- TD 262b OPERATING MANUAL
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OPERATING MANUAL SEAGUARD® RCM

AANDERAA

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Table of Contents

INTRODUCTION

Purpose and scope

This Operating Manual describes the SeaGuard Instrument as a Recording Current Meter (RCM). The manual contains some theory about the ZPulse^{TM} DCS and some operating instructions. For general configuration and use of the SeaGuard Platform, refer TD 262a.

SeaGuard is the latest of our oceanographic instruments. It can be used both in the sea and in fresh water. 3 versions are available: S SeaGuard Shallow Water (SW) with depth rating of 300m, SeaGuard Intermediate Water (IW) with a depth rating of 2000m, and finally the 6000m depth version (DW).

The SeaGuard instrument consists of a platform with sensors attached to it. When used as a Recording Current Meter, the Z-pulse Doppler Current Sensor (DCS) is a standard sensor. All other sensors are optional. Sensors for the SeaGuard instrument are all smart sensors; the sensors are automatically detected and recognized by the platform at instrument power up. The SeaGuard RCM adds a correct configuration dialog for each attached sensor.

The most common ways of deploying the instrument is in an ordinary string mooring, in a bottom frame, or mounted under a buoy.

SeaGuard is a self-recording instrument; data is stored on a Secure Digital card, SD card, for later post-processing and analysis.

Document Overview

Applicable Documents

TD262a	Operating Manual SeaGuard Platform
D366	SeaGuard Platform Data Sheet
B150	SeaGuard Concept Brochure
TN301	SeaGuard Quick Start
FORM135	Instrument Service Order

SEAGUARD® RCM

SeaGuard RCM without its pressure case.

SeaGuard RCM with pressure case

Figure I - 1 SeaGuard RCM Shallow Water with ZPulse DCS and optional sensors on top

SEAGUARD® RCM Sensors

All SeaGuard RCM sensors are equipped with CANbus/AiCaP output. ZPulse DCS is standard sensor on the SeaGuard RCM. The ZPulse DCS comes in two versions 4420/4520 (SW/DW). Optional sensors are Turbidity Sensor 4296 (SW, IW and DW), Pressure Sensor 4117, Temperature Sensor 4060 and Conductivity Sensor 4319. An Oxygen Sensor is under development. Please refer each sensors data sheet for further details.

Note! SR10 sensors can not be used together with the SeaGuard RCM.

Figure I - 2 Sensors from the left: Turbidity Sensor, Pressure Sensor, Temperature Sensor and Conductivity Sensor. ZPulse DCS in background.

CHAPTER 1 Short Description

Description

The SeaGuard Recording Current Meter is a self recording current meter intended to be moored to measure and record the vector averaged speed and direction of ocean currents. The instrument also records Tilt, Heading, Ping count, Single Ping Standard Deviation and Signal Strength.

The SeaGuard RCM is a self recording instrument with storage on a small SD card. SD cards have large storage capacity; the SeaGuard standard card is 512 MB. Storage capacity is therefore no problem.

The ZPulse DCS (Doppler Current Sensor) is standard sensor on the SeaGuard RCM. Pressure-, Temperature-, Turbidity- and Conductivity Sensors are optional sensors. An Oxygen Optode is under development.

The ZPulse DCS is based on the Doppler Shift principle.

To minimize the effect of marine fouling and local turbulence, the ZPulse DCS is measuring the horizontal current at least 0.4 meter away from the instrument, refer Figure 1-1.

The measurements are compensated for instrument tilt and referred to magnetic North by using an internal solid state compass. A microprocessor computes vector averaged speed and direction over the last sampling interval.

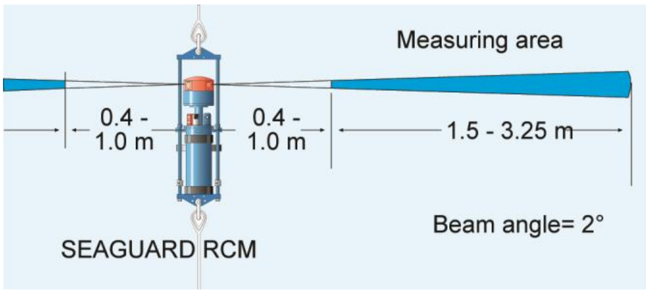


Figure 1-1Measuring area of the SeaGuard RCM.

Short Introduction to the ZPulse DCS Technology

Four transducers transmit short pulses (Pings) of acoustic energy along narrow beams. The same transducers receive backscattered signals from scatteres that are present in the beams, which are used for calculation of the current speed and direction.

Complex acoustic pulses comprising several distinct frequencies are combined into a single acoustic pulse which is sent out in two orthogonal directions at regular time intervals. The ZPulse based DCS separates the received signal into different frequency bands, one for each frequency in the transmitted signal. Further it analyses the frequency shift using a high speed Digital Signal Processor. An ARMA based parametric model processing algorithm is used to find the Doppler frequency.

The ZPulse technology reduces statistical variance with a factor of $\sqrt{2}$. This again reduces the required number of Pings needed in order to achieve an acceptable statistical error.

CHAPTER 2 Preparing for Deployment

The SeaGuard menu system holds the key entries for the configuration and use of the instrument. Tapping the *Menu* button in the lower left corner of the LCD display activates the main menu. Choose *System Configuration* to enable/disable individual node parameters. Choose *Recorder* to set the Timing method needed for the ZPulse DCS.

Note!

This chapter describes only SeaGuard RCM specific system configuration and recorder options. Refer TD262a for a thorough description of configuring the instrument.

Some sensors are rated down to 300m and 2000m. Make sure your sensors are rated for the operating depth that you require.

Configuration of the ZPulse DCS

Open the *System Configuration* from the *Menu* button. Select the *ZPulse DCS* from the list of instrument sensors, and tap *Configure* in the lower part of the window.

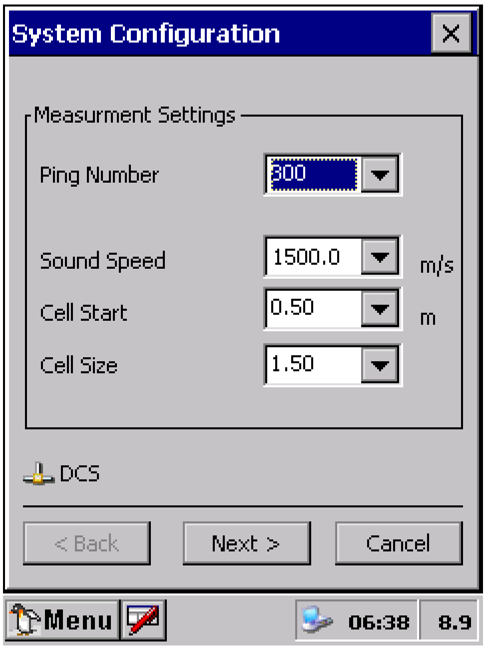


Figure 2-1Deployment Settings; set the Sound Speed, Cell Start and Cell size.

Select the desired *Ping Number* from the drop-down menu. 300 Pings are recommended for most applications, and set as default. Refer page 10 for considerations regarding the *number of Pings* in a deployment.

Set the *Speed of Sound*; choose from the drop-down menu, or type the exact sound speed, suitable for your deployment (values between 1400 and 1600 m/s).

Standard values for the *Speed of Sound*:

- Freshwater: 1473.0 m/s.
- Brackish water: 1500.0 m/s.
- Seawater: 1525.0 m/s.

Note! The Instrument does not calculate the speed of sound based on parameter measurements.

Cell Start is the distance from the instrument to the first cell, refer Figure 1-1. Choose from the drop-down menu or set an optional value between 0.4 and 1.0 meter.

Cell Size is the measurement area, refer Figure 1-1. Choose a value between 1.5 and 2.5 m.

Tap *Next* to store your Measurement settings and continue with the *Operation Settings*, refer Figure 2-2.

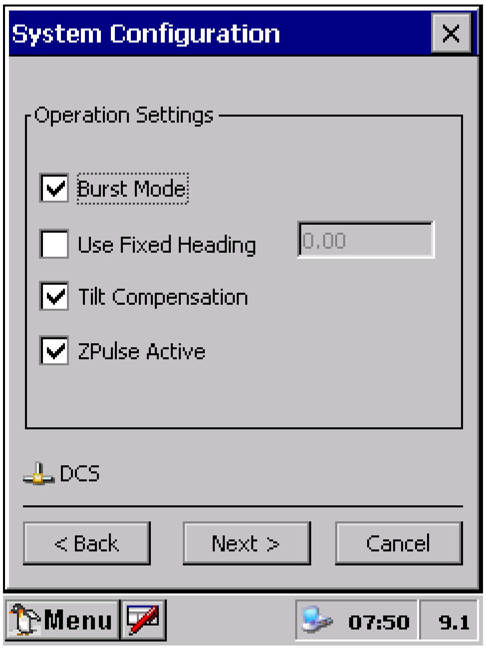


Figure 2-2 Operation Settings.

Operation Settings holds several options:

If you select *Burst Mode,* the Pings are distributed during the last minute of the recording interval. The instrument activates sleep mode between each measurement, which reduces the power consumption relative to no sleep operation. If the recording interval is set to less than one minute, the burst mode is automatically deactivated and the Pings are evenly spread out during the recording interval.

Use Fixed Heading if the instrument is deployed e.g. in a fixed bottom frame mooring in highly magnetic areas. The compass heading is then not used for calculations. In this case the instrument's position should be known (in relation to magnetic north). If the Fixed Heading is set to e.g. 45, transducer 1 must be placed 45º in relation to magnetic north in the clockwise direction. If the Fixed Heading is set to 0, transducer 1 must point towards the magnetic north.

If you select *Tilt Compensation* the horizontal current speed will be calculated based on the measured current speed and the tilt angle. In the calculating procedure it is assumed that the vertical current speed is zero. The instrument measures tilt values outside the compensation range. Refer Appendix 1 for Tilt range.

If Tilt Compensation is not selected the instrument will provide the measured current speed (not the horizontal current speed). We highly recommend that you select Tilt Compensation of your measurements.

ZPulse Active; Activates the ZPulse DCS algorithm, refer page 7. If not selected, the DCS will transmit single frequency pulses/Pings.

Tap *Next* to store the Operational Settings and continue with the *Transducer Activation*, refer Figure 2-3, or *Cancel* to abort.

Select active transducers

In the *Transducer Activation* you can select which transducers are going to Ping.

Note!

The ZPulse DCS transmits pulses in two orthogonal directions simultaneously in time; one along the X-axis, and one along the Y-axis, refer Figure 2-3.

The instrument does not consume less power depending on your choice of active transducers.

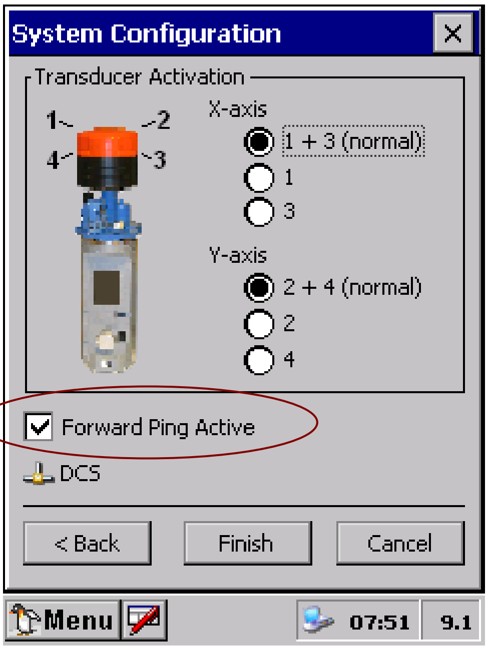


Figure 2-3 Transducer Activation.

Forward Ping Active inactivates the transducers in the downstream direction (direct current) to avoid poor measurements due to e.g. local turbulence in front of the transducers.

Note! If you select to activate only single transducers along one or both axis the Forward Ping Active setting does not inactivate these transducers.

Examples with Forward Ping Active selected:

1. Select transducer *1 + 3 (normal)* along the X-axis and transducers *2 + 4 (normal)* along the Y-axis: The instrument will periodically inactivate one transducer along each axis depending on the current direction. We recommend this configuration for deployments without fixed objects near the instrument, refer chapter *Beam Clearance* on page 12.
2. Select transducer *1* along the X-axis and transducers *2 + 4 (normal)* along the Y-axis: Transducer 1 will stay continuously active for the deployment time, while the instrument will periodically inactivate either transducer 2 or 4 depending on the current direction. We recommend you to select single transducers for one or both axis if your deployment is near fixed installations, refer chapter *Beam Clearance* on page 12.

Example without Forward Ping selected:

1. Select transducer *1 + 3 (normal)* along the X-axis and transducers *2 + 4 (normal)* along the Y-axis: The instrument will transmit/receive on transducers 1 and 2 simultaneously, next on transducers 3 and 4, and continue transmitting/receiving from these pairs every other time for the entire deployment.
2. Select transducer *1 + 3 (normal)* along the X-axis and single transducer *2* along the Y-axis: The instrument will transmit/receive on transducer 1 and 2 simultaneously, next on transducers 3 and 2, and continue transmitting/receiving from these pairs every other time for the entire deployment.

Tap *Finish* to store your settings, or *Cance*l to abort.

Ping Setting

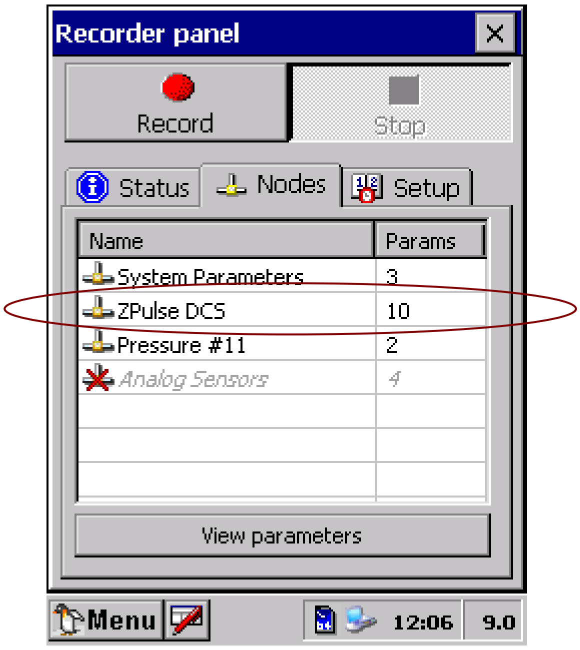
The ZPulse DCS sends out a selected number of Pings (600, 300, 150, 100, 75 or 50 Pings) during each recording interval. The default Ping setting from the factory is 300p e.g. 300 Pings per interval. The active transducer on both the X- and Y- axis (refer Figure 2-3) transmits the selected number of Pings.

Fewer Pings per recording interval reduce the battery consumption; hence the instrument can be deployed for a longer time.

You can achieve a shorter recording interval by reducing the number of Pings in the deployment.

Note! The standard deviation of the measurements will increase as the number of Pings is reduced.

ZPulse DCS Measurement Parameters



The ZPulse DCS provides 10 measurement parameters. These parameters are:

- Absolute Current Speed [cm/s]
- Current Direction [Deg.M]
- North Component of the Current Speed [cm/s]
- East Component of the Current Speed [cm/s]
- Instrument Heading [Deg.M]
- Instrument Tilt in X Direction [Deg]
- Instrument Tilt in Y Direction [Deg]
- Single Ping Standard Deviation [cm/s]
- Signal Strength [dB]
- Ping Count

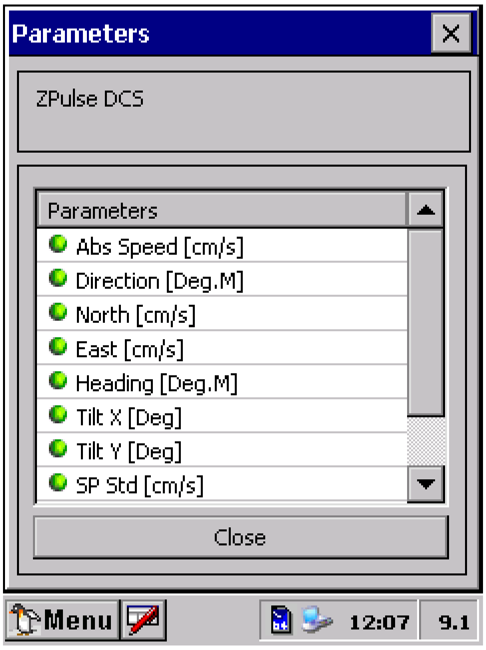


Figure 2-5 ZPulse DCS Parameters.

CHAPTER 3 Deployments

IMPORTANT! Ensure that the protective cap is fitted to the electronic terminal.

Beam Clearance

IMPORTANT!

The instrument should not be installed closer to the surface than 0.75 m and not closer to the bottom than 0.5 m to avoid reflections from the surface and the bottom.

Make sure that no mooring- or mounting parts are covering the Doppler Current Sensor and the optional Turbidity Sensor as these sensors must have line of sight to their measurement volumes.

Note!

To avoid poor measurements the instrument should not be placed nearer any object than: Cellstart + 2 × Cell size in the horizontal direction.

If you deploy the instrument near a fixed object (e.g. a quay) we recommend that you inactivate the transducers that will transmit in the objects direction.

Compass Disturbance

The DCS has a built in compass. Magnetic objects close to the senor can influence the compass heading, current direction, north speed and east speed.

Illustrations of Deployments

The SeaGuard instrument may be deployed using:

- A fixed bottom frame mooring.
- An in-line string mooring.
- Drop line from a small boat.

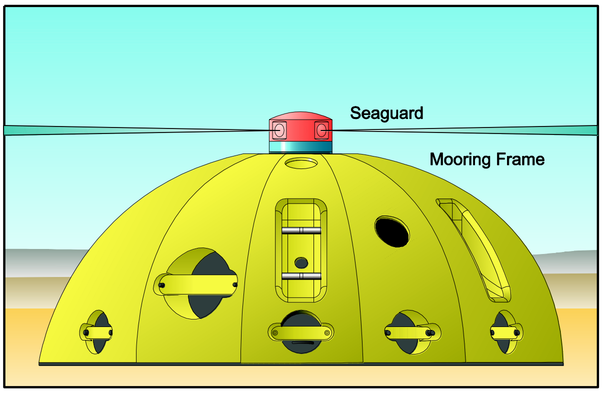


Figure 3-1 Fixed Bottom Mooring Frame 3448.

The fixed bottom frame mooring is typically used in fixed deployment situations i.e. for harbour surveillance systems.

The bottom mounted frame supports extended battery capacity in the form of external battery package.

Refer TN294 for description of the bottom mooring frame.

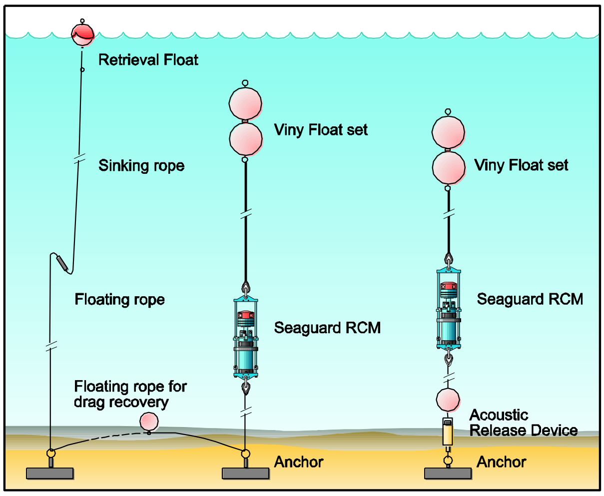


Figure 3-2 In-line Mooring Frame.

The in-line frame may be pre-installed in the mooring string, allowing the instrument to be inserted into the frame at the deployment site by means of two hand-operated screws.

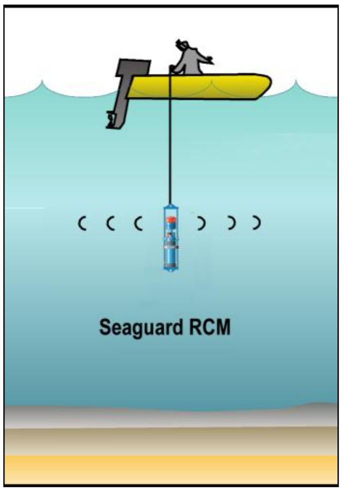


Figure 3-3 Deployment from a small boat

Alternatively, the SeaGuard RCM may simply be moored using a small boat.

Deploying the Bottom Mooring Frame for fixed installations

NOTE! Be sure to use non-magnetic reinforcing rods in the concrete foundation for correct functioning of the compass.

A boat equipped with a winch is needed when installing the SeaGuard RCM in a mooring frame.

An illustration of the SeaGuard RCM deployed in a fixed mooring frame is given in Figure 3-1. The mooring frame should be mounted to a concrete foundation of:

- 110 x 110 x 30cm = 363000cm^3 = 363 liter.

The weight of concrete is approximately 2.4kg per litre giving a total weight of approximately 871kg.

If a concrete foundation is used, lower the instrument using a wire fastened to the block and not to the instrument itself.

If a concrete foundation is not used, the instrument can be lowered to the seabed using a rope.

When the SeaGuard RCM is resting at the sea bottom, give out the rest of the cable and bring ashore.

Make sure that the cable rests on the bottom and is not stretched as the boat moves to the shore.

In general, the cable must be secured to the concrete block, the seabed, and in the brake water zone to the ground.

When a concrete block is used, laying the cable should be done from the shore.

In the brake water zone, the best way to protect the cable is to thread it through a durable plastic tube that is bolted to the ground.

On the seabed, place sand bags or concrete blocks over the cable at strategic places to secure it to the bottom.

In harsh environment it may be necessary to bury the entire cable..

During operation, it is recommended to use a diver to ensure that the instrument and cable are safely installed on the seabed.

For future service, write down the site position from a GPS receiver.

Deploying the In-Line frame

An illustration of the SeaGuard RCM deployed in an in-line mooring frame is given in Figure 3-2. A mooring string is connected to a Viny Float set in one end and an anchor in the other end.

NOTE! Calculations of stability and buoyancy must be carried out for the individual mooring.

The anchor must be of suitable size and weight to keep the instrument in one position.

The instrument and optionally other sensors are connected to the mooring string at desired depths.

For convenience a frame can be connected to the mooring string, and the SeaGuard RCM can be placed into the frame at deployment.

Several in-line frame systems can be linked together using a floating rope or a sink rope between two anchors.

Also, a bottom anchor can be connected to a two-parted string of floating rope and sinking rope with a retrieval float at the upper end to ease the retrieval of the system.

Deploying from a small boat

Figure 3-3 shows drop line using a small boat. When applying this mooring alternative we recommend that you attach a vane to the SeaGuard RCM in order to prevent spinning.

The instrument can also be used for profiling due to its compact design, low drag force and easy handling. The instrument can be lowered into the sea from a small boat using a simple winch. Data can be stored internally and read after retrieval.

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Appendix 1 SeaGuard RCM Specifications

Top-end Plate capability: Up to 6 sensors can be fitted onto the Top-end Plate, of which 4 can be analog sensors (0-5V, requires the optional analog kit)	
Recording System:	Data Storage on SD card
Storage Capacity:	512 MB
Battery Alkaline 3614: or Lithium 3677:	 9V, 15Ah (nominal 12.5Ah; 20W down to 6V at 4°C) 7.2V 30Ah
Recording Interval:	From 2s, depending on the node configuration for each instrument
Recording settings:	Fixed interval settings Customized Sequence setting
Protocol:	AiCaP CANbus based protocol
Depth Capacity:	300m/2000m/6000m
Platform Dimensions: 300m version: 2000m version: 6000m version:	 H: 356mm OD: 139mm H: 352mm OD: 140mm H: 368mm OD: 143mm
External Materials 300m version: 2000/6000m version:	 PET, Titanium, Stainless Steel 316, Durotong DT322 polyurethane Stainless steel 316, Titanium, OSNISIL, Durotong DT322 polyurethane
Weight:	Depends on node configuration
Packing:	Depends on node configuration
Accessories Included:	SeaGuard Studio Alkaline Battery 3614 SD card: 512 MB Standard cable 4299
Optional Accessories:	Recommended Spares In-line mooring frame 4044[1)]/3824A/3910 Lithium Battery 3677 Maintenance Kit 3813/3813B Tools Kit 3986 Bottom Mooring Frame 3438R/3448 Base Brackets 3627 (2) for Frame Protecting Rods 3783 Vane Plate 3681

ZPulse Doppler Current Sensor (DCS) Specifications	
Current Speed: Range: Resolution: Mean Accuracy: Relative: Statistic variance (std)	(Vector averaged) 0-300 cm/s 0.1 mm/s ± 0.15 cm/s ± 1% of reading 0.3 cm/s (ZPulse 0.45 cm/s [2)]
Current Direction: Range: Resolution: Accuracy:	 0 – 360° magnetic 0.01° ±5° for 0-15° tilt ±7.5° for 15-35° tilt
Tilt Circuitry: Range[3)]: Resolution: Accuracy:	 0-45° 0.01° ±1.5°
Compass Circuitry: Resolution: Accuracy:	 0.01° ±3°
Acoustics: Frequency: Power: Beam angle (main lobe):	 1.9 to 2.0 MHz 25 Watts in 1ms pulses 2°
Installation distance: From surface: From bottom:	 0.75m 0.5m
Supply Voltage:	6– 14 Volts
Operating Temperature:	-5 to +50°C

1) In-line Mooring Frame 4044: breaking strength 800kg
2) Based on 300 Pings
3) The Horizontal Current speed is calculated based on tilt within this range