Test Report 2024-120

Version A
Issued 24 Jun 2024

Project GCL-0408
Model Identifier A04813
Primary Test Standard

RSS-102
FCC Parts 2.1091 and 2.1093

Garmin Compliance Lab

Garmin International
1200 E 151st Street
Olathe Kansas 66062 USA

Client-supplied Information

FCC ID:	IPH-04813
IC ID:	1792A-04813

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 RF exposure safety aspects of the transceiver(s). The results are as follows.

Parameter	**Description**	**Key Performance Values [Performance Class]**	**Result**	**Data starts at page**
Transmit Power	The average transmit power presented to the antenna is used to determine the undesired biological effects the test sample could evoke.	This data has no Pass or Fail values under this standard, but is used in subsequent analyses.	Measured	11
Exemption from routine evaluation	Radio emissions at the separation distance are sufficiently low to exempt the radio from a detailed evaluation.	The tuned time-averaged EIRP power was below the exemption limit in each case analyzed.	Exempt	17
Exposure Reference Level (MPE)	Radio emissions at the separation distance are below the exposure reference level where health effects could be a concern.	N/A	N/A	N/A

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

<u>Report Organization</u>

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.

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: Tim Olson, Patrick Flett, Sam Bruner.

2.3 Other Information
Test Sample received:	04 Mar 2024
Test Start Date:	20 Mar 2024
Test End Date:	22 May 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 David Arnett and initially issued on 24 Jun 2024 as Version A.

Report Technical Review: ______ GCL Only

David Arnett
Technical Lead EMC Engineer

Report Approval: ______ GCL Only

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

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

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

5. Description of the Equipment Tested

5.1 Unique Identification

Product Model	A04813
Serial Numbers Tested	8BG000002

This product tested is a device for sensing, data storage, and telemetry.

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, often from 12 Vdc sources
I/O Ports:	USB, microSD
Radio Transceivers:	IEEE 802.11 b/g/n, Bluetooth Low Energy
Radio Receivers:	GNSS
Primary Functions:	Sensing, data storage, communication
Typical use:	Vehicle mounted
Highest internal frequency:	2.484 GHz
Firmware Revision	1.20

5.3 Operating modes

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

M3 (BleTx). Bluetooth Low Energy radio transmits pseudorandom data continuously on a selected frequency and data rate.

M4 (BleLnk). Bluetooth Low Energy radio links to another device according to the standard protocol and exchanges data packets in a very long data exchange session.

M7 (WiFiTx). IEEE 802.11 radio transmits pseudorandom data continuously on a selected channel, modulation scheme, and data rate.

M8 (WiFiLnk). IEEE 802.11 radio links to another device according to the standard protocol and exchanges data packets in a very long data exchange session.

M9 (RxBle). Bluetooth Low Energy radio listens for data but does not transmit.

M10 (RxWiFi). IEEE 802.11 radio listens for data but does not transmit.

M15 (Cam). Video is recorded or streamed for viewing by the test operator.

5.4 EUT Arrangement

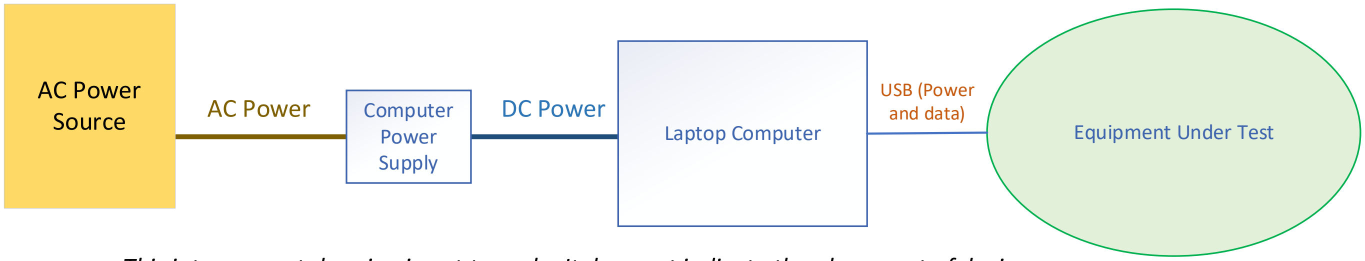
During test, the EUT components and associated support equipment were selected including the following arrangement sets. Not all arrangements were used in the tests contained in this report.

Reference to 12 V power is 12 Vdc vehicular power which is typically set at 13.8 V to match the dynamics of vehicular charging systems. Where 12 V is used, an intermediate power regulator is required because the test sample is only capable of receiving 5 Vdc USB-compatible power. At times, a vehicular On-board Diagnostic (OBD or OBD-II) port connector is the intermediate connector interface. At other times, a vehicular Cigarette Lighter Adapter (CLA) port is the intermediate interface. In all cases, a microSD card is installed in the EUT port.

Arrangement 1: A1 (Pwr) The test sample is provided power over its USB port in a test scenario where the source of that power and its physical layout is not particularly important. No block diagram is needed.

Arrangement 2: A2 (PC) The test sample is connected over a 1 m data cable to a laptop computer.

Arrangement 6: A6 (PC2) The test sample is connected over a 0.5 m data cable to a laptop computer.



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

Figure 1: Block diagram of equipment arrangement A2 or A6

Arrangement 3: A3 (OBD/4m) 12V is supplied to an OBD-style power converter, which then supplies 5 vdc through a 4 m USB-style cable to the test sample.

Arrangement 4: A4 (OBD/8m) 12V is supplied to an OBD-style power converter, which then supplies 5 vdc through an 8 m USB-style cable to the test sample.

Arrangement 5: A5 (Park) 12V is supplied from the vehicle DC power system to directly to a Parking Mode accessory with no intermediate connector. The Parking Mode accessory supplies 5 vdc through a USB-style cable to the test sample.

Arrangement 10: A10 (CLA0/4m) 12V is supplied to a CLA-style power converter type 0, which then supplies 5 vdc through a 4 m USB-style cable to the test sample.

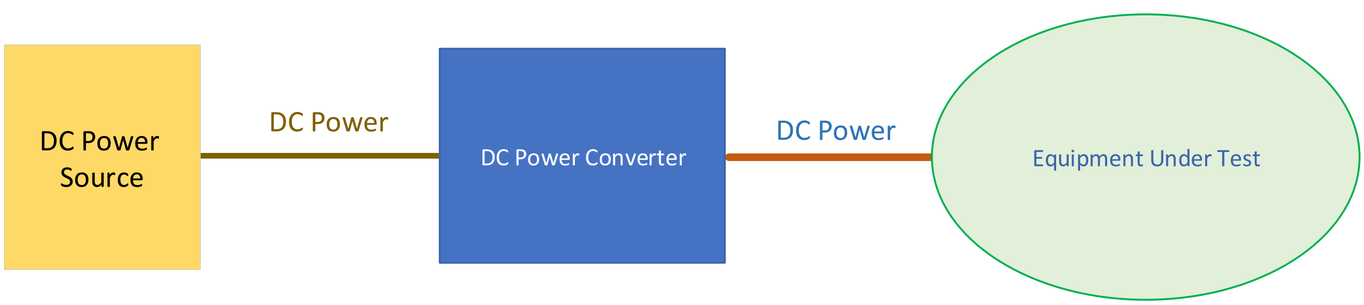
Arrangement 11: A11 (CLA1/4m) 12V is supplied to a CLA-style power converter type 1, which then supplies 5 vdc through a 4 m USB-style cable to the test sample.

Arrangement 12: A12 (CLA3/4m) 12V is supplied to a CLA-style power converter type 3, which then supplies 5 vdc through a 4 m USB-style cable to the test sample.

Arrangement 13: A13 (CLA0/8m) 12V is supplied to a CLA-style power converter type 0, which then supplies 5 vdc through a 8 m USB-style cable to the test sample.

Arrangement 14: A14 (CLA1/8m) 12V is supplied to a CLA-style power converter type 1, which then supplies 5 vdc through a 8 m USB-style cable to the test sample.

Arrangement 15: A15 (CLA3/8m) 12V is supplied to a CLA-style power converter type 3, which then supplies 5 vdc through a 8 m USB-style cable to the test sample.



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

Figure 4: Block diagram of equipment arrangements other than A1, A2, and A6

5.5 Associated Equipment (AE) used

Description	Manufacturer	Model	Serial Number
Car DC Adapter CLA	Garmin	013-00797-00	E18510000249
Car DC Adapter CLA	Garmin	013-00797-01	M230900541
Car DC Adapter CLA	Garmin	013-00797-03	M011231000987
Car DC Adapter OBD	Garmin	320-01425-10	None
Car DC Adapter Parking	Garmin	320-00845-16	None
Laptop PC	Dell	Latitude 7480	13504728854
PC Power Supply	Dell	LA180PM180	None
Laptop	Dell	inspiron	7DCR5R3
Power Supply	Dell	DA65NM191	CN-0KPVMF-DES00-233-EE1V-A00
Laptop	Dell	Latitude 5410	5VSPFB3
Computer	Dell	Latitude 5410	5VSPFB3
Power Supply	Dell	HA65NM191	0BD-7TC0-A02
Power adaptor	Garmin	PSAF10R-050Q	P183100844A1

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

5.6 Cables used

Description	From	To	Length	EMC Treatment
4 m Power	DC power	EUT	405 cm	None
8 m Power	DC power	EUT	812 cm	None
1 m Data	Computer	EUT	106 cm	None

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

6 Test Standards Applied

6.1. Accredited Standards

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

CFR 47, FCC Part 15, Subpart C
ANSI C63.10: 2013, ANSI C63.10: 2020, and ANSI C63.10: 2020 +Cor 1: 2023
RSS-GEN Issue 5 Amd 2
RSS-102

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 Parts 2.1091 and 2.1093

6.3 Variances

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

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

6.4 Laboratory Accreditation

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

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

7 Measurement Instrumentation Uncertainty

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

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

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

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

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

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

8 Selected Example Calculations

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

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

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

8.1 AC Mains conducted emissions at 22 MHz

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

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

8.2 Radiated Emissions at 630 MHz

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

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

8.3 Radiated Emissions at 2.7 GHz

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

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

9 Environmental Conditions During Test

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

Temperature:	20.3 to 23.0 °C
Relative Humidity:	27.7% to 55.8% (non-condensing)
Barometric Pressure	95.7 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

Transmitter Power
Test IDs TR03A
Project GCL0408

Test Date(s)	03 Apr 2024
Test Personnel	Jim Solum
Product Model	A04813
Serial Number tested	8BG000002
Operating Mode	M7 (Wifi Tx)
Arrangement	A1(Pwr)
Input Power	5 Vdc
Test Standards:	FCC Part 15, ANSI C63.10, RSS-GEN, RSS-247 FCC Part 2.1091, FCC Part 2.1093, RSS-102, ANSI C95.3 (as noted in Section 6 of the report).
Antenna Gain	2.37 dBi, as reported by the client
Radio Protocol	IEEE 802.11b/g/n
Pass/Fail Judgment:	**PASS**
Test record created by:	**Jim Solum**
Date of this record:	**09 Apr 2024**

Original record, Version A, was created 9 Apr 2024. Dave Arnett created version B on 19 June 2024 to include embedded duty cycle data.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
RF Power Sensor	Rohde&Schwarz	NRP8S	109927	7-Jul-2023	1-Jul-2024

Table TR03A.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3; TimePowerAnalysisSpreadsheetv11.xls

Test Method

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

ANSI C63.10: 11.9.1.3

Transmit Power Data

Each measurement is made conducted from the antenna port with the transmitter on a specified channel and in a selected transmission protocol. The data record length is 100 msec for the Bluetooth-like protocols and 1 second for WiFi. Where standards cited here apply harmonized test methods and different limits, the more strict limit has applied. Data shown here is for WiFi channels 1 through 11.

The ANSI method finds the highest value (numerical peak) and applies the 30 dBm limit for WiFi and 21dBm for Bluetooth, BLE and ANT from the US and Canadian standards. All values are under the limit.

The results are shown below. Yellow highlighted cells indicate the highest power value for each radio protocol. Grey ‘NT’ entries indicate channels or speeds that were not selected for measurement per the design of the experiment.

Mode	Speed	1	2	3	4	5	6	7	8	9	10	11
B	1	**15.64**	**15.50**	**NT**	**NT**	**NT**	**12.91**	**NT**	**NT**	**NT**	**NT**	**NT**
B	2	**15.59**	**15.54**	**14.30**	**NT**	**NT**	**13.10**	**NT**	**NT**	**15.14**	**16.04**	**15.08**
B	5.5	**NT**	**NT**	**NT**	**NT**	**NT**	**12.89**	**NT**	**NT**	**NT**	**NT**	**NT**
B	11	**NT**	**NT**	**NT**	**NT**	**NT**	**13.04**	**NT**	**NT**	**NT**	**NT**	**NT**
G	6	**NT**	**NT**	**NT**	**NT**	**NT**	**12.56**	**NT**	**NT**	**NT**	**NT**	**NT**
G	9	**15.77**	**15.37**	**NT**	**NT**	**NT**	**12.54**	**NT**	**NT**	**NT**	**NT**	**NT**
G	12	NT	NT	NT	**NT**	**NT**	**12.67**	**NT**	**NT**	**NT**	**NT**	**NT**
G	18	NT	NT	NT	**NT**	**NT**	**12.49**	**NT**	**NT**	**NT**	**NT**	**NT**
G	24	**15.30**	**14.96**	**14.29**	**NT**	**NT**	**12.68**	**NT**	**NT**	**14.65**	**14.93**	**14.93**
G	36	NT	NT	NT	**NT**	**NT**	**12.59**	**NT**	**NT**	**NT**	**NT**	**NT**
G	48	NT	NT	NT	**NT**	**NT**	**10.43**	**NT**	**NT**	**NT**	**NT**	**NT**
G	54	NT	NT	NT	**NT**	**NT**	**8.18**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS0	**14.26**	**13.87**	**NT**	**NT**	**NT**	**11.63**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS1	NT	NT	NT	**NT**	**NT**	**11.39**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS2	**14.04**	**13.94**	**12.97**	**NT**	**NT**	**11.67**	**NT**	**NT**	**13.64**	**13.95**	**13.70**
N	MCS3	**NT**	**NT**	**NT**	**NT**	**NT**	**11.63**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS4	**NT**	**NT**	**NT**	**NT**	**NT**	**10.29**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS5	**NT**	**NT**	**NT**	**NT**	**NT**	**9.27**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS6	**NT**	**NT**	**NT**	**NT**	**NT**	**8.89**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS7	**NT**	**NT**	**NT**	**NT**	**NT**	**8.54**	**NT**	**NT**	**NT**	**NT**	**NT**

Table TR03A.2: WiFi transmit power summary in dBm

Additional Transmit Power Data Analysis

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

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

Mode	Speed	1	2	3	4	5	6	7	8	9	10	11
B	1	**30.82**	**28.14**	**NT**	**NT**	**NT**	**16.06**	**NT**	**NT**	**NT**	**NT**	**NT**
B	2	**28.46**	**26.67**	**21.21**	**NT**	**NT**	**14.85**	**NT**	**NT**	**24.63**	**27.57**	**24.79**
B	5.5	**NT**	**NT**	**NT**	**NT**	**NT**	**11.40**	**NT**	**NT**	**NT**	**NT**	**NT**
B	11	**NT**	**NT**	**NT**	**NT**	**NT**	**8.26**	**NT**	**NT**	**NT**	**NT**	**NT**
G	6	**NT**	**NT**	**NT**	**NT**	**NT**	**10.14**	**NT**	**NT**	**NT**	**NT**	**NT**
G	9	**16.48**	**15.25**	**NT**	**NT**	**NT**	**8.61**	**NT**	**NT**	**NT**	**NT**	**NT**
G	12	**NT**	**NT**	**NT**	**NT**	**NT**	**7.40**	**NT**	**NT**	**NT**	**NT**	**NT**
G	18	**NT**	**NT**	**NT**	**NT**	**NT**	**5.75**	**NT**	**NT**	**NT**	**NT**	**NT**
G	24	**9.00**	**8.36**	**6.74**	**NT**	**NT**	**4.79**	**NT**	**NT**	**7.75**	**8.29**	**7.72**
G	36	**NT**	**NT**	**NT**	**NT**	**NT**	**4.53**	**NT**	**NT**	**NT**	**NT**	**NT**
G	48	**NT**	**NT**	**NT**	**NT**	**NT**	**2.89**	**NT**	**NT**	**NT**	**NT**	**NT**
G	54	**NT**	**NT**	**NT**	**NT**	**NT**	**1.75**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS0	**14.60**	**13.41**	**NT**	**NT**	**NT**	**7.81**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS1	**NT**	**NT**	**NT**	**NT**	**NT**	**5.52**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS2	**7.99**	**7.60**	**6.26**	**NT**	**NT**	**4.39**	**NT**	**NT**	**7.11**	**7.63**	**7.09**
N	MCS3	**NT**	**NT**	**NT**	**NT**	**NT**	**3.68**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS4	**NT**	**NT**	**NT**	**NT**	**NT**	**2.78**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS5	**NT**	**NT**	**NT**	**NT**	**NT**	**2.27**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS6	**NT**	**NT**	**NT**	**NT**	**NT**	**2.07**	**NT**	**NT**	**NT**	**NT**	**NT**
N	MCS7	**NT**	**NT**	**NT**	**NT**	**NT**	**1.98**	**NT**	**NT**	**NT**	**NT**	**NT**

Table TR03A.3: WiFi additional RF exposure power summary in milliwatts

For each modulation rate, there is a percentage of the time when the transmitter is actually on, and when it is off. This is a duty cycle factor that is embedded in the over-all 6-minute duty cycle considered in the RF exposure standards. The table below presents those DC values, as a pure decimal value drawn from the data.

Mode	Speed	DC
B	1	**0.93**
B	2	**0.88**
B	5.5	**0.75**
B	11	**0.64**
G	6	**0.73**
G	9	**0.66**
G	12	**0.61**
G	18	**0.55**
G	24	**0.52**
G	36	**0.47**
G	48	**0.44**
G	54	**0.44**
N	MCS0	**0.72**
N	MCS1	**0.61**
N	MCS2	**0.55**
N	MCS3	**0.51**
N	MCS4	**0.47**
N	MCS5	**0.45**
N	MCS6	**0.44**
N	MCS7	**0.43**

Table TR03A.4: WiFi embedded duty cycle

Setup Diagram

The following block diagrams show how the EUT and test equipment is arranged for test. The client provided a short length of cable to bring the signals out to a connector. This cable was found to have 0.8 dB of loss in this frequency range. This factor was taken into account during the data analysis.

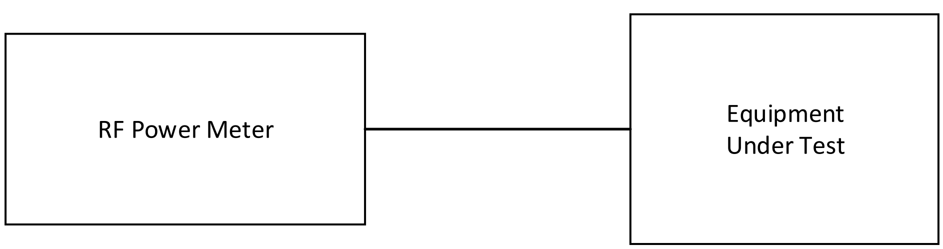


Figure TR03A.1: Test equipment setup

This line is the end of the test record.

Test Record
Transmitter Power
Test IDs TR02
Project GCL0408

Test Date(s)	03 Apr, 09 May 2024
Test Personnel	David Arnett, Jim Solum
Product Model	A04813
Serial Number tested	8BG000002
Operating Mode	M3 (BleTx)
Arrangement	A1 (Pwr)
Input Power	5Vdc
Test Standards:	FCC Part 15, ANSI C63.10, ETSI EN 300 328, RSS-GEN, RSS-247 (as noted in Section 6 of the report).
Antenna Gain	2.37 dBi, as reported by the client
Radio Protocol	Bluetooth Low Energy
Pass/Fail Judgment:	**PASS**
Test record created by:	**Jim Solum**
Date of this record:	**14 May 2024**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
RF Power Sensor	Rohde&Schwarz	NRP8S	109927	7-Jul-2023	1-Jul-2024
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	21-May-2024
Thermometer	Thermco	ACCD370P	220608121	26-Aug-2022	1-Sep-2024
Thermal Chamber	Tenney	T2RC	32774-02	Calibration	Not Required

Table TR02.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3; TimePowerAnalysisSpreadsheet v11.xls

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

ETSI EN 300 328: 5.4.2.2.1
ANSI C63.10: 11.9.1.3

The parameters of duty cycle, transmitter timing, or medium utilization are typically not required for adaptive transceivers or transceivers emitting at 10 dBm EIRP or less, so those results will be omitted from the data set.

Transmit Power Data
Each measurement is made conducted from the antenna port with the transmitter on a specified channel and in a selected transmission protocol.

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

The results are shown below. Yellow highlighted cells indicate the highest power value for each radio protocol. Bluetooth Low Energy at the 1 Mbps data has its lowest and highest channel frequencies set at 2402 MHz and 2480 MHz.

Frequency	(MHz)	2402	2440	2480
BT Low Energy	1 Mbps	**7.11**	**4.77**	**3.97**

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

Frequency	(MHz)	2402	2440	2480
BT Low Energy	1 Mbps	**9.27**	**6.91**	**6.11**

Table TR02.3: Transmit Power Summary in dBm EIRP with ETSI analytical methods

The table below shows BLE 2402 MHz power vs temperature at nominal and hot and cold temperature extremes.

Temperature	°C	Power, dBm EIRP	Limit, dBm EIRP	Result
Nominal	20	9.27	20	Pass
Hot	60	8.64	20	Pass
Cold	-20	9.34	20	Pass

Table TR02.4: BLE 2402 MHz Transmit Power Summary in dBm EIRP with ETSI analytical methods

Additional Transmit Power Data Analysis

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

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

Frequency	(MHz)	2402	2440	2480
BT Low Energy	1 Mbps	**3.13**	**1.82**	**1.51**

Table TR02.5: Additional RF exposure power summary, with units of milliwatt

Setup Diagram

The following block diagrams show how the EUT and test equipment is arranged for test. The client provided a short length of cable to bring the signals out to a connector. This cable was found to have 0.8 dB of loss in this frequency range. This factor was taken into account during the data analysis.

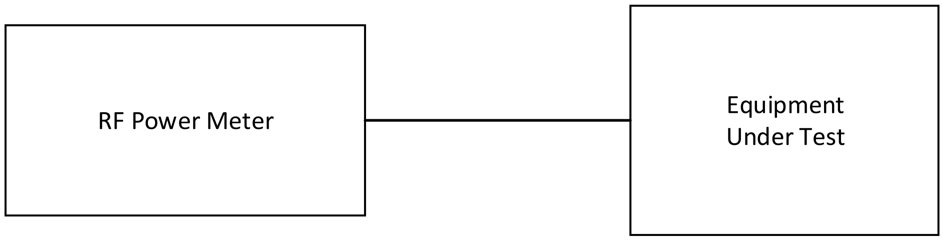


Figure TR02.1: Test equipment setup

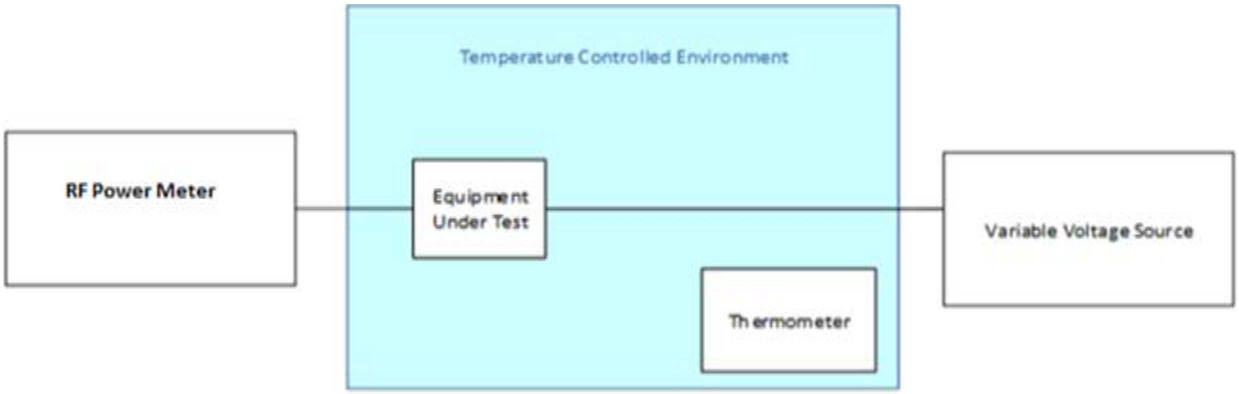


Figure TR02.2: Test equipment setup for transmit power measurements at 60°C and -20°C

This line is the end of the test record.

Test Record
RF Exposure Analysis
Test IDs TR50
Project GCL0408

Product Model	A04813
Test Standards:	FCC Part 1.1310, FCC Part 2.1093, RSS-102 (as noted in Section 6 of the report).
Radio Protocol(s)	Bluetooth Low Energy, IEEE 802.11 b/g/n
Separation Distance	20 cm (as stated by the client)
Antenna Gain	2.37 dBi (as stated by the client)
Tune-up Tolerance	None (as stated by the client)
Judgment:	**EXEMPT from further detailed analysis**
Analysis by:	**David Arnett**
Date of this record:	**21 Jun 2024**

Original record, Version A.

Software used: RFExposureToolV1.xslx

Analytical Method

The analytical method used in the Garmin Compliance Lab considers the limits and requirements of the standards listed above. For determination of the exemption, the requirements of Canada's RSS-102 regulations are just as strict, or are more strict, than each of the other standards listed. Therefore, if the product is judged Exempt under RSS-102, it is judged Exempt for all listed standards.

This test record for RF transmit power uses the exact same raw data set and processes the data according to the methods used for RF exposure evaluation. The RF Exposure analysis yields an average power over time, and an embedded duty cycle value. This test record will simply summarize the RF Exposure average power and duty cycle data from those test records and take those results into the RSS-102 RF exposure analysis.

Transmit Power and Timing Data

Radio	Pwr	DC
BLE	3.13	< 1.0
B 1Mbps	30.82	0.93
G 9 Mbps	16.48	0.66
N MCS0	14.6	0.72

Table TR50.1: Average power in milliwatts and embedded Duty Cycle

Based on these values, the following radio modes and modulations were selected for evaluation and the evaluation per RSS-102 are provided below: IEEE 802.11b at 1 Mbps

Parameter	**Unit**	**Value**
Radio type	**---**	**IEEE 802.11b**
Lowest Tx frequency	MHz	2412
Highest Tx frequency	MHz	2462
Separation distance	cm	20
Tx power to antenna	mW	30.82
Duty cycle embedded above	unitless	0.930
Antenna gain (unused if neg)	dBi	2.37
Usage Rate	unitless	1.000
6-min time averaging factor	unitless	0.930
Tune-up tolerance	%	0.0
Tuned time-averaged EIRP power	**mW**	**53.2**
Controlled Environment?	----	No
Basic exemption level	mW	308.8
Body/Limb use	----	Not worn
Body/Limb multiplier	unitless	1
Final exemption level	**mW**	**308.8**
Judgment:		**Exempt**

Table TR50.2: Analysis of whether the IEEE 802.11 b results meet the exemption level

The sample is judged to be exempt from further evaluation for the risk of RF exposure.

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.