

Test Report 2024-191

Version A

Issued 8 Jan 2025

Project GCL-0425

Model Identifier A04712

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-04712
IC ID: 1792A-04712



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 wireless 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 668.3 kHz 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	20
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 17.04 dBm or 50.58 mW.	PASS	27
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 -2.78 dBi and will document antenna gain separately.	NT	NT
Unwanted Emissions (Spurious)	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 30 dB from in-band levels. The measured reduction was at least 36.29 dB. The margin to the 'Class B' limit was 1.6 dB or greater.	PASS	35
Restricted Bands	The radio must not emit in certain designated restricted frequency bands above a set of limit values. [15.247(d) and 15.205; RSS-247 at 3.3]	Emissions in the restricted bands were at least 5.81 dB below the applicable limits.	PASS	77
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 -5.99 dBm in a band of at least 3 kHz.	PASS	90

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]	NT	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 25.36 dB of margin.	PASS	95

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

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

Table 1: Summary of results

Report Organization

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

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

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

Due to confidentiality, certain material (such as test setup photographs) has been removed from this report and placed in GCL Test Report 2024-188. 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: 23 August 2024

Test Start Date: 29 October 2024

Test End Date: 27 November 2024

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

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

3. Report History and Approval

This report was written by Aditya Prakash and initially issued on 8 Jan 2025 as Version A.

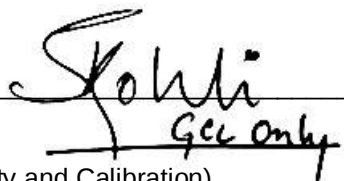
Report Technical Review:

David Arnett
Technical Lead EMC Engineer



Report Approval:

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



4. Test Sample Modifications and Special Conditions

The following special conditions or usage attributes were judged during test to be necessary to achieve compliance with one or more of the standards listed in section 6 of this report:

None

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

Modification 1

Detailed Description: Samples E1 (s/n 3488107710) and E3 (s/n 3488107722), firmware was updated from version 0.42 to 0.48.

Date applied: 06 November 2024

Reason for this modification: Lowered the WiFi power table settings for some channels and modes.

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: Conducted AC Mains Emissions. The change was judged to not impact this test, as WiFi power was reduced after the test was performed.

5. Description of the Equipment Tested

5.1 Unique Identification

Product Model A04712
Serial Numbers Tested 3488107710, 3488107722

This product tested is a Digital device and low power data 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, Bluetooth Low Energy, ANT
Radio Receivers: GPS - L1, GPS - L5, GLONASS - G1, Galileo - E1, Galileo - E5, BDS - B1
Primary Functions: Digital device that processes data received from and transmitted to nearby low power transceivers.
Typical use: Portable in multiple orientations
Highest internal frequency: 2.484 GHz
Highest digital frequency: 40 MHz
Firmware Revision 0.42, 0.48 (see section 4)

5.3 Operating modes

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

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

Mode 2: M4 (Ble Lnk). Bluetooth Low Energy radio is paired to a companion device, transmitting and receiving data on various channels in accordance with the protocol, and maintaining the paired relationship.

Mode 3: M5 (ANT Tx). ANT radio transmitting consistently on a selected channel.

Mode 4: M6 (ANT Lnk). ANT radio is paired to a companion device, transmitting and receiving data in accordance with the protocol, and maintaining the paired relationship.

Mode 5: 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 6: M8 (Wifi Lnk). The IEEE 802.11 b/g/n radio is paired to a companion device, transmitting and receiving data on a selected channel in accordance with the protocol, and maintaining the paired relationship.

Mode 7: M13 (Gnss). The GNSS radio is looking for the satellite signal to get a position lock.

Mode 8: M15 (RxBLE). BLE radio is in receive mode.

Mode 9: M16 (RxANT). ANT radio is in receive mode.

Mode 10: M10 (RxWiFi). WiFi radio is in receive mode.

Mode 11: M19 (ML1). BLE, ANT and WiFi radios are linked to their companion devices simultaneously.

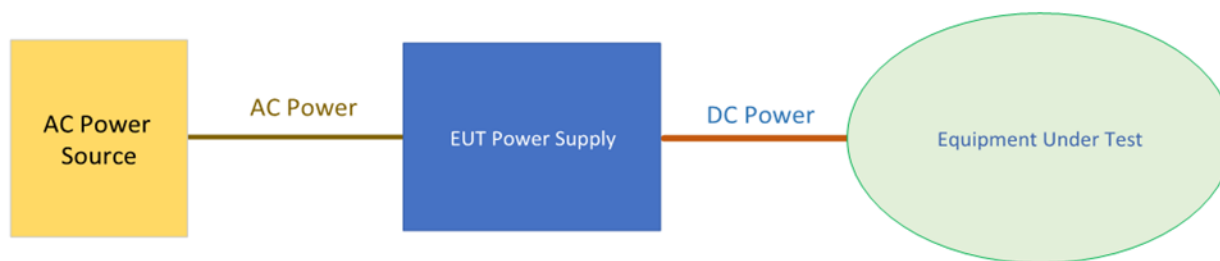
Mode 12: M20 (ML2). BLE and ANT radios are linked to their companion devices simultaneously.

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.

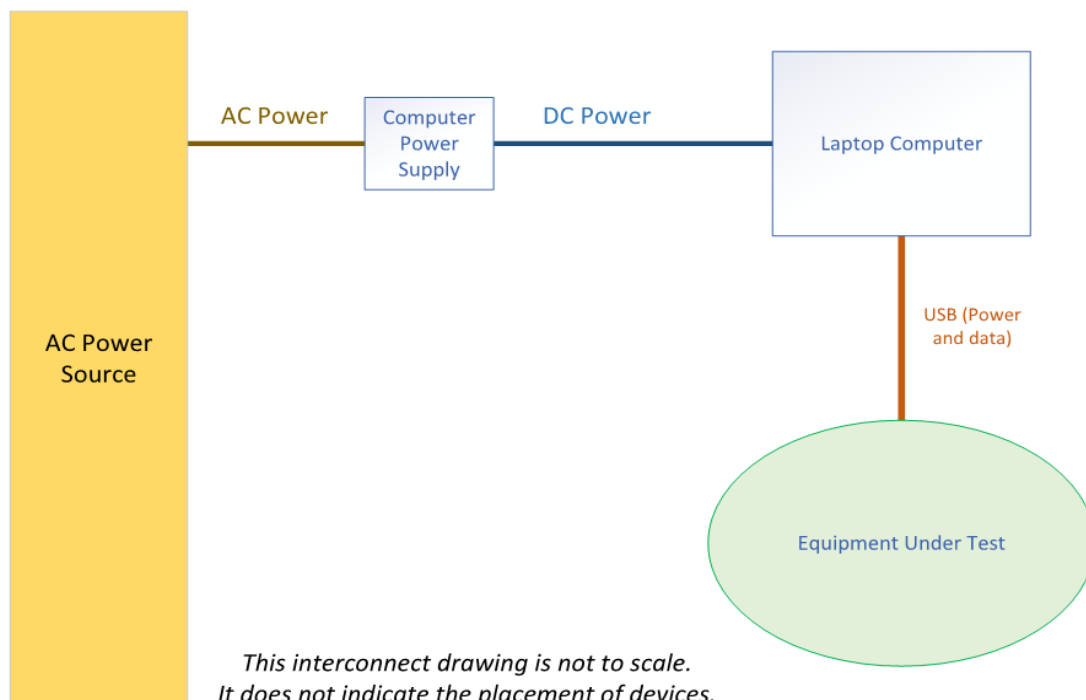
Arrangement 2: A2 (Upwr). The test sample is attached to USB adaptor which is connected to AC mains. The adaptor provides power to the sample over a cable but no user data. See the block diagram in Figure 1.



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

Figure 1: Block diagram of equipment arrangement A2

Arrangement 4: A3 (Udata). The test sample is connected to PC through its USB C port. The PC is providing the power to the device as well as data is being transferred between the test sample and the PC.



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

Figure 2: Block diagram of equipment arrangement A3

5.5 Associated Equipment (AE) used

Description	Manufacturer	Model	Serial Number
USB ANT stick	Garmin	ANT USB-m	None
USB C power adaptor	Phihong (Garmin)	PSAF10R-050Q	P183100844A1
Wi-Fi Adaptor	Alpha network	AWUS036ACS	21BP036AC8259
Laptop	Dell	Latitude 5410	5VSPFB3
Phone	Samsung	SM-G973U (S10)	RF8MC0W9XVR
Power Supply	Dell	HA130PM130	CN-0V363H-CH200-78G-0DC1-A01

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

5.6 Cables used

Description	From	To	Length	EMC Treatment
USB C to USB C cable	Power and/or Data source	EUT	0.5 m	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	1.49 dB	3.8 dB	None
Conducted Emissions, Power Mains, 150 kHz to 30 MHz	1.40 dB	3.4 dB	None
Conducted Emissions, Cat 6 LCL, 150 kHz to 30 MHz	2.80 dB	5 dB	None
Conducted Emissions, Cat 5 LCL, 150 kHz to 30 MHz	3.21 dB	5 dB	None
Conducted Emissions, Cat 3 LCL, 150 kHz to 30 MHz	4.24 dB	5 dB	None
Radiated Emissions, below 30 MHz	0.88 dB	None	6 dB
Radiated Emissions, 30 MHz to 1000 MHz	2.77 dB	6.3 dB	6 dB
Radiated Emissions, 1 GHz to 18 GHz	2.60 dB	5.2 & 5.5 dB	6 dB
Radiated Emissions, 18 GHz to 26.5 GHz	2.73 dB	None	6 dB
*Radio Signal Frequency Accuracy	1.55×10^{-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...	None	None
	0.01% of value		
	0.5 x LSDPV		

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:	19.8 to 21.2 °C
Relative Humidity:	42.4% to 55% (non-condensing)
Barometric Pressure	96.5 to 98.8 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.

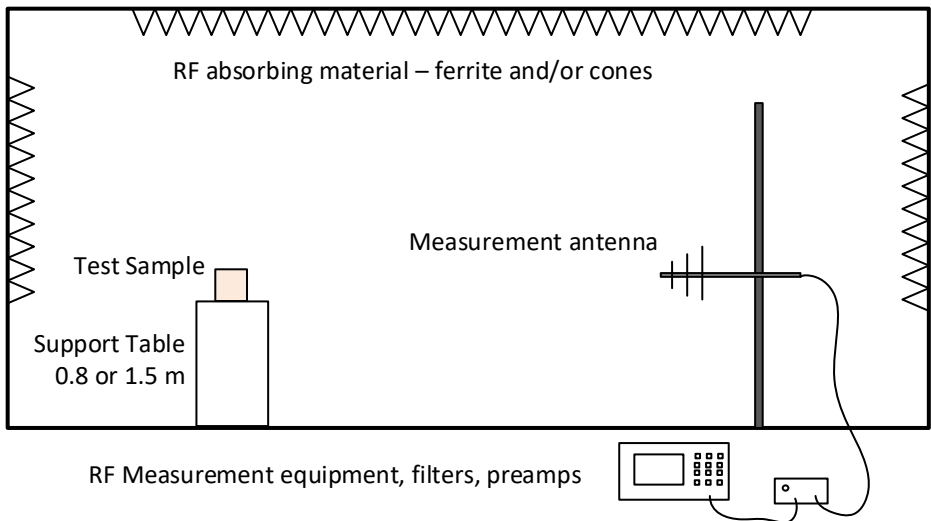


Figure 1: Typical configuration for measurements below 1 GHz

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.

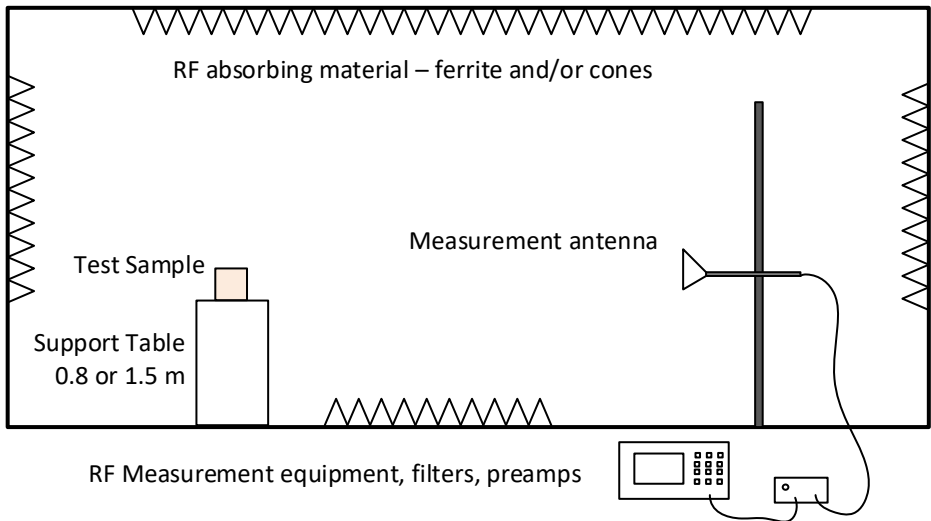


Figure 2: Typical configuration for measurements between 1 GHz and 14 GHz

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.

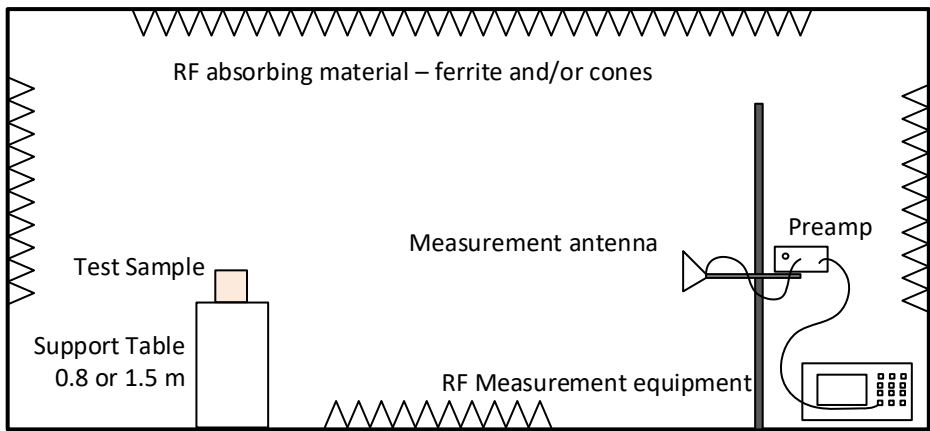


Figure 3: Typical configuration for measurements above 14 GHz

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 TR06, TR07, TR08
Project GCL-0425

Test Date(s) 08, 13 Nov 2024
Test Personnel Jim Solum

Product Model A04712
Serial Number tested 3488107722

Operating Mode M3 (BleTx), M5 (AntTx), M7 (WiFiTx)
Arrangement A1 (Solo)
Input Power Battery

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

Radio Protocol Bluetooth Low Energy (BLE), ANT, IEEE 802.11b/g/n
Radio Band 2400 to 2483.5 MHz

Pass/Fail Judgment: PASS

Test record created by: Jim Solum
Date of this record: 13 Nov 2024

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44 GHz	Keysight	N9048B	MY62220139	21-Oct-2024	21-Oct-2025
MXE Receiver 8.4 GHz	Keysight	N9038B	MY63460112	28-Feb-2024	1-Mar-2025

Table TR06.1: List of test equipment used

Test Software Used: Keysight PXE firmware A.39.28, A.37.02

Test Method

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

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

Test Setup

This block diagram shows the test equipment setup.

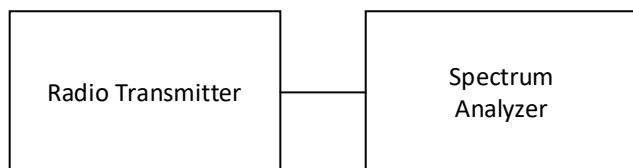


Figure TR06.1: Test setup

Test Data

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

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

	2402 (04)	2440	2480 (78)
BLE 1 Mbps	778.5	819.5	869.7
BLE 2 Mbps	1416.0	1369.0	1695.0
ANT	668.3	669.0	869.3

Table TR06.2: Summary of bandwidth data in kHz for Bluetooth, ANT and BLE modes

	Ch1	Ch6	Ch11
B1	NT	9.648	NT
B2	NT	9.739	NT
B5.5	8.668	8.676	9.375
B11	NT	9.174	NT
G6	16.350	16.410	16.380
G9	NT	16.500	NT
G12	NT	16.550	NT
G18	16.450	16.410	16.510
G24	NT	16.540	NT
G36	NT	16.580	NT
G48	NT	16.570	NT
G54	NT	16.570	NT
NMCS0	NT	17.520	NT
NMCS1	NT	17.540	NT
NMCS2	NT	17.390	NT
NMCS3	NT	17.470	NT
NMCS4	NT	17.520	NT
NMCS5	17.160	17.340	17.320
NMCS6	NT	17.560	NT
NMCS7	NT	17.360	NT

Table TR06.3: Summary of bandwidth data in MHz for IEEE 802.11 WiFi modes

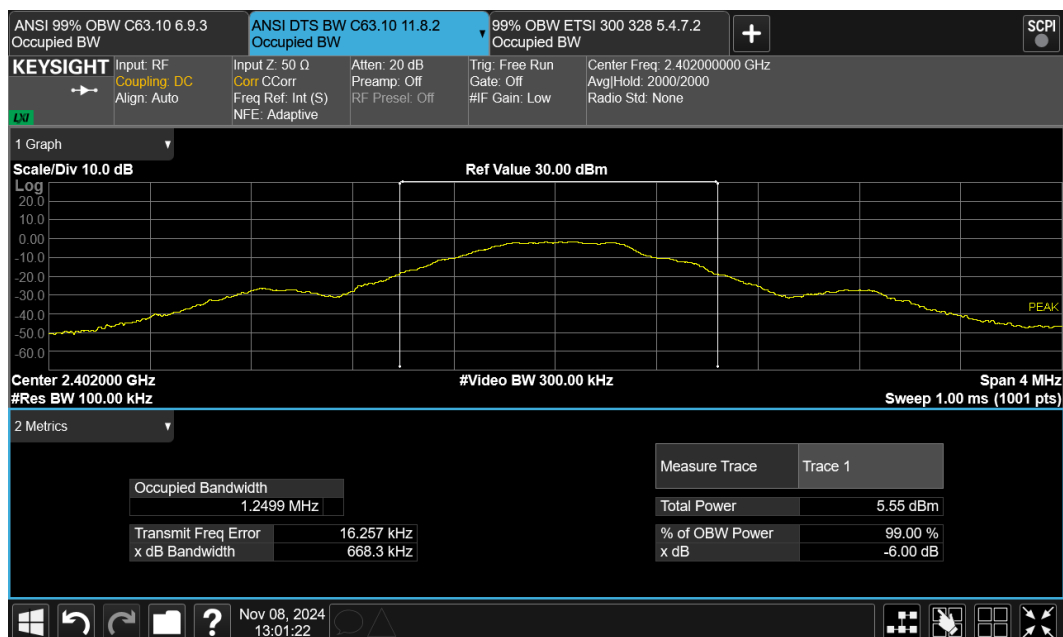


Figure TR06.2: Bandwidth data for ANT at low channel (2402 MHz)

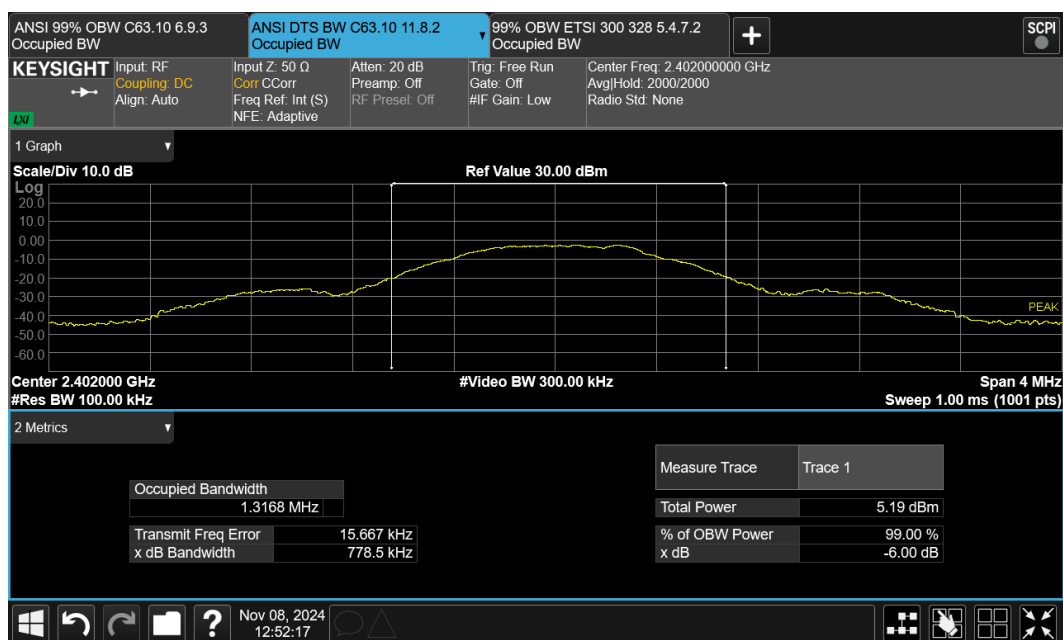


Figure TR06.3: Bandwidth data for BLE1 at low channel (2402 MHz)

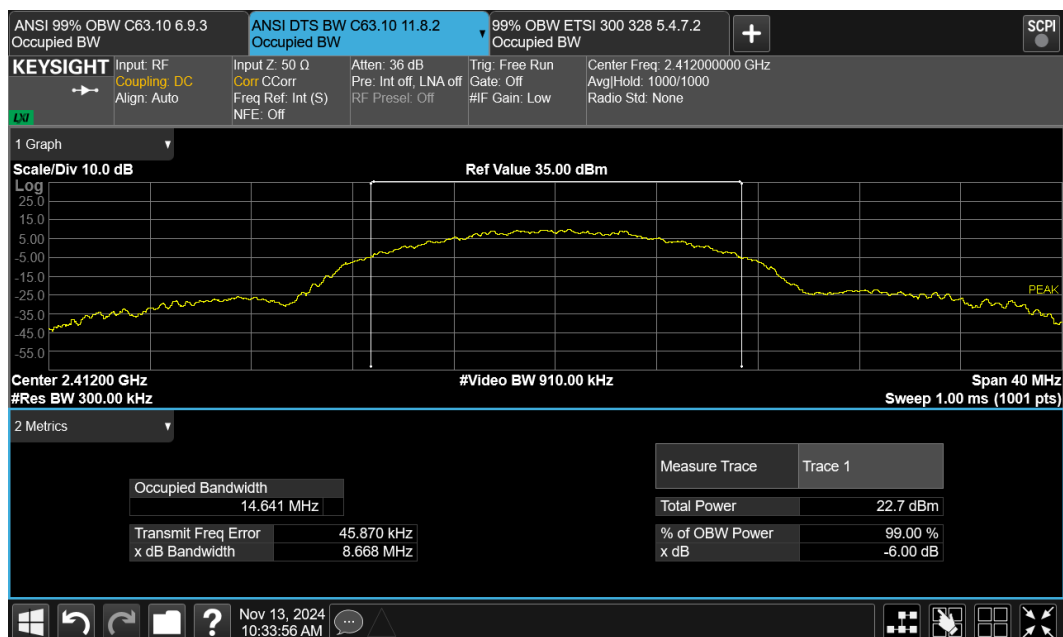


Figure TR06.4: Bandwidth data for 802.11b 5.5 Mbps at channel 1

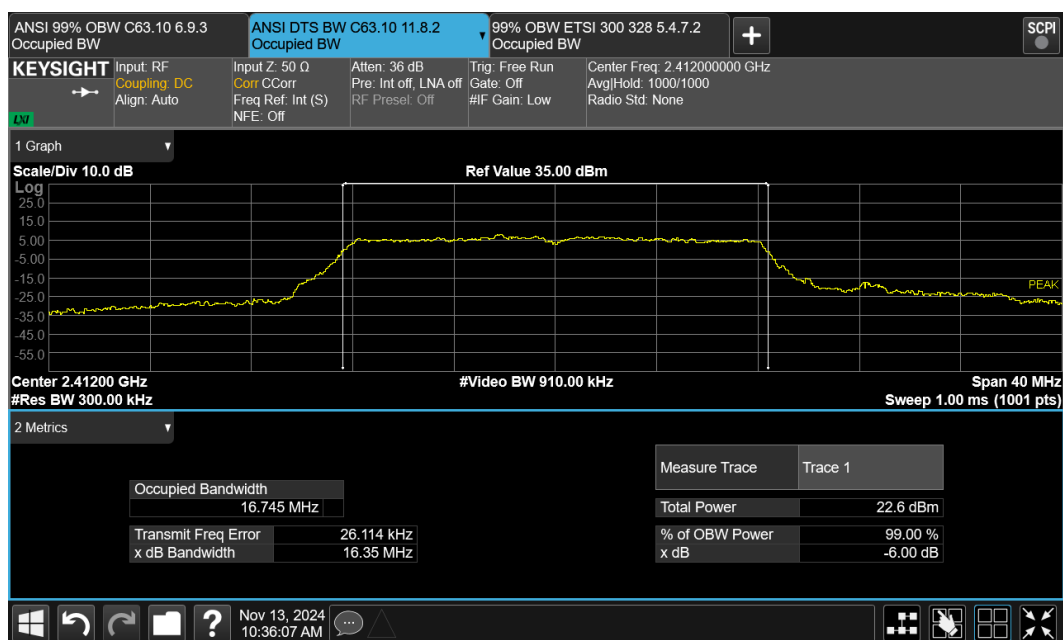


Figure TR06.5: Bandwidth data for 802.11g 6 Mbps at channel 1

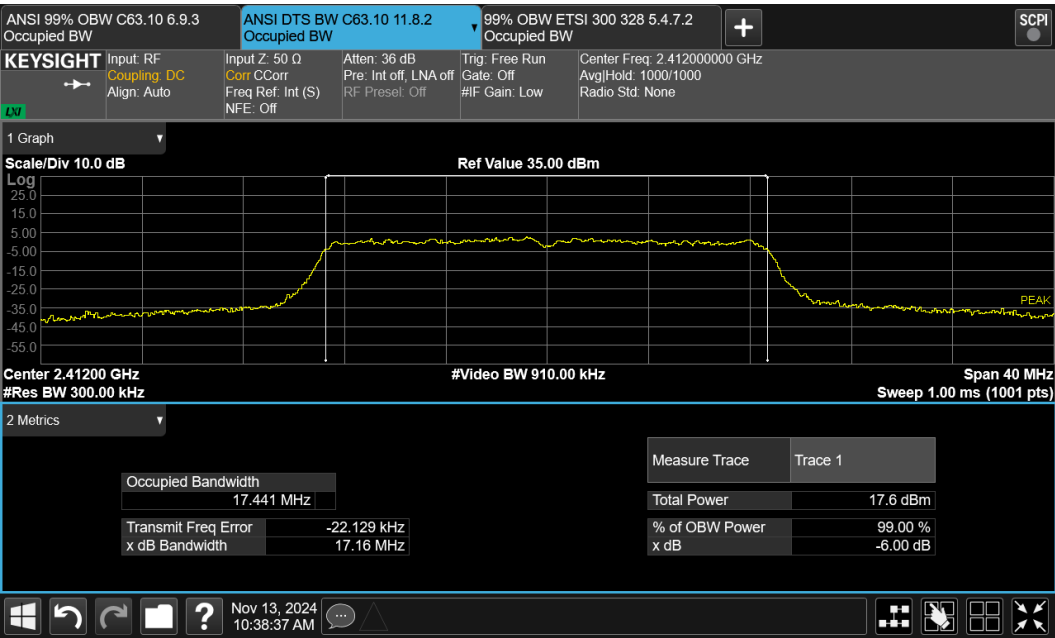


Figure TR06.6: Bandwidth data for 802.11n MCS5 at channel 1

This line is the end of the test record.

Test Record
Transmitter Bandwidth Tests
Test IDs TR10 – TR12
Project GCL0425

Test Date(s) 11 November 2024
Test Personnel Aditya Prakash

Product Model A04712
Serial Number tested 3488107722

Operating Mode M3 (BleTx), M5 (AntTx), M7 (WiFiTx)
Arrangement A1 (Solo)
Input Power Internal battery

Test Standards: FCC Part 2.202, ANSI C63.10, TRC-43, RSS-GEN (as noted in Section 6 of the report).

Radio Protocol Bluetooth Low Energy (BLE), ANT, IEEE 802.11 b/g/n (WiFi)
Radio Band 2480 to 2483.5 MHz

Pass/Fail Judgment: **Reported**

Test record created by: Aditya Prakash
Date of this record: 11 November 2024

Original record, Version A.

Test Equipment Used

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

Table TR10.1 Equipment Used

Software used: Keysight PXE software A.37.02

Background

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

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

Test Setup

This block diagram shows the test equipment setup.

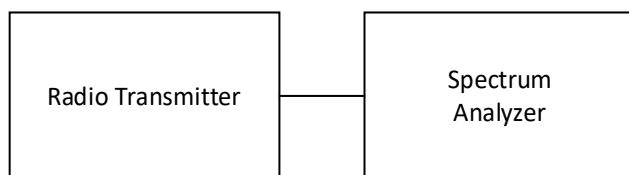


Figure TR10.1: Test setup

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 kHz/MHz as their units of measure.

	2402 (04)	2440	2480 (78)
BLE 1 Mbps	1316.30	1401.70	1315.50
BLE 2 Mbps	2543.30	2420.90	2478.80
ANT	1263.30	1361.80	1332.30

Table TR10.2: Summary of 99% Occupied Bandwidth Data in kHz for Bluetooth, ANT and BLE modes

	Ch1	Ch6	Ch11
B1	NT	15.204	NT
B2	15.291	15.274	15.373
B5.5	NT	14.630	NT
B11	NT	14.785	NT
G6	NT	17.859	NT
G9	NT	17.059	NT
G12	17.537	18.051	16.823
G18	NT	17.851	NT
G24	NT	17.185	NT
G36	NT	16.861	NT
G48	NT	16.641	NT
G54	NT	16.730	NT
NMCS0	NT	17.623	NT
NMCS1	17.988	17.747	17.697
NMCS2	NT	17.608	NT
NMCS3	NT	17.606	NT
NMCS4	NT	17.627	NT
NMCS5	NT	17.494	NT
NMCS6	NT	17.619	NT
NMCS7	NT	17.504	NT

Table TR10.3: Summary of 99% Occupied Bandwidth Data in MHz for IEEE 802.11 WiFi modes

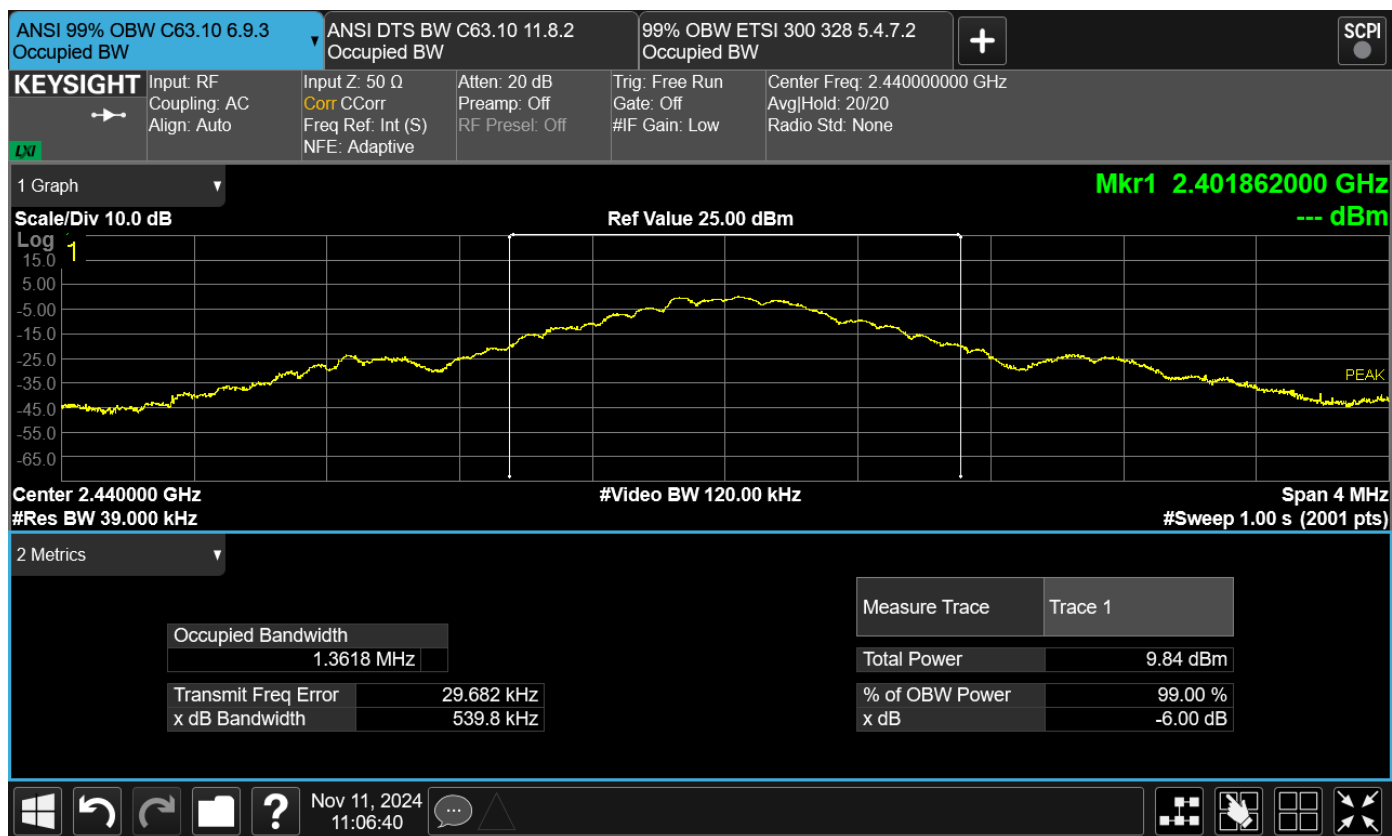


Figure TR10.1: Occupied bandwidth data for ANT at mid channel (2440 MHz)



Figure TR10.2: Occupied bandwidth data for BLE 1 Mbps at mid channel (2440 MHz)

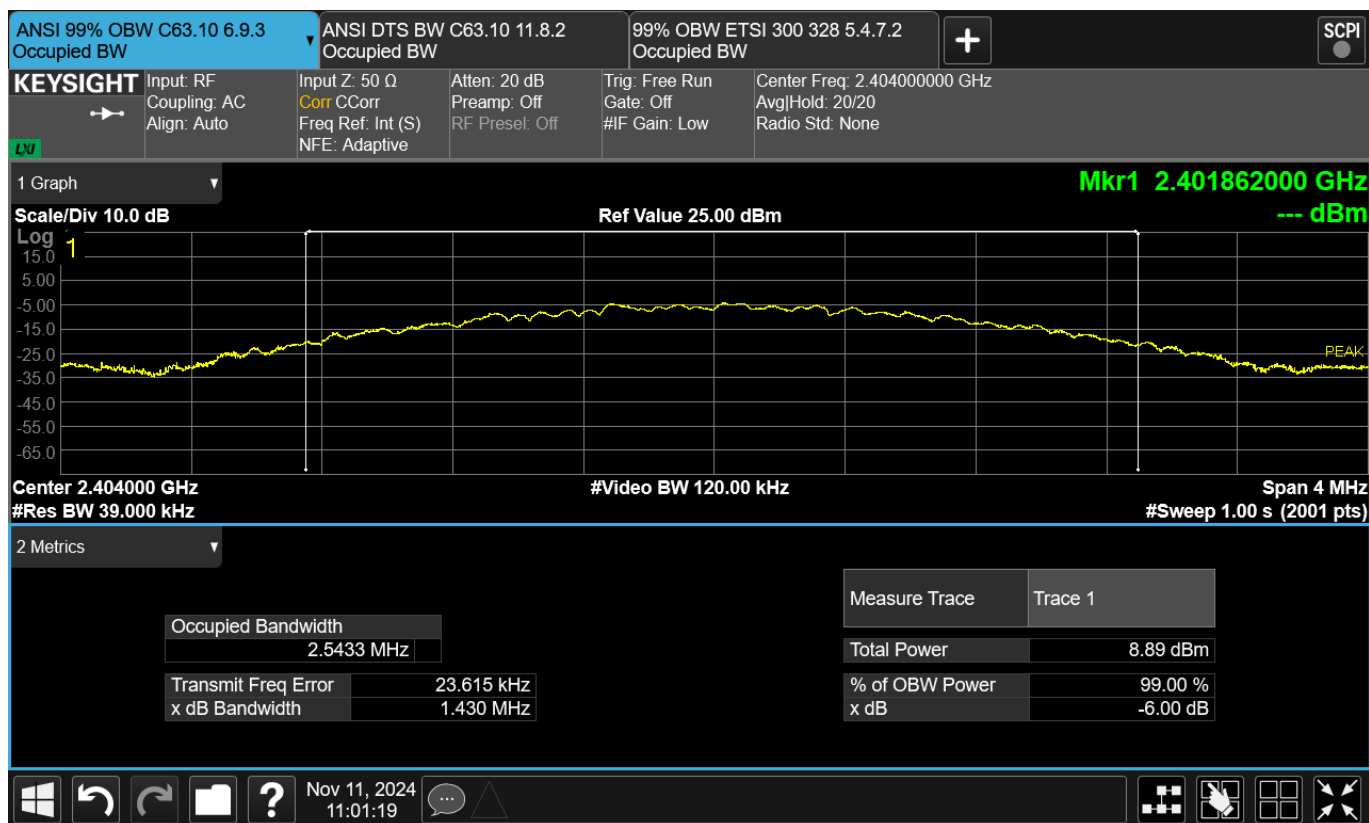


Figure TR10.3: Occupied bandwidth data for BLE 2 Mbps at low channel (2404 MHz)

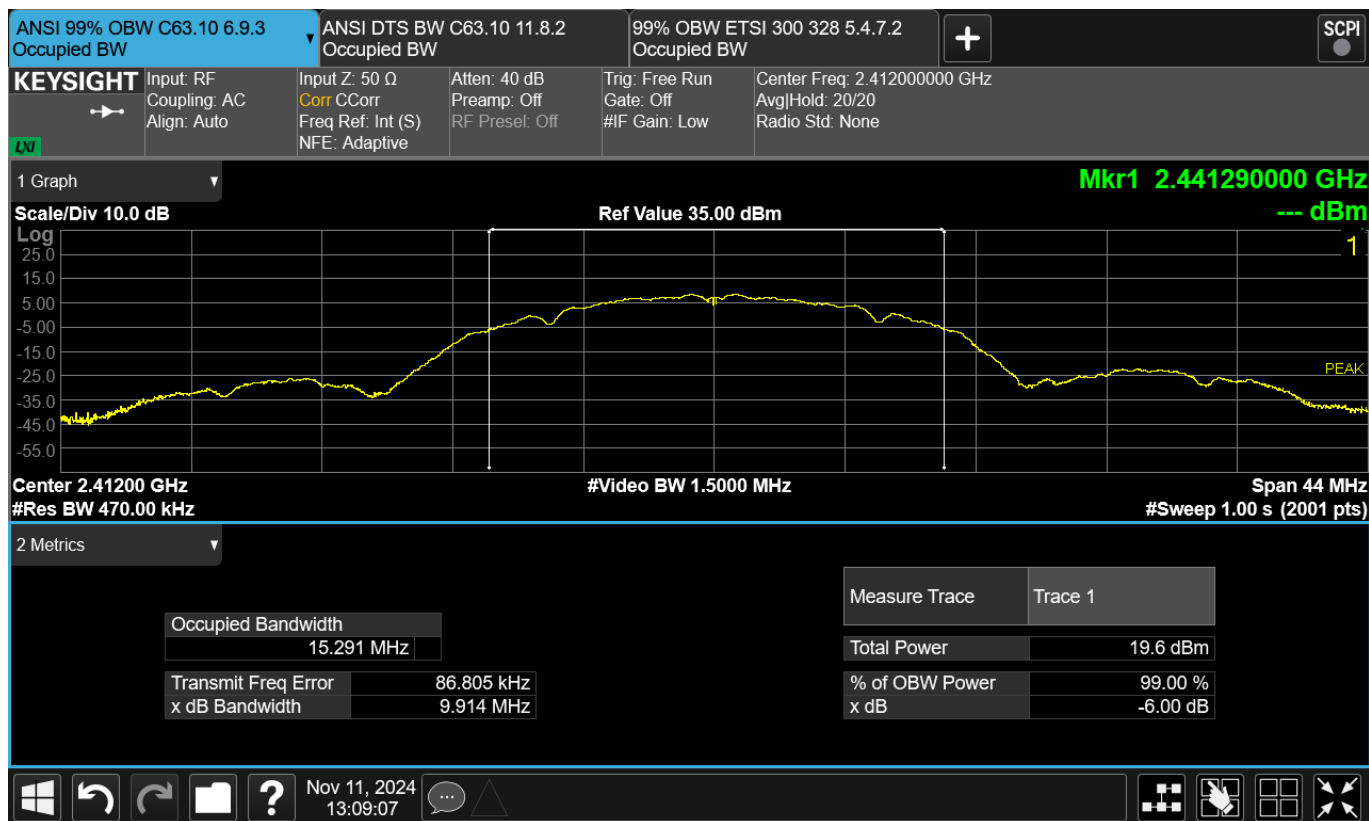


Figure TR10.4: Occupied bandwidth data for 802.11b 2 Mbps at channel 1

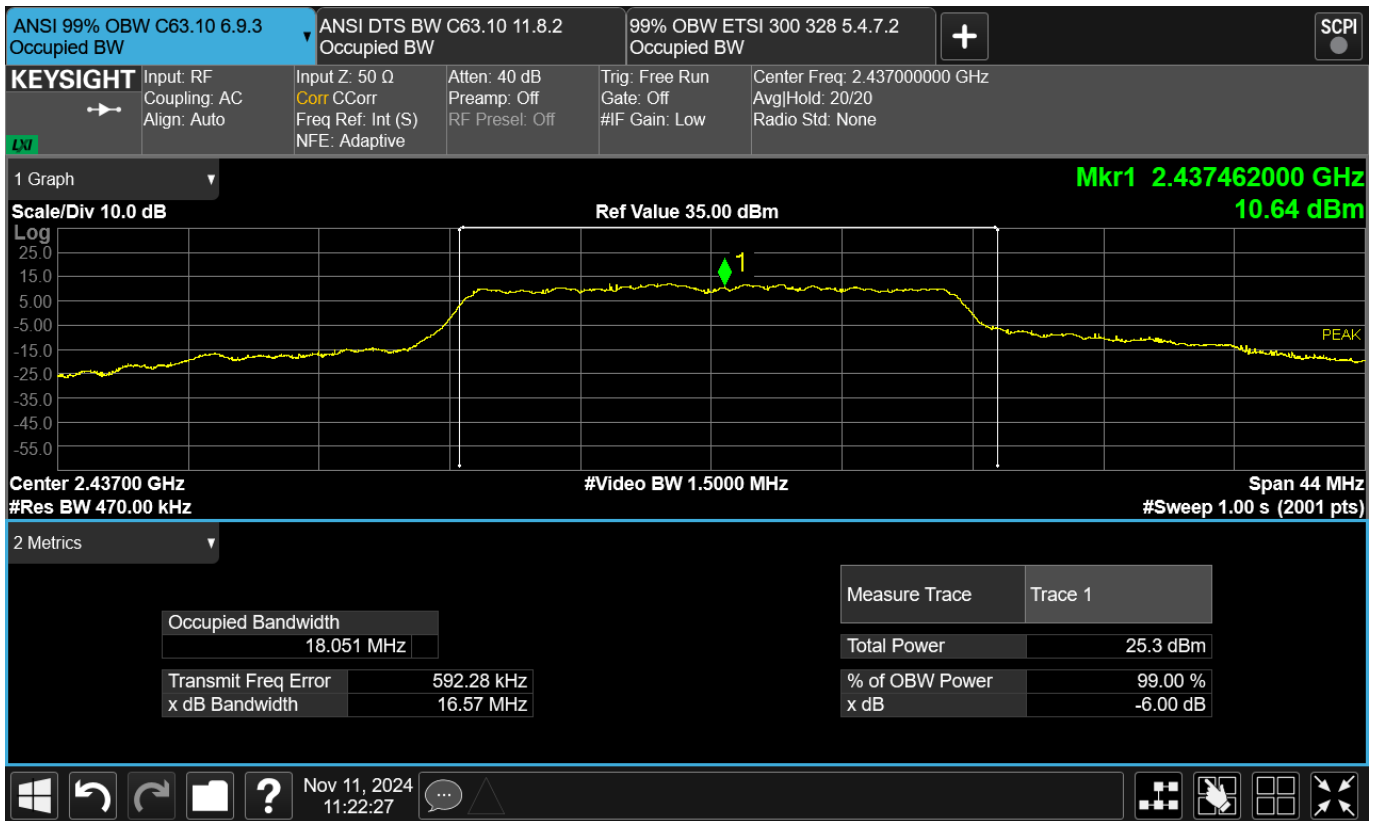


Figure TR10.5: Occupied bandwidth data for 802.11g 12 Mbps at channel 6

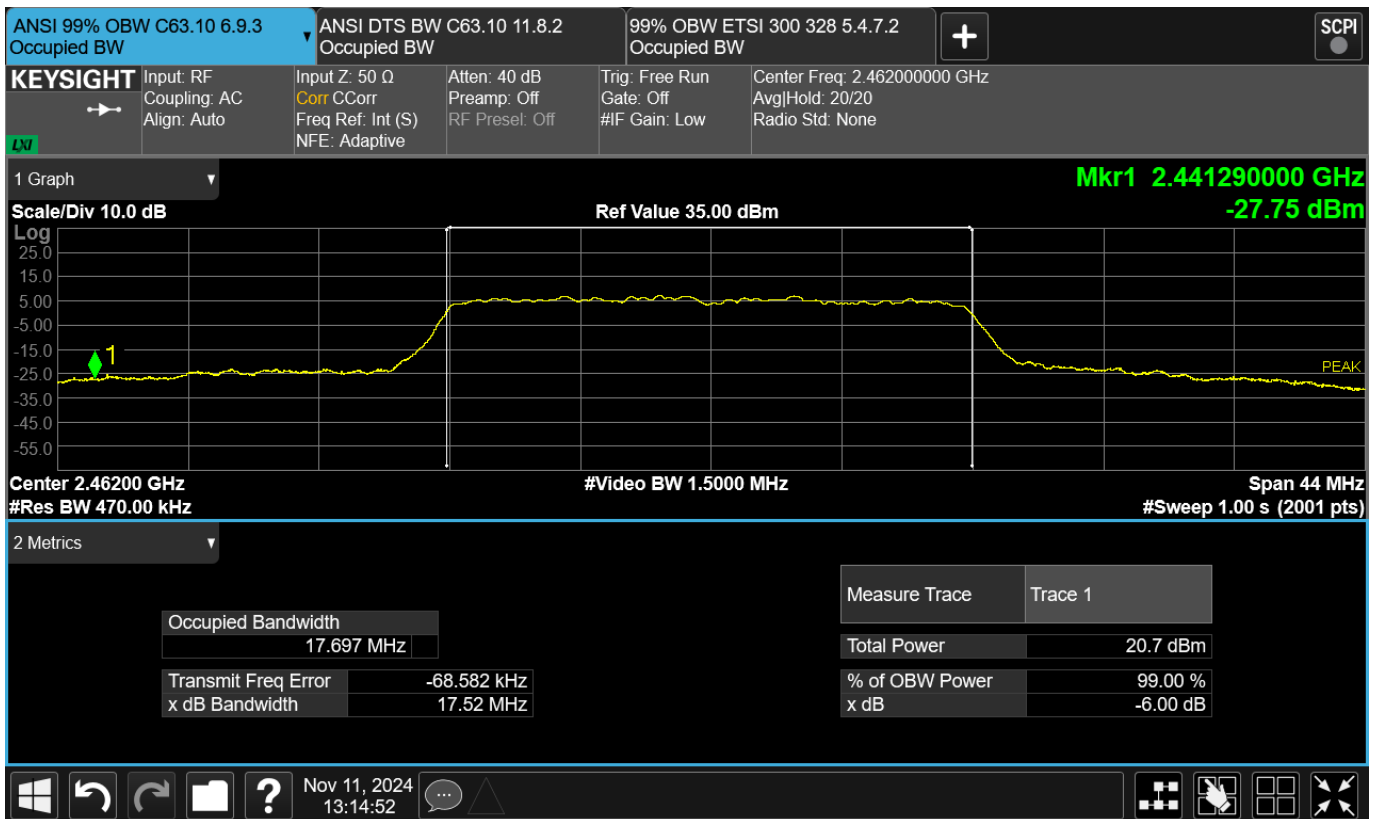


Figure TR10.6: Occupied bandwidth data for 802.11n MCS1 at channel 1

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, ANT, and IEEE 802.11b WiFi. However, they differ for IEEE 802.11g and 11n systems because the Canadian TRC-43 standard provides different analysis methods for Orthogonal Frequency Division Multiplexing systems (OFDM). The tables below will show the analysis for most of the radios signals as a combined approach, then separately analyze the results for IEEE 802.11g and n systems. The tables below may include radio protocols that are not part of the product being evaluated.

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

$$B_N = BCK$$

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

Table TR10.100: Necessary Bandwidth for NFC

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

$$B_N = 2R / \log_2(S)$$

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

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

Table TR10.101: Necessary Bandwidth for ANT and ANT+ Radio Protocols (FCC and TRC-43)

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

Table TR10.102: Necessary Bandwidth for Bluetooth Radio Protocols (FCC and TRC-43)

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

Table TR10.103: Necessary Bandwidth for IEEE 802.11 b Radio Protocol (FCC and TRC-43)

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

Table TR10.104: Necessary Bandwidth for IEEE 802.11 a, g, n, and ac 20 MHz Radio Protocols (FCC)

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

Table TR10.105: Necessary Bandwidth for IEEE 802.11 n and ac 40 MHz Radio Protocols (FCC)

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

The TRC-43 method for OFDM signals simply multiplies the number of subcarriers, K, and the subcarrier spacing, N_s. In both cases, 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 TR10.106: Necessary Bandwidth for IEEE 802.11 a, g, n, and ac Radio Protocols (TRC-43)

This line is the end of the test record.

Page 26 of 98	GCL Test Report 2024-191	Version A
This report may be reproduced in whole. Reproduction of parts or excerpts requires lab management approval.		
Garmin		

Test Record
Transmitter Power, Duty Cycle
Test IDs TR02, TR03, TR46
Project GCL0425

Test Date(s) 7, 19 Nov 2024
Test Personnel Aditya Prakash, Majid Farah

Product Model A04712
Serial Number 3488107722

Operating Mode M3 (BleTx), M5 (AntTx)
Arrangement A1 (Solo)
Input Power Internal battery

Test Standards: FCC Part 15, ANSI C63.10, ETSI EN 300 328, RSS-GEN, RSS-247 (as noted in Section 6 of the report).

Antenna Gain -2.78 dBi, as reported by the client
Radio Protocol Bluetooth Low Energy, ANT
Hopping Frequencies 40 for BT-LE

Pass/Fail Judgment: PASS

Test record created by: Aditya Prakash, Vladimir Tolstik
Date of this record: 02 Dec 2024

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
RF Power Sensor	Rohde&Schwarz	NRP8S	109124	18-Jul-2023	15-Jul-2025
Thermometer	Thermco	ACCD370P	210607316	21-Sep-2023	15-Sep-2025
Thermal Chamber	Tenney	T2RC	32774-02	Calibration	Not Required
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	27-Jun-2024	27-Jun-2025

Table TR02.1: List of test equipment used

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

Test Method

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

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

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

Transmit Power and Timing Data

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

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

ANSI Power

Frequency	(MHz)	2402	2404	2440	2478	2480
BT Low Energy	1 Mbps	-0.98	NT	3.60	NT	-2.09
BT Low Energy	2 Mbps	NT	3.42	3.25	-2.01	NT
ANT	----	-0.50	NT	3.61	NT	-2.09

Table TR02.2: Transmit Power, ANSI method, in dBm

The following figures show the gate settings used for the test cases highlighted in yellow in Table TR02.2. Gate setting diagrams may not be included for radio modes where the duty cycle reported in Table TR02.6 below is greater than 98%, since ANSI C63.10 treats these as continuous transmissions.



Figure TR02.1: Gate setting diagram for BLE Radio, 1 Mbps modulation, 2440 MHz



Figure TR02.2: Gate setting diagram for ANT Radio, 2440 MHz

ETSI Power

Frequency	(MHz)	2402	2404	2440	2478	2480
BT Low Energy	1 Mbps	-3.76	NT	0.82	NT	-4.87
BT Low Energy	2 Mbps	NT	0.64	0.47	-4.79	NT
ANT	----	-3.28	NT	0.83	NT	-4.86

Table TR02.3: Transmit Power, ETSI method, in dBm EIRP

The ETSI method also requires that transmit power be verified for stability at the extremes of operating temperature. The ANT transmitter was verified for power stability vs temperature on 2440 MHz.

Tx Mode	Temp	Power	Limit
	°C	dBm EIRP	dBm EIRP
ANT	60	0.14	20
ANT	20	0.27	20
ANT	-20	0.82	20

Table TR02.4: Transmit Power over temperature, ETSI method, in dBm EIRP

Other Power Analyses

Frequency	(MHz)	2402	2404	2440	2478	2480
BT Low Energy	1 Mbps	0.80	NT	2.29	NT	0.62
BT Low Energy	2 Mbps	NT	2.20	2.11	0.63	NT
ANT	----	0.89	NT	2.30	NT	0.62

Table TR02.5: Transmit Power, RF exposure method, in mW

Frequency	(MHz)	2402	2404	2440	2478	2480
BT Low Energy	1 Mbps	100%	NT	100%	NT	100%
BT Low Energy	2 Mbps	NT	100%	100%	100%	NT
ANT	----	100%	NT	100%	NT	100%

Table TR02.6: Duty cycle for each radio mode

Setup Diagram

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

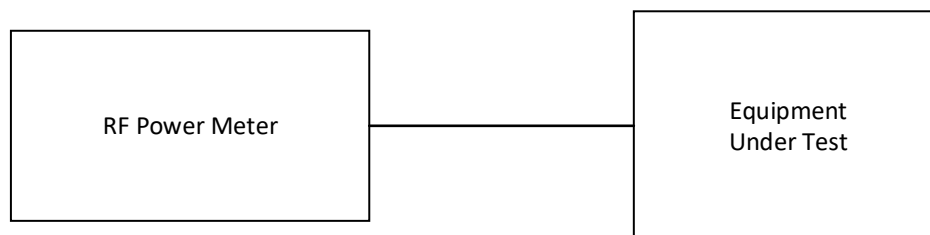


Figure TR02.3: Test equipment setup

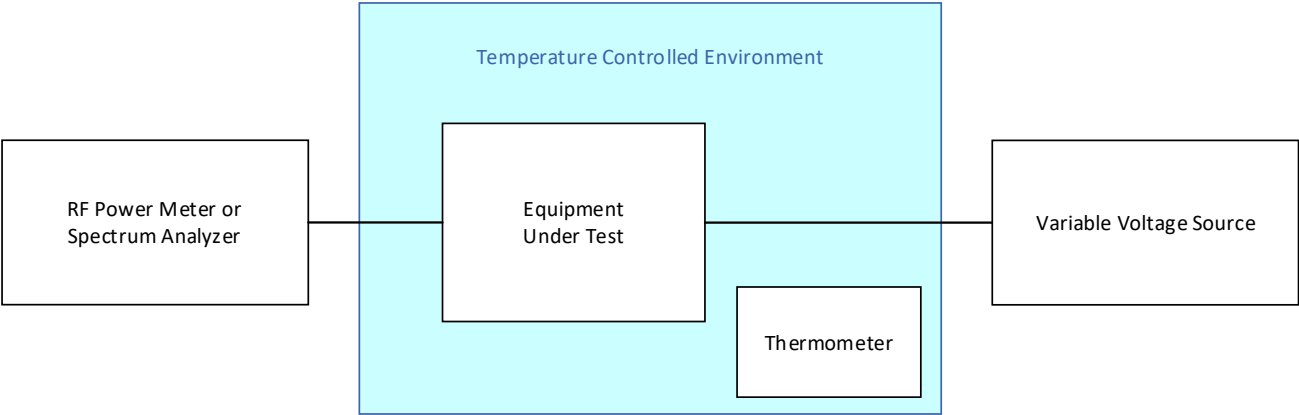


Figure TR02.4: Test equipment setup transmit power over temperature

This line is the end of the test record.

Test Record

Transmitter Power, Duty Cycle, Timing, Medium Utilization

Test IDs TR05

Project GCL0425

Test Date(s) 7 Nov 2024
Test Personnel Aditya Prakash

Product Model A04712
Serial Number 3488107722

Operating Mode M7 (WiFiTx)
Arrangement A1 (Solo)
Input Power Internal battery

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

Antenna Gain -2.78 dBi, as reported by the client
Radio Protocol IEEE 802.11b/g/n

Pass/Fail Judgment: PASS

Test record created by: Aditya Prakash
Date of this record: 8 November 2024

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; TimePowerAnalysisSpreadsheetv12a.xls

Test Method

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

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

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

Transmit Power and Timing Data

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

This test record will show results based on one or more of the following methods of analyzing the same set of raw power data vs. time. The ANSI peak power method looks for the highest power in the data record, with results in dBm units. The ANSI gated average power method determines the average power in the data record but only during times when the transmitter is keyed on, with results in dBm units. Under the US and Canadian rules a limit of 30 dBm is applied independent of which ANSI method is used.

Page 31 of 98	GCL Test Report 2024-191	Version A
This report may be reproduced in whole. Reproduction of parts or excerpts requires lab management approval.		
Garmin		

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 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	15.85	15.86	16.08
B	2	NT	15.67	NT
B	5.5	NT	15.60	NT
B	11	NT	15.31	NT
G	6	15.88	17.04	12.35
G	9	NT	16.94	NT
G	12	NT	16.94	NT
G	18	NT	15.43	NT
G	24	NT	14.27	NT
G	36	NT	10.83	NT
G	48	NT	9.08	NT
G	54	NT	9.06	NT
N	MCS0	NT	13.78	NT
N	MCS1	15.80	14.08	12.58
N	MCS2	NT	14.06	NT
N	MCS3	NT	12.97	NT
N	MCS4	NT	11.29	NT
N	MCS5	NT	9.39	NT
N	MCS6	NT	9.43	NT
N	MCS7	NT	7.82	NT

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

The following figures show the gate settings used for the test cases highlighted in yellow in Table TR05.2. Gate setting diagrams may not be included for radio modes where the duty cycle reported in Table TR05.6 below is greater than 98%, since ANSI C63.10 treats these as continuous transmissions.

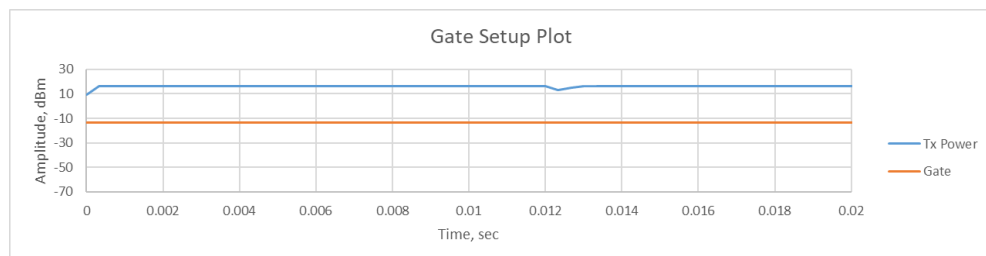


Figure TR05.1: Gate setting diagram for IEEE 802.11b 1 Mbps modulation, Channel 11

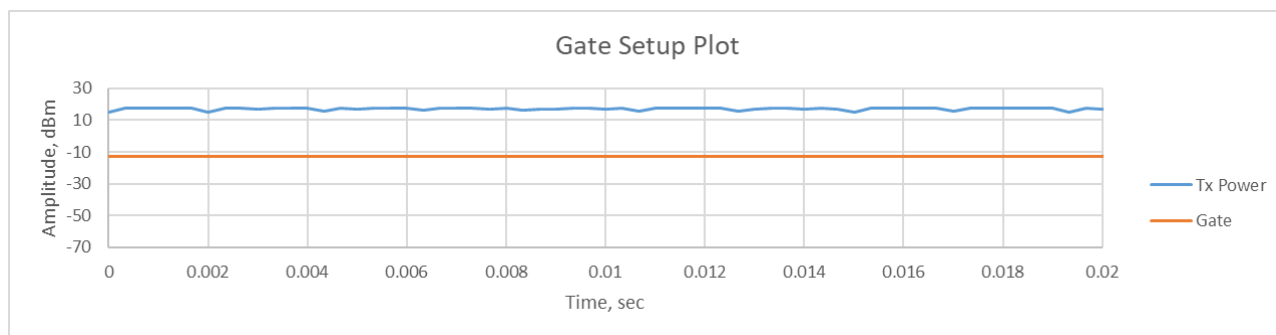


Figure TR05.2: Gate setting diagram for IEEE 802.11g 6 Mbps modulation, Channel 6

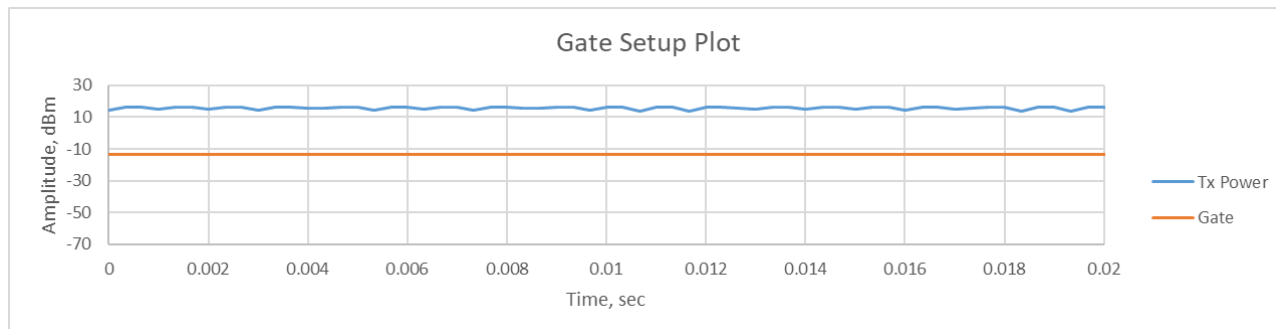


Figure TR05.3: Gate setting diagram for IEEE 802.11n MCS1 modulation, Channel 1

Other Power Analyses

Mode	Speed	1	6	11	13
B	1	38.41	38.57	40.55	NT
B	2	NT	36.86	NT	NT
B	5.5	NT	36.31	NT	NT
B	11	NT	33.94	NT	NT
G	6	38.76	50.58	17.11	NT
G	9	NT	49.44	NT	NT
G	12	NT	49.46	NT	NT
G	18	NT	34.93	NT	NT
G	24	NT	26.75	NT	NT
G	36	NT	12.09	NT	NT
G	48	NT	8.09	NT	NT
G	54	NT	8.04	NT	NT
N	MCS0	NT	23.90	NT	NT
N	MCS1	37.98	25.56	17.95	NT
N	MCS2	NT	25.46	NT	NT
N	MCS3	NT	19.81	NT	NT
N	MCS4	NT	13.45	NT	NT
N	MCS5	NT	7.81	NT	NT
N	MCS6	NT	8.77	NT	NT
N	MCS7	NT	6.03	NT	NT

Table TR05.3: Transmit Power, RF exposure method, in mW

Mode	Speed	1	6	11
B	1	100.0%	100.0%	100.0%
B	2	NT	100.0%	NT
B	5.5	NT	100.0%	NT
B	11	NT	100.0%	NT
G	6	100.0%	100.0%	100.0%
G	9	NT	100.0%	NT
G	12	NT	100.0%	NT
G	18	NT	100.0%	NT
G	24	NT	100.0%	NT
G	36	NT	100.0%	NT
G	48	NT	100.0%	NT
G	54	NT	100.0%	NT
N	MCS0	NT	100.0%	NT
N	MCS1	100.0%	100.0%	100.0%
N	MCS2	NT	100.0%	NT
N	MCS3	NT	100.0%	NT
N	MCS4	NT	100.0%	NT
N	MCS5	NT	88.3%	NT
N	MCS6	NT	100.0%	NT
N	MCS7	NT	100.0%	NT

Table TR05.4: Duty cycle for each radio mode

Setup Diagram

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

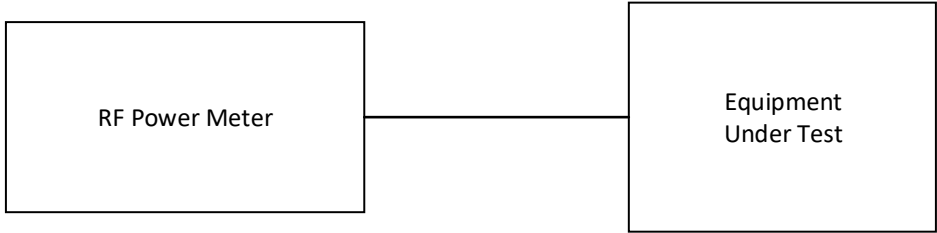


Figure TR05.51: Test equipment setup

This line is the end of the test record.

Test Record

Conducted Spurious Emissions Test TR27, TR28, TR29 Project GCL0425

Test Date(s) 16 Nov 2024
Test Personnel Majid Farah

Product Model A04712
Serial Number tested 3488107722

Operating Mode M3 (BleTx), M5 (AntTx), M7 (WiFiTx)
Arrangement A1 (Solo)
Input Power Battery

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

Pass/Fail Judgment: PASS

Test record created by: Vladimir Tolstik
Date of this test record: 19 Nov 2024

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44 GHz	Keysight	N9048B	MY62220139	21-Oct-2024	21-Oct-2025

Table TR27.1: Test equipment used

Software used: Keysight PXE software A.33.03,

Test Method

The basic test standards provide options for the test method. The following test methods were applied.
ANSI C63.10: 11.11.2 and 11.11.3

Test Setup

This block diagram shows the test equipment setup.

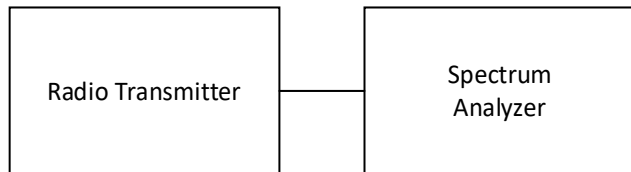


Figure TR27.1: Test setup

Test Data

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

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

Data is collected using the required detector function(s) across the frequency range. The instrument uses a 100 kHz bandwidth detector at half-bandwidth intervals to ensure overlapping measurements. For very wide spectra, this may be done by subranges. The data sets are saved for later analysis.

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

For BLE operating at 2 Mbps, the lowest operating frequency was 2404 MHz, and the highest operating frequency was 2478 MHz. For BLE, operating at 1 Mbps, the lowest operating frequency was 2402 MHz, and the highest operating frequency was 2480 MHz.

The peak level of the fundamental is also identified. For many standards, the harmonics must be reduced from this fundamental level by a 30 decibel ratio. This harmonic limit is calculated and used to determine compliance. Positive margin indicates that the result is compliant. The minimum margin from the peak level for each mode are highlighted in yellow.

Data plots are provided for the worst-case data sets. One plot shows the spectrum at the carrier, and another shows the spectrum across the band. On this second plot, a green reference line is at approximately the 30 dBc maximum spurious emission level.

		2402 (04)	2440	2480 (78)
BLE	1 Mb	48.25	48.59	43.62
BLE	2 Mb	53.70	49.30	41.59
ANT		48.56	48.75	42.33

Table TR27.2: Results Summary for BLE 1 Mbps, BLE 2 Mbps and ANT

	Ch1	Ch6	Ch11
B1	50.75	50.84	50.91
G6	50.04	50.91	46.87
NMCS1	49.77	48.52	46.18

Table TR27.3: Results Summary for IEEE 802.11b/g/n

The graphs below show the spectral data as continuous curves. Superimposed are the harmonic data points reported in the table above. The harmonic limit line is included as a reference.

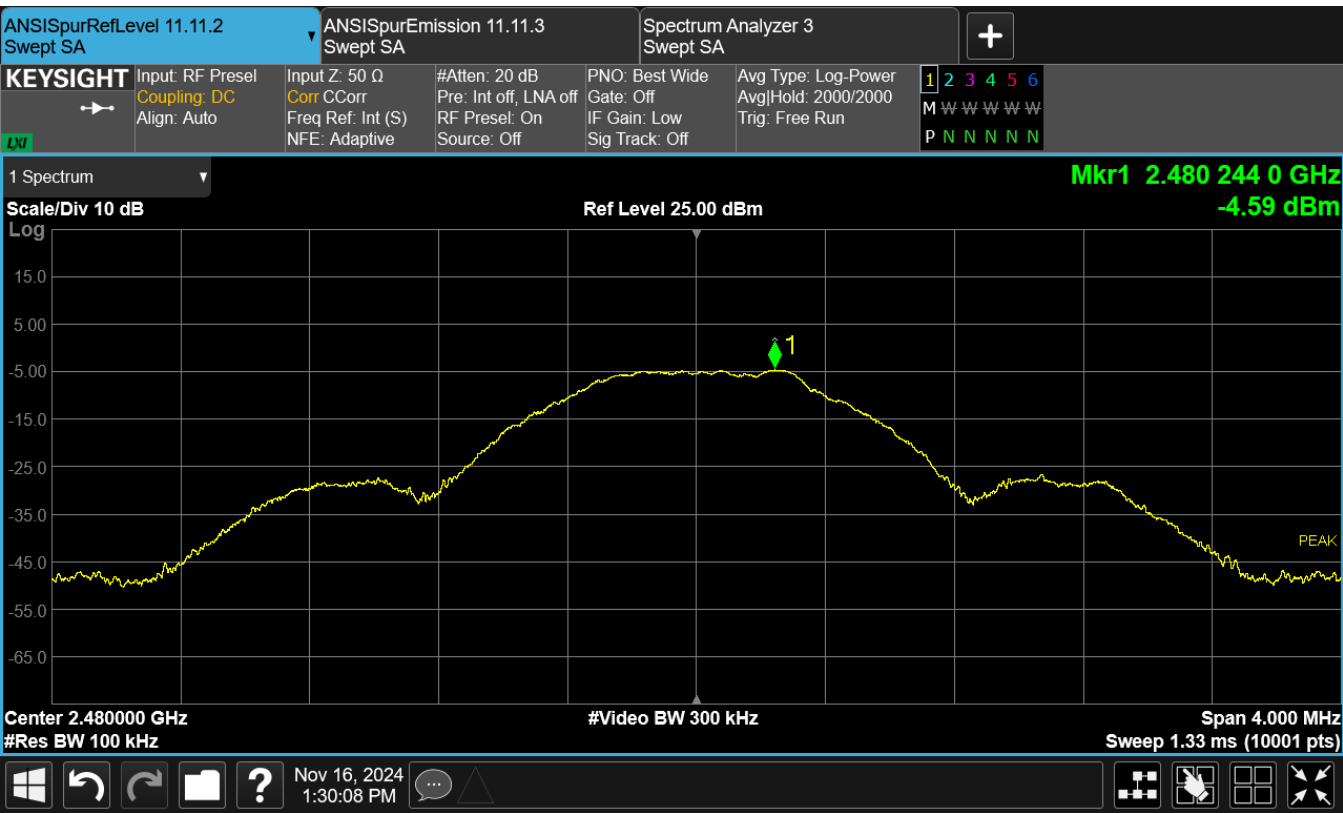


Figure TR27.2: Reference level measurement for BLE 1 Mbps at 2480 MHz

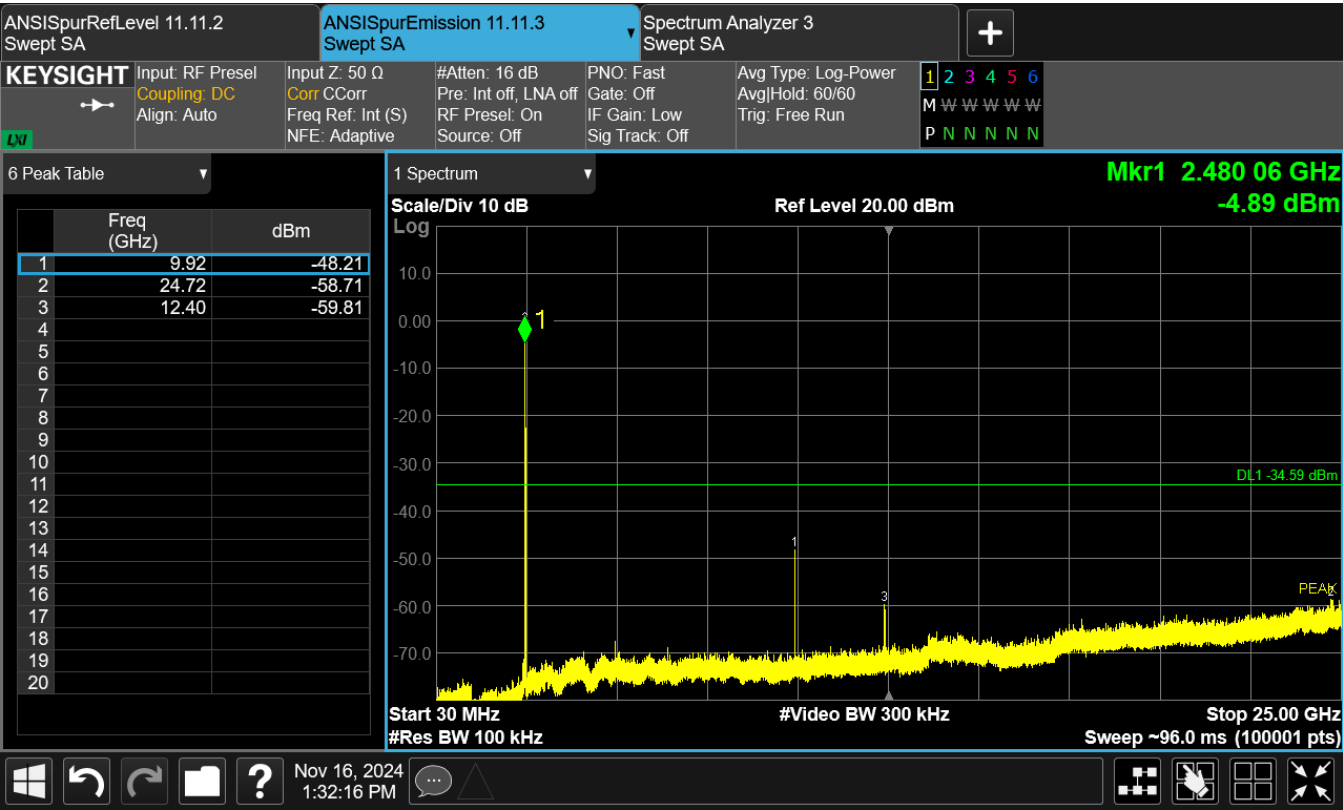


Figure TR27.3: Spectral data for BLE 1 Mbps at 2480 MHz

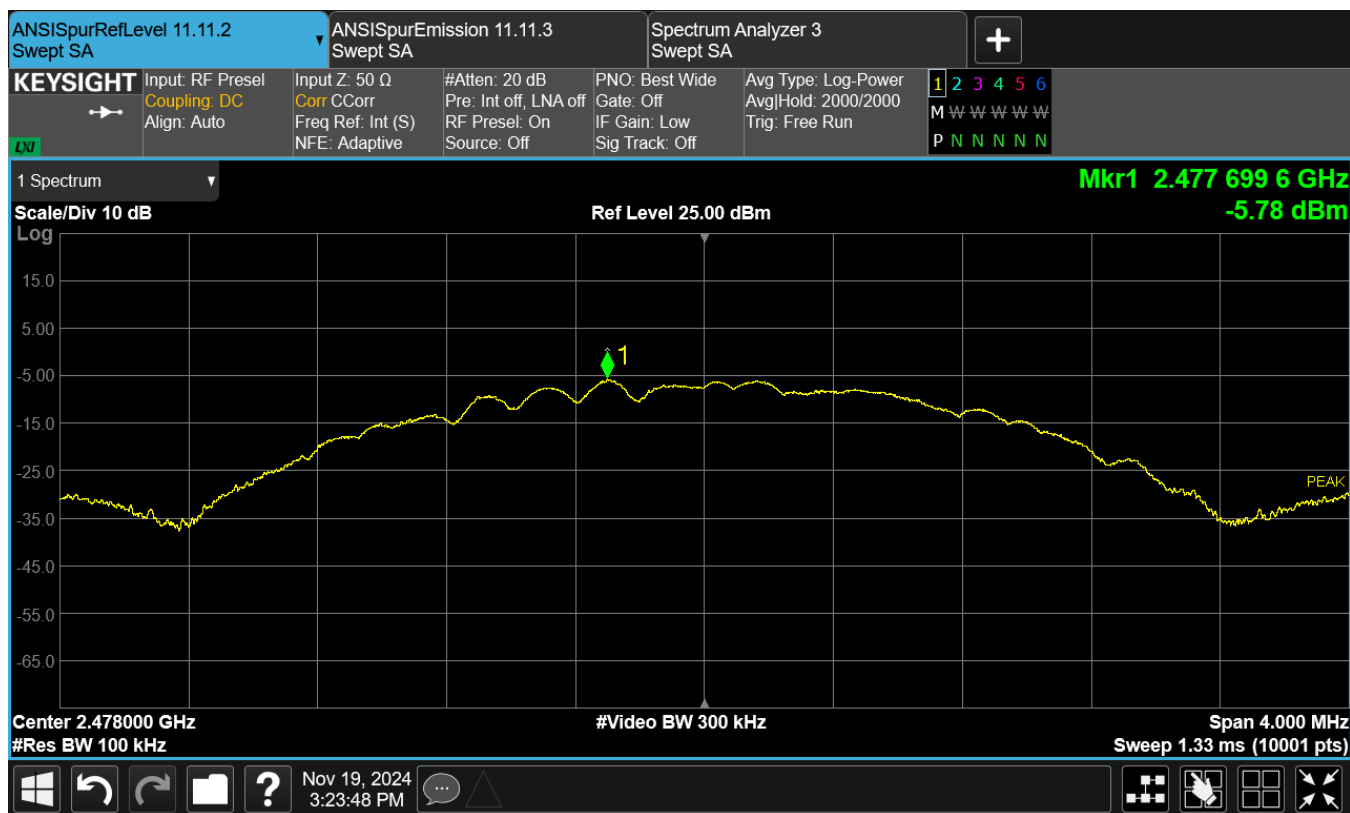


Figure TR27.4: Reference level measurement for BLE 2 Mbps at 2478 MHz

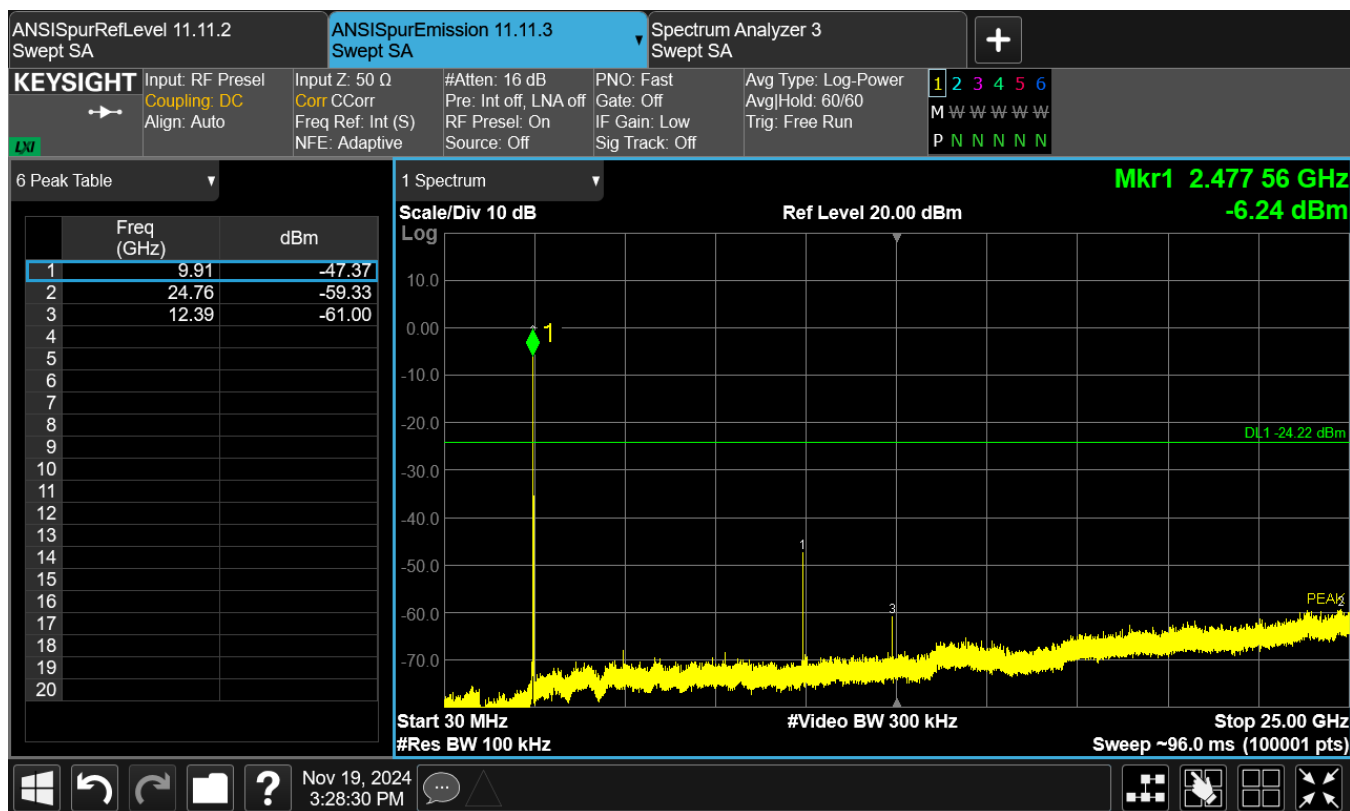


Figure TR27.5: Spectral data for BLE 2 Mbps at 2478 MHz

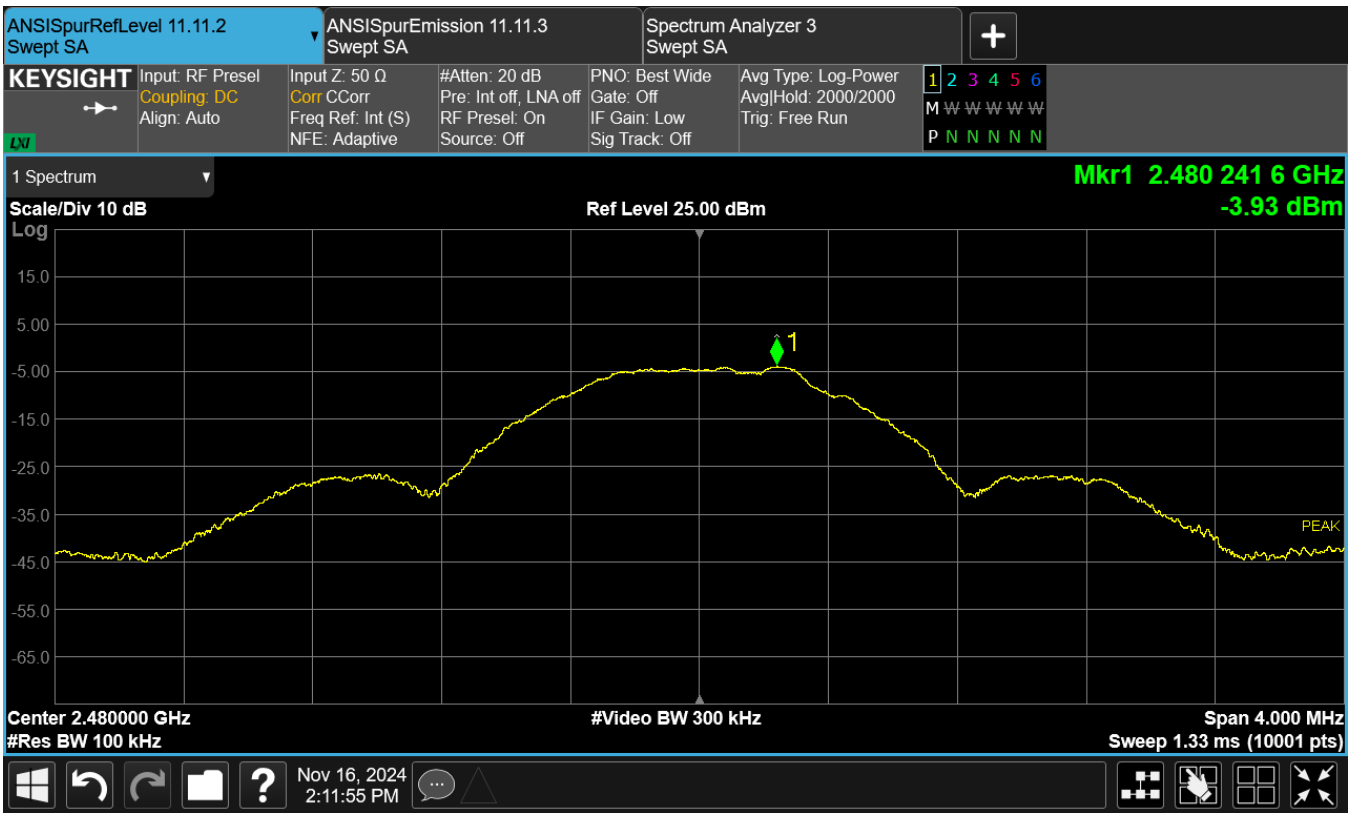


Figure TR27.6: Reference level measurement for ANT at 2480 MHz

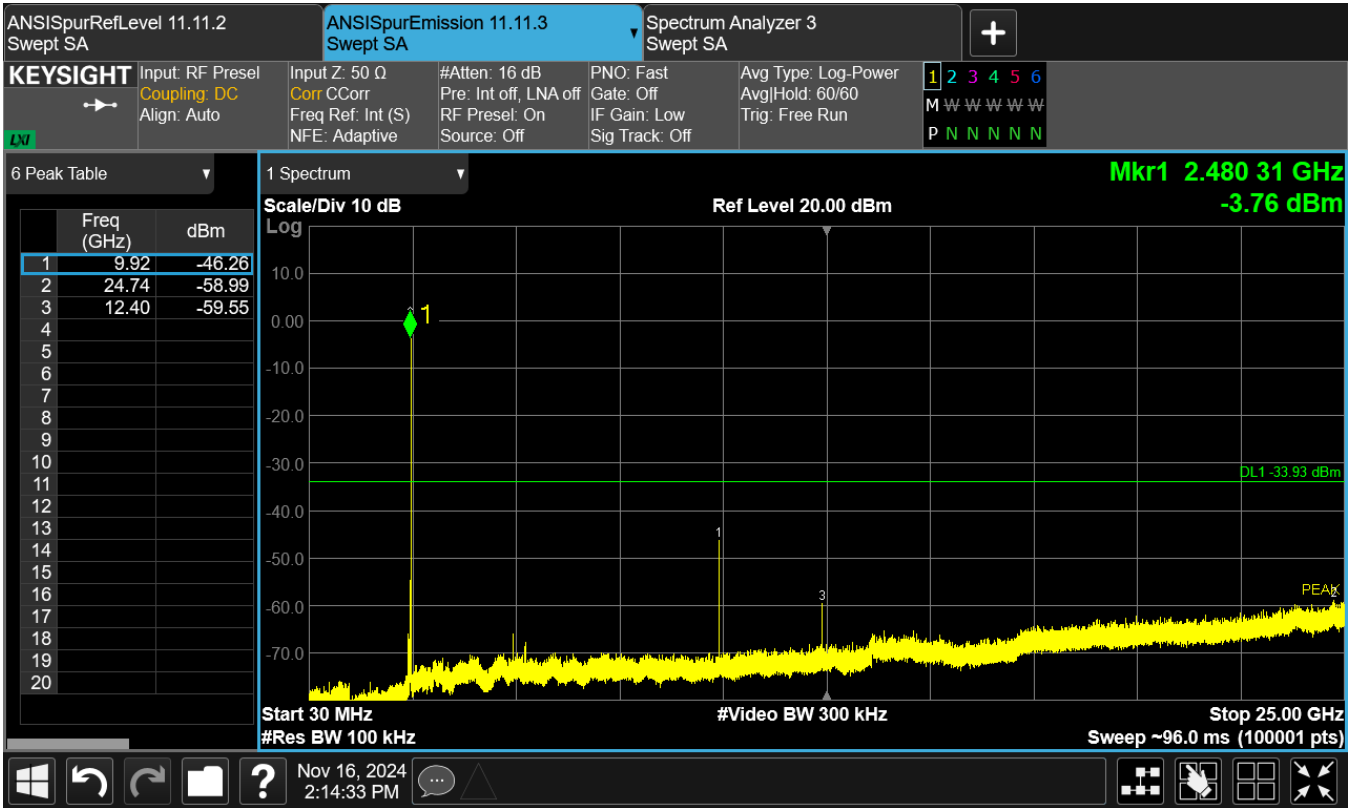


Figure TR27.7: Spectral data for ANT at 2480 MHz

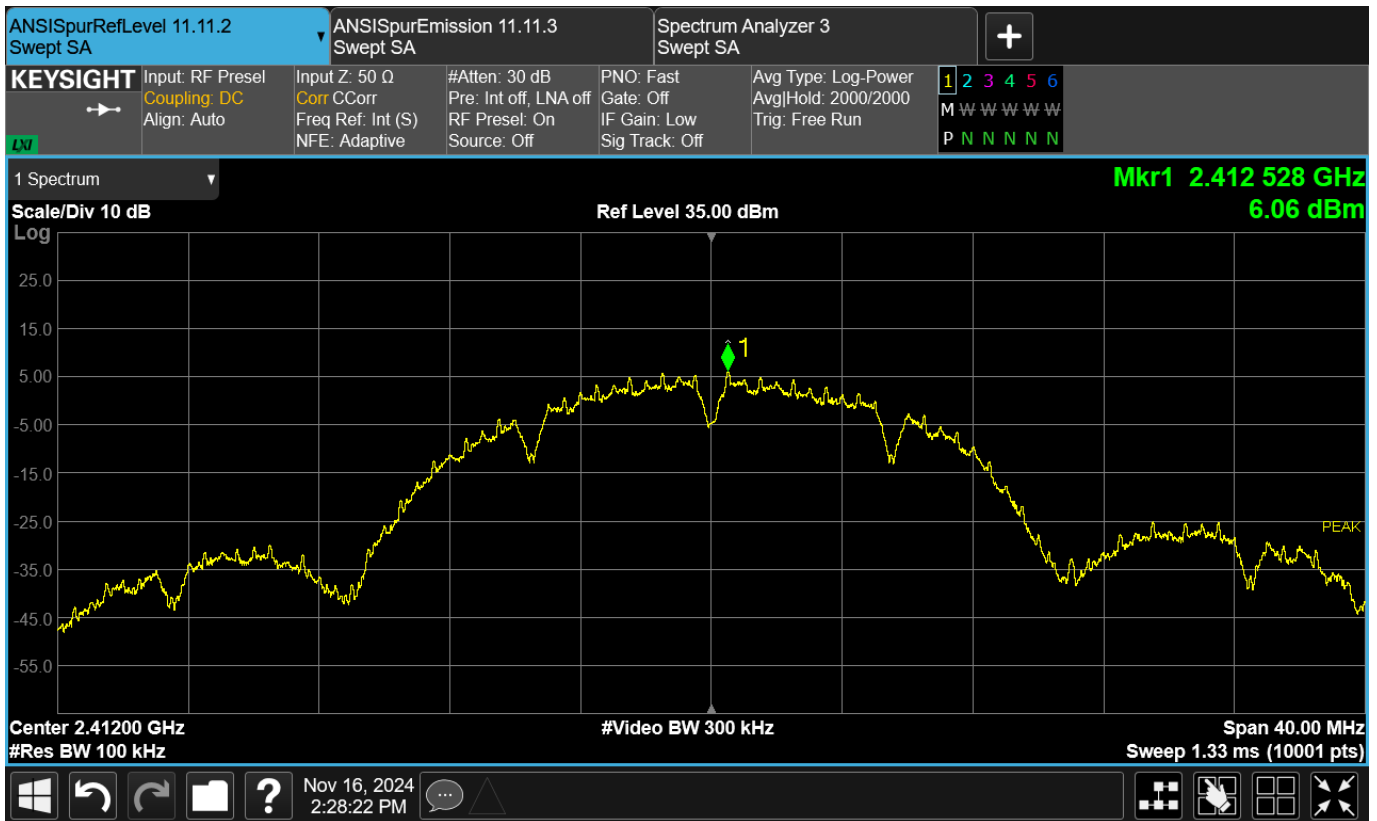


Figure TR27.8: Reference level measurement for IEEE 802.11 B 1 Mbps at 2412 MHz

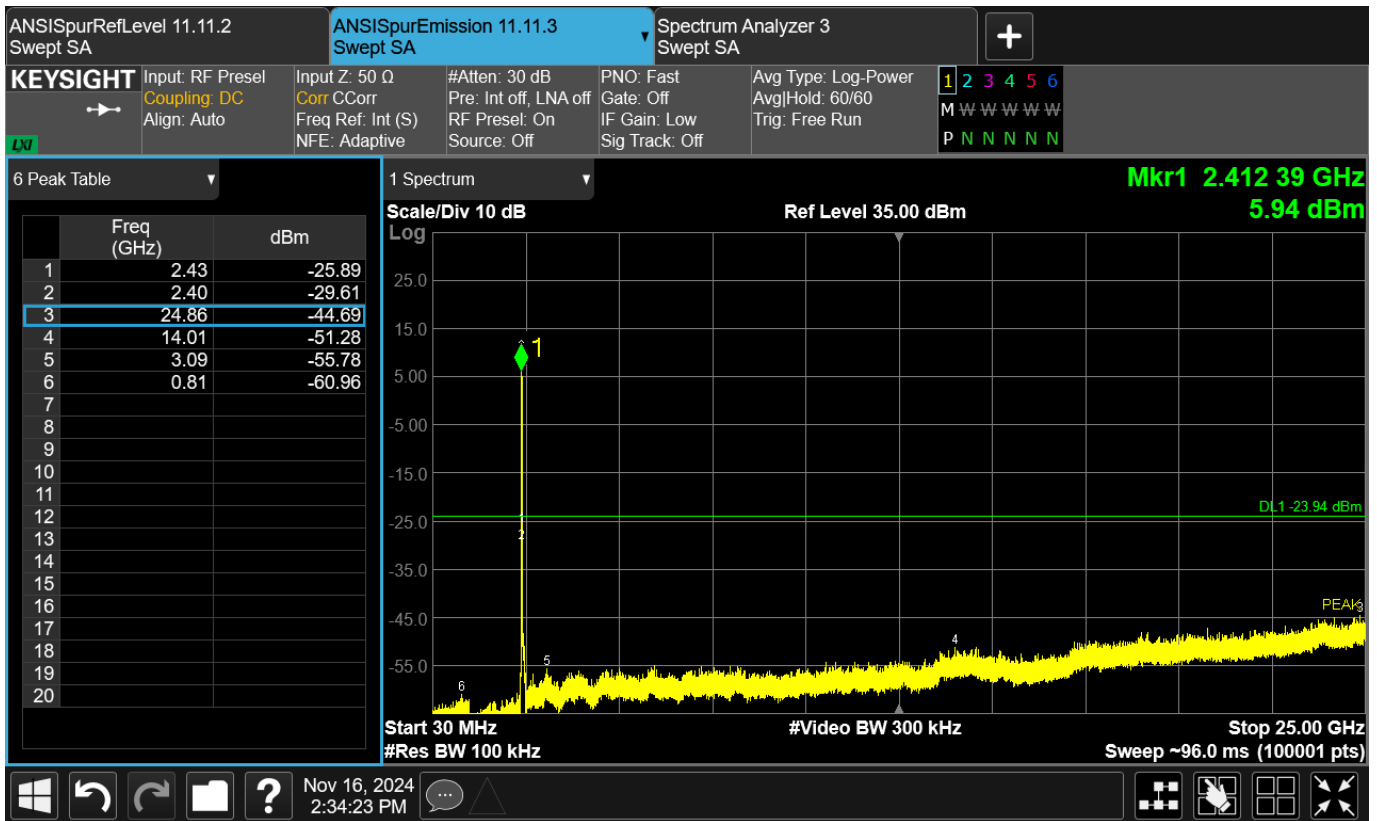


Figure TR27.9: Spectral data for IEEE 802.11 B 1 Mbps at 2412 MHz

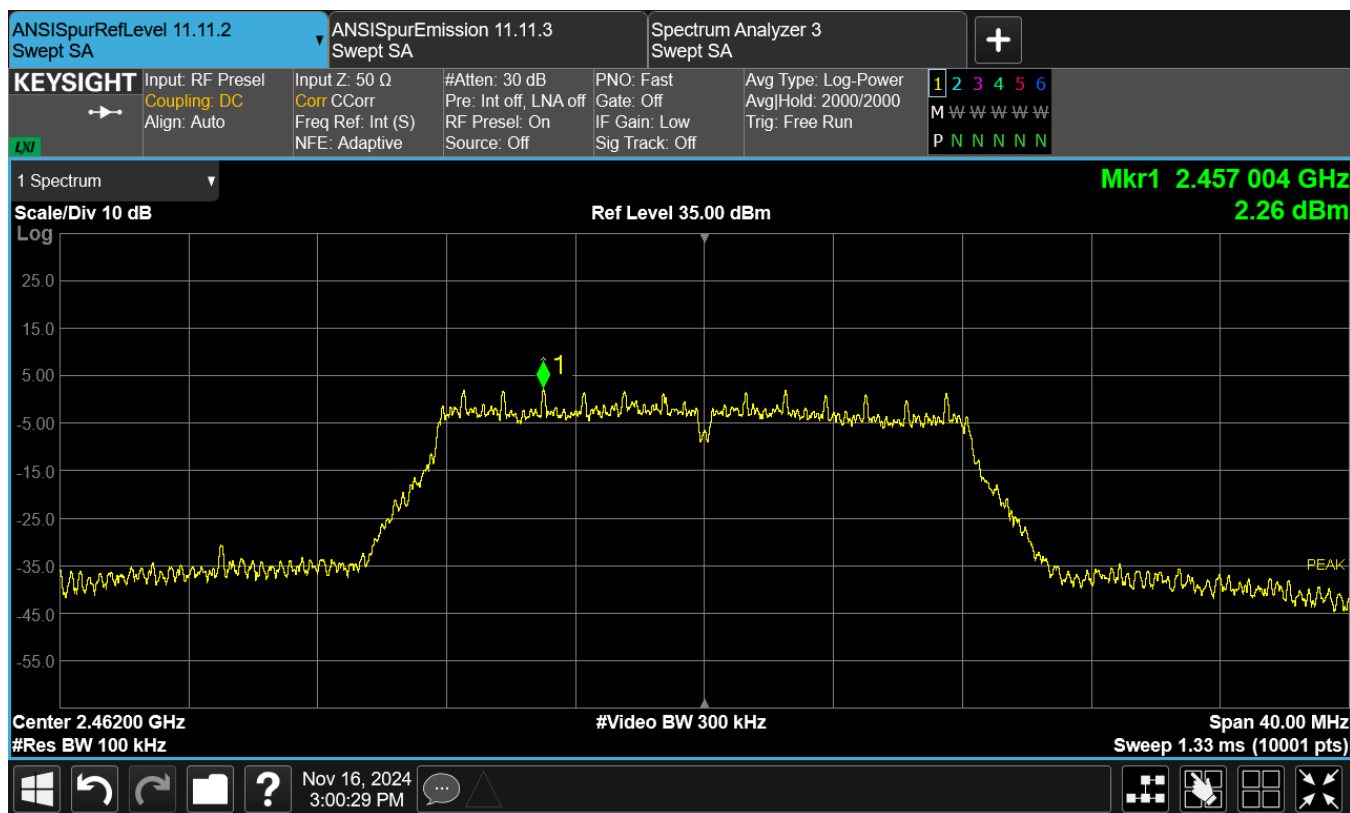


Figure TR27.10: Reference level measurement for IEEE 802.11 G 6 Mbps at 2462 MHz

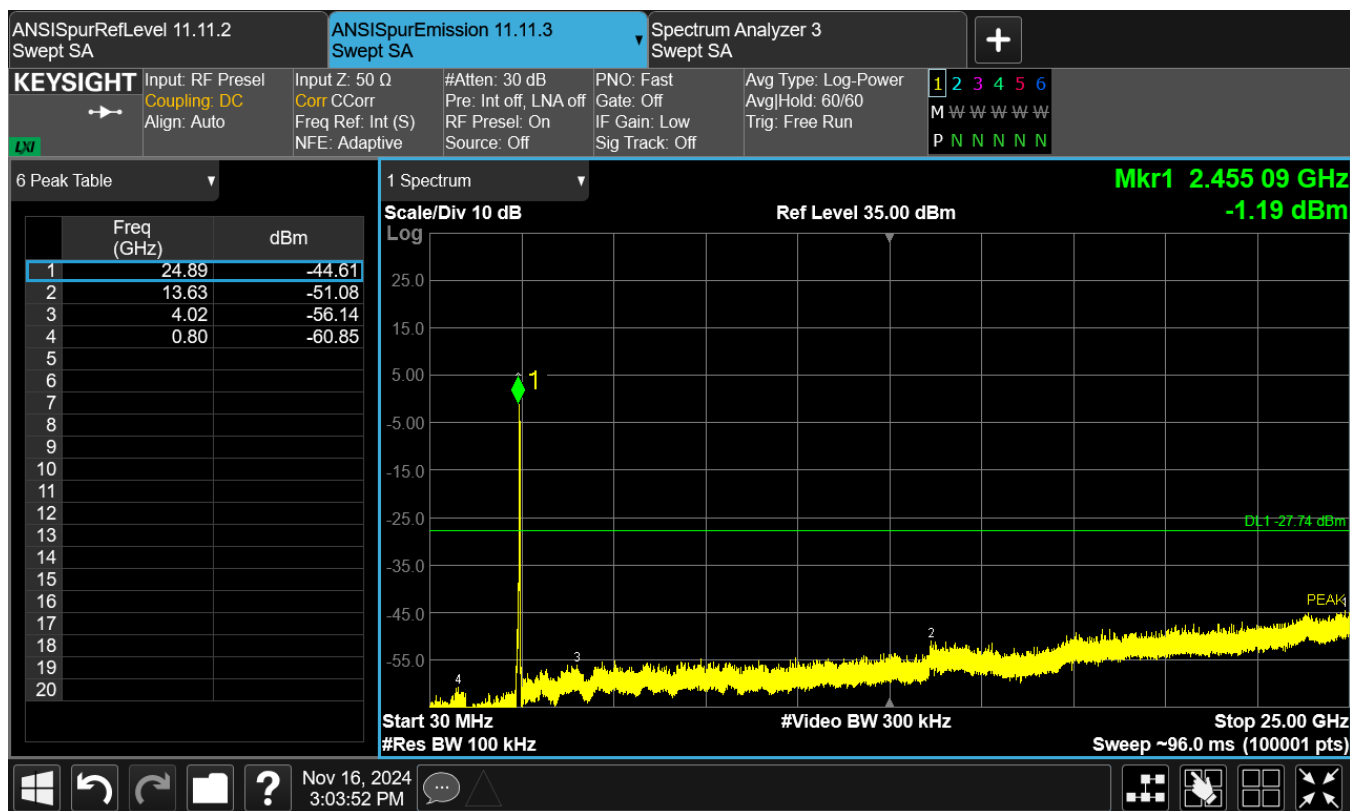


Figure TR27.11: Spectral data for IEEE 802.11 G 6 Mbps at 2462 MHz

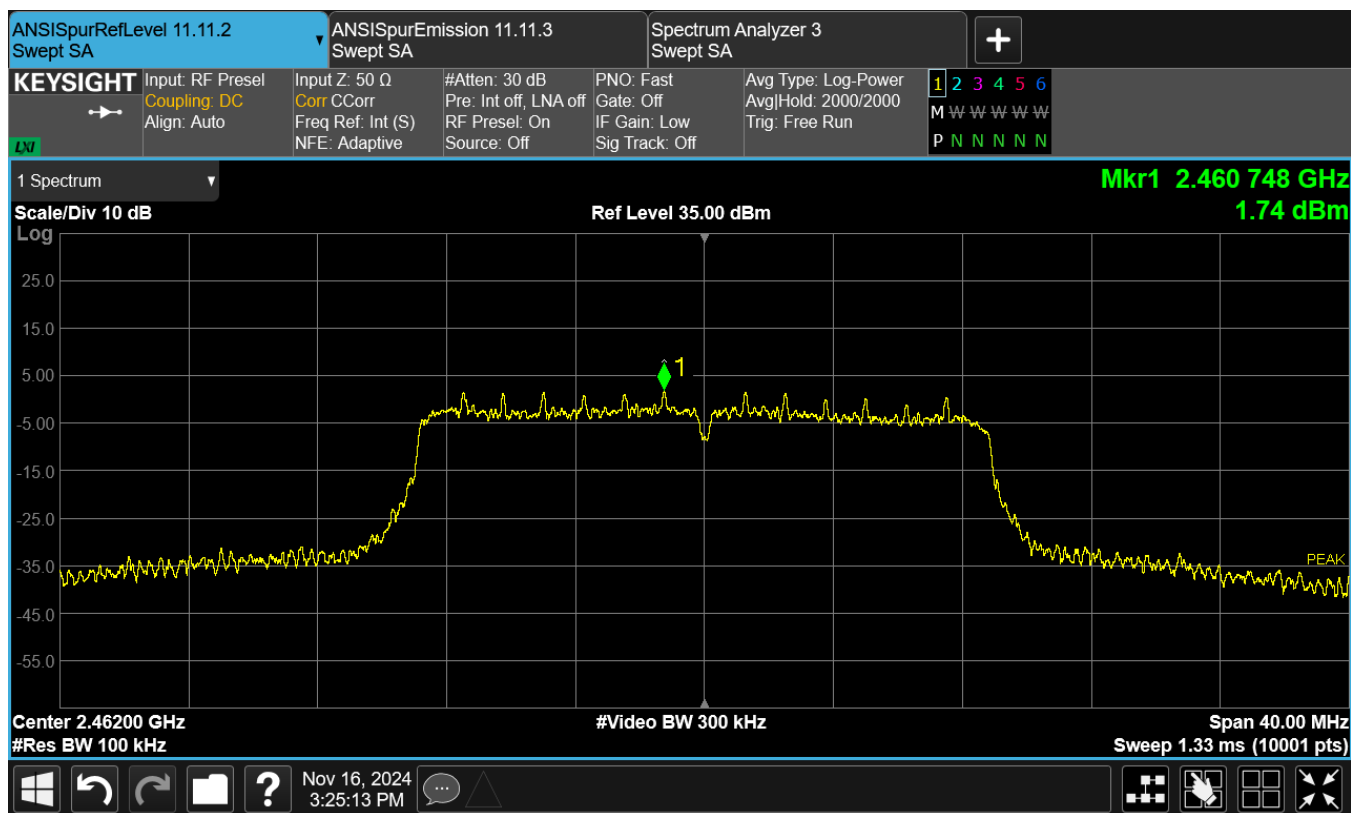


Figure TR27.12: Reference level measurement for IEEE 802.11 NMCS1 at 2462 MHz

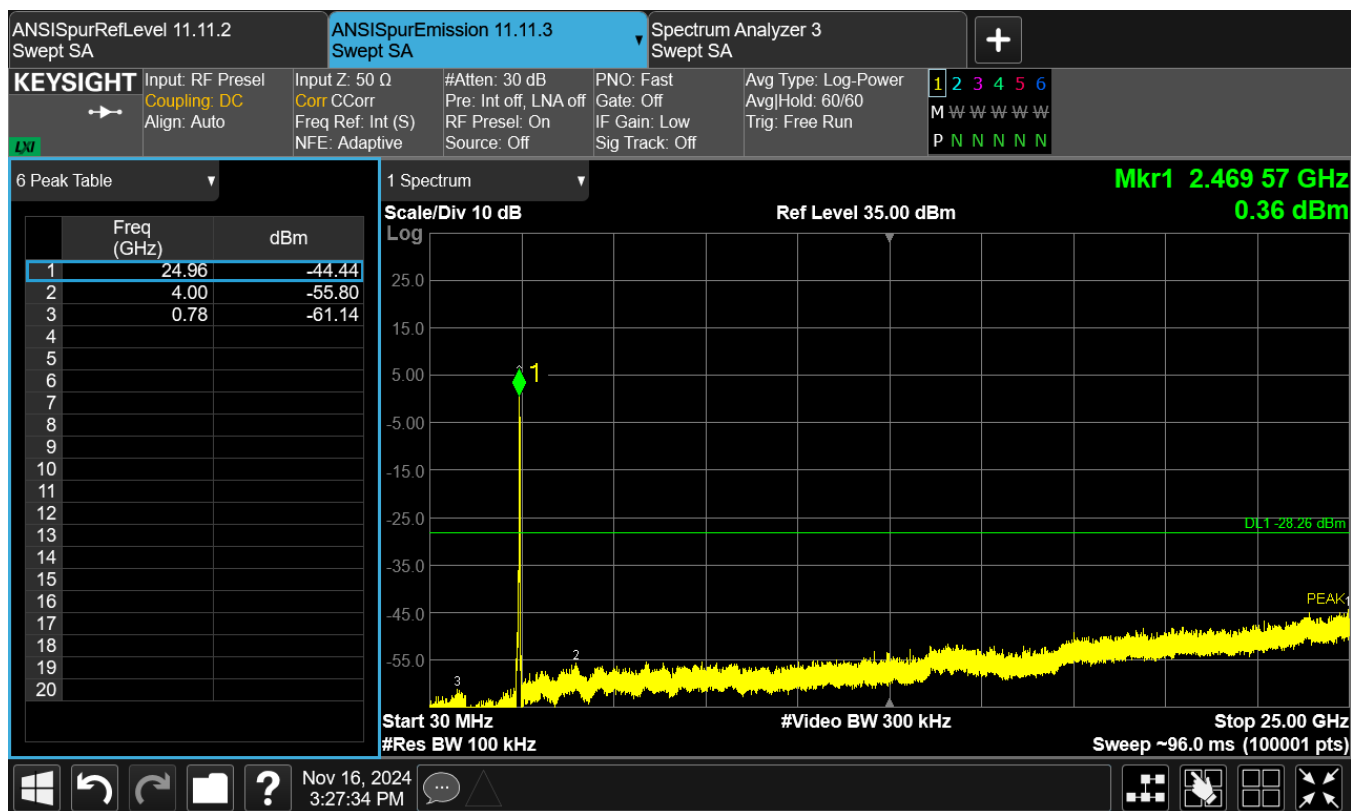


Figure TR27.13: Spectral data for IEEE 802.11 NMCS1 at 2462 MHz

This line is the end of the test record.

Test Record

Radiated Emission Test RE26

Project GCL0425

Test Date(s) 27 Nov 2024
Test Personnel David Kerr

Product Model A04712
Serial Number tested 3488107710

Operating Mode M5 (AntTx) (2402 MHz)
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: 27 Nov 2024

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	174	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	Crecent Lufkin	L1135CME-02	GMN0013784	26-Jun-2024	26-Jun-2027

Table RE26.1: 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 is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

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

Freq.	Level	Detector	Limit	Margin	Peak Level	Pk Limit	Pk Margin	Antenna	Table
MHz	dBuV/m	Type	dBuV/m	dB	dBuV/m	dBuV/m	dB	Orientation	Azimuth, deg
0.04865	32.50	Avg	113.86	81.36	40.99	133.86	92.87	Y	-177

Table RE26.2: Emission summary

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

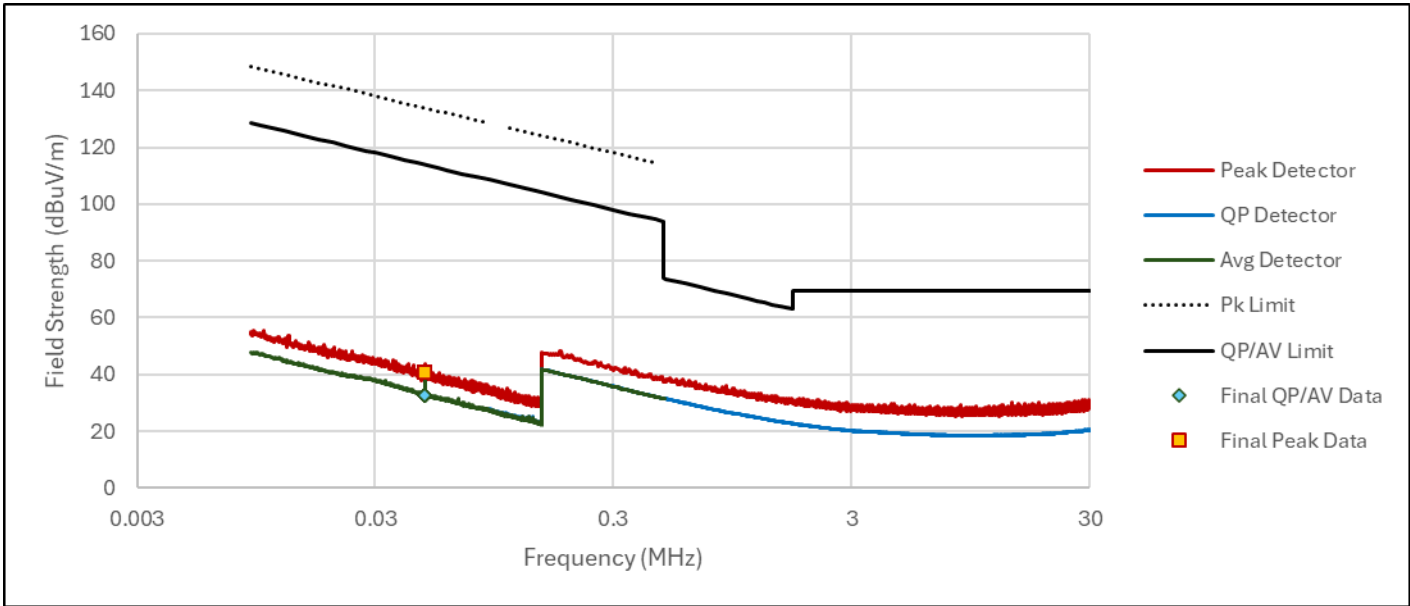


Figure RE26.1: Spectral data

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE26.2: EUT test setup, first view (EUT Y Orientation)

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE26.3: EUT test setup, second view (Antenna Y Orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE27
Project GCL0425

Test Date(s) 26 Nov 2024
Test Personnel David Kerr

Product Model A04712
Serial Number tested 3488107710

Operating Mode M5 (AntTx) (2402MHz)
Arrangement A2 (Upwr)
Input Power USB 5 Vdc

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

Frequency Range: 30 MHz to 1000 MHz
Pass/Fail Judgment: PASS

Test record created by: David A Kerr
Date of this record: 26 Nov 2024

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	233201	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 RE27.1: Test Equipment Used

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

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.

Page 46 of 98	GCL Test Report 2024-191	Version A
This report may be reproduced in whole. Reproduction of parts or excerpts requires lab management approval.		
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 is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

Frequency	Pol.	Reading	Factor	Level	Limit	Margin	Height	Angle
MHz		dB(μV)	dB(1/m)	dB(μV/m)	dB(μV/m)	dB	cm	deg
		QP		QP	QP	QP		
37.800	V	9.9	18.1	28.0	40.0	12.0	100.0	0.0
47.580	V	16.6	14.1	30.7	40.0	9.3	100.0	160.0
53.730	V	14.8	13.5	28.3	40.0	11.7	100.0	169.0
143.430	H	7.8	15.7	23.5	43.5	20.0	156.5	267.0
144.510	H	7.6	15.7	23.3	43.5	20.2	147.1	80.0
210.750	V	1.1	18.4	19.5	43.5	24.0	203.6	319.0

Table RE27.2: Emission summary

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

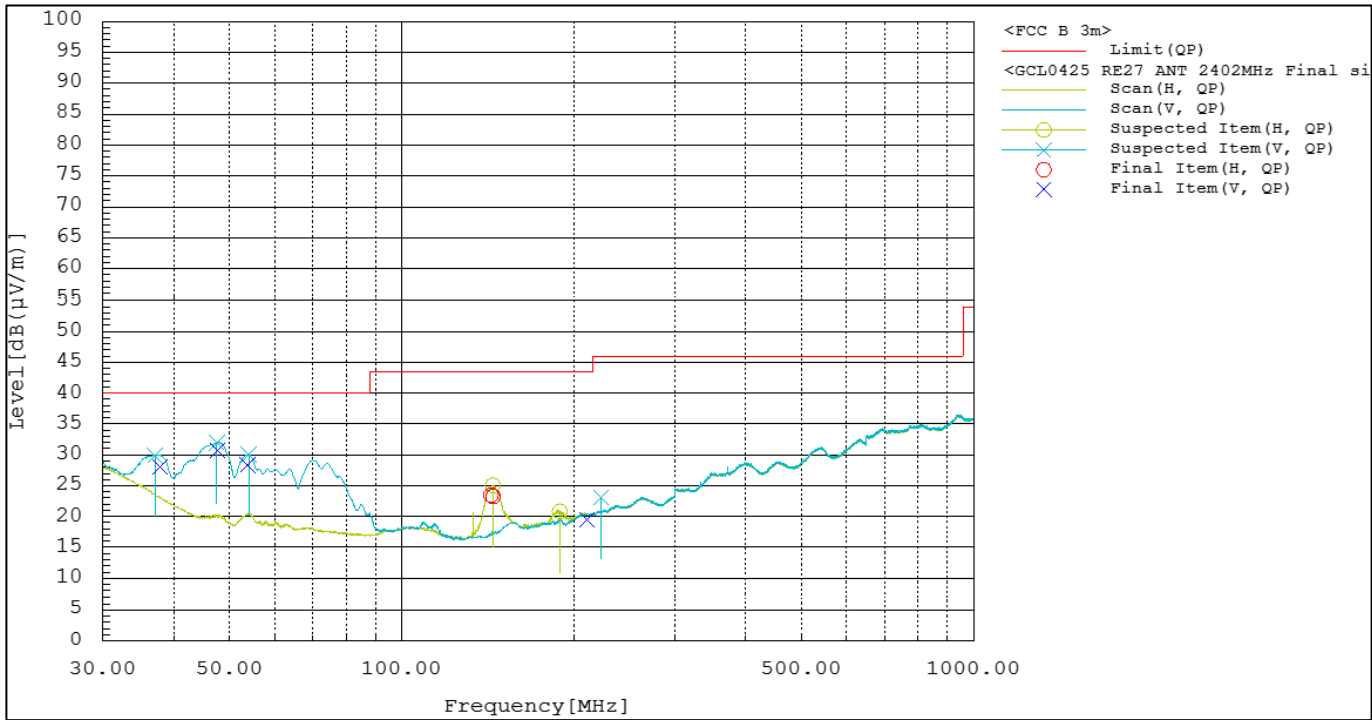


Figure RE27.1: Spectral data

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE27.2: EUT test setup, first view (Y Orientation)

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE27.3: EUT test setup, second view (Y Orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE25
Project GCL0425

Test Date(s) 19 Nov 2024
Test Personnel David Kerr

Product Model A04712
Serial Number tested 3488107710

Operating Mode M5 (AntTx) (2402MHz, 2440MHz, 2480MHz)
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: 19 Nov 2024

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	259208	30-May-2024	30-May-2026
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	7-Mar-2023	7-Mar-2026
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10721	30-Aug-2023	1-Sep-2026
Preamplifier, 500 MHz 18 GHz	Com-Power	PAM-118A	18040133	Calibration	Not Required
Wifi Filter	K&L	8NSL26-2437/E82.2-0/0	1	Calibration	Not Required
3 GHz High Pass filter	Anatech Electronics	0K0R2	1	Calibration	Not Required

Table RE25.1: Test Equipment Used

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

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.

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

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
2216.160	H	33.1	48.6	-4.0	29.1	44.6	54.0	74.0	24.9	29.4	381.8	81.0
12812.540	H	27.5	41.1	14.9	42.4	56.0	54.0	74.0	11.6	18.0	158.2	233.0

Table RE25.2: Emission summary (ANT 2402MHz @ 3 meter)

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
2216.160	H	32.7	47.6	-4.0	28.7	43.6	54.0	74.0	25.3	30.4	258.4	93.0
13312.580	H	26.7	40.1	15.7	42.4	55.8	54.0	74.0	11.6	18.2	335.9	113.0

Table RE25.3: Emission summary (ANT 2440MHz @ 3 meter)

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
2225.840	H	32.9	47.7	-3.9	29.0	43.8	54.0	74.0	25.0	30.2	381.8	93.0
2275.560	H	32.4	45.9	-3.5	28.9	42.4	54.0	74.0	25.1	31.6	217.7	174.0
2307.680	H	32.5	46.0	-3.5	29.0	42.5	54.0	74.0	25.0	31.5	100.0	257.0
11843.780	H	27.6	41.2	14.3	41.9	55.5	54.0	74.0	12.1	18.5	159.8	131.0

Table RE25.4: Emission summary (ANT 2480MHz @ 3 meter)

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

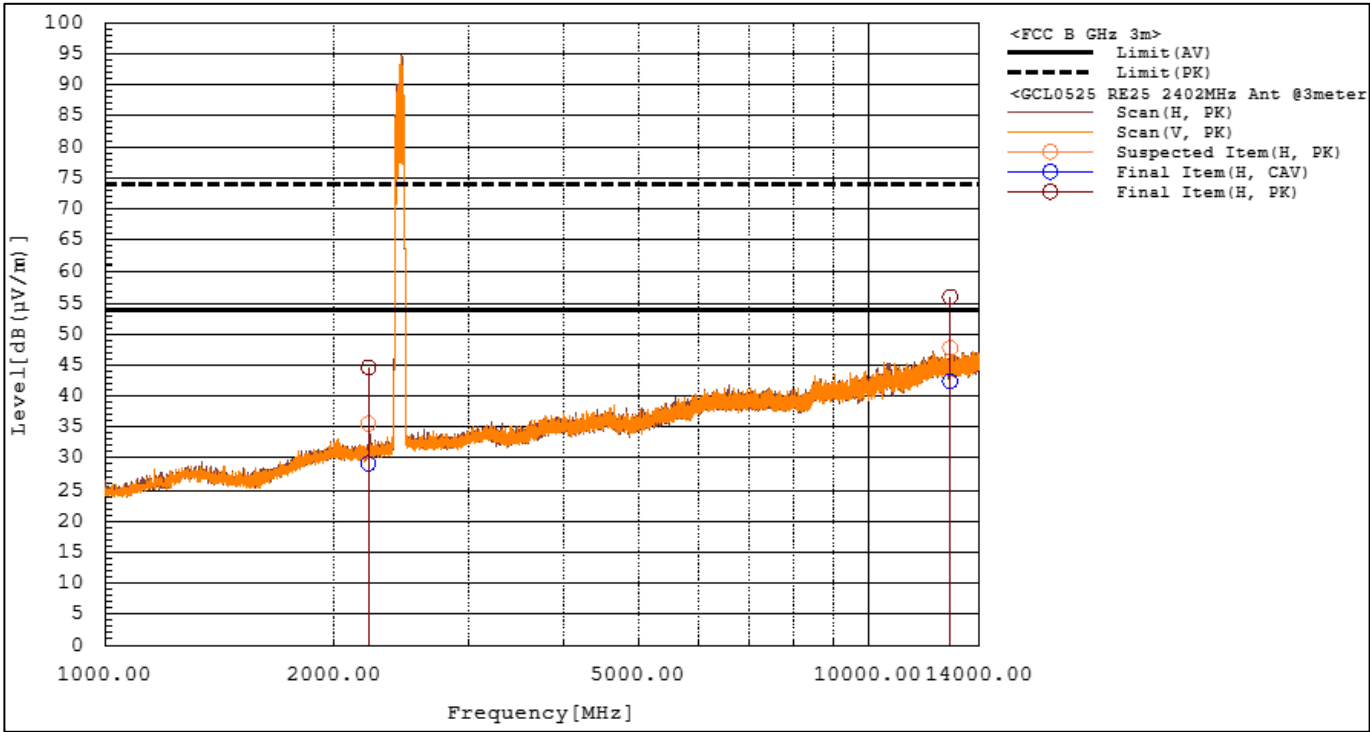


Figure RE25.1: Spectral data (ANT 2402MHz)

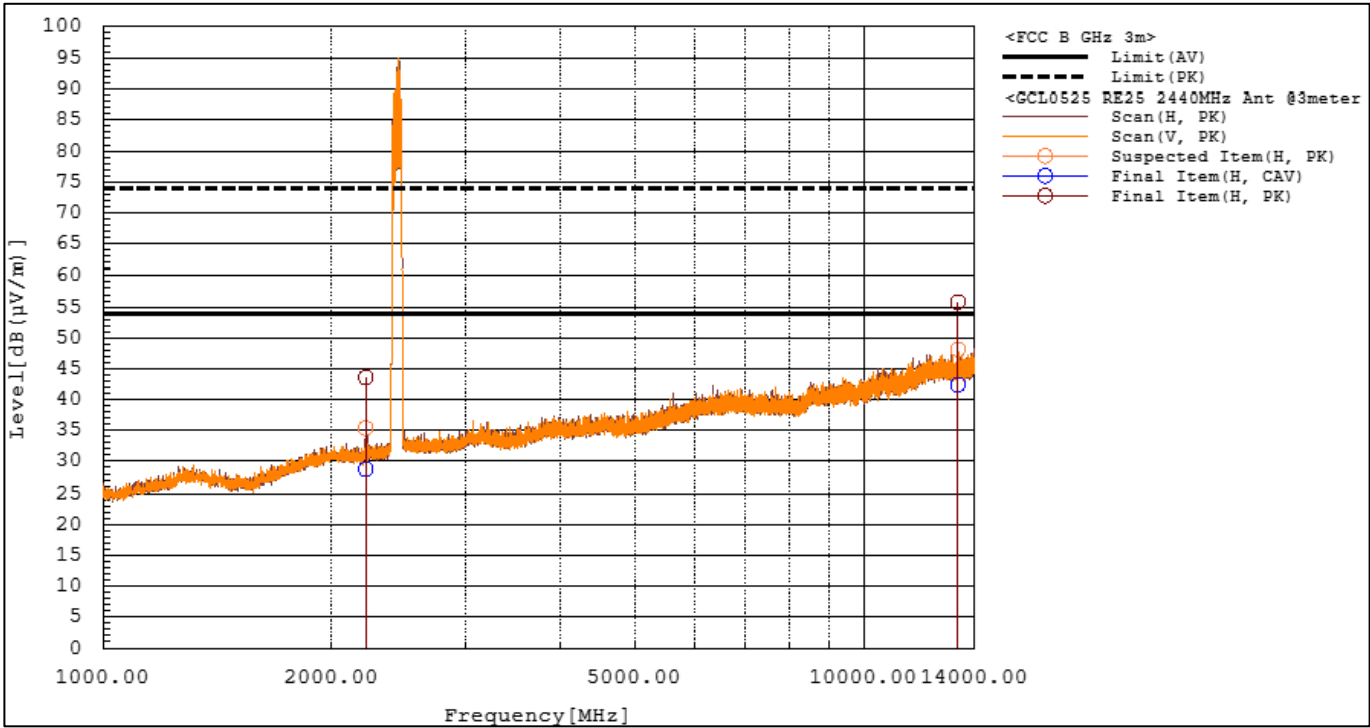


Figure RE25.2: Spectral data (ANT 2440MHz)

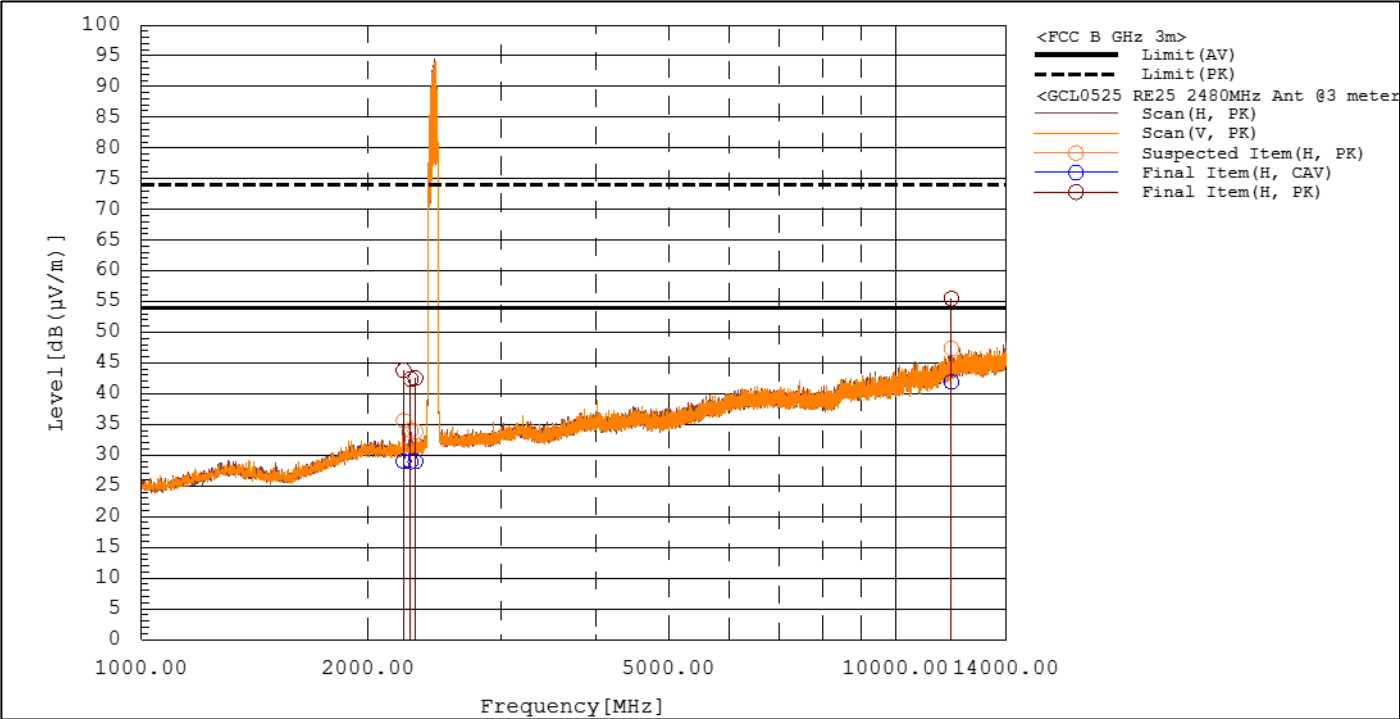


Figure RE25.3: Spectral data (ANT 2480MHz)

Setup Photographs

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



Figure RE25.4: EUT test setup, first view (EUT Y Orientation)

Image removed for client confidentiality.

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

Figure RE25.5: EUT test setup, second view (EUT Y Orientation)

This line is the end of the test record.

Test Record

Radiated Emission Test RE28

Project GCL0425

Test Date(s) 22 Nov 2024
Test Personnel Dave Kerr, Jim Solum

Product Model A04712
Serial Number tested 8G5000252

Operating Mode M5 (AntTx) (2402 MHz)
Arrangement A2 (Upwr)
Input Power USB 5 Vdc

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

Frequency Range: 14 MHz to 25 GHz
Pass/Fail Judgment: PASS

Test record created by: Jim Solum
Date of this record: 22 Nov 2024

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	00259186	29-Apr-2024	29-Apr-2026
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	7-Mar-2023	7-Mar-2026
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
Preamplifier, 14 GHz to 40 GHz	Com-Power	PAM-840A	461364	Calibration	Not Required

Table RE28.1: Test Equipment Used

Software Used: Keysight PXE software A.33.03, EPX test software Version 2023.01.001

Test Data

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

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

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

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

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

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
16814.000	H	20.6	34.1	21.6	42.2	55.7	54.0	74.0	11.8	18.3	400.0	0.0
21285.300	H	23.3	37.0	20.2	43.5	57.2	54.0	74.0	10.5	16.8	130.8	152.0

Table RE28.2: Emission summary

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

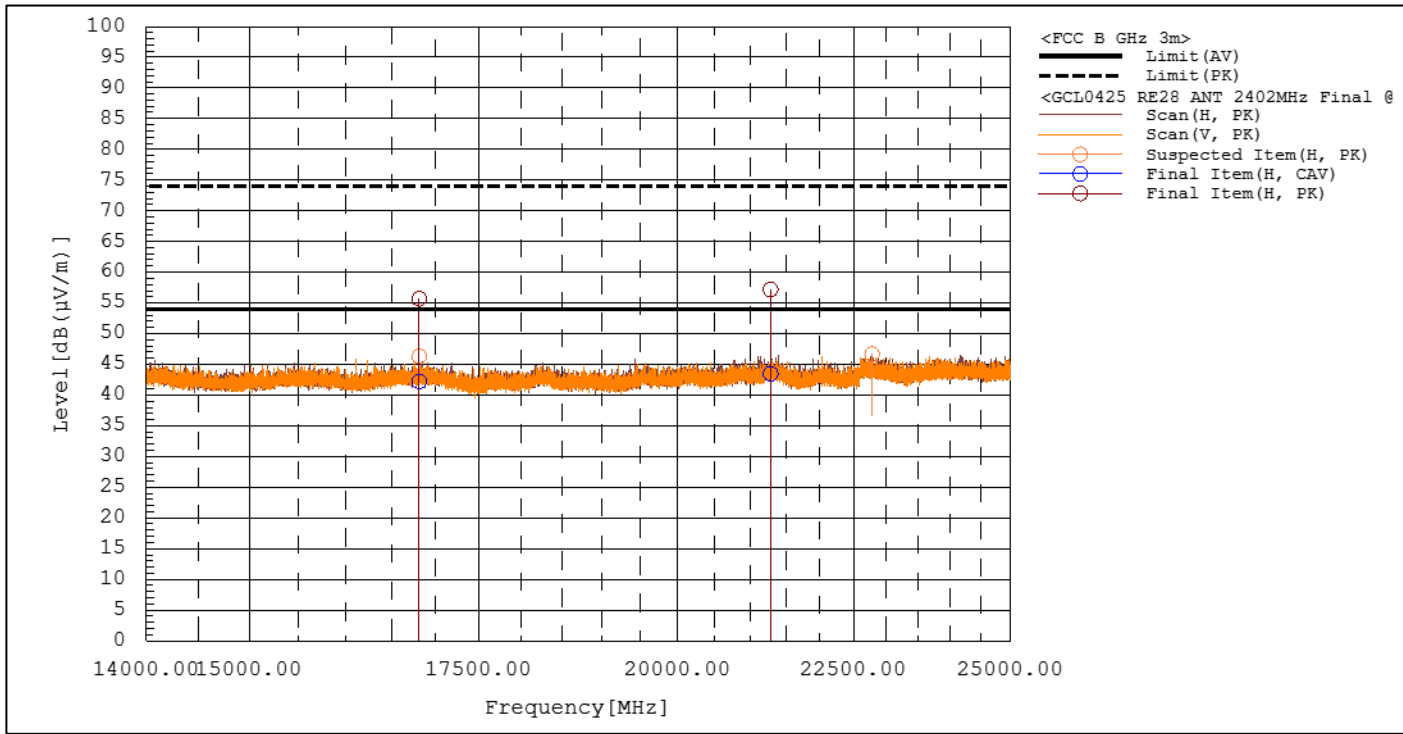


Figure RE28.1: Spectral data

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE28.2: EUT test setup, first view

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE28.3: EUT test setup, second view

This line is the end of the test record.

Test Record
Radiated Emission Test RE33
Project GCL0425

Test Date(s) 27 Nov 2024
Test Personnel David Kerr

Product Model A04712
Serial Number tested 3488107710

Operating Mode M7 (WiFiTx) (CH 11, B2)
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: 27 Nov 2024

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	174	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	Crecent Lufkin	L1135CME-02	GMN0013784	26-Jun-2024	26-Jun-2027

Table RE33.1: 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.

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.

Freq.	Level	Detector	Limit	Margin	Peak Level	Pk Limit	Pk Margin	Antenna	Table
MHz	dBuV/m	Type	dBuV/m	dB	dBuV/m	dBuV/m	dB	Orientation	Azimuth, deg
0.0486	35.46	Avg	113.87	78.41	43.92	133.87	89.95	Y	180
0.067	30.11	Avg	111.08	80.98	40.10	131.08	90.98	X	86
0.1379	23.88	Avg	104.81	80.93	32.93	124.81	91.88	Z	-171

Table RE33.2: Emission summary

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

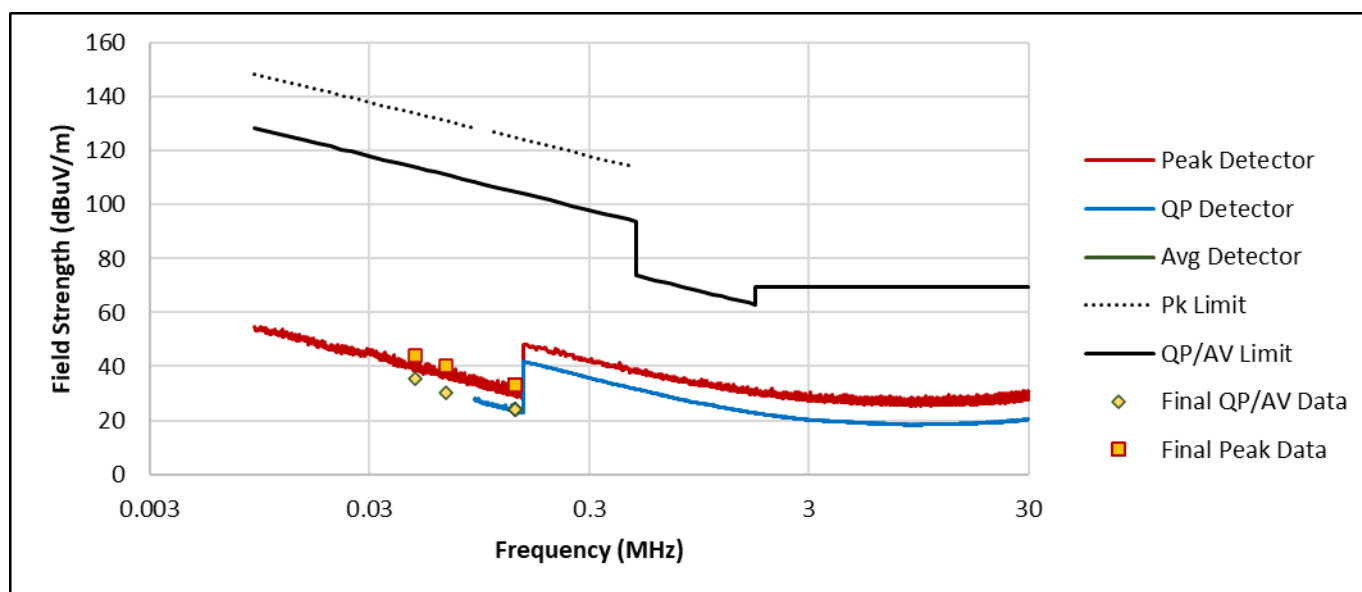


Figure RE33.1: Spectral data

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE33.2: EUT test setup, first view (EUT Y Orientation)

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE33.3: EUT test setup, second view (Antenna Y Orientation)

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE33.4: 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 RE33.5: EUT test setup, second view (Antenna Z Orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE34
Project GCL0425

Test Date(s) 26 Nov 2024
Test Personnel David Kerr

Product Model A04712
Serial Number tested 3488107710

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: 26 Nov 2024

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	233201	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 RE34.1: Test Equipment Used

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

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.

Page 61 of 98	GCL Test Report 2024-191	Version A
This report may be reproduced in whole. Reproduction of parts or excerpts requires lab management approval.		
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 is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

Frequency	Pol.	Reading	Factor	Level	Limit	Margin	Height	Angle
MHz		dB(μV)	dB(1/m)	dB(μV/m)	dB(μV/m)	dB	cm	deg
		QP		QP	QP	QP		
38.400	V	6.1	17.8	23.9	40.0	16.1	100.0	260.0
133.110	H	5.0	15.5	20.5	43.5	23.0	239.7	252.0
143.460	H	6.6	15.7	22.3	43.5	21.2	151.1	79.0
222.750	V	3.8	18.8	22.6	46.0	23.4	100.0	265.0
371.250	V	2.0	24.4	26.4	46.0	19.6	185.6	103.0
940.920	V	0.2	34.7	34.9	46.0	11.1	282.9	153.0

Table RE34.2: Emission summary

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

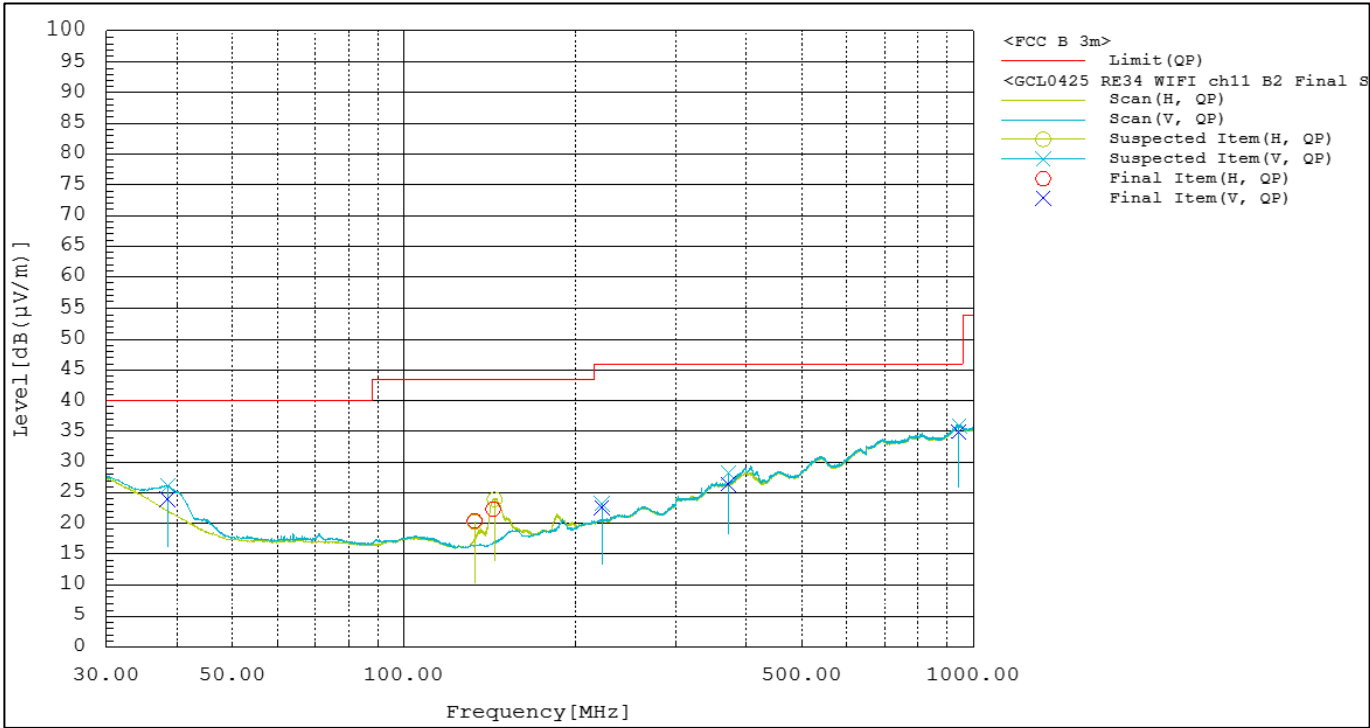


Figure RE34.1: Spectral data

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE34.2: EUT test setup, first view (Y Orientation)

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE34.3: EUT test setup, second view (Y Orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE30
Project GCL0425

Test Date(s) 19 Nov 2024
Test Personnel Jim Solum

Product Model A04712
Serial Number tested 3488107710

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: Jim Solum
Date of this record: 19 Nov 2024

Original record, Version A.

Test Equipment

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

Table RE30.1: Test Equipment Used

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

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 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.

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.

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.

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

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
2216.600	H	33.2	48.5	-4.0	29.2	44.5	54.0	74.0	24.8	29.5	334.1	88.0
3216.200	H	43.5	50.6	-1.0	42.5	49.6	54.0	74.0	11.5	24.4	106.6	340.0
4823.780	H	46.5	52.5	3.1	49.6	55.6	54.0	74.0	4.4	18.4	383.4	336.0
4823.780	V	48.9	54.2	3.1	52.0	57.3	54.0	74.0	2.0	16.7	223.6	37.0
12806.600	V	27.5	41.0	14.9	42.4	55.9	54.0	74.0	11.6	18.1	155.8	273.0

Table RE30.2: Emission summary (B2, Ch1 @ 3 meter)

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
2216.160	H	33.0	48.7	-4.0	29.0	44.7	54.0	74.0	25.0	29.3	201.3	298.0
3249.140	H	42.0	50.0	-1.1	40.9	48.9	54.0	74.0	13.1	25.1	100.0	339.0
4874.000	H	44.7	52.4	2.8	47.5	55.2	54.0	74.0	6.5	18.8	365.9	336.0
4874.000	V	40.5	50.1	2.8	43.3	52.9	54.0	74.0	10.7	21.1	100.0	295.0
13658.180	H	26.3	39.9	15.5	41.8	55.4	54.0	74.0	12.2	18.6	100.0	69.0

Table RE30.3: Emission summary (B2, Ch6 @ 3 meter)

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
2221.440	H	33.0	48.2	-3.9	29.1	44.3	54.0	74.0	24.9	29.7	377.2	68.0
3282.620	H	40.4	48.9	-1.2	39.2	47.7	54.0	74.0	14.8	26.3	100.0	345.0
4923.680	H	48.3	53.4	2.7	51.0	56.1	54.0	74.0	3.0	17.9	361.7	331.0
4923.680	V	49.7	54.6	2.7	52.4	57.3	54.0	74.0	1.6	16.7	285.4	6.0
12559.280	V	27.8	41.6	14.4	42.2	56.0	54.0	74.0	11.8	18.0	197.2	264.0

Table RE30.4: Emission summary (B2, Ch11 @ 3 meter)

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

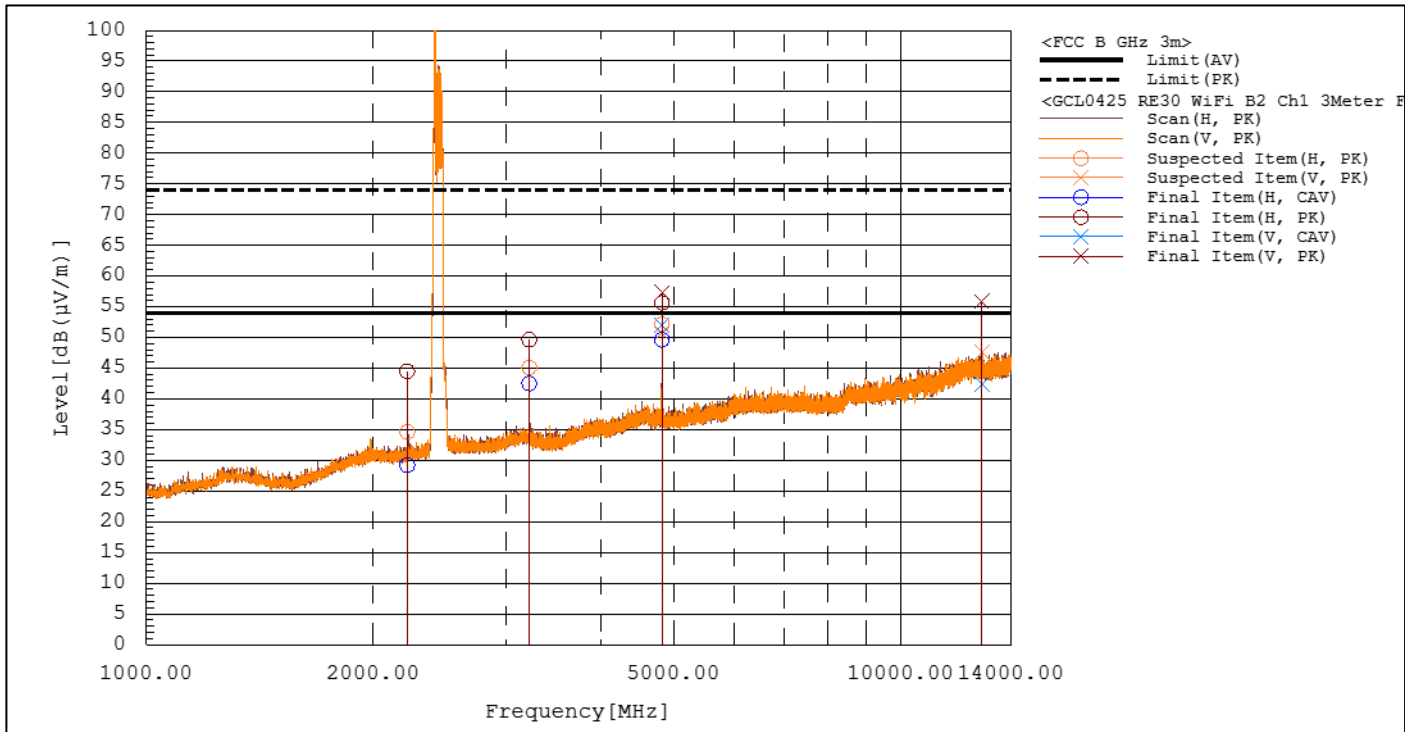


Figure RE30.1: Spectral data (B2, Ch1)

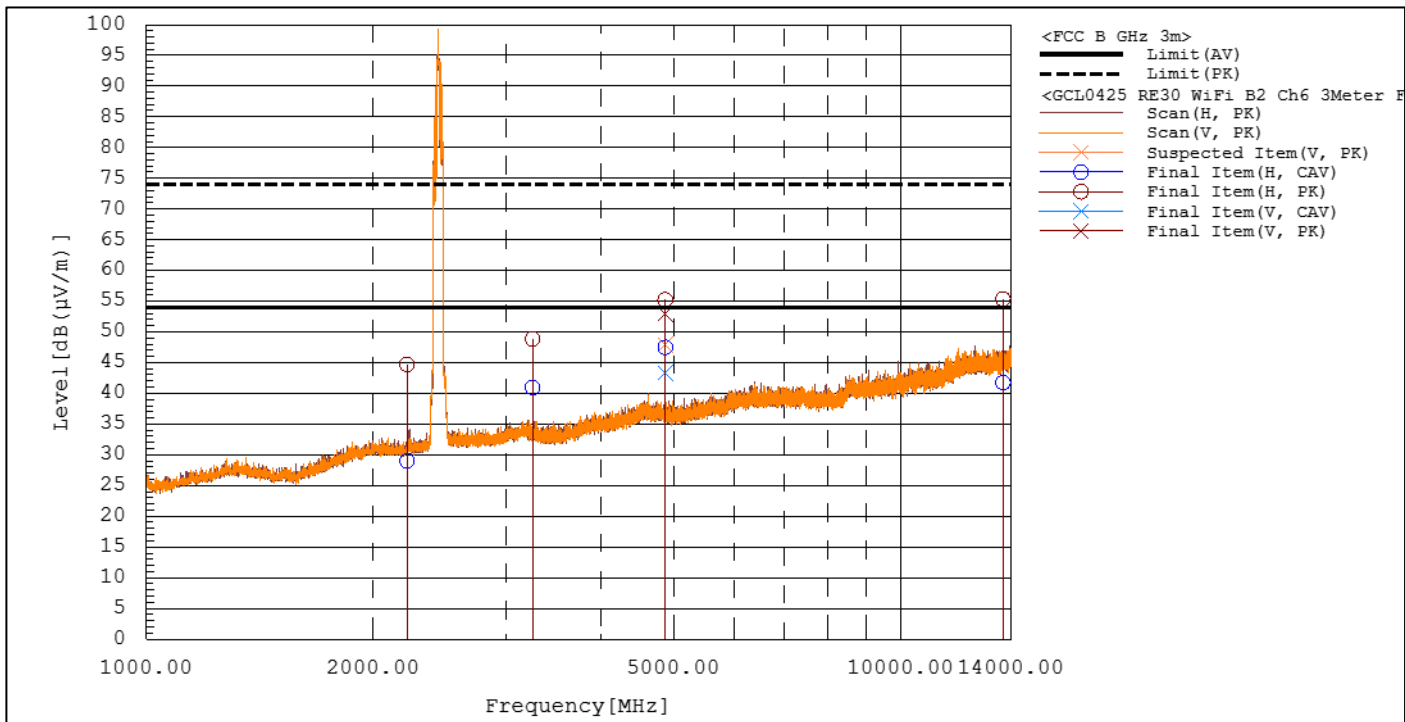


Figure RE30.2: Spectral data (B2, Ch6)

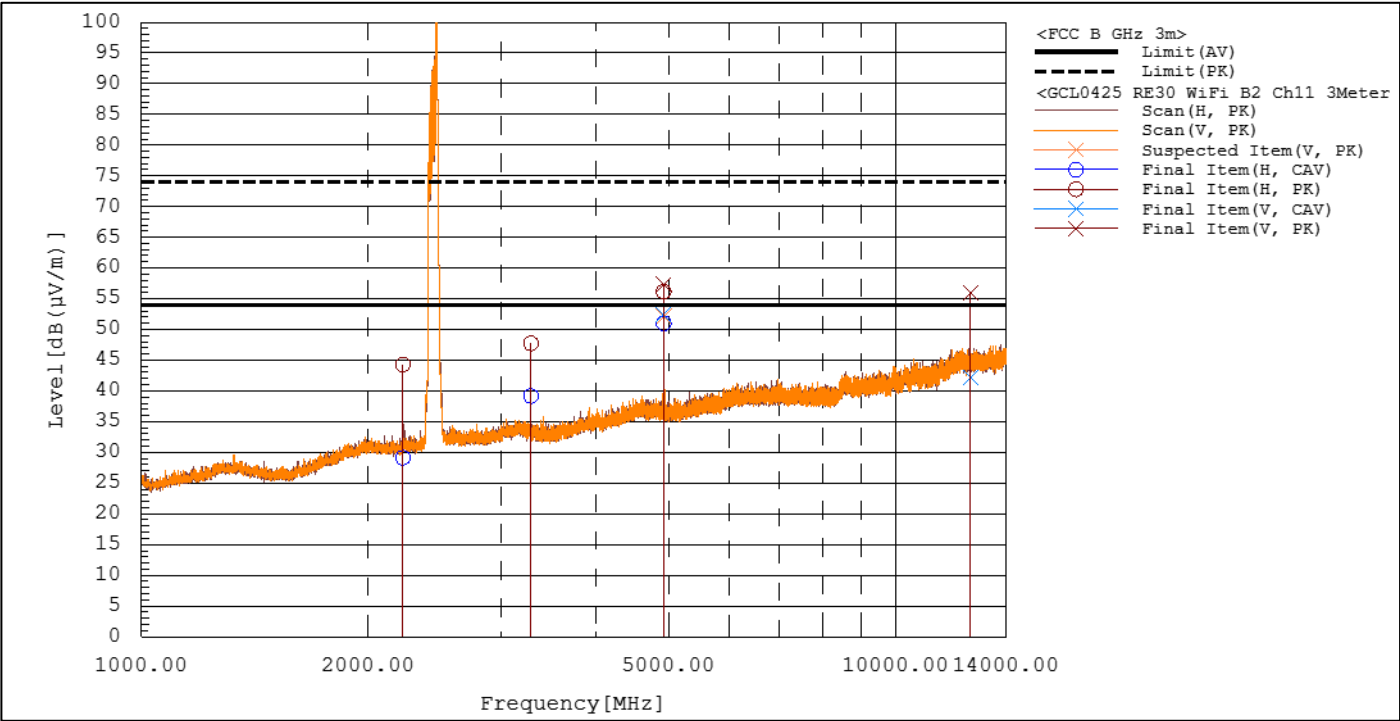


Figure RE30.3: Spectral data (B2, Ch11)

Setup Photographs

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



Figure RE30.4: EUT test setup, first view (EUT Y Orientation)

Image removed for client confidentiality.

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

Figure RE30.5: EUT test setup, second view (EUT Y Orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE31
Project GCL0425

Test Date(s) 20 Nov 2024
Test Personnel Jim Solum

Product Model A04712
Serial Number tested 3488107710

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: Jim Solum
Date of this record: 21 Nov 2024

Original record, Version A.

Test Equipment

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

Table RE31.1: Test Equipment Used

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

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 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.

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.

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.

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

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
2219.240	H	33.1	48.8	-3.9	29.2	44.9	54.0	74.0	24.8	29.1	243.6	101.0
3215.660	H	41.1	49.9	-1.0	40.1	48.9	54.0	74.0	13.9	25.1	114.6	0.0
4825.940	H	35.5	49.2	3.1	38.6	52.3	54.0	74.0	15.4	21.7	339.1	347.0
13335.800	H	26.6	40.3	15.7	42.3	56.0	54.0	74.0	11.7	18.0	297.1	191.0

Table RE31.2: Emission summary (G18, Ch1 @ 3 meter)

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
3249.140	H	42.4	50.6	-1.1	41.3	49.5	54.0	74.0	12.7	24.5	120.5	343.0
4872.380	H	35.4	48.8	2.8	38.2	51.6	54.0	74.0	15.8	22.4	379.0	339.0
12578.720	H	27.9	41.6	14.5	42.4	56.1	54.0	74.0	11.6	17.9	228.8	196.0
2215.720	H	32.7	46.9	-4.0	28.7	42.9	54.0	74.0	25.3	31.1	331.7	40.0

Table RE31.3: Emission summary (G18, Ch6 @ 3 meter)

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(μV)		dB(1/m)	dB(μV/m)		dB(μV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
2215.280	H	32.5	47.9	-4.0	28.5	43.9	54.0	74.0	25.5	30.1	301.9	359.0
3282.620	H	40.0	49.5	-1.2	38.8	48.3	54.0	74.0	15.2	25.7	110.6	0.0
4924.220	H	35.7	49.6	2.7	38.4	52.3	54.0	74.0	15.6	21.7	363.9	334.0
13928.720	V	26.2	40.0	16.0	42.2	56.0	54.0	74.0	11.8	18.0	130.2	230.0

Table RE31.4: Emission summary (G18, Ch11 @ 3 meter)

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

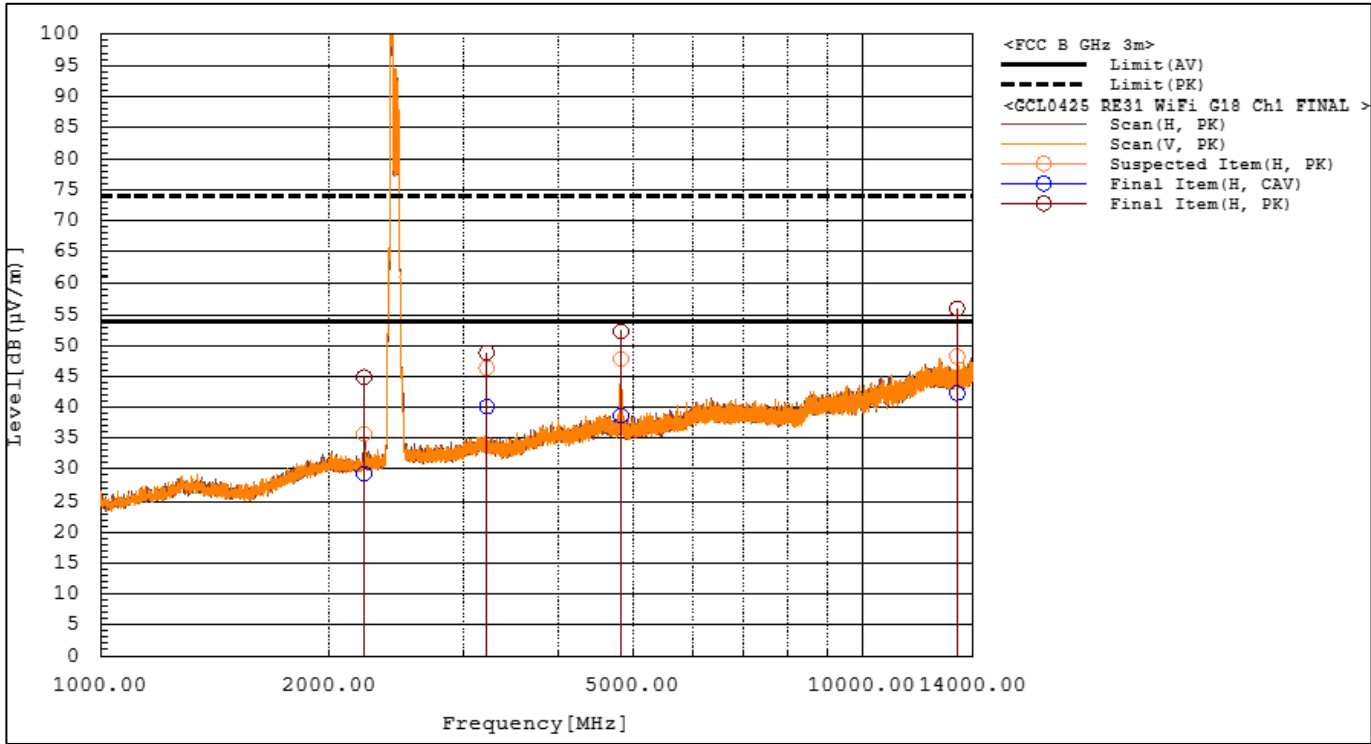


Figure RE31.1: Spectral data (G18, Ch1)

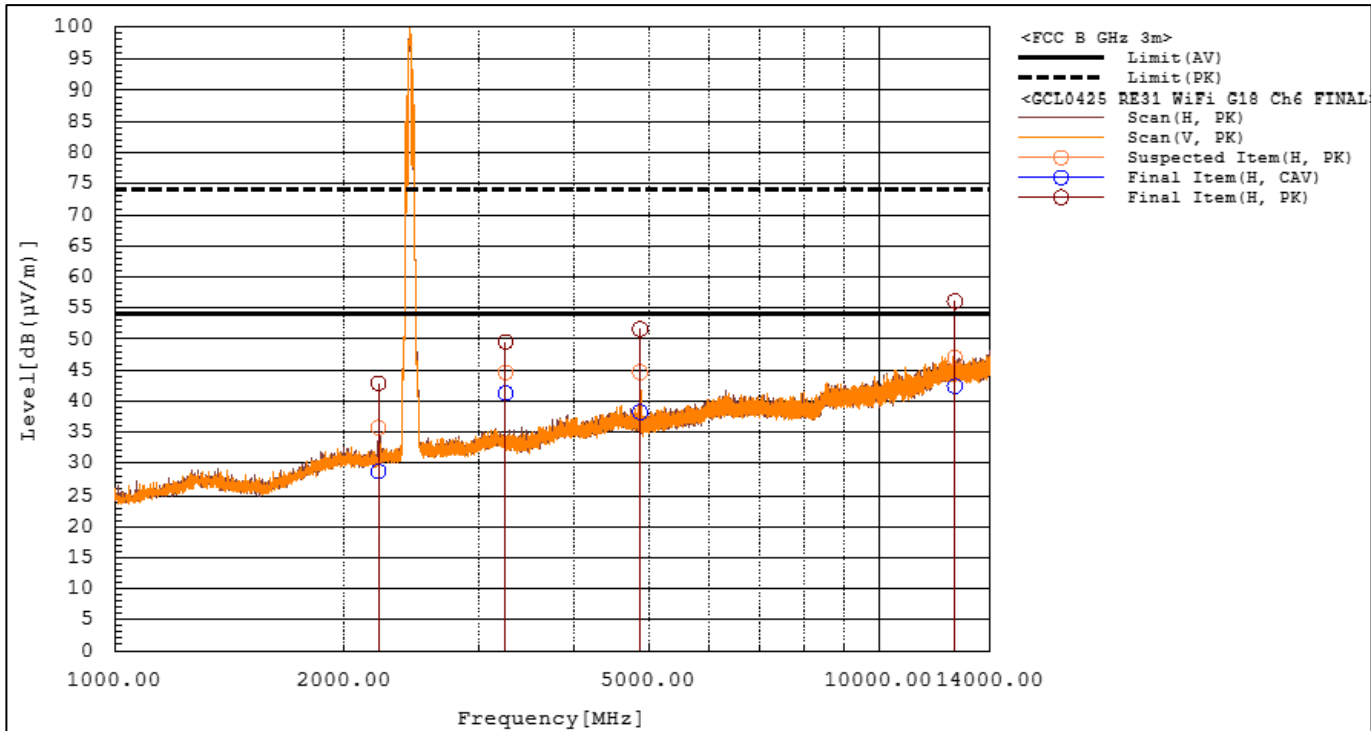


Figure RE31.2: Spectral data (G18, Ch6)

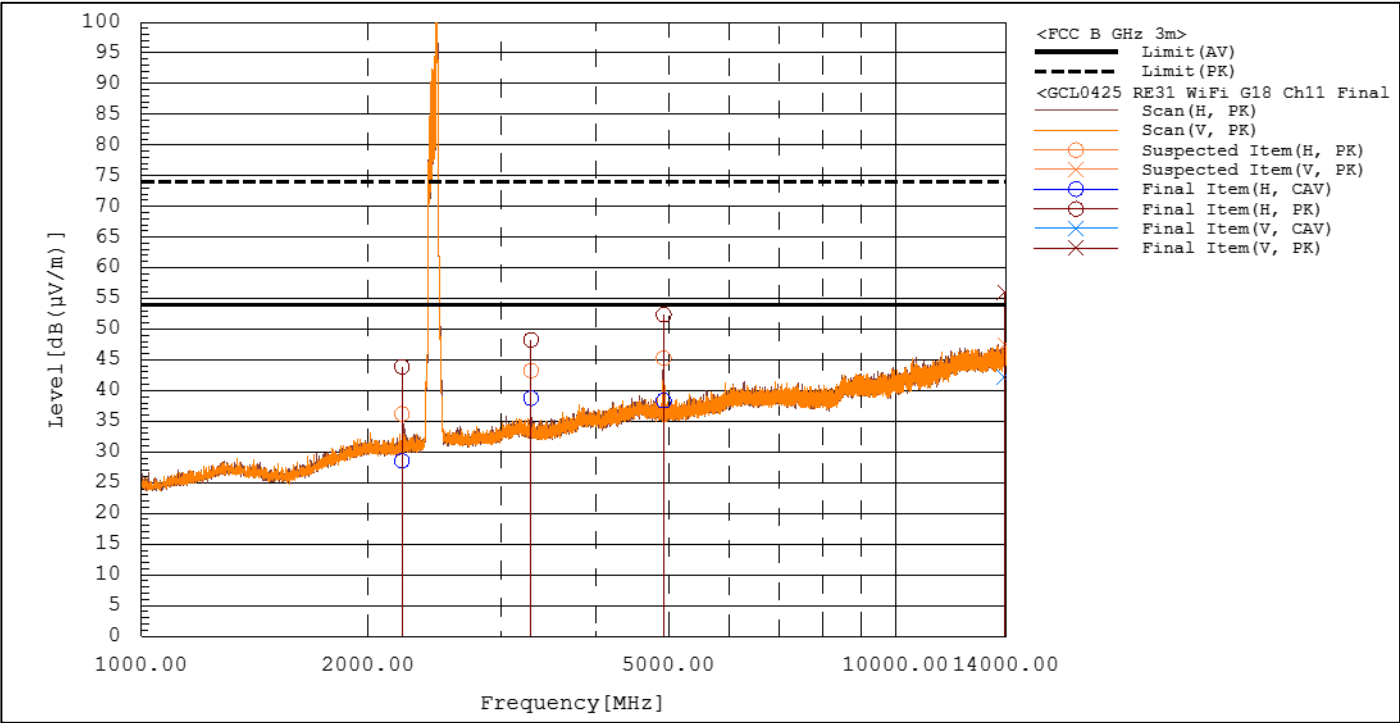


Figure RE31.3: Spectral data (G18, Ch11)

Setup Photographs

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



Figure RE31.4: EUT test setup, first view (EUT Y Orientation)

Image removed for client confidentiality.

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

Figure RE31.5: EUT test setup, second view (EUT Y Orientation)

This line is the end of the test record.

Test Record

Radiated Emission Test RE32

Project GCL0425

Test Date(s) 22 Nov 2024
Test Personnel Jim Solum

Product Model A04712
Serial Number tested 3488107710

Operating Mode M7 (WiFiTx) (CH 11, 802.11b 2 Mbps)
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: 22 Nov 2024

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	00259186	29-Apr-2024	29-Apr-2026
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	7-Mar-2023	7-Mar-2026
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
Preamplifier, 14 GHz to 40 GHz	Com-Power	PAM-840A	461364	Calibration	Not Required

Table RE32.1: Test Equipment Used

Software Used: Keysight PXE software A.33.03, EPX test software Version 2023.01.001

Test Data

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

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

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

The table shows the selected final measurement data between 14 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.

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
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
14772.000	V	16.1	29.9	25.1	41.2	55.0	54.0	74.0	12.8	19.0	400.0	0.0
21997.450	H	23.0	36.6	20.0	43.0	56.6	54.0	74.0	11.0	17.4	355.2	22.0

Table RE32.2: Emission summary

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

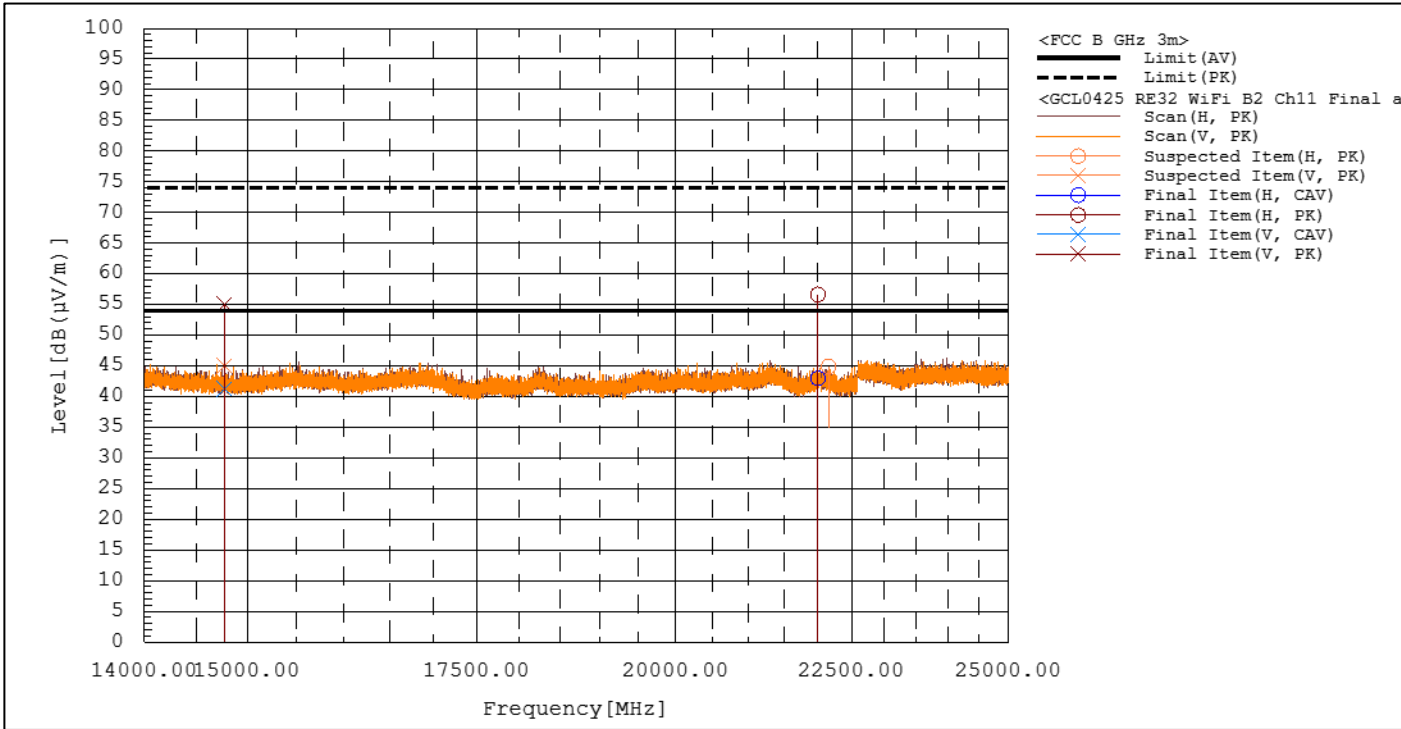


Figure RE32.1: Spectral data

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE32.2: EUT test setup, first view

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE32.3: EUT test setup, second view

This line is the end of the test record.

Test Record

Radiated Emission Test RE01

Project GCL0425

Test Date(s) 17, 18 Nov 2024
Test Personnel David Kerr, Jim Solum

Product Model A04712
Serial Number tested 3488107710

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

Test Standards: FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210 (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: Jim Solum
Date of this record: 18 Nov 2024

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" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
Preamplifier, 500 MHz 18 GHz	Com-Power	PAM-118A	18040133	Calibration	Not Required
Wifi Filter	K&L	8NSL26-2437/E82.2-0/0	1	Calibration	Not Required

Table RE01.1: Test Equipment Used

Software Used

Keysight PXE receiver software A.32.06, RE Signal Maximization Tool v2024Jul31.xlsx.xlsx

Test Data

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

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

Restricted band measurements in the lower band were made while the transmitter was tuned to channels 1, 2 and 3. Measurements in the upper band were made while the transmitter was tuned to channels 9,10 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 3m.

Channel & Modulation	Frequency (MHz)	Avg Limit (dBuV/m)	Pk Limit (dBuV/m)	Avg Level (dBuV/m)	Pk Level (dBuV/m)	Av Margin (dB)	Pk Margin (dB)	Azimuth (degree)	Height (mm)	Polarity
Ch1 B5.5 Peak	2389.5	54	74	39.402	54.751	14.598	19.249	-152	1023	VERT
Ch1 B5.5 Average	2390	54	74	39.523	55.164	14.477	18.836	-152	1023	VERT
Ch1 G12 Peak	2390	54	74	48.402	66.95	5.598	7.05	-152	1023	VERT
Ch1 G12 Average	2390	54	74	48.389	67.164	5.611	6.836	-152	1023	VERT
Ch1 N2 Peak	2390	54	74	48.184	66.15	5.816	7.85	-152	1023	VERT
Ch1 N2 Average	2390	54	74	48.136	66.338	5.864	7.662	-152	1023	VERT

Table RE01.2: FCC restricted bands from 2200 to 2390 MHz (WiFi Ch 1)

Channel & Modulation	Frequency (MHz)	Avg Limit (dBuV/m)	Pk Limit (dBuV/m)	Avg Level (dBuV/m)	Pk Level (dBuV/m)	Av Margin (dB)	Pk Margin (dB)	Azimuth (degree)	Height (mm)	Polarity
Ch2 B5.5 Peak	2390	54	74	37.982	53.966	16.018	20.034	-152	1023	VERT
Ch2 B5.5 Average	2390	54	74	37.981	54.377	16.019	19.623	-152	1023	VERT
Ch2 G12 Peak	2388.8	54	74	45.77	61.909	8.23	12.091	-152	1023	VERT
Ch2 G12 Average	2390	54	74	46.449	62.019	7.551	11.981	-152	1023	VERT
Ch2 N2 Peak	2390	54	74	46.727	63.417	7.273	10.583	-152	1023	VERT
Ch2 N2 Average	2390	54	74	46.738	63.593	7.262	10.407	-152	1023	VERT

Table RE01.3: FCC restricted bands from 2200 to 2390 MHz (WiFi Ch 2)

Channel & Modulation	Frequency (MHz)	Avg Limit (dBuV/m)	Pk Limit (dBuV/m)	Avg Level (dBuV/m)	Pk Level (dBuV/m)	Av Margin (dB)	Pk Margin (dB)	Azimuth (degree)	Height (mm)	Polarity
Ch3 B5.5 Peak	2390	54	74	37.783	52.819	16.217	21.181	-152	1023	VERT
Ch3 B5.5 Average	2390	54	74	37.781	52.794	16.219	21.206	-152	1023	VERT
Ch3 G12 Peak	2388.3	54	74	45.58	63.705	8.42	10.295	-152	1023	VERT
Ch3 G12 Average	2390	54	74	47.063	63.11	6.937	10.89	-152	1023	VERT
Ch3 N2 Peak	2389.5	54	74	45.445	62.387	8.555	11.613	-152	1023	VERT
Ch3 N2 Average	2390	54	74	45.88	62.568	8.12	11.432	-152	1023	VERT

Table RE01.4: FCC restricted bands from 2200 to 2390 MHz (WiFi Ch 3)

Channel & Modulation	Frequency (MHz)	Avg Limit (dBuV/m)	Pk Limit (dBuV/m)	Avg Level (dBuV/m)	Pk Level (dBuV/m)	Av Margin (dB)	Pk Margin (dB)	Azimuth (degree)	Height (mm)	Polarity
Ch9 B5.5 Peak	2491.3	54	74	35.94	50.038	18.06	23.962	25	1652	VERT
Ch9 B5.5 Average	2483.5	54	74	36.843	50.713	17.157	23.287	25	1652	VERT
Ch9 G12 Peak	2483.5	54	74	42.325	58.961	11.675	15.039	25	1652	VERT
Ch9 G12 Average	2483.5	54	74	42.299	60.111	11.701	13.889	25	1652	VERT
Ch9 N2 Peak	2484.3	54	74	42.253	58.651	11.747	15.349	25	1652	VERT
Ch9 N2 Average	2483.5	54	74	42.562	59.568	11.438	14.432	25	1652	VERT

Table RE01.5: FCC restricted band from 2483.5 to 2500 MHz (WiFi Ch 9)

Channel &	Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
Modulation	(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
Ch10 B5.5 Peak	2487.3	54	74	36.545	50.707	17.455	23.293	25	1652	VERT
Ch10 B5.5 Average	2483.5	54	74	36.903	51.696	17.097	22.304	25	1652	VERT
Ch10 G12 Peak	2486.5	54	74	43.231	60.387	10.769	13.613	25	1652	VERT
Ch10 G12 Average	2483.5	54	74	44.305	60.821	9.695	13.179	25	1652	VERT
Ch10 N2 Peak	2483.5	54	74	44.632	61.889	9.368	12.111	25	1652	VERT
Ch10 N2 Average	2483.5	54	74	44.643	61.843	9.357	12.157	25	1652	VERT

Table RE01.6: FCC restricted band from 2483.5 to 2500 MHz (WiFi Ch 10)

Channel &	Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
Modulation	(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
Ch11 B5.5 Peak	2485	54	74	37.887	51.784	16.113	22.216	25	1652	VERT
Ch11 B5.5 Average	2484.3	54	74	38.186	51.902	15.814	22.098	25	1652	VERT
Ch11 G12 Peak	2483.5	54	74	45.99	64.597	8.01	9.403	25	1652	VERT
Ch11 G12 Average	2483.5	54	74	45.989	64.349	8.011	9.651	25	1652	VERT
Ch11 N2 Peak	2483.8	54	74	47.424	64.331	6.576	9.669	25	1652	VERT
Ch11 N2 Average	2483.5	54	74	47.769	64.683	6.231	9.317	25	1652	VERT

Table RE01.7: FCC restricted band from 2483.5 to 2500 MHz (WiFi Ch 11)

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

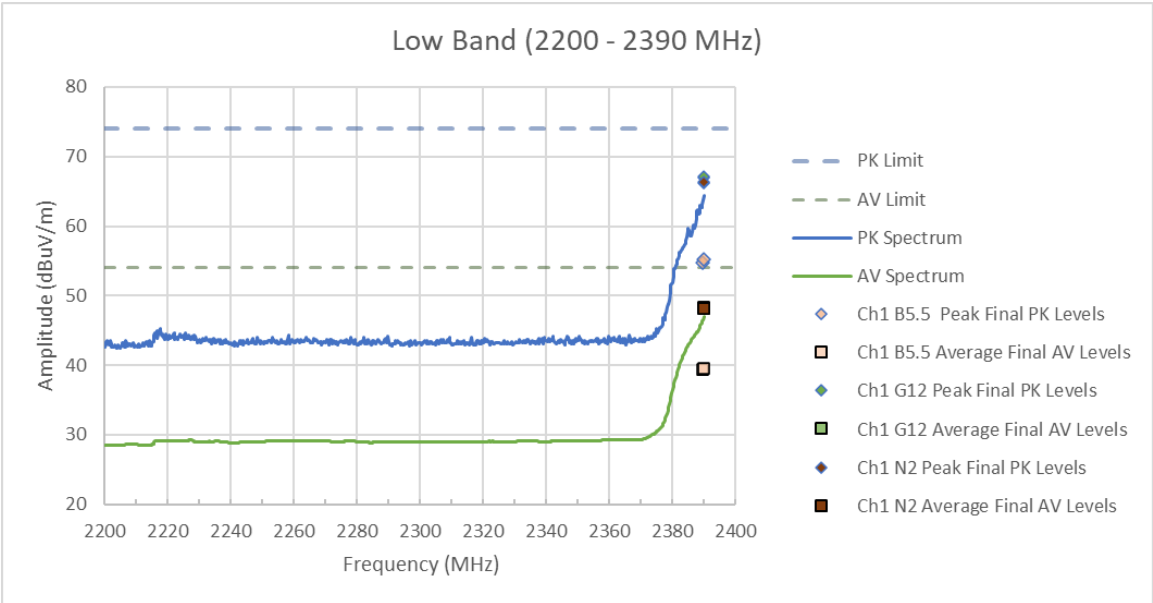


Figure RE01.1: FCC restricted band spectral data from 2200 to 2390 MHz (WiFi Ch 1)

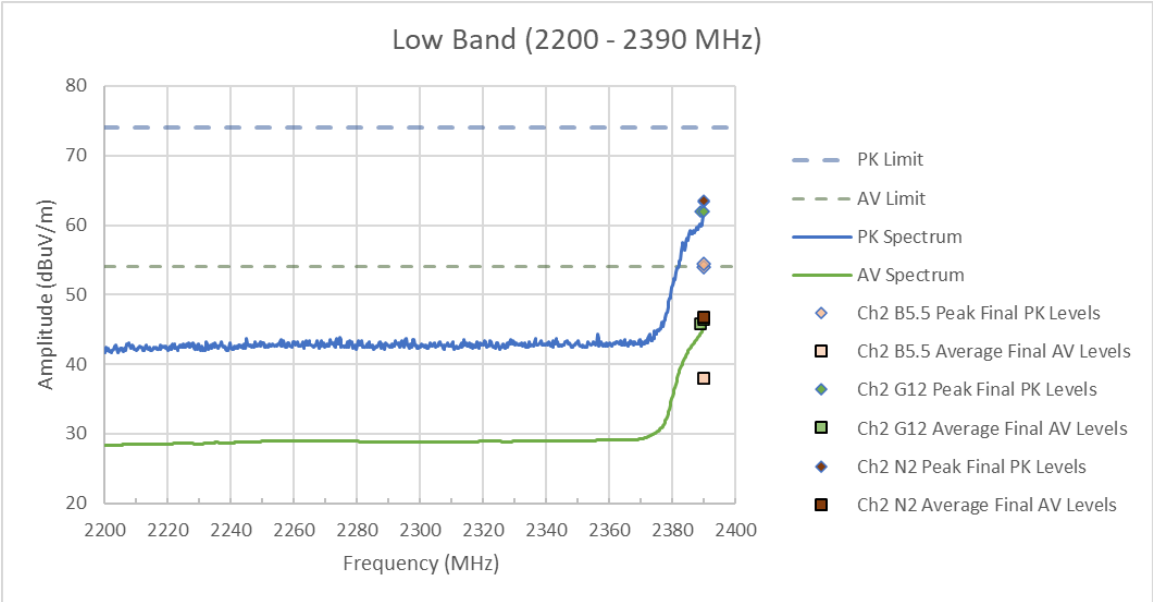


Figure RE01.2: FCC restricted band spectral data from 2200 to 2390 MHz (WiFi Ch 2)

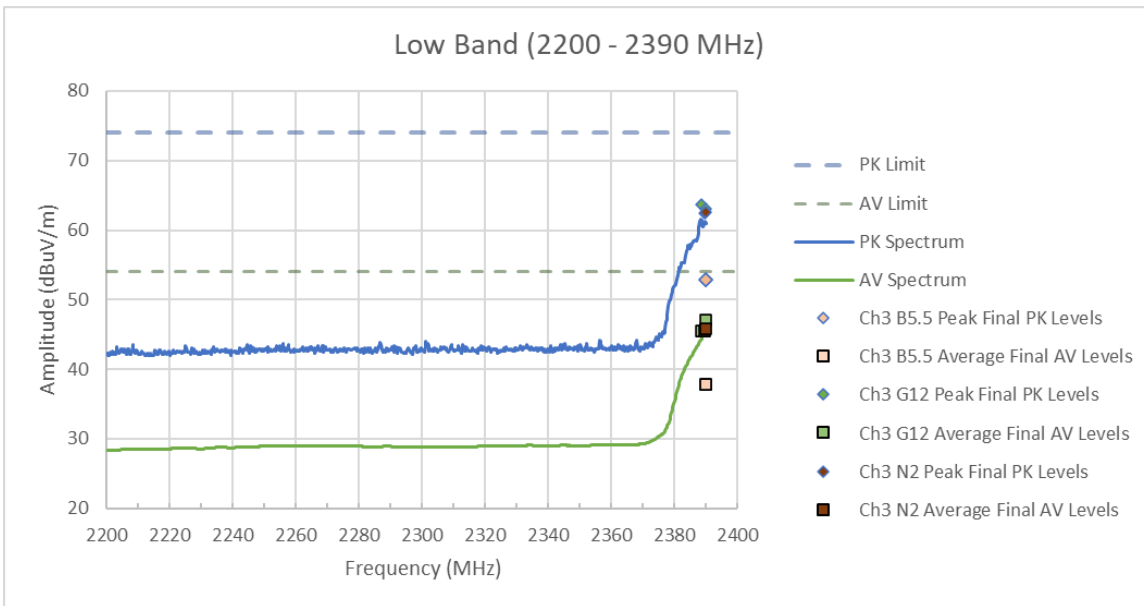


Figure RE01.3: FCC restricted band spectral data from 2200 to 2390 MHz (WiFi Ch 3)

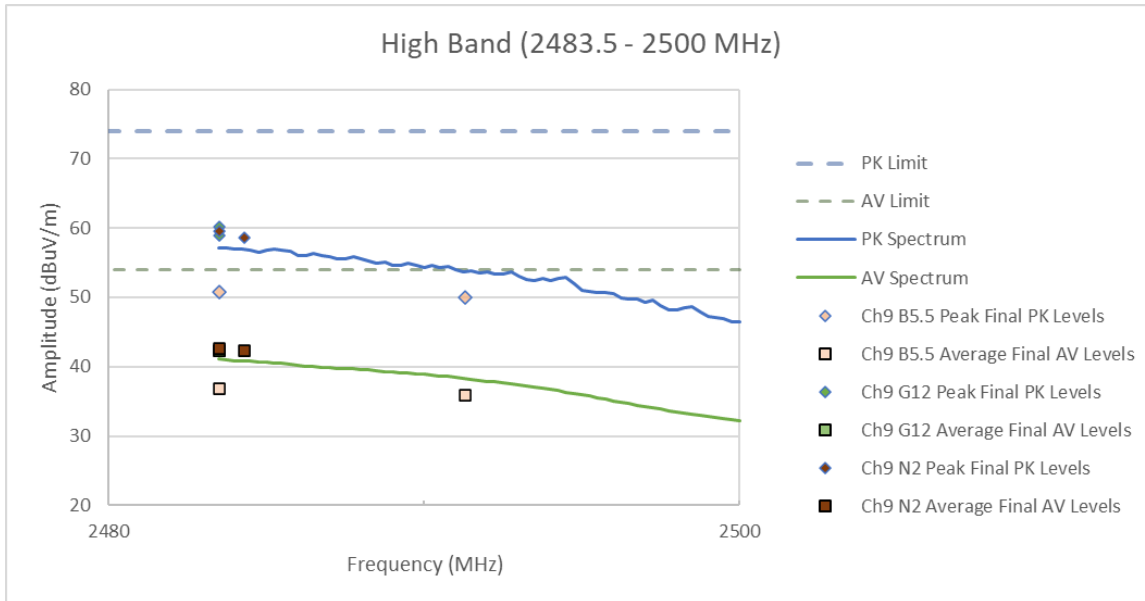


Figure RE01.4: FCC restricted band spectral data from 2483.5 to 2500 MHz (WiFi Ch 9)

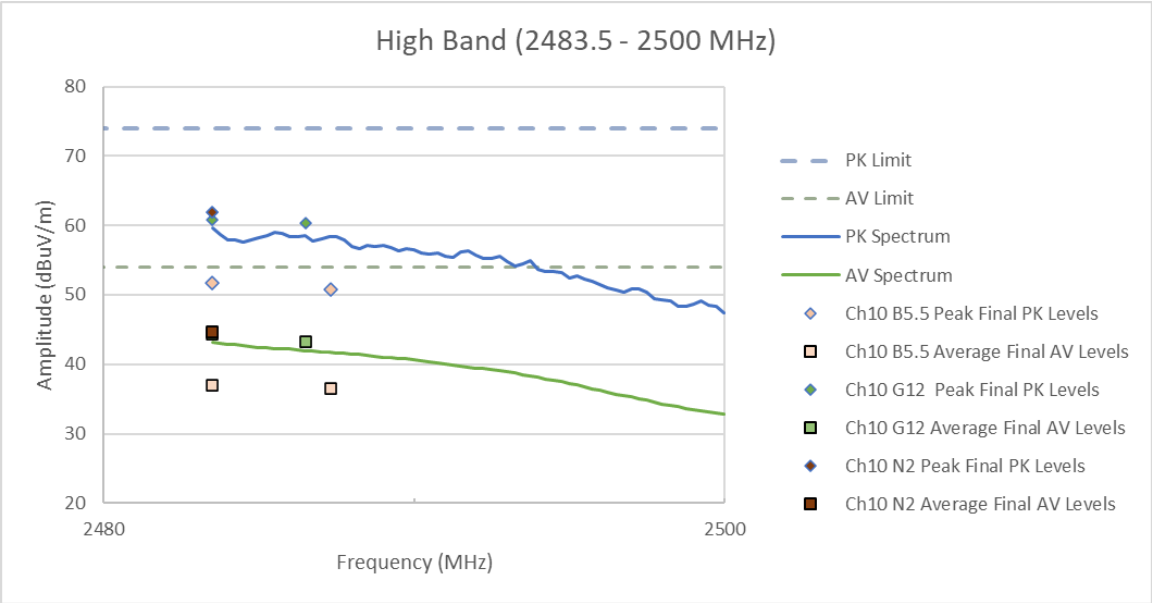


Figure RE01.5: FCC restricted band spectral data from 2483.5 to 2500 MHz (WiFi Ch 10)

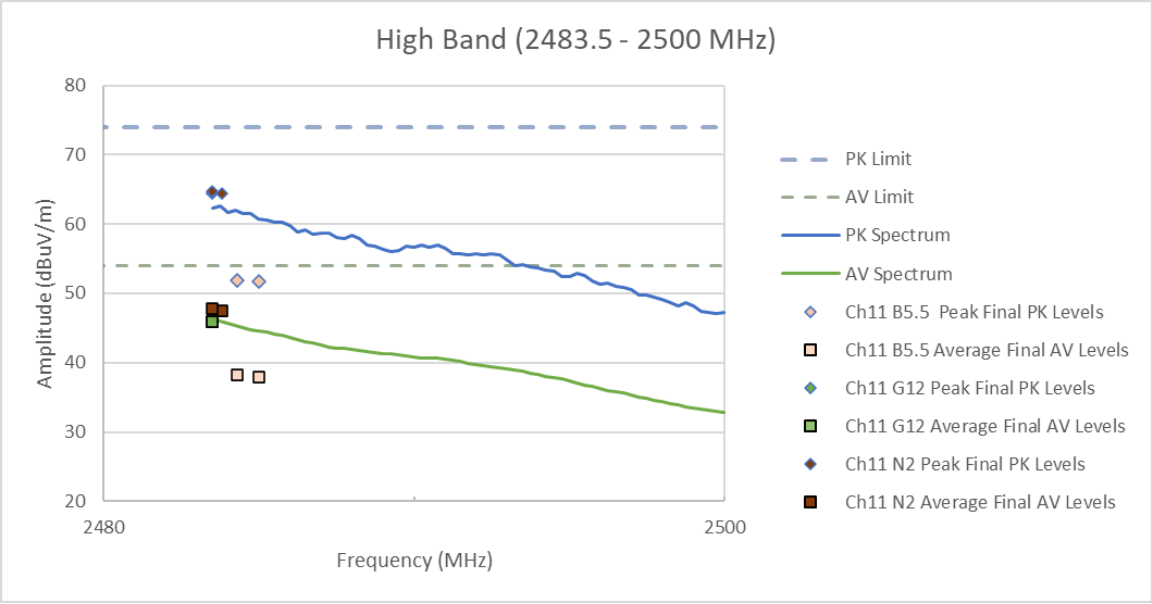


Figure RE01.6: FCC restricted band spectral data from 2483.5 to 2500 MHz (WiFi Ch 11)

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE01.7: EUT test setup, primary view

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE01.8: EUT test setup, reverse view

This line is the end of the test record.

Test Record

Radiated Emission Test RE03, RE04

Project GCL0425

Test Date(s) 18, 19 Nov 2024
Test Personnel David Kerr

Product Model A04712
Serial Number tested 3488107710

Operating Mode M3 (BleTx), M5 (AntTx)
Arrangement A2 (Upwr)
Input Power 5 Vdc

Test Standards: FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210 (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: Jim Solum
Date of this record: 19 Nov 2024

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" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
Preamplifier, 500 MHz 18 GHz	Com-Power	PAM-118A	18040133	Calibration	Not Required
Wifi Filter	K&L	8NSL26-2437/E82.2-0/0	1	Calibration	Not Required

Table RE03.1: Test Equipment Used

Software Used

Keysight PXE receiver software A.32.06, RE Signal Maximization Tool v2024Jul31.xlsx.xlsx

Test Data

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

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

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

Page 84 of 98	GCL Test Report 2024-191	Version A
This report may be reproduced in whole. Reproduction of parts or excerpts requires lab management approval.		
Garmin		

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 3m.

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
2384.8	54	74	31.271	44.974	22.729	29.026	-152	1023	VERT
2390	54	74	31.651	45.402	22.349	28.598	-152	1023	VERT

Table RE03.2: FCC restricted bands from 2200 to 2390 MHz (BLE 1 Mbps 2402 MHz)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
2324	54	74	30.479	44.404	23.521	29.596	-152	1023	VERT
2390	54	74	31.628	45.747	22.372	28.253	-152	1023	VERT

Table RE03.3: FCC restricted bands from 2200 to 2390 MHz (BLE 2 Mbps 2404MHz)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
2374.3	54	74	30.897	44.209	23.103	29.791	-152	1023	VERT
2390	54	74	31.724	45.968	22.276	28.032	-152	1023	VERT

Table RE03.4: FCC restricted bands from 2200 to 2390 MHz (ANT 2402 MHz)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
2496.3	54	74	31.759	45.487	22.241	28.513	25	1652	VERT
2483.5	54	74	32.14	45.702	21.86	28.298	25	1652	VERT

Table RE03.5: FCC restricted band from 2483.5 to 2500 MHz (BLE 1 Mbps 2480 MHz)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
2484.3	54	74	31.984	45.548	22.016	28.452	25	1652	VERT
2483.5	54	74	32.13	46.271	21.87	27.729	25	1652	VERT

Table RE03.6: FCC restricted band from 2483.5 to 2500 MHz(BLE 2 Mbps 2478 MHz)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
2487.8	54	74	31.837	46.054	22.163	27.946	25	1652	VERT
2483.5	54	74	32.226	46.109	21.774	27.891	25	1652	VERT

Table RE03.7: FCC restricted band from 2483.5 to 2500 MHz (ANT 2480 MHz)

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

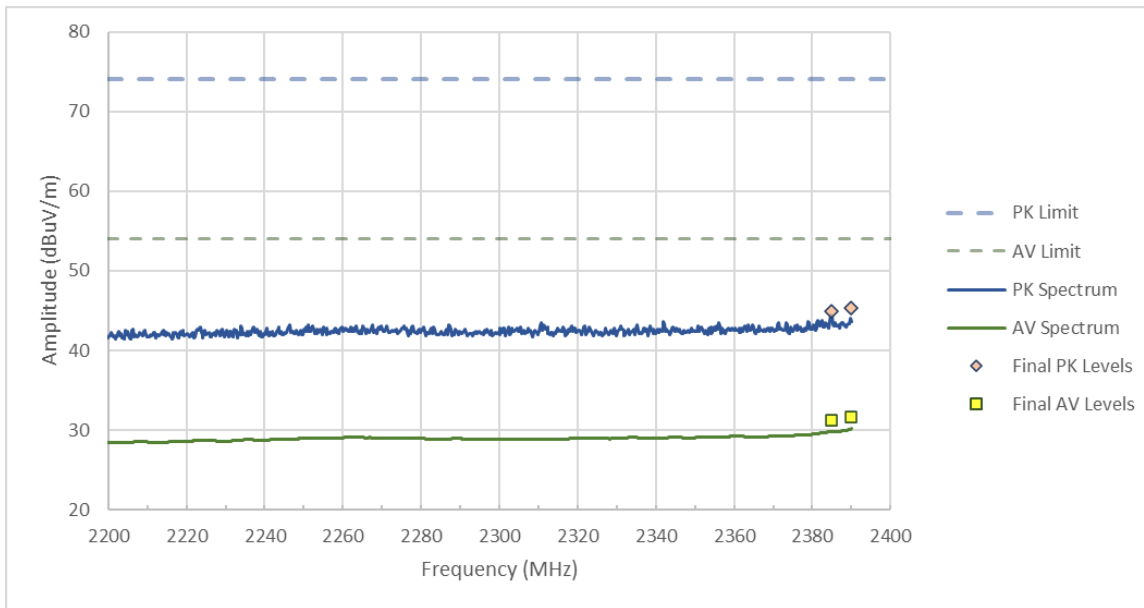


Figure RE03.1: FCC restricted band spectral data from 2200 to 2390 MHz (BLE 1 Mbps 2402 MHz)

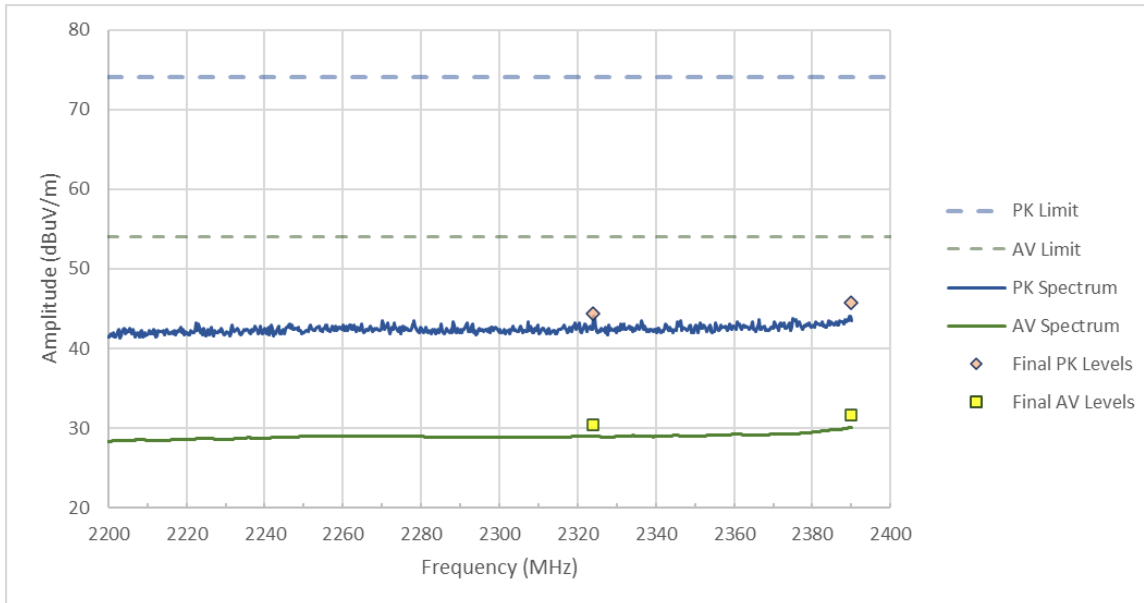


Figure RE03.2: FCC restricted band spectral data from 2200 to 2390 MHz (BLE 2 Mbps 2404 MHz)

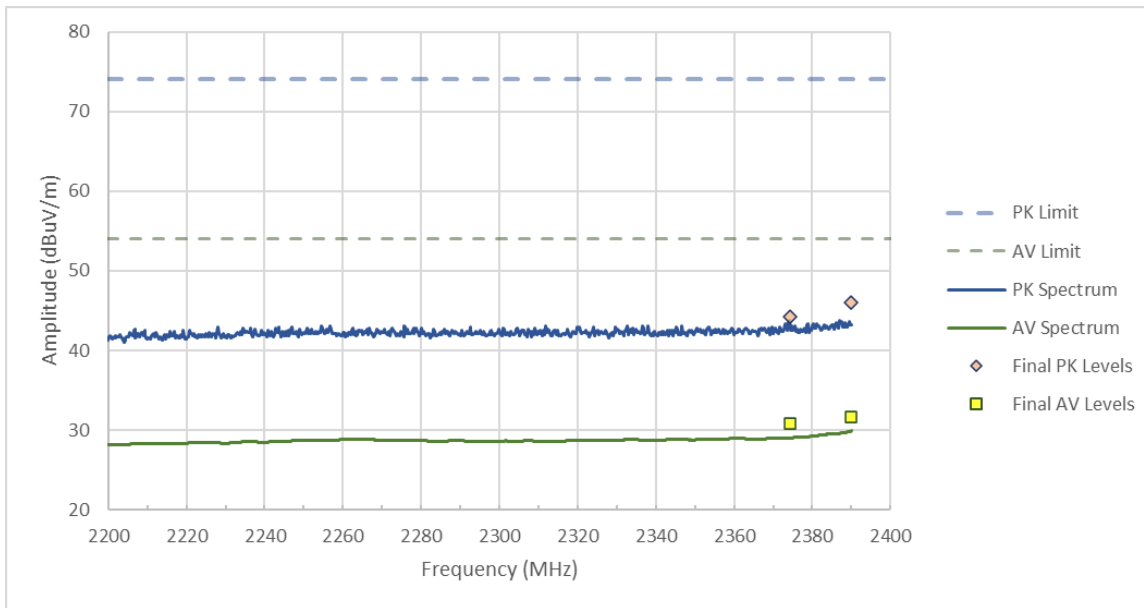


Figure RE03.3: FCC restricted band spectral data from 2200 to 2390 MHz (ANT 2402 MHz)

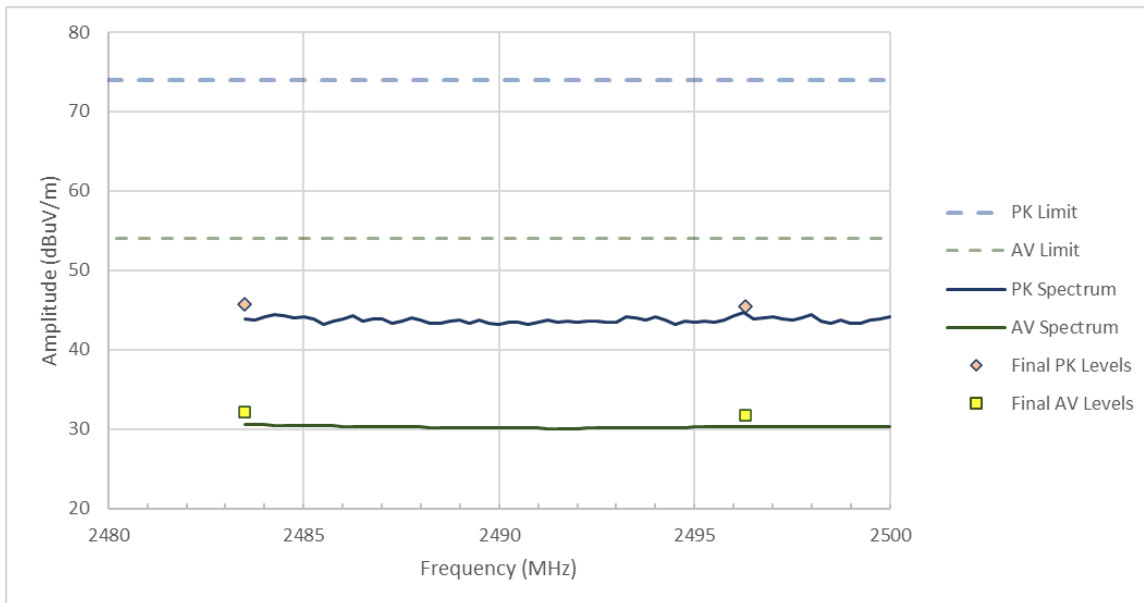


Figure RE03.4: FCC restricted band spectral data from 2483.5 to 2500 MHz (BLE 1 Mbps 2480 MHz)

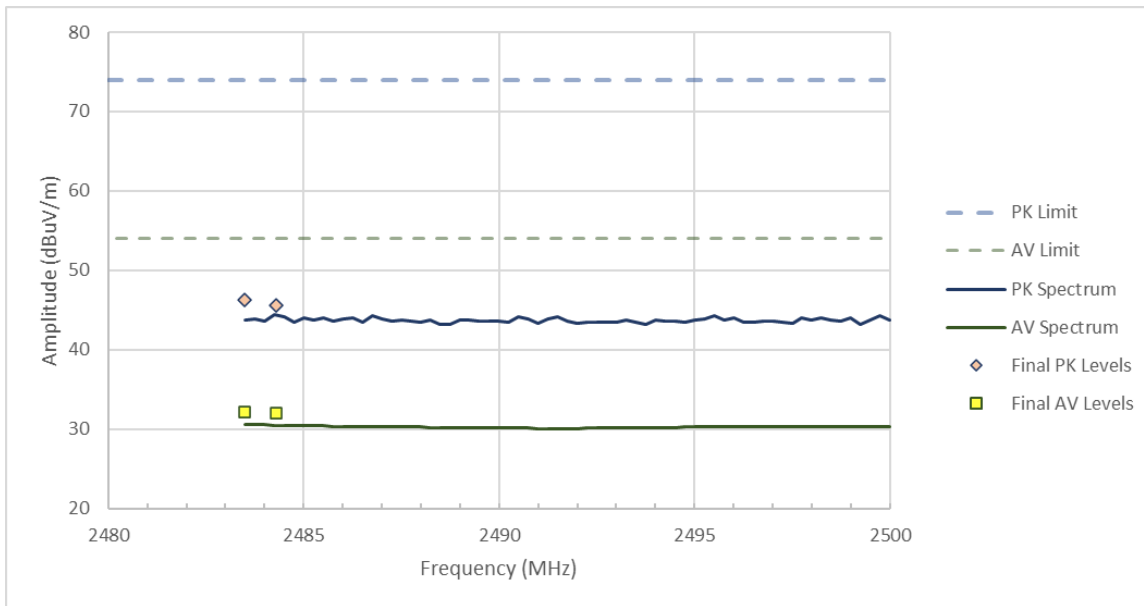


Figure RE03.5: FCC restricted band spectral data from 2483.5 to 2500 MHz (BLE 2 Mbps 2478 MHz)

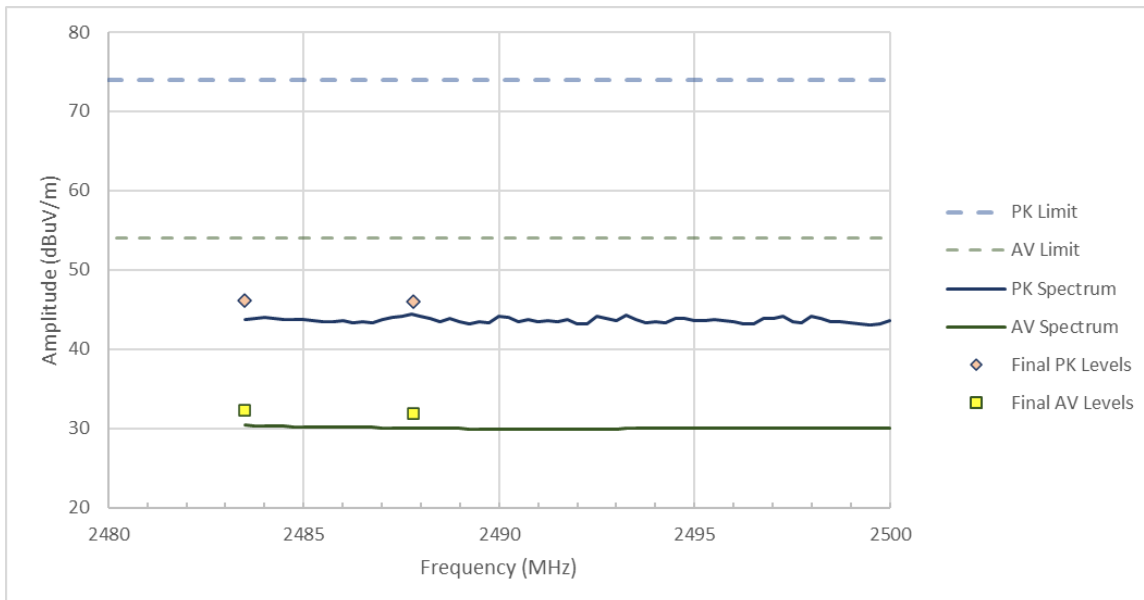


Figure RE03.6: FCC restricted band spectral data from 2483.5 to 2500 MHz (ANT 2480 MHz)

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE03.7: EUT test setup, primary view

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE03.8: EUT test setup, reverse view

This line is the end of the test record.

Test Record
Transmitter Power Spectral Density
Test IDs TR19, TR20, TR21
Project GCL-0425

Test Date(s) 15 November 2024
Test Personnel Aditya Prakash

Product Model A04712
Serial Number tested 3488107722

Operating Mode M3 (BleTx), M5 (AntTx), M7 (WiFiTx)
Arrangement A1 (Solo)
Input Power Internal Battery

Test Standards: FCC Part 15, ANSI C63.10, AS/NZS 4268, RSS-GEN, RSS-210, RSS-247 (as noted in Section 6 of the report).

Antenna Gain -2.78 dBi, as reported by the client
Radio Protocol Bluetooth Low Energy (BLE), ANT, IEEE 802.11 b/g/n (WiFi)

Pass/Fail Judgment: PASS

Test record created by: Aditya Prakash
Date of this record: 15 November 2024
Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44	Keysight	N9048B	MY62220139	21-Oct-2024	21-Oct-2025

Table TR19.1: Test equipment used

Software Used: Keysight PXE software A.33.03, Etsi PSD Analysis Tool 2023May30.xlsx

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.

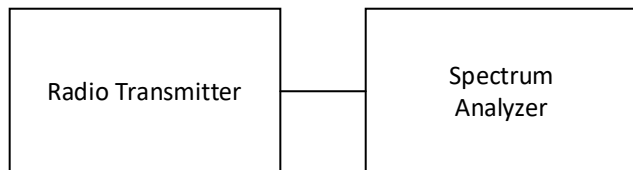


Figure TR19.1: Test setup

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 30 kHz resolution bandwidth.

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

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

	2402 (04)	2440	2480 (78)
BLE 1 Mbps	-17.53	-13.48	-19.79
BLE 2 Mbps	-13.91	-12.94	-20.80
ANT	-14.12	-7.19	-18.32

Table TR19.2: Summary of results for BLE and ANT radios

	Ch1	Ch6	Ch11
B1	NT	-8.300	NT
B2	-6.940	-5.990	-7.270
B5.5	NT	-6.990	NT
B11	NT	-6.550	NT
G6	NT	-7.620	NT
G9	NT	-6.880	NT
G12	NT	-7.020	NT
G18	-7.650	-6.430	-12.740
G24	NT	-8.220	NT
G36	NT	-12.580	NT
G48	NT	-14.520	NT
G54	NT	-14.570	NT
NMCS0	NT	-10.590	NT
NMCS1	NT	-10.590	NT
NMCS2	-9.580	-9.600	-12.140
NMCS3	NT	-11.380	NT
NMCS4	NT	-12.660	NT
NMCS5	NT	-13.080	NT
NMCS6	NT	-13.730	NT
NMCS7	NT	-16.200	NT

Table TR19.3: Summary of results for IEEE 802.11 b/g/n (WiFi)

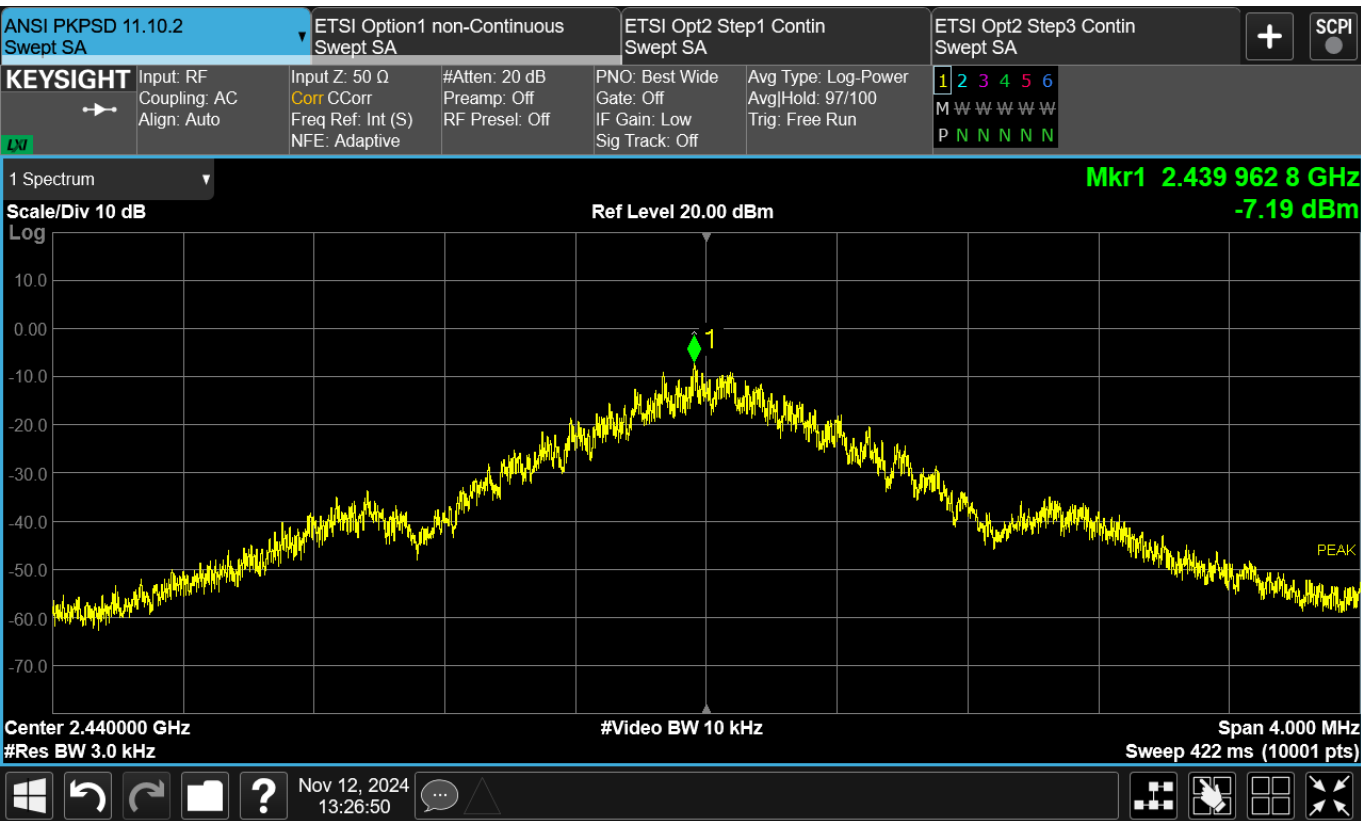


Figure TR19.2: Test data for ANT 2440 MHz

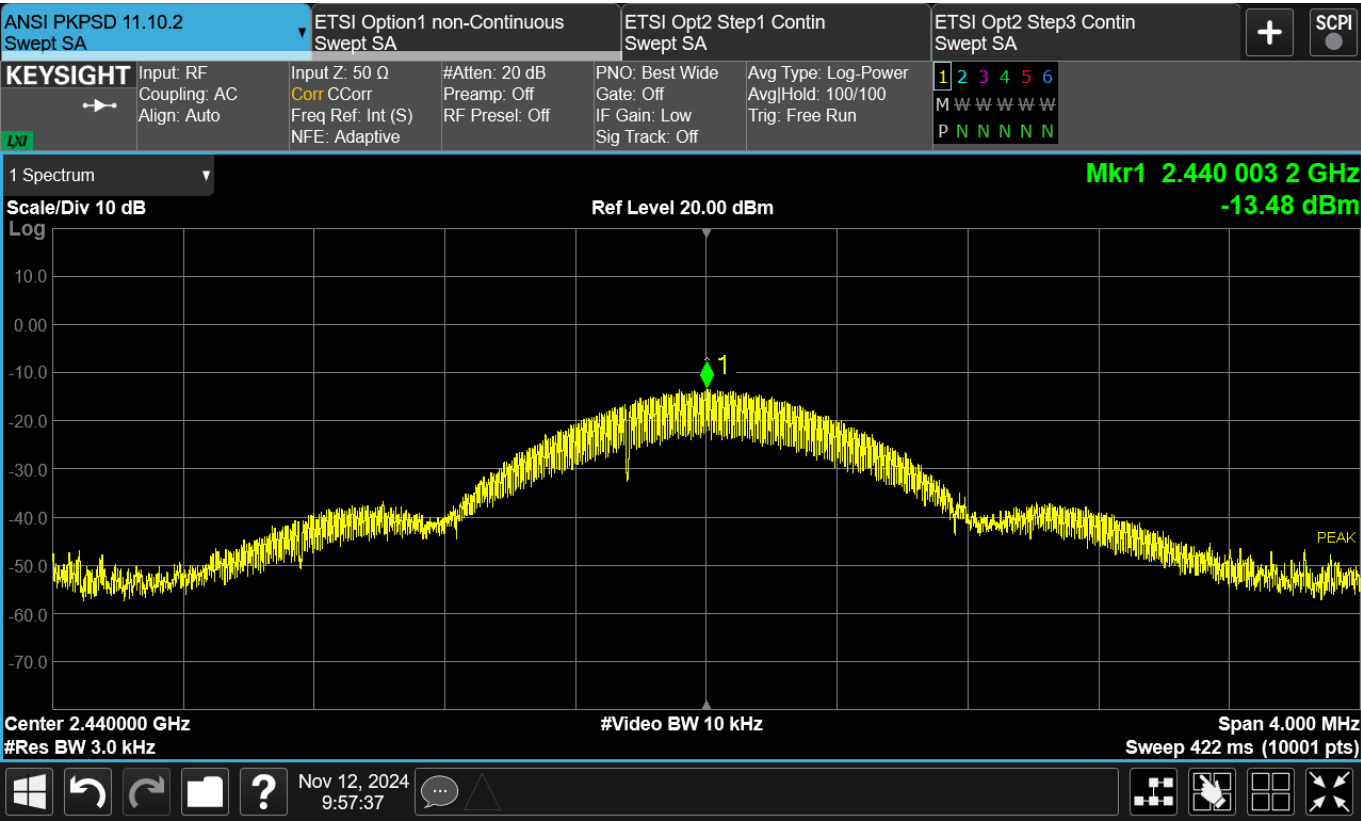


Figure TR19.3: Test data for BLE 1 Mbps 2440 MHz

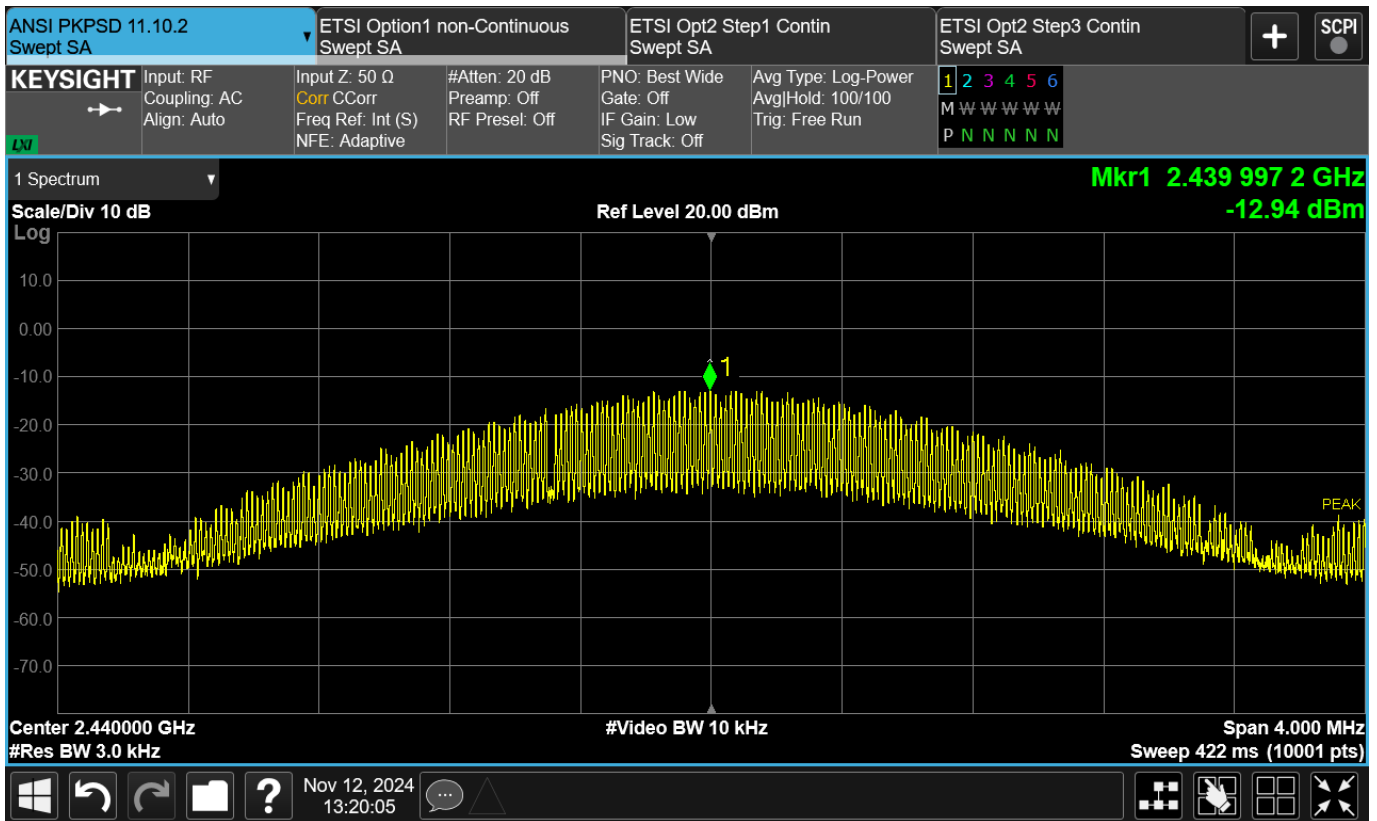


Figure TR19.4: Test data for BLE2 Mbps 2440 MHz

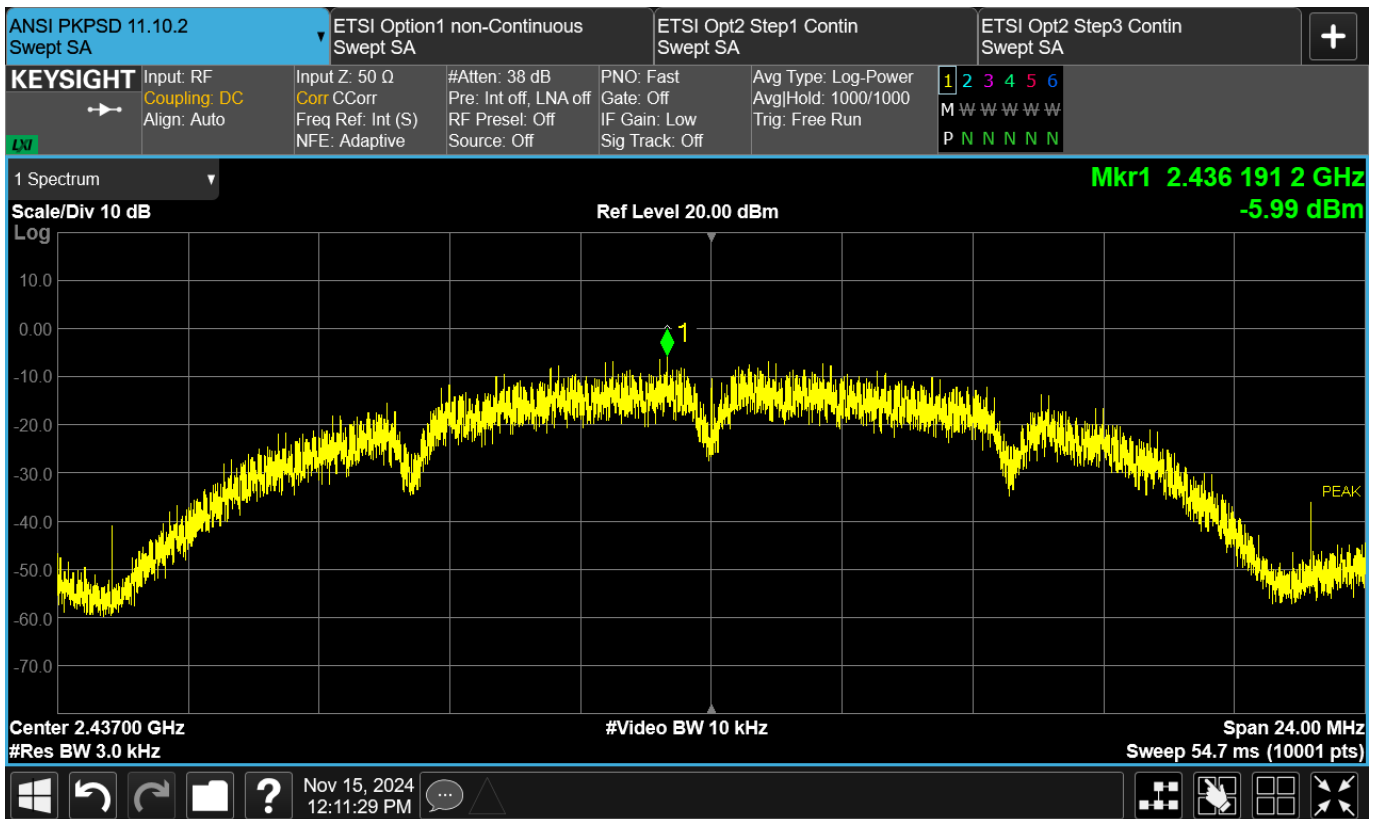


Figure TR19.5: Test data for IEEE 802.11 B 2 Mbps (WiFi) 2437 MHz

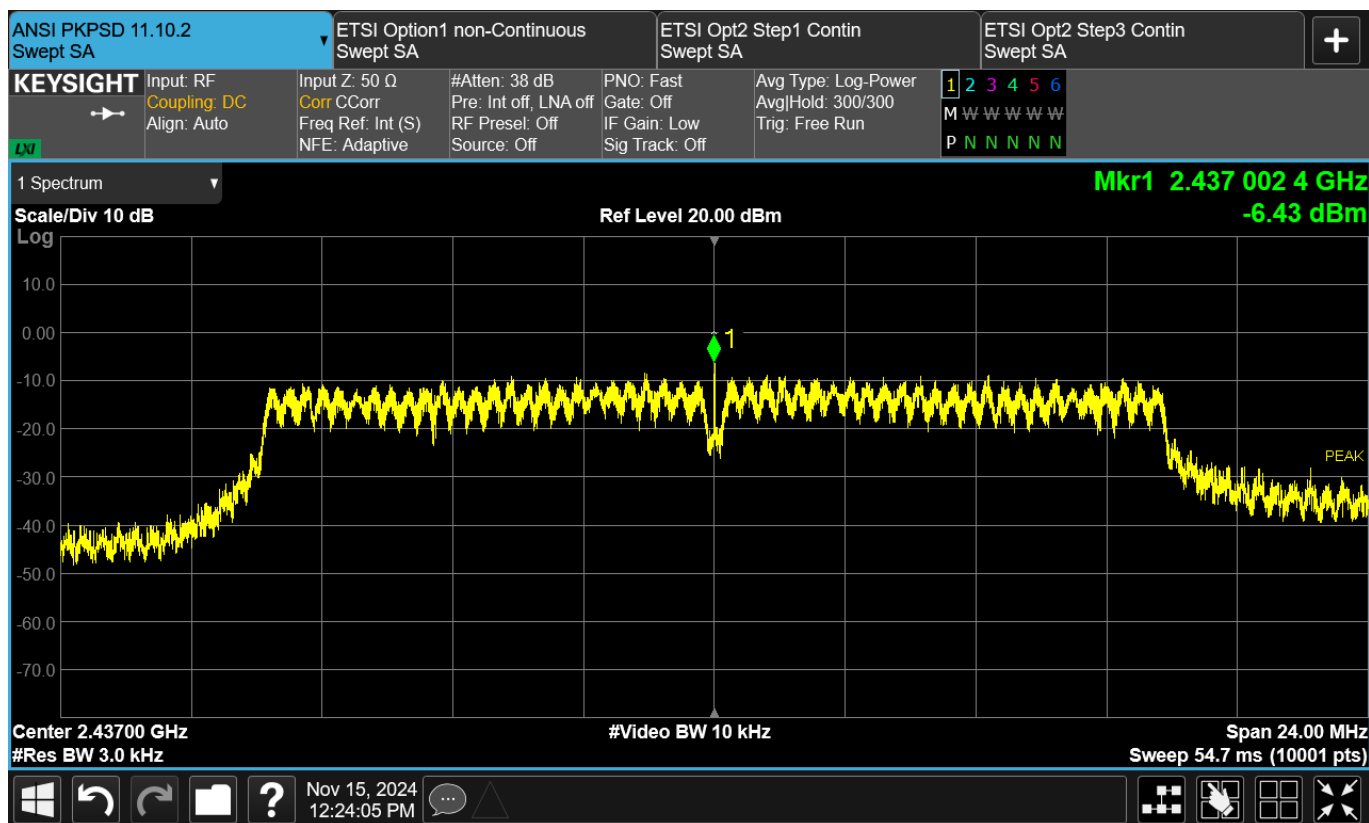


Figure TR19.6: Test data for IEEE 802.11 G 18 Mbps (WiFi) 2437 MHz

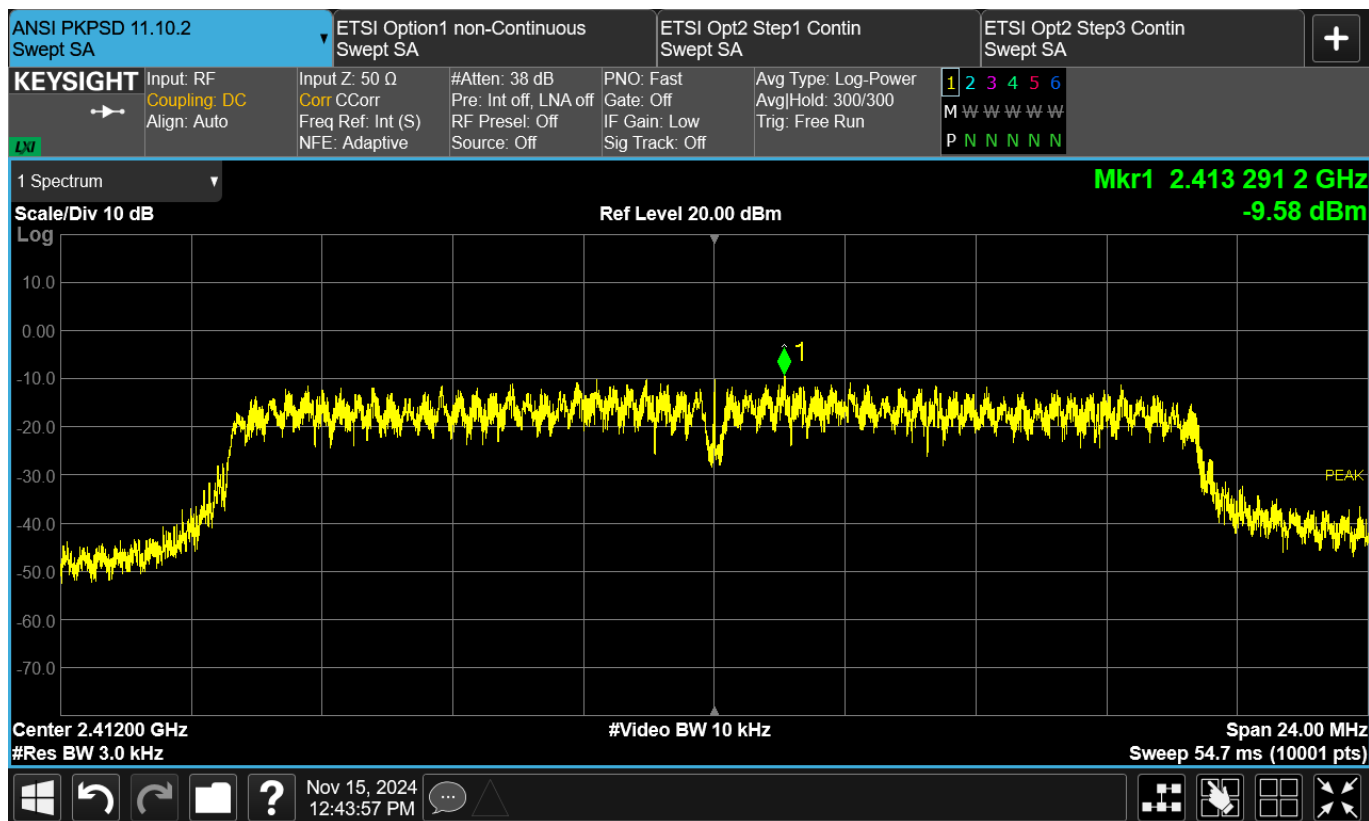


Figure TR19.7: Test data for IEEE 802.11 NMCS2 (WiFi) 2412 MHz

This line is the end of the test record.

Test Record

Conducted Emissions Mains Test CE03

Project GCL0425

Test Date(s) 29 Oct 2024
Test Personnel Jim Solum

Product Model A04712
Serial Number tested 3488107710

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: 30 Oct 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	21-Oct-2024	21-Oct-2025
LISN multiline; 20A 50uH	Com-Power	LIN-120C	20160005	3-Apr-2024	1-Apr-2027
DMM Multimeter 87V	Fluke	87V	63490051	21-Jun-2024	21-Jun-2025
Shockforce G1 Tape Measure	Crecent Lufkin	L1135CME-02	GMN0013784	26-Jun-2024	26-Jun-2027

Table CE03.1: Test Equipment Used

Software Used

Keysight PXE software A.39.28; CE Mains 150k to 30M Data Analysis V3 2024May23.xlsx

Test Data

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

The table shows the selected final measurement data. 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.

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 (kHz)	QP Limit (dBuV)	AV Limit (dBuV)	L1 QP (dBuV)	L2 QP (dBuV)	L1 AV (dBuV)	L2 AV (dBuV)	QP Margin (dB)	AV Margin (dB)
150	66.00	56.00	40.64	40.45	24.02	23.79	25.36	31.98
431	57.23	47.23	27.28	25.55	21.15	19.17	29.95	26.08
10001	60.00	50.00	27.22	26.71	20.44	20.57	32.78	29.43

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.

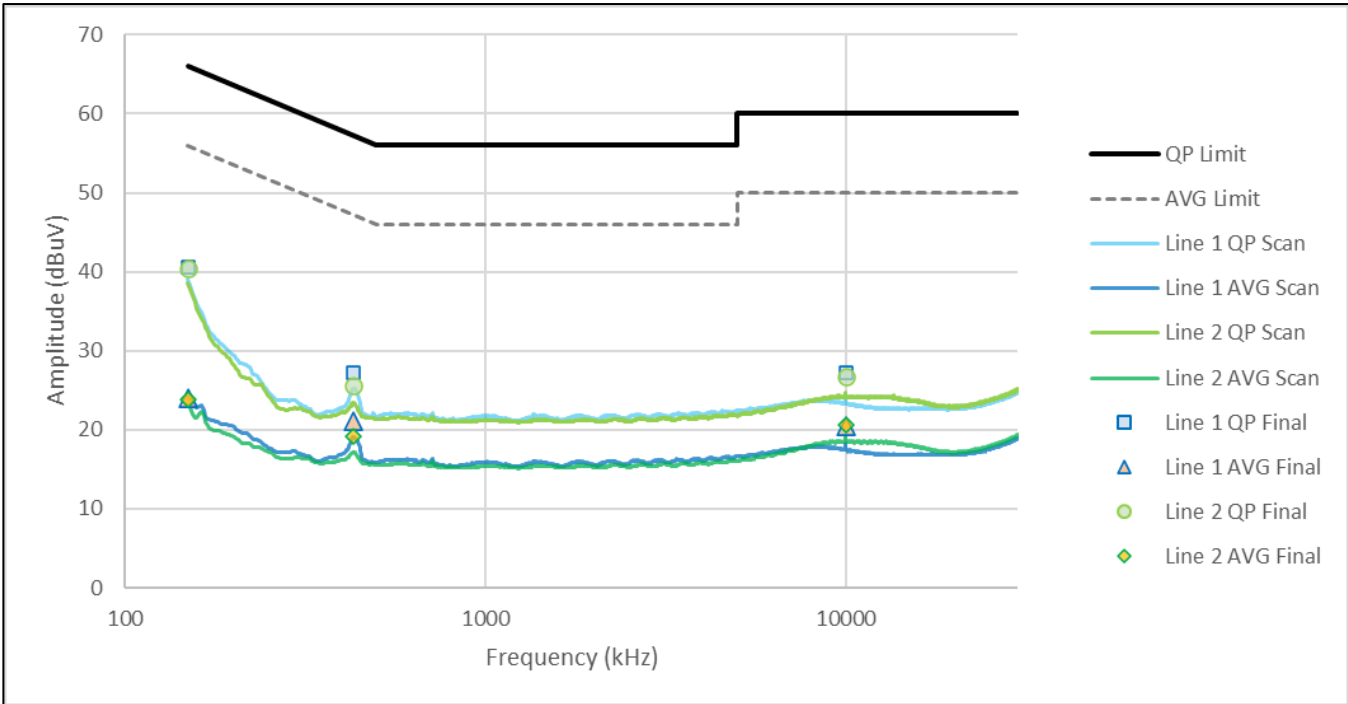


Figure CE03.1: Spectral data

Setup Photographs

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

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure CE03.2: Test setup, first view

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

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.