.28 | 20 | Pass |

Table TR01.4: Transmit Power over temperature, Bluetooth Basic Rate on 2480 MHz, ETSI method, in dBm EIRP

Other Power Analyses

| Frequency | (MHz) | 2402 | 2404 | 2440 | 2478 | 2480 |
|---|---|---|---|---|---|---|
| Bluetooth | Basic | **5.42** | **NT** | **5.48** | **NT** | **6.26** |
| Bluetooth | EDR2 | **4.34** | **NT** | **4.46** | **NT** | **6.13** |
| Bluetooth | EDR3 | **4.33** | **NT** | **4.74** | **NT** | **6.11** |
| BT Low Energy | 1 Mbps | **0.42** | **NT** | **0.42** | **NT** | **0.41** |
| BT Low Energy | 2 Mbps | **NT** | **0.23** | **0.23** | **0.22** | **NT** |
| ANT | ---- | **1.46** | **NT** | **1.44** | **NT** | **1.49** |

Table TR01.5: Transmit Power, RF exposure method, in mW

| Frequency | (MHz) | 2402 | 2404 | 2440 | 2478 | 2480 |
|---|---|---|---|---|---|---|
| Bluetooth | Basic | **100.0%** | **NT** | **100.0%** | **NT** | **100.0%** |
| Bluetooth | EDR2 | **100.0%** | **NT** | **100.0%** | **NT** | **100.0%** |
| Bluetooth | EDR3 | **100.0%** | **NT** | **100.0%** | **NT** | **100.0%** |
| BT Low Energy | 1 Mbps | **46.7%** | **NT** | **46.7%** | **NT** | **46.7%** |
| BT Low Energy | 2 Mbps | **NT** | **28.0%** | **28.0%** | **28.0%** | **NT** |
| ANT | ---- | **100.0%** | **NT** | **100.0%** | **NT** | **100.0%** |

Table TR01.6: Duty cycle for each radio mode

**Setup Diagram**
The following block diagrams show how the EUT and test equipment is arranged for test.

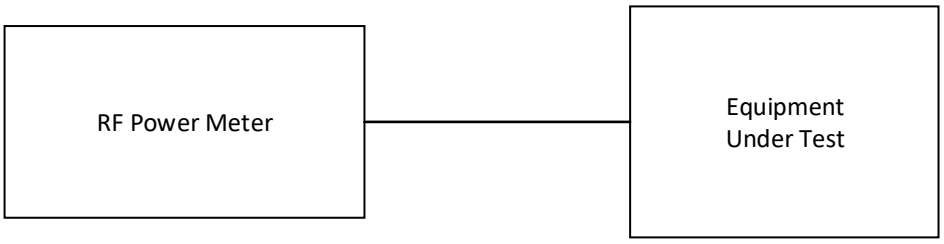



Figure TR02: Test equipment setup

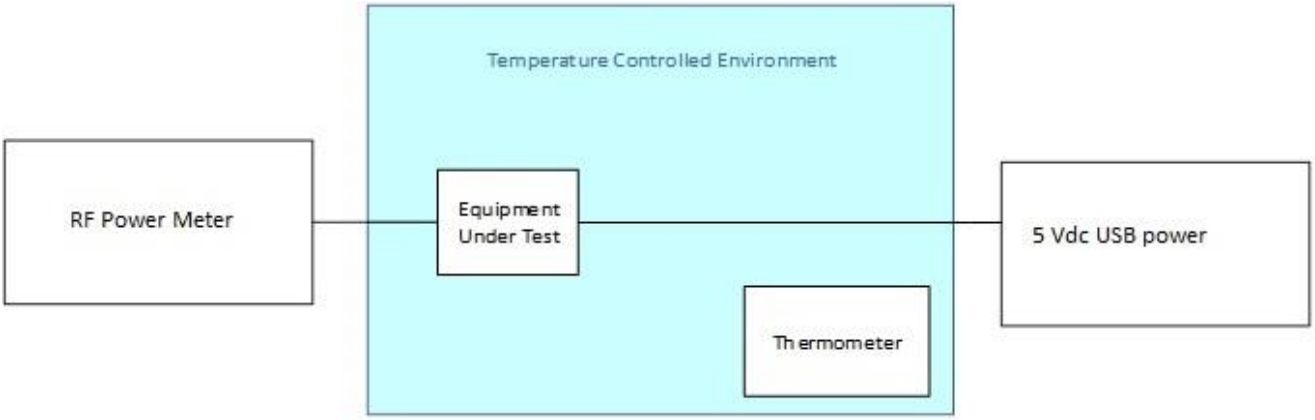



**Figure TR02.3: Test equipment setup during power measurement in extreme conditions**

**This line is the end of the test record.**

## Test Record
**Transmitter Power, Duty Cycle**
**Test IDs TR04a**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 09 Sep 2024 |
| Test Personnel | Vladimir Tolstik supervised by Jim Solum and Majid Farah |
| Product Model | A04999 |
| Serial Number | 8ME000064 |
| Operating Mode | M7 (WiFiTx) |
| Arrangement | A4 (Udc) |
| Input Power | USB 5Vdc |
| Test Standards: | FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247(as noted in Section 6 of the report). |
| Antenna Gain | -0.35 dBi, as reported by the client |
| Radio Protocol | IEEE 802.11b/g/n |

**Pass/Fail Judgment:** **PASS**

**Test record created by:** **Jim Solum**
**Date of this record:** **01 Nov 2024**

Version B. Separated ANSI and ETSI WiFi data into separate test records. Original record, Version A dated 03 Oct 2024

**Test Equipment Used**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| RF Power Sensor | Rohde&Schwarz | NRP8S | 109927 | 18-Jul-2024 | 18-Jul-2026 |

Table TR04a.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3; TimePowerAnalysisSpreadsheetv12a.xls

**Test Method**
The basic test standards provide options for the time evaluation test method. The following test methods were applied.

ANSI C63.10: 11.9.2.3.2 (Gated average power with broadband power meter)

Under the ETSI standard, the parameters of duty cycle, transmitter timing, or medium utilization are typically not required for adaptive transceivers or transceivers emitting at 10 dBm EIRP or less, so those results will typically be omitted from the data set. Duty Cycle data will be included if it is relevant to test methods used for other standards such as Average Detector methods in the ANSI standards that apply duty cycle correction or certain kinds of analysis under the RF exposure standards.

**Transmit Power and Timing Data**
Each measurement is made conducted from the antenna port with the transmitter on a specified channel and in a selected transmission protocol. Where standards cited here apply harmonized test methods and different limits, the more strict limit has applied.

This test record will show results based on one or more of the following methods of analyzing the same set of raw power data vs. time. The ANSI peak power method looks for the highest power in the data record, with results in dBm units. The ANSI gated average power method determines the average power in the data record but only during times when the transmitter is keyed on, with results in dBm units. Under the US and Canadian rules a limit of 30 dBm is applied independent of which ANSI method is used. The ETSI 300 328 method looks at the individual transmission bursts within the data record and reports the power level from the burst with the for the highest average power. The ETSI result is presented in dBm EIRP units, and a 20 dBm EIRP limit is applied. The RF exposure analysis asks for the average power observed over the entire data record time, with results in linear power units such as milliwatts. RF exposure limits are not addressed in this test record. Many of the these standards also care about duty cycle, the portion of the time when the transmitter was actually transmitting. That is presented as a percentage, and no limit applies. All of these results are drawn from the same trace of Tx power data. The results are shown below.

ANSI Power

| Mode | Speed | 1 | 6 | 11 | 13 |
|---|---|---|---|---|---|
| B | 1 | **NT** | **18.80** | **NT** | **NT** |
| B | 2 | **NT** | **18.75** | **NT** | **NT** |
| B | 5.5 | **13.55** | **18.85** | **16.06** | **12.03** |
| B | 11 | **NT** | **18.51** | **NT** | **NT** |
| G | 6 | **9.89** | **16.89** | **13.32** | **8.48** |
| G | 9 | **NT** | **16.86** | **NT** | **NT** |
| G | 12 | **NT** | **16.72** | **NT** | **NT** |
| G | 18 | **NT** | **16.55** | **NT** | **NT** |
| G | 24 | **NT** | **16.45** | **NT** | **NT** |
| G | 36 | **NT** | **16.55** | **NT** | **NT** |
| G | 48 | **NT** | **16.40** | **NT** | **NT** |
| G | 54 | **NT** | **16.35** | **NT** | **NT** |
| N | MCS0 | **9.49** | **16.87** | **13.03** | **8.51** |
| N | MCS1 | **NT** | **16.14** | **NT** | **NT** |
| N | MCS2 | **NT** | **16.10** | **NT** | **NT** |
| N | MCS3 | **NT** | **16.26** | **NT** | **NT** |
| N | MCS4 | **NT** | **16.28** | **NT** | **NT** |
| N | MCS5 | **NT** | **16.09** | **NT** | **NT** |
| N | MCS6 | **NT** | **16.20** | **NT** | **NT** |
| N | MCS7 | **NT** | **16.23** | **NT** | **NT** |

Table TR04a.2: Transmit Power, ANSI method, in dBm

The gate setting diagrams are not included for these radio modes because the duty cycle reported in Table TR04a.4 below is greater than 98%, since ANSI C63.10 treats these as continuous transmissions.

Other Power Analyses

| Mode | Speed | 1 | 6 | 11 | 13 |
|---|---|---|---|---|---|
| B | 1 | **NT** | **75.82** | **NT** | **NT** |
| B | 2 | **NT** | **75.02** | **NT** | **NT** |
| B | 5.5 | **22.66** | **76.73** | **40.33** | **15.95** |
| B | 11 | **NT** | **71.03** | **NT** | **NT** |
| G | 6 | **9.76** | **48.89** | **21.48** | **7.04** |
| G | 9 | **NT** | **48.52** | **NT** | **NT** |
| G | 12 | **NT** | **46.98** | **NT** | **NT** |
| G | 18 | **NT** | **45.21** | **NT** | **NT** |
| G | 24 | **NT** | **44.16** | **NT** | **NT** |
| G | 36 | **NT** | **45.22** | **NT** | **NT** |
| G | 48 | **NT** | **43.67** | **NT** | **NT** |
| G | 54 | **NT** | **43.11** | **NT** | **NT** |
| N | MCS0 | **8.90** | **48.69** | **20.09** | **7.10** |
| N | MCS1 | **NT** | **41.16** | **NT** | **NT** |
| N | MCS2 | **NT** | **40.78** | **NT** | **NT** |
| N | MCS3 | **NT** | **42.23** | **NT** | **NT** |
| N | MCS4 | **NT** | **42.51** | **NT** | **NT** |
| N | MCS5 | **NT** | **40.68** | **NT** | **NT** |
| N | MCS6 | **NT** | **41.70** | **NT** | **NT** |
| N | MCS7 | **NT** | **41.98** | **NT** | **NT** |

Table TR04a.3: Transmit Power, RF exposure method, in mW

| Mode | Speed | 1 | 6 | 11 | 13 |
|---|---|---|---|---|---|
| B | 1 | **NT** | **100.0%** | **NT** | **NT** |
| B | 2 | **NT** | **100.0%** | **NT** | **NT** |
| B | 5.5 | **100.0%** | **100.0%** | **100.0%** | **100.0%** |
| B | 11 | **NT** | **100.0%** | **NT** | **NT** |
| G | 6 | **100.0%** | **100.0%** | **100.0%** | **100.0%** |
| G | 9 | **NT** | **100.0%** | **NT** | **NT** |
| G | 12 | **NT** | **100.0%** | **NT** | **NT** |
| G | 18 | **NT** | **100.0%** | **NT** | **NT** |
| G | 24 | **NT** | **100.0%** | **NT** | **NT** |
| G | 36 | **NT** | **100.0%** | **NT** | **NT** |
| G | 48 | **NT** | **100.0%** | **NT** | **NT** |
| G | 54 | **NT** | **100.0%** | **NT** | **NT** |
| N | MCS0 | **100.0%** | **100.0%** | **100.0%** | **100.0%** |
| N | MCS1 | **NT** | **100.0%** | **NT** | **NT** |
| N | MCS2 | **NT** | **100.0%** | **NT** | **NT** |
| N | MCS3 | **NT** | **100.0%** | **NT** | **NT** |
| N | MCS4 | **NT** | **100.0%** | **NT** | **NT** |
| N | MCS5 | **NT** | **100.0%** | **NT** | **NT** |
| N | MCS6 | **NT** | **100.0%** | **NT** | **NT** |
| N | MCS7 | **NT** | **100.0%** | **NT** | **NT** |

Table TR04a.4: Duty cycle for each radio mode

**Setup Diagram**
The following block diagrams show how the EUT and test equipment is arranged for test.

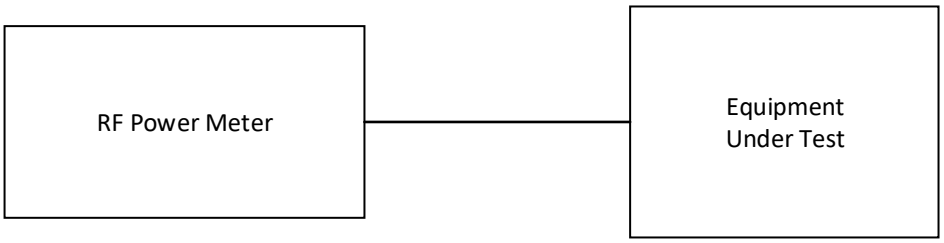



Figure TR04a.1: Test equipment setup

**This line is the end of the test record.**

## Test Record
**Conducted Spurious Emissions**
**Test IDs TR26 – TR28**
**Project GCL-0647**

| | |
|---|---|
| Test Date(s) | 26, 27 Sep 2024 |
| Test Personnel | Majid Farah |
| Product Model | A04999 |
| Serial Number tested | 8ME000064 |
| Operating Mode | M1 (BtTx), M3 (BleTx), M5 (AntTx) |
| Arrangement | A4 (Udc) |
| Input Power | 5 Vdc |
| Test Standards: | FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report). |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | Jim Solum |
| **Date of this test record:** | 01 Oct 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 2-Nov-2024 |
| PXE Receiver 44GHz | Keysight | N9048B | MY62220139 | 13-Mar-2024 | 15-Mar-2025 |

**Table TR26.1: Test equipment used**

**Software used:** Keysight PXE software A.32.06, A.33.03

**Test Method**

The basic test standards provide options for the test method. The following test methods were applied.

ANSI C63.10: 11.11.2 and 11.11.3

**Test Setup**

This block diagram shows the test equipment setup.

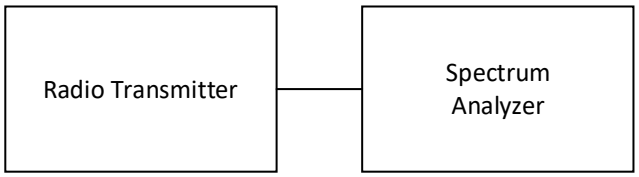



**Figure TR26.1: Test setup**

**Test Data**

The conducted spurious emission test measures the strength of intentional and unintentional radio signals conducted from the transmitter to the antenna across a wide range of frequencies. It does not evaluate whether intentional signals meet specific limits. Rather, it ensures that magnitudes unintentional signals are sufficiently reduced relative to the intentional signal to satisfy the requirements of the relevant standards.

This measurement requires that a coaxial feed line from the transmitter is available as a connector exterior to the test sample. This feed line and connector may be a part of the shipping product, or it may be a special modification to the product for testing purposes. The connector is attached via laboratory cables to the measurement instrument. The results have been adjusted to account for the losses in the laboratory cables. Where feasible, the losses of any added feed lines are also included in that adjustment.

Data is collected using the required detector function(s) across the frequency range. The instrument uses a 100 kHz bandwidth detector.

The data table below shows the final measurement data at harmonics of the carrier. This is identified for each harmonic number n by identifying the nth multiple of the lower radio band edge, and the nth multiple of the upper radio band edge. The data record is searched to identify the frequency in this harmonic range with the largest amplitude. That frequency is selected and reported. Particularly for higher order harmonics, this frequency will often be the measurement instrumentation noise floor.

The peak level of the fundamental is also identified. The harmonics or spurious emissions must be reduced from this fundamental level by 30 dBc. This harmonic limit is calculated and used to determine compliance. A reduction from the carrier that is greater that 30 is a passing result. The minimum margin from the peak level for each mode are highlighted in yellow.

For the Bluetooth, BLE, and ANT radios reported here, the lowest operating frequency was 2402 MHz, and the highest operating frequency was 2480 MHz.

Data plots are provided for the worst-case data sets. One plot shows the spectrum at the carrier, and another shows the spectrum across the band. On this second plot, a green reference line is at approximately the 20 dBc spurious emission level.

| | | 2402 | 2440 | 2480 |
|---|---|---|---|---|
| BT | BR | 55.12 | 57.39 | 60.46 |
| BLE | 1 Mb | 58.42 | 58.56 | 58.08 |
| ANT | | 48.39 | 47.66 | 48.95 |

**Table TR26.2: Results Summary (dBc)**

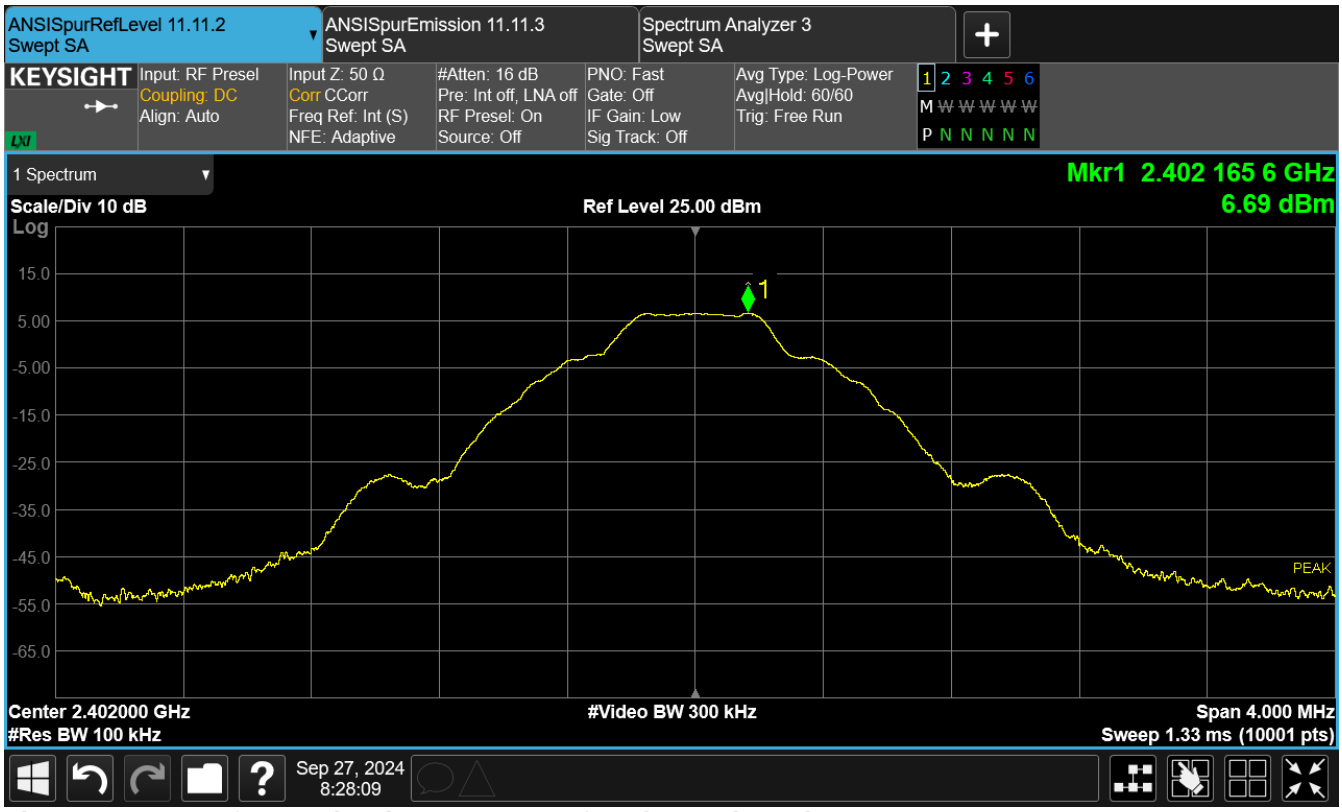



**Figure TR26.2: Reference level measurement for Bluetooth Basic Rate at 2402 MHz**

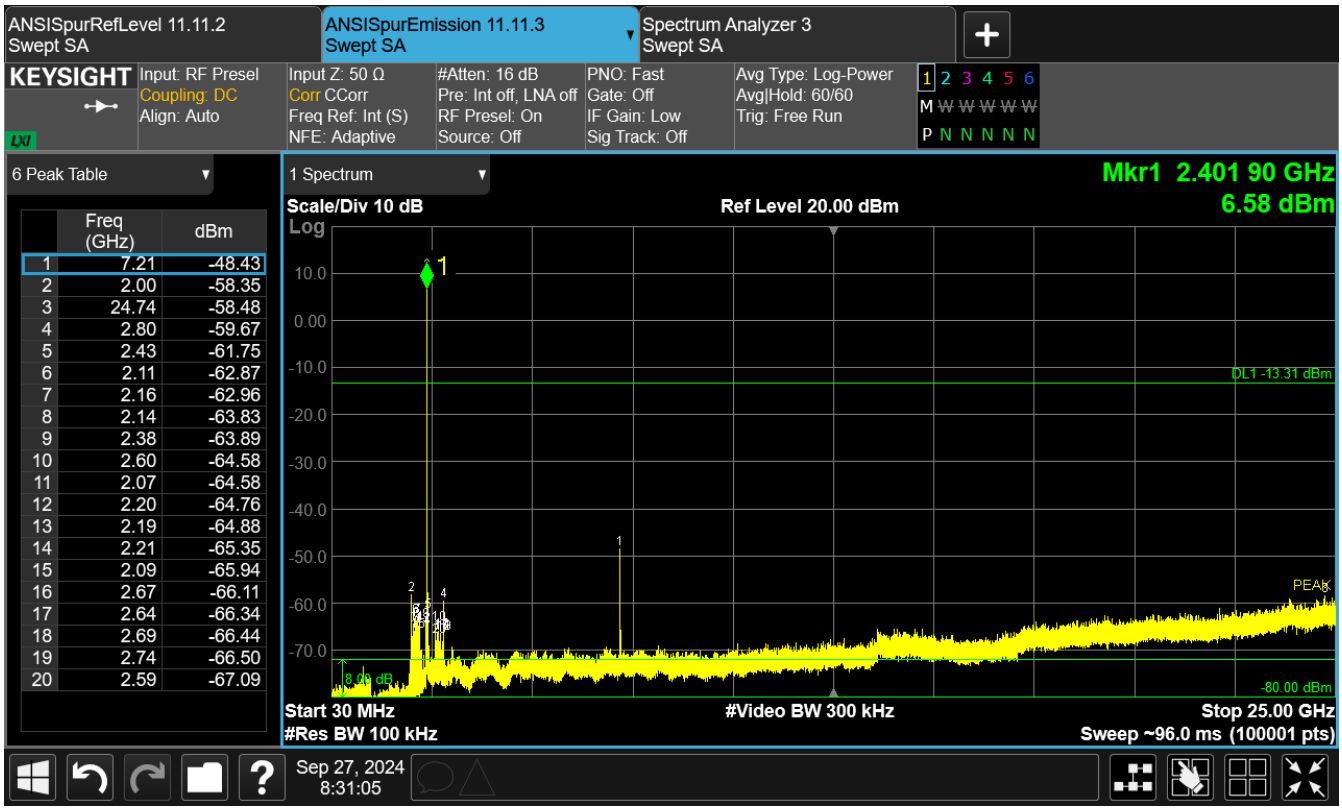



**Figure TR26.3 Spectral data for Bluetooth Basic Rate at 2402 MHz**

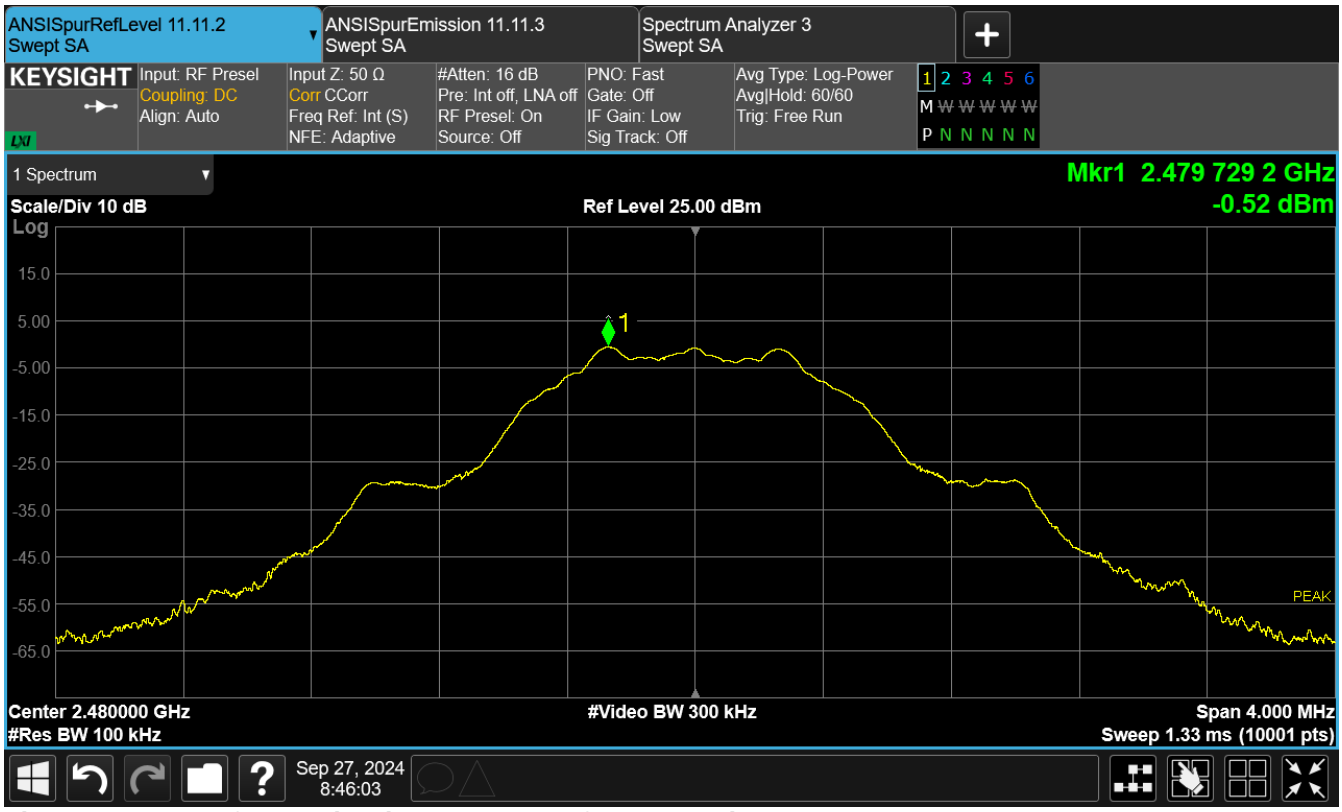



**Figure TR26.4: Reference level measurement for BLE 1 Mbps at 2480 MHz**

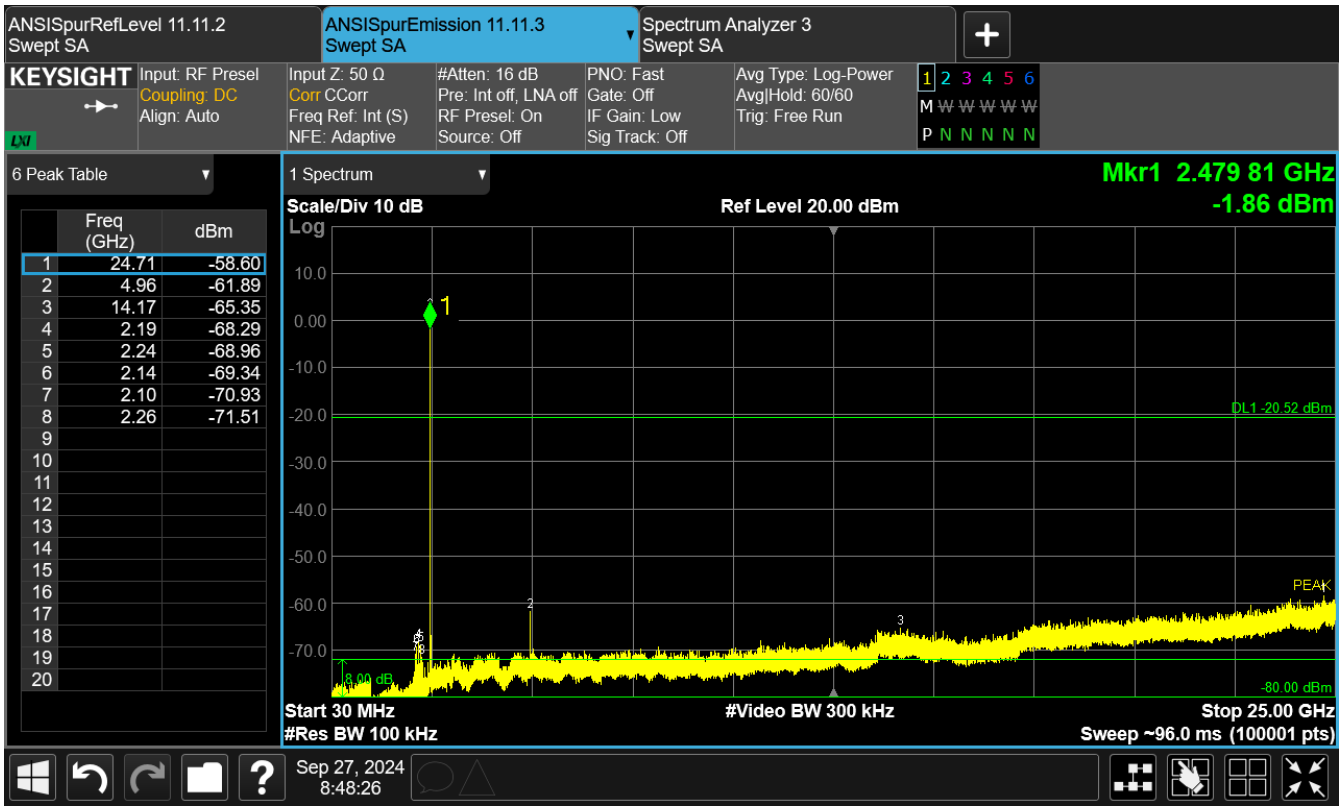



**Figure TR26.5 Spectral data for BLE 1 Mbps at 2480 MHz**

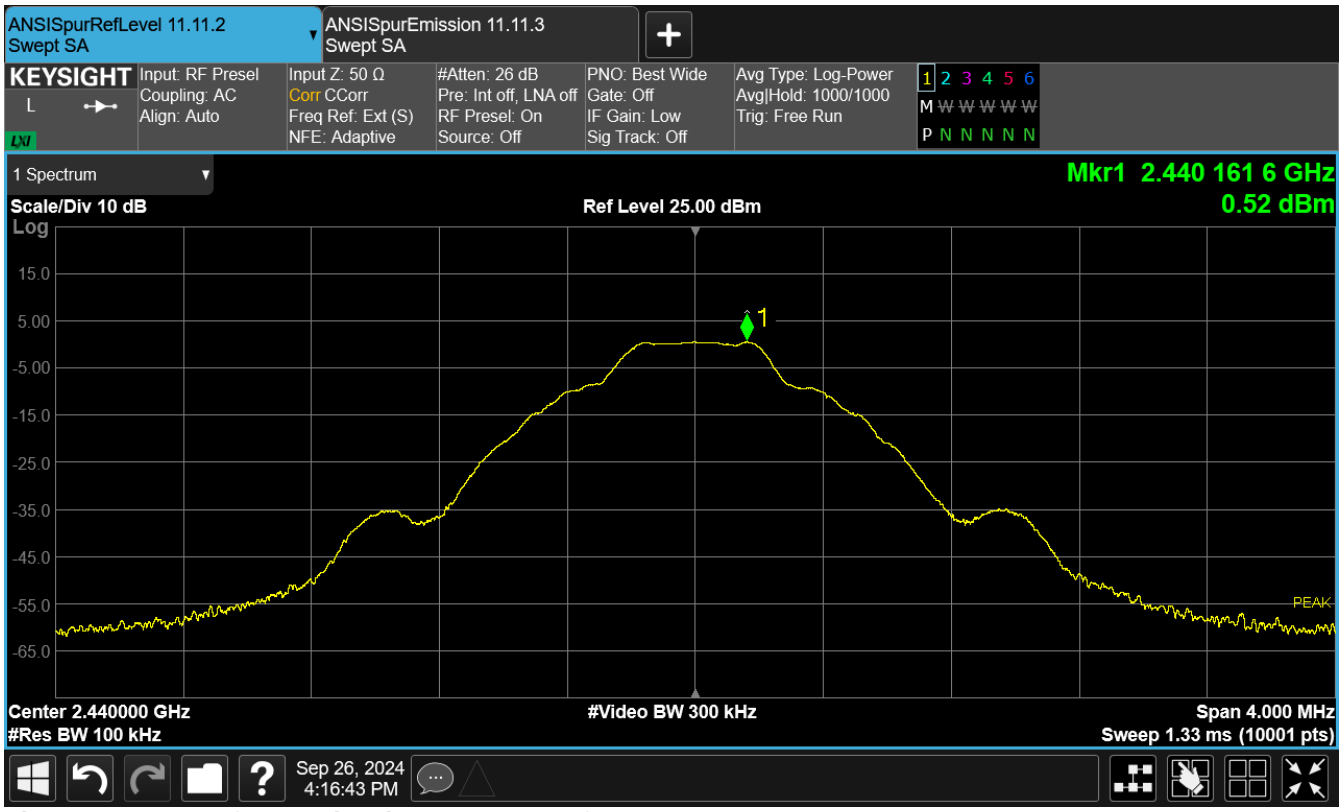



**Figure TR26.6: Reference level measurement for ANT at 2440 MHz**


**Figure TR26.7 Spectral data for ANT at 2440 MHz**

**This line is the end of the test record.**

## Test Record
**Conducted Spurious Emissions**
**Test IDs TR29**
**Project GCL-0647**

| | |
|---|---|
| Test Date(s) | 26 Sep 2024 |
| Test Personnel | Majid Farah |
| Product Model | A04999 |
| Serial Number tested | 8ME000064 |
| Operating Mode | M7 (WiFiTx) |
| Arrangement | A4 (Udc) |
| Input Power | 5 Vdc |
| Test Standards: | FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report). |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | Jim Solum |
| **Date of this test record:** | 01 Oct 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 2-Nov-2024 |

**Table TR29.1: Test equipment used**

**Software used:** Keysight PXE software A.32.06

**Test Method**

The basic test standards provide options for the test method. The following test methods were applied.

ANSI C63.10: 11.11.2 and 11.11.3

**Test Setup**

This block diagram shows the test equipment setup.

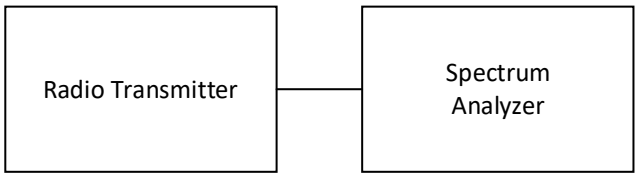



**Figure TR29.1: Test setup**

**Test Data**

The conducted spurious emission test measures the strength of intentional and unintentional radio signals conducted from the transmitter to the antenna across a wide range of frequencies. It does not evaluate whether intentional signals meet specific limits. Rather, it ensures that magnitudes unintentional signals are sufficiently reduced relative to the intentional signal to satisfy the requirements of the relevant standards.

This measurement requires that a coaxial feed line from the transmitter is available as a connector exterior to the test sample. This feed line and connector may be a part of the shipping product, or it may be a special modification to the product for testing purposes. The connector is attached via laboratory cables to the measurement instrument. The results have been adjusted to account for the losses in the laboratory cables. Where feasible, the losses of any added feed lines are also included in that adjustment.

Data is collected using the required detector function(s) across the frequency range. The instrument uses a 100 kHz bandwidth detector.

The data table below shows the final measurement data at harmonics of the carrier. This is identified for each harmonic number n by identifying the nth multiple of the lower radio band edge, and the nth multiple of the upper radio band edge. The data record is searched to identify the frequency in this harmonic range with the largest amplitude. That frequency is selected and reported. Particularly for higher order harmonics, this frequency will often be the measurement instrumentation noise floor.

The peak level of the fundamental is also identified. The harmonics or spurious emissions must be reduced from this fundamental level by 30 dBc. This harmonic limit is calculated and used to determine compliance. A reduction from the carrier that is greater that 30 is a passing result. The minimum margin from the peak level for each mode are highlighted in yellow.

Data plots are provided for the worst-case data sets. One plot shows the spectrum at the carrier, and another shows the spectrum across the band. On this second plot, a green reference line is at approximately the 20 dBc spurious emission level.

| | | Channel No. | | | |
|---|---|---|---|---|---|
| Mode | Data rate (Mbps) | 1 | 6 | 11 | 13 |
| B | 2 | 52.13 | 53.53 | 50.55 | 44.12 |
| G | 18 | 47.92 | 50.26 | 46.44 | 42.46 |
| N | MCS0 | 48.66 | 51.54 | 47.69 | 42.82 |

**Table TR29.2: Results Summary (dBc)**

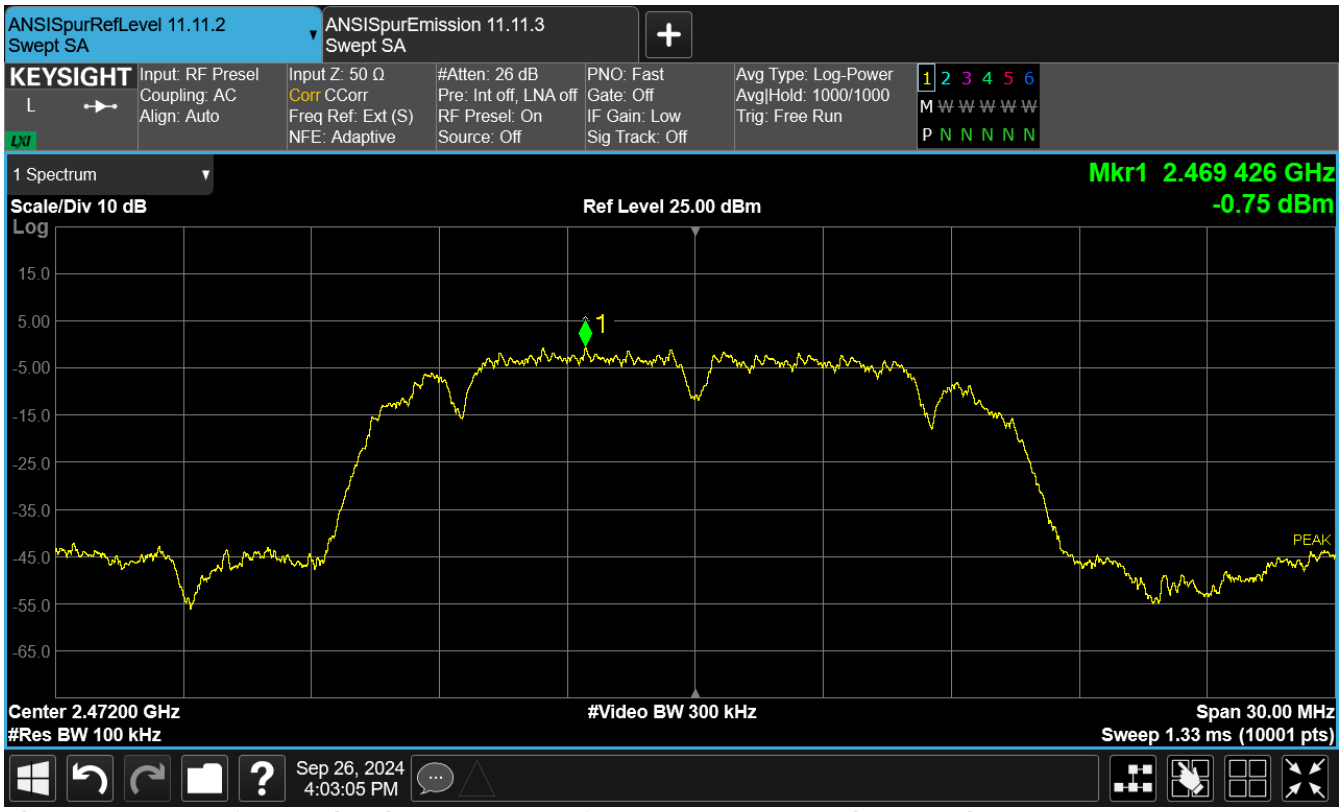



**Figure TR29.2: Reference level measurement for IEEE 802.11 B 2 Mbps on Ch.13**

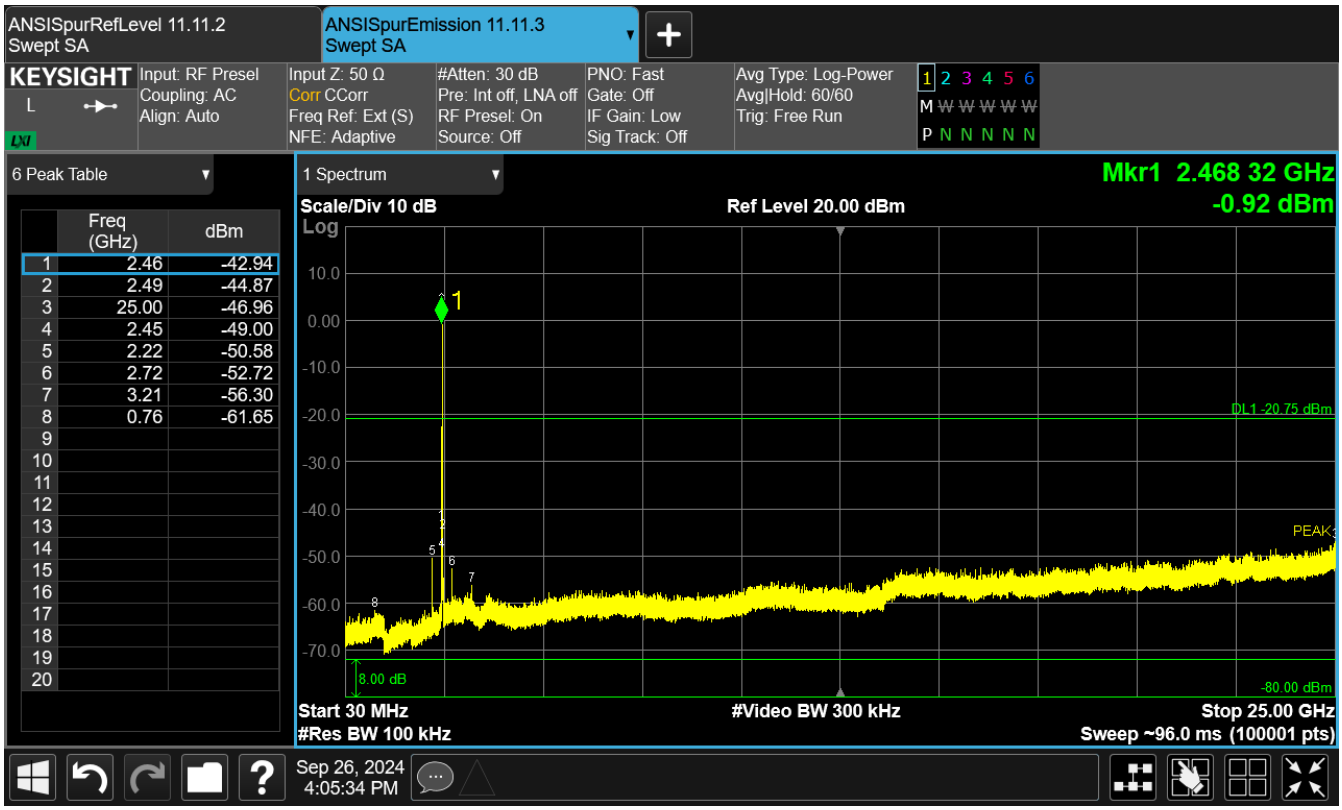



**Figure TR29.3 Spectral data for IEEE 802.11 B 2 Mbps on Ch.13**

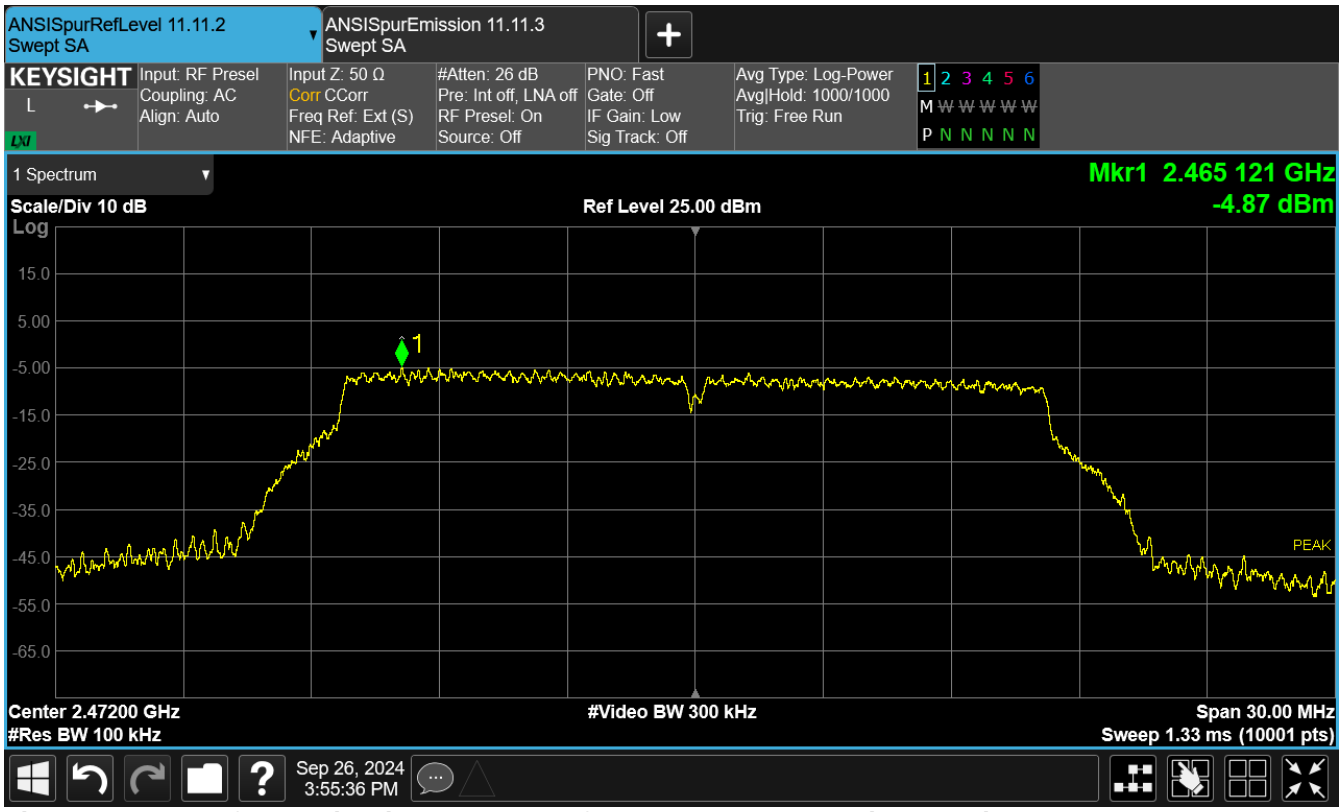



**Figure TR29.4: Reference level measurement for IEEE 802.11 G 18 Mbps on Ch.13**

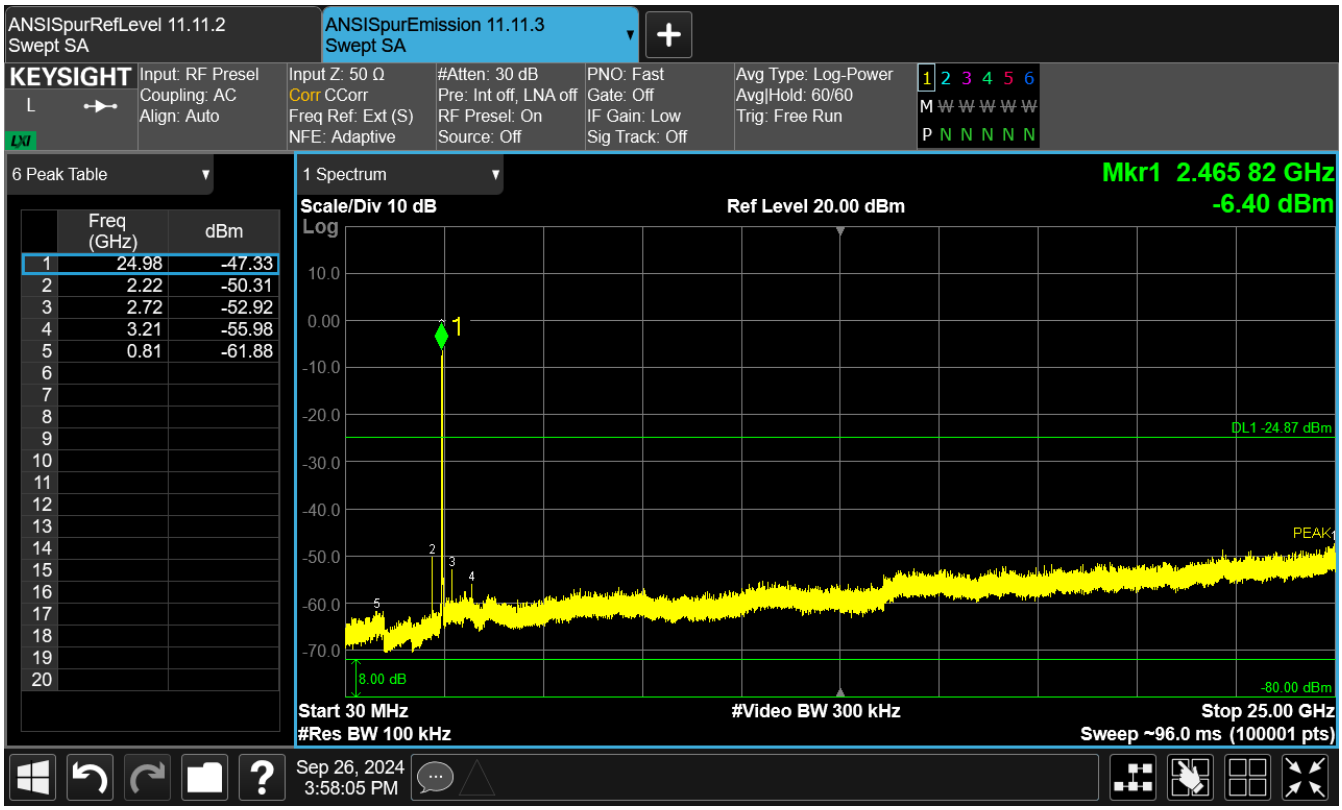



**Figure TR29.5 Spectral data for IEEE 802.11 G 18 Mbps on Ch.13**

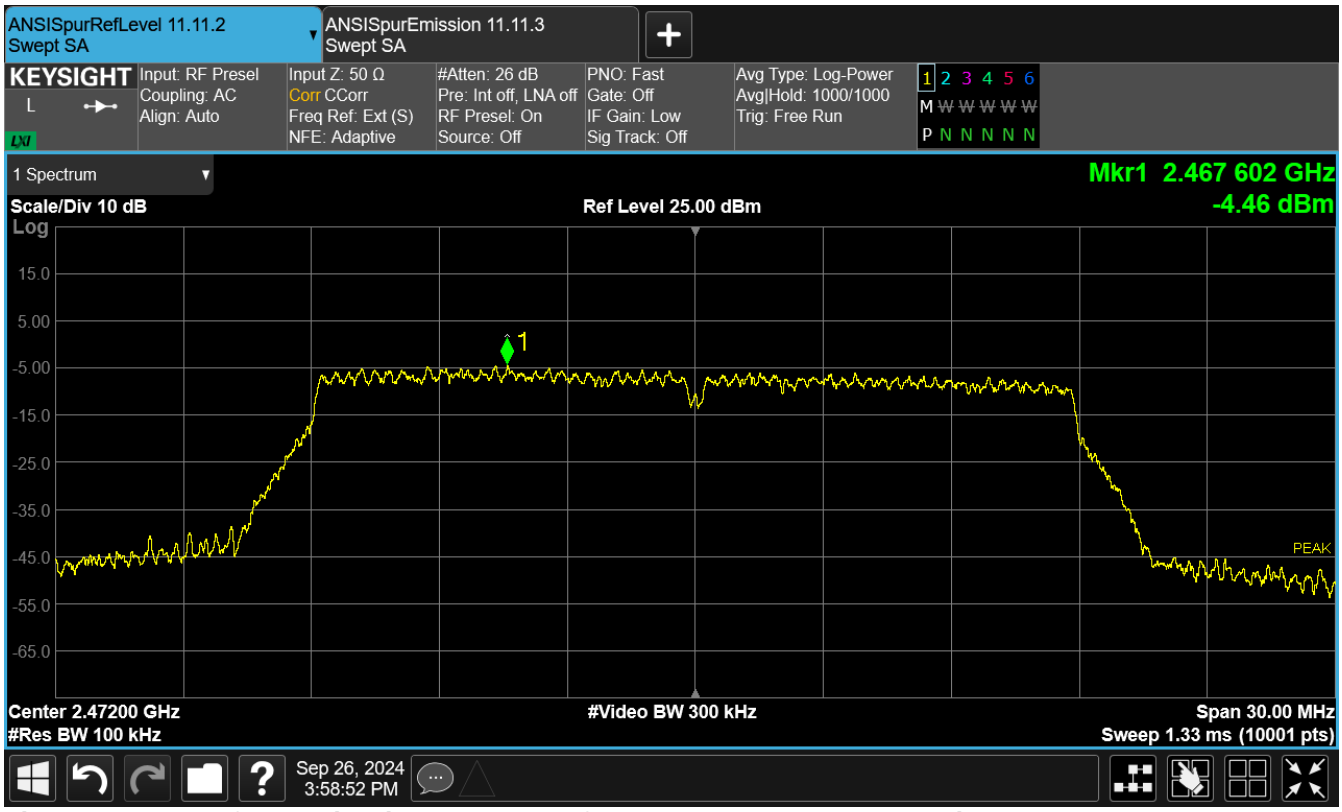



**Figure TR29.6: Reference level measurement for IEEE 802.11 N MCS0 on Ch.13**

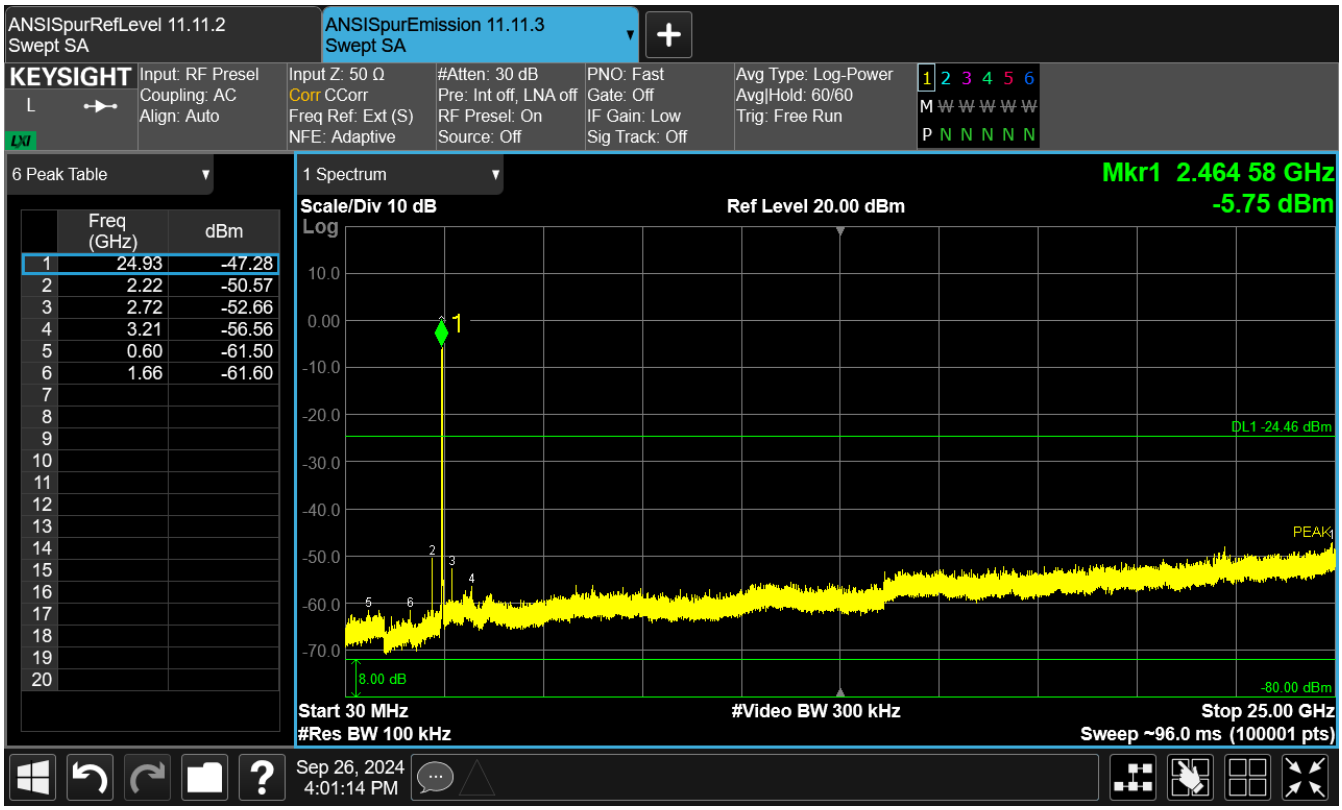



**Figure TR29.7 Spectral data for IEEE 802.11 N MCS0 on Ch.13**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE01**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 10 Sep 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M7 (WiFiTx) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report) |
| Frequency Range: | Restricted Bands (2200-2300 MHz, 2310-2390 MHz, 2483.5-2500 MHz) |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 11 Sep 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 1-Oct-2024 |
| Antenna, Horn, 1-18 GHz | ETS Lindgren | 3117 | 00259208 | 30-May-2024 | 30-May-2026 |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Tape measure, 1" x 33' | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| Preamplifier, 500 MHz 18 GHz | Com-Power | PAM-118A | 18040133 | Calibration | Not Required |
| Wifi Filter | K&L | 8NSL26-2437/E82.2-0 | 1 | Calibration | Not Required |

**Table RE01.1: Test Equipment Used**

**Software Used**
Keysight PXE receiver software A.32.06, Signal Maximization Tool v2024Jul31.xlsx.

**Test Data**

This restricted band investigation began with a benchtop setup wherein the emissions in the restricted bands were observed from a modified test sample with an RF output cable replacing the onboard antenna. The actual emission levels within restricted bands in many of the test sample's available transmission modes are too low to be reliably measured in the radiated environment. By applying the required peak and average detectors and bandwidths to the signals direct from the transmitter, lab staff identified the worst-case operational modes. These were then measured using an unmodified unit in the required radiated environment.

The radiated emission test began with a preliminary scan in each restricted band at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Final field strength measurements were taken in that set of positions.

Restricted band measurements in the lower band were made while the transmitter was tuned to channels 1 and 2. Measurements in the upper band were made while the transmitter was tuned to channels 11,12 and 13.

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The tables show the selected final measurement data between the FCC restricted bands. It includes the strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC restricted band Class B Limit at 3m.

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2390 | 54 | 74 | 38.6 | 68.71 | 15.4 | 5.30 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 38.79 | 68.66 | 15.21 | 5.34 | 166 | 1708 | HORZ |

**Table RE01.2: FCC restricted bands from 2200 to 2390 MHz (CH 1, B 2Mb)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2485 | 54 | 74 | 33.94 | 64.108 | 20.06 | 9.89 | 127 | 1261 | HORZ |
| 2486.8 | 54 | 74 | 34.93 | 63.305 | 19.07 | 10.70 | 127 | 1261 | HORZ |

**Table RE01.3: FCC restricted band from 2483.5 to 2500 MHz (CH 11, B 2Mb)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2390 | 54 | 74 | 41.78 | 68.08 | 12.23 | 5.92 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 42.30 | 69.50 | 11.71 | 4.51 | 166 | 1708 | HORZ |

**Table RE01.4: FCC restricted bands from 2200 to 2390 MHz (CH1, G18)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2483.5 | 54 | 74 | 42.44 | 64.39 | 11.56 | 9.61 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 42.43 | 65.39 | 11.57 | 8.61 | 127 | 1261 | HORZ |

**Table RE01.5: FCC restricted band from 2483.5 to 2500 MHz (CH11, G18)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2389.5 | 54 | 74 | 40.86 | 67.49 | 13.14 | 6.52 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 41.39 | 67.59 | 12.61 | 6.41 | 166 | 1708 | HORZ |

**Table RE01.6: FCC restricted bands from 2200 to 2390 MHz (CH 1, N6)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2483.5 | 54 | 74 | 43.16 | 66.87 | 10.84 | 7.13 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 43.15 | 67.36 | 10.85 | 6.64 | 127 | 1261 | HORZ |

**Table RE01.7: FCC restricted band from 2483.5 to 2500 MHz (CH 11, N6)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2390 | 54 | 74 | 40.66 | 65.91 | 13.34 | 8.09 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 40.67 | 66.13 | 13.33 | 7.88 | 166 | 1708 | HORZ |

**Table RE01.8: FCC restricted bands from 2200 to 2390 MHz (CH 2, B2)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2484 | 54 | 74 | 47.86 | 66.08 | 6.14 | 7.92 | 127 | 1261 | HORZ |
| 2484.3 | 54 | 74 | 48.08 | 65.77 | 5.92 | 8.23 | 127 | 1261 | HORZ |

**Table RE01.9: FCC restricted band from 2483.5 to 2500 MHz (CH 12, B2)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2389.5 | 54 | 74 | 48.50 | 68.23 | 5.50 | 5.77 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 48.94 | 68.25 | 5.06 | 5.75 | 166 | 1708 | HORZ |

**Table RE01.10: FCC restricted bands from 2200 to 2390 MHz (CH 2, G18)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2483.5 | 54 | 74 | 46.30 | 68.22 | 7.70 | 5.78 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 46.29 | 68.57 | 7.71 | 5.44 | 127 | 1261 | HORZ |

**Table RE01.11: FCC restricted band from 2483.5 to 2500 MHz (CH12, G18)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2387.8 | 54 | 74 | 43.48 | 65.48 | 10.52 | 8.52 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 44.95 | 65.11 | 9.05 | 8.89 | 166 | 1708 | HORZ |

**Table RE01.12: FCC restricted bands from 2200 to 2390 MHz (CH 2, N6)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2484 | 54 | 74 | 46.48 | 70.65 | 7.52 | 3.35 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 46.74 | 70.43 | 7.26 | 3.57 | 127 | 1261 | HORZ |

**Table RE01.13: FCC restricted band from 2483.5 to 2500 MHz (CH 12, N6)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2485.8 | 54 | 74 | 45.00 | 63.81 | 9.00 | 10.19 | 127 | 1261 | HORZ |
| 2486.8 | 54 | 74 | 45.78 | 65.43 | 8.22 | 8.57 | 127 | 1261 | HORZ |

**Table RE01.14: FCC restricted band from 2483.5 to 2500 MHz (CH 13, B2)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2484 | 54 | 74 | 43.83 | 66.25 | 10.17 | 7.75 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 44.19 | 66.39 | 9.81 | 7.61 | 127 | 1261 | HORZ |

**Table RE01.15: FCC restricted band from 2483.5 to 2500 MHz (CH 13, G18)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2484.8 | 54 | 74 | 43.02 | 67.18 | 10.98 | 6.82 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 43.73 | 66.69 | 10.27 | 7.31 | 127 | 1261 | HORZ |

**Table RE01.16: FCC restricted band from 2483.5 to 2500 MHz (CH 13, N6)**

The graphs below show the background spectrum observed during pre-scan, as well as the final data points from the table above.

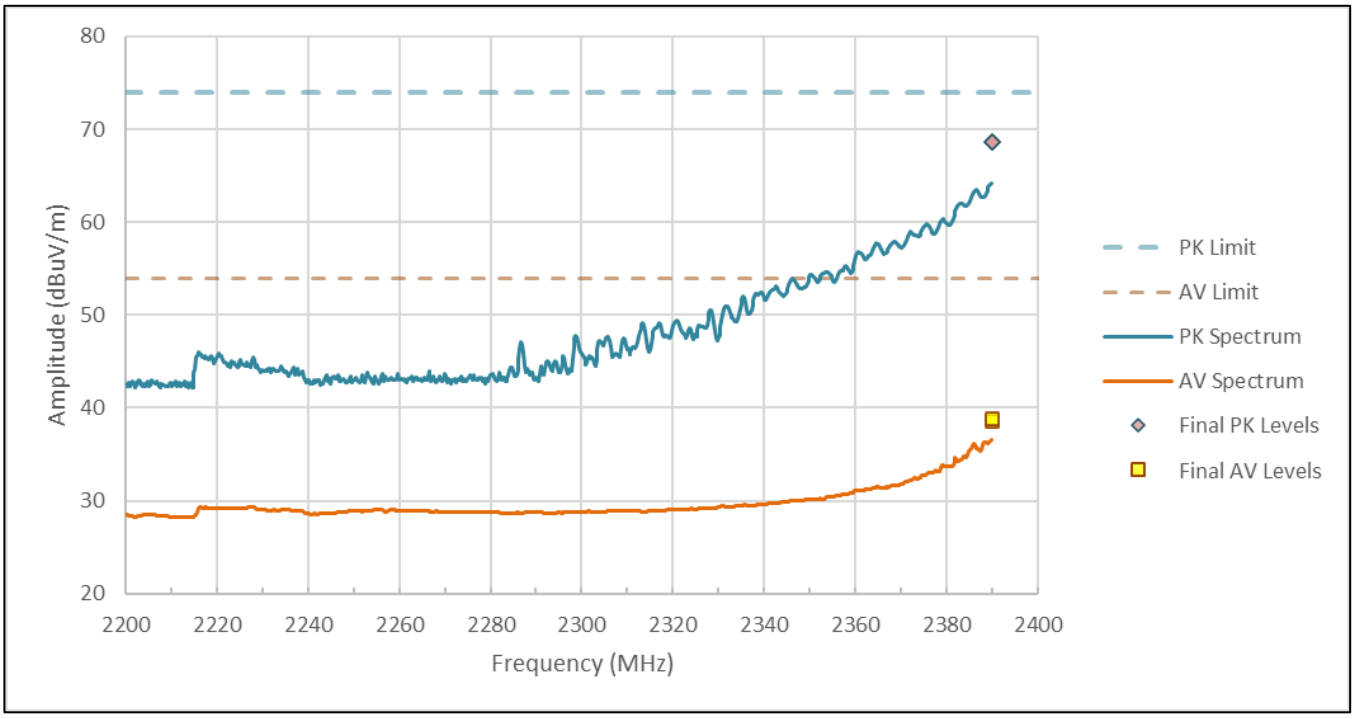



**Figure RE01.1: FCC restricted band spectral data from 2200 to 2390 MHz (CH 1, B 2Mb)**

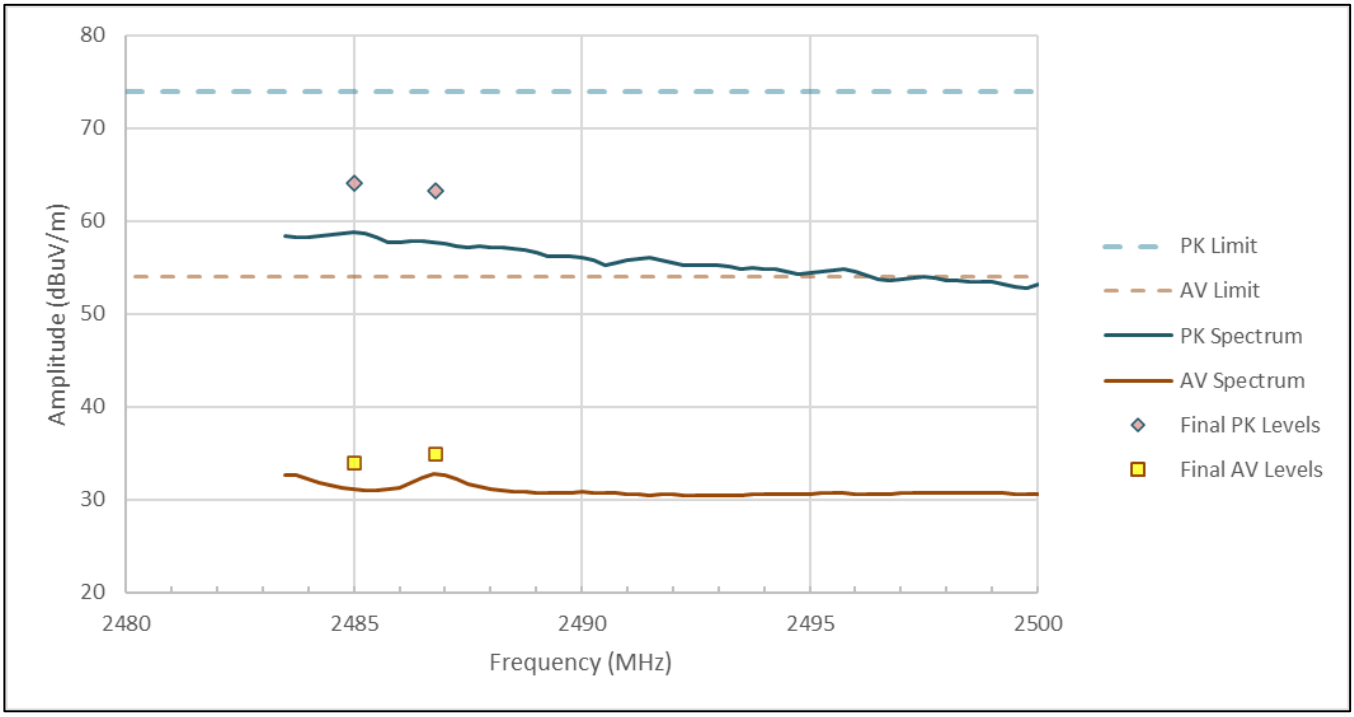



**Figure RE01.2: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH 11, B 2Mb)**

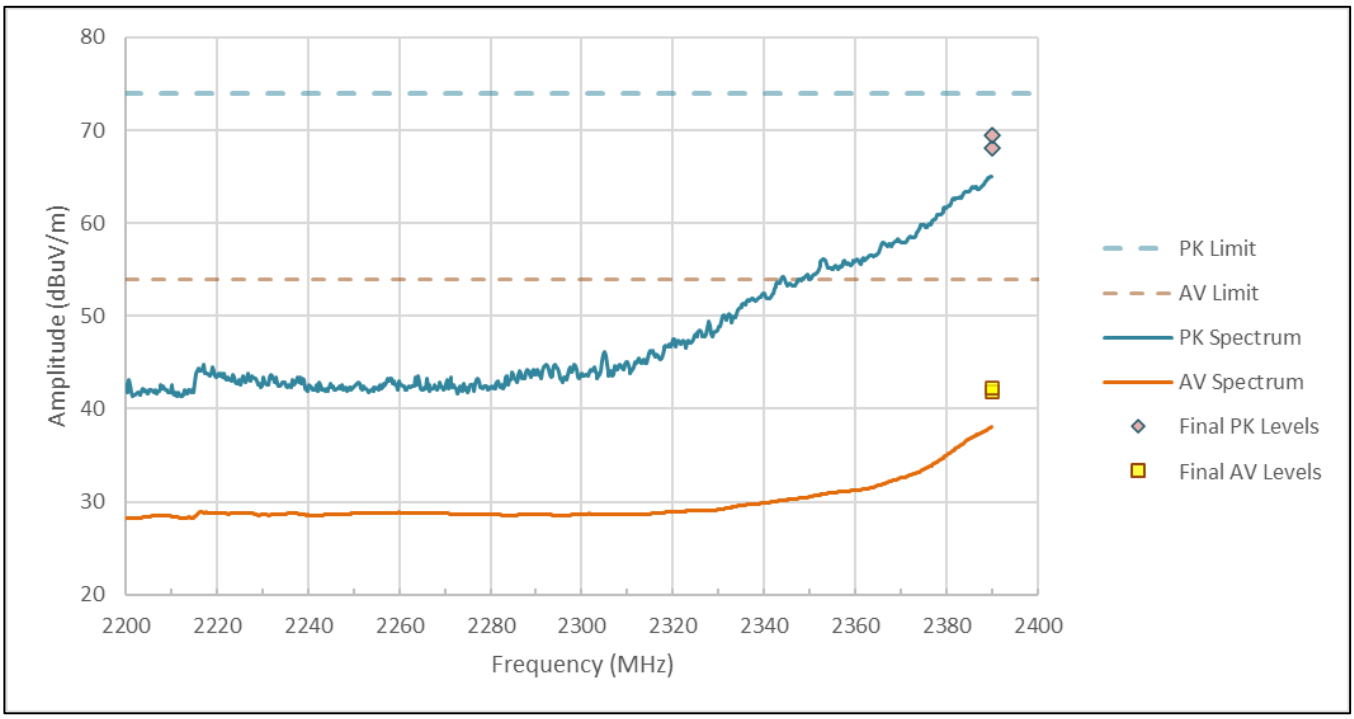



**Figure RE01.3: FCC restricted band spectral data from 2200 to 2390 MHz (CH1, G18)**

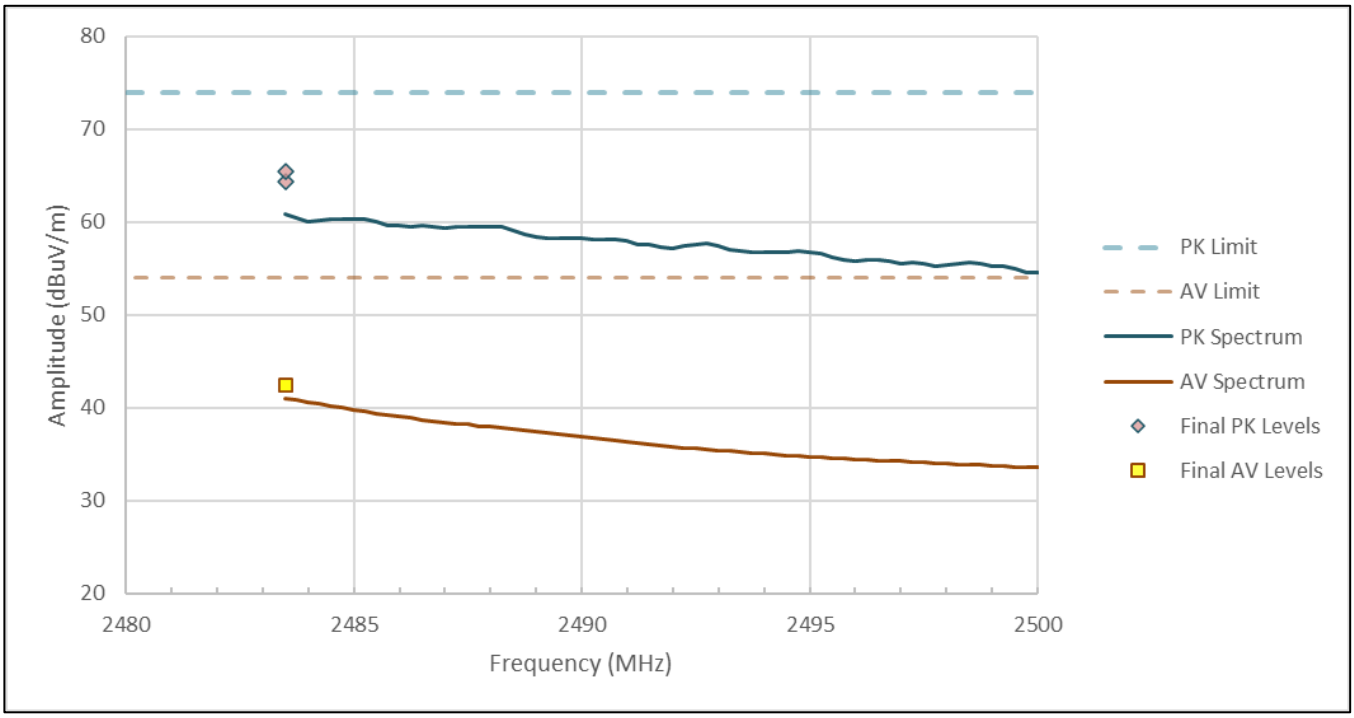



**Figure RE01.4: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH11, G18)**

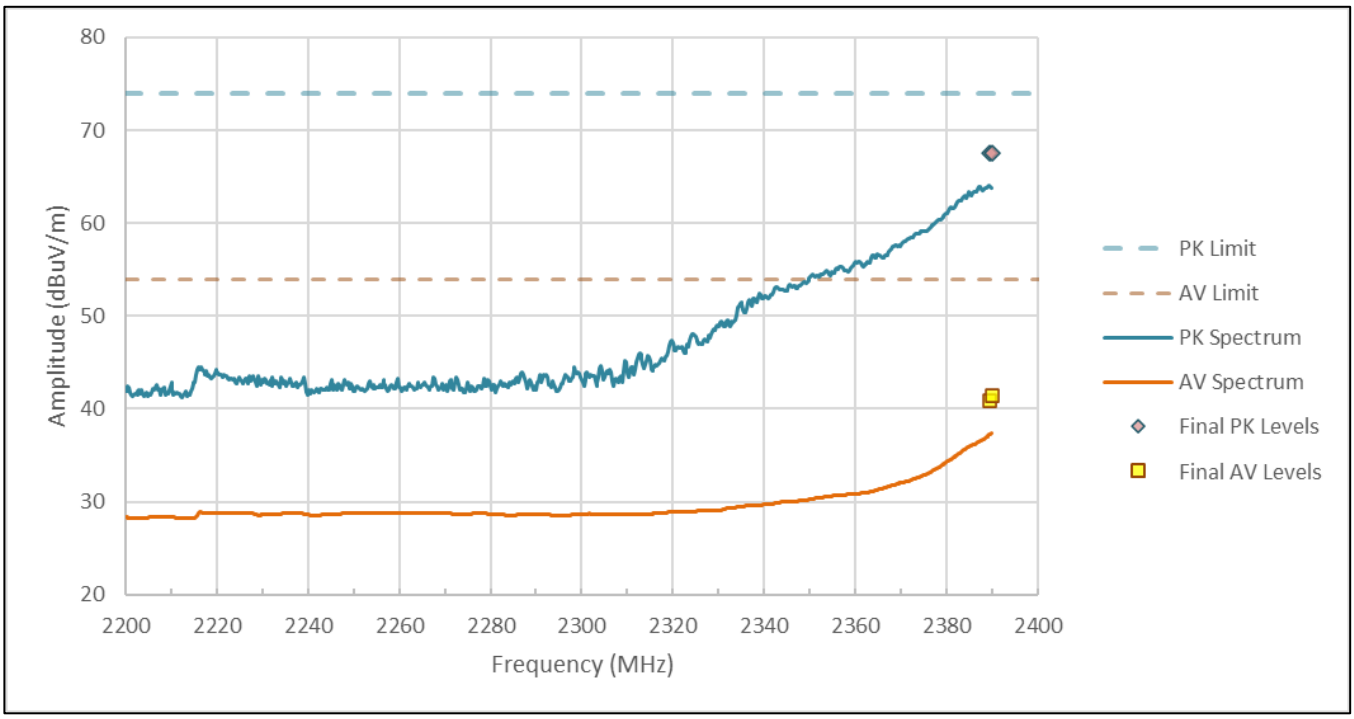



**Figure RE01.5: FCC restricted band spectral data from 2200 to 2390 MHz (CH 1, N6)**

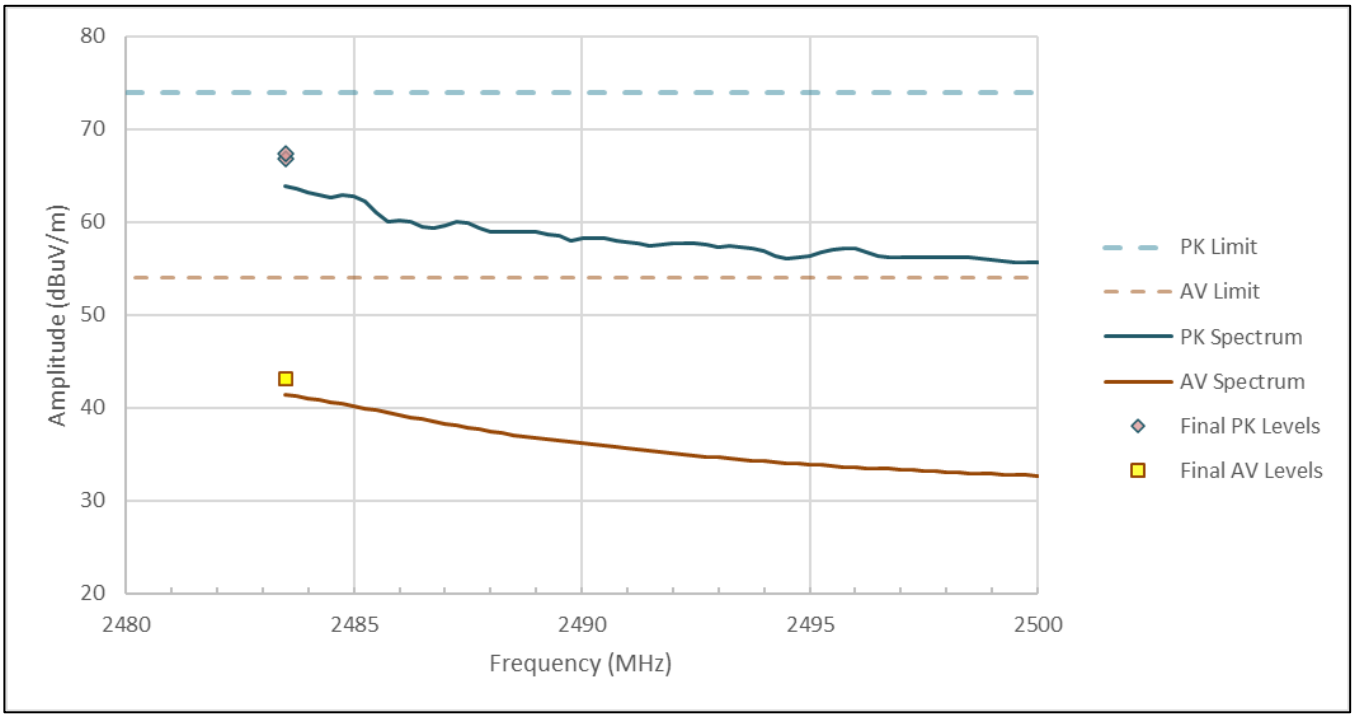



**Figure RE01.6: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH 11, N6)**

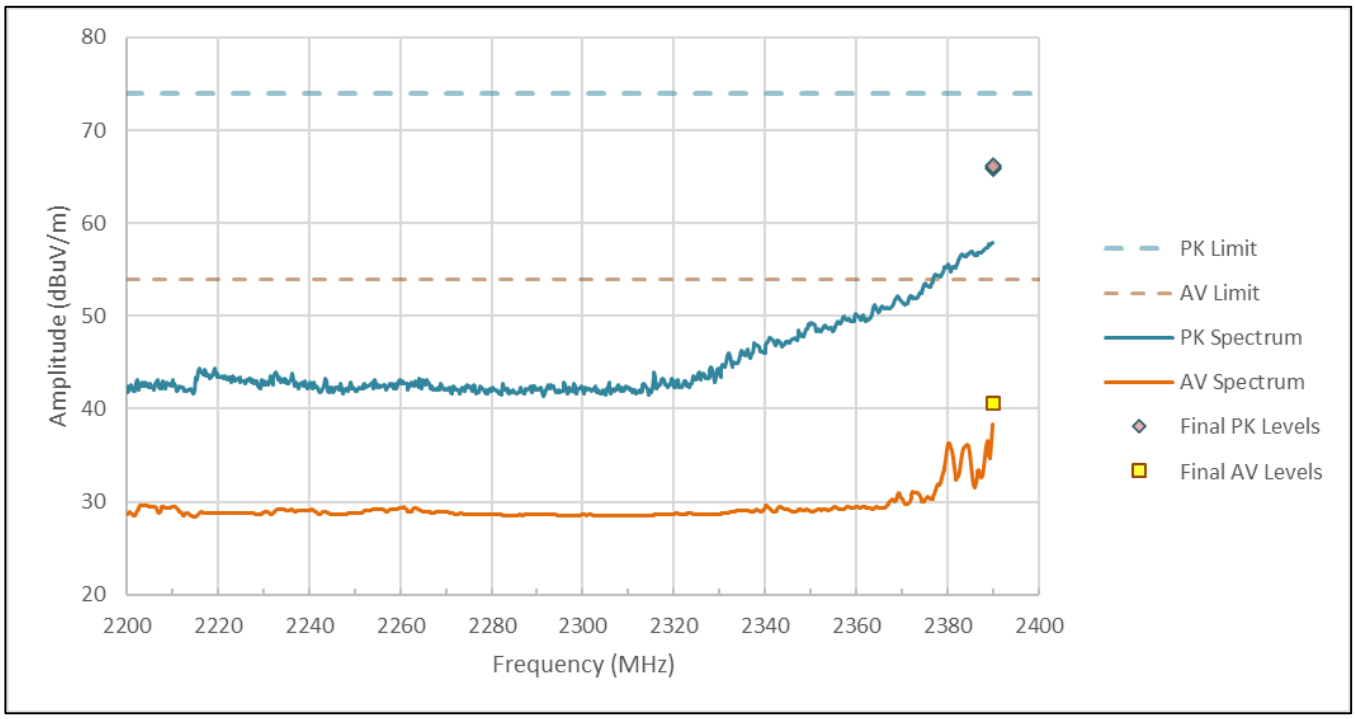



**Figure RE01.7: FCC restricted band spectral data from 2200 to 2390 MHz (CH2, B2)**

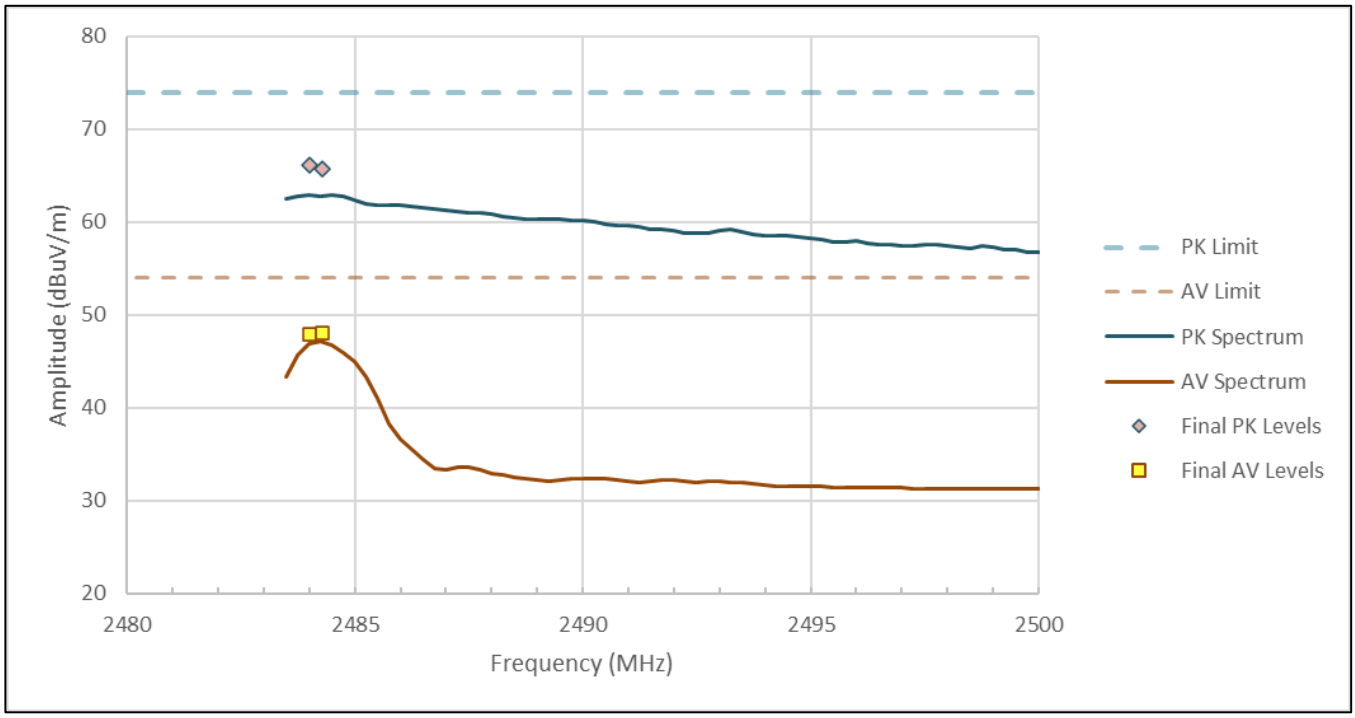



**Figure RE01.8: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH12, B2)**

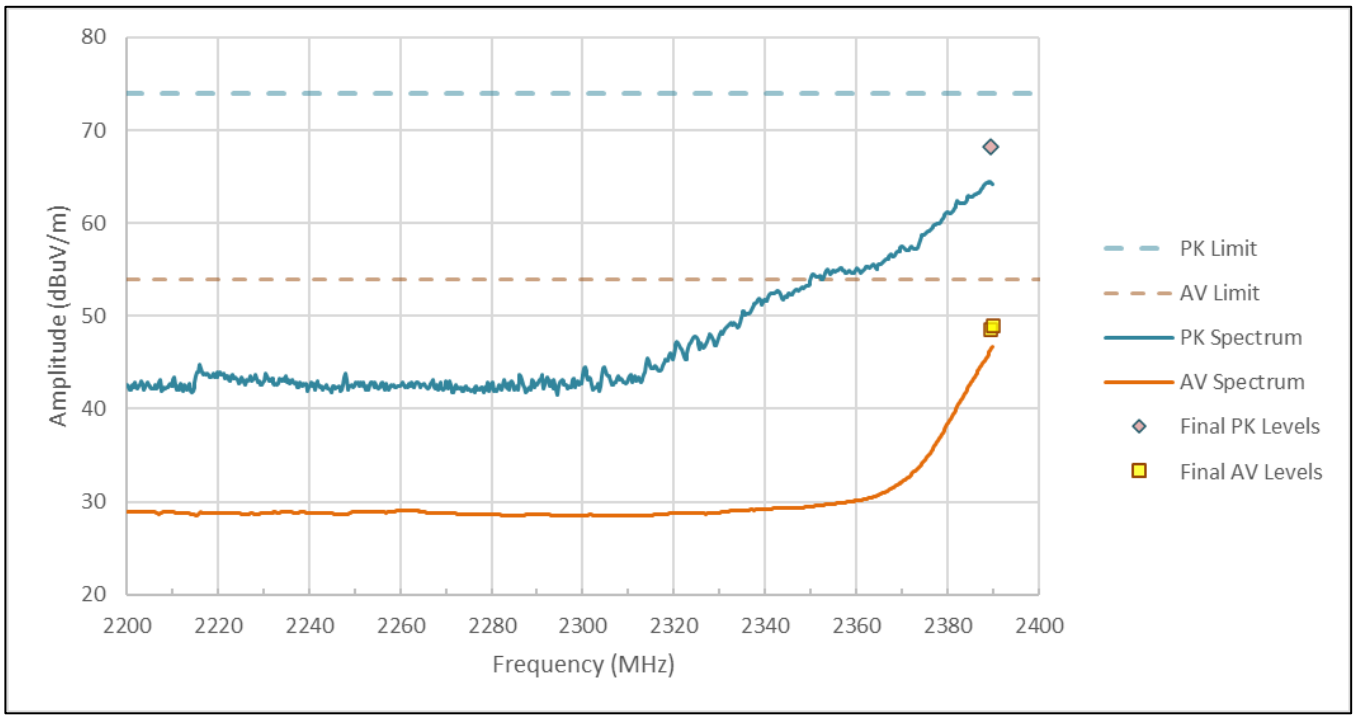



**Figure RE01.9: FCC restricted band spectral data from 2200 to 2390 MHz (CH2, G18)**

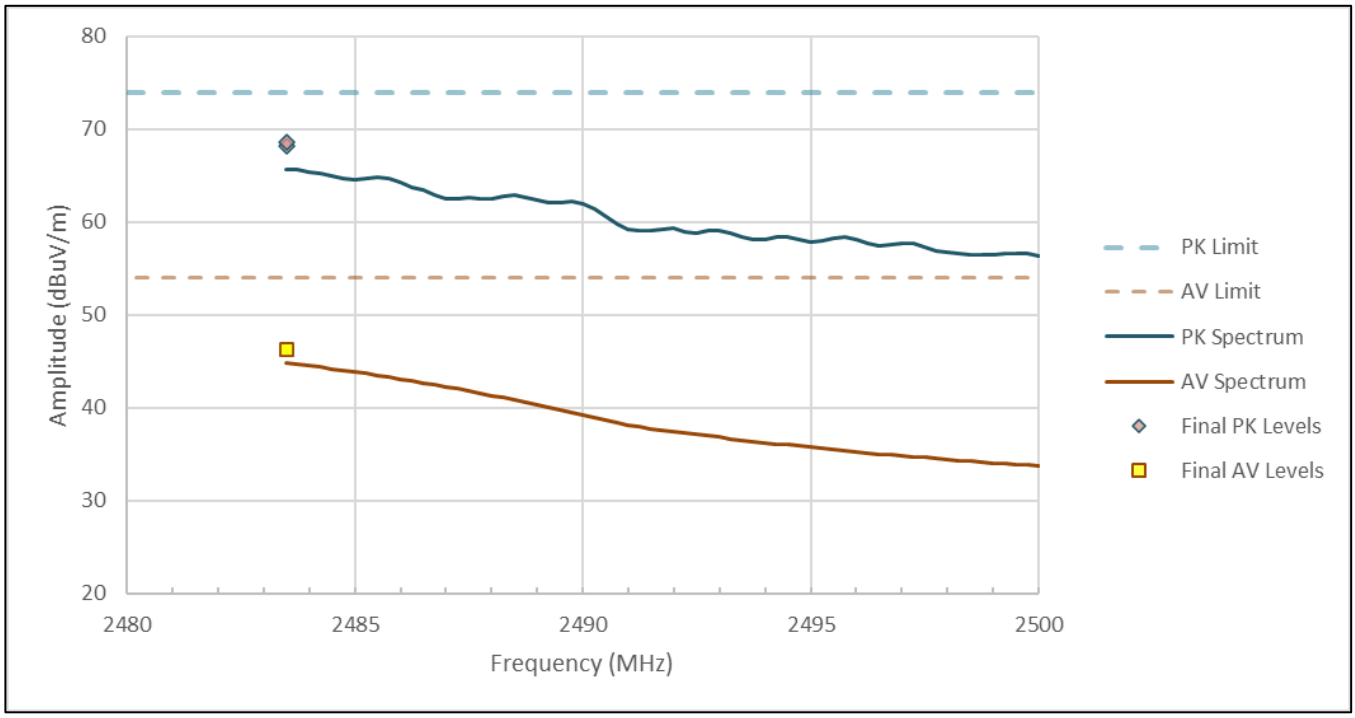



**Figure RE01.10: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH12, G18)**

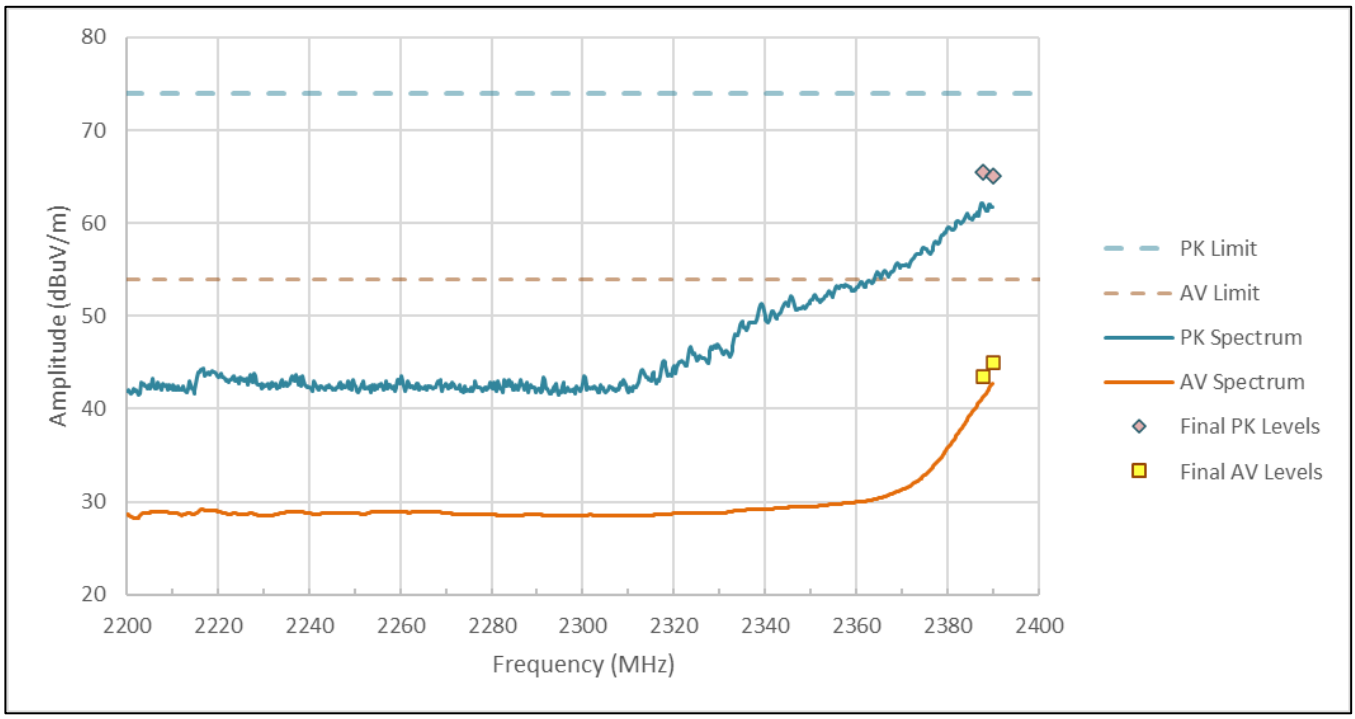



**Figure RE01.11: FCC restricted band spectral data from 2200 to 2390 MHz (CH 2, N6)**

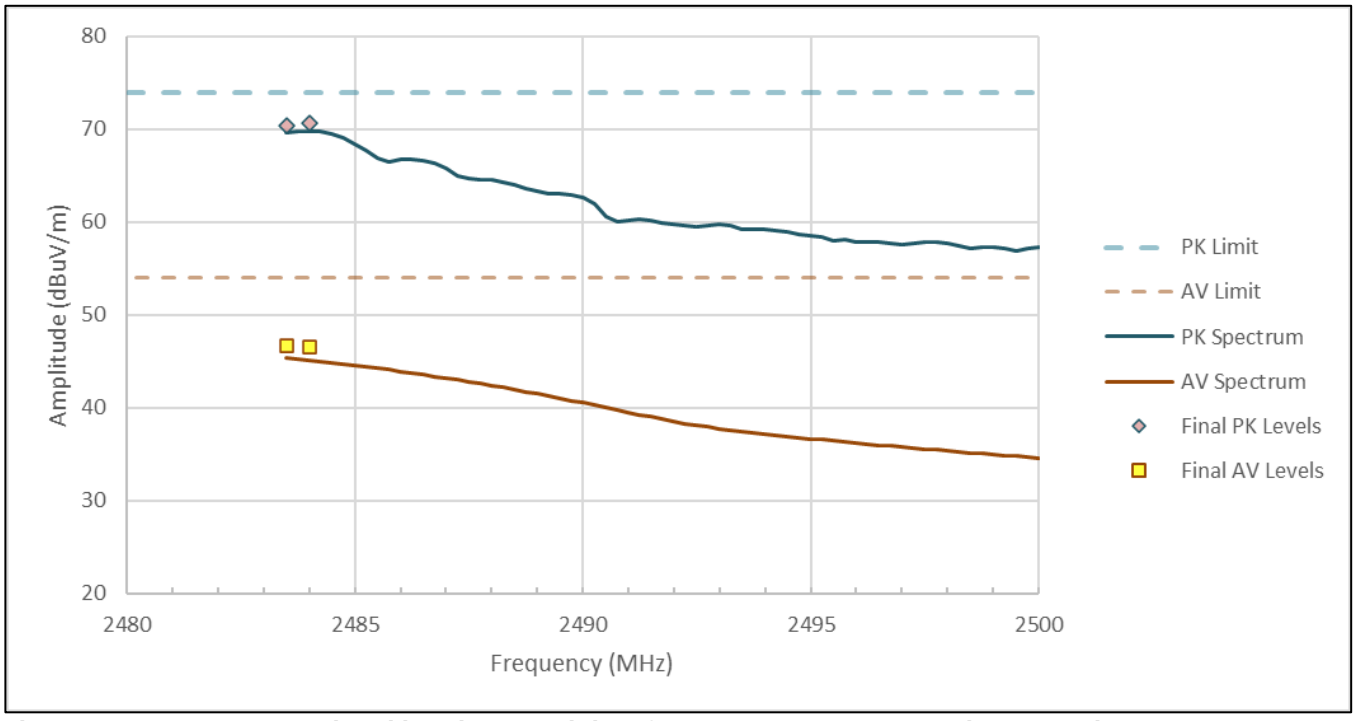



**Figure RE01.12: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH 12, N6)**

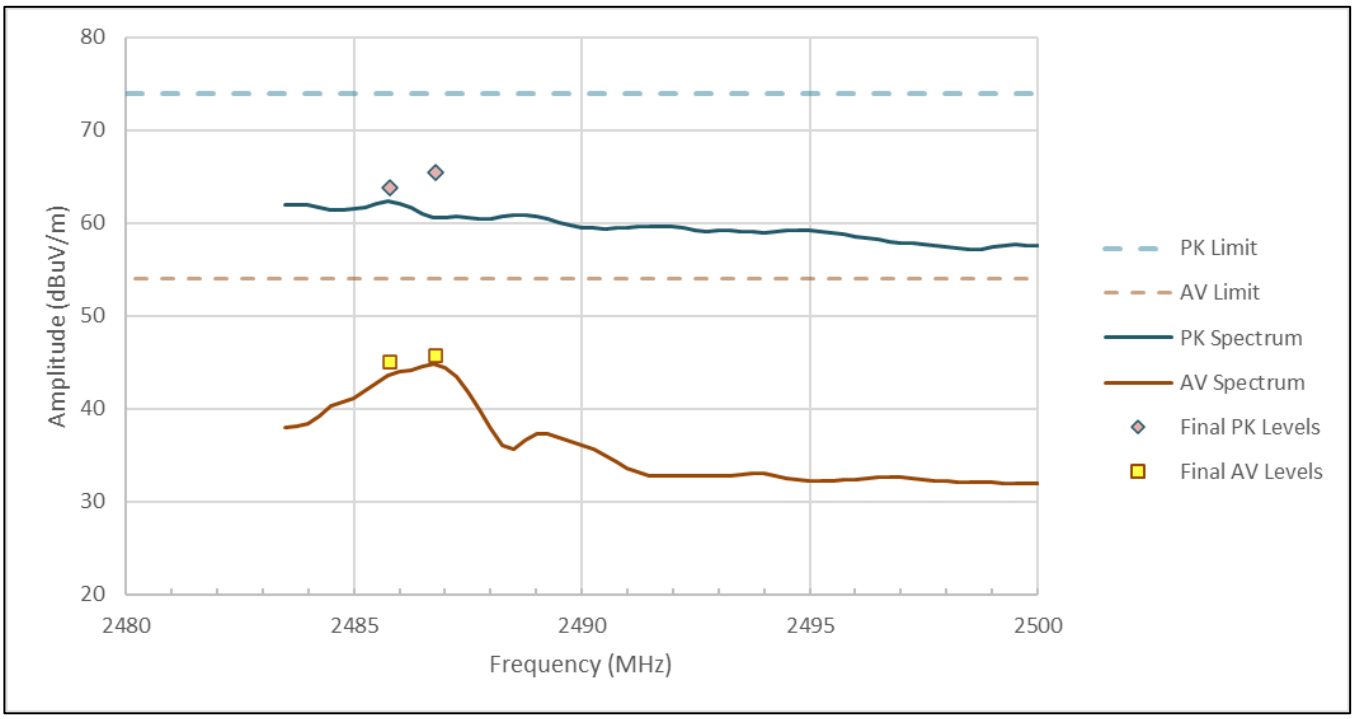



**Figure RE01.13: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH 13, B2)**

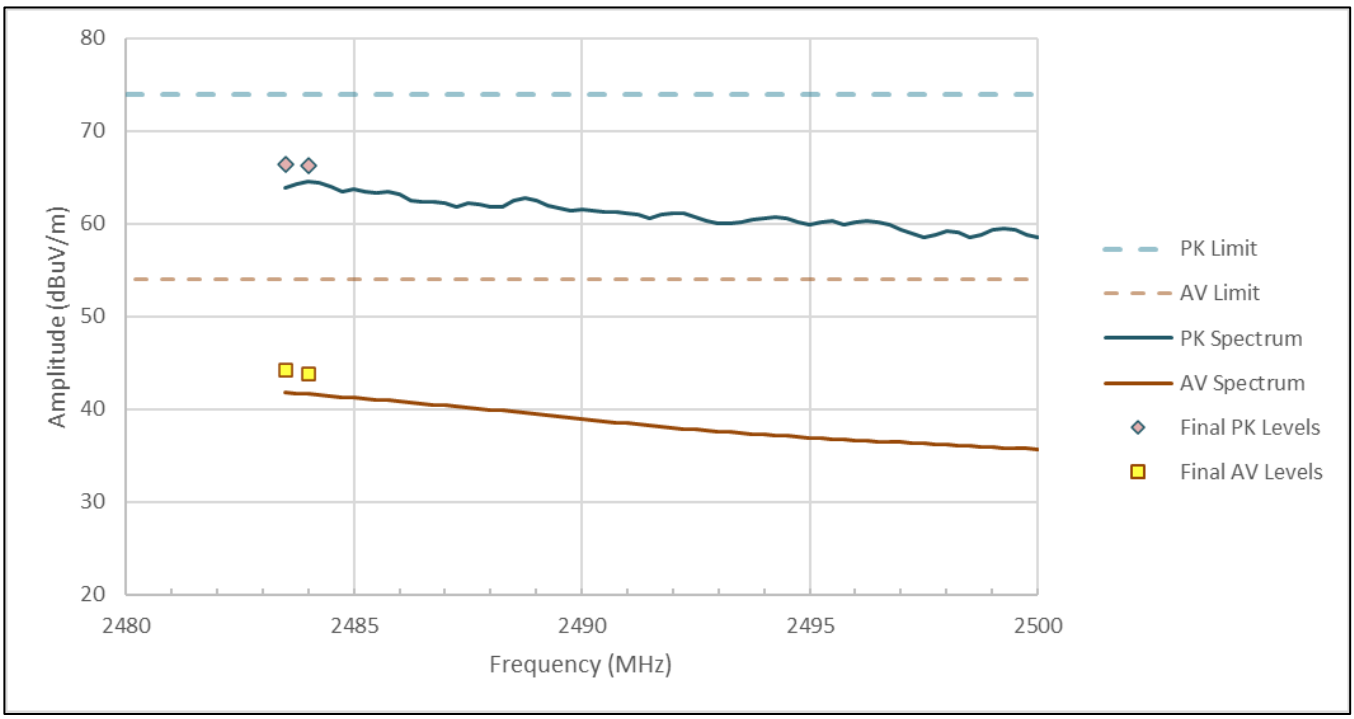



**Figure RE01.14: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH 13, G18)**

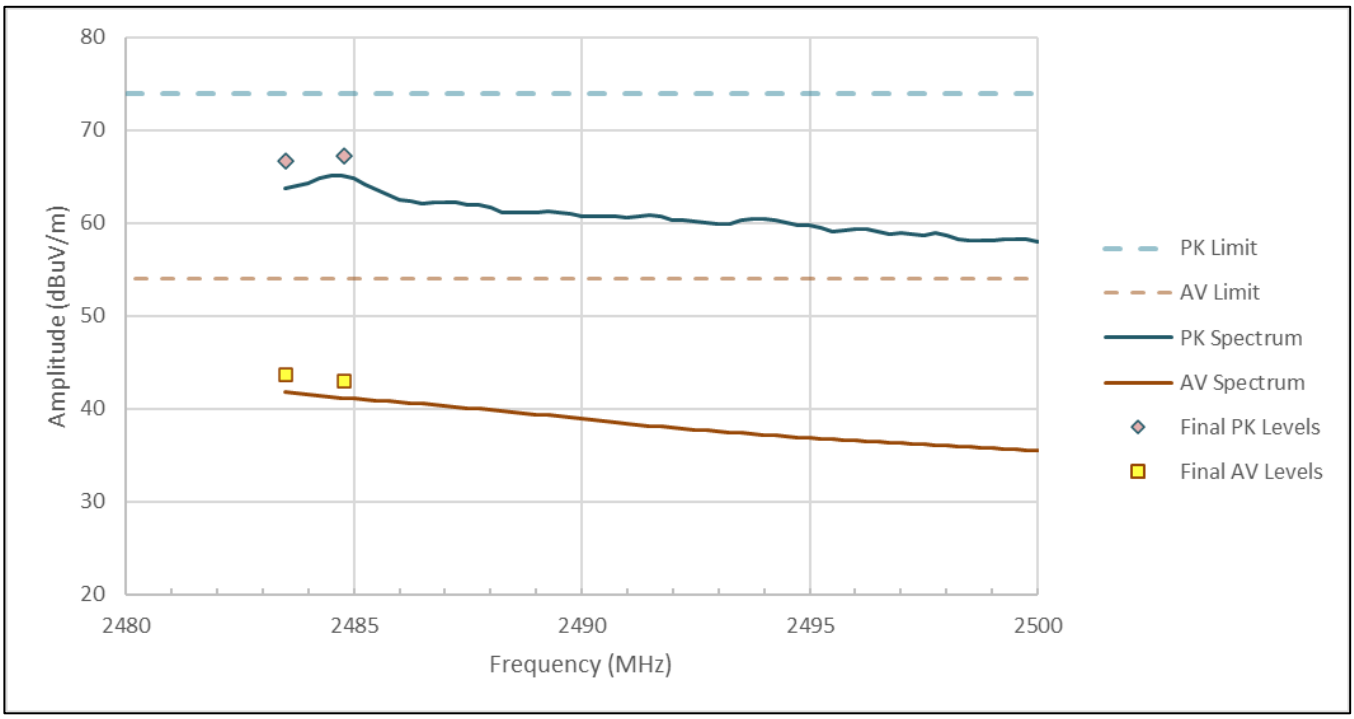



**Figure RE01.15: FCC restricted band spectral data from 2483.5 to 2500 MHz (CH 13, N6)**

### Setup Photographs

The following photographs show the EUT configured and arranged in the manner in which it was measured.

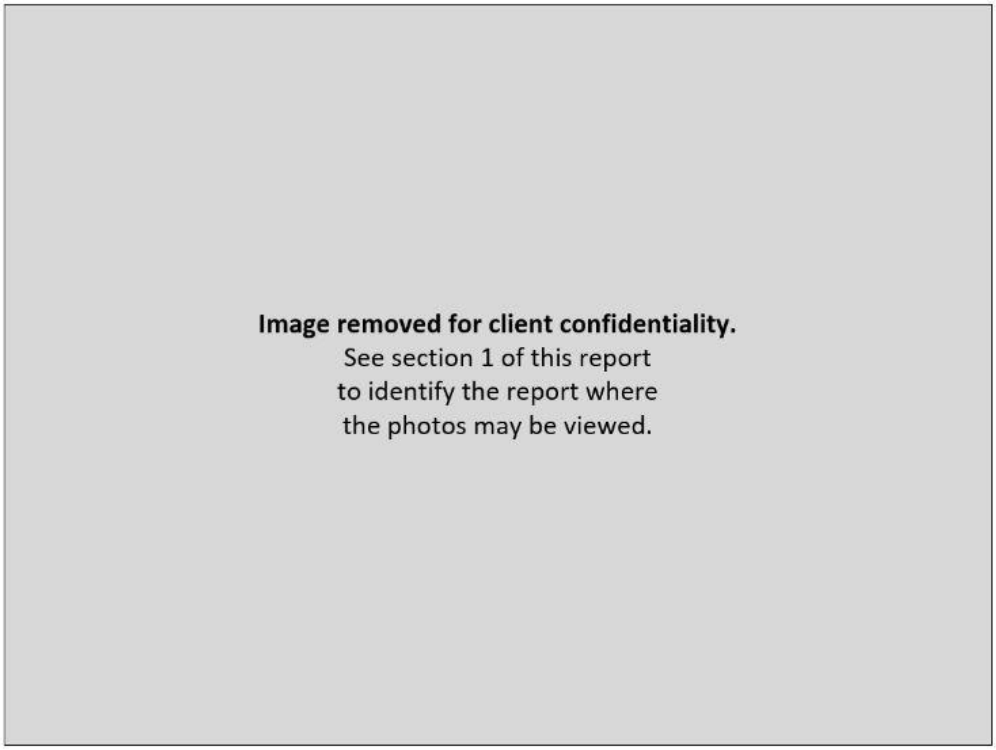



**Figure RE01.16: EUT test setup, primary view**

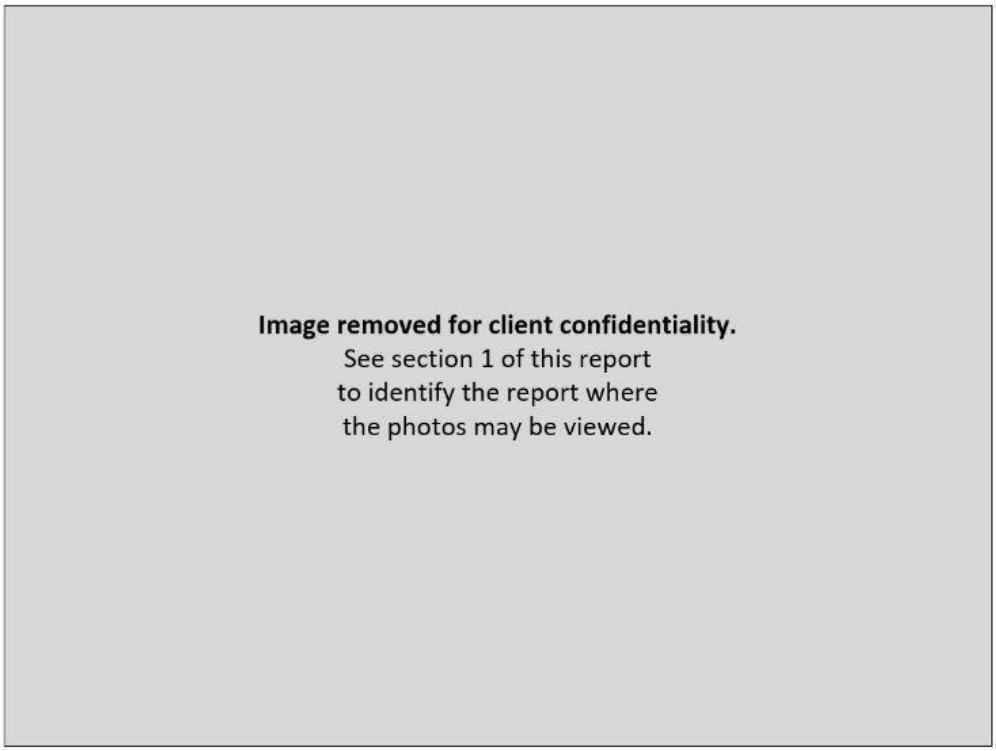



**Figure RE01.17: EUT test setup, reverse view**

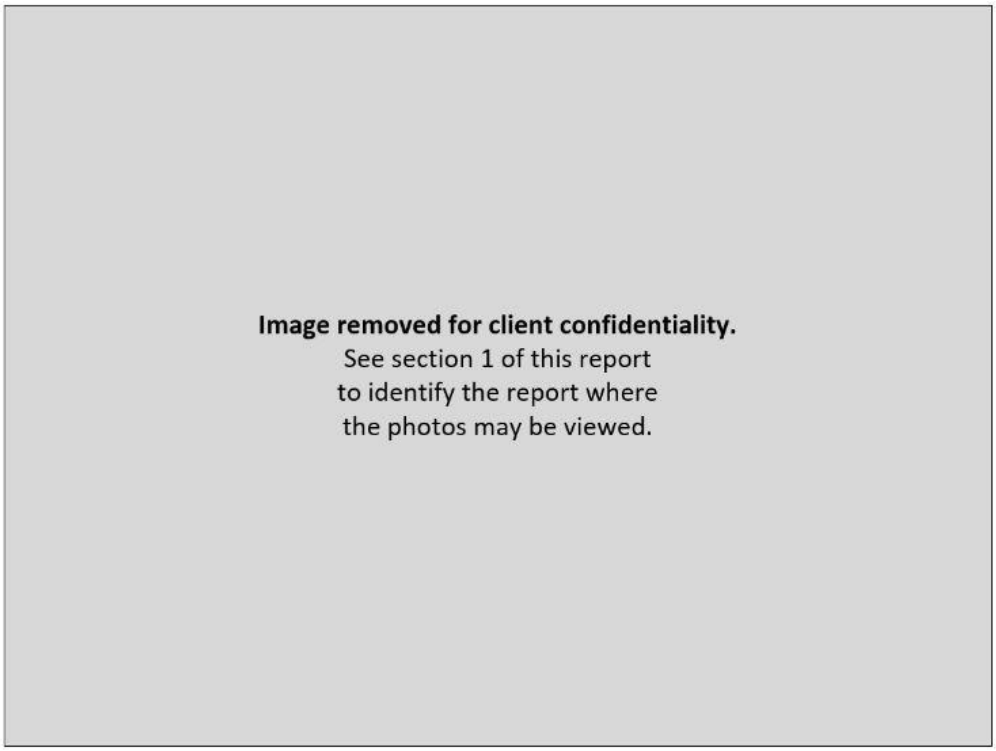



**Figure RE01.18: EUT test setup, primary view ( X orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE02**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 11 Sep 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M1 (BtTx) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report) |
| Frequency Range: | Restricted Bands (2200-2300 MHz, 2310-2390 MHz, 2483.5-2500 MHz) |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 11 Sep 2024 |

Original record, Version A.

### Test Equipment

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 1-Oct-2024 |
| Antenna, Horn, 1-18 GHz | ETS Lindgren | 3117 | 00259208 | 30-May-2024 | 30-May-2026 |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Tape measure, 1" x 33' | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| Preamplifier, 500 MHz 18 GHz | Com-Power | PAM-118A | 18040133 | Calibration | Not Required |
| Wifi Filter | K&L | 8NSL26-2437/E82.2-0 | 1 | Calibration | Not Required |

**Table RE02.1: Test Equipment Used**

### Software Used
Keysight PXE receiver software A.32.06, Signal Maximization Tool v2024Jul31.xlsx.

### Test Data

This restricted band investigation began with a benchtop setup wherein the emissions in the restricted bands were observed from a modified test sample with an RF output cable replacing the onboard antenna. The actual emission levels within restricted bands in many of the test sample's available transmission modes are too low to be reliably measured in the radiated environment. By applying the required peak and average detectors and bandwidths to the signals direct from the transmitter, lab staff identified the worst-case operational modes. These were then measured using an unmodified unit in the required radiated environment.

The radiated emission test began with a preliminary scan in each restricted band at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Final field strength measurements were taken in that set of positions.

Restricted band measurements in the lower band were made while the transmitter was tuned to its lowest frequency of 2402 MHz for the 1 Mbps data rate, and 2404 MHz for the 2 Mbps data rate. Measurements in the upper band were made while the transmitter was tuned to its highest frequency of 2480 MHz for the 1 Mbps data rate, and 2478 MHz for the 2 Mbps data rate.

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The tables show the selected final measurement data between the FCC restricted bands. It includes the strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC restricted band Class B Limit at 3m.

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2216.3 | 54 | 74 | 31.26 | 47.20 | 22.74 | 26.80 | 166 | 1708 | HORZ |
| 2210 | 54 | 74 | 32.25 | 45.17 | 21.75 | 28.84 | 166 | 1708 | HORZ |

**Table RE02.2: FCC restricted bands from 2200 to 2390 MHz (2402MHz, EDR3)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2483.5 | 54 | 74 | 35.26 | 59.59 | 18.75 | 14.41 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 35.26 | 59.68 | 18.74 | 14.32 | 127 | 1261 | HORZ |

**Table RE02.3: FCC restricted band from 2483.5 to 2500 MHz (2480MHz, EDR3)**

The graphs below show the background spectrum observed during pre-scan, as well as the final data points from the table above.

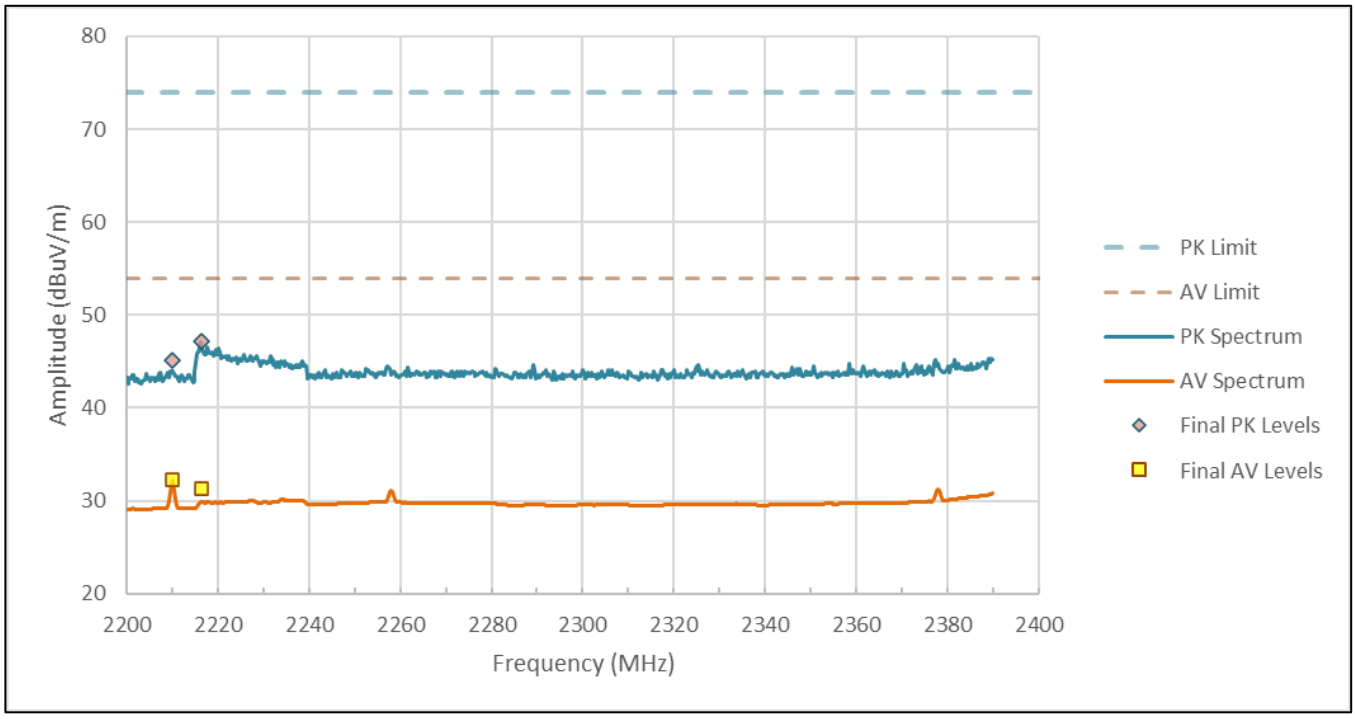



**Figure RE02.1: FCC restricted band spectral data from 2200 to 2390 MHz (2402MHz, EDR3)**

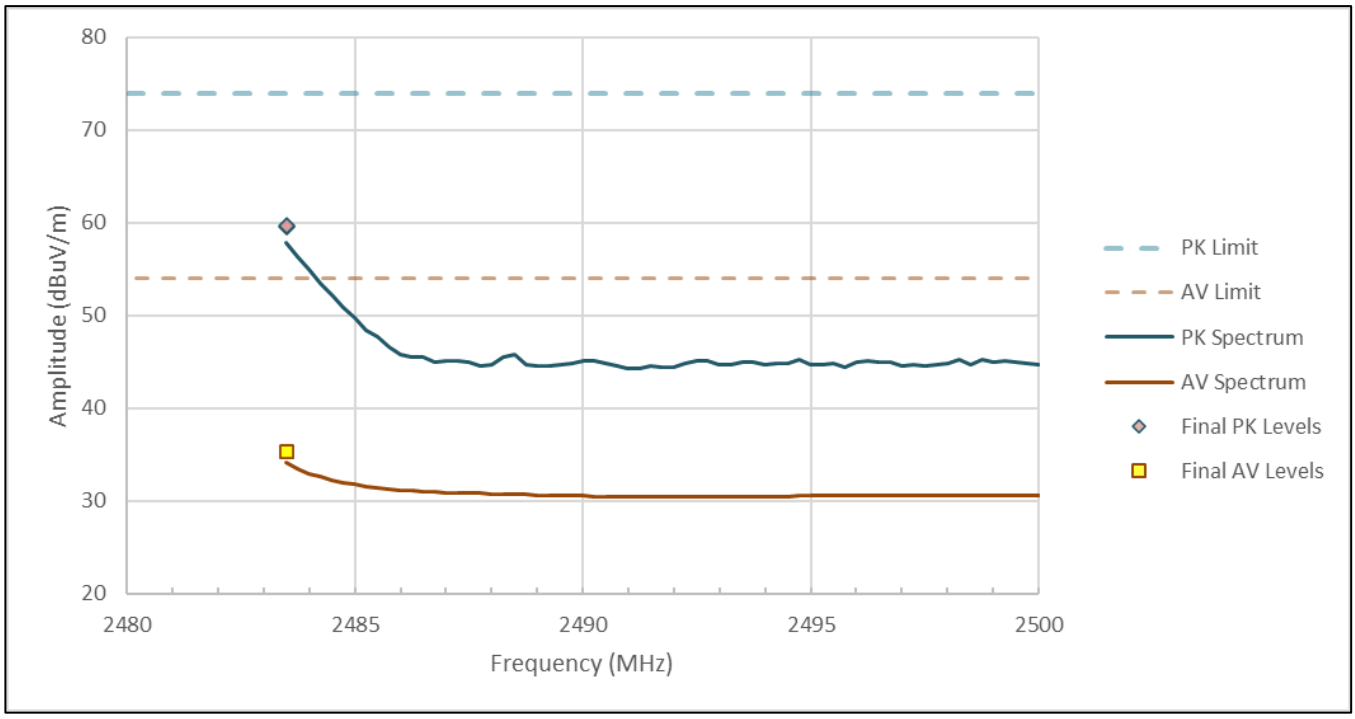



**Figure RE02.2: FCC restricted band spectral data from 2483.5 to 2500 MHz (2480MHz,EDR3)**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure RE02.3: EUT test setup, primary view**

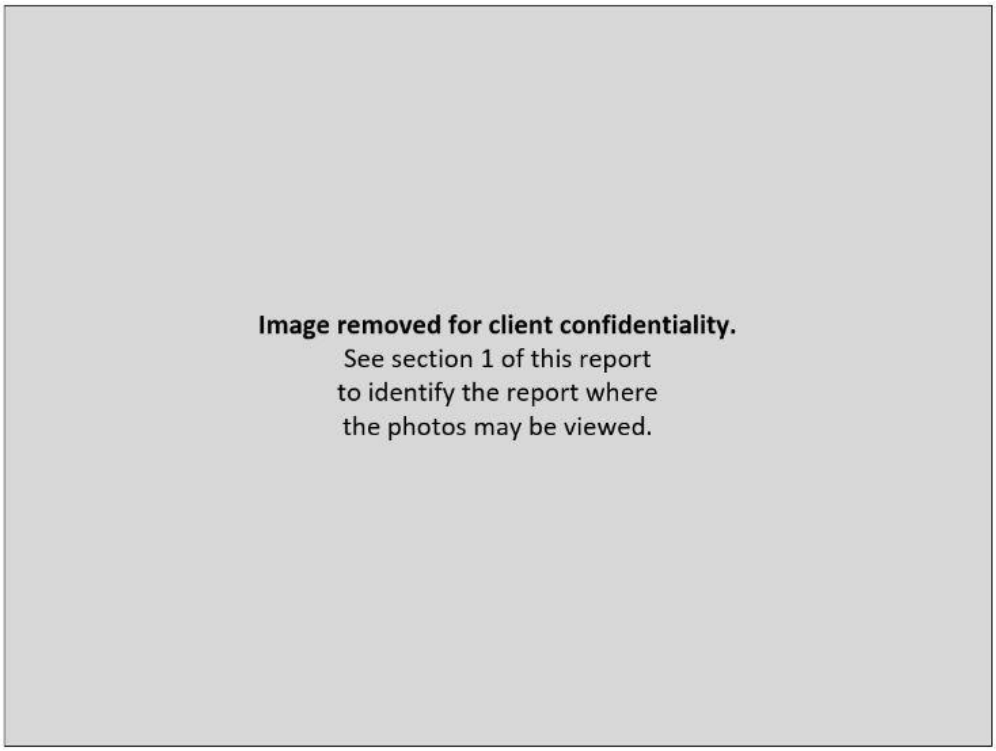



**Figure RE02.4: EUT test setup, reverse view**

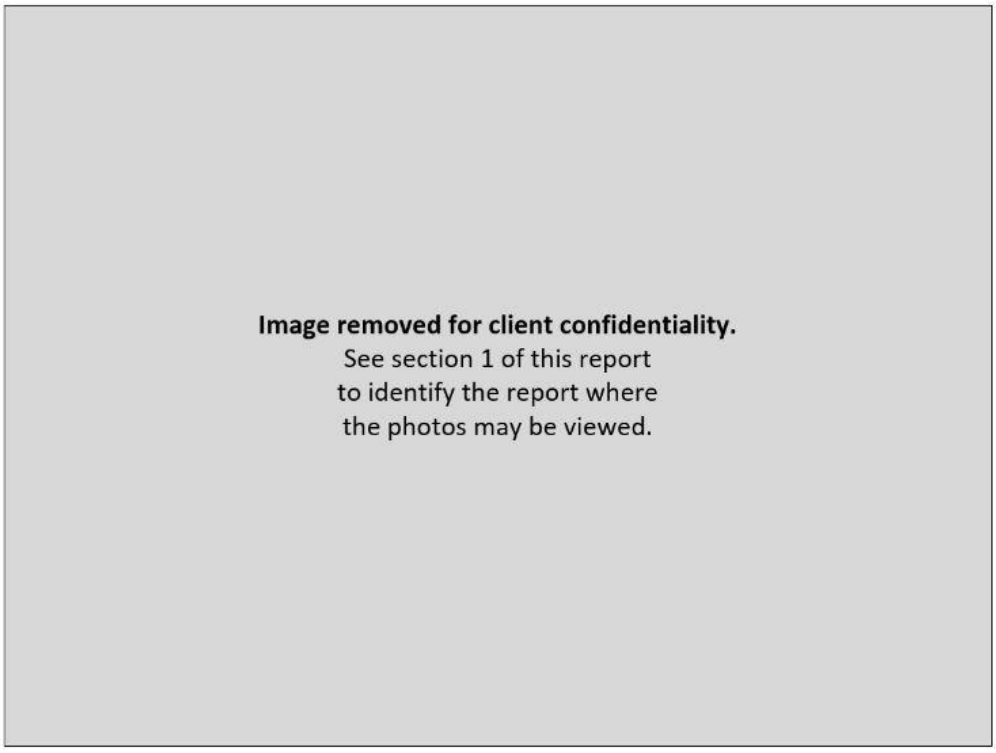



**Figure RE02.5: EUT test setup, primary view ( X orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE03**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 11 Sep 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M3 (BleTx) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report) |
| Frequency Range: | Restricted Bands (2200-2300 MHz, 2310-2390 MHz, 2483.5-2500 MHz) |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 11 Sep 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 1-Oct-2024 |
| Antenna, Horn, 1-18 GHz | ETS Lindgren | 3117 | 00259208 | 30-May-2024 | 30-May-2026 |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Tape measure, 1" x 33' | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| Preamplifier, 500 MHz 18 GHz | Com-Power | PAM-118A | 18040133 | Calibration | Not Required |
| Wifi Filter | K&L | 8NSL26-2437/E82.2-0 | 1 | Calibration | Not Required |

**Table RE03.1: Test Equipment Used**

**Software Used**
Keysight PXE receiver software A.32.06, Signal Maximization Tool v2024Jul31.xlsx.

**Test Data**

This restricted band investigation began with a benchtop setup wherein the emissions in the restricted bands were observed from a modified test sample with an RF output cable replacing the onboard antenna. The actual emission levels within restricted bands in many of the test sample's available transmission modes are too low to be reliably measured in the radiated environment. By applying the required peak and average detectors and bandwidths to the signals direct from the transmitter, lab staff identified the worst-case operational modes. These were then measured using an unmodified unit in the required radiated environment.

The radiated emission test began with a preliminary scan in each restricted band at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Final field strength measurements were taken in that set of positions.

Restricted band measurements in the lower band were made while the transmitter was tuned to its lowest frequency of 2402 MHz for the 1 Mbps data rate, and 2404 MHz for the 2 Mbps data rate.

Measurements in the upper band were made while the transmitter was tuned to its highest frequency of 2480 MHz for the 1 Mbps data rate, and 2478 MHz for the 2 Mbps data rate.

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The tables show the selected final measurement data between the FCC restricted bands. It includes the strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC restricted band Class B Limit at 3m.

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2216.3 | 54 | 74 | 30.80 | 46.09 | 23.20 | 27.92 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 31.88 | 45.61 | 22.12 | 28.39 | 166 | 1708 | HORZ |

**Table RE03.2: FCC restricted bands from 2200 to 2390 MHz (2402MHz, 1Mb)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2483.8 | 54 | 74 | 32.48 | 47.22 | 21.52 | 26.78 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 32.55 | 47.49 | 21.45 | 26.51 | 127 | 1261 | HORZ |

**Table RE03.3: FCC restricted band from 2483.5 to 2500 MHz (2480MHz,1Mb)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2215.8 | 54 | 74 | 30.57 | 45.87 | 23.44 | 28.13 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 31.85 | 45.44 | 22.15 | 28.56 | 166 | 1708 | HORZ |

**Table RE03.4: FCC restricted bands from 2200 to 2390 MHz (2404MHz, 2Mb)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2489.8 | 54 | 74 | 31.83 | 45.79 | 22.17 | 28.21 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 32.39 | 46.62 | 21.61 | 27.38 | 127 | 1261 | HORZ |

**Table RE03.5: FCC restricted band from 2483.5 to 2500 MHz (2478MHz,2Mb)**

The graphs below show the background spectrum observed during pre-scan, as well as the final data points from the table above.

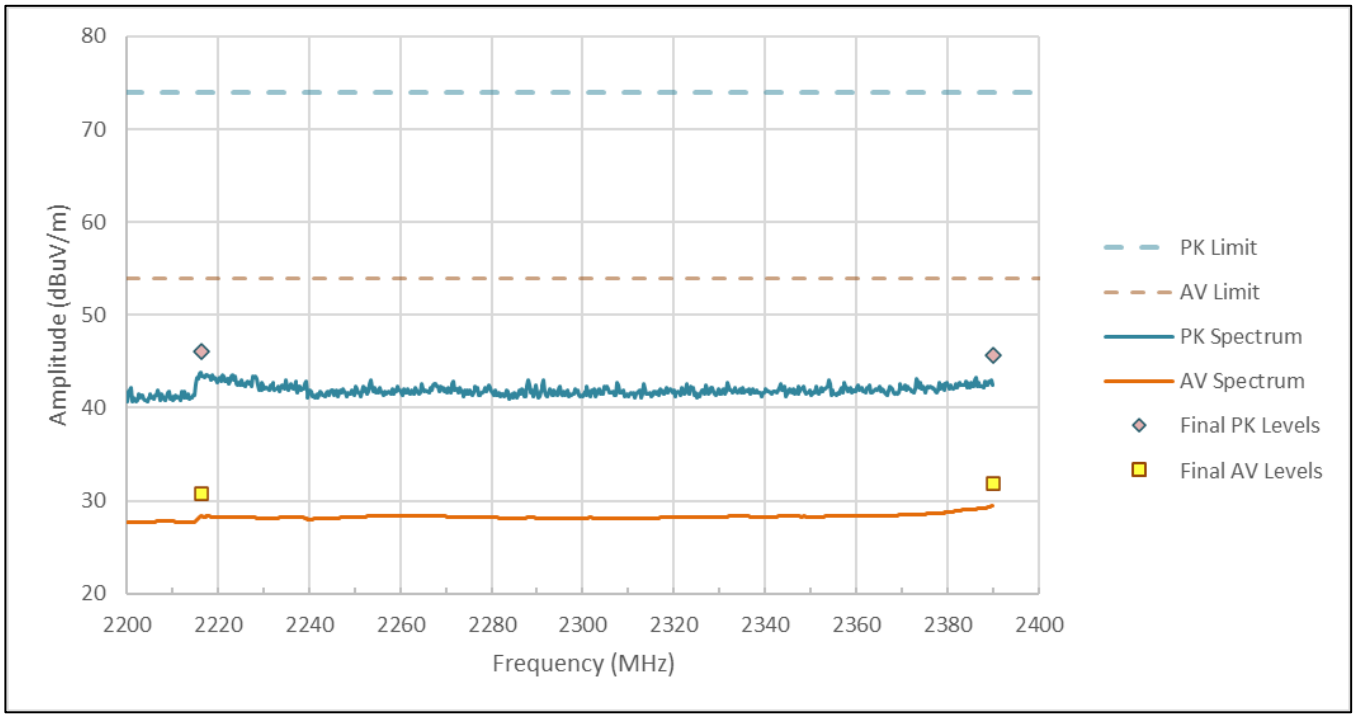



**Figure RE03.1: FCC restricted band spectral data from 2200 to 2390 MHz (2402MHz, 1Mb)**

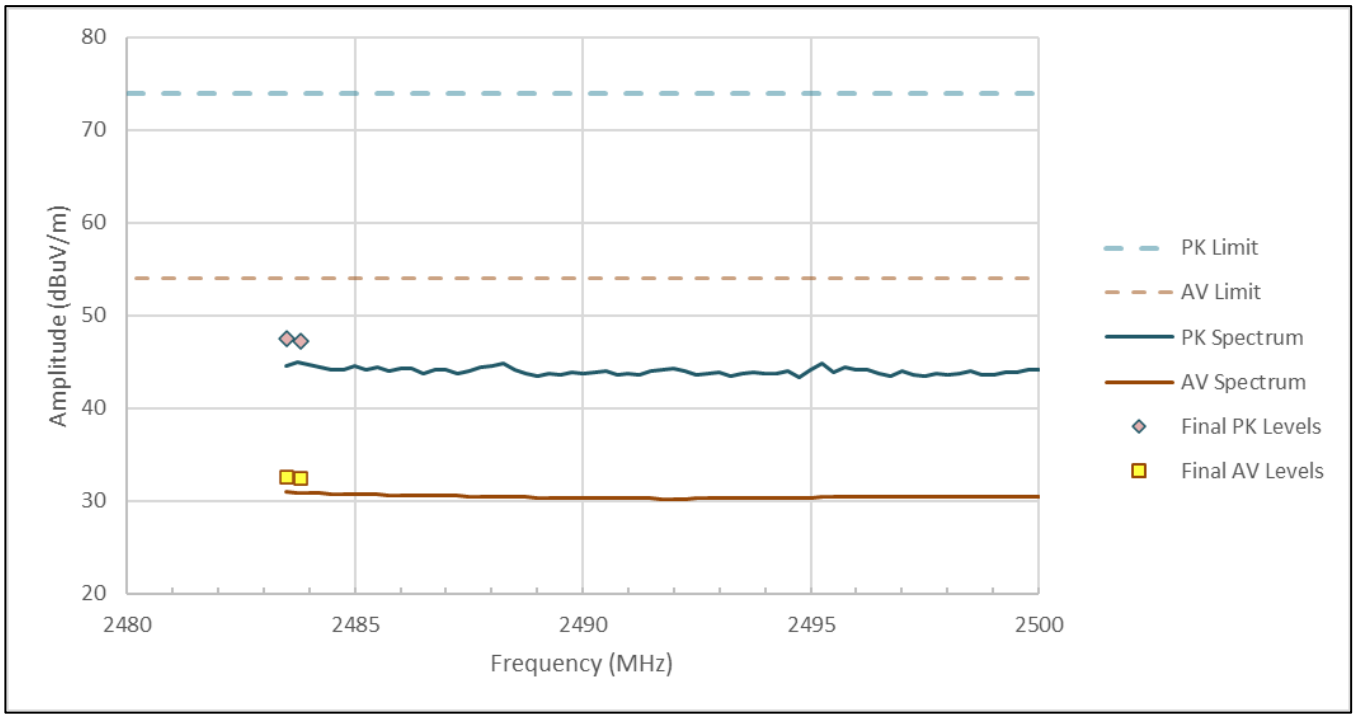



**Figure RE03.2: FCC restricted band spectral data from 2483.5 to 2500 MHz (2480MHz,1Mb)**

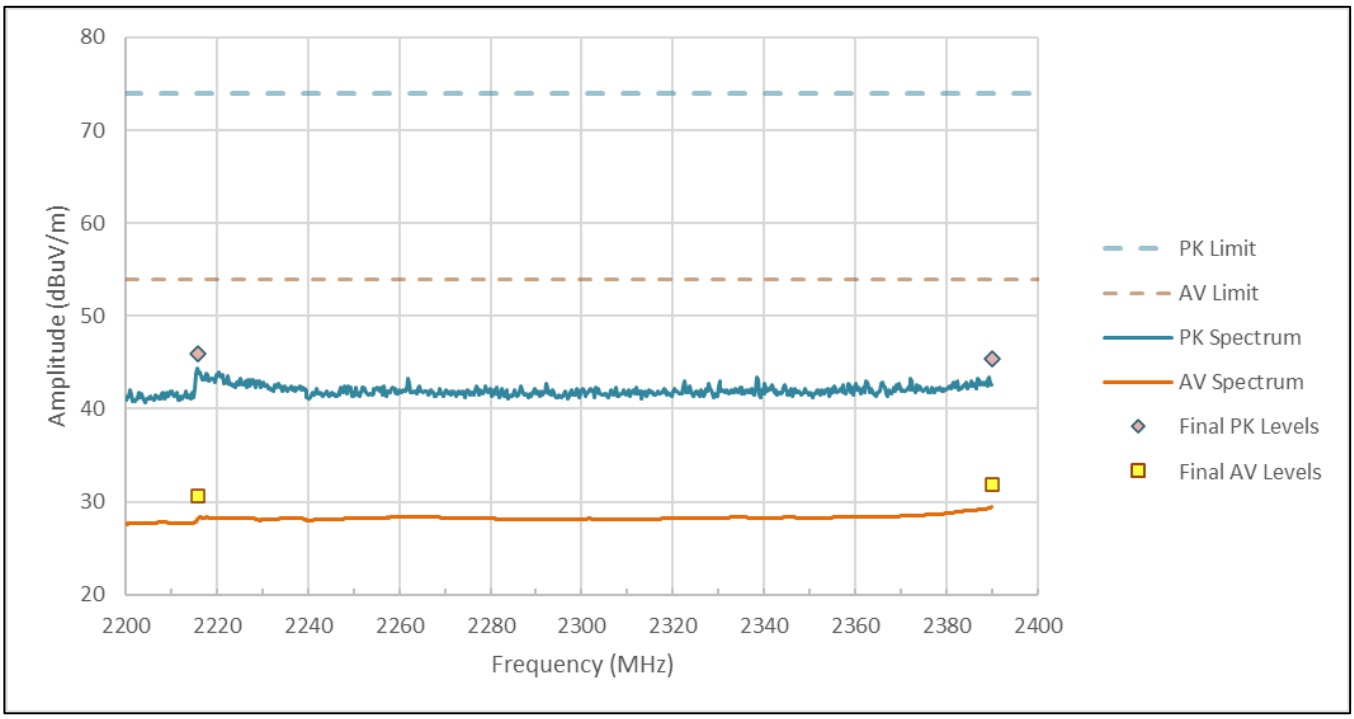



**Figure RE03.3: FCC restricted band spectral data from 2200 to 2390 MHz (2404MHz, 2Mb)**

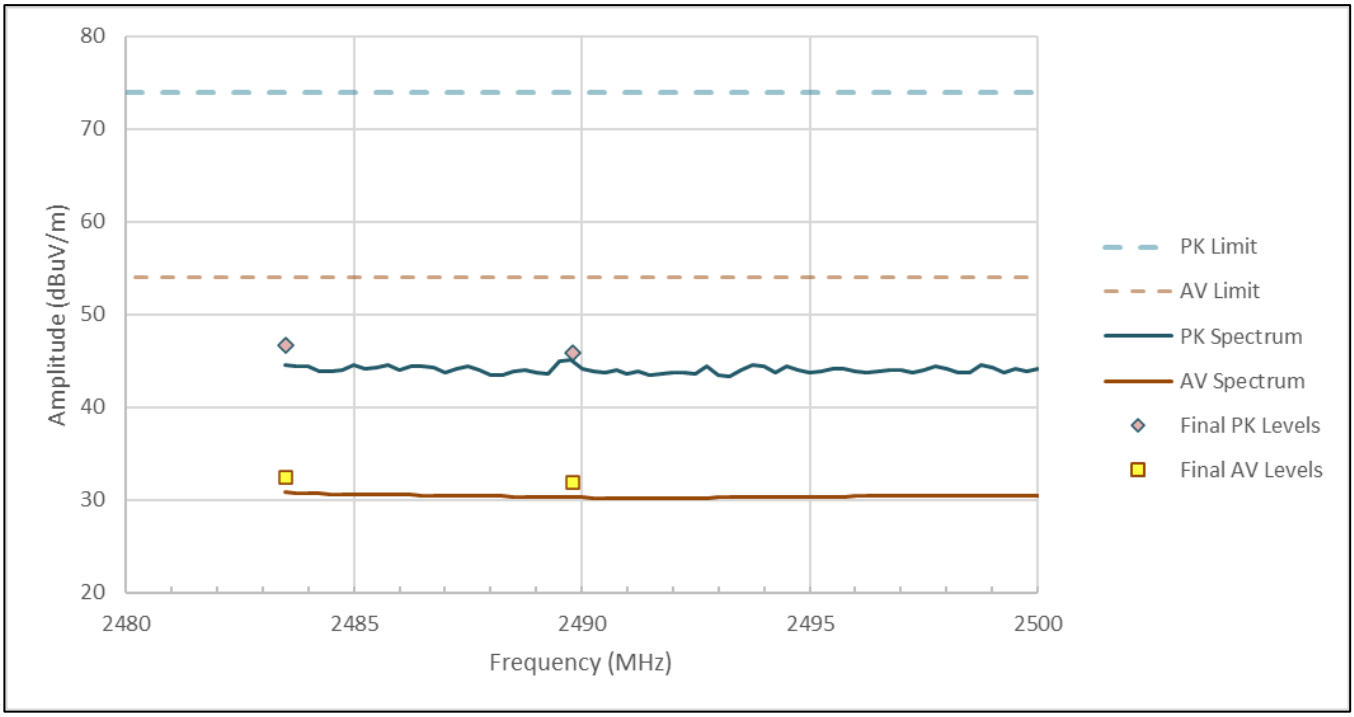



**Figure RE03.4: FCC restricted band spectral data from 2483.5 to 2500 MHz (2478MHz,2Mb)**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.

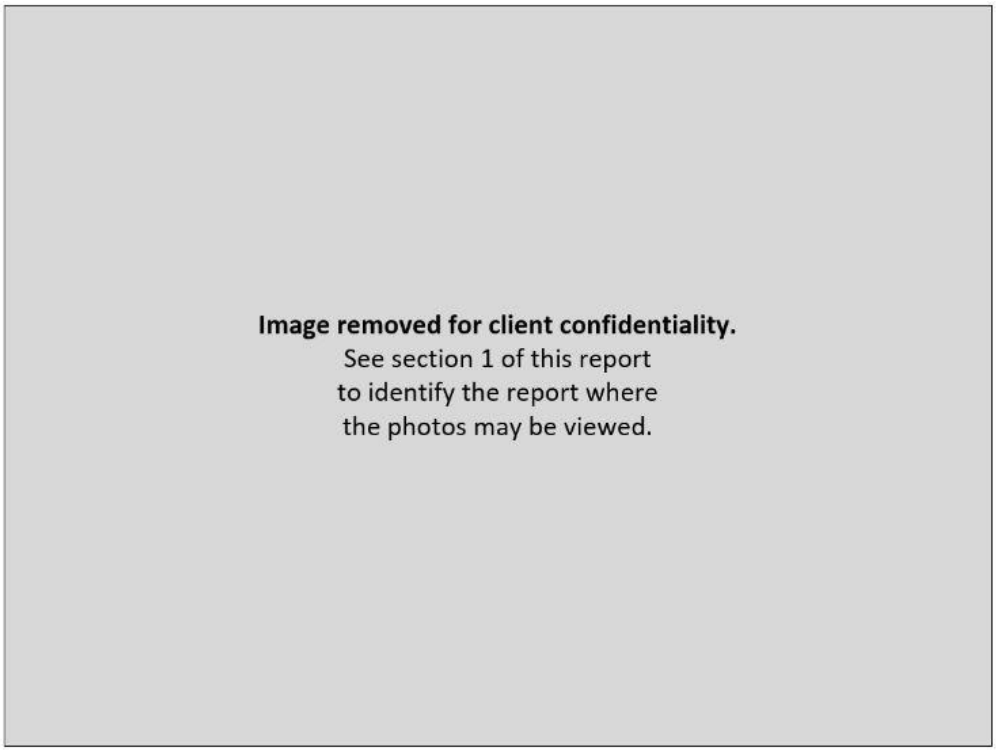



**Figure RE03.5: EUT test setup, primary view**

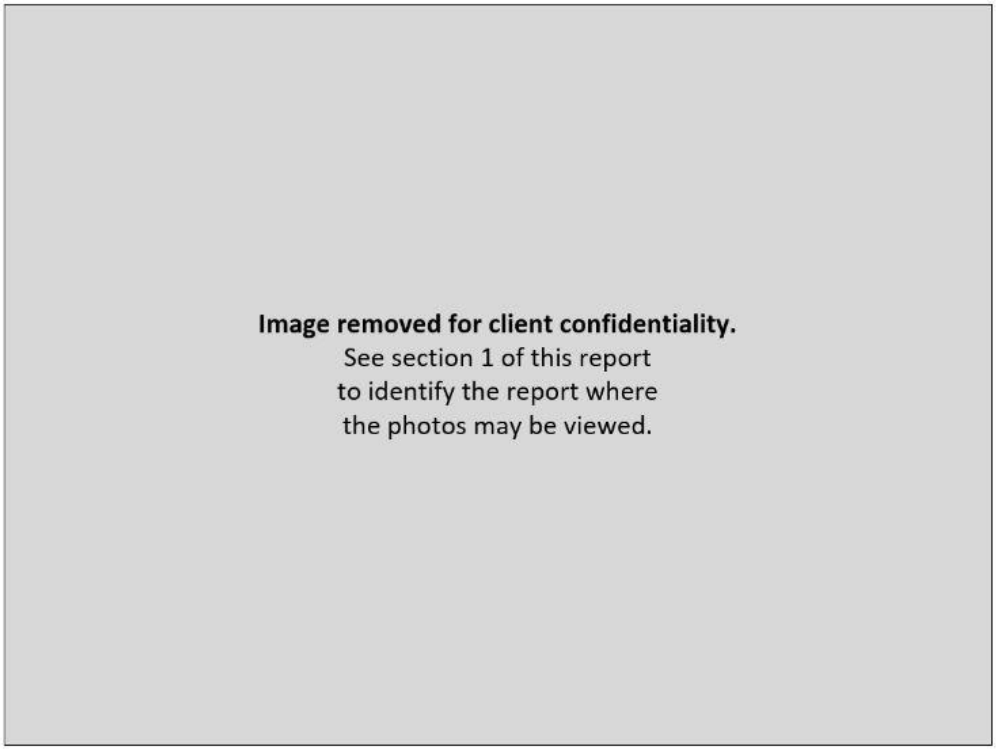



**Figure RE03.6: EUT test setup, reverse view**

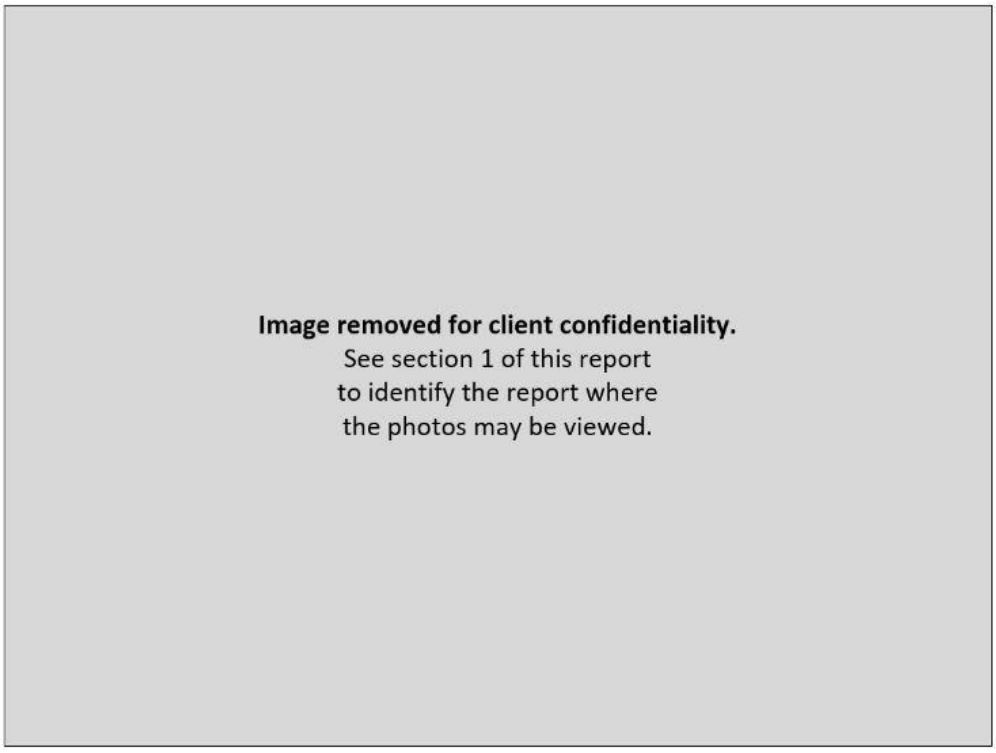



**Figure RE03.7: EUT test setup, primary view ( X orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE04**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 11 Sep 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M5 (AntTx) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15, RSS-GEN RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report) |
| Frequency Range: | Restricted Bands (2200-2300 MHz, 2310-2390 MHz, 2483.5-2500 MHz) |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 11 Sep 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 1-Oct-2024 |
| Antenna, Horn, 1-18 GHz | ETS Lindgren | 3117 | 259208 | 30-May-2024 | 30-May-2026 |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Tape measure, 1" x 33' | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| Preamplifier, 500 MHz 18 GHz | Com-Power | PAM-118A | 18040133 | Calibration | Not Required |
| GPS Filter | K&L | WSN-00445 | 7 | Calibration | Not Required |

**Table RE04.1: Test Equipment Used**

**Software Used**
Keysight PXE receiver software A.32.06, Signal Maximization Tool v2024Jul31.xlsx.

**Test Data**

This restricted band investigation began with a benchtop setup wherein the emissions in the restricted bands were observed from a modified test sample with an RF output cable replacing the onboard antenna. The actual emission levels within restricted bands in many of the test sample's available transmission modes are too low to be reliably measured in the radiated environment. By applying the required peak and average detectors and bandwidths to the signals direct from the transmitter, lab staff identified the worst-case operational modes. These were then measured using an unmodified unit in the required radiated environment.

The radiated emission test began with a preliminary scan in each restricted band at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Final field strength measurements were taken in that set of positions.

Restricted band measurements in the lower band were made while the transmitter was tuned to its lowest frequency of 2402 MHz. Measurements in the upper band were made while the transmitter was tuned to its highest frequency of 2480 MHz.

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The tables show the selected final measurement data between the FCC restricted bands. It includes the strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC restricted band Class B Limit at 3m.

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2216.5 | 54 | 74 | 30.78 | 46.54 | 23.22 | 27.46 | 166 | 1708 | HORZ |
| 2390 | 54 | 74 | 31.85 | 45.62 | 22.15 | 28.39 | 166 | 1708 | HORZ |

**Table RE04.2: FCC restricted bands from 2200 to 2390 MHz (2402MHz, ANT)**

| Frequency | Avg Limit | Pk Limit | Avg Level | Pk Level | Av Margin | Pk Margin | Azimuth | Height | Polarity |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dBµV/m) | (dB) | (dB) | (degree) | (mm) | --- |
| 2484.3 | 54 | 74 | 32.33 | 46.21 | 21.67 | 27.79 | 127 | 1261 | HORZ |
| 2483.5 | 54 | 74 | 32.54 | 46.79 | 21.47 | 27.21 | 127 | 1261 | HORZ |

**Table RE04.3: FCC restricted band from 2483.5 to 2500 MHz (2480MHz, ANT)**

The graphs below show the background spectrum observed during pre-scan, as well as the final data points from the table above.

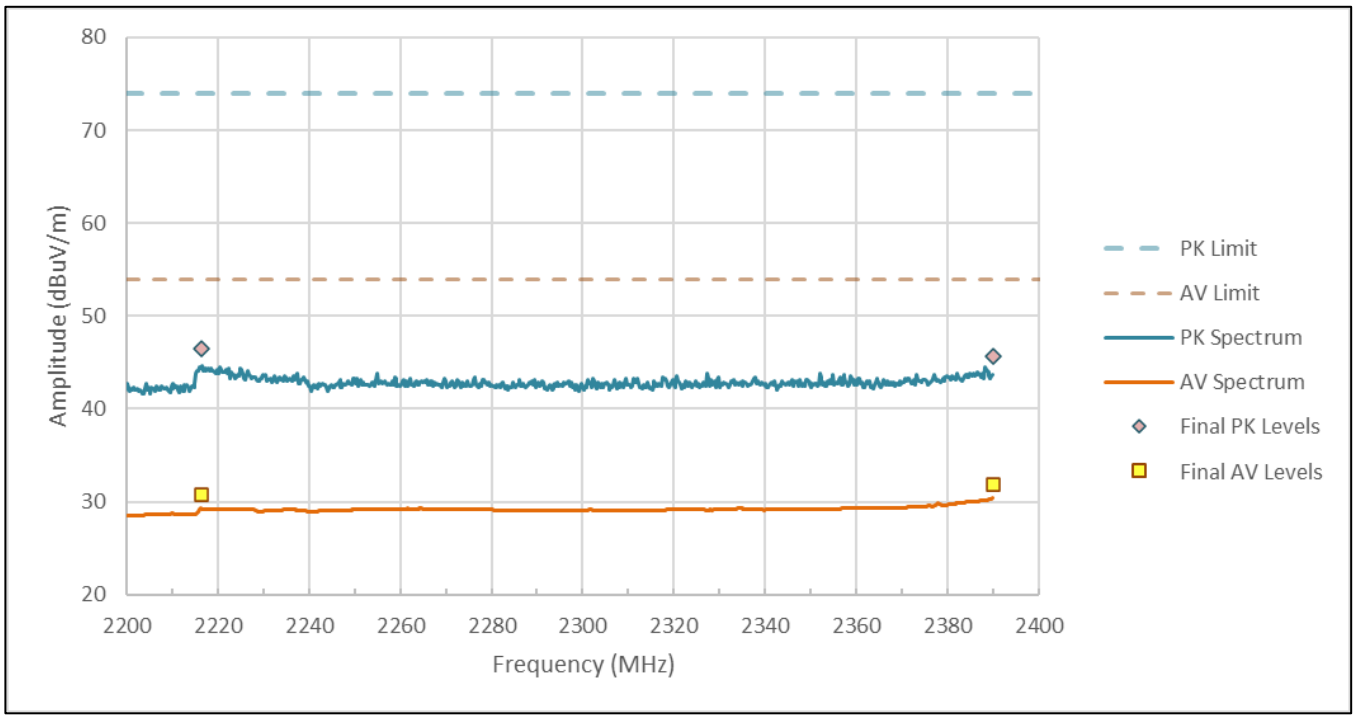



**Figure RE04.1: FCC restricted band spectral data from 2200 to 2390 MHz (2402MHz, ANT)**

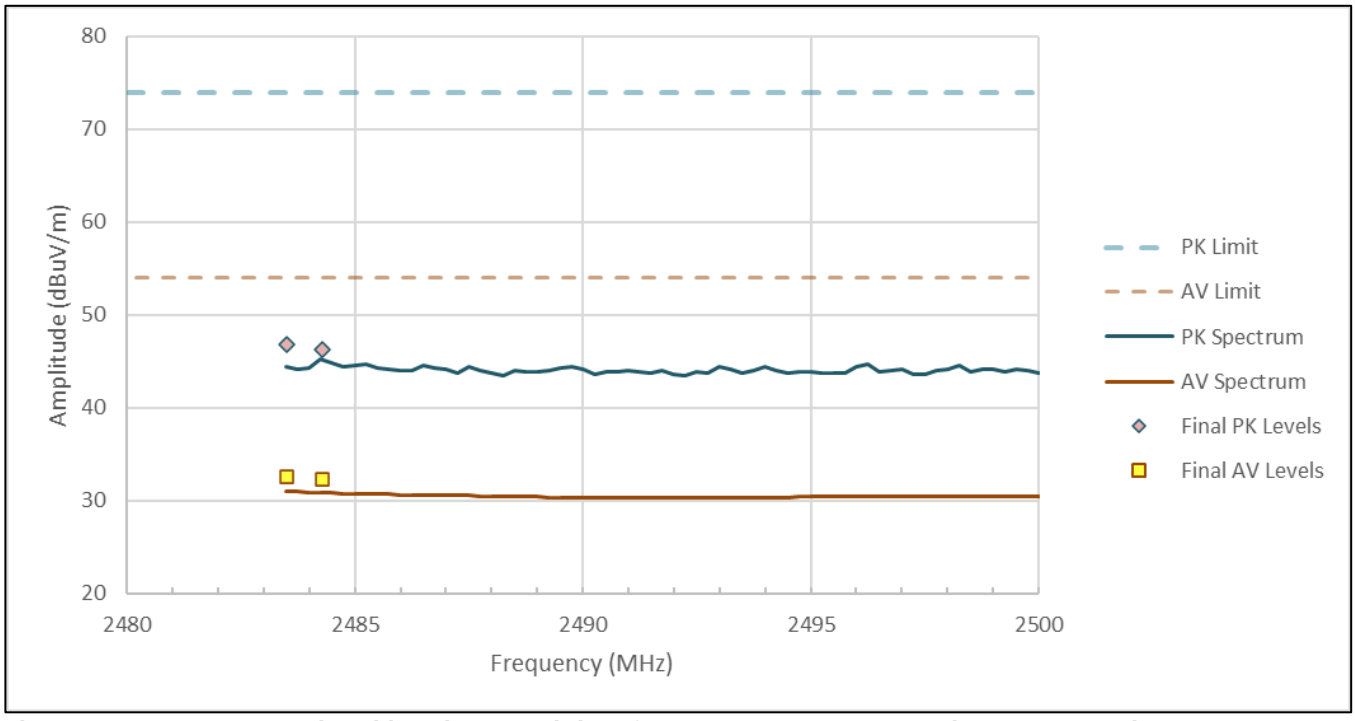



**Figure RE04.2: FCC restricted band spectral data from 2483.5 to 2500 MHz (2480MHz,ANT)**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure RE04.3: EUT test setup, primary view**

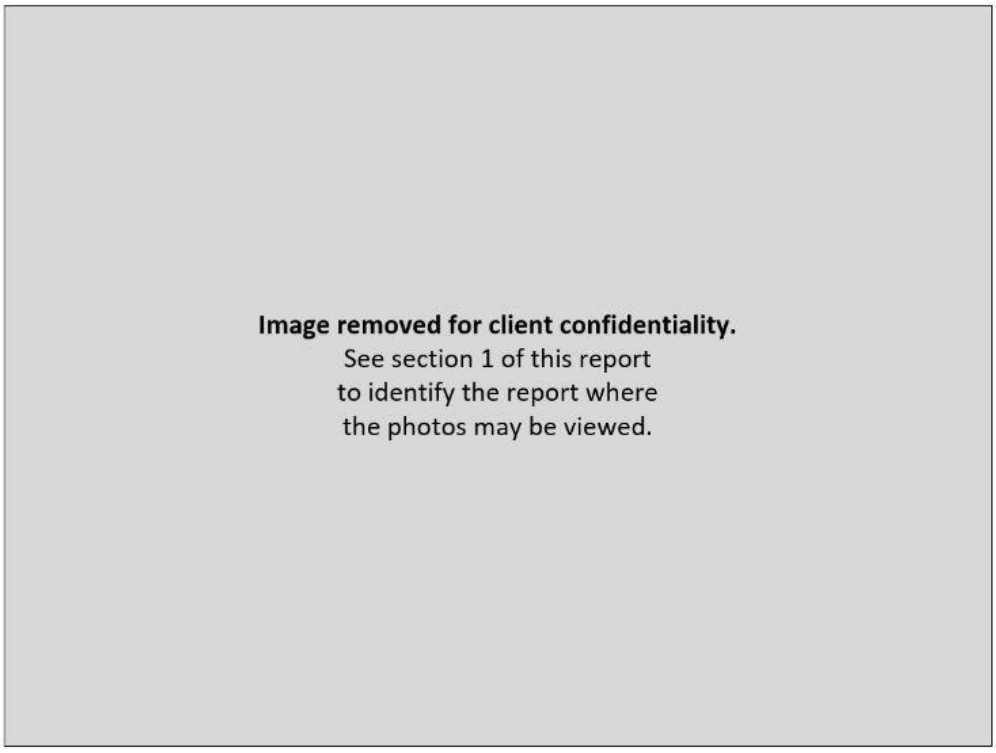



**Figure RE04.4: EUT test setup, reverse view**

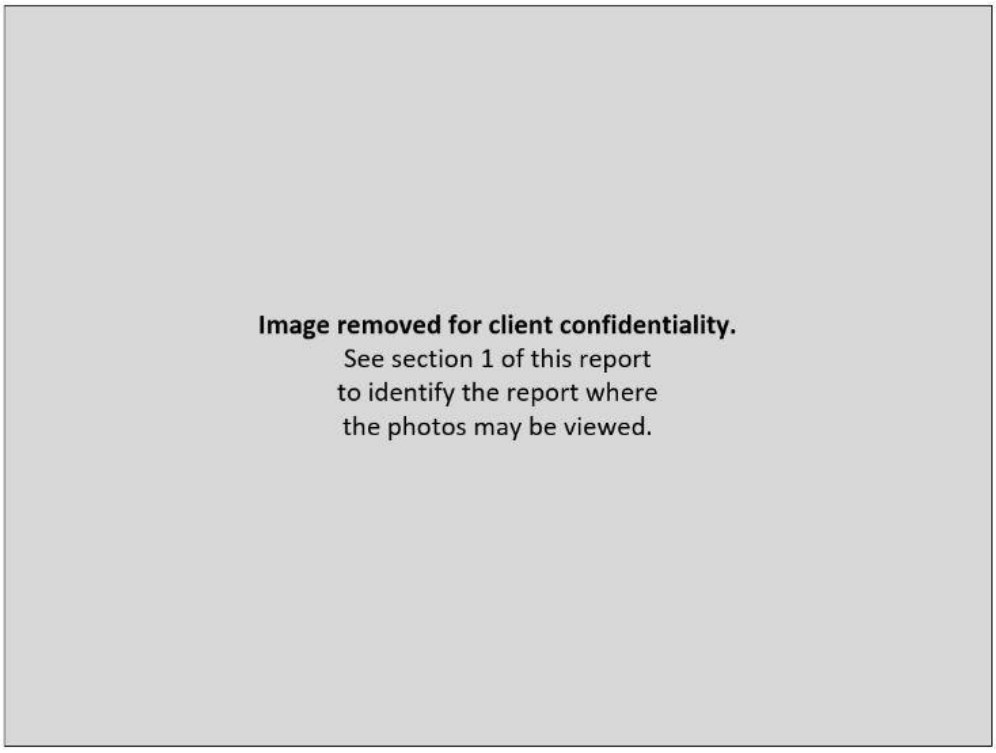



**Figure RE04.5: EUT test setup, primary view ( X orientation)**

**This line is the end of the test record.**

## Test Record
**Transmitter Power Spectral Density**
**Test IDs TR18, TR19, TR20, TR21**
**Project GCL-0647**

| | |
|---|---|
| Test Date(s) | 16, 27 Sep 2024 |
| Test Personnel | Majid Farah, Jim Solum |
| Product Model | A04999 |
| Serial Number tested | 8ME000064 |
| Operating Mode | M1 (BtTx), M3 (BleTx), M5 (AntTx), M7 (WiFiTx) |
| Arrangement | A4 (Udc) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report). |
| Antenna Gain | -0.35 dBi, as reported by the client |
| Radio Protocol | Bluetooth Classic (Including EDR2 and EDR3), Bluetooth Low Energy (BLE), ANT, IEEE 802.11 b/g/n (WiFi) |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | Vladimir Tolstik, Jim Solum |
| **Date of this record:** | 30 Sep 2024 |

Original record, Version A.

**Test Equipment Used**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 44GHz | Keysight | N9048B | MY62220139 | 13-Mar-2024 | 15-Mar-2025 |
| MXE Receiver 8.4 GHz | Keysight | N9038B | MY63460112 | 28-Feb-2024 | 1-Mar-2025 |

**Table TR18.1: Test equipment used**

**Software Used:** Keysight PXE software A.33.03, A.37.02

**Test Method**

The basic test standards provide options for the test method. The following test methods were applied.

ANSI C63.10: PKPSD (11.10.2)

**Test Setup**

This block diagram shows the test equipment setup.

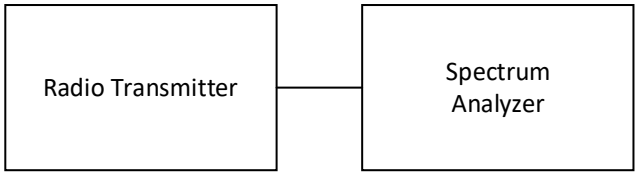



**Figure TR18.1: Test setup**

**Test Data**

Each measurement is made conducted from the antenna port with the transmitter on a specified channel and in a selected transmission protocol. The results include the effects of any measurement cable losses. Results reported are in units of dBm/Bandwidth and do not include the effect of antenna gain. The standard limit is 8 dBm / 3 kHz, and meeting the limit with a wider resolution bandwidths is permitted. All data met the limit using a 3 kHz resolution bandwidth.

For BLE operating at 2 Mbps, the lowest operating frequency was 2404 MHz, and the highest operating frequency was 2478 MHz. For all other Bluetooth, BLE, and ANT radios reported here, the lowest operating frequency was 2402 MHz, and the highest operating frequency was 2480 MHz.

For WiFi radios, the various data speeds were compared on channel 6 to determine the modulation producing the highest PSD value. The indicated speed was then measured on channels 1, 6, 11, and 13 and is reported below.

The highest PSD levels for each mode are highlighted in yellow, and graphical results are provided for those cases.

| | 2402 (04) | 2440 | 2480 (78) |
|---|---|---|---|
| Bluetooth BR | **-5.28** | **-5.24** | **-4.62** |
| Bluetooth EDR2 | **-10.17** | **-9.87** | **-8.66** |
| Bluetooth EDR3 | **-9.72** | **-9.52** | **-8.29** |
| BLE 1 Mbps | **-16.45** | **-16.35** | **-16.39** |
| BLE 2 Mbps | **-18.74** | **-18.54** | **-18.53** |
| ANT | **-10.95** | **-10.57** | **-10.49** |

**Table TR18.2: Summary of results for Bluetooth, BLE and ANT radios**

| | Ch1 | Ch6 | Ch11 | Ch13 |
|---|---|---|---|---|
| B2 | -10.68 | -5.02 | -8.06 | -12.43 |
| G18 | -15.30 | -8.27 | -11.49 | -15.73 |
| NMCS0 | -15.85 | -8.24 | -12.21 | -16.17 |

**Table TR18.3: Summary of results for WiFi radio**

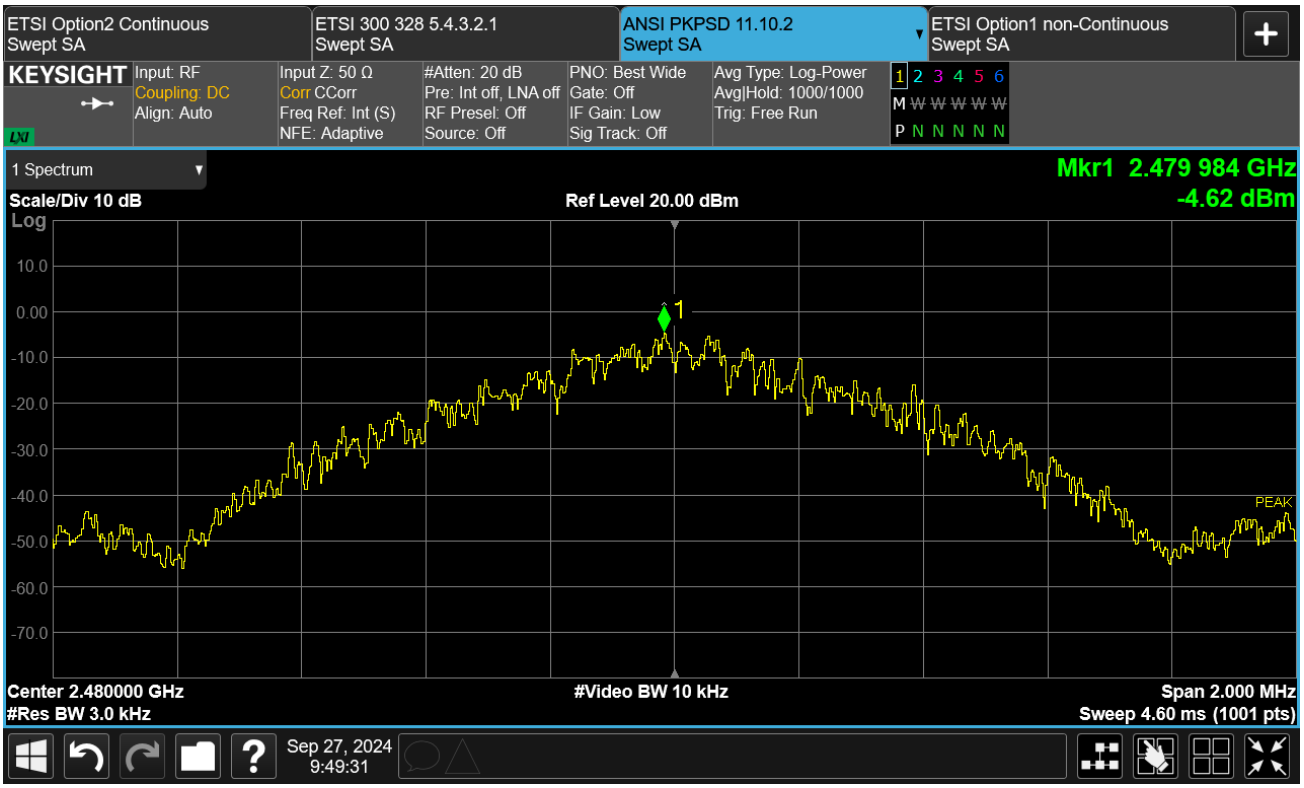



**Figure TR18.2: Test data for Bluetooth Basic Rate at 2480 MHz**

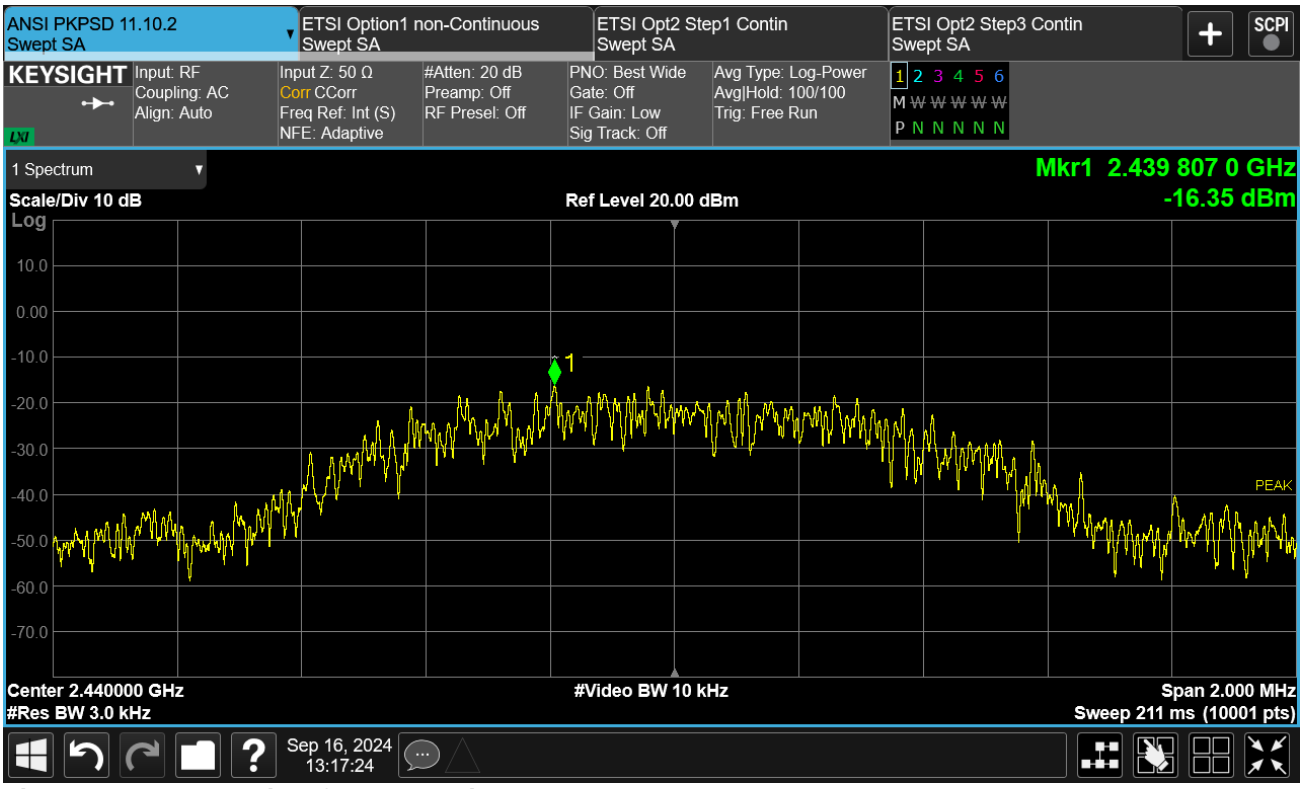



**Figure TR18.3: Test data for BLE 1 Mbps at 2440 MHz**

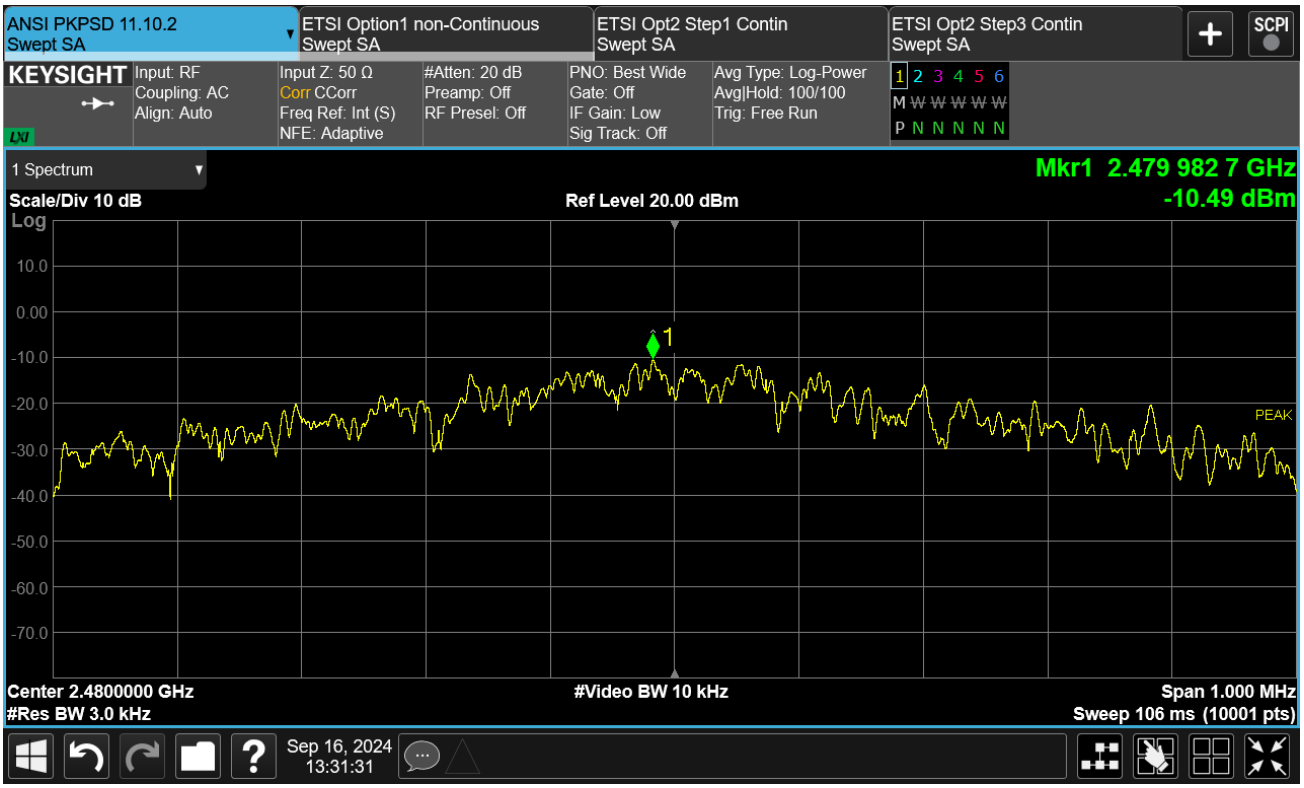



**Figure TR18.4: Test data for ANT at 2480 MHz**

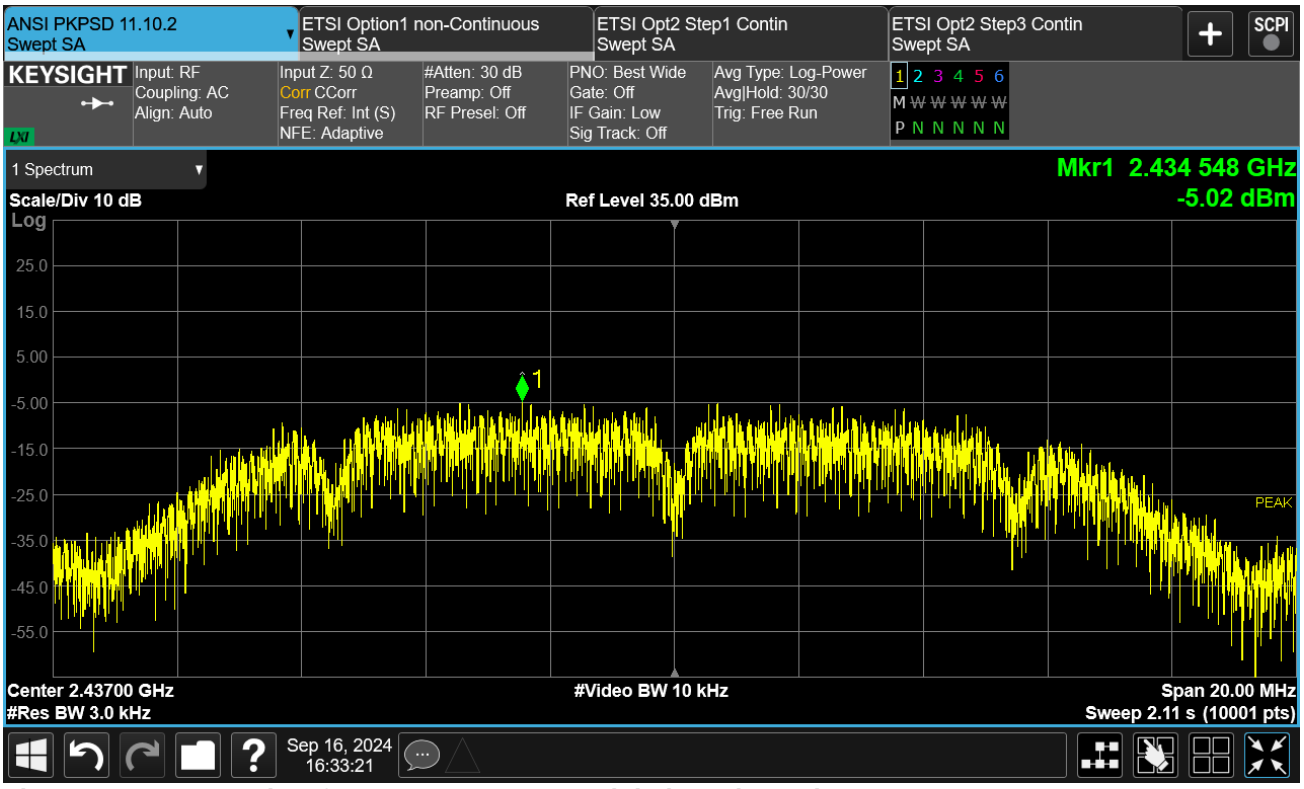



**Figure TR18.5: Test data for IEEE 802.11 B2 modulation, channel 6**

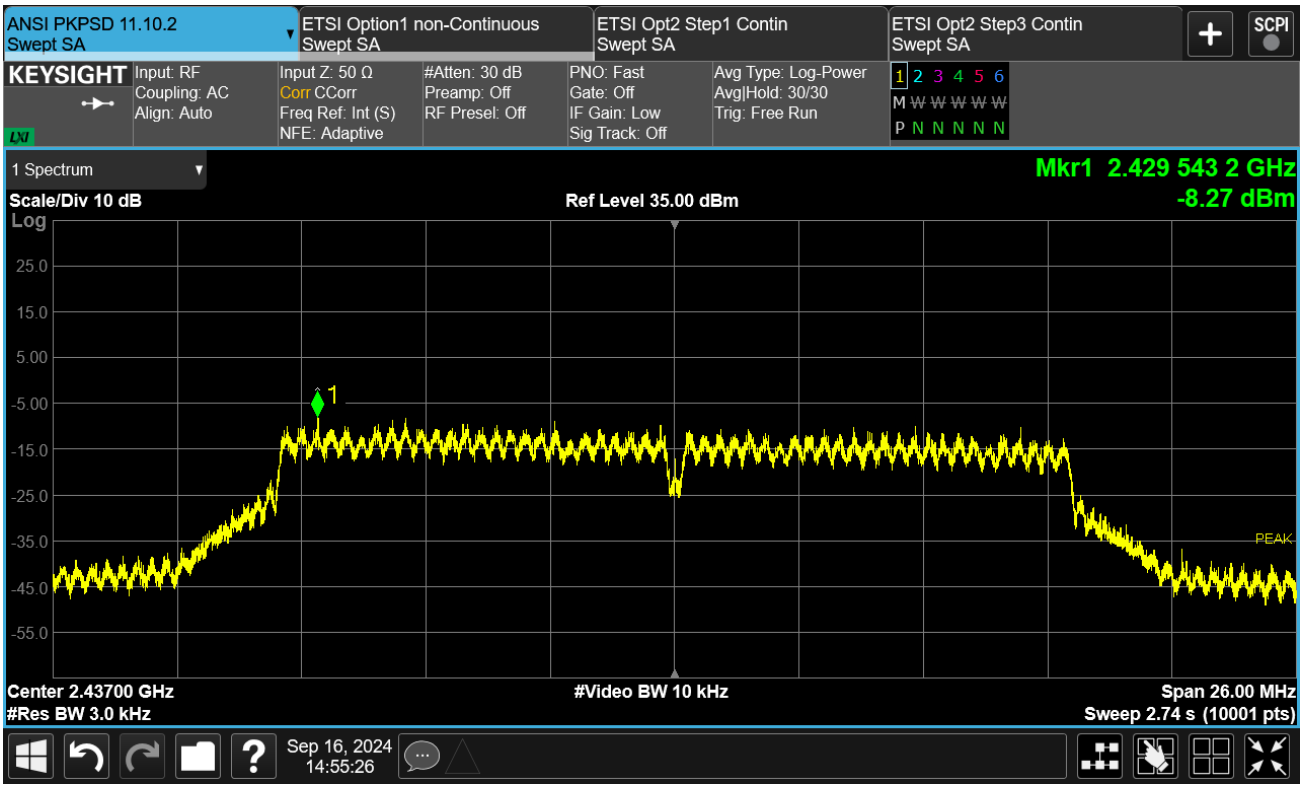



**Figure TR18.6: Test data for IEEE 802.11 G18 modulation, channel 6**

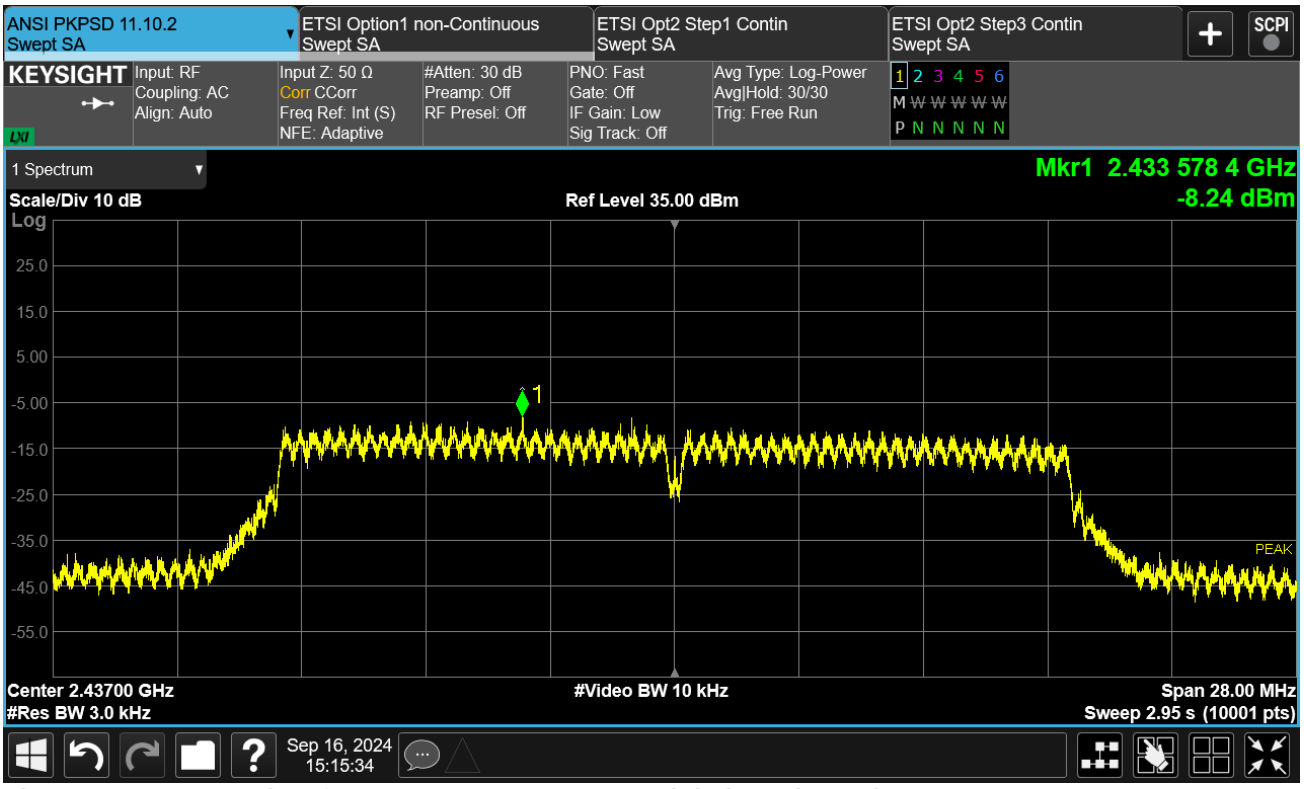



**Figure TR18.7: Test data for IEEE 802.11 NMCS0 modulation, channel 6**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE30**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 11 Oct 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M7 (WiFiTx) (CH 6, B5.5) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247; RSS-247; RSS-GEN; ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 9 kHz to 30 MHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 15 Oct 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| MXE Receiver 8.4 GHz | Keysight | N9038B | MY63460112 | 28-Feb-2024 | 1-Mar-2025 |
| Loop antenna, amplified | Schwarzbeck | FMZB 1519B | 174 | 18-Jul-2024 | 18-Jul-2026 |
| SAC 3m, below 1 GHz | Frankonia | SAC3 | F199004 | 7-Nov-2022 | 7-Nov-2025 |
| Tape measure, 1” x 33’ | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |

**Table RE30.1: Test Equipment Used**

**Software Used:** Keysight MXE software A.37.02, RE 9k to 30M XYZ_orientations_TemplateV7.xlsm, RE 150k to 30M Signal Maximization Tool V1 2021Mar17.xlsx

**Test Data**

For test standards that require reorienting the test sample, preliminary scans were taken in those alternate orientations to find the orientation that produced that largest field at the receive antenna. With intentional radiators, that highest field is usually found at the carrier frequency. The alternate orientations are typically described as X, Y, and Z and explained with a photograph. Subsequent testing was done using on the orientation identified in this way.

radiated emission test process continued with a preliminary scan at multiple turntable angles, and in the three loop antenna polarizations. The loop antenna was positioned at a 1.5 m height. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the loop was set to the worst case orientation for that frequency and the turntable angle was explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 9 kHz and 30 MHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

| Freq. | Level | Detector | Limit | Margin | Peak Level | Pk Limit | Pk Margin | Antenna | Table |
|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | Type | dBuV/m | dB | dBuV/m | dBuV/m | dB | Orientation | Azimuth, deg |
| 0.0119 | 42.27 | Avg | 126.09 | 83.82 | 51.47 | 146.09 | 94.62 | Z | -150 |
| 0.02315 | 36.49 | Avg | 120.31 | 83.82 | 45.14 | 140.31 | 95.18 | Z | -183 |
| 0.04805 | 30.41 | Avg | 113.97 | 83.56 | 39.76 | 133.97 | 94.21 | Z | 11 |
| 0.159 | 35.55 | Avg | 103.58 | 68.02 | 47.53 | 123.58 | 76.04 | X | 180 |
| 0.5843 | 30.00 | QP | 72.27 | 42.28 | 36.65 | None | None | X | 154 |
| 6.8648 | 17.39 | QP | 69.54 | 52.15 | 25.71 | None | None | X | 43 |

**Table RE30.2: Emission summary**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

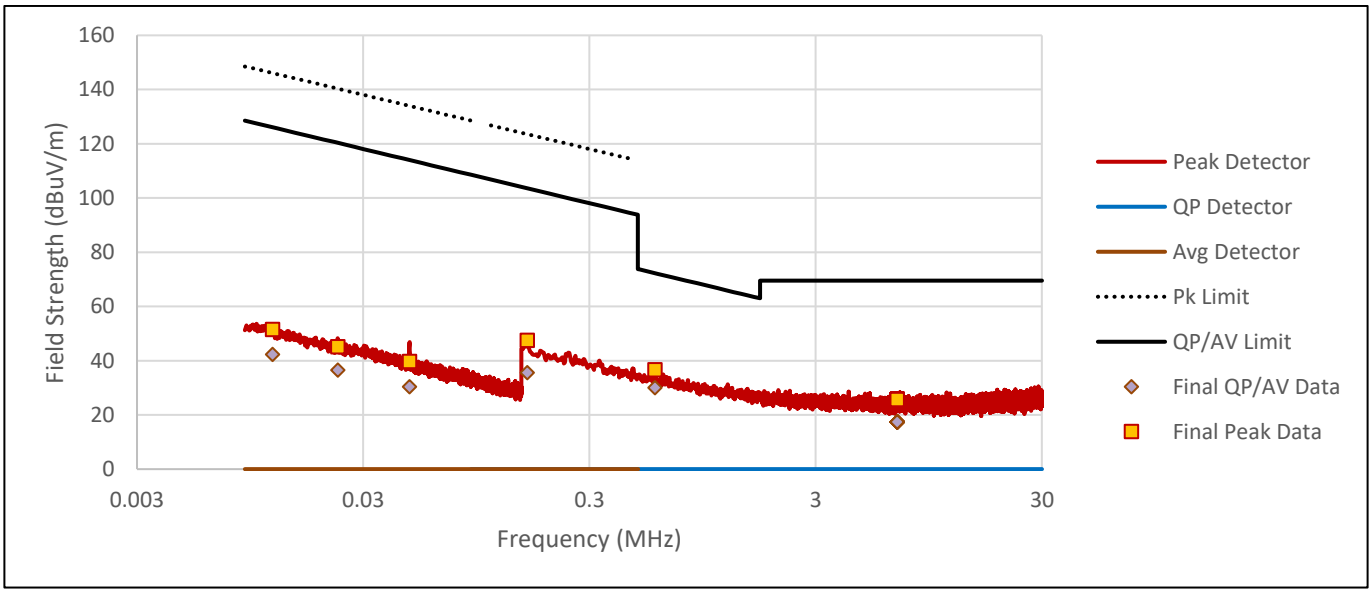



**Figure RE30.1: Spectral data**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure RE30.2: EUT test setup, first view**

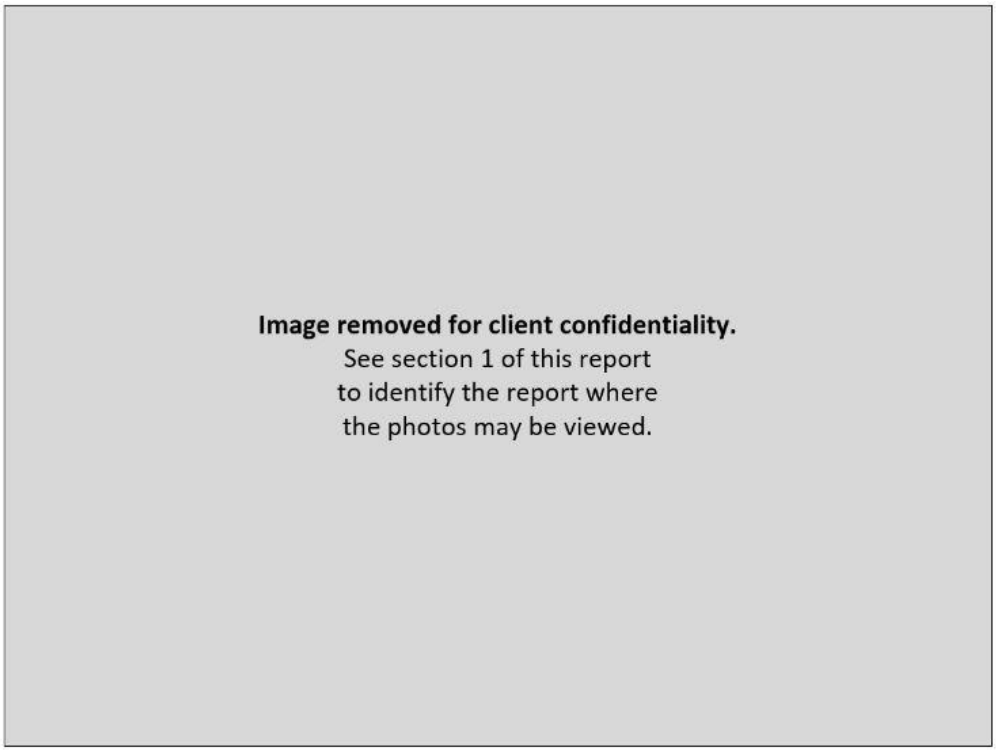



**Figure RE30.3: EUT test setup, second view (X antenna Orientation)**

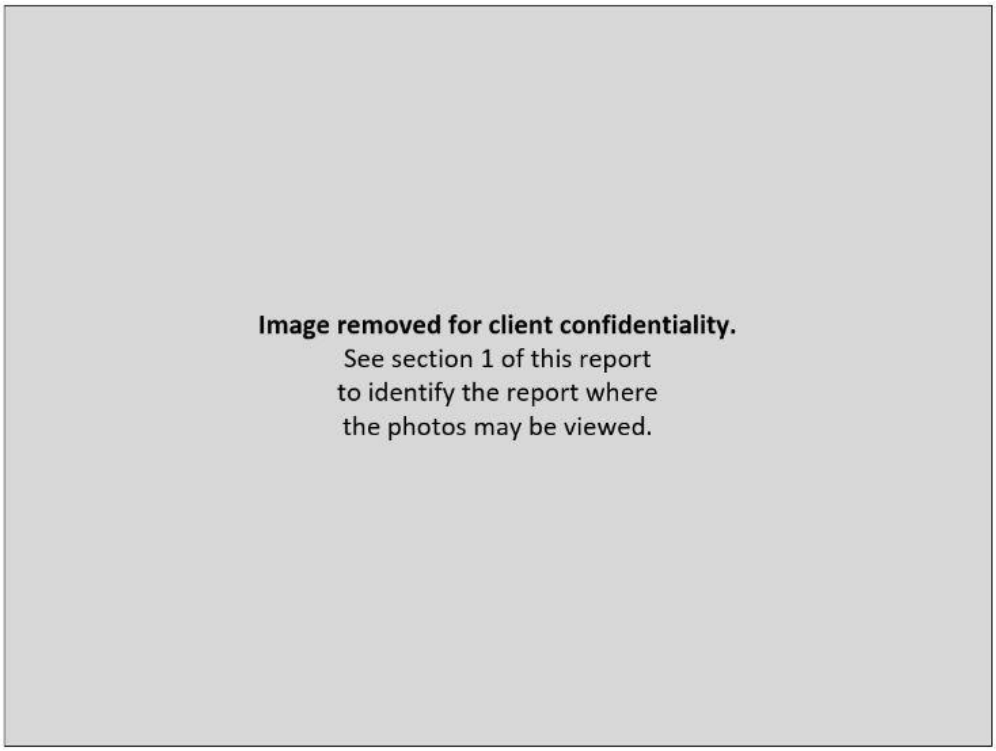



**Figure RE30.4: EUT test setup, second view (Z antenna Orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE31**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 07 Oct 2024 |
| Test Personnel | Jim Solum |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M7 (WiFiTx) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15, ANSI C63.10, RSS-247, RSS-GEN (as noted in Section 6 of the report). |
| Frequency Range: | 30 MHz to 1000 MHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | Jim Solum |
| **Date of this record:** | 07 Oct 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 2-Nov-2024 |
| Antenna, Biconilog, 30M-6 GHz | ETS Lindgren | 3142E | 00233201 | 18-Jul-2024 | 18-Jul-2026 |
| SAC 3m, below 1 GHz | Frankonia | SAC3 | F199004 | 7-Nov-2022 | 7-Nov-2025 |
| Shockforce G1 Tape Measure | Crecent Lufkin | L1135CME-02 | GMN0013784 | 26-Jun-2024 | 26-Jun-2027 |

**Table RE31.1: Test Equipment Used**

**Software Used: : Keysight PXE software A.32.06, EPX test software Version 2023.01.001**

**Test Data**

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

At azimuth angle 180° the ‘front’ reference mark of the turntable is pointed Southward. At 270° the reference mark points West. At 90° it points East. At 173° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 30 MHz and 1 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

| Frequency | Pol. | Reading | Factor | Level | Limit | Margin | Height | Angle |
|---|---|---|---|---|---|---|---|---|
| MHz | | dB(μV) | dB(1/m) | dB(μV/m) | dB(μV/m) | dB | cm | deg |
| | | QP | | QP | QP | QP | | |
| 73.440 | V | 4.2 | 14.0 | 18.2 | 40.0 | 21.8 | 135.4 | 286.0 |
| 153.300 | H | 4.2 | 17.7 | 21.9 | 43.5 | 21.6 | 205.2 | 87.0 |
| 200.070 | H | 3.5 | 17.9 | 21.4 | 43.5 | 22.1 | 143.3 | 266.0 |
| 399.990 | H | 0.5 | 26.2 | 26.7 | 46.0 | 19.3 | 116.0 | 41.0 |
| 940.920 | V | -0.3 | 34.7 | 34.4 | 46.0 | 11.6 | 286.8 | 130.0 |
| 962.160 | V | 0.0 | 34.2 | 34.2 | 54.0 | 19.8 | 167.1 | 187.0 |

**Table RE31.2: Emission summary**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

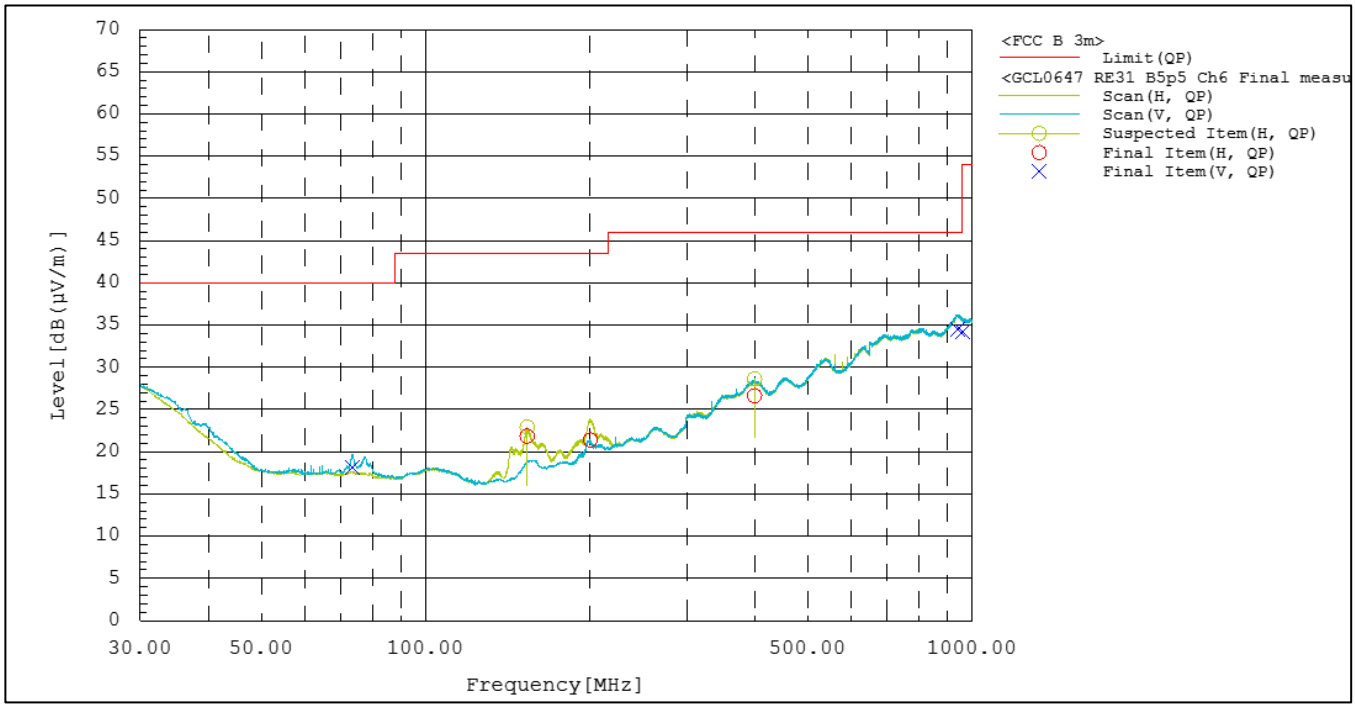



**Figure RE31.1: Spectral data**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure RE31.2: EUT test setup, first view**

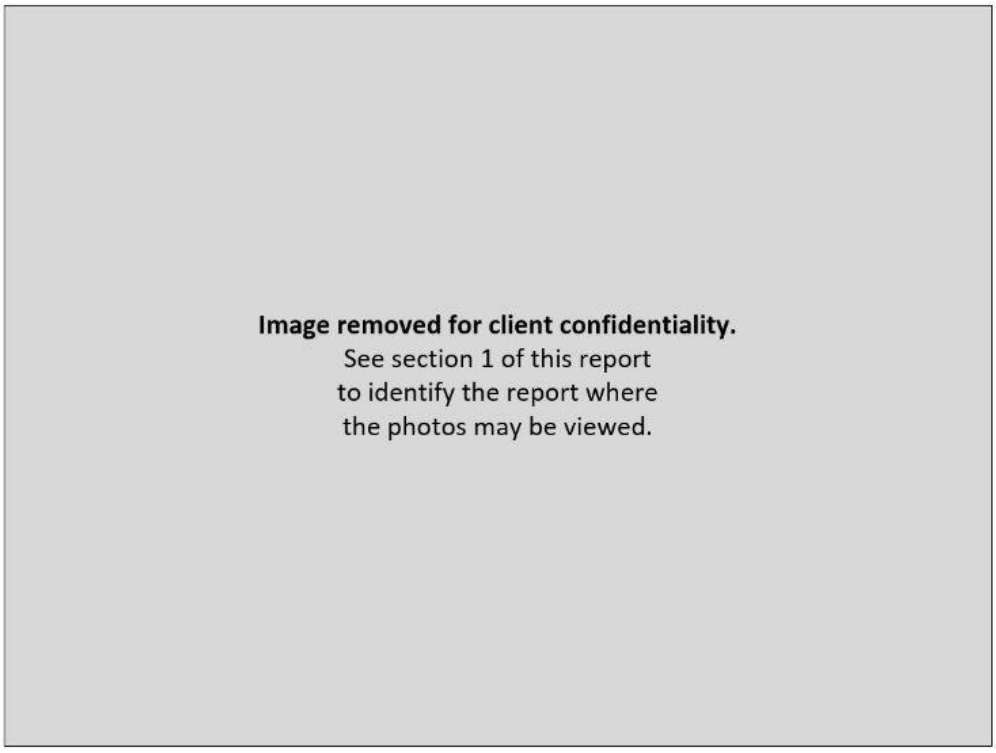



**Figure RE31.3: EUT test setup, second view**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE32**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 12 Sep 2024 |
| Test Personnel | David Kerr, Jim Solum |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M7 (WiFiTx) (Mode 802.11B, 5.5Mbs) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 1 GHz to 14 GHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr, Jim Solum |
| **Date of this record:** | 12 Sep 2024 |

Original record, Version A.

### Test Equipment

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 1-Oct-2024 |
| Antenna, Horn, 1-18 GHz | ETS Lindgren | 3117 | 00259208 | 30-May-2024 | 30-May-2026 |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Tape measure, 1" x 33' | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| Preamplifier, 500 MHz 18 GHz | Com-Power | PAM-118A | 18040133 | Calibration | Not Required |
| Wifi Filter | K&L | 8NSL26-2437/E82.2-0/0 | 1 | Calibration | Not Required |
| 3 GHz High Pass filter | Anatech Electronics | 0K0R2 | 01 | Calibration | Not Required |

**Table RE32.1: Test Equipment Used**

**Software Used:** Keysight PXE software A.32.06, EPX test software Version 2023.01.001

### Test Data

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

In the 1 GHz to 3.2 GHz frequency range, a Chebyshev 'Wifi' notch filter covering the 2.4 GHz ISM band was placed in series just before the preamplifier to ensure it operated in its linear range. This filter is accounted for in the system loss, so it appears in the prescan plots as high noise floor levels from 2400 – 2483 MHz. These are not failing emissions. A 3 GHz high pass filter was applied during testing between 3.2 GHz and 14 GHz to similarly protect the preamplifier.

In the 1 GHz to 14 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

At azimuth angle 180° the 'front' reference mark of the turntable is pointed Southward. At 270° the reference mark points West. At 90° it points East. At 173° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 1 GHz and 14 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 1780.120 | V | 32.2 | 45.8 | -5.5 | 26.7 | 40.3 | 54.0 | 74.0 | 27.3 | 33.7 | 221.4 | 253.0 |
| 2170.840 | H | 42.1 | 50.4 | -3.9 | 38.2 | 46.5 | 54.0 | 74.0 | 15.8 | 27.5 | 167.1 | 353.0 |
| 2317.800 | V | 32.6 | 45.9 | -3.5 | 29.1 | 42.4 | 54.0 | 74.0 | 24.9 | 31.6 | 339.8 | 329.0 |
| 2491.160 | V | 32.5 | 46.1 | -2.3 | 30.2 | 43.8 | 54.0 | 74.0 | 23.8 | 30.2 | 362.8 | 58.0 |
| 6678.680 | H | 30.1 | 43.9 | 6.8 | 36.9 | 50.7 | 54.0 | 74.0 | 17.1 | 23.3 | 243.3 | 196.0 |
| 12059.780 | H | 27.5 | 40.8 | 14.5 | 42.0 | 55.3 | 54.0 | 74.0 | 12.0 | 18.7 | 207.9 | 186.0 |

**Table RE32.2: Emission summary (CH 1, B5.5)**

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2193.280 | H | 43.5 | 51.8 | -4.0 | 39.5 | 47.8 | 54.0 | 74.0 | 14.5 | 26.2 | 178.1 | 354.0 |
| 2341.560 | H | 32.6 | 47.5 | -3.5 | 29.1 | 44.0 | 54.0 | 74.0 | 24.9 | 30.0 | 242.6 | 82.0 |
| 2501.280 | H | 32.8 | 46.8 | -2.5 | 30.3 | 44.3 | 54.0 | 74.0 | 23.7 | 29.7 | 124.3 | 339.0 |
| 1732.160 | V | 32.1 | 46.2 | -6.0 | 26.1 | 40.2 | 54.0 | 74.0 | 27.9 | 33.8 | 193.4 | 0.0 |
| 7300.220 | V | 31.6 | 44.7 | 6.9 | 38.5 | 51.6 | 54.0 | 74.0 | 15.5 | 22.4 | 211.1 | 318.0 |
| 9748.040 | H | 35.6 | 45.1 | 10.3 | 45.9 | 55.4 | 54.0 | 74.0 | 8.1 | 18.6 | 189.3 | 111.0 |

**Table RE32.3: Emission summary (CH 6, B5.5)**

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 6729.980 | H | 30.1 | 43.6 | 6.7 | 36.8 | 50.3 | 54.0 | 74.0 | 17.2 | 23.7 | 148.2 | 172.0 |
| 9847.940 | H | 29.8 | 42.8 | 10.3 | 40.1 | 53.1 | 54.0 | 74.0 | 13.9 | 20.9 | 167.6 | 141.0 |
| 3149.400 | V | 33.0 | 46.6 | -1.4 | 31.6 | 45.2 | 54.0 | 74.0 | 22.4 | 28.8 | 256.6 | 209.0 |
| 1969.320 | H | 33.6 | 47.3 | -3.8 | 29.8 | 43.5 | 54.0 | 74.0 | 24.2 | 30.5 | 161.6 | 348.0 |
| 2215.720 | H | 41.5 | 51.2 | -4.0 | 37.5 | 47.2 | 54.0 | 74.0 | 16.5 | 26.8 | 197.4 | 0.0 |
| 2504.360 | H | 33.1 | 53.1 | -2.5 | 30.6 | 50.6 | 54.0 | 74.0 | 23.4 | 23.4 | 213.6 | 350.0 |

**Table RE32.4: Emission summary (CH 11, B5.5)**

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2224.830 | H | 45.2 | 51.8 | -3.9 | 41.3 | 47.9 | 54.0 | 74.0 | 12.7 | 26.1 | 371.4 | 338.0 |
| 1487.080 | V | 32.1 | 47.4 | -7.8 | 24.3 | 39.6 | 54.0 | 74.0 | 29.7 | 34.4 | 400.0 | 320.0 |
| 2837.440 | V | 33.0 | 46.7 | -2.7 | 30.3 | 44.0 | 54.0 | 74.0 | 23.7 | 30.0 | 379.8 | 98.0 |
| 4528.290 | V | 31.2 | 45.4 | 3.2 | 34.4 | 48.6 | 54.0 | 74.0 | 19.6 | 25.4 | 100.0 | 13.0 |
| 9888.070 | H | 34.6 | 43.9 | 11.2 | 45.8 | 55.1 | 54.0 | 74.0 | 8.2 | 18.9 | 199.3 | 104.0 |
| 11589.110 | H | 27.7 | 41.0 | 13.9 | 41.6 | 54.9 | 54.0 | 74.0 | 12.4 | 19.1 | 276.1 | 18.0 |

**Table RE32.5: Emission summary (CH 13, B5.5)**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

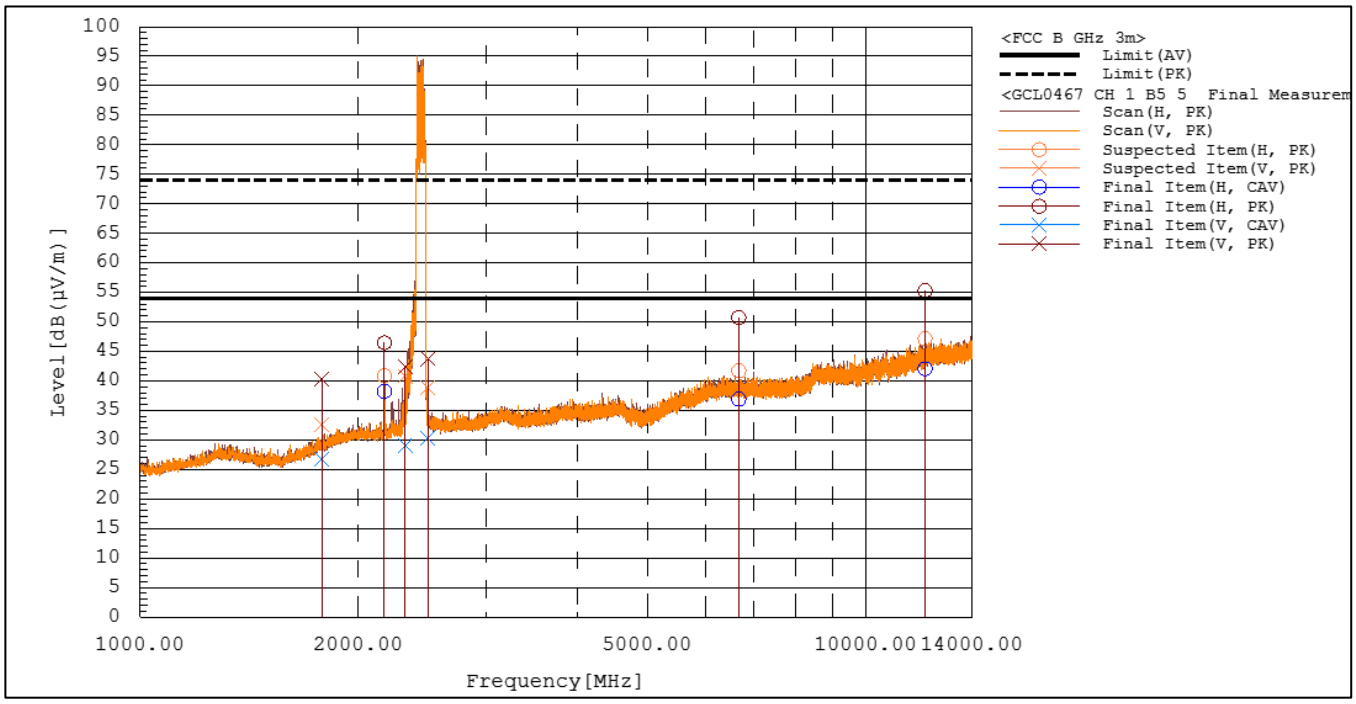



**Figure RE32.1: Spectral data (CH 1, B5.5)**

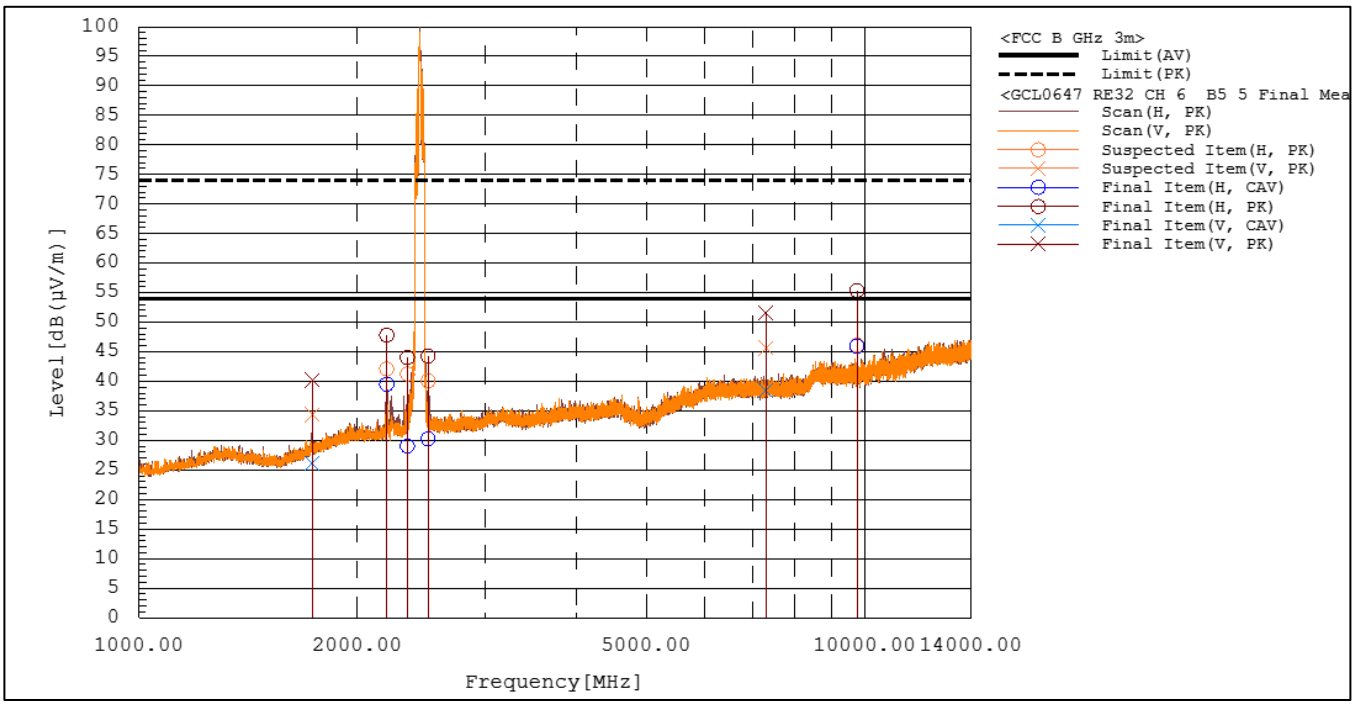



**Figure RE32.2: Spectral data (CH 6, B5.5)**

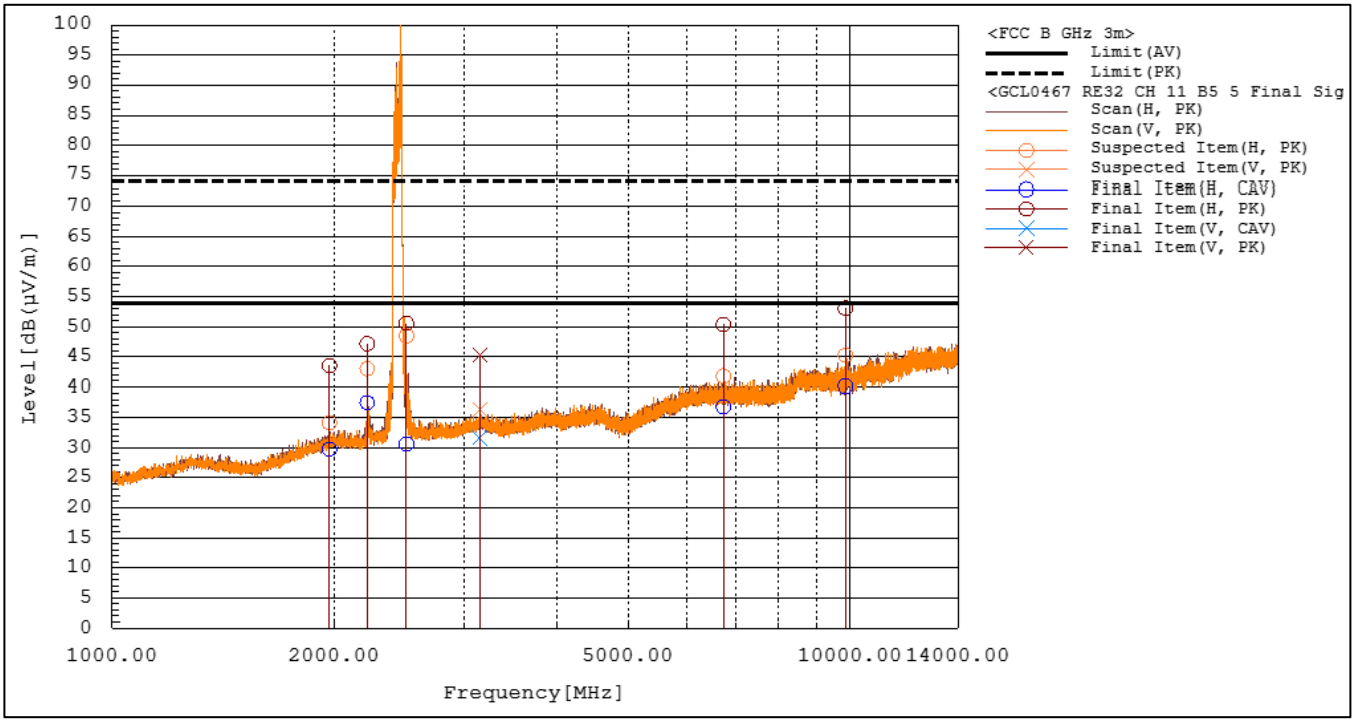



**Figure RE32.3: Spectral data (CH 11, B5.5)**

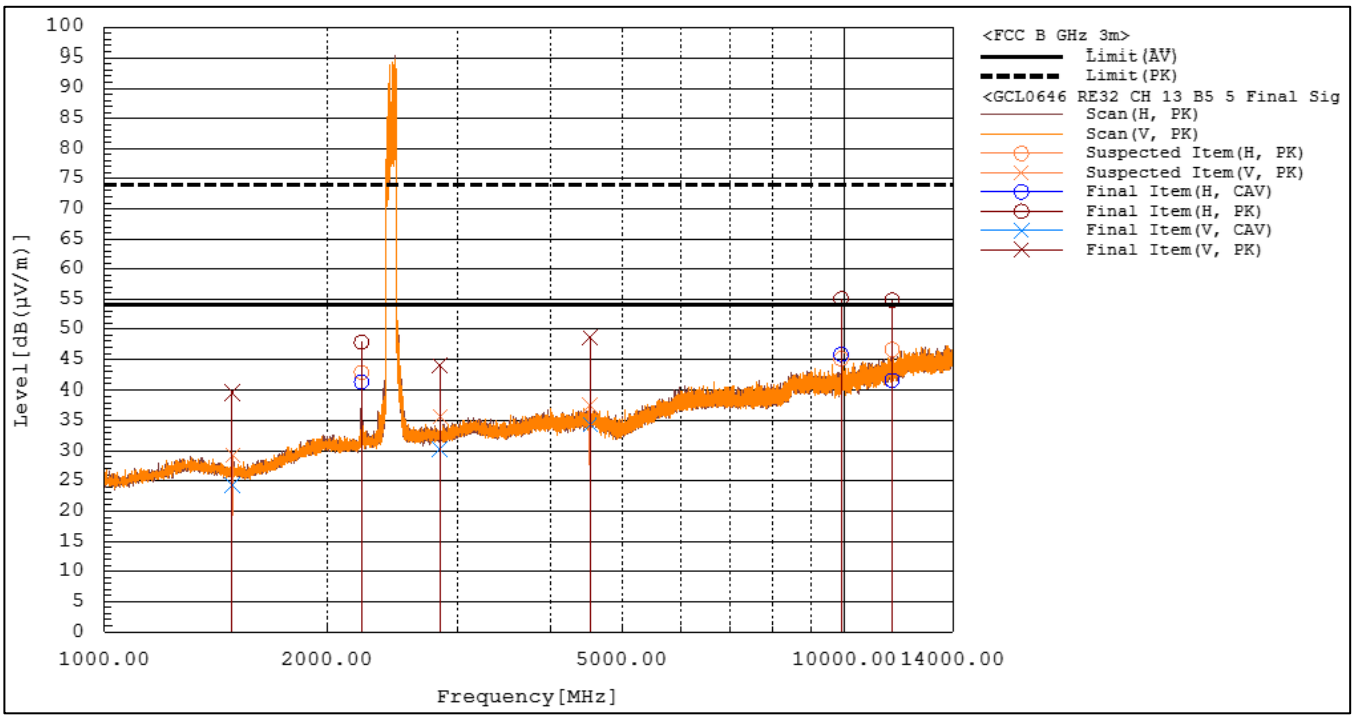



**Figure RE32.4: Spectral data (CH 13, B5.5)**

### Setup Photographs

The following photographs show the EUT configured and arranged in the manner in which it was measured.

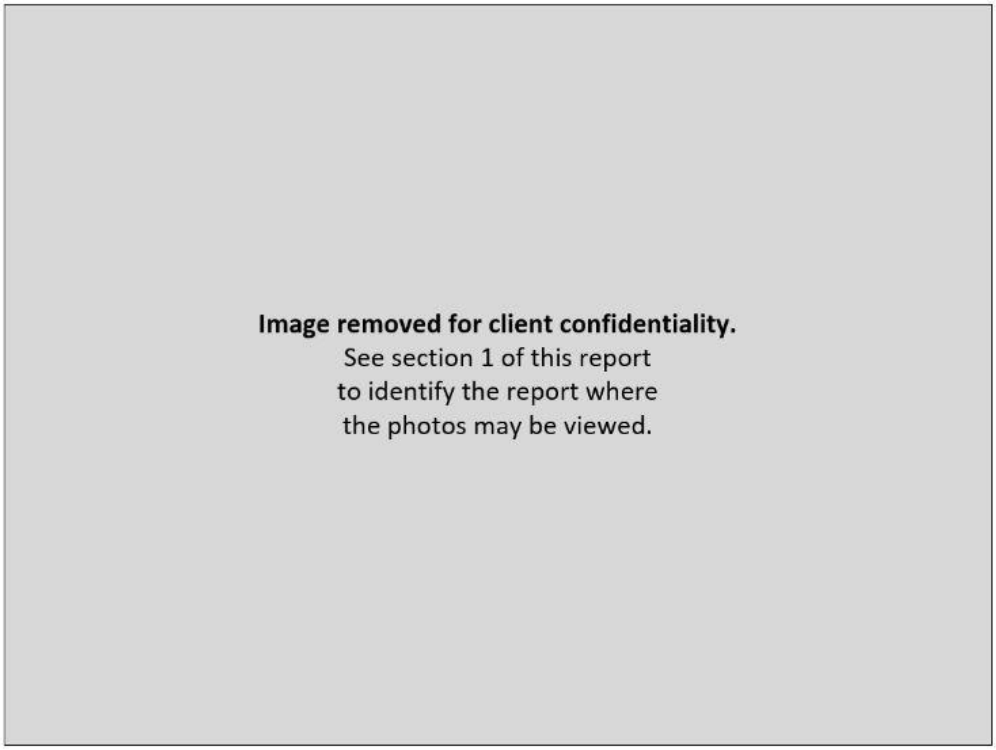



**Figure RE32.5: EUT test setup, first view (EUT X Orientation)**

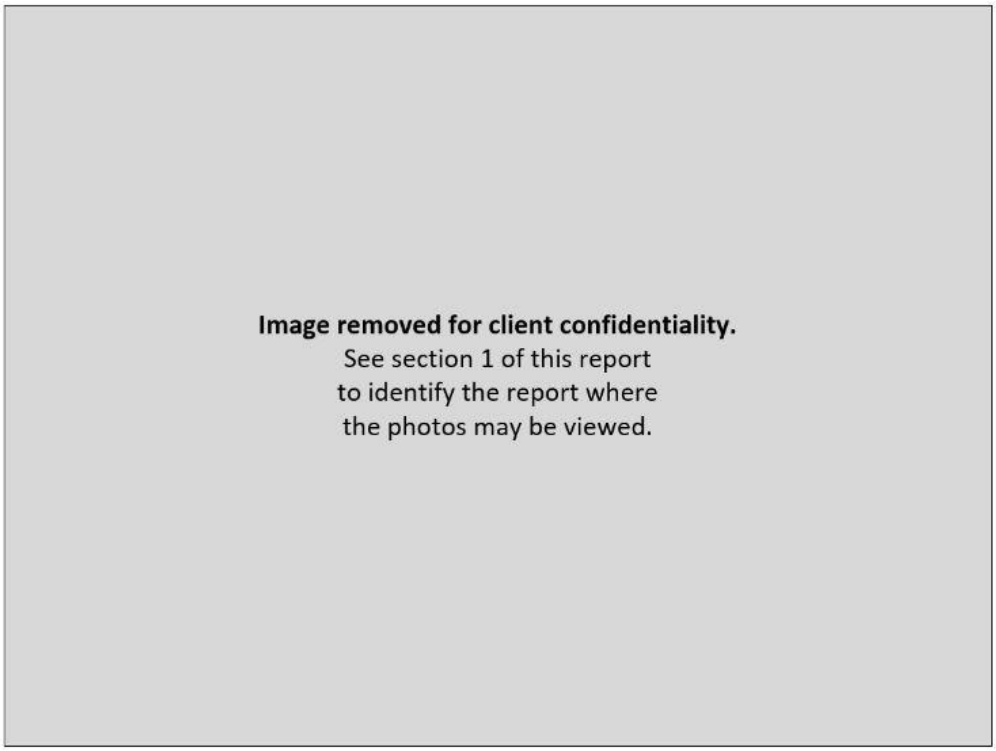



**Figure RE32.6: EUT test setup, second view (EUT X Orientation)**

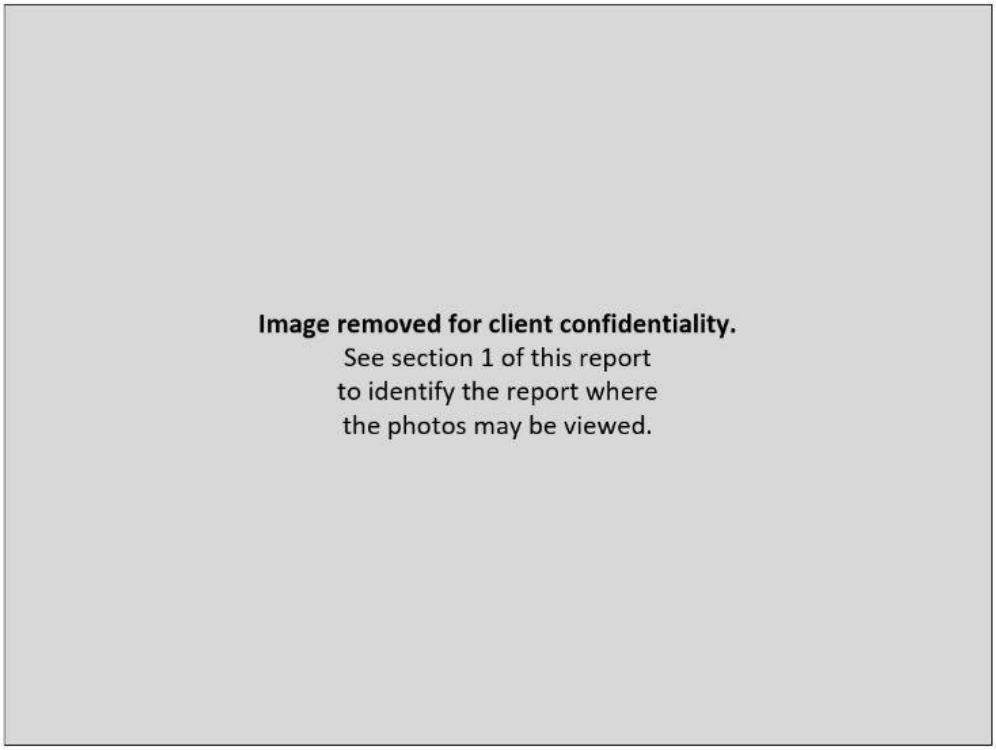



**Figure RE32.7: EUT test setup, first view (EUT X Orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE33**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 13 Sep 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M7 (WiFiTx) (802.11G) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 1 GHz to 14 GHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 13 Sep 2024 |

Original record, Version A.

### Test Equipment

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 1-Oct-2024 |
| Antenna, Horn, 1-18 GHz | ETS Lindgren | 3117 | 00259208 | 30-May-2024 | 30-May-2026 |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Tape measure, 1" x 33' | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| Preamplifier, 500 MHz 18 GHz | Com-Power | PAM-118A | 18040133 | Calibration | Not Required |
| Wifi Filter | K&L | 8NSL26-2437/E82.2-0/0 | 1 | Calibration | Not Required |
| 3 GHz High Pass filter | Anatech Electronics | 0K0R2 | 01 | Calibration | Not Required |

**Table RE33.1: Test Equipment Used**

**Software Used:** Keysight PXE software A.32.06, EPX test software Version 2023.01.001

### Test Data

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

In the 1 GHz to 3.2 GHz frequency range, a Chebyshev 'Wifi' notch filter covering the 2.4 GHz ISM band was placed in series just before the preamplifier to ensure it operated in its linear range. This filter is accounted for in the system loss, so it appears in the prescan plots as high noise floor levels from 2400 – 2483 MHz. These are not failing emissions. A 3 GHz high pass filter was applied during testing between 3.2 GHz and 14 GHz to similarly protect the preamplifier.

In the 1 GHz to 14 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

At azimuth angle 180° the 'front' reference mark of the turntable is pointed Southward. At 270° the reference mark points West. At 90° it points East. At 173° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 1 GHz and 14 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2170.840 | H | 41.7 | 49.9 | -3.9 | 37.8 | 46.0 | 54.0 | 74.0 | 16.2 | 28.0 | 122.3 | 0.0 |
| 2216.160 | H | 33.5 | 49.6 | -4.0 | 29.5 | 45.6 | 54.0 | 74.0 | 24.5 | 28.4 | 337.3 | 128.0 |
| 2343.320 | H | 35.8 | 57.0 | -3.5 | 32.3 | 53.5 | 54.0 | 74.0 | 21.7 | 20.5 | 100.0 | 0.0 |
| 5419.940 | H | 29.9 | 43.7 | 4.2 | 34.1 | 47.9 | 54.0 | 74.0 | 19.9 | 26.1 | 167.9 | 194.0 |
| 9648.140 | H | 30.5 | 43.7 | 10.8 | 41.3 | 54.5 | 54.0 | 74.0 | 12.7 | 19.5 | 167.9 | 146.0 |
| 11827.580 | H | 28.0 | 41.6 | 14.2 | 42.2 | 55.8 | 54.0 | 74.0 | 11.8 | 18.2 | 295.7 | 50.0 |

**Table RE33.2: Emission summary (CH 1, G6)**

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2023.000 | V | 32.6 | 46.4 | -3.6 | 29.0 | 42.8 | 54.0 | 74.0 | 25.0 | 31.2 | 191.7 | 0.0 |
| 2193.280 | H | 43.5 | 51.3 | -4.0 | 39.5 | 47.3 | 54.0 | 74.0 | 14.5 | 26.7 | 314.1 | 333.0 |
| 4870.220 | H | 29.8 | 43.6 | 2.8 | 32.6 | 46.4 | 54.0 | 74.0 | 21.4 | 27.6 | 100.0 | 72.0 |
| 7304.540 | V | 31.3 | 45.3 | 6.9 | 38.2 | 52.2 | 54.0 | 74.0 | 15.8 | 21.8 | 315.5 | 270.0 |
| 9747.500 | V | 30.8 | 45.2 | 10.3 | 41.1 | 55.5 | 54.0 | 74.0 | 12.9 | 18.5 | 210.8 | 306.0 |
| 12481.520 | V | 27.7 | 42.0 | 14.6 | 42.3 | 56.6 | 54.0 | 74.0 | 11.7 | 17.4 | 199.1 | 214.0 |

**Table RE33.3: Emission summary (CH 6, G6)**

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2215.720 | H | 42.6 | 51.7 | -4.0 | 38.6 | 47.7 | 54.0 | 74.0 | 15.4 | 26.3 | 114.4 | 0.0 |
| 2381.600 | H | 33.0 | 49.7 | -3.1 | 29.9 | 46.6 | 54.0 | 74.0 | 24.1 | 27.4 | 179.5 | 180.0 |
| 7375.820 | V | 29.9 | 44.3 | 7.1 | 37.0 | 51.4 | 54.0 | 74.0 | 17.0 | 22.6 | 240.4 | 248.0 |
| 9847.940 | H | 31.5 | 43.6 | 10.3 | 41.8 | 53.9 | 54.0 | 74.0 | 12.2 | 20.1 | 400.0 | 350.0 |
| 11825.420 | H | 27.9 | 41.5 | 14.2 | 42.1 | 55.7 | 54.0 | 74.0 | 11.9 | 18.3 | 351.4 | 240.0 |
| 13936.280 | V | 26.1 | 39.6 | 16.1 | 42.2 | 55.7 | 54.0 | 74.0 | 11.8 | 18.3 | 186.0 | 239.0 |

**Table RE33.4: Emission summary (CH 11, G6)**

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2224.520 | H | 36.1 | 50.2 | -3.9 | 32.2 | 46.3 | 54.0 | 74.0 | 21.8 | 27.7 | 264.5 | 0.0 |
| 2380.280 | H | 33.1 | 47.8 | -3.1 | 30.0 | 44.7 | 54.0 | 74.0 | 24.0 | 29.3 | 182.0 | 180.0 |
| 2806.200 | H | 32.9 | 46.5 | -2.6 | 30.3 | 43.9 | 54.0 | 74.0 | 23.7 | 30.1 | 247.2 | 84.0 |
| 4309.700 | H | 31.4 | 44.7 | 1.7 | 33.1 | 46.4 | 54.0 | 74.0 | 20.9 | 27.6 | 343.2 | 180.0 |
| 9887.900 | H | 29.3 | 42.4 | 11.1 | 40.4 | 53.5 | 54.0 | 74.0 | 13.6 | 20.5 | 100.0 | 150.0 |
| 11811.920 | V | 27.6 | 41.1 | 14.1 | 41.7 | 55.2 | 54.0 | 74.0 | 12.3 | 18.8 | 147.9 | 188.0 |

**Table RE33.5: Emission summary (CH 13, G6)**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

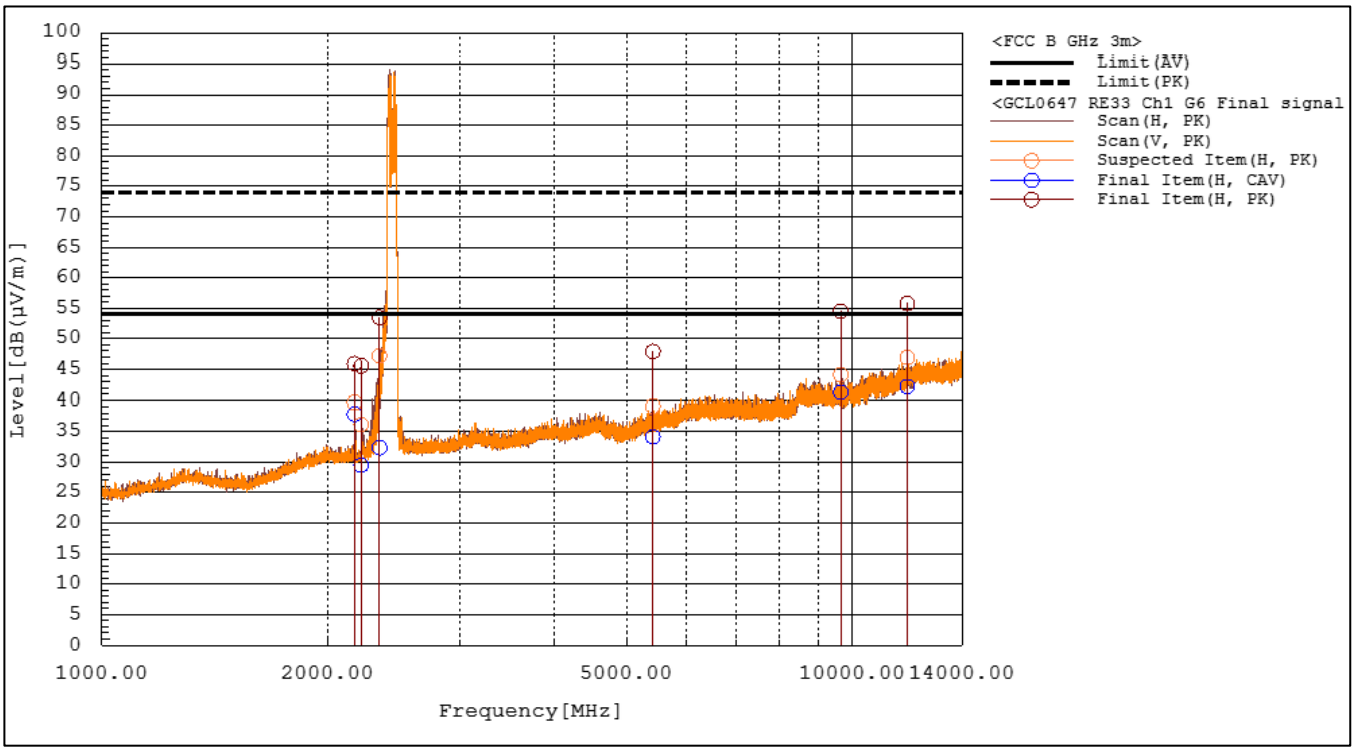



**Figure RE33.1: Spectral data (CH 1, G6)**

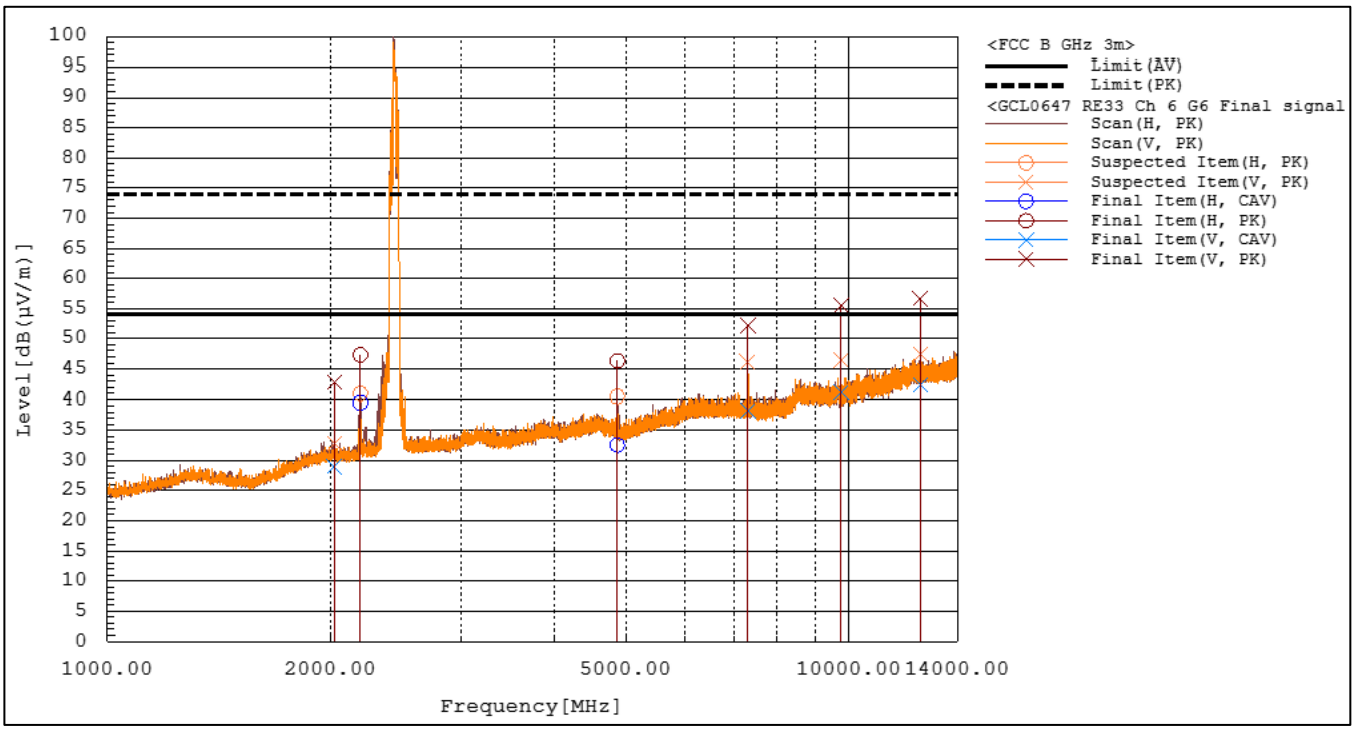



**Figure RE33.2: Spectral data (CH 6, G6)**

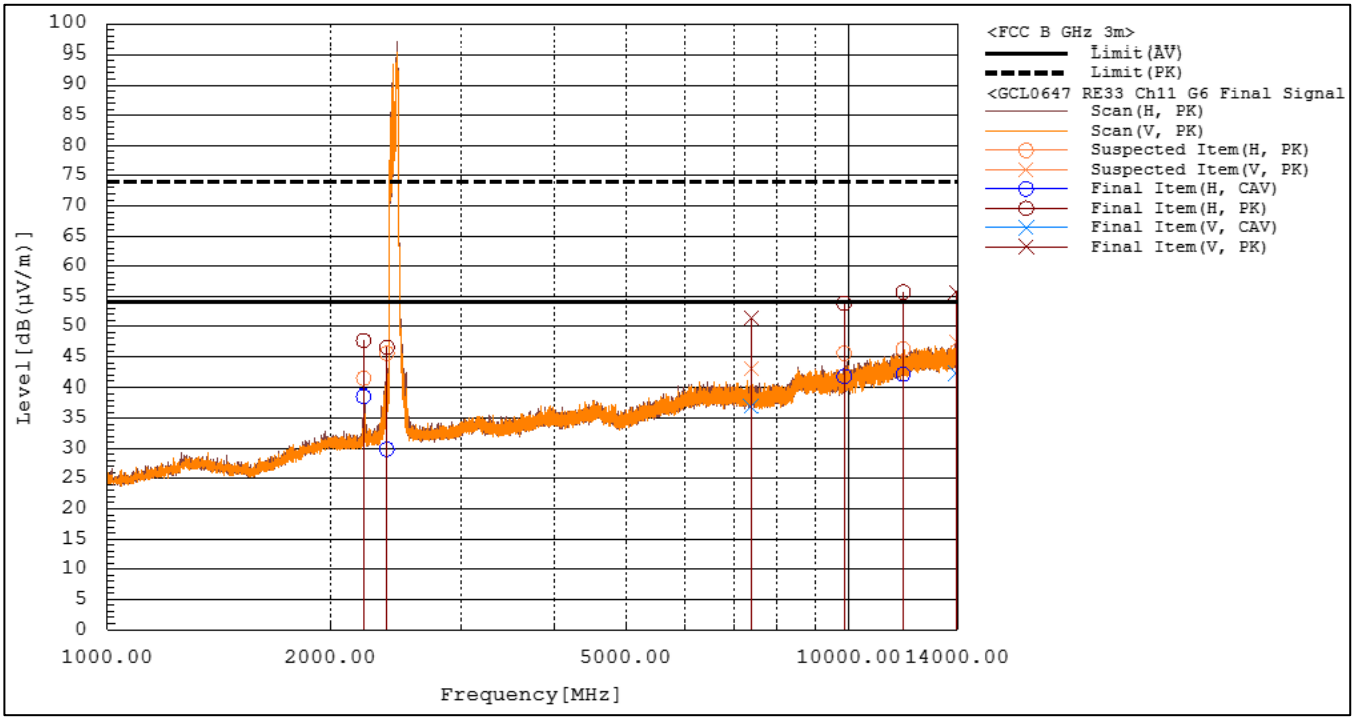



**Figure RE33.3: Spectral data (CH 11, G6)**

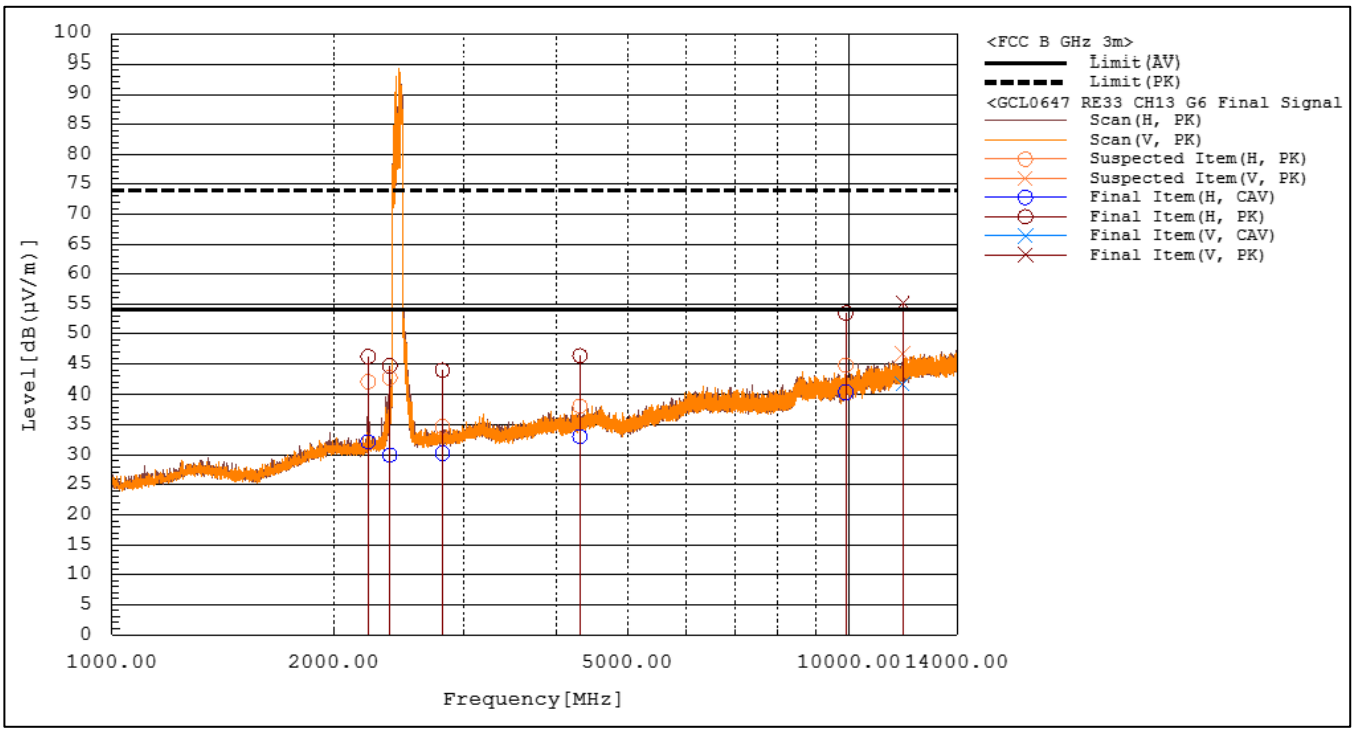



**Figure RE33.4: Spectral data (CH 13, G6)**

### Setup Photographs

The following photographs show the EUT configured and arranged in the manner in which it was measured.

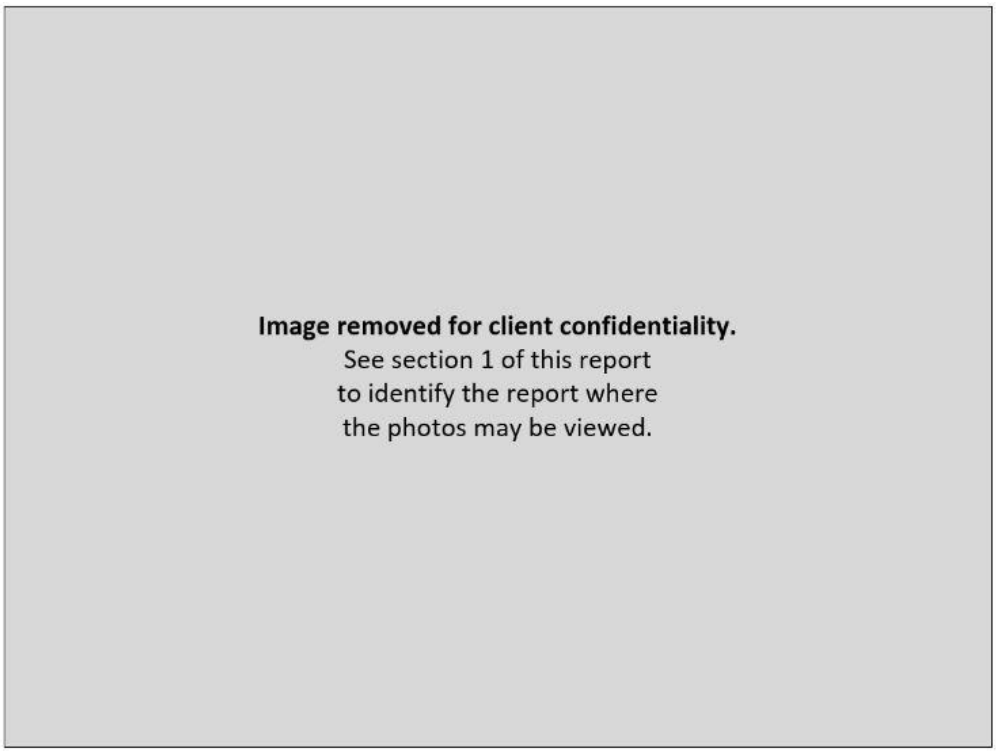



**Figure RE33.5: EUT test setup, first view (EUT X Orientation)**

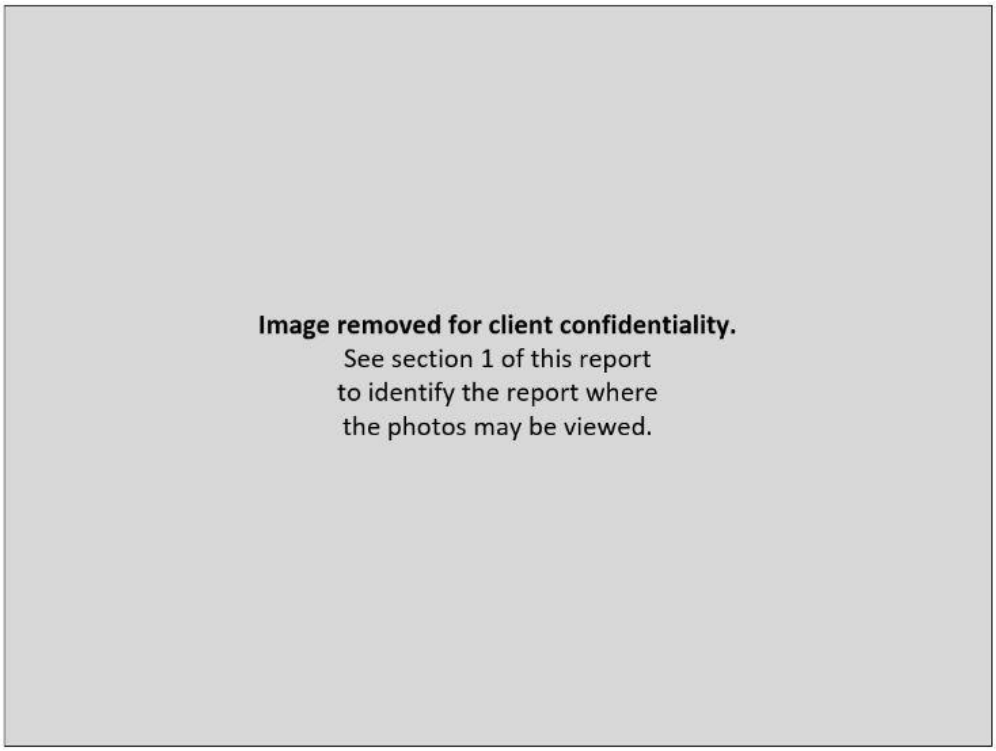



**Figure RE33.6: EUT test setup, second view (EUT X Orientation)**

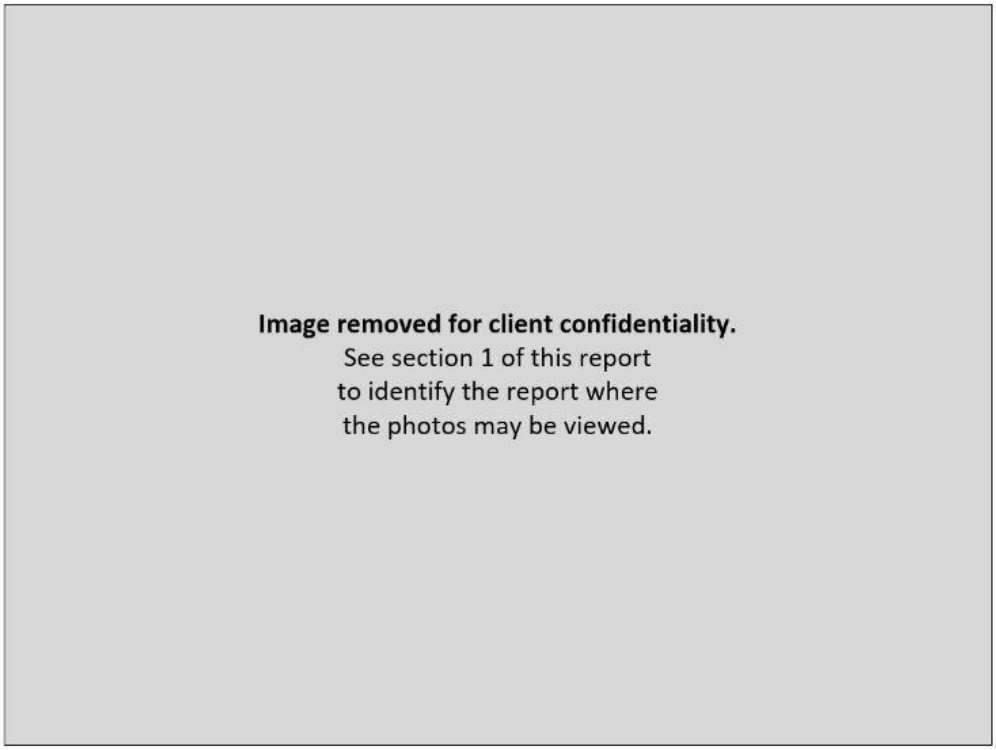



**Figure RE33.7: EUT test setup, first view (EUT X Orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE34**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 19 Sep 2024 |
| Test Personnel | David Kerr Jim Solum |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M7 (WiFiTx) (CH 6, 802.11B 5.5Mbs) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 14 MHz to 25 GHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 25 Sep 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 44GHz | Keysight | N9048B | MY62220139 | 13-Mar-2024 | 15-Mar-2025 |
| Antenna, Horn, 10-40 GHz | ETS Lindgren | 3116C | 259186 | 29-Apr-2024 | 29-Apr-2026 |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Tape measure, 1" x 33' | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| Preamplifier, 18 Ghz to 40 Ghz | Com-Power | PAM-840A | 461364 | Calibration | Not Required |

**Table RE34.1: Test Equipment Used**

**Software Used:** Keysight PXE software A.32.06, EPX test software Version 2023.01.001

**Test Data**

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

In the 14 GHz to 25 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

At azimuth angle 180° the 'front' reference mark of the turntable is pointed Southward. At 270° the reference mark points West. At 90° it points East. At 173° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 14 MHz and 25 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

In this test, fewer than six emissions were observed within 20 dB of the limit. The relevant emissions were measured, including one or more noise floor signals as judged appropriate to the spectrum.

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 14622.000 | H | 15.9 | 29.3 | 25.6 | 41.5 | 54.9 | 54.0 | 74.0 | 12.5 | 19.1 | 203.6 | 46.0 |
| 22670.800 | V | 22.4 | 36.1 | 21.0 | 43.4 | 57.1 | 54.0 | 74.0 | 10.6 | 16.9 | 130.5 | 142.0 |

**Table RE34.2: Emission summary**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

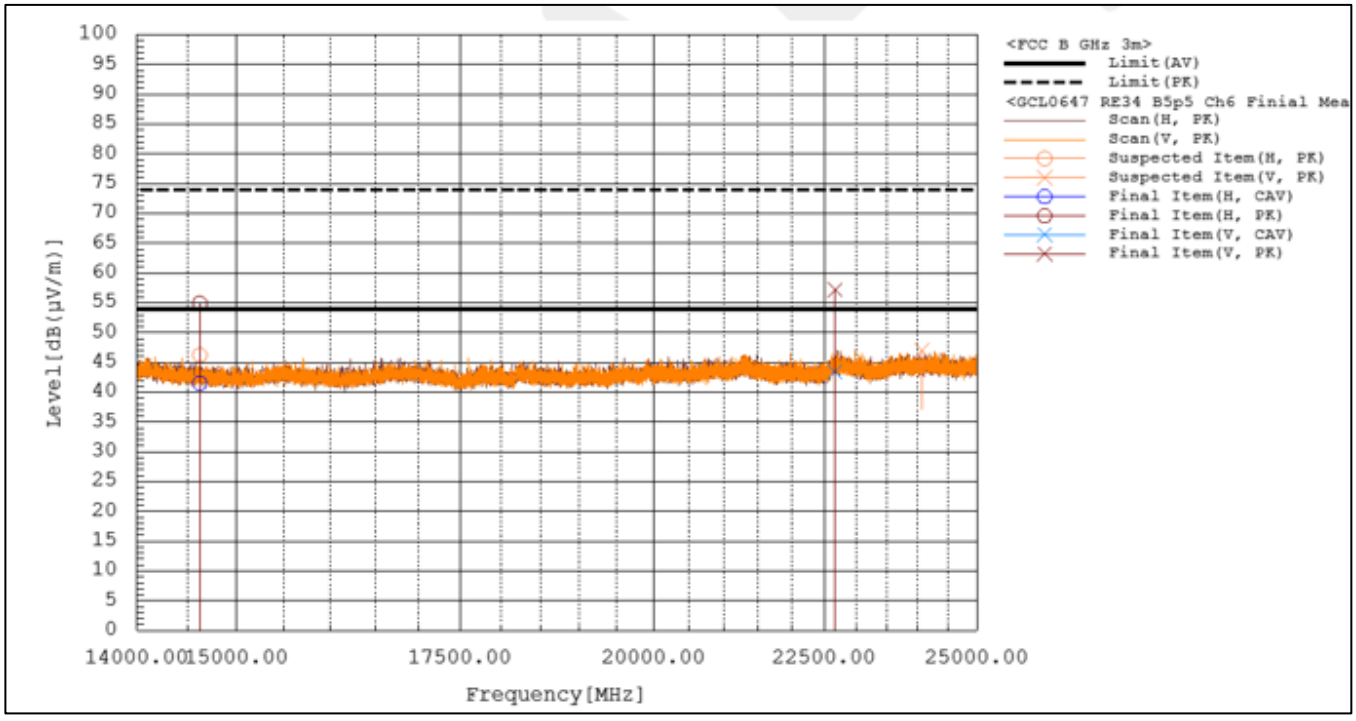



**Figure RE34.1: Spectral data**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure RE34.2: EUT test setup, first view (X orientation)**

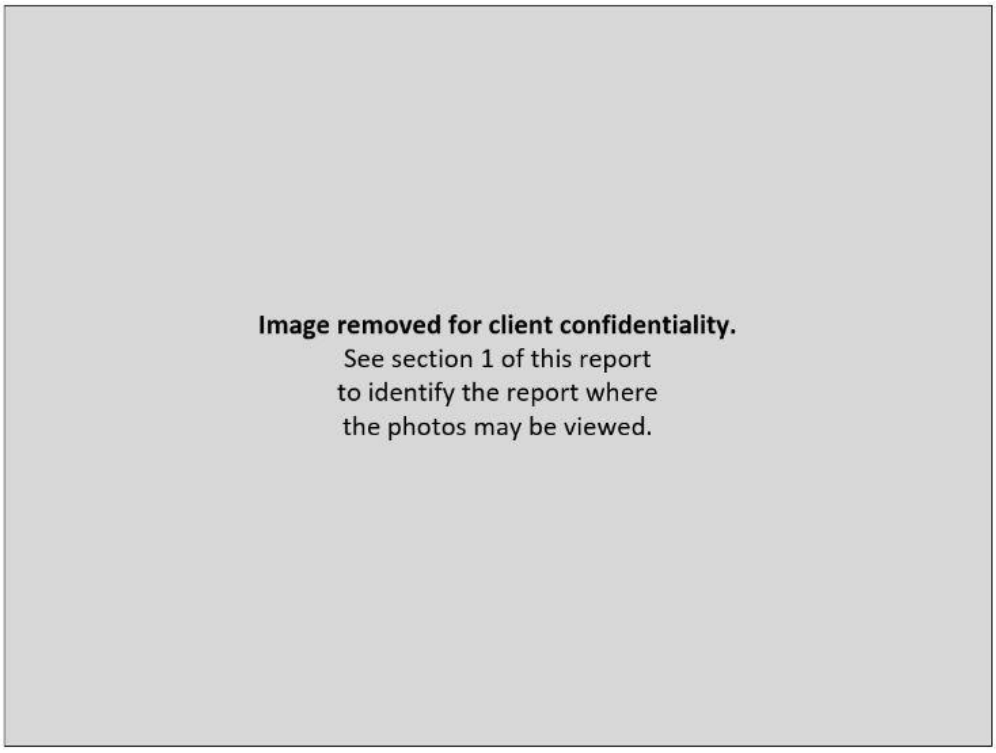



**Figure RE34.3: EUT test setup, second view (X orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE37**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 11 Oct 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M1 (BtTx) (2402MHz, BR) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247; RSS-247; RSS-GEN; ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 9 kHz to 30 MHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 15 Oct 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| MXE Receiver 8.4 GHz | Keysight | N9038B | MY63460112 | 28-Feb-2024 | 1-Mar-2025 |
| Loop antenna, amplified | Schwarzbeck | FMZB 1519B | 174 | 18-Jul-2024 | 18-Jul-2026 |
| SAC 3m, below 1 GHz | Frankonia | SAC3 | F199004 | 7-Nov-2022 | 7-Nov-2025 |
| Tape measure, 1” x 33’ | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |

**Table RE37.1: Test Equipment Used**

**Software Used:** Keysight MXE software A.37.02, RE 9k to 30M XYZ_orientations_TemplateV7.xlsm, RE 150k to 30M Signal Maximization Tool V1 2021Mar17.xlsx

**Test Data**

For test standards that require reorienting the test sample, preliminary scans were taken in those alternate orientations to find the orientation that produced that largest field at the receive antenna. With intentional radiators, that highest field is usually found at the carrier frequency. The alternate orientations are typically described as X, Y, and Z and explained with a photograph. Subsequent testing was done using on the orientation identified in this way.

radiated emission test process continued with a preliminary scan at multiple turntable angles, and in the three loop antenna polarizations. The loop antenna was positioned at a 1.5 m height. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the loop was set to the worst case orientation for that frequency and the turntable angle was explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 9 kHz and 30 MHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

| Freq. | Level | Detector | Limit | Margin | Peak Level | Pk Limit | Pk Margin | Antenna | Table |
|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | Type | dBuV/m | dB | dBuV/m | dBuV/m | dB | Orientation | Azimuth, deg |
| 0.02805 | 35.97 | Avg | 118.65 | 82.67 | 46.78 | 138.65 | 91.87 | X | 155 |
| 0.0483 | 35.50 | Avg | 113.93 | 78.42 | 41.95 | 133.93 | 91.97 | Y | -150 |
| 0.57755 | 29.82 | QP | 72.37 | 42.55 | 35.86 | None | None | Y | 29 |
| 0.9646 | 25.87 | QP | 67.92 | 42.05 | 32.09 | None | None | Y | -102 |
| 8.6223 | 16.92 | QP | 69.54 | 52.62 | 25.61 | None | None | X | 180 |
| 26.049 | 18.05 | QP | 69.54 | 51.49 | 26.02 | None | None | Z | 153 |

**Table RE37.2: Emission summary**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

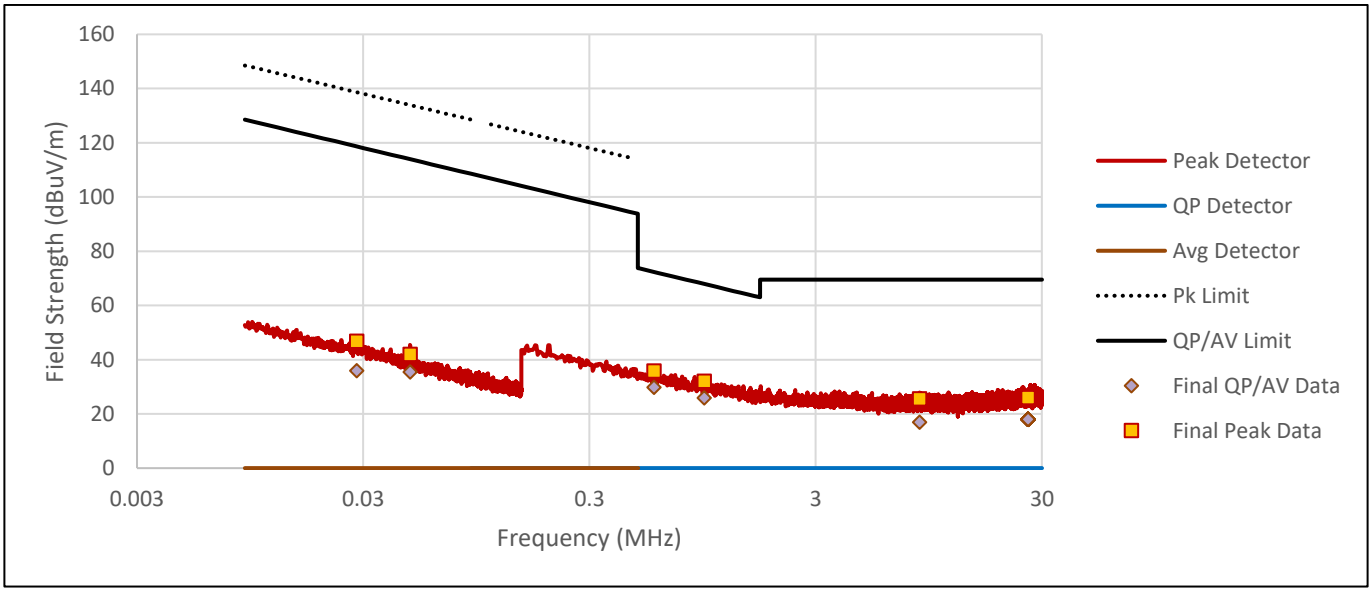



**Figure RE37.1: Spectral data**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure RE37.2: EUT test setup, first view**

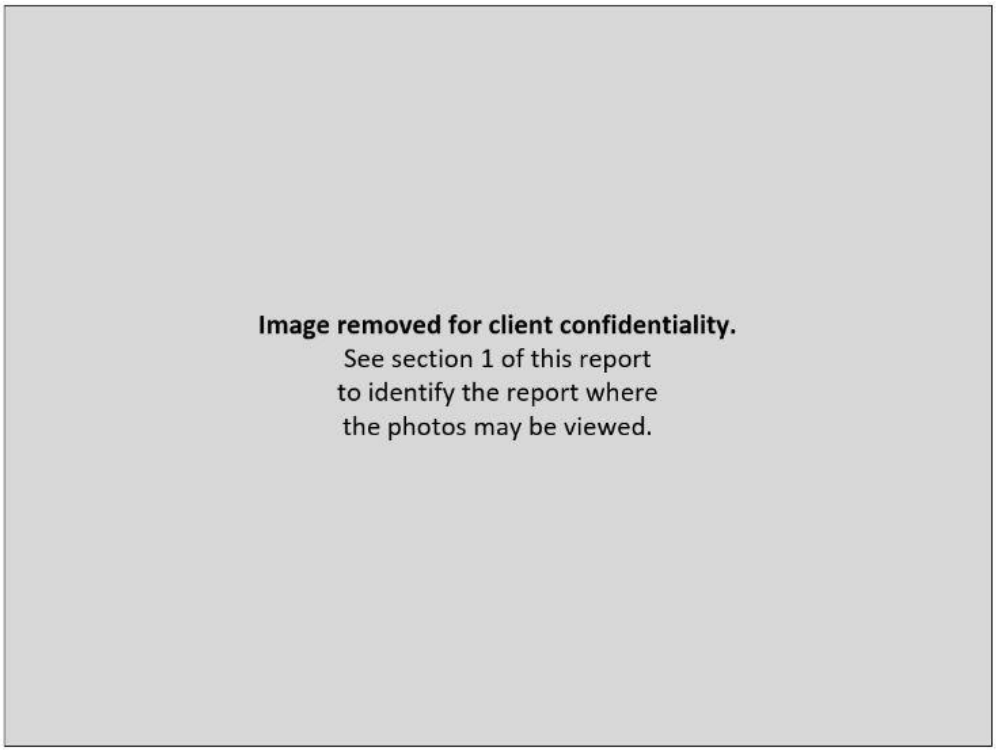



**Figure RE37.3: EUT test setup, second view (X antenna Orientation)**

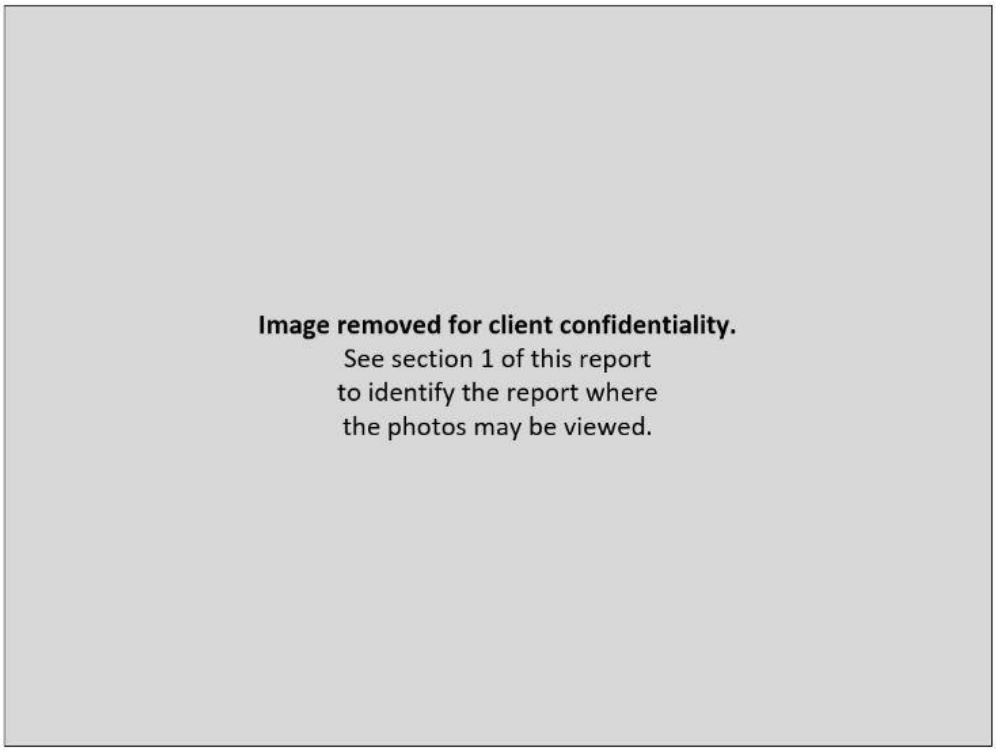



**Figure RE37.4: EUT test setup, second view (Z antenna Orientation)**


**Figure RE37.4: EUT test setup, second view (Y antenna Orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE38**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 09 Oct 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M1 (BtTx) (BT BR 2402MHz) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247; RSS-247; RSS-GEN; ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 30 MHz to 1000 MHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 09 Oct 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 2-Nov-2024 |
| Antenna, Biconilog, 30M-6 GHz | ETS Lindgren | 3142E | 233201 | 18-Jul-2024 | 18-Jul-2026 |
| SAC 3m, below 1 GHz | Frankonia | SAC3 | F199004 | 7-Nov-2022 | 7-Nov-2025 |
| Tape measure, 1” x 33’ | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |

**Table RE38.1: Test Equipment Used**

**Software Used:** Keysight PXE software A.32.06, EPX test software Version 2023.01.001

**Test Data**

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

At azimuth angle 180° the ‘front’ reference mark of the turntable is pointed Southward. At 270° the reference mark points West. At 90° it points East. At 173° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 30 MHz and 1 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

| Frequency | Pol. | Reading | Factor | Level | Limit | Margin | Height | Angle |
|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | dB(1/m) | dB(µV/m) | dB(µV/m) | dB | cm | deg |
| | | QP | | QP | QP | QP | | |
| 31.020 | V | 6.7 | 21.9 | 28.6 | 40.0 | 11.4 | 100.0 | 315.0 |
| 40.230 | V | 12.5 | 16.9 | 29.4 | 40.0 | 10.6 | 100.0 | 47.0 |
| 47.670 | V | 16.5 | 14.1 | 30.6 | 40.0 | 9.4 | 100.0 | 140.0 |
| 54.150 | V | 10.6 | 13.5 | 24.1 | 40.0 | 15.9 | 100.0 | 180.0 |
| 73.530 | V | 12.1 | 14.0 | 26.1 | 40.0 | 13.9 | 100.0 | 333.0 |
| 742.500 | H | 1.9 | 31.3 | 33.2 | 46.0 | 12.8 | 193.8 | 260.0 |

**Table RE38.2: Emission summary**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

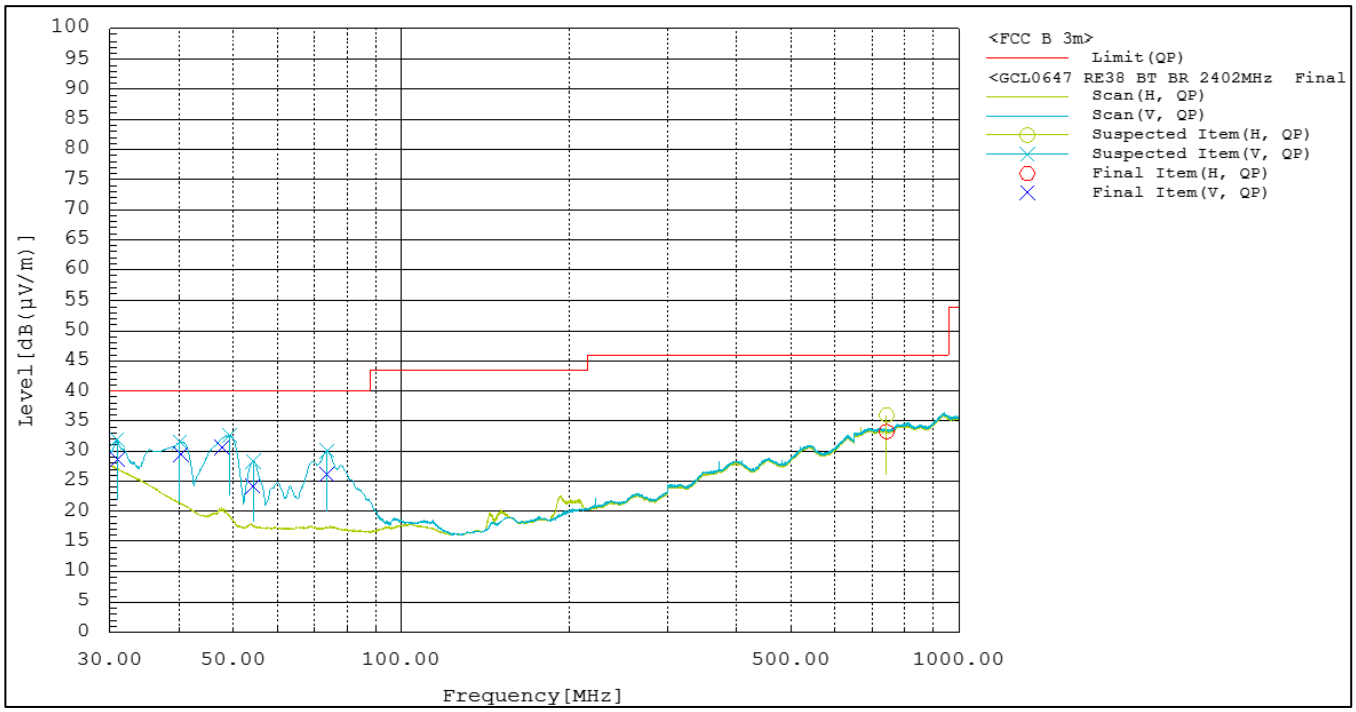



**Figure RE38.1: Spectral data**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure RE38.2: EUT test setup, first view**

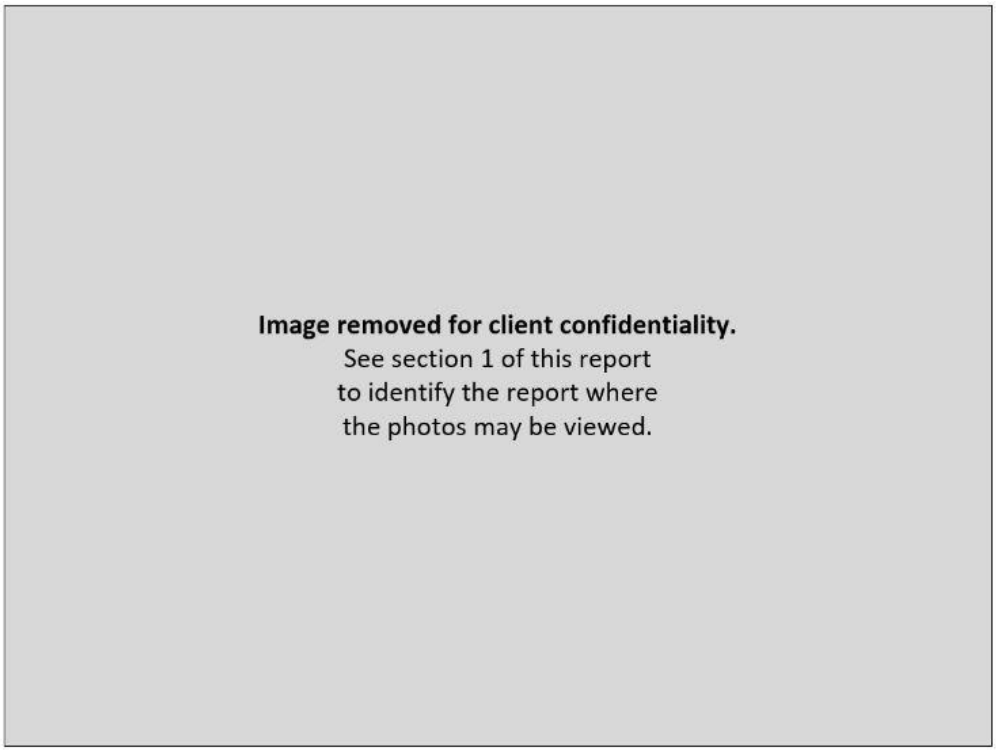



**Figure RE38.3: EUT test setup, second view**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE39**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 08 Oct 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M1 (BtTx) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15, ANSI C63.10, RSS-247, RSS-GEN (as noted in Section 6 of the report). |
| Frequency Range: | 1 GHz to 14 GHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 08 Oct 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 2-Nov-2024 |
| Antenna, Horn, 1-18 GHz | ETS Lindgren | 3117 | 259208 | 30-May-2024 | 30-May-2026 |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Tape measure, 1" x 33' | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| Preamplifier, 500 MHz 18 GHz | Com-Power | PAM-118A | 18040133 | Calibration | Not Required |
| Wifi Filter | K&L | 8NSL26-2437/E82.2-0/0 | 1 | Calibration | Not Required |
| 3 GHz High Pass filter | Anatech Electronics | 0K0R2 | 1 | Calibration | Not Required |

**Table RE39.1: Test Equipment Used**

**Software Used:** Keysight PXE software A.32.06, EPX test software Version 2023.01.001

**Test Data**

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

In the 1 GHz to 3.2 GHz frequency range, a Chebyshev 'Wifi' notch filter covering the 2.4 GHz ISM band was placed in series just before the preamplifier to ensure it operated in its linear range. This filter is accounted for in the system loss, so it appears in the prescan plots as high noise floor levels from 2400 – 2483 MHz.

These are not failing emissions. A 3 GHz high pass filter was applied during testing between 3.2 GHz and 14 GHz to similarly protect the preamplifier.

In the 1 GHz to 14 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

At azimuth angle 180° the 'front' reference mark of the turntable is pointed Southward. At 270° the reference mark points West. At 90° it points East. At 173° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 1 GHz and 14 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2065.680 | H | 32.4 | 45.9 | -3.8 | 28.6 | 42.1 | 54.0 | 74.0 | 25.4 | 31.9 | 199.4 | 111.0 |
| 2215.720 | H | 32.7 | 48.5 | -4.0 | 28.7 | 44.5 | 54.0 | 74.0 | 25.3 | 29.5 | 264.7 | 180.0 |
| 4804.340 | H | 37.3 | 48.1 | 3.2 | 40.5 | 51.3 | 54.0 | 74.0 | 13.5 | 22.7 | 272.8 | 30.0 |
| 7205.180 | V | 29.7 | 43.2 | 7.0 | 36.7 | 50.2 | 54.0 | 74.0 | 17.3 | 23.8 | 187.2 | 74.0 |
| 9418.640 | H | 26.9 | 40.9 | 10.7 | 37.6 | 51.6 | 54.0 | 74.0 | 16.4 | 22.4 | 304.7 | 295.0 |
| 12527.960 | H | 27.5 | 40.9 | 14.5 | 42.0 | 55.4 | 54.0 | 74.0 | 12.0 | 18.6 | 239.1 | 150.0 |

**Table RE39.2: Emission summary (BT, BR, 2402MHz)**

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2215.720 | H | 32.8 | 49.1 | -4.0 | 28.8 | 45.1 | 54.0 | 74.0 | 25.2 | 28.9 | 308.8 | 22.0 |
| 3620.660 | H | 31.3 | 45.0 | -0.6 | 30.7 | 44.4 | 54.0 | 74.0 | 23.3 | 29.6 | 100.0 | 0.0 |
| 4879.400 | H | 35.2 | 47.2 | 2.8 | 38.0 | 50.0 | 54.0 | 74.0 | 16.0 | 24.0 | 248.6 | 27.0 |
| 8210.660 | H | 28.5 | 41.7 | 8.4 | 36.9 | 50.1 | 54.0 | 74.0 | 17.1 | 23.9 | 400.0 | 278.0 |
| 10871.780 | H | 27.0 | 40.2 | 13.2 | 40.2 | 53.4 | 54.0 | 74.0 | 13.8 | 20.6 | 242.9 | 224.0 |
| 13498.340 | V | 26.4 | 39.8 | 15.4 | 41.8 | 55.2 | 54.0 | 74.0 | 12.2 | 18.8 | 148.0 | 82.0 |

**Table RE39.3: Emission summary (BT, BR, 2440MHz)**

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 2066.560 | H | 39.2 | 48.8 | -3.8 | 35.4 | 45.0 | 54.0 | 74.0 | 18.6 | 29.0 | 143.8 | 352.0 |
| 2215.720 | H | 32.6 | 47.3 | -4.0 | 28.6 | 43.3 | 54.0 | 74.0 | 25.4 | 30.7 | 293.7 | 160.0 |
| 4959.860 | H | 36.2 | 46.9 | 2.9 | 39.1 | 49.8 | 54.0 | 74.0 | 14.9 | 24.2 | 223.6 | 0.0 |
| 6387.080 | H | 30.0 | 43.4 | 6.7 | 36.7 | 50.1 | 54.0 | 74.0 | 17.3 | 23.9 | 348.9 | 45.0 |
| 7439.540 | V | 32.1 | 45.0 | 7.1 | 39.2 | 52.1 | 54.0 | 74.0 | 14.8 | 21.9 | 237.0 | 275.0 |
| 13603.640 | H | 26.5 | 40.4 | 15.4 | 41.9 | 55.8 | 54.0 | 74.0 | 12.1 | 18.2 | 214.3 | 295.0 |

**Table RE39.4: Emission summary (BT, BR, 2480MHz)**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

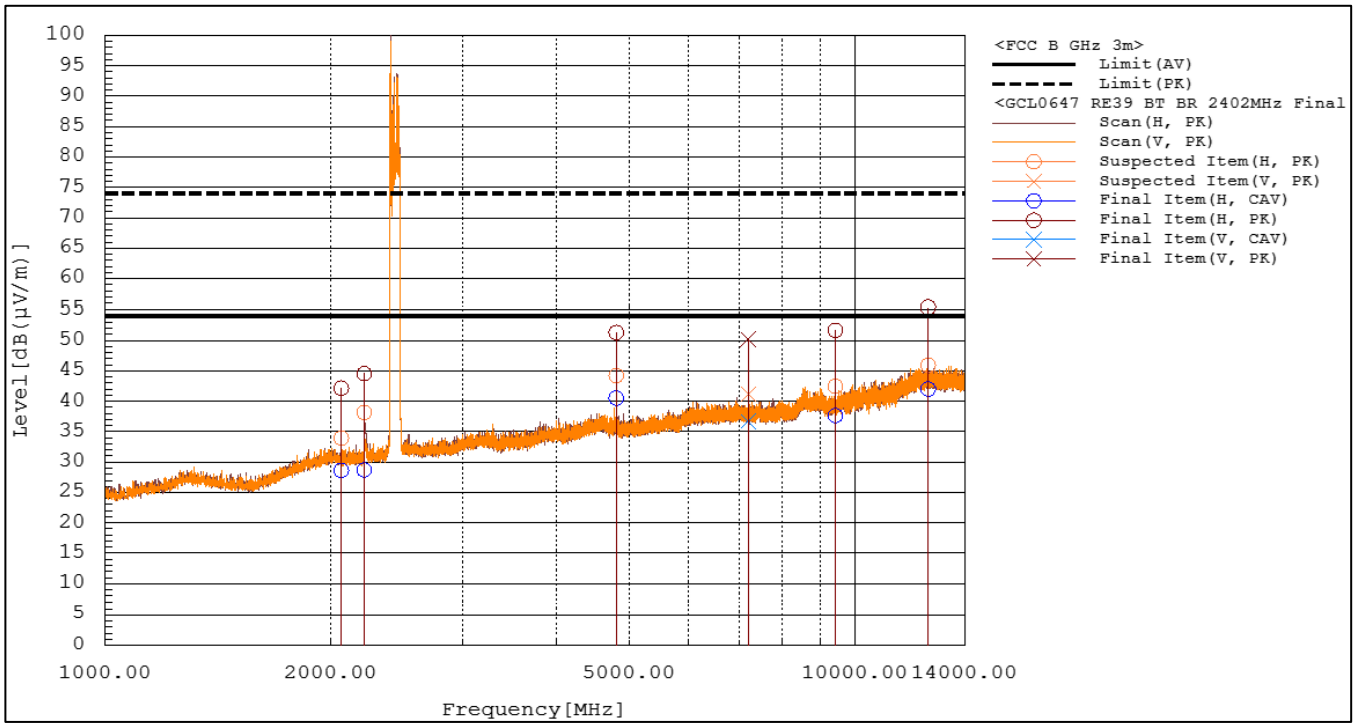



**Figure RE39.1: Spectral data (BT, BR, 2402MHz)**

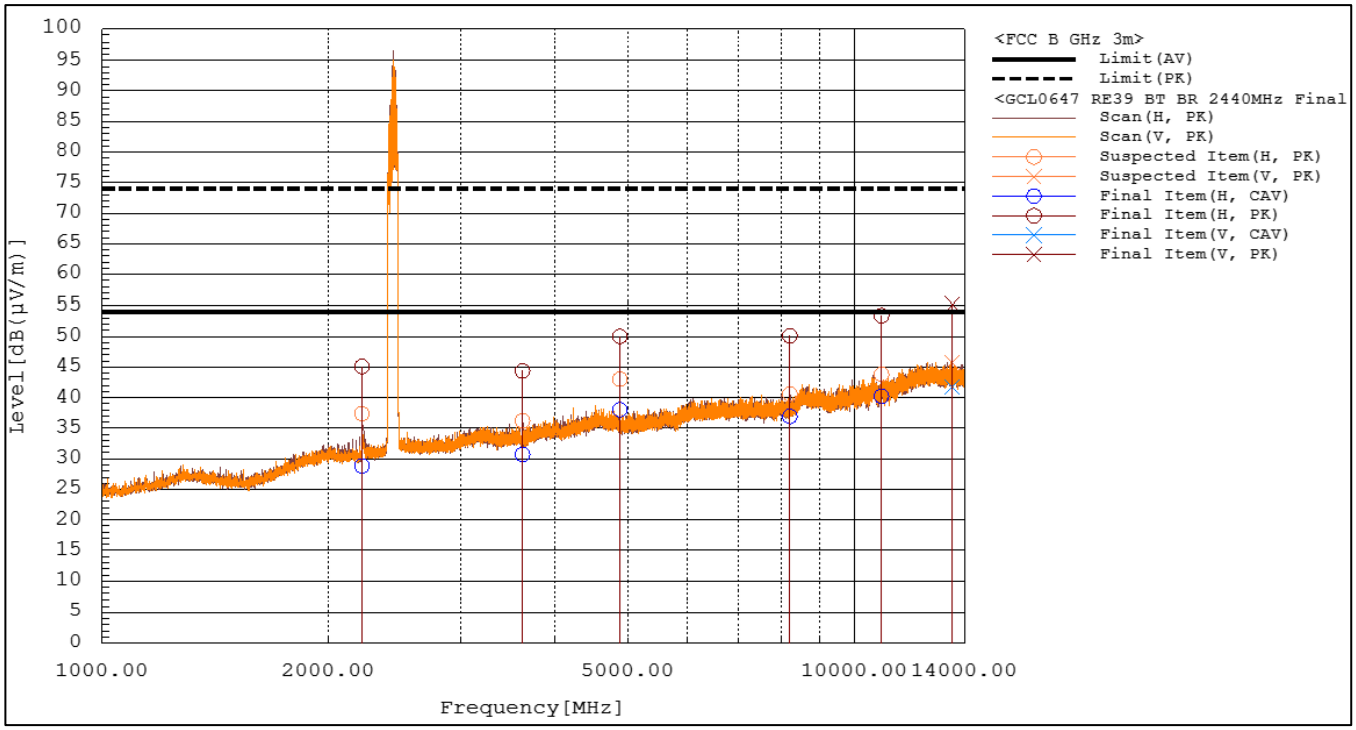



**Figure RE39.2: Spectral data (BT, BR, 2440MHz)**

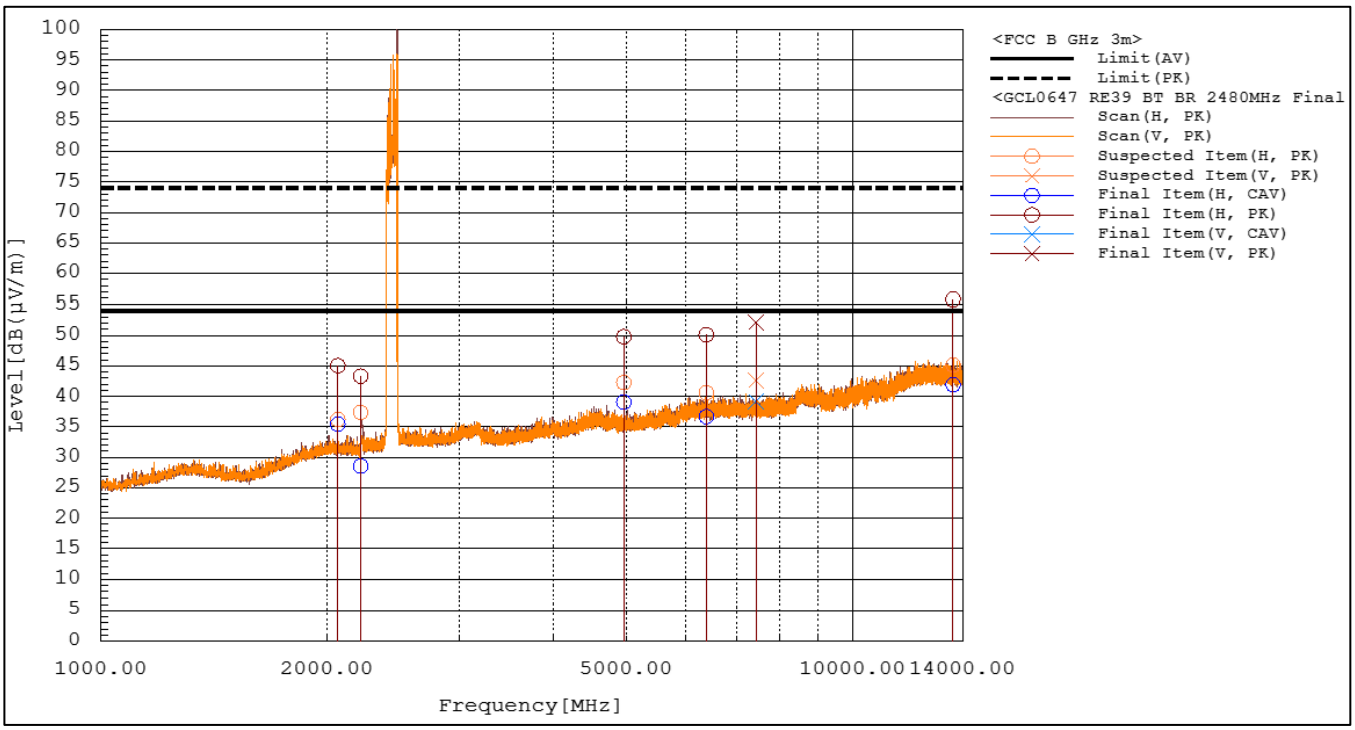



**Figure RE39.3: Spectral data (BT, BR, 2480MHz)**

### Setup Photographs

The following photographs show the EUT configured and arranged in the manner in which it was measured.

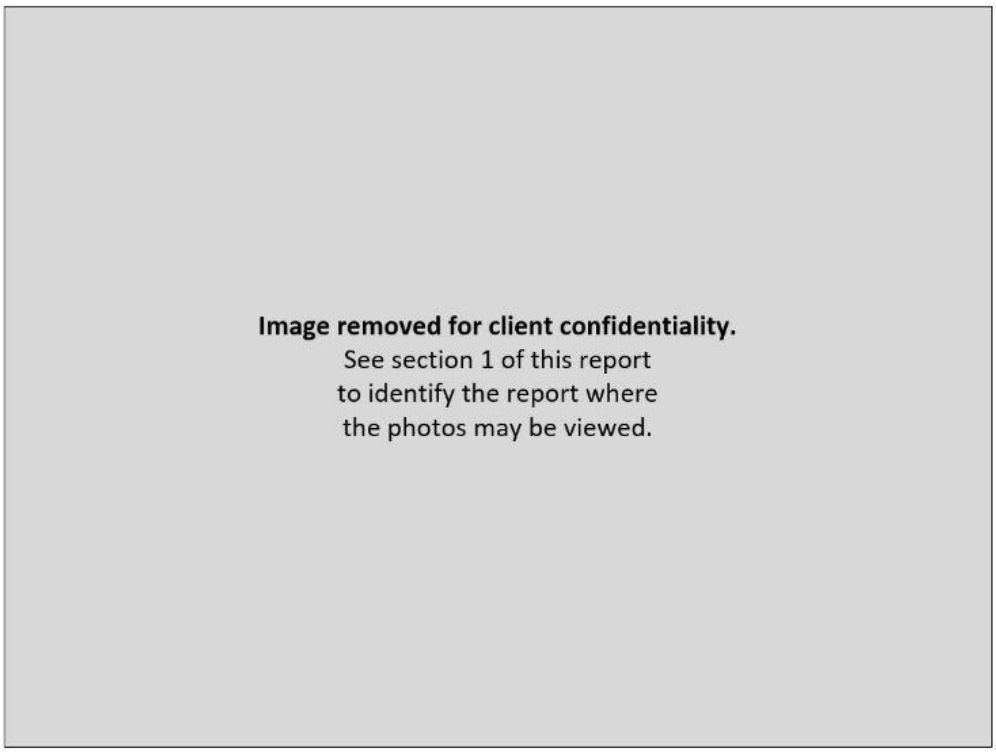



**Figure RE39.4: EUT test setup, first view (BT, BR)**

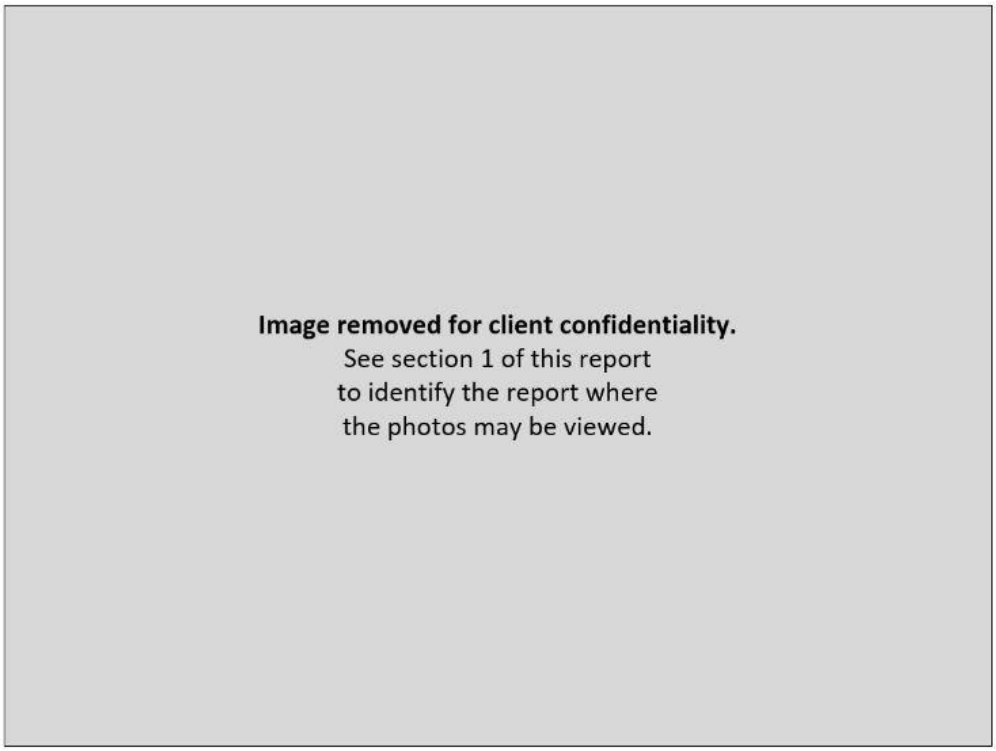



**Figure RE39.5: EUT test setup, second view (BT, BR)**


**Figure RE39.6: EUT test setup, second view (EUT X Orientation)**

**This line is the end of the test record.**

## Test Record
**Radiated Emission Test RE40**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 09 Oct 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M1 (BtTx) (BR, 2402MHz) |
| Arrangement | A2 (Upwr) |
| Input Power | USB 5 Vdc |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 14 MHz to 25 GHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 09 Oct 2024 |

Original record, Version A.

**Test Equipment**

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 2-Nov-2024 |
| Antenna, Horn, 10-40 GHz | ETS Lindgren | 3116C | 259186 | 29-Apr-2024 | 29-Apr-2026 |
| Preamplifier, 18 Ghz to 40 Ghz | Com-Power | PAM-840A | 461364 | Calibration | Not Required |
| FSOATS 3m, above 1 GHz | Frankonia | SAC3 | F199004 | 16-Nov-2022 | 16-Nov-2025 |
| Shockforce G1 Tape Measure | Crecent Lufkin | L1135CME-02 | GMN0013782 | 26-Jun-2024 | 26-Jun-2027 |

**Table RE40.1: Test Equipment Used**

**Software Used:** Keysight PXE software A.32.06, EPX test software Version 2023.01.001

**Test Data**

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

In the 14 GHz to 25 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

At azimuth angle 180° the 'front' reference mark of the turntable is pointed Southward. At 270° the reference mark points West. At 90° it points East. At 173° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 14 MHz and 25 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

In this test, fewer than six emissions were observed within 20 dB of the limit. The relevant emissions were measured, including one or more noise floor signals as judged appropriate to the spectrum.

| Frequency | Pol. | Reading | | Factor | Level | | Limit | | Margin | | Height | Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | | dB(µV) | | dB(1/m) | dB(µV/m) | | dB(µV/m) | | dB | | cm | deg |
| | | CAV | PK | | CAV | PK | AV | PK | CAV | PK | | |
| 14186.700 | V | 14.6 | 29.1 | 27.4 | 42.0 | 56.5 | 54.0 | 74.0 | 12.0 | 17.5 | 100.0 | 0.0 |
| 15391.500 | H | 17.9 | 31.3 | 24.1 | 42.0 | 55.4 | 54.0 | 74.0 | 12.0 | 18.6 | 283.8 | 40.0 |
| 15989.900 | H | 19.7 | 33.4 | 22.1 | 41.8 | 55.5 | 54.0 | 74.0 | 12.2 | 18.5 | 364.9 | 242.0 |
| 19285.500 | H | 23.3 | 37.1 | 18.9 | 42.2 | 56.0 | 54.0 | 74.0 | 11.8 | 18.0 | 374.3 | 0.0 |
| 19883.350 | H | 23.6 | 37.3 | 19.5 | 43.1 | 56.8 | 54.0 | 74.0 | 10.9 | 17.2 | 376.3 | 347.0 |
| 21313.650 | V | 23.5 | 37.3 | 20.2 | 43.7 | 57.5 | 54.0 | 74.0 | 10.3 | 16.5 | 268.8 | 156.0 |

**Table RE40.2: Emission summary**

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above.

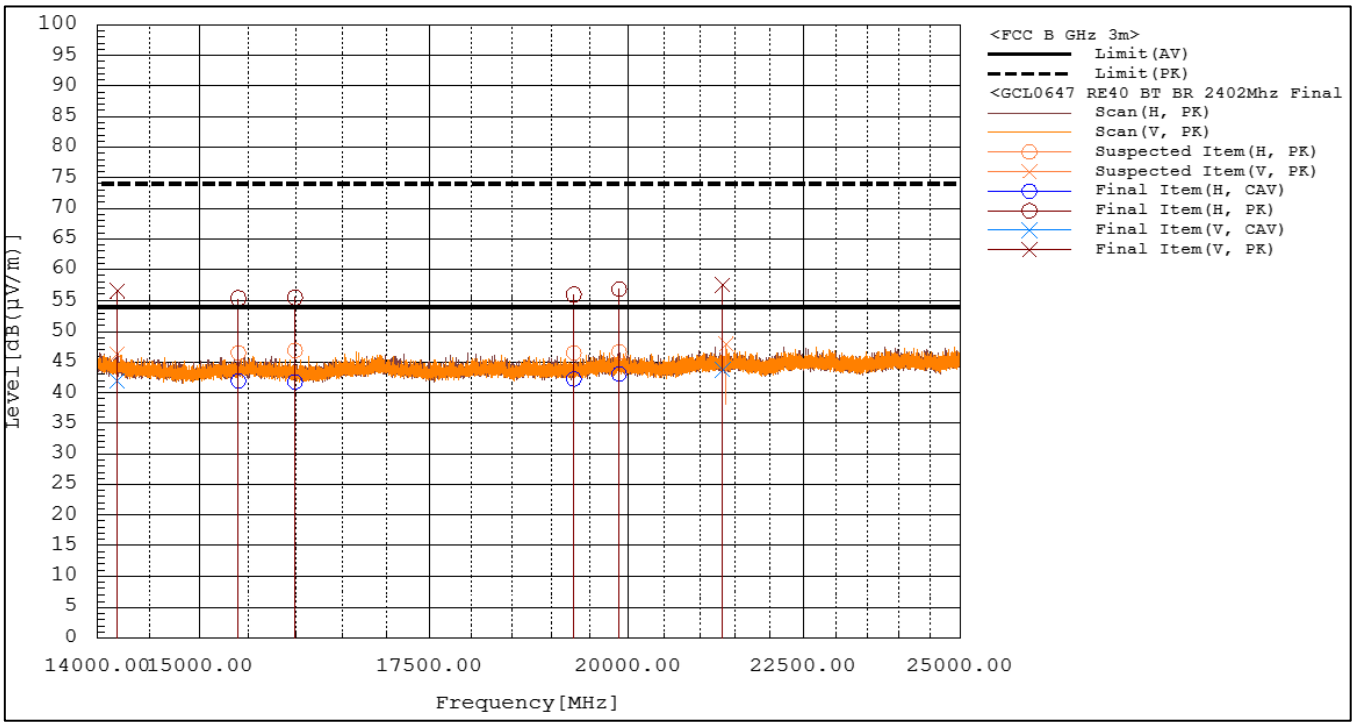



**Figure RE40.1: Spectral data**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure RE40.2: EUT test setup, first view (X orientation)**

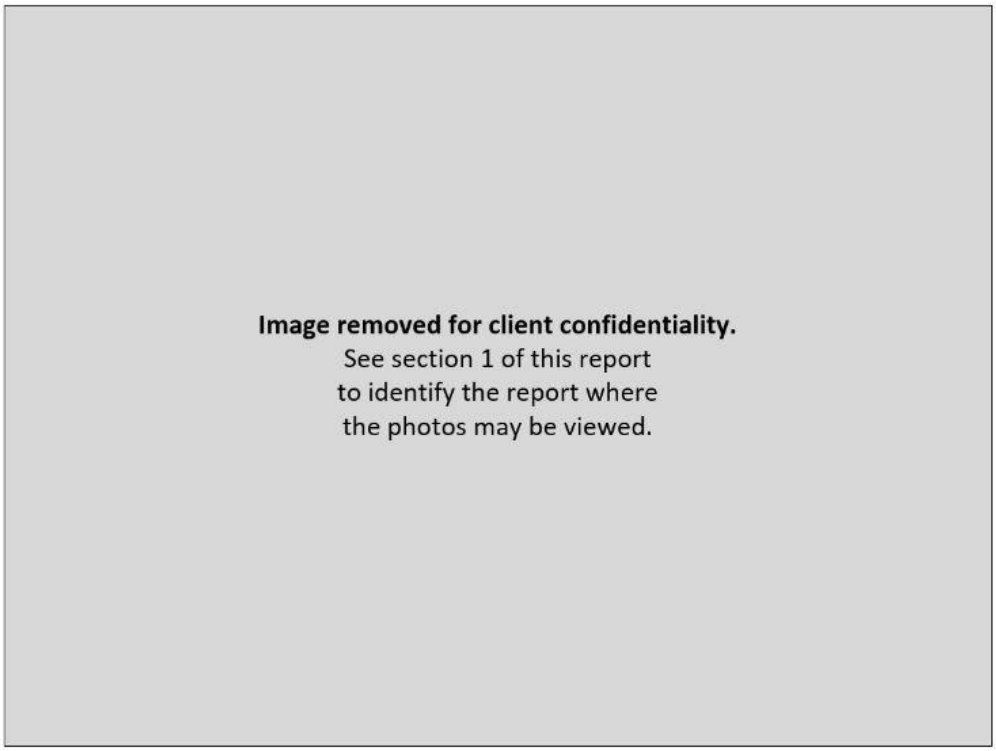



**Figure RE40.3: EUT test setup, second view (X orientation)**

**This line is the end of the test record.**

## Test Record
**Conducted Emissions Mains Test CE01**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 17 Sep 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M1 (BtTx) (2440MHz, EDR2) |
| Arrangement | A2 (Upwr) |
| Input Power | 120 Vac 60 Hz |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 150 kHz to 30 MHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 17 Sep 2024 |

Original record, Version A.

### Test Equipment

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 1-Oct-2024 |
| Tape measure, 1” x 33’ | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| LISN multiline; 20A 50uH | Com-Power | LIN-120C | 20160005 | 3-Apr-2024 | 1-Apr-2027 |
| DMM Multimeter 87V | Fluke | 87V | 63490051 | 21-Jun-2024 | 21-Jun-2025 |

**Table CE01.1: Test Equipment Used**

### Software Used
Keysight PXE software A32.06 CE Mains 150k to 30M Data Analysis V3 2024May23.xlsx

### Test Data

The conducted emission test process began with a set of preliminary scans on both power conductors using both Quasi-Peak and Average detectors across the frequency range. Where the test standard requires cable manipulation, one or more likely worst case frequencies selected by the test personnel. Cables were manipulated to find the maximal signal strength while observing the receiver levels at those selected frequencies. At each of the frequencies selected for final measurements, Quasi-peak and Average detector readings were taken on each conductor.

The table shows the selected final measurement data. It includes at least the six strongest emissions observed relative to the limit lines, along with other data points of interest. The yellow highlight indicate the data points with the least margin to the quasi-peak detector limit and the average detector limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit.

| Frequency | QP Limit | AV Limit | L1 QP | L2 QP | L1 AV | L2 AV | QP Margin | AV Margin |
|---|---|---|---|---|---|---|---|---|
| (kHz) | (dBµV) | (dBµV) | (dBµV) | (dBµV) | (dBµV) | (dBµV) | (dB) | (dB) |
| 168 | 65.06 | 55.06 | 28.70 | 28.40 | 23.80 | 23.24 | 36.36 | 31.26 |
| 353 | 58.90 | 48.90 | 29.14 | 28.42 | 24.89 | 24.16 | 29.76 | 24.01 |
| 713 | 56.00 | 46.00 | 30.52 | 30.16 | 27.21 | 26.97 | 25.48 | 18.79 |
| 740 | 56.00 | 46.00 | 28.37 | 28.01 | 23.76 | 23.49 | 27.63 | 22.24 |
| 1426 | 56.00 | 46.00 | 28.88 | 28.14 | 24.70 | 23.75 | 27.12 | 21.30 |
| 2895 | 56.00 | 46.00 | 28.56 | 27.85 | 24.08 | 23.32 | 27.44 | 21.92 |
| 30000 | 60.00 | 50.00 | 28.68 | 28.63 | 23.44 | 22.91 | 31.32 | 26.56 |

**Table CE01.1: Emission summary**

The graph below shows preliminary scan data as continuous curves. Superimposed are the final measurement data points reported in the table above.

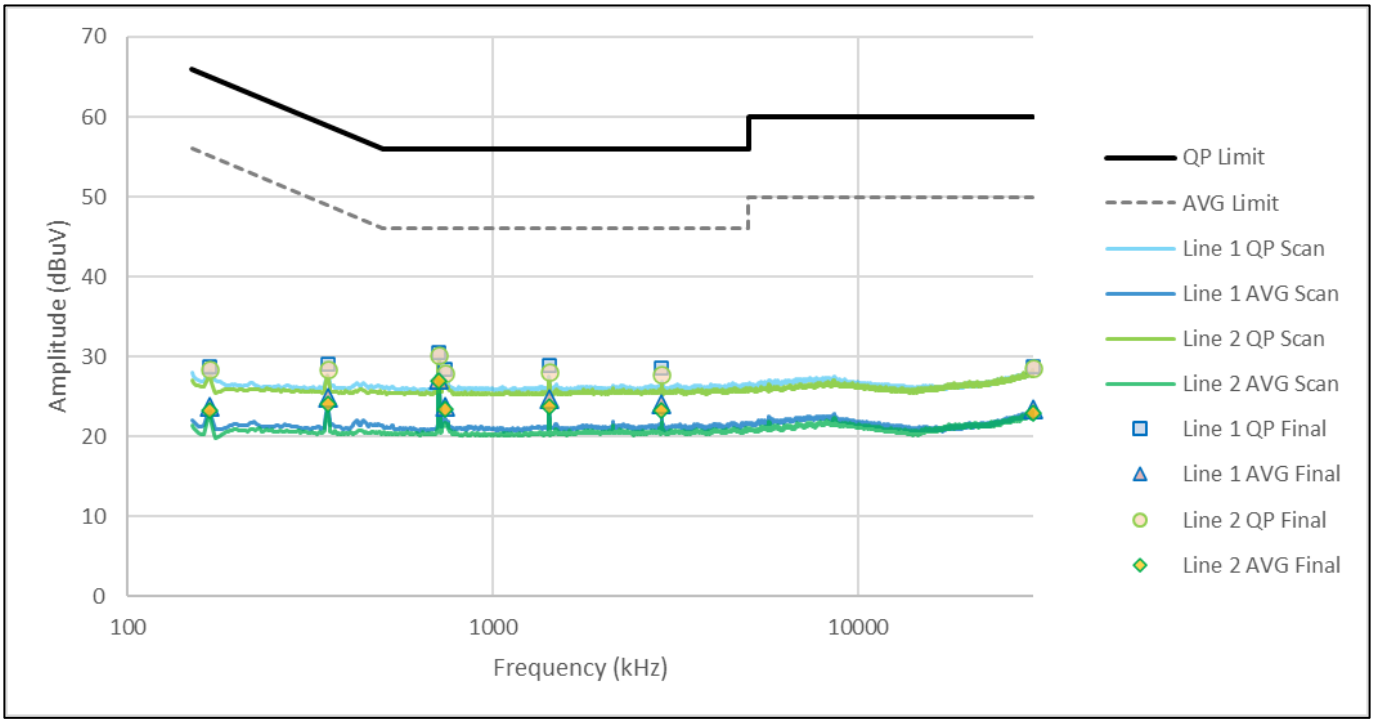



**Figure CE01.1: Spectral data**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure CE01.2: Test setup, first view**

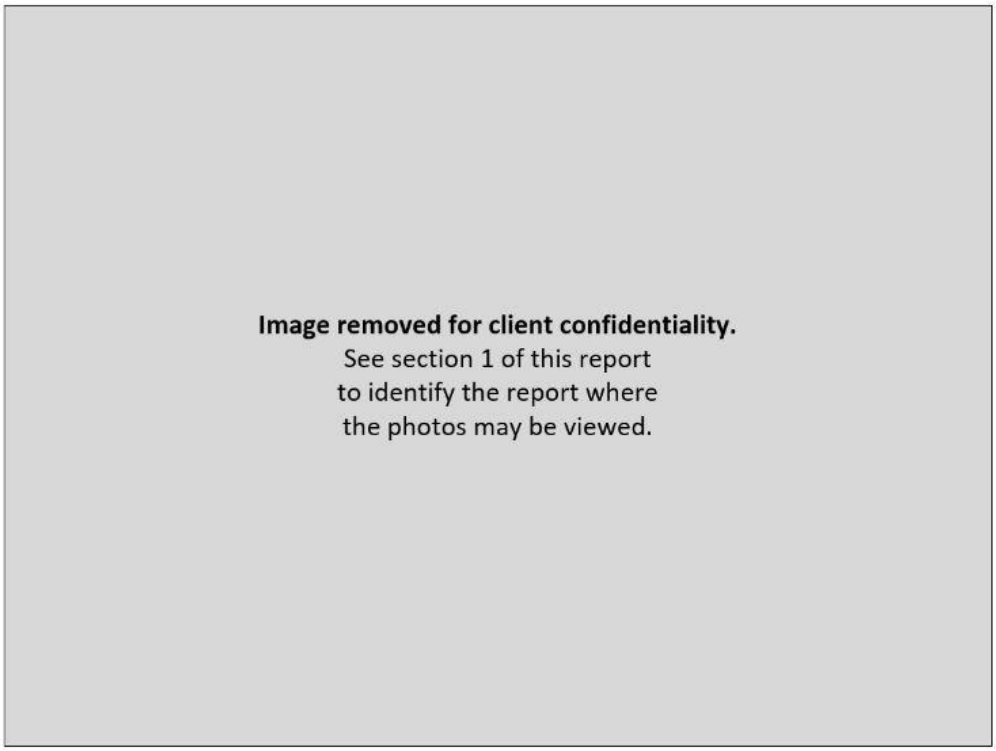



**Figure CE01.3: Test setup, second view**

**This line is the end of the test record.**

## Test Record
**Conducted Emissions Mains Test CE03**
**Project GCL0647**

| | |
|---|---|
| Test Date(s) | 17 Sep 2024 |
| Test Personnel | David Kerr |
| Product Model | A04999 |
| Serial Number tested | 8ME000165 |
| Operating Mode | M7 (WiFiTx) (CH 6, B5.5) |
| Arrangement | A2 (Upwr) |
| Input Power | 120 Vac 60 Hz |
| Test Standards: | FCC Part 15.247, RSS-247, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report). |
| Frequency Range: | 150 kHz to 30 MHz |
| **Pass/Fail Judgment:** | **PASS** |
| **Test record created by:** | David A Kerr |
| **Date of this record:** | 17 Sep 2024 |

Original record, Version A.

### Test Equipment

| Description | Make | Model # | Serial # | Last Cal/Ver | Next Due |
|---|---|---|---|---|---|
| PXE Receiver 26 GHz | Keysight | N9048B | MY59290135 | 27-Sep-2023 | 1-Oct-2024 |
| Tape measure, 1” x 33’ | Lufkin | PHV1410CMEN | 10720 | 16-Jan-2023 | 15-Jan-2026 |
| LISN multiline; 20A 50uH | Com-Power | LIN-120C | 20160005 | 3-Apr-2024 | 1-Apr-2027 |
| DMM Multimeter 87V | Fluke | 87V | 63490051 | 21-Jun-2024 | 21-Jun-2025 |

**Table CE03.1: Test Equipment Used**

### Software Used
Keysight PXE software A32.06 CE Mains 150k to 30M Data Analysis V3 2024May23.xlsx

### Test Data

The conducted emission test process began with a set of preliminary scans on both power conductors using both Quasi-Peak and Average detectors across the frequency range. Where the test standard requires cable manipulation, one or more likely worst case frequencies selected by the test personnel. Cables were manipulated to find the maximal signal strength while observing the receiver levels at those selected frequencies. At each of the frequencies selected for final measurements, Quasi-peak and Average detector readings were taken on each conductor.

The table shows the selected final measurement data. It includes at least the six strongest emissions observed relative to the limit lines, along with other data points of interest. The yellow highlight indicate the data points with the least margin to the quasi-peak detector limit and the average detector limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit.

| Frequency | QP Limit | AV Limit | L1 QP | L2 QP | L1 AV | L2 AV | QP Margin | AV Margin |
|---|---|---|---|---|---|---|---|---|
| (kHz) | (dBµV) | (dBµV) | (dBµV) | (dBµV) | (dBµV) | (dBµV) | (dB) | (dB) |
| 168 | 65.06 | 55.06 | 29.72 | 29.35 | 24.67 | 24.18 | 35.34 | 30.38 |
| 353 | 58.90 | 48.90 | 28.13 | 28.14 | 23.68 | 23.57 | 30.77 | 25.22 |
| 575 | 56.00 | 46.00 | 26.54 | 26.42 | 21.46 | 21.28 | 29.46 | 24.54 |
| 713 | 56.00 | 46.00 | 29.99 | 29.84 | 26.81 | 26.64 | 26.01 | 19.19 |
| 1424 | 56.00 | 46.00 | 27.68 | 27.56 | 23.25 | 23.21 | 28.32 | 22.75 |
| 2918 | 56.00 | 46.00 | 26.81 | 26.68 | 21.71 | 21.72 | 29.19 | 24.28 |

**Table CE03.1: Emission summary**

The graph below shows preliminary scan data as continuous curves. Superimposed are the final measurement data points reported in the table above.

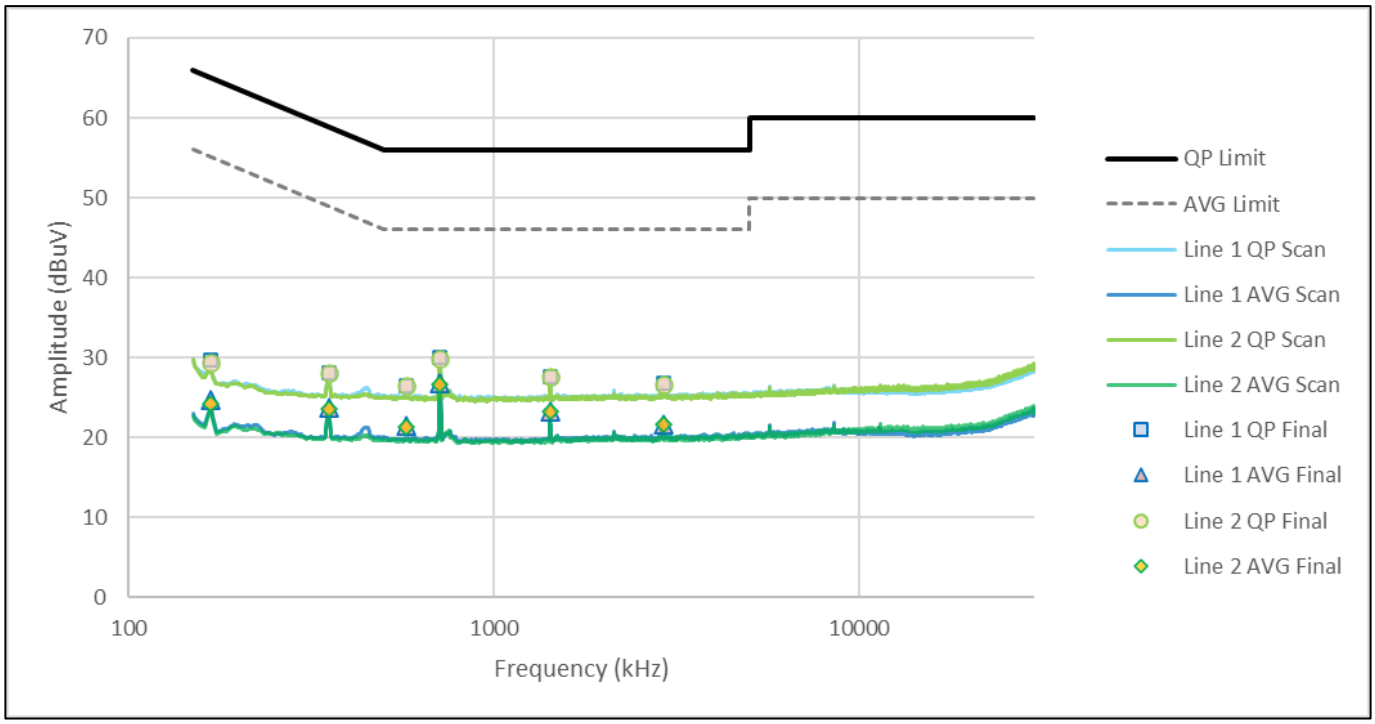



**Figure CE03.1: Spectral data**

**Setup Photographs**

The following photographs show the EUT configured and arranged in the manner in which it was measured.


**Figure CE03.2: Test setup, first view**

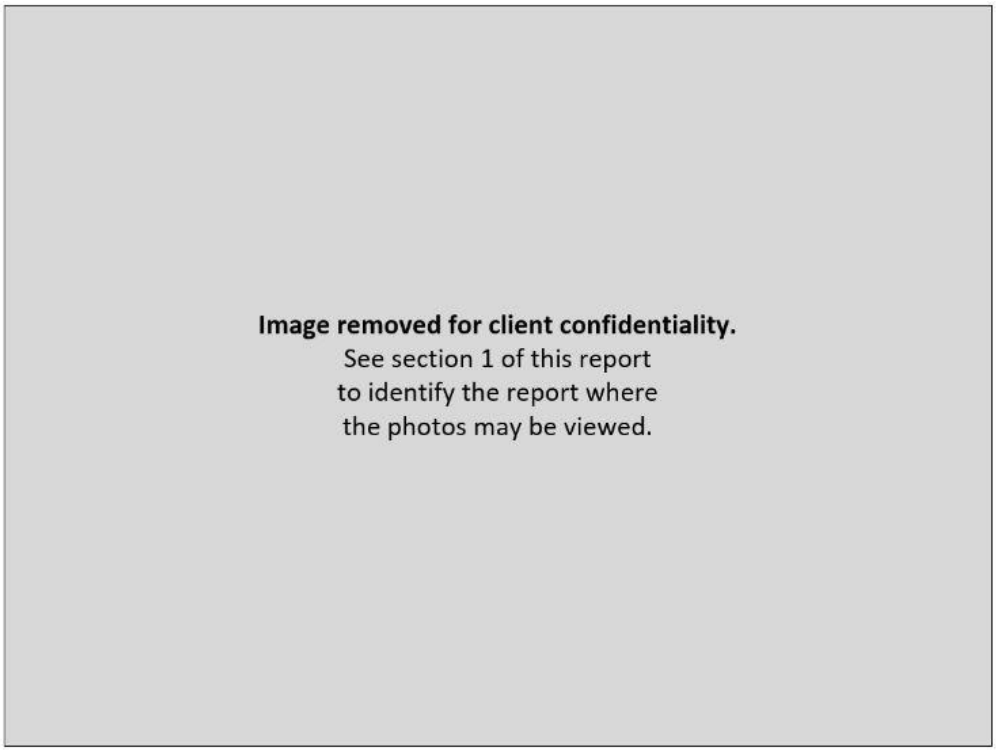



**Figure CE03.3: Test setup, second view**

**This line is the end of the test record.**

**Concluding Notes**

This report stands as an integrated record of the tests performed and must be copied or distributed in its complete form. The reproduction of selected pages or sections separate from the complete report would require specific approval from the manager of the Garmin Compliance Lab.

**This is the final page of the report.**