

Test Report 2025-022

Version B

Issued 11 Jun 2025

Project: GCL-0835

Model Identifier: A04378

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- 04378
IC ID: 1792A- 04378



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 its 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 6 dB bandwidth is 11.32 MHz or greater.	PASS	15
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	19
Transmit Power	The 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 17 dBm or 54 mW.	PASS	25
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 2.71 dBi and will document antenna gain separately.	NT	NT
Unwanted (Spurious) Emissions	The radio should not provide too much radio energy to the antenna at frequencies beyond its intended frequency band. [15.247(d); 15.209, RSS-247 at 5.5, RSS-Gen at 8.9]	Emissions outside the band must meet the 'Class B' limits of 15.209 or be reduced at least 20 dB from in-band levels. The margin to the 'Class B' limit was 1 dB or greater.	PASS	29

Adjacent Restricted Bands	The radio must not emit in certain designated restricted frequency bands to the transmission band above a set of limit values. This entry focuses on bands adjacent to the operating band. [15.247(d) and 15.205; RSS-247 at 3.3]	Emissions in the adjacent restricted bands were at least 6.5 dB below the applicable limits. Compliance for the remaining restricted bands is demonstrated by the spurious emission data.	PASS	54
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 -7 dBm in a band of at least 3 kHz.	PASS	61
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
Frequency Stability	The radio tuning must be robust over a range of temperature and supply voltage conditions. [RSS-Gen at 6.11]	Radio emissions remained within the allowed radio band under all environmental conditions tested.	NT	NT
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 5.5 dB of margin.	PASS	64

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 2025-023. 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: 17 Mar 2025

Test Start Date: 18 Mar 2025

Test End Date: 30 Apr 2025

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 6 May 2025 as Version A.

Version B, issued on 11 June 2025; corrected the FCC ID and IC ID number on page 1. Removed ANT references from test ID TR12 on pages 19, 22, and 23.

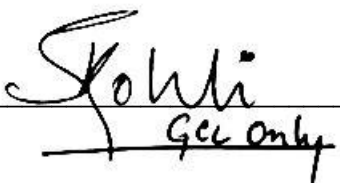
Report Technical Review:

David Arnett
Technical Lead EMC Engineer



Report Approval:

Shruti Kohli
Senior Manager Operations



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: Samples E1 (s/n 7MK001302) and E2's (s/n 7MK001303) firmware was updated from version 1.55 v3 to 1.55 v4

Date applied: 1-Apr-2025

Reason for this modification: The ETSI WiFi power table values were reduced to comply with ETSI Power Spectral Density requirements.

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: ANSI Power Spectral Density. This change was for ETSI only and no impact on testing for North America.

Modification 2

Detailed Description: Samples E1 (s/n 7MK001302) and E2's (s/n 7MK001303) firmware was updated from version 1.55 v4 to 1.55 v5

Date applied: 7-Apr-2025

Reason for this modification: The ETSI WiFi power table Ch1-5 values were further reduced to comply with ETSI Power Spectral Density requirements.

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: ANSI Tx Power, DTS Bandwidth, ANSI Occupied Bandwidth, and ANSI Power Spectral Density. This change was for ETSI only and no impact on testing for North America.

Modification 3

Detailed Description: Samples E1 (s/n 7MK001302) and E2's (s/n 7MK001303) firmware was updated from version 1.55 v5 to 1.55 v6

Date applied: 10-Apr-2025

Reason for this modification: The FCC WiFi G & N Ch11 power table values were reduced to comply with FCC Restricted Bands radiated emissions requirements.

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: ANSI Tx Power (WiFi mode B, G & N Ch's 1 & 6), DTS Bandwidth, ANSI Occupied Bandwidth, ANSI Power Spectral Density, and A/C Mains Conducted Emissions.

Modification 4

Detailed Description: Sample E1's (s/n 7MK001302) firmware was updated from version 1.55 v6 to 1.55 v7

Date applied: 11-Apr-2025

Reason for this modification: The FCC WiFi G & N Ch11 power table values were further reduced to comply with FCC Restricted Bands radiated emissions requirements. The ETSI WiFi mode B power table values were further reduced to comply with ETSI power at temperature requirements.

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: ANSI Tx Power (WiFi B mode, G & N Ch's 1 & 6), DTS Bandwidth, ANSI Occupied Bandwidth, ANSI Power Spectral Density, and A/C Mains Conducted Emissions.

5. Description of the Equipment Tested

5.1 Unique Identification

Product Model A04378
Serial Numbers Tested 7MK001302, 7MK001303

This product tested is a portable transceiver.

The client affirmed that the test samples 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
Radio Receivers: GPS L1, Galileo E1, BeiDou, GLONASS
Primary Functions: Text
Typical use: Portable in multiple orientations
Highest internal frequency: 2.484 GHz
Highest digital frequency: 200 MHz
Firmware Revision: 1.55 v7 (see section 4)

5.3 Operating modes

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

Mode 1: 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 2: 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

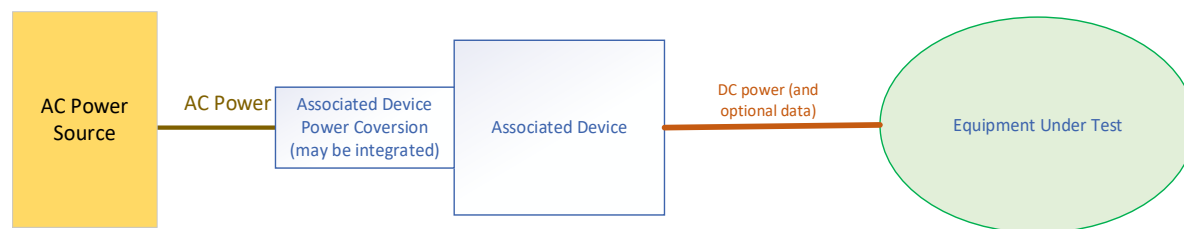
5.4 EUT Arrangement

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.



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

Figure 1: Block diagram of equipment arrangements A2 and A3

5.5 Associated Equipment (AE) used

Description	Manufacturer	Model	Serial/Part Number
USB C power adaptor	Phihong (Garmin)	AQ27A-59CFA	362-00118-00

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 Cable	laptop	test sample	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 boresighting and another does not, swept motion with boresighting will typically be used as it is the more stringent requirement.

Some standards that apply an Average detector provide a variety of methods to handle time-averaging, especially where the transmission is not continuous and the Duty Cycle (DC) is below a value such as 98%. The basic GCL process is to begin by applying an Average detector to the emission with the receiver in Max-Hold data mode. This Max Average method is worst-case compared to any of the methods of time-averaging provided. If the Max Average result complies with the limit, that result is provided in the test record and the emission judged to be compliant without additional detail. If the Max Average result is near or above the limit at one or more emission frequencies, then one of the appropriate time-averaging methods is applied to determine final compliance. When time-averaging is used, the test record will indicate which method of time-averaging was used.

Some standards ask for measurements made with a 'Time Domain Power' function, but that function is not defined in the standards. GCL addresses this gap as follows. Staff capture a zero-span Average detector data record of emission power, with a timespan covering a transmission burst. When the maximum power in the data record is clearly below the limit, this value will be reported. When the maximum power in the data record is near or above the limit, then the average of the power (in linear units) during a transmission burst is calculated and reported.

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	1.70 dB	3.8 dB	None
Conducted Emissions, Power Mains, 150 kHz to 30 MHz	1.48 dB	3.4 dB	None
Conducted Emissions, Cat 6 LCL, 150 kHz to 30 MHz	1.57 dB	5 dB	None
Conducted Emissions, Cat 5 LCL, 150 kHz to 30 MHz	3.06 dB	5 dB	None
Conducted Emissions, Cat 3 LCL, 150 kHz to 30 MHz	4.27 dB	5 dB	None
Radiated Emissions, below 30 MHz	0.88 dB	None	6 dB
Radiated Emissions, 30 MHz to 1000 MHz	2.79 dB	6.3 dB	6 dB
Radiated Emissions, 1 GHz to 18 GHz	2.54 dB	5.2 & 5.5 dB	6 dB
Radiated Emissions, 18 GHz to 26.5 GHz	2.68 dB	None	6 dB
Radiated Emissions, 26.5 GHz to 40 GHz	3.17 dB	None	6 dB
*Radio Signal Frequency Accuracy	$*1.55 \times 10^{-7}$	None	1.0×10^{-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 0.01% of value 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 1470 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

$$(7.145 \text{ dB}\mu\text{V}) + (9.812 \text{ dB}) + (0.216 \text{ dB}) = 17.173 \text{ dB}\mu\text{V}$$

8.2 Radiated Emissions at 630 MHz

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

$$(2.25 \text{ dB}\mu\text{V}) + (27.80 \text{ dB/m}) + (2.89 \text{ dB}) = 32.94 \text{ dB}\mu\text{V/m}$$

8.3 Radiated Emissions at 2.7 GHz

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

$$(43.72 \text{ dB}\mu\text{V}) + (32.22 \text{ dB/m}) + (-36.09 \text{ dB}) = 39.85 \text{ dB}\mu\text{V/m}$$

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:	21 to 24 °C
Relative Humidity:	40% to 55% (non-condensing)
Barometric Pressure	95.0 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.

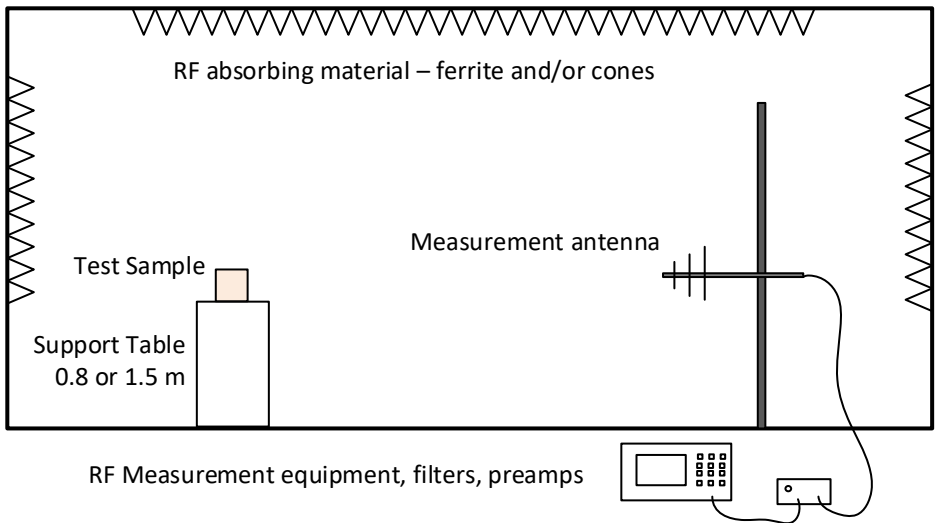


Figure 1: Typical configuration for measurements below 1 GHz

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.

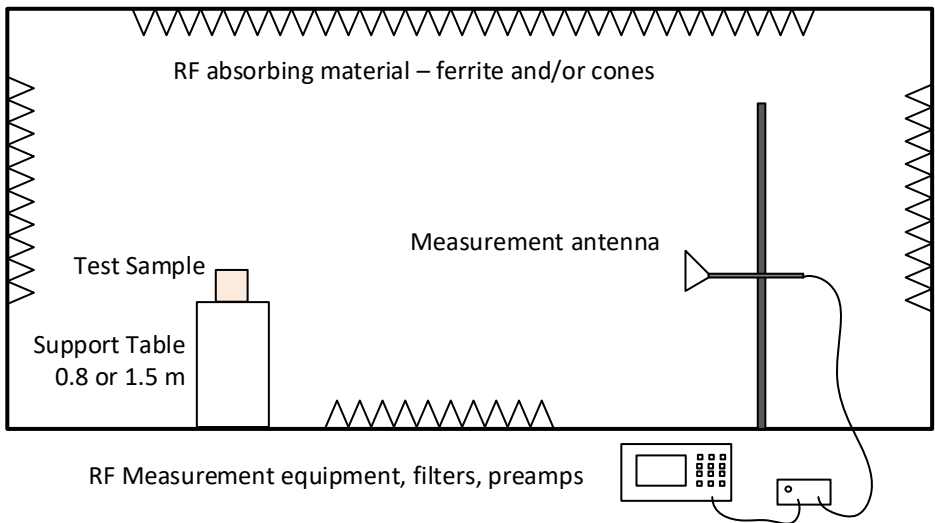


Figure 2: Typical configuration for measurements between 1 GHz and 14 GHz

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.

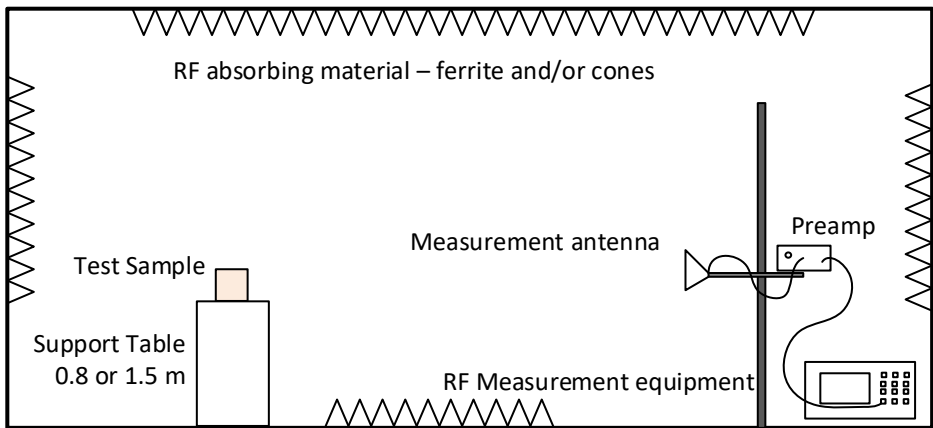


Figure 3: Typical configuration for measurements above 14 GHz

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 TR08
Project GCL-0835

Test Date(s) 03, 04 April 2025
Test Personnel Jim Solum

Product Model A04378
Serial Number tested 7MK001303

Operating Mode M7 (WiFITx)
Arrangement A2 (Upwr)
Input Power 5Vdc

Test Standards: FCC Part 15, ANSI C63.10, RSS-GEN (as noted in Section 6 of the report).

Radio Protocol IEEE 802.11b/g/n
Radio Band 2400 to 2483.5 MHz

Pass/Fail Judgment: PASS

Test record created by: Jim Solum
Date of this record: 07 April 2025

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
MXE Receiver 8.4 GHz	Keysight	N9038B	MY63460112	17-Mar-2025	17-Mar-2026

Table TR08.1: 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.

Test Setup

This block diagram shows the test equipment setup.

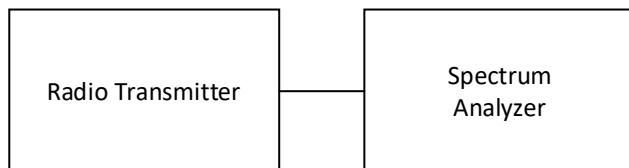


Figure TR08.1: Test setup

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.

	Ch1	Ch6	Ch11
B1	11.32	12.23	11.33
B2	11.63	12.44	11.62
B5.5	11.96	12.10	11.96
B11	12.02	12.27	12.01
G6	16.41	16.47	16.36
G9	16.39	16.41	16.43
G12	16.37	16.57	16.53
G18	16.45	16.50	16.56
G24	16.50	16.42	16.46
G36	16.58	16.57	16.51
G48	16.58	16.51	16.54
G54	16.53	16.42	16.48
NMCS0	17.69	17.80	17.73
NMCS1	17.71	17.70	17.72
NMCS2	17.61	17.74	17.67
NMCS3	17.78	17.84	17.75
NMCS4	17.70	17.70	17.74
NMCS5	17.68	17.68	17.72
NMCS6	17.59	17.66	17.62
NMCS7	17.60	17.67	17.65

Table TR08.3: Summary of bandwidth data in MHz for IEEE 802.11 WiFi modes

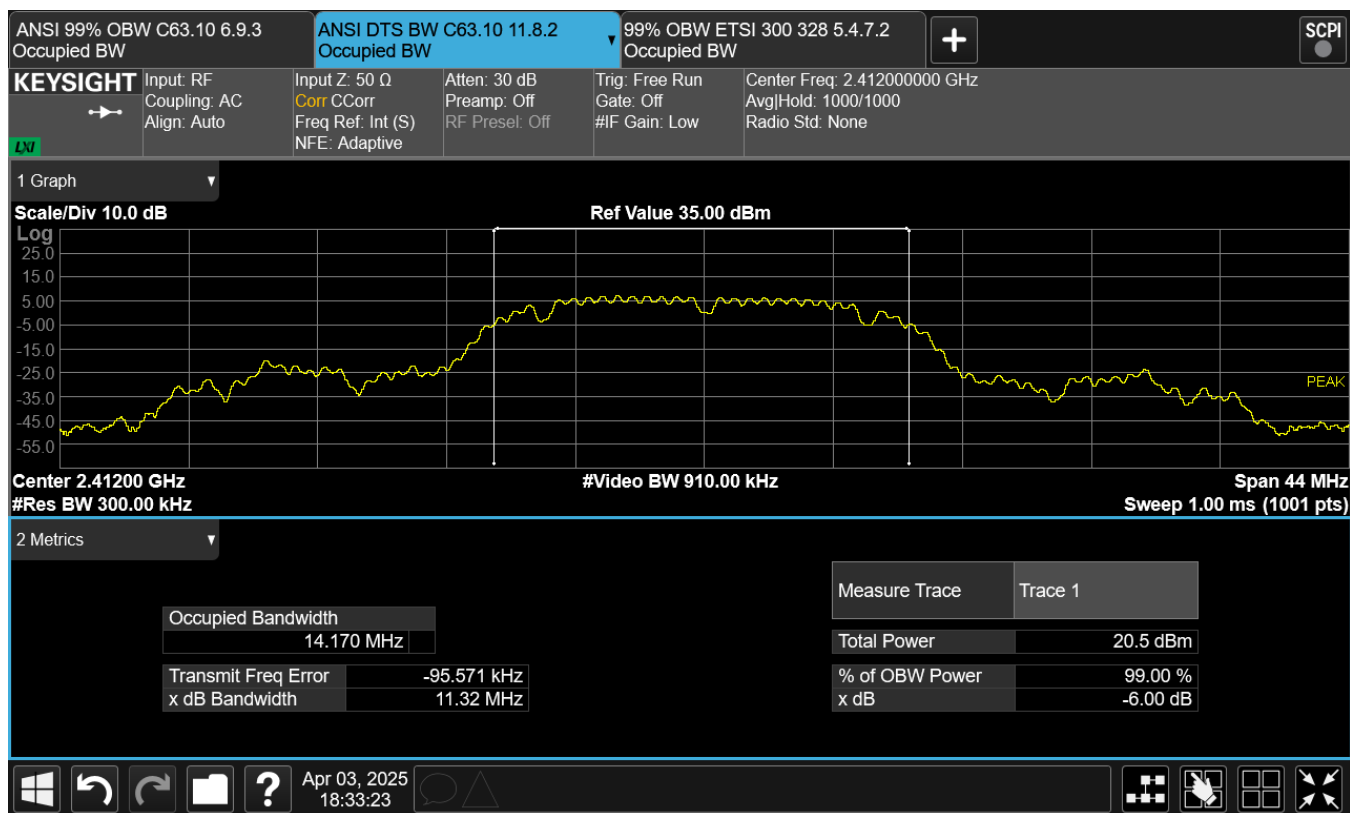


Figure TR08.2: Bandwidth data for 802.11b 1 Mbps at channel 1

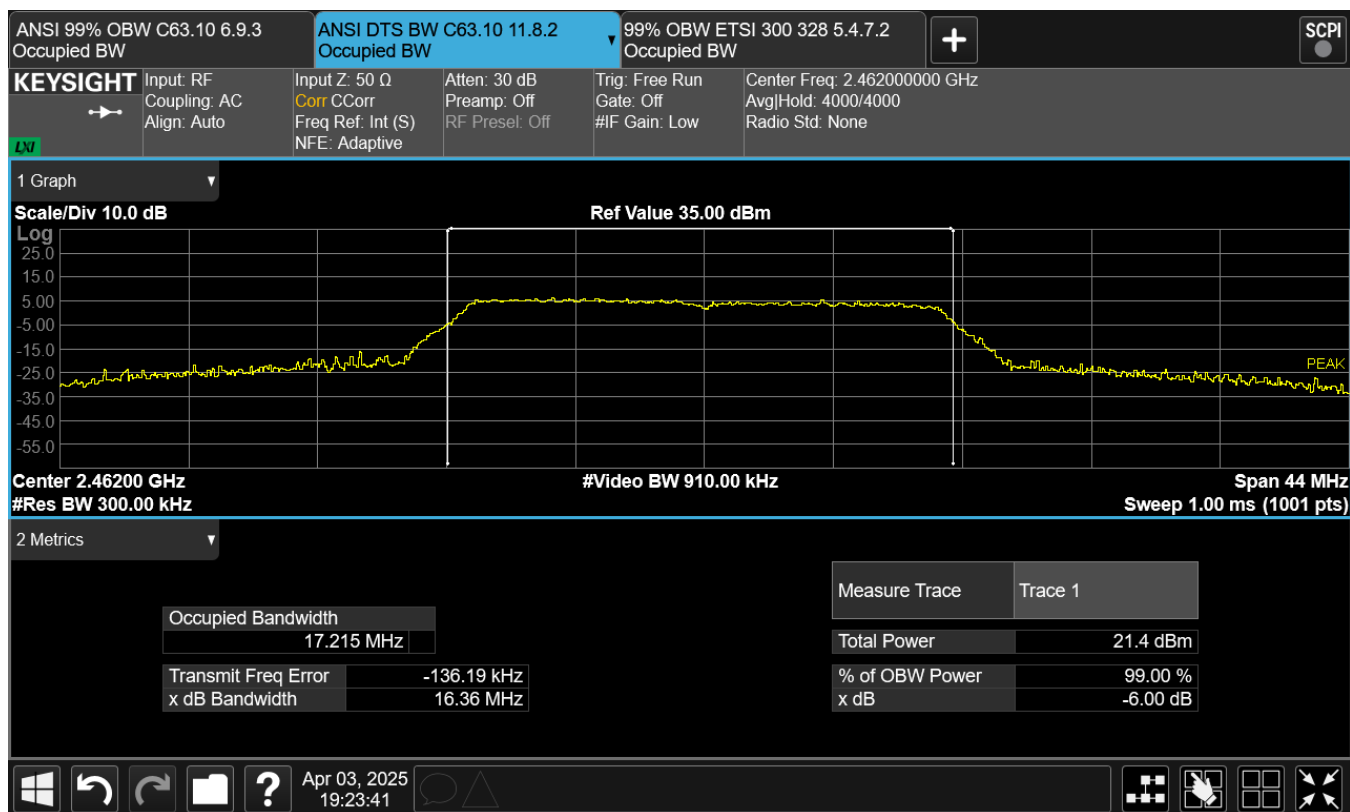


Figure TR08.3: Bandwidth data for 802.11g 6 Mbps at channel 11

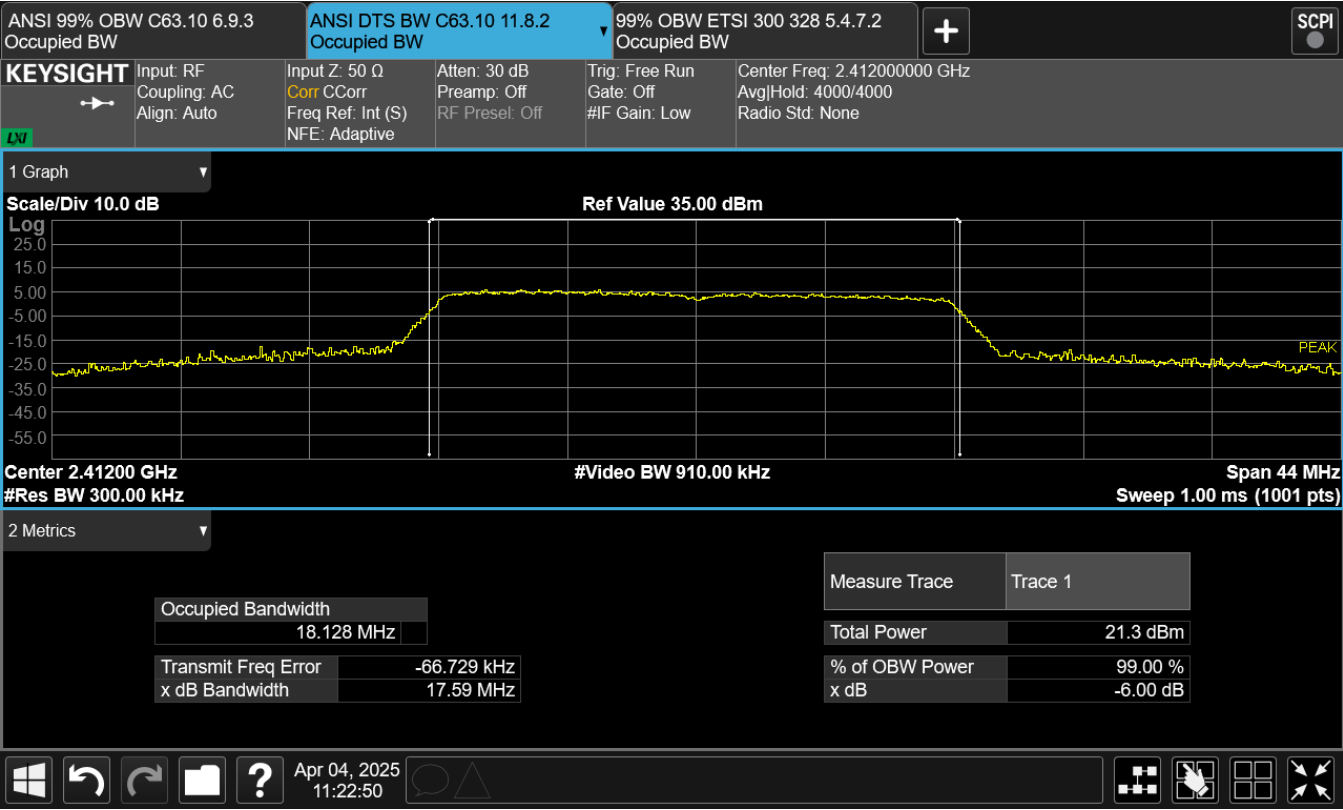


Figure TR08.4: Bandwidth data for 802.11n MCS6 at channel 1

This line is the end of the test record.

Test Record
Transmitter Bandwidth Tests
Test IDs TR12
Project GCL00835

Test Date(s) 03, 04 April 2025
Test Personnel Jim Solum

Product Model A04378
Serial Number tested 7MK001303

Operating Mode M7 (WiFITx)
Arrangement A2 (Upwr)
Input Power 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 IEEE 802.11 b/g/n (WiFi)
Radio Band 2480 to 2483.5 MHz

Pass/Fail Judgment: Reported

Test record created by: Jim Solum
Date of this record: 11 Jun 2025

Version B. Corrected date and removed ANT radio references. Original record, Version A, issued on 07 April 2025

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
MXE Receiver 8.4 GHz	Keysight	N9038B	MY63460112	17-Mar-2025	17-Mar-2026

Table TR12.1 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 and BLE 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.

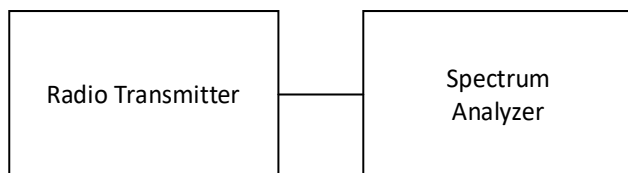


Figure TR12.1: Test setup

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 Bandwidth, 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.

	Ch1	Ch6	Ch11
B1	14.257	14.115	14.079
B2	14.214	14.129	14.079
B5.5	13.900	13.829	13.860
B11	13.952	13.887	13.887
G6	17.437	17.222	17.237
G9	17.348	17.180	17.275
G12	17.089	16.943	17.025
G18	17.072	16.940	17.012
G24	16.994	16.894	16.941
G36	17.013	16.889	16.952
G48	16.987	16.867	16.924
G54	16.987	16.863	16.913
NMCS0	17.950	17.896	17.905
NMCS1	17.949	17.873	17.905
NMCS2	17.971	17.909	17.949
NMCS3	17.951	17.883	17.906
NMCS4	17.958	17.892	17.928
NMCS5	17.933	17.898	17.904
NMCS6	18.122	18.053	18.047
NMCS7	17.927	17.874	17.893

Table TR12.2: Summary of 99% Occupied Bandwidth Data for IEEE 802.11 WiFi modes



Figure TR12.2: Occupied bandwidth data for 802.11b 1 Mbps at channel 1

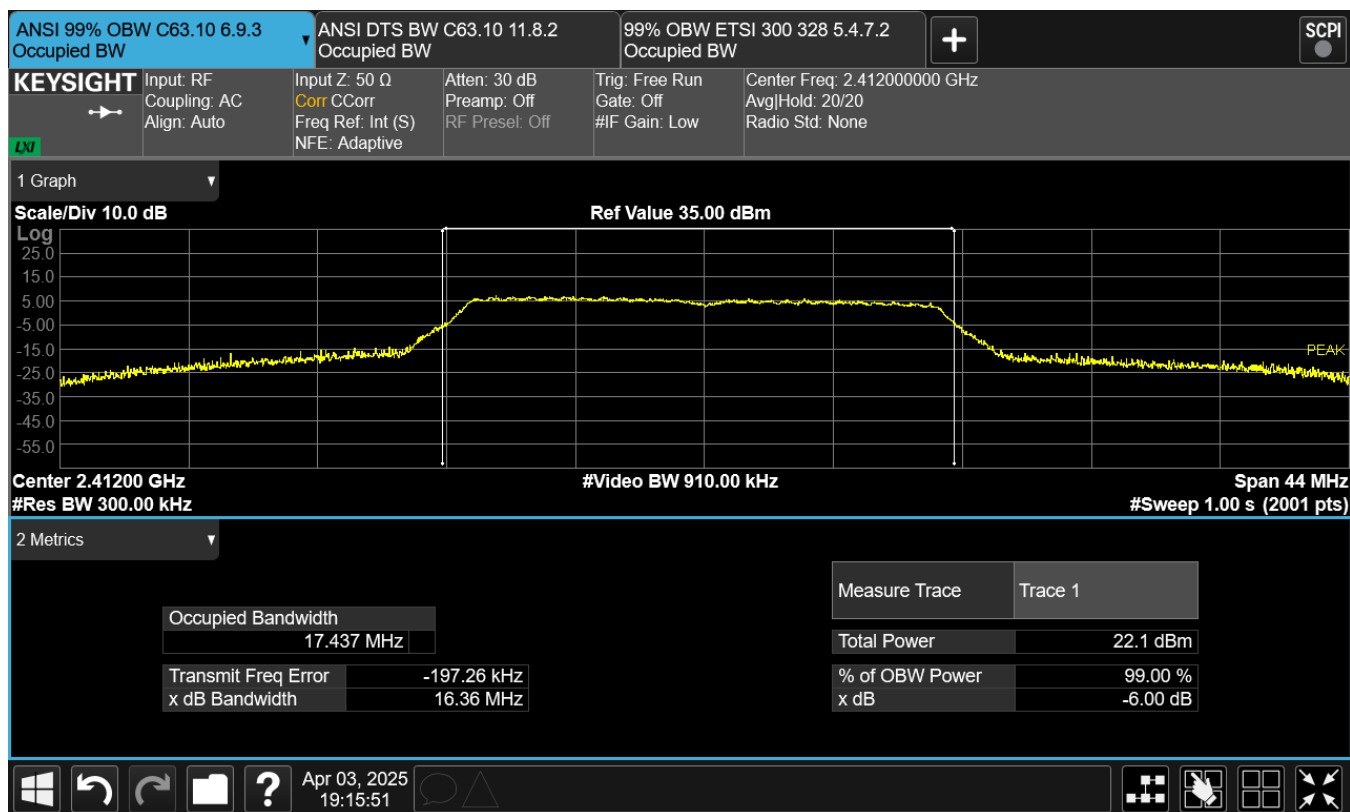


Figure TR12.3: Occupied bandwidth data for 802.11g 6 Mbps at channel 1

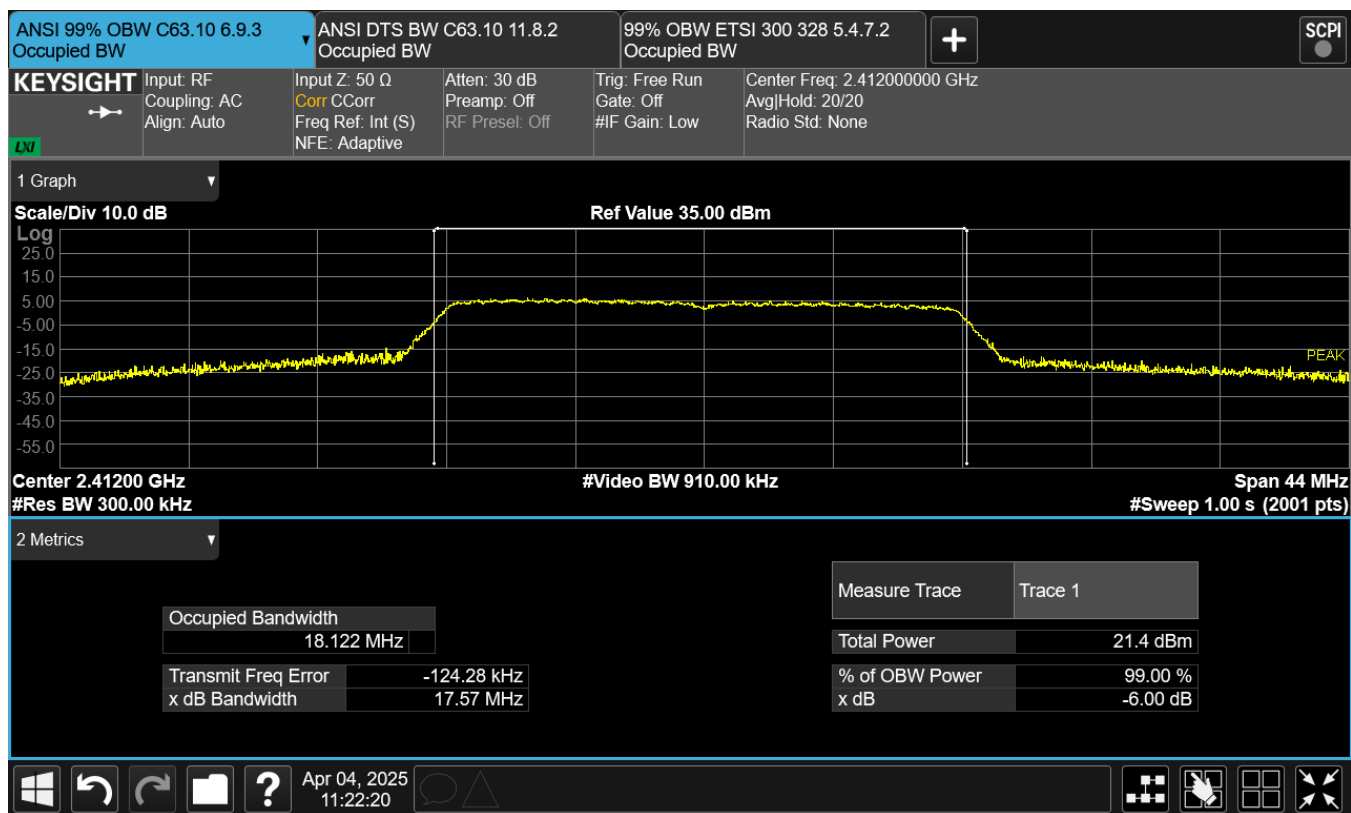


Figure TR12.4: Occupied bandwidth data for 802.11n MCS6 at channel 1

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, 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 TR12.100: Necessary Bandwidth for NFC

The radio modulation schemes 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	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 TR12.101: 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 TR12.102: 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 TR12.103: 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 TR12.104: 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, N_s 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	N _s (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 TR12.105: 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 ID TR05
Project GCL0835

Test Date(s) 02 April 2025
14 April 2025 (G,N Ch11)
Test Personnel Jim Solum
Product Model A04378
Serial Number 7MK001303
Operating Mode M7 (WiFITx)
Arrangement A2 (Upwr)
Input Power 5Vdc
Test Standards: FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247, (as noted in Section 6 of the report).
Antenna Gain 2.71 dBi, as reported by the client
Radio Protocol IEEE 802.11b/g/n
Hopping Frequencies N/A

Pass/Fail Judgment: PASS

Test record created by: Jim Solum
Date of this record: 14 April 2025

Original record, Version A.

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 TR05.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3; TimePowerAnalysisSpreadsheetv12d.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
B	1	16.91	17.29	16.67
B	2	16.89	17.30	16.73
B	5.5	17.02	17.33	16.58
B	11	16.75	17.12	16.41
G	6	14.29	14.58	13.43
G	9	14.31	14.63	13.44
G	12	14.28	14.88	13.30
G	18	14.50	14.66	13.17
G	24	14.23	14.67	13.09
G	36	14.32	14.52	13.04
G	48	14.44	14.69	13.37
G	54	14.36	14.68	13.18
N	MCS0	14.49	14.66	11.96
N	MCS1	14.20	14.56	11.93
N	MCS2	14.13	14.47	11.91
N	MCS3	14.09	14.43	11.91
N	MCS4	14.05	14.42	11.86
N	MCS5	14.06	14.38	11.81
N	MCS6	14.02	14.41	11.81
N	MCS7	13.94	14.35	11.75

Table TR05.2: Transmit Power, ANSI method, in dBm

Other Power Analyses

Mode	Speed	1	6	11
B	1	49.11	53.57	46.42
B	2	48.91	53.71	47.12
B	5.5	50.37	54.08	45.47
B	11	47.33	51.57	43.71
G	6	26.83	28.69	22.03
G	9	26.97	29.01	22.10
G	12	26.77	30.78	21.36
G	18	28.20	29.24	20.76
G	24	26.49	29.32	20.36
G	36	27.01	28.33	20.15
G	48	27.78	29.47	21.75
G	54	27.27	29.39	20.78
N	MCS0	28.14	29.21	15.70
N	MCS1	26.28	28.56	15.59
N	MCS2	25.88	28.02	15.54
N	MCS3	25.66	27.71	15.51
N	MCS4	25.42	27.65	15.34
N	MCS5	25.46	27.43	15.18
N	MCS6	25.23	27.58	15.18
N	MCS7	24.79	27.24	14.95

Table TR05.5: Transmit Power, RF exposure method, in mW

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

Table TR05.6: Duty cycle for each radio mode

Setup Diagram

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

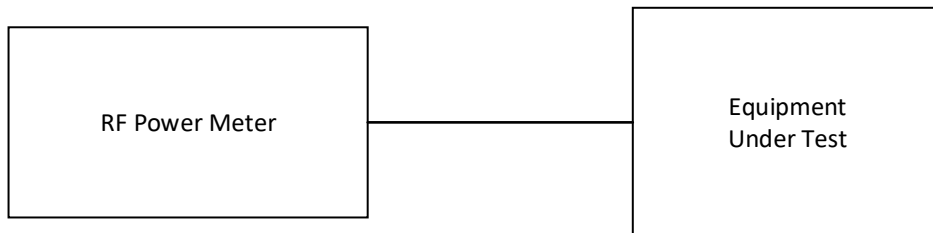


Figure TR05.51: Test equipment setup

This line is the end of the test record.

Test Record
Radiated Emission Test RE21
Project GCL0835

Test Date(s) 22 Apr 2025
Test Personnel David Kerr

Product Model A04378
Serial Number tested 7MK001302

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: 9 kHz to 30 MHz
Pass/Fail Judgment: PASS

Test record created by: David A Kerr
Date of this record: 22 Apr 2025

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Loop antenna, amplified	Schwarzbeck	FMZB 1519B	00174	18-Jul-2024	18-Jul-2026
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	25-Jan-2023	25-Jan-2026
Tape Measure, 1-3/16 in x 33 ft	Crecent Lufkin	L1135CME-02	GMN0013784	26-Jun-2024	26-Jun-2027

Table RE21.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, 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.

The 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 mast for tests that involve changes in antenna elevation.

At 0° the turntable reference mark is pointed directly at the loop antenna location. 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 in 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.

Emissions within the restricted bands were measured with an averaging process described in the ANSI C63.10 methods noted in this paragraph. (See also section 6.3 of this test report.) The duty cycle for the WIFI radios had a duty cycle of 98% or greater and so the trace-averaging method of clause 11.12.2.5.1 was applied.

In this test, fewer than six emissions were observed within 10 dB of the limit. The relevant emissions were measured, including one or more noise floor signals as judged appropriate to the spectrum.

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
24.545	20.91	QP	49.54	28.63	27.85	None	None	Z	0

Table RE21.2: Emission summary (802.11B 2Mbps, Ch 1)

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
18.708	20.18	QP	49.54	29.36	28.73	None	None	X	0

Table RE21.3: Emission summary (802.11B 2Mbps, Ch 6)

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
12.086	19.85	QP	51.94	32.09	27.29	None	None	Z	0

Table RE21.4: Emission summary (802.11B 2Mbps, Ch 11)

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

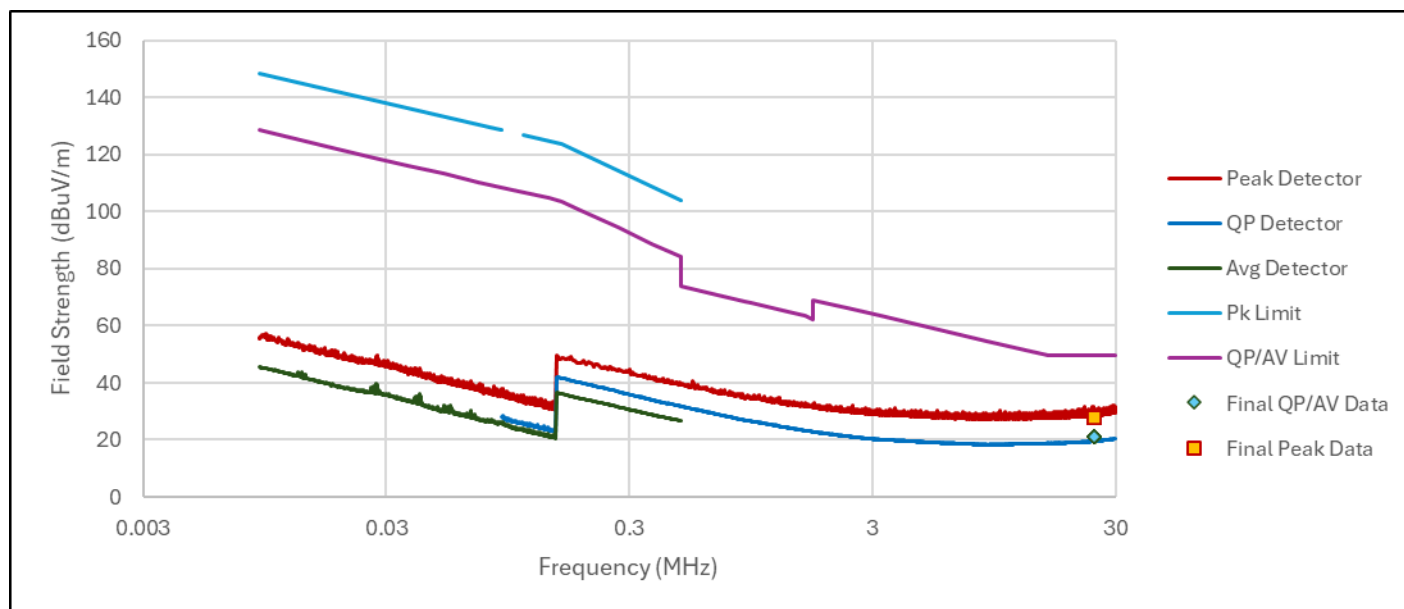


Figure RE21.1: Spectral data (802.11B 2Mbps, Ch 1)

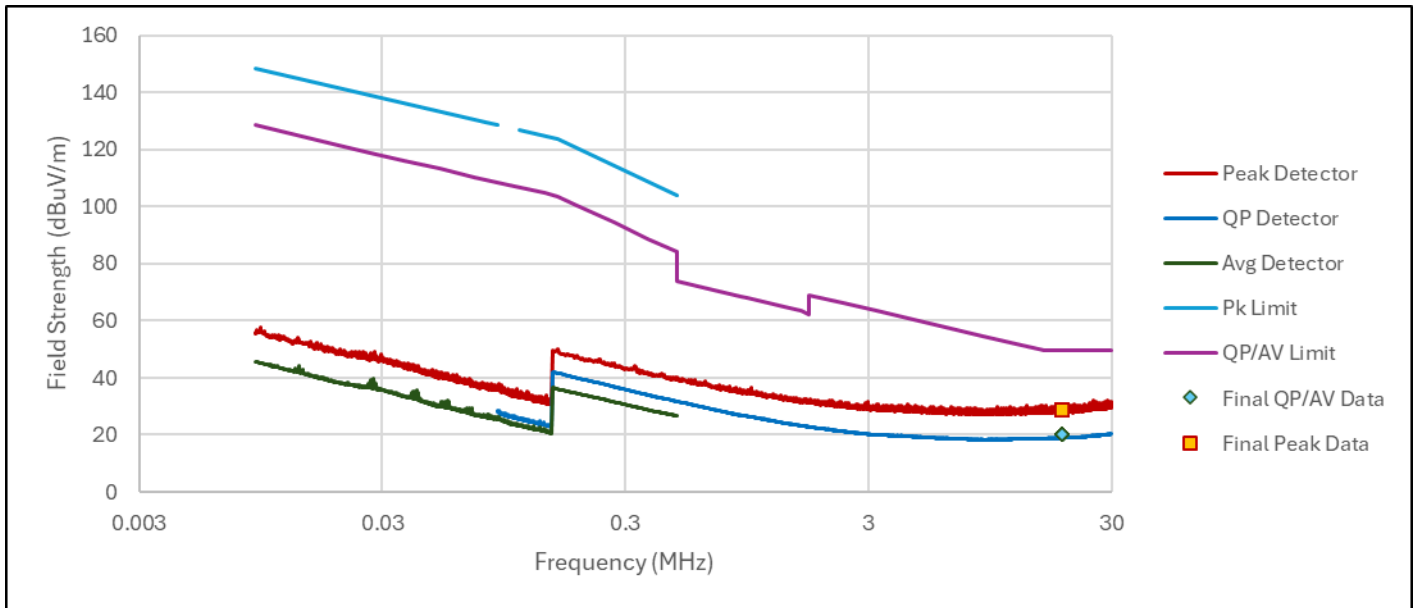


Figure RE21.2: Spectral data (802.11B 2Mbps, Ch 6)

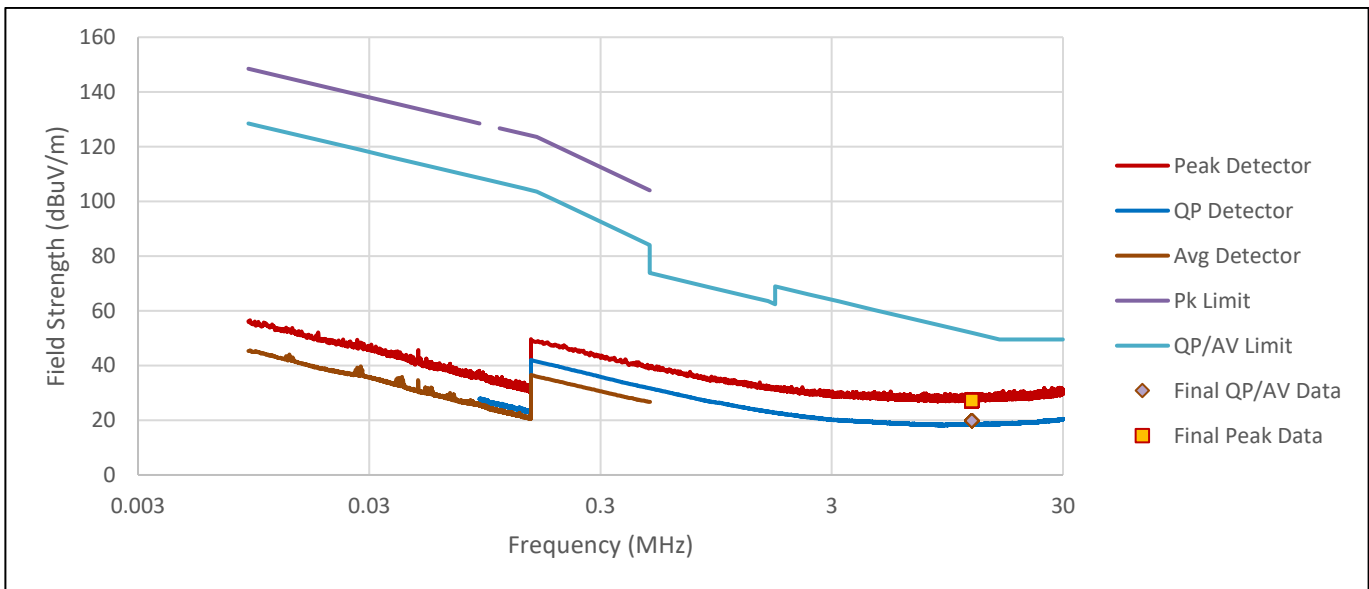


Figure RE21.3: Spectral data (802.11B 2Mbps, Ch 11)

Setup Photographs

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



Figure RE21.4: EUT test setup, first view



Figure RE21.5: EUT test setup, second view (Antenna X orientation)

Image removed for client confidentiality.

See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE21.6: EUT test setup, second view (Antenna Z orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE42
Project GCL0835

Test Date(s) 17 Apr 2025
Test Personnel David Kerr

Product Model A04378
Serial Number tested 7MK001302

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: 30 MHz to 1000 MHz

Pass/Fail Judgment: PASS

Test record created by: David A Kerr

Date of this record: 17 Apr 2025

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Antenna, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	00233201	18-Jul-2024	18-Jul-2026
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	25-Jan-2023	25-Jan-2026
Tape Measure, 1-3/16 in x 33 ft	Crecent Lufkin	L1135CME-02	GMN0013783	26-Jun-2024	26-Jun-2027

Table RE42.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, EPX test software Version 2025.01.000, RE C63p10AvgMeasurementToolV2024Dec20.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.

The radiated emission test process continued with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. 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.

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Garmin		

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 in 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.

Test limits for electric fields above 30 MHz that are stated for a distance other than 3 m are adjusted to 3 m with a factor of 20 dB per decade of distance. Test limits for electric or magnetic fields below 30 MHz that are stated for a distance other than 3 m are adjusted to 3 m by one of two methods. For ETSI testing, the extrapolation uses the curve of ETSI EN 300 330 Annex H figure H.2. For FCC and ISSED testing, the conservative method of ANSI C63.10 clause 6.4.4.1 is applied: 40 dB per decade for distances within the boundary (wavelength / 2 Pi), 20 dB per decade beyond that distance boundary.

Emissions within the restricted bands were measured with an averaging process described in the ANSI C63.10 methods noted in this paragraph. (See also section 6.3 of this test report. The duty cycle for the WIFI radio had a duty cycle of 98% or greater and so the trace-averaging method of clause 11.12.2.5.1 was applied.

Frequency	Pol.	Reading	Factor	Level	Limit	Margin	Height	Angle
MHz		dB(μ V)	dB(1/m)	dB(μ V/m)	dB(μ V/m)	dB	cm	deg
		QP		QP	QP	QP		
71.820	V	10.8	13.8	24.6	40.0	15.4	104.6	0.0
330.000	H	23.85	21.5	23.85	46.0	22.15	100.0	299.0
350.010	V	5.3	23.4	28.7	46.0	17.3	137.6	81.0
360.000	V	5.2	23.6	28.8	46.0	17.2	116.1	98.0
369.990	V	6.4	24.0	30.4	46.0	15.6	120.1	331.0
380.010	V	7.0	24.5	31.5	46.0	14.5	121.8	329.0

Table RE42.2: Emission summary (802.11B 2 Mbs, Ch 1)

Frequency	Pol.	Reading	Factor	Level	Limit	Margin	Height	Angle
MHz		dB(μ V)	dB(1/m)	dB(μ V/m)	dB(μ V/m)	dB	cm	deg
		QP		QP	QP	QP		
43.470	V	11.2	15.2	26.4	40.0	13.6	100.0	110.0
350.010	H	7.1	23.4	30.5	46.0	15.5	100.0	307.0
360.000	H	8.1	23.6	31.7	46.0	14.3	100.0	32.0
369.990	V	5.0	24.0	29.0	46.0	17.0	135.6	85.0
380.010	V	5.6	24.5	30.1	46.0	15.9	100.0	340.0
730.020	H	5.7	30.8	36.5	46.0	9.5	100.0	40.0

Table RE42.3: Emission summary (802.11B 2 Mbs, Ch 6)

Frequency	Pol.	Reading	Factor	Level	Limit	Margin	Height	Angle
MHz		dB(μ V)	dB(1/m)	dB(μ V/m)	dB(μ V/m)	dB	cm	deg
		QP		QP	QP	QP		
44.700	V	12.3	14.7	27.0	40.0	13.0	100.0	200.0
330.000	H	6.1	21.5	27.6	46.0	18.4	327.0	109.0
350.010	H	7.1	23.4	30.5	46.0	15.5	100.0	300.0
369.990	V	5.9	24.0	29.9	46.0	16.1	122.0	326.0
380.010	V	6.8	24.5	31.3	46.0	14.7	116.3	325.0
729.990	H	6.1	30.8	36.9	46.0	9.1	100.0	52.0

Table RE42.4: Emission summary (802.11B 2 Mbs, Ch 11)

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

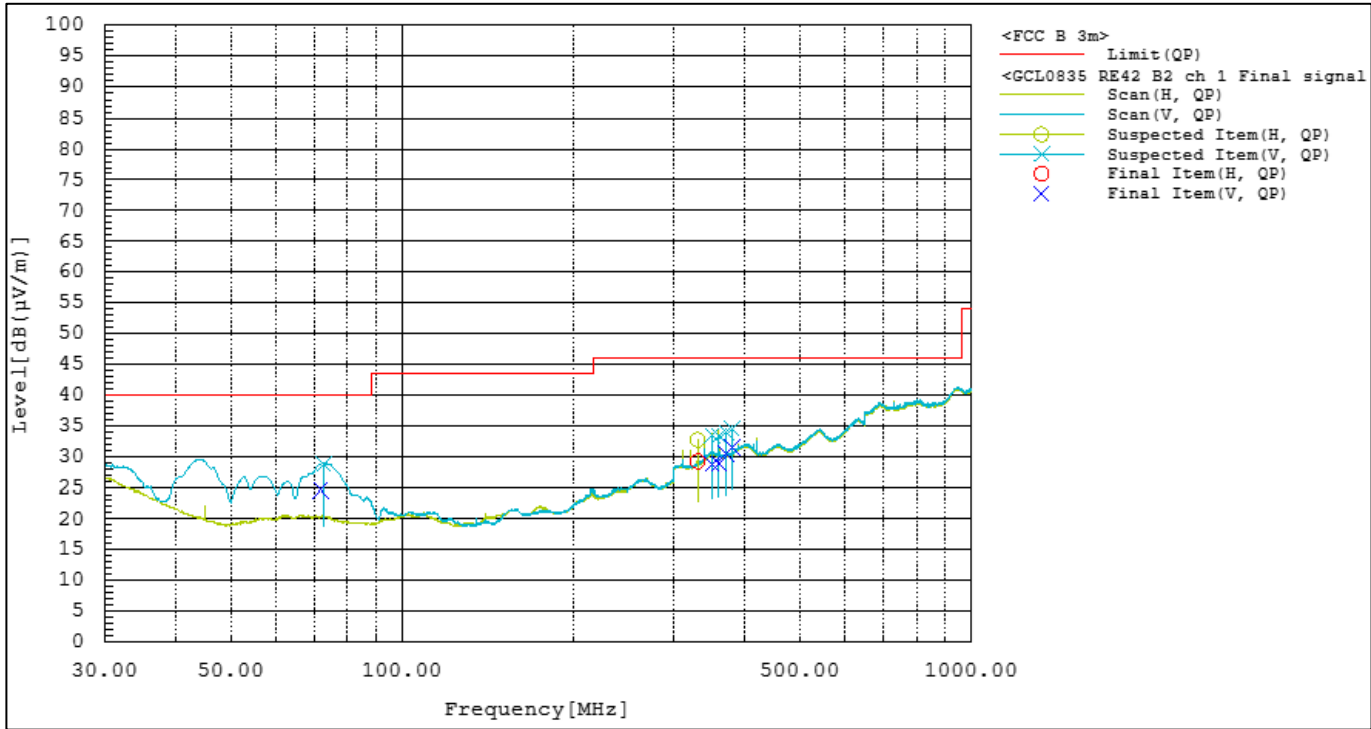


Figure RE42.1: Spectral data (802.11B 2 Mbs, Ch 1)

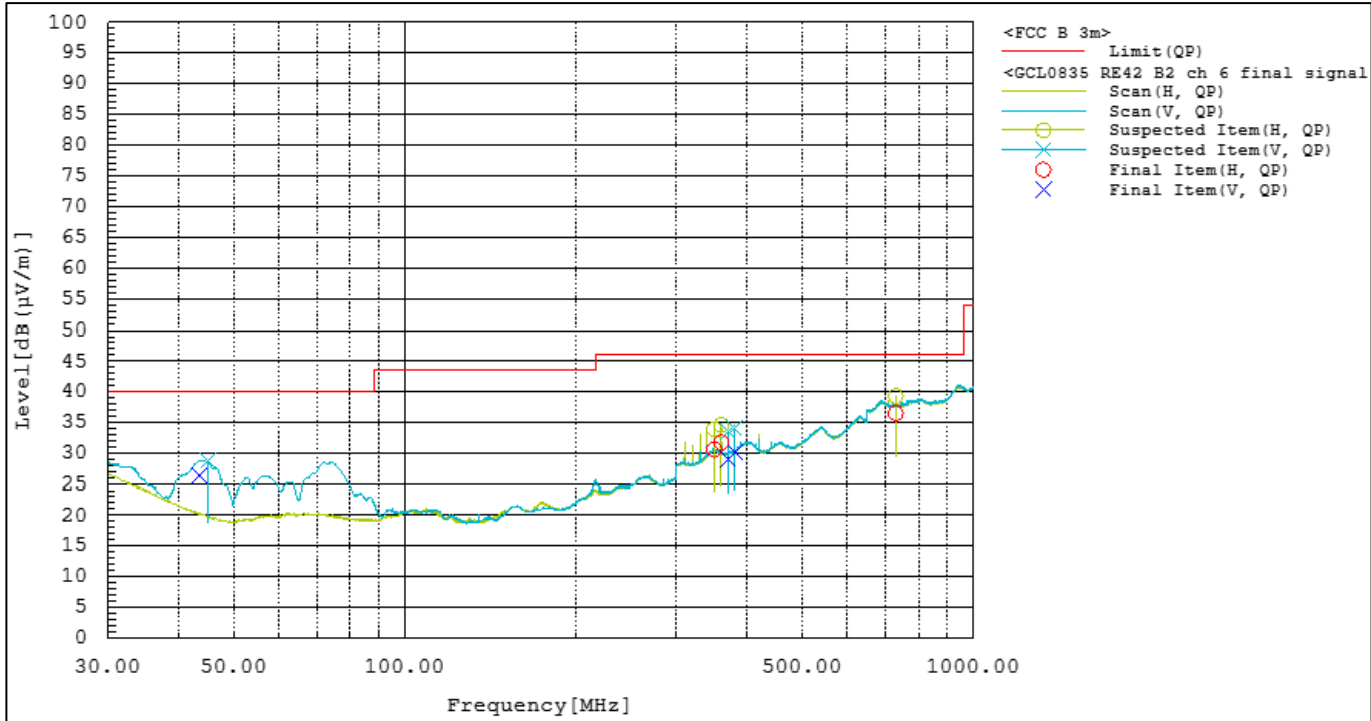


Figure RE42.2: Spectral data (802.11B 2 Mbs, Ch 6)

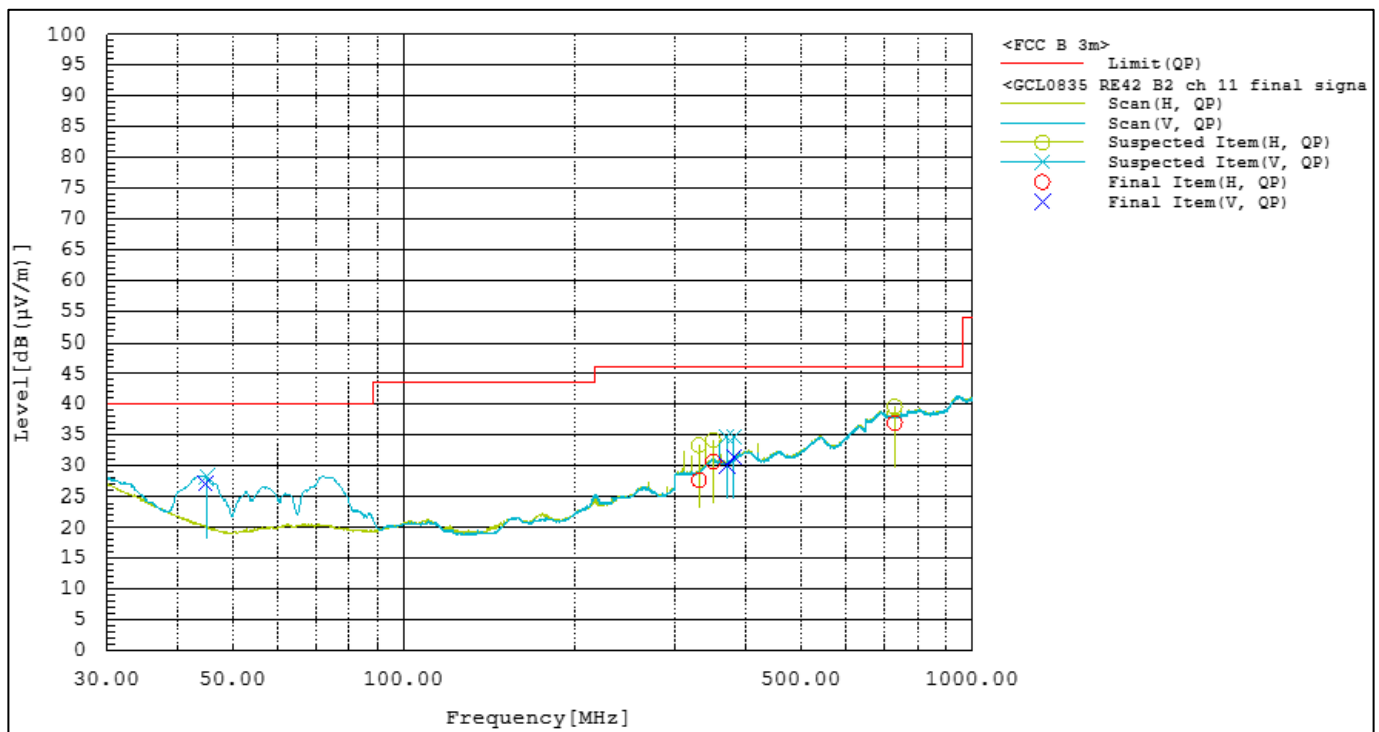


Figure RE42.3: Spectral data (802.11B 2 Mbs, Ch 11)

Setup Photographs

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

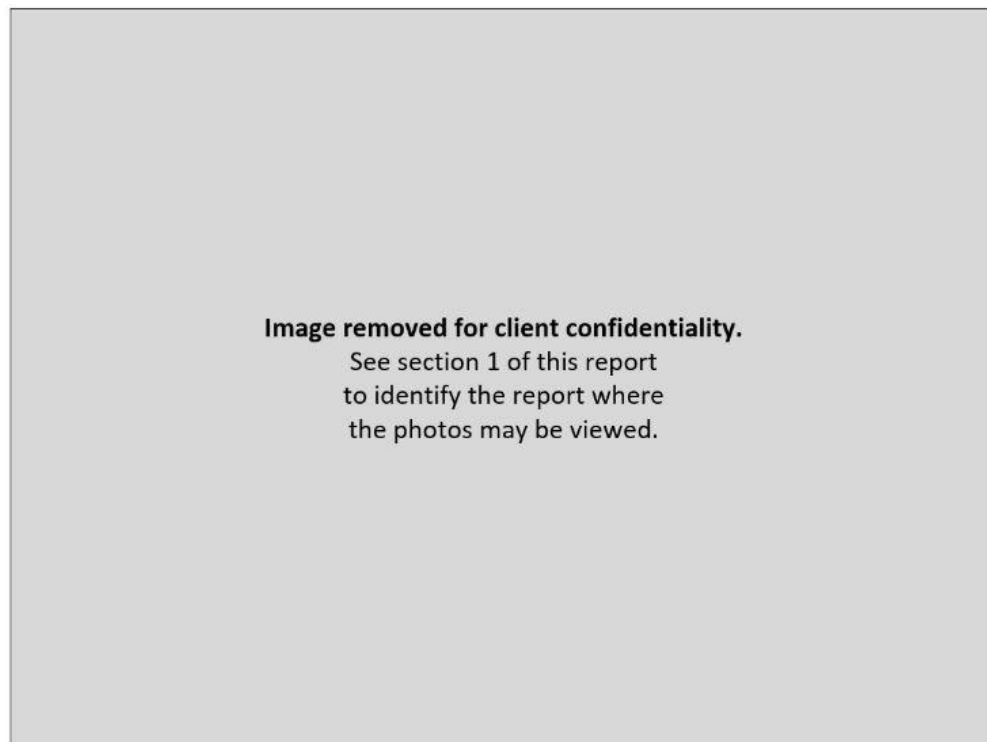


Figure RE42.4: EUT test setup, first view (Z Orientation)

Image removed for client confidentiality.

See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE42.5: EUT test setup, second view (Z Orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE12
Project GCL0835

Test Date(s) 14 Apr 2025
Test Personnel David Kerr

Product Model A04378
Serial Number tested 7MK001302

Operating Mode M7 (WiFiTx)Arrangement (802.11B 2Mbps)
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: 14 Apr 2025

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	30-May-2024	30-May-2026
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	7-Mar-2023	7-Mar-2026
Tape Measure, 1-3/16 in x 33 ft	Crecent Lufkin	L1135CME-02	GMN0013783	26-Jun-2024	26-Jun-2027
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 RE12.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, EPX test software Version 2025 01.000, RE C63p10AvgMeasurementToolV2024Dec20.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.

The radiated emission test process continued with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. 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.

Test limits for electric fields above 30 MHz that are stated for a distance other than 3 m are adjusted to 3 m with a factor of 20 dB per decade of distance. Test limits for electric or magnetic fields below 30 MHz that are stated for a distance other than 3 m are adjusted to 3 m by one of two methods. For ETSI testing, the extrapolation uses the curve of ETSI EN 300 330 Annex H figure H.2. For FCC and ISSED testing, the conservative method of ANSI C63.10 clause 6.4.4.1 is applied: 40 dB per decade for distances within the boundary (wavelength / 2 Pi), 20 dB per decade beyond that distance boundary.

Emissions within the restricted bands were measured with an averaging process described in the ANSI C63.10 methods noted in this paragraph. (See also section 6.3 of this test report.) The duty cycle for the WIFI radios had a duty cycle of 98% or greater and so the trace-averaging method of clause 11.12.2.5.1 was applied.

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
1056.405	V	23.74	50.2	-9.2	*23.74	41.0	54.0	74.0	*30.26	33.0	106.8	260.0
1247.720	V	31.7	46.8	-7.6	24.1	39.2	54.0	74.0	29.9	34.8	167.6	214.0
2227.61	H	29.55	46.4	-4.6	*29.55	41.8	54.0	74.0	*24.45	32.2	286.2	291.0
4823.99	V	53.03	57.5	0.1	*53.03	57.6	54.0	74.0	*0.97	16.4	212.8	284.0
7232.180	V	39.9	48.2	4.4	44.3	52.6	54.0	74.0	9.7	21.4	187.9	303.0
9647.600	V	42.0	47.8	8.2	50.2	56.0	54.0	74.0	3.8	18.0	376.9	285.0

Table RE12.2: Emission summary (802.11 B 2Mbs, Ch 1 Wifi) * = RMS Average, Restricted Band

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
1056.66	V	23.80	48.7	-9.2	*23.80	39.5	54.0	74.0	*30.2	34.5	110.1	12.0
2226.93	H	30.41	48.4	-4.7	*30.41	43.7	54.0	74.0	*23.59	30.3	329.3	310.0
4873.98	V	49.41	55.5	-0.1	*49.41	55.4	54.0	74.0	*4.59	18.6	316.8	284.0
7314.25	V	41.64	45.8	4.4	*41.64	50.2	54.0	74.0	*12.36	23.8	203.4	304.0
9748.040	V	41.8	47.4	8.2	50.0	55.6	54.0	74.0	4.0	18.4	375.0	305.0
12185.06	V	43.57	42.1	12.3	*43.57	54.4	54.0	74.0	*10.43	19.6	248.7	215.0

Table RE12.3: Emission summary (802.11 B 2Mbs, Ch 6 Wifi) * = RMS Average, Restricted Band

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
1056.55	V	23.8	49.6	-9.2	*23.8	40.4	54.0	74.0	*30.2	33.6	110.6	252.0
2227.225	H	30.64	48.7	-4.7	*30.64	44.0	54.0	74.0	*23.36	30.0	373.4	0.0
4923.915	V	49.2	53.9	-0.1	*49.2	53.8	54.0	74.0	*4.8	20.2	296.2	283.0
7383.05	V	40.85	46.1	4.8	*40.85	50.9	54.0	74.0	*23.15	23.1	203.1	302.0
9847.940	V	43.0	48.4	8.0	51.0	56.4	54.0	74.0	3.0	17.6	392.7	293.0
12309.98	V	44.36	43.1	11.7	*44.36	54.8	54.0	74.0	*9.64	19.2	274.6	273.0

Table RE12.4: Emission summary (802.11 B 2Mbs, Ch 11 Wifi) * = RMS Average, Restricted Band

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

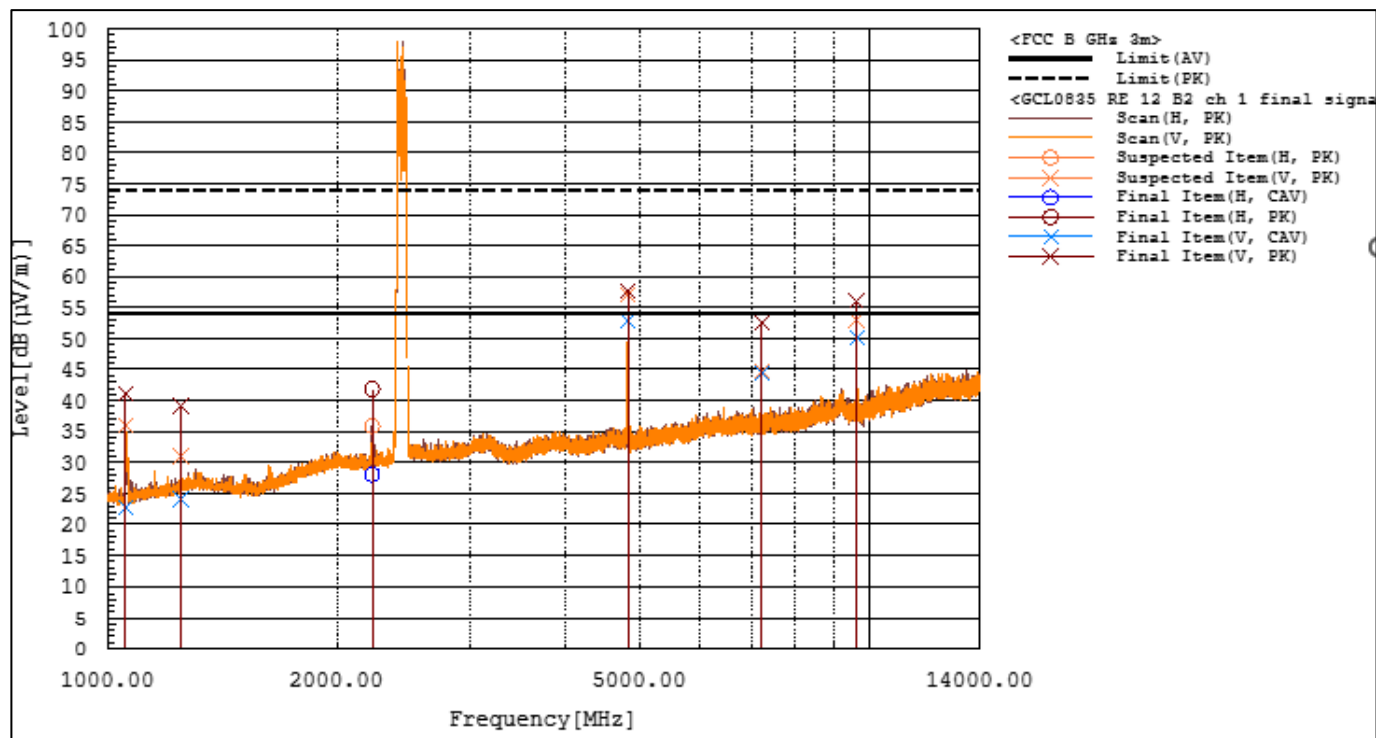


Figure RE12.1: Spectral data (802.11 B 2Mbs, Ch 1 Wifi)

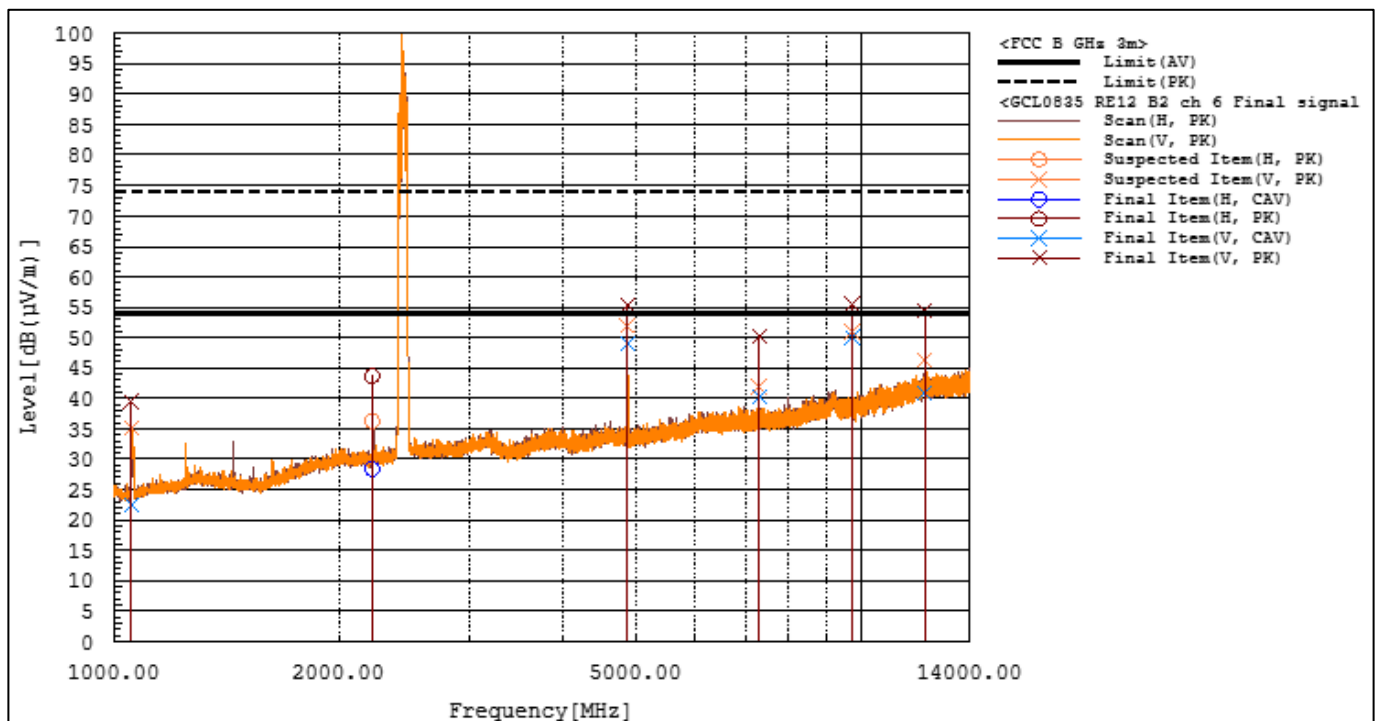


Figure RE12.2: Spectral data (802.11 B 2Mbps, Ch 6 Wifi)

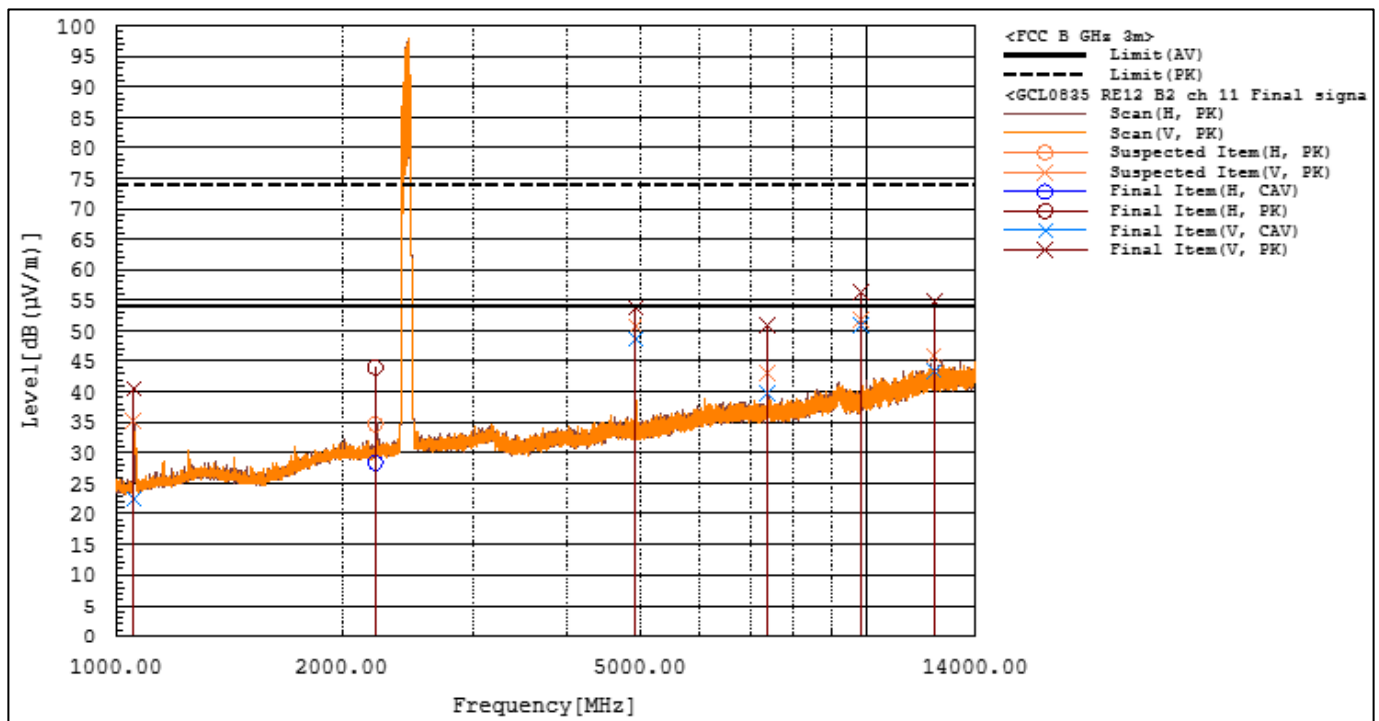


Figure RE12.3: Spectral data (802.11 B 2Mbps, Ch 11 Wifi)

Setup Photographs

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

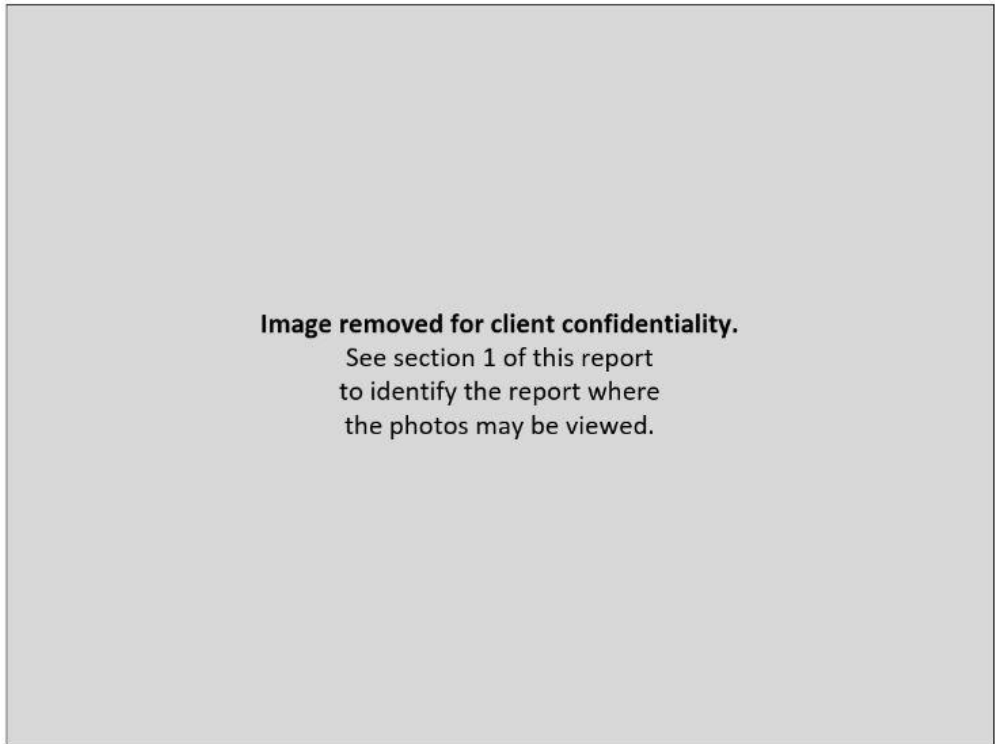


Figure RE12.4: EUT test setup, first view



Figure RE12.5: EUT test setup, second view

This line is the end of the test record.

Test Record

Radiated Emission Test RE13

Project GCL0835

Test Date(s) 15 Apr 2025
Test Personnel David Kerr

Product Model A04378
Serial Number tested 7MK001302

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: 1 GHz to 14 GHz
Pass/Fail Judgment: PASS

Test record created by: David A Kerr
Date of this record: 15 Apr 2025

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	30-May-2024	30-May-2026
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	7-Mar-2023	7-Mar-2026
Tape Measure, 1-3/16 in x 33 ft	Crecent Lufkin	L1135CME-02	GMN0013783	26-Jun-2024	26-Jun-2027
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 RE13.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, EPX test software Version 2025 01.000, RE C63p10AvgMeasurementToolV2024Dec20.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.

The radiated emission test process continued with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. 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 in 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.

Test limits for electric fields above 30 MHz that are stated for a distance other than 3 m are adjusted to 3 m with a factor of 20 dB per decade of distance. Test limits for electric or magnetic fields below 30 MHz that are stated for a distance other than 3 m are adjusted to 3 m by one of two methods. For ETSI testing, the extrapolation uses the curve of ETSI EN 300 330 Annex H figure H.2. For FCC and ISSED testing, the conservative method of ANSI C63.10 clause 6.4.4.1 is applied: 40 dB per decade for distances within the boundary (wavelength / 2 Pi), 20 dB per decade beyond that distance boundary.

Emissions within the restricted bands were measured with an averaging process described in the ANSI C63.10 methods noted in this paragraph. (See also section 6.3 of this test report.) The duty cycle for the WIFI radios had a duty cycle of 98% or greater and so the trace-averaging method of clause 11.12.2.5.1 was applied.

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
1002.5	H	23.71	45.4	-9.1	*23.71	36.3	54.0	74.0	*30.29	37.7	219.3	308.0
1055.925	V	23.7	48.8	-9.2	*23.7	39.6	54.0	74.0	*30.3	34.4	100.0	214.0
2216.125	H	29.78	48.7	-4.7	*29.78	44.0	54.0	74.0	*24.22	30.0	363.5	177.0
4814.15	V	43.82	55.7	0.1	*43.82	55.8	54.0	74.0	*13.1	18.2	210.9	279.0
7228.400	V	35.0	49.8	4.3	39.3	54.1	54.0	74.0	14.7	19.9	181.6	310.0
9648.140	V	42.3	49.4	8.2	50.5	57.6	54.0	74.0	3.5	16.4	175.9	298.0

Table RE13.2: Emission summary (WIFI N0, Ch 1) * = RMS Average, Restricted Band

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
1056.1	V	23.79	49.7	-9.2	*23.79	40.5	54.0	74.0	*30.21	33.5	119.7	270.0
2226.925	H	30.22	48.2	-4.6	*30.22	43.6	54.0	74.0	*23.78	30.4	329.6	31.0
4874.04	V	40.39	52.6	-0.1	*40.39	52.5	54.0	74.0	*13.61	21.5	217.4	285.0
7315.455	H	39.43	49.6	4.5	*39.43	54.1	54.0	74.0	*14.57	19.9	168.0	233.0
9748.040	V	42.4	47.9	8.2	50.6	56.1	54.0	74.0	3.4	17.9	323.9	307.0
12184.92	V	45.55	43.0	12.3	*45.55	55.3	54.0	74.0	*8.45	18.7	338.6	276.0

Table RE13.3: Emission summary (WIFI N0, Ch 6) * = RMS Average, Restricted Band

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
1055.925	V	23.77	49.6	-9.2	*23.77	40.4	54.0	74.0	*30.23	33.6	106.8	282.0
2227.775	H	29.74	47.0	-4.7	*29.74	42.3	54.0	74.0	*24.26	31.7	325.7	46.0
4923.935	V	36.02	49.2	-0.1	*36.02	49.1	54.0	74.0	*17.98	24.9	203.7	279.0
9847.940	V	44.3	48.9	8.0	52.3	56.9	54.0	74.0	1.7	17.1	312.3	283.0
12309.95	V	45.78	43.5	11.7	45.78	55.2	54.0	74.0	8.22	18.8	330.6	274.0

Table RE13.4: Emission summary (WIFI N0, Ch 11) * = RMS Average, Restricted Band

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

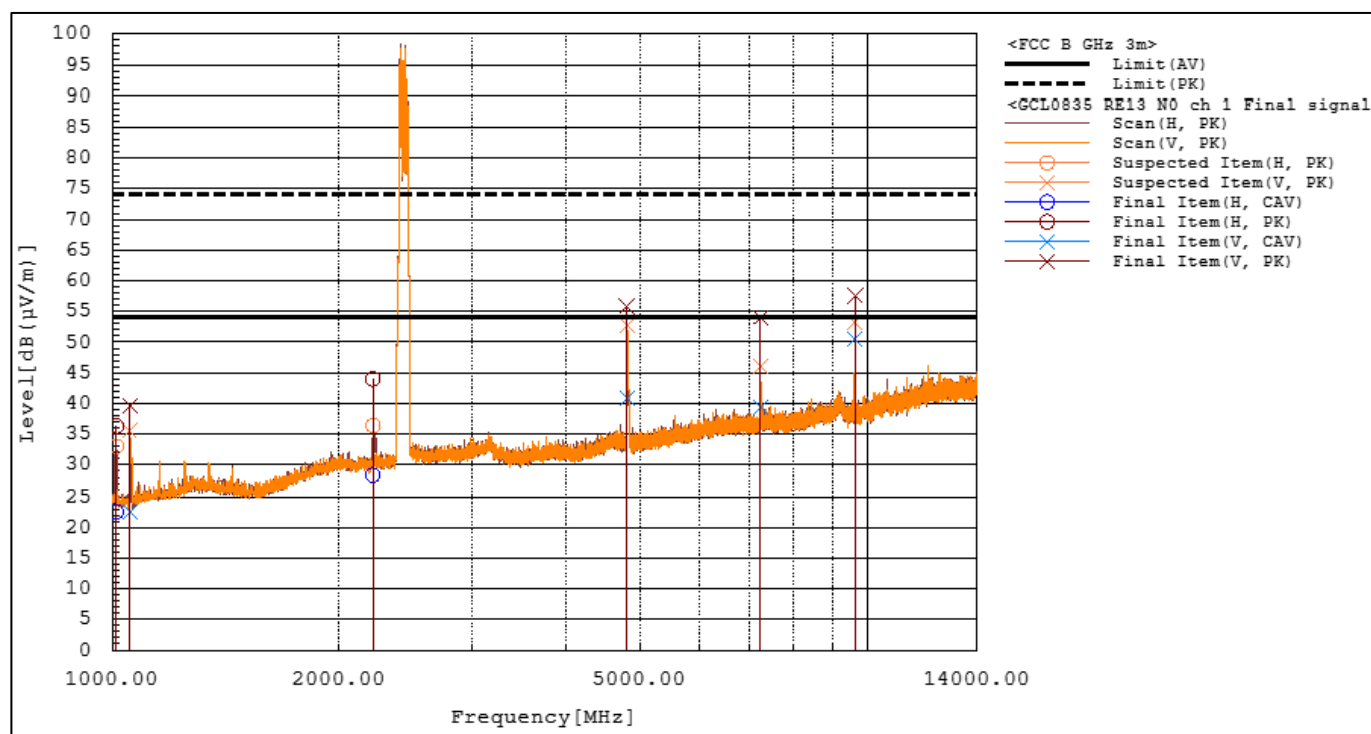


Figure RE13.1: Spectral data (WIFI N0, Ch 1)

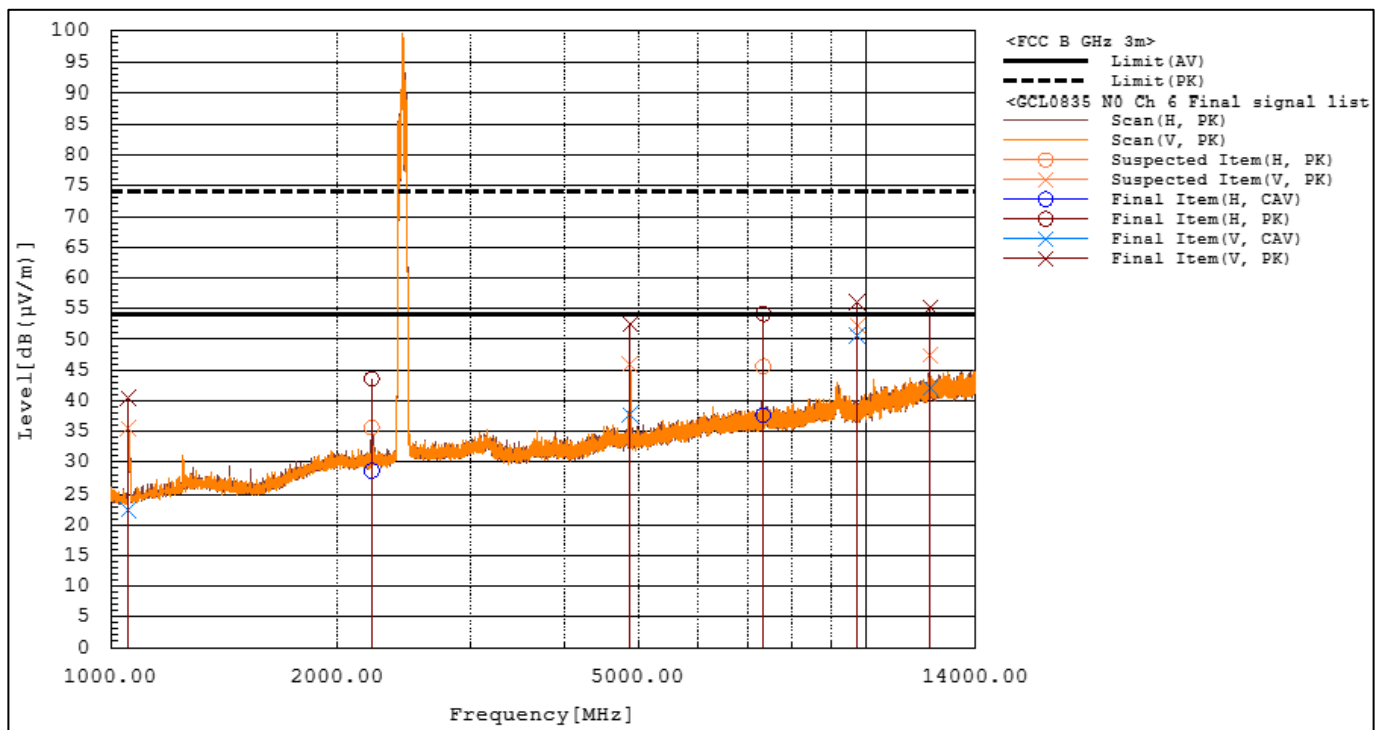


Figure RE13.2: Spectral data (WIFI N0, Ch 6)

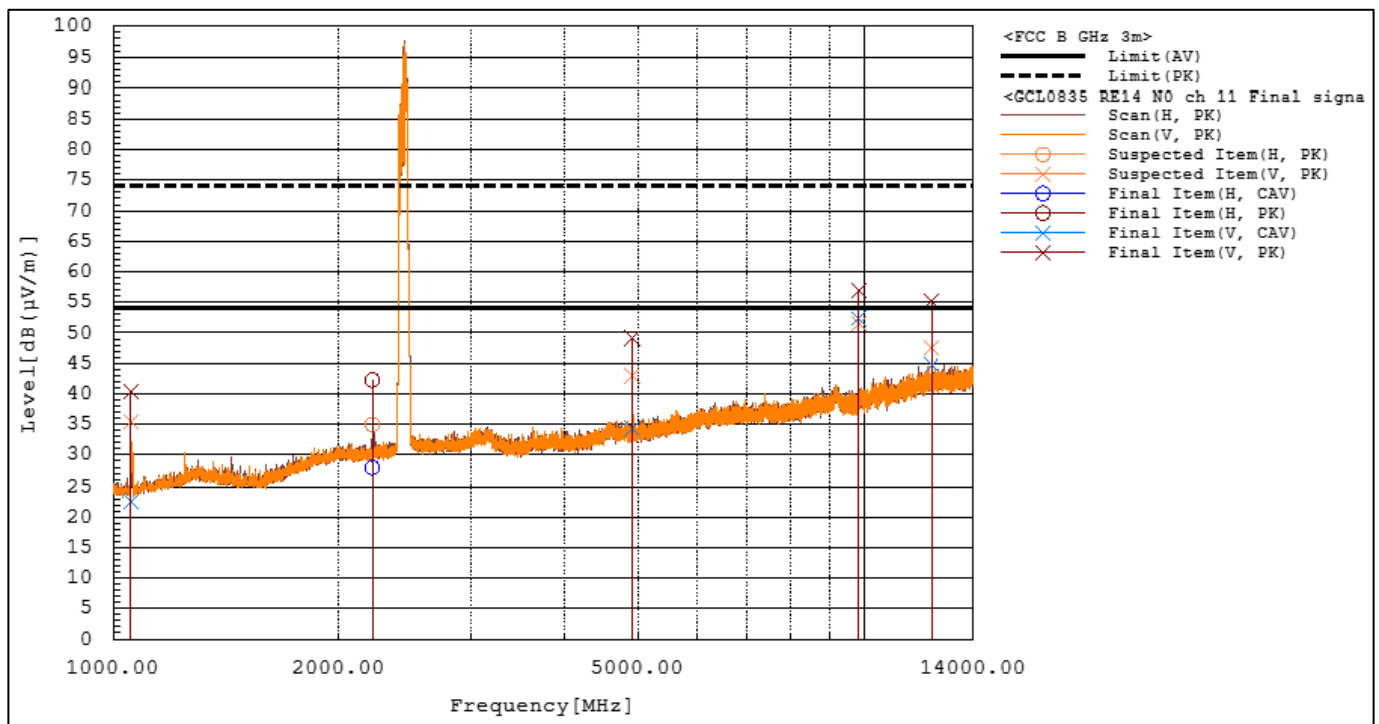


Figure RE13.3: Spectral data (WIFI N0, Ch 11)

Setup Photographs

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



Figure RE13.4: EUT test setup, first view

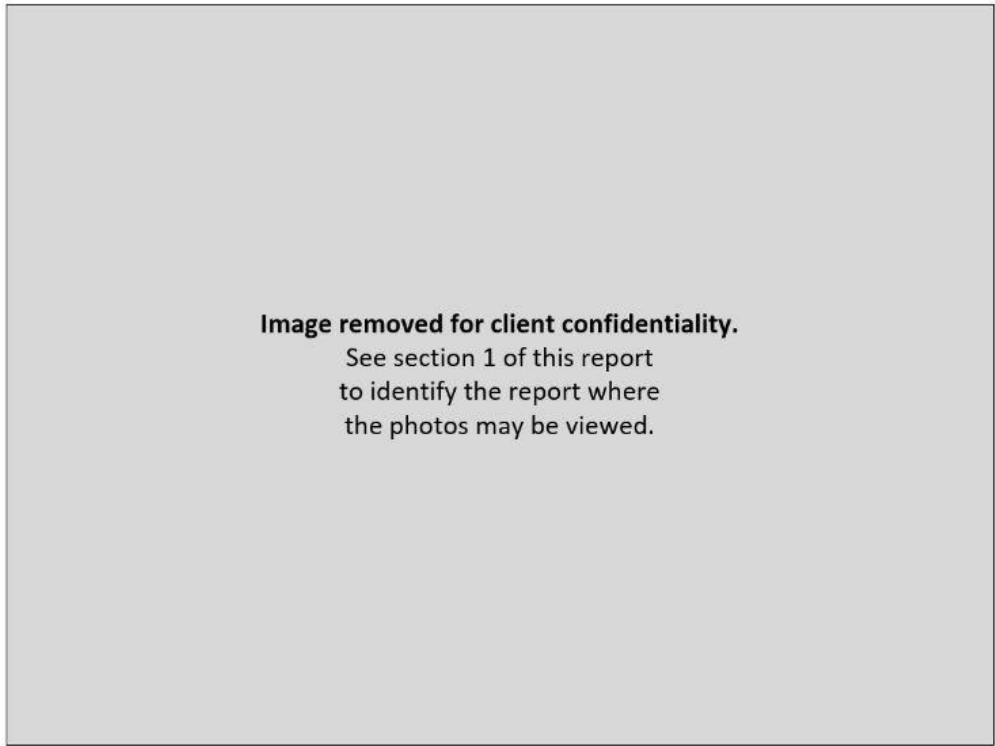


Figure RE13.5: EUT test setup, second view

This line is the end of the test record.

Test Record
Radiated Emission Test RE15
Project GCL0835

Test Date(s) 29, 30 Apr 2025
Test Personnel Jim Solum

Product Model A04378
Serial Number tested 7MK001302

Operating Mode M7 (WiFiTx) (802.11B 2Mbps, ch 1, ch 6, ch 11)
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 GHz to 25 GHz
Pass/Fail Judgment: PASS

Test record created by: Jim Solum
Date of this record: 30 Apr 2025

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44 GHz	Keysight	N9048B	MY62220139	21-Oct-2024	21-Oct-2025
Antenna, Horn, 10-40 GHz	ETS Lindgren	3116C	00227673	14-Sep-2023	15-Sep-2025
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	7-Mar-2023	7-Mar-2026
Preamplifier, 14 GHz to 40 GHz	Com-Power	PAM-840A	461364	Calibration	Not Required

Table RE15.1: Test Equipment Used

Software Used: Keysight PXE software A.33.03, EPX test software Version 2025.01.000

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.

The radiated emission test process continued with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. 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 26.5 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 GHz 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.

Test limits for electric fields above 30 MHz that are stated for a distance other than 3 m are adjusted to 3 m with a factor of 20 dB per decade of distance. Test limits for electric or magnetic fields below 30 MHz that are stated for a distance other than 3 m are adjusted to 3 m by one of two methods. For ETSI testing, the extrapolation uses the curve of ETSI EN 300 330 Annex H figure H.2. For FCC and ISSED testing, the conservative method of ANSI C63.10 clause 6.4.4.1 is applied: 40 dB per decade for distances within the boundary (wavelength / 2 Pi), 20 dB per decade beyond that distance boundary.

Emissions were measured with an averaging process described in the ANSI C63.10 methods noted in this paragraph. (See also section 6.3 of this test report.) The duty cycle for the WIFI radios had a duty cycle of 98% or greater and so the trace-averaging method of clause 11.12.2.5.1 was applied.

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(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		RMS	PK		RMS	PK	AV	PK	RMS	PK		
19295.931	V	29.6	37.4	19.7	49.3	57.1	54.0	74.0	4.7	16.9	327.2	0.0
22157.762	V	25.8	37.6	21.0	46.8	58.6	54.0	74.0	7.2	15.4	353.6	314.0
14471.991	H	20.2	31.2	27.0	47.2	58.2	54.0	74.0	6.8	15.8	381.8	86.0

Table RE15.2: Emission summary (802.11B 2Mbs, Ch 1)

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		RMS	PK		RMS	PK	AV	PK	RMS	PK		
16904.010	V	24.1	31.7	21.5	45.6	53.2	54.0	74.0	8.4	20.8	400.0	0.0
17233.617	H	24.9	36.7	20.9	45.8	57.6	54.0	74.0	8.2	16.4	400.0	344.0
19495.917	V	30.1	39.2	19.7	49.8	58.9	54.0	74.0	4.2	15.1	293.6	180.0
23255.508	H	27.8	36.9	21.9	49.7	58.8	54.0	74.0	4.3	15.2	400.0	0.0

Table RE15.3: Emission summary (802.11B 2Mbs, Ch 6)

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μ V)		dB(1/m)	dB(μ V/m)		dB(μ V/m)		dB		cm	deg
		RMS	PK		RMS	PK	AV	PK	RMS	PK		
14218.596	V	19.9	28.0	27.9	47.8	55.9	54.0	74.0	6.2	18.1	100.0	0.0
16799.786	V	23.9	35.4	21.7	45.6	57.1	54.0	74.0	8.4	16.9	377.1	238.0
19405.291	V	26.4	38.2	19.7	46.1	57.9	54.0	74.0	7.9	16.1	349.9	51.0
19616.675	V	29.5	36.5	19.8	49.3	56.3	54.0	74.0	4.7	17.7	304.6	0.0
24221.970	H	25.6	35.3	22.6	48.2	57.9	54.0	74.0	5.8	16.1	400.0	0.0

Table RE15.4: Emission summary (802.11B 2Mbs, Ch 11)

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

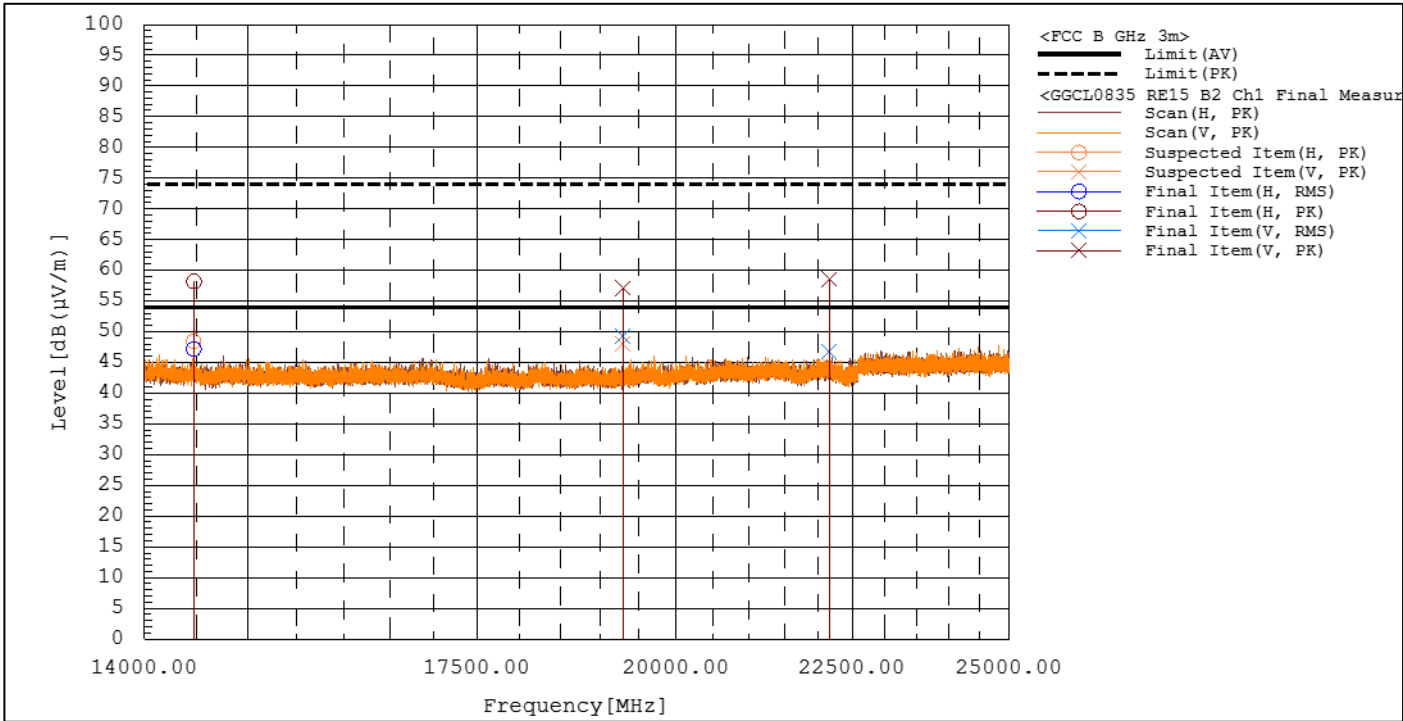


Figure RE15.1: Spectral data (802.11B 2Mbps, Ch 1)

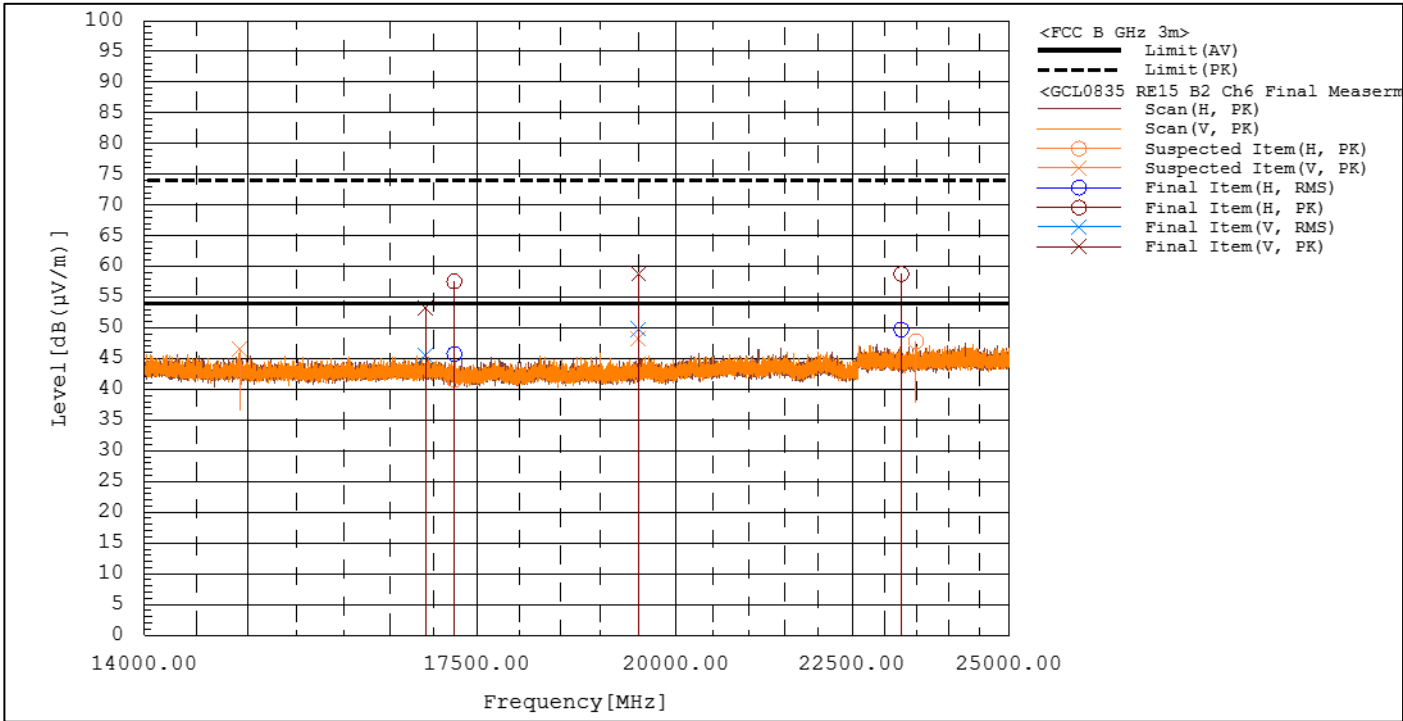


Figure RE15.2: Spectral data (802.11B 2Mbps, Ch 6)

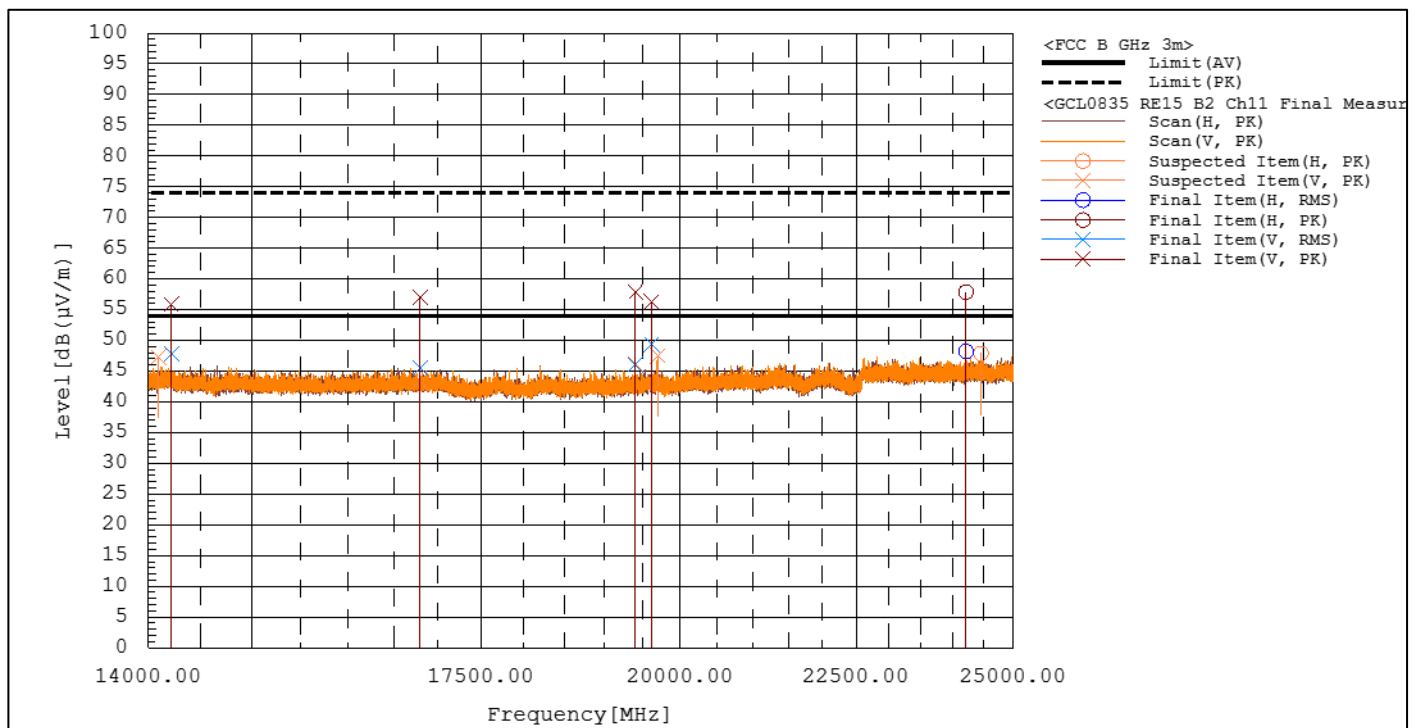


Figure RE15.3: Spectral data (802.11B 2Mbps, Ch 11)

Setup Photographs

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

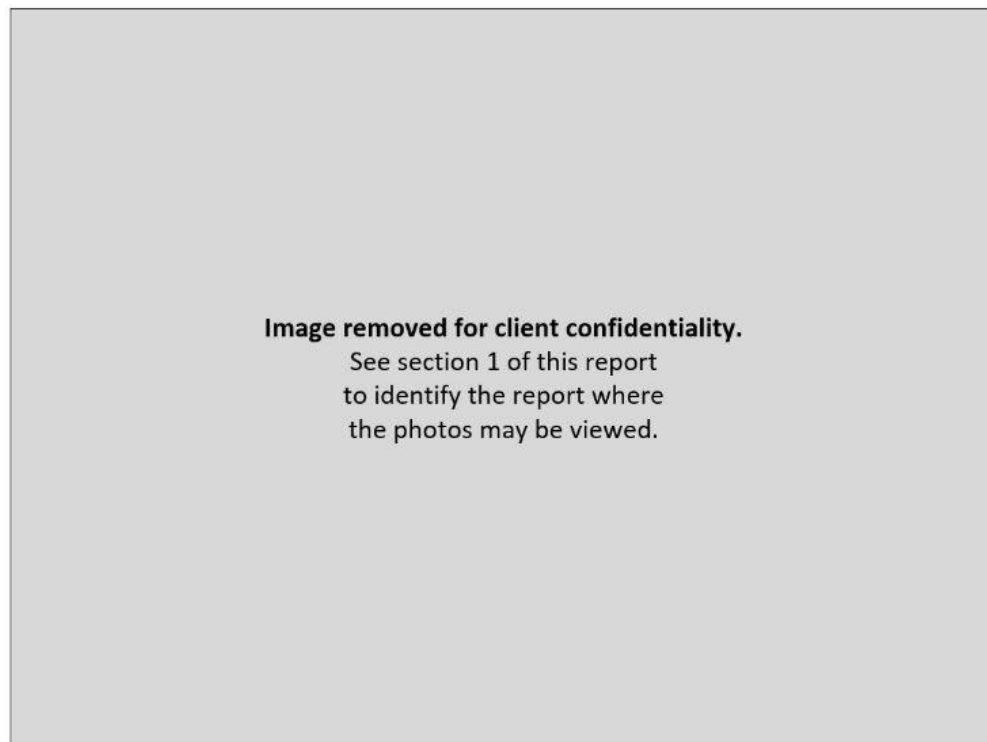


Figure RE15.4: EUT test setup, first view (Z orientation)

Image removed for client confidentiality.

See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE15.5: EUT test setup, second view (Z orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE01
Project GCL0835

Test Date(s) 10, 11, 14 Apr 2025
 Test Personnel David Kerr

Product Model A04378
 Serial Number tested 7MK001302

Operating Mode M7 (WiFitx) (B1 ch1,ch9,ch11 G6 ch1,ch11 N4 ch1 N6 ch11)
 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: 10 Apr 2025

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	30-May-2024	30-May-2026
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	7-Mar-2023	7-Mar-2026
Tape measure, 1 in x 33 ft	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

Table RE01.1: Test Equipment Used

Software Used

Keysight PXE receiver software A.32.06, RE Signal Maximization Tool v2021Feb25.xlsx.

Test Data

US and Canadian laws contain dozens of bands where radio operation is restricted. Compliance with most of those band restrictions is typically demonstrated by a series of spurious emission tests covering a very wide span of frequencies from kilohertz to Gigahertz. This test record focuses on restricted bands that are immediately adjacent to the authorized band in which the test sample radio operate. It shows whether the modulation products are sufficiently suppressed to meet the restricted band requirements.

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 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 11. Measurements in the upper band were made while the transmitter was tuned to channels 9 and 11.

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 a 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 3 m listed at 15.209 and RSS-Gen clause 8.9.

Emissions within the restricted bands were measured with an averaging process described in the ANSI C63.10 methods noted in this paragraph. (See also section 6.3 of this test report. The duty cycle for the WIFI radio had a duty cycle of 98% or greater and so the trace-averaging method of clause 11.12.2.5.1 was applied.

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity	Avg Type	DC Adjust
(MHz)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(degree)	(mm)	---	---	(dB)
2390	54	74	40.50	50.81	13.50	23.19	131	2563	HORZ	2390	40.489
2389.3	54	74	41.43	49.68	12.57	24.32	131	2563	HORZ	2389.3	41.435

Table RE01.2: FCC restricted bands from 2200 to 2390 MHz (11B 1Mbps, Ch 1)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity	Avg Type	DC Adjust
(MHz)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(degree)	(mm)	---	---	(dB)
2390	54	74	46.65	67.96	7.36	6.04	131	2563	HORZ	2390	46.641

Table RE01.3: FCC restricted bands from 2200 to 2390 MHz (11G 6Mbps, Ch 1)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity	Avg Type	DC Adjust
(MHz)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(degree)	(mm)	---	---	(dB)
2390	54	74	48.81	68.69	5.19	5.31	131	2563	HORZ	2390	48.798

Table RE01.4: FCC restricted bands from 2200 to 2390 MHz (11N 4Mbps, Ch 1)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity	Avg Type	DC Adjust
(MHz)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(degree)	(mm)	---	---	(dB)
2484.5	54	74	39.64	49.33	14.36	24.67	131	2563	HORZ	2484.5	39.65
2484.3	54	74	39.81	48.98	14.19	25.02	131	2563	HORZ	2484.3	39.81

Table RE01.5: FCC restricted band from 2483.5 to 2500 MHz (11B 1Mbps, Ch 9)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity	Avg Type	DC Adjust
(MHz)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(degree)	(mm)	---	---	(dB)
2488	54	74	40.14	49.77	13.86	24.23	-150	3650	VERT	2488	40.145
2487.8	54	74	40.61	50.08	13.39	23.92	-150	3650	VERT	2487.8	40.574

Table RE01.6: FCC restricted band from 2483.5 to 2500 MHz (11B 1Mbps, Ch 11)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity	Avg Type	DC Adjust
(MHz)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(degree)	(mm)	---	---	(dB)
2483.5	54	74	41.58	67.55	12.42	6.45	135	2688	HORZ	2483.5	41.579

Table RE01.7: FCC restricted band from 2483.5 to 2500 MHz (11G 6Mbps, Ch 11)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity	Avg Type	DC Adjust
(MHz)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(degree)	(mm)	---	---	(dB)
2483.5	54	74	42.88	68.43	11.12	5.57	135	2688	HORZ	2483.5	42.855

Table RE01.8: FCC restricted band from 2483.5 to 2500 MHz (11N 6Mbps, Ch 11)

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

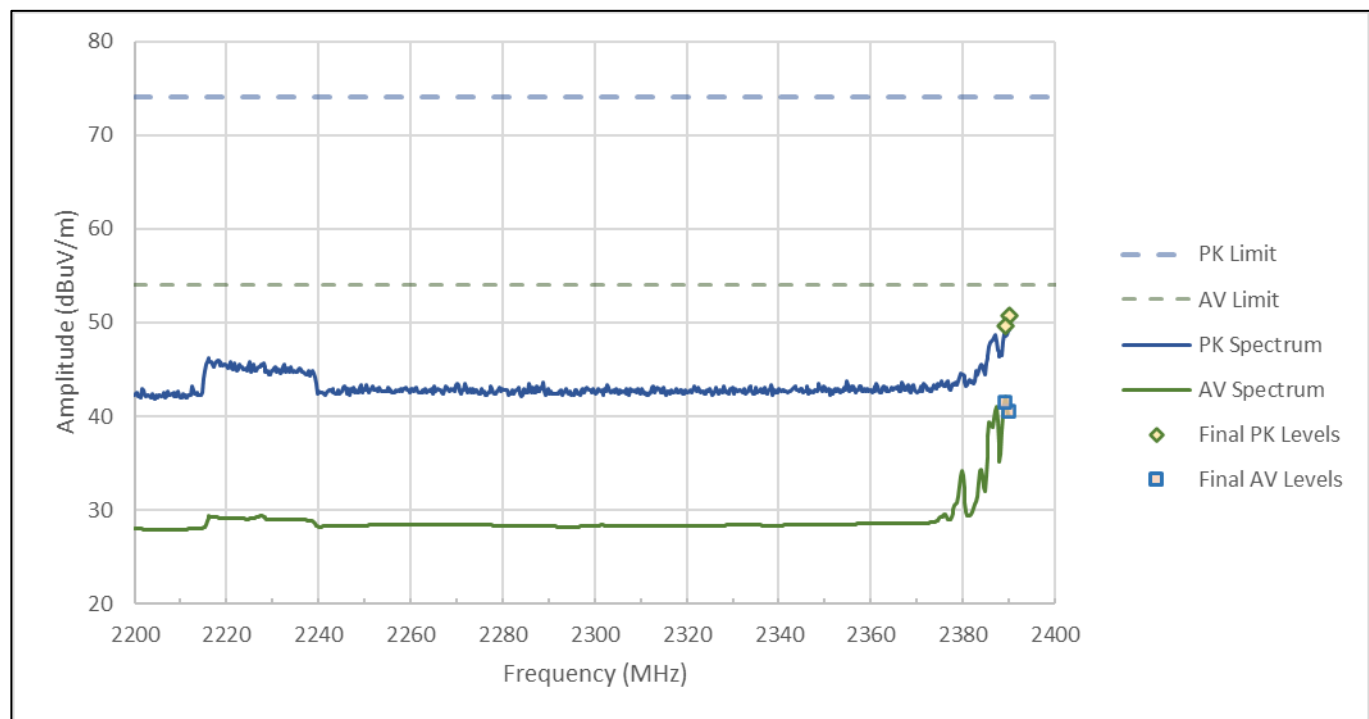


Figure RE01.1: FCC restricted band spectral data from 2200 to 2390 MHz (11B 1Mbps, Ch 1)

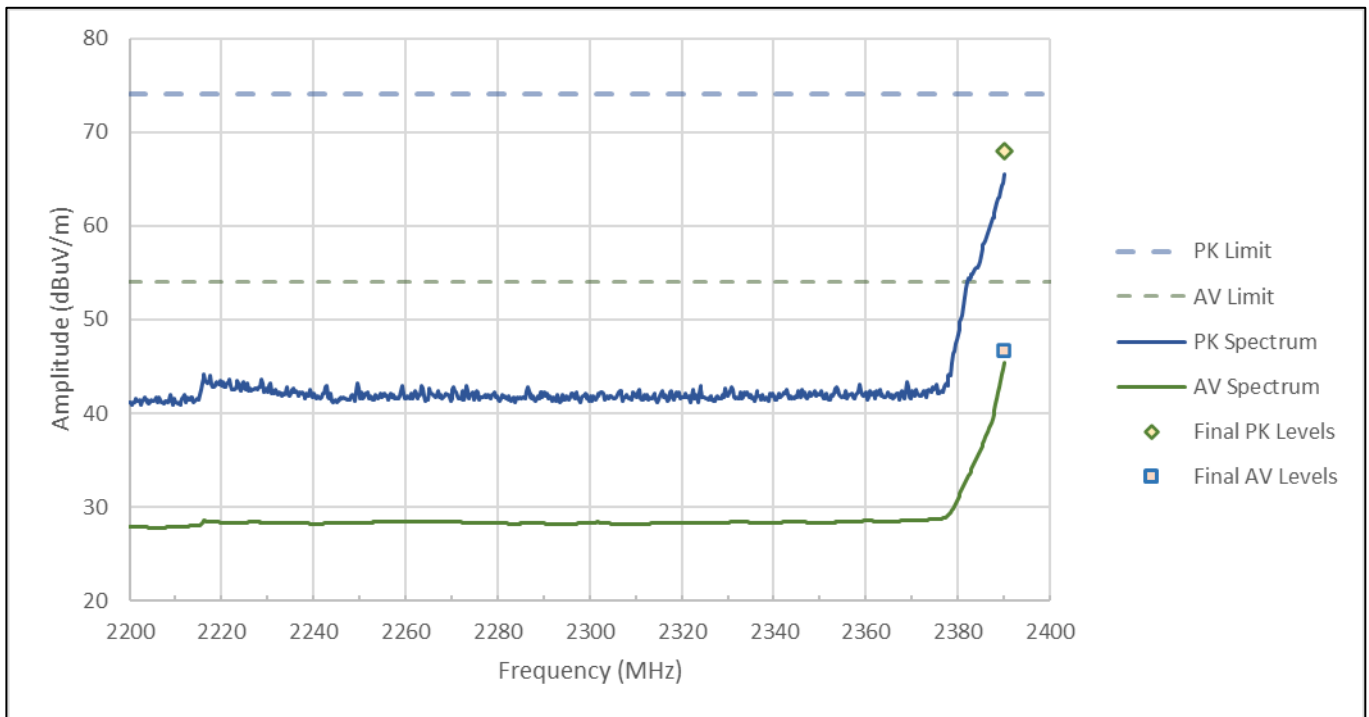


Figure RE01.2: FCC restricted band spectral data from 2200 to 2390 MHz (11G 6Mbps, Ch 1)

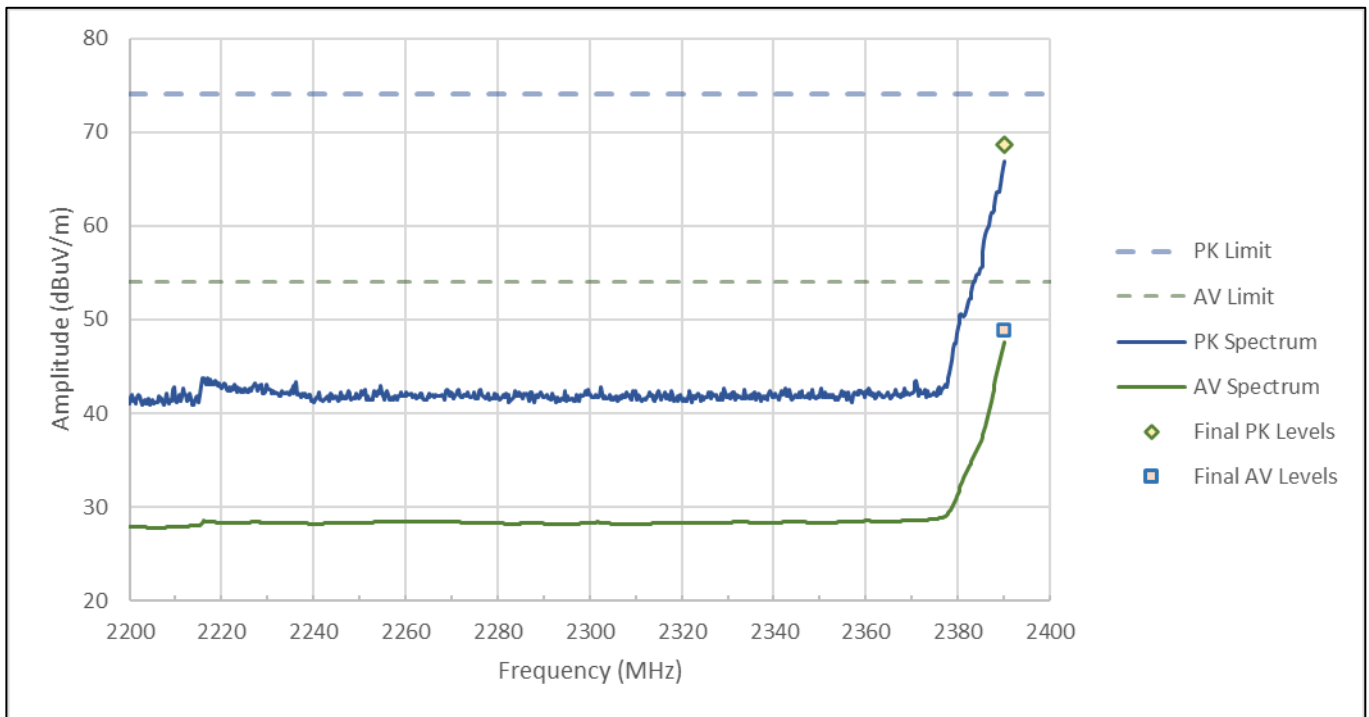


Figure RE01.3: FCC restricted band spectral data from 2200 to 2390 MHz (11N 4Mbps, Ch 1)

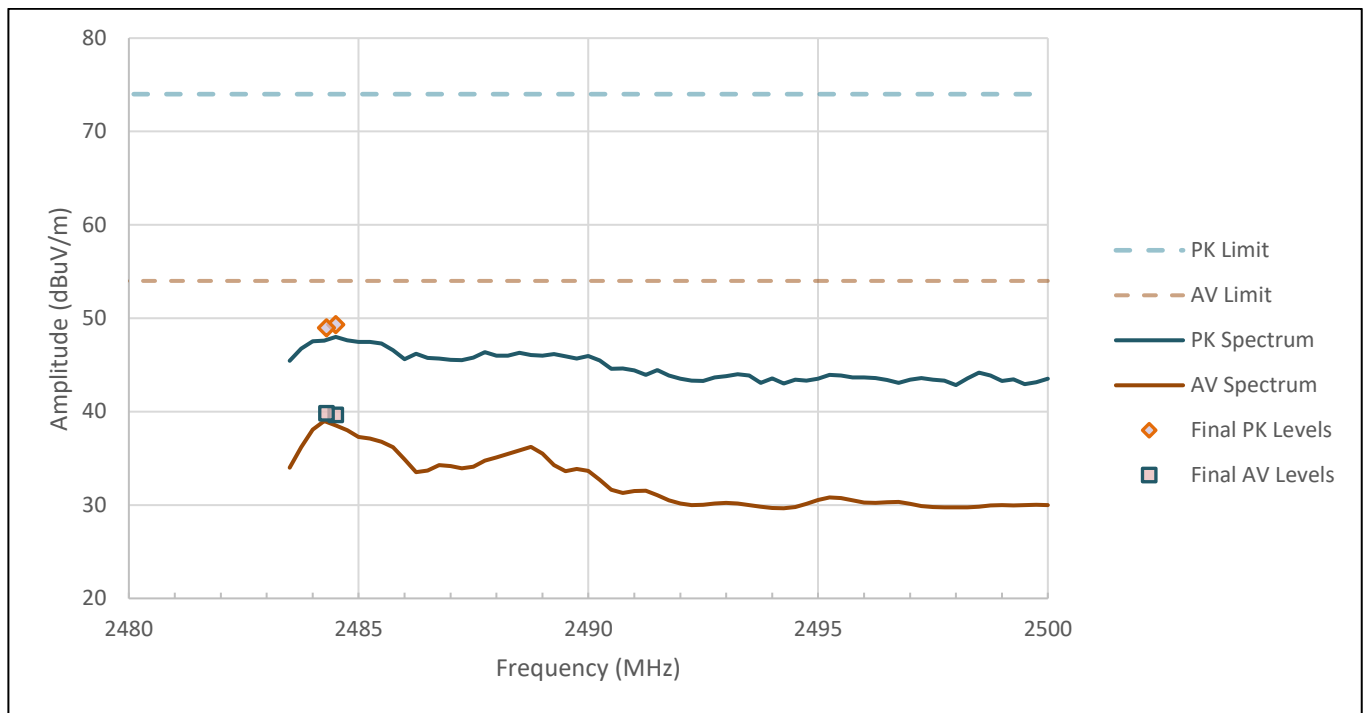


Figure RE01.4: FCC restricted band spectral data from 2483.5 to 2500 MHz (11B 1Mbps, Ch 9)

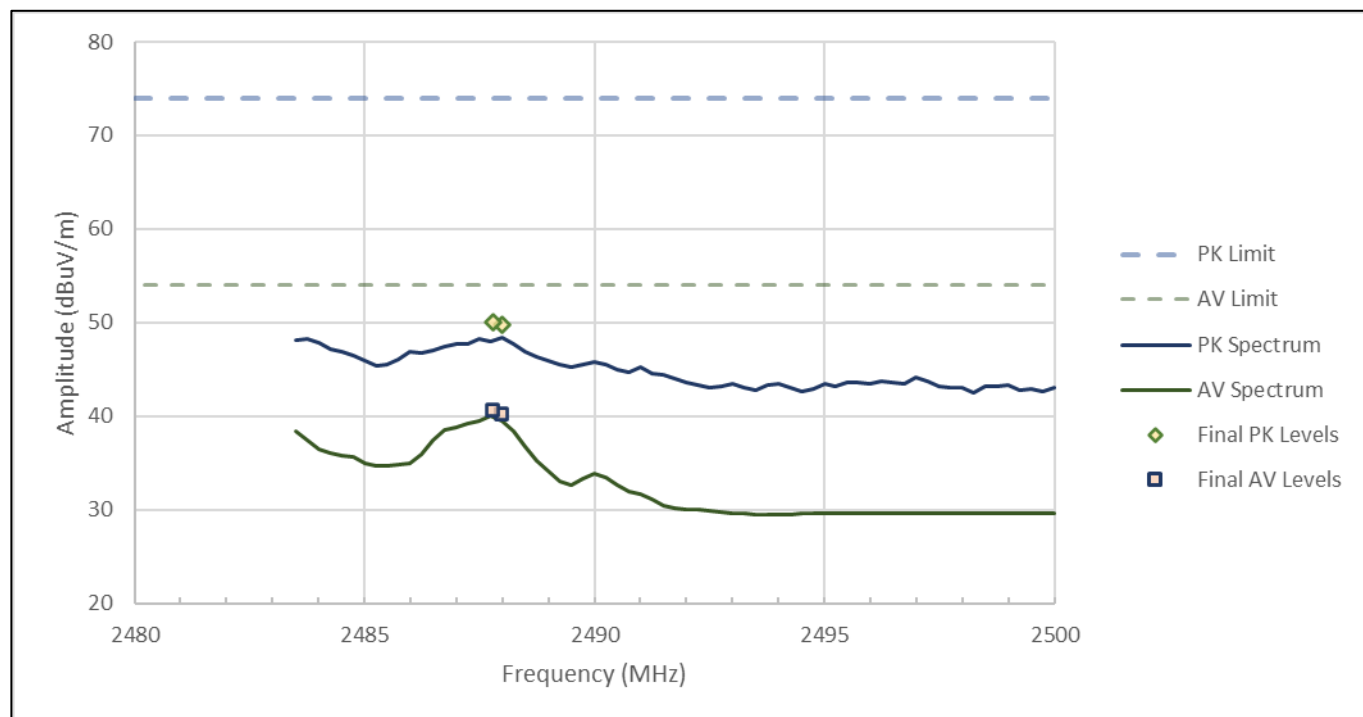


Figure RE01.5: FCC restricted band spectral data from 2483.5 to 2500 MHz (11B 1Mbps, Ch 11)

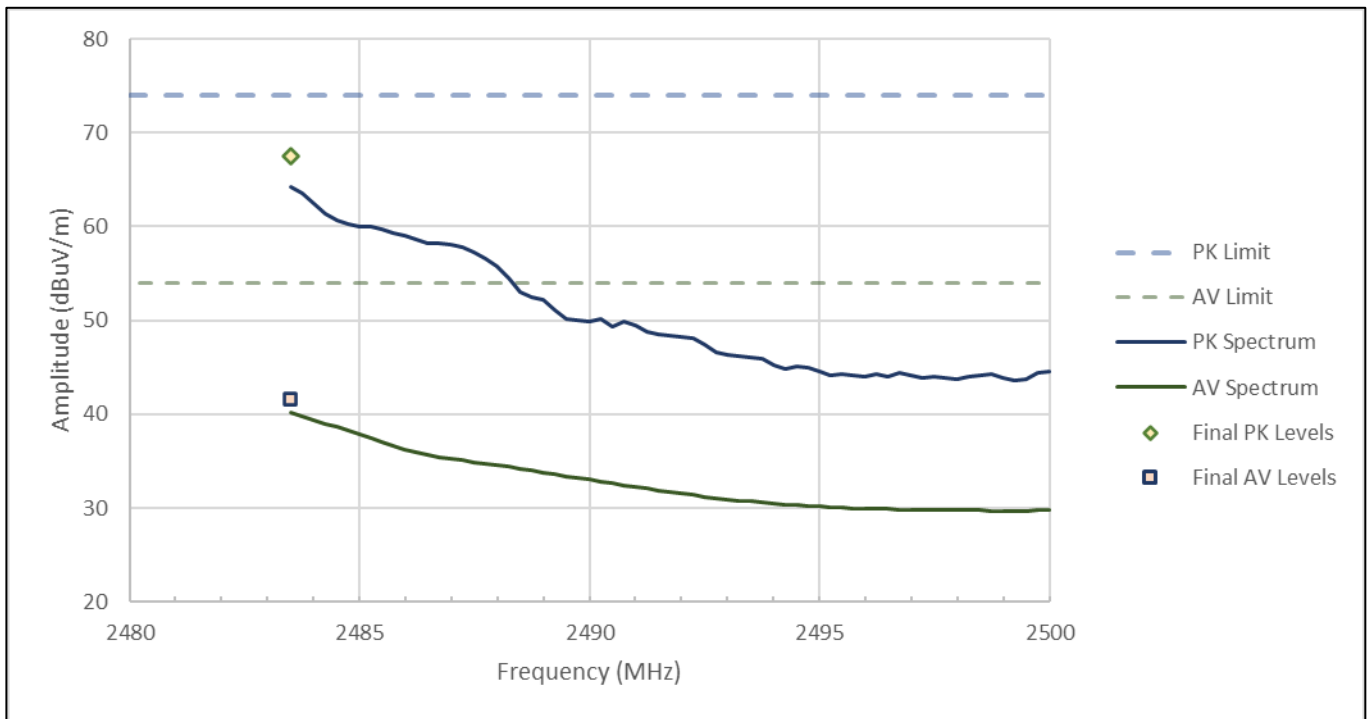


Figure RE01.6: FCC restricted band spectral data from 2483.5 to 2500 MHz (11G 6Mbps, Ch 11)

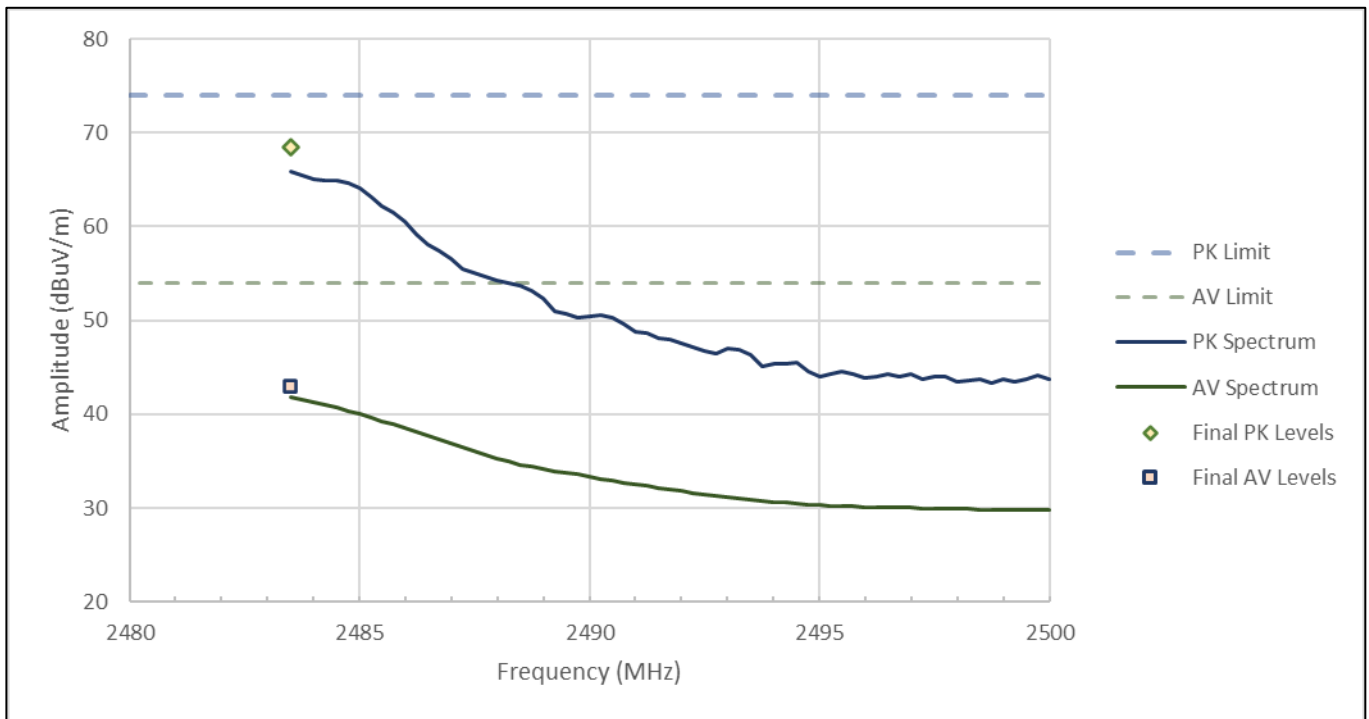


Figure RE01.7: FCC restricted band spectral data from 2483.5 to 2500 MHz (11N 6Mbps, Ch 11)

Setup Photographs

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



Figure RE01.8: EUT test setup, primary view (EUT Z orientation)



Figure RE01.9: EUT test setup, reverse view (EUT Z orientation)

This line is the end of the test record.

Test Record
Transmitter Power Spectral Density
Test IDs TR21
Project GCL-0835

Test Date(s) 26, 27 Mar 2025
Test Personnel Vladimir Tolstik supervised by Jim Solum

Product Model A04378
Serial Number tested 7MK001303

Operating Mode M7 (WiFITx)
Arrangement A2 (Upwr)
Input Power USB 5Vdc

Test Standards: FCC Part 15.247; RSS-247; RSS-GEN; ANSI C63.10 (as noted in Section 6 of the report).

Antenna Gain 2.71 dBi, as reported by the client
Radio Protocol IEEE 802.11 b/g/n (WiFi)

Pass/Fail Judgment: PASS

Test record created by: Vladimir Tolstik
Date of this record: 27 Mar 2025
Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
MXE Receiver 8.4 GHz	Keysight	N9038B	MY63460112	17-Mar-2025	17-Mar-2026

Table TR21.1: Test equipment used

Software Used: Keysight PXE software 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.

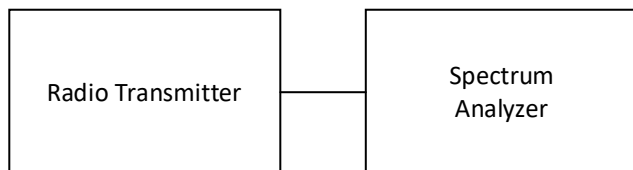


Figure TR21.1: Test setup

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.

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

	Ch1	Ch6	Ch11
B2	-7.60	-6.97	-7.66
NMCS0	-10.99	-9.50	-9.50

Table TR21.2: Summary of results for WiFi radio in dBm / 3 kHz



Figure TR21.2: Test data for IEEE 802.11 B2 modulation, Channel 6

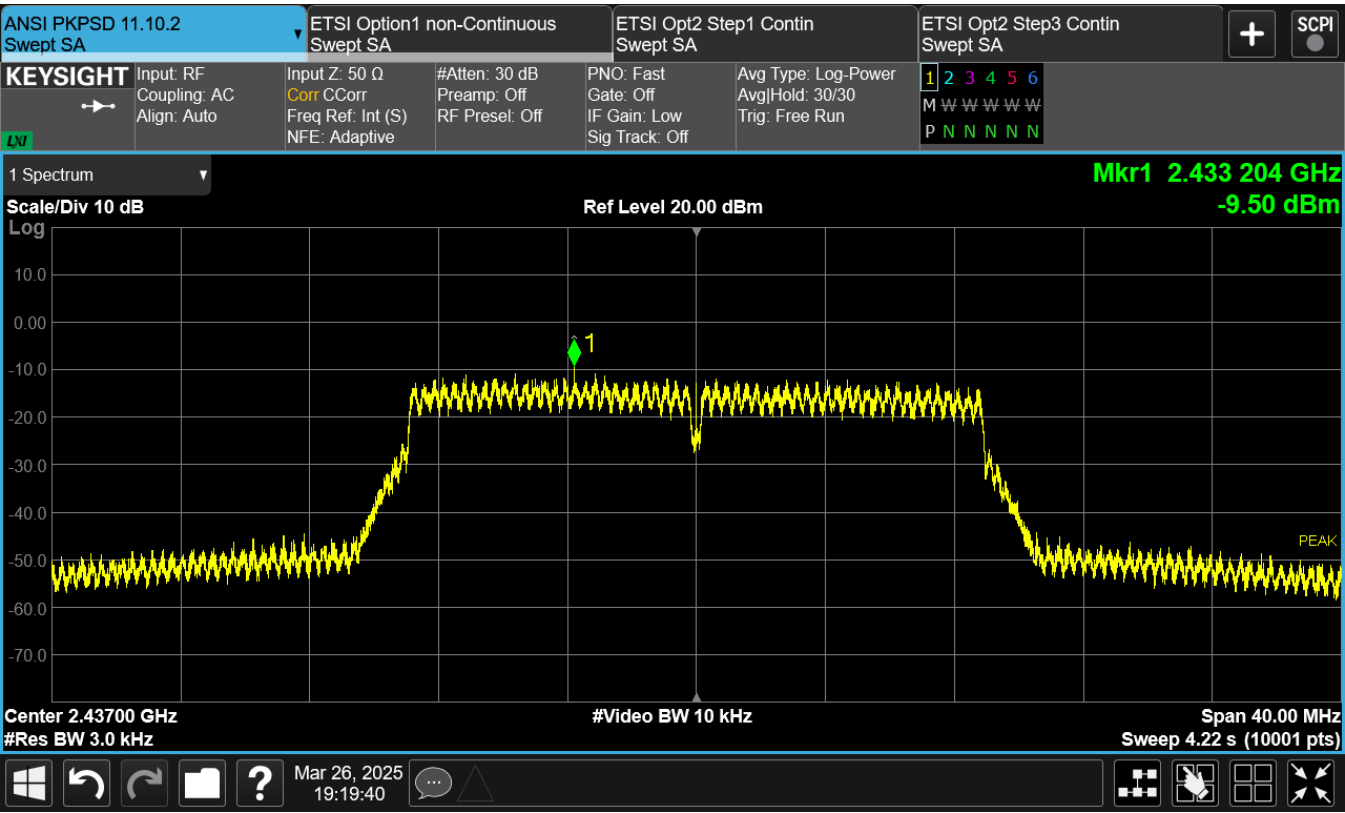


Figure TR21.3: Test data for IEEE 802.11 NMCS0 modulation, channel 6

This line is the end of the test record.

Test Record

Conducted Emissions Mains Test CE03

Project GCL0835

Test Date(s) 09 April 2025
Test Personnel David Kerr, Jim Solum

Product Model A04378
Serial Number tested 7MK001302

Operating Mode M7 (WiFitx)
Arrangement A2 (Upwr)

Input Power 120 Vac 60 Hz

Test Standards: FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report).

Frequency Range: 150 kHz to 30 MHz
Pass/Fail Judgment: PASS

Test record created by: Jim Solum
Date of this record: 10 April 2025

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44 GHz	Keysight	N9048B	MY62220139	21-Oct-2024	21-Oct-2025
Tape measure, 1 in x 33 ft	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
DMM Multimeter	Fluke	87V	63490051	2-Jan-2025	2-Jan-2028
LISN multiline; 20A 50uH	Com-Power	LIN-120C	20160005	3-Apr-2024	1-Apr-2027
Coaxial Power Cable	Com-Power	RG214/U	20230124-01	3-Apr-2024	1-Apr-2027

Table CE03.1: Test Equipment Used

Software Used

Keysight PXE software A.33.03; CE Mains 150k to 30M Data Analysis V3a 2025Jan08.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 Composite FCC/CISPR Class B Limit.

Frequency	QP Limit	AV Limit	L1 QP	L2 QP	L1 AV	L2 AV	QP Margin	AV Margin
(kHz)	(dB μ V)	(dB μ V)	(dB μ V)	(dB μ V)	(dB μ V)	(dB μ V)	(dB)	(dB)
150	66.00	56.00	60.51	60.46	30.67	30.61	5.49	25.33
438	57.10	47.10	43.96	44.26	25.70	20.28	12.84	21.40
440	57.06	47.06	44.01	44.04	25.87	20.24	13.02	21.19
569	56.00	46.00	38.90	39.20	23.14	23.91	16.80	22.09
582	56.00	46.00	39.17	39.19	22.51	24.14	16.81	21.86
1676	56.00	46.00	19.60	19.15	15.22	14.79	36.40	30.78
10001	60.00	50.00	20.68	20.13	16.74	16.22	39.32	33.26

Table CE03.2: Emission summary

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

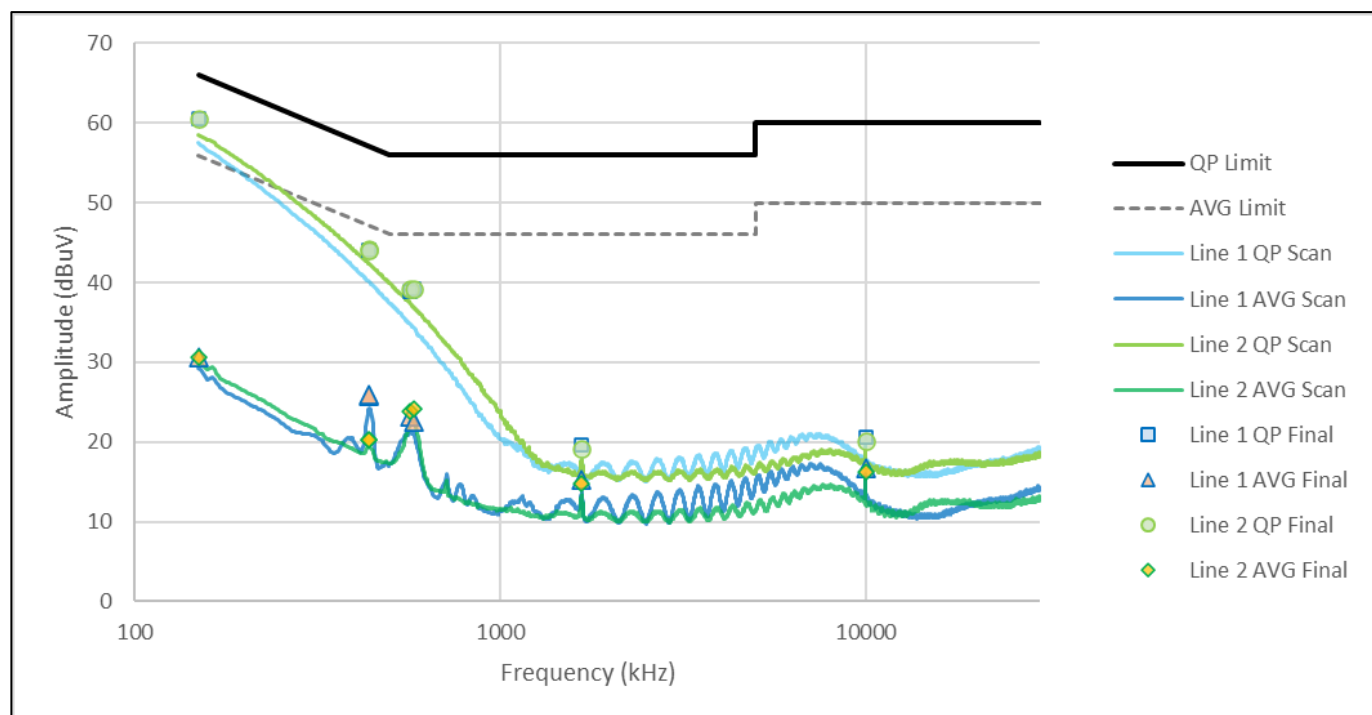


Figure CE03.1: Spectral data

Setup Photographs

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

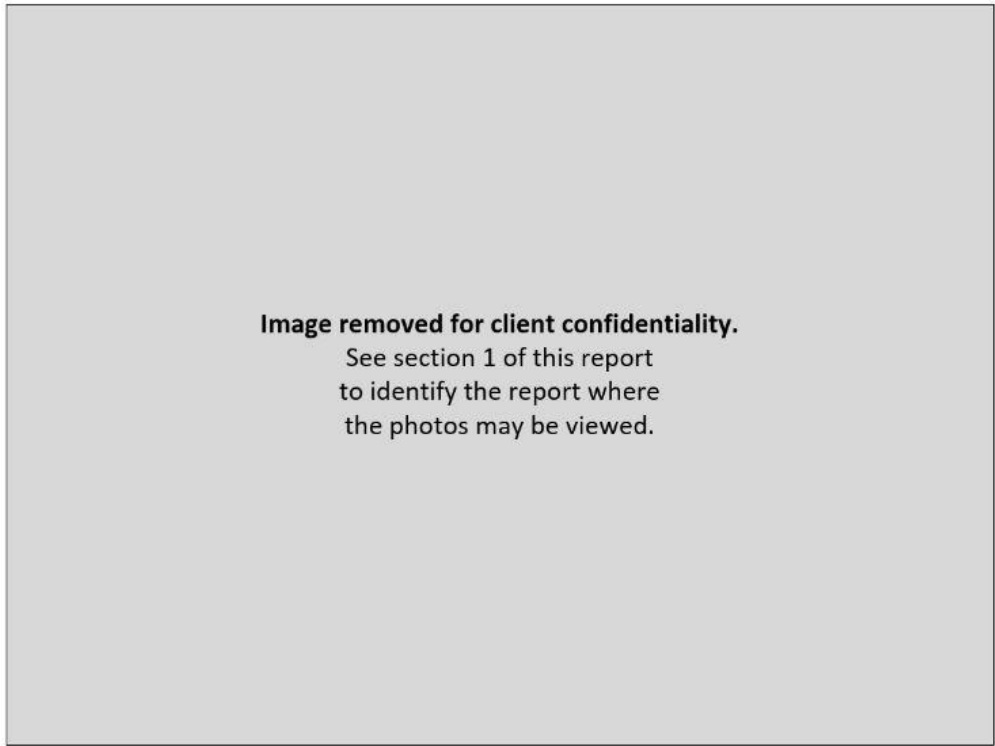


Figure CE03.2: Test setup, first view

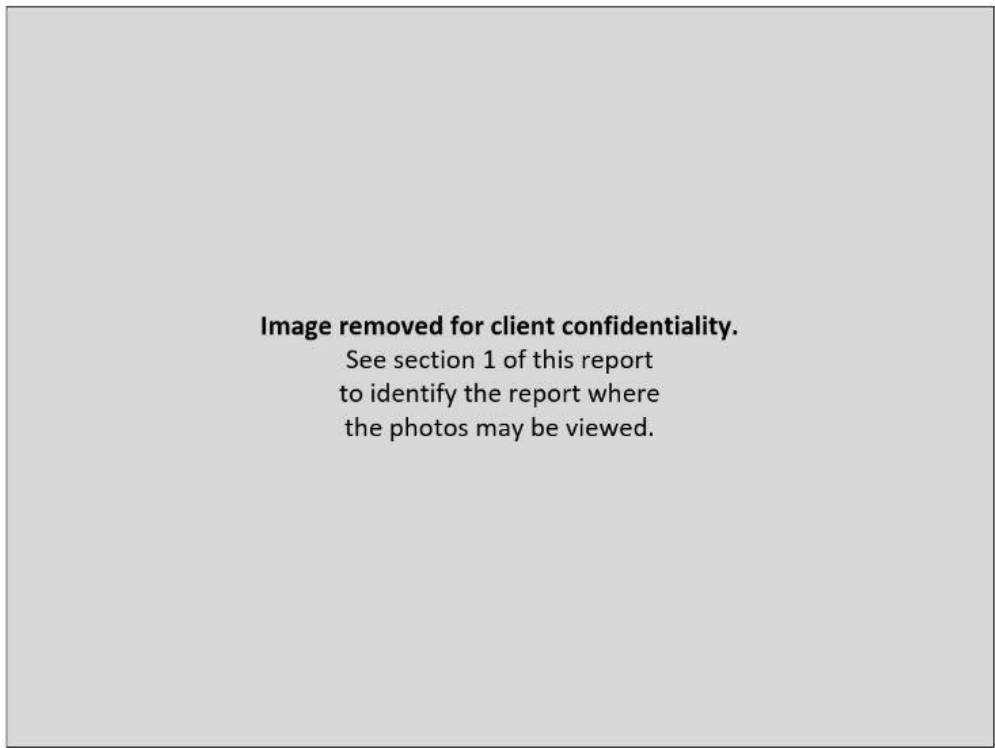


Figure CE03.3: Test setup, second view

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.