Exposure Calculation Report

Ocean Signal Ltd.
AIS SART Model: S200
Brand Variant: ACR Electronics Inc.
AIS SART, Model: Pathfinder AIS

In accordance with EN 60945

Prepared for: Ocean Signal Ltd.
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EXECUTIVE SUMMARY
The calculation of exposure for this product was found to be compliant at a minimum distance of 47cm with EN 60945 assuming continuous exposure of 6 minutes or more. If alternative antennas are used with greater gains, the distance must be recalculated.

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	15-Sept-2025

Table 1

1.2 Introduction

Applicant	Ocean Signal Ltd.
Manufacturer	Ocean Signal Ltd. / ACR Electronics Inc
Model Number(s)	S200 / Pathfinder AIS *
Hardware Version(s)	01.00 / 01.00
Software Version(s)	01.00 / 01.00
Specification/Issue/Date	EN 60945:2002 Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results
Order Number Date	P8980 - QAF 14-September-2023
Related Document(s)	EN 62311: 2008 Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)

*Manufacturer declared variants: Refer to documents “Variant Relation Declaration - AIS SART Model Variants 300625.pdf” and “921S-06454 Issue 01.00 AIS SART Variant Comparison.pdf”.

1.3 Brief Summary of Results

The wireless device described within this report was compliant with the restrictions related to human exposure to electromagnetic fields for both general public and worker/occupational exposures at the minimum compliance distances calculated.

The calculations shown in this report were made in accordance with the procedures specified in the applied test specification(s).

1.3.1 Compliance Boundary

EN 60945 Requirement	Configuration	Calculated minimum compliance boundary (m) (rounded up to nearest 0.01 m) Note 1	
		Worker/Occupational	General Public
EN 60945	162 MHz transmitter operating	0.47 m	0.47 m

Table 2 – Compliance Boundary Calculation Results

Note 1: The calculated minimum compliance boundary was less than the values stated, however the minimum valid distance that can be calculated by the method described in Section 2.1 is beyond the reactive near field boundary of 0.4630 m stated in Section 2.33, therefore a minimum compliance boundary of 0.4630 m is required. A description of antenna field regions is given in EN 62311:2008. Compliance boundaries in the region between 0.2 m and the reactive near field boundary, i.e. 0.2 m to 0.4630 m in this case, can be established by test of the electric and magnetic field strength. Compliance boundaries in the region up to 0.2 m can be established by SAR (specific absorption rate) test.

1.4 Product Information

1.4.1 Technical Description

The Equipment under test (EUT) was an Ocean Signal's S200 AIS (Automatic Identification System) SART (Search and Rescue Transponder).

The primary function of the EUT is to provide location data in emergencies.

1.4.2 Transmitter Description

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

Radio Access Technology	Frequency Band (MHz)	Minimum Frequency (MHz)	Output Power (dBm)	Duty Cycle (%)
AIS	161.975-162.025	161.975	33.0	0.36

Table 3 - Transmitter Description

Note: Transmitter power includes upper bounds of uncertainty therefore maximum values are used in accordance with Section 2.44.

1.4.3 Antenna Description

The following antennas are supported by the equipment under test.

Radio Access Technology	Antenna Model/Description	Gain (dBi)	Antenna length (cm)
AIS	136S-04819: S200 Antenna (Helical)	-3.2	9.32

Table 4 - Antenna description

In the case of more than one type of antenna being supported by the equipment, the calculation is based on the maximum of the antenna gains. If other antennas can be used that have greater gains, the minimum separation distances will need to be recalculated.

Note: Antenna gain includes upper bounds of uncertainty therefore maximum values are used in accordance with Section 2.44.

1.4.4 Equipment Configuration

The device supports the following modes:-

162 MHz transmitter operating.

2 Assessment Details

2.1 Assessment Method

The assessment method is by calculation of the power density S, electric field strength E, magnetic field strength H or magnetic flux density B.

The calculation uses the spherical model applicable under far field conditions and also radiating near field conditions where applicable (see Section 2.3).

$$\boldsymbol{S = E \times H = \frac{E^2}{\eta} = H^2 \times \eta = \frac{P \times G_i}{4 \times \pi \times r^2}}$$

Where:
η - Impedance of free space (377 ohm in far field)
P - Average transmitter power W (P_{av} = P_{max} x Duty Cycle)
G_i - Antenna gain ratio relative to isotropic
r - Separation distance m

The magnetic flux density is related to the magnetic field strength by a constant:

$$\boldsymbol{B = \mu_o \times H}$$

Where:
μ_o Permeability of free space 4 x π E-7 H/m

This assessment assumes that exposure is continuous for 6 minutes or more in accordance with the averaging time required by the exposure standards at the stated minimum compliance boundary separation distance. Exposures of less than 6 minutes at other separation distances are not addressed by this report.

This assessment method of RF exposure is applicable to separation distances of 20 cm or more beyond the reactive near field boundary. Separation distances of less than 20 cm require a Specific Absorption Rate (SAR) assessment.

The reactive near field boundary and far field region boundary depend on the frequency and wavelength and also on the antenna dimension. The boundaries of the field regions are calculated in Section 2.3 to demonstrate the validity of using the spherical model.

The result is compared to the limits in Annex A to determine compliance or to calculate the required compliance distance. The calculation is based on the lowest frequency in each band as the most onerous requirement as the limits increase with frequency for frequencies above 10-50 MHz (dependent on region).

2.2 Individual Antenna Port Exposure Results

2.2.1 Calculation of Compliance Distance

The frequencies shown in the tables below have been chosen based on the frequency that the EUT can transmit. A full list of the regional requirements is shown in Annex A.

Region	Radio Access Technology	Frequency (MHz)	Minimum Calculated Compliance Boundary (m) at Limit for:			
			S Power Density	E Field	H Field	B Field
EN 60945	AIS	161.975	0.00166	N/A	N/A	N/A

Table 5 - Occupational Individual Transmitter Result

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.00166 m, however the minimum valid distance that can be calculated is beyond the reactive near field boundary of 0.4630 m stated in Section 2.4, therefore a minimum compliance boundary of 0.4630 m is required.

Region	Radio Access Technology	Frequency (MHz)	Minimum Calculated Compliance Boundary (m) at Limit for:			
			S Power Density	E Field	H Field	B Field
EN 60945	AIS	161.975	0.00524	N/A	N/A	N/A

Table 6 - General Public Individual Transmitter Result

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.00524 m, however the minimum valid distance that can be calculated is beyond the reactive near field boundary of 0.4630 m stated in Section 2.4, therefore a minimum compliance boundary of 0.4630 m is required.

2.3 Far Field Region Boundary Results

The far field region boundary calculation result is shown in Table 77:

Near Field / Far Field Boundary (Ref: EN 62311:2008)			
Radio Access Technology	Frequency MHz	Reactive Near Field Boundary (Wave Impedance Dependent)	Radiating Near Field Boundary (Antennas on axis)
		λ/4 (m)	$2D^2/\lambda$ (m)
AIS	161.975	0.4630	0.0094

Table 7 - Far Field Boundary

The table below shows the maximum calculated near field / far field region boundaries.

The compliance boundary of 0.463 m is in the far field region and therefore, the approach described in section 2.1 is valid.

Field Region	Reactive Near Field Region	Radiating Near Field Region	Far Field Region $\lambda/4 < r \leq 2D^2/\lambda$ (m)
Maximum Boundary	< 0.4630 m	N/A	> 0.4630 m
Validity of Regions	Spherical model potential under-estimate: SAR / test assessment required	Spherical model over-estimate and conservative	Spherical model valid
Compliance Boundary Location	N/A	N/A	0.4630 m

Table 8 - Assessment Method Validity

2.4 Uncertainty

The basic computation formulas presented in section 2.1 are conservative formulas for the estimation of RF field strength or power density.

No uncertainty estimations are required when using these formulas but there is clear guidance on where and when these formulas are applicable. For the estimate of S, E or H to be conservative, the transmitter power P and antenna gain G_i values shall be the upper bounds of uncertainty therefore maximum values are used.

The spherical formula is valid under far field conditions which are established in section 2.3.

ANNEX A

REGIONAL REQUIREMENTS

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m) (Converted from µT)	Magnetic Flux Density (µT)
All	100	N/A	N/A	N/A

Table A.1 – IEC/EN 60945 Worker/Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m) (Converted from µT)	Magnetic Flux Density (µT)
All	10	N/A	N/A	N/A

Table A.2 – IEC/EN 60945 General Public Limits