Test Report 2023-073

Version A
Issued 29 Nov 2023

Project GCL-0388
Model Identifier A04752
Primary Test Standard
FCC Part 15.247
RSS 247 Issue 2

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

Client-supplied Information

FCC ID: IPH-04752
IC ID: 1792A-04752

ACCREDITED
CERTIFICATE #6162.01

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

1. Summary

The equipment or product described in section 5 of this report was tested at the Garmin Compliance Lab according to standards listed in section 6. This report focuses on the 2.4 GHz DTS transceiver(s). This includes WiFi, BLE and Bluetooth EDR 2 and EDR 3. It does not include Bluetooth Basic rate or ANT. References to the Ant and Basic rate transmitters, or performance data for those transmitters, may appear in this report but are not directly relevant. The results are as follows.

Parameter	Description	Key Performance Values	Result	Data starts at page
Hopping Channels	The radio manages it use of channels appropriately. [15.247(a)(1); RSS-247 at 5.1]	N/A. The radios described in this report are not subjected to the Frequency Hopping rules.	N/A	N/A
DTS Bandwidth	The nature of the radio signal is broadband, being at least 500 kHz wide. [15.247(a)(2); RSS-247 at 5.2(a)]	The 6dB bandwidth is 712 kHz or greater.	PASS	13
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	21
Transmit Power	The peak transmit power presented to the antenna is no greater that 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 12.62 dBm or 18.3 mW. This corresponds to 14.27 dBm EIRP, or 26.7 mW EIRP.	PASS	29
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 1.65 dBi and will document antenna gain separately.	NT	NT
Unwanted Emissions (Conducted Spurious)	The radio should not provide too much radio energy to the antenna at frequencies beyond its intended frequency band. [15.247(d); RSS-247 at 5.5]	Emissions outside the band must be reduced at least 20 dB from in-band levels. The measured reduction was at least 32.6 dB.	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 3.8 dB below the applicable limits.	PASS	47
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 -2.15 dBm in a band of at least 3 kHz.	PASS	65

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 subject to the Frequency Hopping rules. [Alternate] These requirements in 15.247(g) and (h) are not testable. The change entries from N/A to NT	N/A	N/A
Radio Safety	The radio emissions must meet public health & safety guidelines related to human exposure. [15.247(i) and 1.1307; RSS-Gen at 3.4]	NT. Client will report radio energy safety results separately.	NT	NT
Frequency Stability	The radio tuning must be robust over a range of temperature and supply voltage conditions. [RSS-Gen at 6.11]	Radio emissions remained within the allowed radio band under all environmental conditions tested.	PASS	72
Unwanted Emissions (Radiated Spurious)	While transmitting, the radiated emissions must not be too strong. [15.209, RSS-Gen at 8.9]	Emissions other than the fundamental and harmonics must meet the 'Class B' limits. The measured emissions had at least 1.6 dB of margin.	PASS	78
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 8.8 dB of margin.	PASS	116

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

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 2023-076. That report is treated as a part of this document by way of this reference.

2. Test Background

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.

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.

Test Sample received: 01 Aug 2023
Test Start Date: 19 Sep 2023
Test End Date: 03 Nov 2023

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 David Arnett and initially issued on 29 Nov 2023 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:

The WiFi radio must not be operated on 40 MHz bandwidths in the 2.4 GHz band below channel 3 (centered at 2432 MHz) or above channel 9 (centered at 2462 MHz). The transmit power setting for Channel 9 in 40 MHz operation has to be reduced to the level described by Garmin engineering as setting 13.

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: The audio cable from the docking unit was terminated and the audio common wire in that cable was connected to the ground of the dc cable. Specifically, the black wire in the audio cable was connected the blue wire with a 200 Ohm resistor, to the White wire with a 10 kOhm resistor, to the Grey wire with a 10 kOhm resistor, and to the black wire of the Power/CAN bus cable with piece of wire 18 cm long.

Date applied: 25 Oct 2023
Reason for this modification: Without this modification, an emission at 247.62 MHz was above the limit and appeared to be radiating from the previously-unterminated audio cable.

The emission was determined to be unrelated to radio transmitter frequencies and uncorrelated to radio transmission activity. The emission was observed to be present whether the various radios were active or idle. 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: All transmitter characterization tests (transmit power, bandwidths, spectral densities, and other emission tests above 1 GHz); Radiated emission tests above 1 GHz; AC Powerline emission tests. This modification was present during the spurious emission tests below and above 1 GHz for the 5 GHz radio services and no negative effect above 1 GHz was observed due to its presence.

5. Description of the Equipment Tested

5.1 Unique Identification

Product Model	A04752
Serial Numbers Tested	3449554812 (unmodified, with memory card), 3449554852 (modified), 3449554828 (modified)

This product tested is an information collection and distribution system for vehicular use.

The client affirmed that the test samples will be representative of production in all relevant aspects. The product design includes one antenna for the 2.5 GHz and a separate antenna for the 5 GHz radio band. Two test samples were modified to replace the antennas with RF cables. Each modified sample had two RF cables representing the different transmission paths.

5.2 Key Parameters

EUT Input Power:	12 Vdc Nominal (13.8 Vdc expected and generally used in test)
I/O Ports:	USB; micro-SD memory card; docking unit interface to power, audio, and CAN bus
Radio Transceivers:	IEEE 802.11 a/b/g/n/ac, Bluetooth, Bluetooth Low Energy, ANT/ANT+
Radio Receivers:	GNSS
Primary Functions:	Collecting and distributing information
Typical use:	Vehicle mounted in a set orientation
Highest internal frequency:	5.85 GHz
Firmware Revision	1.16

5.3 Operating modes

During test, the EUT was operated in one or more of the following modes. Note that 802.11 n and ac both use MCS-based modulation indices. They are treated as interchangeable in this report, meaning that where one of the two WiFi modes was selected it represents both.

Mode 1: M1 (BtcTx). The unit continuously transmits Bluetooth data packets on a selected channel. Note that for this test series, M1 only relates to EDR2 (2 Mbps using π/4 DPSK) and EDR3 (3 Mbps using 8DPSK modulation). The Bluetooth Basic Rate is handled under mode M6.

Mode 2: M2 (BleTx). The unit continuously transmits Bluetooth Low Energy (BLE) data packets on a selected channel at a 1 Mbps rate using frequency shift keying.

Mode 3: M3 (WiFi2Tx). The unit continuously transmits WiFi data packets on a selected channel in the 2.4 GHz band under the IEEE 802.11 b/g/n/ac protocols using 20 MHz or 40 MHz nominal channel bandwidths.

Mode 4: M4 (WiFi5Tx). The unit continuously transmits WiFi data packets on a selected channel in the 5 GHz band (U-NII-1 and U-NII-3 sub-bands) under the IEEE 802.11 a/n/ac protocols using 20 MHz or 40 MHz nominal channel bandwidths.

Mode 5: M5 (GNSS). The unit attempts to receive and decode GNSS signals from a variety of constellations. Where relevant, GPS signals were provided to the test sample.

Mode 6: M6 (AntTx). The unit continuously transmits Bluetooth Basic Rate data packets on a selected channel. The modulation scheme is GFSK. The client stated that this operating mode represents both Bluetooth Basic rate and ANT/ANT+ transmissions. See mode M1 for EDR2 and EDR3 transmissions.

5.4 EUT Arrangement

During test, the EUT components and associated support equipment were selected including the following arrangement sets. Test sample 3449554812 had a microSD data card installed in all configurations tested. The other test samples did not.

Arrangement 1: A1 (Mounted.) The test sample is connected to a docking interface unit. The docking interface unit connects for multiple functions. It connect the test sample to dc power. It connects the test sample to a typical

accessory containing a VHF radio that is already certified and not exercised in this test series. The docking unit is capable of connecting the test sample to a vehicle CAN bus interface and to an audio system. The CAN bus and audio interfaces were left unterminated per client instruction. See section 4 of this report related audio interface termination.

Arrangement 2: A2 (USB.) The test sample is connected to an AC/DC power converter via its USB port. The docking interface is not connected, and the USB port does not carry data.

Arrangement 3: A3 (PC.) The test sample is connected to a computer via its USB port and the USB interface carries data. The docking interface is not connected.

Arrangement 4: A4 (Dual.) The test sample is connected to computer via its USB port as in A3 (PC) and to the docking interface as in A1 (Mounted).

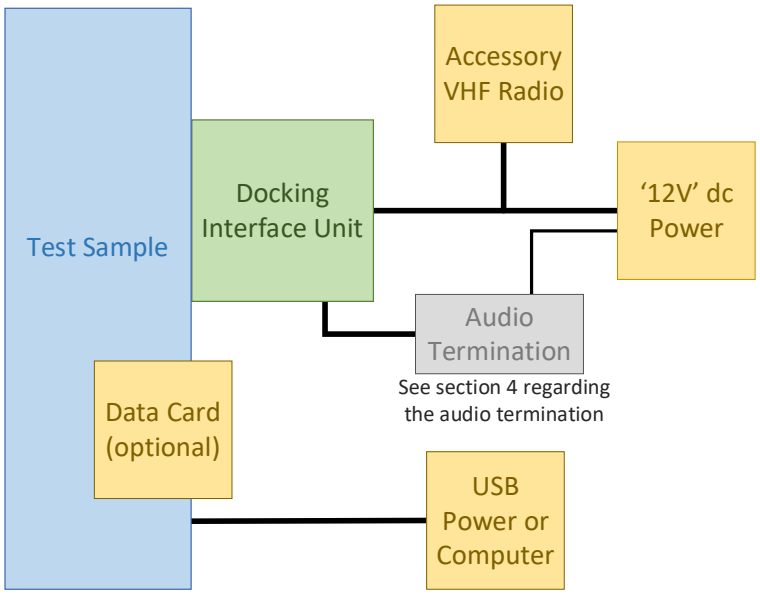

Figure 1: Block diagram of equipment present in arrangements A1 through A4

5.5 Associated Equipment (AE) used

Description	Manufacturer	Model	Serial Number
USB Power Adaptor	Phihong	PSAF10R-050Q	P183100844A1
Laptop	Dell	Inspiron	7DCR5R3
Power Supply	Dell	DA65NM191	CN-0KPVMF-DES00-233-EE1V-A00
Computer	Dell	Latitude 5410	5VSPFB3
Power Supply	Dell	HA65NM191	0BD-7TC0-A02
UHF Radio	Garmin	011-05234-84	75B005065
UHF Radio	Garmin	011-05234-84	75B004799
4G microSD memory card	Transcend	9193AB 4G 07SM1	None

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

5.6 Cables used

Note that the docking interface unit is treated as a cable because its function is interconnection.

Description	From	To	Length	EMC Treatment
Docking Interface 1	EUT port	Audio, CAN, Power, VHF radio	57 cm	None
Docking Interface 2	EUT port	Audio, CAN, Power, VHF radio	57 cm	None
Docking Interface 3	EUT port	Audio, CAN, Power, VHF radio	57 cm	Termination resistors placed on audio port, and ground wire included between audio common line and dc power ground
USB cable	EUT USB port	PC or USB power adapter	50 cm	None

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

5.7 Channel identification

With regard to test modes, the channel numbering for 40 MHz WiFi signals seems to have some inconsistency across the industry. For the purpose of this report, here are the channels numbers used by this lab and their corresponding center frequencies.

Channel #	3	4	5	6	7	8	9
Freq (MHz)	2432	2437	2442	2447	2452	2457	2462

Table 4: Identification of 40 MHz channels

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 15.247
ANSI C63.10: 2013
RSS-GEN Issue 5 Amd 2
RSS-247 Issue 2

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.

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.

6.4 Laboratory Accreditation

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

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

7 Measurement Instrumentation Uncertainty

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

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

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

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

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

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

8 Selected Example Calculations

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

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

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

8.1 AC Mains conducted emissions at 22 MHz

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

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

8.2 Radiated Emissions at 630 MHz

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

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

8.3 Radiated Emissions at 2.7 GHz

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

(43.72 dBuV) + (32.22 dB/m) + (-36.09 dB) = 39.85 dBuV/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:	20.5 to 24.0 °C
Relative Humidity:	19.9% to 55.7% (non-condensing)
Barometric Pressure	96.3 to 99.5 kPa

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
Barometer	Traceable	6453	221702700	3-Aug-2022	1-Aug-2024

Table 5: Environmental monitoring device

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
Project GCL-0388

Test Date(s)	2 Oct 2023
Test Personnel	David Arnett
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M1 (BtcTx), M2 (BleTx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report).
Radio Protocol	Bluetooth Classic EDR2 and EDR3, Bluetooth Low Energy (BLE)
Radio Band	2400 to 2483.5 MHz

Pass/Fail Judgment: **PASS**

Test record created by: **David Arnett**
Date of this record: **4 Oct 2023**
Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220146	3-Jun-2023	3-Jun-2024

Table TR06.1: List of test equipment used

Test Software Used: Keysight PXE firmware A.35.06

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.

In general, the various modulations are evaluated while the radio is tuned to a middle channel to find the worst case modulation. For that modulation, the lowest and highest channels are also evaluated.

Test Setup

This block diagram shows the test equipment setup.

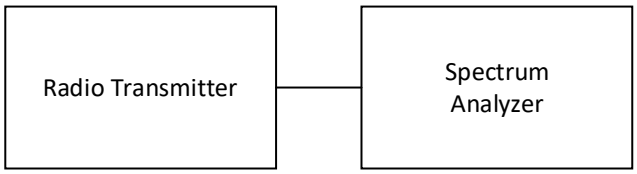

Figure TR06.1: Test setup

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.

Frequency	(MHz)	2402	2440	2480
BT	EDR2	**1.054**	**1.059**	**1.059**
	EDR3	**1.067**	**1.067**	**1.067**
BLE	1 Mbps	**0.719**	**0.716**	**0.712**

Table TR06.2: Summary of bandwidth data in MHz for Bluetooth and BLE modes

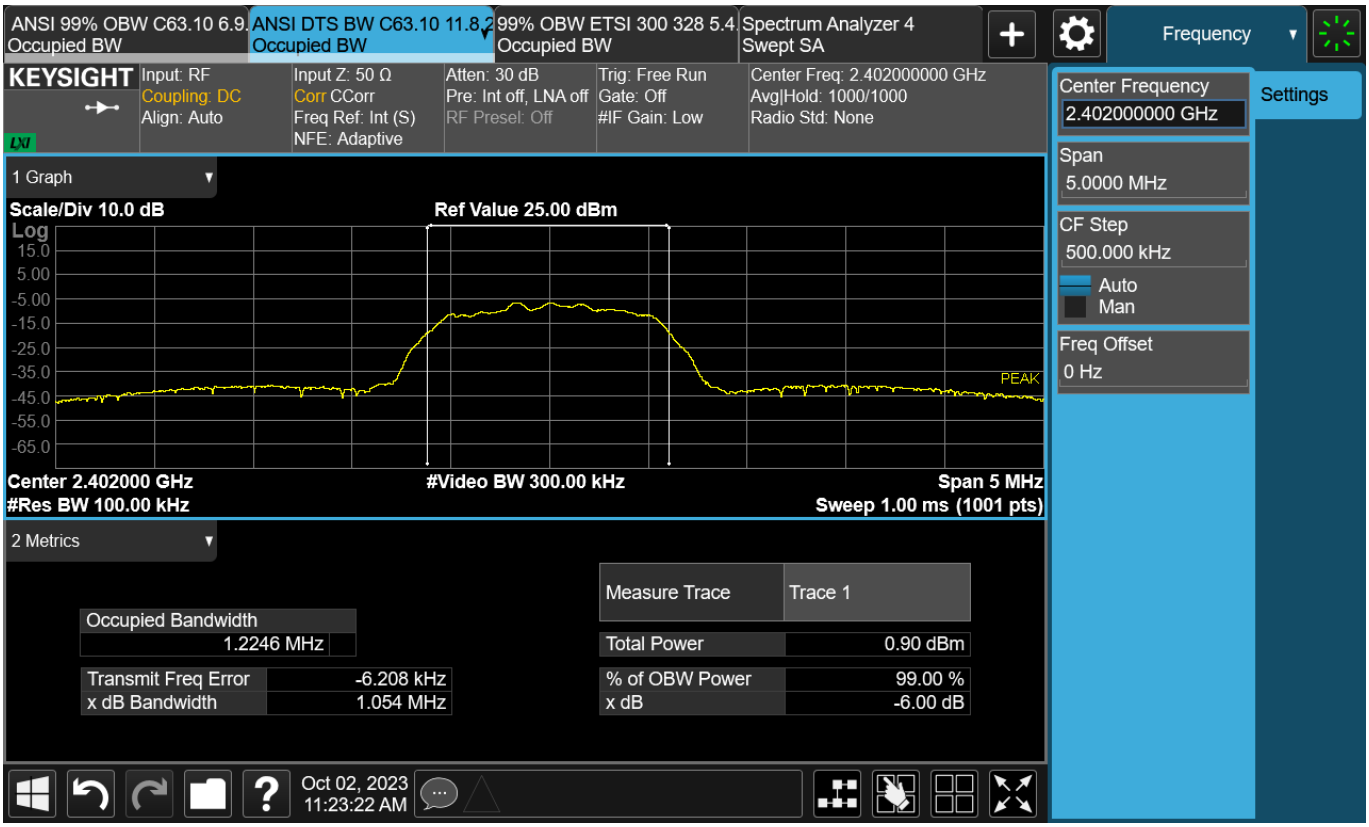

Figure TR06.2: Bandwidth data for Bluetooth EDR2 mode at low channel (2402 MHz)

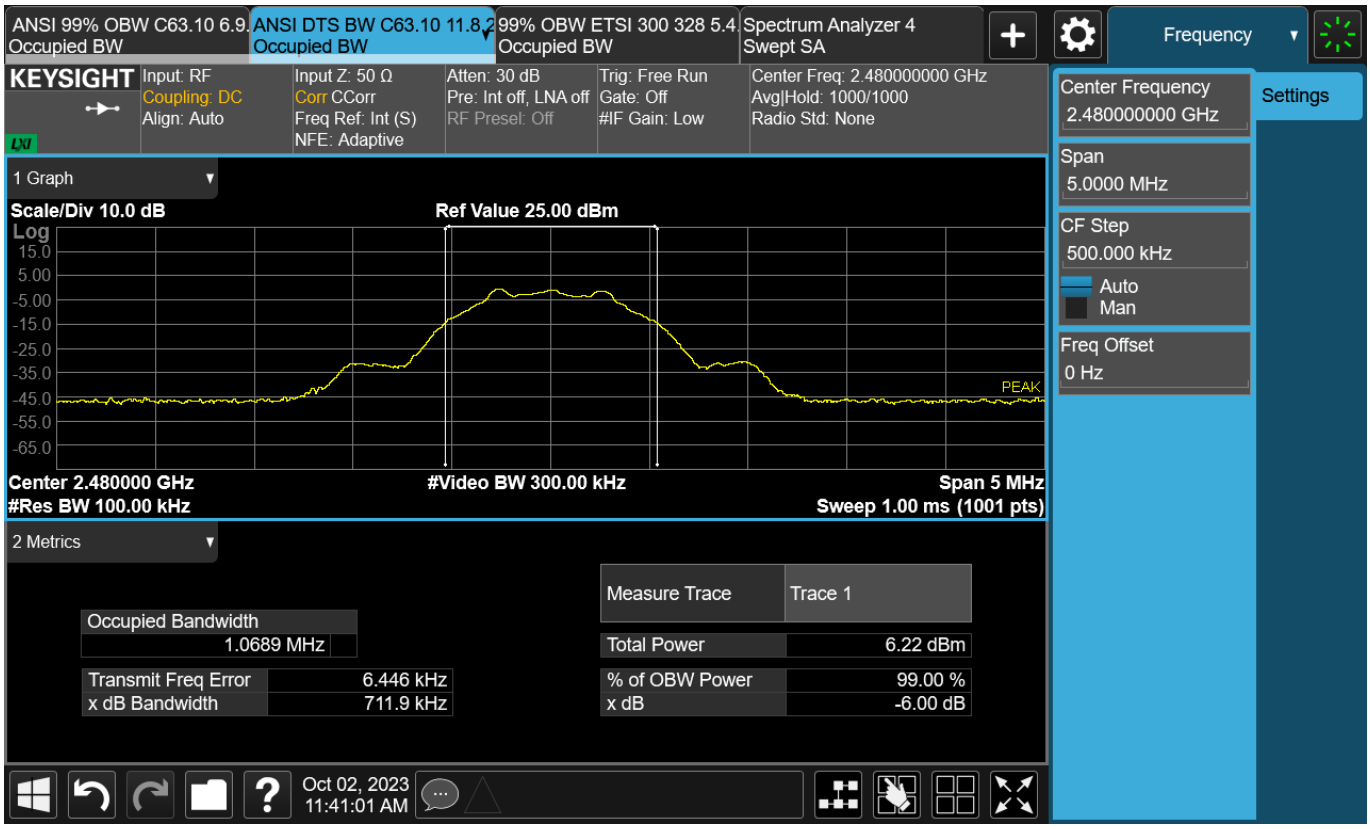

Figure TR06.3: Bandwidth data for BLE at high channel (2480 MHz)

This line is the end of the test record.

Test Record
Transmitter Bandwidth Tests
Test IDs TR08
Project GCL-0388

Test Date(s)	1 Jan 2023
Test Personnel	David Arnett
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M3 (WiFi2Tx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report).
Radio Protocol	IEEE 802.11b/g/n20/n40
Radio Band	2400 to 2483.5 MHz

Pass/Fail Judgment: **PASS**

Test record created by: **David Arnett**
Date of this record: **Date**
Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220146	3-Jun-2023	3-Jun-2024

Table TR08.1: List of test equipment used

Test Software Used: Keysight PXE firmware A.35.06

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.

In general, the various modulations are evaluated while the radio is tuned to a middle channel to find the worst case modulation. For that modulation, the lowest and highest channels are also evaluated. Lowest and highest channels are Not tested (NT) for other modulations.

Test Setup

This block diagram shows the test equipment setup.

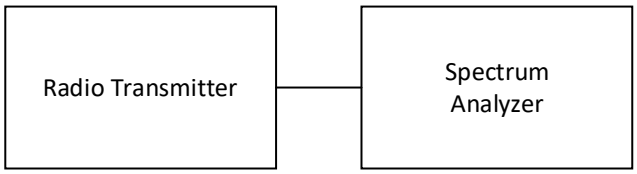

Figure TR08.1: Test setup

Test Data

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

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

Frq (MHz)	2412	2437	2462
Channel	1	6	11
Modulation			
B1	NT	8.115	NT
B2	NT	8.23	NT
B5.5	NT	8.609	NT
B11	7.548	7.541	7.54
G6	15.35	15.14	15.37
G9	NT	15.47	NT
G12	NT	15.17	NT
G18	NT	15.17	NT
G24	NT	16.08	NT
G36	NT	15.69	NT
G48	NT	15.76	NT
G54	NT	15.51	NT
MCS0	NT	15.51	NT
MCS1	NT	15.32	NT
MCS2	15.17	15.18	15.18
MCS3	NT	16	NT
MCS4	NT	15.83	NT
MCS5	NT	15.37	NT
MCS6	NT	16.12	NT
MCS7	NT	16.11	NT

Table TR08.2: Summary of bandwidth data in MHz for IEEE 802.11 WiFi 2.4 GHz with 20 MHz channels

Frq (MHz)	2432	2447	2462
Channel	3	6	9
Modulation			
MCS0	NT	36.43	NT
MCS1	NT	36.12	NT
MCS2	NT	36.25	NT
MCS3	NT	36.15	NT
MCS4	NT	35.96	NT
MCS5	NT	36.26	NT
MCS6	35.73	35.78	35.83
MCS7	NT	36.45	NT

Table TR08.3: Summary of bandwidth data in MHz for IEEE 802.11 WiFi 2.4 GHz with 40 MHz channels

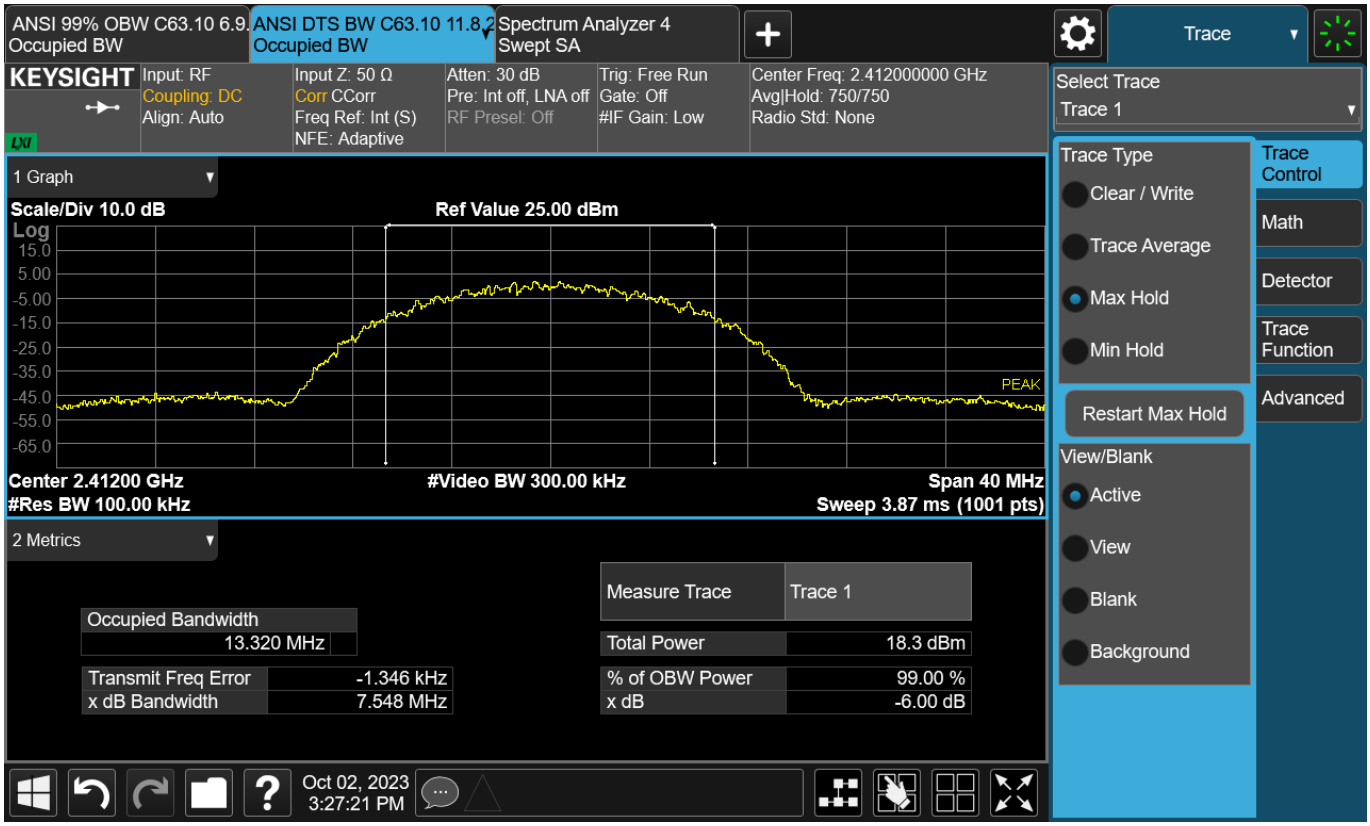

Figure TR08.2: Bandwidth data for 802.11b 11 Mbps at channel 1

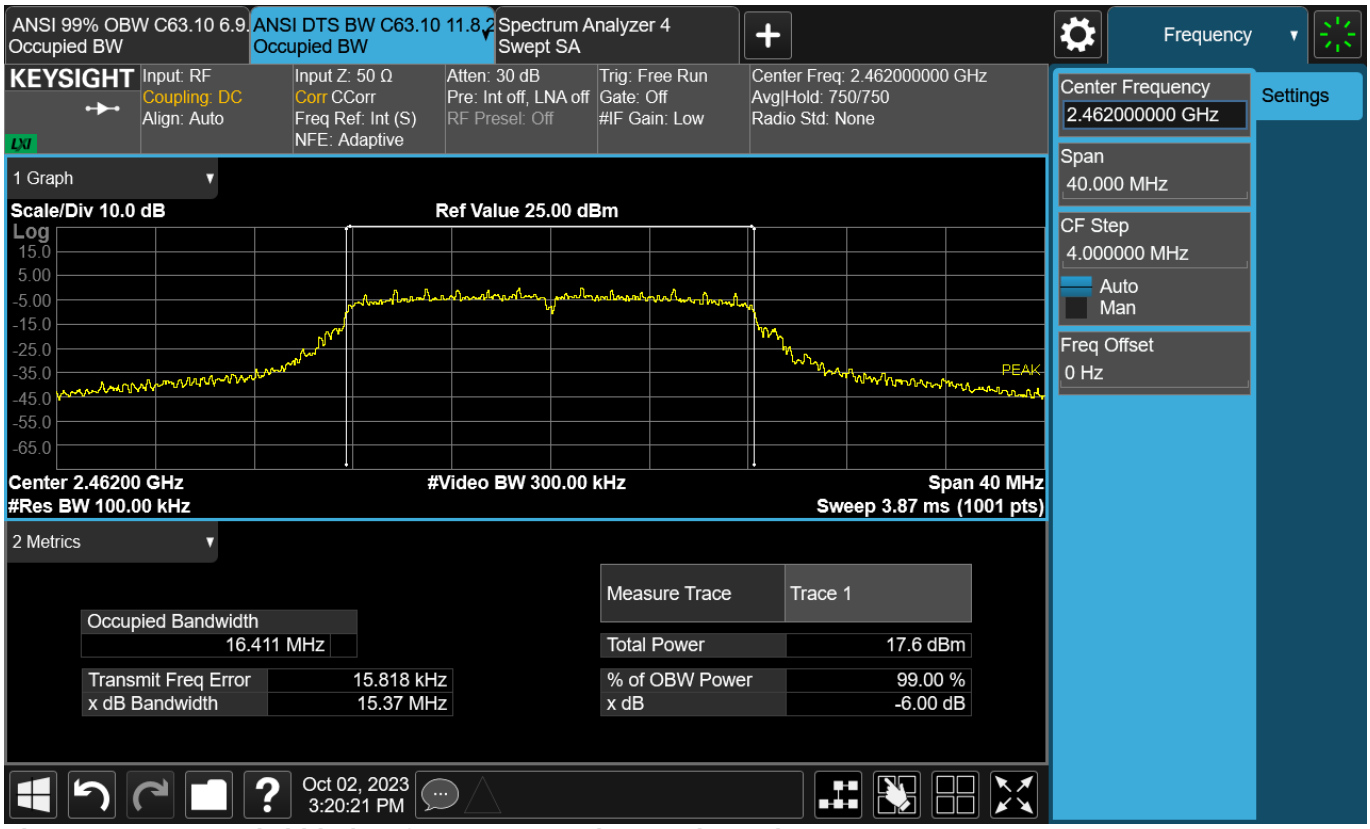

Figure TR08.3: Bandwidth data for 802.11g 6 Mbps at channel 11

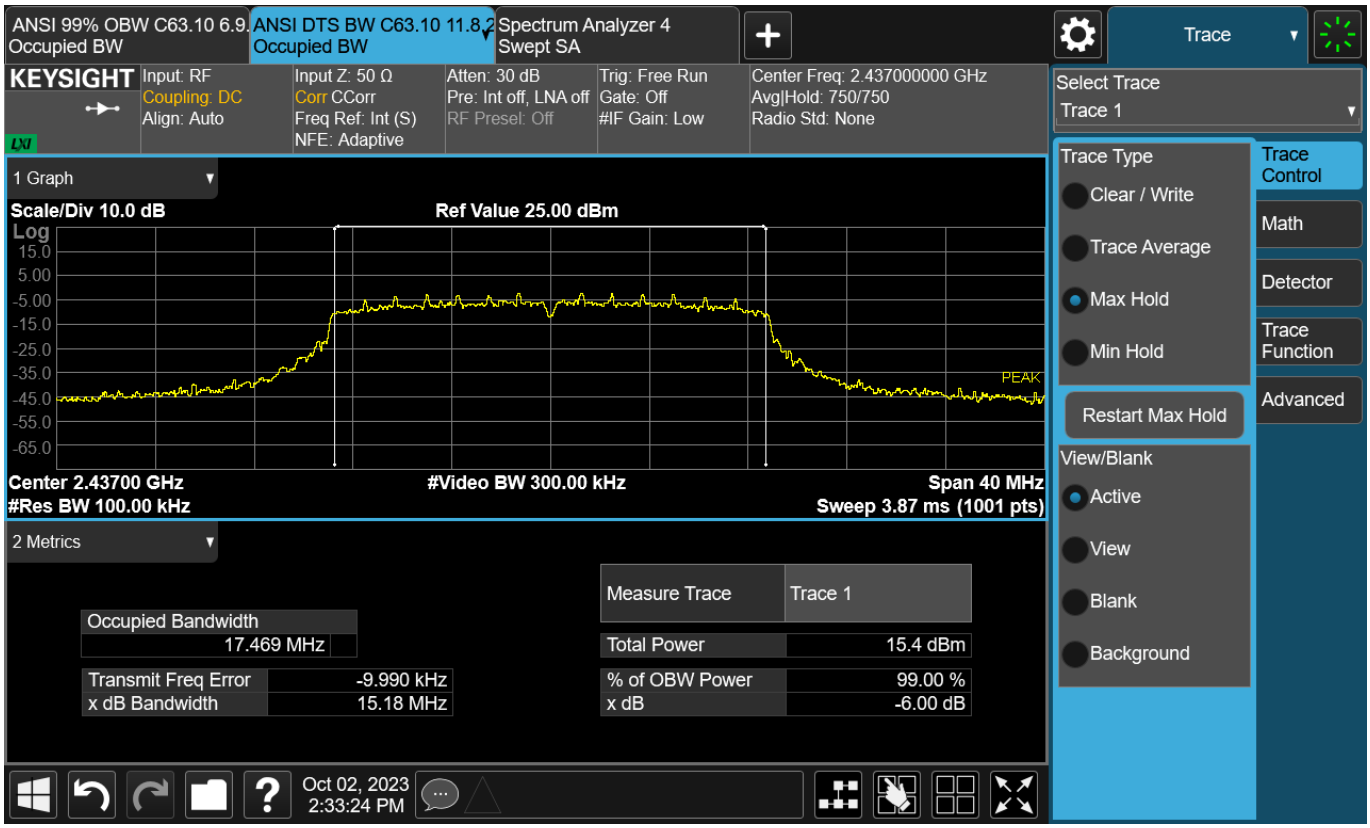

Figure TR08.4: Bandwidth data for 802.11n20 MCS2 at channel 6

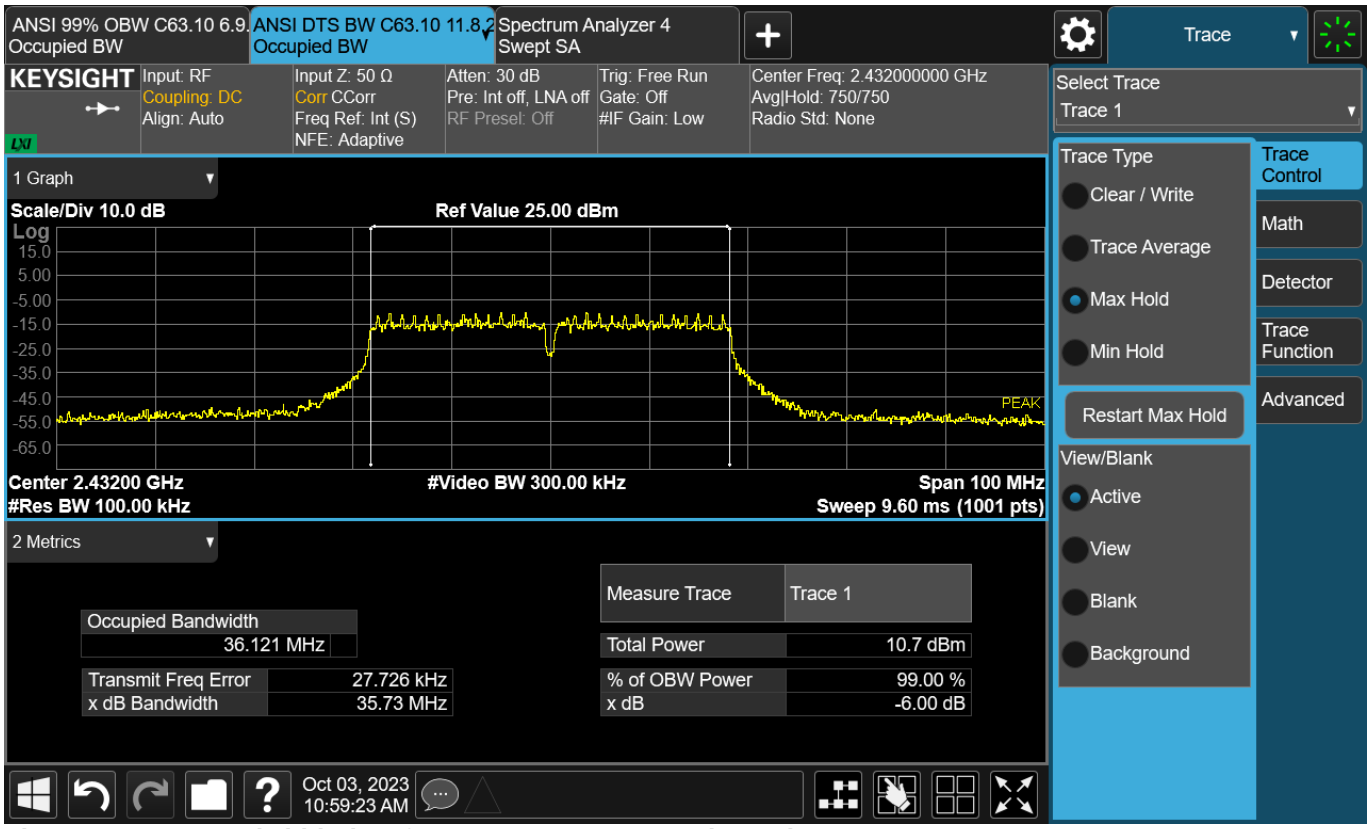

Figure TR08.5: Bandwidth data for 802.11n40 MCS6 at channel 3

This line is the end of the test record.

Test Record
Transmitter Bandwidth Tests
Test IDs TR10 – TR12
Project GCL0388

Test Date(s)	02 Oct 2023
Test Personnel	David Arnett
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M1 (BtcTx), M2 (BleTx), M3 (WiFi2Tx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 2.202, ANSI C63.10, TRC-43, RSS-GEN (as noted in Section 6 of the report).
Radio Protocol	Bluetooth Classic EDR2 and EDR3, Bluetooth Low Energy (BLE), IEEE 802.11 b/g/n (WiFi)
Radio Band	2480 to 2483.5 MHz
Pass/Fail Judgment:	**Reported**
Test record created by:	**David Arnett**
Date of this record:	**5 Oct 2023**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220146	3-Jun-2023	3-Jun-2024

Table TR10.1 Equipment Used

Test Software used: Keysight PXE System Code rev A.35.06

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.

Test Setup

This block diagram shows the test equipment setup.

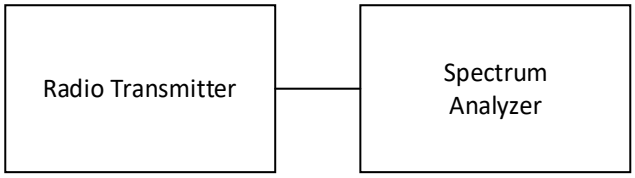

Figure TR10.1: Test setup

Occupied Bandwith, 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.

In general, the various modulations are evaluated while the radio is tuned to a middle channel to find the worst case modulation. For that modulation, the lowest and highest channels are also evaluated. Lowest and highest channels are Not tested (NT) for other modulations.

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

Frequency	(MHz)	2402	2440	2480
BT	EDR2	**1.182**	**1.182**	**1.182**
	EDR3	**1.176**	**1.176**	**1.177**
BLE	1 Mbps	**1.040**	**1.040**	**1.039**

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

Frq (MHz)	2412	2437	2462
Channel	1	6	11
Modulation			
B1	NT	**13.447**	NT
B2	**13.595**	**13.508**	**13.452**
B5.5	NT	**13.263**	NT
B11	NT	**13.303**	NT
G6	NT	**17.356**	NT
G9	NT	**16.653**	NT
G12	NT	**16.671**	NT
G18	NT	**16.793**	NT
G24	**18.059**	**18.035**	**18.046**
G36	NT	**16.572**	NT
G48	NT	**16.568**	NT
G54	NT	**16.617**	NT
MCS0	NT	**16.616**	NT
MCS1	**17.751**	**17.748**	**17.74**
MCS2	NT	**17.71**	NT
MCS3	NT	**17.649**	NT
MCS4	NT	**17.586**	NT
MCS5	NT	**17.618**	NT
MCS6	NT	**17.62**	NT
MCS7	NT	**17.62**	NT

Table TR10.3: Summary of 99% Occupied Bandwidth Data for IEEE 802.11 WiFi 20 MHz modes

Frq (MHz)	2432	2447	2462
Channel	3	6	9
Modulation			
MCS0	**37.56**	**37.551**	**37.643**
MCS1	NT	**37.479**	NT
MCS2	NT	**36.823**	NT
MCS3	NT	**37.176**	NT
MCS4	NT	**36.977**	NT
MCS5	NT	**36.849**	NT
MCS6	NT	**37.206**	NT
MCS7	NT	**37.176**	NT

Table TR10.4: Summary of 99% Occupied Bandwidth Data for IEEE 802.11 WiFi 40 MHz modes

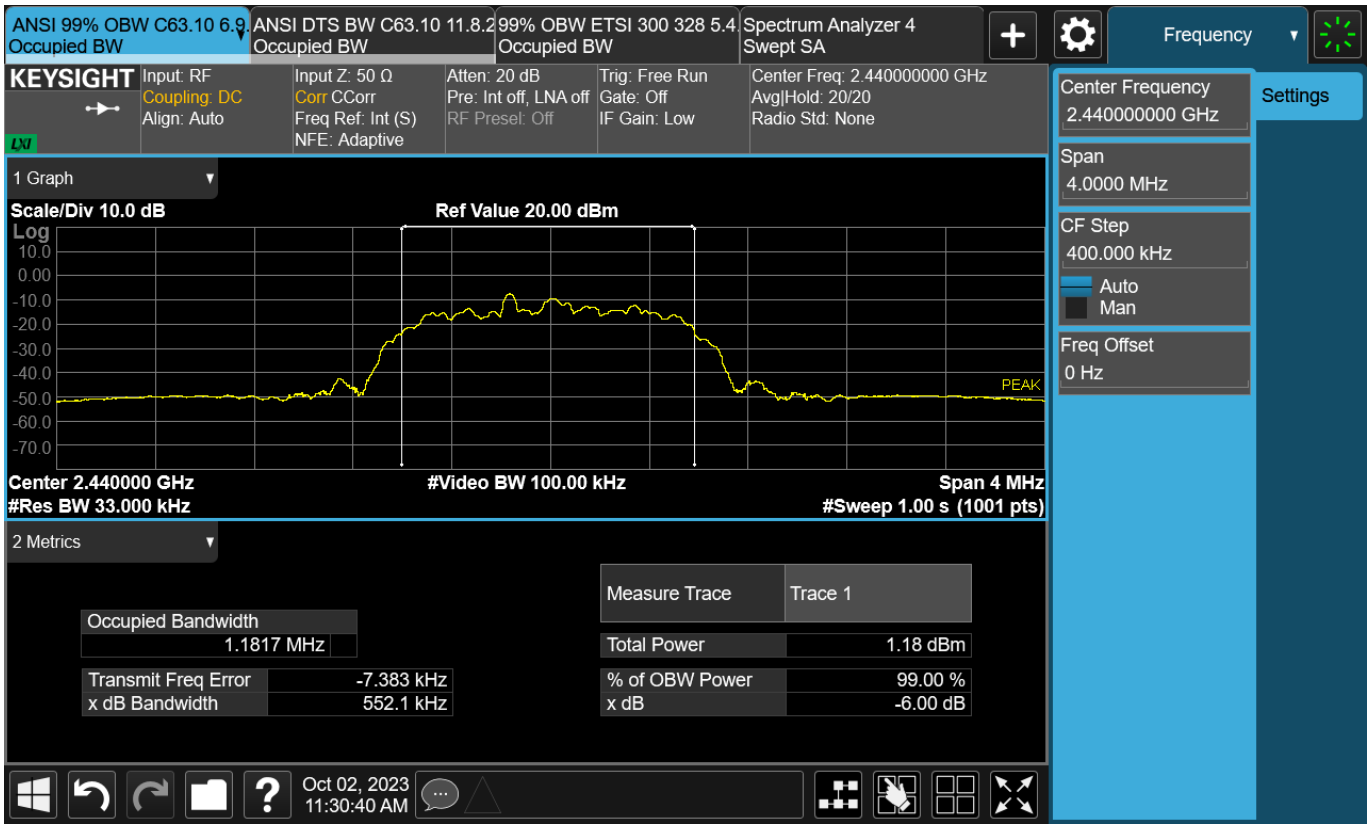

Figure TR10.1: Occupied bandwidth data for Bluetooth EDR2 at mid channel (2440 MHz)

Figure TR10.2: Occupied bandwidth data for BLE at low channel (2402 MHz)

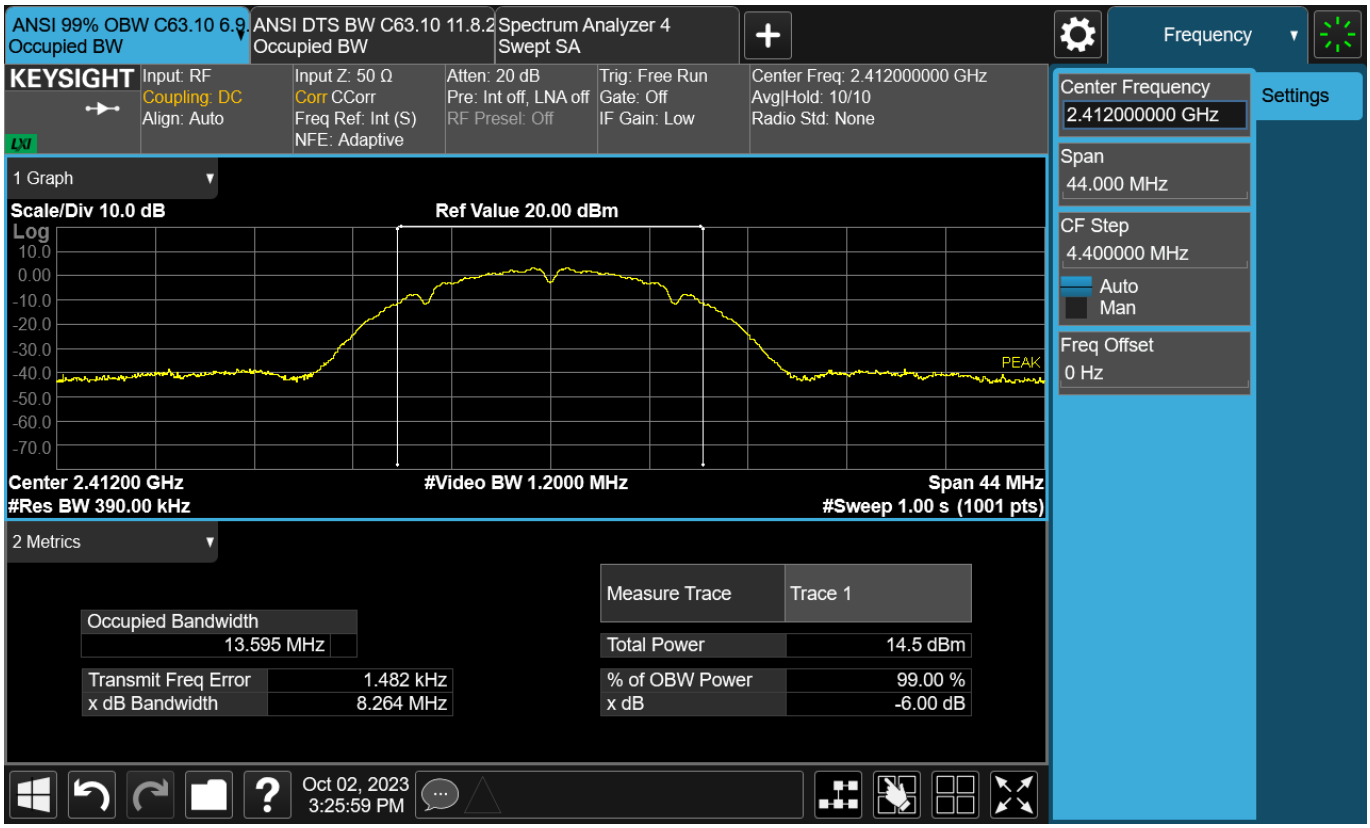

Figure TR10.3: Occupied bandwidth data for 802.11b 2 Mbps at channel 1

Figure TR10.4: Occupied bandwidth data for 802.11g 24 Mbps at channel 1

Figure TR10.5: Occupied bandwidth data for 802.11n MCS1 20MHz at channel 1

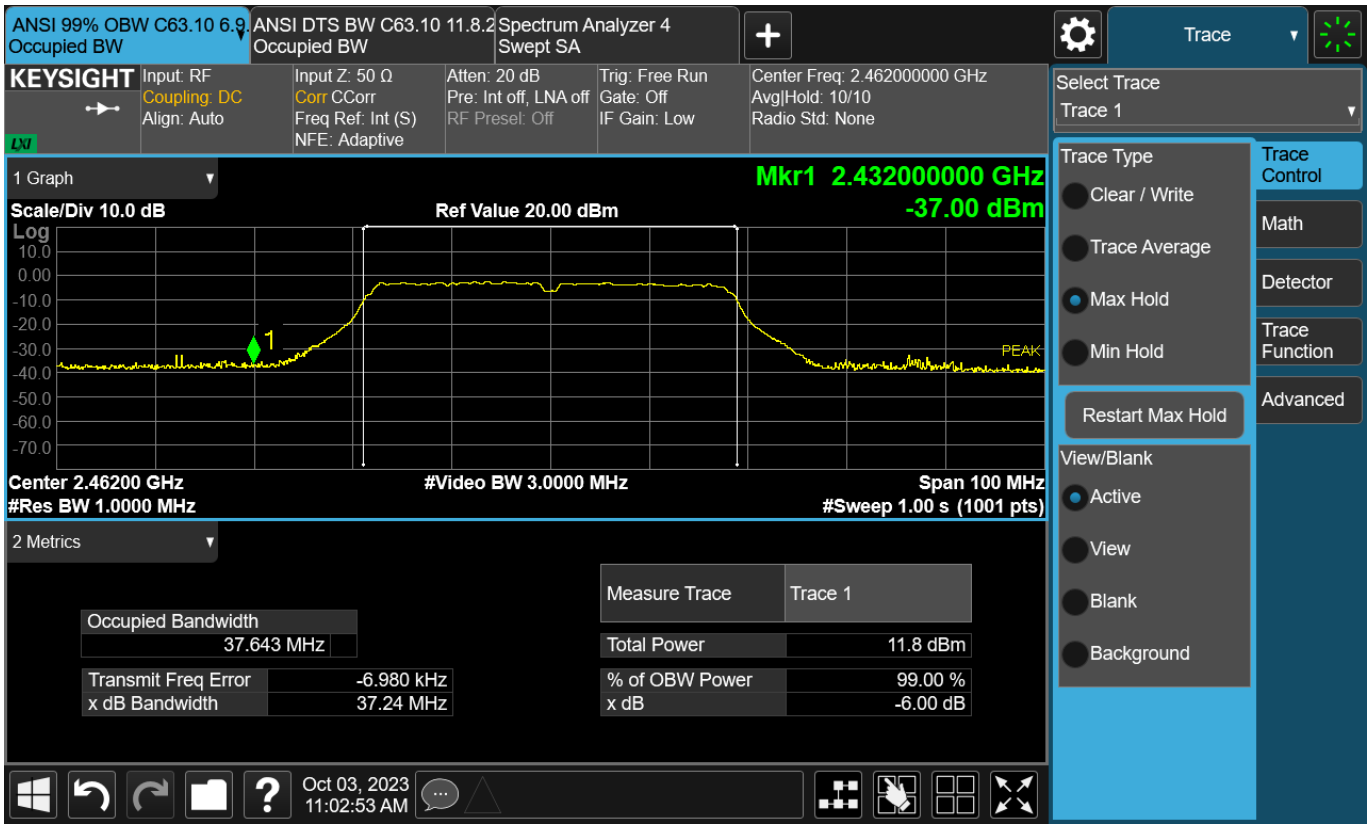

Figure TR10.6: Occupied bandwidth data for 802.11n MCS0 40MHz at channel 9

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, Ns is 312.5 kHz. The count of subcarriers includes nulls. So for example, 802.11 n uses 4 pilot subcarriers, 52 data subcarriers, and one null suppressed subcarrier in the middle for 57 total subcarrier channels.

$$B_N = N_S * K$$

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

Table 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.

Test Record
Transmitter Power
Test IDs TR02
Project GCL0388

Test Date(s)	25 Sep 2023
Test Personnel	Jim Solum
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M1 (BtcTx), M2 (BleTx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210, RSS-247, FCC Part 2.1091, FCC Part 2.1093, RSS-102, ANSI C95.3 (as noted in Section 6 of the report).
Antenna Gain	1.65 dBi, as reported by the client
Radio Protocol	Bluetooth, Bluetooth Low Energy
Pass/Fail Judgment:	**PASS**
Test record created by:	**Jim Solum**
Date of this record:	**12 Oct 2023**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
RF Power Sensor	Rohde&Schwarz	NRP8S	109124	18-Jul-2023	15-Jul-2025

Table TR02.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3; TimePowerAnalysisSpreadsheetV10.xlsx

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

ANSI C63.10: 11.9.1.3

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 be omitted from the data set.

Transmit Power 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 different analytical test methods for the same fundamental data or different limits, the results for both methods are provided and the more-strict limit may be applied. In this case, the ANSI method finds the highest value (numerical peak) and applies the 30 dBm limit from the US and Canadian standards. By contrast, the ETSI method reports the highest numerical average observed during any transmission burst and applies a 20 dBm EIRP limit. All values met the respective limits with more than 10 dB of margin.

The results are shown below. Yellow highlighted cells indicate the highest power value for each radio protocol.

		Frequency (MHz)			ANSI Limit
		2402	2440	2480	(dBm)
BT	EDR2	-6.20	-5.69	-5.29	30
BT	EDR3	-6.23	-5.71	-5.31	30
BLE	1 Mb	-1.00	-0.50	-0.12	30

Table TR02.2: Transmit Power Summary in dBm with ANSI C63.10 analytical methods

Additional Transmit Power Data Analysis

The technical requirements for safety to RF exposure also look at transmitter power. Since data from this report may be compared with data from RF exposure reports, this lab has performed a further analysis of the same raw data for power over time used above. This analysis applies standards such as FCC Part 2.1091, FCC Part 2.1093, RSS-102, ANSI C95.3, EN/IEC 62311, or EN 62479.

These data analyses look at average power over time in linear milliwatt units. These data are averaged over a time period no longer than 1 second.

		Frequency (MHz)		
		2402	2440	2480
BT	EDR2	0.07	0.08	0.09
BT	EDR3	0.07	0.08	0.09
BLE	1 Mb	0.44	0.49	0.54

Table TR02.3: Additional RF exposure power summary in milliwatts

		Frequency (MHz)		
		2402	2440	2480
BT	EDR2	0.334	0.333	0.343
BT	EDR3	0.347	0.347	0.347
BLE	1 Mb	0.613	0.613	0.613

Table TR02.4: Embedded Duty Cycle summary

Setup Diagram

The following block diagrams show how the EUT and test equipment is arranged for test. The client provided a short length of cable to bring the signals out to a connector. This cable was found to have 0.08 dB of loss in this frequency range. This factor was taken into account during the data analysis.

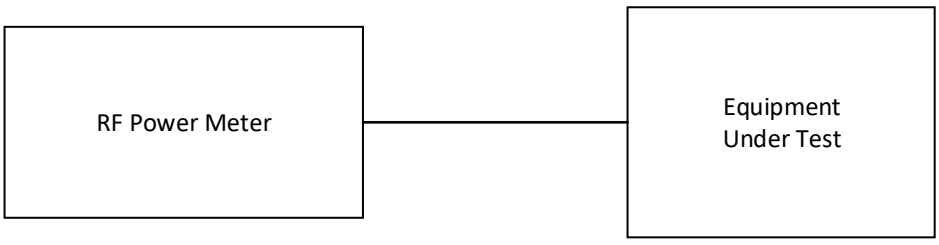

Figure TR02.1: Test equipment setup

This line is the end of the test record.

Test Record
Transmitter Power
Test IDs TR03
Project GCL0388

Test Date(s)	25,26 Sep 2023
Test Personnel	Jim Solum
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M3 (WiFi2Tx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210, RSS-247, FCC Part 2.1091, FCC Part 2.1093, EN/IEC 62311, EN 62479, RSS-102, ANSI C95.3 (as noted in Section 6 of the report).
Antenna Gain	1.65 dBi, as reported by the client
Radio Protocol	IEEE 802.11b/g/n
Pass/Fail Judgment:	**PASS**
Test record created by:	**Jim Solum**
Date of this record:	**12 Oct 2023**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
RF Power Sensor	Rohde&Schwarz	NRP8S	109124	18-Jul-2023	15-Jul-2025

Table TR03.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3; TimePowerAnalysisSpreadsheetV10.xlsx

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

ANSI C63.10: 11.9.1.3

Transmit Power 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.

The ANSI method finds the highest value (numerical peak) and applies the 30 dBm limit from the US and Canadian standards. All values met the limit with better than 10 dB of margin.

Data shown here for channels 1 through 11. Both modes b/g/n with 20 MHz bandwidths and mode n with a 40 MHz bandwidth are displayed. The results are shown below. Yellow highlighted cells indicate the highest power value for each radio protocol. An NT entry in a grey cell indicates a combination of data rate and transmit channel that were not tested.

Mode	Speed	1	2	3	4	5	6	7	8	9	10	11
B	1	11.04	NT	NT	NT	NT	11.12	NT	NT	NT	NT	11.28
B	2	11.08	NT	NT	NT	NT	11.21	NT	NT	NT	NT	11.19
B	5.5	11.20	NT	NT	NT	NT	11.35	NT	NT	NT	NT	11.43
B	11	11.37	11.59	11.10	11.00	11.18	11.59	12.23	12.16	12.11	12.07	11.65
G	6	11.99	NT	NT	NT	NT	12.20	NT	NT	NT	NT	11.94
G	9	11.94	NT	NT	NT	NT	12.05	NT	NT	NT	NT	11.91
G	12	12.04	NT	NT	NT	NT	12.09	NT	NT	NT	NT	12.03
G	18	12.11	NT	NT	NT	NT	12.28	NT	NT	NT	NT	12.07
G	24	12.21	12.15	12.00	12.02	11.93	12.29	12.62	12.58	12.54	12.50	12.14
G	36	11.11	NT	NT	NT	NT	11.84	NT	NT	NT	NT	11.74
G	48	7.13	NT	NT	NT	NT	9.26	NT	NT	NT	NT	8.78
G	54	6.78	NT	NT	NT	NT	9.18	NT	NT	NT	NT	8.83
N	MCS0	9.32	NT	NT	NT	NT	9.22	NT	NT	NT	NT	9.16
N	MCS1	9.36	NT	NT	NT	NT	9.16	NT	NT	NT	NT	9.15
N	MCS2	9.39	9.37	9.20	9.12	9.15	9.19	9.80	9.77	9.71	9.60	9.24
N	MCS3	9.37	NT	NT	NT	NT	9.18	NT	NT	NT	NT	9.18
N	MCS4	7.96	NT	NT	NT	NT	8.83	NT	NT	NT	NT	8.81
N	MCS5	6.07	NT	NT	NT	NT	6.02	NT	NT	NT	NT	5.77
N	MCS6	3.70	NT	NT	NT	NT	6.10	NT	NT	NT	NT	5.74
N	MCS7	5.23	NT	NT	NT	NT	6.16	NT	NT	NT	NT	5.79

Table TR03.2: Transmit Power Summary, with units of dBm. (Channels 1-11, Modes b/g/n, 20 MHz bandwidth)

Mode	Speed	3	4	5	6	7	8	9
N	MCS0	7.06	7.10	7.45	7.58	7.27	7.26	4.14
N	MCS1	6.89	NT	NT	7.42	NT	NT	4.04
N	MCS2	5.50	NT	NT	6.87	NT	NT	2.63
N	MCS3	4.50	NT	NT	6.91	NT	NT	1.72
N	MCS4	4.13	NT	NT	6.72	NT	NT	0.45
N	MCS5	-0.62	NT	NT	2.48	NT	NT	-1.82
N	MCS6	-0.82	NT	NT	2.53	NT	NT	-2.05
N	MCS7	-1.26	NT	NT	2.50	NT	NT	-2.44

Table TR03.3: Transmit Power Summary, with units of dBm. (Channels 1-11, Mode n, 40 MHz bandwidth)

Additional Transmit Power Data Analysis

The technical requirements for safety to RF exposure also look at transmitter power. Since data from this report may be compared with data from RF exposure reports, this lab has performed a further analysis of the same raw data for power over time used above. This analysis applies standards such as FCC Part 2.1091, FCC Part 2.1093, RSS-102, ANSI C95.3, EN/IEC 62311, or EN 62479.

These data analyses look at average power over time in linear milliwatt units. These data are averaged over a time period no longer than 1 second.

Mode	Speed	1	2	3	4	5	6	7	8	9	10	11
B	1	**11.17**	**NT**	**NT**	**NT**	**NT**	**11.35**	**NT**	**NT**	**NT**	**NT**	**11.74**
B	2	**10.20**	**NT**	**NT**	**NT**	**NT**	**10.31**	**NT**	**NT**	**NT**	**NT**	**10.48**
B	5.5	**8.05**	**NT**	**NT**	**NT**	**NT**	**8.29**	**NT**	**NT**	**NT**	**NT**	**8.46**
B	11	**6.25**	**6.50**	**5.87**	**5.74**	**5.97**	**6.45**	**7.61**	**7.38**	**7.40**	**7.33**	**6.65**
G	6	**9.13**	**NT**	**NT**	**NT**	**NT**	**9.57**	**NT**	**NT**	**NT**	**NT**	**9.01**
G	9	**7.53**	**NT**	**NT**	**NT**	**NT**	**7.71**	**NT**	**NT**	**NT**	**NT**	**7.47**
G	12	**6.58**	**NT**	**NT**	**NT**	**NT**	**6.66**	**NT**	**NT**	**NT**	**NT**	**6.57**
G	18	**5.29**	**NT**	**NT**	**NT**	**NT**	**5.41**	**NT**	**NT**	**NT**	**NT**	**5.25**
G	24	**4.42**	**4.32**	**4.23**	**4.24**	**4.15**	**4.49**	**4.88**	**4.82**	**4.78**	**4.74**	**4.36**
G	36	**3.39**	**NT**	**NT**	**NT**	**NT**	**3.42**	**NT**	**NT**	**NT**	**NT**	**3.36**
G	48	**1.42**	**NT**	**NT**	**NT**	**NT**	**1.51**	**NT**	**NT**	**NT**	**NT**	**1.37**
G	54	**1.33**	**NT**	**NT**	**NT**	**NT**	**1.38**	**NT**	**NT**	**NT**	**NT**	**1.28**
N	MCS0	**4.58**	**NT**	**NT**	**NT**	**NT**	**4.31**	**NT**	**NT**	**NT**	**NT**	**4.40**
N	MCS1	**3.25**	**NT**	**NT**	**NT**	**NT**	**3.10**	**NT**	**NT**	**NT**	**NT**	**3.11**
N	MCS2	**2.57**	**2.55**	**2.46**	**2.41**	**2.43**	**2.45**	**2.83**	**2.80**	**2.76**	**2.69**	**2.47**
N	MCS3	**2.15**	**NT**	**NT**	**NT**	**NT**	**2.03**	**NT**	**NT**	**NT**	**NT**	**2.05**
N	MCS4	**1.67**	**NT**	**NT**	**NT**	**NT**	**1.57**	**NT**	**NT**	**NT**	**NT**	**1.59**
N	MCS5	**0.70**	**NT**	**NT**	**NT**	**NT**	**0.69**	**NT**	**NT**	**NT**	**NT**	**0.64**
N	MCS6	**0.66**	**NT**	**NT**	**NT**	**NT**	**0.57**	**NT**	**NT**	**NT**	**NT**	**0.59**
N	MCS7	**0.62**	**NT**	**NT**	**NT**	**NT**	**0.53**	**NT**	**NT**	**NT**	**NT**	**0.58**

Table TR03.4: Additional RF exposure power summary in milliwatts. (Channels 1-11, Modes b/g/n, 20 MHz bandwidth)

Mode	Speed	3	4	5	6	7	8	9
N	MCS0	**1.88**	**1.90**	**2.06**	**2.08**	**1.98**	**1.97**	**0.96**
N	MCS1	**1.22**	**NT**	**NT**	**1.37**	**NT**	**NT**	**0.63**
N	MCS2	**0.95**	**NT**	**NT**	**1.06**	**NT**	**NT**	**0.49**
N	MCS3	**0.79**	**NT**	**NT**	**0.89**	**NT**	**NT**	**0.41**
N	MCS4	**0.60**	**NT**	**NT**	**0.68**	**NT**	**NT**	**0.32**
N	MCS5	**0.26**	**NT**	**NT**	**0.25**	**NT**	**NT**	**0.19**
N	MCS6	**0.25**	**NT**	**NT**	**0.24**	**NT**	**NT**	**0.19**
N	MCS7	**0.22**	**NT**	**NT**	**0.23**	**NT**	**NT**	**0.17**

Table TR03.5: Additional RF exposure power summary in milliwatts. (Channels 1-11, Mode n, 40 MHz bandwidth)

Mode	Speed	1	2	3	4	5	6	7	8	9	10	11
B	1	**0.93**	**NT**	**NT**	**NT**	**NT**	**0.93**	**NT**	**NT**	**NT**	**NT**	**0.93**
B	2	**0.87**	**NT**	**NT**	**NT**	**NT**	**0.87**	**NT**	**NT**	**NT**	**NT**	**0.87**
B	5.5	**0.74**	**NT**	**NT**	**NT**	**NT**	**0.73**	**NT**	**NT**	**NT**	**NT**	**0.74**
B	11	**0.63**	**0.63**	**0.64**	**0.64**	**0.64**	**0.62**	**0.64**	**0.63**	**0.64**	**0.64**	**0.63**
G	6	**0.72**	**NT**	**NT**	**NT**	**NT**	**0.72**	**NT**	**NT**	**NT**	**NT**	**0.72**
G	9	**0.65**	**NT**	**NT**	**NT**	**NT**	**0.64**	**NT**	**NT**	**NT**	**NT**	**0.65**
G	12	**0.61**	**NT**	**NT**	**NT**	**NT**	**0.60**	**NT**	**NT**	**NT**	**NT**	**0.60**
G	18	**0.55**	**NT**	**NT**	**NT**	**NT**	**0.53**	**NT**	**NT**	**NT**	**NT**	**0.54**
G	24	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.49**	**0.51**	**0.51**	**0.51**	**0.51**	**0.50**
G	36	**0.46**	**NT**	**NT**	**NT**	**NT**	**0.45**	**NT**	**NT**	**NT**	**NT**	**0.46**
G	48	**0.44**	**NT**	**NT**	**NT**	**NT**	**0.42**	**NT**	**NT**	**NT**	**NT**	**0.43**
G	54	**0.43**	**NT**	**NT**	**NT**	**NT**	**0.41**	**NT**	**NT**	**NT**	**NT**	**0.42**
N	MCS0	**0.69**	**NT**	**NT**	**NT**	**NT**	**0.66**	**NT**	**NT**	**NT**	**NT**	**0.69**
N	MCS1	**0.58**	**NT**	**NT**	**NT**	**NT**	**0.57**	**NT**	**NT**	**NT**	**NT**	**0.58**
N	MCS2	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**	**0.52**	**0.53**	**0.53**	**0.53**	**0.53**	**0.52**
N	MCS3	**0.49**	**NT**	**NT**	**NT**	**NT**	**0.47**	**NT**	**NT**	**NT**	**NT**	**0.48**
N	MCS4	**0.46**	**NT**	**NT**	**NT**	**NT**	**0.43**	**NT**	**NT**	**NT**	**NT**	**0.44**
N	MCS5	**0.44**	**NT**	**NT**	**NT**	**NT**	**0.41**	**NT**	**NT**	**NT**	**NT**	**0.41**
N	MCS6	**0.42**	**NT**	**NT**	**NT**	**NT**	**0.35**	**NT**	**NT**	**NT**	**NT**	**0.40**
N	MCS7	**0.42**	**NT**	**NT**	**NT**	**NT**	**0.33**	**NT**	**NT**	**NT**	**NT**	**0.41**

Table TR03.6: WiFi embedded duty cycle. (Channels 1-11, Modes b/g/n, 20 MHz bandwidth)

Mode	Speed	3	4	5	6	7	8	9
N	MCS0	**0.58**	**0.58**	**0.58**	**0.55**	**0.58**	**0.58**	**0.58**
N	MCS1	**0.49**	**NT**	**NT**	**0.47**	**NT**	**NT**	**0.49**
N	MCS2	**0.45**	**NT**	**NT**	**0.43**	**NT**	**NT**	**0.45**
N	MCS3	**0.43**	**NT**	**NT**	**0.42**	**NT**	**NT**	**0.43**
N	MCS4	**0.41**	**NT**	**NT**	**0.38**	**NT**	**NT**	**0.41**
N	MCS5	**0.39**	**NT**	**NT**	**0.37**	**NT**	**NT**	**0.40**
N	MCS6	**0.39**	**NT**	**NT**	**0.37**	**NT**	**NT**	**0.39**
N	MCS7	**0.39**	**NT**	**NT**	**0.37**	**NT**	**NT**	**0.39**

Table TR03.7: WiFi embedded duty cycle. (Channels 1-11, Mode n, 40 MHz bandwidth)

Setup Diagram

The following block diagrams show how the EUT and test equipment is arranged for test. The client provided a short length of cable to bring the signals out to a connector. This cable was found to have 0.08 dB of loss in this frequency range. This factor was taken into account during the data analysis.

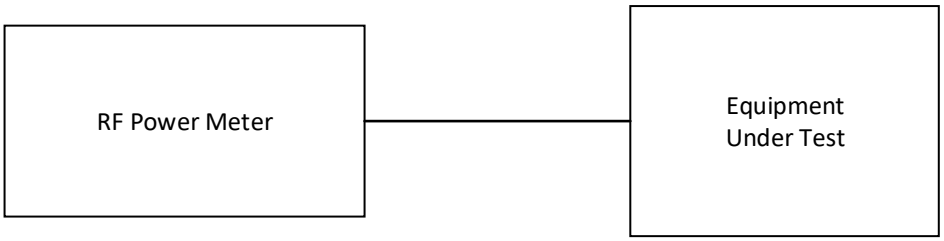

Figure TR03.1: Test equipment setup

This line is the end of the test record.

Test Record
Conducted Spurious Emissions
Test IDs TR19
Project GCL-0388

Test Date(s)	12 Oct 2023
Test Personnel	Majid Farah
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M1 (BtcTx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report).
Pass/Fail Judgment:	**PASS**
Test record created by:	**Majid Farah**
Date of this test record:	**18 Oct 2023**

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

Table TR19.1: Test equipment used

Software used: Keysight PXE software A.32.06.

Test Method

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

Test Setup

This block diagram shows the test equipment setup.

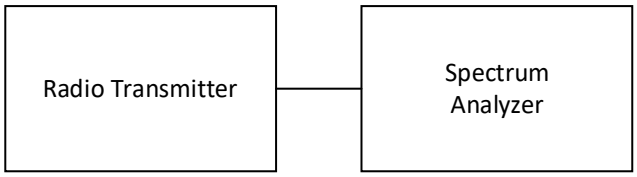

Figure TR19.1: Test setup

Test Data

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

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

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

The data table below shows the final measurement data which may be at harmonics of the carrier, or at frequencies that represent one of the highest data points measured.

The peak level of the fundamental is also identified. The harmonics or spurious emissions must be reduced from this fundamental level by 20 dBc. This harmonic limit is calculated and used to determine compliance. A reduction form the carrier that is greater that 20 is a passing result. The minimum margin from the peak level for each mode are highlighted in yellow.

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

		Frequency (MHz)		
		2402	2440	2480
Bluetooth	EDR2	64.93	62.90	59.49
Bluetooth	EDR3	65.17	63.23	59.00

Table TR19.2: Results Summary

NT: (Not tested) means the requirement is or may not be applicable by EUT or it is not required by standards.

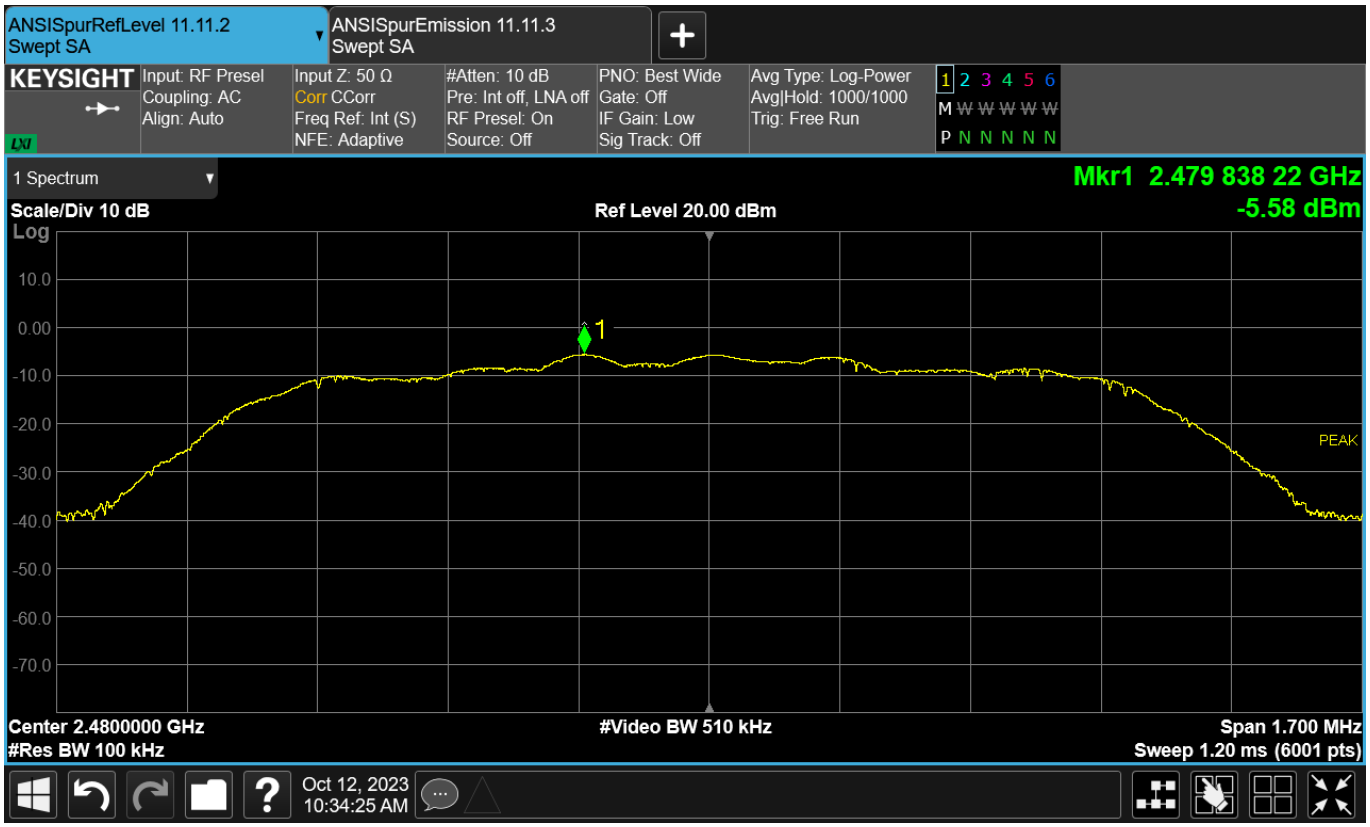

Figure TR19.2: Reference level measurement for Bluetooth EDR3 at 2480 MHz

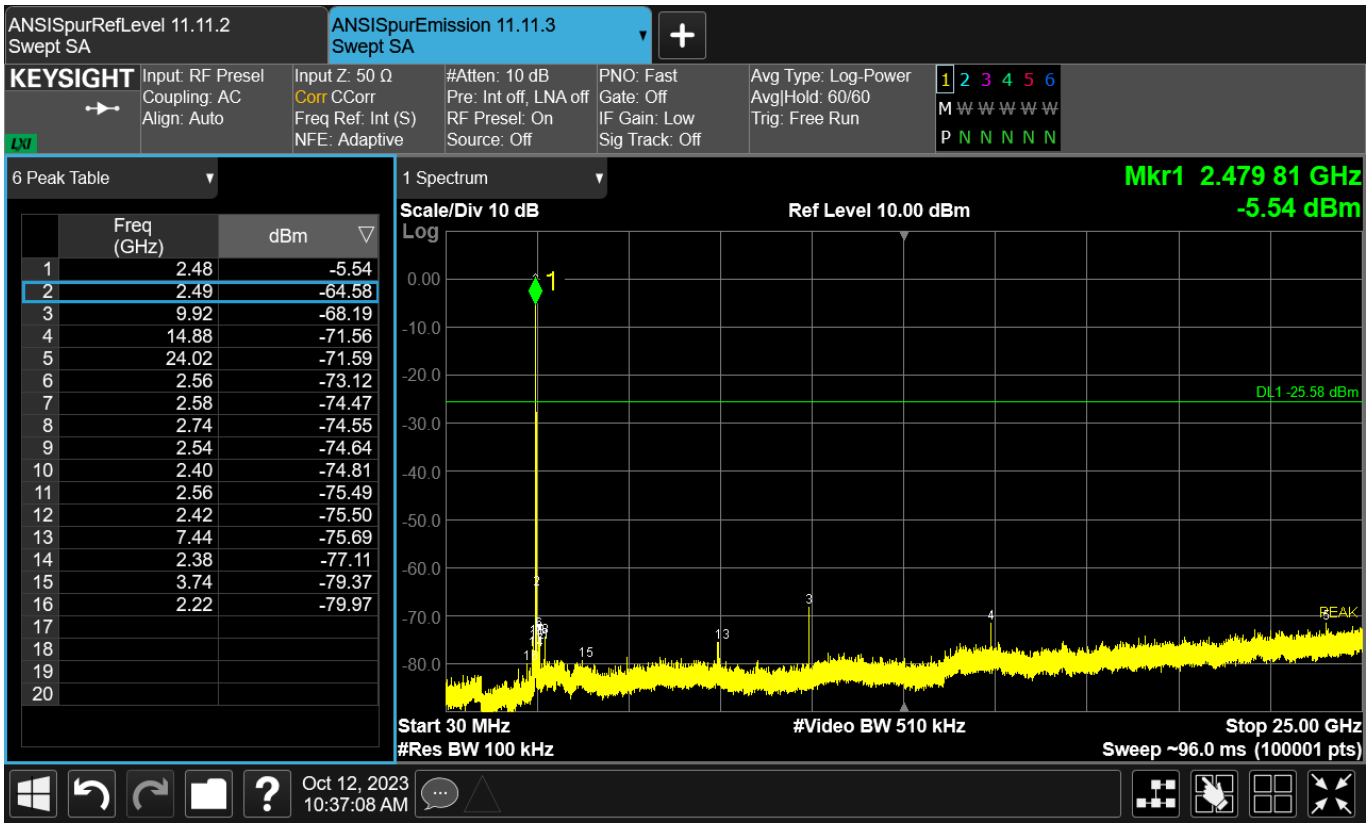

Figure TR19.3: Spectral data for Bluetooth EDR3 at 2480 MHz
This line is the end of the test record.

Test Record
Conducted Spurious Emissions
Test IDs TR20
Project GCL-0388

Test Date(s)	12 Oct 2023
Test Personnel	Majid Farah
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M2 (BleTx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report).
Pass/Fail Judgment:	**PASS**
Test record created by:	**Majid Farah**
Date of this test record:	**18 Oct 2023**

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

Table TR20.1: Test equipment used

Software used: Keysight PXE software A.32.06.

Test Method

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

Test Setup

This block diagram shows the test equipment setup.

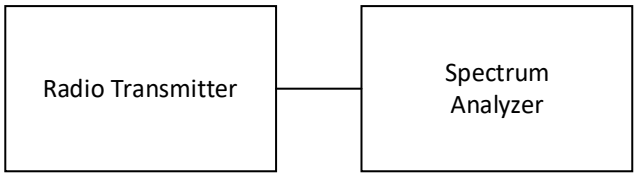

Figure TR20.1: Test setup

Test Data

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

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

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

The data table below shows the final measurement data which may be at harmonics of the carrier, or at frequencies that represent one of the highest data points measured.

The peak level of the fundamental is also identified. The harmonics or spurious emissions must be reduced from this fundamental level by 20 dBc. This harmonic limit is calculated and used to determine compliance. A reduction form the carrier that is greater that 20 is a passing result. The minimum margin from the peak level for each mode are highlighted in yellow.

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

		Frequency (MHz)		
		2402	2440	2480
BLE	1 Mbps	54.68	65.31	47.48

Table TR20.2: Results Summary
NT: (Not tested) means the requirement is or may not be applicable by EUT or it is not required by standards.

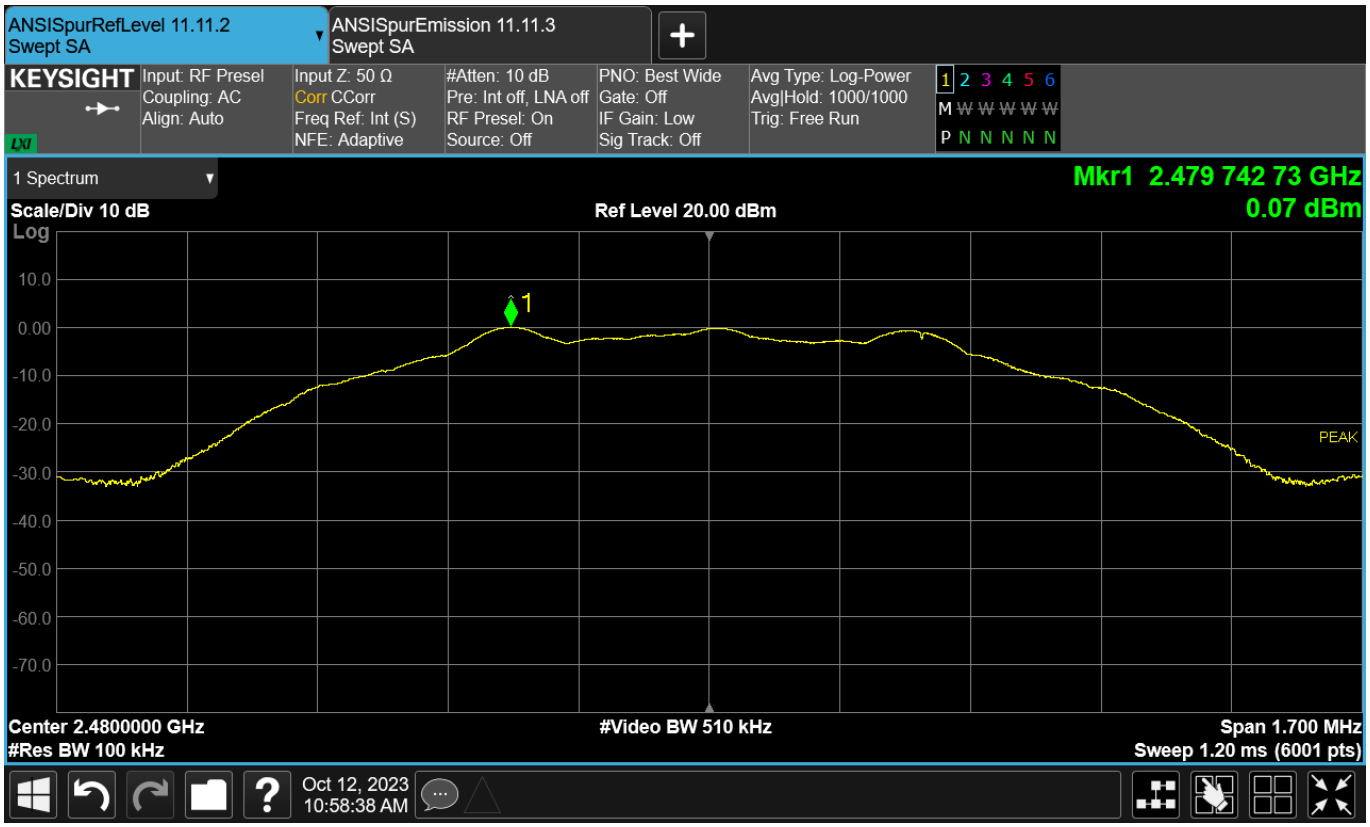

Figure TR20.2: Reference level measurement for Bluetooth low energy (BLE) at 2480 MHz

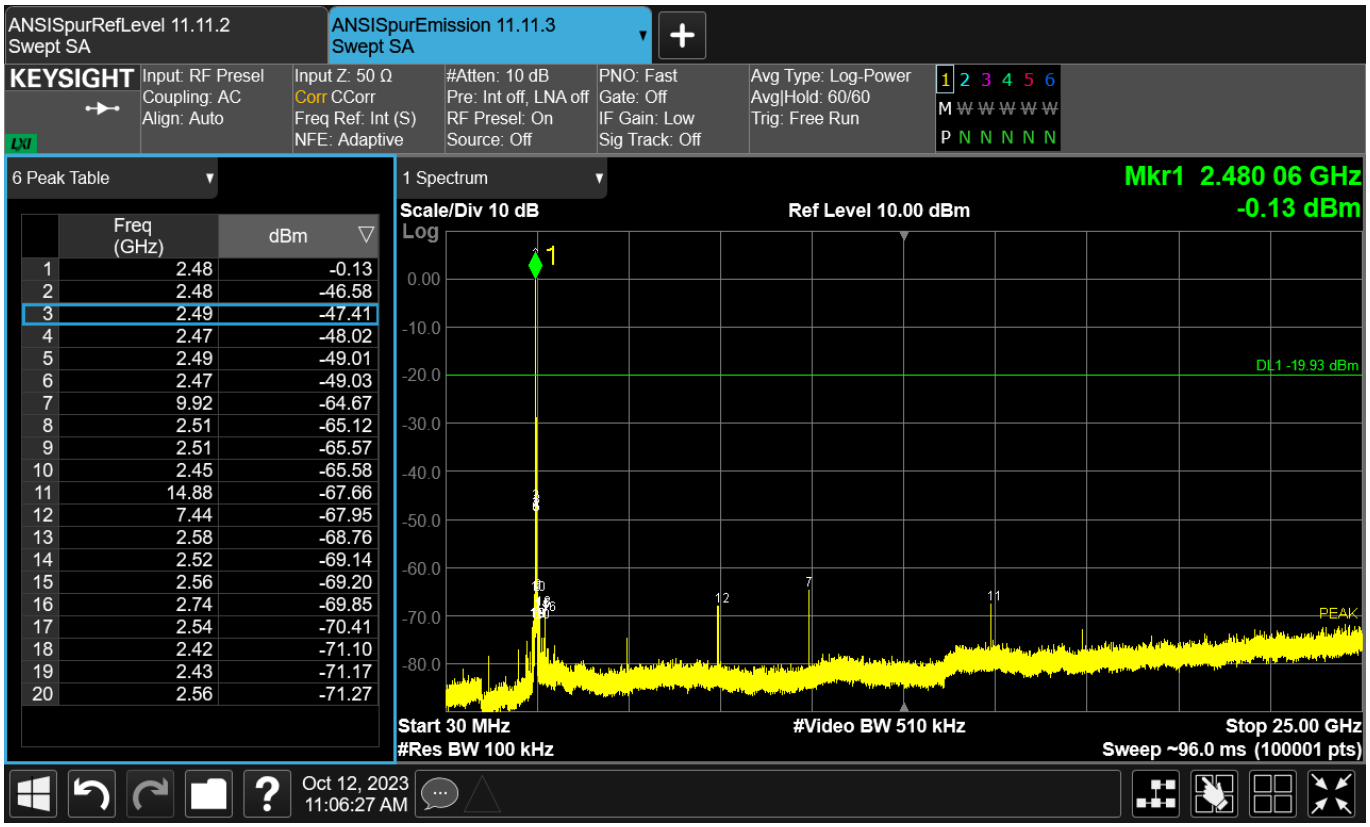

Figure TR20.3: Spectral data for Bluetooth low energy (BLE) at 2480 MHz
This line is the end of the test record.

Test Record
Conducted Spurious Emissions
Test IDs TR21
Project GCL-0388

Test Date(s)	12 Oct 2023
Test Personnel	Majid Farah
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M3 (WiFi2Tx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report).
Pass/Fail Judgment:	**PASS**
Test record created by:	**Majid Farah**
Date of this test record:	**18 Oct 2023**

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
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024

Table TR21.1: Test equipment used

Software used: Keysight PXE(26GHz) software A.32.06. Keysight PXE(44GHz) 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.

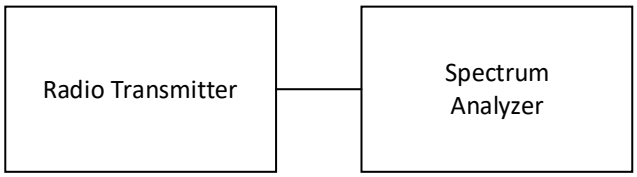

Figure TR21.1: Test setup

Test Data

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

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

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

The data table below shows the final measurement data which may be at harmonics of the carrier, or at frequencies that represent one of the highest data points measured.

The peak level of the fundamental is also identified. The harmonics or spurious emissions must be reduced from this fundamental level by 20 dBc. This harmonic limit is calculated and used to determine compliance. A reduction form the carrier that is greater that 20 is a passing result. The minimum margin from the peak level for each mode are highlighted in yellow.

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

	Frequency (MHz)		
	2412	2437	2462
B 1 Mbps	44.05	45.28	44.77
B 11 Mbps	43.84	43.61	44.12
G 6 Mbps	42.16	41.48	42.34
G 54 Mbps	47.49	47.83	47.84
NMCS0-20MHz	39.10	39.68	39.29
NMCS7-20MHz	44.65	43.98	44.49
NMCS0-40MHz	35.43	35.73	32.64
NMCS7-40MHz	41.94	40.20	40.41

Table TR21.2: Results Summary
NT: (Not tested) means the requirement is or may not be applicable by EUT or it is not required by standards.

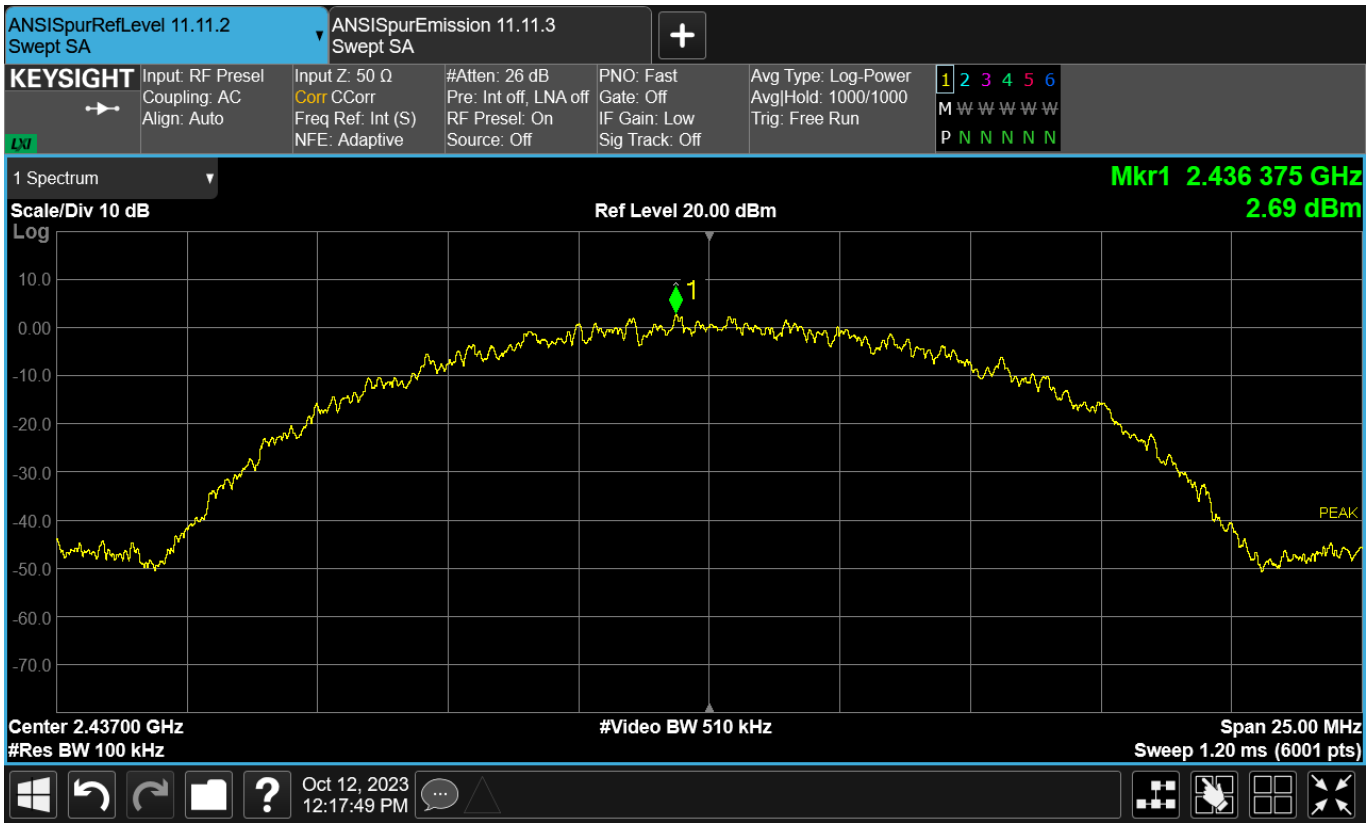

Figure TR21.2: Reference level measurement for IEEE 802.11 B 11Mbps at 2437 MHz

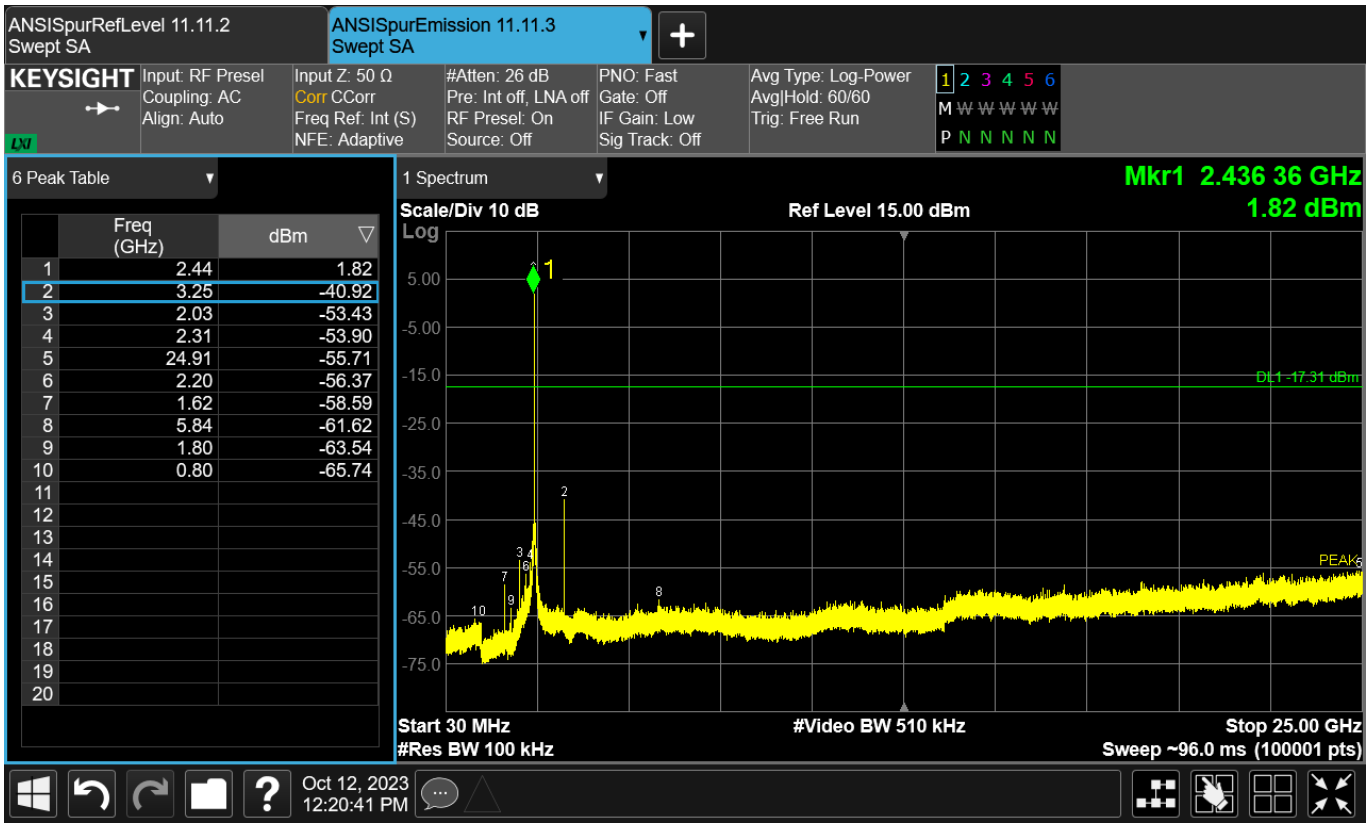

Figure TR21.3: Spectral data for IEEE 802.11 B 11Mbps at 2437 MHz

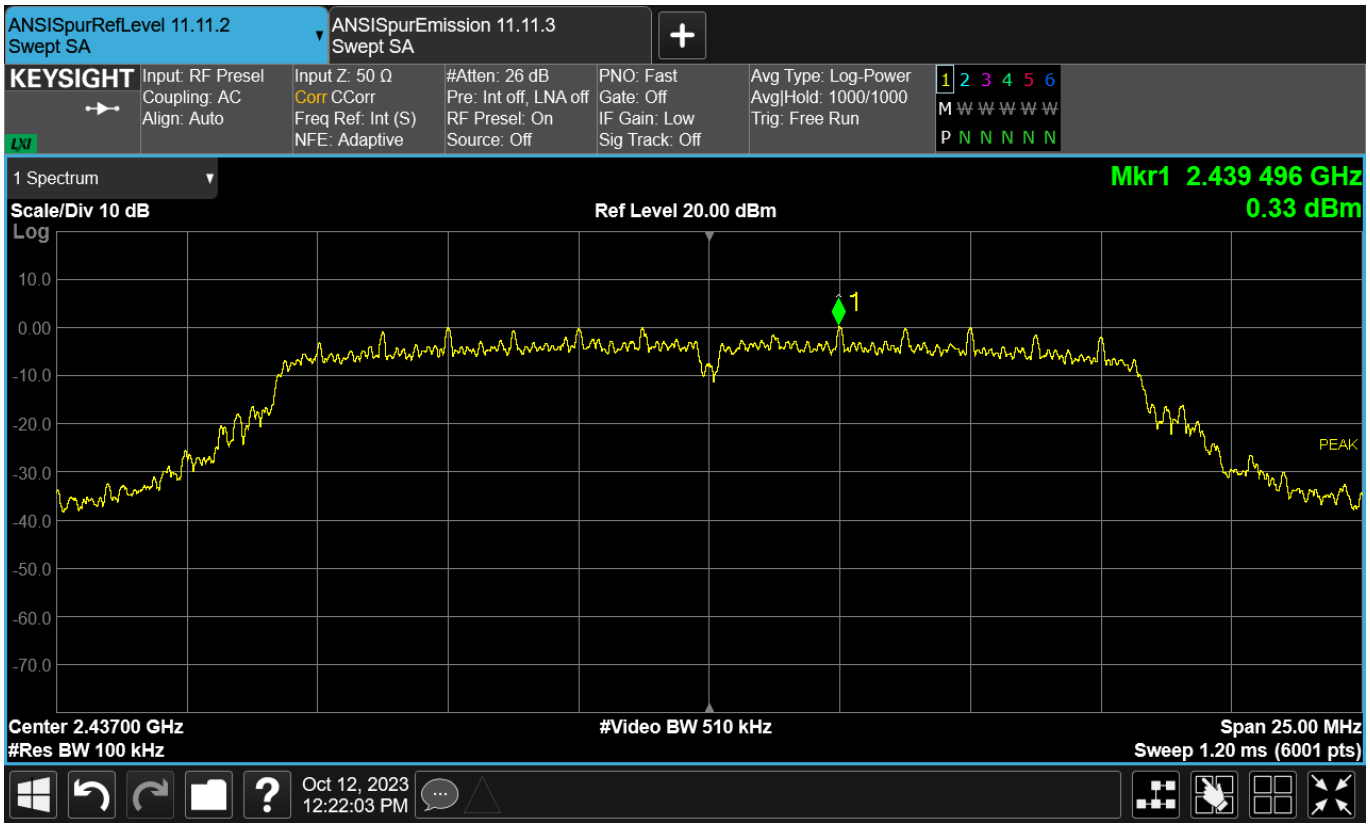

Figure TR21.4: Reference level measurement for IEEE 802.11 G 6Mbps at 2437 MHz

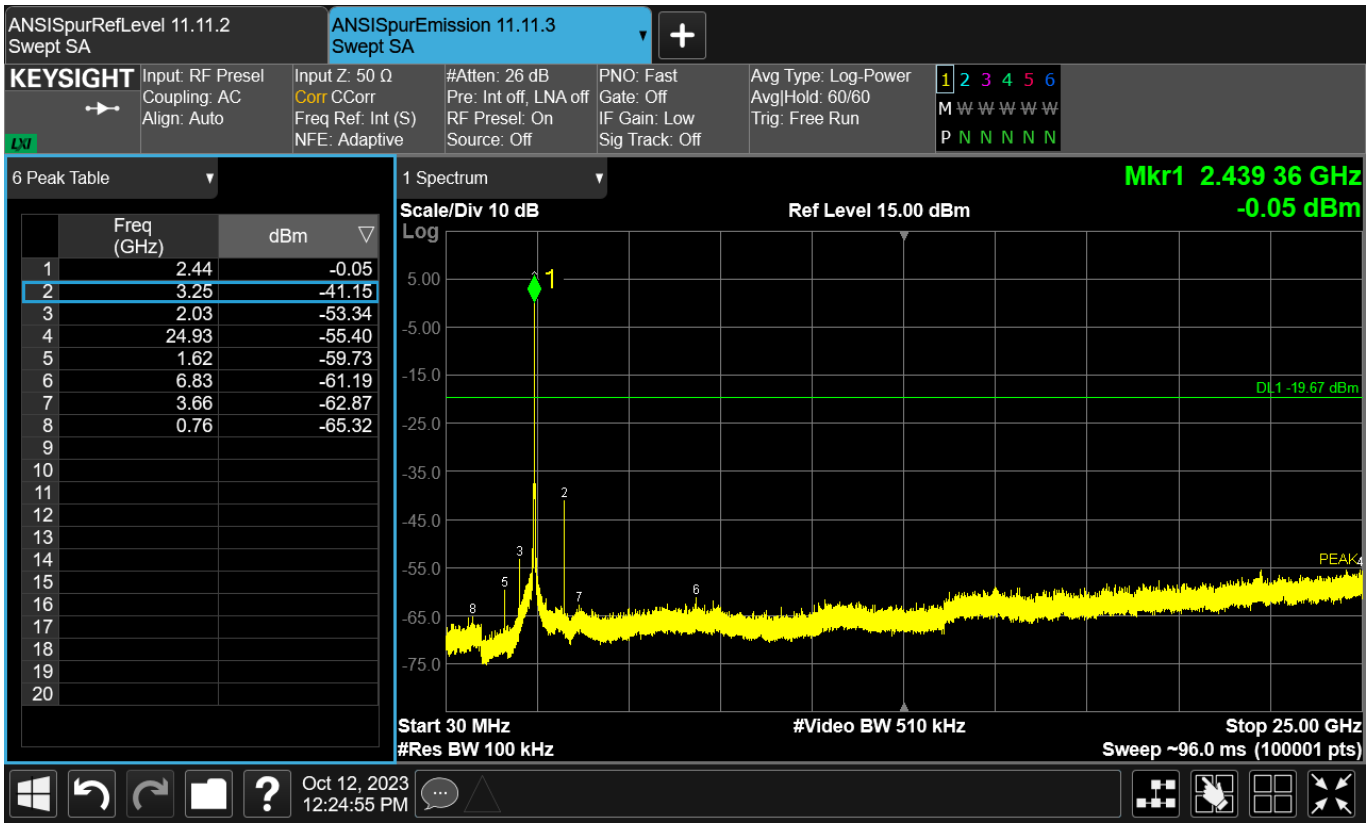

Figure TR21.5: Spectral data for IEEE 802.11 G 6Mbps at 2437 MHz

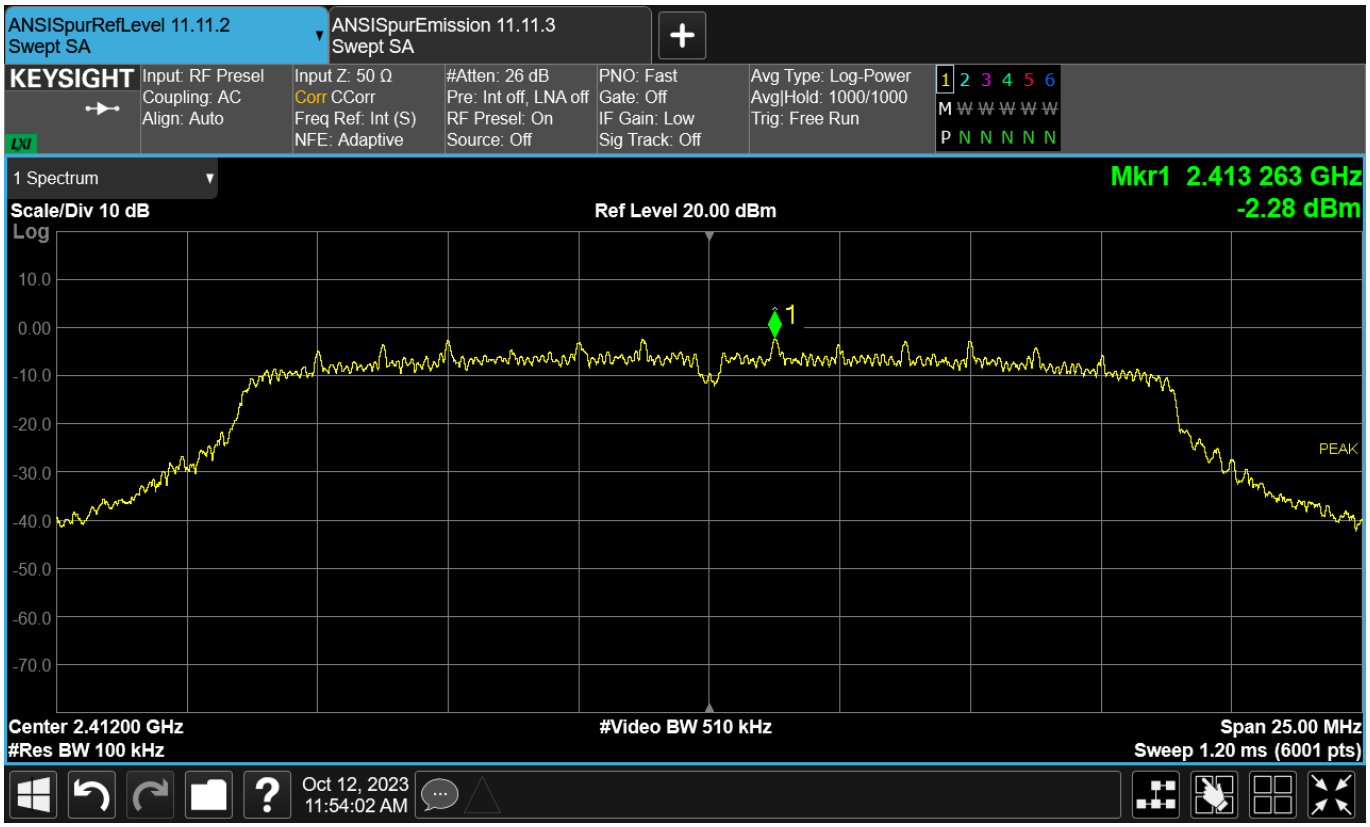

Figure TR21.6: Reference level measurement for IEEE 802.11 NMCS0-20 MHz at 2412 MHz

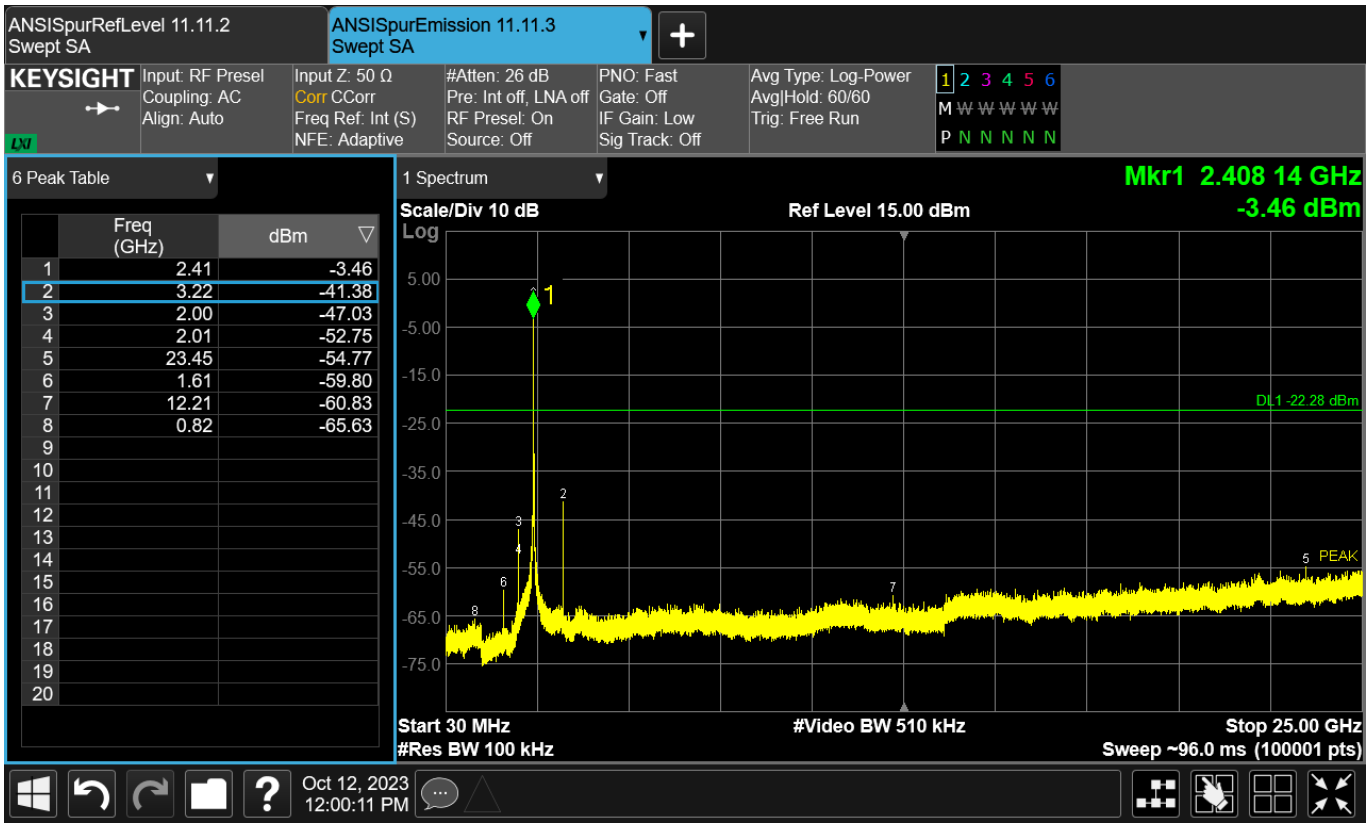

Figure TR21.7: Spectral data for IEEE 802.11 NMCS0-20 MHz at 2412 MHz

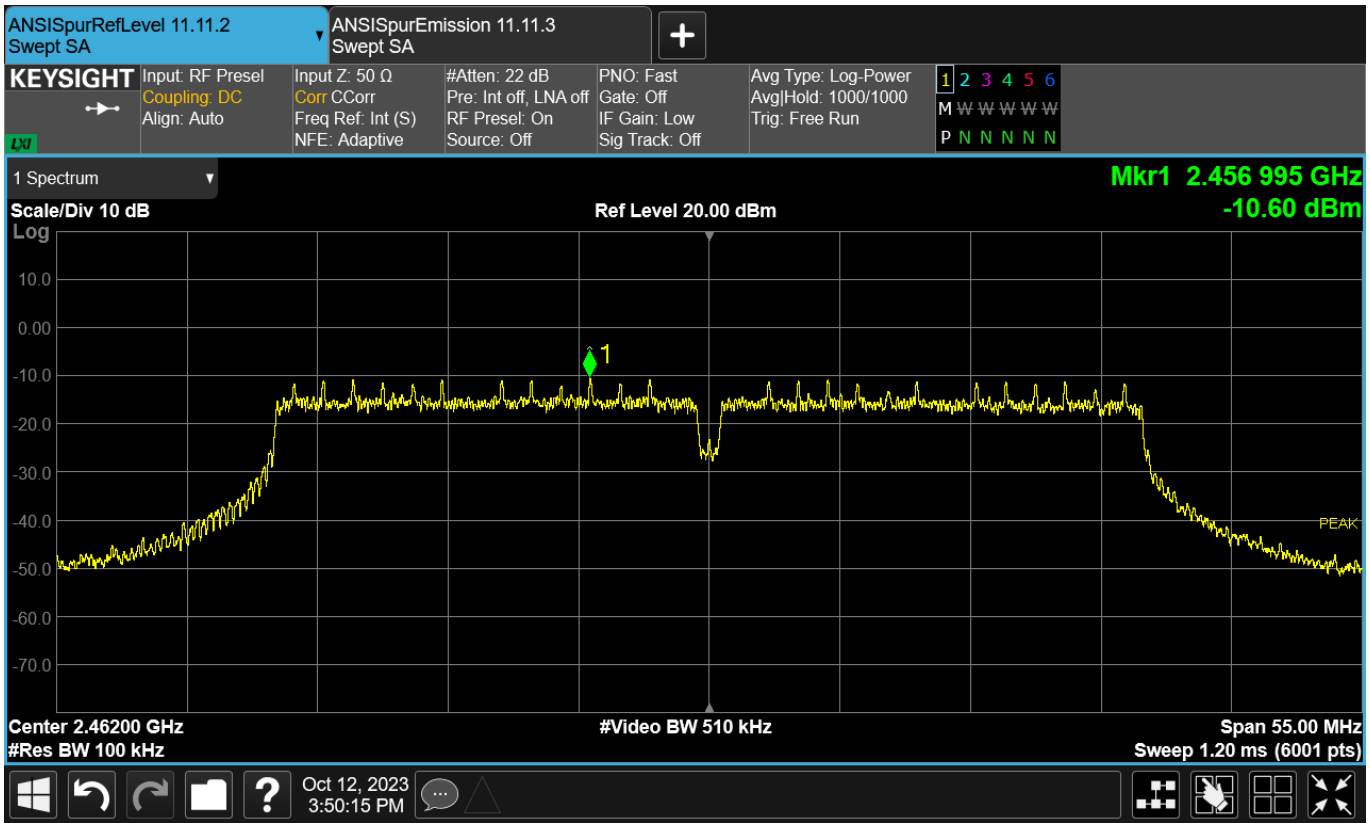

Figure TR21.8: Reference level measurement for IEEE 802.11 NMCS0-40 MHz at 2462 MHz

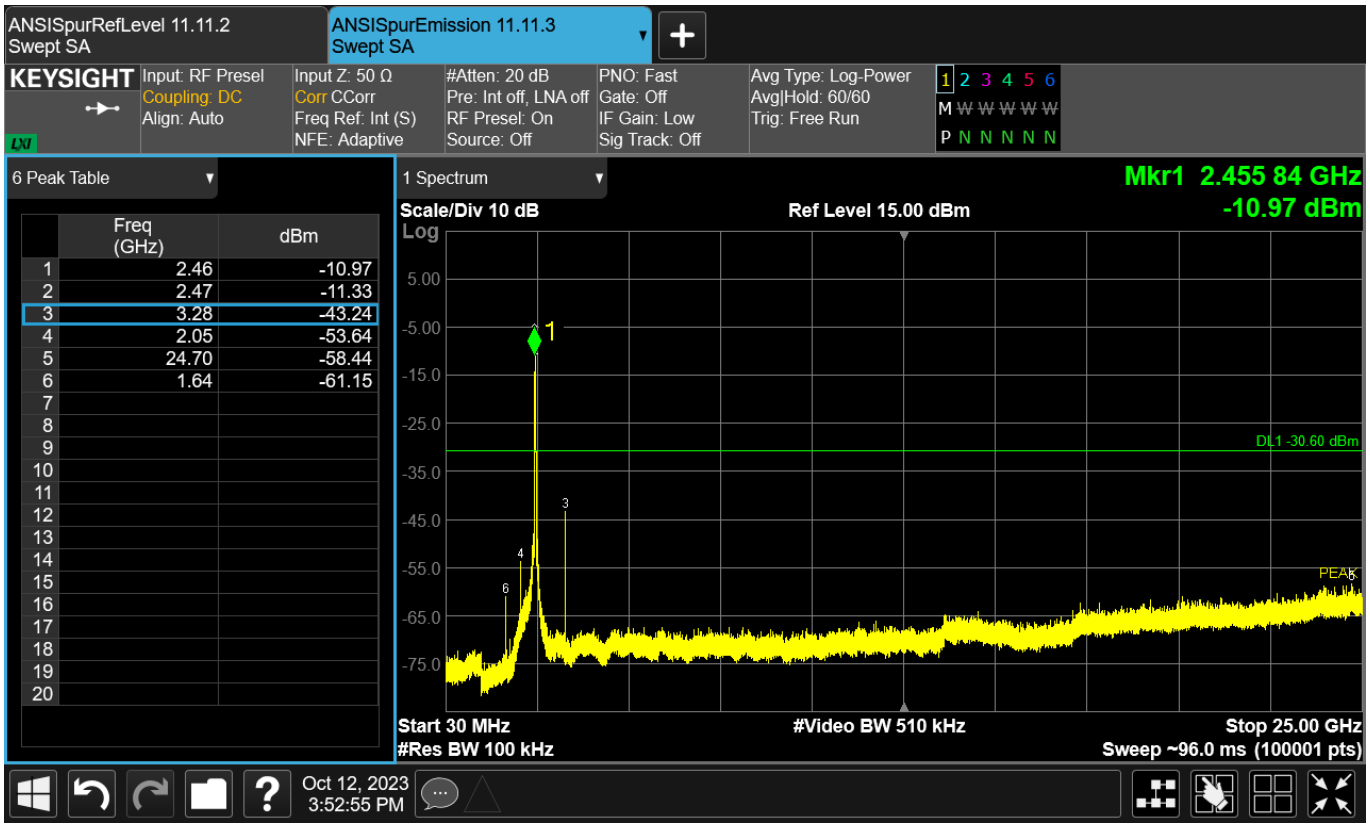

Figure TR21.9: Spectral data for IEEE 802.11 NMCS0-40 MHz at 2462 MHz
This line is the end of the test record.

Test Record
Radiated Emission Test RE02
Project GCL0388

Test Date(s)	19 Sep 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M1 (BtcTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15 (as noted in Section 6 of the report).
Frequency Range:	FCC Restricted Bands (2200-2300 MHz, 2310-2390 MHz, 2483.5-2500 MHz)
Pass/Fail Judgment:	**PASS**
Test record created by:	**David A Kerr**
Date of this record:	**29 Sep 2023**

Original record, Version A.

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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

Table RE02.1: Test Equipment Used

Software Used
N9048B Keysight PXE firmware version A.33.03
RE Signal Maximization Tool v2023Jul14.xlsx
FCC Restricted Band 2p4GHz Template v1b 2023Jun20.xlsx

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.

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

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

The tables show the selected final measurement data between the FCC restricted bands. It includes 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)	---
2386.5	54	74	33.232	46.673	20.768	27.327	-134	1410	HORZ
2390	54	74	33.452	47.103	20.548	26.897	-134	1410	HORZ

Table RE02.2: FCC restricted bands from 2200 to 2390 MHz (EDR2)

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)	---
2483.5	54	74	34.044	57.856	19.956	16.144	-136	1549	HORZ
2483.5	54	74	34.046	57.631	19.954	16.369	-136	1549	HORZ

Table RE02.3: FCC restricted band from 2483.5 to 2500 MHz (EDR2)

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)	---
2389.3	54	74	33.404	46.632	20.596	27.368	-134	1410	HORZ
2390	54	74	33.453	46.751	20.547	27.249	-134	1410	HORZ

Table RE02.4: FCC restricted bands from 2200 to 2390 MHz (EDR3)

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)	---
2483.5	54	74	34.049	57.772	19.951	16.228	-136	1549	HORZ
2483.5	54	74	34.049	57.754	19.951	16.246	-136	1549	HORZ

Table RE02.5: FCC restricted band from 2483.5 to 2500 MHz (EDR3)

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

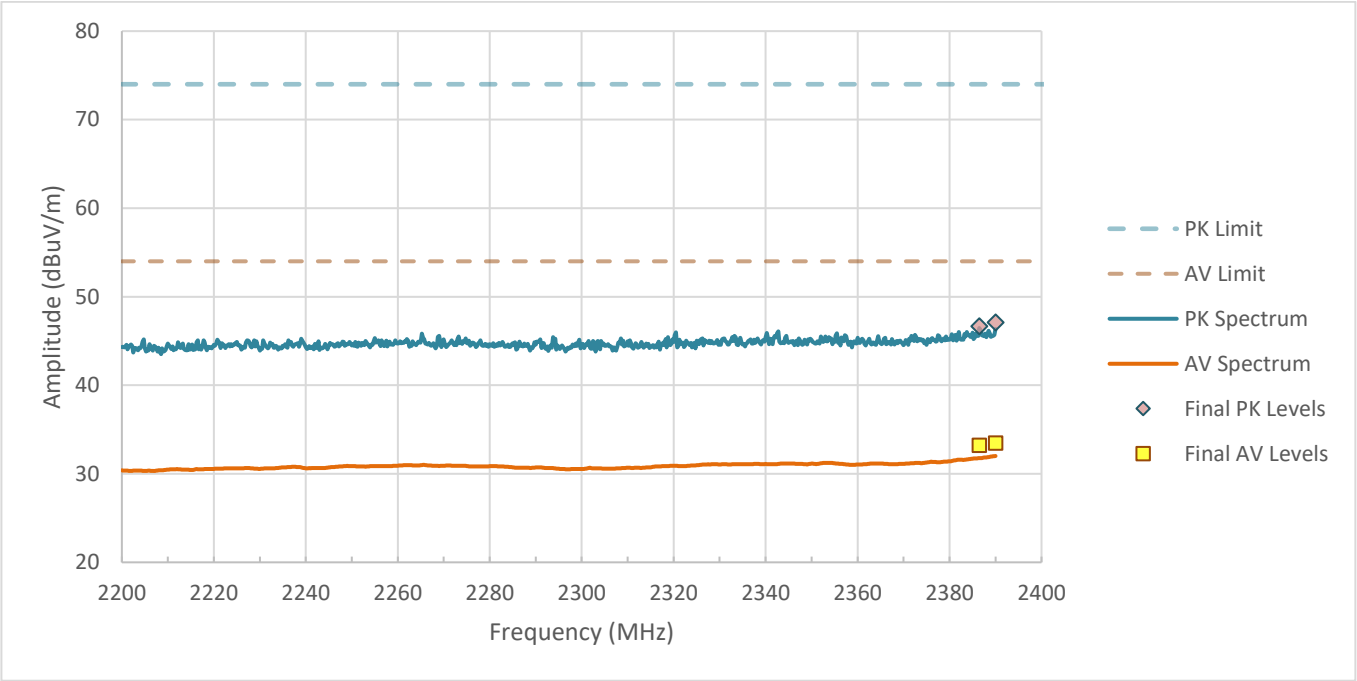

Figure RE02.1: FCC restricted band spectral data from 2200 to 2390 MHz (EDR2)

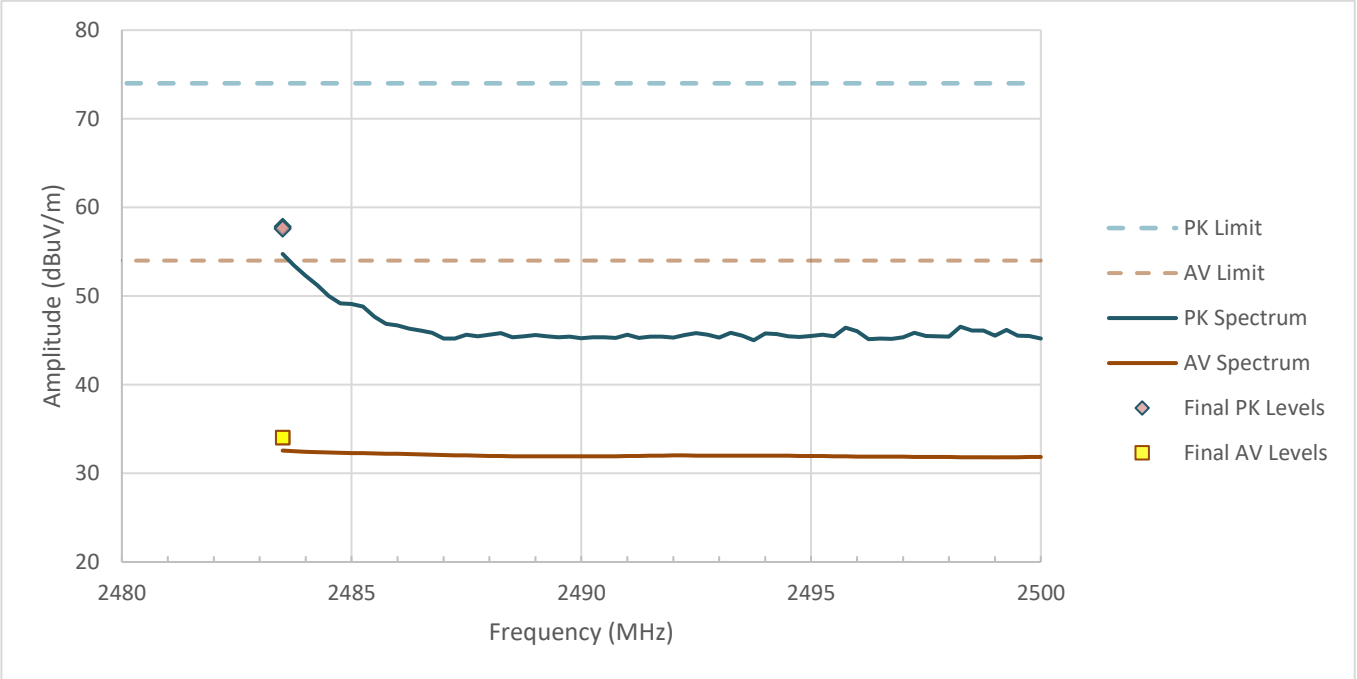

Figure RE02.2: FCC restricted band spectral data from 2483.5 to 2500 MHz (EDR2)

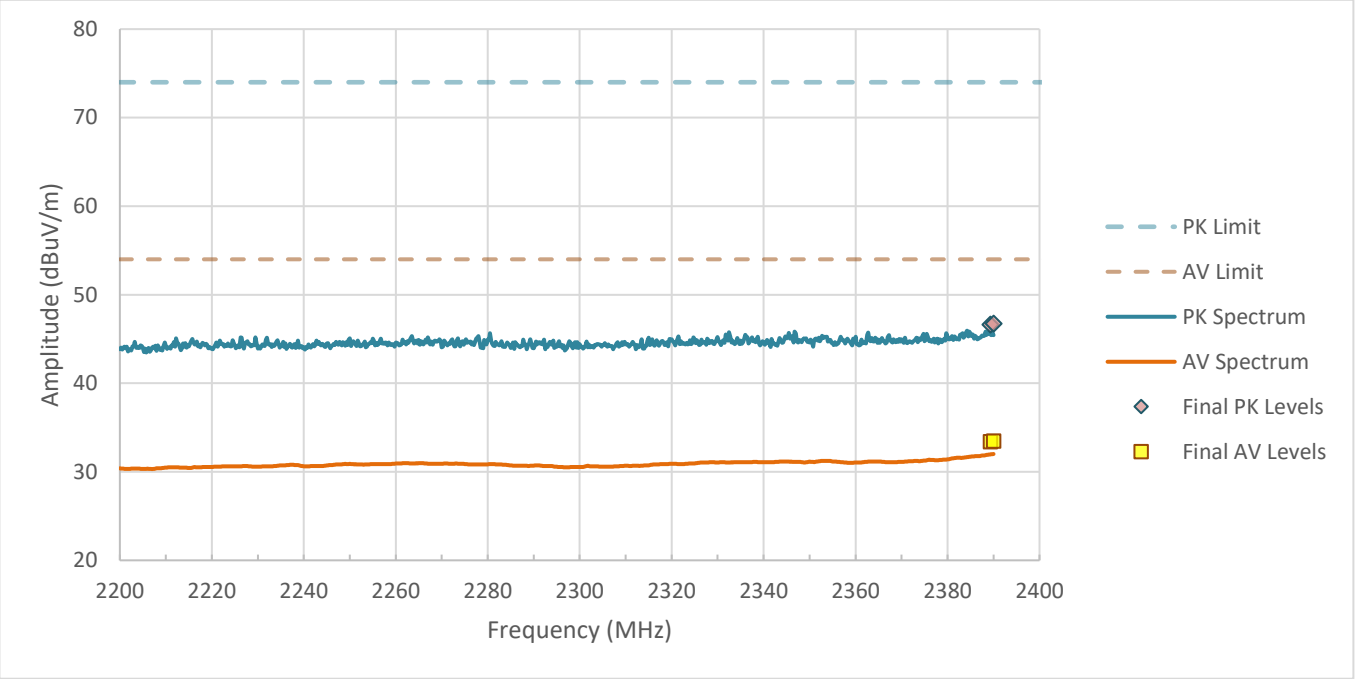

Figure RE02.3: FCC restricted band spectral data from 2200 to 2390 MHz (EDR3)

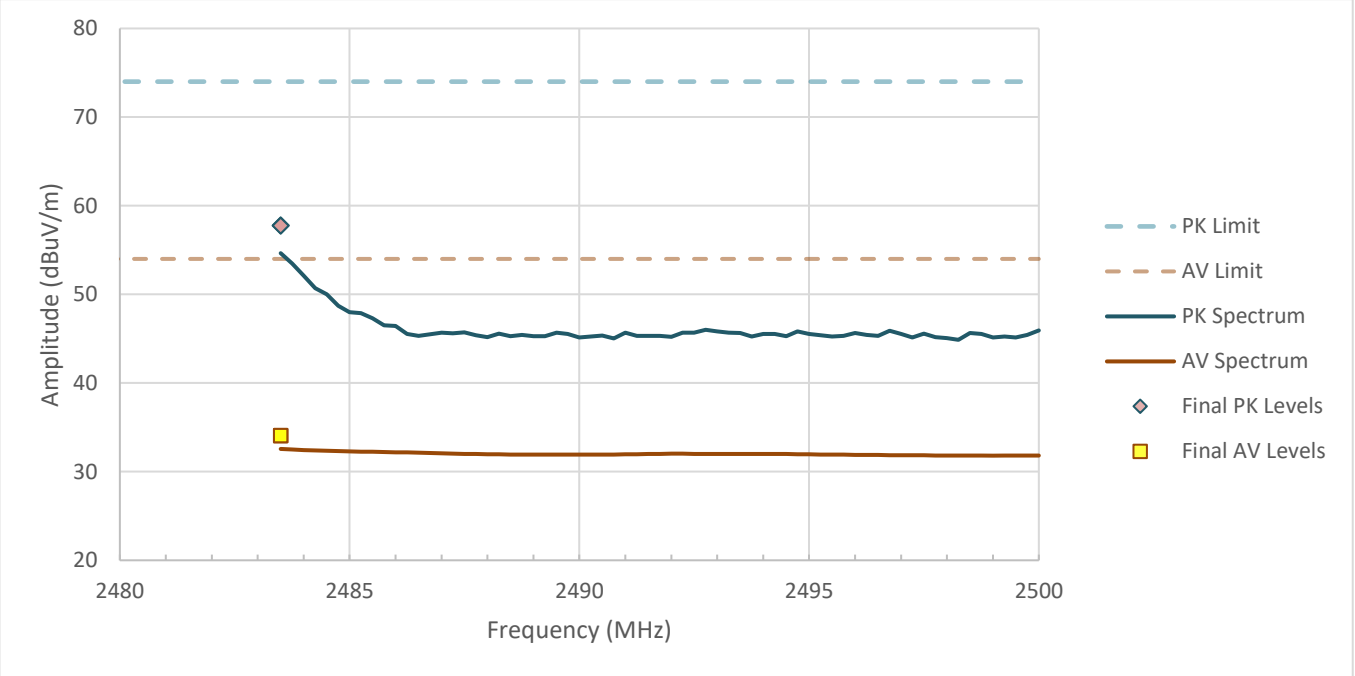

Figure RE02.4: FCC restricted band spectral data from 2483.5 to 2500 MHz (EDR3)

Setup Photographs

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

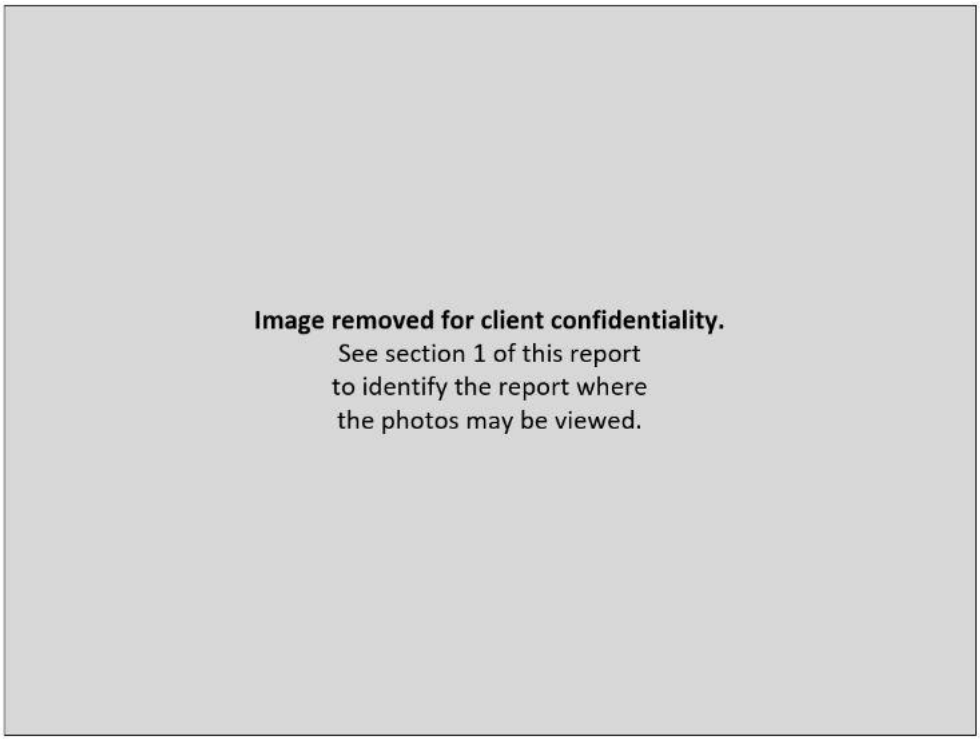

Figure RE02.5: EUT test setup

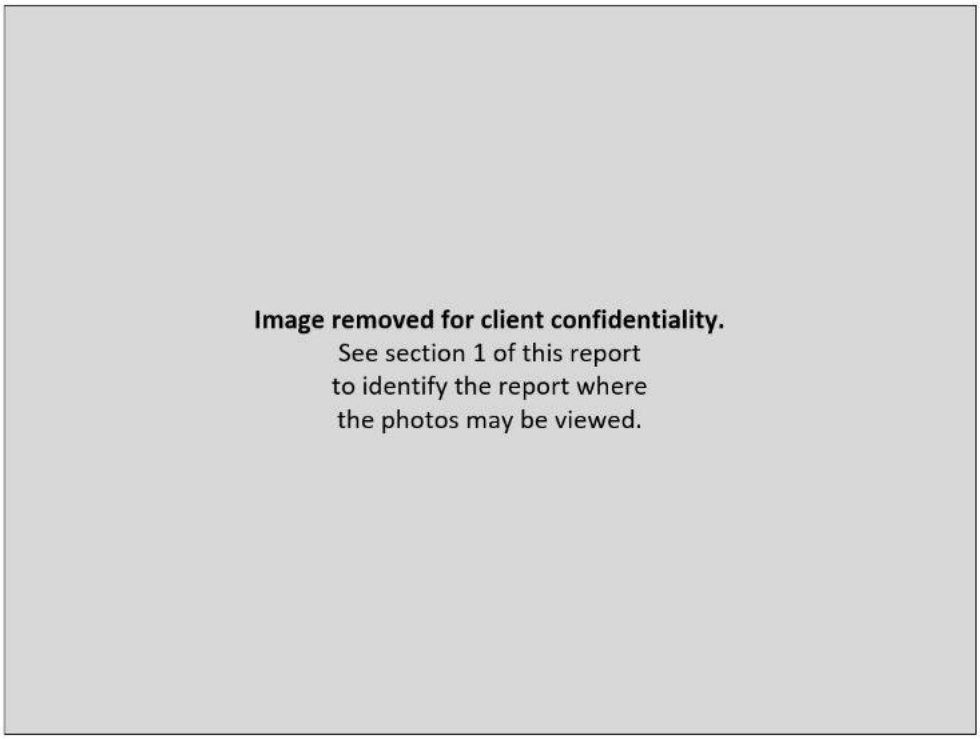

Figure RE02.6: EUT test setup

This line is the end of the test record.

Test Record
Radiated Emission Test RE03
Project GCL0388

Test Date(s)	19 Sep 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M2 (BleTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15 (as noted in Section 6 of the report).
Frequency Range:	FCC Restricted Bands (2200-2300 MHz, 2310-2390 MHz, 2483.5-2500 MHz)
Pass/Fail Judgment:	**PASS**
Test record created by:	**David A Kerr**
Date of this record:	**29 Sep 2023**

Original record, Version A.

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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

Table RE03.1: Test Equipment Used

Software Used
N9048B Keysight PXE firmware version A.33.03
RE Signal Maximization Tool v2023Jul14.xlsx
FCC Restricted Band 2p4GHz Template v1b 2023Jun20.xlsx

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.

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

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

The tables show the selected final measurement data between the FCC restricted bands. It includes 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)	---
2390	54	74	35.082	54.78	18.918	19.22	-134	1410	HORZ
2390	54	74	35.084	54.343	18.916	19.657	-134	1410	HORZ

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

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)	---
2488	54	74	35.602	55.024	18.398	18.976	-136	1549	HORZ
2483.5	54	74	36.788	52.967	17.212	21.033	-136	1549	HORZ

Table RE03.3: FCC restricted band from 2483.5 to 2500 MHz (1Mbps)

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

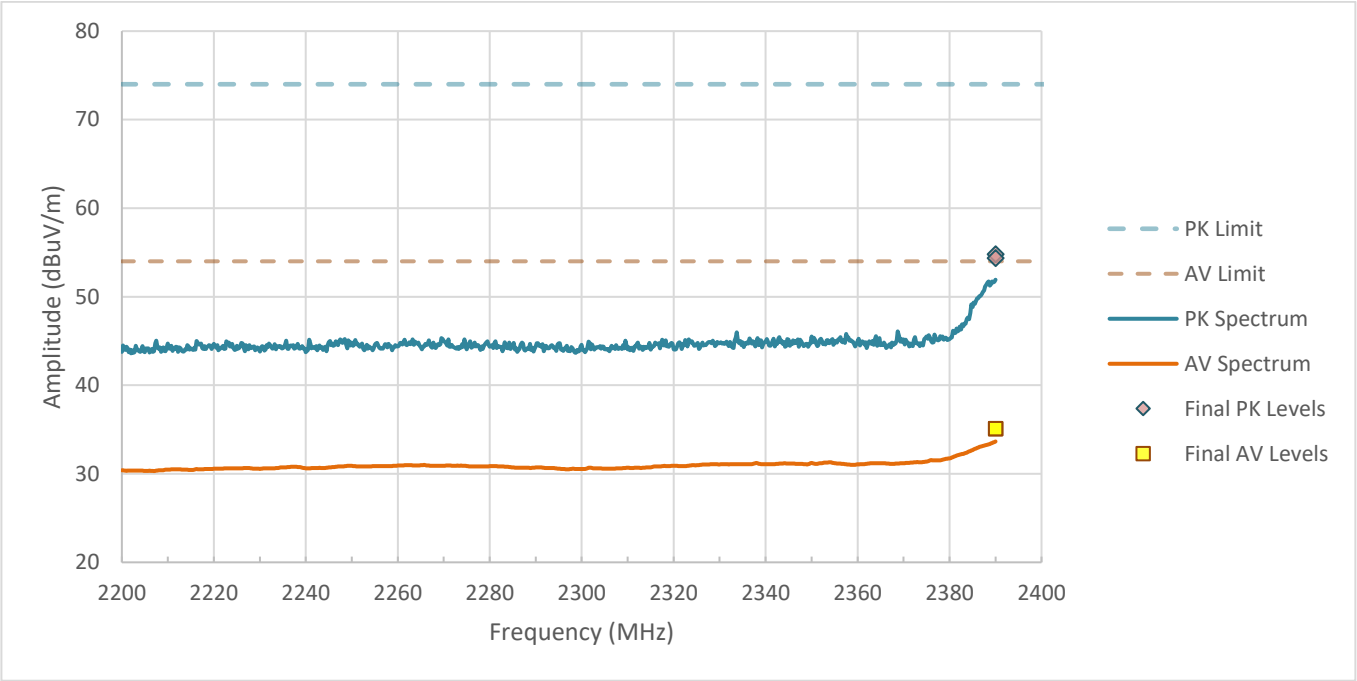

Figure RE03.1: FCC restricted band spectral data from 2200 to 2390 MHz (1Mbps)

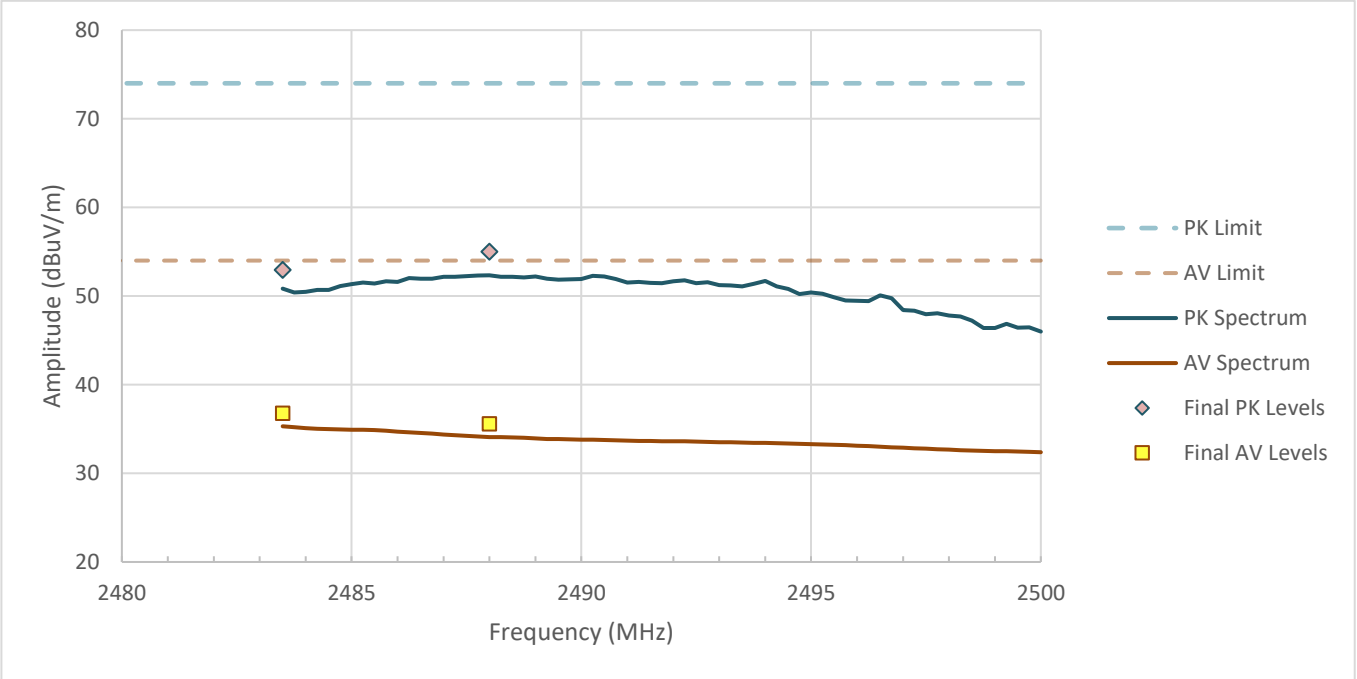

Figure RE03.2: FCC restricted band spectral data from 2483.5 to 2500 MHz (1Mbps)

Setup Photographs

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

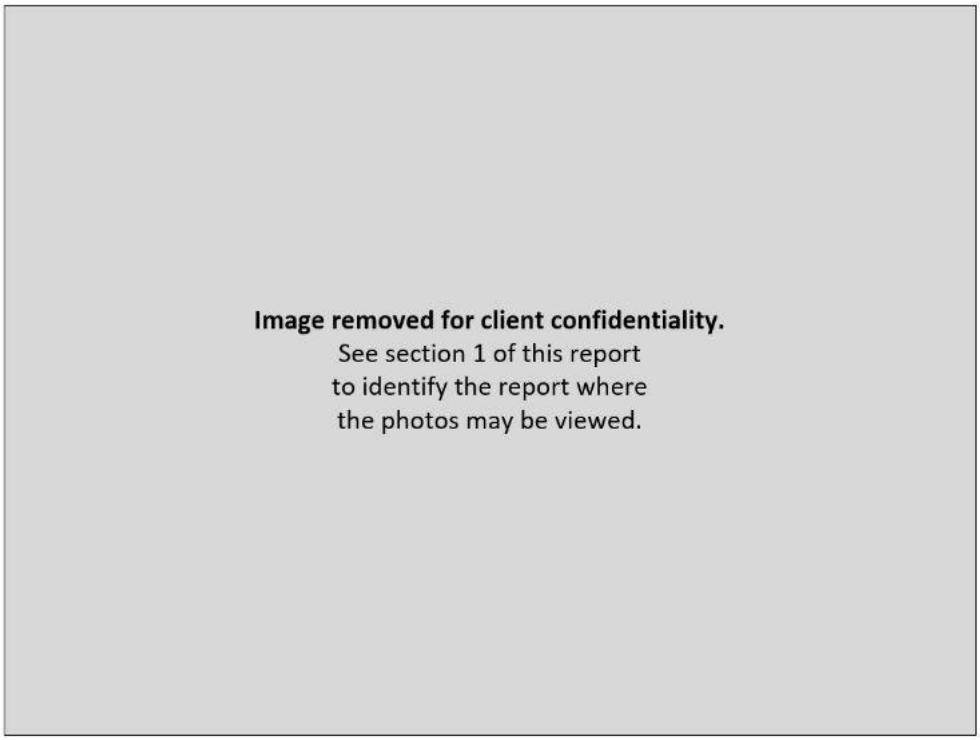

Figure RE03.3: EUT test setup

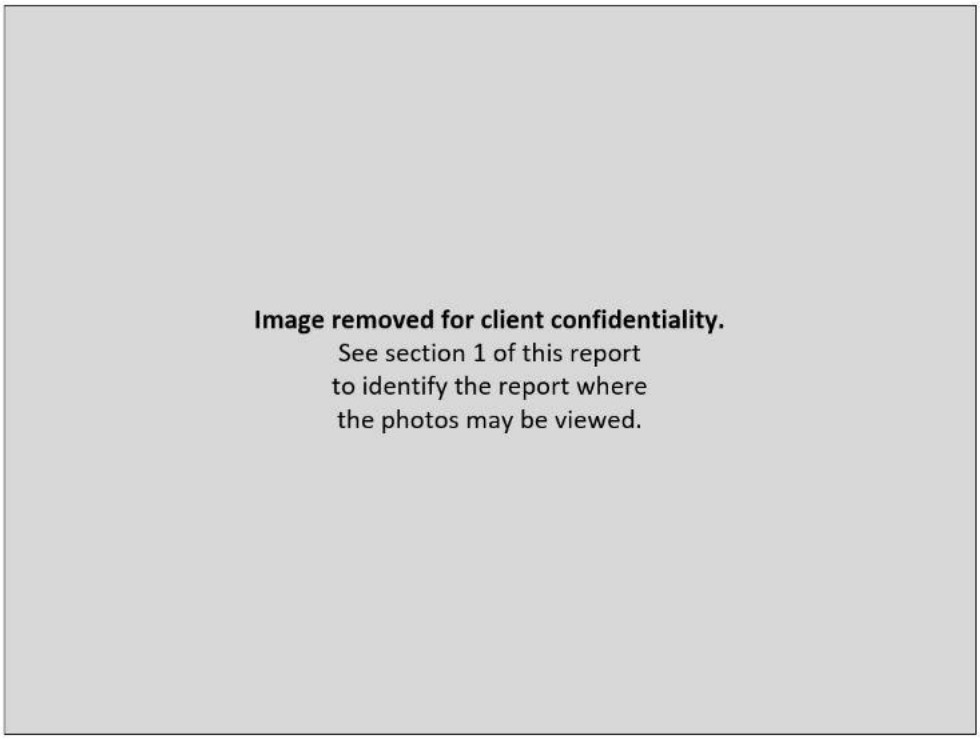

Figure RE03.4: EUT test setup

This line is the end of the test record.

Test Record
Radiated Emission Test RE04
Project GCL0388

Test Date(s)	27 Sep 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M3 (WiFi2Tx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15 (as noted in Section 6 of the report).
Frequency Range:	FCC Restricted Bands (2200-2300 MHz, 2310-2390 MHz, 2483.5-2500 MHz)
Pass/Fail Judgment:	**PASS**
Test record created by:	**David A Kerr**
Date of this record:	**29 Sep 2023**

Original record, Version A.

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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

Table RE04.1: Test Equipment Used

Software Used
N9048B Keysight PXE firmware version A.33.03
RE Signal Maximization Tool v2023Jul14.xlsx
FCC Restricted Band 2p4GHz Template v1b 2023Jun20.xlsx

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.

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

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

The tables show the selected final measurement data between the FCC restricted bands. It includes 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)	---
2389.5	54	74	42.201	60.517	11.799	13.483	-134	1410	HORZ
2390	54	74	42.402	61.216	11.598	12.784	-134	1410	HORZ

Table RE04.2: FCC restricted bands from 2200 to 2390 MHz (Ch1 B11)

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)	---
2390	54	74	42.939	70.102	11.061	3.898	-134	1410	HORZ
2390	54	74	42.945	70.075	11.055	3.925	-134	1410	HORZ

Table RE04.3: FCC restricted bands from 2200 to 2390 MHz (G24)

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)	---
2390	54	74	42.975	68.019	11.025	5.981	-134	1410	HORZ
2390	54	74	42.975	67.103	11.025	6.897	-134	1410	HORZ

Table RE04.4: FCC restricted bands from 2200 to 2390 MHz (Ch 1 N20 MCS2)

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)	---
2381.5	54	74	36.719	65.932	17.281	8.068	-134	1410	HORZ
2390	54	74	37.604	63.327	16.396	10.673	-134	1410	HORZ

Table RE04.5: FCC restricted bands from 2200 to 2390 MHz (Ch3 N40 MCS4)

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)	---
2489.3	54	74	41.322	56.967	12.678	17.033	-136	1549	HORZ
2484	54	74	42.117	58.082	11.883	15.918	-136	1549	HORZ

Table RE04.6: FCC restricted band from 2483.5 to 2500 MHz (Ch11 B5.5)

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)	---
2483.5	54	74	43.828	66.484	10.172	7.516	-136	1549	HORZ
2483.5	54	74	43.835	65.998	10.165	8.002	-136	1549	HORZ

Table RE04.7: FCC restricted band from 2483.5 to 2500 MHz (G9)

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)	---
2483.5	54	74	40.124	62.719	13.876	11.281	-136	1549	HORZ
2483.5	54	74	40.125	63.311	13.875	10.689	-136	1549	HORZ

Table RE04.8: FCC restricted band from 2483.5 to 2500 MHz (Ch11 N20 MCS3)

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)	---
2483.5	54	74	42.068	69.12	11.932	4.88	-133	1396	*
2483.5	54	74	42.069	69.199	11.931	4.801	-133	1396	*

Table RE04.9: FCC restricted band from 2483.5 to 2500 MHz (Ch9 N40 MCS0)

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)	---
2483.5	54	74	39.567	60.826	14.433	13.174	-133	1396	*
2483.5	54	74	39.563	60.588	14.437	13.412	-133	1396	*

Table RE04.10: FCC restricted band from 2483.5 to 2500 MHz (Ch8 N40 MCS0)

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

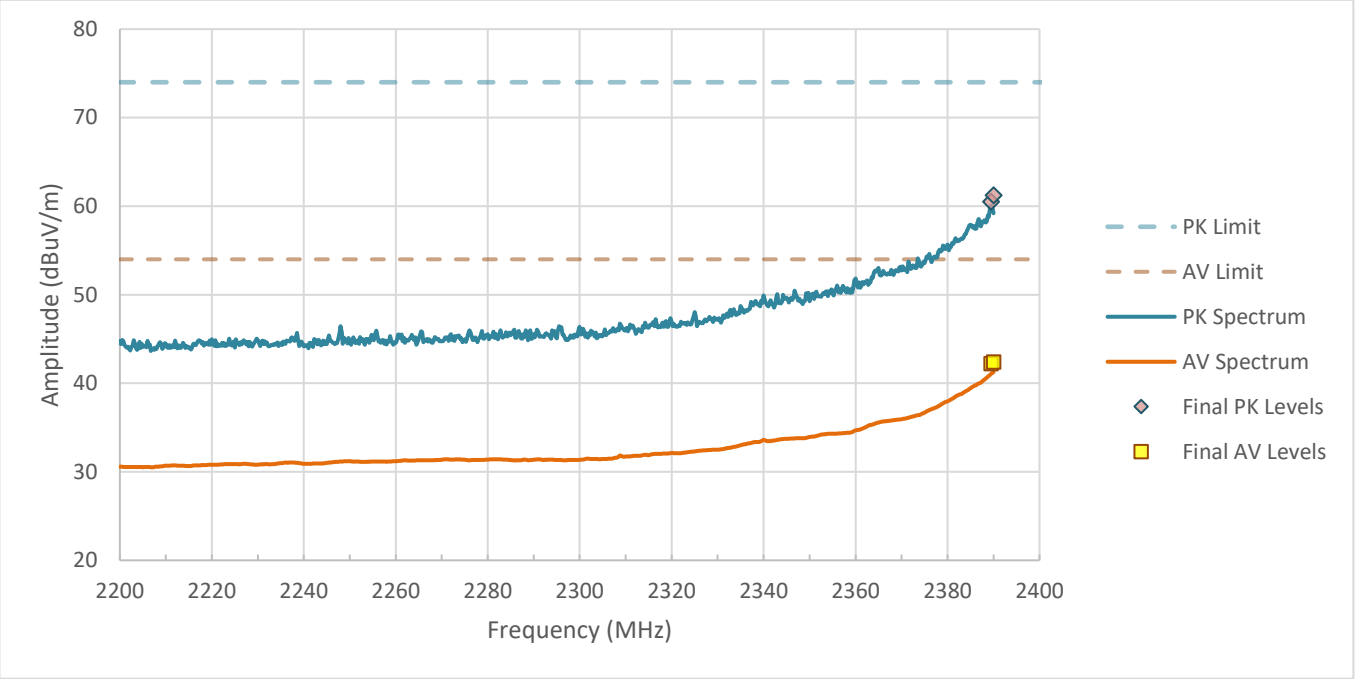

Figure RE04.1: FCC restricted band spectral data from 2200 to 2390 MHz (Ch1 B11)

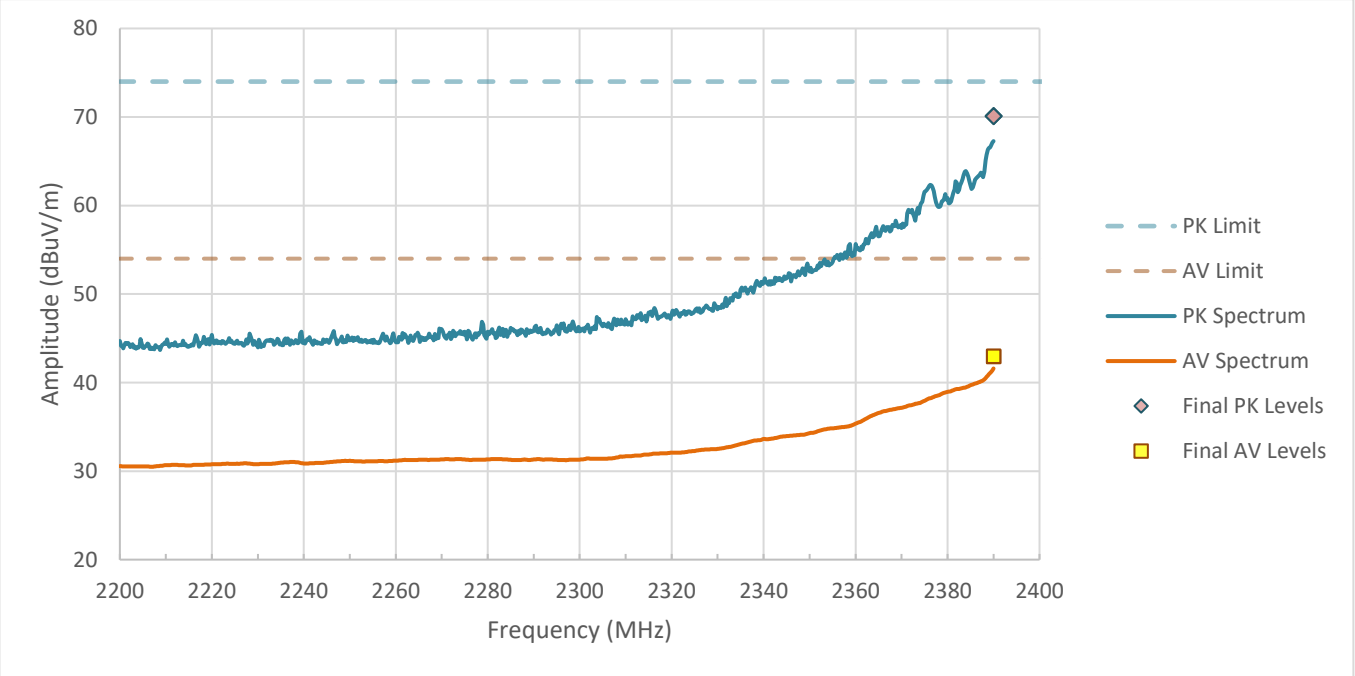

Figure RE04.2: FCC restricted band spectral data from 2200 to 2390 MHz (G24)

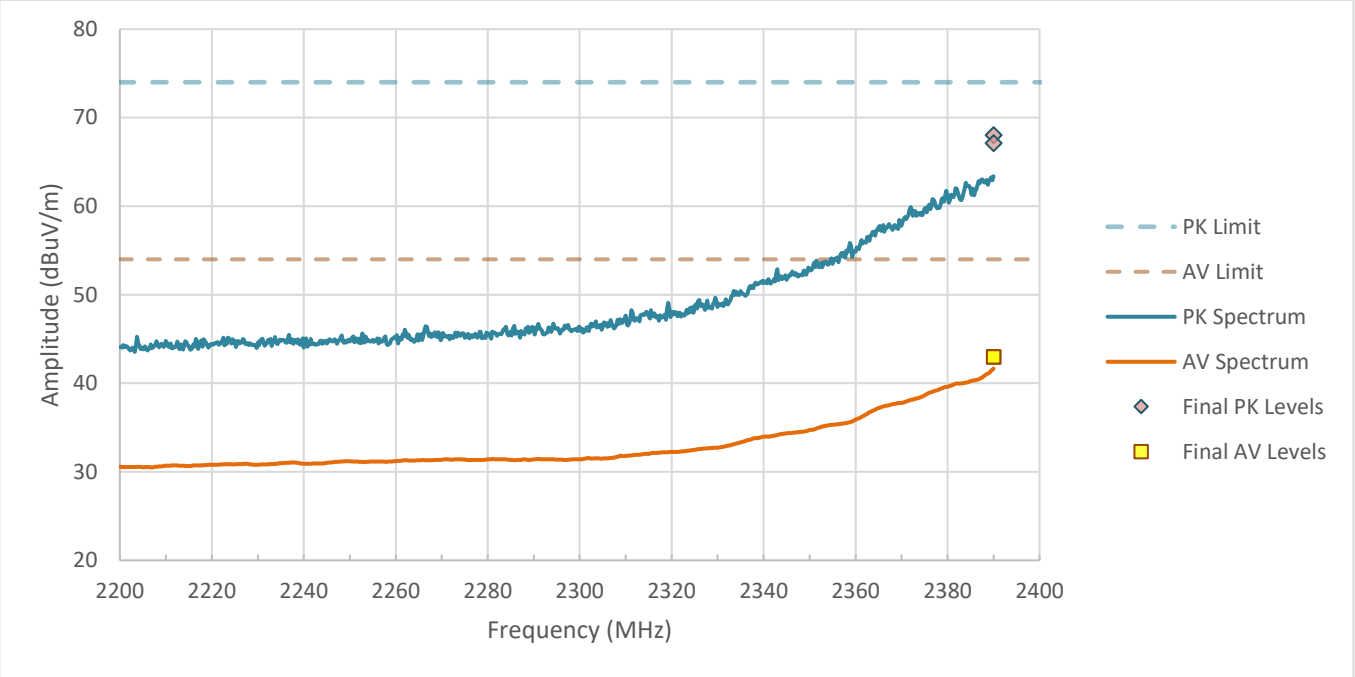

Figure RE04.3: FCC restricted band spectral data from 2200 to 2390 MHz (Ch 1 N20 MCS2)

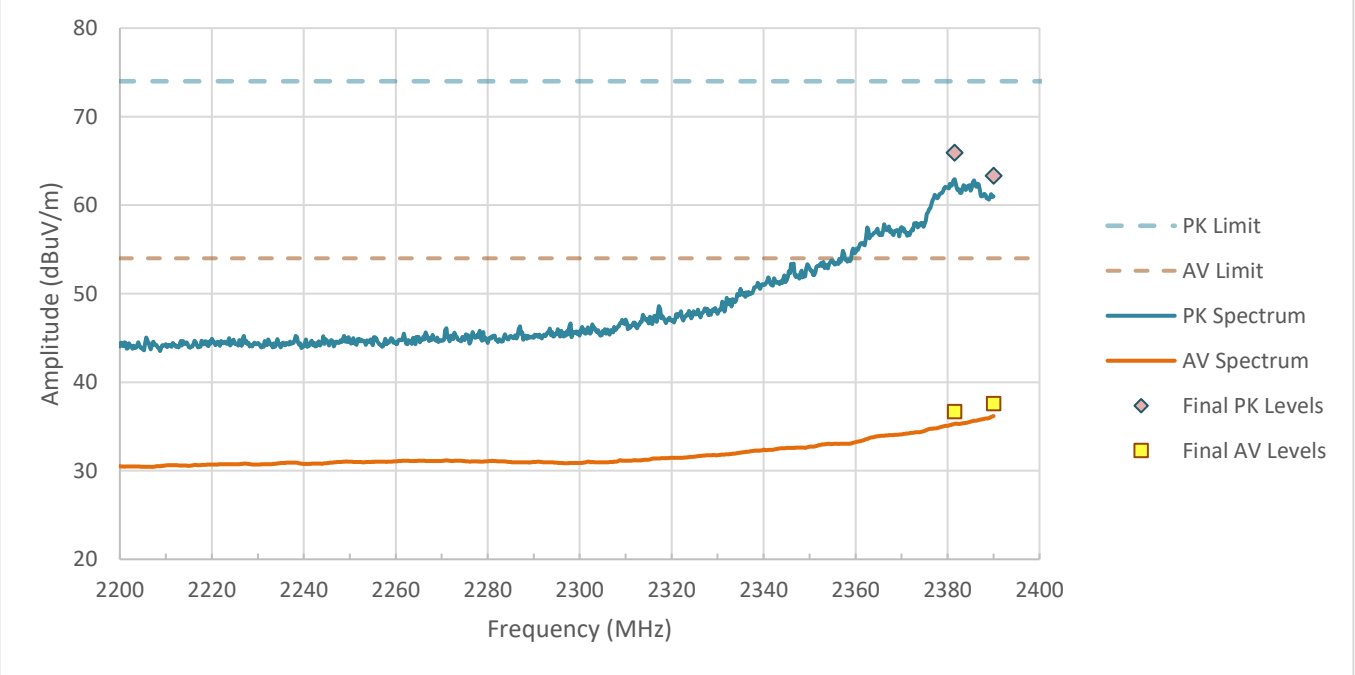

Figure RE04.4: FCC restricted band spectral data from 2200 to 2390 MHz (Ch3 N40 MCS4)

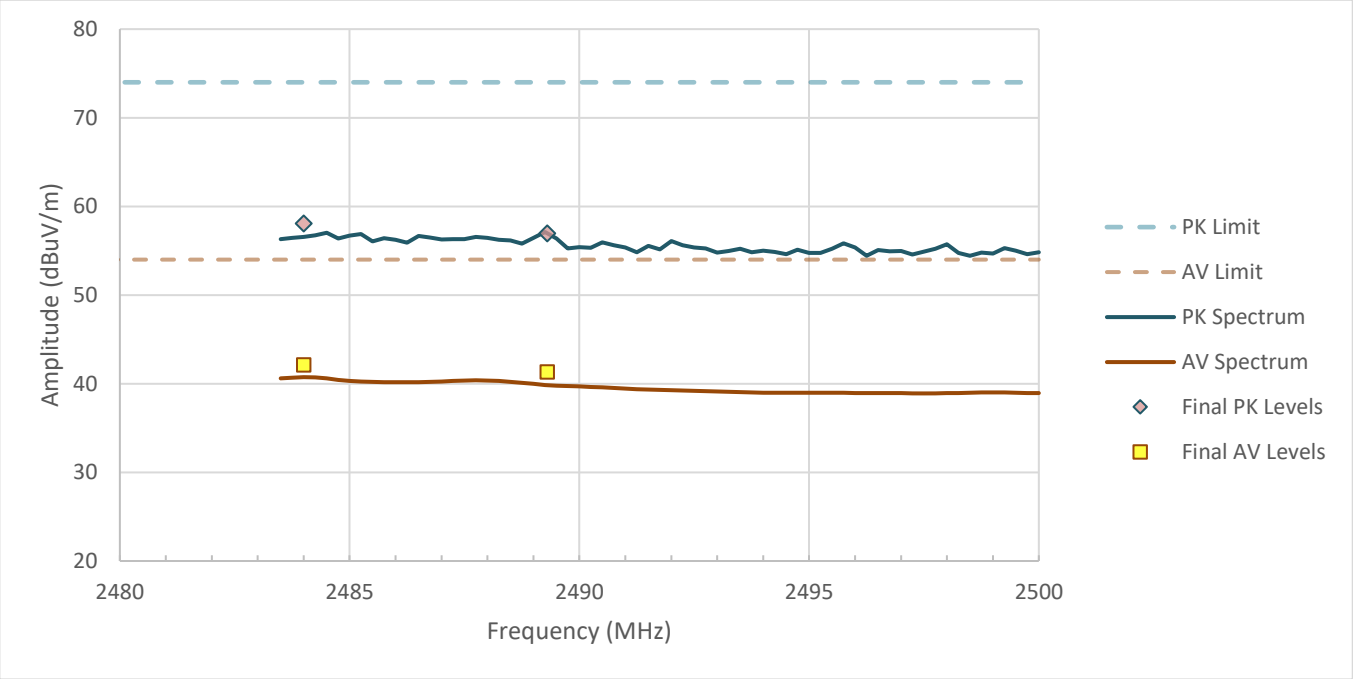

Figure RE04.5: FCC restricted band spectral data from 2483.5 to 2500 MHz (Ch11 B5.5)

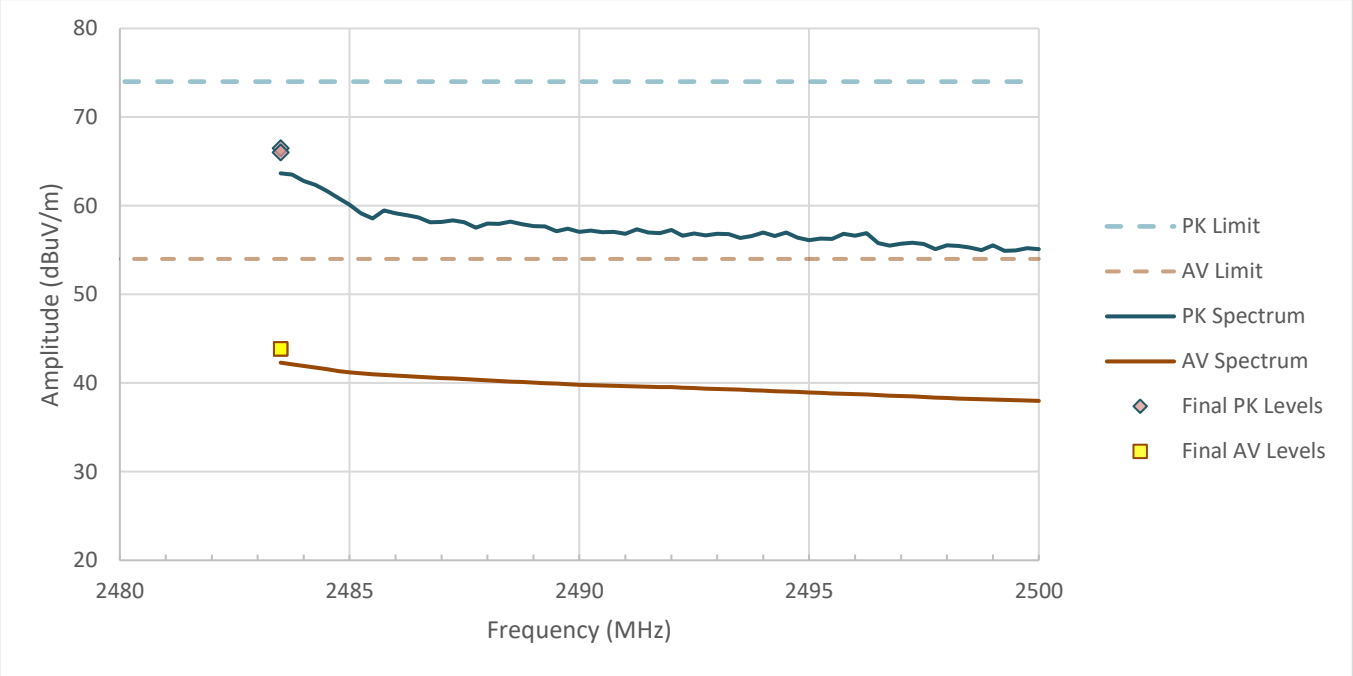

Figure RE04.6: FCC restricted band spectral data from 2483.5 to 2500 MHz (G9)

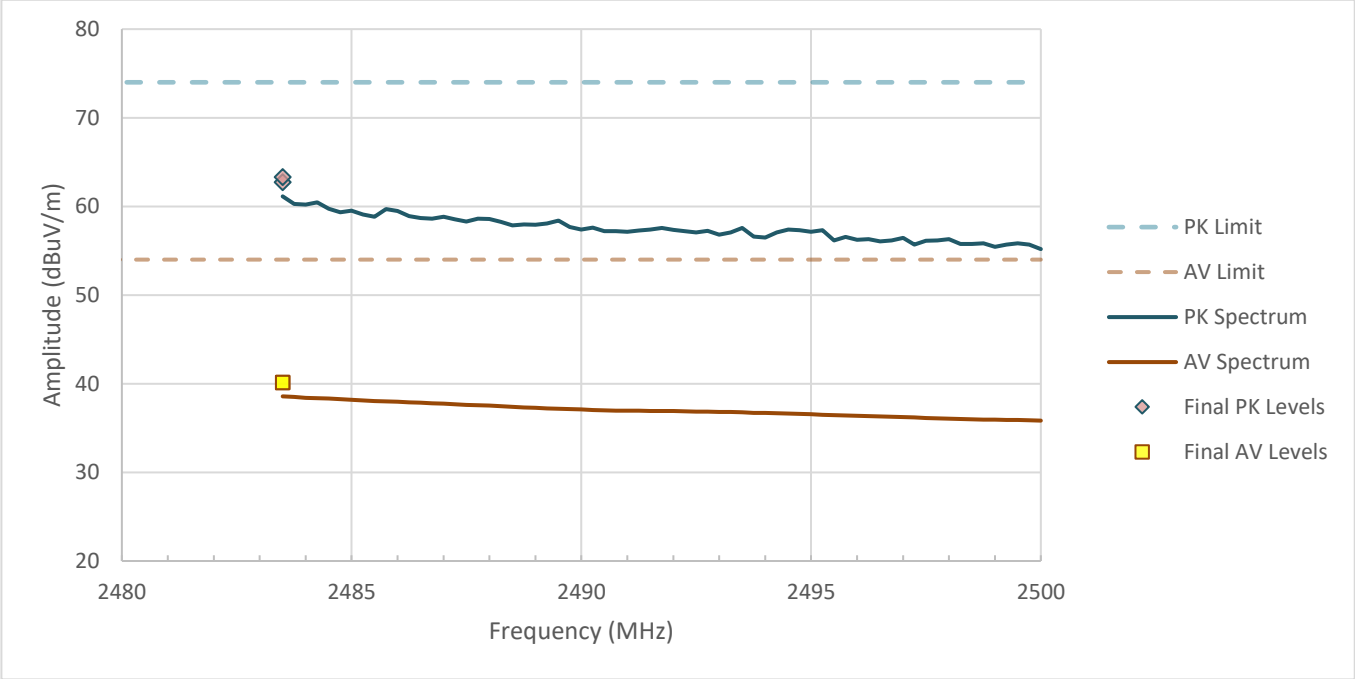

Figure RE04.7: FCC restricted band spectral data from 2483.5 to 2500 MHz (Ch11 N20 MCS3)

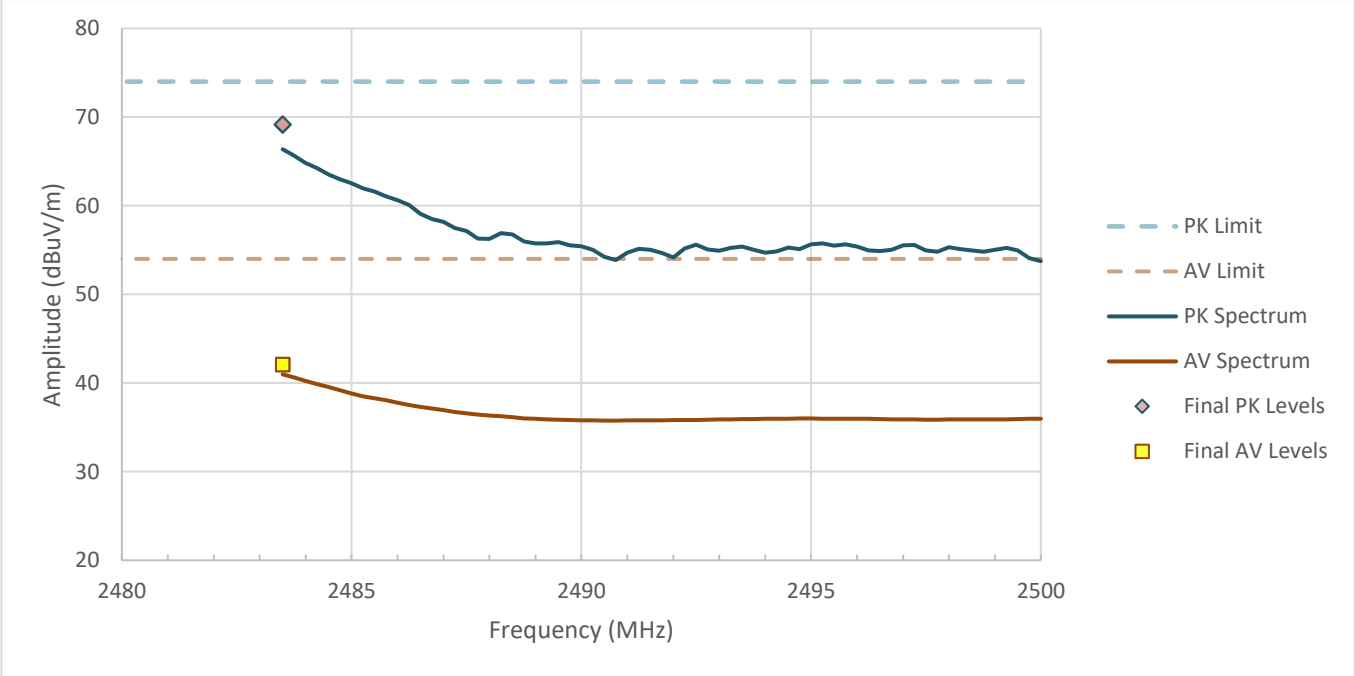

Figure RE04.8: FCC restricted band spectral data from 2483.5 to 2500 MHz (Ch9 N40 MCS0)

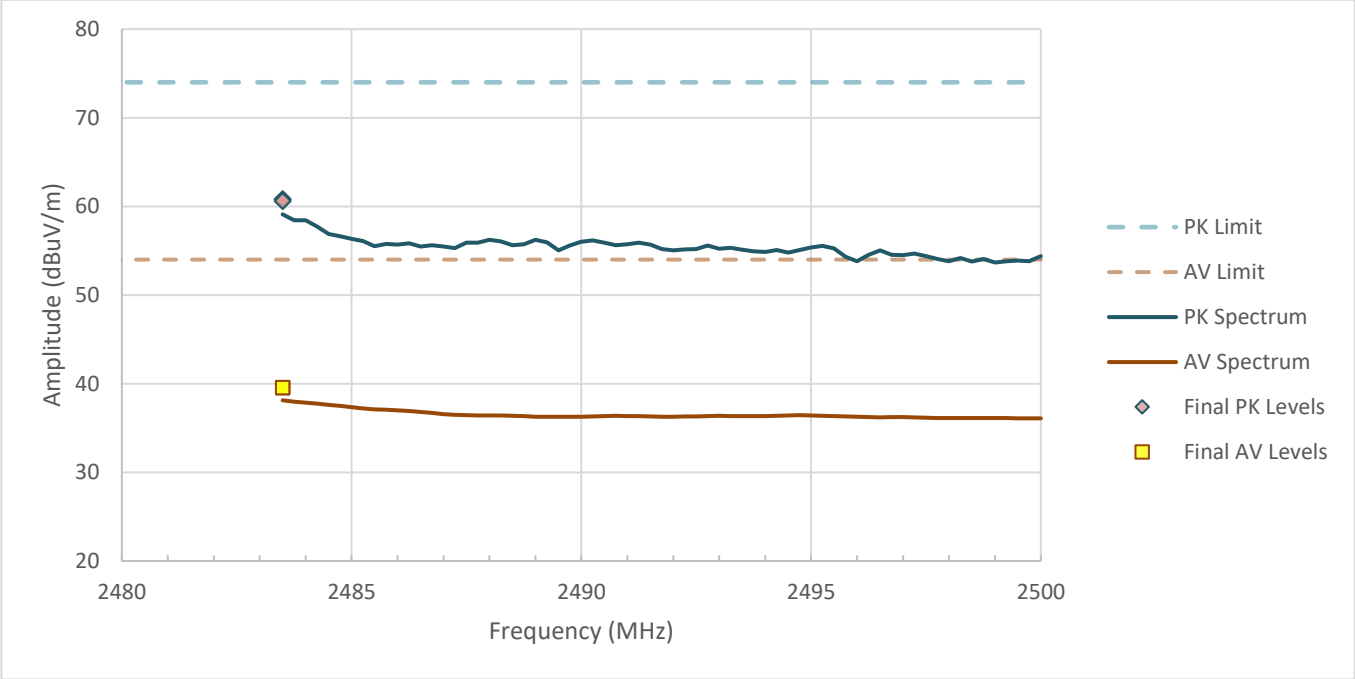

Figure RE04.9: FCC restricted band spectral data from 2483.5 to 2500 MHz MHz (Ch8 N40 MCS0)

Setup Photographs

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

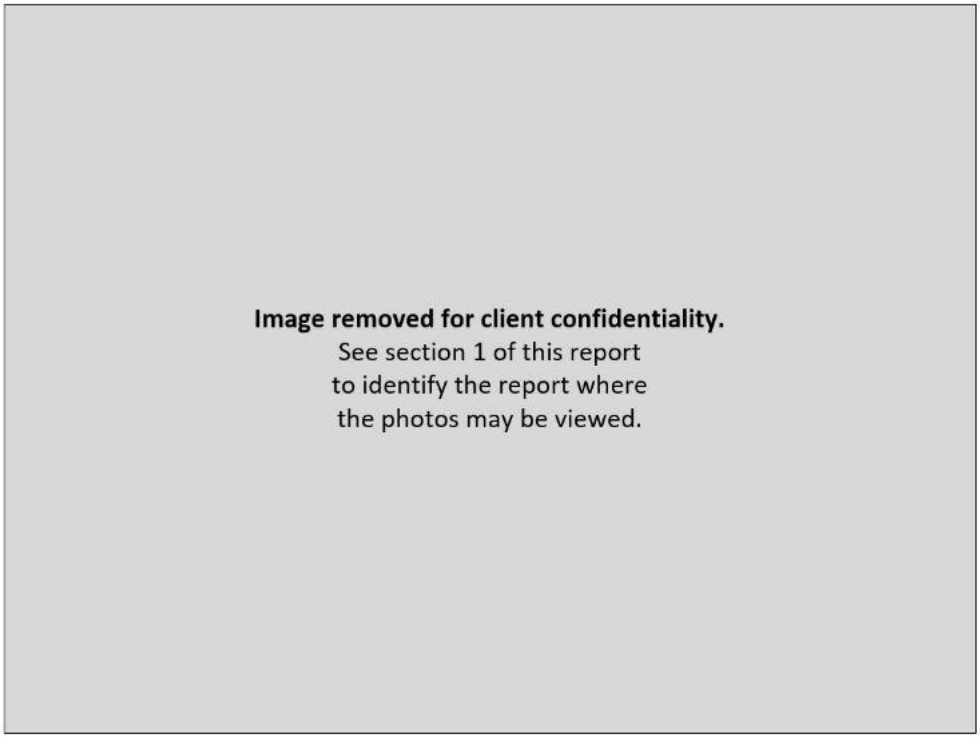

Figure RE04.10: EUT test setup

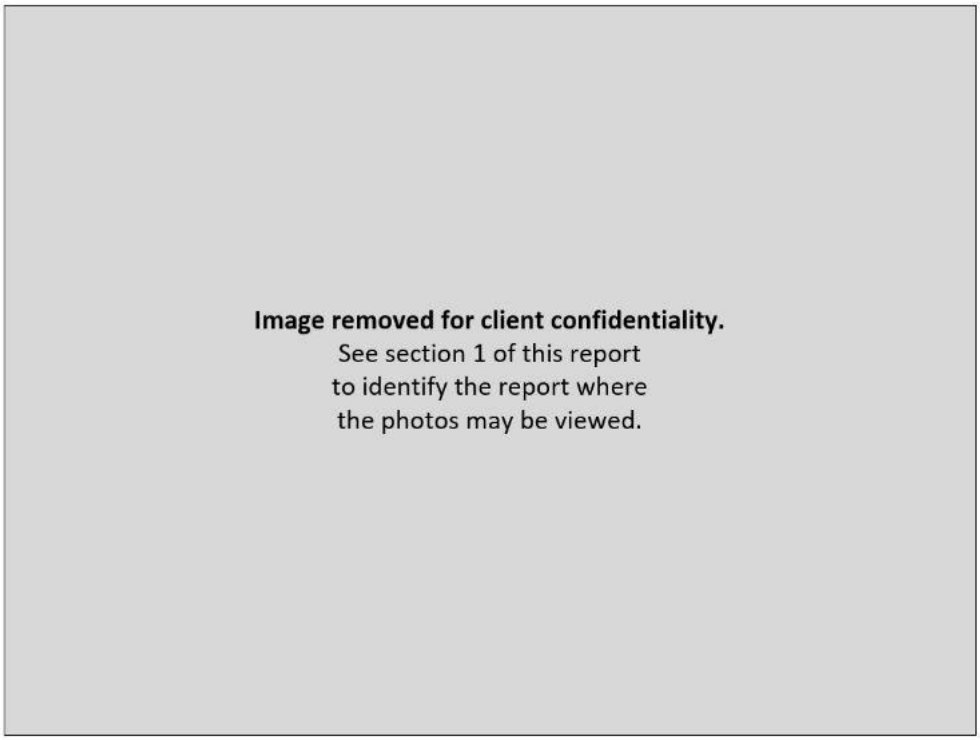

Figure RE04.11: EUT test setup

This line is the end of the test record.

Test Record
Transmitter Power Spectral Density
Test IDs TR14, TR15
Project GCL-0388

Test Date(s)	10 Oct 2023
Test Personnel	David Arnett
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M1 (BtcTx), M2 (BleTx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report).
Antenna Gain	1.46 dBi, as reported by the client
Radio Protocol	Bluetooth Classic (using EDR2 and EDR3), Bluetooth Low Energy (BLE)
Pass/Fail Judgment:	**PASS**
Test record created by:	**David Arnett**
Date of this record:	**1 Nov 2023**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220146	3-Jun-2023	3-Jun-2024

Table TR14.1: Test equipment used

Software Used: Keysight PXE software A.35.06

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.

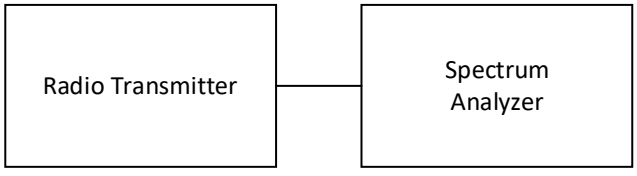

Figure TR14.1: Test setup

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 higher resolution bandwidths is permitted. All data met the limit using a 3 kHz resolution bandwidth.

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

		2402 MHz	2440 MHz	2480 MHz
BT	EDR2	**-19.52**	**-18.8**	**-18.44**
	EDR3	**-19.5**	**-18.95**	**-18.41**
BLE	1 Mbps	**-16.3**	**-15.73**	**-15.38**

Table TR14.2: Summary of results in units dBm/3 kHz

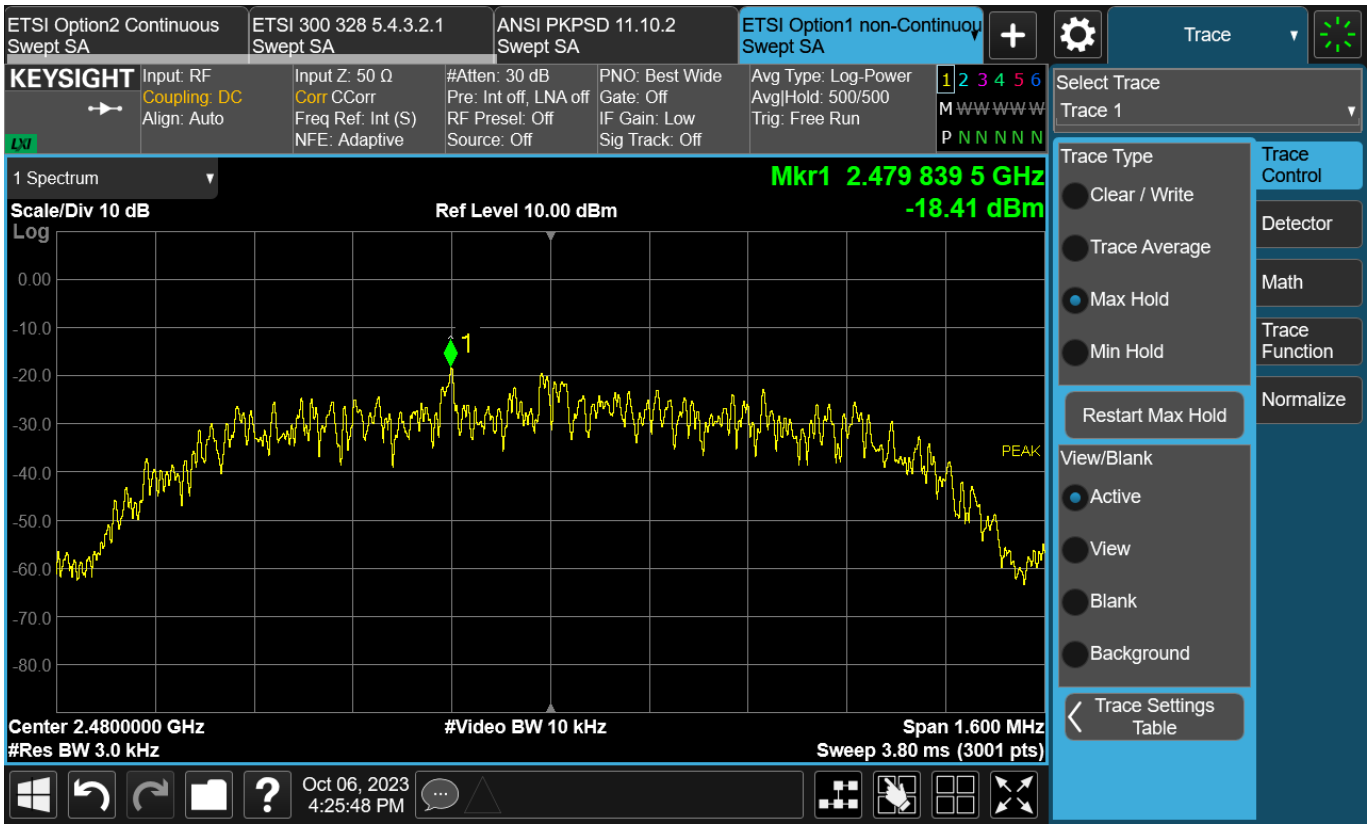

Figure TR14.3: Test data for EDR3 transmissions at 2480 MHz

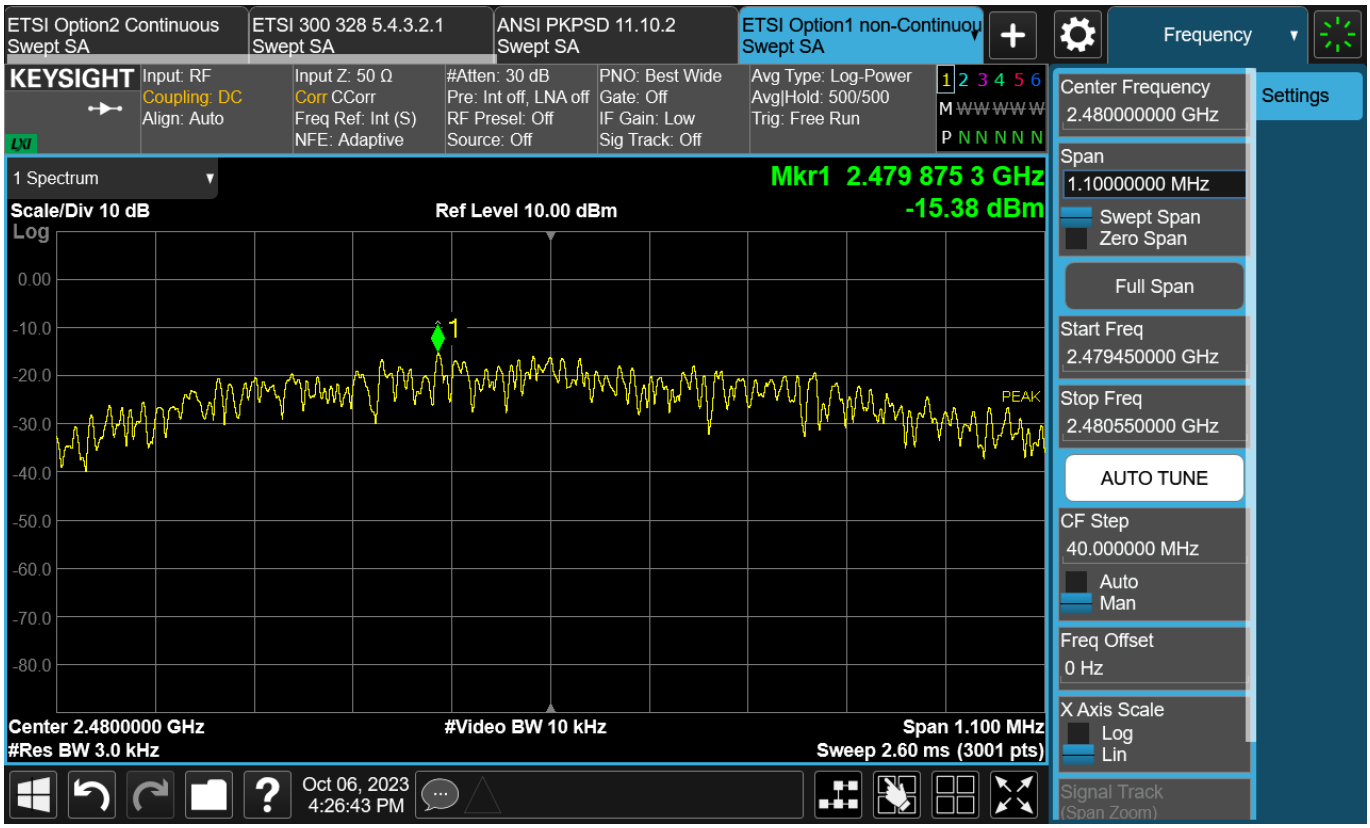

Figure TR14.4: Test data for BLE transmissions at 2480 MHz

This line is the end of the test record.

Test Record
Transmitter Power Spectral Density
Test IDs TR16
Project GCL-0388

Test Date(s)	10 Oct 2023
Test Personnel	David Arnett
Product Model	A04752
Serial Number tested	3449554852
Operating Mode	M3 (WiFi2Tx)
Arrangement	A4 (Dual)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 (as noted in Section 6 of the report).
Antenna Gain	1.46 dBi, as reported by the client
Radio Protocol	IEEE 802.11 b/g/n/ac with 20 MHz and 40 MHz nominal bandwidths
Pass/Fail Judgment:	**PASS**
Test record created by:	**David Arnett**
Date of this record:	**6 Nov 2023**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220146	3-Jun-2023	3-Jun-2024

Table TR16.1: Test equipment used

Software Used: Keysight PXE software A.35.06

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.

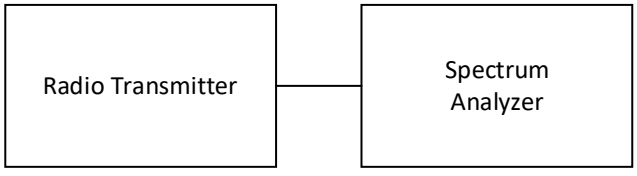

Figure TR16.1: Test setup

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 higher resolution bandwidths is permitted. All data met the limit using a 30 kHz resolution bandwidth.

Data were measured at the low and high data rates for each WiFi type, with n and ac being treated as equivalent since modulation is based on the MCS indices. This was measured on the low, middle, and high channels.

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

Frq (MHz)	2412	2437	2462
Channel	1	6	11
Nom BW	20	20	20
Modulation			
B1	**-3.80**	**-3.72**	**-3.59**
B11	**-2.47**	**-2.50**	**-2.15**
G6	**-4.76**	**-5.16**	**-4.87**
G54	**-6.85**	**-6.97**	**-7.06**
MCS0	**-6.60**	**-7.02**	**-6.80**
MCS7	**-9.62**	**-9.77**	**-9.84**

Table TR16.2: Summary of results for 20 MHz channels in units dBm/30 kHz

Frq (MHz)	2432	2447	2462
Channel	3	6	9
Nom BW	40	40	40
Modulation			
MCS0	**-12.68**	**-11.91**	**-15.12**
MCS7	**-15.00**	**-14.75**	**-15.83**

Table TR16.3: Summary of results for 40 MHz channels in units dBm/30 kHz

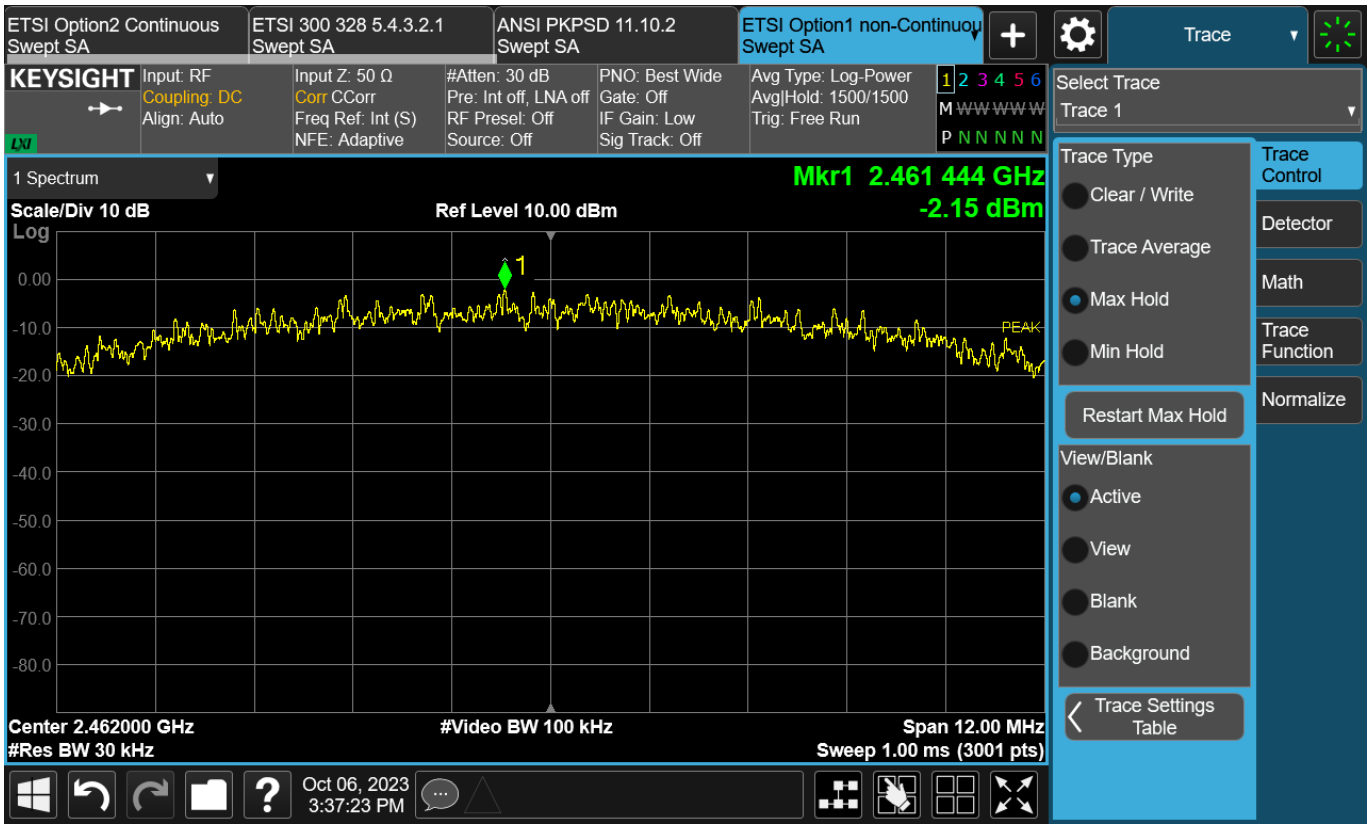

Figure TR16.3: Test data for B11 transmissions at 2462 MHz

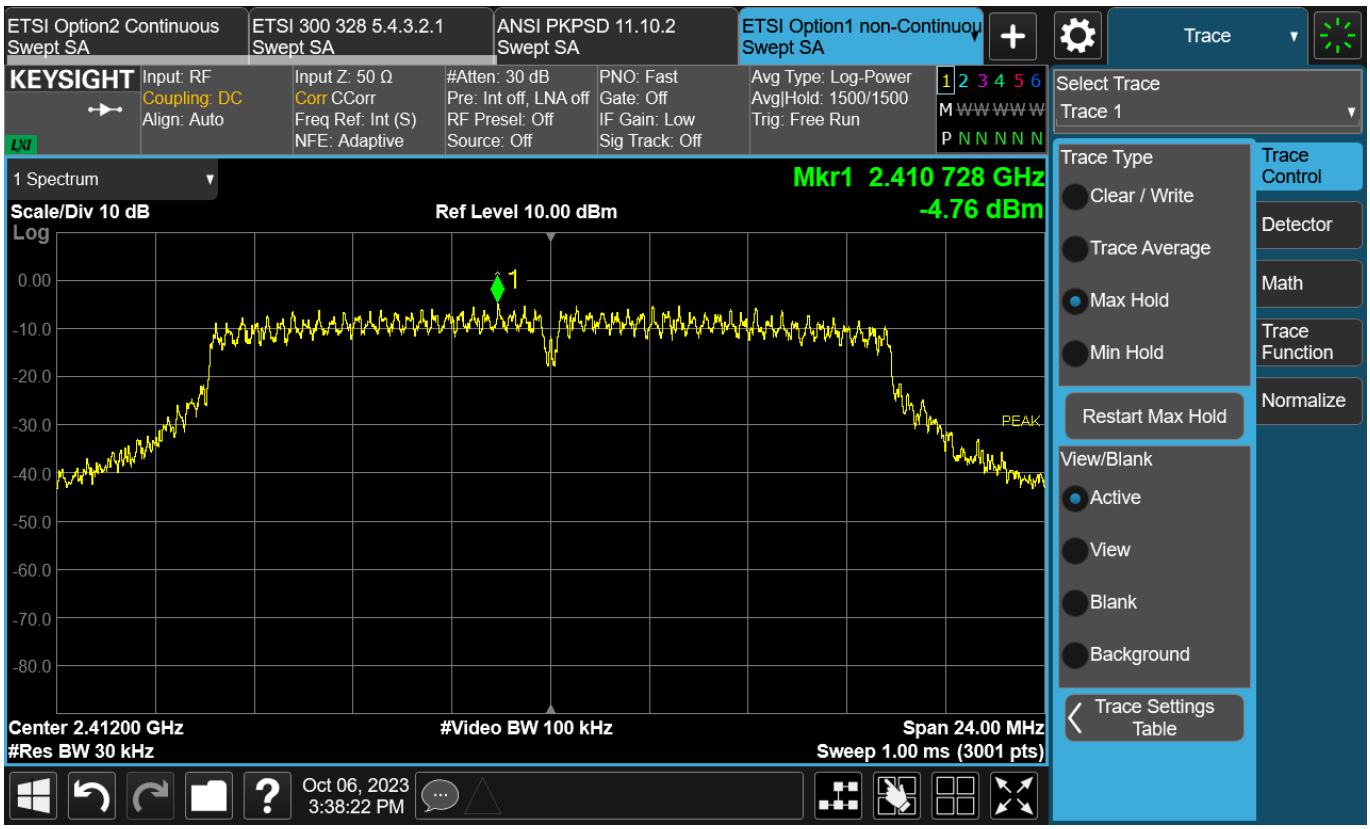

Figure TR16.4: Test data for G6 transmissions at 2412 MHz

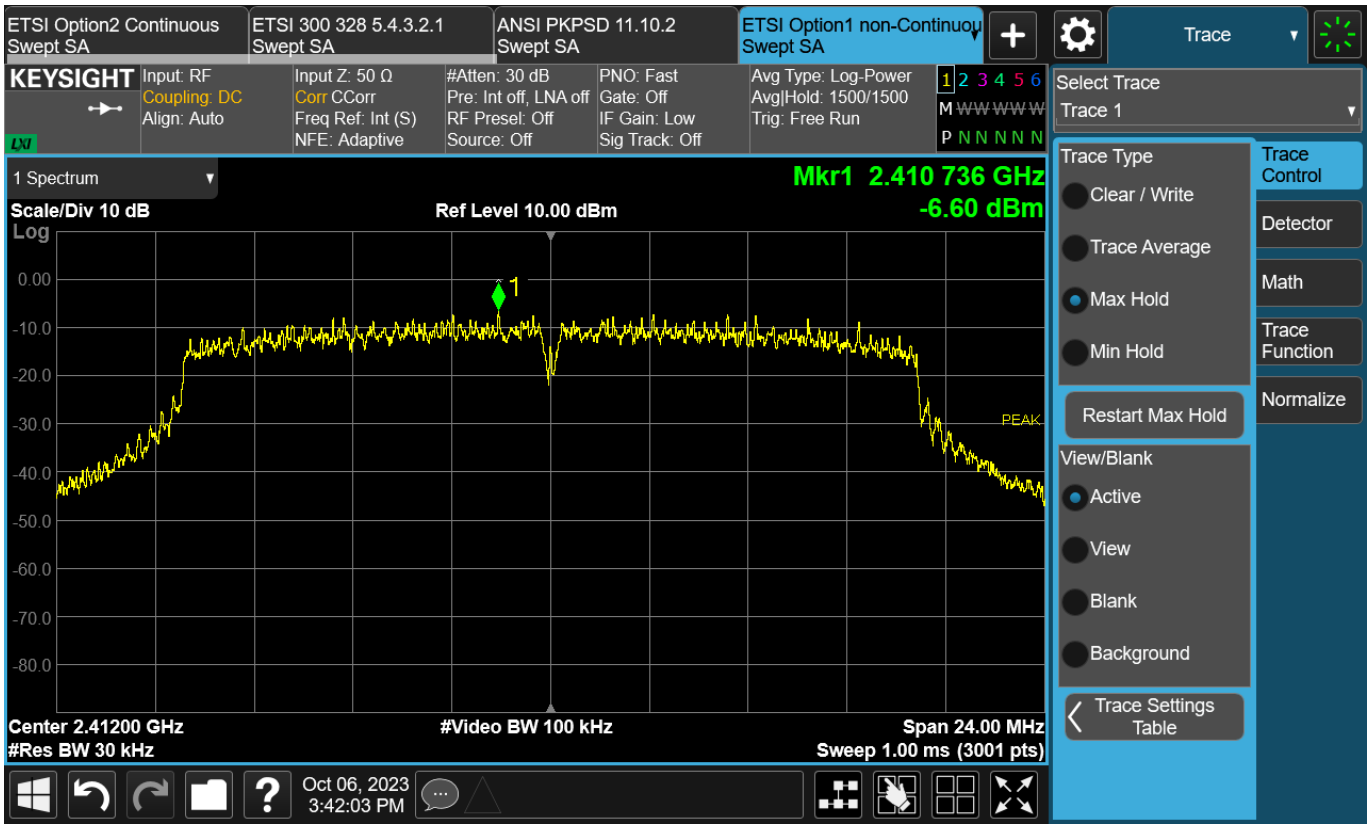

Figure TR16.5: Test data for 20 MHz MCS0 transmissions at 2412 MHz

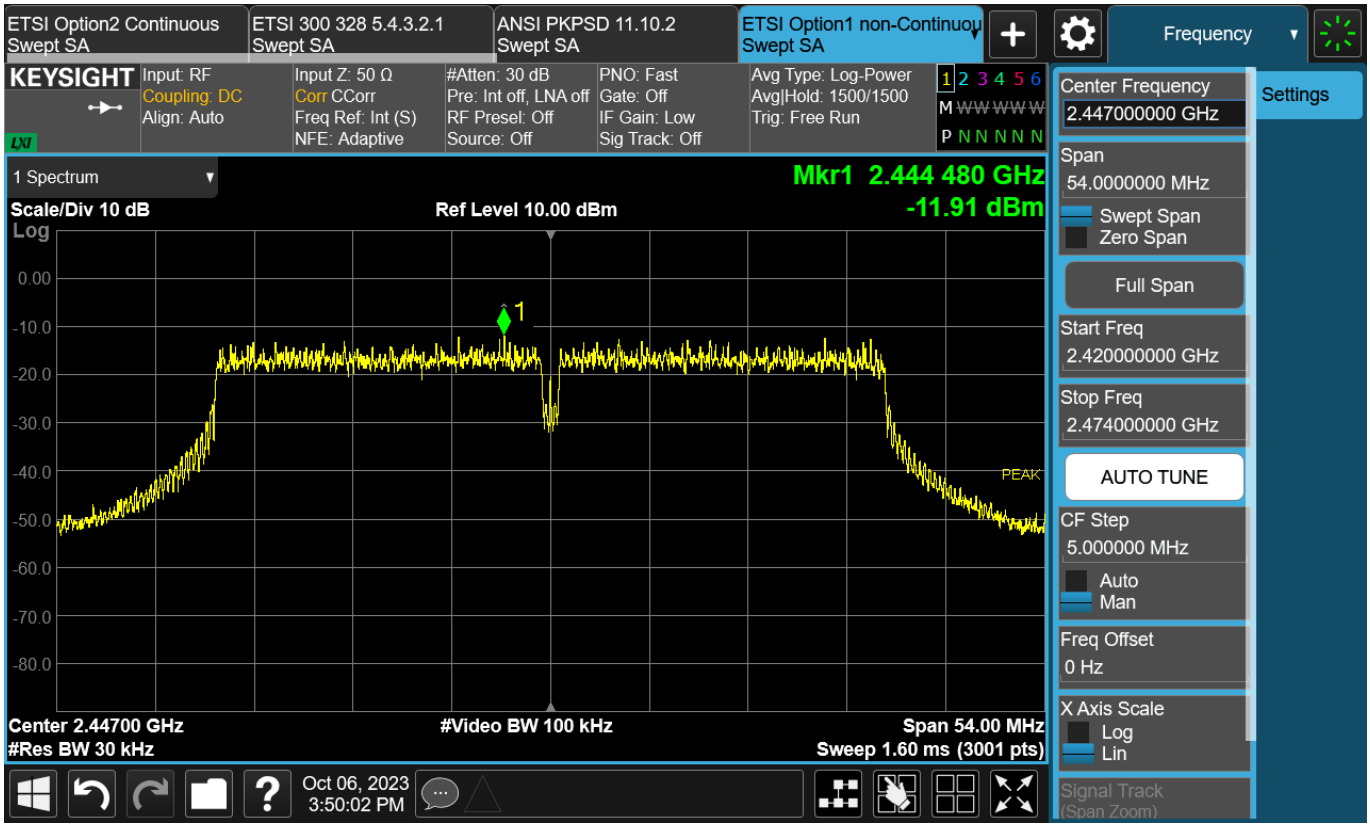

Figure TR16.6: Test data for 40 MHz MCS0 transmissions at 2447 MHz
This line is the end of the test record.

Test Record
Transmitter Stability in Extreme Conditions
Test IDs TR24
Project GCL-0388

Test Date(s)	16 and 17 Oct 2023
Test Personnel	Majid Farah
Product Model	A04752
Serial Number tested	3449554828
Operating Mode	M3 (BtcTx)
Arrangement	A4 (Dual)
Nominal Input Power	12 Vdc
Test Standards:	FCC part 15, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report)
Radio Protocol	Bluetooth (BR, EDR2, EDR3), BLE (Bluetooth Low Energy)
Pass/Fail Judgment:	**PASS**
Test record created by:	**Majid Farah**
Date this record:	**18 Oct 2023**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Thermometer	Thermco	ACCD370P	220608121	26-Aug-2022	1-Sep-2024
Barometer	Traceable	6453	221702700	3-Aug-2022	1-Aug-2024
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024
Thermal Chamber	Tenney	T2RC	31244	Calibration	Not Required

Table TR24.1: Equipment used

Software Used: PXE Software Revision A.33.03, FrequencyStabilityAnalysistemplateV1.xlsx

Test Method

The standards cited require observation of the stability for transmission frequency and/or power at certain environmental extremes. The reference is performance on nominal input voltage and a temperature of 20 °C. Where the standards cited here impose different limits or conditions, the most stringent limits and conditions have been applied.

The acceptance criterion is that the 6 dBc Occupied Bandwidth of the modulated signal should remain within the 2400-2483.5 MHz radio band. The modes utilized include those that showed emissions closest to the band edge during prior bandwidth testing.

Test Data

The test sample(s) were subjected to extreme conditions and performed as shown below. Yellow highlights indicate the highest level for a protocol, for which an image of the spectrum is also provided. In the spectral plots, the data sets have been combined to present the low and high channel results side by side. Orange diamond markers indicate the spectral peak, which the black square markers are at the 2400 MHz or 2483.5 MHz band edge.

Tx Mode	Temp	Volts	Low Ch.	High Ch.
Bluetooth	˚C	Vdc	dBc	dBc
BT EDR2	55.0	12.0	18.0	26.0
BT EDR2	50.0	12.0	27.6	28.2
BT EDR2	40.0	12.0	27.5	28.0
BT EDR2	30.0	12.0	31.0	28.4
BT EDR2	20.0	12.0	18.6	52.5
BT EDR2	10.0	12.0	18.9	22.8
BT EDR2	0.0	12.0	14.8	22.4
BT EDR2	-10.0	12.0	14.5	21.7
BT EDR2	-20.0	12.0	14.0	22.1

Table TR24.2 Difference between peak and band edge levels for Bluetooth EDR2 transmissions during temperature variations

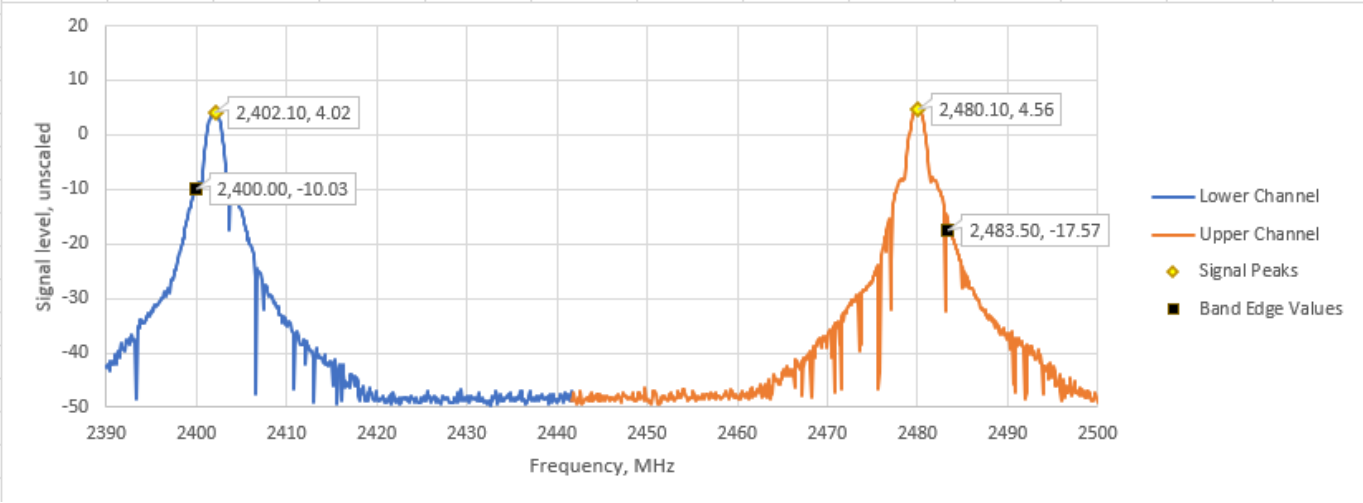

Figure TR24.1: Spectral data for Bluetooth EDR2 at -20 °C which represent low and high channel

Tx Mode	Temp	Volts	Low Ch.	High Ch.
Bluetooth	˚C	Vdc	dBc	dBc
BT EDR2	20	10.2	15.6	23.5
BT EDR2	20	12	18.6	52.5
BT EDR2	20	13.8	15.6	23.2

Table TR24.3 Difference between peak and band edge levels for Bluetooth EDR2 transmissions at 20 °C during voltage variations

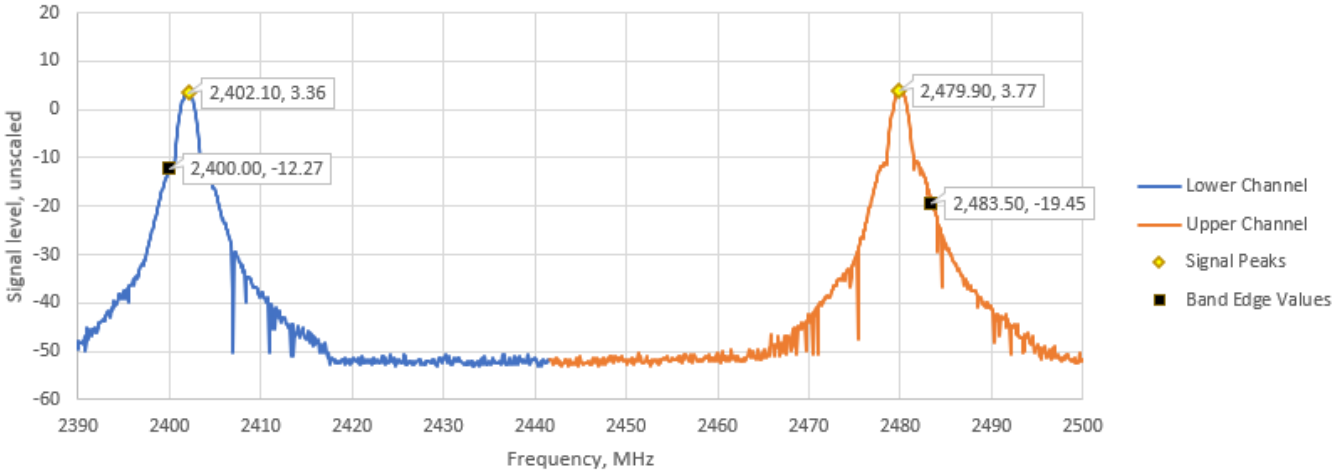

Figure TR24.2: Spectral data for Bluetooth EDR2 at 20 °C and 13.8 Vdc which represent low and high channel

Setup Block Diagram

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

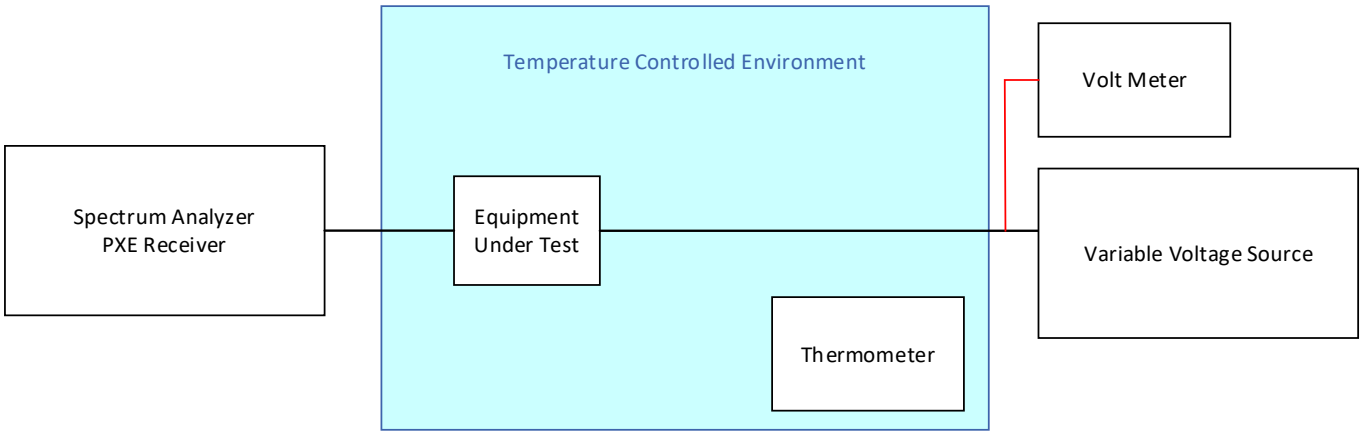

Figure TR24.3: Schematic drawing of the test equipment setup

This line is the end of the test record.

Test Record
Transmitter Stability in Extreme Conditions
Test IDs TR25
Project GCL-0388

Test Date(s)	16 and 17 Oct 2023
Test Personnel	Majid Farah
Product Model	A04752
Serial Number tested	3449554828
Operating Mode	M3 (WiFi2Tx)
Arrangement	A4 (Dual)
Nominal Input Power	12 Vdc
Test Standards:	FCC part 15, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report)
Radio Protocol	WiFi (IEEE 802.11 b/g/n)
Pass/Fail Judgment:	**PASS**
Test record created by:	**Majid Farah**
Date this record:	**18 Oct 2023**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Thermometer	Thermco	ACCD370P	220608121	26-Aug-2022	1-Sep-2024
Barometer	Traceable	6453	221702700	3-Aug-2022	1-Aug-2024
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024
Thermal Chamber	Tenney	T2RC	31244	Calibration	Not Required

Table TR25.1: Equipment used

Software Used: PXE Software Revision A.33.03, FrequencyStabilityAnalysistemplateV1.xlsx

Test Method

The standards cited require observation of the stability for transmission frequency and/or power at certain environmental extremes. The reference is performance on nominal input voltage and a temperature of 20 °C. Where the standards cited here impose different limits or conditions, the most stringent limits and conditions have been applied.

The acceptance criterion is that the 6 dBc Occupied Bandwidth of the modulated signal should remain within the 2400-2483.5 MHz radio band. The modes utilized include those that showed emissions closest to the band edge during prior bandwidth testing.

Test Data

The test sample(s) were subjected to extreme conditions and performed as shown below. Yellow highlights indicate the highest level for a protocol, for which an image of the spectrum is also provided. In the spectral plots, the data sets have been combined to present the low and high channel results side by side. Orange diamond markers indicate the spectral peak, which the black square markers are at the 2400 MHz or 2483.5 MHz band edge.

Tx Mode	Temp	Volts	Low Ch.	High Ch.
WiFi	˚C	Vdc	dBc	dBc
G 24 Mbps	55.0	12.0	30.0	44.3
G 24 Mbps	50.0	12.0	30.1	41.9
G 24 Mbps	40.0	12.0	29.7	44.1
G 24 Mbps	30.0	12.0	29.9	43.2
G 24 Mbps	20.0	12.0	29.7	41.6
G 24 Mbps	10.0	12.0	29.0	43.0
G 24 Mbps	0.0	12.0	28.8	40.0
G 24 Mbps	-10.0	12.0	29.0	41.7
G 24 Mbps	-20.0	12.0	28.7	40.8

Table TR25.2 Difference between peak and band edge levels for IEEE 802.11 G 24 Mbps transmissions during temperature variations

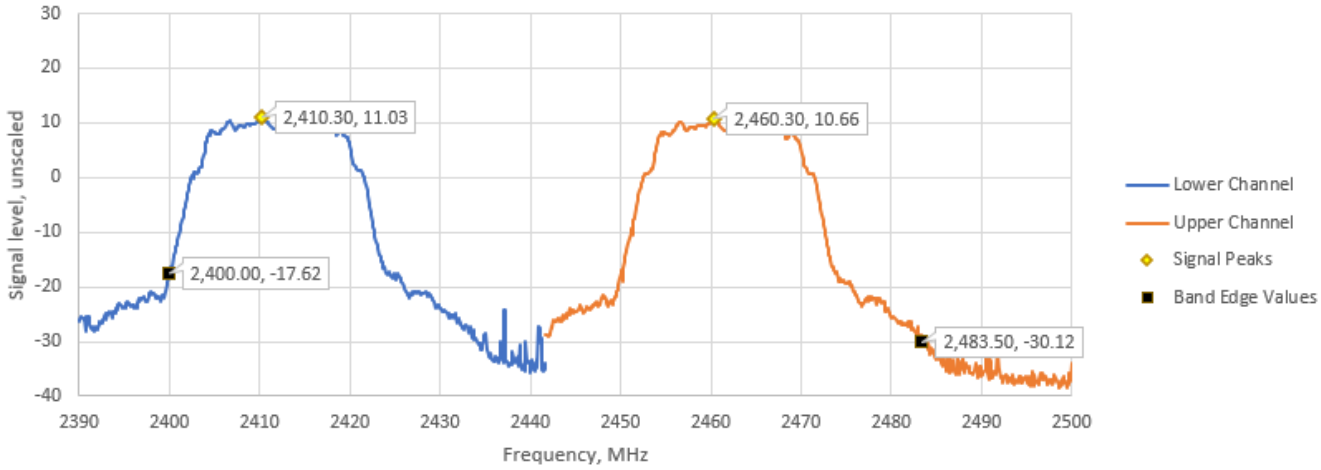

Figure TR25.1: Spectral data for IEEE 802.11 G 24 Mbps at 10 °C which represent low and high channels

Tx Mode	Temp	Volts	Low Ch.	High Ch.
WiFi	˚C	Vdc	dBc	dBc
G 24 Mbps	20.0	10.2	31.2	42.8
G 24 Mbps	20.0	12.0	29.7	41.6
G 24 Mbps	20.0	13.8	29.7	41.2

Table TR25.3 Difference between peak and band edge levels for IEEE 802.11 G 24 Mbps transmissions at 20 °C during voltage variations

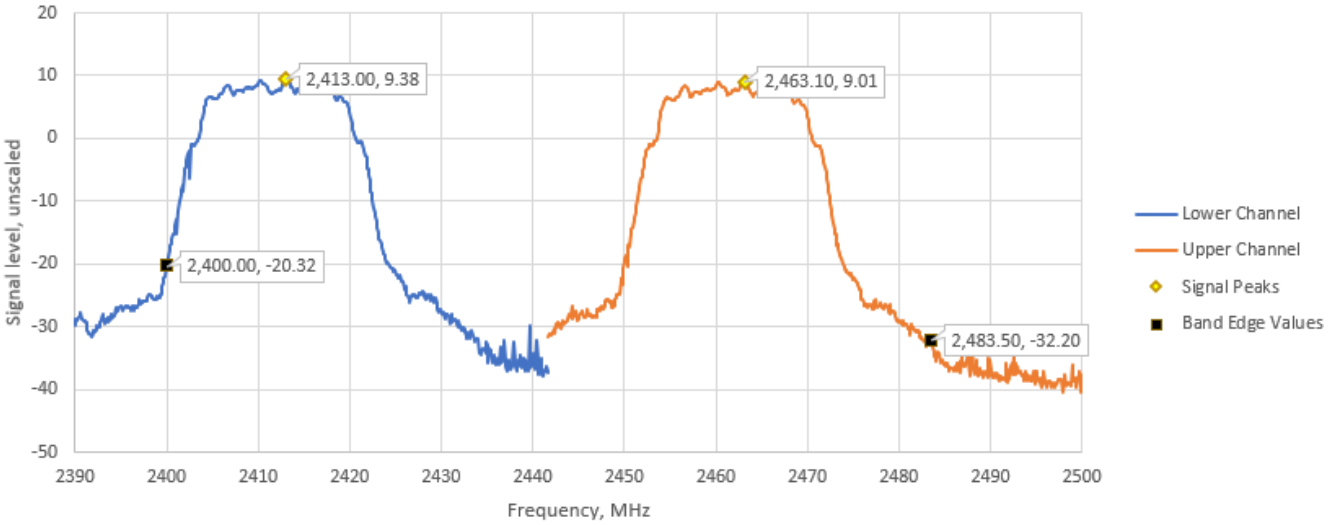

Figure TR25.3: Spectral data for IEEE 802.11 G 24 Mbps at 20 °C and 13.8 Vdc which represent low and high channels

Setup Block Diagram

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

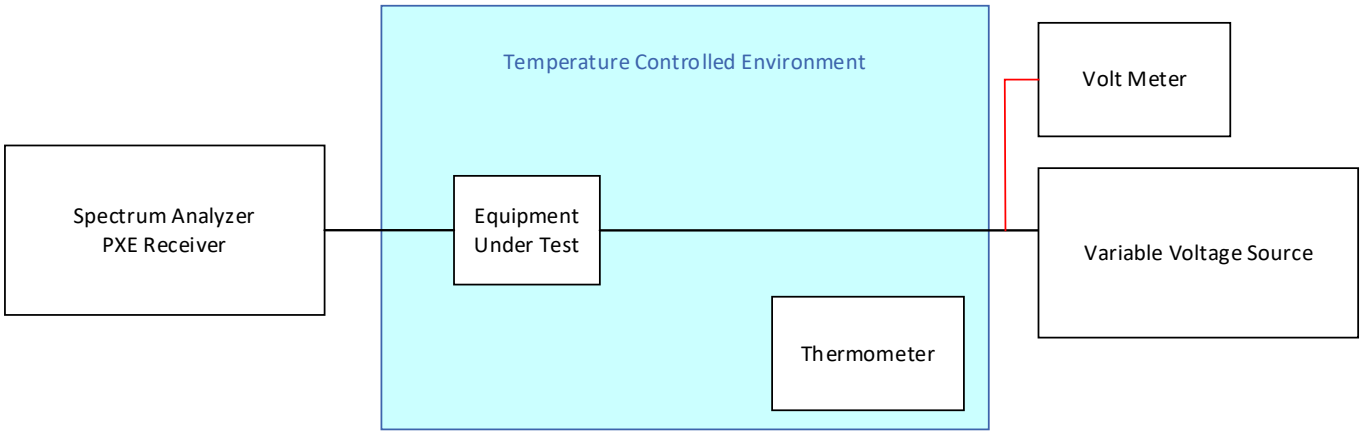

Figure TR25.5: Schematic drawing of the test equipment setup for WiFi (IEEE 802.11 b/g/n)

This line is the end of the test record.

Test Record
Radiated Emission Test RE06
Project GCL388

Test Date(s)	02 Oct 2023
Test Personnel	Jim Solum
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M1 (BtcTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**Jim Solum**
Date of this record:	**03 Oct 2023**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
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
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024

Table RE06.1: Test Equipment Used

Software Used:
Keysight PXE software A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The

designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 1 GHz and 2.2 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.

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		
1522.000	V	31.9	45.3	-3.7	28.2	41.6	54.0	74.0	25.8	32.4	327.8	330.0
1373.250	V	35.8	48.1	-4.0	31.8	44.1	54.0	74.0	22.2	29.9	270.2	14.0
1029.750	H	33.3	46.2	-6.1	27.2	40.1	54.0	74.0	26.8	33.9	116.1	281.0
1098.500	H	35.3	47.7	-6.2	29.1	41.5	54.0	74.0	24.9	32.5	128.1	297.0
1373.250	H	35.8	47.3	-4.0	31.8	43.3	54.0	74.0	22.2	30.7	166.0	78.0
2083.750	H	32.4	46.1	-1.5	30.9	44.6	54.0	74.0	23.1	29.4	106.6	212.0
1922.500	H	33.8	47.2	-1.9	31.9	45.3	54.0	74.0	22.1	28.7	110.5	336.0

Table RE06.2: Emission summary (EDR2 Tx Low, 2402 MHz)

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

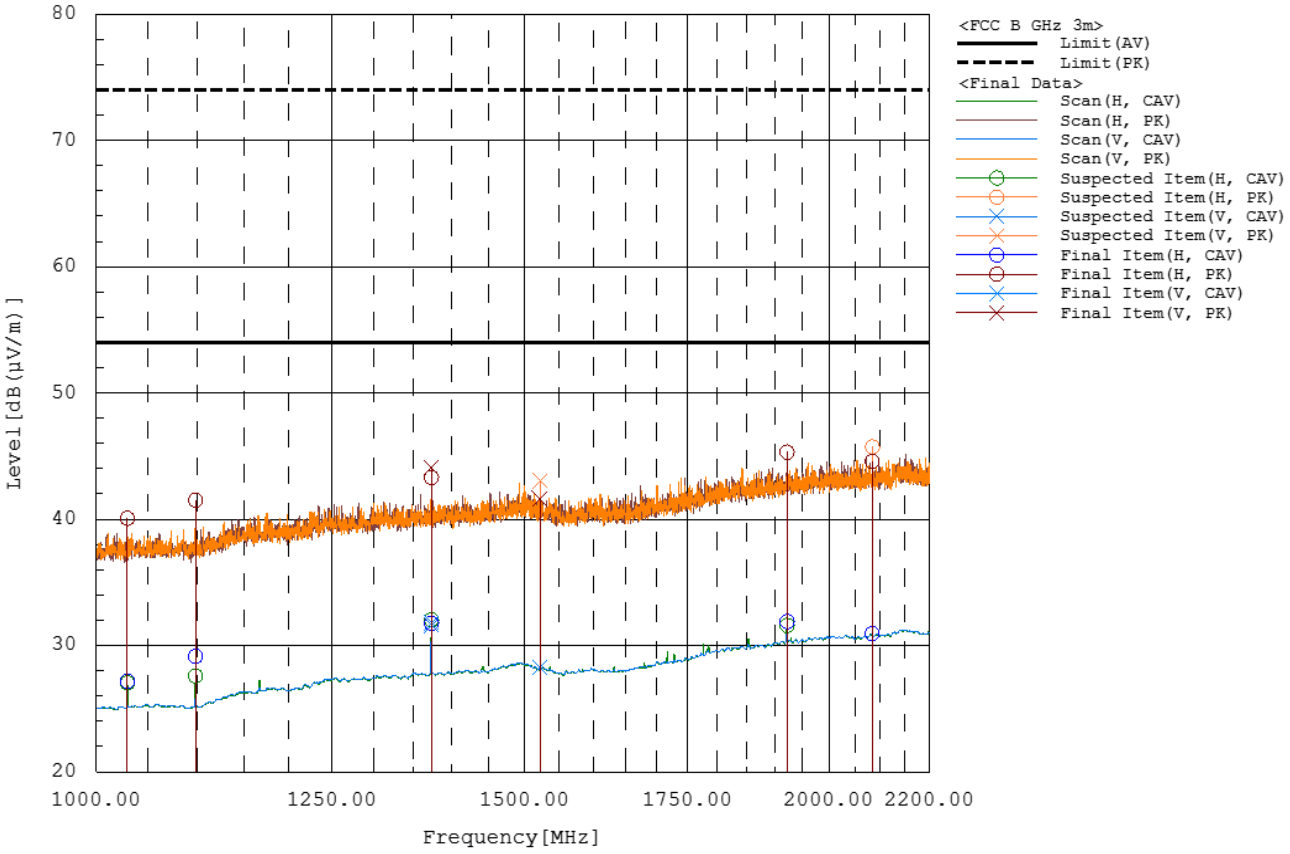

Figure RE06.1: Spectral data (EDR2 Tx Low, 2402 MHz)

Setup Photographs

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

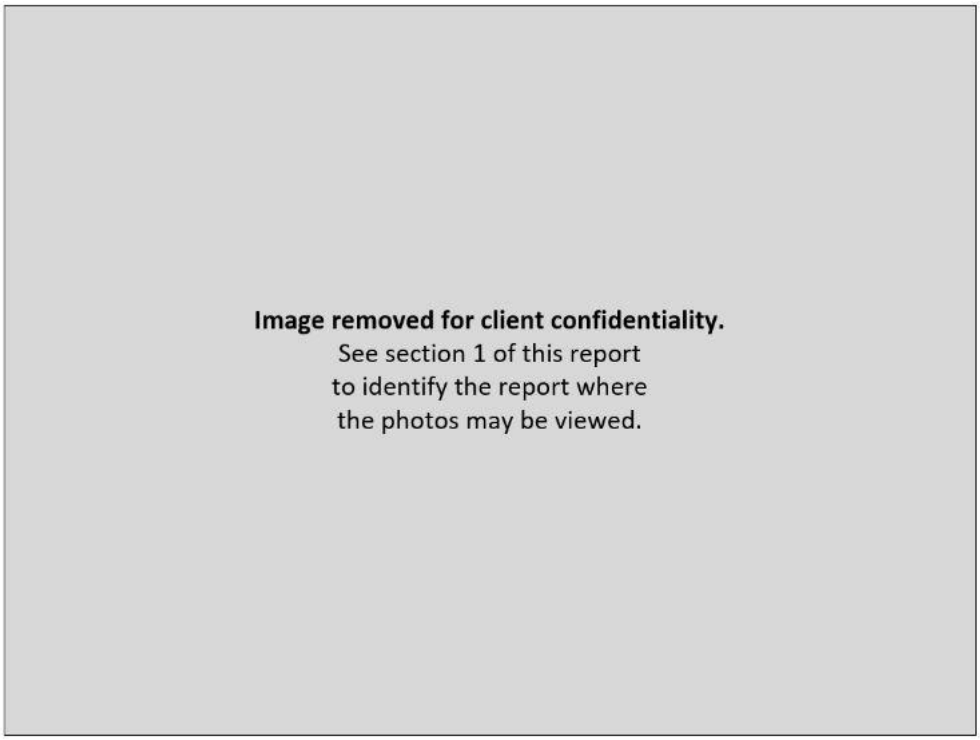

Figure RE06.2: EUT test setup, front view

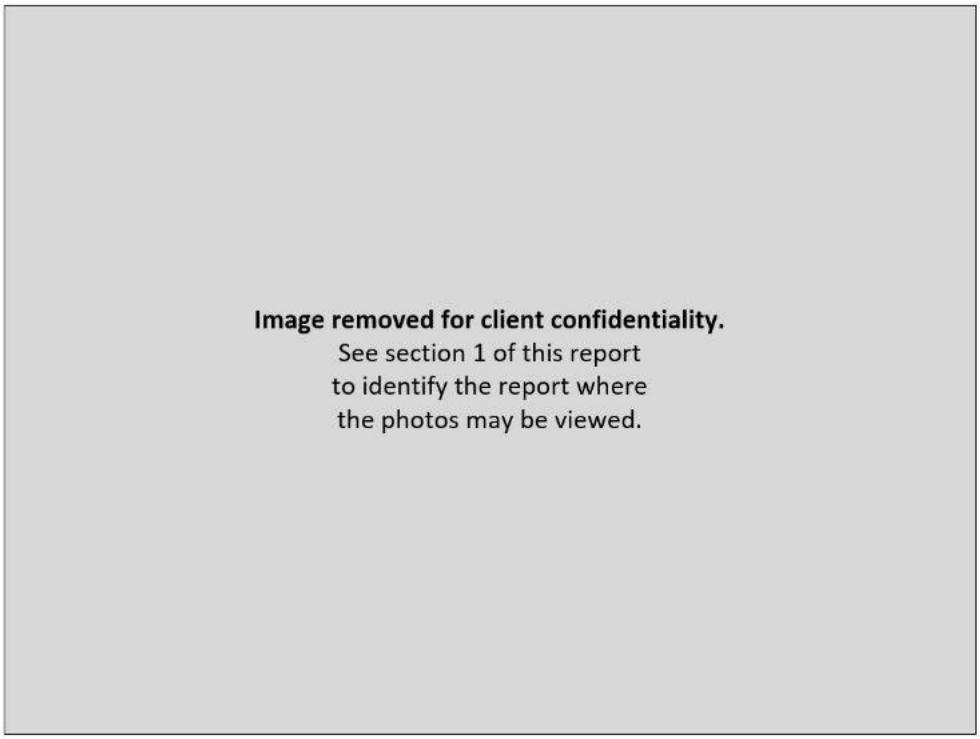

Figure RE06.3: EUT test setup, reverse view

This line is the end of the test record.

Test Record
Radiated Emission Test RE07
Project GCL0388

Test Date(s)	02 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M1 (BtcTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**David A Kerr**
Date of this record:	**03 Oct 2023**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
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
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024

Table RE07.1: Test Equipment Used

Software Used:
Keysight PXE software A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 1 GHz and 2.2 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.

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		
1922.500	V	33.4	47.7	-1.9	31.5	45.8	54.0	74.0	22.5	28.2	339.7	17.0
1029.750	H	33.2	46.3	-6.1	27.1	40.2	54.0	74.0	26.9	33.8	206.7	289.0
1098.500	H	35.3	47.3	-6.2	29.1	41.1	54.0	74.0	24.9	32.9	130.4	293.0
1167.250	H	33.1	46.2	-5.4	27.7	40.8	54.0	74.0	26.3	33.2	112.6	291.0
1373.250	H	36.5	47.5	-4.0	32.5	43.5	54.0	74.0	21.5	30.5	100.0	221.0
2149.250	H	32.5	46.1	-1.2	31.3	44.9	54.0	74.0	22.7	29.1	110.6	94.0

Table RE07.2: Emission summary (EDR2 Tx mid channel)

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

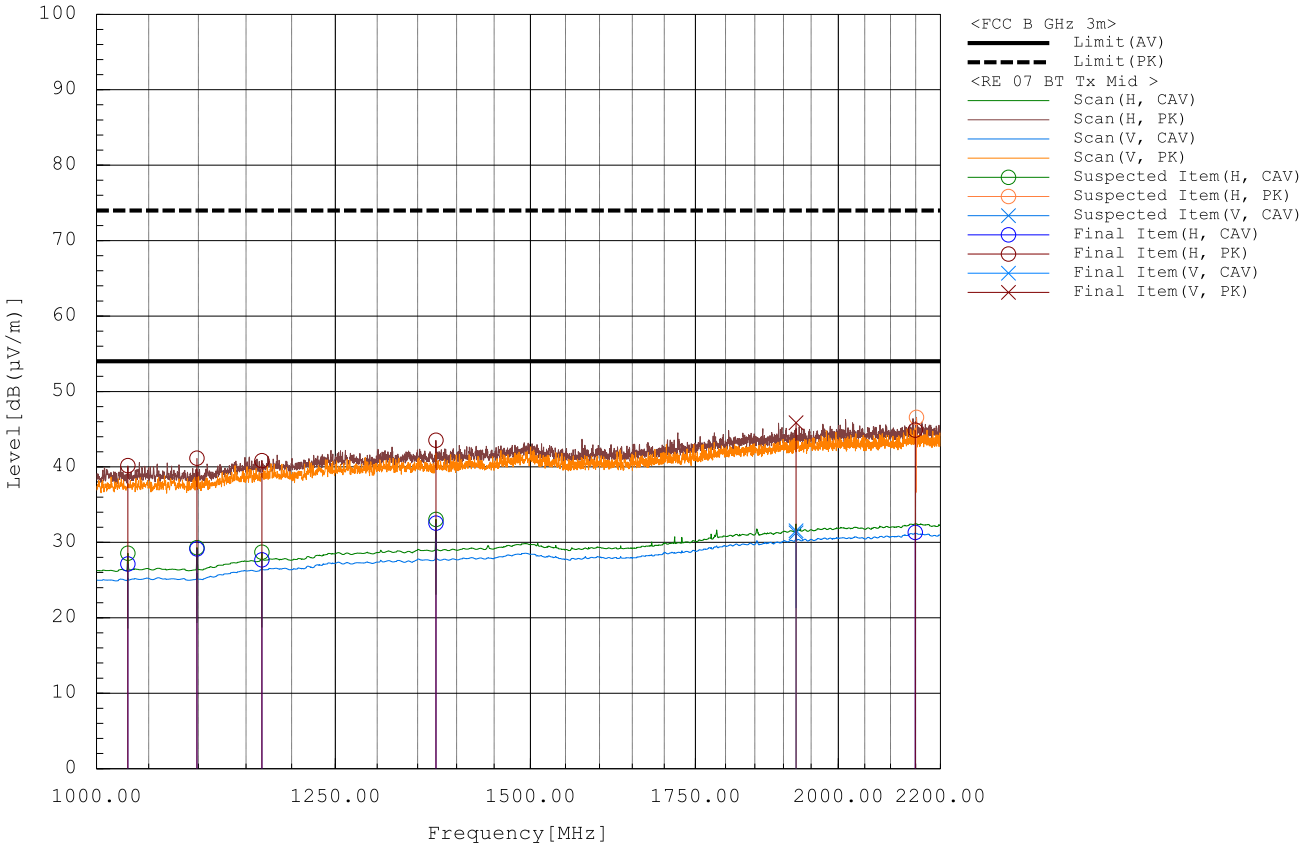

Figure RE07.1: Spectral data (EDR2 Tx mid channel)

Setup Photographs

The photographs that show how the EUT was configured and arranged can be found in Test Record 06, Figure RE06.2 and Figure RE06.3.

This line is the end of the test record.

Test Record
Radiated Emission Test RE08
Project GCL388

Test Date(s)	02 Oct 2023
Test Personnel	Jim Solum
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M1 (BtcTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**Jim Solum**
Date of this record:	**03 Oct 2023**

Original record, Version A.

Test Equipment

A list of test equipment used for this test can be found in Test Record RE06, Table RE06.1.

Software Used:
Keysight PXE software A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 1 GHz and 2.2 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.

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		
1720.750	V	32.3	46.0	-3.3	29.0	42.7	54.0	74.0	25.0	31.3	108.6	180.0
1922.500	V	33.4	47.8	-1.9	31.5	45.9	54.0	74.0	22.5	28.1	207.2	342.0
1029.750	H	33.3	46.2	-6.1	27.2	40.1	54.0	74.0	26.8	33.9	112.6	277.0
1098.500	H	35.4	47.6	-6.2	29.2	41.4	54.0	74.0	24.8	32.6	132.2	298.0
1373.250	H	35.7	47.4	-4.0	31.7	43.4	54.0	74.0	22.3	30.6	164.1	78.0
1922.500	H	34.1	47.3	-1.9	32.2	45.4	54.0	74.0	21.8	28.6	112.6	336.0
2029.250	H	32.5	45.8	-1.5	31.0	44.3	54.0	74.0	23.0	29.7	353.4	130.0

Table RE08.1: Emission summary (EDR2 Tx High, 2480 MHz)

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

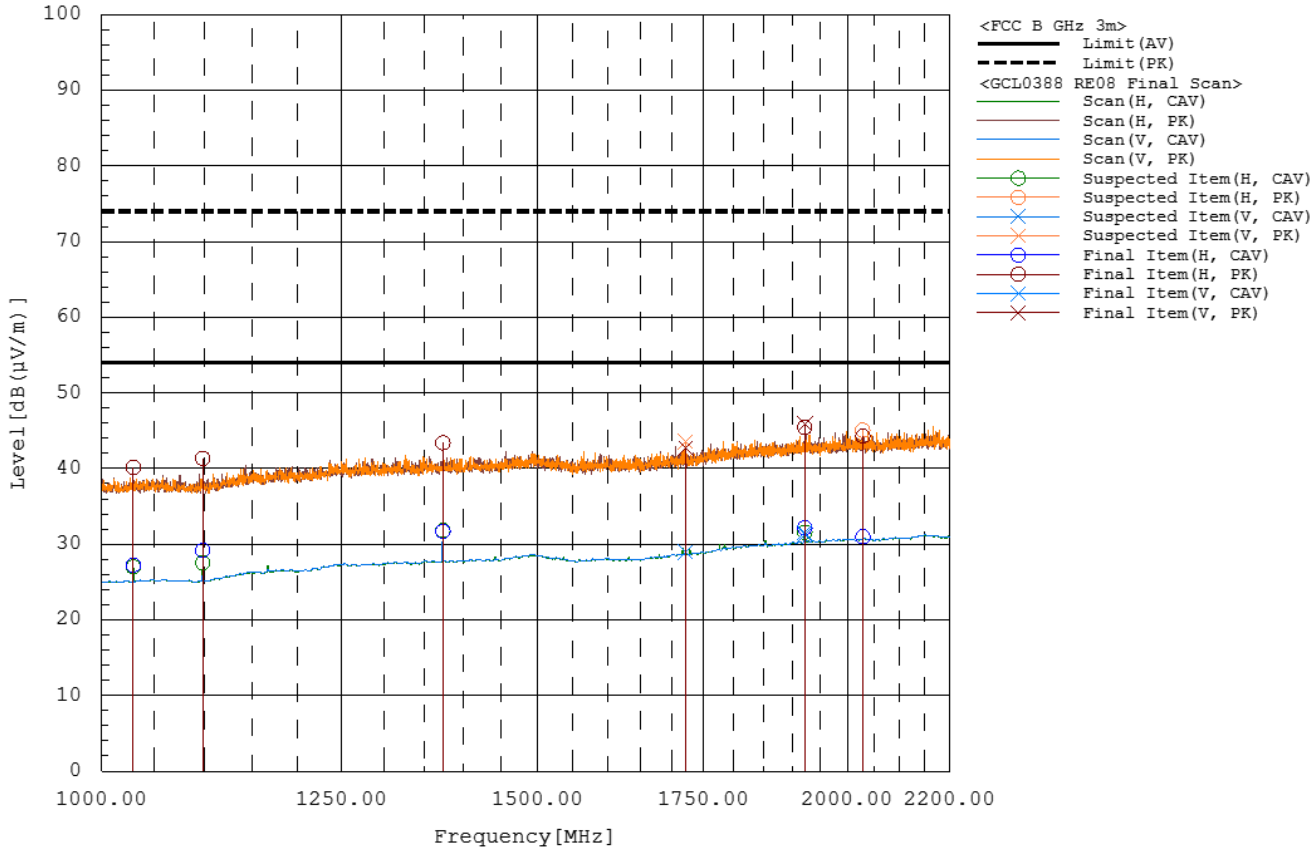

Figure RE08.1: Spectral data (EDR2 Tx High, 2480 MHz)

Setup Photographs

The photographs that show how the EUT was configured and arranged can be found in Test Record 06, Figure RE06.2 and Figure RE06.3.

This line is the end of the test record.

Test Record
Radiated Emission Test RE23
Project GCL0388

Test Date(s)	26 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M1 (BtcTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, 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 Oct 2023**

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, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	233201	19-Jul-2022	15-Jul-2024
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	7-Nov-2022	7-Nov-2025
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
Power supply	Samlex America	SEC1212	03051-7F03-00426	Calibration	Not Required

Table RE23.1: Test Equipment Used

Software Used:
Keysight PXE software A.32.06
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 30 MHz and 1 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m.

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		
114.060	H	10.9	16.2	27.1	43.5	16.4	275.0	113.0
237.360	H	13.6	21.0	34.6	46.0	11.4	128.0	278.0
274.620	H	21.4	21.9	43.3	46.0	2.7	100.0	202.0
549.270	H	3.9	30.7	34.6	46.0	11.4	153.1	330.0
480.600	H	3.9	27.9	31.8	46.0	14.2	196.1	135.0
31.440	V	8.8	22.0	30.8	40.0	9.2	100.0	30.0

Table RE23.2: Emission summary

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

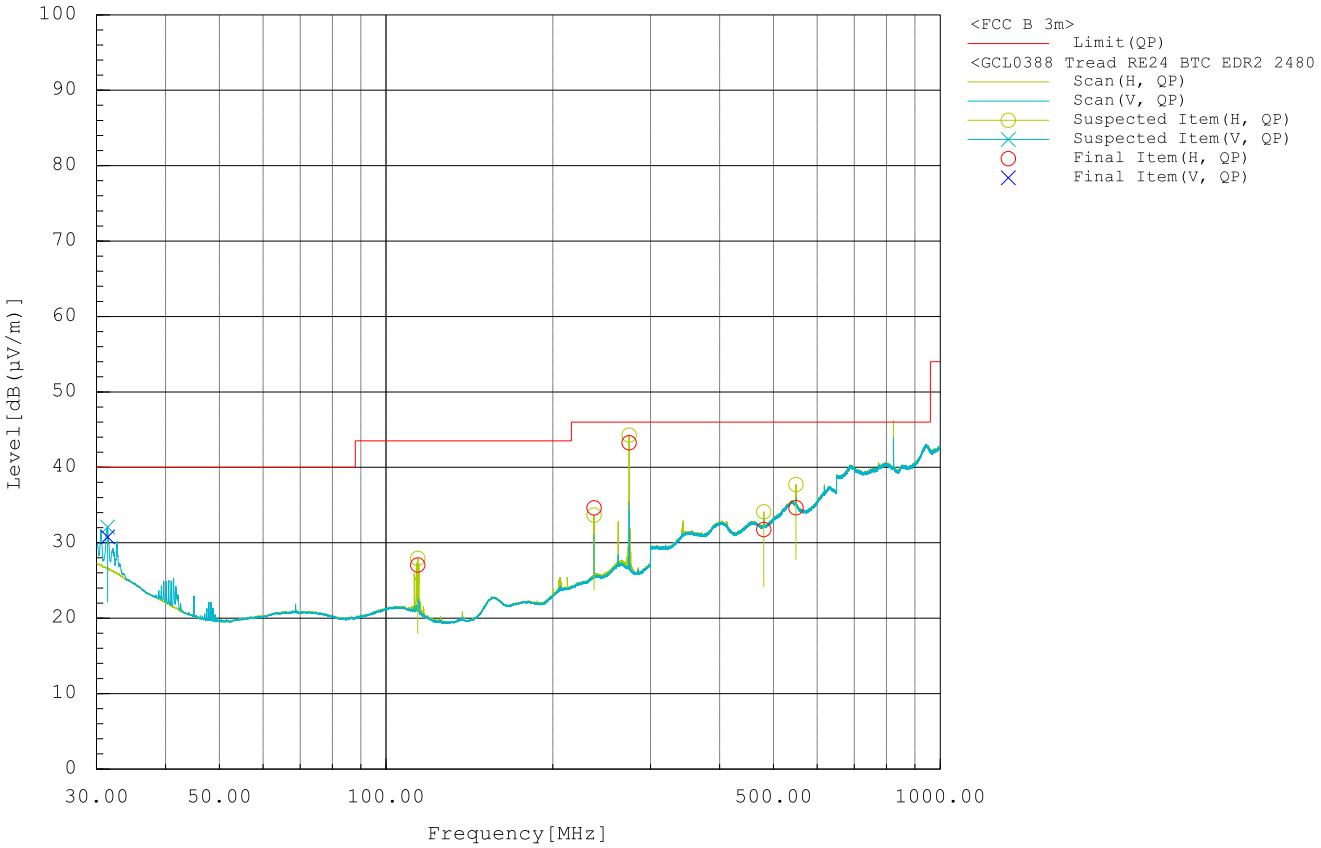

Figure RE23.1: Spectral data

Setup Photographs

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

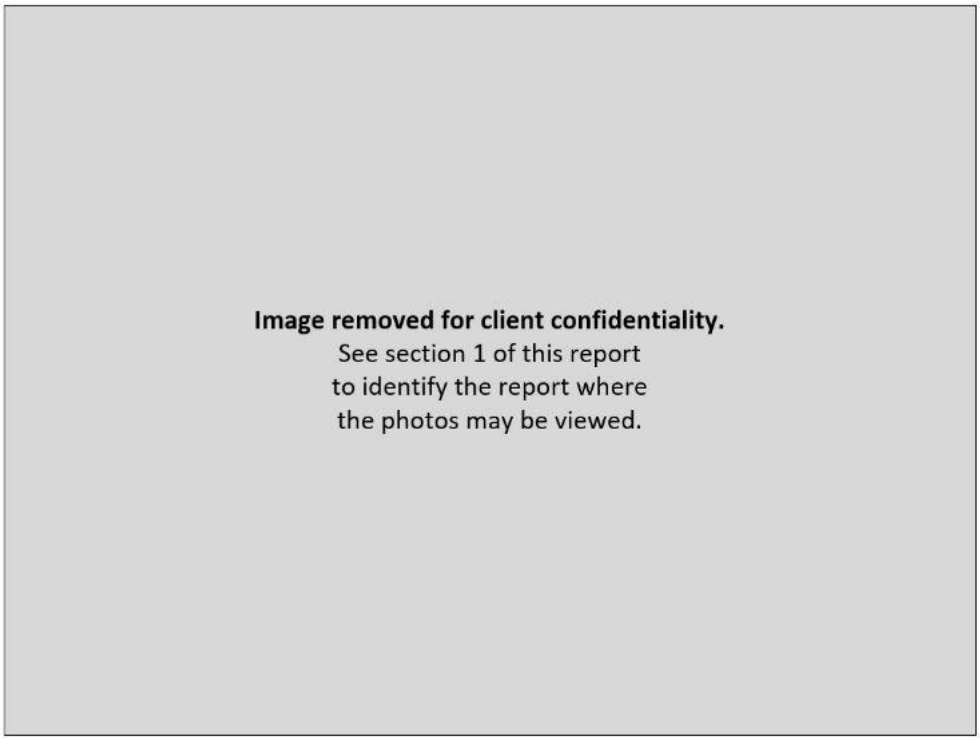

Figure RE23.2: EUT test setup, front view

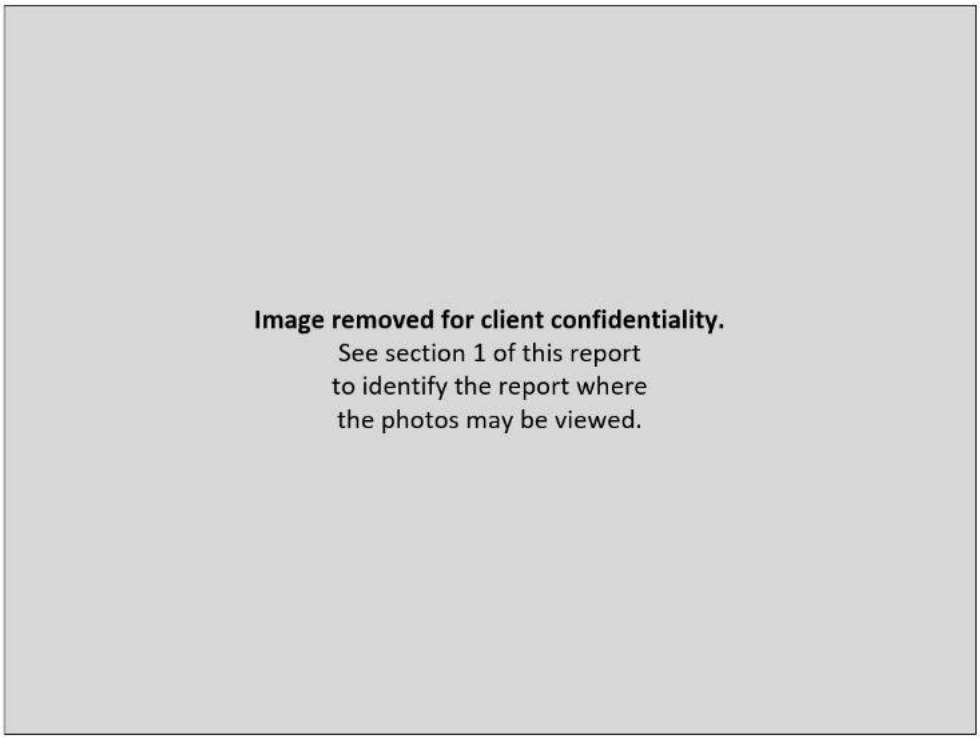

Figure RE23.3: EUT test setup, reverse view

This line is the end of the test record.

Test Record
Radiated Emission Test RE09
Project GCL0388

Test Date(s)	03 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M2 (BleTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**David A Kerr**
Date of this record:	**03 Oct 2023**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
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
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024

Table RE09.1: Test Equipment Used

Software Used:
Keysight PXE software A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 1000 MHz and 2200 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.

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		
1922.500	V	33.8	47.1	-1.9	31.9	45.2	54.0	74.0	22.1	28.8	241.0	342.0
1029.750	H	33.7	46.4	-6.1	27.6	40.3	54.0	74.0	26.4	33.7	108.6	310.0
1098.500	H	36.3	47.7	-6.2	30.1	41.5	54.0	74.0	23.9	32.5	178.0	307.0
1167.250	H	33.2	46.9	-5.4	27.8	41.5	54.0	74.0	26.2	32.5	112.5	298.0
1373.250	H	35.6	47.9	-4.0	31.6	43.9	54.0	74.0	22.4	30.1	126.4	78.0
1373.250	H	35.2	47.7	-4.0	31.2	43.7	54.0	74.0	22.8	30.3	100.0	88.0

Table RE09.2: Emission summary (BLE Tx Low channel)

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

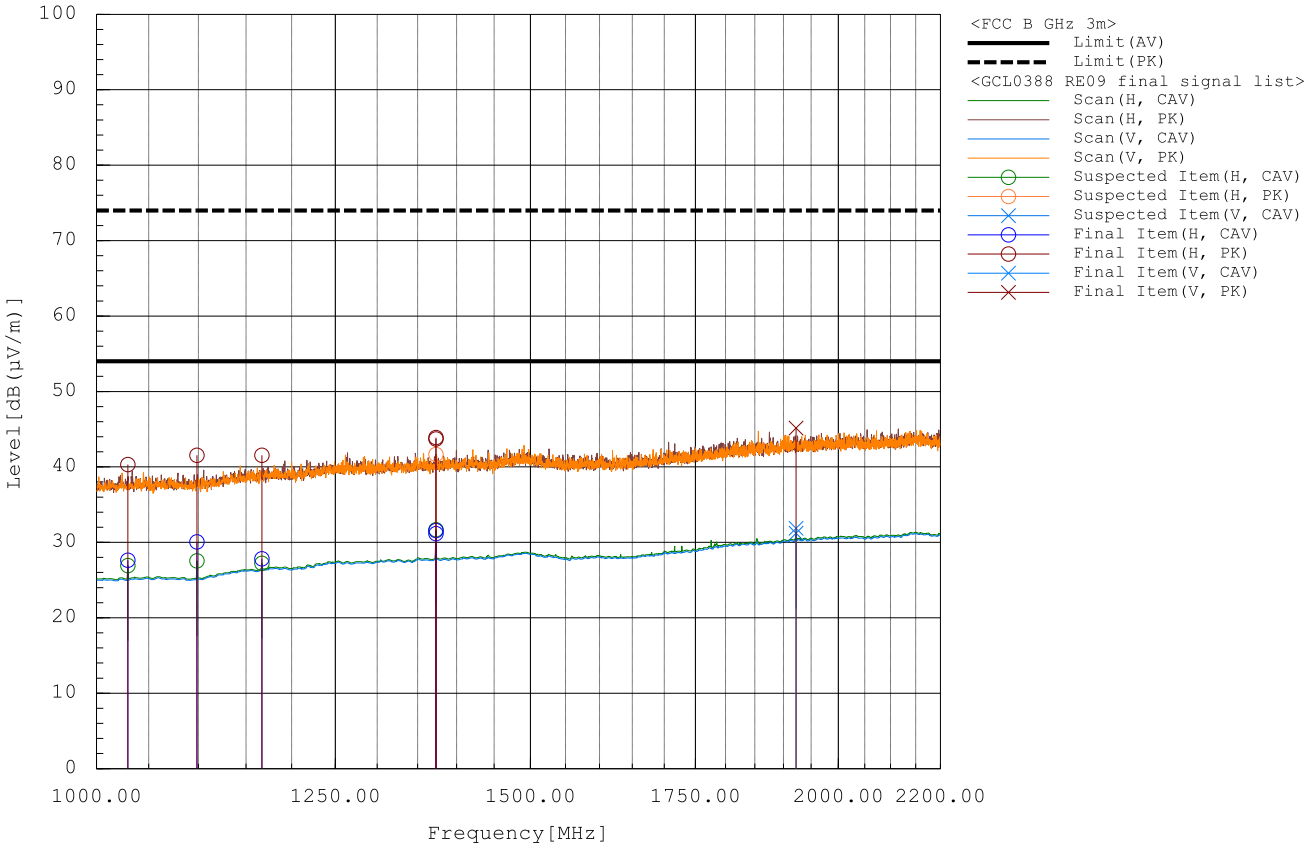

Figure RE09.1: Spectral data (BLE Tx Low channel)

Setup Photographs

The photographs that show how the EUT was configured and arranged can be found in Test Record 06, Figure RE06.2 and Figure RE06.3.

This line is the end of the test record.

Test Record
Radiated Emission Test RE10
Project GCL0388

Test Date(s)	03 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M2 (BleTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**David A Kerr**
Date of this record:	**03 Oct 2023**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
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
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024

Table RE10.1: Test Equipment Used

Software Used:
Keysight PXE software A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 1000 MHz and 2200 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.

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		
2160.000	V	32.5	46.2	-1.2	31.3	45.0	54.0	74.0	22.7	29.0	400.0	184.0
1029.750	H	33.7	46.6	-6.1	27.6	40.5	54.0	74.0	26.4	33.5	114.0	309.0
1098.500	H	36.0	47.7	-6.2	29.8	41.5	54.0	74.0	24.2	32.5	175.5	308.0
1167.250	H	33.1	46.5	-5.4	27.7	41.1	54.0	74.0	26.3	32.9	142.1	310.0
1373.250	H	37.2	48.1	-4.0	33.2	44.1	54.0	74.0	20.8	29.9	138.1	12.0
1922.500	H	33.6	47.6	-1.9	31.7	45.7	54.0	74.0	22.3	28.3	110.6	338.0

Table RE10.2: Emission summary (BleTx Mid channel)

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

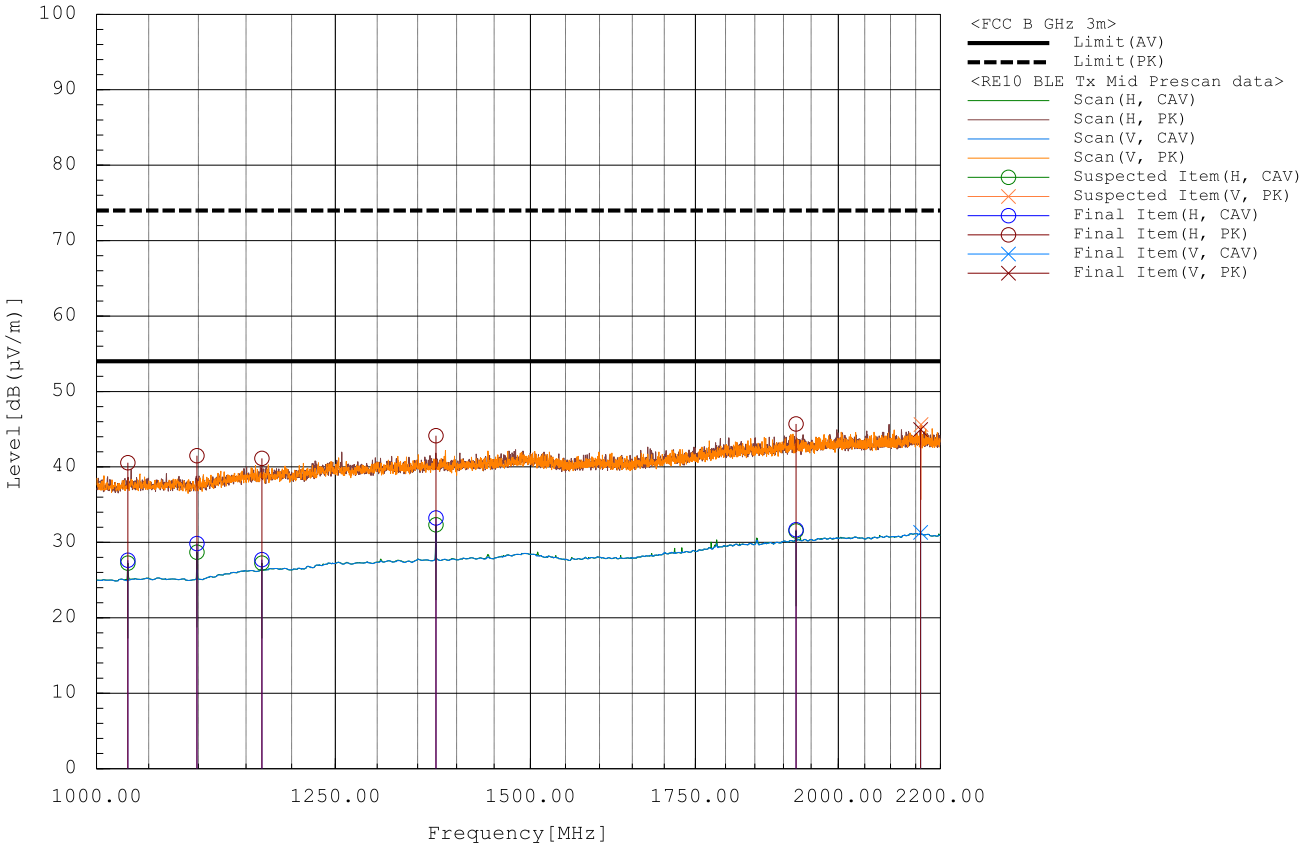

Figure RE10.1: Spectral data (BleTx Mid channel)

Setup Photographs

The photographs that show how the EUT was configured and arranged can be found in Test Record 06, Figure RE06.2 and Figure RE06.3.

This line is the end of the test record.

Test Record
Radiated Emission Test RE11
Project GCL0388

Test Date(s)	03 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M2 (BleTx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**David A Kerr**
Date of this record:	**03 Oct 2023**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
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
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024

Table RE11.1: Test Equipment Used

Software Used:
Keysight PXE software A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 1 GHz and 2.2 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.

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		
1373.250	V	34.2	46.6	-4.0	30.2	42.6	54.0	74.0	23.8	31.4	296.0	0.0
1029.750	H	33.9	47.1	-6.1	27.8	41.0	54.0	74.0	26.2	33.0	114.4	311.0
1098.500	H	36.2	48.3	-6.2	30.0	42.1	54.0	74.0	24.0	31.9	175.5	305.0
1167.250	H	33.2	46.7	-5.4	27.8	41.3	54.0	74.0	26.2	32.7	142.3	306.0
1373.250	H	37.9	48.0	-4.0	33.9	44.0	54.0	74.0	20.1	30.0	120.3	7.0
1922.500	H	33.7	47.7	-1.9	31.8	45.8	54.0	74.0	22.2	28.2	110.6	344.0

Table RE11.2: Emission summary (BleTx High channel)

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

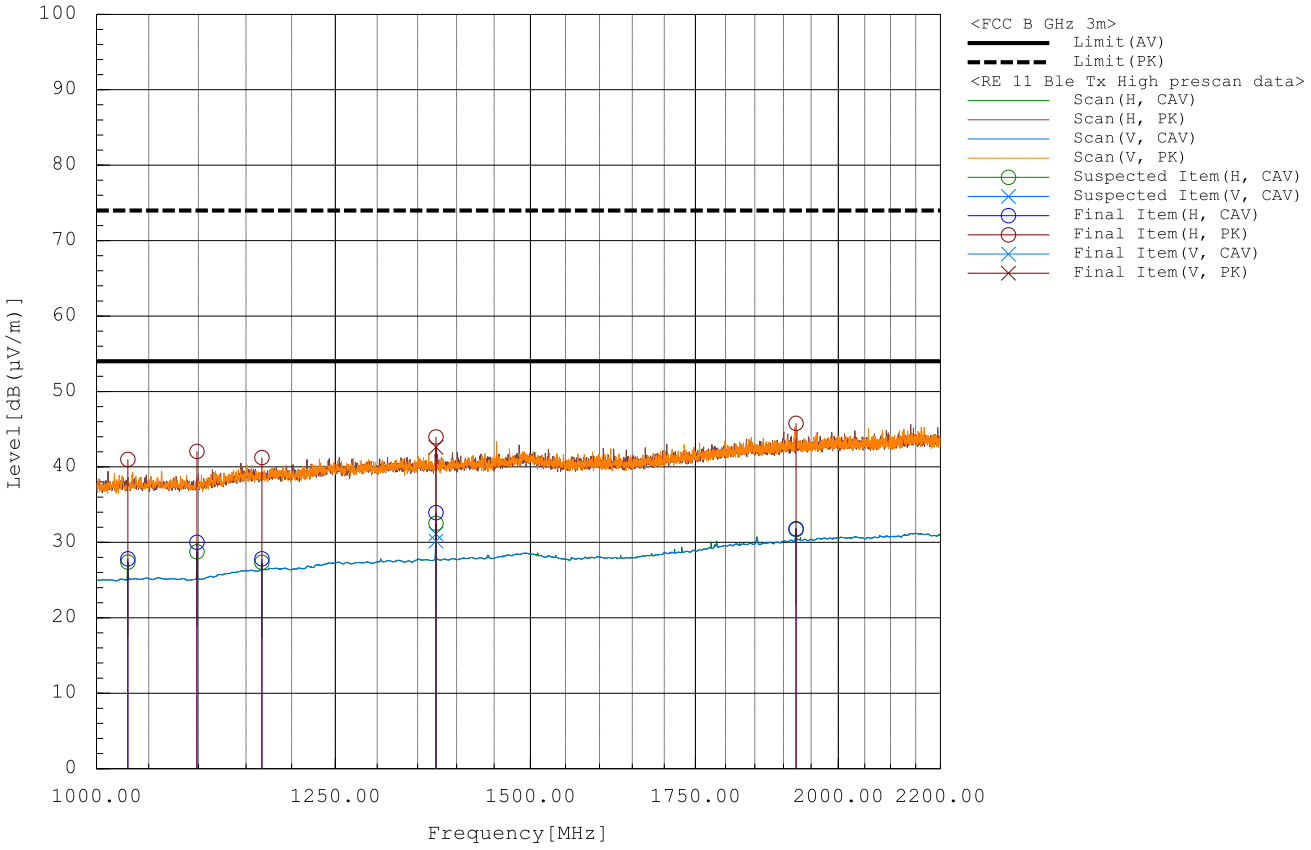

Figure RE11.1: Spectral data (BleTx High channel)

Setup Photographs

The photographs that show how the EUT was configured and arranged can be found in Test Record 06, Figure RE06.2 and Figure RE06.3.

This line is the end of the test record.

Test Record
Radiated Emission Test RE24
Project GCL0388

Test Date(s)	26 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M2 (Ble Tx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, 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 Oct 2023**
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, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	233201	19-Jul-2022	15-Jul-2024
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	7-Nov-2022	7-Nov-2025
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
Power supply	Samlex America	SEC1212	03051-7F03-00426	Calibration	Not Required

Table RE24.1: Test Equipment Used

Software Used:
Keysight PXE software A.32.06
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 30 MHz and 1 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m.

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		
274.620	H	21.5	21.9	43.4	46.0	2.6	100.0	211.0
823.860	H	7.5	34.6	42.1	46.0	3.9	100.0	196.0
114.060	H	10.8	16.2	27.0	43.5	16.5	284.0	120.0
237.360	H	13.4	21.0	34.4	46.0	11.6	134.1	181.0
945.360	V	0.1	36.8	36.9	46.0	9.1	192.1	63.0
31.440	V	7.8	22.0	29.8	40.0	10.2	100.0	38.0

Table RE24.2: Emission summary

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

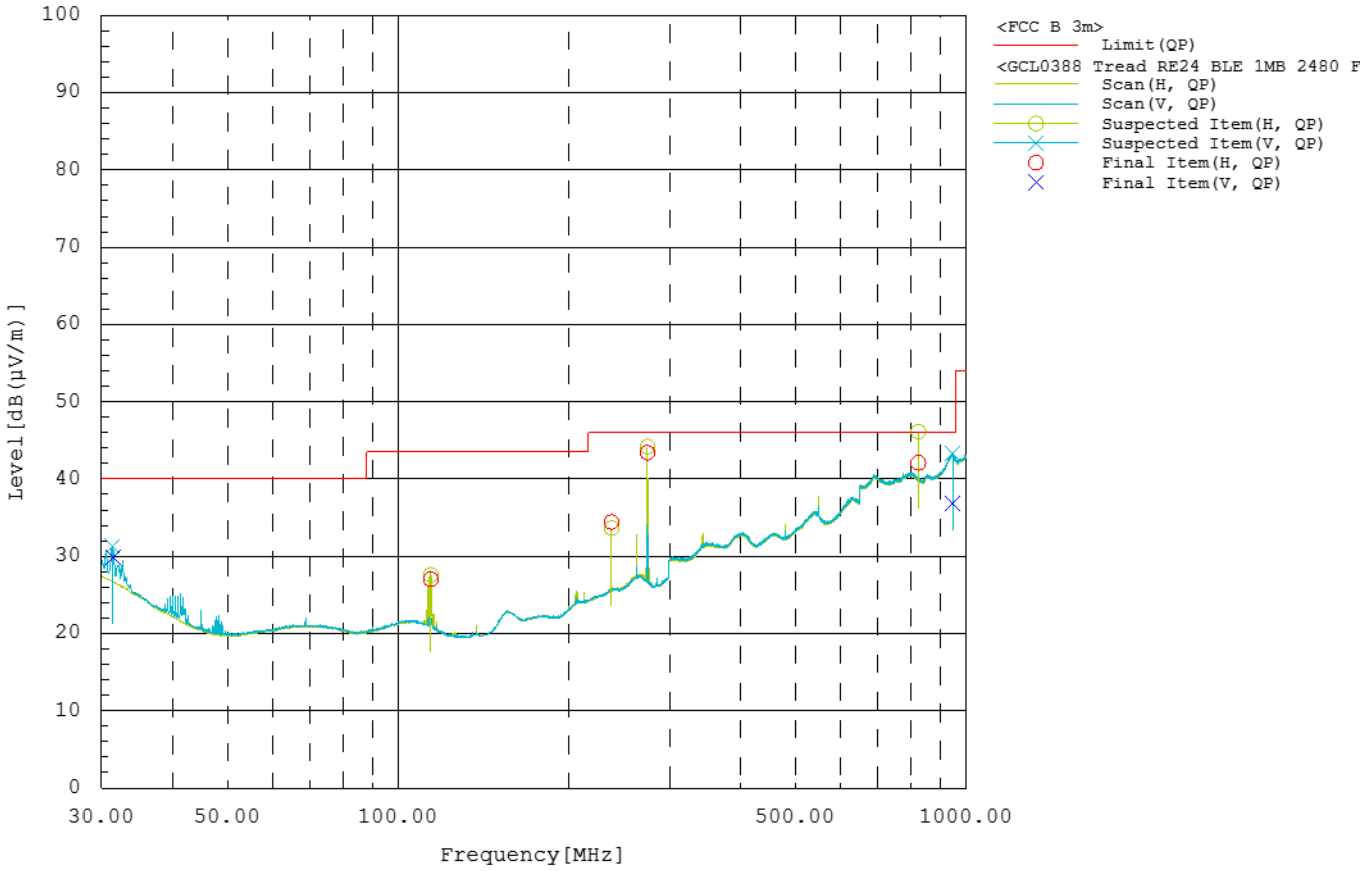

Figure RE24.1: Spectral data

Setup Photographs

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

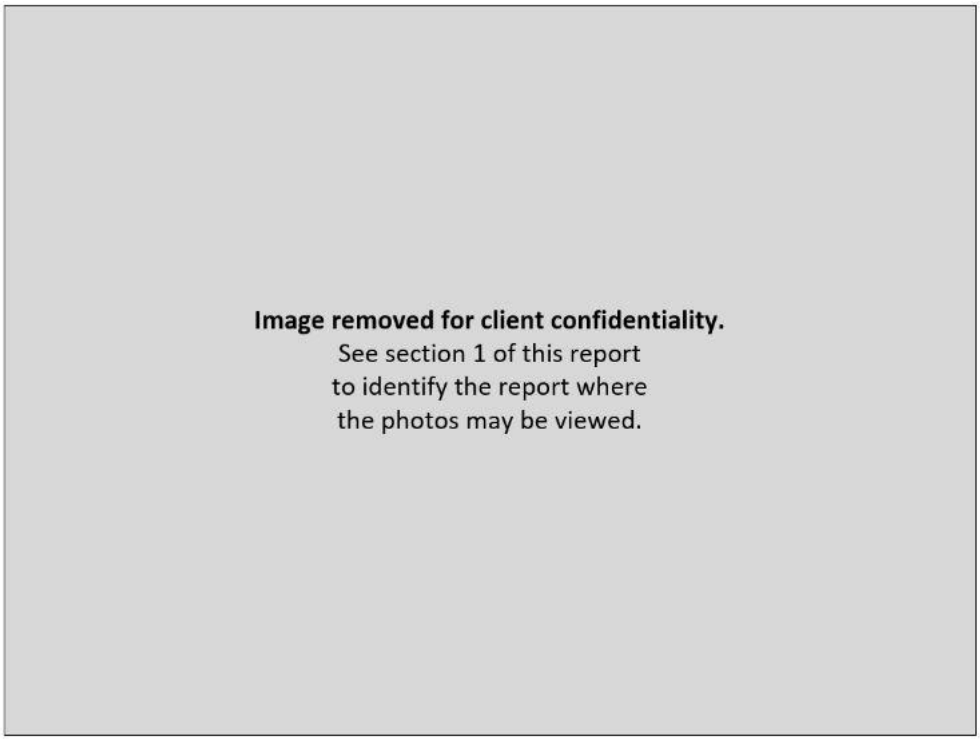

Figure RE24.2: EUT test setup, front view

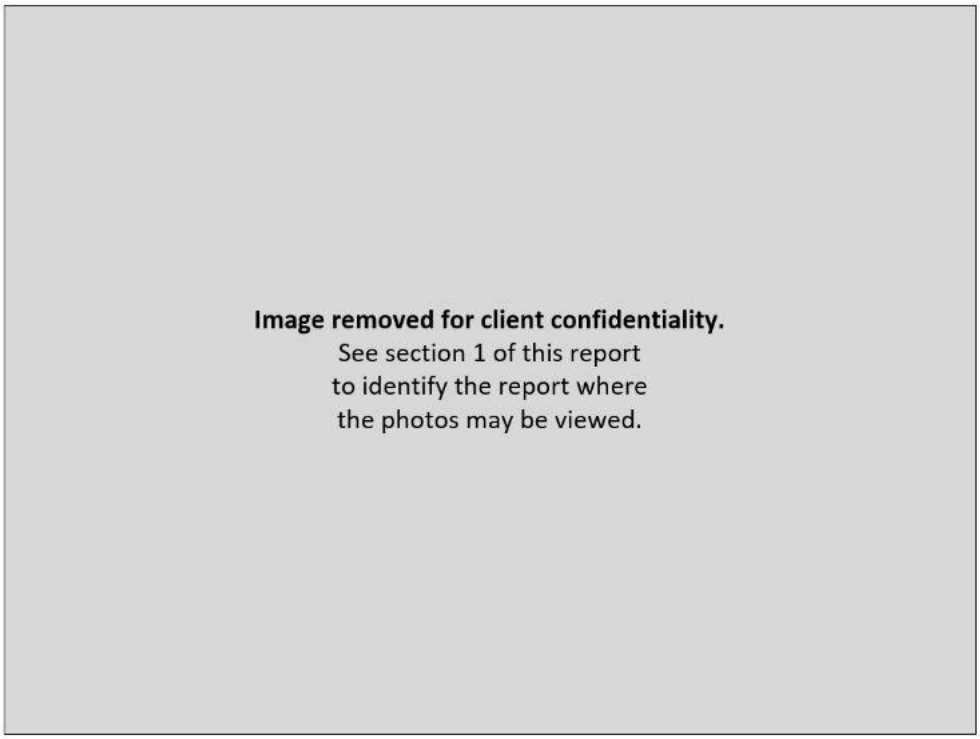

Figure RE24.3: EUT test setup, reverse view

This line is the end of the test record.

Test Record
Radiated Emission Test RE12
Project GCL0388

Test Date(s)	03 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M3 (WiFi2Tx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**David A Kerr**
Date of this record:	**03 Oct 2023**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
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
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024

Table RE12.1: Test Equipment Used

Software Used:
Keysight PXE software A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 1000 MHz and 2200 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.

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		
1922.500	V	33.3	47.2	-1.9	31.4	45.3	54.0	74.0	22.6	28.7	207.6	344.0
1029.750	H	32.7	46.5	-6.1	26.6	40.4	54.0	74.0	27.4	33.6	110.6	314.0
1098.500	H	34.8	47.2	-6.2	28.6	41.0	54.0	74.0	25.4	33.0	173.7	308.0
1373.250	H	37.3	48.7	-4.0	33.3	44.7	54.0	74.0	20.7	29.3	208.8	306.0
1373.250	H	37.4	48.2	-4.0	33.4	44.2	54.0	74.0	20.6	29.8	209.6	308.0
1922.500	H	33.3	46.9	-1.9	31.4	45.0	54.0	74.0	22.6	29.0	110.5	344.0

Table RE12.2: Emission summary (WiFi2Tx B1 20MHz ch 1)

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

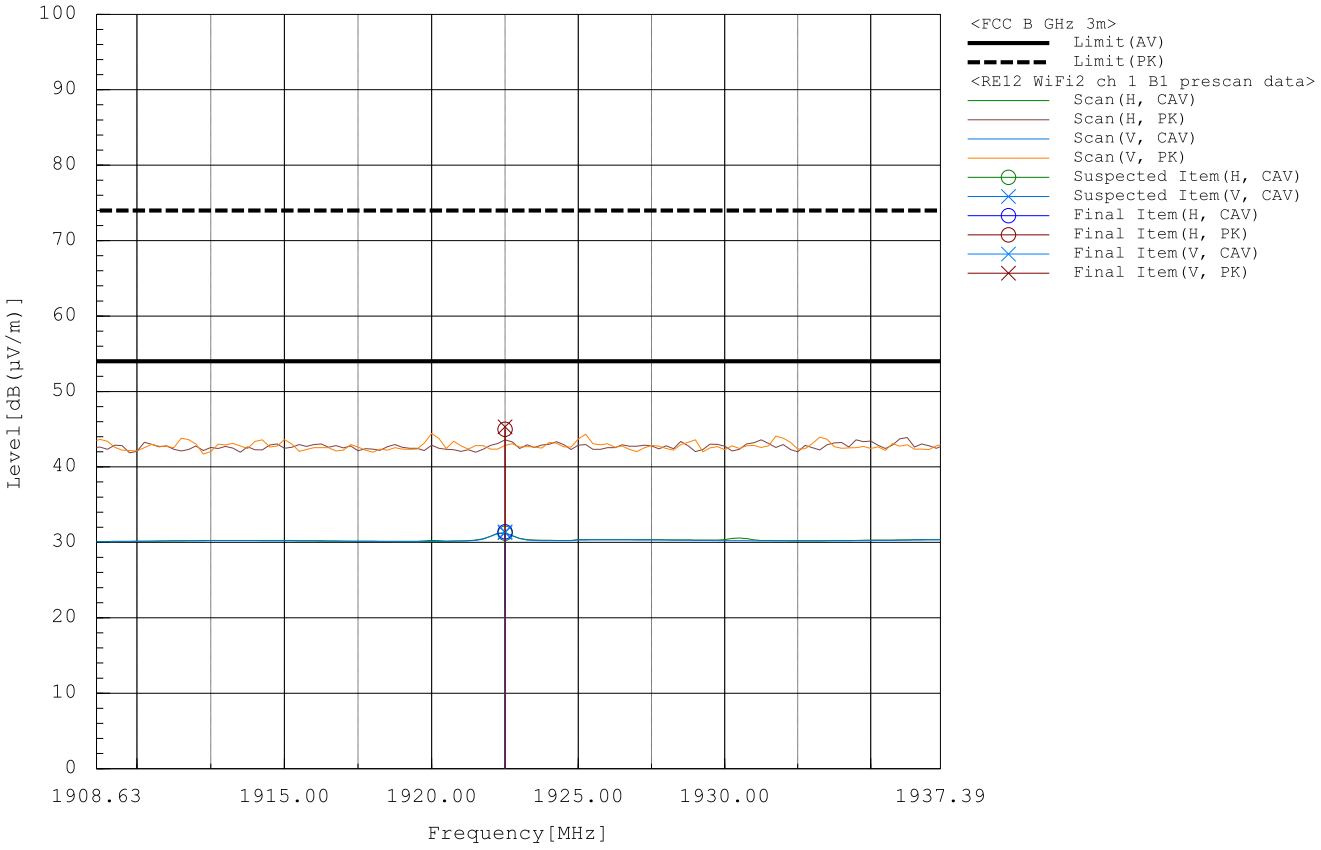

Figure RE12.1: Spectral data (WiFi2Tx B1 20MHz ch 1)

Setup Photographs

The photographs that show how the EUT was configured and arranged can be found in Test Record 06, Figure RE06.2 and Figure RE06.3.

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This line is the end of the test record.

Test Record
Radiated Emission Test RE13
Project GCL0388

Test Date(s)	03 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M3 (WiFi2Tx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2 GHz
Pass/Fail Judgment:	**PASS**

Test record created by: **David A Kerr**
Date of this record: **03 Oct 2023**
Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
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
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
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
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024

Table RE13.1: Test Equipment Used

Software Used:
Keysight PXE software A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 1000 MHz and 2200 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.

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		
1373.250	V	34.0	46.6	-4.0	30.0	42.6	54.0	74.0	24.0	31.4	298.4	10.0
1922.500	V	33.5	47.9	-1.9	31.6	46.0	54.0	74.0	22.4	28.0	210.2	344.0
1029.750	H	32.7	46.3	-6.1	26.6	40.2	54.0	74.0	27.4	33.8	108.6	314.0
1098.500	H	35.4	47.7	-6.2	29.2	41.5	54.0	74.0	24.8	32.5	177.6	308.0
1373.250	H	36.8	47.9	-4.0	32.8	43.9	54.0	74.0	21.2	30.1	207.1	306.0
1373.250	H	36.9	48.2	-4.0	32.9	44.2	54.0	74.0	21.1	29.8	207.7	306.0

Table RE13.2: Emission summary (WiFi2Tx B1 20MHz ch 6)

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

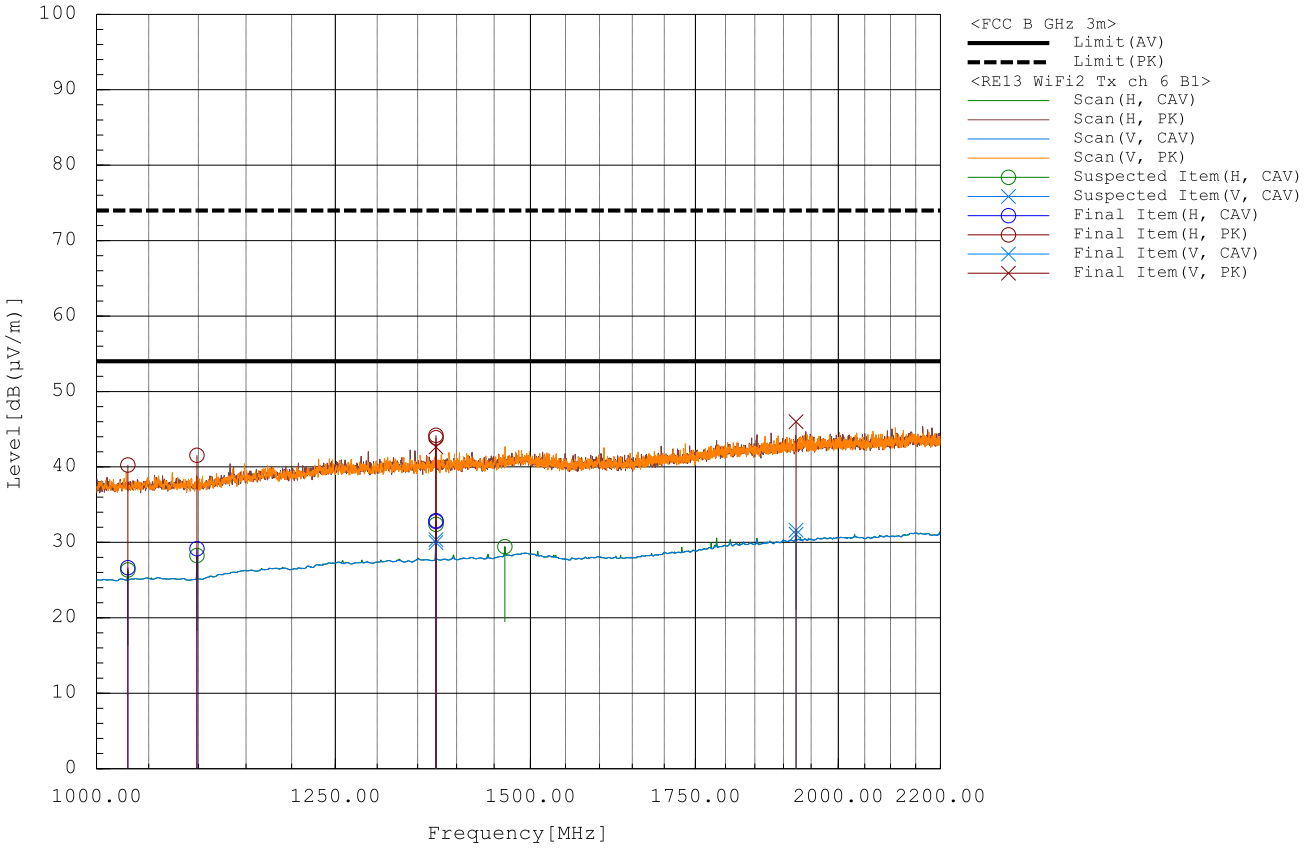

Figure RE13.1: Spectral data (WiFi2Tx B1 20MHz ch 6)

Setup Photographs

The photographs that show how the EUT was configured and arranged can be found in Test Record 06, Figure RE06.2 and Figure RE06.3.

This line is the end of the test record.

Test Record
Radiated Emission Test RE14
Project GCL0388

Test Date(s)	03 Oct 2023
Test Personnel	Jim Solum
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M3 (WiFi2Tx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, ANSI C63.10 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2.2 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**Jim Solum**
Date of this record:	**03 Oct 2023**

Original record, Version A.

Test Equipment

A list of test equipment used for this test can be found in Test Record RE06, Table RE06.1.

Software Used: N9048B Keysight PXE firmware version A.33.03
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 1000 MHz and 2200 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.

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		
1373.250	V	33.9	47.1	-4.0	29.9	43.1	54.0	74.0	24.1	30.9	297.7	12.0
1994.000	V	32.4	46.0	-1.7	30.7	44.3	54.0	74.0	23.3	29.7	355.5	90.0
1098.500	H	35.5	47.8	-6.2	29.3	41.6	54.0	74.0	24.7	32.4	185.9	306.0
1373.250	H	37.3	48.3	-4.0	33.3	44.3	54.0	74.0	20.7	29.7	209.3	308.0
1373.250	H	37.3	48.0	-4.0	33.3	44.0	54.0	74.0	20.7	30.0	209.2	308.0
1091.250	H	31.4	45.5	-6.2	25.2	39.3	54.0	74.0	28.8	34.7	120.5	34.0
1922.500	H	33.2	46.5	-1.9	31.3	44.6	54.0	74.0	22.7	29.4	100.0	347.0

Table RE14.1: Emission summary (WiFi B1 Ch11)

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

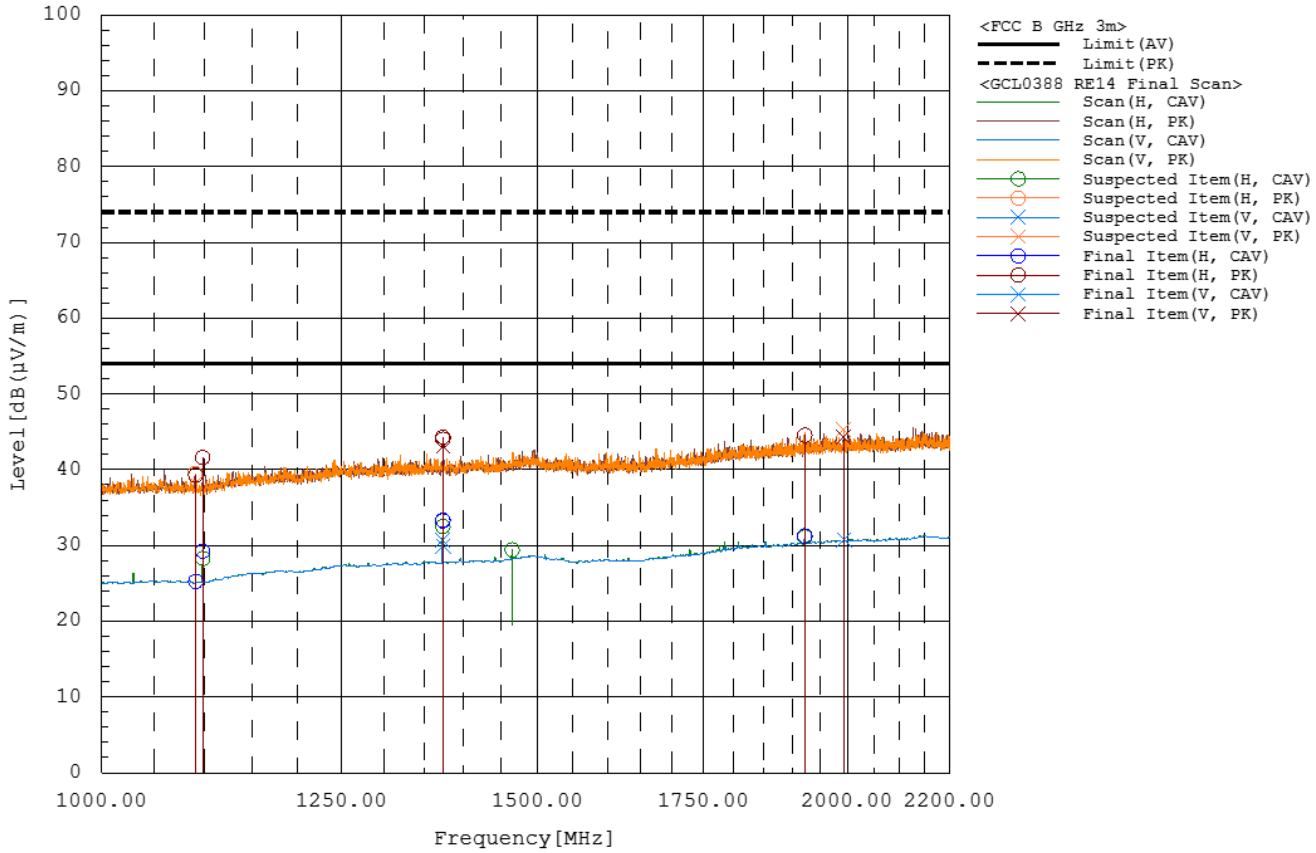

Figure RE14.1: Spectral data (WiFi B1 Ch11)

Setup Photographs

The photographs that show how the EUT was configured and arranged can be found in Test Record 06, Figure RE06.2 and Figure RE06.3.

This line is the end of the test record.

Test Record
Radiated Emission Test RE25
Project GCL0388

Test Date(s)	26 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M3 (WiFi2Tx)
Arrangement	A1 (Mounted)
Input Power	13.8 Vdc
Test Standards:	FCC Part 15, 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:	**Aditya Prakash**
Date of this record:	**30 Oct 2023**

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, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	233201	19-Jul-2022	15-Jul-2024
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	7-Nov-2022	7-Nov-2025
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
Power supply	Samlex America	SEC1212	03051-7F03-00426	Calibration	Not Required

Table RE25.1: Test Equipment Used

Software Used:
Keysight PXE software A.32.06
EPX/RE automation software ver. 2023.01.001

Test Data

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

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

The table shows the selected final measurement data between 30 MHz and 1 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m.

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		
274.620	H	22.5	21.9	44.4	46.0	1.6	100.0	211.0
114.060	H	11.0	16.2	27.2	43.5	16.3	285.6	122.0
549.240	H	4.4	30.7	35.1	46.0	10.9	158.2	328.0
237.360	H	14.0	21.0	35.0	46.0	11.0	118.0	281.0
343.290	H	9.4	24.2	33.6	46.0	12.4	100.0	223.0
41.310	V	6.9	16.7	23.6	40.0	16.4	100.0	137.0

Table RE25.2: Emission summary

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

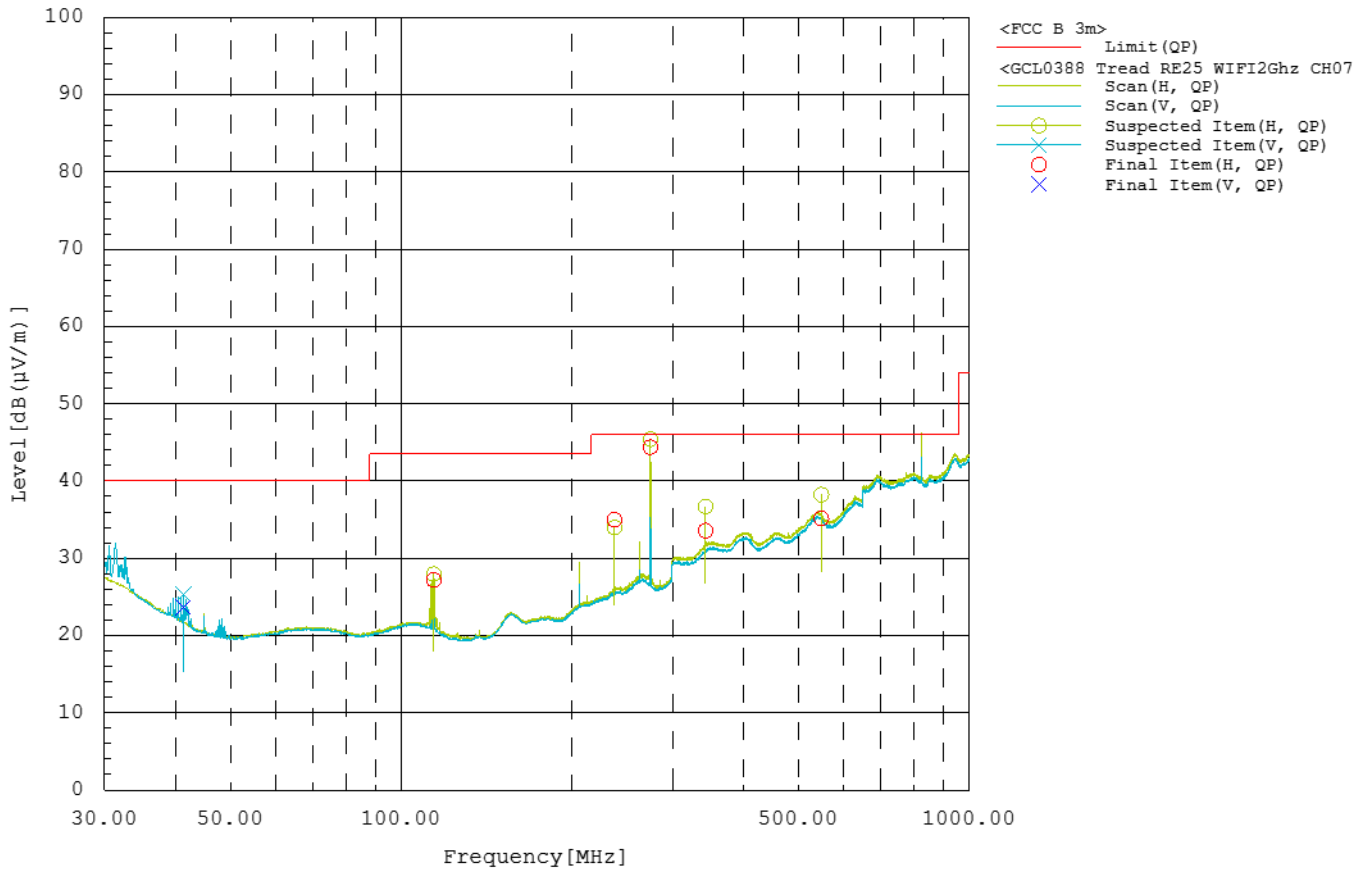

Figure RE25.1: Spectral data

Setup Photographs

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

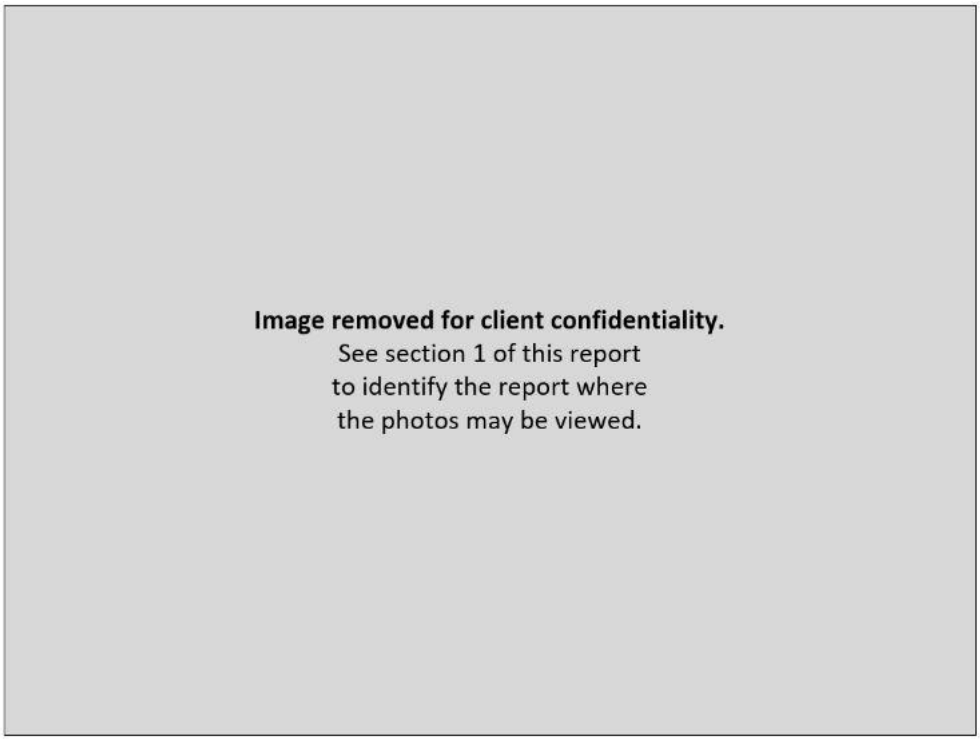

Figure RE25.2: EUT test setup, front view

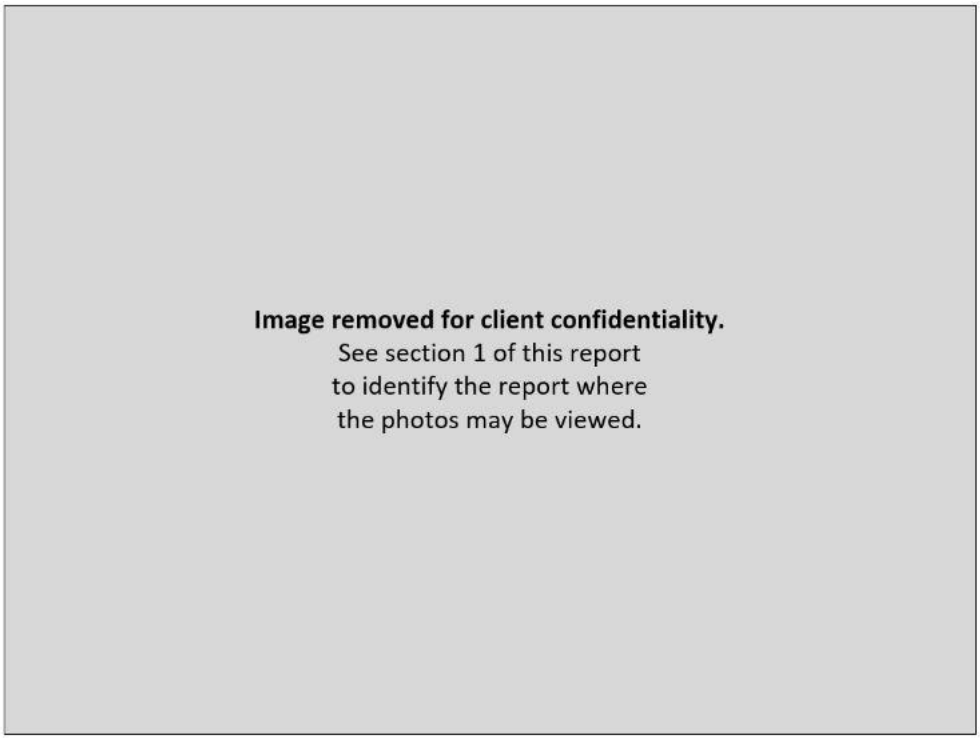

Figure RE25.3: EUT test setup, reverse view

This line is the end of the test record.

Test Record
Conducted Emissions Mains Test CE02
Project GCL0388

Test Date(s)	06 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M1 (BtcTx)
Arrangement	A2 (USB)
Input Power	115 V/ 60 Hz
Test Standards:	FCC Part 15 (as noted in Section 6 of the report).
Frequency Range:	150 kHz to 30 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**Aditya Prakash**
Date of this record:	**10 Oct 2023**

Original record, Version A.

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-23	1-Feb-24
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10721	30-Aug-23	1-Sep-26
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-23	1-Apr-24
LISN multiline; 20A 50uH	Com-Power	LIN-120C	20160005	10-Feb-23	15-Feb-24

Table CE02.1: Test Equipment Used

Software Used
Keysight PXE software A.33.03; CE Mains 150k to 30M Data Analysis V2 2021Jun10.xlsx

Test Data

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

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

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)
620	56	46	44.07	39.46	37.01	31.37	11.93	8.99
674	56	46	44.42	40.35	37.19	31.48	11.58	8.81
728	56	46	37.87	32.73	31.09	26.38	18.13	14.91
1241	56	46	41.06	34.29	32.46	28.23	14.94	13.54
1295	56	46	44.07	36.26	32.73	28.37	11.93	13.27
1347	56	46	41.22	34.49	32.04	27.85	14.78	13.96

Table CE02.2: Emission summary

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

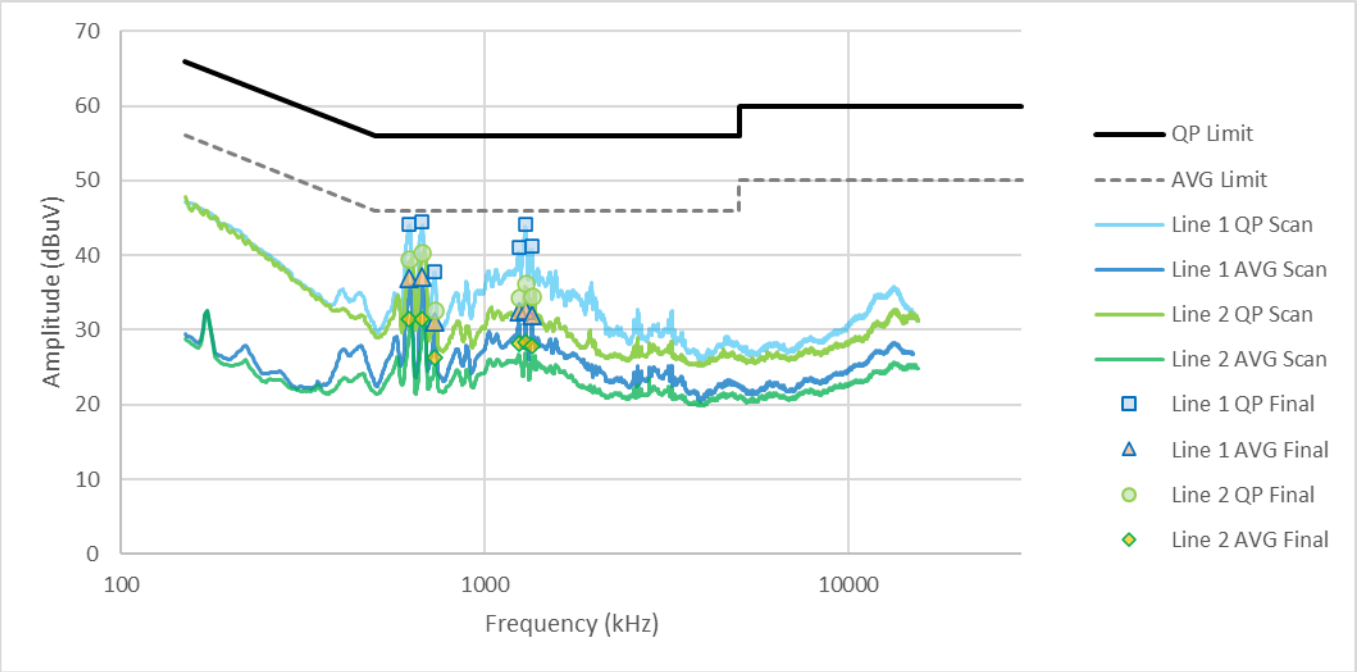

Figure CE02.1: Spectral data

Setup Photographs

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

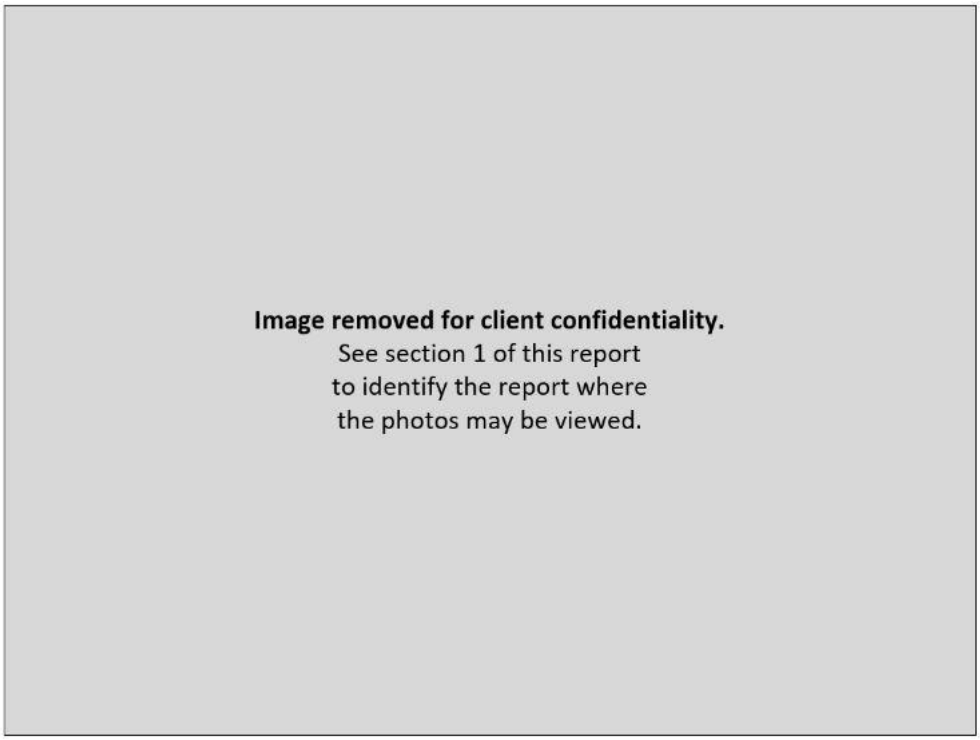

Figure CE02.2: Test setup, front view

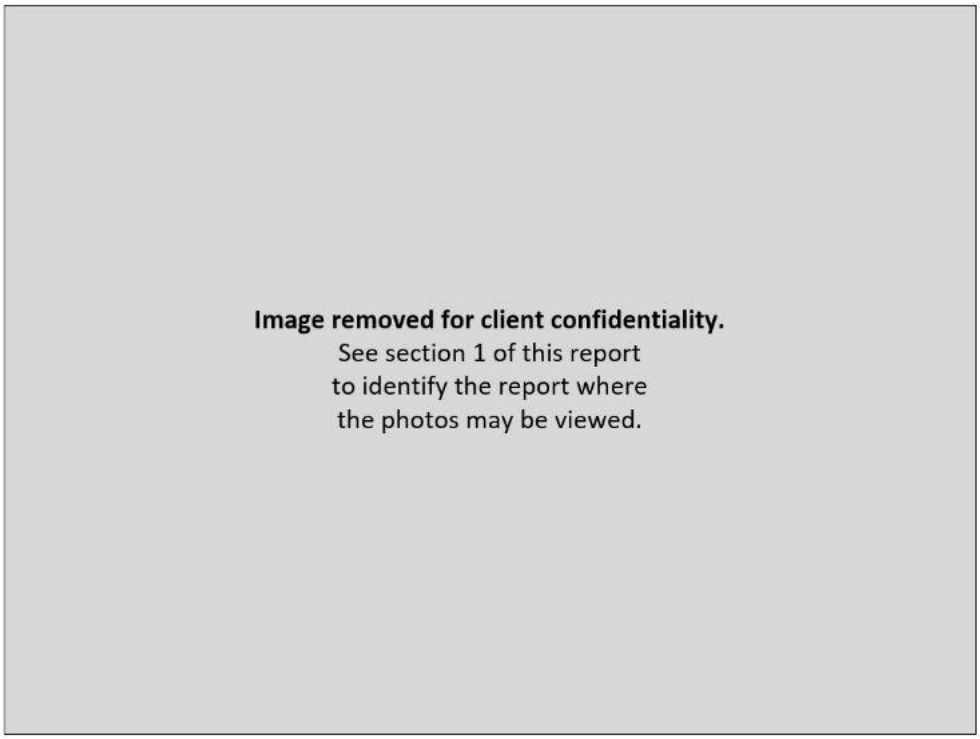

Figure CE02.3: Test setup, side view

This line is the end of the test record.

Test Record

Conducted Emissions Mains Test CE03
Project GCL0388

Test Date(s)	06 Oct 2023
Test Personnel	David Kerr
Product Model	A04752
Serial Number tested	3449554812
Operating Mode	M3 (WiFi2Tx)
Arrangement	A2 (USB)
Input Power	115 V/ 60 Hz
Test Standards:	FCC Part 15 (as noted in Section 6 of the report).
Frequency Range:	150 kHz to 30 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**Aditya Prakash**
Date of this record:	**10 Oct 2023**

Original record, Version A.

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-23	1-Feb-24
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10721	30-Aug-23	1-Sep-26
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-23	1-Apr-24
LISN multiline; 20A 50uH	Com-Power	LIN-120C	20160005	10-Feb-23	15-Feb-24

Table CE03.1: Test Equipment Used

Software Used
Keysight PXE software A.33.03; CE Mains 150k to 30M Data Analysis V2 2021Jun10.xlsx

Test Data

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

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

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	47.86	50.90	31.23	31.88	15.10	24.12
632	56.00	46.00	39.89	39.15	34.05	31.57	16.11	11.95
688	56.00	46.00	40.35	41.24	33.64	31.74	14.76	12.36
728	56.00	46.00	38.15	33.52	31.07	25.71	17.85	14.93
1034	56.00	46.00	38.78	34.13	31.27	27.49	17.22	14.73
1370	56.00	46.00	38.24	35.50	30.56	27.60	17.76	15.44

Table CE03.2: Emission summary

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

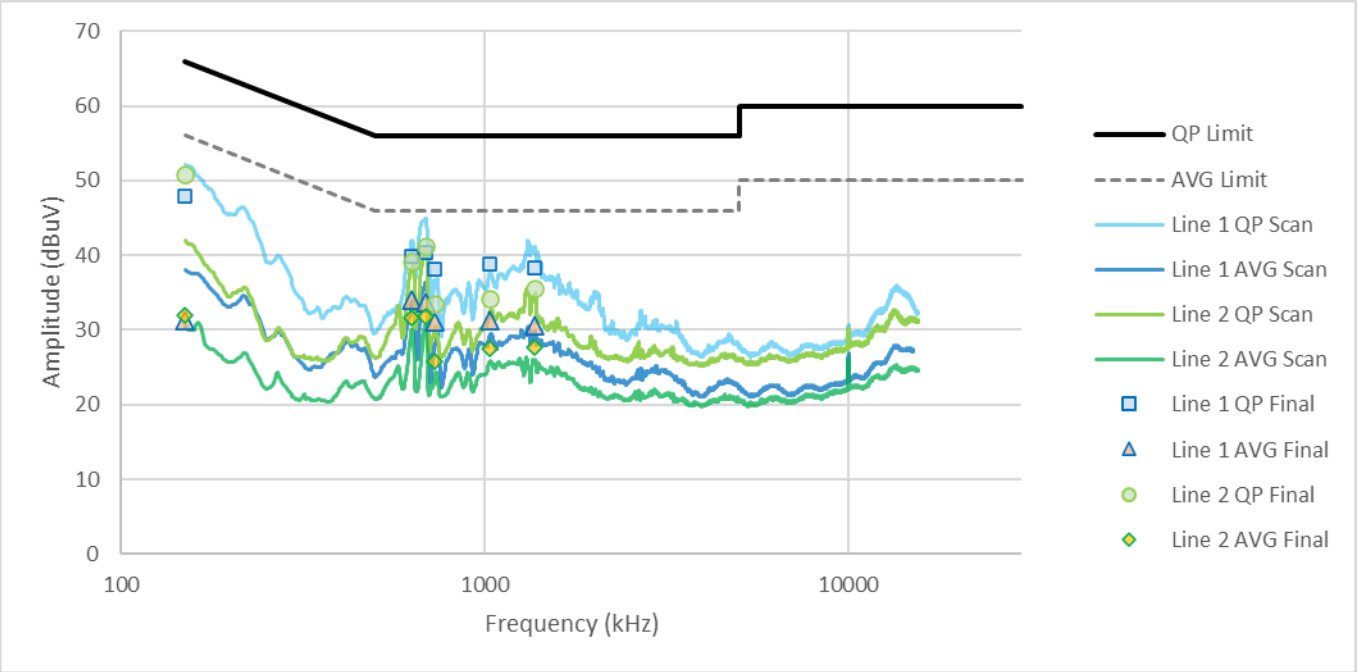

Figure CE03.1: Spectral data

Setup Photographs

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

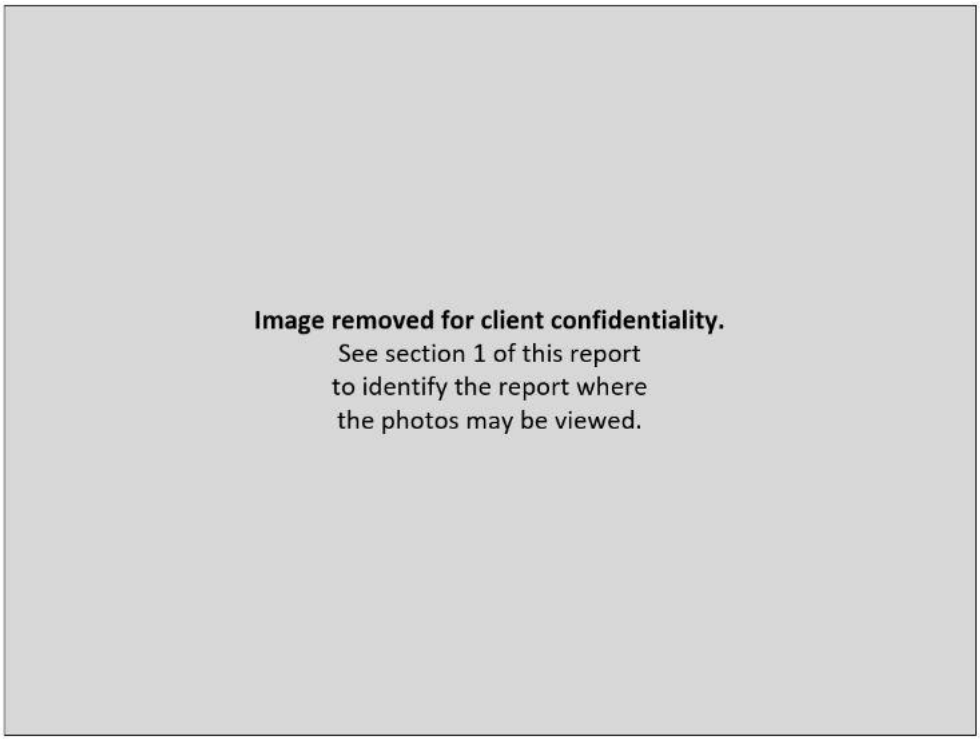

Figure CE03.2: Test setup, front view

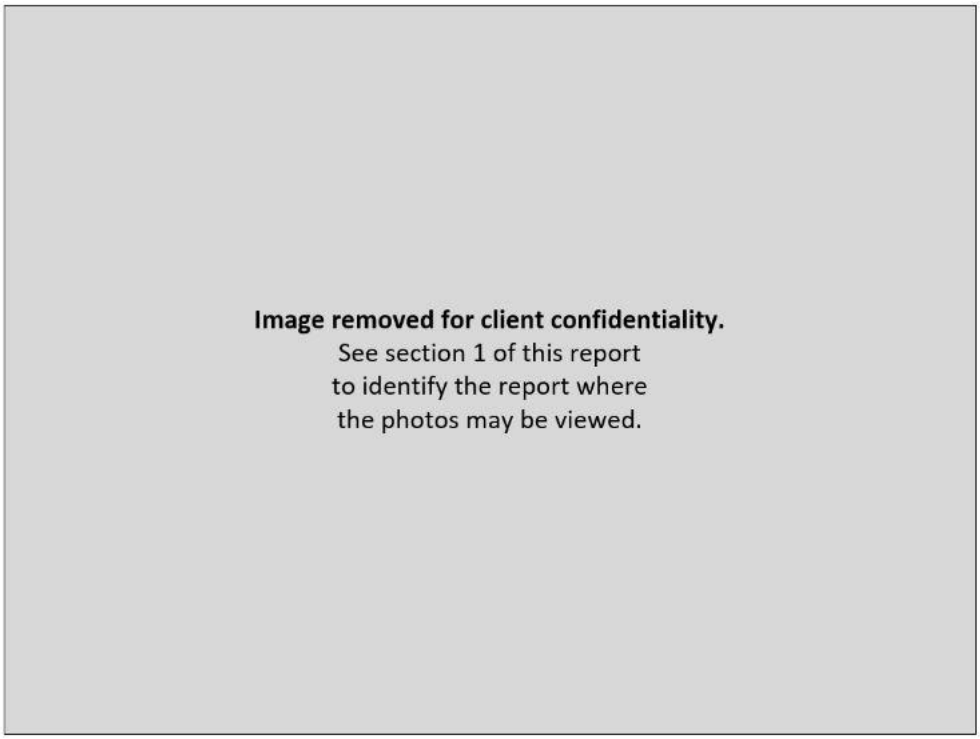

Figure CE03.3: Test setup, side view

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.