Test Report 2023-057

Version B
Issued 20 Sep 2023

Project GCL-0306
Model Identifier A04583
Primary Test Standard
CFR 47, FCC Part 15, referencing parts 1.1310 and 2.1093
RSS-102 Issue 5 Amd. 1

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

Client-supplied Information

FCC ID: IPH-04583
IC ID: 1792A-04583

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 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	10
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	11
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

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.

2. Test Background

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

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

Test Sample received: appx. 24 Jun 2023
Test Start Date: 6 Jul 2023
Test End Date: 8 Aug 2023

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

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

3. Report History and Approval

This report was written by David Arnett and initially issued on 31 Aug 2023 as Version A.
Version B, issued 20 Sep 2023, corrected some product description elements in sections 5.1 and 5.2.

Report Technical Review:

David Arnett
Technical Lead EMC Engineer

Report Approval:

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

4. Test Sample Modifications and Special Conditions

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

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

5.1 Unique Identification

Product Model	A04583
Serial Numbers Tested	3448629705 (Modified for 2.4 GHz conducted testing)

This product tested is a short range transceiver for collecting and sharing data.

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
Radio Receivers:	GNSS (Global Navigation Satellite Systems)
Primary Functions:	Radio reception and transmission
Typical use:	Portable, with varying orientation
Highest internal frequency:	2.484 GHz
Firmware Revision	3.41

5.3 Operating modes

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

Mode 1: M1 (BleTx1MB). Continuous Bluetooth Low Energy transmissions at 1 Mbps rate

Mode 2: M2 (Ble Link). The test sample is linked to a companion device using Bluetooth Low Energy

Mode 3: M3 (GNSS). GNSS signals are provided and the test sample attempts to determine its location

Mode 4: M4 (BleGnss). A BLE link is established as in M2, and GNSS signals are decoded as in M3

5.4 EUT Arrangement

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

Arrangement 1: A1 (Batt) The test sample operates on internal battery power with no external cables

Arrangement 2: A2 (UsbPwr) The test sample is powered over its USB port from a computer or power supply

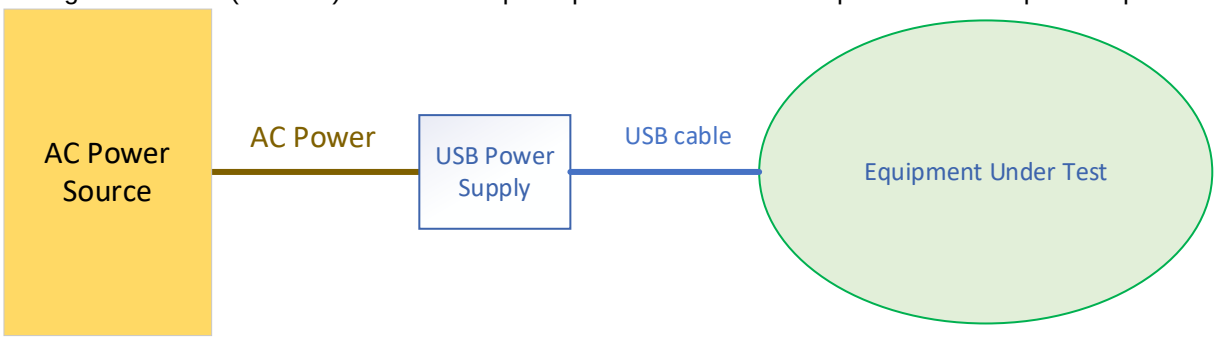
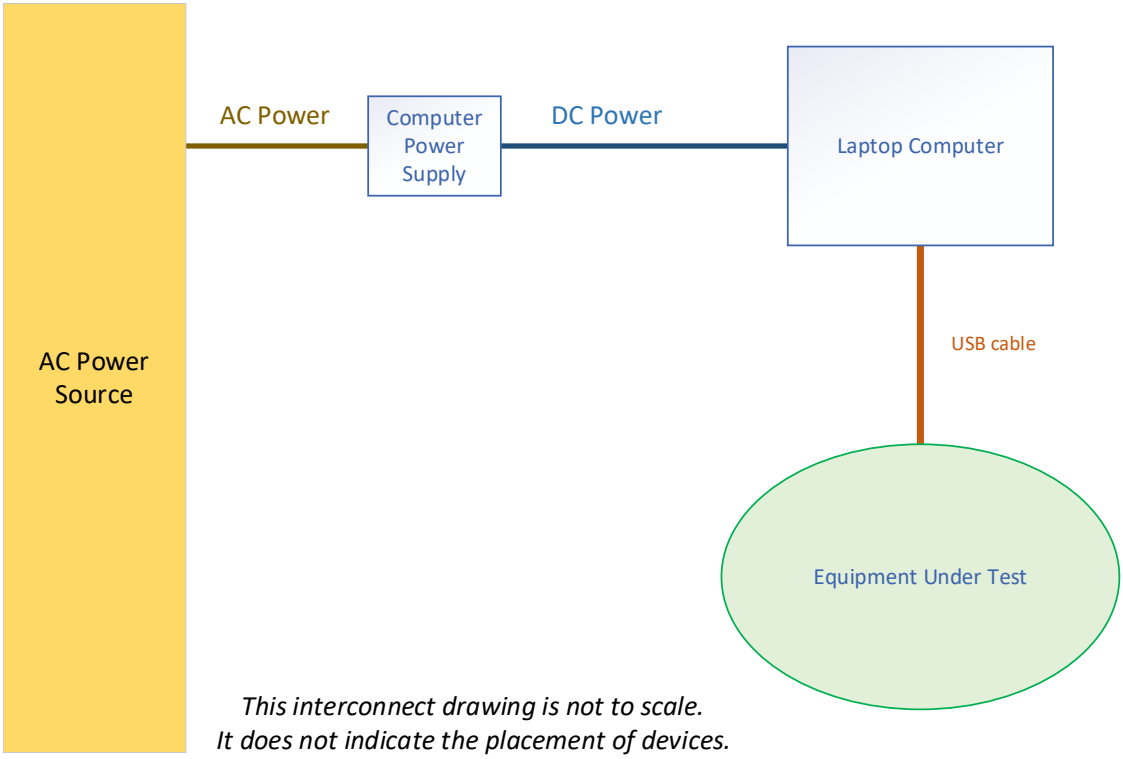


Figure 1: Block diagram of equipment arrangements A2

Arrangement 3: A3 (PC) The test sample is powered and establishes a data link over its USB port



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

Figure 2: Block diagram of equipment arrangements A3

5.5 Associated Equipment (AE) used

Description	Manufacturer	Model	Serial Number
Tablet	Apple	iPad Pro 11inch	DMPZ7582KD6L
Laptop	Dell	Latitude 5410	5VSPFB3
Power Supply	Dell	HA65NM191	0BD-7TC0-A02

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

5.6 Cables used

Description	From	To	Length	EMC Treatment
USB	PC / Power	EUT	56 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, referencing parts 1.1310 and 2.1093
RSS-102 Issue 5 Amd. 1

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:	21.9 to 22.9 °C
Relative Humidity:	43.2% to 53.1% (non-condensing)
Barometric Pressure	97.4 to 98.5 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 TR01B
Project GCL0306

Test Date(s)	14 Jul 2023
Test Personnel	Majid Farah
Product Model	A04583
Serial Number tested	3448629705
Operating Mode	M1 (BleTx1MB)
Arrangement	A2 (UsbPwr)
Input Power	5Vdc
Test Standards:	FCC Part 15, ANSI C63.10, ETSI EN 300 328, RSS-GEN, RSS-247, FCC Part 1.1310, FCC Part 2.1093, RSS-GEN, RSS-102, IEC/EN 62311, and IEC/EN 62479 (as noted in Section 6 of the report).
Antenna Gain	3.54 dBi, as reported by the client
Radio Protocol	Bluetooth Low Energy

Pass/Fail Judgment: **EXEMPT from further detailed analysis**

Test record created by: **Jim Solum and David Arnett**
Date of this record: **29 Aug 2023**
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

Table TR01B.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3, TimePowerAnalysisSpreadsheetv10.xls, RFExposureToolV1.xlsx

Test Method
The test method used in the Garmin Compliance Lab is to take RF power data in a way that is analyzed according to the rules of multiple compatible standards. The data here was previously reported with the data analysis results using the methods of the following test standards

ETSI EN 300 328:	5.4.2.2.1.3
ANSI C63.10:	11.9.1.3

This test record expands on the exact same raw data set and provides the data analysis according to the methods used for RF exposure evaluation. To assure the reader that this is the same data set, those original analysis results will be repeated here followed by the RF exposure data and results.

Transmit Power and Timing 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.

There are three separate analyses performed on the data set from the broadband fast diode power sensor. Under the ANSI method, the analysis reports the peak value of power observed, in dBm units. Under the ETSI method, each transmission burst is analyzed to find the burst with the highest average power, antenna gain is added, and the resulting unit is dBm EIRP. Both analyses will be reported, even though the report in which this record appears may not need each of these methods.

The third analytical method reports the power in linear units, such as milliwatt, where the level is averaged over the measurement record. In addition, short-time duty cycle is reported since this is a portion of the over-all 6-minute time averaging result but this factor is not double-counted in the final result for tuned time-averaged EIRP power. The key question addressed is whether the transmitters require further detailed analysis as described in the standards, or whether the exposure levels are so low that they are exempt from that further analysis.

Where standards cited here apply harmonized test methods and different limits, the more strict limit has applied. The results are shown below.

Frequency	(MHz)	2402	2440	2480	ANSI Limit (dBm)
BT Low Energy	1 Mbps	**4.33**	**4.29**	**4.18**	21

Table TR01B.2: Transmit Power Summary in dBm with ANSI C63.10 analytical methods

Frequency	(MHz)	2402	2440	2480	ETSI Limit (dBm EIRP)
BT Low Energy	1 Mbps	**6.44**	**6.41**	**6.30**	20

Table TR01B.3: Transmit Power Summary in dBm EIRP with ETSI analytical methods

Frequency	(MHz)	2402	2440	2480
BT Low Energy	1 Mbps	**0.41**	**0.41**	**0.40**

Table TR01B.4: Transmit Power Summary in mW with RF Exposure analytical methods

Frequency	(MHz)	2402	2440	2480
BT Low Energy	1 Mbps	**0.213**	**0.213**	**0.213**

Table TR01B.5: Duty cycle embedded in power measurements

Parameter	**Unit**	**Value**
Radio type	**---**	**BLE**
Lowest Tx frequency	MHz	2402
Highest Tx frequency	MHz	2480
Separation distance	cm	0.5
Tx power to antenna	mW	0.41
Duty cycle embedded above	unitless	0.213
Antenna gain (unused if neg)	dBi	3.54
Usage Rate	unitless	1.000
6-min time averaging factor	unitless	0.213
Tune-up tolerance	%	10.0
Tuned time-averaged EIRP power	**mW**	**1.0**
Controlled Environment?	----	No
Basic exemption level	mW	3.9
Body/Limb use	----	Body worn
Body/Limb multiplier	unitless	1
Final exemption level	**mW**	**3.9**
Judgment:		**Exempt**

Table TR01B.6: Analysis of whether the Bluetooth Low Energy results meet the exemption level

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

Setup Diagram
The following block diagrams show how the EUT and test equipment is arranged for test.

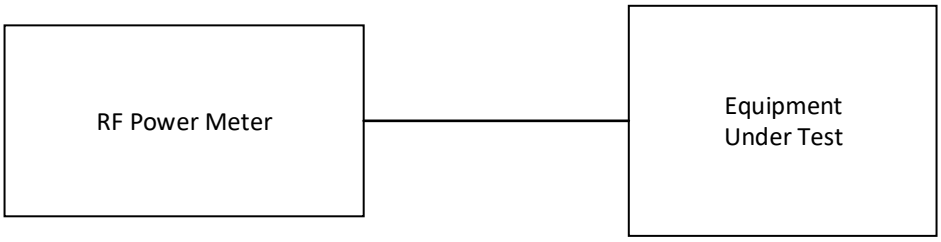


Figure TR01B.1: Test equipment setup

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.