

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

Models: A04676, B04676, C04676

9300-9500MHz

Radar

FCC ID: IPH-04676

IC: 1792A-04676

Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062

FCC Designation: US5305
ISED Registration: 3041A

Test Report Number: 230213

Test Date: February 13, 2023

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: A04676, B04676, C04676
Test: 230213
Test to: 47CFR 1.1310, RSS-102
File: 04676 Garmin MPE TstRpt 230213

SN: 3435842142
FCC ID: IPH-04676
IC: 1792A-04676
Date: March 14, 2023
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Revisions

Revision 1 Issued March 14, 2023

Customer Information

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

M/N: A04676, B04676, C04676 HVIN: A04676, B04676, C04676
 FCC ID: IPH-04676 IC: 1792A-04676
 Operating Frequency Range: 9300-9500 MHz

Equipment Tested

Models: A04676, B04676, C04676

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)	A04676 / 011-06162-01	3433643756
Power cable (0.2-meter)	Custom Cable (No P/N)	N/A
Power cable (14.7-meter)	320-00246-30	N/A
I/O cable (15-meter)	011-05671-00	N/A
Chart Plotter (GPSMap 8208)	011-02812-00	3855826969
Power cable (2-meter)	320-00354-20	N/A
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.

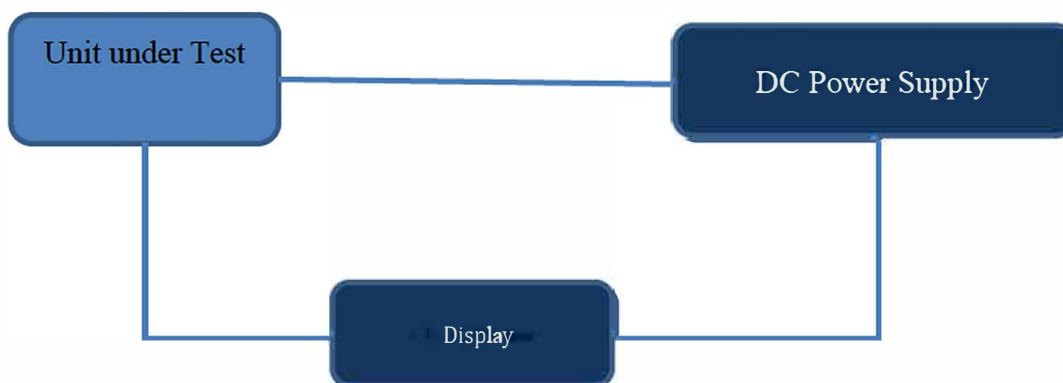
Firmware: 4.13

Antennas: 18": 5.2° horizontal & 25° vertical, with pk-21.3, ave-2.90 dBi gain
 24": 3.7° horizontal & 25° vertical, with pk-22.7, ave-2.82 dBi gain

Equipment Function

The EUT is radar designed to provide bearing and distance information of ship and land targets located within the field of view (near the ship). 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 259th Terrace, Louisburg, KS

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

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

NVLAP Accreditation Lab code 200087-0

Environmental Conditions

Ambient Temperature 21.5° C

Relative Humidity 35 %

Atmospheric Pressure 1019.3 mb

Applicable Standards and Regulatory Limits

In accordance with Title 47 Code of Federal Regulations (47CFR), dated February 13, 2023, 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 04676 (18-inch array)		Test Number 230213	
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)	4,000,000 0	
	Transmitter Output power (W)	4,000 0	
Output Power for % duty Cycle operation (mWatts)	0 099	3,961 600	Antenna Gain (dBi) 2 9
	Output Power for Duty Cycle operation (Watts)	3 962	Antenna Gain (Numeric) 1 95
Tx Frequency (MHz)	9400	Calculation power (Watts) 3 962	dBi + 2 17 = dBi dBi to dBd 2 17
			Antenna Gain (dBd) 0 73
Cable Loss (dB)	0 0	Adjusted Power (dBm) 35 98	Antenna minus cable (dBi) 2 90
			Antenna Gain (Numeric) 1 95
	Calculated ERP (mw) 4,686 737		EIRP = Po(dBm) + Gain (dB)
	Calculated EIRP (mw) 7,724 504		Radiated (EIRP) dBm 38 879
			ERP = EIRP - 2 17 dB
			Radiated (ERP) dBm 36 709
	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> Power density (S) mW/cm² = $\frac{EIRP}{4 \pi r^2}$ 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	1/300
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) =	3,961,600 0000
Duty cycle (percentage of operation)		% =	0 09904
P _A = Adjusted Power due to Duty cycle or Cable Loss (mW)		P _A (mW) =	3,961 60
G _N = Numeric Gain of the Antenna		G _N (numeric) =	1 95
S ₂₀ = Power Density of device at 20cm (mW/m ²)		S ₂₀ (mW/m ²) =	1 54
S ₂₀ = Power Density of device at 20cm (W/m ²)		S ₂₀ (W/m ²) =	15 37
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) =	24 8
R _C = Minimum distance to the Radiating Element for Compliance (cm) Canada		R _C (cm) =	24 8
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 MHz	9400 MHz
		3,961.600 0000 mW	3,961.600 0000 mW
		0 09904 %	0 09904 %
		3,961 60 mW	3,961 60 mW
		1 95 numeric	1 95 numeric
		1 54 mW/m ²	1 54 mW/m ²
		15 37 W/m ²	15 37 W/m ²
		10 000 W/m ²	50 000 W/m ²
		10 000 W/m ²	50 000 W/m ²
		24 8 cm	11 1 cm
		24 8 cm	11 1 cm
		10 00 W/m ²	50 00 W/m ²
		10 00 W/m ²	50 00 W/m ²
		20 cm	20 cm
		24 8 cm	
		0 25 Meters	
Summary: Standalone MPE Calculations and Summary			
	Tx Duty Cycle (%)	Tx Frequency (MHz)	Power Total (mW)
FCC	0 09904	9400	3,962
Canada	0 09904	9400	3,962
		Antenna Gain (numeric)	1 95
		Public Limit S _L (W/m ²)	10 000
		S ₂₀ (W/m ²)	15 37
		R _C (cm)	24 8
		S _C (W/m ²)	10 00
		Limit	Occupational
		Overall Minimum (cm)	Overall Minimum (inches)
	FCC (cm)	24 8	11 1
	FCC (inches)	10 0	5 0
	Canada (cm)	24 8	11 1
	Canada (inches)	10 0	5 0
	Overall Minimum Limit Public	Overall Minimum Limit Occupational	
	25 cm	12 cm	
	10 inches	5 inches	

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 Revision 1

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 Model: 04676
 Test: 230213
 Test to: 47CFR 1.1310, RSS-102
 File: 04676 Garmin MPE TstRpt 230213

SN: 3435842142
 FCC ID: IPH-04676
 IC: 1792A-04676
 Date: March 14, 2023
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HVIN 04676 (24-inch array)		Test Number 230213	
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)	4,000,000 0	
	Transmitter Output power (W)	4,000 0	
Output Power for % duty Cycle operation (mWatts)	0 099	3,961 600	Antenna Gain (dBi) 2 82
	Output Power for Duty Cycle operation (Watts)	3 962	Antenna Gain (Numeric) 1 91
Tx Frequency (MHz)	9400	Calculation power (Watts) 3 962	dBd + 2 17 = dBi dBi to dBd 2 17
			Antenna Gain (dBd) 0 65
Cable Loss (dB)	0 0	Adjusted Power (dBm) 35 98	Antenna minus cable (dBi) 2 82
			Antenna Gain (Numeric) 1 91
	Calculated ERP (mw) 4601 195		EIRP = Po(dBm) + Gain (dB)
	Calculated EIRP (mw) 7583 516		Radiated (EIRP) dBm 38 799
			ERP = EIRP - 2 17 dB
			Radiated (ERP) dBm 36 629
			Duty Cycle Correction 0 038426239
	<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
			10
f = Transmit Frequency (MHz)		f (MHz) =	9400 MHz
P _T = Power Input to Antenna (mW)		P _T (mW) =	3,961,600 0000
Duty cycle (percentage of operation)		% =	0 09904
P _A = Adjusted Power due to Duty cycle or Cable Loss (mW)		P _A (mW) =	3,961 60
G _N = Numeric Gain of the Antenna		G _N (numeric) =	1 91
S ₂₀ = Power Density of device at 20cm (mW/m ²)		S ₂₀ (mW/m ²) =	1 51
S ₂₀ = Power Density of device at 20cm (W/m ²)		S ₂₀ (W/m ²) =	15 09
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) =	24 6
R _C = Minimum distance to the Radiating Element for Compliance (cm) Canada		R _C (cm) =	24 6
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 MHz	9400 MHz
		3,961,600 0000 mW	3,961,600 0000 mW
		0 09904 %	0 09904 %
		3,961 60 mW	3,961 60 mW
		1 91 numeric	1 91 numeric
		1 51 mW/m ²	1 51 mW/m ²
		15 09 W/m ²	15 09 W/m ²
		10 000 W/m ²	50 000 W/m ²
		10 000 W/m ²	50 000 W/m ²
		24 6 cm	11 0 cm
		24 6 cm	11 0 cm
		10 00 W/m ²	50 00 W/m ²
		10 00 W/m ²	50 00 W/m ²
		20 cm	20 cm
		24 6 cm	
		0 25 Meters	
Summary: Standalone MPE Calculations and Summary			
	Tx Duty Cycle (%)	Tx Frequency (MHz)	Power Total (mW)
FCC	0 09904	9400	3,962
Canada	0 09904	9400	3,962
		Antenna Gain (numeric)	1 91
		S _L (W/m ²)	10 000
		S ₂₀ (W/m ²)	15 09
		R _C (cm)	24 6
		S _C (W/m ²)	10 00
		Limit	Overall Minimum (cm)
		Public	Overall Minimum (inches)
		Occupational	
	FCC (cm)	24 6	11 0
	FCC (inches)	10 0	5 0
	Canada (cm)	24 6	11 0
	Canada (inches)	10 0	5 0
	Overall Minimum Limit Public		Overall Minimum Limit Occupational
	25 cm		11 cm
	10 inches		5 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 Communiqué dated January 2009).*

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




For the National Voluntary Laboratory Accreditation Program

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