Report On

RF Exposure Assessment of the
True Heading AB
True Heading/Seapilot Graphene, Graphene+ Marine AIS CSTDMA Class B transponder

FCC ID: 2AC79-GRAPHENE174
IC: 9502a-GRAPHENE174

Document 75928833 Report 03 Issue 2 October 2015

TÜV SÜD Product Service, Octagon House, Concorde Way, Segensworth North,
Fareham, Hampshire, United Kingdom, PO15 5RL
Tel: +44 (0) 1489 558100. Website: www.tuv-sud.co.uk

REPORT ON

RF Exposure Assessment of the
True Heading AB
True Heading/Seapilot Graphene, Graphene+ Marine AIS CSTDMA Class B transponder

Document 75928833 Report 03 Issue 2

October 2015

PREPARED FOR

True Heading AB
Vendevagen 90
182 32 Danderyd
SWEDEN

PREPARED BY

Sarah Jones
Senior Engineer (Projects)

APPROVED BY

Nic Forsyth
Authorised Signatory

DATED 05 October 2015

This report has been revised to issue 2 to correct the FCC ID.

Product Service

CONTENTS

Product Service

SECTION 1

REPORT SUMMARY

RF Exposure Assessment of the
True Heading AB
True Heading/Seapilot Graphene, Graphene+ Marine AIS CSTDMA Class B transponder

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the RF Exposure Assessment of the True Heading AB True Heading/Seapilot Graphene, Graphene+ Marine AIS CSTDMA Class B transponder to the requirements of the applied test specifications.

Objective	To perform RF Exposure Assessment to determine the Equipment Under Test's (EUT's) compliance of the applied rules.
Applicant	True Heading AB
Manufacturer	True Heading AB
Manufacturing Description	Marine AIS CSTDMA Class B transponder
Model Number(s)	True Heading/Seapilot Graphene, Graphene+
Test Specification/Issue/Date	Council Recommendation 1999/519/EC CFR 47 Pt1.1310 Health Canada Safety Code 6 ARPANSA Radiation Protection Series No.3

1.2 REGIONAL REQUIREMENTS

The table below shows the regional requirements that are referenced in this test report. A full list of the requirements is shown in Annex A.

Report Reference	Regional Requirement
EU	Council Recommendation 1999/519/EC
FCC	CFR 47 Pt1.1310
IC	Health Canada Safety Code 6
AUS	ARPANSA Radiation Protection Series No.3

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment under test was a True Heading AB True Heading/Seapilot Graphene, Graphene+ Marine AIS CSTDMA Class B transponder. A full technical description can be found in the manufacturer's documentation.

All reported calculations were carried out on the relevant information supplied for the True Heading/Seapilot Graphene, Graphene+ Marine AIS CSTDMA Class B transponder to demonstrate compliance with the applied test specification(s) the sample assessed was found to comply with the requirements of the applied rules.

1.3.2 Supported Features

The following radio access technologies and frequency bands are supported by the equipment under test.

Radio Access Technology	AIS
	WLAN
Frequency Band	156-162
	2412-2480

1.3.3 Antennas

The following antennas are supported by the equipment under test.

No.	Model	Gain (dBi)
1	AIS	2.15
2	WLAN	2.15

1.4 BRIEF SUMMARY OF RESULTS

The wireless device described within this report has been shown to be capable of compliance with the basic restrictions related to human exposure to electromagnetic fields for both General public and Occupational. The calculations shown in this report were made in accordance the procedures specified in the applied test specification(s).

Required Compliance Boundary (m)	
Occupational	General Population
0.13	0.27

Table 1 – Compliance Boundary Results

The tables below show the summed fractional results from the antenna port summary in section 2.2. Where the result is less than one, the EUT is deemded compliant.

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.13 m as a Fraction of the Limit		
	S Field	E Field	H Field
ICNIRP	0.7582	0.9110	0.9100
FCC	0.7582	0.8701	0.8693
RSS	0.7582	0.9256	0.9045
ARPANSA	0.7582	0.9053	0.9045

Table 2 – Occupational Results

The calculations show that the EUT complies with the occupational exposure levels described in the Council Recommendation 1999/519/EC, CFR 47 Pt1.1310, Health Canada Safety Code 6 and ARPANSA Radiation Protection Series No.3 at the point of investigation, 0.13 m.

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.27 m as a Fraction of the Limit		
	S Field	E Field	H Field
ICNIRP	0.8789	0.9907	0.9990
FCC	0.8789	0.9353	0.9346
RSS	0.8789	0.9565	0.9724
ARPANSA	0.8789	0.9766	0.9737

Table 3 – General Population Results

The calculations show that the EUT complies with the general population exposure levels described in the Council Recommendation 1999/519/EC, CFR 47 Pt1.1310, Health Canada Safety Code 6 and ARPANSA Radiation Protection Series No.3 at the point of investigation, 0.27 m.

SECTION 2

TEST DETAILS

2.1 RATIONALE FOR ASSESSMENT OF THE RF EXPOSURE

The aim of the assessment report is to evaluate the compliance boundary for a set of given input power(s) according to the basic restrictions (directly or indirectly via compliance with reference levels) related to human exposure to radio frequency electromagnetic fields.
The chosen assessment method to establish the compliance boundary in the far-field region is the reference method as defined in the relevant specifications.

The RF exposure assessment is based upon the following criteria:

The True Heading/Seapilot Graphene, Graphene+ Marine AIS CSTDMA Class B transponder operates with the following transmitters active on the antenna ports shown in table 1. For each transmitter, the Radio Access Technology (RAT), EIRP inclusive of antenna gain and duty cycle, gain of the antenna and lowest frequency of operation are shown as they contribute to the calculation of S Field, E field and H field values according to the following formulas.

The power flux (S Field):

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$

The electric field strength (E Field):

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$

The magnetic field strength (H Field):

$$H = \frac{E}{\eta_o}$$

Where:

P = Average Power (W)
G = Antenna Gain (dBi)
r = Distance (cm) or (m)
η_o = 377

2.2 TEST RESULT DETAILS

The frequencies shown in the tables below have been chosen based on the lowest possible frequency that the EUT can transmit.

Antenna Port	Tx No.	Ant No.	RAT	EIRP (W)	Duty Cycle (%)	Gain (dBi)	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.13 m		
								S Field	E Field	H Field
1	1	1	AIS	1.608	49	2.15	156.025	7.5701	53.4214	0.1417
2	1	2	WLAN	0.013	50	2.15	2412	0.0618	4.8262	0.0128

Table 4 – Occupational Transmitter Summary

Antenna Port	Tx No.	Ant No.	RAT	EIRP (W)	Duty Cycle (%)	Gain (dBi)	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.27 m		
								S Field	E Field	H Field
1	1	1	AIS	1.608	49	2.15	156.025	1.7549	25.7214	0.0682
2	1	2	WLAN	0.013	50	2.15	2412	0.0143	2.3237	0.0062

Table 5 – General Population Transmitter Summary

The following tables show the regional requirements for the frequencies used in the RF exposure calculation. A full list of the requirements is shown in Annex A.

Frequency (MHz)	Occupational Limit			General Population Limit		
	S Field (W/m^2)	E Field (V/m)	H Field (A/m)	S Field (W/m^2)	E Field (V/m)	H Field (A/m)
156.025	10.0000	61.0000	0.1620	2.0000	27.0000	0.0710
2412	50.0000	137.0000	0.3630	10.0000	61.0000	0.1620

Table 6 – Council Recommendation 1999/519/EC Limits

Frequency (MHz)	Occupational Limit			General Population Limit		
	S Field (mW/cm^2)	E Field (V/m)	H Field (A/m)	S Field (mW/cm^2)	E Field (V/m)	H Field (A/m)
156.025	1.0000	61.4000	0.1630	0.2000	27.5000	0.0730
2412	5.0000	-	-	1.0000	-	-

Table 7 – CFR 47 Pt1.1310 Limits

Frequency (MHz)	Occupational Limit			General Population Limit		
	S Field (W/m^2)	E Field (V/m)	H Field (A/m)	S Field (W/m^2)	E Field (V/m)	H Field (A/m)
156.025	10.0000	60.0000	0.1630	2.0000	28.0000	0.0730
2412	50.0000	137.0000	0.3640	10.0000	61.4000	0.1630

Table 8 – Health Canada Safety Code 6 Limits

Frequency (MHz)	Occupational Limit			General Population Limit		
	S Field (W/m^2)	E Field (V/m)	H Field (A/m)	S Field (W/m^2)	E Field (V/m)	H Field (A/m)
156.025	10.0000	61.4000	0.1630	2.0000	27.4000	0.0729
2412	50.0000	137.0000	0.3640	10.0000	61.4000	0.1630

Table 9 – ARPANSA Radiation Protection Series No.3 Limits

As the frequency of operation for each transmitter is not the same, in order to evaluate compliance with the limit which is dependent on frequency, the calculated RF exposure fields are divided by the limit to get a fractional exposure value. Any values less than one are compliant with the limit. Table 2 shows a summary of each antenna port and the summation of the fractional RF exposure results of each transmitter.

Antenna Port	EIRP (W)	Regional Requirement	Calculated RF exposure level at compliance boundary of 0.13 m as a Fraction of the Limit		
			S Field	E Field	H Field
1	1.608	EU	0.7570	0.8758	0.8747
		FCC	0.7570	0.8701	0.8693
		IC	0.7570	0.8904	0.8693
		AUS	0.7570	0.8701	0.8693
2	0.013	EU	0.0012	0.0352	0.0353
		FCC	0.0012	N/A	N/A
		IC	0.0012	0.0352	0.0352
		AUS	0.0012	0.0352	0.0352

Table 10 – Occupational Antenna Port Summary

Antenna Port	EIRP (W)	Regional Requirement	Calculated RF exposure level at compliance boundary of 0.27 m as a Fraction of the Limit		
			S Field	E Field	H Field
1	1.608	EU	0.8775	0.9526	0.9609
		FCC	0.8775	0.9353	0.9346
		IC	0.8775	0.9186	0.9346
		AUS	0.8775	0.9387	0.9359
2	0.013	EU	0.0014	0.0381	0.0380
		FCC	0.0014	N/A	N/A
		IC	0.0014	0.0378	0.0378
		AUS	0.0014	0.0378	0.0378

Table 11 – General Population Antenna Port Summary

SECTION 3

DISCLAIMERS AND COPYRIGHT

3.1 DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.

ANNEX A

REGIONAL REQUIREMENTS

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.065 - 1	-	610/f	1.6/f
1 - 10	-	610/f	1.6/f
10 - 400	10	61	0.162
400 - 2000	f/40	3*f^0.5	0.00796*f^0.5
2000 - 300000	50	137	0.363

Table A.1 – Council Recommendation 1999/519/EC Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.003 - 0.15	-	87	5
0.15 - 1	-	87/f	0.73/f
1 - 10	-	87/f^0.5	0.73/f
10 - 400	2	27	0.071
400 - 2000	f/200	1.375*f^0.5	0.00364*f^0.5
2000 - 300000	10	61	0.162

Table A.2 – Council Recommendation 1999/519/EC General Population Limits

Frequency Range (MHz)	S Field (mW/cm^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	900/f^2	1842/f	4.89/f
30 - 300	1	61.4	0.163
300 - 1500	f/300	-	-
1500 - 100000	5	-	-

Table A.3 – CFR 47 Pt1.1310 Occupational Limits

Frequency Range (MHz)	S Field (mW/cm^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	180/f^2	824/f	2.19/f
30 - 300	0.2	27.5	0.073
300 - 1500	f/1500	-	-
1500 - 100000	1	-	-

Table A.4 – CFR 47 Pt1.1310 General Population Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.003 - 1	-	600	4.9
1 - 10	-	600/f	4.9/f
10 - 30	-	60	4.9/f
30 - 300	10	60	0.163
300 - 1500	f/30	3.54*f^0.5	0.0094*f^0.5
1500 - 150000	50	137	0.364

Table A.5 – Health Canada Safety Code 6 Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.003 - 1	-	280	2.19
1 - 10	-	280/f	2.19/f
10 - 30	-	28	2.19/f
30 - 300	2	28	0.073
300 - 1500	f/150	1.585*f^0.5	0.0042*f^0.5
1500 - 150000	10	61.4	0.163

Table A.6 – Health Canada Safety Code 6 General Population Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.1 - 1	-	614	1.63/f
1 - 10	1000/f^2	614	1.63/f
10 - 400	10	61.4	0.163
400 - 2000	f/40	3.07*f^0.5	0.00814*f^0.5
2000 - 300000	50	137	0.364

Table A.7 – ARPANSA Radiation Protection Series No.3 Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.1 - 0.15	-	86.8	4.86
0.15 - 1	-	86.8	0.729/f
1 - 10	-	86.8/f^0.5	0.729/f
10 - 400	2	27.4	0.0729
400 - 2000	f/200	1.37*f^0.5	0.00364*f^0.5
2000 - 300000	10	61.4	0.163

Table A.8 – ARPANSA Radiation Protection Series No.3 General Population Limits