Test Report 2024-154

Version A
Issued 7 Nov 2024

Project: GCL-0647
Model Identifier: A04999
Primary Test Standard(s):
CFR 47, FCC Part 15, Subpart B
ICES-003 Issue 7

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

Client-supplied Information

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

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 unintentional radiators. The results are as follows.

Parameter	Description	Key Performance Values [Performance Class]	Result	Data starts at page
Unintentional Radiated Emissions	Radio emissions that this device may generate via its structures and connected cables that are not necessary for its operation and that may affect radio communication [See for example FCC parts 15.109 and 15.209, ICES-003 at 3.2.2, CISPR 32 Annex A.]	3.2 dB of margin to the Class B limit. Tested 30 MHz to 12.5 GHz at a 3m test distance. Appropriate for use in homes, offices, and industrial facilities. [Class B]	PASS	14
Unintentional Conducted Emissions	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. [See for example FCC parts 15.107 and 15.207, ICES-003 at 3.2.1, CISPR 32 Annex A.]	19.3 dB of margin to the appropriate limit. Tested 150 kHz to 30 MHz. Appropriate for use in homes, offices, and industrial facilities. [Class B]	PASS	21

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 2024-0163. That report is treated as a part of this document by way of this reference.

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2. Test Background

2.1 The Test Lab

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

2.2 The Client

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

2.3 Other Information

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

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

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

3. Report History and Approval

This report was written by Andy Heier and initially issued on 7 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)

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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: 8ME000165
	Updated Group: None for this report

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	1.03

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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.

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5.4 EUT Arrangement

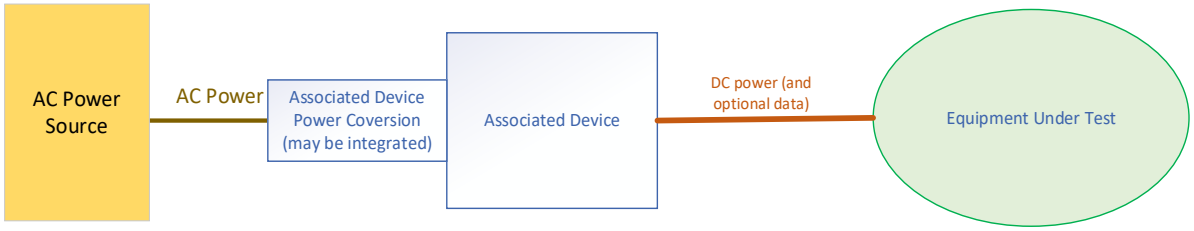
During test, the EUT components and associated support equipment were selected including the following arrangement sets.

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.

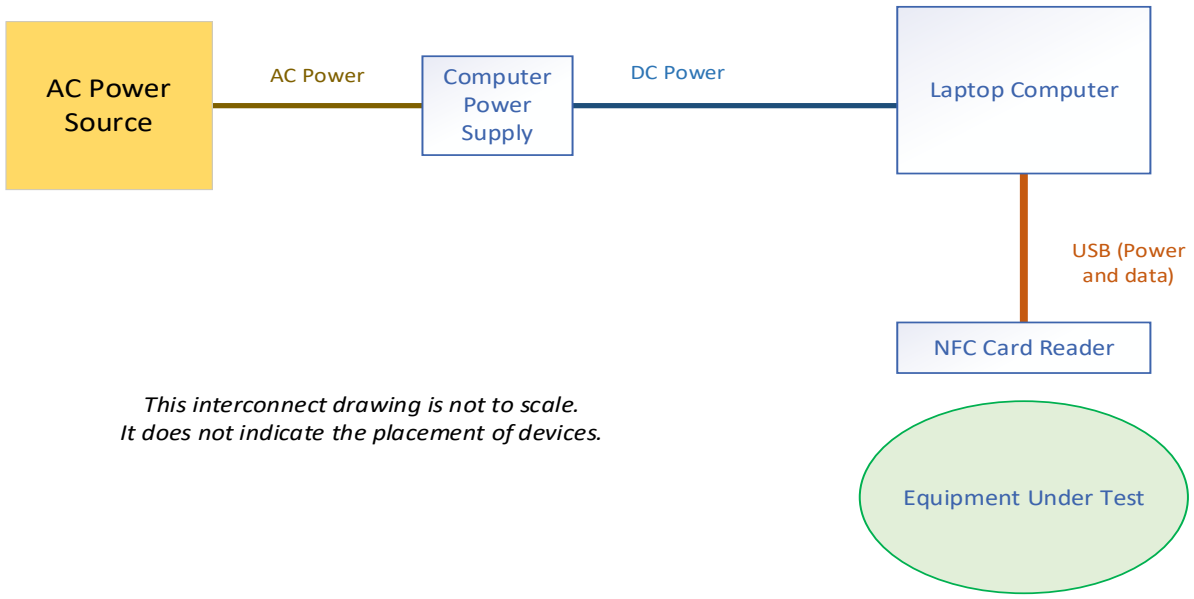
Arrangement 4: A4 (Udc). The test sample is attached to a Mains-powered device connected that provides dc power to the sample and may or may not provide user data. This arrangement is specified in the test plan to provide staff flexibility when the presence or absence of data on the cable is not pertinent.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

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

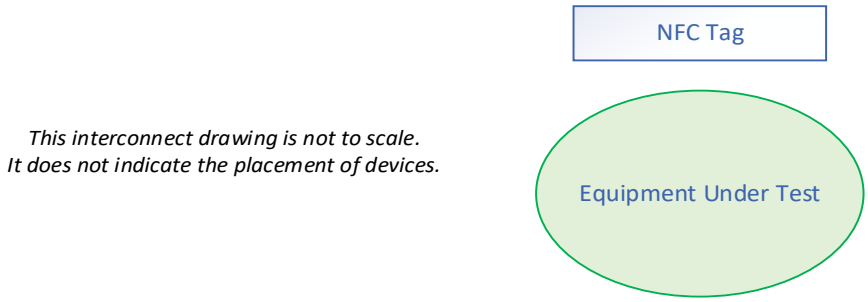

Figure 2: Block diagram of equipment arrangement A7

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

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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 B
ANSI C63.4: 2014
ICES-003 Issue 7

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.

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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.*

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8. Selected Example Calculations

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

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

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

8.1 AC Mains conducted emissions at 22 MHz

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

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

8.2 Radiated Emissions at 630 MHz

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

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

8.3 Radiated Emissions at 2.7 GHz

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

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

9. Environmental Conditions During Test

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

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

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

Table 4: Environmental monitoring device

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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.

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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.

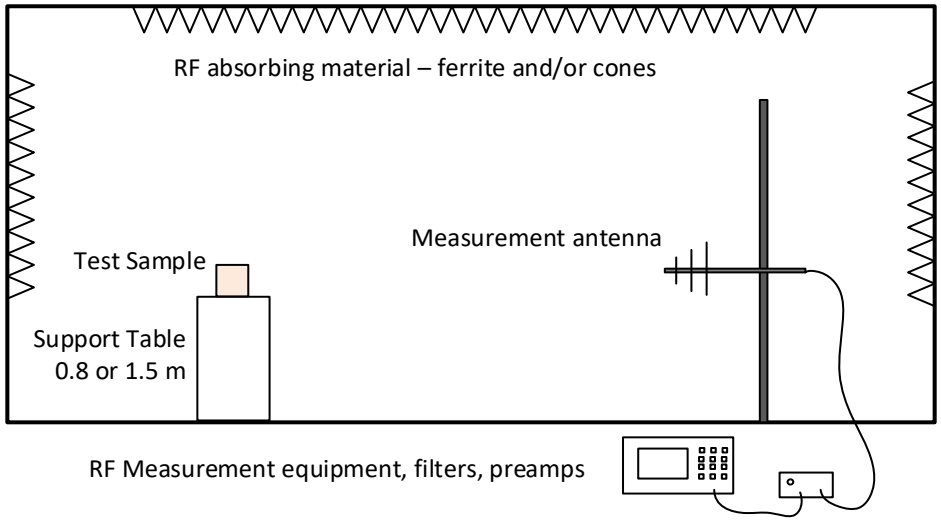

Figure 1: Typical configuration for measurements below 1 GHz

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.

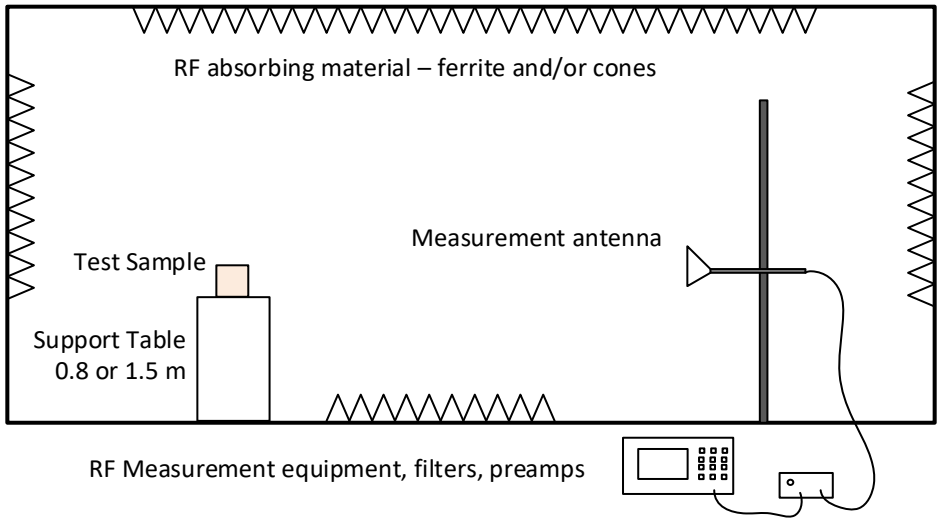

Figure 2: Typical configuration for measurements between 1 GHz and 14 GHz

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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.

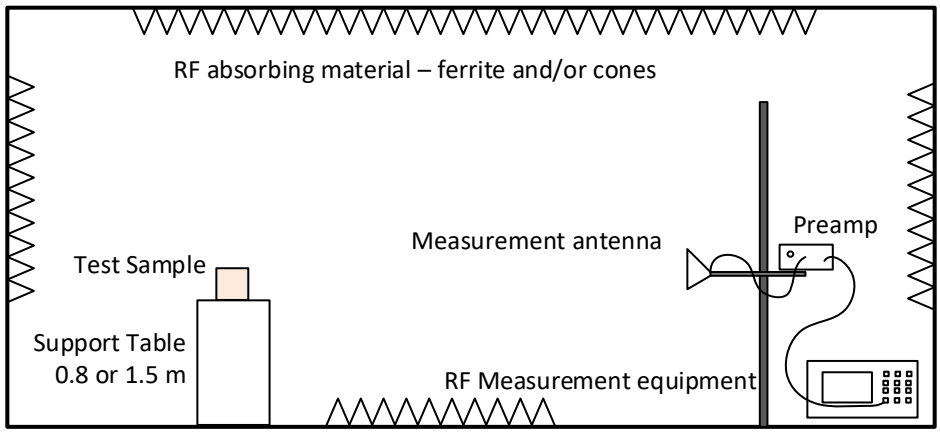

Figure 3: Typical configuration for measurements above 14 GHz

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.

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Test Record
Radiated Emission Test RE09
Project GCL0647

Test Date(s)	07 Oct 2024
Test Personnel	David Kerr
Product Model	A04999
Serial Number tested	8ME000165
Operating Mode	M13 (Gnss)
Arrangement	A3 (Udata)
Input Power	USB 5 Vdc
Test Standards:	FCC Part 15B; ICES 003; ANSI C63.4, CISPR 32; EN55032; AS/NZS CISPR 32 (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:	07 Oct 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	27-Sep-2023	2-Nov-2024
Antenna, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	233201	18-Jul-2024	18-Jul-2026
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	7-Nov-2022	7-Nov-2025
Tape measure, 1” x 33’	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
Vector Signal Generator	Rohde&Schwarz	SMBV100B	101011	14-Sep-2023	15-Sep-2025

Table RE09.1: Test Equipment Used

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

Test Data

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

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

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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 Composite FCC/CISPR Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

Frequency	Pol.	Reading	Factor	Level	Limit	Margin	Height	Angle
MHz		dB(μV)	dB(1/m)	dB(μV/m)	dB(μV/m)	dB	cm	deg
		QP		QP	QP	QP		
34.800	V	13.7	19.8	33.5	40.0	6.5	100.0	24.0
36.870	V	10.6	18.6	29.2	40.0	10.8	100.0	12.0
43.020	V	14.2	15.5	29.7	40.0	10.3	100.0	276.0
79.860	V	15.3	13.9	29.2	40.0	10.8	108.3	324.0
121.500	H	21.9	14.9	36.8	40.0	3.2	158.7	193.0
299.820	H	4.0	20.8	24.8	46.0	21.2	106.3	297.0

Table RE09.2: Emission summary

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

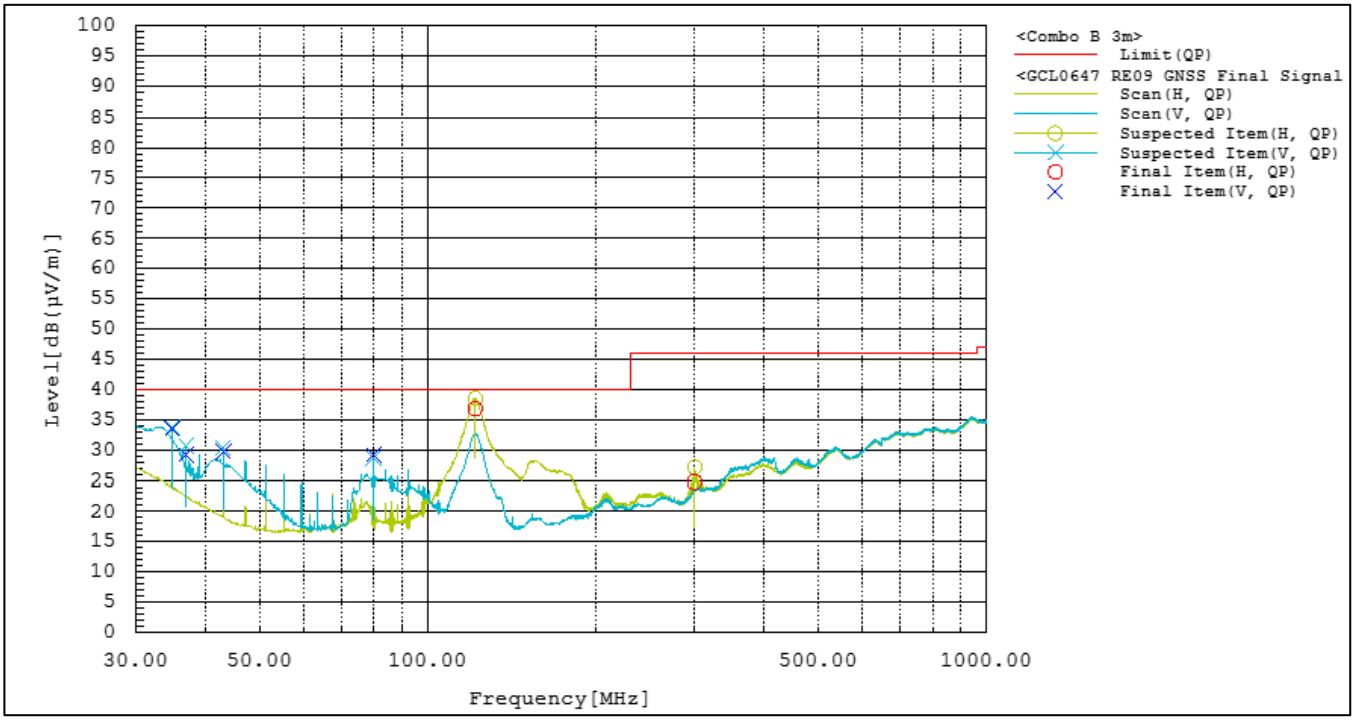

Figure RE09.1: Spectral data

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Setup Photographs

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

Figure RE09.2: EUT test setup, first view

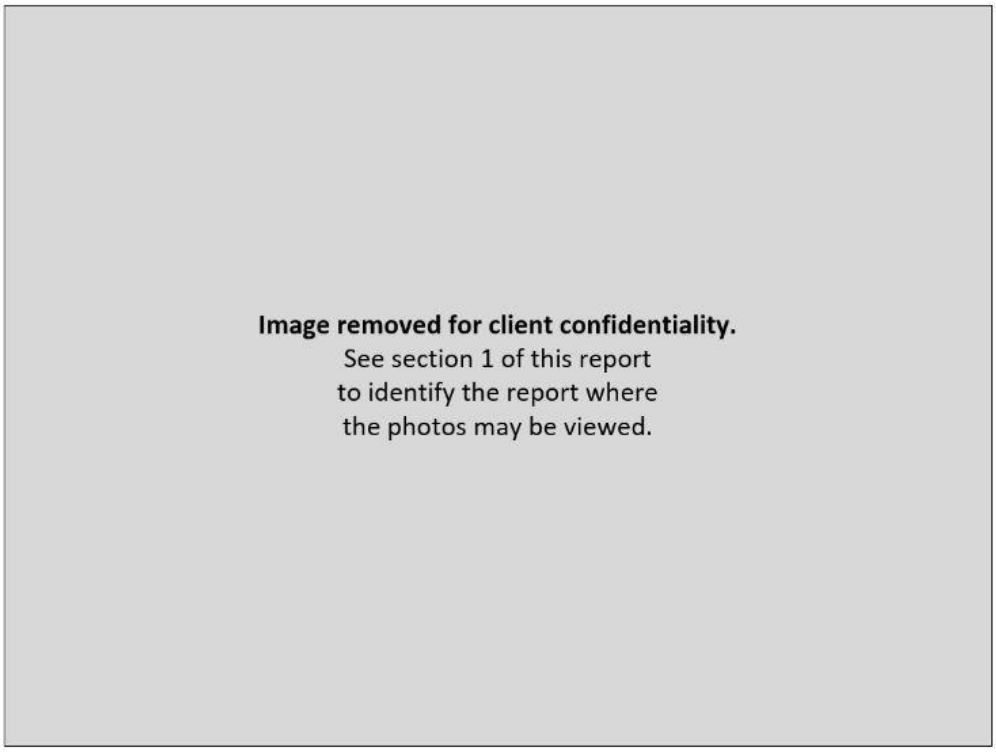

Figure RE09.3: EUT test setup, second view

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Test Record
Radiated Emission Test RE10
Project GCL0647

Test Date(s)	18 Sep 2024
Test Personnel	David Kerr, Jim Solum, Vladimir Tolstik
Product Model	A04999
Serial Number tested	8ME000165
Operating Mode	M13 (Gnss)
Arrangement	A3 (Udata)
Input Power	USB 5 Vdc
Test Standards:	FCC Part 15B, ICES 003, ANSI C63.4, CISPR 32, EN55032, AS/NZS CISPR 32 (as noted in Section 6 of the report).
Frequency Range:	1 GHz to 12.5 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	David A Kerr
Date of this record:	18 Sep 2024

Original record, Version A

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	27-Sep-2023	1-Oct-2024
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	259208	30-May-2024	30-May-2026
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	16-Nov-2022	16-Nov-2025
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
Preamplifier, 500 MHz 18 GHz	Com-Power	PAM-118A	18040133	Calibration	Not Required
Vector Signal Generator	Rohde&Schwarz	SMBV100B	103450	12-Jun-2024	12-Jun-2026

Table RE10.1: Test Equipment Used

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

Test Data

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

In the 1 GHz to 12.5 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

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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 12.5 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 Composite FCC/CISPR Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(µV)		dB(1/m)	dB(µV/m)		dB(µV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
1330.750	V	35.2	55.9	-7.3	27.9	48.6	50.0	70.0	22.1	21.4	274.6	180.0
1596.750	V	35.5	52.9	-8.3	27.2	44.6	50.0	70.0	22.8	25.4	247.4	194.0
2132.000	V	33.7	60.2	-4.8	28.9	55.4	50.0	70.0	21.1	14.6	189.3	221.0
2391.750	V	34.8	55.1	-4.2	30.6	50.9	50.0	70.0	19.4	19.1	387.2	152.0
2659.750	V	35.7	65.3	-3.9	31.8	61.4	50.0	70.0	18.2	8.6	300.6	178.0
3199.750	V	35.8	55.8	-2.8	33.0	53.0	54.0	74.0	21.0	21.0	179.9	205.0
4248.000	V	31.5	49.8	-1.4	30.1	48.4	54.0	74.0	23.9	25.6	150.2	189.0
4782.500	V	33.1	48.2	0.5	33.6	48.7	54.0	74.0	20.4	25.3	285.9	145.0
6386.000	V	30.5	48.6	4.1	34.6	52.7	54.0	74.0	19.4	21.3	238.7	177.0

Table RE10.2: Emission summary

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

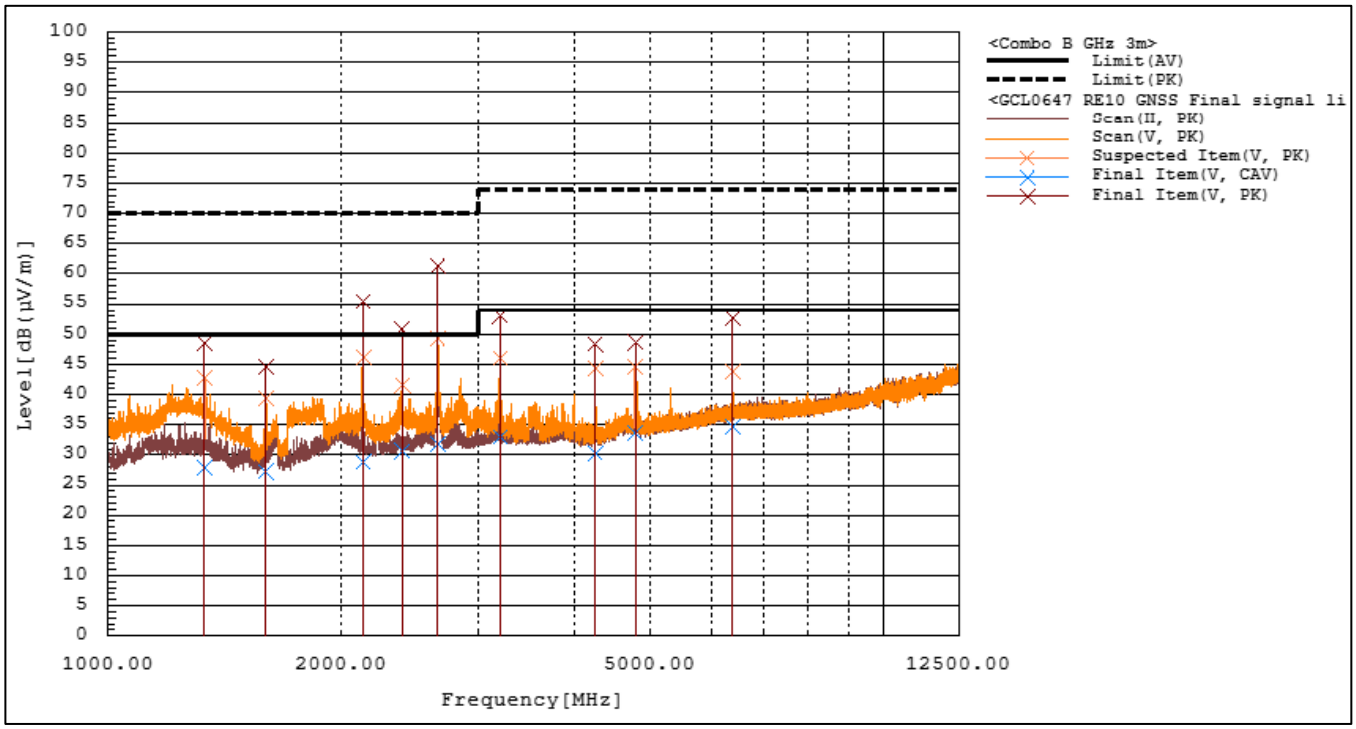

Figure RE10.1: Spectral data

Setup Photographs

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

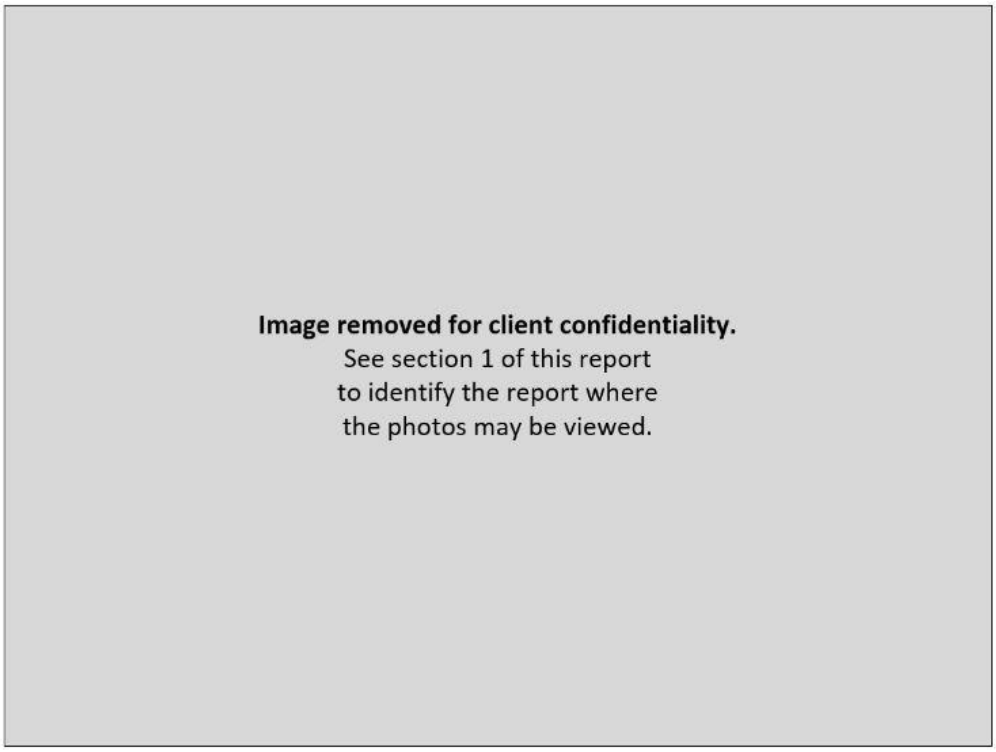

Figure RE10.2: EUT test setup, first view

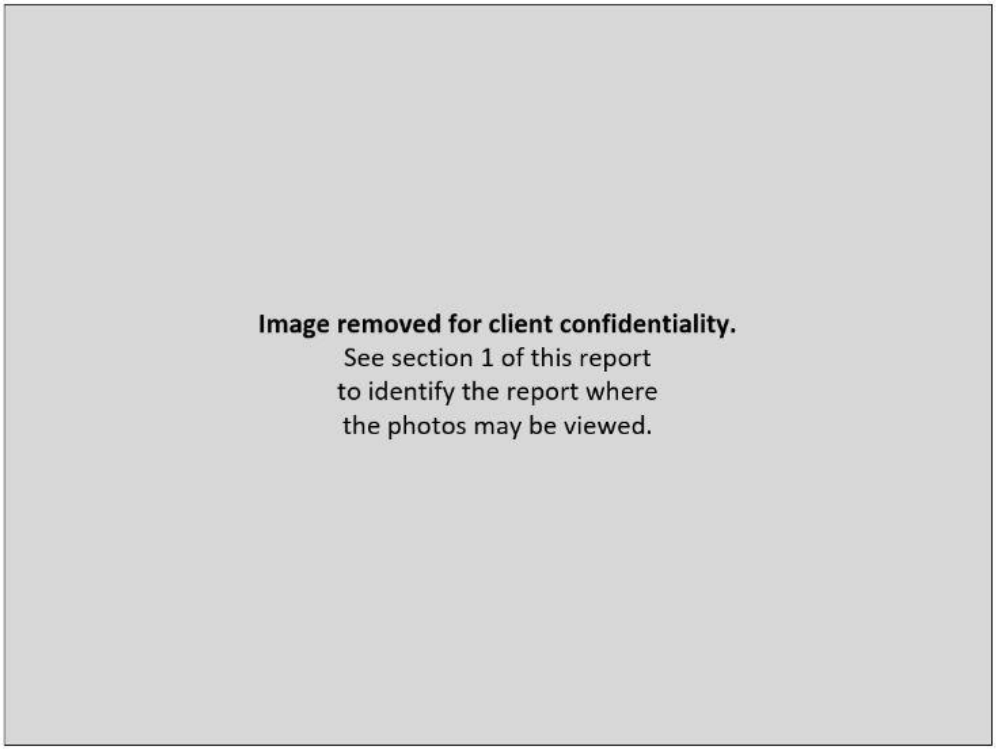

Figure RE10.3: EUT test setup, second view

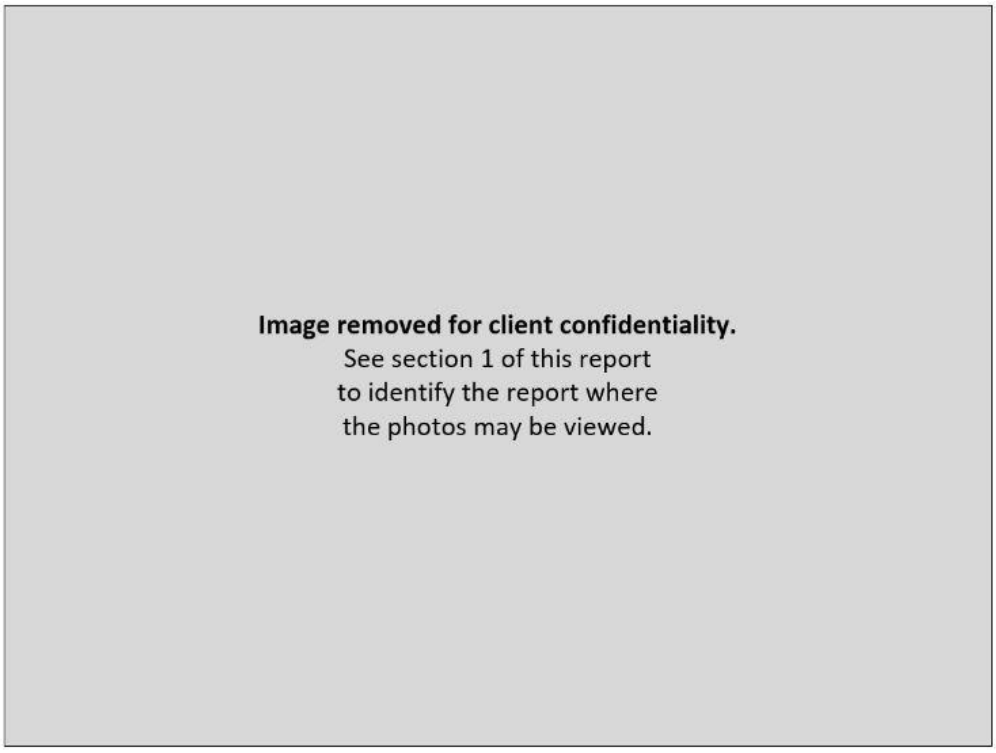

Figure RE10.3: EUT test setup, (EUT X orientation)

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Test Record
Conducted Emissions Mains Test CE05
Project GCL0647

Test Date(s)	17 Sep 2024
Test Personnel	David Kerr
Product Model	A04999
Serial Number tested	8ME000165
Operating Mode	M13 (Gnss)
Arrangement	A2 (Upwr)
Input Power	120 Vac 60 Hz
Test Standards:	FCC Part 15B, ICES 003, ANSI C63.4 (as noted in Section 6 of the report).
Frequency Range:	150 kHz to 30 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	David A Kerr
Date of this record:	17 Sep 2024

Original record, Version A.

Test Equipment

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

Table CE05.1: Test Equipment Used

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

Test Data

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

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

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Frequency	QP Limit	AV Limit	L1 QP	L2 QP	L1 AV	L2 AV	QP Margin	AV Margin
(kHz)	(dBµV)	(dBµV)	(dBµV)	(dBµV)	(dBµV)	(dBµV)	(dB)	(dB)
166	65.17	55.17	28.68	28.84	23.58	23.89	36.33	31.28
353	58.90	48.90	28.06	27.98	23.60	23.43	30.85	25.30
713	56.00	46.00	29.79	29.89	26.68	26.68	26.11	19.32
740	56.00	46.00	27.53	27.59	22.95	23.03	28.41	22.97
1426	56.00	46.00	27.51	27.45	23.00	22.86	28.49	23.00
1496	56.00	46.00	27.03	27.11	21.95	22.00	28.89	24.00
2137	56.00	46.00	26.70	26.69	21.94	21.85	29.30	24.06
2924	56.00	46.00	26.75	26.68	21.65	21.58	29.25	24.35

Table CE05.1: Emission summary

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

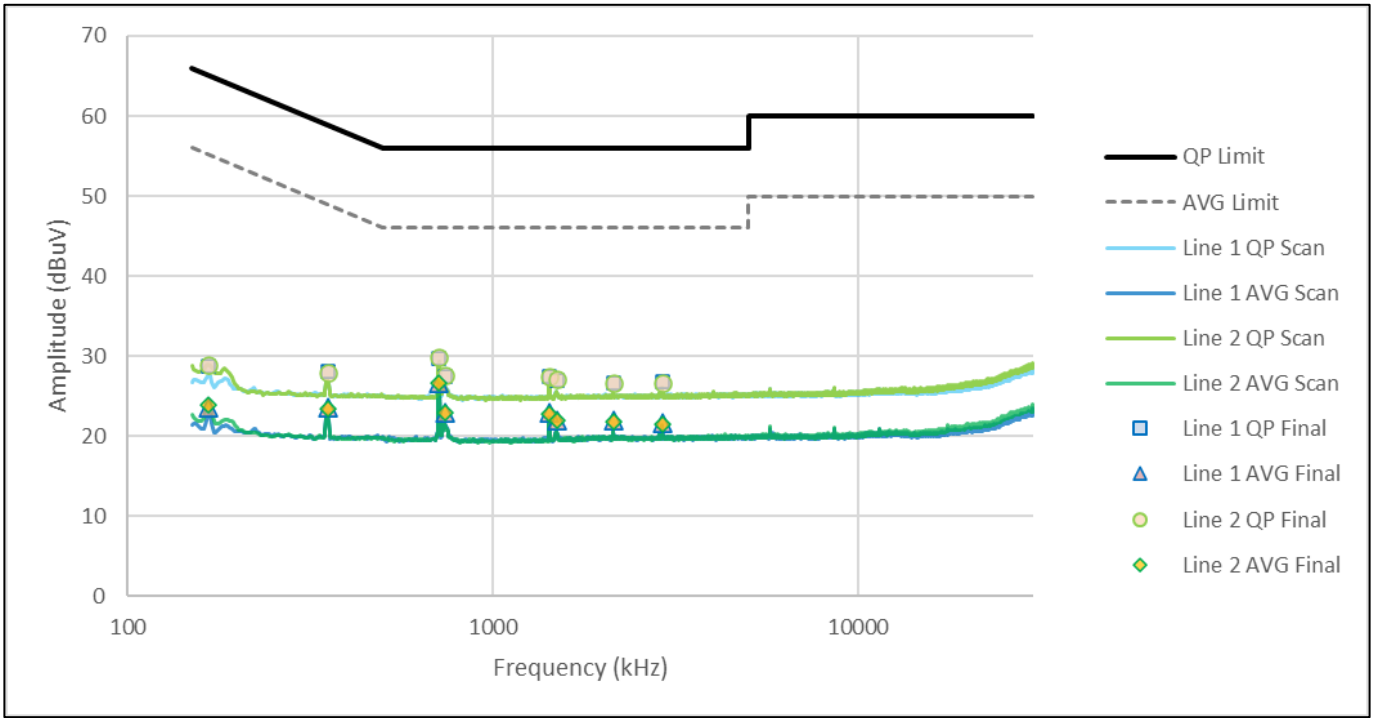

Figure CE05.1: Spectral data

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Setup Photographs

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

Figure CE05.2: Test setup, first view

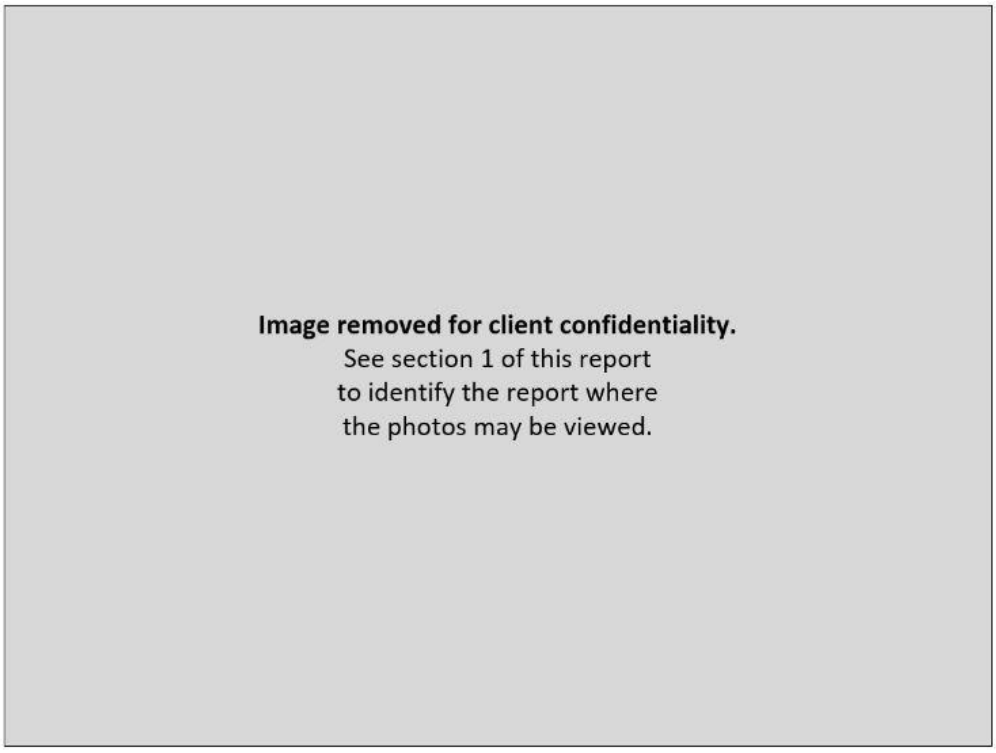

Figure CE05.3: Test setup, second view

This line is the end of the test record.

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Concluding Notes

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