

**ADVANCED
NAVIGATION**



Subsonus Reference Manual

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1 Revision History

Version	Date	Changes
2.3.1	2025-04-14	Minor formatting changes and corrections
2.3	2024-10-24	Updated Firmware Changelog to v3.71
2.2	2024-04-30	Updated Firmware Changelog, see 2.1 Firmware Changelog Updated Navigation Specifications, see 5.2 Navigation Specifications Added Mapping Enhancements, see 9.1.1.7 Mapping Enhancements Added Modem Configuration, see 9.1.3.9 Modem Configuration Added Sound Velocity Configuration, see 9.1.3.10 Sound Velocity Configuration Added Display Configuration, see 9.1.3.11 Display Configuration Added System Configuration, see 9.1.3.12 System Configuration Added ANPP state packets Heave and External Time, see 11.4.19 Heave Packet and 11.4.16 External Time Packet Minor editorial changes
2.1	2024-03-20	Updated Firmware changelog, see 2.1 Firmware Changelog Updated PoE specifications, see 5.1 Hardware Specifications Added ground loop insulation requirement for pole mounting, see 7.3.1.1 Pole Mount Bracket Updated information about Out of Water Detection, see 8.4 Out of Water Detection Magnetometers Range added to Sensor Ranges Packet (184), see 11.5.2 Sensor Ranges Packet Added procedure for Factory Restore via web UI, see 9.1.4 Tools Menu Minor editorial changes
2.0	2023-09-06	Updated Firmware changelog, see 2.1 Firmware Changelog Updated Software Changelog, see 9.2 Using Subsonus Tools Updated Device ID table, see 11.3.3 Device Information Packet Added Basestation Packet, see Basestation Packet Added 6 Getting Started section, including 6.3 Function Testing Revised 7.1 Installation Checklist to include external aiding devices Added Inertial Alignment Tool Added information for DVL integration, see 7.5 External Aiding Devices, Subsea Subsonus Aiding and 9.1.1.5 Display Settings Added new Remote ANPP packets (22, 100-110) for DVL, see 11 Advanced Navigation Packet Protocol Migrated documentation platform, various formatting and copy changes
1.9	2021-10-22	Updated Firmware changelog, see 2.1 Firmware Changelog Updated Data Protocol, see 9.1.3.1 Acoustic Configuration
1.8	2020-10-23	Updated Firmware changelog, see 2.1 Firmware Changelog Updated system status table 11.4.1.1 System Status Updated Configuration of Generic Pinger, see 11.5.12 Device Configuration Packet
1.7	2019-	Updated Firmware changelog, see 2.1 Firmware Changelog

Version	Date	Changes
	12-17	
1.6	2019-08-06	Updated Firmware changelog, see 2.1 Firmware Changelog Updated Tag evaluation kit GNSS Compass specification, see 4 Evaluation Kit and 7.4 Surface Unit Reference Source
1.5	2019-06-04	Updated Firmware changelog, see 2.1 Firmware Changelog Renamed Filter Status Flag, see 8.6 Status Added NMEA Depth Sensor Device, see 11.5.12 Device Configuration Packet Added Generic ANPP Aiding Device, see 11.5.12 Device Configuration Packet
1.4	2019-01-16	Updated firmware changelog, see 2.1 Firmware Changelog Added 11.4.18 Geoid Height Packet Added 11.5.2 Sensor Ranges Packet Added Subsonus Tag device configuration ANPP packet , see 11.5.12 Device Configuration Packet Added Subsonus Tag evaluation kit, see 4 Evaluation Kit Added 11.5.15 Acoustic Data Priority Packet Updated local and remote Device Address instructions, see 9.1.3.2 Device Address Configuration Updated system status table, see 11.4.1.1 System Status Updated filter status table, see 11.4.1.2 Filter Status Updated valid Device Address table, see 11.5.12.3 Device Address Updated Subsonus device configuration ANPP packet, see 11.5.12 Device Configuration Packet
1.3	2018-08-24	Updated firmware changelog, see 2.1 Firmware Changelog
1.2	2018-02-09	Added device address configuration packet, see 11.5.12 Device Configuration Packet Added 11.5.10 Time Configuration Packet Added 11.5.12 Device Configuration Packet Added 11.5.13 Port Configuration Packet Updated Configuration of GNSS Compass Aiding, see 9.1.3.3 Device Configuration Updated Configuration of Spatial Dual Aiding, see 9.1.3.3 Device Configuration Updated Device Address, see 9.1.3.2 Device Address Configuration Updated Compass Information, see 7.4 Surface Unit Reference Source
1.15	2017-07-13	Split State packet into 11.4.1 System State Packet and 11.4.6 Remote State Packet Modified descriptions on data for 11.4.5 Remote Track Packet Split the Raw Sensors Packet into 11.4.8 Raw Sensors Packet and 11.4.9 Remote Raw Sensors Packet Added Device Address section, see 9.1.3.2 Device Address Configuration Added 11.3.3.1 Device ID description table
1.1	2017-07-08	Updated firmware changelog, see 2.1 Firmware Changelog Updated hardware changelog, see 2.2 Hardware Changelog Updated sensor co-ordinate frame, see 12.3 The Sensor Co-ordinate Frame Product artwork updated Added part numbers for Subsonus extension cables, see 3 Part Numbers and

Version	Date	Changes
		<p>Ordering Mechanical drawing updated to current hardware revision, see 5.1 Hardware Specifications</p> <p>Setup guides updated to V1.5x firmware, see 9.1 Using the Web UI</p> <p>Added Vehicle Profiles, see 9.1.3.4 Filter Aiding</p> <p>Updated disassembly procedure, see 10 Maintenance</p> <p>Detail added to biofouling removal procedure, see 10 Maintenance</p> <p>Added Modem Data, see 9 Interfacing with Subsonus</p> <p>Updated 11.4.1 System State Packet</p> <p>Updated Track Packet, see 11.4 State Packets</p> <p>Added Filter Aiding Sources explanation, see 8.2 INS Filter Aiding Sources</p> <p>Updated 11.5.11 NMEA Output Configuration Packet</p> <p>Added 11.5.14 Modem Configuration Packet</p> <p>Added IP Dataports Configuration Packet</p>
1.0	2015-05-20	Initial Release

Table 1: Revision History

2 Introduction

Subsonus is a next generation USBL underwater acoustic positioning system that provides high accuracy position, velocity and heading at depths of up to 1000 metres. The system features an industry leading calibrated hydrophone array combined with an internal tightly coupled INS, all packed into a miniature titanium enclosure small enough to fit in the palm of your hand.



Figure 1: Subsonus

Subsonus can provide amazing results but it does need to be set up properly and operated with an awareness of its limitations. Please read this manual carefully to ensure success within your application.

If you have any questions, please contact support@advancednavigation.com.

Use the links below for detailed information about Subsonus.

- [**3 Part Numbers and Ordering**](#)
- [**4 Evaluation Kit**](#)
- [**5 Specifications**](#)
- [**6 Getting Started**](#)
- [**7 Installing Subsonus**](#)
- [**8 Using Subsonus**](#)
- [**9 Configuring and Monitoring Subsonus**](#)
- [**10 Maintenance**](#)
- [**11 Advanced Navigation Packet Protocol**](#)
- [**12 Reference Information**](#)

2.1 Firmware Changelog

Version	Date	Changes
3.71	2024-10-24	Incorporated an End User License Agreement (EULA) at signup. Addressed a few minor fixes.
3.60	2024-07-19	Added support for Hydrus firmware v1.4,
3.50	2024-04-15	Added system configuration setting for Auto Device Configuration (New Subsonus) in the web UI Added ability to auto discover and configure GNSS Compass for a Subsonus surface unit Fixed intermittent system reset triggered by out of water
3.40	2023-10-18	Added support for Hydrus firmware v1.2 Various UI improvements
3.30	2023-09-06	Various bug and web UI fixes for Hydrus Hide Hydrus current mission when it is untracked Add ability to acoustically command Hydrus to go to surface, or go to recovery location, without a mission running
3.11	2023-01-31	Added support for Waterlinked and Nortek DVLs Added support for Generic NMEA Depth Sensor for filter aiding Added automatic device discovery for Advanced Navigation Boreas, Certus and Certus Evo INS products Added Inertial Alignment page for automatic alignment error detection, see 9.1.4.3 Inertial Alignment Tool Added ability to export Subsonus log files as KML for use in third party applications or for re-import into live 3D view Fixed Packet 52 External Time Packet behaving as read only Added ability to manually set the time if no time source is configured UI improvements
3.0	2020-10-22	Major firmware release – not compatible with older Subsonus Firmware versions. Subsonus Tag requires FW2.0 or newer to be compatible. Added new Acoustic Data Protocol - Standard Acoustic Data Protocol is now named ‘High Speed Mode’ - New Acoustic Data Protocol introduced, called ‘High Reliability Mode’ Improved acoustic discovery time Improved address conflict resolution Added support for Advanced Navigation products Certus and Certus Evo
2.40	2020-10-16	Added 3D Globe Added built in Mapping layers Added visualisation of water layer and seafloor layer Added switch to view data in Relative Mode Added automatic alignment error detection to aiding source Added visualisation of Advanced Navigation aiding sources in view Visual look and feel changes Updated defaults of live data visualisation in view

Version	Date	Changes
2.30	2019-12-17	User interface updates: Discovery information display added Tracking information display added Device management interface added Device colours and colour behaviour updated Device Address display updated Tracking graph error indication added
2.20	2019-08-06	Added support for Subsonus Tag Dynamic power control
2.10	2019-06-01	INS performance improvements Added option to visualise all devices in 3D view Added device name to menu bar Added device list scaling options Added generic ANPP aiding device Updated atmospheric depth correction input
2.0	2019-01-16	Automatic acoustic discovery and tracking of Subsonus Tag Full acoustic configuration of Subsonus Tag Live update of Subsonus Tag sensors and attitude at Surface 3D visualisation of sub-sea position and attitude of Subsonus Tag at Surface Way-pointing System added Vehicle models available in 3D view Improved acoustic communication and positioning reliability in high noise environments Improved work flow and management of tracked devices
1.70	2018-08-22	Acoustic Performance Improvements Velocity of Sound calibration update Out of water low power control added Disable Magnetic heading control added Added “Multiple Masters Detected” status flag Added “Low Power Mode” status flag Added web page timeout control Added “Depth Below Surface” NMEA packet
1.60	2018-02-09	Added device configuration ANPP packet Added data port configuration ANPP packet Added time configuration ANPP packet Added data stream port configuration ANPP packet Added separate INS devices types for Advanced Navigation devices Data stream update to support per device data sources Live data display for remote devices in 3D view Copy data from 3D view Detachable Camera control added in 3D view Device Following Camera control added in 3D view Grid Plot option for 3D view Coordinate frame display control for 3D view Data copy from 3D view Warning alerts added Night mode web interface theme added

Version	Date	Changes
		WB2 Transponder support added Automatic Device Address conflict handling updated
1.50	2017-07-15	Support for tracking multiple different device types at once 3D view engine updated Alignment configuration aiding 3D view added Offset configuration aiding 3D view added Subsonus status display updated Device and connection management update Remote acoustic data configuration update. Micron transponder support added
1.40	2017-02-03	Modem data configuration page added Support for hemisphere GNSS binary protocol added Ethernet settings changes are now checked for validity Partial WB2 transponder support added NMEA input changed to device configuration
1.30	2016-10-22	Device configuration packet packet added
1.20	2016-04-27	Save/load configuration tools added NMEA packets added to output data stream types.
1.10	2015-08-17	Vehicle profile selection added Pinger tracking support added Updated network settings packet
1.0	2015-03-04	Initial release

Table 2: Firmware Changelog

2.2 Hardware Changelog

Version	Date	Changes
1.3	2017-03-15	Minor internal improvements
1.2	2016-11-02	Updated internal INS sensors
1.1	2015-04-28	Protective cage fasteners changed to field serviceable design Mounting footprint changed to 60mm square spacing Moulded polyurethane array shape updated
1.0	2015-02-12	Initial release

Table 3: Hardware Changelog

3 Part Numbers and Ordering

3.1 Evaluation Kit

Part Number	Description	Notes
SUBSONUS-EK	Subsonus Evaluation Kit	Subsonus Evaluation Kit Contains everything required to start operating Subsonus for subsea acoustic positioning. Includes items listed in 4.1 Subsonus Evaluation Kit Contents
SUBSONUS-TAG-EK	Subsonus Tag Evaluation Kit	Subsonus Tag Evaluation Kit Contains everything required to start operating Subsonus Tag for subsea acoustic positioning. Includes items listed in 4.2 Subsonus Tag Evaluation Kit Contents

Table 4: Evaluation Kit Part Numbers

3.2 Standalone Units

Part Number	Description	Notes
SUBSONUS-H	Subsonus with connector installed in horizontal port	Typically best choice for mounting Subsonus close to a flat surface such as the top of a vehicle Typically used as the subsea unit
SUBSONUS-V	Subsonus with connector installed in vertical port	Typically best choice for mounting Subsonus on a pole Typically used as the surface unit

Table 5: Standalone Unit Part Numbers

3.3 Accessories

Part Number	Description	Notes
SS-10M-CABLE	Subsonus 10 metre RJ45 cable	Subsonus 10 metre cable, RJ45 Ethernet connector to MCIL8F connector with cap
SS-3M-EXCABLE	Subsonus 3 metre extension cable	Subsonus 3 metre extension cable, MCIL8M connector to MCIL8F connector with caps
SS-20M-EXCABLE	Subsonus 20 metre extension cable	Subsonus 20 metre extension cable, MCIL8M connector to MCIL8F connector with caps
SS-80M-EXCABLE	Subsonus 80 metre extension cable	Subsonus 80 metre extension cable, MCIL8M connector to MCIL8F connectors with caps
SS-POLE-BRACKET	Subsonus Surface Pole Mount Bracket	Subsonus Surface Pole Mount Bracket
GC2-POE	GNSS Compass Ethernet Variant	GNSS Compass Ethernet variant Power over Ethernet interface Supports GPS, GLONASS, Galileo & BeiDou constellation L1/L2 10mm RTK Supports DGPS and SBAS Does not support L band No cables included
GC-POE-CABLE-20M	20m Ethernet cable for GNSS Compass	20m CAT5e Ethernet cable with RJ45 Compatible with Ethernet units only (G2C-POE) IP67 environmentally sealed connector
POE-INJECTOR-DC	DC PoE Injector	24V DC PoE Injector 25W 802.3at Type 2 "PoE+"
SUPPLY-24V	24 V power supply	100-240 V AC Mains to 24 V DC Power Supply (DC jack) Includes 2-pin plug types A/C/G/I

Table 6: Ordering Part Numbers for Accessories

Note: The 80m extension cable is subject to availability.

4 Evaluation Kit

The Subsonus evaluation kit contains everything required to start operating a Subsonus system. This includes two Subsonus units and the GNSS compass required for a moving (vessel mounted) application.

The evaluation kit system can demonstrate the full positioning, heading transfer and modem data capabilities of the Subsonus with the output navigation data referenced to a global coordinate frame. It is designed to allow customers to quickly set up the system and achieve maximum performance.

Due to Advanced Navigation's desire for customers to experience the best results, the evaluation kit price is subsidised relative to buying the equipment pieces individually to promote purchasing the ideal equipment set.

4.1 Subsonus Evaluation Kit Contents

- 1 x Subsonus with vertical connector, pre-loaded with surface configuration
- 1 x Subsonus with horizontal connector, pre-loaded with subsea configuration
- 2 x Subsonus universal mounting bracket, see [Figure 7: Subsonus Pole Mount Bracket](#)
- 2 x Subsonus connector to RJ45 connector 10 metre cables
- 3 x 24V DC PoE (Power over Ethernet) power supply injectors
- 3 x 24V DC power supply
- 1 x Advanced Navigation GNSS Compass (PoE), see [7.4 Surface Unit Reference Source](#)
- 1 x 4 port generic network router with DHCP server
- 2 x Subsonus kit case
- 1 x 20m Ethernet cable for GNSS Compass
- 3 x Cable Ethernet 2m

4.2 Subsonus Tag Evaluation Kit Contents

- 1 x Subsonus with vertical connector, pre-loaded with surface configuration
- 1 x Subsonus Tag
- 1 x Qi® charger with power supply and cable
- 1 x Subsonus universal mounting bracket, see [7.3.1.1 Pole Mount Bracket](#)
- 1 x Subsonus connector to RJ45 connector 10 metre cables
- 2 x 24V DC PoE (Power over Ethernet) power supply injectors
- 2 x 24V DC power supply
- 1 x Advanced Navigation GNSS Compass (PoE), see [7.4 Surface Unit Reference Source](#)
- 2 x 2 metre Cat6a Ethernet cables
- 1 x 4 port generic network router with DHCP server
- 1 x Android handset for Bluetooth configuration
- 1 x Subsonus Tag kit case
- 1 x 20m Ethernet cable for GNSS Compass
- 1 x Subsonus kit case

5 Specifications

5.1 Hardware Specifications

Parameter	Value
Operating Voltage	9 to 60 V or Power over Ethernet (Type 2 PoE+ IEEE 802.3at)
Power Consumption (average)	10 watts
Power Consumption (peak)	25 watts
Timing Synchronisation Support	PTP and NTP
Interface	Ethernet
Depth rating	1000 m
Operating Temperature	-20 °C to 40 °C
Storage temperature	-40 °C to 85 °C
Shock Limit	25 g
Dimensions	106 x 106 x 93 mm
Weight in Air	1170 g
Weight in Water	650 g

Table 7: Hardware Specifications

5.1.1 Mechanical Drawings

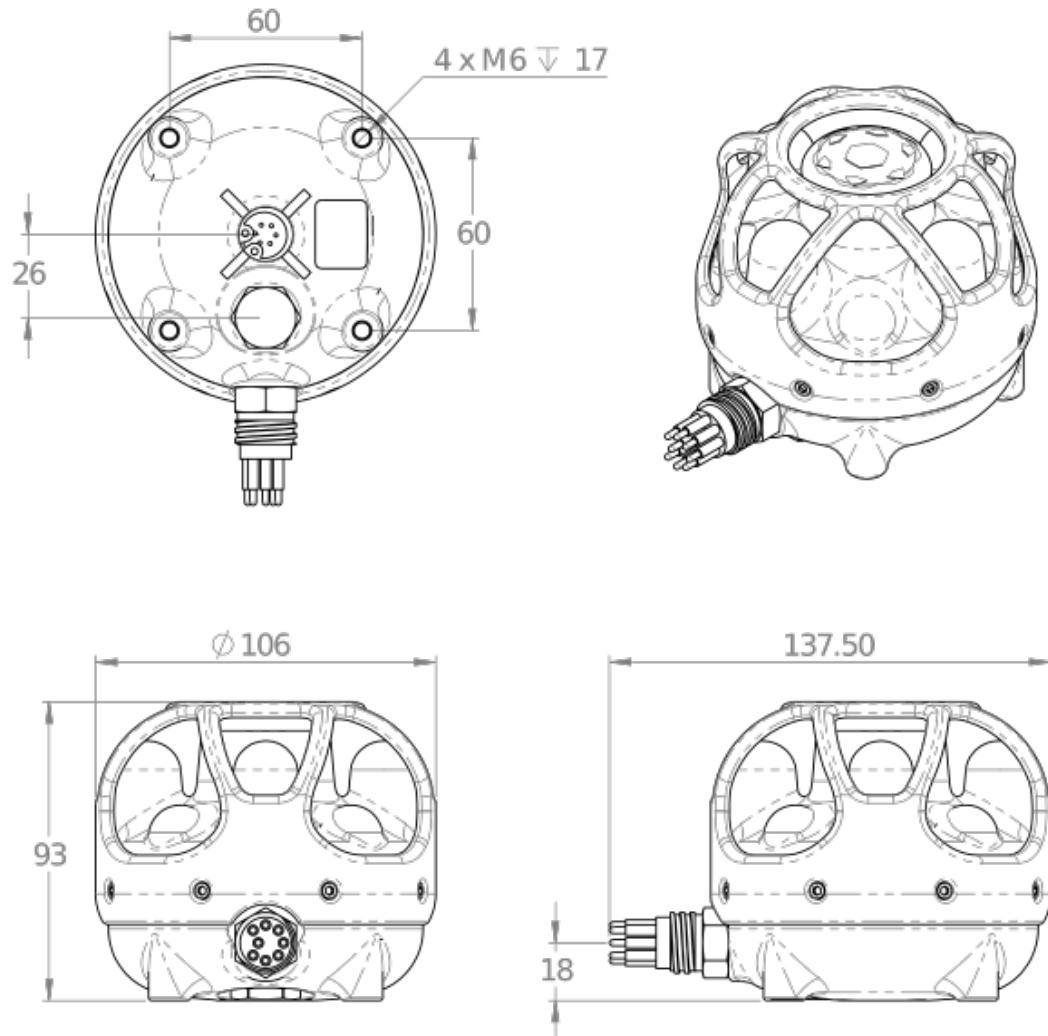


Figure 2: Subsonus mechanical drawing showing unit fitted with horizontal connector option

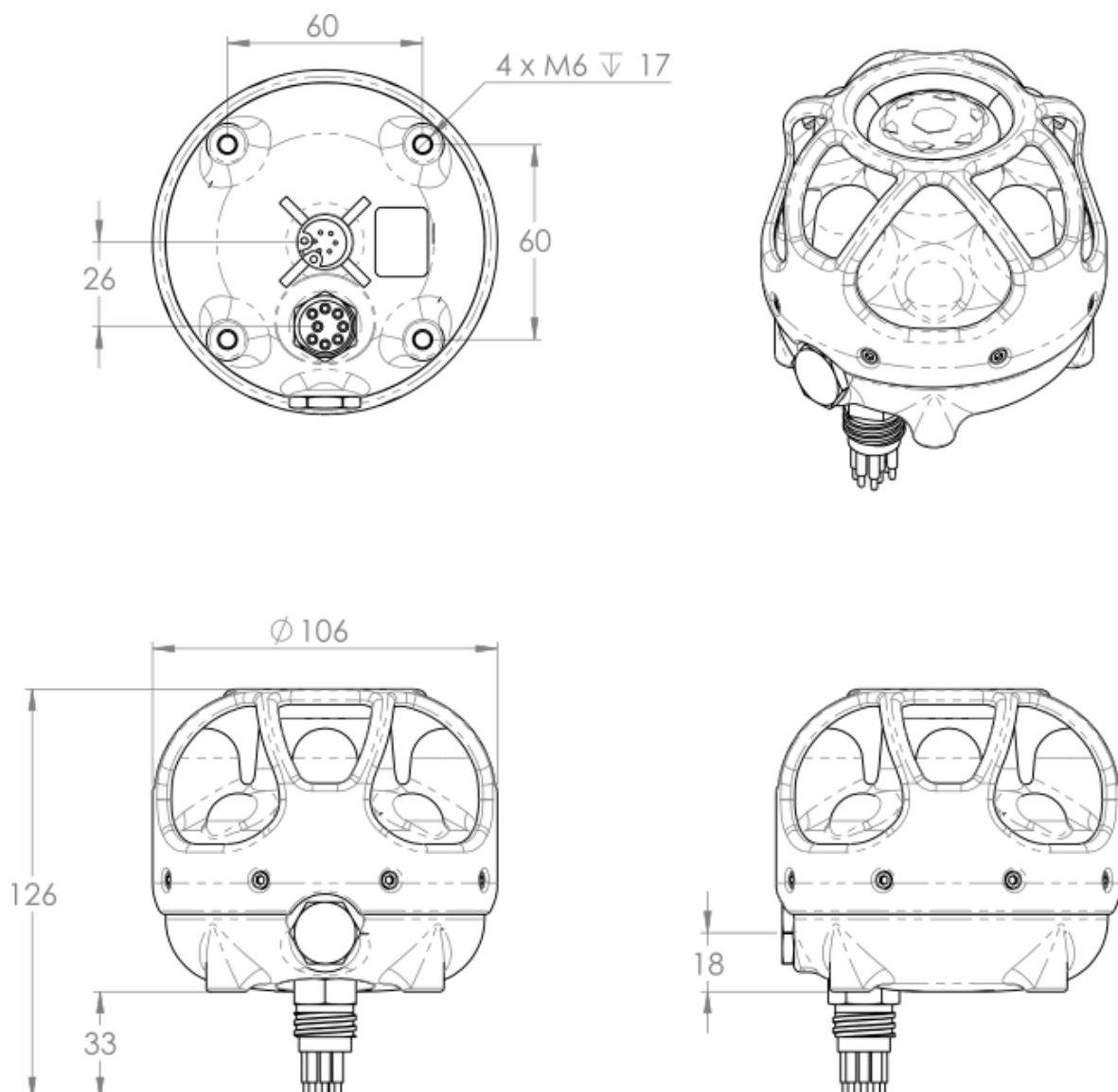


Figure 3: Subsonus mechanical drawing showing unit fitted with vertical connector option

5.2 Navigation Specifications

5.2.1 Navigation

Parameter	Value
Position Accuracy (5 m range)	0.1 m
Position Accuracy (100 m range)	0.5 m
Position Accuracy (1000 m range)	5.0 m
Velocity Accuracy	0.01 m/s
Roll & Pitch Accuracy	0.1 °
Heading Accuracy (Acoustic)	0.3 °
Heave Accuracy	5% or 0.05 m
Internal Filter Rate	1000 Hz
Data Output Rate	Up to 1000 Hz
Latency	0.6 ms

Table 8: Navigation Specifications

5.2.2 Acoustics

Parameter	Value
Hydrophones	8
Frequency	30 kHz (broadband)
Acoustic Coverage	300 ° hemispherical
Accuracy	0.25% of slant range

Table 9: Acoustic Specifications

5.3 Sensor Specifications

Parameter	Value
Pressure Sensor Range	1000 m
Pressure Sensor Accuracy	1.5 m
GNSS Antenna	Integrated into top of hydrophone array
GNSS Receiver	u-blox M8Q

Table 10: Sensors Specifications

5.4 Connector Pin-out

Power and data connection is made through a single MCBH8M connector. The connector pin-out is shown below in [Figure 4: Subsonus MCBH8M connector](#). The mating connector is a MCIL8F. Advanced Navigation stocks an MCIL8F mating connectors with 10 metres of cable to an RJ45 Ethernet connector. There are extension cables available, see [3 Part Numbers and Ordering](#)

There are two options available to power the unit. It can either be powered using PoE (Power over Ethernet) or it can be powered from a DC source. See [5.4.1 PoE \(Power over Ethernet\) Pin-out](#) and [5.4.2 DC Power Pin-out](#) respectively. The system can be connected either way and it automatically determines the power source method. The evaluation kits are powered using the PoE method.

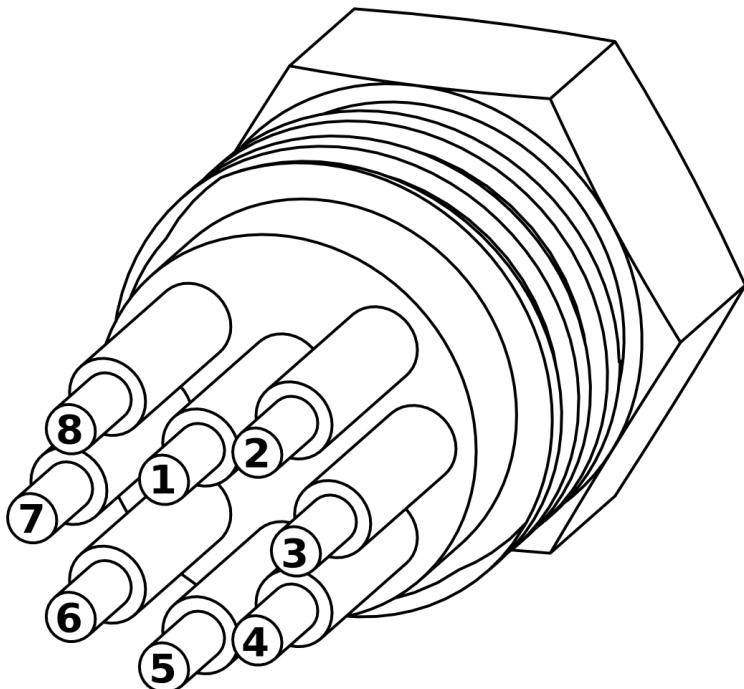


Figure 4: Subsonus MCBH8M connector

5.4.1 PoE (Power over Ethernet) Pin-out

Pin	Colour	Function	RJ45 Pin
1	Blue/White	Ethernet DC+	5
2	Blue	Ethernet DC+	4
3	Orange/White	Ethernet Tx+	1
4	Orange	Ethernet Tx-	2
5	Green/White	Ethernet Rx+	3
6	Green	Ethernet Rx-	6
7	Brown/White	Ethernet DC-	7
8	Brown	Ethernet DC-	8

Table 11: Power over Ethernet pin-out

5.4.2 DC Power Pin-out

Pin	Colour	Function	RJ45 Pin
1	Blue/White	Power Supply	
2	Blue	Power Supply	
3	Orange/White	Ethernet Tx+	1
4	Orange	Ethernet Tx-	2
5	Green/White	Ethernet Rx+	3
6	Green	Ethernet Rx-	6
7	Brown/White	Ground	
8	Brown	Ground	

Table 12: DC power pin-out

6 Getting Started

This section details how to install, configure and get a Subsonus setup operational.

6.1 Prerequisites

The prerequisites required before interfacing with or configuring a unit include the following:

- A laptop, tablet or computer connected to a local network with a router that hosts DHCP (do not use a switch).
- Ensure Firefox or Chrome is installed. These are the recommended web browsers for the Subsonus web UI.
- Install zeroconf (Apple Bonjour) from one of the links below:
<https://www.advancednavigation.com.au/Bonjour.msi> (32-bit installer)
<https://www.advancednavigation.com.au/Bonjour64.msi> (64-bit installer)

Note: It is highly recommended that the equipment be function tested in a controlled environment prior to installation and deployment. See [6.3 Function Testing](#) for wet function testing instructions.

6.2 Quick Start Guide

1. Mount the surface unit following the guidelines in [7.3.1 Surface Unit Mounting](#).
2. Mount the subsea unit following the guidelines in [7.3.2 Subsea Unit Mounting](#).
3. Configure the devices for your desired application. See the sections found under [9.1 Using the Web UI](#) for information on configuring Subsonus. Note that the alignment configuration cannot be performed until the units are mounted.
4. Install and set up any external aiding devices, such as a DVL, and ensure that any position and alignment offsets are accurately measured once mounted. These offsets must be later entered during alignment configuration. see [Add DVL](#)
5. Remove the cable pigtail from the connector on the Subsonus units and the supplied cables. Install the cables to the units, ensuring that the connectors are mated correctly and the jackets are screwed on hand tight. see [7.2 Connection Diagrams](#)

Note: The connectors used on Subsonus require silicone grease to ensure they seal correctly. Keep the sealing faces free of debris or damage and ensure the female connector is completely sealed with grease before every mating. Recommended silicone grease: Dow MOLYKOTE™ 111.

6. Set up the reference data source, see [7.4 Surface Unit Reference Source](#). Ensure that the alignment between the surface unit and reference source is correct and measured.
7. Connect the Subsonus cable to PoE injector and the PoE injector into a local network (with DHCP) - see [7.2 Connection Diagrams](#) for more information. Power everything on.

Note: When the PoE injectors are being supplied power, the DC Run LED will indicate green and when the PoE OUT is connected and power is being drawn from the PoE RUN LED indicator will also change to green. When Subsonus is on, it will beep.

8. Open your web browser and type in the address <http://surface.local/> to connect to the surface (vertical connector) Subsonus unit. The trailing forward slash is required on some web browsers.

Note: If you cannot connect to the Subsonus at this address, see [9.4.2 Host Name Discovery](#).

9. Ensure that the previously set configurations are all correct, and that the surface (master) Subsonus is correctly set to track the target(s) e.g. Subsonus Tag or a Hydrus.
10. Set the alignment of the surface Subsonus according to [9.1.3.5 Alignment Configuration](#)
11. Measure the offset between the surface unit reference source and surface Subsonus unit. This is a critical measurement.
12. Add the reference source as an aiding device for the surface Subsonus, see [Subsea Subsonus Aiding](#), ensuring that the offsets are correctly entered in the web UI.
13. Open your web browser and type in the address <http://subsea.local/> to connect to the subsea (horizontal connector) Subsonus unit. The trailing forward slash is required on some web browsers.

Note: If you cannot connect to the Subsonus at this address, see [9 Interfacing with Subsonus](#)

14. Set the alignment of the subsea Subsonus according to [9.1.3.5 Alignment Configuration](#)
15. Configure any subsea external aiding devices, see [Subsea Subsonus Aiding](#), ensuring that the offsets are correctly entered in the web UI.
16. The system is now ready to deploy. Click on the **Main** page to see the status. It may take a couple minutes to initialise, after which time the location of the surface and subsea units will appear in the web UI.

6.3 Function Testing

The following list describes how to function test the Subsonus in a large tub.

1. Fill a large tub or test tank with water. Ensure the tub is large enough and the water is deep enough to submerge both devices.
A minimum size of 1 m x 1 m x 0.4 m deep is recommended.
2. Remove the cable pigtail from the connector on the Subsonus unit and the supplied cable. Install the cable to the unit, ensuring that the connectors are mated correctly and the jackets are screwed on hand tight.

Note: The connectors used on Subsonus require silicone grease to ensure they seal correctly. Keep the sealing faces free of debris or damage and ensure the female connector is completely sealed with grease before every mating. Recommended silicone grease: Dow MOLYKOTE™ 111

3. Connect the Subsonus cable to PoE injector and the PoE injector into a local network (with DHCP) - see [7.2 Connection Diagrams](#) for more information. Power everything on.

Note: When the PoE injectors are being supplied power, the DC Run LED will indicate green and when the PoE OUT is connected and power is being drawn from the PoE RUN LED indicator will also change to green. When Subsonus is on, it will beep.

4. Repeat steps 2-4 for the second Subsonus unit.

5. Place both devices into the tub of water, ensuring they are submerged. Failure to submerge Subsonus units while powered on for extended periods may cause an increase in temperature, causing damage. Face the units toward each other so that the hydrophones are facing one another, as far apart in the test tank as possible.
6. Open your web browser and type in the address <http://surface.local/> to connect to the surface Subsonus unit. The trailing forward slash is required on some web browsers.
If you cannot connect to the Subsonus at this address, see [9 Interfacing with Subsonus](#)
7. Navigate to "Configuration"→"Acoustics" and ensure the Operation Mode for the surface unit is set to "Master". Confirm that the Device Address is set to 1.
8. Navigate to "Configuration"→"Devices" in the web UI or click on the plus icon in the Main View under the Device List (see [9.1.1.2 Device List](#)). Click on "Run Acoustic Discovery"
The second Subsonus will appear under "Discovered Devices". Add the device to begin tracking using the default configurations.
If the subsea Subsonus does not appear:
 - Navigate to <http://subsea.local/> to confirm that the device is connected to the network and powered up correctly. If you cannot connect to the Subsonus at this address, see [9 Interfacing with Subsonus](#)
 - Navigate to "Configuration"→"Acoustics" and ensure the Operation Mode for the subsea unit is set to "Slave". Confirm that the device addresses for both units are unique. see [7.6.1 Device Address Identification](#) for more information on device addresses.
 - Navigate back to the Surface Subsonus web UI and follow the prompts in [Creating a Track Target \(Subsea device\)](#).
9. Once the surface unit (master) is set to track the slave, you should hear the devices communicating. Note that location data will be inaccurate due to the lack of GNSS position data (see [7.4 Surface Unit Reference Source](#) for more information)
10. Monitor the acoustic data being transmitted in the Device List (see [9.1.1.2 Device List](#)). If there are many missed replies, confirm that the units are close together, and the blue hydrophones facing one another.

7 Installing Subsonus

To install and quickly get started with Subsonus, follow the instructions provided in [7.1 Installation Checklist](#)

See	For
7.2 Connection Diagrams	Information on how to connect Subsonus to different equipment
7.3 Mounting Position	Guidelines for selecting the mounting location and orientation for the unit(s)
7.6 Subsonus Device Addresses	Information on device unit address configuration
7.4 Surface Unit Reference Source	Recommended sources of time, position, velocity and heading data for the surface Subsonus
7.7 Third Party Acoustic Devices	Information on Subsonus' compatibility with third party transponders, beacons and pingers

Table 13: Additional Information

Note: For ordering an evaluation kit, a standalone kit or accessories for Subsonus, see [3 Part Numbers and Ordering](#).

7.1 Installation Checklist

The following checklist provides the basic steps for connecting, mounting and configuring a Subsonus unit.

1. Ensure all prerequisites are met, see [6.1 Prerequisites](#).
2. Function test the units according to the guidelines in [6.3 Function Testing](#)
3. Mount the surface and subsea units following the guidelines in [7.3 Mounting Position](#).
4. Set up the reference data source, see [7.4 Surface Unit Reference Source](#). It is crucial that the surface unit reference source and surface Subsonus unit are aligned as closely as possible to the vessel bow-stern axis, and that any alignment offsets are accurately measured once mounted. These offsets must be later entered during configuration. See [9.1.3.5 Alignment Configuration](#) and [9.1.3.3 Device Configuration](#)
5. Install and set up any external aiding devices, such as a DVL, according to the instructions provided with the device. Ensure that any position and alignment offsets between Subsonus and the DVL are accurately measured once mounted. These offsets must be later entered during configuration. See [Subsea Subsonus Aiding](#).
6. Install cables to the units and make sure the connector is mated correctly and the jacket is screwed on hand tight.
7. Connect the Subsonus cables to PoE injectors and the PoE injectors into a local network (with DHCP). Power everything on. When the PoE injectors are delivering power to Subsonus the LED indicator will change from orange to white.
8. Open your web browser and type in the address <http://surface.local/> to connect to the surface (vertical connector) Subsonus unit. The trailing forward slash is required on some web browsers.
If you cannot connect to the Subsonus at this address, see [9 Interfacing with Subsonus](#).
9. Ensure that the offset between the surface Subsonus and the GNSS Compass has been accurately measured and entered in the web UI. See [Offset Measurement](#) for directional information when

measuring the offset.

10. To connect to the other unit (horizontal connector), type in the address <http://subsea.local/>. It is recommended to use different browser windows for each unit so that it is clear which unit is being configured in which window. The Surface and Subsea units can be identified by their assigned names in the web browser title bar.
If you cannot connect to the Subsonus at this address, see [9 Interfacing with Subsonus](#).
11. Configure any subsea external aiding devices, see [Subsonus Surface Unit Reference Source Aiding](#), ensuring that the offsets are correctly entered in the web UI.
12. The system is now ready for further configuration and deployment. See the sections found under [9.1 Using the Web UI](#) for information on configuring the Subsonus to your desired application.

Note: Configuration of the surface unit must be performed in the surface Subsonus web UI, and subsea unit in the subsea Subsonus web UI. It is recommended to use different browser windows if both web UIs are open at the same time.

13. Once configured, the devices are ready to deploy. Monitor the system from the surface Subsonus web UI. Click on the main page to see the status. It may take a couple of minutes to initialise after which time the location of the surface and subsea units will appear.

7.2 Connection Diagrams

Subsonus can be connected to different equipment depending on the application and reference data. The following two illustrations show examples of position aiding connection solutions for the Surface Subsonus.

7.2.1 GNSS Compass Aided Surface Connection

This connection diagram shows the connections required to set up position aiding for a Surface Subsonus using the Advanced Navigation GNSS Compass.

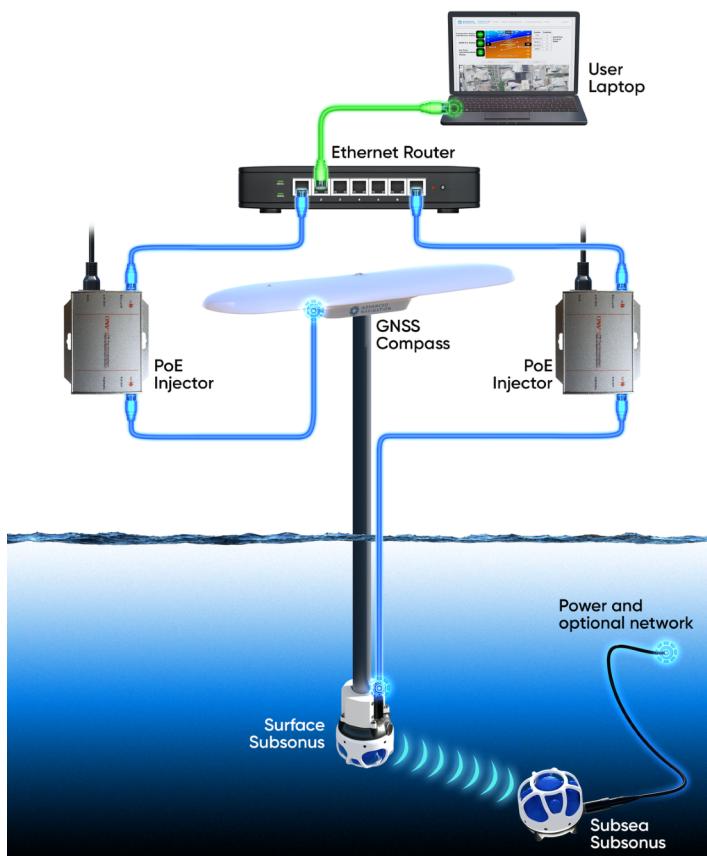


Figure 5: GNSS Compass aided surface connection

7.2.2 Third Party Aided Surface Connection

Subsonus can be used with a third party GNSS reference source. If the third party GNSS Compass communicates over Ethernet, it can be connected to the Subsonus as per the diagram above. If the third party GNSS Compass communicated over Serial, a Serial to Ethernet converter must be used.

See [7.4.3 Third Party GNSS/INS or GNSS Compass](#) for more information.

Note: A timing source is required when using a third party GNSS, for example a PTP or NTP server. This is to ensure time sync with the Subsonus unit.

7.3 Mounting Position

7.3.1 Surface Unit Mounting

The surface Subsonus unit is typically mounted on a pole that is attached to the side of a ship and pointing down into the water, see [Figure 6: Typical Subsonus Surface Mounting](#).

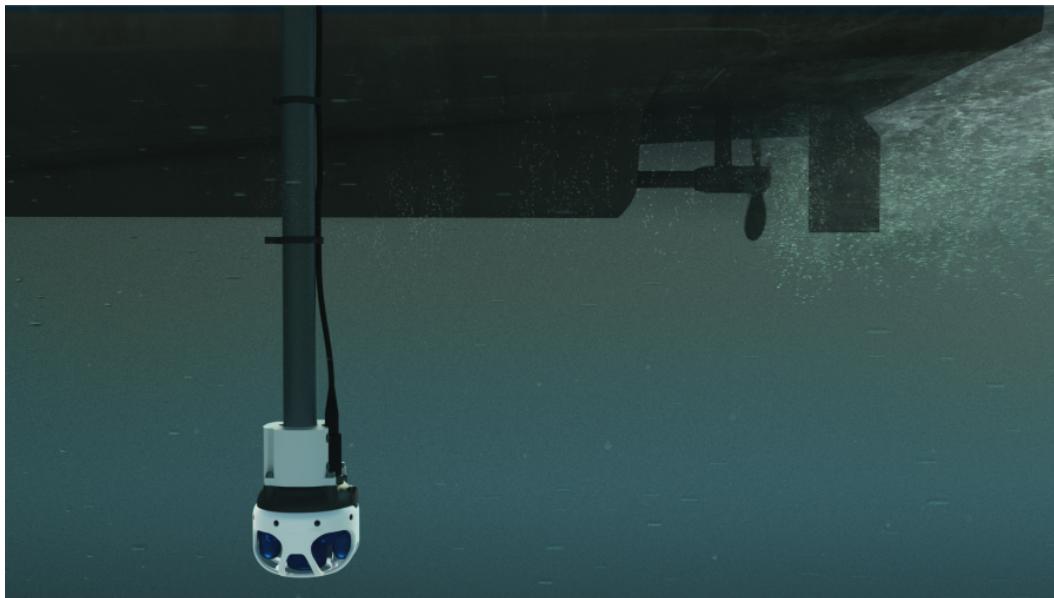


Figure 6: Typical Subsonus Surface Mounting

Mounting goals with the surface unit are:

1. Insulation between the Subsonus unit and the pole is required to avoid ground loops.
2. The Subsonus unit should be mounted with the hydrophone array and cage pointing directly down into the water.
3. The connector blanking bolt on the side of Subsonus must be aligned so that it is pointing in the backwards direction of the vessel, opposite to the direction of travel. There is an arrow on the underside of the unit - this arrow must point toward the front of the vessel when the Subsonus is mounted.
4. The Subsonus unit should be mounted at least 1 metre under the surface of the water, and at least 0.5 m below the vessel keel. The surface unit should be deep enough that it never comes out of the water.
5. The Subsonus unit should be mounted at least 1 metre away from the boat hull or jetty.
6. The Subsonus unit should be mounted away from propellers and thrusters. It should be mounted in a position where it will have minimal air bubbles passing over or below the hydrophones.

7.3.1.1 Pole Mount Bracket

Advanced Navigation stocks a reinforced acetal plastic pole mount bracket for Subsonus that allows customers to quickly mount the surface unit to a 15-35mm diameter pole, as shown below.



Figure 7: Subsonus Pole Mount Bracket

The surface Subsonus unit can also be mounted to fixed structures such as jetties or buoys, where the same mounting goals apply except that in this scenario the connector alignment does not matter.

7.3.2 Subsea Unit Mounting

The subsea Subsonus unit is typically mounted on the top of the subsea vehicle and pointing towards the surface, as shown below.

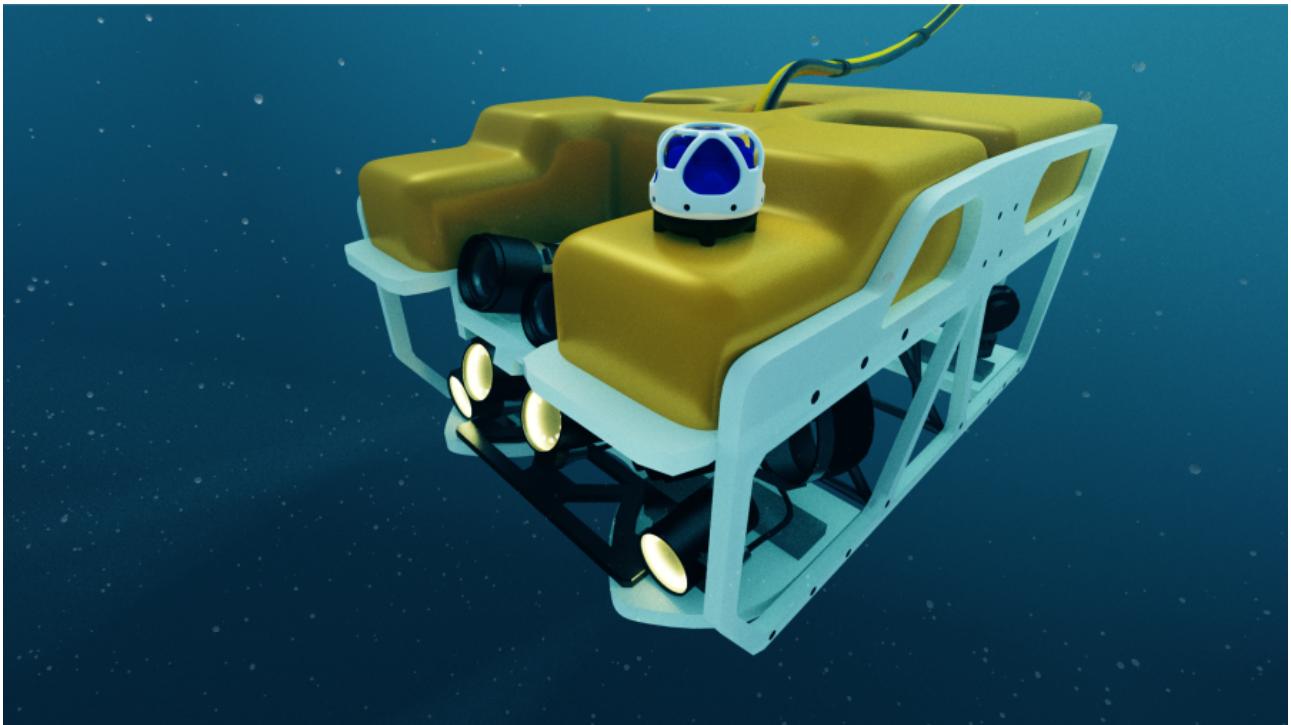


Figure 8: Typical Subsonus subsea mounting

Mounting goals with the Subsea unit are:

1. The Subsonus unit should be mounted on top of the vehicle, with its hydrophone array and cage pointing towards the surface when the subsea vehicle is in a level orientation.
2. The connector on the side of Subsonus needs to be aligned so that it is pointing in the backwards direction of the vehicle, opposite to the direction of travel. There is an arrow on the underside of the unit - this arrow must point toward the front of the vehicle when the Subsonus is mounted.
3. The Subsonus unit should be mounted on the top of the vehicle with minimal obstructions to its view of the surface.
4. The Subsonus unit should be mounted away from propellers, thrusters, and any air/gas exhausts. It should be mounted in a position where it will have minimal air bubbles passing over or above the hydrophones.
5. Subsonus has an internal GNSS antenna in the top of the hydrophone array. Some users may wish to obtain a GNSS fix when the vehicle is surfaced. In order to do so, the Subsonus unit should be mounted high enough on the vehicle that the blue hydrophone array is above the water line when the vehicle is surfaced.

7.4 Surface Unit Reference Source

The surface Subsonus unit requires a source of time, position, velocity and heading data to function. This data can be provided by either a GNSS Compass or a GNSS/INS. There are three options available for the reference source.

1. [7.4.1 Advanced Navigation GNSS Compass](#)
2. [7.4.2 Advanced Navigation GNSS/INS](#)
3. [7.4.3 Third Party GNSS/INS or GNSS Compass](#)

The recommended source is the Advanced Navigation GNSS Compass which will give the best results. Many survey ships will have an existing high accuracy GNSS/INS in which case they can use either an Advanced Navigation GNSS/INS or Third Party GNSS/INS or GNSS Compass option.

When the Advanced Navigation GNSS Compass is used as the reference source, Subsonus operates in full GNSS/INS mode. When a third party GNSS/INS or GNSS Compass is used, Subsonus will operate in AHRS mode and not perform any further processing on the reference data.

7.4.1 Advanced Navigation GNSS Compass



Figure 9: Advanced Navigation GNSS Compass

Advanced Navigation manufactures an all in one GNSS Compass system powered using PoE (Power over Ethernet) that is an ideal reference source for Subsonus. The Advanced Navigation GNSS Compass is supplied with the Subsonus Evaluation Kit. For detailed installation instructions, refer to the [Advanced Navigation GNSS Compass Reference Manual](#).

7.4.1.1 Mounting Options

The GNSS Compass accepts a standard 5/8" survey mount or 4 x M8 panel mount bolts, see [Figure 10: Advanced Navigation GNSS Compass mechanical drawing](#) for mechanical details.

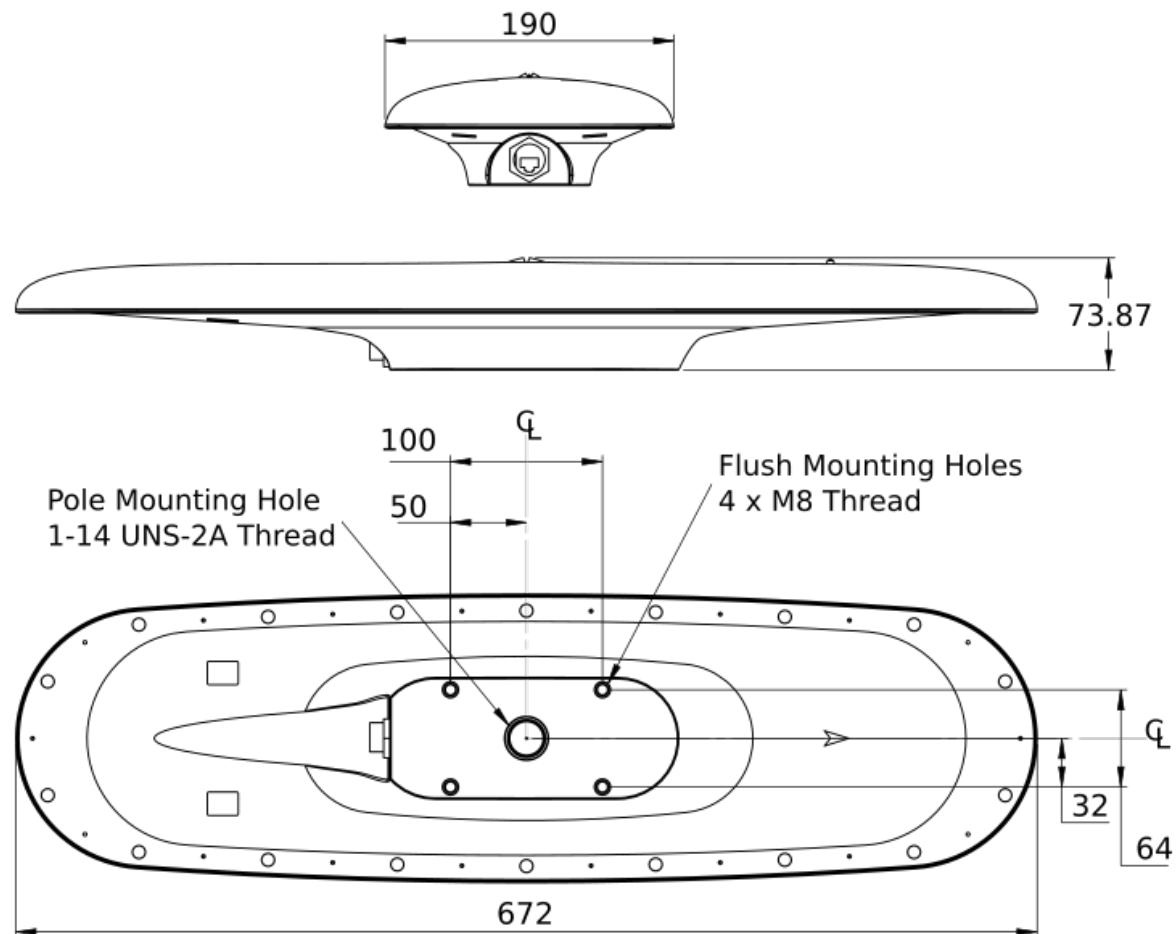


Figure 10: Advanced Navigation GNSS Compass mechanical drawing

The ideal mounting position for the GNSS Compass is on top of the surface Subsonus pole. The mounting alignment between the Subsonus and the GNSS Compass is extremely important, see [Figure 11: Advanced Navigation GNSS Compass mounting](#)

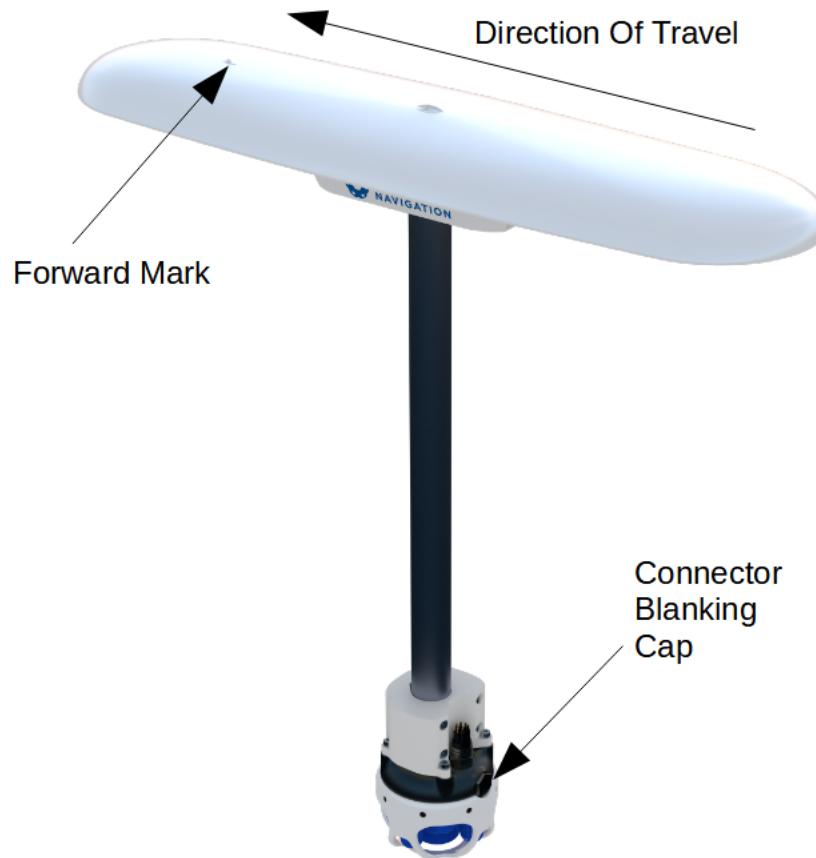


Figure 11: Advanced Navigation GNSS Compass mounting

7.4.1.2 Mounting Position

When planning a mounting location for GNSS Compass, refer to [Mounting location example](#), and be mindful of the following recommendations.

- Mount the unit in clear view of the sky
- Mounting the unit at least 3m from transmitting devices, otherwise they may degrade heading performance due to interference.
- Mount the unit in an area that will not exceed the rated temperature range, and with minimal temperature fluctuations.
- Mount the unit away from high levels of vibration where possible.
- Mount the unit at least 10 cm away (and preferably as far as possible) from sources of dynamic magnetic interference such as high current wiring or large motors for best performance.

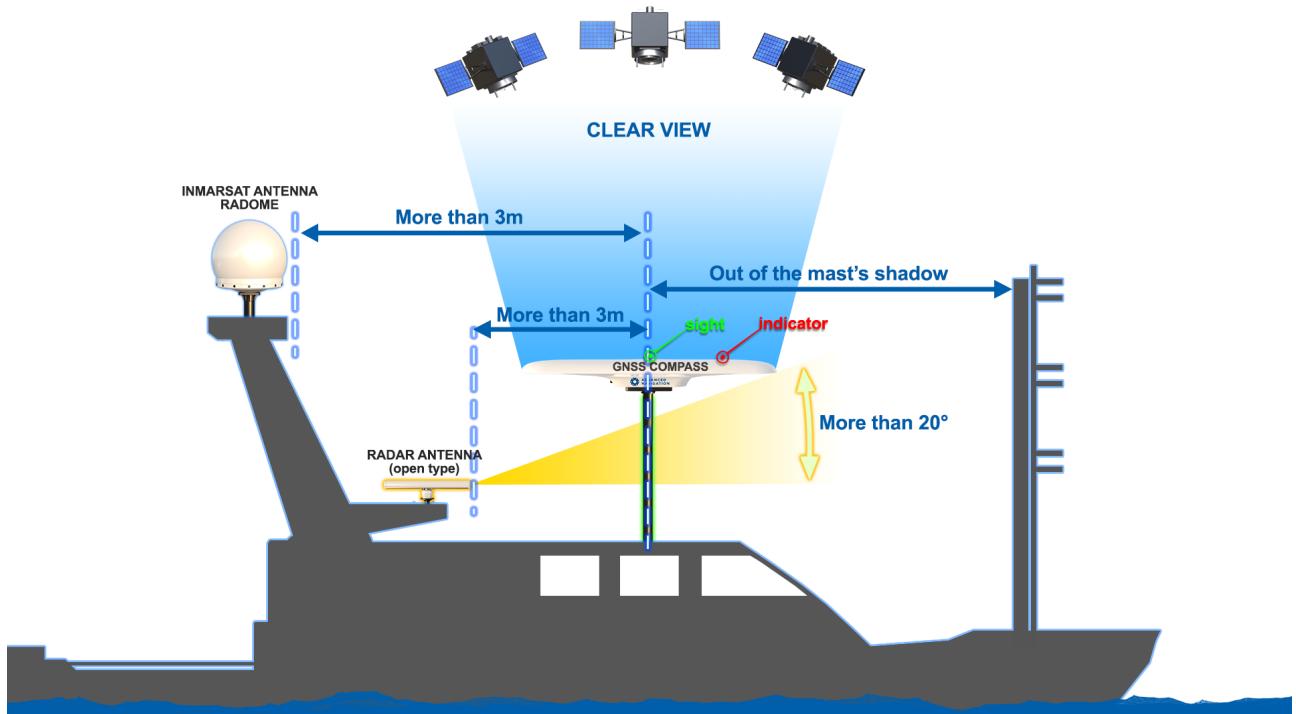


Figure 12: Mounting location example

7.4.1.3 Mounting Alignment

The GNSS Compass should be mounted with its forward indicator pointed in the direction of travel of the vehicle. The connector blanking cap on Subsonus should be pointing in the opposite direction of the GNSS Compass forward indicator, see [Figure 11: Advanced Navigation GNSS Compass mounting](#). It is critical to accurately align the GNSS Compass with Subsonus, and also to align the GNSS Compass unit with the forward direction of the vessel, see [Figure 13: GNSS Compass Alignment](#).

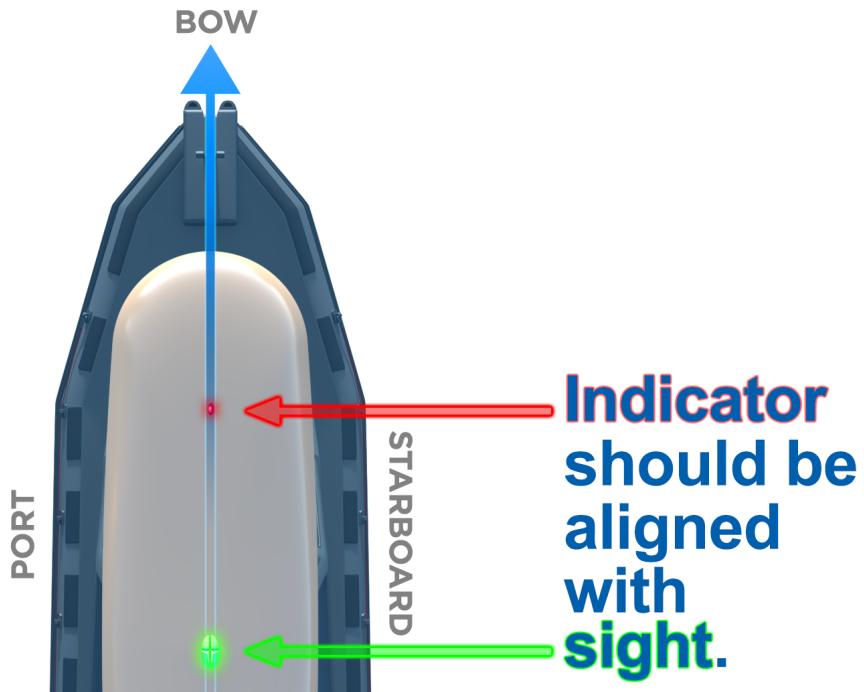


Figure 13: GNSS Compass Alignment

Note: The Subsonus will not function correctly if the GNSS Compass is not correctly aligned to the Subsonus unit. The Subsonus will also not function correctly if the GNSS Compass is not correctly aligned to the vessel. It is extremely important to accurately measure any offsets encountered.

Offset Measurement

Regardless of whether the recommended mounting has been performed, there will be a position offset (lever arm) between the GNSS Compass and Surface Subsonus.

In order to calculate the lever arm between the GNSS Compass for positioning of the Subsonus, the position offset data must be entered during system configuration. Without this information, the position data for the Subsonus will be incorrect. See [Subsonus Surface Unit Reference Source Aiding](#).

Once both units are mounted to the vessel, the offset **from** the Subsonus **to** the base of the GNSS Compass must be accurately measured. If Subsonus and GNSS Compass share a pole for mounting, there will only be an offset in the Z direction.

Toward the bow of the vessel is positive X, to the starboard is positive Y and up is negative Z. See [12.3 The Sensor Co-ordinate Frame](#) and [Figure 14: GNSS Compass and Subsonus Offset direction](#) for more information.

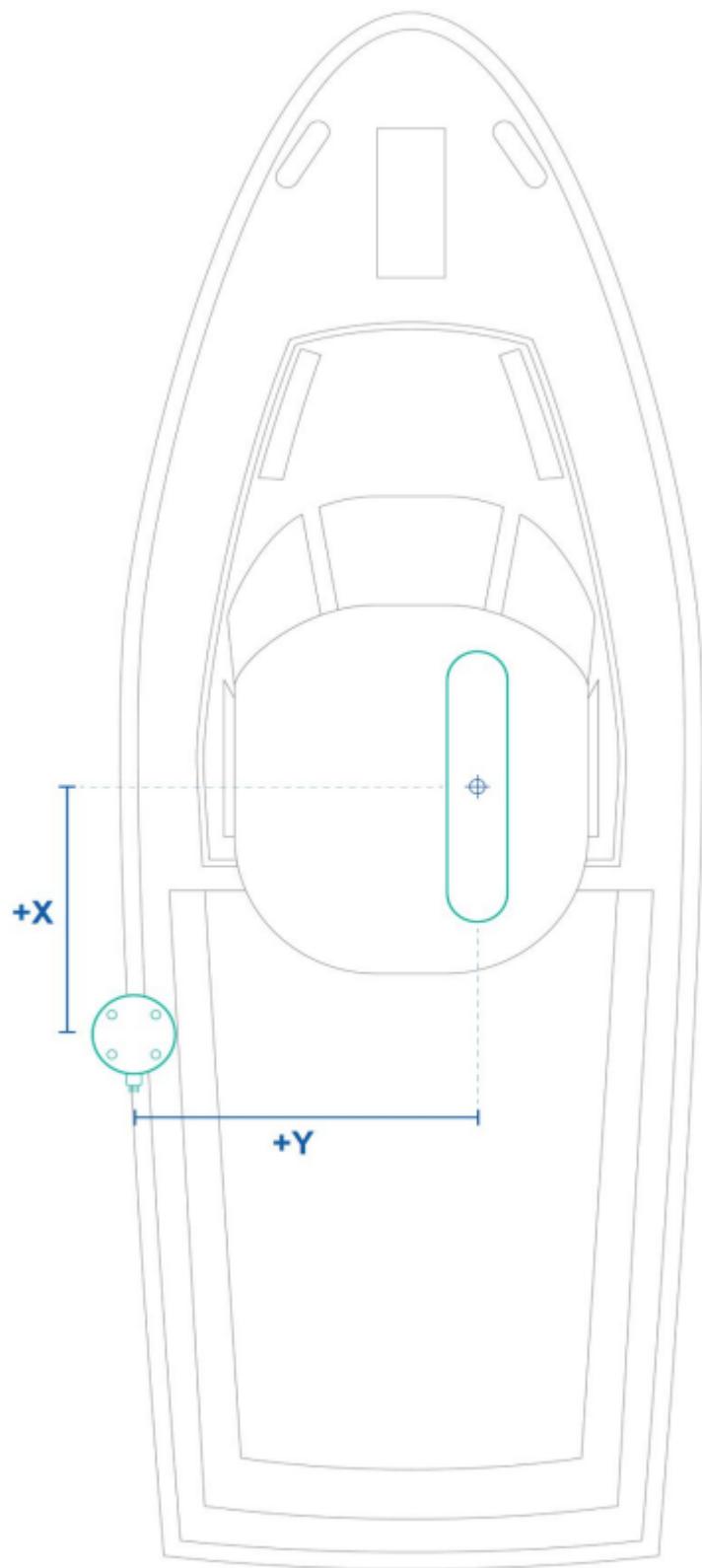


Figure 14: GNSS Compass and Subsonus Offset direction

7.4.1.4 Configuration

Once plugged into the same network, Subsonus will automatically recognise the presence of an Ethernet GNSS Compass, as surface Subsonus units are automatically configured to look for the GNSS Compass data stream using the ANPP. To confirm that the surface Subsonus has recognised and configured the GNSS Compass, open the Subsonus web UI. On the main view, the GNSS Compass should be visible on the Device list on the left hand side of the map. See [Figure 15: GNSS Compass shown in device list](#).

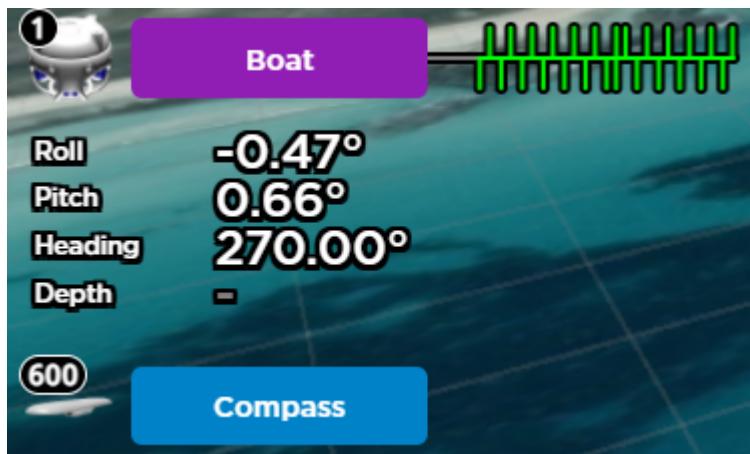


Figure 15: GNSS Compass shown in device list

The GNSS Compass will also appear under “Configuration”→“Devices”. See [Figure 16: GNSS Compass appearing in active devices](#)

If the GNSS Compass does not appear in Active Devices, it must be manually configured. See [Subsonus Surface Unit Reference Source Aiding](#) for information on how to add a new device.

Active Devices

Name	Type	Network	Acoustic Communications	Actions
1 Boat (This Device)	Subsonus	-	-	<button>Configuration</button>
600 Compass	GNSS Compass	Connected Aiding	-	<button>Configuration</button> <button>Delete</button>

Figure 16: GNSS Compass appearing in active devices

7.4.2 Advanced Navigation GNSS/INS

Subsonus supports any of Advanced Navigation's GNSS/INS products. Subsonus will automatically detect the Advanced Navigation device as it does with an Advanced Navigation GNSS Compass. An operator will be required to configure offsets between the devices before use, see [9.1.3.3 Device Configuration](#).

7.4.3 Third Party GNSS/INS or GNSS Compass

Third party GNSS/INS and GNSS Compass systems work with Subsonus if they can output NMEA messages GPZDA, GPGGA, GPVTG and GPHDT. It is recommended that the third party system is able to output NMEA messages at 10Hz, although slower speeds are possible.

If the third party system has an Ethernet interface, it should be configured to send the NMEA messages to Subsonus over a TCP port, please see [9 Interfacing with Subsonus](#).

Note: It is recommended to synchronise the third party device and Subsonus with a PTP or NTP time server

7.5 External Aiding Devices

External aiding devices can be connected to the Subsonus system via Ethernet. The data can then be shared from the subsea unit to the surface via either Ethernet or acoustic signals, see [8.3 Subsonus Data Sharing](#) for more information.

7.5.1 Doppler Velocity Input

A Doppler velocity input such as a DVL can be added to the Subsonus system. Additional velocity data provided by the DVL significantly improves dead reckoning.

Once configured, the DVL data is logged automatically, and the DVL beams and reflection points can be seen in the web UI Main view, see [9.1.1.4 Navigation Visualisation](#).

Advanced Navigation has made configuring a Nortek or Waterlinked DVL simple and streamlined, see [9.1.3.3 Device Configuration](#).

7.6 Subsonus Device Addresses

It is possible to track as many targets as required from a single surface Subsonus unit (which comes at a compromise of interrogation frequency per device). Every Subsonus being operated within a 3km radius must have a unique address otherwise communication collisions will occur. If only one Subsonus is to be tracked, this section can be disregarded as the factory default unit addresses will work out of the box.

Every Subsonus unit has an address which allows units to communicate one at a time. By default, Subsonus units with vertical connectors (typically used as the surface unit) have a device address of 1 and units with horizontal connectors (typically used as subsea units) have an address of 2.

For information on how to assign a device address, see [9.1.3.2 Device Address Configuration](#)

7.6.1 Device Address Identification

To determine the Subsonus device address, the unit must be powered and connected to the Subsonus web UI.

1. Open the local Subsonus web interface
2. Navigate to “Configuration”→“Devices”
3. The number next to the device is the device address. For example, the following Subsonus has a device address of 1:

Active Devices

Name	Type	Network	Acoustic Communications	Actions
 Boat (This Device)	Subsonus	-	-	<button>Configuration</button>

Figure 17: Device Address Identification

If there are any other devices configured to be tracked by the surface Subsonus, these devices will also appear on this page, with their respective device addresses.

7.7 Third Party Acoustic Devices

Subsonus supports operation with a number of third party transponders, beacons and pingers, however, performance will be significantly reduced compared to Subsonus to Subsonus operation. A number of features such as acoustic heading, data transfer, speed of sound gradients and dynamic transmit power will not function with third party equipment.

Contact support@advancednavigation.com to discuss operation with third party equipment.

8 Using Subsonus

This section covers the following topics:

- [8.1 Initialisation](#)
- [8.2 INS Filter Aiding Sources](#)
- [8.3 Subsonus Data Sharing](#)
- [8.4 Out of Water Detection](#)
- [8.5 Water Velocity](#)
- [8.6 Status](#)

8.1 Initialisation

After power on, the Subsonus typically takes 30 seconds to become ready for use. After this time the unit will not be able to start providing navigation data until its filter aiding sources have initialised. The initialisation progress can be monitored from the "View"→"Status" page in the Subsonus web UI, under "Filter Status"→"Initialisation". For normal operation all sections should be initialised, indicated by a green dot. See [Figure 18: Filter Status page](#) below.

Filter Status				
Initialisation	GNSS Status	Active Position and Velocity Sources	Active Heading Sources	Tracking
<input checked="" type="radio"/> Orientation	<input type="radio"/> 2D GNSS	<input type="radio"/> Internal GNSS	<input type="radio"/> Acoustic Heading	<input type="radio"/> Data Connection Active
<input checked="" type="radio"/> Navigation	<input type="radio"/> 3D GNSS	<input checked="" type="radio"/> External GNSS	<input type="radio"/> Magnetic Heading	<input type="radio"/> USBL Tracking
<input checked="" type="radio"/> Heading	<input type="radio"/> SBAS GNSS	<input type="radio"/> Acoustic Position	<input type="radio"/> Velocity Heading	
<input checked="" type="radio"/> Time	<input type="radio"/> Differential GNSS	<input checked="" type="radio"/> Pressure Depth Position	<input checked="" type="radio"/> Dual Antenna Heading	
<input checked="" type="radio"/> Pressure Depth	<input type="radio"/> Omnistar GNSS	<input checked="" type="radio"/> External Position	<input type="radio"/> External Heading	
<input checked="" type="radio"/> Velocity Of Sound	<input type="radio"/> RTK Float GNSS	<input type="radio"/> Fixed Position	<input type="radio"/> Fixed Heading	
	<input checked="" type="radio"/> RTK GNSS	<input type="radio"/> Fixed Roll Pitch		
		<input type="radio"/> External Velocity		
		<input checked="" type="radio"/> Pressure Depth Velocity		

Figure 18: Filter Status page

8.2 INS Filter Aiding Sources

The INS filter in Subsonus can accept position and velocity aiding from multiple sources. These filter aiding sources can be configured in the web UI - see [9.1.3.4 Filter Aiding](#)

8.2.1 GNSS Compass

A GNSS Compass is most commonly used to provide a vessel mounted Subsonus unit with absolute position, velocity and heading. When using the Advanced Navigation GNSS Compass as an aiding source it will typically initialise within 5 minutes. Detailed information about the satellite constellations, fix type and system health can be viewed in the web UI of the GNSS Compass.

8.2.2 Acoustic Positioning

The USBL hydrophone array in Subsonus resolves angles and distances underwater. Typically a pair of Subsonus units are operated together in bi-directional acoustic communication to resolve relative positioning between the two devices and transfer navigation data.

A Subsonus configured as a slave device is positioned with respect to a master unit that also has access to an absolute world coordinate system reference such as GNSS or a fixed location. The USBL and acoustic modem functions of Subsonus can then transfer the absolute position data from the master Subsonus to the slave Subsonus.

A Subsonus will start acoustic positioning within 10 seconds of the hydrophone array being submerged underwater and acoustic contact with another Subsonus unit being established.

8.2.3 Acoustic Heading

A unique feature of Subsonus is its ability to transfer heading data acoustically. The bi-directional measurement and communication between two Subsonus units equipped with USBL hydrophone arrays allows the known heading of a vessel mounted surface Subsonus unit to be transferred to a subsea Subsonus unit. The integrity of this acoustic heading data is significantly better than magnetic heading sensors which are prone to disturbance from nearby metal objects.

The acoustic heading feature is enabled and active by default.

8.2.4 Pressure Depth

Subsonus contains a pressure depth sensor that can measure up to 100 bar. The sensor can provide both position and velocity aiding to the navigation filter. To use the position aiding capability the pressure sensor offset must be set before submerging Subsonus. This offset can be set on the filter aiding configuration page "Configuration"→"Filter Aiding", see [9.1.3.4 Filter Aiding](#).

8.2.5 Magnetic Heading

Subsonus contains a magnetic heading sensor which can be used when a more accurate aiding source such as GNSS or acoustic heading is unavailable. The magnetic heading features automatic calibration that occurs continuously when a second heading source is available. In the event that the Subsonus unit is going to be mounted in the presence of a strong magnetic interference source (such as close to a motor or high current wiring) then the magnetic heading should be disabled. This can be done on the filter aiding configuration page. If magnetic heading is disabled Subsonus will maintain heading using its gyroscopes in conditions where acoustic heading is unavailable.

8.2.6 Internal GNSS

The Subsonus contains an internal GNSS receiver and antenna mounted in the top of the hydrophone array. If the Subsonus is out of the water with the hydrophone array facing the sky the system will typically acquire a 3D GNSS fix within 30 seconds. This will be displayed as an aiding source on the "view"→"status" page. The internal GNSS receiver can be disabled on the filter aiding page. See [9.1.3.4 Filter Aiding](#).

When Subsonus is taken below the water level the GNSS positioning will stop since the GNSS satellite signals cannot penetrate water. The USBL acoustic positioning will take over at this point. When the unit breaches the water surface again the acoustic positioning will cease and Subsonus will automatically start using the internal GNSS positioning again.

8.2.7 External Data Sources

Subsonus can be configured to use external aiding data from other instruments such as external velocity from a DVL. Please contact support@advancednavigation.com for further information about using external data

aiding with Subsonus.

8.3 Subsonus Data Sharing

Subsonus can share data via an Ethernet network, or acoustically. The data sharing method for a tracked device can be seen in the Device information window of the Subsonus Web UI. See [Tracked Devices Configuration](#)

8.3.1 Networked

8.3.1.1 Network Link Feature

The Subsonus Network Link feature enables automatic high-speed data communication between Subsonus units connected to the same Ethernet network. The purpose of this feature is to maximise performance in applications where a network data link already exists between the two units. A common example is the use of an ROV tether connection to link a Subsonus mounted on the vessel to a Subsonus being tracked on the ROV.

Network Link increases navigation performance by transporting all navigation data that would normally be transmitted acoustically between two Subsonus units. The increase in bandwidth permits a much faster update rate of all navigation data parameters used by the Subsonus INS. It also allows acoustic position updates to occur more frequently by increasing the ping rate.

Network Link will automatically detect the presence of a connection between the Ethernet interfaces of two tracking Subsonus units and begin working. If a problem with the Ethernet connection occurs the units will return to using the acoustic data connection.

8.3.1.2 Example ROV Network Connection Diagram

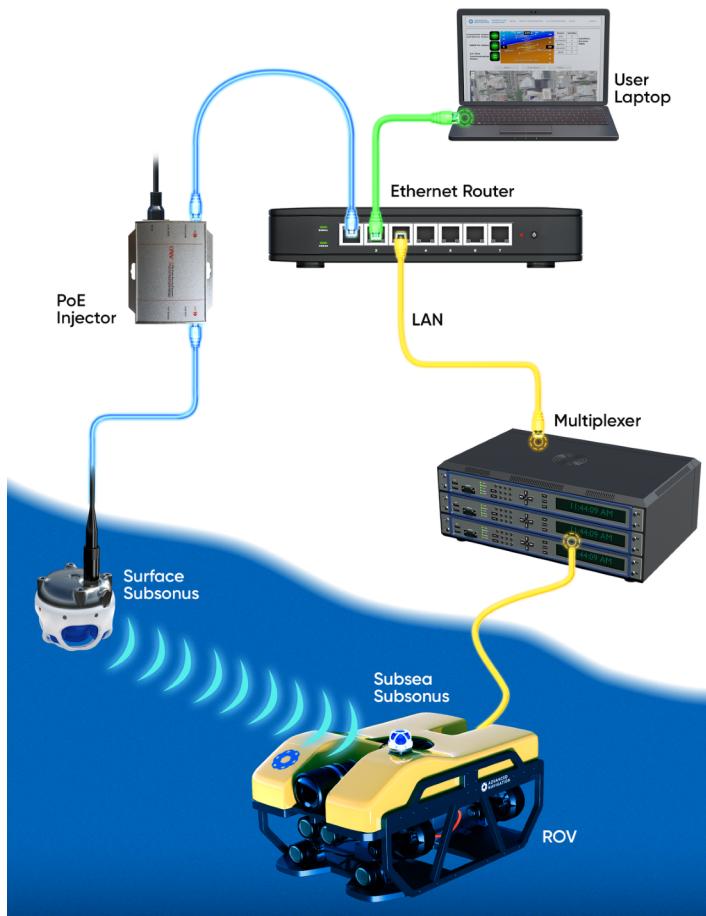


Figure 19: Example ROV Network Connection Diagram

8.3.2 Not Networked

When Subsonus is not connected to an Ethernet network, the device functions as an acoustic modem and transports data using acoustic signals. The transfer of navigation data is much slower when using acoustic communication than when the unit is networked.

When a network connection is lost but power is still connected and available, Subsonus will automatically default to acoustic data transfer.

8.4 Out of Water Detection

By default, Subsonus automatically detects when it is out of water and enters low power mode. This is indicated by an alert in the status summary in the Web UI main view. See [9.1.1 Main View](#) for more information on the status summary.

All system functions remain fully operational out of the water, however the unit needs to be submerged in order to enable acoustic communications and for tracking to work. When the system is returned to water it will automatically switch back to full power mode within 20 seconds.

The Subsonus should be kept cool whenever it is out of the water and powered on, especially for extended periods of time. In the event that Subsonus is subjected to temperatures beyond its operating limits, it will safely

shut down to protect itself. In case of an over-temperature shutdown event, the power must be cycled to restart operation once the unit has cooled down.

Note: To change the default behaviour of entering low power mode when out of water, navigate to **Configuration → System** and check or uncheck the **Enable low power mode when out of water** check-box. Depending on how Subsonus has been configured, this may or may not require you to be logged in.

8.5 Water Velocity

If Subsonus is fitted to a vessel or vehicle that is capable of traveling at speed, the velocity of the water flowing over Subsonus should be considered. As the velocity increases, the noise produced by water flow can reduce the acoustic performance of Subsonus. Typically speeds below 5kn will not affect performance.

Speeds between 5 and 10kn will experience a reduction in acoustic sensitivity (tracking range) and increased measurement noise (position error). The impact can be monitored using the signal performance monitoring fields available in the track packet. For advice about applications where Subsonus could be subjected to water speeds above 10 knots. Contact support@advancednavigation.com before beginning operation.

8.6 Status

The Subsonus Status page shows the current system health in the form of System Status and Filter Status. See [9.1.2.1 Status Page](#)

8.6.1 System Status

System status shows any problems or system failures. See [11.4.1.1 System Status](#)

8.6.2 Filter Status

Filter status shows the INS filter status. See [11.4.1.2 Filter Status](#)

9 Configuring and Monitoring Subsonus

Subsonus can be configured and monitored through:

- the Web user interface, accessed on a connected computer via Ethernet. See [9.1 Using the Web UI](#)
- Subsonus Tools, accessed on a computer. See [9.2 Using Subsonus Tools](#)
- the Advanced Navigation Packet Protocol ([ANPP](#))

The Subsonus Web UI is the recommended interface to configure the Subsonus as it is designed to be simple and easy to use without any software or system requirements. It should work with most Windows, MacOS and Linux operating systems.

9.1 Using the Web UI

The following section provides information and step-by-step guides on how to configure Subsonus units using the web UI.

9.1.1 Main View

The Main View of the web UI allows visualisation of acoustic tracking and navigation on a live, interactive 2D or 3D view.

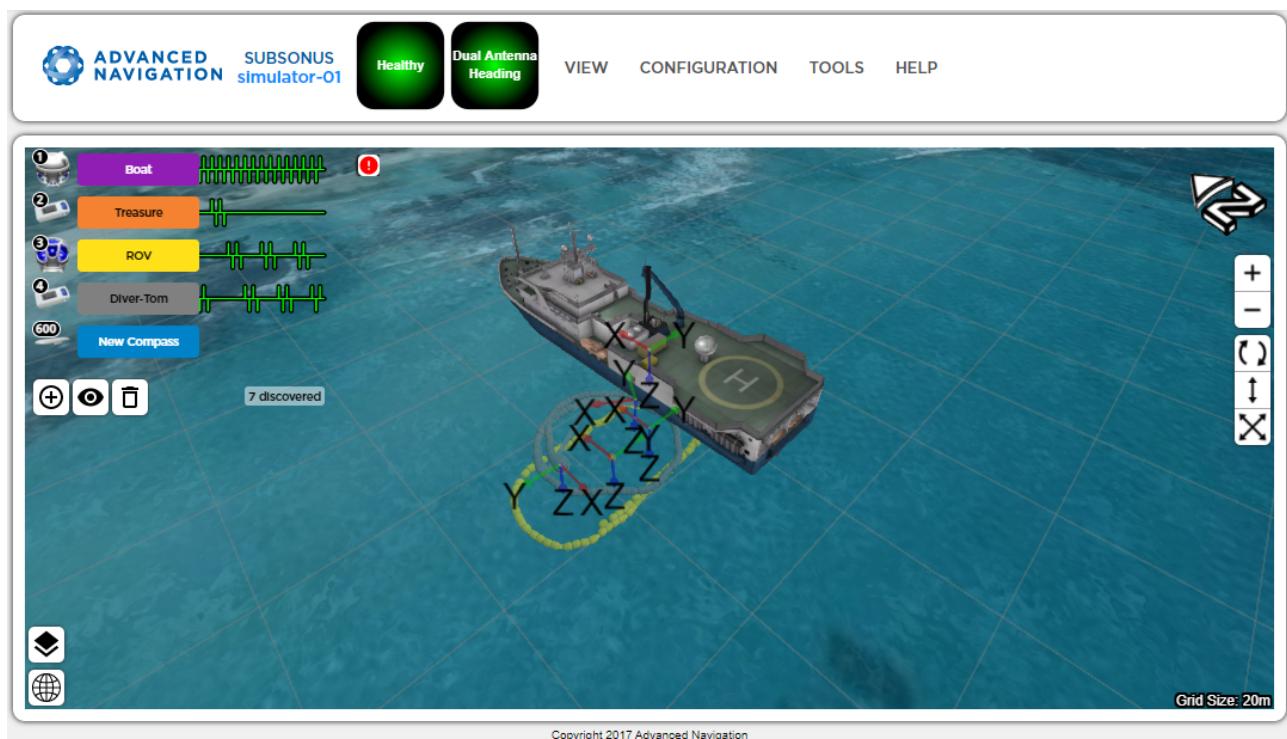


Figure 20: Web UI Main View

9.1.1.1 Menu Bar

The menu bar will be visible on all pages. This menu is used to navigate between pages, and displays a status summary of the device.



Figure 21: Menu Bar

Status Summary

The menu bar displays a status summary of the device. A summary of warnings, errors and alerts will be displayed in this indicator. The left indicator indicates system status and the right indicates filter status. The summary indicator can be clicked on to navigate to the status page.



Figure 22: Status Summary



Figure 23: System Status Failure



Figure 24: Filter Status Warning



Login/Logout

Subsonus supports a user system that allows control of the device to be password protected when enabled. If this system is enabled the Menu bar will display a “Login” or “Logout” control.

9.1.1.2 Device List

The main view displays a list of devices including acoustically trackable targets and way-point markers. Devices are listed on the main view on the top left of the screen, only devices that can be displayed in the view are listed. The device list can be expanded to display live information about a device, to do this click on the name of the device to expand.

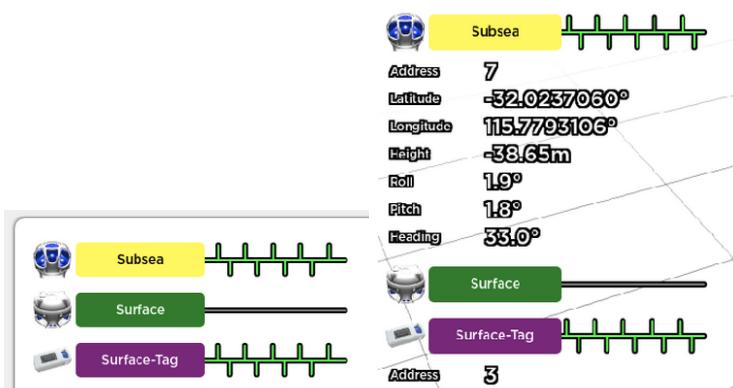


Figure 25: Collapsed device list

	Subsea	
	Surface	
	Surface-Tag	

Figure 26: Expanded device list

Tracking Indicator

Acoustic tracking is indicated by the green trail with upward and downward ticks beside the device name. Each upward tick indicates an interrogation from the master to the slave and is displayed on the trail of both units involved in the conversation. A reply to an interrogation is indicated by a downward tick. The trail scrolls from right to left with the rightmost tick indicating the most recent acoustic interaction. With only two units periodic up and down ticks indicate healthy acoustic communication.

An untracked device will display a greyed out trail.

Tracking can be started and stopped for devices by clicking on the tracking trail for that device. Stopping tracking by clicking on the trail requires confirmation be given.

If the master unit has not discovered a track target it will run acoustic discovery, this is indicated on the trail with upward ticks spaced apart wider than normal.

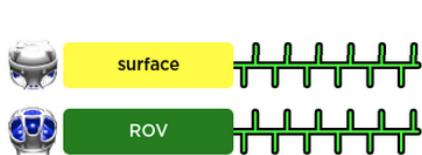


Figure 27: Healthy tracking, one slave

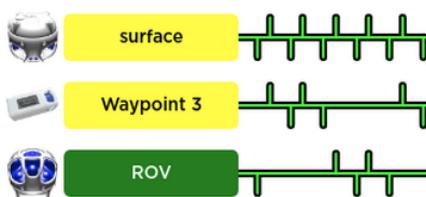


Figure 28: Healthy tracking, two slaves

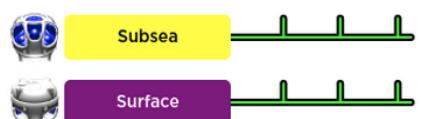


Figure 29: Slave not replying

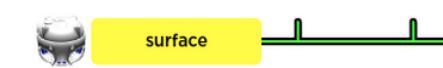


Figure 30: Master running discovery

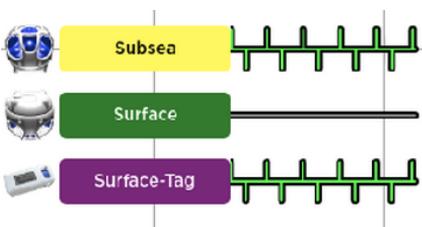


Figure 31: Untracked device



Figure 32: Stop tracking confirmation

Live Data Display

Live data related to the tracked device can be displayed in the device list by clicking on the device name. The type of data displayed can be changed to display absolute data such as Latitude, Longitude and Height and relative data, such as the North, East and down distance between the Subsonus and its tracking target. Also available is an ROV pilot profile.

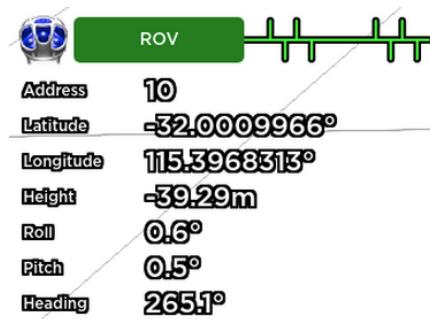


Figure 33: Absolute reference display

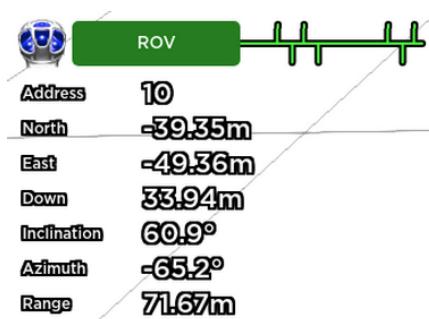


Figure 34: Relative reference display

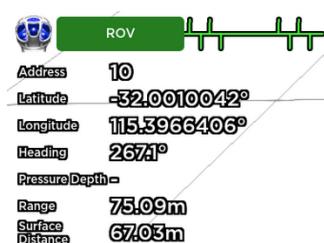


Figure 35: ROV Pilot display

9.1.1.3 Right Click Menu

Devices in the view or on the device list can be configured via a mouse right click menu. If the selected device is unclear when right clicking on the main view the right click menu will display a list of devices allowing selection of the desired device.

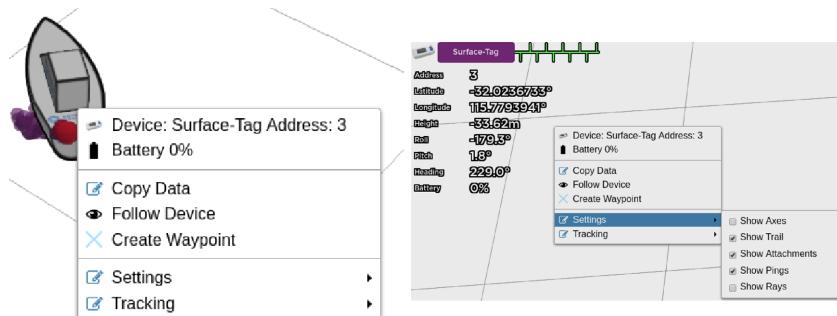


Figure 36: Device right click menu

Figure 37: Device list right click menu

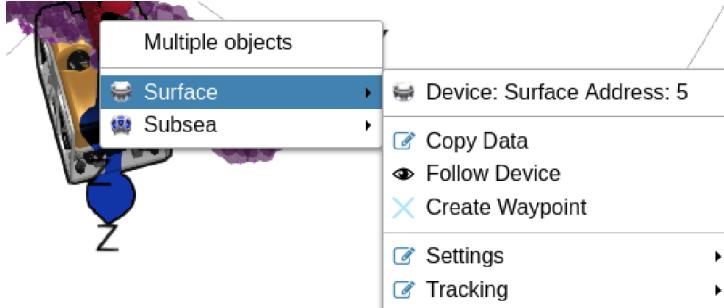
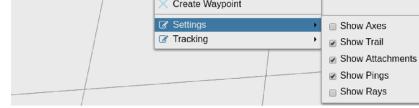


Figure 38: Multiple object right click menu

Follow Device

The “Follow Device” button in the right click menu can be clicked to focus the scene camera on that device, zooming in will then zoom towards the followed device. Dragging the view or clicking “Stop Following Device” device on the right click menu to disable this behaviour.

Waypoints

Waypoints can be created in the view by clicking the “Create Waypoint” button on the Right Click Menu. When clicked a position marker is created at the most recent position that the device was observed.

A Waypoint can then be seen in the device list with the absolute position in the device data display.

Waypoints can also be deleted via the right click menu.

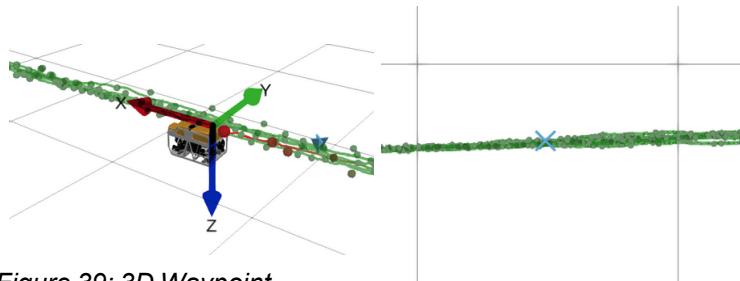


Figure 39: 3D Waypoint display

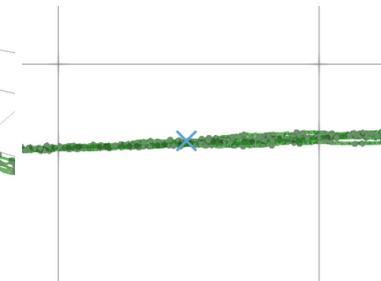


Figure 40: 2D Waypoint display

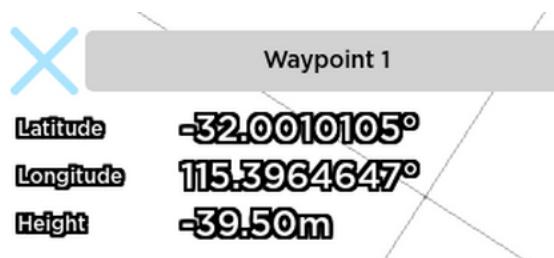


Figure 41: Waypoint device information

Copy Data

Live Display data can be copied from the view, for a device, at any time by clicking the “Copy Data” button on the Right Click Menu. Clicking this button will place the latest values displayed in the live data display onto the computer clip-board, this can then be pasted into any text editor.

Absolute Data Copied	Relative Data Copied	ROV Pilot Data Copied
Device: ROV Address: 9 Latitude: -32.0010029° Longitude: 115.3966731° Height: -39.53m Roll: -1.6° Pitch: -0.5° Heading: 268.1°	Device: ROV Address: 9 North: -1.64m East: -123.40m Down: 33.82m Inclination: 75.6° Azimuth: -60.6° Range: 127.96m	Device: ROV Address: 9 Latitude: -32.0010165° Longitude: 115.3963014° Heading: 264.3° Pressure Depth: - Range: 133.12m Surface Distance: 128.75m

Figure 42: Subsonus track target copied data example

9.1.1.4 Navigation Visualisation

Subsonus classes navigation as a continuous trail of positions produced by a navigation filter or INS. This is represented on the main view as a line trail.

Spheres on the trail reflect acoustic position updates. The spheres will be larger along with a thicker trail for recent updates and smaller and thinner for historical data.

Multiple devices with valid navigation solutions can be displayed in the main view. A particular device can be followed closely in the main view by right clicking and selecting “Follow Device”. Once being followed, the device will remain centered in the view.

To change the colour of the trail for a particular device, select settings icon next to the device in the Device List, see [9.1.1.2 Device List](#)

Navigation data can be displayed or hidden for all applicable devices in the Device List of the in the main view.

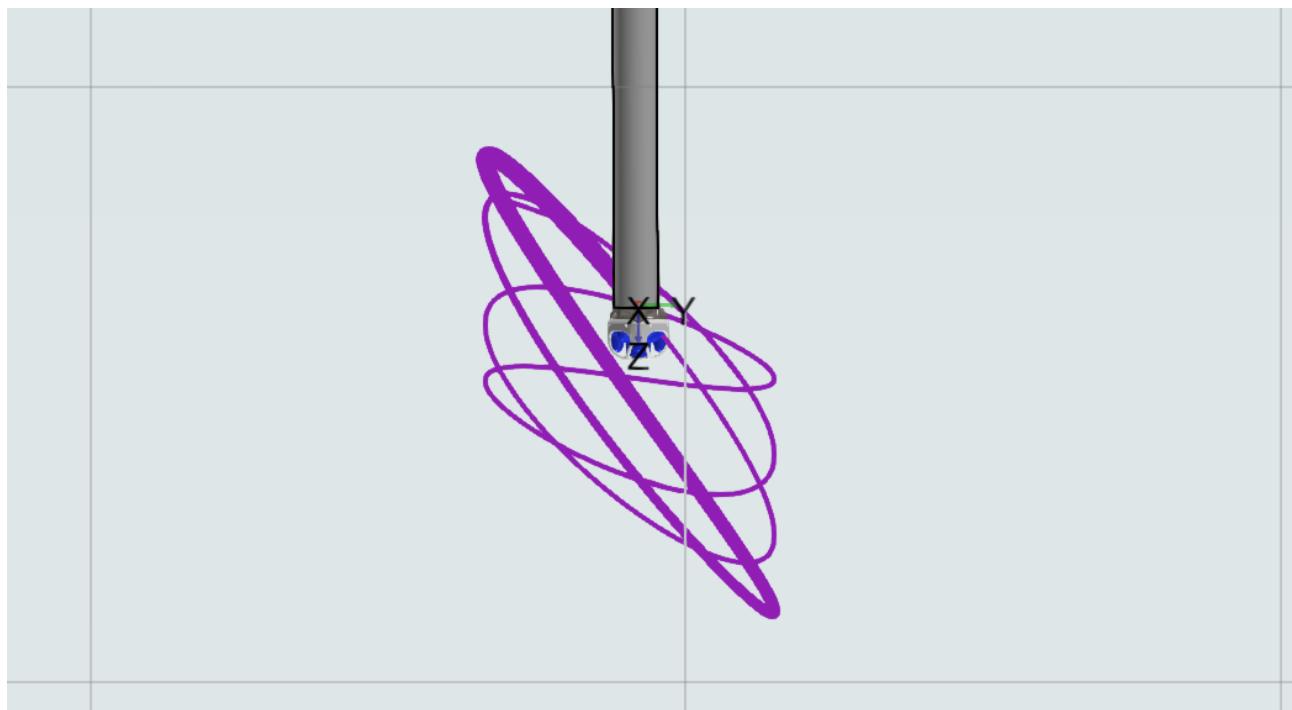


Figure 43: Surface Subsonus navigation trail example



Figure 44: Subsea device navigation trail example

9.1.1.5 Display Settings

To change profiles click on the “Settings” button, this button appears when hovering the mouse over the live data display. Once in the settings menu select the display mode from the “Info Display Mode” drop list. To return to the live data display press the back button.

Within the settings menu, data display settings can be set. To change the colour of each device's trail, select the desired colour from the dropdown.

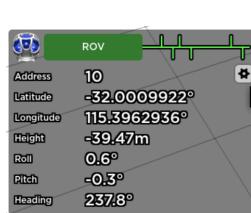


Figure 45: Settings button

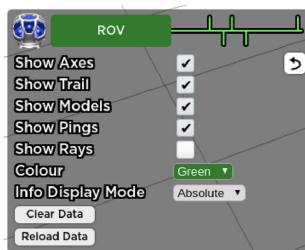


Figure 46: Settings display

Axes Visualisation

Axes are displayed on devices that are orientation aware in the view, such as Subsonus and Subsonus Tag. These axes indicate the orientation of the device, with after alignment correction is applied. Changing orientation will rotate the axes in 3D giving a live orientation update. Axes will automatically scale in the view to be visible from any zoom level.

Display of the Axes can be toggled on and off for each device using the "Show Axes" tickbox in the device display settings menu or from the right click menu.

Acoustic Position Visualisation

The web UI displays acoustic positions as spheres in the main view, acoustic position updates are normally non periodic and update less often than a navigation solution. Here, the trail can also be turned on and off, allowing for only the acoustic ping spheres to display.

Acoustic positions can be displayed or hidden for all tracked devices via the "Show Pings" tickbox in the device display settings menu.



Figure 47: Acoustic positions with navigation trail

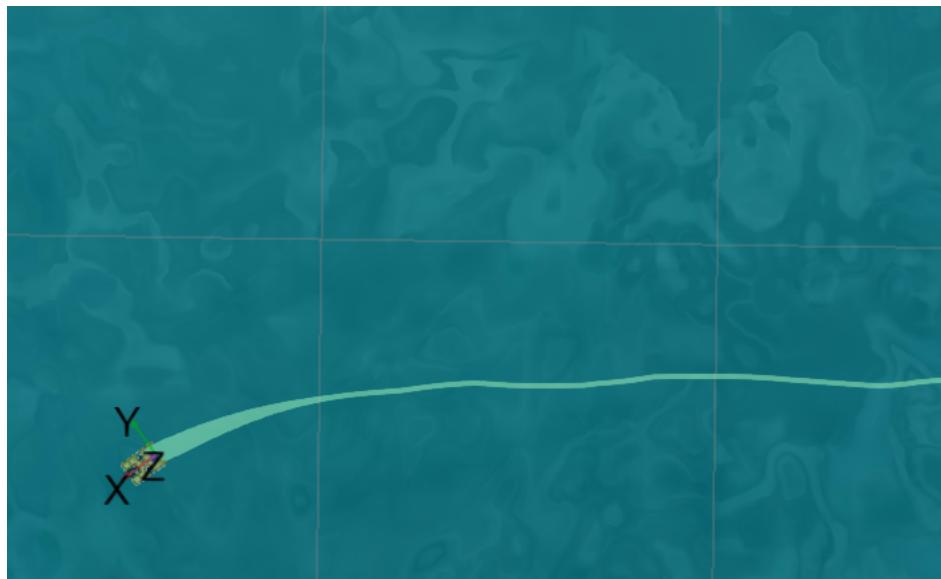


Figure 48: Acoustic position only

Acoustic Rays

Acoustic positions or ping's can be visualised in the view with rays from the surface Subsonus to the target. This visualisation is especially useful for track targets that don't have range information, such as emergency beacons. Rays are visible by default on beacons (sends a transmit periodically) and off by default on transponders (reply to an interrogation from Subsonus).

Display of rays can be toggled on and off for each device using the "Show Pings" tickbox in the device display settings menu.

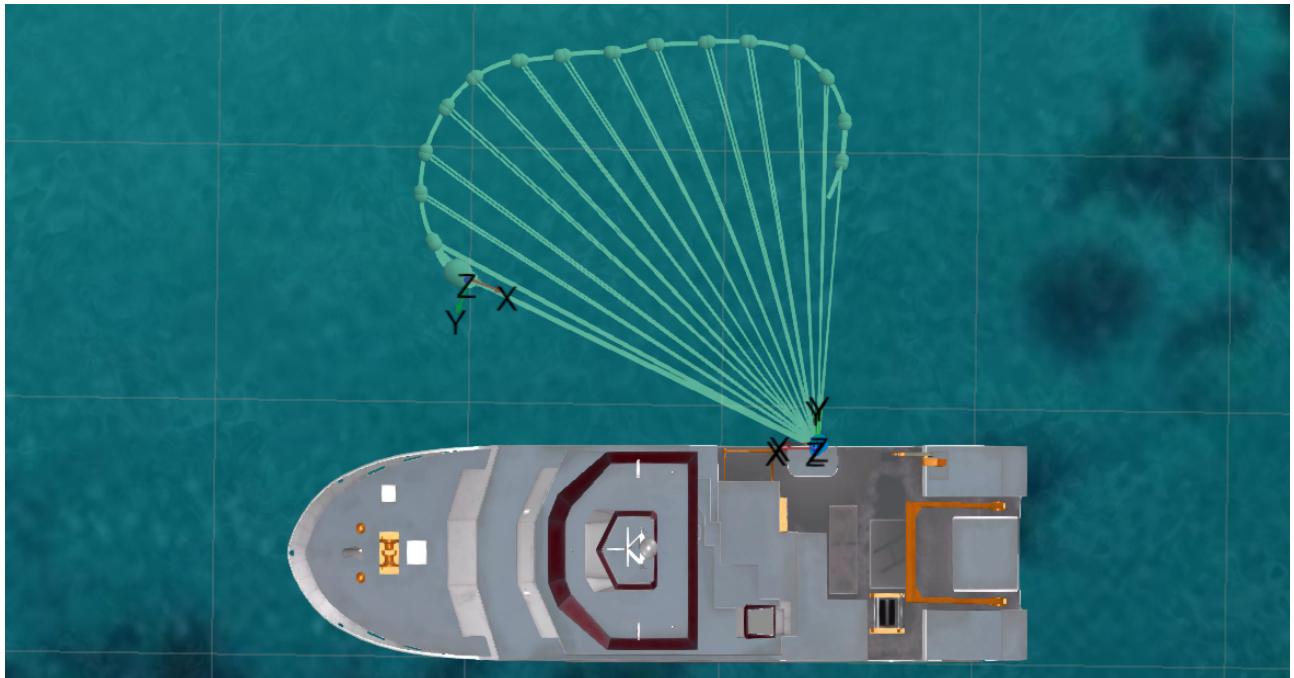


Figure 49: Rays displayed on Subsonus

DVL Pings, Velocities and Cones

DVL pings and velocity vectors are displayed as rays from the DVL, and spheres at the endpoint of each ray. Cones are displayed using transparent cone shapes that fall along the line of the velocity displays. All three DVL visualisation tools are visible by default.

Display of pings can be toggled on and off for each device using the "Show DVL Pings" tickbox in the device display settings menu, velocities are toggles using the "Show DVL Velocities" tickbox, and cones with the "Show DVL Cones" tickbox.

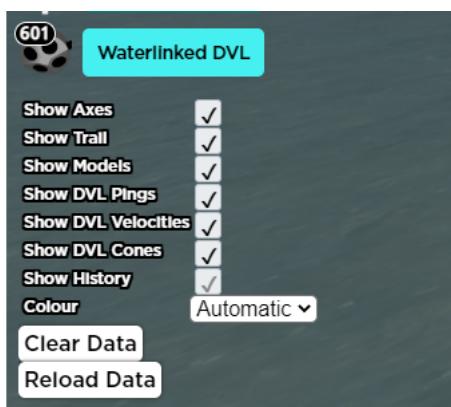


Figure 50: Display Settings in main view for DVL

With all three display settings enabled, each DVL on the main view will be displayed as follows:



Figure 51: DVLs with Pings, Cones and Velocity Displays Enabled

Attached Model Display

Subsonus, Subsonus Tag and Way-point devices in the view can have models attached, allowing visualisation of the environment in the 3D view, see section [9.1.3.3 Device Configuration](#) on how to attach models. By attaching models to Waypoints, a 3D environment can be created for a job.

Display of the attached models can be toggled on and off for each device using the "Show Models" tickbox in the device display settings menu or from the right click menu.

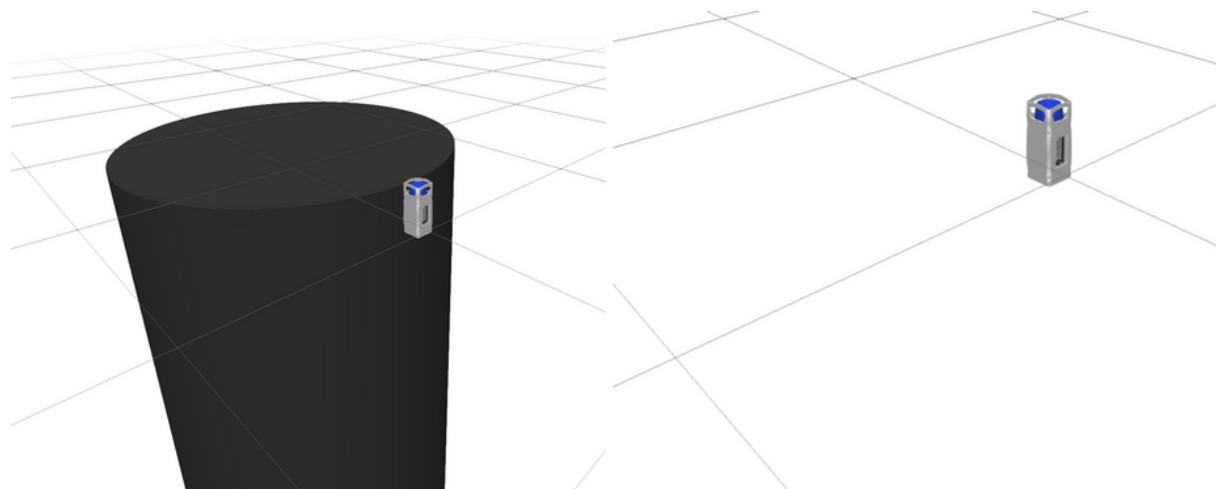


Figure 52: Subsonus Tag with cylinder model attached

Figure 53: Subsonus Tag with no model attached/hidden model

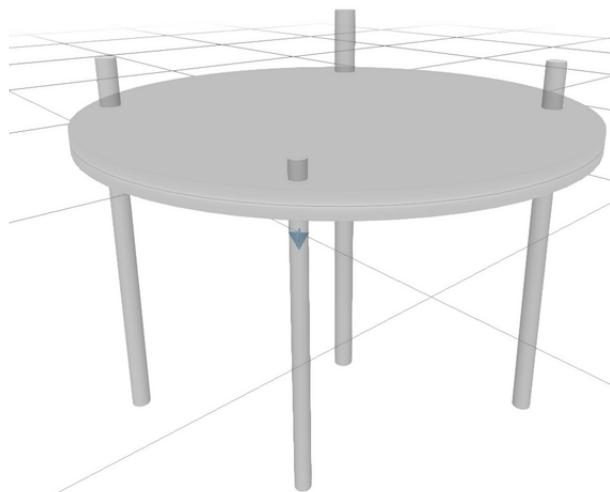


Figure 54: Fixed position way-points with models attached

9.1.1.6 Camera Controls

The camera in the scene can be controlled using a mouse and modifier keys on a keyboard.

Lateral Translation

To move the camera in the scene left click the mouse button and drag up and down, left and right. Release the button to cancel translation.

Orientation

Orientation/view angle of the camera can be changed by clicking the middle mouse button and dragging the mouse. Holding the “CTRL” key or enabling the “Rotation Lock” button in the top right of the screen then clicking the left mouse button and dragging the mouse.

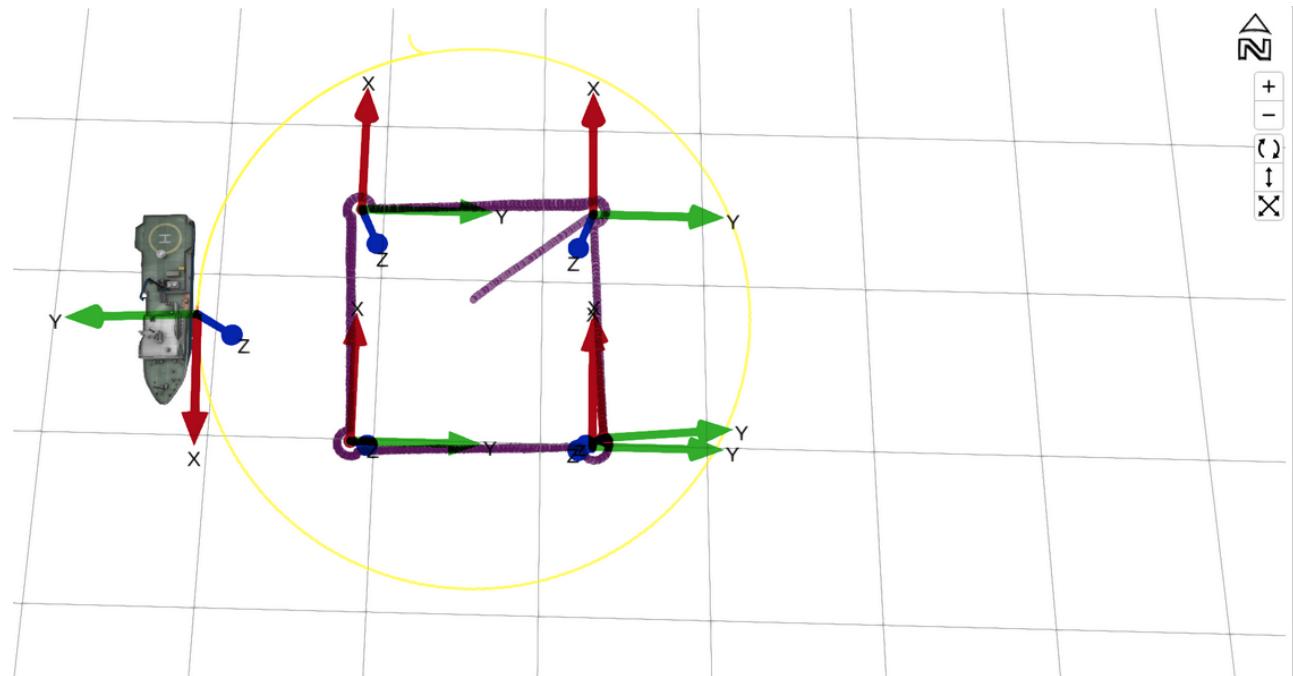


Figure 55: Start of rotation

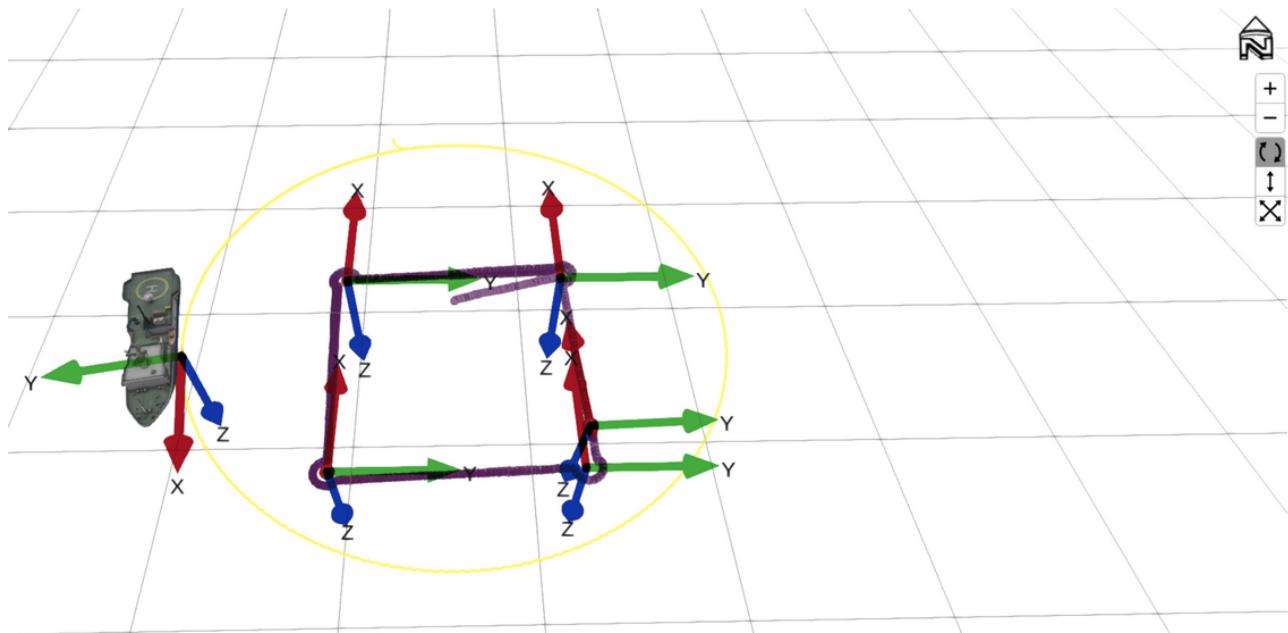


Figure 56: Mid rotation, note rotation button selected

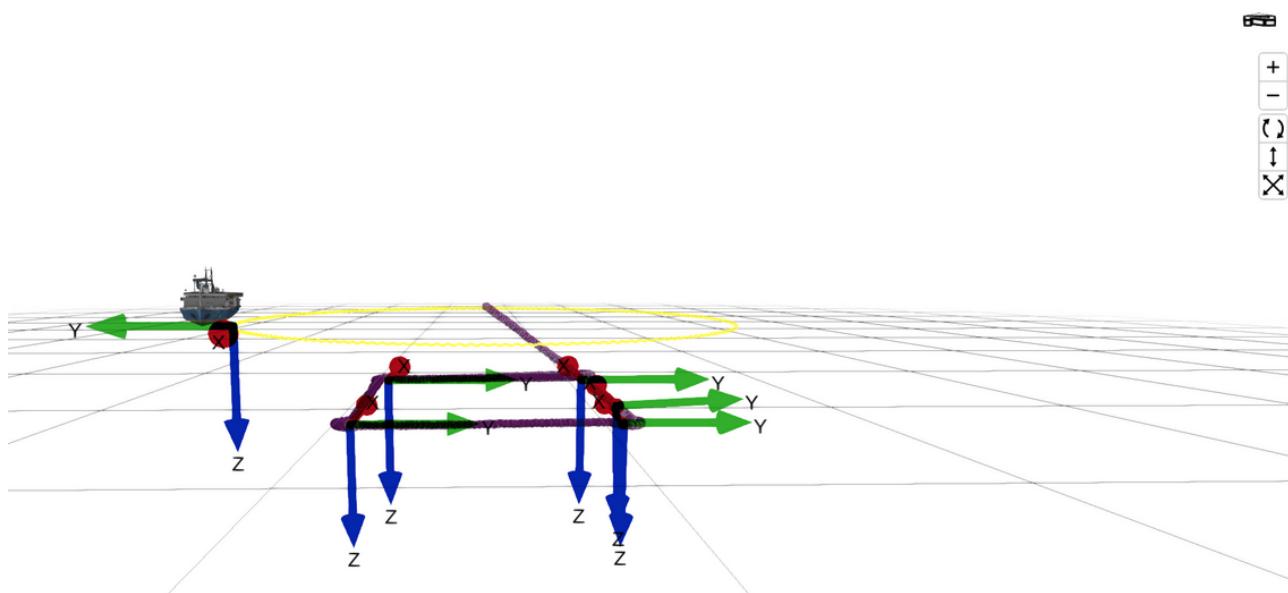


Figure 57: End of rotation

Vertical Translation

The virtual “ground plane” that the grid, visible in the scene, rests on can be translated vertically up or down by holding the “Shift” key or enabling the “Vertical Move” button in the top right of the screen then clicking the left mouse button and dragging the mouse.

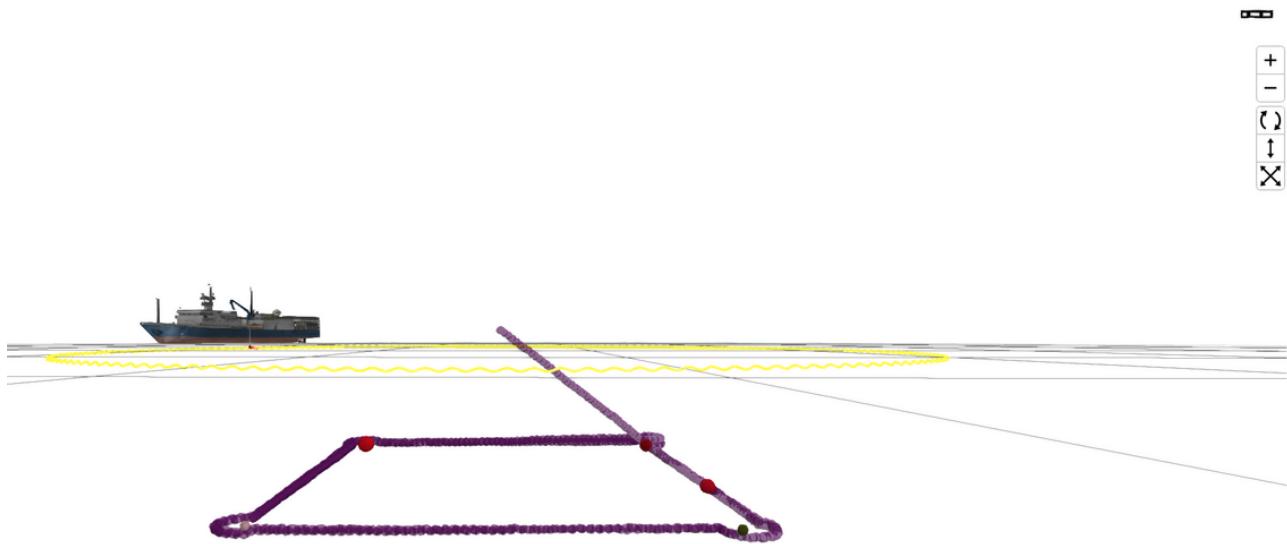


Figure 58: Start, grid at bottom of boat

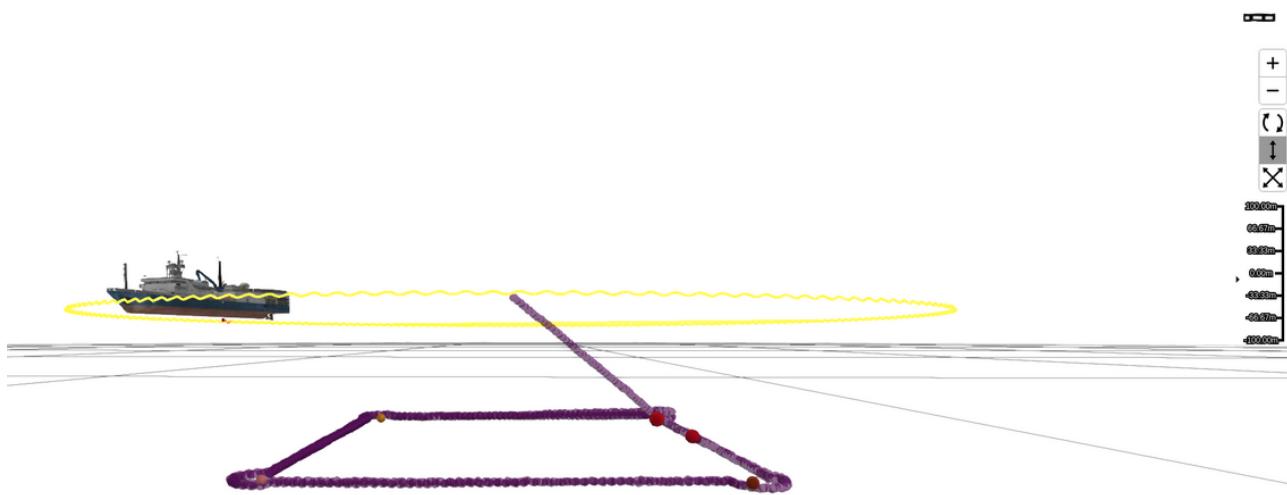


Figure 59: Moving grid, button toggled and scale visible

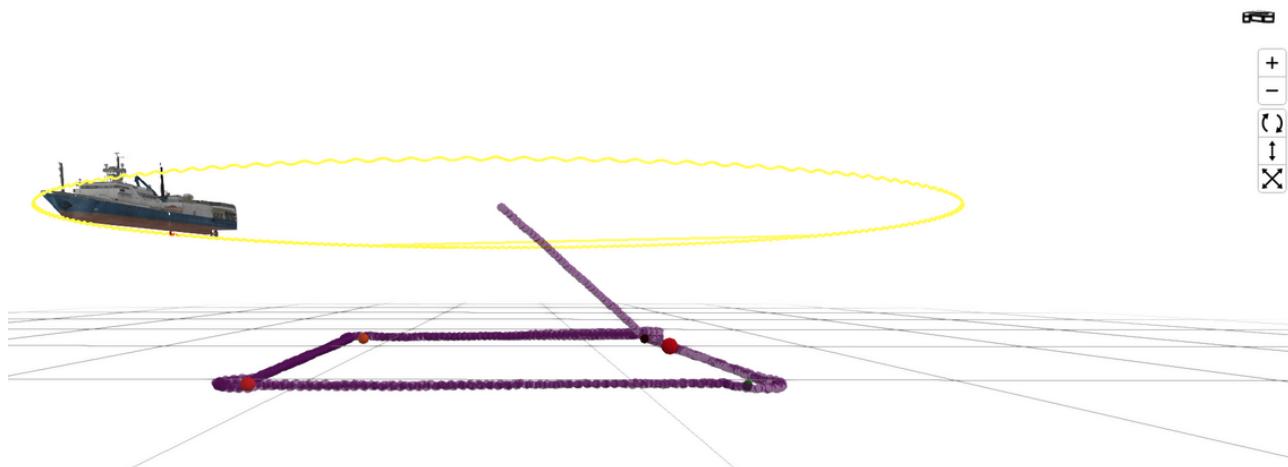


Figure 60: Grid moved, level with ROV track

Zoom

The camera can be zoomed in or out by scrolling the mouse wheel, pressing the “+” and “-” buttons on the keyboard or by clicking on the “+” and “-” buttons in the top right of the screen. The camera will zoom towards or away from the device being followed.

Zoom in and out buttons

Fit Scene

The camera controls allow a user to automatically recentre the camera to include all devices in the field of view by pressing the “Fit scene” button or pressing space-bar on the keyboard.

Fit scene button

2D/3D Switch

The main scene can be switched to display in 2D or 3D, this can be done by clicking on the “North Arrow” indicator to toggle between the modes.

In 2D Mode the scene can be viewed from the top down, or from each side facing the cardinal directions. To switch between these views the arrow buttons on the keyboard can be used, or the camera rotation can drag between 2D view snap points.

North arrow, 3D mode

North arrow, 3D rotated

2D view, top down indicator

Facing North

Facing East

Facing South

Facing West

3D Grid/Radar Display

The 3D view can be configured to display a Grid or Radar style plot on its ground plane.

The selected display can be changed on the “Configuration”→“Display” page.

The Grid view is locked to an absolute reference and the positions of the grid lines do not change. The grid scale in metres is displayed in the bottom right of the view.

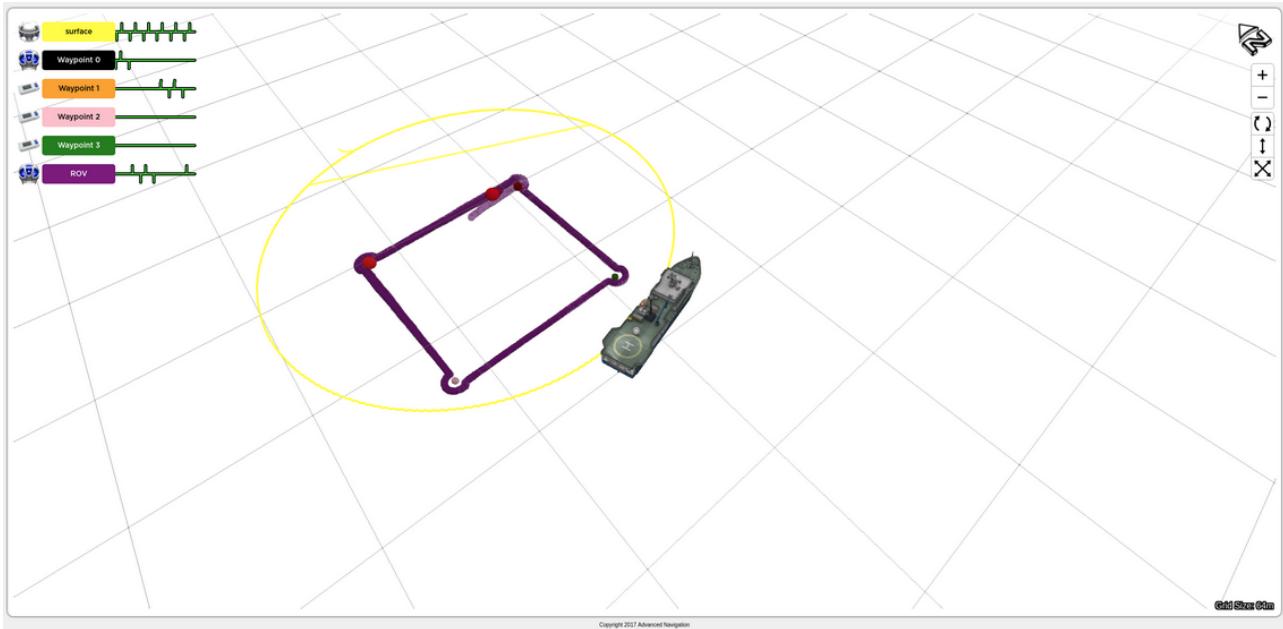


Figure 61: Grid view, absolute reference

The Radar plot is centred on the camera follow target and will move as the target moves, showing relative scales between the target and other objects or devices in the scene. The range from the centre, in metres, is displayed on each ring. The centre of the Radar plot can be changed by following the desired device via the right click menu.

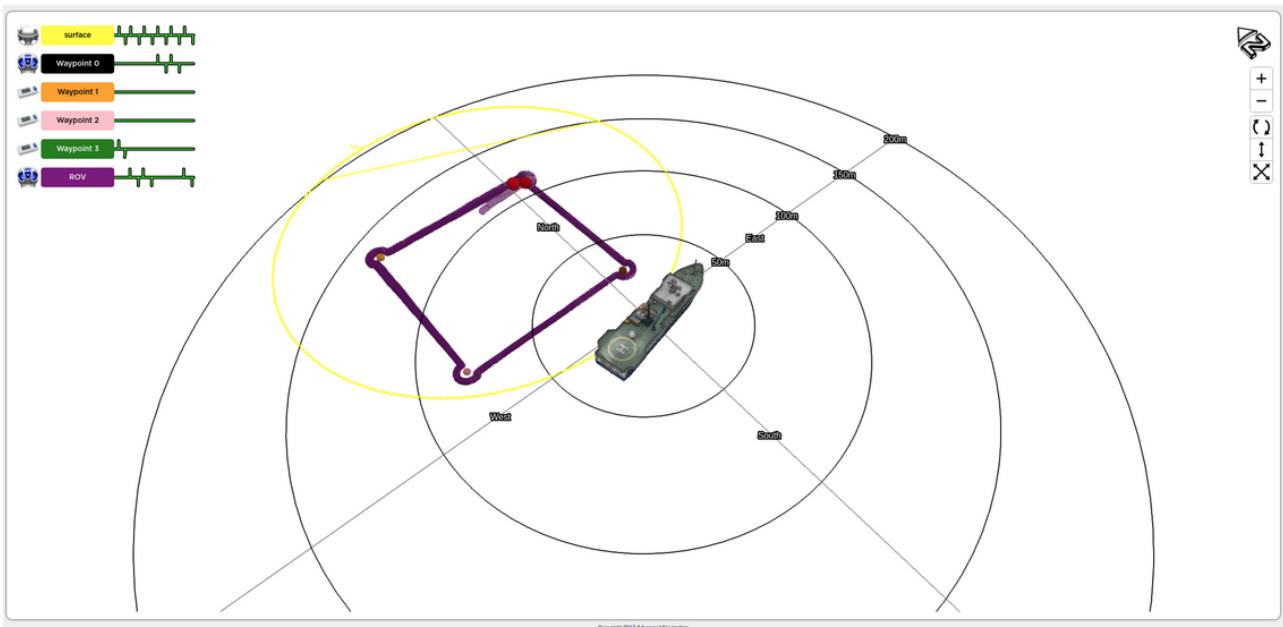


Figure 62: Radar view, centred on surface Subsonus

2D Grid/Radar Display

The 2D view can be configured to display a Grid or Radar plot in the scene.

In 2D mode the grid displays Latitude and Longitude value markers on each grid line. When the view is side on the vertical height is displayed. Latitude and Longitude markers can be hidden or displayed as desired from the “Configuration”→“Display” page. The Latitude/Longitude markers display format can also be selected: decimal degrees (DDD), degrees and decimal minutes (DMM) or degrees minutes seconds (DMS).

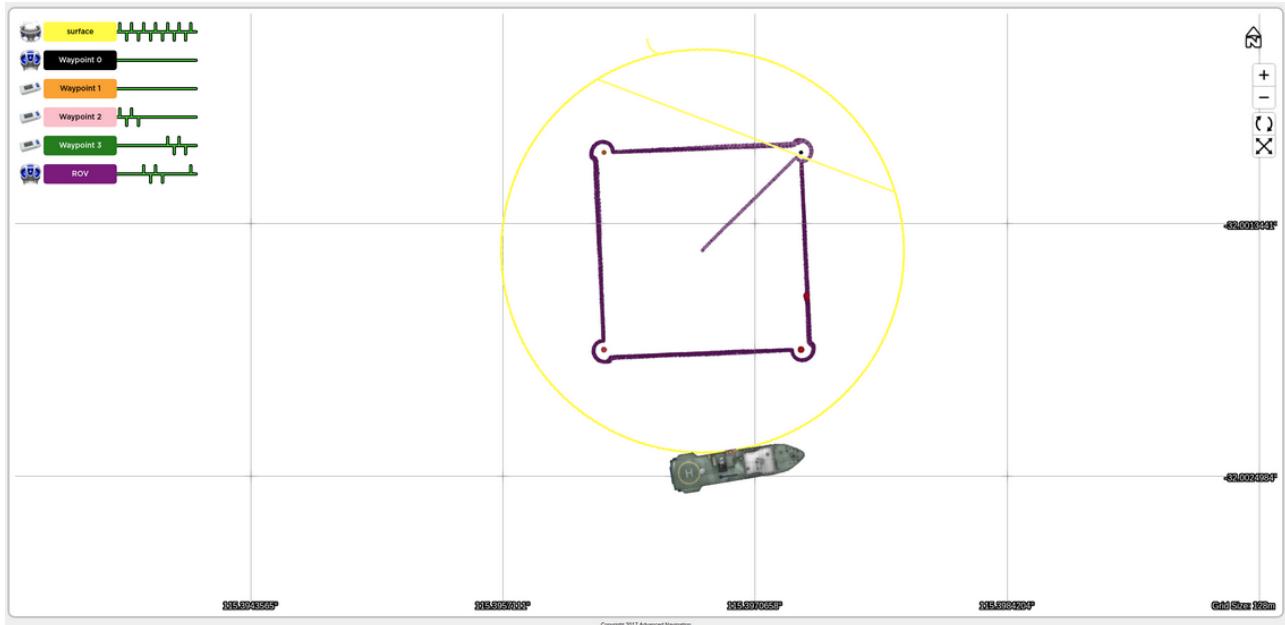


Figure 63: 2D grid view with Latitude and Longitude labels on grid lines

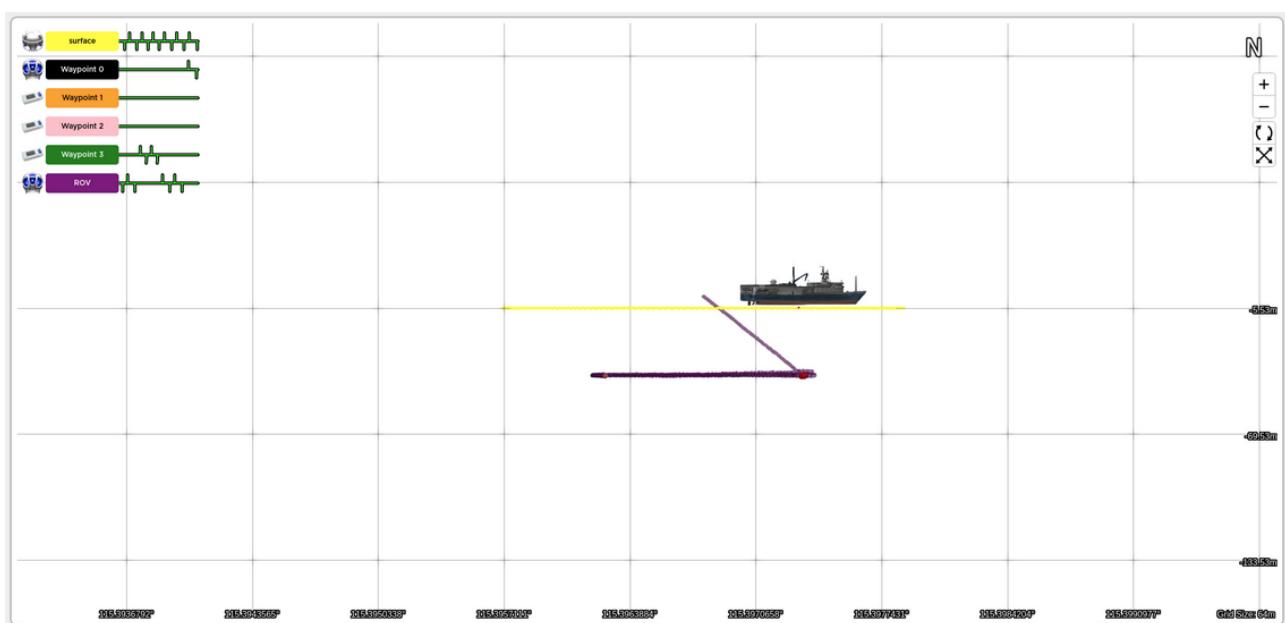


Figure 64: North facing view with Longitude and height grid markers

In 2D mode the Radar plot works in the same way as in 3D mode apart from the display in side views. When in side view a hemisphere plot is displayed showing distance down along with the distance north south or east west depending on the selected view.

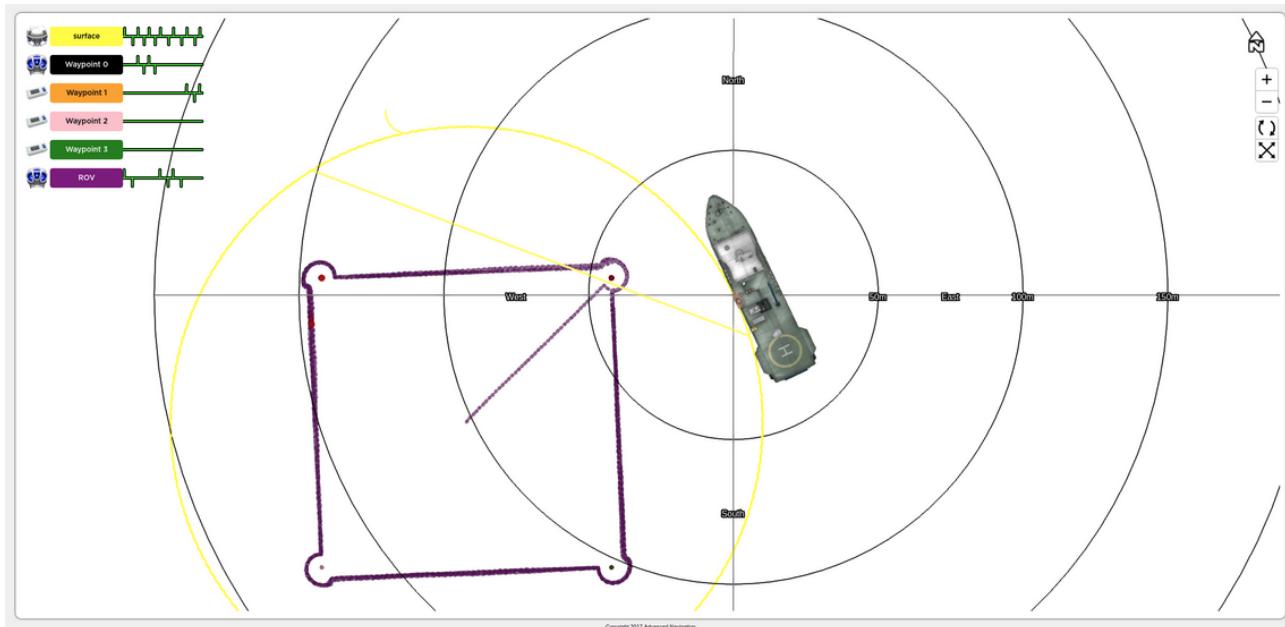


Figure 65: 2D radar plot, centred on surface Subsonus

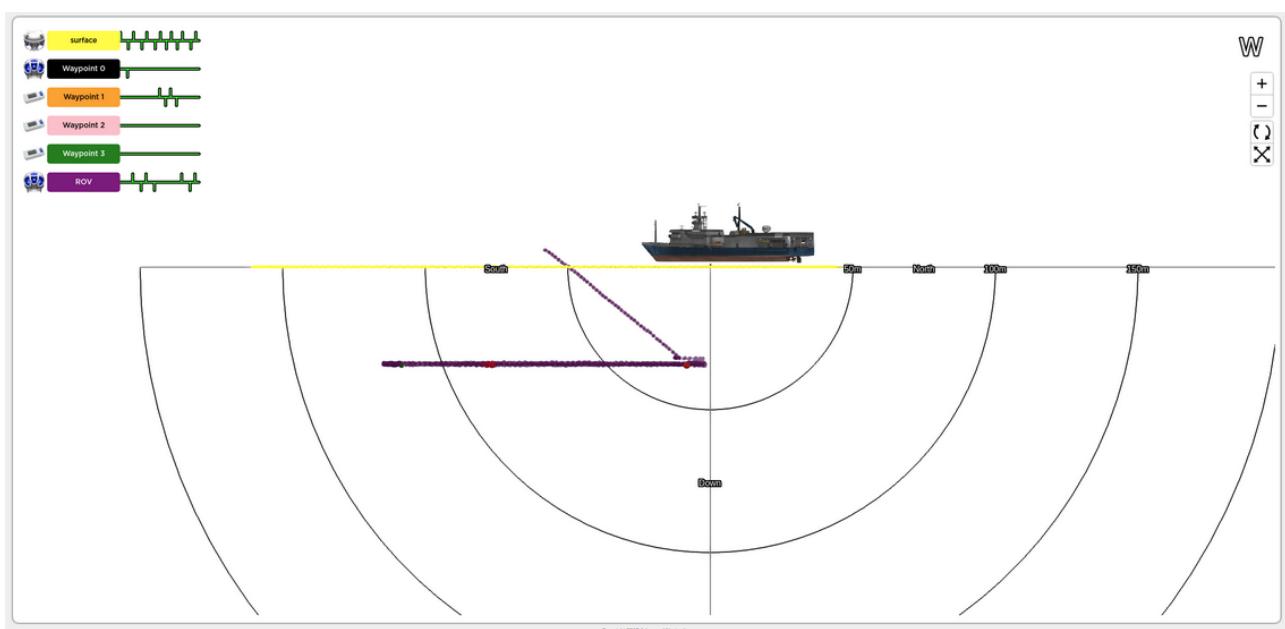


Figure 66: 2D radar plot, side view facing West

9.1.1.7 Mapping Enhancements

Mapping enhancements are overlay files that contain additional data to supplement and enrich the existing Subsonus mapping system. Mission enhancements are appended to missions as individual layers that can be shown or hidden. Mapping layers are essentially spatial datasets that can include information such as contours, underwater infrastructure, and known obstructions.

Adding a mapping layer with to a mission plan can help you and optimise mission task survey paths by taking the most direct transit path between known points of interest and by pro-actively avoiding known underwater features or obstructions.

Mapping layers makes it possible to leverage previously acquired data by importing spatial datasets from multiple sources into the same mission plan. For example, data from a prior reconnaissance mission conducted with Hydrus could be combined with a dataset obtained from a side scan sonar survey. This data integration functionality facilitates efficient planning for subsequent missions, allowing targeted exploration of specific areas of interest with ease, thus maximising the value of existing data.

The following industry standard GIS data formats are supported for custom mapping layers:

- GeoJSON (used for defining georeferenced waypoints, lines, polygons and simple geometries)
- KML/KMZ (standard GIS format for spatial information and metadata)
- ESRI shape world files for non-topological geometry vectors: .wld, .pgw, .pngw, .jgw, .jpgw, .bgw, .bpmw
 - Supported image file types associated with world files: .jpg, .png, .bmp

Note: If required and to enable data interoperability, various third-party software tools are available for converting proprietary file formats to the above-mentioned, supported interchangeable formats.

All mapping enhancements functionalities are available via the **Mapping Layers** button in the **Main** view.

Mapping Layers

The default mapping layers are shown at the top of the **Mapping Layers** pane:

- **Water** - Water surface animation layer (for visualisation purposes).
- **Satellite** - Satellite image layer. Enabling this layer can be useful for identifying and using geographical references and landmarks.
- **Seafloor** - This mapping layer visualises the seafloor as per the **Seafloor Depth** settings found in the **Map Options** dialog.

User configurable, custom mapping layers are shown underneath the default mapping layers. To add custom mapping layers, see [Map Options](#).

Click the **Mapping Layers** button in the **Main** view to access the **Mapping Layers** pane.

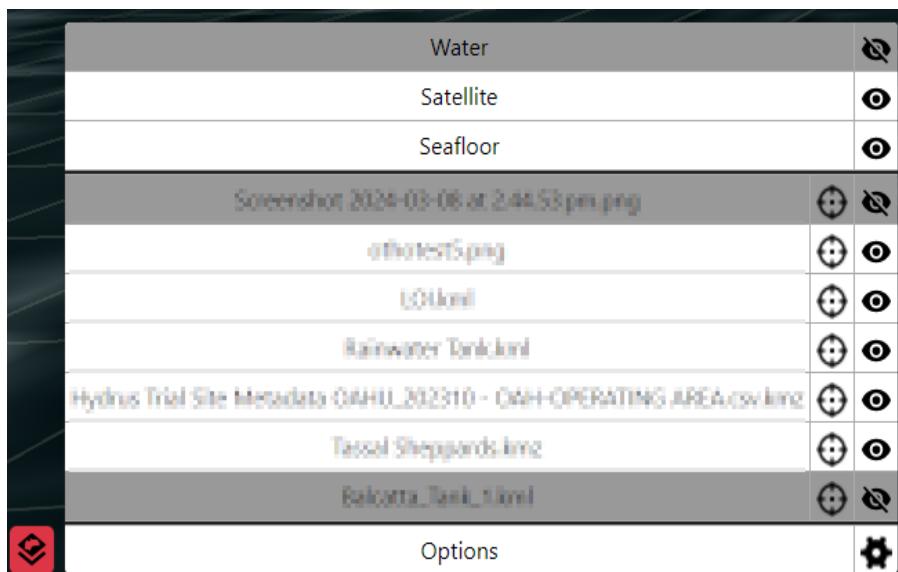


Figure 67: Mapping Layers Pane

Map Options

The following procedure outlines how to customise the map options, including how to upload custom mapping layer files to your mission or a recorded session:

1. Ensure your Mapping Enhancement files are prepared and saved in a supported format. Take note of the file's location on your computer for easy access during the upload process.
2. Click on the **Mapping Layers** button. Then click **Options**.

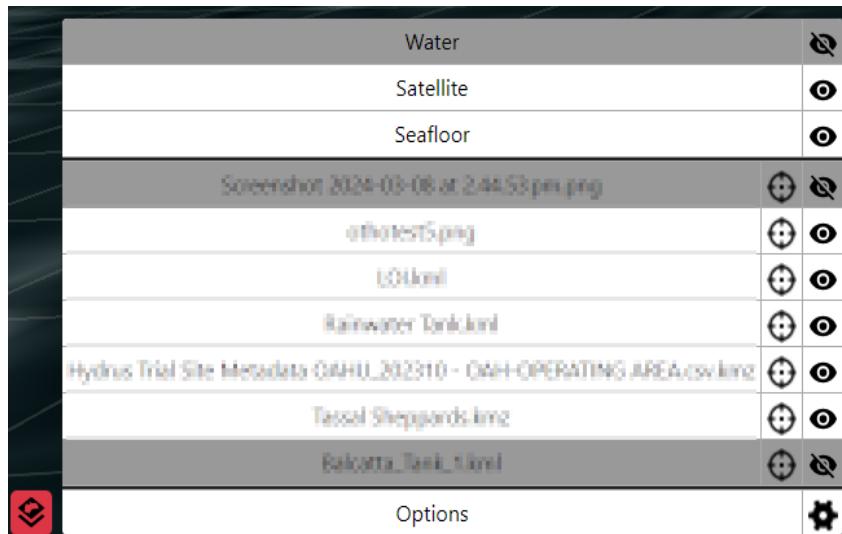
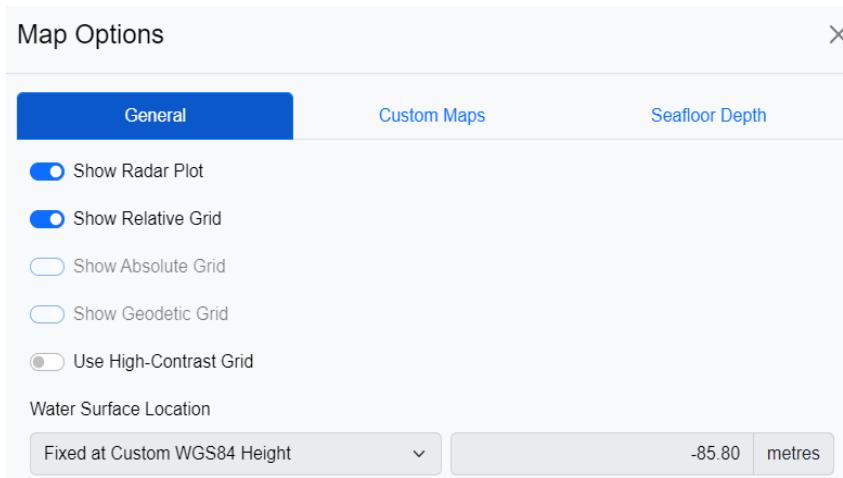
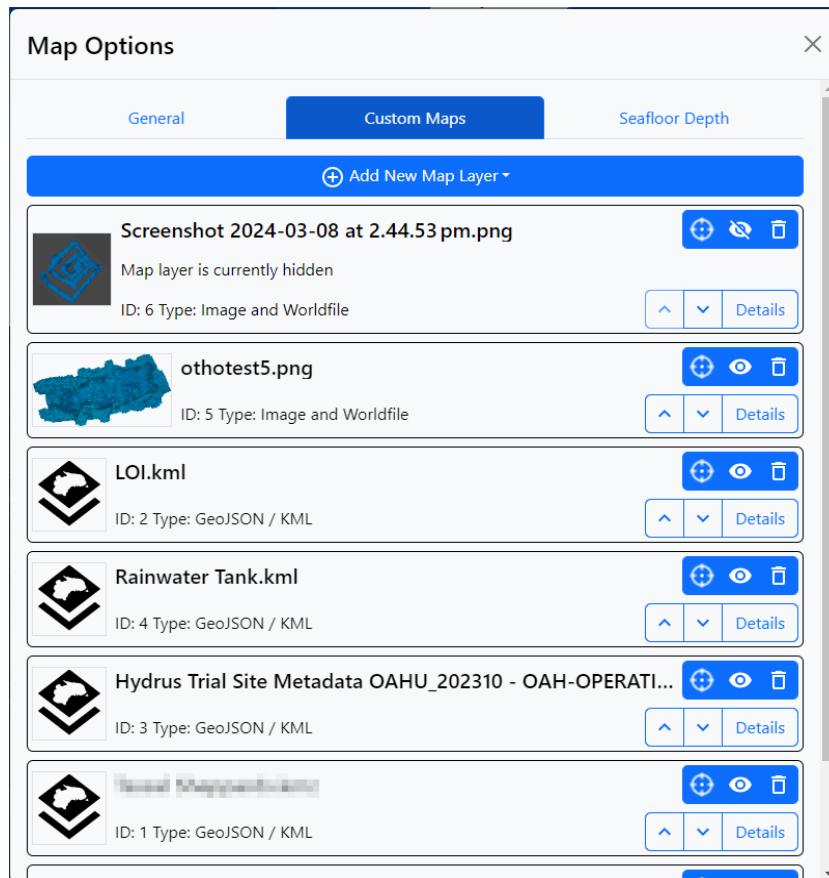


Figure 68: Mapping Layers Pane

3. Set the **General** tab settings as per your preference:
 - Show Radar Plot - Toggles the radar plot in the map view
 - Show Absolute Grid - Toggles the absolute grid in the map view (only available in Absolute Position Mode)
 - Show Relative Grid - Toggles the relative grid in the map view (only available in Relative Position Mode)
 - Show Geodetic Grid - Toggles the geodetic grid (longitude and latitude) in the map view
 - Use High-Contrast Grid - Toggles the high-contrast grid in the map view (increases the grid contrast for better visibility)
 - Water Surface Location - Specifies the water surface level. This can be set to 0 m WGS84 height, custom WGS84 height or determined by a depth sensor input.

*Figure 69: Map Options - General*

4. In the **Custom Maps** tab, click **Add New Map Layer**.

*Figure 70: Map Options - Custom Maps*

5. Add a **GeoJSON** layer:
 - Click **Choose file** and browse to the GeoJSON file to be uploaded.
 - Configure your import preferences:

- Import Points
 - Import Lines
 - Import Polygons
- Click **Upload**.

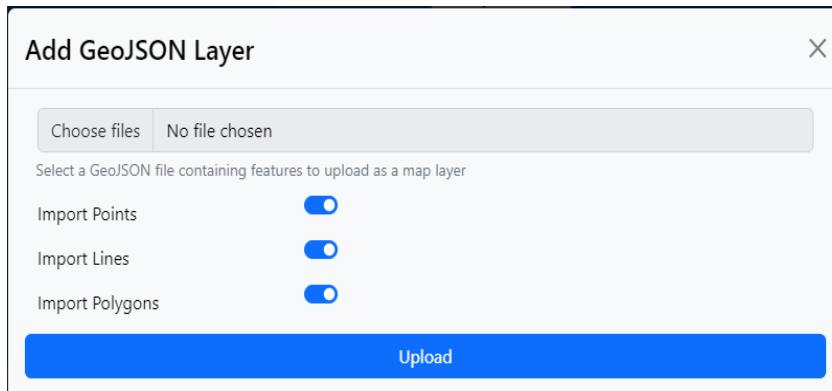


Figure 71: Map Options - Custom Maps - Add GeoJSON Layer

6. Add a **KML/KMZ** layer:

- Click **Choose file** and browse to the KML/KMZ file to be uploaded.
- Configure your import preferences:
 - Import Points
 - Import Lines
 - Import Polygons
- Select a Height mode from the dropdown list (EGM96 or WGS84).

Note: The altitude model that coordinate heights will be positioned relative to. The KML specification requires EGM96, but some KML files may be defined with heights relative to the WGS84 ellipsoid instead.

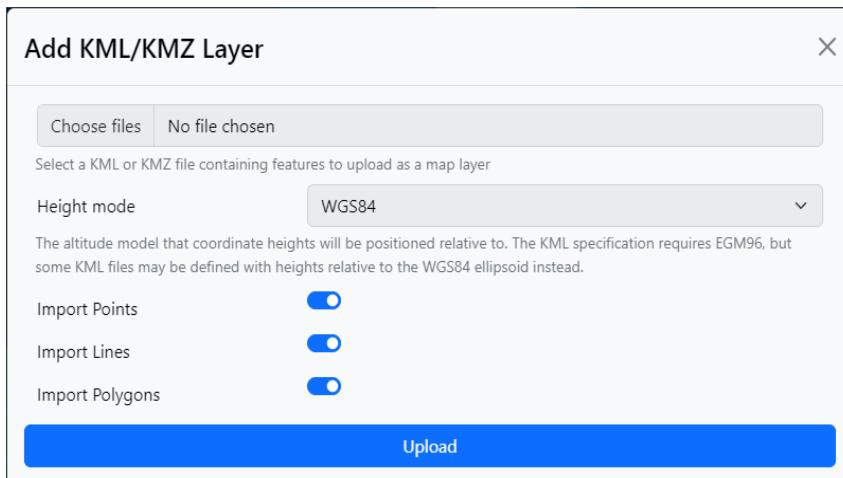


Figure 72: Map Options - Custom Maps -Add KML/KMZ Layer

7. Add **Image and Worldfile** layer:

- Click **Choose file** and browse to the ESRI-compatible world file (.wld, .pgw, .pngw, .jgw, .jpgw, .bgw, .bmpw)
- Click **Open** and then click **Upload**
- Click **Choose file** and browse to the image file associated with the world file (.jpg, .png, .bmp)
- Click **Open** and then click **Upload**

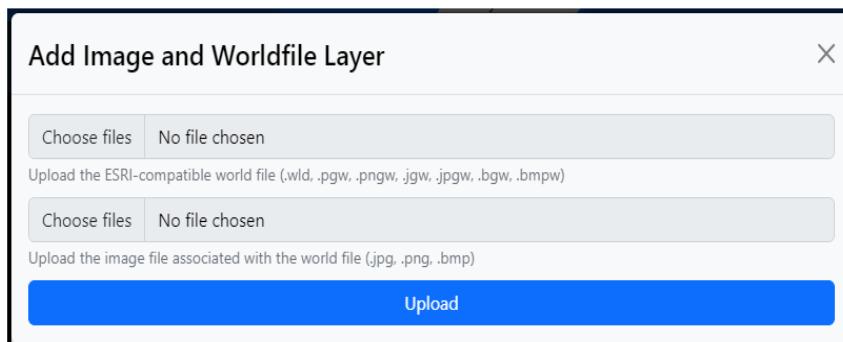


Figure 73: Map Options - Custom Maps - Add Image and Worldfile Layer

8. Using the mapping layer controls:

- Cross-hair icon button - Moves the camera in the map pane to the centre of the layer
- Eye icon button - Shows and hides the layer in the map pane
- Bin icon button- Deletes the layer from the mission / session
- Up / down arrows - Change the order of the layer in the mapping layer stack
- Details button - Opens the **Details** dialog for the layer

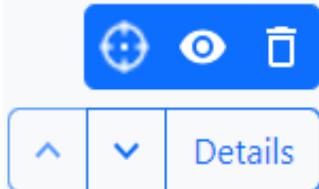


Figure 74: Map Options - Custom Maps - Layer Buttons

The **Details** view for GeoJSON / KML type layers offers preview of metadata and allows for file downloads.

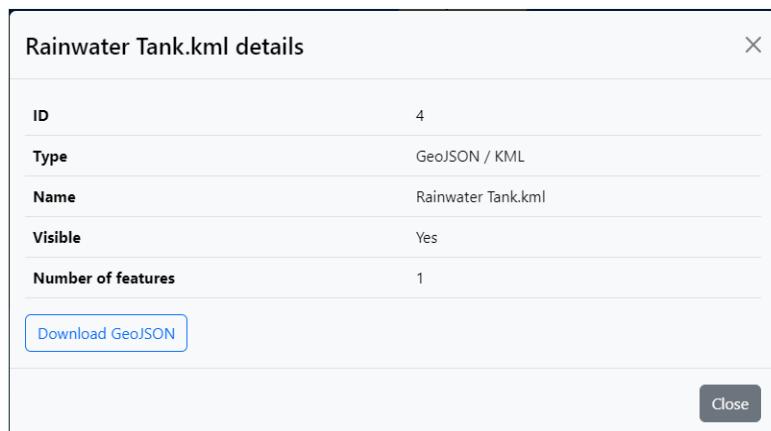


Figure 75: Map Options - Custom Maps - Layer Details GeoJSON / KML

For Image and Worldfiles type layers, the detail dialog offers users to edit the worldfile contents in a text field.

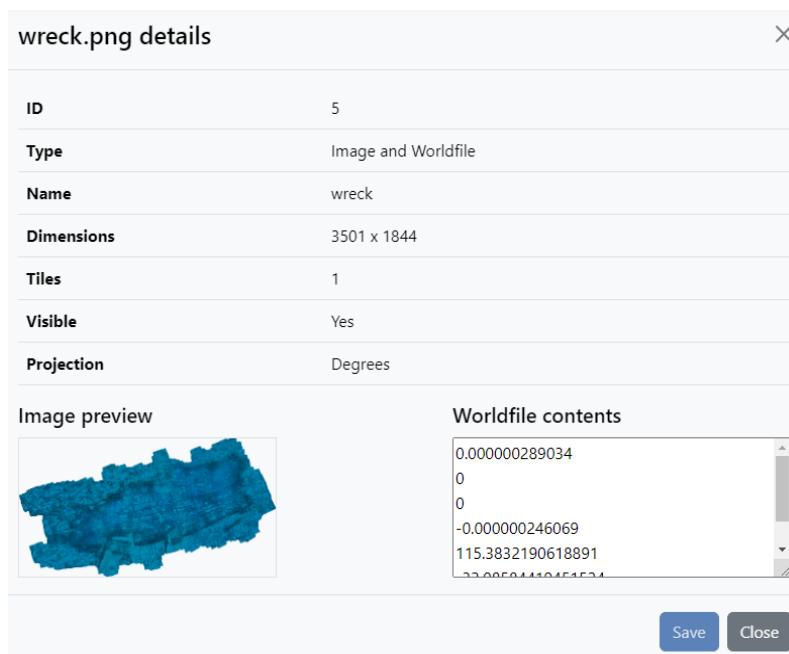


Figure 76: Map Options - Custom Maps - Layer Details Image and Worldfile

9. In the **Seafloor Depth** tab, configure your preferences for the Seafloor layer:

- **Depth Mode**

Fixed depth below the water's surface

- Objects positioned relative to the water's surface may appear below the seafloor
- Objects positioned relative to the seafloor may appear above the water's surface

Relative depth below the water's surface or deepest object

- Objects positioned relative to the seafloor may appear above the water's surface
- Objects positioned relative to the seafloor may infinitely lower the seafloor

Sticky depth below the deepest object

- Objects positioned relative to the seafloor may appear above the water's surface
- The seafloor will never be raised, only lowered

- **Depth Below Surface (metres)**

- **Depth Below Deepest Device (metres)**

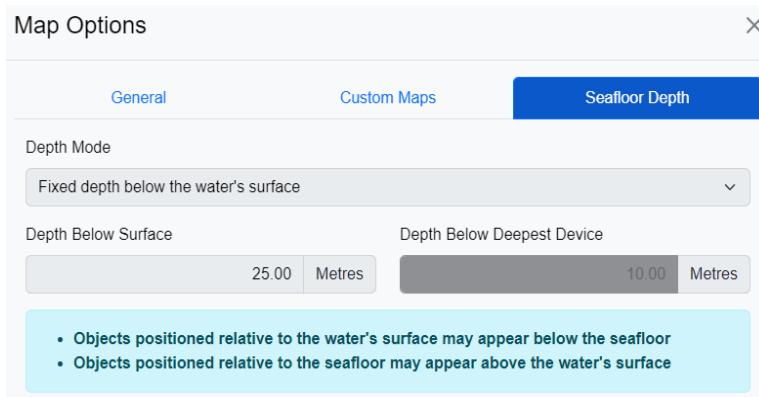


Figure 77: Map Options - Seafloor Depth

9.1.2 View Menu

The View menu contains pages displaying information about the device or operation to the user.

9.1.2.1 Status Page

System Status

System Status displays any problems with the system. This includes any failures, sensors and alarms: caused by failed components, misconfiguration of the device or sensors operating outside of their operating range as well as anything that prohibits acoustic tracking.

System Status

Failures	Over Range	Alarms
<input type="radio"/> System	<input type="radio"/> Accelerometers	<input type="radio"/> Over Temperature
<input type="radio"/> Accelerometers	<input type="radio"/> Gyroscopes	<input type="radio"/> Out Of Water
<input type="radio"/> Gyroscopes	<input type="radio"/> Magnetometers	<input type="radio"/> Pressure Depth Offset
<input type="radio"/> Magnetometers	<input type="radio"/> Pressure	<input type="radio"/> Multiple Position Sources (Fixed Position + GNSS)
<input type="radio"/> Depth		<input type="radio"/> Multiple Position Sources (Multiple GNSS)
<input type="radio"/> GNSS		<input type="radio"/> Multiple Position Sources (External INS + GNSS)
<input type="radio"/> Logging Memory		<input type="radio"/> Fixed Position Slave
<input type="radio"/> Array Memory		<input type="radio"/> Bad GNSS Time Sync
<input type="radio"/> INS Comms		<input type="radio"/> Device Address Conflict
<input type="radio"/> Filter Aiding Comms		<input type="radio"/> Multiple Masters Detected
		<input type="radio"/> Low Power Mode
		<input type="radio"/> Modem Data Error

Figure 78: System Status Page

System status indicators display a red dot if there is a problem, no indicators should be red for normal operation.



Figure 79: Out of water alarm, active

Filter Status

Filter Status displays the state of the navigation filter, this indicates filter initialisation, data sources and operation flags.

Filter Status				
Initialisation	GNSS Status	Active Position and Velocity Sources	Active Heading Sources	Tracking
● Orientation	○ 2D GNSS	○ Internal GNSS	○ Acoustic Heading	○ Data Connection Active
● Navigation	○ 3D GNSS	● External GNSS	○ Magnetic Heading	○ USBL Tracking
● Heading	○ SBAS GNSS	○ Acoustic Position	○ Velocity Heading	
● Time	○ Differential GNSS	● Pressure Depth Position	● Dual Antenna Heading	
● Pressure Depth	○ Omnistar GNSS	● External Position	○ External Heading	
● Velocity Of Sound	○ RTK Float GNSS	○ Fixed Position	○ Fixed Heading	
	● RTK GNSS	○ Fixed Roll Pitch		
		○ External Velocity		
		● Pressure Depth Velocity		

Figure 80: Filter Status Page

Initialisation

This section indicates what sections of the navigation filter are initialised, for normal operation all sections should be initialised, indicated by a green dot.

In the event a section is not initialised the Subsonus set-up should be checked and the user should confirm that there are no system status warnings or failures.

GNSS Status

If a Subsonus is using a GNSS system as it's position source the fix type will be indicated here.

Active Position, Velocity and Heading Sources

This section indicates what the position or velocity input to the navigation filter is, this section displays any position or velocity source that has been received by the filter in the last five seconds. In the event that an update is sporadic, for example an acoustic position update may only be received every 20 seconds in some applications, the "Acoustic position" flag will toggle on and off. This is not an issue unless the updates are so sporadic that the Navigation filter becomes uninitialised.

Tracking

The "Data Connection Active" flag indicates that there is an Ethernet link between the Subsonus and its track target.

The "USBL Tracking" flag indicates that there is an acoustic connection between the Subsonus and its track target.

9.1.2.2 Device Information

The Device Information page displays the Hardware version, Firmware version and Serial numbers of the device. This information may be requested when contacting Advanced Navigation for support.

Device Information

Subsonus Serial:	0872E301BF782E0400000000
Array Serial:	1339616C185B3B2900000000
Internal INS Serial:	0047004E3235510C30333937
Hardware Version:	1.300
Firmware Version:	2.000
Recovery Firmware Version:	1.009

Figure 81: Device Information Page

9.1.3 Configuration Menu

See the following for how to configure a Subsonus. Note that the unit connected in the web UI is the device being configured - the name of the active device is shown on the top left of the web UI main view.

9.1.3.1 Acoustic Configuration

Settings controlling acoustic tracking and behaviour are configured on this page. The page is divided into a simple and Advanced section, to display the Advanced section press the “Advanced” button.

Subsonus can be configured to act as an acoustic master or an acoustic slave. An acoustic master can be configured to track multiple slave devices, however, an acoustic slave will only respond to interrogations from a master. A master Subsonus also provides position and heading to a slave device. The Subsonus on the Surface vessel is usually the Master, providing a position from a GNSS system to any subsea devices that are configured as slaves.

Operation Mode

To access the Subsonus Acoustics Configuration page:

1. Navigate to **Configuration** → **Acoustics**.
2. In the **Operation Mode** drop-down, select **Master** or **Slave** as required.

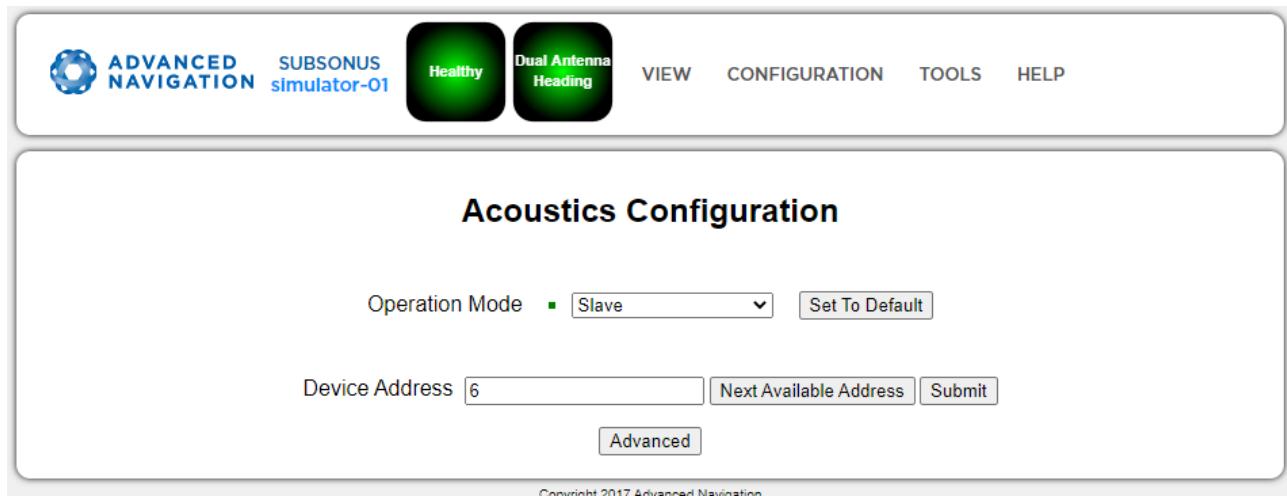


Figure 82: Acoustics Configuration Page

Device Address

The Acoustic Device Address of the Subsonus is configured here, for more information of the behaviour and use of device addresses refer to [9.1.3.2 Device Address Configuration](#)

Acoustic Data Priority

In the Advanced section, acoustic data priority for the Subsonus can be configured, these settings dictate how often Subsonus transports certain acoustic data to its track partners.

9.1.3.2 Device Address Configuration

A “Device Address” is a number used by Subsonus to control tracking behavior as well as associate data streams with devices and to identify devices for configuration using ANPP. Each device needs to be assigned a unique Device Address to function properly.

Device Addresses are usually assigned sequentially. If two devices are assigned the same address a “conflict” occurs and the Subsonus web interface will display an alert. The conflict can be resolved by changing one of the devices to a different address. Subsonus cannot track two devices with the same address simultaneously.

By default, Subsonus units with vertical connectors (typically used as the surface unit) have a device address of 1 and units with horizontal connectors (typically used as subsea units) have an address of 2.

Subsonus Master Device Address Tracking Behavior

A Subsonus Master will track a Subsonus Slave by its device address. Once the Master has a Device Addresses to track, it will ignore other devices unless its configuration changes.

Acoustic Device Discovery

If a Master has not established acoustic communication with a Subsonus on a Device Address it is set to track, it will run Acoustic Device Discovery. In this mode the master will discover all Subsonus devices and display information on the Devices Page, however it will not establish communication with these devices unless they are configured with an address that the master is configured to track.

Once the Master has acoustically discovered devices on all its tracked addresses it will stop device discovery.

Device Discovery can be manually run from the “Configuration”→“Acoustics” page.

Subsonus Slave Device Address Tracking Behaviour

A Subsonus Slave can be tracked by a Subsonus Master and will respond to a master on any Device Address.

Automatic Device Address

A Slave set to device Address Zero will be automatically assigned a device address by the first master that acoustically discovered it. Once this address is set, it is permanent and any address conflicts must be resolved by the user.

Device Address Conflict

Subsonus needs to have a unique Device Address to communicate. If multiple devices have the same Device Address a conflict will occur. Conflicts can only be resolved by changing the Device Address of one of the devices or by removing a device from the conversation. A Subsonus Device Address can be changed locally on the Subsonus web interface or remotely via acoustics from the Master Subsonus.

Device Address Conflict Display

Devices with Address conflicts will be displayed on the “Configuration”→“Devices” page of the Subsonus web UI. Devices with conflicting addresses will be indicated by a red “alert” icon alongside the entry in the device list, see [Figure 83: Conflicted Subsonus device address](#). Hovering over the alert icon with the mouse will display the reason for the alert. To resolve a conflict, the Device Address of each device must be made unique.

Active Devices

Name	Type	Network	Acoustic Communications	Actions
 Boat (This Device)	Subsonus	-	-	Configuration

Figure 83: Conflicted Subsonus device address

Manually Assigning a Device Address

Typically, device addresses will be numerically ascending values from 2 i.e. 2, 3, 4, 5 and so on.

Addresses in the range 256 to 699 are reserved and cannot be used.

Assigning a Local Subsonus Address

To set a Subsonus address:

1. Open the local Subsonus web interface
2. Navigate to “Configuration”→“Acoustics”
3. To automatically assign the next available Device Address Click “Next Available Address”, alternatively a device address can be entered manually.

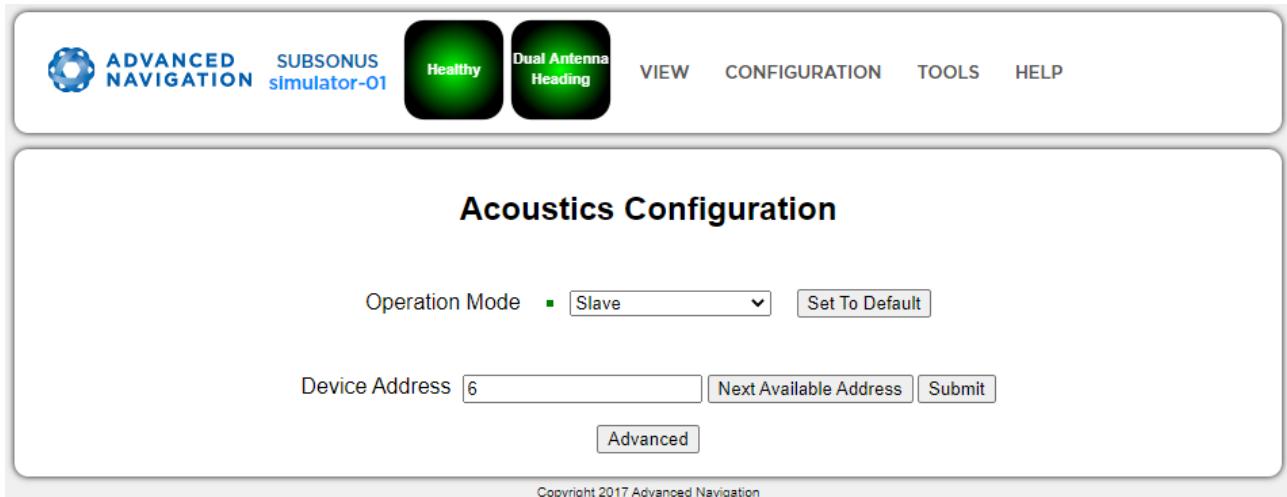


Figure 84: Acoustics Configuration Page

4. Click “Save Changes” to complete the operation

Assigning a Remote Subsonus Address

To change the Address of a Remote Subsonus:

1. Open the local Subsonus web interface
2. Navigate to “Configuration”→“Devices”
3. Locate the device to change, click the "Configuration" icon next to the device→“Acoustics”

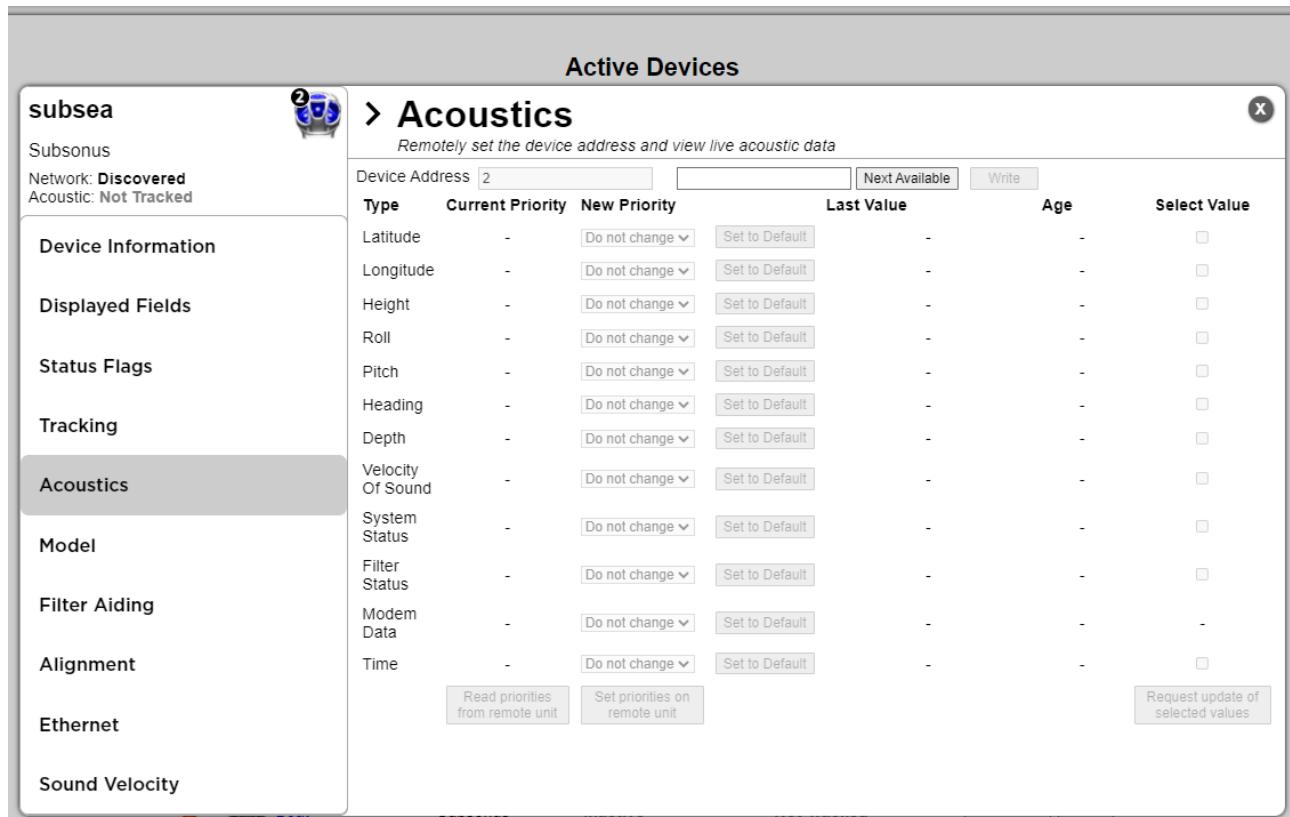


Figure 85: Screen shot of the Configuration window for remote devices

- To overwrite the Address on the remote device, enter the new value and click “Write”

ANPP Device Address use

Device addresses should be assigned sequentially. The valid range is specified in [11.5.12.3 Device Address](#). If two devices are assigned the same address a “conflict” occurs and the Subsonus web interface will display an alert. The conflict can be resolved by changing one of the devices to a different address.

When a Subsonus is shipped from the factory it will have its address set to zero (automatic). This means Subsonus can automatically assign a new, valid address during initial discovery. If you have purchased an evaluation kit then the addresses of the surface and subsea units will have been pre-configured to 1 and 2 respectively.

Setting the Device Address

Remote Packet Device Identification

Acoustically trackable devices will reference this Device Address in the “Remote” ANPP packets for example a “Remote Track Packet” uses the Device Address field to indicate the device tracked to produce that packet.

Device Configuration Packet

The Device Address can be used by the ANPP “Device Configuration Packet” to configure devices.

Data Stream Data Source Identification

Data streams can be configured to only output data for a specific device, this “Data Source” selection is controlled by the Device Address. See [9.1.3.6 Data Stream Configuration](#).

Set Data Stream Data Source

To configure a data stream to only output packets for a particular address:

1. Navigate to “Configuration”→“Data Streams”
2. Locate the Data Stream to configure
3. Select the “Edit Stream” option from the “Select Action” list
4. Select the source address required from the “Data Source” list, for example “2: subsea”
5. Configure the packets and rates required for the data stream by clicking “Add Message”

9.1.3.3 Device Configuration

Devices that are available to be tracked or are to be added as aiding devices are visible on the “Configuration”→“Devices” page.

Active Devices				
Name	Type	Network	Acoustic Communications	Actions
 Boat (This Device)	Subsonus	-	-	<button>Configuration</button>
 Compass	GNSS Compass	Connected Aiding	-	<button>Configuration</button> <button>Delete</button>
 Reef 1	Waypoint	-	-	<button>Configuration</button> <button>Delete</button>
 Reef 2	Waypoint	-	-	<button>Configuration</button> <button>Delete</button>

[Create new Device](#)
[Run Acoustic Discovery](#)
[Discover Device Address](#) [Device Address](#)

Figure 86: Devices Page

Creating a Track Target (Subsea device)

Targets can be created for Subsonus to track. These can be other Subsonus units, third party transponders, generic fixed tone transponders or periodic pingers such as emergency beacons. Subsonus should be configured as an acoustic master to track these devices.

To add a track target to Subsonus:

1. Navigate to the “Configuration”→“Devices” page.
2. Click the “Add New Device” button, a “Create New Device” wizard should appear.



Create a new Device

Device Type:

Name:

Device Address:

Figure 87: Screenshot of New Device wizard

3. For “Device Type” select the required track target.
4. Enter the device specific configuration settings.

5. To track the device immediately, enable the "Track Device" flag.
6. Press the "Save Changes" button.

Alternatively, you can click the "Run Acoustic Discovery" button to discover acoustic devices.

Tracked Devices Configuration

To configure tracked devices, click on the "Configuration" button next to the active device. The screen shown in [Figure 88: Remote device Configuration window](#) will appear.

To determine the data sharing method being used by the target, see the Network and Acoustic status information. When tracking acoustically, the Acoustic status will display "Tracking".



Figure 88: Remote device Configuration window

Each tab allows the user to configure or see the following:

Device Configuration:	Displays the Hardware version, Firmware version and Serial numbers of the device. This information may be required by Application Support engineers.
Displayed Fields:	Allows the user to select the data displayed on the Main View for each device (see 9.1.1 Main View)
Status Flags:	Displays current alarms, warning and status states
Tracking:	<p>Allows the user to select the acoustic data protocol used during tracking operations. By default the data protocol is set to "Auto", in this mode Subsonus will automatically select the optimal data protocol based on the acoustic conditions. The user may select between "High Speed" mode or "High Reliability" mode.</p> <ul style="list-style-type: none"> • "High Speed" is the standard acoustic protocol historically used by Subsonus. In standard acoustic conditions it offers very high data transfer rates and a high level of resilience to acoustic noise and multipath. • "High Reliability" is an acoustic protocol optimised to allow Subsonus to track targets in difficult acoustic conditions, such as where there is high background noise, or high levels of acoustic multipath. When operating in this mode the level of data being transmitted between units is decreased. <p>Also allows the user to enable or disable tracking for each device. When operating in slave mode, a Subsonus will automatically be configured to track a master unit.</p>
Model:	Allows the user to choose a pre-set model to attach to a device
Acoustics:	Allows the user to set or change the Device Address of a tracked target, as well as view

	live acoustic data
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Subsonus Surface Unit Reference Source Aiding

Position and heading aiding for Subsonus can be provided by a surface reference source such as an Advanced Navigation GNSS Compass or INS device (such as Certus, Certus Evo, Boreas) - see [7.4 Surface Unit Reference Source](#). When Subsonus connects to an Advanced Navigation product, it will automatically configure the required packets at the required rates.

Connect Device

1. Connect the GNSS Compass or INS device to the Network.

Add discovered Advanced Navigation Product

1. Navigate to the “Configuration”→“Devices” page
2. Locate the device in the Discovered Devices list
3. Select “Action” → “Add Device”
4. Locate the device in the Active Devices list
5. Select “Action” → “Configuration”
6. For “Offset [X,Y,Z]” enter the offsets from the Subsonus to the aiding device. For the GNSS Compass, this is the base of the unit. Ensure the offset directions are correct, forward is positive X, to the right is positive Y and up is negative Z

Note: The values set for the offset between the surface Subsonus and surface unit reference source must be correct for the devices to function accurately.

7. Under the "Local Settings" tab, check the “Enable Device” to use the device as an aiding source
8. Press the “Save Changes” button

Add new undiscovered Advanced Navigation Product

1. Navigate to the “Configuration”→“Devices” page
2. Click the “Add New Device” button, a “Create New Device” wizard should appear.
3. Select the device type from “Device Type” in the “Advanced Navigation Aiding Source” section and update the device name as desired, click “Next”
4. For “Offset [X,Y,Z]” enter the offsets from the Subsonus to the aiding device. For the GNSS Compass, this is the base of the unit. Ensure the offset directions are correct, forward is positive X, to the right is positive Y and up is negative Z

Note: The values set for the offset between the surface Subsonus and surface unit reference source must be correct for the devices to function accurately.

5. Enter the IP Address or host-name of the device (e.g [gnss-compass.local](#), [certus.local](#) etc) . This can be found using the Device Discovery tool in Subsonus Tools, see [9.2.5 Device Discovery](#)
6. Enter the Port Number 16718, click “Next”
7. Enable the device as an aiding source, click “Next”
8. Press the “Save Changes” button

Generic NMEA GNSS Compass Aiding

1. Navigate to the “Configuration”→“Devices” page.
2. Click the “Add New Device” button, a “Create New Device” wizard should appear.
3. Enter a device name, click “Next”.
4. For “Device Type” select “GNSS Compass – Generic NMEA”, click “Next”.
5. For “Offset [X,Y,Z]” enter the offsets from the Subsonus to the NMEA Position provided by the device.

Note: The values set for the offset between the surface Subsonus and NMEA device must be correct for the devices to function accurately.

6. Enter the IP address or host-name of the device hosting the TCP server providing this data.
7. Enter the TCP Server Port Number, click “Next”.
8. Press the “Save Changes” button.

Subsea Subsonus Aiding

Subsea Subsonus aiding devices such as a DVL can be configured for additional external velocity data, see [7.5 External Aiding Devices](#). Certain DVLs are preconfigured to be discovered by the subsea Subsonus when connected to the same network, including Nortek and Waterlinked DVLs.

Add DVL

1. Navigate to the “Configuration”→“Devices” page of the **subsea** Subsonus web UI, if the DVL is on the subsea vehicle.
2. Click the “Create New Device” button, a “Create New Device” wizard should appear.



Figure 89: Screenshot of New Device wizard

3. For “Device Type” select the required DVL, “Nortek DVL” or “Waterlinked DVL”.
4. Enter the device specific configuration settings, ensuring the device address is unique.
5. For “Offset [X,Y,Z]” enter the offsets from the subsea Subsonus to the reference position of the DVL as defined in the DVL technical reference manual.
6. Enter the IP address or host-name of the device hosting the TCP server providing this data.
7. Enter the TCP Server Port Number, click “Next”.
8. Press the “Save Changes” button.

Note: The values set for the offset between the surface Subsonus and DVL must be correct for the devices to function accurately.

9. Once the DVL is listed under “Active Devices”, select the “Configuration” button.
10. Under the “Local Settings” tab, check the “Enable Device” to use the DVL as an aiding source
11. Press the “Save Changes” button

Subsonus Remote Acoustic Data

Unless there is a network link between the Subsonus units they will acoustically transfer their position, orientation, depth, VOS, system status, filter status and time to the remote device.

Subsonus also supports sending user data over the acoustic link, please see [9.8 Modem Data Transfer](#) for details.

9.1.3.4 Filter Aiding

Settings controlling the navigation filter and behaviour are configured on this page. The page is divided into a simple and Advanced section, to display the Advanced section press the “Advanced” Button.

Filter Aiding Configuration

INS Filter Options

INS Selection □ Internal INS

Vehicle Profile □ 3D Observation-Class

INS Connection Status **Okay**

Pressure Depth Sensor

Current Depth (meters) -1.000

Correct Acoustic Pings with Depth □

Aid INS Filter with Depth □

Depth Sensor Selection □ Internal

Figure 90: Filter Aiding Page

INS Filter Options

INS filter options allow configuration of what INS is used in Subsonus, this includes the Internal INS, a Fixed Position or an External Advanced Navigation INS.

The Internal INS allows configuration of a Vehicle Profile, this describes to the Navigation filter the expected operating conditions of the device allowing constraints to be placed on the filter for better performance. For a full list of available vehicle profiles, see [Vehicle Types](#)

The Fixed Position allows direct entry of a position and heading as well as optionally a roll and pitch. this is most useful for a surface unit that is mounted to a barg

Pressure Depth Sensor

The Pressure Depth sensor in Subsonus can be used to provide Position and Velocity correction to acoustic positions as well as velocity constraints for vertical movement to the navigation filter. This is more important for the subsea device than the surface device

In order to be used an offset must be provided for local atmospheric conditions. If the offset is set to zero the pressure sensor will be uninitialised.

The corrected sensor reading is calculated by subtracting the offset from the raw sensor value. The corrected sensor reading value should be zero when Subsonus is out of the water.

Advanced INS Controls

Sensor ranges

The operating range of some sensors contained in the internal INS can be configured, in most operating conditions for Subsonus the default settings are appropriate and should not be changed.

Magnetic Heading

Magnetic heading can be disabled in this section, in the default, automatic, configuration it will be used only when there is no better heading source available.

Manual Position and Heading

The INS Filter can be manually initialised with a position and heading using the input fields in this section. This can be used to set a datum, for example, if the INS is malfunctioning. Position and Heading can also be manually set for a fixed position Subsonus, for example, if the surface Subsonus unit was mounted to a Jetty. Manual initialisation should not be used in normal operation.

INS Filter reset

The INS filter can be re-initialised with the “Reset INS Filter” button.

9.1.3.5 Alignment Configuration

Subsonus must be aligned to any position or heading aiding sources. The Alignment page allows the user to enter an alignment offset to a Subsonus in the event that it cannot be installed inline with a vehicle or a heading reference source.

The page contains a visual representation of the axis as well as the physical device relative to these axis.

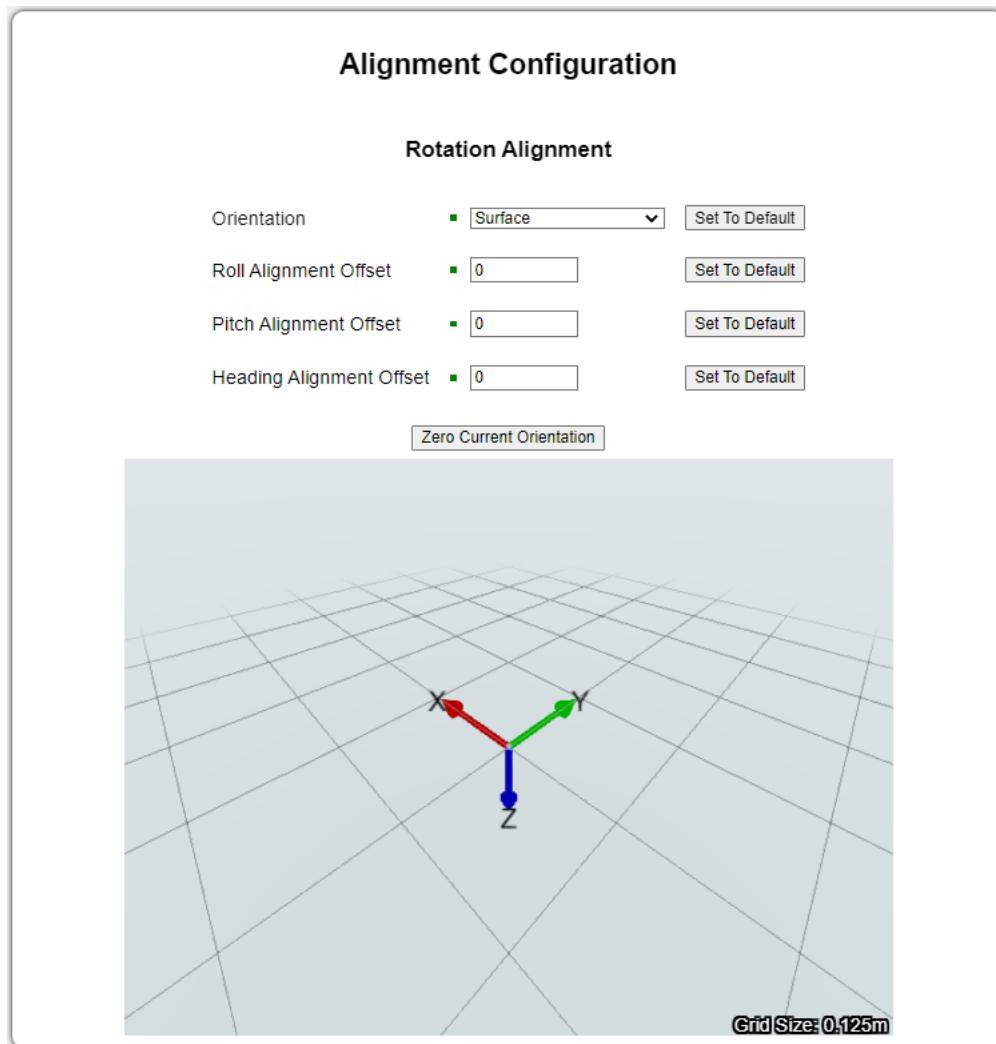


Figure 91: Screenshot of Alignment Configuration page

Orientation

Subsonus can be configured as a Surface or a Subsea device. Ensure the correct orientation is selected for the device. The model in the visual representation will flip to display the orientation that is chosen.

Alignment Offset

If Subsonus is not mounted in a standard orientation an Alignment Offset will need to be configured. The surface unit alignment offsets must be correct in order to ensure accurate positioning data of the subsea unit relative to the vessel. The offset is the difference in degrees between the axes of the Subsonus device and the axes of the vessel.

Roll is rotation about the X-axis, Pitch is rotation about the Y-axis and Heading is rotation about the Z-axis. See [12.3 The Sensor Co-ordinate Frame](#) for the alignment directions.

9.1.3.6 Data Stream Configuration

Subsonus can be configured to output both ANPP or ASCII (NMEA) messages on both TCP server and TCP client ports. Each port can be configured with single or multiple messages, at varying rates and from different devices.

To add a message to a port:

1. Navigate to the "Configuration" → "Data Streams" page.
2. Find the configuration section for the port to configure, or click on "Add Data Stream"

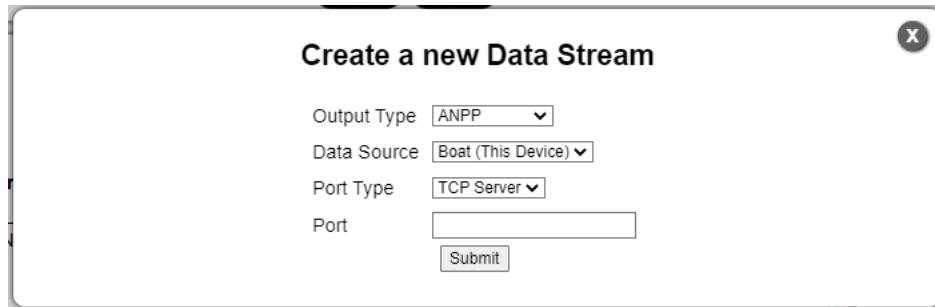


Figure 92: Screenshot of Add a New Data Stream Configuration window

3. Select the "Data Source" for the Port. This setting allows users to split data from different devices. Each device can be found by its device address, see [7.6 Subsonus Device Addresses](#)
4. Once the Data Stream is added, click on "Add Messages" to select the packets. Only the packets available for the selected device will be available. ANPP messages can have the "All Devices" option selected, in this configuration the "System State Packet" and "Track Packet" of other devices are identified by the "Device ID" field in the packet.

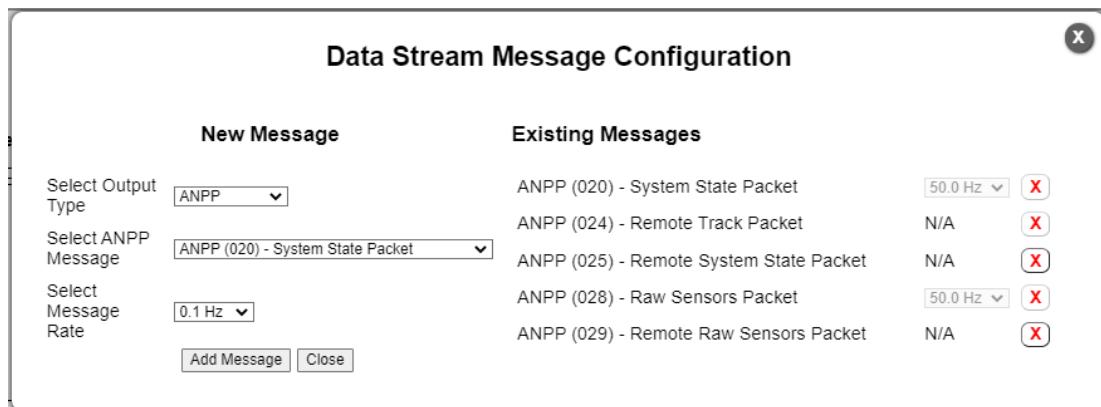


Figure 93: Screenshot of Message Configuration window

5. Select the packet frequency, some packets are event driven and will be output as soon as they are available, in this case the selected packet will be output whenever available regardless of the selected Frequency.
6. Click the "Add Message" button, this will add the packet to the port.
7. For TCP Client connections, enter the server IP address and port number to connect to. Subsonus will automatically reconnect to a server whenever the server is available, the TCP client port is enabled and has messages to output.

9.1.3.7 Ethernet Configuration

Subsonus can be configured for ipv4 network settings with manual (static) or dynamic (DHCP) settings. The Ethernet Configuration settings can be found by navigating to “Configuration”→“Ethernet Settings” in the web UI.

The screenshot shows the "Ethernet Configuration" page with the following fields:

Unit Name	<input type="text" value="Boat"/>	<input type="button" value="Set To Default"/>
Ethernet Mode	<input type="button" value="DHCP Client"/>	<input type="button" value="Set To Default"/>
Fixed IP Address	<input type="text" value="192.168.1.20"/>	<input type="button" value="Set To Default"/>
Netmask	<input type="text" value="255.255.255.0"/>	<input type="button" value="Set To Default"/>
Default Gateway	<input type="text"/>	<input type="button" value="Set To Default"/>
Broadcast Address	<input type="text"/>	<input type="button" value="Set To Default"/>
DNS Server Address	<input type="text"/>	<input type="button" value="Set To Default"/>
Link Mode	<input type="button" value="Auto Negotiation"/>	<input type="button" value="Set To Default"/>

Figure 94: Ethernet Settings Page

DHCP

By default Subsonus is configured as a DHCP client. It requires a DHCP server to be present on the network and will be automatically assigned an IP address by the server.

To configure DHCP Client mode:

1. Navigate to the “Configuration”→“Ethernet Settings” page.
2. For “Ethernet Mode” select “DHCP Client”.
3. Press “Update Network Settings”.

Static IP

Subsonus can be configured with a static IP address, this mode may be required when operating on a network that does not have a DHCP server present. Note that configuring a static IP address may break the ability to access Subsonus from the current network configuration, please be sure when configuring static IP addresses.

To configure Static IP mode:

1. Navigate to the “Configuration”→“Ethernet Settings” page.
2. For “Ethernet Mode” select “Static IP”.
3. Enter a Fixed IP Address, for example 192.168.1.10.
4. Enter a valid netmask, for example 255.255.255.0.
5. If required, enter a gateway IP Address.
6. If required, enter a broadcast address.
7. If required enter a DNS server address.

Link Mode

Link mode is the speed of the Ethernet connection, the modes can be configured as:

- Auto Negotiation (Default) – automatically determine the best link mode.
- 100 Mbps Full Duplex.
- 100 Mbps Half Duplex.
- 10 Mbps Full Duplex.
- 10 Mbps Half Duplex.

This setting should be left on automatic unless the application directly requires a specific link mode.

9.1.3.8 Time Configuration

Subsonus needs access to a time source for correct log file recording and synchronisation with other devices. Time configuration settings can be found in the **Configuration → Time** page.

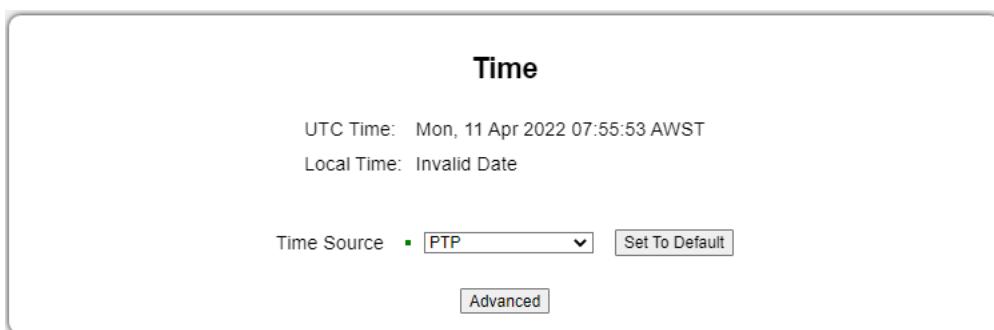


Figure 95: Screenshot of Time Configuration page

Time Source

- “PTP” (default) Subsonus will act as a PTP slave and receive time from a PTP master on the same network (e.g. GNSS Compass). Subsonus will also accept acoustic time updates if no valid server is detected.
- “Acoustic” Subsonus will only synchronise time acoustically with another Subsonus and will not use any other source.
- “NTP” Subsonus will act as an NTP slave and attempt to source time from one of the configured NTP servers. Subsonus will also accept acoustic time updates if no valid server is detected.
- “External INS” Subsonus will synchronise its time to an external INS if one has been configured.
- “None” Subsonus will not attempt to update its time from any external source.

Serve PTP

Subsonus can be configured to act as a PTP master on a network. This option is not available when operating with “PTP” selected as the time source.

Serve NTP

Subsonus can be configured to act as an NTP server on a network. This option is not available when operating with “NTP” selected as the time source.

Update External INS

Subsonus can be configured to update a connected external INS with time. This option is not available when operating with “External INS” selected as the time source.

9.1.3.9 Modem Configuration

To access the modem configuration page, navigate to **Configuration** → **Modem Configuration** in the Subsonus web UI. For details on the Modem Configuration ANPP packet, see [11.5.14 Modem Configuration Packet](#).

Data Interface

- **TCP port** - Local port for sending and receiving modem data on this Subsonus.

Data Sending Rules

- **Buffer size** - Maximum amount of data in bytes to be buffered before it is discarded (oldest data is discarded first).
- **Buffer timeout** - Maximum time to hold data in buffer (in seconds). Data age is on the age of the last byte in the data. If data expires it will be discarded). Set to 0 to disable.
- **Data chunk size** - Maximum size of a chunk in bytes. Sending enough data to exceed this size will create a new chunk.
- **Data chunk timeout** - Maximum time in seconds between bytes in a data chunk. Exceeding this timeout will create a new data chunk. Set to 0 to disable this feature.
- **Disable chunk rules for ANPP** - Disabling chunk rules for ANPP means that chunks are created based on modem data ANPP packets and not on size or timeout constraints.
- **Disable TCP aiding for modem data** - This setting only affects this device. When selected, modem data packets are forced to always be sent acoustically. Use this option to model non-network connected systems in a network connected environment by setting it on all devices.

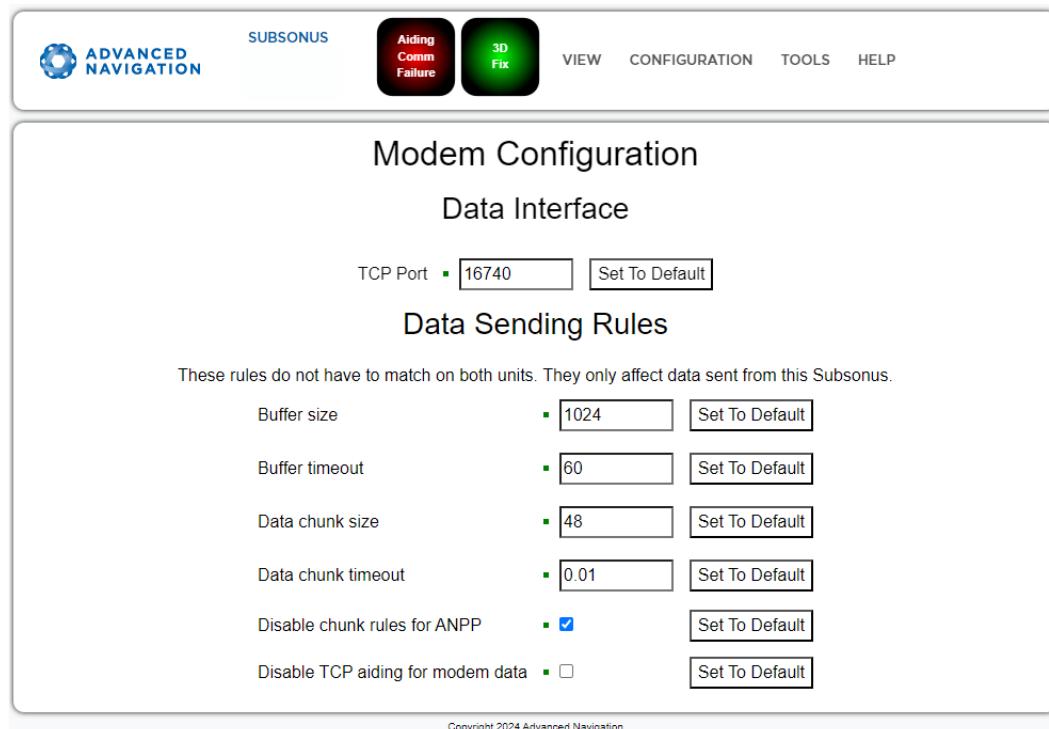


Figure 96: Subsonus WebUI - Modem Configuration Page

9.1.3.10 Sound Velocity Configuration

The velocity of sound underwater has a strong influence on communications relying on acoustics. The speed of sound in water varies depending on several factors, primarily temperature, pressure (depth), and salinity. Generally, the speed of sound increases with increasing temperature and pressure but decreases with increasing salinity. The difference in sound velocity between two environments could exceed 100 m/s or more. Consequently, propagation of the acoustic signals that are sent and received between Subsonus and other devices are affected by differences in sound velocity.

In environments where the speed of sound varies significantly, such as coastal areas or regions with thermoclines, acoustic signals may experience refraction, scattering, and attenuation, leading to distortion and signal loss. Additionally, differences in sound velocity between device locations can result in mismatches in signal timing, affecting the accuracy and reliability of communication.

To mitigate the challenges, in **Internal** velocity of sound mode, Subsonus accounts for variations in sound velocity by measuring the time taken for sound to travel between its own hydrophones. The distance between each hydrophone is known to a high precision which allows for an accurate measure of sound velocity.

A user configurable **Fixed** velocity of sound mode is also available. This mode is usually for scenarios where the a sound velocity profile has been conducted. Fixed is also the recommended velocity of sound mode when operating outside the normal range of underwater sound velocity.

To configure sound velocity settings, navigate to **Configuration → Sound Velocity Configuration** in the Subsonus web UI.

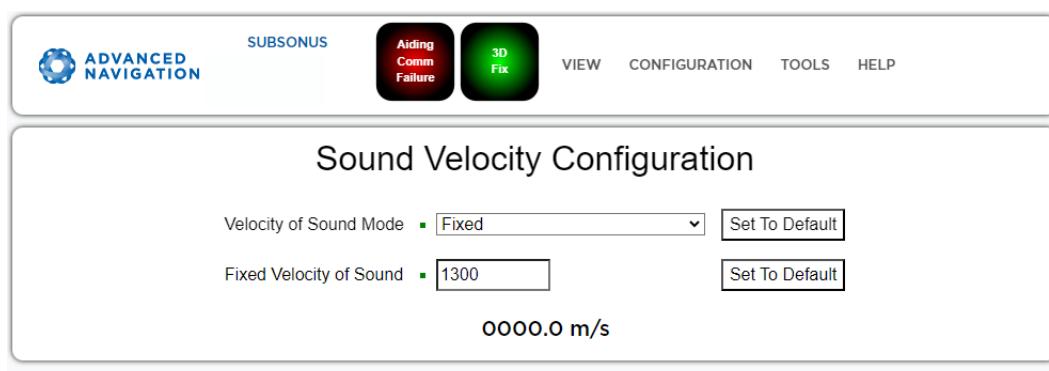


Figure 97: Subsonus Web UI - Sound Velocity Configuration Page

9.1.3.11 Display Configuration

The Display Configuration page provides user preference settings for various visualisation parameters in the Main View of the Subsonus web UI. To access the display configuration page, navigate to **Configuration** → **Display Configuration**.

- Display History** - The number acoustic samples to display in the 3D view.
- Trail History** - The number past Subsonus positions to display in the 3D view.
- DVL Point History** - The number of DVL point position to display in the 3D view.
- Show Grid Coordinates (2D)** - Show/hide grid coordinates in 2D mode.
- Coordinate Format** - DDD (decimal degrees), DMM (degrees and decimal minutes), DMS (degrees, minutes and seconds).
- Offline Timeout** - Offline timeout threshold setting for Main View to disconnect after no activity / data received.
- UI Overlay Scale** - UI element size scale (percentage).

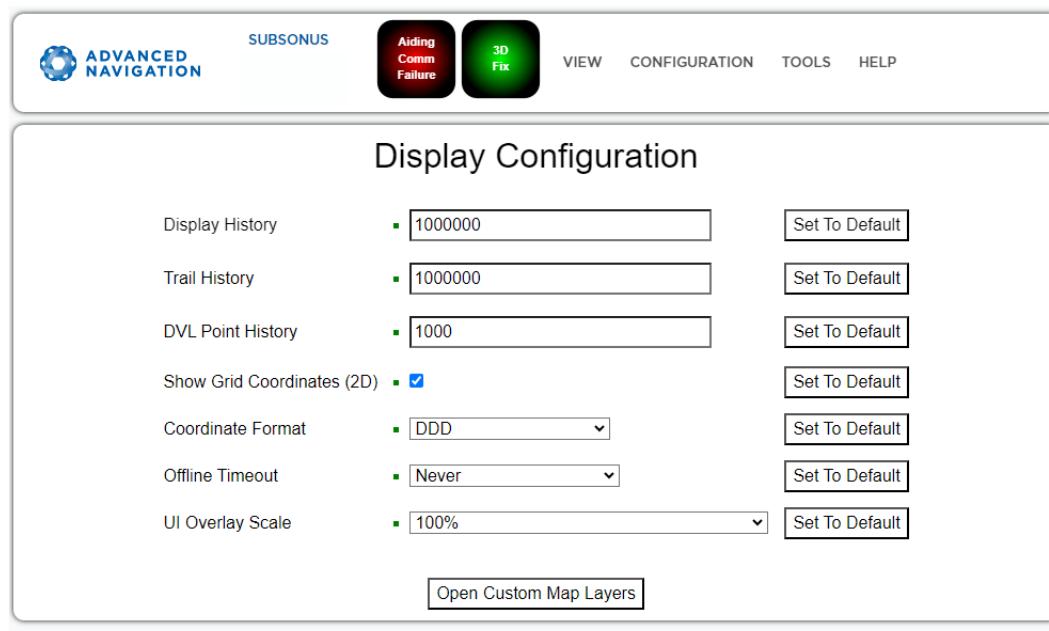


Figure 98: Subsonus Web UI - Display Configuration Page

9.1.3.12 System Configuration

To access the system configuration page, navigate to **Configuration → System Configuration** in the Subsonus web UI.

- **Enable low power mode when out of water** - Enables or disables Subsonus from entering low power mode when out of water is detected.
- **Auto Device Configuration (New Subsonus)** - Enables or disables automatic detection and configuration of certain devices that Subsonus finds via network discovery. With this setting enabled, when Subsonus discovers a GNSS compass device on the network, it will add and set up the device automatically. This is the same as setting up devices manually through the **Devices** page.

Note: For Subsonus units configured as Master, when detecting a GNSS Compass the vertical offset will be assigned a default value of 2 metres above Subsonus (Z=-2).

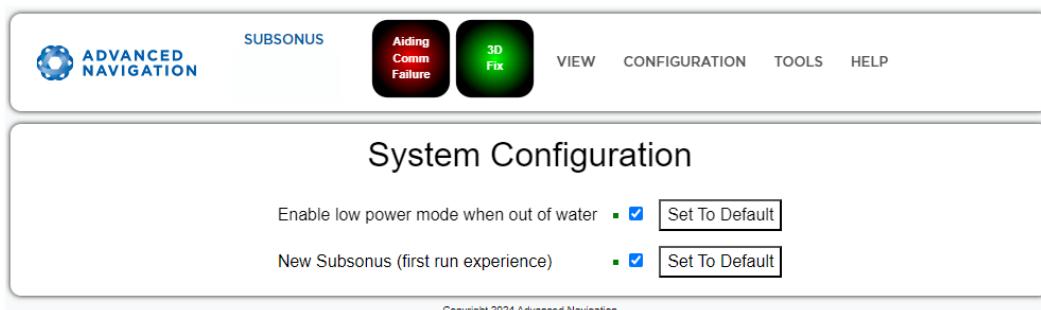


Figure 99: Subsonus Web UI - System Configuration Page

9.1.4 Tools Menu

The Tools menu contains tools for performing certain procedures with Subsonus.

9.1.4.1 Firmware Update

This page is used to update the Subsonus device firmware,

Subsonus contains firmware. Advanced Navigation regularly provides firmware updates to improve performance and add features. These are described on the [Subsonus](#) product page of the Advanced Navigation website. Advanced Navigation recommends that you upgrade to the latest version whenever available.

The firmware update function is robust, such that power loss, file corruption or other issues cannot brick the device.

Note: Advanced Navigation device firmware files have the extension .anfw.

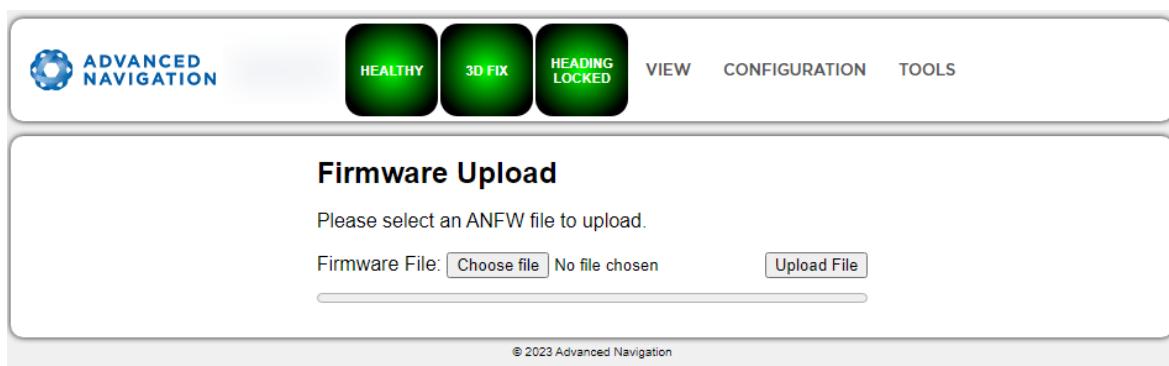


Figure 100: Web UI Firmware Update Page

Click "Choose File" and select the appropriate ANFW file for upload.

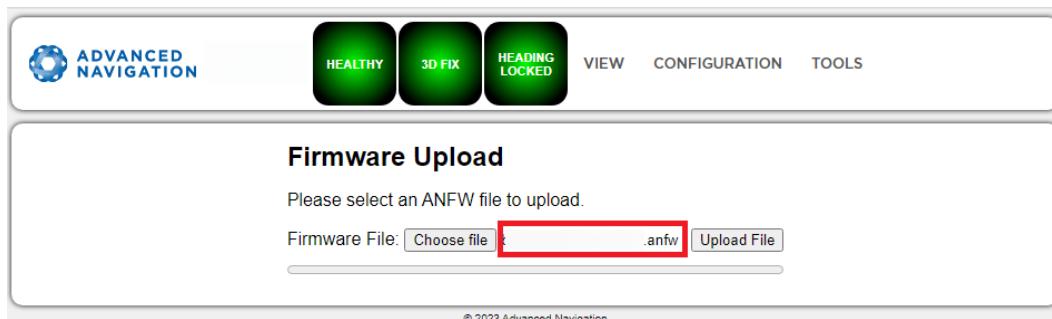


Figure 101: Firmware Update Choose File

Wait while the system uploads the firmware.



Figure 102: Firmware Update Uploading Firmware

Once uploaded, the system will automatically verify the firmware prior to reboot.

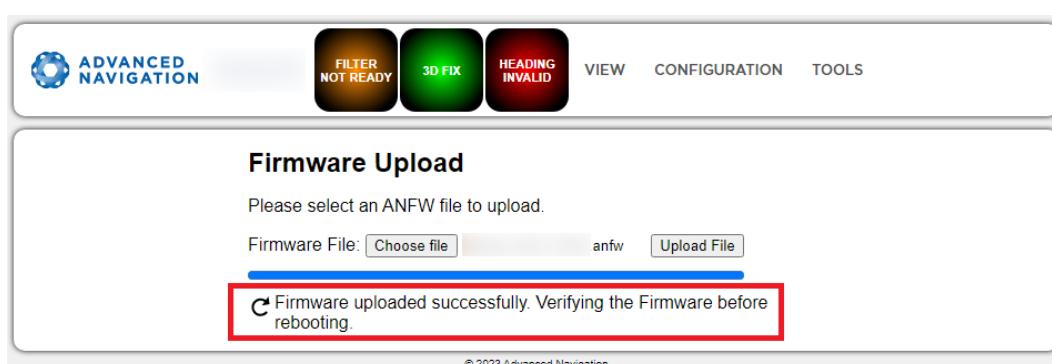


Figure 103: Firmware Update Verifying

Upon successful verification, a dialog box will appear indicating the device is rebooting to apply the update.

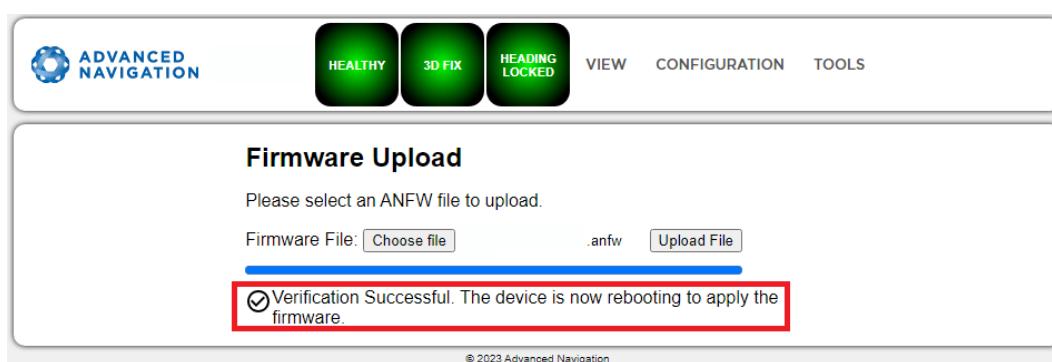


Figure 104: Firmware Update Complete

9.1.4.2 Factory Restore

The following procedure describes how to perform a factory restore of a Subsonus unit via the web interface.

Note: A factory restore will reset all configuration settings back to their factory defaults and cannot be undone. Firmware, state data logs and network settings will not be affected.

1. Connect to the Subsonus via Ethernet and establish a connection using the web UI.
2. Navigate to **Tools** → **Factory Restore**. From the **Select Configuration** drop-down menu, select the appropriate configuration for the Subsonus:
 - **Evaluation Kit Surface** for vertical connector, or
 - **Evaluation Kit Subsea** for a horizontal connector.



3. Press **Factory Restore**.
4. Wait until the factory restore is complete. The Subsonus will reboot and beep on startup once finished.
5. Navigate to the **Configuration** → **Ethernet** page.
6. Ensure that **Ethernet Mode** is set to **DHCP Client**.
7. Ensure that **Link Mode** is set to **Auto Negotiation**.

9.1.4.3 Inertial Alignment Tool

The Inertial Alignment tool is to detect gross orientation misalignment between Subsonus and an Advanced Navigation aiding source. The tool uses the networked aiding source (such as GNSS Compass or Certus) to track motion of the vessel and determine the relative alignment.

The Inertial Alignment Tool can be found under **Tools → Inertial Alignment**.

Note: Third party aiding sources are not compatible with this tool.

The Inertial Alignment tool determines the reference frame misalignment between Subsonus and the aiding source by comparing each devices internal inertial measurements. For the tool to function correctly and converge upon accurate offset values, the following is required:

- Both units to be rigidly coupled **to one another**. E.g. rigidly mounted to either end of a single pole.
- Minimal (if not the complete absence of) wobble from extended poles or non-rigid mounting orientations.
- The vessel to which the devices are mounted to be moving (e.g driving the vessel around in a figure eight motion).

Ensure that the aiding device is mounted as described in [**Surface Unit Reference Source**](#). If this cannot be achieved, then the correct offsets must be entered.

See [**Device Configuration**](#) for more information on entering alignment offsets manually for aiding devices.

Using the Tool

1. Navigate to **Tools → Inertial Alignment**.
2. Select the **Aiding Source** option from the dropdown. The alignment values for the **Roll**, **Pitch** and **Heading** will start to appear.
3. The values update constantly in real time. Once the values appear to be in the acceptable range, click **Apply to Subsonus**.

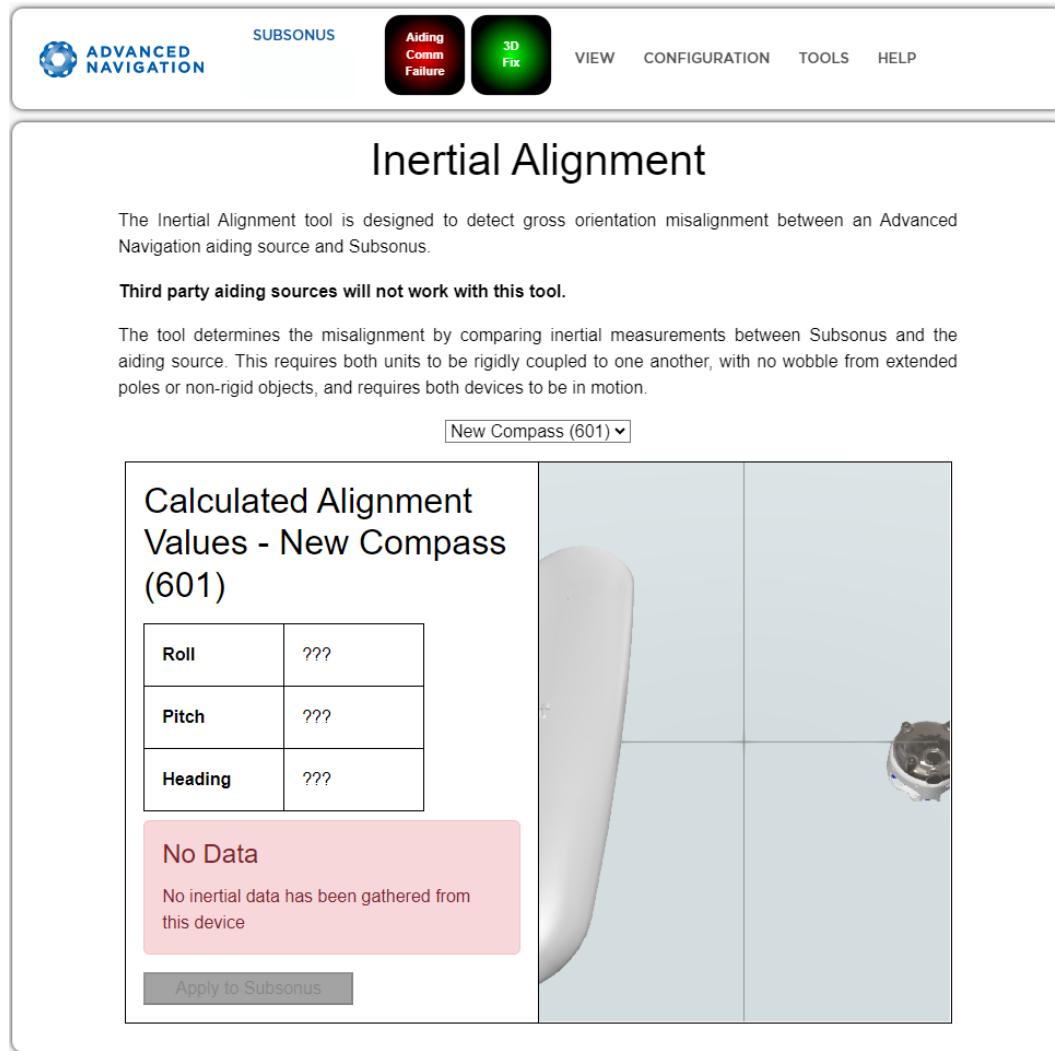


Figure 105: Inertial Alignment Tool

9.2 Using Subsonus Tools

Subsonus Tools is a software tool provided by Advanced Navigation for device discovery, logging and log conversion. Subsonus Tools is available for download from the [Advanced Navigation website](#).

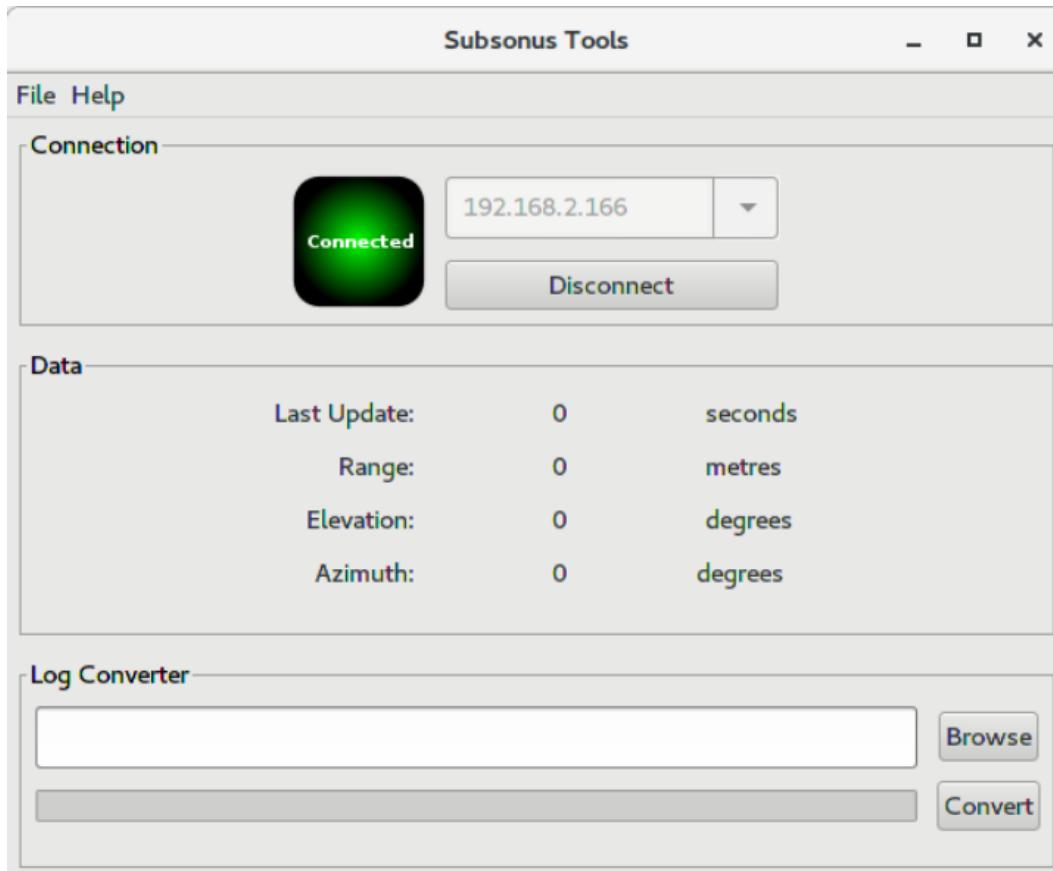


Figure 106: Screenshot of Subsonus Tools application

9.2.1 Software Change Log

Version	Date	Changes
3.1	31/01/2023	Updates to include ANPP packets introduced in FW v3.1
2.0	16/01/2019	Updates to ANPP log file decoding
1.1	01/05/2017	Device Discovery tool added
1.0	02/12/2015	Initial Release Logging of TCP data Log conversion to CSV

Figure 107: Subsonus Tools software change log

9.2.2 Installation

Subsonus Tools does not need to be installed and can be run from any directory by double clicking on it. Subsonus Tools requires a recent version of Java, available at <http://www.java.com>. On some systems to open the program it may be necessary to right click and select open with → Java Runtime Environment.

9.2.3 Troubleshooting

If the application will not start, the most common reason is that you have 32-bit Java installed on a 64-bit operating system. Uninstall Java and reinstall the 64-bit version.

Please contact support@advancednavigation.com if you encounter any issues.

9.2.4 Main View

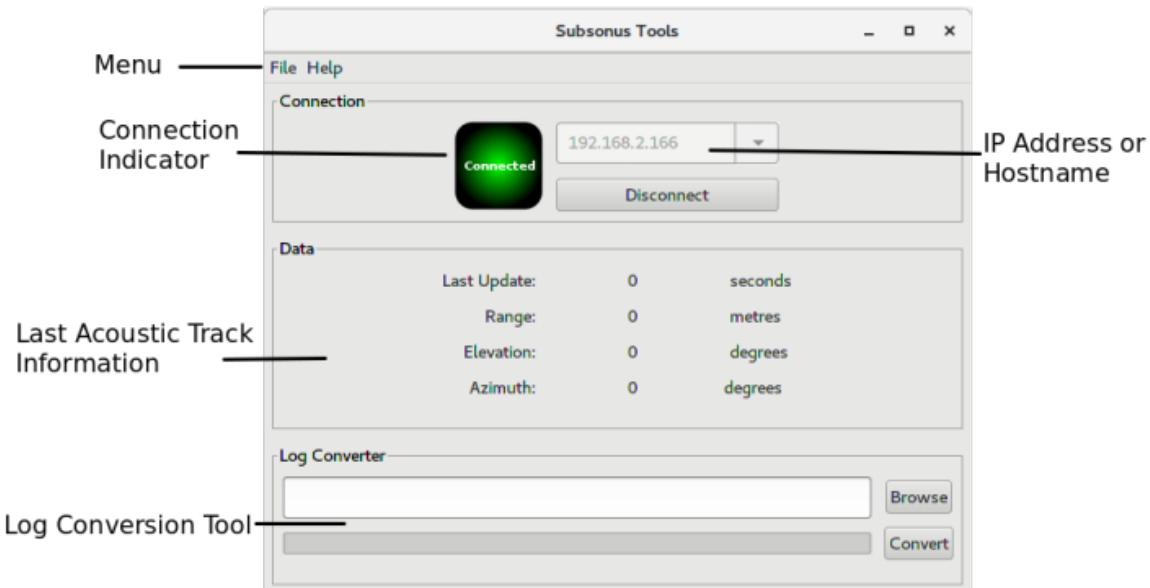


Figure 108: Screenshot of Subsonus Tools Main view

9.2.5 Device Discovery

Device discovery allows network discovery and reconfiguration of devices on the local network regardless of network settings.

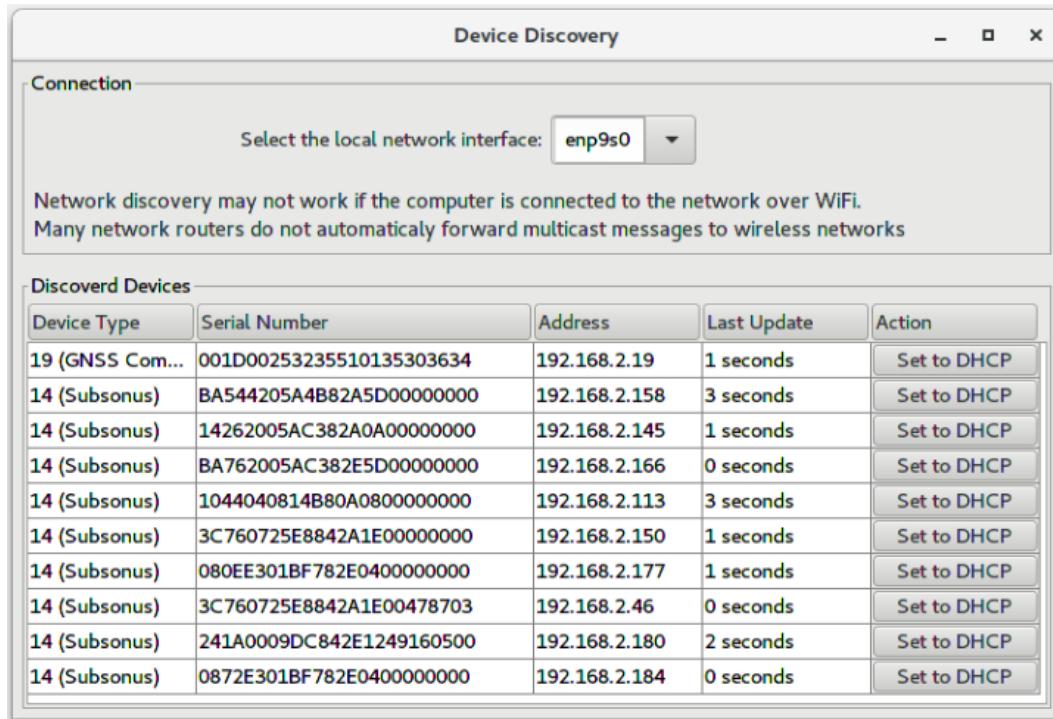


Figure 109: List of discovered network Advanced Navigation products

9.2.5.1 Discovery Connection

Discovery operates by sending packets via multi-cast through a physical network connection. It is recommended that a physical connection is used as many WiFi connections will not forward multi-cast packets. Select the appropriate interface from the list.

9.2.5.2 Set to DHCP

Once discovered devices on uncontactable network addresses can be reset to DHCP by pressing the “Set to DHCP” button for that device.

9 Interfacing with Subsonus

9.3 IP Address

By default Subsonus uses DHCP to assign itself an address. The system can be assigned a static IP on the network configuration page. Advanced Navigation recommends using zeroconf to connect to the unit, however it is also possible to use the direct IP address to connect.

9.4 Network Discovery

9.4.1 Zeroconf

Zeroconf is a network protocol used for finding devices on a network without an IP address. Subsonus has zeroconf support and it is typically the easiest way to connect to it on a network. Zeroconf for Windows (Apple Bonjour) can be downloaded from one of the links below:

<https://www.advancednavigation.com/Bonjour.msi> (32-bit installer)

<https://www.advancednavigation.com/Bonjour64.msi> (64-bit installer)

Once zeroconf is installed you can open a web browser and enter the address <http://an-subsonus-1.local/> to connect to a Subsonus. Note that the trailing forward slash is required on some browsers.

When operating multiple units the automatic discovery address will increment, for newly added units, for example if two Subsonus units are connected to the same network they will be available at <http://an-subsonus-1.local/> and <http://an-subsonus-2.local/>, a third unit will go to <http://an-subsonus-3.local/> and so on.

9.4.2 Host Name Discovery

A Subsonus unit can be accessed in three different ways once Zeroconf is supported:

1. Automatic discovery host name, <http://an-subsonus-1.local/>
2. Direct IP addresses access, for example if the unit is located at 192.168.1.2 <http://192.168.1.2>
To determine IP address, Open Subsonus Tools and navigate to "File"→"Discovery". The device should appear in a few seconds, with the IP address shown.
3. User host name access, for example if the unit is named "Surface": <http://surface.local/>

Evaluation kit units will have user host names of "Subsea" and "Surface" on arrival.

9.4.3 Subsonus to Subsonus Discovery

Subsonus units will automatically discover other units connected to the same network. Multi-cast needs to be enabled on the network for this feature to operate. For more information on this feature see [IP Dataports Configuration Packet](#).

9.5 Advanced Navigation Packet Protocol Machine Interface

Subsonus features a full machine interface that allows access to all data and system configuration. The machine interface uses the binary AN packet protocol described in [11 Advanced Navigation Packet Protocol](#) over TCP.

The AN packet protocol machine interface is available over four TCP server ports. These are ports 16718, 16719, 16720 and 16721.

Subsonus can also connect to an external TCP server as an ANPP TCP client.

9.6 NMEA Input/Output

9.6.1 NMEA Input

Subsonus only accepts NMEA input from devices added on the Devices page, see section [9.1.3.2 Device Address Configuration](#). This allows Subsonus to correct NMEA messages using user supplied offsets to the device. Offsets are measured from Subsonus to the position source. Heading sources must be aligned to Subsonus.

The Subsonus surface unit requires a reference source of position, velocity, time and heading to function. This can be supplied to the unit using NMEA. The messages required are GPGGA, GPVTG and GPHDT at 10Hz.

The full list of supported input NMEA messages is listed below in [Table 14: Supported NMEA Input Messages](#).

Message ID	Description
GPGGA GNGGA	3D position
GPGLL GNGLL	2D position
GPRMC GNRMC	2D position, 2D velocity and coarse time
GPVTG GNVTG	2D velocity
GPHDT GNHDT HEHDT	Heading
GPGSV GNGSV	Satellites
GPGSA GNGSA	Dilution of Position
GPZDA GNZDA	Time

Table 14: Supported NMEA Input Messages

9.6.2 NMEA Output

Subsonus supports NMEA output over TCP server ports. These ports can be fully configured but by default ports 16722, 16723, 16724 and 16725 are set. Subsonus can also connect to an external TCP server as a TCP client.

Subsonus can output a configurable combination of NMEA messages GPZDA, GPGGA, GPVTG, GPRMC, GPHDT, GPGLL and PASHR at up to 50 Hz. The output NMEA messages can be configured in the NMEA output configuration page. An example output is shown below:

```
$GPZDA,031644.460,07,05,2013,00,00*52
$GPGGA,031644.460,3352.3501851,S,15112.2355488,E,6,00,1.4,150.0,M,0.0,M,,*7E
$GPVTG,089.19,T,089.19,M,000.00,N,000.00,K,E*27
$GPRMC,031644.460,A,3352.3501851,S,15112.2355488,E,0.0,89.2,070513,12.5,W,E*02
$GPHDT,89.2,T*06
```

\$PASHR,031644.460,089.19,T,-00.01,-00.47,-00.00,,,0,0*2E

9.7 Time Synchronisation

Subsonus supports time synchronisation using either PTP or NTP. When operating Subsonus with either the Advanced Navigation GNSS Compass or the Advanced Navigation ILU the time will be automatically synchronised with an accuracy of around 50 nanoseconds.

9.8 Modem Data Transfer

Subsonus includes acoustic modem functionality as a standard feature. Two Subsonus units can be used to transfer user data as well as completing their normal navigation tasks.

User data can be sent to Subsonus either ‘transparently’ on a specified network port, or via ANPP messages. At the other end of the link the data is available on both a transparent port and via ANPP. This allows support for a wide range of common customer instruments without requiring programming experience.

Basic modem functions can be configured using the web interface. The provided defaults will work in most applications.

Data Interface Setup		Default
TCP Port	Required. This is the local network port Subsonus will accept user data on.	16740
Data Interface Setup		Default
These rules do not have to match on both units. They only affect data sent from this Subsonus.		
Buffer size	Maximum amount of data to buffer before data is discarded (oldest data is discarded first)	1024 Bytes
Buffer timeout	Maximum time to hold data in buffer. (Data age is based on the age of the last byte in the data chunk. If data expires it will be discarded). Set to 0 to disable.	60 Seconds
Data chunk size	The maximum size of a chunk. Sending enough data to exceed this size will create a new chunk.	48 Bytes
Data chunk timeout	The maximum time between bytes in a data chunk. Exceeding this timeout will create a new data chunk. Set to 0 to disable this feature.	10 ms

Table 15: Modem Data Transfer Setup

Subsonus ensures that user data is intact upon arrival by packaging the user data into “data chunks” which are indivisible. Data chunks may be discarded if the buffer fills up or the buffer timeout is exceeded but partial data chunks will not be delivered over transparent pipes.

For complex applications, ANPP messages may be used for fine grained control and monitoring of the modem link. These messages are defined in [11 Advanced Navigation Packet Protocol](#).

10 Maintenance

10.1 Disassembly Warning

Subsonus requires special tools to be disassembled. The only part of Subsonus which can be temporarily removed and replaced in the field for the purpose of cleaning is the white protective cage. Please see [10.3.1 Removal and Replacement of Cage](#) for instructions on how to do this. No other parts of Subsonus should be disassembled.

The electrical connector and blanking cap covering the alternate connector port of Subsonus must never be unscrewed. Attempting to do this will cause permanent damage to internal components.

10.2 Inspections

The following inspections should be performed prior to deployment and after retrieval.

10.2.1 Damage

Inspect the titanium base and protective cage for deep scratches and cracks. Inspect the blue hydrophone array for any cuts, gouges or damage. In the event of any damage, please email a photo to support@advancednavigation.com for advice before deployment.

10.2.2 Connectors

The connectors and cables should be inspected for damage and checked to ensure they are fully mated.

Every time the connectors are un-mated the inside should be inspected for debris, bent or damaged pins and cracked or damaged rubber. Silicon lubricant such as Dow Corning Molykote 111 should be applied to the male pins and the female socket prior to re-mating.

10.2.3 Biofouling

Inspect for biofouling such as barnacles and other marine growth. Follow the service procedures in [10.3 Cleaning](#) for removal of biofouling.

10.3 Cleaning

Soft marine growth should be gently removed using a soft bristled brush and soapy water. If hard marine growth such as barnacles have attached to the hydrophone array they should not be pulled off with force as this may permanently damage the molded surface.

The recommended way to remove hard marine growth is to soak the unit in a weak solution (8-10%) of Sulphamic acid. An example product containing Sulphamic acid is Lime-A-Way thick gel. Once the acid has softened the growth it should fall away when brushed down. Strong acids should not be used to remove biofouling as this can cause surface damage to the plastics. If the growth cannot be easily removed the unit should be returned to the factory.

10.3.1 Removal and Replacement of Cage

The white protective cage covering the Subsonus hydrophone array may be temporarily removed to assist with cleaning. The steps are as follows:

1. Use a 2.5mm hexagonal bit to unscrew the 8 visible fasteners around the cage perimeter.
2. Gently separate the cage from Subsonus by lifting it away from the hydrophone array.
3. Inspect the hydrophone array and interior surface of the cage, clean as required.
4. Replace cage, torque the fasteners to 0.3 ± 0.05 Nm.

Never leave Subsonus with the cage removed. The cage is a critical component required to ensure the hydrophone array is protected from impacts and surface damage.

11 Advanced Navigation Packet Protocol

The Advanced Navigation Packet Protocol (ANPP) is a binary protocol designed with high error checking, high efficiency and safe design practices. It has a well defined specification and is very flexible. ANPP is proprietary and is used across all Advanced Navigation products. A packet type can be identified by its unique Packet ID. For more information about packets, see [11.1 About Packets](#).

The following packet types are available:

- [11.3 System Packets](#) - These packets have ID values of less than 20.
- [11.4 State Packets](#) - These packets have ID values between 20 and 179.
- [11.5 Configuration Packets](#) - These packets have IDs greater than 179.

The following table lists Advanced Navigation packets by type.

Packet ID	Name	Length	R/W
System Packets			
0	11.3.1 Acknowledge Packet	4	R
1	11.3.2 Request Packet	Varies	W
3	11.3.3 Device Information Packet	24	R
4	11.3.4 Restore Factory Settings Packet	4	W
5	11.3.5 Reset Packet	4	W
12	11.3.6 Hostname Packet	16	R/W
Packet ID	Name	Length	R/W
State Packets			
20	11.4.1 System State Packet	116	R
21	11.4.2 Unix Time Packet	8	R
22	11.4.3 Formatted Time Packet	14	R
23	11.4.4 Status Packet	8	R
24	11.4.5 Remote Track Packet	211	R
25	11.4.6 Remote State Packet	130	R
26	11.4.7 DVL System State Packet	204	R
28	11.4.8 Raw Sensors Packet	52	R
29	11.4.9 Remote Raw Sensors Packet	52	R
44	11.4.10 External Position and Velocity Packet	64	R/W
45	11.4.11 External Position Packet	40	R/W
46	11.4.12 External Velocity Packet	28	R/W
47	11.4.13 External Body Velocity Packet	20	R/W
48	11.4.14 External Heading Packet	12	R/W
49	11.4.15 Running Time Packet	8	R

Packet ID	Name	Length	R/W
52	11.4.16 External Time Packet	8	W
53	11.4.17 External Depth Packet	16	R/W
54	11.4.18 Geoid Height Packet	4	R
58	11.4.19 Heave Packet	16	R
66	11.4.20 Modem Status Packet	26	R/W
68	11.4.21 Modem Data Packet	Varies	R/W
100	11.4.22 Remote Geodetic Position Packet	34	R
101	11.4.23 Remote Orientation Packet	34	R
102	11.4.24 Remote Depth Packet	14	R
103	11.4.25 Remote Velocity of Sound Packet	14	R
104	11.4.26 Remote Subsonus System Status Packet	14	R
105	11.4.27 Remote Subsonus Filter Status Packet	14	R
106	11.4.28 Remote Subsonus Tag System Status Packet	14	R
107	11.4.29 Remote Time Packet	18	R
108	11.4.30 Remote Operation Mode Packet	11	R
109	11.4.31 Remote Battery Percentage Packet	11	R
110	11.4.32 Remote G-force Packet	14	R
Packet ID	Name	Length	R/W
Configuration Packets			
181	11.5.1 Packets Period Packet	Varies	R/W
184	11.5.2 Sensor Ranges Packet	4	R/W
185	11.5.3 Installation Alignment Packet	73	R/W
186	11.5.4 System Options Packet	12	R/W
187	11.5.5 Fixed Position Packet	38	R/W
189	11.5.6 Magnetic Calibration Values Packet	49	R/W
190	11.5.7 Magnetic Calibration Configuration Packet	1	W
191	11.5.8 Magnetic Calibration Status Packet	3	R
192	11.5.9 Device Address Configuration Packet	2	W
193	11.5.10 Time Configuration Packet	194	R/W
195	11.5.11 NMEA Output Configuration Packet	Varies	R/W
196	11.5.12 Device Configuration Packet	Varies	R/W
197	11.5.13 Port Configuration Packet	41	R/W
198	11.5.14 Modem Configuration Packet	40	R/W
200	11.5.15 Acoustic Data Priority Packet	Varies	R/W

Table 16: Advanced Navigation Packets

11.1 About Packets

11.1.1 Packet Structure

The ANPP packet structure and the header format are shown in the tables below. Example source code is provided in multiple languages via the SDK, available from the [Subsonus](#) product page of the Advanced Navigation website.

Header					
Header LRC	Packet ID	Packet Length	CRC16	Packet Data	

Table 17: ANPP Packet Structure

Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	Header LRC
2	1	u8	1	Packet ID
3	2	u8	1	Packet Length
4	3	u16	2	CRC

Table 18: ANPP Header Format

11.1.1.1 Header LRC

The header LRC (Longitudinal Redundancy Check) provides error checking on the packet header. It also allows the decoder to find the start of a packet by scanning for a valid LRC. Only the lower 8 bits of the calculation below are provided in the LRC field of the packet header. The LRC can be found using the following:

$$LRC = (PacketID + PacketLength + crc_0 + crc_1) \oplus 0xFF + 1$$

11.1.1.2 Packet ID

The packet ID is used to distinguish the contents of the packet. Packet IDs range from 0 to 255. See [11. Advanced Navigation Packet Protocol](#).

System packets have packet IDs in the range 0 to 19. These packets are implemented the same by every device using ANPP.

State packets are packets that contain data that changes with time, i.e. temperature. State packets can be set to output at a certain rate. State packets are packet IDs in the range 20 to 179.

Configuration packets are used for reading and writing device configuration. Configuration packets are packet IDs in the range 180 to 255.

11.1.1.3 Packet Length

The packet length denotes the length of the packet data, i.e. from byte index 5 onwards inclusive. Packet length has a range of 0 – 255.

11.1.1.4 CRC

The CRC is a CRC16-CCITT. The starting value is 0xFFFF. The CRC covers only the packet data.

11.1.2 Packet Requests

Any of the state and configuration packets can be requested at any time using the [11.3.2 Request Packet](#).

11.1.3 Packet Acknowledgement

When configuration packets are sent to Subsonus, it will reply with an acknowledgement packet that indicates whether the configuration change was successful or not. See [11.3.1 Acknowledge Packet](#).

External data packets will also generate negative acknowledgement packets if there is a problem with the packet. Positive acknowledgements will not be sent. See [External Data](#) for a list of External Data Packets.

11.1.4 Packet Rates

The packet rates can be configured either using the web UI, or Subsonus Manager or through the [11.5.1 Packets Period Packet](#). By default Subsonus is configured to output the [11.4.1 System State Packet](#) at 20 Hz and the [11.4.8 Raw Sensors Packet](#) at 20 Hz. When configuring packet rates it is essential to ensure the baud rate is capable of handling the data throughput. This can be calculated using the rate and packet size. The packet size is calculated by adding the packet overhead to the packet length; the packet overhead is a fixed value of 5. For example to output the system state packet at 50Hz the calculation would be:

Data throughput = (100 (packet length) + 5 (fixed packet overhead)) * 50 (rate)

Data throughput = 5250 bytes per second

Minimum baud rate = data throughput x 10 bits per byte (including framing bits) x 1.1 (10% margin) = 57750 Baud

Closest standard baud rate = 115200 Baud

When multiple packets are set to output at the same rate, the order the packets output is from lowest ID to highest ID.

11.1.5 Packet Timing

Packets are output in order of packet ID from lowest ID to highest ID and all packets that are output in one sequence have their data matched to the same time of validity. The time of validity can be found in either the [11.4.1 System State Packet](#), the [11.4.2 Unix Time Packet](#) or the [11.4.3 Formatted Time Packet](#). For example if the [11.4.2 Unix Time Packet](#), [11.4.4 Status Packet](#) and [NED Velocity Packet](#) packet were all set to output at 10 Hz, at each 0.1 second period the three packets would output consecutively by order of packet ID with all data synchronised between them and the [11.4.2 Unix Time Packet](#) providing the time of validity for the other two packets.

11.2 Data Types

The following data types are used in the packet protocol. All data types in the protocol are little endian byte ordering.

Abbreviation	Bytes	Also known as
u8	1	unsigned char, unsigned byte, uint8_t
s8	1	char, byte, int8_t
u16	2	unsigned short, uint16_t
s16	2	short, int16_t
u32	4	unsigned int, unsigned long, uint32_t
s32	4	int, long, int32_t
u64	8	unsigned long long, uint64_t

Abbreviation	Bytes	Also known as
s64	8	long long, int64_t
fp32	4	float
fp64	8	double

Table 19: Data Type Abbreviations used in the ANPP

11.3 System Packets

11.3.1 Acknowledge Packet

Acknowledgement Packet				
Field # Bytes Offset Data Type Size				Description
1	0	u8	1	Packet ID being acknowledged
2	1	u16	2	CRC of packet being acknowledged
3	3	u8	1	11.3.1.1 Acknowledge Result

Table 20: Acknowledge Packet

11.3.1.1 Acknowledge Result

Value	Description
0	Acknowledge success
1	Acknowledge failure, CRC error
2	Acknowledge failure, packet size incorrect
3	Acknowledge failure, values outside of valid ranges
4	Acknowledge failure, system flash memory failure
5	Acknowledge failure, system not ready
6	Acknowledge failure, unknown packet

Table 21: Acknowledge Result

11.3.2 Request Packet

Request Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	u8	1	Packet ID requested
+					Field 1 repeats for additional packet requests

Table 22: Request Packet

11.3.3 Device Information Packet

Device Information Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	u32	4	Software version
2		4	u32	4	11.3.3.1 Device ID
3		8	u32	4	Hardware revision
4		12	u32	4	Subsonus Serial number part 1
5		16	u32	4	Subsonus Serial number part 2
6		20	u32	4	Subsonus Serial number part 3

Table 23: Device Information Packet

11.3.3.1 Device ID

Value	Description
1	Spatial
4	Spatial FOG
5	Spatial Dual
11	Orientus (>v3)
13	Air Data Unit
14	Subsonus
16	Spatial FOG Dual
17	Motus
19	GNSS Compass
21	Subsonus Tag
22	Poseidon
26	Certus
28	Boreas D90
41	Boreas D70
43	Boreas A90
44	Boreas A70
49	Certus Mini A
50	Certus Mini N
51	Certus Mini D

Table 24: Device IDs

11.3.4 Restore Factory Settings Packet

Restore Factory Settings Packet				
Packet ID		4		
Length		4		
Read / Write		Write		
Field #	Bytes Offset	Data Type	Size	Description
1	0	u32	4	Verification sequence (set to 0x85429E1C for surface or 0xDEFA8581 for Subsea)

Table 25: Restore Factory Settings Packet

11.3.5 Reset Packet

Reset Packet					
Field #		Bytes Offset	Data Type	Size	Description
1	0		u32	4	11.3.5.1 Verification Sequence Values

Table 26: Reset Packet

11.3.5.1 Verification Sequence Values

Value	Description
0x21057A7E	Standard hot start reset
0x9A5D38B7	Cold start reset

Table 27: Verification Sequence Values

11.3.5.2 DHCP Mode

Bit	Description
0	DHCP Enabled
1	Automatic DNS
2-4	Link Mode. See 11.3.5.3 Link Mode Index
5-7	Reserved (set to zero)

Table 28: DHCP Mode

11.3.5.3 Link Mode Index

Value	Description
0	Automatic
1	100 Mbps, Full Duplex
2	100 Mbps, Half Duplex
3	10 Mbps, Full Duplex
4	10 Mbps, Half Duplex
5, 6, 7	Reserved

Table 29: Link Mode Index

11.3.5.4 Discovery Network Setting Overwrite

Settings 7,8 and 9 are optional over standard network interfaces but required to overwrite settings over multi-cast discovery. To overwrite network settings for a device over multi-cast send this packet to address 239.48.81.7 port 48817, the serial number must be set to the serial number of the device you want to overwrite settings for.

11.3.6 Hostname Packet

IP Configuration Packet					
Packet ID		12			
Length		16			
Read / Write		Read / Write			
Field #		Bytes Offset	Data Type	Size	Description
1		0	u8[16]	16	Hostname in ASCII with null termination

Table 30: Hostname Packet

11.4 State Packets

Subsonus supports a ANPP number of packets providing extensive functionality. However for the majority of users the easiest approach is to configure Subsonus using the web UI or Subsonus Tools software and then support only the single system state packet shown in [11.4.1 System State Packet](#). Advanced functionality can be added as required through the other packets.

This section covers the following topics:

Packet ID	Name	Length	R/W
State Packets			
20	11.4.1 System State Packet	116	R
21	11.4.2 Unix Time Packet	8	R
22	11.4.3 Formatted Time Packet	14	R
23	11.4.4 Status Packet	8	R
24	11.4.5 Remote Track Packet	211	R
25	11.4.6 Remote State Packet	130	R
26	11.4.7 DVL System State Packet	204	R
28	11.4.8 Raw Sensors Packet	52	R
29	11.4.9 Remote Raw Sensors Packet	52	R
44	11.4.10 External Position and Velocity Packet	64	R/W
45	11.4.11 External Position Packet	40	R/W
46	11.4.12 External Velocity Packet	28	R/W
47	11.4.13 External Body Velocity Packet	20	R/W
48	11.4.14 External Heading Packet	12	R/W
49	11.4.15 Running Time Packet	8	R
52	11.4.16 External Time Packet	8	W
53	11.4.17 External Depth Packet	16	R/W
54	11.4.18 Geoid Height Packet	4	R
58	11.4.19 Heave Packet	16	R
66	11.4.20 Modem Status Packet	26	R/W
68	11.4.21 Modem Data Packet	Varies	R/W
100	11.4.22 Remote Geodetic Position Packet	34	R
101	11.4.23 Remote Orientation Packet	34	R
102	11.4.24 Remote Depth Packet	14	R
103	11.4.25 Remote Velocity of Sound Packet	14	R
104	11.4.26 Remote Subsonus System Status Packet	14	R
105	11.4.27 Remote Subsonus Filter Status Packet	14	R

Packet ID	Name	Length	R/W
106	11.4.28 Remote Subsonus Tag System Status Packet	14	R
107	11.4.29 Remote Time Packet	18	R
108	11.4.30 Remote Operation Mode Packet	11	R
109	11.4.31 Remote Battery Percentage Packet	11	R
110	11.4.32 Remote G-force Packet	14	R

Table 31: State Packets

11.4.1 System State Packet

System State Packet				
Field #	Bytes Offset	Data Type	Size	Description
1	0	u32	4	11.4.1.1 System Status
2	4	u32	4	11.4.1.2 Filter Status
3	8	u32	4	11.4.1.4 Unix Time Seconds
4	12	u32	4	11.4.1.5 Microseconds
5	20	fp64	8	Latitude (rad)
6	28	fp64	8	Longitude (rad)
7	36	fp64	8	Height (m)
8	40	fp32	4	Velocity north (m/s)
9	44	fp32	4	Velocity east (m/s)
10	48	fp32	4	Velocity down (m/s)
11	52	fp32	4	Body acceleration X (m/s/s)
12	56	fp32	4	Body acceleration Y (m/s/s)
13	60	fp32	4	Body acceleration Z (m/s/s)
14	64	fp32	4	G force (g)
15	68	fp32	4	Roll (radians)
16	72	fp32	4	Pitch (radians)
17	76	fp32	4	Heading (radians)
18	80	fp32	4	Angular velocity X (rad/s)
19	84	fp32	4	Angular velocity Y (rad/s)
20	88	fp32	4	Angular velocity Z (rad/s)
21	92	fp32	4	Latitude standard deviation (m)
22	96	fp32	4	Longitude standard deviation (m)
23	100	fp32	4	Height standard deviation (m)
24	104	fp32	4	Roll Standard Deviation (rad)
25	108	fp32	4	Pitch Standard Deviation (rad)
26	112	fp32	4	Heading Standard Deviation (rad)

Table 32: System State Packet

11.4.1.1 System Status

This field contains 16 bits that indicate problems with the system. These are boolean fields with a zero indicating false and one indicating true.

Bit	Description
0	System Failure
1	Accelerometer Sensor Failure
2	Gyroscope Sensor Failure
3	Magnetometer Sensor Failure
4	Pressure Sensor Failure
5	GNSS Failure
6	Accelerometer Over Range
7	Gyroscope Over Range
8	Magnetometer Over Range
9	Pressure Over Range
10	Minimum Temperature Alarm
11	Out of Water Alarm
12	Pressure Depth Offset Alarm
13	Logging Memory Failure
14	Filter Aiding Communication Failure
15	Fixed Position with GNSS Aiding Alarm
16	Fixed Position with Acoustic Aiding Alarm
17	Multiple Aiding Sources Alarm
18	Aided External INS Alarm
19	Aiding GNSS Time Sync Alarm
20	Multiple Master Alarm
21	Modem Data Disabled Alarm
22	Brownout Alarm
23	Aiding Alignment Alarm
24-31	Reserved

Table 33: System Status

11.4.1.2 Filter Status

This field contains 16 bits that indicate the status of the filters. These are boolean fields with a zero indicating false and one indicating true.

Bit	Description
0	Orientation Filter Initialised
1	Navigation Filter Initialised
2	Heading Initialised
3	UTC Time Initialised
4	11.4.1.3 GNSS Fix Status
5	
6	
7	Acoustic Heading Active
8	Acoustic Position Active
9	Internal GNSS Enabled
10	Magnetic Heading Active
11	Velocity Heading Enabled
12	Pressure Depth Position Active
13	External Position Active
14	External Velocity Active
15	External Heading Active
16	Dual Antenna Heading Active
17	Fixed Position Active
18	Fixed Heading Active
19	Fixed Roll/Pitch Active
20	Pressure Depth Height Active
21	External GNSS Enabled
22	Pressure Depth Initialised
23	Internal VOS Initialised
24	USBL Tracking Active
25-31	Reserved

Table 34: Filter Status

11.4.1.3 GNSS Fix Status

Value	Bit 6	Bit 5	Bit 4	Description
0	0	0	0	No GNSS fix
1	0	0	1	2D GNSS fix
2	0	1	0	3D GNSS fix
3	0	1	1	SBAS GNSS fix
4	1	0	0	Differential GNSS fix
5	1	0	1	PPP GNSS fix
6	1	1	0	RTK Float GNSS fix
7	1	1	1	RTK Fixed GNSS fix

Table 35: GNSS Fix Status

11.4.1.4 Unix Time Seconds

This field provides the Unix time in seconds, using the standard epoch of January 1, 1970.

11.4.1.5 Microseconds

This field provides the sub-second component of time. It is represented as microseconds since the last second. Minimum value is 0 and maximum value is 999999.

11.4.2 Unix Time Packet

Unix Time Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	u32	4	Unix time stamp (seconds). See 11.4.1.4 Unix Time Seconds
2		4	u32	4	Microseconds

Table 36: Unix Time Packet

11.4.3 Formatted Time Packet

Formatted Time Packet				
Packet ID			22	
Length			14	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u32	4	Microseconds
2	4	u16	2	Year
3	6	u16	2	Year day, 0 - 365
4	8	u8	1	Month, 0 - 11
5	9	u8	1	Month Day, 1 - 31
6	10	u8	1	Week Day, 0 – 6 (0 = Sunday)
7	11	u8	1	Hour, 0 - 23
8	12	u8	1	Minute, 0 - 59
9	13	u8	1	Second, 0 - 59

Table 37: Formatted Time Packet

11.4.4 Status Packet

Status Packet				
Packet ID			23	
Length			8	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u32	4	System Status
2	4	u32	4	Filter Status

Table 38: Status Packet

11.4.5 Remote Track Packet

The Remote Track packet contains position, velocity and orientation information obtained through **an acoustic track event only**. The local Subsonus is the sender of this packet and will output the position of the remote object based on the acoustic positioning calculation performed by the master unit.

This packet is generated when the Subsonus calculates an acoustic position or angle. The fields in this packet contain data for both the Local device and the Remote device.

Note: The Remote Tracked will output the position of the remote device based on the calculations performed by the master using the **acoustic** position data only. For higher accuracy position data, outputting the State Packets from the remote unit directly is recommended, as this is calculated using data from the remote INS, acoustic communication and any external aiding devices such as a DVL.

Remote Track Packet				
Packet ID				24
Length				211
Read / Write				Read
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address
2	2	u8	1	11.4.5.1 Tracking Status
3	3	u32	4	11.4.1.1 System Status
4	7	u32	4	11.4.1.2 Filter Status
5	11	u32	4	11.4.5.2 Data Valid Flags
6	15	u32	4	11.4.1.4 Unix Time Seconds
7	19	u32	4	11.4.1.5 Microseconds
8	23	fp64	8	Local Latitude (rad)
9	31	fp64	8	Local Longitude (rad)
10	39	fp64	8	Local Height (m)
11	47	fp32	4	Local Velocity north (m/s)
12	51	fp32	4	Local Velocity east (m/s)
13	55	fp32	4	Local Velocity down (m/s)
14	59	fp32	4	Local Roll (radians)
15	63	fp32	4	Local Pitch (radians)
16	67	fp32	4	Local Heading (radians)
17	71	fp32	4	Local Latitude standard deviation (m)
18	75	fp32	4	Local Longitude standard deviation (m)
19	79	fp32	4	Local Height standard deviation (m)
20	83	fp32	4	Local Roll standard deviation (rad)
21	87	fp32	4	Local Pitch standard deviation (rad)
22	91	fp32	4	Local Heading standard deviation (rad)
23	95	fp32	4	Local Depth (m)
24	99	u32	4	Remote Age in Microseconds, see 11.4.5.3 Remote Age
25	103	fp32	4	Remote Range (m)
26	107	fp32	4	Remote Azimuth (rad)
27	111	fp32	4	Remote Elevation (rad)
28	115	fp32	4	Remote Position Raw X (m) (no correction)
29	119	fp32	4	Remote Position Raw Y (m) (no correction)

Remote Track Packet				
30	123	fp32	4	Remote Position Raw Z (m) (no correction)
31	127	fp32	4	Remote Position X (m) (roll pitch correction)
32	131	fp32	4	Remote Position Y (m) (roll pitch correction)
33	135	fp32	4	Remote Position Z (m) (roll pitch correction)
34	139	fp32	4	Remote North (m) (roll, pitch, heading correction)
35	143	fp32	4	Remote East (m) (roll, pitch, heading correction)
36	147	fp32	4	Remote Down (m) (roll, pitch, heading correction)
37	151	fp64	8	Remote Latitude (rad)
38	159	fp64	8	Remote Longitude (rad)
39	167	fp64	8	Remote Height (m)
40	175	fp32	4	Remote Range standard deviation (m)
41	179	fp32	4	Remote Azimuth standard deviation (rad)
42	183	fp32	4	Remote Elevation standard deviation (rad)
43	187	fp32	4	Remote Latitude standard deviation (m)
44	191	fp32	4	Remote Longitude standard deviation (m)
45	195	fp32	4	Remote Height standard deviation (m)
46	199	fp32	4	Remote Depth (m)
47	203	s8	1	Signal Level (dBV)
48	204	s8	1	Signal To Noise Ratio (SNR)
49	205	u8	1	Signal Correlation Ratio
50	206	u8	1	Signal Correlation Interference
51	207	u32	4	reserved

Table 39: Remote Track Packet

11.4.5.1 Tracking Status

Bit	Description
0	Data Connection Active (Status, Velocity and Orientation Valid)
1	Depth correction applied
2-7	Reserved (set to zero)

Table 40: Tracking Status

11.4.5.2 Data Valid Flags

Bit	Description
0	Local Time Valid

Bit	Description
1	Local Position Valid
2	Local Velocity Valid
3	Local Orientation Valid
4	Local Position Standard Deviation Valid
5	Local Orientation Standard Deviation Valid
6	Local Depth Valid
7	Remote Age Valid
8	Remote Range Valid
9	Remote Azimuth Valid
10	Remote Elevation Valid
11	Remote Raw XYZ Valid
12	Remote Roll Pitch Corrected XYZ Valid
13	Remote NED Valid
14	Remote Geodetic Position Valid
15	Remote Range Standard Deviation Valid
16	Remote Azimuth Standard Deviation Valid
17	Remote Elevation Standard Deviation Valid
18	Remote Position Standard Deviation Valid
19	Remote Depth Valid
20	Signal Level Valid
21	Signal to Noise Ratio Valid
22	Signal Correlation Ratio Valid
23	Signal Correlation Interference Valid
24-31	Reserved

Table 41: Track Packet Data Valid

11.4.5.3 Remote Age

Age is the difference in time from the Observer time-stamp to the track device transmit. This value will increase with range.

11.4.6 Remote State Packet

The Remote State Packet contains data transferred from a Remote tracked device. This data is the state of the Remote devices INS transferred across an acoustic or a network link. This packet may only contain partial data, indicated by valid flags, and will be generated whenever remote data is received on the local Subsonus.

Remote State Packet				
Packet ID				25
Length				130
Read / Write				Read
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address
2	2	u32	4	System status valid flags, see 11.4.1.1 System Status
3	6	u32	4	Filter status valid flags, see 11.4.1.2 Filter Status
4	10	u32	4	11.4.1.1 System Status
5	14	u32	4	11.4.1.2 Filter Status
6	18	u32	4	11.4.6.1 Data Valid Flags
7	22	u32	4	11.4.1.4 Unix Time Seconds
8	26	u32	4	11.4.1.5 Microseconds
9	30	fp64	8	Latitude (rad)
10	38	fp64	8	Longitude (rad)
11	46	fp64	8	Height (m)
12	54	fp32	4	Velocity north (m/s)
13	58	fp32	4	Velocity east (m/s)
14	62	fp32	4	Velocity down (m/s)
15	66	fp32	4	Body acceleration X (m/s/s)
16	70	fp32	4	Body acceleration Y (m/s/s)
17	74	fp32	4	Body acceleration Z (m/s/s)
18	78	fp32	4	G force (g)
19	82	fp32	4	Roll (radians)
20	86	fp32	4	Pitch (radians)
20	90	fp32	4	Heading (radians)
22	94	fp32	4	Angular velocity X (rad/s)
23	98	fp32	4	Angular velocity Y (rad/s)
24	102	fp32	4	Angular velocity Z (rad/s)
25	106	fp32	4	Latitude standard deviation (m)
26	110	fp32	4	Longitude standard deviation (m)
27	114	fp32	4	Height standard deviation (m)
28	118	fp32	4	Roll Standard Deviation (rad)
29	122	fp32	4	Pitch Standard Deviation (rad)
30	126	fp32	4	Heading Standard Deviation (rad)

*Table 42: Remote State Packet***11.4.6.1 Data Valid Flags**

This field contains a bit mask that determines if data contained in the remote system state packet is valid.

Bit	Description
0	Time Seconds Valid
1	Time Microseconds Valid
2	Latitude Valid
3	Longitude Valid
4	Height Valid
5	Velocity North Valid
6	Velocity East Valid
7	Velocity Down Valid
8	Body Acceleration X Valid
9	Body Acceleration Y Valid
10	Body Acceleration Z Valid
11	G force Valid
12	Roll Valid
13	Pitch Valid
14	Heading Valid
15	Angular Velocity X Valid
16	Angular Velocity Y Valid
17	Angular Velocity Z Valid
18	Latitude Standard Deviation Valid
19	Longitude Standard Deviation Valid
20	Height Standard Deviation Valid
21	Roll Standard Deviation Valid
22	Pitch Standard Deviation Valid
23	Heading Standard Deviation Valid
24-32	Reserved

*Table 43: Remote State Data Valid Flags***11.4.7 DVL System State Packet**

This packet may only contain partial data, indicated by valid flags, and will be generated whenever remote data is received on the local Subsonus.

DVL System State Packet	
Packet ID	26

DVL System State Packet				
Length			240	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2	2	u32	4	Observer System status, see 11.4.1.1 System Status
3	6	u32	4	Observer Filter status, see 11.4.1.2 Filter Status
4	10	u64	8	11.4.7.1 Data Valid Flags
5	18	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
6	22	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
7	26	fp64	8	Observer Latitude (radians)
8	34	fp64	8	Observer Longitude (radians)
9	42	fp64	8	Observer height (m)
10	50	fp32	4	Observer Velocity North (m/s)
11	54	fp32	4	Observer Velocity East (m/s)
12	58	fp32	4	Observer Velocity down (m/s)
13	62	fp32	4	Observer roll (radians)
14	66	fp32	4	Observer pitch (radians)
15	70	fp32	4	Observer heading (radians)
16	74	fp32	4	Observer Latitude standard deviation (radians)
17	78	fp32	4	Observer Longitude standard deviation (radians)
18	82	fp32	4	Observer height standard deviation (m)
19	86	fp32	4	Observer roll standard deviation (radians)
20	90	fp32	4	Observer pitch standard deviation (radians)
21	94	fp32	4	Observer heading standard deviation (radians)
22	98	fp32	4	Observer depth (m)
23	102	u32	4	Remote Unix Time Seconds (DVL timestamp), see 11.4.1.4 Unix Time Seconds
24	106	u32	4	Remote Microseconds, see 11.4.1.5 Microseconds
25	110	u8	1	11.4.7.2 Remote DVL Type
26	111	fp32	4	Remote bottom velocity North (m/s)
27	115	fp32	4	Remote bottom velocity East (m/s)
28	119	fp32	4	Remote bottom velocity Down (m/s)
29	123	fp32	4	Remote bottom velocity North standard deviation (m/s)

DVL System State Packet				
30	127	fp32	4	Remote bottom velocity East standard deviation (m/s)
31	131	fp32	4	Remote bottom velocity down standard deviation (m/s)
32	135	fp32	4	Remote water velocity North (m/s)
33	139	fp32	4	Remote water velocity East (m/s)
34	143	fp32	4	Remote water velocity Down (m/s)
35	147	fp32	4	Remote water velocity North standard deviation (m/s)
36	151	fp32	4	Remote water velocity East standard deviation (m/s)
37	155	fp32	4	Remote water velocity down standard deviation (m/s)
38	159	fp32	4	Remote water velocity layer depth (m)
39	163	fp32	4	Remote depth (m)
40	167	fp32	4	Remote altitude (m)
41	171	fp32	4	Remote temperature (°C)
42	175	u8	1	11.4.7.3 Track Type
43	176	fp32	4	Remote puck 1 velocity (m/s)
44	180	fp32	4	Remote puck 2 velocity (m/s)
45	184	fp32	4	Remote puck 3 velocity (m/s)
46	188	fp32	4	Remote puck 4 velocity (m/s)
47	192	fp32	4	Remote puck 1 velocity standard deviation (m/s)
48	196	fp32	4	Remote puck 2 velocity standard deviation (m/s)
49	200	fp32	4	Remote puck 3 velocity standard deviation (m/s)
50	204	fp32	4	Remote puck 4 velocity standard deviation (m/s)
51	208	fp32	4	Remote puck 1 distance (m)
52	212	fp32	4	Remote puck 2 distance (m)
53	216	fp32	4	Remote puck 3 distance (m)
54	220	fp32	4	Remote puck 4 distance (m)
55	224	fp32	4	Remote puck 1 distance standard deviation (m)
56	228	fp32	4	Remote puck 2 distance standard deviation (m)
57	232	fp32	4	Remote puck 3 distance standard deviation (m)
58	236	fp32	4	Remote puck 4 distance standard deviation (m)

Table 44: DVL System State Packet

11.4.7.1 Data Valid Flags

This field contains a bit mask that determines if data contained in the DVL system state packet is valid.

Bit	Description
0	Observer time valid
1	Observer position valid
2	Observer velocity valid
3	Observer orientation valid
4	Observer position standard deviation valid
5	Observer orientation standard deviation valid
6	Observer depth valid
7	Remote time valid
8	Remote bottom velocity valid
9	Remote bottom velocity standard deviation valid
10	Remote water velocity valid
11	Remote water velocity standard deviation valid
12	Remote depth valid
13	Remote altitude valid
14	Remote temperature valid
15	Remote puck 1 valid
16	Remote puck 2 valid
17	Remote puck 3 valid
18	Remote puck 4 valid
19	Remote puck 1 velocity valid
20	Remote puck 2 velocity valid
21	Remote puck 3 velocity valid
22	Remote puck 4 velocity valid
23	Remote puck 1 velocity error valid
24	Remote puck 2 velocity error valid
25	Remote puck 3 velocity error valid
26	Remote puck 4 velocity error valid
27	Remote puck 1 range valid
28	Remote puck 2 range valid
29	Remote puck 3 range valid
30	Remote puck 4 range valid
31	Remote puck 1 range error valid

Bit	Description
32	Remote puck 2 range error valid
33	Remote puck 3 range error valid
34	Remote puck 4 range error valid
35-64	Reserved (set to 0)

Table 45: Data Valid Flags

11.4.7.2 Remote DVL Type

Value	Description
0	Generic
1	Advanced Navigation Hydrus
2	Water Linked A50
3	Water Linked A125
4	Nortek DVL1000
5	Nortek DVL500
6	Nortek DVL333
7	Teledyne Wayfinder
8	Teledyne Pathfinder

Table 46: Remote DVL Type

11.4.7.3 Track Type

Value	Description
0	Bottom
1	Water

Table 47: Track Type

11.4.8 Raw Sensors Packet

Raw Sensors Packet				
Packet ID			28	
Length			52	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	fp32	4	Accelerometer X (m/s/s)
2	4	fp32	4	Accelerometer Y (m/s/s)
3	8	fp32	4	Accelerometer Z (m/s/s)
4	12	fp32	4	Gyroscope X (rad/s)

Raw Sensors Packet				
5	16	fp32	4	Gyroscope Y (rad/s)
6	20	fp32	4	Gyroscope Z (rad/s)
7	24	fp32	4	Magnetometer X (mG)
8	28	fp32	4	Magnetometer Y (mG)
9	32	fp32	4	Magnetometer Z (mG)
10	36	fp32	4	Internal Temperature (deg C)
11	40	fp32	4	Pressure depth (m)
12	44	fp32	4	Water Temperature (deg C)
13	48	fp32	4	Velocity of Sound (m/s)

Table 48: Raw Sensors Packet

11.4.9 Remote Raw Sensors Packet

The Remote Raw Sensors Packet contains raw sensor data transferred from a Remote tracked device. This data is the sensor reading transferred across an acoustic or a network link. This packet may contain partial data, indicated by valid flags, and will be generated whenever relevant remote data is received on the local Subsonus.

Remote Raw Sensors Packet				
Packet ID			29	
Length			20	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address
2	2	u16	2	Data Valid, see 11.4.9.1 Data Valid Flags
3	4	fp32	4	Pressure Depth (m)
4	8	fp32	4	Water Temperature (Degrees C)
5	12	fp32	4	Velocity Of Sound (m/s)
6	16	fp32	4	Internal Temperature (Degrees C)

Table 49: Remote Raw Sensors Packet

11.4.9.1 Data Valid Flags

Bit	Description
1	Water Temperature Valid
2	Velocity Of Sound Valid
3	Internal Temperature Valid
4-15	Reserved

Table 50: Remote Raw Sensors Data Valid

11.4.10 External Position and Velocity Packet

External Position and Velocity Packet				
Packet ID			44	
Length			64	
Read / Write			Read / Write	
Field #	Bytes Offset	Data Type	Size	Description
1	0	fp64	8	Latitude (rad)
2	8	fp64	8	Longitude (rad)
3	16	fp64	8	Height (m)
4	24	fp32	4	Velocity north (m/s)
5	28	fp32	4	Velocity east (m/s)
6	32	fp32	4	Velocity down (m/s)
7	36	fp32	4	Latitude standard deviation (m)
8	40	fp32	4	Longitude standard deviation (m)
9	44	fp32	4	Height standard deviation (m)
10	48	fp32	4	Velocity north standard deviation (m/s)
11	52	fp32	4	Velocity east standard deviation (m/s)
12	56	fp32	4	Velocity down standard deviation (m/s)
13	60	fp32	4	Delay (s)

Table 51: External Position and Velocity Packet

11.4.11 External Position Packet

External Position Packet				
Packet ID				45
Length				40
Read / Write				Read / Write
Field #	Bytes Offset	Data Type	Size	Description
1	0	fp64	8	Latitude (rad)
2	8	fp64	8	Longitude (rad)
3	16	fp64	8	Height (m)
4	24	fp32	4	Latitude standard deviation (m) Must be non-zero positive value
5	28	fp32	4	Longitude standard deviation (m) Must be non-zero positive value
6	32	fp32	4	Height standard deviation (m) Must be non-zero positive value
7	36	fp32	4	Delay (s)

Table 52: External Position Packet

11.4.12 External Velocity Packet

External Velocity Packet				
Packet ID				46
Length				28
Read / Write				Read / Write
Field #	Bytes Offset	Data Type	Size	Description
1	0	fp32	4	Velocity north (m/s)
2	4	fp32	4	Velocity east (m/s)
3	8	fp32	4	Velocity down (m/s)
4	12	fp32	4	Velocity north standard deviation (m/s)
5	16	fp32	4	Velocity east standard deviation (m/s)
6	20	fp32	4	Velocity down standard deviation (m/s)
7	24	fp32	4	Delay (s)

Table 53: External Velocity Packet

11.4.13 External Body Velocity Packet

This packet has been defined to support a single velocity standard deviation for all three axes, or, different values for all three axes. Modify the packet length in the packet header accordingly, depending on which format you are using.

External Body Velocity Packet				
Packet ID				47
Length				20
Read / Write				Read / Write
Field #	Bytes Offset	Data Type	Size	Description
1	0	fp32	4	Velocity X (m/s)
2	4	fp32	4	Velocity Y (m/s)
3	8	fp32	4	Velocity Z (m/s)
4	12	fp32	4	Velocity X standard deviation (m/s)
5	16	fp32	4	Delay (s)

Table 54: External Body Velocity Packet

11.4.14 External Heading Packet

External Heading Packet				
Packet ID				48
Length				12
Read / Write				Read / Write
Field #	Bytes Offset	Data Type	Size	Description
1	0	fp32	4	Heading (rad)
2	4	fp32	4	Heading standard deviation (rad)
3	8	fp32	4	Delay (s)

Table 55: External Heading Packet

11.4.15 Running Time Packet

This packet provides the running time in seconds since the most recent power on.

Running Time Packet				
Packet ID				49
Length				8
Read / Write				Read
Field #	Bytes Offset	Data Type	Size	Description
1	0	u32	4	Running time (seconds)
2	4	u32	4	11.4.1.5 Microseconds

Table 56: Running Time Packet

11.4.16 External Time Packet

External Time Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	u32	4	11.4.1.4 Unix Time Seconds
2		4	u32	4	11.4.1.5 Microseconds

Table 57: External Time Packet

11.4.17 External Depth Packet

External Depth is the measured distance below Mean Sea Level

External Depth Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	fp32	4	Depth (m)
2		4	fp32	4	Depth standard deviation (m)
3		8	fp32	4	Delay (s)

Table 58: External Depth Packet

11.4.18 Geoid Height Packet

This packet provides the offset at the current location between the WGS84 ellipsoid and the EGM96 geoid model. This can be used to determine the current height above mean sea level and also depth through the following equations:

$$\text{Height Above Mean Sea Level} = \text{WGS84 Height} - \text{Geoid Height}$$

$$\text{Depth} = \text{Geoid Height} - \text{WGS84 Height}$$

WGS84 Height is the height at the current location in the System State packet, see [11.4.1 System State Packet](#)

Geoid Height Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	fp32	4	Geoid height (m)

Table 59: Geoid Height Packet

11.4.19 Heave Packet

Heave Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	fp32	4	Heave (m)
2		4		12	Reserved (Set to 0)

Table 60: Heave Packet

11.4.20 Modem Status Packet

Modem Status Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	u32	4	11.4.1.4 Unix Time Seconds
2		4	u32	4	Microseconds
3		8	u16	2	Data chunk ID
4		10	u16	2	11.4.20.1 Modem Data Description
5		12	u16	2	11.4.20.2 Modem Link Status
6		14	u16	2	11.4.20.3 Modem Event
7		16	u16	2	Number of acoustic transmissions
8		18	u16	2	Number of acoustic packets lost
9		20	u16	2	Number of bit errors detected
10		22	u16	2	Number of bit errors corrected
11		24	u16	2	Latency (milliseconds)

Table 61: Modem Status Packet

Note: All statistics returned are for the current data chunk

11.4.20.1 Modem Data Description

Bit	Description
0	Error detection enabled
1	Error correction enabled
2	Data discarded

Bit	Description
3	Data timed out
4	Data was corrupt
5	Data was corrected
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

*Table 62: Modem Data Description***11.4.20.2 Modem Link Status**

Bit	Description
0	No medium available to transmit
1	Network link utilise
2	30kHz acoustic band utilised
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

Table 63: Modem Link Status

11.4.20.3 Modem Event

Bit	Description
0	See 11.4.20.4 Modem Event Type
1	
2	
3	
4	
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

Table 64: Modem Event

11.4.20.4 Modem Event Type

Value	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
0	0	0	0	0	0	Data chunk created from complete ANPP message
1	0	0	0	0	1	Data chunk created from timeout requirements
2	0	0	0	1	0	Data chunk created from size requirements
3	0	0	0	1	1	Data chunk discarded due to buffer overflow
4	0	0	1	0	0	Data chunk discarded due to buffer timeout
5	0	0	1	0	1	Data chunk discarded due to preemptive buffer timeout
6	0	0	1	1	0	Data chunk discarded due to buffer contention
7	0	0	1	1	1	Data chunk discarded due to out of sequence ANPP packet
8	0	1	0	0	0	Data chunk discarded due to sender
9	0	1	0	0	1	Data chunk pending discard due to buffer timeout
10	0	1	0	1	0	Sent message
11	0	1	0	1	1	Message partially acknowledged

Value	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
12	0	1	1	0	0	Message acknowledged
13	0	1	1	0	1	Received message
+						Reserved

Table 65: Modem Event Type

11.4.21 Modem Data Packet

Modem Data Packet				
Packet ID				68
Length				Variable, up to 255 bytes
Read / Write				Read / Write
Field #	Bytes Offset	Data Type	Size	Description
1	0	u32	4	11.4.1.4 Unix Time Seconds
2	4	u32	4	Microseconds
3	8	u32	4	Serial number part 1
4	12	u32	4	Serial number part 2
5	16	u32	4	Serial number part 3
6	20	u16	2	Number of packets in sequence
7	22	u16	2	Packet sequence number
8	24	u16	2	Modem data description, see 11.4.20 Modem Status Packet
9	26	u8	1	Data size
10	27			User data

Table 66: Modem Data Packet

11.4.21.1 Modem Data Packet Information

These fields are identical to the fields in the Modem Status Packet (see [11.4.20 Modem Status Packet](#)). A sequence of Modem Data Packets are always preceded by a Modem Status Packet. When sending a sequence of Modem Data Packets to Subsonus, it is not required to precede the packet(s) with a Mode Status Packet.

11.4.21.2 Modem Data Serial Number

When Subsonus returns a Modem Data Packet then this serial number will be the serial number of the unit which sent the data. When sending a Modem Data Packet to Subsonus, set these fields to 0.

11.4.22 Remote Geodetic Position Packet

This packet contains an acoustically communicated position of a remote device. This packet may only contain partial data, indicated by valid flags, and will be generated whenever remote data is received on the local Subsonus.

Remote Geodetic Position Packet				
Packet ID			100	
Length			34	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4	10	fp64	8	Latitude (radians)
5	18	fp64	8	Longitude (radians)
6	26	fp64	8	Height (m)

Table 67: Remote Geodetic Position Packet

11.4.23 Remote Orientation Packet

This packet contains an acoustically communicated orientation of a remote device. This packet may only contain partial data, indicated by valid flags, and will be generated whenever remote data is received on the local Subsonus.

Remote Orientation Packet				
Packet ID			101	
Length			23	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4	10	u8	1	11.4.23.1 Data Valid Flags
5	11	fp32	4	Roll (radians)
6	15	fp32	4	Pitch (radians)
7	19	fp32	4	Heading (radians)

Table 68: Remote Orientation Packet

11.4.23.1 Data Valid Flags

This field contains a bit mask that determines if data contained in the Remote Orientation packet is valid.

Bit	Description
0	Roll valid
1	Pitch valid
2	Heading valid
3-8	Reserved (set to 0)

Table 69: Data Valid Flags

11.4.24 Remote Depth Packet

This packet contains an acoustically communicated depth of a remote device. This packet will be generated whenever remote data is received on the local Subsonus.

Remote Depth Packet					
Field #		Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses	
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds	
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds	
4	10	fp32	4	Depth (m)	

Table 70: Remote Depth Packet

11.4.25 Remote Velocity of Sound Packet

This packet contains an acoustically communicated velocity of sound through water from a remote device.

Remote Velocity of Sound Packet					
Field #		Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses	
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds	
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds	
4	10	fp32	4	Velocity of sound (m/s)	

Table 71: Remote Velocity of Sound Packet

11.4.26 Remote Subsonus System Status Packet

This packet contains the acoustically communicated system status from the remote Subsonus to the surface Subsonus unit. This packet will be generated whenever remote data is received on the local Subsonus.

Remote Subsonus System Status Packet						
Field #			Bytes Offset	Data Type	Size	Description
1			0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2			2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
3			6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4			10	u32	4	Remote Subsonus system status, see 11.4.1.1 System Status

Table 72: Remote Subsonus System Status Packet

11.4.27 Remote Subsonus Filter Status Packet

This packet contains the acoustically communicated filter status from the remote Subsonus to the surface Subsonus unit. This packet will be generated whenever remote data is received on the local Subsonus.

Remote Subsonus Filter Status Packet						
Field #			Bytes Offset	Data Type	Size	Description
1			0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2			2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
3			6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4			10	u32	4	Remote Subsonus Filter status, see 11.4.1.2 Filter Status

Table 73: Remote Subsonus Filter Status Packet

11.4.28 Remote Subsonus Tag System Status Packet

This packet contains the acoustically communicated system status from the remote Subsonus Tag to the surface Subsonus unit. This packet will be generated whenever remote data is received on the local Subsonus.

Remote Subsonus Tag System Status Packet				
Packet ID			106	
Length			14	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4	10	u32	4	Remote Subsonus Tag system status, see 11.4.1.1 System Status

Table 74: Remote Subsonus Tag System Status Packet

11.4.29 Remote Time Packet

This packet contains the acoustically communicated Time from the remote unit to the surface Subsonus unit.

Remote Time Packet				
Packet ID			107	
Length			18	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4	10	u32	4	Remote Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
5	14	u32	4	Remote Microseconds, see 11.4.1.5 Microseconds

Table 75: Remote Time Packet

11.4.30 Remote Operation Mode Packet

This packet contains the acoustically communicated operation mode from the remote unit to the surface Subsonus unit.

Remote Operation Mode Packet		
Packet ID		108
Length		11

Remote Operation Mode Packet				
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4	10	u8	1	Operation mode

Table 76: Remote Operation Mode Packet

11.4.31 Remote Battery Percentage Packet

This packet contains the acoustically communicated battery percentage from the remote unit to the surface Subsonus unit. This packet will be generated whenever remote data is received on the local Subsonus.

Remote Battery Percentage Packet				
Packet ID			109	
Length			11	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4	10	u8	1	Battery percentage

Table 77: Remote Battery Percentage Packet

11.4.32 Remote G-force Packet

This packet contains the acoustically communicated g-force from the remote unit to the surface Subsonus unit.

Remote G Force Packet				
Packet ID			110	
Length			14	
Read / Write			Read	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	Device Address, see 7.6 Subsonus Device Addresses
2	2	u32	4	Observer Unix Time Seconds, see 11.4.1.4 Unix Time Seconds

Remote G Force Packet				
3	6	u32	4	Observer Microseconds, see 11.4.1.5 Microseconds
4	10	fp32	4	G-force (g)

Table 78: Remote G-force Packet

11.5 Configuration Packets

Configuration packets can be both read from and written to the Subsonus. On many of the configuration packets the first byte is a permanent flag. A zero in this field indicates that the settings will be lost on reset, a one indicates that they will be permanent (i.e. stored in flash).

Note: The number of configuration packets with the permanent flag set to high should be minimised to reduce the risk of exhausting the flash cycles.

This section covers the following topics:

Packet ID	Name	Length	R/W
Configuration Packets			
181	11.5.1 Packets Period Packet	Varies	R/W
184	11.5.2 Sensor Ranges Packet	4	R/W
185	11.5.3 Installation Alignment Packet	73	R/W
186	11.5.4 System Options Packet	12	R/W
187	11.5.5 Fixed Position Packet	38	R/W
189	11.5.6 Magnetic Calibration Values Packet	49	R/W
190	11.5.7 Magnetic Calibration Configuration Packet	1	W
191	11.5.8 Magnetic Calibration Status Packet	3	R
192	11.5.9 Device Address Configuration Packet	2	W
193	11.5.10 Time Configuration Packet	194	R/W
195	11.5.11 NMEA Output Configuration Packet	Varies	R/W
196	11.5.12 Device Configuration Packet	Varies	R/W
197	11.5.13 Port Configuration Packet	41	R/W
198	11.5.14 Modem Configuration Packet	40	R/W
200	11.5.15 Acoustic Data Priority Packet	Varies	R/W

11.5.1 Packets Period Packet

This packet allows the user to configure, add, remove, modify and clear state packets (packets 20 through 180).

Packets Period Packet	
Packet ID	181
Length	1 + (3 x number of packet periods)

Packets Period Packet				
Read / Write				Read / Write
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	Clear Existing Packet Periods
2	1	u8	1	11.5.13.2 Port ID
3	2	u8	1	Packet ID
4	3	u8	1	11.5.1.2 Packet Rate
+				Fields 2-4 repeat for additional packet periods

Table 79: Packets Period Packet

11.5.1.1 Clear Existing Packets

When set to a value associated with a port it deletes any existing packet rates on that port. When set to zero existing packet rates remain. Only one packet rate can exist per packet ID, so new packet rates will overwrite existing packet rates for the same packet ID.

11.5.1.2 Packet Rate

Value	Description
0	Disabled
1	0.1 Hz
2	0.2 Hz
3	0.5 Hz
4	1 Hz
5	2 Hz
6	5 Hz
7	10 Hz
8	20 Hz
9	50 Hz
10-255	Reserved

Table 80: ANPP Packet periods

11.5.2 Sensor Ranges Packet

Sensor Ranges Packet				
Packet ID				184
Length				4
Read / Write				Read / Write
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	Reserved

Sensor Ranges Packet				
2	1	u8	1	11.5.2.1 Accelerometers Range
3	2	u8	1	Reserved
4	3		1	Reserved (set to 0)

Table 81: Sensor Ranges Packet

11.5.2.1 Accelerometers Range

Value	Description
0	2 g (19.62 m/s/s)
1	4 g (39.24 m/s/s)
2	16 g (156.96 m/s/s)

Table 82: Accelerometers Range

11.5.2.2 Magnetometers Range

Value	Description
0	2 Gauss
1	4 Gauss
2	8 Gauss

Table 83: Magnetometers Range

11.5.2.3 Gyroscopes Range

Value	Description
0	250 degrees/second
1	500 degrees/second
2	2000 degrees/second

Table 84: Gyroscopes Range

11.5.3 Installation Alignment Packet

Installation Alignment Packet				
Packet ID				185
Length				73
Read / Write				
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	Permanent
2	1	fp32	4	Alignment DCM[0][0]
3	5	fp32	4	Alignment DCM[0][1]
4	9	fp32	4	Alignment DCM[0][2]

Installation Alignment Packet				
5	13	fp32	4	Alignment DCM[1][0]
6	17	fp32	4	Alignment DCM[1][1]
7	21	fp32	4	Alignment DCM[1][2]
8	25	fp32	4	Alignment DCM[2][0]
9	29	fp32	4	Alignment DCM[2][1]
10	33	fp32	4	Alignment DCM[2][2]
11	37	fp32	4	11.5.3.2 Operating Orientation
12	41	fp32	4	Reserved (set to 0)
13	45	fp32	4	Reserved (set to 0)
14	49	fp32	4	Reserved (set to 0)
15	53	fp32	4	Reserved (set to 0)
16	57	fp32	4	Reserved (set to 0)
17	61	fp32	4	Reserved (set to 0)
18	65	fp32	4	Reserved (set to 0)
19	69	fp32	4	Reserved (set to 0)

Table 85: Installation Alignment Packet

11.5.3.1 Alignment DCM

The alignment DCM (Direction Cosine Matrix) is used to represent an alignment offset of Subsonus from its standard alignment. A DCM is used rather than Euler angles for accuracy reasons. To convert Euler angles to DCM, use the formula below with angles in radians.

$$\text{DCM}[0][0] = \cos(\text{heading}) * \cos(\text{pitch})$$

$$\text{DCM}[0][1] = \sin(\text{heading}) * \cos(\text{pitch})$$

$$\text{DCM}[0][2] = -\sin(\text{pitch})$$

$$\text{DCM}[1][0] = -\sin(\text{heading}) * \cos(\text{roll}) + \cos(\text{heading}) * \sin(\text{pitch}) * \sin(\text{roll})$$

$$\text{DCM}[1][1] = \cos(\text{heading}) * \cos(\text{roll}) + \sin(\text{heading}) * \sin(\text{pitch}) * \sin(\text{roll})$$

$$\text{DCM}[1][2] = \cos(\text{pitch}) * \sin(\text{roll})$$

$$\text{DCM}[2][0] = \sin(\text{heading}) * \sin(\text{roll}) + \cos(\text{heading}) * \sin(\text{pitch}) * \cos(\text{roll})$$

$$\text{DCM}[2][1] = -\cos(\text{heading}) * \sin(\text{roll}) + \sin(\text{heading}) * \sin(\text{pitch}) * \cos(\text{roll})$$

$$\text{DCM}[2][2] = \cos(\text{pitch}) * \cos(\text{roll})$$

11.5.3.2 Operating Orientation

Value	Description
0	Unchanged
1	Surface Orientation
2	Subsea Orientation

Table 86: Operating Orientation

11.5.4 System Options Packet

System Options Packet				
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	11.5.4.1 Operation Mode
2	1	u8	1	11.5.4.2 Vehicle Profile
3	2	u8	1	Enable pressure depth aiding
4	3	fp32	4	Pressure depth zero offset (m)
5	7	u8	1	Force fixed velocity of sound
6	8	fp32	4	Fixed velocity of sound value (m/s)

Table 87: System Options Packet

11.5.4.1 Operation Mode

Value	Description
0	Unchanged
1	Master
2	Slave
3	Listen only

Table 88: Operation Mode

11.5.4.2 Vehicle Profile

Value	Description
0	Unchanged
1	Unlimited
2	Stationary
3	Buoy
4	Diver
5	3D observation class
6	3D work class
7	Towfish
8	Glider
9	Small boat
10	Large ship

Table 89: Vehicle Profile

11.5.5 Fixed Position Packet

Fixed Position Packet				
Packet ID		187		
Length		38		
Read / Write		Read / Write		
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	Enable Fixed Position Set to 1 to enable fixed position mode Set to 0 to revert to Internal INS
2	1	u8	1	11.5.5.1 Fixed Position Flags
3	2	fp64	8	Fixed Latitude (radians)
4	10	fp64	8	Fixed Longitude (radians)
5	18	fp64	8	Fixed Height (m)

Fixed Position Packet				
6	26	fp32	4	Fixed Roll (radians)
7	30	fp32	4	Fixed Pitch (radians)
8	34	fp32	4	Fixed Heading (radians)

Table 90: Fixed Position Packet

11.5.5.1 Fixed Position Flags

The use of internal INS values while in fixed position mode can be enabled by setting the fixed position flags.

Bit	Description
0	Use internal roll and pitch
1-7	Reserved

Table 91: Fixed Position Flags

11.5.6 Magnetic Calibration Values Packet

This packet can be used to inspect the magnetic calibration values or write custom magnetic calibration values to the system. Under normal operation with automatic magnetic calibration the user should not need to use this packet.

Magnetic Calibration Values Packet				
Packet ID	Length	Read / Write	189	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	Permanent
2	1	fp32	4	Hard iron bias X
3	5	fp32	4	Hard iron bias Y
4	9	fp32	4	Hard iron bias Z
5	13	fp32	4	Soft iron transformation XX
6	17	fp32	4	Soft iron transformation XY
7	21	fp32	4	Soft iron transformation XZ
8	25	fp32	4	Soft iron transformation YX
9	29	fp32	4	Soft iron transformation YY
10	33	fp32	4	Soft iron transformation YZ
11	37	fp32	4	Soft iron transformation ZX
12	41	fp32	4	Soft iron transformation ZY
13	45	fp32	4	Soft iron transformation ZZ

Table 92: Magnetic Calibration Values Packet

11.5.7 Magnetic Calibration Configuration Packet

Magnetic Calibration Configuration Packet					
Field #		Bytes Offset	Data Type	Size	Description
1	0	u8	1		11.5.7.1 Magnetic Calibration Actions

Table 93: Magnetic Calibration Configuration Packet

11.5.7.1 Magnetic Calibration Actions

Value	Description
0	Cancel magnetic calibration
2	Start 2D magnetic calibration
3	Start 3D magnetic calibration
4	Reset calibration to defaults

Table 94: Magnetic Calibration Actions

11.5.8 Magnetic Calibration Status Packet

Magnetic Calibration Status Packet					
Field #		Bytes Offset	Data Type	Size	Description
1	0	u8	1		11.5.8.1 Magnetic Calibration Status
2	1	u8	1		Magnetic calibration progress (%)
3	2	u8	1		Local magnetic error (%)

Table 95: Magnetic Calibration Status Packet

11.5.8.1 Magnetic Calibration Status

Value	Description
0	Magnetic calibration not completed
1	2D magnetic calibration completed
2	3D magnetic calibration completed
3	Custom values magnetic calibration completed
5	2D calibration in progress
6	3D calibration in progress

Value	Description
7	2D calibration error: excessive roll
8	2D calibration error: excessive pitch
9	Calibration error: sensor over range event
10	Calibration error: time-out
11	Calibration error: system error
12	Calibration error: interference error

Table 96: Magnetic Calibration Status

11.5.9 Device Address Configuration Packet

Device Address Configuration Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	u16	2	Device Address

Table 97: Device Address Configuration Packet

11.5.10 Time Configuration Packet

Time Configuration Packet					
Field #		Bytes Offset	Data Type	Size	Description
1		0	u8	1	11.5.10.1 Time Source
2		1	u8	1	11.5.10.2 Time Configuration Flags
3		2	str	64	Ntp Server 1, Hostname or IP Address
4		66	str	64	Ntp Server 2, Hostname or IP Address
5		130	str	64	Ntp Server 3, Hostname or IP Address

Table 98: Time Configuration Packet

11.5.10.1 Time Source

Value	Description
0	PTP
1	NTP
2	External INS
3	Acoustic
4	None

Table 99: Time Source

11.5.10.2 Time Configuration Flags

Bit	Description
0	Serve PTP
1	Serve NPT
2	Update External INS
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved

Table 100: Time Configuration Flags

11.5.11 NMEA Output Configuration Packet

NMEA Output Configuration Packet				
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	11.5.11.1 NMEA Fix Behaviour
2	1	u8	1	11.5.11.2 Clear Existing Packets
3	2	u8	1	11.5.13 Port Configuration Packet
4	3	u8	1	11.5.11.3 NMEA Message
5	4	u8	1	Packet rate, see 11.5.1 Packets Period Packet
+				Fields 3-5 repeat for additional settings

Table 101: NMEA Output Configuration Packet

11.5.11.1 NMEA Fix Behaviour

Value	Description
0	Normal
1	Always indicate 3D fix when the navigation filter is initialised

Table 102: NMEA Fix Behaviour

11.5.11.2 Clear Existing Packets

When set to a value associated with a port (see [11.5.13 Port Configuration Packet](#)) it deletes any existing packet rates on that port. When set to zero existing packet rates remain on all ports. Only one packet rate can exist per message and port, so new packet rates will overwrite existing packet rates for the same message and port.

11.5.11.3 NMEA Message

Value	Description
0	No Message
1	GPZDA
2	GPGGA
3	GPVTG
4	GPRMC
5	GPHDT
6	GPGGL
7	PASHR
8	TSS1
9	Simrad
10	GPGGA (Remote)
11	GPHDT (Remote)
12	GPDBS
13	GPDBS (Remote)
14	PASHR (Remote)
9-255	Reserved

Table 103: NMEA Messages

11.5.11.4 Remote Packets

In case the Port (see [11.5.13 Port Configuration Packet](#)) is configured with a remote device as its data source, only Remote packets can be added to the port. Remote packets are aperiodic and will be generated whenever available. Packet rate should be configured as 9 (50 Hz) for aperiodic packets.

Note that not all remote packets are compatible with all remote devices, if an incompatible packet is added it will never be generated by Subsonus.

11.5.12 Device Configuration Packet

Device Configuration Packet				
Field #	Bytes Offset	Data Type	Size	Description
1	0	u16	2	11.5.12.1 Device Type
2	2	u16	2	11.5.12.2 Device Key
3	4	u16	2	11.5.12.3 Device Address
4	6	str	16	11.5.12.4 Display Name
5	22	u8	1	11.5.12.5 Active Flag
+				Varies by device type, see sections 11.5.12.11 Subsonus Device Packet and below

Table 104: Device Configuration Packet

11.5.12.1 Device Type

Value	Description
0	No Device
1	Advanced Navigation Subsonus
2	Advanced Navigation Subsonus Tag
3	Advanced Navigation GNSS Compass
4	Advanced Navigation INS
5	Fixed Tone Pinger Generic
6	Fixed Tone Transponder Generic
7	Fixed Tone Transponder Benthowave
8	Fixed Position Device
9	Fixed Tone Pinger Emergency
10	Hemisphere GNSS Compass
11	WB2 Transponder
12	Generic NMEA GNSS Compass
13	Micron Transponder
14	Advanced Navigation Spatial
15	Advanced Navigation FOG
16	Advanced Navigation Dual
17	Advanced Navigation FOG Dual
18	NMEA Depth Sensor
19	Generic ANPP Device

Table 105: Device Type

11.5.12.2 Device Key

Device Key is a unique index that can be used to reference a device on the Subsonus. Device Keys are locally unique to the Subsonus and should be used to resolve Device Address conflicts.

Value	Name	Description
0	New Device	Set Device Key to 0 to create a new Device
1	This Device	The Subsonus device receiving the packet
2	Device Address	Set to 2 to use the Device Address to refer to a device

Table 106: Device key

11.5.12.3 Device Address

Device Address is a user settable address used to index devices on the system. All devices need to be assigned a device address. Device Address is used for both acoustic tracking and data stream control.

Value	Name	Description
0	Automatic	Device Address will be automatically assigned
1-255	Subsonus, Subsonus Tag	Range of valid Device Address for Subsonus and Subsonus Tag
256-499	Reserved	
500-599	3rd Party Trackable	All trackable third party transponders and beacons
600-699	Non-Trackable	All non trackable devices
700-65000	Subsonus, Subsonus Tag	Range of valid Device Address for Subsonus and Subsonus Tag

Table 107: Device Address Ranges

11.5.12.4 Display Name

This field is a user settable display name for the Device, the display name is up to 15 characters long and requires a null termination in the string. Subsonus devices with a network connection will automatically update the display name to match the Subsonus host name, see [11.3.6 Hostname Packet](#)

Display names are limited to letters (a-z, A-Z), numbers (0-9), and the minus '-' character as per the RFC 952 hostname standard.

11.5.12.5 Active Flag

Devices can be 1 - "Active" or 0 "Inactive"

Devices must be "Active" to be used by Subsonus. Automatically discovered devices are "Inactive"

To delete a device from the system, set this flag to "Inactive"

11.5.12.6 Tracked Flag

This flag can be enabled: 1 or disabled: 0. When enabled an acoustically trackable device will be scheduled for tracking by a Subsonus operating in Master mode.

11.5.12.7 Enable Flag

This flag can be set to enabled: 1 or disabled: 0. When enabled a device will be used as a position or heading aiding source.

11.5.12.8 Port and Hostname

The Port and Hostname refer to a TCP server that the Subsonus will connect to in order to communicate with the device. These settings are not required for a Subsonus device and will be automatically configured by device discovery if a change is detected by Subsonus.

11.5.12.9 External INS

This flag can be enabled: 1 or disabled: 0. When enabled Subsonus will use the device as an external INS instead of its internal INS.

11.5.12.10 Data Protocol

This setting allows setting of the acoustic data protocol used to communicate with the device when tracking.

Value	Name	Description
0	Automatic	Tracking will attempt Fast tracking but automatically fall back to reliable in the event acoustic tracking is not performing
1	High Reliability	Slower acoustic data encoding with high redundancy for reliable communication
2	High Speed	Broadband signal encoding, with less redundancy for faster communication

Table 108: Data Protocol

11.5.12.11 Subsonus Device Packet

Device Configuration Packet				
Field #	Bytes Offset	Data Type	Size	Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u16	2	Port, see 11.5.12.8 Port and Hostname
7	25	str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8	57	u8	1	Tracked, see 11.5.12.6 Tracked Flag
9	58	i32	4	Operation Mode, (Read Only set to Zero)
10	62	u32	4	Serial Number part 1, (Read Only set to Zero)
11	66	u32	4	Serial Number part 2, (Read Only set to Zero)
12	70	u32	4	Serial Number part 3, (Read Only set to Zero)
13	74	fp32	4	Interrogation Period (sec)
14	78	u8	1	Data Protocol, see 11.5.12.10 Data Protocol

Table 109: Subsonus Device Configuration Packet

11.5.12.12 Subsonus Tag Device Packet

Device Configuration Packet							
Field #			Bytes Offset		Data Type	Size	Description
1-5			0		-	23	Common, see 11.5.12 Device Configuration Packet
6			23		u8	1	Tracked, see 11.5.12.6 Tracked Flag
7			24		u32	4	Serial Number part 1, (Read Only set to Zero)
8			28		u32	4	Serial Number part 2, (Read Only set to Zero)
9			32		u32	4	Serial Number part 3, (Read Only set to Zero)
10			36		fp32	4	Interrogation Period (sec)
11			40		u8	1	Data Protocol, see 11.5.12.10 Data Protocol

Table 110: Subsonus Tag Device Configuration Packet

11.5.12.13 Advanced Navigation GNSS Compass

Device Configuration Packet							
Field #			Bytes Offset		Data Type	Size	Description
1-5			0		-	23	Common, see 11.5.12 Device Configuration Packet
6			23		u16	2	Port, see 11.5.12.8 Port and Hostname
7			25		str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8			57		u32	4	Serial Number part 1, (Read Only set to Zero)
9			61		u32	4	Serial Number part 2, (Read Only set to Zero)
10			65		u32	4	Serial Number part 3, (Read Only set to Zero)
11			69		u8	1	Enable, see 11.5.12.7 Enable Flag
12			70		fp32	4	Offset X (m)
13			74		fp32	4	Offset Y (m)
14			78		fp32	4	Offset Z (m)

Table 111: GNSS Compass Device Configuration Packet

11.5.12.14 Advanced Navigation INS

Device Configuration Packet							
Field #			Bytes Offset		Data Type	Size	Description
1-5			0		-	23	Common, see 11.5.12 Device Configuration Packet
6			23		u16	2	Port, see 11.5.12.8 Port and Hostname
7			25		str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8			57		u32	4	Serial Number part 1, (Read Only set to Zero)
9			61		u32	4	Serial Number part 2, (Read Only set to Zero)
10			65		u32	4	Serial Number part 3, (Read Only set to Zero)
11			69		u8	1	11.5.12.9 External INS
12			70		u8	1	Enable, see 11.5.12.7 Enable Flag
13			71		fp32	4	Offset X (m)
14			75		fp32	4	Offset Y (m)
15			79		fp32	4	Offset Z (m)

Table 112: Advanced Navigation INS Device Configuration Packet

11.5.12.15 Advanced Navigation Spatial INS

Device Configuration Packet				
Field #	Bytes Offset	Data Type	Size	Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u16	2	Port, see 11.5.12.8 Port and Hostname
7	25	str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8	57	u32	4	Serial Number part 1, (Read Only set to Zero)
9	61	u32	4	Serial Number part 2, (Read Only set to Zero)
10	65	u32	4	Serial Number part 3, (Read Only set to Zero)
11	69	u8	1	11.5.12.9 External INS
12	70	fp32	4	Offset X (m)
13	74	fp32	4	Offset Y (m)
14	78	fp32	4	Offset Z (m)

Table 113: Spatial INS Device Configuration Packet

11.5.12.16 Advanced Navigation Spatial FOG INS

Device Configuration Packet				
Field #	Bytes Offset	Data Type	Size	Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u16	2	Port, see 11.5.12.8 Port and Hostname
7	25	str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8	57	u32	4	Serial Number part 1, (Read Only set to Zero)
9	61	u32	4	Serial Number part 2, (Read Only set to Zero)
10	65	u32	4	Serial Number part 3, (Read Only set to Zero)
11	69	u8	1	11.5.12.9 External INS
12	70	fp32	4	Offset X (m)
13	74	fp32	4	Offset Y (m)
14	78	fp32	4	Offset Z (m)

Table 114: Spatial FOG Device Configuration Packet

11.5.12.17 Advanced Navigation Dual INS

Device Configuration Packet							
Field #			Bytes Offset		Data Type	Size	Description
1-5			0		-	23	Common, see 11.5.12 Device Configuration Packet
6			23		u16	2	Port, see 11.5.12.8 Port and Hostname
7			25		str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8			57		u32	4	Serial Number part 1, (Read Only set to Zero)
9			61		u32	4	Serial Number part 2, (Read Only set to Zero)
10			65		u32	4	Serial Number part 3, (Read Only set to Zero)
11			69		u8	1	11.5.12.9 External INS
12			70		u8	1	Enable, see 11.5.12.7 Enable Flag
13			71		fp32	4	Offset X (m)
14			75		fp32	4	Offset Y (m)
15			79		fp32	4	Offset Z (m)

Table 115: Advanced Navigation Dual INS Device Configuration Packet

11.5.12.18 Advanced Navigation FOG Dual INS

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u16	2	Port, see 11.5.12.8 Port and Hostname
7	25	str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8	57	u32	4	Serial Number part 1, (Read Only set to Zero)
9	61	u32	4	Serial Number part 2, (Read Only set to Zero)
10	65	u32	4	Serial Number part 3, (Read Only set to Zero)
11	69	u8	1	11.5.12.9 External INS
12	70	u8	1	Enable, see 11.5.12.7 Enable Flag
13	71	fp32	4	Offset X (m)
14	75	fp32	4	Offset Y (m)
15	79	fp32	4	Offset Z (m)

Table 116: FOG Dual INS Device Configuration Packet

11.5.12.19 Generic NMEA GNSS Compass

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u16	2	Port, see 11.5.12.8 Port and Hostname
7	25	str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8	57	u8	1	Enable, see 11.5.12.7 Enable Flag
9	58	fp32	4	Offset X (m)
10	62	fp32	4	Offset Y (m)
11	66	fp32	4	Offset Z (m)

Table 117: Generic NMEA GNSS Compass Device Configuration Packet

11.5.12.20 Hemisphere GNSS Compass

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u16	2	Port, see 11.5.12.8 Port and Hostname
7	25	str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8	57	u8	1	Enable, see 11.5.12.7 Enable Flag
9	58	fp32	4	Offset X (m)
10	62	fp32	4	Offset Y (m)
11	66	fp32	4	Offset Z (m)

Table 118: Hemisphere GNSS Compass Device Configuration Packet

11.5.12.21 NMEA Depth Sensor

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u16	2	Port, see 11.5.12.8 Port and Hostname
7	25	str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8	57	u8	1	Enable, see 11.5.12.7 Enable Flag
9	58	fp32	4	Offset X (m)
10	62	fp32	4	Offset Y (m)
11	66	fp32	4	Offset Z (m)

Table 119: NMEA Depth Sensor Configuration Packet

11.5.12.22 Generic ANPP Device

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u16	2	Port, see 11.5.12.8 Port and Hostname
7	25	str	32	Hostname or IP address, see 11.5.12.8 Port and Hostname
8	57	u8	1	Enable, see 11.5.12.7 Enable Flag
9	58	fp32	4	Offset X (m)
10	62	fp32	4	Offset Y (m)
11	66	fp32	4	Offset Z (m)
12	70	fp32	4	Alignment X (radians)
13	74	fp32	4	Alignment Y (radians)
14	78	fp32	4	Alignment Z (radians)

Table 120: Generic ANPP Device Configuration Packet

11.5.12.23 Fixed Position Device

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	fp64	8	Latitude (rad)
7	31	fp64	8	Longitude (rad)
8	39	fp64	8	Height (m)

Table 121: Fixed Position Device Configuration Packet

11.5.12.24 Generic Fixed Tone Pinger

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u8	1	Tracked, see 11.5.12.6 Tracked Flag
7	24	fp32	4	Transmit Frequency (Hz)
8	28	fp32	4	Transmit Duration (sec)
9	32	fp32	4	Acoustic Echo Time (sec)

Table 122: Fixed Tone Pinger Device Configuration Packet

11.5.12.25 Fixed Tone Emergency Pinger

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u8	1	Tracked, see 11.5.12.6 Tracked Flag

Table 123: Fixed Tone Emergency Pinger Device Configuration Packet

11.5.12.26 Generic Fixed Tone Transponder

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u8	1	Tracked, see 11.5.12.6 Tracked Flag
7	24	fp32	4	Interrogation Period (sec)
8	28	fp32	4	Interrogation Duration (sec)
9	32	fp32	4	Interrogation Frequency (Hz)
10	36	fp32	4	Transmit Frequency (Hz)
11	40	fp32	4	Transmit Duration (sec)
12	44	fp32	4	Reply Delay (sec)

Table 124: Fixed Tone Transponder Device Configuration Packet

11.5.12.27 Benthowave Fixed Tone Transponder

Device Configuration Packet				
Field #			Bytes Offset	Data Type Size Description
1-5	0	-	23	Common, see 11.5.12 Device Configuration Packet
6	23	u8	1	Tracked, see 11.5.12.6 Tracked Flag
7	24	fp32	4	Interrogation Period (sec)
8	28	fp32	4	Interrogation Duration (sec)
9	32	fp32	4	Interrogation Frequency (Hz)
10	36	fp32	4	Transmit Frequency (Hz)
11	40	fp32	4	Transmit Duration (sec)
12	44	fp32	4	Reply Delay (sec)
13	48	u8	1	One Way Delay

Table 125: Benthowave Fixed Tone Transponder Device Configuration Packet

11.5.12.28 WB2 Transponder

Device Configuration Packet							
Field #			Bytes Offset		Data Type	Size	Description
1-5			0		-	23	Common, see 11.5.12 Device Configuration Packet
6			23		u8	1	Tracked, see 11.5.12.6 Tracked Flag
7			24		u8	1	Wake Enable
8			25		u16	2	Reply Code
9			27		u16	2	Interrogation Code
10			29		fp32	4	Interrogation Period (sec)
11			33		fp32	4	Reply Delay (sec)

Table 126: WB2 Transponder Device Configuration Packet

11.5.12.29 Micron Transponder

Device Configuration Packet							
Field #			Bytes Offset		Data Type	Size	Description
1-5			0		-	23	Common, see 11.5.12 Device Configuration Packet
6			23		u8	1	Tracked, see 11.5.12.6 Tracked Flag
7			24		u16	2	Interrogation Code
8			26		fp32	4	Interrogation Period (sec)

Table 127: Micron Transponder Device Configuration Packet

11.5.13 Port Configuration Packet

Port Configuration Packet				
Packet ID			197	
Length			41	
Read / Write			Read / Write	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	11.5.13.1 Port Control Flags
2	1	u8	1	11.5.13.2 Port ID
3	2	u8	1	11.5.13.3 Output Type
4	3	u16	2	11.5.13.4 Data Source
5	5	u8	1	11.5.13.5 Port Type
6	6	u8	1	Enable
7	7	u16	2	Port Number
8	9	str	32	Server Address

Table 128: Port Configuration Packet

11.5.13.1 Port Control Flags

Bit	Description
0	Delete Port
1	Data Source Mask - see 11.5.13.4 Data Source
2-7	Reserved

Table 129: Port Control Flags

11.5.13.2 Port ID

Ports are configured as ANPP ports or as NMEA ports, ANPP packets can only be added to ANPP ports, NMEA packets can only be added to NMEA ports. Port ID 1 and Port ID 255 not configurable. Port ID's 2 to 8 are present by default but can be modified or deleted.

Value	ANPP	NMEA	Configurable	Port
0				No Port
1	true		false	TCP Port 16718
2	true		true	TCP Port 16719
3	true		true	TCP Port 16720
4	true		true	TCP Port 16721
5		true	true	TCP Port 16722
6		true	true	TCP Port 16723
7		true	true	TCP Port 16724
8		true	true	TCP Port 16725
11-254			true	Reserved
255	true		false	ANPP Logging

Table 130: ANPP Ports

11.5.13.3 Output Type

Value	Description
0	ANPP
1	NMEA

Table 131: Output Types

11.5.13.4 Data Source

Data Source controls the port data source, for example if set to '5' only packets relevant to Device Address 5 will be produced for that port.

If the "Data Source Mask" flag is set advanced data source options can be configured.

Value	Description
0	Invalid
1	All Devices - (ANPP Only)
2	This Device - always the source device regardless of device address

Table 132: Data Source Mask Data Sources

11.5.13.5 Port Type

Value	Description
0	TCP Server
1	TCP Client

Table 133: Port Types

11.5.14 Modem Configuration Packet

Modem Configuration Packet				
Field #	Bytes Offset	Data Type	Size	Description
1	0	u32	4	Reserved (set to 0)
2	4	u32	4	Reserved (set to 0)
3	8	u32	4	11.5.14.1 Unit Select
4	12	u16	2	Buffer Size (bytes)
5	14	f32	4	Buffer Timeout (sec)
6	18	u16	2	Data Chunk Size (bytes)
7	20	f32	4	Data Chunk Timeout (sec)
8	24	u16	2	Reserved (set to 0)
9	26	u16	2	11.5.14.2 Modem Configuration Flags
10	28	u32	4	Reserved (set to 0)
11	32	u32	4	Reserved (set to 0)
12	36	u32	4	Reserved (set to 0)

Table 134: Modem Configuration Packet

11.5.14.1 Unit Select

Set to 0 to configure the sending parameters for the current unit, set to 1 to configure the sending parameters for the unit with which this unit is communicating.

11.5.14.2 Modem Configuration Flags

Bit	Description
0	Disable TCP Aiding
1	Disable Data Chunk Rules for ANPP Data
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

Table 135: Modem Configuration Flags

11.5.15 Acoustic Data Priority Packet

Acoustic Data Priority Packet				
Packet ID			200	
Length			1 + (2 x number of priorities)	
Read / Write			Read / Write	
Field #	Bytes Offset	Data Type	Size	Description
0	0	u8	1	Clear Existing
1	1	u8	1	11.5.15.1 Acoustic Data ID
2	2	u8	1	11.5.15.2 Acoustic Data Priority
3	-			Fields 2-3 repeat for additional priorities

Table 136: Acoustic Data Priority Packet

11.5.15.1 Acoustic Data ID

Value	Description
1	Latitude
2	Longitude
3	Height
4	Roll
5	Pitch
6	Heading
7	Depth
8	Velocity of Sound
9	System Status
10	Filter Status
11	Modem Data
12	Time

Table 137: Acoustic Data ID

11.5.15.2 Acoustic Data Priority

Value	Description
0	Off
1	Low
2	Medium
3	High

Table 138: Acoustic Data Priority

12 Reference Information

This chapter is a learning reference that briefly covers knowledge essential to understanding Subsonus and INS generally. It explains the following concepts in simple terms so that people unfamiliar with the technology may understand it:

- [**12.1 USBL Acoustic Positioning**](#)
- [**12.2 Inertial Navigation Systems**](#)
- [**12.3 The Sensor Co-ordinate Frame**](#)
- [**12.4 Roll, Pitch and Heading**](#)

12.1 USBL Acoustic Positioning

USBL is a system that uses acoustic sound waves to determine position underwater. A USBL set up consists of two acoustic transceivers that transmit and receive acoustic sound waves between them which allows each unit to determine the location of the other unit.

USBL stands for Ultra-short Baseline. It is an old, loosely defined phrase referring to an acoustic positioning system with multiple hydrophones in a single unit.

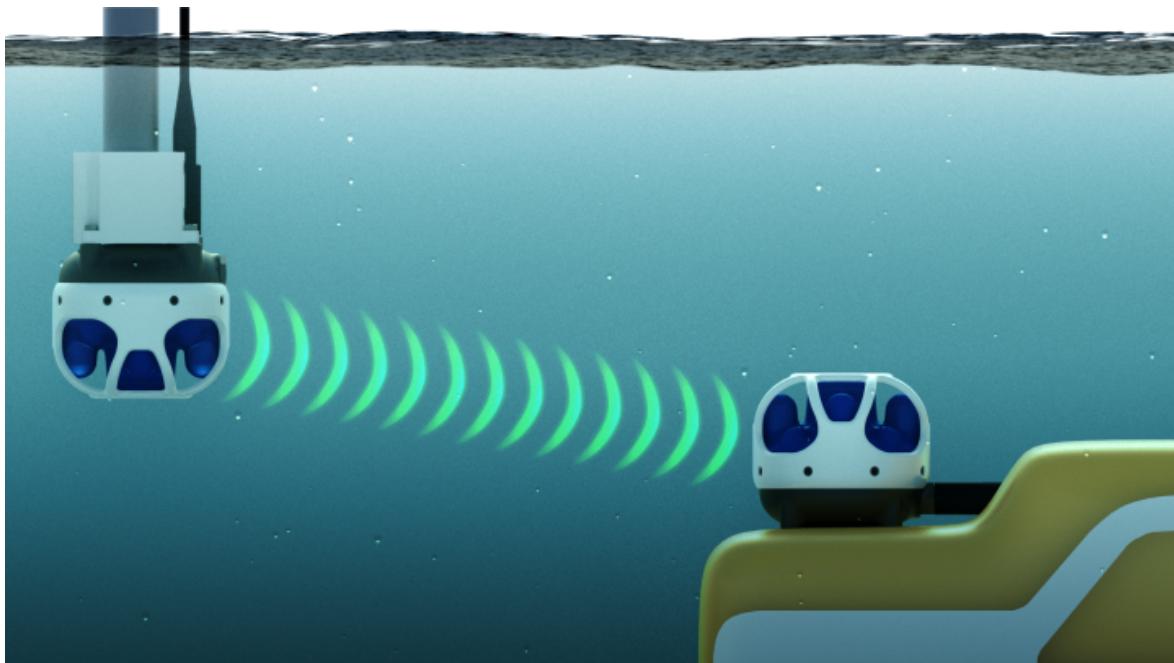


Figure 110: Typical USBL positioning set up

A typical USBL set up will have a USBL transceiver mounted on a pole attached to the side of a ship and another USBL transceiver mounted on a vehicle underwater, as shown above. The USBL system mounted on the pole is known as the surface unit and the USBL system underwater is known as the subsea unit.

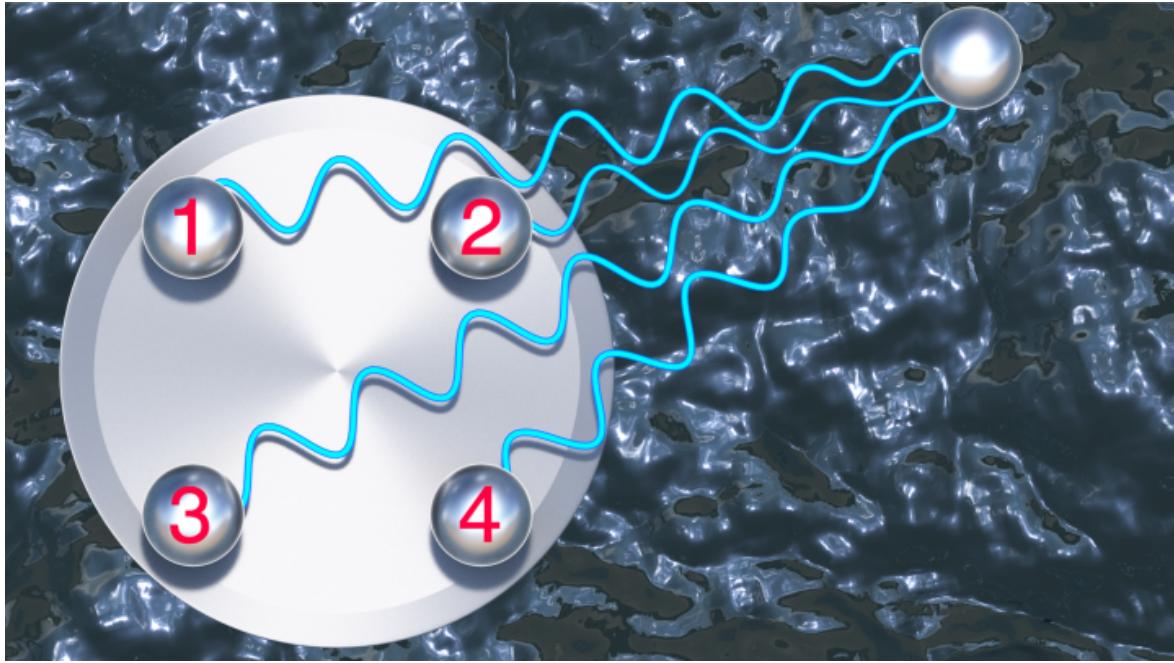


Figure 111: USBL hydrophones receiving acoustic sound waves

The way a USBL system works is that one unit will first transmit an acoustic sound wave signal. That acoustic signal travels through the water at the speed of sound and arrives at the receiving USBL a short time later. The receiving USBL receives the response on each of its hydrophones, which are separated by a known distance. By comparing the acoustic signals' time of arrival at each of the hydrophones, it is possible to determine the direction the signal has come from. By comparing the time at which the signal was transmitted with the time at which the signal was received, the amount of time the signal was travelling through the water can be determined. This travel time can be used to calculate the distance (range) between the USBLs by using the speed of sound through water. With both distance and bearing, the relative position of the transmitter can be determined.

This process of transmitting and receiving acoustic sound wave signals between the USBLs alternates back and forth continuously between the two units, allowing each unit to determine the position of the other. Subsonus is able to perform acoustic positioning updates in this way at up to 10 times per second which is limited by the speed of sound through water.

Figure 111: USBL hydrophones receiving acoustic sound waves shows 4 receive hydrophones which is typical of current USBL systems, however Subsonus actually uses 8 hydrophones which allows it to more accurately determine the direction and range of the acoustic signal.

Subsonus is the first low cost USBL system on the market to feature acoustic heading. Acoustic heading works by determining the angular offset between the surface and the subsea unit. This angular offset can then be subtracted from the surface units known accurate heading to provide accurate heading for the subsea unit.

12.2 Inertial Navigation Systems

An inertial navigation system uses motion to determine position from a starting point. Inertial navigation systems are very accurate over short periods but experience a exponentially increasing error over long periods. On Subsonus an inertial navigation system fuses the acoustic position and velocity with inertial sensors and a depth sensor to achieve an optimal solution with accuracy far beyond that of a standalone acoustic positioning system. The inertial navigation system also fills in the gaps between acoustic updates and for periods when acoustic updates are not available. Subsonus is one of the first USBL systems on the market to offer an integrated, tightly-coupled inertial navigation system.

12.3 The Sensor Co-ordinate Frame

Inertial sensors have 3 different axes: X, Y and Z and these determine the references around which angles and accelerations are measured. It is very important to align these axes correctly in installation, otherwise the system won't work correctly.

12.3.1 Subsea Unit

There are two different orientation configurations of Subsonus, the subsea unit and the surface unit. Typically the subsea unit is mounted upright on top of a subsea vehicle.

These axes are marked on the top of the subsea device as shown in [Figure 112: Subsea Subsonus Axes](#) below, with the X axis pointing away from the connector, the Z axis pointing down through the base of the unit and the Y axis pointing off to the right.

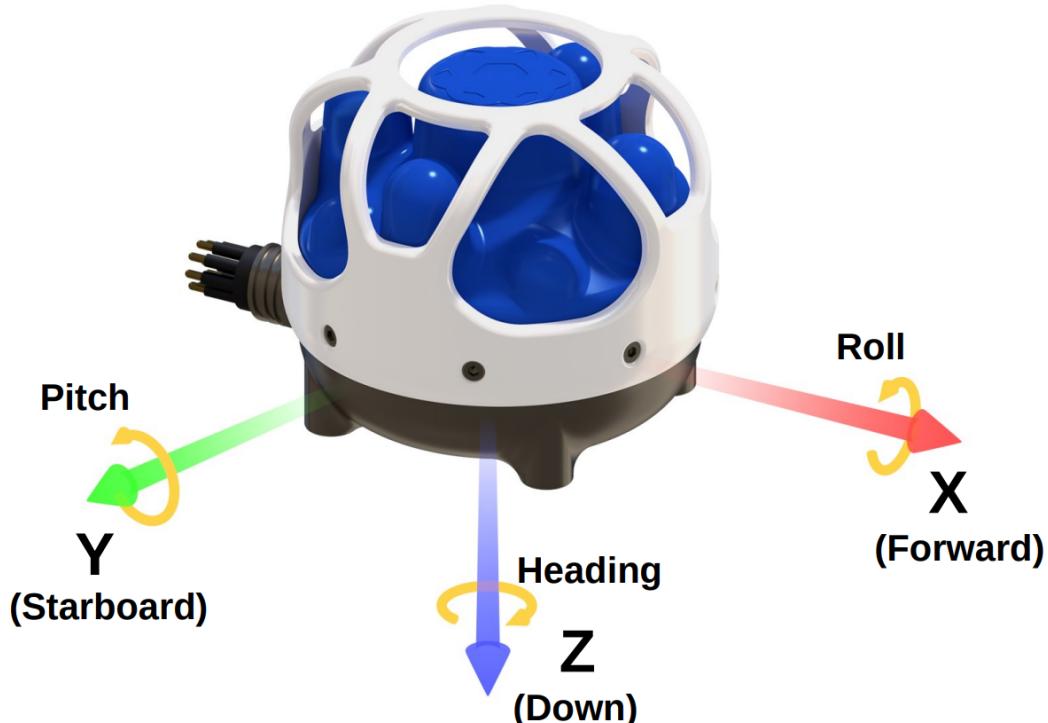


Figure 112: Subsea Subsonus Axes

12.3.2 Surface Unit

The surface unit is mounted upside down on a pole attached to the side of a ship. As the surface unit is mounted upside down its axes are different from the subsea variant, see [Figure 112: Subsea Subsonus Axes](#).

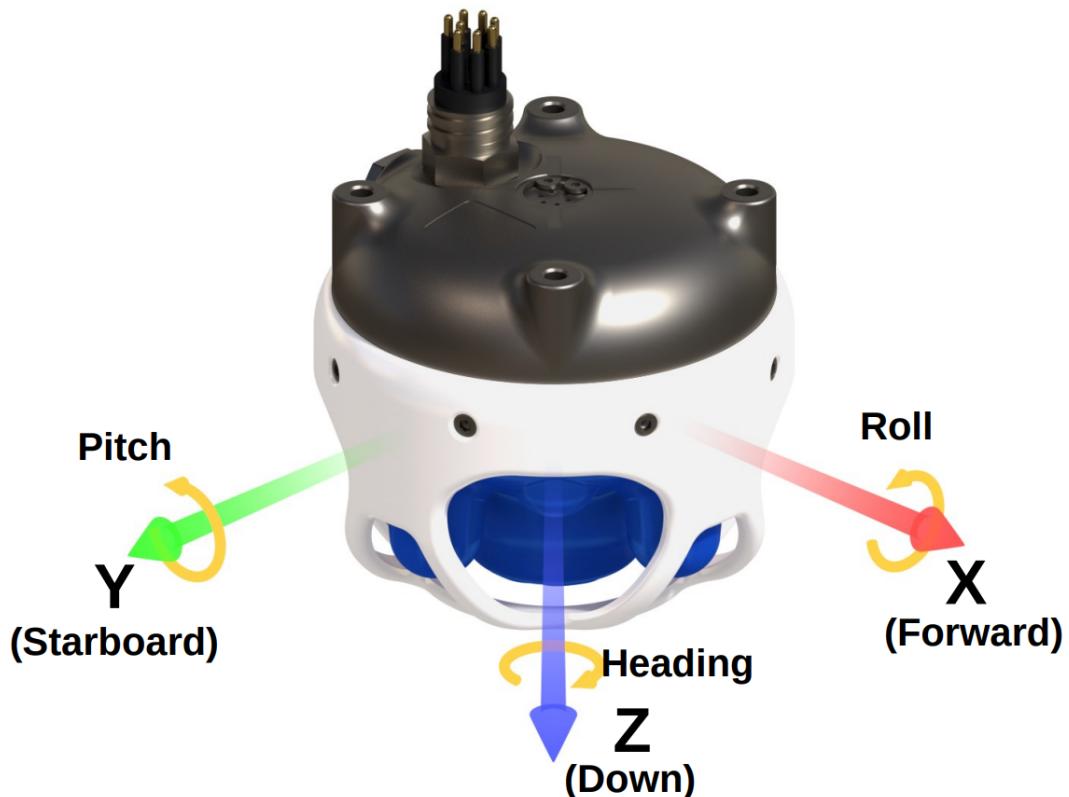


Figure 113: Surface Subsonus Axes

12.3.3 Right Hand Rule

When installed in an application the X axis should be aligned such that it points forwards and the Z axis aligned so that it points down when the system is level. A good way to remember the sensor axes is the right hand rule, which is visualised in [Figure 114: First Right-hand Rule](#).

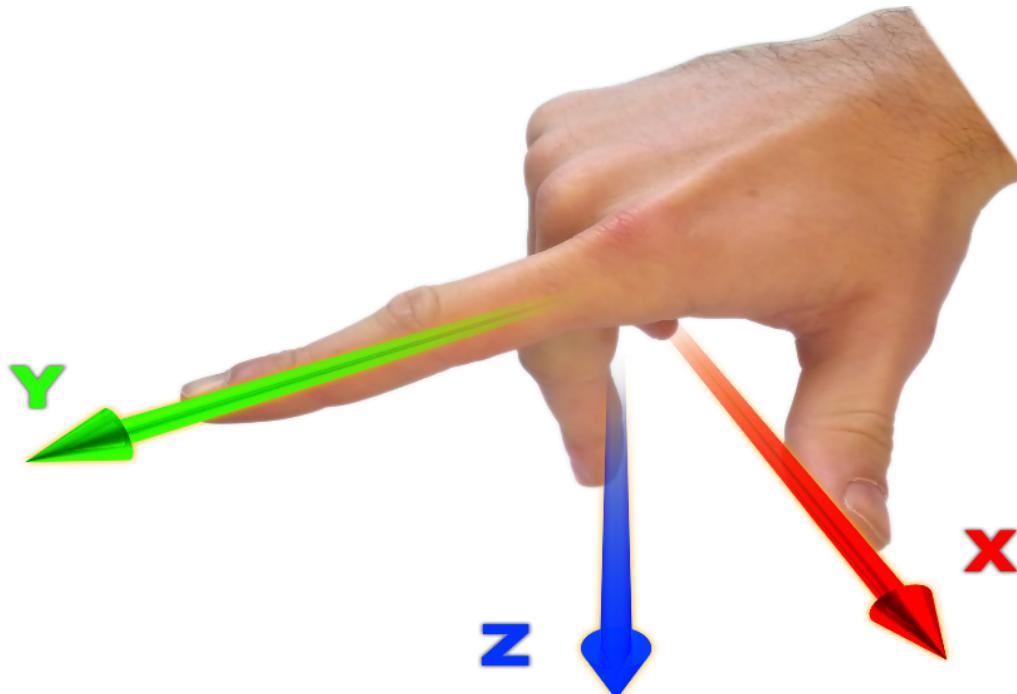


Figure 114: First Right-hand Rule

You take your right hand and extend your thumb, index and middle. Your thumb then denotes the positive X axis, your index denotes the positive Y axis and your middle denotes the positive Z axis.

12.4 Roll, Pitch and Heading

Orientation can be described by the three angles roll, pitch and heading: these are known as the Euler angles. The rotation axes of roll, pitch and heading are shown visually in [Figure 112: Subsea Subsonus Axes](#). The arrow indicates the positive rotation direction.

Roll is the angle around the X axis and is zero when the unit is level. Pitch is the angle around the Y axis and is zero when the unit is level. Heading is the angle around the Z axis and is zero when the positive X axis is pointing to true north.

12.4.1 Second Right Hand Rule

The two right hand rules are often the best way to memorise the sensor axes and directions of positive rotation. The first right hand rule gives the positive axis directions and is described in [12.3 The Sensor Co-ordinate Frame](#). The second right hand rule shown in the figure below provides the direction of positive rotation. To use it, point your thumb in the positive direction of that axis, then the direction that your fingers curl over shows the positive rotation on that axis.

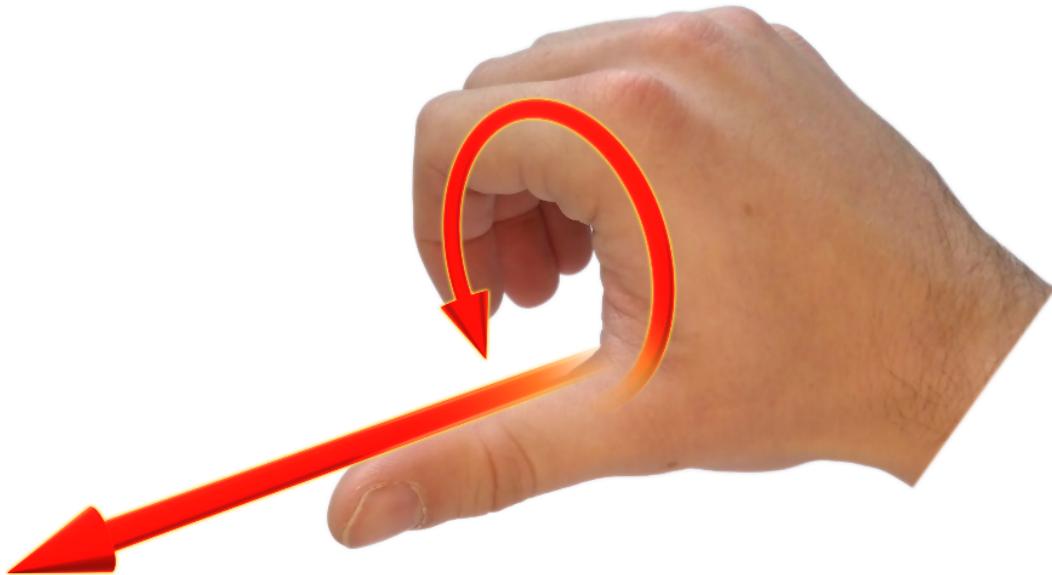


Figure 115: Second right Hand Rule

12.4.2 Rotation Order

When multiple axes are rotated, to imagine the final orientation the three rotations must be performed in the order heading first, then pitch and then roll. To deduce the final orientation the unit should first be considered level with the X axis pointing north and the Z axis pointing down. Heading is applied first, then pitch is applied and finally roll is applied to give the final orientation. This can be hard for some people to grasp at first and is often best learned experimentally by rotating Subsonus with your hand whilst watching the orientation plot in real time on the computer.