Sonardyne
SOUND IN DEPTH

UM-8253-SPRINT

User Manual for Type 8253 SPRINT 3rd Generation

Issue A Rev 3

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

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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	*3.9* All	page 17 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 300/500/700 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 300/500/700 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

This product contains U.S. Department of Commerce controlled items. As such the SPRINT 300/500/700 must not be removed from the housing, be disassembled or repaired, outside of the terms and conditions detailed in the U.S. Department of Commerce Re-Export Licence under which the product was sold. If any servicing or repair of the SPRINT 300/500/700, or SPRINT 300/500/700 component of the product is required, consult your nearest Sonardyne office for advice.

1.4 Related Publications

To make sure the equipment is operated safely, a *Sonardyne Safety Manual* is supplied with this user manual. It is important that the *Sonardyne Safety Manual* is read and fully understood before proceeding with any activity on the equipment.

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-8300-099	*User Manual for 6G Terminal Lite*

1.5 Conventions

Table 1–2 Conventions used in this Manual

Format	Conventions

Table 1–2 Conventions used in this Manual (continued)

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 300/500/700 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 300/500/700 mounting angles. It is strongly recommended the SPRINT 300/500/700 mounting angles are not modified while the SPRINT 300/500/700 is in operation as an AHRS device. When any changes are applied the user will be prompted to reset the SPRINT 300/500/700 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 300/500/700 will be lost. It is recommended to note any required settings before restoring factory settings.

⚠ If connected to the SPRINT 300/500/700 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 300/500/700 is restarted.

⚠ 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 300/500/700 Attitude and Heading Reference System (AHRS)/Inertial Navigation System (INS).

The SPRINT 300/500/700 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 300/500/700 is equally suited to a variety of other applications where the accuracy of heading and attitude measurements is of critical importance. SPRINT 300/500/700 can operate either as a stand-alone AHRS or as part of an integrated system.

The SPRINT 300/500/700 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 300/500/700 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 300/500/700 benefits from Sonardyne's world-class manufacturing, support and training organisation, which has a well-established record for providing trusted solutions.

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 300/500/700 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.

The SPRINT system does not need to be physically co-located with the Doppler Velocity Log or integrated into the same housing. Only ‘coarse’ alignments and offsets from the INS to the DVL are needed from the user. Fine offsets and misalignments are then calculated in the field using a calibration routine. This approach allows for more flexible mounting configurations to be considered.

3.3 Theory of Operation

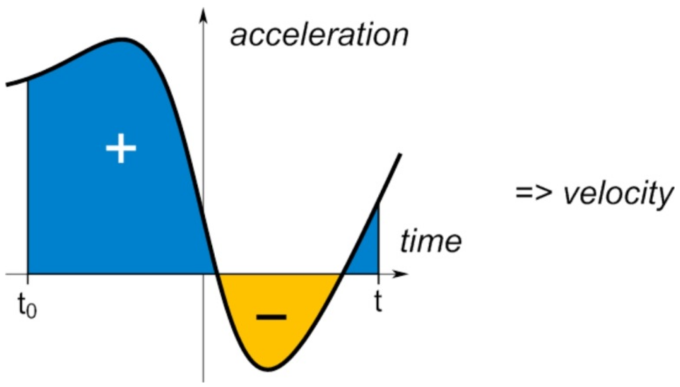
3.3.1 Inertial Navigation

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.

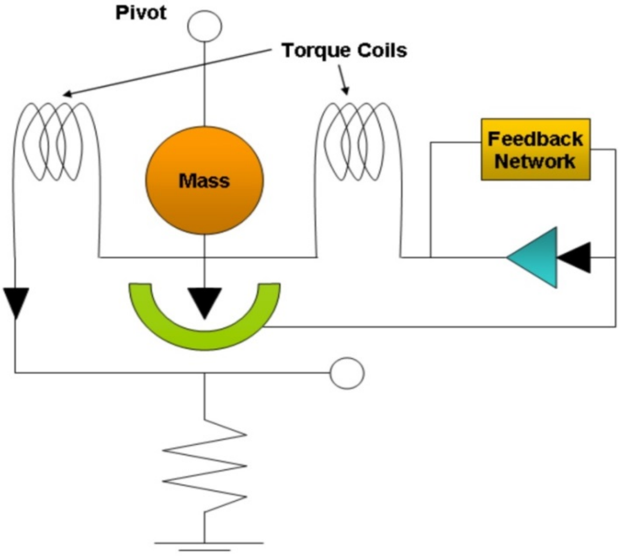
** Velocity at time ‘t’ is the sum of the areas under the acceleration curve (yellow counts as negative) plus the initial velocity at time t_0.

3.3.2 Inertial Sensors

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.

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*):

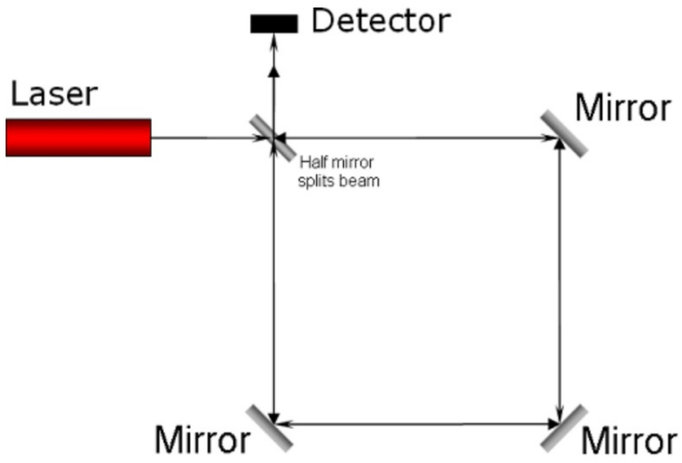
Laser beams are made to travel in both opposite directions within a cavity (“ring”) formed by typically 3 or 4 mirrors. When the cavity rotates relative to inertial space one beam has to travel further than the other. A part of the laser light is allowed to escape via a semi-transparent mirror and is 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



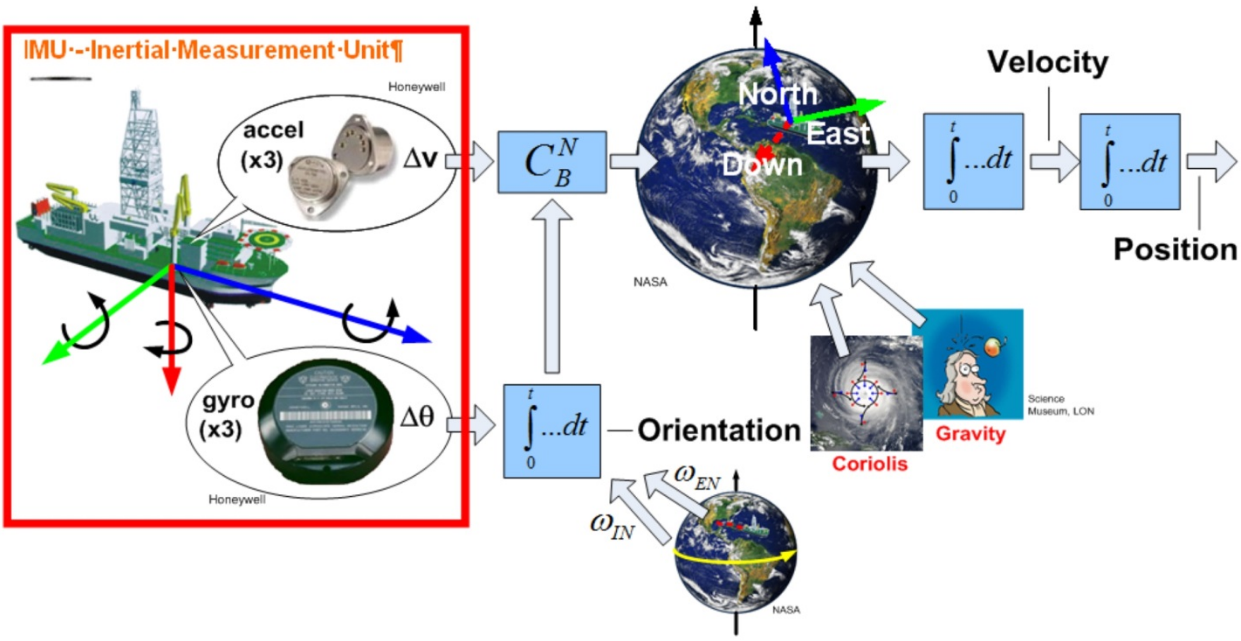
3.3.3 Strap-down Inertial Navigation

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.

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.

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.

Navigation frame

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

Inertial frame

Non-rotating frame (relative to inertial space).

Note

Definitions of SPRINT system(and SPRINT 300/500/700) specific reference frames are provided in *Appendix A "SPRINT 300/500/700 Angle Definitions "* and *Appendix B "Reference Frames and Angular Conventions"*.

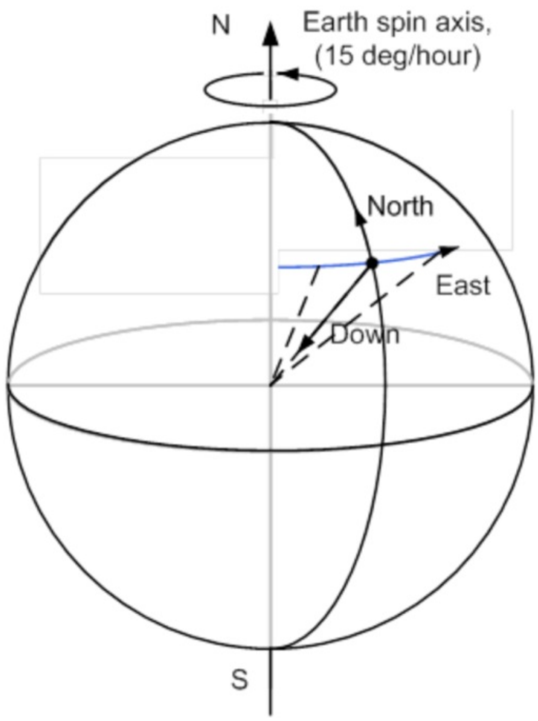
3.3.6 Gyrocompassing – North Finding

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).

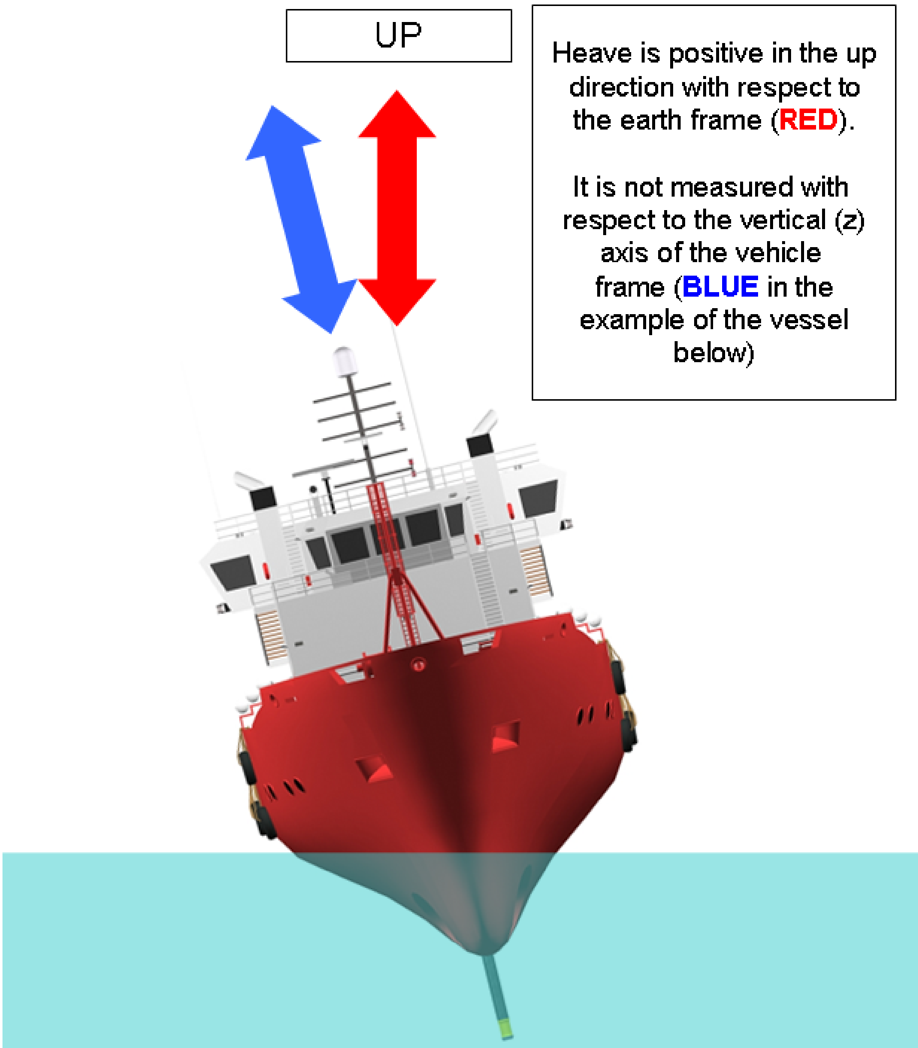
Vehicle position change in the N/E direction (from, e.g. steaming) will cause the gravity vector to change in this direction also and not be pure E/W. This will bias the gyro-compassing determined heading if not compensated for by e.g. measurements from a GPS receiver.

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 300/500/700 may not be valid for those instruments.

If the SPRINT 300/500/700 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 300/500/700 was installed in the remote location. Note that the closer to the remote location the SPRINT 300/500/700 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.

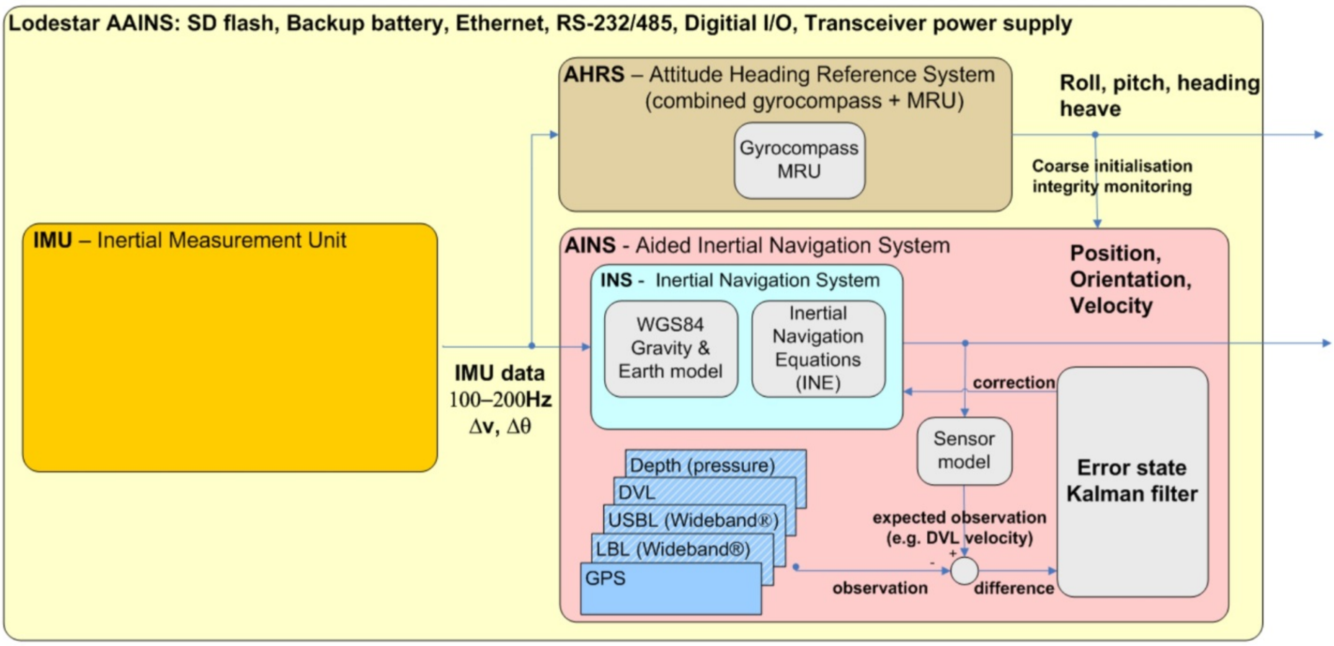
The Kalman filter determines INS errors from external sensor measurements. The difference between a measurement (observation) and its expected value (based on the INS) is fed into the Kalman filter and is used to refine its state vector and covariance matrix. The state vector is composed of INS errors 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

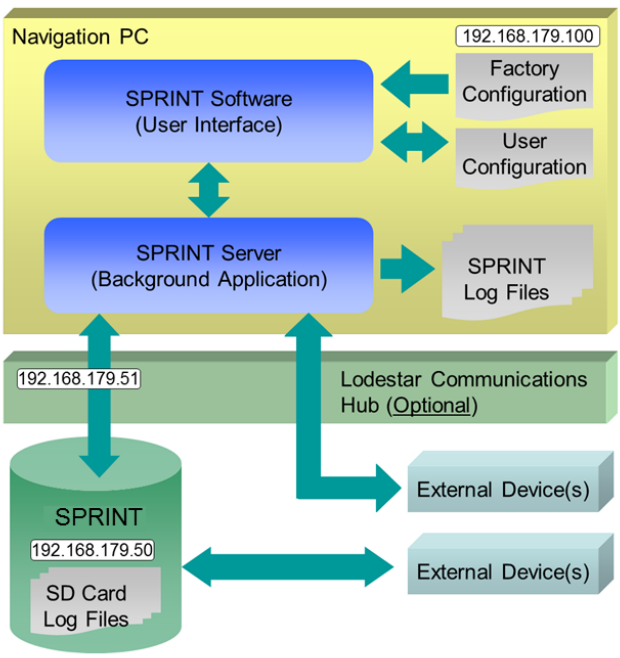
Aiding Source	**Aiding Type**			**Aiding Considerations**	
	Position Aiding (Horizontal)	Velocity Aiding	Depth Aiding (Vertical)	External Time Sync Required?	Can be used to Initialise INS?
USBL	✓	×	✓	×	✓
LBL	✓	×	×	×	×
External Position	✓	×	✓	×	✓
DVL	×	✓	×	×	×
Zero Velocity	×	✓	×	×	×
Pressure Depth	×	×	✓	×	×
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 300/500/700 and SPRINT system.
- SPRINT system Server, which routes all communications between the SPRINT 300/500/700, User Interface and any other topside external devices. The SPRINT server also logs all data from the SPRINT 300/500/700 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 300/500/700 IP address will only be used if the SPRINT 300/500/700 is to be connected to the topside components using an Ethernet connection.

External devices may be connected directly to the SPRINT 300/500/700 and Navigation Computer as well as to the LCH.

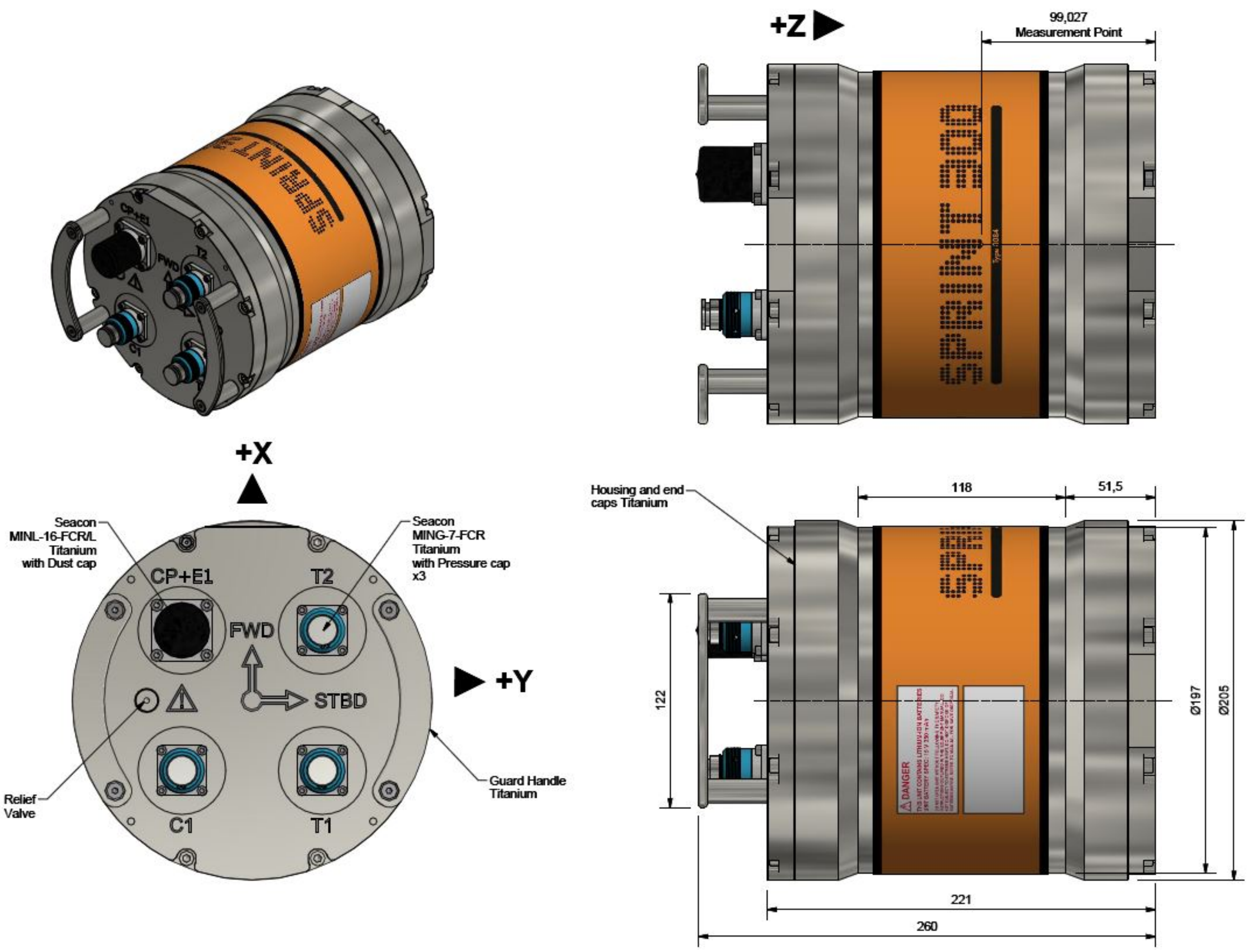
The SPRINT system stores the configuration of the SPRINT 300/500/700 and Software/Server. A Factory (default) Configuration is provided as a starting point for setup. Thereafter a User Configuration is stored by the software every time a configuration change is made or by user request. If the SPRINT 300/500/700 used by the SPRINT system is swapped, the software will prompt the user to re-apply the User Configuration to the new SPRINT 300/500/700 to continue operation as before.

As well as storing the log files in real time on the Navigation PC, the SPRINT 300/500/700 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 300/500/700 SD card can be retrieved offline using the PC Utility software.

3.5 Physical Layout

A typical 4000 m SPRINT 300/500/700 with 4 x Seacon connectors is shown in *Figure 3–9*.

Figure 3–9 Typical SPRINT 300/500/700 Layout



Alternate housing types and connector options are available; see *Section 14 "Technical Specifications"* for descriptions of all versions.

3.6 Power

The SPRINT 300/500/700 is powered from an external 20 to 50 V dc power supply through the CP port (26 V dc for FMC Schilling Seanet Connector variants). A power supply is not provided with the SPRINT 300/500/700. See *Section 14 "Technical Specifications"* for power requirements.

3.7 Power Pass Through

The SPRINT 300/500/700 is capable of passing through input power (20 to 50 V dc from an external power supply) to sensors connected to the SPRINT 300/500/700 C1, T1 and 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.

3.8 Battery

The SPRINT 300/500/700 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.

3.9 Connector Ports

3.9.1 Standard Ports

The standard SPRINT 300/500/700 is provided with 4 x Seacon connector ports as shown in *Figure 3–10*. The connector port functions are described in *Table 3–2*.

Figure 3–10 SPRINT 300/500/700 Connector Ports

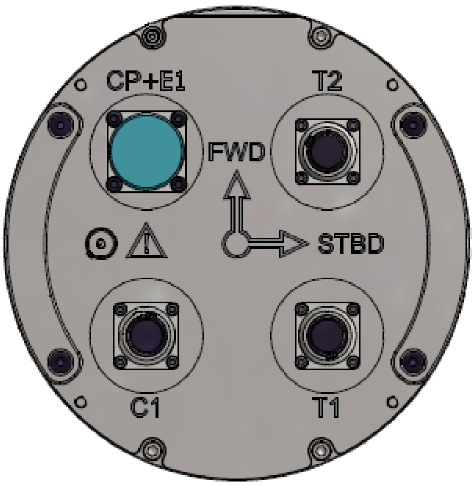


Table 3–2 SPRINT 300/500/700 Connector Port Type and Functions

Port	Standard Connectors	
	Type	**Function**
CP/E1	Seacon MINL-16FCR/L	RS232 and RS485 Full Duplex Communications and Input Power Ethernet (100 Mbit/s) Communications and Input Trigger.
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.
T2	Seacon MING-7-FCR	RS232 and RS485 Half Duplex Communications, Output Trigger and Power Pass Through.

CP/E1 Pin out Functions

The SPRINT 300/500/700 CP/E1 cable connector pin functions are shown in *Table 3–3*.

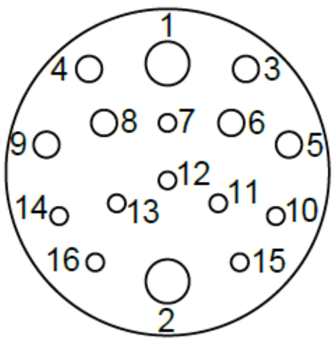


Table 3–3 SPRINT 300/500/700 CP/E1 Pin Out

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

C1 Pin out Functions

The SPRINT 300/500/700 C1 cable connector pin functions are shown in *Table 3–4*.

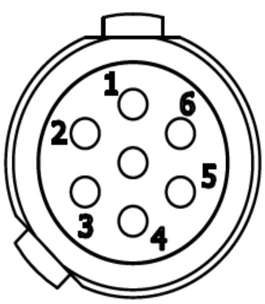


Table 3–4 SPRINT 300/500/700 C1 Pin Out

Seacon Pin No.	Function
1	Screen
2	Comms / Trig Ground
3	Trigger In
4	DC 0 V
5	RS232 Tx
6	RS232 Rx
7	DC ±~0.5 V

T1/T2 Pin out Functions

The SPRINT 300/500/700 T1/T2 cable connector pin functions are shown in *Table 3–5*.

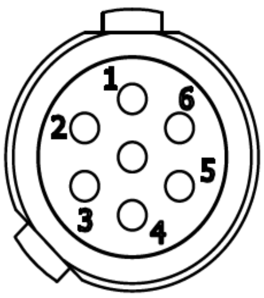


Table 3–5 SPRINT 300/500/700T1/T2 Pin Out

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

Table 3–5 SPRINT 300/500/700T1/T2 Pin Out (continued)

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

3.9.2 Seacon CS-MSAJ-9 Ports

SPRINT 300/500/700 used on Oceaneering ROVs are provided with 4 x Seacon CS-MSAJ-9 connector ports as shown in *Figure 3–11*. The connector port functions are described in *Table 3–6*.

Figure 3–11 SPRINT 300/500/700 Connector Ports

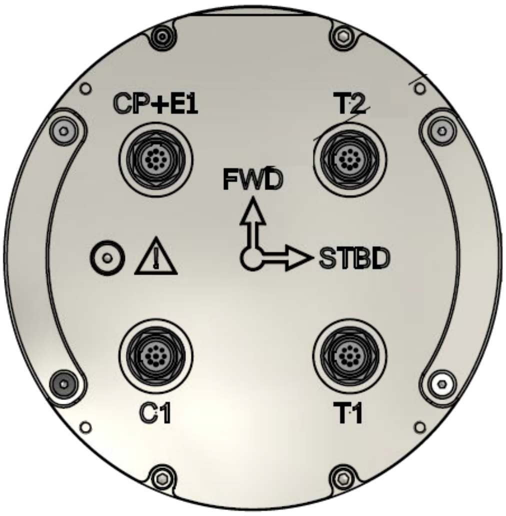


Table 3–6 Seacon CS-MSAJ-9 Connector Port Type and Functions

Port	Oceaneering Connectors	
	Type	Function
CP/E1	Seacon CS-MSAJ-9	RS232 Communications Input Power Ethernet (100 Mbit/s)
C1	Seacon CS-MSAJ-9	RS232 Communications, Input Trigger, Power Pass Through
T1	Seacon CS-MSAJ-9	RS232 RS485 Half Duplex Communications, Output Trigger and Power Pass Through
T2	Seacon CS-MSAJ-9	RS232 and RS485 Half Duplex Communications, Output Trigger and Power Pass Through

CP/E1 Pin out Functions

The Seacon CS-MSAJ-9 CP/E1 connector pin functions are shown in *Table 3–7*.

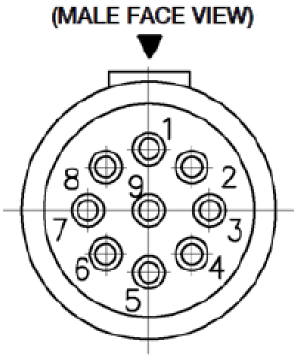


Table 3–7 Seacon CS-MSAJ-9 CP/E1 Pin Out

Seacon Pin No.	Function
1	DC In
2	Comms Ground
3	Rx
4	Tx
5	DC 0 V
6	Ethernet TD -
7	Ethernet RD -
8	Ethernet TD +
9	Ethernet RD +

C1 Pin out Functions

The Seacon CS-MSAJ-9 C1 connector pin functions are shown in *Table 3–8*.

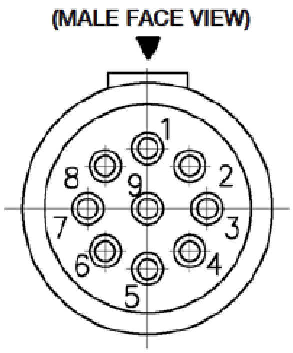


Table 3–8 Seacon CS-MSAJ-9 C1 Pin Out

Seacon Pin No.	Function
1	Rx
2	DC Out
3	Comms Ground

Table 3–8 Seacon CS-MSAJ-9 C1 Pin Out (continued)

Seacon Pin No.	Function
6	Tx
7	DC 0 V
9	Chassis Ground

T1/T2 Pin out Functions

The Seacon CS-MSAJ-9 T1/T2 connector pin functions are shown in *Table 3–9*.

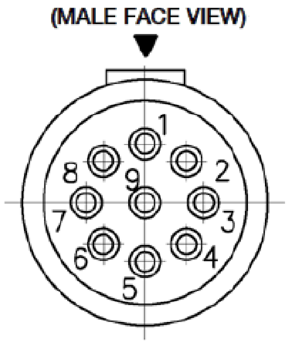


Table 3–9 Seacon CS-MSAJ-9 T1/T2 Pin Out

Seacon Pin No.	Function
1	DC Out
2	Comms / Trig Ground
3	Tx
4	Rx
5	DC 0 V
6	Trigger Out

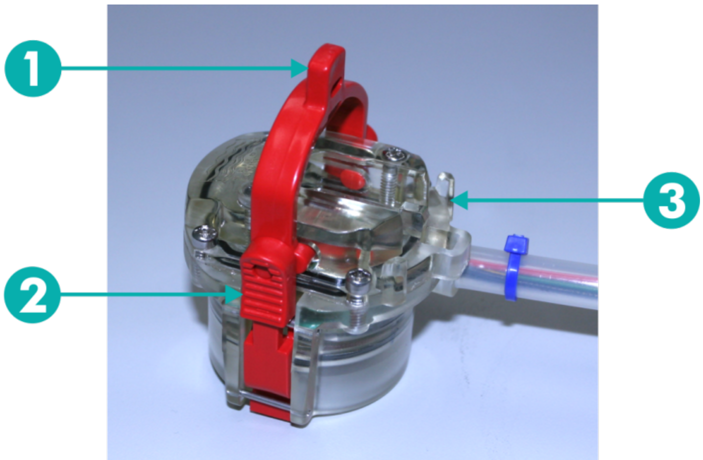
3.9.3 FMC Schilling Seanet Ports

The Seanet SPRINT 300/500/700 is provided with 4 x FMC Schilling Seanet connector ports as shown in *Figure 3–15*. The connector port functions are described in *Table 3–10*.

Description

The Seanet FMC Schilling connector has a transparent housing to allow the confirmation LEDs to be viewed. The connector is locked onto the connector port using a locking bail arm; see *Figure 3–12*.

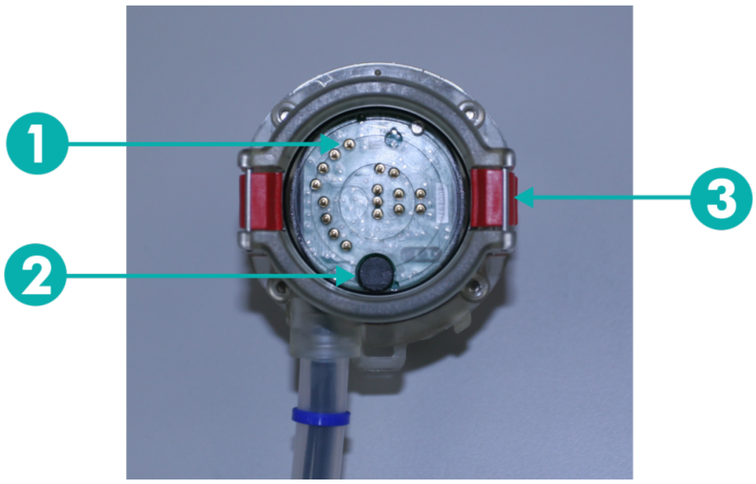
Figure 3–12 Seanet FMC Schilling Connector



Item	Description
1	Locking Bail Arm
2	Push-Button Release x2
3	Transparent Connector Body

The connector pins and face are self-lubricated by means of an internal plunger on the connector face that is compressed and releases the lubricant when the connector is locked onto the port; see *Figure 3–13*.

Figure 3–13 FMC Schilling Seanet Connector Underside



Item	Description
1	Connector Pins
2	Self-Lubricating Plunger
3	Locking Clamp x2

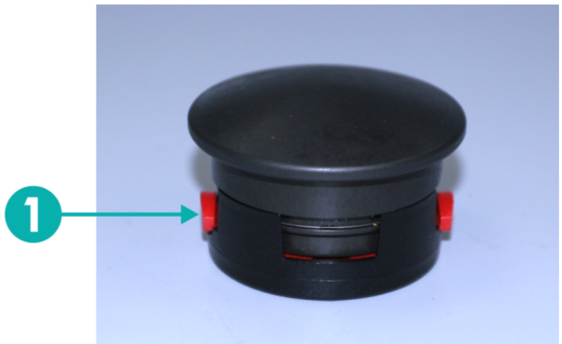
The Seanet FMC Schilling connectors are manufactured by FMC Technologies Ltd. Contact the manufacturer for more information.

Covers

Seanet FMC Schilling connector covers must be fitted to any unused connector ports before the unit is operated subsea.

The cover has two push-button releases that must be pressed to unlock and remove the cover; see *Figure 3–14*.

Figure 3–14 Seanet FMC Schilling Connector Cover



Item	Description
1	Push-Button Release x 2

Figure 3–15 Seanet FMC Schilling Seanet Connect Ports

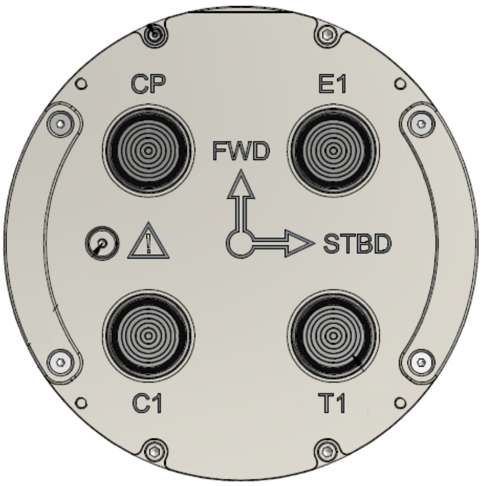


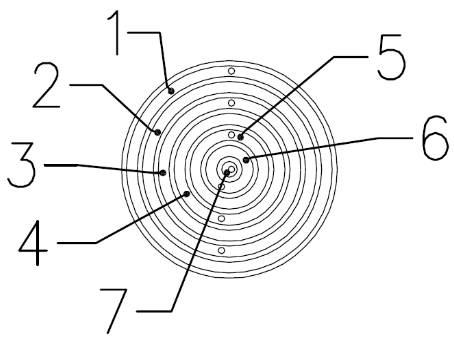
Table 3–10 Seanet FM Schilling Connector Port Functions

Seanet FM Schilling Port	Function
CP	RS232 Communications and Input Power
E1	Ethernet (100 Mbit/s) Communications
C1	Input Trigger
T1	RS232 Communications

Pin out Functions

The Seanet FM Schilling connector pin functions are shown in *Figure 3–16*.

Figure 3–16 Seanet FM Schilling Connector Pin Out



Seanet Port Pin	Function		
1	+24 V (do not exceed 8 Amps)		
2	24 V Return / Trigger In Ground		
3	N/A		
	RS-232	Ethernet	Trigger
4	N/A	RD-	N/A
5	Tx	RD+	Trigger In
6	Rx	TD-	N/A
7	N/A	TD+	N/A

3.9.4 Trigger Input

The SPRINT 300/500/700 trigger input characteristics are shown in *Table 3–11*.

Table 3–11 SPRINT 300/500/700 Trigger Input

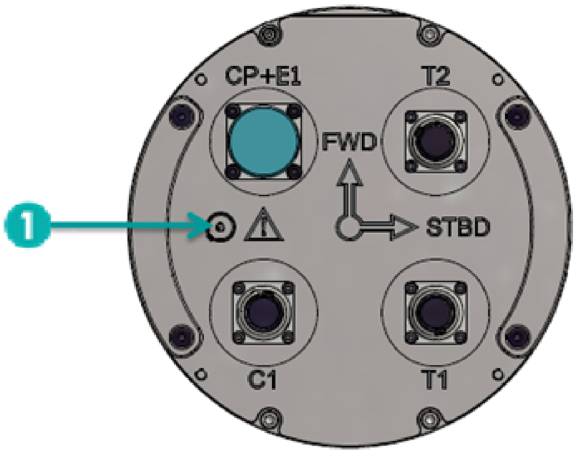
Parameter	Specification	
Voltage	Recommended	0 V–5 V
	Minimum	0 V–3.6 V
Pulse Width	Recommended	10 ms
	Minimum	5 µs

3.10 Pressure Relief Vent Valve

A pressure relief vent valve is provided to stop a build-up of gas inside the SPRINT 300/500/700 housing caused by the charging process or a failing battery.

The pressure relief vent valve must be checked before installing and operating the SPRINT 300/500/700; see *Section 9.7 "Pressure Relief Vent Valve"*.

Figure 3–17 Pressure Relief Vent Valve



Item	Description
1	Pressure Relief Vent Valve

Note

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

Section 4 – Planning

4.1 Navigation Scenario

Interface*		**Navigation Scenario**		
		Construction	**Dynamic**	**ROV Guidance**
SPRINT 300/500/700 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 300/500/700		✓	✓	
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:			
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		✓	✓	✓
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 300/500/700 (ROV)		✓	✓	✓
AHRS Attitude Output (No UTC timestamp)	Either			
From SPRINT topside (LCH)		✓	×	✓
From SPRINT 300/500/700 (ROV)		✓	✓	✓

Notes

***See *Appendix D "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 6.4.8 "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 300/500/700 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 300/500/700 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 300/500/700 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.

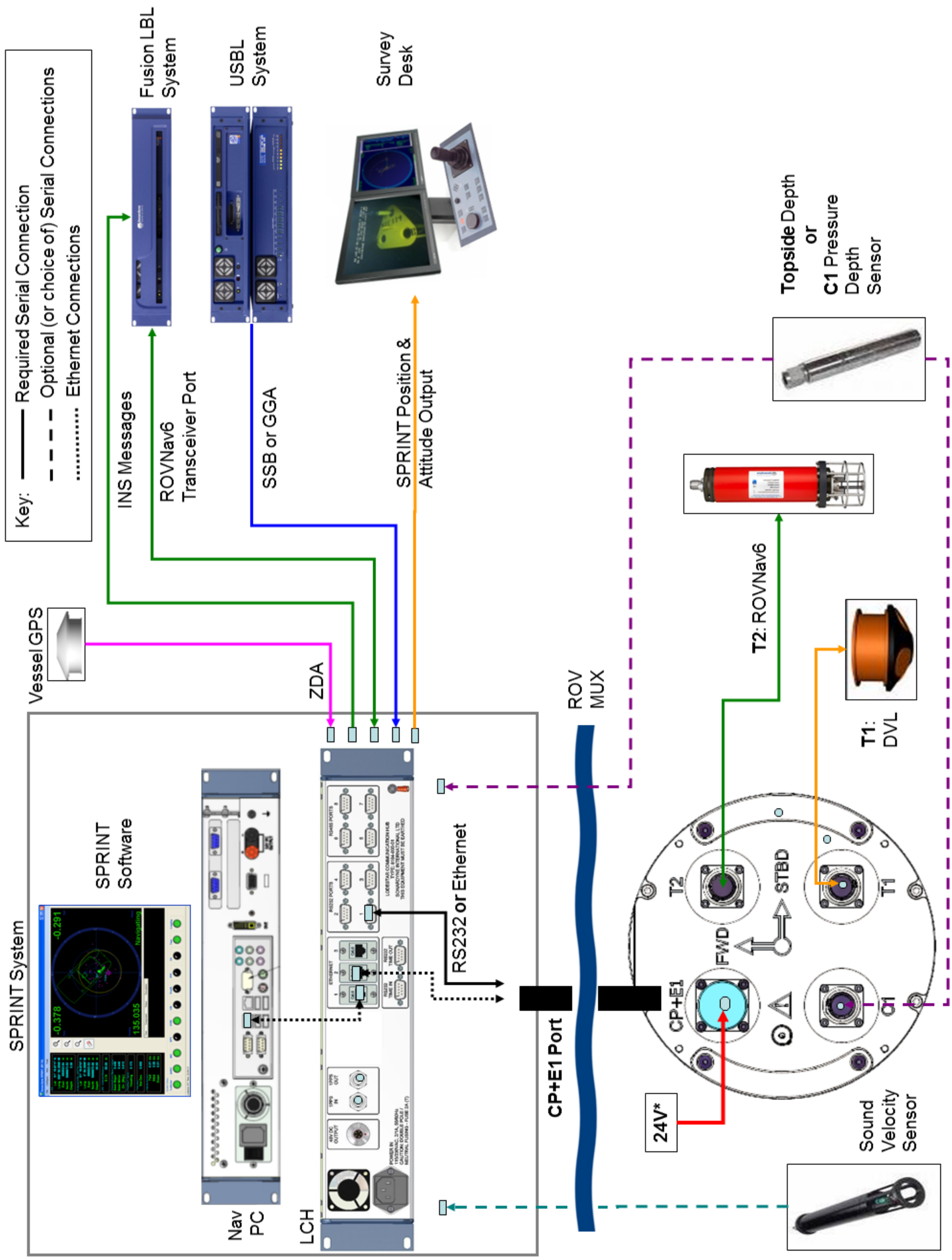
4.2 Interfaces

Prior to installation the following interfaces should be planned according to the SPRINT 300/500/700 navigation scenario (✓indicates a supported interface, “×” indicates a non-supported interface):

4.3 Connections

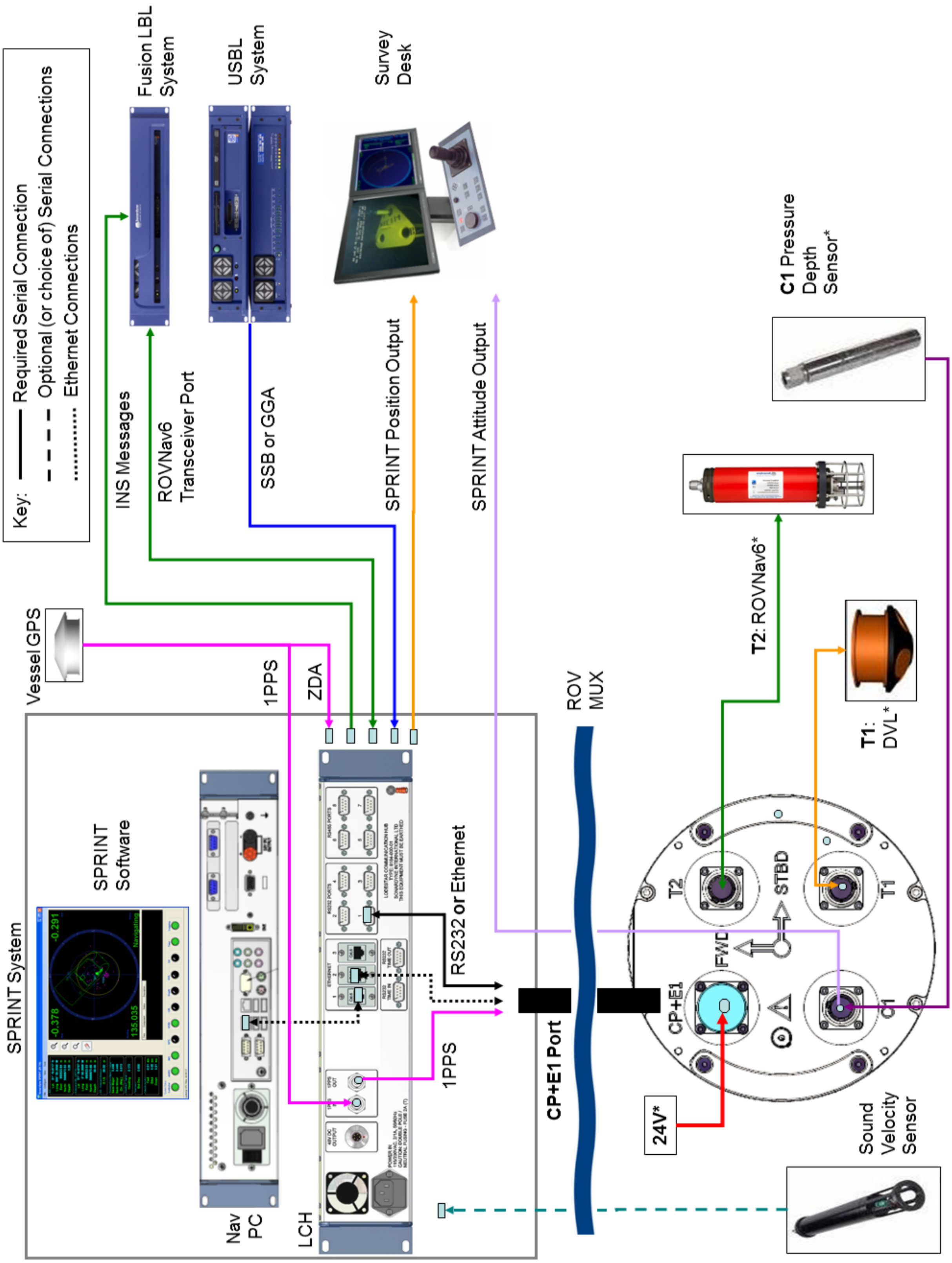
To guarantee the successful operation of theSPRINT system, the system connectivity must be considered at the installation planning stage. A suggested system connectivity diagram for the ‘construction survey’ configuration is shown in *Figure 4–1*.

Figure 4–1 Construction Survey Interface Diagram



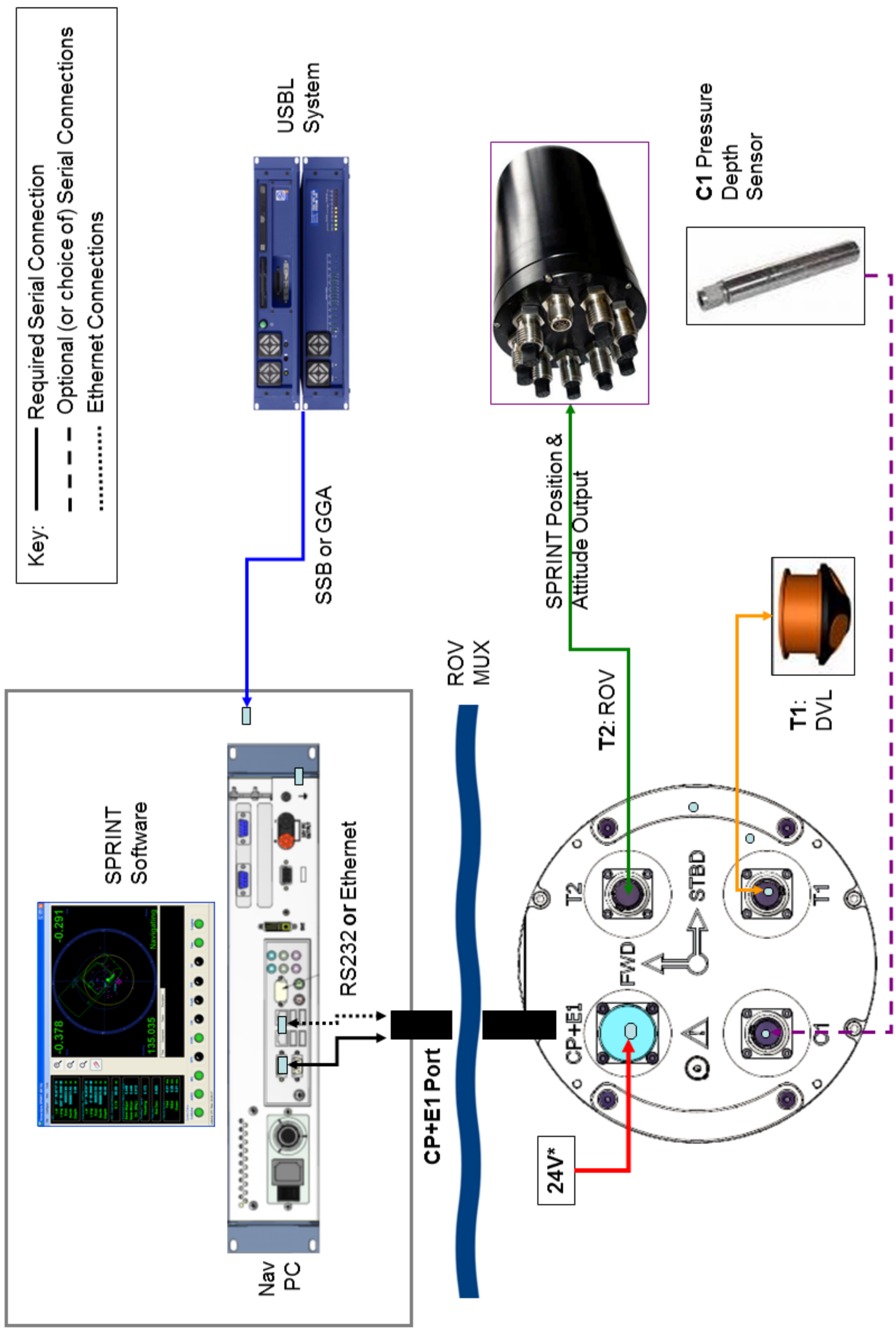
A suggested system connectivity diagram for the ‘dynamic survey’ configuration is shown in *Figure 4–2*.

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 300/500/700 LCH and the SPRINT 300/500/700 (if used). If the distance between the SPRINT 300/500/700 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 300/500/700 could be considered.

4.4.2 Subsea

A typical cabling diagram for all the required subsea connections to and from the SPRINT 300/500/700 on the vehicle is shown in *Appendix F "SPRINT 300/500/700 Wiring Diagram"*. This diagram should be used to produce vehicle and sensor specific SPRINT 300/500/700 cables prior to installation. If required, there are also individual cable pin-outs for each specific SPRINT 300/500/700 port available in the *UM-8084-101 "Lodestar Hardware Manual"*.

4.5 Time Synchronisation

The SPRINT 300/500/700 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 300/500/700 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 300/500/700 performs a simple pressure to depth (metres) conversion. The pressure to depth conversion scale factors are provided in *Appendix H "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 300/500/700 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. Contact Sonardyne for specific guidance if DVL is not available.

- 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

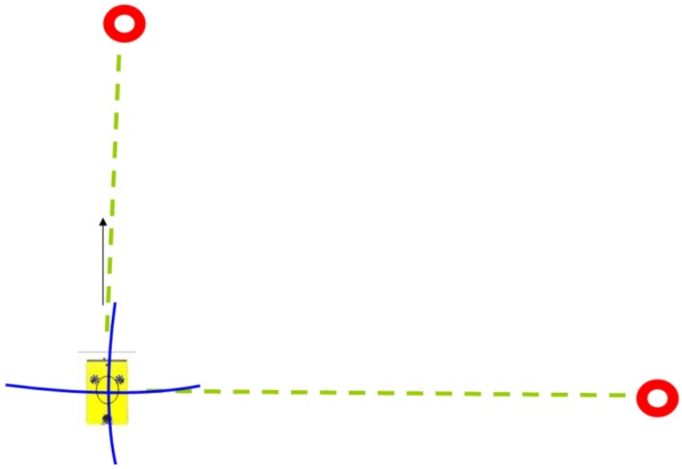
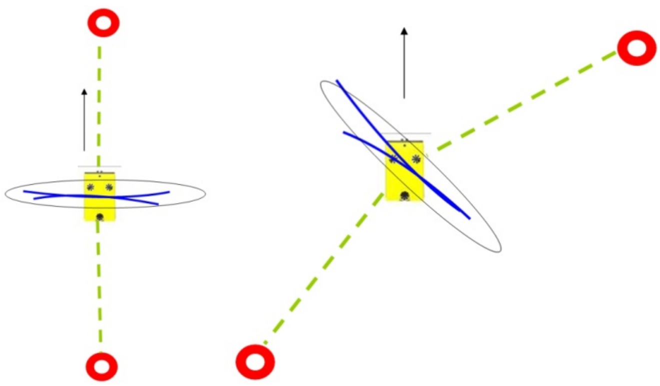


Figure 4–5 Examples of Poor Sparse Array Geometry



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 12.11 "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 300/500/700 before deployment. .

5.2 Unpacking and Inspecting

The SPRINT 300/500/700 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 300/500/700 must be returned to the factory for repair and recalibration.

Note

Always handle the SPRINT 300/500/700 with care. Store the unit in the shipping container until it is ready to be installed in the prepared location.

Inspect the SPRINT 300/500/700 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 300/500/700 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 300/500/700 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 14 "Technical Specifications"*.
- The location must provide a mounting surface that is of sufficient strength to support the weight of the SPRINT 300/500/700 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 300/500/700.
- Do not store tools, equipment or chemicals where they can damage the SPRINT 300/500/700 or the connection cables.
- Make sure the SPRINT 300/500/700 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.

5.4 Mounting

5.4.1 Site Preparation

The SPRINT 300/500/700 can be installed in any convenient orientation with respect to the vessel's body frame. Compensate for any misalignment between the SPRINT 300/500/700 and the vessel by carefully measuring the mounting angles and entering them in the AHRS or SPRINT system; see *Section 5.5 "Vehicle Alignment"*.

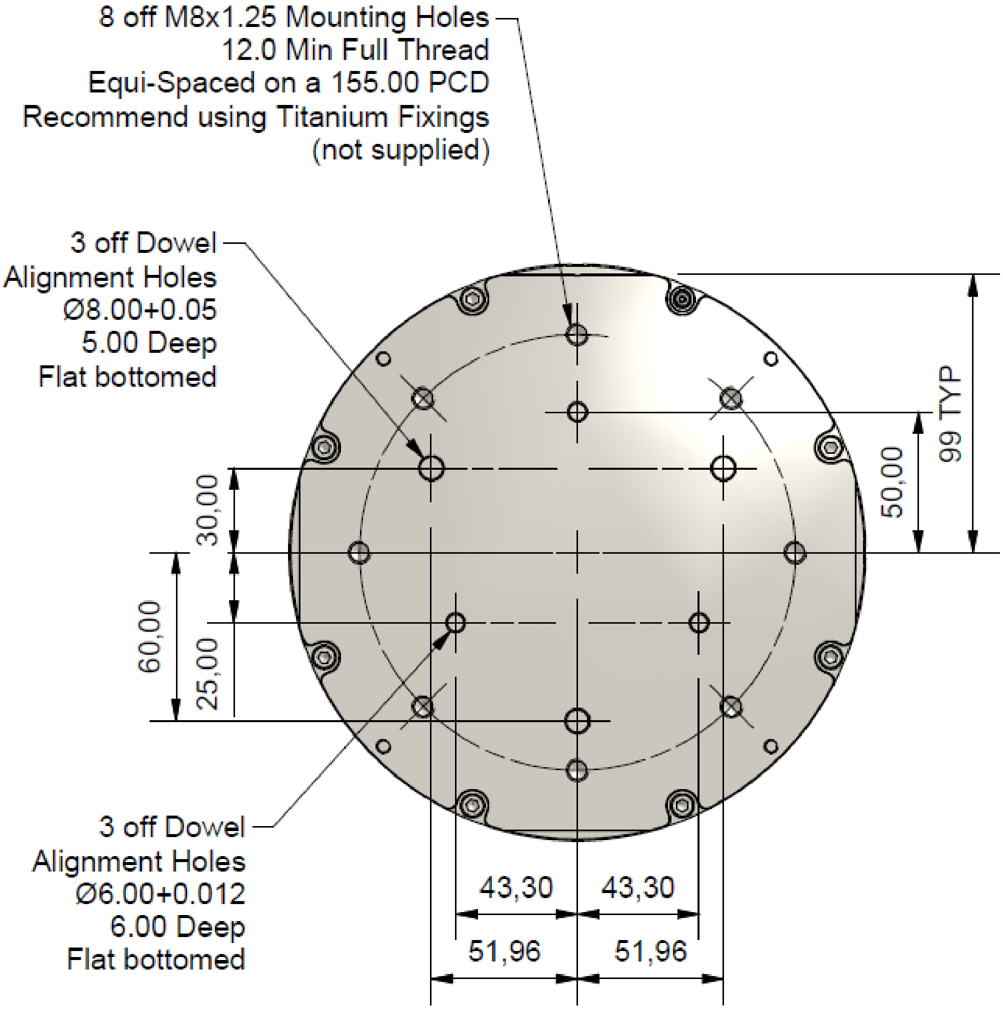
5.4.2 Mounting Holes and Dowels

The SPRINT 300/500/700 has a set of eight mounting holes on the underside of the unit. In addition there are two sets of three-dowel alignment holes and four alignment flats. The mounting holes, dowel alignment holes and alignment flats are shown in *Figure 5–1*.

Note

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

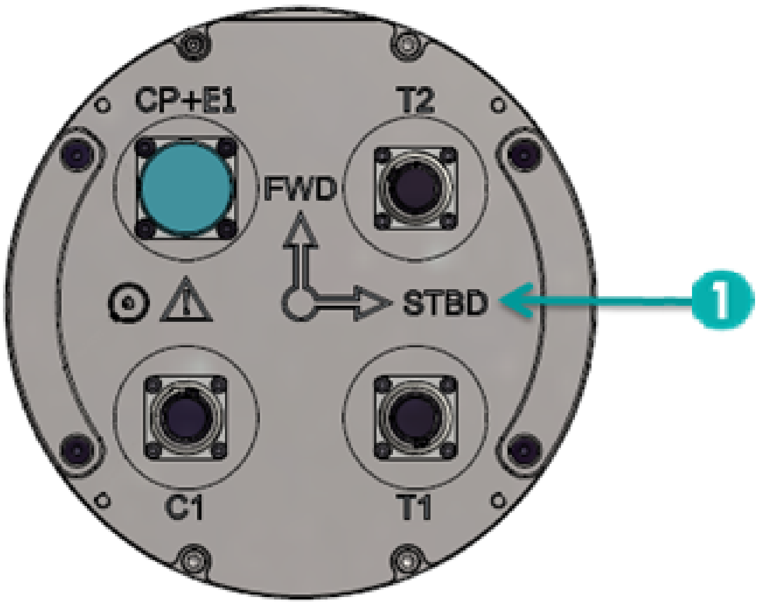
Figure 5–1 SPRINT 300/500/700 Mounting and Alignment



5.5 Vehicle Alignment

The nominal alignment of the SPRINT 300/500/700 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 Markings

Four flats machined into the base plate serve as alignment references.

If it is not possible to mount the SPRINT 300/500/700 within the limits described above for coarse alignment or if you wish to mount the SPRINT 300/500/700 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 300/500/700 to provide accurate attitude and positions with respect to the vehicles reference frame, any misalignment between the SPRINT 300/500/700 and vehicle reference frame must be corrected by determining and applying mounting angles in the SPRINT system software. A definition for the SPRINT 300/500/700 reference frame including mounting angle convention is described in *Appendix B "Reference Frames and Angular Conventions"*. Typically there are two stages in determining the SPRINT 300/500/700 mounting angles.

First determine the initial ‘coarse’ mounting angles. If the SPRINT 300/500/700 mounting is at the default as described in *Appendix B "Reference Frames and Angular Conventions"* then the SPRINT 300/500/700 mounting angles will all be zero. If the SPRINT 300/500/700 mounting is non-standard (e.g. the SPRINT 300/500/700 is mounted horizontally) then the mounting angles must be applied in the SPRINT system. A selection of SPRINT 300/500/700 mounting orientations and related mounting angles are provided in *Appendix C "SPRINT 300/500/700 Mounting Angle Examples"*.

After the (coarse) mounting angles of the SPRINT 300/500/700 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).

Ensure the results of any additional mounting angle calculation match the conventions listed in *Appendix C "SPRINT 300/500/700 Mounting Angle Examples"* before they are applied to the SPRINT system.

5.5.2 SPRINT Instrument Frame

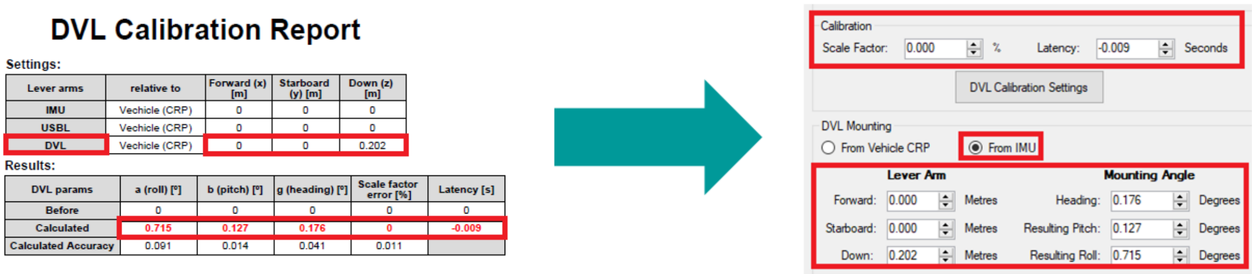
The SPRINT system has two types of lever arm and mounting angle measurement references - vehicle frame and instrument frame:

- 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).

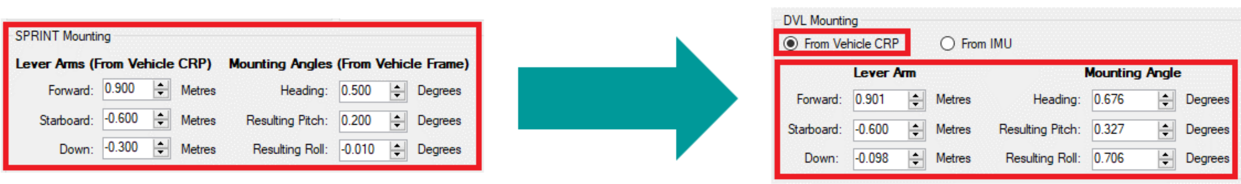
SPRINT instrument frame is recommended for pre-calibrated co-located SPRINT 300/500/700 and Syrinx DVL systems. This measurement frame simplifies the process of aligning SPRINT and aiding sensors to the vehicle CRP / Frame with minimum user interaction by auto calculating lever arms and mounting angles of DVL with respect to the vehicle’s CRP / Frame (instrument frame lever arms and mounting angles must be applied prior to entering SPRINT vehicle measurements).

To configure the SPRINT system using instrument frame:

1. To Configure DVL: import the DVL Calibration file (.ccl) or manually input DVL calibration values with From IMU lever arms and Mounting angles selected; see *Section 6.4.9 "DVL Aiding"* for sensor configuration.



2. Apply the SPRINT lever arms and mounting angles from the Vehicle CRP; the figure below shows an example of the automatically calculated DVL and Depth from vehicle CRP/Frame values.



Note

See *Section 6.4.3 "SPRINT System Configurations"* and *Section 14 "Technical Specifications"* unit dimensions (measurement point).

5.6 Preparing the SPRINT 300/500/700 for use

The following checks and procedures must be carried out to make sure the SPRINT 300/500/700 is serviceable and ready for use:

- Check the pressure relief vent valve; see *Section 9.7 "Pressure Relief Vent Valve"*
- Secure connector cables and fit the connector covers to all unused connector ports.
- Check communications with the SPRINT 300/500/700.

5.7 SPRINT System Software

The SPRINT system software should be installed to configure, operate and monitor the SPRINT 300/500/700 for combined AHRS and INS 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.

5.8 PC Utility

The PC utility software is used to configure and operate the SPRINT 300/500/700 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 – Combined INS & AHRS Operation

6.1 Introduction

A SPRINT 300/500/700 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 300/500/700 is only to be configured and operated as an AHRS only; see *Section 7 "Standalone AHRS Operation"*.

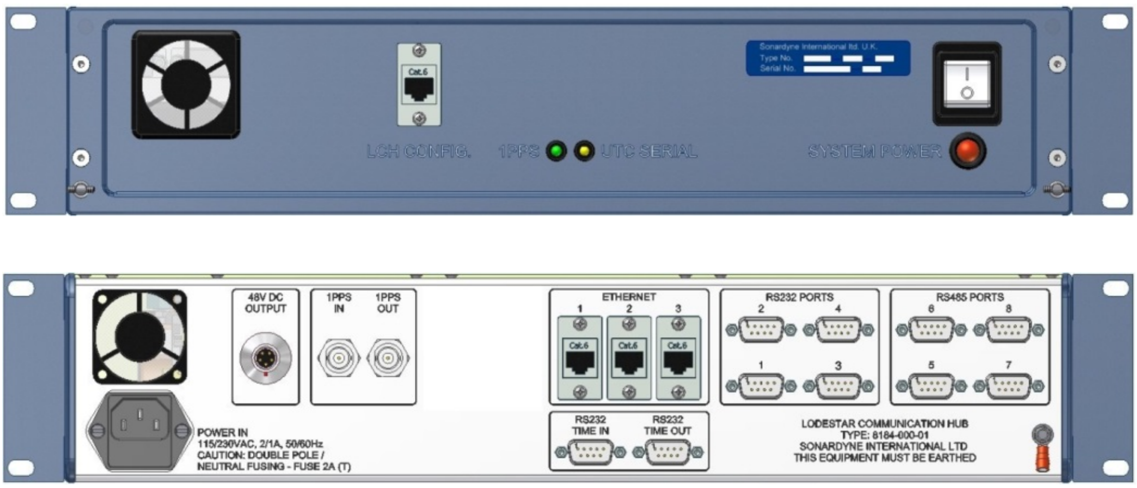
6.2 Changing the Console Port (CP) Baud Rate

If the SPRINT 300/500/700 is to be connected using a serial interface, the console port baud rate must be set at 115200. SPRINT 300/500/700 units shipped as part of a SPRINT system will be pre-configured with this baud rate. If the SPRINT 300/500/700 has not been pre-configured for this baud rate, the PC utility software can be used to configure the console port baud rate.

6.3 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 6–1 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 6–1 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 300/500/700 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 300/500/700 used with the SPRINT system. If this Port needs to be modified, the default SPRINT 300/500/700 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.

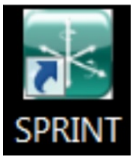
   Note

   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**.

6.4 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:

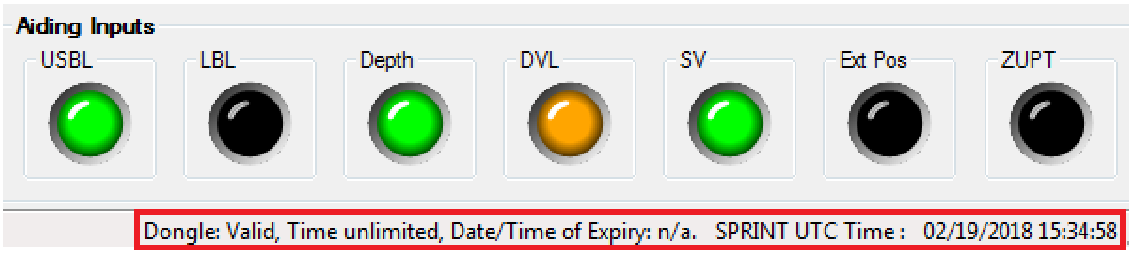


6.4.1 SPRINT system Security Dongle

SPRINT 300/500/700 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 6–4* and *Figure 6–5*.

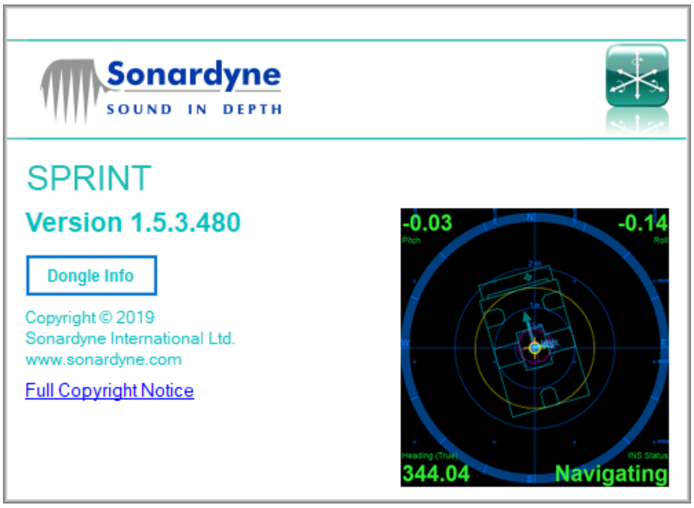
1. The security dongle validity and date/time of expiry information is displayed on the SPRINT system information pane.

Figure 6–2 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 6–3 Dongle information



3. Refer to *Figure 6–4* and *Figure 6–5*. SPRINT system aiding options for S5 and S10 systems are displayed along with dongle validity, type of expiry and date/time of expiry.

Figure 6–4 SPRINT S5 Settings

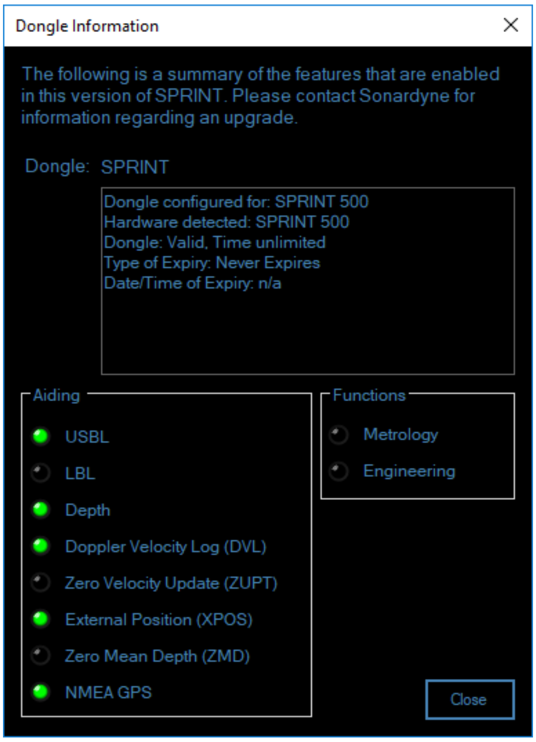
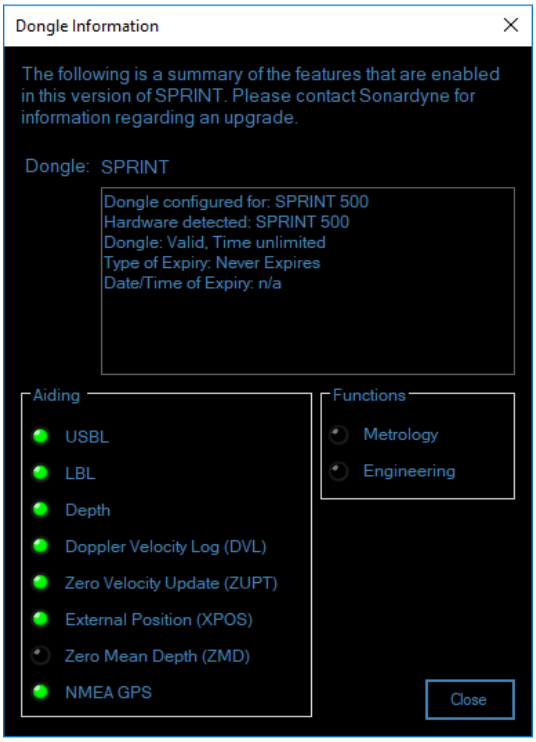


Figure 6–5 SPRINT S10 Settings

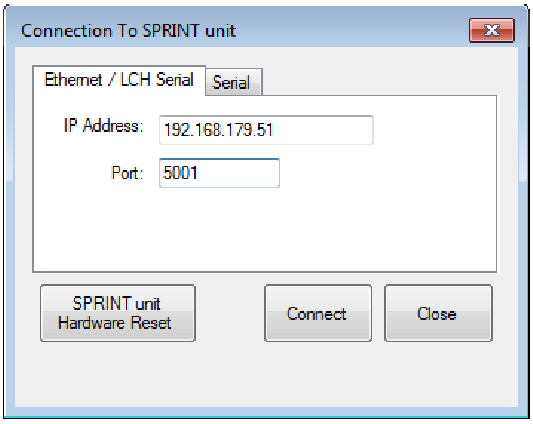


6.4.2 SPRINT System Connection

To connect the SPRINT 300/500/700 to the SPRINT system, follow the instructions below:

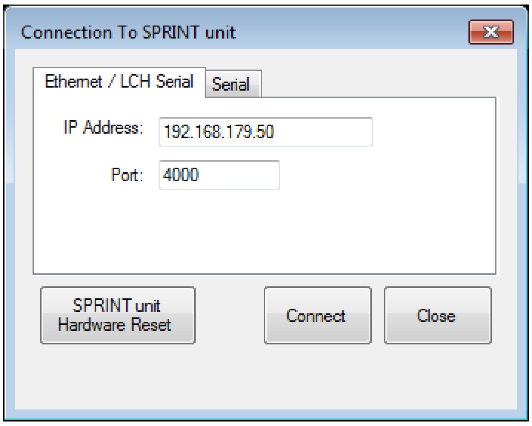
1. If this is the first time the SPRINT 300/500/700 has been connected to the SPRINT system software or the connection is not active, the connection window should automatically be displayed. If the connection window does not appear, open it by clicking **Configure > SPRINT > Connection**.
2. On the **Connection** window, click the Ethernet/LCH tab and enter the **IP Address and Port**:
   - If the SPRINT 300/500/700 is connected by means of a serial connection to the LCH, enter IP Address: **192.168.179.51** and **Port 5001**.

Figure 6–6 Serial Connection to the SPRINT 300/500/700



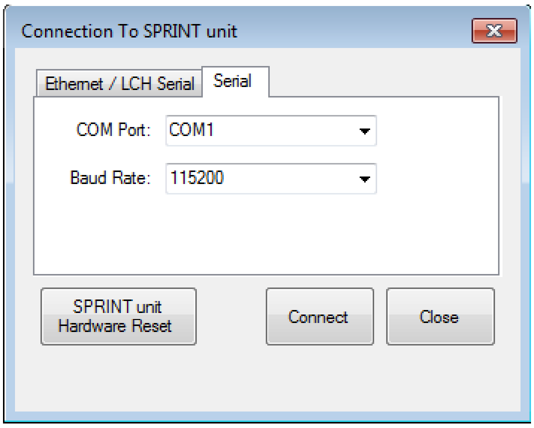
   - If the SPRINT 300/500/700 is connected directly by means of an Ethernet connection to the LCH, enter IP Address: **192.168.179.50** and **Port 4000**.

Figure 6–7 Ethernet Connection to the SPRINT 300/500/700



- If the SPRINT 300/500/700 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 6–8 Direct Serial Connection to SPRINT 300/500/700 for MWSK



Note

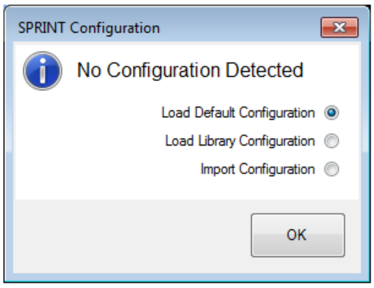
Only use serial comms connection if operating Mid Water Station Keeping (MWSK); not recommended for survey operations.

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

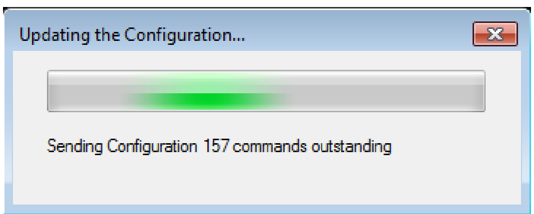
Note

If this is the first time the SPRINT 300/500/700 has connected to the SPRINT system software, the configuration options below will be displayed (no options will be displayed if the SPRINT 300/500/700 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.

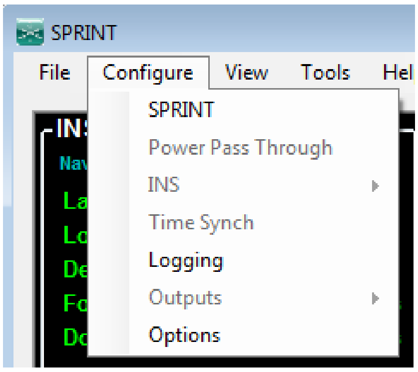


5. Select a configuration option and then click **OK**.



6. If the SPRINT 300/500/700 is not connected, the SPRINT system will prevent access to any menu options to retrieve or configure SPRINT 300/500/700 settings.

Figure 6–9 No SPRINT 300/500/700 Connection for Configuration

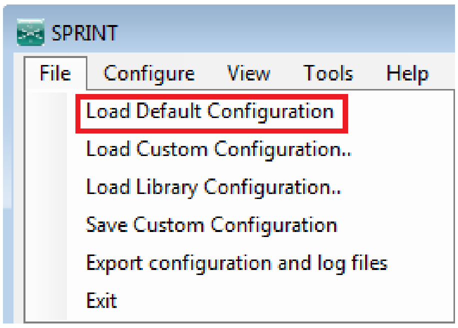


7. In addition, the system status LEDs at the bottom of the main application window will indicate that there is no SPRINT 300/500/700 connection, as shown below.

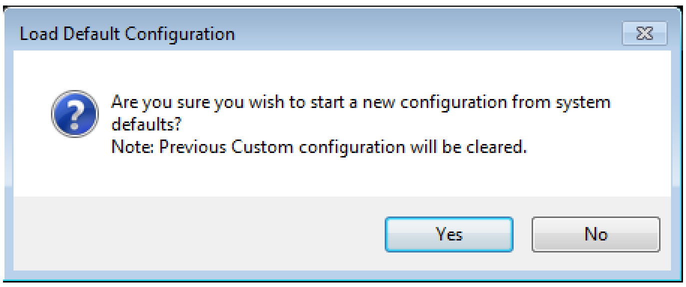
6.4.3 SPRINT System Configurations

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

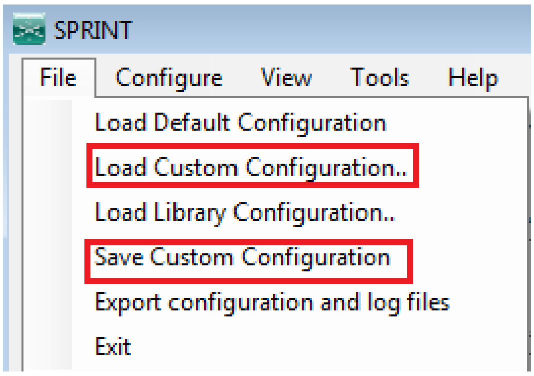
1. When the SPRINT 300/500/700 connection has been established, click **File > Load Default Configuration** (this will load default SPRINT configuration).



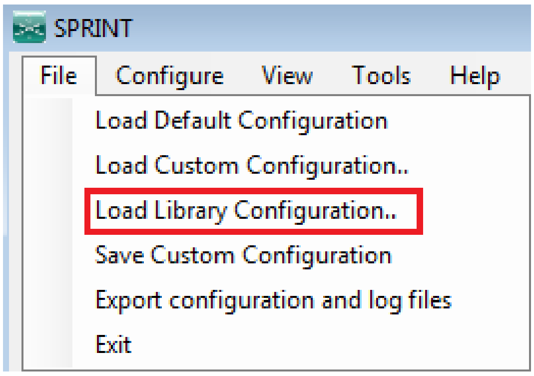
2. Click **Yes** to load the default configuration.



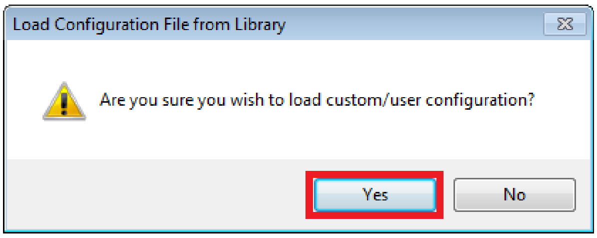
3. The SPRINT 300/500/700 configuration can be saved to the PC by clicking **Save Custom Configuration** (this configuration can also be loaded onto the SPRINT 300/500/700 from the PC by clicking **Load Custom Configuration**).



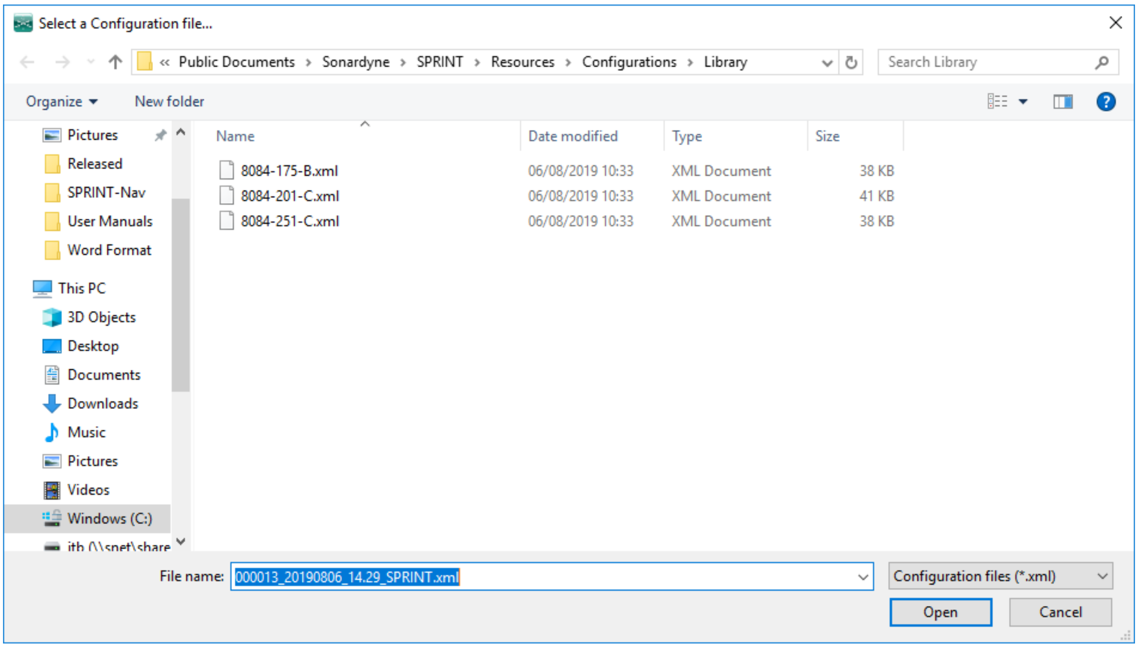
4. Click **Load Library Configuration** .



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**.

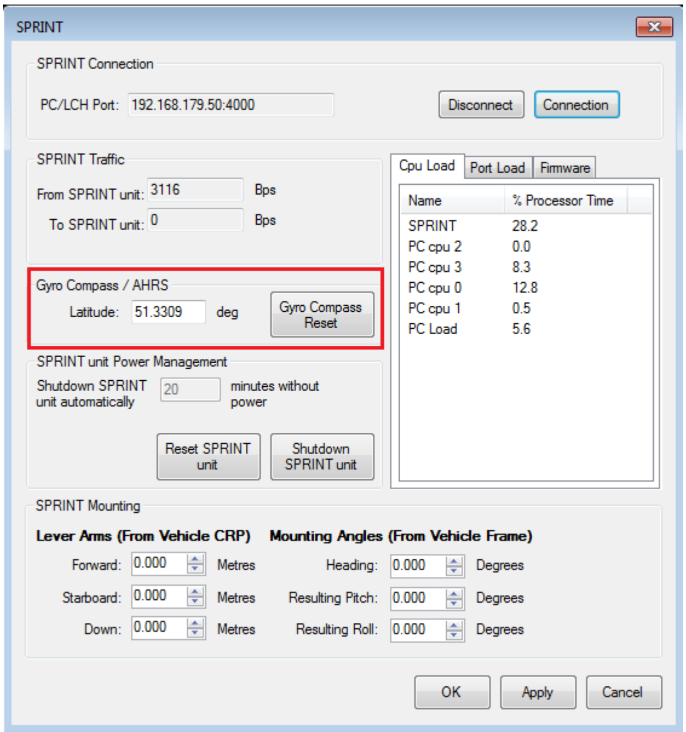


6.4.4 SPRINT 300/500/700Settings

To configure the SPRINT 300/500/700 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 6–10 SPRINT 300/500/700 Gyro Compass Settings



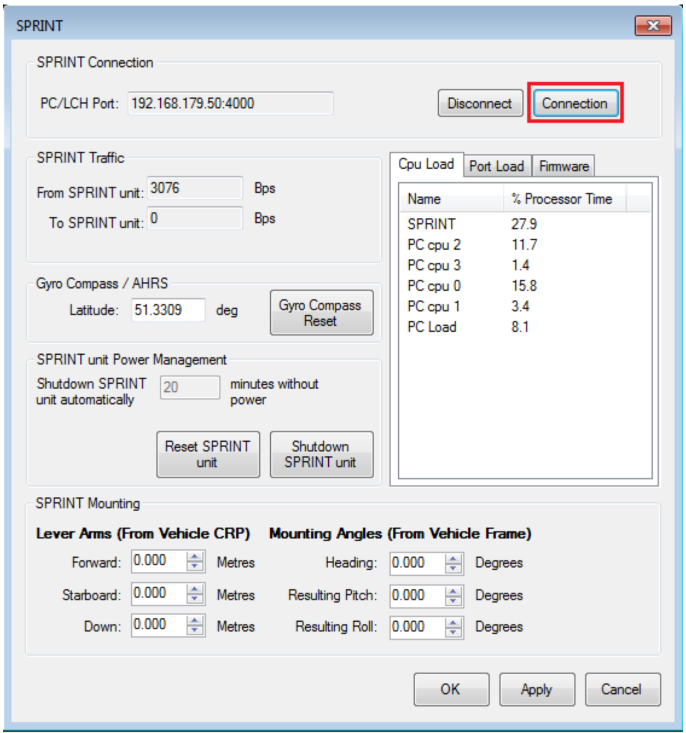
Note

Failure to update the default Latitude to match the current working area could result in poor SPRINT 300/500/700 gyrocompass and inertial performance. After any change of default Latitude the SPRINT 300/500/700 Gyro Compass algorithm is reset. During INS operations the SPRINT 300/500/700 Latitude value will be automatically updated by position aiding messages (USBL).

3. Set the **SPRINT Power Management** time period. The SPRINT 300/500/700 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 300/500/700 can be manually shutdown at any time by pressing the **Shutdown SPRINT** button, after which the SPRINT system will also close.
7. The SPRINT 300/500/700 (firmware) can be manually reset at any time by pressing the **Reset SPRINT** button.

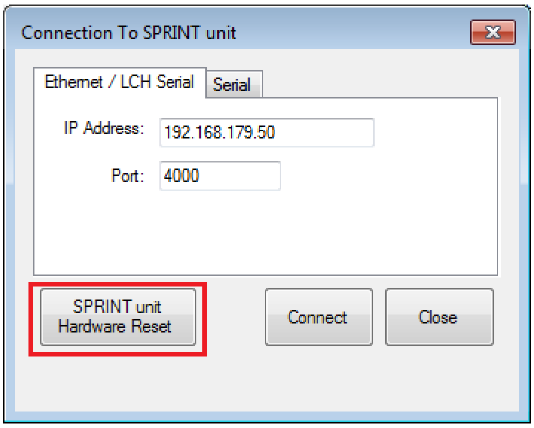
8. The SPRINT 300/500/700 can be reset if the connection to theSPRINT 300/500/700 is via Ethernet port (E1). Click the **Connection** button to open the SPRINT connection window, as shown below.

Figure 6–11 SPRINT Connection

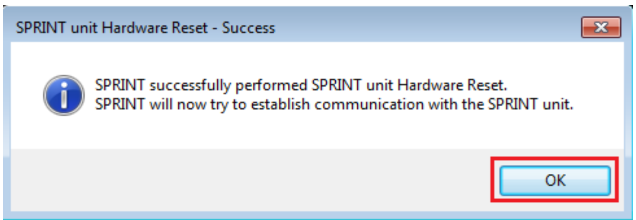


9. Click the **SPRINT Hardware Reset** button and then wait 3 minutes for the SPRINT 300/500/700 to re-establish communications with the SPRINT system.

Figure 6–12 SPRINT 300/500/700 Hardware Reset



10. Click **OK** to close and establish connection to the SPRINT 300/500/700.

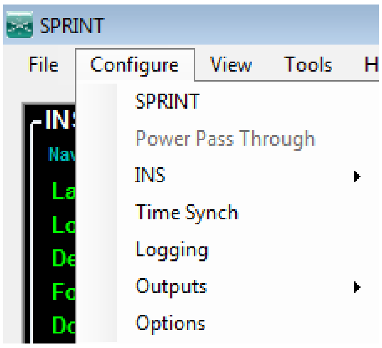


6.4.5 SPRINT System Power Pass Through

To enable the **Power Pass Through**:

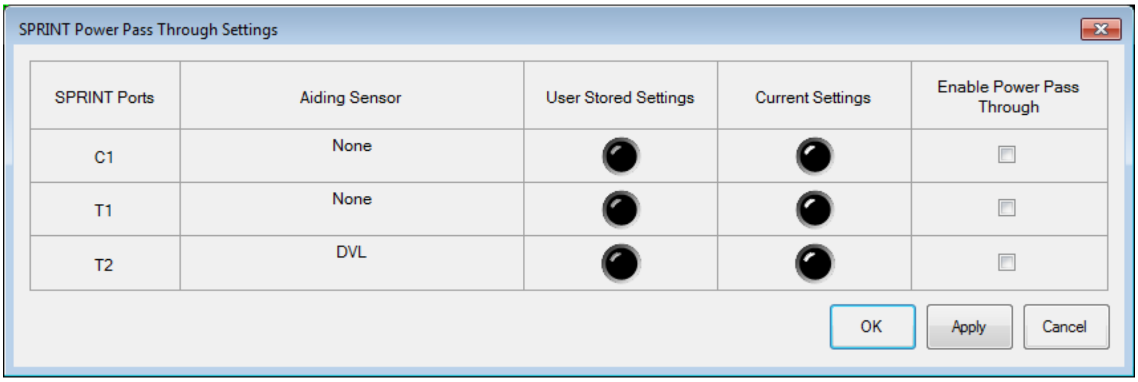
1. Click **Configure > Power Pass Through**

Figure 6–13 SPRINT System Power Pass Through



2. The configured aiding sensor is displayed for each SPRINT 300/500/700 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 300/500/700 and Syrinx DVL.

Figure 6–14 Power Pass Through Settings

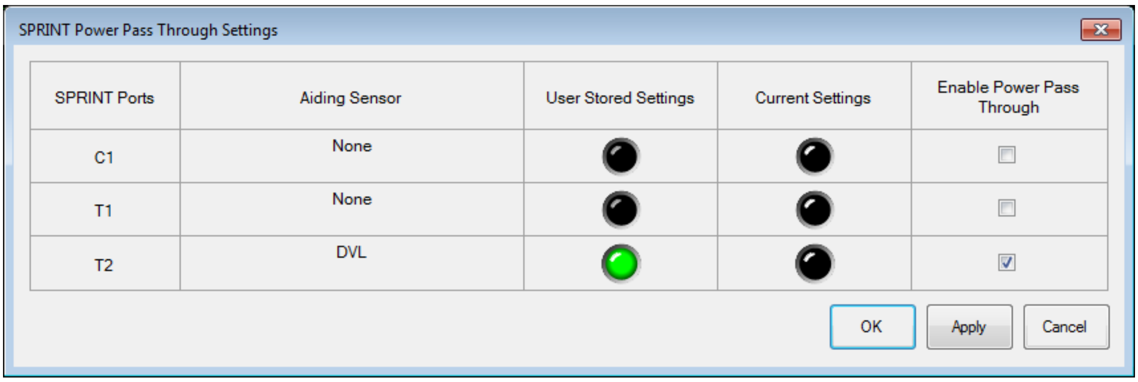


Note

The SPRINT 300/500/700 will disable all enabled Power Pass Through Ports when powered cycled.

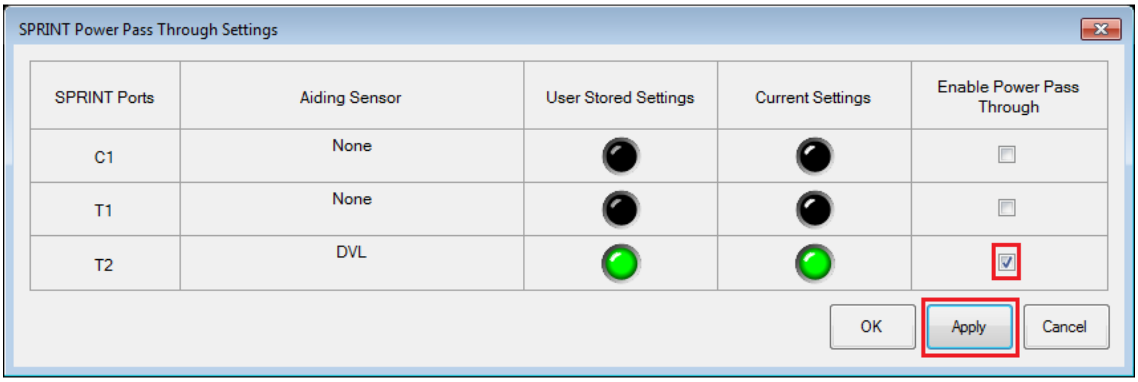
3. If the SPRINT port has previously had Power Pass Through enabled then the status light is green in the **User Stored Settings** column, as shown below.

Figure 6–15 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 6–16 Power Pass Through Current Settings

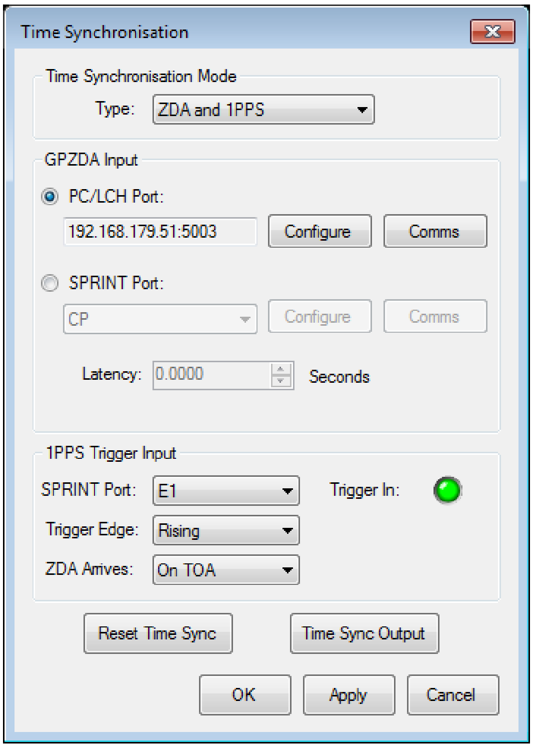


6.4.6 SPRINT 300/500/700Time Synchronisation

To configure the SPRINT 300/500/700 Time Synchronisation:

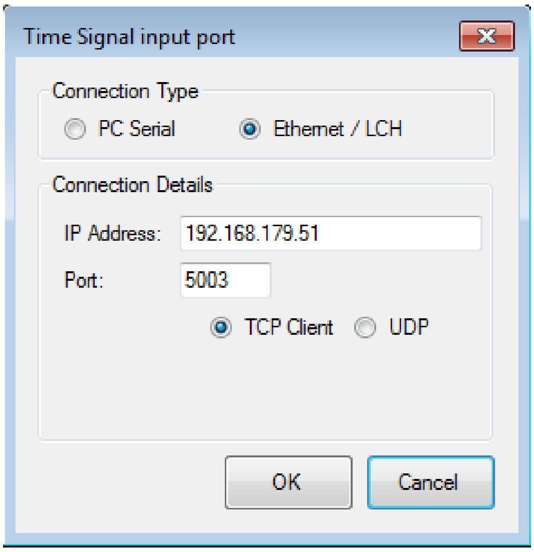
1. Click **Configure > Time Synchronisation**, or right-click the **Time** LED.
2. On the **Time Synchronisation** window, select **Type: ZDA Only** (default) or **ZDA and 1PPS**.

Figure 6–17 SPRINT 300/500/700 Time Synchronisation



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

Figure 6–18 Adding IP Address



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

Note

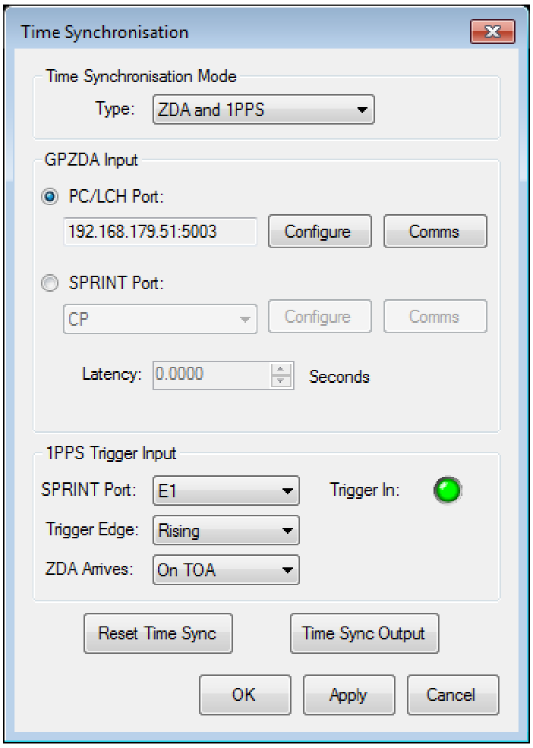
The Time Synchronisation can be reset at any time by selecting Reset Time Synch.

5. If **GPZDA** and **1PPS** is selected, configure the **1PPS Trigger Input** settings. The default SPRINT 300/500/700 input setting for 1PPS is **SPRINT Port C1**.
6. Click **OK** to close and save all entered settings.

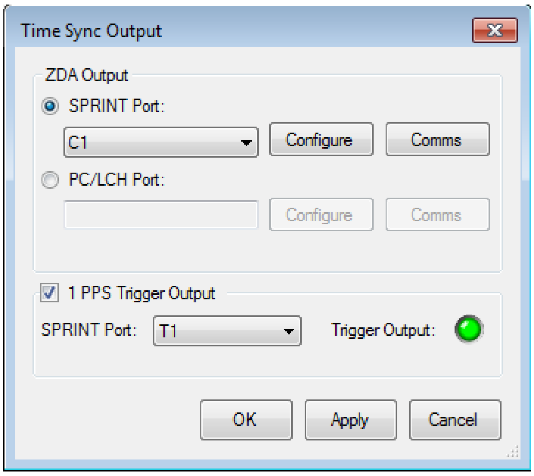
Time Sync to External Instrument

The SPRINT 300/500/700 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 300/500/700 will not output the time synch).

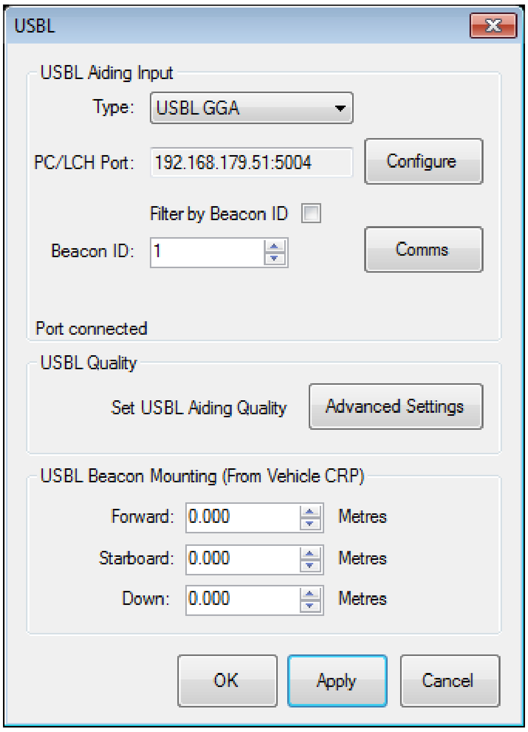
6.4.7 USBL Aiding

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 6–19*.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 6–18*).
4. If required, specify a **Beacon ID** filter; see *Appendix D "INS Message Definitions"* for details of the beacon ID field of the different USBL aiding messages.

Figure 6–19 USBL Aiding

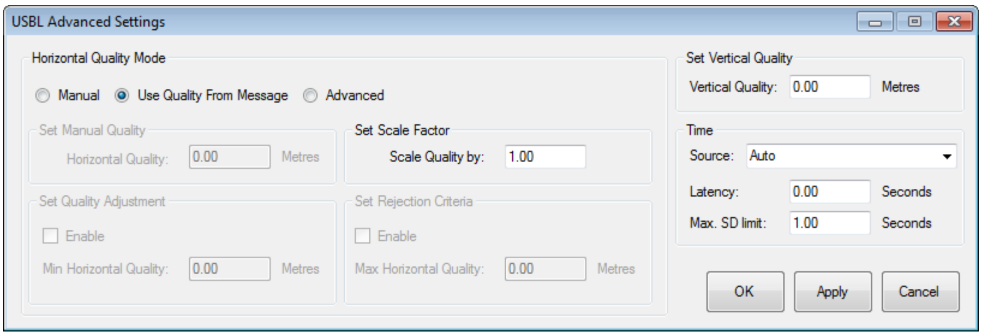


5. USBL Aiding Quality Settings can be configured by clicking **Advanced Settings**; see *Figure 6–20*.

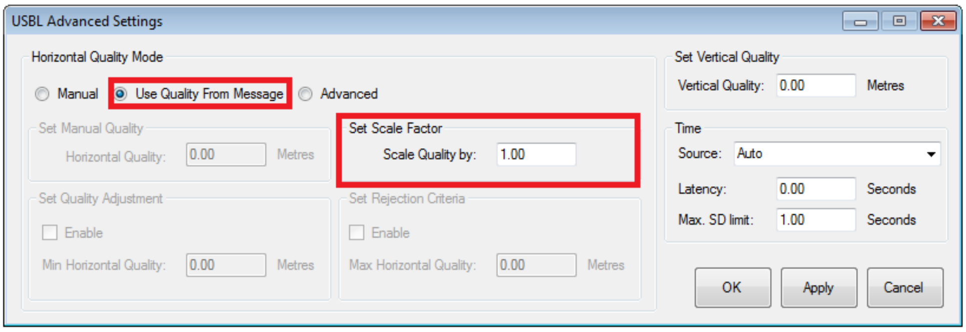
Note

The default setting is for the SPRINT system to use the quality value provided by the USBL system in the aiding message; see *Figure 6–28* of accepted USBL message types see *Appendix D "INS Message Definitions"*.

Figure 6–20 USBL Aiding Quality Settings

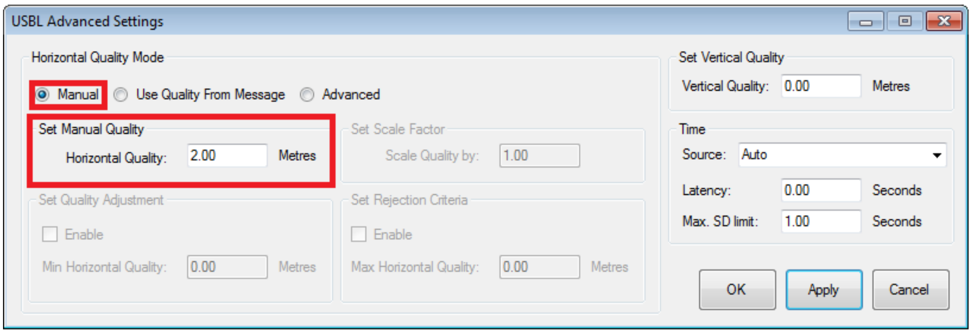


a. **Use Quality from Message**: The quality value from the USBL message can be scaled to resolve for systematically incorrect USBL Quality.



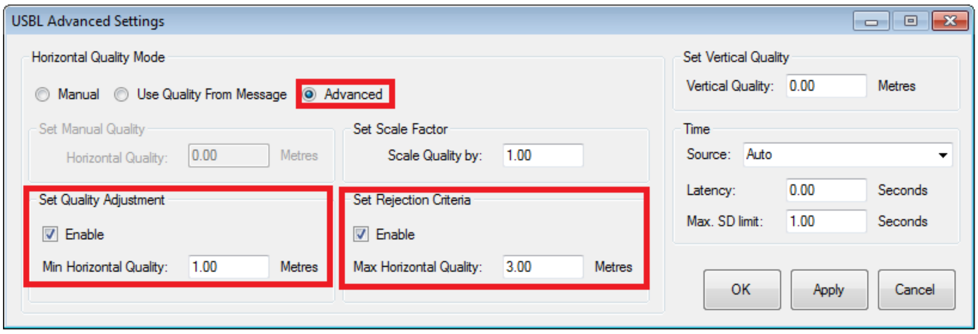
b. **Manual**: In some cases, it may be required to set a manual horizontal quality value:

- 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.



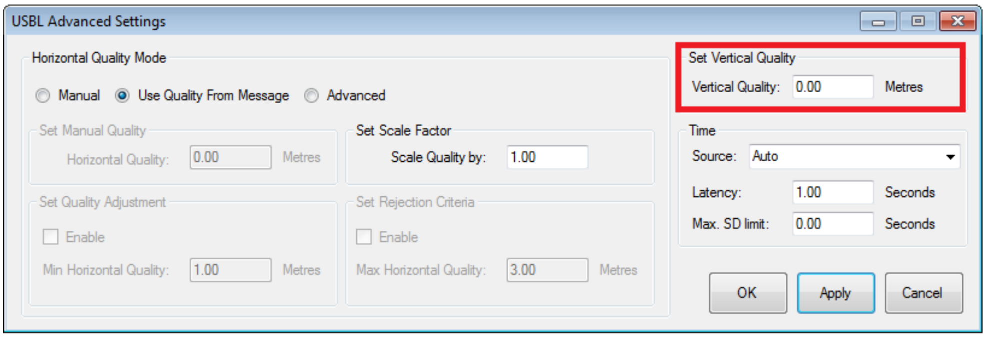
c. **Advanced**: This configuration allows horizontal quality to be used from the USBL message whilst able to set scale factor, minimum and maximum quality values for the USBL position.

- 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

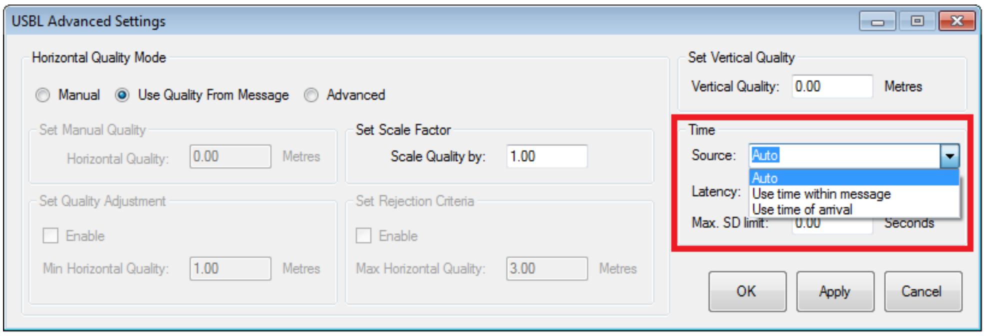


6. On the USBL Beacon Mounting (from Vehicle CRP) enter the Lever Arm offsets from the ROV CRP to the USBL beacon. After changing the lever arms the INS algorithm will be automatically reset to use the new settings.
7. USBL Aiding Time Source:

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.

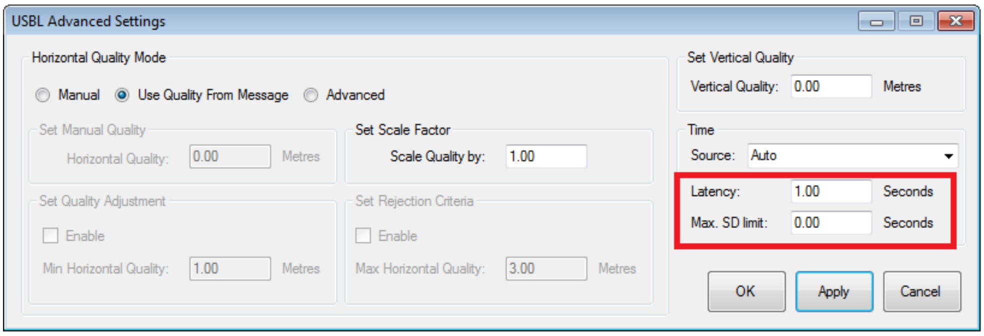
b. **Use Time within Message**: This mode will use the time stamp within the USBL aiding message.

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 6.4.24 "Marksman & Ranger 2 USBL Aiding"*.

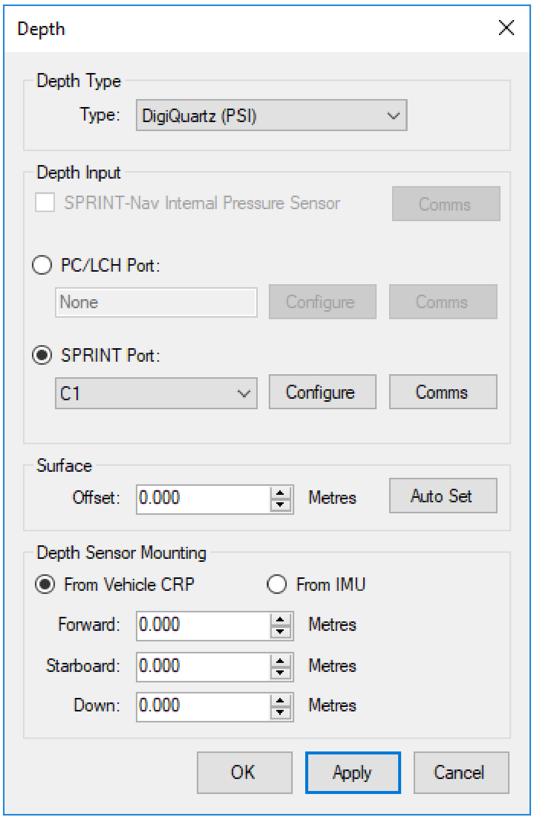
6.4.8 Depth Aiding

To configure the Depth aiding:

1. Click **Configure > INS > Depth Input** or right-click on the Depth Aiding LED.
2. 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 6–21*.
3. Select a **Depth Input** by selecting either **PC/LCH Port** or **SPRINT Port**.
4. 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 6–18*).

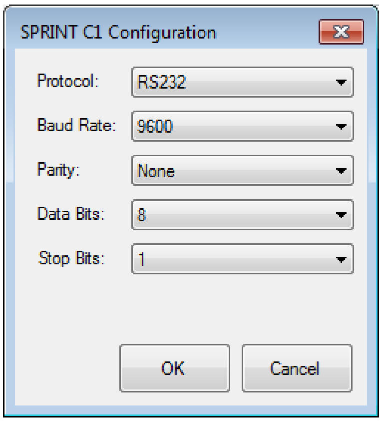
5. If the sensor is connected directly to the SPRINT 300/500/700, select **SPRINT Port** and the relevant connection point (**C1, T1, T2**).

Figure 6–21 Depth Aiding



6. Click **Configure** and enter the SPRINT 300/500/700 port configuration settings; see *Figure 6–22*.

Figure 6–22 SPRINT 300/500/700 Port Configuration



7. Click **OK** to save all entered settings and return to the **Depth** window; see *Figure 6–21*.
8. 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**.
9. 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).
10. Click **OK** to close and save all entered settings.

11. To view Pressure Depth Aiding residuals and depth, right-click on the **Depth** aiding LED and select **View Pressure Depth Aiding**; see *Figure 6–23* and *Figure 6–24*

Figure 6–23 Enable Aiding Plot

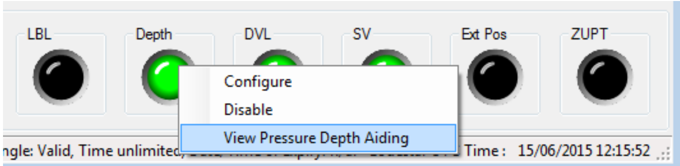
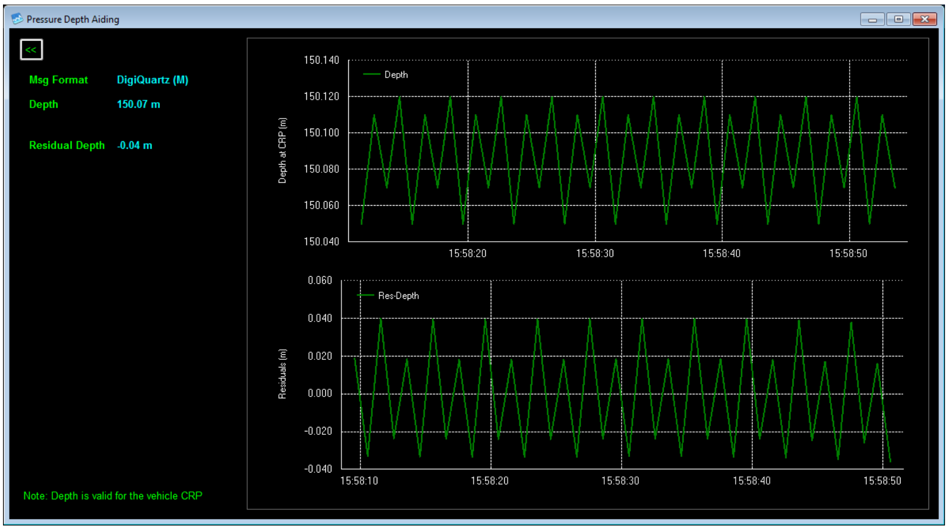


Figure 6–24 Pressure Depth Aiding Plot



6.4.9 DVL Aiding

To configure the DVL Aiding:

1. Click **Configure > INS > DVL Input** or right-click on the **DVL Aiding** LED.
2. Select the **SPRINT Port** from the drop-down list and then click **Apply**; see *Figure 6–25*.
3. Select the type of DVL to be connected: **Syrinx**, **TRDI DVL** or **Other**.
4. If the DVL is to be triggered by SPRINT, select the **Triggered by SPRINT unit** check box
5. Select the **Hex-ASCII DVL Data Output** checkbox if the DVL will be outputting ASCII data; if left unchecked the SPRINT 300/500/700 will expect binary data (default).

Note

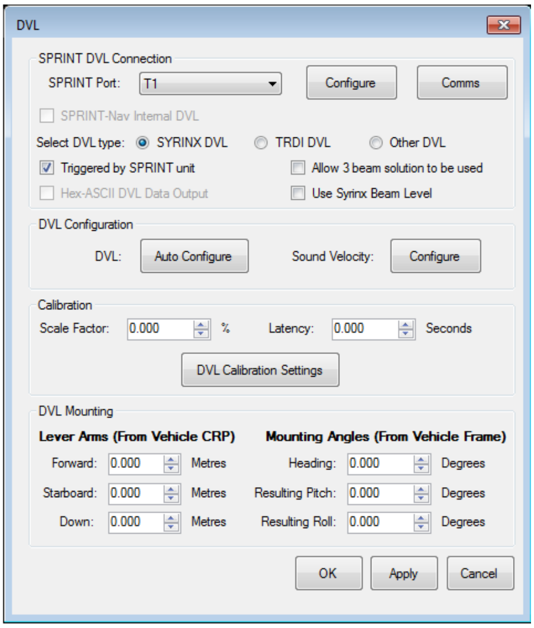
The Use Syrinx Beam Level check box is to enable beam level aiding for SPRINT-Nav hardware, not for use on separate Syrinx and SPRINT unit mounting.

6. Enter the **Scale Factor** and **Latency** values from the DVL calibration.
7. 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).

Note

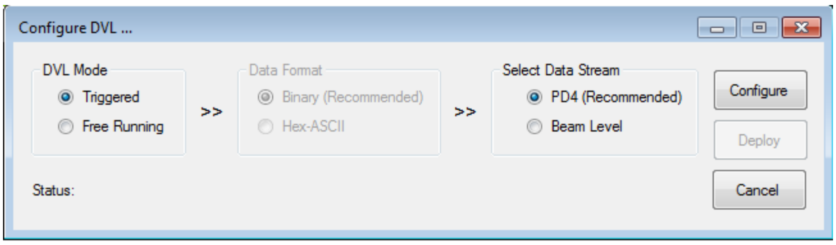
The DVL mounting angles, scale factor and latency can be calculated using the calibration procedure explained in *Section 6.11 "DVL Calibration Procedure"*. If the DVL input is being configured on deck prior to the calibration, it is recommended that the default mounting angles, scale factor and latency values are used.

Figure 6–25 DVL Aiding



8. If the DVL connected to the SPRINT 300/500/700 is a Sonardyne Syrinx DVL or Teledyne RDI, 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 6–26*

Figure 6–26 DVL Auto Configuration



Note

Make sure the Syrinx/TRDI DVL is connected to the SPRINT 300/500/700 and powered before trying to configure it.

DVL Mode: If the DVL cabling will allow the SPRINT 300/500/700 to send a trigger to the selected DVL , select **Triggered**, otherwise select **Free Running**.

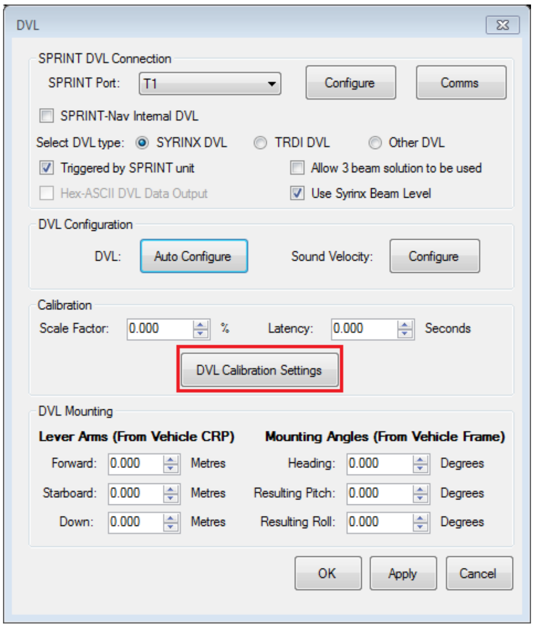
Data Format: The data format output of the DVL will be set to Binary by default. If Hex-ASCII is required, select **Hex-ASCII**.

Select Data Stream: This function sets the data stream message output of the Syrinx DVL (beam level only to be used for Sonardyne SPRINT-Nav hardware).

9. Click **Configure** to configure the DVL; the software will display the progress of the configuration process.

10. If the DVL is already configured, the **Deploy** button will command the DVL to start making measurements.
11. When the DVL has been configured, return to the **DVL** dialog box.
12. Click **OK** or **Apply** to save the settings.
13. Click **DVL Calibration Settings** to set DVL Alignment and import DVL Calibration file from Janus. For more information see *Section 6.11 "DVL Calibration Procedure"*.

Figure 6–27 DVL Calibration Settings

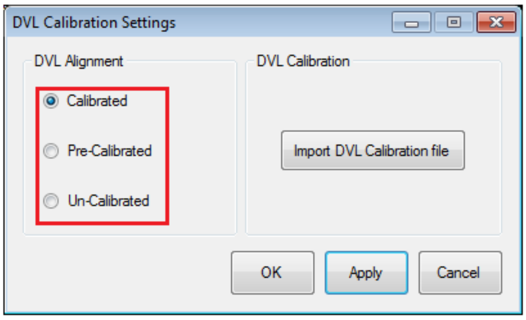


14. The DVL Alignment to vehicle frame quality options are described below.

    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.

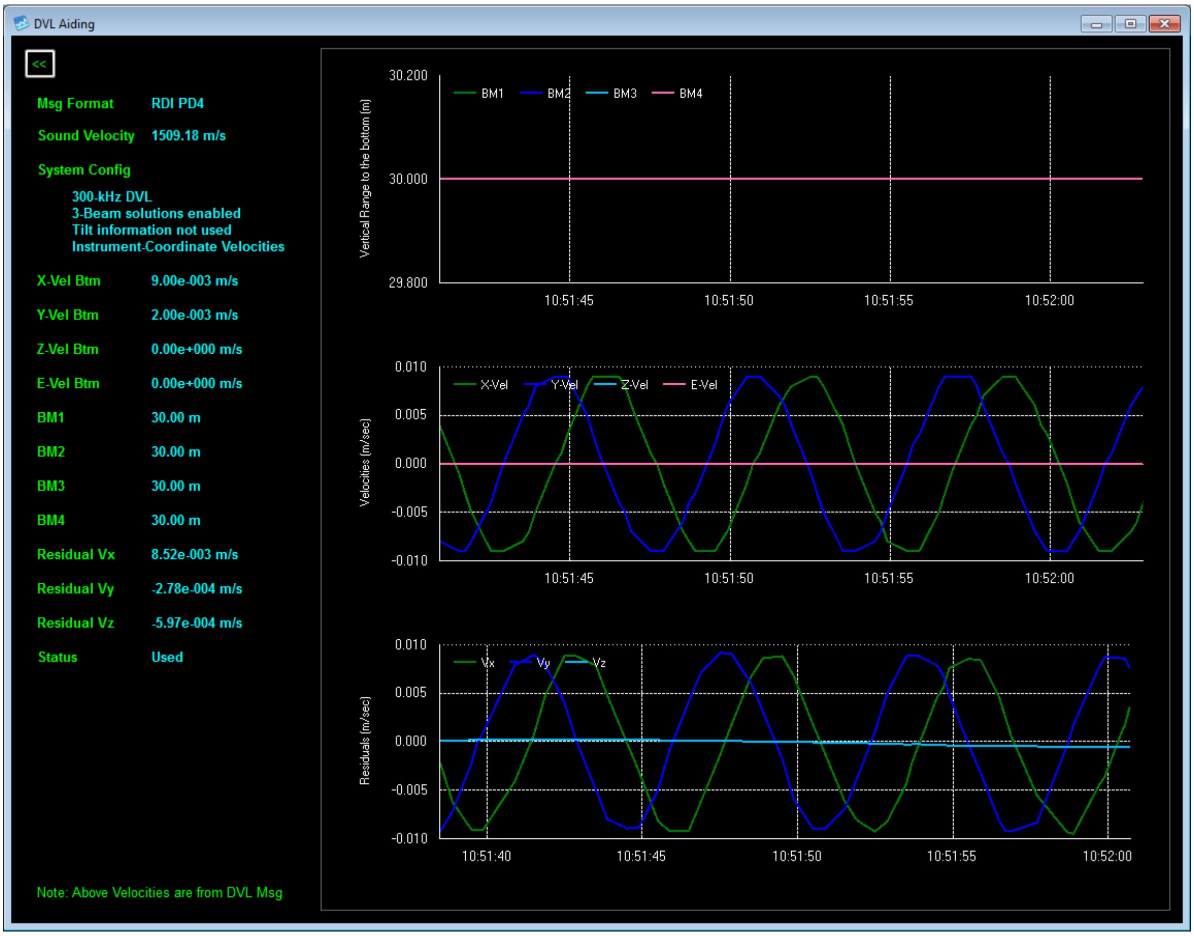
    Pre-Calibrated: This option should only be selected if the SPRINT 300/500/700 is co-located with a DVL and has been pre-calibrated using GPS (RTK) prior to installation on the ROV.

    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).



15. 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 6–28 DVL Aiding Plot



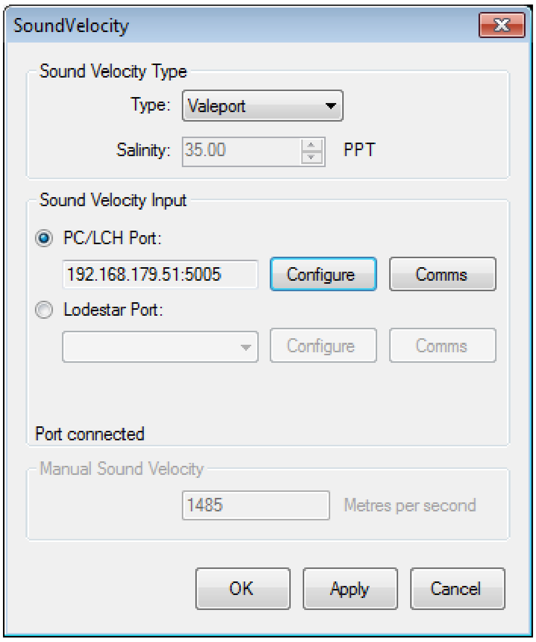
6.4.10 Sound Velocity

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 6–29*.
   - **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 300/500/700 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 6–29 Sound Velocity Configuration



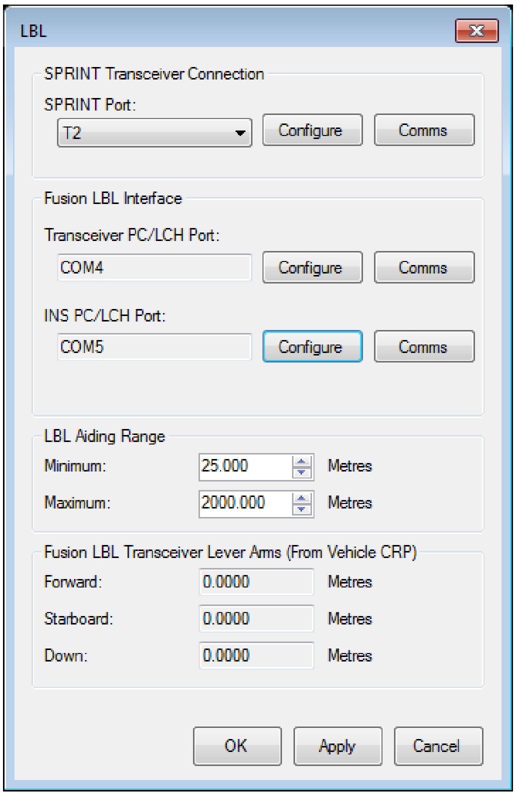
6.4.11 LBL

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 Port** that the LBL transceiver is physically connected to (usually T2); see *Figure 6–30* and then configure the baud rate as required by clicking **Configure**; see *Figure 6–22*.
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 6–30 LBL Aiding Configuration



5. Refer to *Section 6.7 "Fusion LBL Aiding"* to configure Fusion LBL for use with SPRINT.

Note

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

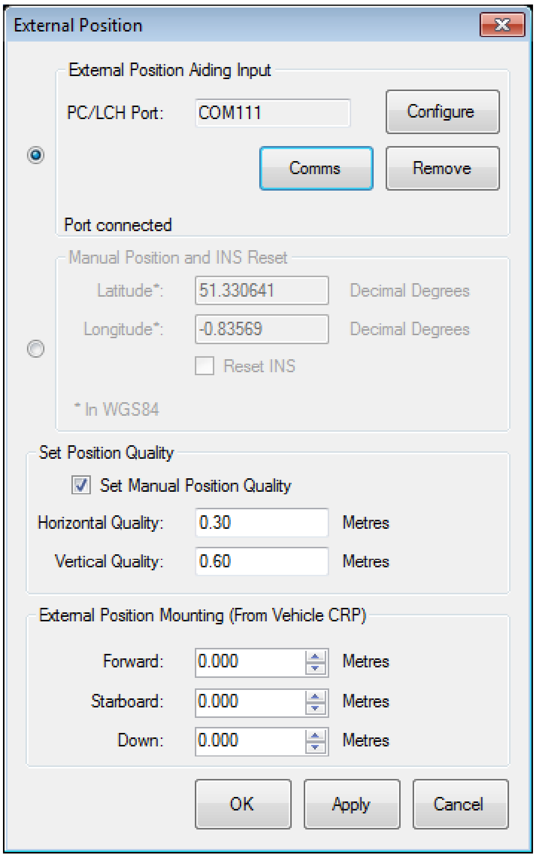
6.4.12 External Position Aiding

To configure External Position Aiding:

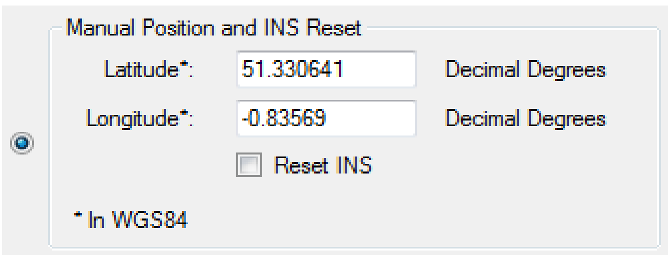
1. Click **Configure > INS > External Position Input** or right-click on the **Ext Pos** Aiding LED and select **Enable**; see *Section D.14 "Proprietary XPOS Report"* for External position (XPOS) message format.

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

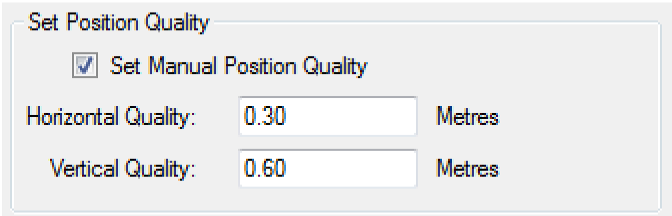
Figure 6–31 External Position Aiding Configuration



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 6–18*.
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 D.14 "Proprietary XPOS Report"* for External position (XPOS) message format.

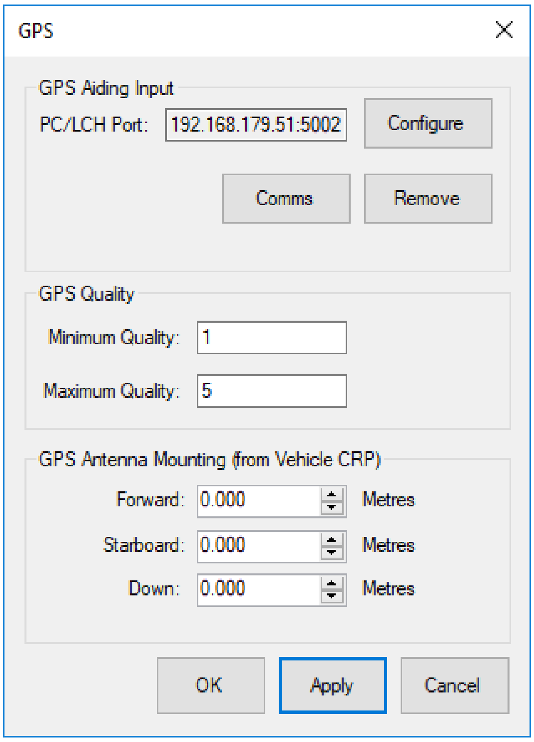


6. Click **OK** to close and save all entered settings.

6.4.13 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

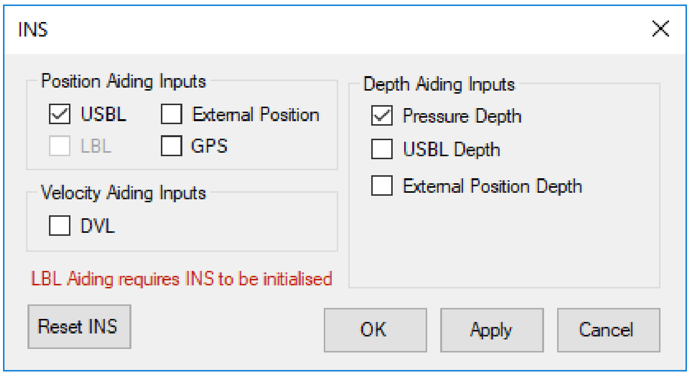
If enabling GPS on deck to compensate AHRS, ensure GPS aiding is disabled and USBL aiding is enabled prior to vehicle deployment.

6.4.14 INS

To configure the INS:

1. Click **Configure > INS**.

Figure 6–32 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.

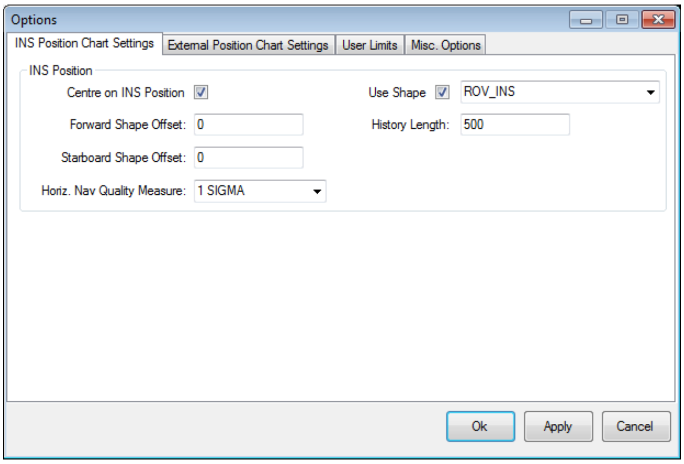
6.4.15 Options

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 6–33 INS Position Chart Settings

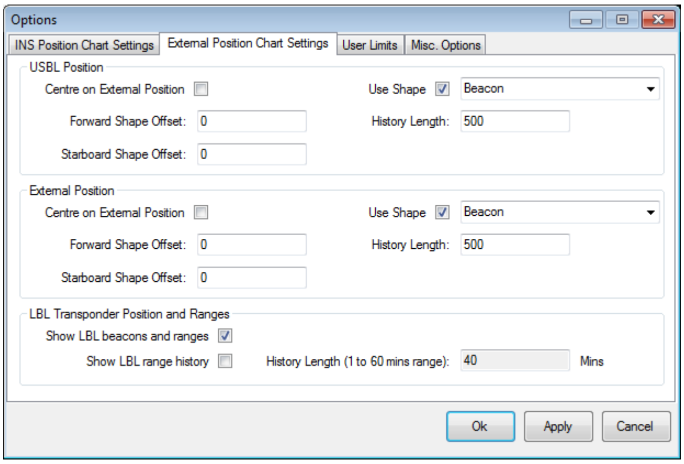


3. Click the **External Position Chart Settings** tab to configure preferences for the software external chart display. If using Windows® 7, double click on either the USBL, INS or Transponder chart shapes to centre on the main chart.

Note

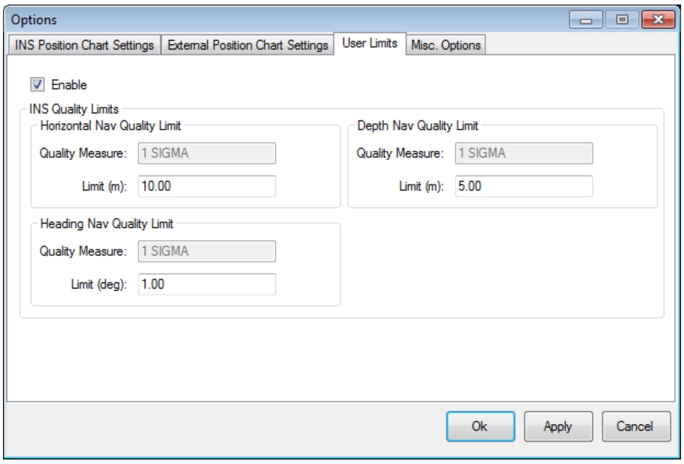
Show LBL range history can only be enabled if using Windows® 7.

Figure 6–34 External Position Chart Settings



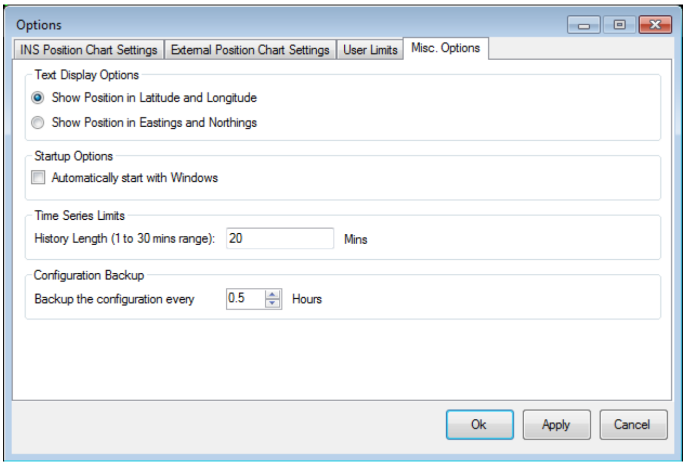
4. Click the **User Limits** tab to configure navigation horizontal and depth quality limits (if the limits are enabled the software will alert the user if the limits are exceeded; see *Section 6.10.7 "Navigation Quality Limits"* for more details).

Figure 6–35 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 6–36 Misc. Options



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

Note

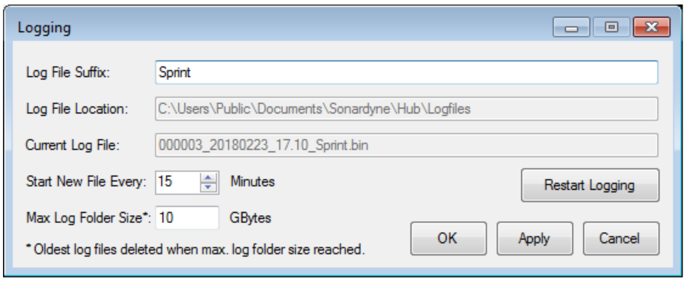
The Show LBL beacons and range history option within the External Position Chart Settings tab can only be enabled when using Windows® 7.

6.4.16 Logging

To configure the Logging process:

1. Click **Configure > Logging**.

Figure 6–37 Logging Configuration



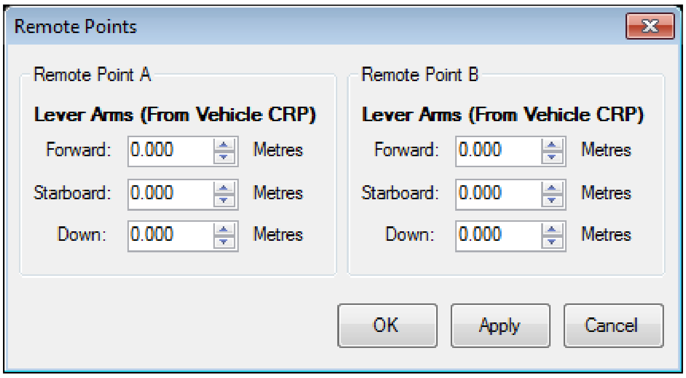
2. Default settings for logging are already defined but may be changed as required.
3. Click **Restart Logging** to close the current log file and open a new one.

6.4.17 Remote Output Points

To configure the Remote Output Points:

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

Figure 6–38 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.

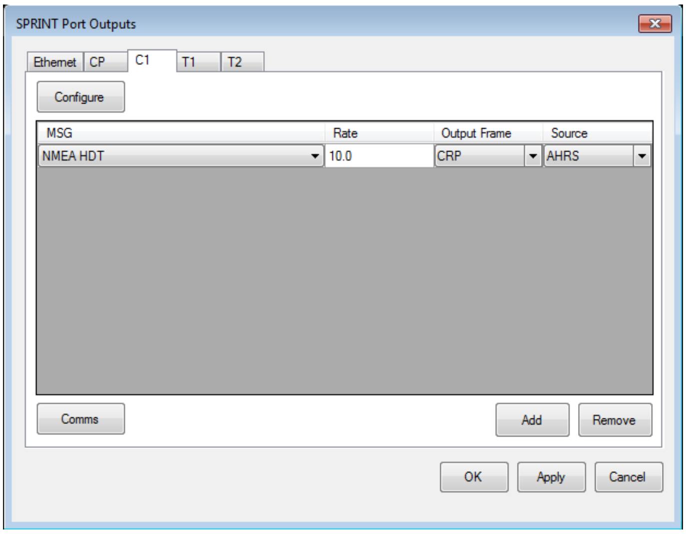
3. Enter any lever arms for the remote points from the CRP to the remote point specified.
4. Click **OK** to close and save all entered settings.

6.4.18 SPRINT 300/500/700Output

To configure outputs from the SPRINT 300/500/700 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 6–39 SPRINT system Output Configuration



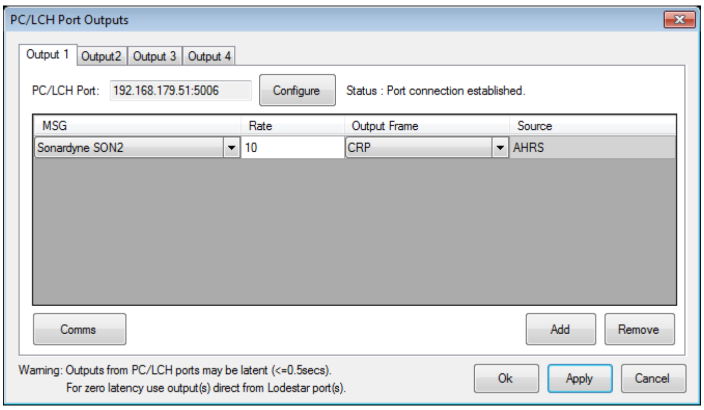
2. Click the tab for the required port to configure.
3. Select the message type, output rate and if a remote output point is to be used (the default output will be with respect to the vehicle CRP). For some outputs (such as a raw sensor feed) an output rate cannot be specified as this is defined by the 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.

6.4.19 PC Port Outputs

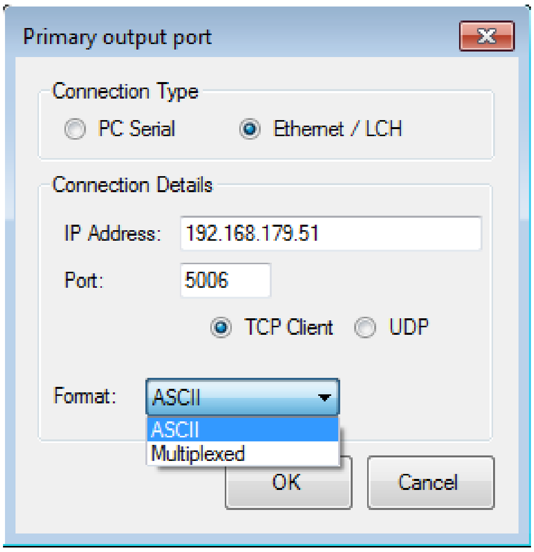
The system supports two local output ports (primary and secondary). To configure outputs from the local PC or LCH ports:

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

Figure 6–40 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 6–18*).
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.

6.4.20 View Lever Arms

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

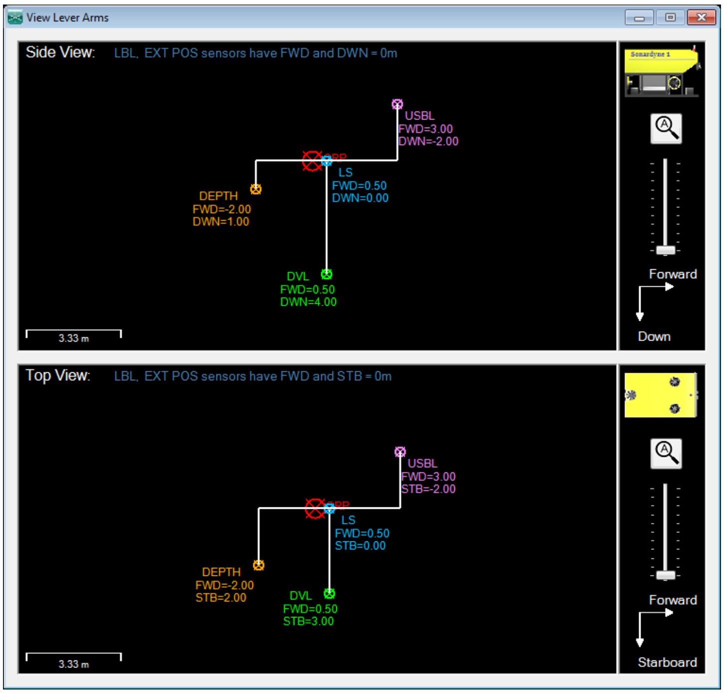
1. Click **View > Lever Arms**.
2. Side and top views of all offsets are displayed as shown below.

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

Note

Scale is dependent on the level of zoom applied.

Figure 6–41 View Lever Arms



6.4.21 View Comms Map

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

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

Figure 6–42 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	

6.4.22 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.

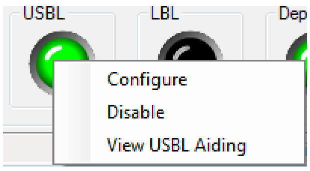
2. Click the **Zoom In** button to zoom in the chart display.

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.



6.4.23 Fusion LBL Aiding

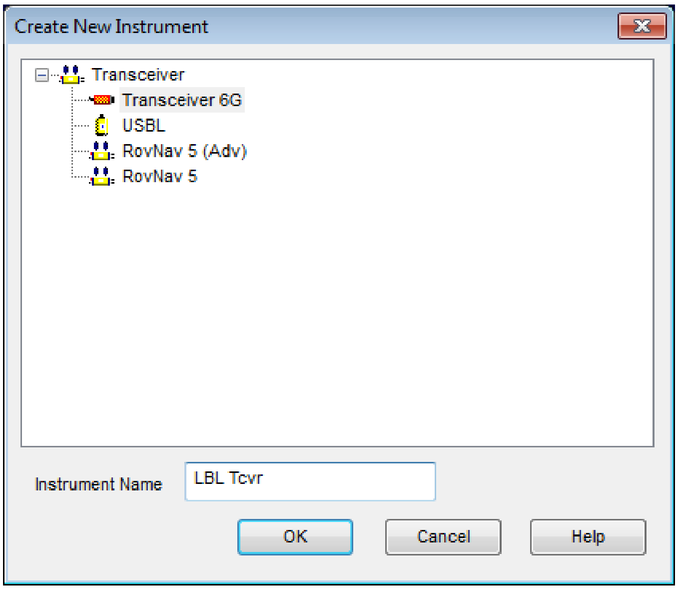
To interface Fusion LBL to SPRINT system for aiding, follow the steps below (for further information on operation of Fusion, see *UM-8025 "User Manual for Fusion LBL"*).

This procedure assumes the following connections have already been configured:

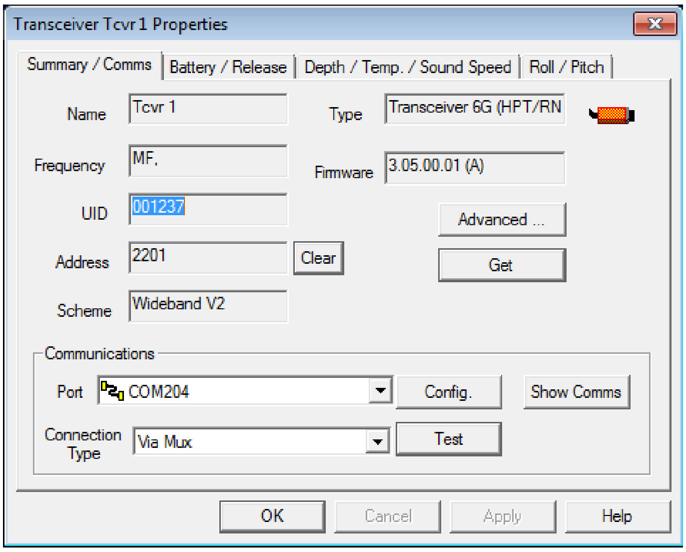
- A SPRINT 300/500/700 is running and connected to the SPRINT system software.
- LBL Transceiver is physically connected to SPRINT 300/500/700 T1 or T2 port and is powered.
- The Fusion LBL interface ports have been configured in SPRINT (see *Section 6.4.2 "SPRINT System Connection"*

- Transceiver PC Port
- INS PC Port

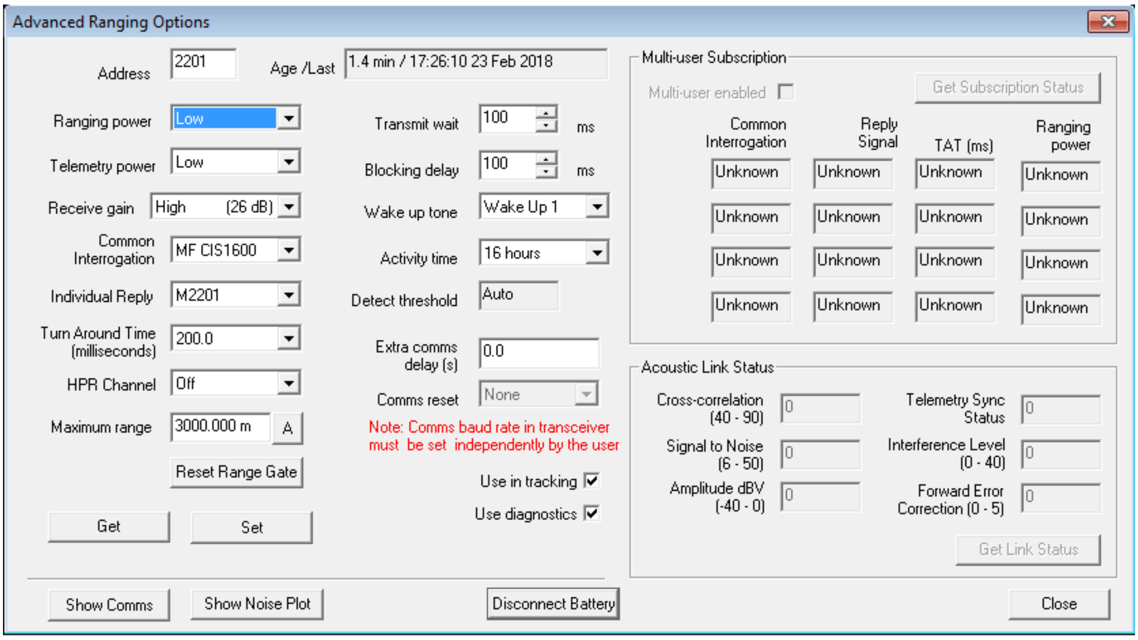
1. Open Fusion LBL and add an LBL Transceiver from the acoustic instruments group on the job tree.



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**.

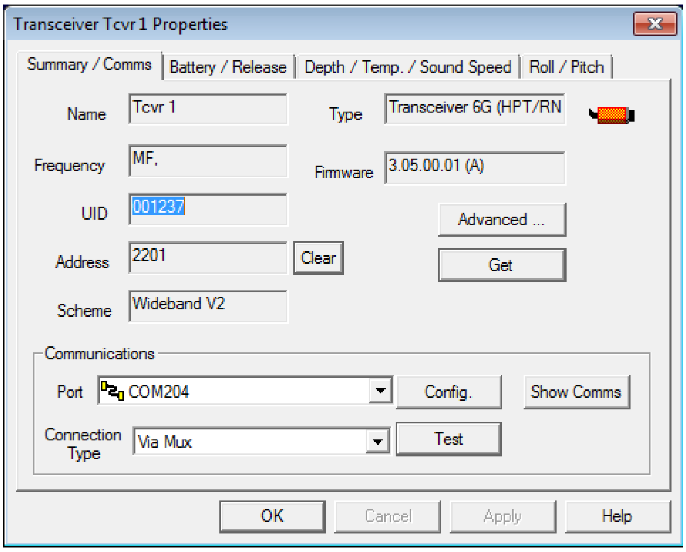


Note

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.

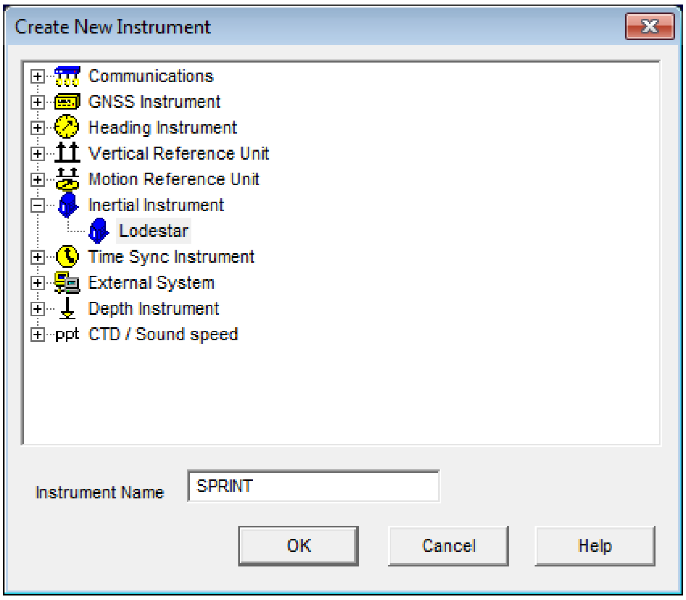
5. On the Transceiver LBL Tcvr Properties **Summary/Comms** tab, click **Test** to check connection and communications to the Transceiver.

6. Once connection is established the Fusion software will confirm that the instrument is working.

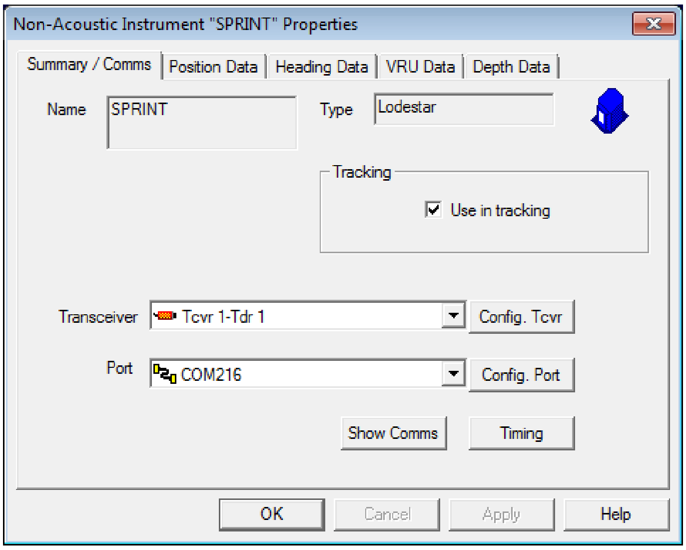


7. Click **OK** to close the Transceiver LBL Tcvr Properties page.

8. Add a SPRINT 300/500/700 from the non-acoustic INS instruments group on the job tree:



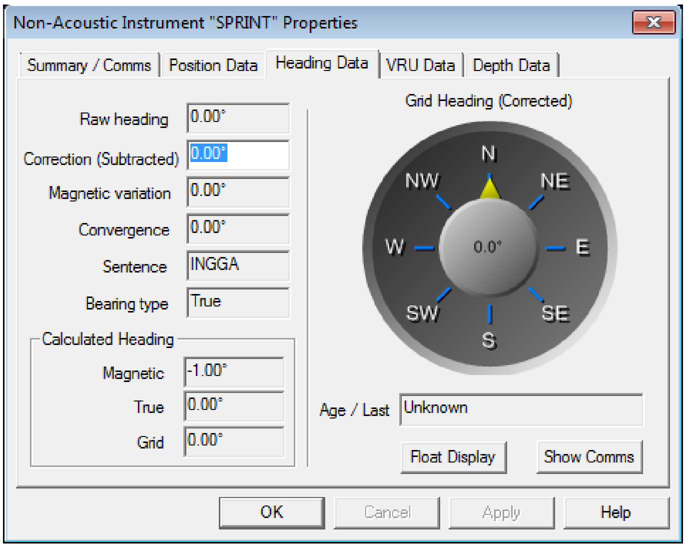
9. After adding the SPRINT 300/500/700, specify the PC COM port that has been configured in the SPRINT system.



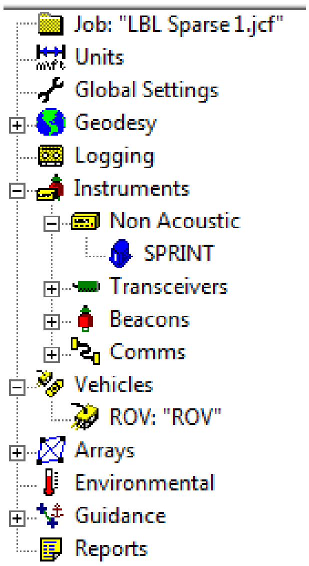
10. The PC port may be a physical COM port of a virtual serial port pair if Fusion is running on the same PC as the SPRINT system.

11. Select the transceiver connected to the SPRINT 300/500/700 from the **Transceiver** drop-down list.

12. To check the SPRINT 300/500/700's output to Fusion, select either the **Heading**, **VRU**, **Depth** or **Position** tabs (the data displayed will be sourced from the SPRINT 500/700).

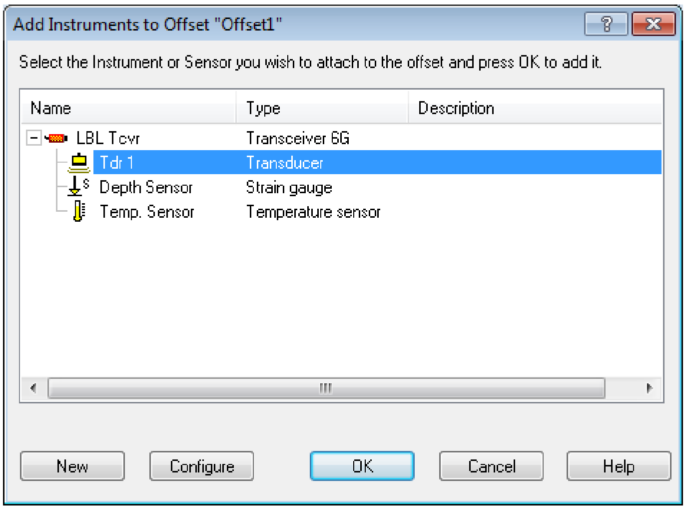


13. Click **OK** to close and save entered settings.
14. After adding the INS (SPRINT 500/700) and Transceiver, they should be listed on the Fusion LBL Job Tree.

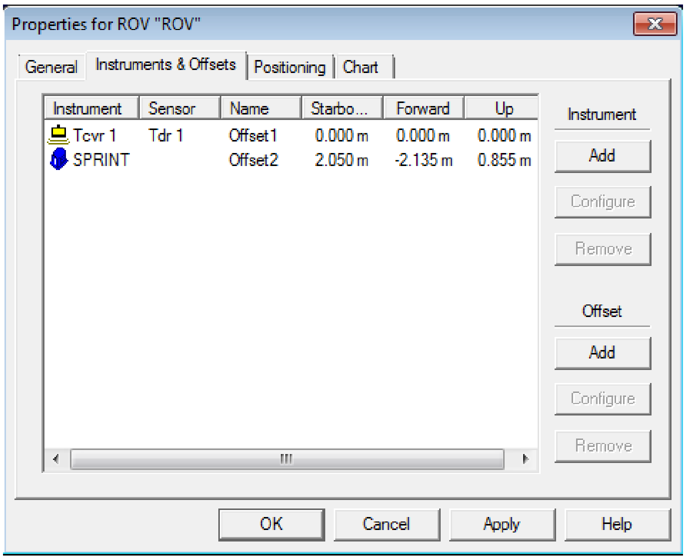


15. The instruments must now be added to an ROV. Select the ROV from the job tree and then open the **Instruments** tab on the ROV properties dialog box.

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



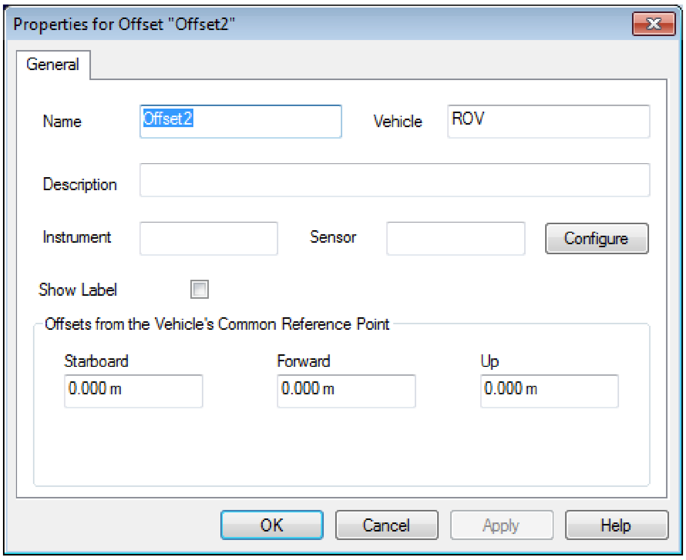
17. After adding each instrument, click **Configure** on the **Offset** pane and enter the instrument offsets.



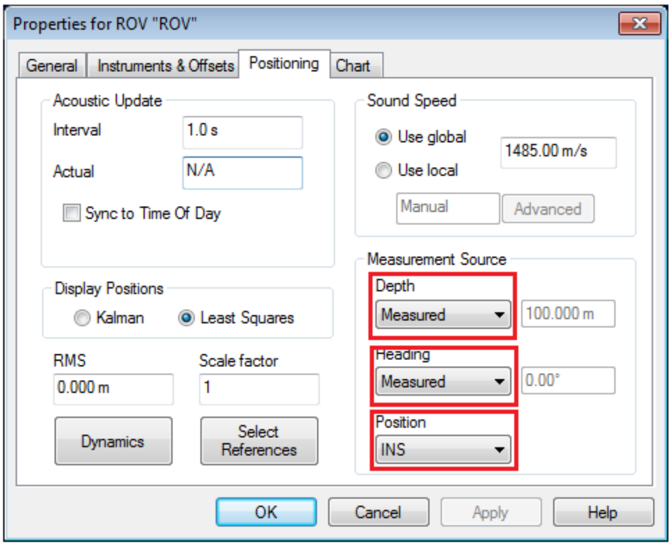
18. Enter the offsets for both instruments with respect to the vehicle CRP.

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.

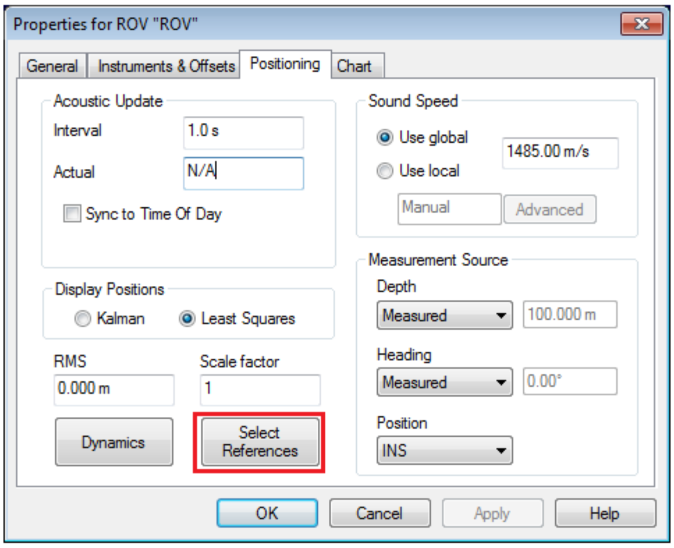


19. Click **OK** to close and save all entered settings.
20. On the **Properties for ROV** window, click the **Positioning** tab:



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.

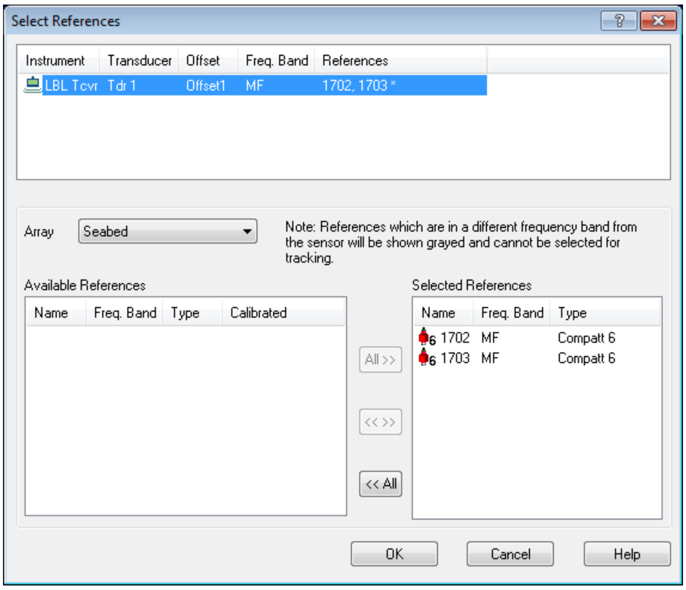
24. To specify the reference beacons for this ROV, click **Select References**.



Note

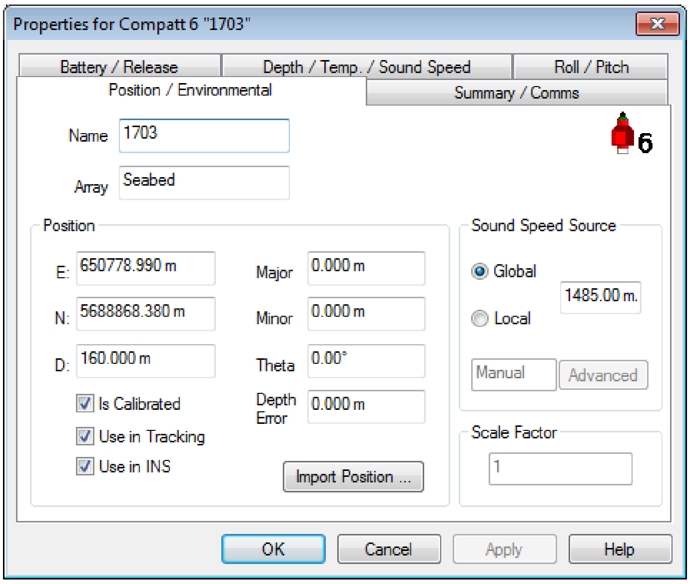
Not all reference beacons specified need to be used for INS LBL aiding but must be specified if the SPRINT system is to record the observations for other purposes, such as post processing in Janus.

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.

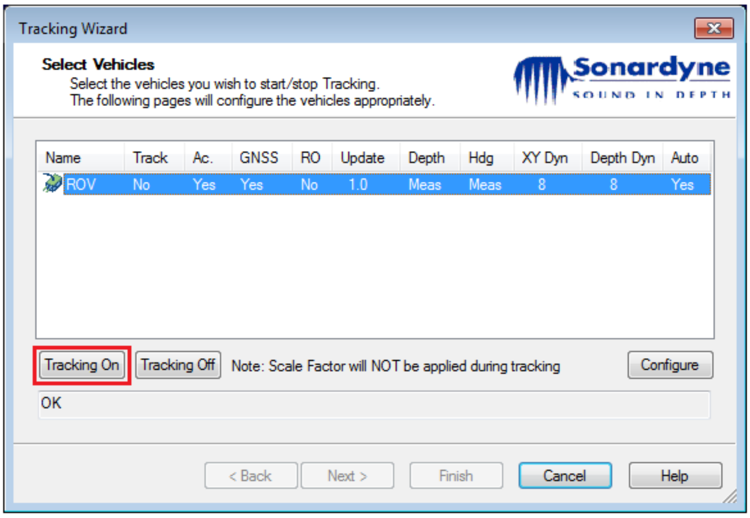
27. To disable a beacon for INS aiding but to still record LBL data in the SPRINT system (for use offline) open the properties page for the Compatt and deselect Use in INS.



28. The ROV can now be tracked using INS with LBL aiding; click the green **Go** button to start the tracking wizard.

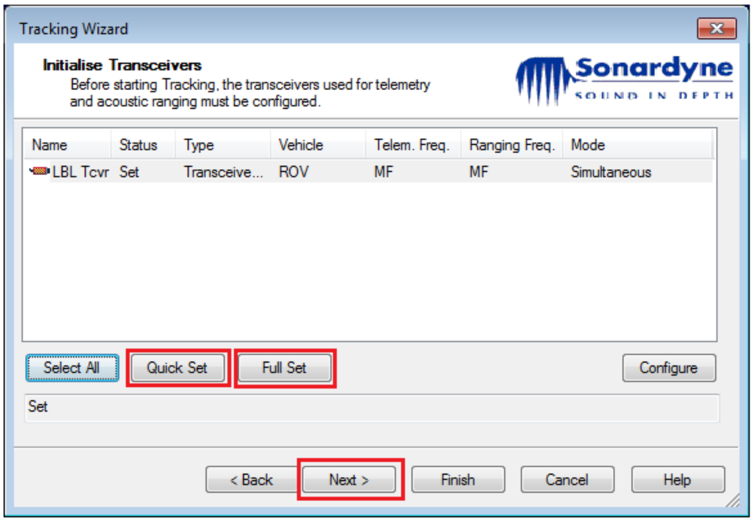
29. Select the correct ROV for tracking and then click **Tracking On**.

30. Click **Next**.

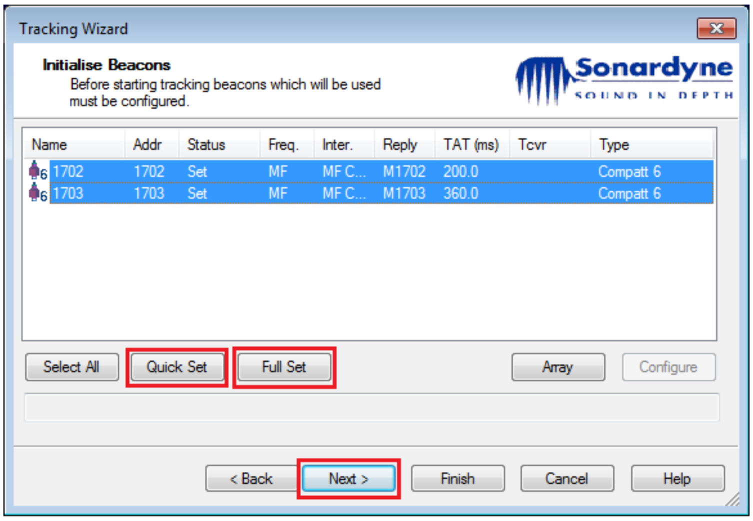


31. If prompted, the transceiver may need to be set by clicking either the **Quick Set** or **Full Set** button.

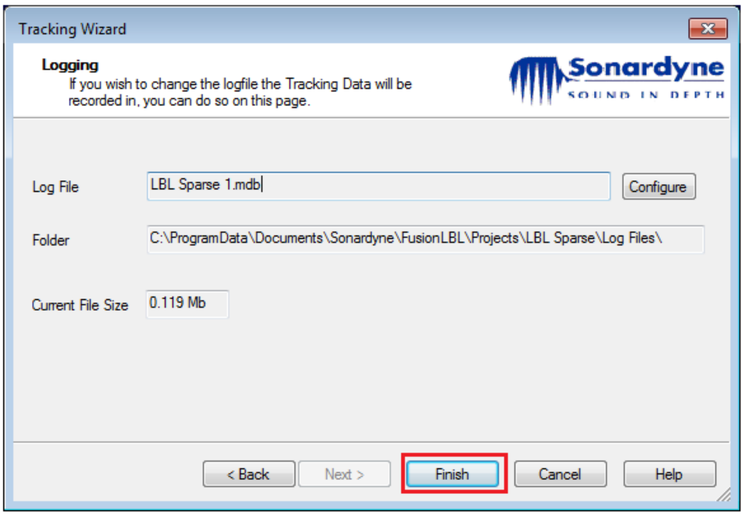
32. Click **Next**.



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.



6.4.24 Marksman & Ranger 2 USBL Aiding

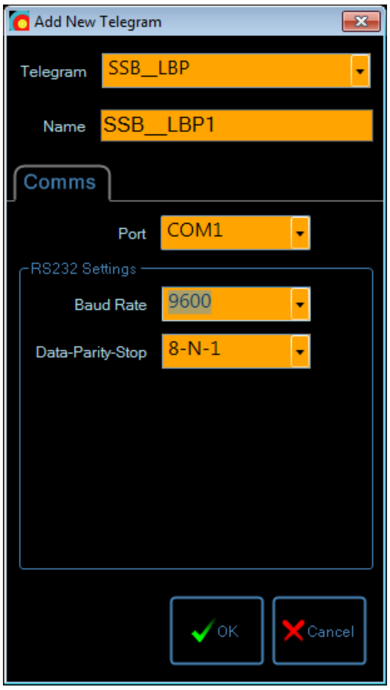
This procedure assumes the USBL system has already been configured as follows:

- 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.

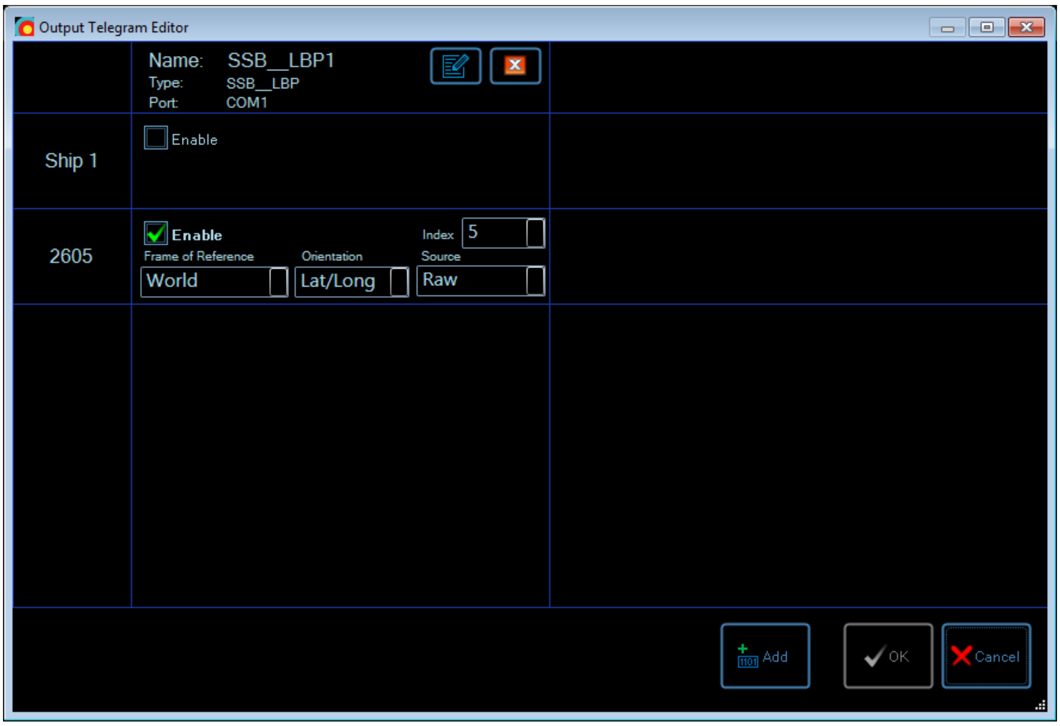
To interface Marksman or Ranger 2 USBL to the SPRINT system for aiding:

1. Add a new SSB telegram output.

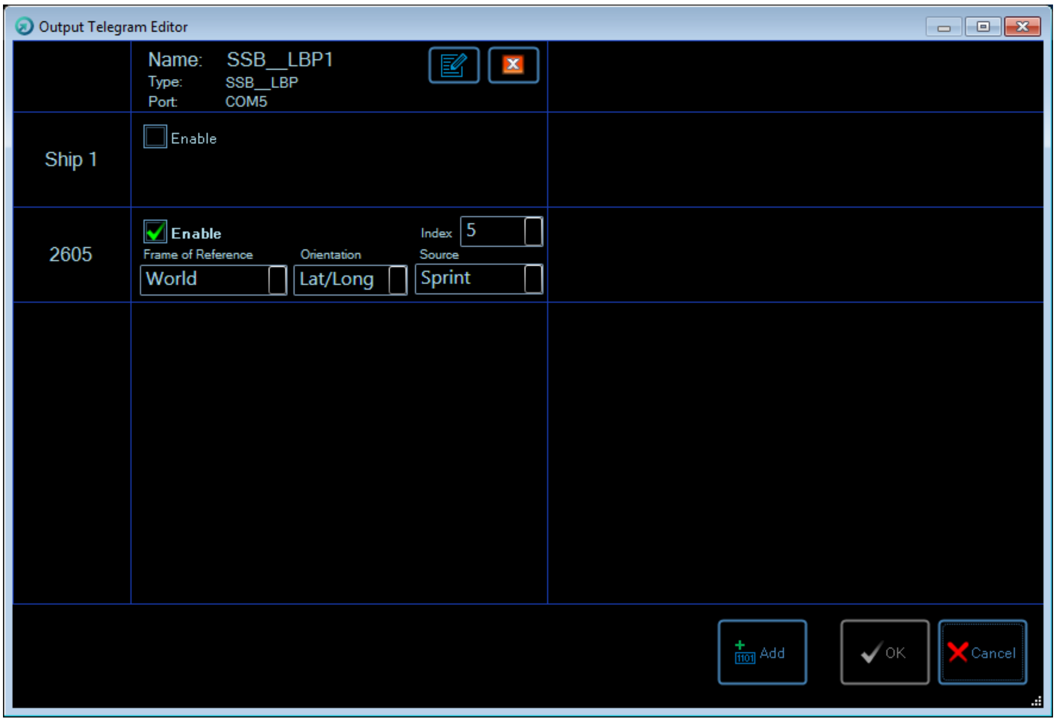
2. Select **9600** as the baud rate and select an appropriate port to output the message to the SPRINT system.



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



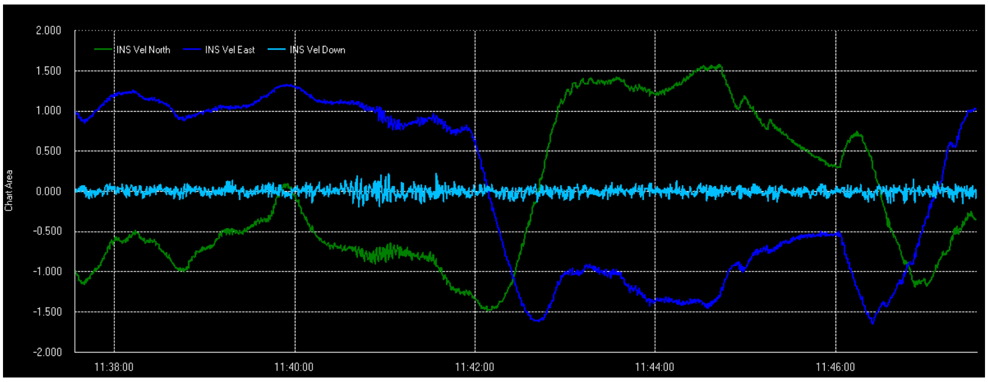
4. If using Marksman/Ranger 2 V4.06.01 or later. set the following telegram options:
   - Frame of Reference: select **World**
   - Orientation: select **Lat/Long**
   - Source: select **Sprint**



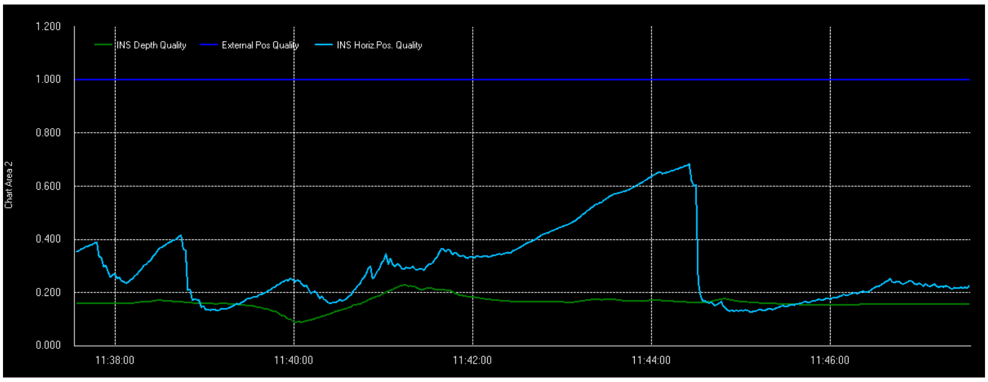
6.4.25 Time Series Plots

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.



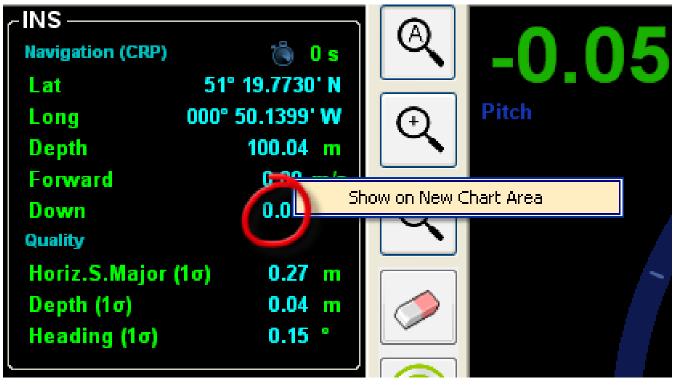
This time series plot shows INS Depth, External position and INS horizontal position qualities.



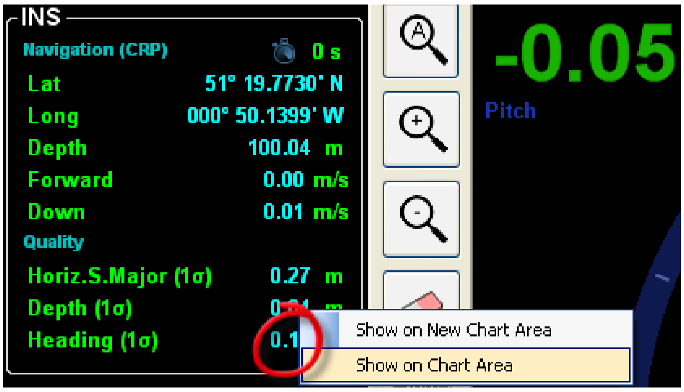
Displaying Plots

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

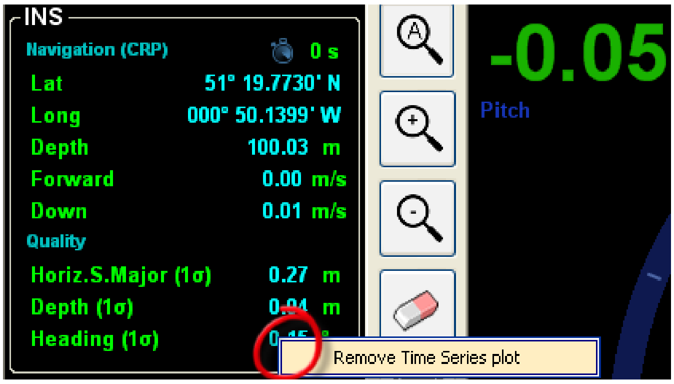
1. To display navigation measurements (apart from Lat and Long), quality and INS statistics, right-click a value on the navigation text panel and select **Show on New Chart Area**.



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**.



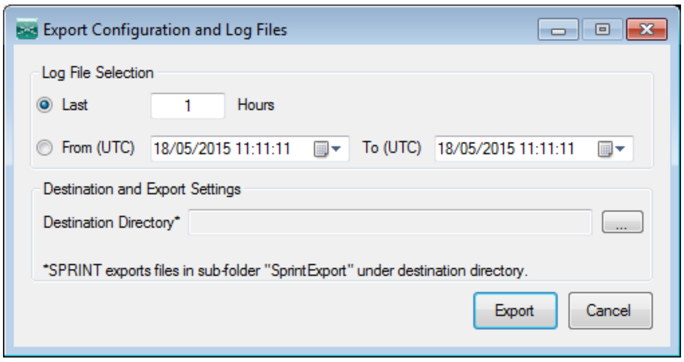
Note

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.

6.4.26 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.

6.5 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 6.3*	
2	Check Dongle is Valid	*Section 6.4*	
3	Configure the SPRINT 300/500/700 Connection	*Section 6.4.2*	
4	Configure SPRINT 300/500/700	*Section 6.4.3*	

No	Action	Manual Section	Checked (Sign and Date)
5	Configure Time Synchronisation	*Section 6.4.6*	
6	Configure USBL Aiding	*Section 6.4.7*	
7	Configure Depth Aiding	*Section 6.4.8*	
8	Configure DVL Aiding	*Section 6.4.9*	
9	Configure Sound Velocity	*Section 6.4.10*	
10	Configure LBL Aiding	*Section 6.4.11*	
11	Configure External Position Aiding	*Section 6.4.12*	
12	Configure GPS Aiding	*Section 6.4.13*	
13	Configure INS Aiding	*Section 6.4.14*	
14	Configure Options	*Section 6.4.15*	
15	Configure Logging	*Section 6.4.16*	
16	Configure Outputs	*Section 6.4.17* *Section 6.4.18* *Section 6.4.19*	

Note

See *Appendix G "SPRINT 300/500/700 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.

6.6 INS

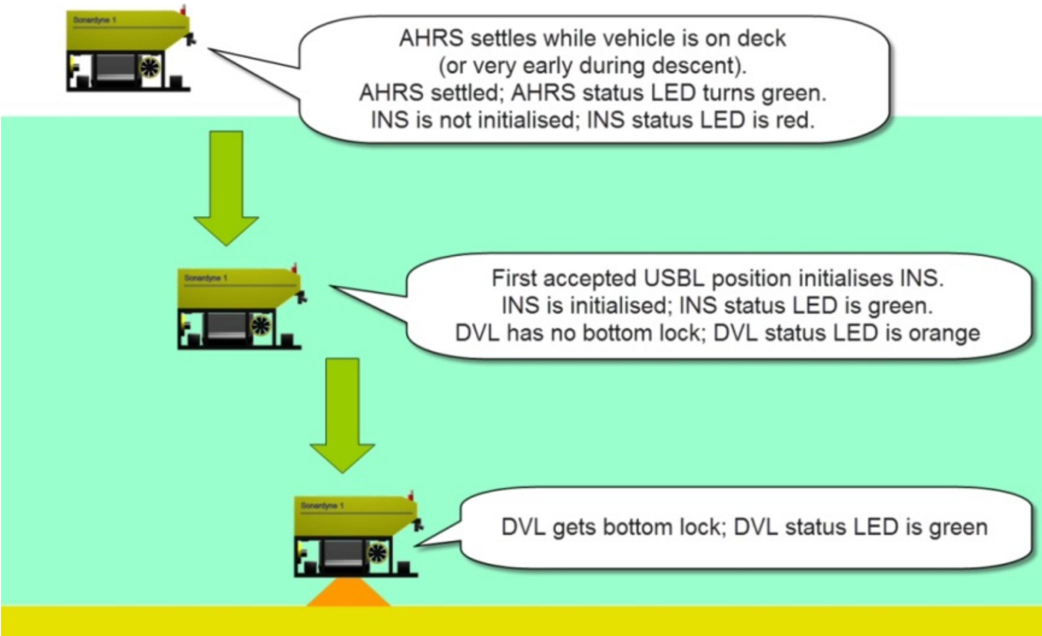
6.6.1 Initialisation

To initialise the INS:

1. The AHRS algorithm should be settled. This will take 10 minutes from the SPRINT 300/500/700 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 6.10.2 "System and Aiding Status"*.
2. The SPRINT 300/500/700 should be time synchronised. On the main software window the Time Synch status LED will be green when the SPRINT 300/500/700 is Time Synchronised; see *Section 6.10.2 "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 6–43 Descent and INS Initialisation Sequence

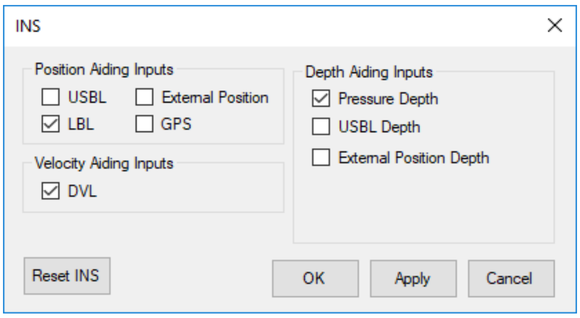


6.7 Fusion LBL Aiding

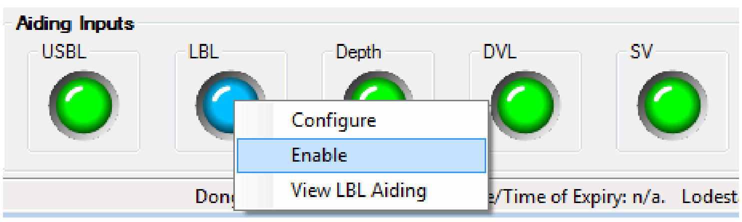
6.7.1 Transition from USBL to LBL aided INS

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 6.10.5 "INS with Fusion LBL Aiding"*.

6.8 Zero Velocity (ZUPT) Aiding

6.8.1 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.

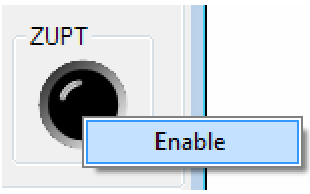
Note

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

6.8.2 Enabling Zero Velocity (ZUPT) aiding

Zero Velocity Aiding can be enabled by clicking the **ZUPT** button on the main SPRINT window, see *Figure 6–44*. It can disabled by pressing the **ZUPT** button again. When active the INS status on the navigation chart will display **Navigating (ZERO VELOCITY)**.

Figure 6–44 Enabling 'ZUPT' Aiding



6.8.3 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.

6.9 Pre-Dive Check List

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

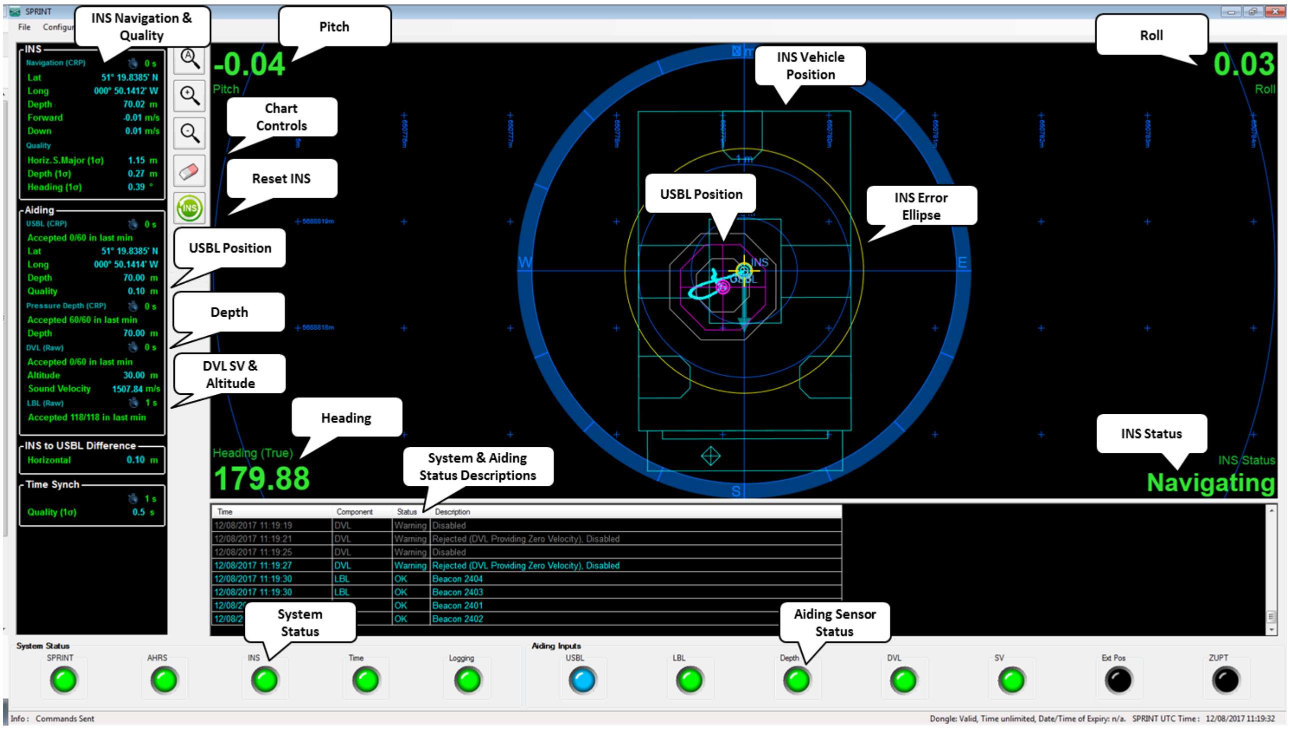
No	Action	Checked (Sign and Date)
1	Check the SPRINT 300/500/700 is powered.	
2	Check all aiding sensors (Depth, DVL, Sound Velocity, and LBL Transceiver) are powered.	
3	Check the default Latitude in the SPRINT system.	
4	Check the SPRINT 300/500/700, AHRS, Logging and Time Synch status LED's are green (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.	

6.10 Monitoring the System

6.10.1 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 6–45*.

Figure 6–45 SPRINT system Main Application Window



6.10.2 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 6–46 System and Aiding Status LEDs

The following system components are always monitored:

- SPRINT 300/500/700 (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 6–2 "System and Aiding Status Traffic Light LED Colours"*.

Table 6–2 System and Aiding Status Traffic Light LED Colours

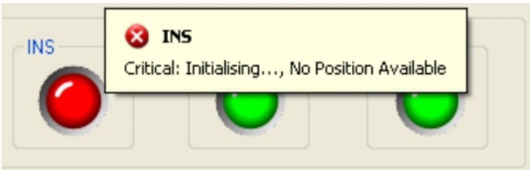
Status	LED Traffic Light Colour	Example States
Critical	Red	Communications Failure to Component Hardware Issue Component not Initialised or running correctly

Table 6–2 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 6–47* (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.

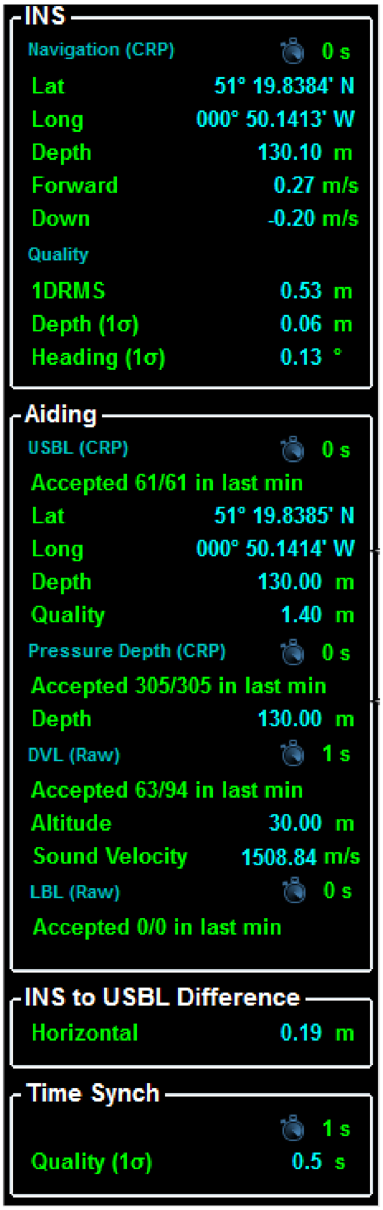
Figure 6–47 Component Status Popup



6.10.3 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 300/500/700 time synchronisation status.

Figure 6–48 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.

6.10.4 INS Statistics

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

Figure 6–49 INS Statistics

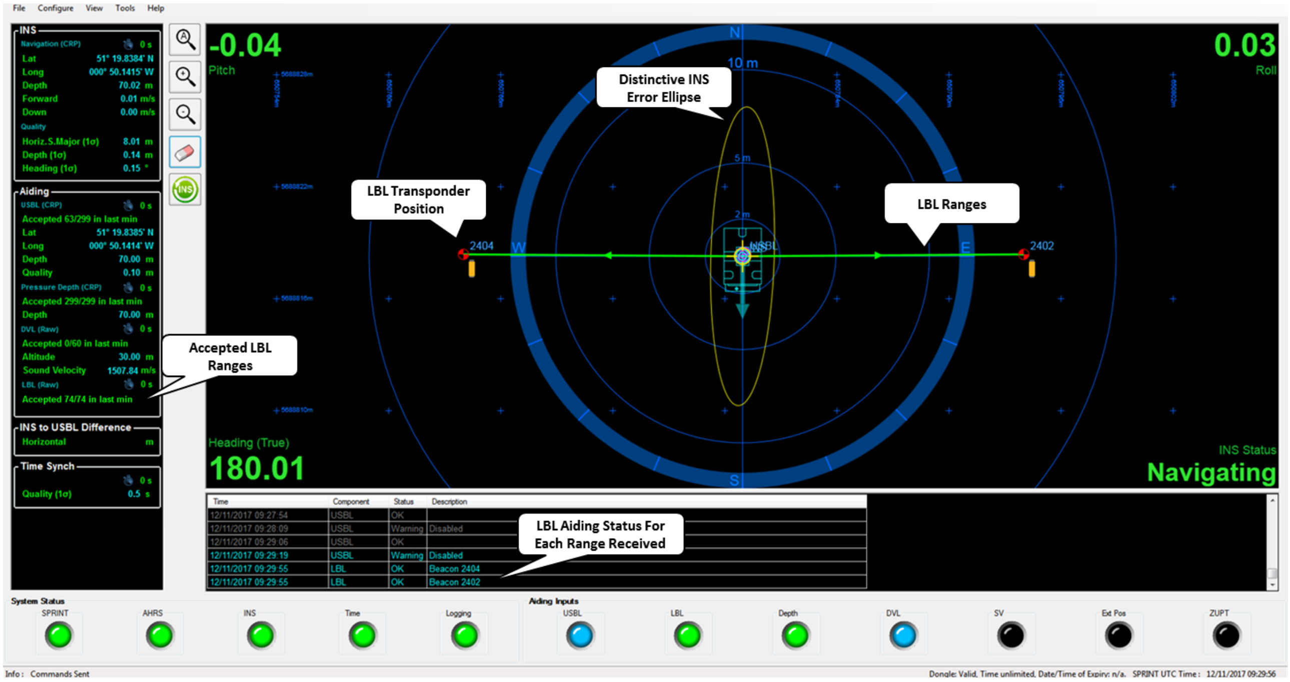
Note

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

6.10.5 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 6–50*. 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 6–50 SPRINT System with Fusion LBL Aiding



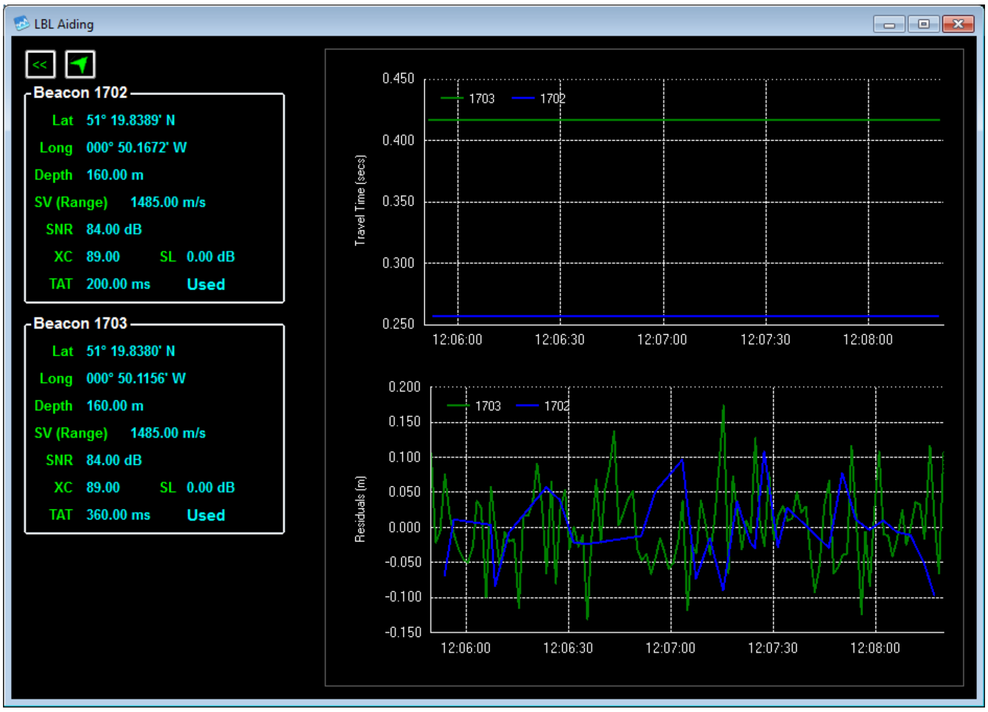
If any LBL ranges are rejected, the LBL aiding LED will change to amber/orange and the beacon address and reason for rejection will be displayed. Examples showing reasons of LBL rejection are shown in *Figure 6–51*.

Figure 6–51 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 6–52 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.

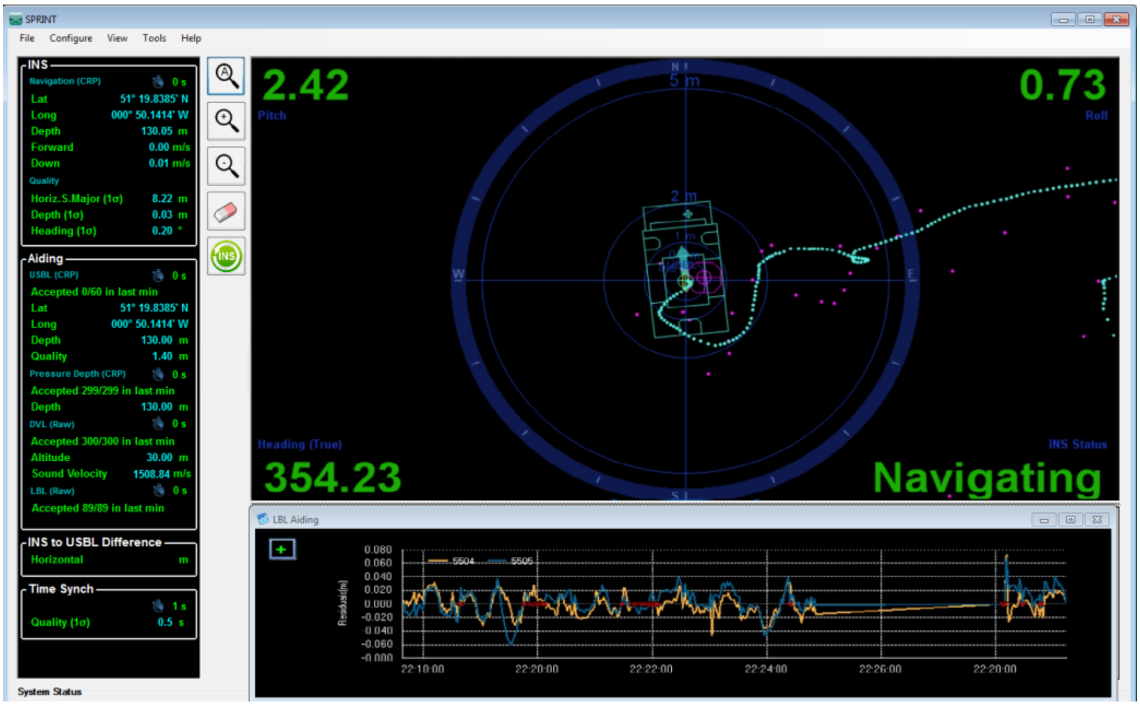
The upper graph displays travel time for all tracked beacons while the lower graph displays the LBL aiding range residuals. The residuals displayed are the differences between the INS estimated and the actual received LBL ranges and are therefore an extremely useful indication of LBL aiding health. The 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 6–53 Monitoring LBL Aiding

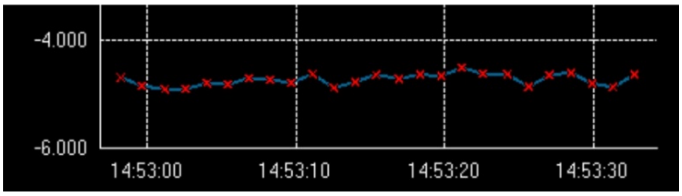


If the residuals are not centred around zero, this would indicate that there is a systematic error with LBL aiding, such as:

- 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.

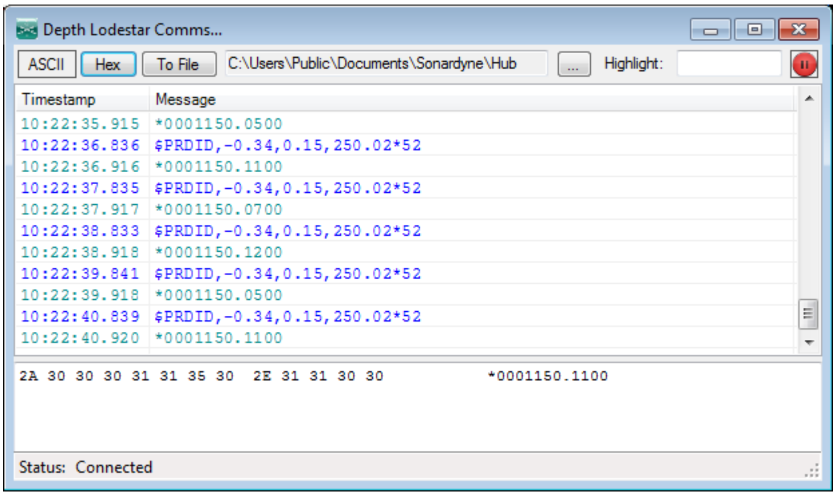
Figure 6–54 LBL Aiding Rejection in Residuals Graph



6.10.6 Communications Monitor

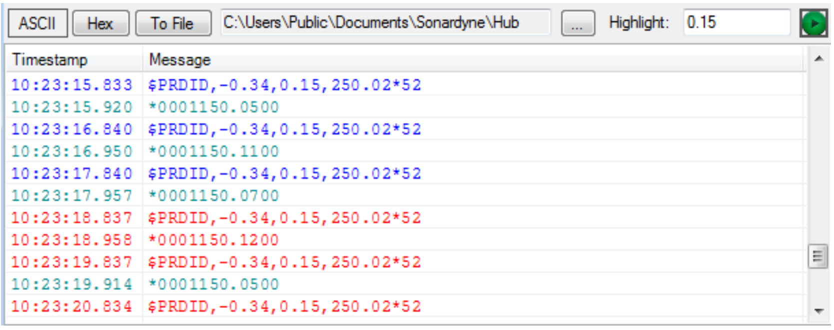
On any of the dialog boxes in the SPRINT system that allow the configuration of input or output communication, a comms monitoring function is provided. When the **Comms** button is clicked, a new window is displayed showing the received or sent data on the configured port; see *Figure 6–55*. The actual message contents are provided in the **Message** column.

Figure 6–55 Communications Monitor



The data received on the port is displayed green and the data sent on the port displayed blue as shown in *Figure 6–55*. 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 6–56 Communications Monitor Filter



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

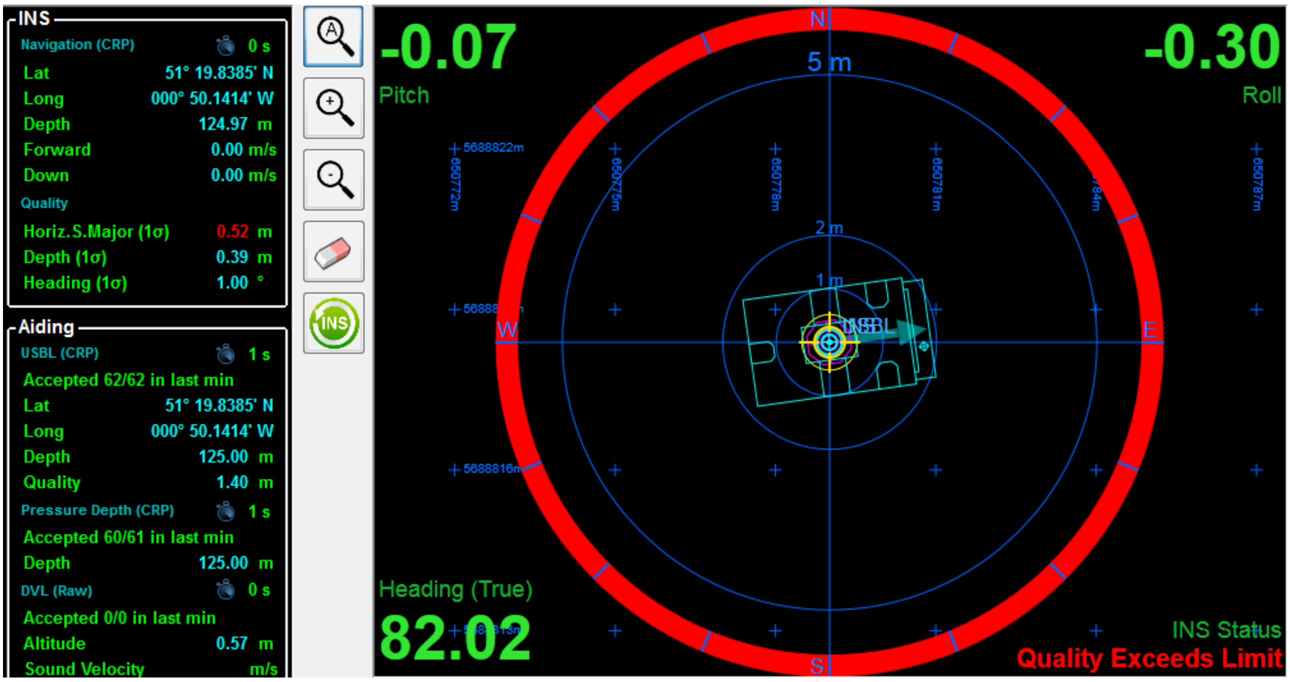
6.10.7 Navigation Quality Limits

Navigation quality limits can be enabled and configured in the SPRINT system; see *Section 6.4.15 "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 6–57*:

- 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 6–57 Navigation Quality Limits Exceeded



6.11 DVL Calibration Procedure

An accurate calibration will typically require ~15–20 minutes of manoeuvring at the seabed. A quick calibration can be done in just a few minutes.

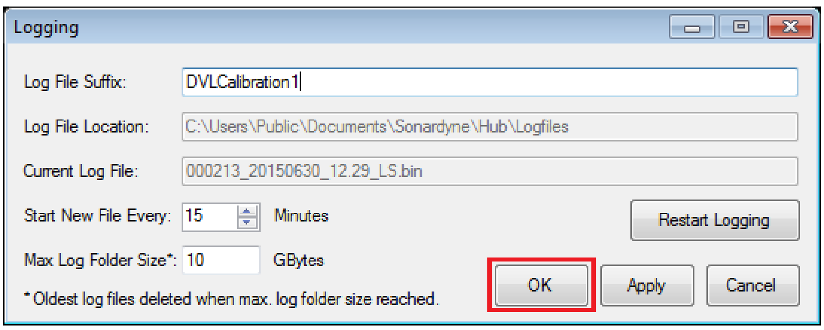
Prior to the start of the calibration, make sure the following conditions apply:

- The subsea vehicle must be within DVL range of the seabed with good bottom lock.
- The subsea vehicle is being tracked with USBL and the SPRINT system is receiving USBL aiding.
- The Pressure Depth input is active and the SPRINT system is receiving Pressure Depth aiding.
- The correct sound velocity is being used by the SPRINT system.

Follow the instructions below to undertake a DVL calibration.

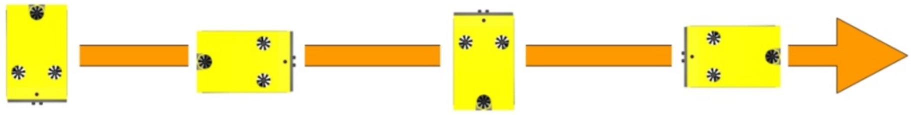
1. It is recommended to start a new log file with a suffix that will be clearly identifiable as DVL calibration data.
2. Open the **Logging** dialog box and enter the required log file suffix (e.g. **DVLCalibration**).

Figure 6–58 DVL Calibration Logging Configuration



3. Click **OK** to close and save all entered settings.
4. The subsea vehicle can now undertake some specific manoeuvres. A suggested and efficient approach would be to travel along an approximate linear path and the vessel to follow the ROV and maintain a constant heading (to minimise USBL systematic error) whilst performing:
   - Accelerations along various axes including up/down.
   - Heading changes +/- 90°, i.e. sideways movement maintained for a few minutes.
   - Random high dynamic manoeuvres
5. A total position change of ~500 metres is sufficient. For deep water, make the trajectory/duration longer for optimum performance.

Figure 6–59 DVL Calibration ROV Manoeuvres



6. To minimise USBL systematic error, the surface vessel must follow the ROV, maintaining a fixed heading (directly above the ROV) during the calibration.
7. When the calibration manoeuvres have been completed the subsea vehicle can continue with other operations.
8. Open the **Logging** dialog box and enter a log file suffix to indicate the log files no longer contain any DVL calibration data, the default log file suffix is **LS**.
9. Create a working folder on the hard drive for the DVL calibration log files; e.g. **My Documents\DVLCal** and create a subfolder in the working folder called **LogFiles**.

Note

SPRINT system binary log files have a .BIN extension.

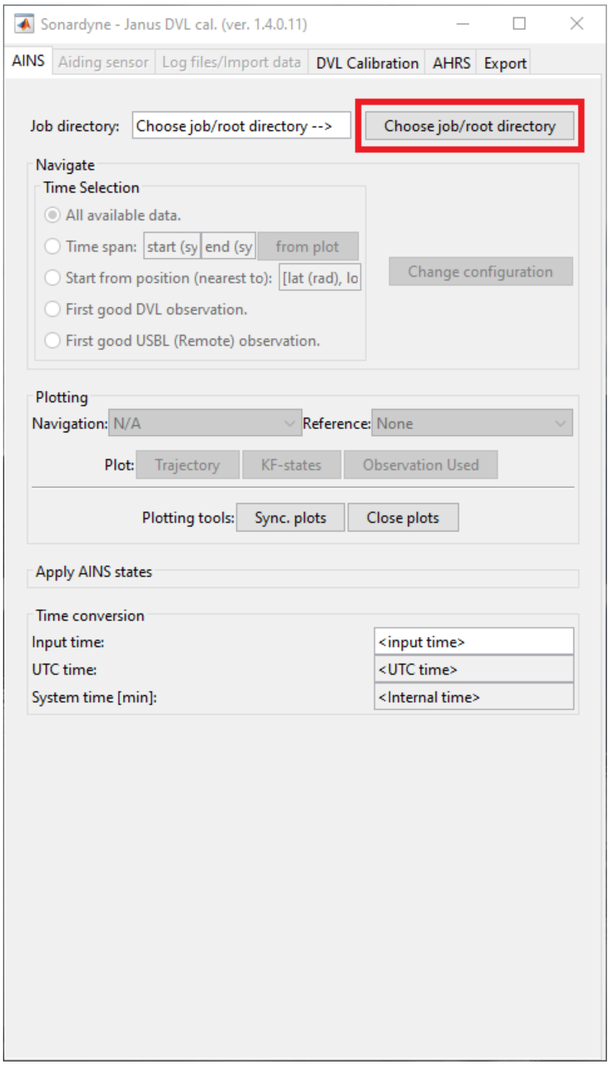
10. Copy the relevant log files from the SPRINT system logging location into the **LogFiles** folder.

Note

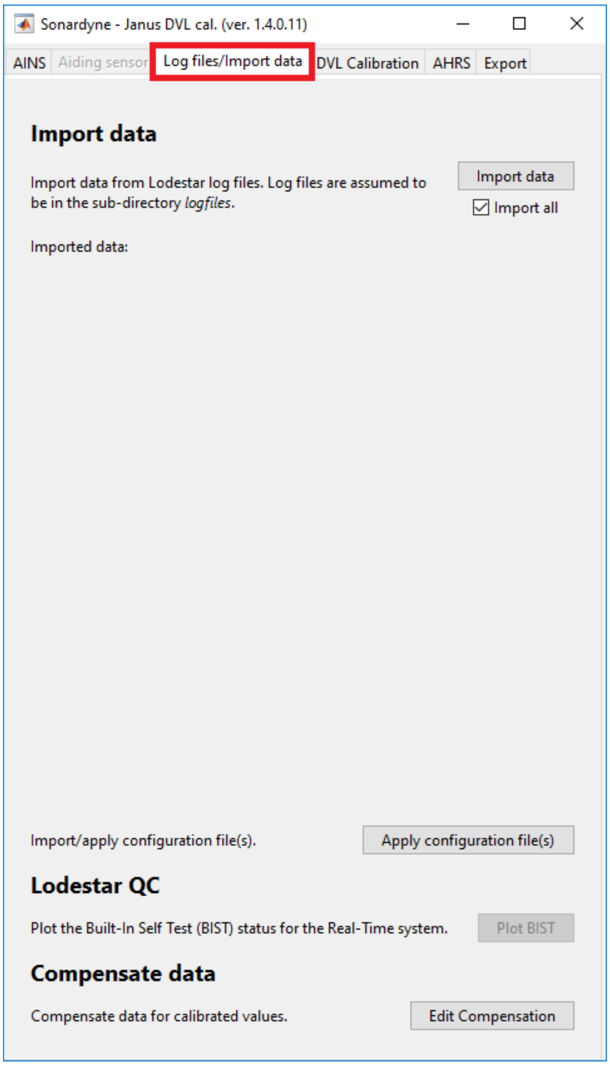
It is important to only copy the log files covering the time period of the DVL calibration manoeuvres as time taken to process the log files will increase with the amount of data used.

11. Run the DVL Calibration tool by double-clicking the icon on the desktop (it may be necessary to wait up to 10 seconds for the application to run)
12. The DVL calibration application will open on the **AINS** tab.

13. Click the **Choose job/root directory** button and select the parent working folder, e.g. **My Documents\DVLCal** and then click **OK**.

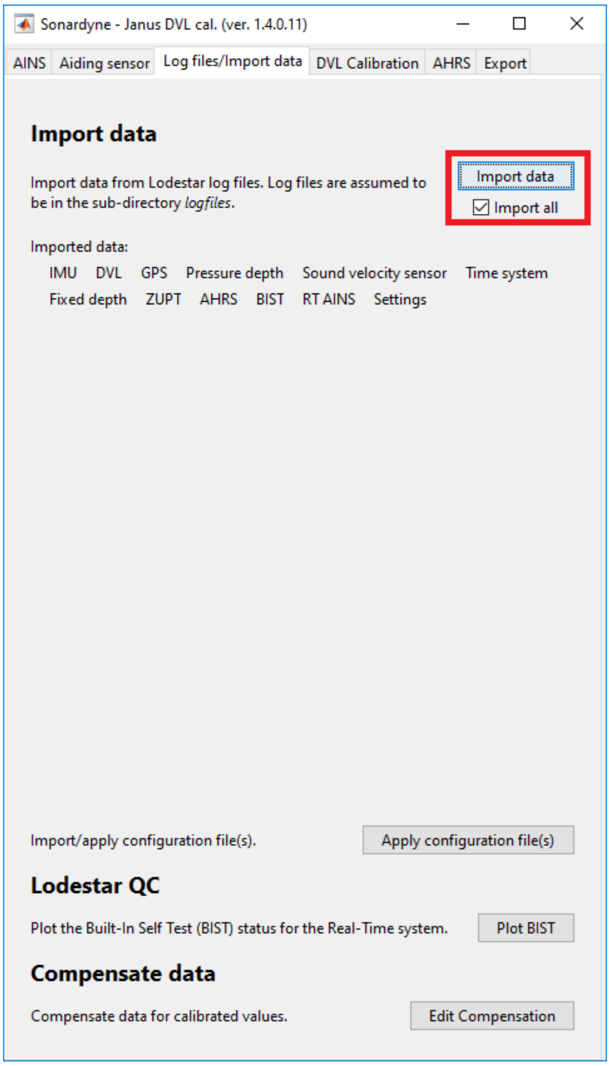


14. Click the **Log files/Import data** tab.

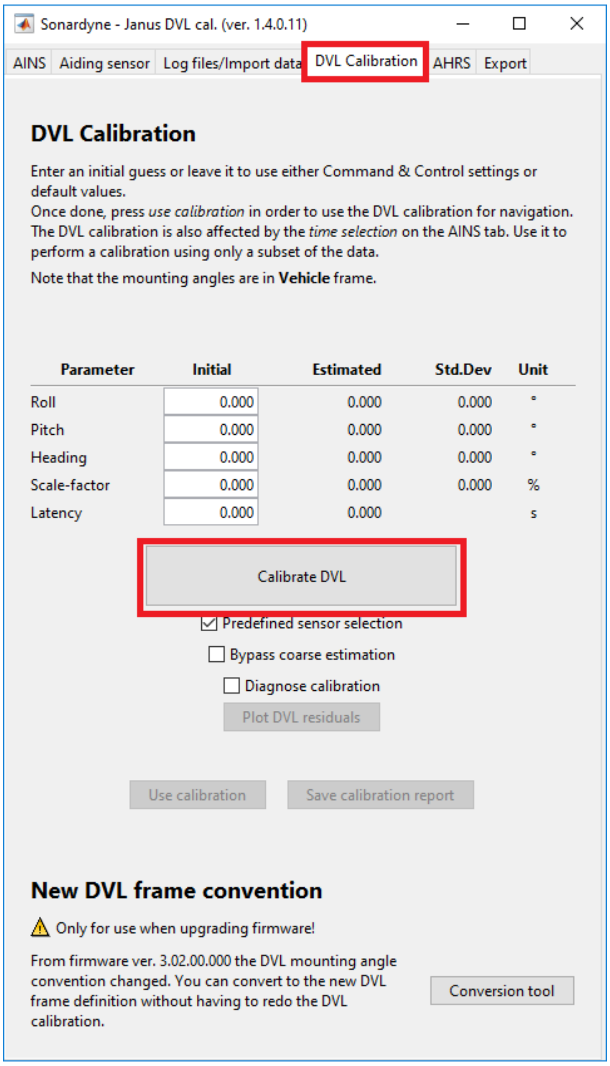


15. Click **Import data** to import the data from the log files (this may take several minutes).

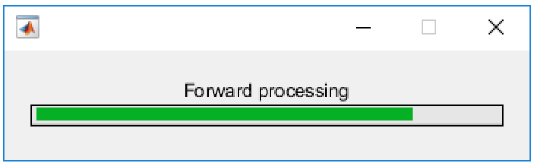
16. When the import is completed a list of imported data is displayed.



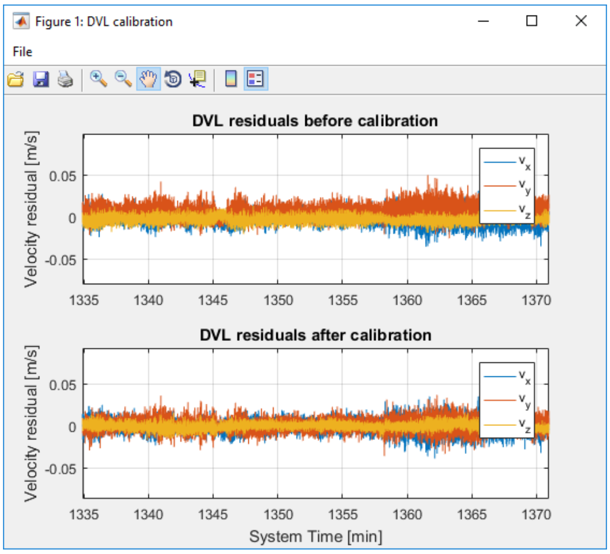
17. Click the **DVL Calibration** tab.



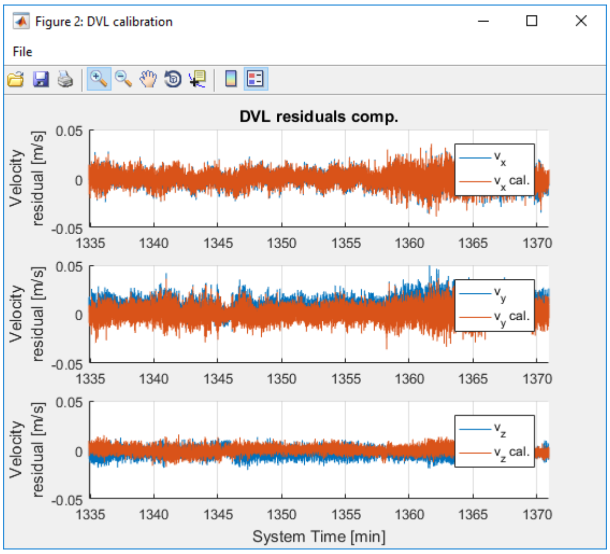
18. The initial (default) values will be displayed (they do not need to be modified).
19. Click **Calibrate DVL** (a progress indicator shows the processing status).



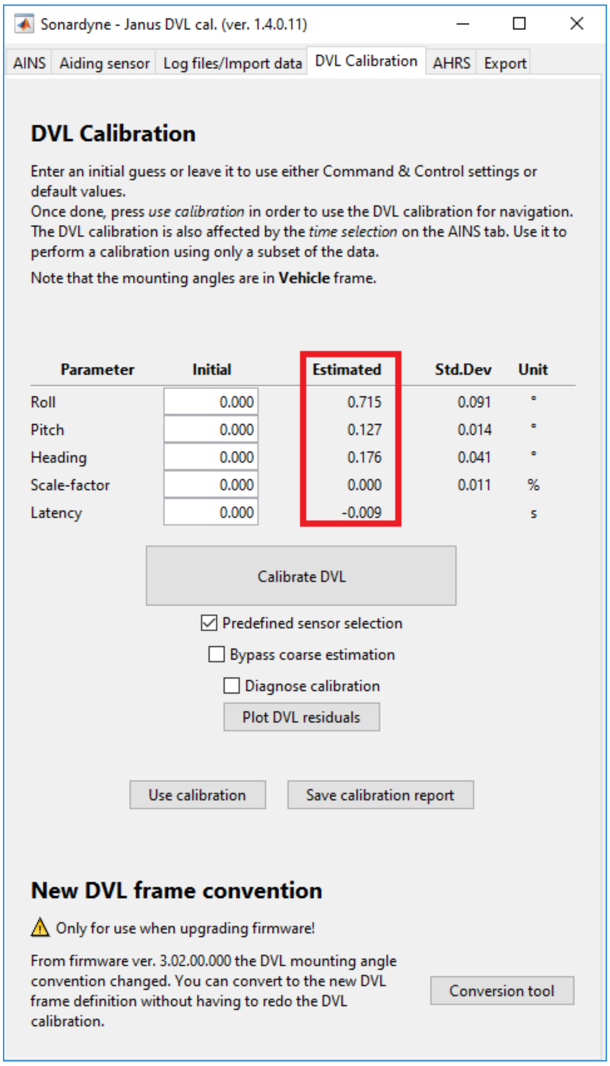
20. When completed, two figures will be displayed. **Figure 1: DVL Calibration** displays the DVL velocity residuals for all axes before and after calibration.



21. **Figure 2: DVL Calibration** displays the DVL velocity residuals for each axes before and after calibration.



22. On the **DVL Calibration** tab the estimated calibration values are displayed.



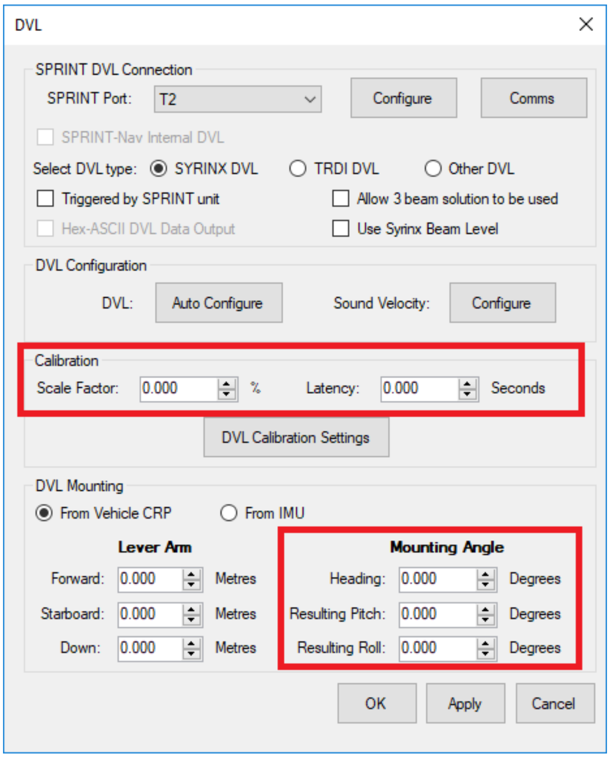
23. It is recommended that a (PDF) copy of the DVL calibration report is saved by clicking **Save calibration report** and specifying an appropriate location.

24. Open the report to retrieve the results (they are also available directly from the **DVL Calibration** tab).

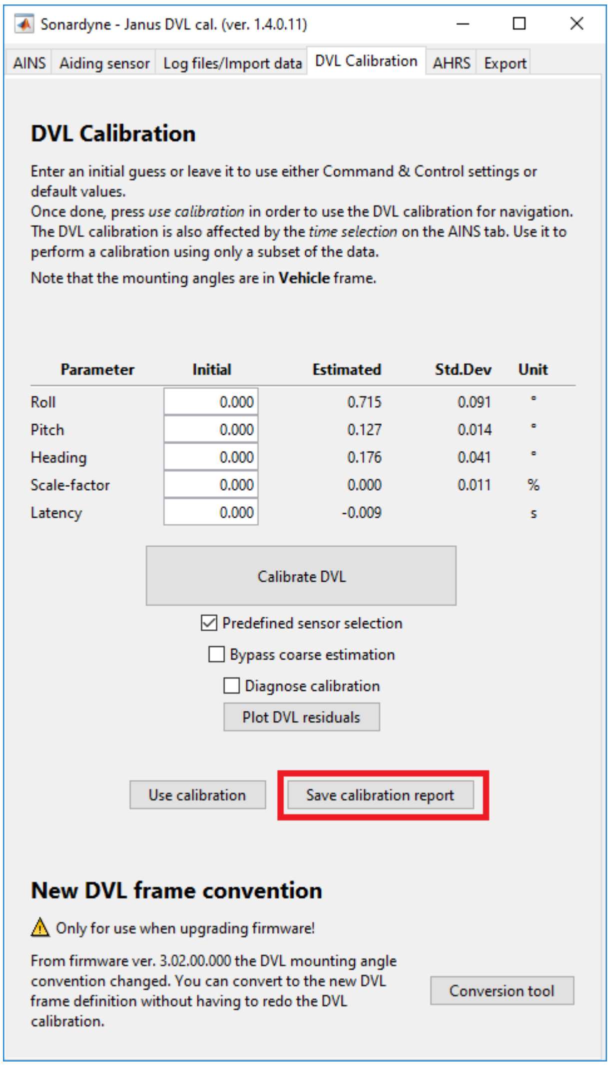
DVL params	a (roll) [º]	b (pitch) [º]	g (heading) [º]	Scale factor error [%]	Latency [s]
Before	0	0	0	0	0
Calculated	0.715	0.127	0.176	0	-0.009
Calculated Accuracy	0.091	0.014	0.041	0.011	

25. In the SPRINT system, navigate to the DVL dialog box; **Configure > INS > DVL Input**.

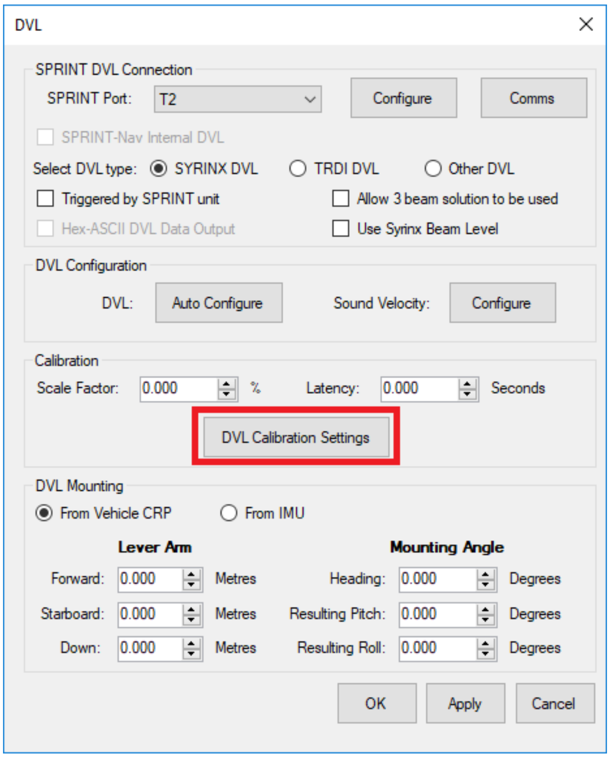
26. Enter the calculated values and click **Apply** or **OK** to save the changes.



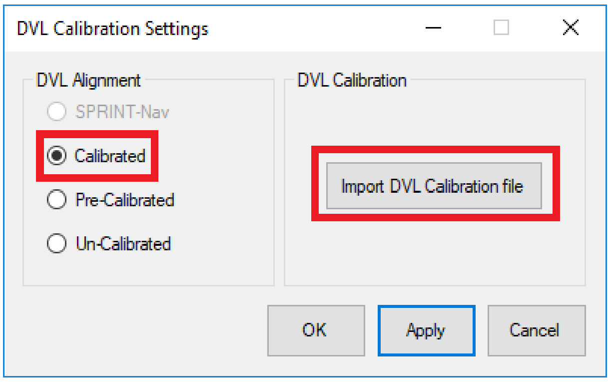
27. DVL Calibration results can be imported into the SPRINT system; click **Save Calibration Report** to produce the import file within the Janus DVL Calibration data folder.



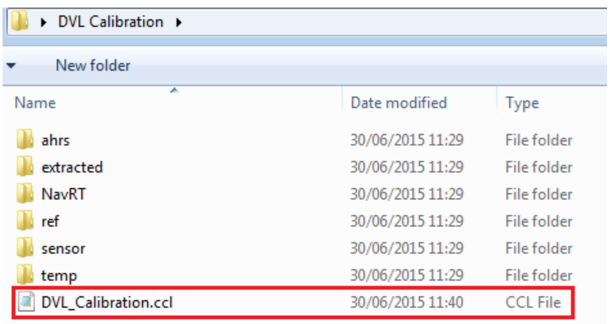
28. To apply the DVL Calibration settings, open DVL Aiding in the SPRINT system and click **DVL Calibration Settings**.



29. Select **Calibrated** on the **DVL ALignment** pane and then click **Import DVL Calibration File**.



30. Select the DVL Calibration file (.ccl) and then click **OK** to apply the DVL mounting angles, scale factor and latency.



Note

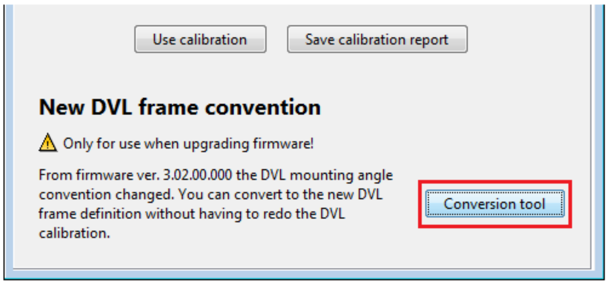
The DVL Calibration import is supported by Janus software V1.1 and above.

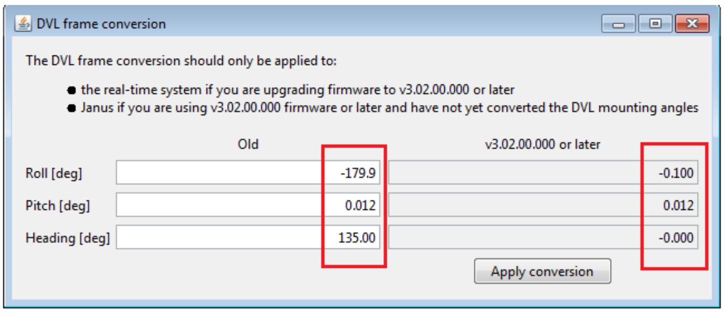
6.12 DVL Frame Convention

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.





Section 7 – Standalone AHRS Operation

7.1 Introduction

The SPRINT 300/500/700 can be configured and operated as a standalone AHRS as explained below.

7.2 Configuring using PC Utility

7.2.1 Connection

Connect the PC to the SPRINT 300/500/700 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 300/500/700 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 300/500/700's default settings.

If the SPRINT 300/500/700 is being used as a standalone surface AHRS then connect GPS to the SPRINT 300/500/700 using a spare IO port and arrange to supply the NMEA 0183 $GPGGA and $GPVTG sentences to the SPRINT 300/500/700.

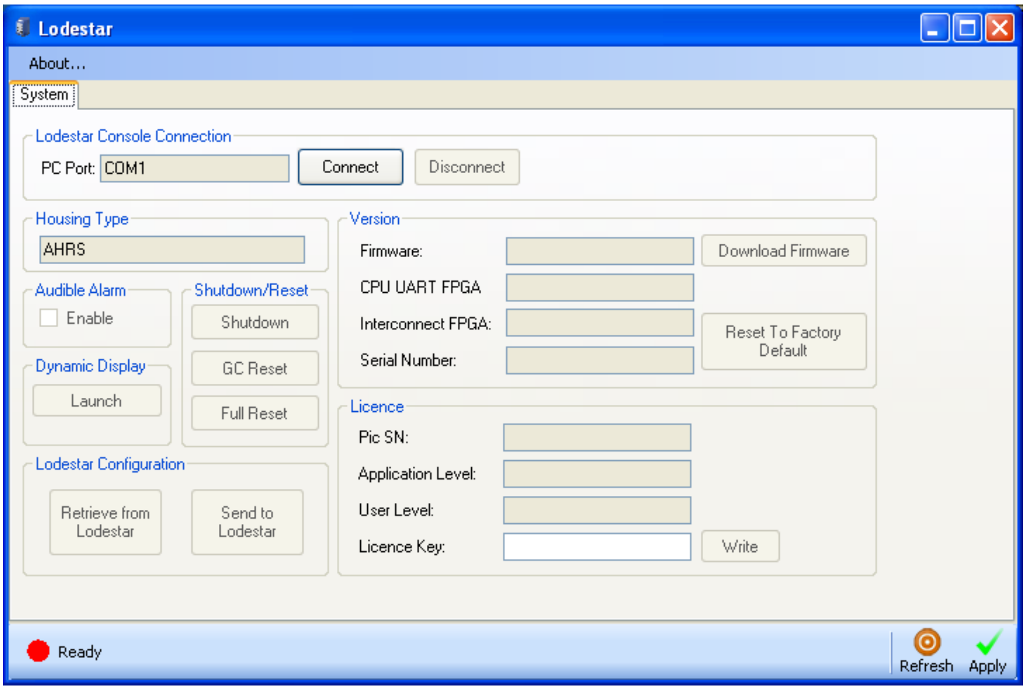
Connect the SPRINT 300/500/700's IO ports to the external instrumentation as required.

Start the SPRINT 300/500/700 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 300/500/700; see *Figure 7–1*.

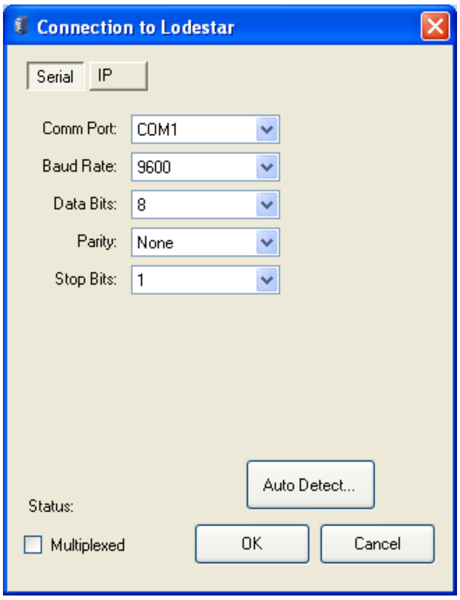
Configure the connection to the SPRINT 300/500/700 by clicking **Connect**.

Figure 7–1 Configuration Software Main Window (not connected)



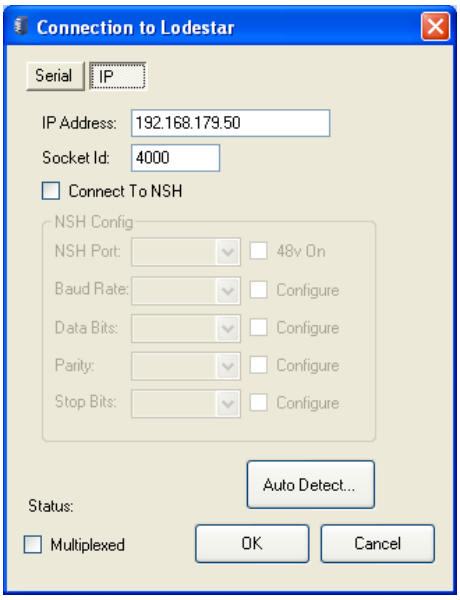
The application will default to a serial connection on PC port COM 1 as shown in below.

Figure 7–2 SPRINT 300/500/700 Serial Connection Settings



To configure an Ethernet or NSH connection, click **IP** and the default SPRINT 300/500/700 Ethernet connection parameters are displayed, as shown below.

Figure 7–3 SPRINT 300/500/700 Ethernet Connection Settings



Note

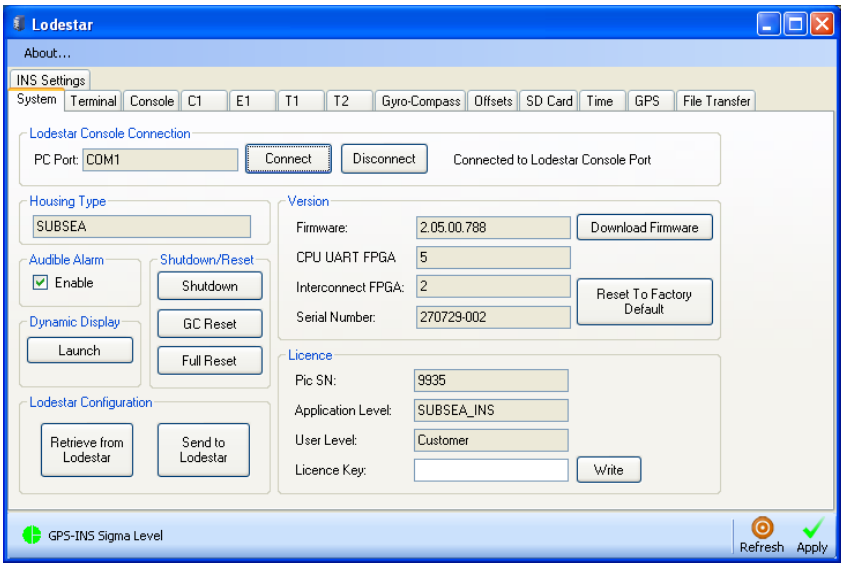
Before proceeding, make sure the SPRINT 300/500/700 has been running for at least one minute before trying to connect via the configuration software. This allows time for the SPRINT 300/500/700 to start up and receive commands.

Once the connection parameters match the physical connection between the SPRINT 300/500/700 and the PC, click **OK**.

A window will appear indicating communication status with the SPRINT 300/500/700.

Once connected, the software will populate with the SPRINT 300/500/700 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 300/500/700; see *Figure 7–4*.

Figure 7–4 Configuration Software Main Window (connected)



Note

If the status indicator remains red and the SPRINT 300/500/700 configuration is not updated, the software was unable to connect to the SPRINT 300/500/700. Check the SPRINT 300/500/700 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 12 "Troubleshooting"*.

7.2.2 Shutdown and Reset

The SPRINT 300/500/700 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 300/500/700.
- **GC Reset** will restart the SPRINT 300/500/700 AHRS algorithms.
- **Full Reset** will re-boot the SPRINT 300/500/700, completely resetting it.

7.2.3 Gyrocompass Configuration

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

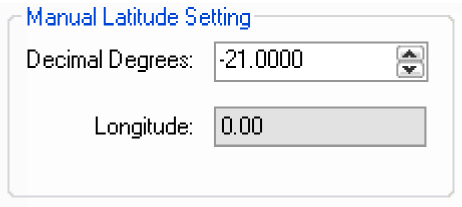
It is essential to set the default Latitude if the SPRINT 300/500/700 is operated without a GPS input. It is also important to set this parameter even when the SPRINT 300/500/700 is used with a GPS input, because the SPRINT 300/500/700 can revert to using the default Latitude if the GPS input fails for any reason.

Note

If the SPRINT 300/500/700 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 300/500/700 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.

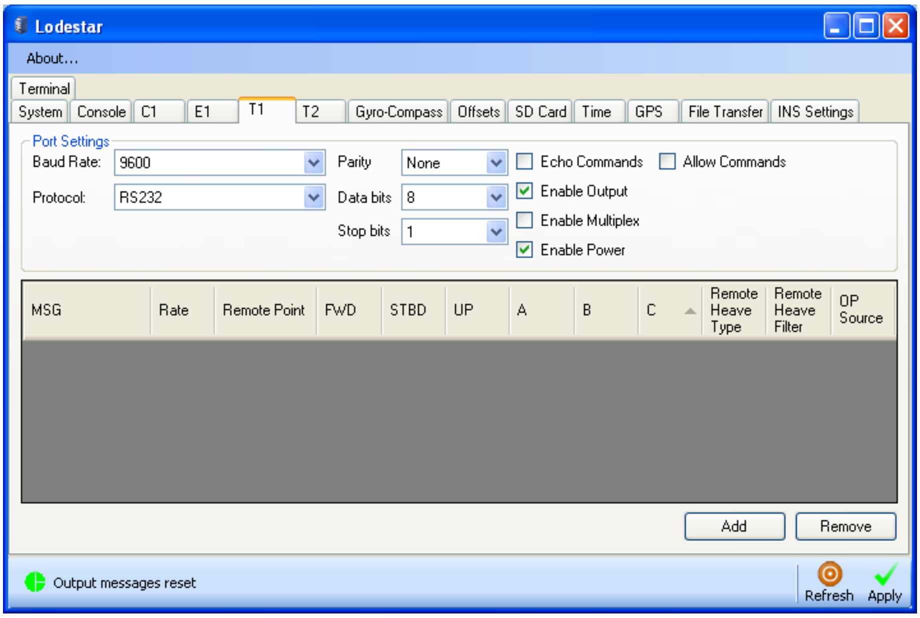
The default Latitude can be set by entering the operating Latitude on the **Manual Latitude Setting** pane; see *Figure 7–5*. After setting the Latitude, click **Apply** on the main application window.

Figure 7–5 Manual Latitude Setting Panel



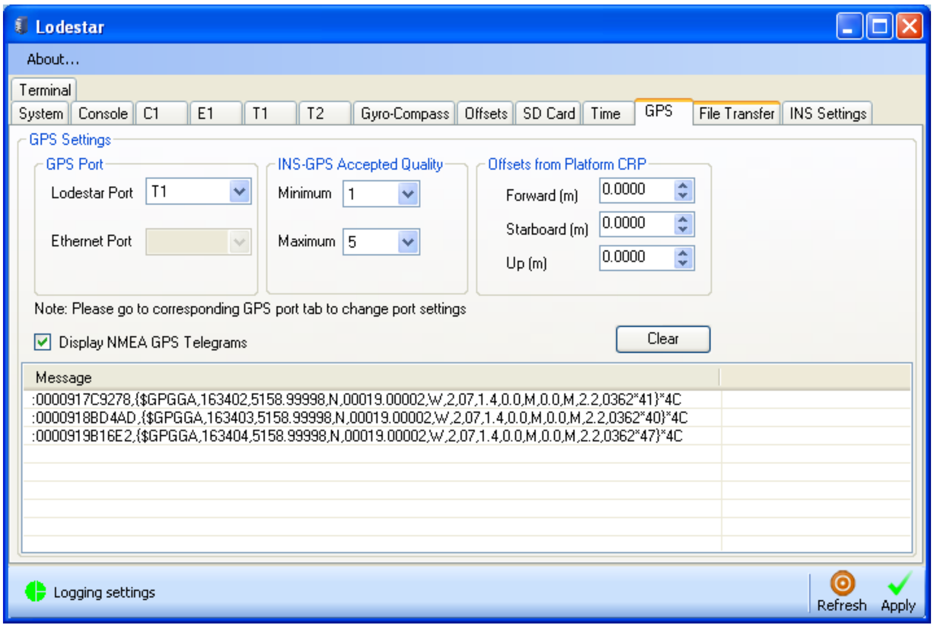
Where possible it is strongly recommended to connect a GPS receiver supplying the necessary NMEA 0183 GPGGA and GPVTG sentences to the SPRINT 300/500/700.

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**.

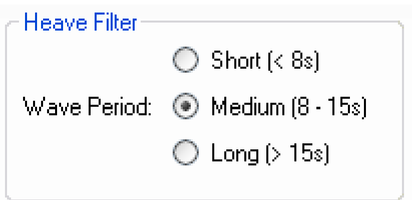


4. Click the **GPS** tab and configure the GPS port to be the port the GPS is connected (**T1**).
5. Enter the offsets from the vessel CRP to the GPS antenna and then click **Apply** to send the changes to the SPRINT 300/500/700.

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 300/500/700 can be configured on the **Heave Filter** for the anticipated surface wave period experienced by the vehicle.



7.2.4 Mounting Angle & Lever Arm Configuration

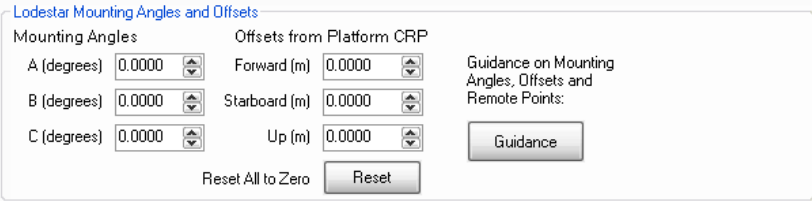
Click the **Offsets** tab on the configuration software.

If mounting angles for the SPRINT 300/500/700 need to be configured, this can be done by entering the appropriate values in the **A**, **B** and **C Mounting Angle** boxes, as shown in *Figure 7–6*. Similarly if there are any offsets that need to be applied for the SPRINT 300/500/700 with respect to the vehicle CRP these can be applied in the **Forward**, **Starboard** and **Up** entry boxes. See *Appendix C "SPRINT 300/500/700 Mounting Angle Examples"* for definitions and an example of the SPRINT 300/500/700 mounting angles and offsets.

CAUTION

It is strongly recommended the SPRINT 300/500/700 mounting angles are not modified while the SPRINT 300/500/700 is in operation as an AHRS device. When any changes are applied the user will be prompted to reset the SPRINT 300/500/700 AHRS algorithm and it will be several minutes before the SPRINT 300/500/700 output is settled.

Figure 7–6 Mounting Angles and Offsets Panel



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

SPRINT 300/500/700 measurements may be required for vehicle sensors that are not located near to the vehicle CRP, such as remote heave.

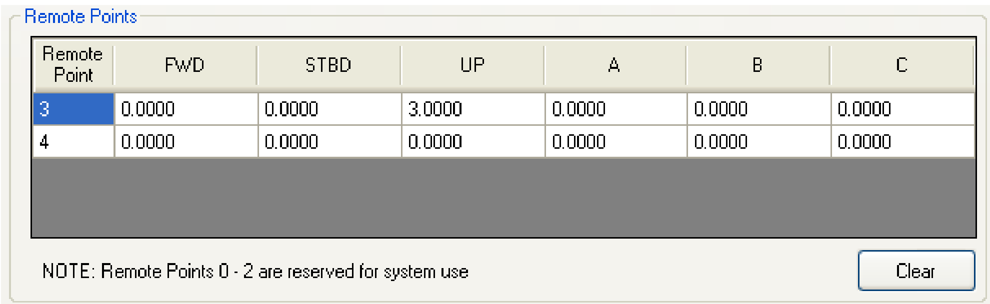
For the SPRINT 300/500/700 to be able to supply these systems with measurements, offset distances must be measured and applied in the SPRINT 300/500/700 configuration.

The SPRINT 300/500/700 supports up to two remote outputs (extendable on request) and these are listed in the **Remote Point** list; see *Figure 7–7*. 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 300/500/700 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 7–7 Remote Point List


Remote Points

Remote Point	FWD	STBD	UP	A	B	C
3	0.0000	0.0000	3.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

NOTE: Remote Points 0 - 2 are reserved for system use

Clear

Click **Guidance** on the **Offsets** tab to view a summary guidance page explaining the SPRINT 300/500/700 angles and offsets.

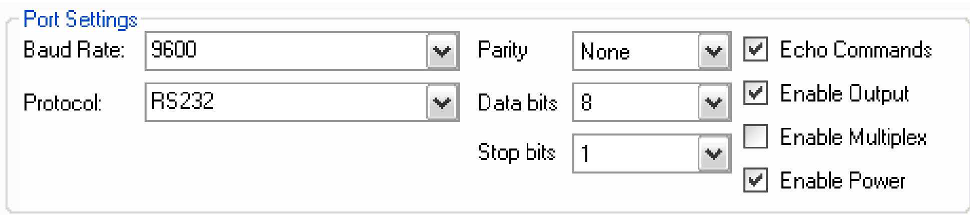
7.2.5 Port Configuration

The settings for each SPRINT 300/500/700 port are available by selecting the appropriate tab in the main application window.

Serial Ports

The settings for the port can be viewed or modified on the **Port Settings** Pane; see *Figure 7–8*.

Figure 7–8 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 300/500/700. 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:

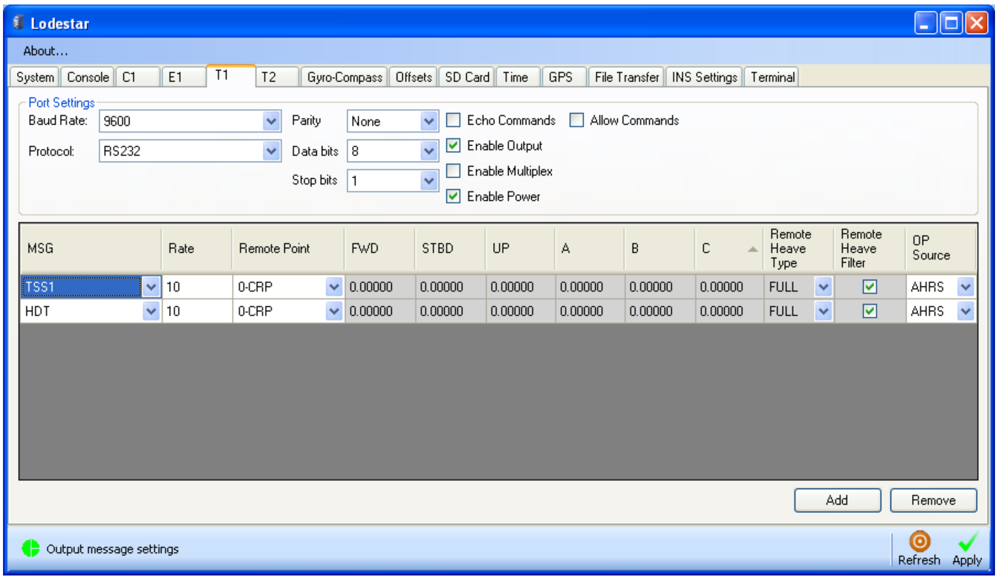
- Echo Commands will output any commands received by the SPRINT 300/500/700 on this port.
- Enable Output will turn the message output ON/OFF on this port.
- Enable Multiplex will enable/disable multiplex communications on this port.
- Enable Power will enable/disable power to this port.

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 7–9*.

Figure 7–9 Output Message Table



Note

The SPRINT 300/500/700 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 300/500/700.

Ethernet

The default IP settings of the SPRINT 300/500/700t are listed below:

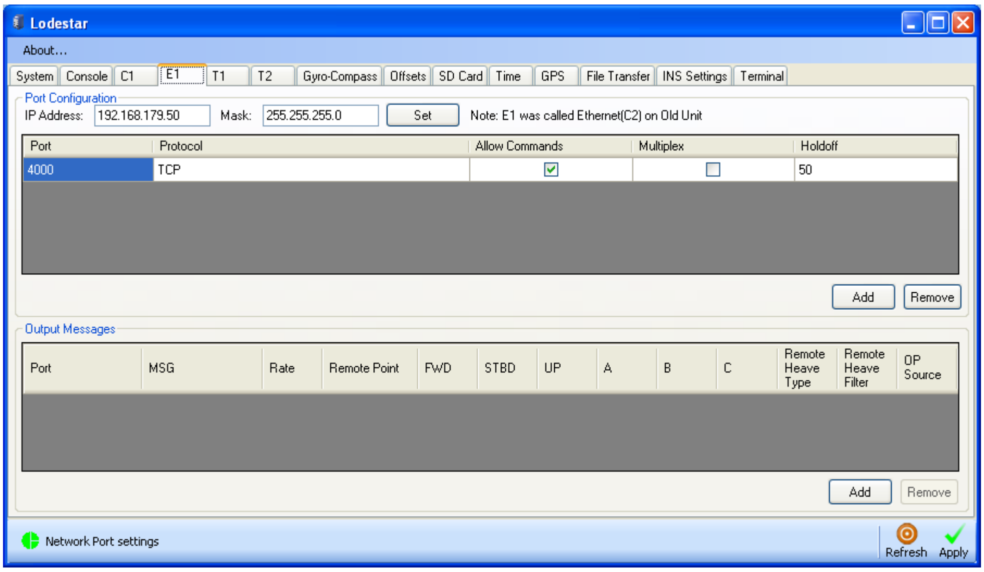
- IP Address: 192.168.179.50
- Subnet Mask: 255.255.255.0
- Command port/socket: 4000

Note

The command port 4000 is always available to make sure the user can always communicate with the SPRINT 300/500/700 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 7–10*.

Figure 7–10 IP Port Configuration Panel



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

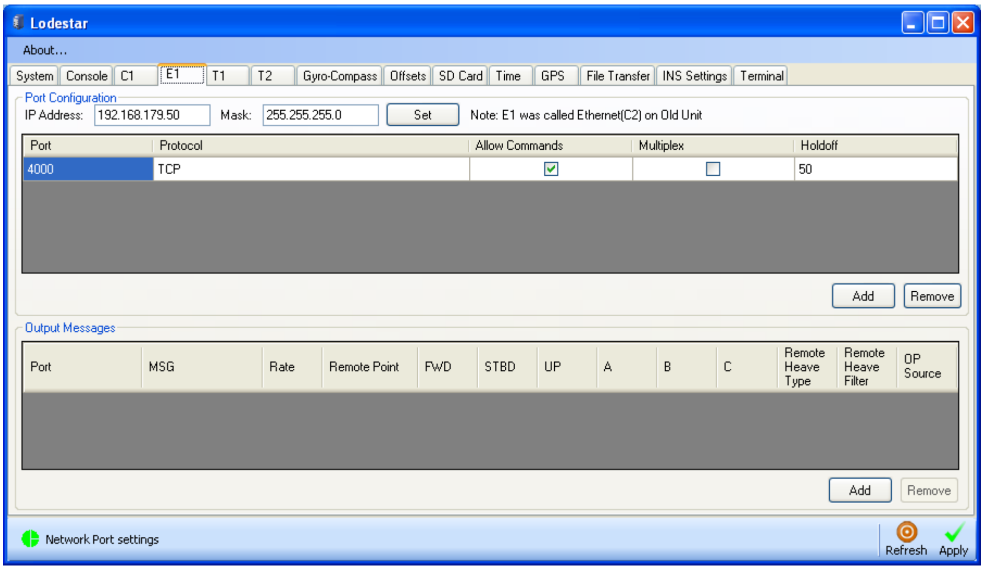
CAUTION

If connected to the SPRINT 300/500/700 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 300/500/700 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 300/500/700 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 300/500/700.

The Ethernet output messages can be viewed or modified in the output message table; see *Figure 7–11*.

Figure 7–11 Ethernet Output Message Table



Note

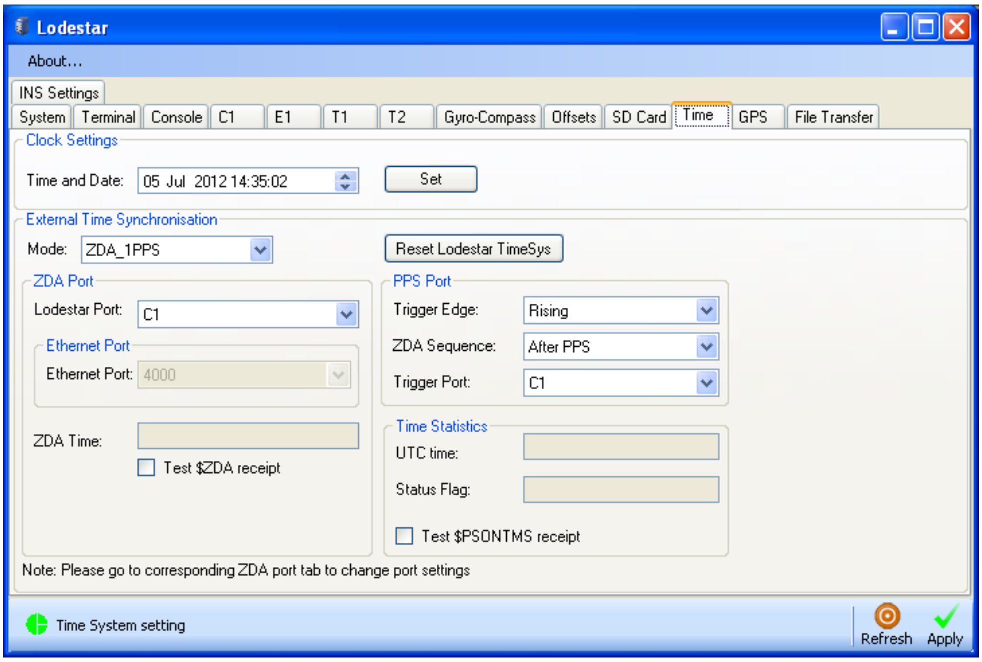
SPRINT 300/500/700 output messages are described in *UM-8084-109 Lodestar AHRS Messages.*

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 300/500/700.

7.2.6 Configure Time Settings

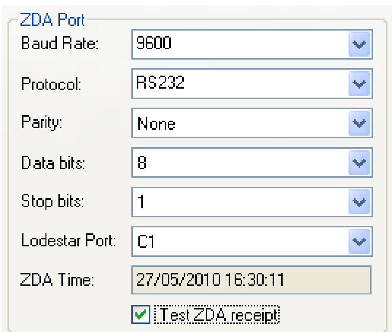
The time and date configured in the SPRINT 300/500/700 is displayed in the **Clock Settings** panel on the **Time** tab; see *Figure 7–12*.

Figure 7–12 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 300/500/700, make sure the input is connected now.
3. The GPZDA input can be configured on the **ZDA Port** pane; see *Figure 7–13*.
4. Select the SPRINT 300/500/700 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 300/500/700.
6. The GPZDA input **Test ZDA receipt** (if available) can be selected; see *Figure 7–13*.

Figure 7–13 ZDA Port Panel



7. If the PPS input is available and is not already connected to SPRINT 300/500/700, connect it now. The SPRINT 300/500/700 can accept an input trigger on the following ports:

Table 7–1 PPS Input Ports

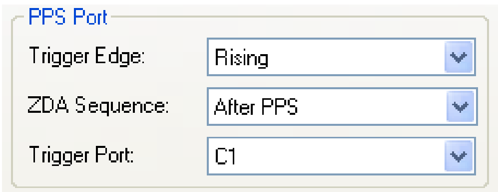
SPRINT Type	SPRINT V2 Port	SPRINT V3 Port
Subsea	C1	C1
	E1 (Ethernet)	E1 (Ethernet)
	T1	-
	T2	-

Note

The test cables supplied with the SPRINT 300/500/700 have BNC connectors that can be used to input the PPS pulse to the SPRINT 300/500/700.

8. The PPS input pulse can be configured on the **PPS Port** panel; see *Figure 7–14*.

Figure 7–14 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.

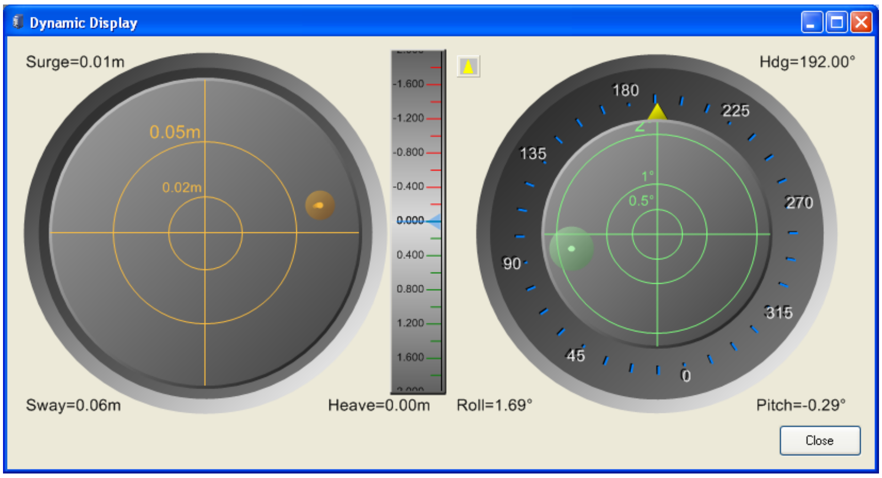
9. On the **Trigger Port** drop-down list, select the SPRINT port that is receiving the 1PPS signal.
10. Click **Apply** on the main application window to save this configuration on the SPRINT 300/500/700.

7.2.7 Checking Output

There are several methods that can be used to check the output from the SPRINT 300/500/700, explained below.

A dynamic display can be viewed that allows you to view the real time output from the SPRINT 300/500/700. 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 7–15*.

Figure 7–15 Dynamic Display



Note

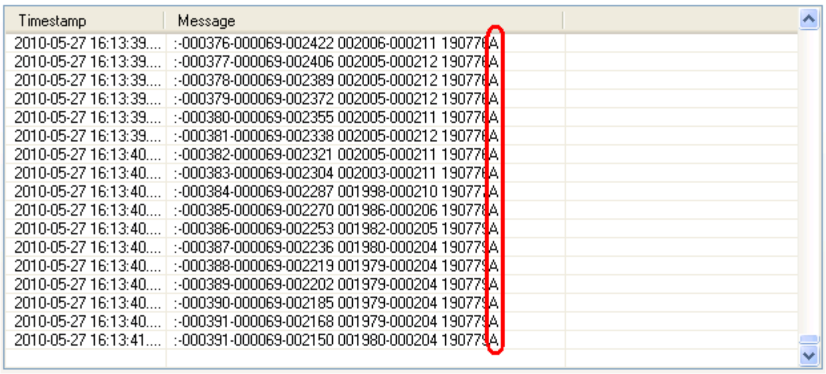
If the output is incorrect, check the following settings are correct:
- Mounting angles and offsets
- Default Latitude or automatic GPS compensation

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 300/500/700, 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 300/500/700; see *Figure 7–16*.

Figure 7–16 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 300/500/700 is receiving full GPS compensation and is also fully settled. Descriptions of all possible states are listed below.

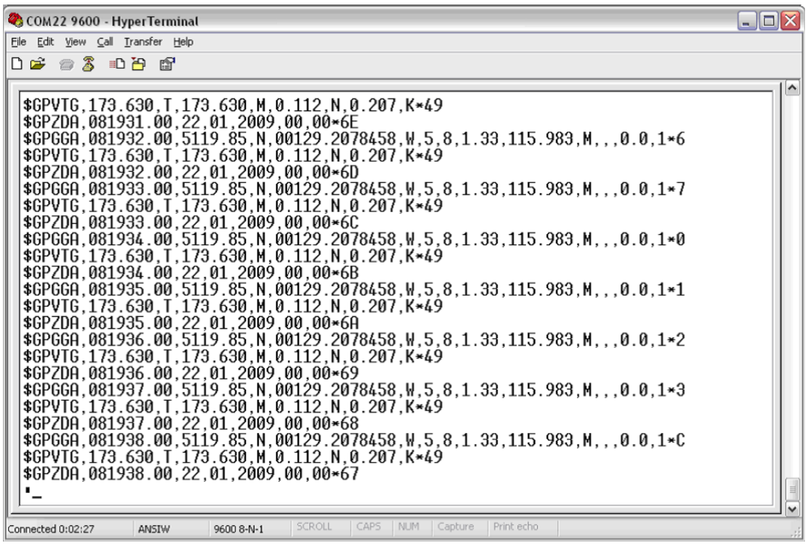
An upper case character indicates the SPRINT 300/500/700 is settled whereas a lower case character indicates the unit is still settling.

- **a** or **A** means the SPRINT 300/500/700 is receiving and decoding valid GPGGA and GPVTG telegrams successfully.
- **g** or **G** means the SPRINT 300/500/700 is receiving and decoding only valid GPGGA telegrams.

- **v** or **V** means the SPRINT 300/500/700 is receiving and decoding only valid GPVTG telegrams.
- **u** or **U** means the SPRINT 300/500/700 is not receiving or decoding any valid GPGGA and GPVTG telegrams.

If a GPS is connected to the SPRINT 300/500/700 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 7–17*.

Figure 7–17 Example GPS output in HyperTerminal



Section 8 – Retrieval and Storage

8.1 Introduction

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

8.2 Retrieval

On retrieval from the installation location, the following procedures must be carried out before the SPRINT 300/500/700 is stored.

1. Clean the SPRINT 300/500/700; see *Section 9.4 "Cleaning"*.
2. Inspect the SPRINT 300/500/700; see *Section 9.5 "Inspection"*.
3. Place connector covers on all connector ports.

8.3 Storage

On completion of all checks in the previous section the SPRINT 300/500/700 can be placed in storage as described below.See *Table 8–1* for the recommended storage conditions.

1. Store the SPRINT 300/500/700 in its transit case.
2. Equipment must be kept in a dry, non-condensing atmosphere (20% to 80% humidity), free from corrosive agents and isolated from sources of vibration.
3. 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.
4. It is recommended to visually insect the equipment at least annually.
5. When equipment is taken from low temperature storage for immediate use its temperature should be raised to normal operating temperature before use.

Table 8–1 Storage Conditions

Item	Specification
Storage Temperature	-20°C to 60°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 9 – Maintenance

9.1 Introduction

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

9.2 Retrieval from the Water

See *Section 8 "Retrieval and Storage"*.

9.3 Dismantling

Dismantling of the SPRINT 300/500/700 must only be carried out by Sonardyne qualified personnel.

9.4 Cleaning

Note

Do not use any abrasive brushes or sharp tools to remove marine growth when cleaning the SPRINT 300/500/700 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.

9.5 Inspection

Regularly inspect the instrument for the following:

1. Inspect the pressure relief vent valve; see *Section 9.7 "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.

9.6 Lubrication

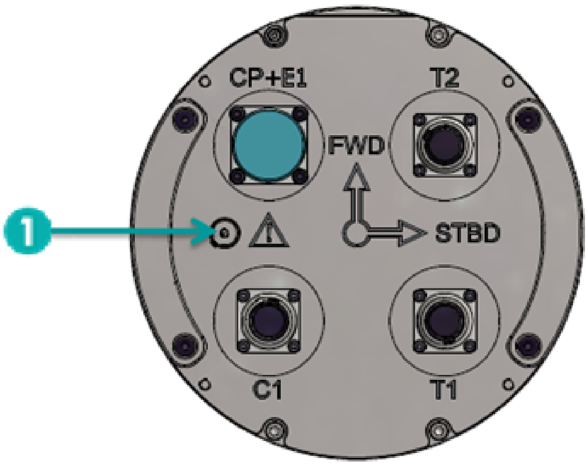
9.6.1 Connectors

The Seacon connectors are dry mating and do not require lubrication on the connector pins/sockets.

9.7 Pressure Relief Vent Valve

9.7.1 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

9.7.2 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.

9.8 Corrosion

The SPRINT 300/500/700 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.

9.9 Calibration

The SPRINT 300/500/700 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 300/500/700 based products do not require re-calibration 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.

Section 10 – Firmware Update for SPRINT 300/500/700

10.1 Introduction

The SPRINT 300/500/700 firmware can be updated in the field by using the PC Utility software tool (included with the SPRINT 300/500/700). Sonardyne support will notify customers when new firmware updates become available.

The SPRINT 300/500/700 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.

10.2 Updating the Firmware

10.2.1 Prerequisites

To update the firmware, the following prerequisites must be met:

- The new firmware file (IMU.hex)
- A serial connection to the SPRINT 300/500/700 on the CP port.
- A PC Utility software installation.

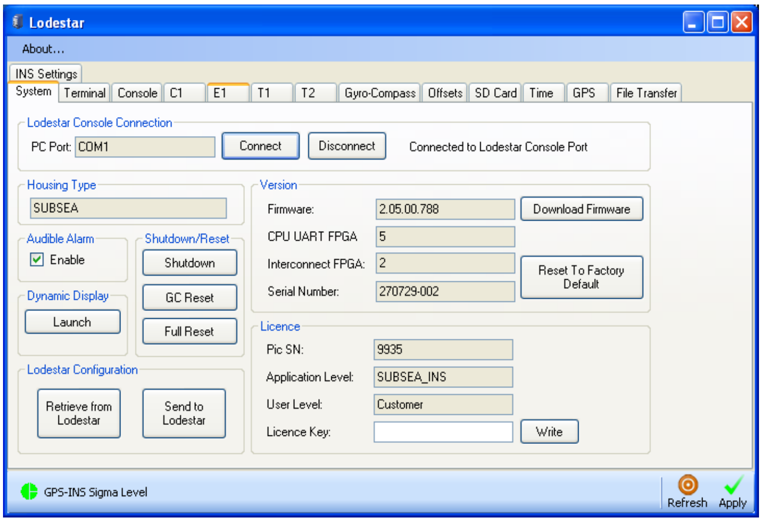
10.2.2 Update Procedure

1. Connect the SPRINT 300/500/700 CP port to the PC either directly via RS232 or through a Navigation Sensor Hub (NSH).

Note

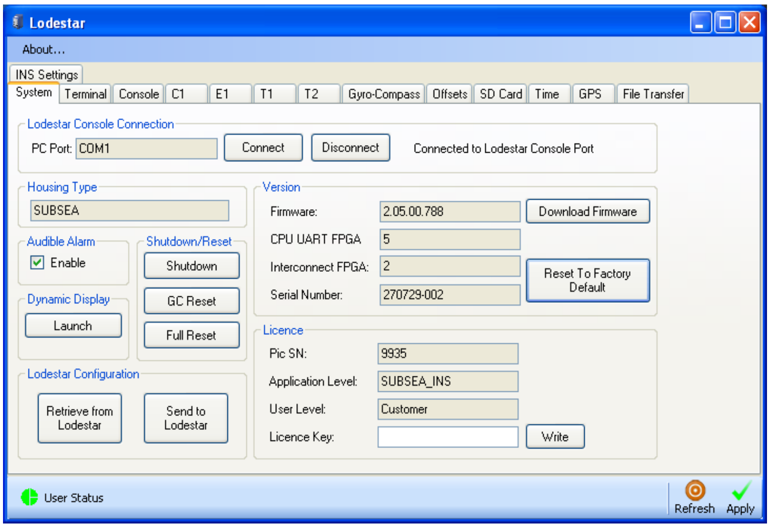
Wait two minutes after applying power to allow the SPRINT 300/500/700 to start up.

2. Click **Start > Programs > Sonardyne > Lodestar > Lodestar** to open the PC Utility.
3. Click **Connect** to connect to the SPRINT 300/500/700.

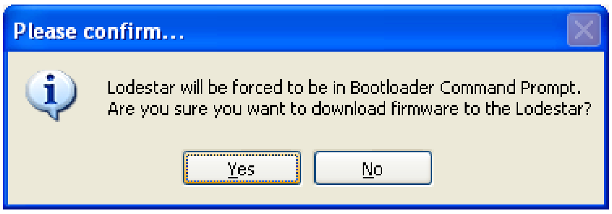


4. Once connected click **Retrieve from Lodestar (SPRINT 300/500/700)** to store the configuration of the SPRINT 300/500/700 as a text file (this is recommended for a backup).

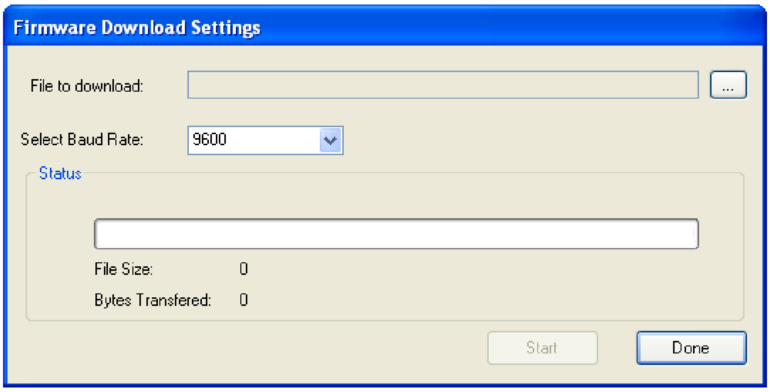
5. Click **Download Firmware**.



6. Click **Yes** to confirm.

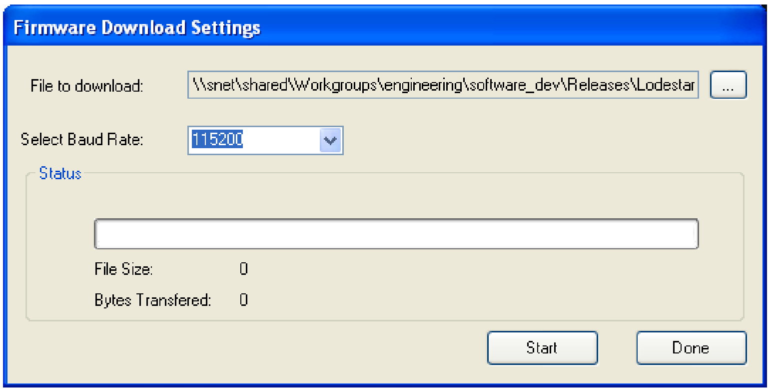


7. Browse to the folder and select the new IMU.HEX file to download (supplied by Sonardyne).



8. A warning will be displayed asking if you are sure that selected file is a SPRINT 300/500/700) firmware file.
9. Click **Yes** to continue.

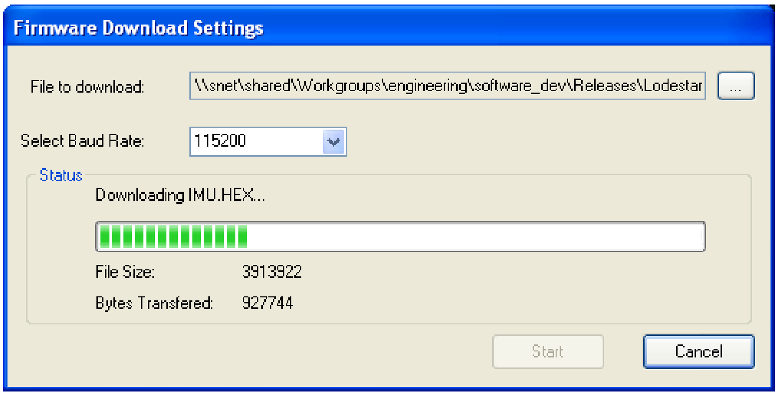
10. Select a **Baud Rate** for the download (Sonardyne recommends **115200** baud for all firmware downloads).



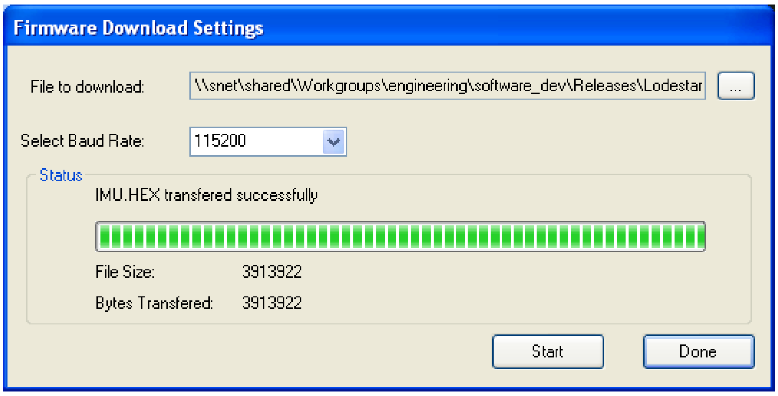
11. Click **Start** to commence the download (at this point the progress bar will show download status; download time at **115200** is less than five minutes).

Note

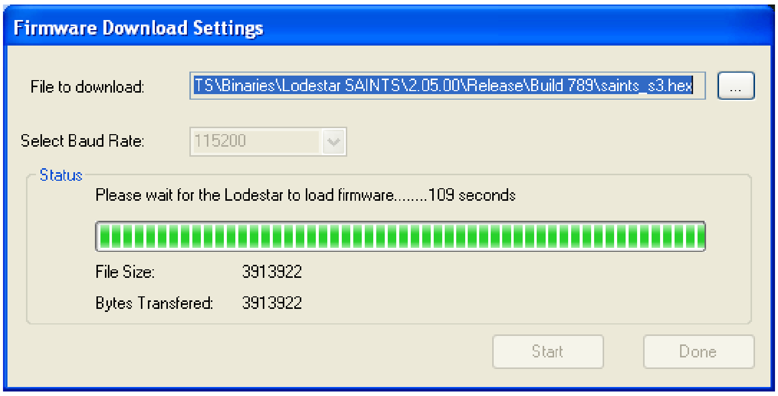
It is recommended not to interact with the PC while the download is in progress.



12. Once the download is complete click **Done**.



13. At this point the utility will re-boot the SPRINT 300/500/700.



14. Once complete, the PC Utility software will re-program the SPRINT 300/500/700 with the same configuration it had before the update.

Section 11 – Retrieving On-board Log Files

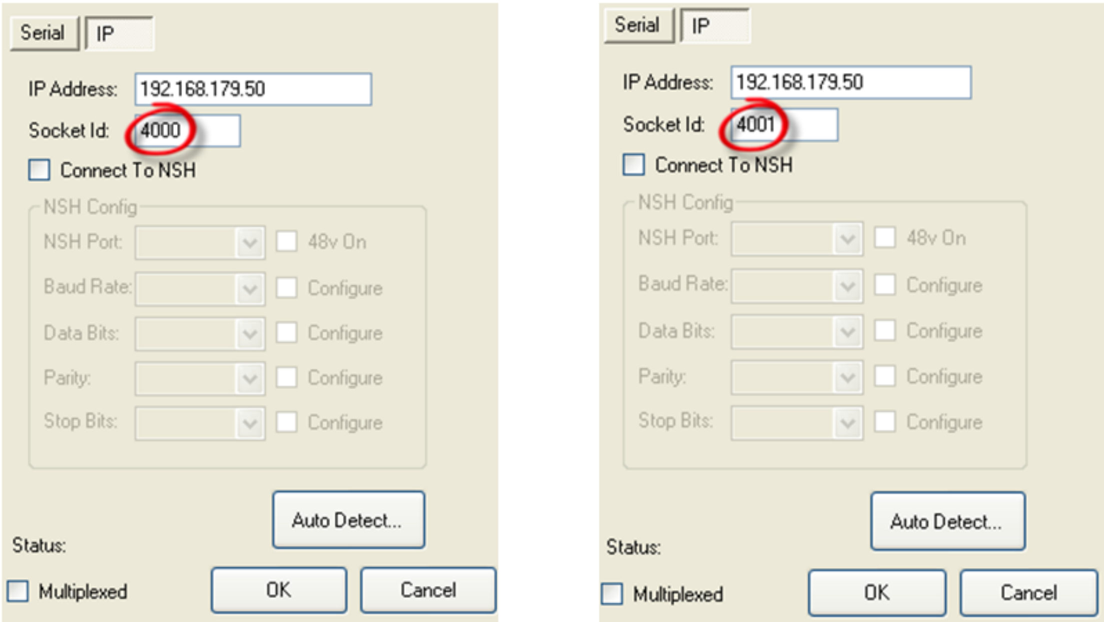
11.1 Introduction

On-board log files can be retrieved from the SPRINT 300/500/700 using the PC Utility software.

11.2 SPRINT 300/500/700 Connection and Retrieval

1. Connect to Ethernet port 4000 or 4001 (if the unit has been configured for SPRINT INS operation); see *Figure 11–1*.

Figure 11–1 SPRINT 300/500/700 Ethernet Connection



2. Once the connection has been established, select the **E1** tab and ensure multiplex is cleared; see *Figure 11–2* and *Figure 11–3*.
3. Apply the changes and wait for progress bar to complete before selecting a new tab.

Figure 11–2 SPRINT 300/500/700 Ethernet Port 4000 Configuration

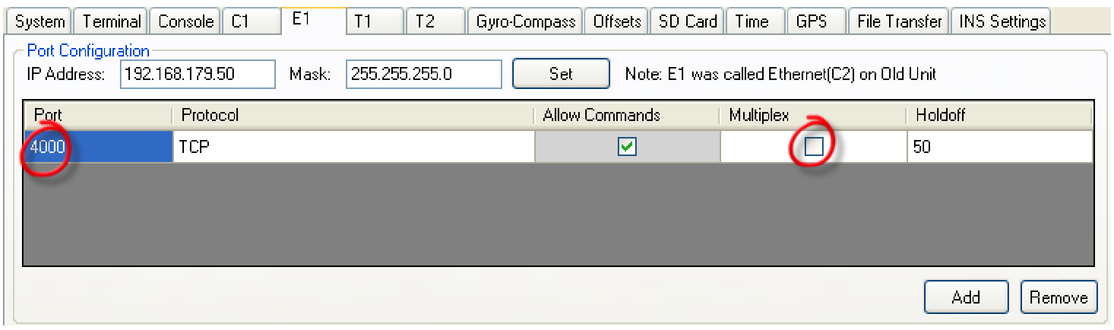
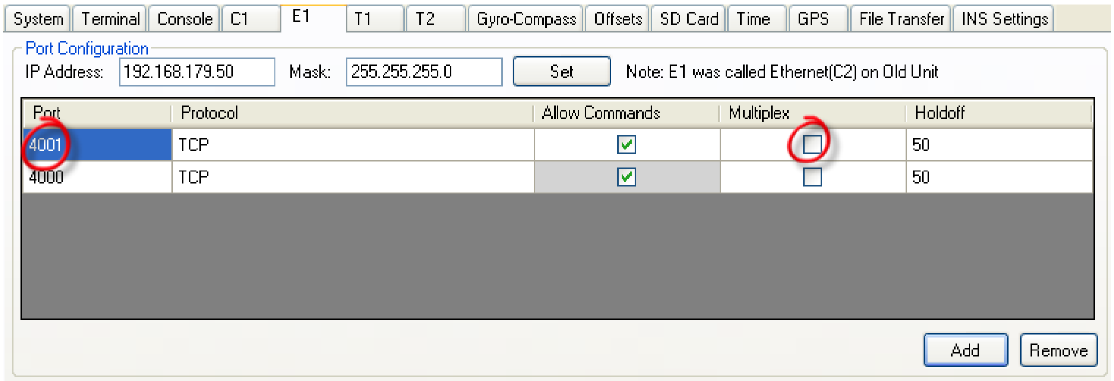


Figure 11–3 SPRINT 300/500/700 Ethernet Port 4001 Configuration

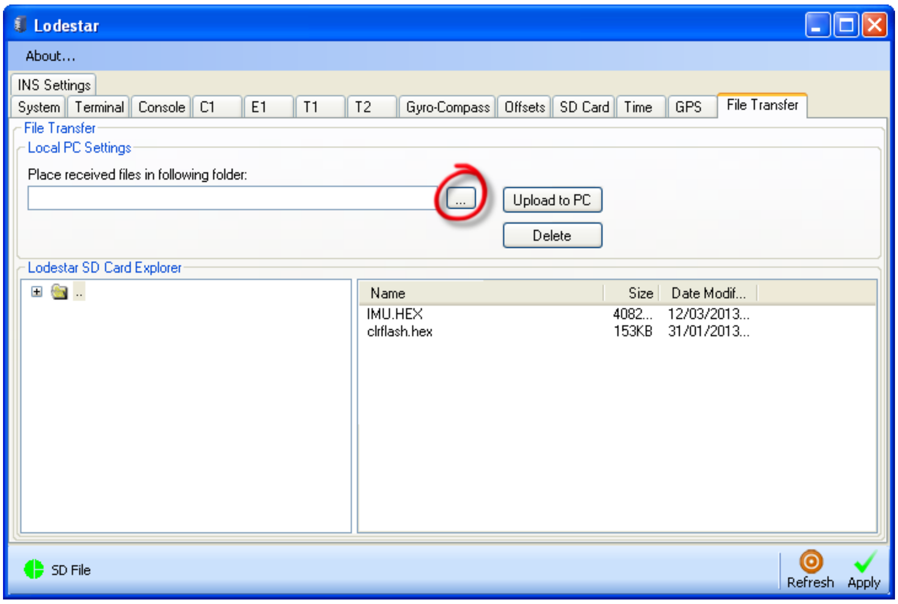


Note

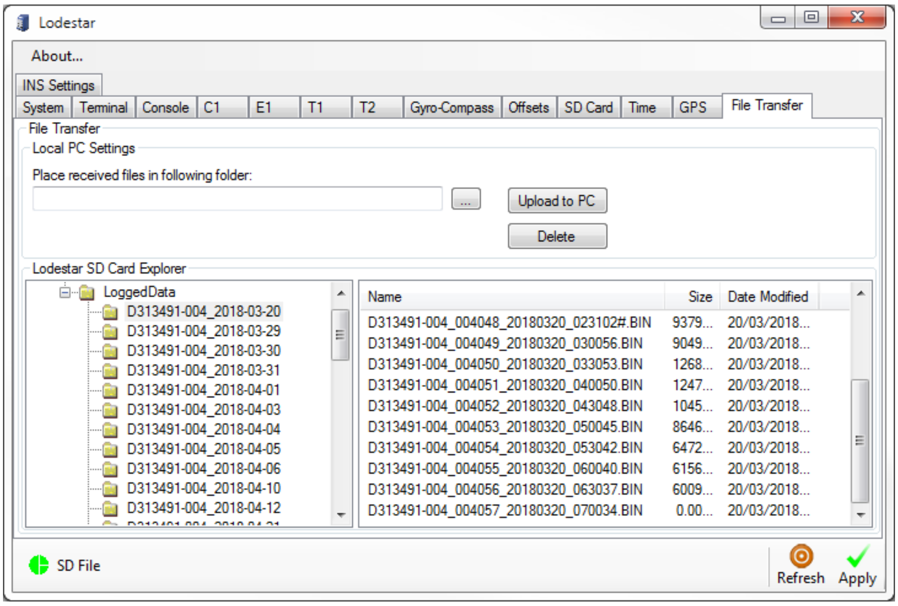
The SPRINT 300/500/700 port used for file transfer must have multiplex mode disabled and must not be configured for AHRS/INS operations (input/output messages enabled).

4. On the **File Transfer** tab and select the data destination folder; see *Figure 11–4*.
5. On the **Lodestar SD Card Explorer** pane, click **+** to expand the folders and open the **LoggedData** folder.

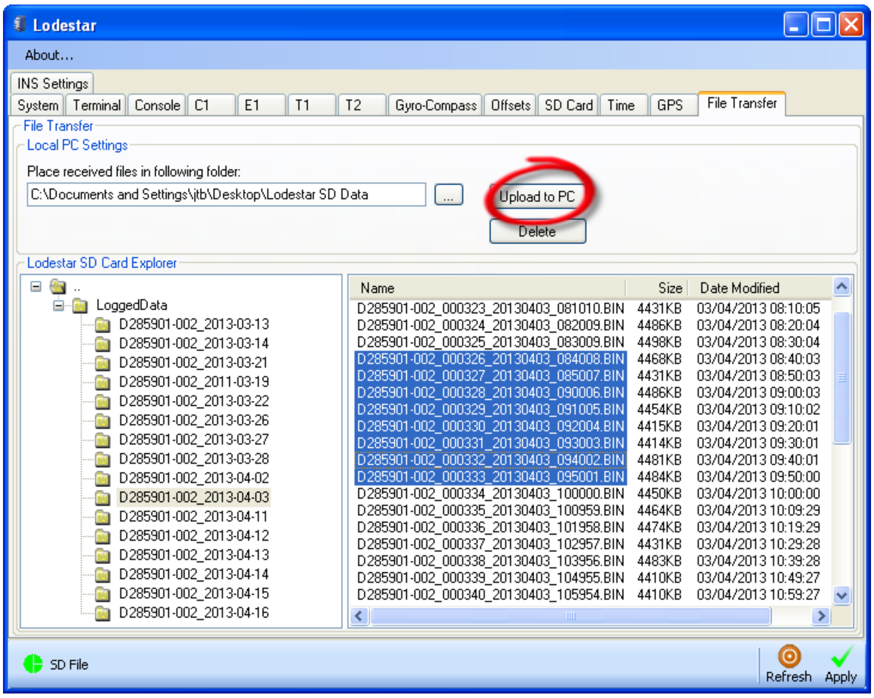
Figure 11–4 SD Files Destination Folder



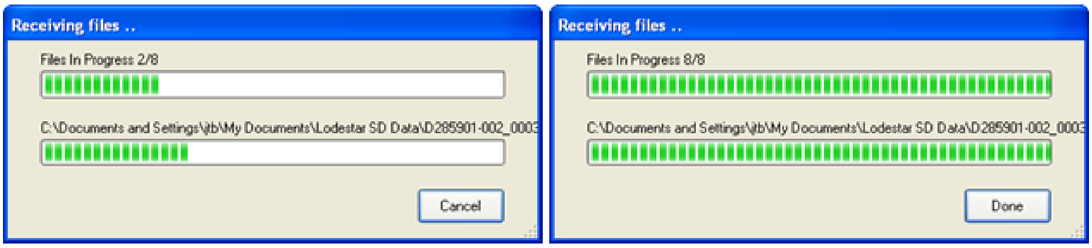
6. The folders and files use the following naming convention:
   - Folders: **D[serial number]_[yyyymmdd**
   - Files: **D[serial number]_[file counter]_[yyyymmdd]_[hhmmss][#].BIN**
     (**#** is only present on first file created after boot-up)



6. Select the log file(s) for retrieval and click **Upload to PC**.



7. A progress bar displays the data upload.



8. After file transfer completes, click the **System** tab and then click **Disconnect** prior to removing the test cable connected to the SPRINT 300/500/700.

Section 12 – Troubleshooting

12.1 Introduction

This section provides guidance for troubleshooting and fault identification.

Before calling Sonardyne Support, preliminary checks should first be made on the SPRINT 300/500/700 so a full description relating to the problem can be provided.

If technical support from Sonardyne is required, provide information about the SPRINT 300/500/700 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.

12.2 SPRINT 300/500/700 Hardware Test Procedure

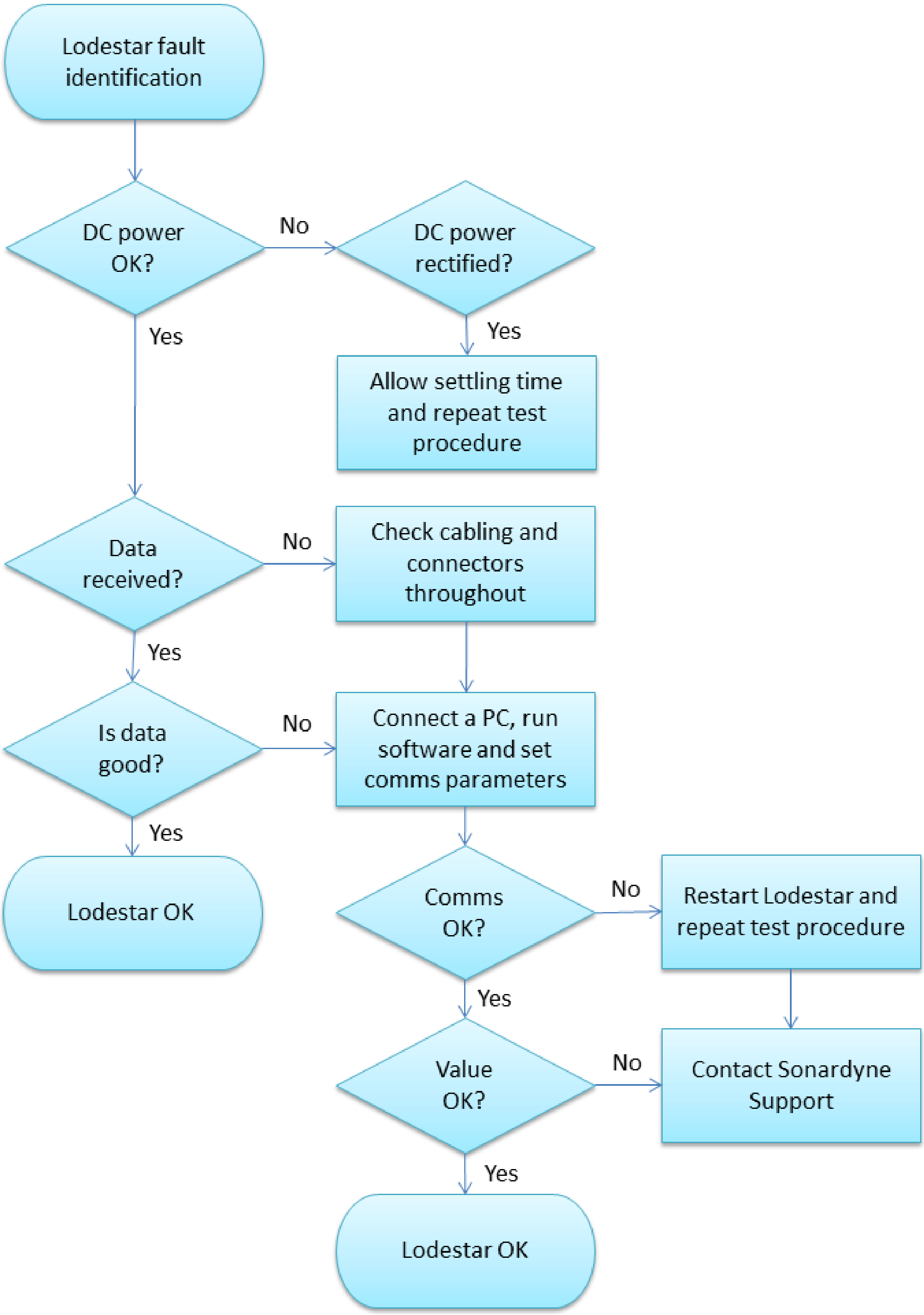
Figure 12–1 shows the recommended test procedure to follow if it is suspected that SPRINT 300/500/700 has developed a fault.

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 300/500/700. The SPRINT 300/500/700 must only be accessed internally and dismantled by qualified Sonardyne personnel.

Figure 12–1 SPRINT 300/500/700 Hardware Test Procedure



12.3 SPRINT 300/500/700 Connection

When connecting the SPRINT 300/500/700, carry out the following:

1. ALWAYS configure and check the SPRINT 300/500/700 connection prior to mounting on subsea vehicle.
2. Make sure the SPRINT 300/500/700 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 300/500/700 is mounted on the vehicle, connect a laptop using test cables to verify the SPRINT 300/500/700 operation and sensor communications.
4. Ethernet – check vehicle supports 100 megabit.
5. Serial – check 232 485 cable select for console port connection issues.

12.4 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 300/500/700 mounting angles, lever arms and remote output points if configured.

12.5 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).

12.6 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 300/500/700 is synchronised to difference time base than GPS/USBL the behaviour to notice is:
   - SPRINT 300/500/700 accepts position data while static
   - SPRINT 300/500/700 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.

12.7 Aiding Inputs (All)

When using Aiding Inputs, make sure to:

1. Check input using:
   - Comms Monitor
   - SPRINT 300/500/700 Port Traffic
2. Check lever arms and mounting angles.

12.8 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

12.9 Depth Aiding

When using Depth Aiding make sure:

1. The correct units are selected.
2. To check surface correction.

12.10 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.

12.11 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?

12.12 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

12.13 Recovery Procedures

The following procedures can be followed to recover the SPRINT 300/500/700 to a known state in the event of a problem.

12.13.1 SPRINT 300/500/700 Hardware Reset

The SPRINT 300/500/700 can be commanded to perform a hardware reset if it becomes unresponsive.

To perform a hardware reset you must be connected to the SPRINT 300/500/700 serially via the CP port using a terminal package such as HyperTerminal.

Make sure the connection to the SPRINT 300/500/700 is 9600 baud and RS232 protocol. If these conditions are met, the SPRINT 300/500/700 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 300/500/700 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.

12.13.2 Restore SPRINT 300/500/700 Factory Settings

The SPRINT 300/500/700 can be commanded to restore its factory default settings.

If factory settings are restored, all previous user defined settings in theSPRINT 300/500/700 will be lost. It is recommended a careful note is taken of any required settings before restoring factory settings.

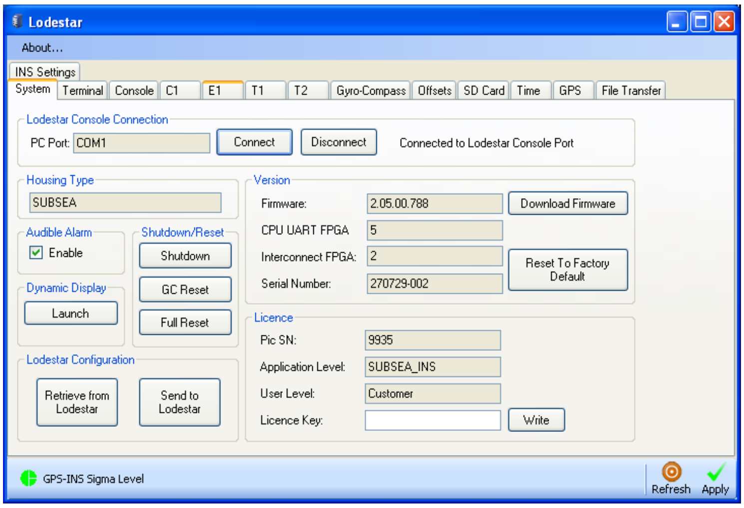
The PC Utility software can be used to restore theSPRINT 300/500/700 to its default state. This procedure will succeed even if the current baud rate of theSPRINT 300/500/700 isn't known.

1. Connect the SPRINT 300/500/700 CP port to the PC either directly via RS232 or through a Navigation Sensor Hub (NSH).

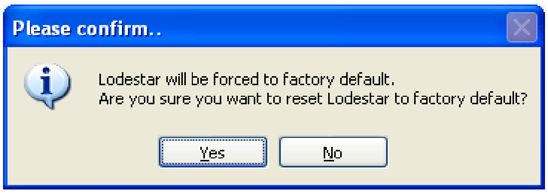
Note

Wait two minutes after applying power to allow the SPRINT 300/500/700 to start up.

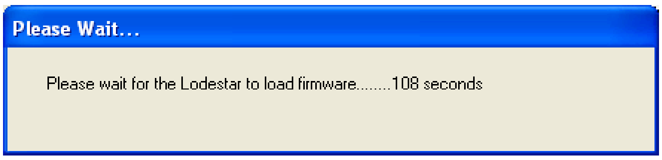
2. Click **Start > Programs > Sonardyne > Lodestar > Lodestar** to open the PC Utility.
3. Click **Connect** and select the COM port that the SPRINT 300/500/700 is connected to.
4. Click **Reset to Factory Default**.



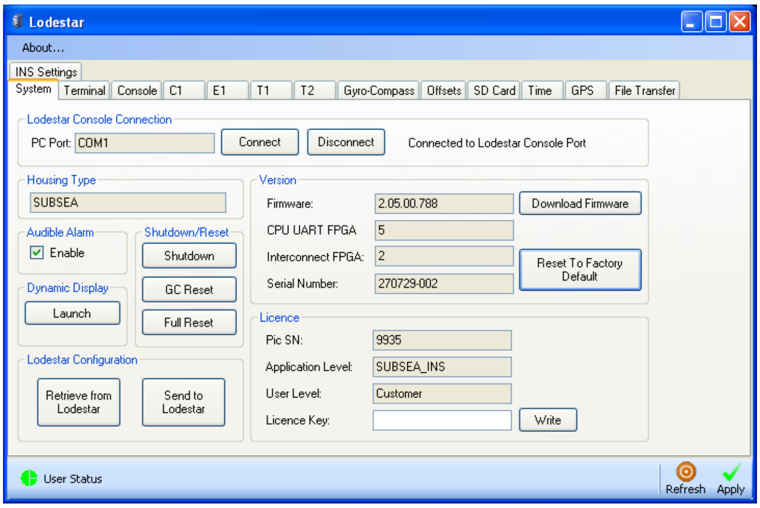
5. Click **Yes** to confirm.



6. The PC Utility will reboot the SPRINT 300/500/700 and reset it to factory default state. It will then wait for the SPRINT 300/500/700 to re-boot.



7. After the boot process has completed the PC Utility software will attempt to connect to the SPRINT 300/500/700 using factory default settings. If successful the SPRINT 300/500/700 information will be displayed.



Section 13 – Spares

13.1 Introduction

When ordering spare parts, please provide:

a. The part number

b. The description

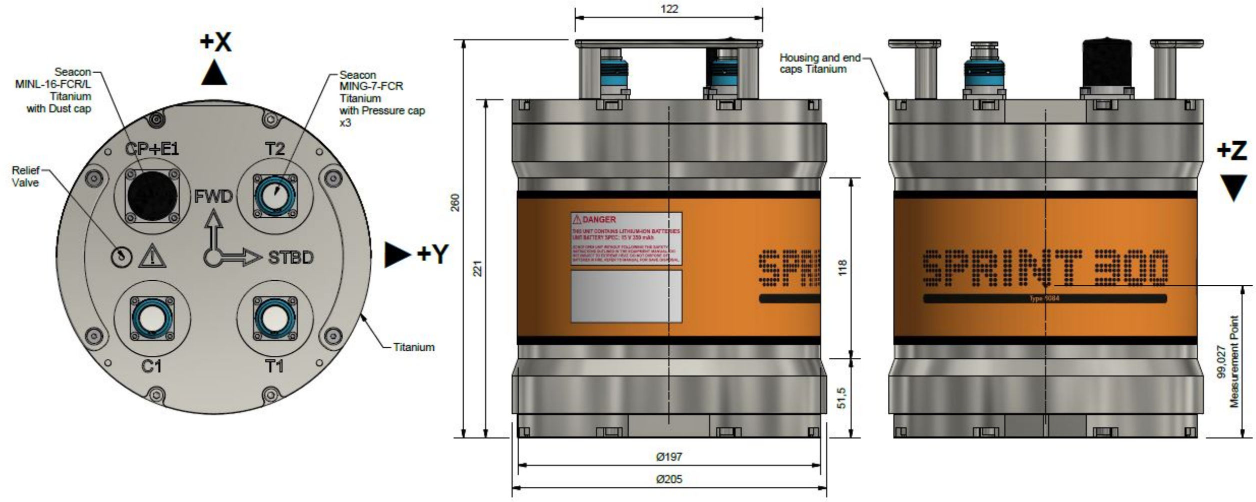
Enquiries about, or orders for spare parts should be directed to your local Sonardyne office or agent (see back page for Sonardyne office addresses).

13.2 SPRINT 300/500/700 Spares List

Description	Stock Code
SPRINT 300/500/700 Battery	270-0610
SPRINT 300/500/700 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

Section 14 – Technical Specifications

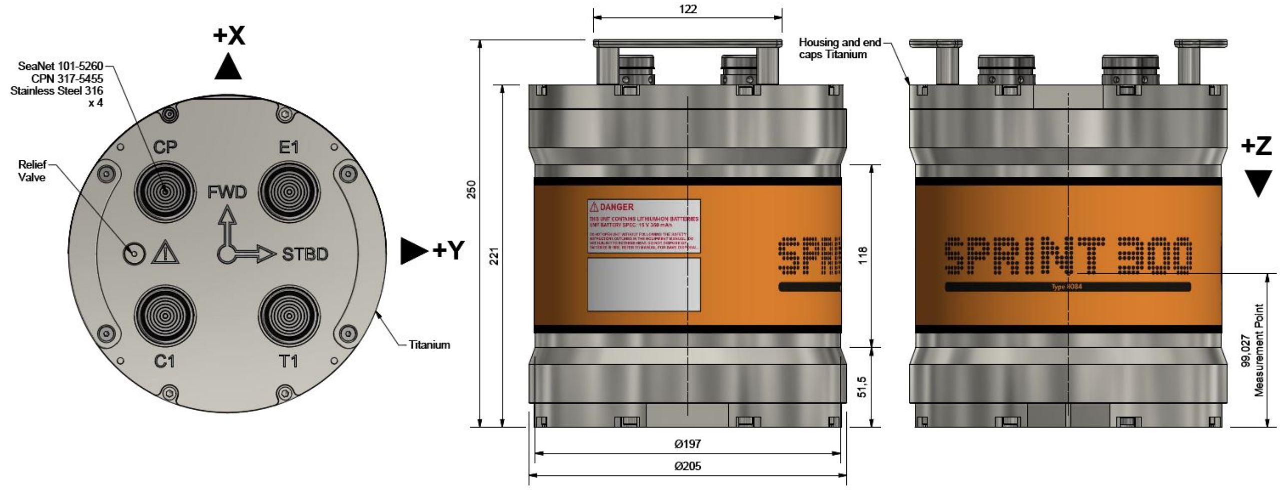
14.1 Type 8253-4511 SPRINT 300 4000 m 4 x Seacon



Feature		**Type 8253-000-4511**
Depth Rating		4,000 metres
Physical	Size (Dia x Length)	205 x 260 mm
	Weight in Air/Water*	18.5/11.5 kg
	Mechanical Contruction	Titanium
	Connectors	4 x Seacon
Performance	Heading Accuracy	0.2º (Lodestar AHRS), 0.05º (SPRINT INS) Secant Latitude
	Roll and Pitch Accuracy	0.01º
	Settle Time	<10 minutes in dynamic conditions (AHRS), Instantaneous (INS)
	INS Aiding Supported	USBL, Depth, DVL, Zero Velocity, Manual Position, LBL (position), GNSS
	USBL/LBL Aided	3 x precision improvement over USBL/LBL (Position)
	USBL/LBL and DVL Aided	3 to 7 x precision improvement over USBL/LBL (Position)
	DVL Aided Accuracy	0.2% position error for distance travelled (3rd party DVL) 0.16% position error for distance travelled (Sonardyne Syrinx DVL)
	DVL Aiding Loss/Drift	1.2 m over 1 min, 5 m over 2 mins (CEP50)
	Station Keeping	<1 m over 1 hour (3rd party DVL) <1 m over 24 hours (Sonardyne Syrinx DVL)
Environmental	Temperature	-20 to +55°C (operating), -20 to +60°C (storage)
	Shock Rating	22 g, 11 ms half sine
Power	Power Requirement	20–50 V dc, 15 W nominal, 35 W max
	Power Pass Through	3 x for external aiding sensors (up to 3A per sensor)
	Back Up Battery Type/Life	Li-ion/5 minutes
Data/Comms	Data Storage	8 GB internal memory
	Digital Ports/Protocol	Up to 4 digital Ports/RS232 or RS485
	Other Ports	1 x Ethernet, 4 Triggers
	Output Rate	Up to 100 Hz
	Output Telegrams	Industry standard AHRS/INS telegrams including acceleration and rotation rates**

* Estimated Weights
** Specific outputs may be limited below quoted performance for reasons of export classification and control and should not be used as IMU data.

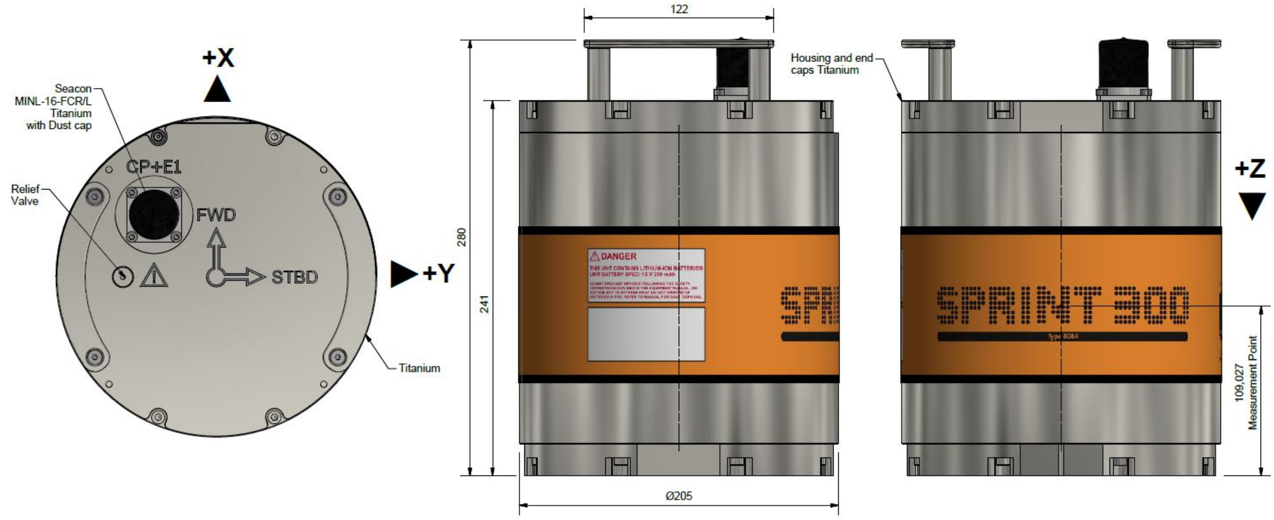
14.2 Type 8253-9909 SPRINT 300 4000 m 4 x Seanet®



Feature		Type 8253-000-9909
Depth Rating		4,000 metres
Physical	Size (Dia x Length)	205 x 260 mm
	Weight in Air/Water*	18.5/11.5 kg
	Mechanical Contruction	Titanium
	Connectors	4 x Seanet®
Performance	Heading Accuracy	0.2º (Lodestar AHRS), 0.05º (SPRINT INS) Secant Latitude
	Roll and Pitch Accuracy	0.01º
	Settle Time	<10 minutes in dynamic conditions (AHRS), Instantaneous (INS)
	INS Aiding Supported	USBL, Depth, DVL, Zero Velocity, Manual Position, LBL (position), GNSS
	USBL/LBL Aided	3 x precision improvement over USBL/LBL (Position)
	USBL/LBL and DVL Aided	3 to 7 x precision improvement over USBL/LBL (Position)
	DVL Aided Accuracy	0.2% position error for distance travelled (3rd party DVL) 0.16% position error for distance travelled (Sonardyne Syrinx DVL)
	DVL Aiding Loss/Drift	1.2 m over 1 min, 5 m over 2 mins (CEP50)
	Station Keeping	<1 m over 1 hour (3rd party DVL) <1 m over 24 hours (Sonardyne Syrinx DVL)
Environmental	Temperature	-20 to +55°C (operating), -20 to +60°C (storage)
	Shock Rating	22 g, 11 ms half sine
Power	Power Requirement	20–50 V dc, 15 W nominal, 35 W max
	Power Pass Through	3 x for external aiding sensors (up to 3A per sensor)
	Back Up Battery Type/Life	Li-ion/5 minutes
Data/Comms	Data Storage	8 GB internal memory
	Digital Ports/Protocol	Up to 4 digital Ports/RS232 or RS485
	Other Ports	1 x Ethernet, 4 Triggers
	Output Rate	Up to 100 Hz
	Output Telegrams	Industry standard AHRS/INS telegrams including acceleration and rotation rates**

* Estimated Weights
** Specific outputs may be limited below quoted performance for reasons of export classification and control and should not be used as IMU data.

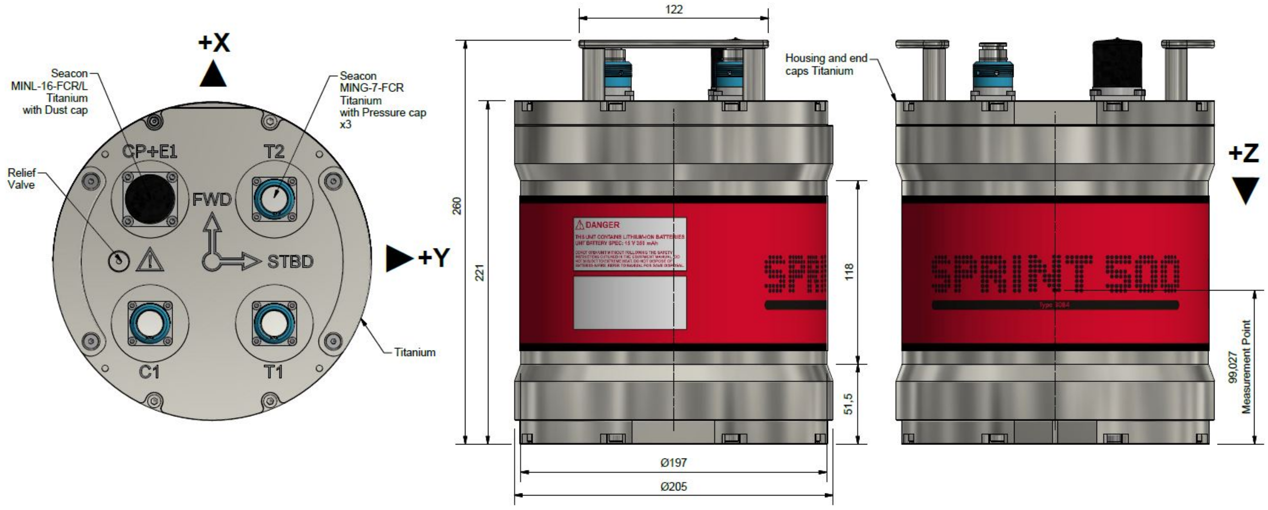
14.3 Type 8253-6571 SPRINT 300 6000 m 1 x Seacon



Feature		Type 8253-000-6571
Depth Rating		6,000 metres
Physical	Size (Dia x Length)	205 x 280 mm
	Weight in Air/Water*	22/14 kg
	Mechanical Contruction	Titanium
	Connectors	1 x Seacon
Performance	Heading Accuracy	0.2º (Lodestar AHRS), 0.05º (SPRINT INS) Secant Latitude
	Roll and Pitch Accuracy	0.01º
	Settle Time	<10 minutes in dynamic conditions (AHRS), Instantaneous (INS)
	INS Aiding Supported	USBL, Depth, DVL, Zero Velocity, Manual Position, LBL (position), GNSS
	USBL/LBL Aided	3 x precision improvement over USBL/LBL (Position)
	USBL/LBL and DVL Aided	3 to 7 x precision improvement over USBL/LBL (Position)
	DVL Aided Accuracy	0.2% position error for distance travelled (3rd party DVL) 0.16% position error for distance travelled (Sonardyne Syrinx DVL)
	DVL Aiding Loss/Drift	1.2 m over 1 min, 5 m over 2 mins (CEP50)
	Station Keeping	<1 m over 1 hour (3rd party DVL) <1 m over 24 hours (Sonardyne Syrinx DVL)
Environmental	Temperature	-20 to +55°C (operating), -20 to +60°C (storage)
	Shock Rating	22 g, 11 ms half sine
Power	Power Requirement	20–50 V dc, 15 W nominal, 35 W max
	Power Pass Through	3 x for external aiding sensors (up to 3A per sensor)
	Back Up Battery Type/Life	Li-ion/5 minutes
Data/Comms	Data Storage	8 GB internal memory
	Digital Ports/Protocol	Up to 4 digital Ports/RS232 or RS485
	Other Ports	1 x Ethernet, 4 Triggers
	Output Rate	Up to 100 Hz
	Output Telegrams	Industry standard AHRS/INS telegrams including acceleration and rotation rates**

* Estimated Weights
** Specific outputs may be limited below quoted performance for reasons of export classification and control and should not be used as IMU data.

14.4 Type 8253-4510 SPRINT 500 4000 m 4 x Seacon



Feature		Type 8253-000-4510
Depth Rating		4,000 metres
Physical	Size (Dia x Length)	205 x 260 mm
	Weight in Air/Water*	18.5/11.5 kg
	Mechanical Contruction	Titanium
	Connectors	4 x Seacon
Performance	Heading Accuracy	0.1º (Lodestar AHRS), <0.04º (SPRINT INS) Secant Latitude
	Roll and Pitch Accuracy	0.01º
	Settle Time	<5 minutes in dynamic conditions (AHRS), Instantaneous (INS)
	INS Aiding Supported	USBL, Depth, DVL, Zero Velocity, Manual Position, LBL (position), GNSS
	USBL/LBL Aided	3 x precision improvement over USBL/LBL (Position)
	USBL/LBL and DVL Aided	4 to 10 x precision improvement over USBL/LBL (Position)
	DVL Aided Accuracy	0.1% position error for distance travelled (3rd party DVL) 0.08% position error for distance travelled (Sonardyne Syrinx DVL)
	DVL Aiding Loss/Drift	0.8 m over 1 min, 3.2 m over 2 mins (CEP50)
	Station Keeping	<1 m over 1 hour (3rd party DVL) <1 m over 24 hours (Sonardyne Syrinx DVL)
	LBL & DVL Aided Accuracy	3 cm confined area, 20 cm wide area (dynamic)
	'Synthetic' LBL Aided Accuracy	<20 cm @ 200 m distance to single transponder
Environmental	Temperature	-20 to +55°C (operating), -20 to +60°C (storage)
	Shock Rating	22 g, 11 ms half sine
Power	Power Requirement	20–50 V dc, 15 W nominal, 35 W max
	Power Pass Through	3 x for external aiding sensors (up to 3A per sensor)
	Back Up Battery Type/Life	Li-ion/5 minutes
Data/Comms	Data Storage	8 GB internal memory
	Digital Ports/Protocol	Up to 4 digital Ports/RS232 or RS485
	Other Ports	1 x Ethernet, 4 Triggers
	Output Rate	Up to 100 Hz
	Output Telegrams	Industry standard AHRS/INS telegrams including acceleration and rotation rates**

* Estimated Weights
** Specific outputs may be limited below quoted performance for reasons of export classification and control and should not be used as IMU data.

Appendix A – SPRINT 300/500/700 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

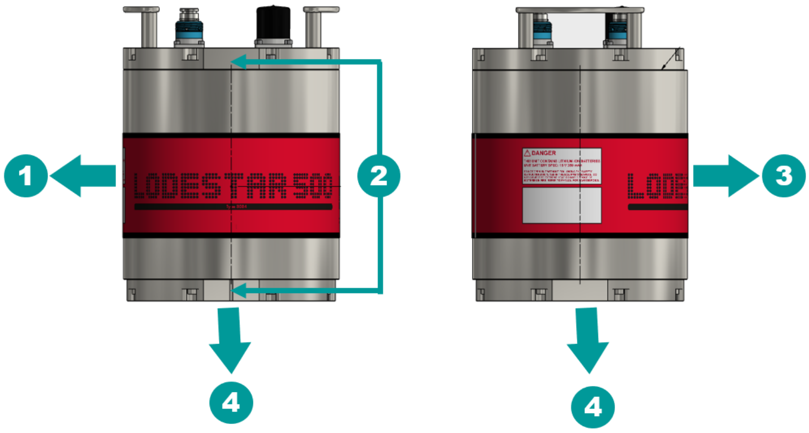
B.1 SPRINT 300/500/700 Frame

The SPRINT 300/500/700 frame is a fixed right-hand coordinate frame X Y Z. Typically the SPRINT 300/500/700 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 300/500/700 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 300/500/700 should be made with respect to the unit's centre of axis; see *UM-8084-101 Lodestar Hardware Manual*.

The SPRINT 300/500/700 angular outputs are defined in Gravity (or Datawell) angles; see *Appendix A "SPRINT 300/500/700 Angle Definitions "* for more information.

Figure B–1 SPRINT 300/500/700 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

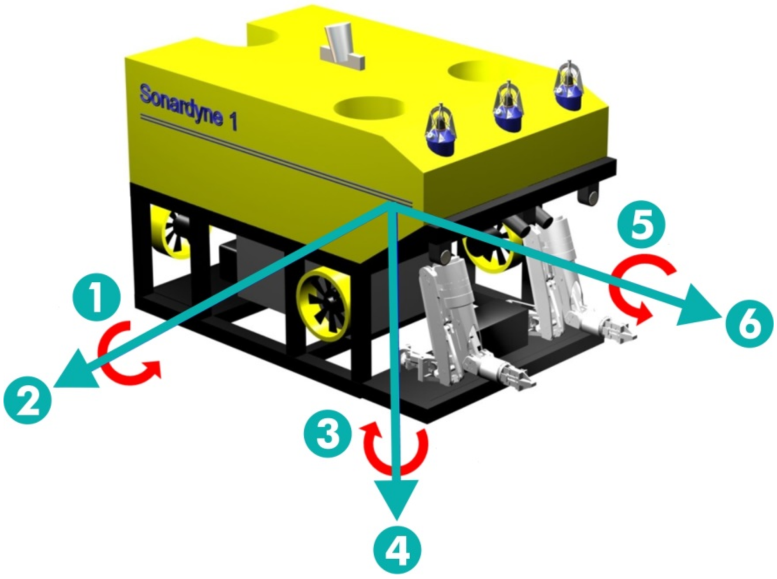
For most applications, measurements are required with respect to the vehicle's reference frame. The definition of the vehicle reference frame is shown below.

Unless otherwise stated for a particular output telegram, the SPRINT 300/500/700 will output measurements with respect to this frame.

Before installing the SPRINT 300/500/700 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 300/500/700. 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 300/500/700 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 300/500/700 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 300/500/700 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

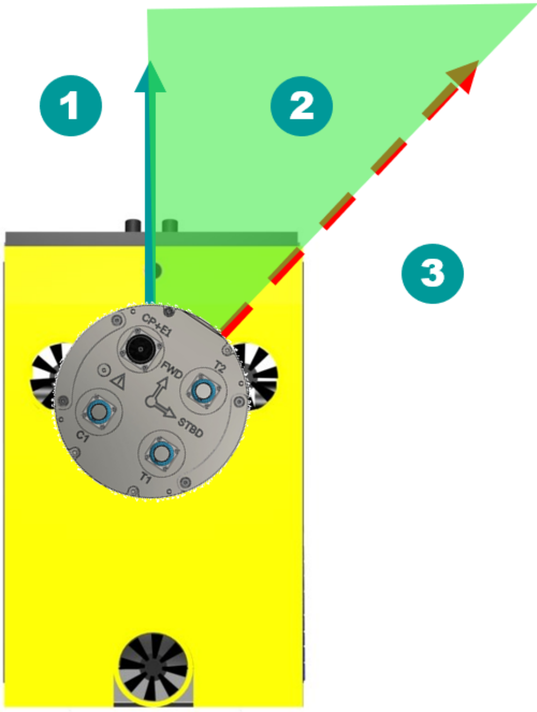
Only the misalignment for angle C (heading) can be measured independently. The misalignments for angles B (pitch) and A (roll) are the resultant misalignments after the preceding misalignments have been applied.

Mounting angles are specified as Euler angles; the convention for measuring each mounting angle is shown below.

Note

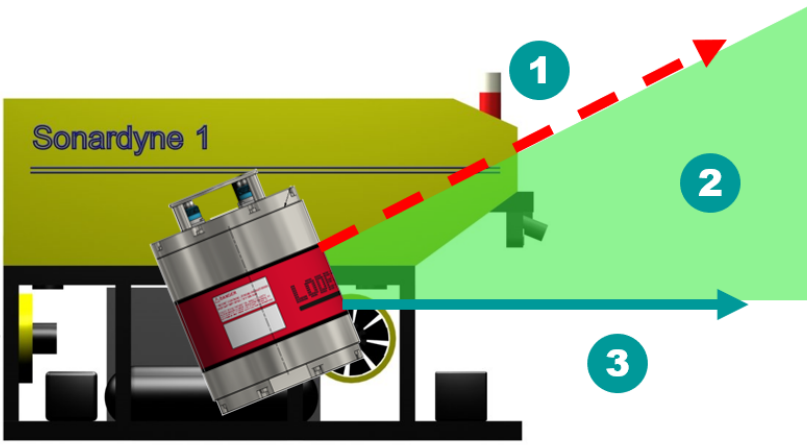
To simplify the definition and convention of each mounting angle, each angle is depicted independently but in practice they are non-commutative and must be measured in the order defined previously.

Figure B–3 SPRINT 300/500/700 Heading Mounting Angle Example



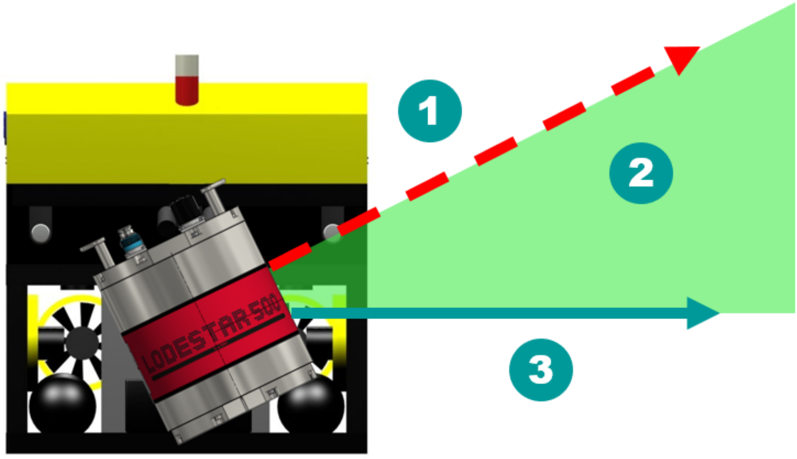
Item	Description
1	Heading Output (Mounting Angle +40°)
2	Positive (+) Mounting Angle Applied
3	Heading Output (Mounting Angle 0°)

Figure B–4 SPRINT 300/500/700 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 300/500/700 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.

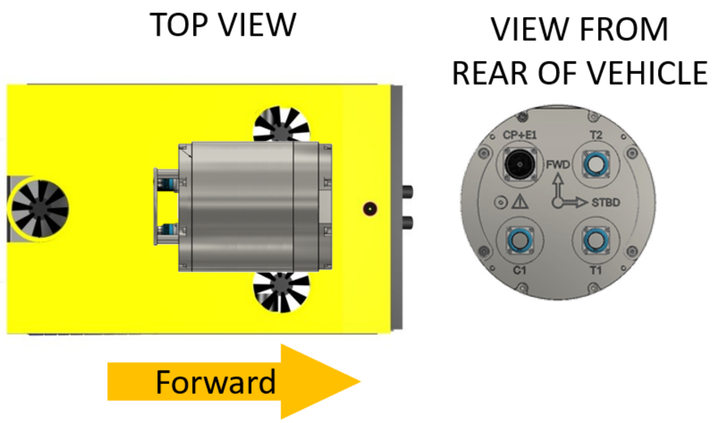
Appendix C – SPRINT 300/500/700 Mounting Angle Examples

C.1 Introduction

This section provides some examples of alternate SPRINT 300/500/700 mountings and the associated “coarse” mounting angles that should be used in the system configuration.

C.2 Configuration A

If the SPRINT 300/500/700 is mounted in the following configuration:

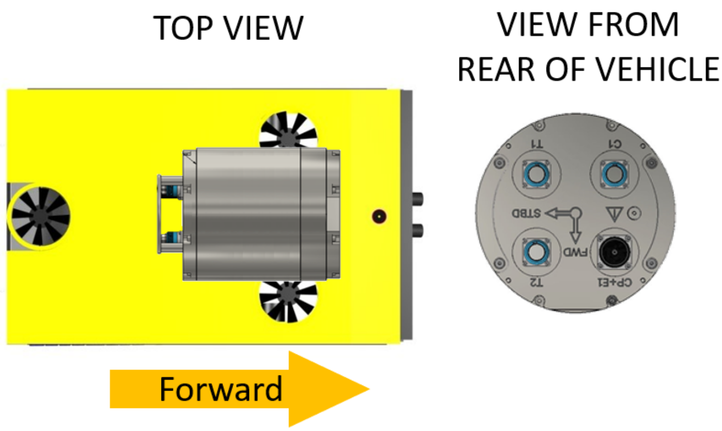


Then use the following mounting angles on the SPRINT 300/500/700 configuration:

- Heading: 0
- Resulting Pitch: 90
- Resulting Roll: 0

C.3 Configuration B

If the SPRINT 300/500/700 is mounted in the following configuration:

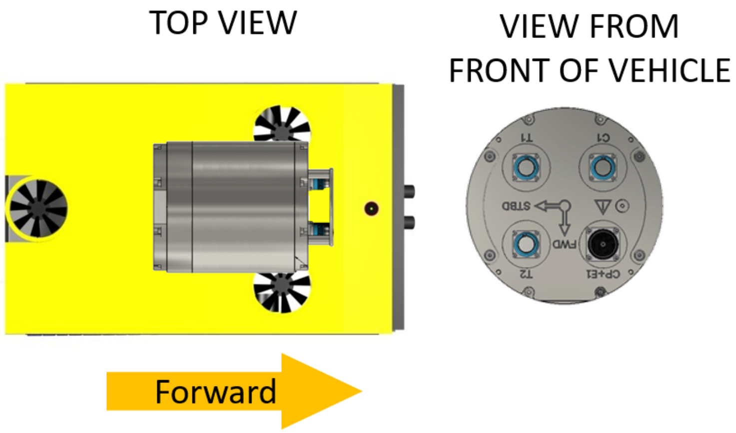


Then use the following mounting angles on the SPRINT 300/500/700 configuration:

- Heading: 180
- Resulting Pitch: -90
- Resulting Roll: 0

C.4 Configuration C

If the SPRINT 300/500/700 is mounted in the following configuration:

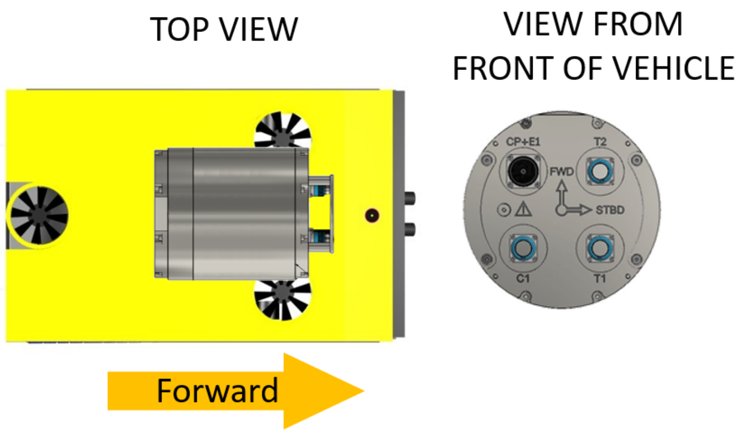


Then use the following mounting angles on the SPRINT 300/500/700 configuration:

- Heading: 0
- Resulting Pitch: -90
- Resulting Roll: 0

C.5 Configuration D

If the SPRINT 300/500/700 is mounted in the following configuration:



Then use the following mounting angles on the SPRINT 300/500/700 configuration:

- Heading: 180
- Resulting Pitch: 90
- Resulting Roll: 0

Appendix D – INS Message Definitions

D.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 D–1 SPRINT Input & Output Messages

Message	INS Input	INS Output
GGA	✓ GPGGA NPGGA	✓ INGGA
PSIMSSB	✓	×
Sonardyne External Position	✓	×
DVL PD4	✓	×
DVL PD5	✓	×
DigiQuartz Pressure Depth	✓	×
Valeport Midas SVX2 Depth	✓	×
PSONDEP Depth	✓	×
NMEA DPT Depth	✓	×
Sonardyne External Depth	✓	×
ZDA	✓	×
Valeport Sound Velocity	✓	×
PSONSS Sound Velocity	✓	×
INS Navigation	×	✓
INS Navigation Quality	×	✓
Time System	×	✓
Sonardyne PSONNAV	×	✓
Sonardyne LNAV	×	✓

D.2 Simrad SSB – SSBL Position Report ($PSIMSSB)

Reference: Kongsberg APOS Release 4.2.2 Manual (29.April. 2005)

Description

The PSIMSSB sentence contains the position of a SSBL beacon which is sent after each USBL measurement. The operator may define various parameters.

Format

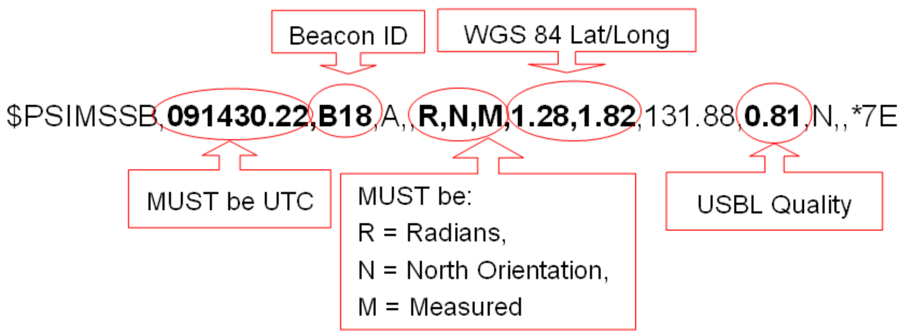
$PSIMSSB,hhmmss.ss,ccc,a,ccc,a,a,a,x.x,x.x,x.x,x.x,a,x.x,x.x*hh <cr><lf>

Table D–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

Supported Input Format

Sonardyne Marksman/Ranger 2 and Kongsberg HiPAP:



D.3 Proprietary $PSONDEP Report

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.

Format

$PSONDEP,x.xx,y.y,c*hh<cr><lf>

Table D–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)

Supported Input Format

D.4 Proprietary $PSONSS Report

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.

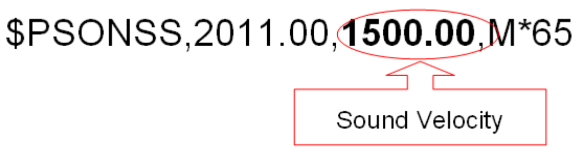
Format

$PSONSS,x.x,y.y,c*hh<cr><lf>

Table D–4 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)

Supported Input Format



D.5 Digiquartz Pressure Sensor Report

Description

Pressure depth output from Paroscientific Digiquartz intelligent pressure depth sensor.

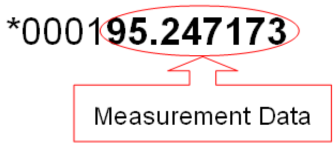
Format

*0001nnn__<cr><lf>

Table D–5 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

Supported Input Format



D.6 $__DPT Report

Description

This is NMEA string outputs water depth.

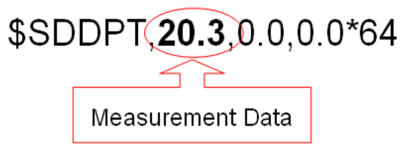
Format

$__DPT,x.x,y.y,z.z*hh<cr><lf>

Table D–6 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)

Supported Input Format



D.7 Valeport Sensor Telegram

Description

This simple string outputs the data from the Valeport Mini SVS sensor. Sound Velocity only m/sec supported.

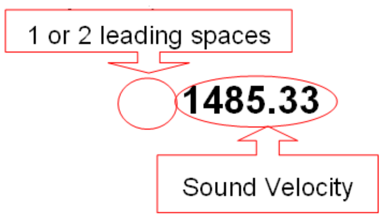
Format

<space>xxxx.xxx<cr><lf>

Table D–7 Valeport Sensor Telegram Formatting

Field	Description
<space>	A space character
xxxx.xxx	Sound Speed in metres per second
<cr><lf>	Termination (0x0D 0x0A)

Supported Input Format



D.8 $__GGA Report

Description

This NMEA string outputs longitude and latitude at a UTC time.

Format

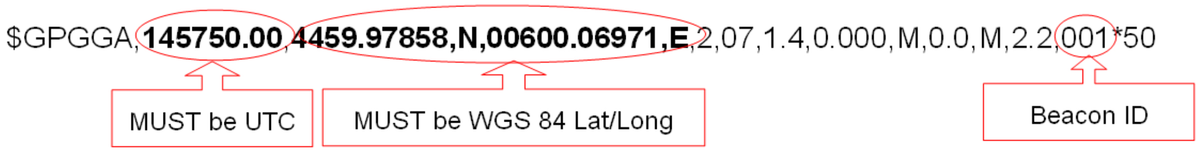
$--GGA, hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.xxx,M,x.x,M,x.x,xxxx*hh<cr><lf>

Table D–8 GGA Formatting

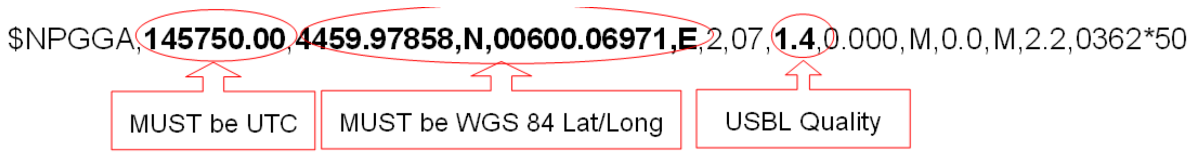
Field	Description
$	Start character
--	Sender Code (IN ? or GP)
GGA	Sentence Formatter
hhmmss.ss	UTC
llll.ll,a	Latitude, N/S 2 fixed digits degrees, 2 fixed digits minutes, variable digits of decimal minutes.
yyyyy.yy,a	Longitude, E/W 3 fixed digits degrees, 2 fixed digits minutes, variable digits of 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:



D.9 $_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 D–9 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

Supported Input Format

$GPZDA,**162408.00**,02,04,2007,,*6C

MUST be UTC

D.10 Navigation (Nav) Data

The navigation (Nav) data message is the generic navigation output fromSPRINT 300/500/700 AINS and is closely related the navigation quality message (NavQual); see *Section D.11 "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 D–10 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.

D.11 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 D–11 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)

D.12 Time System Data

The Time System data format is defined below.

Note

Source of RTC to UTC update; 0 = NO SOURCE; 1 = SPRINT 300/500/700 RTC; 2 = Standalone GPZDA; 3 = Standalone GPGGA; 4 = GPZDA 1PPS.

Fields in italic are for advanced users only and are subject to change.

Table D–12 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

D.13 Midas SVX2 Depth

Description

This message is tab delimited and provides Sound Velocity, Depth, Temperature and conductivity.

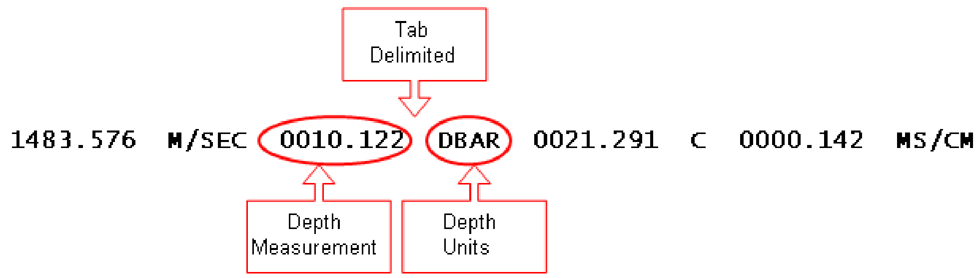
Format

ssss.sss<tab>uuuu<tab>dddd.ddd<tab>xxxx<tab>tttt.ttt<tab>xxxx<tab>cccc.ccc<tab>zzzz<tab><cr><lf>

Table D–13 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

Supported Input Format



D.14 Proprietary XPOS Report

Description

This proprietary message provides an external position and depth.

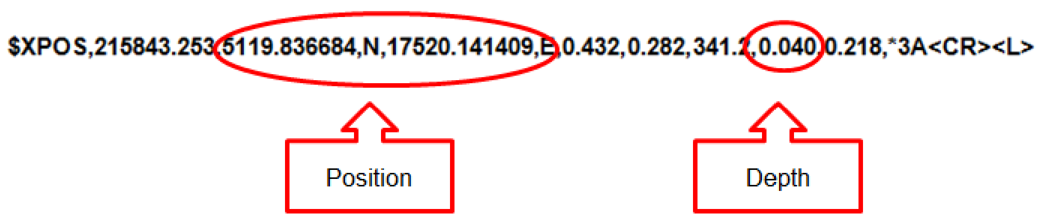
Format

$XPOS,hhmmss.sss,llll.llllll,a,yyyyy.yyyyyy,a,x.xxx,x.xxx,x.xxx,d.ddd,d.ddd,aa*hh<cr><lf>

Table D–14 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	

Supported Input Format



D.15 Proprietary XDepth Report

Description

This purpose of this string is to support an external depth input into Sonardyne software and instruments from a non-specific source.

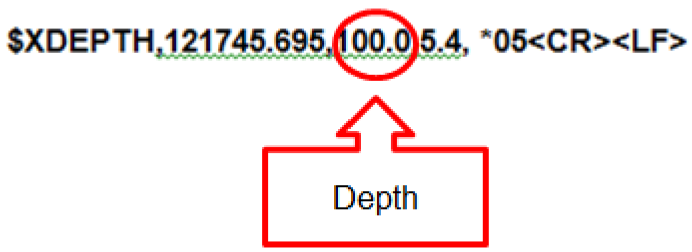
Format

$XDEPTH,hhmmss.sss,d.ddd,x.xxx,aa*hh<cr><lf>

Table D–15 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

Supported Input Format



D.16 Proprietary PSONNAV

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.

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 D–16 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

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>

D.17 LNav/LNavUTC

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 D–17 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}×90 deg	Yes, see Note 12	Int32	Latitude, Note 2
11-14	4	Longitude	2^{-31}×180 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}×180 deg	No	Int16	Note 6
23-24	2	Pitch	2^{-15}×180 deg	No	Int16	Note 7
25-26	2	Heading	2^{-15}×180 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):

Table D–17 LNav/LNavUTC Data (continued)

Byte# (from 0)	Size (bytes)	Field name	Units	Optional	Data type	Notes
						- semi-major axis
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 1st 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 D–18 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 E – AHRS Message Definitions

E.1 PRDID

Description

This Proprietary ADCP (RDI) telegram consists of pitch roll and heading

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

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.

Example

$PRDID,-0.17,-0.59,172.66*77

E.2 TSS1

Description

The TSS proprietary string outputs accelerations, heave and roll and pitch.

Format

:XXAAAASMHHHHQMRRRRSMPPPP<CR><LF>

Field	Description
:	Start character
XX	Horizontal Acceleration (not populated by SPRINT 300/500/700)
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

Notes

- Vertical acceleration is positive in the up direction.
- Horizontal acceleration is not populated by the SPRINT 300/500/700.
- 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.

Example

:003D04 0000H-0058 -0017

E.3 TSS2

Description

This TSS proprietary string outputs heading, heave, roll and pitch.

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

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

Example

:17263 0001H-0058 -0017A

E.4 TSS3

Description

The TSS proprietary string outputs remote heave, heave, roll and pitch.

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

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

Example

:R 0001 0001H-0059 -0017

E.5 EM1000

Description

Format suitable for use with Simrad EM series multibeam sonars.

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	

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.

Example

00900200FF730000 hex

E.6 EM3000

Description

Format suitable for use with Simrad EM3000 series multibeam sonars.

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.

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.

Example

00900200FF730000 hex

E.7 PHTRO

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.

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

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.

Example

$PHTRO,-0.17,P,-0.56,B*46

E.8 HDT

Description

NMEA True Heading

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

Notes

- The Heading type indicator is always ‘T’ when transmitted by the SPRINT 300/500/700, to indicate that heading information is with respect to true north.

Example

$HEHDT,172.597,T*20

E.9 THS

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.

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

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)

Example

$HETHS,172.59,E*11

E.10 MDL

Description

This message provides heading, pitch and roll in degrees

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

Example

H1726P-0016R-0058

E.11 TEMP

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.

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

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.

Example

$HETXT,1,1,66,43.1,43.5,42.9,43.8,42.9,43.9*7C

E.12 TXT

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.

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

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.

Example

:0003ADA31BA8,{$INTXT,01,01,3,External Power Supply was Not Good, now cleared*2C}*55

E.13 ALR

Description

This telegram indicates the local alarm condition and status

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

Notes

- This sentence is used to report an alarm condition on a device and its current state of acknowledgement. In particular for the SPRINT 300/500/700 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.

Example

:0003E482E0A7,{$INALR,150951.00,099,A,V,Alarm: Status = 0x00000004*78}*7

E.14 SON2

Description

The SPRINT 300/500/700 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.

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

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.

Example

:152359000 000222-000022 359999 1234S

E.15 POSMV GROUP 111 Heave and True Heave

Description

This telegram contains data for delayed heave calculations along with time matched real-time heave data. Heave sign is positive down.

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	$#

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

E.16 POSMV GROUP 113 Heave and True Heave

Description

This telegram contains quality data for delayed heave calculations.

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	$#

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

E.17 VTG

Description

This NMEA string outputs speed and course over ground (SOG & COG)

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

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

Example

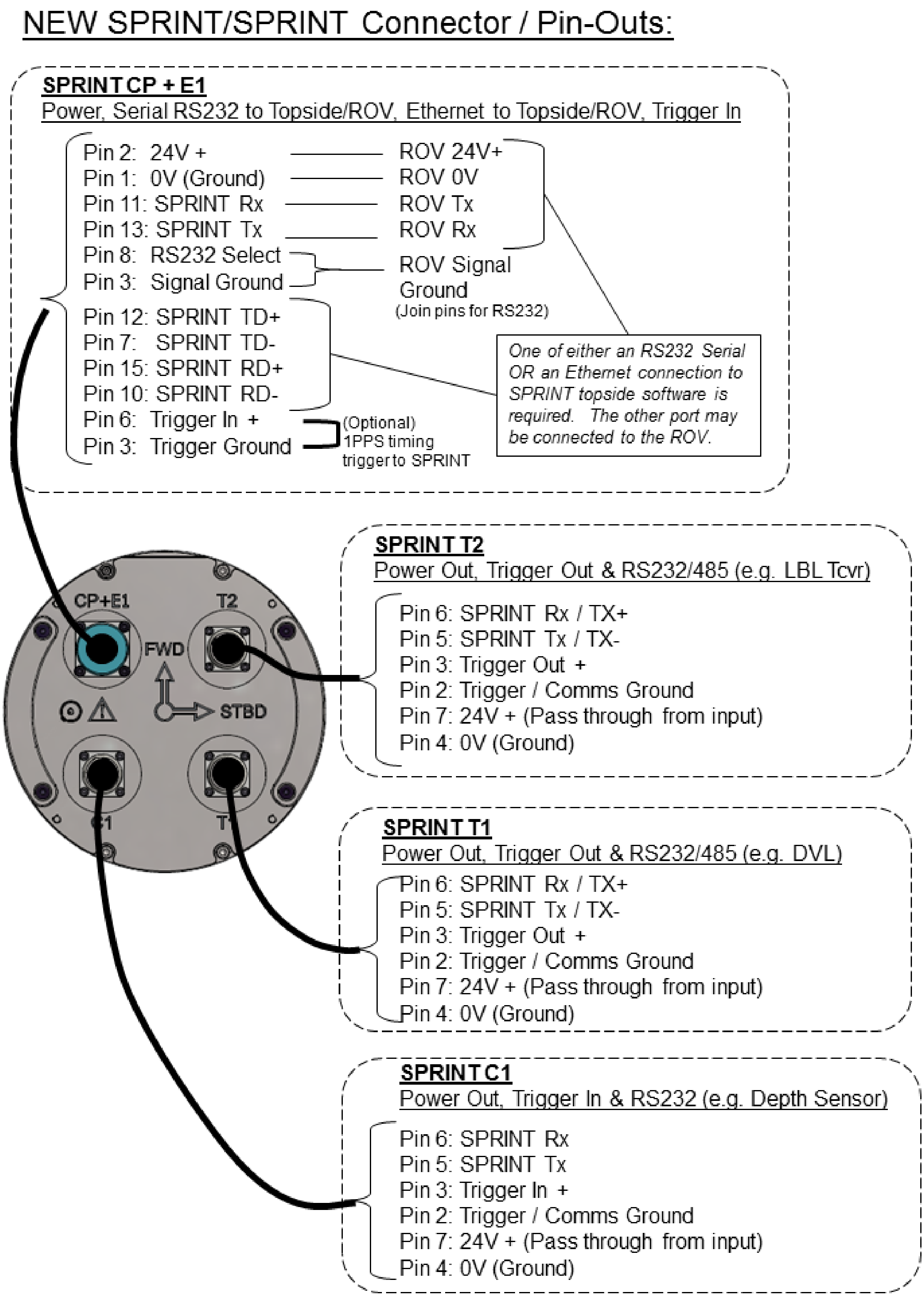
$GPVTG,,T,,,,N,,K*03

$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

Appendix F – SPRINT 300/500/700 Wiring Diagram

Figure F–1 Typical SPRINT 300/500/700 Wiring Diagram (Standard Seacon Endcap)



Appendix G – SPRINT 300/500/700 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) measured			Forward__________

	(Metres)?			Starboard________ Down_____________
	Cable connection wired as per system wiring diagram?			
	DVL facing down with alignment mark facing forward on the vehicle? NB: Misalignments can be calculated by the DVL calibration procedure			
	Is DVL triggered by Lodestar? (If no then DVL will be free-running/untriggered)			
	DVL powered ?			
	If multiple DVLs present, has check been run on the SPRINT aiding DVLto confirm correct offsets?			
	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			Format__________

Topside Checks		Yes	No	Notes
	with SPRINT?			
	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 H – Pressure to Depth Conversion

Pascal to Metres of head: 0.00009938710

PSI to Pascals: 6894.75729

Metres to PSI: 1.42233433

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
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
MWSK	Mid Water Station Keeping
PC	Personal Computer
RLG	Ring Laser Gyroscope, A sensor that measures rotation
RMS	Root Means Square
ROV	Remotely Operated Vehicle
Sonardyne	Sonardyne International Limited and its affiliates.
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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SOUND IN DEPTH

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