

RF Exposure Evaluation Report

Application No.: SZEM2103002197CR
Applicant: Navico Inc.
Address of Applicant: 4500 S. 129th East Avenue, Ste. 200, Tulsa, Oklahoma, 74134 United States
Manufacturer: Navico Auckland Ltd.
Address of Manufacturer: 44 Arrenway Drive, Rosedale, Auckland 0632, New Zealand
Factory: Shenzhen Fastrain Technology Co., Ltd.
Address of Factory: No.3 Baolong 4th Rd., Baolong Industrial Area, Longgang District, Shenzhen, China

Equipment Under Test (EUT):

Product Name: MARINE BLACK BOX DSC/AIS VHF RADIO SYSTEM
Model No.: NRS-2
Trade mark: NAVICO
FCC ID: RAYVHFNRS2A
Standards: 47 CFR Part 1.1307
47 CFR Part 1.1310
Date of Receipt: 2021-03-01
Date of Test: 2021-03-03 to 2021-04-13
Date of Issue: 2021-04-14

Test Result :	PASS*
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* In the configuration tested, the EUT complied with the standards specified above.

Keny Xu
EMC Laboratory Manager



Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2021-04-14		Original

Authorized for issue by:			
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3 General Information

3.1 General Description of EUT

Power supply:	12 VDC battery system
Cable:	DC cable: longer than 300cm unshielded
Sample Type:	Mobile device
Classification:	Uncontrolled Environment
Transmitter Frequency Range:	VHF:156.025MHz-157.425MHz 802.11b/g/n HT20: 2412MHz-2462MHz
AIS Transmitter Frequency Range:	AIS Class B:161.975MHz(CH87), 162.025MHz(CH88)
DSC Transmitter Frequency Range:	156.525MHz(CH70), Meets Global DSC Class D standards.
GNSS Receiver Frequency Range:	1559MHz-1610MHz(GLONASS:G1, GPS:L1)
Modulation Type:	VHF:FM for Analog; DSC:FSK; AIS:GMSK; GNSS: BPSK; 802.11b: DSSS (CCK, DQPSK, DBPSK) 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) 802.11n(HT20): OFDM (BPSK, QPSK, 16QAM, 64QAM)
Frequency Spacing:	VHF: 25KHz 802.11b/g/n HT20: 5MHz
Channel Numbers:	802.11b/g/n HT20: 11 Channels
Emission Type:	16K0G3E for VHF 16K0G2B for DSC 9K05GXW for AIS
Rated Output Power:	25W/1W for VHF/DSC; 2W for AIS;
VHF/DSC Antenna Connectors:	SO-239(50 ohm, External Antenna)
AIS Antenna Connectors:	SO-239(50 ohm, External Antenna)
VHF/DSC Antenna Gain:	6dBi
AIS Antenna Gain:	6dBi
GNSS Antenna Connector:	SMA for External antenna
GNSS Antenna Gain:	1.5dBi





WiFi Antenna Type:	Integral
WiFi Antenna Gain:	5.3dBi



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Shenzhen Branch (Shenzhen) EEC Laboratory

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3.2 Test Location

All tests were performed at:

SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch

No. 1 Workshop, M-10, Middle section, Science & Technology Park, Shenzhen, Guangdong, China
518057

Telephone: +86 (0) 755 2601 2053 Fax: +86 (0) 755 2671 0594

No tests were sub-contracted.

3.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

• **A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

• **VCCI**

The 3m Fully-anechoic chamber for above 1GHz, 10m Semi-anechoic chamber for below 1GHz, Shielded Room for Mains Port Conducted Interference Measurement and Telecommunication Port Conducted Interference Measurement of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-20026, R-14188, C-12383 and T-11153 respectively.

• **FCC –Designation Number: CN1178**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1178. Test Firm Registration Number: 406779.

• **Innovation, Science and Economic Development Canada**

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CAB identifier: CN0006.

IC#: 4620C.

3.4 Deviation from Standards

None.

3.5 Abnormalities from Standard Conditions

None.

3.6 Other Information Requested by the Customer

None.



4 RF Exposure Evaluation

4.1 RF Exposure Compliance Requirement

4.1.1 Limits

According to FCC Part1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in part1.1307(b)

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
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
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
(B) 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
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

F= Frequency in MHz

Friis Formula

Friis transmission formula: $P_d = (P_{out} * G) / (4 * \pi * R^2)$

Where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

R = distance between observation point and center of the radiator in cm

For Uncontrolled Environment, the MPE limit of VHF is 0.2 mW/cm², the MPE limit of 802.11b/g/n is 1.0 mW/cm². If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

4.1.2 Test Procedure

Software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.



4.1.3 EUT RF Exposure Evaluation

The best case gain of the antenna is 6dBi. 6dB logarithmic terms convert to numeric result is nearly 3.98.

Test Frequency (MHz)	Maximum Antenna Gain (dBi)	Maximum Antenna Gain (Numeric)	Output Power (dBm)	Max Tune-up tolerance power (dBm)	Max Tune-up tolerance power*50% ^a (mW)	Power density (mW/cm ²)	Minimum Distance to Human body (cm)
156.025	6	3.98	43.65	43.98	12501.73	0.20	140.72
156.025	6	3.98	29.23	30	500.00	0.20	28.14
156.300	6	3.98	43.79	43.98	12501.73	0.20	140.72
156.300	6	3.98	29.31	30	500.00	0.20	28.14
156.650	6	3.98	43.75	43.98	12501.73	0.20	140.72
156.650	6	3.98	29.79	30	500.00	0.20	28.14
156.800	6	3.98	43.86	43.98	12501.73	0.20	140.72
156.800	6	3.98	29.18	30	500.00	0.20	28.14
157.425	6	3.98	43.91	43.98	12501.73	0.20	140.72
157.425	6	3.98	29.07	30	500.00	0.20	28.14
156.525	6	3.98	43.84	43.98	12501.73	0.20	140.72
156.525	6	3.98	28.87	30	500.00	0.20	28.14

Note ^a: These channels may be operated as half-duplex frequency channels.

Test Frequency (MHz)	Maximum Antenna Gain (dBi)	Maximum Antenna Gain (Numeric)	Output Power (dBm)	Max Tune-up tolerance power (dBm)	Max Tune-up tolerance power (mW)	Power density (mW/cm ²)	Minimum Distance to Human body (cm)
162.025	6	3.98	32.82	33.0	997.63	0.20	39.75

For VHF Transmitter:

The maximum rated power of duplex is 25W, the low rated power of duplex is 1W which declared by manufacturer.

Then the maximum rated power of half-duplex is 12.5W, the low rated power of half-duplex is 0.5W.

To satisfy RF exposure requirements, a separation distance of 140.72cm or more should be maintained between this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended.

The minimum distance between this device and persons during device operation is 210 cm which declared by manufacturer. Through the calculation, the maximum power density at 210cm is:

$$Pd = (Pout * G) / (4 * \pi * R^2) = (12501.73 * 3.98) / (4 * 3.1416 * 210 * 210) = 0.0898 \text{ mW/cm}^2$$



For AIS Transmitter:

The rated power is 2W, which declared by manufacturer

To satisfy RF exposure requirements, a separation distance of 40.0cm or more should be maintained between this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended.

The minimum distance between this device and persons during device operation is 210 cm which declared by manufacturer. Through the calculation, the maximum power density at 210cm is:

$$Pd = (Pout \cdot G) / (4 \cdot \pi \cdot R^2) = (997.63 \cdot 3.98) / (4 \cdot 3.1416 \cdot 210 \cdot 210) = 0.0072 \text{ mW/cm}^2$$

For 802.11b/g/n HT20:

The best case gain of the antenna is 5.3dBi. 5.3dB logarithmic terms convert to numeric result is nearly 3.39

The max tune-up tolerance power Into Antenna & RF Exposure Evaluation Distance:

Channel	Frequency (MHz)	Max tune-up tolerance power(dBm)	Max tune-up Tolerance power to Antenna (mW)	Power Density at R = 20cm (mW/cm ²)	Limit (mW/cm ²)	MPE Ratio	Result
High	2462MHz	12	15.85	0.0107	1.0	0.0107	PASS

The simultaneous transmission result between of 2.4G WiFi, VHF and AIS:

The SAR Exclusion Threshold Level:

$$= CPD1/LPD1 + CPD2/LPD2 + CPD3/LPD3 \text{ (CPD = Calculation power density, LPD = Limit of power density)}$$

$$= (0.0898/0.2) + (0.0072/0.2) + (0.0107/1) = 0.4957 < 1$$

Since the SAR Exclusion Threshold Level is well below the SAR low threshold level, so the EUT is considered to comply with SAR requirement without testing.

- End of the Report -

