FCC Part 15.225 Certification Application Report

Test Lab:		Applicant:	
Rhein Tech Laboratories, Inc. 360 Herndon Parkway Suite 1400 Herndon, VA 20170 E-Mail: atcbinfo@rheintech.com	Phone: 703-689-0368 Fax: 703-689-2056 www.rheintech.com	Garmin International Inc. 1200 E. 151st Street Olathe, Kansas 66062	
FCC ID	IPH-A3405	**Test Report Date**	August 1, 2018
Platform	N/A	**RTL Work Order #**	2018134
Model #	AA3405	**RTL Quote #**	QRTL18-134A
American National Standard Institute	ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
FCC Classification	DXX – Part 15 Low Power Communication Device Transmitter		
FCC Rule Part(s)	Part 15.225: Operation within the band 13.110-14.010 MHz (10-01-17) Part 2.1049: Measurements required: Occupied Bandwidth (06-14-17)		
Frequency Range (MHz)	**Output Power (W)**	**Frequency Tolerance**	**Emission Designator**
13.56	N/A	N/A	N/A

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this test report. No modifications were made to the equipment during testing in order to achieve compliance with these standards. Furthermore, there was no deviation from, additions to, or exclusions from, the applicable parts of FCC Part 2, FCC Part 15, and ANSI C63.10.

Signature: _____ Date: August 1, 2018

Typed/Printed Name: Desmond A. Fraser Position: President

These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by ANAB. Refer to certificate and scope of accreditation AT-1445.

Table of Contents

Figure Index

Table Index

Plot Index

Appendix Index

Photograph Index

1 General Information

1.1 Scope

Applicable Standards:

- FCC Part 2.1049: Measurements required: Occupied Bandwidth
- FCC Part 15.225: Operation within the band 13.110-14.010 MHz

1.2 Description of EUT

Equipment Under Test	Body-worn transmitter
Model #	AA3405
Power Supply	Battery operated
Modulation Type	ASK
Frequency Range	13.56 MHz
Antenna Connector Type	Magnet Loop
Antenna Type	Internal

1.3 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located at 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report and approved by the Federal Communications Commission to perform AC line conducted and radiated emissions testing.

1.4 Related Submittal(s)/Grant(s)

This is an original certification application for Garmin International Inc. Model #: AA3405, FCC ID: IPH-A3405.

1.5 Modifications

No modifications were made to the equipment during testing in order to achieve compliance with these standards.

2 Test Information

2.1 Description of Test Modes

Table 2-1: Channels Tested

Frequency (MHz)
13.56

2.2 Exercising the EUT

The EUT is a watch with a touch screen capability and one manual button on the right side. The EUT was supplied with test firmware programmed with modulation types and rates. The EUT was tested in all three orthogonal planes in order to determine worst-case emissions. The EUT was provided with software to continuously transmit during testing. The carrier was also checked to verify that information was being transmitted. An NFC card was provided to be placed near the EUT for proper normal operating mode. The NFC card has a blue LED that would light when placed in close proximity to the EUT.

2.3 Test Result Summary

Table 2-2: Test Result Summary

FCC Standard	Test	Pass/Fail or N/A
FCC 15.207	AC Power Conducted Emissions	Pass
FCC 15.209	Radiated Emissions	Pass
FCC 15.225(a), (d)	Field Strength of Fundamental and Harmonics	Pass
	99% Bandwidth	Pass
FCC 15.225(e)	Frequency Stability	Pass

2.4 Test System Details

The test samples were received on July 16, 2018. The FCC identifiers for all applicable equipment, plus descriptions of all cables used in the tested system, are identified in the following table.

Table 2-3: Equipment Under Test

Part	Manufacturer	Model	Serial Number	FCC ID	Cable Description	RTL Bar Code
Body-worn transmitter	Garmin International Inc.	AA3405	N/A	IPH-A3405	N/A	23067

Table 2-4: Auxiliary Equipment

Part	Manufacturer	Model	Serial Number	FCC ID	Cable Description	RTL Bar Code
NFC Detector Board	NXP	PCB2377-2	N/A	N/A	N/A	23066

2.5 Configuration of Tested System

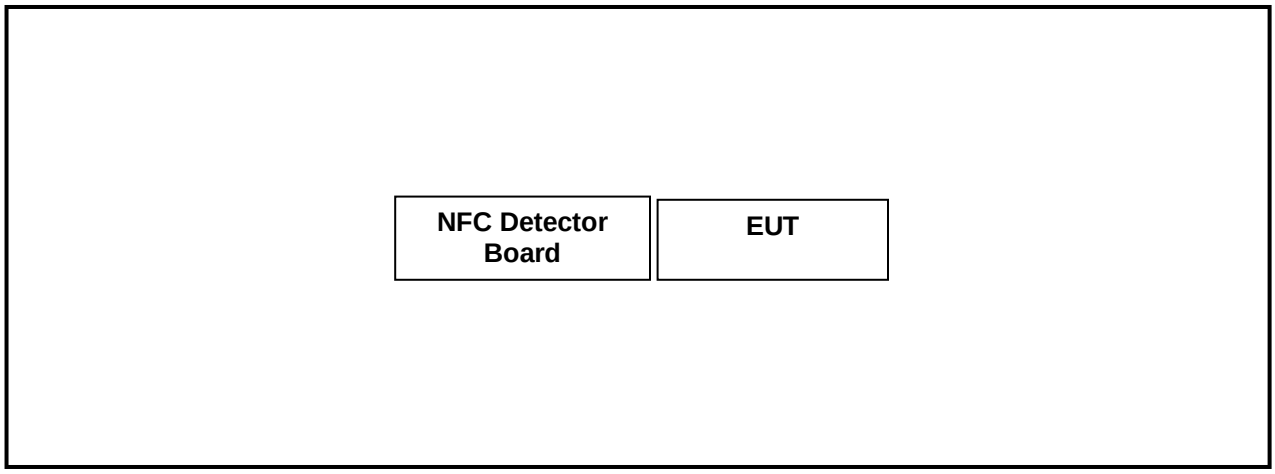


Figure 2-1: Configuration of System Under Test

3 AC Conducted Emissions - FCC 15.207

3.1 Site and Test Description

The power line conducted emissions measurements were performed in a Series 81 type shielded enclosure manufactured by Rayproof. The EUT was assembled on a wooden table 80 centimeters high. Power was fed to the EUT through a 50-ohm/50 microhenry Line Impedance Stabilization Network (LISN). The EUT LISN was fed power through an A.C. filter box on the outside of the shielded enclosure. The filter box and EUT LISN housing are bonded to the ground plane of the shielded enclosure. A second LISN, the peripheral LISN, provides isolation for the EUT test peripherals. This peripheral LISN was also fed A.C. power. A metal power outlet box, which is bonded to the ground plane and electrically connected to the peripheral LISN, powers the EUT host peripherals.

The spectrum analyzer was connected to the AC line through an isolation transformer. The 50-ohm output of the EUT LISN was connected to the spectrum analyzer input through a Solar 100 kHz high-pass filter. The filter is used to prevent overload of the spectrum analyzer from noise below 100 kHz. Conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable).

The analyzer's 6 dB bandwidth was set to 9 kHz. Video filter less than 10 times the resolution bandwidth is not used. Average measurements are performed in linear mode using a 10 kHz resolution bandwidth, a 1 Hz video bandwidth, and by increasing the sweep time in order to obtain a calibrated measurement. The emission spectrum was scanned from 150 kHz to 30 MHz. The highest emission amplitudes relative to the appropriate limits were measured and have been recorded.

3.2 Test Limits

Table 3-1: Conducted Emissions Limits

Line-Conducted Emissions		
Limit (dBµV)		
Frequency (MHz)	**Quasi-Peak**	**Average**
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5.00	56	46
5.00 to 30.00	60	50

3.3 Measurement Uncertainty

Measurement uncertainties shown for these tests are expanded uncertainties expressed at 95% confidence level using a coverage factor k = 2.

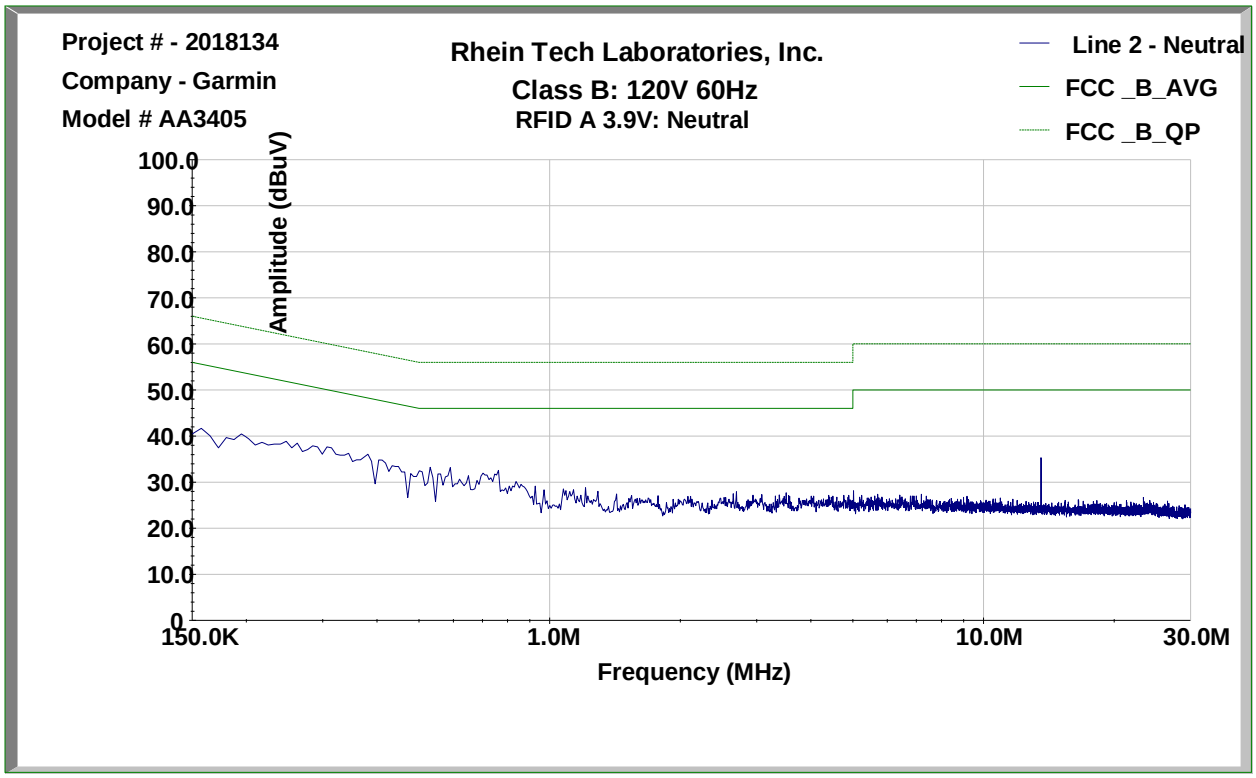
Conducted Emissions: ±2.5 dB

3.4 Conducted Emissions Test Data

Table 3-2: Conducted Emissions Environmental Condition

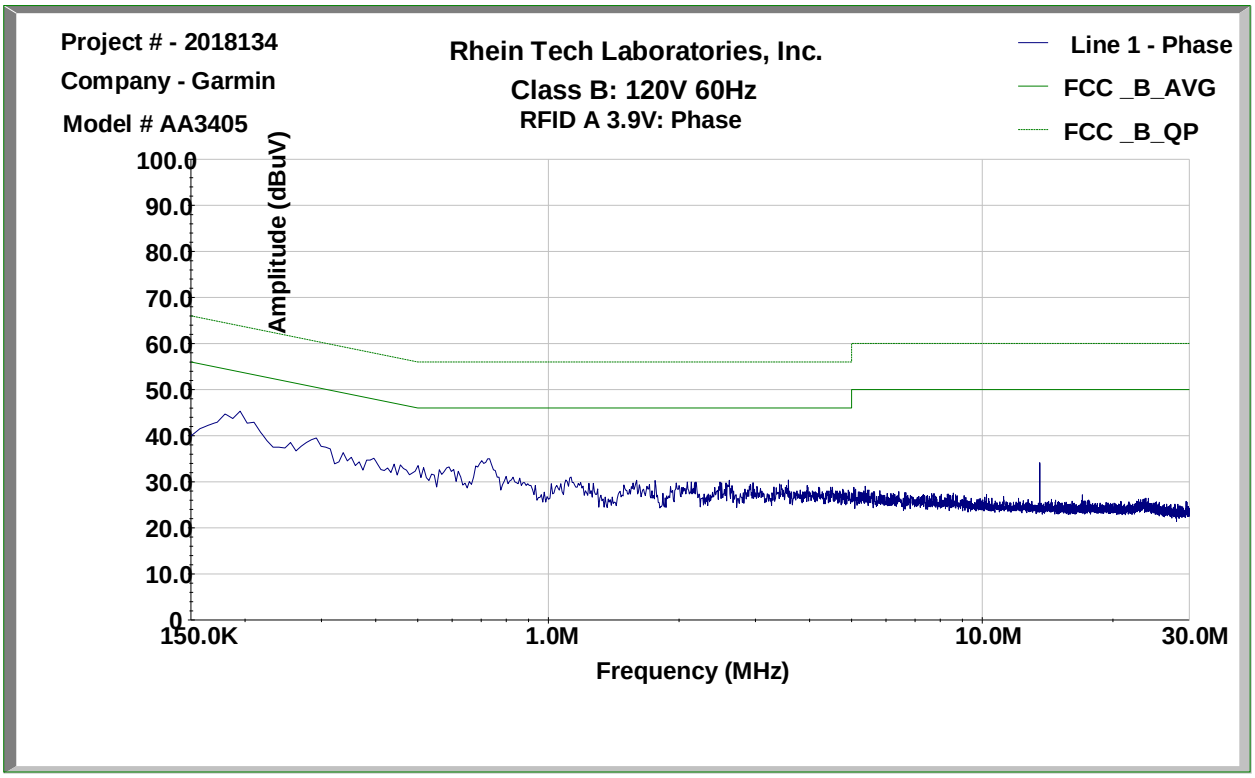
Date	Temperature (°F)	Humidity (%)	Pressure (kPa)
July 26, 2018	73.0	25	101.2

Plot 3-1: Conducted Emissions – Neutral



Note: Technology Type A was observed.

Plot 3-2: Conducted Emissions – Phase



Note: Technology Type A was observed.

Result: Pass

Table 3-3: Conducted Emissions Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900339	Hewlett Packard	85650A	Quasi-Peak Adapter (30 Hz – 1 GHz)	2521A00743	4/26/19
900968	Hewlett Packard	8567A	Spectrum Analyzer (10 kHz – 1.5 GHz)	2602A00160	4/26/19
900970	Hewlett Packard	85662A	Spectrum Analyzer Display	2542A11239	4/26/19
901082	AFJ International	LS16	16A LISN	16010020081	2/13/21
Test Software	Quantum Change	TILE!7	TILE! Test Software	7.1.3.20	N/A

Test Personnel:

Khue N. Do		July 26, 2018
EMC Test Engineer	Signature	Date of Test

4 Radiated Emissions – FCC 15.209, 15.225(a) & (d)

4.1 Limits of Radiated Emissions Measurement

Table 4-1: Radiated Emissions Limits

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (m)
0.009-0.490	2400/f (kHz)	300
0.490-1.705	2400/f (kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

As shown in 15.35(b), for frequencies above 1000 MHz, the field strength limits are based on average detector however, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 99% under any circumstances of modulation.

15.225(a) states "The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters."

20 * log(15,848) = 84.0 dBµV/m at 30 m.

15.225(d) stated "The field strength of any emissions appearing outside of the 13.110– 14.010 MHz band shall not exceed the general radiated emission limits in §15.209."

4.2 Radiated Emissions Measurement Test Procedure

Before final measurements of radiated emissions were made on the open-field three/ten meter range, the EUT was scanned indoors at one and three meter distances. This was done in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process was repeated during final radiated emissions measurements on the open-field range, at each frequency, in order to ensure that maximum emission amplitudes were attained.

Final radiated emissions measurements were made on the three/ten-meter, open-field test site. The EUT was placed on a nonconductive turntable 0.8 meters above the ground plane. The spectrum was examined from 9 kHz to the 10^{th} harmonic of the highest fundamental transmitter frequency (135.6 MHz).

At each frequency, the EUT was rotated 360°, and the antenna was raised and lowered from 1 to 4 meters in order to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarizations. For frequencies between 30 MHz and 1000 MHz, the spectrum analyzer's 6 dB bandwidth was set to 120 kHz, and the analyzer was operated in the CISPR quasi-peak detection mode. For emissions above 1000 MHz, emissions are measured using the average detector function with a minimum resolution bandwidth of 1 MHz. No video filter less than 10 times the resolution bandwidth was used. The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

4.3 Measurement Uncertainty

Measurement uncertainties shown for these tests are expanded uncertainties expressed at 95% confidence level using a coverage factor k = 2.

Radiated Emissions: ±4.6 dB

4.4 Radiated Emissions Test Data

Table 4-2: Radiated Emissions Environmental Condition

Date	Temperature (°F)	Humidity (%)	Pressure (kPa)
July 30, 2018	75.0	85	99.6

Table 4-3: Radiated Emissions Test Data (Fundamental)

TVDD (V)	Frequency (MHz)	Quasi-Peak Reading (dBµV/m)	Site Correction Factor (dB/m)	Quasi-Peak Corrected (dBµV /m)	Quasi-Peak Limit (dBµV /m)	Quasi-Peak Margin (dB)	Result (Pass / Fail)
3.20	13.56	-1.4	30.5	29.1	84.0	-54.9	Pass
3.90	13.56	-1.3	30.5	29.2	84.0	-54.8	Pass
4.75	13.56	-1.2	30.5	29.3	84.0	-54.7	Pass

Note 1: Technology Type A was observed.

Note 2: Fundamental measurements were taken at 3m. Levels were extrapolated to 30 m from 3 m (-20.0 dB).

20 * log (30 m / 3 m) = 20.0 dB

4.5 Radiated Emissions Harmonics/Spurious Test Data

Table 4-4: Radiated Emissions Harmonics/Spurious: TVDD 3.20 V

Emission Frequency (MHz)	Analyzer Reading (dBµV/m)	Site Correction Factor (dB/m)	Corrected (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result (Pass / Fail)
27.12	-17.8	32.7	14.9	29.5	-14.6	Pass
40.68	17.0	-16.1	0.9	40.0	-39.1	Pass
54.24	24.0	-22.3	1.7	40.0	-38.3	Pass
67.80	26.4	-23.3	3.1	40.0	-36.9	Pass
81.36	23.1	-21.3	1.8	40.0	-38.2	Pass
94.92	40.4	-18.7	21.7	43.5	-21.8	Pass
108.48	15.9	-17.3	-1.4	43.5	-44.9	Pass
122.04	27.1	-17.0	10.1	43.5	-33.4	Pass
135.60	16.3	-17.4	-1.1	43.5	-44.6	Pass

Note: Technology Type A was observed.

Table 4-5: Radiated Emissions Harmonics/Spurious: TVDD 3.90 V

Emission Frequency (MHz)	Analyzer Reading (dBµV/m)	Site Correction Factor (dB/m)	Corrected (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result (Pass / Fail)
27.12	-17.3	32.7	15.4	29.5	-14.1	Pass
40.68	17.1	-16.1	1.0	40.0	-39.0	Pass
54.24	24.1	-22.3	1.8	40.0	-38.2	Pass
67.80	26.9	-23.3	3.6	40.0	-36.4	Pass
81.36	23.7	-21.3	2.4	40.0	-37.6	Pass
94.92	41.4	-18.7	22.7	43.5	-20.8	Pass
108.48	16.6	-17.3	-0.7	43.5	-44.2	Pass
122.04	28.0	-17.0	11.0	43.5	-32.5	Pass
135.60	16.9	-17.4	-0.5	43.5	-44.0	Pass

Note: Technology Type A was observed.

Table 4-6: Radiated Emissions Harmonics/Spurious: TVDD 4.75 V

Emission Frequency (MHz)	Analyzer Reading (dBµV/m)	Site Correction Factor (dB/m)	Corrected (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result (Pass / Fail)
27.12	-17.7	32.7	15.0	29.5	-14.5	Pass
40.68	18.5	-16.1	2.4	40.0	-37.6	Pass
54.24	24.3	-22.3	2.0	40.0	-38.0	Pass
67.80	27.7	-23.3	4.4	40.0	-35.6	Pass
81.36	24.2	-21.3	2.9	40.0	-37.1	Pass
94.92	41.0	-18.7	22.3	43.5	-21.2	Pass
108.48	17.0	-17.3	-0.3	43.5	-43.8	Pass
122.04	28.1	-17.0	11.1	43.5	-32.4	Pass
135.60	17.0	-17.4	-0.4	43.5	-43.9	Pass

Note: Technology Type A was observed.

Result: Pass

4.6 Radiated Emissions Digital Test Data

Table 4-7: Digital Radiated Emissions Test Data

Emission Frequency (MHz)	Antenna (H / V)	Height (m)	Analyzer Reading (dBµV/m)	Site Correction Factor (dB/m)	Corrected (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result (Pass / Fail)
149.16	H	1.0	15.9	-17.9	-2.0	43.5	-45.5	Pass
162.72	V	1.0	17.6	-18.1	-0.5	43.5	-44.0	Pass
216.96	V	1.0	12.8	-18.9	-6.1	46.0	-52.1	Pass
230.52	H	1.0	12.8	-17.4	-4.6	46.0	-50.6	Pass
244.08	H	1.0	14.6	-15.8	-1.2	46.0	-47.2	Pass
271.20	V	1.0	12.7	-14.2	-1.5	46.0	-47.5	Pass

Note: Technology Type A was observed.

Result: Pass

Table 4-8: Radiated Emissions Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900791	Chase	CBL6111B	Bilog Antenna (30 MHz – 2000 MHz)	N/A	10/4/20
900811	Rhein Tech Laboratories	PR-1040	OATS 1 Preamplifier 40dB (30 MHz – 2 GHz)	1003	7/6/19
900878	Rhein Tech Laboratories	AM3-1197-0005	3 meter antenna mast, polarizing	Outdoor Range 1	N/A
900913	Hewlett Packard	85462A	EMI Receiver RF Section (9 kHz – 6.5 GHz)	3325A00159	4/4/19
900914	Hewlett Packard	8546OA	RF Filter Section, (100 kHz – 6.5 GHz)	3330A00107	4/4/19
901242	Rhein Tech Laboratories	WRT-000-0003	Wood rotating table	N/A	N/A
901583	Agilent Technologies	N9010A	Spectrum Analyzer (10 Hz – 26.5 GHz)	MY51250846	2/6/20
901663	Rohde & Schwarz	HFH2-Z2	Loop Antenna (9 kHz – 30 MHz)	827525/019	5/1/19

Test Personnel:

Khue N. Do		July 30, 2018
EMC Test Engineer	Signature	Date of Test

5 Occupied Bandwidth – FCC Part 2.1049

5.1 99% Bandwidth Test Procedure

The 99% bandwidths per FCC Part 2.1049 were measured using a 50-ohm spectrum analyzer. The modulated carrier was adjusted on the analyzer so that it was displayed entirely on the spectrum analyzer. The sweep time was auto and allowed through several sweeps with the max hold function used in peak detector mode.

• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
• The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.

5.2 Measurement Uncertainty

Measurement uncertainties shown for these tests are expanded uncertainties expressed at 95% confidence level using a coverage factor k = 2.

99% OBW: ±1.0 dB

5.3 99% Bandwidth Test Data

Table 5-1: 99% OBW Environmental Condition

Date	Temperature (°F)	Humidity (%)	Pressure (kPa)
July 26, 2018	73.0	25	101.2

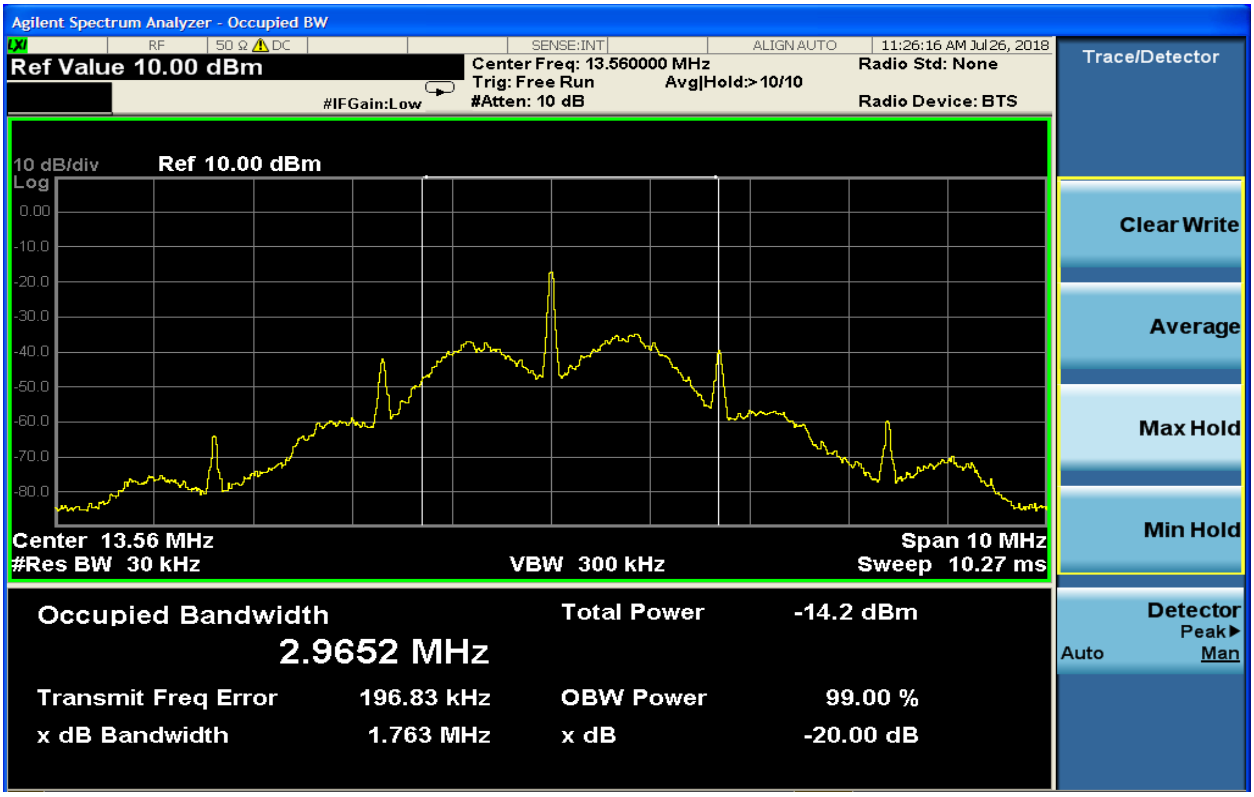
Table 5-2: 99% Bandwidth

TVDD (V)	99% Bandwidth (MHz)
3.20	2.9652
3.90	2.9618
4.75	2.9602

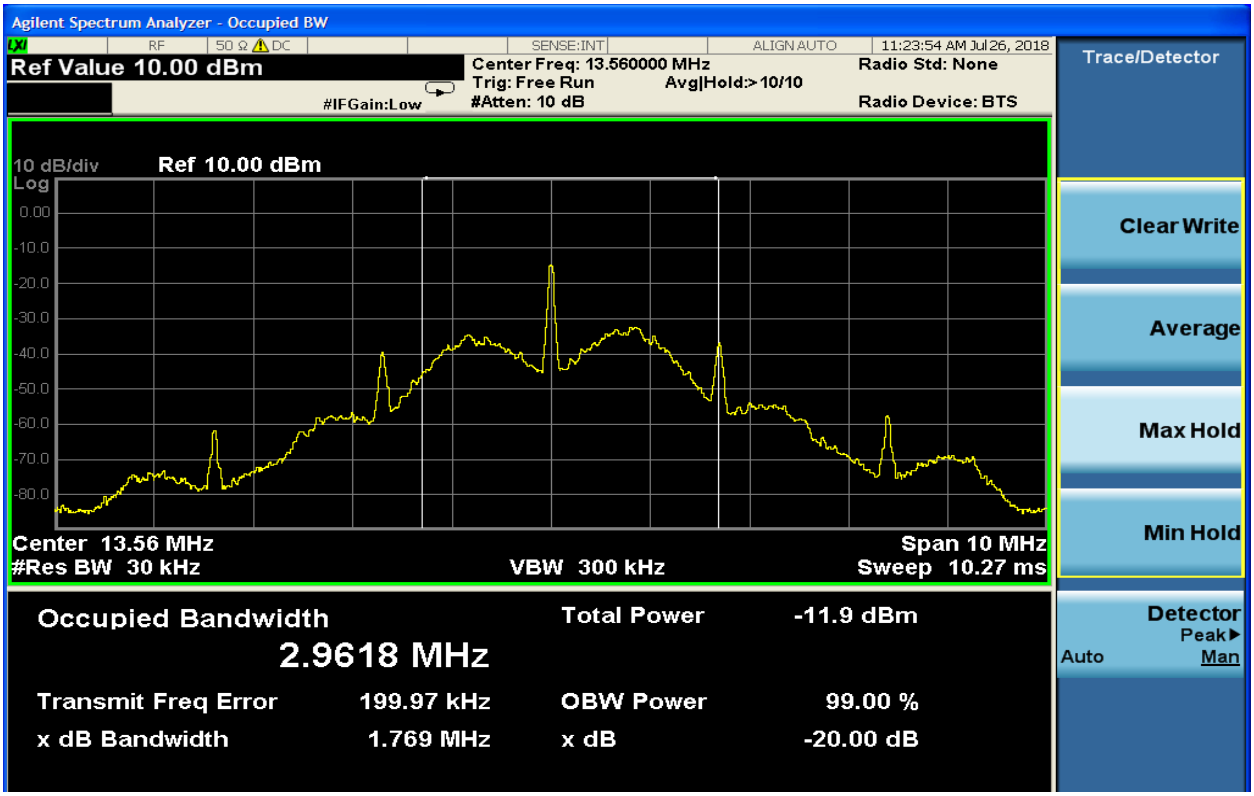
Note: Technology Type A was observed.

5.4 99% Bandwidth Plots

Plot 5-1: 99% Bandwidth – 3.20 V



Plot 5-2: 99% Bandwidth – 3.90 V



Plot 5-3: 99% Bandwidth – 4.75 V

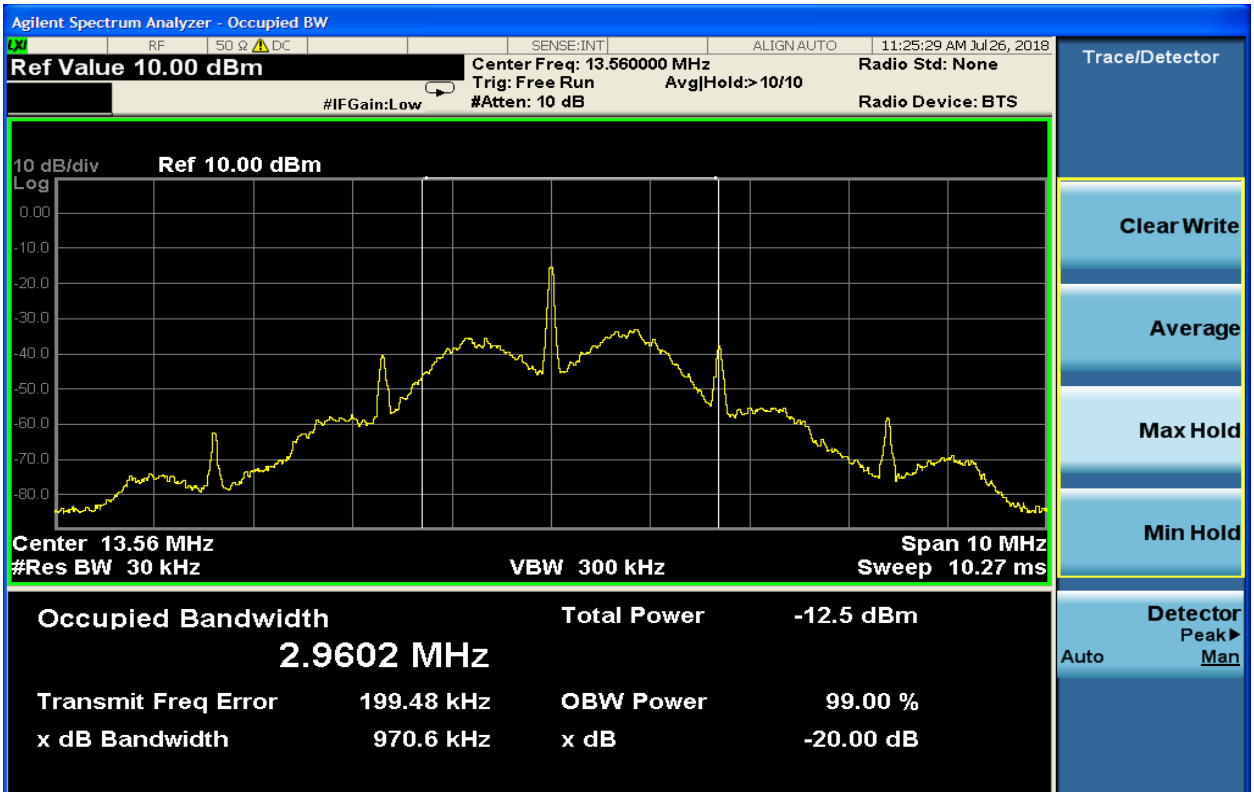


Table 5-3: 99% Bandwidth Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901583	Agilent Technologies	N9010A	EXA Signal Analyzer (10 Hz – 26.5 GHz)	MY51250846	2/6/20

Test Personnel:

Khue N. Do		July 26, 2018
EMC Test Engineer	Signature	Date of Test

6 Frequency Stability – FCC 2.1055, 15.225(e)

6.1 Test Procedure

The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

15.255(e): The frequency tolerance of the carrier signal shall be maintained within ± 0.01 % of the operating frequency over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 °C. For battery-operated equipment, the equipment tests shall be performed using a new battery.

The EUT was evaluated over the temperature range -20 °C to +50 °C.

The temperature was initially set to -20 °C and a 1-hour period was observed for stabilization of the EUT. The frequency stability was measured within one minute after application of primary power to the transmitter. The temperature was raised at intervals of 10 degrees centigrade through the range. A ½-hour period was observed to stabilize the EUT at each measurement step and the frequency stability was measured within one minute after application of primary power to the transmitter. Additionally, the power supply voltage of the EUT was varied ±15 % nominal input voltage.

6.2 Measurement Uncertainty

Measurement uncertainties shown for these tests are expanded uncertainties expressed at 95% confidence level using a coverage factor k = 2.

Frequency Stability: ±1.0 dB

6.3 Test Data

Table 6-1: Frequency Stability Environmental Condition

Date	Temperature (°F)	Humidity (%)	Pressure (kPa)
July 30, 2018	75.0	25	101.2
July 31, 2018	73.0	24	101.2

Table 6-2: Temperature Frequency Stability

Temperature (°C)	Measured Frequency (MHz)	Percent of Operating Frequency (%)	Result (Pass / Fail)
-20.0	13.55990	-0.00074	Pass
-10.0	13.56005	0.00037	Pass
0.0	13.56075	0.00554	Pass
10.0	13.55995	-0.00038	Pass
20.0	13.55995	-0.00038	Pass
30.0	13.56055	0.00406	Pass
40.0	13.56045	0.00333	Pass
50.0	13.56015	0.00111	Pass

Table 6-3: TVDD Voltage Frequency Stability at 20°C

TVDD (V)	Measured Frequency (MHz)	Percent of Operating Frequency (%)	Result (Pass / Fail)
3.20	13.55990	-0.00074	Pass
3.90	13.56005	0.00037	Pass
4.75	13.56075	0.00554	Pass

Result: Pass

Table 6-4: Frequency Stability Test Equipment

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900946	Tenney Engineering, Inc.	TH65	Temperature Chamber with Humidity	11380	3/26/19
901583	Agilent Technologies	N9010A	EXA Signal Analyzer (10 Hz – 26.5 GHz)	MY51250846	2/6/20
901672	Rohde & Schwarz	FSEM30	Spectrum Analyzer	1079.8500.30	4/17/19

Test Personnel:

Khue N. Do		July 30 – 31, 2018
EMC Test Engineer	Signature	Dates of Test

7 Conclusion

The data in this measurement report shows that the EUT as tested, Garmin International Inc. Model # AA3405, FCC ID: IPH-A3405, complies with the applicable requirements of Parts 2 and 15 of the FCC Rules and Regulations.