Test Report 2024-156

Version A
Issued 26 Nov 2024

Project: GCL-0647
Model Identifier: A04999
Primary Test Standard(s):
CFR 47, FCC Part 15.225
RSS-210 Issue 11

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

Client-supplied Information

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

ACCREDITED
CERTIFICATE #6162.01

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

1. Summary

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

Parameter	Description	Key Performance Values	Result	Data starts at page
Transmitter intentional emissions	Emissions while transmitting must be limited according to a mask that varies across the frequency range 13.110 to 14.010 MHz.[15.225(a) through (c), RSS-210 B.6]	14.8 dB of margin to the intentional emission limit.	PASS	14
Transmitter spurious emissions	Emissions beyond the intended radio band while transmitting must be suppressed a general limit. [FCC 15.225 (d) and RSS 210 B.6]	0.6 dB of margin to the Class B limit.	PASS	24
Conducted Emissions AC Power Port	Radio emissions that this device may generate via its ac power network connections that are not necessary for its operation and that may affect radio communication. [FCC Part 15.205 and RSS-GEN 8.8]	27.8 dB of margin to the appropriate limit. Tested 150 kHz to 30 MHz applying combined Class B limits.	PASS	30
Frequency stability under extreme Conditions	The ability for the radio to accurately maintain carrier frequency stable with changes in temperature and supply voltage. [FCC 15.225 (e) and RSS 210 B.6]	The Carrier frequency was stable within 0.01% of the target frequency.	PASS	33
Other Bandwidths	Bandwidth values are presented for 99% Occupied Bandwidth	There are requirements to report these numbers, but they do not have performance limits.	Reported	35

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

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

Table 1: Summary of results

Report Organization

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

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

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

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

2. Test Background

2.1 The Test Lab

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

2.2 The Client

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

2.3 Other Information

Test Sample received: 04 Nov 2024
Test Start Date: 13 Nov 2024
Test End Date: 21 Nov 2024

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

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

3. Report History and Approval

This report was written by Andy Heier and initially issued on 27 Nov 2024 as Version A.

Report Technical Review:

David Arnett
Technical Lead EMC Engineer

Report Approval:

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

4. Test Sample Modifications and Special Conditions

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

The following modifications to the test sample(s) were made, and are judged necessary to achieve compliance with one or more of the standards listed in section 6 of this report:
None

5. Description of the Equipment Tested

5.1 Unique Identification

Product Model	A04999
Serial Numbers Tested	Initial Group: None in this report Updated Group: 8ME000392, 8MD000349

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

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

5.2 Key Parameters

EUT Input Power:	5 Vdc
I/O Ports:	USB
Radio Transceivers:	IEEE 802.11 b/g/n, Bluetooth, Bluetooth Low Energy, ANT, NFC
Radio Receivers:	GPS L1, Galileo E1, BeiDou, GLONASS
Primary Functions:	Data collection and communication
Typical use:	Portable in multiple orientations
Highest internal frequency:	2.484 GHz
Firmware Revision	3.01

5.3 Operating modes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.4 EUT Arrangement

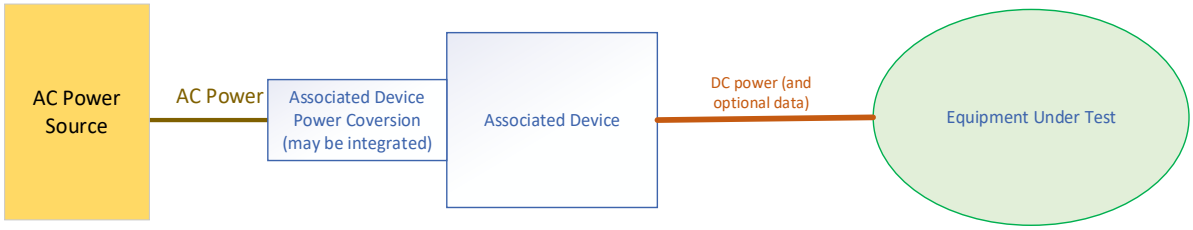
During test, the EUT components and associated support equipment were selected including the following arrangement sets.

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

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

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

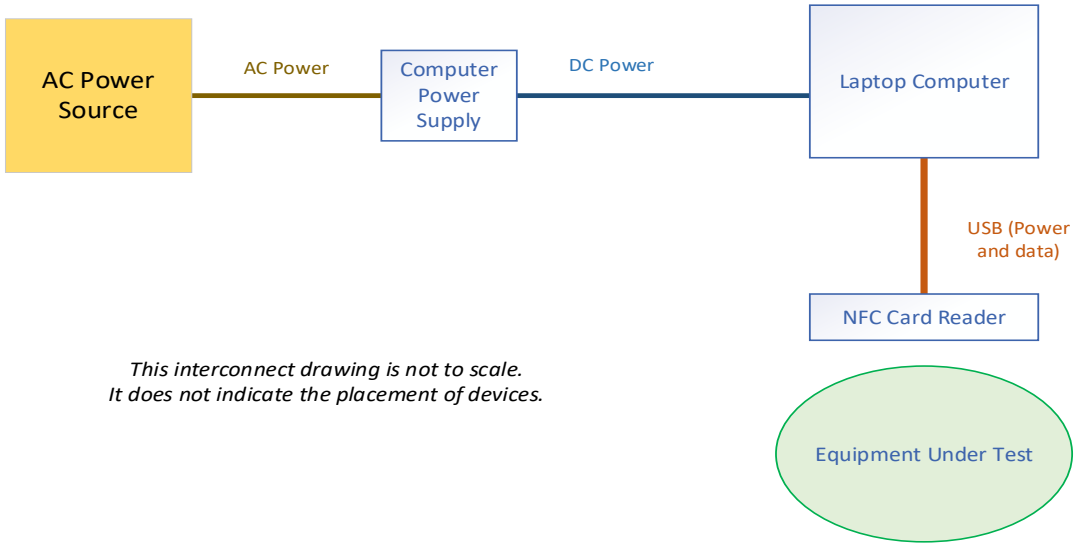
Arrangement 4: A4 (Udc). The test sample is attached to a Mains-powered device connected that provides dc power to the sample and may or may not provide user data. This arrangement is specified in the test plan to provide staff flexibility when the presence or absence of data on the cable is not pertinent.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



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

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

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



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

Figure 2: Block diagram of equipment arrangement A6

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

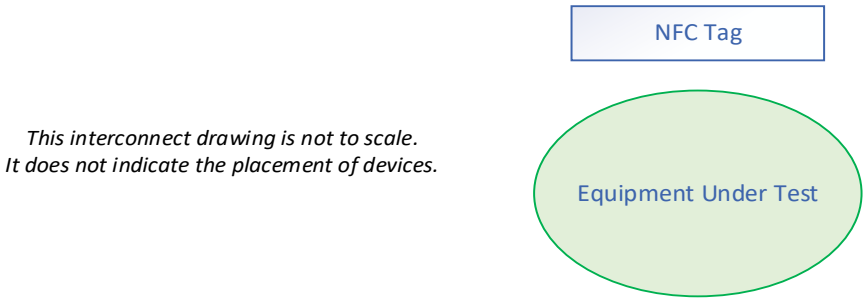


Figure 2: Block diagram of equipment arrangement A7

5.5 Associated Equipment (AE) used

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

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

5.6 Cables used

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

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

6. Test Standards Applied

6.1. Accredited Standards

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

CFR 47, FCC Part 15, Subpart C
ANSI C63.10: 2020 and ANSI C63.10: 2020 +Cor 1: 2023
RSS-210 Issue 11

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.

(None)

6.3 Variances

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

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

6.4 Laboratory Accreditation

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

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

7. Measurement Instrumentation Uncertainty

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

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

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

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

Test Type		**U_{LAB}**	**U_{CISPR}**	**U_{ETSI}**
Conducted DC voltage		0.09% + 2 x LSDPV	None	1%
Conducted AC voltage below 500 Hz		1.0% + 3 x LSDPV	None	2%
Conducted Emissions, Mains Voltage		0.10% + 10 mV	None	None
Conducted Emissions, Mains Current		0.10% + 3 mA	None	None
Conducted Emissions, Mains Power		0.15% + 100 mW	None	None
Conducted Emissions, Power Mains, 9 kHz to 150 kHz		1.49 dB	3.8 dB	None
Conducted Emissions, Power Mains, 150 kHz to 30 MHz		1.40 dB	3.4 dB	None
Conducted Emissions, Cat 6 LCL, 150 kHz to 30 MHz		2.80dB	5 dB	None
Conducted Emissions, Cat 5 LCL, 150 kHz to 30 MHz		3.21 dB	5 dB	None
Conducted Emissions, Cat 3 LCL, 150 kHz to 30 MHz		4.24 dB	5 dB	None
Radiated Emissions, below 30 MHz		0.88 dB	None	6 dB
Radiated Emissions, 30 MHz to 1000 MHz		2.77 dB	6.3 dB	6 dB
Radiated Emissions, 1 GHz to 18 GHz		2.60 dB	5.2 & 5.5 dB	6 dB
Radiated Emissions, 18 GHz to 26.5 GHz		2.73 dB	None	6 dB
*Radio Signal Frequency Accuracy		*1.55 x 10^-7	None	1.0 x 10^-7
Radio Signal Occupied Bandwidth		0.95%	None	5%
Radio Power or Power Spectral Density		0.98 dB	None	1 dB
Temperature		0.38 °C	None	1 °C
Barometric Pressure		0.38 kPA	None	None
Relative Humidity		2.85% RH	None	±5% RH
Signal Timing	The greater of these three...	0.63 µsec 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 dBµV) + (9.812 dB) + (0.216 dB) = 17.173 dBµV

8.2 Radiated Emissions at 630 MHz

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

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

8.3 Radiated Emissions at 2.7 GHz

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

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

9. Environmental Conditions During Test

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

Temperature:	20 to 22 °C
Relative Humidity:	37% to 55% (non-condensing)
Barometric Pressure	95.1 to 98.2 kPa

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

Table 4: Environmental monitoring device

10. Immunity Performance Criteria

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

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

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

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

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

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

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

11. 3m RF Chamber Block Diagrams

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

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

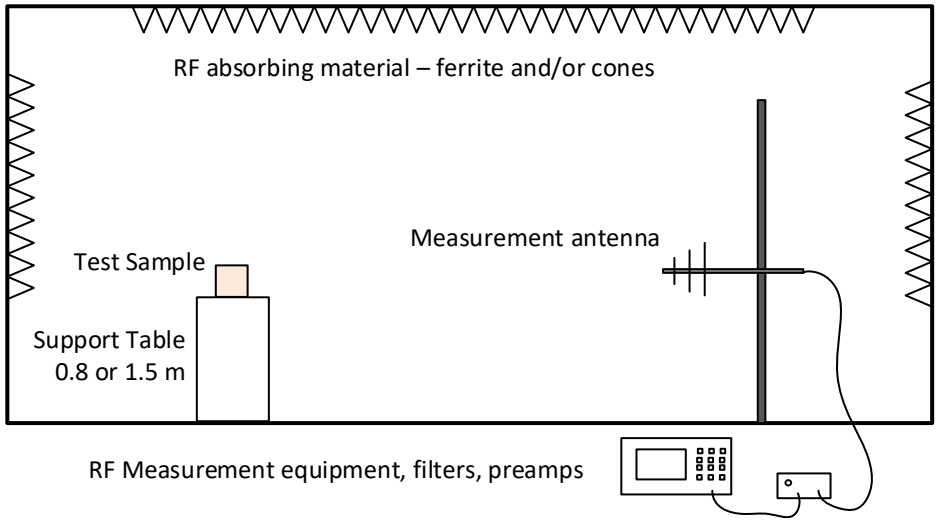


Figure 1: Typical configuration for measurements below 1 GHz

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

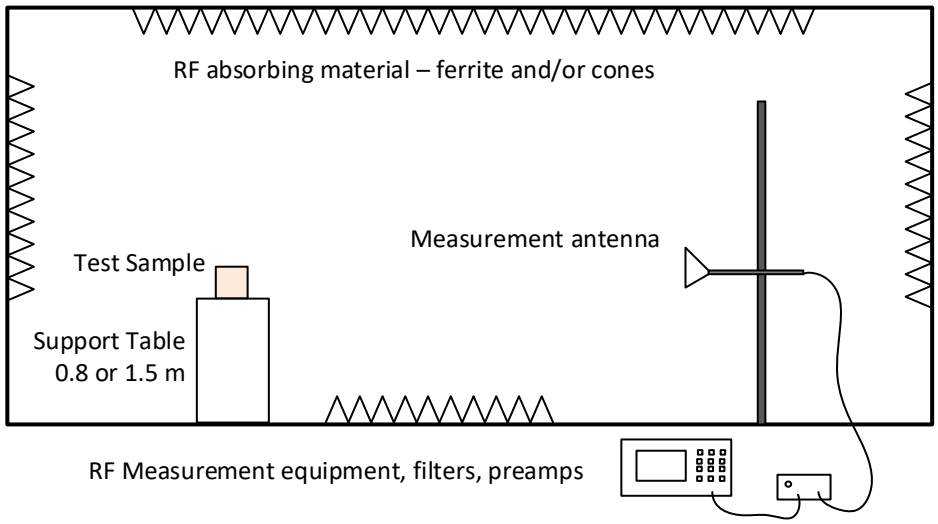


Figure 2: Typical configuration for measurements between 1 GHz and 14 GHz

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

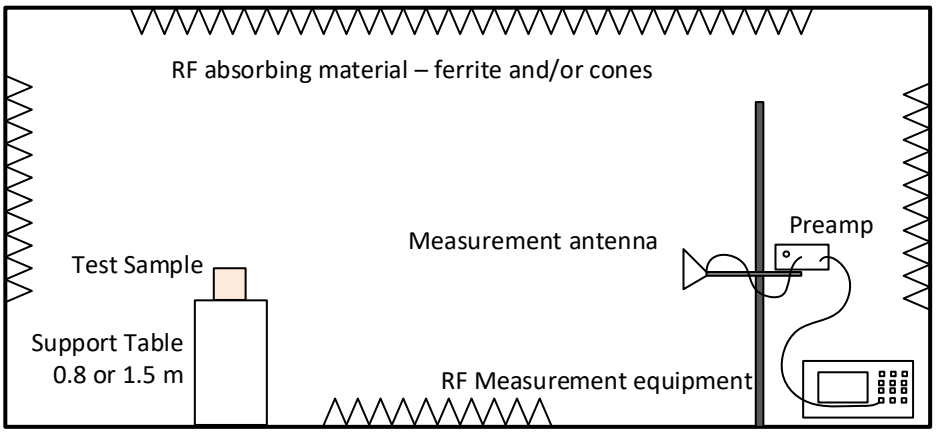


Figure 3: Typical configuration for measurements above 14 GHz

ANNEX

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

Test Record
Radiated Emission Test RE13
Project GCL0647

Test Date(s)	13 Nov 2024
Test Personnel	David Kerr
Product Model	A04999
Serial Number tested	8ME000392
Operating Mode	M16 (NfcTag)
Arrangement	A6 (NFCu)
Input Power	Battery
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	9 kHz to 30 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	Jim Solum
Date of this record:	15 Nov 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Loop antenna, amplified	Schwarzbeck	FMZB 1519B	00174	18-Jul-2024	18-Jul-2026
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	25-Jan-2023	25-Jan-2026
Tape measure, 1” x 33’	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026

Table RE13.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, RE 150k to 30M Signal Maximization Tool V1 2021Mar17.xlsx, RE FccCanada 9k30mAnalysis2.xlsx

Test Data

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

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

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

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

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

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

Freq.	Level	Detector	Limit	Margin	Peak Level	Pk Limit	Pk Margin	Antenna	Table
MHz	dBuV/m	Type	dBuV/m	dB	dBuV/m	dBuV/m	dB	Orientation	Azimuth, deg
13.56	26.77	QP	105.39	78.63	38.21	None	None	x	-108

Table RE13.2: Emission summary

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

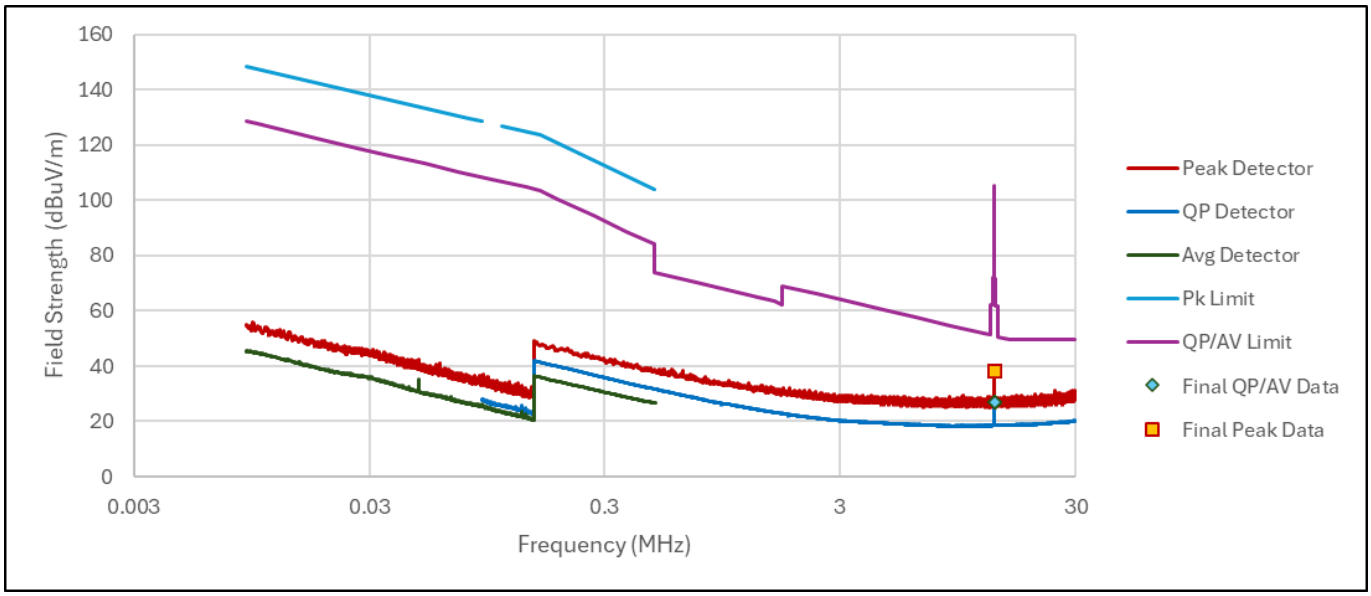


Figure RE13.1: Spectral data

Setup Photographs

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

Figure RE13.2: EUT test setup, first view

Figure RE13.3: EUT test setup, second view (Antenna X orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE18
Project GCL0647

Test Date(s)	12 Nov 2024
Test Personnel	David Kerr
Product Model	A04999
Serial Number tested	8ME000392
Operating Mode	M12 (NfcLnk),Type A
Arrangement	A6 (NFCu)
Input Power	Battery
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	9 kHz to 30 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	Jim Solum
Date of this record:	14 Nov 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Loop antenna, amplified	Schwarzbeck	FMZB 1519B	00174	18-Jul-2024	18-Jul-2026
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	25-Jan-2023	25-Jan-2026
Tape measure, 1” x 33’	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026

Table RE18.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, RE 150k to 30M Signal Maximization Tool V1 2021Mar17.xlsx, RE FccCanada 9k30mAnalysis2.xlsx

Test Data

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

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

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

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

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

Freq.	Level	Detector	Limit	Margin	Peak Level	Pk Limit	Pk Margin	Antenna	Table
MHz	dBuV/m	Type	dBuV/m	dB	dBuV/m	dBuV/m	dB	Orientation	Azimuth, deg
0.6136	44.99	QP	71.85	26.86	49.10	None	None	x	-148
0.79125	48.57	QP	69.64	21.07	52.60	None	None	x	-136
1.5113	49.27	QP	64.02	14.75	51.30	None	None	x	-157
2.373	35.49	QP	66.08	30.58	40.76	None	None	x	-156
3.0188	36.65	QP	63.99	27.34	41.59	None	None	x	-168
13.56	60.80	QP	105.39	44.60	61.10	None	None	x	-5

Table RE18.2: Emission summary

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

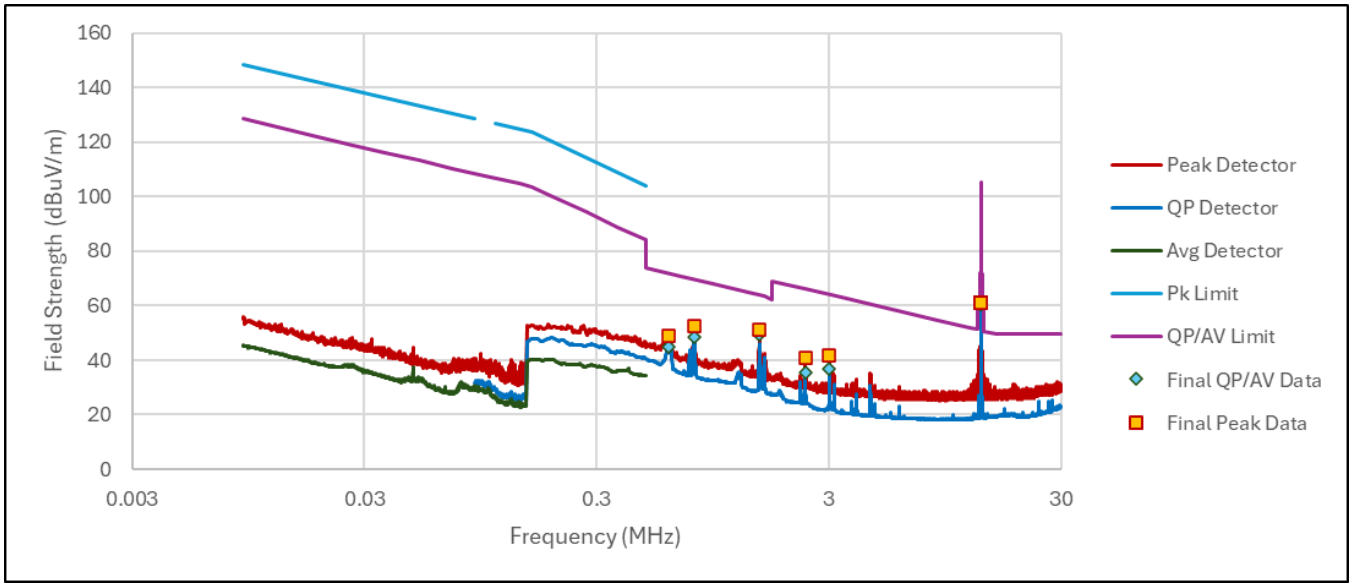


Figure RE18.1: Spectral data

Setup Photographs

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

Figure RE18.2: EUT test setup, first view

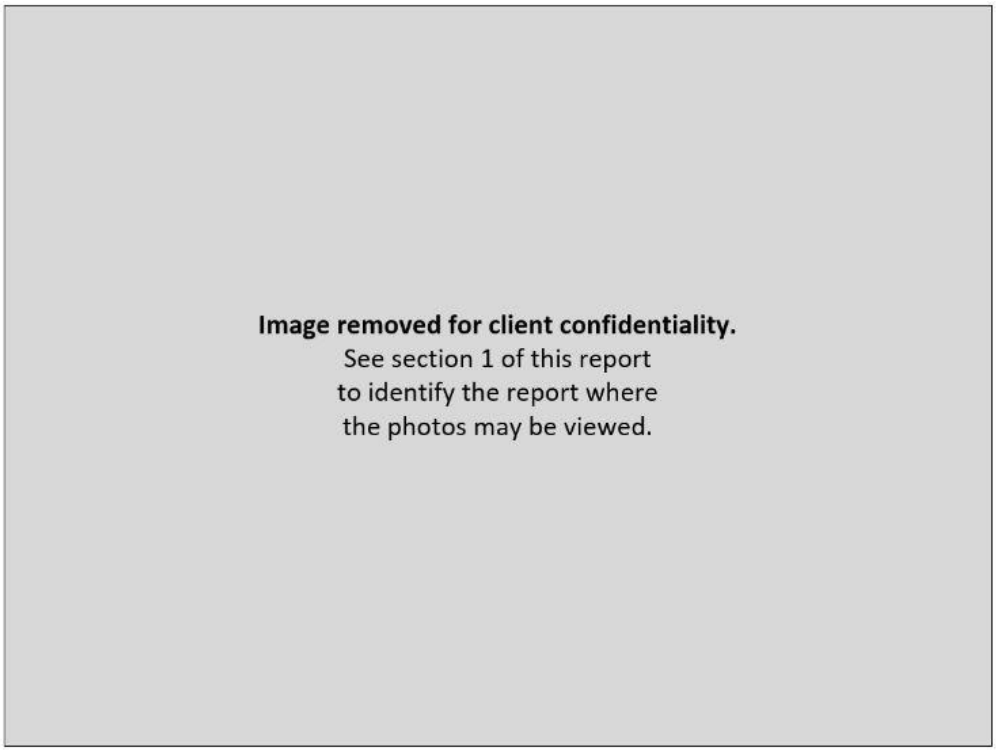


Figure RE18.3: EUT test setup, second view (Antenna X orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE19
Project GCL0647

Test Date(s)	12 Nov 2024
Test Personnel	Jim Solum
Product Model	A04999
Serial Number tested	8ME000392
Operating Mode	M12 (NfcLnk), Type B
Arrangement	A6 (NFCu)
Input Power	Battery
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	9 kHz to 30 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	Jim Solum
Date of this record:	14 Nov 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Loop antenna, amplified	Schwarzbeck	FMZB 1519B	00174	18-Jul-2024	18-Jul-2026
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	25-Jan-2023	25-Jan-2026
Tape measure, 1” x 33’	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026

Table RE19.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, RE 150k to 30M Signal Maximization Tool V1 2021Mar17.xlsx, RE FccCanada 9k30mAnalysis2.xlsx

Test Data

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

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

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

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

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

Freq.	Level	Detector	Limit	Margin	Peak Level	Pk Limit	Pk Margin	Antenna	Table
MHz	dBuV/m	Type	dBuV/m	dB	dBuV/m	dBuV/m	dB	Orientation	Azimuth, deg
0.0487	36.41	Avg	113.86	77.45	45.34	133.86	88.52	Y	92
0.6113	45.41	QP	71.88	26.47	50.45	None	None	X	-153
0.7913	48.87	QP	69.64	20.77	53.30	None	None	X	-143
1.509	45.28	QP	64.03	18.75	50.97	None	None	X	-168
2.373	36.79	QP	66.08	29.29	42.10	None	None	X	-142
3.0165	36.22	QP	63.99	27.77	42.54	None	None	X	154
13.56	63.95	QP	105.39	41.44	64.30	None	None	X	-5

Table RE19.2: Emission summary

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

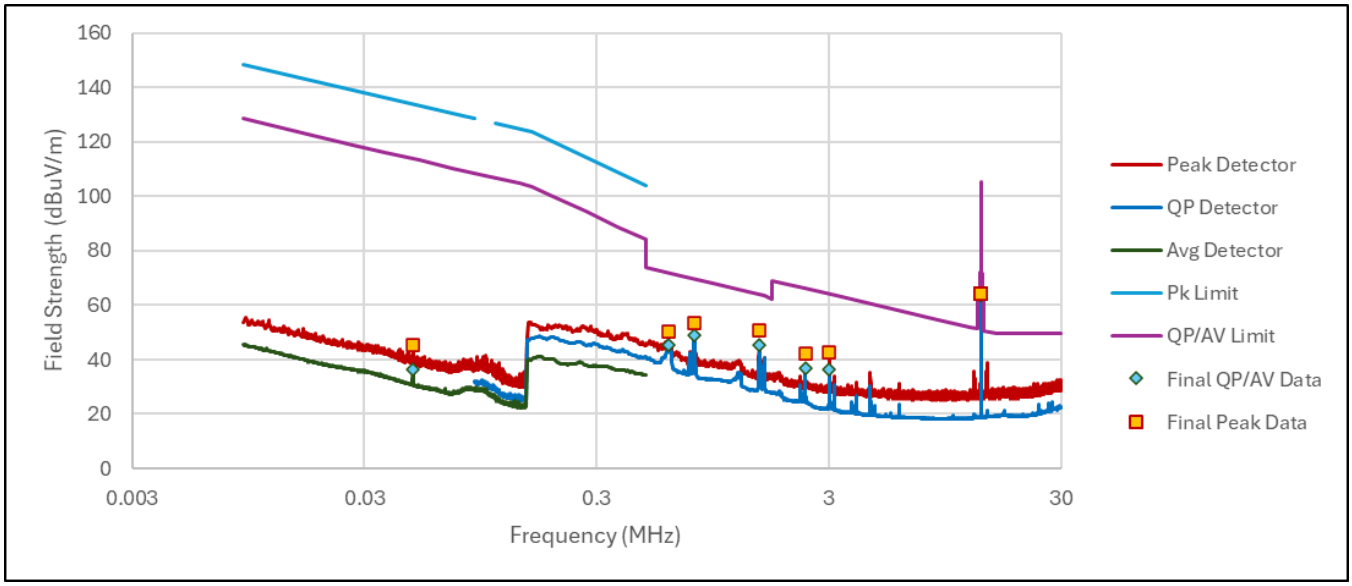


Figure RE19.1: Spectral data

Setup Photographs

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

Figure RE19.2: EUT test setup, first view

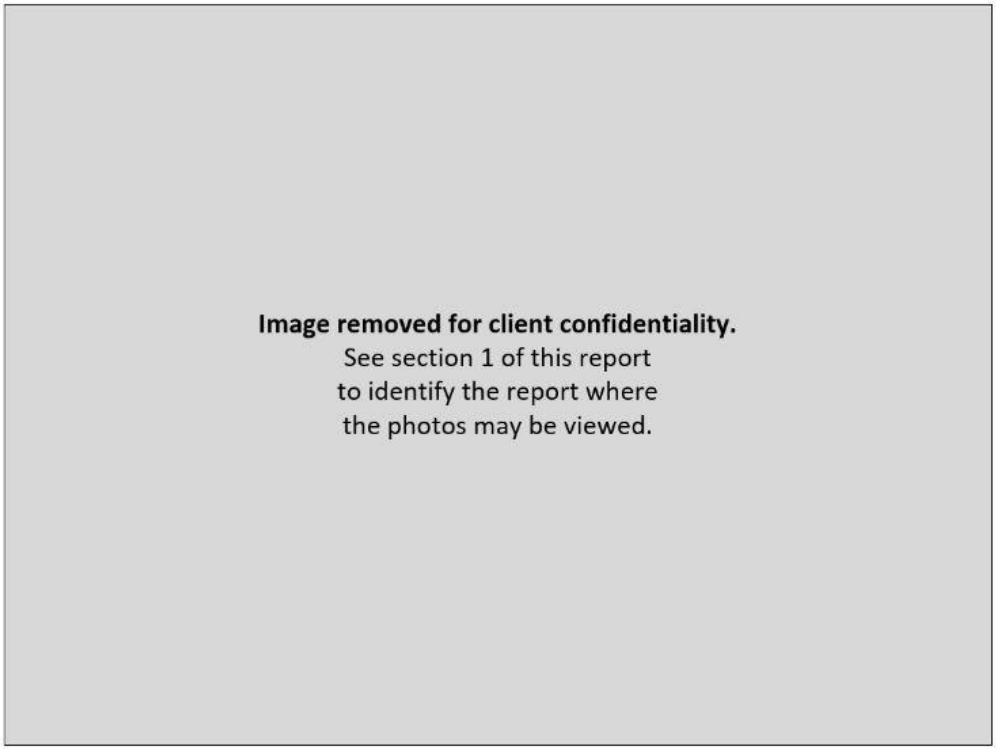


Figure RE19.3: EUT test setup, second view (Antenna X polarization)

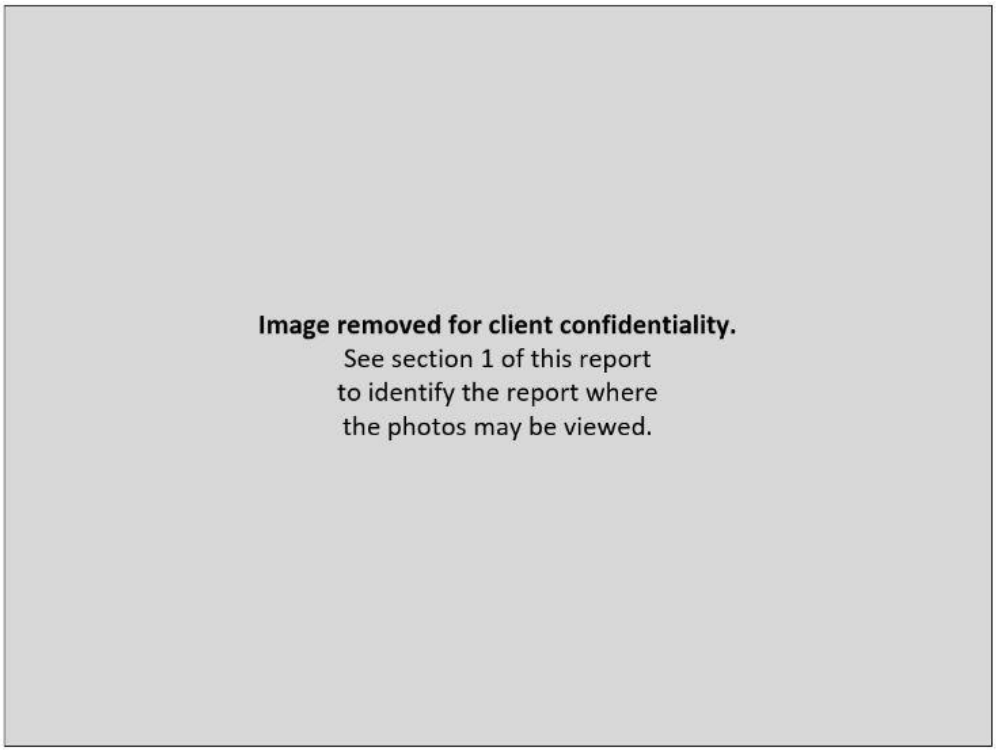


Figure RE19.4: EUT test setup, second view (Antenna Y polarization)

This line is the end of the test record.

Test Record
Radiated Emission Test RE20
Project GCL0647

Test Date(s)	14 Nov 2024
Test Personnel	Jim Solum
Product Model	A04999
Serial Number tested	8MD000349
Operating Mode	M12 (NfcLnk),Type B
Arrangement	A6 (NFCu)
Input Power	Battery
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	30 MHz to 1000 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	Jim Solum
Date of this record:	15 Nov 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Antenna, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	00233201	18-Jul-2024	18-Jul-2026
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	25-Jan-2023	25-Jan-2026
Tape measure, 1” x 33’	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026

Table RE20.1: Test Equipment Used

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

Test Data

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

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

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

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

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

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		
30.030	V	17.0	22.4	39.4	40.0	0.6	108.5	52.0
82.260	V	15.1	13.9	29.0	40.0	11.0	100.0	0.0
205.500	H	6.7	18.3	25.0	43.5	18.5	158.7	341.0
542.400	V	9.0	29.4	38.4	46.0	7.6	100.0	43.0
949.200	V	4.5	34.5	39.0	46.0	7.0	100.0	348.0
976.320	V	4.7	33.9	38.6	54.0	15.4	108.4	347.0

Table RE20.2: Emission summary

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

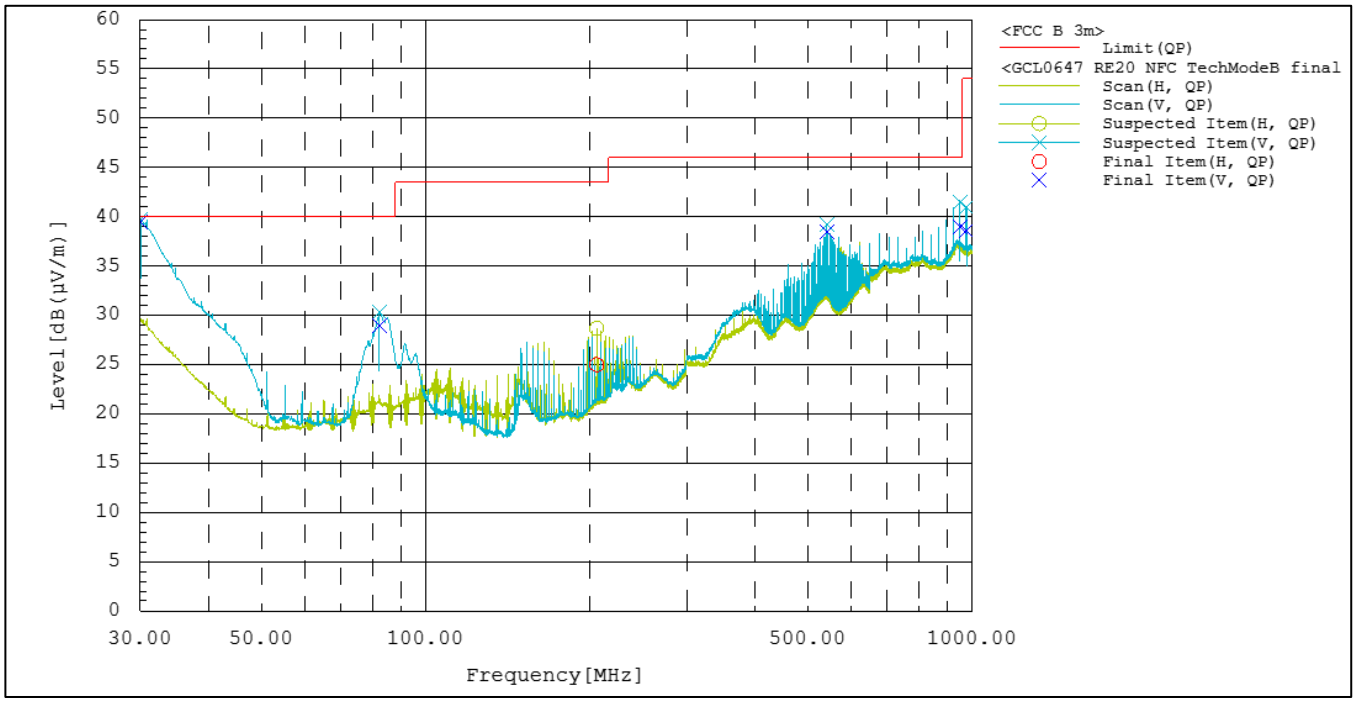


Figure RE20.1: Spectral data

Setup Photographs

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

Figure RE20.2: EUT test setup, first view

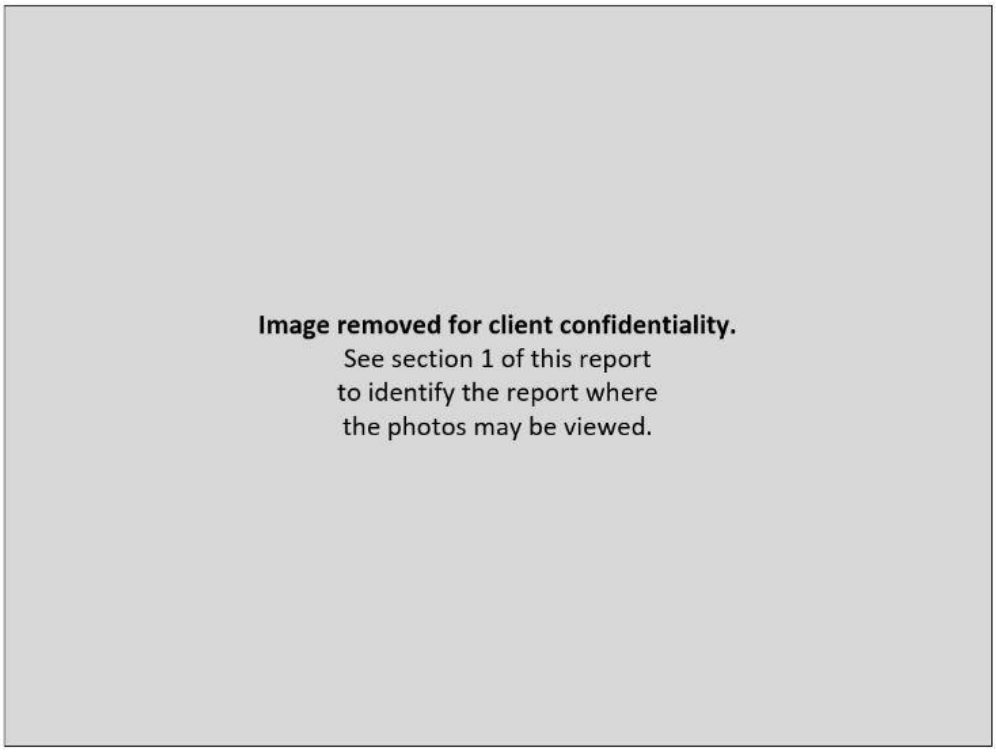


Figure RE20.3: EUT test setup, second view

This line is the end of the test record.

Test Record
Radiated Emission Test RE25
Project GCL0647

Test Date(s)	21 Nov 2024
Test Personnel	David Kerr, Jim Solum
Product Model	A04999
Serial Number tested	8ME000392
Operating Mode	M12 (NfcLnk) (Type B)
Arrangement	A6 (NFCu)
Input Power	Battery
Test Standards:	FCC Part 15.225; RSS-210; RSS-GEN; ANSI-C63.10 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 2 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	David A Kerr, Jim Solum
Date of this record:	21 Nov 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	24-Oct-2024	24-Oct-2025
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	259208	30-May-2024	30-May-2026
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	7-Mar-2023	7-Mar-2026
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
Preamplifier, 500 MHz 18 GHz	Com-Power	PAM-118A	18040133	Calibration	Not Required

Table RE25.1: Test Equipment Used

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

Test Data

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

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

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

Table RE25.2: Emission summary

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		
1121.500	V	32.5	50.0	-9.0	23.5	41.0	54.0	74.0	30.5	33.0	278.0	157.0
1130.000	V	33.3	54.7	-9.0	24.3	45.7	54.0	74.0	29.7	28.3	285.4	220.0
1143.000	V	33.4	55.8	-9.0	24.4	46.8	54.0	74.0	29.6	27.2	357.2	210.0
1329.000	V	34.1	49.7	-7.3	26.8	42.4	54.0	74.0	27.2	31.6	151.4	74.0
1437.250	H	42.5	49.7	-8.0	34.5	41.7	54.0	74.0	19.5	32.3	162.2	303.0
1966.250	H	34.6	47.0	-4.6	30.0	42.4	54.0	74.0	24.0	31.6	339.7	331.0

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

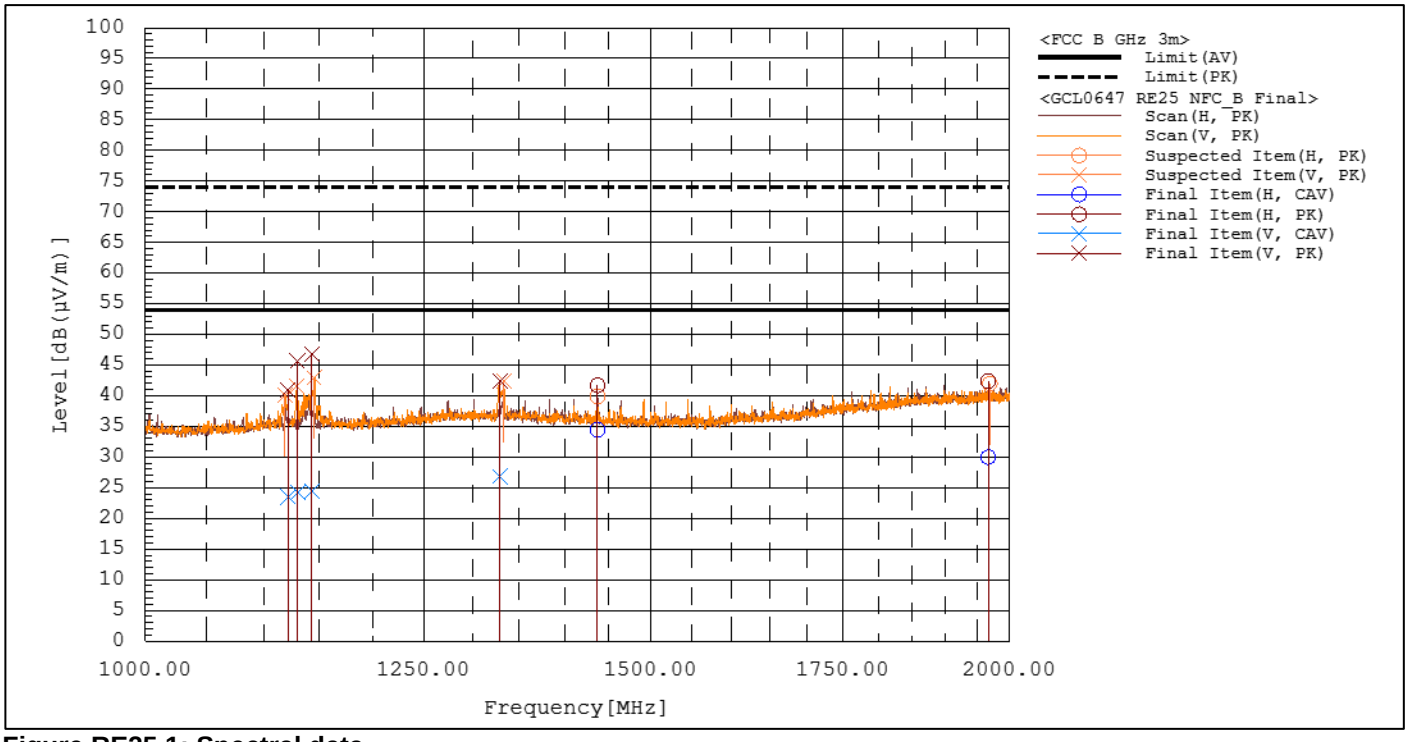


Figure RE25.1: Spectral data

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, first view (X orientation)

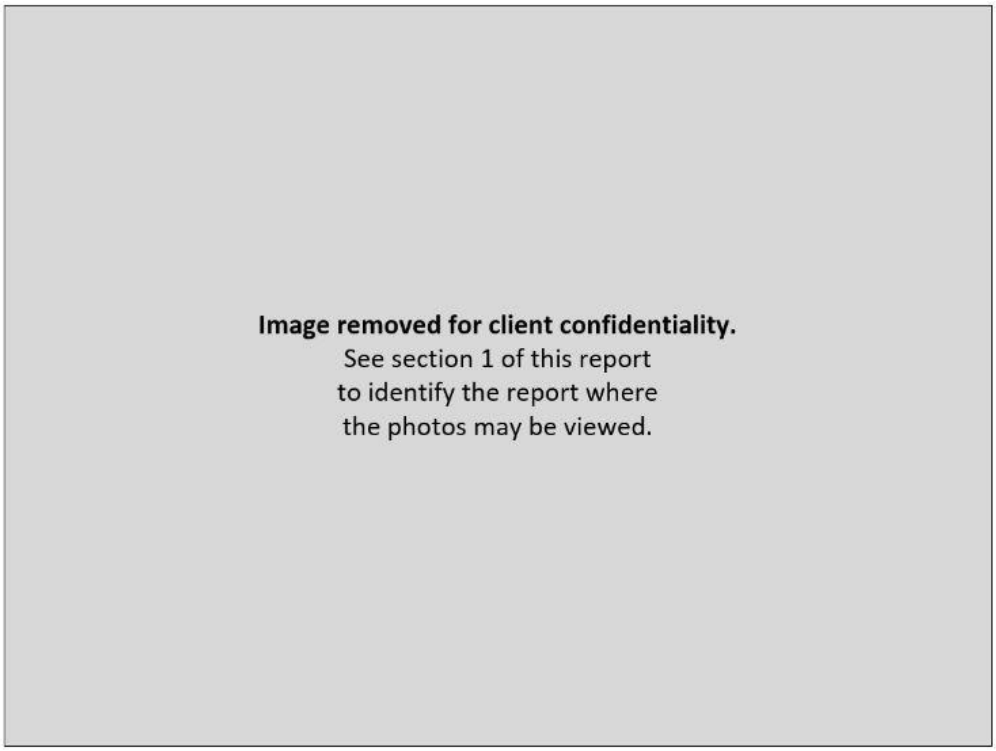


Figure RE25.3: EUT test setup, second view (X orientation)

This line is the end of the test record.

Test Record
Conducted Emissions Mains Test CE04
Project GCL0647

Test Date(s)	20 Nov 2024
Test Personnel	Andy Heier
Product Model	A04999
Serial Number tested	8ME000392
Operating Mode	M16 (NFCtag)
Arrangement	A2 (Upwr)
Input Power	120 Vac 60 Hz
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	150 kHz to 30 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	Andy Heier
Date of this record:	20 Nov 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44 GHz	Keysight	N9048B	MY62220139	21-Oct-2024	21-Oct-2025
LISN multiline; 20A 50uH	Com-Power	LIN-120C	20160005	3-Apr-2024	1-Apr-2027

Table CE04.1: Test Equipment Used

Software Used
Keysight PXE software A.33.03; CE Mains 150k to 30M Data Analysis V3 2024May23.xlsx

Test Data

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

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

Frequency	QP Limit	AV Limit	L1 QP	L2 QP	L1 AV	L2 AV	QP Margin	AV Margin
(kHz)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)
150	66.00	56.00	33.40	33.34	20.96	20.31	32.60	35.04
443	57.01	47.01	24.86	22.22	19.27	17.23	32.16	27.75
713	56.00	46.00	22.79	21.54	17.07	16.35	33.21	28.93
1140	56.00	46.00	22.79	21.34	16.84	15.93	33.21	29.16
7841	60.00	50.00	25.33	24.39	19.00	18.57	34.67	31.00
13560	60.00	50.00	24.67	23.30	19.21	17.87	35.33	30.79

Table CE04.2: Emission summary

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

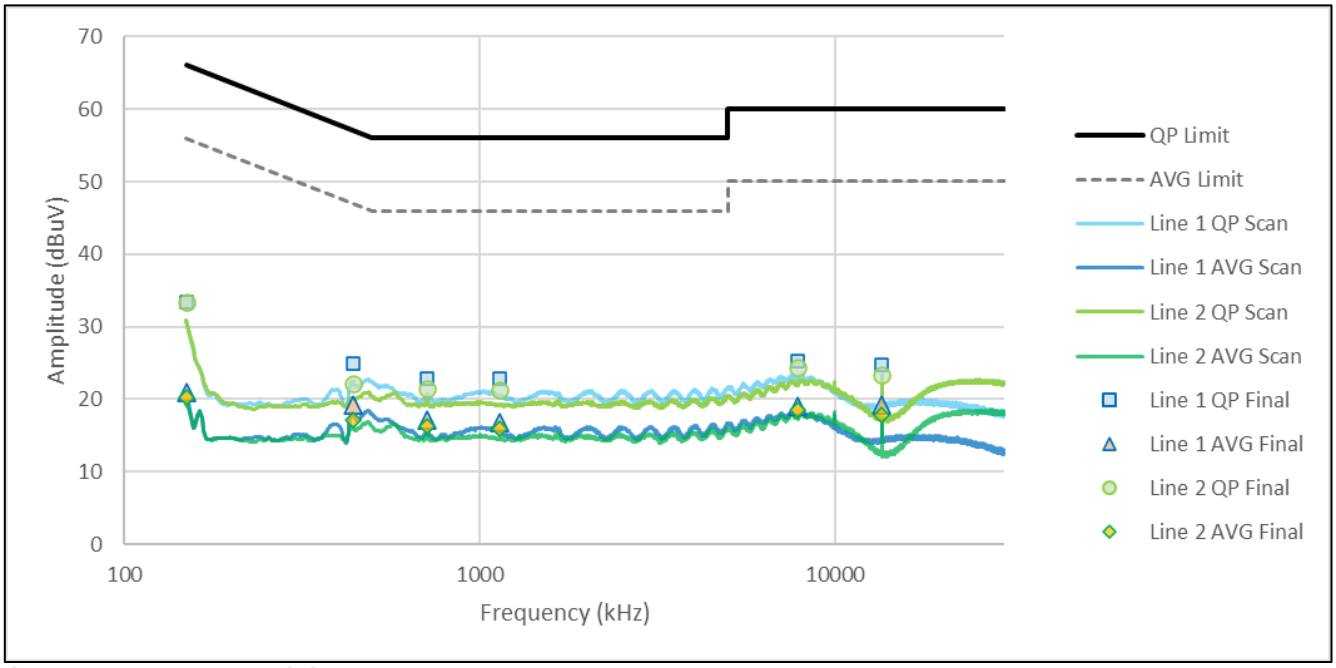


Figure CE04.1: Spectral data

Setup Photographs

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

Figure CE04.2: Test setup, first view

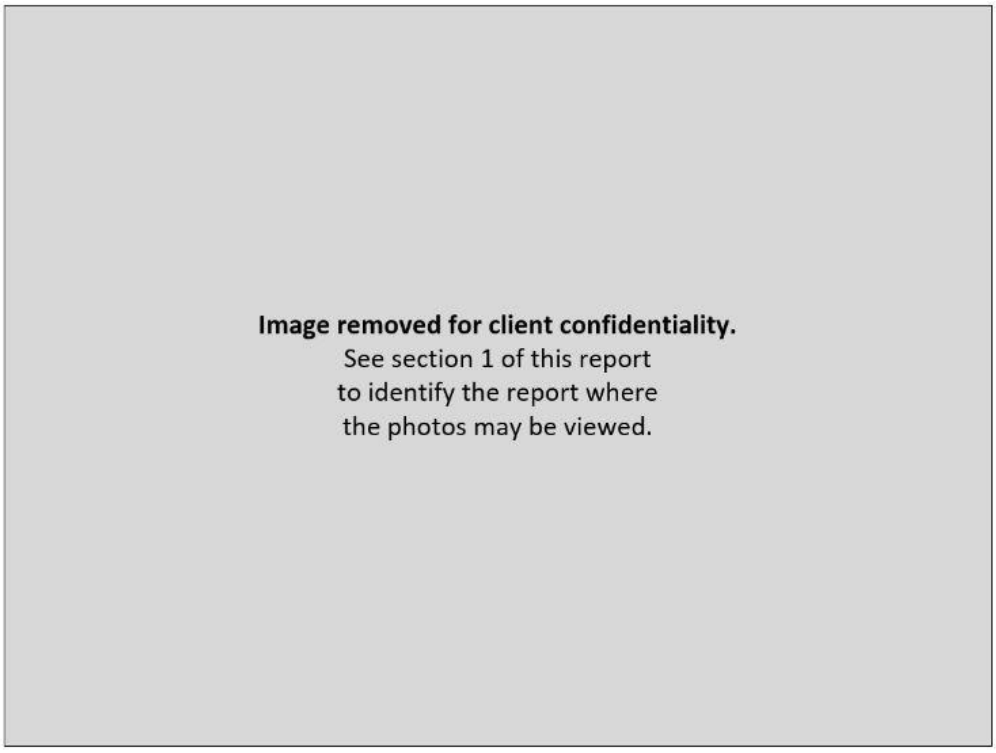


Figure CE04.3: Test setup, second view

This line is the end of the test record.

Test Record
Transmitter Stability in Extreme Conditions
Test IDs TR45
Project GCL0647

Test Date(s)	14, 15 Nov 2024
Test Personnel	Vladimir Tolstik supervised by Majid Farah
Product Model	A04999
Serial Number tested	8ME000392
Operating Mode	M16 (NfcTag)
Arrangement	A4 (Udc)
Nominal Input Power	USB 5 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-210 (as noted in Section 6 of the report)
Radio Protocol	NFC
Pass/Fail Judgment:	**PASS**
Test record created by:	Vladimir Tolstik
Date this record:	18 Nov 2024

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
MXE Receiver 8.4 GHz	Keysight	N9038B	MY63460112	28-Feb-2024	1-Mar-2025
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	27-Jun-2024	27-Jun-2025
Thermometer	Thermco	ACCD370P	210607316	21-Sep-2023	15-Sep-2025
Thermal Chamber	Tenney	T2RC	32774-02	Calibration	Not Required

Table TR45.1: List of test equipment used

Software Used: MXE Software Revision A.37.02

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 Standard indicated carrier frequency stability shall not exceed 0.01% of operation frequency. The frequency was required to remain between the limits of 13.558644 and 13.561356 MHz.

Test Data

The test sample(s) were subjected to extreme conditions and performed as shown below.

Yellow highlights indicate the maximum and minimum measured carrier frequency. The maximum frequency measured was 13,560,143 Hz and the minimum was 13,560,050 Hz. The margin to high side of limit is 1312 Hz and margin for low side of the limit is 1406 Hz.

			NFC carrier frequency (Hz)			
Tx Mode	Temp	Volts	Time interval (minutes)			
	˚C	Vdc	0	2	5	10
NFC	60	5	13,560,050	13,560,051	13,560,052	13,560,054
NFC	50	5	13,560,050	13,560,050	13,560,050	13,560,050
NFC	40	5	13,560,070	13,560,066	13,560,067	13,560,066
NFC	30	5	13,560,078	13,560,082	13,560,087	13,560,090
NFC	20	5	13,560,107	13,560,112	13,560,116	13,560,118
NFC	20	4.25	13,560,119	N/A	N/A	N/A
NFC	20	5.75	13,560,120	N/A	N/A	N/A
NFC	10	5	13,560,131	13,560,133	13,560,135	13,560,137
NFC	0	5	13,560,142	13,560,143	13,560,142	13,560,142
NFC	-10	5	13,560,133	13,560,133	13,560,130	13,560,129
NFC	-20	5	13,560,097	13,560,101	13,560,095	13,560,086

Table TR45.2: Frequency stability data for NFC transmission with temperature and voltage variations

Setup Block Diagram

The following block diagram shows the EUT configured and arranged in the manner in which it was measured.

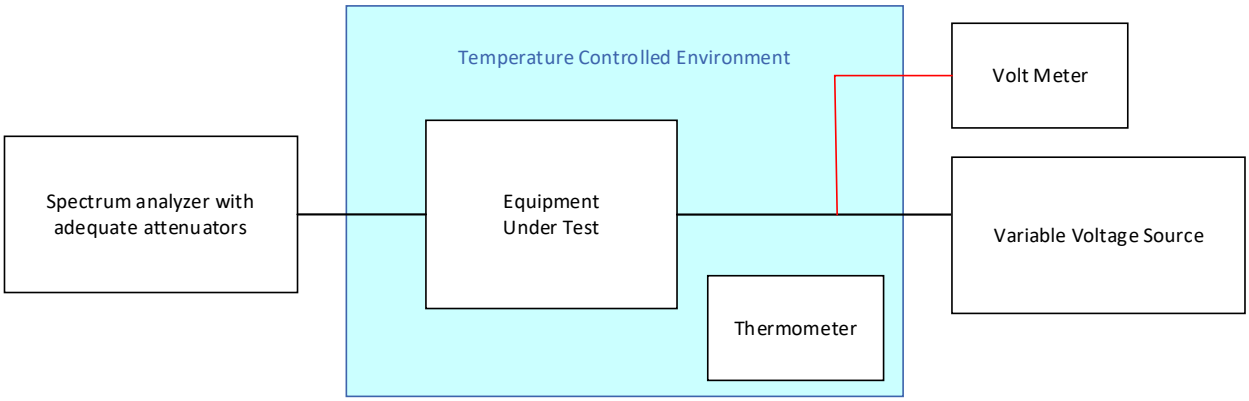


Figure TR45.1: Schematic drawing of the test equipment setup for NFC

This line is the end of the test record.

Test Record
Transmitter Bandwidth Tests
Test IDs TR13
Project GCL-0647

Test Date(s)	15 Nov 2024
Test Personnel	Majid Farah
Product Model	A04999
Serial Number tested	8ME000392
Operating Mode	M16 (NfcTag)
Arrangement	A4 (Udc)
Input Power	USB 5 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN (as noted in Section 6 of the report).
Radio Protocol	NFC
Radio Band	13.56 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	Majid Farah
Date of this record:	18 Nov 2024

Version A.

Test Equipment Used

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

Table TR13.1: List of test equipment used

Test Software Used: Keysight PXE firmware A.33.03

Background
There are regulatory requirements to present an additional type of bandwidth analysis: 99% Occupied Bandwidth. There are no limits or functional requirements around this 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.

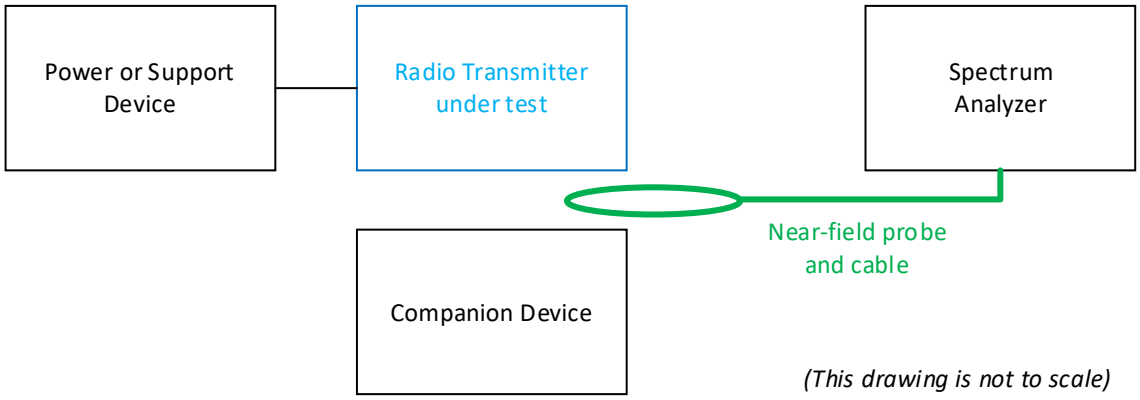


Figure TR13.1: Test setup

Occupied Bandwidth, 99% Test Method

During this test a small loop probe is placed between the transmitter and companion device (an NFC tag) because the test sample only transmits in response to a nearby companion device. This loop probe is then connected by a cable 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 with significant sweep so that the varied effects of modulation are appropriately assessed. Since the focus is on the relative distribution of energy across a range of frequencies, the absolute amplitudes recorded during this test are not relevant and may not include cable losses or attenuation factors.

Occupied Bandwidth, 99% Test Data

The measured 99% occupied bandwidth data is 3.4888 MHz shown by the spectral data.

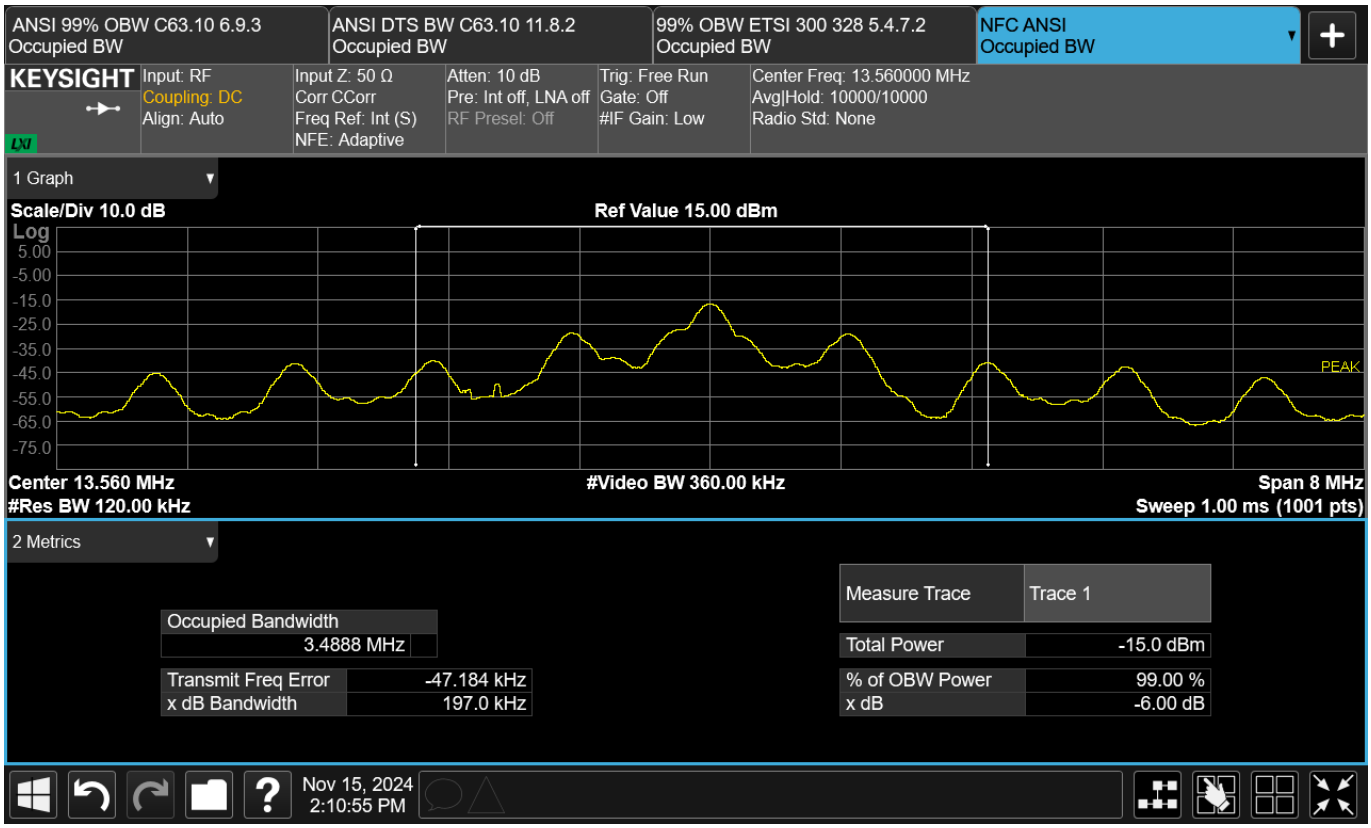


Figure TR13.1: Occupied bandwidth data

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.