UM-8253-SPRINT-Nav

User Manual for Type 8253 SPRINT-Nav

Issue B Rev 1

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920-0034

Third party and open source software used with this product is acknowledged in ***Appendix L*****.**

Contacting the Sonardyne Support Team

24-hour Emergency Telephone Helpline: +44 (0) 1252 877600

The Sonardyne 24-hour helpline is answered at the UK Headquarters during normal office hours (08:00 to 17:00). Outside these hours, your call is automatically transferred to an agency, which logs the details of your emergency and alerts the appropriate Sonardyne personnel.

Our aim is to make sure emergency requests are dealt with immediately during office hours, and are responded to within 30 minutes at all other times.

Please note the helpline is for emergency use only.

If you require non-emergency product support, please contact your nearest Sonardyne office. Alternatively, contact the Sonardyne Head Office:

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Note

Email and telephone support is available during normal UK office hours (08:00 to 17:00).

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Amendment History

The amendment history records all amendments and additions made to this manual.

Issue	Revision	Date	Comments	Section	Page
A	1	01/03/2017	Initial issue	All	All
A	2	22/08/2018	Updated for V1.5.1 firmware release General update	All All	All All
A	3	15/10/2019	Connector ports updated General update	*3.10* All	page 17 All
B	1	01/03/2020	400 kHz High Alititude SPRINT-Nav added ADCP function added Manual updated with new branding	All	All

Section 1 – Introduction

1.1 Scope of this Manual

This user manual defines the safe installation, operation and maintenance of the 3rd generation Type 8084 SPRINT system when operated with SPRINT software. If the SPRINT-Nav is to be integrated within a subsea vehicle for ROV/AUV control, refer to the *IM-8084 Integration Guide* for Lodestar and SPRINT products.

1.2 Purpose of this Manual

This user manual contains information for anyone involved in SPRINT INS/AHRS operations. This manual includes technical information to configure, operate and maintain SPRINT INS/AHRS and specific information concerning SPRINT-Nav inertial systems supplied by Sonardyne.

To make sure the safety of the installer and operator is maintained it is important that all warnings and cautions in *Section 2 "Safety"* of this manual and in any additional manuals are read and fully understood.

1.3 U.S. Department of Commerce License

The sensors within this product are classified by the US Department of Commerce. This means the Gyroscopes and Accelerometers, and the SPRINT component must not be removed from the housing, disassembled or repaired other than by Sonardyne International Ltd staff at its Blackbushe headquarters in the UK. The following actions are however permitted to be carried out by the customer (in accordance with guidance on maintenance found in this product manual):

- Removing and replacing the top endcap
- Replacing the battery
- Removing and replacing the Syrinx DVL component
- Removing and replacing the pressure sensor module or blanking plate

1.4 Related Publications

The following publications can be referred to in conjunction with this manual.

Table 1–1 Related Publications

Publication	Title
Sonardyne Safety Manual	*Operational and Safety Precautions*
UM-8084-101	*Lodestar Hardware Manual*
UM-8084-109	*Lodestar AHRS Messages*
UM-8084	*Integration Guide for Lodestar and SPRINT*
UM-8025	*User Manual for Fusion LBL*
UM-0250	*User Manual for Marksman*
UM-8251	*User Manual for Ranger 2*
UM-8254	*Acoustically Aided INS QC and Post Processing Tool*
UM-8275	*User Manual for Syrinx DVL*
UM-8253	*SPRINT-Nav Configuration for ADCP Addendum*

Table 1–1 Related Publications (continued)

Publication	Title
QSG-OG-8275	*Quick Start Guide for Syrinx DVL*
UM-8300-099	*User Manual for 6G Terminal Lite*

1.5 Conventions

The following conventions are used in this manual.

Table 1–2 Conventions used in this Manual

Format	Conventions
Boldface Type	User Input, Menu Options, Keys, e.g. Click **OK**
Italic Type	References to Figures, Tables, Sections and other internal/external source
Arrow (>)	Selection of an additional menu item e.g. **File>Save**

Section 2 – Safety

2.1 Introduction

Before any activity is carried out on this system, it is recommended that the included *Sonardyne Safety Manual* and all warnings and cautions in this manual are read and fully understood.

It is recommended that the operator complies with the Health and Safety Regulations applicable to the vessel and the region before operating this equipment.

Operators and service personnel must be familiar with the normal operating and safety procedures for the subsea equipment being operated.

Documentation must be consulted whenever a ⚠ or ⚡ warning symbol is found on the equipment, in order to determine the nature of the potential hazard and any actions which must be taken.

If any additional equipment is used with this system, any warnings and cautions in the equipment user manual must be read and fully understood.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

The safety of any system incorporating this equipment is the responsibility of the assembler of the system.

2.2 Safety Procedures

2.2.1 Warnings

⚠ **Personal protection. Appropriate protective equipment such as protective footwear, hard hat and gloves must be worn when handling or carrying out any procedures involving Sonardyne and other equipment.**

⚠ **Heavy equipment. Many Sonardyne products and equipment types, such as transponders, transceivers, cable drums etc. require Manual Handling Equipment (MHE) for lifting due to their heavy weight. If MHE is not available, it is the responsibility of the operator to perform a manual handling risk assessment prior to carrying out manual lifting/handling. Refer to the individual equipment documentation for weight specifications.**

⚠ **Risk of crush injury. Do not stand underneath suspended equipment.**

⚠ **Dismanting. This instrument must only be accessed internally and dismantled by qualified Sonardyne personnel.**

⚠ **Risk of toxic gases and Corrosive Liquids. Do not stand in direct line with the end of the unit when operating the pressure relief vent valve. Sudden release of high pressure gases could cause injury to personnel. Wear Personal Protective Equipment such as goggles when operating the pressure relief vent valve.**

⚠ **High internal pressure. Make sure the Pressure Relief Vent Valve is manually operated to release any internal pressure before attempting to dismantle the equipment.**

⚠ **Ensure the work environment is well ventilated. Toxic gases may be released when operating the pressure relief vent valve.**

⚠ **High internal pressure. Due to the high internal pressure risk, dismantling the sub-sea equipment must only be carried out by trained personnel.**

⚠ **Risk of burns. Do not carry out maintenance if the housing is hot. Lower the instrument into cold water and wait for the housing to cool.**

⚠ **Lithium-ion Battery Pack. This instrument contains a backup lithium-ion battery pack. Refer to the Sonardyne Safety Manual for safety information for lithium-ion batteries.**

2.2.2 Cautions

⚠ **Risk of equipment damage. All instruments must be maintained according to their individual operating manuals. Failure to follow recommended procedures could result in instrument failure, and loss of system integrity.**

⚠ **Molykote 44 is a mild irritant. When lubricating the connector faces, personal protective equipment such as gloves and goggles must be worn.**

⚠ **Incorrect Power Supply. Make sure the SPRINT-Nav is supplied with 24 V dc only. Do not use an ac power supply.**

⚠ **Damage to connectors. Failure to clean sand or silt correctly could result in damage to the connectors and O-ring seals.**

⚠ **SPRINT-Nav mounting angles. It is strongly recommended the SPRINT-Nav mounting angles are not modified while the SPRINT-Nav is in operation as an AHRS device. When any changes are applied the user will be prompted to reset the SPRINT-Nav AHRS algorithm and it will be several minutes before the Lodestar output is settled.**

⚠ **Restoring factory settings. If factory settings are restored all previous user defined settings in SPRINT-Nav will be lost. It is recommended to note any required settings before restoring factory settings.**

⚠ **If connected to the SPRINT-Nav via the Ethernet port and you wish to change the IP address or subnet mask, it is strongly recommended that after changing the values the configuration application is closed. Reconnect using the new IP address by adding it in the Ethernet Connection Settings and then click "Connect". It also recommended that the SPRINT-Nav is restarted.**

⚠ **Risk of equipment malfunction. Minimise any sources of high-level acoustic noise in the 600 kHz band ±150 kHz. Examples of such noise sources include such devices as multi-beam echo sounders or other DVLs. Other vessels using similar devices may also cause acoustic interference. High noise levels can disrupt the acoustic measurements and lead to loss of system integrity.**

⚠ **Risk of equipment malfunction. Mandatory software, embedded software and firmware update notices must be applied as soon as practically possible.**

Section 3 – Technical Description

3.1 Introduction

Sonardyne International Limited has applied its comprehensive experience in producing advanced and dependable marine solutions to the development of the SPRINT-Nav Attitude and Heading Reference System (AHRS)/Inertial Navigation System (INS).

SPRINT-Nav has an integrated Syrinx DVL and optional modular pressure sensor.

The SPRINT-Nav is a solid state AHRS/INS that includes three Ring Laser Gyroscopes (RLGs) and three linear accelerometers. These inertial-grade components provide raw data to the Sonardyne-developed gyrocompass algorithm, which uses them to produce a full range of accurate real-time motion and attitude measurements in all sea states.

Developed originally to provide accurate heading and attitude measurements for Sonardyne's family of acoustic positioning systems, SPRINT-Nav is equally suited to a variety of other applications where the accuracy of heading and attitude measurements is of critical importance. SPRINT-Nav can operate either as a stand-alone AHRS or as part of an integrated system.

The SPRINT-Nav provides the following as standard:

- Battery backup to maintain uninterrupted operation in the event of brief power failure
- 8 GB of internal memory.
- Upgrade capability to a full INS that provides additional outputs of position, velocity, orientation and angular velocity at high update rates.
- Fast follow-up speed of 900° per second.
- Support for all industry standard telegrams.
- MTBF inertial sensors (RLG and Accelerometer) > 400,000 hours
- Flexible mounting arrangements
- Heave measurement accuracy the greater of 5 cm or 5% of measured heave.
- Robust heave algorithm.
- Data output through RS232 serial, RS485 serial or Ethernet interfaces.

The SPRINT-Nav has undergone independent and exhaustive testing against an industry-recognised reference and has proved capable of delivering accurate measurements in highly dynamic marine environments.

The SPRINT-Nav benefits from Sonardyne's world-class manufacturing, support and training organisation, which has a well-established record for providing trusted solutions.

Syrinx is a navigation grade Doppler Velocity Log (DVL) designed for use on subsea or surface vehicles as a standalone navigation sensor or as an aiding sensor for a navigation system such as an Inertial Navigation System (INS). The SPRINT-Nav all-in-one navigation unit provides a direct internal connection between the SPRINT INS and the Syrinx DVL.

Syrinx is a 4-beam Janus-style array DVL with 30° beam angle from vertical. Available as part of the Lodestar-Nav and SPRINT-Nav products, each are housed in a non-corrosive titanium housing with depth rating options of 4000 m and 6000 m. All four of the DVL transducers are individually replaceable.

Syrinx as part of the SPRINT-Nav combined unit is primarily configured by the SPRINT-Nav through the provided inertial navigation monitoring software named "SPRINT".

The SPRINT-Nav can optionally capture Acoustic Doppler Current Profile (ADCP) data to measure water currents as a function of distance from the device.

SPRINT-Nav can be configured either by Ethernet connection or serial connection. Ethernet connectivity allows configuration of the device without the requirement for software, using the Embedded DVL Manager software (DVL Manager). Alternatively, Syrinx DVL can also be configured through a terminal package utilising the serial connection.

3.2 Inertial Navigation

The Inertial Navigation System (INS) sensor outputs are combined mathematically to compute the position, velocity and attitude of the vehicle. The output is extremely low noise and very accurate in the short term but slowly degrades over time. Therefore, it is necessary to seamlessly aid the INS with complimentary acoustic positioning and other aiding sources.

Acoustic Aiding with Sonardyne's latest Sixth Generation (6G®) vessel-based transceivers and subsea beacons maximise the benefits of the system by providing the most precise and reliable acoustic aiding input.

Depending on the functionality level of the SPRINT system being used, various aiding options will be available, whilst others may be disabled:

- USBL
- DVL
- Pressure Depth
- External Position
- Zero Velocity (ZUPT)
- LBL

3.2.1 USBL Aiding

The vessel-mounted USBL transceiver determines the range and bearing to an acoustic beacon fitted to the subsea vehicle. Using vessel DGPS for position and VRU/MRU/AHRS for vessel motion compensation, an absolute position for the vehicle mounted beacon is calculated by the USBL system.

This position is fed into the SPRINT system as an absolute positioning aiding input. Additionally, the USBL system is synchronised to Coordinated Universal Time (UTC) to provide an accurate timestamp. Whilst the use of Sonardyne USBL provides a tighter acoustic / inertial integration and the best possible USBL positioning performance, the SPRINT system can accept position aiding from any USBL system that uses correct time-stamped positions in an industry standard telegram. Although the SPRINT system improves USBL system precision and short term accuracy, it will not resolve any inherent systematic errors that are present. Users must therefore make sure the USBL system they are using is correctly calibrated and recommended operating practices are observed, for example, using regular sound velocity profiles.

3.2.2 Sparse LBL Aiding

In Sparse LBL operations, two or more (instead of four or five) beacons are deployed on the seabed and their positions derived using 'box-in' or other top-down calibration techniques. With a known beacon position, the INS can navigate in Sparse LBL mode using the ranges from one or more seabed deployed beacon to acoustically aid the INS and constrain error growth in the absolute position output. In this configuration, the vehicle mounted LBL transceiver (ROVNav 6) communications will be routed to the vessel via the SPRINT-Nav for optimal time stamping of acoustic range data.

3.2.3 ZUPT (Zero Velocity) Aiding

In certain operational situations the subsea vehicle will be static (e.g. during average position fixes). In these situations, particularly if there is risk of loss of other aiding, it is beneficial to be able to aid the INS with 'zero velocity' updates to estimate inertial sensor errors. This feature is available in the SPRINT system and is easily activated from the main user interface.

3.2.4 Vehicle-Mounted Sensor Aiding

The SPRINT system has the ability to use vehicle-mounted aiding sensors such as Doppler velocity logs (DVL) and pressure/depth sensors. The use of these sensors provides further benefits for subsea navigation such as the ability to provide precise and continuous navigation output even if external acoustic positioning is lost for periods of time.

SPRINT-Nav provides a precise and repeatable co-located mounting arrangement between the SPRINT inertial sensors, the Syrinx DVL transducers and the pressure sensor module. This allows for increased performance as standard that would allow most operations (excluding those with very high precision requirements) to operate without performing an in-field calibration. An in-field calibration is always recommended by Sonardyne to increase the performance and to compensate for any potential errors, especially for high precision operations such as side-scanning or dynamic laser mapping.

3.3 Theory of Operation

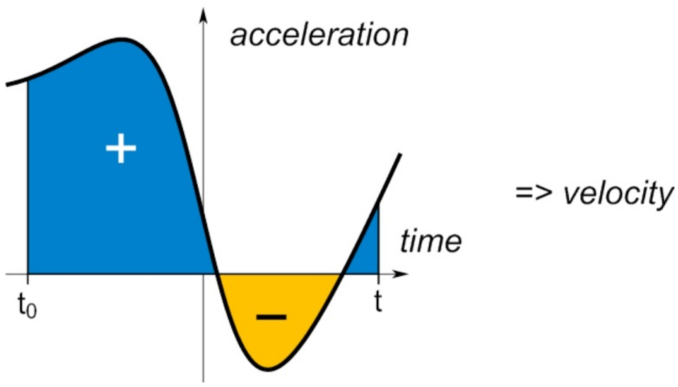
3.3.1 Inertial Navigation

Inertial navigation is the computation of velocity, position and orientation from measurements of acceleration and rotation.

Acceleration (velocity change) is measured by an orthogonal triad of accelerometers. Rotation (angular change) is measured by an equally orthogonal triad of gyroscopes; see *Section 3.3.2*. The composite mechanical structure is called the Inertial Sensor Assembly (ISA). An Inertial Measurement Unit (IMU) is composed of the ISA and a processor that performs various forms of compensation using e.g. factory calibration coefficients. The outputs of an IMU are compensated delta angles and delta velocities typically at a rate of 100–200 Hz.

Inertial navigation is based on the dead-reckoning principle. INS velocity is computed from an initial value by integration (see *Figure 3–1*) of acceleration over time. Similarly, position is computed from velocity and orientation (attitude and heading) is computed from integration of measured rotation (angular change).

Figure 3–1 Computation of Velocity via integration of Acceleration (1D example)**



It can be imagined how a fixed error (bias) in acceleration when integrated will cause an error in velocity that grows proportionally with time giving rise to quadratic with time error in position.

This simplified description of the inertial navigation process match fairly well in the short term especially for stable platform INS where the accelerometers were physically pointed in fixed directions (e.g. North, East and Down). In practise, the 3D vector mathematics are somewhat more involved, especially for modern strap-down INS where the sensors are strapped onto the vehicle body.

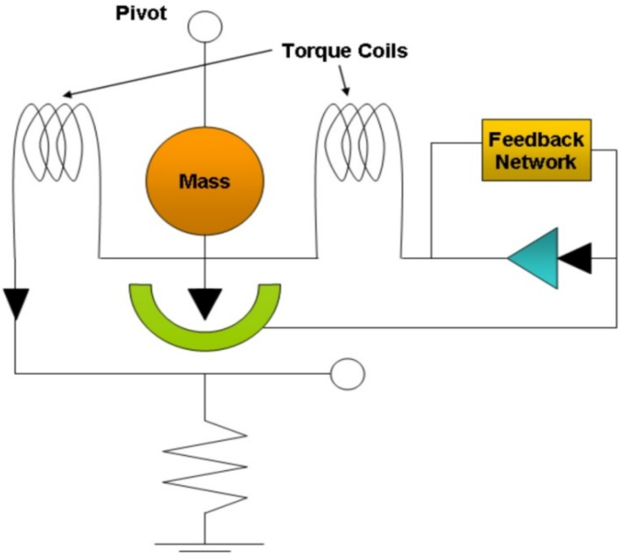
** Velocity at time 't' is the sum of the areas under the acceleration curve (yellow counts as negative) plus the initial velocity at time t_0.

3.3.2 Inertial Sensors

3.3.2.1 Accelerometer

Most accelerometers used for inertial navigation are of the force-feedback pendulous type illustrated in *Figure 3–2*. A proof mass at the end of a pivoted or flexible arm is balanced via feedback control keeping its deflection close to zero. The coil current generating the counter acting force is a measure of acceleration along the single axis of free movement.

Figure 3–2 Force Feedback Pendulous Accelerometer



It is impossible to distinguish between true kinematic acceleration (velocity change relative to the Earth) and gravity. A stationary accelerometer with its sensitive axis pointed up will measure +1 g even though it is obviously not moving anywhere. The term specific force is the sum of kinematic acceleration and gravity and has been coined to express what an accelerometer really measures.

3.3.2.2 Gyroscope

Modern gyroscopes are based on a variety of different physical principles. Most navigation grade gyroscopes are currently based on optics using the "Sagnac" effect to sense rotation, e.g. the Ring Laser Gyro (RLG; see *Figure 3–3*):

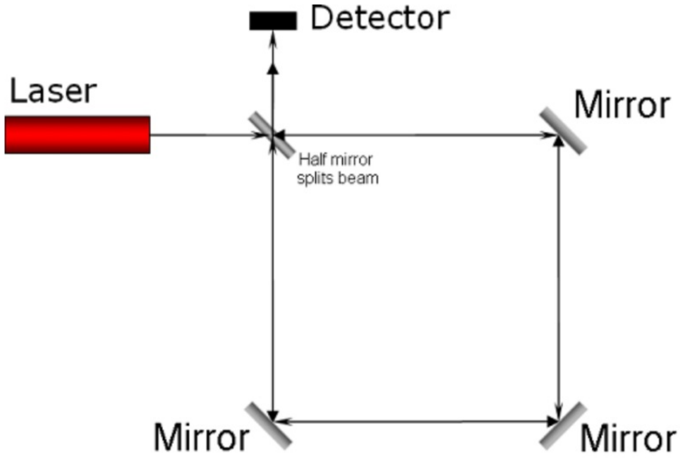
Laser beams are made to travel in both opposite directions within a cavity ("ring") formed by typically 3 or 4 mirrors. When the cavity rotates relative to inertial space one beam has to travel further than the other. A part of the laser light is allowed to escape via a semi-transparent mirror and is used to form a fringe pattern. Optical sensors count the direction and number of fringes passed which is a precise (digital) measure of how much RLG has rotated relative to inertial space.

In a Fibre Optic Gyroscope (FOG) light travels through loops of optic fibre rather than a closed path. Both RLG's and FOG's can achieve very high performance.

Other commonly used gyro technologies are:

- Conventional spinning metal gyroscope
- "Dynamically Tuned Gyro" (DTG). Ingenious compact mechanical strap down device.
- Hemispherical Resonator Gyro (HRG). Resonant device made of very high Q quartz ("Wine glass") – Coriolis force device
- Micro Electro-Mechanical Devices (MEMS) based gyros (Coriolis force)

Figure 3–3 Ring Laser Gyroscope Principle of Operation



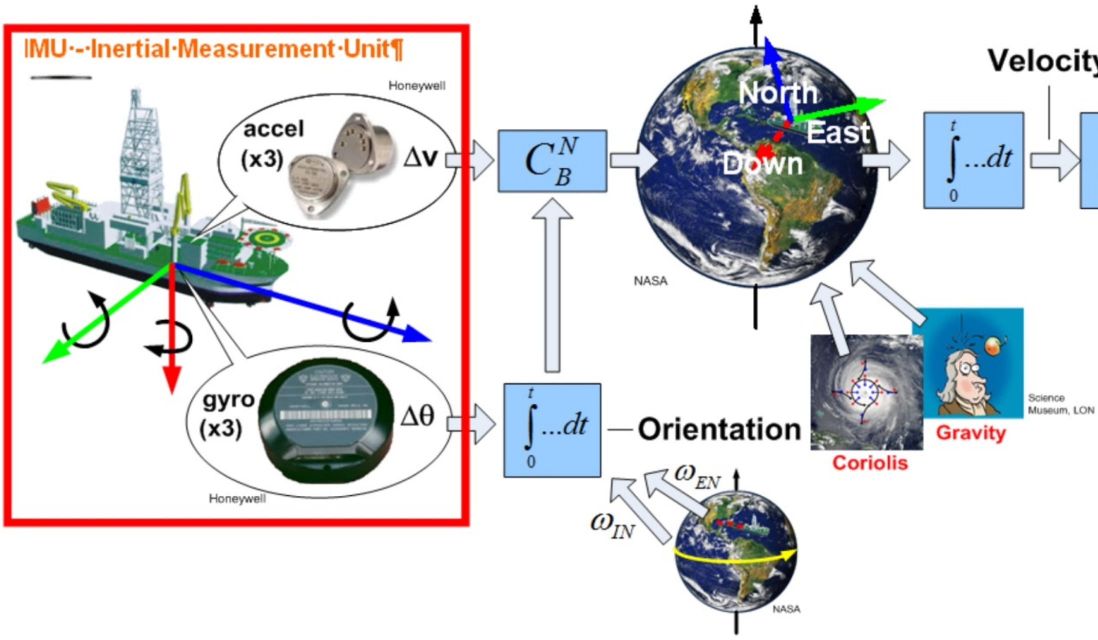
3.3.3 Strap-down Inertial Navigation

The process of strap-down inertial navigation is shown in *Figure 3–4*. Vehicle orientation relative to the Earth is maintained within the navigation computer via integration of measurements from the gyroscope triad and is compensated for Earth rotation and vehicle motion over the surface of the Earth. Known orientation is used to transform accelerometer specific force into a navigation frame (often North-East-Down – NED).

Specific force is compensated for gravity and Coriolis force to obtain kinematic acceleration. Gravity is computed using a mathematical model and is dependent on vehicle position on the Earth, most importantly latitude and depth/height. Coriolis force is a "mathematical artefact" that arises and requires compensations because the navigation frame rotate with the Earth and is therefore not a true inertial frame (fixed relative to the stars). Finally, acceleration is integrated to obtain velocity and velocity is integrated into position.

Typically the strap-down computations are set to execute at 100–200 Hz whereas the inertial sensors may be sampled at several kHz. The raw rate is reduced using a coning and sculling algorithm that e.g. very precisely takes into account the non-commutativity of rotations (sequence of rotations matter).

Figure 3–4 "Strap-Down" Inertial Navigation



3.3.4 Errors in Inertial Navigation

The sources and error propagations in inertial navigation are complex and not always intuitive. The initial part of *Section 3.3.1* describes how a constant error in acceleration would cause error in position to grow with time squared. In a real INS with external aiding (as described in *Section 3.3.8*) a fixed accelerometer bias would primarily cause an error in roll/pitch which would make gravity couple into the horizontal plane by just enough to counteract the position drift.

Simulation techniques and tools are available for accurately predicting INS performance in various scenarios and taking all significant error sources into account. Somewhat counter intuitively, gyroscope errors in general play a more significant role than accelerometer errors.

3.3.5 Reference frames

A number of reference frames are used within inertial navigation.

3.3.5.1 Vehicle frame

Axes are along the vehicle axis, typically forward, starboard and down. The vehicle frame is typically used for navigation outputs (e.g. roll, pitch and heading) and for defining various sensor lever arms ("offsets") and mounting angles.

3.3.5.2 IMU frame

Axes are along the inertial sensor axes as typically marked on the IMU/INS housing. IMU frame is used for many INS internal computations.

3.3.5.3 Navigation frame

Frame used for the inertial navigation computation of position and velocity (most often local level e.g. North, East and Down).

3.3.5.4 Inertial frame

Non-rotating frame (relative to inertial space).

Note

Definitions of SPRINT system(and SPRINT-Nav) specific reference frames are provided in *Appendix A "SPRINT-Nav Angle Definitions "* and *Appendix B "Reference Frames and Angular Conventions"*.

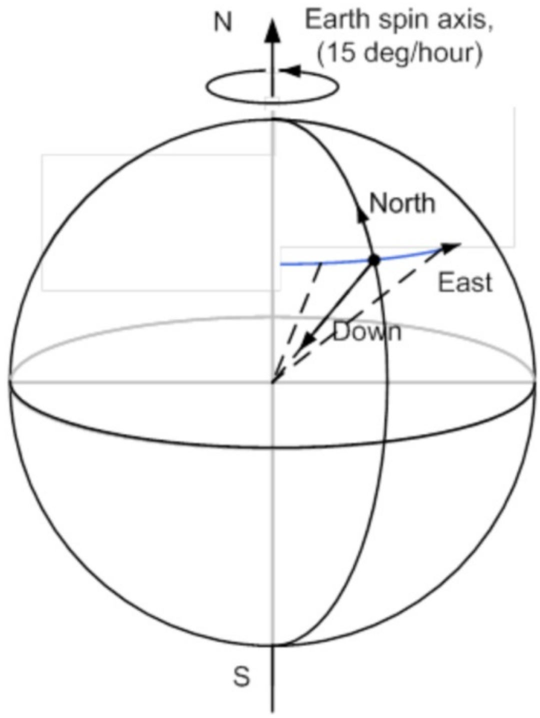
3.3.6 Gyrocompassing – North Finding

An AHRS can determine its orientation (roll, pitch and heading) relative to the Earth by "gyrocompassing". Basically the direction of up/down and the Earth spin axis can be sensed using the AHRS sensors.

For a slow moving (i.e. marine) vehicle, the measured acceleration (specific force) vector will point "up", i.e. the measured vector will be parallel with the local gravity vector (down). In practise, measured acceleration is averaged (filtered) to cancel out effect of vehicle motion.

The local gravity vector will follow the rotation of Earth relative to inertial space; see *Figure 3–5*. The direction of East can be determined by tracking the systematic change in the direction of the gravity vector relative to inertial space over time. Knowing the direction of down and East allows the direction of North and full orientation to be determined.

Figure 3–5 Earth Rotation



The Earth rotates by just 15 deg/hour and the gyroscopes used for tracking the change of direction of gravity must be accurate to considerably better values. Furthermore, it can be shown that the local gravity vector direction changes only by the cosine of Latitude part of Earth rotation, i.e. change is reduced towards the Poles. This explains why heading accuracy is typically specified as x.xxx degrees * Secant Lat (secant = 1 / cosine).

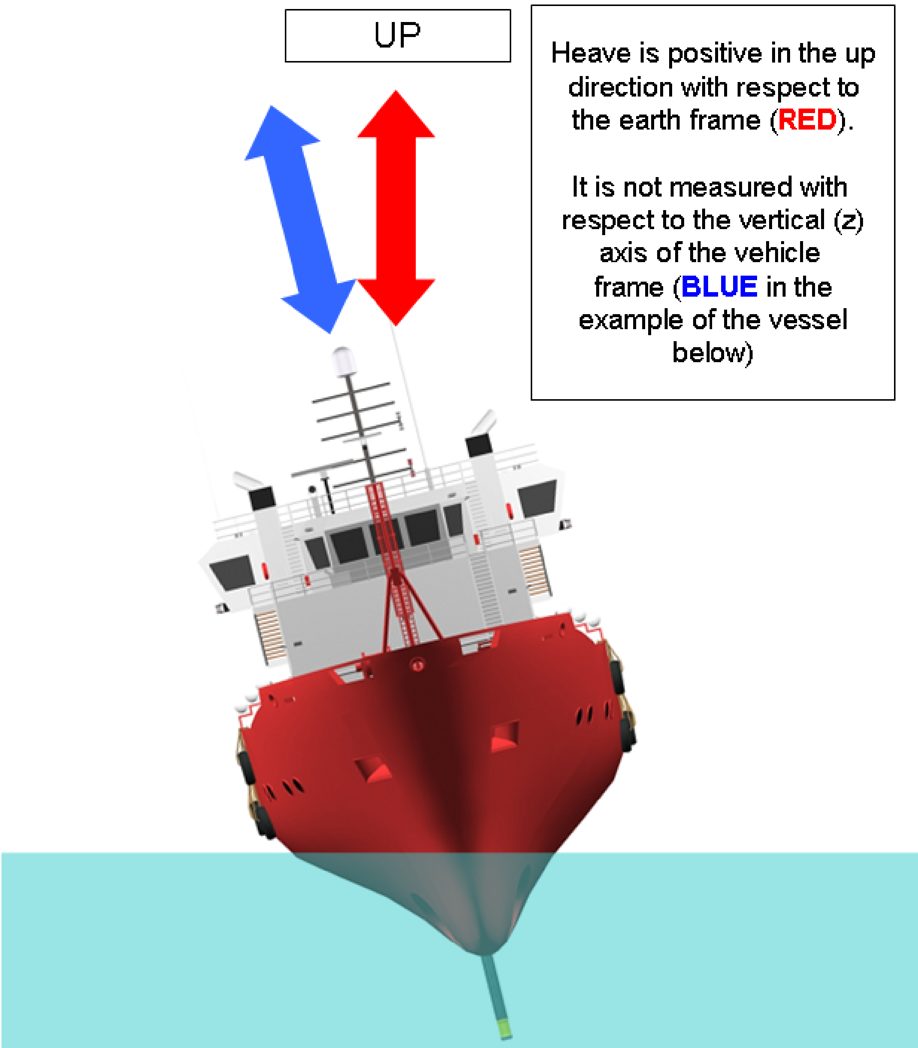
Vehicle position change in the N/E direction (from, e.g. steaming) will cause the gravity vector to change in this direction also and not be pure E/W. This will bias the gyro-compassing determined heading if not compensated for by e.g. measurements from a GPS receiver.

An inertial based Attitude and Heading Reference System use the described principles to generate robust roll, pitch and heading.

3.3.7 Heave, Surge and Sway

The heave, or vertical motion of the vehicle in the Earth up direction, is determined by the double integration of the vertical acceleration. A high pass filter is used to zero the systematic biases of the vertical position, which are a characteristic of the internal sensors. Similarly, the horizontal motions of the vehicle with zero mean in the forward and starboard axes respectively are surge and sway. Heave is output with respect to the earth frame, rather than the vehicle frame; see *Figure 3–6*.

Figure 3–6 Heave Definition



Some instruments on the vehicle may require heave compensation. It is likely that few, if any, of these instruments are installed very close to the centre of the vehicle frame, and so measurements of heave with respect to the vehicle CRP or the SPRINT-Nav may not be valid for those instruments.

If the SPRINT-Nav has information about the offset distances to a remote instrument, then it can calculate and supply measurements of remote heave for that instrument using remote vectors. The remote output will resemble what would be output if the SPRINT-Nav was installed in the remote location. Note that the closer to the remote location the SPRINT-Nav is situated, the more accurate the output will be.

3.3.8 Aided INS

The drift of a typical commercial airplane inertial system is in the order of 1 NMPH (Nautical Mile Per Hour). This is adequate for guidance from one airport to another and e.g. crossing the Atlantic but hardly useful for navigation of slow moving marine vehicles intended to do e.g. seabed mapping.

Improved performance can be achieved by Aiding the INS with measurements from one or more external sensors; see *Figure 3–7*. IMU data feeds into two separate algorithms: AHRS and AINS. The AHRS is used as a convenience for providing the AINS with initial estimates of attitude/heading thereby simplifying its design.

The INS block is described in *Section 3.3.3* and provides the position, orientation and velocity output. The role of the error state Kalman filter is to estimate and compensate errors in the inertial navigation and thereby constantly keep the INS on track, while monitoring the correction feed.

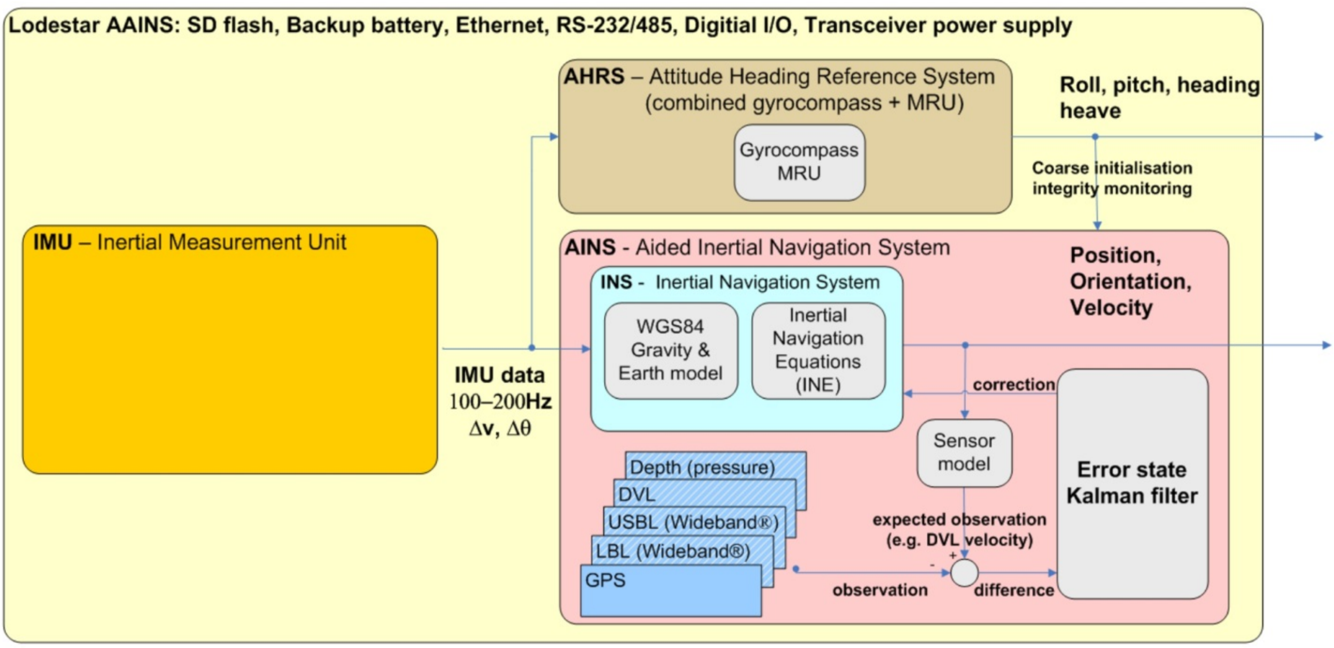
The Kalman filter determines INS errors from external sensor measurements. The difference between a measurement (observation) and its expected value (based on the INS) is fed into the Kalman filter and is used to refine its state vector and covariance matrix. The state vector is composed of INS errors in position, orientation and velocity and often also key inertial sensor errors such as gyroscope and accelerometer bias. Errors in external sensors can also be modelled for improved performance.

The covariance matrix is the "memory" of the Kalman filter and it holds the uncertainty of each state and the correlation between states. Useful performance metrics such as expected positioning accuracy is extracted directly from the covariance matrix.

The Kalman filter manages asynchronous data and the considerable latency often found in acoustic observations. An Aided INS is often referred to as a "hybrid inertial system".

The combination of a DVL and INS provides accurate heading/attitude and the ability to perform dead-reckoning to an accuracy of just a few meters per hour. This functionality is extremely useful for subsea navigation. Further combination with USBL or (sparse) LBL provides absolute positioning that is considerably more accurate and robust than acoustic positioning by itself.

Figure 3–7 SPRINT system Acoustically Aided INS Functional Block Diagram



The INS aiding options available in SPRINT system are listed in *Table 3–1*. Only certain position aiding inputs, such as USBL can be used to initialise Inertial Navigation and that these aiding inputs must be UTC time synchronised.

Table 3–1 SPRINT INS Aiding Options

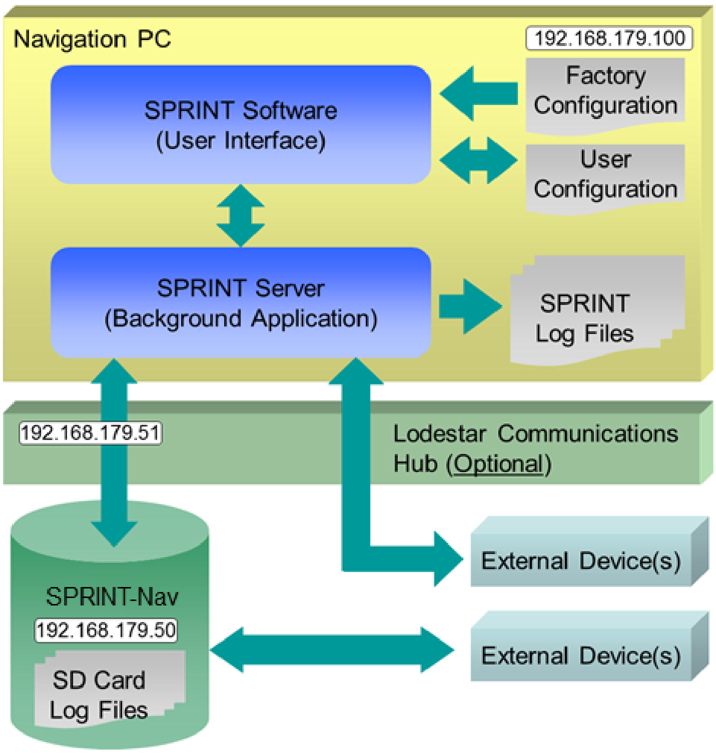
Aiding Source	Aiding Type			Aiding Considerations	
	Position Aiding (Horizontal)	Velocity Aiding	Depth Aiding (Vertical)	External Time Sync Required?	Can be used to Initialise INS?
USBL	✓	×	✓	×	✓
LBL	✓	×	×	×	×
External Position	✓	×	✓	×	✓
DVL	×	✓	×	×	×
Zero Velocity	×	✓	×	×	×
Pressure Depth	×	×	✓	×	×
External Depth	×	×	✓	×	×

3.4 System Architecture

3.4.1 Architecture

The architecture of the SPRINT system is shown in *Figure 3–8*.

Figure 3–8 Logical SPRINT system Architecture



The Navigation PC runs the SPRINT system software which comprises two components:

- User Interface, which provides configuration, control and monitoring of the SPRINT-Nav and SPRINT system.
- SPRINT system Server, which routes all communications between the SPRINT-Nav, User Interface and any other topside external devices. The SPRINT server also logs all data from the SPRINT-Nav on the Navigation PC, including raw sensor feeds.

The optional Lodestar Communications Hub (LCH) is a serial device server and Ethernet hub used by the Navigation PC. An Ethernet link is provided between the Navigation PC and the LCH (ports). For this reason IP Addresses and Ports are used to specify serial as well as Ethernet devices connected to the LCH. The IP addresses of each of the main system components are shown above but note that the SPRINT-Nav IP address will only be used if the SPRINT-Nav is to be connected to the topside components using an Ethernet connection.

External devices may be connected directly to the SPRINT-Nav and Navigation Computer as well as to the LCH.

The SPRINT system stores the configuration of the SPRINT-Nav and Software/Server. A Factory (default) Configuration is provided as a starting point for setup. Thereafter a User Configuration is stored by the software every time a configuration change is made or by user request. If the SPRINT-Nav used by the SPRINT system is swapped, the software will prompt the user to re-apply the User Configuration to the new SPRINT-Nav to continue operation as before.

As well as storing the log files in real time on the Navigation PC, the SPRINT-Nav also stores a rolling backup of all the log files on its onboard SD card. The size of the log data is variable depending on the number/update rate of aiding sensors and also the number of outputs specified. Typically for a USBL/DVL/Depth aided system, the log files are populated at the rate of 0.5 MB per minute, which will provide over 10 days continuous onboard storage. The log files on the SPRINT-Nav SD card can be retrieved offline using the PC Utility software.

3.5 SPRINT-Nav Variants

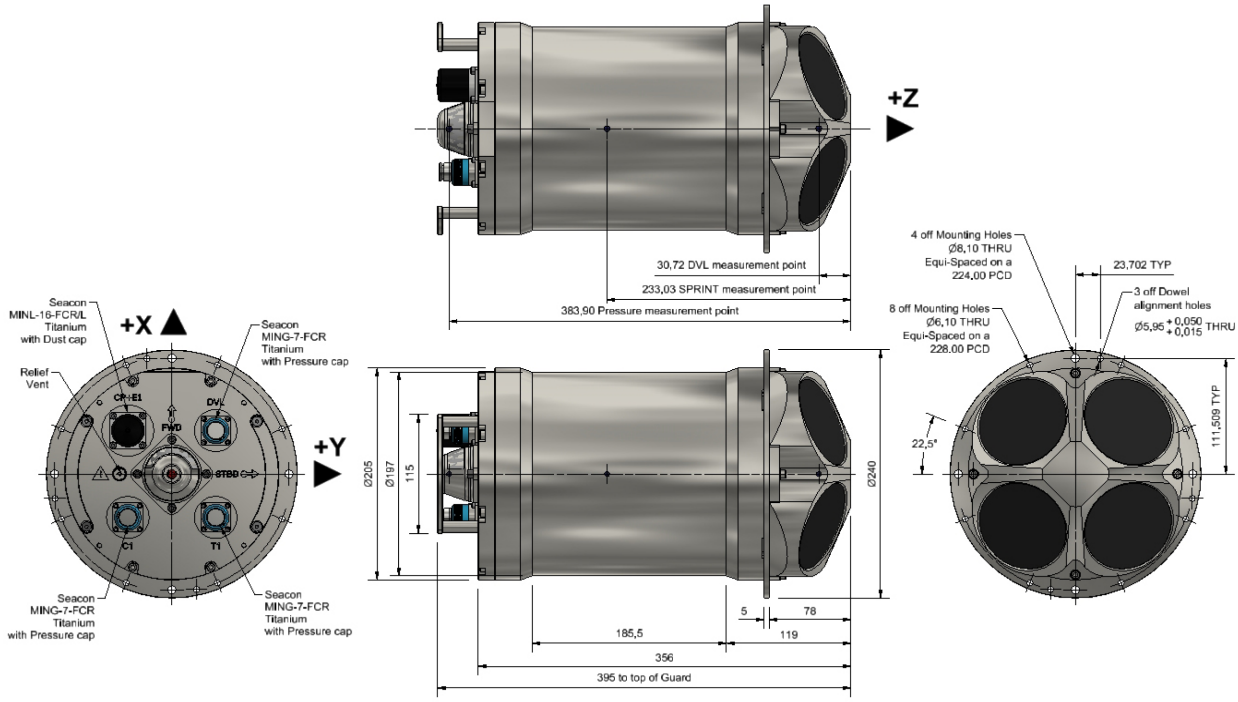
The SPRINT-Nav is available in three levels of performance (300/500/700), two depth ratings (4,000 m/6,000 m) and two frequences: 600 kHz or 400 kHz HA for higher altitude tracking.

For more information on the SPRINT-Nav variants see *Section 19 "Technical Specifications"*.

3.6 Physical Layout

A typical 4000 m SPRINT-Nav with 4 x Seacon connectors is shown in *Figure 3–9*.

Figure 3–9 Typical SPRINT-Nav Layout



3.7 Power

The SPRINT-Nav is powered from an external 24 V ±10% dc power supply through the CP port. A power supply is not provided with the SPRINT-Nav. See *Section 19 "Technical Specifications"* for power requirements. The Syrinx component can be powered separately if desired using a 24 V ±10% dc supplied through the DVL port.

Note

SPRINT and Syrinx DVL Ethernet connections are both via CP+E1 connector; for Syrinx DVL Ethernet to be active, the SPRINT must be powered up with the power pass through enabled on port T2.

Separate power supplies must be used when powering SPRINT and Syrinx DVL through their external connectors (as opposed to powering via Power Pass Through).

3.8 Power Pass Through

The SPRINT-Nav is capable of passing through input power (24 V dc from an external power supply) to sensors connected to the SPRINT-Nav C1, T1 and internal DVL (T2) ports. Each port can support output of up to 3 A. There is over-current and short circuit protection in the Power Pass Through ports and if tripped the SPRINT system alerts the operators with an option to re-enable pass through.

3.9 Battery

The SPRINT-Nav contains a backup lithium-ion battery to cope with short external power interruptions and has a life of approximately five minutes with no external power. The battery is charged from the external power supply and when depleted, takes approximately twenty minutes to reach full charge. The battery does not provide power to the Syrinx DVL component or to external sensors connected to the C1 or T1 ports.

3.10 Connector Ports

3.10.1 Standard Ports

The standard SPRINT-Nav is provided with 4 x Seacon connector ports as shown in *Figure 3–10*.

Figure 3–10 SPRINT-Nav Connector Ports

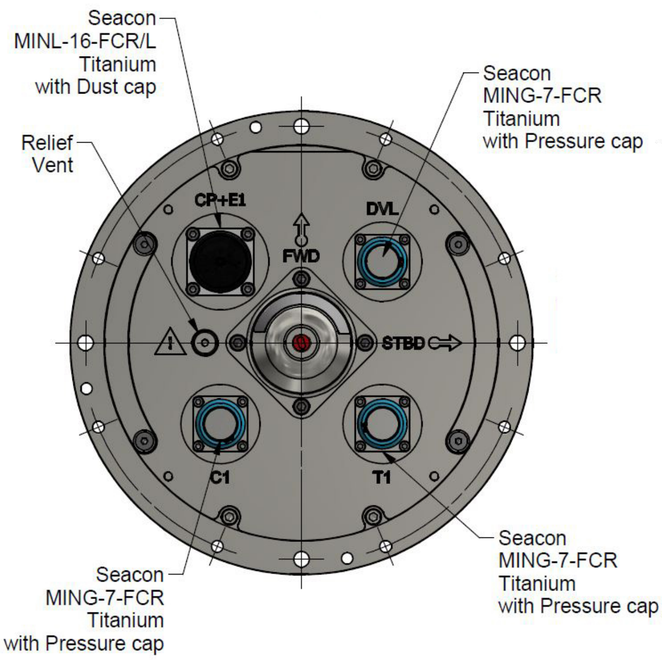


Table 3–2 SPRINT-Nav Connector Port Type and Functions

Port	Standard Connector	Function
CP/E1	Seacon MINL-16FCR/L	RS232 and RS485 Full Duplex Communications and Input Power. Ethernet (100 Mbit/s) Communications and Input Trigger. Syrinx DVL Ethernet communications.
C1	Seacon MING-7-FCR	RS232 Communications, Input Trigger and Power Pass Through.
T1	Seacon MING-7-FCR	RS232 and RS485 Half Duplex Communications, Output Trigger and Power Pass Through.
DVL	Seacon MING-7-FCR	Alternative 24 V dc power input for Syrinx DVL only, RS232 AUX communications to Syrinx DVL, Trigger input to Syrinx DVL.

3.10.1.1 Type 8084-000-458X/658X-D (1x16 and 3x7 pin connectors) CP/E1 Pin Out Functions

The SPRINT-Nav CP/E1 cable connector pin functions are shown below.

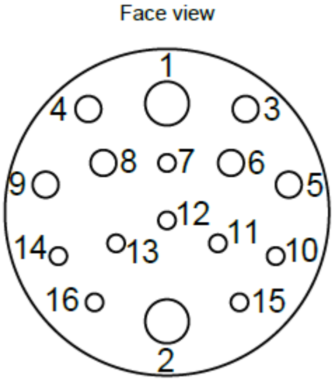


Table 3–3 SPRINT-Nav Type 8084-000-458X/658X-D CP/E1 Pin Out

Seacon Pin No.	Function
1	DC 0 V
2	DC In
3	Comms/Trig Ground
4	Screen
6	Trigger In
7	SPRINT/Syrinx DVL Ethernet TD -
8	RS232/485 Select Connect to 0 V1/Pin3 for RS232 Do not connect for RS485
9	Not Connected
10	SPRINT/Syrinx DVL Ethernet RD -
11	RS232 Rx / RS485 Tx +
12	SPRINT/Syrinx DVL Ethernet TD +
13	RS232 Tx / RS485 Tx -
14	RS485 Rx -
15	SPRINT/Syrinx DVL Ethernet RD +
16	RS485 Rx +

3.10.1.2 DVL Pin out Functions

The SPRINT-Nav DVL cable connector pin functions are shown below.

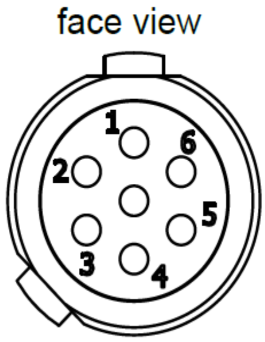


Table 3–4 SPRINT-Nav DVL Connector Pin Out

Seacon Pin No.	Function
1	Not Connected
2	Comms/Trig Ground
3	Trigger In
4	DC 0 V
5	RS232 Tx
6	RS232 Rx
7	DC In

3.10.1.3 C1 Pin out Functions

The SPRINT-Nav C1 cable connector pin functions are shown below.

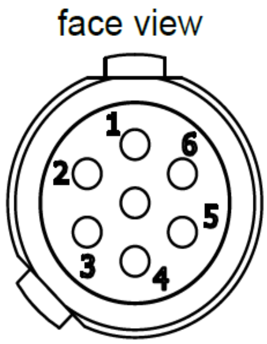


Table 3–5 SPRINT-Nav C1 Pin Out

Seacon Pin No.	Function
1	Screen
2	Comms / Trig Ground
3	Trigger In
4	DC 0 V
5	RS232 Tx

Table 3–5 SPRINT-Nav C1 Pin Out (continued)

Seacon Pin No.	Function
6	RS232 Rx
7	DC ±~0.5 V

3.10.1.4 T1 Pin out Functions

The SPRINT-Nav T1 cable connector pin functions are shown below.

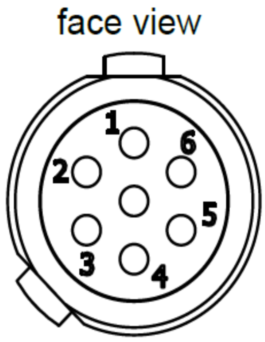


Table 3–6 SPRINT-NavT1 Pin Out

Seacon Pin No.	Function
1	Screen
2	Comms / Trig Ground
3	Trigger Out
4	DC 0 V
5	Tx Tx -
6	Rx Tx +
7	DC ±~0.5 V

3.10.1.5 Type 8084-000-458X/658X-C (2x16 and 2x7 pin connectors) CP/E1 Pin Out Functions

The SPRINT-Nav CP+E1 cable connector pin functions are shown below.

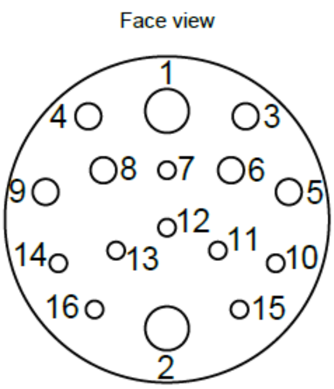


Table 3–7 SPRINT-NavType 8084-000-458X/658X-C (2x16 and 2x7 pin connectors) CP/E1 Pin Out

Seacon Pin No.	Function
1	DC 0 V
2	DC In
3	Comms/Trig Ground
4	Screen
6	Trigger In
7	Ethernet TD -
8	RS232/485 Select Connect to 0 V1/Pin3 for RS232 Do not connect for RS485
9	Not Connected
10	Ethernet RD -
11	RS232 Rx / RS485 Tx +
12	Ethernet TD +
13	RS232 Tx / RS485 Tx -
14	RS485 Rx -
15	Ethernet RD +
16	RS485 Rx +

3.10.1.6 Type 8084-000-458X/658X-C DVL Pin out Functions

The SPRINT-Nav DVL cable connector pin functions are shown below.

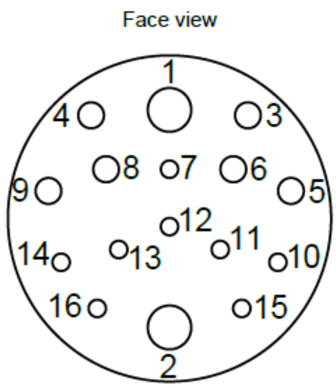


Table 3–8 Type 8084-000-458X/658X-C SPRINT-Nav DVL Connector Pin Out

Seacon Pin No.	Function
1	DC 0 V
2	DC In
3	Comms/Trig Ground
4	Not Connected
6	Trigger In

Table 3–8 Type 8084-000-458X/658X-C SPRINT-Nav DVL Connector Pin Out (continued)

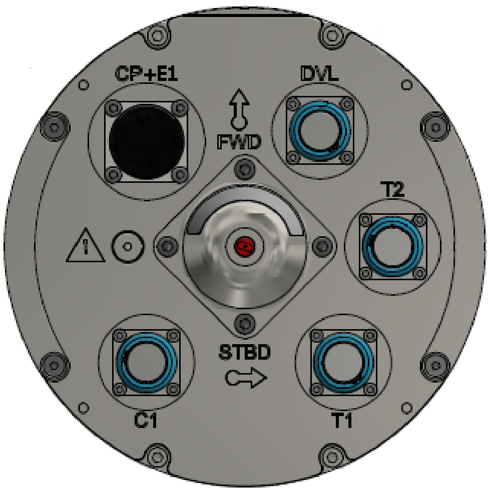
Seacon Pin No.	Function
7	Ethernet TD -
8	Not Connected
9	Not Connected
10	Ethernet RD -
11	RS232 RX
12	Ethernet TD +
13	RS232 TX
14	Not Connected
15	Ethernet RD +
16	Not Connected

Note

C1 and T1 conector pinouts for Type 8084-000-458X/658X-C are the same as Type 8084-000-458X/658X-D.

3.10.1.7 Type 8084-000-9926 SPRINT-Nav T2 Pin out Functions

This variant of the SPRINT-Nav has an additional external connector, T2. This connection provides a uni-directional, Tx serial connection from the SPRINT.



Cable connector pin functions are shown below.

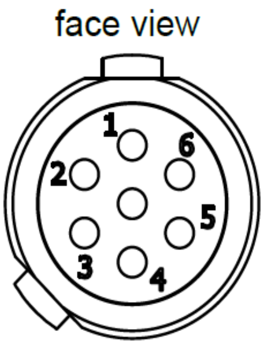


Table 3–9 Type 8084-000-9926 T2 Pin out

Seacon Pin No.	Function
1	Screen
2	Comms/Trig Ground
3	N/C
4	N/C
6	Tx
7	N/C
8	N/C

3.10.2 Trigger Input

The SPRINT-Nav trigger input characteristics are shown in *Table 3–10*.

Table 3–10 SPRINT-Nav Trigger Input

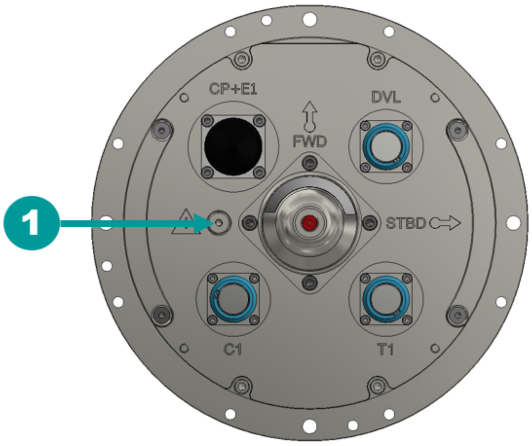
Parameter	Specification	
Voltage	Recommended	0 V–5 V
	Minimum	0 V–3.6 V
Pulse Width	Recommended	10 ms
	Minimum	5 µs

3.11 Pressure Relief Vent Valve

A pressure relief vent valve is provided to stop a build-up of gas inside the SPRINT-Nav housing caused by the charging process or a failing battery.

The pressure relief vent valve must be checked before installing and operating the SPRINT-Nav; see *Section 11.7 "Pressure Relief Vent Valve"*.

Figure 3–11 Pressure Relief Vent Valve



Item	Description
1	Pressure Relief Vent Valve

3.12 Transducers

The housing contains four transducers that are recessed for physical protection. Each transducer is paired with another of similar acoustic characteristics to ensure consistent performance. An individual sensor can be replaced if it is damaged.

3.13 Syrinx DVL (Standalone) Power and Communications

If you intend to use the Syrinx DVL component of the SPRINT-Nav combined unit, read the following details.

The CP+E1/DVL test box is provided for both SPRINT (serial and Ethernet) and Syrinx DVL (Ethernet) connections.

Ethernet communications to the Syrinx DVL is established via CP+E1/DVL test box with SPRINT power pass through enabled on T2 (internal DVL). To configure the Syrinx connect to the URL **192.168.179.200**; for further information see *Section 9 "Standalone Syrinx DVL Operation"*.

If the Syrinx DVL is powered externally via the SPRINT-Nav DVL port then only DVL Serial AUX port and external triggers are available (connection using C1,T1,T2 Test Box, DC OUT +V and DC OUT 0V as 24 Vdc Input).

Serial communications to the Syrinx AUX RS232 channel is established via C1, T1, T2 test box via Terminal software.

Note

If using Type 8084-000-458X/658X-C, see UM-8084-Lodestar-Nav Issue A2 for Standalone DVL connection instructions.

3.14 DVL Operation

The Syrinx DVL is a complete digital signal processor controlled acoustic transmitter and receiver device. There are two variants of the SYRINX DVL, a standard frequency unit operating in a 600 kHz ± 130 kHz bandwidth and a high-altitude variant operating at 400 kHz ± 130 kHz bandwidth. Transmission is either by self-triggering or on receipt of an external trigger signal.

The main functions of the Syrinx DVL are:

- Transmit digital acoustic signals.
- Reception of reflected digital acoustic signals.
- Measurement of time and Doppler shift in the received reflected acoustic signal either from the seabed, or from mid-water scatterers within the water column.
- Provide output telegrams via Ethernet or serial which contain instrument or beam level velocity information.
- At low altitudes, the Syrinx DVL switches to a different operating mode. In this mode it uses a different velocity measurement principle based on temporal correlation which allows the DVL to maintain velocity estimation precision at very low altitude.
- Transformation from beam orientation Doppler shift measurements into specific output frame velocities.

The electronic components are as follows:

- Voltage regulation circuits.
- Digital signal processing module.
- Transmit circuit controlled by the processor.
- Receiver circuit controlled by the processor.
- Communications module providing dual RS232 and Ethernet communications.

Section 4 – Planning

4.1 Navigation Scenario

Interface*		Navigation Scenario		
		Construction	Dynamic	ROV Guidance
SPRINT-Nav Connection	Either:			
Ethernet (100 Mbit only)		✓	✓	
Serial RS232 115,200 baud		✓	✓	
LCH		✓	✓	Optional
Time Synchronisation**	Either:			
GPZDA UTC message with configurable latency to 1 PPS		✓	×	Optional
GPZDA UTC message & 1PPS sent to SPRINT-Nav		✓	✓	
None				Optional
USBL Aiding***	Either:			
PSIMSSB message (UTC time, WGS 84 Lat/Long Radians)		✓	✓	✓
USBL GGA message (UTC time, WGS 84 Lat/Long Degrees)		✓	✓	✓
Sonardyne External Position (UTC time, WGS 84 Lat/Long Degrees)		✓	✓	✓
DVL Aiding****	Either:			
Sonardyne proprietary ASONDV Beam level Message (Recommended with SPRINT)		✓	✓	✓
RDI Binary PD4/5 Message (Recommended)		✓	✓	✓
RDI Binary PD0 Message		✓	✓	✓
Pressure Depth Aiding	One Of:			
DigiQuartz kPA/PSI/Metres		✓	✓	✓
Valeport Midas SVX2		✓	✓	✓
NMEA DPT message		✓	×	✓
Sonardyne SONDEP message		✓	×	✓
Tritech Winson (processed) message)		✓	×	✓
Sonardyne External Depth		✓	✓	✓
SPRINT-Nav Internal Pressure Sensor		✓	✓	✓
LBL Aiding				
Fusion 6G LBL 1.11.04 (or later) with appropriate dongle		✓	✓	×
INS Position Output (with UTC timestamp)	Either:			
From SPRINT topside (LCH)		✓	✓	Optional
From SPRINT-Nav (ROV)		✓	✓	✓
AHRS Attitude Output (No UTC timestamp)	Either			
From SPRINT topside (LCH)		✓	×	✓
From SPRINT-Nav (ROV)		✓	✓	✓

Notes

***See *Appendix C "INS Message Definitions"* for all message formats.**
**** It is assumed that in either mode of time synchronisation that the GPZDA message is received no faster than 1 Hz (once a second) otherwise the system may not be able to synchronise.**
***** All USBL aiding inputs must be raw/measured and should not be subject to any filtering.**
****** See *Section 7.4.8 "Depth Aiding"*for supported DVL configurations.**

Prior to installation it is important to consider the navigation scenario to determine the optimum system configuration and interfaces. Typically the scenario is defined by the positioning (or attitude) accuracy specifications of a mission or project but equally important is the timeliness (or latency) of positioning or attitude provided by the SPRINT system.

Two common navigation scenarios are explained below. The recommended configuration for each navigation scenario is explained in the installation and configuration sections. If there is uncertainty as to which scenario is to be supported it is recommended that 'Dynamic Survey' is selected.

4.1.1 Construction Survey

In this scenario the SPRINT-Nav ROV will be used to position subsea structures or pipelines that are slow moving. The positioning and attitude accuracy tolerances can be high but the timeliness requirements of the outputs is relatively low, typically less than 0.5 seconds, as the ROV is often moving very slowly or performing static fixes during critical positioning phases.

4.1.2 Dynamic Survey

In this scenario the SPRINT-Nav ROV will be used to perform dynamic, high accuracy surveys such as multibeam pipeline out-of-straightness. The positioning and attitude accuracy tolerances are high and so is the timeliness of the outputs as the ROV motion must be compensated correctly when processing multibeam data. Any significant latency in ROV position or attitude will result in errors or artefacts in the final multibeam terrain model. In this scenario accurate alignment and instrument offsets will be more critical than in the 'construction' survey.

4.1.3 ROV Guidance

In this scenario the SPRINT-Nav will be used to provide ROV guidance, providing orientation at all times and INS position when the INS is available. The INS can be initialised using either USBL or manual (external) positions. In this scenario, the SPRINT system can provide accurate ROV guidance either mid water with USBL or at the seabed using DVL-INS "dead reckoning" without USBL.

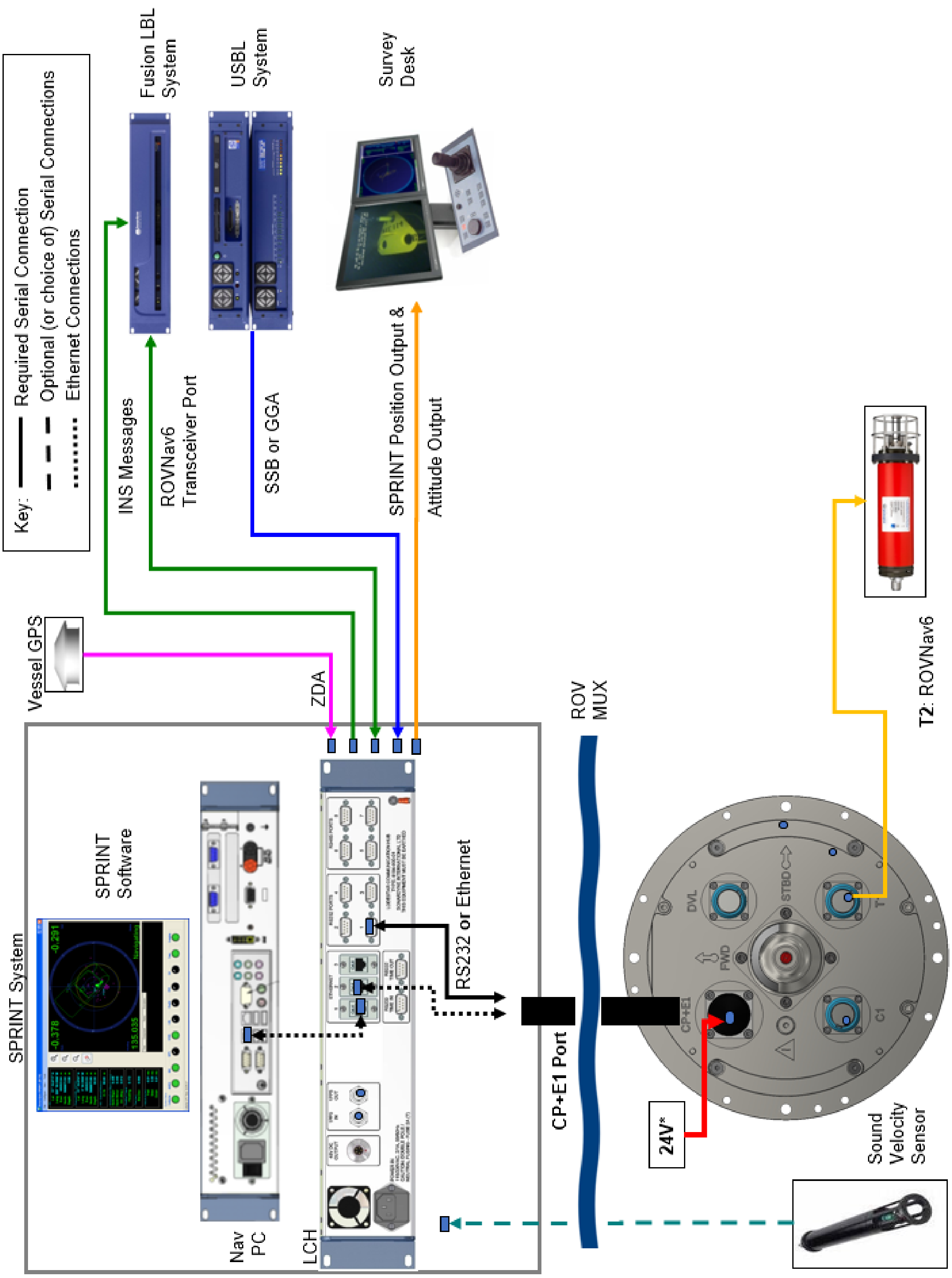
4.2 Interfaces

Prior to installation the following interfaces should be planned according to the SPRINT-Nav navigation scenario (✓indicates a supported interface, "×" indicates a non-supported interface):

4.3 Connections

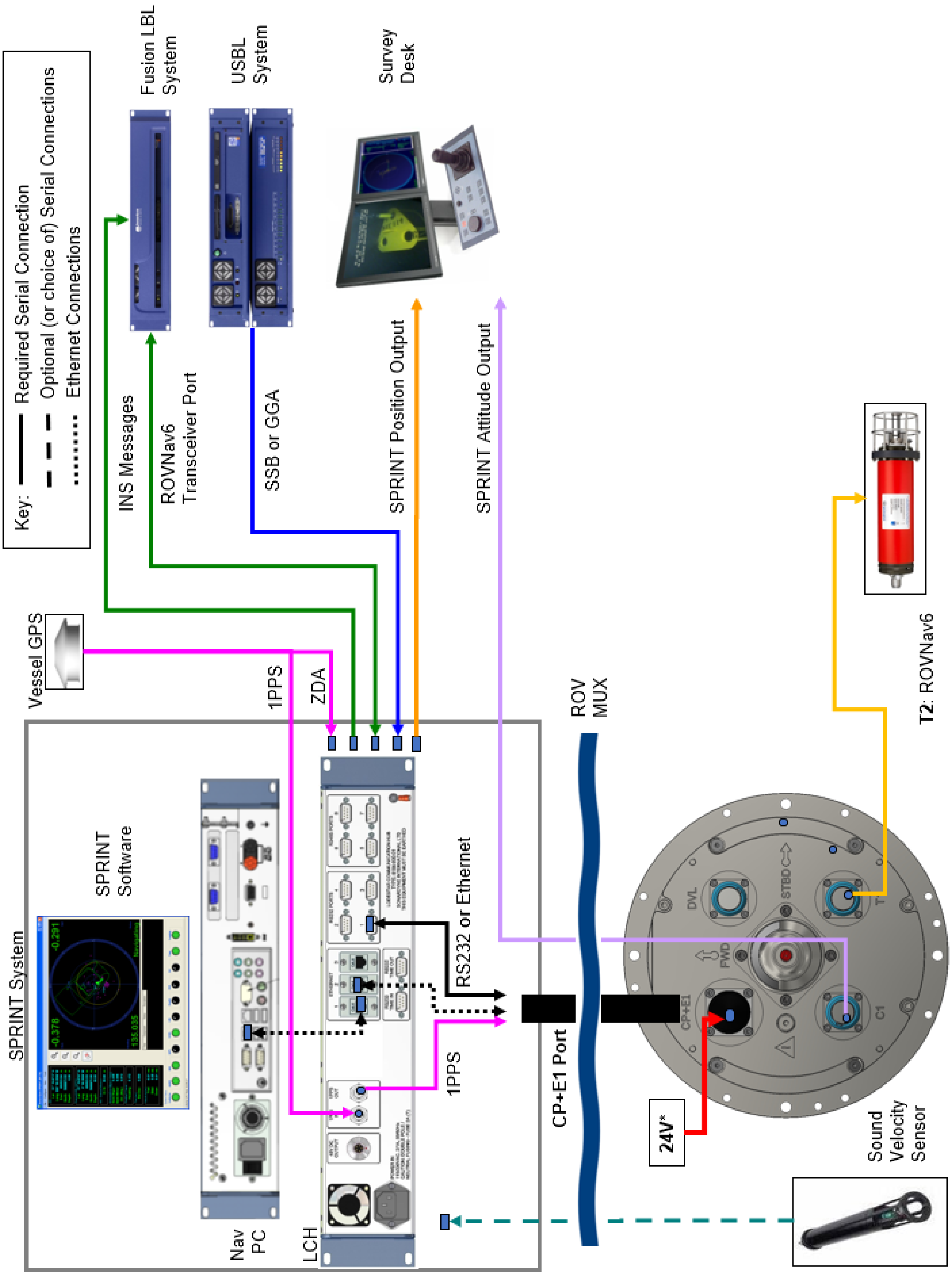
To guarantee the successful operation of theSPRINT system, the system connectivity must be considered at the installation planning stage. A suggested system connectivity diagram for the 'construction survey' configuration is shown in *Figure 4–1*.

Figure 4–1 Construction Survey Interface Diagram



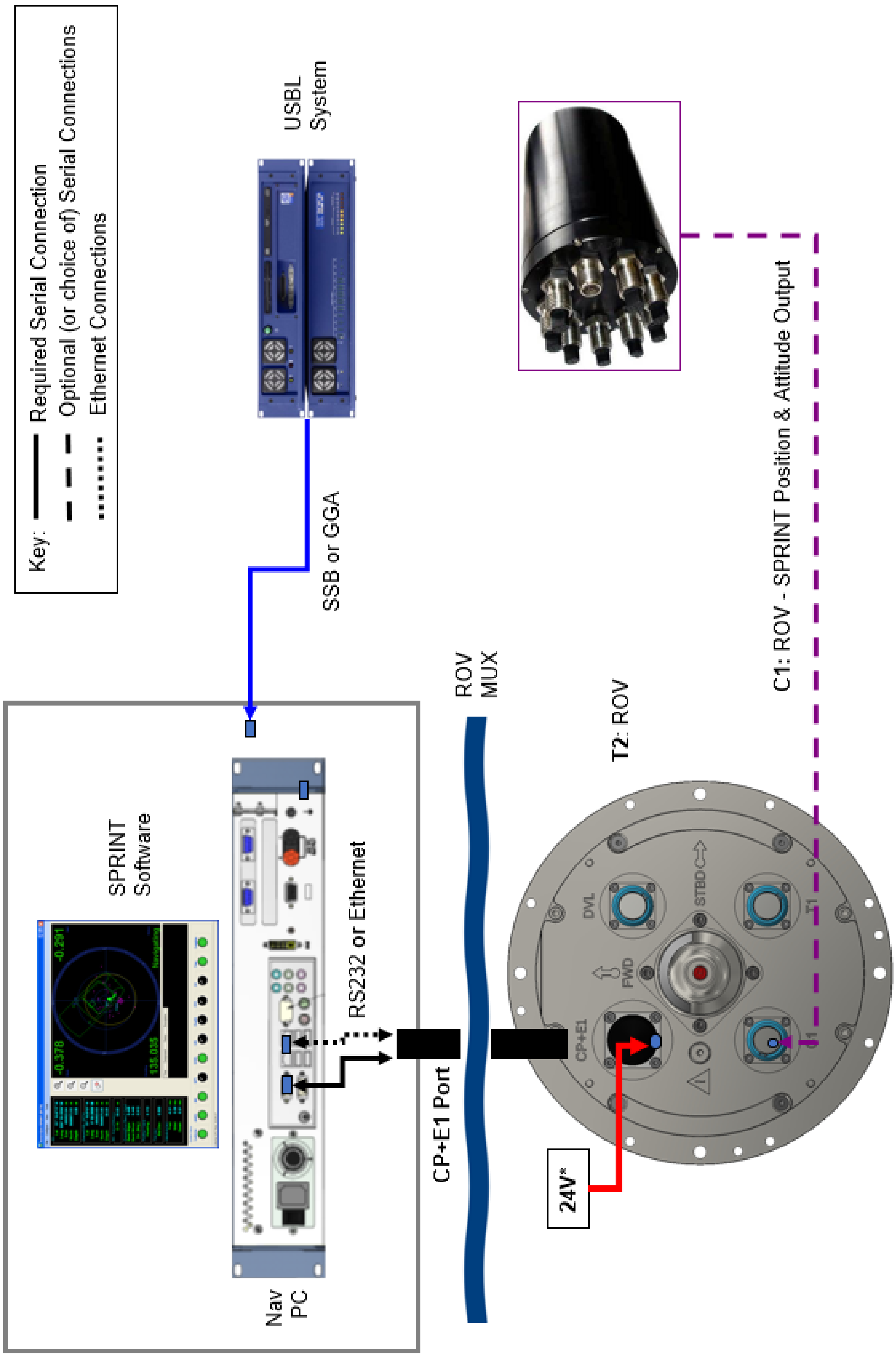
A suggested system connectivity diagram for the 'dynamic survey' configuration is shown in *Figure 4–2*.

Figure 4–2 Dynamic Survey Interface Diagram



A suggested system connectivity diagram for the 'ROV guidance' configuration is shown in *Figure 4–3*.

Figure 4–3 ROV Guidance Interface Diagram



4.4 Cabling

The system cabling must be carefully planned prior to installation to avoid issues. Subsea cables can be costly and time consuming to correct or replace during the installation phase.

4.4.1 Topside

The majority of topside interfaces will be serial. Consideration should be given for any serial cable run length, as this could lead to data corruption if the length exceeds RS232/485 limits, particularly the serial connection between the SPRINT-Nav LCH and the SPRINT-Nav (if used). If the distance between the SPRINT-Nav LCH and the ROV (de) multiplexer is excessive for an 115,200 baud rate RS232 serial link then alternate interfaces should be planned to make sure the data is not corrupted, such as Serial to Ethernet or RS232 to RS422/485 converters. Alternatively an Ethernet connection to the SPRINT-Nav could be considered.

4.4.2 Subsea

A typical cabling diagram for all the required subsea connections to and from the SPRINT-Nav on the vehicle is shown in *Appendix I "SPRINT-Nav Wiring Diagram"*. This diagram should be used to produce vehicle and sensor specific SPRINT-Nav cables prior to installation.

4.5 Time Synchronisation

The SPRINT-Nav will be time synchronised to UTC by receiving a ZDA message and optionally a 1PPS timing pulse from a GNSS receiver. The SPRINT system will be interfaced to other systems, such as USBL, Survey Software or Multi-beam that are also time synchronised to UTC using connections to GNSS receivers. A common source of perceived INS position error is inconsistent time synchronisation across the various systems interfaced with the SPRINT system.

There are three fundamentally different types of GNSS ZDA/1PPS time synchronisation:

- ZDA arrives before its associated 1PPS
- ZDA arrives after its associated 1PPS (most common)
- 1PPS and ZDA are asynchronous (seen with many modern GNSS systems)

Different models and configurations of GNSS receiver may use any of the three types listed above.

It is very important that the type of synchronisation used by each GNSS receiver is understood prior to the SPRINT-Nav installation to avoid timing issues. This may require consultation with the GNSS manufacturer. If possible, the use of a common GNSS receiver for time synchronising all systems will greatly reduce the risk of issues.

4.6 Depth

The SPRINT system supports either pressure or depth aiding input to determine the depth of the INS. There are several factors that should be considered during the planning phase.

4.6.1 Pressure to Depth Conversion

In the case of a pressure aiding input the SPRINT-Nav performs a simple pressure to depth (metres) conversion. The pressure to depth conversion scale factors are provided in *Appendix K "Pressure to Depth Conversion"*.

If there is a requirement for a different pressure to depth conversion calculation to be used, the operator can either:

- Convert the pressure sensor data to metres using the required conversion and pass this to the SPRINT-Nav as a depth (m) aiding message.
- Apply a pressure depth offset to the SPRINT system at operating depth so the INS depth is consistent with the intended depth datum.
- Convert the INS depth output from the system to another datum using the provided conversion calculations.

4.6.2 Surface Pressure

Most pressure sensors will measure ambient air pressure at the surface. This is the equivalent of approximately 10 metres of water depth. The SPRINT system allows the operator to measure the surface pressure on deck and remove it from any subsequent depth calculation. Depending on project requirements surface pressure may be removed as described above or the INS depth could also include surface pressure – this should be decided at the planning stage.

4.6.3 LBL References

Whichever method or configuration of SPRINT system pressure depth is used, the INS depth should always be consistent and relatively accurate to any LBL reference depths.

4.7 (Sparse) LBL Array Planning

4.7.1 Features and Operational Guidelines

The INS can be aided by LBL range observations from a Fusion 6G system.

Due to its DVL-inertial dead-reckoning capability, the INS can manage with less than the 4 or 5 beacons traditionally required for acoustic LBL tracking, hence the term ‘Sparse’ LBL.

Consider the following features and operational guidelines for sparse LBL:

- The minimum number of beacons at one site is two. Use of three beacons will support loss of acoustics to any single beacon and INS integrity if there is an error with aiding from any single beacon. For this reason the recommended number of beacons for a sparse array is three.
- In specific scenarios with favourable vehicle dynamics / trajectory the INS can be aided with range observations from just a single beacon. Additional operational guidelines should be considered – contact Sonardyne for advice.
- The INS can be actively aided by up to 6 beacons but can record LBL aiding observations for up to 10 beacons for analysis and post processing.
- Acoustic update rate to each beacon should be faster than 10 seconds – this is primarily for screening of observations prior to INS use.
- Pressure depth provided to the INS and beacon depths should be consistent. Relative depth errors will cause error in INS positioning if line of sight is not horizontal.
- Sound velocity in Fusion must be correct. Make regular updates if change is expected (> 0.5 m/s).
- LBL (range) aiding must be used in conjunction with DVL aiding, particularly in very sparse arrays.

- Ensure placement of LBL aiding beacons provides adequate acoustic line of sight and good geometry to the LBL transceiver during planned operations.

4.7.2 Sparse Array Geometry

The reference beacons in the sparse array should be placed so the line of sight to at least two of the beacons is approximately orthogonal to reduce the error in opposing directions.

An example of good geometry is shown below in *Figure 4–4* and examples of poor array geometry are shown below in *Figure 4–5*.

Figure 4–4 Example of Good Sparse Array Geometry

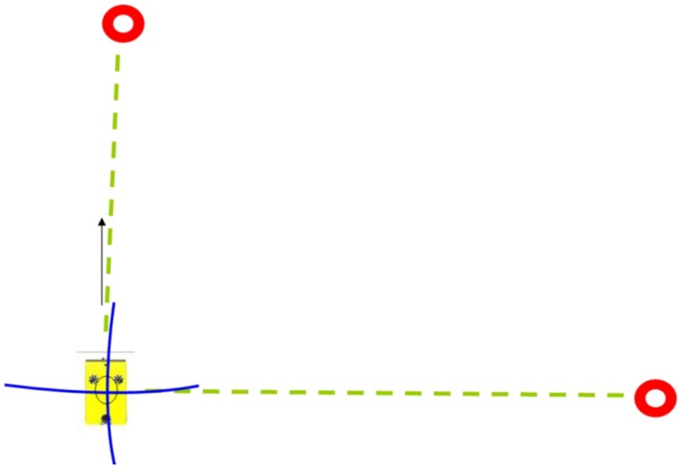
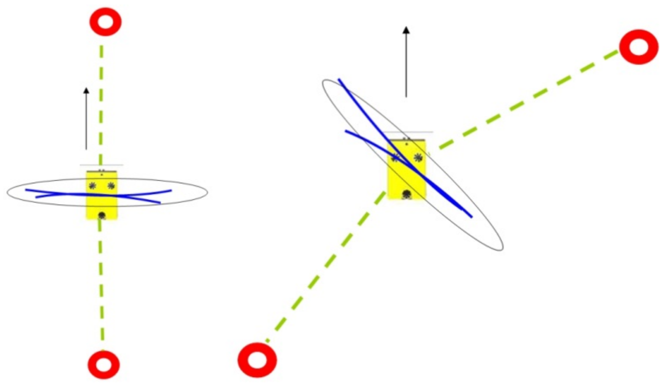


Figure 4–5 Examples of Poor Sparse Array Geometry



4.7.3 First Use of 'Sparse' LBL Aided INS

It is recommended that with first use of 'Sparse LBL Aiding', full LBL array navigation is also available to provide an independent position reference. Refer to the procedure detailed below:

1. Deploy a full LBL array.
2. Run full LBL acoustic tracking in Fusion.
3. Use SPRINT with LBL aiding from two or more of the array beacons (depending on operational requirements).
4. Compare the positioning performance of SPRINT sparse LBL against full acoustic LBL.

Gross difference between the two positions will indicate an issue for investigation/resolution; see *Section 16.11 "LBL Aiding"* for troubleshooting advice.

4.8 Planning Check List

Use the list below to assist in making sure the planning for the SPRINT system is complete prior to system installation:

No	Action	Manual Section	Checked (Sign and Date)
1	Plan navigation scenario	*Section 4.1*	
2	Plan (and prepare) required interfaces	*Section 4.2*	
3	Plan system connections	*Section 4.3*	
4	Plan system cabling	*Section 4.4*	
5	Plan system time synchronisation	*Section 4.5*	
6	Plan system depth	*Section 4.6*	
7	Plan sparse LBL array(s) if required	*Section 4.7*	

Section 5 – Installation

5.1 Introduction

Before installing the equipment, ensure *Section 2 – Safety* is read and fully understood.

This section explains how to install the SPRINT-Nav before deployment. The deployment method for the SPRINT-Nav is important to ensure correct operation while minimising any interference from external sources and objects.

5.2 Unpacking and Inspecting

The SPRINT-Nav includes a number of delicate and sensitive electronic components. In particular, the accelerometers and RLGs that form the Inertial Measurement Unit (IMU) are sensitive to shock and vibration. If damaged, these components cannot be replaced in the field, and the complete SPRINT-Nav must be returned to the factory for repair and recalibration.

The transducers are also sensitive to impact and should be protected against direct impact with hard surfaces using the array protector. Further protection should be used to prevent damage where appropriate

Note

Always handle the SPRINT-Nav with care. Store the unit in the shipping container until it is ready to be installed in the prepared location.

Inspect the SPRINT-Nav and all the supplied parts on receipt and check the shipment includes all the items listed on the shipping documents. Inform Sonardyne immediately if there are any parts missing, or if any of the supplied parts show signs of damage.

5.3 Installation Location

The SPRINT-Nav can be installed at any convenient location on the vehicle. However, to gain optimal performance from the system, identify a location to install the SPRINT-Nav that conforms as closely as possible to the following criteria:

- The location must not be subject to excessive vibration or impulse shock.
- The location must not exceed the environmental limits for temperature defined in *Section 19 "Technical Specifications"*.
- The location must provide a mounting surface that is of sufficient strength to support the weight of the SPRINT-Nav safely and without flexing.
- The location must provide access for power and communication connections.
- There must be sufficient space to allow easy access to install the SPRINT-Nav.
- Do not store tools, equipment or chemicals where they can damage the SPRINT-Nav or the connection cables.
- Make sure the SPRINT-Nav and its connection cables do not cause an obstruction to personnel operating in the area.
- Do not use a location where the connection cables are likely to suffer damage from mechanical stresses or chemical attack.
- The location must provide line of sight to the seabed for all 4 Syrinx DVL transducers abiding by the clearance levels described in *Section 6.3 "Deployment Guidelines"*.

5.4 Mounting

5.4.1 Site Preparation

The SPRINT-Nav can be installed in any convenient orientation with respect to the vessel's body frame. Compensate for any misalignment between the SPRINT-Nav and the vessel by carefully measuring the mounting angles and entering them in the AHRS or SPRINT system; see *Section 5.5 "Vehicle Alignment"*.

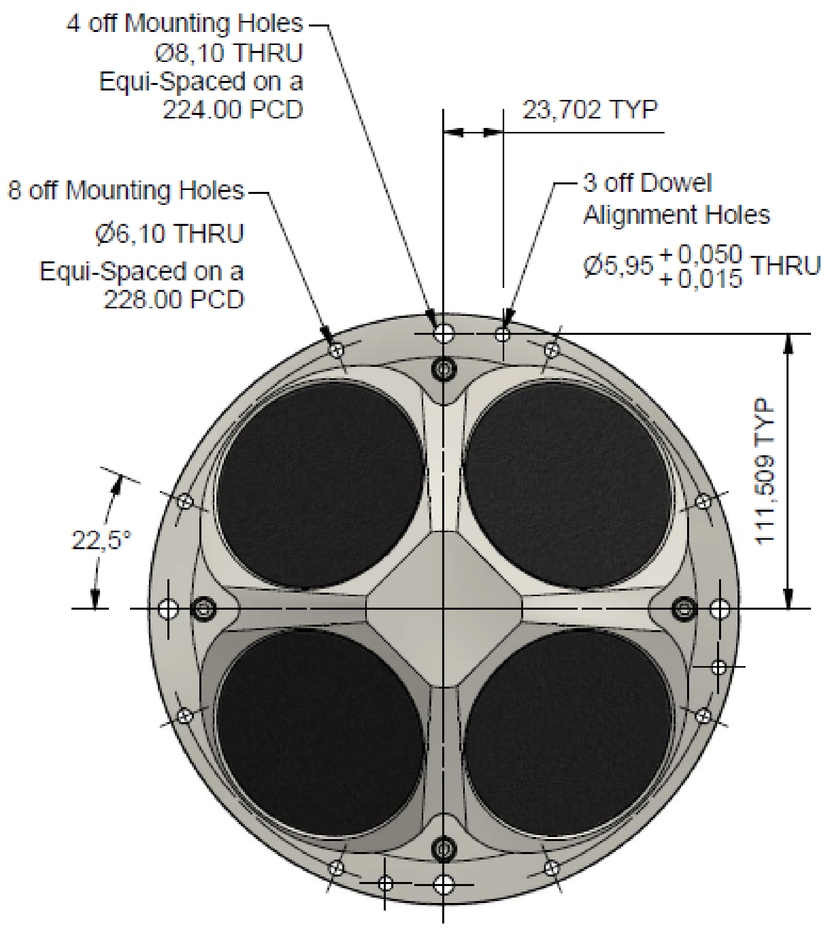
5.4.2 Mounting Holes and Dowels

The SPRINT-Nav has a set of eight mounting holes (a further four alternative mounting holes are available) on the outer mounting ring of the unit. In addition there a set of three-dowel alignment holes. The mounting holes are shown in *Figure 5–1*.

Note

The forward direction is UP in *Figure 5–1*.

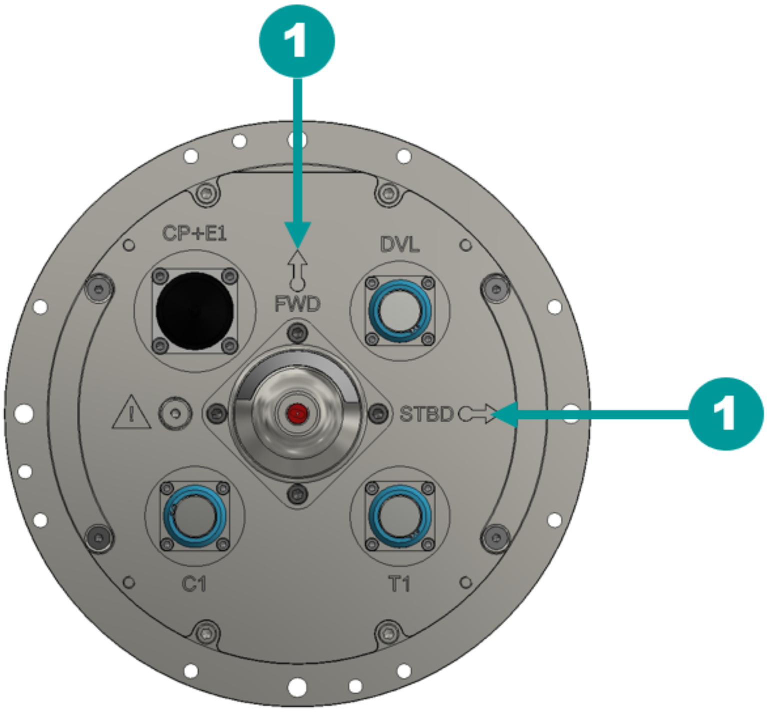
Figure 5–1 SPRINT-Nav Mounting and Alignment



5.5 Vehicle Alignment

The nominal alignment of the SPRINT-Nav to the vehicle frame (FWD and STBD) is engraved on the top endcap as shown in *Figure 5–2*.

Figure 5–2 Endcap Alignment Markings



Item	Description
1	FWD and STBD Endcap Alignment Mark-ings

If it is not possible to mount the SPRINT-Nav within the limits described above for coarse alignment or if you wish to mount the SPRINT-Nav at other angles with respect to the reference axes on the vessel, ROV or platform, the mounting angles must be measured and configured.

5.5.1 Alignment

For the SPRINT-Nav to provide accurate attitude and positions with respect to the vehicles reference frame, any misalignment between the SPRINT-Nav and vehicle reference frame must be corrected by determining and applying mounting angles in the SPRINT system software; see *Appendix B "Reference Frames and Angular Conventions"*.

Determine the initial ‘coarse’ mounting angles and then apply them in the SPRINT system; see *Appendix B "Reference Frames and Angular Conventions"*.

After the (coarse) mounting angles of the SPRINT-Nav have been determined using the guidance provided above, the angles can be refined using existing methods for ‘Gyro to ROV’ calibration.

These methods may include:

- Manual calculation using traditional survey methods such as a dimensional control survey (usually performed in a static environment onshore).

- Automated calculation provided by Survey software using comparison of ROV gyro against vessel reference gyro (can be performed offshore in a dynamic environment).

5.5.2 Offsets Transformations

Offsets for Yaw, Pitch and Roll can be entered to transform the data from the default instrument frame to a vehicle frame output. The values can be entered in the SPRINT system for the SPRINT-Nav, and also allows mounting angles for the Syrinx DVL, though in a combined SPRINT-Nav, the SPRINT sensors and Syrinx DVL transducers are mechanically aligned. If the Syrinx DVL is used as a standalone unit, the mounting angle offsets can be entered in the DVL Manager Configuration page and should be the gross differences between the vehicles forward direction & 0° orientation of pitch and roll and the mounting orientation of the SPRINT-Nav. Alternatively, offsets can be entered in the OFS command; see *Section 9.8.4 "OFS – Offset Command"*.

SPRINT-Nav Rotation Conventions:

- Positive Yaw = Positive heading change
- Positive Pitch = Bow up
- Positive Roll = Starboard down

SPRINT-Nav applies transformations to the velocity data in the following order:

- 1st: Yaw
- 2nd: Roll
- 3rd: Pitch

Notes

PD0, PD3, PD4, PD6 and PD13 output telegrams automatically use the same instrument frame as RDI (assume Port-Fwd beam is facing direction of travel). If the Forward mark of the DVL is facing direction of travel, a +45° Yaw value is required.

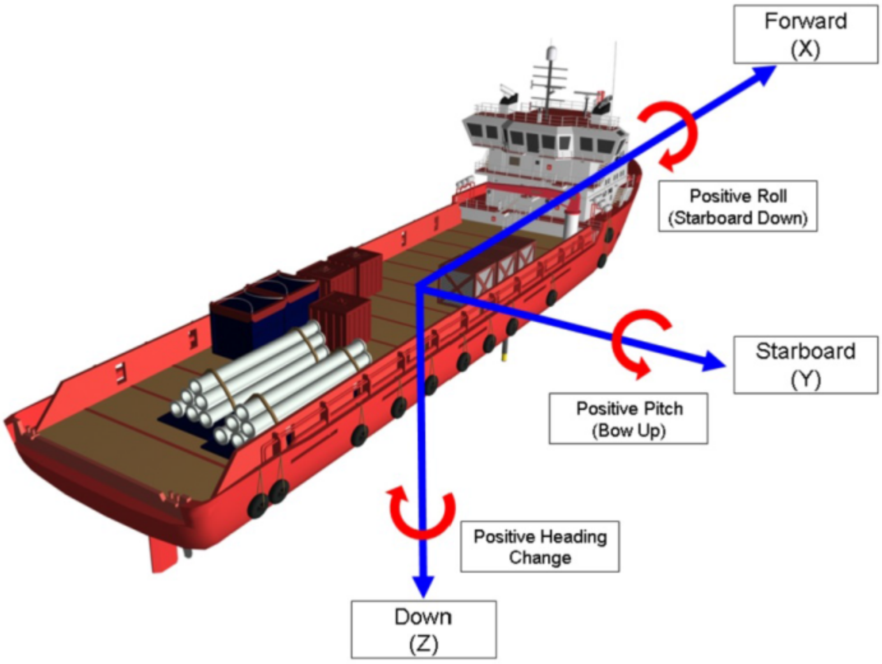
All velocity conventions assume transducers are facing down to the seabed.

5.5.2.1 Sonardyne Telegrams Velocity Conventions

Conventions (assuming transducers facing down):

- Positive X = Forward
- Positive Y = Staboard
- Positive Z = Down

Figure 5–3 SPRINT-Nav Sign Conventions



5.5.2.2 Conventions for RDI Message Outputs

When a PD4 or PD0 message output is configured, Syrinx automatically applies the same instrument frame and velocity conventions as would be used in an RDI DVL (assuming Port-Fwd beam is facing direction of travel).

If the forward mark of the SPRINT-Nav housing is facing direction of travel, a **+45° Yaw** value must be added in the DVL Manager or using the OFS command; see *Section 9.8.4 "OFS – Offset Command"*. This is the same configuration as would be required in an RDI DVL (e.g. RDI command: EA+04500).

Note

The +45° yaw value is added automatically by the SPRINT system when configuring a SPRINT-Nav for PD4 output.

RDI Velocity Conventions:

- Positive X = Staboard
- Positive Y = Forward
- Positive Z = Up

Note

The conventions above are used by Syrinx when outputting RDI PDx format telegrams.

5.5.2.3 SPRINT-Nav Instrument Frame

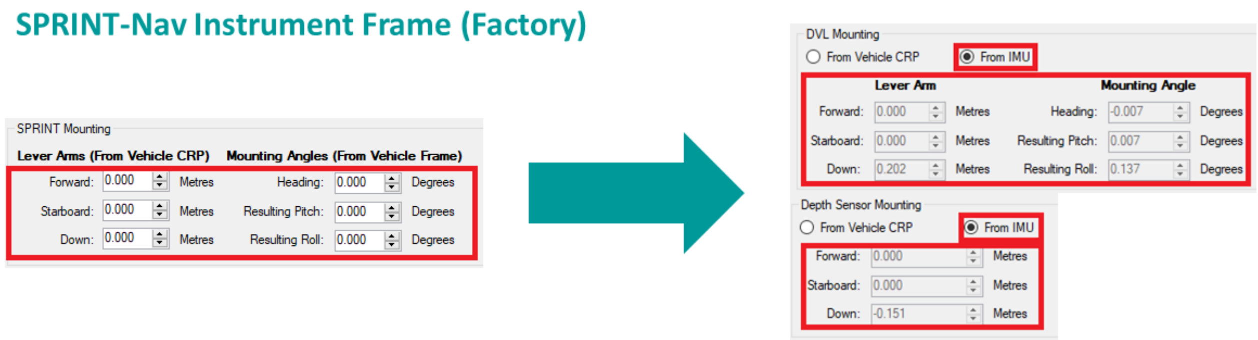
The SPRINT-Nav system has two types of lever arm and mounting angle measurement references - vehicle frame and instrument frame:

- Vehicle frame: SPRINT and sensor lever arms and mounting angles relative to Vehicle CRP/Frame (from vehicle CRP/Frame).
- Instrument frame: sensor lever arms and mounting angles relative to SPRINT IMU (from measurement point of the sensor assembly).

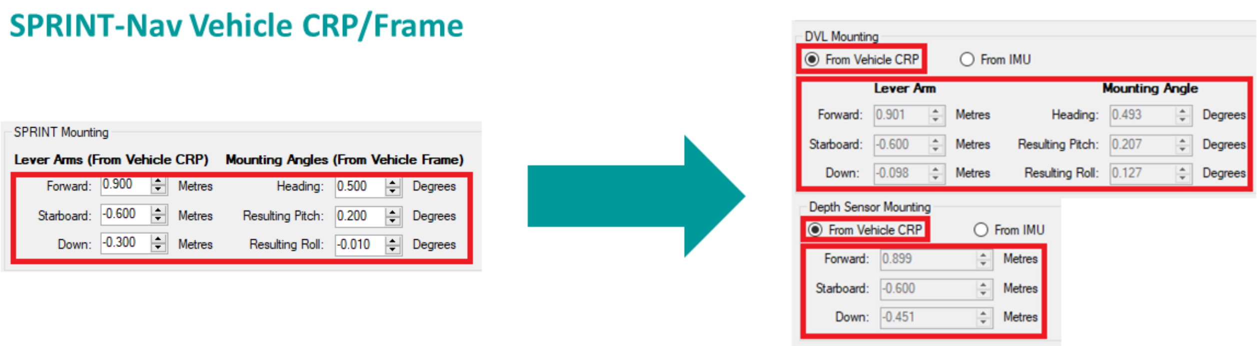
The Instrument frame measurements for the SPRINT-Nav Syrinx DVL and internal pressure sensor are stored as factory default within memory. The vehicle frame measurements (lever arms and mounting angles) are automatically configured by the SPRINT-Nav; apply the SPRINT-Nav (IMU) lever arms and mounting angles (from vehicle CRP/Frame) to update the pressure sensor and DVL measurements.

To configure the SPRINT-Nav using Instrument Frame:

1. Import the DVL Calibration file (.ccl), this is stored in the SPRINT-Nav from the factory but can be reapplied using the .ccl file in the USB Memory device included with the unit.



2. Apply SPRINT-Nav (IMU) lever arms and mounting angles from the vehicle CRP/Frame. This will then calculate pressure sensor and DVL lever arms and mounting angles from the vehicle CRP/Frame, as shown in the figure below.



Note

See *Section 7.4.3 "SPRINT System Configurations"* and *Section 1 "Technical Specifications"* unit dimensions (measurement point).

5.5.2.4 Syrinx Lever Arm Measurements

The SPRINT-Nav has a fixed lever arm between the measurement point of the sensor assembly and the measurement point of the Syrinx DVL transducers. The values are shown below:

SPRINT-Nav 4,000 m		SPRINT-Nav 6,000 m	
Forward	0.00 m	Forward	0.00 m
Starboard	0.00 m	Starboard	0.00 m
Down	0.20231 m (400 kHz 0.20301 m)	Down	0.20711 m

5.5.2.5 Internal Pressure Sensor Levar Arm Measurements

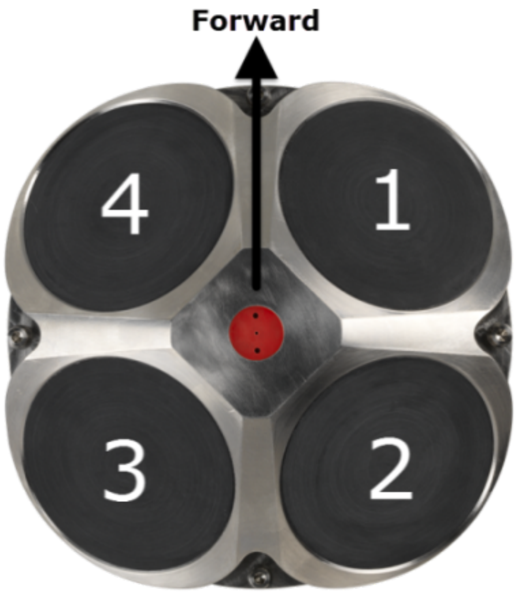
The SPRINT-Nav has a fixed lever arm between the measurement point of the sensor assembly and the measurement point of the internal pressure sensor. The values are shown below:

SPRINT-Nav 4,000 m		SPRINT-Nav 6,000 m	
Forward	0.00 m	Forward	0.00 m
Starboard	0.00 m	Starboard	0.00 m
Down	-0.15087 m	Down	-0.15607 m

5.5.3 Beam Numbering

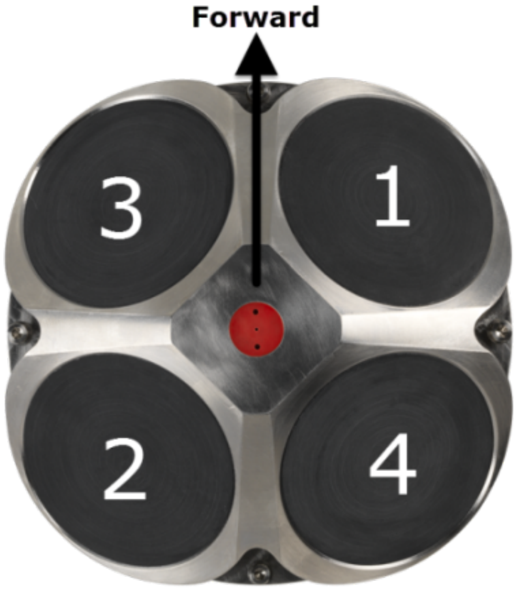
When operating SPRINT-Nav under normal conditions (DVL Manager & Sonardyne telegram outputs), the beams are numbered as shown in *Figure 5–4*.

Figure 5–4 SPRINT-Nav Beam Numbering



When operating SPRINT-Nav using RDI output telegrams (PD4 or PD0), the beams are numbered in the same pattern as RDI DVLs as shown below:

Figure 5–5 SPRINT-Nav PD4 & PD0 Beam Numbering



5.6 Trigger Specification

The Syrinx DVL component requires a rising or falling edge trigger. The positive level should be between 3.3 V and 12 V and should be a non-differential trigger. The minimum pulse width should be 500 µs. When using the SPRINT-Nav for inertial navigation and have selected to trigger the Syrinx DVL, the trigger will be provided internally from the SPRINT hardware to the Syrinx hardware. The details of the trigger are as follows:

- Voltage: 5 V non differential
- Pulse width: 10 ms

5.7 Preparing the SPRINT-Nav for use

The following checks and procedures must be carried out to make sure the SPRINT-Nav is serviceable and ready for use:

- Check the pressure relief vent valve; see *Section 11.7 "Pressure Relief Vent Valve"*
- Secure connector cables and fit the connector covers to all unused connector ports.
- Check communications with the SPRINT-Nav.

5.8 SPRINT System Software

The SPRINT system software should be installed to configure, operate and monitor the SPRINT-Nav for combined AHRS, INS and Syrinx DVL operation. To install the software:

1. Close all applications running on the Navigation Computer.
2. Log into the Administrator user account and insert the SPRINT software installation media.
3. Navigate to the drive containing the software installation media and double-click **Setup.exe**.
4. Follow the on-screen instructions to install and run the SPRINT software.

Note

If upgrading from a previous version of SPRINT, archive and delete both "SPRINT" and "Hub" folders from "C:\Users\Public\Documents\Sonardyne". Failure to delete these folders will cause incorrect software operation.

5.9 PC Utility

The PC utility software is used to configure and operate the SPRINT-Nav for standalone AHRS and also for maintenance functions such as firmware upgrade and onboard log files retrieval. To install the software:

1. Close all applications running on the PC and insert the software installation media.
2. Navigate to the drive containing the software installation media and double-click **Setup.exe**.
3. Follow the on-screen instructions to install and run the PC Utility.

Section 6 – Deployment

6.1 Introduction

Before deploying the equipment, ensure *Section 2 – Safety* is read and fully understood.

The deployment method for the SPRINT-Nav is important to ensure correct operation while minimising any interference from external sources and objects.

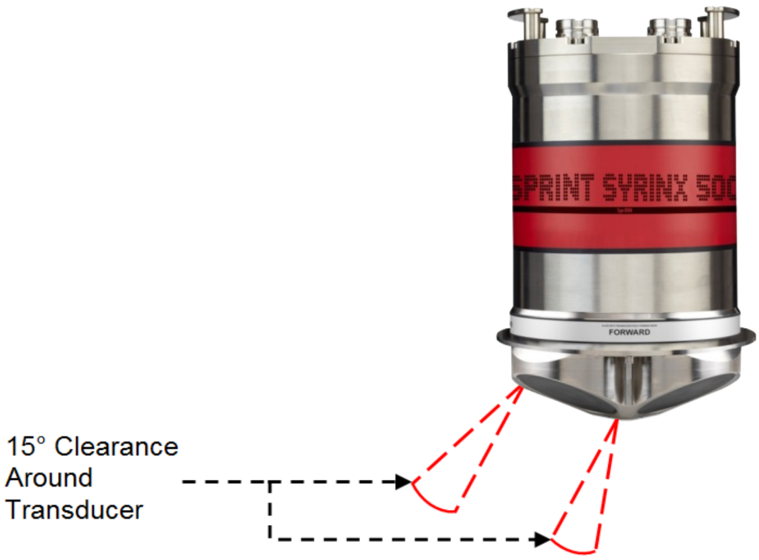
6.2 Pre-Deployment Checks

1. Inspect the SPRINT-Nav for any signs of mishandling, external damage or leakages; see *Section 11.5 "Inspection"*.
2. If necessary, clean the SPRINT-Nav; see *Section 11.4 "Cleaning"*.
3. Check that the sensor bung (central between transducers) is not blocked.
4. Check the pressure relief vent valve is flush with the housing face; see *Section 11.7 "Pressure Relief Vent Valve"*.

6.3 Deployment Guidelines

When deploying the SPRINT-Nav, the following guidelines should be used to determine where and how the SPRINT-Nav is mounted for optimal performance of the Syrinx DVL component.

1. The SPRINT-Nav requires clear line of sight below the vehicle on which it is mounted (for conventional downward-facing mounting arrangements).
   - This includes 15° clearance around the direction that is orthogonal to the transducer face. The transducer face is orientated at 30° azimuth from the vertical (downward) direction, with each beam at a 90° offset in yaw respective to one another, and all beams rotated 45 degrees in yaw from the forward mark.



2. The SPRINT-Nav should be mounted at the greatest distance possible away from the seabed (taking into account *Step 1* above).
   - This is to offset the minimum altitude of operation of the SPRINT-Nav of <0.4 m.
   - If the SPRINT-Nav can be mounted 0.4 m or greater above the bottom of the vehicle with clear line of sight, bottom lock should rarely be lost even if the vehicle settles on the seabed.
3. The orientation of the SPRINT-Nav is also important and can affect performance in certain scenarios.
   - For most operations, the desired orientation is to line up the SPRINT-Nav forward mark (label or machined grove on housing) with the forward heading of the vehicle.
   - For following pipelines where altitude measurements above the pipe are very important, the SPRINT-Nav can be rotated by 45 degrees so that beams then face forward, aft, port and starboard rather than inter-cardinal directions. This will result in the forward and aft beams being directed onto the pipe surface. Mounting angles will need to be adjusted appropriately in this instance.
   - If the SPRINT-Nav is mounted at a known angle offset, ensure that the correct offsets are applied for yaw, pitch and roll either in the SPRINT-Nav or the navigation software to ensure velocities are used in the correct direction.
4. If the SPRINT-Nav is not the Central Reference Point (CRP) of the vehicle, measure the physical lever arms from the SPRINT-Nav central measurement point (see *Section 19.4 "Central Measurement Point Dimensions"* for the CRP of the vehicle. The lever arms may be required in navigation systems to ensure the reference location of the velocity outputs is known and accounted for.

Section 7 – Combined INS & AHRS Operation

7.1 Introduction

A SPRINT-Nav can be configured and operated as both as a combined INS and AHRS using the SPRINT system, this is mode of operation is explained in this section.

If the SPRINT-Nav is only to be configured and operated as an AHRS only; see *Section 8 "Standalone AHRS Operation"*.

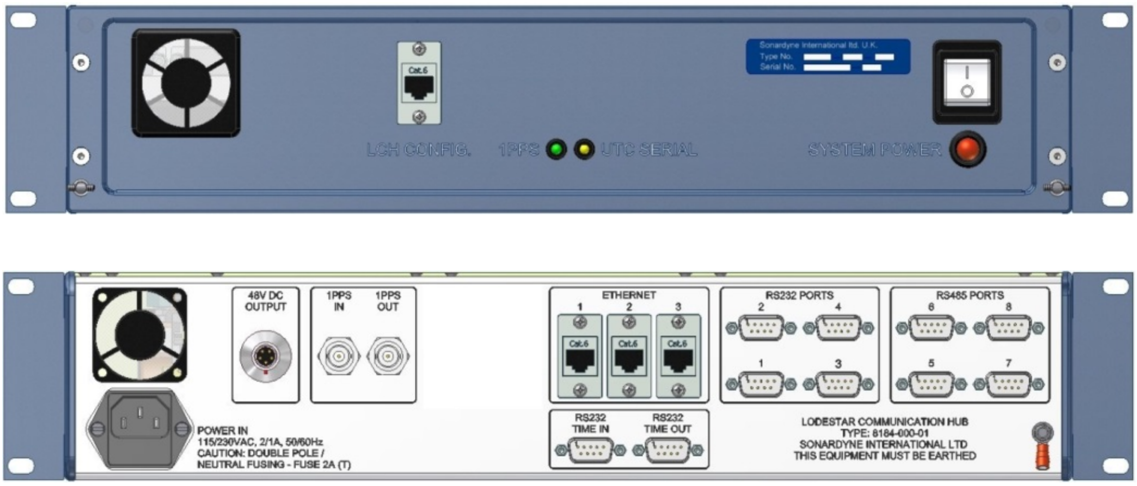
7.2 Changing the Console Port (CP) Baud Rate

If the SPRINT-Nav is to be connected using a serial interface, the console port baud rate must be set at 115200. SPRINT-Nav units shipped as part of a SPRINT system will be pre-configured with this baud rate. If the SPRINT-Nav has not been pre-configured for this baud rate, the PC utility software can be used to configure the console port baud rate.

7.3 Configuring Lodestar Communication Hub (LCH)

The LCH is optionally provided with the SPRINT system and provides an 8-port serial device server interface to extending the communications of the topside computer.

Figure 7–1 LCH Front and Rear



The LCH can provide a variety of configurable serial settings for each serial input device or output port required topside, such as:

- Baud rates from 50 to 921,600.
- RS-232, RS-422, RS-485 Half Duplex or RS-485 Full Duplex.
- Data bits, Stop bits, parity, flow control and FIFO.

The LCH also contains a 1PPS conditioner that can be used to condition and boost the 1PPS signal before it is sent to the SPRINT.

The LCH is supplied pre-configured with the following settings for serial input/output interfaces:

Table 7–1 Serial Input / Output Interfaces

LCH Port	Local TCP Port	Purpose	Baud Rate	Data Bits	Stop Bits	Parity	FIFO	Flow Control	Interface
Port 1	5001	SPRINT-Nav Console Port	115200	8	1	None	Enable	None	RS-232
Port 2	5002	GPS Input	9600	8	1	None	Enable	None	RS-232
Port 3	5003	ZDA Input	9600	8	1	None	Enable	None	RS-232
Port 4	5004	USBL Input	9600	8	1	None	Enable	None	RS-232
Port 5	5005	Depth or S.V. Input	9600	8	1	None	Enable	None	RS-232
Port 6	5006	Primary Output	9600	8	1	None	Enable	None	RS-232
Port 7	5007	Secondary Output	9600	8	1	None	Enable	None	RS-232
Port 8	5008	DO NOT USE							

If it is necessary to modify any setting for system operation, follow the procedure below:

Note

The LCH Port 1 is pre-configured to match the default serial connection configuration of a SPRINT-Nav used with the SPRINT system. If this Port needs to be modified, the default SPRINT-Nav connection configuration will need to be changed. It is advised to contact Sonardyne Support for further instructions.

It is necessary to know the IP address of the LCH unit. At the time of manufacture the IP address is set to 192.168.179.51. The IP address can be discovered as follows:

1. Open NPort Administrator by navigating from the start menu: **Programs > NPort Administration Suite > NPort Administrator**.
2. Click the Search button on the toolbar and wait 5 seconds for the search to complete. The model and IP address of the LCH comms unit will appear.

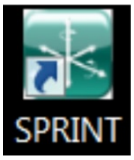
   Note

   The LCH factory default IP address is 192.168.179.51

3. Once the IP address is known, open **Internet Explorer**.
4. Enter the LCH IP address into the address bar e.g. **http://192.168.179.51**.
5. A web configuration page will be displayed.
6. To change any of the port settings, expand the **Serial Settings** item on the left hand pane.
7. Select the port to be configured; the current settings will be displayed on the right hand pane.
8. Change the settings as required and then click **Submit** to save the settings.
9. Click **Save/Restart** and wait approximately 30 seconds for the changes to be applied and the LCH to restart. The LCH will beep twice when it is ready.
10. When all changes have been made close **Internet Explorer**.

7.4 SPRINT system Software Configuration

Insert the security dongle into the Navigation Computer and then open the SPRINT system software by double-clicking the SPRINT desktop icon:

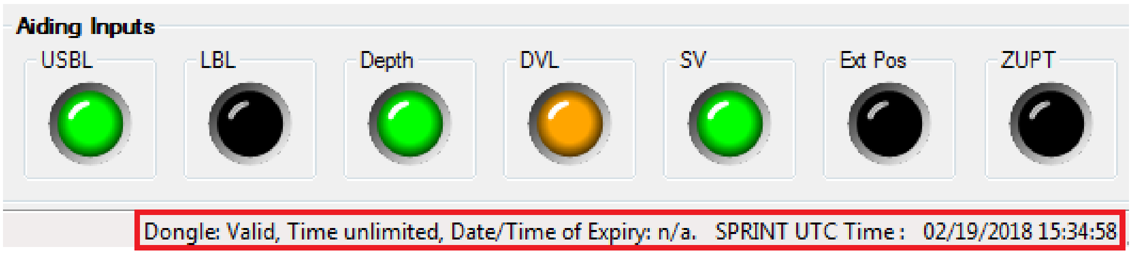


7.4.1 SPRINT system Security Dongle

SPRINT-Nav are available with different combinations of aiding options. The security dongle enables the appropriate aiding option in the SPRINT system software. Example S5 and S10 aiding options are shown in *Figure 7–4* and *Figure 7–5*.

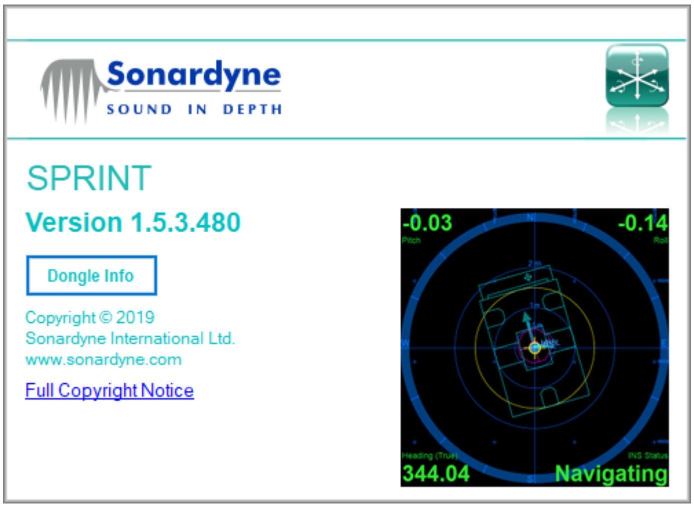
1. The security dongle validity and date/time of expiry information is displayed on the SPRINT system information pane.

Figure 7–2 Dongle Information Pane



2. The SPRINT aiding options (S5 or S10) can be viewed by selecting **Help > About > Dongle Info** from the SPRINT system menu bar.

Figure 7–3 Dongle information



3. Refer to *Figure 7–4* and *Figure 7–5*. SPRINT system aiding options for S5 and S10 systems are displayed along with dongle validity, type of expiry and date/time of expiry.

Figure 7–4 SPRINT S5 Settings

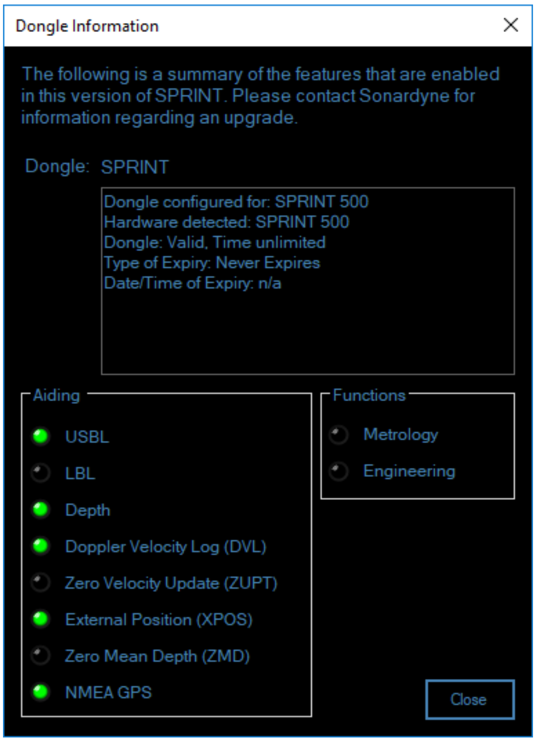
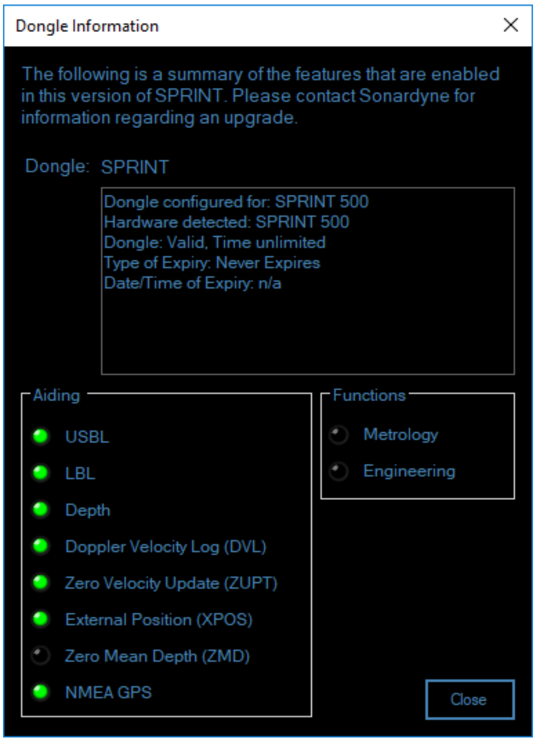


Figure 7–5 SPRINT S10 Settings

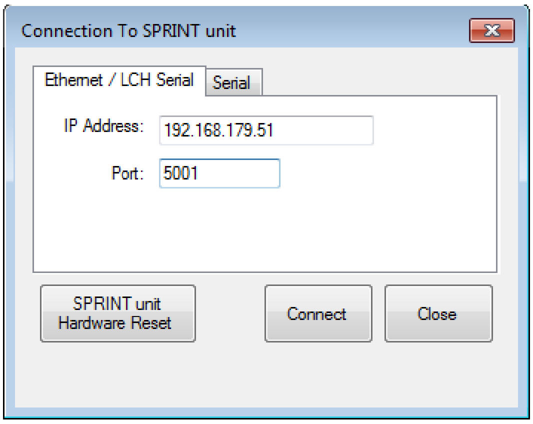


7.4.2 SPRINT System Connection

To connect the SPRINT-Nav to the SPRINT system, follow the instructions below:

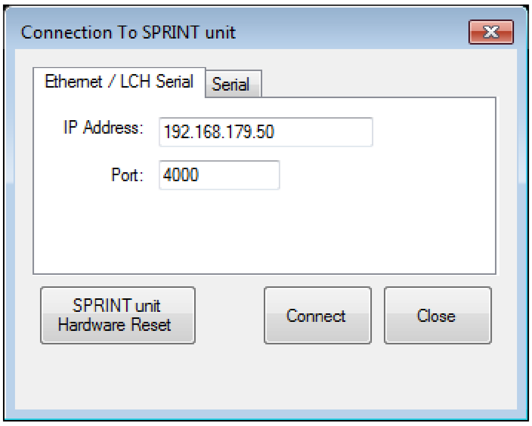
1. If this is the first time the SPRINT-Nav has been connected to the SPRINT system software or the connection is not active, the connection window should automatically be displayed. If the connection window does not appear, open it by clicking **Configure > SPRINT > Connection**.
2. On the **Connection** window, click the Ethernet/LCH tab and enter the **IP Address and Port**:
   - If the SPRINT-Nav is connected by means of a serial connection to the LCH, enter IP Address: **192.168.179.51** and **Port 5001**.

Figure 7–6 Serial Connection to the SPRINT-Nav



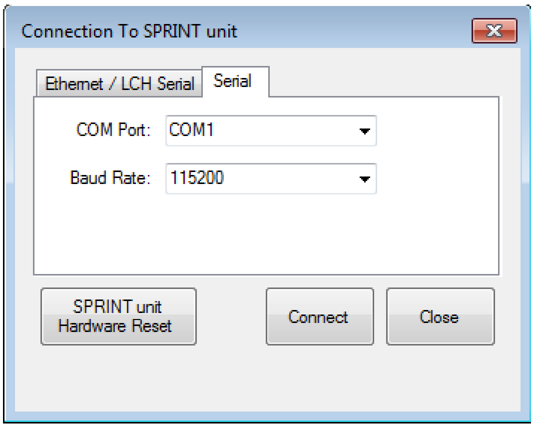
   - If the SPRINT-Nav is connected directly by means of an Ethernet connection to the LCH, enter IP Address: **192.168.179.50** and **Port 4000**.

Figure 7–7 Ethernet Connection to the SPRINT-Nav



- If the SPRINT-Nav is connected using a PC serial comms port, set the baud rate as follows: on the **Serial** tab, select the **Com** port and set the **Baud Rate** to **115200**.

Figure 7–8 Direct Serial Connection to SPRINT-Nav for MWSK



Note

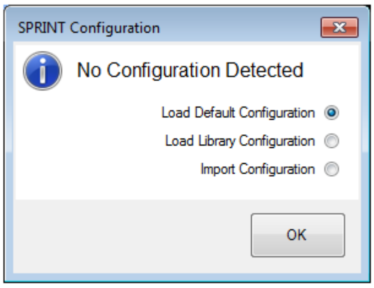
Only use serial comms connection if operating Mid Water Station Keeping (MWSK); not recommended for survey operations.

3. Click **Connect**.
4. If connecting for the first time select a configuration option, otherwise skip to *Step 5*.

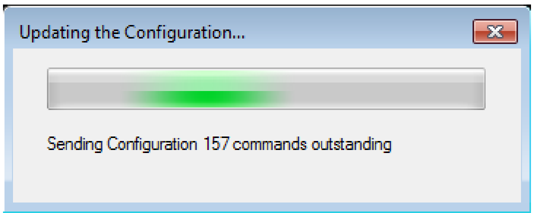
Note

If this is the first time the SPRINT-Nav has connected to the SPRINT system software, the configuration options below will be displayed (no options will be displayed if the SPRINT-Nav has previously connected to the SPRINT system software).

- **Load Default Configuration**: loads the default SPRINT configuration without aiding inputs or message outputs configured.
- **Load Library Configiration**: loads a preconfigured SPRINT configuration from the SPRINT library (e.g. 8084-251-B Gyro iUSBL configuration).
- **Import Configuration**: loads a custom configuration.

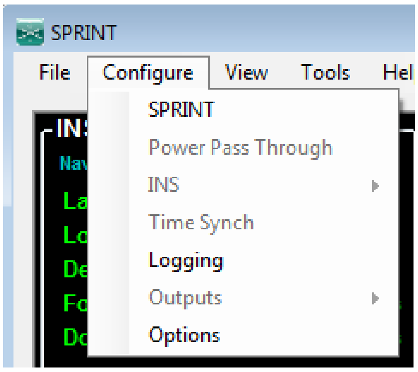


5. Select a configuration option and then click **OK**.



6. If the SPRINT-Nav is not connected, the SPRINT system will prevent access to any menu options to retrieve or configure SPRINT-Nav settings.

Figure 7–9 No SPRINT-Nav Connection for Configuration

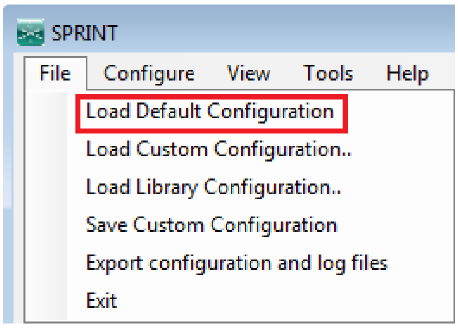


7. In addition, the system status LEDs at the bottom of the main application window will indicate that there is no SPRINT-Nav connection, as shown below.

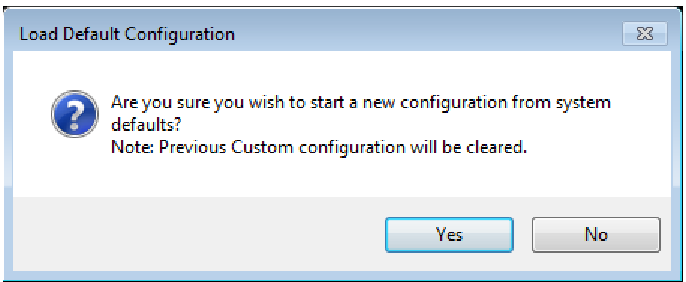
7.4.3 SPRINT System Configurations

To load the factory configuration or a configuration file from the Library, follow the instructions below:

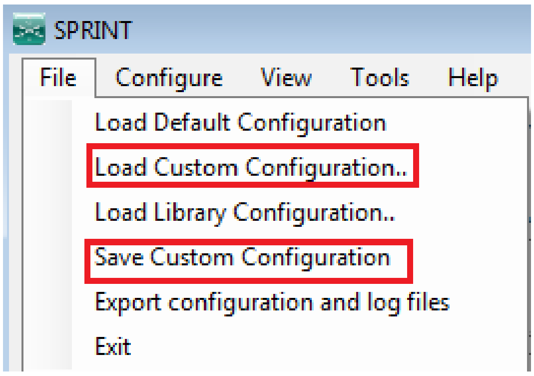
1. When the SPRINT-Nav connection has been established, click **File > Load Default Configuration** (this will load default SPRINT configuration).



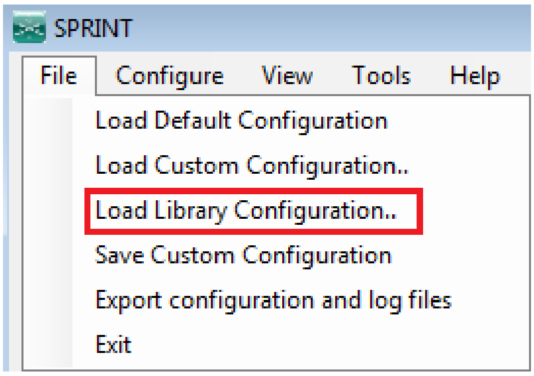
2. Click **Yes** to load the default configuration.



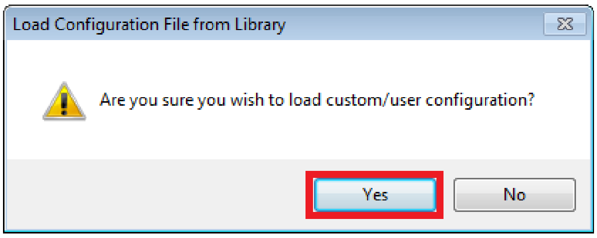
3. The SPRINT-Nav configuration can be saved to the PC by clicking **Save Custom Configuration** (this configuration can also be loaded onto the SPRINT-Nav from the PC by clicking **Load Custom Configuration**).



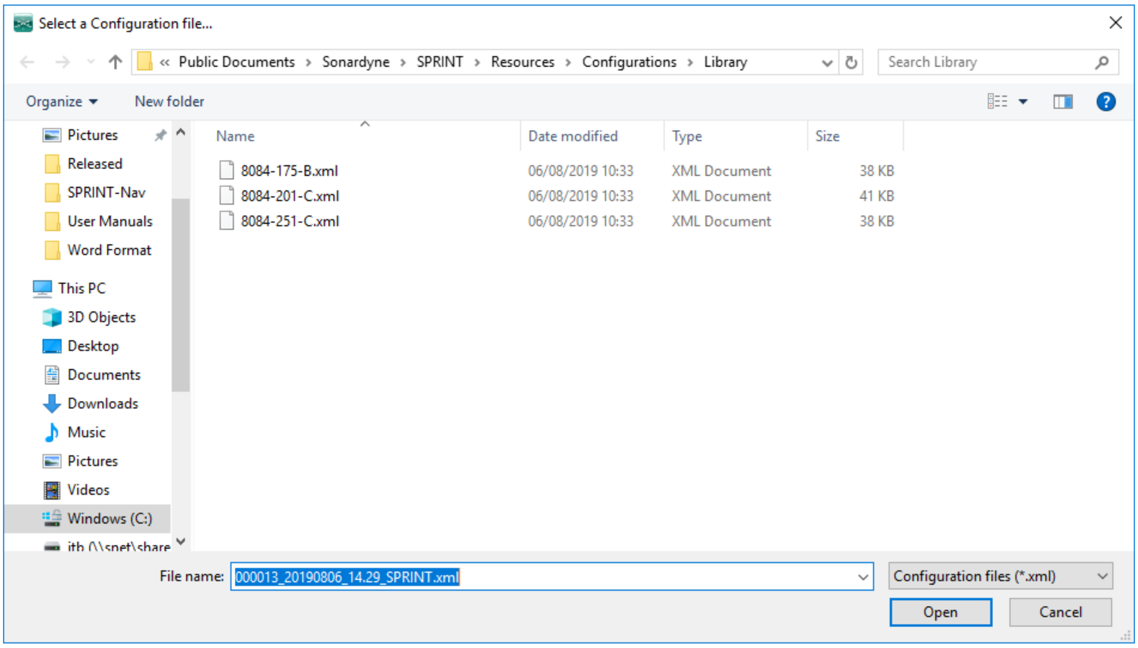
4. Click **Load Library Configuration** .



5. Click **Yes** to load the configuration file from library.



6. For example, to load the default configuration for a SPRINT GyroiUSBL, select the configuration file **8084-251-B.xml** and then click **Open**.

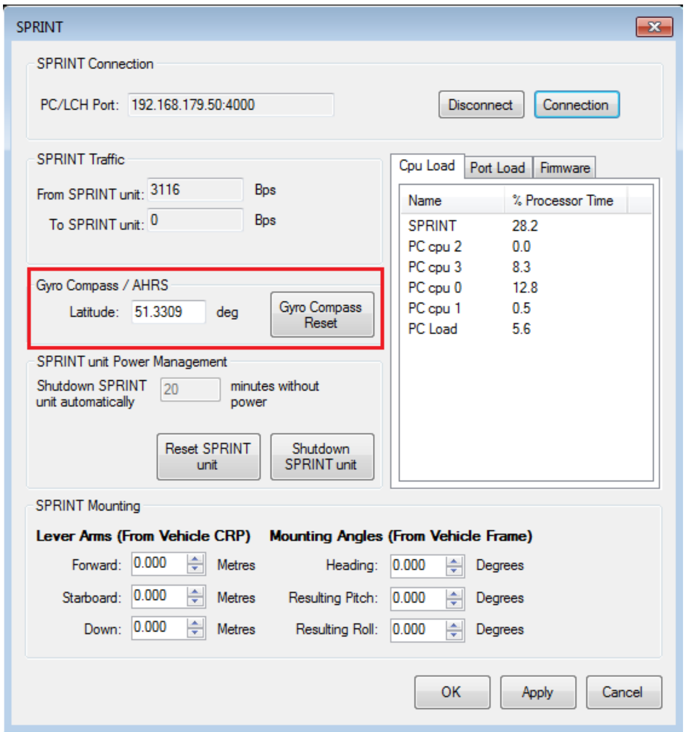


7.4.4 SPRINT-NavSettings

To configure the SPRINT-Nav settings, proceed as follows:

1. Click **Configure > SPRINT** or right-click on the **System Status AHRS LED**.
2. Enter a default **Latitude** value.
3. After any manual change of the default latitude the Gyrocompass algorithm will be automatically reset. The Gyrocompass algorithm can be manually reset at any time by clicking **Gyro Compass Reset**.

Figure 7–10 SPRINT-Nav Gyro Compass Settings



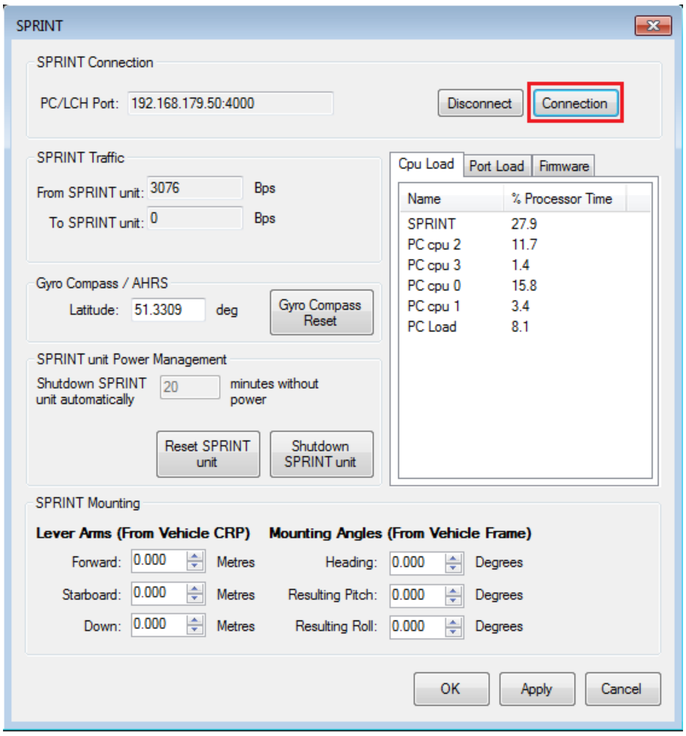
Note

Failure to update the default Latitude to match the current working area could result in poor SPRINT-Nav gyrocompass and inertial performance. After any change of default Latitude the SPRINT-Nav Gyro Compass algorithm is reset. During INS operations the SPRINT-Nav Latitude value will be automatically updated by position aiding messages (USBL).

3. Set the **SPRINT Power Management** time period. The SPRINT-Nav will run on its internal battery for the selected time period after the external power supply has been stopped.
4. Enter the **Lever Arms (From Vehicle CRP)** offset values. After changing these values, the Gyrocompass/AHRS and INS algorithms will be automatically reset to use the new settings.
5. Enter the **Mounting Angles (From Vehicle Frame)** offset values. After changing these values, the Gyrocompass/AHRS and INS algorithms will be automatically reset to use the new settings.
6. The SPRINT-Nav can be manually shutdown at any time by pressing the **Shutdown SPRINT** button, after which the SPRINT system will also close.
7. The SPRINT-Nav (firmware) can be manually reset at any time by pressing the **Reset SPRINT** button.

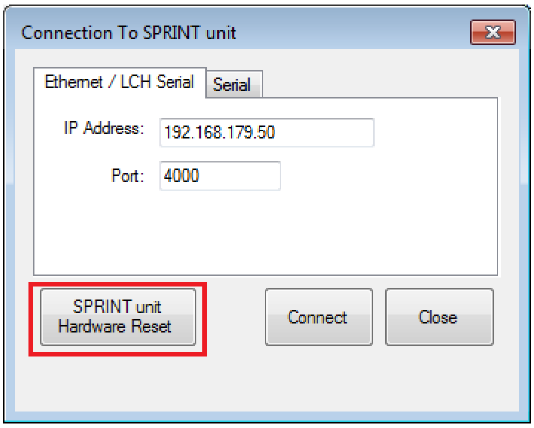
8. The SPRINT-Nav can be reset if the connection to theSPRINT-Nav is via Ethernet port (E1). Click the **Connection** button to open the SPRINT connection window, as shown below.

Figure 7–11 SPRINT Connection

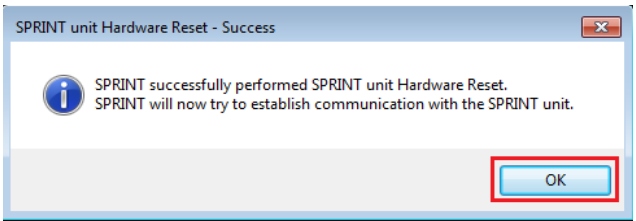


9. Click the **SPRINT Hardware Reset** button and then wait 3 minutes for the SPRINT-Nav to re-establish communications with the SPRINT system.

Figure 7–12 SPRINT-Nav Hardware Reset



10. Click **OK** to close and establish connection to the SPRINT-Nav.

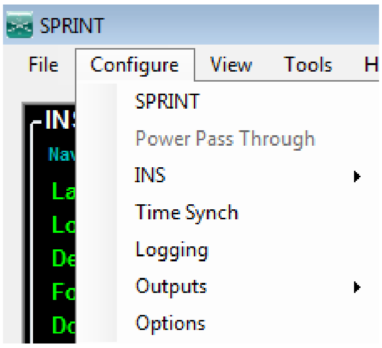


7.4.5 SPRINT System Power Pass Through

To enable the **Power Pass Through**:

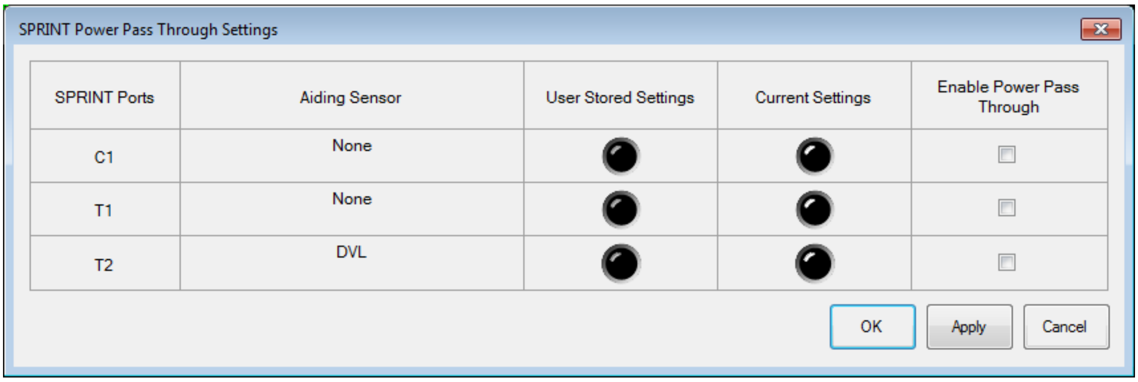
1. Click **Configure > Power Pass Through**

Figure 7–13 SPRINT System Power Pass Through



2. The configured aiding sensor is displayed for each SPRINT-Nav port (C1/T1/T2) with its previous and current status. Status lights are black if the power pass through is disabled. T2 port is the internal connection between the SPRINT-Nav and Syrinx DVL.

Figure 7–14 Power Pass Through Settings

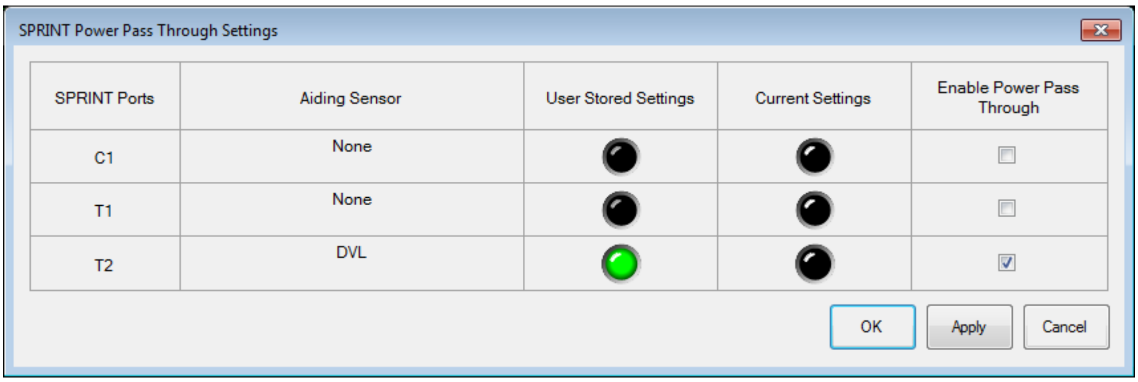


Note

The SPRINT-Nav will disable all enabled Power Pass Through Ports when powered cycled.

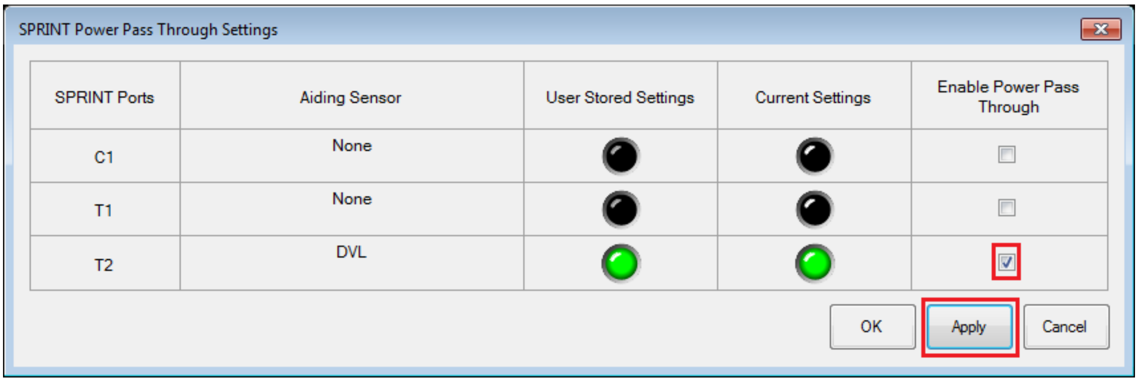
3. If the SPRINT port has previously had Power Pass Through enabled then the status light is green in the **User Stored Settings** column, as shown below.

Figure 7–15 Power Pass Through Settings



4. To enable the Power Pass Through, select the **Enable Power Pass Through** check boxes and then click **Apply**, as shown below.

Figure 7–16 Power Pass Through Current Settings

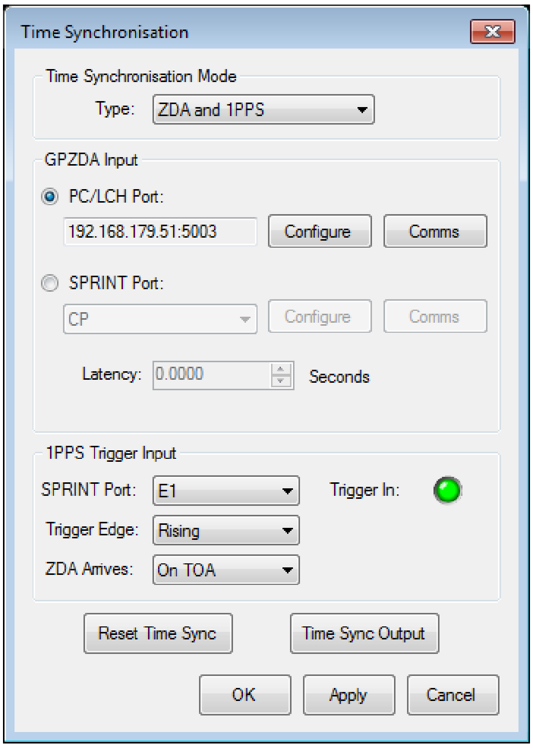


7.4.6 SPRINT-NavTime Synchronisation

To configure the SPRINT-Nav Time Synchronisation:

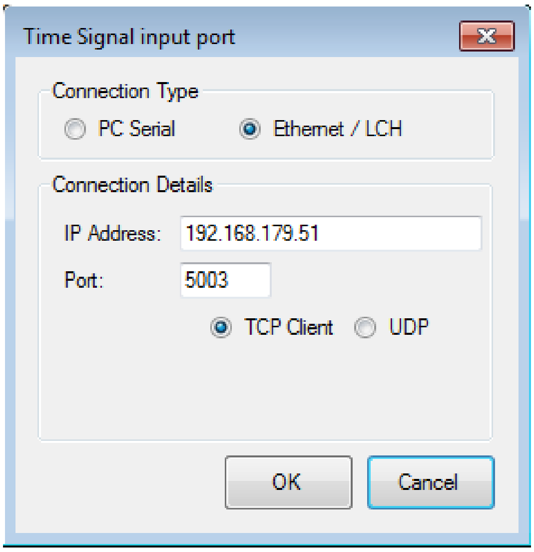
1. Click **Configure > Time Synchronisation**, or right-click the **Time** LED.
2. On the **Time Synchronisation** window, select **Type: ZDA Only** (default) or **ZDA and 1PPS**.

Figure 7–17 SPRINT-Nav Time Synchronisation



3. Click **Configure** and enter the PC Port Serial **IP Address 192.168.179.51**, **Socket 5003** via the LCH.

Figure 7–18 Adding IP Address



4. Click **OK** to return to the **Time Synchronisation** window and enter the ZDA **Latency** value.

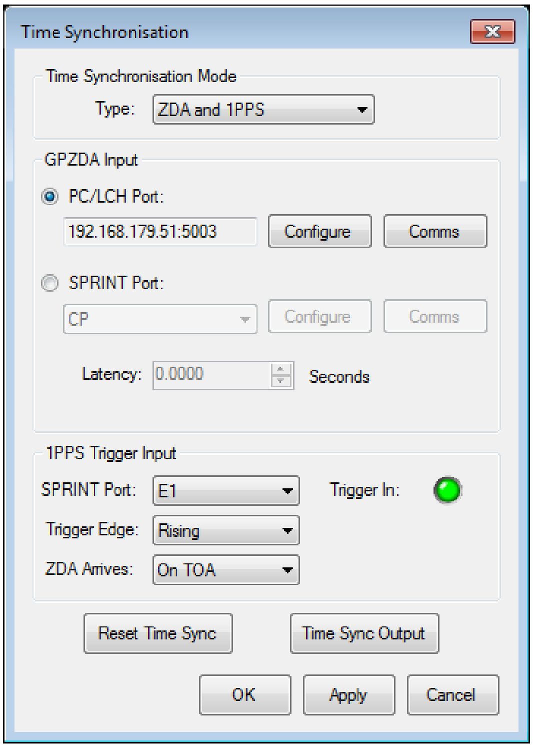
Note
The Time Synchronisation can be reset at any time by selecting Reset Time Synch.

5. If **GPZDA** and **1PPS** is selected, configure the **1PPS Trigger Input** settings. The default SPRINT-Nav input setting for 1PPS is **SPRINT Port C1**.
6. Click **OK** to close and save all entered settings.

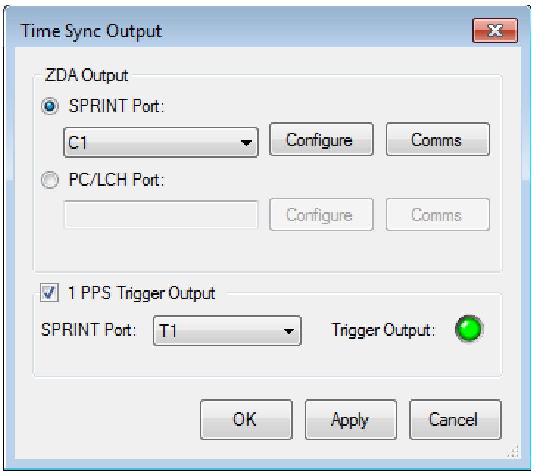
7.4.6.1 Time Sync to External Instrument

The SPRINT-Nav can also be configured to output a time sync (ZDA+1PPS) to an external instrument.

1. Click **Time Sync Output** in the **Time Synchronisation** dialog box.



2. Select the **SPRINT Port** for **ZDA Output** and **1 PPS Output** and then click **Apply**.



Note

Both the ZDA and 1 PPS must be configured if a time sync output is required (f only one parameter is configured then the SPRINT-Nav will not output the time synch).

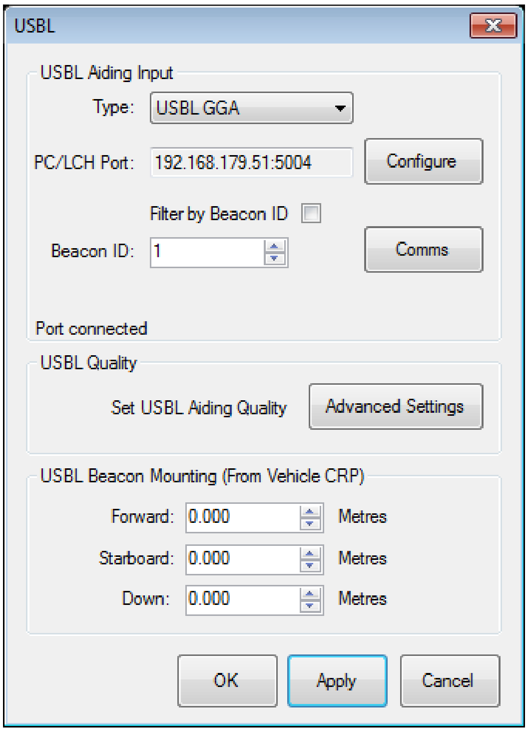
7.4.7 USBL Aiding

To configure the USBL Aiding:

1. Click **Configure > INS > USBL Input** or right-click on the **USBL** Aiding LED.
2. Select **USBL Aiding Input Type: PSIMSSB** (Default) or **USBL GGA (Acoustic)**; see *Figure 7–19*.Typical USBL aiding inputs are shown below:
   - Sonardyne Ranger/Fusion USBL or EIVA NaviPac: **Acoustic GGA**.
   - Sonardyne Marksman/Ranger 2 or Kongsberg HiPAP: **PSIMSSB**.

3. On the **PC/LCH Port** enter the IP Address for the serial input via the LCH (**192.168.179.51:5004**) by clicking **Configure**; see *Figure 7–18*).
4. If required, specify a **Beacon ID** filter; see *Appendix C "INS Message Definitions"* for details of the beacon ID field of the different USBL aiding messages.

Figure 7–19 USBL Aiding

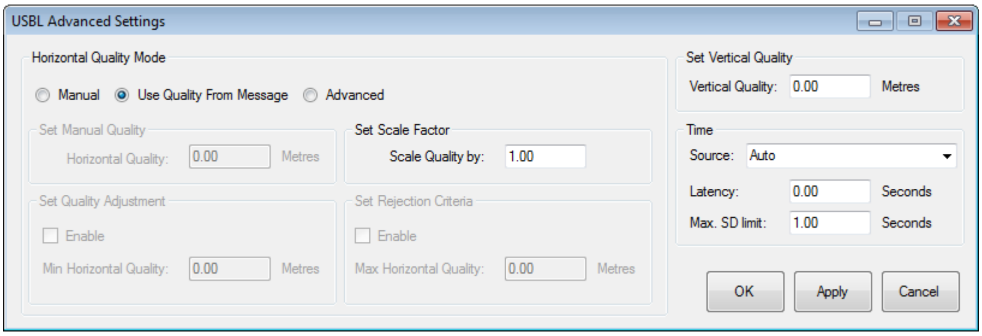


5. USBL Aiding Quality Settings can be configured by clicking **Advanced Settings**; see *Figure 7–20*.

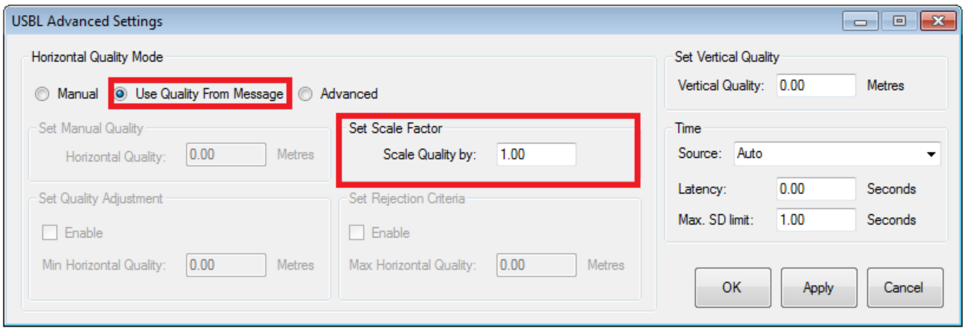
Note

The default setting is for the SPRINT system to use the quality value provided by the USBL system in the aiding message; see *Figure 7–28* of accepted USBL message types see *Appendix C "INS Message Definitions"*.

Figure 7–20 USBL Aiding Quality Settings

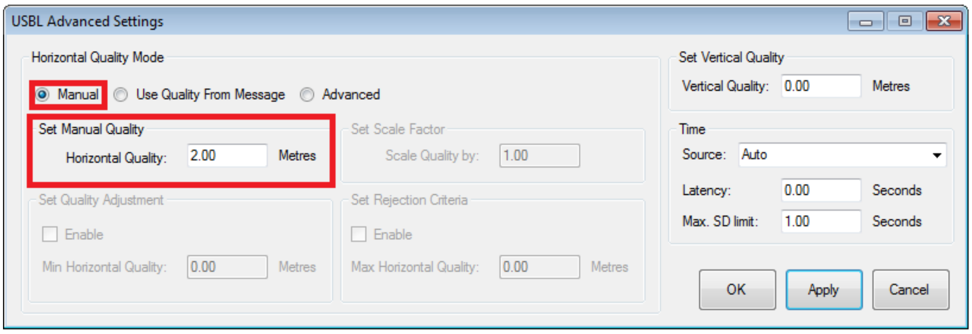


a. **Use Quality from Message**: The quality value from the USBL message can be scaled to resolve for systematically incorrect USBL Quality.



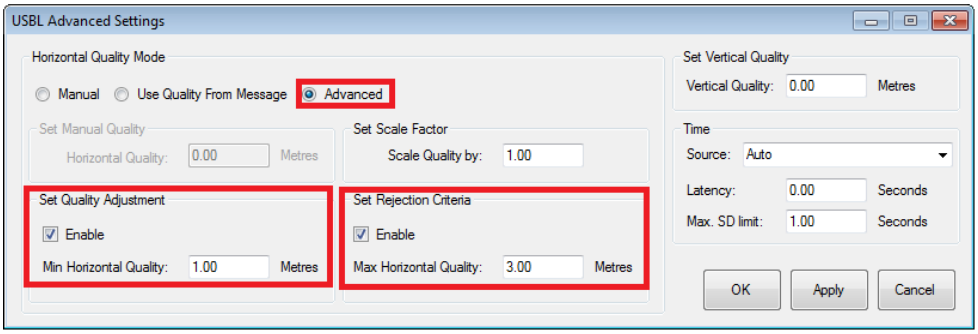
b. **Manual**: In some cases, it may be required to set a manual horizontal quality value:

- If using Sonardyne Ranger, Fusion USBL or other USBL systems where no quality value is provided.
- The quality value provided by the USBL system is overly optimistic.



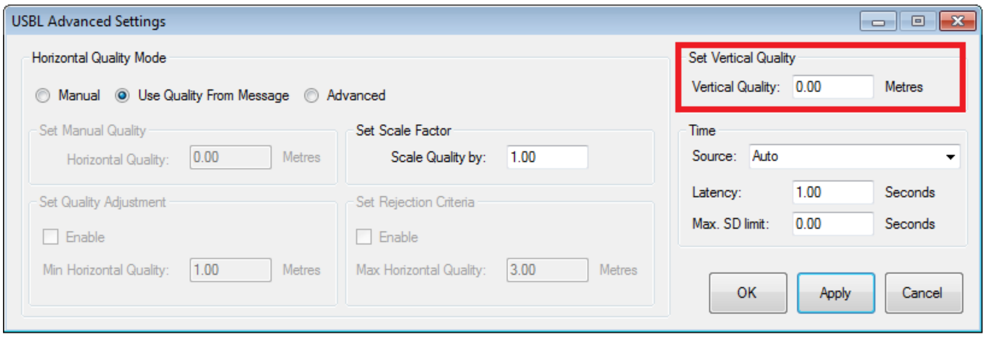
c. **Advanced**: This configuration allows horizontal quality to be used from the USBL message whilst able to set scale factor, minimum and maximum quality values for the USBL position.

- Min Horizontal Quality: Use this quality to improve shallow water USBL aiding (quality adjustment), when the USBL system is reporting a false (overly optimistic) position accuracy, the minimum quality value can be set.
- Max Horizontal Quality: Use this quality value to reject very poor USBL aiding (quality pre-filter).



d. **Vertical USBL Quality**: If USBL depth aiding is used, the configured vertical quality will be used by the INS. The value should be set according to the method of depth measurement:

- Acoustic
- Sensor Measurement

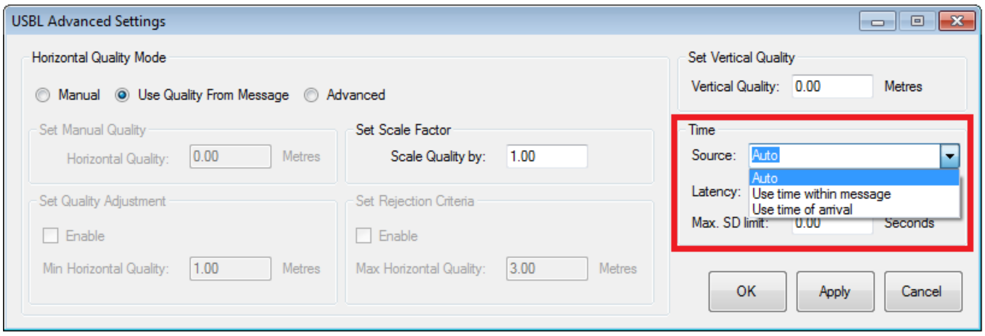


6. On the USBL Beacon Mounting (from Vehicle CRP) enter the Lever Arm offsets from the ROV CRP to the USBL beacon. After changing the lever arms the INS algorithm will be automatically reset to use the new settings.
7. USBL Aiding Time Source:

a. **Auto**: This mode will accept the USBL aiding message as Time Of Arrival, unless a time sync has been configured, then the Time within the USBL message will be used.

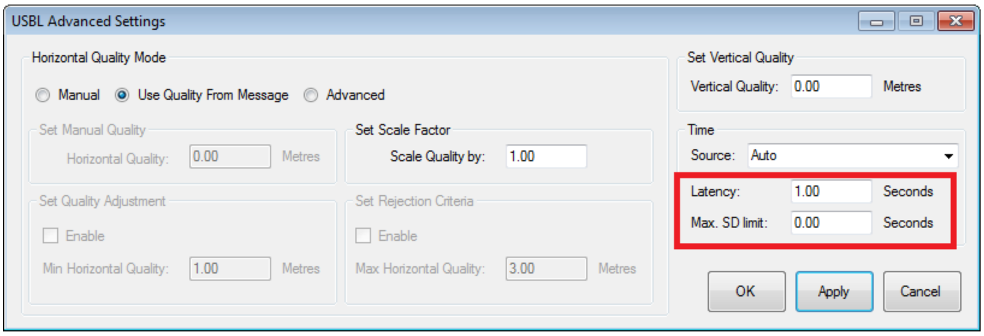
b. **Use Time within Message**: This mode will use the time stamp within the USBL aiding message.

c. **Use Time of Arrival** : This mode will validate the USBL aiding message on time of arrival only (time the telegram is received).



d. **Latency**: This sets the latency that is applied to the USBL aiding message.

e. **Max SD limit**: This sets the Max Time System SD rejection criteria for the USBL message when the SPRINT system is time synchronised (ZDA or ZDA + 1PPS) with time source configured as Auto or Use Time within message.



8. Click **OK** to close and save all entered settings.

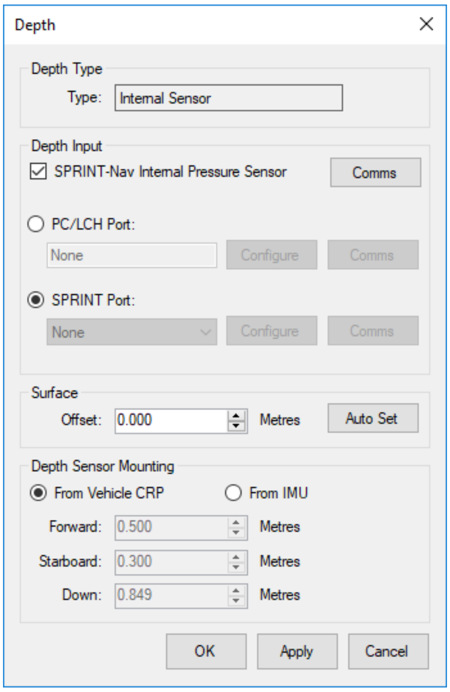
Note

If Sonardyne Marksman or Ranger 2 software is being used for USBL aiding, configuration instructions are provided in *Section 7.4.24 "Marksman & Ranger 2 USBL Aiding"*.

7.4.8 Depth Aiding

To configure the Depth aiding:

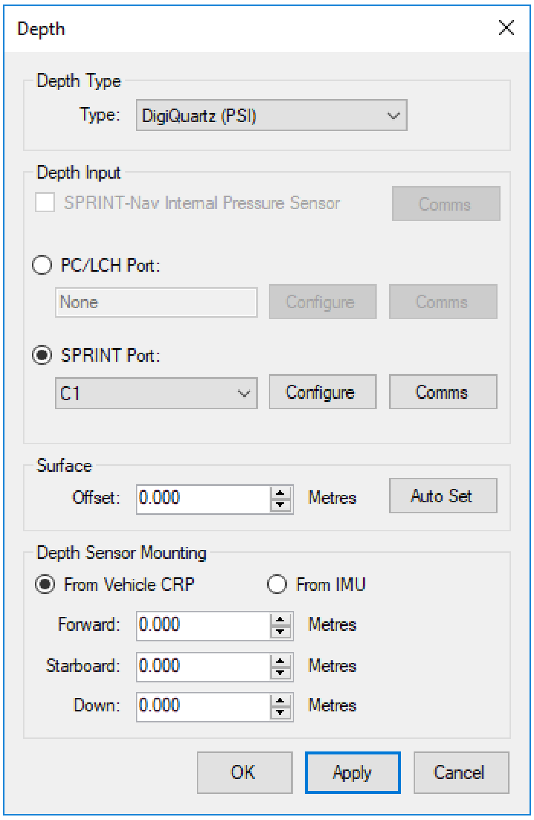
1. Click **Configure > INS > Depth Input** or right-click on the Depth Aiding LED.
2. If using the internal pressure sensor continue to *Step 3*; if not using the internal pressure sensor skip to *Step 4*.
3. Internal pressure sensor; select **SPRINT-Nav Internal Pressure Sensor**, click **Apply** and then skip to *Step 5*.



4. No internal pressure sensor; on the **Depth Type** drop-down list, select **DigiQuartz** (kPa, PSI or Metres); **NMEA DPT**, **External Depth** or **Son Depth**; see *Figure 7–21*.

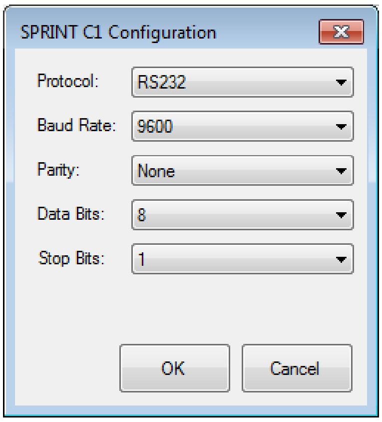
5. Select a **Depth Input** by selecting either **PC/LCH Port** or **SPRINT Port**.
6. If the sensor is connected via a serial connection, select the **PC/LCH Port** and enter the IP Address for the serial input via the LCH (**192.168.179.51:5005**) by clicking **Configure** (as shown in *Figure 7–18*).
7. If the sensor is connected directly to the SPRINT-Nav, select **SPRINT Port** and the relevant connection point (**C1, T1, T2**).

Figure 7–21 Depth Aiding



8. Click **Configure** and enter the SPRINT-Nav port configuration settings; see *Figure 7–22*.

Figure 7–22 SPRINT-Nav Port Configuration



9. Click **OK** to save all entered settings and return to the **Depth** window; see *Figure 7–21*.
10. Enter the **Surface Offset** value in metres if required. If the ROV is on deck and the ambient surface pressure is to be removed from raw pressure depth value, click **Auto Set**.

11. Enter the **Depth Sensor Mounting (from Vehicle CRP)** Lever Arm offset from ROV CRP to Sensor (after changing the lever arms the INS algorithm will be automatically reset to use the new settings).
12. Click **OK** to close and save all entered settings.
13. To view Pressure Depth Aiding residuals and depth, right-click on the **Depth** aiding LED and select **View Pressure Depth Aiding**; see *Figure 7–23* and *Figure 7–24*

Figure 7–23 Enable Aiding Plot

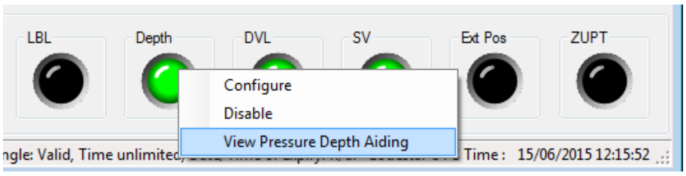
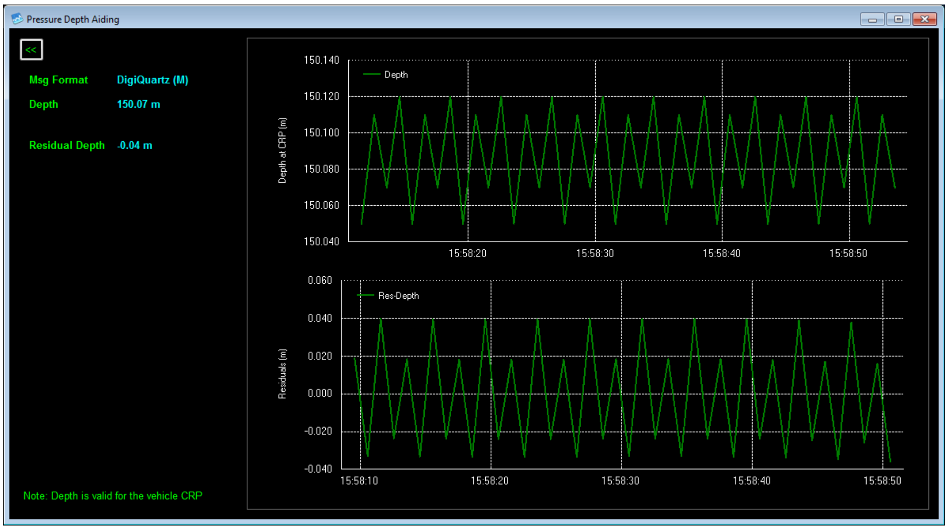


Figure 7–24 Pressure Depth Aiding Plot



7.4.9 DVL Aiding

To configure the DVL Aiding:

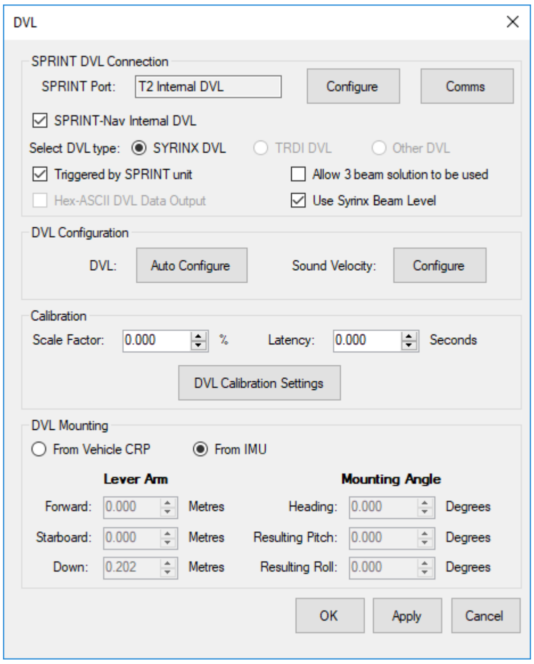
1. Enable Power Pass through on SPRINT-Nav port T2; see *Section 7.4.5 "SPRINT System Power Pass Through"*.
2. Click **Configure > INS > DVL Input** or right-click on the **DVL Aiding** LED.
3. Select the **SPRINT-Nav Internal DVL** check box and then click **Apply** (this will configure the SPRINT-Nav).
4. The SPRINT-Nav can automatically program the Syrinx DVL. To configure, click the **Auto Configure** to open the DVL configuration dialog box; see *Figure 7–25*.
   a. DVL Mode: select **Triggered**
   b. Select Data Stream: select **Beam Level**
5. Click **Configure** to configure the Syrinx DVL; the configuration progress will be displayed.
6. After the Syrinx DVL has been configured, click **OK**.
7. Click **DVL Calibration Settings** to import the DVL Calibration file.

Note

The SPRINT-Nav DVL is already production calibrated to instrument frame. The calibration file will need to be imported by clicking "Import DVL Calibration file" when configuring the SPRINT-Nav from default settings. The calibration file is located on the SPRINT software media: SPRINT-Nav sn xxxxxx-xxx Beam Calibration.ccl

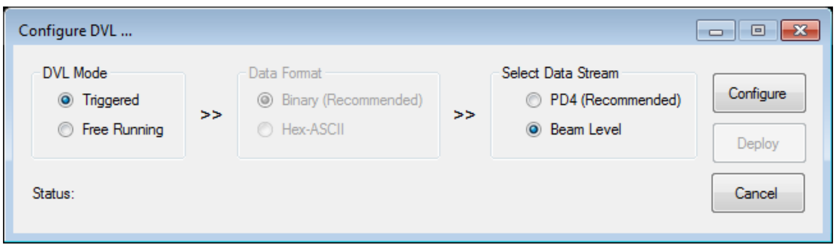
8. The DVL Aiding (Beam) window displays the raw Beam velocities, beam velocity error, vertical ranges and residuals as well as the acoustic signal information from each range (Signal to Noise, Signal level and Cross Correlation) that can be selected on the view menu or by right-clicking on the **DVL Aiding** LED and selecting **View DVL Aiding**.
9. If the Syrinx DVL is configured for PD4 output, the **DVL Aiding (Beam)** window displays the raw DVL velocities, vertical ranges and residuals that can be selected on the view menu or by right-clicking on the **DVL Aiding** LED and selecting **View DVL Aiding** (aidng data can be viewed for all aiding sources except SV).
10. Enter the **Scale Factor** and **Latency** values from the DVL calibration.
11. Enter the **Lever Arms** offsets from the ROV CRP to DVL and the the **Mounting Angles** from the ROV frame to the DVL (after changing the mounting angles or lever arms the INS algorithm will be automatically reset to use the new settings).

Figure 7–25 DVL Aiding



12. The SPRINT system can automatically program it for use with SPRINT. To configure the DVL click the **Auto Configure** button; the DVL configuration dialog box will open; see *Figure 7–26*

Figure 7–26 DVL Auto Configuration



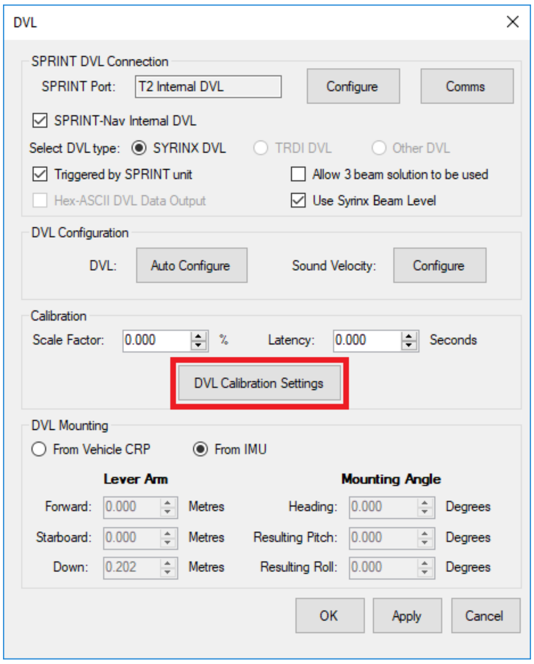
DVL Mode: If the DVL cabling will allow the SPRINT-Nav to send a trigger to the selected DVL , select **Triggered**, otherwise select **Free Running**.

Data Format: The data format output of the DVL will be set to Binary by default. If Hex-ASCII is required, select **Hex-ASCII**.

Select Data Stream: This function sets the data stream message output of the Syrinx DVL (this option is disabled if using a standalone SPRINT with DVL).

13. Click **Configure** to configure the DVL; the software will display the progress of the configuration process.
14. If the DVL is already configured, the **Deploy** button will command the DVL to start making measurements.
15. When the DVL has been configured, return to the **DVL** dialog box.
16. Click **OK** or **Apply** to save the settings.
17. Click **DVL Calibration Settings** to set DVL Alignment and import DVL Calibration file from Janus.

Figure 7–27 DVL Calibration Settings



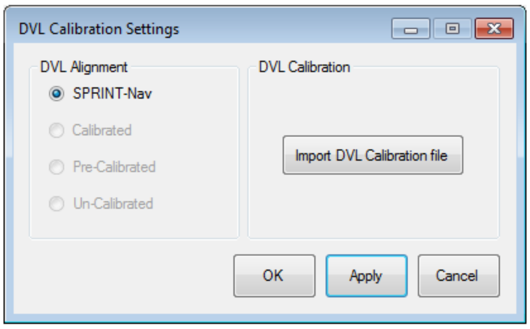
18. The DVL Alignment to vehicle frame quality options are described below.

SPRINT-Nav: This option is automatically selected if connected to a SPRINT-Nav (this option is disabled if using a standalone SPRINT with DVL).

Calibrated: The calibrated alignment option is set as default and must be selected if applying a DVL Calibration by either importing a DVL Calibration file or manual entry.

Pre-Calibrated: This option should only be selected if the SPRINT-Nav is co-located with a DVL and has been pre-calibrated using GPS (RTK) prior to installation on the ROV.

Un-Calibrated: If it is not possible to perform a DVL calibration then this option may be selected to relax the DVL alignment error, reducing INS rejection (the DVL must be aligned within 3° of the vehicle frame).



19. The **DVL Aiding** window displays the raw DVL velocities, vertical ranges and residuals that can be selected on the **View** menu or by right-clicking on the **DVL**Aiding LED and selecting **View DVL Aiding** (aiding data plots can be viewed for all aiding sources except SV).

Figure 7–28 DVL Aiding Plot

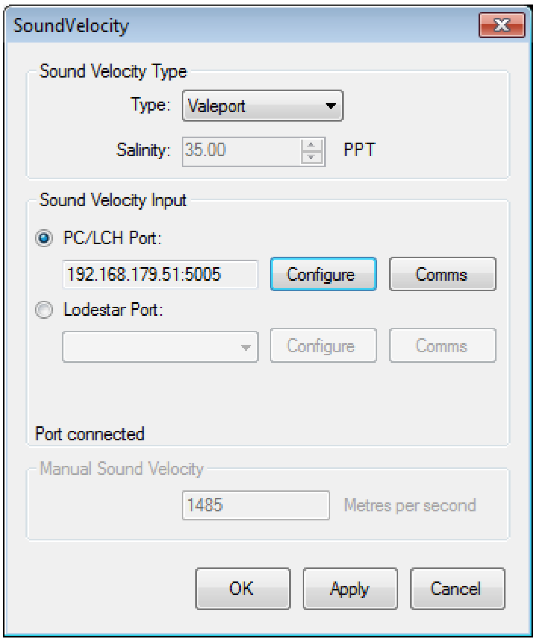
7.4.10 Sound Velocity

To configure the Sound Velocity:

1. Click **Configure > INS > DVL Input**.
2. Click **Sound Velocity** or right-click on the **SV** Aiding LED and then click **Configure**.
3. Select the **Sound Velocity Type** from the options shown below; see *Figure 7–29*.
   - **DVL Derived**: valid for most ocean conditions; with this method the sound velocity is automatically calculated using the salinity value and measurements from other aiding sensors such as DVL (Temperature) and Pressure/Depth (Pressure).
   - Various options for receiving sound velocity measurement messages from a sensor or other sources, such as a **Valeport Mini-SVS**.
   - **Manual Sound Velocity**.

4. If Sound Velocity messages will be received from a sensor or other source, specify and configure either:
   - The SPRINT-Nav port which will receive the Sound Velocity message (on the vehicle).
   - The LCH or PC port which will receive the Sound Velocity message (topside).
5. If **Manual Sound Velocity** is selected, a value can be entered in the **Manual Sound Velocity** box.
6. Click **OK** to close and save all entered settings.

Figure 7–29 Sound Velocity Configuration



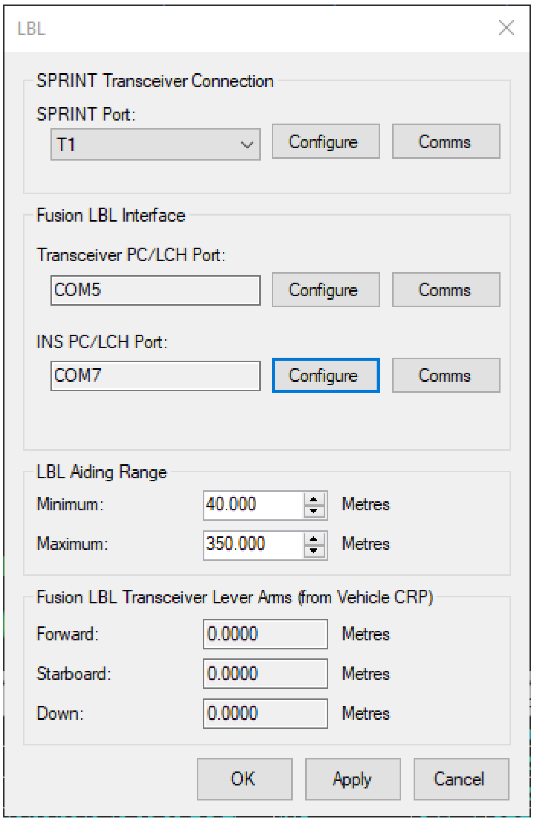
7.4.11 LBL

To configure LBL aiding:

1. Click **Configure > INS > LBL Input** or right-click on the **LBL** Aiding LED.
2. **SPRINT Transceiver Connection**: Select the **SPRINT-Nav Port** that the LBL transceiver is physically connected to (usually T1 for SPRINT-Nav); see *Figure 7–30* and then configure the baud rate as required by clicking **Configure**; see *Figure 7–22*.
3. **Fusion LBL Interface**: Specify the PC port that will be used to provide LBL transceiver communications to the Fusion LBL software.

4. Click **OK** to close and save all entered settings.

Figure 7–30 LBL Aiding Configuration



5. Refer to *Section 7.7 "Fusion LBL Aiding"* to configure Fusion LBL for use with SPRINT.

Note

Depending on the SPRINT version purchased, LBL aiding may not be available.

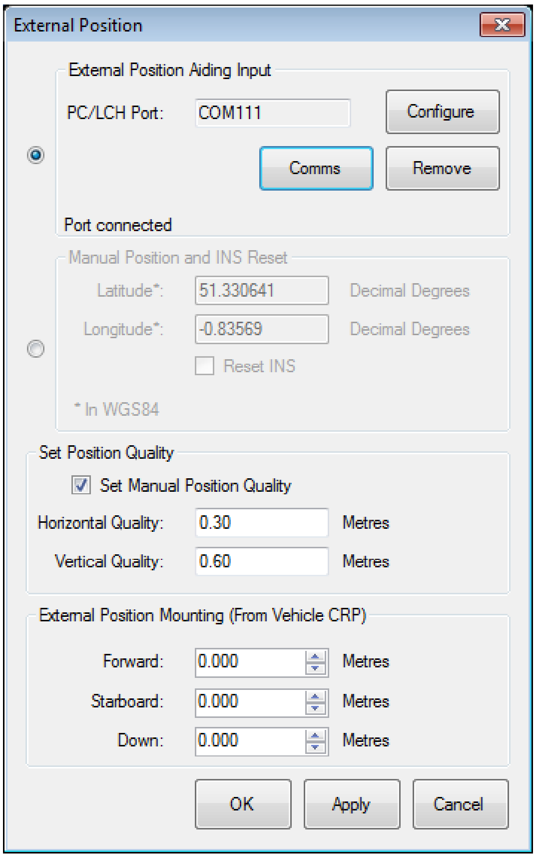
7.4.12 External Position Aiding

To configure External Position Aiding:

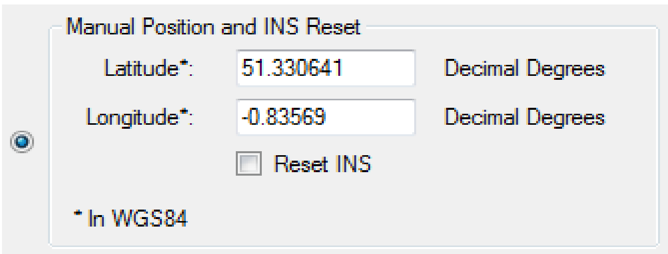
1. Click **Configure > INS > External Position Input** or right-click on the **Ext Pos** Aiding LED and select **Enable**; see *Section C.15 "Proprietary XPOS Report"*for External position (XPOS) message format.

2. To configure External Position as an aiding source, select the **External Position Aiding Input**.

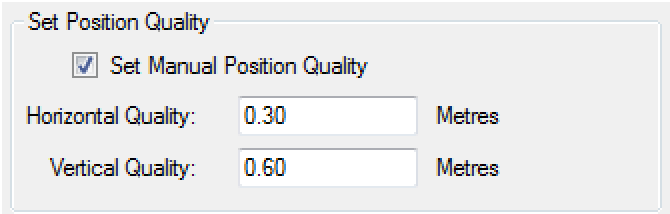
Figure 7–31 External Position Aiding Configuration



3. Click **Configure** and select **PC Serial** or **Ethernet/LCH**. If using an **Ethernet/LCH** port, enter the IP Address for the serial input and socket (**192.168.179.51:5004**) by clicking **Configure**, as shown in *Figure 7–18*.
4. To send a manual External Position, select **Manual Position**, enter the Latitude and Longitude and then click **Apply** or **OK**. Manual Position aiding will be used by the INS without restarting the INS unless the 'Reset INS check box' is selected.



5. External Position Quality settings can be configured on the **Set Position Quality** pane. Manual Horizontal and Vertical Position Qualities are set as default. Clear the **Set Manual Position Quality** check box to use the default values. See *Section C.15 "Proprietary XPOS Report"*for External position (XPOS) message format.

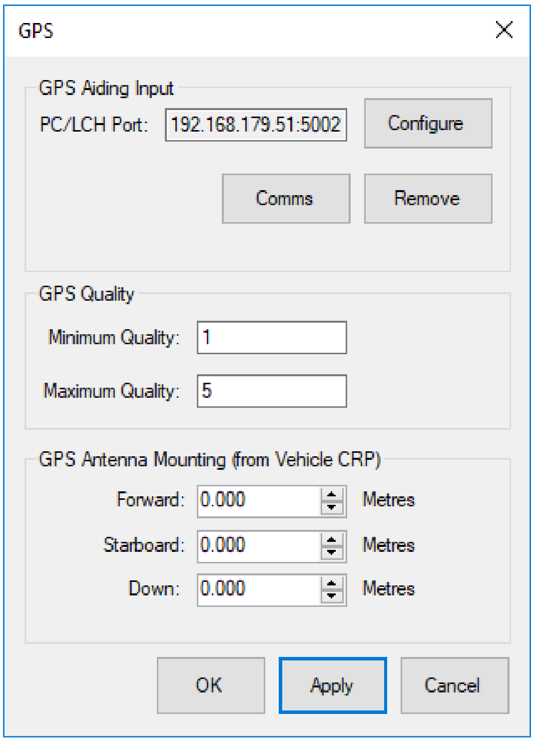


6. Click **OK** to close and save all entered settings.

7.4.13 GPS Aiding

To configure GPS aiding:

1. Click **Configure > INS > GPS Input** or right-click on the **GPS** aiding LED.
2. Click **Configure** to set up the aiding input Ethernet/comms port.
   a. Ethernet/LCH port:
      i. Select **Ethernet/LCH** and enter the IP address for the serial input via the LCH (**192.168.179.51:5002**).
      ii. Click **OK**.
   b. Serial port:
      i. Select **PC Serial** and select the comm port and baud rate.
      ii. Click **OK**.



3. The quality of GPS Aiding can be rejected/accepted by selecting **Minimum Quality** and **Maximum Quality**.

Note

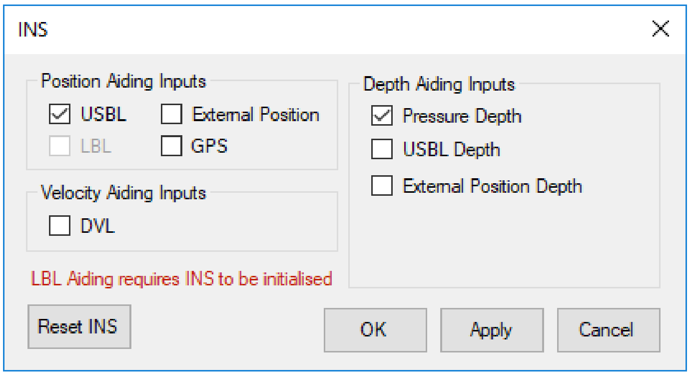
If enabling GPS on deck to compensate AHRS, ensure GPS aiding is disabled and USBL aiding is enabled prior to vehicle deployment.

7.4.14 INS

To configure the INS:

1. Click **Configure > INS**.

Figure 7–32 INS Configuration



2. Select the INS Aiding Inputs; **USBL**, **Pressure Depth** and **DVL** are selected by default.

Note

The INS can be reset at any time by clicking Reset INS.

---

3. Click **OK** to close and save all entered settings.

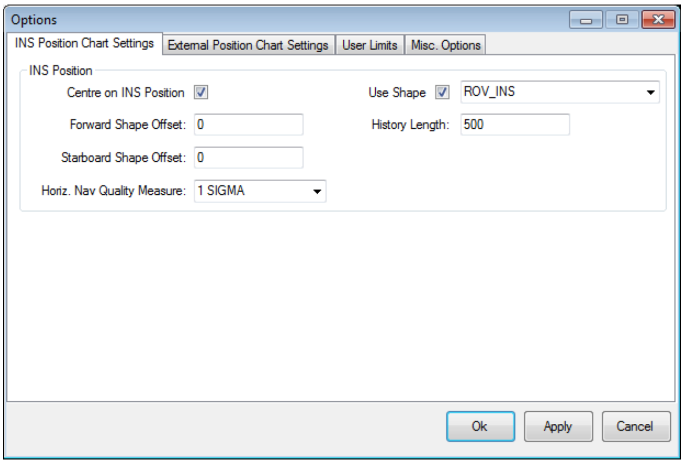
7.4.15 Options

To configure software options proceed as follows:

1. Click **Configure > Options**.

2. Click the **INS Position Chart Settings** tab to configure preferences for the software INS chart display.

Figure 7–33 INS Position Chart Settings

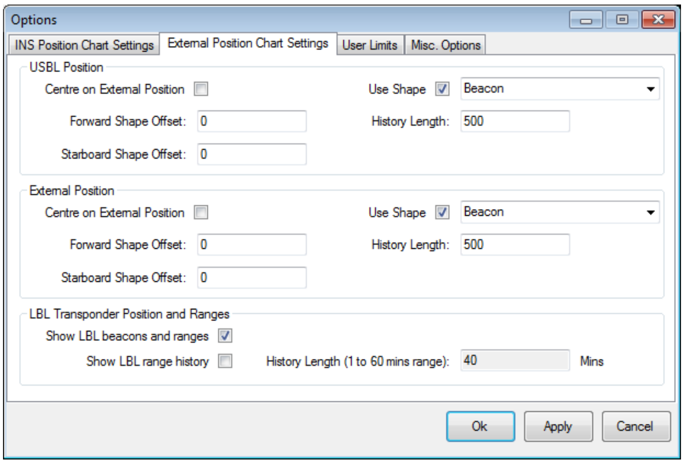


3. Click the **External Position Chart Settings** tab to configure preferences for the software external chart display. If using Windows® 7, double click on either the USBL, INS or Transponder chart shapes to centre on the main chart.

Note

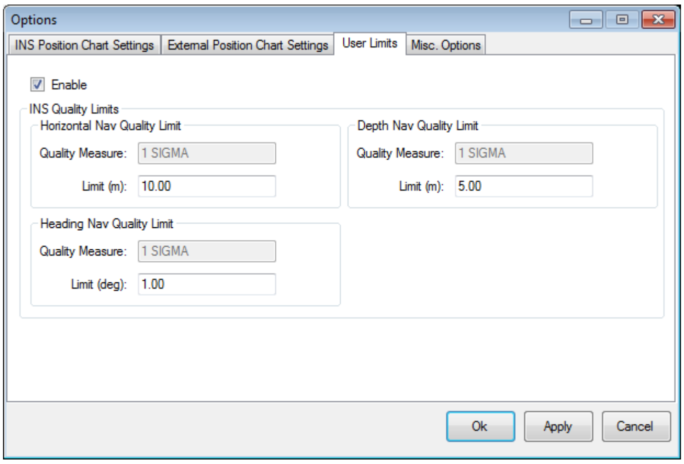
Show LBL range history can only be enabled if using Windows® 7.

Figure 7–34 External Position Chart Settings



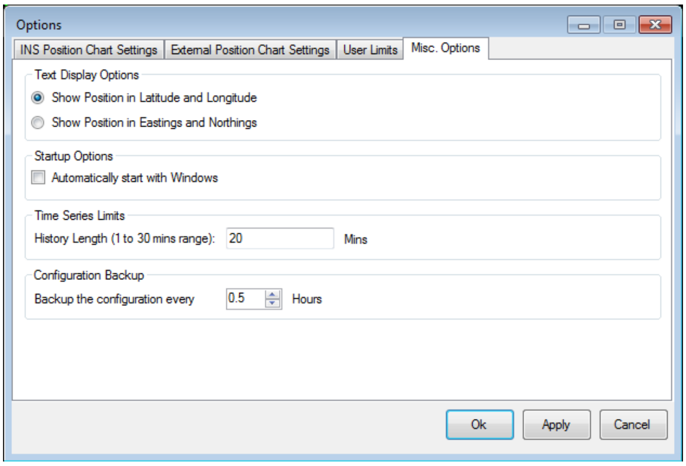
4. Click the **User Limits** tab to configure navigation horizontal and depth quality limits (if the limits are enabled the software will alert the user if the limits are exceeded; see *Section 7.10.7 "Navigation Quality Limits"* for more details).

Figure 7–35 User Limits



5. Click the **Misc. Options** tab to configure the position text type and history length of the time series plots (it is recommended to select the **Automatically Start with Windows** option).

Figure 7–36 Misc. Options



6. Click **OK** to close and save all entered settings.

Note

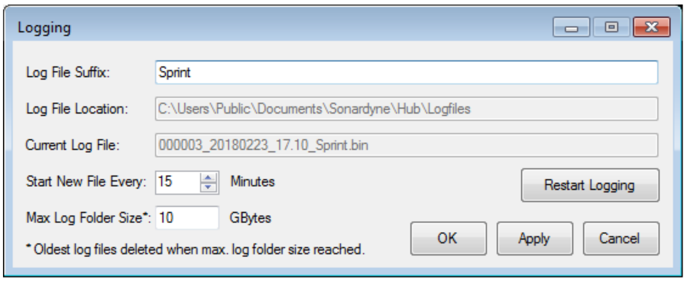
The Show LBL beacons and range history option within the External Position Chart Settings tab can only be enabled when using Windows® 7.

7.4.16 Logging

To configure the Logging process:

1. Click **Configure > Logging**.

Figure 7–37 Logging Configuration



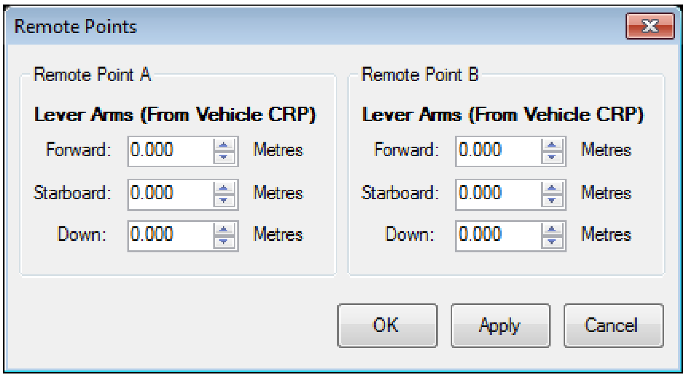
2. Default settings for logging are already defined but may be changed as required.
3. Click **Restart Logging** to close the current log file and open a new one.

7.4.17 Remote Output Points

To configure the Remote Output Points:

1. Click **Configure > Outputs > Remote Points**.

Figure 7–38 Remote Output Points Configuration



2. The system can support navigation and attitude outputs with respect to two remote points on the vehicle.

Note

By default all outputs will be with respect to the CRP of the vehicle.

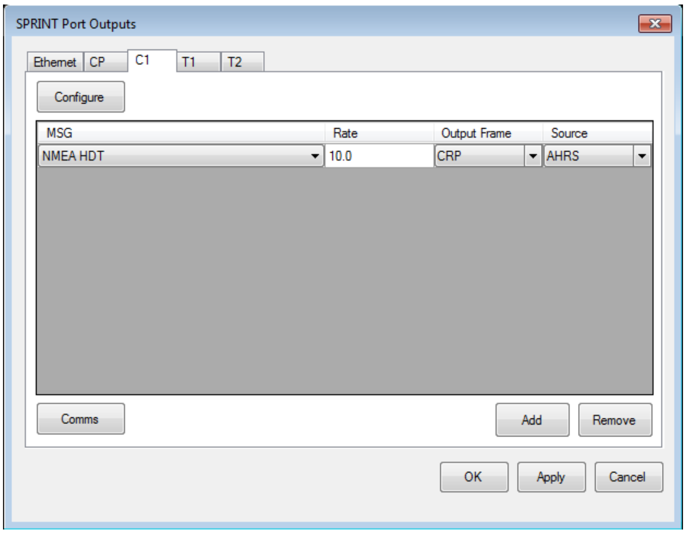
3. Enter any lever arms for the remote points from the CRP to the remote point specified.
4. Click **OK** to close and save all entered settings.

7.4.18 SPRINT-NavOutput

To configure outputs from the SPRINT-Nav ports:

1. Click **Configure > Outputs > SPRINT > Port Outputs**. SPRINT ports that are not currently in use (connected to the topside system or to an ROV sensor) will be available to configure as an output.

Figure 7–39 SPRINT system Output Configuration



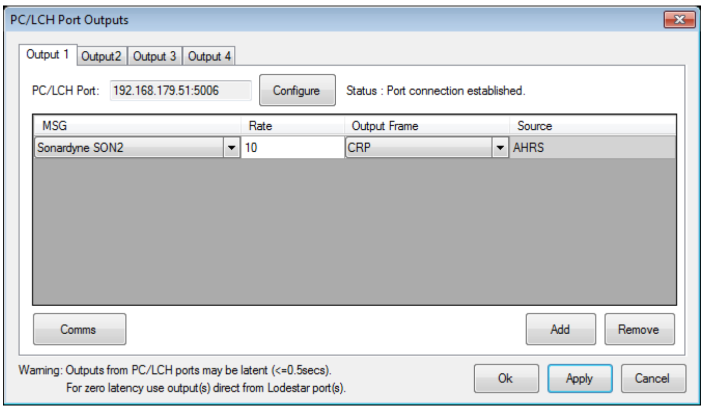
2. Click the tab for the required port to configure.
3. Select the message type, output rate and if a remote output point is to be used (the default output will be with respect to the vehicle CRP). For some outputs (such as a raw sensor feed) an output rate cannot be specified as this is defined by the sensor itself.
4. Click **Apply** to configure the output.
5. If further outputs are required, click **Add** and repeat the configuration steps outlined above.
6. After configuration, click **OK** to close and save all entered settings.

7.4.19 PC Port Outputs

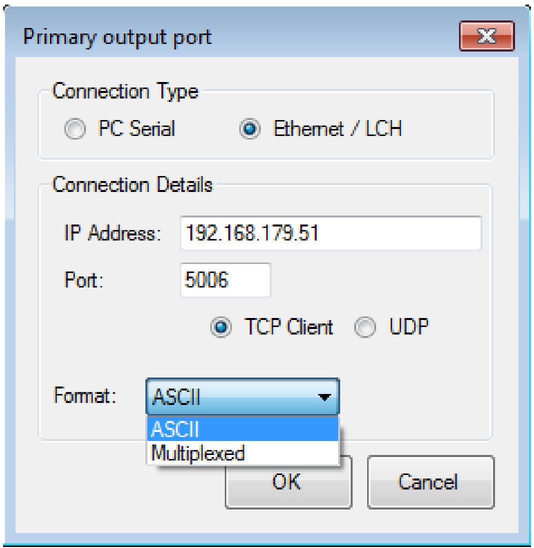
The system supports two local output ports (primary and secondary). To configure outputs from the local PC or LCH ports:

1. Click **Configure > Outputs > PCA CH Port Outputs**.

Figure 7–40 PC Output Configuration



2. Click the tab for the required port to configure.
3. Configure the **PC/LCH Port**; enter the IP Address for the serial input via the LCH by clicking **Configure** (as shown in *Figure 7–18*).
4. Output ports can be configured for multiplexed messages as shown below.



5. Select the message type, output rate and if a remote output point is to be used (the default output will be with respect to the vehicle CRP). For some outputs (such as a raw sensor feed) an output rate cannot be specified as this is defined by the sensor itself.
6. Click **Apply** to configure the output.
7. If further outputs are required, click **Add** and repeat the configuration steps outlined above.
8. Click **OK** to close and save all entered settings.

Note
The Data Rate and Output Frame cannot be changed when selecting DVL, SVS and any Depth messages.

7.4.20 View Lever Arms

To view a 3D representation of the configured sensor offsets:

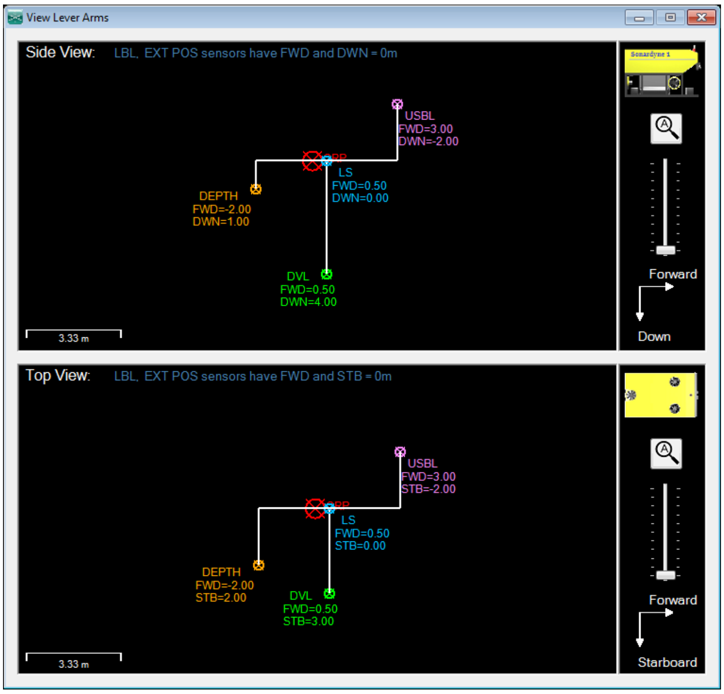
1. Click **View > Lever Arms**.
2. Side and top views of all offsets are displayed as shown below.

3. Check that all offsets are correct and no errors are present.

Note

Scale is dependent on the level of zoom applied.

Figure 7–41 View Lever Arms

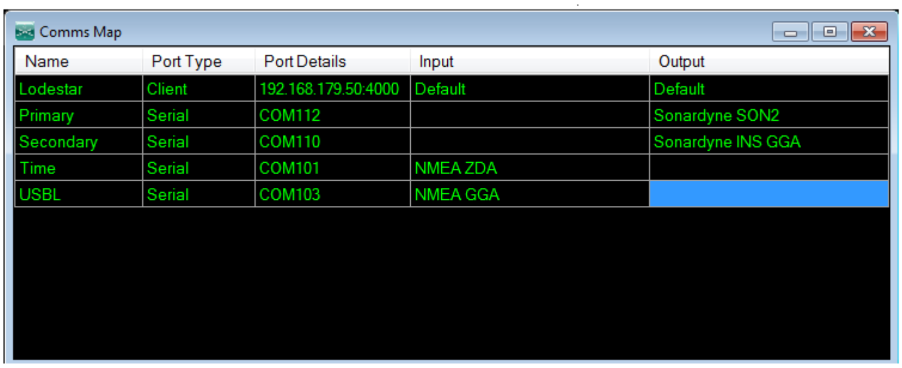


7.4.21 View Comms Map

To view the SPRINT topside comms configuration, proceed as follows:

1. Click **View > Comms Map**.

Figure 7–42 View Comms Map



Comms Map

Name	Port Type	Port Details	Input	Output
Lodestar	Client	192.168.179.50:4000	Default	Default
Primary	Serial	COM112		Sonardyne SON2
Secondary	Serial	COM110		Sonardyne INS GGA
Time	Serial	COM101	NMEA ZDA	
USBL	Serial	COM103	NMEA GGA	

7.4.22 Main SPRINT System Software Window

To configure outputs from the local PC or LCH ports:

1. Click the **Zoom All** button to auto zoom the chart on the main software window to keep all chart shapes visible at all times.

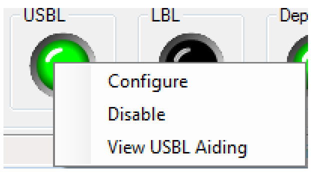
2. Click the **Zoom In** button to zoom in the chart display.

3. Click the **Zoom Out** button to zoom out the chart display.

4. Click the **Erase History** button to erase any position history trails on the chart display.

5. Click the **INS reset** button to reset the INS.

6. All aiding inputs can be enabled/disabled for INS use or configured by right-clicking on the appropriate aiding input LED and selecting the required option.



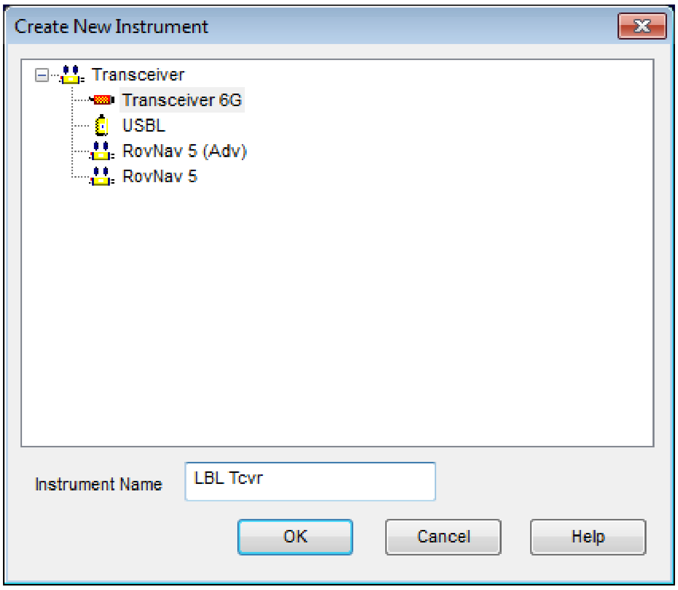
7.4.23 Fusion LBL Aiding

To interface Fusion LBL to SPRINT system for aiding, follow the steps below (for further information on operation of Fusion, see *UM-8025 "User Manual for Fusion LBL"*).

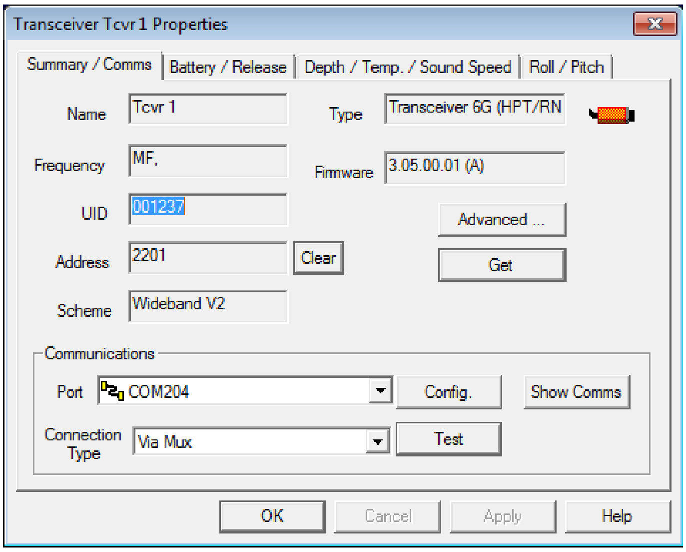
This procedure assumes the following connections have already been configured:

- A SPRINT-Nav is running and connected to the SPRINT system software.
- LBL Transceiver is physically connected to SPRINT-Nav T1 port and is powered.
- The Fusion LBL interface ports have been configured in SPRINT (see *Section 7.4.2 "SPRINT System Connection"*
  - Transceiver PC Port
  - INS PC Port

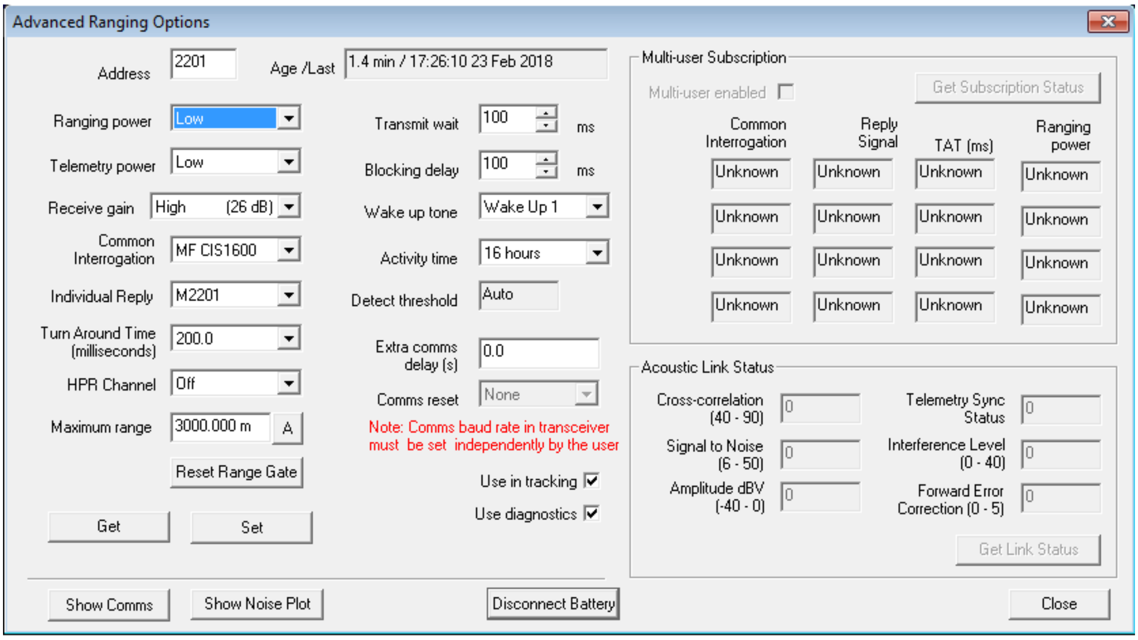
1. Open Fusion LBL and add an LBL Transceiver from the acoustic instruments group on the job tree.



2. After adding an LBL transceiver, specify the PC COM port configured in SPRINT.
3. On the LBL Transceiver properties window, click **Advanced** to open the advanced transceiver options window.



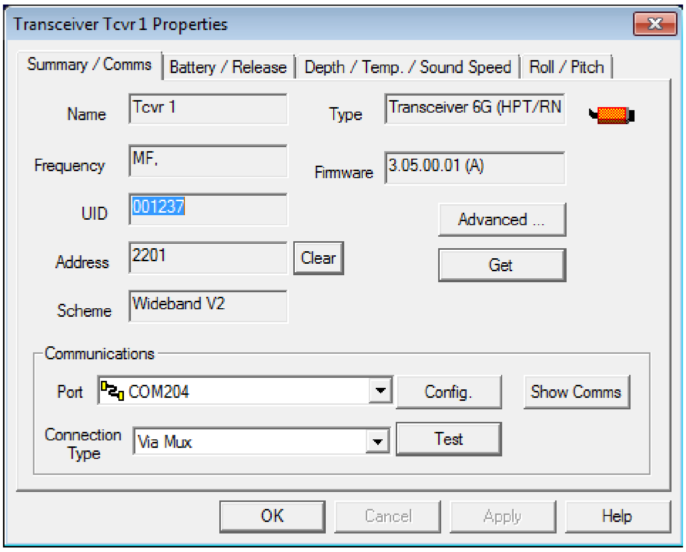
4. On the **Comms reset** drop-down list, select **None** and then click **Close**.



Note

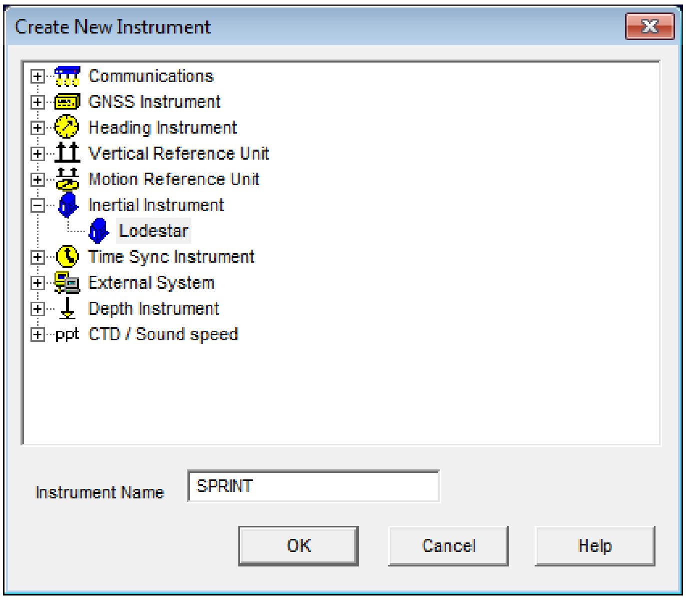
In later versions of Fusion, the baud rate of the transceiver may be automatically changed when it is added. In this case the baud rate of the transceiver must be manually changed in the SPRINT system to match Fusion and the new baud rate of the Transceiver.

5. On the Transceiver LBL Tcvr Properties **Summary/Comms** tab, click **Test** to check connection and communications to the Transceiver.
6. Once connection is established the Fusion software will confirm that the instrument is working.

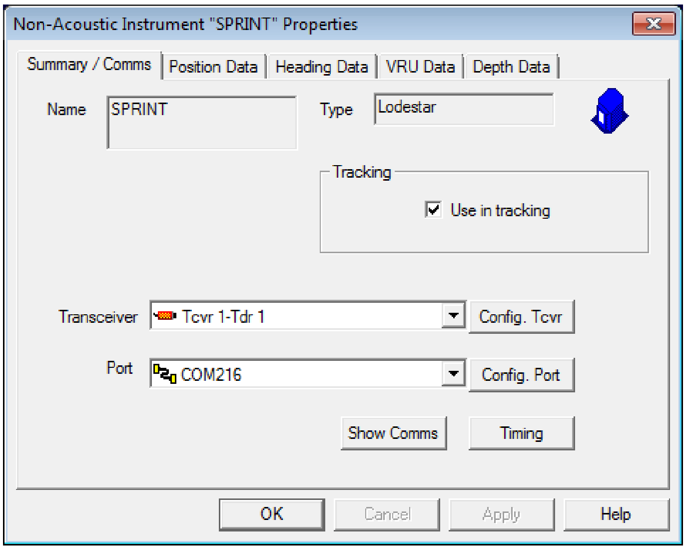


7. Click **OK** to close the Transceiver LBL Tcvr Properties page.

8. Add a SPRINT-Nav from the non-acoustic INS instruments group on the job tree:

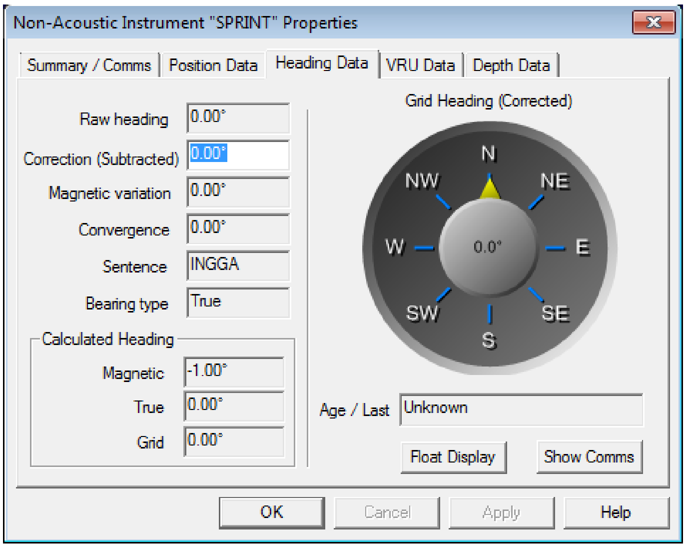


9. After adding the SPRINT-Nav, specify the PC COM port that has been configured in the SPRINT system.



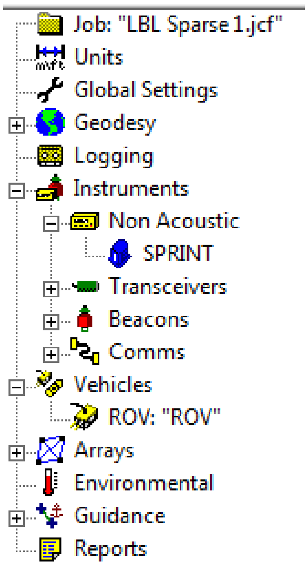
10. The PC port may be a physical COM port of a virtual serial port pair if Fusion is running on the same PC as the SPRINT system.
11. Select the transceiver connected to the SPRINT-Nav from the **Transceiver** drop-down list.

12. To check the SPRINT-Nav's output to Fusion, select either the **Heading**, **VRU**, **Depth** or **Position** tabs (the data displayed will be sourced from the SPRINT-Nav).



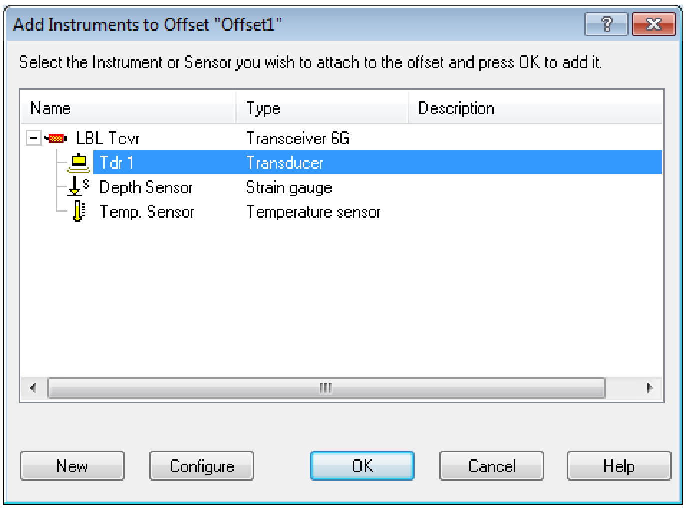
13. Click **OK** to close and save entered settings.

14. After adding the INS (SPRINT-Nav) and Transceiver, they should be listed on the Fusion LBL Job Tree.

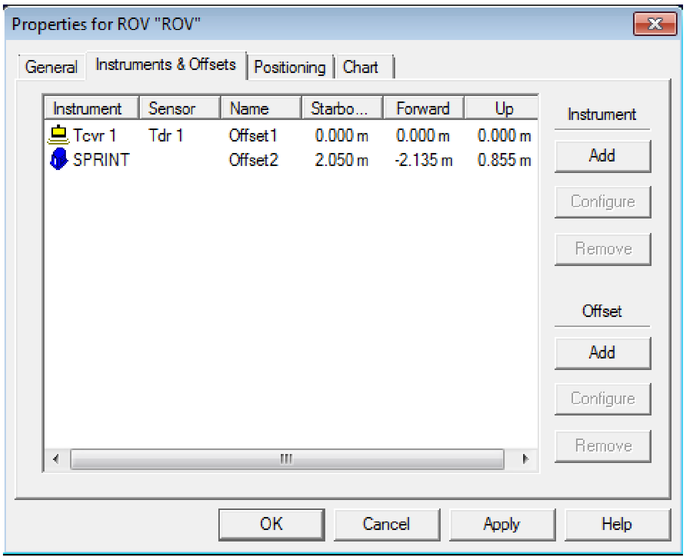


15. The instruments must now be added to an ROV. Select the ROV from the job tree and then open the **Instruments** tab on the ROV properties dialog box.

16. Add the INS and the appropriate Transducer by clicking the **Add** button and selecting from the list of available instruments.



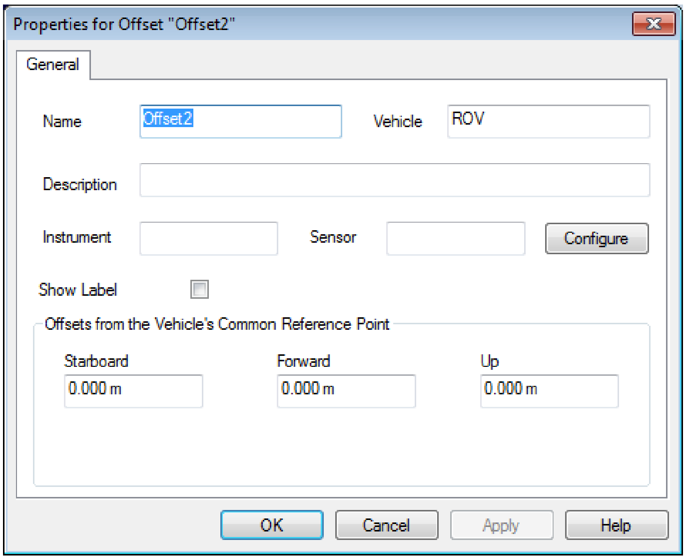
17. After adding each instrument, click **Configure** on the **Offset** pane and enter the instrument offsets.



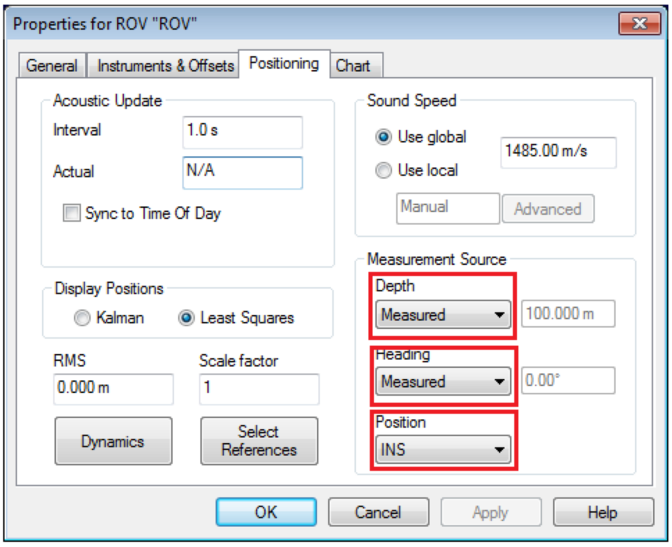
18. Enter the offsets for both instruments with respect to the vehicle CRP.

Note

The convention for the instruments may differ from the SPRINT system. These values only require entry at this point as they will automatically be sent to the SPRINT system.

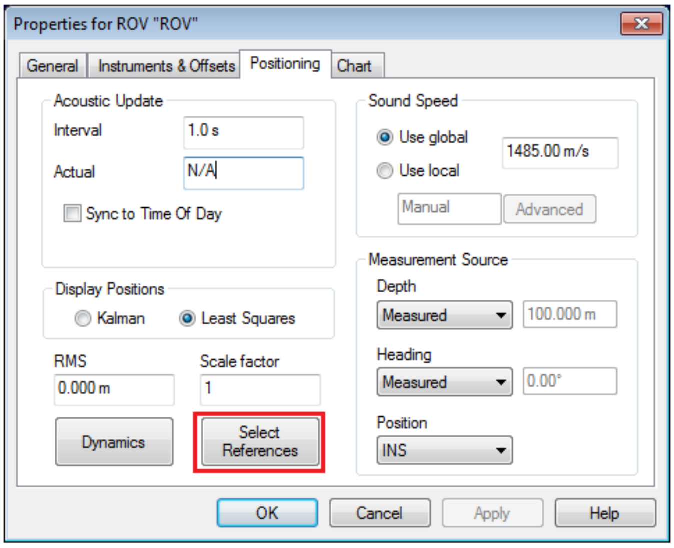


19. Click **OK** to close and save all entered settings.
20. On the **Properties for ROV** window, click the **Positioning** tab:



21. To use the depth output from the SPRINT system, select **Measured** as the **Depth** measurement source.
22. To use the heading output from the SPRINT system, select **Measured** as the **Heading** measurement source.
23. To use the INS position output from the SPRINT system, select **INS** as the **Position** measurement source. Alternatively, for LBL acoustic solution, select **Acoustic** as the **Position** measurement source.

24. To specify the reference beacons for this ROV, click **Select References**.



Note

Not all reference beacons specified need to be used for INS LBL aiding but must be specified if the SPRINT system is to record the observations for other purposes, such as post processing in Janus.

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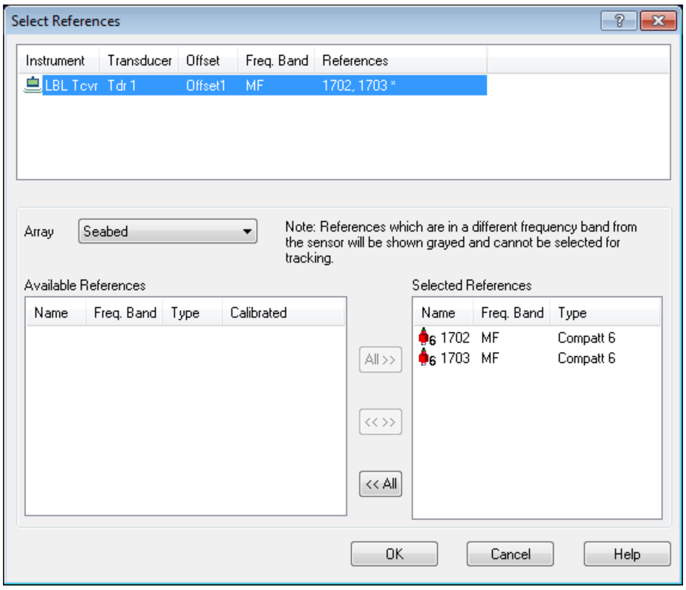
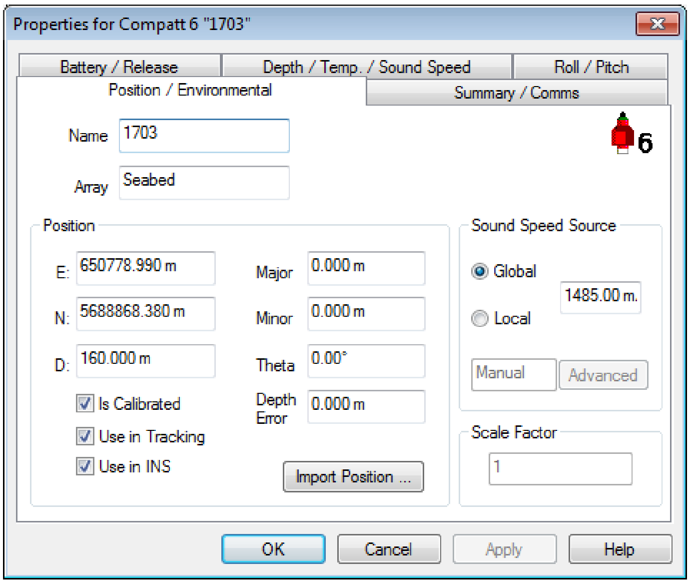
25. After adding the references, click **OK** to close the **Select References** window.

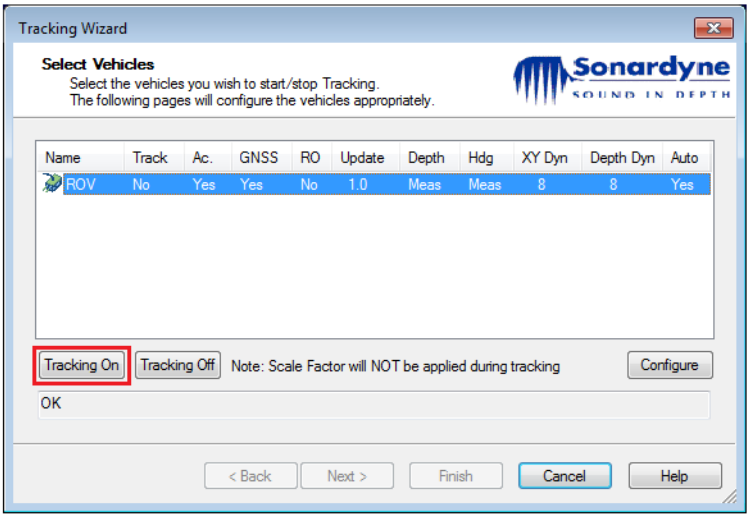


26. Click **OK** to close the **Properties for ROV** window. By default, all reference beacons added as references will be used for INS aiding.

27. To disable a beacon for INS aiding but to still record LBL data in the SPRINT system (for use offline) open the properties page for the Compatt and deselect Use in INS.

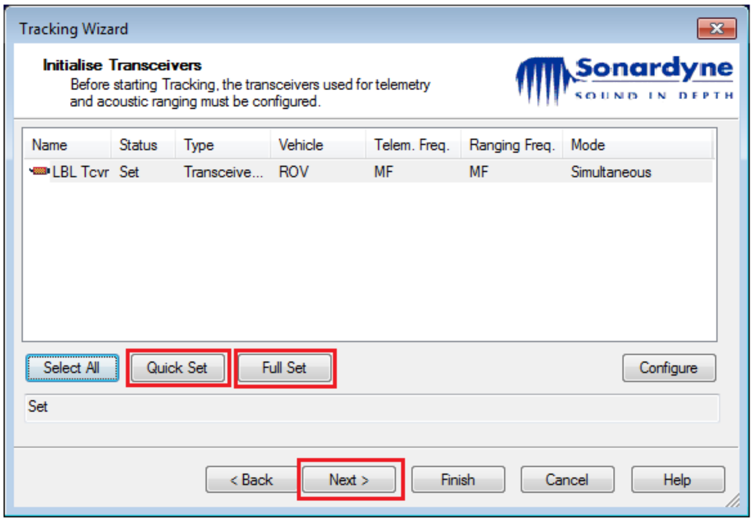


28. The ROV can now be tracked using INS with LBL aiding; click the green **Go** button to start the tracking wizard.
29. Select the correct ROV for tracking and then click **Tracking On**.
30. Click **Next**.

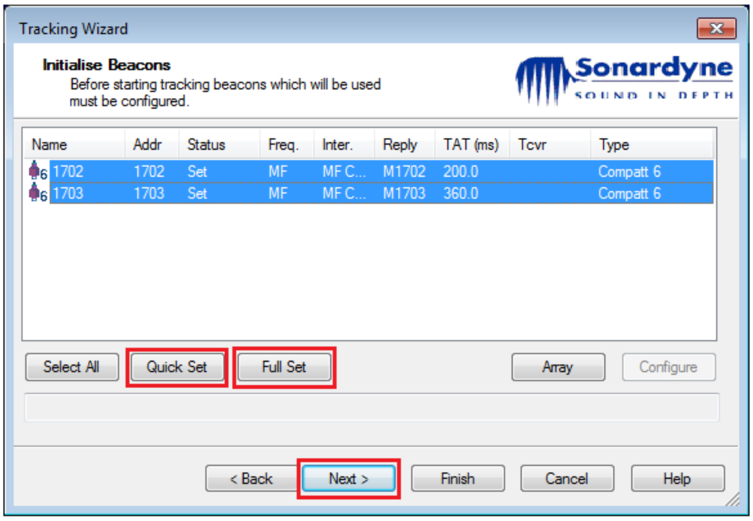


31. If prompted, the transceiver may need to be set by clicking either the **Quick Set** or **Full Set** button.

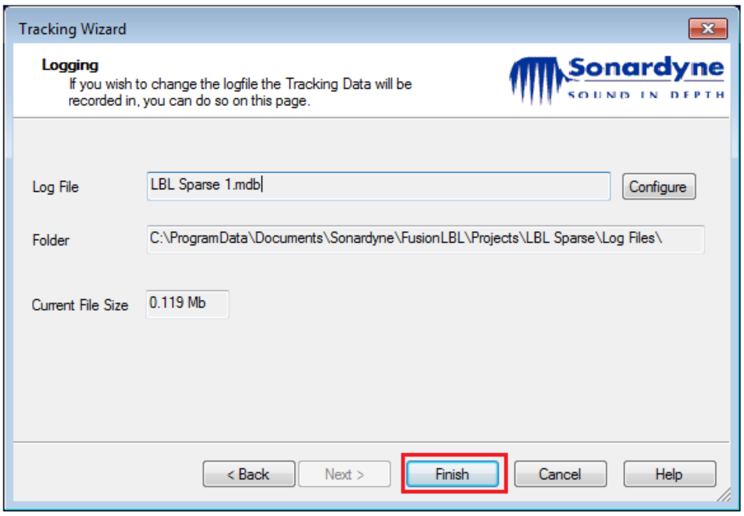
32. Click **Next**.



33. If prompted, the beacons may need to be set using either the **Quick Set** or **Full Set** button:
34. Click **Next**.



35. Click **Finish** to start tracking and configure any specific Fusion log files.



7.4.24 Marksman & Ranger 2 USBL Aiding

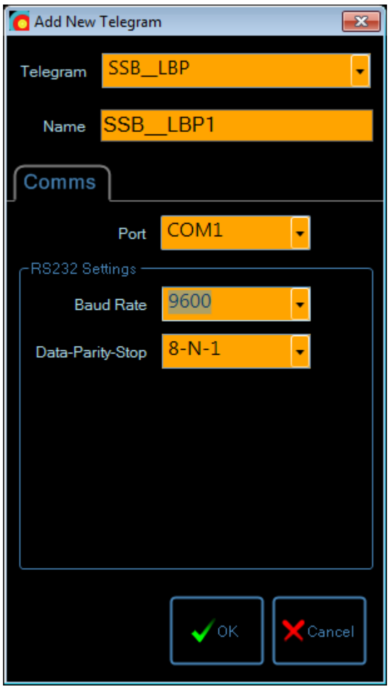
This procedure assumes the USBL system has already been configured as follows:

- Calibrated and compensated for vessel movement with a high grade MRU/AHRS.
- UTC time synchronised.
- Is using GPS (WGS84) to provide absolute positions.
- Using correct sound velocity.
- Is configured to track the ROV USBL beacon as a mobile beacon.

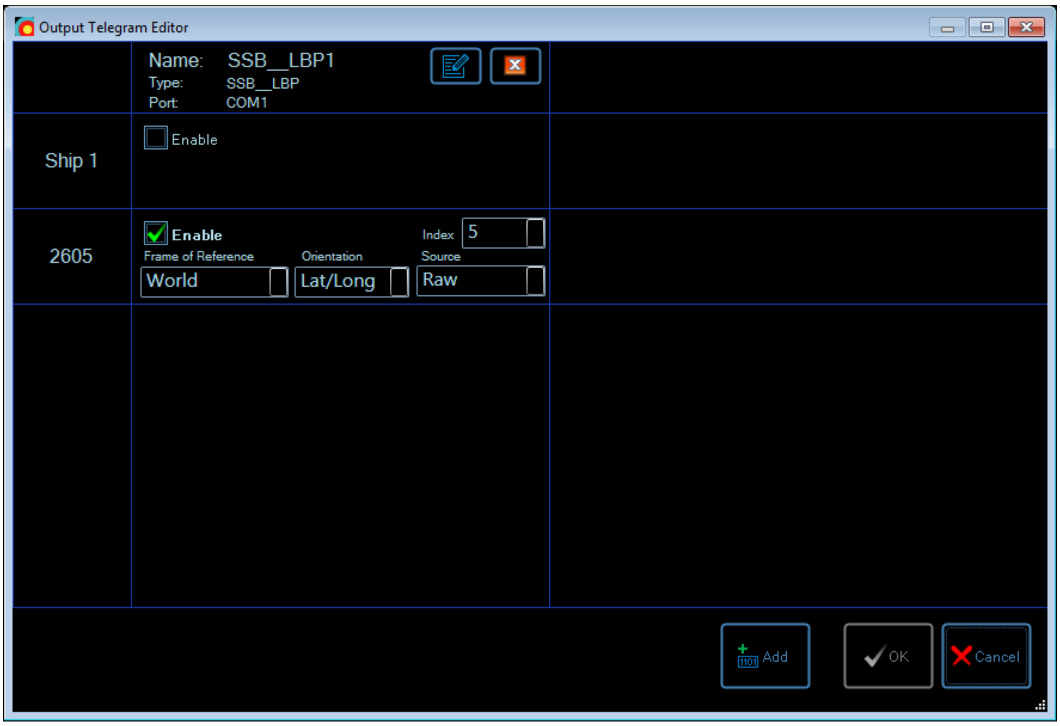
To interface Marksman or Ranger 2 USBL to the SPRINT system for aiding:

1. Add a new SSB telegram output.

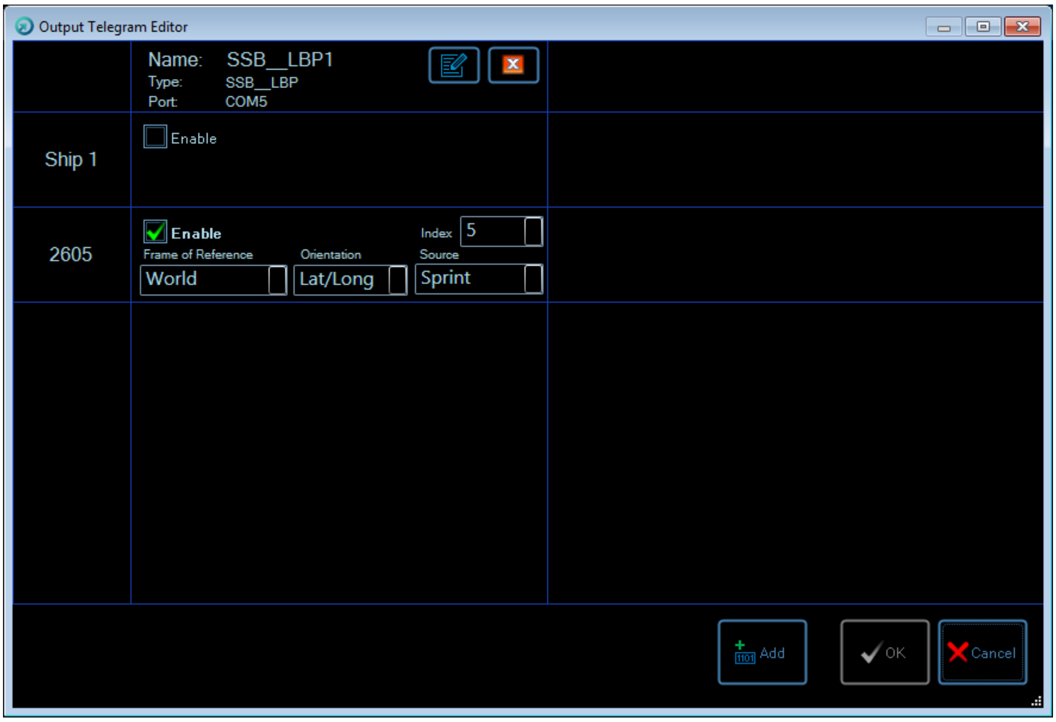
2. Select **9600** as the baud rate and select an appropriate port to output the message to the SPRINT system.



3. Specify the following telegram options.
   - Frame of Reference: select **World**
   - Orientation: select **Lat/Long**
   - Source: select **Raw**



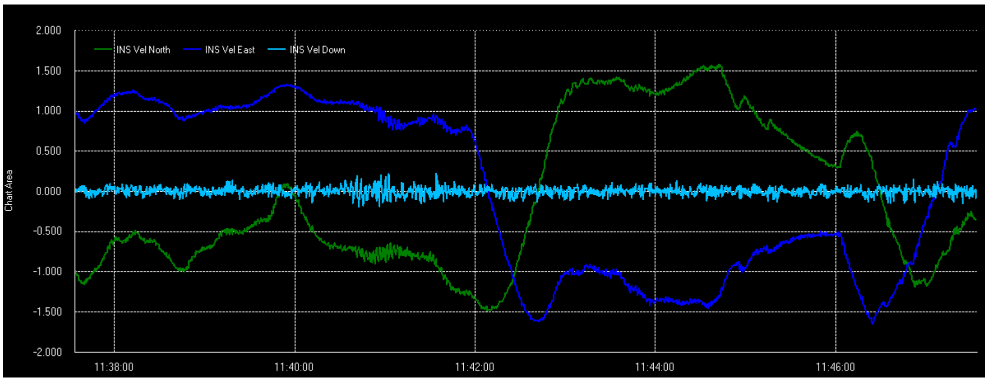
4. If using Marksman/Ranger 2 V4.06.01 or later. set the following telegram options:
   - Frame of Reference: select **World**
   - Orientation: select **Lat/Long**
   - Source: select **Sprint**



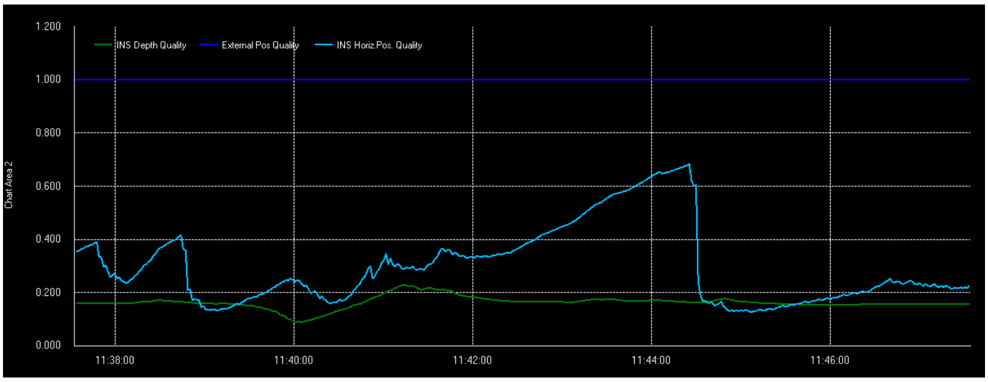
7.4.25 Time Series Plots

Navigation and quality data displayed on the user interface can be graphically displayed on a chart as Time Series Plots. Examples of plotted charts are shown below.

This time series plot shows INS Velocities North/East/Down.



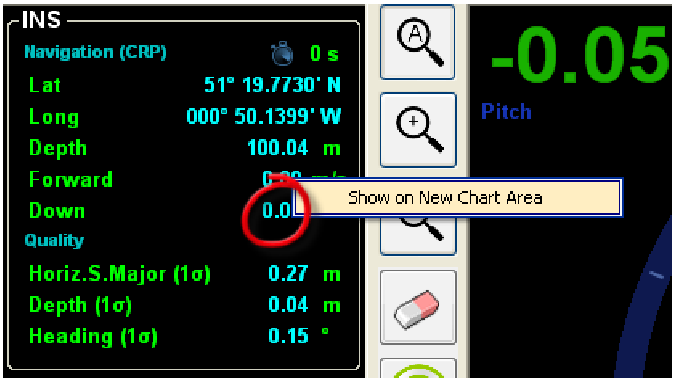
This time series plot shows INS Depth, External position and INS horizontal position qualities.



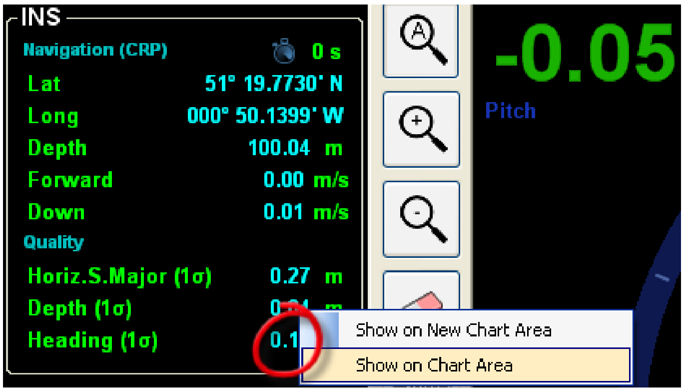
7.4.25.1 Displaying Plots

The following steps describe how to display data as single and multiple plots.

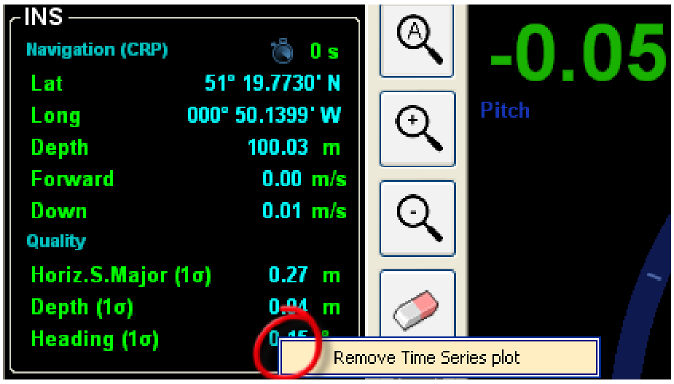
1. To display navigation measurements (apart from Lat and Long), quality and INS statistics, right-click a value on the navigation text panel and select **Show on New Chart Area**.



2. To display additional plots on the same chart, right-click a value on the navigation text panel and select **Show on Chart Area**.



3. To remove data from a chart, right-click the value on the navigation text panel and select **Remove Time Series Plot**.



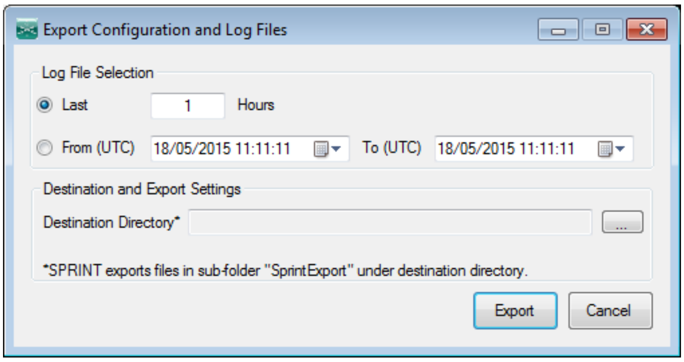
Note

There is a limitation of three sensor inputs per plot and a maximum of four Time Series Plots displayed simultaneously, plus the LBL Aiding Plot.

7.4.26 Exporting Configuration and Log Files

To export system configuration and log files:

1. Click **File > Export Configuration**.



2. Specify either the **Last** number of hours to export or a date/time range.
3. Specify a destination directory for the exported file.
4. Click **Export** to create the export file.

7.5 Configuration Check List

Use the summary list below to assist in the system configuration, prior to operation:

No	Action	Manual Section	Checked (Sign and Date)
1	Configure the LCH	*Section 7.3*	
2	Check Dongle is Valid	*Section 7.4*	
3	Configure the SPRINT-Nav Connection	*Section 7.4.2*	
4	Configure SPRINT-Nav	*Section 7.4.3*	

No	Action	Manual Section	Checked (Sign and Date)
5	Configure Time Synchronisation	*Section 7.4.6*	
6	Configure USBL Aiding	*Section 7.4.7*	
7	Configure Depth Aiding	*Section 7.4.8*	
8	Configure DVL Aiding	*Section 7.4.9*	
9	Configure Sound Velocity	*Section 7.4.10*	
10	Configure LBL Aiding	*Section 7.4.11*	
11	Configure External Position Aiding	*Section 7.4.12*	
12	Configure GPS Aiding	*Section 7.4.13*	
13	Configure INS Aiding	*Section 7.4.14*	
14	Configure Options	*Section 7.4.15*	
15	Configure Logging	*Section 7.4.16*	
16	Configure Outputs	*Section 7.4.17* *Section 7.4.18* *Section 7.4.19*	

Note

See *Appendix J "SPRINT-Nav Installation and Setup Check List"* for a full step-by-step installation and setup check list that can be printed and used as a hard copy reference.

7.6 INS

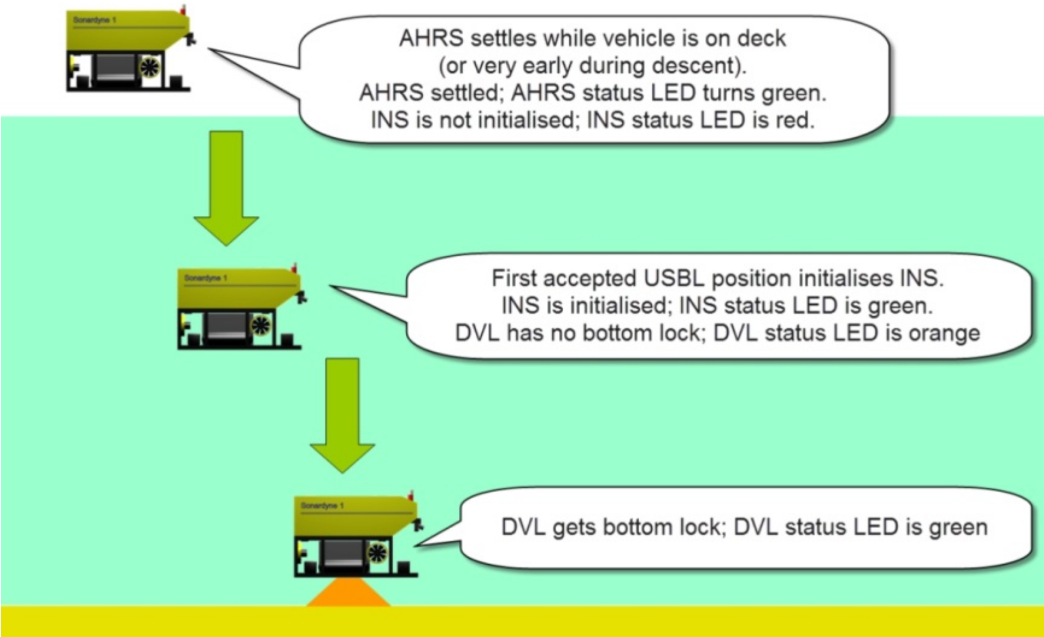
7.6.1 Initialisation

To initialise the INS:

1. The AHRS algorithm should be settled. This will take 10 minutes from the SPRINT-Nav start-up in the default SPRINT system configuration. The ROV can be moving. On the main software window the AHRS status LED will be green when the AHRS is settled; see *Section 7.10.2 "System and Aiding Status"*.
2. The SPRINT-Nav should be time synchronised. On the main software window the Time Synch status LED will be green when the SPRINT-Nav is Time Synchronised; see *Section 7.10.2 "System and Aiding Status"*.
3. A starting position for the INS algorithm. In normal operation this will be provided by the first accepted USBL position for the vehicle during descent.

Figure 1–42 shows a typical descent and INS initialisation sequence.

Figure 7–43 Descent and INS Initialisation Sequence

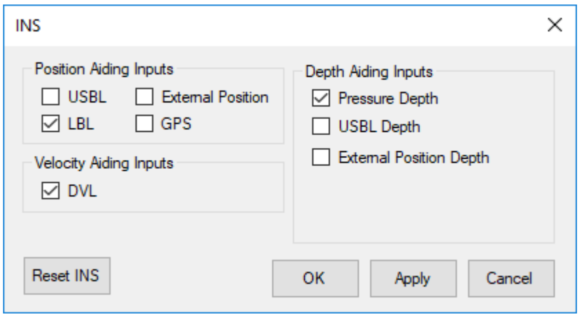


7.7 Fusion LBL Aiding

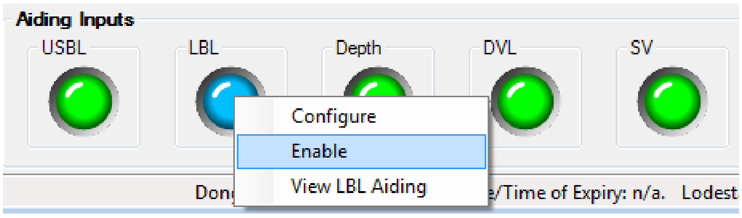
7.7.1 Transition from USBL to LBL aided INS

To transition from USBL aided INS to LBL :

1. Make sure the SPRINT system has good USBL and DVL aiding (e.g. bottom lock). The ROV should continue with some dynamics during the following steps.
2. Check Fusion is tracking and that ranges are being received on the Fusion measurements panel.
3. Select the **DVL** and **LBL** check boxes.



4. LBL aiding can also be selected by right-clicking on the **LBL** Aiding LED.



5. LBL aiding can then be monitored in operation as described in *Section 7.10.5 "INS with Fusion LBL Aiding"*.

7.8 Zero Velocity (ZUPT) Aiding

7.8.1 Features and Operational Guidelines

Zero velocity aiding feeds ‘zero’ velocities in to the INS (with an amount of error) to help the INS estimate sensor bias errors when a vehicle is not moving. It can be used to:

- Stop INS position drift if DVL, USBL or LBL aiding is lost
- Provide better static fix results if aiding data is poor (e.g. USBL)

Rules for Zero Velocity (ZUPT) Aiding:

- Must ONLY be used when the ROV is truly static
- Must NEVER be used when the ROV is moving
- Switching between USBL and LBL aiding must NOT be carried out when the INS is ZUPT aided as it will not be allowed to move between the two positioning sources.

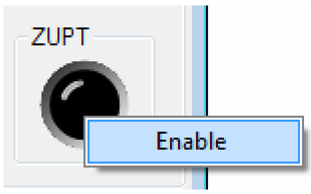
Note

If Zero Velocity (ZUPT) aiding is used when the vehicle is moving the INS integrity and performance could be affected.

7.8.2 Enabling Zero Velocity (ZUPT) aiding

Zero Velocity Aiding can be enabled by clicking the **ZUPT** button on the main SPRINT window, see *Figure 7–44*. It can disabled by pressing the **ZUPT** button again. When active the INS status on the navigation chart will display **Navigating (ZERO VELOCITY)**.

Figure 7–44 Enabling ‘ZUPT’ Aiding



7.8.3 Static Fixes with Zero Velocity (ZUPT) Aiding

Follow the steps below if **Zero Velocity Aiding (ZUPT)** is to be used while taking a static fix.

1. The SPRINT system should be ‘healthy’ with green LEDs before taking a static ZUPT fix.
2. Manoeuvre the vehicle in to position for the static fix.
3. Once the vehicle is static enable ZUPT mode.
4. Record the static fix using 3rd party software.
5. Turn off ZUPT mode.
6. The vehicle can now move away from the static fix position.

Note

ZUPT aiding may not be available depending on the SPRINT system version purchased.

7.9 Pre-Dive Check List

Use the list below to assist in making sure the SPRINT system is ready before a dive.

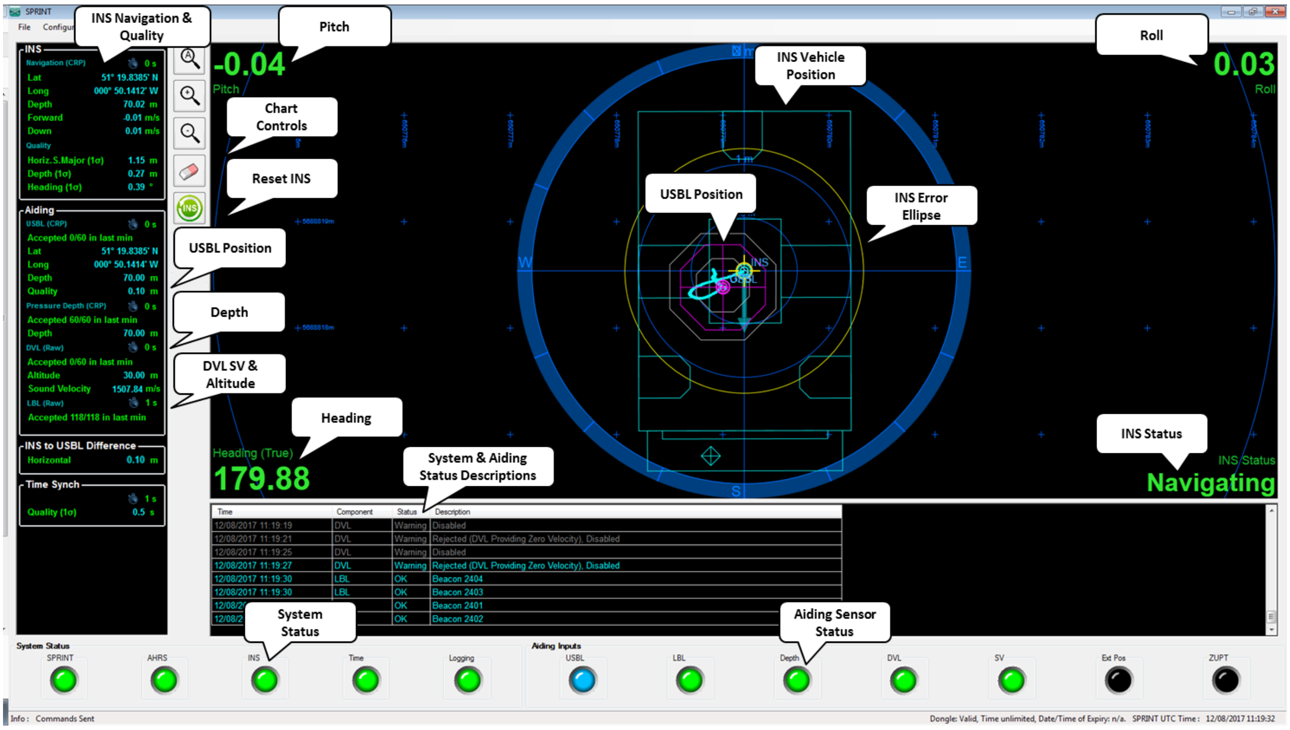
No	Action	Checked (Sign and Date)
1	Check the SPRINT-Nav is powered.	
2	Check all aiding sensors (Depth, DVL, Sound Velocity, and LBL Transceiver) are powered (check power pass-through).	
3	Check the default Latitude in the SPRINT system.	
4	Check the SPRINT-Nav, AHRS, Logging and Time Synch status LED's are green (OK).	
5	Check the Depth status LED is blue (not used). A red (critical) status could indicate there is no data being received.	
6	If a DVL is being used, check the DVL status LED is blue (not used). A red (critical) status could indicate there is no data being received.	
7	If an SV feed is being used, check the SV status LED is blue (not used). A red (critical) status could indicate there is no data being received.	
8	If connected to an LBL transceiver, open the Fusion software and check the Transceiver connection by performing a 'Get' or 'Test' on the transceiver instrument page.	
9	Check or set the (surface) pressure offset on the depth aiding page of the SPRINT system.	

7.10 Monitoring the System

7.10.1 Main Application Window

The main SPRINT system application window, with USBL, DVL and Depth aiding active, with key features highlighted is shown below in *Figure 7–45*.

Figure 7–45 SPRINT system Main Application Window



7.10.2 System and Aiding Status

All the major system components and aiding inputs can be monitored using the system and aiding status LEDs 'traffic light status' at the bottom of the main application window:

Figure 7–46 System and Aiding Status LEDs

The following system components are always monitored:

- SPRINT-Nav (Hardware)
- AHRS (Attitude Heading Reference System)
- INS (Inertial Navigation System)
- Time (Synchronisation)
- (Local PC) Logging

Aiding inputs are monitored if they are specified for INS aiding in the INS Settings configuration. The colour of the monitoring 'traffic light' LEDs is explained in *Table 7–2 "System and Aiding Status Traffic Light LED Colours"*.

Table 7–2 System and Aiding Status Traffic Light LED Colours

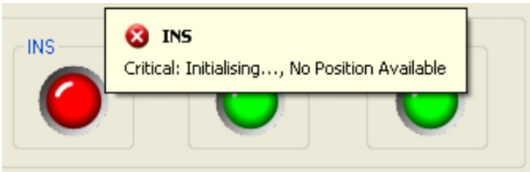
Status	LED Traffic Light Colour	Example States
Critical	Red	Communications Failure to Component Hardware Issue Component not Initialised or running correctly

Table 7–2 System and Aiding Status Traffic Light LED Colours (continued)

Status	LED Traffic Light Colour	Example States
		Timeout for Critical Instrument (typically 30 second limit)
Warning	Orange / Amber	Aiding Sensor Data Rejected AHRS Algorithm Settling
OK	Green	Data Received within Time Limit Data Accepted and Used
Not Used or Disabled	Blue	Aiding data is received but as the INS is not initialised it is not yet being used.

A text description for each component status is provided in the status list and can also be seen by placing a mouse over the appropriate LED, as shown in *Figure 7–47* (with the example of the INS being unable to initialise as it is not receiving position). If there is an issue, the status text will provide guidance to resolve it.

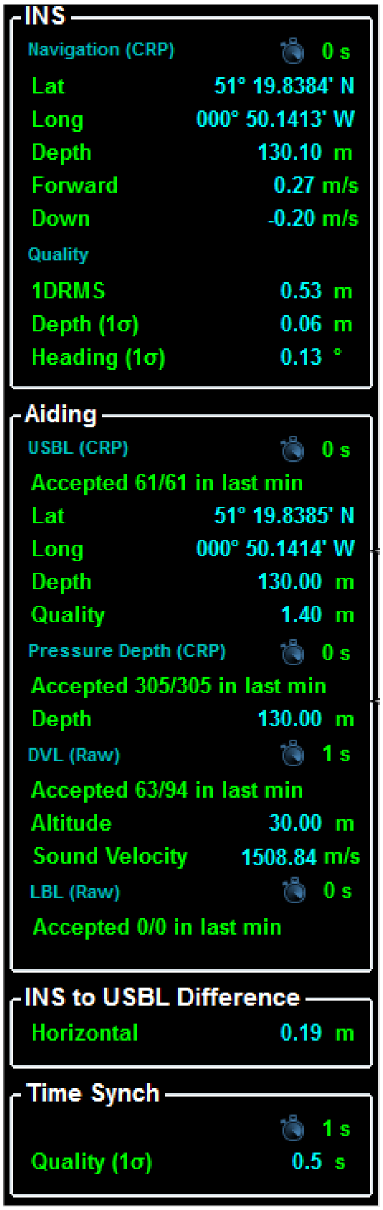
Figure 7–47 Component Status Popup



7.10.3 Navigation Text Panel

Real time navigation data is displayed on the navigation text panel. All positions can either be displayed in WGS 84 decimal degrees or UTM Eastings and Northings. Various quality metrics are also displayed on the panel for both the INS and the SPRINT-Nav time synchronisation status.

Figure 7–48 Navigation Text Panel



Note

The displayed USBL beacon position and external depth are with respect to the vehicle CRP to allow for direct comparison with the INS position, which is also with respect to the vehicle CRP.

7.10.4 INS Statistics

To view detailed INS performance statistics, click **View > INS Statistics**:

Figure 7–49 INS Statistics

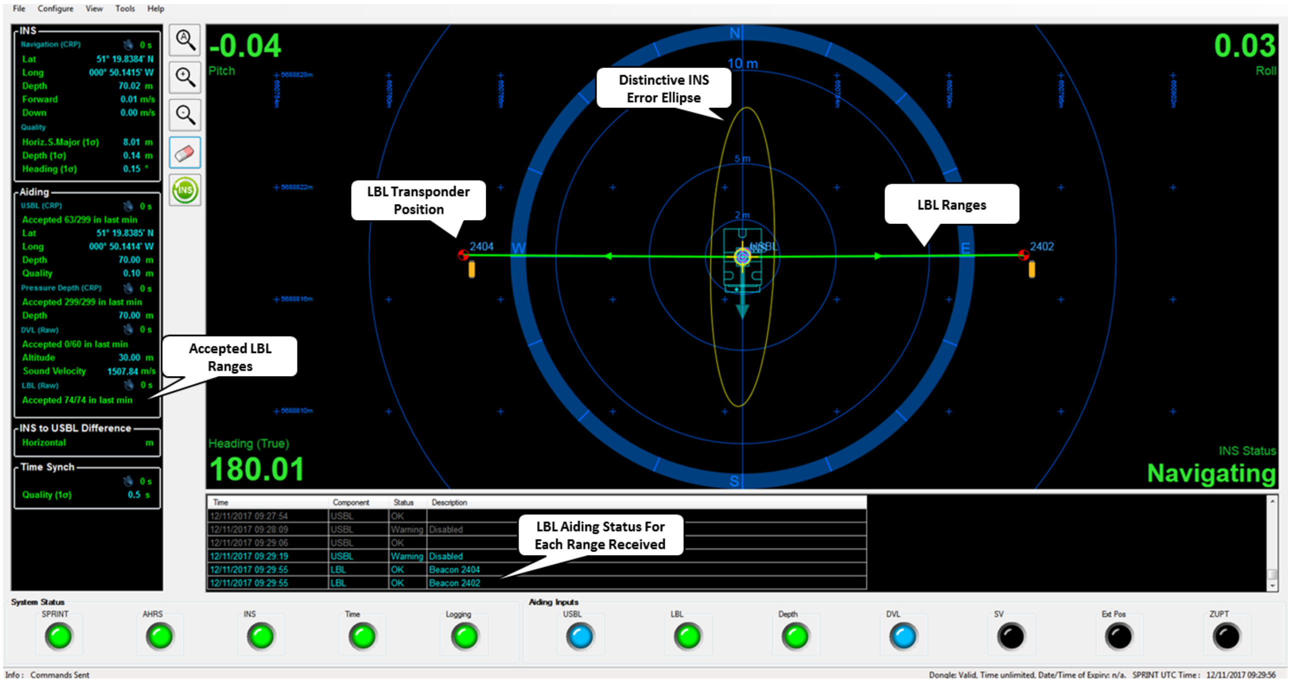
Note

If the INS Statistics display is closed while in use as Time Series Plots, the plots will be deleted.

7.10.5 INS with Fusion LBL Aiding

When LBL is selected and used as an aiding source in the SPRINT system, there are some features that should be noted. See the LBL aiding example in *Figure 7–50*. When LBL aiding is active the USBL position is still displayed for comparison but is not used for aiding. Additionally the INS error ellipse may take a distinctive shape that is representative of the geometry of the vehicle with respect to the reference beacons used for aiding.

Figure 7–50 SPRINT System with Fusion LBL Aiding



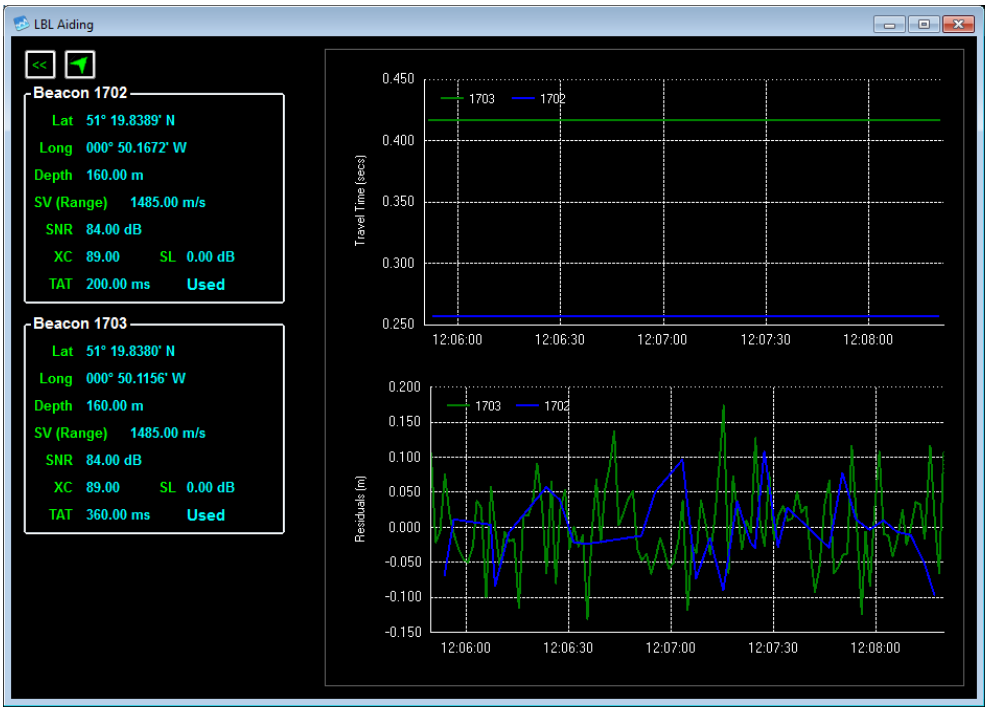
If any LBL ranges are rejected, the LBL aiding LED will change to amber/orange and the beacon address and reason for rejection will be displayed. Examples showing reasons of LBL rejection are shown in *Figure 7–51*.

Figure 7–51 LBL Aiding Rejection

OK	Beacon 1703
Warning	Beacon 1703 Rejected (Range Prediction Exceeded: Bad Range Received), Rejected (Range Rate Exceeded: Bad Range Received)
Warning	Beacon 1703 Rejected (Outside INS Prediction)

Click **View > LBL Aiding** to see additional LBL aiding information as shown below.

Figure 7–52 LBL Aiding Window



The LBL aiding window will display aiding information for all LBL beacons which are currently being tracked while the SPRINT system is LBL aided.

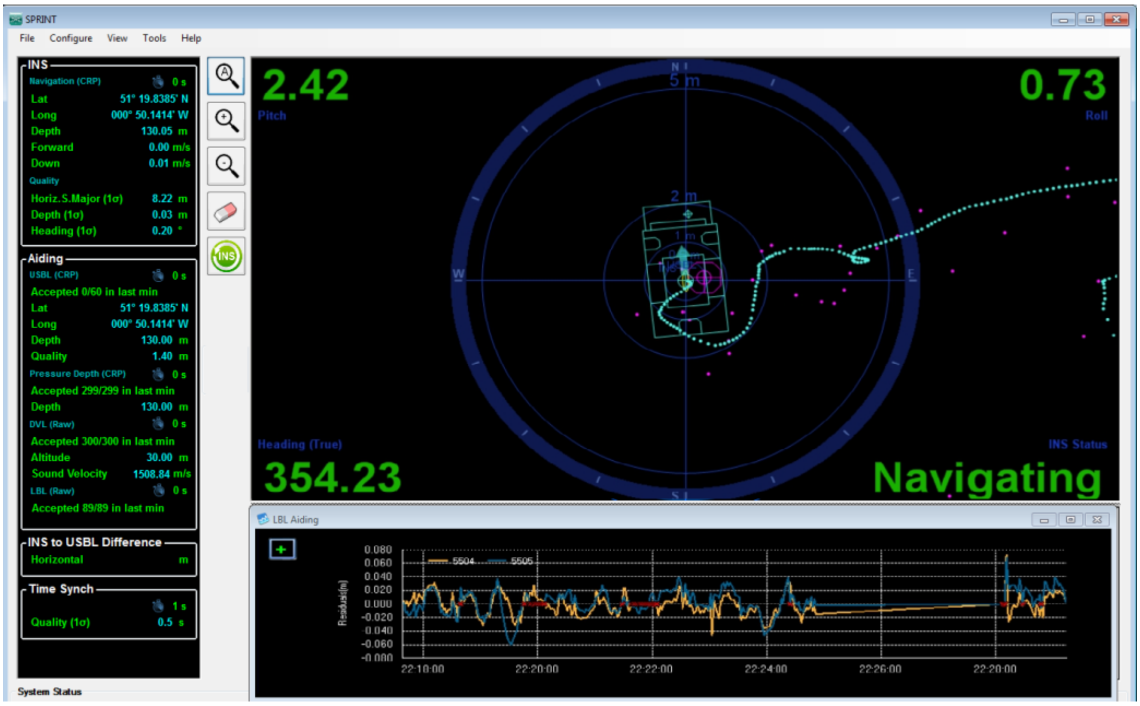
The upper graph displays travel time for all tracked beacons while the lower graph displays the LBL aiding range residuals. The residuals displayed are the differences between the INS estimated and the actual received LBL ranges and are therefore an extremely useful indication of LBL aiding health. The residuals should typically be low (<10 cm) and centred around zero.

To edit the LBL aiding chart contents:

1. Press the minus sign **–** on the keyboard to hide the beacon text.
2. Right-click on the charts to enable options to:
   - Maximise or hide one of the charts
   - Show or hide data from individual beacons
   - Copy and save the charts
3. Dragging the mouse over a section of the chart will zoom into the area selected.

It is recommended that during critical INS positioning with LBL aiding, the LBL aiding window is kept open to monitor the aiding, as shown below.

Figure 7–53 Monitoring LBL Aiding

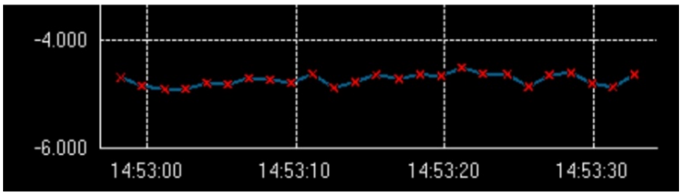


If the residuals are not centred around zero, this would indicate that there is a systematic error with LBL aiding, such as:

- Sound velocity
- Beacon to INS relative depth

If LBL aiding observations are rejected, it will be indicated by a red cross on the residuals display, as shown below.

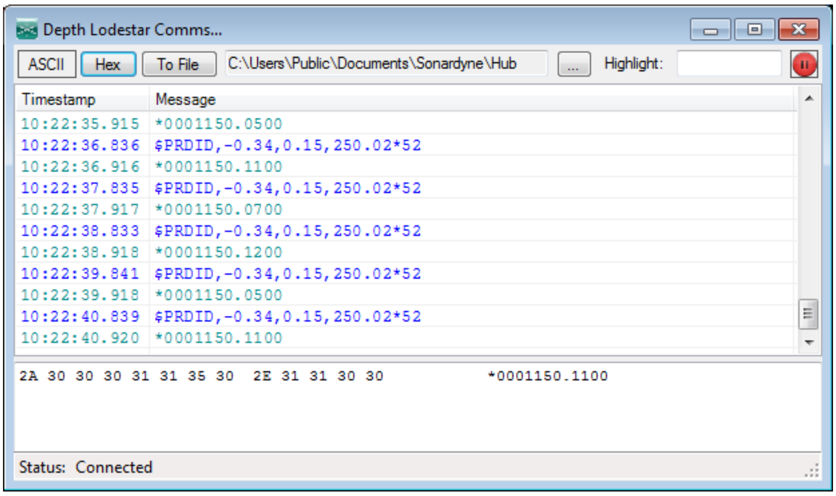
Figure 7–54 LBL Aiding Rejection in Residuals Graph



7.10.6 Communications Monitor

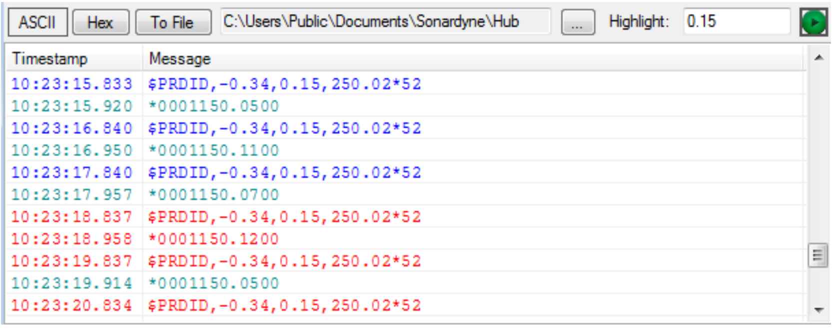
On any of the dialog boxes in the SPRINT system that allow the configuration of input or output communication, a comms monitoring function is provided. When the **Comms** button is clicked, a new window is displayed showing the received or sent data on the configured port; see *Figure 7–55*. The actual message contents are provided in the **Message** column.

Figure 7–55 Communications Monitor



The data received on the port is displayed green and the data sent on the port displayed blue as shown in *Figure 7–55*. The communications can be saved to a file by selecting a location and clicking the **To File** button. The communications can be filtered by entering Filter text. Any communication containing the filter text is displayed red as shown below.

Figure 7–56 Communications Monitor Filter



The communications stream can be paused by clicking the **Pause** button.

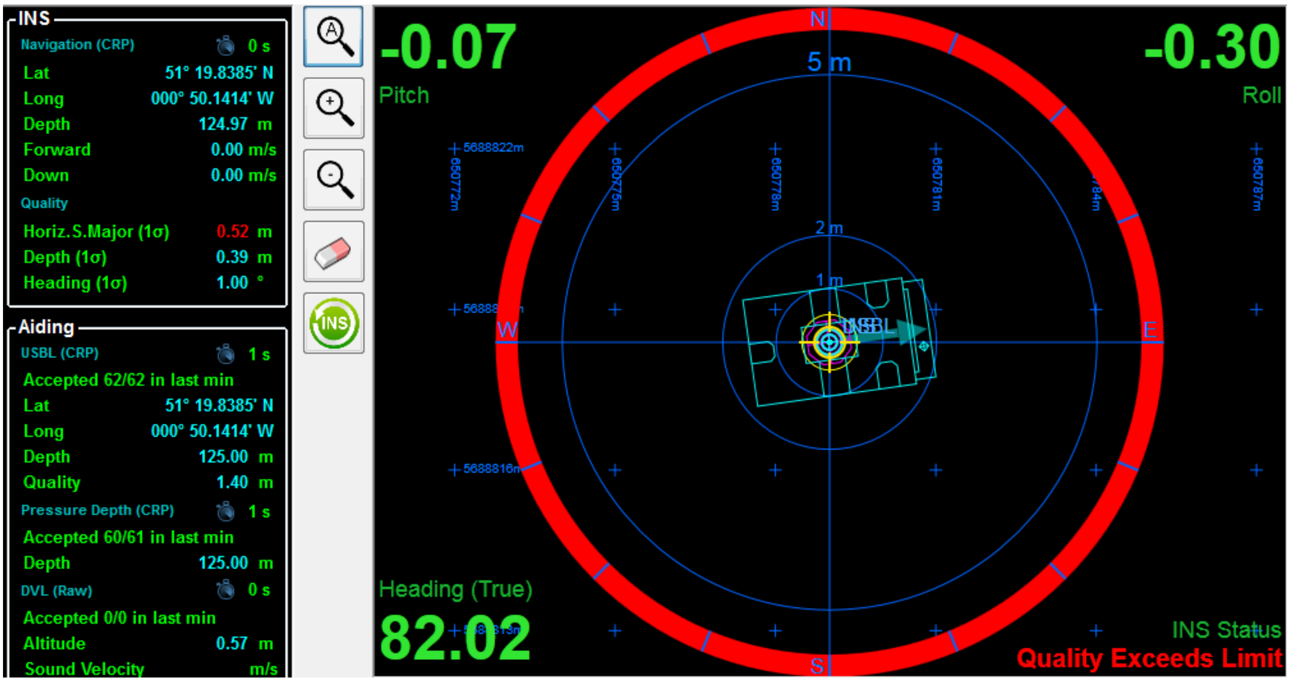
7.10.7 Navigation Quality Limits

Navigation quality limits can be enabled and configured in the SPRINT system; see *Section 7.4.15 "Options"*. If enabled, the horizontal navigational quality limit will be displayed on the chart as a red circle (INS horizontal quality is displayed as a yellow circle or ellipse).

If either the vertical or horizontal quality limits are exceeded, the SPRINT system will alert you, see *Figure 7–57*:

- The 'Compass Ring' on the navigation chart will flash red.
- The INS status on the navigation chart will read **Quality Exceeds Limit**.
- The relevant quality value on the navigation text panel will flash red.

Figure 7–57 Navigation Quality Limits Exceeded



7.11 DVL Calibration

All SPRINT-Nav products are precalibrated from the factory. The calibration file (xxxxxx-xxx DVL_Beam_Calibration.ccl) is also stored on the USB media and can be reapplied to the SPRINT-Nav via the DVL configuration page in the SPRINT system; see *Section 7.4.9 "DVL Aiding"*

Note

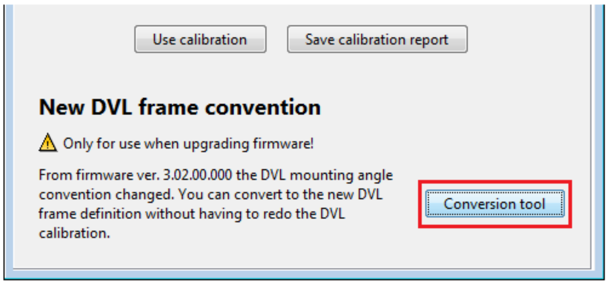
Refer to *UM-8253-SPRINT* user manual *"DVL Calibration Procedure"* for calibrating the co-located and separately located DVL and SPRINT units.

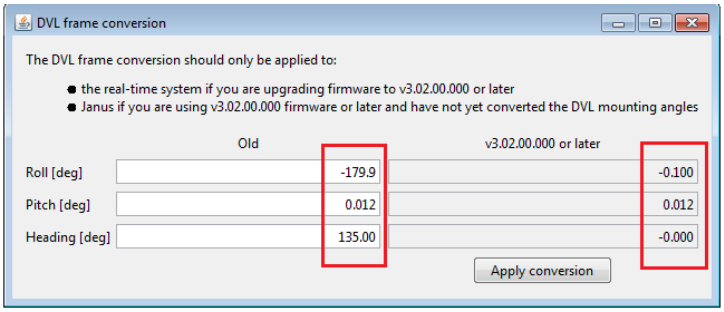
7.12 DVL Frame Convention

The default mounting for the DVL frame convention has changed (instrument FWD mark aligned with vehicle FWD mark), as shown below.

Mounting	SPRINT System 1.4 Convention	SPRINT System 1.5.1+ Convention
Heading	135.00	0.00
Pitch	0.00	0.00
Roll	-179.90	0.00

The DVL frame convention tool allows DVL mounting angles in SPRINT system V1.4 to be converted to SPRINT system V1.5.1 (or later) convention without the requirement to perform an additional DVL calibration.


Use calibration
Save calibration report
New DVL frame convention
Only for use when upgrading firmware!
From firmware ver. 3.02.00.000 the DVL mounting angle convention changed. You can convert to the new DVL frame definition without having to redo the DVL calibration.
Conversion tool


DVL frame conversion
The DVL frame conversion should only be applied to:
the real-time system if you are upgrading firmware to v3.02.00.000 or later
Janus if you are using v3.02.00.000 firmware or later and have not yet converted the DVL mounting angles
Old
v3.02.00.000 or later
Roll [deg]
-179.9
-0.100
Pitch [deg]
0.012
0.012
Heading [deg]
135.00
-0.000
Apply conversion

Section 8 – Standalone AHRS Operation

8.1 Introduction

The SPRINT-Nav can be configured and operated as a standalone AHRS as explained below.

8.2 Configuring using PC Utility

8.2.1 Connection

Connect the PC to the SPRINT-Nav via a serial port on the PC or alternatively an Ethernet connection. Default connection details are provided below.

The software will default to COM 1 on the PC.

The SPRINT-Nav default Ethernet properties are:

- IP Address: 192.168.179.50
- Subnet Mask: 255.255.255.0
- Command port/socket: 4000

The software will default to these values if the Ethernet option is chosen. Make sure the PC Ethernet port is configured correctly to allow communication with the SPRINT-Nav's default settings.

If the SPRINT-Nav is being used as a standalone surface AHRS then connect GPS to the SPRINT-Nav using a spare IO port and arrange to supply the NMEA 0183 $GPGGA and $GPVTG sentences to the SPRINT-Nav.

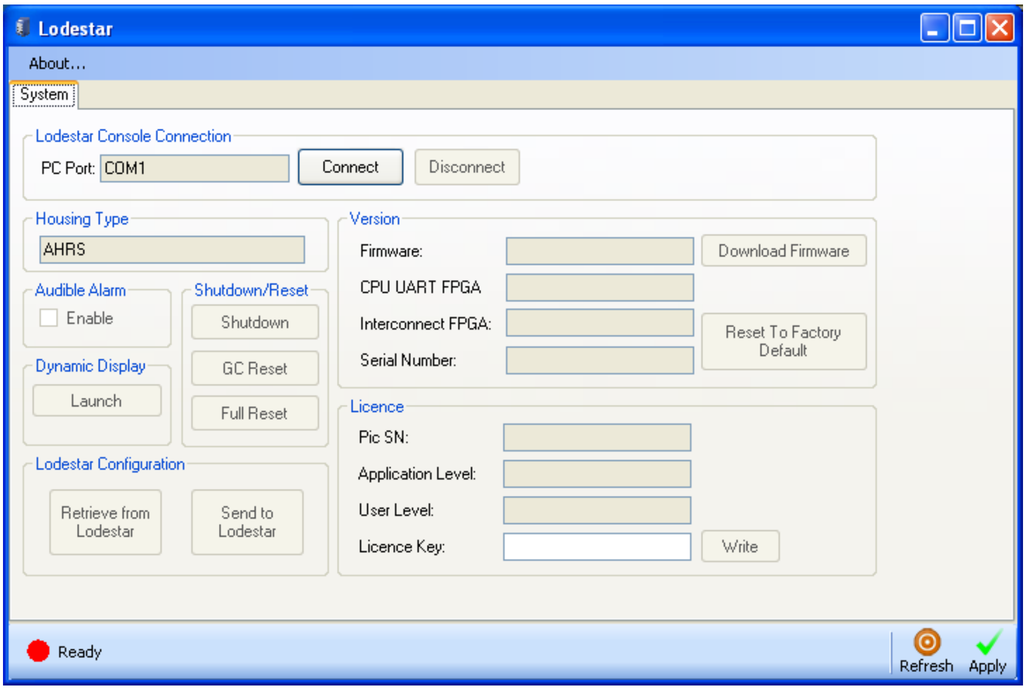
Connect the SPRINT-Nav's IO ports to the external instrumentation as required.

Start the SPRINT-Nav configuration software (if it is not already running) by double-clicking the program's icon on the PC's desktop.

Once a physical connection has been made it is necessary for the PC Utility to communicate with SPRINT-Nav; see *Figure 8–1*.

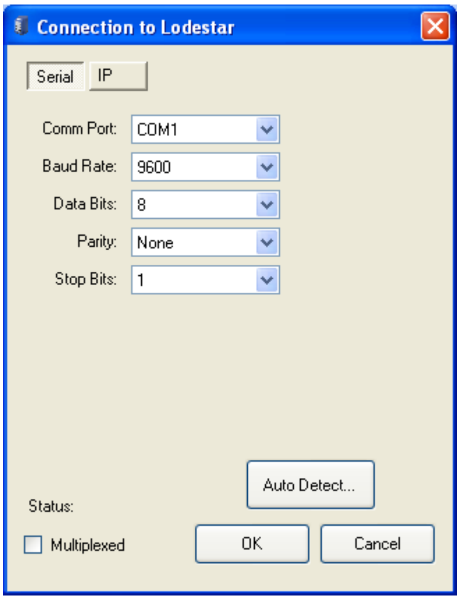
Configure the connection to the SPRINT-Nav by clicking **Connect**.

Figure 8–1 Configuration Software Main Window (not connected)



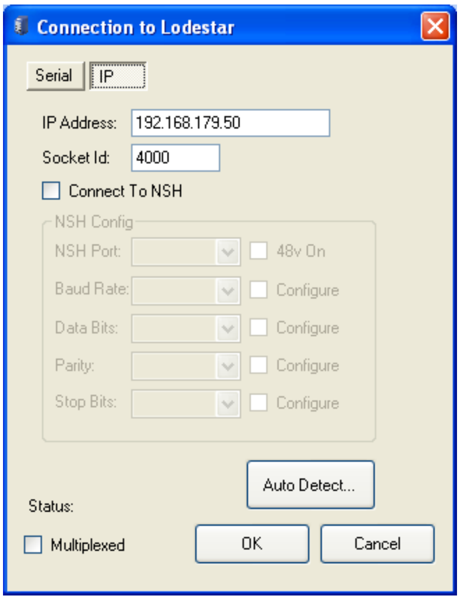
The application will default to a serial connection on PC port COM 1 as shown in below.

Figure 8–2 SPRINT-Nav Serial Connection Settings



To configure an Ethernet or NSH connection, click **IP** and the default SPRINT-Nav Ethernet connection parameters are displayed, as shown below.

Figure 8–3 SPRINT-Nav Ethernet Connection Settings



Note

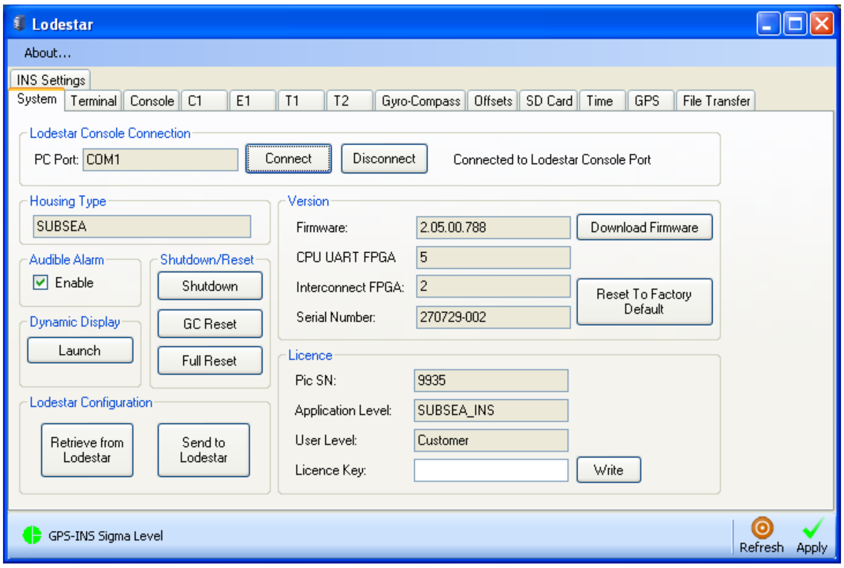
Before proceeding, make sure the SPRINT-Nav has been running for at least one minute before trying to connect via the configuration software. This allows time for the SPRINT-Nav to start up and receive commands.

Once the connection parameters match the physical connection between the SPRINT-Nav and the PC, click **OK**.

A window will appear indicating communication status with the SPRINT-Nav.

Once connected, the software will populate with the SPRINT-Nav configuration and the status indicator circle on the bottom left hand side of the application will turn green, indicating a good communication link with the SPRINT-Nav; see *Figure 8–4*.

Figure 8–4 Configuration Software Main Window (connected)



Note

If the status indicator remains red and the SPRINT-Nav configuration is not updated, the software was unable to connect to the SPRINT-Nav. Check the SPRINT-Nav is powered, all cables are connected to the correct ports and the settings entered on the 'configure connection' window are correct and then retry connecting. If this is not successful refer to ***Section 16 "Troubleshooting for SPRINT"*****.**

8.2.2 Shutdown and Reset

The SPRINT-Nav can be commanded to shut down or reset from the configuration software using the buttons on the **Shutdown/Reset** pane:

- **Shutdown** will shut down and turn off the SPRINT-Nav.
- **GC Reset** will restart the SPRINT-Nav AHRS algorithms.
- **Full Reset** will re-boot the SPRINT-Nav, completely resetting it.

8.2.3 Gyrocompass Configuration

Select the **Gyro-Compass** tab in the Configuration Software.

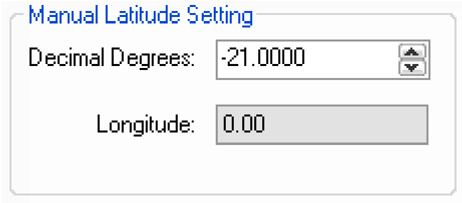
It is essential to set the default Latitude if the SPRINT-Nav is operated without a GPS input. It is also important to set this parameter even when the SPRINT-Nav is used with a GPS input, because the SPRINT-Nav can revert to using the default Latitude if the GPS input fails for any reason.

Note

If the SPRINT-Nav receives telegrams from a GPS receiver or any position aiding such as USBL, these will automatically update the default Latitude. However, if the GPS input fails, then the SPRINT-Nav will revert back to using the default Latitude. Make sure the default Latitude setting is kept up to date in case the GPS input fails or is not available.

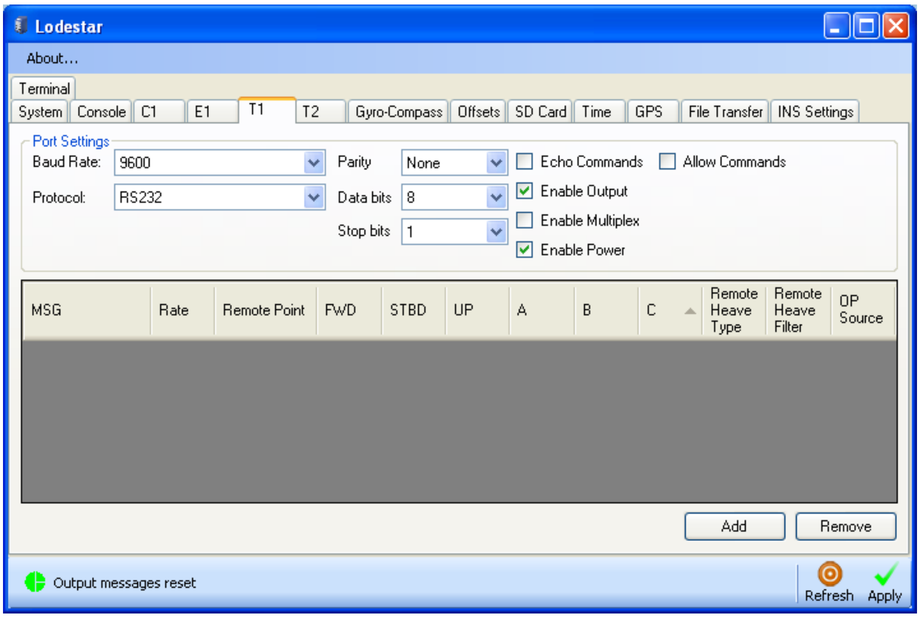
The default Latitude can be set by entering the operating Latitude on the **Manual Latitude Setting** pane; see *Figure 8–5*. After setting the Latitude, click **Apply** on the main application window.

Figure 8–5 Manual Latitude Setting Panel



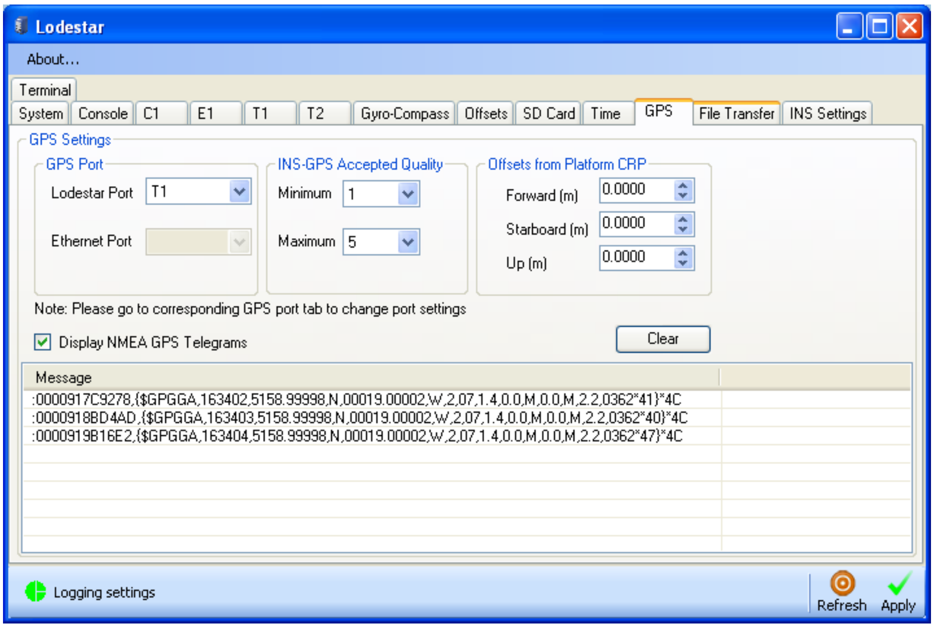
Where possible it is strongly recommended to connect a GPS receiver supplying the necessary NMEA 0183 GPGGA and GPVTG sentences to the SPRINT-Nav.

1. Click on the tab that corresponds to the GPS input (**T1**).
2. Configure the baud rate and protocol.
3. Ensure the **Enable Output** and **Enable Power** are selected and then click **Apply**.

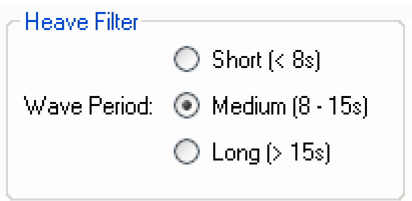


4. Click the **GPS** tab and configure the GPS port to be the port the GPS is connected (**T1**).
5. Enter the offsets from the vessel CRP to the GPS antenna and then click **Apply** to send the changes to the SPRINT-Nav.

6. Select **Display NMEA GPS Telegrams** to show any GGA telegrams that are being correctly received and decoded.



7. If required, the Heave output from the SPRINT-Nav can be configured on the **Heave Filter** for the anticipated surface wave period experienced by the vehicle.



8.2.4 Mounting Angle & Lever Arm Configuration

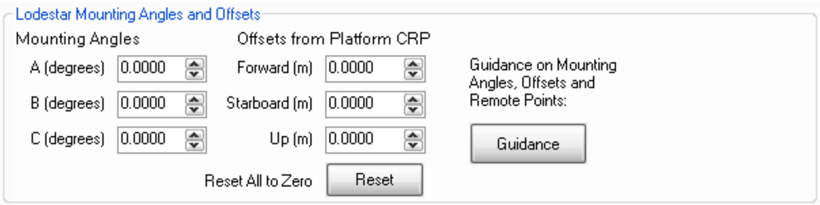
Click the **Offsets** tab on the configuration software.

If mounting angles for the SPRINT-Nav need to be configured, this can be done by entering the appropriate values in the **A**, **B** and **CMounting Angle** boxes, as shown in *Figure 8–6*. Similarly if there are any offsets that need to be applied for the SPRINT-Nav with respect to the vehicle CRP these can be applied in the **Forward**, **Starboard** and **Up** entry boxes.

CAUTION

⚠ **It is strongly recommended the SPRINT-Nav mounting angles are not modified while the SPRINT-Nav is in operation as an AHRS device. When any changes are applied the user will be prompted to reset the SPRINT-Nav AHRS algorithm and it will be several minutes before the SPRINT-Nav output is settled.**

Figure 8–6 Mounting Angles and Offsets Panel



All mounting angles can be reset to zero using the button available.

SPRINT-Nav measurements may be required for vehicle sensors that are not located near to the vehicle CRP, such as remote heave.

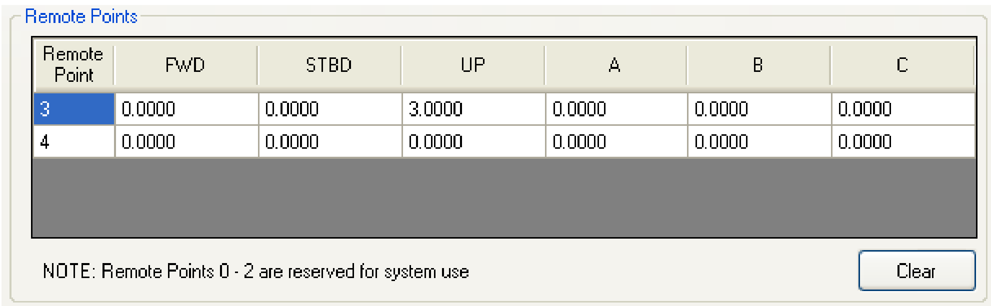
For the SPRINT-Nav to be able to supply these systems with measurements, offset distances must be measured and applied in the SPRINT-Nav configuration.

The SPRINT-Nav supports up to two remote outputs (extendable on request) and these are listed in the **Remote Point** list; see *Figure 8–7*. The remote points are numbered **3** and **4** (remote points 0 to 2 are reserved for system use).

The offsets can be entered in the X, Y and Z columns and then saved in the SPRINT-Nav by clicking **Apply** on the main application window.

Additionally, angular adjustments can be entered in the **A**, **B** and **C** columns and saved by clicking **Apply** on the main application window.

Figure 8–7 Remote Point List



Click **Guidance** on the **Offsets** tab to view a summary guidance page explaining the SPRINT-Nav angles and offsets.

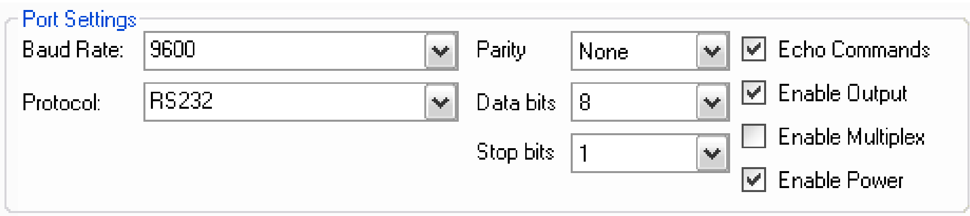
8.2.5 Port Configuration

The settings for each SPRINT-Nav port are available by selecting the appropriate tab in the main application window.

8.2.5.1 Serial Ports

The settings for the port can be viewed or modified on the **Port Settings** Pane; see *Figure 8–8*.

Figure 8–8 Port Settings Panel



The **Baud Rate**, **Protocol**, **Parity**, **Data** and **Stop Bits** can be configured by selecting the appropriate value from the drop-down lists and then clicking **Apply**.

Note

Several settings on the console port are fixed to make sure the user can always communicate with the SPRINT-Nav. Protocol is selected by the protocol select pin on the console cable and cannot be set in the configuration software. Also, the power to the console port cannot be turned off.

Further settings can be modified by selecting the check boxes on the **Port Settings** Pane:

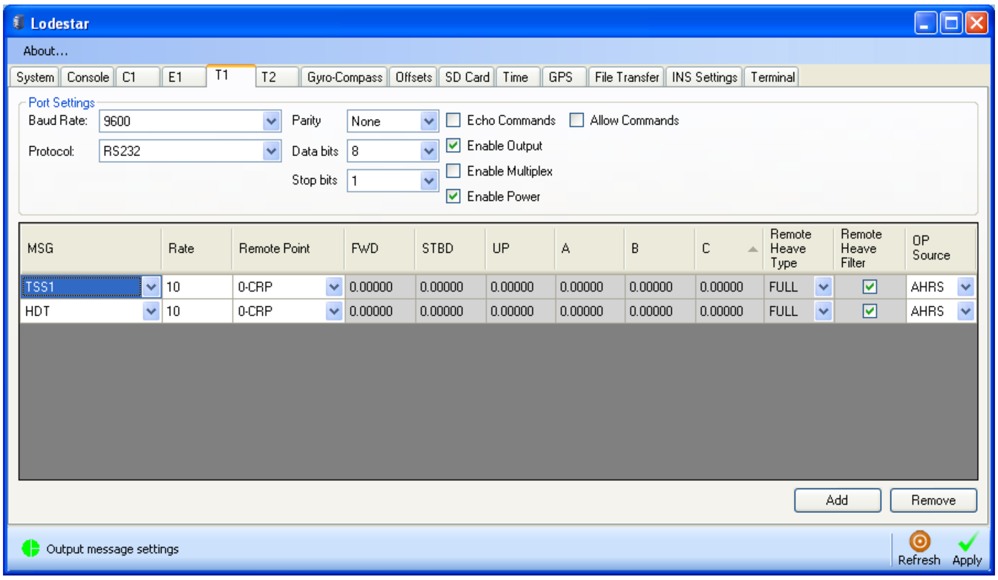
- Echo Commands will output any commands received by the SPRINT-Nav on this port.
- Enable Output will turn the message output ON/OFF on this port.
- Enable Multiplex will enable/disable multiplex communications on this port.
- Enable Power will enable/disable power to this port.

Note

The Enable Power setting does not activate external power for the selected port; it allows a user to turn off a communication port completely to lower power consumption. If the power for a port is turned off it can no longer send or receive data.

The output messages for the appropriate port can be viewed or modified in the output message table; see *Figure 8–9*.

Figure 8–9 Output Message Table



Note

The SPRINT-Nav output messages are described in *UM-8084-109 Lodestar AHRS Messages*.

1. Click **Add**/**Remove** to add or remove an output.
2. Select the required output message type from the drop-down list in the **MSG** column.
3. Select an output rate (up to 100 Hz) by entering the required value in the **Rate** column.
4. If this message is to be output with respect to a remote point on the vehicle, select the appropriate remote point (already setup on the **Offset** tab) from the list in the **Remote Point** column. After selecting the Remote Point, the appropriate offsets and angles are displayed in the table.
5. If this message is to be output with respect to the vehicle CRP, leave **None** selected in the **Remote Point** column.
6. After all settings have been updated, click **Apply** on the main application window to save the configuration to the SPRINT-Nav.

8.2.5.2 Ethernet

The default IP settings of the SPRINT-Navt are listed below:

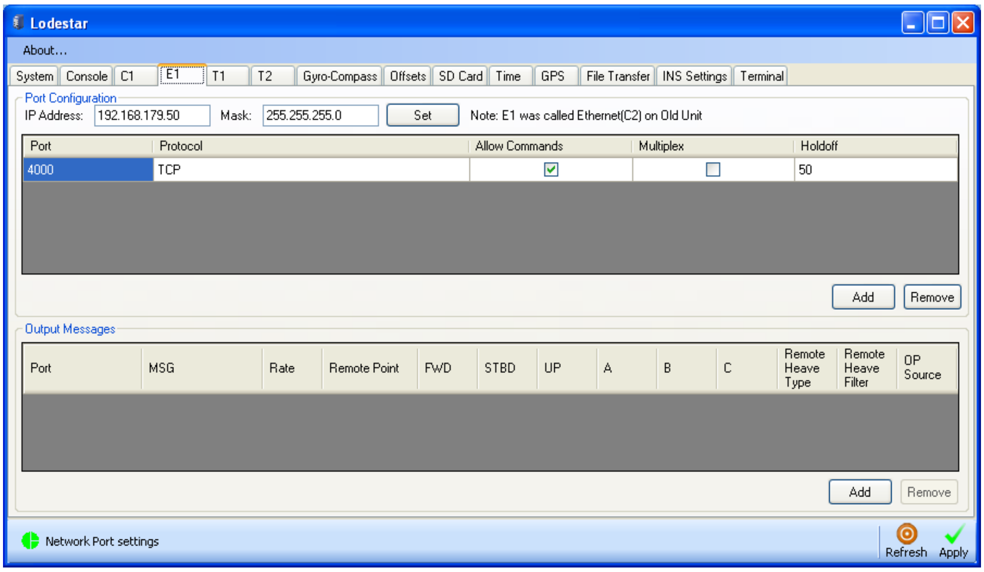
- IP Address: 192.168.179.50
- Subnet Mask: 255.255.255.0
- Command port/socket: 4000

Note

The command port 4000 is always available to make sure the user can always communicate with the SPRINT-Nav via an Ethernet connection. This port is not shown or listed in the configuration application as it should never be removed or modified.

The IP port settings can be viewed and modified on the **Port Configuration** pane; see *Figure 8–10*.

Figure 8–10 IP Port Configuration Panel



The IP address and subnet mask can be modified by changing the value and then clicking **Set**.

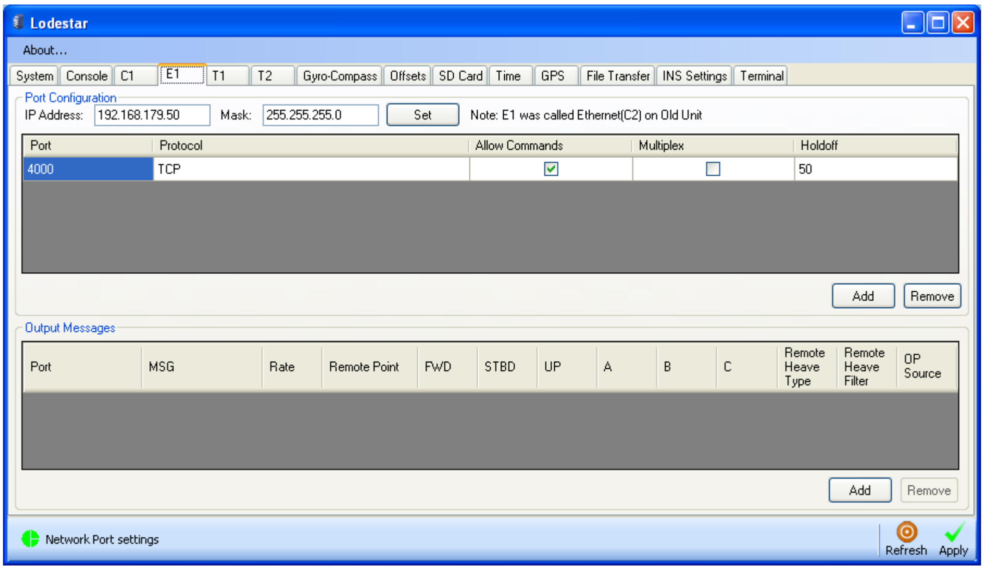
CAUTION

If connected to the SPRINT-Nav via the Ethernet port and you wish to change the IP address or subnet mask, it is strongly recommended that after changing the values the configuration application is closed. Reconnect using the new IP address by adding it in the Ethernet Connection Settings and then click "Connect". It also recommended that the SPRINT-Nav is restarted.

1. Click **Add/Remove** to add or remove an Ethernet port (also referred to as a socket).
2. The Ethernet port settings available are:
   - **Protocol**: can be TCP/IP (secure but slow) or UDP (broadcast fire and forget).
   - **Allow Commands**: enables the SPRINT-Nav to be commanded on this port.
   - **Multiplex**: enables/disables multiplex communications on this Ethernet port.
   - **Holdoff**: the timeout in milliseconds for data to be output on a network port in the event there isn't enough data to be output within that time.
3. After all settings have been updated on the tab, click **Apply** on the main application window to save the configuration to the SPRINT-Nav.

The Ethernet output messages can be viewed or modified in the output message table; see *Figure 8–11*.

Figure 8–11 Ethernet Output Message Table



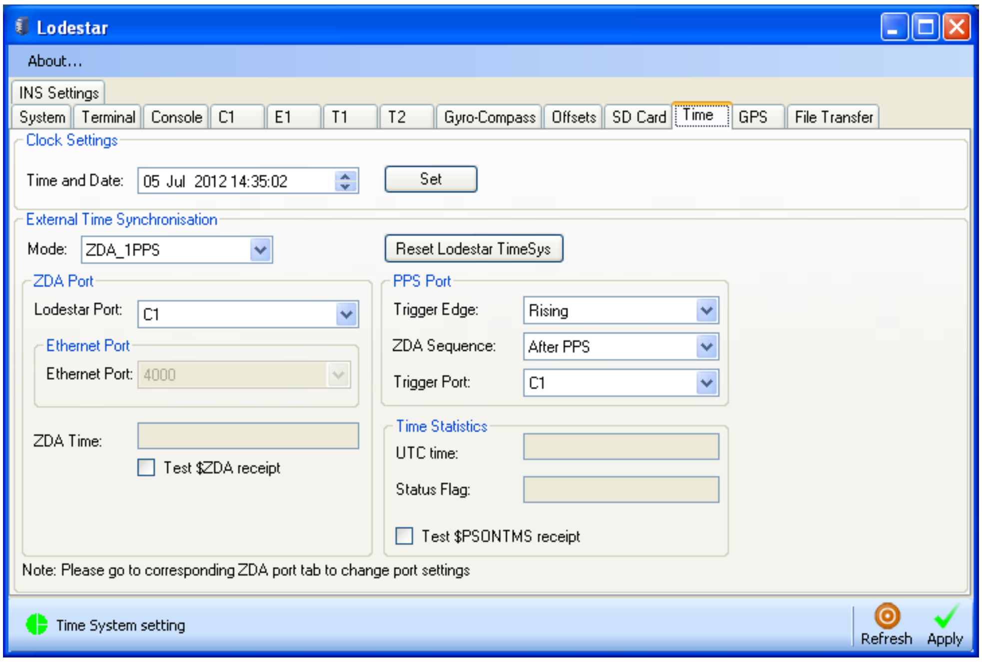
Note
SPRINT-Nav output messages are described in *UM-8084-109 Lodestar AHRS Messages.*

1. Click **Add/Remove** to add or remove a message output.
2. Select the Ethernet port from which this message will be output from the drop-down list in the **Port** column.
3. Select the required output message type from the drop-down list in the **MSG** column. Select an output rate (up to 100 Hz) by entering the required value in the **Rate** column.
4. If this message is to be output with respect to a remote point on the vehicle, select the appropriate remote point (already setup on the **Offset** tab) from the list in the **Remote Point** column. After selecting the Remote Point the appropriate offsets and angles are displayed in the table.
5. If this message is to be output with respect to the vehicle CRP, leave **None** selected in the **Remote Point** column.
6. After all settings have been updated on the tab, click **Apply** on the main application window to save the configuration to the SPRINT-Nav.

8.2.6 Configure Time Settings

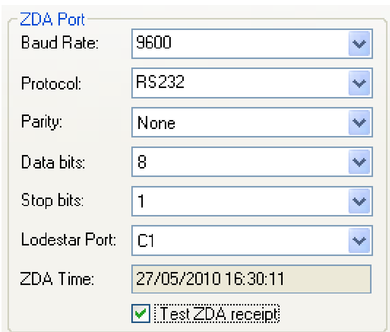
The time and date configured in the SPRINT-Nav is displayed in the **Clock Settings** panel on the **Time** tab; see *Figure 8–12*.

Figure 8–12 Clock Settings panel



1. The time and date can be modified using the up/down arrows on the **Time and Date** box and then clicking **Set**.
2. If GPS input is available and a GPS receiver is not already supplying the necessary NMEA 0183 GPZDA sentences to the SPRINT-Nav, make sure the input is connected now.
3. The GPZDA input can be configured on the **ZDA Port** pane; see *Figure 8–13*.
4. Select the SPRINT-Nav port the GPS is connected to from the drop-down list. The settings for the selected port are displayed and can be changed if required.
5. Click **Apply** on the main application window to save this configuration on the SPRINT-Nav.
6. The GPZDA input **Test ZDA receipt** (if available) can be selected; see *Figure 8–13*.

Figure 8–13 ZDA Port Panel



7. If the PPS input is available and is not already connected to SPRINT-Nav, connect it now. The SPRINT-Nav can accept an input trigger on the following ports:

Table 8–1 PPS Input Ports

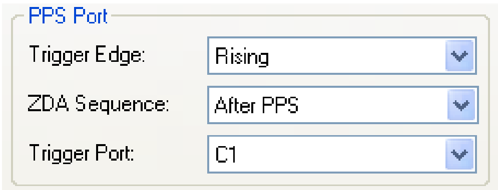
SPRINT Type	SPRINT V2 Port	SPRINT V3 Port
Subsea	C1	C1
	E1 (Ethernet)	E1 (Ethernet)
	T1	-
	T2	-

Note

The test cables supplied with the SPRINT-Nav have BNC connectors that can be used to input the PPS pulse to the SPRINT-Nav.

8. The PPS input pulse can be configured on the **PPS Port** panel; see *Figure 8–14*.

Figure 8–14 PPS Port panel



- **Trigger Edge**: specifies whether the timing pulse should be measured on the rising (high) or falling (low) of the input signal.
- **ZDA Sequence**: specifies when the ZDA message arrives with respect to the PPS timing pulse.
- **After PPS**: should be selected if the ZDA arrives shortly after the PPS pulse.
- **Before PPS**: should be selected if the ZDA arrives shortly before the PPS pulse.
- **Time of Arrival**: should be selected is the ZDA arrives at the same time as the PPS pulse.

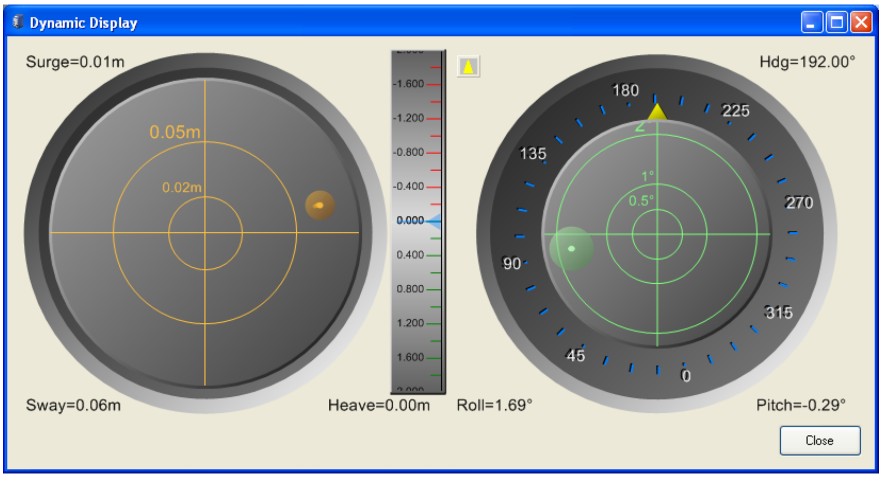
9. On the **Trigger Port** drop-down list, select the SPRINT port that is receiving the 1PPS signal.
10. Click **Apply** on the main application window to save this configuration on the SPRINT-Nav.

8.2.7 Checking Output

There are several methods that can be used to check the output from the SPRINT-Nav, explained below.

A dynamic display can be viewed that allows you to view the real time output from the SPRINT-Nav. This can be launched by clicking **Dynamic Display** on the **System** tab. The display shows heading, roll, pitch, heave, surge and sway measurements with respect to the CRP of the vehicle; see *Figure 8–15*.

Figure 8–15 Dynamic Display



Note

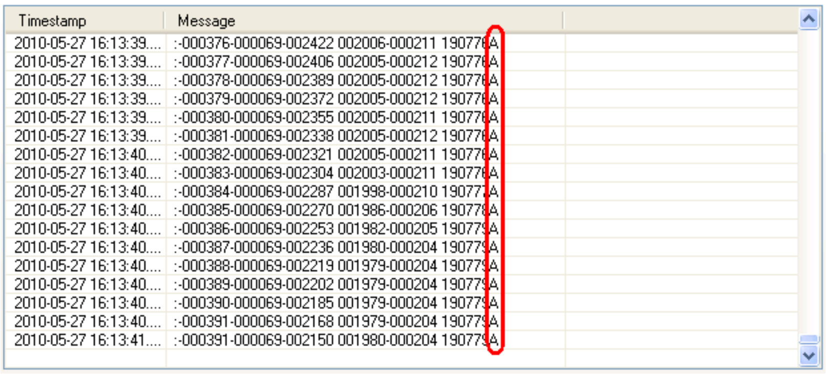
If the output is incorrect, check the following settings are correct:
- Mounting angles and offsets
- Default Latitude or automatic GPS compensation

The method for checking the automatic GPS compensation is detailed below.

While the **Dynamic Display** window is open, click the **Terminal** tab on the main application window.

The **Terminal** tab displays the output from the SPRINT-Nav, which in this case is the Sonardyne proprietary SON1 telegram. The last character of each received message is a status flag that indicates the type of GPS compensation received by the SPRINT-Nav; see *Figure 8–16*.

Figure 8–16 Terminal check of GPS compensation



Timestamp	Message
2010-05-27 16:13:39....	:-000376-000069-002422 002006-000211 190776A
2010-05-27 16:13:39....	:-000377-000069-002406 002005-000212 190776A
2010-05-27 16:13:39....	:-000378-000069-002389 002005-000212 190776A
2010-05-27 16:13:39....	:-000379-000069-002372 002005-000212 190776A
2010-05-27 16:13:39....	:-000380-000069-002355 002005-000211 190776A
2010-05-27 16:13:39....	:-000381-000069-002338 002005-000212 190776A
2010-05-27 16:13:40....	:-000382-000069-002321 002005-000211 190776A
2010-05-27 16:13:40....	:-000383-000069-002304 002003-000211 190776A
2010-05-27 16:13:40....	:-000384-000069-002287 001998-000210 190777A
2010-05-27 16:13:40....	:-000385-000069-002270 001986-000206 190778A
2010-05-27 16:13:40....	:-000386-000069-002253 001982-000205 190779A
2010-05-27 16:13:40....	:-000387-000069-002236 001980-000204 190779A
2010-05-27 16:13:40....	:-000388-000069-002219 001979-000204 190779A
2010-05-27 16:13:40....	:-000389-000069-002202 001979-000204 190779A
2010-05-27 16:13:40....	:-000390-000069-002185 001979-000204 190779A
2010-05-27 16:13:40....	:-000391-000069-002168 001979-000204 190779A
2010-05-27 16:13:41....	:-000391-000069-002150 001980-000204 190779A

The status flag should be **A** indicating the SPRINT-Nav is receiving full GPS compensation and is also fully settled. Descriptions of all possible states are listed below.

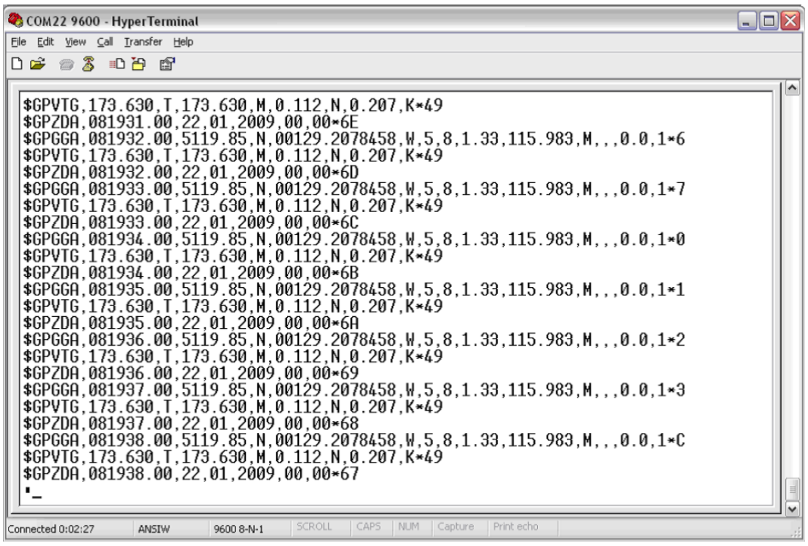
An upper case character indicates the SPRINT-Nav is settled whereas a lower case character indicates the unit is still settling.

- **a** or **A** means the SPRINT-Nav is receiving and decoding valid GPGGA and GPVTG telegrams successfully.
- **g** or **G** means the SPRINT-Nav is receiving and decoding only valid GPGGA telegrams.
- **v** or **V** means the SPRINT-Nav is receiving and decoding only valid GPVTG telegrams.

- **u** or **U** means the SPRINT-Nav is not receiving or decoding any valid GPGGA and GPVTG telegrams.

If a GPS is connected to the SPRINT-Nav and the GPS input flag is not **A**, make sure the GPS receiver is sending the correct telegrams by connecting a terminal application, such as HyperTerminal, to the GPS receiver's output as shown in *Figure 8–17*.

Figure 8–17 Example GPS output in HyperTerminal



Section 9 – Standalone Syrinx DVL Operation

9.1 Introduction

Before operating the equipment, ensure *Section 2 – Safety* is read and fully understood.

The SPRINT-Nav DVL component is referred to as the "Syrinx DVL" or "DVL". This section describes direct connection through the Ethernet connection or AUX RS232 connection via the Syrinx DVL port of the SPRINT-Nav.

9.2 Syrinx DVL Input Power

The Syrinx DVL can be powered using two different methods as described below.

9.2.1 SPRINT-Nav Power Pass Through

The Syrinx DVL must be powered by the SPRINT power pass through method to connect via Ethernet. The power input of the SPRINT-Nav on CP+E1 (24 Vdc) is passed through to the Syrinx DVL using either one of the following methods:

- SPRINT system; see *Section 7.4.5 "SPRINT System Power Pass Through"*, or
- Lodestar PC Utility/Manual commands

To use Lodestar PC Utility/Manual commands:

1. Connect to the SPRINT-Nav via CP+E1; see *Section 8 "Standalone AHRS Operation"*.
2. Using Lodestar PC Utility V4.3.0.80:
   When connection to the SPRINT-Nav has been established, select the **T2** tab, select **Enable Power-Pass** option and then click **Apply**.
3. Using previous versions of Lodestar PC Utility :
   a. Type: **PORT 4 PWRPASS 1** and then press Enter.
   b. The command will be repeated, followed by an OK reply.
   c. Select the **System** tab and click **Disconnect**.

Note

Power Pass Through can be turned off using the following command: PORT 4 PWRPASS 0

9.2.2 External Syrinx DVL Power Input

The Syrinx DVL can be powered externally on the SPRINT-Nav Syrinx DVL connector with 24 Vdc (only if the auxiliary RS232 serial communications and Triggers are to be used).

9.3 Ethernet Connectivity

The Syrinx DVL is designed to be configured and communicated with via Ethernet where possible. It is recommended that Ethernet connection is used when the vehicle communication infrastructure allows for this. If Ethernet connectivity is not possible, serial communications can be used as an alternative. The Syrinx supports 10 Base T Full Duplex Ethernet connections only.

9.3.1 Internet Browser Recommendations

Syrinx DVL has been tested on the Windows® 7 operating system using the following web browsers:

- Google Chrome® (75.0.3770.90)
- Microsoft Edge (42.17134.1098.0)
- Internet Explorer (11.1304.17134.0)

Other HTML5 compatible browsers may be used but have not been thoroughly tested. It is recommended to install and use the latest version of the internet browser for communicating with DVL Manager.

Note

It is not recommended to view DVL Manager using Windows® XP (and previous versions of Windows) as this may cause issues with connectivity and the display of the DVL Manager interface.

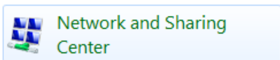
9.4 DVL Configuration

9.4.1 DVL Manager Connection

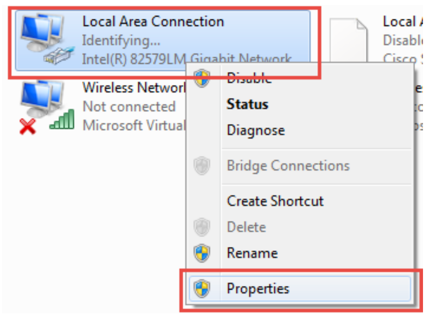
The following steps show how to configure a computer to connect to the Syrinx DVL when configured to the default static IP address. If using DHCP functionality, the IP address of the Syrinx DVL must be known and the network must be configured correctly to allow communications.

To connect to the Syrinx DVL from DVL Manager:

1. Connect the Ethernet cable from the PC to the Syrinx DVL (if the test PC is already configured to communicate with Syrinx DVL via Ethernet, skip to *Step 10*).
2. To configure the network settings, click **Start > Control Panel**.
3. Click **Network and Sharing Center**.



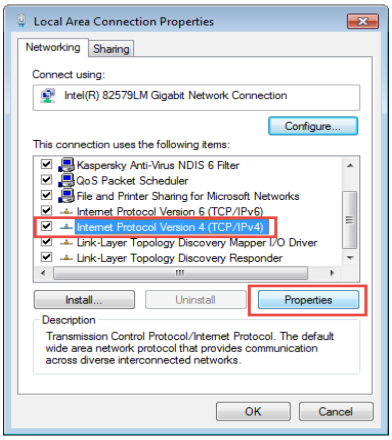
4. On the left pane, click **Change adapter settings**, right-click the **Local Area Connection** and then select **Properties**.



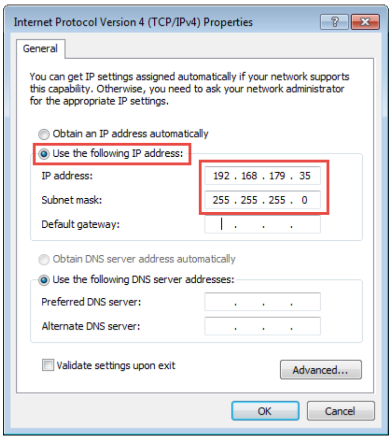
Note

The correct port can often be identified by the connection specifying "Identifying" if the port is currently set to obtain an IP address automatically.

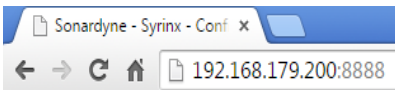
5. On the **Networking** tab, click **Internet Protocol Version 4 (TCP/IPv4)** and then click **Properties**.



6. Select **Use the following IP address** and then enter an IP address with the following values: **192.168.179.xxx** (where xxx is any value between 1-254 other than **1**, **50**, **51**, **100**, **150** & **200** as these are used by other Sonardyne instruments).



7. Enter the Subnet mask **255.255.255.0**.
8. Click **Ok** and then click **Close**.
9. In the internet browser, enter the IP address of the DVL (**192.168.179.200**) and press enter:



10. The Embedded DVL Manager will open.

Note

The first time a connection to DVL Manager is made, the "Home" page will be displayed. This page displays the DVL details including serial number and internal hardware. On subsequent connections, DVL Manager will automatically display the "DVL Config page".

9.4.2 DVL Manager Home Page

The DVL Manager Home page displays information about the Syrinx DVL:

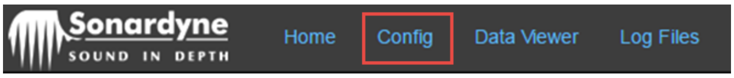
- Serial number
- Unique Identification Number (UID)
- PCB serial numbers
- Embedded software versions

Click **Support** to open the Syrinx DVL User Manual.

Figure 9–1 DVL Manager Home Page

9.4.3 DVL Manager Configuration Page

If DVL Manager opens on the Home page, click **Config**.



The DVL Manager Configuration page is shown below.

Figure 9–2 DVL Manager Configuration Page

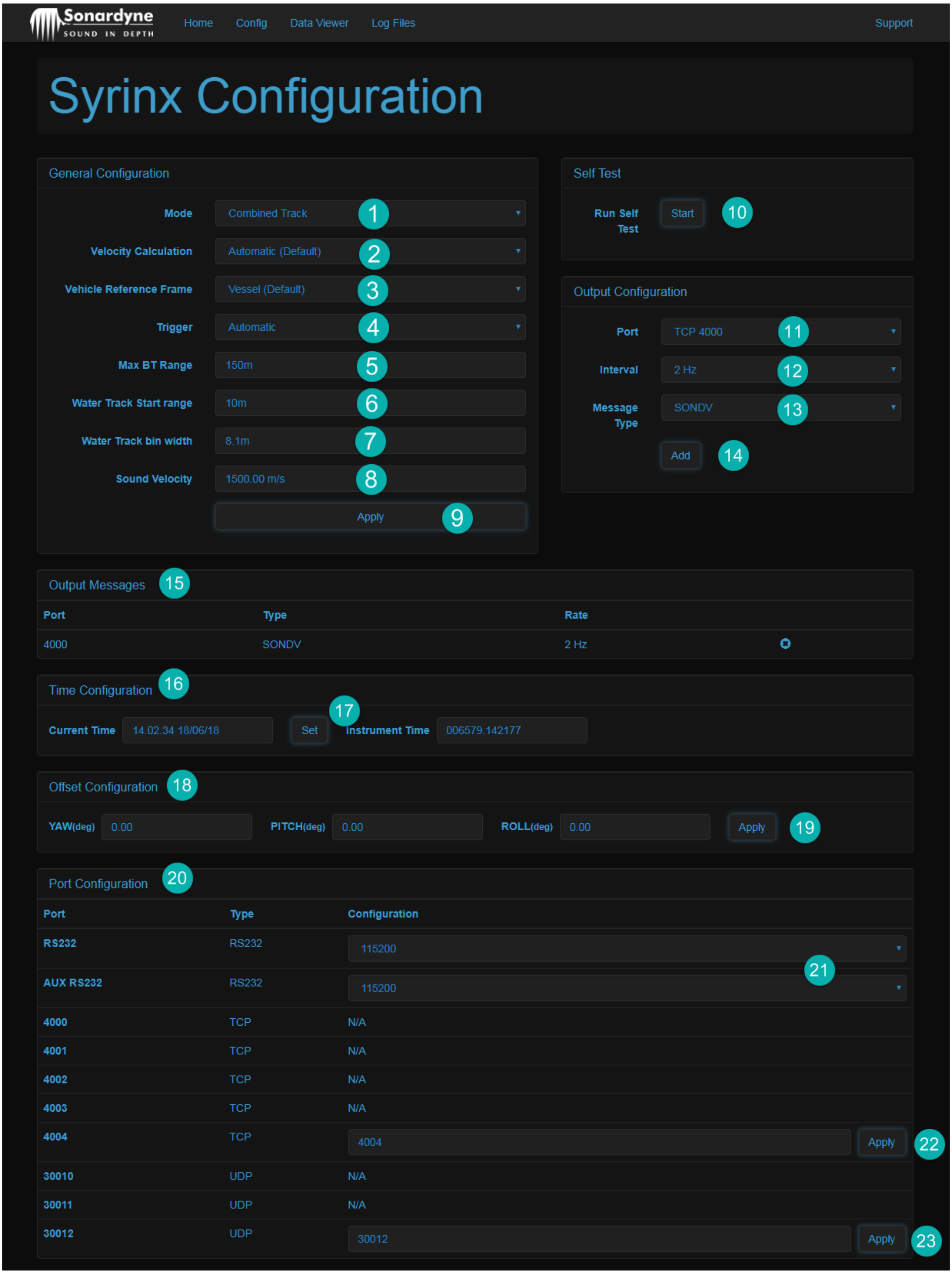


Table 9–1 DVL Manager Configuration Page Features

Item	Description
1	Operating Mode Control
2	Velocity Calculation Control
3	Vehicle Reference Frame Control
4	Automatic/Triggered Operation Control
5	Maximum Bottom Track Range Control (mode dependent)
6	Water Track Start Range (mode dependent)
7	Water Track Bin Width (mode dependent)
8	Sound Velocity Control
9	Apply Configuration Changes
10	Self-Test
11	Telegram Output Port Control
12	Telegram Output Interval Control (N/A if triggered)
13	Output Message Type Control
14	Add Output Telegram (as specified by controls 11, 12 & 13)
15	List of Output Messages
16	Time Configuration Control
17	Set Time Control
18	Offset Configuration Controls
19	Apply Offset Configuration Settings
20	List of Port Configurations
21	Baud Rate Controls for RS232 and AUX RS232 Ports
22	TCP Configurable Port Number Control
23	UDP Configurable Port Number Control

9.4.4 Example Steps to Configure DVL via Ethernet

The below example shows steps to configure the DVL for:

- Free running operation in bottom track mode (No external trigger input)
- Maximum range of 150 m (400 kHz maximum range exceeds 200 m)
- Sound velocity of 1500 m/s
- PD4 telegram output @ 5 Hz on Ethernet TCP port 4001.

To configure the Syrinx DVL:

1. On the **General Configuration > Mode** drop-down list ①, select **Bottom Track**.
2. On the **Velocity Calculation** drop-down list ②, select **Automatic**.
3. On the **Vehicle Reference Frame** drop-down list ③, select Vessel.
4. On the **Trigger** drop-down list ④, select **Automatic**.
5. On the **Max BT Range** ⑤ , enter **150m**.
6. The **Sound Velocity** ⑧ value default is **1500 m/s** (this value can be left as it is).
7. Click **Apply** ⑨.
8. On the **Output Configuration > Port** drop-down ⑪ select **TCP 4001**.
9. On the **Interval** drop-down list ⑫ select **2 Hz**.
10. On the **Message Type** drop-down list ⑬ select **SONDV**.
11. Click **Add** ⑭.
12. The telegram output will now appear in the **Output Messages** ⑮ list.

Note
Syrinx DVL is configured as a TCP server for the purpose of transmitting data via TCP Ethernet communications.

9.4.5 DVL Manager Data Viewer

To open the live Data Viewer, click **Data Viewer**.

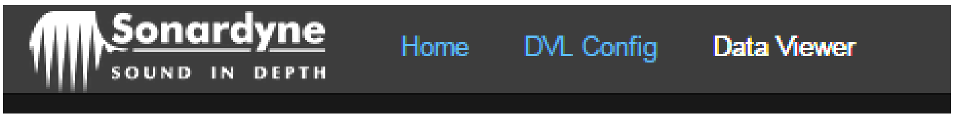
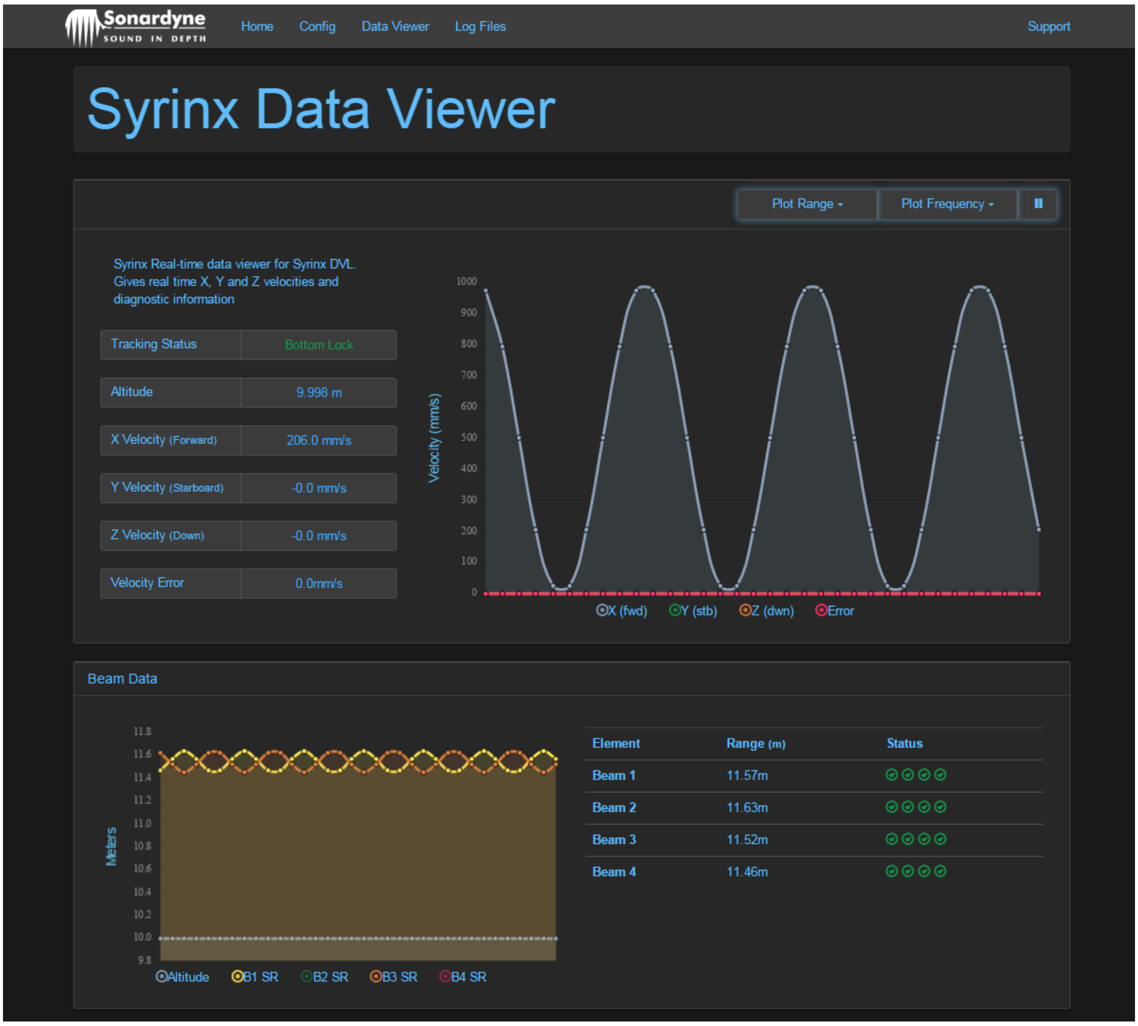


Figure 9–3 DVL Manager Data Viewer



The Data Viewer will automatically start displaying data if the unit is in free running mode (and able to collect valid data in water, or is configured to simulate mode), or if configured for trigger input and a trigger is being provided. Controls for the graph are located in the upper right corner of the graph.

Plot Range changes the number of data points being displayed on the chart.

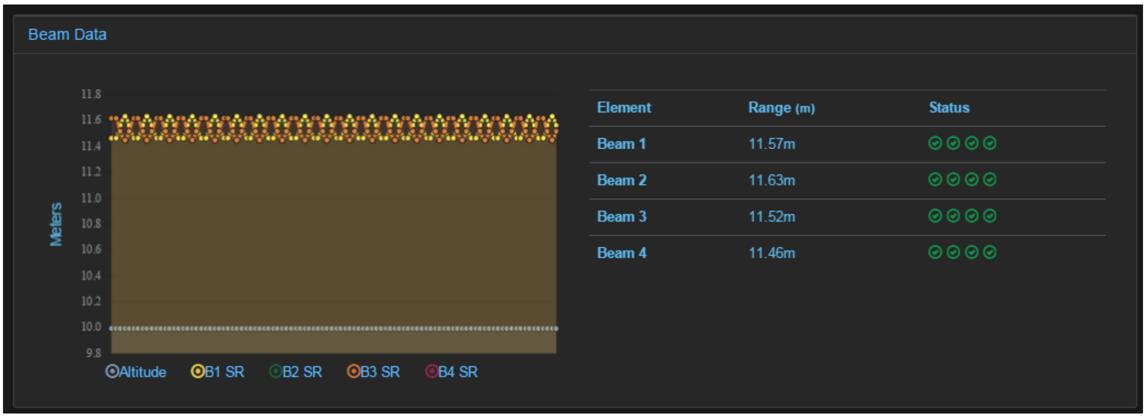
Plot Frequency changes the update rate of the chart data display.

Play/Pause pauses the display. This will not stop the data stream to the chart, and when play is pressed, previous data will no longer be displayed on the chart as the chart will update to show the most recent data.

The **Beam Data** contains slant range and diagnostic information for each of the beams as shown below as well as a chart showing beam slant ranges and altitude.

Beam slant range and altitude plots can be enabled and disabled on the chart by selecting the coloured icons beneath the chart.

Figure 9–4 Beam Diagnostics



- Slant range (direct distance from transducer to reflector)
- Status indicators for:
  - Used status (whether the beam is used in the velocity solution)
  - Error status (whether the error value on the beam exceeds the threshold for quality)
  - Correlation score (quality of returned signal)
  - Signal strength (strength of returned signal)

Each status indicator will show a green tick, or an orange cross depending on the data.

Table 9–2 Beam Diagnostics Details

Symbol	Used Status	Error Status	Correlation Score	Signal Strength
	Beam used in velocity calculation	Error value low – data is reliable	Correlation score high – signal return is as expected	Signal strength is high – external noise is not affecting operations
	Beam not used in velocity calculation	Error value high – data is less reliable	Correlation score low – signal return is sub-optimal	Signal strength is low – external noise is affecting operations

See *Section 17 "Troubleshooting for Syrinx DVL"* for detailed explanations of issues and possible resolutions.

9.4.6 DVL Manager Configuration

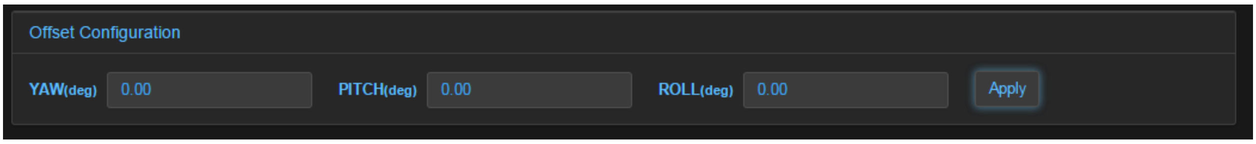
The advanced controls on the **Config** tab should only be changed by an experience operator with a complete understanding of the consequences once changes have been made.

WARNING

The following settings can have adverse effects on navigation if used incorrectly. Advanced settings should only be changed by an experienced operator who fully understands the consequences of changes being made. If in doubt, contact Sonardyne Support.

Offset Configuration:

Offsets for Yaw, Pitch and Roll can be entered to transform the data from instrument frame to a vehicle frame output. The values entered should be the gross differences between the vehicles forward direction & 0° orientation of pitch and roll and the mounting orientation of the Syrinx DVL.



Notes

PD0, PD3, PD4, PD5, PD6 or PD13 output telegrams automatically use the same instrument frame as RDI (assume Port-Fwd beam is facing direction of travel). If the FORWARD mark of the Syrinx DVL is facing direction of travel, a +45° Yaw value is required.

Refer to CFG command VRF setting for reference mode (must be in Vessel or Earth reference frame for offsets to be applied).

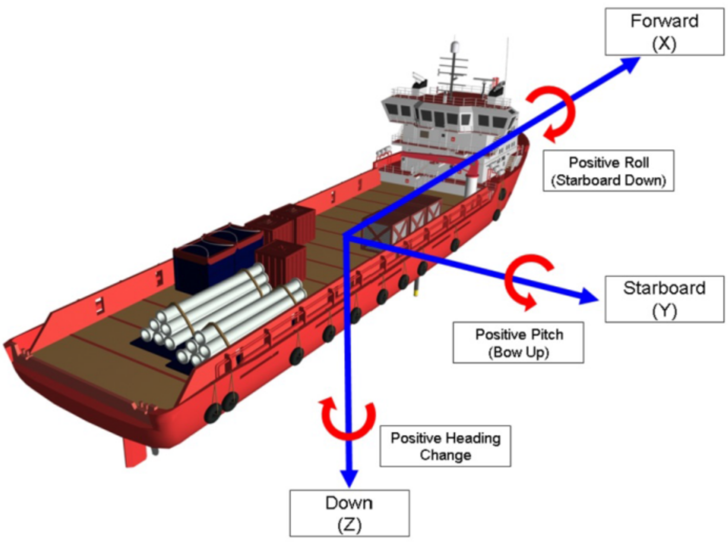
Conventions (assuming transducers facing down):

- Positive Yaw = Positive heading change
- Positive Pitch = Bow up
- Positive Roll = Starboard down

Syrinx applies transformations to the velocity data in the following order:

- 1st: Yaw
- 2nd: Roll
- 3rd: Pitch

Figure 9–5 Syrinx DVL Sign Conventions



Conventions for RDI Message Outputs

When a PD0, PD3, PD4, PD5, PD6 or PD13 message output is configured, Syrinx automatically applies the same instrument frame and velocity conventions as would be used in an RDI DVL (assuming Port-Fwd beam is facing direction of travel). If forward mark of Syrinx DVL housing is facing direction of travel, a **+45° Yaw** value must be added in the DVL Manager or using the OFS command; see *Section 9.8.4 "OFS – Offset Command"*. This is the same configuration as would be required in an RDI DVL (e.g. RDI command: EA+04500).

Note

Refer to CFG command VRF setting for reference mode (must be in Vessel or Earth reference frame for offsets to be applied).

9.4.7 DVL Manager Log Files

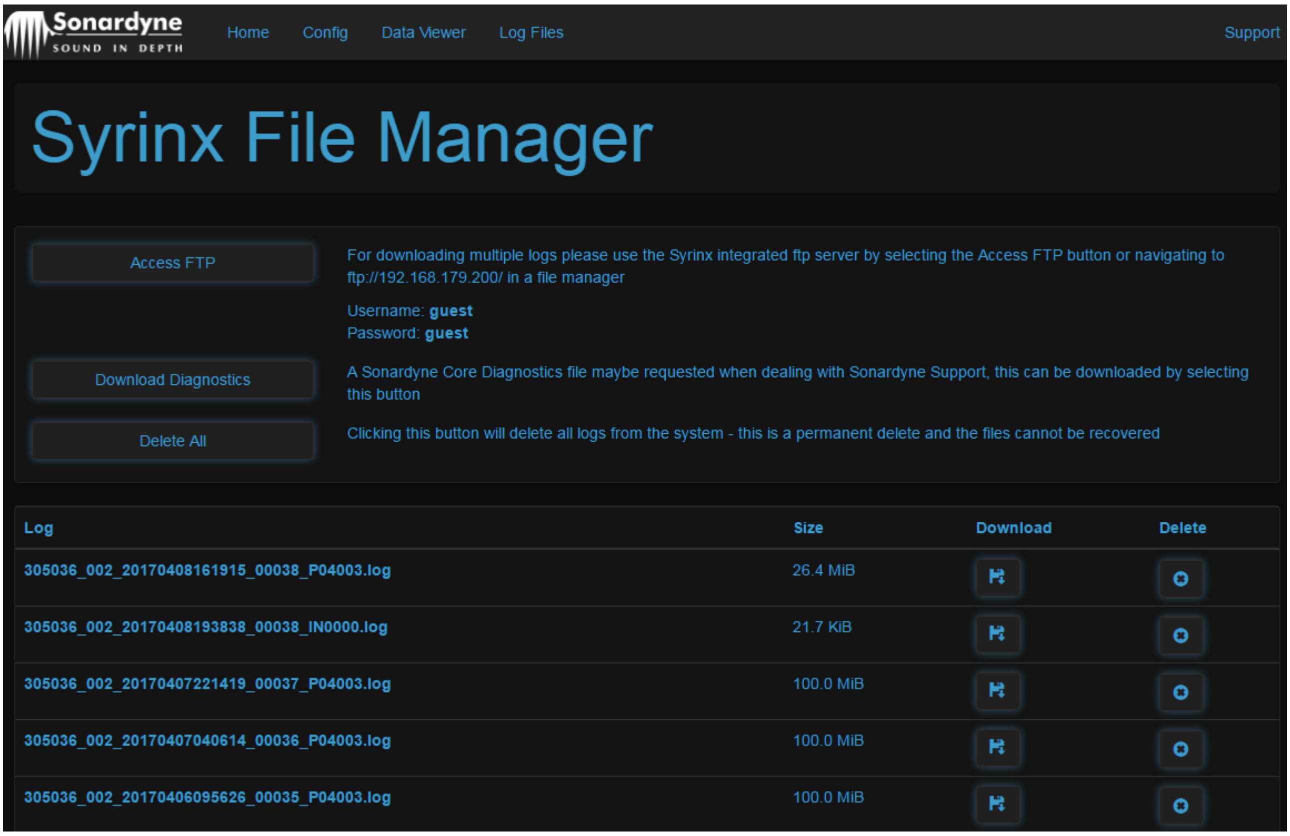
The Syrinx DVL automatically logs all user configured output telegrams as well as all user actions, plus some diagnostic information for Sonardyne support analysis.

The DVL File Manager allows log files to be downloaded and deleted, either individually or multiple file downloads via read only ftp as described below.

9.4.7.1 Download an Individual File

To download an individual file:

Click the file's corresponding icon, browse to a location and then click **OK** to save the file.



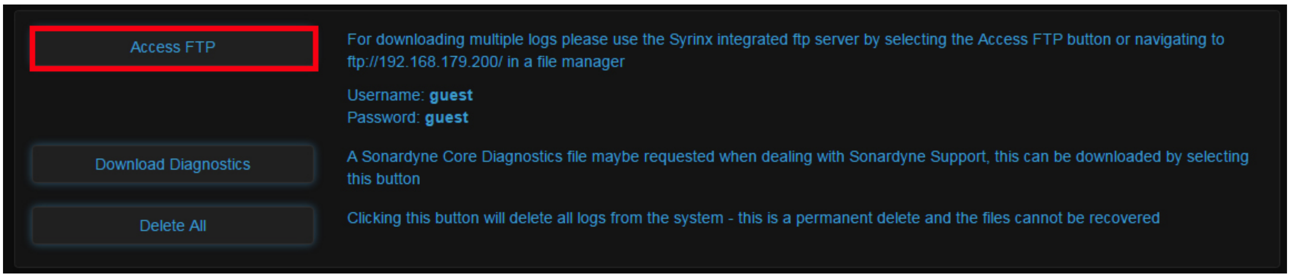
9.4.7.2 Download Multiple Files using an FTP Client

To download multiple log files via ftp, click **Access FTP** on the DVL File Manager or use your preferred FTP client to access the server with the following details:

Server address: The IP address of the DVL (default **192.168.179.200**)

Username: **guest**

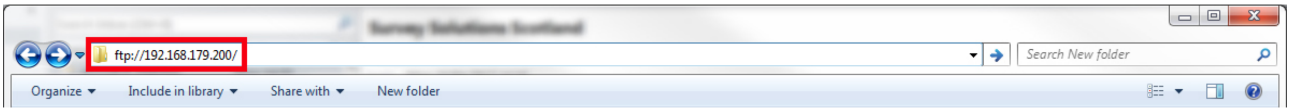
Password: **guest**



9.4.7.3 Download Multiple Files using Windows Explorer as an FTP Client

The following example uses Windows Explorer as an FTP client (it is assumed the DVL's IP address has not been changed from the default 192.168.179.200.

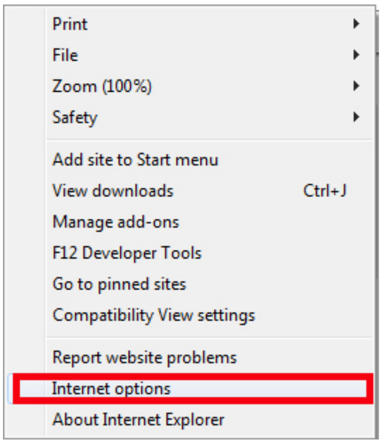
1. Open a Windows Explorer window, enter **ftp://192.168.179.200/** and then press Enter.



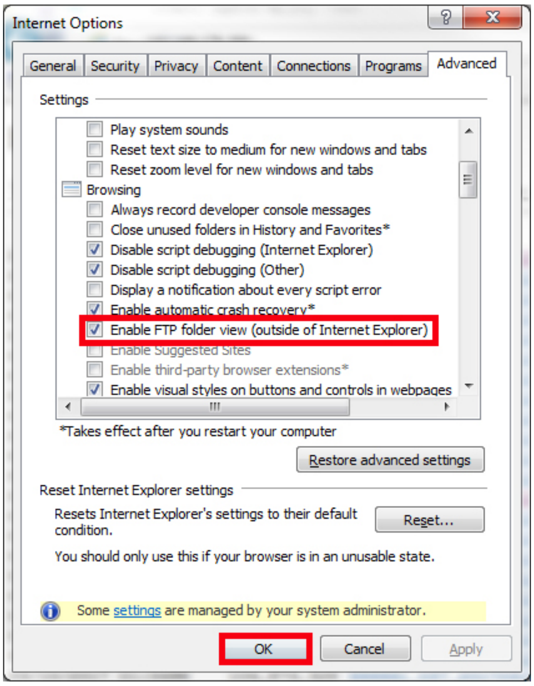
Note

If an Internet Explorer window opens instead of the FTP Log On window, change the Internet Options settings; follow step 2, otherwise skip to step 4.

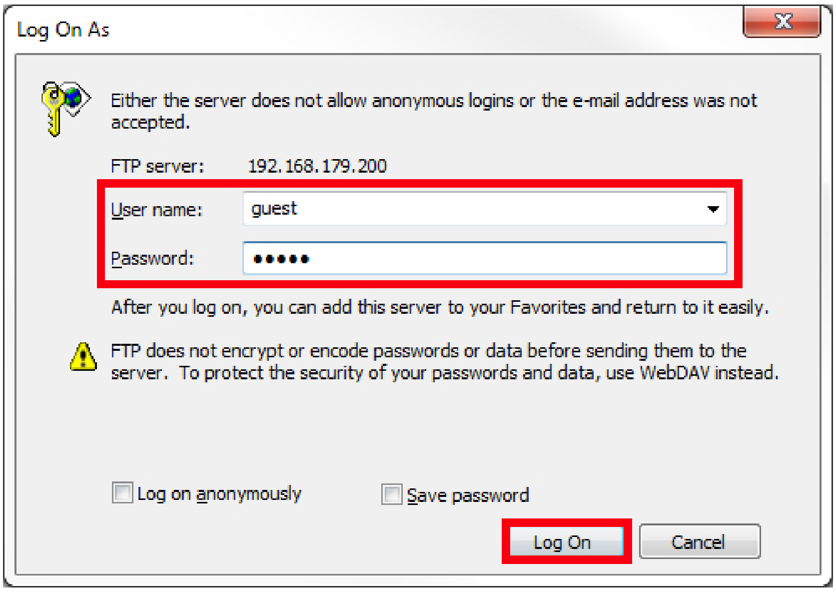
2. Click the settings icon on the Internet Explorer browser and select **Internet Options**.



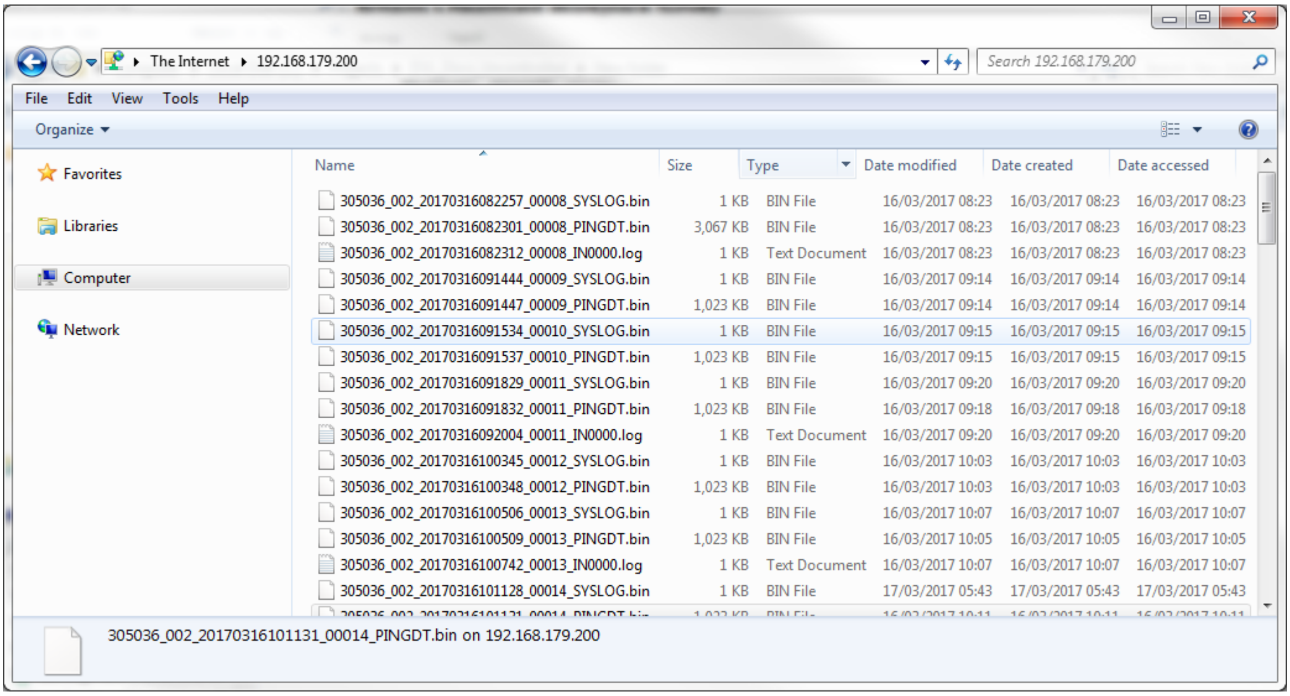
3. On the **Advanced** tab, select **Enable FTP folder view (outside of Internet Explorer)** and then click **OK**.



4. Enter the FTP user credentials
   a. User name : **guest**
   b. Password: **guest**
5. Click **Log On**.



6. A directory listing of the DVL Logs will be displayed in Windows Explorer.



7. Select and copy the required files to the new location.

9.4.7.4 Delete an Individual File

Click the file's corresponding icon.

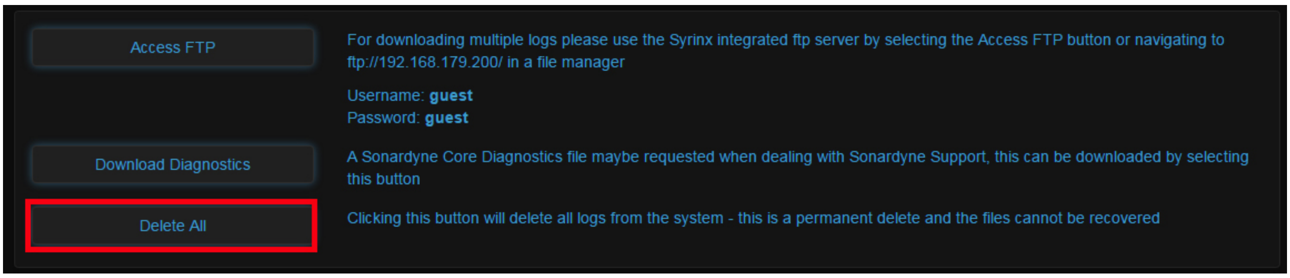
Notes

If the file is currently in use the contents will be cleared but the file will not be deleted.

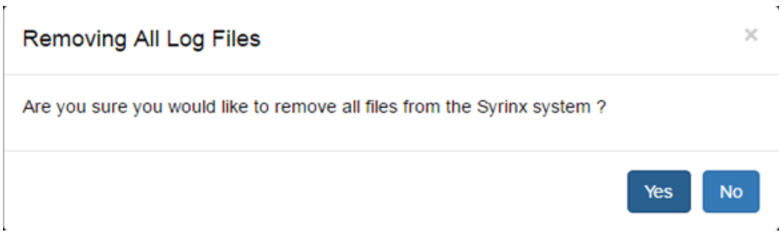
Be aware that once the icon is clicked the file will be deleted without any further confirmation required.

9.4.7.5 Delete All Files

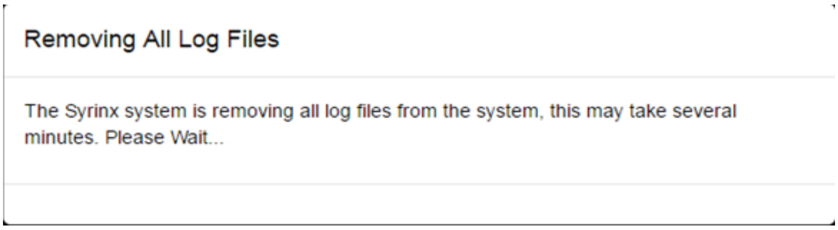
1. Click **Delete All**.



2. Click **Yes** to confirm removal of all files.

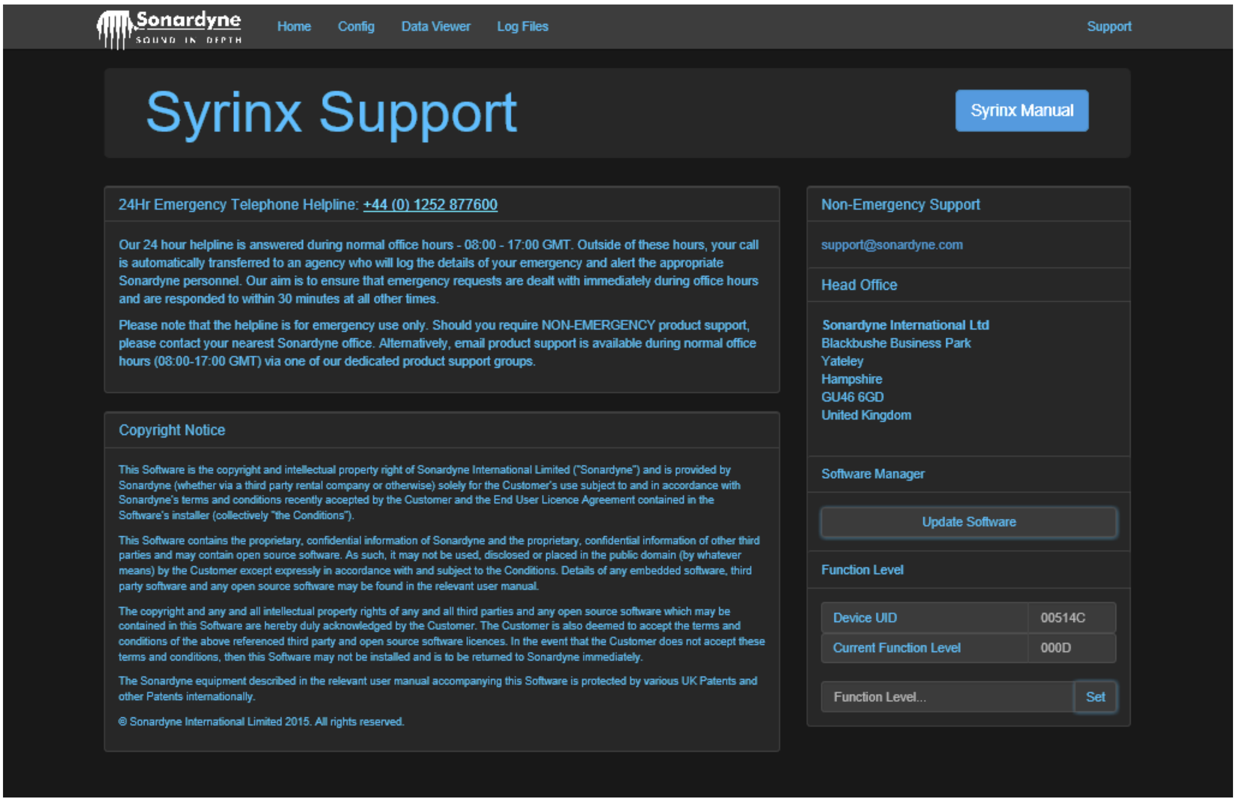


3. The Syrinx system will confirm that the files are being removed.



9.4.8 DVL Manager Support Page

Click **Support** to open the support page similar to the support page shown below.



The support page contains a link to the Syrinx DVL user manual that can be displayed in the browser or downloaded to the PC. Embedded software (firmware) updates to the Syrinx DVL are performed on the support page of the DVL Manager; see *Section 13 "Software Update for Syrinx DVL Manager"* for instructions on how to update Syrinx DVL embedded software.

Functionality updates are also performed on the support page; see *Section 13.5 "Functionality Update"* for instructions on how to update the functionality.

To contact Sonardyne Support, click the email address hyper link on the **Non-Emergency Support** pane. This will open your default email software and generate an email containing hardware and other details of your device required for effective support of the product.

Note

Internet Explorer web browser can operate in a “protected mode” which can prevent the email link from working as intended. To disable “protected mode”, click Tools>Internet Options, click the Security tab and then clear the Enable Protected Mode check box. Restart your browser and re-check if the email link works. Contact Sonardyne Support if the problem persists.

9.5 ADCP Configuration

9.5.1 ADCP Functionality

Acoustic Doppler Current Profiling (ADCP) capability can be enabled for Syrinx via a firmware upgrade. This capability allows water currents to be measured at different depths, also known as current profiling.

If ADCP functionality is enabled on your Syrinx DVL, two additional modes are available: ADCP and DVL+ADCP.

Note

To confirm if ADCP functionality is enabled on your Syrinx DVL, either:
1 Click "Support" on the menu bar and check the functionality level, or
2 Click "Config" on the menu bar; if ADCP functionality is enabled, the modes"ADCP" and "DVL+ADCP" will be present in the drop-down list.

9.5.2 Mode Types

Both ADCP and DVL+ADCP modes produce ADCP data in the industry standard PD0 format (see *Appendix F* for a full description of the PD0 format). The PD0 data is logged to file on the device for later retrieval and can optionally be streamed out of one of the ports; see *Section 9.6* and *9.7*.

Similarly to bottom tracking, ADCP velocities can be specified in Beam, Instrument, Vessel or Earth frame.

9.5.2.1 ADCP Mode

In ADCP mode, every ping from Syrinx is optimised for measuring current profiles. The seabed is not bottom tracked, though an estimate of the bottom track velocity may be performed if the seabed is in range of the ADCP ping. Water profile data is captured as PD0 format data packets, written to disk, and (optionally) exported live. In this mode, the maximum range of profile is limited to the capability of the hardware. The maximum profile range is 80 m (600 kHz variant) and 120 m (400 kHz variant).

9.5.2.2 DVL+ADCP Mode

In DVL+ADCP mode, the standard bottom tracking pings used in Auto mode are alternated with ADCP pings. The bottom track pings attempt to acquire and then track the seabed exactly as in standard DVL operation. DVL+ADCP mode therefore allows simultaneous navigation using bottom tracking and the capture of current profile data. The bottom track and ADCP pings are merged into a single PD0 ensemble, written to disk, and (optionally) exported live. In this mode, the profile range is limited to the maximum bottom tracking range as specified in *Section 9.4.4 "Example Steps to Configure DVL via Ethernet"*.

9.5.2.3 Configuration Options

When Syrinx is put into ADCP or DVL+ADCP mode, the number of depth cells and the width of each cell must be specified. The PD0 data produced contains current velocity data for the specified number of depth cells, where the velocity in each depth cell is an average of the velocity over the depth range encompassed by the cell.

In either mode, additional configuration options are available on the Config page in the ADCP Configuration panel (see the figure below).

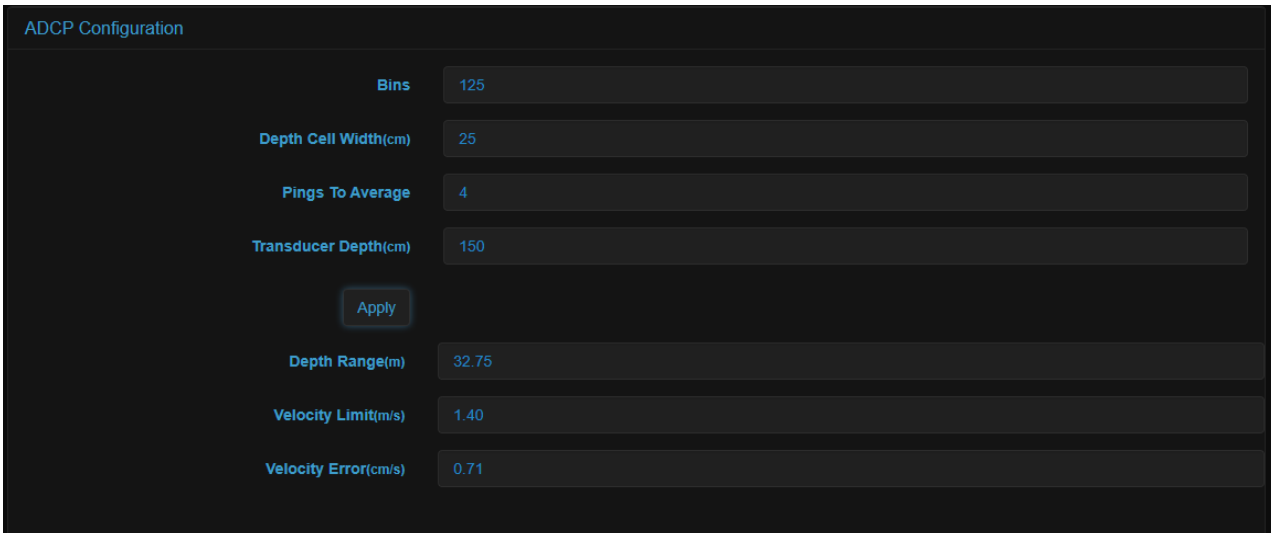
In ADCP or DVL+ADCP mode, the WT start range and WT bin width reflect the start and extent of the profile respectively. In particular, the WT bin width is equal to the product ADCP bin width x number of ADCP bins.

9.5.3 ADCP Configuration Steps

The following example shows how to configure the ADCP profile data to use 125 bins, each of vertical width 0.25 m, for a profile depth of 31.25 m. The Syrinx transducers are at depth 1.5 m, so the actual depth of water profiled is from 1.5 m to 32.75 m.

Connect to the Syrinx DVL as described in *Section 9.4 "DVL Configuration"* and then configure the ADCP as described below.

In the following DVL Manager configuration page example, four pings are averaged per PD0 ensemble to increase the accuracy of the velocity data:



1. **ADCP Configuration > Bins**, enter **125**.
2. **ADCP Configuration > Depth Cell Width (cm)**, enter **25**.
3. **ADCP Configuration > Pings To Average**, enter **4**.
4. **ADCP Configuration > Transducer Depth (cm)**, enter **150**.
5. Click **Apply**.

After clicking Apply, ADCP data is logged to the device as PD0 files (these are identified on the Log Files page by having the .pd0 extension).

Notes

Each time the ADCP configuration is changed (e.g. by changing the bin width) the current .pd0 file is closed and a new .pd0 file will be opened.~

The Depth Range, Velocity Limit and Velocity Error are not modifiable, but are all updated after clicking Apply.

To stream ADCP data from the device, configure an output port to use PD0 messages via the **Output Configuration > Message** Type drop-down list. In the example below, PD0 data is streamed by a TCP server listening on port 4001:

Output Messages

Port	Type	Rate	
4001	PD0	2 Hz	

After clicking **Apply**, ADCP data is logged to the device as PD0 files (these are identified on the Log Files page by having the .pd0 extension). File sizes are limited to 16 MB; a new file is created when this limit is exceeded.

9.5.4 Downloading ADCP Data

To download ADCP data, see *Section 9.4.7 "DVL Manager Log Files"*.

9.5.5 External Sources of Data

Syrinx DVL can import data from other devices to improve the value of the captured current profiles. The imported data falls into two categories: ASCII strings, and binary messages from the Sonardyne Lodestar navigation system. A Syrinx set up to import ASCII strings should not be configured to import Lodestar messages at the same time, and vice versa.

9.5.5.1 ASCII Strings

All ASCII strings can be imported from any available port on Syrinx, for example, Serial port, TCP, or UDP. The available ports are listed under **Port Configuration** on the Web UI Config page; see *Figure 9–2*.

NMEA Strings

NMEA strings are imported in order to specify the geographical position of Syrinx and its heading.

- GGA strings are used to inform Syrinx of its geographical position, i.e. its Latitude and Longitude. The GGA data is embedded into the PD0 data produced by Syrinx when in ADCP mode.
- VTG strings are used to inform Syrinx of its heading and its speed over ground. The VTG data is embedded into the PD0 data produced by Syrinx when in ADCP or DVL+ADCP mode.

SON2

The SON2 message is used to inform Syrinx of its pitch, roll and heading from an external attitude sensor. The SON2 data is embedded into the PD0 data produced by Syrinx when in ADCP or DVL+ADCP mode.

9.5.5.2 Lodestar Messages

If Syrinx DVL is in use as part of a Sonardyne SPRINT Nav hybrid navigator system, it can import Lodestar messages from SPRINT. Currently, only multiplexed binary LNAV messages are supported. LNAV messages contain a solution for the vehicle's position, speed, heading and attitude obtained from an inertial navigation system (INS). The INS is normally guided by bottom tracking measurements or USBL/LBL range data.

LNAV messages should not be output to Syrinx if the ASCII string messages above are already present; in any case, NMEA strings and the SON2 message will take precedence over any LNAV data.

For Syrinx to receive LNAV messages, the SPRINT-Nav system must be configured to output multiplexed LNAV messages on a TCP server with port 5000. A message rate of 5 Hz is recommended. See the SPRINT-Nav user manual for details on how to perform this configuration.

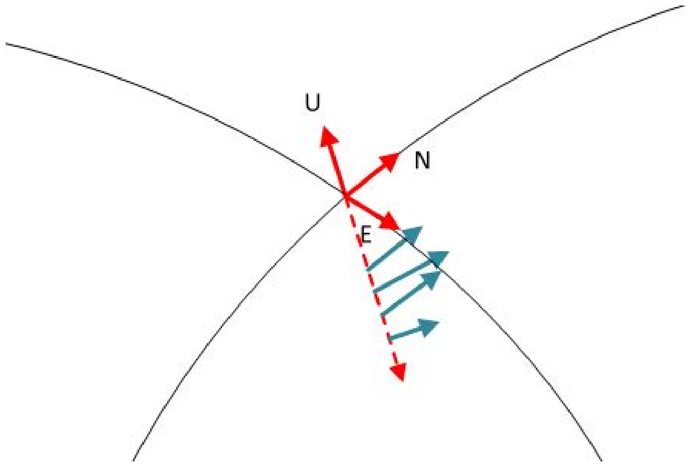
9.5.6 Frames of Reference

Syrinx ADCP velocities may be produced in one of four reference frames: Earth, Vessel, Instrument, and Beam. The coordinate system used for each frame follows the convention set out in PD0; see *Appendix F* for details. Different frames of reference may be best suited for different applications. The desired frame of reference may be selected with the CFG command (see *9.8.1 "CFG Command"*), via the Web UI (see *9.4.3 "DVL Manager Configuration Page"*), or using the Sonardyne Echo Observer software.

9.5.6.1 Earth Frame

In Earth frame, velocities are expressed in terms of Eastward, Northward, and Upward (ENU) components. Each component is reported in the PD0 data for each depth cell according to the PD0 definition in *Appendix F*. Earth frame velocities are often used to express how the currents are moving with respect to geographic location, such as in estuarine surveys.

Figure 9–6 ADCP Velocities Measured in Earth Frame

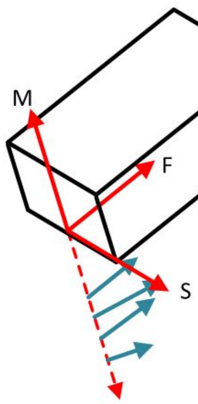


Red Lines	Indicate three independent directions: East, North and Up axes
Red Dashed Line	Indicates increasing depth
Blue Lines	Indicate the flow of water at different depths

9.5.6.2 Vessel Frame

In Vessel frame, velocities are expressed in terms of Starboard, Forward and Mast (SFM) components. Each component is reported in the PD0 data for each depth cell according to the PD0 definition in *Appendix F*. Vessel frame is often used to express how the currents are moving with respect to the vessel, such as in station keeping applications.

Figure 9–7 ADCP Velocities Measured in Vessel Frame

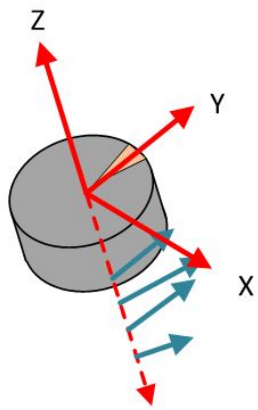


Red Lines	Indicate three independent directions: Starboard, Forward and Mast axes
Red Dashed Line	Indicates increasing depth
Blue Lines	Indicate the flow of water at different depths

9.5.6.3 Instrument Frame

In Instrument frame, velocities are expressed in terms of X, Y and Z coordinates. Each component is reported in the PD0 data for each depth cell according to the PD0 definition in *Appendix F*.

Figure 9–8 ADCP Velocities Measured in Instrument Frame

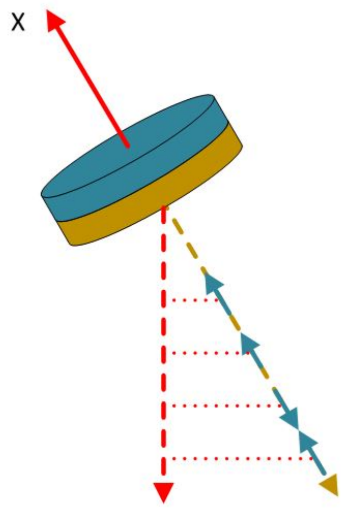


Syrinx DVL Grey Cylinder	Orange triangle indicates the forward notch (transducers are facing downwards)
Red Lines	Indicate three independent directions: X, Y and Z axes
Red Dashed Line	Indicates increasing depth
Blue Lines	Indicate the flow of water at different depths

9.5.6.4 Beam Frame

In Beam frame, velocities are expressed in the direction of the principal acoustic axis of the transducer. The principal acoustic axis is the direction of greatest sensitivity of the transducer. By convention, the direction of positive water flow is along the principal acoustic axis towards the transducer.

Figure 9–9 ADCP Velocities Measured in Beam Frame for one Transducer



Yellow	Active face of the transducer
Red Line	Principal acoustic axis of the device
Yellow Dashed Line	Direction in which water velocities are measured
Red Dashed Line	Indicates increasing depth
Blue Lines	Indicate the flow of water at different depths

9.6 Ethernet Connection via Terminal Software

Syrinx can be communicated with over Ethernet through terminal software either using TCP or UDP connections. There are 4 fixed TCP ports, one configurable TCP port, 2 fixed UDP ports and one configurable UDP port.

The default IP address of the Syrinx DVL is:

- 192.168.179.200

Fixed TCP ports available for connection are as follows:

- 4000
- 4001
- 4002
- 4003

The UDP connection to the Syrinx DVL is not symmetrical. UDP Unicast is used to send data to the Syrinx DVL on its own IP address (default 192.168.179.200), while UDP Multicast is used to transmit data from the Syrinx DVL to the Multicast address: 230.229.228.227. The fixed UDP ports used are the same for both Unicast receive and Multicast transmit as follows:

- 30010
- 30011

The configurable TCP and UDP ports can be configured via the PORT command (see *Section 9.8.5 "PORT Command"*

9.7 Serial Connectivity

9.7.1 Serial Configuration

Syrinx supports the following configurable Baud rates:

- 2400, 4800, 9600, 19200, 38400, 57600, 115200

The Syrinx DVL has a fixed serial configuration of:

- Data Bits: 8
- Parity: None
- Stop Bits: 1

9.7.2 Serial Reset

There are two main methods of resetting the Syrinx DVL, the first is a serial break and the second is by sending an UNLK command.

- A serial break of length greater than 50 milliseconds will force the instrument to reset.
- If the serial sequence of characters “UNLK” is sent (with a carriage return) at 9600 baud then the instrument will reset. The UNLK command must be sent at 9600 baud regardless of the current configured baud rate of the instrument.
- Following a serial reset the instrument will output the serial response defined for the PORT Command from the serial ports. This response is always sent at 9600 baud and so can be used to identify the baud rate of the Syrinx DVL should it not be known.

Example:

<UNLK or Serial BREAK

>PORT:PID0,P0;BR57600,P1;BR19200

Port 0 (P0) is configured to 57600 baud and P1 is configured to 19200 baud.

9.8 Manual Syrinx DVL Configuration

Syrinx DVL can also be configured manually either via serial connection or through a TCP or UDP Ethernet connection when using a terminal package to view and transmit communications.

Notes

All commands must be appended with a Carriage Return Line Feed (CRLF) at the end of each message.

When using SYS software version 1.00.18.00 or earlier, all commands must be sent with all characters capitalised. For later versions, capitalisation is not required.

9.8.1 CFG Command

The CFG command is used to set the operating mode of the Syrinx DVL, i.e. auto/water track, trig/free-running.

Command:	**<CFG:{AUTO,WT,WBT,SIM,ADCP,DVLADCP},{FREE,TRIG+,TRIG-},WLS;{AUTO,3BEAM,JANUS,DISx}, Rxx,SVxx,TDxx.xx**	
	<CFG Requests the set operating mode	
Reply:	**>CFG:AUTO,TRIG+,WLS;AUTO,R150,SV1500.00,WTSR31,WTBW52,TD1.174,VRF;INST**	
Parameter:	Configuration mode	How the DVL will be configured: **AUTO** The DVL will automatically adjust it's power/gain/signal **WT** The DVL will operate in Water-track mode (i.e. not bottom-lock, the user can adjust settings via the CONFIG command **WBT** Sets the unit to flip flop mode between AUTO and WT with a 50:50 duty cycle **SIM** The DVL will operate in simulate mode and bottom-track (N.b if required functionality level is set) **ADCP** Acoustic Doppler Current Profiling mode (only allowed if functionality set to ADCP) **DVLADCP** Sets the unit to flip flop mode between AUTO and ADCP with a 50:50 duty cycle (only allowed if functionality set to ADCP)
	Trigger mode	Sets the unit's trigger mode: **TRIGx** Sets the unit into externally triggered mode **+** sets the DVL to trigger on a positive edge **-** sets the DVL to trigger on a negative edge **FREE** Sets the unit into free-running mode. The **OUT** command will set the rate, if no outputs set then the unit will default to 1 second updates (internal diagnostic only as no actual output configured)
	WLS	Weighted Least Squares Mode sets the internal mode for the velocity solution. Options are: **AUTO** Use 4 or 3 beams automatically depending on acoustic data **3BEAM** only use 3 Beam solution, i.e. exclude worst beam **JANUS** Only use 4 Beam solution **DISx** Do not use an element (i.e. if one is known to be faulty) pass in 1→4 for the element number
	Rxx	This field specifies the bottom track maximum search range of the unit in meters.
	SVxx	Sound Velocity in m/s

	WTSR	Water Track Start Range. This sets the start range for the water track measurement. The unit will adjust the value and report the actual value used based on what is acoustically possible. This is in deci-meters.
	WTBW	Water Track Bin Width. This parameter sets the bin width for the water track measurement. The unit will adjust the value and report the actual value used based on what is acoustically possible. This is in deci-meters.
	TDxx.xx	The minimum delay between triggering the unit and acoustic transmission in milliseconds. Depending on mode there is up to a 512 μs variance in transmit time starting from the minimum value. Tigger Delay has a minimum value of 1.174 ms and can be set in whole milliseconds only. NOTE: The actual minimum delay may differ to the requested value by up to +255 μs due to system limitation
	VRF (Vehicle Reference Frame)	Sets the Vehicle Reference Frame mode of the unit. **BEAM** Where applicable use beam velocities in output messages **INST** Output velocities in the instrument reference frame, ignoring offsets **VESSEL** (default) Output velocities in the Vessel reference frame (Forward, Starboard, Down), taking into account offsets **EARTH** Output velocities in the Earth reference frame (North, East, Down), taking in to account offsets, Heading, Pitch and Roll

CFG command example:

<CFG:AUTO,TRIG+

Set the Syrinx DVL to configure its own power/gain/signal. Set the Syrinx DVL to be triggered externally by a positive going pulse.

>CFG:AUTO,TRIG+,WLS;AUTO,R150,SV1500.00,WTSR139,WTBW28,TD1.174,VRF;VESSEL

9.8.2 ADCP Command

The ADCP command is used to configure the ADCP mode on the Syrinx DVL.

Command:	**<ADCP: BINSxx, WDTHxx, AVGxx, TRDPxx**	
	<ADCP Requests the sensor configuration of available sensors	
Reply:	**>ADCP:BINS50,WDTH80,AVG5,TRDP120,VL5.58,SD18.08**	
Parameter:	BINSxx	Number of bins in the output PD0 data.
	WDTHxx	Width of bins in centimeters, i.e. 80 = 0.8m Command capping (See ADCP operation for logical process): Minimum = 10cm Maximum = 200cm
	AVGxx	Number of pings to average per PD0 ensemble, i.e. 5. Command capping (See ADCP operation for logical process): Minimum = 1 ping Maximum = 32 pings
	TRDPxx	Transducer depth The value is in cm
	VLxx.xx	Beam frame Velocity Ambiguity Limit as determined by the unit. Ensure the water velocity (relative to the Syrinx) remains under this limit The value is in m/s
	SDxx.xx	Beam frame standard deviation of the velocity measurement in each PD0 bin as determined by the unit. Note that this value takes ping averaging and depth cell width into account The value is in cm/s

ADCP command example:

<ADCP

>ADCP:BINS10,WDTH80,AVG5,TRDP120,VL5.58,SD18.08

ADCP set to use 10 bins of 0.8 m in length, with the transducer depth set to 1.2 m. Five pings will be averaged into a PD0 ensemble.

If Syrinx is in DVL+ADCP mode, the total ADCP range (bin width x number of bins) must be less than or equal to the maximum bottom track search range set by the CFG command. If this is not the case, the requested number of ADCP bins will be reduced so that this condition is satisfied.

9.8.3 SCFG Command

The SCFG command is used to configure the various sensors available on the Syrinx DVL.

Command:	**<SCFG: PR;OFSxxxx.xx,SV;{DER,EXT,MAN}**	
	<SCFG Requests the sensor configuration of available sensors	
Reply:	**>SCFG: PR;OFS101.33,SV;MAN,SAL35.000**	
Parameter:	PR	If the optional pressure sensor is fitted this allows configuration of the pressure offset. Reply contains the currently configured offset **TARE** Use a current pressure reading from the on board pressure sensor as the offset value **OFS** can be passed with an optional pressure offset, if an offset is provided then this value is used as the offset value (E.g. OFS101.33, to offset the unit in air) if no value is provided (OFS) then a current pressure reading is taken and used for the offset instead, same as TARE **RST** Resets the pressure offset to 0
	SV	Sets the Sound Velocity source to be used by the Syrinx DVL. **DER** Use a derived solution for sound velocity. This requires the optional pressure sensor to be fitted to the unit **EXT** Use an external Sound Velocity supplied to the DVL (Valeport, PSONSS) **MAN** Use the manually set Sound Velocity (Value can be set via CFG command)
	SALxx.xx	This is the value used for manual Salinity (ppt) when calculating derived Sound Velocity

SCFG command example:

<SCFG:PR;RST,SV;MAN,SAL38

Reset the pressure offset to 0, set the Sound Velocity mode to use the manually configured sound velocity and set a manual salinity value of 38ppt.

>SCFG:PR;OFS0.00,SV;MAN,SAL38.000

9.8.4 OFS – Offset Command

This command is used to set the Syrinx DVL offsets as shown below. The offsets are applied in the Sonardyne reference frame as described in *Section 5.5.2 "Offsets Transformations"*.

To add security to the command the UID will be needed to program the offsets to avoid unintentional overwriting of the values.

Command:	**<OFS:Uxxxxxx,YAWxx.xx,PITCHyy.yy,ROLLzz.zz**	
	<OFS	
Reply:	**> OFS:Uxxxxxx,YAW0,PITCH0,ROLL0**	
Parameter:	YAW	Yaw angle in degrees, Starboard positive
	PITCH	Pitch angle in degrees, Bow up positive
	ROLL	Roll angle in degrees, Starboard down positive

OFS command example:

<OFS:U004531,YAW45.00,PITCH0.00,ROLL0.00

Set yaw offset to +45° pitch & roll offsets to 0°.

>OFS:U004531,YAW45.00,PITCH0.00,ROLL0.00

Negative degree offsets can be applied by inserting a "-" prior to the offset value.

9.8.5 PORT Command

The PORT command is used to set the baud rate of any serial ports on the instrument. It is also used to display Ethernet port information, and to configure the two configurable Ethernet ports.

Command:	**<PORT: Px;BRdddddd,TCPeeeee (sets the serial and Ethernet port(s))**	
	<PORT: Requests port information	
Reply:	**>PORT:PIDx,Px;BRdddddd,Px;{TCP,UDP},Px;{TCP,UDP};CFGx**	
Parameter:	PIDx	Port ID of the current port.
	Px	Port number: 0. See above for details of ports
	BRx	Baud Rate 9600 default, other options, 2400,4800,9600,38400,115200
	TCP or UDP	Identifies the port type if not a serial port.
	TCPx or UDPx	Used to configure the configurable TCP and UDP ports where x is the new port number.
	CFGx	Indicates a configurable Ethernet port, where x indicates which config port is being referred to (currently always 1 as there is only one TCP configurable port and one UDP configurable port).

Port command example:

Set Port 0 to a Baud Rate of 57600

<PORT:P0;BR57600

Reply:

>PORT:PID0,P0;BR57600,P1;BR9600,P4000;TCP,P4001;TCP,P4002;TCP,P4003;TCP,P30010;UDP,P30011;UDP,P5555;TCP;CFG1,P30013;UDP;CFG1

Set configurable TCP port to 5005:

<PORT:TCP5005

Reply:

>PORT:PID0,P0;BR57600,P1;BR9600,P4000;TCP,P4001;TCP,P4002;TCP,P4003;TCP,P30010;UDP,P30011;UDP,P5005;TCP;CFG1,P30013;UDP;CFG1

The Baud rate must be specified exactly as shown in the table above otherwise no change will be made to this field.

ERR[BAUDRATE] is output when the requested baudrate does not match the bandwidth requirements of the currently set-up output messages for that port.

ERR[INUSE] is output when the requested Ethernet port is already in use when configuring the Ethernet ports.

Notes

The PORT command response is sent out of both serial ports at 9600 Baud, following a hard reset.

Serial port baud rates are monitored to maintain output integrity. If a requested command would cause the bandwidth of a port to be less than its current total output, the error ERR[BAUDRATE] is returned e.g. >PORT:ERR[BAUDRATE].

It is recommended to use the highest possible baud rate when operating the Syrinx DVL at high update rates (>5 Hz) to ensure data communication is not lost/delayed through bitrate limitation.

9.8.6 OUT – Output Command

The OUT (OUTput) command is used to set the different output types on certain ports. Multiple outputs can be produced on the same port.

Supported fixed ports include:

P0: RS232 Port 0

P1: AUX RS232 Port 1

P4000: Ethernet TCP Port 4000

P4001: Ethernet TCP Port 4001

P4002: Ethernet TCP Port 4002

P4003: Ethernet TCP Port 4003

P30010: Ethernet UDP Port 30010

P30011: Ethernet UDP Port 30011

Outputs can be configured to the configurable TCP and UDP ports by specifying the port number chosen for example for port 5432, the port can be specified as P5432.

Command:	**<OUT:Px;MSG@x.x;MSG@y.y,Pz;MSG@z.z** **<OUT:Px;MSG@NONE** **<OUT:Px;NONE** **<OUT:NONE** **<OUT:NONE;ALL**	
	<OUT Requests information	
Reply:	**> OUT:Px;SONDV@z.z;MSG@z.z**	
Parameter:	Px	Port number: See above for details of ports, examples are 0,1,4000,4001,4002,4003,30010,30011
	MSG	This is the identifier; MSG itself is not a valid mnemonic. SONDV – Sonardyne basic DVL output (ASCII) ASONDV – Sonardyne advanced output (BINARY) TIME – Sonardyne TIME message (BINARY) SNS – Sonardyne SNS message (BINARY) PD0 – RDI PD0 message output PD3 – RDI PD3 message output PD4 – RDI PD4 message output PD5 – RDI PD5 message output PD6 – RDI PD6 message output PD13 – RDI PD13 message output APD0 – Hexadecimal ASCII representation of RDI PD0 APD3 – Hexadecimal ASCII representation of RDI PD3 APD4 – Hexadecimal ASCII representation of RDI PD4 APD5 – Hexadecimal ASCII representation of RDI PD5 DBT – NMEA Depth Below Transducer message
	z.z	Interval between outputs in fractional seconds. Note this may not be valid for the message selected, if not the value is ignored. Value also ignored if DVL configured to triggered mode. If not specified, the default interval of 0.2 seconds (5Hz is used). This can be set to “MAX” to output the message at the highest achievable rate. This rate will vary with operating altitude.
	None	Depending on where in the message chain this is placed it will remove message outputs. OUT:NONE Removes all output messages on the port that the message was sent in on. OUT:Px;NONE Removes all output messages on port x. OUT:Px;MSG@NONE Removes message type MSG from port x. OUT:NONE;ALL Removes all output messages on all ports, excluding webserver and Lodestar ports 8000, 8010 and 8011 .

OUT command example:-

<OUT:P0;SONDV@0.5,P4001;PD4

Output Sonardyne proprietary DVL output on port 0 at 2 Hz (1 message every 0.5 seconds), PD4 message on port 4001.

>OUT:P0;SONDV@0.5,P4001;PD4@0.2

Notes

Serial port baud rates are monitored to maintain output integrity. If a requested command would cause the total output on a port to exceed its bandwidth, the error ERR[BAUDRATE] is returned e.g. >OUT:ERR[BAUDRATE].

The default interval for configured messages is 0.2 seconds (5 Hz) if not specified when set.

The default output port will be the port the message is received on if not specified e.g. OUT:SONDV@1 would output a SONDV message at 1 Hz on the port the message received on.

MAX update rate can be set to instruct the Syrinx DVL to output data at the highest possible rate.

Sending NONE disables messages on the respective level it is used at:

<OUT:NONE

Removes all output messages on the port the command was sent to the Syrinx DVL on.

<OUT:NONE;ALL

Removes all output messages currently configured on any port of the Syrinx DVL.

<OUT:P4001;NONE

Removes all output messages currently setup on port 4001.

<OUT:P4001;PD4@NONE

Removes the PD4 message setup on P4001.

9.8.7 TIME Command

The TIME command is used to set or get the Real Time Clock (RTC) date and time of the Syrinx DVL Instrument. The date and time can be set based on the first character of the serial / Ethernet command.

Command:	**<TIME:[TDhh.mm.ss;dd/mm/yy]**	
	<TIME:[TRIG]	
Reply:	**>TIME:TDhh.mm.ss;dd/mm/yy,ITFxxxxxx.yyyyyy**	
Parameter:	TDx	Time Date
	TRIG	Optional input parameter and instructs the unit to output the time on the next trigger input. Nb. The time cannot be set on a trigger input. NB: An immediate acknowledgement is returned of format **>TIME:OK**
	ITFxxx.yyy	Instrument time frame in decimal is reported on every time command but cannot be set. Where: xxxx = seconds yyyyyy = micro seconds (i.e. 6d.p) Note: ITF is not on the same time domain as the TDS string. The TDS string sets the RTC clock, whereas the ITF is the monotonically increasing count in the FPGA – see section on Time system for further information.

Time command example:-

<TIME:TD09.06.56;04/06/09 Set time and date (Command)

>TIME:TD09.06.56;04/06/09,ITF13.111321 Time and as set. (Response)

<TIMEGet time and date (Command)

>TIME:TD09.07.10;04/06/09,ITF13.111321 Current Time and date (Response)

<TIME:TRIG Get time and date (Command)

>TIME:OK Request acknowledgement (Response)

>TIME:TD09.07.10;04/06/09,ITF13.111321 Current Time and date (Response) on a trigger

Note

If the trigger input is used and no trigger is received the time will not be set. There is no time out on this best effort attempt, however any new TIME commands will override the original request to set the time.

9.8.8 RSFD – Reset Settings Factory Default Command

The RSFD (Reset Settings Factory Default) command is used to set the Syrinx DVL back to the default factory mode.

Command:	**<RSFD:SERIAL,ETHERNET**	
Reply:	**>RSFD:OK**	
Parameter:	SERIAL	Optional parameter, if present resets the serial ports to 9600 baud
	ETHERNET	Optional parameter, if present resets the units network settings to default (static IP 192.168.179.200 subnet 255.255.255.0) and resets the configurable UDP and TCP ports.

RSFD command example:

<RSFD

>RSFD:OK

Settings will have been reset to the defaults. The settings will depend on current firmware.

<RSFD:SERIAL

>RSFD:OK

Settings will have been reset to the defaults. The settings will depend on current firmware however the serial ports will default back to their default rate.

<RSFD:SERIAL,ETHERNET

>RSFD:OK

Settings will have been reset to the defaults. The settings will depend on current firmware however the serial ports will default back to their default rate and network and Ethernet port settings have been reset.

When an RSFD command is sent to the Syrinx DVL, the following settings will be applied:

Offsets: Yaw +0°, Pitch +0°, Roll +0°

Outputs: All will be removed

Serial Settings: Serial ports will be reset to 9600 Baud rate

Ethernet Settings: Resets the units network settings to default (static IP 192.168.179.200 subnet 255.255.255.0) and resets the configurable UDP and TCP ports.

Configuration: Syrinx DVL will be set to Bottom track mode, free running, 3&4 beam solutions, maximum operating range based on system hardware, Vessel Reference Frame, trigger delay set to minimum, water track start range 100 dm, water track bin width 20 dm.

Sensor Configuration: Sound velocity set to manual 1500 m/s, 35 ppt salinity, 0 pressure offset.

Optional:

Serial Settings: Serial ports will be reset to 9600 Baud rate.

Ethernet Settings: Resets the unit's network settings to default (static IP 192.168.179.200 subnet 255.255.255.0) and resets the configurable UDP and TCP ports.

Note

The setting changes above may differ subtly between firmware versions, depending on available functionality (such as configurable ports).

Real Time Clock

The Real Time Clock (RTC) fitted within the Syrinx DVL has a backup battery life of ~3 hours. If the RTC has not been set (or has lost its time during power down) then the last known Syrinx time (an internal log of the last known RTC time) will be retrieved from file and used to source the RTC and the system time.

9.8.9 ETH – Ethernet Command

The ETH (ETHernet) command is used to configure persistent changes to the Ethernet/IP networking configuration.

Command:	**<ETH:IPxxx.xxx.xxx.xxx,SUBNETxxx.xxx.xxx.xxx ...OR... DHCP_(EN/DIS)ABLE;Rx;Tx**	
Reply:	**>ETH:IP192.168.179.150,SUBNET255.255.255.0,MAC8CE7B3002F17,DHCP_<ENABLED|DISABLED>;R3;T6,CABLE_<(DIS)CONNECTED>**	
Parameter:	IPxxx.xxx.xxx.xxx	Set the IP address of the unit. Dotted decimal format with bytes in 1-254 range (e.g. 192.168.179.200) This field will be set to 0.0.0.0 if no IP address has been allocated.
	SUBNETxxx.xxx.xxx.xxx	Set the subnet mask of the subnet (dotted decimal format with each byte within a 0-255 range; The default is 255.255.255.0). This field will be set to 0.0.0.0 if no IP address has been allocated.
	DHCP_(EN/DIS)ABLE	Enable /Disable DHCP
	Rx	Optional number of retries when trying to contact the DHCP server (default 3) max: 20
	Tx	Optional timeout (seconds) when trying to contact the DHCP server (default 6). Max 30
	MACxxxxxxxxxxx	MAC address of the unit, which cannot be changed. (Hexadecimal format).
	CABLE_<(DIS)CONNECTED>	PHY link enabled or disabled

ETH command example:

<ETH

>ETH:IP192.168.179.200,SUBNET255.255.255.0,MAC8CE7B3345678,DHCP_DISABLED;R3;T6,CABLE_CONNECTED

<ETH:IP192.168.179.199,SUBNET255.255.254.0

>ETH:IP192.168.179.199,SUBNET255.255.254.0,MAC8CE7B3345678,DHCP_DISABLED;R3;T6,CABLE_CONNECTED

<ETH:DHCP_ENABLE;R10;T2

>ETH:IP192.168.89.84,SUBNET255.255.254.0,MAC8CE7B3345678,DHCP_ENABLED;R10;T2,CABLE_CONNECTED

<ETH:DHCP_DISABLE

>ETH:IP192.168.179.200,SUBNET255.255.255.0,MAC8CE7B3345678,DHCP_DISABLED;R3;T6,CABLE_CONNECTED

Setting no parameters returns a status information string.

Setting a dotted decimal format IP address or subnet disables any existing DHCP configuration. If either the IP or subnet parameter is missing when switching from DHCP to static IP then default values are used for the omitted parameter (IP: 192.168.179.200, subnet: 255.255.255.0).

Use the ‘DHCP_ENABLE’ parameter to enable DHCP and disable static IP configuration. Optional sub-parameters; R (retires) and T (timeout) can be used to configure the DHCP client retries and timeout settings. Defaults of R3 and T6 are used when no value specified.

'DHCP_DISABLE' will return the unit to its default static IP and subnet (IP192.168.179.200, Subnet 255.255.255.0).

Cable connection status is always returned whether the PHY detects a physical link connection or not.

The unit should be power-cycled after applying network changes.

Notes

Setting a dotted decimal format IP address disables an existing DHCP configuration.

An IP address can also be set with an optional update of its associated subnet mask. The default subnet mask is 255.255.255.0. Omitting the subnet mask will use the last saved subnet mask.

9.8.10 CKHW – Check Hardware Command

The CKHW (ChecK HardWare) command is used to perform a hardware check on the Syrinx DVL.

Command:	**<CKHW**
Reply:	**> CKHW:PASS[RTC;PASS,PIC;PASS,AFE;PASS,DSP;PASS,ONEWIRE;PASS,TEMP;PASS]**
Parameter:	none

All items in square brackets are subject to change and give diagnostics as to which hardware component passed or failed. Although may change they are always in the following form so a generic parse can be used.

ID;PASS or ID;FAIL

Example:

<CKHW

>CKHW:PASS [RTC;PASS,PIC;PASS,AFE;PASS,DSP;PASS,ONEWIRE;PASS,TEMP;PASS]

9.9 Advanced Settings

9.9.1 DHCP Mode

It is recommended to operate with a static IP address where possible to keep network integration as simple as possible. If DHCP is required, this can be enabled via the ETH command.

Enabling DHCP mode through the ETH command (see *Section 9.8.9 "ETH – Ethernet Command"*) will then allow a DHCP network to assign an IP address and subnet to the instrument.

Setting an IP address through the ETH command will disable DHCP mode.

DHCP Option 60

Syrinx DVL also supports DHCP option 60, where a Vendor Class Identifier is provided to identify the Syrinx DVL to the DHCP server. Syrinx will provide the following under DHCP option 60:

Syrinx DVL 8275-4530:

Length: 23

Vendor Class Identifier: SONARDYNE_TYPE8275-4530

Syrinx DVL 8275-6530

Length: 23

Vendor Class Identifier: SONARDYNE_TYPE8275-6530

Section 10 – Retrieval and Storage

10.1 Introduction

Before retrieving the equipment, ensure *Section 2 – Safety* is read and fully understood.

10.2 Retrieval

On retrieval from the installation location, the following procedures must be carried out before the SPRINT-Nav is stored.

1. Clean the SPRINT-Nav; see *Section 11.4 "Cleaning"*.
2. Inspect the SPRINT-Nav; see *Section 11.5 "Inspection"*.
3. Place connector covers on all connector ports.

10.3 Storage

On completion of all checks in the previous section the SPRINT-Nav can be placed in storage as described below.See *Table 10–1* for the recommended storage conditions.

1. Refit the transducer protection cover.
2. Store the SPRINT-Nav in its transit case.
3. Equipment must be kept in a dry, non-condensing atmosphere (20% to 80% humidity), free from corrosive agents and isolated from sources of vibration.
4. The transit case should be stored on solid, level, clean and damp proof floors. It must not be stored directly on damp/dirty floors or areas prone to flooding. It is recommended to store the case on suitable shelving raised off the floor.
5. It is recommended to visually insect the equipment at least annually.
6. When equipment is taken from low temperature storage for immediate use its temperature should be raised to normal operating temperature before use.

Table 10–1 Storage Conditions

Item	Specification
Storage Temperature	-20°C to 55°C (see Note below)
Relative Humidity	20 to 80% (non-condensing)

Note

To prolong the life of the lithium-ion backup battery, it is recommended to store the instrument in the temperature range of 0° to 30°C.

Section 11 – Maintenance

11.1 Introduction

Before any maintenance is performed, ensure *Section 2 – Safety* is read and fully understood.

To ensure the SPRINT-Nav provides long and effective service, it is important to carry out general and scheduled maintenance.

11.2 Retrieval from the Water

See *Section 10 "Retrieval and Storage"*.

11.3 Dismantling

Dismantling of the SPRINT-Nav must only be carried out by Sonardyne qualified personnel.

11.4 Cleaning

Note

Do not use any abrasive brushes or sharp tools to remove marine growth when cleaning the SPRINT-Nav as this may damage the instrument.

1. Thoroughly wash the instrument in warm clean fresh water to remove accumulations of salt, sand or silt and marine growth, paying particular attention to the electrical connectors.
2. Remove any attached cabling or dummy plugs/protective caps and clean the external socket.
3. Dry the instrument and any attached cabling with a clean lint free cloth.
4. Replace any attached dummy plugs/protective caps.

11.5 Inspection

Regularly inspect the instrument for the following:

1. Inspect the pressure relief vent valve; see *Section 11.7 "Pressure Relief Vent Valve"*.
2. Inspect the housing for signs of damage. At full working depth, the instrument housing is at risk of failure if damage is not repaired.
3. Inspect the connectors and cables for signs of abrasion, damage or corrosion.
4. Check the security of the connectors. Any movement will require attention and the connector to be secured.

11.6 Lubrication

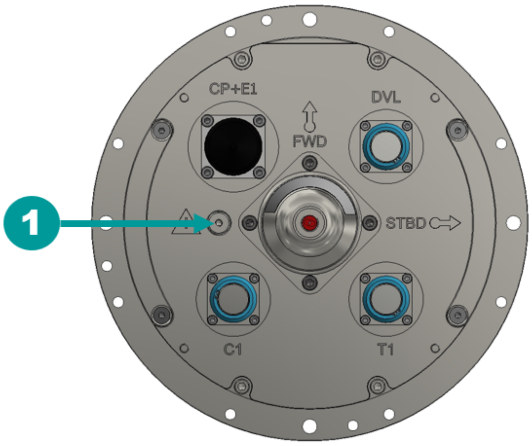
11.6.1 Connectors

The Seacon connectors are dry mating and do not require lubrication on the connector pins/sockets.

11.7 Pressure Relief Vent Valve

11.7.1 Checking the Pressure Relief Vent Valve

Check the pressure relief vent valve is flush with the endcap. If the pressure relief vent valve is not flush it could indicate a pressure build-up during previous operations due to a fault developing in the backup battery pack.



Item	Description
1	Pressure Relief Vent Valve

11.7.2 Operating the Pressure Relief Vent Valve

To operate the pressure relief vent valve:

Note

Refer to Warnings in *Section 2 – Safety* "high internal pressure, risk of toxic gases and corrosive liquids".

1. Screw an M4 bolt into the pressure relief vent valve.
2. Slowly pull the M4 bolt to withdraw the vent valve and wait for any internal pressure to be released.
3. With the pressure relief vent valve pulled out inspect the O-rings for any signs of damage.
4. If necessary, lubricate the O-rings using petroleum jelly.
5. The valve should retract back into place; remove the M4 bolt and check the valve is flush with the endcap face.

11.8 Corrosion

The SPRINT-Nav housing is manufactured from titanium and is highly resistant to corrosion. Under normal use the housing should not show any signs of corrosion and no maintenance is necessary.

11.9 Calibration

The SPRINT-Nav uses rugged and durable high quality inertial sensors of unrivalled and thoroughly field proven reliability: The sensors are used in systems qualified for the most demanding and safety critical applications and are standard fit for use in the main navigation systems of the majority of today's commercial and business aircraft. The inertial sensors are maintenance free.

SPRINT-Nav based products do not require re-calibration (excluding the pressure sensor) subsequent to initial factory calibration unless:

- the unit has been subject to excessive shock beyond quoted specification.
- performance re-verification is requested by the customer.

Performance re-verification is often possible in the field without return to factory; contact Sonardyne Support for more information.

11.9.1 Pressure Sensor

It is important that the SPRINT-Nav pressure sensor module is recalibrated annually by returning it to one of Sonardyne's regional or head offices (addesses can be found at the back of this manual).

The pressure sensor removal and replacement procedure must be performed very carefully to ensure no damage is caused to the internal connections; see *Section 11.11 "Removing and Replacing the Pressure Sensor Module"*. The pressure sensor can be replaced with the supplied blanking plate or another Sonardyne pressure sensor module to allow the SPRINT-Nav to remain operational.

It is recommended to retain the shipping container for the SPRINT-Nav as the base of this container can be used as a stand to keep the SPRINT-Nav stable while it is worked on.

11.10 Scheduled Maintenance

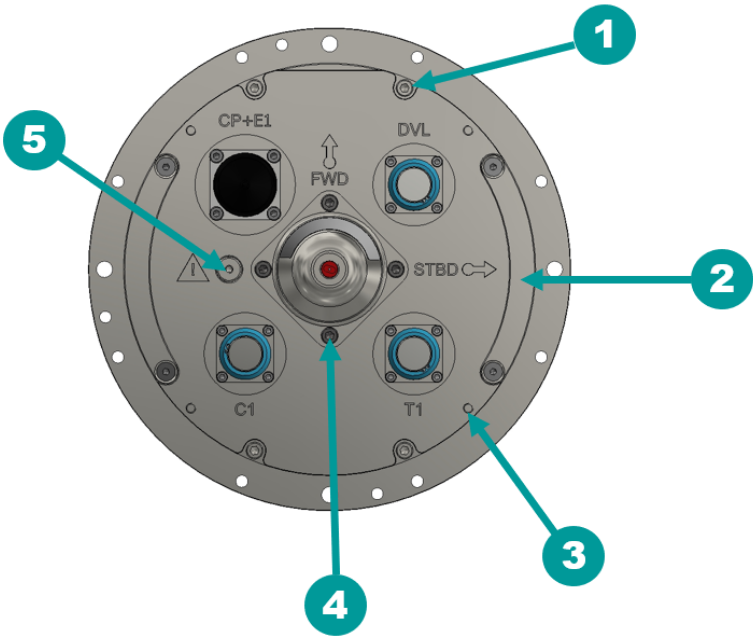
Table 11–1 Scheduled Maintenance Timetable

Maintenance Schedule			
Task	**Before/ After each Deployment**	**6 Monthly**	**Annually**
Clean and inspect; see *Section 11.4* and *Section 11.5*.	**X**		-
Run Self-Test; see *Section 15.3*.	**-**	**X**	-
Pressure Sensor Calibration (see *Section 11.9.1*.	**-**		**X**

11.11 Removing and Replacing the Pressure Sensor Module

The SPRINT-Nav endcap and pressure sensor module securing bolt locations are shown in *Figure 11–1*.

Figure 11–1 SPRINT-Nav Endcap Description



Item	Description
1	Endcap Securing Bolts x 8
2	Endcap Handles x 2
3	Jack-up Threaded Holes x 4
4	Pressure Sensor Securing Bolts x 4
5	Pressure Relief Vent Valve

11.11.1 Removing the Pressure Sensor Module

1. Power down the SPRINT-Nav, remove all external cables and replace with connector caps.
2. Place the SPRINT-Nav on an Electro-Static Displacement (ESD) protected surface.

Notes

An ESD wristband must be worn by the engineer to ensure no damage is caused to the internal electronics.

It is recommended to use the base of the shipping container as a stand in order to keep the equipment stable in an upright position when working on the top endcap.

3. Remove the eight endcap securing bolts (do not remove carrying handle fastening bolts).

CAUTION

Retain the endcap securing titanium bolts for reuse. Alternative fastening bolts will corrode in seawater and will compromise the integrity of the housing.

4. Open the pressure relief valve; see *Section 11.7.2 "Operating the Pressure Relief Vent Valve"*.

Note

Each time the top endcap is removed or fitted to the housing, pressure relief vent valve should be opened to equalise the pressure difference between the inside and outside of the housing.

5. Separate and lift the endcap from the housing by evenly screwing four of the endcap securing bolts into the jack-up threaded holes on the top endcap.

CAUTION

Jack-up bolts must be evenly screwed into place to ensure the endcap is lifted evenly on all sides. Failure to do so may cause fusing of the housing and endcap.

6. After the endcap has lifted high enough, use the Sonardyne Endcap Removal Tool (641-3488) to evenly lever the endcap away from the housing.

CAUTION

For safety reasons due to the weight of the endcap, two people are required to carry out the following steps.

7. Carefully lift the endcap a small height from the housing (<10 cm) paying attention not to pull or twist the endcap internal cables.

CAUTION

Lifting the endcap too far will cause damage to the internal PCBs or connectors and may damage the SPRINT-Nav.

Note

The pressure sensor is has six connectors between the top endcap and the PCB stack. Five connectors will be connected to the uppermost PCB, and one smaller connector will be connected to the second most upper PCB.

8. Remove each connector by pulling the connector housing while pinching the fastening clip lever.

CAUTION

Do not remove the connectors by the pulling the cable.

9. Once all the cables are detached, place the endcap on a bench, resting it on its internal face.
10. Remove the four pressure sensor securing bolts and retain them for reuse.
11. Remove the pressure sensor module by carefully pushing it through the endcap.
12. Place the pressure sensor module into the protective case provided within the shipping case of the SPRINT-Nav.

11.11.2 Replacing the Pressure Sensor Module

After the pressure sensor module has been removed, it must be replaced with either an identical Sonardyne pressure sensor module or the provided blanking plate. When fitting the pressure sensor module or blanking plate the two provided spare two O-rings must be fitted and lubricated with Vaseline to ensure a watertight seal.

CAUTION

⚠ **Do not use non-Sonardyne parts as the integrity of the housing and watertight seals will be compromised and may lead to flooding of the housing.**

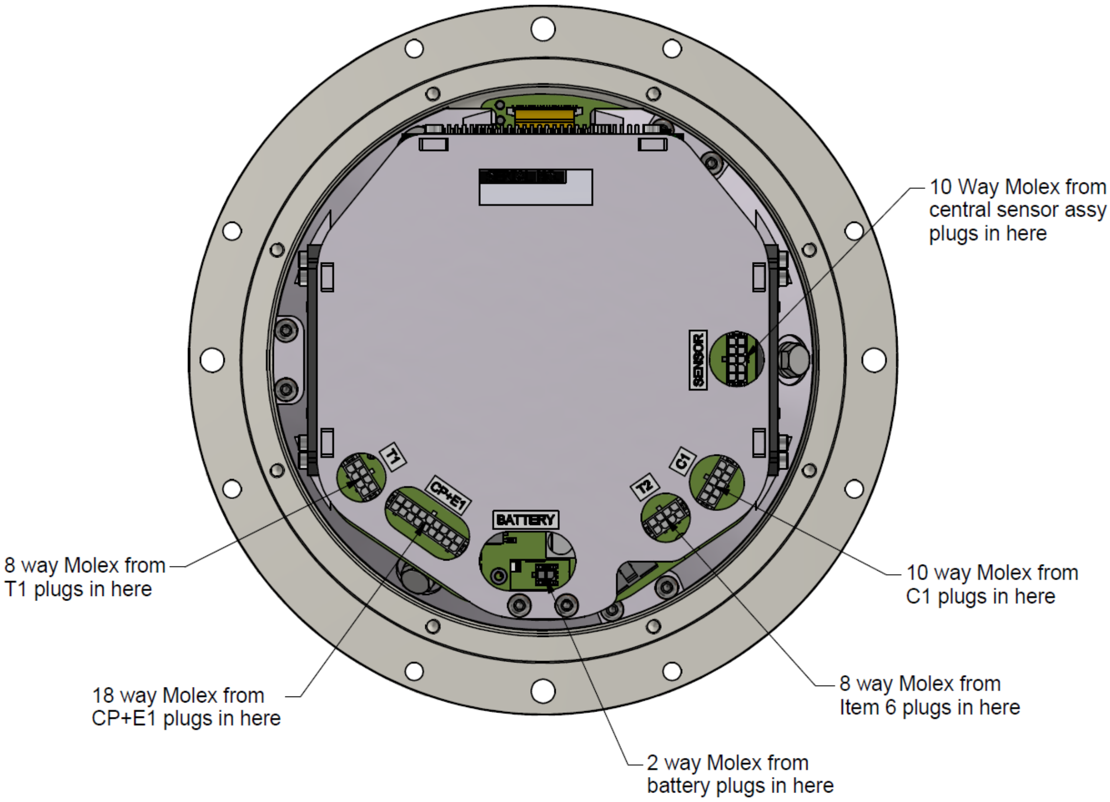
1. When fitting the pressure sensor module or blanking plate, apply "Never Seez®" or equivalent lubricant to the thread of the four securing bolts and tighten to 10.0 Nm.

   CAUTION

   ⚠ **For safety reasons due to the weight of the endcap, two people are required to carry out the following steps.**

2. Hold the endcap above the housing and attach the connectors back into their correct slots, ensuring the correct orientation for each connector. This can be confirmed by ensuring the pinch clip on the cable connector is aligned with the catch on the connector receptacle. An audible "click" from the fastening clip may be heard when the connector seats correctly; see *Figure 11–2* for a description of the connector ports.

Figure 11–2 Connector Ports



CAUTION

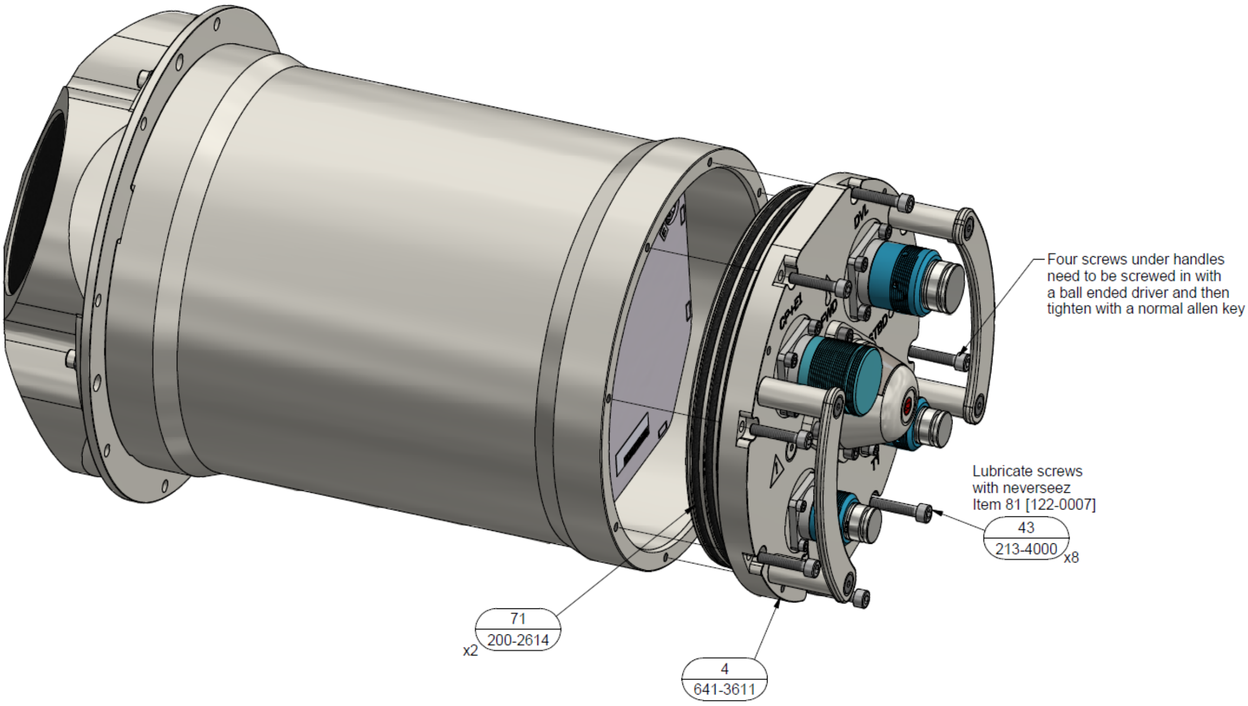
⚠ **Ensure the connectors are connected to the correct ports as some connectors will fit multiple ports. Engravings of each connector can be found on the external face of the top endcap and should match with labels on the metal chassis plate above the PCB stack.**

3. Configure the battery cable through the appropriate slot and attach to the lower PCB.

Note

There should be no unattached cables remaining after this step.

4. Apply Vaseline to the two O-rings on the top endcap to ensure a watertight seal.



5. Open the pressure relief valve; see *Section 11.7.2 "Operating the Pressure Relief Vent Valve"*.
6. Carefully place the top endcap level on the top of the housing ensuring the forward arrow engraving on the top of the endcap is aligned with the forward mark on the label, and the forward mark (vertical line) engraved in the DVL transducer endcap below the external mounting ring.
7. Apply gentle and even force on all sides of the top endcap to close the housing a small amount. Ensure the pressure relief vent valve is opened at regular intervals.

CAUTION

Only light pressure should be applied when seating the endcap.

8. Apply "Never Seez®" or equivalent lubricant to the thread of the eight securing bolts and tighten evenly.
9. Remove the four bolts from the jack-up threaded holes.
10. Once the endcap is seated into the housing tube far enough that the endcap securing bolts can reach their threads, place the endcap securing bolts into position.
11. Screw the endcap securing bolts evenly on all sides ensuring all bolts are fully tightened.
12. Close the pressure relief vent valve by pushing it inwards until it is flush with the endcap face.

Section 12 – Firmware Update for SPRINT-Nav

12.1 Introduction

The SPRINT-Nav firmware can be updated in the field by using the PC Utility software tool (included with the SPRINT-Nav). Sonardyne support will notify customers when new firmware updates become available.

The SPRINT-Nav will accept firmware updates on the CP port only.

To update the firmware using PC Utility software via a serial connection, follow the procedures below.

12.2 Updating the Firmware

12.2.1 Prerequisites

To update the firmware, the following prerequisites must be met:

- The new firmware file (IMU.hex)
- A serial connection to the SPRINT-Nav on the CP port.
- A PC Utility software installation.

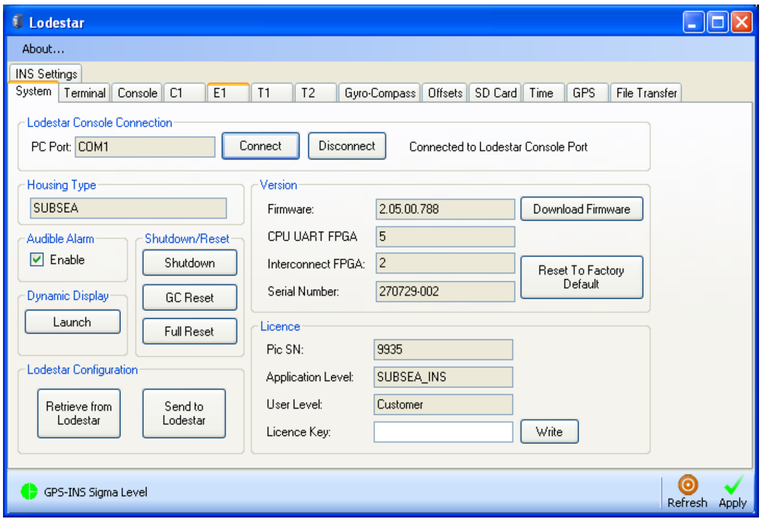
12.2.2 Update Procedure

1. Connect the SPRINT-Nav CP port to the PC either directly via RS232 or through a Navigation Sensor Hub (NSH).

Note

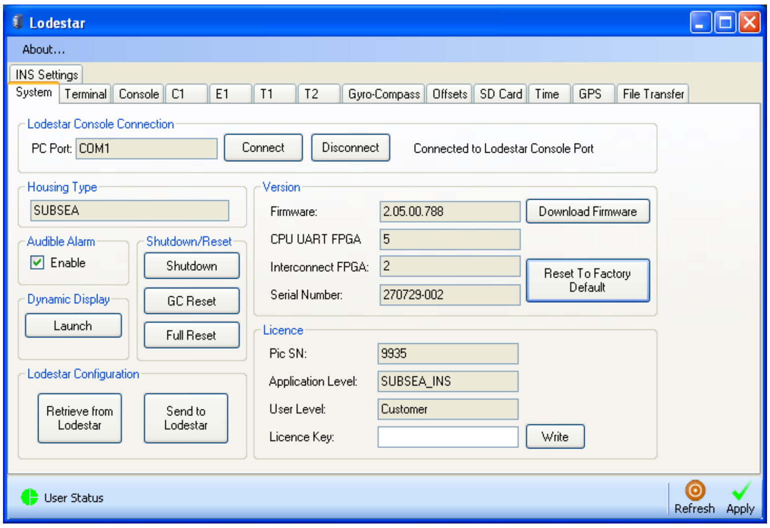
Wait two minutes after applying power to allow the SPRINT-Nav to start up.

2. Click **Start > Programs > Sonardyne > Lodestar > Lodestar** to open the PC Utility.
3. Click **Connect** to connect to the SPRINT-Nav.

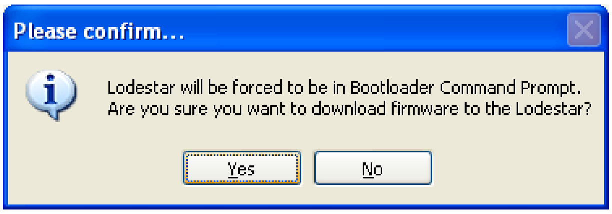


4. Once connected click **Retrieve from Lodestar (SPRINT-Nav)** to store the configuration of the SPRINT-Nav as a text file (this is recommended for a backup).

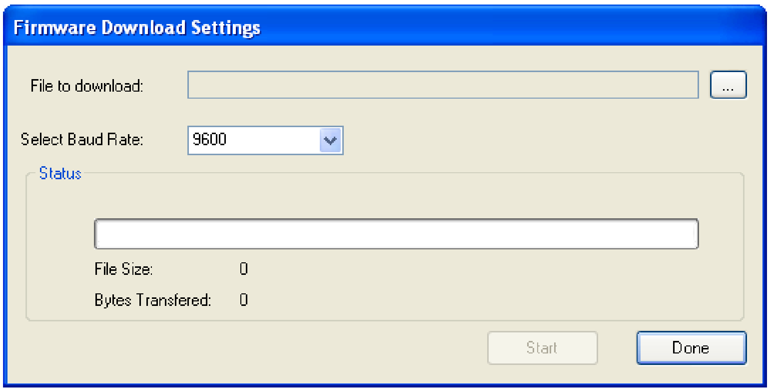
5. Click **Download Firmware**.



6. Click **Yes** to confirm.

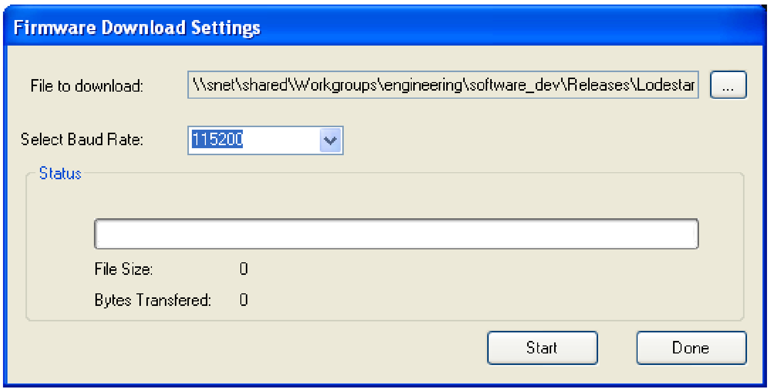


7. Browse to the folder and select the new IMU.HEX file to download (supplied by Sonardyne).



8. A warning will be displayed asking if you are sure that selected file is a SPRINT-Nav) firmware file.
9. Click **Yes** to continue.

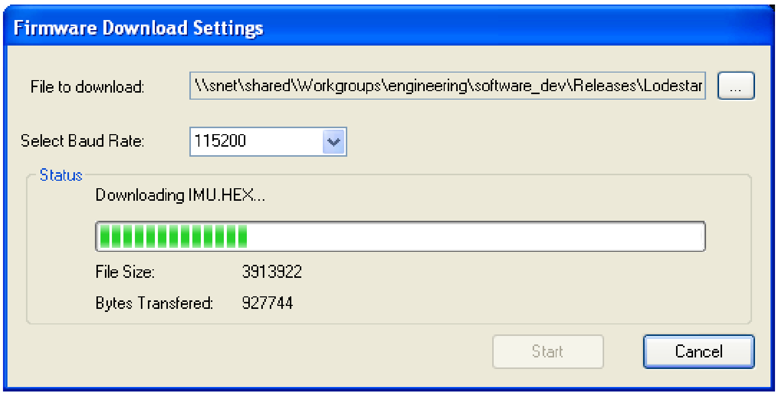
10. Select a **Baud Rate** for the download (Sonardyne recommends **115200** baud for all firmware downloads).



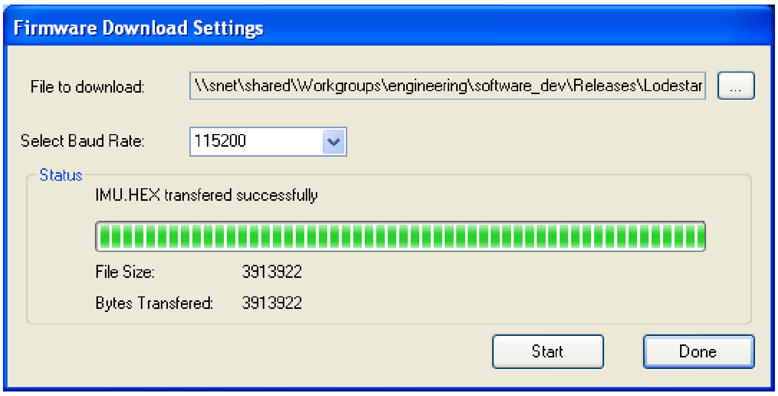
11. Click **Start** to commence the download (at this point the progress bar will show download status; download time at **115200** is less than five minutes).

Note

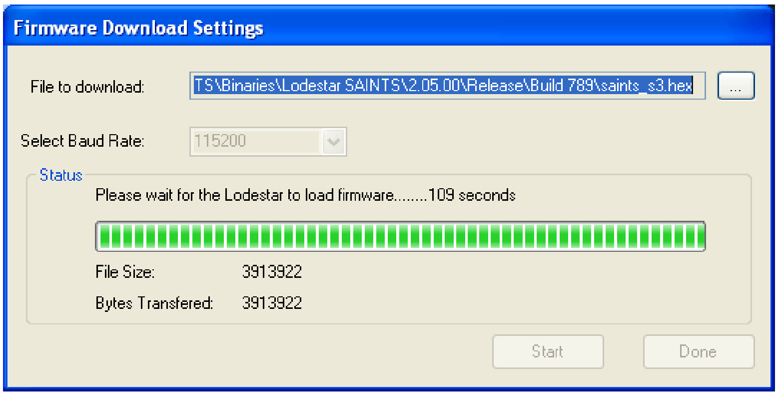
It is recommended not to interact with the PC while the download is in progress.



12. Once the download is complete click **Done**.



13. At this point the utility will re-boot the SPRINT-Nav.



14. Once complete, the PC Utility software will re-program the SPRINT-Nav with the same configuration it had before the update.

Section 13 – Software Update for Syrinx DVL Manager

13.1 Introduction

The following sections explain how to update the embedded DVL Manager software from a web browser.

Note

Sonardyne Support and the Sonardyne website will provide details when a software update becomes available.

13.2 Prerequisites

To update the firmware, the following prerequisites must be met:

- The new embedded software file (.SWU file).
- A web browser; see *Section 9.3.1 "Internet Browser Recommendations"* for more information on web browsers.

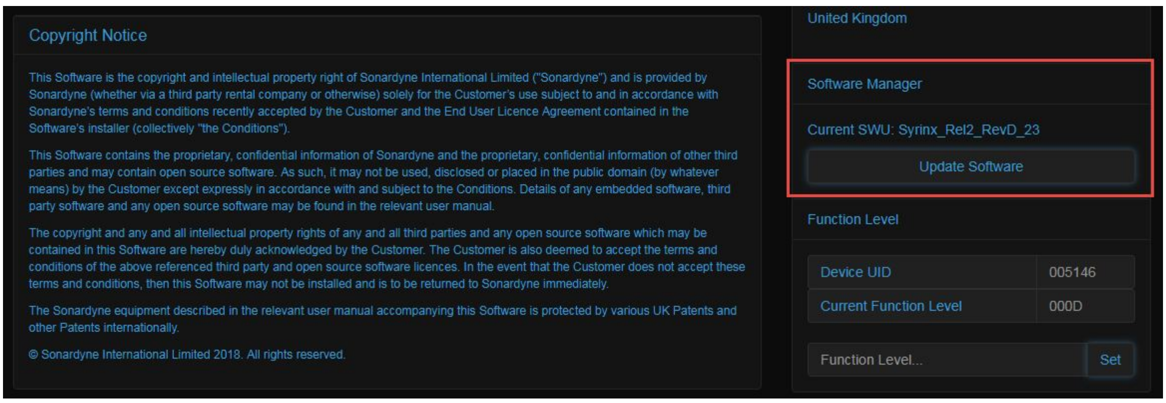
13.3 Connections

- An Ethernet connection to the Syrinx DVL either direct or through a network
- The PC updating the embedded software must be configured correctly for displaying DVL Manager; see *Section 9.4.1 "DVL Manager Connection"* for step by step instructions on connecting to the DVL Manager.

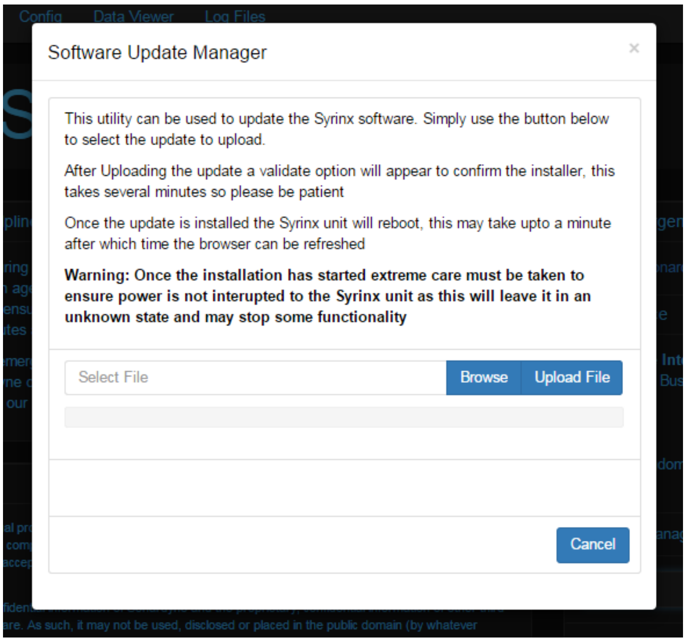
13.4 Updating the Software

1. Save the updated software file (*.swu format) to a folder on the PC e.g. **Downloads**.
2. Connect to DVL Manager; see *Section 9.4.1 "DVL Manager Connection"*.
3. On the DVL Manager Home page, click **Support**.

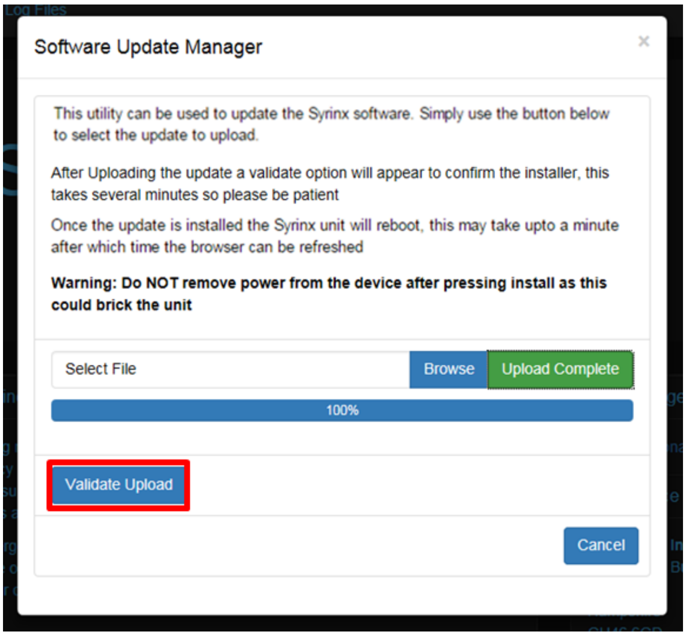
4. On the DVL Manager Support page, click **Update Software**.



5. On the **Software Update Manager** popup, click **Browse** and navigate to the new software file (ensure that the file type .swu as provided by Sonardyne support).

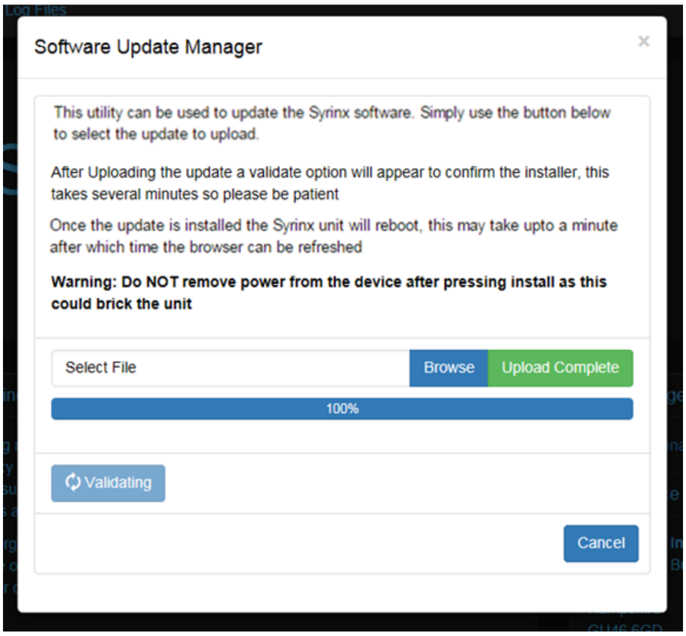


6. Select the new software file and then click **Open**.
7. Click **Upload File** to copy the file to the Syrinx DVL (a progress bar shows the status).
8. Once the file is uploaded, click **Validate Upload** (this will request the Syrinx DVL to confirm that the file uploaded isn't corrupted and the installer is compatible with the current firmware version).



Note

The validation process can take a few minutes to complete.



9. After validation, click **Install** to start the installation process.

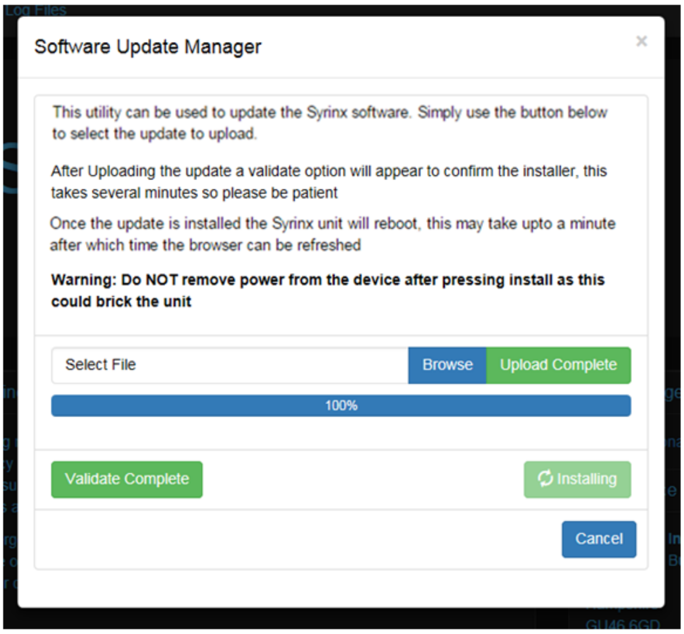
Note

After the installation has started extreme care must be taken to ensure power is not interrupted to the Syrinx DVL or PC as this will leave the unit in an unknown state and may stop some functionality.

10. The installation can be cancelled at any point by clicking **Cancel**.

Note

If an installation continues to fail contact Sonardyne Support.



11. Once the install is complete the web browser page will refresh.
12. The new software version can be verified on the DVL Manager home page.

If any problems are encountered during the software update, see *Section 17 "Troubleshooting for Syrinx DVL"*

13.5 Functionality Update

13.5.1 Introduction

The following sections explain how to update the Syrinx DVL functionality using a web browser.

13.5.2 Prerequisites

Before updating the functionality, ensure the following are available:

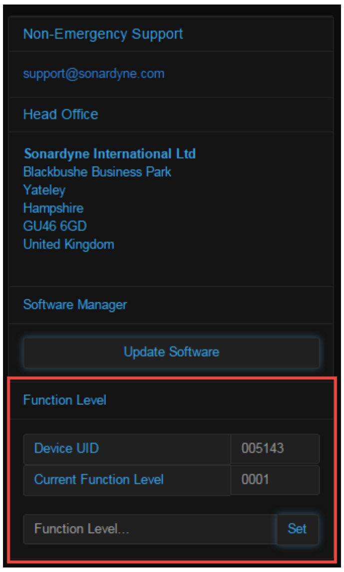
- The new functionality string (provided by Sonardyne Support). Sonardyne Support will require the Device UID in order to generate this string(see step *3* below to locate the Device UID.
- A web browser; see *Section 9.3.1 "Internet Browser Recommendations"* for more information on web browsers.

13.5.3 Connections

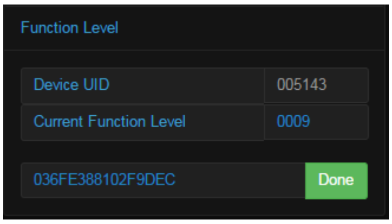
- An Ethernet connection to the Syrinx DVL either direct or through a network.
- The PC updating the functionality must be configured correctly for displaying DVL Manager; see *Section 9.4.1 "DVL Manager Connection"* for step by step instructions on connecting to the DVL Manager.

13.5.4 Updating the Functionality

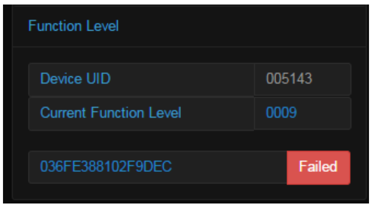
1. Connect to DVL Manager; see *Section 9.4.1 "DVL Manager Connection"*.
2. On the DVL Manager Home page, click **Support**.
3. On the **Function Level** pane, type the provided code into the **Current Function Level** box and then click **Set**.



4. If the code is correct and entered correctly, the **Set** button will display **Done**.



5. If the code is incorrect, entered incorrectly or applied again once already completed, the **Set** button will display **Failed**.



6. If the test fails, verify the code has been entered correctly and that the code is only used once. If this is the case and **Failed** is still displayed, contact Sonardyne Support.
7. Once completed, any additional functionality will be available immediately, without the need to restart the device.

Section 14 – Retrieving On-board Log Files

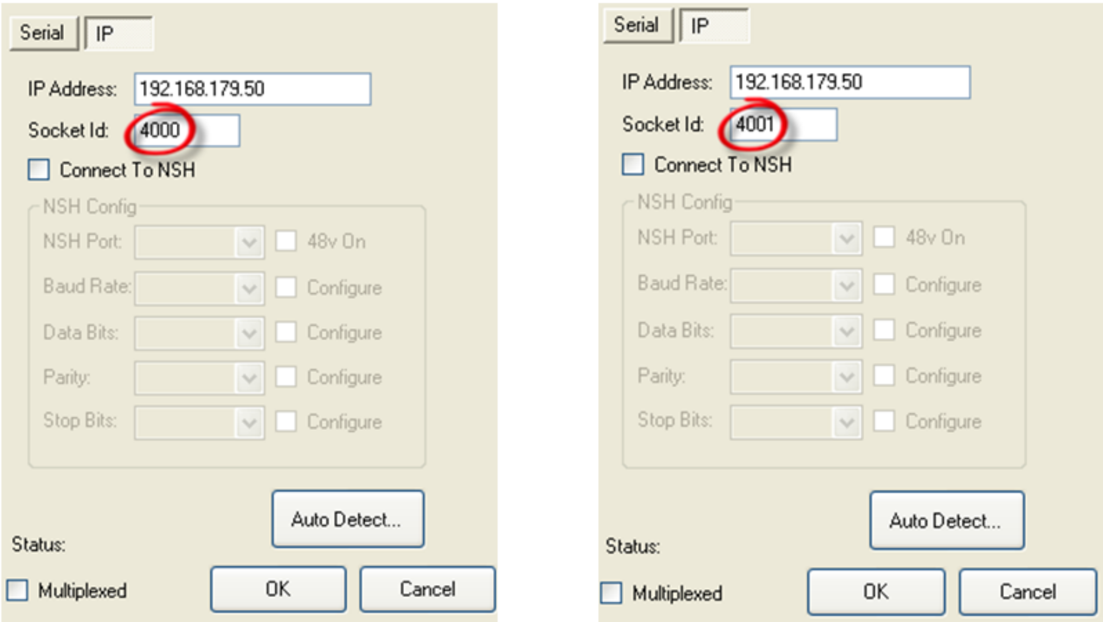
14.1 Introduction

On-board log files can be retrieved from the SPRINT-Nav using the PC Utility software.

14.2 SPRINT-Nav Connection and Retrieval

1. Connect to Ethernet port 4000 or 4001 (if the unit has been configured for SPRINT INS operation); see *Figure 14–1*.

Figure 14–1 SPRINT-Nav Ethernet Connection



2. Once the connection has been established, select the **E1** tab and ensure multiplex is cleared; see *Figure 14–2* and *Figure 14–3*.
3. Apply the changes and wait for progress bar to complete before selecting a new tab.

Figure 14–2 SPRINT-Nav Ethernet Port 4000 Configuration

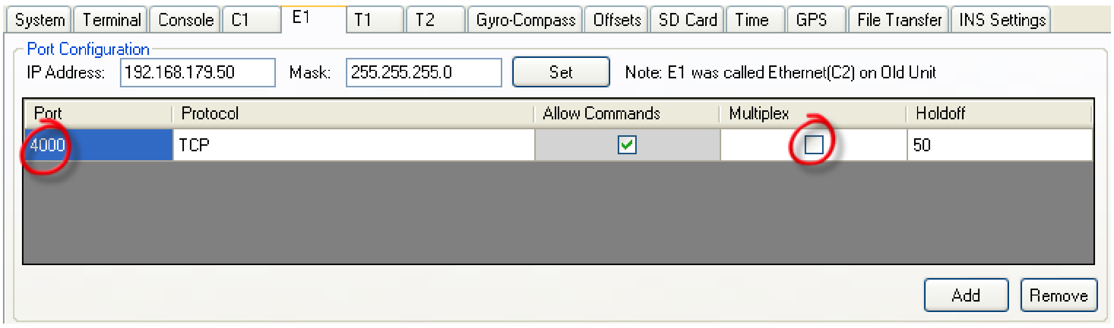
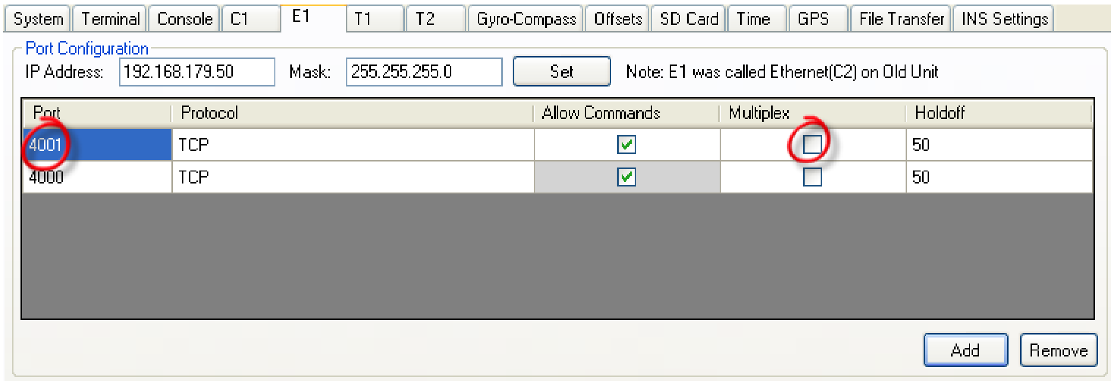


Figure 14–3 SPRINT-Nav Ethernet Port 4001 Configuration



Note

The SPRINT-Nav port used for file transfer must have multiplex mode disabled and must not be configured for AHRS/INS operations (input/output messages enabled).

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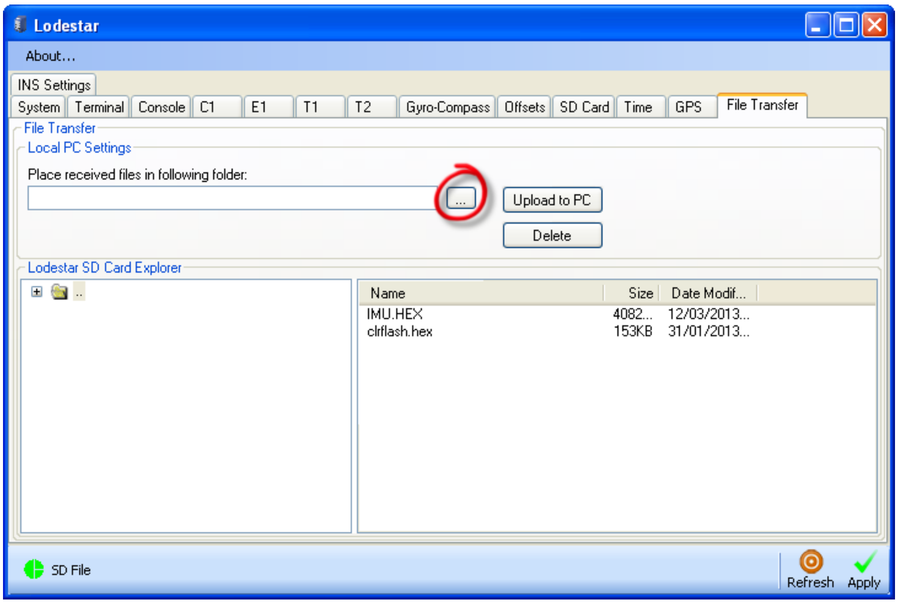
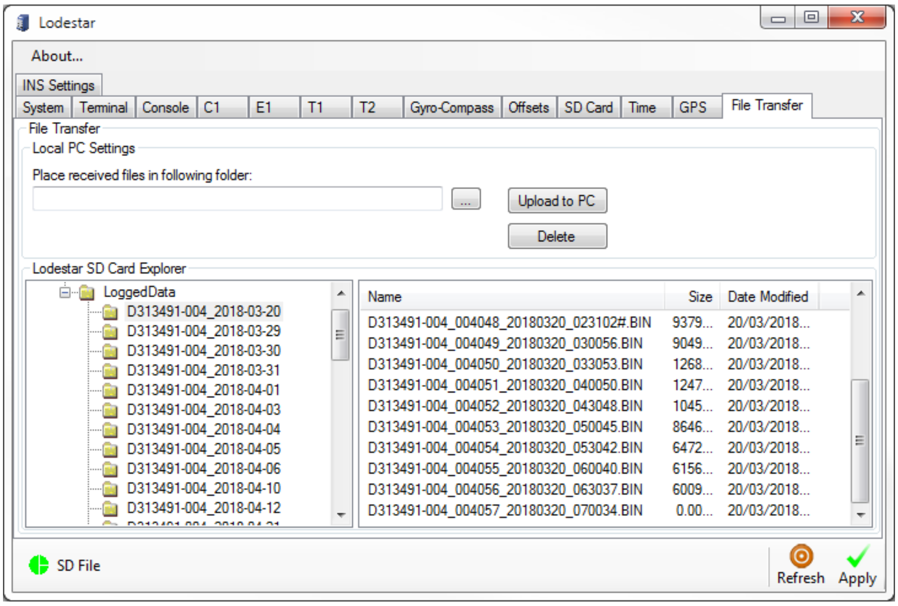
4. On the **File Transfer** tab and select the data destination folder; see *Figure 14–4*.
5. On the **Lodestar SD Card Explorer** pane, click **+** to expand the folders and open the **LoggedData** folder.

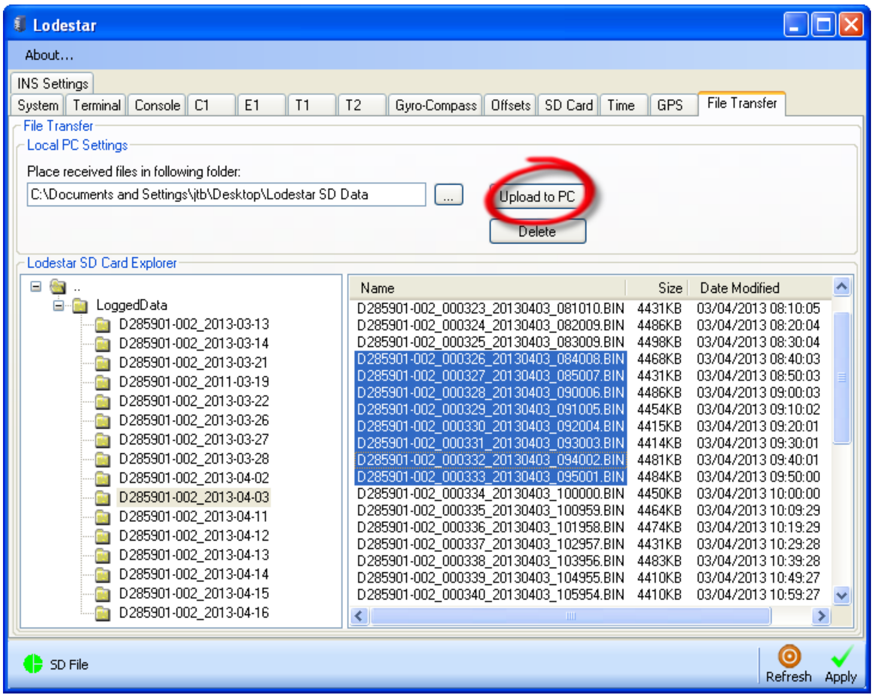
Figure 14–4 SD Files Destination Folder



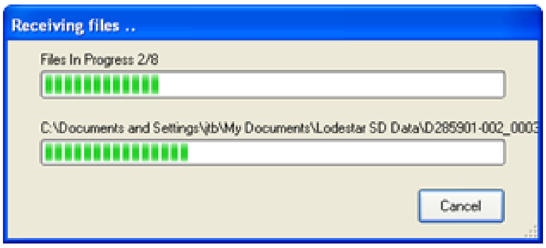
6. The folders and files use the following naming convention:
   - Folders: **D[serial number]_[yyyymmdd**
   - Files: **D[serial number]_[file counter]_[yyyymmdd]_[hhmmss][#].BIN** (**#** is only present on first file created after boot-up)

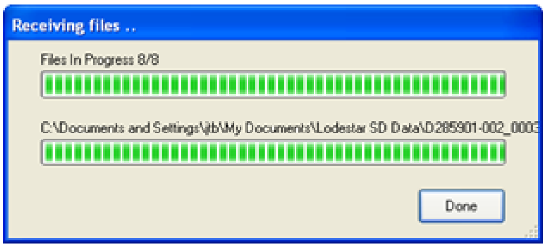


7. Select the log file(s) for retrieval and click **Upload to PC**.



8. A progress bar displays the data upload.





9. After file transfer completes, click the **System** tab and then click **Disconnect** prior to removing the test cable connected to the SPRINT-Nav.

14.3 Retrieving Syrinx DVL Log Files for Support Analysis

Log files can be downloaded through an Ethernet connection to the Syrinx DVL and sent to Sonardyne Support for analysis; see *Section 9.4.7 "DVL Manager Log Files"*.

The files that may be required include:

- Output message telegram log files
- User action log files
- Raw data log files
- Crash Dump file

Sonardyne support will provide instructions for files that may be required to help diagnose issues.

Section 15 – Functional Testing of Syrinx DVL

15.1 Introduction

To ensure the Syrinx DVL component functions correctly, a number of functions can be tested using the Ethernet test box provided with the instrument.

15.2 Test Equipment

The following equipment is required for functional testing to be completed.

- Ethernet test box
  - Part number 641-0468 (8275-000-4530/4531/6530/6531)
- Web browser; see *Section 9.3.1 "Internet Browser Recommendations"* for browser recommendations
- Test PC with Ethernet capability
- Cat5/6 cable to connect to test PC
- 24 V power supply (into 4 mm sockets on test box)

15.3 Self-Test

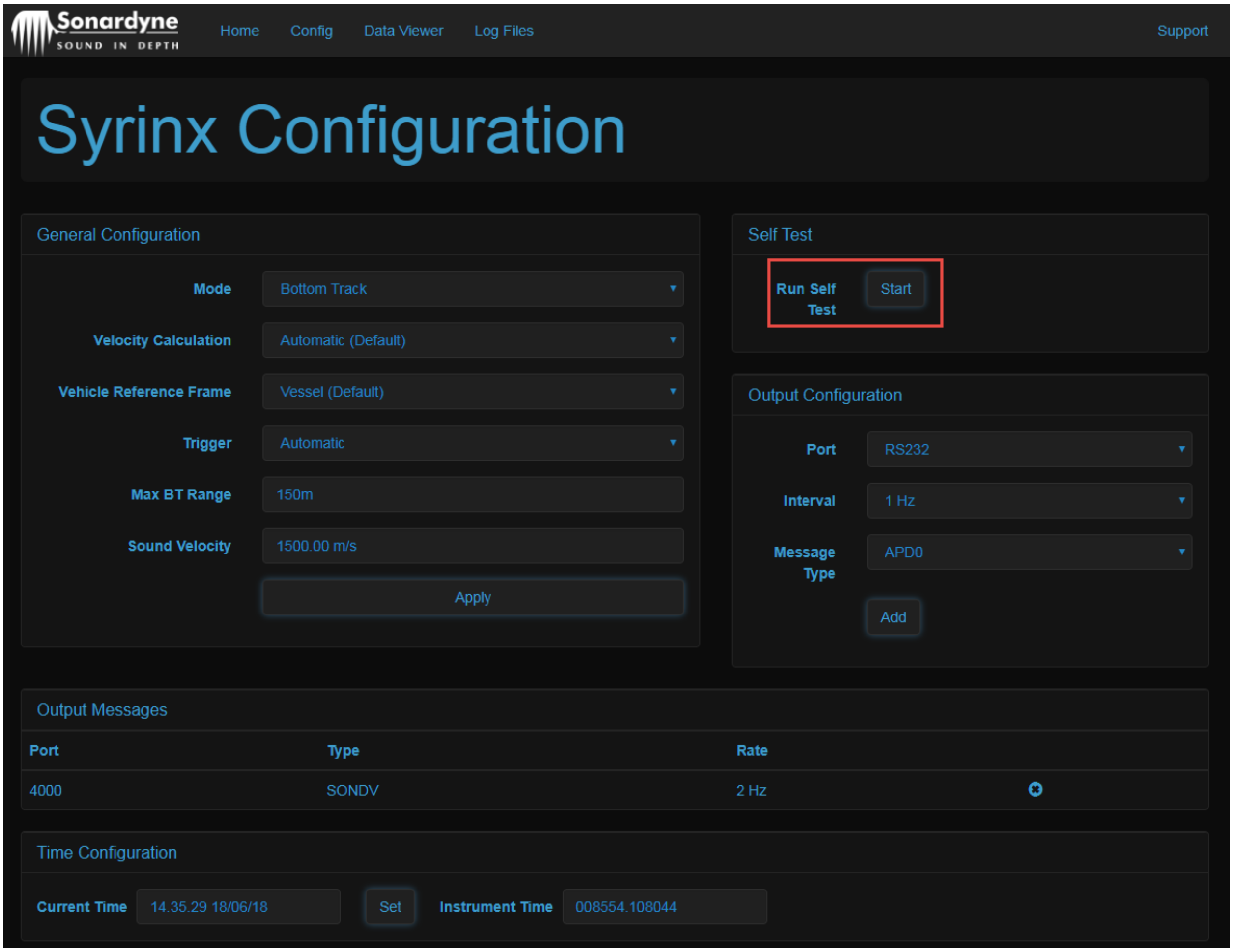
Before testing, provide 24 V power to the test box 4 mm sockets and connect the Ethernet cable to the test box and test PC.

1. Connect to the DVL Manager; *Section 9.4.1 "DVL Manager Connection"*.
2. On the **Config** page, click **Run Self-Test** to start the Syrinx DVL built in self-test.
3. The results will be displayed once complete.

Note

If the Self-Test fails for any reason, contact Sonardyne Support.

Figure 15–1 DVL Manager Configuration Page



15.4 Functional Test using Ethernet Connection

This functional test verifies that the Syrinx DVL can be connected to through the vehicle wiring using Ethernet and can be used to verify acoustic operation.

Note

The test assumes the DVL is deployed in water.

If the connection to the DVL requires configuring, follow *Steps 1* to *10* of *Section 9.4.1 "DVL Manager Connection"* and then go to *Step 1* below.

1. On the Syrinx Configuration page, click **Config** on the top menu.
2. On the **General Configuration > Mode** drop-down list, select:
   a. **Auto**, if the Syrinx DVL is less than 140 m altitude from the seabed, or
   b. **Water Track**, if the Syrinx DVL is greater than 140 m altitude from the seabed.
3. On the **Velocity Calculation**drop-down list, select **Automatic**.
4. On the **Trigger** list, select:
   a. **Automatic** if not using an external trigger to operate the Syrinx DVL.
   b. **Trig+** or **Trig-** if using an external trigger to operate the Syrinx DVL.

5. If in bottom track mode, on the **Max BT Range** box, select the appropriate maximum range for bottom lock or, if in water track mode set appropriate water track settings covering the area to measure water velocities at, using the **Water Track Start Range** and **Water Track Bin Width** boxes.
6. Click **Apply**.
7. Click the **Data Viewer** on the menu bar.
8. The Data Viewer will open and the graph in the centre of the screen should display live data if the Syrinx DVL is functioning correctly; see *Figure 15–2*.

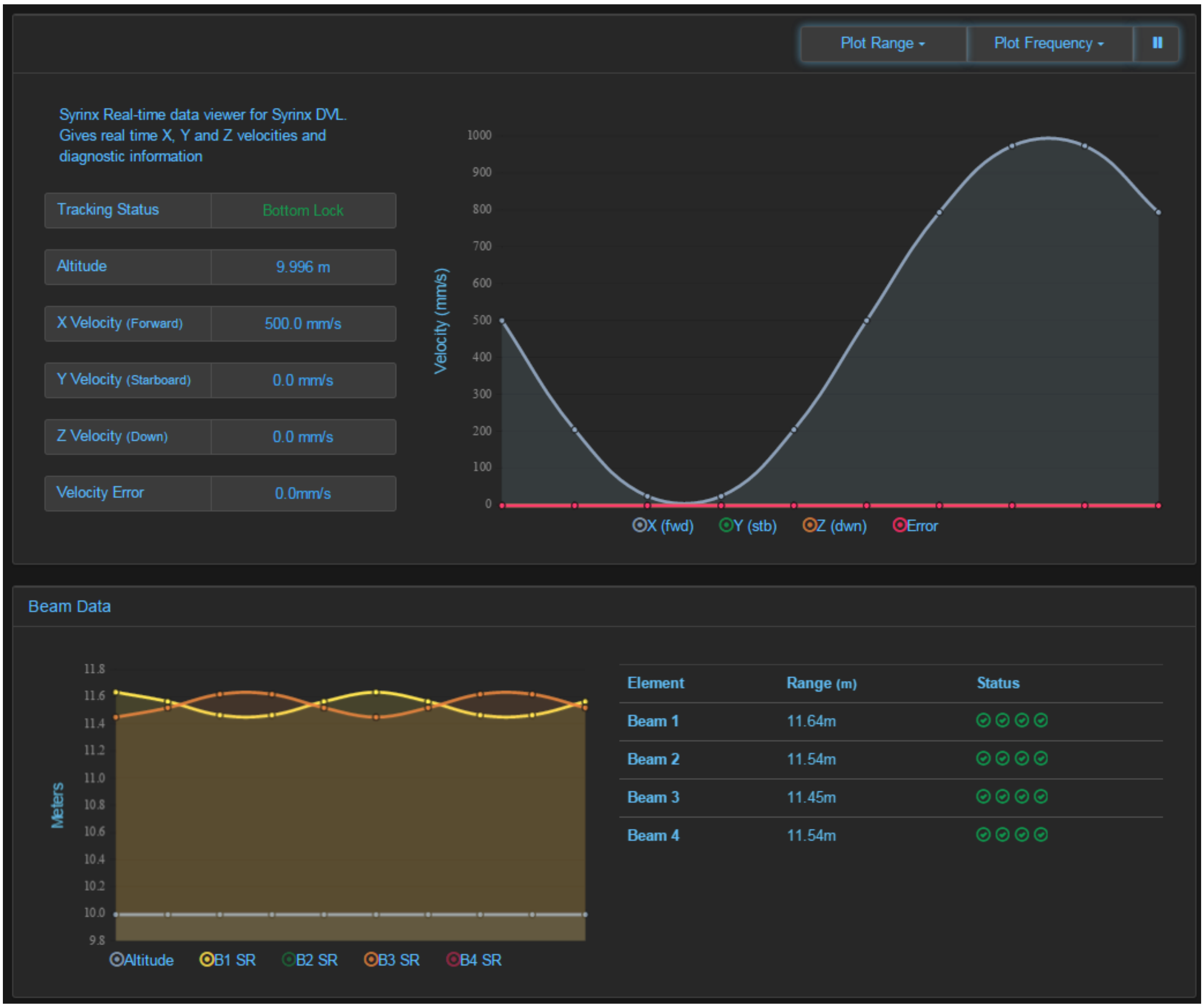
Notes

If no data is observed in Auto mode, verify the Syrinx DVL is between 0.4 m & 140 m altitude and repeat the test (altitudes of up to 175 m can be achieved with certain seabed types).

If no data is observed and the Syrinx DVL is configured to Trig+ or Trig- mode, verify input trigger to Syrinx DVL is working correctly and repeat the test.

9. The Data Viewer update rate can be changed on the **Plot Frequency** drop-down list on the upper right corner of the chart.
10. The Data Viewer can display larger or smaller numbers of data points on the **Plot Range** drop-down list on the upper right corner of the chart.

Figure 15–2 Syrinx DVL Data Viewer



15.5 Functional Test using Serial Connection

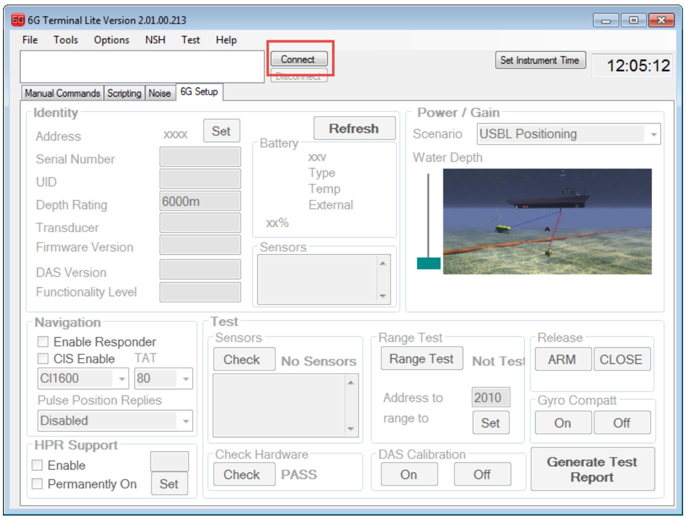
This functional test verifies that the Syrinx DVL can be connected to through the vehicle wiring with a serial connection and can be used to verify acoustic operation.

Note

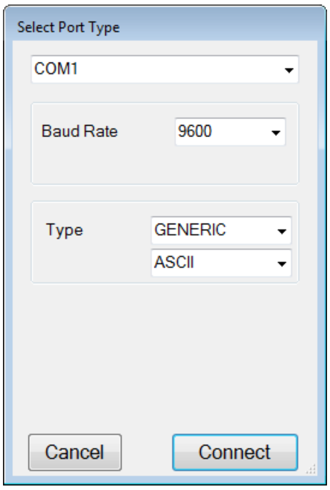
The test assumes the DVL is deployed in water.

1. Double-click the **6G Terminal Lite** desktop icon to start the software.

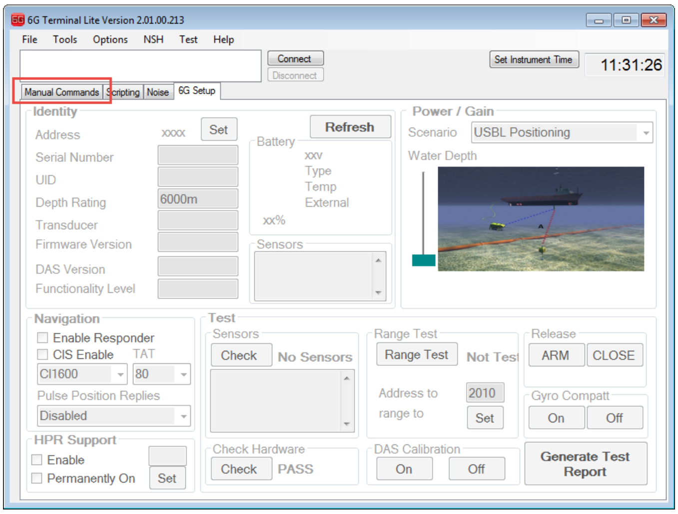
2. On the **6G Setup** tab, click **Connect**.



3. On the drop-down lists, select the **Baud Rate** of the serial connection and the **Type** as **Generic** and **ASCII**.



4. A “PORT” command will be sent to the DVL. If the communications are successful, a “PORT” reply will display in blue font in the comms window.
5. On the **Manual Commands** tab configure the DVL to either **Water Track** or **Bottom Track** mode:
   a. To configure and test **Water Track** mode: send the command **CFG:WT,WTSR100,WTBW80,FREE** to the Syrinx DVL (this will configure the Syrinx DVL to water track mode, operating with an internal trigger and collecting velocity data at 100 dm start range and measure across an 80 dm bin width measuring the water velocity 10 m to 18 m from the Syrinx DVL).
   b. To configure and test **Bottom Track** mode: send the command **CFG:AUTO,R150,FREE** to the Syrinx DVL. This will configure the Syrinx DVL to bottom track mode up to the maximum range (this is the default setting) using an internal trigger.



6. To verify that the Syrinx DVL is tracking correctly, configure a "SONDV" telegram output on the connected port using the following command:
   OUT:P0;SONDV@1

Note
In the command above, "P0" assumes the connection is the primary serial port. If using the secondary serial port, replace "P0" with "P1" as shown in the following example: "OUT:P1;SONDV@1"

7. If the Syrinx DVL is collecting valid velocity measurements, a SONDV telegram output message can be observed on the 6G Terminal Lite comms viewer. An example of the SONDV telegram message is shown below:
   SONDV:TS;BL,VX+13.1,VY+23.1,VZ+0.1,JVE+0.12,B1R14.14,B2R14.23,B3R12.11,B4R16.02

Note
If ">SONDV:TS;ABL" is observed when configured to bottom tracking mode, this indicates that the DVL has not acquired bottom lock. Verify the DVL is between 0.4 m & 140 m altitude and repeat the test.

8. To disable the output telegram, send the command **OUT:NONE**
9. To perform a built in Self-Test, send the command **CKHW** and verify that the reply displays **PASS** in all tests.

Note

If the Self-Test fails for any reason, contact Sonardyne Support.

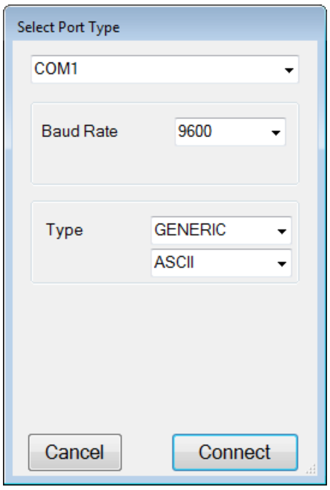
15.6 Checking the Syrinx DVL Hardware Configuration

The Syrinx DVL comes in a number of configurations to cover multiple applications. The hardware configuration can be checked using 6G Terminal Lite as described below.

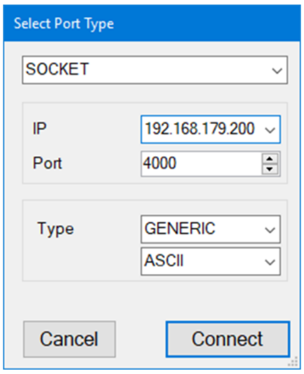
To retrieve the Syrinx DVL configuration details either an Ethernet or Serial can be used.

To connect using a serial or Ethernet connection:

1. Open 6G Terminal as described in *Section 15.5*
2. For a serial connection:
   a. Select the **Baud Rate** of the serial connection.
   b. Select the **Type** as **Generic** and **ASCII**.

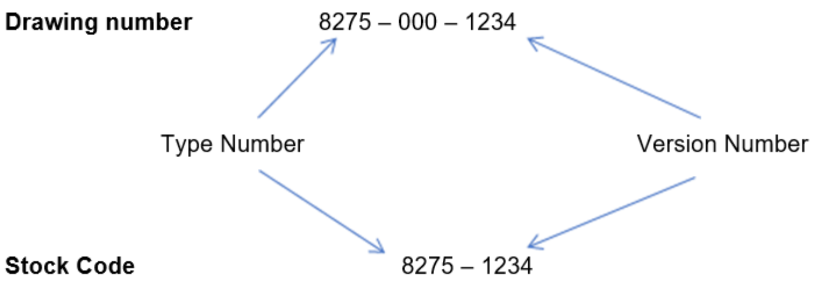


3. For an Ethernet connection:
   a. Select **Socket** and configure the **IP** and **Port** to:
      - **192.168.179.200**
      - **4000**
   b. Select the **Type** as **Generic** and **ASCII**.



4. On the **Manual Commands** tab, send the command **FS** to the Syrinx DVL.
5. The reply will look similar to the text string below, showing details of several of the SYRINX DVL's configuration/hardware.

   >FS:U006B1E,FL0001,**TYPE8275-4561**,SN330615-001,VERPIC;V2.01.00.04,VERFPGA;V1.00.00.14,VERSYS;V3.02.26.00,VERDSP;V2.01.01.06
6. Using the **TYPE** number listed, you can reference the table below to confirm the configuration.



The reported TYPE number shown in step 5 above is **8275-4561**:

- **8275** refers to the product type (SYRINX),
- **4561** refers to the version configuration which, using the table below is:
  - **4** - 4000m
  - **5** - Titanium
  - **6** - 400kHz
  - **1** - Subcon Connectors

Number	Depth Rating	Material	Tdr Type	Other
1	<1000 m	Aluminium 6082		**Subconn Connectors**
2	2000 m	Aluminium 7075		
3	3000 m	S/Duplex	600 kHz	
4	**4000 m**	Ali Bronze		
5	5000 m	**Titanium**		
6	6000 m	Stainless Steel	**400 kHz**	
7	7000 m	Composite		
8	>8000 m	ABS/Plastic		
9	Special	Special	Special	Special
0	No Code	No Code	No Code	No Code

Section 16 – Troubleshooting for SPRINT

16.1 Introduction

This section provides guidance for troubleshooting and fault identification.

Before calling Sonardyne Support, preliminary checks should first be made on the SPRINT-Nav so a full description relating to the problem can be provided.

If technical support from Sonardyne is required, provide information about the SPRINT-Nav configuration in use at the time when the problem occurred. Do this by supplying a copy of the relevant configuration file saved automatically by the SPRINT INS log files, which can be exported from the SPRINT system software.

16.2 SPRINT-Nav Hardware Test Procedure

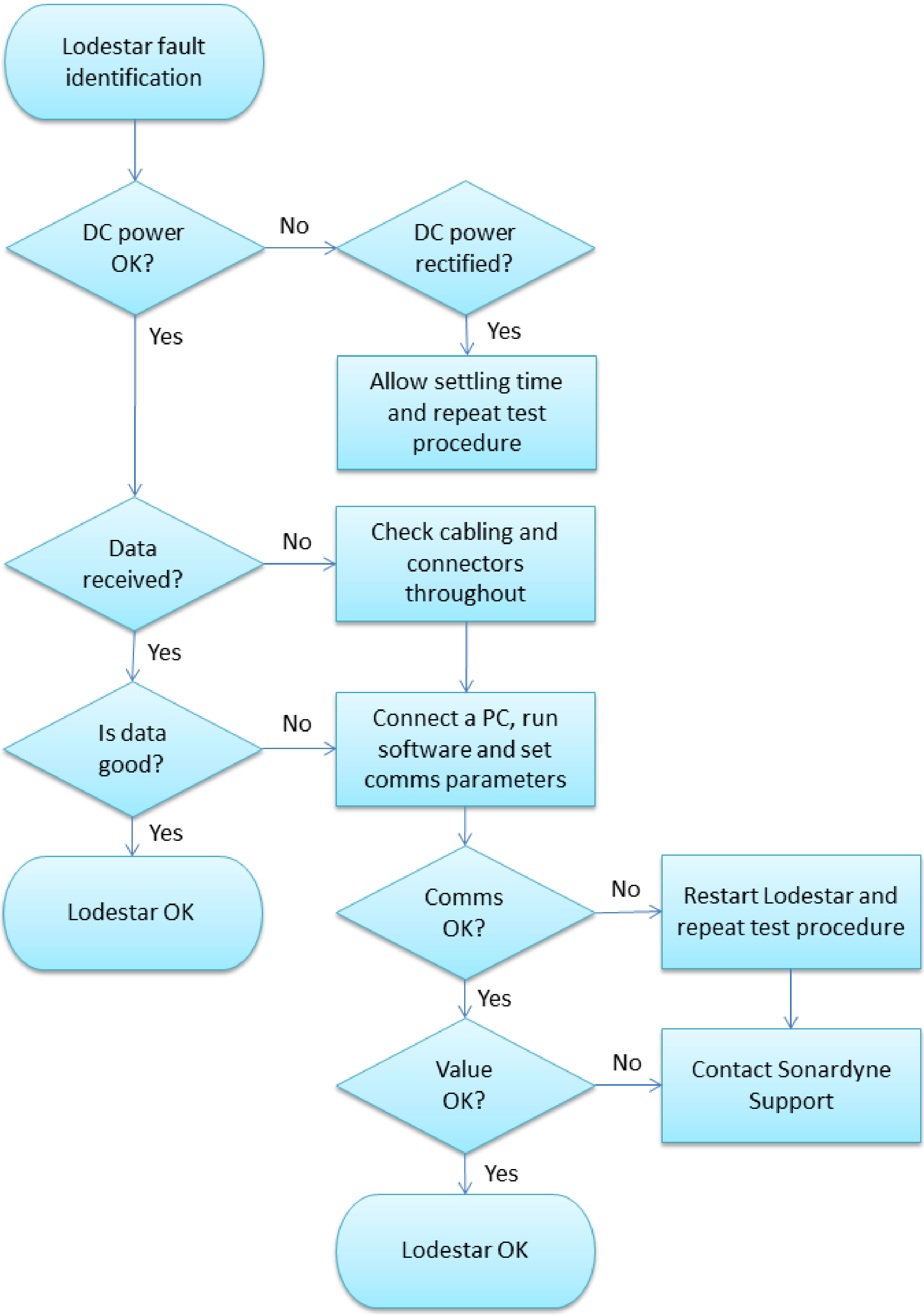
Figure 16–1 shows the recommended test procedure to follow if it is suspected that SPRINT-Nav has developed a fault.

Use this test procedure after installation to check the system operates correctly, or if a fault is suspected during normal operation.

Note

There are no user-serviceable parts inside the SPRINT-Nav. The SPRINT-Nav must only be accessed internally and dismantled by qualified Sonardyne personnel.

Figure 16–1 SPRINT-Nav Hardware Test Procedure



16.3 SPRINT-Nav Connection

When connecting the SPRINT-Nav, carry out the following:

1. ALWAYS configure and check the SPRINT-Nav connection prior to mounting on subsea vehicle.
2. Make sure the SPRINT-Nav is fully charged (2–3 hours) prior to vehicle connection tests to eliminate any communication failures due to intermittent connections and power loss.
3. Once the SPRINT-Nav is mounted on the vehicle, connect a laptop using test cables to verify the SPRINT-Nav operation and sensor communications.
4. SPRINT Ethernet – check vehicle supports 100 megabit.
5. Syrinx DVL Ethernet – check vehicle supports 10 megabit.
6. Serial – check 232 485 cable select for console port connection issues.

16.4 Attitude Heading Reference System (AHRS)

When using the AHRS, make sure:

1. The default Latitude is set.
2. There is a constant bias noted. If so, check SPRINT-Nav mounting angles, lever arms and remote output points if configured.

16.5 Inertial Navigation System (INS)

When using the INS, make sure:

1. Generally, INS will always reject for a valid reason. Rejection indicates issues for investigation on the aiding sensor.
2. The most common reason for rejection of time stamped data (GPS / USBL) is an incorrectly configured time synchronisation.
3. If bad aiding data is accepted as good then INS may report Bias, Accelerometer or Heading warnings.
4. Following other troubleshooting steps first (INS is last port of call for issues/errors).

16.6 Time Synchronisation

When using the Time Synchronisation process, make sure:

1. If ZDA only is used, latency MUST be set.
2. The ideal method is ZDA and 1PPS, verify the PPS indicator LED on the Time Synchronisation window is active once per second.
3. Make sure any time stamped aiding (GPS/USBL) is also UTC time synched; check in comms viewer.
4. If the SPRINT-Nav is synchronised to difference time base than GPS/USBL the behaviour to notice is:
   - SPRINT-Nav accepts position data while static
   - SPRINT-Nav rejects position data as soon as it moves

Note

Rejection reason might be 'outside INS estimate' rather than indicating a time synch issue, an INS cannot tell the difference.

16.7 Aiding Inputs (All)

When using Aiding Inputs, make sure to:

1. Check input using:
   - Comms Monitor
   - SPRINT-Nav Port Traffic
2. Check lever arms and mounting angles.

16.8 USBL Aiding

When using USBL Aiding:

1. Make sure the USBL system is UTC time synched.
2. Check UTC time stamp in telegram is correct.
3. Make sure the Radians Lat/Long are selected for PSIMSSB message.
4. Check that **measured** rather than **filtered** is selected (raw position is required).
5. Make sure beacon ID is correct.
6. Check USBL setup:
   - Lever arms and angular corrections (calibration)
   - Sound velocity

16.9 Depth Aiding

When using Depth Aiding make sure:

1. The correct units are selected.
2. To check surface correction.

16.10 Doppler Velocity Log (DVL) Aiding

When using a Doppler Velocity Log Aiding system, make sure:

1. The DVL is configured correctly.
2. The sound velocity is correct.
3. The latency and scale factor are configured correctly.

16.11 LBL Aiding

When using LBL Aiding:

1. Is Fusion sound velocity correct?
2. Is ROV to Beacon(s) relative depths correct?:
   - Tide
   - Absolute->Corrected

3. Has INS had time to move between USBL and LBL?
4. How does this beacon fit into array?
5. Can the acoustic LBL position be used for comparison?
6. Are the minimum/maximum range settings correct?

16.12 External Position Aiding

When using External Position Aiding:

1. Make sure the External Positioning system is UTC time synched.
2. Check UTC time stamp in telegram is correct.
3. Make sure the Lat/Long are in WGS84 degrees.
4. Check External Position setup:
   - Lever Arms
   - Quality

16.13 Recovery Procedures

The following procedures can be followed to recover the SPRINT-Nav to a known state in the event of a problem.

16.13.1 SPRINT-Nav Hardware Reset

The SPRINT-Nav can be commanded to perform a hardware reset if it becomes unresponsive.

To perform a hardware reset you must be connected to the SPRINT-Nav serially via the CP port using a terminal package such as HyperTerminal.

Make sure the connection to the SPRINT-Nav is 9600 baud and RS232 protocol. If these conditions are met, the SPRINT-Nav can be restarted by typing **UNLK**, and then return in the terminal window (note the use of uppercase letters). You may need to type **UNLK** and press return several times.

If the SPRINT-Nav is connected via Ethernet to the SPRINT system, a hardware reset can also be performed using the **Reset SPRINT** button on the **SPRINT** dialog box.

16.13.2 Restore SPRINT-Nav Factory Settings

The SPRINT-Nav can be commanded to restore its factory default settings.

If factory settings are restored, all previous user defined settings in theSPRINT-Nav will be lost. It is recommended a careful note is taken of any required settings before restoring factory settings.

The PC Utility software can be used to restore theSPRINT-Nav to its default state. This procedure will succeed even if the current baud rate of theSPRINT-Nav isn’t known.

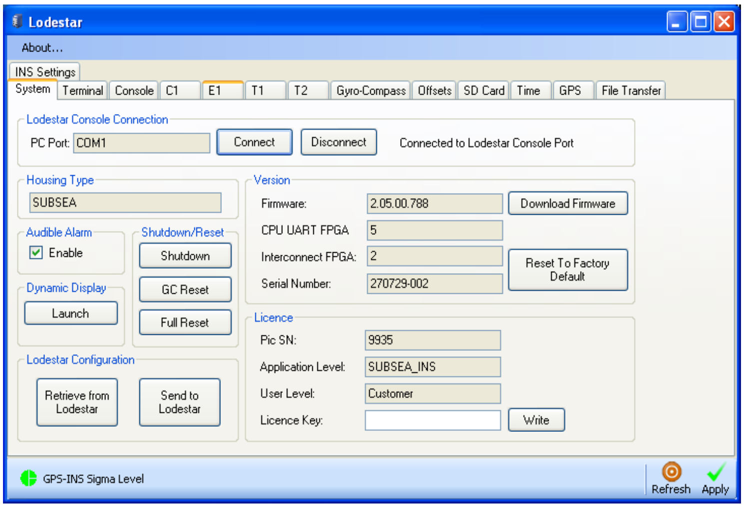
1. Connect the SPRINT-Nav CP port to the PC either directly via RS232 or through a Navigation Sensor Hub (NSH).

   Note

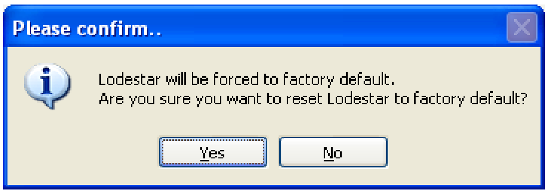
   Wait two minutes after applying power to allow the SPRINT-Nav to start up.

2. Click **Start > Programs > Sonardyne > Lodestar > Lodestar** to open the PC Utility.
3. Click **Connect** and select the COM port that the SPRINT-Nav is connected to.

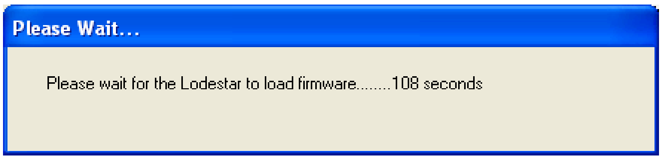
4. Click **Reset to Factory Default**.



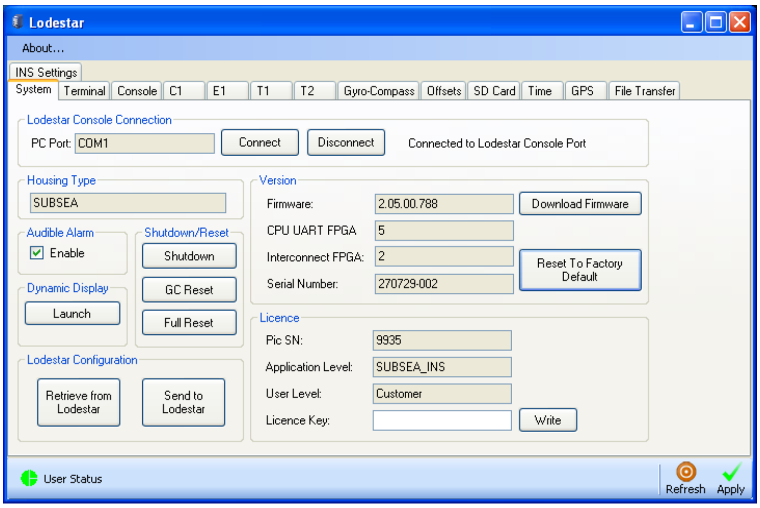
5. Click **Yes** to confirm.



6. The PC Utility will reboot the SPRINT-Nav and reset it to factory default state. It will then wait for the SPRINT-Nav to re-boot.



7. After the boot process has completed the PC Utility software will attempt to connect to the SPRINT-Nav using factory default settings. If successful the SPRINT-Nav information will be displayed.



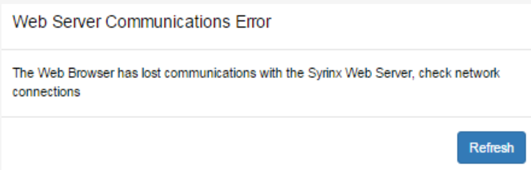
Section 17 – Troubleshooting for Syrinx DVL

17.1 Introduction

If the Syrinx DVL system fails to operate, refer to the following fault diagnosis table to determine the possible cause and action to take. If the Syrinx DVL still fails to operate, contact Sonardyne Support.

17.2 No communication from the DVL

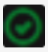
Table 17–1 Fault Diagnosis Table

Fault	Action
Connection to the Syrinx DVL has been lost.	Remove the power supply for 5 seconds and then reapply power to the Syrinx DVL.
If resetting the Syrinx DVL does not restore the connection and the error shown below is displayed in your web browser.  	Check the PC IP address and subnet mask; see *Section 9.3*.
If the IP address and subnet mask is correct but there is still no connection.	Check the cable and all connections. Verify power supplied to DVL is 24 V +- 10% and allows current draw of up to 600 mA. Check the firewall settings or anti-virus software is not blocking the connection. If using a custom network, connect to the Syrinx DVL directly through the Ethernet test cable provided with Syrinx DVL to determine if the fault lies with the unit or the network.
No communication with Syrinx DVL via serial connection.	Verify that the serial port settings are correct. Connect to the serial port on 9600 Baud rate and power cycle the DVL. The Syrinx DVL will output a PORT message @ 9600 Baud Rate including the Baud rate the port is set to. The serial port will then be configured to this Baud rate.
To remove all data output from a port.	Send an **OUT:NONE**<CR><LF> command on the port.
To remove all data output from all ports.	Send an **OUT:NONE;ALL**<CR><LF> command on any port.

17.3 Acoustic Data Analysis

The **Data viewer** page displays status indicators: a green tick, or an orange cross depending on the data returned from Syrinx DVL.

A likely explanation for the  symbol is shown below.

Symbol	Used Status	Error Status	Correlation Score	Signal Strength
	Beam used in velocity calculation	Error value low – data is reliable	Correlation score high – signal return is as expected	Signal strength is high – external noise is not affecting operations
	Beam not used in velocity calculation	Error value high – data is less reliable	Correlation score low – signal return is sub-optimal	Signal strength is low – external noise is affecting operations
Explanation	Beam not used due to poor quality signal. See other diagnostic information for details	Error may be high if data from a single beam does not fit with the results from the other 3 beams. May be due to a partial reflection, or a reflection from an object in the water column (such as marine life)	Low correlation score may be due to multipath replies, scattered reflections from an uneven seabed, reflections from other matter in the water column (including marine life) or external noise.	Signal strength may be low due to operation at very high altitudes, poor reflections from certain seabed types, or other devices causing noise around the operating frequency band of the Syrinx DVL.

17.4 Ethernet & Serial Connector Troubleshooting

See *Section 9.3 "Ethernet Connectivity"* and *Section 9.7 "Serial Connectivity"*.

17.5 Ethernet Connection Troubleshooting

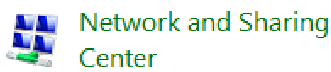
See *Appendix H "Ethernet Connection Troubleshooting Flowchart"* for a detailed flowchart to assist in the diagnosis of possible Ethernet connection issues.

17.5.1 Fixing Ethernet Communication Speed

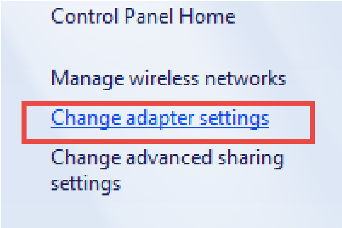
Depending on cabling configurations, auto-negotiating the communication speed of the PC connected to the Syrinx DVL or fixing the speed to 100 Mb/s or 1 Gb/s may cause connection issues.

The instructions on how to fix the connection speed (for Windows® 7) are shown below.

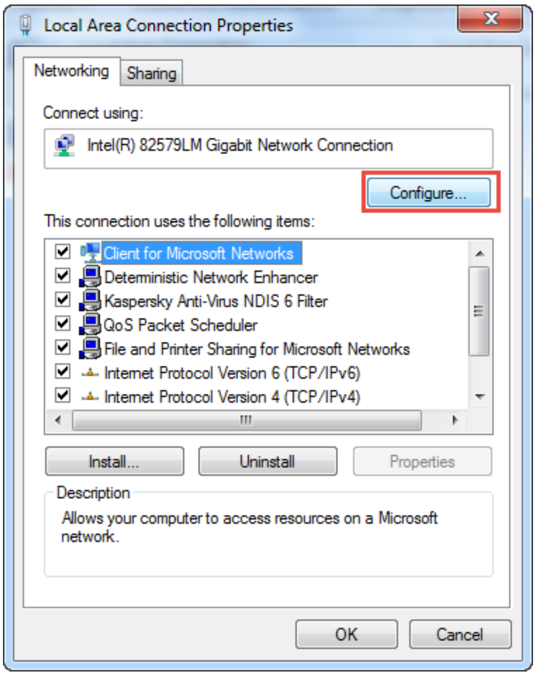
1. Open the **Control Panel** and select **Network and Sharing Center**.



2. Click **Change Adapter Settings**.

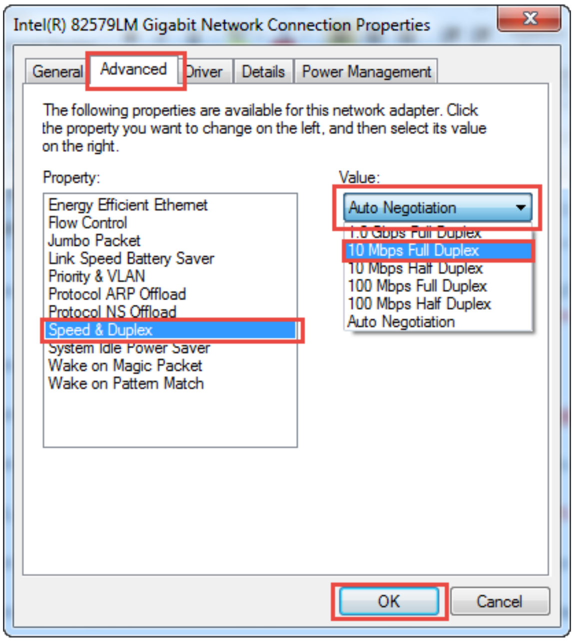


3. Right-click on the Local Area Connection (connected to the Syrinx DVL) and select **Properties**.
4. Click **Configure**.



5. Click the **Advanced** tab and select **Speed and Duplex** on the **Property:** pane.

6. Select **10 Mbps Full Duplex** on the **Value:** drop-down list and then click **OK**.



Section 18 – Spares

18.1 Introduction

When ordering spare parts, please provide the part number (CPN) and a description.

Enquiries about, or orders for spare parts should be directed to your local Sonardyne office or agent. For addresses and contact details, see the back page of this manual or visit our website: https://www.sonardyne.com/get-in-touch/.

18.2 SPRINT-Nav Spares List

Description	Stock Code
SPRINT-Nav Battery	270-0610
SPRINT-Nav Transit Case	790-1139
Standard Seacon CP+E1 5m Cable Tail	317-3250
Standard Seacon C1/T1/T2 5m Cable Tail	317-3265
Standard Seacon CP+E1/D1 2m Test Cable	820-6942
Standard Seacon C1/T1/T2 2m Test Cable	820-6951
Right-angled Seacon CP+E1/D1 5m Cable Tail	317-3295
Right-angled Seacon C1/T1/T2 5m Cable Tail	317-3277
DVL Array Protector	810-0101

Section 19 – Technical Specifications

19.1 SPRINT-Nav Variants

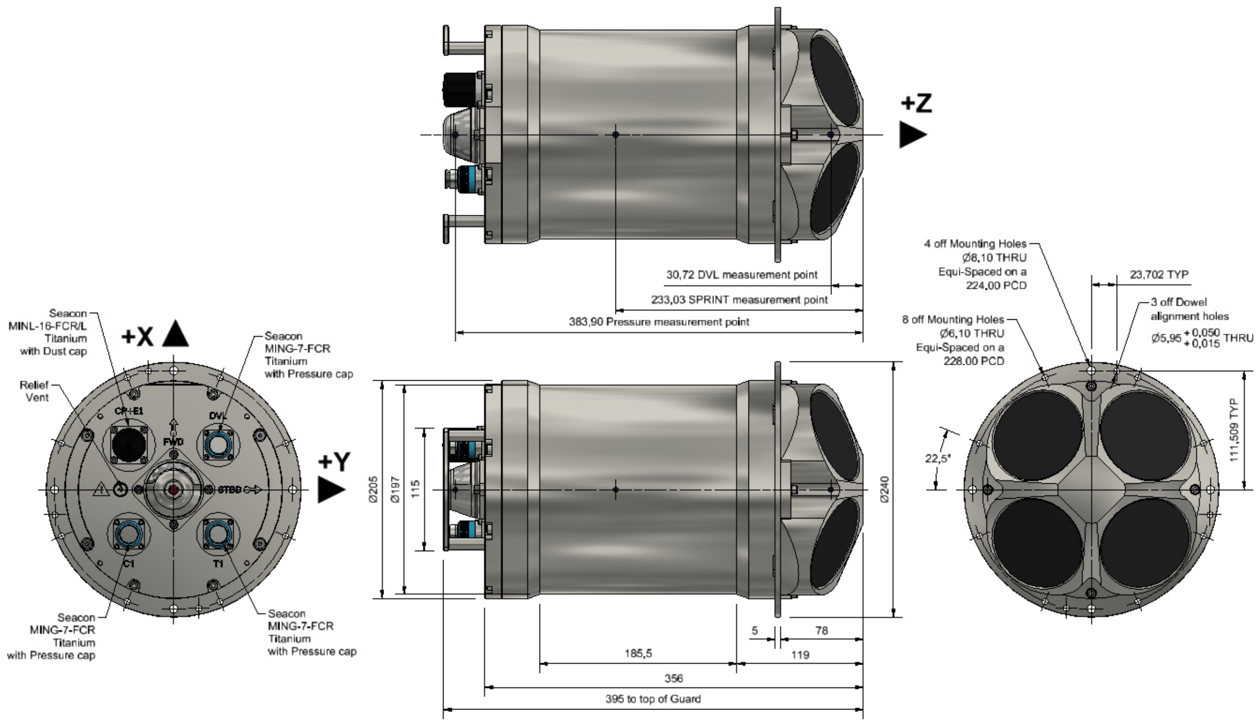
The SPRINT-Nav variants are described in *Table 19–1*.

Table 19–1 SPRINT-Nav Variants

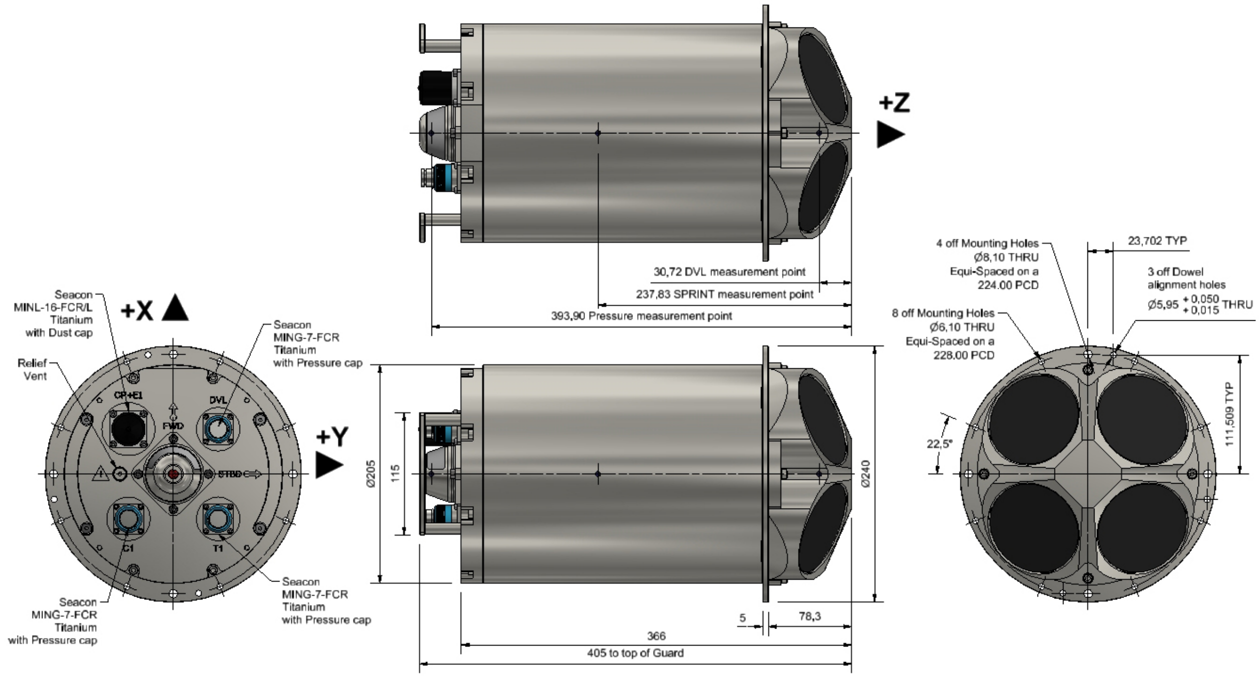
Type	Variant	Frequency	Depth Rating
8084-4581	SPRINT-Nav 300	600 kHz	4,000 m
8084-4580	SPRINT-Nav 500	600 kHz	4,000 m
8084-4582	SPRINT-Nav 700	600 kHz	4,000 m
8084-6581	SPRINT-Nav 300	600 kHz	6,000 m
8084-6580	SPRINT-Nav 500	600 kHz	6,000 m
8084-6582	SPRINT-Nav 700	600 kHz	6,000 m
8084-4501	SPRINT-Nav 300 HA	400 kHz	4,000 m
8084-4500	SPRINT-Nav 500 HA	400 kHz	4,000 m
8084-4502	SPRINT-Nav 700 HA	400 kHz	4,000 m

19.2 Technical Drawings

19.2.1 Type 8084-4581/4580/4582 SPRINT-Nav 300/500/700 4000 m



19.2.2 Type 8084-6581/6580/6582 SPRINT-Nav 300/500/700 6000 m



19.3 Technical Specifications

19.3.1 SPRINT-Nav Specifications

Performance		SPRINT-Nav 300	SPRINT-Nav 500	SPRINT-Nav 700
DVL Aided[1]	Typical Survey	0.04%	0.02%	0.01%
	Distance from Origin	0.12%	0.07%	0.05%
	High Altitude Option (HA)[2]	0.12%	0.08%	0.06%
Altitude Min / Max	Standard	0.4 m /175 m		
	High Altitude Option (HA) [2]	0.4 m /230 m		
USBL & DVL Aided	Precision Improvement	Better than 3 times	Better than 4 times	Better than 6 times
Station Keeping		<1 m over 24 hours	<1 m over 24 hours	<1 m over 24 hours
LBL/DVL Aided		3 cm confined area, 20 cm wide area (dynamic)		
INS/AHRS Heading (Secant Latitude)		0.05º (INS) 0.20º (AHRS)	0.04º (INS) 0.10º (AHRS)	0.02º (INS) 0.08º (AHRS)
AHRS/INS Roll and Pitch		0.01º		
Pressure Sensor		0.01% FS removable module		
Power				
Power Requirements		20–50 V dc, 15 W nominal, 35 W max		
Internal Battery Backup		Li-ion/5 minutes		
Physical / Comms				
Data Storage		8 GB internal memory		
Serial Ports/Protocol		4x RS232 or RS485		
Other Ports		Ethernet, 4 Triggers		
Construction		Titanium		
Diameter x Height (including connectors and mounting ring)	4,000 m	Ø240 x 395 mm		
	6,000 m	Ø240 x 405 mm		
Weight Air/Water[3]	4,000 m	23.9/13.1 kg		
	6,000 m	28.1/17.2 kg		
Environmental				
Depth Rating		4,000/6,000 m		
Operating Temperature		-5 to 50°C		
Storage Temperature		-25 to 55°C		

[1] CEP50

[2] High Altitude DVL 400 kHz

[3] Estimated Weights

19.3.2 Syrinx DVL Component Specifications

19.3.2.1 Performance

Parameter	Specification
Bottom Velocity Single Ping Precision	
St dev at @ 1 m/s	±0.22 cm/s
Long Term Accuracy	±0.12% ±0.1 cm/s
Minimum/Maximum Altitude	600 kHz: 0.4/175 m 400 kHz: 0.5/>210 m
Velocity Range	>10 m/s
Velocity Resolution	0.01 cm/s
Data Output Rate	25 Hz max

19.3.2.2 Water Reference Velocity

Parameter	Specification
Accuracy	±0.2% ±0.1 cm/s
Layer Size	Selectable
Minimum/Maximum Range	0.5/70 m
Internal Logging	32 GB Internal memory

19.3.2.3 ADCP

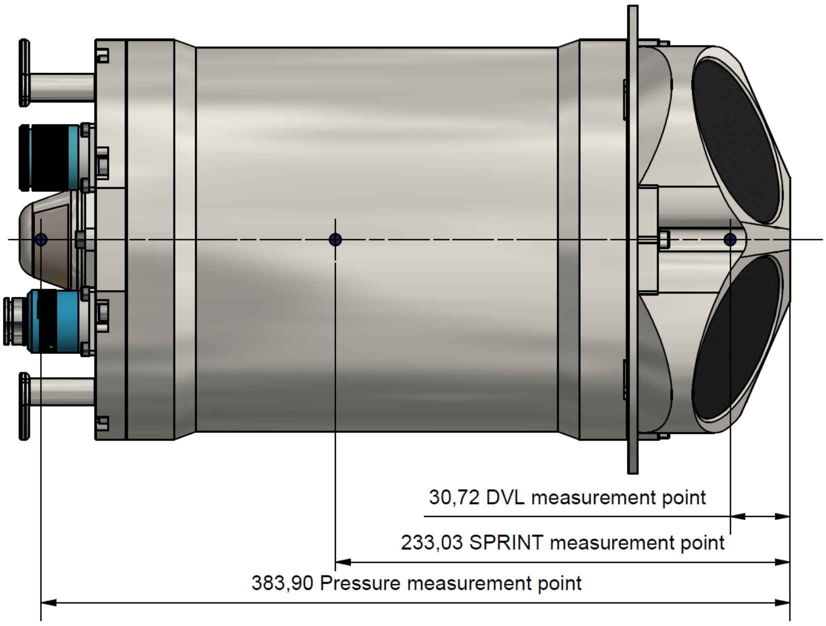
Parameter	Specification
Cell Size	0.1–20 m
Velocity Resolution	0.1 cm/s
Minimum Blanking Distance	0.3 m
Profiling Range	600 kHz: 0.4–80 m 400 kHz: 0.4–120 m
Velocity Range (along beam)	Up to ±11.2 m/s
Minimum Accuracy (along beam)	0.2% of measured value
Maximum Number of Cells	256
Maximum Ping Rate	4 Hz (ADCP) or 2.5 Hz (DVL+ADCP)

19.3.2.4 Acoustics

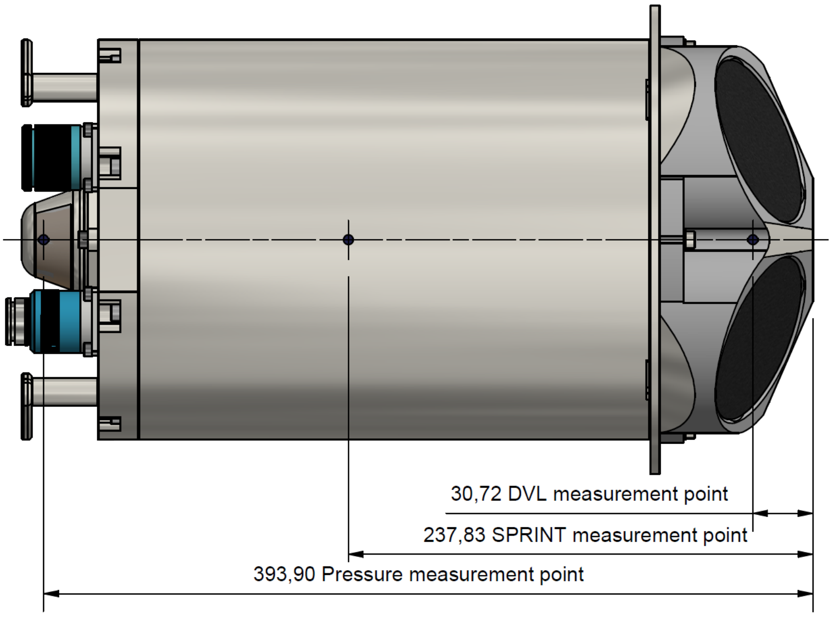
Parameter	Specification
Beam Width	±1.5 Degrees
Beam Angle	30 Degrees
Maximum Transmit Source Level (dB re 1 uPa @ 1 m)	217 dB

19.4 Central Measurement Point Dimensions

19.4.1 Type 8253/8084-4580/4581/4582 Central Measurement Points



19.4.2 Type 8253/8084-6580/6581/6582 Central Measurement Points



Appendix A – SPRINT-Nav Angle Definitions

A.1 Euler angles (Tate Bryan Rotations)

The "Tate Bryan" rotations given hereafter are commonly and henceforward referred to as the Euler angles even though they are formally just a specific sequence of a larger set of possible Euler angle rotation sequences. The Euler angle rotation sequence from NED (Earth Frame; x-North, y-East, z-Down) to body frame is:

1. Rotation by the heading angle ϕ (phi) about Zned.
2. Rotation by the pitch angle θ (theta) about the resulting Y axis.
3. Rotation by the roll angle ψ (psi) about the resulting X axis.

Similarly, the rotation sequence from a reference frame (ROV) to a sensor frame (IMU, USBL, DVL) is:

1. Rotation by the gamma angle about Zref.
2. Rotation by the beta angle about the resulting Y axis.
3. Rotation by the alpha angle about the resulting X axis.

A.2 Heading (Azimuth, Yaw)

Heading is the angle between Xned and the projection of Xb into the horizontal plane (XYned) measured about Zned. Heading is in the interval [0º ... 359.999º], Yaw is in the interval [-179.999º ... +180.000º].

A.3 Pitch

Pitch is the angle between Xb and the horizontal plane (XYned). Pitch is positive when Xb is pointed above the horizontal plane. Pitch angle lies in the interval [-90º ... +90º].

A.4 Roll

Roll is the angle between Yb and the horizontal plane measured in the ZYb plane. Roll is positive when Yb is pointed below the horizontal plane. Roll angle lies in the interval [-180º ... +180º].

A.5 Gravity (Datawell) Angles

Gravity angles are typically returned by a gyro and traditional VRUs measuring the angle of the gravity vector using 2 independent orthogonally mounted tilt sensors e.g. Datawell, TSS or Watson VRUs. These are generally defined as follows:

A.6 Pitch

Angle between the vessel forward axis and the horizontal, positive when bow is pointed above horizontal.

A.7 Roll

Angle between the vessel starboard axis and the horizontal, positive when starboard is pointed below horizontal.

A.8 Heading

Angle from the North axis to the vertical projection of the vessel forward axis onto the horizontal, measured about the down axis.

Appendix B – Reference Frames and Angular Conventions

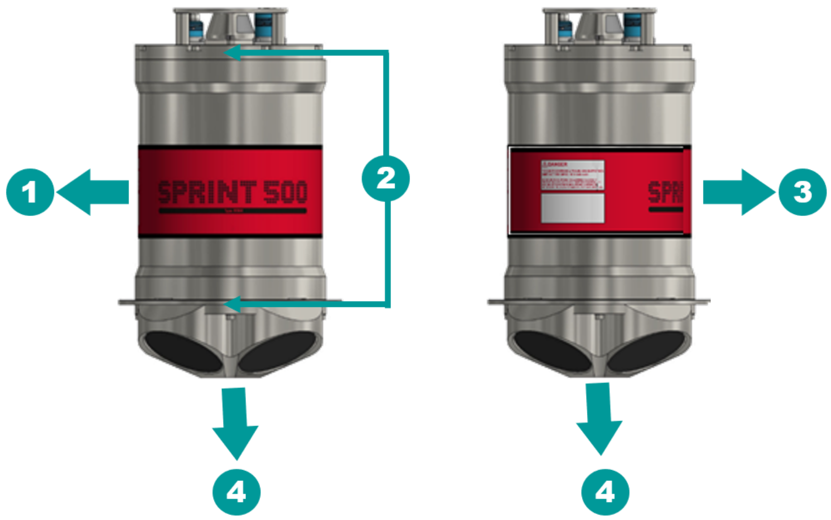
B.1 SPRINT-Nav Frame

The SPRINT-Nav frame is a fixed right-hand coordinate frame X Y Z. Typically the SPRINT-Nav is mounted so that the X axis is approximately coincident with vehicle forward; the Y axis is coincident with vehicle starboard; and the Z axis is coincident with vehicle down.

The SPRINT-Nav has the X and Y directions displayed on the top of the unit as an orientation aid during installation. Additionally, all measurements involving the SPRINT-Nav should be made with respect to the unit's centre of axis; see *UM-8084-101 Lodestar Hardware Manual*.

The SPRINT-Nav angular outputs are defined in Gravity (or Datawell) angles; see *Appendix A "SPRINT-Nav Angle Definitions "* for more information.

Figure B–1 SPRINT-Nav Reference Frame



Item	Description
1	Y Axis Positive (+) Starboard
2	Orientation Marks (Forward)
3	X Axis Positive (+) Forward
4	Z Axis Positive (+) Down

B.2 Vehicle Reference Frame

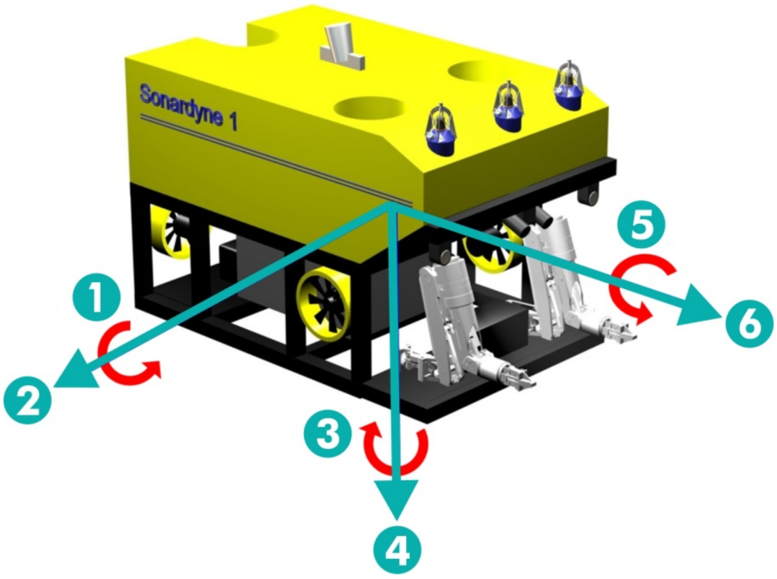
For most applications, measurements are required with respect to the vehicle's reference frame. The definition of the vehicle reference frame is shown below.

Unless otherwise stated for a particular output telegram, the SPRINT-Nav will output measurements with respect to this frame.

Before installing the SPRINT-Nav it is important to understand the concept of the vehicle reference frame. Often the chosen centre of a vehicle's reference frame is its centre of motion or mass and is usually defined and documented prior to the installation of equipment such as the SPRINT-Nav. The centre of the vehicle's reference frame is often referred to as the CRP or central reference point.

In a typical installation, the SPRINT-Nav may not be perfectly aligned to the installation vehicle reference frame.

Figure B–2 Vehicle Reference Frame



Item	Description
1	Positive Pitch (Bow up)
2	Starboard (Y)
3	Positive Heading Change
4	Down (Z)
5	Positive Roll (Starboard Down)
6	Forward (X)

B.3 Mounting Angles

In some cases, for the SPRINT-Nav to output measurements that are correct for the vehicle reference frame, mounting angles in the three axes must be carefully measured and configured.

The rotation sequence from a reference frame (vehicle) to the actual SPRINT-Nav frame is:

1. Rotation by the C (Heading) angle about the Z axis of the reference frame.
2. Rotation by the B (Pitch) angle about the resulting Y axis.
3. Rotation by the A (Roll) angle about the resulting X axis.

Note

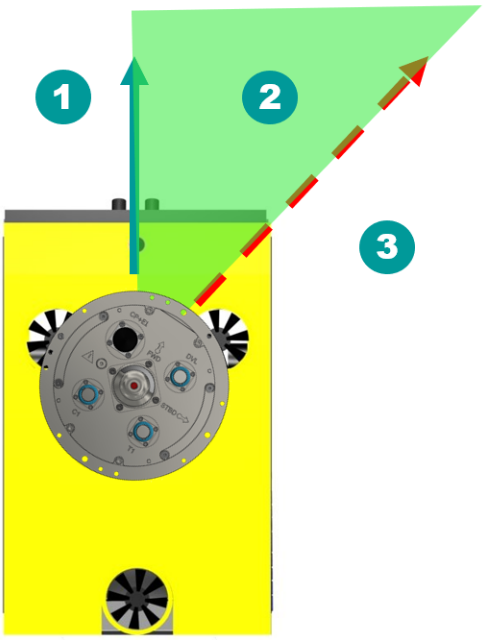
Only the misalignment for angle C (heading) can be measured independently. The misalignments for angles B (pitch) and A (roll) are the resultant misalignments after the preceding misalignments have been applied.

Mounting angles are specified as Euler angles; the convention for measuring each mounting angle is shown below.

Note

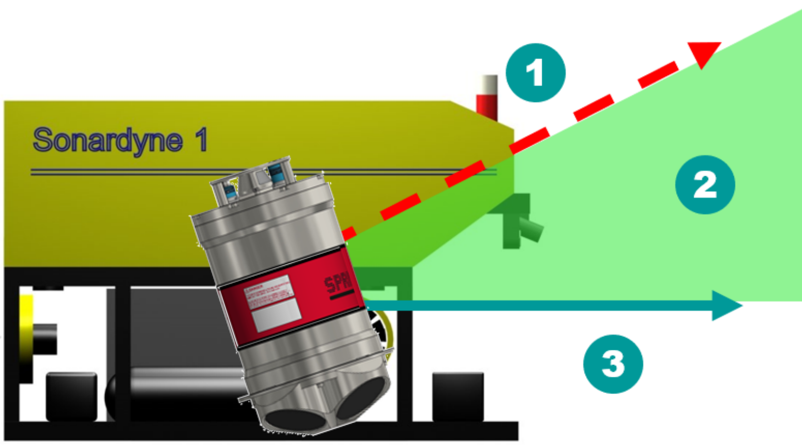
To simplify the definition and convention of each mounting angle, each angle is depicted independently but in practice they are non-commutative and must be measured in the order defined previously.

Figure B–3 SPRINT-Nav Heading Mounting Angle Example



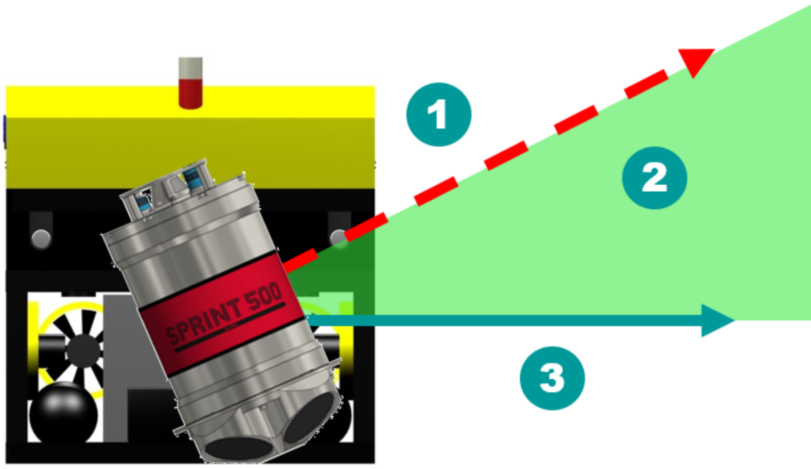
Item	Description
1	Heading Output (Mounting Angle +40°)
2	Positive (+) Mounting Angle Applied
3	Heading Output (Mounting Angle 0°)

Figure B–4 SPRINT-Nav Pitch Mounting Angle Example



Item	Description
1	Pitch Output (Mounting Angle 0°)
2	Positive (+) Mounting Angle Applied
3	Pitch Output (Mounting Angle +30°)

Figure B–5 SPRINT-Nav Roll Mounting Angle Example *



Item	Description
1	Roll Output (Mounting Angle 0°)
2	Positive (+) Mounting Angle Applied
3	Roll Output (Mounting Angle +30°)

*Vehicle view is bow-on.

Note

If mounting angles for either heading, pitch or roll exceed 2°, contact Sonardyne support for assistance.

Appendix C – INS Message Definitions

C.1 Introduction

This section lists messages that are specific to the SPRINT (INS) system input and output. Other messages are available for output, such as Lodestar (SPRINT) AHRS output messages; see *UM-8084-109 Lodestar AHRS Messages*.

Table C–1 SPRINT Input & Output Messages

Message	INS Input	INS Output
GGA	✓ GPGGA NPGGA	✓ INGGA
PSIMSSB	✓	×
Sonardyne External Position	✓	×
DVL ASONDV	✓	×
DVL PD4	✓	×
DVL PD5	✓	×
DigiQuartz Pressure Depth	✓	×
Valeport Midas SVX2 Depth	✓	×
PSONDEP Depth	✓	×
NMEA DPT Depth	✓	×
Sonardyne External Depth	✓	×
SPRINT-Nav Internal Depth	✓	×
ZDA	✓	×
Valeport Sound Velocity	✓	×
PSONSS Sound Velocity	✓	×
INS Navigation	×	✓
INS Navigation Quality	×	✓
Time System	×	✓
Sonardyne PSONNAV	×	✓
Sonardyne LNAV	×	✓

C.2 Simrad SSB – SSBL Position Report ($PSIMSSB)

Reference: Kongsberg APOS Release 4.2.2 Manual (29.April. 2005)

C.2.0.1 Description

The PSIMSSB sentence contains the position of a SSBL beacon which is sent after each USBL measurement. The operator may define various parameters.

C.2.0.2 Format

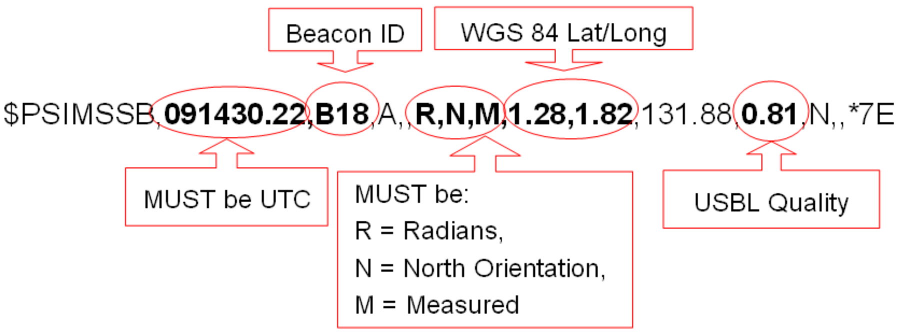
$PSIMSSB,hhmmss.ss,ccc,a,ccc,a,a,a,x.x,x.x,x.x,x.x,a,x.x,x.x*hh <cr><lf>

Table C–2 PSIMSSB Formatting

Field	Description
$	Start character
PSIM	Proprietary Simrad code
SSB	Sentence Formatter
hhmmss.ss	Empty or UTC time of reception
ccc	Beacon code, Examples: B01, B33, B47
a	Status, A for OK, V for not OK
ccc	Error_code, Empty or 3 character error code
a	C for Cartesian, P for polar, U for UTM coordinates, R for radians
a	Orientation, H vessel heading up; N for north; E for East:
a	Software filter, M=Measured, F=Filtered, P=Predicted
x.x	x coordinate
x.x	y coordinate
x.x	Depth in metres
x.x	Expected accuracy of the position
a	Additional info, N=None,C= Compass, I=Inclinometer, T=Time from Beacon to Transceiver
x.x	First add value, empty or Tp compass or Tp x inclination
x.x	Second add value, empty or Tp y inclination.
*hh	Terminator and checksum (or empty?)
<cr><lf>	return plus linefeed

C.2.0.3 Supported Input Format

Sonardyne Marksman/Ranger 2 and Kongsberg HiPAP:



C.3 Proprietary $PSONDEP Report

C.3.0.1 Description

The purpose of this proprietary string is to support depth input into Sonardyne software and instruments from a non-specific source. This string is already used in several subsea positioning applications with both Ranger and Fusion software.

C.3.0.2 Format

$PSONDEP,x.xx,y.y,c*hh<cr><lf>

Table C–3 PSONDEP Formatting

Field	Description
$	Start_character
PSONDEP	Address
x.xx	Depth
y.y	Observation Error
c	Units (M=metres)
*hh	Terminator and Checksum
<cr><lf>	Termination (0x0D 0x0A)

C.3.0.3 Supported Input Format

C.4 Proprietary $PSONDIGI Report

C.4.0.1 Description

This proprietary string outputs the pressure data from the SPRINT-Nav internal pressure sensor in PSI.

C.4.0.2 Format

Table C–4 PSONDIGI Formatting

Field	Description
*	Start_character
dd	00
ss	01
x.xx	Pressure Measurement in PSI
<cr><lf>	Termination (0x0D 0x0A)

C.4.0.3 Example

*000114.573<cr><lf>

C.4.0.4 Notes

Any configured surface offset is converted from metres into PSI (by multiplying by 1.4593) and is then subtracted from the raw pressure measurement.

C.5 Proprietary $PSONSS Report

C.5.0.1 Description

The purpose of this proprietary string is to support sound speed input into Sonardyne software and instruments from a non-specific source. This string is already used in several subsea positioning applications with both Ranger and Fusion software.

C.5.0.2 Format

$PSONSS,x.x,y.y,c*hh<cr><lf>

Table C–5 PSONSS Formatting

Field	Description
$	Start_character
PSONSS	Address
x.x	Depth
y.y	Sound Speed in Units per second
c	Units
*hh	Terminator and Checksum
<cr><lf>	Termination (0x0D 0x0A)

C.5.0.3 Supported Input Format

C.6 Digiquartz Pressure Sensor Report

C.6.0.1 Description

Pressure depth output from Paroscientific Digiquartz intelligent pressure depth sensor.

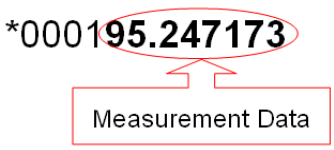
C.6.0.2 Format

*0001nnn__<cr><lf>

Table C–6 Digiquartz Formatting

Field	Description
*	Start character
00	Destination ID (00 is ID of serial host)
01	Source ID (01 is ID of sender device)
nnn__	Measurement Data (units=Metres H2O / KPA / PSI)
<cr><lf>	return plus linefeed

C.6.0.3 Supported Input Format



C.7 $__DPT Report

C.7.0.1 Description

This is NMEA string outputs water depth.

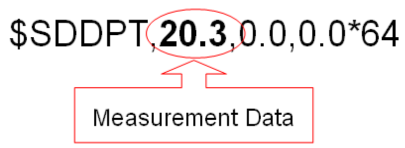
C.7.0.2 Format

$__DPT,x.x,y.y,z.z*hh<cr><lf>

Table C–7 DPT Formatting

Field	Description
$	Start_character
__DPT	Address
x.x	Water depth relative to the transducer, in metres
y.y	Offset from transducer, in metres. (NOT USED)
z.z	Maximum range scale in use
*hh	Terminator and Checksum
<cr><lf>	Termination (0x0D 0x0A)

C.7.0.3 Supported Input Format



C.8 Valeport Sensor Telegram

C.8.0.1 Description

This simple string outputs the data from the Valeport Mini SVS sensor. Sound Velocity only m/sec supported.

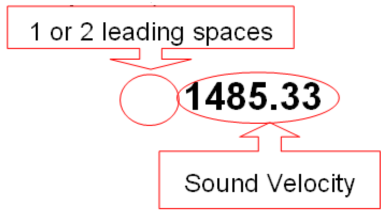
C.8.0.2 Format

<space>xxxx.xxx<cr><lf>

Table C–8 Valeport Sensor Telegram Formatting

Field	Description
<space>	A space character
xxxx.xxx	Sound Speed in metres per second
<cr><lf>	Termination (0x0D 0x0A)

C.8.0.3 Supported Input Format



C.9 $__GGA Report

C.9.0.1 Description

This NMEA string outputs longitude and latitude at a UTC time.

C.9.0.2 Format

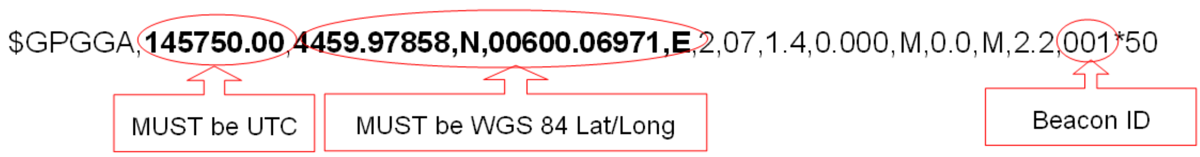
$--GGA, hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.xxx,M,x.x,M,x.x,xxxx*hh<cr><lf>

Table C–9 GGA Formatting

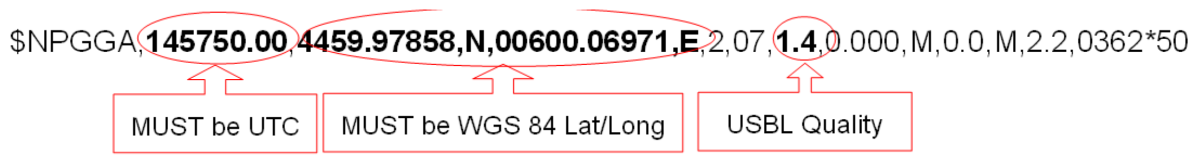
Field	Description
$	Start character
--	Sender Code (IN ? or GP)
GGA	Sentence Formatter
hhmmss.ss	UTC
llll.ll,a	Latitude, N/S 2 fixed digits degrees, 2 fixed digits minutes, variable digits of decimal minutes.
yyyyy.yy,a	Longitude, E/W 3 fixed digits degrees, 2 fixed digits minutes, variable digits of decimal minutes.
x	GPS quality Indicator 0-8
xx	Number of satellites
x.x	Horizontal dilution of precision
x.xxx,M	Antenna altitude above/below mean sea level (geoid), Metres (units of antenna altitude)
x.x,M	Geoidal Separation, Metres
x.x	Age of Differential data, not relevant.
xxxx	Differential Reference Station ID
*hh	Terminator and checksum
<cr><lf>	Terminator, return plus linefeed

Supported Input Formats

Sonardyne Ranger:



EIVA NaviPac:



C.10 $_ZDA Report

Description

This NMEA string outputs UTC,day,month,year and local time zone.

Format

$--ZDA,hhmmss.sss,xx,xx,xxxx,xx,xx*hh <cr><lf>

Table C–10 ZDA Formatting

Field	Description
$	Start character
--	Sender Code
ZDA	Sentence Formatter
hhmmss.sss	Hours, minutes, seconds, and decimal seconds
xx	Day, 0 to 31
xx	Month, 01 to 12
xxxx	Year
xx	Local Zone hours 00 to ±13
xx	Local Zone minutes 00 to 59
*hh	Terminator and checksum
<cr><lf>	return plus linefeed

C.10.0.1 Supported Input Format

C.11 Navigation (Nav) Data

The navigation (Nav) data message is the generic navigation output fromSPRINT-Nav AINS and is closely related the navigation quality message (NavQual); see *Section C.12 "Navigation Quality Estimate (NavQual)"*.

Note

Nav and NavQual are intended for advanced users including internal (Sonardyne) and external system integrators. Nav values are valid for vehicle CRP / frame, except acceleration which is valid for the IMU zero point but expressed in vehicle frame. For best accuracy it is recommended to use CRP=IMU zero point. AINS algorithm is the only source for the NAV message.

Table C–11 Navigation Data

Byte#	Field name	Unit (LSB)	Data type	Note
0-5 / 6	timeTag	1e-6 sec	Uint48	System time
6-9 / 4	lat	2^-31*90 x° [-90;90]	Int32	+North (LSB ~= 0.5cm)
10-13 / 4	lon	2^-31*180° [-180; 180]	Int32	+East (LSB ~= 1cm @ Equator)
14-17 / 4	depth	1e-3 m	Int32	
18-19 / 2	altitude	1e-2 m	Uint16	Height above seabed (from DVL)
20-21 / 2	roll	2^-15*180° [-180; 180]	Int16	Angle between y and horizontal. Roll is positive when y is pointed below the horizontal (starboard down)
22-23 / 2	pitch	2^-15*180° [-90;90]	Int16	Angle between x and horizontal. Pitch is positive when x is pointed above the horizontal (bow up)
24-25 / 2	heading	2^-15*180° [0;360]	Uint16	Angle between North and projection of X onto the horizontal (measured about down).
26-27 / 2	vN	1e-3 m/s	Int16	Vehicle North-velocity (max 32 m/s)
28-29 / 2	vE	1e-3 m/s	Int16	Vehicle East-velocity (max 32 m/s)
30-31 / 2	vDwn	1e-3 m/s	Int16	Vehicle Down-velocity (max 32 m/s)
32-33 / 2	wx	1e-2°/s	Int16	Angular rate about x axis (max ~327°/s)
34-35 / 2	wy	1e-2°/s	Int16	Angular rate about x axis (max ~327°/s)
36-37 / 2	wz	1e-2°/s	Int16	Angular rate about x axis (max ~327°/s)
38-39 / 2	ax	1e-3 m/s^2	Int16	X-acceleration (max ~ 3.2 G)
40-41 / 2	ay	1e-3 m/s^2	Int16	X-acceleration (max ~ 3.2 G)
42-43 / 2	az	1e-3 m/s^2	Int16	X-acceleration (max ~ 3.2 G)
44-45 / 2	mode	N/A	Bit16	Logical. Bit# 0: data valid 1:INS initialised 2: INS application not enable 3-14: Reserved 15: System failure

Note

Altitude = 0 imply invalid.

C.12 Navigation Quality Estimate (NavQual)

The navigation quality message reports the expected accuracy of the data given in the “nav” message.

Notes

Horizontal position 1DRMS = sqrt(posMajor^2 + posMinor^2)

CEP(50%) ~= 0.589 * (posMajor + posMinor).

Error ellipse (1 sigma) is 39.4% probability (i.e. 39.4% likelihood that true value is within ellipse).

95% percent probability error ellipse is 2.447 * 1 sigma error ellipse.

Roll, pitch 1 sigma ~= max(stdLevN,stdLevE) for roll, pitch << 45deg.

Velocity rms = sqrt(velMajor^2+ velMinor^2).

Table C–12 Navigation Quality Estimate – Rate: 1 Hz

Byte#	Field name	Unit (LSB) / range	Data type	Note
0-5 / 6	timeTag	1e-6 sec	Uint48	System time
6-9 / 4	posMajor	m	Float32	Position (horizontal) error ellipse: - semi-major axis (1 sigma)
10-13/ 4	posMinor	-	Float32	- semi-minor axis (1 sigma)
14-17 / 4	dirPMajor	deg [0;360[	Float32	- direction of semi-major axis
18-21 / 4	stdDepth	m	Float32	Depth (1 sigma)
22-25 / 4	stdLevN	deg	Float32	Level error about North (1 sigma)
26-29 / 4	stdLevE	deg	Float32	Level error about East (1 sigma)
30-33 / 4	stdHeading	deg	Float32	Heading (1 sigma)
34-37 / 4	velMajor	m/s	Float32	Velocity (horizontal) error ellipse: - semi-major axis (1 sigma)
38-41 / 4	velMinor	m/s	Float32	- semi-minor axis (1 sigma)
42-45 / 4	dirVMajor	deg [0;360[	Float32	- direction of semi-major axis
46-49 / 4	velDown	m/s	Float32	Down velocity (1 sigma)

C.13 Time System Data

The Time System data format is defined below.

Note

Source of RTC to UTC update; 0 = NO SOURCE; 1 = SPRINT-Nav RTC; 2 = Standalone GPZDA; 3 = Standalone GPGGA; 4 = GPZDA 1PPS.

Fields in italic are for advanced users only and are subject to change.

Table C–13 Time System Data

Field#	Byte# (from 0)	Size (bytes)	Field name	Unit/LSB	Data type	Notes
1	0-5	6	sysTime	1e-6 sec	Uint48	System time (and message timeTag)
2	6-13	8	utcTime	1e-6 sec	Uint64	UTC time – seconds since midnight 1970.01.01
3	14-19	6	timeSinceUpdate	1e-6 sec	Uint48	Time since last accepted UTC time update, e.g. from ZDA/PPS
4	20-23	4	stdDev	sec	Float32	Expected standard deviation of UTC time field
5	24	1	Source	logical	Uint8	Currently used source of UTC sync
6	25	1	ppsRising	logical	Uint8	0: PPS valid on falling edge (low to high voltage). 1: PPS valid on rising edge.
7	26	1	zdaCount	#	Uint8	LS byte of ZDA message count
8	27	1	ppsCount	#	Uint8	LS byte of PPS message count
9	28	1	zdaRejCount	#	Uint8	LS byte of ZDA message rejection count
10	29	1	ppsRejCount	#	Uint8	LS byte of PPS signal rejection count
11	30	1	ppsZdaProcCount	#	Uint8	LS byte of accepted PPS/ZDA pairs
12	31	1	filtResetCount	#	Uint8	LS byte of UTC filter reset count

Example: Converting IMU time tag from [sys] to [utc]

imu.timeTag[sys] = 1234567890 usec

Get the preceding time system message:

timeSys.sysTime = 1234101010 usec

timeSys.utcTime = 1254273030984001 usec

timeSys.stdDev = 0.0000124 sec low std.dev. => UTC can be trusted

imu.timeTag [utc] = imu.timeTag[sys] + (timeSys.utcTime - timeSys.sysTime)

= 1234567890 + (1254273030984001 - 1234101010) usec

= 1254273031450881 usec = 20090930T011031 (ISO 8601) = 2009-09-30 01:10:31

C.14 Midas SVX2 Depth

C.14.0.1 Description

This message is tab delimited and provides Sound Velocity, Depth, Temperature and conductivity.

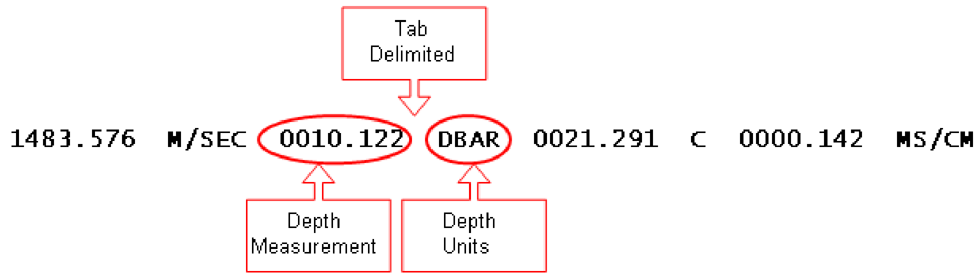
C.14.0.2 Format

ssss.sss<tab>uuuu<tab>dddd.ddd<tab>xxxx<tab>tttt.ttt<tab>xxxx<tab>cccc.ccc<tab>zzzz<tab><cr><lf>

Table C–14 Navigation Data

Field	Description
ssss.sss	Sound Velocity in metres per second
uuuu	Sound Velocity Units (M/SEC)
dddd.ddd	Depth
xxxx	Depth Units (DBAR)
tttt.ttt	Temperature
xxxx	Temperature Units (C)
cccc.ccc	Conductivity
zzzz	Conductivity Units (MS/CM)
<cr><lf>	return plus linefeed

C.14.0.3 Supported Input Format



C.15 Proprietary XPOS Report

C.15.0.1 Description

This proprietary message provides an external position and depth.

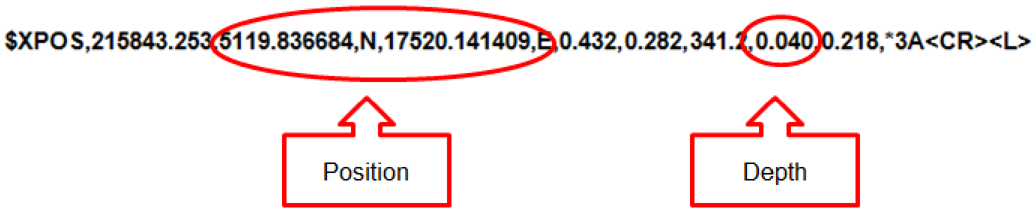
C.15.0.2 Format

$XPOS,hhmmss.sss,llll.llllll,a,yyyyy.yyyyyy,a,x.xxx,x.xxx,x.xxx,d.ddd,d.ddd,aa*hh<cr><lf>

Table C–15 XPOS Format

Field	Description	Units
$XPOS	Start Character	n/a
hhmmss.sss	UTC	
llll.llllll	Latitude: 2 fixed digits degrees, 2 fixed digits minutes, minimum 6 digits of decimal minutes (2mm resolution or better).	Degrees [0;90]
a	N/S	
yyyyy.yyyyyy	Longitude, 3 fixed digits degrees, 2 fixed digits minutes, minimum 6 digits of decimal minutes.	Degrees [0;180]
a	E/W	
x.xxx	posMajor – if not used then field will be null	Metres
x.xxx	posMinor – if not used then field will be null	Metres
x.xxx	dirPMajor – if not used then field will be null	Degrees
d.ddd	Depth – if not used then field will be Null	Metres
d.ddd	stdDepth – if not used then field will be Null	Metres
aa	Spare*	n/a
*hh	Terminator and Checksum	
<cr><lf>	Carrier return and line feed	

C.15.0.3 Supported Input Format



C.16 Proprietary XDepth Report

C.16.0.1 Description

This purpose of this string is to support an external depth input into Sonardyne software and instruments from a non-specific source.

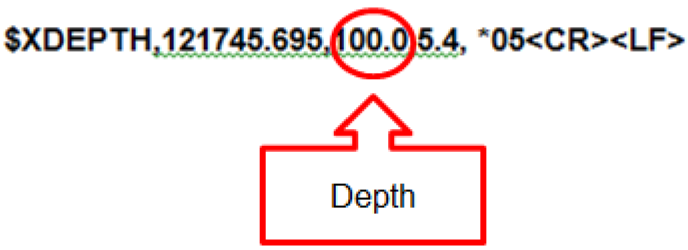
C.16.0.2 Format

$XDEPTH,hhmmss.sss,d.ddd,x.xxx,aa*hh<cr><lf>

Table C–16 XDepth Formatting

Field	Description
$XDEPTH	Start Character
hhmmss.sss	UTC...
d.ddd	Depth in metres
x.xxx	Depth Standard Deviation in metres
aa	Spare
<cr><lf>	return plus linefeed

C.16.0.3 Supported Input Format



C.17 Proprietary PSONNAV

C.17.0.1 Description

The purpose of this proprietary message provides output navigation which consists of a UTC timestamp, position, depth, attitude and heading with associated accuracy estimates.

C.17.0.2 Format

$PSONNAV,hhmmss.sss,llll.llllll,a,yyyyy.yyyyyy,a,x.xxx,x.xxx,x.xxx,a,d.ddd,x.xxx,r.rrr,p.ppp,h.hhh ,x.xxx,a,aaaaaaa, , , , , ,*hh<cr><lf>

Table C–17 Digiquartz Formatting

Field	Description
&	Start character
PSONNAV	Address
hhmmss.sss	UTC Timestamp
llll.llllll,a	Latitude
yyyyy.yyyyyy,a	Longitude
x.xxx	Major Axis position error ellipse
x.xxx	Minor Axis position error ellipse
x.xxx	Direction of major Axis position error ellipse
a	Position Status
d.ddd	Depth
x.xxx	Depth standard deviation
r.rrr	Roll
p.ppp	Pitch
h.hhh	heading
x.xxx	Heading standard deviation
a	Orientation status
aaaaaaa	Sensor status
, , , , , ,	Null fields for future use
<cr><lf>	return plus linefeed

C.17.0.3 Supported Input Format

$PSONNAV,153239.443,5119.838453,N,00050.141452,W,0.155,0.155,1.861,A,-0.040,0.218,0.798,0.079,279.846,0.133,A,AI,,,,,,*46<cr><lf>

C.18 LNav/LNavUTC

C.18.0.1 Description

The long navigation (LNav) and long navigation UTC (LNavUTC) data messages are two generic navigation outputs from Lodestar INS / AHRS that differ in only what time is represented in the timeTag field of the message. LNav contains System Time, whilst LNavUTC contains UTC. The remaining message content is essentially the combination of the Nav and NavQual messages.

Table C–18 LNav/LNavUTC Data

Byte# (from 0)	Size (bytes)	Field name	Units	Optional	Data type	Notes
1-6	6	Time Tag	10^{-6} seconds (LNav) 10^{-5} seconds (LNavUTC)	No	Uint48	System Time (LNav). UTC (LNavUTC), Note 1
6-10	4	Latitude	$2^{-31}\times90$ deg	Yes, see Note 12	Int32	Latitude, Note 2
11-14	4	Longitude	$2^{-31}\times180$ deg	Yes, see Note 12	Int32	Longitude, Note 3
15-18	4	Depth	10^{-3} metres	Yes, see Note 12	Int32	Depth below sea level, Note 4
19-20	2	Altitude	10^{-2} metres	Yes, see Note 12	Uint16	Height above seabed, Note 5 & Note 13
21-22	2	Roll	$2^{-15}\times180$ deg	No	Int16	Note 6
23-24	2	Pitch	$2^{-15}\times180$ deg	No	Int16	Note 7
25-26	2	Heading	$2^{-15}\times180$ deg	No	Uint16	Note 8
27-28	2	vN	10^{-3} m/s	Yes, see Note 12	Int16	Vehicle North-velocity
29-30	2	vE	10^{-3} m/s	Yes, see Note 12	Int16	Vehicle East-velocity
31-32	2	vDwn	10^{-3} m/s	Yes, see Note 12	Int16	Vehicle Down-velocity
33-34	2	wFwd	10^{-2} deg/s	No	Int16	Angular rate about Vehicle Fwd axis
35-36	2	wStbd	10^{-2} deg/s	No	Int16	Angular rate about Vehicle Stbd axis
37-38	2	wDwn	10^{-2} deg/s	No	Int16	Angular rate about Vehicle Dwn axis
39-40	2	aFwd	10^{-3} m/s^2	No	Int16	Vehicle Fwd-acceleration
41-42	2	aStbd	10^{-3} m/s^2	No	Int16	Vehicle Stbd-acceleration
43-44	2	aDwn	10^{-3} m/s^2	No	Int16	Vehicle Dwn-acceleration
45-48	4	posMajor	Metres	Yes, see Note 12	Float32	Horizontal position 1σ error ellipse (Note 9): - semi-major axis

Table C–18 LNav/LNavUTC Data (continued)

Byte# (from 0)	Size (bytes)	Field name	Units	Optional	Data type	Notes
49-52	4	posMinor	Metres	Yes, see Note 12	Float32	- semi-minor axis
53-56	4	dirPMajor	Degrees	Yes, see Note 12	Float32	- direction of semi-major axis
57-60	4	stdDepth	Metres	Yes, see Note 12	Float32	1σ depth error
61-64	4	stdLevN	Degrees	Yes, see Note 12	Float32	1σ level error about North (Note 10)
65-68	4	stdLevE	Degrees	Yes, see Note 12	Float32	1σ level error about East (Note 10)
69-72	4	stdHeading	Degrees	Yes, see Note 12	Float32	1σ heading error
73-76	4	velMajor	m/s	Yes, see Note 12	Float32	Horizontal velocity 1σ error ellipse (Note 11): - semi-major axis
77-80	4	velMinor	m/s	Yes, see Note 12	Float32	- semi-minor axis
81-84	4	dirVMajor	Degrees	Yes, see Note 12	Float32	- direction of semi-major axis
85-88	4	velDown	m/s	Yes, see Note 12	Float32	1σ down velocity error
89-90	2	Status	N/A	No	Bit16	Note 14

Note 1 – For the LNavUTC the time is the time since 1^{st} Jan 1970 with a resolution of 0.01ms.

Note 2 – Latitude, north is positive. 0.5cm resolution.

Note 3 – Longitude, east is positive. 1cm resolution at equator.

Note 4 – Depth, down is positive.

Note 5 – Approximate vertical distance from the DVL to the seabed, assuming small vehicle roll / pitch and a flat seabed. Altitude is calculated from the last received message from the DVL: Valid beam ranges are averaged whilst taking their direction relative to DVL down into account. Vehicle roll / pitch and non-zero DVL mounting angles are not compensated for.

Note 6 – Roll is the angle between the Stbd-axis and horizontal. Roll is positive when Stbd is pointed below the horizontal (starboard down).

Note 7 – Pitch is the angle between the Fwd-axis and horizontal. Pitch is positive when Fwd is pointed above the horizontal (bow up).

Note 8 – Heading is the angle between North and projection of the Fwd-axis onto the horizontal (measured about the down direction).

Note 9 –

- Horizontal position 1DRMS = sqrt(posMajor^2 + posMinor^2)
- CEP(50%) ~= 0.589 × (posMajor + posMinor)

- Error ellipse (1σ) is 39.4% probability (i.e. 39.4% likelihood that true value is within ellipse)
- 95% percent probability error ellipse is 2.447 × 1σ error ellipse

Note 10 – Roll & pitch 1σ ~= max(stdLevN,stdLevE) for roll, pitch << 45deg.

Note 11 – Velocity RMS = sqrt(velMajor^2+ velMinor^2)

Note 12 – Will be populated with zero values if data unavailable (e.g. INS is not initialised / DVL data invalid)

Note 13 – Altitude is referenced from the DVL's measurement point. It doesn't reflect any lever arms setup between DVL-IMU/CRP, or Remote Point setup for generation of the contents for this message.

Note 14 - The status bits are described below (if bit = 0 then status is OK):

Table C–19 LNav/LNavUTC Status

Status Bit	Field name	Notes/Bit Set
0	bOrientationStatus	Orientation Invalid (e.g. AHRS not OK or unsettled)
1	bPosStatus	Position (& Velocity) Invalid (e.g. INS not OK or not initialised)
2	bAltitudeStatus	0 indicates that the altitude field has been updated in this message compared to the last time the LNAV message was sent. 1 indicates that the altitude data is either old (no update from DVL since last LNAV message sent) or invalid.
3	Not Used	Reserved for future use
4	bOrientationSource	0 indicates Orientation source = AHRS, 1 indicates Orientation source = INS
5	bSubseaUSBLUsed	0 indicates data received and some or all used within the last second, otherwise 1
6	bDepthUsed	0 indicates data received and some or all used within the last second, otherwise 1
7	bDVLUsed	0 indicates data received and some or all used within the last second, otherwise 1
8	bLBLUsed	0 indicates data received and some or all used within the last second, otherwise 1
9	bZUPTUsed	0 indicates data received and some or all used within the last second, otherwise 1
10	bXPOSUsed	0 indicates data received and some or all used within the last second, otherwise 1
11	bGPSUsed	0 indicates data received and some or all used within the last second, otherwise 1
12	bZMDUsed	0 indicates data received and some or all used within the last second, otherwise 1
13	bUSBLUsed	0 indicates data received and some or all used within the last second, otherwise 1
14-15	Not Used	Reserved for future use

Appendix D – AHRS Message Definitions

D.1 PRDID

D.1.0.1 Description

This Proprietary ADCP (RDI) telegram consists of pitch roll and heading

D.1.0.2 Format

$PRDID,PPP.PP,RRR.RR,hhh.hh*hh*hh<CR><LF>

Field	Description
$PRDID	Header
Pitch	Pitch, -30.0 to +30.0, degrees
Roll	Roll, -30.0 to +30.0, degrees
Heading	True Heading, 0 to 359.99, degrees
*hh	Terminator and checksum
<CR><LF>	Terminator, return plus linefeed

D.1.0.3 Notes

- The data string has variable length with leading zeros and minus signs added where necessary.
- Positive roll is port-side up, starboard down. Positive pitch is bow up, stern down.
- The attitude measurements contained in the data string will be in real time.
- There is no status indicator in the data string. This data string does include the optional checksum allowed within the NMEA 0183 standard.
- The data string will include gyro heading information only if it is available. If there is no heading information available, the heading field will be null.

D.1.0.4 Example

$PRDID,-0.17,-0.59,172.66*77

D.2 TSS1

D.2.0.1 Description

The TSS proprietary string outputs accelerations, heave and roll and pitch.

D.2.0.2 Format

:XXAAAASMHHHHQMRRRRSMPPPP<CR><LF>

Field	Description
:	Start character
XX	Horizontal Acceleration (not populated by SPRINT-Nav)
AAAA	Vertical Acceleration, vehicle frame
S	Space
M	Space if positive, minus if negative
HHHH	Heave
Q	Status Flag, H,h,F,f. Heading or Fully aided, settled or settling
M	Space if positive, minus if negative
RRRR	Roll
S	Space
M	Space if positive, minus if negative
PPPP	Pitch
<CR><LF>	Terminator, return plus linefeed

D.2.0.3 Notes

- Vertical acceleration is positive in the up direction.
- Horizontal acceleration is not populated by the SPRINT-Nav.
- The motion measurements contained in the data string will be in real time, valid for the instant when the system begins to transmit the string.
- Motion measurements include ASCII-coded decimal values.
- Heave measurements are in cm in the range –99.99 to +99.99 metres. Positive heave is above datum.
- Roll and pitch measurements are in degrees in the range –99.99° to +99.99°. Positive roll is port-side up, starboard down. Positive pitch is bow up, stern down.
- Status flag H – The system is using heading from the settled gyrocompass.
- Status flag h – The gyrocompass heading is not settled.
- Status flag f – The system is receiving aiding data from both GGA and VTG NMEA messages but the gyrocompass is not settled.
- Status flag F – The system is receiving aiding data from both GGA and VTG NMEA messages and the gyrocompass is settled.

D.2.0.4 Example

:003D04 0000H-0058 -0017

D.3 TSS2

D.3.0.1 Description

This TSS proprietary string outputs heading, heave, roll and pitch.

D.3.0.2 Format

:DDDDDSMHHHHQMRRRRSMPPPPE<CR><LF>

Field	Description
:	Start character
DDDDD	Heading x 100 degrees
S	Space
M	Space if positive, minus if negative
HHHH	Heave in centimetres
Q	Status Flag, H,h,F,f. Heading or Fully aided, settled or settling
M	Space if positive, minus if negative
RRRR	Roll x 100 degrees
S	Space
M	Space if positive, minus if negative
PPPP	Pitch x 100 degrees
E	Heading status flag, as for other TSS messages
<CR><LF>	Terminator, return plus linefeed

D.3.0.3 Notes

- The angle measurements are in hundredths (i.e. x 100)
- The motion measurements contained in the data string will be in real time, valid for the instant when the System begins to transmit the string.
- Motion measurements include ASCII-coded decimal values.
- Heave measurements are in cm in the range –99.99 to +99.99 metres. Positive heave is above datum.
- Roll and pitch measurements are in degrees in the range –99.99° to +99.99°. Positive roll is port-side up, starboard down. Positive pitch is bow up, stern down.
- Status flag is as for TSS1
  - Status flag H – The system is using heading from the settled gyrocompass.
  - Status flag h – The gyrocompass heading is not settled.
  - Status flag f – The system is receiving aiding data from both GGA and VTG NMEA messages but the gyrocompass is not settled.
  - Status flag F – The system is receiving aiding data from both GGA and VTG NMEA messages and the gyrocompass is settled.
- Heading Status flag can take the following values:
  - A – If Status flag above is H or h
  - f – if Status flag above is f
  - F – if Status flag above is F

D.3.0.4 Example

:17263 0001H-0058 -0017A

D.4 TSS3

D.4.0.1 Description

The TSS proprietary string outputs remote heave, heave, roll and pitch.

D.4.0.2 Format

:RMhhhhSMHHHHQMRRRRSMPPPP<CR><LF>

Field	Description
:R	Start character and format identifier
M	Space or minus sign
hhhh	Remote Heave
S	Space
M	Space if positive, minus if negative
HHHH	Heave
Q	Status Flag, H,h,F,f. Heading or Fully aided, settled or settling
M	Space if positive, minus if negative
RRRR	Roll
S	Space
M	Space if positive, minus if negative
PPPP	Pitch
<CR><LF>	Terminator, return plus linefeed

D.4.0.3 Notes

- After the start character (a colon, ASCII 3Ah) the TSS3 data string includes an upper case 'R' to identify the string as using TSS3 remote heave format.
- The motion measurements contained in the data string will be in real time, valid for the instant when the System begins to transmit the string.
- Motion measurements include ASCII-coded decimal values.
- Heave measurements are in cm in the range –99.99 to +99.99 metres. Positive heave is above datum.
- Roll and pitch measurements are in degrees in the range –99.99° to +99.99°. Positive roll is port-side up, starboard down. Positive pitch is bow up, stern down.
- Status flag H – The system is using heading from the settled gyrocompass.
- Status flag h – The gyrocompass heading is not settled.
- Status flag f – The system is receiving aiding data from both GGA and VTG NMEA messages but the gyrocompass is not settled.
- Status flag F – The system is receiving aiding data from both GGA and VTG NMEA messages and the gyrocompass is settled.
- Status flag A – General alarm

D.4.0.4 Example

:R 0001 0001H-0059 -0017

D.5 EM1000

D.5.0.1 Description

Format suitable for use with Simrad EM series multibeam sonars.

D.5.0.2 Format

ABRRPPAAHH bytes 0-9

Byte	Field		Field
0	A	MSB	Header, 0x00
1	BB	LSB	Header, 0x90
2	RR	LSB	Roll, Range +/- 20 deg. Units 0.01 deg.
3		MSB	
4	PP	LSB	Pitch, Range +/- 20 deg. Units 0.01 deg.
5		MSB	
6	AA	LSB	Heave +/- 20m, units 1 cm
7		MSB	
8	HH	LSB	Heading Range 0-359.99 deg. Units 0.01 deg.
9		MSB	

D.5.0.3 Notes

- MSB = most significant byte, LSB = least significant byte
- The data string is a 10-byte message of 16-bit 2's complement numbers, each expressed as two binary-coded digits.
- Positive heave is above datum. Positive roll is port-side up, starboard down. Positive pitch is bow up, stern down.
- The motion measurements contained in the data string will be in real time.
- The data string does not include a status flag.
- The system updates the heading field in the data string only when it receives new heading information from the gyrocompass. Depending on the transmission rate of the gyrocompass there may therefore be a difference between the instantaneous heading and the value included in the data output string.
- The gyro heading is NOT a 2's complement number.

D.5.0.4 Example

00900200FF730000 hex

D.6 EM3000

D.6.0.1 Description

Format suitable for use with Simrad EM3000 series multibeam sonars.

D.6.0.2 Format

ABRRPPAAHH bytes 0-9

Byte	Field
A	Header, MSB, 0x00
B	Header LSB, 0x90 when settled or 0x91 when unsettled
RR	Roll, Range 0-359.99 deg. Units 0.01 deg.
PP	Pitch, Range 0-359.99 deg. Units 0.01 deg.
AA	Heave +/- 20m, units 1 cm
HH	Heading Range 0-359.99 deg. Units 0.01 deg.

D.6.0.3 Notes

- MSB = most significant byte, LSB = least significant byte
- The data string is a 10-byte message of 16-bit 2’s complement numbers, each expressed as two binary-coded digits.
- Positive heave is above datum. Positive roll is port-side up, starboard down. Positive pitch is bow up, stern down.
- The motion measurements contained in the data string will be in real time.
- The Status byte = 91h for an unsettled unit or 90h for a settled unit.
- The system updates the heading field in the data string only when it receives new heading information from the gyrocompass. Depending on the transmission rate of the gyrocompass there may therefore be a difference between the instantaneous heading and the value included in the data output string.
- The gyrocompass heading is NOT a 2’s complement number.

D.6.0.4 Example

00900200FF730000 hex

D.7 PHTRO

D.7.0.1 Description

This proprietary Octans telegram consists of pitch and roll. This is similar to the NMEA 0183 standard. The units for the measurements are degrees; the angles are as described below.

D.7.0.2 Format

$PHTRO,x.xx,a,y.yy,b*hh<CR><LF>

Field	Description
$PHTRO	Header
x.xx	x.xx is the pitch in degrees
,	comma
a	a is ‘M’ for bow up, ‘P’ for bow down
,	comma
y.yy	y.yy is the roll in degrees
,	comma
b	b is ‘B’ for port down, ‘T’ for port up
*hh	Terminator and checksum
<CR><LF>	Carriage return and linefeed characters

D.7.0.3 Notes

- The data string has variable length with a leading zero if magnitude < 1 and minus signs added where necessary e.g. –0.59.
- By default, positive roll is port-side up, starboard down, positive pitch is bow down, stern up. The “a” and “b” codes will be “P” and “T” respectively.
- The attitude measurements contained in the data string will be in real time, valid for the instant when the system begins to transmit the first byte of the string.
- There is no status indicator in the data string.

D.7.0.4 Example

$PHTRO,-0.17,P,-0.56,B*46

D.8 HDT

D.8.0.1 Description

NMEA True Heading

D.8.0.2 Format

$HEHDT,x.x,T*hh<CR><LF>

Field	Description
$	Start Character
HE	Talker identifier
HDT	Mnemonic for true heading
,	Comma separator
xxx.xxx	Heading in degrees and decimal fraction
,	Comma separator
T	Heading Type True/Grid/Magnetic
*hh	Checksum
<CR><LF>	Terminator, return plus linefeed

D.8.0.3 Notes

- The Heading type indicator is always ‘T’ when transmitted by the SPRINT-Nav, to indicate that heading information is with respect to true north.

D.8.0.4 Example

$HEHDT,172.597,T*20

D.9 THS

D.9.0.1 Description

This telegram is the NMEA defined “True heading and status” telegram - actual vessel heading in degrees true produced by any device or system producing true heading.

D.9.0.2 Format

$__THS,XX.XX,a*hh<CR><LF>

Field	Description
Field	Description
$	Start Character
_	Talker identifier (HE)
THS	Mnemonic for true heading and status
,	Comma separator
XX.XX	Heading in degrees and decimal fraction
,	Comma separator
a	Mode indicator
*hh	Checksum
<CR><LF>	Terminator, return plus linefeed

D.9.0.3 Notes

- This sentence includes a “mode indicator” field providing critical safety related information about the heading data, and replaces the deprecated HDT sentence. The sender code for a north seeking gyrocompass is “HE”. For inertial navigation systems “IN” is used, though IN is for integrated navigation systems, see ISO 61162-1 for details.
- Mode indicator states:
  - A = Autonomous (aided with GGA and VTG)
  - E = Estimated (dead reckoning, neither GGA and VTG are present)
  - M = Manual input
  - S = Simulator mode
  - V = Data not valid (including standby)

D.9.0.4 Example

$HETHS,172.59,E*11

D.10 MDL

D.10.0.1 Description

This message provides heading, pitch and roll in degrees

D.10.0.2 Format

HaaaaPbccccRdeeee<CR><LF>

Field	Description
H	Heading start character
aaaa	Heading in tenths of degrees i.e. aaa(deg).a(decimal)
P	Pitch start character
b	[+] bow down or [-] stern down
cccc	Pitch in hundredths of degrees i.e. cc(deg).cc(decimal)
R	Roll start character
d	[+] port down or [-] starboard down
eeee	Roll in hundredths of degrees i.e. ee(deg).ee(decimal)
<CR><LF>	Terminator, return plus linefeed

D.10.0.3 Example

H1726P-0016R-0058

D.11 TEMP

D.11.0.1 Description

This format provides the temperature of the x, y and z sensors and the x, y and z sensor cases, using the NMEA TXT sentence.

D.11.0.2 Format

$HETXT,d,d,dd,dd,dd,dd,dd,dd,dd*hh<CR><LF>

Field	Description
$	Start Character
HE	Talker identifier
TXT	Mnemonic for text message
d	Total number of messages (01 - 99)
d	Message number (01 – 99)
d	Text identifier (01 - 99)
dd.d	X sensor temperature, degrees Celsius
dd.d	Y sensor temperature, degrees Celsius
dd.d	Z sensor temperature, degrees Celsius
dd.d	X case temperature, degrees Celsius
dd.d	Y case temperature, degrees Celsius
dd.d	Z case temperature, degrees Celsius
*hh	checksum
<CR><LF>	Terminator, return plus linefeed

D.11.0.3 Notes

- This message follows the standard spec for the __TXT message, where the first number is the total number of messages, the second number is the message number and the third the text identifier.
- Following this there are 6 integer numbers and a checksum.

D.11.0.4 Example

$HETXT,1,1,66,43.1,43.5,42.9,43.8,42.9,43.9*7C

D.12 TXT

D.12.0.1 Description

For the transmission of short text messages. Longer text messages may be transmitted by using multiple sentences. Used particularly for additional information following an alarm condition. This sentence is used to provide more detailed information on the cause of an alarm condition reported by a device.

D.12.0.2 Format

$__TXT,xx,xx,xx,c—c*hh<CR><LF>

Field	Description
$__TXT	Header with sender code
xx	Total number of sentences
xx	Sentence number
xx	Text identifier
ccc	ccc = Textual information on alarm source
*hh	Checksum
<CR><LF>	Terminator, return plus linefeed

D.12.0.3 Notes

- The sender code for a north seeking gyrocompass is “HE”. For inertial navigation systems “IN” is used, though IN is for integrated navigation systems, see ISO 61162-1 for details.

D.12.0.4 Example

:0003ADA31BA8,{$INTXT,01,01,3,External Power Supply was Not Good, now cleared*2C}*55

D.13 ALR

D.13.0.1 Description

This telegram indicates the local alarm condition and status

D.13.0.2 Format

$__ALR,hhmmss.ss,xxx,A,B,c---c*hh<CR><LF>

Field	Description
$HEALR	Header with compass sender code
hhmmss.ss	Time of Alarm condition, UTC
xxx	Unique alarm condition number (identifier) at alarm source, default 99
A	Alarm condition (A = threshold exceeded, V = not exceeded)
B	Alarm's acknowledge state (A = acknowledged, V = unacknowledged)
c—c	Alarm's description text (e.g. "External Power Supply Failed")
*hh	Checksum
<CR><LF>	Terminator, return plus linefeed

D.13.0.3 Notes

- This sentence is used to report an alarm condition on a device and its current state of acknowledgement. In particular for the SPRINT-Nav it will indicate if the external power supply has failed and the unit is running under the backup battery. When the external power is restored, the ALR report will also be sent.
- The sender code for a north seeking gyrocompass is "HE". For inertial navigation systems "IN" is used, though IN is for integrated navigation systems, see ISO 61162-1 for details
- The message is repeated either when the cause of the alarm changes, when an acknowledgement is received or after 60 seconds, whichever is the sooner.
- If an acknowledgement is received, this is retained in the repeated alarm message as long as the cause of the alarm message does not change.

D.13.0.4 Example

:0003E482E0A7,{$INALR,150951.00,099,A,V,Alarm: Status = 0x00000004*78}*7

D.14 SON2

D.14.0.1 Description

The SPRINT-Nav provides a Sonardyne proprietary SON2 telegram, consisting of UTC time, pitch, roll and heading with an estimated heading error. The heading error of the gyro-compass algorithm can not be measured, only estimated from the sensor noise.

D.14.0.2 Format

$PRDID,PPP.PP,RRR.RR,hhh.hh*hh*hh<CR><LF>

Field	Description
:	Start character
hhmmsssss	UTC time, hours, minutes, seconds and milliseconds
M	Space if positive, minus if negative
RRRRRR	Roll x 1000 degrees
M	Space if positive, minus if negative
PPPPPP	Pitch x 1000 degrees
M	Space if positive, minus if negative
HHHHHH	Heading x 1000 degrees
M	Space separator
VVV	Estimated variance
S	Status Flag, U,u,A,a,V,v,G,g
<CR><LF>	Terminator, return plus linefeed

D.14.0.3 Notes

- Positive roll is starboard down, port up.
- Positive pitch is bow up, stern down.
- The SON2 data string contains 39 characters in six data fields.
- The time is UTC time expressed as time of day hours, minutes, seconds and milliseconds.
- The angle measurements are in thousandths (i.e. x 1000 degrees)
- The motion measurements contained in the data string will be in real time, valid for the instant when the System begins to transmit the string.
- Due to the definition of the angles, the actual range of roll and pitch together are restricted. But the format allows for roll and pitch in degrees in the range −179.999° to +180.000°. Positive roll is port-side up, starboard down. Positive pitch is bow up, stern down.
- The precision of the heading estimate is tan-1(σ/15) secant latitude rms when the filter time constant is 1 hr. σ is the angular random walk (°/√ hr). After half an hour after start up the filter time constant is effectively ½ hr and so the result is root 2 times worse. If allowed to run for 2 hours the result is √2 times better than the 1 hour case. Note that the number is rms so only 95 % of the time is the heading precision within 2 times the figure. An optimist would say that σ is 0.007°/√ hr. So be aware of the cost of cutting short the settling time.
- The Status flag can take one of the following values:
  - If there is both VTG and GGA the status is A or a
  - If there is VTG only the status is V or v

- If there is GGA only the status is G or g
- If there is neither VTG nor GGA the status is U or u

- Upper case denotes the Gyros have settled, lower case denotes the Gyros are settling.
- If outputting u or U status, as soon as a VTG and/or GGA is received the status changes appropriately. However if VTG and/or GGA is not seen, it takes 5 seconds for the new (lesser) status to be updated on the message.

D.14.0.4 Example

:152359000 000222-000022 359999 1234S

D.15 POSMV GROUP 111 Heave and True Heave

D.15.0.1 Description

This telegram contains data for delayed heave calculations along with time matched real-time heave data. Heave sign is positive down.

D.15.0.2 Format

Byte	Field	Format	Description / value
1-4	Start	char	$GRP
5-6	ID	ushort	111
7-8	Byte count	ushort	76 (Bytes)
9-16	Time 1	double	seconds
17-24	Time 2	double	seconds
25-32	Distance tag	double	metres
33	Time type	byte	Bit2 set = Time1 UTC time (fixed) Bit4 set = Time2 POS time (fixed)
34	Distance type	byte	0 = N/A (fixed)
35-38	True heave	float	(,) metres
39-42	True heave RMS	float	[0,) metres
43-46	Status	Ulong	Bit0 set = True heave valid Bit1 set = realtime heave valid
47-50	Heave	float	(,) metres
51-54	Heave RMS	float	[0.) metres
55-62	Heave time 1	double	seconds
63-70	Heave time 2	double	seconds
71-74	Rejected IMU data count	ulong	[0,)
75-78	Out of range data count	ulong	[0,)
79-80	Pad	byte	0
81-82	Checksum	ushort	
83-84	Group end	char	$#

D.15.0.3 Notes

- Time 1 is the system time of validity for the data. The type of data is indicated in the time type field. UTC time is the seconds of the week.
- Time 2 is the system time of validity for the data. The type of data is indicated in the time type field. POS time is the time in seconds since power on.
- The checksum is calculated so that the sum of short pairs (16 bits) over the complete telegram has a sum of zero.
- Byte is 8 bits MSB first.
- Short is the INTEL format 16 bits MSB first.
- Long is 32 bits MSB first.
- Float is INTEL format from IEEE-754 floating point definition.
- Double is 8 bytes, MSB first.
- MSB = Most Significant Bit, LSB = Least Significant Bit

D.16 POSMV GROUP 113 Heave and True Heave

D.16.0.1 Description

This telegram contains quality data for delayed heave calculations.

D.16.0.2 Format

Byte	Field	Format	Description / value
1-4	Start	char	$GRP
5-6	ID	ushort	113
7-8	Byte count	ushort	68 (Bytes)
9-16	Time 1	double	seconds
17-24	Time 2	double	seconds
25-32	Distance tag	double	metres
33	Time type	byte	Bit2 set = Time1 UTC time (fixed) Bit4 set = Time2 POS time (fixed)
34	Distance type	byte	0 = N/A (fixed)
35-42	Heave time 1	double	Seconds
43-50	Quality control 1	double	0 (fixed)
51-58	Quality control 2	double	0 (fixed)
59-66	Quality control 3	double	0 (fixed)
67-70	Status	Ulong	0 (fixed). Quality control not used.
71-72	Pad	byte	0
73-74	Checksum	ushort	
75-76	Group end	char	$#

D.16.0.3 Notes

- Time 1 is the system time of validity for the data. The type of data is indicated in the time type field. UTC time is the seconds of the week.

- Time 2 is the system time of validity for the data. The type of data is indicated in the time type field. POS time is the time in seconds since power on.
- The checksum is calculated so that the sum of short pairs (16 bits) over the complete telegram has a sum of zero.
- Byte is 8 bits MSB first.
- Short is the INTEL format 16 bits MSB first.
- Long is 32 bits MSB first.
- Float is INTEL format from IEEE-754 floating point definition.
- Double is 8 bytes, MSB first.
- MSB = Most Significant Bit, LSB = Least Significant Bit

D.17 VTG

D.17.0.1 Description

This NMEA string outputs speed and course over ground (SOG & COG)

D.17.0.2 Format

$--VTG,x.x,T,x.x,M, x.x,N,x.x,K,a*hh<CR><LF>

Field	Description
$	Start character
--	Sender Code (e.g. GP, HE or IN)
VTG	Sentence Formatter
x.x,T	COG, degrees True
x.x,M,	COG, degrees Magnetic
x.x,N,	SOG, knots
x.x,K	SOG, km/hr
a	Mode Indicator
*hh	Terminator and checksum
<CR><LF>	Terminator, return plus linefeed

D.17.0.3 Notes

- The Mode indicator can have any of the following values:
  - A = Autonomous
  - D = Differential
  - E = Estimated (dead reckoning)
  - M = Manual input
  - S = Simulator
  - N = Data not valid

D.17.0.4 Example

$GPVTG,,T,,,,N,,K*03

$GPVTG,000.00,T,,M,0.00,N,0.0,K*60

$GPVTG,000.00,T,000.00,M,20.00,N,37.04,K*4C

D.18 PSONDIGI

D.18.0.1 Description

The PSONDIGI message outputs the pressure data from the SPRINT-Nav internal pressure sensor in PSI.

Field	Description
*	Start character
dd	00
ss	01
x.xx	Pressure Measurment in PSI
<CR><LF>	Terminator, return plus linefeed

D.18.0.2 Notes

- Any configured surface offset is converted from metres into PSI (by multiplying by 1.4593) and is then subtracted from the raw pressure measurement.

D.18.0.3 Example

*000114.573<cr><lf>

Appendix E – Syrinx DVL Telegram Message Formats

E.1 Sonardyne ASCII Messages

E.1.1 SONDV message (ASCII)

The SONDV message is the Sonardyne basic Syrinx DVL message, containing bottom referenced velocity and altitude info only.

Message:	>**SONDV**:TSxx, ITFxxx.yyy,VX±xx.x,VY±xx.x,VZ±xx.x,JVE±xx.x,B1Rxx.xxSyy, B2Rxx.xxSyy,B3Rxx.xxSyy,B4Rxx.xxSyy, SVxx.xx	
Parameter:	TS;xx	Tracking status where xx can be: ABL Acquiring bottom lock BL Bottom lock WT Water track BD Bad data
	ITFxxxxxx.yyyyyy	Instrument time frame of the transmission of the acoustic pulse from the Syrinx. xxxx = seconds yyyyyy = micro seconds (i.e. 6d.p)
	VX±xx.x	Velocity along X-axis, mm/s
	VY±xx.x	Velocity along Y-axis, mm/s
	VZ±xx.x	Velocity along Z-axis, mm/s
	JVE±xx.x	Janus Velocity error, mm/s
	BnRxx.xx;Sy	Beam n, where n is the beam the data refers to. Fields are:
		xx.xx Slant range in meters (using SV output in the message)
		Syy Binary Status as follow: xxxxxxx1 indicates used in Janus solution xxxxxx1x indicates BVE high xxxxx1xx indicates correlation is low xxxx1xxx indicates signal strength low xxx1xxxx indicates signal to noise is low
	SVxxxx.xx	Sound Velocity set in Syrinx DVL in m/s to two decimal places (value used in calculating janus velocities

TS;BD indicates bottom lock has been acquired but the data has been rejected due to failing internal quality metric checks. The number of low quality beams before data is rejected is dependent on the WLS mode.

Should TS be either ABL or BD then the rest of the parameters are not output as the data is invalid.

SONDV message example:-

>SONDV:TS;BL,ITF2314.000123,VX505.6,VY-0.1,VZ-0.0,JVE0.1,B1R24.07;S01,B2R23.09;S01,B3R22.10;S01,B4R23.09;S01,SV1500.00

>SONDV:TS;BD

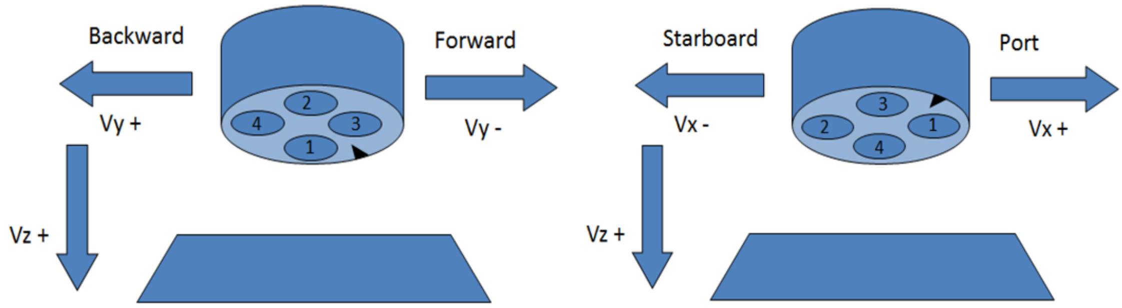
>SONDV:TS;ABL

E.2 Teledyne RDI Binary Messages

E.2.1 Teledyne RDI PD0 Message

Syrinx supports the Teledyne RDI PD0 output message. With Syrinx DVLoutput transformation offsets set to Yaw = 0, Pitch = 0, Roll = 0, the velocity conventions are as follows:

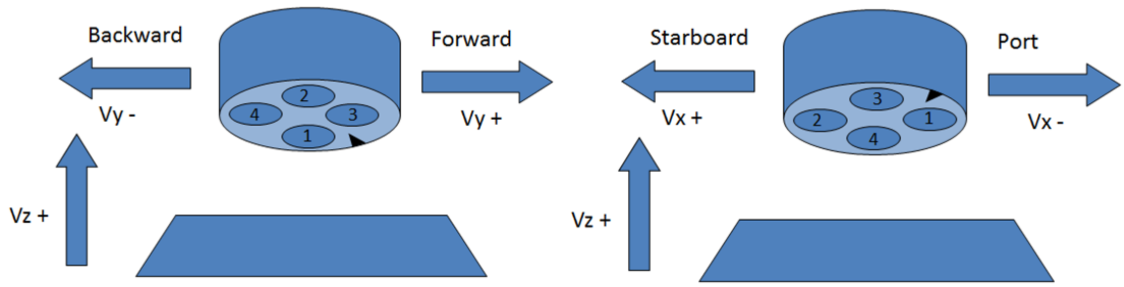
Figure E–1 PD0 Velocity Conventions



E.2.2 Teledyne RDI PD4 Message

Syrinx supports the Teledyne RDI PD3, PD4, PD6 & PD13 output messages. With Syrinx DVL output transformation offsets set to Yaw = 0, Pitch = 0, Roll = 0, the velocity conventions are as follows:

Figure E–2 PD3, PD4, PD6 & PD13 Velocity Conventions



Appendix F – Third Party PD0/PD3/PD4/PD5/PD6/PD13 Definitions

F.1 Teledyne RDI DVL Binary Data Format (PD0)

PD0 is an industry-standard binary data format that is commonly used to describe the configuration of the DVL or ADCP device, bottom-tracking information, profile information such as velocities and intensities, and any external data such as NMEA strings.

An overview of a typical PD0 message and its substructure is shown below.

Table F–1 PD0 Structure Overview

ALWAYS OUTPUT	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (59 BYTES)
	VARIABLE LEADER DATA (65 BYTES)
ADCP-command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
CFG-command	**BOTTOM TRACK DATA** (85 BYTES)
General NMEA	**General NMEA** (14 BYTES + msg body)
NMEA Strings	**GPS GGA** (97 BYTES) **GPS VTG** (45 BYTES)
ALWAYS OUTPUT	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Note that the PD0 specification can vary slightly in other manufacturers' instruments. The following sections specify how PD0 messages are formatted by Sonardyne instruments.

F.1.1 ID Codes for PD0

Table F–2 shows the unique ID for each section of PD0 data. The flexibility of the format means that not all sections are necessarily present in a PD0 message.

Table F–2 Section Unique IDs

Description	ID hex. (Little Endian)	Supported Modes
Header ID	0x7F7F	All
Fixed Leader Data ID	0x0000	All
Variable Leader Data ID	0x0080	All
Velocity ID	0x0100	ADCP, DVL+ADCP
Correlation Magnitude ID	0x0200	ADCP, DVL+ADCP
Echo Intensity ID	0x0300	ADCP, DVL+ADCP
Percentage Good ID	0x0400	ADCP, DVL+ADCP
Bottom Track Data ID	0x0600	All
NMEA Data		
General binary data	0x2022	ADCP, DVL+ADCP
DBT ASCII ID	0x2100	ADCP, DVL+ADCP
GGA ASCII ID	0x2101	ADCP, DVL+ADCP
VTG ASCII ID	0x2102	ADCP, DVL+ADCP
HDT ASCII ID	0x2104	ADCP, DVL+ADCP
Sonardyne Extensions		
System Configuration	0x6060	ADCP, DVL+ADCP
Variable Leader	0x6160	ADCP, DVL+ADCP

F.1.2 PD0 Structure Specifications

This section describes each of the PD0 structures in detail.

F.1.2.1 PD0 Header

Table F–3 PD0 Header Summary

	Bit Positions								
Byte	7	6	5	4	3	2	1	0	
1	Header ID = 0x7F								
2	Data Source ID = 0x7F								
3	Number of bytes in Ensemble								LSB
4									MSB
5	Spare								
6	Number of data types								
7	Offset for data type #1								LSB
8									MSB
9	Offset for data type #2								LSB
10									MSB
11	Offset for data type #3								LSB
12									MSB
2N + 5	Offset for data type #N								LSB
2N + 6									MSB

Each section in *Table F–3* is described in detail below.

Table F–4 PD0 Header Field Descriptions

Hex Digit	Binary byte	Field	Description
1,2	1	Header ID	Stores the Header ID byte (0x7F).
3,4	2	Data Source ID	Stores the Data Source ID byte (0x7F for Syrinx).
5-8	3,4	Number of bytes in ensemble	This field contains the number of bytes from the start of the current ensemble up to, but not including, the 2-byte checksum (see *Table F–3*).
9,10	5	Spare	Undefined.
11,12	6	Number of data types	This field contains the number of data types selected for collection. By default, fixed/variable leader, velocity, correlation magnitude, echo intensity, and percent good are selected for collection. This field will therefore have a value of six (4 data types + 2 for the Fixed/Variable Leader data).
13-16	7,8	Offset for Data Type #1	This field contains the internal memory address offset where Syrinx will store information for data type #1 (with this firmware, always the Fixed Leader). Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #1 begins (the first byte of the ensemble is Binary Byte #1).
17-20	9,10	Offset for Data Type #2	This field contains the internal memory address offset where Syrinx will store information for data type #2 (with this firmware, always the Variable Leader). Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #2 begins (the first byte of the ensemble is Binary Byte #1).
21-24 thru 2n+13 to 2n+16	11,12 thru 2n+5, 2n+6	Offset for Data Type #3 through #n	These fields contain internal memory address offset where Syrinx will store information for data type #3 through data type #n. Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #1 begins (the first byte of the ensemble is Binary Byte #1).

F.1.2.2 PD0 Fixed Leader

Table F–5 PD0 Fixed Leader Summary

	Bit Positions								
Byte	7	6	5	4	3	2	1	0	
1	Fixed Leader ID = 0x00								LSB 00h
2									MSB 00h
3	CPU F/W VER.								
4	CPU F/W REV.								
5	System Configuration								LSB
6									MSB
7	Real/Sim flag								
8	Lag length								
9	Number of beams								
10	Number of cells								
11	Pings per ensemble								LSB
12									MSB
13	Depth cell length								LSB
14									MSB
15	Blank after transmit								LSB
16									MSB
17	Profiling mode								
18	Low Corr Thresh								
19	No. code reps								
20	%GD minimum								
21	Error velocity maximum								LSB
22									MSB
23	TPP Minutes								
24	TPP Seconds								
25	TPP Hundredths								
26	Coordinate transform								
27	Heading alignment								LSB
28									MSB
29	Heading bias								LSB
30									MSB
31	Sensor source								
32	Sensors available								
33	Bin 1 distance								LSB
34									MSB

Table F–5 PD0 Fixed Leader Summary (continued)

	Bit Positions	
35	Xmit pulse length based on	LSB
36		MSB
37	(starting cell) WP ref layer average (ending cell)	LSB
38		MSB
39	False target thresh	
40	Spare	
41	Transmit lag distance	LSB
42		MSB
43	CPU board serial number	LSB
↓		↓
50		MSB
51	System bandwidth	LSB
52		MSB
53	System power	
54	Spare	
55		LSB
↓	Instrument serial number	↓
58		MSB
59	Beam angle	

Each section in *Table F–5* is described in detail below.

Table F–6 PD0 Fixed LeadeDecsriptionr Field Descriptions

Hex Digit	Binary Style	Field	Description									
1-4	1,2	Fixed Leader ID	Stores the Fixed Leader identification word (0x0000).									
5,6	3	CPU F/W Ver	Contains the version number of the CPU firmware									
7,8	4	CPU F/W Rev	Contains the revision number of the CPU firmware									
9-12	5,6	System Configuration	This field defines the Syrinx hardware configuration. Convert this field (2 bytes, LSB first) to binary and interpret as follows.									
			LSB									
			Bits	7	6	5	4	3	2	1	0	
				-	-	-	-	-	0	0	0	75-kHz System
				-	-	-	-	-	0	0	1	150-kHz System
				-	-	-	-	-	0	1	0	300-kHz System
				-	-	-	-	-	0	1	1	600-kHz System
				-	-	-	-	-	1	0	0	1200-kHz System
				-	-	-	-	-	1	0	1	2400-kHz System
				-	-	-	-	0	-	-	-	Concave beam pat.
				-	-	-	-	1	-	-	-	Convex beam pat.
				-	-	0	0	-	-	-	-	Sensor config #1
				-	-	0	1	-	-	-	-	Sensor config #2
				-	-	1	0	-	-	-	-	Sensor config #3
				-	0	-	-	-	-	-	-	XDCR HD not att.
				-	1	-	-	-	-	-	-	XDCR HD attached
				0	-	-	-	-	-	-	-	Down facing beam
				1	-	-	-	-	-	-	-	Up-facing beam
			MSB									
			Bits	7	6	5	4	3	2	1	0	
				-	-	-	-	-	-	0	0	15E Beam angle
				-	-	-	-	-	-	0	1	20E Beam angle
				-	-	-	-	-	-	1	0	30E Beam angle
				-	-	-	-	-	-	1	1	Other beam angle
				0	1	0	0	-	-	-	-	4-beam Janus config
				0	1	0	1	-	-	-	-	5-bm Janus cfig demod)
				1	1	1	1	-	-	-	-	5-bm Janus cfig. (2 demd)
				-	-	-	-	-	-	0	0	15E Beam angle
			Example: Hex 5249 (i.e. hex 49 followed by hex 52) identifies a 150-kHz system, convex beam pattern, down-facing, 30E beam angle, 5 beams (3 demods).									

Hex Digit	Binary Style	Field	Description
13,14	7	PD/Real/Sim flag	This field is set by default as real data (0)
15,16	8	Lag length	The lag time is the time period between sound pulses.
17,18	9	Number of beams	Contains the number of beams used to calculate velocity data (not physical beams). Syrinx needs only three beams to calculate water-current velocities. The fourth beam provides an error velocity that determines data validity. If only three beams are available, Syrinx does not make this validity check.
19,20	10	Number of cells	Contains the number of depth cells over which Syrinx collects data. Scaling: LSD = 1 depth cell; Range = 1 to 256 depth cells
21-24	11,12	Pings per ensemble	Contains the number of pings averaged together during a data ensemble. Scaling: LSD = 1 ping; Range = 0 to 16384 pings
25-28	13,14	Depth cell length	Contains the length of one depth cell. Scaling: LSD = 1 centimetre; Range = 1 to 16384 cm
29-32	15,16	Blank after transmit	Contains the blanking distance used by Syrinx to allow the transmit circuits time to recover before the receive cycle begins. Scaling: LSD = 1 centimetre; Range = 0 to 16384 cm
33,34	17	Signal processing mode	Contains the signal processing mode. This field will always be set to 1.
35,36	18	Low corr thresh	Contains the minimum threshold of correlation that water-profile data can have to be considered good data. Scaling: LSD = 1 count; Range = 0 to 255 counts
37,38	19	No. code reps	Contains the number of code repetitions in the transmit pulse. Scaling: LSD = 1 count; Range = 0 to 255 counts
39,40	20	%Gd Minimum	Contains the minimum percentage of water-profiling pings in an ensemble that must be considered good to output velocity data. Scaling: LSD = 1 percent; Range = 1 to 100 percent
41-44	21,22	Error velocity threshold	This field contains the actual threshold value used to flag water-current data as good or bad. If the error velocity value exceeds this threshold, Syrinx flags all four beams of the affected bin as bad. Scaling: LSD = 1mm/s; Range = 0 to 5000 mm/s
45,46	23	Minutes	These fields contain the amount of time between ping groups in the ensemble.
47,48	24	Seconds	
49,50	25	Hundredths	
51,52	26	Coord transform	Contains the coordinate transformation processing parameters. These firmware switches indicate how Syrinx collected data. xxx00xxx = No transformation (beam coordinaes) xxx01xxx = Instrument coordinates xxx10xxx = Ship coordinates xxx11xxx = Earth coordinates xxxxx1xx = Tilts (Pitch and Roll) used in ship or Earth transformation xxxxxx1x = 3-beam solution used if one beam is below the correlation threshold xxxxxxx1 = Bin mapping used

Hex Digit	Binary Style	Field	Description
53-56	27,28	Heading Alignment	Contains a correction factor for physical heading misalignment Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
57-60	29,30	Heading Bias	Contains a correction factor for electrical/mechanical heading bias Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
61,62	31	Sensor Source	Contains the selected source of environmental sensor data. These firmware switches indicate the following: x1xxxxxx = Calculates speed of sound from depth, salinity and temperature sensors xx1xxxxx = Uses depth sensor xxx1xxxx = Uses transducer heading sensor xxxx1xxx = Uses pitch sensor xxxxx1xx = Uses roll sensor xxxxxx1x = Uses conductivity sensor for salinity xxxxxxx1 = Uses transducer temperature sensor Note: If the field = 0, or if the sensor is not available, Syrinx uses the manual command setting. If the field = 1, Syrinx uses the reading from the internal sensor or an external synchro sensor (only applicable to heading, roll and pitch).
63,64	32	Sensor Avail	This field reflects which sensors are available. The bit patter is the same as listed above.
65-68	33,34	Dis 1 / Bin 1 distance	This field contains the distance to the middle of the first depth cell (bin). This distance is a function of the depth cell length, the blank after transmit distance, and the speed of sound. Scaling: LSD = 1 centimetre, Range = 0 to 65535 cm (2150 feet)
69-72	35,36	WT Xmit pulse length	This field contains the length of the transmit pulse. Scaling: LSD = 1 centimetre, Range = 0 to 65535 cm (2150 feet)
73-76	37,38	Ref Lyr Ang (Starting cell, Ending cell)	Contains the starting depth cell (LSB, byte 37) and the ending depth cell (MSB, byte 38) used for water reference layer averaging. Scaling: LSD = 1 centimetre, Range = 1 to 128 depth cells
77,78	39	False target threshold	Contains the threshold value used to reject data received from a false target, usually fish. Scaling: LSD = 1 count; Range = 0 to 255 counts (255 disables)
79,80	40	Spare	Range = 0 to 5
81-84	41,42	Transmit lag distance	This field contains the distance between pulse repetitions. Scaling: LSD = 1 centimetre; Rand = 0 to 65535 centimetres
85-100	43-50	CPU Board Serial Number	Contains the serial number of the CPU board.
101-105	51-52	System Bandwidth	Contains the bandwidth of the system.
106-107	53	System Power	Contains the power mode setting for Syrinx. Range 0 to 255.
108-109	54	Spare	Spare
110-119	55-58	Serial #	Instrument serial number
120-121	59	Beam angle	Beam angle

F.1.2.3 PD0 Variable Leader

The PD0 Variable Leader contains information that may change between ensembles.

Table F–7 PD0 Variable Leader Summary

	Bit Positions								
Byte	7	6	5	4	3	2	1	0	
1	Variable Leader ID								80h
2									00h
3	Ensemble Number								LSB
4									MSB
5	RTS YEAR								
6	RTS MONTH								
7	RTS DAY								
8	RTS HOUR								
9	RTS MINUTE								
10	RTS SECOND								
11	RTS HUNDREDTHS								
12	ENSEMBLE # MSB								
13	BIT RESULT								LSB
14									MSB
15	SPEED OF SOUND								LSB
16									MSB
17	DEPTH OF TRANSDUCER								LSB
18									MSB
19	HEADING								LSB
20									MSB
21	PITCH (TILT 1)								LSB
22									MSB
23	ROLL (TILT 2)								LSB
24									MSB
25	SALINITY								LSB
26									MSB
27	TEMPERATURE								LSB
28									MSB
29	MPT MINUTES								
30	MPT SECONDS								
31	MPT HUNDREDTHS								
32	HDG STD DEV								
33	PITCH STD DEV								
34	ROLL STD DEV								

Table F–7 PD0 Variable Leader Summary (continued)

	Bit Positions	
35	ADC CHANNEL 0	
36	ADC CHANNEL 1	
37	ADC CHANNEL 2	
38	ADC CHANNEL 3	
39	ADC CHANNEL 4	
40	ADC CHANNEL 5	
41	ADC CHANNEL 6	
42	ADC CHANNEL 7	
43		LSB
44	ERROR STATUS WORD (ESW)	
45		
46		MSB
47	SPARE	
48		
49		LSB
50	PRESSURE	
51		
52		MSB
53		LSB
54	PRESSURE SENSOR VARIANCE	
55		
56		MSB
57	SPARE	
58	RTC CENTURY	
59	RTC YEAR	
60	RTC MONTH	
61	RTC DAY	
62	RTC HOUR	
63	RTC MINUTE	
64	RTC SECOND	
65	RTC HUNDREDTH	

Each section in *Table F–7* is described in detail below.

Table F–8 PD0 Variable Leader Detailed Description

Hex Digit	Binary byte	Field	Description
1-4	1,2	Variable Leader ID	Stores the Variable Leader identification word (0x8000).

5,8	3,4	Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply.
			Scaling: LSD = 1 ensemble; Range = 1 to 65535 ensembles
			NOTE: The first ensemble collected = #1. At 'rollover', we have the following sequence:
			1 = Ensemble number 1
			↓
			65535 = Ensemble number 65535 | Ensemble
			0 = Ensemble number 65536 | # MSB field
			1 = Ensemble number 65537 | (Byte 12)
			Incr.

9,10 11,12 13,14 15,16 17,18 19,20 21,22	5 6 7 8 9 10 11	RTC Year RTC Month RTC Day RTC Hour RTC Minute RTC Second RTC Hundredths	These fields contain the time from Syrinx's realtime clock (RTC) that the current data ensemble began.
23-24	12	Ensemble # MSB	This field increments each time the Ensemble Number field (bytes 3,4) "rolls over". This allows ensembles up to 16,777,215. See Ensemble Number field above.
25-28	13-14	BIT / BIT Result	This field contains the results of Syrinx's Built-in Test (BIT) function. A zero code indicates a successful BIT result. Byte 13 Byte 14 (reserved for future use) 1xxxxxxx xxxxxxxx = Reserved x1xxxxxx xxxxxxxx = Reserved xx1xxxxx xxxxxxxx = Reserved xxx1xxxx xxxxxxxx = Demod 1 Error xxxx1xxx xxxxxxxx = Demod 0 Error xxxxx1xx xxxxxxxx = Reserved xxxxxx1x xxxxxxxx = Timing card error xxxxxxx1 xxxxxxxx = Reserved
29-32	15,16	Speed of Sound	Contains either manual or calculated speed of sound information. Scaling: LSB = 1 m/s; Range = 1400 to 1600 m/s
33-36	17,18	Depth of Transducer	Contains the depth of the transducer below the water surface. This value is a manual setting. Scaling: LSD = 1 decimetre; Range = 1 to 9999 decimetres

Table F–8 PD0 Variable Leader Detailed Description (continued)

Hex Digit	Binary byte	Field	Description
37-40	19,20	Heading	Contains Syrinx heading angle. This value is taken from NMEA VTG or HDT strings, or a Sonardyne INS SON2 or LNAV message. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees
41-44	21,22	Pitch	Contains Syrinx pitch angle. This value is taken from a tilt sensor or Sonardyne INS SON2 or LNAV message. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
45-48	23,24	Roll	Contains Syrinx roll angle. This value is taken from a tilt sensor or Sonardyne INS SON2 or LNAV message. It is assumed that Syrinx is always downward facing. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
49-52	25,26	Salinity	Contains the salinity value at the transducer head. This is a manual setting. Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt
53-56	27,28	Temperature	Contains the temperature of the water at the transducer head. This is taken from a temperature sensor. Scaling: LSD = 0.01 degree; Range = -5.00 to +40.00 degrees
57,58	29	MPT minutes	This field contains the Minimum Pre-Ping Wait Time between ping groups in the ensemble
59,60	30	MPT seconds	
61,62	31	MPT hundredths	
63,64	32	Hdg Std Dev	These fields contain the standard deviation (accuracy) of the heading and tilt angles from the tilt sensor. Scaling (Heading): LSD = 1°; Range = 0 to 180°. Scaling (Tilts): LSD = 0.1°; Range = 0 to 20°.
65,66	33	Pitch Std Dev	
67,68	34	Roll Std Dev	
85-86	43	Error Status Word	Contains the long word containing bit flags. The ESW is cleared (set to zero) between each ensemble. Note that each number above represents one bit set – they may occur in combinations. For example, if the long word value is 0000C000 (hexadecimal), then it indicates that both a cold wake-up (0004000) and an unknown wake-up (00008000) occurred. Low 16 bits LSB Bits 07 06 05 04 03 02 01 00 x x x x x x x 1 Bus error exception x x x x x x 1 x Address error exception x x x x x 1 x x Illegal instruction exception x x x x 1 x x x Zero divide exception x x x 1 x x x x Emulator exception x x 1 x x x x x Unassigned exception x 1 x x x x x x Watchdog restart occurred 1 x x x x x x x Batter saver power

Table F–8 PD0 Variable Leader Detailed Description (continued)

Hex Digit	Binary byte	Field	Description
87-88	44		Low 16 bits MSB Bits 15 14 13 12 11 10 09 08 x x x x x x x 1 Pinging x x x x x x 1 x Not used x x x x x 1 x x Not used x x x x 1 x x x Not used x x x 1 x x x x Not used x x 1 x x x x x Not used x 1 x x x x x x Cold wakeup 1 x x x x x x x Unknown wakeup
89-90	45		High 16 bits LSB Bits 24 23 22 21 20 19 18 17 x x x x x x x 1 Clock read error x x x x x x 1 x Unexpected alarm x x x x x 1 x x Clock jump forward x x x x 1 x x x Clock jump backward x x x 1 x x x x Not used x x 1 x x x x x Not used x 1 x x x x x x Not used 1 x x x x x x x Not used
91,92	46		High 16 bits MSB Bits 32 31 30 29 28 27 26 25 x x x x x x x 1 Not used x x x x x x 1 x Not used x x x x x 1 x x Not used x x x x 1 x x x Power fail (unrecorded) x x x 1 x x x x Spurious lev. 4 intr (DSP) x x 1 x x x x x Spurious lev. 5 intr (UART) x 1 x x x x x x Spurious lev. 6 intr (CLK) 1 x x x x x x x Level 7 interrupt occurred
93-96	47-48	Reserved	Reserved for Sonardyne use.
97-104	49-52	Pressure	Contains the pressure of the water at the transducer head relative to one atmosphere (sea level). Output is in deca-pascals. Scaling: LSD = 1 deca-pascal; Range= 0 to 4,294,967,295 deca-pascals.

Table F–8 PD0 Variable Leader Detailed Description (continued)

Hex Digit	Binary byte	Field	Description
105-112	53-56	Pressure variance	Contains the standard deviation of the pressure sensor data. Output is in deca-pascals. Scaling: LSD = 1 deca-pascal; Range= 0 to 4,294,967,295 deca-pascals.
113-114	57	Spare	Spare
115-116	58	RTC Century	These fields contain the time from Syrinx real-time clock (RTC) that the current data ensemble began.
117-118	59	RTC Year	
119-120	60	RTC Month	
121-122	61	RTC Day	
123-124	62	RTC Hour	
125-126	63	RTC Minute	
127-128	64	RTC Seconds	
129-130	65	RTC Hundredths	

F.1.2.4 PD0 Velocity Data

The PD0 Velocity Data contains the measured velocities of each beam for each depth cell.

Table F–9 PD0 Velocity Data Summary

	Bit Positions								
Byte	7/S	6	5	4	3	2	1	0	
1	Velocity ID								LSB 00h
2									MSB 01h
3 4	Depth Cell #1, Velocity 1								LSB MSB
5 6	Depth Cell #1, Velocity 2								LSB MSB
7 8	Depth Cell #1, Velocity 3								LSB MSB
9 10	Depth Cell #1, Velocity 4								LSB MSB
11 12	Depth Cell #2, Velocity 1								LSB MSB
13 14	Depth Cell #2, Velocity 2								LSB MSB
15 16	Depth Cell #2, Velocity 3								LSB MSB
17 18	Depth Cell #2, Velocity 4								LSB MSB
↓	Sequence continues for up to 128 cells								↓
1019 1020	Depth Cell #128, Velocity 1								LSB MSB
1021 1022	Depth Cell #128, Velocity 2								LSB MSB
1023 1024	Depth Cell #128, Velocity 3								LSB MSB
1025 1026	Depth Cell #128, Velocity 4								LSB MSB

Syrinx packs ADCP velocity data for each depth cell of each beam into a two-byte, two's complement integer in the range [-32768, 32767] with the LSB sent first. Syrinx scales the velocity data in millimetres per second (mm/s). A value of -32768 (8000h) indicates bad velocity values.

All velocities are relative to a stationary instrument. To obtain absolute velocities, algebraically remove the velocity of the instrument. For example,

Relative water current velocity: East 650 mm/s

Instrument velocity: (-) East 600 mm/s

Absolute water velocity: East 50 mm/s

Changing the coordinate frame of reference changes the interpretation of the velocity data in PD0:

Coord System	Vel 1	Vel 2	Vel 3	Vel 4
Beam	To Beam 1	To Beam 2	To Beam 3	To Beam 4
Instrument	Bm1 – Bm3	Bm4 – Bm2	To Xducer	Err Vel
Vehicle	Port – Stbd	Aft – Fwd	To Surface	Err Vel
Earth	To East	To North	To Surface	Err Vel

Positive values of velocity indicate water movement toward Syrinx.

Each section in *Table F–9* is described in detail below.

Table F–10 PDO Velocity Data Description

Hex Digit	Binary byte	Field	Description
1-4	1,2	Velocity ID	Stores the velocity data identification word (0x0001h).
5-8	3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1. See above.
9-12	5,6	Depth Cell 1, Velocity 2	Stores velocity data for depth cell #1, velocity 2. See above.
13-16	7,8	Depth Cell 1, Velocity 3	Stores velocity data for depth cell #1, velocity 3. See above.
17-20	9,10	Depth Cell 1, Velocity 4	Stores velocity data for depth cell #1, velocity 4. See above.
21-4100	11-2050	Cells 2-256 (if used)	These fields store the velocity data for depth cells 2 through 256 (depending on the setting of the ADCP command) for all four beams. These fields follow the same format listed above for depth cell 1.

Correlation Magnitude, Echo Intensity, and Percent-Good Data Format

The PD0 Correlation Magnitude, Echo Intensity and Percent-Good contain the respective values of each beam for each depth cell.

Table F–11, *Table F–12* and *Table F–12*: Correlation Magnitude, Echo Intensity, Percent-Good Data Summary

Correlation magnitude data give the magnitude of the normalised echo autocorrelation at the lag used for estimating the Doppler phase change. Syrinx represents this magnitude by a linear scale between 0 and 255, where 255 is perfect correlation (i.e. a solid target). A value of zero indicates bad correlation values.

Table F–11 Correlation Magnitude Data Format

Hex Digit	Binary byte	Field	Description
1-4	1,2	ID Code	Stores the correlation magnitude data identification word (0x0002h).
5-6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam 1. See above.
7-8	4	Depth Cell 1, Field 2	Stores correlation magnitude data for depth cell #1, beam 2. See above.
9-10	5	Depth Cell 1, Field 3	Stores correlation magnitude data for depth cell #1, beam 3. See above.

Table F–11 Correlation Magnitude Data Format (continued)

Hex Digit	Binary byte	Field	Description
11-12	6	Depth Cell 1, Field 4	Stores correlation magnitude data for depth cell #1, beam 4. See above.
21-2052	11-1026	Cells 2-256 (if used)	These fields store the correlation magnitude data for depth cells 2 through 256 (depending on the setting of the ADCP command) for all four beams. These fields follow the same format listed above for depth cell 1.

The echo intensity scale factor is about 0.45 dB per Syrinx ADCP count. Syrinx does not directly check for the validity of echo intensity data.

Table F–12 Echo Intensity Data Format

Hex Digit	Binary byte	Field	Description
1-4	1,2	ID Code	Stores the echo intensity data identification word (0x0003h).
5-6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam 1. See above.
7-8	4	Depth Cell 1, Field 2	Stores echo intensity data for depth cell #1, beam 2. See above.
9-10	5	Depth Cell 1, Field 3	Stores echo intensity data for depth cell #1, beam 3. See above.
11-12	6	Depth Cell 1, Field 4	Stores echo intensity data for depth cell #1, beam 4. See above.
21-2052	11-1026	Cells 2-256 (if used)	These fields store the echo intensity data for depth cells 2 through 256 (depending on the setting of the ADCP command) for all four beams. These fields follow the same format listed above for depth cell 1.

The percent-good data field is a data-quality indicator that reports the percentage (0 to 100) of good data collected for each depth cell of the velocity profile. The coordinate frame used by Syrinx determines how percent-good data are interpreted, as shown below:

Coord System	Vel 1	Vel 2	Vel 3	Vel 4
Percentage Of Good Pings For:				
Beam	Beam 1	Beam 2	Beam 3	Beam 4
Instrument	3-Beam	Xforms	More than	4-Beam
Vehicle	Xforms	Rejected	One beam	Xforms
Earth	(Note 1)	(Note 2)	Bad in bin	

1. Shows the percentage of successful velocity calculations (50%) using 3-beam solutions
2. Shows percent of error velocity (5%) that was higher than the default setting.

At the start of the velocity profile, the backscatter echo strength is typically high on all four beams. Under this condition, Syrinx uses all four beams to calculate the orthogonal and error velocities. As the echo returns from far away depth cells, echo intensity decreases. At some point, the echo will be weak enough on any given beam to cause Syrinx ADCP to reject some of its depth cell data. This causes Syrinx ADCP to calculate velocities with three beams instead of four beams. When Syrinx does 3-beam solutions, it stops calculating the error velocity because it needs four beams to do this. At some further depth cell, Syrinx ADCP rejects all cell data because of the weak echo. As an example, let us assume depth cell 60 has returned the following percent-good data:

Field #1 = 50, Field #2 = 5, Field #3 = 0, Field #4 = 45

If Syrinx is set to use beam coordinates, the example values show the percentage of pings having food solutions in cell 60 for each beam based on the low correlation threshold. Here, beam 1=50%, beam 2=5%, beam3=0% and beam4=45%. These are not typical nor desired percentages. Ideally, all four beams should be equal and above 25%.

If Syrinx is set to use Instrument, Vehicle or Earth coordinates, the example value show:

Field #1 – Percentage of good 3-beam solutions – shows the percentage of successful velocity calculations (50%) using 3-beam solutions.

Field #2 – Percentage of transformations rejected – Shows percent of error velocity (5%) that was higher than 5000mm/s. This large value prevents Syrinx from rejecting data based on error velocity.

Field #3 – Percentage of more than one beam bad in bin – 0% of the velocity data were rejected because not enough beams had good data

Field #4 – Percentage of good 4-beam solutions – 45% of the velocity data collected during the ensemble for depth cell 60 were calculated using four beams.

Table F–13 Percent-Good Data Format

Hex Digit	Binary byte	Field	Description
1-4	1,2	ID Code	Stores the percent-good data identification word (0x0004h).
5-6	3	Depth Cell 1, Field 1	Stores percent-good data for depth cell #1, beam 1. See above.
7-8	4	Depth Cell 1, Field 2	Stores percent-good data for depth cell #1, beam 2. See above.
9-10	5	Depth Cell 1, Field 3	Stores percent-good data for depth cell #1, beam 3. See above.
11-12	6	Depth Cell 1, Field 4	Stores percent-good data for depth cell #1, beam 4. See above.
21-2052	11-1026	Cells 2-256 (if used)	These fields store the percent-good data for depth cells 2 through 256 (depending on the setting of the ADCP command) for all four beams. These fields follow the same format listed above for depth cell 1.

F.1.2.5 PD0 Bottom Track

The PD0 Bottom Track section contains information regarding bottom-tracking. This information may change between ensembles.

Table F–14 PD0 Bottom Track Summary

	Bit Positions								
Byte	7/S	6	5	4	3	2	1	0	
1	Bottom-Track ID								LSB 00h
2									MSB 06h

Table F–14 PD0 Bottom Track Summary (continued)

	Bit Positions	
3	BT pings per ensemble	LSB
4		MSB
5	BT delay before re-acquire	
6		
7	BT corr mag min	
8	BT eval amp min	
9	BT percent good min	
10	BT mode	
11	BT err vel max	LSB
12		MSB
13	Reserved	
14		
15		
16		
17	Beam #1 BT range	LSB
18		MSB
19	Beam #2 BT range	LSB
20		MSB
21	Beam #3 BT range	LSB
22		MSB
23	Beam #4 BT range	LSB
24		MSB
25	Beam #1 BT vel	LSB
26		MSB
27	Beam #2 BT vel	LSB
28		MSB
29	Beam #3 BT vel	LSB
30		MSB
31	Beam #4 BT vel	LSB
32		MSB
33	Beam #1 BT corr	
34	Beam #2 BT corr	
35	Beam #3 BT corr	
36	Beam #4 BT corr	
37	Beam #1 eval amp	
38	Beam #2 eval amp	
39	Beam #3 eval amp	

Table F–14 PD0 Bottom Track Summary (continued)

	Bit Positions	
40	Beam #4 eval amp	
41	Beam #1 BT % good	
42	Beam #2 BT % good	
43	Beam #3 BT % good	
44	Beam #4 BT % good	
45	Ref layer min	LSB
46		MSB
47	Ref layer near	LSB
48		MSB
49	Ref layer far	LSB
50		MSB
51	Beam #1 ref layer vel	LSB
52		MSB
53	Beam #2 ref layer vel	LSB
54		
55	Beam #3 ref layer vel	LSB
56		MSB
57	Beam #4 ref layer vel	LSB
58		MSB
59	Beam #1 ref corr	
60	Beam #2 ref corr	
61	Beam #3 ref corr	
62	Beam #4 ref corr	
63	Beam #1 ref int	
64	Beam #2 ref int	
65	Beam #3 ref int	
66	Beam #4 ref int	
67	Beam #1 ref % good	
68	Beam #2 ref % good	
69	Beam #3 ref % good	
70	Beam #4 ref % good	
71	BT max depth	LSB
72		MSB
73	Beam #1 RSSI amp	
74	Beam #2 RSSI amp	
75	Beam #3 RSSI amp	
76	Beam #4 RSSI amp	

Table F–14 PD0 Bottom Track Summary (continued)

	Bit Positions	
77	Gain	
78	(*see byte 17)	MSB
79	(*see byte 19)	MSB
80	(*see byte 21)	MSB
81	(*see byte 23)	MSB
82	Reserved	
83		
84		
85		

Each section in *Table F–14* is described in detail below.

Table F–15 Bottom Track Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the bottom-track data identification word (00 60h)
5-8	3,4	BT pings per ensemble	Stores the number of bottom-track pings to average together in each ensemble. Scaling: LSD = 1 ping; Range = 0 to 999 pings
9-12	5,6	BT delay before re-acquire	Stores the number of ADCP ensembles to wait after losing the bottom before trying to re-acquire it. Scaling: LSD = 1 ensemble; Range = 0 to 999 ensembles
13,14	7	BT corr mag min	Stores the minimum correlation magnitude value. Scaling: LSD = 1 count; Range = 0 to 255 counts
15,16	8	BT eval amp min	Stores the minimum evaluation amplitude value. Scaling: LSD = 1 count; Range = 1 to 255 counts
17,18	9	BT % good min	Stores the minimum percentage of bottom-track pings in an ensemble that must be good to output velocity data.
19,20	10	BT mode	Stores the bottom-tracking mode
21-24	11,12	BT err vel max	Stores the error velocity maximum value. Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s (0 = did not screen data)
25-32	13-16	Reserved	
33-48	17-24	Beam #1-4 BT range	Contains the lower two bytes of the vertical range from Syrinx to the sea bottom as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT range = 0. See bytes 78 through 81 for MSB description and scaling. Scaling: LSD = 1 cm; Range = 0 to 65535 cm
49-64	25-32	Beam #1-4 BT vel	The meaning of the velocity depends on the selected coordinate system. The four velocities are as follows: 1. Beam coordinates: Beam 1, Beam 2, Beam 3, Beam 4

Table F–15 Bottom Track Data Format (continued)

Hex Digit	Binary Byte	Field	Description
			2. Instrument coordinates: 1→2, 4→3, toward face, error 3. Ship coordinates: Starboard, Fwd, Upwards, error 4. Earth coordinatres: East, North, Upward, error
65-72	33-36	Beam #1-4 BT corr	Contains the correlation magnitude in relation to the seam bottom as determined by each beam. Bottom-track correlation magnitudes have the same format and scale factor as water-profiling magnitudes.
73-80	37-40	Beam #1-4 BT eval amp	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo. Scaling: LSD = 1 counts; Range = 0 to 255 counts
81-88	41-44	Beam #1-4 BT % good	Contains bottom-track percentage-good data for each beam, which indicate the reliability of bottom-track data. It is the percentage of bottom-track pings which have passed Syrinx's bottom-track validity algorithm during an ensemble. Scaling: LSD = 1 percent; Range = 0 to 100 percent
89-92 93-96 97-100	45,46 47,48 49,50	Ref Layer (Min, Near, Far)	Stores the minimum layer size, the near boundary, and the far boundary of the BT water-reference layer. Scaling (minimum layer size): LSD = 1dm; Range = 0-999 dm Scaling (near/far boundaries): LSD = 1dm; Range = 0-9999 dm
101-116	51-58	Beam #1-4 Ref Layer Vel	Contains velocity data for the water reference layer for each beam. Reference layer velocities have the same format and scale factor as water-profiling velocities.
117-124	59-62	Beam #1-4 Ref Corr	Contains correlation magnitude data for the water reference layer for each beam. Reference layer correlation magnitudes have the same format and scale factor as water-profiling magnitudes.
125-132	63-66	Beam #1-4 Ref Int	Contains echo intensity data for the reference layer for each beam. Reference layer intensities have the same format and scale factor as water-profiling intensities.
133-140	67-70	Beam #1-4 Ref % Good	Contains percent-good data for the water reference layer for each beam. They indicate the reliability of reference layer daya. It is the percentage of bottom-track pings that have passed a reference layer validity algorithm during an ensemble. Scaling: LSD = 1 percent; Range = 0 to 100 percent
141-144	71,72	BT Max Depth	Stores the maximum tracking depth value. Scaling: LSD = 1 decimetre; Range = 80 to 9999 decimetres
145-152	73-76	Beam #1-4 RSSI Amp	Contains the Receiver Signal Strength Indicator (RSSI) value in the centre of the bottom echo as determined by each beam. Scaling: LSD = 0.45dB per count; Range = 0 to 255 counts
153,154	77	Gain	Contains the Gain level for shallow water.

Table F–15 Bottom Track Data Format (continued)

Hex Digit	Binary Byte	Field	Description
155-162	78-81	Beam #1-4 BT Range MSB	Contains the most significant byte of the vertical range from Syrinx to the sea bottom as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT range = 0. See bytes 17 through 24 for LSB description and scaling. Scaling: LSD = 65,536 cm Range = 65,536 to 16,777,215 cm
163-170	82-85	Reserved	Reserved

F.1.2.6 NMEA Data within PD0

This document only describes the NMEA messages that Syrinx understands and how those messages are embedded within a PD0 message. For more details, see the NMEA specification at http://www.nmea.org

F.1.2.7 PD0 General NMEA

PD0 General NMEA data are binary messages corresponding the NMEA strings from which they derive.

Each PD0 General NMEA message starts with a 14-byte header as described below:

Table F–16 General NMEA Header Fields

General ID	Specific ID	Msg Size	Delta Time	Message Body
0x2022	See below			
2 bytes	2 bytes	2 bytes	8 bytes	N bytes

The Specific ID header field in *Table F–17* encodes the identity of the data held in the Message Body as follows:

Table F–17 General NMEA Specific IDs

NMEA Message	Specific ID
GGA	104
VTG	105
DBT	106
HDT	107

The content of the GGA binary message is shown below.

Table F–18 General NMEA GGA Binary Format

Binary Byte	Field	Description
1-7	szHeader	NMEA GGA string, i.e $GPGGA
8-17	szUTC	UTC Timestamp
18-25	dLatitude	Latitude of GPS receiver in decimal degrees

Table F–18 General NMEA GGA Binary Format (continued)

Binary Byte	Field	Description
26	tcNS	Character to describe latitude hemisphere, i.e. N = North, S = South
27-34	dLongitude	Longitude of GPS receiver in decimal degrees
35	tcEW	Character to describe longitude hemisphere, i.e. E = East, W = West
36	ucQuality	GPS Quality indicator: 0 = fix not available or invalid 1 = GPS fix 2 = Differential GPS fix 3 = GPS PPS Mode, fix valid 4 = Real Time Kinematic. System used in RTK mode with fixed integers 5 = Float RTK. Satellite system used in RTK mode, floating integers 6 = Estimated (dead reckoning) mode 7 = Manual Input Mode 8 = Simulaor mode 9 = Position computed using almanac This shall not be a null field.
37	ucNmbSat	GPS Number of satellites used in fix, 00-12
38-41	fHDOP	Horizontal dilution of precision
42-45	fAltitude	Altitude of GPS receiver above/below mean-sea-level (geoid)
46	tcAltUnit	Units of Altitude measurement, M = metres
47-50	fGeoid	Geoidal separation. The difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid); a negative value indicates that the mean-sea-level below the ellipsoid
51	tcGeoidUnit	Units of Geoidal Separation measurement, M = metres
52-55	fAgeDGPS	Age of differential GPS. Time in seconds since last SC104 Type 1 or 9 update, null field when DGPS is used
56-57	sRefStationId	Differential reference station ID, 0000-1023

The content of the VTG binary message is shown below.

Table F–19 General NMEA VTG Binary Format

Binary Byte	Field	Description
1-7	szHeader	NMEA VTG string, i.e $GPVTG
8-11	fCOGTrue	Course-over-ground, degrees true
12	tcTrueIndicator	T
13-16	tCOGMagn	Course-over-ground, degrees magnetic
17	tcMagnIndicator	M
18-21	fSpdOverGroundKts	Speed over ground measured in knots
22	tcKtsIndicator	N
23-26	fSpdOverGroundKmh	Speed over ground measured in km/h

Table F–19 General NMEA VTG Binary Format (continued)

Binary Byte	Field	Description
27	tcKmhIndicator	K
28	tcModeIndicator	Mode indicator: A=Autonomous mode D=Differential mode E=Estimated (dead reckoning) mode) M=Manual input mode S=Simulator mode N=Data not valid This shall not be a null field

The content of the DBT binary message is shown below.

Table F–20 General NMEA HDT Binary Format

Binary Byte	Field	Description
1-7	szHeader	NMEA DBT string, i.e $XXDBT
8-11	fWaterDepth_ft	Water depth in feet
12	tcFeetIndicator	f
13-16	fWaterDepth_m	Water depth in Metres
17	tcMeterIndicator	M
18-21	fWaterDepth_F	Water depth in Fathoms
22	tcFathomIndicator	F

The content of the HDT binary message is shown below.

Table F–21 General NMEA HDT Binary Format

Binary Byte	Field	Description
1-7	szHeader	NMEA DBT string, i.e $XXDBT
8-15	dHeading	Heading, Degrees true
16	tcFeetIndicator	T

F.1.2.8 PD0 NMEA Strings

PD0 NMEA strings are messages containing the ASCII content of a NMEA string received from an external sensor.

Each PD0 NMEA string starts with a 14-byte header as described below.

Table F–22 NMEA String Header Fields

Message	General ID	Specific ID	Msg Size	Delta Time	Message Body
GGA	0x2101	100	98		
VTG	0x2102	101	60		

Table F–22 NMEA String Header Fields (continued)

Message	General ID	Specific ID	Msg Size	Delta Time	Message Body
DBT	0x2100	102	43		
HDT	0x2104	103	32		
	2 bytes	2 bytes	2 bytes	8 bytes	N bytes

The message body contains the NMEA string.

All NMEA strings start with $ followed by a message identifier – this will hereafter be referred to as the message start delimiter. This delimiter is five characters long, with the first two characters identifying the NMEA talker, and the last three of those characters identifying the type of message. For example, a GGA string starts with $XXGGA, where XX identifies the NMEA talker.

The NMEA message then consists of a fixed number of fields, each of which is separated by a comma.

Each NMEA string end is delimited by an asterisk * followed by a two-byte checksum (hereafter denoted by hh and a carriage-return <CR> and line-feed <LF>. The asterisk will hereafter be referred to as the message end delimiter.

Each NMEA string supported by Syrinx is described below.

The content of the GGA string is as follows:

$XXGGA,hhmmss.ss,llll.ll,a,yyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>

The fields between the message start and end delimiters are shown below.

Table F–23 NMEA GGA String Description

	Width in Bytes	Description
hhmmss.ss	Variable	UTC of position – 2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal-fraction of seconds. Leading zeros are always included for hours, minutes, and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is required.
llll.ll	Variable	Latitude – 2 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal-fraction of minutes. Leading zeros are always included for degrees and minutes to maintain fixed length of the first 4 characters. The decimal point and associated decimal-fraction are optional if full resolution is not required.
a	1	Latitude hemisphere. N or S.
llll.ll	Variable	Longitude – 3 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal-fraction of minutes. Leading zeros are always included for degrees and minutes to maintain fixed length of the first 5 characters. The decimal point and associated decimal-fraction are optional if full resolution is not required.
a	1	Longitude hemisphere. E or W.
x	1	GPS Quality indicator: 0 = fix not available or invalid 1 = GPS fix 2 = Differential GPS fix 3 = GPS PPS Mode, fix valid

Table F–23 NMEA GGA String Description (continued)

	Width in Bytes	Description
		4 = Real Time Kinematic. System used in RTK mode with fixed integers 5 = Float RTK. Satellite system used in RTK mode, floating integers 6 = Estimated (dead reckoning) mode 7 = Manual Input Mode 8 = Simulator mode 9 = Position computed using almanac This shall not be a null field.
xx	2	GPS Number of satellites used in fix, 00-12
x.x	3	Horizontal dilution of precision
x.x	3	Altitude of GPS receiver above/below mean-sea-level (geoid)
M	1	Units of Altitude measurement, M = metres
x.x	3	Geoidal separation. The difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid); a negative value indicates that the mean-sea-level below the ellipsoid
M	1	Units of Geoidal Separation measurement, M = metres
x.x	3	Age of differential GPS. Time in seconds since last SC104 Type 1 or 9 update, null field when DGPS is used
xxxx	4	Differential reference station ID, 0000-1023

The content of the VTG string is as follows:

$XXVTG,x.x,T,x.x,M,x.x,N,x.x,K,a*hh<CR><LF>

The fields between the message start and end delimiters are shown below.

Table F–24 NMEA VTG String Description

	Width in Bytes	Description
x.x	Variable	Track, degrees True
T	1	T
x.x	Variable	Track, degrees Magnetic
M	1	M
x.x	Variable	Speed, knots
N	1	N
x.x	Variable	Speed, km/hr
K	1	K

The content of the DBT string is as follows:

$XXDBT,x.x,f,x.x,M,x.x,F*hh<CR><LF>

The fields between the message start and end delimiters are shown below.

Table F–25 NMEA DBT String Description

	Width in Bytes	Description
x.x	Variable	Water depth in feet
f	1	f
x.x	Variable	Water depth in Metres
M	1	M
x.x	Variable	Water depth in Fathoms
F	1	F

The content of the HDT string is as follows:

$XXHDT,x.x,T*hh<CR><LF>

The fields between the message start and end delimiters shown below.

Table F–26 NMEA HDT String Description

	Width in Bytes	Description
x.x	Variable	Heading, degrees True
T	1	T

F.1.2.9 Sonardyne PD0 System Configuration

This structure is a PD0 extension specific to Sonardyne devices. It contains information which will not change unless the system configuration is updated by the user.

Table F–27 Sonardyne System Configuration Description

Binary Byte	Field	Description
1,2	ID Code	Sonardyne System Configuration ID, 0x6060 LSB
3,4	Type number	Sonardyne Device Type number, i.e. 8275-3130
5,6	Sub Type Field 1	i.e. 8275-3130
7,8,9	Serial Number	First part of the Sonardyne serial number 313735-002
10	Sequence number	First part of the Sonardyne serial number 313735-002
11-14	DSP Firmware	DSP firmware version, 4 bytes, xx.xx.xx.xx
15-18	ARM Firmware	ARM firmware version, 4 bytes, xx.xx.xx.xx
19-22	FPGA Firmware	FPGA firmware version, 4 bytes, xx.xx.xx.xx
23-26	Webserver	Webserver firmware version, 4 bytes, xx.xx.xx.xx
27-30	Offset X GPS (float32)	Lever arm X for GPS
31-34	Offset Y GPS (float32)	Lever arm Y for GPS
35-38	Offset Z GPS (float32)	Lever arm Z for GPS
39-42	Pitch Offset (float32)	In degrees
43-46	Roll Offset	In degrees

Table F–27 Sonardyne System Configuration Description (continued)

Binary Byte	Field	Description
	(float32)	
47-50	Heading Offset (float32)	In degrees

F.1.2.10 Sonardyne PD0 Variable Leader

This structure is a PD0 extension specific to Sonardyne devices. It contains information which may change depending on the mode of operation of the instrument and may change from ping to ping.

Table F–28 Sonardyne Variable Leader Description

Binary Byte	Field	Description		
1,2	ID Code	Sonardyne Variable Structure, 0x6160 LSB		
3	Status	Bit	Definition	
		0,1,2,3	Version of the message. Current Version: 3 Updated 22/01/20	
		4,5,6	Mode of instrument:	
			0	Searching for bottom lock
			1	Bottom Ambiguity Resolve
			2	Acquired bottom lock / tracking
			3	Water track mode
			4	Manual mode
			5	ADCP mode
			6	Test Mode1
			7	Test Mode2
4	Ping ID	Sequential ID which will wrap around, this allows different messages to be output from the same data and combined later. i.e. advanced diagnostics may be turned on which is contained in a separate message. Valid range is 0–255.		
5,6,7,8,9,10	T0 Time	Time of start of acoustic transmission expressed in the instrument time frame in units of microseconds. Note:The instrument time frame is a free running monotonically increasing count from the time the unit was powered up. Drift rate is << 1e-4.		
11,12,13,14	Waveform	Bit	Definition	
		0,1,2,3,4,5	Ping BT product. Valid range 1–63.	
		6,7,8,9,10,11	Number of code repeats. Valid range 1–63	
		12,13,14,15	Number of Beams. Valid range 1–15	
		16,17,18,19	Transmit bandwidth. See bandwidth modes below	

Table F–28 Sonardyne Variable Leader Description (continued)

Binary Byte	Field	Description			
			Value	WB 125 kHz	
			0	WB 62.5 kHz	
			1	WB 31.25 kHz	
			2	WB 15.625 kHz	
			3	NB 7.8125 kHz	
			4	NB 3.90625 kHz	
			5	Future use	
			6–15		
			Rx Bandwidth = 2*Tx Bandwidth For example: TxBw = 2 = 15.625 kHz RxBw = 2*15.625 kHz = 31.25 kHz		
		20,21,22,23	Beams used in solution This field contains the beams used by the DSP for bottom tracking. Bits 20 to 23 = beams 1 to 4 in order. Set (1) = beam used in tracking algorithms.		
		24–31	reserved		
15,16	Rx Gain	Receiver gain during this ping			
17,18	Tx Gain	Transmitter gain during this ping			
19	Sensor Data validity	If sensor data has not been received in last 2 seconds the flag will be cleared to show the data is not valid. Bit 0: GGA available / valid Bit 1: VTG velocity available / valid Bit 2: INS position available / valid Bit 3: AHRS data available / valid			
20,21	INS Beam 0 velocity	Signed 16-bit integer: The meaning of the velocity depends on the selected coordinate system. The four velocities are as follows: 1. Beam coordinates: Beam 1, Beam 2, Beam 3, Beam 4 2. Instrument coordinates: 1→2, 4→3, toward face, unused 3. Ship coordinates: Starboard, Fwd, Upwards, unused 4. Earth coordinates: East, North, Upward, unused			
22,23	INS Beam 1 velocity				
24,25	INS Beam 2 velocity				
26,27	INS Beam 3 velocity				
28,29	INS Heading	Unsigned 16-bit integer: INS vessel heading; units are $2^{-15} \times 180$ deg			
30,31	INS Pitch	Signed 16-bit integer: INS vessel pitch; units are $2^{-15} \times 180$ deg			
32,33	INS Roll	Signed 16-bit integer: INS vessel roll; units are $2^{-15} \times 180$ deg			

Table F–28 Sonardyne Variable Leader Description (continued)

Binary Byte	Field	Description
34,35	Beam Velocity Ambiguity Limit	Unsigned 16-bit integer: Beam-frame velocity ambiguity limit; units are mm/s
36	Beam Velocity Noise	Unsigned 8-bit integer: Beam-frame velocity noise; units are mm/s
37, 38	(Reserved)	For future use.

F.1.2.11 Checksum Format

The checksum is used to verify the integrity of the received PD0 message.

Table F–29 Checksum Summary

	Bit Positions								
Byte	7	6	5	4	3	2	1	0	
1	Checksum data								LSB
2									MSB

The checksum is described below.

Table F–30 Checksum Format Details

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Checksum data	This field contains a modulo 65535 checksum. Syrinx computes the checksum by summing all the bytes in the output buffer excluding the checksum.

F.2 Teledyne RDI DVL Binary Data Format (PD3)

The DVL sends this data format only when the PD3 command is used. In multiple byte parameters, the least significant byte always comes before the more significant bytes.

Hex Digit	Binary Byte	Field	Description
1,2	1	DVL Data ID	Stores the DVL (speed log) identification word (7Eh)
3,4	2	Data Structure	These byte contains the Data Structure. Bit # 0 = Ship or Earth BT Velocity 1 = Vertical BT Velocity 2 = Water Velocity 3 = Beam Vertical Range to Bottom 4 = Average Vertical Range to Bottom 5 = Reserved 6 = Reserved

Hex Digit	Binary Byte	Field	Description
			7 = Sensor/Other Data Byte
5-8	3,4	X-Vel Btm	† Bit #0: Always output. If the data bit is set to 0, than Ship coordinates are used. If the data bit is set to 1, than Earth coordinates are used. These fields contain the velocity of the vessel in relation to the bottom in mm/s. Positive values indicate vessel motion to (X) Starboard/East, (Y) Forward/North, (Z) Upward.
9-12	5,6	Y-Vel Btm	
13-16	7,8	Z-Vel Btm	† Bit #1: Vertical velocities.
17-20	9,10	X-Vel Water	† Bit #2: These fields contain the velocity of the vessel in relation to the water reference layer in mm/s. Positive values indicate vessel motion to (X) Starboard/East, (Y) For-ward/North, (Z) Upward.
21-24	11,12	Y-Vel Water	† Bit #2: These fields contain the velocity of the vessel in relation to the water reference layer in mm/s. Positive values indicate vessel motion to (X) Starboard/East, (Y) For-ward/North, (Z) Upward.
25-28	13,14	Z-Vel Water	† Bit #1 and Bit #2
29-32 33-36 37-40 41-44	15,16 17,18 19,20 21,22	Bm1 Bm2 Rng to Bm3 Bottom Bm4	† Bit #3: These fields contain the vertical range from the DVL to the bottom as determined by each beam. This vertical range does not compensate for the effects of pitch and roll. When a bottom detection is bad, the field is set to zero. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm
45-48	23,24	Avg Rng to Btm	† Bit #4: These fields contain the average vertical range from the DVL to the bottom as determined by each beam.
49-80	25-40	Spare	Spare
81,82	41	Sensor/Other Data	† Output if Bit #7 of "Data to Follow" byte is set. These fields contain the Sensor/Other data. Bit # 0 = Time 1 = Heading 2 = Pitch 3 = Roll 4 = Temperature 5 = Active Built-In-Test
83-90	42	Time: HH	‡ Sensor/Other Data Bit #0: These fields contains the time of the ping in Hours, Minutes Seconds, Hundredths of seconds respectively. Time (Hours)
	43	TIME; MM	Time (Minutes)
	44	Time: SS	Time (Seconds)
	45	TIME; HH	Time (Hundredths)
91-94	46,47	Heading	‡ Sensor/Other Data Bit #1: this field contains the Heading in hundredths of degrees.
95-98	48,49	Pitch	‡ Sensor/Other Data Bit #2: this field contains the Pitch in hundredths of degrees.
99-102	50,51	Roll	‡ Sensor/Other Data Bit #3: this field contains the Roll in hundredths of degrees.
103-106	52,53	Temp	‡ Sensor/Other Data Bit #4: this field contains the Temperature in hundredths of degrees.

Hex Digit	Binary Byte	Field	Description
107-110	54,55	BIT results	‡ Sensor/Other Data Bit #5: this field contains the Built-In-Test results. Each bit specifies the result of built-in-test during an ensemble. If the bit is set, the test failed. BYTE 54 BYTE 55 (BYTE 55 RESERVED FOR FUTURE USE) 1xxxxxxx xxxxxxxx = RESERVED x1xxxxxx xxxxxxxx = RESERVED xx1xxxxx xxxxxxxx = RESERVED xxx1xxxx xxxxxxxx = DEMOD 1 ERROR xxxx1xxx xxxxxxxx = DEMOD 0 ERROR xxxxx1xx xxxxxxxx = RESERVED xxxxxx1x xxxxxxxx = DSP ERROR xxxxxxx1 xxxxxxxx = RESERVED
111-114	56,57	Checksum	This is the 16-bit checksum of all the preceding binary bytes.

† This block of data is only output if the bit is set to 1 in the Data Structure byte.

‡ This block of data is only output if the bit is set to 1 in the Sensor/Other Data byte.

F.3 Teledyne RDI DVL Binary Data Format (PD4)

Notes

The data structure type determines whether PD4.

System Config field used to identify DVL as Syrinx (xxxxx111)

Hex Digit	Binary Byte	Field	Description	Used By Sonardyne (Value given if not used)
1,2	1	DVL Data ID	Stores the DVL (speed log) identification word (7Dh).	Used
3,4	2	Data Structure	Identifies which data pattern will follow based on the Pdcommand. 0 = PD4 = Bytes 1 through 47. 1 = PD5 = Bytes 1 through 45 and bytes 46 through 88 from PD5 table	Used
5-8	3,4	No. of Bytes	Contains the number of bytes sent in this data structure, not including the final checksum.	Used (0x002D as always PD4)
9,10	5	System Config	Defines the DVL hardware/firmware configuration. Convert to binary and interpret as follows. BIT 76543210 00xxxxxx BEAM-COORDINATE VELOCITIES 01xxxxxx INSTRUMENT-COORDINATE VELOCITIES 10xxxxxx SHIP-COORDINATE VELOCITIES	Currently fixed with Instrument Co-ordinate bit (01xxxxxxxx even with offsets) 0 for tilt information as not used

Hex Digit	Binary Byte	Field	Description	Used By Sonardyne (Value given if not used)
			11xxxxxx EARTH-COORDINATE VELOCITIES xx0xxxxx TILT INFORMATION NOT USED IN CALCULATIONS xx1xxxxx TILT INFORMATION USED IN CALCULATIONS xxx0xxxx 3-BEAM SOLUTIONS NOT COMPUTED xxx1xxxx 3-BEAM SOLUTIONS COMPUTED xxxxx010 300-kHz DVL xxxxx011 600-kHz DVL xxxxx100 1200-kHz DVL Note: Field used for Syrinx identifier: xxxxx111 Syrinx DVL	3-Beam bit to be set when 3 beam mode enabled ID bits set to xxxxx111 To identify Sonardyne Syrinx DVL
11-14	6,7	X-Vel Btm	These fields contain the velocity of the vessel in relation to the bottom in mm/s. Positive values indicate vessel motion to east (X), north (Y), and up (Z). LSD = 1 mm/s (see NOTES at end of this table).	Used : -32768 = error
15-18	8,9	Y-Vel Btm		Used : -32768 = error
19-22	10,11	Z-Vel Btm		Used : -32768 = error
23-26	12,13	E-Vel Btm		Used, only valid if 4-beam solution output.
27-30	14,15	Bm1	These fields contain the vertical range from the ADCP to the bottom as determined by each beam. This vertical range does not compensate for the effects of pitch and roll. When a bottom detection is bad, the field is set to zero. Scaling: LSD = 1 centimetre; Range = 0 to 65535 cm	Used : 0 = error
31-34	16,17	Bm2 Rng to		Used : 0 = error
35-38	18,19	Bm3 Bottom		Used : 0 = error
39-42	20,21	Bm4		Used : 0 = error
43,44	22	Bottom Status	This field shows the status of bottom-referenced correlation and echo amplitude data. Convert to binary and interpret as follows. A zero code indicates status is OK. BIT 76543210 1xxxxxxx BEAM 4 LOW ECHO AMPLITUDE x1xxxxxx BEAM 4 LOW CORRELATION xx1xxxxx BEAM 3 LOW ECHO AMPLITUDE xxx1xxxx BEAM 3 LOW CORRELATION xxxx1xxx BEAM 2 LOW ECHO AMPLITUDE	Not Used Value = 0

Hex Digit	Binary Byte	Field	Description	Used By Sonardyne (Value given if not used)
			xxxxx1xx BEAM 2 LOW CORRELATION xxxxxx1x BEAM 1 LOW ECHO AMPLITUDE xxxxxxx1 BEAM 1 LOW CORRELATION	
45-48	23,24	X-Vel Ref Layer	These fields contain the velocity of the vessel in relation to the water-mass reference layer in mm/s. Positive values indicate vessel motion to east (X), north (Y), and up (Z). LSD = 1 mm/s (See NOTES at end of this table.)	0x8000
49-52	25,26	Y-Vel Ref Layer		0x8000
53-56	27,28	Z-Vel Ref Layer		0x8000
57-60	29,30	E-Vel Ref Layer		0x8000
61-64	31,32	Ref Layer Start	These fields contain the starting boundary (near surface) and the ending boundary (near bottom) of the water-mass reference layer (BL-command). If the minimum size field is zero, the ADCP does not calculate reference-layer data. Scaling: LSD = 1 dm; Range = 0-9999 dm	Used if in water track or combined mode
65-68	33,34	Ref Layer End		Used if in water track or combined mode
69,70	35	Ref Layer Status	This field shows the status of reference layer depth and correlation data. Convert to binary and interpret as follows. A zero code indicates status is OK. BIT 76543210 xxx1xxxx ALTITUDE IS TOO SHALLOW xxxx1xxx BEAM 4 LOW CORRELATION xxxxx1xx BEAM 3 LOW CORRELATION xxxxxx1x BEAM 2 LOW CORRELATION xxxxxxx1 BEAM 1 LOW CORRELATION	Not Used Value = 0
71,72	36	TOFP Hour	These fields contain the time of the first ping of the current ensemble.	Used
73,74	37	TOFP Minute		Used
75,76	38	TOFP Second		Used
77,78	39	TOFP Hundredth		Used
79-82	40,41		BIT Results These fields contain the results of the ADCP's Built-in Test function. A zero code indicates a successful BIT result. BYTE 40 BYTE 41 (BYTE 41 RESERVED FOR FUTURE USE) 1xxxxxxx xxxxxxxx = RESERVED x1xxxxxx xxxxxxxx = RESERVED xx1xxxxx xxxxxxxx = RESERVED xxx1xxxx xxxxxxxx = DEMOD 1 ERROR	Not Used Value = 0 (See Functional Test for information on how to run Syrinx Self-test.

Hex Digit	Binary Byte	Field	Description	Used By Sonardyne (Value given if not used)
			xxxx1xxx xxxxxxxx = DEMOD 0 ERROR xxxxx1xx xxxxxxxx = RESERVED xxxxxx1x xxxxxxxx = DSP ERROR xxxxxxx1 xxxxxxxx = RESERVED	
83-86	42,43	Speed of Sound	Contains either manual or calculated speed of sound information (EC-command). Scaling: LSD = 1 metres per second; Range = 1400 to 1600 m/s	Used See SCFG for SV settings
87-90	44,45		Temperature Contains the temperature of the water at the transducer head. Scaling: LSD = 0.01 C; Range = -5.00 to +40.00C	Used
91-94	46,47	Checksum	This field contains a modulo 65536 checksum. The DVL computes the checksum by summing all the bytes in the output buffer excluding the checksum. NOTE: This field contains the checksum only when the PD4-command is used. If PD5 is used, the remaining bytes are explained in *Section F.4*.	Used

F.4 Teledyne RDI DVL Output Data Format (PD5)

Hex Digit	Binary Byte	Field	Description
91,92	46	Salinity	Contains the salinity value of the water at the transducer head (ES-command). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt
93-96	46,48	Depth	Contains the depth of the transducer below the water surface (ED-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters
97-100	49,50	Pitch	Contains the DVL pitch angle (EP-command). This value may be a manual setting or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
101-104	51,52	Roll	Contains the DVL roll angle (ER-command). This value may be a manual setting or a reading from a tilt sensor. For up-facing DVLs, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing DVLs, positive values mean that Beam #1 is spatially higher than Beam #2. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
105-108	53,54	Heading	Contains the DVL heading angle (EH-command). This value may be a manual setting or a reading from a heading sensor. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees

Hex Digit	Binary Byte	Field	Description
109-116	55-58	DMG/Btm East	These fields contain the Distance Made Good (DMG) over the bottom since the time of the first ping after initialization or <BREAK>. Scaling: LSD = 1 dm; Range = -10,000,000 to 10,000,000 dm
117-124	59-62	DMG/Btm North	
125-132	63-66	DMG/Btm Up	
133-140	67-70	DMG/Btm Error	
141-148	71-74	DMG/Btm Ref East	These fields contain the distance made good over the watermass reference layer since the time of the first ping after initialization or <BREAK>. Scaling: LSD = 1 dm; Range = -10,000,000 to 10,000,000 dm
149-156	75-78	DMG/Ref North	
157-164	79-82	DMG/Ref Up	
165-172	83-86	DMG/Ref Error	
173-176	87,88	Checksum	This field contains a modulo 65536 checksum. The DVL computes the checksum by summing all the bytes in the output buffer excluding the checksum

F.5 Teledyne RDI DVL Output Data Format (PD6)

The Syrinx DVL sends this data format only when the PD6 output is used. The Syrinx DVL may not sent all data lines dependent on operating mode.

Line	Description
1	SYSTEM ATTITUDE DATA :SA,±PP.PP,±RR.RR,HH.HH <CR><LF> where: PP.PP = Pitch in degrees RR.RR = Roll in degrees HHH.HH = Heading in degrees
2	TIMING AND SCALING DATA :TS,YYMMDDHHmmsshh,SS.S,+TT.T,DDDD.D,CCCC.C,BBB <CR><LF> where: YYMMDDHHmmsshh = Year, month, day, hour, minute, second, hundredths of seconds SS.S = Salinity in parts per thousand (ppt) TT.TT = Temperature in C DDDD.D = Depth of transducer face in meters CCCC.C = Speed of sound in meters per second BBB = Built-in Test (BIT) result code
3	WATER-MASS, INSTRUMENT-REFERENCED VELOCITY DATA :WI,±XXXXX,±YYYYY,±ZZZZZ,±EEEEE,S <CR><LF> where: ±XXXXX = X-axis vel. data in mm/s (+ = Bm1 Bm2 xdcr movement relative to water mass)

Line	Description
	±YYYYY = Y-axis vel. data in mm/s (+ = Bm4 Bm3 xdcr movement relative to water mass) ±ZZZZZ = Z-axis vel. data in mm/s (+ = transducer movement away from water mass) ±EEEEE = Error velocity data in mm/s S = Status of velocity data (A = good, V = bad)
4	WATER-MASS, SHIP-REFERENCED VELOCITY DATA :WS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF> where: ±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement rel. to water mass) ±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement rel. to water mass) ±NNNNN = Normal velocity data in mm/s (+ = ship movement away from water mass) S = Status of velocity data (A = good, V = bad)
5	WATER-MASS, EARTH-REFERENCED VELOCITY DATA :WE,±EEEEE,±NNNNN,±UUUUU,S <CR><LF> where: ±EEEEE = East (u-axis) velocity data in mm/s (+ = DVL movement to east) ±NNNNN = North (v-axis) velocity data in mm/s (+ = DVL movement to north) ±UUUUU = Upward (w-axis) velocity data in mm/s (+ = DVL movement to surface) S = Status of velocity data (A = good, V = bad)
6	WATER-MASS, EARTH-REFERENCED DISTANCE DATA :WD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF> where: +EEEEEEEE.EE = East (u-axis) distance data in meters +NNNNNNNN.NN = North (v-axis) distance data in meters +UUUUUUUU.UU = Upward (w-axis) distance data in meters DDDD.DD = Range to water-mass center in meters TTT.TT = Time since last good-velocity estimate in seconds
7	BOTTOM-TRACK, INSTRUMENT-REFERENCED VELOCITY DATA :BI,±XXXXX,±YYYYY,±ZZZZZ,±EEEEE,S <CR><LF> where: ±XXXXX = X-axis velocity data in mm/s (+ = Bm1 Bm2 xdcr movement relative to bottom) ±YYYYY = Y-axis velocity data in mm/s (+ = Bm4 Bm3 xdcr movement relative to bottom) ±ZZZZZ = Z-axis velocity data in mm/s (+ = transducer movement away from bottom) ±EEEEE = Error velocity data in mm/s S = Status of velocity data (A = good, V = bad)
8	BOTTOM-TRACK, SHIP-REFERENCED VELOCITY DATA :BS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF> where: ±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement relative to bottom) ±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement relative to bottom) ±NNNNN = Normal velocity data in mm/s (+ = ship movement away from bottom) S = Status of velocity data (A = good, V = bad)
9	BOTTOM-TRACK, EARTH-REFERENCED VELOCITY DATA :BE,±EEEEE,±NNNNN,±UUUUU,S <CR><LF> where:

Line	Description
	±EEEEE = East (u-axis) velocity data in mm/s (+ = DVL movement to east) ±NNNNN = North (v-axis) velocity data in mm/s (+ = DVL movement to north) ±UUUUU = Upward (w-axis) velocity data in mm/s (+ = DVL movement to surface) S = Status of velocity data (A = good, V = bad)
10	BOTTOM-TRACK, EARTH-REFERENCED DISTANCE DATA :BD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF> where: +EEEEEEEE.EE = East (u-axis) distance data in meters +NNNNNNNN.NN = North (v-axis) distance data in meters +UUUUUUUU.UU = Upward (w-axis) distance data in meters DDDD.DD = Range to bottom in meters TTT.TT = Time since last good-velocity estimate in seconds

The PD6 output does not pad spaces with zeroes. The spaces are left intact. The example below shows a realistic output from a scenario where the Syrinx DVL is locked onto the bottom.

```
:SA,  -2.31,  +1.92, 75.20
:TS,04081111563644,35.0,+21.0,   0.0,1524.0,  0
:WI,-32768,-32768,-32768,-32768,V
:BI,   +24,    -6,   -20,    -4,A
:WS,-32768,-32768,-32768,V
:BS,   -13,   +21,   -20,A
:WE,-32768,-32768,-32768,V
:BE,   +17,   +18,   -20,A
:WD,       +0.00,       +0.00,       +0.00,  20.00,  0.00
:BD,       -0.02,       -0.03,       +0.02,   7.13,  0.21
```

F.6 Teledyne RDI DVL Data Output Format (PD13)

The Syrinx DVL sends this data format only when the PD13 output is used. The Syrinx DVL may not sent all data lines depending on operating mode.

Line	Description
1	SYSTEM ATTITUDE DATA :SA,±PP.PP,±RR.RR,HH.HH <CR><LF> where: PP.PP = Pitch in degrees RR.RR = Roll in degrees HHH.HH = Heading in degrees
2	TIMING AND SCALING DATA :TS,YYMMDDHHmmsshh,SS.S,+TT.T,DDDD.D,CCCC.C,BBB <CR><LF> where: YYMMDDHHmmsshh = Year, month, day, hour, minute, second, hundredths of seconds SS.S = Salinity in parts per thousand (ppt) TT.TT = Temperature in C DDDD.D = Depth of transducer face in meters CCCC.C = Speed of sound in meters per second

Line	Description
	BBB = Built-in Test (BIT) result code
3	PRESSURE AND RANGE TO BOTTOM DATA :RA,PPP.PP,RRRR.RR,RRRR.RR,RRRR.RR,RRRR.RR where: PPP.PP = Pressure in kPa RRRR.RR = Range to the bottom in deci-meters Beam 1, Beam 2, Beam 3, Beam 4
4	WATER-MASS, INSTRUMENT-REFERENCED VELOCITY DATA :WI,±XXXXX,±YYYYY,±ZZZZZ,±EEEEE,S <CR><LF> where: ±XXXXX = X-axis vel. data in mm/s (+ = Bm1 Bm2 xdcr movement relative to water mass) ±YYYYY = Y-axis vel. data in mm/s (+ = Bm4 Bm3 xdcr movement relative to water mass) ±ZZZZZ = Z-axis vel. data in mm/s (+ = transducer movement away from water mass) ±EEEEE = Error velocity data in mm/s S = Status of velocity data (A = good, V = bad)
5	WATER-MASS, SHIP-REFERENCED VELOCITY DATA :WS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF> where: ±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement rel. to water mass) ±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement rel. to water mass) ±NNNNN = Normal velocity data in mm/s (+ = ship movement away from water mass) S = Status of velocity data (A = good, V = bad)
6	WATER-MASS, EARTH-REFERENCED VELOCITY DATA :WE,±EEEEE,±NNNNN,±UUUUU,S <CR><LF> where: ±EEEEE = East (u-axis) velocity data in mm/s (+ = DVL movement to east) ±NNNNN = North (v-axis) velocity data in mm/s (+ = DVL movement to north) ±UUUUU = Upward (w-axis) velocity data in mm/s (+ = DVL movement to surface) S = Status of velocity data (A = good, V = bad)
7	WATER-MASS, EARTH-REFERENCED DISTANCE DATA :WD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF> where: +EEEEEEEE.EE = East (u-axis) distance data in meters +NNNNNNNN.NN = North (v-axis) distance data in meters +UUUUUUUU.UU = Upward (w-axis) distance data in meters DDDD.DD = Range to water-mass center in meters TTT.TT = Time since last good-velocity estimate in seconds
8	BOTTOM-TRACK, INSTRUMENT-REFERENCED VELOCITY DATA :BI,±XXXXX,±YYYYY,±ZZZZZ,±EEEEE,S <CR><LF> where: ±XXXXX = X-axis velocity data in mm/s (+ = Bm1 Bm2 xdcr movement relative to bottom) ±YYYYY = Y-axis velocity data in mm/s (+ = Bm4 Bm3 xdcr movement relative to bottom) ±ZZZZZ = Z-axis velocity data in mm/s (+ = transducer movement away from bottom) ±EEEEE = Error velocity data in mm/s S = Status of velocity data (A = good, V = bad)

Line	Description
9	BOTTOM-TRACK, SHIP-REFERENCED VELOCITY DATA :BS,±TTTTT,±LLLLL,±NNNNN,S <CR><LF> where: ±TTTTT = Transverse vel. data in mm/s (+ = Port Stbd ship movement relative to bottom) ±LLLLL = Longitudinal vel. data in mm/s (+ = Aft Fwd ship movement relative to bottom) ±NNNNN = Normal velocity data in mm/s (+ = ship movement away from bottom) S = Status of velocity data (A = good, V = bad)
10	BOTTOM-TRACK, EARTH-REFERENCED VELOCITY DATA :BE,±EEEEE,±NNNNN,±UUUUU,S <CR><LF> where: ±EEEEE = East (u-axis) velocity data in mm/s (+ = DVL movement to east) ±NNNNN = North (v-axis) velocity data in mm/s (+ = DVL movement to north) ±UUUUU = Upward (w-axis) velocity data in mm/s (+ = DVL movement to surface) S = Status of velocity data (A = good, V = bad)
11	BOTTOM-TRACK, EARTH-REFERENCED DISTANCE DATA :BD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF> where: +EEEEEEEE.EE = East (u-axis) distance data in meters +NNNNNNNN.NN = North (v-axis) distance data in meters +UUUUUUUU.UU = Upward (w-axis) distance data in meters DDDD.DD = Range to bottom in meters TTT.TT = Time since last good-velocity estimate in seconds

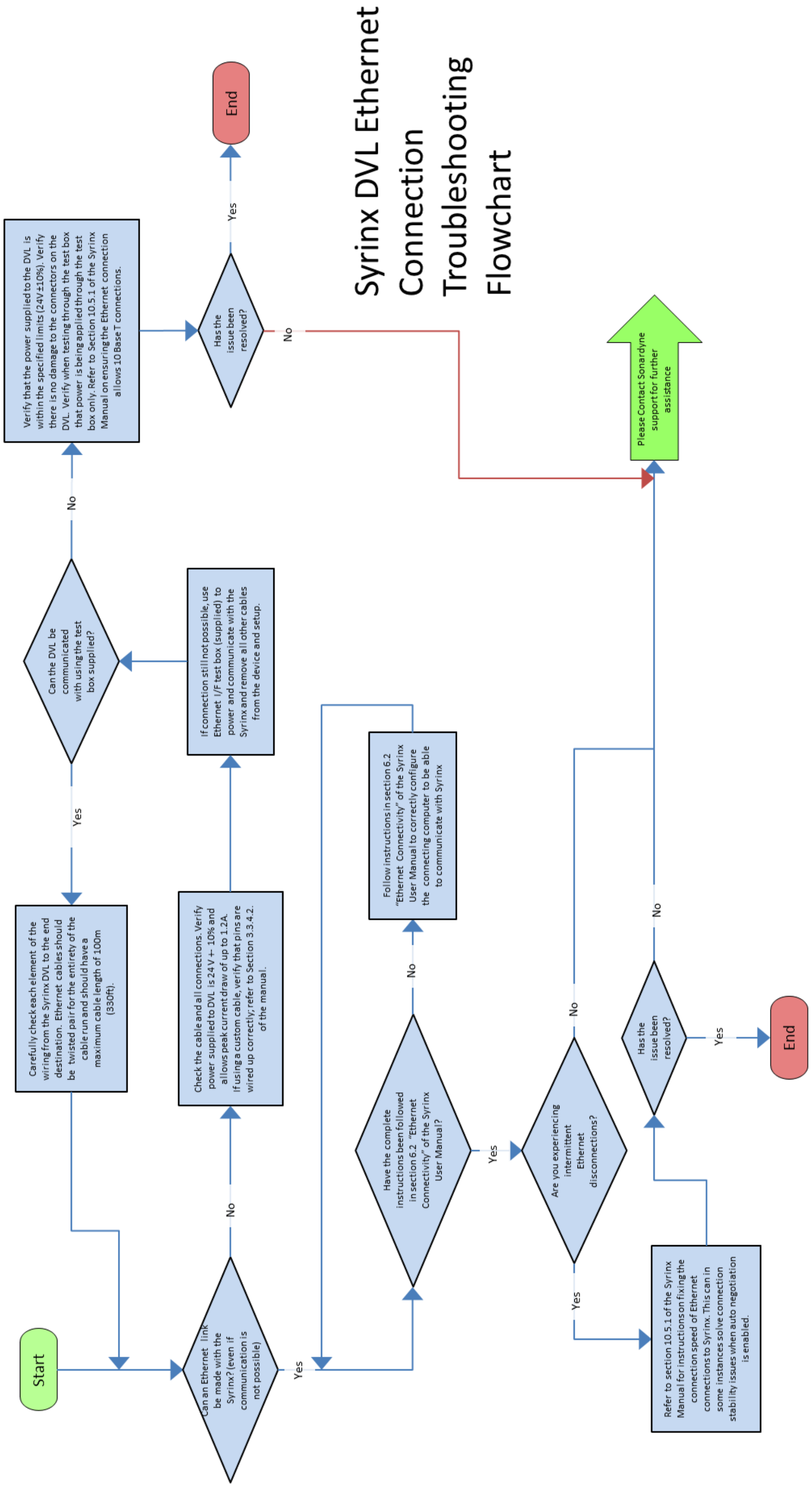
Appendix G – NMEA Definitions (Applicable to Syrinx DVL V1.00)

G.1 DBT NMEA Message

This message is an ASCII message and reports the Depth Below Transducer.

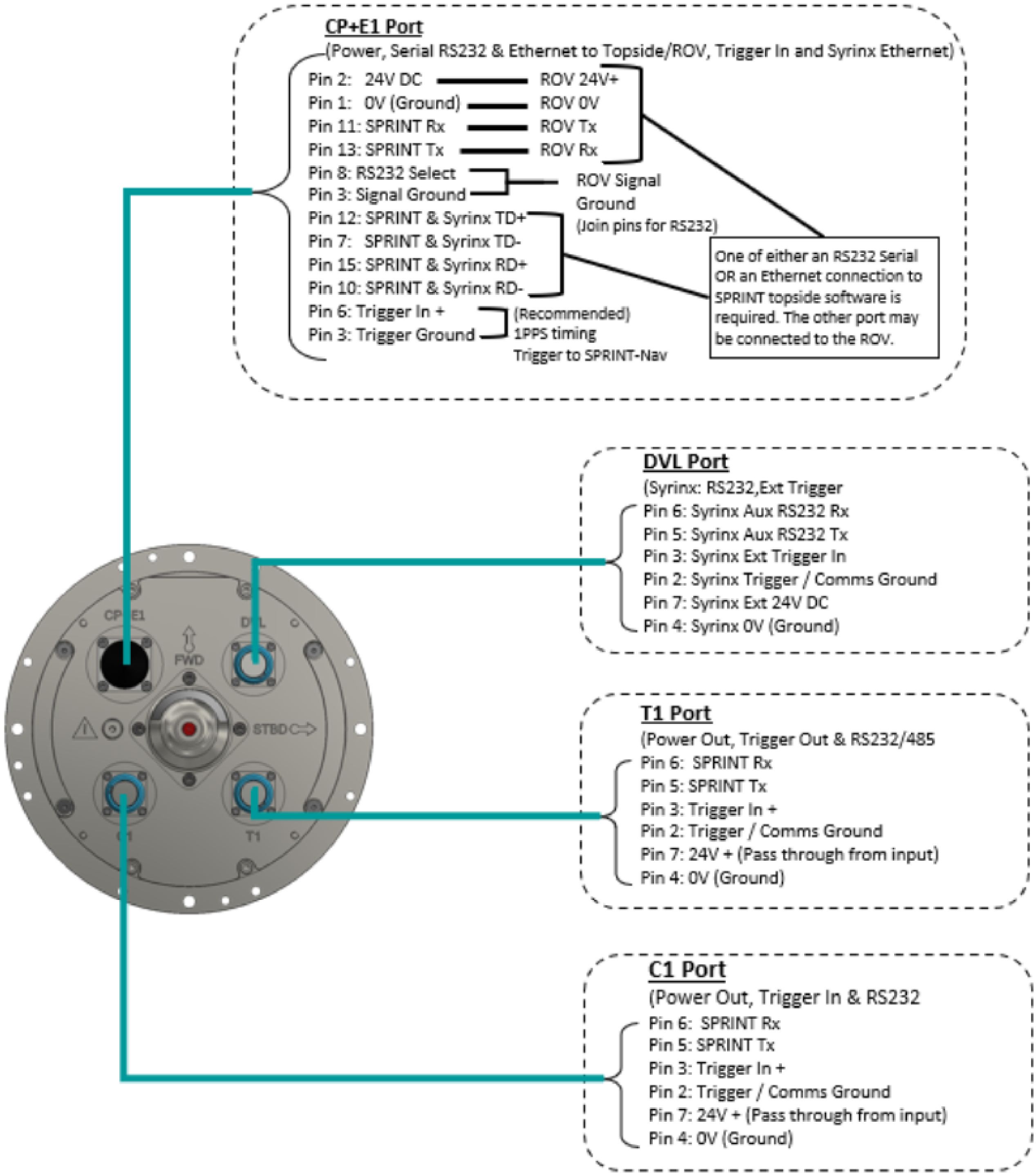
$DBT,x.x,f,y.y,M,z.z,F*hh	
x.x	Depth in feet
y.y	Depth in meters
z.z	Depth in fathoms.
hh	Checksum, eight-bit exclusive OR (no start or stop bits) of all characters in the sentence, including "," and "^" delimiters, between but not including the "$" or "!" and the "*" delimiters. The hexadecimal value of the most significant and least significant four bits of the result is converted to two ASCII characters (0-9, A-F) for transmission. The most significant character is transmitted first.

Appendix H – Ethernet Connection Troubleshooting Flowchart



Appendix I – SPRINT-Nav Wiring Diagram

Figure I–1 Typical SPRINT-Nav Wiring Diagram (Standard Seacon Endcap)



Appendix J – SPRINT-Nav Installation and Setup Check List

Post-Transit Checks		Yes	No	Notes
	Prior to installation on the vehicle has the SPRINT been powered and connected to the SPRINT topside (PC & LCH) to check operation and basic communication?			

Vehicle Checks		Yes	No	Notes
Vehicle	Vehicle CRP defined and identifiable?			
	Is Lodestar mounted rigidly and away from any source of vibration or (non-vehicle frame) independent movement?			
	[Serial] Vehicle MUX connection configured/available @ 115,200 baud rate?			
	[Ethernet] Vehicle MUX connection configured/available @ 100 Mbit?			
	Cable connection wired as per system wiring diagram?			
	[Serial] 232/485 select pin wired correctly?			
	Powered by 24 v?			
	Offsets from vehicle CRP to Lodestar 'Centre of Axis' measured (Metres)?			Forward___________ Starboard_________ Down_______________
	Mounting Angles from vehicle frame to Lodestar frame measured (Degrees)? NB: Not required if Lodestar mounted nominally: Connectors are uppermost on Lodestar and 'X' orientation mark is aligned with forward direction of vehicle body			Forward___________ Starboard_________ Down_______________
USBL	Offsets from vehicle CRP to USBL beacon (centre of transducer) measured (Metres)?			Forward___________ Starboard_________ Down_______________
	If multiple USBL beacons present, has acoustic check been run on the SPRINT aiding beacon to confirm correct address and offsets?			
	If SPRINT aiding beacon is responder, has responder trigger been checked?			
Depth	Offsets from vehicle CRP to depth sensor (point of measurement) measured (Metres)?			Forward___________ Starboard_________ Down_______________
	Cable connection wired as per system wiring diagram?			
	Sensor powered?			
	If multiple depth sensors present, has check been run on the SPRINT aiding sensor to confirm correct offsets?			
	Has output format been checked (for compatability) prior to connection with Lodestar or SPRINT?			Format_______________ Units _______________
	Have serial settings been checked?			Baud Rate________ Data Bits________ Stop Bits________ Parity___________
LBL	Offsets from vehicle CRP to the LBL Transducer measured (Metres)?			Forward___________ Starboard_________ Down_______________
	Cable connection wired as per system wiring diagram?			
	Sensor powered?			
	If LBL transducers present, has check been run on the SPRINT aiding sensor to confirm correct offsets?			
DVL	Offsets from vehicle CRP to DVL (centre of transducer faces)			Forward___________

Vehicle Checks		Yes	No	Notes
	measured (Metres)?			Starboard_________ Down______________
	Is DVL triggered by Lodestar? (If no then DVL will be free-running/untriggered)			
	DVL powered (power pass through)?			
	Can DVL be auto-configured by SPRINT (customer does have a specific output requirement?)			
	If No:			
	Has configuration been checked (for compatability) prior to connection with Lodestar?			Format______________ Units ______________
	Have serial settings been checked?			Baud Rate________ Data Bits________ Stop Bits________ Parity___________
Remote Output Points	Is position output from SPRINT required from a point other than the vehicle CRP?			
	If Yes:			
	Offsets from vehicle CRP to remote point(s) measured (Metres)?			Forward___________ Starboard_________ Down______________

Topside Checks		Yes	No	Notes
LCH	Is LCH powered?			
	Is LCH connected to the SPRINT PC?			
	Can the LCH Admin Page be opended?			
Lodestar	[Serial] Is Lodestar connected to serial port 1 on the LCH?			
	[Ethernet] Is Lodestar connected to Ethernet port 2 on the LCH?			
	Has the default/work site Latitude been set in the SPRINT software (Lodestar)?			
	Has the Lodestar shutdown delay been checked in the SPRINT Software (Lodestar)?			
	Have the Lodestar offsets been configured in the SPRINT Software (Lodestar)?			
	Have the Lodestar mounting angles been configured in the SPRINT Software (Lodestar)?			
Time Synch	Has output format been checked (for compatability) prior to connection with SPRINT?			Format (GPZDA)
	Have serial settings been checked?			Baud Rate________ Data Bits________ Stop Bits________ Parity___________
	Has the LCH ZDA serial port been checked/configured with the correct serial settings?			
	Is GPZDA output @ 1Hz?			
	Does GPZDA message contain UTC time and date?			
	Is the latency between the GPZDA and the actual UTC time known?			
	Has the Time Synch been configured in the SPRINT software (Time Synch)?			
USBL	Has output format been checked (for compatability) prior to connection with SPRINT?			Format___________

Topside Checks		Yes	No	Notes
	Have serial settings been checked?			Baud Rate________ Data Bits________ Stop Bits________ Parity____________
	Has the LCH USBL serial port been checked/configured with the correct serial settings?			
	Is USBL position in WGS84 Latitude Longitude?			
	Is the USBL position the 'raw' USBL position and not corrected for offsets or filtered/smoothed?			
	Does USBL message contain UTC timestamp?			
	Does USBL message contain USBL quality? NB: Quality field in PSIMSSB message or in certain applications HDOP field in USBL GGA message is populated with USBL quality			
	If No:			
	Has the manual USBL quality value been configured in the SPRINT Software (USBL Input)?			
	Does USBL feed contain messages for multiple beacons identified by beacon ID? NB: Beacon ID field in PSIMSSB message or in certain applications reference station ID in USBL GGA message is populated with beacon ID			
	If Yes:			
	Has the USBL beacon ID filter been configured in the SPRINT Software (USBL Input)?			
	Have the USBL beacon offsets been configured in the SPRINT Software (USBL Input)?			
	Has the USBL type been configured in the SPRINT Software (USBL Input)?			
Depth	Has output format been checked (for compatability) prior to connection with Lodestar or SPRINT?			Format_______________ Units _______________
	If Depth sensor feed is connected to Topside (not Lodestar):			
	Have serial settings been checked?			Baud Rate________ Data Bits________ Stop Bits________ Parity____________
	Has the LCH USBL serial port been checked/configured with the correct serial settings?			
	Has the correct port been specified and configured if depth sensor is connected directly to the Lodestar?			
	Does a surface correction need to be applied?			
	Have the depth sensor offsets been configured in the SPRINT Software (Depth Input)?			
	Has the Depth type and units been configured in the SPRINT Software (Depth Input)?			
DVL	Has the correct Lodestar port been specified in the SPRINT software (DVL)			

Topside Checks		Yes	No	Notes
	Has the DVL been auto-configured by the SPRINT software?			
	Yes			
	Has the DVL been 'deployed' after the auto-configuration?			
	No			
	Have the Lodestar port settings been configured to match the DVL serial settings?			
	Has the correct 'triggered by Lodestar' setting been configured in the SPRINT Software (DVL)			
	Has the correct 'Binary or Hex ASCII' setting been configured in the SPRINT Software (DVL)			
	If a new installation, have the default DVL mounting angles been configured in the SPRINT software (DVL)			Heading__135 Pitch____0.0 Roll__-179.9
	If a new installation have the latency and scale factor values been set to zero (default) in the SPRINT software (DVL)			
	Have the DVL offsets been configured in the SPRINT Software (DVL)?			
Sound Velocity	Has the correct Sound Velocity type been specified in the SPRINT software (Sound Velocity)?			
	Yes (automatic DVL derived to be used)			
	Has the salinity value been checked/set in the SPRINT software (Sound Velocity)?			
	Yes (Manual)			
	Has the manual sound velocity be set in the SPRINT software (Sound Velocity)?			
	Yes (Sound velocity message feed to be used)			
	Has input format been checked (for compatability) prior to connection with SPRINT?			Format__________
	Have serial settings been checked?			Baud Rate_______ Data Bits_______ Stop Bits_______ Parity__________
	Has the LCH serial port been checked/configured with the correct serial settings?			
	Sound Velocity sensor offsets are optional - have they been configured in the SPRINT Software (Sound Velocity)?			
LBL	Have the serial settings for the INS port been checked in the Fusion software?			Baud Rate_______ Data Bits_______ Stop Bits_______ Parity__________
	Have the serial settings for the Fusion INS port been checked in the SPRINT software?			As above
	Have the serial settings for the LBL port been checked in the Fusion software?			Baud Rate_______ Data Bits_______ Stop Bits_______ Parity__________
	Have the serial settings for the Fusion LBL port been checked in the SPRINT software?			As above
	Have the LBL transceiver AND Lodestar offsets been configured in the Fusion Software?			
	Has the transceiver Comms Reset been set to "None" in the Fusion software (Transceiver Advanced)?			
	Has the transceiver connection been tested in Fusion (Get or Get All)?			
Remote Output Points	Is position output from SPRINT required from a point other than vehicle the CRP?			

Topside Checks		Yes	No	Notes
	If Yes:			
	Have remote point(s) offsets been configured in the SPRINT software (Remote Points)			
Outputs	Have Lodestar (direct) outputs been configured in the SPRINT software (Lodestar Outputs)?			
	Have PC/LCH outputs been configured in the the SPRINT software (PC/LCH Outputs)?			
INS	Have the correct INS aiding options been specified in the SPRINT software (INS Aiding)?			

Appendix K – Pressure to Depth Conversion

Pascal to Metres of head: 0.00009938710

PSI to Pascals: 6894.75729

Metres to PSI: 1.42233433

Appendix L – Open Source Software Licence Notices and Terms

The system contains the following open source software and their corresponding license notices and terms.

L.1 Open Source Software

L.1.1 Eigen

This product uses the Eigen C++ template library for linear algebra: matrices, vectors, numerical solvers, and related algorithms which is distributed under MPL2 license terms .

Please refer to the Eigen website http://eigen.tuxfamily.org

See the LICENSES section for the MPL2 license terms

Corresponding Source Code Form is available on request for a period of three years after our last shipment of this product.

Please contact Sonardyne support for further details regarding purchase costs of the physical media and postage and packaging charges.

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This offer is valid to anyone in receipt of this information

You may also find a copy of the source at the following git server
https://github.com/eigenteam/eigen-git-mirror

The manifest of application packages in this build and their corresponding links are as follows and source code is available on request (or downloadable via their respective URLs), see the licencing section for the full corresponding licences.

Package	Version	Licence	URL
SSE Code for 4x4 matrix inversion	1	Intel Licence Agreement	https://software.intel.com/en-us/articles/optimized-matrix-library-for-use-with-the-intel-pentiumr-4-processors-sse2-instructions/
AMD reordering simplicial sparse Cholesky factorization adapted from SuiteSparse (Tim Davies)			
SSE implementation of exp,log,cos,sin math functions from GMM++ (Yousef Saad)		GPLv3+ LGPLv3+	http://getfem.org/gmm.html
IncompleteLUT preconditioner coming from ITSOL	2	LGPLv2.1	https://www-users.cs.umn.edu/~saad/software/ITSOL/

Package	Version	Licence	URL
Algorithms for non linear optimization		Mini pack copyright notice	

L.1.2 Yocto Linux Operating System

This product uses an Arrow revised build of the Altera (OpenEmbedded-derived) Yocto Linux Operating system which is distributed under GPLv2 licence terms.

Please refer to the Yocto OpenEmbedded website http://www.yoctoproject.org/

See the LICENSES section for the GPLv2 license terms.

Corresponding source code is available on request for a period of three years after our last shipment of this product, which will be no earlier than 08/12/2018.

Please contact Sonardyne support for further details regarding purchase costs of the physical media and postage and packaging charges.

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Email: support@sonardyne.com

You may also find a copy of the source at the following git server http://git.rocketboards.org/linux-socfpga.git

The manifest of application packages in this build and their corresponding links are as follows and source code is available on request (or downloadable via their respective URLs), See the licencing section for the full corresponding licences.

Package	Version	Licence	URL
autoconf	2.69	GPLv2 GPLv3	www.gnu.org/software/autoconf/
base-files	3.0.14	GPLv2	https://packages.debian.org/search?keywords=base-files
base-passwd	3.5.26	GPLv2+	http://packages.debian.org/search?keywords=base-pa
bash	4.2	GPLv3+	www.gnu.org/software/bash/
binutils	2.22	GPLv3	http://www.gnu.org/software/bfd/
binutils-symlinks	2.22	GPLv3	http://www.gnu.org/software/bfd/
busybox	1.20.2	GPLv2 bzip2	http://www.busybox.net/
busybox-syslog	1.20.2	GPLv2 bzip2	http://www.busybox.net/
busybox-udhcpc	1.20.2	GPLv2 bzip2	http://www.busybox.net/
diffutils	3.2	GPLv3+	https://www.gnu.org/software/diffutils/
dtc	1.3.0+git1+ 033089f2909 9bdfd5c2d6 986cdb9fd0 7b16cfde0	GPLv2 BSD	https://git.kernel.org/cgit/utils/dtc/dtc.git
e2fsprogs	1.42.1	GPLv2 LGPLv2 BSD MIT	http://e2fsprogs.sourceforge.net/

Package	Version	Licence	URL
e2fsprogs-badblocks	1.42.1	GPLv2	http://e2fsprogs.sourceforge.net/
elfutils	0.148	GPL-2+ Elfutils-Exception	https://fedorahosted.org/elfutils/
ethtool	3.5	GPLv2+	https://www.kernel.org/pub/software/network/ethtool/
gator	1	GPLv2	https://github.com/ARM-software/gator
gawk	4.0.1	GPLv3	https://www.gnu.org/software/gawk/
gawk-common	4.0.1	GPLv3	https://www.gnu.org/software/gawk/
gdb	7.5	GPLv2 GPLv3 LGPLv2 LGPLv3	https://www.gnu.org/software/gdb/
gdbserver	7.5	GPLv2 GPLv3 LGPLv2 LGPLv3	https://www.gnu.org/software/gdb/
gnu-config	20111111	GPLv2	http://savannah.gnu.org/projects/config
grep	2.9	GPLv3	https://www.gnu.org/software/grep/
gsrd-altera	1	BSD	http://git.rocketboards.org/poky-socfpga.git
i2c-tools	3.1.0	GPLv2	https://packages.debian.org/wheezy/i2c-tools
initramfs-altera	1	MIT	https://github.com/sgstreet/meta-altera/blob/master/recipes-core/initrdscripts/initramfs-altera_1.0.bb
initscripts	1	GPLv2	https://github.com/altera-opensource/meta-altera-refdes/tree/master/recipes-gsrd/altera-gsrd-initscripts
initscripts-altera	1	BSD	https://github.com/altera-opensource/meta-altera-refdes/blob/master/recipes-gsrd/altera-gsrd-initscripts/altera-gsrd-initscripts.bb
iptables	1.4.15	GPLv2+	https://packages.debian.org/wheezy/iptables
iputils	s20101006	BSD GPLv2+	https://github.com/iputils/iputils
iputils-arping	s20101006	BSD GPLv2+	https://github.com/iputils/iputils
iputils-ping	s20101006	BSD GPLv2+	https://github.com/iputils/iputils
iputils-ping6	s20101006	BSD GPLv2+	https://github.com/iputils/iputils
iputils-tracepath	s20101006	BSD GPLv2+	https://github.com/iputils/iputils
iputils-tracepath6	s20101006	BSD GPLv2+	https://github.com/iputils/iputils
iputils-traceroute6	s20101006	BSD GPLv2+	https://github.com/iputils/iputils
kernel-3.13.0-00298-g3c7cbb9	3.13	GPLv2	https://github.com/altera-opensource/linux-socfpga
kernel-image-3.13.0-00298-g3c7cbb9	3.13	GPLv2	https://github.com/altera-opensource/linux-socfpga
kernel-module-ansi-cprng	3.13	GPLv2	https://www.kernel.org/
kernel-module-g-mass-storage	3.13	GPLv2	https://www.kernel.org/
kernel-module-gpio-altera	3.13	GPLv2	https://www.kernel.org/
kernel-module-krng	3.13	GPLv2	https://www.kernel.org/
kernel-module-libcomposite	3.13	GPLv2	https://www.kernel.org/
kernel-module-rng	3.13	GPLv2	https://www.kernel.org/
kernel-module-rng-core	3.13	GPLv2	https://www.kernel.org/
kernel-module-usb-f-mass-storage	3.13	GPLv2	https://www.kernel.org/
kernel-modules	3.13	GPLv2	https://www.kernel.org/
kernel-vmlinux	3.13	GPLv2	https://www.kernel.org/
kmod	9	GPL-2.0+ LGPL-2.1+	https://www.kernel.org/

Package	Version	Licence	URL
libblkid1	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://packages.debian.org/search?keywords=libblkid1
libbz2-0	1.0.6	bzip2	https://packages.debian.org/search?keywords=libbz2-1.0
libc6	2.18-r2013.10.2	MIT	https://packages.debian.org/wheezy/libc6
libc6-dbg	2.18-r2013.10.2	MIT	https://packages.debian.org/wheezy/libc6-dbg
libcom-err2	1.42.1	GPLv2 LGPLv2 BSD MIT	https://packages.debian.org/wheezy/libcomerr2
libcrypto1.0.0	1.0.0j	openssl	https://packages.debian.org/wheezy/libcrypto1.0.0-udeb
libe2p2	1.42.1	GPLv2 LGPLv2 BSD MIT	https://packages.debian.org/wheezy/libe2p2
libexpat1	2.1.0	MIT	http://e2fsprogs.sourceforge.net/
libext2fs2	1.42.1	GPLv2 LGPLv2 BSD MIT	http://e2fsprogs.sourceforge.net/
libgcc-s1	2013.03	MIT	http://www.gnu.org/software/gcc/
libkmod2	9	LGPL-2.1+	https://packages.debian.org/wheezy/libkmod2
liblzo2-2	2.06	GPLv2+	https://packages.debian.org/wheezy/liblzo2-2
libncurses5	5.9	MIT	https://packages.debian.org/wheezy/libncurses5
libncursesw5	5.9	MIT	https://packages.debian.org/wheezy/libncursesw5
libpci3	3.1.10	GPLv2+	https://packages.debian.org/wheezy/libpci3
libpcre	8.31	BSD	https://packages.debian.org/wheezy/libpcre++-dev
libpcreposix0	8.31	BSD	https://packages.debian.org/wheezy/libpcrecpp0
libperl5	5.14.2	Artistic-1.0 GPL-1.0	https://packages.debian.org/wheezy/libperl5.14
libpopt0	1.16	MIT	https://packages.debian.org/wheezy/libpopt0
libreadline6	6.2	GPLv3+	https://packages.debian.org/wheezy/libreadline6
libss2	1.42.1	GPLv2 LGPLv2 BSD MIT	https://packages.debian.org/wheezy/libss2
libssl1.0.0	1.0.0j	openssl	https://packages.debian.org/wheezy/libssl1.0.0
libstdc++6	2013.03	MIT	https://packages.debian.org/wheezy/libstdc++6
libsysfs2	2.1.0	LGPLv2.1	https://packages.debian.org/wheezy/libsysfs2
libthread-db1	2013.03	MIT	http://git.savannah.gnu.org/cgit/hurd/libpthread.git/
libtinfo5	5.9	MIT	https://packages.debian.org/wheezy/libtinfo5
libusb-1.0-0	1.0.8	LGPLv2.1+	https://packages.debian.org/wheezy/libusb-1.0-0
libuuid1	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://packages.debian.org/wheezy/libuuid1
libwrap0	7.6	BSD	https://packages.debian.org/wheezy/libwrap0
libz1	1.2.8-r0.2	Zlib	zlib.net/
libz-dbg	1.2.8-r0.2	Zlib	zlib.net/
lighttpd	1.4.31	BSD	https://www.lighttpd.net/
lighttpd-module-access	1.4.31	BSD	https://www.lighttpd.net/
lighttpd-module-accesslog	1.4.31	BSD	https://www.lighttpd.net/
lighttpd-module-cgi	1.4.31	BSD	https://www.lighttpd.net/
lighttpd-module-dirlisting	1.4.31	BSD	https://www.lighttpd.net/
lighttpd-module-indexfile	1.4.31	BSD	https://www.lighttpd.net/
lighttpd-module-staticfile	1.4.31	BSD	https://www.lighttpd.net/
m4	1.4.16	GPLv3	http://www.gnu.org/software/m4/m4.html

Package	Version	Licence	URL
make	3.82	GPLv3 LGPLv2	https://www.gnu.org/software/make/
minicom	2.6.1	GPLv2+	https://packages.debian.org/wheezy/comm/minicom
mtd-utils	1.5.0	GPLv2+	https://packages.debian.org/wheezy/mtd-utils
ncurses-terminfo-base	5.9	MIT	http://www.gnu.org/software/ncurses/
net-tools	1.60-23	GPLv2+	https://packages.debian.org/wheezy/net-tools
netbase	5	GPLv2	https://packages.debian.org/wheezy/netbase
openssh	6.0p1	BSD	http://www.openssh.com/
openssh-keygen	6.0p1	BSD	http://www.openssh.com/
openssh-scp	6.0p1	BSD	http://www.openssh.com/
openssh-sftp-server	6.0p1	BSD	http://www.openssh.com/
openssh-ssh	6.0p1	BSD	http://www.openssh.com/
openssh-sshd	6.0p1	BSD	http://www.openssh.com/
openssl	1.0.0j	openssl	https://www.openssl.org
oprofile	0.9.7	LGPLv2.1+ GPLv2	http://oprofile.sourceforge.net/news/
pciutils	3.1.10	GPLv2+	https://github.com/gittup/pciutils
pciutils-ids	3.1.10	GPLv2+	https://github.com/gittup/pciutils
perl	5.14.2	Artistic-1.0 GPL-1.0	www.perl.org
pio-interrupt-altera	0.1	GPL-2.0	git://git.rocketboards.org/linux-refdesigns.git
portmap	6	BSD	https://packages.debian.org/wheezy/rpcbind
sed	4.2.1	GPLv3+	https://www.gnu.org/software/sed/manual/sed.html
setserial	2.17	GPLv2.0	https://packages.debian.org/wheezy/setserial
shadow	4.1.4.3	BSD Artistic-1.0	http://downloads.isee.biz/pub/denzil-build/tmp/work/igep00x0-poky-linux-gnueabi/shadow-securetty-4.1.4.3-r1/packages-split/shadow-securetty/
shadow-securetty	4.1.4.3	MIT	http://downloads.isee.biz/pub/denzil-build/tmp/work/igep00x0-poky-linux-gnueabi/shadow-securetty-4.1.4.3-r1/packages-split/shadow-securetty-dev/
strace	4.7	BSD	https://packages.debian.org/wheezy/strace
sysfsutils	2.1.0	GPLv2	https://packages.debian.org/wheezy/sysfsutils
sysvinit	2.88dsf	GPLv2+	http://savannah.nongnu.org/projects/sysvinit
sysvinit-inittab	2.88dsf	GPLv2	http://savannah.nongnu.org/projects/sysvinit
sysvinit-pidof	2.88dsf	GPLv2+	http://savannah.nongnu.org/projects/sysvinit
tinylogin	1.4	GPLv2	http://tinylogin.busybox.net/
update-modules	1	GPLv2	https://www.kernel.org/pub/linux/utils/kernel/modutils/
update-rc.d	0.7	GPLv2+	https://packages.debian.org/wheezy/sysv-rc
usbutils	6	GPLv2+	https://packages.debian.org/wheezy/usbutils
usbutils-ids	6	GPLv2+	https://packages.debian.org/wheezy/usbutils
util-linux	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://packages.debian.org/wheezy/util-linux
util-linux-cfdisk	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://github.com/karelzak/util-linux
util-linux-fdisk	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://github.com/karelzak/util-linux
util-linux-losetup	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://github.com/karelzak/util-linux
util-linux-mkfs	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://github.com/karelzak/util-linux
util-linux-mount	2.21.2	GPLv2+	https://github.com/karelzak/util-linux

Package	Version	Licence	URL
		LGPLv2.1+ BSD	
util-linux-sfdisk	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://github.com/karelzak/util-linux
util-linux-swaponoff	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://github.com/karelzak/util-linux
util-linux-umount	2.21.2	GPLv2+ LGPLv2.1+ BSD	https://github.com/karelzak/util-linux
wget	1.14	GPLv3	https://www.gnu.org/software/wget/
poky	6.0.1	GPLv2/MIT	http://www.pokylinux.org/getit/
cracklib-dbg	2.9.0-r0.2	LGPL2.1	https://packages.debian.org/sid/libpam-cracklib-dbgsym
libgmp10	5.1.1-r0.2	LGPL-3	https://packages.debian.org/wheezy/libgmp10
libmpc3	1.0.1-r0.2	LGPL2.1	https://packages.debian.org/jessie/libmpc3
libmpfr4	3.1.2-r0.2	LGPL-3	http://www.mpfr.org/
libpam-dbg	1.1.6-r5.2	BSD	https://fedorahosted.org/linux-pam/
libpopt0	1.16-r3.2	GPLv2	https://packages.debian.org/sid/libpopt0

This offer is valid to anyone in receipt of this information.

L.1.3 Linux Kernel Drivers

Sonardyne Linux kernel drivers (HPI, UART, OneWire) which are distributed under GPLv2 license terms.

See the LICENSES section for the GPLv2 license terms.

Corresponding source code is available on request for a period of three years after our last shipment of this product, which will be no earlier than 08/12/2018.

Please contact Sonardyne support for further details regarding purchase costs of the physical media and postage and packaging charges.

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L.1.4 opkg 0.2.4

which is distributed under GPLv2 license terms

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L.1.5 Python® 2.7.3

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L.1.6 Tornado 4.2

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L.1.7 jQuery JavaScript Library v2.1.4

Includes Sizzle.js

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L.1.8 YAML-cpp 0.5.2

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L.1.9 Pyyaml 3.1.1

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L.1.10 Bootstrap 3.3.5

L.1.11 chart.js 1.0.2

L.1.12 Futures 3.0.3

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L.1.13 jquery-cookie 1.4.1

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If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a "work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

• a) Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

• b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.

• c) Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.

• d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

• e) Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

For an executable, the required form of the "work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

7. You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise permitted, and provided that you do these two things:

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The “Minimal Corresponding Source” for a Combined Work means the Corresponding Source for the Combined Work, excluding any source code for portions of the Combined Work that, considered in isolation, are based on the Application, and not on the Linked Version.

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The object code form of an Application may incorporate material from a header file that is part of the Library. You may convey such object code under terms of your choice, provided that, if the incorporated material is not limited to numerical parameters, data structure layouts and accessors, or small macros, inline functions and templates (ten or fewer lines in length), you do both of the following:

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• e) Provide Installation Information, but only if you would otherwise be required to provide such information under section 6 of the GNU GPL, and only to the extent that such information is necessary to install and execute a modified version of the Combined Work produced by recombining or relinking the Application with a modified version of the Linked Version. (If you use option 4d0, the Installation Information must accompany the Minimal Corresponding Source and Corresponding Application Code. If you use option 4d1, you must provide the Installation Information in the manner specified by section 6 of the GNU GPL for conveying Corresponding Source.)

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b) Convey the object code in, or embodied in, a physical product (including a physical distribution medium), accompanied by a written offer, valid for at least three years and valid for as long as you offer spare parts or customer support for that product model, to give anyone who possesses the object code either (1) a copy of the Corresponding Source for all the software in the product that is covered by this License, on a durable physical medium customarily used for software interchange, for a price no more than your reasonable cost of physically performing this conveying of source, or (2) access to copy the Corresponding Source from a network server at no charge.

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d) Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.

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A separable portion of the object code, whose source code is excluded from the Corresponding Source as a System Library, need not be included in conveying the object code work.

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“Installation Information” for a User Product means any methods, procedures, authorization keys, or other information required to install and execute modified versions of a covered work in that User Product from a modified version of its Corresponding Source. The information must suffice to ensure that the continued functioning of the modified object code is in no case prevented or interfered with solely because modification has been made.

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Corresponding Source conveyed, and Installation Information provided, in accord with this section must be in a format that is publicly documented (and with an implementation available to the public in source code form), and must require no special password or key for unpacking, reading or copying.

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Definitions

Term	Definition
6G®	Sonardyne's sixth generation technology hardware platform
AAINS	Acoustically Aided Navigation System
AC	Alternating Current
Accelerometer	A sensor that measures changes in velocity (acceleration)
AHRS	Attitude and Heading Reference System. An inertial sensor that provides outputs of heading, pitch and roll
CRP	Common Reference Point
DC	Direct Current
DVL	Doppler Velocity Log
ESD	Electro-Static Displacement
FOG	Fibre Optic Gyroscope
FWD	Forward
GNSS	Global Navigation Satellite System
IMU	Inertial Measurement Unit
INS	Inertial Navigation System . A navigation aid that uses inertial sensors to continuously calculate the position, orientation and velocity of a moving object
ISA	International Sensor Assembly
LBL	Long Baseline
LCH	Lodestar Communication Hub
LED	Light Emitting Diode
Lodestar	Lodestar is a combined solid state Attitude and Heading Reference System (AHRS)
MTBF	Mean Time Between Failure
PC	Personal Computer
RLG	Ring Laser Gyroscope, A sensor that measures rotation
ROV	Remotely Operated Vehicle
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Sonardyne Wideband®2	6G® transponders and transceivers use Sonardyne Wideband® 2 ultra-wide bandwidth signals giving a faster and robust transmission of data, more precise ranging and mitigation from multipath in shallow water and amongst steel structures in deep-water.
SPRINT	An Acoustically aided inertial navigation system for subsea vehicles. The system extends the operating limits of USBL and improves the operational efficiency of LBL by using sparse arrays
STBD	Starboard
USBL	Ultra-Short Baseline
UTC	Universal Coordinated Time

Term	Definition
UTM	Universal Transverse Mercator. A Projection system that is used to transform geodetic co-ordinates into an orthogonal two-dimensional system suitable for representation on a plane such as a chart. Normally the co-ordinates are called eastings and northings, which are equivalent to x and y respectively. The UTM system is a worldwide system. Each projection covers 6 degrees of longitude with the central meridian at 3, 9 degrees etc. east of Greenwich and from 84 degrees north to 80 degrees south. The scale factor on a central meridian is 0.9996 (with some exceptions).

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