

Application For Grant of Certification

FOR

FOR

Model: A4AVGL00

13.56 MHz

Low Power Transmitter

FCC ID: IPH-02422

IC: 1792A-02422

FOR

Garmin International, Inc.

1200 East 151st Street

Olathe, KS 66062

Test Report Number: 140710

Authorized Signatory: *Scot D. Rogers*

Scot D. Rogers



ROGERS LABS, INC.

4405 West 259th Terrace
 Louisburg, KS 66053
 Phone / Fax (913) 837-3214

**Engineering Test Report For
 Grant of Certification Application**

FOR
 CFR 47, PART 15C - Intentional Radiators
 CFR 47 Paragraph 15.225 and Industry Canada RSS-210
 License Exempt Intentional Radiator

For

Garmin International, Inc.

1200 East 151st Street
 Olathe, KS 66062

Model: A4AVGL00

Low Power Transmitter

Frequency Range 13.56 MHz
 FCC ID#: IPH-02422
 IC: 1792A-02422

Test Date: July 10, 2014

Certifying Engineer: *Scot D. Rogers*
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Revisions

Revision 1 Issued August 25, 2014



Forward

The following information is submitted for consideration in obtaining Grant of Certification for low power intentional radiator per CFR 47 Paragraph 15.225, and Industry Canada RSS-210, operation at 13.56 MHz as Near Field Communications Device.

Name of Applicant: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

Model: A4AVGL00

FCC I.D.: IPH-02422 Industry Canada ID: 1792A-02422

Frequency Range: 13.56 MHz

Operating power: maximum average power 74.9 dBµV/m @ 30 meters, 99 percent occupied bandwidth 1.0 MHz

Opinion / Interpretation of Results

Tests Performed	Margin (dB)	Results
Emissions as per CFR 47 paragraphs 2 and 15.205	-14.8	Complies
Emissions as per CFR 47 paragraphs 2 and 15.207	-14.0	Complies
Emissions as per CFR 47 paragraphs 2 and 15.209	-13.1	Complies
Harmonic Emissions per CFR 47 15.225	-13.1	Complies

Equipment Tested

<u>Equipment</u>	<u>Model / PN</u>	<u>Serial Number</u>
EUT	A4AVGL00	3883870922bw
EUT (#2)	A4AVGL00	3883849939bw
EUT Mount	011-02459-53	N/A
AC Adapter	010-11478-0x	N/A
CLA	011-11838-00	N/A
GTM36	010-02796-xx	N/A
GTM60	010-01031-00	N/A
FMI45	010-11796-x0	N/A
GTM70	010-11894-00	N/A
Laptop Computer	studio XPS (PP35L)	921LBN1
USB Printer	Dell 0N5819	5D1SL61
DC Power supply	1670A	N961313540

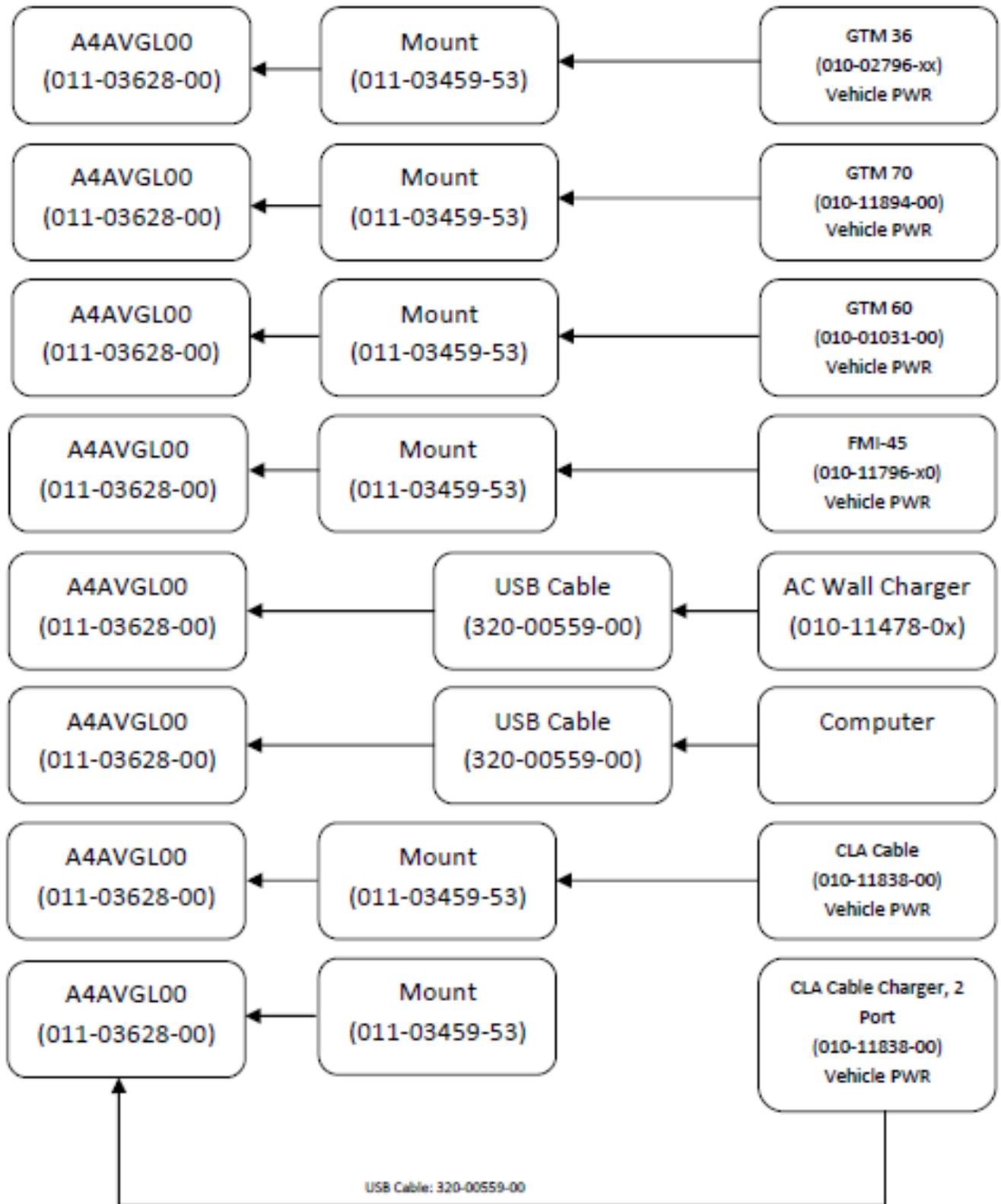
Test results in this report relate only to the items tested.



Equipment Function and Configuration

The EUT is a portable GPS (hand-held or vehicle mounted) navigation computer system providing mapping display and interface options as presented below in configuration diagrams. The completed system offers end user ability to utilize GPS information for display of location and navigational aid and wireless connectivity. The EUT incorporates multiple transmitters with operation capability of 13.56 MHz (per CFR47 15.225 and RSS-210) Near Field Communications (NFC) RFID transmitter, low power device in the 2402-2480 MHz frequency band (CFR 47 15.249 and RSS-210), and Digital Transmission System operation in the frequency band of 2412-2462 MHz (per CFR47 15.247 and RSS-210). The design utilizes internal fixed antenna systems and offers no provision for antenna replacement or modification. Two samples were provided for testing, one production design and the other modified for testing purposes replacing integral antenna with RF connection port. Both samples were provided with test software enabling testing personnel ability to enable transmitter function on defined channels. During testing, the EUT was arranged as described by the manufacturer emulating typical user equipment configurations. For testing purposes, the A4AVGL00 received powered from internal battery, external AC adapter, and/or external DC supply or support equipment and was configured to operate in available modes. As requested by the manufacturer and required by regulations, the equipment was tested for emissions compliance using the available configurations with the worst-case data presented. Test results in this report relate only to the products described in this report.

Equipment Configuration





Application for Certification

- (1) Manufacturer: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

- (2) Identification: Model: A4AVGL00
FCC I.D.: IPH-02422 IC ID: 1792A-02422

- (3) Instruction Book:
Refer to Exhibit for Instruction Manual.

- (4) Description of Circuit Functions:
Refer to Exhibit of Operational Description.

- (5) Block Diagram with Frequencies:
Refer to Exhibit of Operational Description.

- (6) Report of Measurements:
Report of measurements follows in this Report.

- (7) Photographs: Construction, Component Placement, etc.:
Refer to Exhibit for photographs of equipment.

- (8) List of Peripheral Equipment Necessary for operation. The equipment operates from DC power supplied from internal battery or supporting equipment as documented in this report. The EUT offers no other connection ports than those presented.

- (9) Transition Provisions of CFR47 15.37 are not requested.

- (10) Not Applicable. The unit is not a scanning receiver.

- (11) Not Applicable. The EUT does not operate in the 59 – 64 GHz frequency band.

- (12) The equipment is not software defined and this section is not applicable.

Applicable Standards & Test Procedures

In accordance with the Federal Communications Commission and Code of Federal Regulations CFR 47, dated October 1, 2013, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, applicable parts of paragraph 15, Part 15C paragraph 15.225 and Industry Canada RSS-210, the following information is submitted. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in the ANSI C63.10-2009 Document.

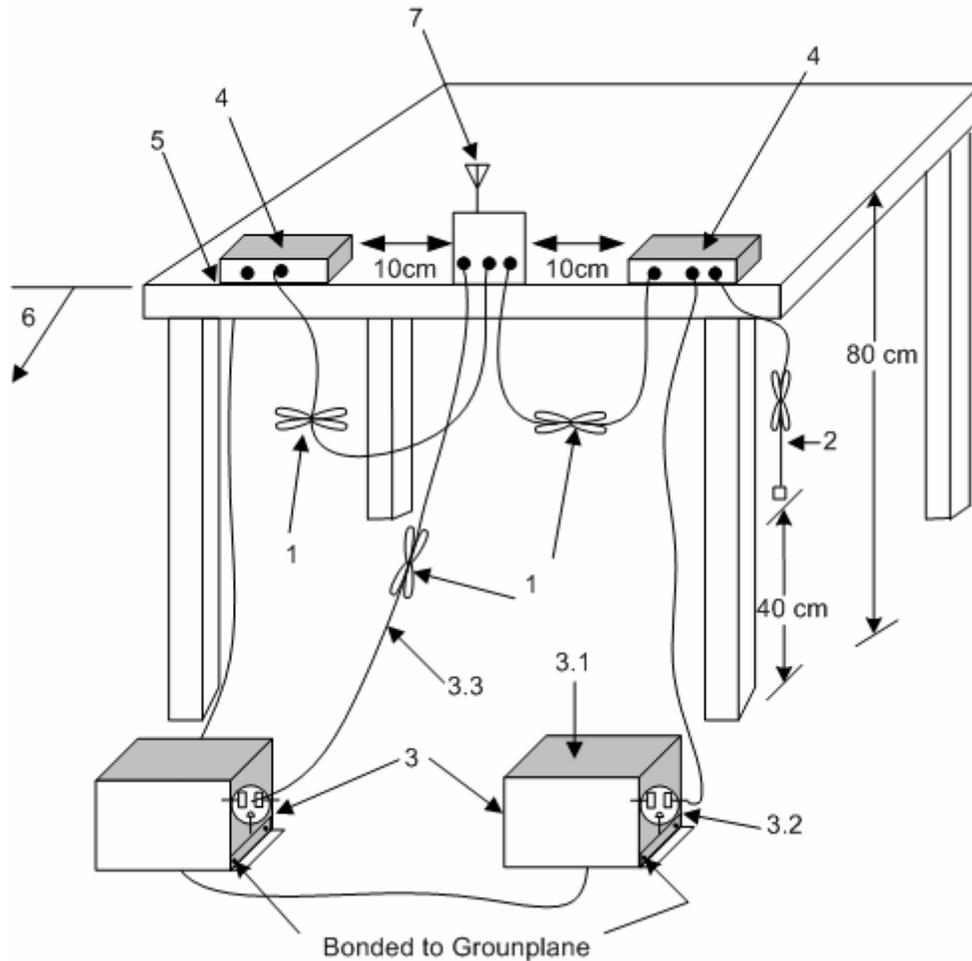
Equipment Testing Procedures

AC Line Conducted Emission Test Procedure

Testing for the AC line-conducted emissions was performed as defined in ANSI C63.10-2009. The test setup, including the EUT, was arranged in the test configurations as presented during testing. The test configuration was placed on a 1 x 1.5-meter wooden bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50- μ Hy choke. EMI was coupled to the spectrum analyzer through a 0.1 μ F capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table. Refer to diagram 1 showing typical test arrangement and photographs in exhibits for EUT placement used during testing.

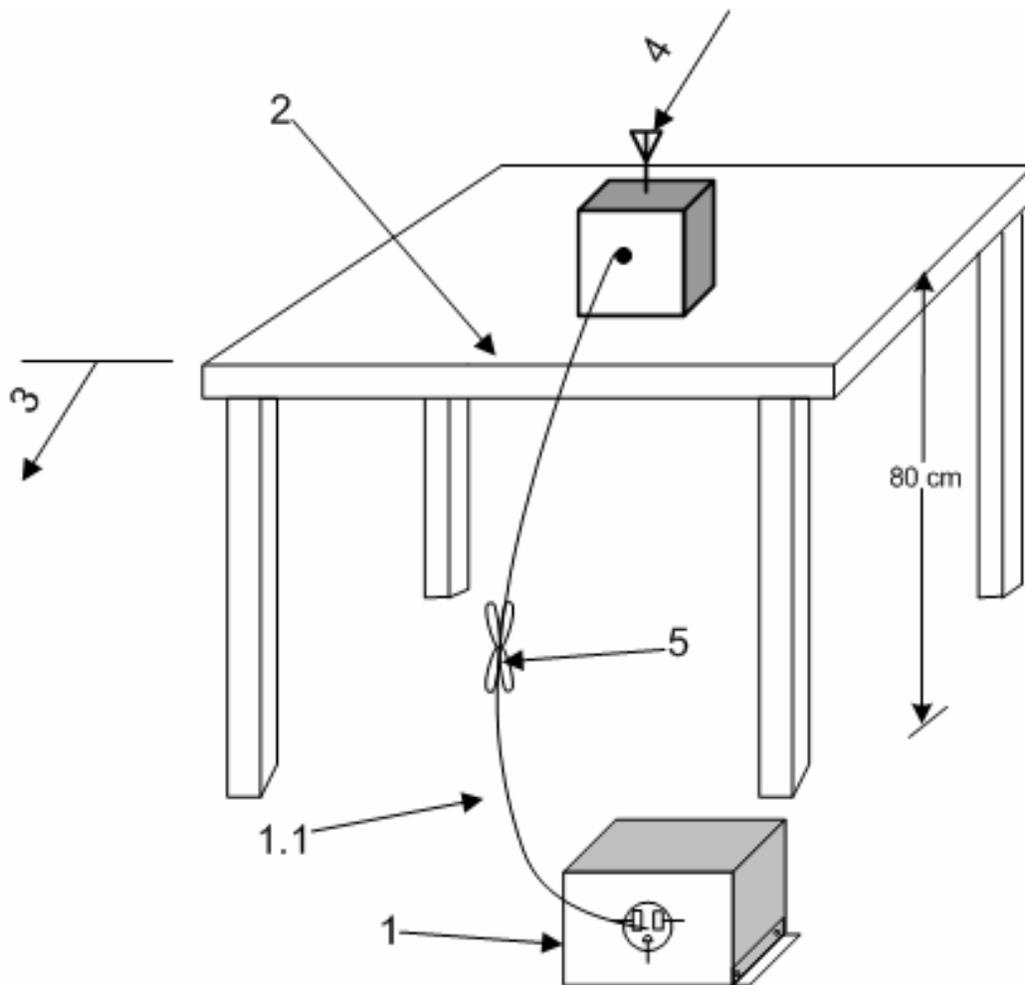
Radiated Emission Test Procedure

The EUT was placed on a rotating 1 x 1.5-meter wooden platform, 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. Radiated emissions testing was performed as required in CFR47 15, RSS-210 and specified in sections 6 and 7 of ANSI C63.10-2009. EMI energy was maximized by equipment placement permitting orientation in three orthogonal axis, raising and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken using a spectrum analyzer. The frequency spectrum from 9 kHz to 25,000 MHz was searched for during preliminary investigation. Refer to diagrams 2 and 3 showing typical test arrangement and photographs in the test setup exhibits for specific EUT placement during testing.



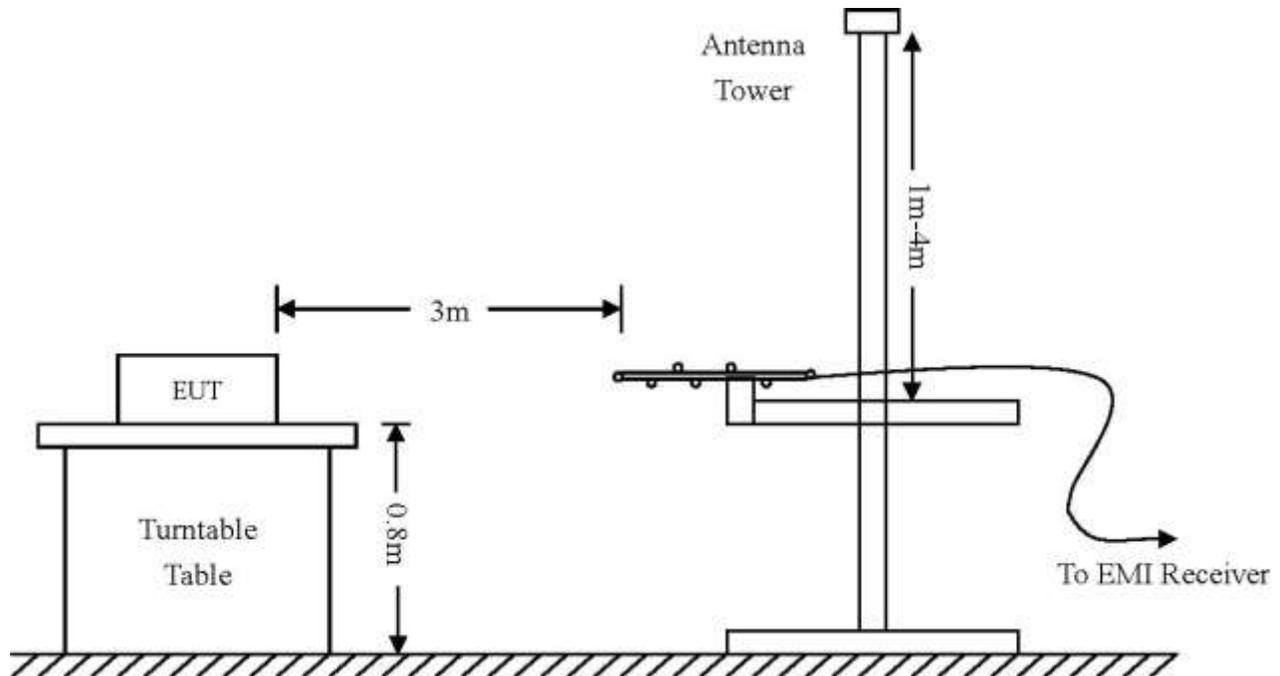
1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long see (see 6.2.3.1).
2. I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m (see 6.2.2).
3. EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3).
 - 3.1 All other equipment powered from additional LISN(s).
 - 3.2 Multiple-outlet strip can be used for multiple power cords of non-EUT equipment.
 - 3.3 LISN at least 80 cm from nearest part of EUT chassis
4. Non-EUT components of EUT system being tested
5. Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.3.1).
6. Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane (see 6.2.2 for options).
7. Antenna may be integral or detachable. If detachable, the antenna shall be attached for this test.

Diagram 1 Test arrangement for Conducted emissions



1. A LISN is optional for radiated measurements between 30 MHz to 1000 MHz, but not allowed for measurements below 30 MHz and above 1000 MHz. (See 6.4.3, 6.5.1, and 6.6.3.) If used, connect EUT to one LISN. Unused LISN measuring port connectors shall be terminated in 50Ω. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3.1).
 - 1.1 LISN spaced at least 80 cm from nearest part of EUT chassis.
2. The EUT shall be placed in the center of the table to the extent possible. (See 6.2.3.1 and 6.3.4)
3. A vertical conducting plane, if used for conducted tests per 6.2.2, shall be removed for radiated emission tests.
4. Antenna may be integral or detachable, depending on the EUT.
5. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long.

Diagram 2 Test arrangement for radiated emissions of tabletop equipment



Frequency: 9 kHz-30 MHz	Frequency: 30 MHz- 1 GHZ	Frequency: Above 1 GHZ
RBW = 9 kHz	RBW = 120 kHz	RBW = 1 MHz
VBW = 30 kHz	VBW = 120 kHz	VBW = 1 MHz
Sweep time = Auto	Sweep time = Auto	Sweep time = Auto
Detector = PK, QP	Detector = PK, QP	Detector = PK, AV

Diagram 3 Test arrangement for radiated emissions tested on Open Area Test Site (OATS)

Test Site Locations

Conducted EMI The AC power line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS

Radiated EMI The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS

Site Registration Refer to Annex for Site Registration Letters (FCC: 90910, IC 3041A-1)

NVLAP Accreditation Lab code 200087-0

Rogers Labs, Inc.
4405 W. 259th Terrace
Louisburg, KS 66053
Phone/Fax: (913) 837-3214
Revision 1

Garmin International, Inc.
Model: A4AVGL00 SN: 3883849939bw FCC ID#: IPH-02422
Test #: 140710 IC: 1792A-02422
Test to: CFR47 (15.225), RSS-210 Date: August 25, 2014
File: Garmin A4AVGL00 NFC DXX TstRpt 140710 Page 12 of 33



Units of Measurements

Conducted EMI Data is in dB μ V; dB referenced to one microvolt

Radiated EMI Data is in dB μ V/m; dB/m referenced to one microvolt per meter

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured

A.F. = Receive antenna factor, Gain = amplification gains and/or cable losses

RFS (dB μ V/m @ 3m) = FSM (dB μ V) + A.F. (dB) - Gain (dB)

Environmental Conditions

Ambient Temperature 24.0° C

Relative Humidity 39%

Atmospheric Pressure 1017.9 mb

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the CFR47 Part 15C and RSS-210 requirements. There were no modifications or deviations to the specifications.



List of Test Equipment

A Rohde and Schwarz ESU40 and/or Hewlett Packard 8591EM was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Rohde and Schwarz ESU40 and/or Hewlett Packard 8562A Spectrum Analyzer was used as the measuring device for testing the emissions at frequencies above 1 GHz. The analyzer settings used are described in the following table. Refer to the appendix for a complete list of test equipment.

AC Line Conducted Emissions (0.150 -30 MHz)		
RBW	AVG. BW	Detector Function
9 kHz	30 kHz	Peak / Quasi Peak
Emissions (30-1000 MHz)		
RBW	AVG. BW	Detector Function
120 kHz	300 kHz	Peak / Quasi Peak
Emissions (Above 1000 MHz)		
RBW	Video BW	Detector Function
100 kHz	100 kHz	Peak
1 MHz	1 MHz	Peak / Average

<u>Equipment</u>	<u>Manufacturer</u>	<u>Model (SN)</u>	<u>Band</u>	<u>Cal Date</u>	<u>Due</u>
<input checked="" type="checkbox"/> LISN	Comp. Design	FCC-LISN-2-MOD.CD(126)	.15-30MHz	10/13	10/14
<input checked="" type="checkbox"/> Cable	Time Microwave	750HF290-750 (L10M)	9kHz-40 GHz	10/13	10/14
<input checked="" type="checkbox"/> Cable	Belden	RG-58 (L1-CAT3-11509)	9kHz-30 MHz	10/13	10/14
<input checked="" type="checkbox"/> Cable	Belden	RG-58 (L2-CAT3-11509)	9kHz-30 MHz	10/13	10/14
<input type="checkbox"/> Antenna	ARA	BCD-235-B (169)	20-350MHz	10/13	10/14
<input type="checkbox"/> Antenna	EMCO	3147 (40582)	200-1000MHz	10/13	10/14
<input checked="" type="checkbox"/> Antenna	Com Power	AH-118 (10110)	1-18 GHz	10/13	10/14
<input checked="" type="checkbox"/> Antenna	Com Power	AH-840 (101046)	18-40 GHz	5/14	5/15
<input checked="" type="checkbox"/> Antenna	EMCO	6509 (9502-1374)	.001-30 MHz	10/13	10/14
<input checked="" type="checkbox"/> Antenna	Sunol	JB-6 (A100709)	30-1000 MHz	10/13	10/14
<input checked="" type="checkbox"/> Antenna	Standard	FXRY638A (621786)	10-18 GHz	5/14	5/15
<input type="checkbox"/> Antenna	EMCO	3143 (9607-1277)	20-1200 MHz	5/14	5/15
<input type="checkbox"/> Analyzer	HP	8591EM (3628A00871)	9kHz-1.8GHz	5/14	5/15
<input type="checkbox"/> Analyzer	HP	8562A (3051A05950)	9kHz-110GHz	5/14	5/15
<input checked="" type="checkbox"/> Analyzer	Rohde & Schwarz	ESU40 (100108)	20Hz-40GHz	5/14	5/15
<input checked="" type="checkbox"/> Amplifier	Com-Power	PA-010 (171003)	100Hz-30MHz	10/13	10/14
<input checked="" type="checkbox"/> Amplifier	Com-Power	CPPA-102 (01254)	1-1000 MHz	10/13	10/14
<input checked="" type="checkbox"/> Amplifier	Com-Power	PAM-118A (551014)	0.5-18 GHz	10/13	10/14

Intentional Radiators

As per CFR47, Subpart C, paragraph 15.225 and RSS-210 the following information is submitted.

Antenna Requirements

The EUT incorporates integral antenna system and offers no provision for connection to alternate system. The antenna connection point complies with the unique antenna connection requirements. The unique antenna connection requirements are fulfilled. There are no deviations or exceptions to the specification.

Restricted Bands of Operation

Spurious emissions falling in the restricted frequency bands of operation were measured at the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were investigated at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. Peak and average amplitudes of frequencies above 1000 MHz were compared to the required limits with worst-case data presented below. Test procedures of ANSI C63.10-2009 paragraph 6 were used during testing. No other significant emission was observed which fell into the restricted bands of operation. Computed emission values take into account the received radiated field strength, receive antenna correction factor, amplifier gain stage, and test system cable losses.

Table 1 Radiated Emissions in Restricted Bands Data

Frequency in MHz	Horizontal Peak (dBμV/m)	Horizontal Quasi-Peak (dBμV/m)	Horizontal Average (dBμV/m)	Vertical Peak (dBμV/m)	Vertical Quasi-Peak (dBμV/m)	Vertical Average (dBμV/m)	Limit @ 3m (dBμV/m)
108.4	31.3	24.8	N/A	29.8	24.5	N/A	43.5
135.5	30.4	25.2	N/A	24.5	20.3	N/A	43.5

Summary of Results for Radiated Emissions in Restricted Bands

The EUT demonstrated compliance with the radiated emissions requirements of CFR 47 Part 15C and RSS-210 Intentional Radiators. The EUT demonstrated a worst-case minimum margin of -14.8 dB below the radiated emissions requirements in restricted frequency bands. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.

AC Line Conducted EMI Procedure

The EUT was arranged in typical equipment configurations as offered by manufacturer. Testing was performed with the EUT placed on a 1 x 1.5-meter wooden bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screen room 80-cm from the rear of the EUT. Testing for the line-conducted emissions were the procedures of ANSI C63.10-2009 paragraph 6. The AC adapter for the EUT was connected to the LISN for line-conducted emissions testing. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the EUT. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 μ F capacitor, internal to the LISN. Power line conducted emissions testing was carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequencies of each of the emissions, which demonstrated the highest amplitudes. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz then data was recorded with maximum conducted emissions levels. Refer to figures one and two showing plots of the worst-case AC Line conducted emissions of the AC Adapter options while charging the EUT. Refer to figures three and four showing plots of the worst-case AC Line conducted emissions of the laptop AC Adapter while charging the EUT.

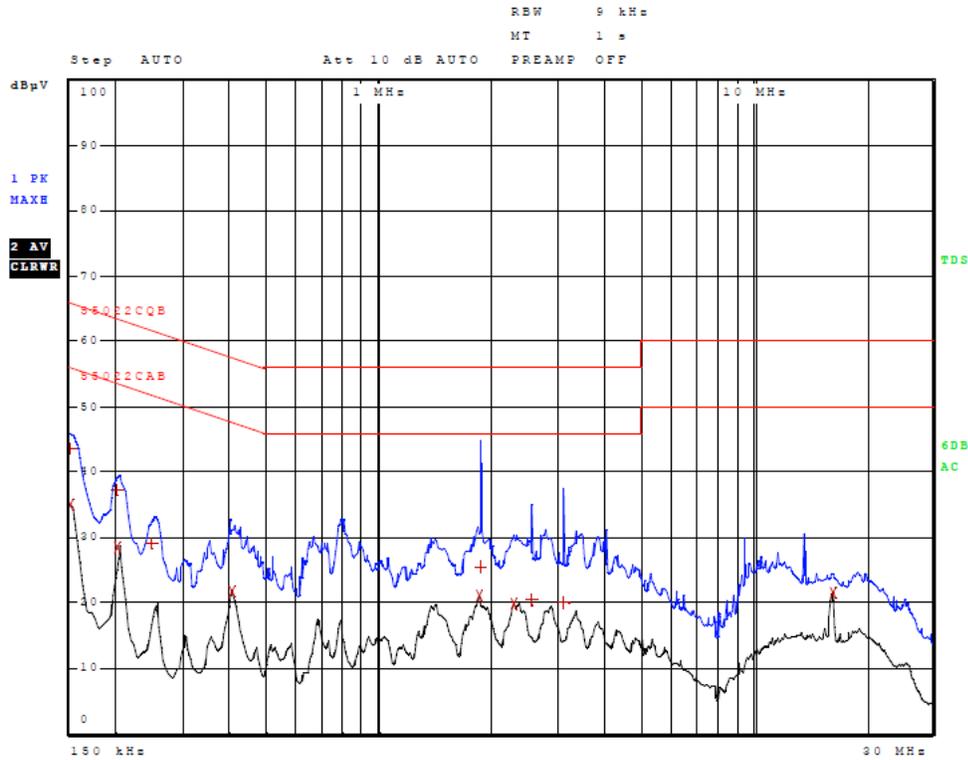


Figure 1 AC Line Conducted emissions of EUT line 1 (EUT AC Adapter)

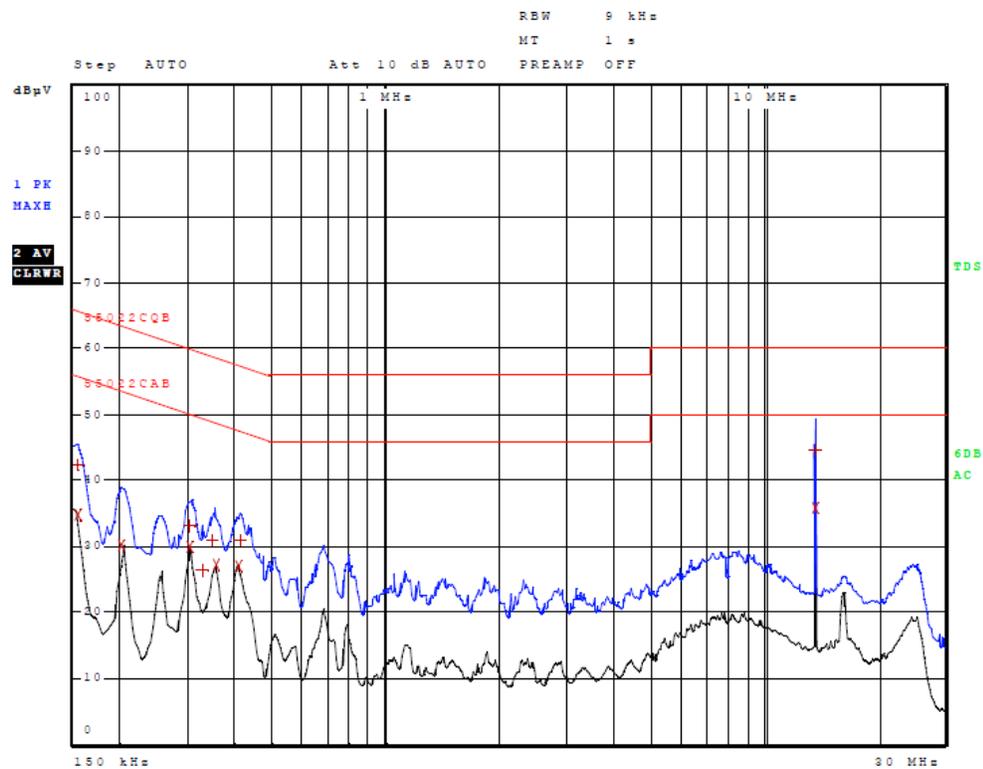


Figure 2 AC Line Conducted emissions of EUT line 2 (EUT AC Adapter)

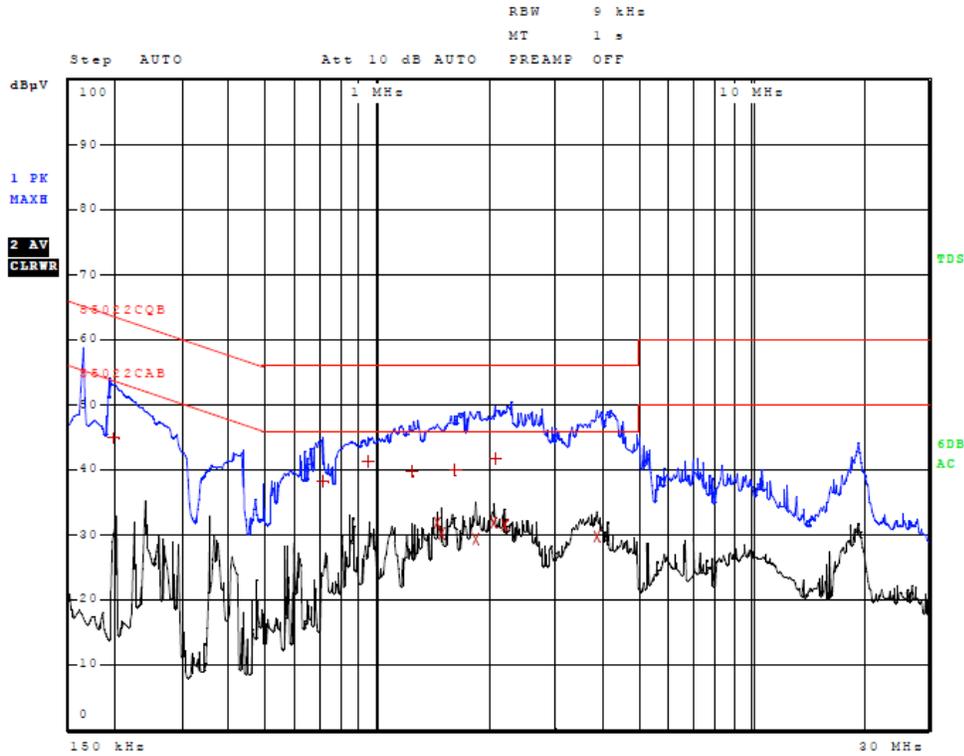


Figure 3 AC Line Conducted emissions of EUT line 1 (EUT – USB -CPU AC Adapter)

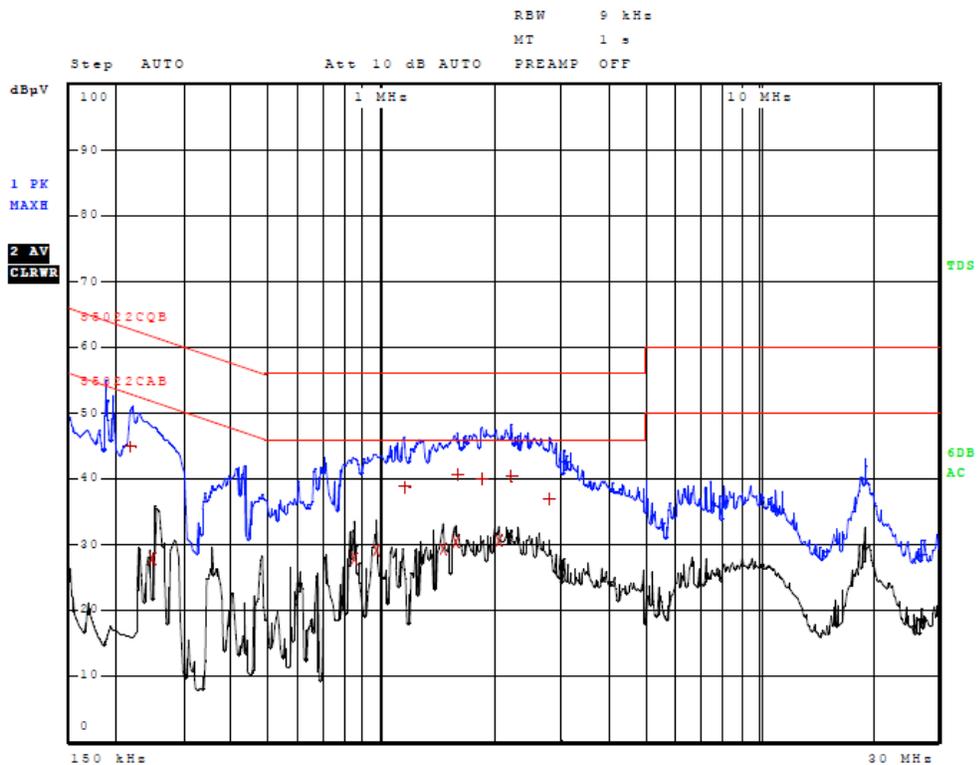


Figure 4 AC Line Conducted emissions of EUT line 2 (EUT – USB -CPU AC Adapter)



Table 2 Data AC Line Conducted Emissions Line L1 (EUT AC Adapter)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
2	150.000000000 kHz	34.89	Average	-21.11
1	150.000000000 kHz	43.54	Quasi Peak	-22.46
2	202.000000000 kHz	28.53	Average	-25.00
1	202.000000000 kHz	37.19	Quasi Peak	-26.34
1	250.000000000 kHz	29.06	Quasi Peak	-32.70
2	402.000000000 kHz	21.70	Average	-26.11
2	1.850000000 MHz	21.12	Average	-24.88
1	1.862000000 MHz	25.50	Quasi Peak	-30.50
2	2.286000000 MHz	19.83	Average	-26.17
1	2.550000000 MHz	20.38	Quasi Peak	-35.62
1	3.098000000 MHz	20.06	Quasi Peak	-35.94
2	16.232000000 MHz	21.50	Average	-28.50

Other emissions present had amplitudes at least 20 dB below the limit.

Table 3 Data AC Line Conducted Emissions Line L2 (EUT AC Adapter)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	154.000000000 kHz	42.26	Quasi Peak	-23.52
2	154.000000000 kHz	34.84	Average	-20.94
2	202.000000000 kHz	30.17	Average	-23.36
2	302.000000000 kHz	29.87	Average	-20.32
1	306.000000000 kHz	33.10	Quasi Peak	-26.98
1	326.000000000 kHz	26.28	Quasi Peak	-33.28
1	350.000000000 kHz	31.03	Quasi Peak	-27.93
2	354.000000000 kHz	27.14	Average	-21.73
2	406.000000000 kHz	27.02	Average	-20.71
1	410.000000000 kHz	30.94	Quasi Peak	-26.71
1	13.560000000 MHz	44.67	Quasi Peak	-15.33
2	13.560000000 MHz	35.91	Average	-14.09

Other emissions present had amplitudes at least 20 dB below the limit.



Table 4 Data AC Line Conducted Emissions Line L1 (EUT – USB - CPU)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	198.000000000 kHz	44.91	Quasi Peak	-18.78
1	710.000000000 kHz	38.13	Quasi Peak	-17.87
1	946.000000000 kHz	41.21	Quasi Peak	-14.79
1	1.246000000 MHz	39.86	Quasi Peak	-16.14
2	1.438000000 MHz	31.88	Average	-14.12
2	1.478000000 MHz	30.17	Average	-15.83
1	1.618000000 MHz	40.04	Quasi Peak	-15.96
2	1.834000000 MHz	29.39	Average	-16.61
2	2.046000000 MHz	31.91	Average	-14.09
1	2.058000000 MHz	41.61	Quasi Peak	-14.39
2	2.182000000 MHz	31.35	Average	-14.65
2	3.870000000 MHz	29.78	Average	-16.22

Other emissions present had amplitudes at least 20 dB below the limit.

Table 5 Data AC Line Conducted Emissions Line L2 (EUT – USB - CPU)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	218.000000000 kHz	44.93	Quasi Peak	-17.97
2	250.000000000 kHz	27.81	Average	-23.94
2	842.000000000 kHz	27.86	Average	-18.14
2	966.000000000 kHz	29.17	Average	-16.83
1	1.150000000 MHz	38.72	Quasi Peak	-17.28
2	1.450000000 MHz	29.32	Average	-16.68
2	1.578000000 MHz	30.38	Average	-15.62
1	1.590000000 MHz	40.56	Quasi Peak	-15.44
1	1.854000000 MHz	39.94	Quasi Peak	-16.06
2	2.050000000 MHz	30.66	Average	-15.34
1	2.206000000 MHz	40.40	Quasi Peak	-15.60
1	2.778000000 MHz	36.87	Quasi Peak	-19.13

Other emissions present had amplitudes at least 20 dB below the limit.

Summary of Results for AC Line Conducted Emissions

The EUT demonstrated compliance with the AC Line Conducted Emissions requirements of CFR 47 Part 15B, RSS-GEN, and other applicable standards. The EUT AC Adapter worst-case configuration demonstrated a minimum margin of -14.0 dB below the limit. The EUT –USB-CPU worst-case configuration demonstrated a minimum margin of -14.0 dB below the limit. Other emissions were present with amplitudes at least 20 dB below the limit and worst-case amplitudes recorded.



General Radiated Emissions Procedure

The EUT was arranged in a typical equipment configuration and operated through all available modes with worst-case data recorded. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Test procedures of ANSI C63.10-2009 paragraph 6 were used during testing. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Each radiated emission was then maximized at the OATS location before final radiated emissions measurements were performed. Final data was taken with the EUT located at the OATS at a distance of 3 meters between the EUT and the receiving antenna. The frequency spectrum from 9 kHz to 25,000 MHz was searched for general radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Loop from 9 kHz to 30 MHz, Broadband Biconical from 30 to 200 MHz, Biconilog from 30 to 1000 MHz, Log Periodic from 200 MHz to 1 GHz and or double Ridge or pyramidal horns and mixers from 1 GHz to 40 GHz, notch filters and appropriate amplifiers and external mixers were utilized.

Table 6 General Radiated Emissions from EUT Data (Highest Emissions)

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
40.7	27.5	20.7	N/A	31.0	25.3	N/A	40.0
54.2	30.3	24.0	N/A	31.0	26.9	N/A	40.0
67.8	17.0	12.9	N/A	24.5	17.8	N/A	40.0
81.3	26.6	21.8	N/A	24.0	17.9	N/A	40.0
94.9	29.1	21.6	N/A	28.2	20.6	N/A	43.5
108.4	31.3	24.8	N/A	29.8	24.5	N/A	43.5
122.0	32.6	26.4	N/A	26.7	21.3	N/A	43.5
135.5	30.4	25.2	N/A	24.5	20.3	N/A	43.5

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded above for frequencies below 1000 MHz. Peak and Average amplitude emissions are recorded above for frequency range above 1000 MHz.

Summary of Results for General Radiated Emissions

The EUT demonstrated compliance with the radiated emissions requirements of CFR47 Part 15C paragraph 15.209 and RSS-210 Intentional Radiators. The EUT demonstrated a minimum margin of -13.1 dB below the requirements. Other emissions were present with amplitudes at least 20 dB below the Limits.



Operation in the Band 13.110 - 14.010 MHz Band

The transmitter output power; harmonic and general emissions were measured on an open area test site at 3 and 10 meters. Test procedures of ANSI C63.10-2009 paragraph 6 were used during testing. The EUT was placed on a wooden turntable 0.8 meters above the ground plane and at a distance of 3 and 10 meters from the FSM antenna. The peak and quasi-peak amplitude of frequencies below 1000 MHz were measured using a spectrum analyzer. Plots were taken of transmitter performance for reference in this and other documentation. Refer to figure five showing the operation in the frequency band. The amplitude of each radiated emission was measured on the OATS at a distance of 3 and/or 10 meters from the FSM antenna (OATS testing was performed on sample 1 representative of production equipment with integral antenna). The measured amplitude was then corrected for comparison with the limits. Measurements taken at 3 meters of the fundamental and emissions below 30 MHz were corrected using the square of an inverse linear distance extrapolation factor (40 dB/decade) as provided in the standards and requirements. The amplitude of each radiated emission was maximized by varying the FSM antenna height, polarization, and by rotating the turntable. A Loop antenna was used for measuring emissions from 0.009 to 30 MHz, Biconilog Antenna for 30 to 1000 MHz, Double-Ridge, and/or Pyramidal Horn Antennas from 1 GHz to 25 GHz. Emissions were measured in dB μ V/m @ 3 meters. Testing performed demonstrated compliance with the following requirements (per CFR47 15.225).

- (a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters (84 dB μ V/M @ 30m).
- (b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters (50.5 dB μ V/M @ 30m).
- (c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters (40.5 dB μ V/M @ 30m).
- (d) 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.
- (e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees 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 degrees C. For battery-operated equipment, the equipment tests shall be performed using a new battery.
- (f) In the case of radio frequency powered tags designed to operate with a device authorized under this section, the tag may be approved with the device or be considered as a separate device subject to its own authorization. Powered tags approved with a device under a single application shall be labeled with the same identification number as the device.

Table 7 NFC Transmitter Emissions in Frequency Band 13.110-14.010 MHz

Frequency in MHz	Level (dBμV/m)	ACFL (dB/m)	Amplifier Gain (dB)	30m Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
13.560	33.5	41.4	40	34.9	84.0	-53.7

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded above for frequencies below 1000 MHz. Peak and Average amplitude emissions are recorded above for frequency range above 1000 MHz.

NOTES:

1. Fundamental radiated emission measurements were performed using a loop antenna. The antenna was positioned in three orthogonal positions (X front, Y side, Z top) and the position with the highest emission level was recorded.
2. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst-case emissions.
3. Measurements were performed at 3m and the data was extrapolated to the specified measurement distance of 30m using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)(2).
Extrapolation Factor = $20 \log_{10} (30/3)^2 = 40\text{dB}$
4. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector.
5. Field Strength Level [dBμV/m] = Level read from Analyzer [dBμV] + AFCL [dB/m] – Amplifier Gain (dB)
6. AFCL [dB/m] = Antenna Factor [dB/m] + Cable Loss [dB]
7. Margin [dB] = Field Strength Level [dBμV/m] – Limit [dBμV/m]

Table 8 Transmitter Harmonic Radiated Emissions Data

Frequency in MHz	Horizontal Peak (dBμV/m)	Horizontal Quasi-Peak (dBμV/m)	Horizontal Average (dBμV/m)	Vertical Peak (dBμV/m)	Vertical Quasi-Peak (dBμV/m)	Vertical Average (dBμV/m)	Limit @ 3m (dBμV/m)
40.7	27.5	20.7	N/A	31.0	25.3	N/A	40.0
54.2	30.3	24.0	N/A	31.0	26.9	N/A	40.0
67.8	17.0	12.9	N/A	24.5	17.8	N/A	40.0
81.3	26.6	21.8	N/A	24.0	17.9	N/A	40.0
94.9	29.1	21.6	N/A	28.2	20.6	N/A	43.5
108.4	31.3	24.8	N/A	29.8	24.5	N/A	43.5
122.0	32.6	26.4	N/A	26.7	21.3	N/A	43.5
135.5	30.4	25.2	N/A	24.5	20.3	N/A	43.5

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded above for frequencies below 1000 MHz. Peak and Average amplitude emissions are recorded above for frequency range above 1000 MHz.

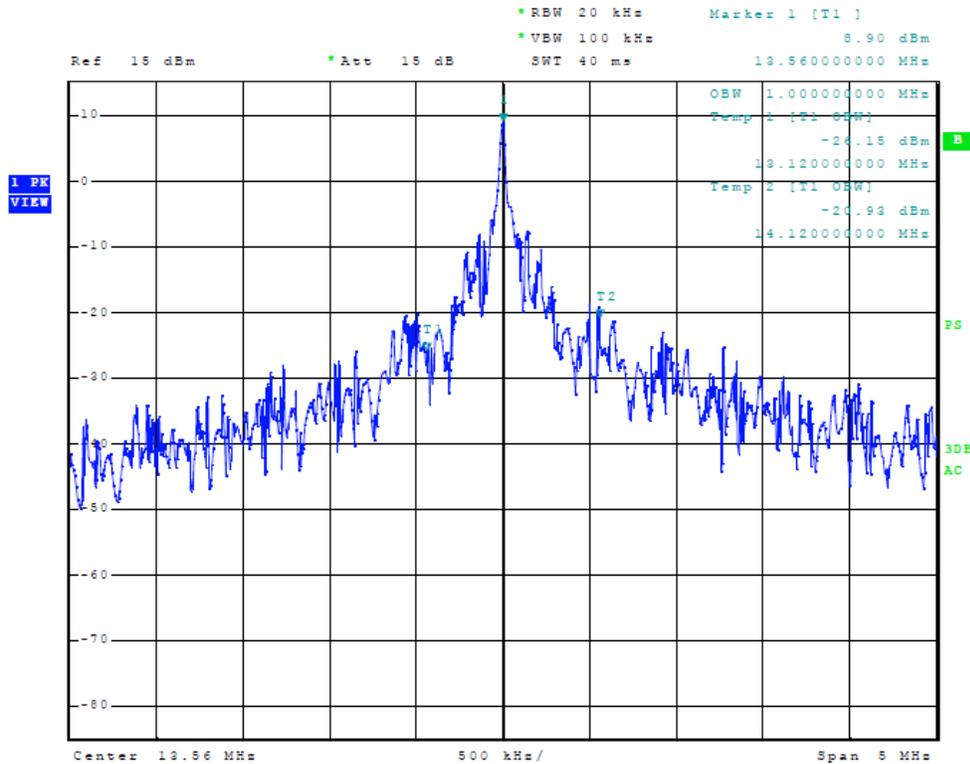


Figure 5 Plot of NFC 99 percent Occupied Bandwidth

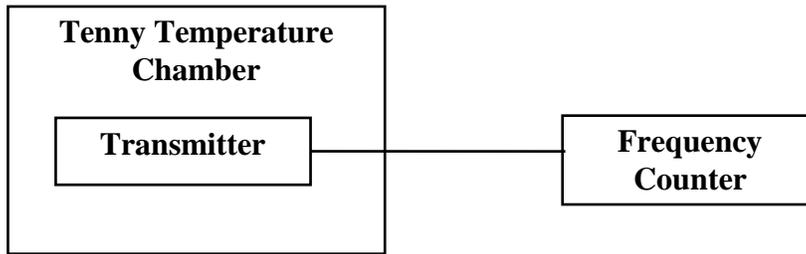
Frequency Stability

Measurements Required

The frequency stability shall be measured with variations of ambient temperature from -30° to +50° centigrade. Measurements shall be made at the extremes of the temperature range and at intervals of not more than 10° centigrade through the range. A period sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. In addition to temperature stability, the frequency stability shall be measured with variation of primary supply voltage as follows:

- (1) Vary primary supply voltage from 85 to 115 percent of the nominal value.
- (2) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided.

Test Arrangement



The measurement procedure outlined below shall be followed during measurement of frequency variation over temperature.

Step 1: The transmitter shall be installed in an environmental test chamber whose temperature is controllable. Provision shall be made to measure the frequency of the transmitter.

Step 2: With the transmitter inoperative (power switched “OFF”), the temperature of the test chamber shall be adjusted to +25°C. After a temperature stabilization period of one hour at +25°C, the transmitter shall be switched “ON” with standard test voltage applied.

Step 3: The carrier shall be keyed “ON”, and the transmitter shall be operated at full radio frequency power output at the duty cycle, for which it is rated, for duration of at least 5 minutes. The radio frequency carrier frequency shall be monitored and measurements shall be recorded.

Step 4: The test procedures outlined in Steps 2 and 3, shall be repeated after stabilizing the transmitter at the environmental temperatures specified, -30°C to +50°C in 10-degree increments.

The frequency stability was measured with variations in the power supply voltage from 85 to 115 percent of the nominal value. A BK Precision DC Power Supply was used during measurement of frequency variation over input power. The frequency was measured and the variation in parts per million calculated. Data was taken per CFR47 Paragraphs 2.1055 and applicable paragraphs of part 15.225 and RSS-210.

13.110 – 14.010 MHz Transmitter Emissions Data

Table 9 Frequency Stability vs. Temperature Results

Channel Frequency 13.56000 MHz	Frequency Stability Vs. Temperature Ambient Frequency (13.56000)								
	Temperature °C	-30	-20	-10	0	+10	+20	+30	+40
Change (Hz)	32	45	43	37	4	-3	2	-13	-13
PPM	2.353	3.333	3.164	2.758	0.324	-0.184	0.140	-0.937	-0.951
%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Limit (%)	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01

Table 10 Frequency Stability vs. Input Power Supply Voltage Results

Channel Frequency 13.56000 MHz	Frequency Stability Vs. Voltage Variation 12.0 volts nominal; Results In Hz change		
	Voltage V _{dc}	10.20	12.0
Change (Hz)	0	0	0
%	0	0	0
Limit (%)	±0.01	±0.01	±0.01

The EUT demonstrated compliance with specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 15.225 and RSS-210. There are no deviations or exceptions to the specifications.

Summary of Results for NFC Transmitter Emissions

The EUT demonstrated compliance with the radiated emissions requirements of FCC CFR 47 Part 15.225, RSS-210 and other applicable standards for Intentional Radiators. The EUT worst-case configuration demonstrated minimum margin of -53.7 dB below the fundamental emission limit. The EUT worst-case configuration demonstrated minimum radiated harmonic emission margin of -13.1 dB below the limits. Other emissions were present with amplitudes at least 20 dB below the limits.



NVLAP Lab Code 200087-0

Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Rogers Labs Test Equipment List
- Annex C Rogers Qualifications
- Annex D FCC Site Registration Letter
- Annex E Industry Canada Site Registration Letter

**Annex A Measurement Uncertainty Calculations**

Measurement uncertainty calculations were made for the laboratory. Result of measurement uncertainty calculations are recorded below for AC line conducted and radiated emission measurements.

Measurement Uncertainty	$U_{(E)}$	$U_{(lab)}$
3 Meter Horizontal 30-200 MHz Measurements	2.08	4.16
3 Meter Vertical 30-200 MHz Measurements	2.16	4.33
3 Meter Vertical Measurements 200-1000 MHz	2.99	5.97
10 Meter Horizontal Measurements 30-200 MHz	2.07	4.15
10 Meter Vertical Measurements 30-200 MHz	2.06	4.13
10 Meter Horizontal Measurements 200-1000 MHz	2.32	4.64
10 Meter Vertical Measurements 200-1000 MHz	2.33	4.66
3 Meter Measurements 1-6 GHz	2.57	5.14
3 Meter Measurements 6-18 GHz	2.58	5.16
AC Line Conducted	1.72	3.43



Annex B Rogers Labs Test Equipment List

List of Test Equipment	Calibration Date
Spectrum Analyzer: Rohde & Schwarz ESU40	5/14
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520 Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	5/14
Spectrum Analyzer: HP 8591EM	5/14
Antenna: EMCO Biconilog Model: 3143	5/14
Antenna: Sunol Biconilog Model: JB6	10/13
Antenna: EMCO Log Periodic Model: 3147	10/13
Antenna: Com Power Model: AH-118	10/13
Antenna: Com Power Model: AH-840	10/13
Antenna: Antenna Research Biconical Model: BCD 235	10/13
Antenna: EMCO 6509	10/13
LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohm/0.1 µf	10/13
R.F. Preamp CPPA-102	10/13
Attenuator: HP Model: HP11509A	10/13
Attenuator: Mini Circuits Model: CAT-3	10/13
Attenuator: Mini Circuits Model: CAT-3	10/13
Cable: Belden RG-58 (L1)	10/13
Cable: Belden RG-58 (L2)	10/13
Cable: Belden 8268 (L3)	10/13
Cable: Time Microwave: 4M-750HF290-750	10/13
Cable: Time Microwave: 10M-750HF290-750	10/13
Frequency Counter: Leader LDC825	2/14
Oscilloscope Scope: Tektronix 2230	2/14
Wattmeter: Bird 43 with Load Bird 8085	2/14
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/14
R.F. Generators: HP 606A, HP 8614A, HP 8640B	2/14
R.F. Power Amp 65W Model: 470-A-1010	2/14
R.F. Power Amp 50W M185- 10-501	2/14
R.F. Power Amp A.R. Model: 10W 1010M7	2/14
R.F. Power Amp EIN Model: A301	2/14
LISN: Compliance Eng. Model 240/20	2/14
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08	2/14
Antenna: EMCO Dipole Set 3121C	2/14
Antenna: C.D. B-101	2/14
Antenna: Solar 9229-1 & 9230-1	2/14
Audio Oscillator: H.P. 201CD	2/14
ELGAR Model: 1751	2/14
ELGAR Model: TG 704A-3D	2/14
ESD Test Set 2010i	2/14
Fast Transient Burst Generator Model: EFT/B-101	2/14
Field Intensity Meter: EFM-018	2/14
KEYTEK Ecat Surge Generator	2/14
Shielded Room 5 M x 3 M x 3.0 M	



Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 17 years' experience in the field of electronics. Engineering experience includes six years in the automated controls industry and remaining years working with the design, development and testing of radio communications and electronic equipment.

Positions Held

Systems Engineer: A/C Controls Mfg. Co., Inc. 6 Years

Electrical Engineer: Rogers Consulting Labs, Inc. 5 Years

Electrical Engineer: Rogers Labs, Inc. Current

Educational Background

- 1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.
- 2) Bachelor of Science Degree in Business Administration Kansas State University.
- 3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.

Scot D. Rogers



NVLAP Lab Code 200087-0

Annex D FCC Site Registration Letter

FEDERAL COMMUNICATIONS COMMISSION

Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

June 28, 2013

Registration Number: 90910

Rogers Labs, Inc.
4405 West 259th Terrace,
Louisburg, KS 66053

Attention: Scot Rogers,

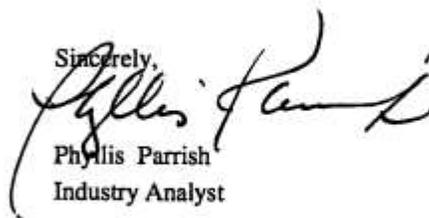
Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Renewal: June 28, 2013

Dear Sir or Madam:

Your request for renewal of the registration of the subject measurement facility has been received. The information submitted has been placed in your file and the registration has been renewed. The name of your organization will remain on the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,



Phyllis Parrish
Industry Analyst

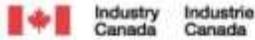
Rogers Labs, Inc.
4405 W. 259th Terrace
Louisburg, KS 66053
Phone/Fax: (913) 837-3214
Revision 1

Garmin International, Inc.
Model: A4AVGL00 SN: 3883849939bw FCC ID#: IPH-02422
Test #: 140710 IC: 1792A-02422
Test to: CFR47 (15.225), RSS-210 Date: August 25, 2014
File: Garmin A4AVGL00 NFC DXX TstRpt 140710 Page 32 of 33



NVLAP Lab Code 200087-0

Annex E Industry Canada Site Registration Letter



June 19, 2013

OUR FILE: 46405-3041
Submission No: 168037

Rogers Labs Inc.
4405 West 259th Terrace
Louisburg
KS, USA
66053

Attention: Mr. Scot D. Rogers

Dear Sir:

The Bureau has received your application for the renewal of 3/10m OATS. Be advised that the information received was satisfactory to Industry Canada. The following number(s) is now associated to the site(s) for which registration / renewal was sought (**Site# 3041A-1**). Please reference the appropriate site number in the body of test reports containing measurements performed on the site. In addition, please keep for your records the following information:

- The company address code associated to the site(s) located at the above address is: **3041A**

Furthermore, to obtain or renew a unique site number, the applicant shall demonstrate that the site has been accredited to ANSI C63.4-2003 or later. A scope of accreditation indicating the accreditation by a recognized accreditation body to ANSI C63.4-2003 or later shall be accepted. Please indicate in a letter the previous assigned site number if applicable and the type of site (example: 3 metre OATS or 3 metre chamber). If the test facility is not accredited to ANSI C63.4-2003 or later, the test facility shall submit test data demonstrating full compliance with the ANSI standard. The Bureau will evaluate the filing to determine if recognition shall be granted.

The frequency for re-validation of the test site and the information that is required to be filed or retained by the testing party shall comply with the requirements established by the accrediting organization. However, in all cases, test site re-validation shall occur on an interval not to **exceed three years**. There is no fee or form associated with an OATS filing. OATS submissions are encouraged to be submitted electronically to the Bureau using the following URL;

http://strategis.ic.gc.ca/epic/internet/inceb-bhst.nsf/en/h_tt00052e.html.

If you have any questions, you may contact the Bureau by e-mail at certification.bureau@ic.gc.ca Please reference our file and submission number above for all correspondence.

Yours sincerely,

Bill Payn
For: Wireless Laboratory Manager
Certification and Engineering Bureau
3701 Carling Ave., Building 94
P.O. Box 11490, Station "H"
Ottawa, Ontario K2H 8S2
Email: Bill.Payn@ic.gc.ca
Tel. No. (613) 990-3639
Fax. No. (613) 990-4752

Rogers Labs, Inc.
4405 W. 259th Terrace
Louisburg, KS 66053
Phone/Fax: (913) 837-3214
Revision 1

Garmin International, Inc.
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