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TEST REPORT

WatchMate Vision Class B
AIS Transponder with built in display

tested to

47 Code of Federal Regulations

Part 15 - Radio Frequency Devices

Subpart C – Intentional Radiators

including

Section 15.247 - Operation in the band 2400 – 2483.5 MHz

for

VESPER MARINE Ltd

This Test Report is issued with the authority of:

Andrew Cutler - General Manager

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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1. STATEMENT OF COMPLIANCE

The **WatchMate Vision Class B AIS Transponder with built in display** complies with FCC Part 15 Subpart C including Section 15.247 as an Intentional Radiator when the methods as described in ANSI C63.4 - 2003 are applied.

2. RESULTS SUMMARY

The results of testing carried out April and May 2012 are summarised below.

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Class 2 Permissive Change Certification required.
15.203	Antenna requirement	Complies. Antenna is integral to the device.
15.204	External PA and antenna modifications	Noted.
15.205	Restricted bands of operation	Complies.
15.207	Conducted limits	Not applicable. Device does not directly or indirectly connect to the public AC mains supply.
15.209	Radiated emission limits	Noted. See 15.247 requirements.
15.247		
(a)(2)	Minimum bandwidth	Complies
(b)(3)	Peak output power	Complies
(c)	Directional antenna gains greater than 6 dBi	Not applicable
(d)	Out of band emissions	Complies
(e)	Power spectral density	Complies
(f)	Hybrid systems	Not applicable
(g)	Use of all channels	Not applicable
(h)	Intelligent frequency hopping	Not applicable
(i)	Radio frequency hazards	Complies

3. INTRODUCTION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification.

The client selected the test sample.

This report relates only to the sample tested.

This report contains no corrections or erasures.

Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

4. CLIENT INFORMATION

Company Name	VESPER MARINE Ltd
Address	103 Westhaven Drive St Marys Bay Auckland 1010
Country	New Zealand
Contact	Mr Carl Omundsen

5. DESCRIPTION OF TEST SYSTEM

Brand Name	WatchMate
Model	Vision
Product	Class B AIS Transponder with built in display
Manufacturer	Vesper Marine Ltd
Country of Origin	New Zealand
Serial Numbers	Sample not serialised
Module FCC ID	U9R-W2SW0001
System FCC ID	To be determined

The sample tested was the WatchMate Vision which was tested with a built in display and a WiFi module.

The client advises that this report may also be applied to the following other model which are identical to the model that was tested except for the following differences which simplify the device:

- Model XB-8000. This model is identical to the Vision however it does not have a display
- Model XB-6000. This model is identical to the Vision however it does not have a display and it does not contain a WiFi module

The system tested is primarily an AIS Transponder that operates in the VHF Marine band between 156 – 165 MHz.

This system also contains a GPS receiver and a Wireless Access Point that operated in the 2.4 GHz band.

The Wireless Access Point will allow access to various information contained within the AIS system using personal computers with appropriate software at various locations throughout the vessel that are away from the AIS Transponder.

The Wireless Access Point has used a previously certified FCC 2.4 GHz Wireless Module, FCC ID: U9R-W2SW0001, however modifications have been made.

This report covers testing that was carried out in order to verify that the changes made to the module have not degraded its EMC performance which would allow a Class 2 permissive change certification to be undertaken.

The Wireless Access Point has the following RF specifications:

FCC Band:	2400 to 2483.5 MHz
Operating Frequency Band:	2412 MHz to 2462 MHz
Number of Channels:	12
Channel spacing:	5 MHz
Rated Conducted Power:	0.003 W (+15 dBm)
Antenna Type:	Mica 2.4 GHz SMD Antenna with 1.2 dBi gain
Power Supply:	9 Vdc to 30 Vdc
Modulation:	802.11b/g using DSSS / CCK modulation supporting data rates of 1, 2, 5.5 and 11 Mbps

The device has the following ports that were terminated as follows:

- AIS transmit / receive antenna port connected to a 50 ohm dummy load
- USB port was connected to a powered USB power supply device using a 5 metre length of data cable
- GPS antenna port connected to a GPS antenna using a 10 metre length of data cable
- NMEA0183 input / output port was connected to a 5 metre length of data cable that was not terminated at the request of the client
- NMEA2000 port was connected to a 10 metre length of cable that was terminated with a 12 Vdc battery

6. RESULTS

Standard

The sample was tested in accordance with 47 CFR Part 15 Subpart C.

Methods and Procedures

The measurement methods and procedures as described in ANSI C63.4 - 2003 were used.

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 is required for this device.

A FCC compliant module device, FCC ID: U9R-W2SW001, has been used however the client has modified the antenna.

Therefore testing is required in order to carryout a Class 2 Permissive Change Certification.

Section 15.203: Antenna requirement

The Access Point antenna is a PCB mounted antenna that is integral to the device.

Result: Complies.

Section 15.204: External radio frequency power amplifiers and antenna modifications

Device does not have an external radio frequency power amplifier and the user manual will address the issue of antenna modifications

Result: Complies.

Section 15.205: Restricted bands of operation

Refer to measurements made with reference to Section 15.247 (d).

Result: Complies.

Section 15.207 – Conducted emissions

Device does not directly or indirectly connect to the public AC mains supply as it would be operated on board a boat that would be self powered

Result: Not applicable.

Section 15.247(a)(2) – Minimum Bandwidth

Systems using digital modulation in the 2400 – 2483.5 MHz band are required to have a minimum 6 dB bandwidth of at least 500 kHz.

Radiated measurements were made at the test site using a 100 kHz resolution bandwidth when the system was operating on a low, middle and high channel.

Frequency (MHz)	Bandwidth (MHz)
2412.000	9.900
2437.000	9.859
2462.000	9.930

Result: Complies

Section 15.247(b)(3) – Maximum Peak Conducted Power

As this device has an integral pcb mounted antenna it was not possible to make conducted power measurements at the output of the transmitter.

Therefore radiated measurements were made that were then converted back to a conducted measurement using an assumed antenna gain factor and cable loss between the antenna and the output of the transmitter.

The client advises that the antenna used as a typical gain of 1.2 dBi.

The rated output conducted power is stated to be 30 mW

Testing was carried out on a low, middle and high channel.

Given the width of the emission measurements were made in 5 MHz steps using a resolution bandwidth of 5 MHz using a peak detector with the overall power determined by summing each of the levels measured.

Measurements were made using both vertical and horizontal polarisations with the device being rotated and height scanned to determine the highest radiated power level.

Only the vertical results have been shown as the horizontal emissions were less

Channel 1: 2412 MHz Vertical

Freq (MHz)	Level (dBuV/m)	Power (dBm)	Summed Power (dBm)	Antenna Gain (dBi)	Conducted Power (dBm)	Conducted Power (mW)
2402.000	93.9	-1.3	16.3	1.2	15.1	32.4
2407.000	102.1	6.9				
2412.000	110.1	14.9				
2417.000	103.2	8.0				
2422.000	94.0	-3.4				

Channel 6: 2438 MHz Vertical

Freq (MHz)	Level (dBuV/m)	Power (dBm)	Summed Power (dBm)	Antenna Gain	Conducted Power (dBm)	Conducted Power (mW)
2425.000	93.2	-2.0	15.7	1.2	14.5	28.2
2430.000	102.7	7.5				
2435.000	107.5	12.3				
2440.000	106.0	10.8				
2445.000	100.2	2.8				

Channel 12: 2462 MHz Vertical

Freq (MHz)	Level (dBuV/m)	Power (dBm)	Summed Power (dBm)	Antenna Gain	Conducted Power (dBm)	Conducted Power (mW)
2452.000	94.9	-0.3	16.9	1.2	15.7	37.2
2457.000	103.7	8.5				
2462.000	110.5	15.3				
2467.000	103.6	8.3				
2472.000	94.3	-3.1				

The radiated power level in dBm was determined by formula from the field strength using the formula Field strength (V/m) = (square root of (30 x transmitter power (watts))) / distance (metres).

The maximum peak conducted power limit is 1 watt.

The measured conducted power compares favourably with the rated power of 30 mW.

Result: Complies

Section 15.247(d) – Out of Band Emissions

As this device has an integral pcb mounted antenna it was not possible to make conducted spurious emission measurements at the output of the transmitter.

Therefore radiated emission measurements were made at the test site covering the following areas of concern.

- general emissions from the device with the limits as per section 15.209 being applied

- bandedge emission measurements when operating on 2412 MHz and 2462 MHz and in particular the restricted bands between 2310 – 2390 MHz and between 2483.5 – 2500.0 MHz

- spurious emissions from the access point transmitter and in particular the harmonic emissions up to 10*Fc when operating on a high, middle and low channel

When making radiated emission measurements from the device the following general conditions were applied:

Radiated emission testing was carried out over the frequency range of 30 to 25,000 MHz.

Testing was carried out at the laboratory's open area test site - located at 670 Kawakawa - Orere Rd, RD5, Papakura, New Zealand.

This site conforms to the requirements of CISPR 16 and ANSI C63.4 - 2003.

Before testing was carried out, a receiver Self Test and Internal Calibration was undertaken along with a check of all connecting cables and programmed antenna factors.

The device was placed on the fibreglass test table that has a dielectric constant near 1 which is a total of 0.8 m above the test site ground plane.

Measurements of the radiated field were made with the antenna located at a 3 metre horizontal distance from the boundary of the digital devices under test.

Testing is carried out by initially scanning the device using a spectrum analyser to determine the frequencies of interest and then further investigating and measuring the frequencies of interest using a measuring receiver.

When an emission is located, it is positively identified and its maximum level is found by rotating the automated turntable, and by varying the antenna height with an automated antenna tower.

Below 1 GHz the emission the emission is measured in both vertical and horizontal antenna polarisations using a Quasi Peak detector with a bandwidth of 120 kHz.

Above 1 GHz the emission is measured in both vertical and horizontal antenna polarisations using a Peak and average detector with a bandwidth of 1 MHz.

During the test, a number of ambient emissions are identified (list of which can be provided upon request).

The emission level is determined in field strength by taking the following into consideration:

Level (dBμV/m) = Receiver Reading (dBμV) + Antenna Factor (dB/m) + Coax Loss (dB)

Pre testing of the device showed that while it can operate between 9 – 30 Vdc the level of emissions above 30 MHz did not vary.

Therefore all measurements were made using a 12 Vdc lead acid battery.

Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

Section 15.209 – General Radiated Emissions

Device was placed in the centre of the test table and was powered at 12 Vdc using a lead acid battery that was placed on test site ground plane.

Attached to the device were:

- A powered NEMA 2000 bus cable that was powered at 12 Vdc using a 2nd lead acid battery.
- dummy load to the VHF AIS transmitter and receiver
- GPS antenna to the GPS terminal which was placed to the left of the device under test.
- USB cable which was lead to a passive USB load that was approximately 5 metres from the device under test.

Device was placed upright with the display showing various targets.

A WiFi link was established with a laptop computer that was placed 10 metres from the device under test that was showing raw AIS and NMEA data (gibberish !).

Frequency MHz	Vertical dBµV/m	Horizontal dBµV/m	Limit dBµV/m	Margin dB	Antenna
33.600	24.5		40.0	15.5	Vertical
40.810	25.6		40.0	14.4	Vertical
44.545	28.5		40.0	11.5	Vertical
61.850	31.0		40.0	9.0	Vertical
63.500	31.8		40.0	8.2	Vertical
65.218	27.1		40.0	12.9	Vertical
72.190	17.6		40.0	22.4	Vertical
76.000	19.1		40.0	20.9	Vertical
99.940	25.1		40.0	14.9	Vertical
117.000	28.7	27.5	43.5	14.8	Vertical
124.136	37.2	32.5	43.5	6.3	Vertical
140.629	33.3		43.5	10.2	Vertical
148.962	33.1	35.2	43.5	8.3	Horizontal
156.000	17.1	21.2	43.5	22.3	Horizontal
157.500	17.2	21.5	43.5	22.0	Horizontal
159.000	18.3	21.9	43.5	21.6	Horizontal
160.496	17.1	21.5	43.5	22.0	Horizontal
162.000	17.0	21.2	43.5	22.3	Horizontal
163.500	17.0	21.2	43.5	22.3	Horizontal
173.793	31.8	33.5	43.5	10.0	Horizontal
192.000	25.1		43.5	18.4	Vertical
198.619	31.0		43.5	12.5	Vertical
223.450	28.1		46.0	17.9	Vertical
233.956	35.8	41.6	46.0	4.4	Horizontal
248.271	34.1	39.6	46.0	6.4	Horizontal
249.603	31.5		46.0	14.5	Vertical

General Radiated Emissions Continued:

Frequency MHz	Vertical dBµV/m	Horizontal dBµV/m	Limit dBµV/m	Margin dB	Antenna
261.815	41.9	45.2	46.0	0.8	Horizontal
279.000	25.2		46.0	20.8	Vertical
288.000	32.6	39.1	46.0	6.9	Horizontal
297.926	33.2	41.5	46.0	4.5	Horizontal
323.954	39.8	45.9	46.0	0.1	Horizontal
392.721	41.3	43.2	46.0	2.8	Horizontal
523.632	43.4	42.0	46.0	2.6	Vertical
654.539	44.9	45.6	46.0	0.4	Horizontal
785.433	38.7	42.1	46.0	3.9	Horizontal
971.854	38.1	36.7	46.0	7.9	Vertical

No further emissions were detected within 10 dB of the average limit when measurements were attempted between 1 – 2 GHz using a peak detector using both vertical and horizontal polarisations

Result: Complies.

Bandedge measurements

When the access point transmitter was transmitting on 2463 MHz no emissions were observed to be within 10 dB of the appropriate limit in the 2483.5 – 2500 MHz restricted band when measurements were attempted using either a peak or average detector with a resolution bandwidth of 1 MHz.

When the access point transmitter was transmitting on 2412 MHz no emissions were observed within 20 dB of the -20 dBc limit applied to spurious emissions that fall outside of the restricted bands when compared to the peak level at 2412 MHz when measured with a 100 kHz resolution bandwidth.

When the access point transmitter was transmitting on 2412 MHz no emissions were observed to be within 10 dB of the appropriate limit in the 2310 – 2390 MHz restricted band when measurements were attempted using either a peak or average detector with a resolution bandwidth of 1 MHz.

Result: Complies.

Transmitter Spurious Emissions:

Measurements were attempted at a distance of 3 metres using a peak and average detector with a 1 MHz bandwidth.

However at this distance no emissions were detected so measurements were then attempted at a distance of 50 cm with the same result.

The restricted band limits have been applied to un restricted band frequencies as all frequencies comply with the more stringent restricted band limits.

Low frequency: 2412 MHz

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin	Detector
4824.000	< 50.0	< 50.0	74.0	-	Peak
4824.000	< 45.0	< 45.0	54.0	-	Average
7236.000	< 50.0	< 50.0	74.0	-	Peak
7236.000	< 45.0	< 45.0	54.0	-	Average
9648.000	< 50.0	< 50.0	74.0	-	Peak
9648.000	< 45.0	< 45.0	54.0	-	Average
12060.000	< 50.0	< 50.0	74.0	-	Peak
12060.000	< 45.0	< 45.0	54.0	-	Average
14472.000	< 50.0	< 50.0	74.0	-	Peak
14472.000	< 45.0	< 45.0	54.0	-	Average
16884.000	< 50.0	< 50.0	74.0	-	Peak
16884.000	< 45.0	< 45.0	54.0	-	Average
19296.000	< 50.0	< 50.0	74.0	-	Peak
19296.000	< 45.0	< 45.0	54.0	-	Average
					Average
21708.000	< 50.0	< 50.0	74.0	-	Peak
21708.000	< 45.0	< 45.0	54.0	-	Average
24120.000	< 50.0	< 50.0	74.0	-	Peak
24120.000	< 45.0	< 45.0	54.0	-	Average

Low frequency: 2438 MHz

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin	Detector
4876.000	< 50.0	< 50.0	74.0	-	Peak
4876.000	< 45.0	< 45.0	54.0	-	Average
7314.000	< 50.0	< 50.0	74.0	-	Peak
7314.000	< 45.0	< 45.0	54.0	-	Average
9752.000	< 50.0	< 50.0	74.0	-	Peak
9752.000	< 45.0	< 45.0	54.0	-	Average
12190.000	< 50.0	< 50.0	74.0	-	Peak
12190.000	< 45.0	< 45.0	54.0	-	Average
14628.000	< 50.0	< 50.0	74.0	-	Peak
14628.000	< 45.0	< 45.0	54.0	-	Average
17066.000	< 50.0	< 50.0	74.0	-	Peak
17066.000	< 45.0	< 45.0	54.0	-	Average
19504.000	< 50.0	< 50.0	74.0	-	Peak
19504.000	< 45.0	< 45.0	54.0	-	Average
					Average
21942.000	< 50.0	< 50.0	74.0	-	Peak
21942.000	< 45.0	< 45.0	54.0	-	Average
24380.000	< 50.0	< 50.0	74.0	-	Peak
24380.000	< 45.0	< 45.0	54.0	-	Average

Low frequency: 2462 MHz

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin	Detector
4924.000	< 50.0	< 50.0	74.0	-	Peak
4924.000	< 45.0	< 45.0	54.0	-	Average
7386.000	< 50.0	< 50.0	74.0	-	Peak
7386.000	< 45.0	< 45.0	54.0	-	Average
9848.000	< 50.0	< 50.0	74.0	-	Peak
9848.000	< 45.0	< 45.0	54.0	-	Average
12310.000	< 50.0	< 50.0	74.0	-	Peak
12310.000	< 45.0	< 45.0	54.0	-	Average
14772.000	< 50.0	< 50.0	74.0	-	Peak
14772.000	< 45.0	< 45.0	54.0	-	Average
17234.000	< 50.0	< 50.0	74.0	-	Peak
17234.000	< 45.0	< 45.0	54.0	-	Average
19696.000	< 50.0	< 50.0	74.0	-	Peak
19696.000	< 45.0	< 45.0	54.0	-	Average
					Average
22158.000	< 50.0	< 50.0	74.0	-	Peak
22158.000	< 45.0	< 45.0	54.0	-	Average
24620.000	< 50.0	< 50.0	74.0	-	Peak
24620.000	< 45.0	< 45.0	54.0	-	Average

Result: Complies

Section 15.247(e) – Power Spectral Density

As this device has an integral pcb mounted antenna it was not possible to make conducted spurious emission measurements at the output of the transmitter.

Therefore radiated emission measurements were made at the test site that have been converted to conducted power measurements using the calculated antenna gain.

Initial measurements were made using a 1 MHz resolution bandwidth in order to determine the maximum emissions level from the device.

At this maximised point the resolution bandwidth of the spectrum analyser was reduced to 3 kHz and a field strength was determined in dBuV/m.

The radiated power level in dBm was determined by formula from the field strength using the formula Field strength (V/m) = (square root of (30 x transmitter power (watts))) / distance (metres).

Measurements were made using both vertical and horizontal polarisations.

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Antenna Gain (dB)	Conducted Power (dBm)	Limit (dBm)	Polarisation
2411.8898	88.2	-9.2	1.2	-10.2	8.0	Horizontal
2412.4900	83.2	-14.2	1.2	-15.4	8.0	Vertical
2462.4870	89.3	-8.1	1.2	-9.3	8.0	Horizontal
2461.4860	83.9	-13.5	1.2	-14.7	8.0	Vertical
2436.4907	84.4	-13.0	1.2	-14.2	8.0	Horizontal
2436.4925	83.8	-13.6	1.2	-14.8	8.0	Vertical

Result: Complies

Section 15.247(i) – Radio Frequency Hazard Information

As per Section 15.247 (b) (4) spread spectrum transmitters operating in the 2400 – 2483.5 MHz band are required to be operated in a manner that ensures that the public is not exposed to RF energy levels in accordance with CFR 47, Section 1.1307(b)(1).

The device when in operation is fixed and a safe distance could be maintained when events are undertaken.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of 1 mW/cm^2 has been applied.

The maximum distance from the antenna at which the MPE is met or exceeded is calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain and separation distance in metres:

E, V/m = (√(30 * P * G)) / d
Power density, mW/cm2 = E2/3770
E for MPE: 1 = E2/3770
E = √ 1*3770
E = 61.4 V/m

The highest radiated power has been measured to be 16.9 dBm or 0.0489 watts EiRP when operating on 2462 MHz.

Therefore:
E = √ (30 * P * G) / d
d = √ (30 * P * G) / E
d = √ (30 * 0.0489) / 61.4
d = 0.0197 m or 2 cm

Result: Complies

Wireless Access Point transmitter complies if a minimum safe distance of 20 cm is specified in the set up instructions for this system.

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	Not applic
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	Not applic
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	Not applic
Receiver	R & S	ESIB 40	100171	R-27-1	21 Oct 2012
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	7 Feb 2013
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	7 Feb 2013
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	7 Feb 2013
Horn Antenna	EMCO	3115	9511-4629	E1526	10 May 2013
Horn Antenna	EMCO	3116	92035	-	10 May 2013

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies Ltd registration with the Federal Communications Commission as a listed facility, registration number: 90838, which was updated on 15 February, 2011.

All testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025, 2005.

All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025, 2005.

International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

9. PHOTOGRAPHS

Radiated emissions test set ups.