GARMIN
Garmin International, Inc.
1200 East 151st Street
Olathe, Kansas 66062
P: 913-397-8200 F: 913-397-8282

27-Feb-26

Manufacturer: Garmin International, Inc.
Address: 1200 E. 151st St.
Olathe, KS 66062-3426
U.S.A.
Chile Representative: Matías Rodríguez Correa
Rosario Norte 660 piso 24, Las Condes Santiago
Province CP 7550083, Chile
Contact Email: matias.rodriguez@garmin.com

Subject: SUBTEL, Chile (Resolution 737) Certification Compliance 2026

Commercial Name: Instinct 3, 50mm, Solar

	Información (Information)
Tipo de equipo (Equipment type)	Portable Digital Transceiver
Marca (Brand)	Garmin GARMIN.
Modelo (Model)	A04883
Tecnología o modulación (Technology or modulation)	ASK for NFC / GFSK for ANT / GFSK for BLE
Frecuencias (Frequencies)	13.56 MHz / 2402-2480 MHz / 2402-2480 MHz
Ganancia de antena (dBi) (Antenna gain (dBi)	ANT –2.30 dBi / BLE –2.30 dBi
P.i.r.e. (E.I R P.)	-34.40 dBm, 0.00 mW /1.03 dBm, 1.26 mW / 1.03 dBm, 1.26 mW
Módulos (Modules)	NFC, ANT, BLE

As all measurements for NFC are made in radiated mode to comply with the field strength limits, gain information is not required to be noted in the reports or any additional documentation.

Declaration of Conformity Statement: the equipment previously identified complies with the provisions established in the Technical Standard for Small Range Equipment, approved by Exempt Resolution No.1,985 of 2017, of the Undersecretary of Telecommunications.

Declaración de conformidad: El equipo anteriormente identificado cumple con las disposiciones establecidas en la Norma Técnica para Equipos de Corto Alcance, aprobada mediante la Resolución Exenta N° 1.985 de 2017, de la Subsecretaría de Telecomunicaciones.

TEST REPORT

Report Number: R15444895-E1

Applicant	:	Garmin International Inc 1200 E 151st St Olathe, Kansas 66062-3426, United States
Model	:	A04883
FCC ID	:	IPH-04883
IC	:	1792A-04883
EUT Description	:	Device
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C: 2024 ISED RSS-247 ISSUE 3: 2023 ISED RSS-GEN ISSUE 5 + A1 + A2: 2021 ISED RSS-210 ISSUE 11:2024

Date Of Issue:
2024-08-30

Prepared by:
UL LLC
12 Laboratory Dr.
Research Triangle Park, NC 27709 U.S.A.
TEL: (919) 549-1400

CERT #0751.06

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2024-08-30	Initial Issue	Chandler Stanley

UL LLC
12 Laboratory Dr., RTP, NC 27709, U.S.A. TEL:(919) 549-1400

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UL LLC
12 Laboratory Dr., RTP, NC 27709, U.S.A. TEL:(919) 549-1400

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Garmin International Inc
1200 E 151st St
Olathe, Kansas 66062-3426, United States

EUT DESCRIPTION: Device

MODEL: A04883

SERIAL NUMBER: 477207590

SAMPLE RECEIPT DATE: 2024-08-13

DATE TESTED: 2024-08-13 to 2024-08-16

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C: 2024	Refer to Section 2
ISED RSS-247 Issue 3: 2023	Refer to Section 2
ISED RSS-GEN Issue 5 + A1 + A2: 2021	Refer to Section 2
ISED RSS-210 Issue 11:2024	Refer to Section 2

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document.

Approved & Released For
UL LLC By:

Brian Kiewra
Project Engineer
Consumer, Medical and IT Segment
UL LLC

Prepared By:

Chandler Stanley
Engineer
Consumer, Medical and IT Segment
UL LLC

2. TEST RESULTS SUMMARY

This report contains data provided by the customer which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.
Below is a list of the data provided by the customer:

1. Antenna gain and type (see section 6.3)

BLE				
FCC Clause	**ISED Clause**	**Requirement**	**Result**	**Comment**
See Comment		Duty Cycle	Reporting purposes only	ANSI C63.10 Section 11.6.
-	RSS-GEN 6.7	99% OBW	Not Performed	ANSI C63.10 Section 6.9.3.
15.247 (a) (2)	RSS-247 5.2 (a)	6dB BW		None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power		
See Comment		Average power		Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (e)	RSS-247 5.2 (b)	PSD		None.
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions		
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Complies	
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Not Performed	
ANT/ANT+				
FCC Clause	**ISED Clause**	**Requirement**	**Result**	**Comment**
15.249 (a)	RSS-210 B.10 (a)	Fundamental/harmonic measurements	Not Performed	None.
15.249 (d)	RSS-210 B.10 (b)	Radiated Emissions	See Comment	Band Edge is Compliant.

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2020, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, RSS-GEN Issue 5 + A1 + A2, RSS-210 Issue 11, and RSS-247 Issue 3.

4. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, certification # 0751.06, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
☐	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
☒	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A		27265	

5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	U_{Lab}
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	6.01 dB
Conducted Emissions (0.150-30MHz) - LISN	3.40 dB
Temperature	0.57°C
Humidity	3.39%
DC Supply voltages	1.70%

Uncertainty figures are valid to a confidence level of 95%.

5.4. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:
Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a device that contains a BLE and ANT/ANT+ radio and a GNSS receiver. This report covers the full radiated emissions testing of the BLE and ANT/ANT+ radios with the exception for ranges above 1GHz for ANT/ANT+.

6.2. MAXIMUM OUTPUT POWER

Not Performed.

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer' are as follows:

The radio utilizes a Stamped metal antenna, with a maximum gain of -2.3 dBi.

6.4. SOFTWARE AND FIRMWARE

Software Version: 408

6.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz and above 18GHz were performed with the EUT set to transmit at the channel and mode that had the highest recorded power and PSD as the worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit on low and high channels, as well as middle channel for radiated spurious emissions. Band edge and radiated spurious emissions were performed on the worst-case power and PSD mode. For BLE, band edge was also tested at 2Mbps since this has the widest bandwidth.

ANT/ANT+ was tested at its only data-rate. ANT/ANT+ was only tested below 1GHz for spurious emissions, while full radiated testing was performed for BLE.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that Z orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Z orientation.

6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
AC Adaptor	Sony	XQZ-UC11-010-236-21	32223W09205418	NA

I/O CABLES

I/O Cable List						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	Propriety	1	Propriety	Shielded	<3m	Charges to USB C

TEST SETUP

For testing, the EUT was programmed to transmit at the desired frequencies and power settings. The EUT was connected to AC Line via a charging cable as worst-case.

SETUP DIAGRAMS

Please refer to 15444895-EP1 for setup diagrams

7. MEASUREMENT METHOD

On Time and Duty Cycle: ANSI C63.10, Section 11.6 : Zero-Span Spectrum Analyzer Method.

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1, and 6.10.5

General radiated emissions: ANSI C63.10 Subclause - 6.3-6.6

8. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville – Chamber 1)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
0.009-30MHz					
135144	Active Loop Antenna	ETS-Lindgren	6502	2024-01-24	2025-01-24
30-1000 MHz					
90629	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2024-01-30	2026-01-30
1-18 GHz					
135143	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2024-02-07	2026-02-07
18-40 GHz					
204704	Horn Antenna, 18-26.5GHz	Com-Power	AH-826	2023-07-20	2025-07-20
Gain-Loss Chains					
91974	Gain-loss string: 0.009-30MHz	Various	Various	2024-05-08	2025-05-08
91976	Gain-loss string: 25-1000MHz	Various	Various	2024-05-08	2025-05-08
91979	Gain-loss string: 1-18GHz	Various	Various	2024-05-08	2025-05-08
135999	Gain-loss string: 18-40GHz	Various	Various	2024-05-08	2025-05-08
Receiver & Software					
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2024-03-05	2025-03-05
81018	Spectrum Analyzer	Agilent	E4446A	2024-07-31	2025-07-31
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
Additional Equipment used					
241205	Environmental Meter	Fisher Scientific	15-077-963	2023-09-05	2025-09-05

9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

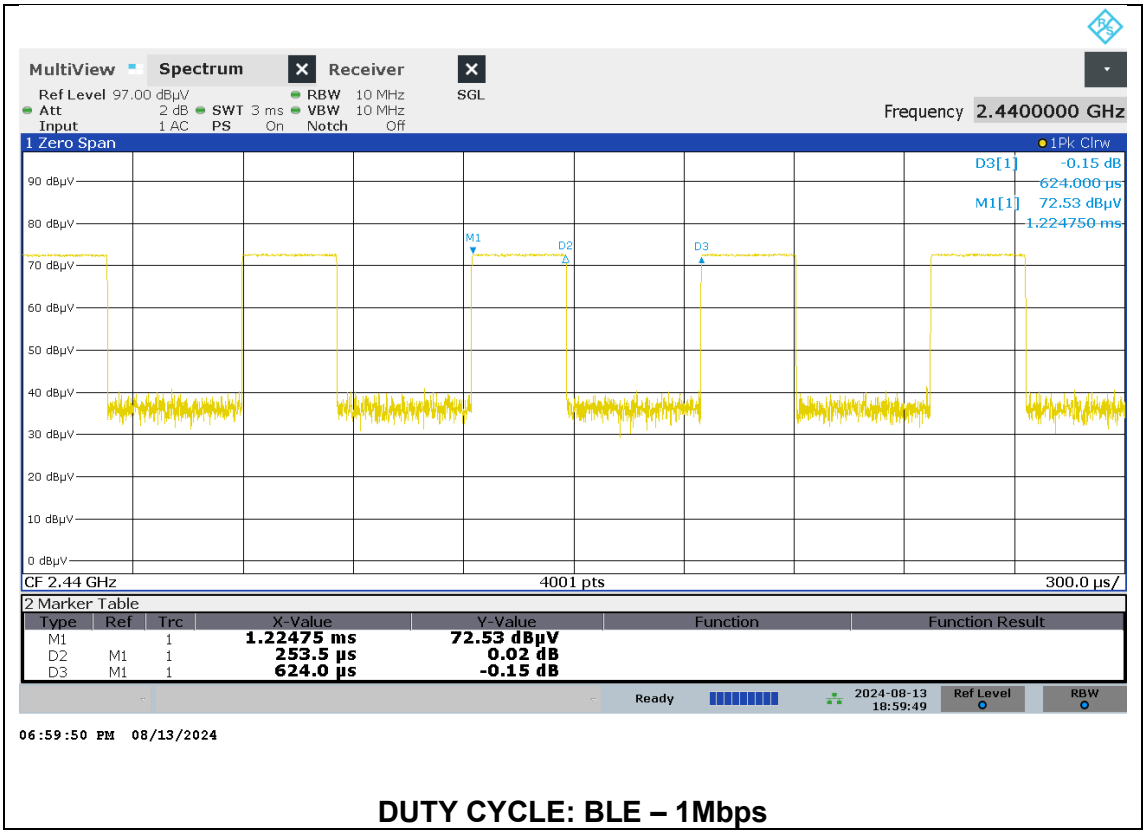
PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

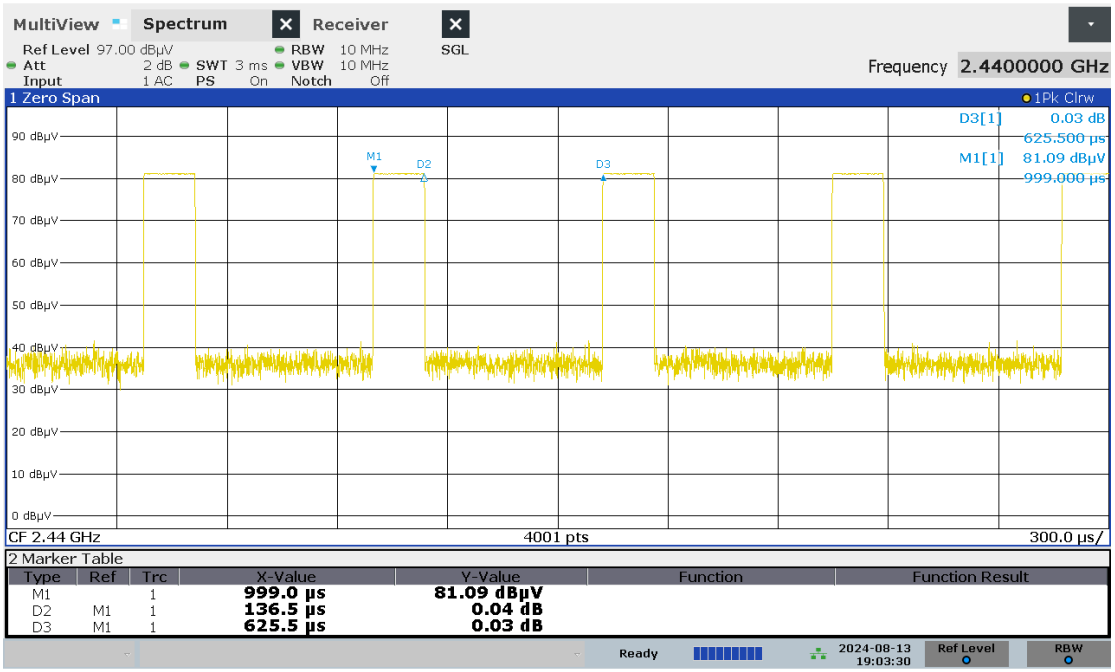
ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
2.4GHz Band						
BLE - 1 Mbps	0.254	0.624	0.406	40.63	7.82	3.945
BLE - 2 Mbps	0.137	0.626	0.218	21.82	13.22	7.326
ANT/ANT+	2.100	2.226	0.943	94.34	0.51	0.476

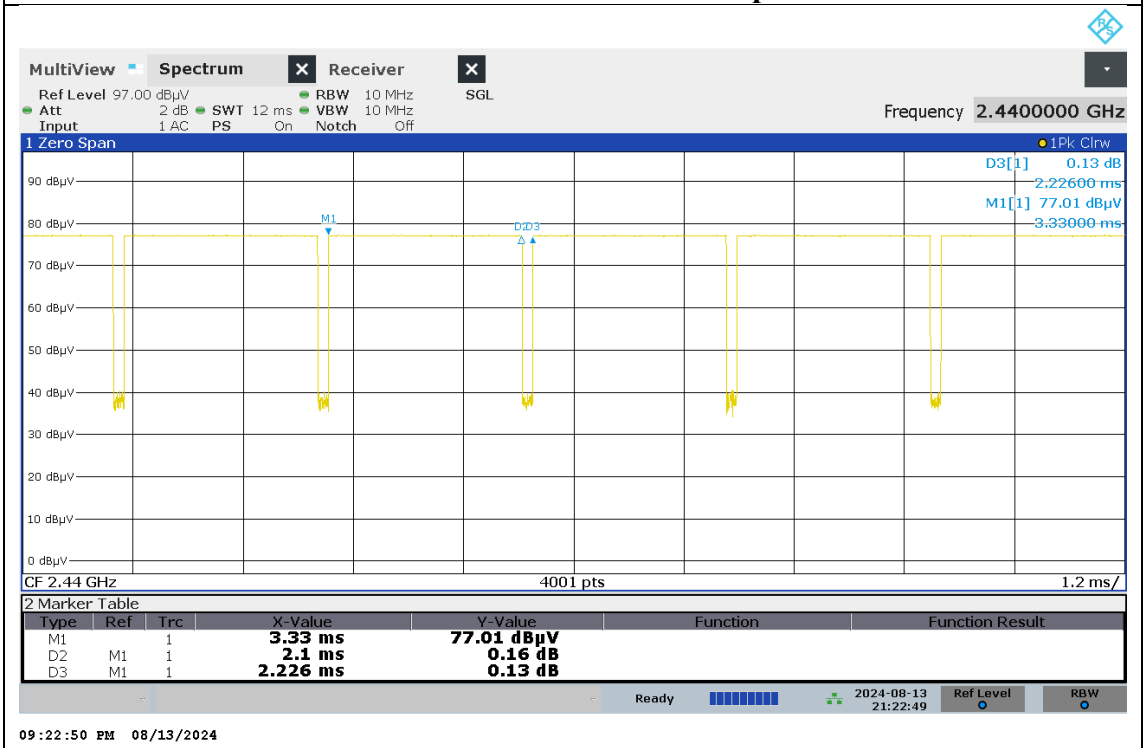
DUTY CYCLE PLOTS
Tested By: 11993 and 85501



DUTY CYCLE: BLE – 1Mbps



DUTY CYCLE: BLE – 2Mbps



DUTY CYCLE: ANT/ANT+

10. RADIATED TEST RESULTS

10.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209
RSS-GEN, Section 8.9 and 8.10.

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
0.009-0.490	2400/F(kHz) @ 300 m	-
0.490-1.705	24000/F(kHz) @ 30 m	-
1.705 - 30	30 @ 30m	-
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

RSS-GEN, Section 8.9 and 8.10.

Frequency Range (MHz)	Field Strength Limit (uA/m) at 3 m	Field Strength Limit (dBuA/m) at 3 m
0.009-0.490	6.37/F(kHz) @ 300 m	-
0.490-1.705	63.7/F(kHz) @ 30 m	-
1.705 - 30	0.08 @ 30m	-

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements in the 30-1000MHz range, 9kHz for peak and/or quasi-peak detection measurements in the 0.15-30MHz range and 200Hz for peak and/or quasi-peak detection measurements in the 9 to 150kHz range. Peak detection is used unless otherwise noted as quasi-peak or average (9-90kHz and 110-490kHz).

For pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements. Linear Voltage Averaging was used.

The spectrum from 1 GHz to 18 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band. Below 1GHz and above 18GHz emissions, the channel with the highest power spectral density was tested.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

3D antenna use - For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel).

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

KDB 414788 Open Field Site (OFS) and Chamber Correlation Justification

OFS and chamber correlation testing had been performed and chamber measured test result is the worst-case test result.

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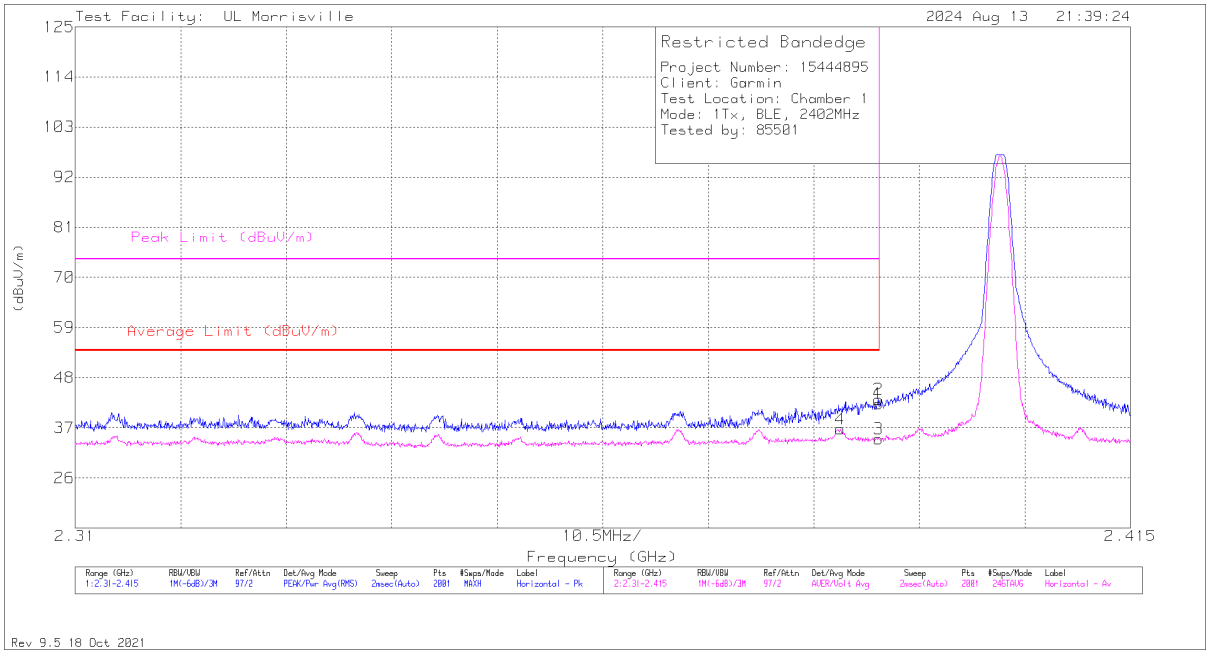
12 Laboratory Dr., RTP, NC 27709, U.S.A. TEL:(919) 549-1400

10.2. TRANSMITTER ABOVE 1 GHz

10.2.1. BLE (1Mbps)

BANDEDGE (LOW CHANNEL)

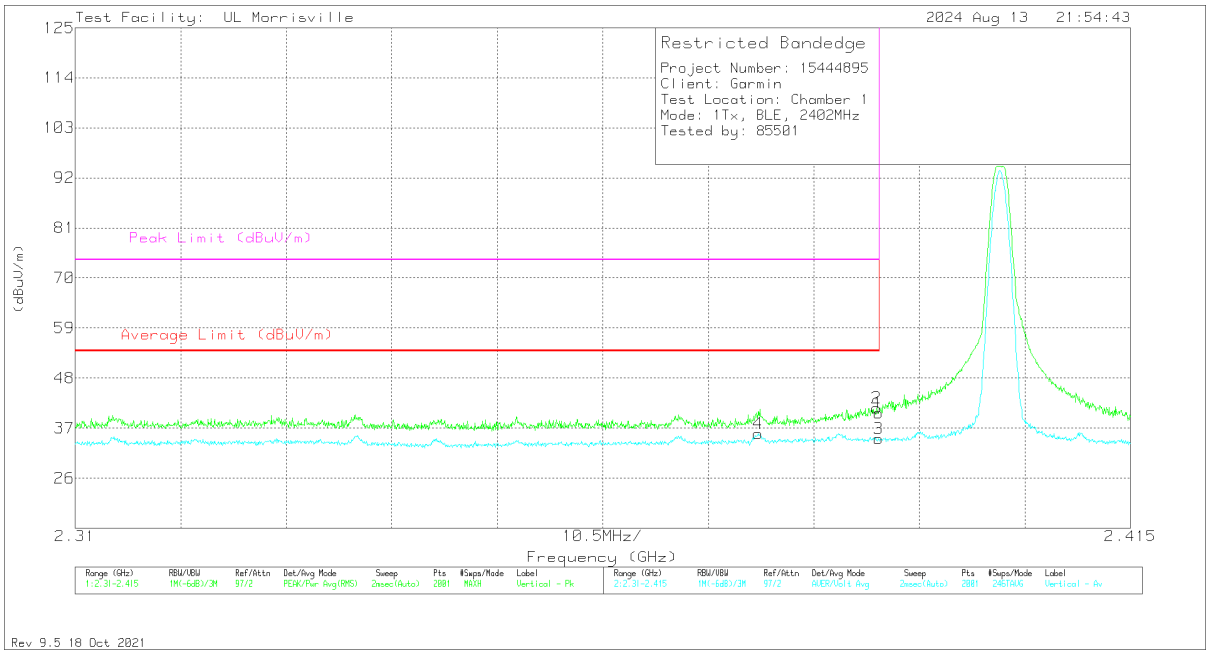
HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	34.3	Pk	31.9	-24	0	42.2	-	-	74	-31.8	135	170	H
2	* ** 2.38991	35.31	Pk	31.9	-24	0	43.21	-	-	74	-30.79	135	170	H
3	* ** 2.38996	18.87	ADV	31.9	-24	7.82	34.59	54	-19.41	-	-	135	170	H
4	* ** 2.38613	20.86	ADV	31.9	-23.9	7.82	36.68	54	-17.32	-	-	135	170	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

VERTICAL RESULT

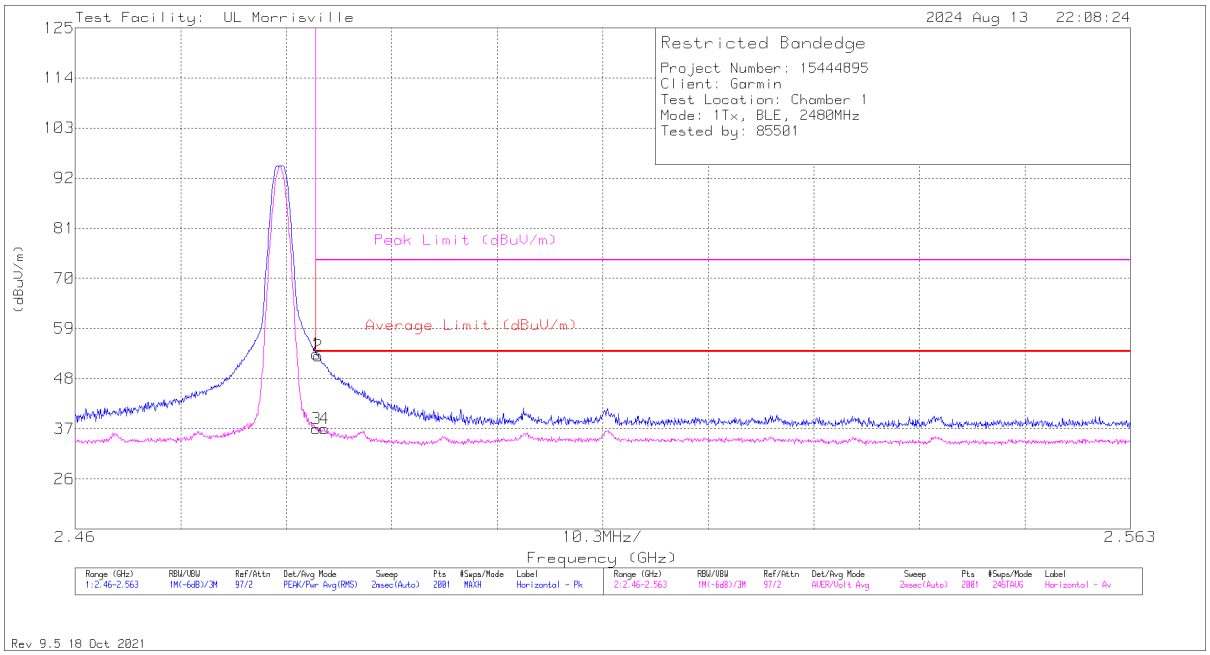


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	32.47	Pk	31.9	-24	0	40.37	-	-	74	-33.63	270	171	V
2	* ** 2.38975	33.48	Pk	31.9	-24	0	41.38	-	-	74	-32.62	270	171	V
3	* ** 2.38996	18.94	ADV	31.9	-24	7.82	34.66	54	-19.34	-	-	270	171	V
4	* ** 2.37794	20.28	ADV	31.9	-24.2	7.82	35.8	54	-18.2	-	-	270	171	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	44.92	Pk	32.2	-23.7	0	53.42	-	-	74	-20.58	130	155	H
2	* ** 2.48374	44.53	Pk	32.2	-23.7	0	53.03	-	-	74	-20.97	130	155	H
3	* ** 2.48354	20.75	ADV	32.2	-23.7	7.82	37.07	54	-16.93	-	-	130	155	H
4	* ** 2.48436	20.82	ADV	32.2	-23.8	7.82	37.04	54	-16.96	-	-	130	155	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
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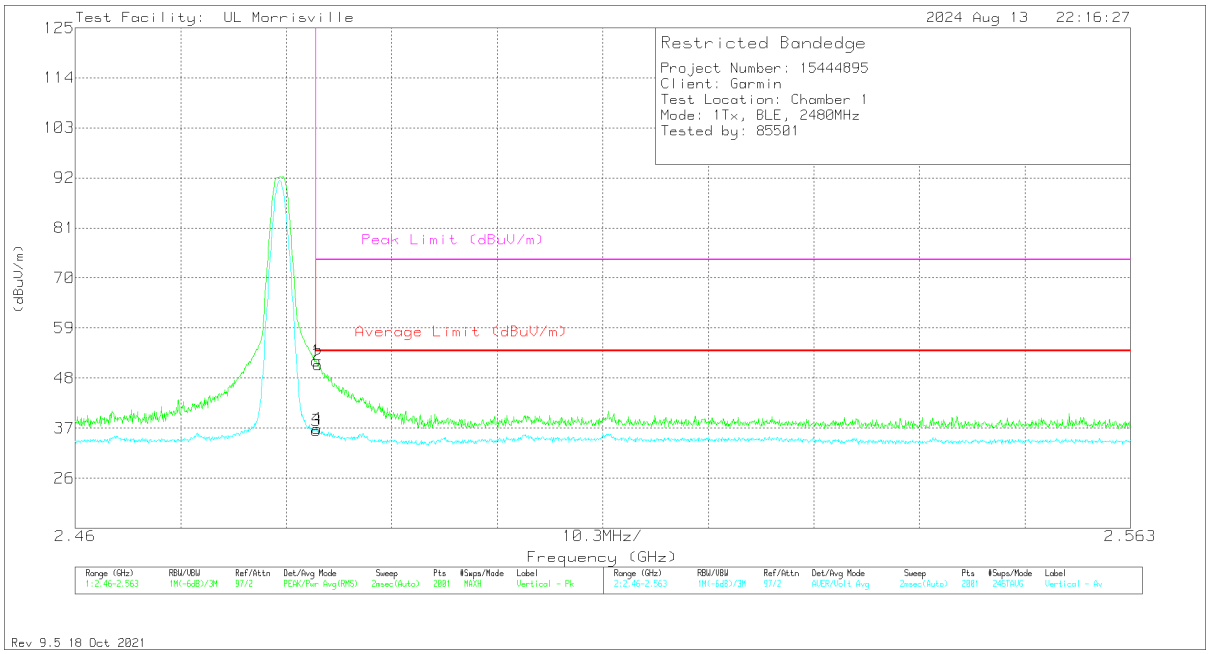
VERTICAL RESULT

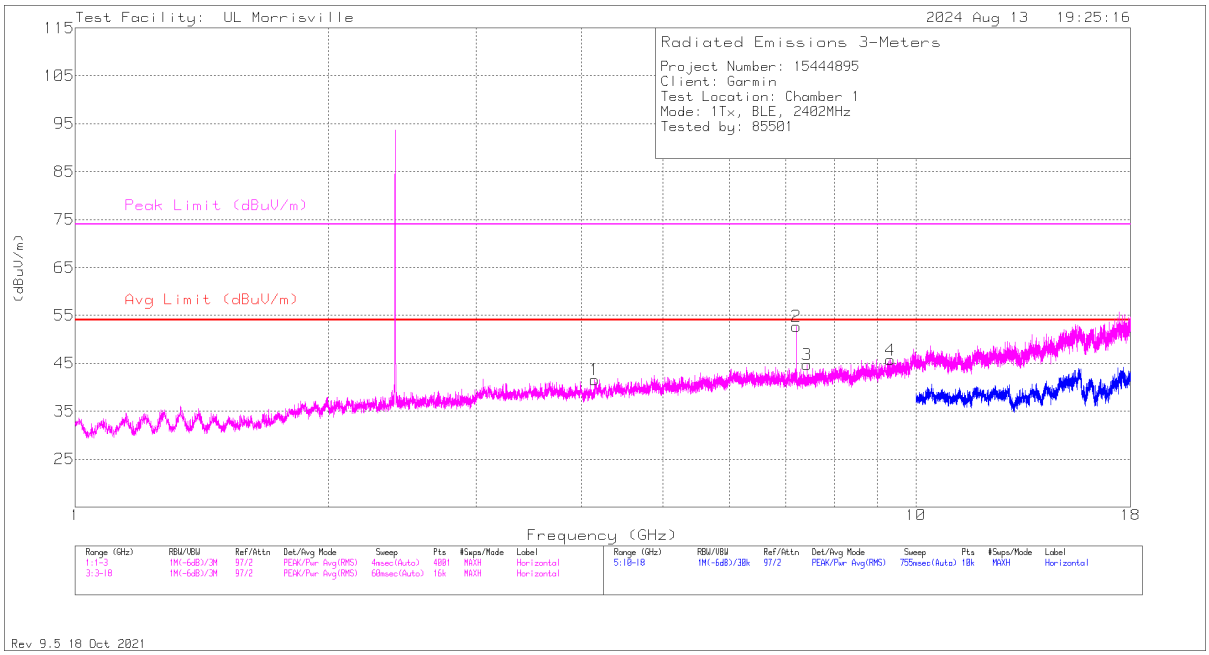


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	43.24	Pk	32.2	-23.7	0	51.74	-	-	74	-22.26	270	164	V
2	* ** 2.48369	42.46	Pk	32.2	-23.7	0	50.96	-	-	74	-23.04	270	164	V
3	* ** 2.48354	20.13	ADV	32.2	-23.7	7.82	36.45	54	-17.55	-	-	270	164	V
4	* ** 2.48359	20.52	ADV	32.2	-23.7	7.82	36.84	54	-17.16	-	-	270	164	V

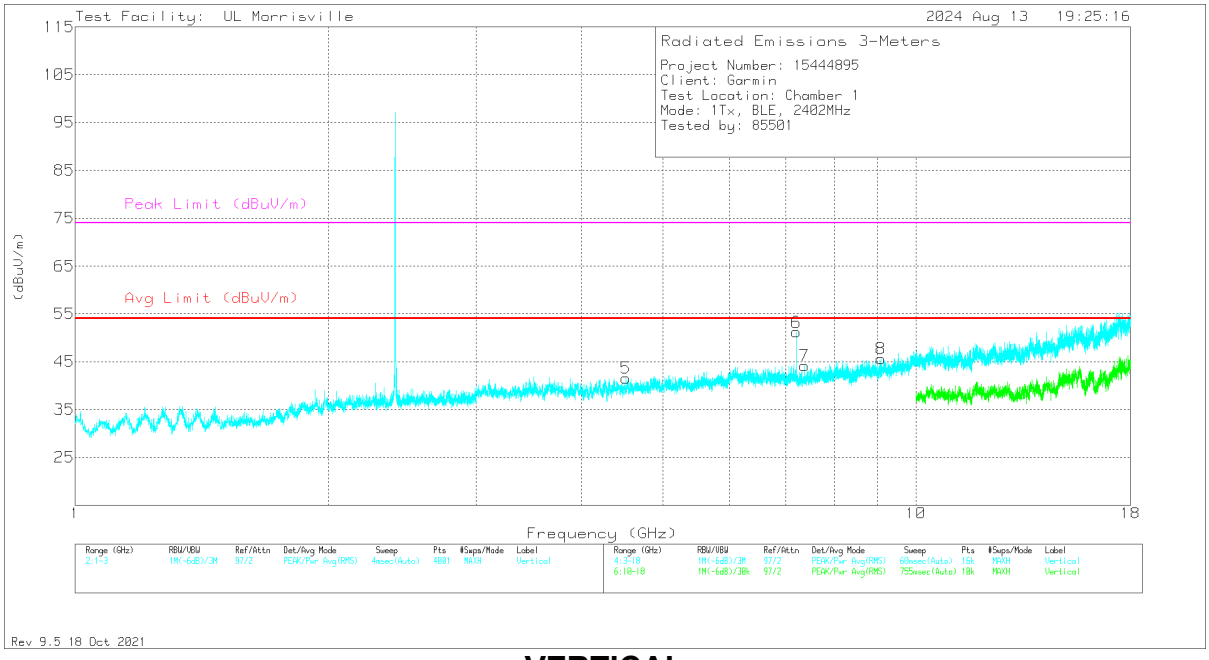
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



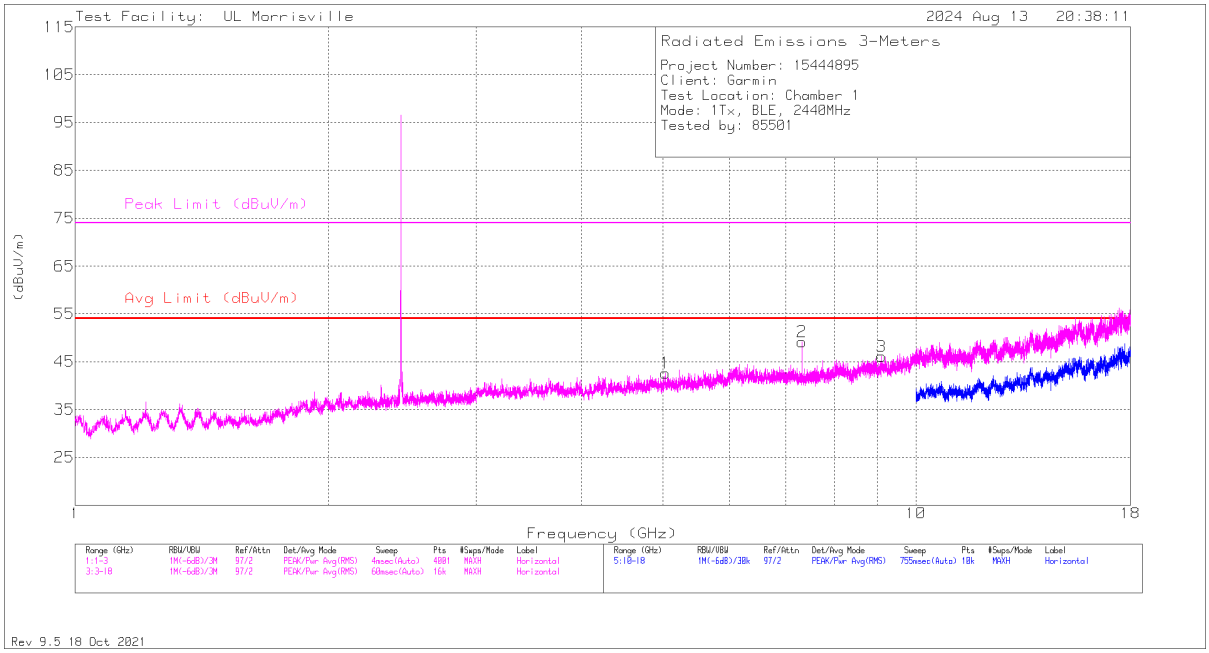
VERTICAL

RADIATED EMISSIONS

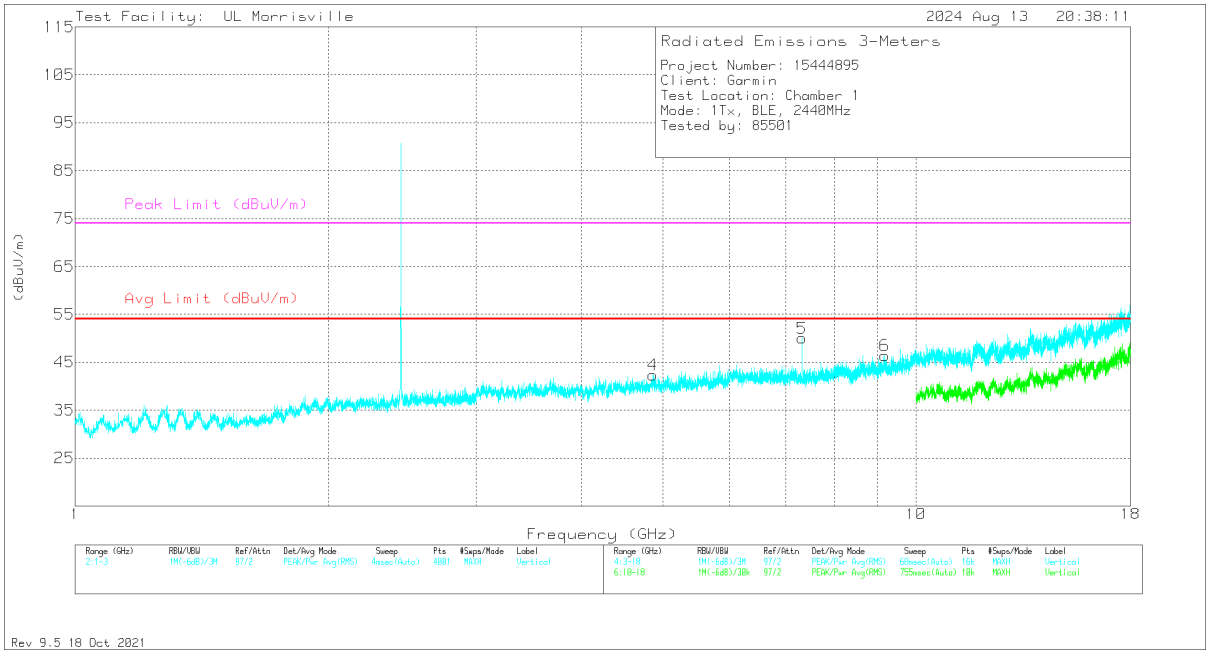
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 4.15125	53.57	Pk	33.4	-45.4	41.57	54	-12.43	74	-32.43	0-360	200	H
3	* ** 7.425	50.54	Pk	35.4	-41.2	44.74	54	-9.26	74	-29.26	0-360	101	H
4	* ** 9.33188	49.89	Pk	36.2	-40.4	45.69	54	-8.31	74	-28.31	0-360	101	H
5	* ** 4.5225	53.6	Pk	33.9	-45.9	41.6	54	-12.4	74	-32.4	0-360	200	V
7	* ** 7.3725	50.24	Pk	35.4	-41.4	44.24	54	-9.76	74	-29.76	0-360	200	V
8	* ** 9.09563	49.9	Pk	35.9	-40.2	45.6	54	-8.4	74	-28.4	0-360	101	V
2	7.20563	59.55	Pk	35.4	-42.2	52.75	-	-	-	-	0-360	101	H
6	7.20656	57.99	Pk	35.4	-42.2	51.19	-	-	-	-	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector

MID CHANNEL RESULTS



HORIZONTAL



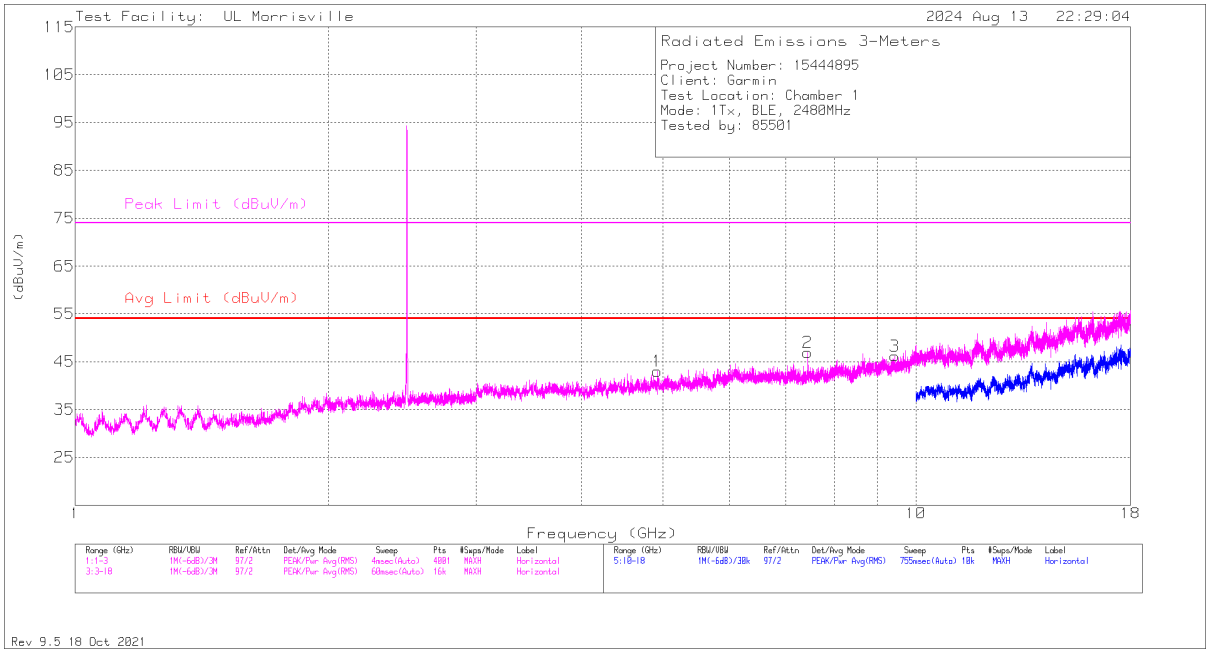
VERTICAL

RADIATED EMISSIONS

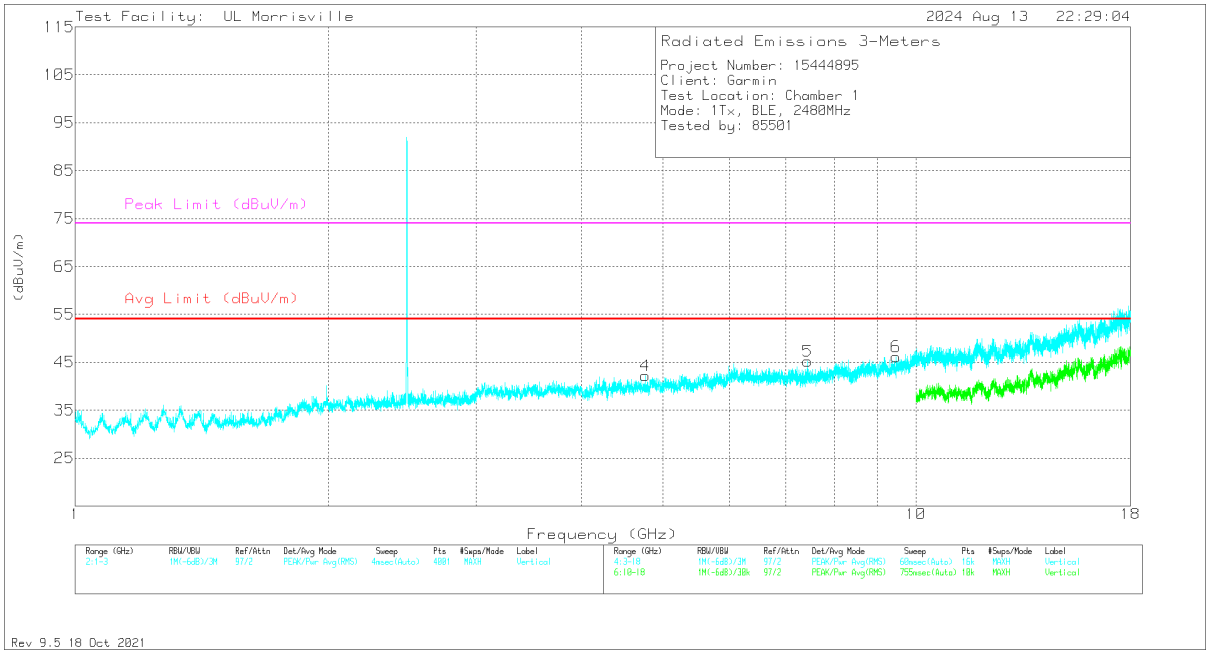
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 5.03344	52.68	Pk	34.3	-44.4	0	42.58	54	-11.42	74	-31.42	0-360	199	H
2	* ** 7.31923	58.35	PK2	35.4	-41.6	0	52.15	-	-	74	-21.85	44	101	H
	* ** 7.31927	45.36	ADV	35.4	-41.6	7.82	46.98	54	-7.02	-	-	44	101	H
3	* ** 9.10969	50.39	Pk	35.9	-40.2	0	46.09	54	-7.91	74	-27.91	0-360	199	H
4	* ** 4.86375	53.7	Pk	33.9	-45.2	0	42.4	54	-11.6	74	-31.6	0-360	101	V
5	* ** 7.31925	58.64	PK2	35.4	-41.6	0	52.44	-	-	74	-21.56	244	102	V
	* ** 7.31959	45.7	ADV	35.4	-41.7	7.82	47.22	54	-6.78	-	-	244	102	V
6	* ** 9.17813	50.27	Pk	36	-39.9	0	46.37	54	-7.63	74	-27.63	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
PK2 - Maximum Peak
ADV - Linear Voltage Average

HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 4.92469	53.92	Pk	34.1	-45	43.02	54	-10.98	74	-30.98	0-360	101	H
2	* ** 7.44094	52.62	Pk	35.4	-41.1	46.92	54	-7.08	74	-27.08	0-360	200	H
3	* ** 9.43594	50.11	Pk	36.3	-40.2	46.21	54	-7.79	74	-27.79	0-360	200	H
4	* ** 4.76719	53.47	Pk	33.8	-45.1	42.17	54	-11.83	74	-31.83	0-360	200	V
5	* ** 7.44	50.88	Pk	35.4	-41.1	45.18	54	-8.82	74	-28.82	0-360	101	V
6	* ** 9.47813	50.33	Pk	36.4	-40.6	46.13	54	-7.87	74	-27.87	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector

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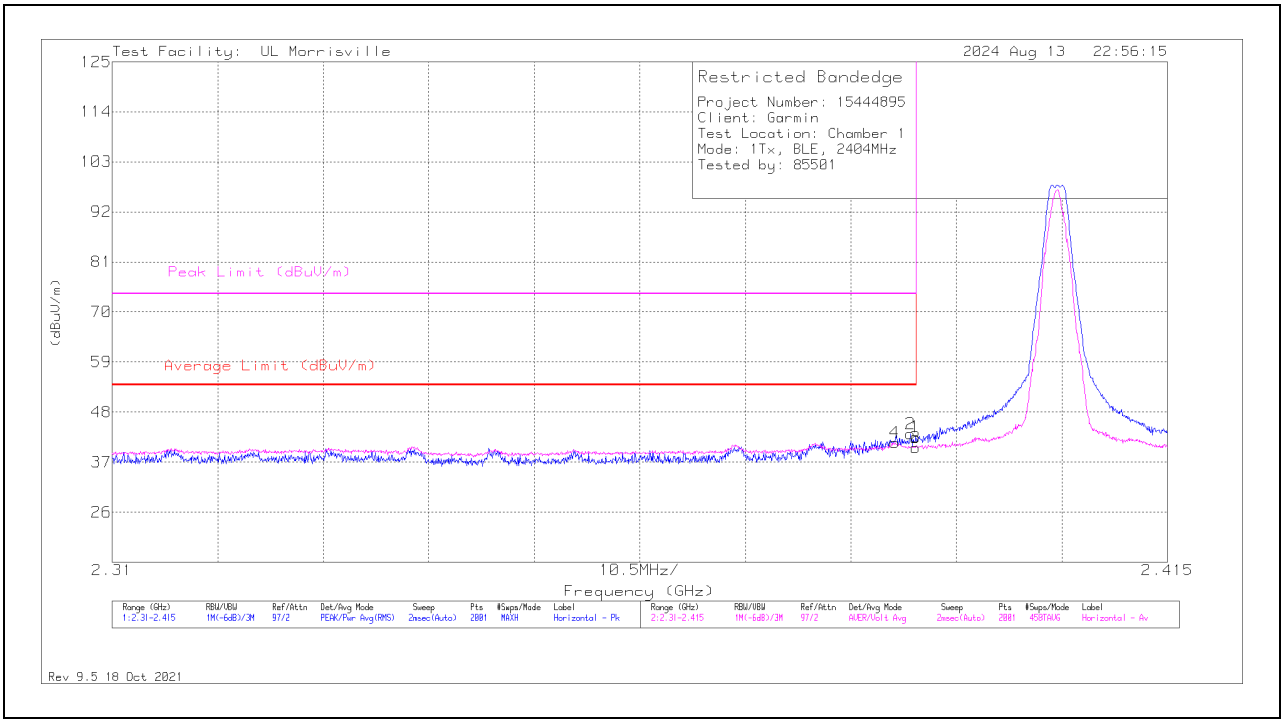
12 Laboratory Dr., RTP, NC 27709, U.S.A. TEL:(919) 549-1400

10.2.2. BLE (2Mbps)

BANDEDGE (LOW CHANNEL)

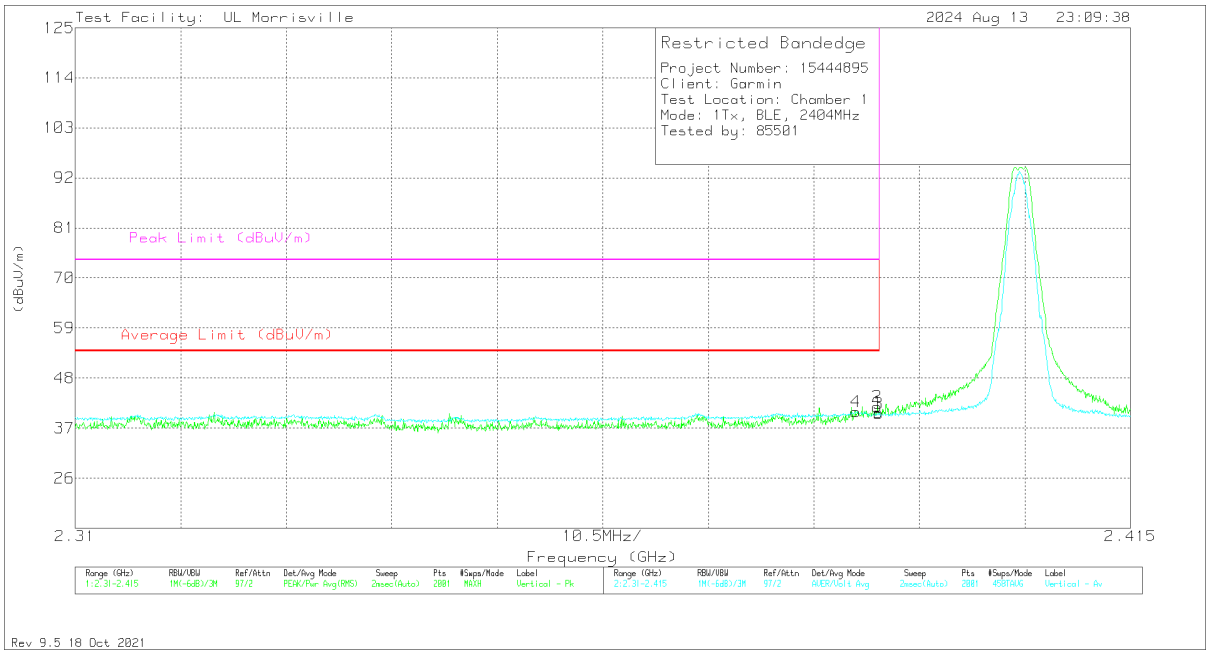
HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	34.68	Pk	31.9	-24	0	42.58	-	-	74	-31.42	134	118	H
2	* ** 2.38943	35.32	Pk	31.9	-24	0	43.22	-	-	74	-30.78	134	118	H
3	* ** 2.38996	19.1	ADV	31.9	-24	13.22	40.22	54	-13.78	-	-	134	118	H
4	* ** 2.38786	20.05	ADV	31.9	-23.9	13.22	41.27	54	-12.73	-	-	134	118	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

VERTICAL RESULT

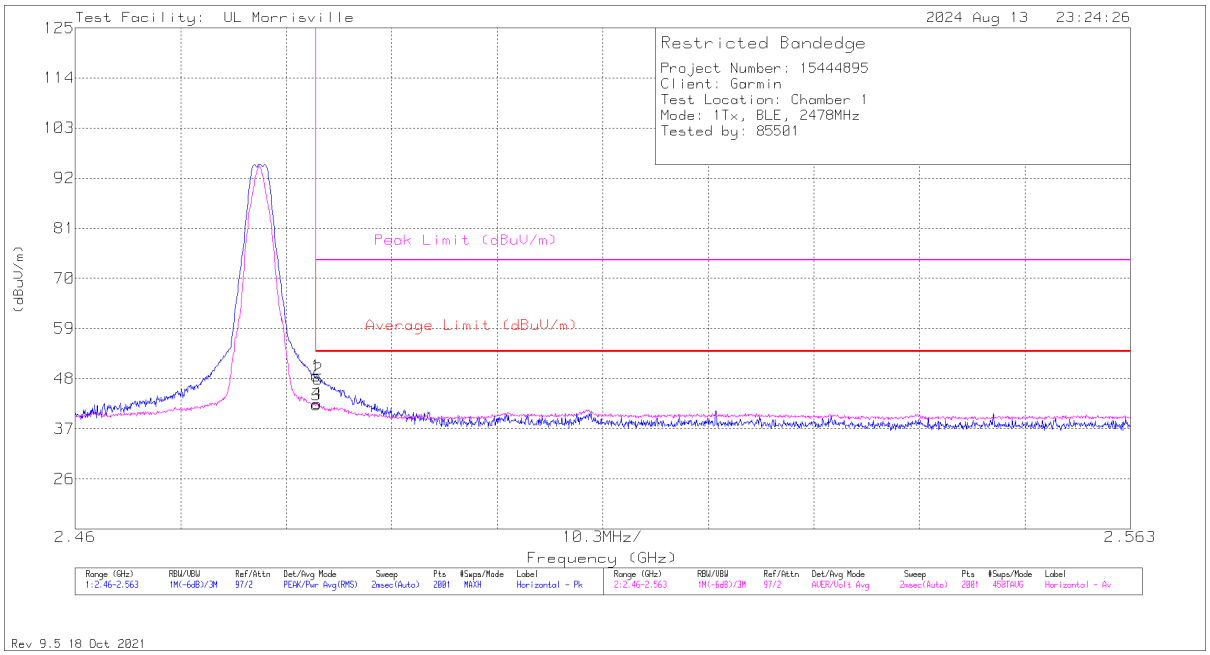


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	32.6	Pk	31.9	-24	0	40.5	-	-	74	-33.5	262	110	V
2	* ** 2.3898	33.86	Pk	31.9	-24	0	41.76	-	-	74	-32.24	262	110	V
3	* ** 2.38996	19.12	ADV	31.9	-24	13.22	40.24	54	-13.76	-	-	262	110	V
4	* ** 2.3877	19.41	ADV	31.9	-23.9	13.22	40.63	54	-13.37	-	-	262	110	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

BANDEDGE (HIGH CHANNEL)

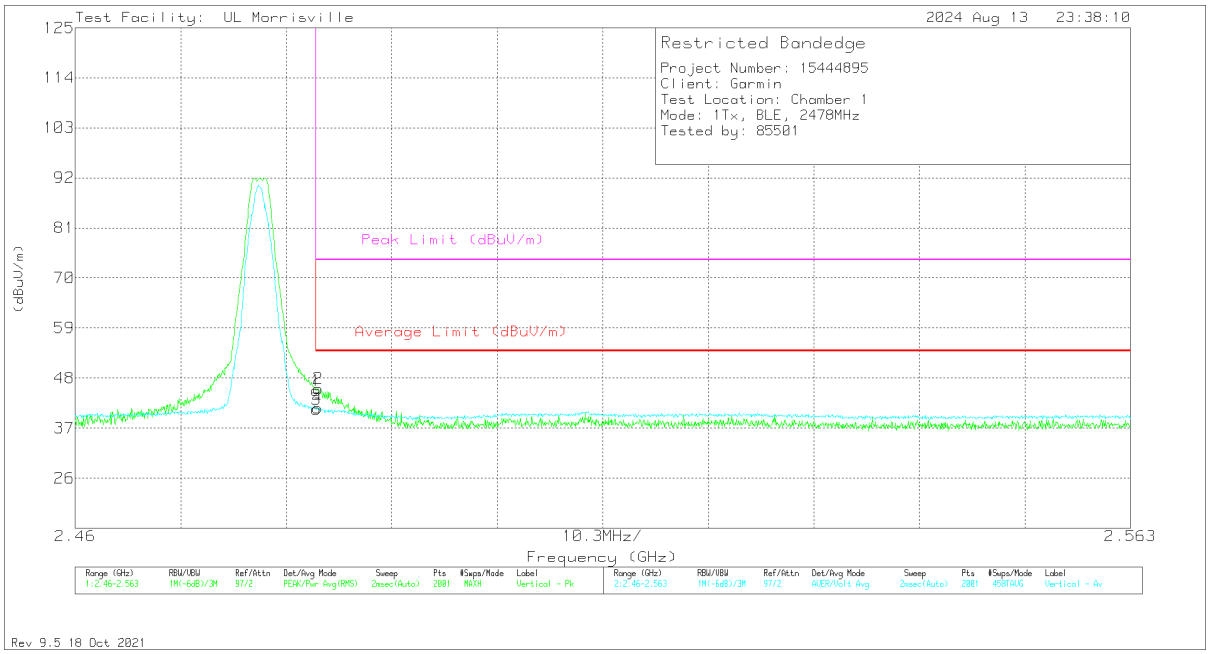
HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	40.08	Pk	32.2	-23.7	0	48.58	-	-	74	-25.42	137	155	H
2	* ** 2.48374	39.36	Pk	32.2	-23.7	0	47.86	-	-	74	-26.14	137	155	H
3	* ** 2.48354	20.54	ADV	32.2	-23.7	13.22	42.26	54	-11.74	-	-	137	155	H
4	* ** 2.48359	20.78	ADV	32.2	-23.7	13.22	42.5	54	-11.5	-	-	137	155	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

VERTICAL RESULT



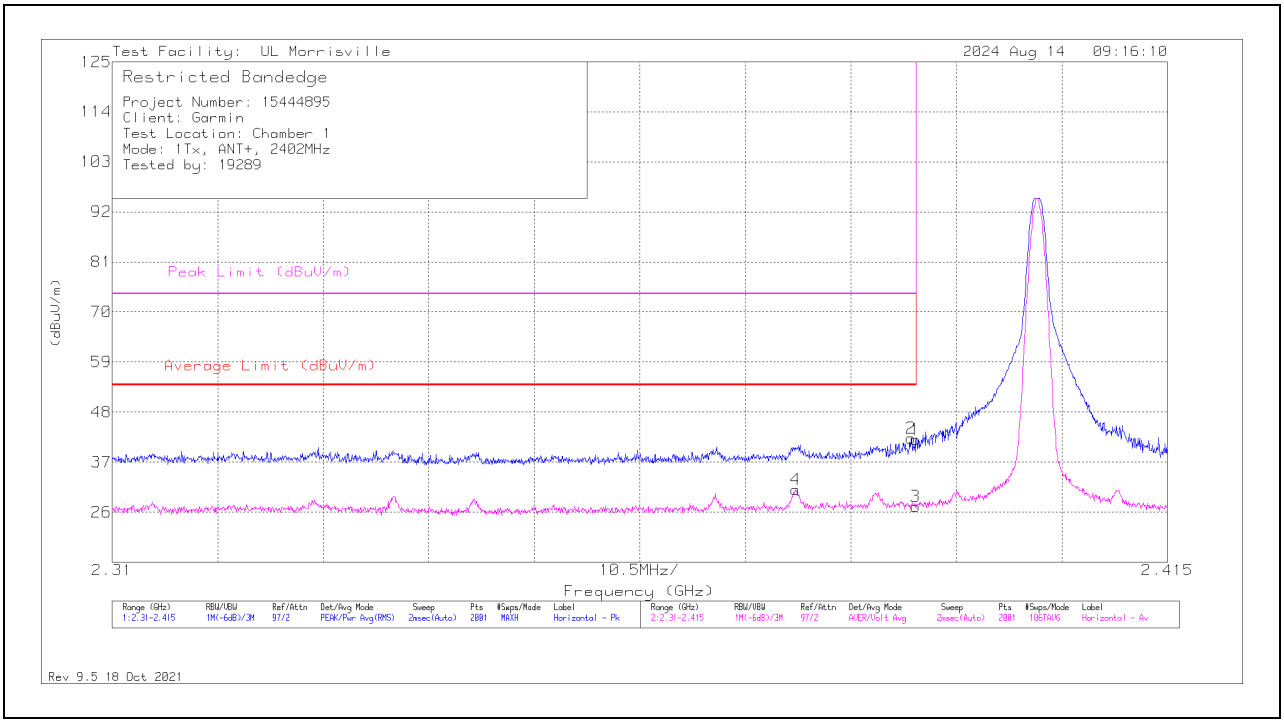
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	36.77	Pk	32.2	-23.7	0	45.27	-	-	74	-28.73	267	158	V
2	* ** 2.48374	37.15	Pk	32.2	-23.7	0	45.65	-	-	74	-28.35	267	158	V
3	* ** 2.48354	19.45	ADV	32.2	-23.7	13.22	41.17	54	-12.83	-	-	267	158	V
4	* ** 2.48364	19.76	ADV	32.2	-23.7	13.22	41.48	54	-12.52	-	-	267	158	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

10.2.3. ANT/ANT+

BANDEDGE (LOW CHANNEL)

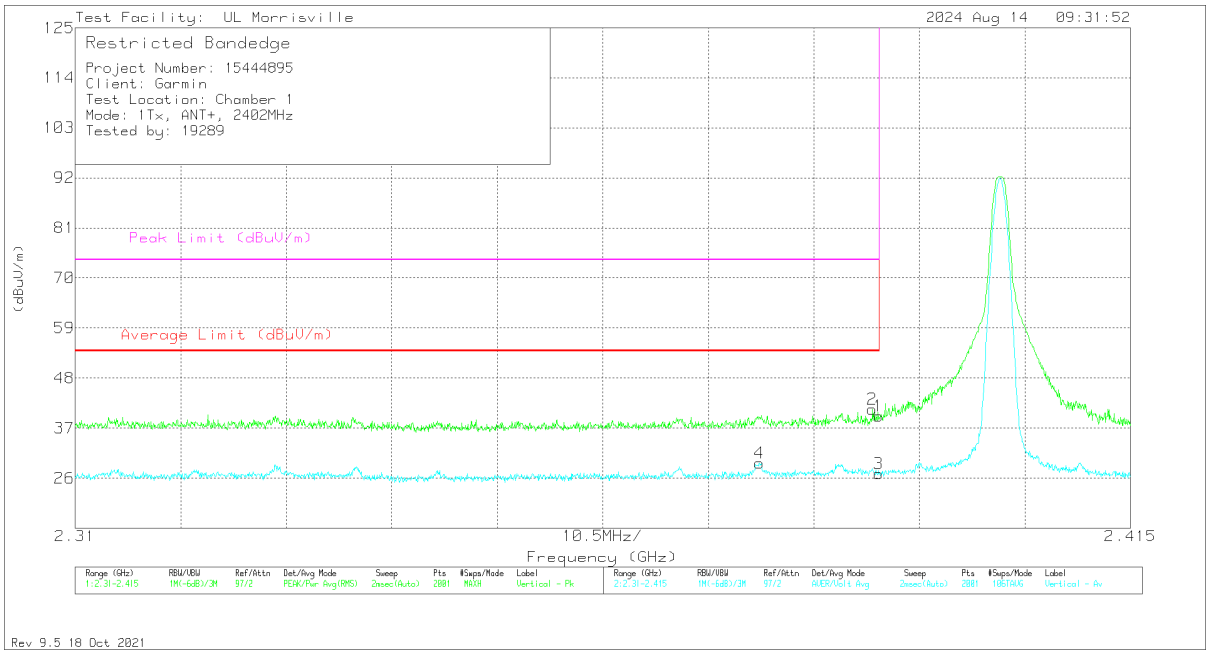
HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	34.13	Pk	31.9	-24	0	42.03	-	-	74	-31.97	287	116	H
2	* ** 2.38949	34.41	Pk	31.9	-24	0	42.31	-	-	74	-31.69	287	116	H
3	* ** 2.38996	18.86	ADV	31.9	-24	.51	27.27	54	-26.73	-	-	287	116	H
4	* ** 2.37799	22.79	ADV	31.9	-24.2	.51	31	54	-23	-	-	287	116	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

VERTICAL RESULT

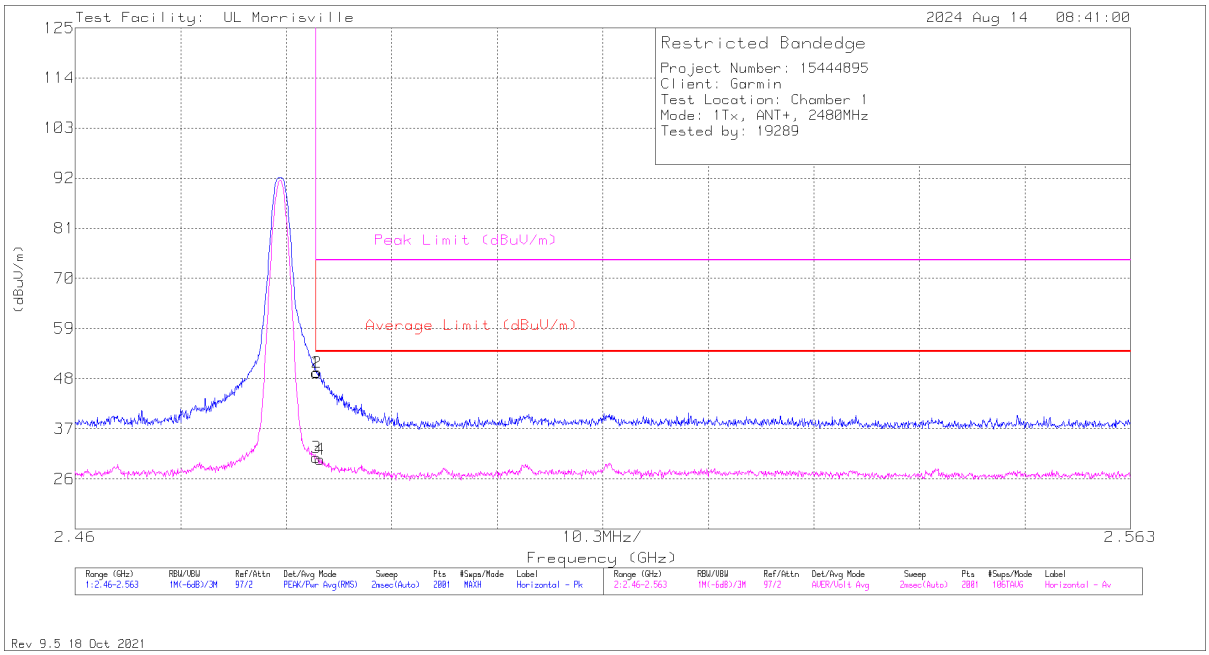


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	31.78	Pk	31.9	-24	0	39.68	-	-	74	-34.32	343	103	V
2	* ** 2.38933	33.24	Pk	31.9	-24	0	41.14	-	-	74	-32.86	343	103	V
3	* ** 2.38996	18.59	ADV	31.9	-24	.51	27	54	-27	-	-	343	103	V
4	* ** 2.37809	21.05	ADV	31.9	-24.2	.51	29.26	54	-24.74	-	-	343	103	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

BANDEDGE (HIGH CHANNEL)

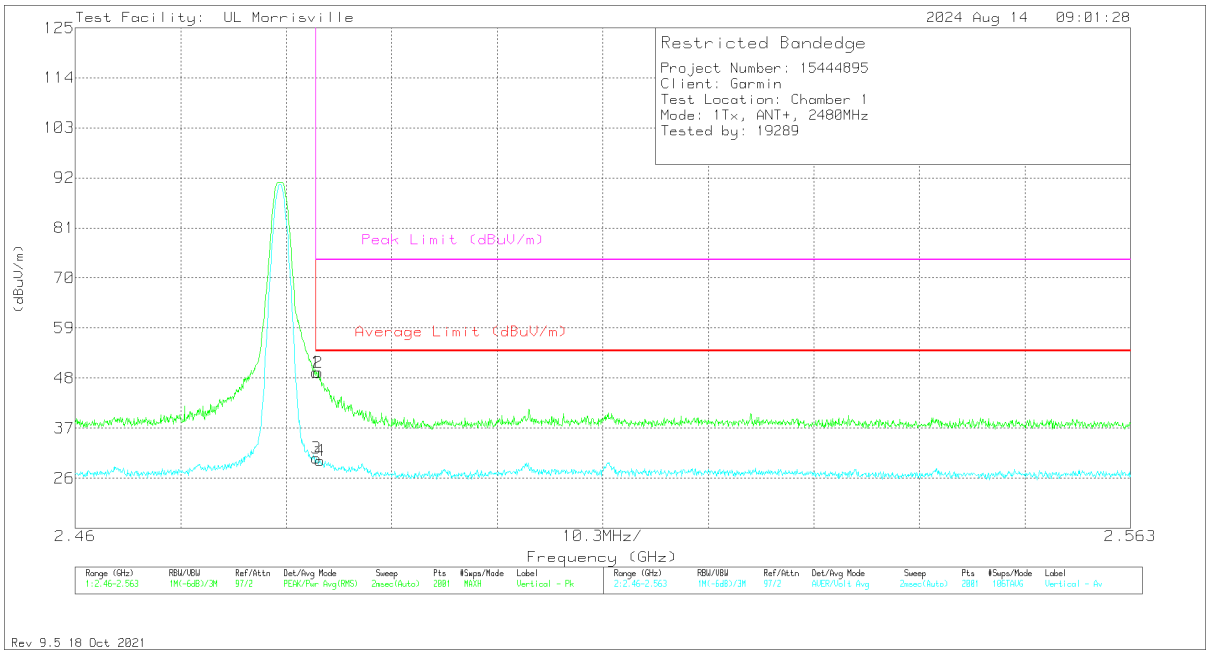
HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	40.76	Pk	32.2	-23.7	0	49.26	-	-	74	-24.74	284	133	H
2	* ** 2.48359	40.85	Pk	32.2	-23.7	0	49.35	-	-	74	-24.65	284	133	H
3	* ** 2.48354	21.66	ADV	32.2	-23.7	.51	30.67	54	-23.33	-	-	284	133	H
4	* ** 2.4839	21.25	ADV	32.2	-23.7	.51	30.26	54	-23.74	-	-	284	133	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

VERTICAL RESULT



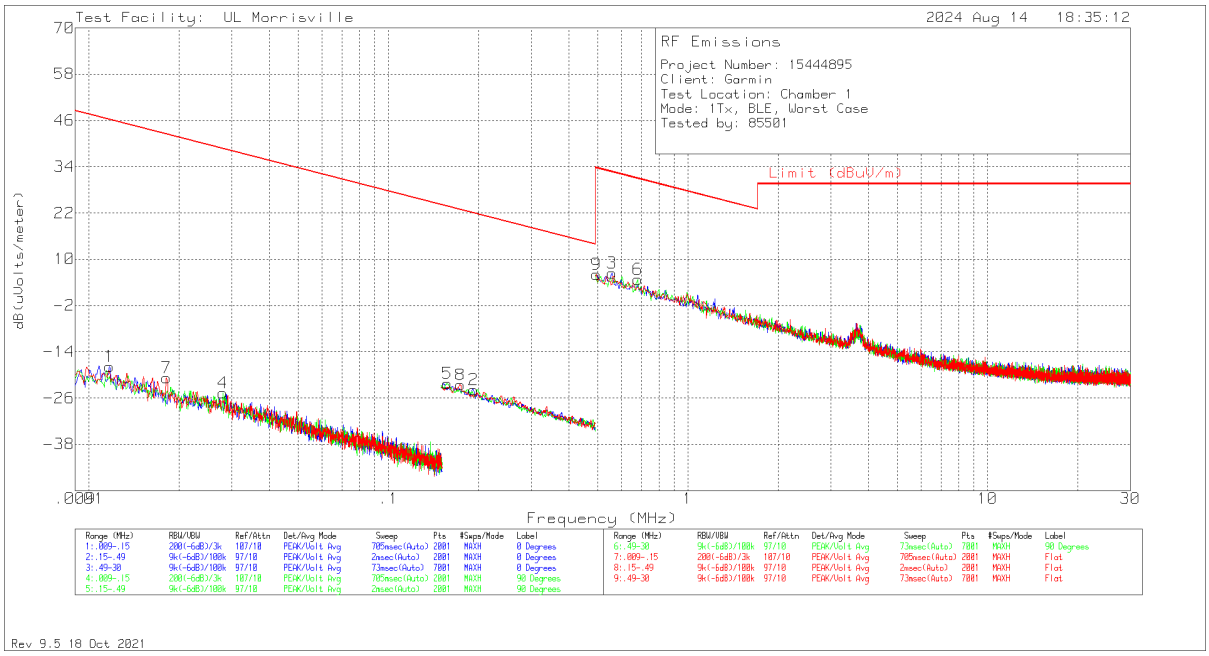
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	135143 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	40.76	Pk	32.2	-23.7	0	49.26	-	-	74	-24.74	97	122	V
2	* ** 2.48374	40.72	Pk	32.2	-23.7	0	49.22	-	-	74	-24.78	97	122	V
3	* ** 2.48354	21.37	ADV	32.2	-23.7	.51	30.38	54	-23.62	-	-	97	122	V
4	* ** 2.4839	20.82	ADV	32.2	-23.7	.51	29.83	54	-24.17	-	-	97	122	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

10.3. WORST CASE BELOW 30MHZ (BLE)

SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)

Note: All measurements were made at a test distance of 3 m. The measured data was extrapolated from the test distance (3m) to the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were 40*Log (test distance / specification distance).

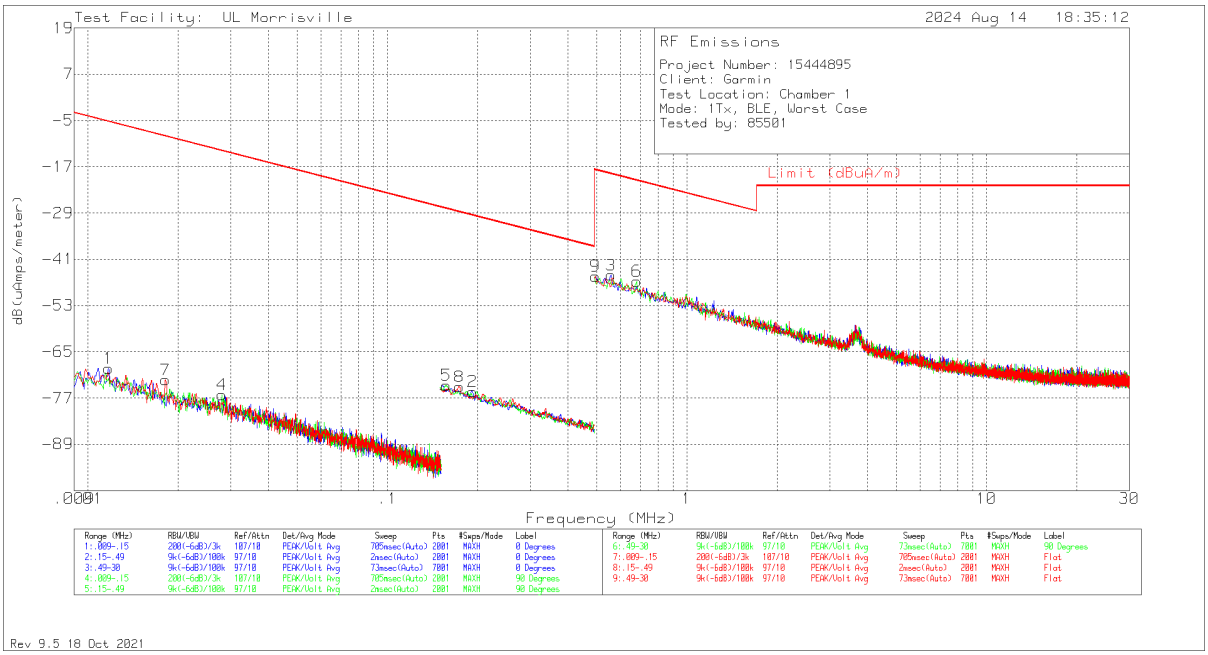


ANTENNA - THREE ORIENTATIONS – E FIELD

Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135144 (dBuV/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	QP/AV Limit (dBuV/m)	PK Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
1	.0117	44.32	Pk	17.7	.1	-80	-17.88	46.24	66.24	-64.12	0-360	0 degs
7	.01816	44.28	Pk	14.8	.1	-80	-20.82	42.42	62.42	-63.24	0-360	Flat
4	.02803	41.68	Pk	13.6	.1	-80	-24.62	38.65	58.65	-63.27	0-360	90 degs
5	.15689	46.53	Pk	11.1	.1	-80	-22.27	23.69	43.69	-45.96	0-360	90 degs
8	.17414	46.18	Pk	11.1	.1	-80	-22.62	22.79	42.79	-45.41	0-360	Flat
2	.19216	45	Pk	11.1	.1	-80	-23.8	21.93	41.93	-45.73	0-360	0 degs
9	.49422	34.84	Pk	11.1	.1	-40	6.04	33.73	-	-27.69	0-360	Flat
3	.55746	35.14	Pk	11.1	.1	-40	6.34	32.68	-	-26.34	0-360	0 degs
6	.67972	33.43	Pk	11.2	.1	-40	4.73	30.96	-	-26.23	0-360	90 degs

Pk - Peak detector



ANTENNA - THREE ORIENTATIONS – H FIELD

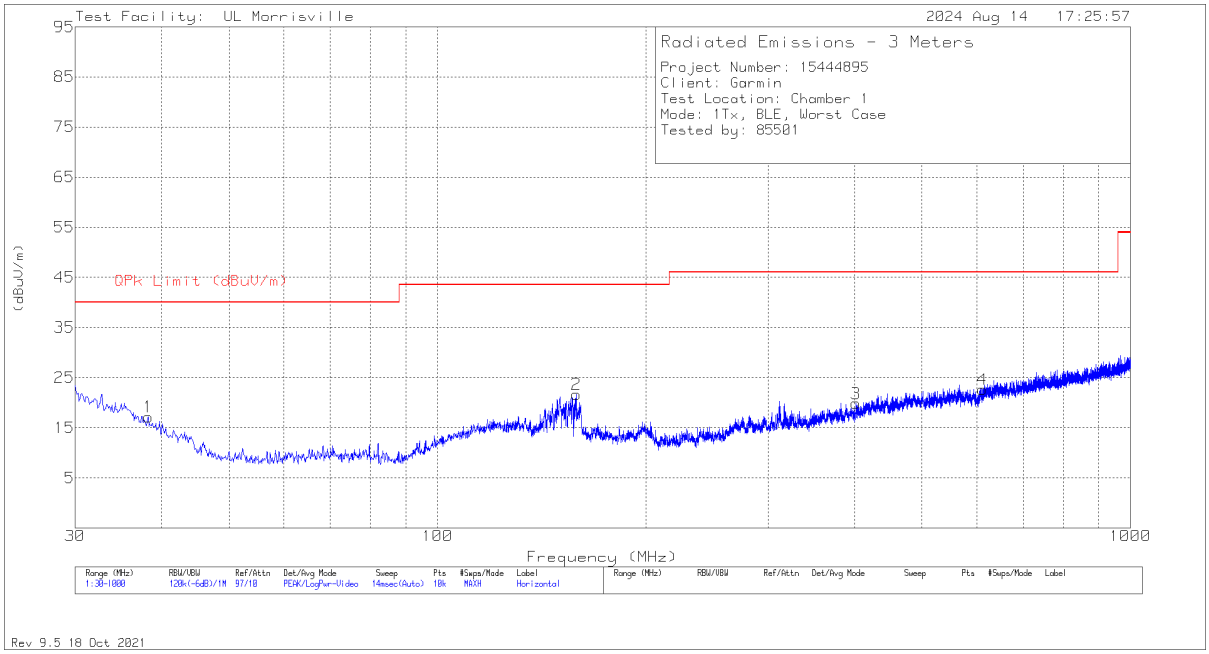
Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135144 (dBuV/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uAmps/meter)	QP/AV Limit (dBuA/m)	PK Limit (dBuA/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
1	.0117	44.32	Pk	-33.8	.1	-80	-69.38	-5.26	14.74	-64.12	0-360	0 degs
7	.01816	44.28	Pk	-36.7	.1	-80	-72.32	-9.08	10.92	-63.24	0-360	Flat
4	.02803	41.68	Pk	-37.9	.1	-80	-76.12	-12.85	7.15	-63.27	0-360	90 degs
5	.15689	46.53	Pk	-40.4	.1	-80	-73.77	-27.81	-7.81	-45.96	0-360	90 degs
8	.17414	46.18	Pk	-40.4	.1	-80	-74.12	-28.71	-8.71	-45.41	0-360	Flat
2	.19216	45	Pk	-40.4	.1	-80	-75.3	-29.57	-9.57	-45.73	0-360	0 degs
9	.49422	34.84	Pk	-40.4	.1	-40	-45.46	-17.77	-	-27.69	0-360	Flat
3	.55746	35.14	Pk	-40.4	.1	-40	-45.16	-18.82	-	-26.34	0-360	0 degs
6	.67972	33.43	Pk	-40.3	.1	-40	-46.77	-20.54	-	-26.23	0-360	90 degs

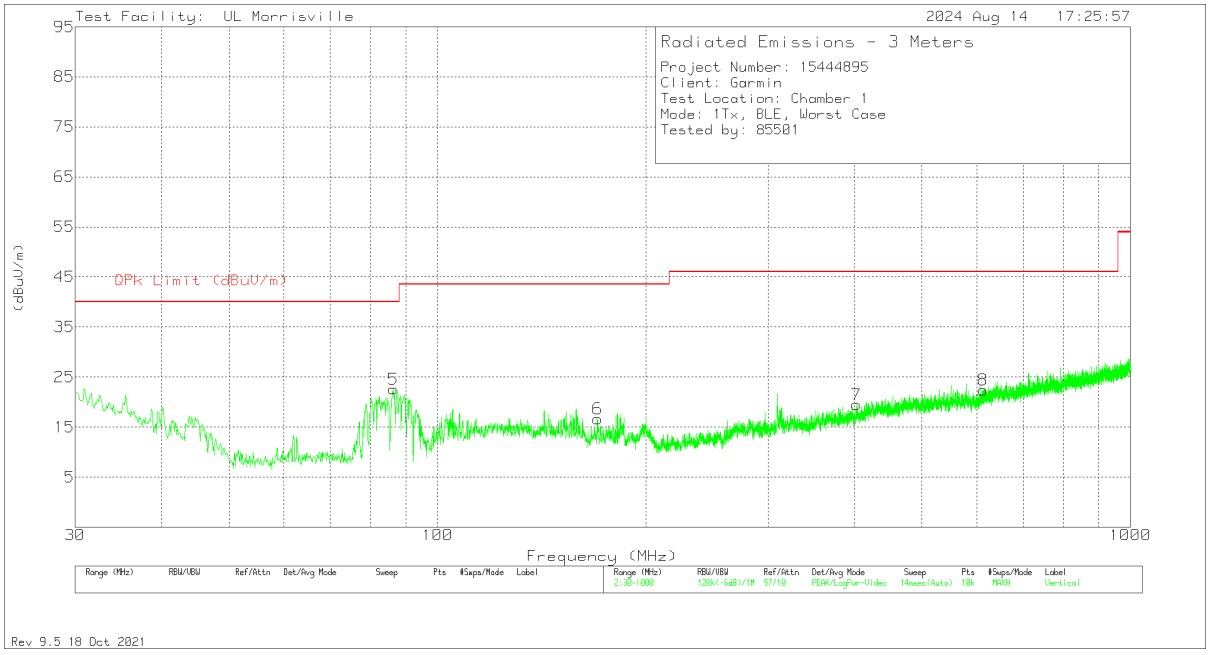
Pk - Peak detector

10.4. WORST CASE BELOW 1 GHZ (BLE)

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)



HORIZONTAL



VERTICAL

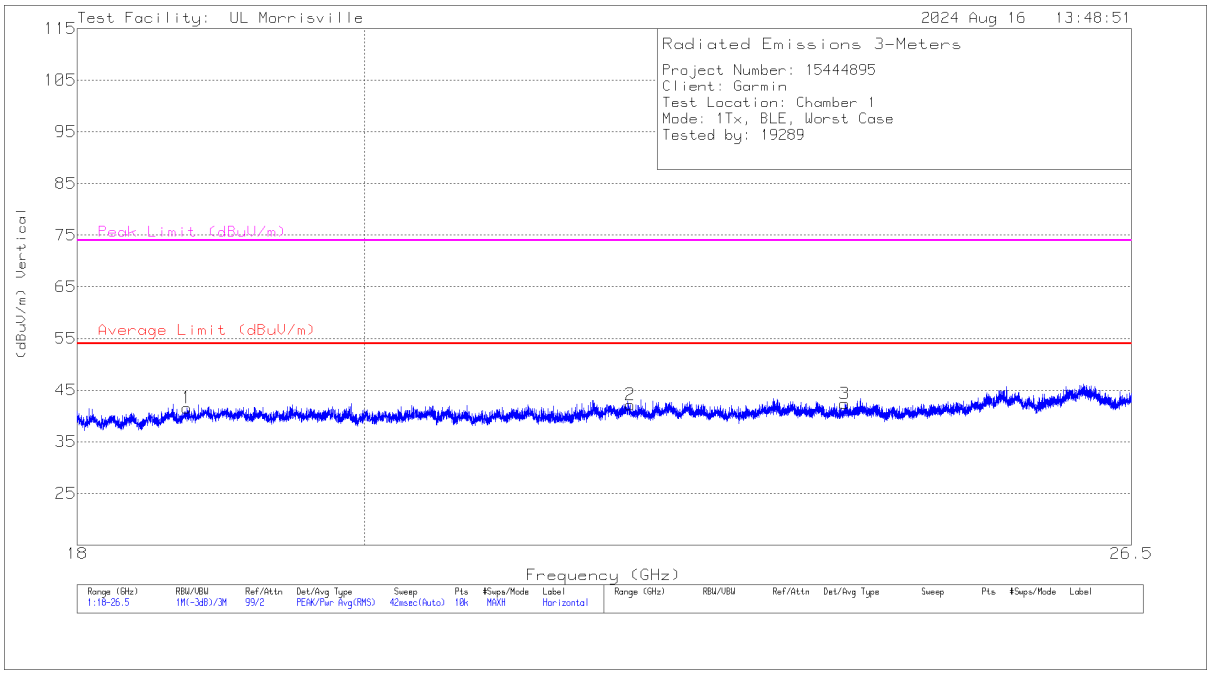
Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	90629 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 38.245	27.85	Pk	21	-31.7	17.15	40	-22.85	0-360	200	H
3	* ** 401.995	27.24	Pk	21.5	-28.9	19.84	46.02	-26.18	0-360	399	H
4	* ** 612	25.9	Pk	25.1	-28.4	22.6	46.02	-23.42	0-360	200	H
6	* ** 170.165	28.82	Pk	18.1	-30.3	16.62	43.52	-26.9	0-360	100	V
7	* ** 402.674	26.77	Pk	21.6	-28.9	19.47	46.02	-26.55	0-360	100	V
8	* ** 612.873	25.47	Pk	25.1	-28.2	22.37	46.02	-23.65	0-360	100	V
5	86.357	40.29	Pk	13.6	-31.3	22.59	40	-17.41	0-360	100	V
2	158.525	33.72	Pk	18.4	-30.5	21.62	43.52	-21.9	0-360	200	H

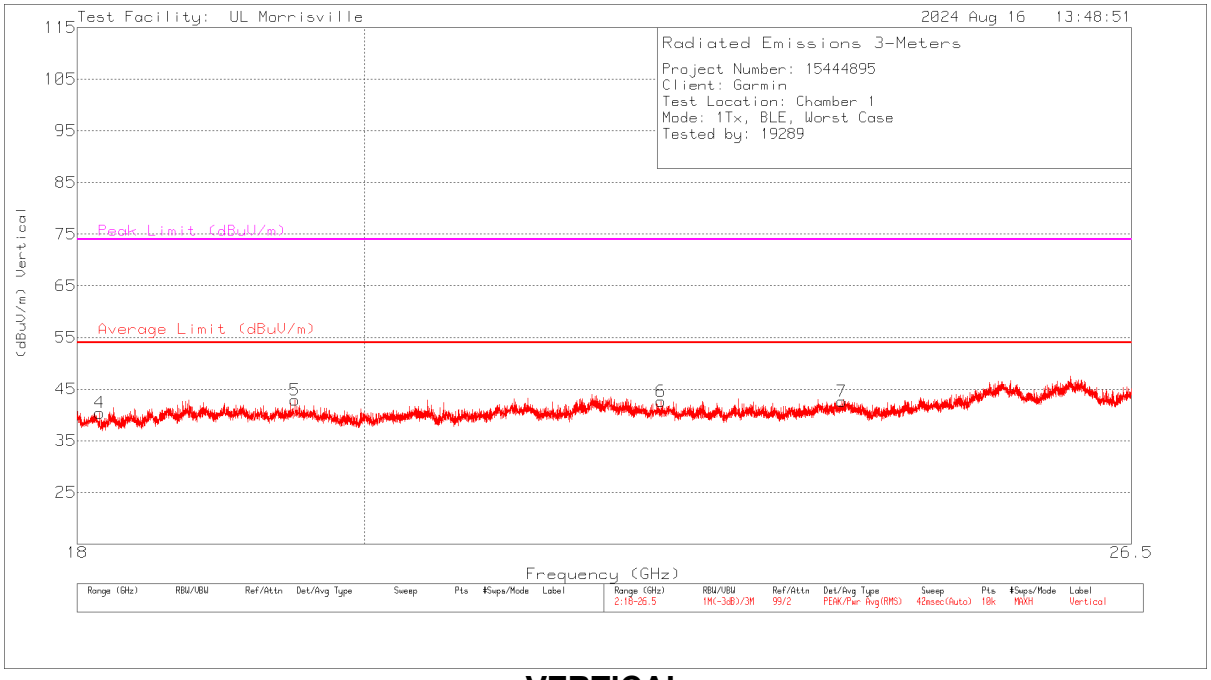
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector

10.5. WORST CASE 18-26 GHZ (BLE)

SPURIOUS EMISSIONS 18-26 GHz (WORST-CASE CONFIGURATION)



HORIZONTAL



VERTICAL

18 – 26GHz Data

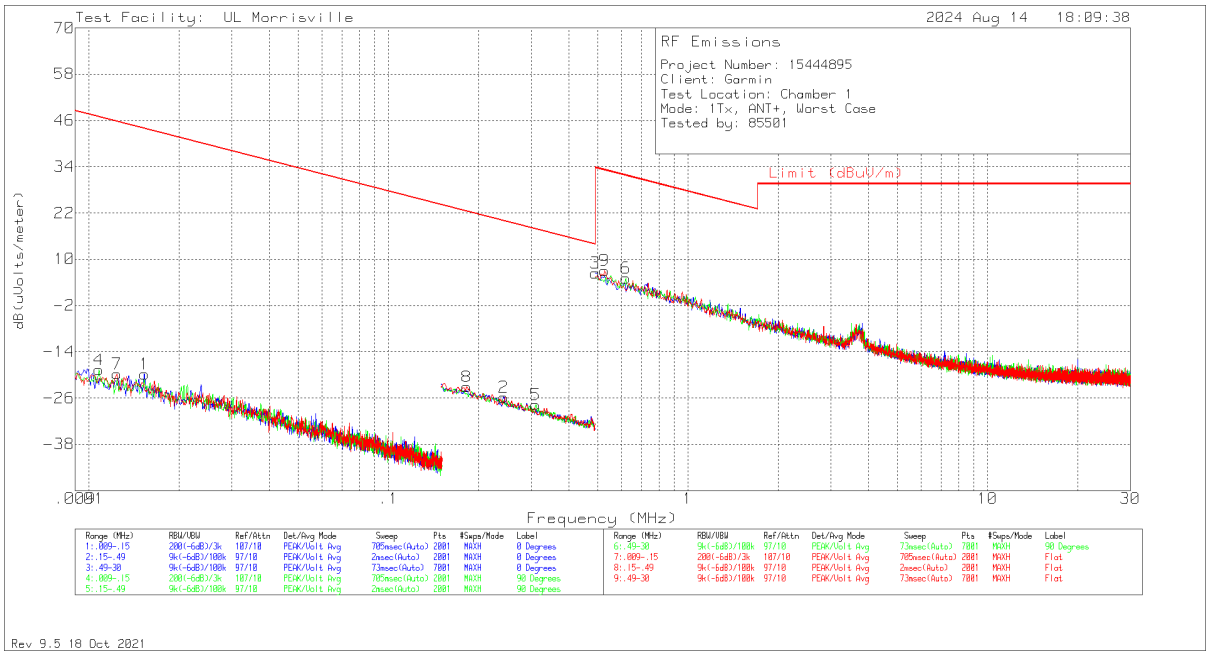
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	204704 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 18.73943	48.47	Pk	33.2	-40.1	0	41.57	54	-12.43	74	-32.43	0-360	250	H
2	* ** 22.04985	48.17	Pk	34.2	-40.2	0	42.17	54	-11.83	74	-31.83	0-360	250	H
3	* ** 23.85421	47.88	Pk	34.4	-39.9	0	42.38	54	-11.62	74	-31.62	0-360	299	H
4	* ** 18.14789	47.6	Pk	32.9	-40.1	0	40.4	54	-13.6	74	-33.6	0-360	250	V
5	* ** 19.49585	49.65	Pk	33.3	-40.1	0	42.85	54	-11.15	74	-31.15	0-360	101	V
6	* ** 22.29887	48.62	Pk	34.2	-40.2	0	42.62	54	-11.38	74	-31.38	0-360	150	V
7	* ** 23.82787	48.13	Pk	34.4	-39.9	0	42.63	54	-11.37	74	-31.37	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector

10.6. WORST CASE BELOW 30MHZ (ANT/ANT+)

SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)

Note: All measurements were made at a test distance of 3 m. The measured data was extrapolated from the test distance (3m) to the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were 40*Log (test distance / specification distance).

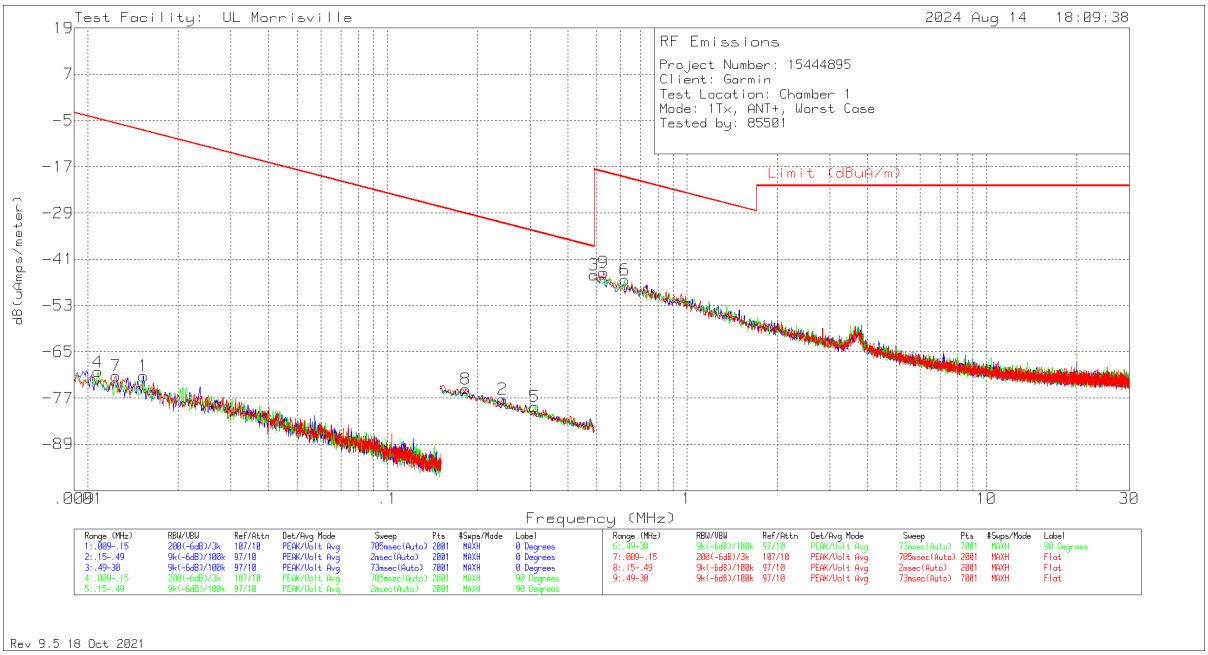


ANTENNA - THREE ORIENTATIONS – E FIELD

Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135144 (dBuV/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	QP/AV Limit (dBuV/m)	PK Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
4	.01078	43.08	Pk	18.1	.1	-80	-18.72	46.96	66.96	-65.68	0-360	90 degs
7	.01241	42.78	Pk	17.4	.1	-80	-19.72	45.73	65.73	-65.45	0-360	Flat
1	.01532	44.05	Pk	16.1	.1	-80	-19.75	43.9	63.9	-63.65	0-360	0 degs
8	.18264	45.68	Pk	11.1	.1	-80	-23.12	22.37	42.37	-45.49	0-360	Flat
2	.24299	42.99	Pk	11.1	.1	-80	-25.81	19.89	39.89	-45.7	0-360	0 degs
5	.31057	41.11	Pk	11.1	.1	-80	-27.69	17.76	37.76	-45.45	0-360	90 degs
3	.49	35.16	Pk	11.1	.1	-40	6.36	13.8	33.8	-7.44	0-360	0 degs
9	.52794	35.9	Pk	11.1	.1	-40	7.1	33.15	-	-26.05	0-360	Flat
6	.6207	33.86	Pk	11.2	.1	-40	5.16	31.75	-	-26.59	0-360	90 degs

Pk - Peak detector



ANTENNA - THREE ORIENTATIONS – H FIELD

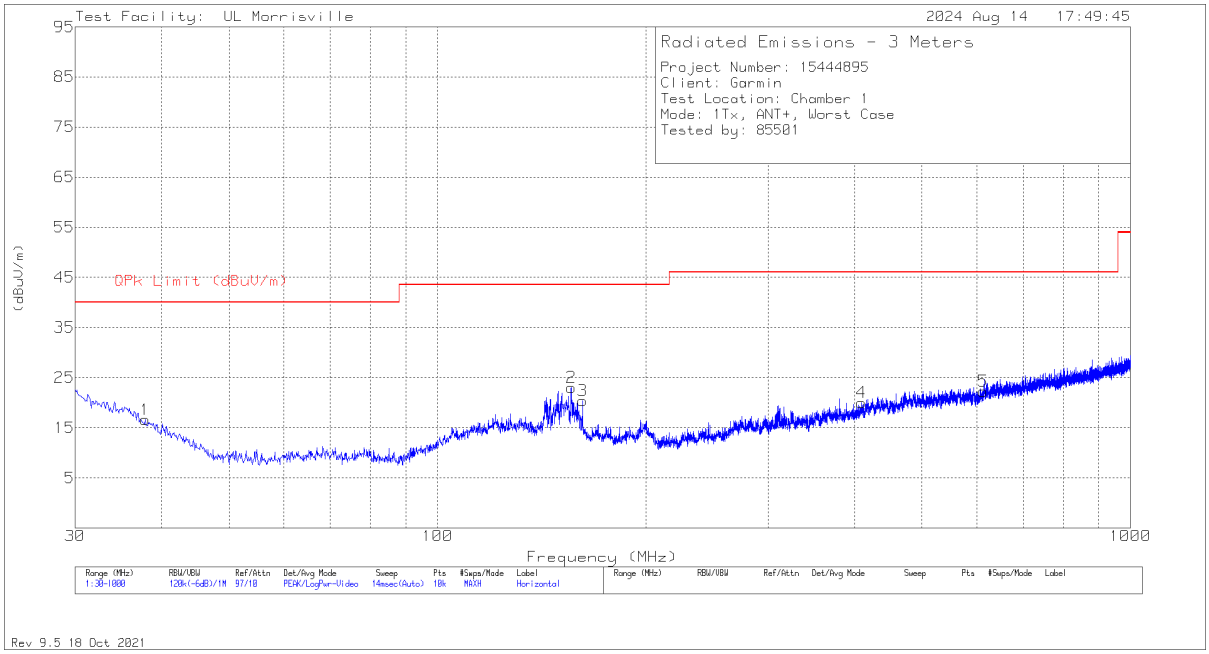
Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135144 (dBuV/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uAmps/meter)	QP/AV Limit (dBuA/m)	PK Limit (dBuA/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
4	.01078	43.08	Pk	-33.4	.1	-80	-70.22	-4.54	15.46	-65.68	0-360	90 degs
7	.01241	42.78	Pk	-34.1	.1	-80	-71.22	-5.77	14.23	-65.45	0-360	Flat
1	.01532	44.05	Pk	-35.4	.1	-80	-71.25	-7.6	12.4	-63.65	0-360	0 degs
8	.18264	45.68	Pk	-40.4	.1	-80	-74.62	-29.13	-9.13	-45.49	0-360	Flat
2	.24299	42.99	Pk	-40.4	.1	-80	-77.31	-31.61	-11.61	-45.7	0-360	0 degs
5	.31057	41.11	Pk	-40.4	.1	-80	-79.19	-33.74	-13.74	-45.45	0-360	90 degs
3	.49	35.16	Pk	-40.4	.1	-40	-45.14	-37.7	-17.7	-7.44	0-360	0 degs
9	.52794	35.9	Pk	-40.4	.1	-40	-44.4	-18.35	-	-26.05	0-360	Flat
6	.6207	33.86	Pk	-40.3	.1	-40	-46.34	-19.75	-	-26.59	0-360	90 degs

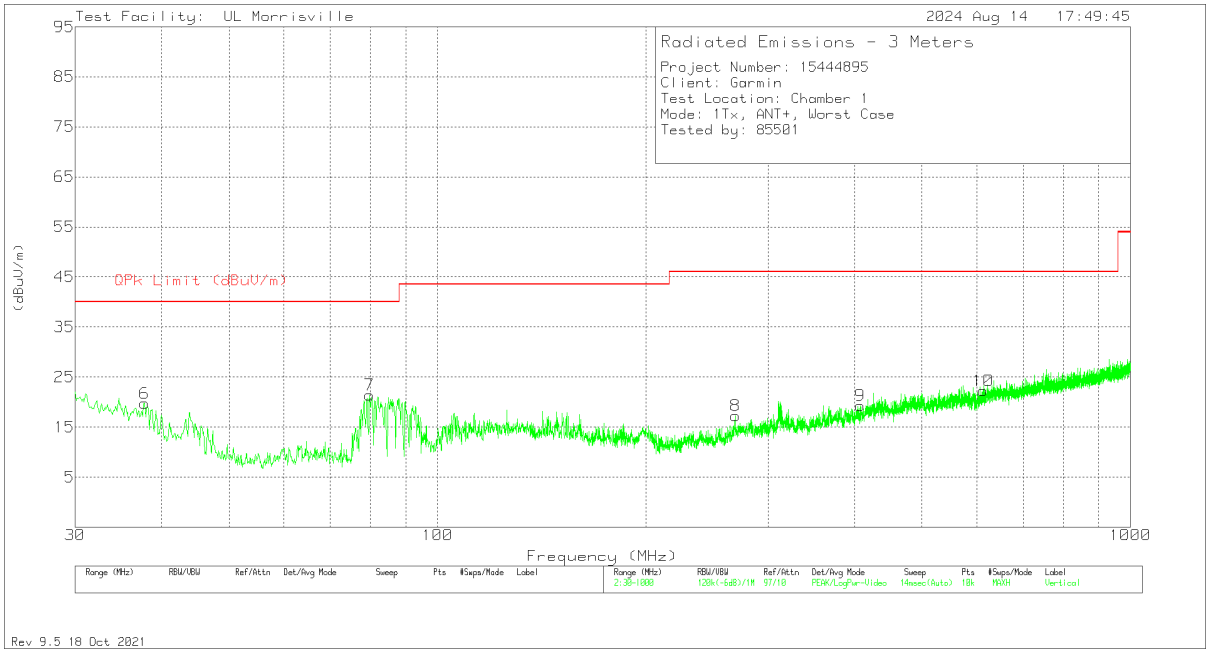
Pk - Peak detector

10.7. WORST CASE BELOW 1 GHZ (ANT/ANT+)

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)



HORIZONTAL



VERTICAL

Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	90629 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 37.857	27.09	Pk	21.3	-31.8	16.59	40	-23.41	0-360	200	H
3	* ** 162.017	32	Pk	18.5	-30.1	20.4	43.52	-23.12	0-360	200	H
4	* ** 408.979	27.01	Pk	21.7	-28.7	20.01	46.02	-26.01	0-360	399	H
5	* ** 612.776	25.53	Pk	25.1	-28.3	22.33	46.02	-23.69	0-360	299	H
6	* ** 37.76	30.12	Pk	21.4	-31.8	19.72	40	-20.28	0-360	100	V
8	* ** 269.202	27.41	Pk	19.2	-29.3	17.31	46.02	-28.71	0-360	100	V
9	* ** 407.524	26.53	Pk	21.7	-29	19.23	46.02	-26.79	0-360	100	V
10	* ** 612.679	25.43	Pk	25.1	-28.3	22.23	46.02	-23.79	0-360	100	V
7	79.761	38.27	Pk	14	-30.9	21.37	40	-18.63	0-360	100	V
2	155.906	34.96	Pk	18.5	-30.4	23.06	43.52	-20.46	0-360	200	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector

11. SETUP PHOTOS

Please refer to R15444895-EP1 for setup photos

END OF TEST REPORT

Test Report 2024-141

Version A
Issued 15 Aug 2024

Project GCL-0462
Model Identifier: A04883
Primary Test Standard(s):
CFR 47, FCC Part 15.249
RSS-210 Issue 11

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

Client-supplied Information

FCC ID:	IPH-04883
IC ID:	1792A-04883

ACCREDITED
CERTIFICATE #6162.01

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

1. Summary

The equipment or product described in section 5 of this report was tested at the Garmin Compliance Lab according to standards listed in section 6. This report focuses on the 2.4 GHz ANT transceiver(s) and limited to 1 GHz to 25 GHz band. Test records within this report may include data for the Bluetooth Low Energy (BLE) transceiver(s), but BLE is addressed in a separate report. In the frequency stability test record and AC mains conducted emissions, was used to show compliance for both BLE and ANT. The results are as follows.

Parameter	Description	Key Performance Values	Result	Data starts at page
Radio Modulation	Summary of the kinds of communication this radio can achieve, as stated by the client. [RSS-GEN at Annex A item 10b]	Digitally modulated spread spectrum at rates as high as 1 Mbps.	Reported	NT
Restricted Bands	The radio must not emit in certain designated restricted frequency bands above a set of limit values. [15.205; RSS-210 at 7.1]	Emissions in the restricted bands were at least 16.17 dB below the applicable limits.	PASS	14
Carrier and Harmonic Emissions	The field strength from the radio carrier and its harmonics must meet specific limits at a 3 m test distance. Other unwanted emissions also must meet what is commonly called the Class B limit. [15.249(a); RSS-210 at B.10]	The limit is 50 mV/m (94 dBuV/m) in the carrier band, and 0.5 mV/m (54 dBuV/m) at all other frequencies. This sample demonstrated 0.6 dB of margin or greater. At other non-harmonic frequencies, unwanted emissions had at least 2.7 dB of margin.	PASS	18
Other Bandwidths	Regulatory agencies also require the reporting of signal bandwidths using alternate processes. [2.202; RSS-GEN at 6.7]	These values are reported but have no actual performance requirements.	Reported	33
Frequency Stability	The radio tuning must be robust over a range of temperature and supply voltage conditions. [RSS-Gen at 6.11]	Radio emissions remained within the allowed radio band under all environmental conditions tested.	PASS	38
Unwanted Emissions (Mains Conducted)	While transmitting, the emissions conducted into the power mains must not be too strong. [15.207, RSS-Gen at 8.8]	Emissions other than the fundamental and harmonics must meet the 'Class B' limits. The measured emissions had at least 20.84 dB of margin.	PASS	41

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

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 2024-146. That report is treated as a part of this document by way of this reference.

2. Test Background

2.1 The Test Lab

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

2.2 The Client

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

2.3 Other Information

Test Sample received: 17 Jun 2024
Test Start Date: 18 Jun 2024
Test End Date: 10 Jul 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 Majid Farah and initially issued on 15 Aug 2024 as Version A.

Report Technical Review:

Majid Farah
Senior EMC Engineer

Report Approval:

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

4. Test Sample Modifications and Special Conditions

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

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

Modification 1
Detailed Description: A change of firmware from Version 2.10 to 2.11
Date applied: 20 Jun 2024
Reason for this modification:
This modification was performed on all samples due to a connectivity issue between EUT and companion device during BLE Receiver blocking testing. The client stated this firmware change only affects the BLE test page. Based on the client's statement GCL judged the presence of this modification has no effect on any other tests.

5. Description of the Equipment Tested

5.1 Unique Identification

Product Model	A04883
Serial Numbers Tested	3477207590, 3477207518

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

The client affirmed that the test samples will be representative of production in all relevant aspects.

5.2 Key Parameters

EUT Input Power:	5 Vdc
I/O Ports:	USB
Radio Transceivers:	Bluetooth Low Energy (BLE), ANT, NFC
Radio Receivers:	GPS L1, GPS L5, Galileo E1, Galileo E5a/b, BeiDou, GLONASS
Primary Functions:	Data collection and communication
Typical use:	Portable in multiple orientations
Highest internal frequency:	2.484 GHz
Firmware Revision	2.11 (see also section 4 of this report)

5.3 Operating modes

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

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

Mode 4: M4 (BleLnk). 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 (AntTx). ANT radio transmitting consistently on a selected channel.

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

Mode 9: M9 (RxBtBlA). The radio was set to receive 2.4 GHz signals but not transmitted in Bluetooth, Bluetooth low energy or ANT.

Mode 11: M11 (NfcTag). The NFC radio was transmitting and actively linked to a passive NFC tag.

Mode 12: M12 (NfcLnk). The NFC radio was transmitting and actively linked to an NFC card reader.

Mode 13: M13 (GnssY). 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 Radio was powered, but not transmitting or linked to any devices.

Mode 15: M15 (Normal). EUT is in normal operational mode (User mode) if some Transmitters are on during normal operational mode exclude radiations on those frequency.

Mode 17: M13 (GnssN). The Global Navigation Satellite System receiver is monitoring the GNSS bands, attempting to detect a constellation and determine location. The EUT is in GNSS receiving mode but no GNSS signal provided.

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

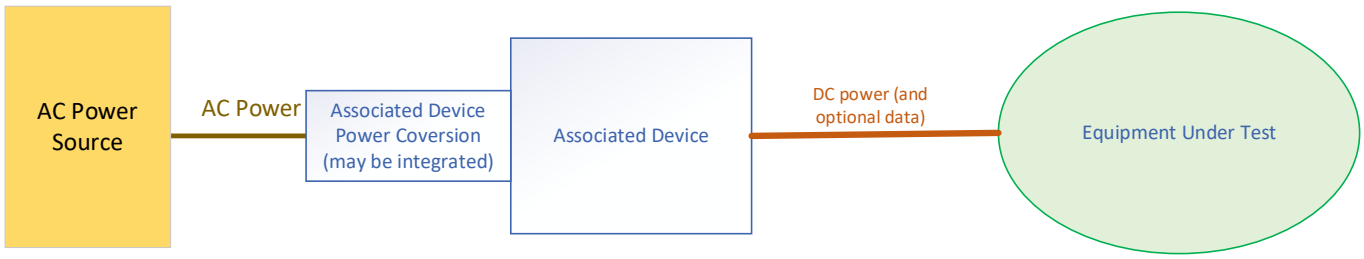
During test, the EUT components and associated support equipment were selected including the following arrangement sets.

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 for arrangements A2, A3, A4

Arrangement 5: A5 (NFCp) The test sample is placed near an NFC Card Reader or NFC tag. The NFC Card Reader is connected to a laptop computer. The test sample is powered by a device that does not include data over the cable, just as with A2. For clarity, test sample is NOT powered by, or connected to, the laptop computer that powers the NFC Card Reader.

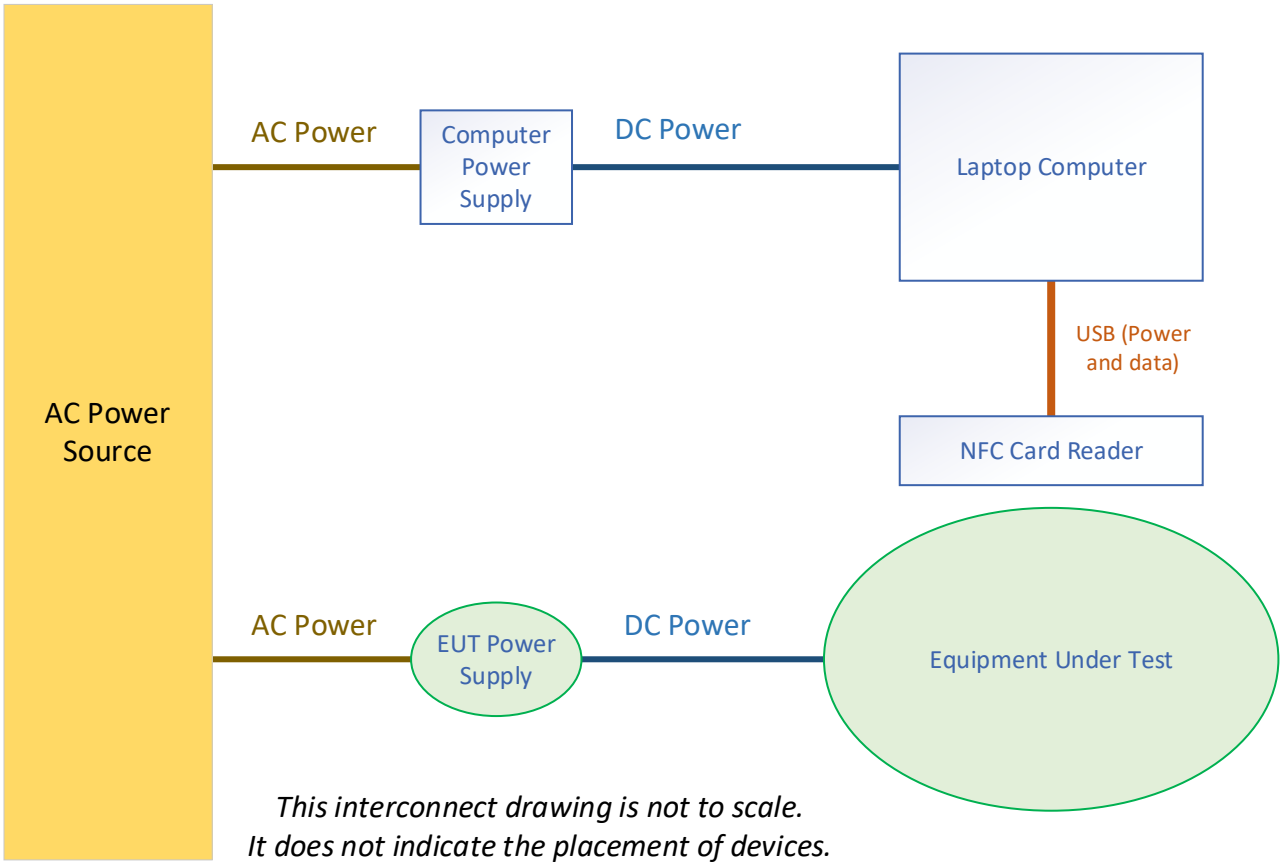


Figure 2: Block diagram of equipment arrangement A5

Arrangement 6: A6 (NFCu) The test sample is placed near an NFC Card Reader or NFC tag. The NFC Card Reader is connected to a laptop computer. The test sample is powered by its own batteries rather than an external power source. Either NFC Card reader or NFC tag can be used during test.

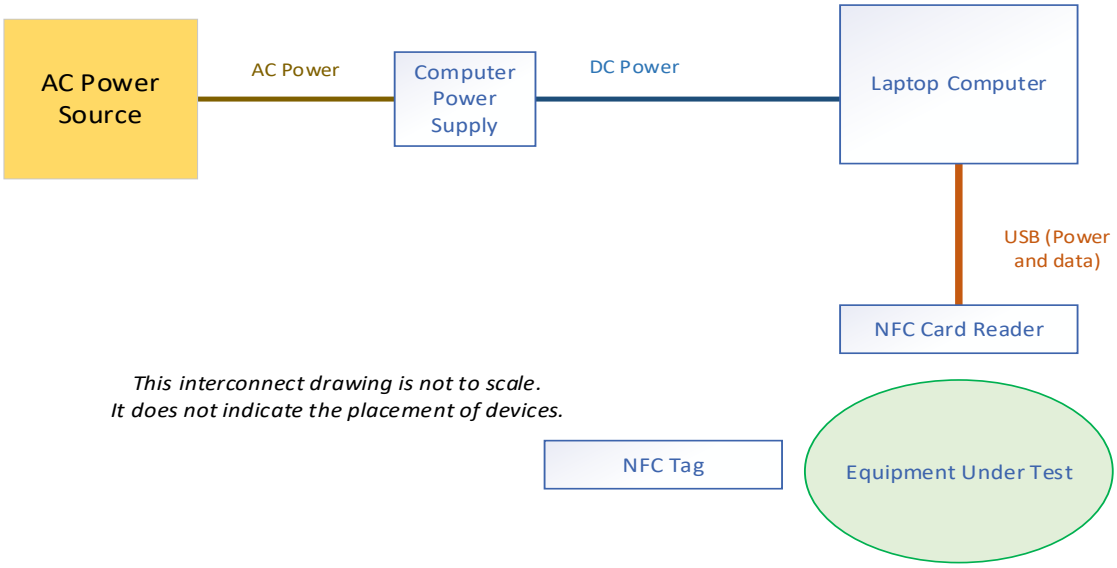


Figure 3: Block diagram of equipment arrangement A6

5.5 Associated Equipment (AE) used

Description	Manufacturer	Model	Serial Number
USB C power adaptor	Phihong (Garmin)	AQ27A-59CFA	362-00118-00
Laptop	Dell	Precision 5540	3JYG33
Power Supply	Dell	HA130PM130	CN-0V363H-CH200-78G-0DC1-A01
Laptop	Dell	Latitude 5410	5VSPFB3
Power Supply	Dell	HA65NM191	CN-0H374X-CH200-0BD-7TC0-A020BD-7TC0-A02
Phone	Samsung	SM-G973U (S10)	RF8MC0W9XVR
NFC Card Reader	ACS	ACR1252U-M1	RR554-118449
NFC Tag	SANPOPO	NTAG215	PD-STICKER-B-30
Auxiliary device	Garmin	A04882	3475112460

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.

AS/NZS 4268: 2017
CFR 47, FCC Part 15.249
ANSI C63.10: 2020, and ANSI C63.10: 2020 +Cor 1: 2023
RSS-GEN Issue 5 Amd 2
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.

FCC Part 2.202
TRC-43 Issue 3

6.3 Variances

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

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

6.4 Laboratory Accreditation

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

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

7 Measurement Instrumentation Uncertainty

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

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

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

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

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

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

8 Selected Example Calculations

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

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

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

8.1 AC Mains conducted emissions at 22 MHz

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

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

8.2 Radiated Emissions at 630 MHz

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

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

8.3 Radiated Emissions at 2.7 GHz

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

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

9 Environmental Conditions During Test

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

Temperature:	19.8 to 21.3 °C
Relative Humidity:	42.5% to 60% (non-condensing)
Barometric Pressure	96.8 to 98.9 kPa

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

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.

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 RE04
Project GCL0462

Test Date(s)	20 June 2024
Test Personnel	David Kerr
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M5 (AntTx)
Arrangement	A2 (Upwr)
Input Power	USB 5 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-210, RSS-GEN (as noted in Section 6 of the report)
Frequency Range:	Restricted Bands (2200-2300 MHz, 2310-2390 MHz, 2483.5-2500 MHz)
Pass/Fail Judgment:	**PASS**
Test record created by:	David A Kerr
Date of this record:	20 June 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	227596	14-Sep-2023	14-Sep-2025
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	16-Nov-2022	16-Nov-2025
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
Preamplifier, 500 MHz 18 GHz	Com-Power	PAM-118A	18040133	Calibration	Not Required
Wifi Filter	K&L	8NSL26-2437/E82.2-0/0	1	Calibration	Not Required

Table RE04.1: Test Equipment Used

Software Used
Keysight PXE receiver software A.32.06, RE Signal Maximization Tool v2023Jul14.xlsx, FCC Restricted Band 2p4GHz Data Analysis Template v1b 2023Jun20.xlsx.

Test Data

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

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

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

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

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
2274	54	74	37.826	49.001	16.174	24.999	171	4000	HORZ
2274	54	74	37.798	49.397	16.202	24.603	171	4000	HORZ

Table RE04.2: FCC restricted bands from 2200 to 2390 MHz (ANT, X orientation)

Frequency	Avg Limit	Pk Limit	Avg Level	Pk Level	Av Margin	Pk Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(degree)	(mm)	---
2483.5	54	74	36.556	58.333	17.444	15.667	-156	1019	VERT
2483.5	54	74	36.569	58.411	17.431	15.589	-156	1019	VERT

Table RE04.3: FCC restricted band from 2483.5 to 2500 MHz (ANT, X orientation)

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

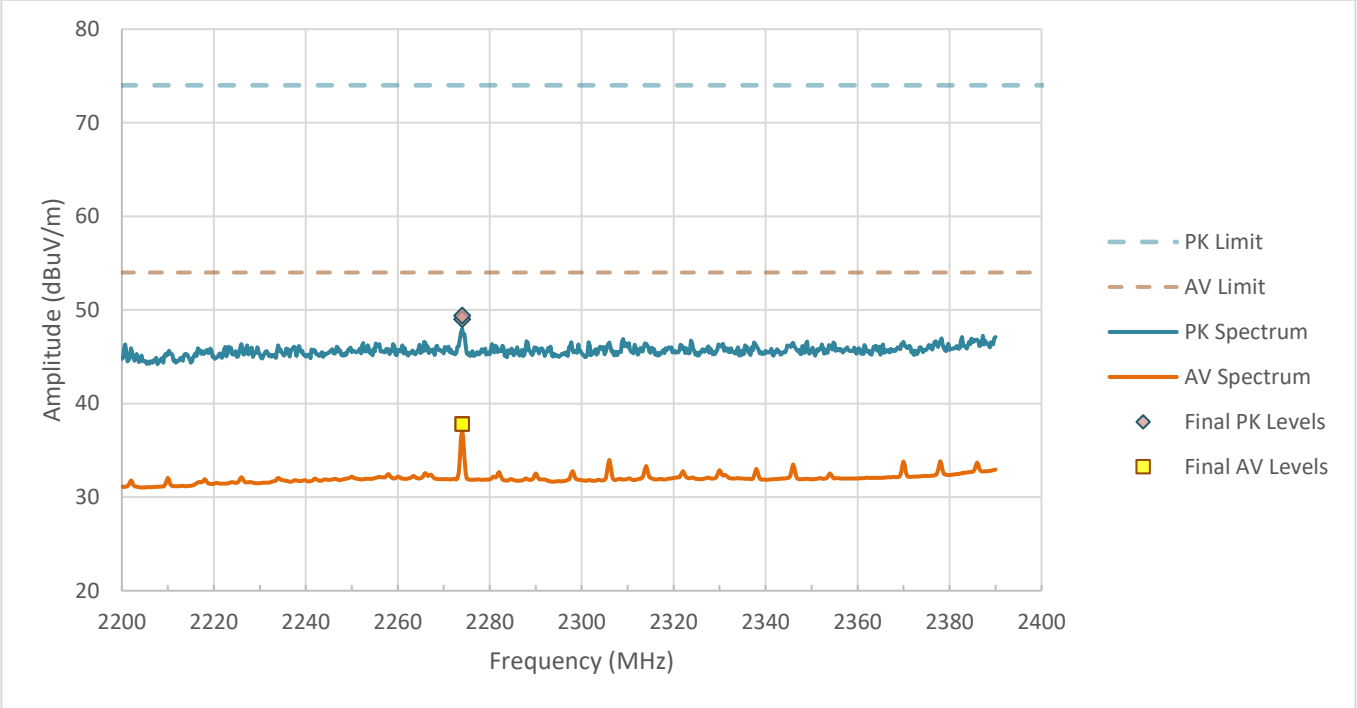


Figure RE04.1: FCC restricted band spectral data from 2200 to 2390 MHz (ANT, X orientation)

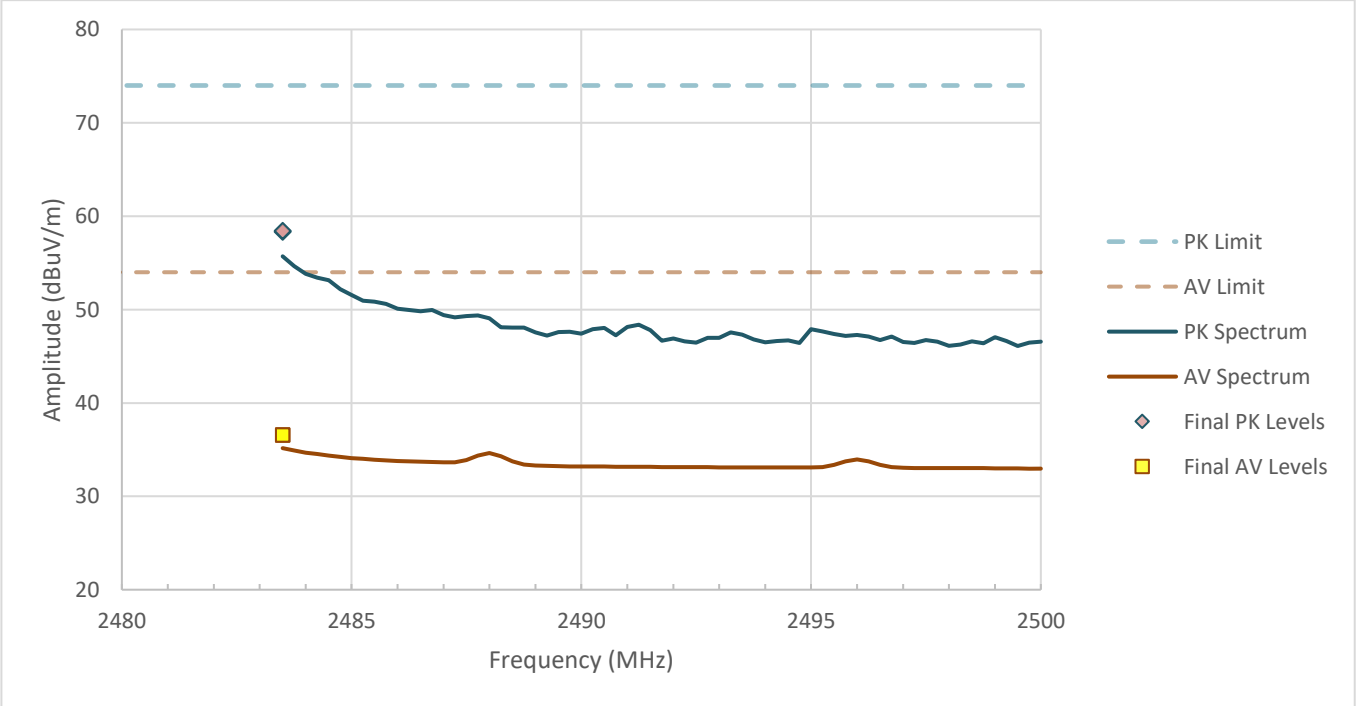


Figure RE04.2: FCC restricted band spectral data from 2483.5 to 2500 MHz (ANT, X orientation)

Setup Photographs

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

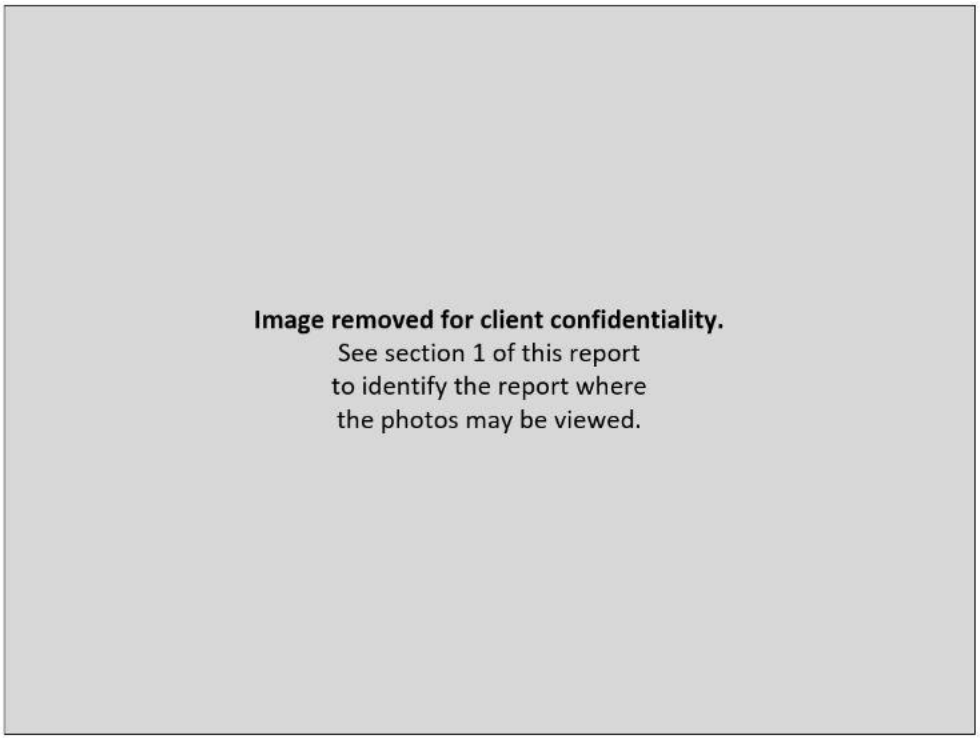


Figure RE04.3: EUT test setup, primary view (X orientation)

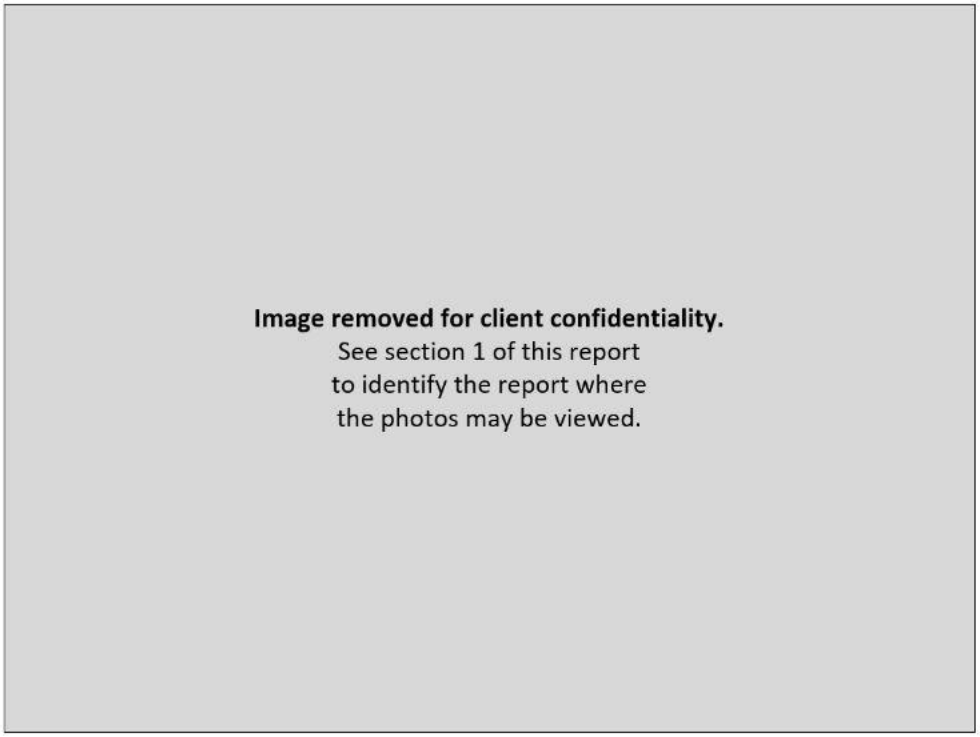


Figure RE04.4: EUT test setup, reverse view (X orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE24
Project GCL0462

Test Date(s)	24 Jun 2024, 25 Jun 2024
Test Personnel	Vladimir Tolstik, assisted by Dave Kerr and Jim Solum
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M5 (AntTx)
Arrangement	A2 (Upwr)
Input Power	USB 5 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	1000 MHz to 3200 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	David A Kerr**,** Vladimir Tolstik
Date of this record:	25 Jun 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	00227596	14-Sep-2023	14-Sep-2025
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

Table RE24.1: 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.

The table shows the selected final measurement data between 1000 MHz and 3200 MHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

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

The test sample was transmitting with a 96.3% duty cycle during this test. The duty cycle was measured using a fast diode detector RF power sensor and calculated according to ANSI C63.10. The client states that the maximum duty cycle for the ANT protocol is 13%. The CISPR Average detector has a square law response for signal pulses with these ANT timing parameters. In the data tables below, the Average detector values for the carrier frequencies have been adjusted downward by 17.6 dB, which comes from 20 * log (13% / 96.3%). The Peak detector values are not reduced for duty cycle, nor were the other emissions adjusted for duty cycle.

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		
2402.000	V	37.1	55.9	40.7	77.8	96.6	94.0	114.0	16.2	17.4	126.3	341.0
3050.000	V	7.7	24.2	43.1	50.8	67.3	54.0	74.0	3.2	6.7	345.2	291.0

Table RE24.2: Emission summary (X orientation, ANT 2402MHz)

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		
2440.000	V	36.1	54.9	40.9	77	95.8	94.0	114.0	17	18.2	262.5	16.0
3125.750	V	7.5	25.1	43.6	51.1	68.7	54.0	74.0	2.9	5.3	260.8	131.0

Table RE24.3: Emission summary(X orientation, ANT 2440MHz)

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		
2480.000	H	35.5	54.3	41.2	76.7	95.5	94.0	114.0	17.3	18.5	400.0	10.0
3160.250	H	7.5	24.8	43.8	51.3	68.6	54.0	74.0	2.7	5.4	284.0	183.0

Table RE24.4: Emission summary (X orientation, ANT 2480MHz)

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

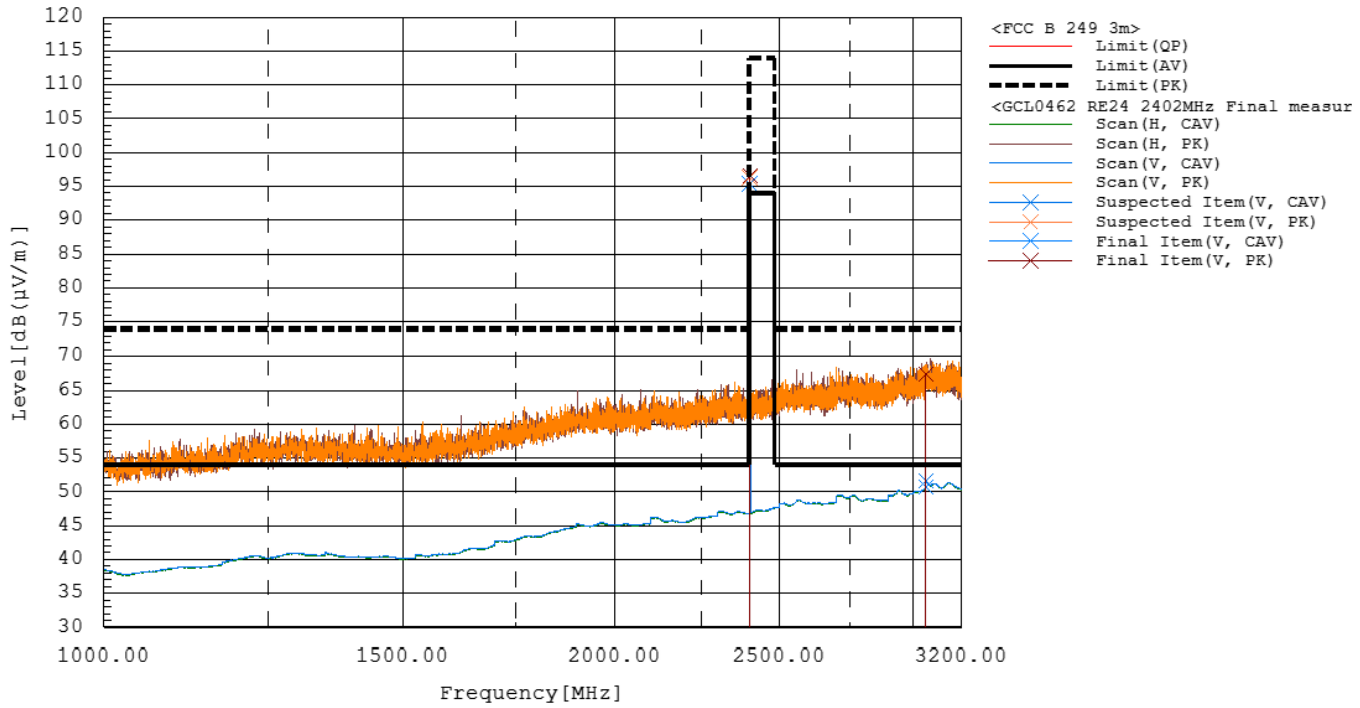


Figure RE24.1: Spectral data (X orientation, ANT 2402MHz)

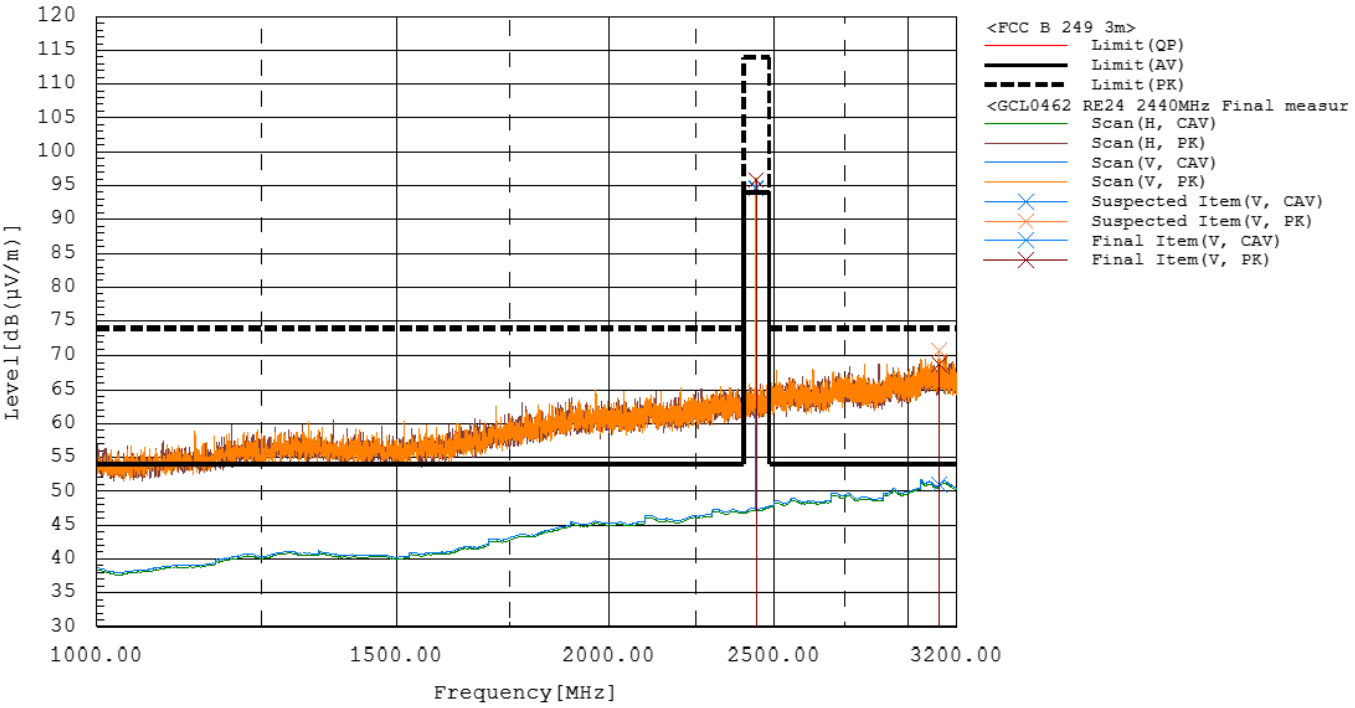


Figure RE24.2: Spectral data (X orientation, ANT 2440MHz)

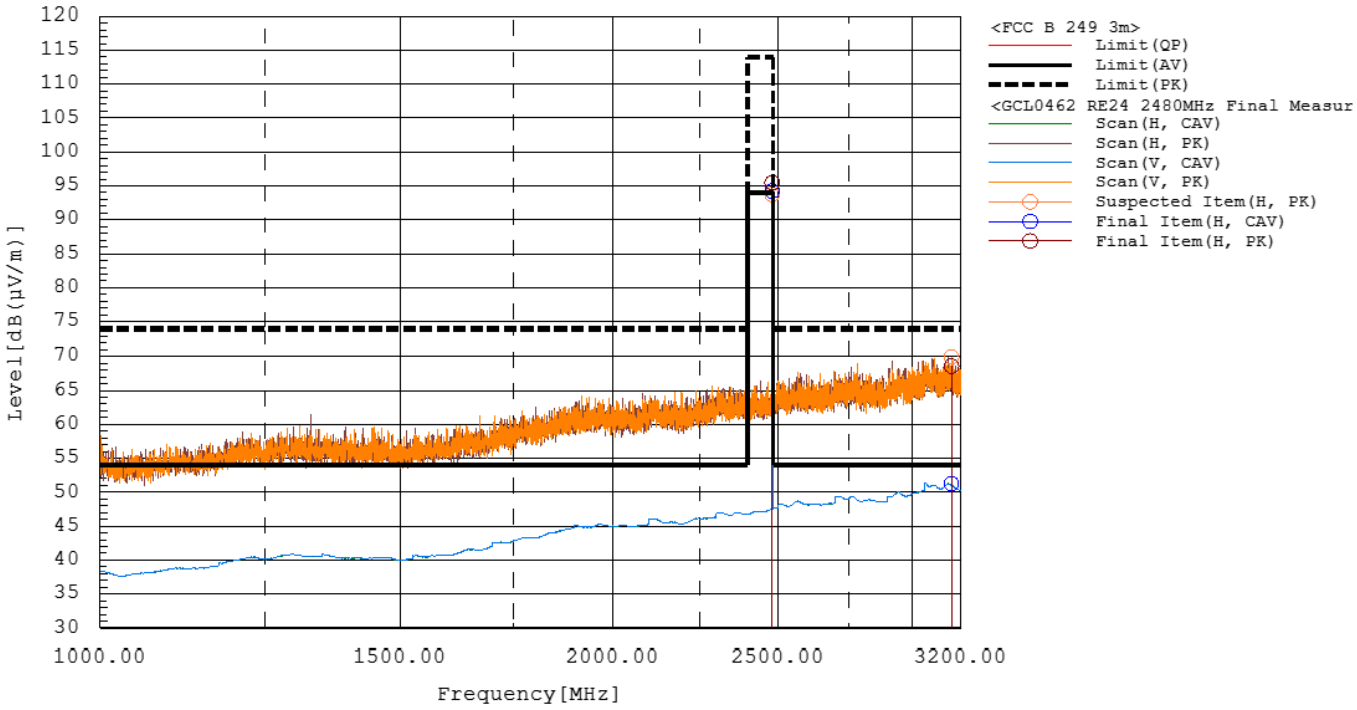


Figure RE24.3: Spectral data (X orientation, ANT 2480MHz)

Setup Photographs

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

Figure RE24.4: EUT test setup, first view

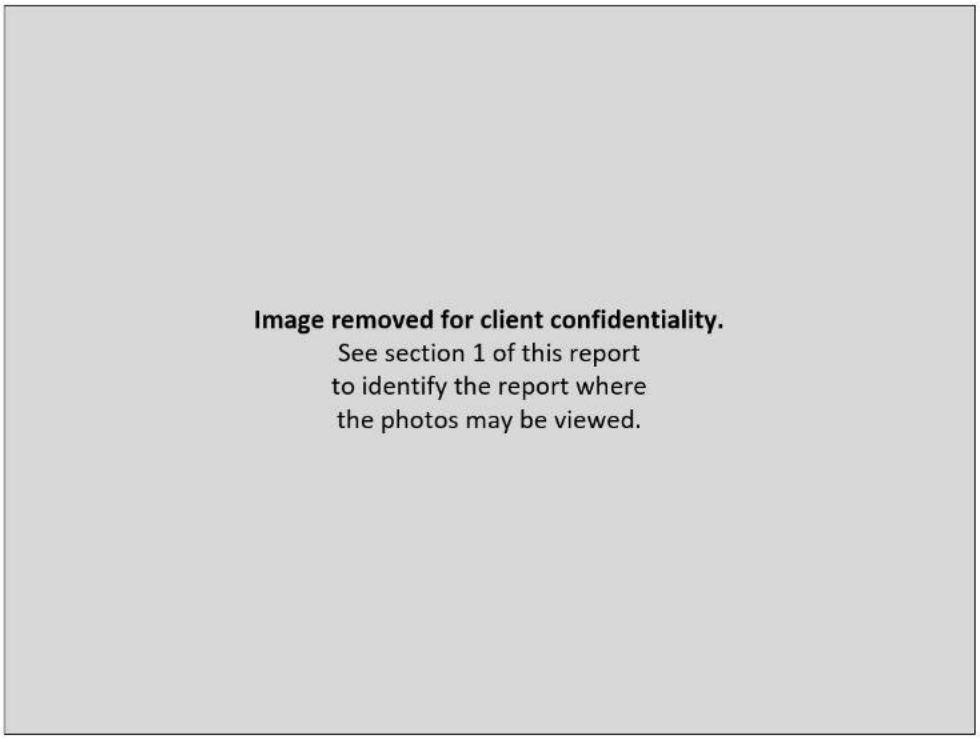


Figure RE24.5: EUT test setup, second view

This line is the end of the test record.

Test Record
Duty Cycle Effects SP01

Test Date	19 Jan 2023
Test Personnel	David Arnett
Product Model	A04600
Serial Number tested	3431708548
Operating Mode	Special: ANT Transmit per the sample studied
Arrangement	Special: USB Powered per the sample studied
Input Power	5V dc

Test record created by: **David Arnett**
Date of this test record: **27 Jan 2023**
Original record, Version A, created 27 Jan 2023.
Version B was created on 29 May 2024 for use in general test projects.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
RF Power Sensor	Rohde&Schwarz	NRP8S	109927	13-Jul-2022	15-Jul-2023
PXE 44GHz	Keysight	N9048B	MY59500016	2-Feb-2022	2-Feb-2023

Table SP01.1: Test equipment used

Test Software used: Keysight MXE System Code rev. A.33.03, R&S Power Viewer V11.3

Background

The question this test record addresses is how the radiated emission results above 1 GHz are affected by a change in transmission duty cycle. This is a general question related to the dynamics of the ANT transmission protocol and the CISPR detectors, not a specific product. As such this test record is relevant to many Garmin products other than the specific model used in the study.

ANSI C63.10 at various locations (such as 11.9.2.2.5.j) indicates that adjustment of measured average values using the measured duty cycle (D) is to be based on a linear law: 10 log(1/D). However, CISPR 16-1-1:2019 shows that a CISPR Average detector has square law pulse repetition response: 20 log(1/D). See, for example, figure 9 of CISPR 16-1-1, showing that a change in pulse repetition by a factor of 10 results in a 20 dB change in the instrument reading. The same figure shows that the reading of a CISPR peak detector should not be affected by the pulse repetition rate. This assumes the pulses are of sufficient duration to be detected.

The test application software in the test sample has two relevant modes for ANT radio transmissions. One is the regular ANT transmit test mode which produces near-continuous data. This is the operating mode used during radiated emission tests. The other is Packet mode which produces packets of a fixed length at a specified rate. That rate is expressed in units of packets-per-Hertz. These modes can be used to understand how the ANT duty cycle affects the Average Detector emission results, and whether it follows a linear or square law response.

Test Data
The client for the January 2023 project reported that the ANT radio protocol has a maximum duty cycle of 13.8%, which is much lower than the duty cycle used during radiated emission testing. The test modes discussed above allow a range of duty cycles to be evaluated above and below this protocol-limited value.

The duty cycles available in the various modes were first evaluated using the NRP8S, which is a fast diode RF power meter. This sample was one of the modified units providing a coaxial output from the transmitter rather than using the internal antenna. The packet length in Packet mode was measured at 156 usec, and duty cycles were measured for each available setting. The transmit power level from this sample was then evaluated in the same modes in a conducted manner by feeding the transmitter output through a coaxial cable to the input of the PXE Receiver. Data was recorded at the carrier frequency using peak and average detectors as they are usually set up

in a CISPR-compliant receiver during radiated emission tests above 1 GHz. All amplitude data in dBm units were then normalized to the Peak detector level as measured at the maximum duty cycle.

The resulting duty cycle and normalized amplitude data are presented in Table SP01.2.

Packet Rate (Hz)	Duty Cycle (%)	Peak (dB)	Avg (db)
Ant Tx Mode	96.300%	0	-1.2
255	3.978%	0	-27.98
128	1.997%	0	-33.89
64	0.998%	0.1	-39.69
32	0.499%	0	-45.4
16	0.250%	0.1	-50.62
8	0.125%	0	-55.42
4	0.062%	0.1	-58.95
2	0.031%	0	-61.33
1	0.016%	0.1	-61.99

Table SP01.2: Duty Cycle and Normalized Amplitude for ANT transmitter

Figure SP01.1 below plots this data along with the curves for the linear law response in ANSI C63.10 (green) and the square law response for a CISPR 16-1-1 Average detector (yellow). The average data is observed to follow the square law response for duty cycles above 0.5%, and the Peak detector data is unaffected by the duty cycle.

The orange triangles in the plot show the factors that were used in January 2023 for converting measured data in ANT Transmit test mode to the levels one would find when ANT has the maximum duty cycle permitted by the radio protocol. For comparison of data to a peak detector limit, that adjustment was 0 dB. For comparison of data to an average detector limit, that change was 20 * log (13.8% / 96.3%) or -16.83 dB.

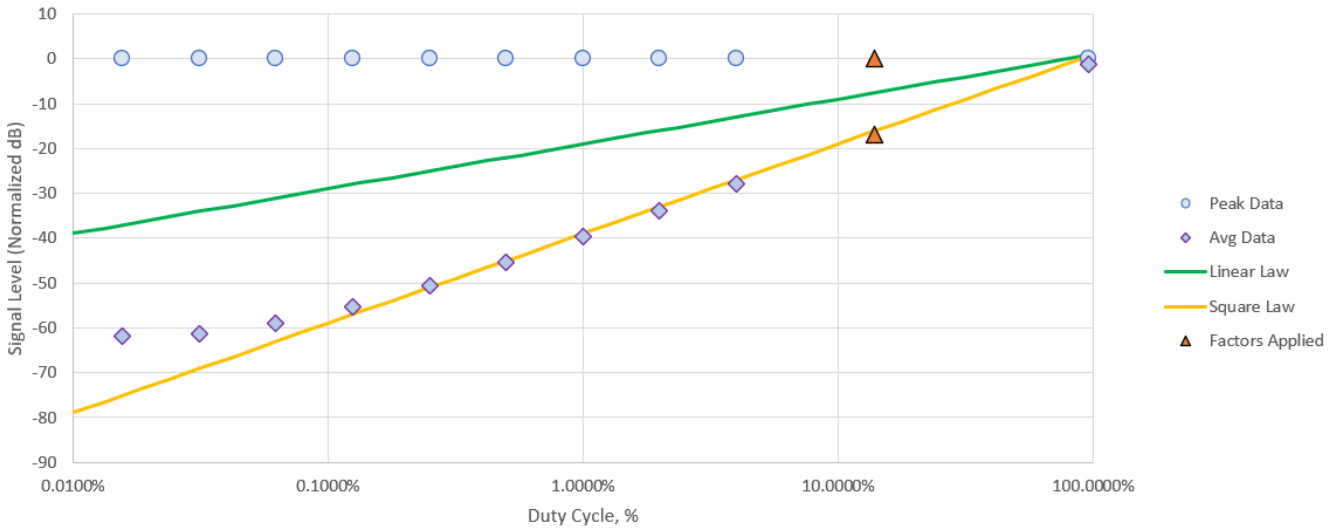


Figure SP01.1: Normalized Amplitude for ANT transmitter and linear or square law references

The Garmin Compliance lab uses this general result for projects involving ANT transmitter field measurements. The actual duty cycle, d_r, is measured for the test mode that will be used during radiated emission testing. The client reports the maximum duty cycle that the unit can produce in actual usage, d_u. Radiated emission data that has been measured using a CISPR Average detector can be reduced using $20*\log_{10}(d_u/d_r)$ before comparing against a limit. Radiated emission data measured using a Peak detector is not reduced but is reported as measured.

This line is the end of the test record.

Test Record
Radiated Emission Test RE25
Project GCL0462

Test Date(s)	25, 26, 27 Jun 2024
Test Personnel	Vladimir Tolstik assisted by David Kerr and Jim Solum
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M5 (AntTx)
Arrangement	A2 (Upwr)
Input Power	USB 5 Vdc
Test Standards:	FCC Part 15, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	3200 MHz to 18000 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	Vladimir Tolstik
Date of this record:	27 Jun 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	00227596	14-Sep-2023	14-Sep-2025
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
3 GHz High Pass filter	Anatech Electronics	0K0R2	01	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

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 3.2 GHz to 18 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

At azimuth angle 180° the 'front' reference mark of the turntable is pointed Southward. At 270° the reference mark points West. At 90° it points East. At 173° the turntable reference mark is pointed directly at the antenna. The

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

The table shows the selected final measurement data between 3.2 GHz and 18 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

Frequency	Pol.	Reading		Factor	Level		Limit		Margin		Height	Angle
MHz		dB(µV)		dB(1/m)	dB(µV/m)		dB(µV/m)		dB		cm	deg
		CAV	PK		CAV	PK	AV	PK	CAV	PK		
4804.000	V	31.7	45.4	7.1	38.8	52.5	54.0	74.0	15.2	21.5	125.6	331.0
7205.500	V	42.0	51.2	11.4	53.4	62.6	54.0	74.0	0.6	11.4	100.0	13.0
9608.000	V	27.8	41.6	15.1	42.9	56.7	54.0	74.0	11.1	17.3	310.3	241.0
12010.000	V	27.5	41.8	18.2	45.7	60.0	54.0	74.0	8.3	14.0	200.7	286.0
14412.000	V	26.2	40.8	20.9	47.1	61.7	54.0	74.0	6.9	12.3	313.4	353.0
16814.000	V	25.7	40.4	24.6	50.3	65.0	54.0	74.0	3.7	9.0	152.5	252.0

Table RE25.2: Emission summary (X orientation, 2402 MHz)

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		
4880.000	H	31.6	45.2	6.6	38.2	51.8	54.0	74.0	15.8	22.2	306.4	353.0
7319.500	H	37.4	48.5	11.7	49.1	60.2	54.0	74.0	4.9	13.8	100.0	30.0
9760.000	H	28.9	43.2	14.9	43.8	58.1	54.0	74.0	10.2	15.9	298.3	306.0
12200.000	H	26.9	40.6	19.0	45.9	59.6	54.0	74.0	8.1	14.4	321.6	262.0
14640.000	H	26.4	40.8	21.4	47.8	62.2	54.0	74.0	6.2	11.8	250.0	0.0
17080.000	H	25.5	40.9	24.6	50.1	65.5	54.0	74.0	3.9	8.5	100.0	327.0

Table RE25.3: Emission summary (X orientation, 2440 MHz)

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		
4960.000	H	31.5	44.9	6.7	38.2	51.6	54.0	74.0	15.8	22.4	286.6	0.0
7440.500	H	32.8	45.9	11.7	44.5	57.6	54.0	74.0	9.5	16.4	100.0	326.0
9920.000	H	29.3	43.1	16.0	45.3	59.1	54.0	74.0	8.7	14.9	365.8	142.0
12400.000	H	27.7	41.5	18.8	46.5	60.3	54.0	74.0	7.5	13.7	272.5	251.0
14880.000	H	26.2	40.9	21.6	47.8	62.5	54.0	74.0	6.2	11.5	208.2	348.0
17360.000	H	25.6	40.1	24.1	49.7	64.2	54.0	74.0	4.3	9.8	116.4	141.0

Table RE25.4: Emission summary (X orientation, 2480 MHz)

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

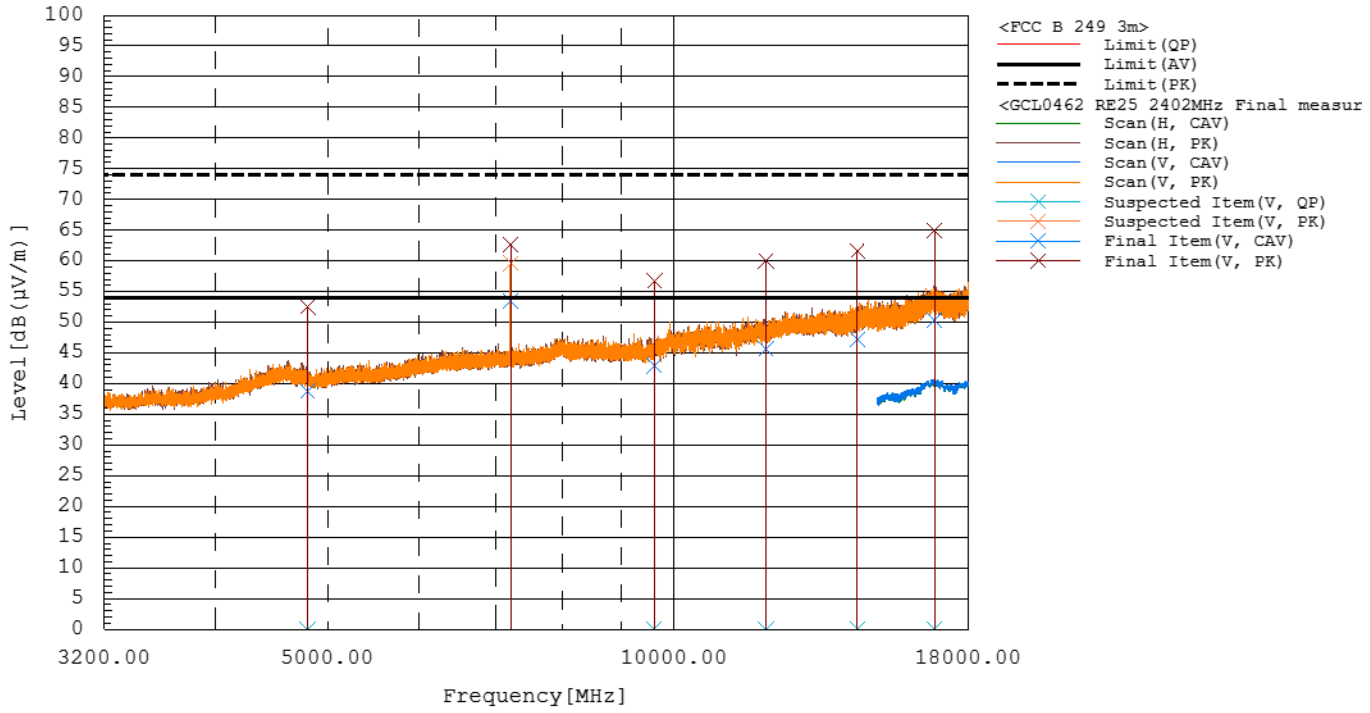


Figure RE25.1: Spectral data (X orientation, 2402 MHz)

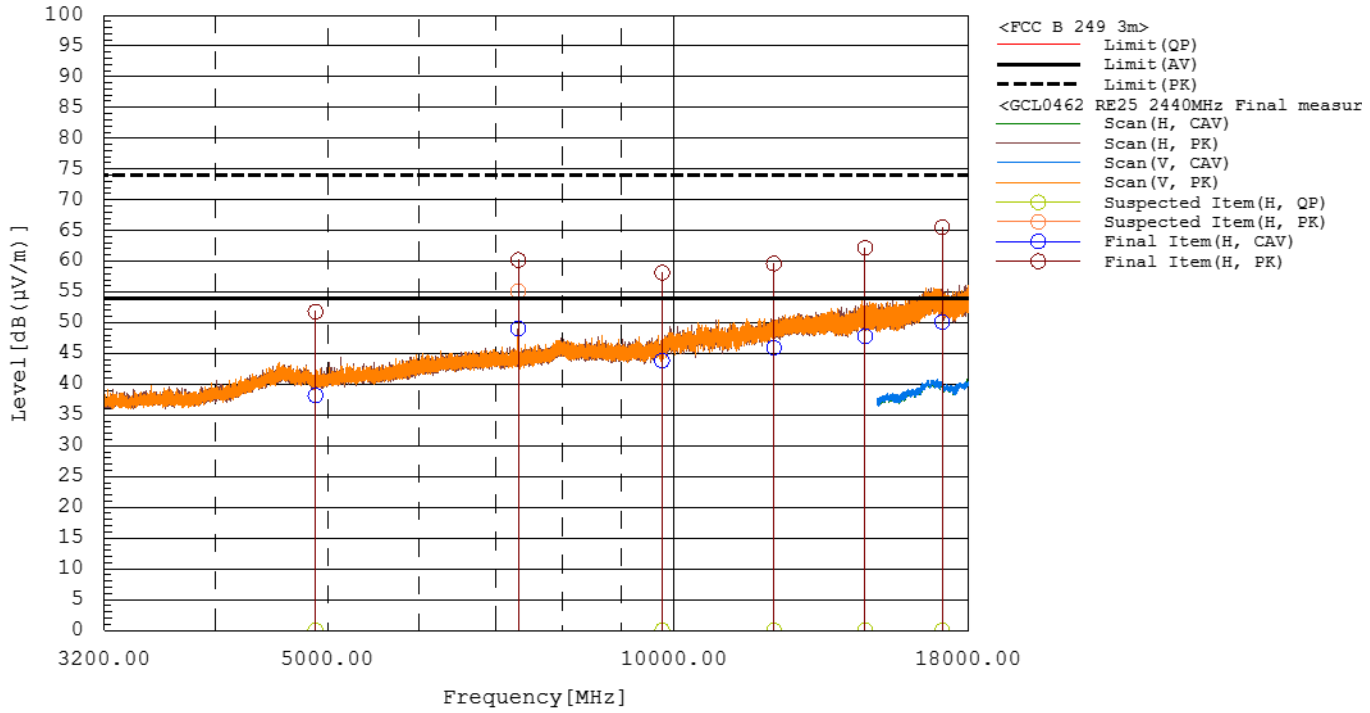


Figure RE25.2: Spectral data (X orientation, 2440 MHz)

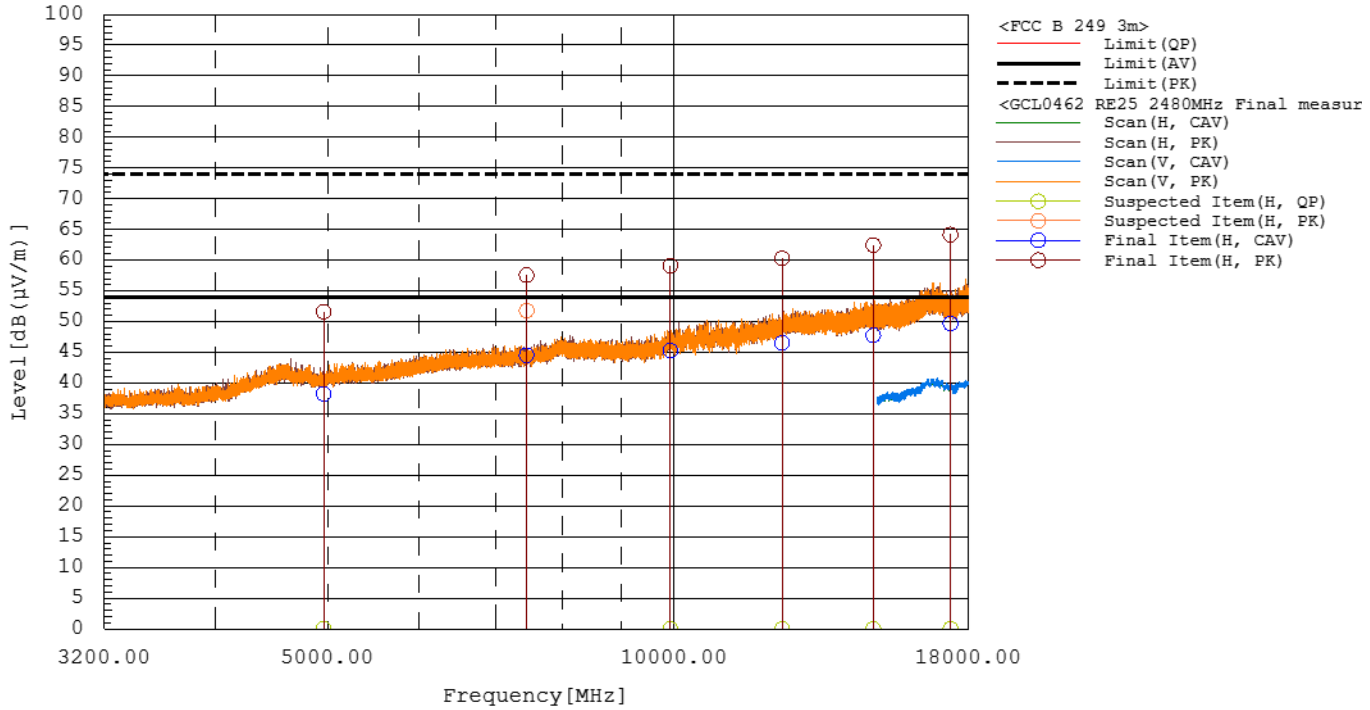


Figure RE25.3: Spectral data (X orientation, 2480 MHz)

Setup Photographs

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

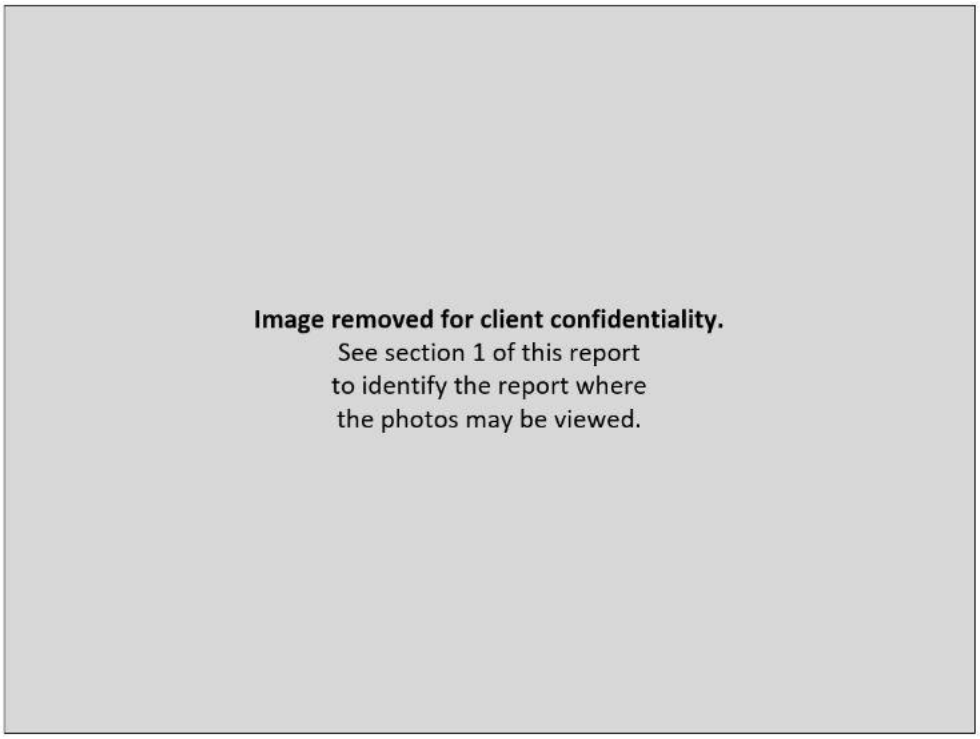


Figure RE25.2: EUT test setup, first view

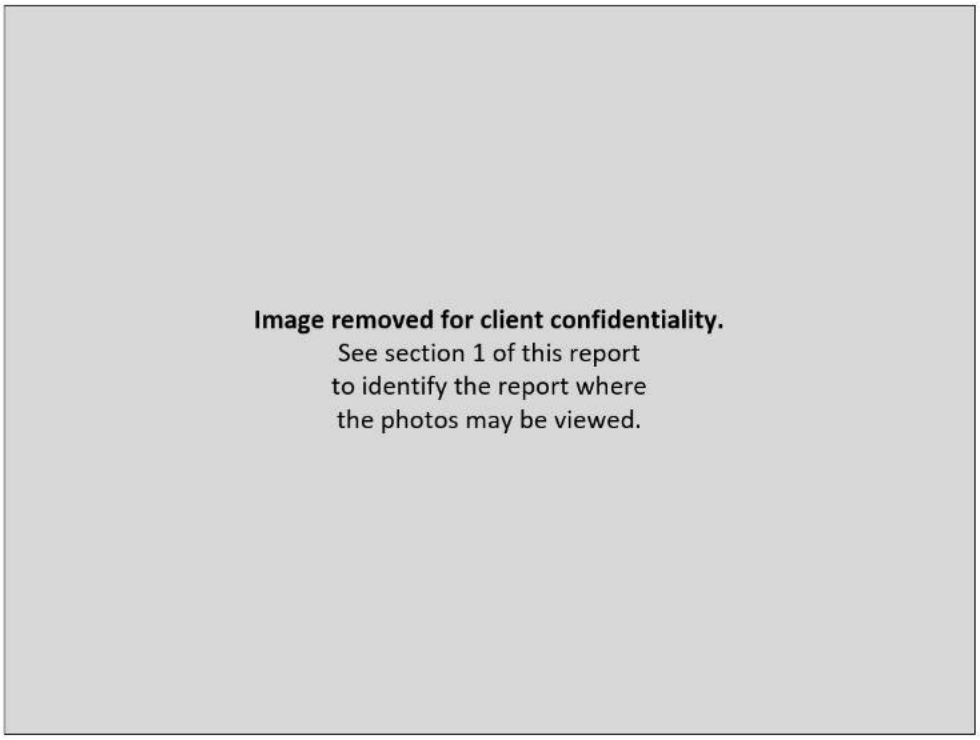


Figure RE25.3: EUT test setup, second view

This line is the end of the test record.

Test Record
Radiated Emission Test RE26
Project GCL0462

Test Date(s)	5 Jul 2024
Test Personnel	David Kerr, Aditya Prakash
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M5 (AntTx)
Arrangement	A2 (Upwr)
Input Power	5 Vdc
Test Standards:	FCC Part 15, ANSI C63.4, ICES-003, ANSI C63.10, ANSI C63.26, AS/NZS 4268, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	18 GHz to 25 GHz
Pass/Fail Judgment:	**PASS**
Test record created by:	Aditya Prakash
Date of this record:	8 Jul 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	13-Mar-2024	15-Mar-2025
Antenna, Horn, 10-40 GHz	ETS Lindgren	3116C	00227673	14-Sep-2023	15-Sep-2025
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, 18 Ghz to 40 Ghz	Com-Power	PAM-840A	461364	Calibration	Not Required
3 GHz High Pass filter	Anatech Electronics	0K0R2	01	Calibration	Not Required

Table RE26.1: Test Equipment Used

Software Used: Keysight PXE software A.33.03, RE Signal Maximization Tool v2021Feb25.xlsx, RE 18G to 44G Data AnalysisV2.xlsx

Test Data

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

In the 18 GHz to 25 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

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

The table shows the selected final measurement data between 18 GHz and 25 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the Composite FCC Class B Limit at 3m. Any unintentional radio emission limits are not applied to intentional radio signals.

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

Frequency	Avg Limit	Avg Level	Pk Level	Av Margin	Azimuth	Height	Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	(degree)	(mm)	---
19520.000	54.0	43.7	57.0	10.3	35	2719	HORZ
21960.000	54.0	44.5	58.0	9.5	33	3833	VERT
22588.250	54.0	44.4	58.2	9.6	148	3743	HORZ
24400.000	54.0	44.8	58.6	9.2	130	1267	HORZ

Table RE26.2: Emission summary

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

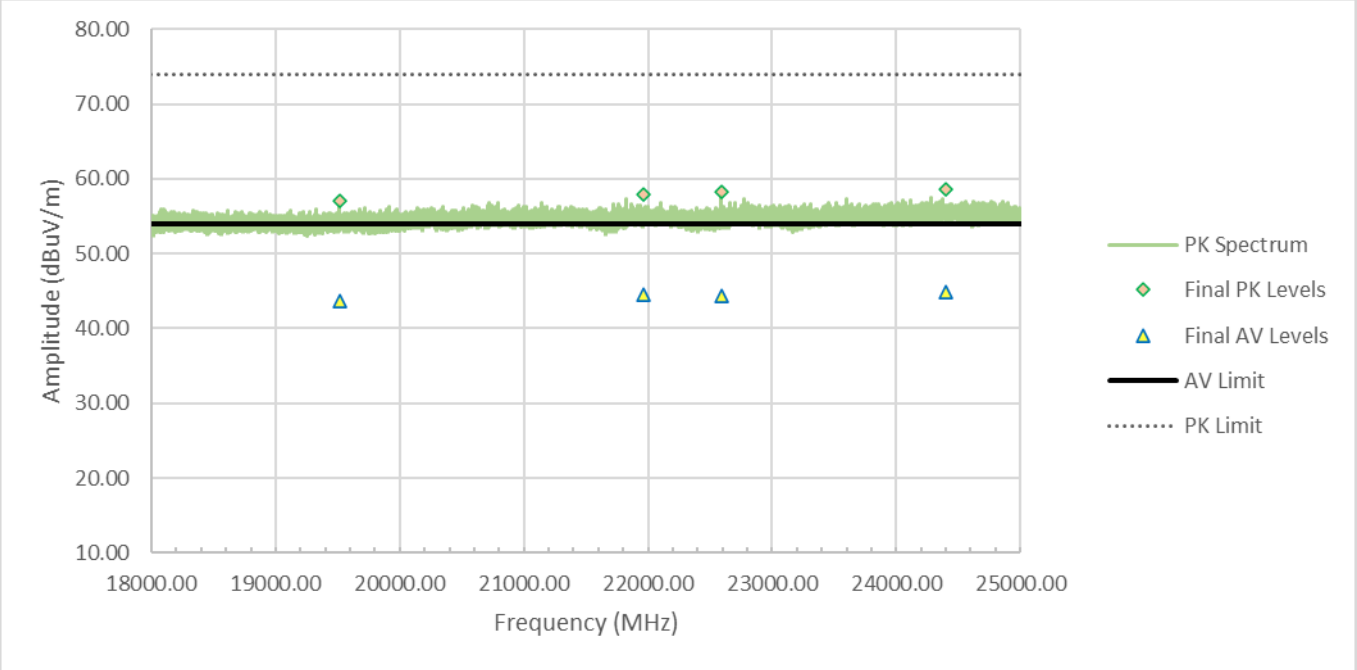


Figure RE26.1: Spectral data

Setup Photographs

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

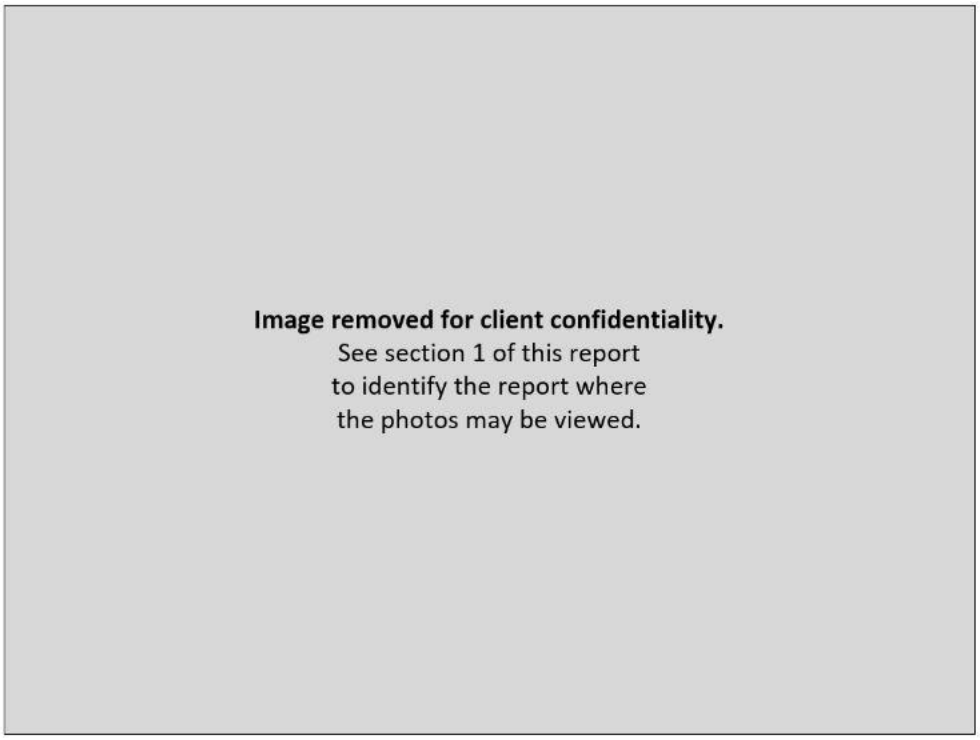


Figure RE26.2: EUT test setup, first view

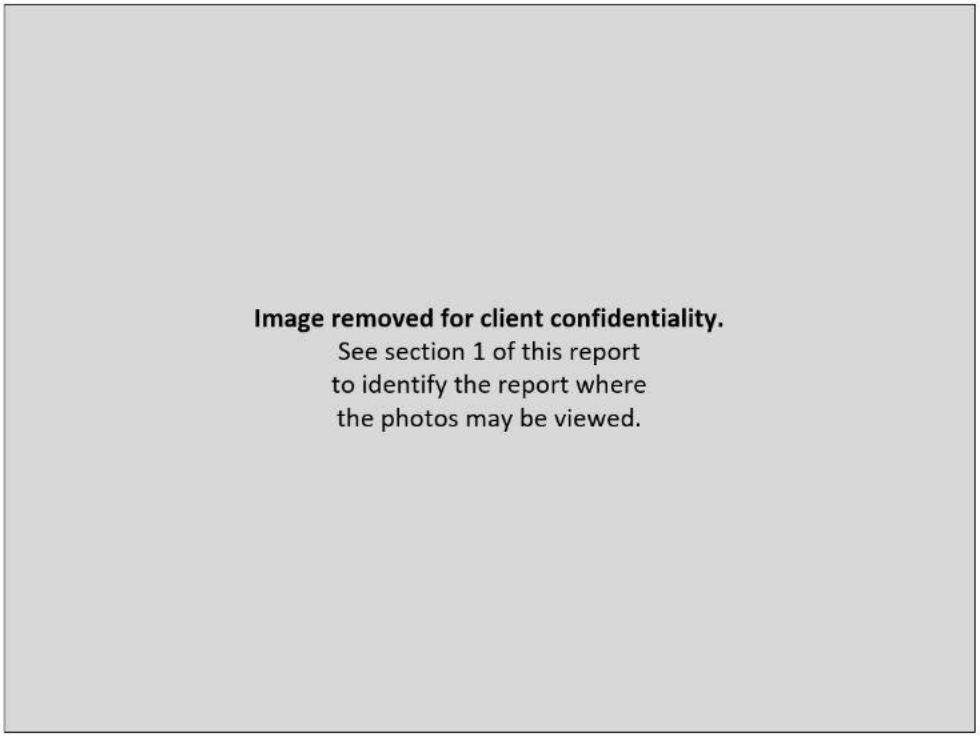


Figure RE26.3: EUT test setup, second view

This line is the end of the test record.

Test Record
Transmitter Bandwidth Tests
Test IDs TR10, TR11
Project GCL0462

Test Date(s)	26 Jun 2024
Test Personnel	Majid Farah
Product Model	A04883
Serial Number tested	3477207518
Operating Mode	M3 (BleTx), M5 (AntTx)
Arrangement	A4 (Udc)
Input Power	5 Vdc
Test Standards:	FCC Part 2.202, ANSI C63.10, TRC-43, RSS-GEN (as noted in Section 6 of the report).
Radio Protocol	Bluetooth Low Energy (BLE), ANT
Radio Band	2400 to 2483.5 MHz
Pass/Fail Judgment:	**Reported**
Test record created by:	**Majid Farah**
Date of this record:	**1 Jul 2024**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	13-Mar-2024	15-Mar-2025

Table TR10.1: List of test equipment used

Test Software Used: Keysight PXE firmware A.33.03

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

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

Test Setup

This block diagram shows the test equipment setup.

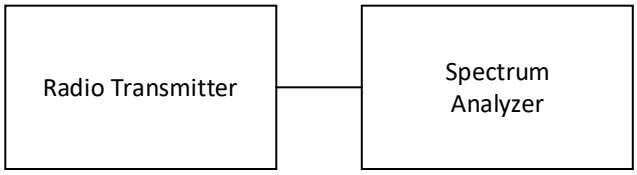


Figure TR10.1: Test setup

Occupied Bandwidth, 99% Test Method

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

Occupied Bandwidth, 99% Test Data

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

Mode	Speed	2402 (04)	2442	2480 (78)
BLE	1 Mbps	**1.0470**	**1.0481**	**1.0502**
BLE	2 Mbps	**2.0494**	**2.0515**	**2.0531**
ANT	Fixed	**0.9824**	**0.9840**	**0.9836**

Table TR10.2: Summary of 99% occupied bandwidth data in MHz for ANT and BLE modes

Figure TR10.2: Bandwidth data for BLE 1 Mbps at 2480 MHz

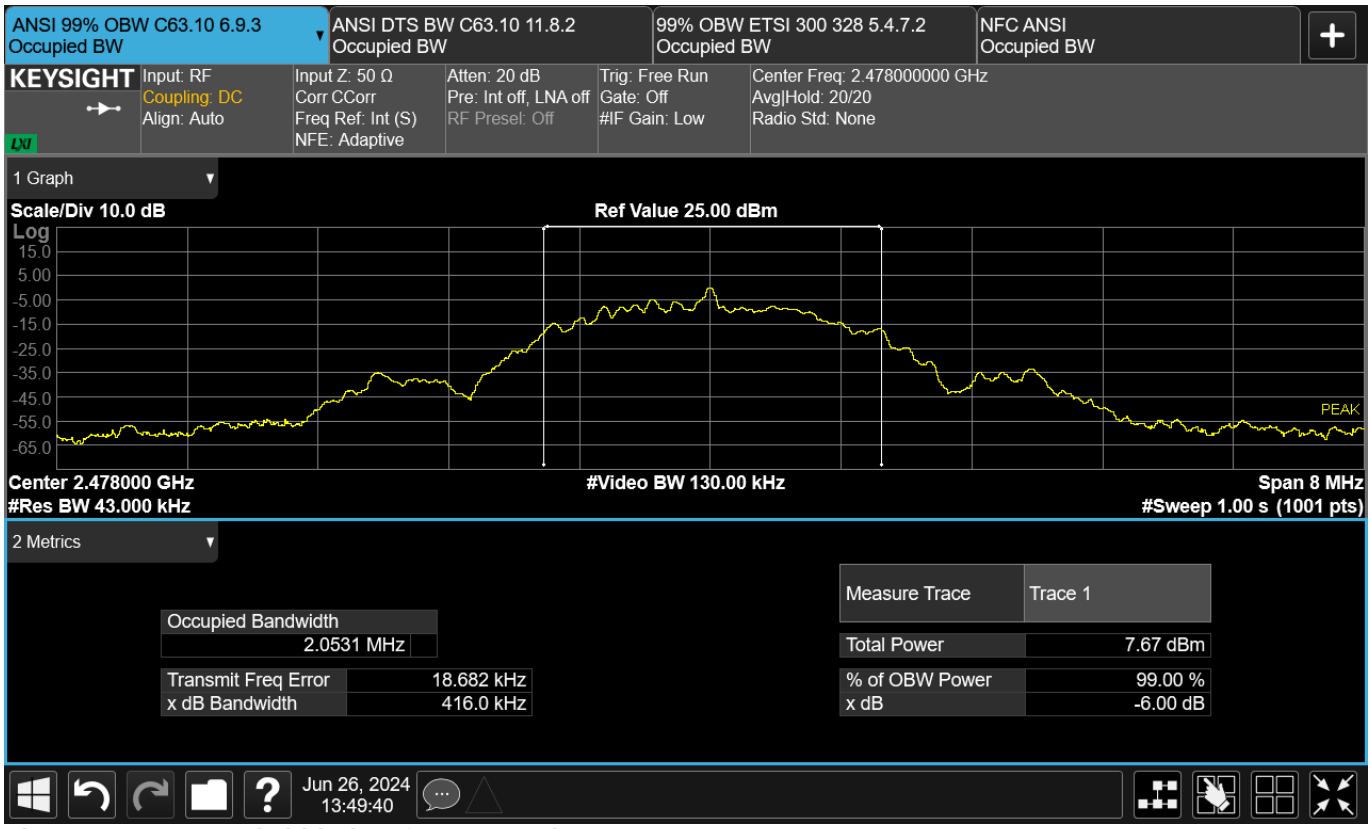


Figure TR10.3: Bandwidth data for BLE 2 Mbps at 2478 MHz

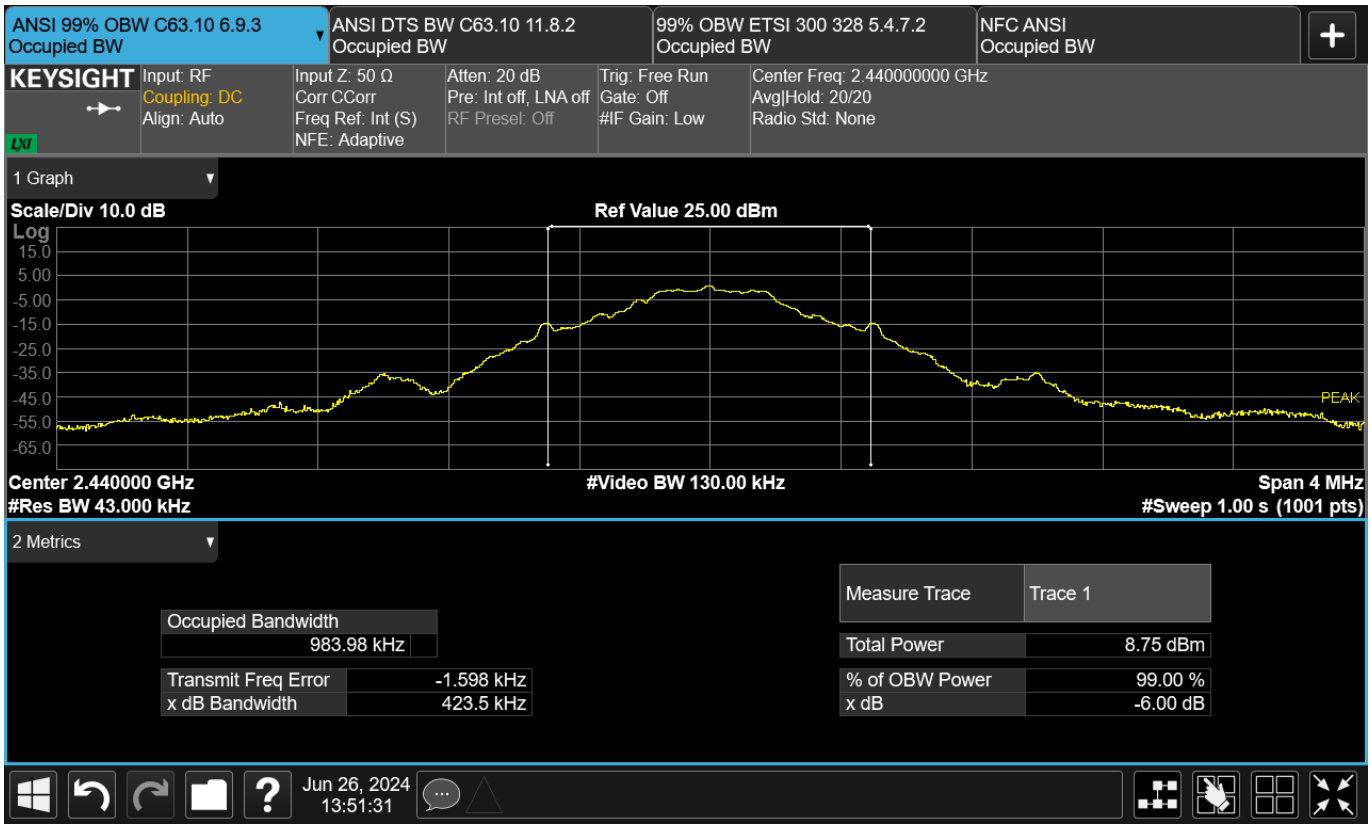


Figure TR10.4: Bandwidth data for ANT at 2440 MHz

Necessary Bandwidth Calculations

The Necessary Bandwidth is a theoretical value based on the specifications for a communication protocol, rather than the hardware implementation and a subsequent lab measurement. The analysis methods in FCC Part 2.202 and TRC-43 are the same for Bluetooth, ANT, and IEEE 802.11b WiFi. However, they differ for IEEE 802.11g and 11n systems because the Canadian TRC-43 standard provides different analysis methods for Orthogonal Frequency Division Multiplexing systems (OFDM). The tables below will show the analysis for most of the radios signals as a combined approach, then separately analyze the results for IEEE 802.11g and n systems. The tables below may include radio protocols that are not part of the product being evaluated.

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

$$B_N = 2R / Log_2(S)$$

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

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

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

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

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

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

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

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

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

As a note, the bit rate for IEEE 802.11 n WiFi is calculated based on the IEEE standard's short guard interval of 400 nsec. If only the long guard interval of 800 nsec were implemented, the bit rate for MCS7would decrease to 65 Mbps for a Necessary Bandwidth of 21.7 MHz.

The TRC-43 method for OFDM signals simply multiplies the number of subcarriers, K, and the subcarrier spacing, N_S. In both cases, Ns is 312.5 kHz. The count of subcarriers includes nulls. So for example, 802.11 n uses 4 pilot subcarriers, 52 data subcarriers, and one null suppressed subcarrier in the middle for 57 total subcarrier channels.

$B_N = N_S * K$

Radio Type	Ns (MHz)	K	BN (MHz)
802.11g	0.3125	53	16.6
802.11n	0.3125	57	17.8

Table TR10.105: Necessary Bandwidth for IEEE 802.11 g and n 20 MHz Radio Protocols (TRC-43)

This line is the end of the test record.

Test Record
Transmitter Stability in Extreme Conditions
Test IDs TR43
Project GCL-0462

Test Date(s)	02 Jul 2024
Test Personnel	Vladimir Tolstik supervised by Majid Farah
Product Model	A04883
Serial Number tested	3477207518
Operating Mode	M3 (BleTx)
Arrangement	A4 (Udc)
Nominal Input Power	USB 5 Vdc
Test Standards:	FCC part 15, RSS-GEN, ANSI C63.10 (as noted in Section 6 of the report)
Radio Protocol	BLE (Bluetooth Low Energy)
Pass/Fail Judgment:	**PASS**
Test record created by:	Vladimir Tolstik
Date this record:	03 Jul 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
MXE Receiver 8.4 GHz	Keysight	N9038B	MY63460112	28-Feb-2024	1-Mar-2025
Thermometer	Thermco	ACCD370P	210607316	21-Sep-2023	15-Sep-2024
Thermal Chamber	Tenney	T2RC	32774-02	Calibration	Not Required
DMM Multimeter 87V	Fluke	87V	63490051	21-Jun-2024	21-Jun-2025

Table TR43.1: 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 acceptance criterion is that the 6 dBc Occupied Bandwidth of the modulated signal should remain within the 2400-2483.5 MHz radio band.

The modes utilized include those that showed emissions closest to the band edge during prior bandwidth testing.

Test Data

The test sample(s) were subjected to extreme conditions and performed as shown below. Yellow highlights indicate the highest level for a protocol, for which an image of the spectrum is also provided. In the spectral plots, the data sets have been combined to present the low and high channel results side by side. Markers 1 and 3 indicate the spectral peak while markers 2 and 4 are at the 2400 MHz or 2483.5 MHz band edge. Markers 2 and 4 in the table below spectral data show differences to Markers 1 and 3.

Tx Mode	Temp	Volts	Low Ch.	High Ch.
Bluetooth	˚C	Vdc	dBc	dBc
BLE 1 Mbps	60	5	-35.34	-36.07
BLE 1 Mbps	50	5	-34.91	-35.25
BLE 1 Mbps	40	5	-34.17	-34.29
BLE 1 Mbps	30	5	-32.26	-35.25
BLE 1 Mbps	20	5	-31.92	-34.93
BLE 1 Mbps	10	5	-29.96	-34.18
BLE 1 Mbps	0	5	-29.27	-34.75
BLE 1 Mbps	-10	5	-27.94	-34.50
BLE 1 Mbps	-20	5	-27.63	-32.87

Table TR43.2 Difference between peak and band edge levels for BLE 1 Mbps transmissions during temperature variations

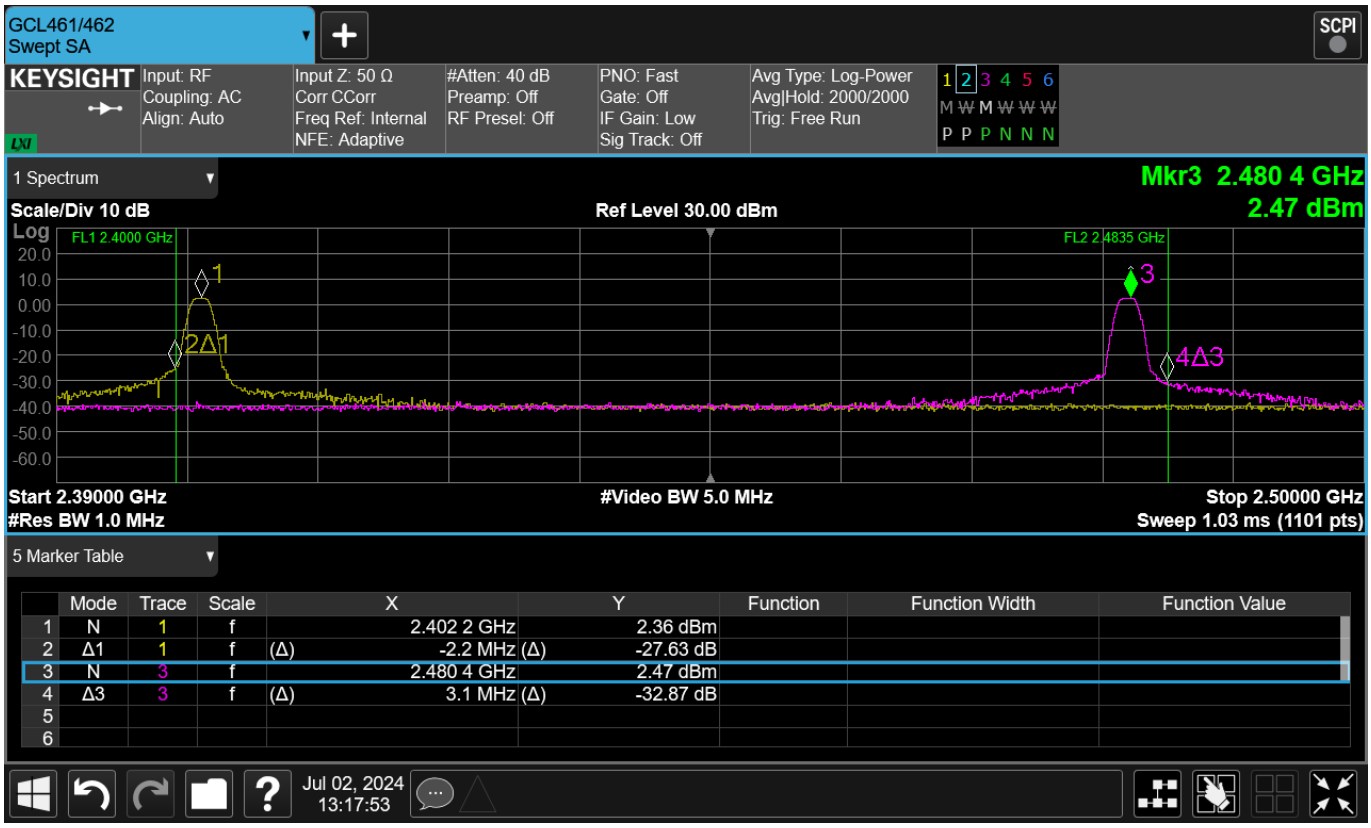


Figure TR43.1: Spectral data for BLE 1 Mbps at -20 °C which represent low and high channel

Tx Mode	Temp	Volts	Low Ch.	High Ch.
Bluetooth	˚C	Vdc	dBc	dBc
BLE 1 Mbps	20	4.25	-30.51	-34.38
BLE 1 Mbps	20	5	-31.92	-34.93
BLE 1 Mbps	20	5.75	-31.12	-35.65

Table TR43.3 Difference between peak and band edge levels for BLE 1 Mbps transmissions at 20 °C during voltage variations

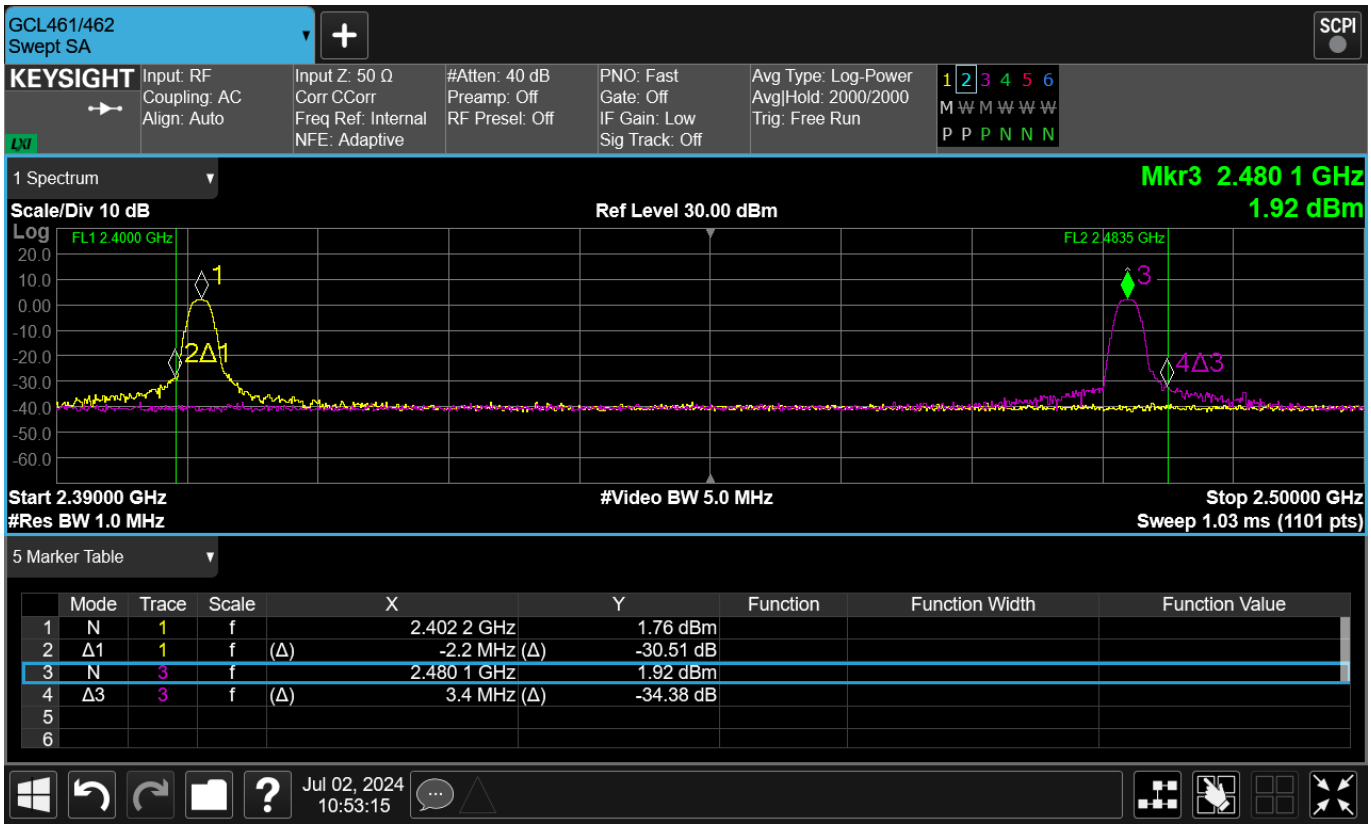


Figure TR43.2: Spectral data for BLE 1 Mbps at 20 °C which represent low and high channel at 4.25 V.

Setup Block Diagram

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

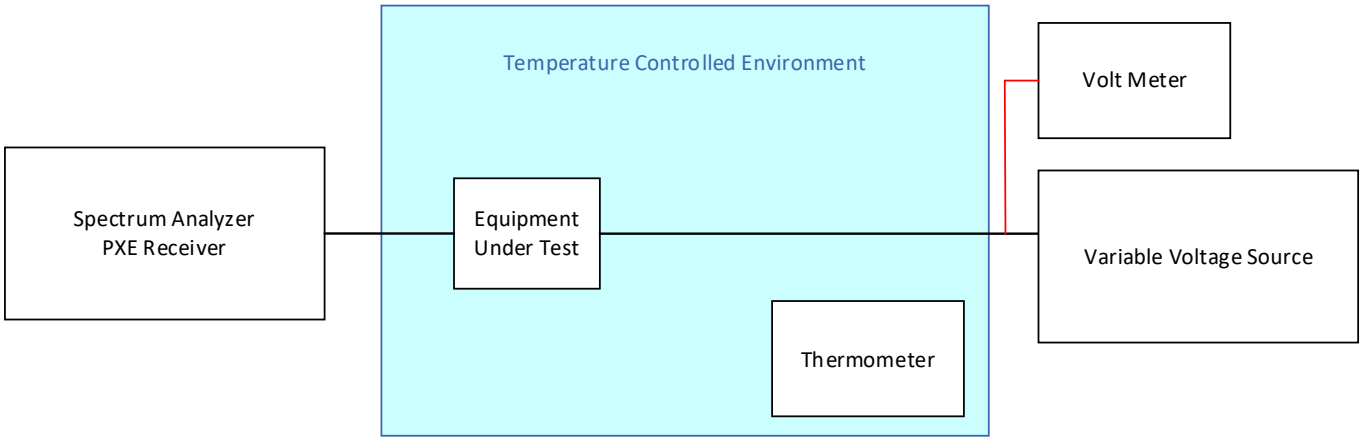


Figure TR43.3: Schematic drawing of the test equipment setup

This line is the end of the test record.

Test Record
Conducted Emissions Mains Test CE01
Project GCL0462

Test Date(s)	01 July 2024
Test Personnel	David Arnett assisted by Andy Heier
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M3 (BleTx)
Arrangement	A2 (Upwr)
Input Power	120 Vac 60 Hz
Test Standards:	FCC Part 15, ANSI C63.10, RSS-247 (as noted in Section 6 of the report).
Frequency Range:	150 kHz to 30 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	David Arnett, Andy Heier
Date of this record:	1 July 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	13-Mar-2024	15-Mar-2025
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10721	30-Aug-2023	1-Sep-2026
LISN multiline; 20A 50uH	Com-Power	LIN-120C	20160005	3-Apr-2024	1-Apr-2027

Table CE01.1: 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 (kHz)	QP Limit (dBuV)	AV Limit (dBuV)	L1 QP (dBuV)	L2 QP (dBuV)	L1 AV (dBuV)	L2 AV (dBuV)	QP Margin (dB)	AV Margin (dB)
150	66.00	56.00	32.56	32.83	23.52	23.28	33.17	32.48
164	65.28	55.28	30.80	30.81	26.67	26.57	34.47	28.62
1676	56.00	46.00	29.35	29.24	25.16	24.92	26.65	20.84
8086	60.00	50.00	28.02	27.40	22.62	22.23	31.98	27.38
10001	60.00	50.00	29.48	29.44	25.52	25.61	30.52	24.39
27348	60.00	50.00	29.29	29.58	24.09	24.39	30.42	25.61

Table CE01.2: Emission summary

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

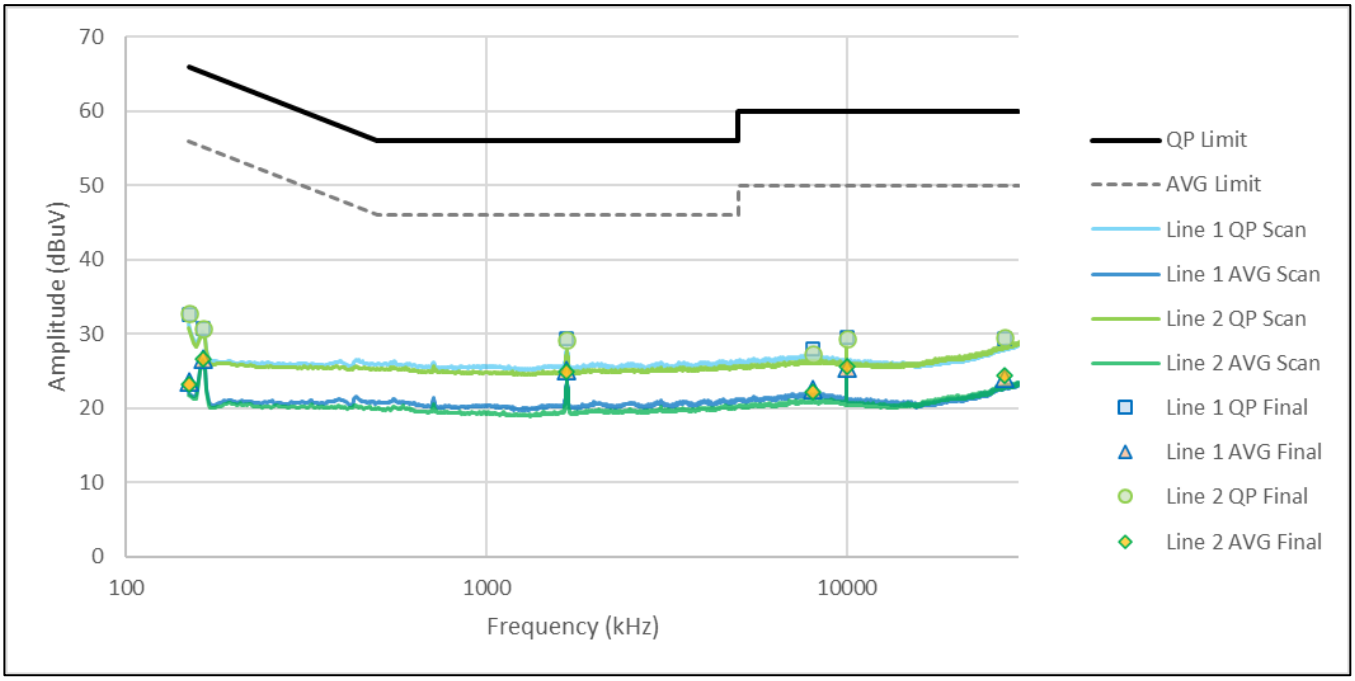


Figure CE01.1: Spectral data

Setup Photographs

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

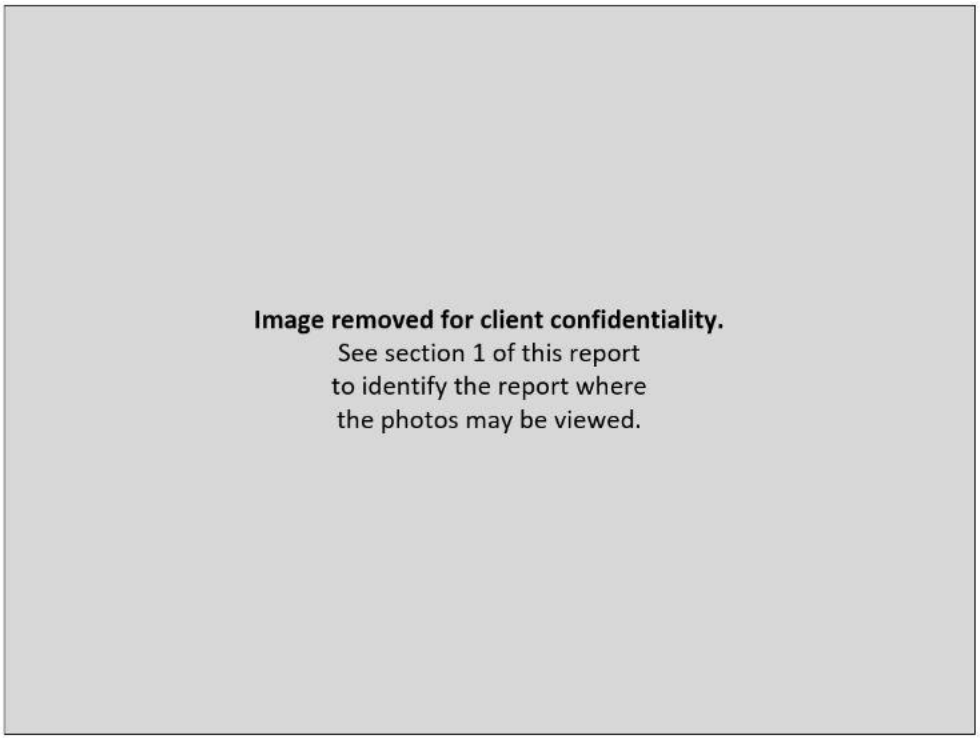


Figure CE01.2: Test setup, first view

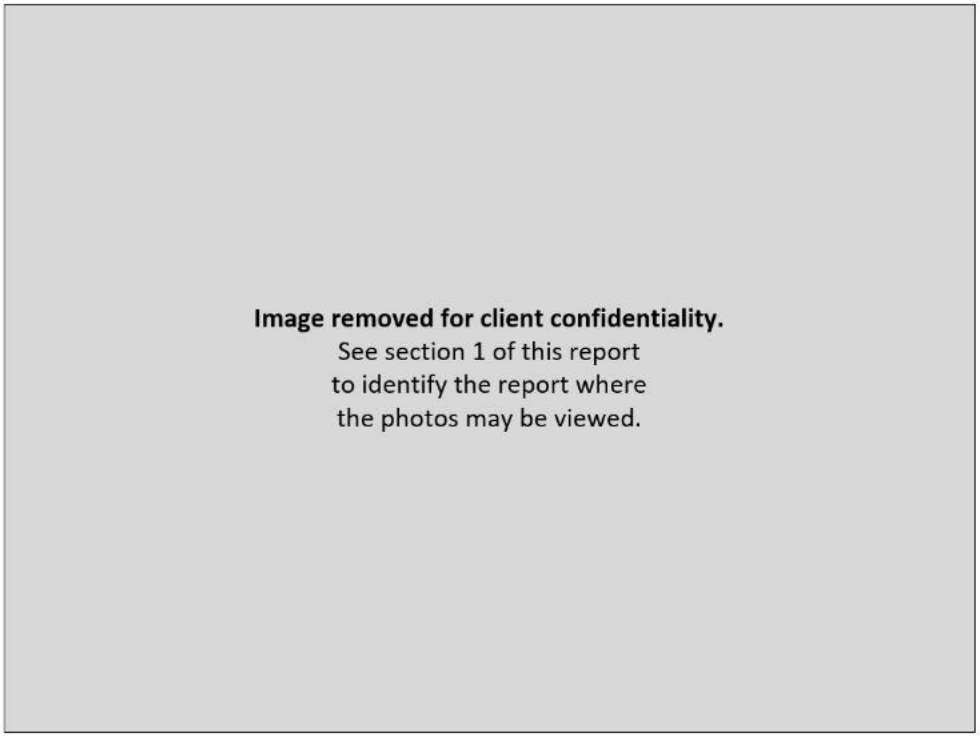


Figure CE01.3: Test setup, second view

This line is the end of the test record.

Concluding Notes

This report stands as an integrated record of the tests performed and must be copied or distributed in its complete form. The reproduction of selected pages or sections separate from the complete report would require specific approval from the manager of the Garmin Compliance Lab.

This is the final page of the report.

Test Report 2024-138

Version A
Issued 15 Aug 2024

Project GCL-0462
Model Identifier: A04883
Primary Test Standard(s):
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-04883
IC ID: 1792A-04883

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 13.56 MHz Near Field Communication (NFC) Transceiver(s). The results are as follows.

Parameter	Description	Key Performance Values	Result	Data starts at page
Radio Modulation	Summary of the kinds of communication this radio can achieve, as stated by the client. [RSS-GEN at Annex A item 10b]	Digitally modulated OOK and BPSK signaling at rates as high as 106 kbps.	Reported	NT
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]	25.8 dB of margin to the intentional emission limit.	PASS	13
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]	10.2 dB of margin to the Class B limit.	PASS	19
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]	7.20 dB of margin to the appropriate limit. Tested 150 kHz to 30 MHz applying combined Class B limits.	PASS	22
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 with caveat	25
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	28

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

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 2024-146. That report is treated as a part of this document by way of this reference.

2. Test Background

2.1 The Test Lab

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

2.2 The Client

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

2.3 Other Information

Test Sample received: 17 Jun 2024
Test Start Date: 18 Jun 2024
Test End Date: 06 Aug 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 Majid Farah and initially issued on 15 Aug 2024 as Version A.

Report Technical Review:

Majid Farah
Senior EMC Engineer

Report Approval:

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

4. Test Sample Modifications and Special Conditions

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

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

Modification 1
Detailed Description: A change of firmware from Version 2.10 to 2.11
Date applied: 20 Jun 2024
Reason for this modification:
This modification was performed on all samples due to a connectivity issue between EUT and companion device during BLE Receiver blocking testing. The client stated this firmware change only affects the BLE test page. Based on the client's statement GCL judged the presence of this modification has no effect on any other tests.

5. Description of the Equipment Tested

5.1 Unique Identification

Product Model	A04883
Serial Numbers Tested	3477207590, 3477207650

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

The client affirmed that the test samples will be representative of production in all relevant aspects.

5.2 Key Parameters

EUT Input Power:	5 Vdc
I/O Ports:	USB
Radio Transceivers:	Bluetooth Low Energy (BLE), ANT, NFC
Radio Receivers:	GPS L1, GPS L5, Galileo E1, Galileo E5a/b, BeiDou, GLONASS
Primary Functions:	Data collection and communication
Typical use:	Portable in multiple orientations
Highest internal frequency:	2.484 GHz
Firmware Revision	2.11 (see also section 4 of this report)

5.3 Operating modes

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

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

Mode 4: M4 (BleLnk). 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 (AntTx). ANT radio transmitting consistently on a selected channel.

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

Mode 9: M9 (RxBtBlA). The radio was set to receive 2.4 GHz signals but not transmitted in Bluetooth, Bluetooth low energy or ANT.

Mode 11: M11 (NfcTag). The NFC radio was transmitting and actively linked to a passive NFC tag.

Mode 12: M12 (NfcLnk). The NFC radio was transmitting and actively linked to an NFC card reader.

Mode 13: M13 (GnssY). 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 Radio was powered, but not transmitting or linked to any devices.

Mode 15: M15 (Normal). EUT is in normal operational mode (User mode) if some Transmitters are on during normal operational mode exclude radiations on those frequency.

Mode 17: M13 (GnssN). The Global Navigation Satellite System receiver is monitoring the GNSS bands, attempting to detect a constellation and determine location. The EUT is in GNSS receiving mode but no GNSS signal provided.

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

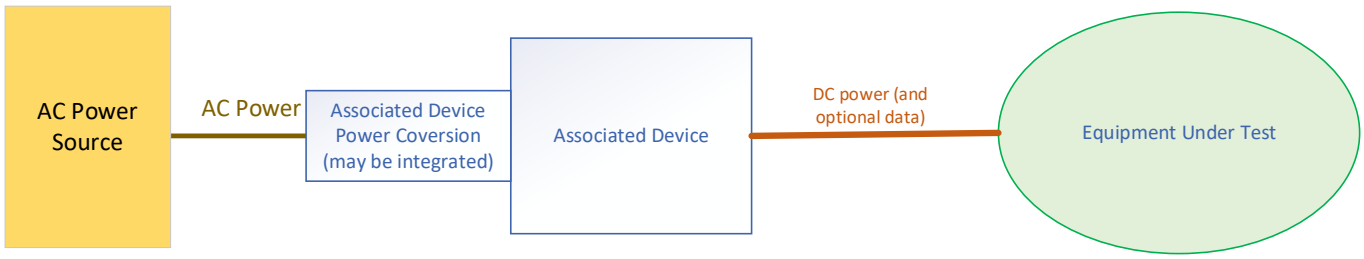
During test, the EUT components and associated support equipment were selected including the following arrangement sets.

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 for arrangements A2, A3, A4

Arrangement 5: A5 (NFCp) The test sample is placed near an NFC Card Reader or NFC tag. The NFC Card Reader is connected to a laptop computer. The test sample is powered by a device that does not include data over the cable, just as with A2. For clarity, test sample is NOT powered by, or connected to, the laptop computer that powers the NFC Card Reader.

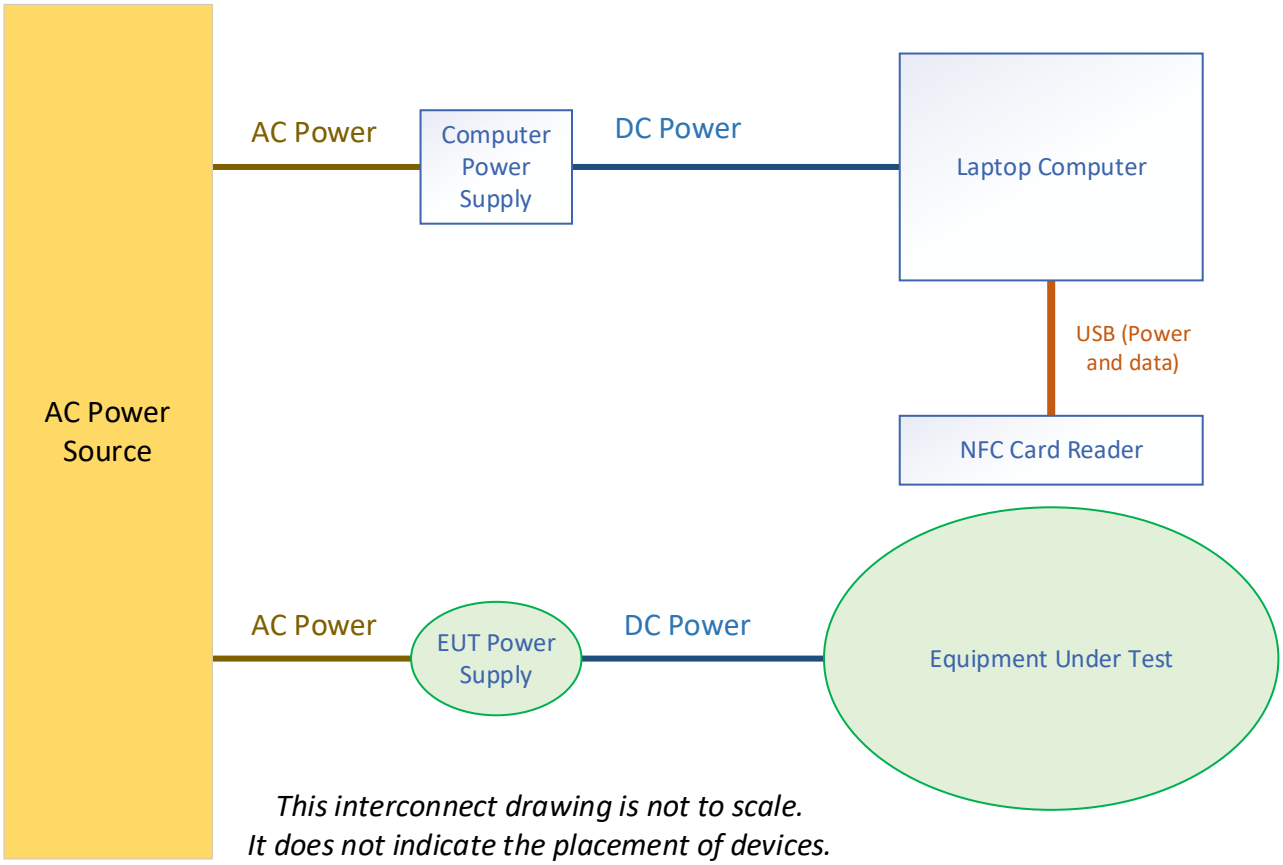


Figure 2: Block diagram of equipment arrangement A5

Arrangement 6: A6 (NFCu) The test sample is placed near an NFC Card Reader or NFC tag. The NFC Card Reader is connected to a laptop computer. The test sample is powered by its own batteries rather than an external power source. Either NFC Card reader or NFC tag can be used during test.

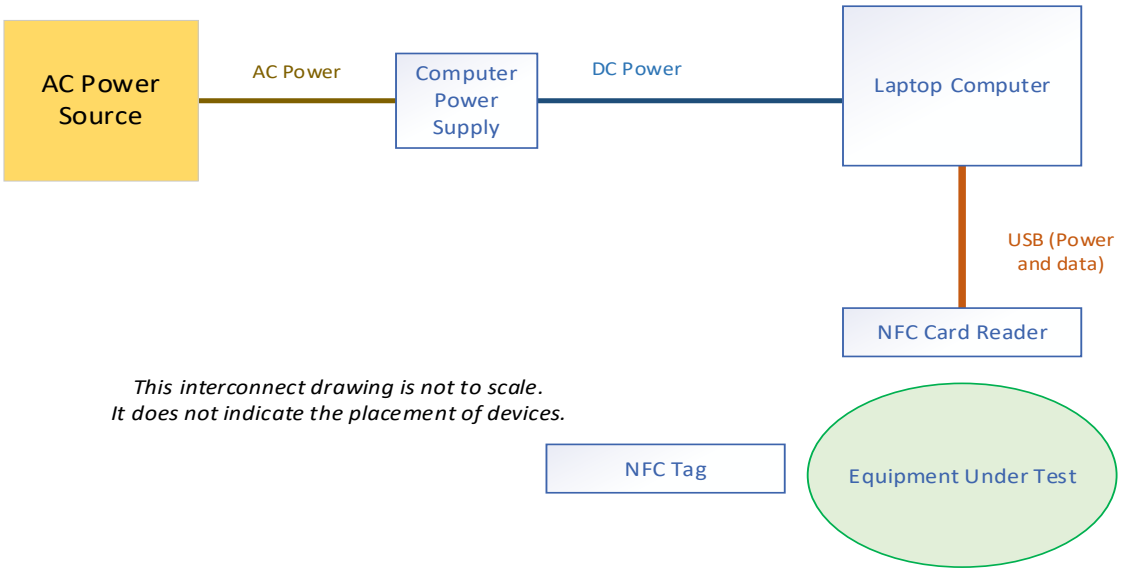


Figure 3: Block diagram of equipment arrangement A6

5.5 Associated Equipment (AE) used

Description	Manufacturer	Model	Serial Number
USB C power adaptor	Phihong (Garmin)	AQ27A-59CFA	362-00118-00
Laptop	Dell	Precision 5540	3JYG33
Power Supply	Dell	HA130PM130	CN-0V363H-CH200-78G-0DC1-A01
Laptop	Dell	Latitude 5410	5VSPFB3
Power Supply	Dell	HA65NM191	CN-0H374X-CH200-0BD-7TC0-A020BD-7TC0-A02
Phone	Samsung	SM-G973U (S10)	RF8MC0W9XVR
NFC Card Reader	ACS	ACR1252U-M1	RR554-118449
NFC Tag	SANPOPO	NTAG215	PD-STICKER-B-30
Auxiliary device	Garmin	A04882	3475112460

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.

AS/NZS 4268: 2017
CFR 47, FCC Part 15.225
ANSI C63.10: 2020, and ANSI C63.10: 2020 +Cor 1: 2023
RSS-GEN Issue 5 Amd 2
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 boresighting and another does not, swept motion with boresighting will typically be used as it is the more stringent requirement.

6.4 Laboratory Accreditation

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

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

7 Measurement Instrumentation Uncertainty

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

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

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

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

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

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

8 Selected Example Calculations

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

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

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

8.1 AC Mains conducted emissions at 22 MHz

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

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

8.2 Radiated Emissions at 630 MHz

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

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

8.3 Radiated Emissions at 2.7 GHz

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

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

9 Environmental Conditions During Test

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

Temperature:	19.8 to 21.3 °C
Relative Humidity:	42.5% to 60% (non-condensing)
Barometric Pressure	96.8 to 110 kPa

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

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 RE18, RE19
Project GCL0462

Test Date(s)	10 Jul 2024
Test Personnel	Jim Solum
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M12 (NFC lnk)
Arrangement	A6 (NFCu)
Input Power	Battery
Test Standards:	FCC Part 15, ANSI C63.10, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	10 MHz to 30 MHz
Pass/Fail Judgment:	**PASS with caveat**
Test record created by:	Vladimir Tolstik
Date of this record:	11 Jul 2024

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	27-Sep-2023	1-Oct-2024
Loop antenna, amplified	Schwarzbeck	FMZB 1519B	00174	12-Jun-2023	18-Jul-2024
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	7-Nov-2022	7-Nov-2025
Tape measure, 1” x 33’	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026

Table RE18.1: Test Equipment Used

Software Used

PXE Firmware version A.32.06
RE 150k to 30M Signal Maximization Tool V1 2021Mar17.xlsx
RE 9k to 30M XYZ_orientations_TemplateV7.xlsx
RE NFC 150k to 30M Data Analysis Template V21 2023Jun19.xlsx

Caveat

The NFC transceiver under test only operates when in the close vicinity of an NFC Reader. In this test, the client provided the ACR1252 manufactured by Advanced Card Systems as described in section 5.5 of the test report.

Emissions presented here show the combined signals from the NFC reader and the device under test. Signals for each were not distinguishable during the test. Per the client, the device under test matches its transmitting frequency to correspond to that of the reader device. The data presented here, and the conclusions drawn, apply to the device under test and the NFC Reader when tested together as a system.

Test Data

The radiated emission test process began with a preliminary scan at multiple turntable angles, and three antenna polarizations typically described as X, Y, and Z. Subsequent testing was done using the antenna polarization(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, 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 -90° the reference mark points West. At 90° it points East.

The designation of the X, Y, and Z antenna polarizations are reported by use of photographs.

The table shows the selected final measurement data between 10MHz 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. The dBuA/m limits and measured dBuA/m values in the chart below are obtained from the dBuV/m limits and measured dBuV/m measured values. The two values differ by 51.52 dB based on the 377 Ohm characteristic impedance of free space. A positive margin value indicates that the emission was below the test limit. The test limits are for FCC Part 15 & RSS-210.

Frequency (MHz)	Limit (dBuV/m)	Limit (dBuA/m)	Measured (dBuV/m)	Measured (dBuA/m)	Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Orientation
12.711	49.5	-2.0	20.7	-30.8	28.8	-177	1500	X
13.348	60.5	9.0	27.3	-24.2	33.2	180	1500	X
13.461	70.5	19.0	27.3	-24.2	43.2	-185	1500	X
13.560	104.0	52.5	60.8	9.3	43.2	-182	1500	X
13.771	60.5	9.0	26.8	-24.7	33.7	180	1500	X
14.408	49.5	-2.0	21.2	-30.3	28.3	-27	1500	Z

Table RE18.2: Emission summary NFC Type A

Frequency (MHz)	Limit (dBuV/m)	Limit (dBuA/m)	Measured (dBuV/m)	Measured (dBuA/m)	Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Orientation
10.232	49.5	-2.0	20.7	-30.8	28.8	92	1500	X
13.348	60.5	9.0	26.9	-24.6	33.6	180	1500	X
13.560	104.0	52.5	60.4	8.9	43.6	-180	1500	X
13.672	70.5	19.0	26.4	-25.1	44.1	-177	1500	X
13.771	60.5	9.0	26.4	-25.1	34.1	5	1500	X
27.429	49.5	-2.0	23.7	-27.8	25.8	58	1500	Y

Table RE18.3: Emission summary NFC Type B

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

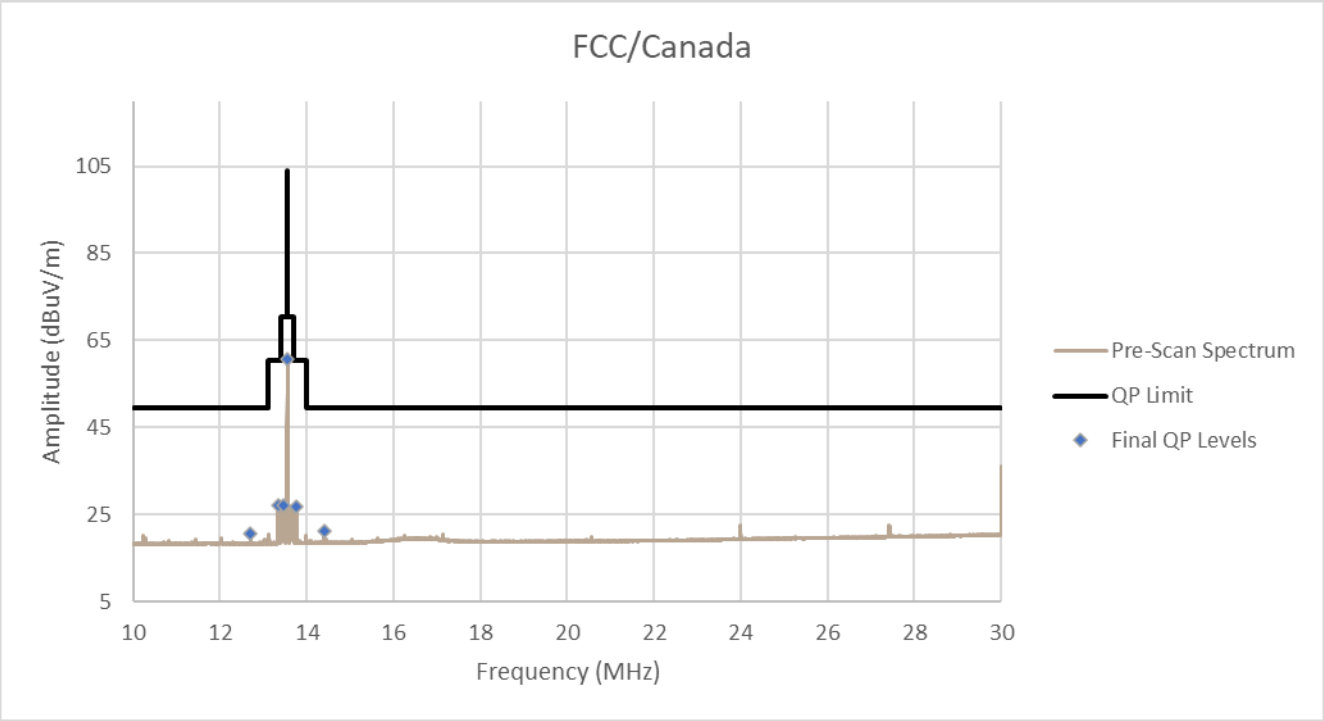


Figure RE18.1: Spectral data NFC Type A

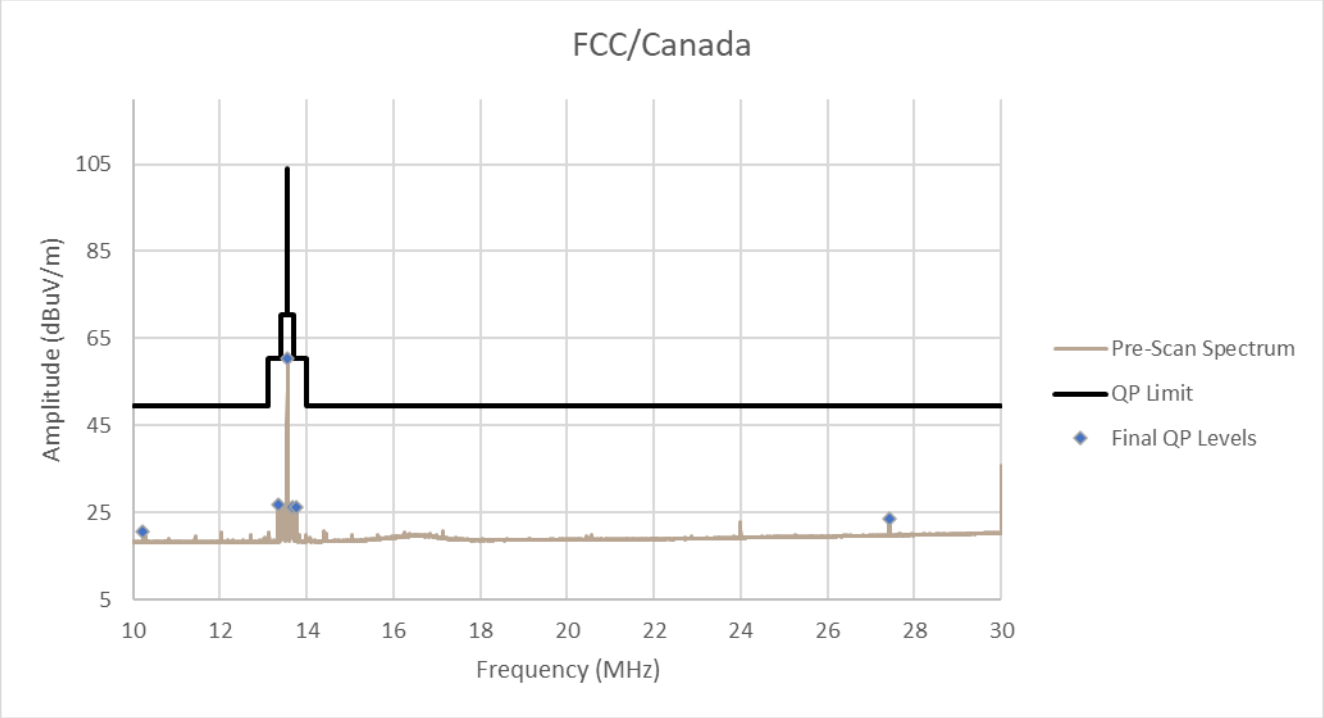


Figure RE18.2: Spectral data NFC Type B

Setup Photographs

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

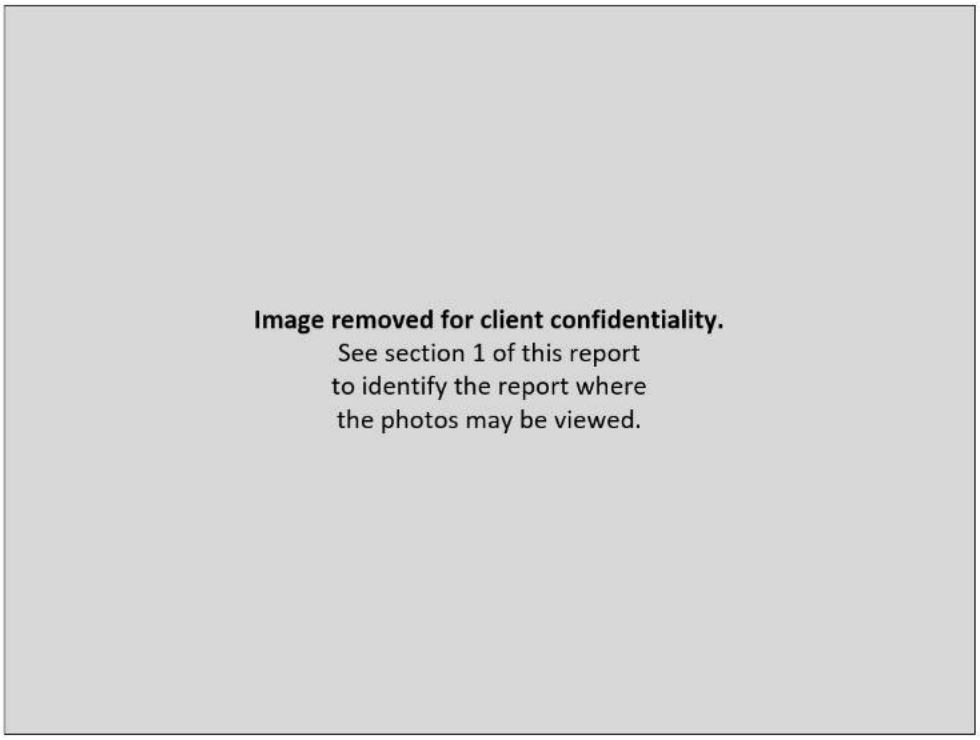


Figure RE18.3: EUT test setup, front view (Antenna X Orientation)

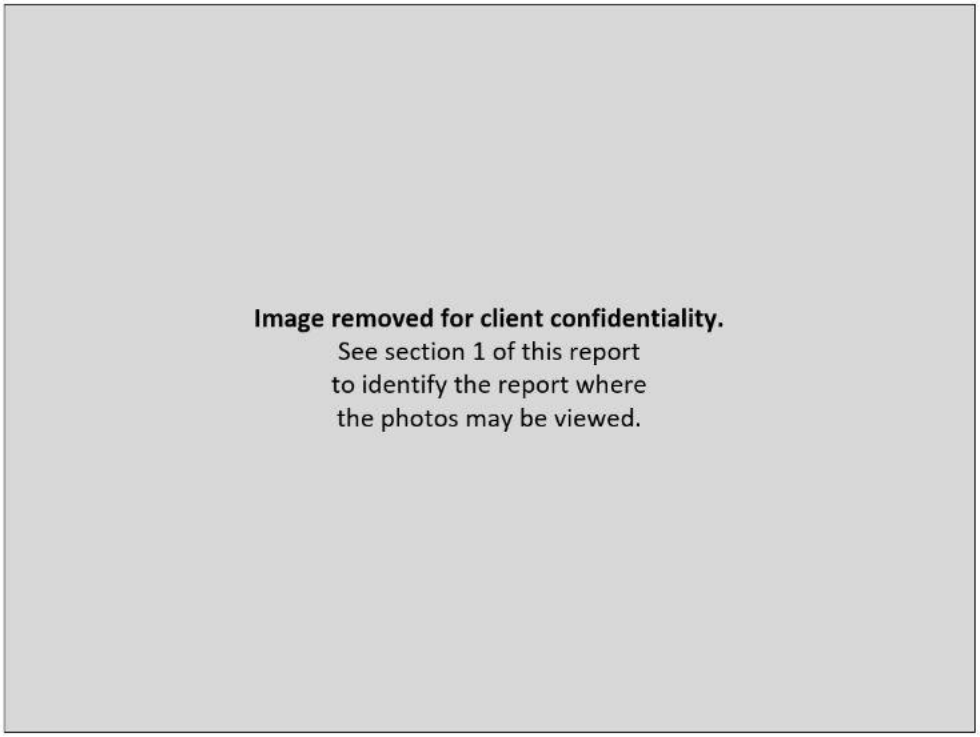


Figure RE18.4: EUT test setup, reverse view (Antenna X Orientation)

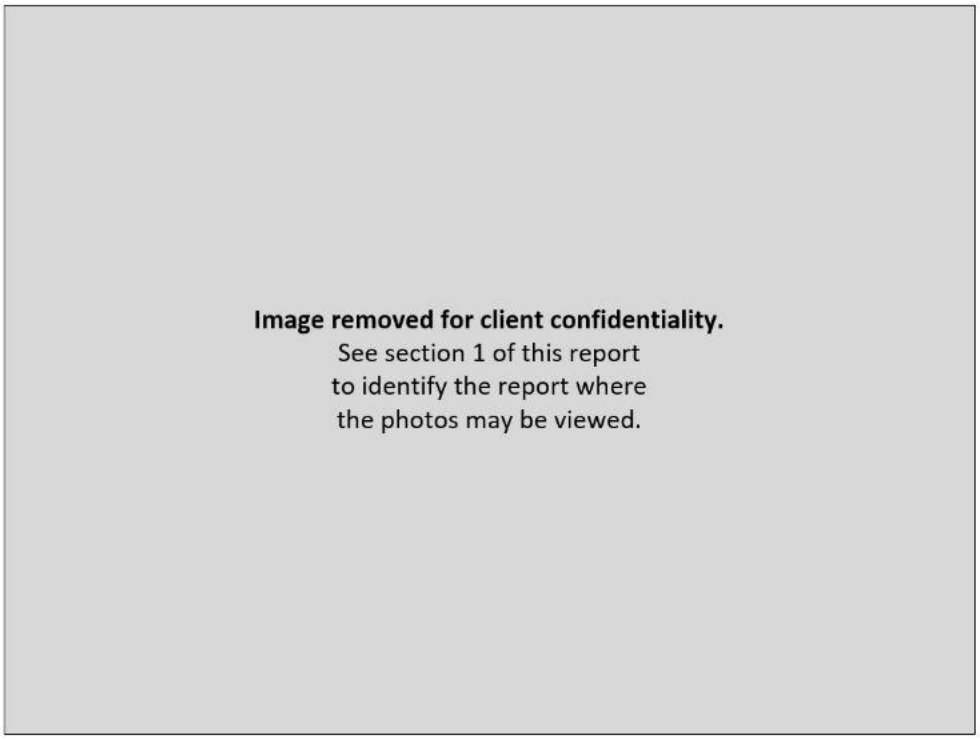


Figure RE18.5: EUT test setup, front view (Antenna Y Orientation)

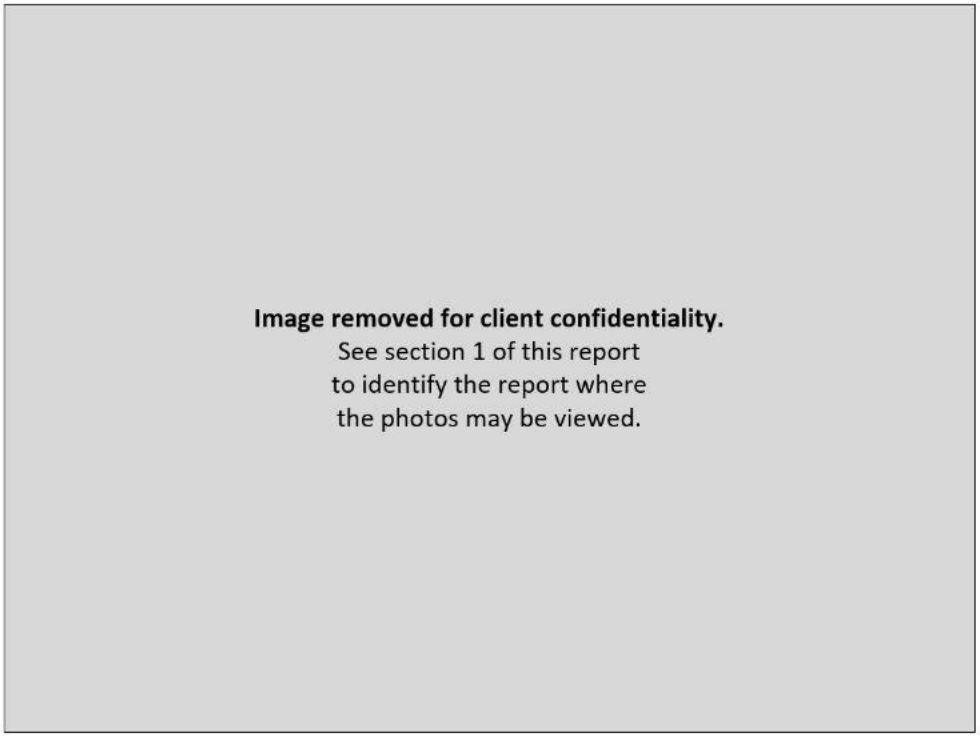


Figure RE18.6: EUT test setup, reverse view (Antenna Y Orientation)

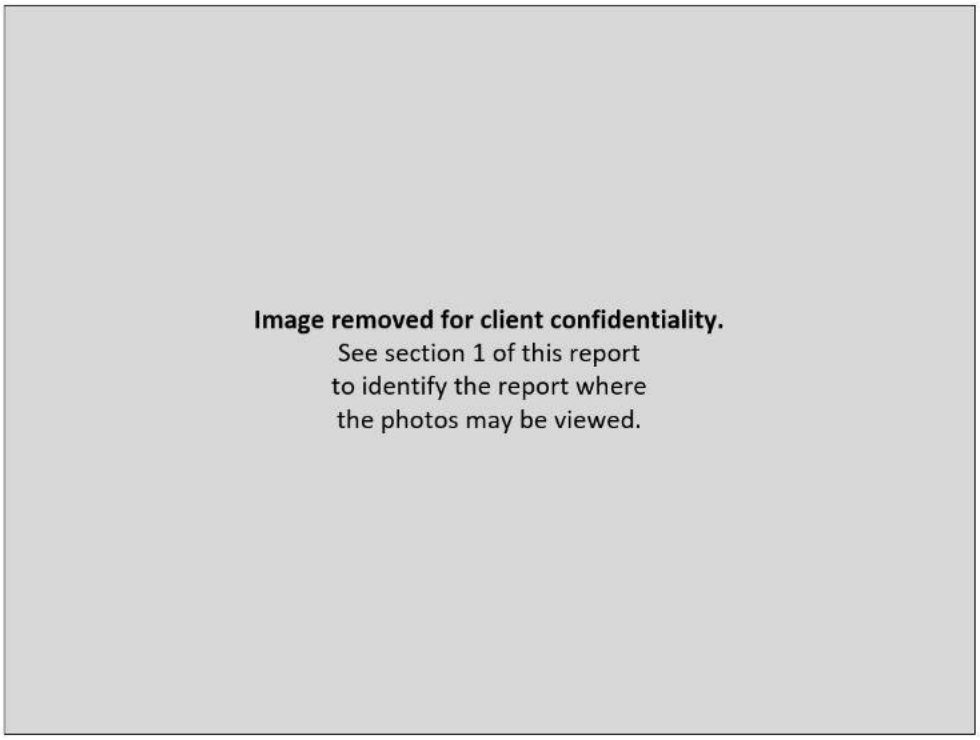


Figure RE18.7: EUT test setup, front view (Antenna Z Orientation)

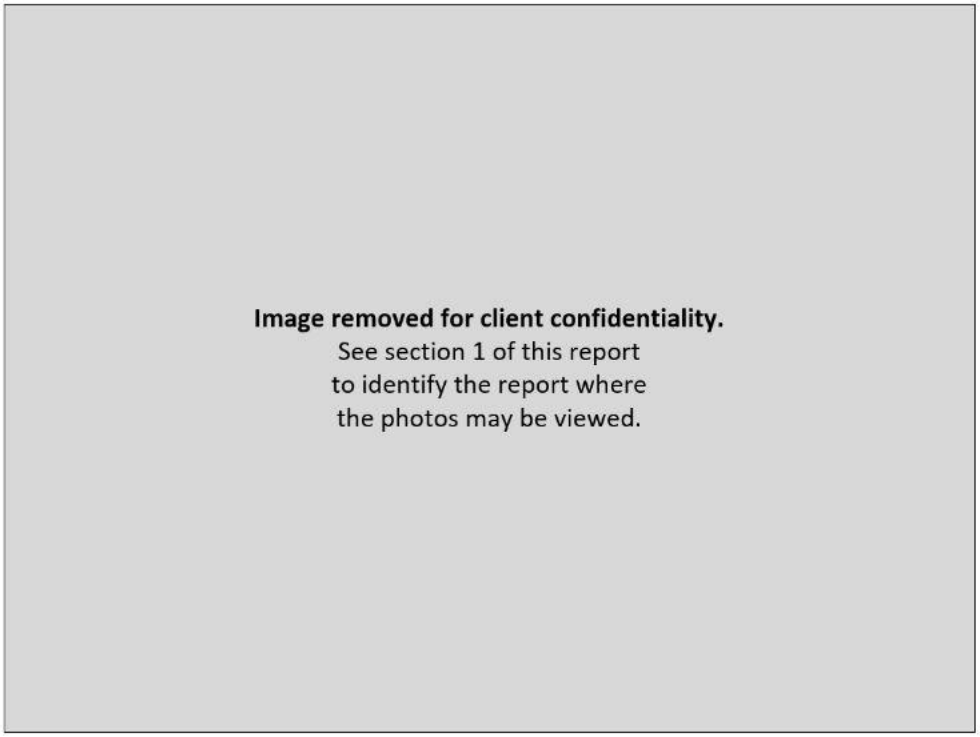


Figure RE18.8: EUT test setup, reverse view (Antenna Z Orientation)

This line is the end of the test record.

Test Record
Radiated Emission Test RE20
Project GCL0462

Test Date(s)	11 Jul 2024
Test Personnel	David Kerr
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M12 (NfcLnk)
Arrangement	A6 (NFCu)
Input Power	Battery
Test Standards:	FCC Part 15, ANSI C63.10, RSS-210 (as noted in Section 6 of the report).
Frequency Range:	30 MHz to 150 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	David A Kerr
Date of this record:	11 Jul 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, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	233204	2-Nov-2023	1-Nov-2025
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	7-Nov-2022	7-Nov-2025
Shockforce G1 Tape Measure	Crecent Lufkin	L1135CME-02	GMN0013782	26-Jun-2024	26-Jun-2027

Table RE20.1: 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.

The table shows the selected final measurement data between 30 MHz and 150 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.

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		
30.870	V	7.5	22.3	29.8	40.0	10.2	100.0	0.0
40.680	V	7.5	17.1	24.6	40.0	15.4	108.3	67.0
70.650	V	5.6	14.6	20.2	40.0	19.8	112.1	333.0
82.950	V	4.6	14.4	19.0	40.0	21.0	116.1	329.0
113.670	V	6.0	16.2	22.2	43.5	21.3	108.3	335.0
144.390	V	6.1	16.4	22.5	43.5	21.0	100.0	108.0

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.

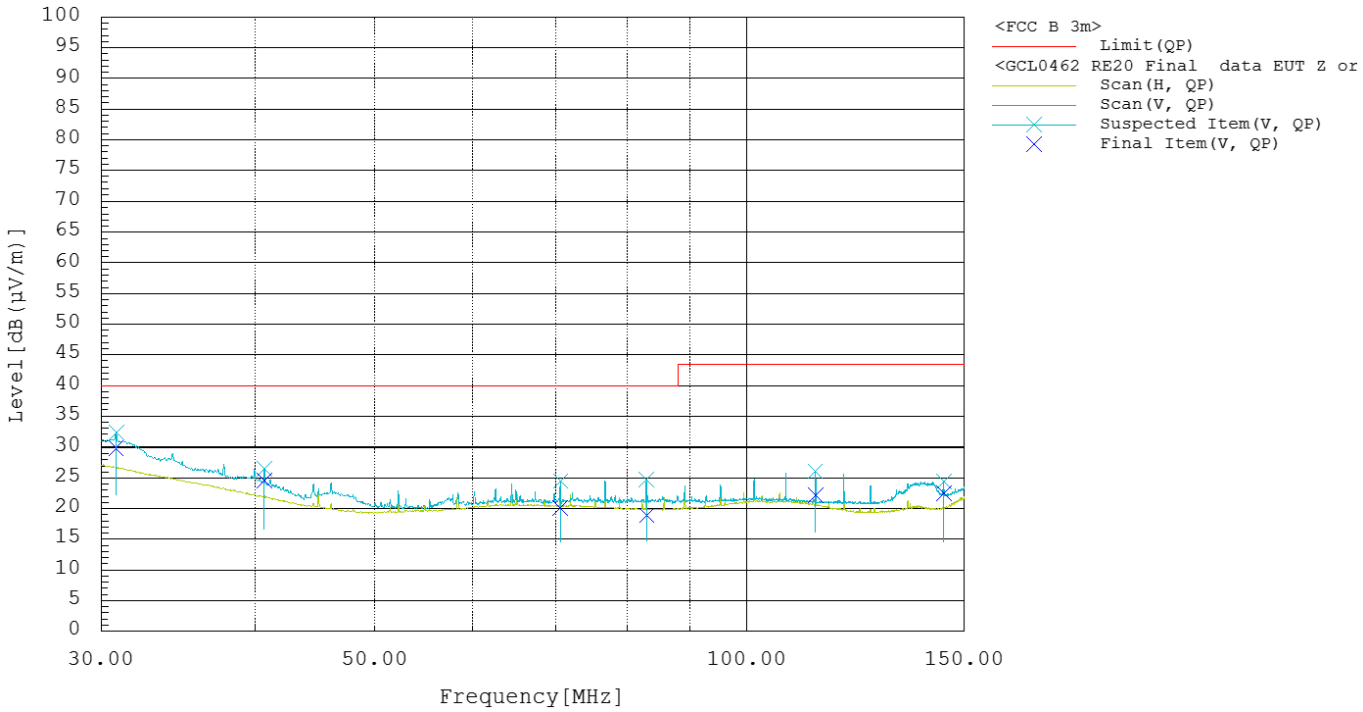


Figure RE20.1: Spectral data

Setup Photographs

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

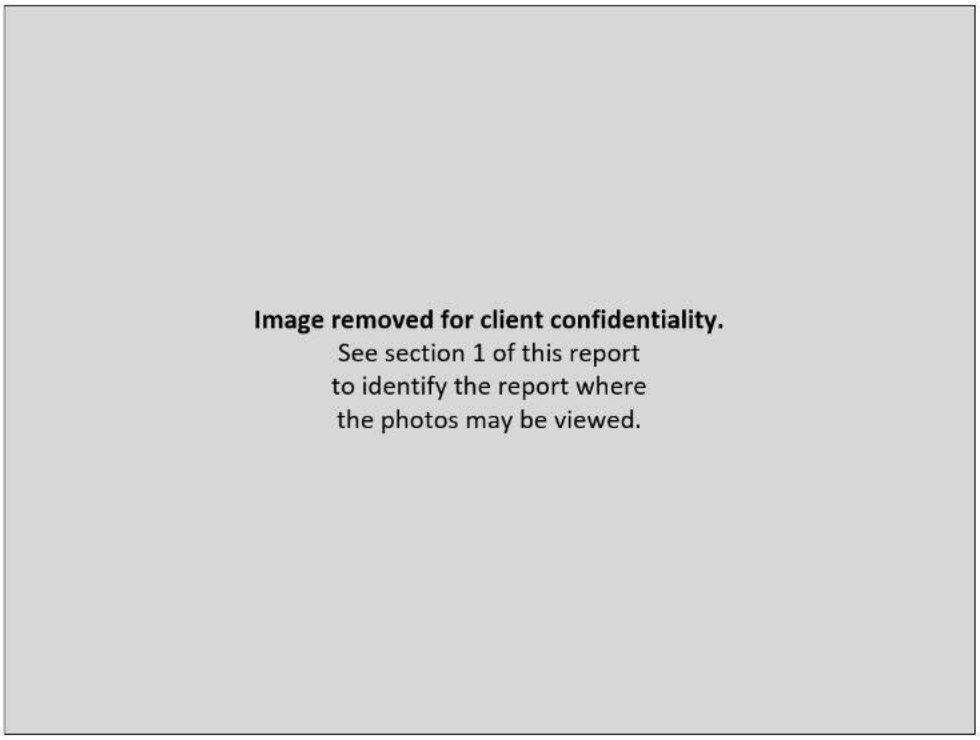


Figure RE20.2: EUT test setup, first view (X orientation, Type A NFC)

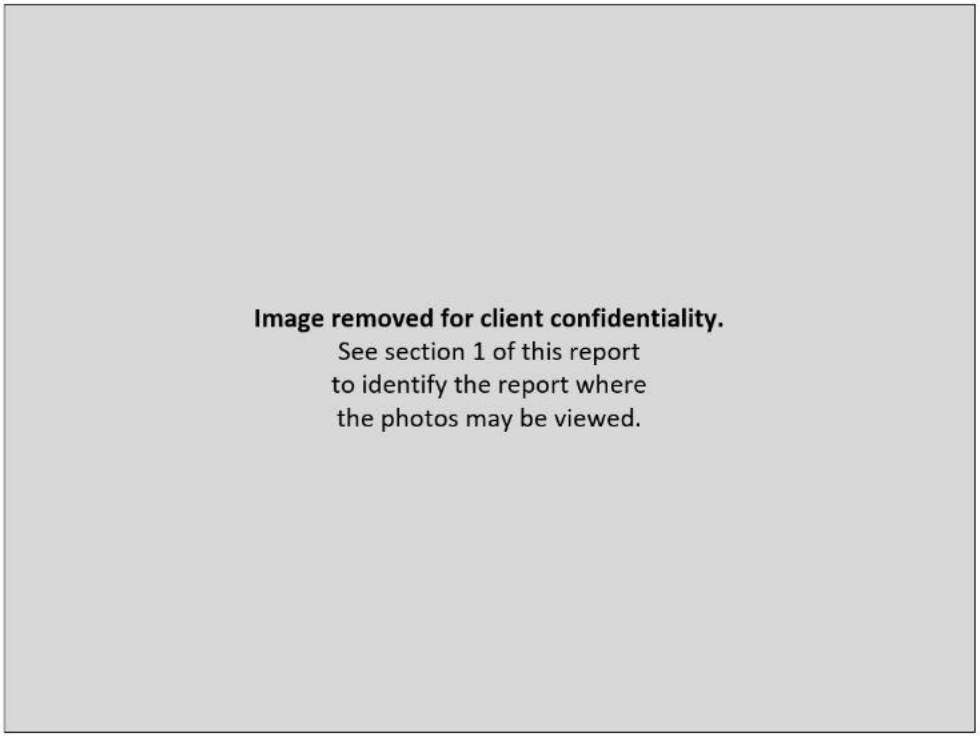


Figure RE20.3: EUT test setup, second view (X orientation, Type A NFC)

This line is the end of the test record.

Test Record
Conducted Emissions Mains Test CE04
Project GCL0462

Test Date(s)	01 July 2024
Test Personnel	David Arnett assisted by Andy Heier
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M12 (NFCLnk)
Arrangement	A2 (Upwr)
Input Power	120 Vac 60 Hz
Test Standards:	FCC Part 15, ANSI C63.10, 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:	David Arnett, Andy Heier
Date of this record:	1 July 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	13-Mar-2024	15-Mar-2025
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10721	30-Aug-2023	1-Sep-2026
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 (kHz)	QP Limit (dBuV)	AV Limit (dBuV)	L1 QP (dBuV)	L2 QP (dBuV)	L1 AV (dBuV)	L2 AV (dBuV)	QP Margin (dB)	AV Margin (dB)
150	66.00	56.00	41.26	55.16	24.45	27.03	10.84	28.97
186	64.21	54.21	40.08	39.31	23.84	23.42	24.13	30.38
3428	56.00	46.00	40.74	38.18	38.80	36.52	15.26	7.20
6857	60.00	50.00	31.14	29.93	27.70	25.92	28.86	22.30
10286	60.00	50.00	40.03	37.93	38.10	36.23	19.97	11.90
13560	N/A	N/A	51.18	50.20	48.51	47.77	N/A	N/A
16989	60.00	50.00	33.72	32.86	31.44	30.19	26.28	18.56
17142	60.00	50.00	38.57	36.99	36.79	35.42	21.43	13.21
20571	60.00	50.00	33.63	32.74	31.16	30.03	26.37	18.84
24000	60.00	50.00	36.81	35.55	34.99	33.69	23.19	15.01
27429	60.00	50.00	33.49	32.63	30.34	29.07	26.51	19.66

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.

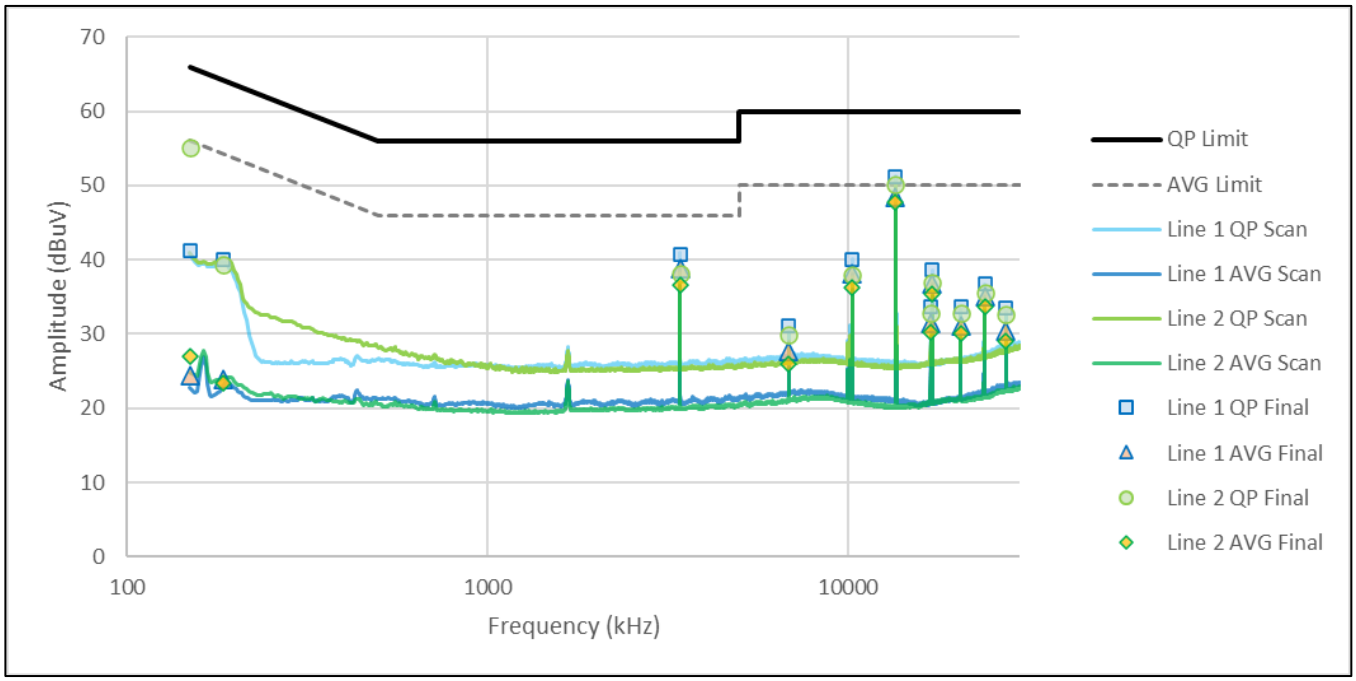


Figure CE04.1: Spectral data

Setup Photographs

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

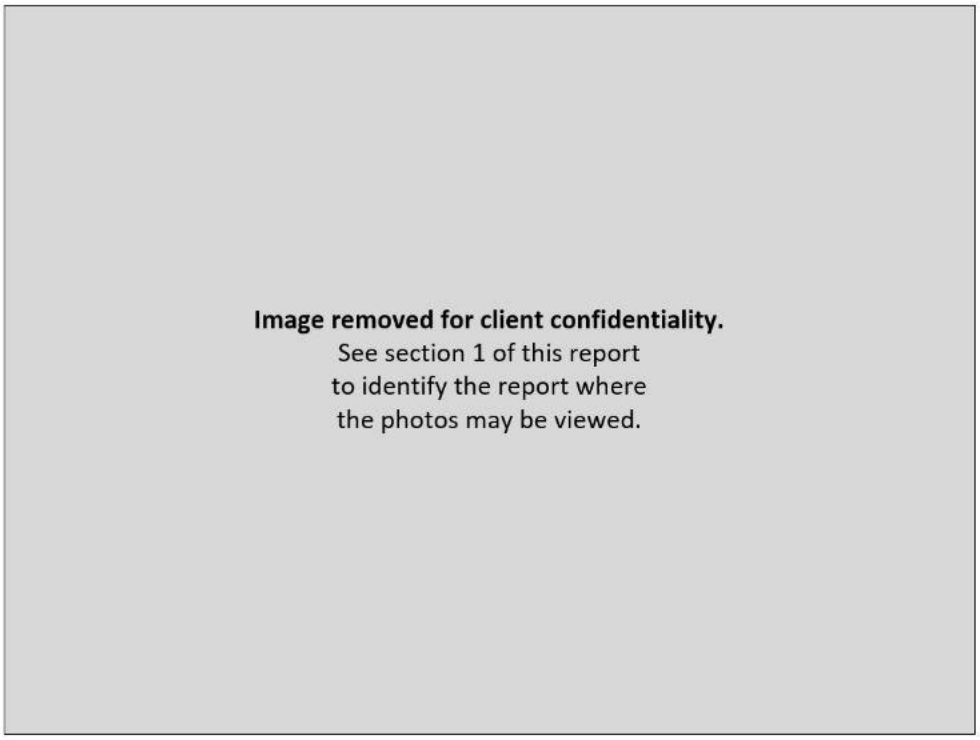


Figure CE04.2: Test setup, first view

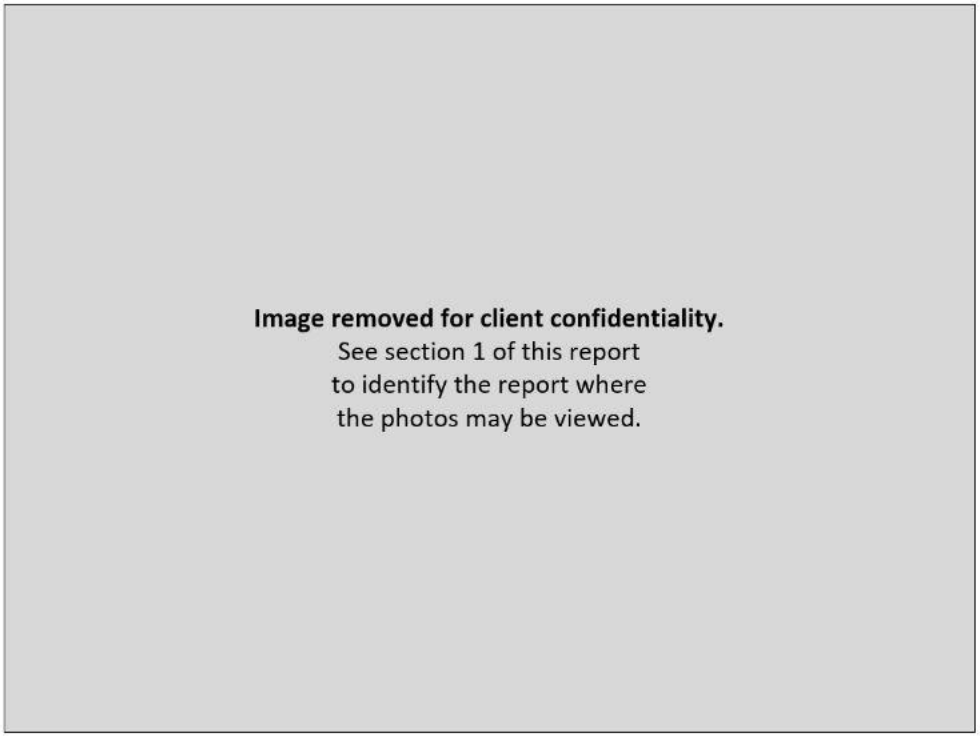


Figure CE04.3: Test setup, second view

This line is the end of the test record.

Test Record
Transmitter Stability in Extreme Conditions
Test IDs TR45
Project GCL-0462

Test Date(s)	02 Jul 2024
Test Personnel	Vladimir Tolstik supervised by Majid Farah
Product Model	A04883
Serial Number tested	3477207650
Operating Mode	M12 (NfcLnk)
Arrangement	A4 (Udc)
Nominal Input Power	USB 5 Vdc
Test Standards:	FCC part 15, RSS-GEN, RSS-210, ANSI C63.10 (as noted in Section 6 of the report)
Radio Protocol	NFC
Pass/Fail Judgment:	**PASS with caveat**
Test record created by:	Vladimir Tolstik
Date this record:	03 Jul 2024

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
MXE Receiver 8.4 GHz	Keysight	N9038B	MY63460112	28-Feb-2024	1-Mar-2025
Thermometer	Thermco	ACCD370P	210607316	21-Sep-2023	15-Sep-2024
Thermal Chamber	Tenney	T2RC	32774-02	Calibration	Not Required
Near Field Probe Set	Com-Power	PS-400	151544	Calibration	Not Required
DMM Multimeter 87V	Fluke	87V	63490051	21-Jun-2024	21-Jun-2025

Table TR45.1: 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.

Caveat

The NFC transceiver under test only operates when in the close vicinity of an NFC Reader. In this test, the client provided the ACR1252 manufactured by Advanced Card Systems as described in section 5.5 of the test report.

Emissions presented here show the combined signals from the NFC reader and the device under test. Signals for each were not distinguishable during the test. Per the client, the device under test matches its transmitting frequency to correspond to that of the reader device. The data presented here, and the conclusions drawn, apply to the device under test and the NFC Reader when tested together as a system.

Test Data

The test sample(s) were subjected to extreme conditions and performed as shown below.
During NFC test mode, each measurement was made conducted from a near field probe located at a close distance to the sample and NFC reader. The sample needs to be attached to an NFC reader for continuous transmission.

Yellow highlights indicate the maximum and minimum measured carrier frequency. The maximum frequency measured was 13,559,937 Hz and the minimum was 13,559,798 Hz. The margin to high side of limit is 1419 Hz and margin for low side of the limit is 1154 Hz.

			NFC carrier frequency (Hz)			
Tx Mode	Temp	Volts	Time interval (minutes)			
	˚C	Vdc	0	2	5	10
NFC	60	5	13,559,798	13,559,800	13,559,802	13,559,804
NFC	50	5	13,559,799	13,559,799	13,559,799	13,559,799
NFC	40	5	13,559,819	13,559,816	13,559,814	13,559,814
NFC	30	5	13,559,850	13,559,847	13,559,845	13,559,844
NFC	20	5	13,559,877	13,559,875	13,559,875	13,559,874
NFC	20	4.25	13,559,873	N/A	N/A	N/A
NFC	20	5.75	13,559,873	N/A	N/A	N/A
NFC	10	5	13,559,919	13,559,913	13,559,910	13,559,908
NFC	0	5	13,559,935	13,559,934	13,559,933	13,559,932
NFC	-10	5	13,559,935	13,559,936	13,559,937	13,559,937
NFC	-20	5	13,559,916	13,559,920	13,559,918	13,559,917

Table TR45.2: Carrier frequency measurement for NFC transmission during temperature and voltage variations

Setup Block Diagram

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

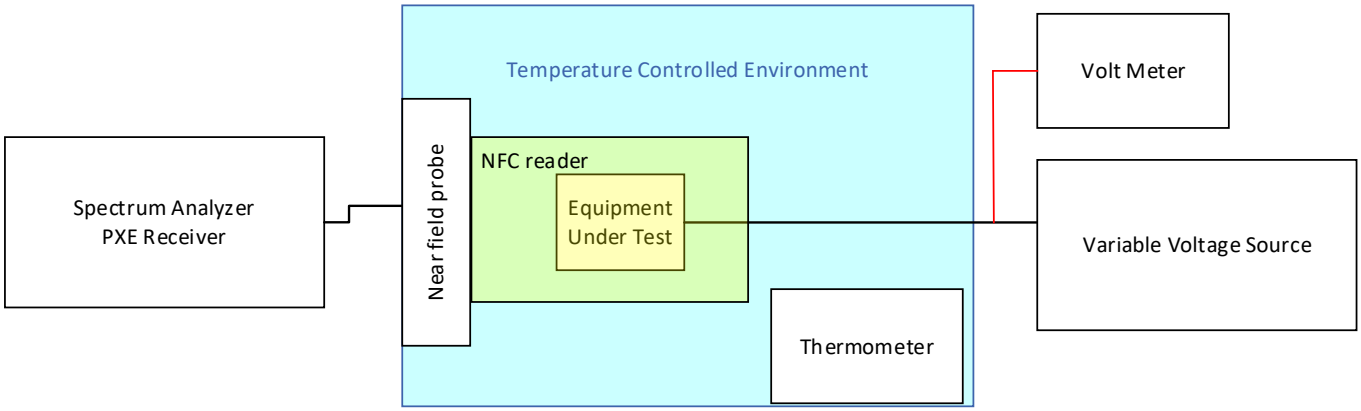


Figure TR45.1: Schematic drawing of the test equipment setup for NFC

This line is the end of the test record.

Test Record
Transmitter Bandwidth Tests
Test IDs TR13
Project GCL-0462

Test Date(s)	2 Jul 2024, 6 Aug 2024
Test Personnel	Majid Farah
Product Model	A04883
Serial Number tested	3477207590
Operating Mode	M12 (NfcLnk)
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:	**06 Aug 2024**

Version A was created on 8 Jul 2024. Version B on 6 August applied the 1 kHz minimum RBW principle with remeasured Type B data.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	13-Mar-2024	15-Mar-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 these data, beyond a reporting requirement. The contents of this test record are for information, and do not affect compliance of the devices that are the subject of this report.

Test Setup

This block diagram shows the test equipment setup.

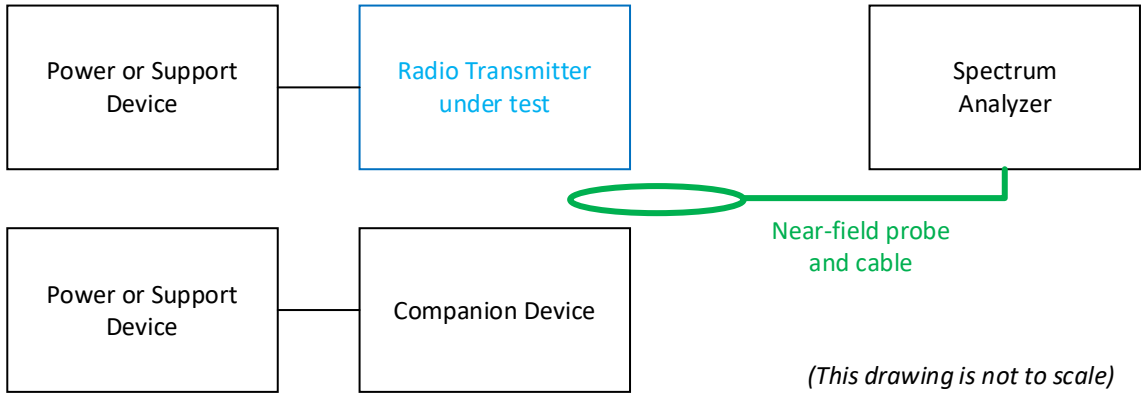


Figure TR13.1: Test setup

Caveat

The NFC transceiver under test only operates when in the close vicinity of an NFC Reader. In this test, the client provided the ACR1252 manufactured by Advanced Card Systems as described in section 5.5 of the test report.

Emissions presented here show the combined signals from the NFC reader and the device under test. Signals for each were not distinguishable during the test. Per the client, the device under test matches its transmitting frequency to correspond to that of the reader device. The data presented here, and the conclusions drawn, apply to the device under test and the NFC Reader when tested together as a system.

Occupied Bandwidth, 99% Test Method

During this test a small loop probe is placed between transmitter and the companion device because the test sample only transmits in response to a nearby NFC reader. This loop probe is then connected by cables to the spectrum analyzer. The analyzer has a built-in capability to identify the minimum bandwidth that contains a specified percentage of the total power observed. The spectrum is scanned hundreds of times so that the varied effects of modulation are appropriately assessed. Since the focus is on the relative distribution of energy across a range of frequencies, the absolute amplitudes recorded during this test are not relevant and may not include cable losses or attenuation factors.

Occupied Bandwidth, 99% Test Data

The data for each type of data transmission (A and B) is summarized below, followed by the spectral data for both types. The analysis threshold for this test was the bandwidth containing 99% of the observed power using the ANSI C63.10 method.

NFC type B transmission placed more than 99% of the energy in the carrier, so the test process was limited to the minimum 1 kHz RBW limit for this frequency band found in ANSI C63.4 section 13.7 standard.

	Bandwidth
NFC Mode	MHz
Type A	1.9867
Type B	0.0022

Table TR13.2: Summary of 99% Occupied Bandwidth Data for 13.56 MHz NFC modes

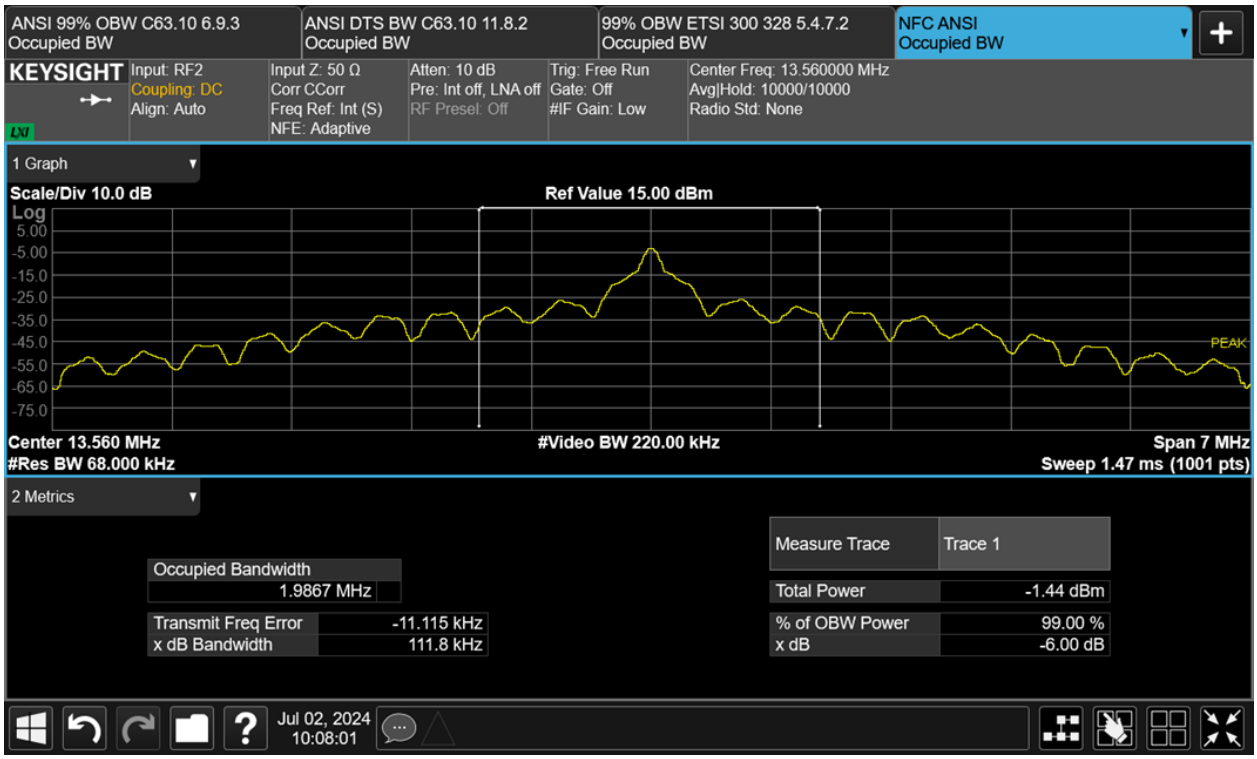


Figure TR13.1: Occupied bandwidth data for NFC Type A transmission

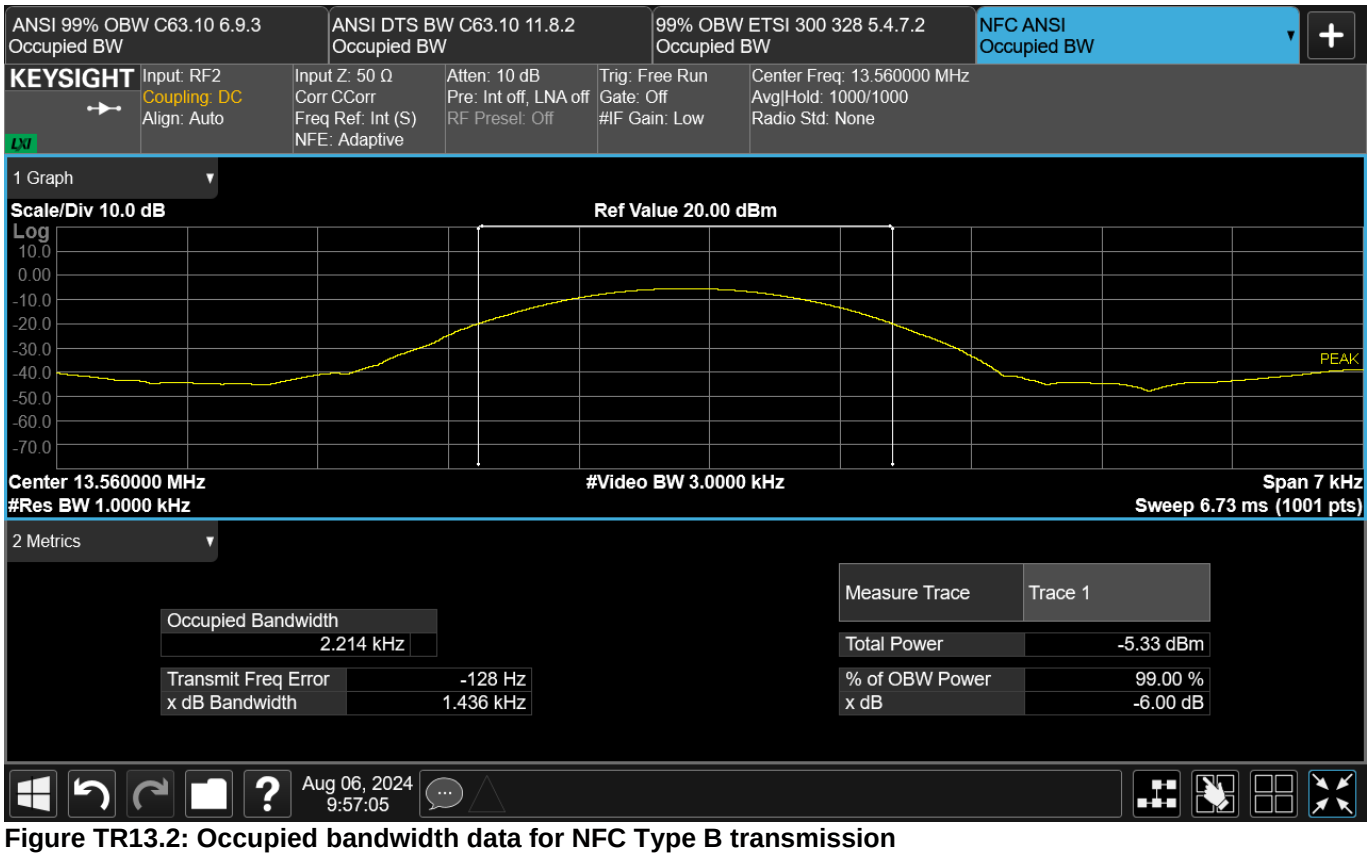


Figure TR13.2: Occupied bandwidth data for NFC Type B transmission

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.

SAR EVALUATION REPORT

IEEE Std 1528-2013
IEC/IEEE 62209-1528:2020

For
Low Power Digital Device Transmitter

FCC ID: IPH-04883
Model Name: A04883

Report Number: R15485855-S13
Issue Date: 2024-09-24

Prepared for
Garmin International Inc
1200 E 151st St
Olathe, KS, 66062-3426, US

Prepared by
UL LLC
12 LABORATORY DR
RTP, NC 27709, U.S.A.
TEL: (919) 549-1400

Revision History

Rev.	Date	Revisions	Revised By
V1	2024-09-24	Initial Issue	--

Table of Contents

1. Attestation of Test Results

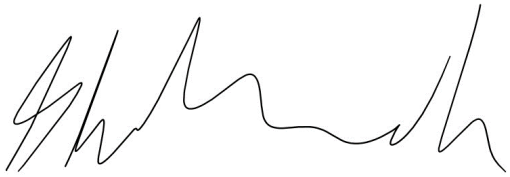
Applicant Name	Garmin International Inc	
FCC ID	IPH-04883	
Model Name	A04883	
Applicable Standards	Published RF exposure KDB procedures. IEEE Std 1528-2013 IEC/IEEE 62209-1528:2020	
Exposure Category	SAR Limits (W/Kg)	
	Extremities (hands, wrists, ankles, etc.) (10g of tissue)	
General population / Uncontrolled exposure	4	
RF Exposure Conditions	Equipment Class - Highest Reported SAR (W/kg)	
	DSS	DXX
Extremity	0.067	0.000
Simultaneous TX	0.067	0.067
Date Tested	2024-09-16	
Test Results	Pass	

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested can demonstrate compliance with the requirements as documented in this report.

This report contains data provided by the customer which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to ensure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not considered unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL LLC and all revisions are noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the U.S. Government, or any agency of the U.S. government.

Approved & Released By:	Prepared By:
	
Richard Jankovics Staff Engineer UL LLC	Sarah Kuhaneck Engineer Project Associate UL LLC

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE 1528-2013, IEC/IEEE 62209-1528:2020, the following FCC Published RF exposure KDB procedures:

- 447498 D01 General RF Exposure Guidance v06
- 447498 D03 Supplement C Cross-Reference v01
- 865664 D02 RF Exposure Reporting v01r02

In addition to the above, the following information was used:

- TCB Workshop October 2016; RF Exposure Procedures (DUT Holder Perturbations)
- TCB Workshop April 2019; RF Exposure Procedures (Tissue Simulating Liquids (TSL))

3. Facilities and Accreditation

UL LLC is accredited by A2LA, cert. # 0751.06 for all testing performed within the scope of this report. Testing was performed at the locations noted below.

The test sites and measurement facilities used to collect data are located at 2800 Perimeter Park Dr, Morrisville, NC, USA.

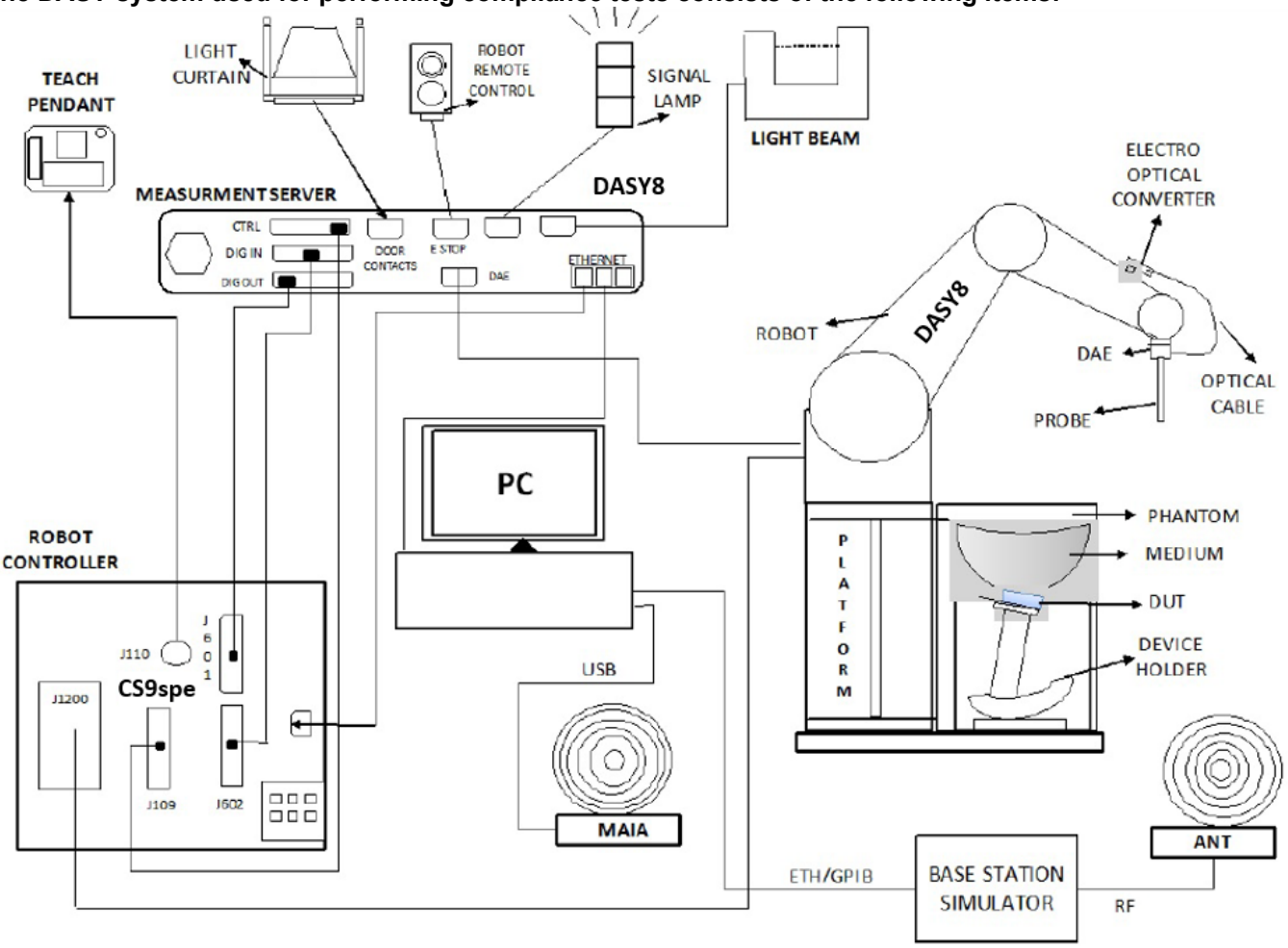
- SAR Lab 1A

	Address	ISED CABID	ISED Company Number	FCC Registration
☐	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
☒	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A	US0067	27265	825374

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Win10 and the DASY8[1] software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

[1] DASY8 software used: DASY16.4.0 and older generations.

4.2. SAR Scan Procedures

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEC/IEEE 62209-1528, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">≤ 1.5·$\Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

4.3. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
Network Analyzer	Keysight	E5063A	MY54100681	2024-07-31	2025-07-31
Dielectric Probe	SPEAG	DAKS-12	1037	2024-03-11	2025-03-11
Shorting Block	SPEAG	DAK-12 Short	2044	2024-03-11	2025-03-11
Thermometer	Fisher Scientific	15-078-181	181705017	2023-03-30	2025-03-30

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
Signal Generator	Keysight	N5181A	MY50140788	2024-08-01	2025-08-01
3-Path Diode Power Sensor	Rohde & Schwarz	NRP8S	112236	2024-07-12	2025-07-12
3-Path Diode Power Sensor	Rohde & Schwarz	NRP8S	112237	2024-07-12	2025-07-12
Dual Directional Coupler	Werlatone	C5100-10	92249		N/A

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
E-Field Probe	SPEAG	EX3DV4	7710	2024-01-16	2025-01-16
Data Acquisition Electronics	SPEAG	DAE4	1715	2024-02-12	2025-02-12
System Validation Dipole	SPEAG	CLA13	1017	2024-03-07	2025-03-07
Environmental Indicator	Control Company	06-662-4	240072459	2024-01-24	2026-01-24

5. Measurement Uncertainty

Per KDB 865664 D01, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg. The expanded SAR measurement uncertainty must be ≤ 30%, for a confidence interval of k = 2. If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

Therefore, the measurement uncertainty is not required.

6. Device Under Test (DUT) Information

6.1. DUT Description

Device Dimension	Overall (Length x Width x Thickness): 57 mm x 52 mm x 15 mm This is a an extremity wrist-worn wearable device	
Back Cover	The Back Cover is not removable	
Battery Options	The rechargeable battery is not user accessible.	
Test sample information	**S/N**	**Notes**
	477207650	Radiated NFC
Hardware Version	A04883	
Software Version	408	

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
Bluetooth	2.4 GHz	LE	N/A[2]
ANT/ANT+	2.4 GHz	GFSK	N/A[2]
NFC	13.56 MHz	Type A/B	100% (Type A)[1]

Notes:

1. Duty cycle for NFC is referenced from §9.3
2. Measured Duty Cycle is not required due to SAR test exemption.

7. RF Exposure Conditions (Test Configurations)

Refer to “SAR Photos and Ant locations” Appendix for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Test Position	Antenna-to-edge/surface	SAR Required	Note
Bluetooth LE	Extremity	0	Back	N/A	No	1
ANT/ANT+	Extremity	0	Back	N/A	No	1
NFC	Extremity	0	Back	N/A	Yes	

Notes:

SAR is not required per KDB 447498 D01 §4.2.3

SAR Test Exclusion Calculations for WLAN

Antennas < 50mm to adjacent edges

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)	Calculated Threshold Value
		dBm	mW	Back	Back
Bluetooth LE	2480	6.00	4	0	1.3 -EXEMPT-
ANT/ANT+	2480	6.00	4	0	1.3 -EXEMPT-

Note(s):

According to KDB 447498, if the calculated threshold value is >7.5 then SAR testing is required.

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.
The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.
The dielectric constant (εr) and conductivity (σ) of typical tissue-equivalent media recipes are expected to be within ± 5% of the required target values; but for SAR measurement systems that have implemented the SAR error compensation algorithms documented in IEC/IEEE 62209-1528:2020, to automatically compensate the measured SAR results for deviations between the measured and required tissue dielectric parameters, the tolerance for εr and σ may be relaxed to ± 10%. This is limited to frequencies ≤ 3 GHz.

Tissue Dielectric Parameters
IEC/IEEE 62209-1528

Table 2 – Dielectric properties of the tissue-equivalent medium

Frequency MHz	Real part of the complex relative permittivity, ε_r'	Conductivity, σ S/m	Penetration depth (E-field), δ mm
4	*55,0*	*0,75*	293,0
13	*55,0*	*0,75*	165,5
30	55,0	0,75	112,8
150	52,3	0,76	62,0
300	45,3	0,87	46,1
450	43,5	0,87	43,0
750	*41,9*	*0,89*	39,8
835	41,5	0,90	39,0
900	41,5	0,97	36,2
1 450	40,5	1,20	28,6
1 800	40,0	1,40	24,3
1 900	40,0	1,40	24,3
1 950	40,0	1,40	24,3
2 000	40,0	1,40	24,3
2 100	*39,8*	*1,49*	22,8
2 450	39,2	1,80	18,7
2 600	*39,0*	*1,96*	17,2
3 000	38,5	2,40	14,0
3 500	*37,9*	*2,91*	11,4
4 000	*37,4*	*3,43*	10,0
4 500	*36,8*	*3,94*	9,7

Frequency MHz	Real part of the complex relative permittivity, ε_r'	Conductivity, σ S/m	Penetration depth (E-field), δ mm
5 000	*36,2*	*4,45*	1,5
5 200	*36,0*	*4,66*	8,4
5 400	*35,8*	*4,86*	8,1
5 600	*35,5*	*5,07*	7,5
5 800	35,3	5,27	7,3
6 000	*35,1*	*5,48*	7,0
6 500	*34,5*	*6,07*	6,7
7 000	*33,9*	*6,65*	6,4
7 500	*33,3*	*7,24*	6,1
8 000	*32,7*	*7,84*	5,9
8 500	*32,1*	*8,46*	5,3
9 000	*31,6*	*9,08*	4,8
9 500	*31,0*	*9,71*	4,4
10 000	*30,4*	*10,40*	4,0

NOTE For convenience, permittivity and conductivity values are linearly interpolated for frequencies that are not a part of the original data from Drossos et al. [2]. They are shown in italics in Table 2. The italicized values are linearly interpolated (below 5800 MHz) or extrapolated (above 5800 MHz) from the non-italicized values that are immediately above and below these values.

Dielectric Property Measurements Results:

SAR Lab	Date	Tissue Type	Band (MHz)	Freq. (MHz)	Relative Permittivity (εr)			Conductivity (σ)		
					Measured	Target	Delta	Measured	Target	Delta
SAR 1A	2024-09-16	Head	13	13	52.8	55.0	-3.95%	0.72	0.75	-4.48%
				12	52.8	55.0	-3.96%	0.72	0.75	-4.49%
				14	52.8	55.0	-3.98%	0.72	0.75	-4.47%

8.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
  For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole/CLA input power (forward power) was recorded.
- The results are normalized to 1 W input power.

System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within ±10% of the manufacturer calibrated dipole SAR target. Refer to Appendix B for the SAR System Check Plots.

SAR Lab	Date	Dipole Type & Serial Number	Dipole Cal. Due Date	Input Power (dBm)	Measured results for 1-g SAR				Measured results for 10-g SAR				Plot No.
					Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	
1A	2024-09-16	CLA13 SN: 1017	2025-03-07	16.0	0.020	0.502	0.548	-8.33%	0.013	0.327	0.342	-4.52%	1

9. Conducted Output Power Measurements

9.1. Bluetooth LE

Maximum Output Power (Tune-up Limit) for Bluetooth LE

Maximum tune-up tolerance limit is 6 dBm. This power level qualifies for exclusion of SAR testing. Please refer to section 10.2. Standalone SAR Test Exclusion Considerations & Estimated SAR.

Band	Mode	Channel	Frequency (MHz)	Tune-up Power Limit (dBm)
Bluetooth 2.4 GHz	LE	0	2402	6.0
		19	2440	6.0
		39	2480	6.0

9.2. ANT/ANT+

Maximum Output Power (Tune-up Limit) for ANT/ANT+

Maximum tune-up tolerance limit is 6 dBm. This power level qualifies for exclusion of SAR testing. Please refer to section 10.2. Standalone SAR Test Exclusion Considerations & Estimated SAR.

Band	Mode	Frequency (MHz)	Tune-up Power Limit (dBm)
ANT/ANT+ 2.4 GHz	GFSK	2402	6.0
		2440	6.0
		2480	6.0

9.3. NFC

Conducted output power cannot be measured for NFC, therefore a 2 dB scaling factor shall be used to account for potential variations between samples.

Duty Factor Measured Results

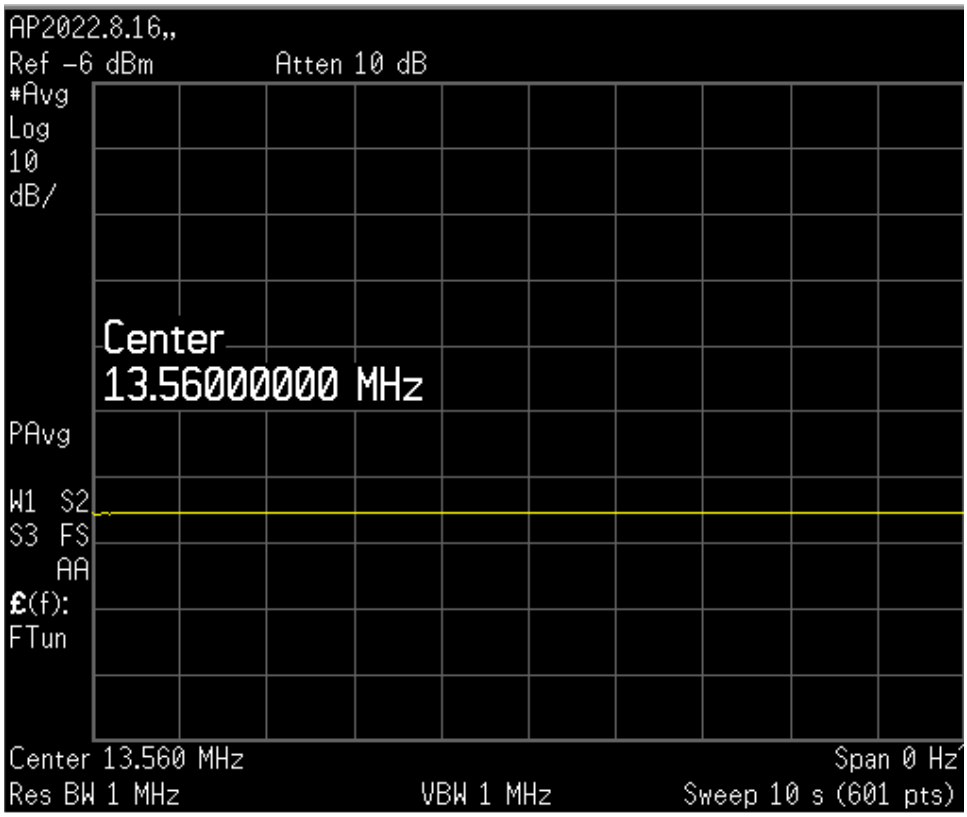
Mode	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
Type A	1.000	1.000	100.0%	1.00

Note(s):

Duty Cycle = (T on / period) * 100%

Duty Cycle plots

Type A



10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

- Reported SAR(W/kg) for NFC = Measured SAR * Tune-up scaling factor (2 dB)

10.1. NFC

RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Freq. (MHz)	10-g SAR (W/kg)		Plot No.
					Meas.	Scaled	
Extremity	Type A	0	Back	13.56	0.000	**0.000**	1

Note(s):

Conducted output power measurements for NFC are not practical, therefore a 2 dB scaling factor shall be used to account for potential variations between samples.

10.2. Standalone SAR Test Exclusion Considerations & Estimated SAR

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)] ≤ 3.0, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- *(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√$f_{(GHz)}$/x]* W/kg for test separation distances ≤ 50 mm;
  where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

RF Air interface	RF Exposure Conditions	Frequency (GHz)	Max. tune-up tolerance Power		Min. test separation distance (mm)	SAR test exclusion Result*	Estimated 10-g SAR (W/kg)
			(dBm)	(mW)			
Bluetooth LE	Extremity	2.480	6.0	4	5	1.3	**0.067**
ANT/ANT+	Extremity	2.480	6.0	4	5	1.3	**0.067**

Conclusion:

*: The computed value is ≤ 7.5; therefore, this qualifies for Standalone SAR test exclusion.

11. Simultaneous Transmission Conditions

RF Exposure Condition	Item	Capable Transmit Configurations		
Extremity	1	DSS	+	DXX

11.1. Simultaneous transmission SAR test exclusion considerations

KDB 447498 D01 General RF Exposure Guidance provides two procedures for determining simultaneous transmission SAR test exclusion: Sum of SAR and SAR to Peak Location Ratio (SPLSR)

Sum of SAR

To qualify for simultaneous transmission SAR test exclusion based upon Sum of SAR the sum of the reported standalone SARs for all simultaneously transmitting antennas shall be below the applicable standalone SAR limit. If the sum of the SARs is above the applicable limit then simultaneous transmission SAR test exclusion may still apply if the requirements of the SAR to Peak Location Ratio (SPLSR) evaluation are met.

11.2. Estimated SAR for Simultaneous Transmission SAR Analysis

Considerations for SAR estimation

1. When standalone SAR test exclusion applies, standalone SAR must also be estimated to determine simultaneous transmission SAR test exclusion.
2. Dedicated Host Approach criteria for SAR test exclusion is likewise applied to SAR estimation, with certain distinctions between test exclusion and SAR estimation:
   - When the separation distance from the antenna to an adjacent edge is ≤ 5 mm, a distance of 5 mm is applied for SAR estimation; this is the same between test exclusion and SAR estimation calculations.
   - When the separation distance from the antenna to an adjacent edge is > 5 mm but ≤ 50 mm, the actual antenna-to-edge separation distance is applied for SAR estimation.
   - When the minimum test separation distance is > 50 mm, the estimated SAR value is 0.4 W/kg
3. Please refer to Estimated SAR Tables to see which test positions are inherently compliant as they consist of only estimated SAR values for all applicable transmitters and consequently will always have sum of SAR values < 1.2 W/kg. Simultaneous transmission SAR analysis was therefore not performed for these test positions.

Estimated SAR for Bluetooth LE:

RF Air interface	RF Exposure Conditions	Frequency (GHz)	Max. tune-up tolerance Power		Min. test separation distance (mm)	Estimated 10-g SAR (W/kg)
			(dBm)	(mW)		
Bluetooth LE	Extremity	2.480	6.0	4	5	0.067

Estimated SAR for Bluetooth LE:

RF Air interface	RF Exposure Conditions	Frequency (GHz)	Max. tune-up tolerance Power		Min. test separation distance (mm)	Estimated 10-g SAR (W/kg)
			(dBm)	(mW)		
ANT/ANT+	Extremity	2.480	6.0	4	5	0.067

11.3. Sum of SAR for DSS & DXX

RF Exposure conditions	Test Position	Standalone SAR (W/kg)			∑ 1-g SAR (W/kg)	
		1	2	2	1+3	2+3
		Bluetooth LE	ANT/ANT+	NFC		
Extremity	Back	0.067	0.067	0.000	**0.067**	**0.067**

Appendixes

Refer to separated files for the following appendixes.

Appendix A: SAR Setup Photos

Appendix B: SAR System Check Plots

Appendix C: SAR Highest Test Plots

Appendix D: SAR Tissue Ingredients

Appendix E: SAR Probe Certificates

Appendix F: SAR CLA Certificate

END OF REPORT