

ROGERS LABS, INC.

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

Test Report - Maximum Permissible Exposure, Radio Frequency (RF) Exposure Report 47CFR, PART 1.1310 / MPE and RSS-102 Issue 5

Model: A04560

9300-9500 MHz

Shipborne Radar

FCC ID: IPH-04560

IC: 1792A-04560

Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062

FCC Designation: US5305
ISED Registration: 3041A

Test Report Number: 221201

Test Date: December 1, 2022

Authorized Signatory: *Scot D. Rogers*
Scot D. Rogers

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

Garmin International, Inc.
Model: A04560
Test: 221201
Test to: 47CFR 1.1310, RSS-102
File: A04560 Garmin MPE TstRpt 221201

SN: 3434382009
FCC ID: IPH-04560
IC: 1792A-04560
Date: March 14, 2023
Page 1 of 11

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Revisions

Revision 1 Issued March 14, 2023



NVLAP Lab Code 200087-0

Customer Information

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

M/N: A04560 HVIN: A04560
FCC ID: IPH-04560 IC: 1792A-04560
Operating Frequency Range: 9300-9500 MHz

Equipment Tested

Model: A04560

Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

<u>Equipment</u>	<u>Model / PN</u>	<u>Serial Number</u>
EUT (test sample, Power Load or antenna)	A04560	3434382009
Radar Voltage Converter	011-01315-50	6SA000150
Power cable (0.8-meter)	Custom Cable (No P/N)	N/A
Power cable (2-meter)	Custom Cable (No P/N)	N/A
Power cable (15-meter)	320-00246-40	N/A
I/O cable (2-meter)	320-01038-00	N/A
I/O cable (15-meter)	011-05671-00	N/A
Chart Plotter (GPSMap 8208)	010-01016-01	3855826969
DC Power Supply	BK 1745	209C13
Marine Battery (12Volt)	Duracell	N/A

Test results in this report relate only to the items tested. Worst-case configuration data recorded in this report.

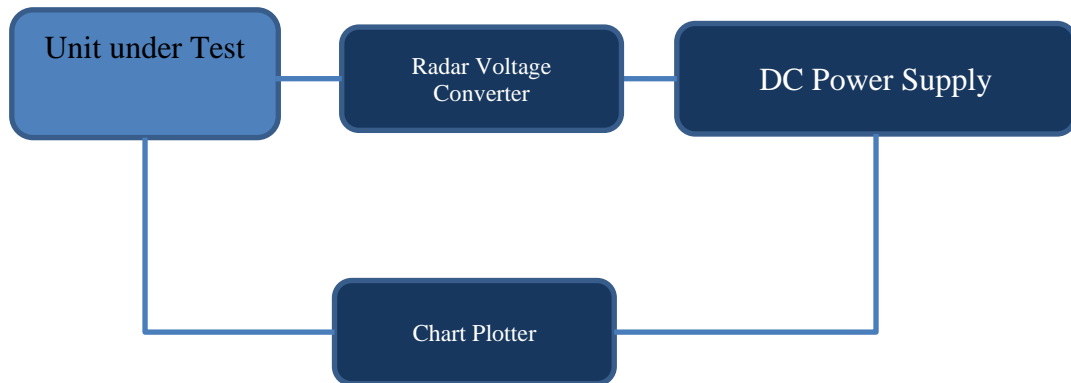
Software: 0.21, Antennas: 4-foot open array (pk-27, ave-3.99 dBi), 6-foot open array (pk-29, ave-3.85 dBi)

Rogers Labs, Inc.	Garmin International, Inc.	SN: 3434382009
4405 West 259 th Terrace	Model: A04560	FCC ID: IPH-04560
Louisburg, KS 66053	Test: 221201	IC: 1792A-04560
Phone/Fax: (913) 837-3214	Test to: 47CFR 1.1310, RSS-102	Date: March 14, 2023
Revision 1	File: A04560 Garmin MPE TstRpt 221201	Page 3 of 11

Equipment Function

The EUT is ship borne marine radar designed to provide bearing and distance information of ship and land targets located within the field of view (near the ship). The radar unit must be integrated into a full Marine system installation for operation, including chart plotter for display and control purposes. As the radar sweeps through 360°, reflected signals are interpreted and displayed on the chart plotter as indication of potential above surface hazards. Test results in this report relate only to the products described in this report.

Equipment Configuration



Test Site Locations

Conducted EMI	AC line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259 th Terrace, Louisburg, KS
Antenna port	Antenna port conducted emissions testing was performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259 th 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 West 259 th Terrace, Louisburg, KS

Registered Site information: FCC Site: US5305, ISED: 3041A, CAB Identifier: US0096

NVLAP Accreditation Lab code 200087-0

Environmental Conditions

Ambient Temperature	21.2° C
Relative Humidity	25 %
Atmospheric Pressure	1032.3 mb

Applicable Standards and Regulatory Limits

In accordance with Title 47 Code of Federal Regulations (47CFR), dated December 1, 2022, Parts 1 and 2 (2.1091 and 2.1093), and Innovation, Science and Economic Development, the following information is submitted. Test procedures used follow the guidance of FCC KDB 447498 D01 General RF Exposure Guidance v06 as per 47CFR 1.1310, and 2.1093, and Innovation, Science and Economic Development (ISED) RSS-102 Issue 5.

FCC Limits for Maximum Permissible Exposure

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*(900/f ²)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	<30
1.34-30	824/f	2.19/f	*(180/f ²)	<30
30-300	27.5	0.073	0.2	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

f = frequency in MHz. * = Plane-wave equivalent power density.

ISED RSS-102 RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ₂₁	83	90	-	Instantaneous*
0.1-10	-	0.73/ <i>f</i>	-	6**
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ <i>f</i> ^{0.25}	0.1540/ <i>f</i> ^{0.25}	8.944/ <i>f</i> ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 <i>f</i> ^{0.3417}	0.008335 <i>f</i> ^{0.3417}	0.02619 <i>f</i> ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}

Note: *f* is frequency in MHz.
 *Based on nerve stimulation (NS).
 ** Based on specific absorption rate (SAR).

ISED RSS-102 RF Field Strength Limits for Controlled Use Devices (Controlled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ₂₃	170	180	-	Instantaneous*
1-10	-	1.6/ <i>f</i>	-	6**
1.29-10	193/ <i>f</i> ^{0.5}	-	-	6**
10-20	61.4	0.163	10	6
20-48	129.8/ <i>f</i> ^{0.25}	0.3444/ <i>f</i> ^{0.25}	44.72/ <i>f</i> ^{0.5}	6
48-100	49.33	0.1309	6.455	6
100-6000	15.60 <i>f</i> ^{0.25}	0.04138 <i>f</i> ^{0.25}	0.6455 <i>f</i> ^{0.5}	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/ <i>f</i> ^{1.2}
150000-300000	0.354 <i>f</i> ^{0.5}	9.40 x 10 ⁻⁴ <i>f</i> ^{0.5}	3.33 x 10 ⁻⁴ <i>f</i>	616000/ <i>f</i> ^{1.2}

Note: *f* is frequency in MHz.
 *Based on nerve stimulation (NS).
 ** Based on specific absorption rate (SAR).

Applicable information and equations

f = Transmit Frequency (MHz)

PT = Power Input to Antenna (mW)

Duty cycle (percentage of operation)

PA = Adjusted Power due to Duty cycle or Cable Loss (mW)

GN = Numeric Gain of the Antenna

S20 = Power Density of device at 20cm (mW/m²) $S20=(PAGN)/(4\pi R20)^2$

RC = Minimum distance to the Radiating Element for Compliance (cm) FCC $RC=\sqrt{(PAGN/4\pi SL)}$

SC = Power Density of the device at the Compliance Distance RC (W/m²) FCC $SC=(PAGN)/(4\pi RC)^2$

Power Density

$E(V/m) = \text{SQRT} (30 * P * G) / D$

$Pd(W/m^2) = E^2 / 377$

$S = \text{EIRP} / (4 * \text{PI} * D^2)$

Where:

D = Separation Distance in cm

EIRP = Equivalent Isotropic Radiated Power, in mW

S = Power density in mW/cm²

Power density converted from units of mW/cm² to units of W/m² by multiplying by 10
mW/cm² by 10 => W/cm²

Distance

$D = \text{SQRT} [\text{EIRP} / (4 * \text{PI} * S)]$

Where:

D = Separation Distance in cm

EIRP = Equivalent Isotropic Radiated Power, in mW

S = Power density in mW/cm²

Source-based time-average EIRP = (DC / 100) * EIRP

Where:

DC = Duty Cycle in percent as applicable

EIRP = Equivalent Isotropic Radiated Power, in mW

RF Exposure Results

HVIN: A04560 (4-foot array)		Test Number: 221201																																														
MPE Calculator	RF Exposure uses EIRP for calculation. EIRP is based on TX power added to the antenna gain in dBi.																																															
	dBi = dB gain compared to an isotropic radiator.																																															
	S = power density in mW/cm ²																																															
	Transmitter Output power (mW)	25,000,000.0																																														
	Transmitter Output power (W)	25,000.0																																														
Output Power for % duty Cycle operation (mWatts)	0.0478	11,950.000	Antenna Gain (dBi) 3.99																																													
Output Power for Duty Cycle operation (Watts)	11.950		Antenna Gain (Numeric) 2.51																																													
Tx Frequency (MHz)	9400	Calculation power (Watts) 11.950	dBd + 2.17 = dBi dBi to dBd 2.17																																													
			Antenna Gain (dBd) 1.82																																													
Cable Loss (dB)	0.0	Adjusted Power (dBm) 40.77	Antenna minus cable (dBi) 3.99																																													
			Antenna Gain (Numeric) 2.51																																													
	Calculated ERP (mw) 18170.543		EIRP = Po(dBm) + Gain (dB)																																													
	Calculated EIRP (mw) 29948.006		Radiated (EIRP) dBm 44.764																																													
			ERP = EIRP - 2.17 dB																																													
			Radiated (ERP) dBm 42.594																																													
			Duty Cycle Correction 0.021397039																																													
	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> $\text{Power density (S) mW/cm}^2 = \frac{\text{EIRP}}{4 \pi r^2}$ </div>																																															
	<table border="1" style="width: 100%;"> <thead> <tr> <th colspan="2">Occupational Limit</th> <th colspan="3">FCC radio frequency radiation exposure limits per 1.1310</th> </tr> <tr> <th></th> <th></th> <th>Frequency (MHz)</th> <th>Occupational Limit (mW/cm²)</th> <th>Public Limit (mW/cm²)</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>mW/cm²</td> <td>30-300</td> <td>1</td> <td>0.2</td> </tr> <tr> <td>50.0</td> <td>W/m²</td> <td></td> <td></td> <td></td> </tr> <tr> <th colspan="2">General Public Limit</th> <td>300-1,500</td> <td>1/300</td> <td>1/1500</td> </tr> <tr> <td>1</td> <td>mW/cm²</td> <td>1,500-10,000</td> <td>5</td> <td>1</td> </tr> <tr> <td>10.0</td> <td>W/m²</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>			Occupational Limit		FCC radio frequency radiation exposure limits per 1.1310					Frequency (MHz)	Occupational Limit (mW/cm ²)	Public Limit (mW/cm ²)	5	mW/cm ²	30-300	1	0.2	50.0	W/m ²				General Public Limit		300-1,500	1/300	1/1500	1	mW/cm ²	1,500-10,000	5	1	10.0	W/m ²													
Occupational Limit		FCC radio frequency radiation exposure limits per 1.1310																																														
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5	mW/cm ²	30-300	1	0.2																																												
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General Public Limit		300-1,500	1/300	1/1500																																												
1	mW/cm ²	1,500-10,000	5	1																																												
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Occupational Limit		IC radio frequency radiation exposure limits per RSS-102																																														
		Frequency (MHz)	Occupational Limit (W/m ²)	Public Limit (W/m ²)																																												
50	W/m ²																																															
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		300-6,000		0.02619 f ^{0.6834}																																												
		6,000-15,000	50	10																																												
f = Transmit Frequency (MHz)		f (MHz) =	9400	9400	MHz																																											
P _T = Power Input to Antenna (mW)		P _T (mW) =	11,950,000.0000	11,950,000.0000	mW																																											
Duty cycle (percentage of operation)		% =	0.0478	0.0478	%																																											
P _A = Adjusted Power due to Duty cycle or Cable Loss (mW)		P _A (mW) =	11,950.00	11,950.00	mW																																											
G _N = Numeric Gain of the Antenna		G _N (numeric) =	2.51	2.51	numeric																																											
S ₂₀ = Power Density of device at 20cm (mW/m ²)		S ₂₀ =(P _A G _N)/(4πR ₂₀ ²)	5.96	5.96	mW/m ²																																											
S ₂₀ = Power Density of device at 20cm (W/m ²)		S ₂₀ =(P _A G _N)/(4πR ₂₀ ²)	59.58	59.58	W/m ²																																											
S _L = Power Density Limit (W/m ²) FCC		S _L (W/m ²) =	10.000	50.000	W/m ²																																											
S _L = Power Density Limit (W/m ²) Canada		S _L (W/m ²) =	10.000	50.000	W/m ²																																											
R _C = Minimum distance to the Radiating Element for Compliance (cm) FCC		R _C =√(P _A G _N /4πS _L)	48.8	21.8	cm																																											
R _C = Minimum distance to the Radiating Element for Compliance (cm) Canada		R _C =√(P _A G _N /4πS _L)	48.8	21.8	cm																																											
S _C = Power Density of the device at the Compliance Distance R _C (W/m ²) FCC		S _C =(P _A G _N)/(4πR _C ²)	10.00	50.00	W/m ²																																											
S _C = Power Density of the device at the Compliance Distance R _C (W/m ²) Canada		S _C =(P _A G _N)/(4πR _C ²)	10.00	50.00	W/m ²																																											
R ₂₀ = 20cm		R ₂₀ =	20	20	cm																																											
		For Compliance with Canada General Population Limits, User Manual must indicate a minimum separation distance of	48.8	cm																																												
		Or in Meters for Compliance with Canada General Population Limits, a minimum separation distance of	0.49	Meters																																												
Summary: Standalone MPE Calculations and Summary				Public Limit	Public																																											
	Tx Duty Cycle (%)	Tx Frequency (MHz)	Power Total (mW)	Antenna Gain (numeric)	S _L (W/m ²)	S ₂₀ (W/m ²)	R _C (cm)	S _C (W/m ²)																																								
	FCC	0.0478	9400	11,950	2.51	10.000	59.58	48.8	10.00																																							
	Canada	0.0478	9400	11,950	2.51	10.000	59.58	48.8	10.00																																							
			Limit	Occupational	Overall Minimum (cm)	Overall Minimum (inches)																																										
	FCC (cm)	48.8	21.8																																													
	FCC (inches)	20.0	9.0																																													
	Canada (cm)	48.8	21.8																																													
	Canada (inches)	20.0	9.0																																													
	Overall Minimum Limit Public			Overall Minimu Limit Occupational																																												
	49 cm			22 cm																																												
	20 inches			9 inches																																												

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Garmin International, Inc.
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 File: A04560 Garmin MPE TstRpt 221201

SN: 3434382009
 FCC ID: IPH-04560
 IC: 1792A-04560
 Date: March 14, 2023
 Page 9 of 11

HVIN: A04560 (6-foot array)		Test Number: 221201	
MPE Calculator	RF Exposure uses EIRP for calculation. EIRP is based on TX power added to the antenna gain in dBi. dBi = dB gain compared to an isotropic radiator. S = power density in mW/cm ²		
	Transmitter Output power (mW)	25,000,000.0	
	Transmitter Output power (W)	25,000.0	
Output Power for % duty Cycle operation (mWatts)	0.0478	11,950.000	Antenna Gain (dBi) 3.85
	Output Power for Duty Cycle operation (Watts)	11.950	Antenna Gain (Numeric) 2.43
Tx Frequency (MHz)	9400	Calculation power (Watts) 11.950	dBd + 2.17 = dBi 2.17
			Antenna Gain (dBd) 1.68
Cable Loss (dB)	0.0	Adjusted Power (dBm) 40.77	Antenna minus cable (dBi) 3.85
			Antenna Gain (Numeric) 2.43
	Calculated ERP (mw) 17594.134		EIRP = Po(dBm) + Gain (dB)
	Calculated EIRP (mw) 28997.991		Radiated (EIRP) dBm 44.624
			ERP = EIRP - 2.17 dB
			Radiated (ERP) dBm 42.454
			Duty Cycle Correction 0.021330119
	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> Power density (S) mW/cm² = $\frac{\text{EIRP}}{4 \pi r^2}$ r (cm) EIRP (mW) </div>		
	Occupational Limit	FCC radio frequency radiation exposure limits per 1.1310	
5	mW/cm ²	Frequency (MHz)	Occupational Limit (mW/cm ²)
50.0	W/m ²	30-300	1
	General Public Limit	300-1,500	f/300
1	mW/cm ²	1,500-10,000	5
10.0	W/m ²		1
	Occupational Limit	IC radio frequency radiation exposure limits per RSS-102	
50	W/m ²	Frequency (MHz)	Occupational Limit (W/m ²)
50.0	W/m ²	100-6,000	0.6455 f ^{0.5}
	General Public Limit	6,000-15,000	50
10	W/m ²	48-300	1.291
10	W/m ²	300-6,000	0.02619 f ^{0.6834}
		6,000-15,000	50
f = Transmit Frequency (MHz)		f (MHz) =	9400
P _T = Power Input to Antenna (mW)		P _T (mW) =	11,950,000.0000
Duty cycle (percentage of operation)		% =	0.0478
P _A = Adjusted Power due to Duty cycle or Cable Loss (mW)		P _A (mW) =	11,950.00
G _N = Numeric Gain of the Antenna		GN (numeric) =	2.43
S ₂₀ = Power Density of device at 20cm (mW/m ²)		S ₂₀ (mW/m ²) =	5.77
S ₂₀ = Power Density of device at 20cm (W/m ²)		S ₂₀ (W/m ²) =	57.69
S _L = Power Density Limit (W/m ²) FCC		S _L (W/m ²) =	10,000
S _L = Power Density Limit (W/m ²) Canada		S _L (W/m ²) =	10,000
R _C = Minimum distance to the Radiating Element for Compliance (cm) FCC		R _C (cm) =	48.0
R _C = Minimum distance to the Radiating Element for Compliance (cm) Canada		R _C (cm) =	48.0
S _C = Power Density of the device at the Compliance Distance R _C (W/m ²) FCC		S _C (W/m ²) =	10.00
S _C = Power Density of the device at the Compliance Distance R _C (W/m ²) Canada		S _C (W/m ²) =	10.00
R ₂₀ = 20cm		R ₂₀ =	20
		General Public	Occupational
		9400	9400
		11,950,000.0000	11,950,000.0000
		0.0478	0.0478
		11,950.00	11,950.00
		2.43	2.43
		5.77	5.77
		57.69	57.69
		10,000	50,000
		10,000	50,000
		48.0	21.5
		48.0	21.5
		10.00	50.00
		10.00	50.00
		20	20
		48.0 cm	
		0.48 Meters	
Summary: Standalone MPE Calculations and Summary			
	Tx Duty Cycle (%)	Tx Frequency (MHz)	Power Total (mW)
FCC	0.0478	9400	11,950
Canada	0.0478	9400	11,950
		Antenna Gain (numeric)	Public Limit
			S _L (W/m ²)
			S ₂₀ (W/m ²)
			R _C (cm)
			S _C (W/m ²)
		Limit	Public
		Overall Minimum (cm)	Occupational
	FCC (cm)	48.0	21.5
	FCC (inches)	19.0	9.0
	Canada (cm)	48.0	21.5
	Canada (inches)	19.0	9.0
	Overall Minimum Limit Public	Overall Minimum Limit Occupational	
	49 cm	22 cm	
	20 inches	9 inches	

Annex

Laboratory Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 200087-0

Rogers Labs, Inc.
Louisburg, KS

*is accredited by the National Voluntary Laboratory Accreditation Program for specific services,
listed on the Scope of Accreditation, for:*

Electromagnetic Compatibility & Telecommunications

*This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality
management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).*

2022-03-22 through 2023-03-31
Effective Dates




For the National Voluntary Laboratory Accreditation Program

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

Garmin International, Inc.
Model: A04560
Test: 221201
Test to: 47CFR 1.1310, RSS-102
File: A04560 Garmin MPE TstRpt 221201

SN: 3434382009
FCC ID: IPH-04560
IC: 1792A-04560
Date: March 14, 2023
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