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RF Exposure Evaluation Report

Application No.:	SZEM2101000028CR
Applicant:	Flir Belgium BVBA
Address of Applicant:	Luxemburgstraat 2, Meer 2321, Belgium
Manufacturer:	Shenzhen Fastrain Technology Co., Ltd.
Address of Manufacturer:	No.3 Baolong 4th Rd., Baolong Industrial Area, Longgang District, Shenzhen, China
Factory:	Shenzhen Fastrain Technology Co., Ltd.
Address of Factory:	No.3 Baolong 4th Rd., Baolong Industrial Area, Longgang District, Shenzhen, China
Product Name:	YachtSense Link – Marine Cloud Router
Model No.:	E70640
Trade Mark:	Raymarine
FCC ID:	PJ5-RAY4GHUB
Standards:	47 CFR Part 1.1307 47 CFR Part 1.1310 47 CFR Part 2.1091
Date of Receipt:	2021-01-04
Date of Test:	2021-01-07 to 2021-02-24
Date of Issue:	2021-02-24
Test Result :	**PASS***

* In the configuration tested, the EUT complied with the standards specified above.

Keny Xu
EMC Laboratory Manager

2 Version

Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
01		2021-02-24		Original

Authorized for issue by:				
				
		Edison Li /Project Engineer		
				
		Eric Fu /Reviewer		

3 Contents

4 General Information

4.1 General Description of EUT

Power supply:	Nominal Supply Voltage:12/24V dc Operating Voltage Range:8V dc to 32V dc
Cable(s):	DC cable:150cm unshielded Network cable:110cm unshielded 5 in 1 SANAV antenna length:500cm unshielded 5 in 1 Sinclair antenna length:500cm unshielded
Internal Source:	More than 108MHz

Details of Boat WLAN(AP mode)

Operation Frequency:	802.11b/g/n(HT20): 2412MHz to 2462MHz 802.11n(HT40): 2422MHz to 2452MHz
Modulation Type:	802.11b: DSSS(CCK, DQPSK, DBPSK) 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) 802.11n(HT20 and HT40): OFDM (BPSK, QPSK, 16QAM, 64QAM)
Channel Numbers:	802.11b/g, 802.11n HT20: 11 Channels 802.11n HT40: 7 Channels
Sample Type:	Fixed device
Antenna Type:	Dipole antenna
Antenna Gain:	Antenna1/ Antenna2:5.3dBi Note: MIMO for 802.11n

Details of Dock WLAN(Station mode)

Operation Frequency:	802.11b/g/n(HT20): 2412MHz to 2462MHz 802.11n(HT40): 2422MHz to 2452MHz
Modulation Type:	802.11b: DSSS(CCK, DQPSK, DBPSK) 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) 802.11n(HT20 and HT40): OFDM (BPSK, QPSK, 16QAM, 64QAM)
Channel Numbers:	802.11b/g, 802.11n HT20: 11 Channels 802.11n HT40: 7 Channels
Sample Type:	Fixed device

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Antenna Type:	Smart antenna
Antenna Gain:	Sinclair LM715(E6685) Rugged mobile antenna, 5 in 1, LTE&WiFi MIMO with GNSS, Sinclair1 Antenna/ Sinclair2 Antenna:1.9dBi SANAV 5-in-1 5G NR/ 4G LTE/ WiFi/ GNSS Combination Antenna SANAV1 Antenna:4.55dBi, SANAV2 Antenna:4.45dBi(Note: MIMO for 802.11n) Note: MIMO for 802.11n

Details of Dock WLAN(Station mode)

Operation Frequency	Band	Mode	Frequency Range(MHz)	Number of channels
	UNII Band I	802.11a/n(HT20)/ac(HT20)	5180-5240	4
		802.11n(HT40)/ac(HT40)	5190-5230	2
		802.11ac(HT80)	5210	1
	UNII Band II-A	802.11a/n(HT20)/ac(HT20)	5260-5320	4
		802.11n(HT40)/ac(HT40)	5270-5310	2
		802.11ac(HT80)	5290	1
	UNII Band II-C	802.11a/n(HT20)/ac(HT20)	5500-5700	11
		802.11n(HT40)/ac(HT40)	5510-5670	5
		802.11ac(HT80)	5530,5610	2
	UNII Band III	802.11a/n(HT20)/ac(HT20)	5745-5825	5
		802.11n(HT40)/ac(HT40)	5755-5795	2
		802.11ac(HT80)	5775	1
Modulation Type:	802.11a: OFDM(64QAM, 16QAM, QPSK, BPSK) 802.11n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM)			
DFS Function:	Slave without radar detection			
TPC Function:	Not support			
Sample Type:	Fixed device			
Antenna Type:	Smart antenna			
Antenna Gain:	Sinclair LM715(E6685) Rugged mobile antenna, 5 in 1, LTE&WiFi MIMO with GNSS Sinclair1 Antenna/ Sinclair2 Antenna:3.9dBi			

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	SANAV 5-in-1 5G NR/ 4G LTE/ WiFi/ GNSS Combination Antenna SANAV1 Antenna:5.84dBi, SANAV2 Antenna:4.02dBi Note: MIMO for 802.11n

Details of GSM/WCDMA/LTE module*:		
Operation Frequency Band:	GSM850/GSM1900, WCDMA Band II,IV,V; LTE FDD Band 2,4,5,7,12,13,25,26,38,41	
Modulation Type:	WCDMA: QPSK LTE: QPSK, 16QAM	
HSDPA UE Category:	24	
HSUPA UE Category:	6	
LTE Category:	4	
Antenna Type:	Smart antenna	
Antenna Ports:	Tx & Rx Port	1
	Rx-only Port	1
Antenna Gain:	Sinclair LM715(E6685) Rugged mobile antenna, 5 in 1, LTE&WiFi MIMO with GNSS Mobile Main Antenna:1.9dBi, Mobile Aux Antenna:3.9dBi SANAV 5-in-1 5G NR/ 4G LTE/ WiFi/ GNSS Combination Antenna GSM850: Mobile Main Antenna:1.49dBi, Mobile Aux Antenna:4.66dBi GSM1900: Mobile Main Antenna:3.95dBi, Mobile Aux Antenna:4.92dBi WCDMA Band II: Mobile Main Antenna:3.95dBi, Mobile Aux Antenna:4.92dBi WCDMA Band IV: Mobile Main Antenna:3.95dBi, Mobile Aux Antenna:5.82dBi WCDMA Band V: Mobile Main Antenna:1.49dBi, Mobile Aux Antenna:4.66dBi LTE Band 2: Mobile Main Antenna:3.95dBi, Mobile Aux Antenna:4.92dBi LTE Band 4: Mobile Main Antenna:3.95dBi, Mobile Aux Antenna:5.82dBi LTE Band 5: Mobile Main Antenna:1.49dBi, Mobile Aux Antenna:4.66dBi LTE Band 7: Mobile Main Antenna:4.29dBi, Mobile Aux Antenna:4.29dBi LTE Band 12: Mobile Main Antenna:2.42dBi, Mobile Aux Antenna:5.32dBi LTE Band 13: Mobile Main Antenna:2.42dBi, Mobile Aux Antenna:5.32dBi LTE Band 25: Mobile Main Antenna:3.95dBi, Mobile Aux Antenna:4.92dBi LTE Band 26: Mobile Main Antenna:1.49dBi, Mobile Aux Antenna:4.66dBi LTE Band 38: Mobile Main Antenna:4.29dBi, Mobile Aux Antenna:4.29dBi LTE Band 41: Mobile Main Antenna:4.29dBi, Mobile Aux Antenna:4.29dBi	

*: The GSM/WCDMA/LTE single module approval by TCB(FCC ID:XMR201903EG25G), Grant at 03/29/2019.

4.2 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.

4.3 Test Facility

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

• **CNAS (No. CNAS L2929)**

CNAS has accredited SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

• **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**

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

CAB identifier: CN0006.

IC#: 4620C.

4.4 Deviation from Standards

None.

4.5 Abnormalities from Standard Conditions

None.

4.6 Other Information Requested by the Customer

None.

5 RF Exposure Evaluation

5.1 RF Exposure Compliance Requirement

5.1.1 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: $Pd = (Pout*G)/(4* Pi * R^2)$

Where

Pd = power density in mW/cm^2

Pout = output power to antenna in mW

G = gain of antenna in linear scale

Pi = 3.1416

For Uncontrolled Environment, the MPE limit of 300MHz to 1500MHz is f/1500 mW/cm^2 , the MPE limit of 1500MHz to 100000MHz is 1.0 mW/cm^2 . 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.

5.1.2 Test Procedure

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

5.1.3 EUT RF Exposure Evaluation

1) Test Results

Note: The Boat WLAN antenna, Dock WLAN antenna and GSM/WCDMA/LTE antenna can synchronous transmission at the same time.

For 2.4G WiFi(Boat WLAN):

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

Antenna	Max Antenna Gain (dBi)	Max Antenna Gain (Numeric)	Max tune-up tolerance power (dBm)	Max tune-up Tolerance power to Antenna (mW)	Power Density at R = 50 cm (mW/cm^2)	Limit (mW/cm^2)	MPE Ratios	Result
MIMO	5.3	3.39	17.02	50.35	0.0054	1	0.0054	PASS

Note: Refer to report No. SZEM210100002802 or EUT test Max Conducted Peak Output Power value.
The distancer (4th column) calculated from the Fries transmission formula is far greater than 50 cm separation requirement, the MPE limit of 1500MHz to 100000MHz is 1.0 mW/cm^2.

For 2.4G WiFi(Dock WLAN, Sinclair antenna):

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

Antenna	Max Antenna Gain (dBi)	Max Antenna Gain (Numeric)	Max tune-up tolerance power (dBm)	Max tune-up Tolerance Power to Antenna(mW)	Power Density at R = 50 cm (mW/cm^2)	Limit (mW/cm^2)	MPE Ratios	Result
MIMO	1.9	1.55	17.96	62.52	0.0031	1	0.0031	PASS

Note: Refer to report No. SZEM210100002802 or EUT test Max Conducted Peak Output Power value.
The distancer (4th column) calculated from the Fries transmission formula is far greater than 50 cm separation requirement, the MPE limit of 1500MHz to 100000MHz is 1.0 mW/cm^2.

For 2.4G WiFi(Dock WLAN, SANAV antenna):

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

Antenna	Max Antenna Gain (dBi)	Max Antenna Gain (Numeric)	Max tune-up tolerance power (dBm)	Max tune-up Tolerance Power to Antenna(mW)	Power Density at R = 50 cm (mW/cm^2)	Limit (mW/cm^2)	MPE Ratios	Result
MIMO	4.55	2.85	17.96	62.52	0.0057	1	0.0057	PASS

Note: Refer to report No. SZEM210100002802 or EUT test Max Conducted Peak Output Power value.
The distancer (4th column) calculated from the Fries transmission formula is far greater than 50 cm separation requirement, the MPE limit of 1500MHz to 100000MHz is 1.0 mW/cm^2.

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For 5G WiFi(Dock WLAN, Sinclair antenna):

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

Antenna	Max Antenna Gain (dBi)	Max Antenna Gain (Numeric)	Max tune-up tolerance power (dBm)	Max tune-up Tolerance power to Antenna (mW)	Power Density at R = 50 cm (mW/cm^2)	Limit (mW/cm^2)	MPE Ratios	Result
MIMO	3.9	2.45	17.59	57.41	0.0045	1	0.0045	PASS

Note: Refer to report No. SZEM210100002803 or EUT test Max Conducted Peak Output Power value.
The distancer (4th column) calculated from the Fries transmission formula is far greater than 50 cm separation requirement, the MPE limit of 1500MHz to 100000MHz is 1.0 mW/cm^2.

For 5G WiFi(Dock WLAN, SANAV antenna):

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

Antenna	Max Antenna Gain (dBi)	Max Antenna Gain (Numeric)	Max tune-up tolerance power (dBm)	Max tune-up Tolerance power to Antenna (mW)	Power Density at R = 50 cm (mW/cm^2)	Limit (mW/cm^2)	MPE Ratios	Result
MIMO	5.84	3.84	17.59	57.41	0.0070	1	0.0070	PASS

Note: Refer to report No. SZEM210100002803 or EUT test Max Conducted Peak Output Power value.
The distancer (4th column) calculated from the Fries transmission formula is far greater than 50 cm separation requirement, the MPE limit of 1500MHz to 100000MHz is 1.0 mW/cm^2.

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For GSM/WCDMA/LTE module(Sinclair antenna):

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

Type	Test Freq. (MHz)	Max Antenna Gain (dBi)	Max Antenna Gain (Numeric)	Max tune-up tolerance power (dBm)	Max tune-up Tolerance power to Antenna (mW)	Power Density at R=50cm (mW/cm^2)	Limit (mW/cm^2)	MPE Ratios	Result
GSM850	824.2	3.9	2.45	33	1995.26	0.1559	0.5495	0.2837	PASS
PCS1900	1850.2	3.9	2.45	30	1000.00	0.0781	1	0.0781	PASS
WCDMA Band II	1852.4	3.9	2.45	24	251.19	0.0196	1	0.0196	PASS
WCDMA Band IV	1712.4	3.9	2.45	24	251.19	0.0196	1	0.0196	PASS
WCDMA Band V	826.4	3.9	2.45	24	251.19	0.0196	0.5509	0.0356	PASS
LTE Band2	1850.7	3.9	2.45	23	199.53	0.0156	1	0.0156	PASS
LTE Band4	1710.7	3.9	2.45	23	199.53	0.0156	1	0.0156	PASS
LTE Band5	824.7	3.9	2.45	23	199.53	0.0156	0.5498	0.0284	PASS
LTE Band7	2502.5	3.9	2.45	23	199.53	0.0156	1	0.0156	PASS
LTE Band12	699.7	3.9	2.45	23	199.53	0.0156	0.4665	0.0334	PASS
LTE Band13	779.5	3.9	2.45	23	199.53	0.0156	0.5197	0.0300	PASS
LTE Band25	1850.7	3.9	2.45	23	199.53	0.0156	1	0.0156	PASS
LTE Band26	814.7	3.9	2.45	23	199.53	0.0156	0.5431	0.0287	PASS
LTE Band38	2572.5	3.9	2.45	23	199.53	0.0156	1	0.0156	PASS
LTE Band41	2498.5	3.9	2.45	23	199.53	0.0156	1	0.0156	PASS

Note: Refer to report No. HR/2019/1001601 or EUT test Max Conducted Peak Output Power value.

The distancer (4th column) calculated from the Fries transmission formula is far greater than 50 cm separation requirement.

the MPE limit of 300MHz to 1500MHz is f/1500 mW/cm^2, the MPE limit of 1500MHz to 100000MHz is 1.0 mW/cm^2.

For GSM/WCDMA/LTE module(SANAV antenna):

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

Type	Test Freq. (MHz)	Max Antenna Gain (dBi)	Max Antenna Gain (Numeric)	Max tune-up tolerance power (dBm)	Max tune-up Tolerance power to Antenna (mW)	Power Density at R=50cm (mW/cm^2)	Limit (mW/cm^2)	MPE Ratios	Result
GSM850	824.2	4.66	2.92	33	1995.26	0.1857	0.5495	**0.3380**	PASS
PCS1900	1850.2	4.92	3.10	30	1000.00	0.0988	1	0.0988	PASS
WCDMA Band II	1852.4	4.92	3.10	24	251.19	0.0248	1	0.0248	PASS
WCDMA Band IV	1712.4	5.82	3.82	24	251.19	0.0305	1	0.0305	PASS
WCDMA Band V	826.4	4.66	2.92	24	251.19	0.0234	0.5509	0.0424	PASS
LTE Band2	1850.7	4.92	3.10	23	199.53	0.0197	1	0.0197	PASS
LTE Band4	1710.7	5.82	3.82	23	199.53	0.0243	1	0.0243	PASS
LTE Band5	824.7	4.66	2.92	23	199.53	0.0186	0.5498	0.0338	PASS
LTE Band7	2502.5	4.29	2.69	23	199.53	0.0171	1	0.0171	PASS
LTE Band12	699.7	5.32	3.40	23	199.53	0.0216	0.4665	0.0463	PASS
LTE Band13	779.5	5.32	3.40	23	199.53	0.0216	0.5197	0.0416	PASS
LTE Band25	1850.7	4.92	3.10	23	199.53	0.0197	1	0.0197	PASS
LTE Band26	814.7	4.66	2.92	23	199.53	0.0186	0.5431	0.0342	PASS
LTE Band38	2572.5	4.29	2.69	23	199.53	0.0171	1	0.0171	PASS
LTE Band41	2498.5	4.29	2.69	23	199.53	0.0171	1	0.0171	PASS

Note: Refer to report No. HR/2019/1001601 or EUT test Max Conducted Peak Output Power value.

The distancer (4th column) calculated from the Fries transmission formula is far greater than 50 cm separation requirement.

the MPE limit of 300MHz to 1500MHz is f/1500 mW/cm^2, the MPE limit of 1500MHz to 100000MHz is 1.0 mW/cm^2.

The simultaneous transmission result between of Boat WLAN, Dock WLAN and GSM/WCDMA/LTE module:
The SAR Exclusion Threshold Level:
=CPD1 / LPD1 + CPD2 / LPD2 + CPD3 / LPD3
(CPD = Calculation power density, LPD = Limit of power density)
= (0.0054/1) +(0.0070/1) +(0.1857/0.5495)= 0.3504 < 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 Report