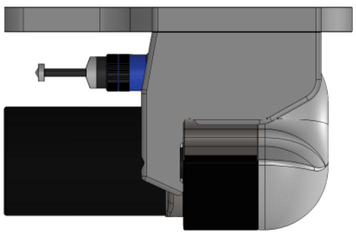
NORBIT

User and Technical Manual
NORBIT GUI 10.4.3

WBMS



iWBMSc
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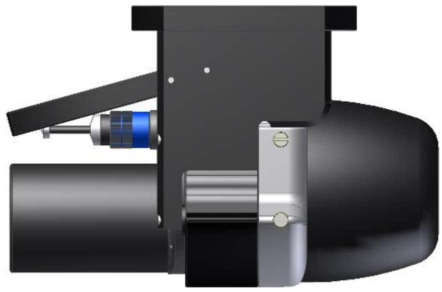

iWBMSh
iWBMS

TN-140075-9 WBMS Bathy Manual

April 2020

Notice

We make every effort to provide the latest technical documentation. There may be updates. For this, please contact subsea_support@NORBIT.com for the latest information.

Copyright Statement

Disclaimer

While every effort is made to ensure the information given is accurate, NORBIT does not accept liability for any errors or omissions. All non-metric weights and measurements are approximate. Specifications, equipment, and other information in this document are subject to change without notice.

All performance metrics mentioned in this document, such as attainable depths, was derived from tests in Portland, Oregon and Seattle/Tacoma, Washington, USA in May 2017. Acoustic conditions are described when describing performance capabilities.

Sonar Kits

This manual covers the following NORBIT products:

WBMS	12003
iWBMSe	12006
iWBMSc	12005
iWBMS/STX	12004
iWBMSh/STX	12007

Release Notice

This is the April 17, 2020 release of the NORBIT WBMS user and technical manual.

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1 Introduction

1.1 Terms & Abbreviations

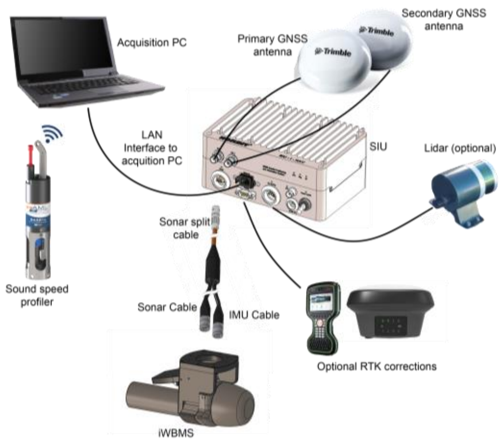
AMPS	Amperes
Aux	Auxiliary
Bandwidth	Range of frequency sweep
CW	Continuous Wave (single frequency)
EA	Equal Angle beam distribution
ED	Equal Distance beam distribution
FM	Frequency Modulation (swept frequency)
GAMS	GNSS Azimuth Measurement Subsystem
GNSS	Global Navigation Satellite System
GPS	US Global Positioning Satellites (often describes all GNSS)
GUI	Graphical User Interface
HAW	Heading Alignment Wizard
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
INS	Inertial Navigation System
iSIUc	SIU - Compact
iSIU	Integrated SIU
iWBMSe	Integrated WBMS – Entry Level (SurfMaster)
iWBMSc	Integrated WBMS – Compact (pre-mid-grade with STIM300)
iWBMS	Integrated WBMS – Standard (mid-grade with WaveMaster)
iWBMSh	Integrated WBMS – Pro (with top level OceanMaster)
LED	Light Emitting Diode
MBES	Multibeam Echosounder Sonar
NTP	Network Time Protocol
POS	Positioning & Orientation System
PPK	Post Processed Kinematic
PPS	Pulse Per Second
PTP	Precise Time Protocol
RTK	Real Time Kinematic
Rx	Receive
SBAS	Satellite Based Augmentation System
SIU	Sonar Interface Unit
SNR	Signal to Noise Ratio
SONAR	Sound Navigation and Ranging
SOSP	Speed of Sound Profile
SPAN	Synchronized Position Attitude Navigation
STX	Steerable Transmission
Tx	Transmit
USACE	USA Army Corps of Engineers
VDC	Volts – Direct Current
WBMS	Wideband Multibeam System

1.2 Technical Overview

The NORBIT Wide Band Multibeam Sonar (WBMS) is the most compact, high resolution, wide swath multibeam sonar available. With a dry-weight of less than 4.5kg (10lbs), beam widths of only 0.9° at 400kHz, and low power consumption, the stand-alone multibeam sonar easily mounts to a survey platform of any size and may be powered by a small battery (e.g. laptop extension battery pack) or standard AC plug.

The WBMS is optimized to transmit a frequency modulated (FM) sound wave centered at either 200kHz (for deep waters) or 400kHz. From the returning signal, 256 or 512 beams are formed within a user-selectable 5° to 210° fan-shaped swath, utilizing the integrated sound speed probe. The curved receiver arrays of the NORBIT systems allow for narrow beams over a wide swath with significantly reduced beam spreading compared to flat arrays. The curved array allows for a more forgiving sonar in areas of surface sound speed variations. NORBIT has implemented cutting edge signal gain compensation, adaptive gating/thresholding, and proprietary amplitude and phase detection algorithms to achieve accurate and repeatable bottom detections.

For projects requiring maximum sounding coverage, NORBIT has developed a steerable transmission sonar called the STX. The STX can sweep through a 20° along-track sector in scanning mode, providing a 3D scan of the environment. The STX can be operated as a forward-looking sonar or as a conventional multibeam, making this one of the most versatile systems developed by NORBIT. The STX is ideal for complex surveys where coverage gaps must be minimal, structural detections must be accurate and the survey completed in as little time as possible.



All processing and export of time-stamped bottom detection occurs within the sonar head. The system requires very little user intervention to achieve clean and repeatable bathymetry. Hardware installation is similarly very easy and quick. A single cable powers and connects the sonar to a small Sonar Interface Unit (SIU). The SIU similarly connects to a data acquisition/sonar control PC by a single ethernet cable.

The NORBIT WBMS is unique to the industry as the first platform designed as a cylindrical array wideband system with frequency modulated (FM) transmission signals. With latest FPGA circuits, integrated surface sound speed probe, and 21st century engineering, the system provides the resolution and capabilities of much bulkier systems. Efficiency savings begin with installation: the compact (and lightweight) form-factor enables for simpler, less robust, mounting infrastructure than earlier generation box-shaped multibeam sonar systems. Low power requirements allow added flexibility on very small survey vessels as well as any vessel of opportunity.

NORBIT offers many options for a tightly integrated bathymetric mapping solution that combines all sensors required to carry-out high-grade bathymetric surveys. The integrated system, with a complete GNSS/INS system, drastically streamlines the setup process and reduces measurement uncertainties. NORBIT offers a range of integrated systems and peripherals to suit varying survey demands and budgets.

1.3 Advantages of the Cylindrical Array

The WBMS broke the industry mold by bringing a low cost and compact yet highly accurate cylindrical receiver array with highest signal bandwidth to the market. Below are some of the advantages a cylindrical array offers.

- Unlike a flat array, bottom detections from a cylindrical array are much less susceptible to surface sound speed errors.
- The WBMS does not begin to beam steer until ± 30° from nadir. This results in lower incidence of depth error from the reduced beam width spreading as steering increases (flat receiver arrays steer all beams but nadir).
- At all frequencies, the WBMS provides increased swath coverage with a smaller beam footprint for a fixed aperture.
- The cylindrical array of the WBMS can cover a full 210°. Flat array systems would lose data fidelity at much lower swath angles (± 80°) and would necessitate mounting two or three sonars at angles to achieve higher swath coverage.
- The cylindrical array presents a more hydrodynamic profile allowing for faster transit, less vibration, and use of lighter mounting hardware. Sturdier mounting, such as hull mounts, enables a maximum transit speed of >20 knots.

1.4 Advantages of the INS Integrated System

Factory integration of critical sensors yields a forgiving acquisition experience for the onboard surveyor. Offsets between sonar measurement reference and inertial motion unit reference centers are fixed and predefined within the system setup. The user need only measure from top center of sonar bracket to bottom of primary antenna mount.

Cabling and software integration between sonar, positioning, heading, attitude and sound speed probe is handled internally. The onboard surveyor need only connect the wet end to the topside via a single cable and then connect the primary and secondary GNSS cables (which are each labelled on both ends of the cable to remove installation uncertainty).

1.5 How to Use this Manual

This manual describes the complete installation and operation of all the NORBIT bathymetric Wide Band Multibeam Systems (WBMS). This may be the WBMS, iWBMSe, iWBMSc, iWBMS, iWBMSh or any of these in dual head configuration.

The reader is strongly encouraged to read this manual thoroughly. Doing so will encourage safe and efficient operation in the collection of high quality beamformed bottom detections.

NORBIT makes every effort to ensure that the information contained in this manual is accurate and fully updated to correspond with the latest sonar firmware and software releases. The sonar firmware version being employed must correspond with the version listed at the bottom of each page in this manual.

This manual is optimized for digital viewing using PDF viewing software. If a suitable browser is not available then any web GUI (Firefox, Chrome, etc.) would work. The table of contents section will link directly to each section listed. At the bottom of each page is a link to return to Table of Contents.

1.6 System Specifications

While continual improvements are being implemented, specifications may change. To obtain the most current specification sheets please visit https://www.NORBIT.com/subsea/

1.7 Export, Shipping Weight & Dimensions

The compact size of the WBMS systems allows for simplified shipping and handling. The lightest NORBIT system wet-end is the 0.9° x 1.9º WBMS at 4.5kg in air while the heaviest system is the 0.9° x 0.95º iWBMSh which has an integrated IMU and provides the highest resolution data and is 11kg in air and 7kg in water.

1.7.1 ITAR Restrictions

Except for the iWBMSc, all others in the iWBMS(x) family contain an Applanix POS MV. All systems are free of Canadian and EU export controls.

When exported from the U.S., the U.S. Department of Commerce ECCN **7A994** reference number needs to be quoted on all shipping documentation.

CAUTION: For US-Based Systems
For shipping internationally, all shipping documents should quote ECCN 7A994. This number is the same for all Applanix & NovAtel systems. NORBIT strongly recommends DHL as a preferred shipper when shipping internationally.

Due to system configuration and selected components, there are no import or export restrictions on the WBMS sonar which facilitates unimpeded global operations.

1.7.2 Shipping

Each NORBIT system (including all components) are shipped in a single, lightweight Pelican case that meets airline baggage guidelines.

Airline Checked Luggage: Despite the rugged freight case construction with dense form-cut foam shock absorption, it is prudent to handle the full cases with care. Please ensure an airline “Fragile” label is prominently displayed.

Airline Carry-On Baggage: The WBMS case may be hand-carried onto many airplanes but when checking through airport security it is often required to remove the sonar from the case for x-ray.

1.8 Caring for Your Investment

To protect the sonar from undue damage, please follow these reasonable minimum guidelines, especially while operating in harsh environments.

Never support the WBMS by the sound speed probe or strictly by the projector. For the stand-alone WBMS when shipping in a non-foam cut case, remove the sound speed probe and replace it with blue dust cap. Ensure all connectors are protected with provided caps/covers when not in use.

For the integrated versions, especially the larger iWBMSh 1°, take extra precaution against drops or rough handling, especially when shipping via courier. Use “Fragile” labels where/when possible to add further protection for the system suite.

Replace connector caps on sonar, SIU and cables when not in use to keep out debris and moisture. Choose a dry location at room temperature for prolonged storage. Never wet store system in sealed environment; dry the system before returning to the case. When returning to office, open the case.

⚠ **CAUTION: Sonar Protection**

When submerged for long periods, the sonar is at risk of becoming fouled by barnacles etc. (especially in warm salty water) or may be subjected to stray electric currents. NORBIT offers both titanium housing, additional anodes and factory applied bio-fouling paint that is approved and tested against acoustical losses. Contact subsea_support@NORBIT.com for info.

Do not leave system in the sun for long durations. Prolonged exposure to UV rays may cause degradation of the polyurethane coating on the transducers; potential damage includes drying and crack formation which would permanently expose and damage sensitive sonar electronics.

Never allow wet end to rest on the polyurethane as this may scratch or wear this sensitive area. Always use a sturdy padding (foam) under the sonar when mounting it.

To clean the WBMS, only use mild, nonabrasive soap, fresh water, and a soft brush to gently scrub the sonar. Using any other method may damage the sonar. Do not use a power washer to clean the sonar. This can damage the housing and cause the sonar to improperly beam form.

To protect the system from corrosion, take extra care when handling to not scratch the anodized aluminum housing (not a concern for titanium housing). It is also a good practice to rinse off the sonar after use, especially if used in saltwater, and allow it to dry completely prior to storage. As an added layer of corrosion protection, it is recommended that the vessel anodes be checked on a regular basis. This will further protect the WBMS.

If the WBMS is hull mounted, NORBIT provides an option for performance neutral antifouling paint application. Painting of the sonar outside of NORBIT may cause negative impacts to system performance and pushes the system outside of warranty.

If the sonar will be in the water for extended periods, it is recommended that sacrificial anodes be used to protect against electrolysis. Anodes can be collared around the cable connection and the inserted into the receiver frame, as shown in the adjacent images. Care must be taken to not scratch the anodizing on the aluminum housing during installation. Spare anodes can be purchased directly from NORBIT.

NORBIT offers antifouling paint service. If your system is protected with antifouling paint then additional care is required to ensure the paint is not scraped or rubbed off during mobilization, shipping or handling. After retrieving the sonar from the water wipe down the system with a clean towel to clear off dirt, grime, marine growth, etc. that may otherwise compromise the sonar body.

⚠ **CAUTION: Do Not Connect/Disconnect Cables with Power On**

To prevent damage to system electronics always turn off power before disconnecting or swapping cables.

1.9 Maintenance Schedule

It is good practice to perform periodic inspections or checks of the sonar system. The table below lists several checks, recommended by NORBIT, to guide users in performing maintenance checks.

1.9.1 Before Each Survey

Component	Inspection	Additional Notes
Receiver Array	Inspect polyurethane for gouges, nicks or separation from housing. The array face should be smooth and uniform.	Water intrusion will result in excessive damage and be costly to repair. Contact NORBIT Support for further information. Always store sonar away from sun.
Projector Array	Inspect the projector array for gouges or nicks and check the attachment area of the projector with the sonar housing. The projector surface should be smooth and uniform. A delamination protection ring should be tightly fitted to projector at the housing attachment point.	Water intrusion will result in excessive damage and be costly to repair. Contact NORBIT Support for further information. Always store sonar away from sun.
O-Rings on wet end cable connections	Check O-rings for damage and particulates that may interfere with O-ring operation and keep it lightly lubricated. Use Silicone Grease that is min 90% pure.	If missing a spare O-ring, please remove and borrow one from the cable wet-end protective cap. But be sure to get the appropriate one replaced from NORBIT support.
Sound Speed Probe	Remove sound speed probe and check connector for corrosion. Probe O-ring should be in good condition. Replace probe and ensure a tight fit. Apply light coating of silicone grease to O-ring prior to re-attaching probe. Compare value with value from profiler at same depth. Difference should not be greater than 1m/s	Bad or missing surface sound speed will create beam steering errors and affect outer swath data performance. It is recommended that the probe be calibrated every 18-24 months.
Sonar Housing	Inspect housing for scratches and corrosion. Ensure anode is in good condition (for aluminum housing).	Small scratches compromise the galvanic barrier of the aluminum housing. Contact NORBIT for further information.
Sonar Cable Connector	Check for debris and clean out with compressed air. Cable connector must be dry and clean. Use protective cap when not in-use.	Sonar connection is not wet-mateable. Do not disconnect or connect when sonar is submerged or in wet areas.
Sonar Cable	Check connectors and clean out with compressed air. Run cable through hand and check that cable is smooth, without kinks and without tears. Check that pins are shiny and not bent. Check O-rings for wear and replace as necessary. Use small amount of silicone lubricant.	A bad connection or bad cable will corrupt survey data. Treat the cable with great care (do not walk on it).
Sonar Mounting Bolts	Check that threads on plastic sleeves are in-tack and not de-threaded. Vibration over long term can loosen bolts and compromise data quality or loss of wet-end.	Use only stainless-steel bolts and washers. Contact NORBIT for spare parts. Use Loctite 242 Blue, lock washers and/or nylon nuts.
Mounting Bracket	Check that all hardware for the mounting bracket is tight. Care must be taken when checking the mounting screws for the sonar as over tightening may damage the connections	The bracket is very robust and provides electrical isolation from the vessel.
Electrical & Galvanic Isolation Shield	Check that plate is included in shipping case and used between sonar and sonar bracket when mounted. For the WBMS (non-integrated systems), it is imperative to use the included electrical isolation shield.	This protects the aluminum sonar housing from galvanic corrosion.

WBMS Firmware & GUI Versions	Ensure that both firmware and GUI versions match and are latest.	Prior to each new survey. Contact NORBIT support for details.
Integrated INS Firmware & GUI Version	Ensure that both firmware and GUI versions match and are latest. This may require an annual maintenance cost.	Prior to each new survey. At least once each year. Contact NORBIT support for details.

1.9.2 After Each Survey

Component	Inspection	Additional Notes
Complete Kit	Perform all inspections in the previous section.	Ensures that users are ready for the next survey.
Wet-End	The complete wet end should be rinsed with fresh water. Clean off any marine growth with soft rag. If barnacles have taken refuge on the sonar, then remove these very carefully so as not to pit or nick the polyurethane. If any damage occurs to the anodized aluminum or polyurethane, then take a high-resolution picture and send to NORBIT support for help. Allow the kit to dry before locking down the lid. Once back at the office, store with lid open.	Ensure that the kit is ready to provide long lasting operation.

1.9.3 Monthly

Component	Inspection	Additional Notes
Complete Kit	Perform all inspections in the previous sections.	Ensures that users are ready for the next survey.
Sound Speed Probe	Compare surface sound speed probe with another sensor. If it is not within 1m/s difference and the comparison conditions are similar, then determine which sensor is bad and return for calibration.	The surface sound speed sensor should provide reliable data for an 18-24-month period.

1.9.4 Annually

Component	Inspection	Additional Notes
Complete Kit	Perform all inspections in the previous sections.	Ensures that users are ready for the next survey.
INS Annual Warranty	The integrated INS require its own annual maintenance. The latest INS firmware versions necessitate an active maintenance warranty that must be kept up to date and without lapse. Please contact NORBIT support prior to any INS FW update.	Applanix releases important performance updates via NORBIT tested and approved firmware version. Contact NORBIT for more information.

1.9.5 Biennially

Component	Inspection	Additional Notes
Complete Kit	Perform all inspections in the previous sections.	Ensures that users are ready for the next survey.
WBMS Calibration Services	Long term use requires preventative maintenance and calibration service for the sonar. It is recommended to send purchased system once every two years for a calibration service. The first bathymetric WBMS systems are still in operation as they have been cared for and returned to the factory for increased longevity.	Calibration service includes surface sound speed calibration.

1.10 Hull mounted and bio-fouled systems cleaning procedure

The procedures below outline the safe way to clean hull mounted systems or those with extreme biofouling. Please ensure that these steps are followed exactly as outlined, as failure to do so could result in damage to your system. If there are any questions or doubts about these procedures contact NORBIT support.

⚠ **CAUTION: Do NOT use Power Washer**

If cleaning a hull mounted system, a power washer must not be used. This will irreparably damage the system. If hauling out the vessel for hull cleaning, ensure that those cleaning the hull are informed about not putting any part of the power washer stream on the NORBIT system.

⚠ **CAUTION: Superfine Abrasives Only**

When using scrubbing pads on the NORBIT, ensure that you are using a super fine abrasive pad such as 3M™ Scotch-Brite™ Light Cleansing Hand Pad 7445. A very abrasive scrubbing pad will damage the polyurethane on the sonar.

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1. Remove the system from the vessel and place water and dust resistant caps on the sonar bulkhead as well as the end of the cable.
2. Manually remove as much fouling from the sonar as possible.
3. Obtain a bucket large enough to fit the entirety of the sonar. In the container, mix in a 50/50 ratio of CLR® (Calcium, Lime, Rust cleaner) to water.
4. With the bulkhead cap tightened, completely submerge the system in the 50/50 solution for approximately 2 hours.
5. Remove the sonar from the solution and scrub the sonar using a super fine abrasive pad and water.
6. If the system still has fouling, repeat the soaking process. This process can be repeated until all biofouling has been removed from the system.
7. Allow the system to dry fully prior to storage.

Cleaning of system with a power washer, causing exposure of the ceramics.

1.11 Factory Calibration

NORBIT recommends that the WBMS and SIU be sent back to NORBIT for factory calibration every two years. The calibration will examine the WBMS and the SIU. In addition, the sound speed sensor will be calibrated. The factory calibration will ensure that the WBMS maintains high data quality and repeatability.

The Calibration turnaround is typically one week, if scheduled ahead through NORBIT support. It is the responsibility of the user to schedule the calibration. NORBIT will not recall systems for calibration.

For integrated INS kits, it may be necessary to update the INS firmware. INS firmware upgrade may incur additional cost as deemed appropriate by Applanix. Please contact NORBIT Support to find out if this applies to your system. Keeping up to date is important to take advantage of rapidly changing latest positioning techniques.

1.12 Options & Upgrades

If necessary, NORBIT offers the following affordable upgrades:

- Custom cable lengths. Please specify length with order. Maximum is 50m.
- NORBIT acquisition software – DCT (Data Collection Tool)
- 3rd party Bathymetric/Hydrographic survey data acquisition & processing software
    - HYPACK & HYSWEEP
    - QINSy, Qimera & Fledermaus
    - EIVA
    - CARIS
    - BeamworX
- GNSS RTK Base Station Kit. Simple to use RTK base station with/without FCC license free radios.
- Post Processed Kinematic Software. Offers centimeter positioning even with GNSS outages.
    - For Compact: Waypoint Inertial Explorer (NovAtel)
    - For iWBMS: Applanix POSPac MMS (Trimble)
    - GNSS Base for PPK
- High-Resolution Forward-Looking Sonar. Visualization, navigation and or obstacle avoidance.
- Deep mode (200kHz center frequency) for 550m depths
- Integrated LiDAR utilizing the same SIU as the integrated WBMS
- Dual-Head WBMS
- 1° Transmit array
- 100, 4500 & 6000m Depth Ratings (WBMS only)
- Performance neutral antifouling paint.
- Diagnostic/Preventative Service
- Onsite Support and Training. From classroom instruction to on-project support service

1.13 Support

For basic troubleshooting, please refer to the Troubleshooting section in this document. For further support please contact NORBIT Subsea Support:

NORBIT Subsea AS
Stiklestadveien 1
7041 Trondheim
Norway

Phone: +47 739 82 569 (UTC+2) *
Email: subsea_support@NORBIT.com
*UTC time offsets above may be ±1hr off due to daylight savings time

2 Hardware Installation

For well-seasoned multibeam users, a quick setup plan is found in Quick Start. All first-time NORBIT WBMS operators, however, are strongly encouraged to fully review this manual prior to commencing a survey project. The warning boxes may not cover all critical notices.

⚠ **CAUTION: Properly Seal Wet-End Connection**

Inspect O-Ring each time before connecting wet-cable and replace as needed. Apply a thin coat of synthetic grease (e.g. Molykote 55) to the O-Rings. Strongly hand-tighten wet-connector (push in and tighten repeatedly until firmly connected). If connector sticks when tightening, apply a very thin coat of grease to the threads.

⚠ **CAUTION: Voltage Limitation on DB9**

The DB9 connection on the SIU is not rated for voltages higher than 5V. Application of voltages on any pin of the connector over 5V **will damage the system**. Check all potential connections for unexpected voltages.

2.1 Power Requirements

The WBMS family of systems requires clean power for proper operation. As most vessels utilize an inverter for this purpose it is important that it be **a true sine wave inverter**. A modified sine wave inverter may cause unexplained issues even when using the included power brick. In general, inexpensive inverters are likely modified sine wave. Use high quality inverters for providing power to the WBMS family of systems. If dirty power is assumed, connect the system directly to a 12-24VDC battery and test.

Additionally, power can be provided directly from a 12V deep cycle battery using the included pigtail that plugs into the power port on the SIU.

2.1.1 Power Consumption

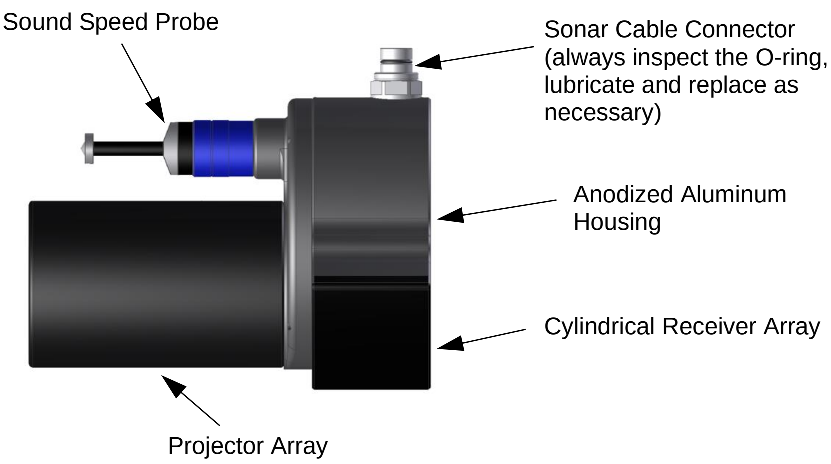
The following table outlines the expected power draw for NORBIT multibeam systems. This list does not cover all configurations but covers most current configurations. Contact NORBIT support if your power requirements dictate a lower power consumption. There are several ways in which lower consumption can be achieved.

System	Average	Maximum
WBMS-bathy_Pn_12003-AACDB4	40W	55W
WBMS_STX_Pn_12003-APBDD4	50W	65W
WBMS-bathy_Long Range_Pn_12003-AACDB2	40W	60W
iWBMSc_Compact_Pn_12005-AACDB4	45W	65W
iWBMSe_Pn_12006-AACDB4	55W	70W
iWBMSe_Long Range_Pn_12006-AACCB2	55W	70W
iWBMS_Pn_12004__AACDB4	60W	75W
iWBMS-Long Range_Pn_12004-AACDB2	60W	75W
iWBMSh_Pn_12007-AACDB4	60W	75W
iWBMSh STX_12007-APBDD4	70W	80W
iWBMSh_Dual Head_Pn_12007-DACDB4	100W	160W

2.2 Wet-End Overview

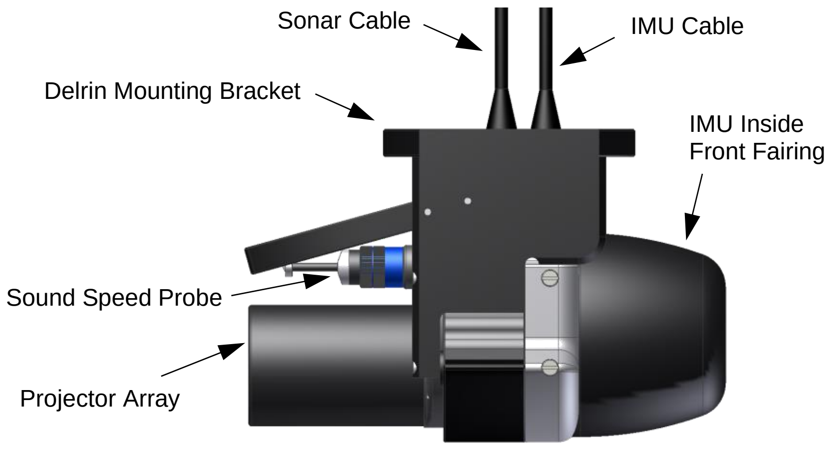
2.2.1 WBMS Sonar Head

The WBMS sonar is comprised of a cylindrical receiver array and a cylindrical projector array. The receiver housing contains latest FPGA boards where all sonar processing occurs. Data leaving the WBMS wet-end is ready for survey data acquisition via Ethernet protocol.



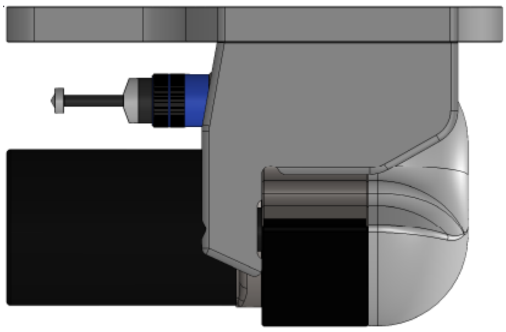
2.2.2 iWBMS, iWBMSh, iWBMSe & STX Sonar Head and IMU

iWBMS, iWBMSh, iWBMSe and STX models contain the well-known Applanix GNSS/INS systems. The systems are equipped with either a MEMS-based or one of two FOG IMUs. The systems are optionally available with POSPac MMS for full positioning and attitude PPP or PPK solutions. The IMU is housed inside the ballistic grade front fairing of the wet-end assembly.



iWBMS with standard 1.9°projector. The 0.95° projector adds only 10cm to the length.

The iWBMSe has the Applanix SurfMaster (AP-18) while the iWBMSc comes with the Sensor STIM300 IMU and NovAtel antennas for a complete GNSS/INS system. These MEMS-based IMU's are housed inside the projector of the wet end assembly for both systems resulting in a very compact form factor. Some customers request the iWBMSe IMU to be mounted on the front nose (like the iWBMS/iWBMSh) so that they may be easily upgraded later. The systems are optionally available with POSPac MMS or Waypoint Inertial Explorer for full positioning and attitude PPP or PPK solutions.



⚠ **CAUTION: Voltage Ratings**

The DB9 and PPS connections on the SIU are not rated for voltages higher than 5V. Application of voltages on any pin of the connector over 5V could damage the system. Check all potential connections for unexpected voltages. Do not input a PPS pulse into the BNC connection of the **integrated SIU** as this could damage the GNSS boards inside the system.

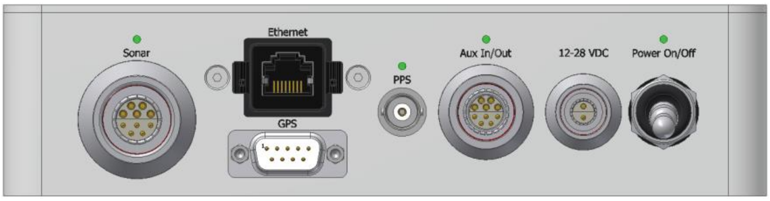
The newly introduced STX comes in two models: 200kHz and 400kHz, with up to a 1x1° beam width transmission capability. The lower frequency system is optimum for deeper water applications. Like the iWBMS systems, the STX may be integrated with an inertial measurement unit (Applanix WaveMaster II or OceanMaster) for a complete bathymetric solution. The dimensions of the STX with 1x1° projector will be nearly identical to that of the iWBMS. The STX provides a versatile bathymetric tool – it can be used as a forward-looking sonar or operated as a conventional multibeam bathymetric sonar. The topside interface unit is identical to the SIU-I-NAV described earlier. To provide yet another option, the STX, in bathy mode, may be coupled to another NORBIT sonar to form a dual-head system for increased coverage and faster results. However, due to the STX's higher power requirements a dual-head system compromising of at least one STX will require two topside units. The STX, like other WBMS systems, can be controlled via the WBMS GUI 10.4.0. Detailed descriptions of the GUI and STX offsets will be in later sections. and the related offsets will be outlined in a later section.

2.3 Dry-End Overview

All WBMS systems include a compact topside Sonar Interface Unit (SIU) which distributes power, time information and data between the sonar wet-end and the survey acquisition system. This environmentally sealed fan-less topside is dust-proof and splash resistant, facilitating worry-free use on vessels with little to no protection from the elements.

CAUTION: Cover Connection Ports
When operating in open environments, all connection ports on the SIU should be tightly sealed either with the NORBIT supplied cables or, if the port is unused, with the port covers provided with the system.

2.3.1 WBMS Sonar Interface Unit (SIU)



PN: 29024

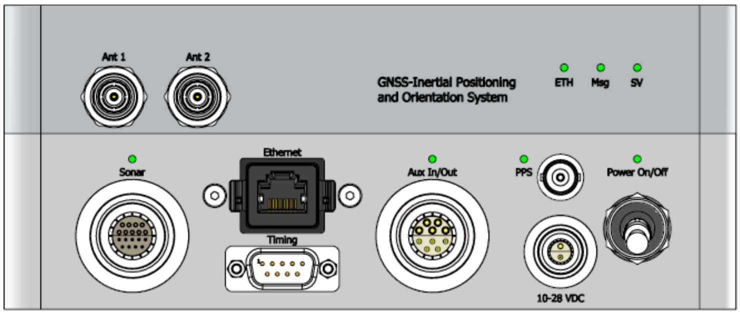
Connector	Description
Sonar LEMO	Interface cable to the sonar
GPS RS-232	ZDA Timing input
PPS BNC	1 PPS input for external sensor
Ethernet RJ45	For communication between topside PC and sonar SAMTEC Part# RCE-01-G-05.00-D
AUX LEMO	For communication with auxiliary devices
Power LEMO FUSE SOCKET*	Input DC voltage Rear; 6A slow-blow

*Please note that SIU-I model 29024-5 and newer will not have the 6A fuse in the rear. Instead there will be an internal 20A fuse

This SIU works with all WBMS Bathy, STX and FLS systems. The iWBMSe and iWBMSc require an 18-pin to 10-pin adaptor.

The SIU will shut down automatically at 70°C to prevent damage to electronics due to overheating.

2.3.2 iWBMS Sonar Interface Unit (SIU-I-NAV)



PN: 29028

Connector	Description
Sonar LEMO	18-pin interface to sonar and IMU
Ant 1 TNC	Primary GNSS antenna. Antenna closest to WBMS
Ant 2 TNC	Secondary GNSS antenna
GPS RS-232*	GNSS corrections input (RTK/DGPS)
PPS BNC	1 PPS output for external sensor (not typically used)
Ethernet RJ45	For communication between topside PC and sonar SAMTEC Part# RCE-01-G-05.00-D
AUX LEMO	10-pin interface for communication with auxiliary devices
Power LEMO Fuse Socket**	Input DC voltage Rear; 12A slow blow

* Please note that NORBIT has a split serial option. This option allows for ASCII/Binary output of GNSS/INS information to 3 serial connections. Please contact NORBIT support for more information.
**Please note that SIU-I-NAV and SIU-I-Compact-NAV models 29028-5, 29029-3 and newer will not have the 12A fuse in the rear. Instead there will be an internal 20A fuse.

The SIU will shut down automatically at 70°C to prevent damage to electronics due to overheating.

2.3.3 LED Status Indicators & Description

All SIU versions have activity LED's that behave as detailed below:

Indicator	Pattern	Description
Sonar LED	Off Led Blinking (ISO) 1Hz Blinking 1Hz Green steady Blinking 5Hz	Sonar Off Sonar Booting Sonar Stand By Sonar pinging Sonar Over Current Failure
PPS LED	Orange blinking (1Hz) Orange blinking (5Hz) Off On, steady	Sync/timing ok No sync, NMEA missing No sync, NMEA and PPS missing No sync, PPS missing
AUX LED	Always OFF	Not currently in use
Power LED	Green Green – flashing at 5Hz Off	Input voltage ok Input voltage <10v or >28V No input voltage
ETH	Flashing	Applanix/NovAtel established valid Ethernet connection
Msg	Flashing	Applanix/NovAtel receiving RTK corrections
SV	Flashing	Applanix/NovAtel detecting satellite vehicles

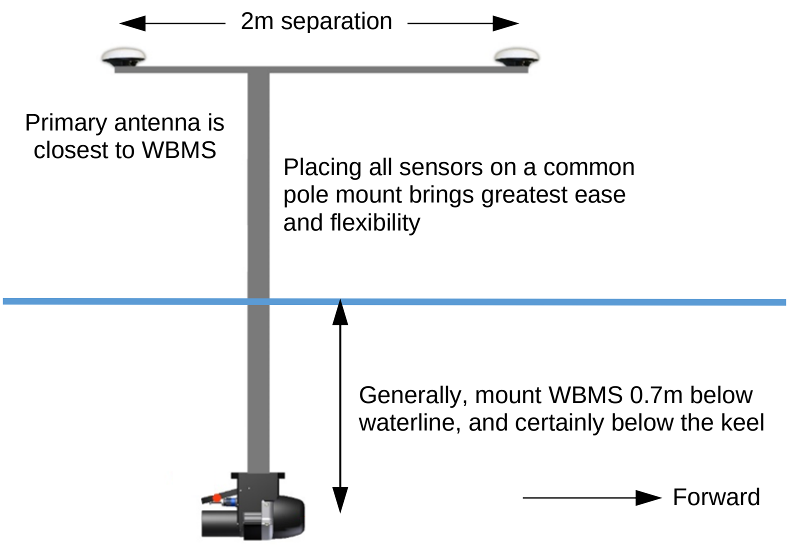
2.3.4 SIU Aux Port

The 10-pin Aux port on the integrated SIU allows users to expand WBMS capabilities by integrating additional sensors. For the full pin description, refer to the appendices at the end of the manual. The Aux port can connect to an additional WBMS to operate in a traditional dual head configuration with either sonar projecting down, or one looking forward for obstacle avoidance in challenging environments. This port can also communicate with the iLiDAR, a topographic laser, to simultaneously collect multibeam and topographic data. For further information on these options please contact NORBIT.

2.4 Mounting Considerations

2.4.1 Installation Planning

The integrated WBMS family of sonars are engineered for greater simplicity and efficiency of installation; these systems were designed to be mounted on any marine vessel. For any questions about mounting, please contact NORBIT Support. If not using an integrated WBMS, then fixing the IMU on the survey pole reduces the need for well-designed and robust mounting systems that allow the most minimal flexing with respect to the survey platform.



Review the survey platform (ship, launch, jet-ski, sea-kayak, USV, ROTV, ROV, AUV, etc.), record the vessel layout and where cables could be secured to avoid tripping hazards or require chafe protection. Have a walk around the vessel to best formulate the most ideal install locations. Attempt to mount the systems nearest to vessel CoR. This is often off the port or starboard gunwale at the fore/aft location of the approximate CoR. Beware of hull reflections or bubble sweep-down; mount the sonar at or below the keel depth.

To reduce the likelihood of unexpected equipment failure and data quality degradation, care must be taken when routing sensor cables on a vessel. Run the cable as far as possible from high power electrical cables or devices. Electrical interference from such sources may result in loss of system performance. It is advised to keep bends in the cables to a minimum and to avoid kinks, twist or unnecessarily stretching the cables. Avoid pinching them in windows, doors and other equipment. Cables should be secured to avoid excess movement or prevent wear on the cable sheath. Long cables should be kept away from power sources and separated from itself (not coiled tightly and placed in a corner) to avoid electrical interference.

The sonar cable is simply a bundled LAN and DC power cable. It is possible, therefore, for cables to easily be repaired on-site by an experienced electronics technician. Please contact NORBIT support for detailed guidance. Cable length may be up to 50m or be ordered to a custom length.

⚠ **CAUTION: Cables Are Not Wet Mateable**

Only connect cables to connectors when dry. Use compressed air to ensure they are clean and dry.

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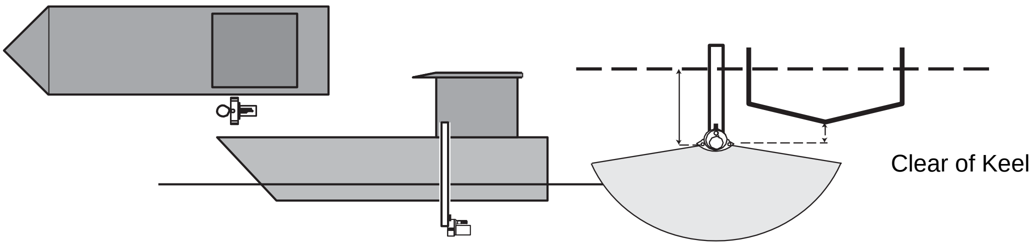
Prior to installation, always inspect cables for nicks and sheath wear. If there are any hazards that may expose cables to abrasion, it is advised that a chafing guard to protect the cable be made such as adding rubber tape around the cable at the point of concern. Ensure pins are not bent and that they are shiny for robust connectivity.

2.4.2 Sonar Mounting Location

Generally, the WBMS Reference Point should be clear of the lowest part of the hull, at the mounting location. This is to avoid reflections from hull and water surface. A strong hull-reflection will reduce SNR for all beams (simply rotating the wedge in software will not blank out a strong reflection). Additional sonar draft may be required depending on the characteristics of the vessel hull which may create bubbles during vessel motion, especially as sea state worsens. It is critical that the sound speed sensor on the WBMS has clean bubble-free water.

Mount the sonar in a location that will minimize interference from engine noise and the effect of vessel motion on data quality; for most vessels, this location is approximately down 3/4 the length of the hull on the port or starboard side. In certain cases, the sonar can be successfully mounted near the outboard motors, e.g. on the transom of a 2.5m inflatable boat.

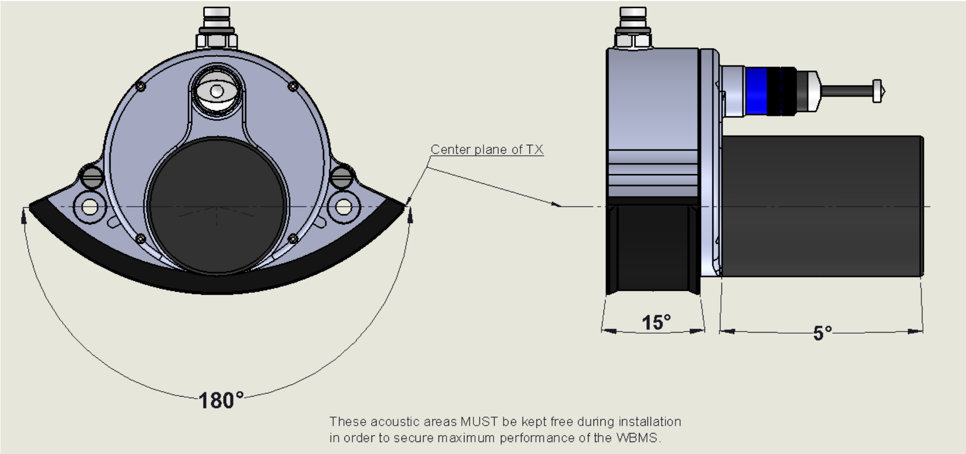


While the antennas may be oriented in any direction horizontally, it is good practice to orient them to be parallel or perpendicular to the vessel centerline.

Label the Antenna1 cable at both ends before installation to identify which of the two cables is the Primary when connecting to the SIU.

2.4.3 Acoustic Clearance Zones

In shallow water conditions, when danger of collision with sonar is especially high, users may want to build a safety cage around the sonar. The image below indicates areas that must be kept clear to receive a clean signal.



2.5 Sensor Mounting

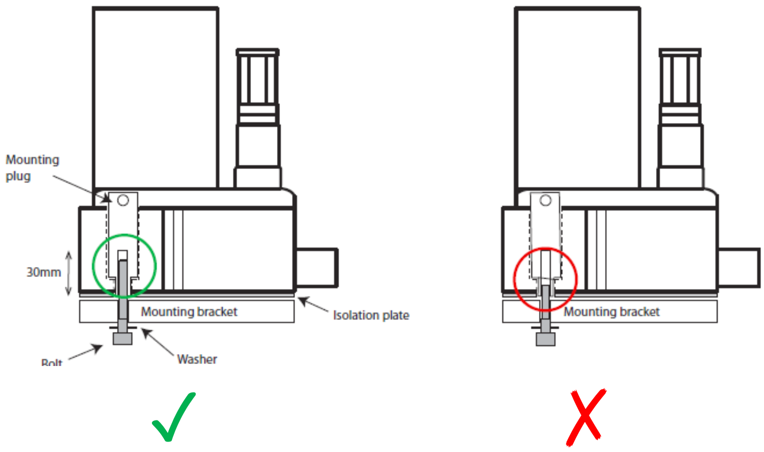
2.5.1 WBMS Sonar Head

The sonar must be mounted with the transmitter (projector) pointing aft, so that the receiver is measuring in the quietest, least turbulent water for best SNR. Mount the sonar in-line with the keel or centerline of the survey platform and parallel to the water surface to within about 0.5°. Higher misalignment and offsets between sensors will translate to a higher error in sounding position. Consequently, it is best to mount all sensors (sonar, IMU, GNSS antennas) as close together as possible.

It is best practice to feed the sonar cable through the mounting pole to protect against vibration or flotsam collision during surveys. The sonar cables should never be connected or disconnected underwater. Ensure connectors are always clean and dry. Screw on the protective caps on sonar wet-end, cables and SIU when system is stored.

The bolts that secure the sonar to the pole/bracket should be 30-35mm longer than the thickness of the mounting bracket and made of high-quality stainless steel to prevent corrosion especially in saltwater environments. Use a lock washer and/or an anaerobic thread adhesive such as Loctite 242 Blue to prevent loosening of sonar during long deployments.

It is also possible to permanently hull mount the sonar. For more information refer to section 2.5.4.



CAUTION: Electrically Isolate WBMS from Metal Boat

If using a custom-built WBMS mount that is not provided by NORBIT, please use a non-conductive plate to electrically isolate the sonar. This will help prevent corrosion.

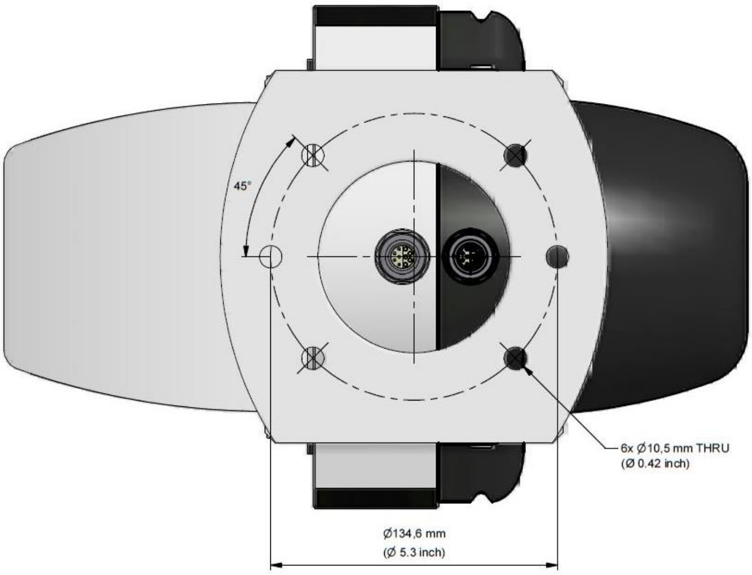
2.5.2 iWBMS Sonar Head & IMU

As noted in the section above, the sonar must be mounted with the transmitter (projector) pointing aft. Mount the sonar in line with the keel or centerline of the survey platform to within 0.5°. This is not so critical when the entire assembly is mounted to a single survey pole.

Accommodations must be made for the sonar/IMU cable when mounting. Cables must run up through the center of the iWBMS(x) bracket.

⚠ **CAUTION: Run Cables Through Center of Bracket**
The mounting bracket requires that wet-end cables be run through the top center opening of the iWBMS(x) bracket, which is attached to customer supplied sonar mounting pole. If the mounting pole is a pipe (recommended), its minimum inner diameter should be 5.8cm. If a pipe is not used, ensure that exposed cables are securely fastened to avoid damage.

Use at least 4 bolts (2 forward and 2 aft) made of high-quality stainless steel to ensure of anti-corrosion especially in saltwater environments. Use a lock washer and/or an anaerobic thread adhesive such as Loctite 242 Blue to prevent loosening of sonar during long deployments.



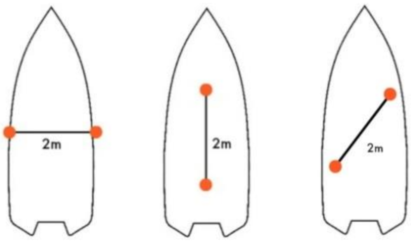
The bolt hole pattern shown above is applicable for all integrated WBMS systems. The sonar and IMU cables should never be connected or disconnected underwater. Ensure all connector pins and sockets are clean, dry and shin. Always use the supplied connector caps on wet-end, cables and topside. Use a synthetic O-ring lubricant on connector O-rings that are in good condition.

If pole-mounting the iWBMS(x), the cables should be run through the sonar pole. The pole should have a minimum internal diameter of 5.8cm to allow the connector(s) to pass through. The iWBMSe and iWBMSc requires the pole be centered over the single connector.

The iWBMS(x) has been tested at a transit speed of 20 knots without damage to the system. If not conducting a survey, it is best to transit with the sonar out of the water especially if the mount is less robust. This is to protect the system from physical damage from flotsam.

2.5.3 GNSS Antennas

GNSS antennas should be mounted on a stable structure that will not wobble or flex during surveys. They must have a clear view of the sky to the horizon so that every satellite may be continuously tracked without obstruction and are as far as possible from transmitting devices such radars and radio antennas. The GNSS mounting locations should be free from vibration and rigid with respect to each other and the IMU.

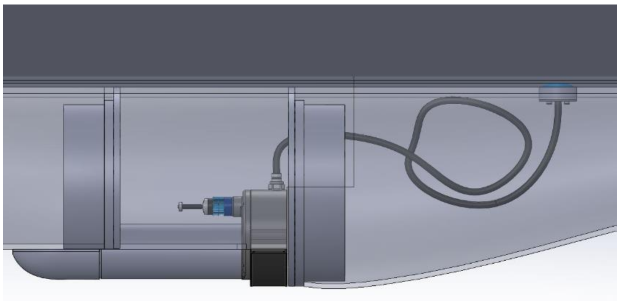


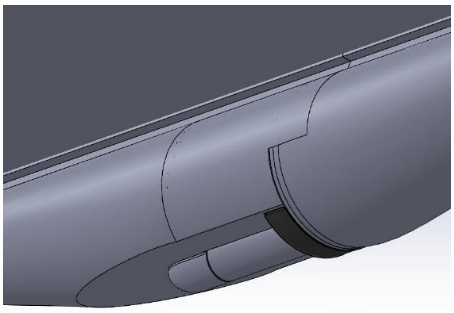
The Primary Antenna (or Antenna 1) should be nearest to the IMU so that offset measurement errors are minimized.

The Secondary Antenna (or Antenna 2) should be a fixed distance from Antenna 1. It is recommended that the antennas be at least 2m apart. Shorter distances may be used but will likely result in decreased performance, which can be mitigated by using a higher-grade IMU. The separation must be rigid and not flex by more than 5mm during the survey. The antennas should be positioned parallel to the water surface to within 2-3cm.

2.5.4 Hull Mount

The WBMS can be permanently hull-mounted to a vessel for operations that do not require the system to be portable. The following images are examples of hull-mounted assemblies. When hull-mounting, the sonar pod must be carefully designed to prevent formation of bubbles and to allow water to flow over the SV sensor.





To inquire about NORBIT's complete hull-mounted design and installation service, please contact subsea_support@NORBIT.com

2.6 Time Synchronization (for Non-Integrated Systems)

Timing is crucial for synchronizing signals from the sonar, GNSS and IMU. Only the WBMS requires PPS & NMEA ZDA hardware input. All integrated WBMS systems receive timing from the internal GNSS card. The system can handle baud rates from 4800 to 115200 and will have no problem maintaining sync with other NMEA messages output on the same port as the ZDA+PPS. Ensure that the baud rate is fast enough to allow throughput of all strings.

The PPS can be input in two ways:

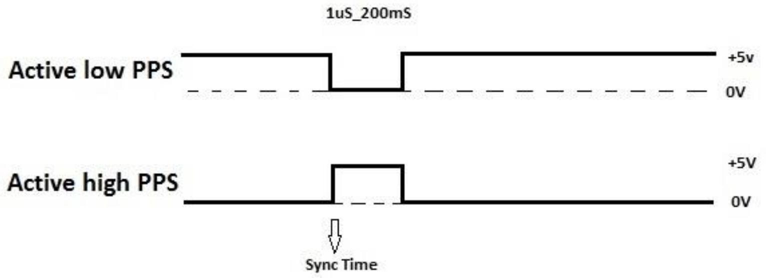
- To BNC "PPS" connector on SIU
- To Serial "GPS" DB9 connector on SIU (pin 9 for pulse & pin 5 for ground)

The PPS signal can be either active low or active high. The SIU synchronizes to the falling edge of an active low signal, or the rising edge of an active high signal. The voltage on the PPS should not exceed 5V, doing so may cause unwanted issues. In addition, the time duration should be 1μ-200ms.

For the standalone WBMS, the SIU should receive a PPS TTL input at 3.3V (5V tolerant). The SIU can autodetect negative or positive PPS input and has ±15kV ESD protection, ±60V fault protection.

The integrated GNSS/INS WBMS systems can output a (positive or negative configurable) PPS TTL signal at 5V. However, this is NOT fault protected and is rated for a maximum absolute voltage of 6V.

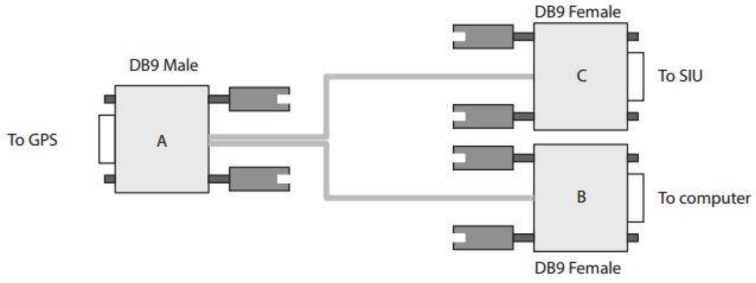
⚠ **CAUTION: Don't Connect Active PPS to SIU for Integrated Systems**
The integrated versions of the SIU outputs PPS pulses. Attaching an active PPS cable to this port will damage internal electronics and void the warranty.



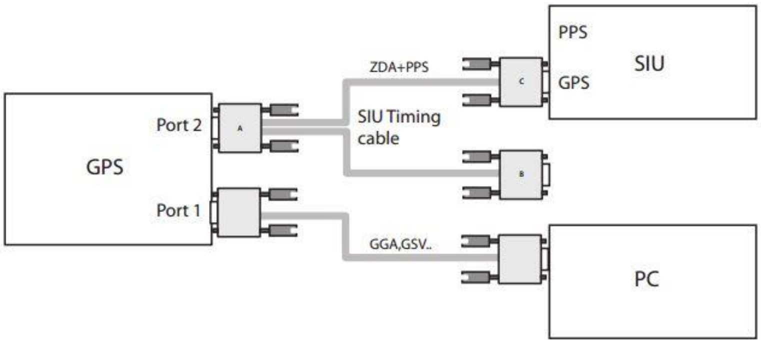
The timing cable pinouts are as follows:

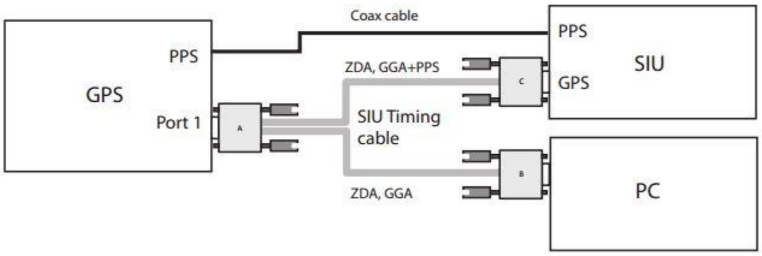
Connector A	Connector B	Connector C	Description
1	1	1	Not Connected
2	2	2	Transmit Data (from GNSS)
3	3	NC	Receive Data (to GNSS) ex. for NTRIP
4	NC	NC	Not Connected
5	5	5	Ground
6	NC	NC	Not Connected
7	NC	NC	Not Connected
8	NC	NC	Not Connected
9	NC	9	PPS (from GNSS)

To connect a GNSS to a stand-alone WBMS, the accompanying timing cable should be used. The cable splits the signal so that both the survey computer and SIU can be connected to the same port from the GNSS.



The following are two examples of ways to connect the SIU and PC to the GNSS:





3 Offsets & Reference Points

For quality, repeatable bathymetric data, the offsets between the sonar, attitude and positioning sensors on the survey platform must be fixed and well known. The 3 axes should be accurately aligned with the survey platform, or any angular misalignments should be measured and applied to the acquisition/processing software.

Each sensor has predefined measurements between the WBMS Reference Point (sonar acoustic center) and the IMU Reference Point, the WBMS Reference Point and the Top Center of Bracket, and the IMU mounting angles. The relevant offsets and misalignments are applied automatically in the WBMS GUI, so the user does not have to input them. The only case where the user must know these values is if a custom installation is used, or if the Applanix firmware is older than 9.03 and all offsets are entered manually in POSView.

By default, all data output from the integrated systems (position, attitude and depth information) is valid at the WBMS Reference Point. Thus, all sensors in the acquisition and processing software must have the same offset to this location. The offsets for each sonar are detailed in the next section.

Note that Top Center of Bracket is merely a convenient point from which to measure other sensors; however, no data output is valid at this location.

⚠ **CAUTION: Upgrade Applanix Firmware for NORBIT 10.4**

For iWBMS, iWBMSh and iWBMSe, the integrated Applanix must have at least 9.03 firmware. This enables the NORBIT GUI to take control of the system and automate many of the setup parameters. Users of older firmware versions are encouraged to contact NORBIT Support for upgrading.

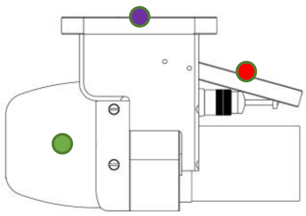
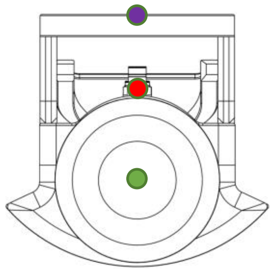
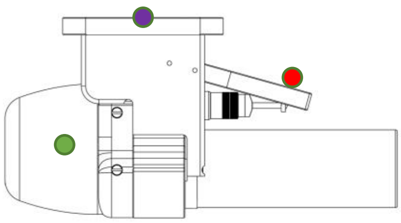
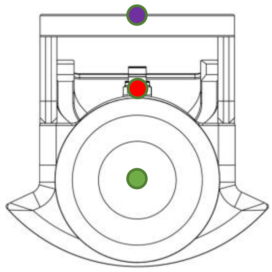
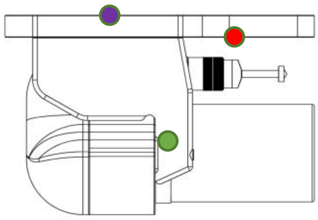
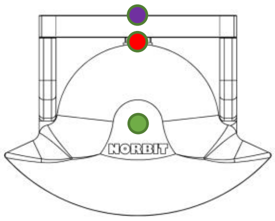
3.1 Reference Points

In the drawings below, the **WBMS Reference Point** (red dot) is where all sonar and navigation data are valid by default. This point is located at the center of the projector in the fore-aft direction, and at the center of the cylindrical receiver array in the port-starboard and vertical directions.

The green dot indicates the **IMU Reference Point**. Generally, the user need not concern themselves with the IMU reference point, unless the IMU is physically decoupled from the sonar.

The purple dot indicates the **Top Center of Bracket**. This is merely a convenient point from which to measure the primary GNSS antenna offset, as the WBMS and IMU reference points are not necessarily physical points that can be directly measured.

Refer to section 3.2 for all relevant offsets and mounting angles for each WBMS configuration.

Sonar Kit and Bracket PN	Side View	Front View
12004 & 12007 **iWBMS, iWBMSh** Projector: Standard 1.9° Bracket PN: 35021		
12004 & 12007 **iWBMS, iWBMSh** Projector: Narrow 0.9° Bracket PN: 35021		
12005 & 12006 **iWBMSc, iWBMSe** Projector: Standard 1.9° Bracket PN: 35047		

3.2 Sonar Offsets & Mounting Angles

Sonar Kit and Bracket PN	Name in GUI	Sonar Part No. (* denotes values that may be ignored for this purpose)	WBMS Ref. Point to IMU Ref. Point (+Fwd, +Stbd, +Down)	IMU Mounting Angles (+Port up, +Bow up, +Clockwise)	WBMS Ref. Point to Top Center of Bracket (+Fwd, +Stbd, +Down)
12004 iWBMS, 400kHz (Applanix WaveMaster) Bracket PN: 35021 IMU PN: 24006-4X	iWBMS-0.9°x1.9°	24003-*-*C**** 24003-1b (legacy)	0.198, 0, 0.079	90, 0, -90	0.122, 0, -0.07
IMU PN: 24006-8X			0.206, 0, 0.079	0, -90, 0	
12004 iWBMS, 200kHz (Applanix WaveMaster) Bracket PN: 35021 IMU PN: 24006-4X	iWBMS-1.9°x1.9	24007-*-*C****	0.241, 0, 0.078	90, 0, -90	0.170, 0, -0.07
IMU PN: 24006-8X			0.256, 0, 0.079	0, -90, 0	
12004 iWBMS, 400kHz (Applanix WaveMaster) Bracket PN: 35021 IMU PN: 24006-4X	iWBMS-0.9°x0.9°	24003-*-*B****	0.248, 0, 0.079	90, 0, -90	0.172, 0, -0.07
IMU PN: 24006-8X			0.255, 0, 0.079	0, -90, 0	
12004 STX, (Applanix WaveMaster) Bracket PN: 35021 IMU PN: 24006-4X	iSTX-0.9°x0.9°	24016-*-*B***B	0.234, 0, 0.079	90, 0, -90	0.158, 0, -0.07
IMU PN: 24006-8X			0.242, 0, 0.079	0, -90, 0	
12005 iWBMSc, 400kHz NAV Kit (NovAtel) Bracket PN: 35047	iWBMSc-0.9°x1.9°	24005-*-*C****	0.061, 0.022, 0.102	90, 0, -90	0.117, 0, -0.023
12006 iWBMSe, (Applanix SurfMaster) Bracket PN: 35047	iWBMSe-0.9°x1.9°	24018-*-*C****	0.053, 0, 0.096	0, 0, 180	0.117, 0, -0.023
12006 iWBMSe, (Applanix SurfMaster) Bracket PN: 35047	iWBMSe-0.9°x0.9°	24018-*-*B****	0.103, 0, 0.095	0, 0, 180	0.167, 0, -0.023
12006 iWBMSe, 200kHz (Applanix SurfMaster) Bracket PN: 35047	iWBMSe-1.9°x1.9°	24022-*-*C****	0.100, 0, 0.095	0, 0, 180	0.188, 0, -0.023
12007 iWBMS NAV (Applanix OceanMaster) 400kHz Bracket PN: 35021	iWBMS-0.9°x1.9°	24003-*-*C****	0.198, 0, 0.079	90, 0, -90	0.122,0, -0.07
12007 iWBMS 400kHz (Applanix OceanMaster) Bracket PN: 35021	iWBMS-0.9°x0.9°	24003-*-*B****	0.248, 0, 0.079	90, 0, -90	0.172, 0, -0.07
12007 STX (Applanix OceanMaster) Bracket PN: 35021	iSTX-0.9°x0.9°	24016-*-*B***B	0.234, 0, 0.079	90, 0, -90	0.158, 0, -0.07
SONARS NO LONGER IN PRODUCTION					
12005 iWBMSc, 400kHz (NovAtel) Bracket PN: 35027	iWBMSc-0.9°x1.9°	24005-*-*C****	0.076, 0.022, 0.102	90, 0, -90	0.087, 0, 0.07
12006 iWBMSe, 400kHz (Applanix SurfMaster) Bracket PN: 35021	iWBMSe-0.9°x0.9°	24003-*-*C****	0.175, 0, 0.079	90, 0, -90	0.122, 0, -0.07

4 System Operation

The sonar system is configured and controlled by the WBMS GUI. Several computers each with an installed GUI may be connected to the sonar, yet only one may be the primary and control the sonar system, while the secondary computers monitor operation.

The sonar may also be controlled in headless/passive mode. See Section 4.1.3 for more information.

4.1 WBMS GUI Installation

For all systems with integrated Applanix inertial navigation systems, POSView is no longer required, provided the installed Applanix firmware is v9.03 or later. If in doubt, please contact NORBIT with the product serial numbers (dry-end and wet-end units) for the latest compatible software.

The software installation file is provided on a USB stick inside the shipping case or it can be downloaded from a link provided by NORBIT via email.

Navigate to the provided USB stick or the email sent from NORBIT, click on the executable file (**WBMS_89001_XYZ.exe**, for example) and follow the prompts. This installs the WBMS Graphical User Interface (GUI) and copies firmware to the PC. Upon connection to the sonar, a check of firmware compatibility is performed. If there is a firmware mismatch, the user is prompted to update the firmware. Click **Perform Update**, as described in section 4.3. It is very important that power be maintained to the sonar during the update procedure.

4.1.1 PC System Requirements

Since all sonar data processing happens inside the sonar head, the GUI can be run on the same computer as the acquisition software. The following are the recommended minimum system requirements. The system requirements may change depending on acquisition software used.

Hardware	Requirements
Operating System	Windows 10 Pro is recommended Windows 8.1 (Fully Updated) Windows 7/Vista/XP * - Unsupported (Windows XP is untested)
Computer Processor	2-GHz or better
Computer Memory	4-GB or more
Screen Resolution	1400x900 or higher *Screens with lower resolution can be used however data visualization may be reduced. This will not impair data acquisition
Graphics Card	(Optional)
Internet Connection	100/10000Mbit Ethernet card
HDD	Only GUI: <1GB, Full system with logging: > 100GB

*The GUI **may** work on Windows 7 if Microsoft Visual C++ 2015 (Redistributable Update 3 RC) is installed on the PC. The installation file is provided in the USB drive. It can also be downloaded free of cost from Microsoft. Microsoft has stopped mainstream support of Windows 7 as of January 13, 2015. Starting with 10.3 NORBIT does not test software for compatibility with Windows 7.

The WBMS systems are network based, which enables the user to run the Graphical User Interface (GUI) software on the same computer as the acquisition software or even on separate computers.

4.1.2 iWBMSc (Compact) INS GUI Installation

If operating the Compact model, be certain that the included NovAtel Connect software is installed. Only version 1.8 and later should be used with the Compact. Navigate to the **NovAtelConnect_Setup.exe** provided by NORBIT and follow the prompts. For detailed instructions on setting up and utilizing NovAtel Connect please go to Connecting INS to Connect.

4.1.3 Operation Without GUI (Headless/Passive Mode)

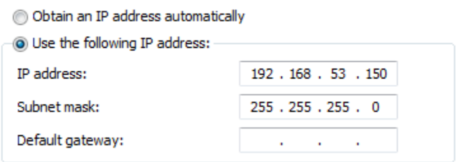
Some setup of the NORBIT WBMS, such as AUV/ROV may require use of the system without the NORBIT GUI. NORBIT refers to this as headless mode. When operating in this mode, users can interface with the sonar on a script level, directly giving commands to the sonar without the use of the NORBIT interface.

For other users requiring the GUI to only monitor sonar operation, a passive mode can be selected in the GUI. This allows the sonar state to be monitored in the GUI, and at the same time allow for other methods of sonar control via custom software etc.

For further information on either of these modes please contact NORBIT support.

4.2 Network Configuration

The WBMS and integrated WBMS versions connect to the acquisition computer via a 1 Gigabit Ethernet network cable from the SIU. To communicate with the SIU, the computer network adaptor must be configured to the same subnet as the SIU.



To set up the IP address of the computer navigate to your laptop/PC network adaptor setting and change the **TCP/IPv4** settings. It is important that the last 3 numbers of the computer IP address not conflict with the IP address of the WBMS or the INS. The INS systems come pre-configured with an IP address of **192.168.53.100**. The IP address of the sonar is always **192.168.53.XX**, where XX represents the last two numbers of the WBMS serial number (found on the sonar head, next to the cable connector). A subnet mask of **255.255.255.0** should be used. NORBIT recommends setting the IP address of the laptop/PC to **192.168.53.150**, to avoid conflict with other systems.

In rare circumstances, some users may wish to change the IP address of the sonar. For instructions on how to do this, see the Troubleshooting section in this document. It is recommended to NOT change the sonar IP address unless necessary. A forgotten sonar IP address will require a lengthy unbricking process.

NOTE: Changing IP Address of INS Disables GUI Functionality
Changing the IP address of the Applanix INS from the factory configured IP address (192.168.53.100) will disable all INS capabilities within the GUI.

4.2.1 WBMS DHCP Connection

Unless otherwise required, please make sure that DCHP servers are not running on the same network as the sonar. During boot up, this will cause an automatic assignment of IP address. If this occurs, and a DHCP network is not desired, then power off the SIU, assign a static IP address to the computer and then re-power the SIU.

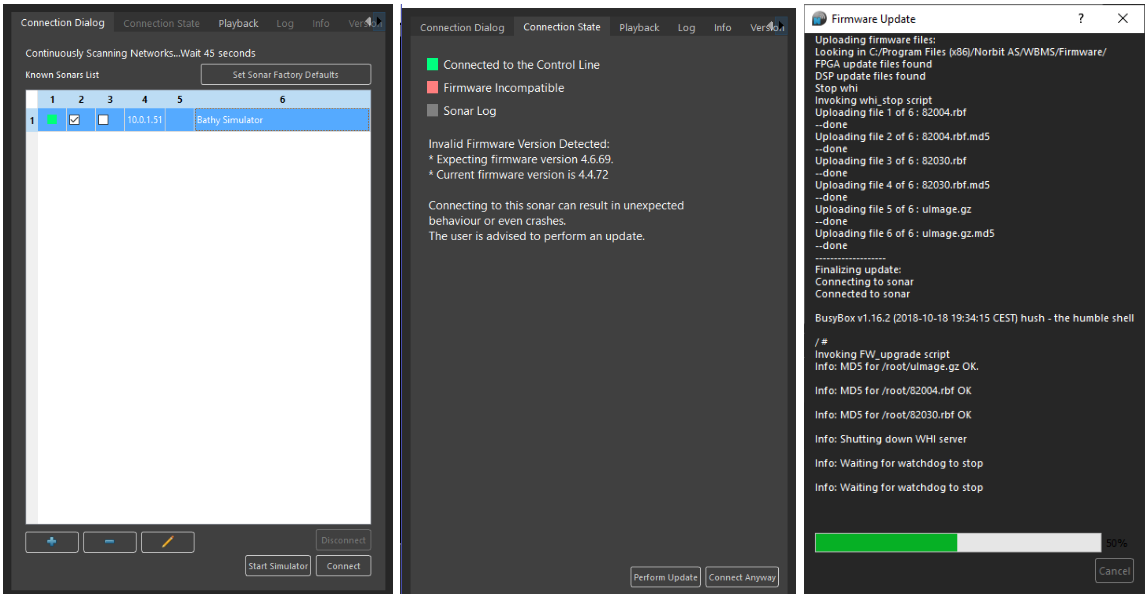
4.3 Connect to Sonar

Upon launching the GUI, the **Connection Dialog** is displayed. If a sonar is active and, on the network, a green light is displayed next to it. A red light indicates that the sonar is not online. If a red light is shown, and the sonar is powered on, check the network configuration (see section 4.2).

When a green light is displayed, select the sonar to highlight it and press **Connect**. After the first successful connection is made, all subsequent connections to the sonar are automatic.

Once connected, an automatic check is performed to ensure that the firmware is compatible. A warning is displayed on the **Connection State** tab if the firmware is incompatible. To correct this, click **Perform Update** and follow the on-screen instructions.

Please note that it is unsafe to turn off power to the sonar once the upgrade process has started, and that doing so risks corrupting the system configuration. Operating a firmware and GUI with mismatching versions may cause unstable operation.



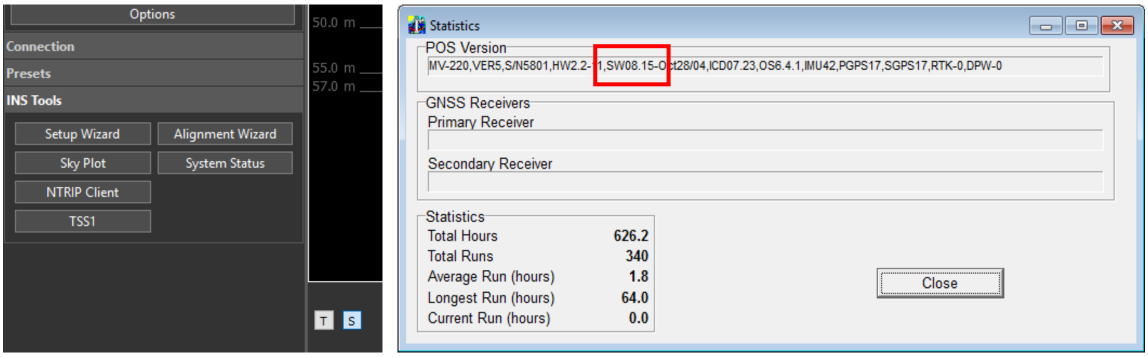
When the upgrade is complete, reboot the sonar and follow the connection procedure as described above.

The menus shown above are described in more detail in section 4.6.5.

4.4 INS Tools for iWBMS, iWBMSh & iWBMSe

NORBIT has integrated Applanix functionality to the NORBIT GUI, meaning that both the sonar and INS may be setup and controlled from the same user interface. The **INS Tools** are found at the bottom of the settings menu, and the **INS Setup Wizard** allows users to configure offsets and GNSS corrections.

For users with standalone WBMS systems, or iWBMSc, most settings under **INS Tools** are greyed out. Users with integrated systems must have Applanix firmware v9.03 or later. To request an upgrade, open POSView and select **View** > **Statistics**, and send a screenshot of this display to NORBIT Support. The currently installed firmware is shown under **POS Version**, and is highlighted in the example below.



NOTE: Firmware Upgrade Cost

For some users, firmware upgrades may incur additional cost from Applanix. To find out if this applies to your system, please contact NORBIT support with a screenshot of the Statistics window, as shown above.

4.4.1 INS Setup Wizard

4.4.1.1 Factory Settings

NORBIT advises that, prior to each new installation, the factory default settings are restored. Open the **INS Setup Wizard** and select **Factory**. Note, this only resets the INS configuration and has no impact on the sonar configuration or GUI display preferences.

CAUTION: Incorrect Offsets When Changing Computers

Offsets entered in the wizard are stored on the computer from which the setup was performed. If the survey computer is changed, the displayed **Measure Point to Antenna Bottom** offset is from WBMS Ref. Point (not Top Center of Bracket) to primary antenna phase center. Although the displayed offset is incorrect, it does not affect operation unless the configuration is re-saved. To display the correct offset, it must be re-entered and saved. NORBIT recommends reviewing all inputs prior to each survey.

Applying factory settings configures the system to output Ethernet Realtime groups `1, 3, 7, 10, 11, 20, 102, 103, 111, 112,` and `113.`

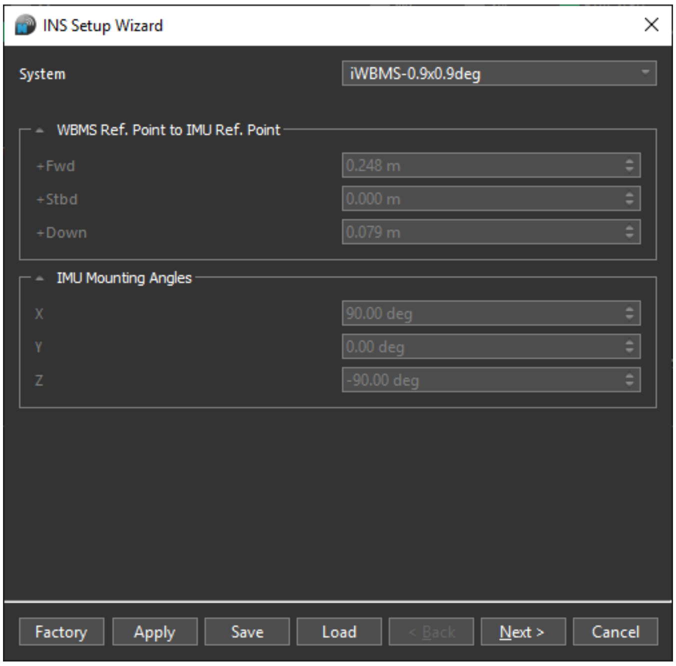
It also configures Ethernet logging to record groups `1, 2, 4, 5, 9, 10, 99, 102, 110, 111, 112, 113, 10001, 10007, 10008, 10009, 10011, 10012, 20000 Diagnostics,` and `Applanix Diagnostics`, as well as ZDA and PPS for sonar timing. This data can be used to extract delayed heave (also known as True Heave), or to post-process GNSS data using POSPac.

Note that the above group selections are pre-configured and cannot be changed in the NORBIT GUI. All groups required by the acquisition software (HYPACK, QINSy, PDS, EIVA, etc.) are included in the pre-configured selection.

4.4.1.2 IMU Offset & Mounting Angles

The first page of the setup wizard shows the sonar model in the **System** selection and the relevant offsets and mounting angles applicable for that model. The model is automatically detected, and for most users there is nothing to change here.

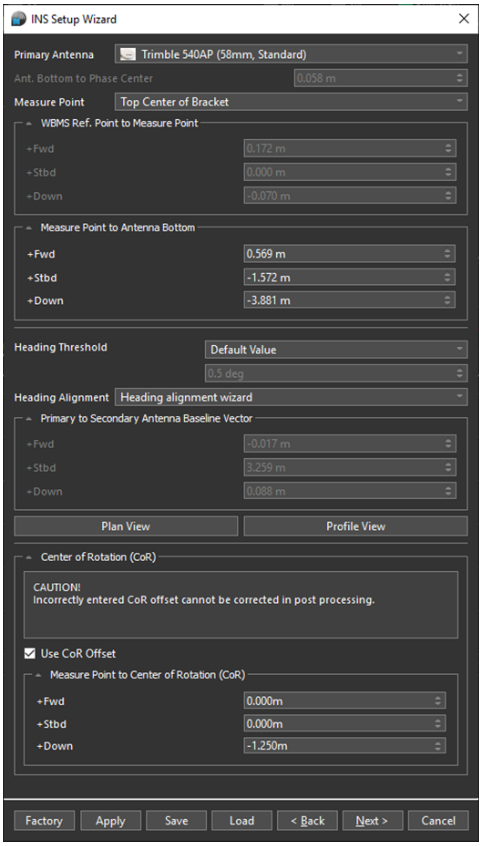
The offsets are collapsed by default. To display them, click the down arrow. If custom offsets or mounting angles are required, select the **Custom** system option. This is only required for advanced installations, where the IMU is physically decoupled from the sonar and installed at a separate location on the vessel.



4.4.1.3 Antenna Offsets

Offsets related to the GNSS antennas are found on the second page of the setup wizard. Select the **Primary Antenna** model, which in most cases will be **Trimble 540AP**, to ensure that the correct phase center offset is applied.

Select the **Measure Point** to define a convenient reference point from which to measure the primary antenna offset. **Top Center of Bracket** should be selected; however, a **Custom** point may also be defined. The system uses the entered antenna offset, together with the offset from **WBMS Ref. Point to Measure Point**, to relate the antenna position to the sonar.



Carefully measure the distance from **Measure Point to Antenna Bottom** and enter the correct values, bearing in mind the sign convention (positive down).

Should a positive value be entered for the down offset, a warning message alerts users that a positive value places the sonar above the GNSS antennas. The user is prompted to verify that the correct offset has been applied. If a special mounting arrangement is employed and a positive number is correct, the warning may be ignored.

Users can specify the **Heading Threshold** for the heading alignment procedure which follows later. The **Default Value** (0.5º) is suitable in most cases. It may be necessary to change the threshold, e.g. if operating a large vessel and aggressive maneuvering is not feasible. If the heading calibration does not start within 30 minutes, select **Custom** and increase the threshold in 0.5º increments until the calibration starts successfully. Every time a heading alignment is performed, a patch test should be performed afterwards.

For **Heading Alignment** method, select **Heading Alignment Wizard** to populate the fields in **Primary to Secondary Antenna Baseline Vector** with zeros initially. Correct values are displayed after the calibration is complete (described in section 4.4.2). If the antenna baseline vector is already known, i.e. if it was measured using land survey techniques, the results can be entered manually by selecting **Custom**.

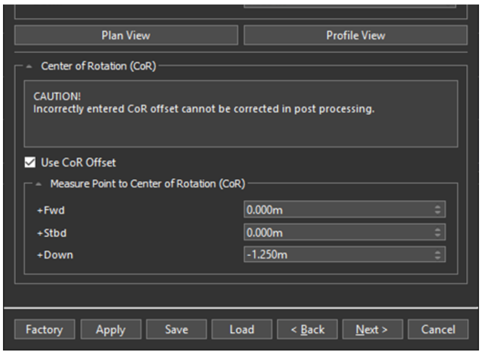
Selecting **Plan View** or **Profile View** displays a diagram showing the antenna positions with respect to the WBMS Reference Point. This can be used for a visual check of the system layout/offsets.

⚠ **NOTE: NORBIT GUI and POSView/POSPac Offsets Are Different**

The offsets displayed in POSView (and POSPac) for **Ref. to Primary GNSS Lever Arm** are not the same as those entered in the NORBIT GUI. The NORBIT GUI offsets are referenced from the **Measure Point** (typically **Top Center of Bracket**), whereas the POSView/POSPac offsets are referenced from **WBMS Ref. Point**.

4.4.1.4 Center of Rotation Offset

The vessel **Center of Rotation** (CoR) offset should be entered relative to the **Measure Point**. Note that the center of rotation is more of an area rather than a well-defined point on the vessel, therefore an approximation will suffice. Select **Use CoR Offset** and enter the measured values under **Measure Point to Center of Rotation (CoR).**



The vessel center of rotation is a point on the vessel that experiences only rotations with changes in attitude. Any heave measured at this point arises entirely from vertical movements that affect the whole vessel equally. The multibeam transducer, being some distance from the vessel's CoR, will therefore experience a small component of heave as the vessel moves vertically in the water, and a much larger component of apparent heave with changes in vessel attitude.

To separate these effects, the INS can translate the IMU measurements to the vessel CoR. Having done so, it applies filtering to the measurements of pure heave and then translates the filtered measurements back to the heave record.

This method for measuring heave avoids the errors that can occur if you filter direct heave measurements made from a point different from the vessel CoR.

By entering these values in the GUI, the user avoids a possible heave artefact that may occur as the INS records the heave measurements made from an IMU that is not located at the vessel CoR. Applanix systems apply a dynamic filter to the heave record to normalize the vertical data back to zero over time. This can result in a visible heave artefact if the vertical orientation of the sonar is constant for a period.

NOTE: Artefact Scenario

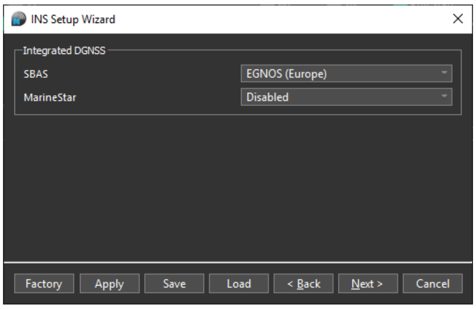
If the weight on a boat was shifted port or starboard for multiple minutes during a survey, the sonar would be moved vertically in the water column. At the beginning of this vertical shift, the heave would be recorded correctly. However, after a period the heave value would start to settle back to zero and the location of the multibeam in the water will not be recorded correctly.

The CoR, for most commercial vessels, is documented in the vessel design plans. For other vessels, this point at which the vessel's roll and pitch axes intersect must be determined. This location can be hard to determine, as the vessel CoR may change from day to day and even during the day. For smaller vessels, the CoR moves depending on fuel stowage and even distribution of personnel body weight. Generally, choose a CoR location that is about ¾ distance from bow to stern, centered on the keel, and located at approximately water level. Choose a location and attempt to keep the weight distribution constant throughout the survey. If in doubt, take the boat to open water and measure its motion while passing over waves in different directions.

It should be noted that these offsets **only** impact heave calculations and do not impact positioning.

NORBIT

4.4.1.5 Integrated DGNSS

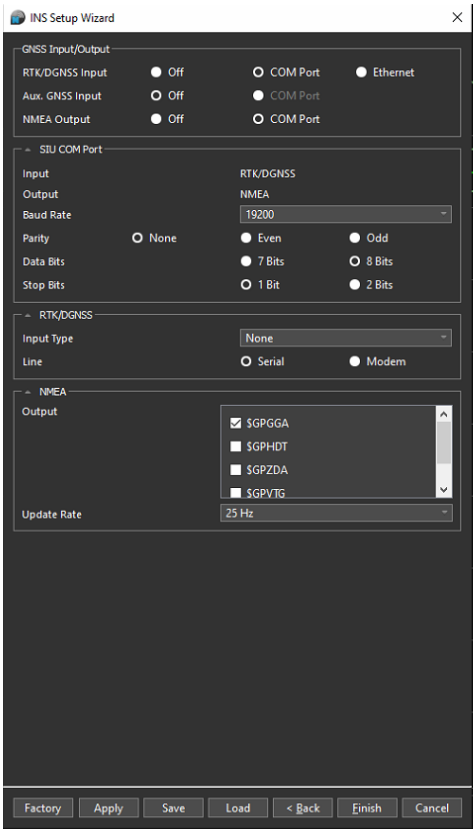


The **Integrated GNSS** page of the setup wizard allows users to specify the desired satellite GNSS correction service. Satellite Based Augmentation Service (**SBAS**) may be configured here. This is a correction source that is regional and free.

Alternatively, **Marinestar**, a paid subscription service providing decimeter accuracy, may be selected. Refer to section 4.4.5 for details on activating a subscription.

4.4.1.6 RTK/Aux GNSS Input & NTRIP Client

If no RTK or auxiliary GNSS is interfaced, select **Off** for each input. Otherwise, select the signal input source (**COM port** or **Ethernet**). Depending on the selections made, additional options may become available.



RTK corrections may be transmitted to the vessel from a land base station, via radio, and interfaced to the system via the serial COM port on the SIU. The radio on the vessel must therefore have a serial output, containing only the correction message. The incoming radio baud rate must match with the selection in the setup wizard.

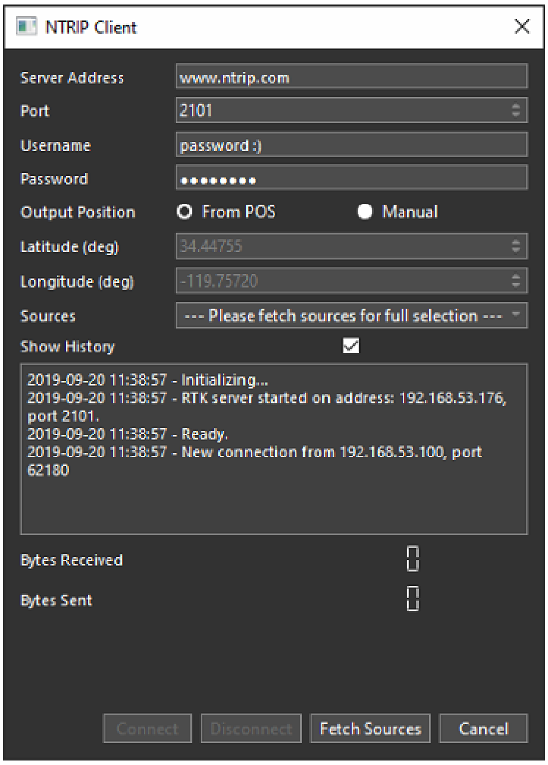
Select the correct RTK **Input Type** (**CMR**, **CMR+**, **CMRx**, **RTCM**, etc.) as well as the input **Line**, either **Serial** or **Modem**. Please note that if an input type other than **None** is selected, the INS only uses GPS satellites, so it will likely result in fewer satellite vehicles being detected. Selecting **None** enables the INS to use additional satellites from other constellations such as GLONASS.

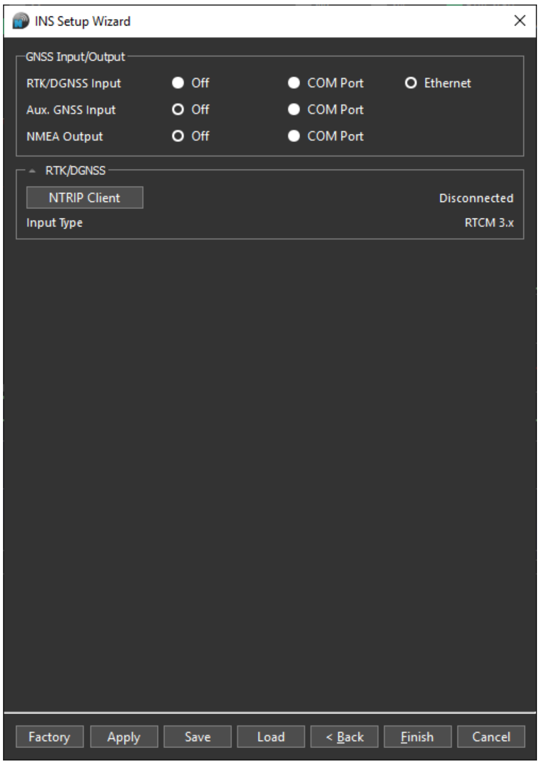
Select the desired **NMEA** output messages. If using a radio link to receive corrections, you may need to set this output to **Off** to avoid issues related to decoding the correction message from the radio's output.

When an external GNSS system is used, select **Aux. GNSS Input**. Then enter the offset to the auxiliary antenna phase center. It is important to note that this offset must be measured from the **WBMS Ref. Point** (see section 3.1) to the phase center of the auxiliary antenna. When the auxiliary system is connected, the INS compares its own solution against the quality of the auxiliary solution and automatically selects the best.

To enable RTK corrections via NTRIP, select **Ethernet** as the **RTK/DGNSS Input**. Select **NTRIP Client** and enter the login details. Select **Fetch Sources**, and then select the source from the dropdown menu. Click **Connect**.

When the NTRIP client shows **Bytes Received** and **Bytes Sent** values increasing, a connection is established. If, for any reason, the numbers are not increasing, select **Disconnect** and **Connect** to restart the service. Losing connection to the internet, even for a brief period, may cause the NTRIP connection to fail.





The client may be accessed at any time by selecting **INS Tools** on the settings menu, then select **NTRIP Client**. The connection status can be monitored on the INS status bar at the top of the GUI.

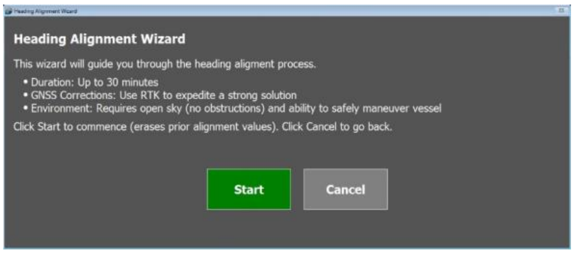
Click **Finish** to complete the setup wizard. If **Heading Alignment Wizard** was selected in section 4.4.1.3, finishing the setup wizard automatically starts the alignment wizard. If performing a heading alignment calibration is not possible at this time, you may select **Cancel**, with no loss of input values, and perform the calibration later.

4.4.2 Heading Alignment Wizard

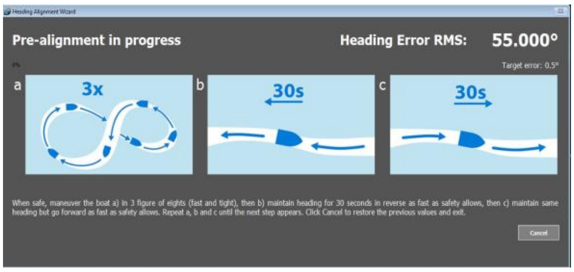
A heading alignment must be performed when the iWBMS is first installed, or when one of the INS sensors (IMU or GNSS antennas) is moved. The heading alignment determines the vector offset from primary antenna to secondary antenna, and in doing so ensures proper alignment of the IMU with the GNSS antenna pair.

If a heading alignment was not performed at the end of the **INS Setup Wizard**, select **INS Tools** > **Alignment Wizard** and follow the on-screen instructions.

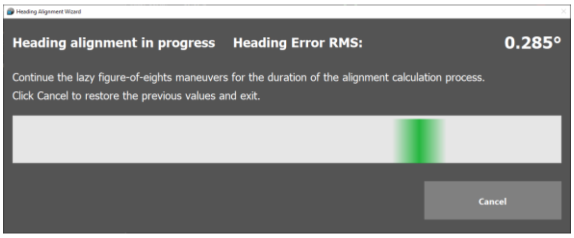
Step 1. With the Alignment Wizard open, press **Start** to begin the calibration. The best results are achieved using RTK GNSS, with a clear sky view, away from tall structures that impede GNSS performance. The installation must be completely rigid and free from vibration. The primary antenna offset must be accurately measured and applied during the INS setup stage described in the preceding section.



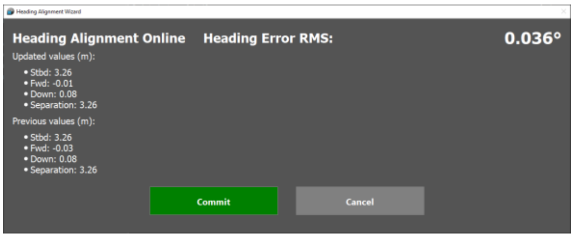
Step 2. Follow the recommended maneuvers during the pre-alignment stage and observe the display as the **Heading Error RMS** decreases from its initial value of 55 degrees. Once the value drops below the defined threshold (**Target Error**) and stabilizes, the heading alignment begins. Continue to maneuver the vessel until this occurs.



Step 3. Follow the instructions and continue to perform figure-of-eight maneuvers while the heading alignment is in progress. The overall time to complete the calibration depends on the size of the vessel and the speed at which the maneuvers are performed, as well as positioning quality.



Step 4. The computed results are displayed and are unique to each installation. If the primary to secondary antenna baseline was manually measured beforehand, the calculated results should be very similar. Check that the results are sensible and select **Commit** to save the results. NORBIT recommends performing a patch test after the heading alignment.



4.4.2.1 Understanding Heading Alignment Results

Understanding the alignment results allows the user to verify the installation and refine it if necessary.

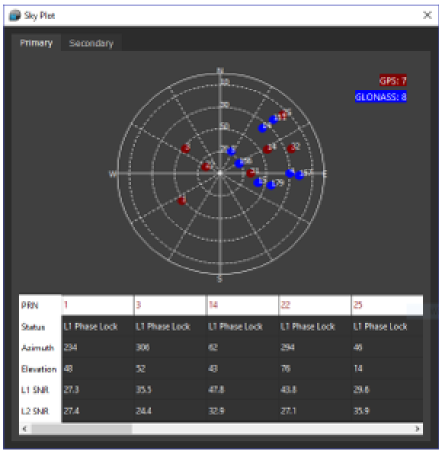
The heading alignment establishes the baseline vector from primary to secondary GNSS antenna. The X, Y and Z components of the vector from primary to secondary antenna should closely match with the measured values. Although it is not required to manually measure the values, it is strongly recommended to do so as a check.

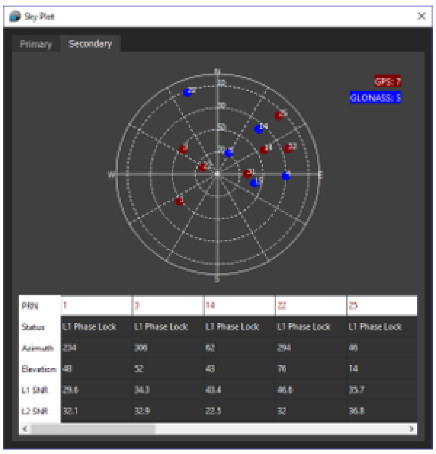
In this example, where the antennas are mounted along the X (fore-aft) direction, the Y component of the heading alignment can be used to check if the iWBMS is in alignment with the antennas. A small value in the Y component indicates that the iWBMS is closely aligned with the antenna orientation. A larger value indicates that the iWBMS is mounted with a yaw offset with respect to the antennas, as shown in the image. This can be used to bring the antennas and iWBMS into alignment either by adjusting the mounting angle of the WBMS in the Z axis, or by adjusting the antennas. By using an iterative process of adjustment and calibrations, the user can achieve a high degree of alignment between the antennas and the WBMS.

The Z component is the vertical separation between the 2 antennas.

4.4.3 Sky Plot

The **Sky Plot** displays currently tracked satellites on the primary and secondary GNSS antennas.

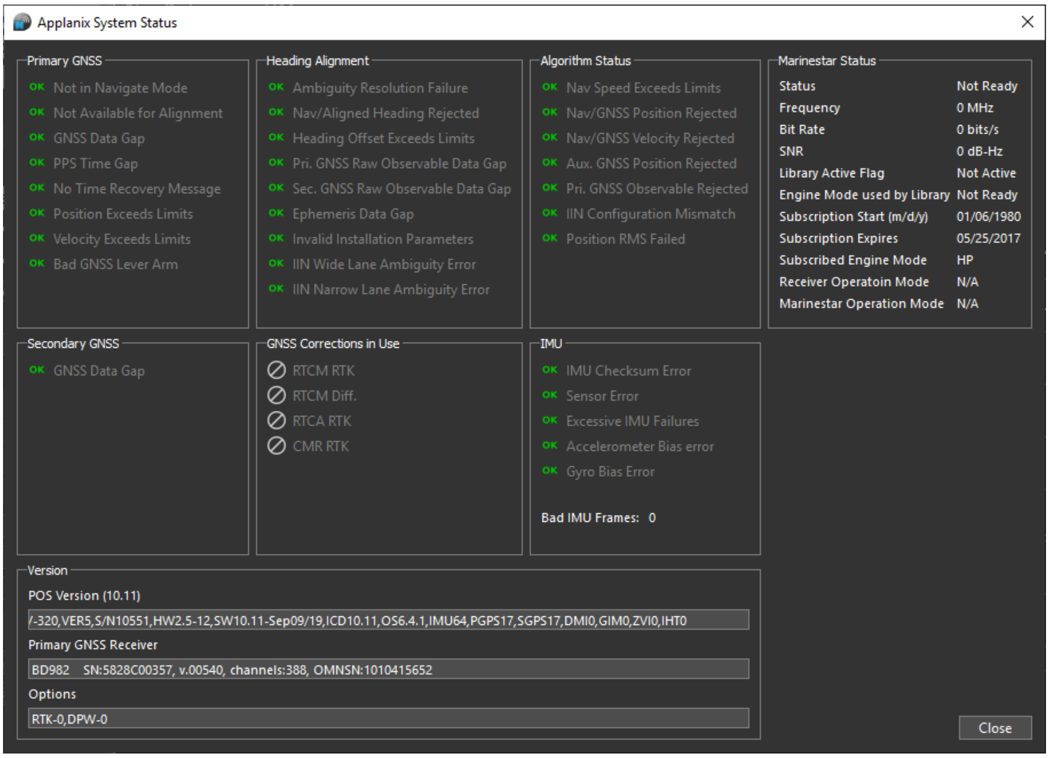




4.4.4 System Status

The **System Status** window displays the status of the INS system and reports any fault conditions that may occur during operation. Check this display if the **Faults** indicator on the GUI status bar appears red. Note that some items may display a red indicator intermittently during initialization and operation.

The example below shows a system without any errors. This window may serve as an important diagnostic and troubleshooting indicator.



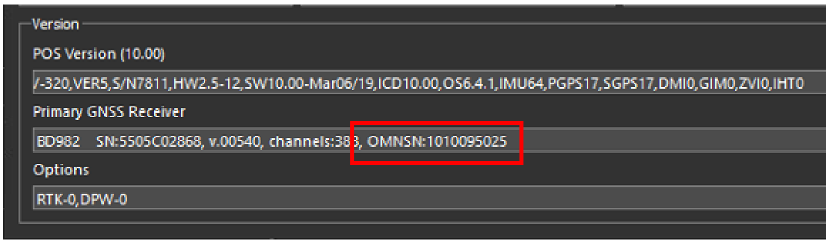
Version information is displayed at the bottom. It displays all INS related hardware, software and firmware versions. For users requiring an authorization code to upgrade the INS firmware, NORBIT support may ask for a screenshot of this display.

Additionally, the **Marinestar Status**, and importantly the subscription expiry date, is shown on the right-hand side.

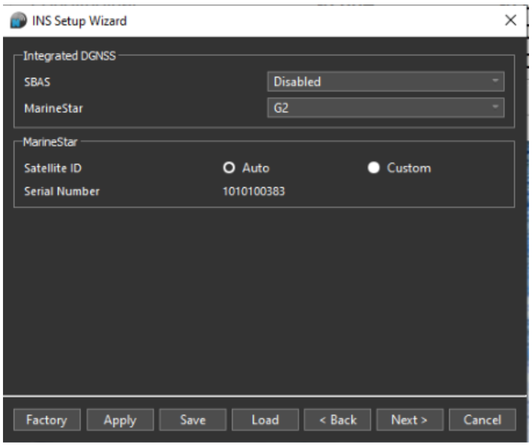
4.4.5 Subscribing to Marinestar

Follow the steps below to activate a Marinestar subscription for decimeter-level GNSS corrections, assuming RTK is not available:

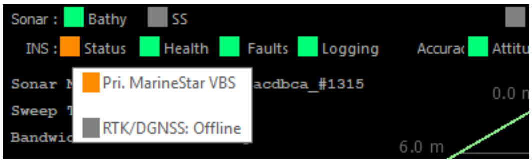
1. Select **INS Tools** > **System Status** and obtain the **OMNSN** number:



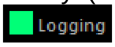
2. Go to http://www.fugroMarinestar.com/Order_form and request a subscription. In your request, you must supply the OMNSN number from the previous step.
3. Arrange a time with Fugro to activate the subscription, as the system must be powered on and tracking satellites when the activation code is transmitted. Be sure to consider time zone differences when organizing the activation time.
4. Enable **Marinestar** in the **INS Setup Wizard**, as described in section 4.4.1.5. In most cases you can leave the selection to **Auto**, however you may be advised to set a specific mode and frequency by Fugro, in which case choose the **Custom** option.



5. Prior to your arranged activation time, ensure that the system is powered on and tracking satellites. Advise Fugro when the system is ready.
6. It may take 30-45 minutes after the code is sent for the subscription to activate.
7. Confirm that the subscription is valid by observing the **System Status** window. If it is active, you should expect to see the status updates as well as an updated expiration date. When the system utilizes Marinestar corrections in the INS solution, the INS status displays **Pri. Marinestar…** when the mouse is moved over the **Status** indicator.

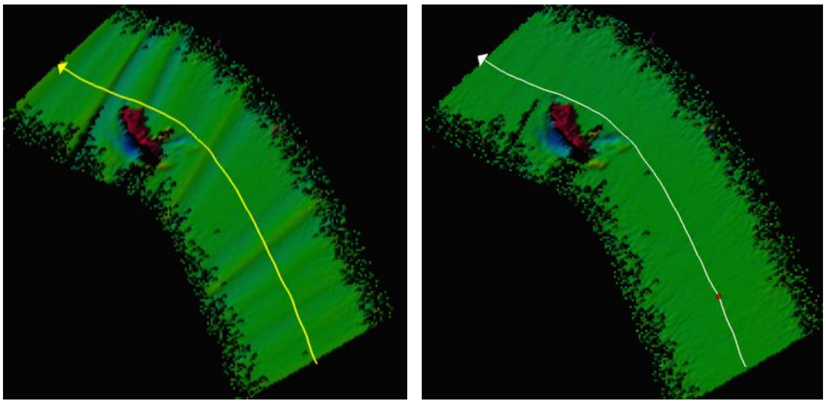


4.4.6 Logging

The GUI automatically logs raw Applanix INS/True Heave data when the GUI is launched, using the Applanix binary (*.000) format. The log folder path is displayed by hovering over the **Logging** indicator: 

The logging location may be changed by selecting **Advanced** > **Options** > **Paths**. It is also possible to disable logging, by deselecting **GNSS/INS Raw Observables**. NORBIT recommends that users do **not** disable INS logging. Refer to the Advanced section for more details.

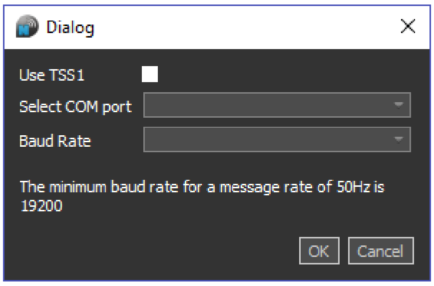
The *.000 file serves a dual purpose. First, it may be applied as True Heave in post-processing to reduce heave artefacts, without the need for a POSPac license. The example below shows a comparison of data with real time heave (left) and True Heave (right).



Secondly, the *.000 files can be processed in POSPac MMS for application of PPK data with improved position quality. Post-processing the GNSS data allows RTK dropouts to be recovered.

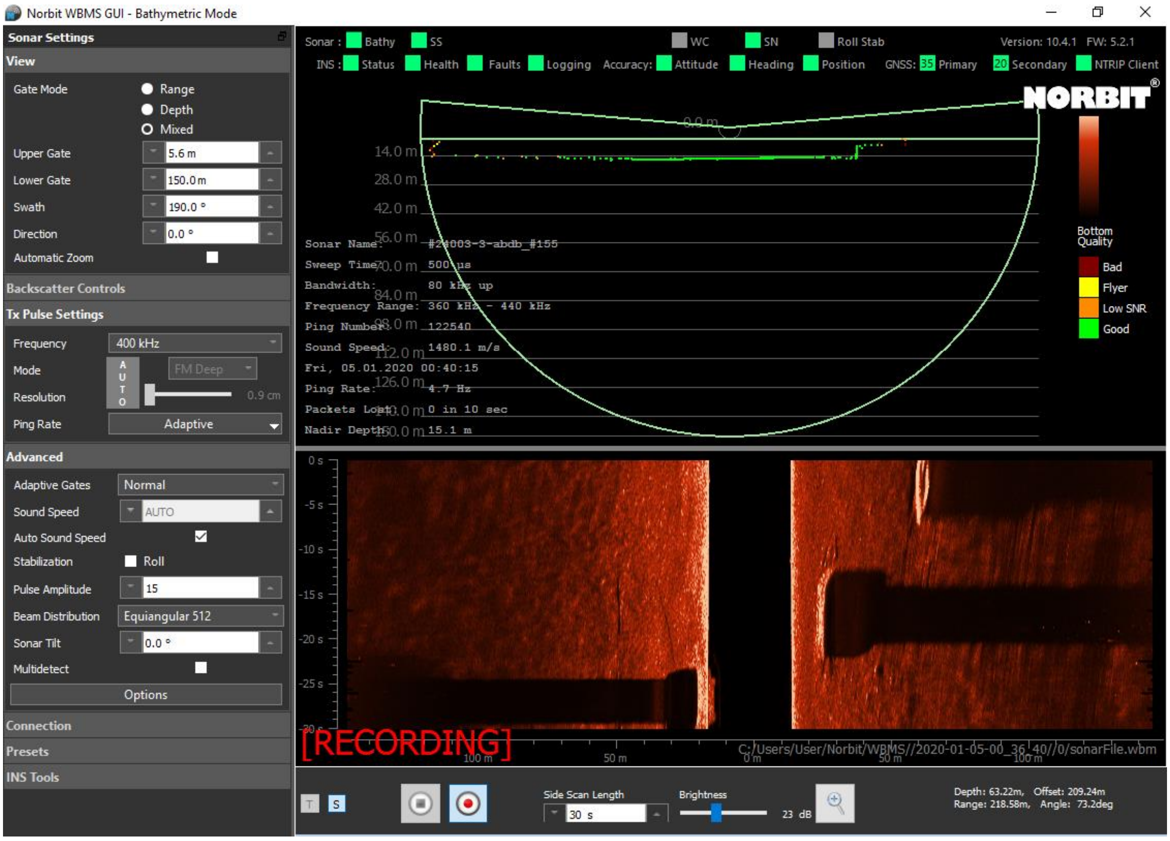
4.4.7 TSS1

For standalone (non-integrated) WBMS systems, a TSS1 message can be interfaced from an external motion sensor for roll stabilization. The TSS1 message should be interfaced to the computer via a COM port. Select **Use TSS1**, then select the **COM port** and **Baud Rate**. Click **OK**. The baud rate must match the output from the motion sensor.



4.5 Main WBMS GUI Display

When a successful connection is established, the sonar wedge is displayed, and logging of GNSS/INS raw observables automatically begins. Backscatter data may also be displayed. The image below shows an example of the main display with both raw sonar and GNSS/INS data being recorded.



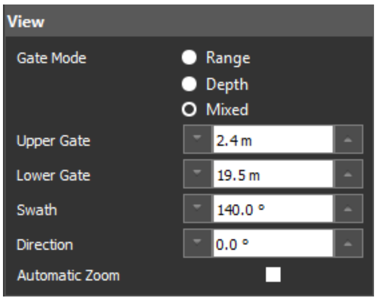
The sonar wedge shows a single ping of data from a thin slice of the water column. The wedge comprises 256 or 512 overlapping beams, which each contains a depth sounding.

The sonar wedge is used to assess data quality and swath coverage. Currently applied settings and statistics are summarized and displayed right of the sonar settings, and left of the sonar wedge, e.g. frequency, sound speed, date and time, and ping number. The software and firmware versions are displayed at the top right corner. Check the NORBIT support web pages to verify that you have the latest version.

4.6 Sonar Settings Menus

The left column contains several expandable menus. NORBIT recommends that the **View** menu always be expanded, as this requires the most attention and operator input.

4.6.1 View



Most sonar control features can be found in the **View** menu. The user may specify **Gate Mode**, the **Upper** and **Lower Gates**, **Swath** angle and swath pointing **Direction**. The table below describes each function in detail.

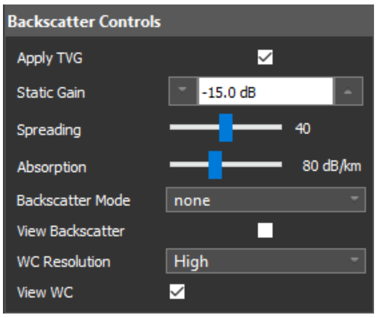
Sonar range is a function of the **Lower Gate**, angular **Swath** width and swath pointing **Direction**. These parameters affect the total distance bottom detections can be from the sonar, and the ping rate is then determined by factoring in the speed of sound in water.

Function	Description
Gate Mode	Allows for selection of manual gates by upper and lower depth (**Depth** mode), by upper and lower range (**Range** mode) or by upper depth and lower range (**Mixed** mode). **Depth** gates are suitable for most environments. **Range** gates are ideal for shallow water bank to bank surveys, or when changing the **Direction**. A bottom search is performed between the **Upper Gate** and **Lower Gate** independently for each beam. When **Depth** mode is active, changing the **Direction**, or operating with a physically tilted head may drastically reduce the ping rate. To avoid this, select **Range** or **Mixed** mode.
Upper Gate	Sets the upper limit (minimum depth) for bottom detections. Change values by entering a number and press Enter, by using up/down arrows next to the corresponding control bar, or by interactively clicking and dragging the gate to the desired depth on the wedge. For most surveys the minimum should be at least 1m to avoid false detections at the surface. **Minimum Value:** 0.1m **Maximum Value:** 599m
Lower Gate	Maximum depth for calculating bottom detections. Change values by entering a number and press Enter, by using up/down arrows next to the corresponding control bar, or by interactively clicking and dragging the gate to the desired depth on the wedge. **Minimum Value:** 1.0m **Maximum Value:** 600m
Swath	User-defined total angular swath coverage. For typical harbor dredge surveys, this value is normally set to 120-150° **Minimum Value:** 5° **Maximum Value:** 210°
Direction	Direction of swath pointing angle. 0° places the swath symmetrically around nadir. Under normal operations, direction angle is dependent on swath width as no portion of the swath may exceed the 179° allowable view. If the survey requires that depth be attained above the sonar draft, the direction can be extended further up by first selecting 180° **Swath**. Next select the desired **Direction,** then select the final desired overall **Swath**. Useful when surveying slopes, shoreline or for mapping structures such as piers, bulkheads, etc. To maximize the ping rate while using this feature, it is recommended that **Range** mode be activated and regularly adjusted. Use of **Depth** mode may yield low ping rates when using this feature.
Automatic Zoom	Makes the active portion of the wedge full screen. This ensures that detections are clearly visible on the display, even when the range is very high. This is most effective when using **Adaptive Ping Rate** with a large lower depth/range gate.

CAUTION: Steering Direction Limited in Equidistant Mode

In **Equidistant** mode, the swath angle cannot be increased such that any part of the swath exceeds an 80° pointing angle, i.e. 10º from horizontal (so, a 160° swath with 0° rotation or a 120° swath pointed 20° is the maximum.)

4.6.2 Backscatter Controls



Backscatter Controls change the data dynamics and apply gain to fit in the dynamic range of the output data format (s7k). The sonar hardware has a limited time varied gain (TVG) which operates up to around 30m. Thereafter, TVG yields a constant level. This may be a problem for some processing software when creating seamless mosaics. The **Apply TVG** option removes this native sonar TVG applied by the hardware and instead applies the user specified TVG described by the mathematical formula:

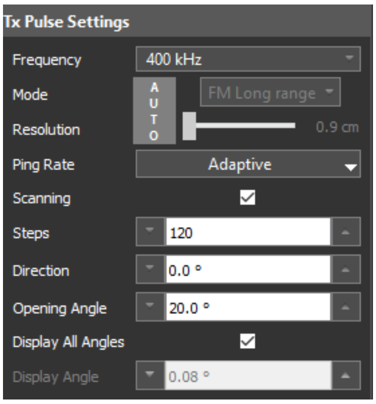
$$TVG = Spreading*Log_{10}(R) + 2*Absorption*R/1000 + Gain$$

This TVG curve is a standard continuous function to let the signal fit in the data format (s7k) range and prevent signal saturation. This digital gain is applied to all imagery output data: side scan, snippets, snippet-side scan and water column. For most cases, a **Static Gain** setting of -15dB, **spreading** 40 and **Absorption** of 80dB/km will sufficiently scale the data.

Function	Description
Apply TVG	Removes the native sonar TVG that is applied in the sonar hardware and instead applies the user specified TVG, based on **Static Gain**, **Spreading** and **Absorption**. When TVG is applied, all parameters are reported along with the data to the acquisition software to more effectively process the data e.g. for mosaicking. When the option is deselected, the native sonar TVG is not removed and no additional digital gain is applied to the data. Therefore, it is prudent to always enable this option.
Static Gain	Sets a fixed gain value that is used to together with **Spreading** and **Absorption** to form the TVG curve. The default setting of -15dB is suitable in most cases. Adjust this setting if the sonar signal becomes saturated, in which case the **SS/WC/SN** indicator will appear red on the main GUI display (see section 4.7).
Spreading	Sets the spreading component of the TVG calculation. Spreading loss is a geometrical phenomenon in which signal intensity is reduced as the range increases and wave fronts are spread over an increasingly larger area. The default setting is 40.
Absorption	Sets the absorption component of the TVG calculation. Transmission loss due to absorption is caused by conversion of acoustic energy into heat. The rate of absorption loss depends on the water environment and sonar operating frequency. The default setting of 80dB/km is recommended for 400kHz operation.
Backscatter Mode	Sets the backscatter mode to one of three options: **None**, **Side Scan**, or **Snippet/Scan**, the latter of which is a side scan composed of snippet data. Snippet collection rate will be limited to maximum 18Hz. These limits to data output rate were implemented to ensure smooth collection of data without burdening computational resources. If side scan data is requested by the acquisition software when **Snippet/Scan** mode is selected, **snippet-side scan** will be generated so that (unlike regular side scan) a correctly positioned side scan can be derived from snippets data. When surveying with a WBMS STX model, if snippets and/or side scan data are required, users are advised to deactivate **Scanning** in **Tx Pulse Settings**. If the goal is to classify bottom types, collection of Snippets will be most helpful. If that is not the case, snippets should be deactivated to conserve disk space and computational resources.
View Backscatter	Displays backscatter data under the sonar wedge. Even if it is not displayed in the GUI, backscatter data is still sent to the acquisition software if a TCP subscription is made. The **SN/SS** indicators at the top of the GUI appear green when a subscription is active.
WC Resolution	Sets the resolution of water column data. Water column data is output on record 7042. It is advised to keep the resolution low when computational resources are scarce.
View WC	Displays water column data on the sonar wedge. WC data collection is limited to 5Hz. Note that it will only be recorded to raw wbm/s7k files if the **View WC** checkbox is enabled.

CAUTION: Snippets Is Data Intensive
To ensure smooth data collection, make sure that the acquisition PC is not near its maximum CPU load. If CPU load is too great, artefacts may appear in the snippets record.

4.6.3 Tx Pulse Settings



The **Tx Pulse Settings** control the acoustic transmission (Tx) signals. Typically, with default settings, these values are automatically determined based on sonar range. For most survey applications, these settings need not be changed.

If the GUI detects a WBMS STX model, this menu activates additional options to allow transmit pulse steering. These controls are not visible if a standard WBMS is detected. All functions are explained in the table below.

For additional information on STX operation, refer to section 5.3.

Function	Description
Frequency	Sets center frequency of transmitted pulse. The WBMS is optimized for a center frequency of 400kHz for standard systems and 200kHz for deep/long range systems. For a given depth, higher frequencies theoretically have higher bottom detection resolution, but also higher signal attenuation, especially in the presence of sediments. For most applications, however, NORBIT recommends maintaining a frequency close to the center frequency of that system (200 or 400kHz). **Standard Systems:** 200kHz – 700kHz (optimized for 400kHz) **Long Range Systems:** 160kHz – 400kHz (optimized for 200kHz)
Mode	Sets sweep time of the signal transmission. The available selections are **FM Long Range** (recommended setting for most applications), **FM Short Range** (applicable for surveys in very shallow water, less than 5m), or **CW** (legacy option). With **FM Long Range**, a long sweep time of 500µs is used. The **FM Short Range** option reduces this value to 200µs. Decreasing sweep time increases effective ping rate. For **CW** mode, the duration of the signal transmission increases range performance at the expense of detection quality. NORBIT systems are optimized for FM operation.
Resolution	Sets the acoustic range resolution by controlling pulse bandwidth. The resolution is calculated as c/2*BW, where c is the speed of sound and BW is the bandwidth. When maximum resolution (0.9cm) is set in **FM Long Range** or **FM Short Range** modes, 80kHz bandwidth is used. Therefore, with a center frequency of 400kHz, transmission sweeps from 360-440kHz. Decreasing resolution enhances range performance in deep water by reducing bandwidth. In **CW** mode, frequency transmission is constant, i.e. 0 kHz bandwidth. However, the system is designed from conception as an FM system and performs optimally in this mode, yielding highest resolution regardless of depth. **Auto** selection is recommended.
Automatic Mode and Resolution (Auto)	Adjusts **Mode** and **Resolution** for best performance in nearly all survey conditions, as determined by the software. For backscatter, unless very high ping rate is desired in shallow water, disable **Auto** and set **Mode** to **FM Long Range** and **Resolution** to **0.9cm** to ensure full processing of the backscatter signal. The system will otherwise switch between 200 and 500µs and some software cannot process out the signal change.

Ping Rate	Sets the rate at which acoustic pulses are transmitted. Certain factors such as depth will limit the maximum achievable ping rate. For instance, in deeper water, lower ping rates will be the norm since signal travel time and path length from projector to reflective bottom, and then back to receiver, are longer. Tx pulse **Mode** also affects ping rate. The system automatically transmits with 200µs sweep time in shallow waters so that maximum ping rate is maintained.
Ping Rate: Full Range	If enabled, sets the ping rate to maximum possible value over the total effective range as defined by the **Swath** width, swath **Direction** and **Lower Gate**. Ping rate is a function of the two-way travel-time of the signal from projector to the bottom and back, plus a small duration for ping processing and capacitor charge. The effective range is determined from the angular swath width, swath pointing angle and lower depth or range gate.
Ping Rate: Adaptive	System searches for greatest bottom detection range based on adaptive gate over a certain number of pings and revises the transmission timing to match this. **Lower Gate** may therefore be set to very deep values, but the system will ping at a much higher rate as it is based on maximal adaptive gate for range. This is ideal for high resolution data over rapidly changing bottoms or for surveys that don't allow for full-time, hands-on operators (e.g. on AUVs). While operating in this mode, sonar bandwidth and sweep time are determined by the **Lower Gate**. If surveying in shallow waters, the **Lower Gate** should not be set too deep unless **Auto Mode**/**Resolution** is disabled.
Ping Rate: Fixed	Sets the maximum ping rate of the sonar. Even if possible, the sonar will not ping faster than the fixed rate. Useful for general bathymetric surveys with deep and shallow water to reduce data volume in very shallow waters as the system will continually attempt to ping as fast as possible up to the user defined threshold or the sonar range.
Ping Rate: External	Most users do not require this. Ping is triggered externally and only happens if the sonar is 'ready' when the signal arrives, e.g. if the sonar cannot ping faster than 10Hz due to range, but the external signal is 12Hz, then every other event will be skipped resulting in a 6Hz ping rate per every other signal. The external signal polarity is configurable. Minimum delay from transmit signal to center of transmit pulse is 500µs (half the transmit pulse buffer plus additional). An adjustable trigger delay is possible in millisecond resolution.
Scanning (STX only):	If checked, this option directs sonar to sweep an along-track sector of angle given by Opening Angle. If unchecked, the sonar is directed to ping in one direction, effectively behaving as a conventional multibeam sonar. **NOTE: It is not advised to conduct an entire multibeam survey with scanning active. Use scanning only when attempting to further develop areas of interest. For most applications, step size should be limited to 20.**
Steps (STX only):	This is configurable only if **Scanning** is enabled and the opening angle is set to a non-zero value. The number of steps corresponds to the number of slices, or pings, in each defined along-track sector.
Direction (STX only):	The value in this field defines the angular direction forming the center of the along-track sector, e.g. for a direction of 5°, and opening angle 20°, the STX will scan across a sector from -5° to 15°.
Display all Ang (STX only):	If checked, this instructs the GUI to display all angles in the sector being scanned by the STX. If unchecked, the GUI will display the angle defined in **Display Angle**.
Display Angle (STX only):	If **Display all Ang** is unchecked, this field will be greyed out. However, if the previous field is unchecked, the user may define a single angle within the sector to visualize on the display.

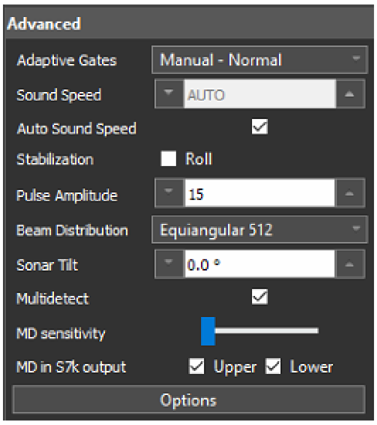
CAUTION: Data Quality Is a Function of TX Pulse Settings

High quality sonar data requires excellent Signal to Noise (SNR). Therefore, the sonar **Tx Pulse Settings** directly impacts data quality. For most conditions (temperature & salinity dependent) use **FM Long Range** mode and **0.9cm** resolution. If useable swath width becomes narrow (due to noisy outer beams) then gradually decrease **Resolution**. If in doubt. use **Auto** selection.

CAUTION: Bottom Classification Surveys Using Snippets

If backscatter data quality is the priority of the survey, deactivate **Auto** and manually define **Mode** and **Resolution**. Changing these settings during a survey, or operating in **Auto** mode, may cause data degradation as the processing software is not able to compensate for variable pulse characteristics. In general, **FM Long Range** mode should be used, however this limits the ping rate to a maximum of 20Hz. If a faster ping rate is required, select **FM Short Range**.

4.6.4 Advanced



It is prudent for the sonar operator to understand the **Advanced** settings in the rare event that they need to be changed.

If a WBMS STX system is utilized, an additional checkbox appears for activating pitch stabilization. Note that pitch stabilization should **not** be used when **Scanning** is selected.

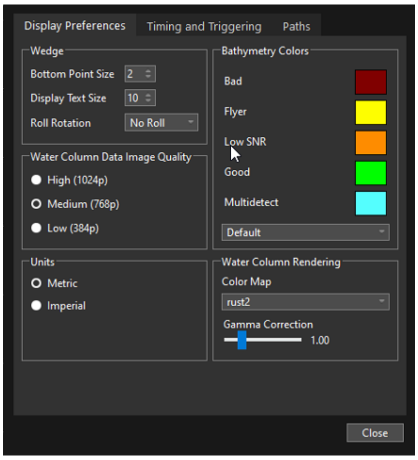
When **Multidetect** is selected, additional options become available to control the detection sensitivity and customize the output. All functions contained are explained in the table below.

Function	Description
Adaptive Gates	**Adaptive Gates** work in a similar way to upper/lower gates, except they follow the shape of the seafloor. Note that they are **not** visible on the sonar wedge. If the gates are too narrow, bottom detections may be noisy for large depth changes. In areas with steep gradients it is recommended that the gates be turned **Off**. If the gates are too wide (or off), false bottom detections may occur due to noise, second returns or fish. The following applications are well suited for the corresponding settings: • Dredging Surveys: **Normal** Adaptive Gates • Engineering Surveys: **Normal** or **Wide** Adaptive Gates • General Bathy Surveys >40m: **Narrow** Adaptive Gates • General Bathy Surveys <40m: **Normal** Adaptive Gates • Wreck or Complex Structure Surveys: **Wide** Adaptive Gates or **Off** In some sea states the gates may need to be set wider to avoid cutting out data during large roll events. It is advisable to use adaptive gates in nearly all environments.

Sound Speed	This option controls how the surface sound speed is applied. If **Auto Sound Speed** is selected (recommended) the sonar only takes in values from the sensor installed at the sonar head. If this sound speed probe fails, users can disable the auto option and manually input the speed, based on a sound speed profiler for example. An incorrect surface sound speed will irreparably compromise the beam pointing direction resulting in bad data. Minimum value is 1300m/s, maximum is 1700m/s. When **Auto Sound Speed** is deselected, the last value at the head is used to populate the SV value. Please note that this range reflects default hardware capabilities. For marine conditions requiring a larger range, other models of the sound speed probe are available; please contact NORBIT for more information.
Auto Sound Speed	If this option is selected the speed of sound is read from the probe at the sonar head. This is recommended unless the probe is damaged, out of calibration or there are too many bubbles affecting the data quality, e.g. when surveying in rapids or surf-zone. If necessary, this option may be deselected, and the value set manually. If the sonar is powered on and out of the water, or there are excessive bubbles, the GUI displays a warning that the sonar is "Out of water". If the sonar is pinging out of water, it automatically takes measures to prevent damage due to overheating. If the sonar temperature exceeds 65°C it will shut down automatically as a safety precaution.
Roll Stabilization	Roll stabilization allows for a wider swath width in more dynamic sea states. Roll stabilization compensates up to ±10º of roll and is limited to 160º swath angle. Note that roll stabilization is unrelated to roll compensation for georeferencing purposes, which is handled separately.
Pitch Stabilization (STX only)	When activated, pitch stabilization allows for pitch compensated transmit beams for a more even along-track coverage with minimal loss. **STX scanning must be deactivated prior to use.**
Pulse Amplitude	Sets the pulse amplitude (transmission power). For shallow waters (<10m) in highly reflective areas (lock chamber, for example) it may be necessary to reduce the pulse amplitude to reduce acoustic reflections/noise in the survey area. Otherwise it is best to leave it set to 15.
Beam Distribution	There are 4 modes to select from: • **Equiangular 512 or 256**: The angular swath coverage is divided equally by 512 or 256 (the total number of beams) to determine angular beam spacing. Use to increase resolution around the nadir zone. • **Equidistant 512 or 256**: The maximum chord distance of the swath is divided by 512 or 256 to determine the linear beam spacing. Use to increase resolution at outer swath edges. There is a short 1 second lag when switching modes. Do not switch while logging data.
Sonar Tilt	Specifies the tilting angle in special mounting configurations such as dual head when the sonar is mounted at an angle. Allows the user to normalize the display in the GUI, otherwise a flat seafloor will appear as a slope. Note, additional considerations are required when the integrated IMU is tilted; refer to technical note TN-190018 for details.
Multidetect	As of GUI release 10.4, users can collect up to 3 detections per beam: one extra detection above and below the bottom detection. The upper and lower gates control which part of the water column is considered for extra detections. The **Adaptive Gates** control how close the extra detection will be to the bottom detection: if set to **Wide** or **Off**, the extra detections could be further away from the bottom detection, and if set to **Narrow**, the extra detection will be closer to the bottom detection.
Multidetect Sensitivity	Adjusting the slider increases or decreases the sensitivity of the multi-detection algorithm to qualify the water column as a potential extra detection.
Multidetect in S7k Output	The user can select whether to output an extra detection above (**Upper**) and/or below (**Lower**) the bottom detection in s7k files generated by the GUI.

<table>
<tr>
<td>Options (Display Preferences, Timing and Triggering, Paths)</td>
<td>

Display Preferences



Bottom Point Size – Changes the point size on the wedge. Adjustable from 1-10.

Display Text Size – Changes the text size on the wedge area. Adjustable from 1-12.

Roll Rotation – Viewing options to show the roll stabilized wedge.

Water Column Data Image Quality – Sets the resolution of the water column display. This does not affect output resolution. To ensure system resources are kept to a minimum for low-grade field laptops, run with medium or low graphics selected.

Units – Selects the display units in the GUI to be either metric or imperial.

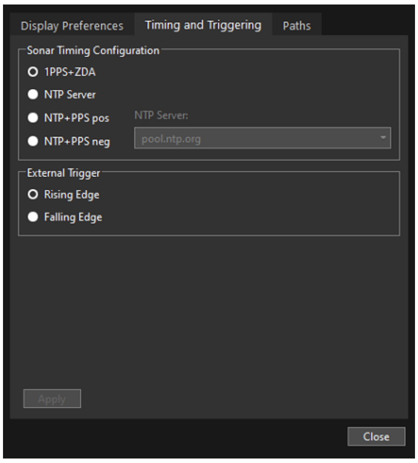
Bathymetry Quality Colors – Changes color palette of bottom detection quality flags.

Color Map – Offers different color settings for visualizing the swath intensity data.

Gamma Correction – Changes the visual contrast of the wedge intensity data. Setting the gamma too low will mute the intensity in the wedge display to nearly all off (black). Setting gamma too high will fuse the darkest areas with brightest areas. A value of 2 is often the best.

Timing and Triggering

Users can specify the synchronization method for sonar timing. For more installations, **1PPS+ZDA** should be selected, in which case the GNSS signal provides the time stamp and associated 1PPS signal to the sonar.



If timing direct from the SIU (via the GNSS receiver) is not possible, e.g. on ROV/AUV or other types of custom installations, then timing from an **NTP Server** may be used.

NTP+PPS has the same accuracy as 1PPS+ZDA and is recommended for all other installation types where 1PPS+ZDA is not possible. A PPS pulse must be sent to the system on the timing pin, and an NTP server should be made available on the network. If the timing error exceeds 10ms, the sonar will discard timing. Select **NTP+PPS pos/neg** if using time from an NTP server to provide PPS. “pos” and “neg” refers to a positive and negative signal spike, respectively. When this mode is activated, an error of >100ms renders the data unusable.

If there is no PPS available, NTP without PPS can be used by selecting **NTP Server**. It possesses less accuracy but is OK to use for platforms with lower dynamics. This option requires that the NTP server is at a low STRATUM (<2) value and not too far away in the network (public servers are usually not good enough).

More advanced users can use an external signal to trigger the sonar. The **External Trigger** polarity can be set to **Rising Edge** or **Falling Edge**. **NOTE: For integrated systems, triggering via the BNC connector is not possible. Inputting any voltage to the BNC of an integrated SIU can cause damage to the internal electronics.**

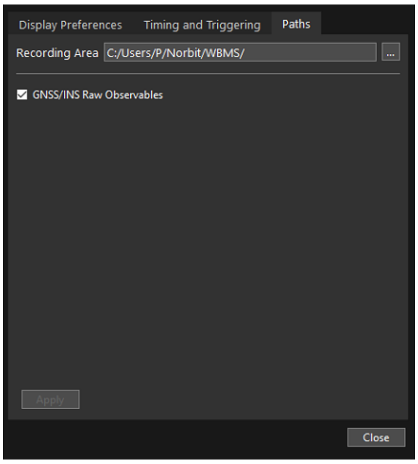
</td>
</tr>
</table>

Paths

User can specify the folder path for recording native NORBIT (*.wbm), Applanix (*.000), and s7k (*.s7k) files. Each respective format is stored in a different folder, e.g. Applanix files are stored in the **Applanix Logs** folder.

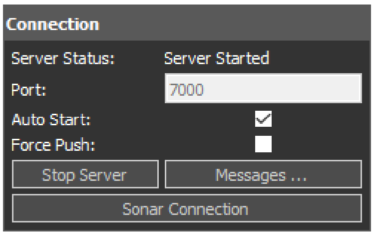
Users can choose to disable Applanix data logging by deselecting **GNSS/INS Raw Observables**. However, NORBIT recommends that this option is always enabled.

Note that the GUI must be closed/re-opened when the recording path is changed, otherwise data will continue to be recorded to the previous location.



4.6.5 Connection

The WBMS operates in a native data format. To ensure compatibility with other data acquisition and processing software, the system includes a proxy that translates native WBMS data to the well-known s7k data format. The proxy is therefore run from the GUI and is initiated automatically. The connection can be reset should a conflict arise. If necessary, to avoid conflict with other sensors, the **Port** number can also be changed.



In a dual head configuration, the **Port** number set in the GUI applies to the primary sonar only. The secondary sonar port is one greater than the primary. For example, if the **Port** is set to **17000**, the primary sonar will use port **17000**, and the secondary sonar will use port **17001**.

⚠ **NOTE: Enable Force Push for PDS and EIVA Acquisition**

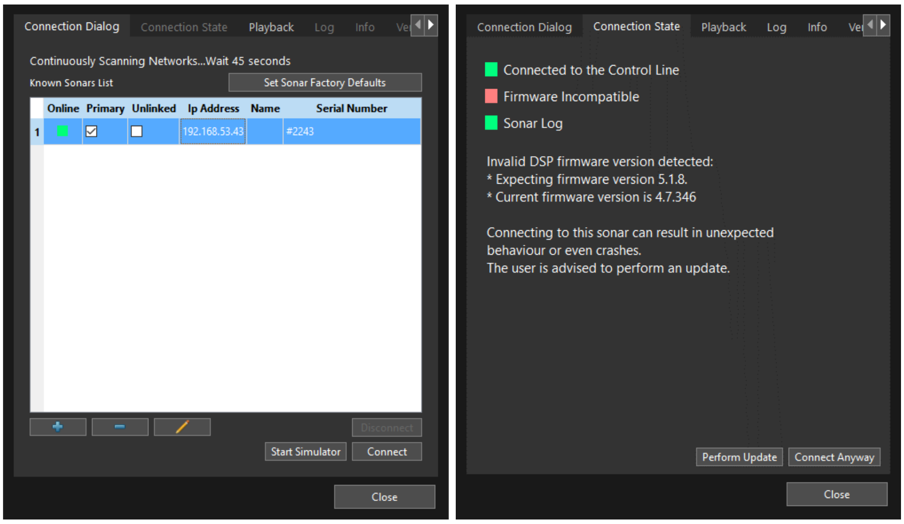
To receive sonar and INS data into PDS or EIVA, the **Force Push** option must be selected. HYPACK and QINSy users should ensure that this option is deselected.

4.6.5.1 Connection Dialog & Connection State

Select **Sonar Connection** to open the **Connection Dialog** (described also in section 4.3). Selecting **Set Sonar Factory Defaults** resets the sonar configuration but does not reset the integrated INS. NORBIT recommends restoring factory defaults whenever a new version of the GUI or firmware is installed. Note that, when this option is selected, raw GNSS/INS logging briefly terminates.

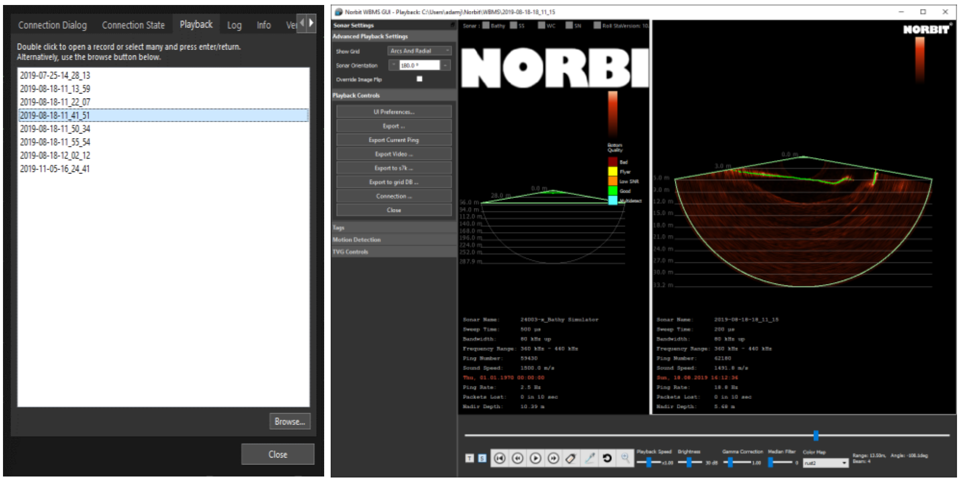
Connection State contains basic information about the current connection status. If any of the indicators are red, action is required by the user. Such is the case in the example presented here, which shows that the sonar is not loaded with the firmware expected by the GUI.

To shut down and disconnect the sonar, select **Connection Dialog**, select the sonar on the **Known Sonars List**, and select **Disconnect**.

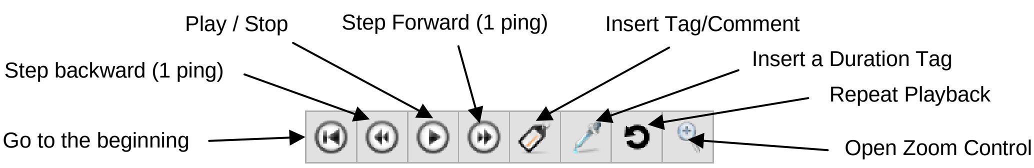


4.6.5.2 Playback

The **Playback** tab displays all detected GUI recordings. If there are GUI recordings in other folders, USB drives, etc. select **Browse** and navigate to the correct folder. To play back a recording, double-click the file name. This opens a second display next to the active wedge showing the recorded data. By default, recordings are stored in: *C:\Users\<user>\NORBIT\WBMS*
During playback, only bathymetry and water column data will be displayed.



The playback window can be resized by clicking/dragging the central divider. **Settings** and **Controls** are found on the left. Users can change the **Sonar Orientation** as required. To export the current ping, or a series of pings, use the **Export Current Ping** and **Export** buttons. Playback controls are displayed at the bottom:



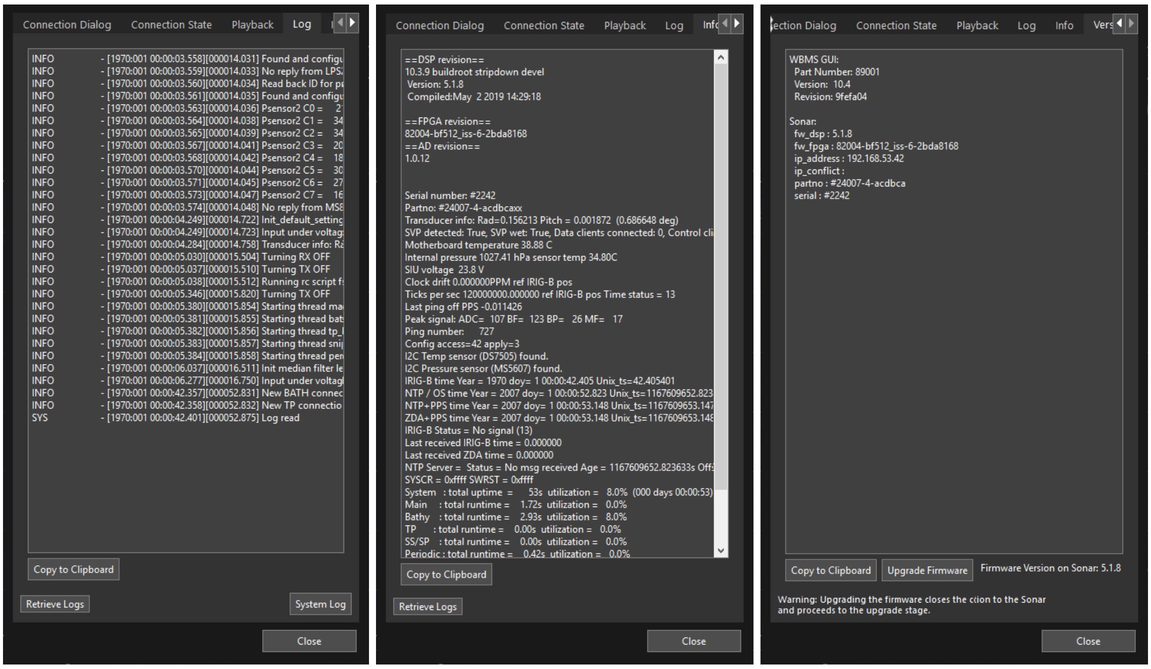
Other options including s7k export and video export are found on the left menu.

4.6.5.3 Log, Info & Version

The **Log** tab contains a record of system events. This is useful for troubleshooting, and NORBIT support may ask for a copy during support cases.

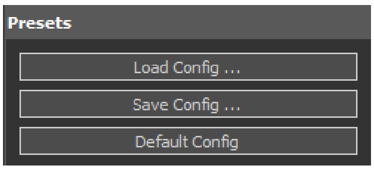
The **Info** tab contains a record of serial numbers, part numbers, revision numbers, and various system statistics.

The **Version** tab displays the current WBMS GUI version, as well as the current firmware version.



4.6.6 Presets

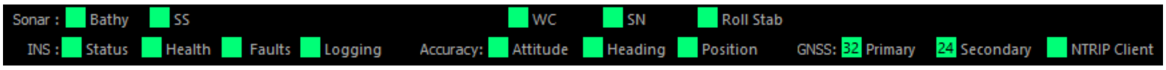
Users can save preferred sonar configurations to a file by selecting **Save Config**. These files can be loaded by selecting **Load Config**, as and when required. The saved configuration files are stored in the folder: *C:\Users\<user>\AppData\Roaming\NORBIT\PredefinedSonarSettings*



Configuration files contain all sonar settings (frequency, swath angle, static gain, etc.) and all GUI display preferences. Users may transfer the files between computers to load desired presets.

This functionality allows rapid reconfiguration of the sonar with minimal operator input. For example, a preset could be made for quay wall surveys with settings appropriate for that application, i.e. Equiangular beam distribution, range gates, and swath direction steered to either the port or starboard side.

4.7 Upper GUI Status Indicators



The first row of indicators (***Sonar***) shows the streaming status of various data types as it is requested by acquisition software. Data not requested shows a grey indicator. If the **SS**, **SN** or **WC** indicators are red, it indicates that the signal is saturated. Adjust the TVG settings under **Backscatter Controls**, as described in section 4.6.2.

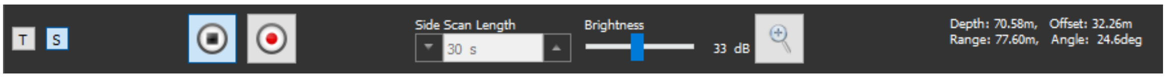
Indicator	Description
Bathy	Bathymetric bottom detection points
SS	Side Scan
WC	Water Column
SN	Snippets
Roll Stab	Roll Stabilization Status

The second row of indicators (***INS***) relate to the function and health of the integrated Applanix system. Mouseover the indicators to display additional information such as current position, GNSS mode, and accuracy. Should a fault be detected, more information can be found by selecting **INS Tools**, then **System Status.**

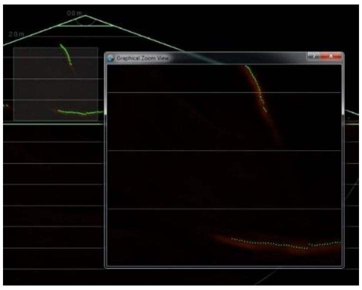
The **Status** indicator provides the current solution status (RTK, Pri. DGNSS, etc.) as well as the status of the current corrector stream. At times the indicator may appear red and may report **Pri. Fixed** Status. This alerts the user that the correctors have changed status and that the RTK fix may soon be lost. Additionally, if using NTRIP, the **NTRIP** indicator may change color to red, indicating a loss in connection.

For users with Applanix firmware v10, the primary GNSS antenna shows many more satellites than the secondary antenna. Currently, only the primary antenna is tracking all GNSS constellations and SBAS satellites.

4.8 Lower GUI Viewer Bar



By default, the sonar starts pinging once connected to the GUI. The Play  /Stop  button is used to start/stop sonar pinging. Once stopped, the Stop button changes to a Play button. Pinging should be stopped when the GUI is running with the sonar out of water, to prevent the electronics overheating.



Users may also set the **Side Scan Length** and adjust display **Brightness**. The **Brightness** control bar only adjusts the wedge intensity displayed on the GUI; it does **not** affect the raw data signal. This can be used to effectively increase the illumination of received acoustic data. Applying too much brightness will saturate the image of the more reflective areas of the acoustic display, while applying too little results in a very dark image.

To the right of the **Brightness** control is the **Zoom** tool. This opens an adjustable pop-up window on the sonar wedge. The window can be dragged to any location on the wedge to magnify any segment of the swath. The zoom pop-up window remains on top of all open windows.


Displays a time trace for each beam separately when the water column is active. Right clicking allows the user to zoom in, while left clicking resets the zoom. Channels can be selected using the arrows at the bottom. A graphical selection appears on the wedge.


Hide/unhides the sonar settings menu. The user still has control of the gates, and therefore the sonar range, by clicking/dragging the gates interactively on the wedge.

Selecting  activates raw data recording with the native NORBIT format (*.wbm), and simultaneously generates files with the s7k format (*.s7k). Recorded data can be played back at any time (even during real time sonar operation and recording), as described in section 4.6.5.2. The GUI recording files are saved by default in: *C:\Users\user\NORBIT\WBMS*. Each recording session generates a folder with the naming convention YYYY-MM-DD-HH_MM_SS. If NORBIT requests data for a support case, please compress the files beforehand as they may become very large, especially when water column is included.

4.8.1 Optimizing Backscatter Display

Tuning the display **Brightness** and **Gamma Correction** (in **Options**) does not have any impact on the raw data signal and is only used to adjust the display. However, TVG settings impact data output. See section 4.6.2 for details.

To optimize backscatter images visually:

1. Adjust **Brightness** on the display control bar
2. Under **Backscatter Controls**, ensure that **Apply TVG** is selected
3. Adjust the settings for **Static Gain, Spreading and Absorption** until the side scan image appears unsaturated, and ensure that the **SS/SN/WC** indicators are green.

These settings are dependent on current environmental conditions (water sediment content, salinity, temperature, etc.) and may have to be adjusted as the survey progresses. Ensure that the **SS** and **SN** indicators remain green (unsaturated) as saturated soundings will not be salvageable.

4.9 Data Formats, Recording & Output

4.9.1 Raw Data Recording

Users may record bathymetry data with full motion and navigation data (for Applanix integrated systems only) in the native NORBIT format with extension *.wbm. Since NORBIT GUI 10.4 was released, s7k files are generated automatically at the same time as wbm files and include True Heave data. The s7k format has a publicly available data format definition (DFD). If requested, NORBIT Support can provide documentation on the DFD. The logging location for *.wbm, *.s7k and *.000 files can be changed by selecting **Advanced** > **Options** > **Paths.** See section Advanced for more details.

The data types stored within raw data files depends on the selections made within **Backscatter Controls**. The **View WC** Checkbox controls whether compressed water column data is recorded, and the **Backscatter Mode** (but not the **View Backscatter** selection), controls what backscatter imagery is recorded. Note, this is only relevant for raw data files recorded in the GUI and does not affect data output to acquisition software (see
Data Output via Network Subscription.)

All acquisition software subscriptions overwrite selections made in the GUI. Meaning that, if the GUI does **not** have **Side scan** selected for **Backscatter Mode**, but side scan is requested by the acquisition software, side scan will be recorded in the wbm files regardless.

The table below shows what selections are required to log specific data types to raw files in case there is no acquisition software subscription. Please note that the **View Backscatter** selection has no impact on recorded data types, whereas the **View WC** selection does.

Note also that beam intensity values, at the bottom detection point, are recorded within the bathymetry packets. This is automatically output and requires no configuration in the GUI. It can be used to provide coarse backscatter, separately from the side scan and snippets outputs.

Backscatter Mode Selection	View WC Checkbox	Recorded Data Types in WBM file	7k Records in s7k file
None	☐	✓ Bathymetry ✗ Compressed Water Column ✗ Side scan ✗ Snippets	✓ 7027 ✗ 7042 ✗ 7007 ✗ 7028
None	☑	✓ Bathymetry ✓ Compressed Water Column ✗ Side scan ✗ Snippets	✓ 7027 ✓ 7042 ✗ 7007 ✗ 7028
Side scan	☑	✓ Bathymetry ✓ Compressed Water Column ✓ Side scan ✗ Snippets	✓ 7027 ✓ 7042 ✓ 7007 ✗ 7028
Snippets/scan	☑	✓ Bathymetry ✓ Compressed Water Column ✓ Side scan ✓ Snippets	✓ 7027 ✓ 7042 ✓ 7007 ✓ 7028

4.9.2 Data Output via Network Subscription

Currently the NORBIT GUI supports streaming s7k records 7000, 7004, 7006, 7007, 7027, 7028, and 7042 via the subscription model (record 7500 with ID 1051). All subscriptions can be ended with record 7500, ID 1052.

Supported single request records (via record 7500 with ID 1050): 7001

Successful requests are replied with record 7501 (ACK) while unsuccessful ones return record 7502 (NACK). This is based on RESON's data format definition (DFD) version 2.43. The following table describes the current s7k records output by the Proxy Server contained in the NORBIT GUI:

Record	Description
7000	Sonar settings
7004	Beam Geometry
7006	Bottom detection results (obsolete bathymetric data)
7007	Side scan data
7027	Bathymetry data (including beam intensity values for coarse backscatter)
7028	Snippets data
7042	Compressed water column data
7500	7k remote control with ID 1051
7501	7k remote control acknowledge
7502	7k remote control not acknowledge

4.9.3 Data Rates

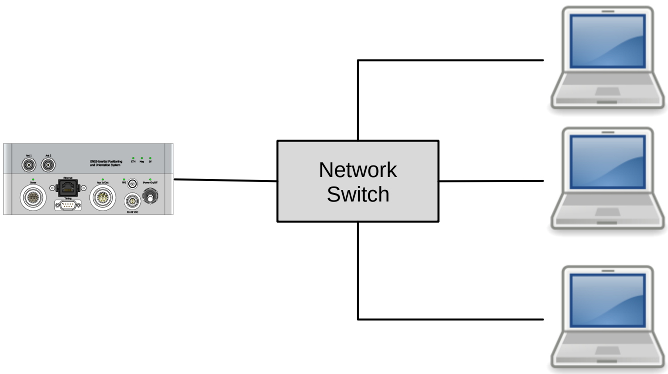
Estimated data rates for a single head system at maximum ping rate for different subscriptions are given below:

Ping Rate	Bathy	Applanix	WC	SS	SN	SNS	Data Rate
50 Hz	✓	✓	✗	✗	✗	✗	5 Mbps
50 Hz	✓	✓	✓	✓	✗	✗	13 Mbps
50 Hz	✓	✓	✓	✓	✓	✗	13 Mbps
50 Hz	✓	✓	✗	✗	✗	✓	11 Mbps

4.10 Interfacing with Multiple Computers

It may be necessary to have more than one PC to communicate with the sonar, e.g. one computer to configure and control the sonar system and a second, more computationally resourceful PC, for running acquisition software such as HYPACK or QINSy. To achieve this, two additional hardware items are required:

1. A Network Switch
2. An Ethernet cable for each PC connecting to the sonar



Step 1. Connect the sonar to the Ethernet switch and then the controlling PC to the switch. Configure the network settings on the controlling PC as described in Section 4.2, noting the IP address of this computer. Install the WBMS GUI and configure it as described above. Power on the sonar and launch the WBMS GUI.

Step 2. Connect the second PC to the Ethernet switch. Ensure that the IP address of this PC does not conflict with those of the other systems. From here, the user has at least two options for interfacing with the sonar. First, the user may communicate from a second instance of the GUI, running on this PC. If configured properly, the IP address of the first PC should appear online in the **Connection Dialog** and users may connect to it as usual. Another option is to open the acquisition software, e.g. HYPACK sonar settings (see Appendix), initialize the program to query the IP address of the first PC. This configures the acquisition program to request data from the GUI running in the first PC.

5 Theory of Operation

To operate the sonar effectively, users should be aware of certain basic principles of sonar signal processing. Possessing this knowledge gives users confidence to adjust the settings for optimal bathymetry and backscatter data collection, as well as aiding troubleshooting.

5.1 Range vs. Bandwidth

For higher quality bottom detection, the bandwidth should be maximized. The NORBIT WBMS implements a bandwidth of 80kHz throughout its operational range. Only the sweep time is adjusted in shallow waters. If in manual mode and operating in shallow waters, select **FM Short Range** mode to maximize ping rate.

The NORBIT WBMS has been tested to 175m using 80kHz bandwidth. It is recommended that for most scenarios, users select the **Auto** option under **Tx pulse settings**.

5.2 Bottom Detection

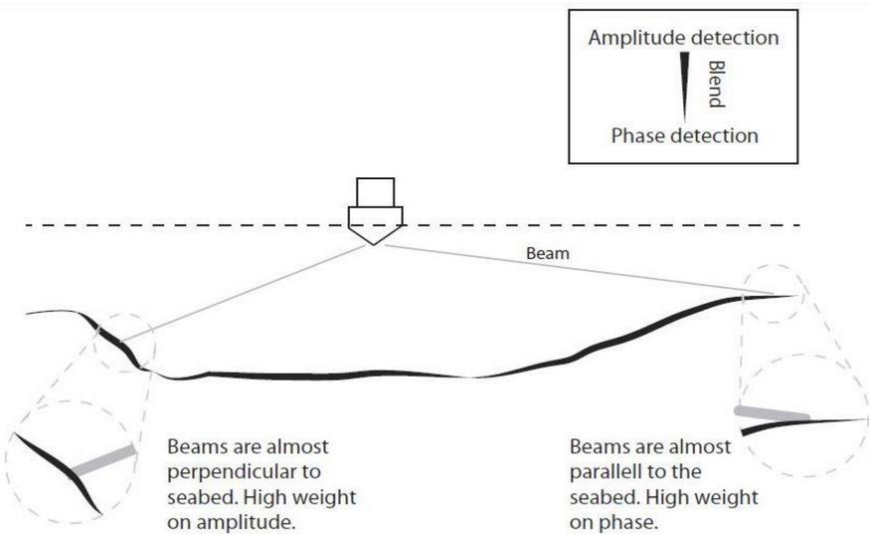
The WBMS seamlessly utilizes three methods for bottom detection:

- Amplitude
- Phase
- Weighted Blend

Amplitude based detection is most accurate when the reflecting area is close to perpendicular to the beams. Phase based detection is most accurate when the reflecting area is at an angle to the beam.

Thick lines show high emphasis on amplitude detection. Thin lines show high emphasis on phase detection.

The WBMS automatically weights the amplitude and phase detection to give a seamless transition between the two at any area of the swath. This means that there are no predefined beams for amplitude, phase or blend.

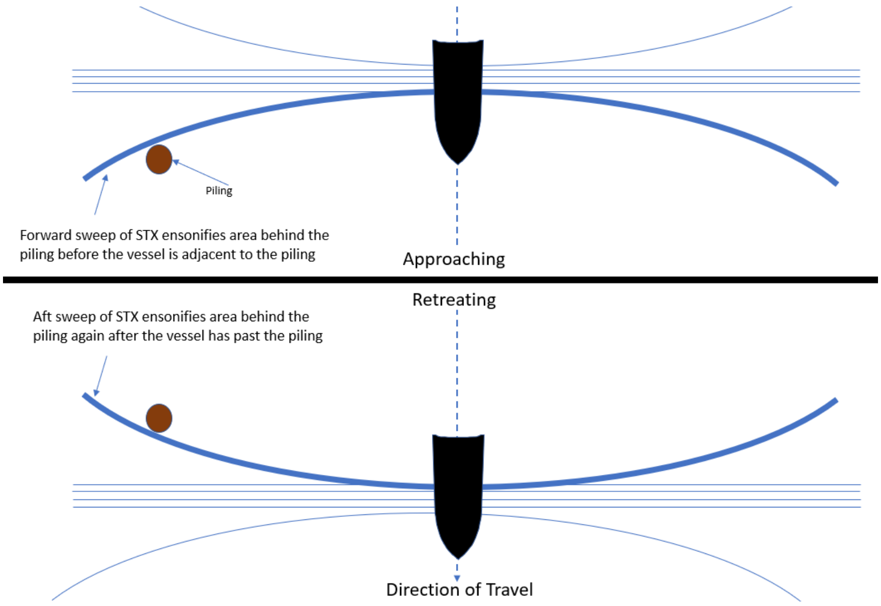


5.3 STX (Steerable Transmitter) Usage

The NORBIT STX is a steerable projector system that allows the transmit beam to be directed forward 10° and aft 10°, in a scanning pattern, along the vessel track. This scanning allows the system to ensonify areas that otherwise would not be, such as behind pilings. This functionality aids inspection surveys by giving a more complete picture of the survey area or target.

When scanning is activated, the STX begins steering the transmit beam. Each step-in angle occurs with each ping. The time to complete a full fore/aft scan depends on the current ping rate, for example a ping rate of 20Hz, and a step size of 20, means 1 second per scan. For this reason, it is not recommended, for most applications, to have a step size of more than 20. For best results it is advised that the speed be kept as slow as is safely possible. In addition, it is recommended that two passes be performed: one pass as close as is safely possible to the structure, and a second pass slightly further away. This ensures that maximum coverage is achieved.

The STX can also be used to capture additional details on complex structures on the seafloor, such as shipwrecks. Steering the transmit beam allows multiple hits, at various angles, on the target during a single pass.



NOTE: Larger STX step sizes

For most applications it is recommended to not exceed a step size of 20. In special cases, the step size can be increased up to 120. Contact NOTBIT support for further information and guidance.

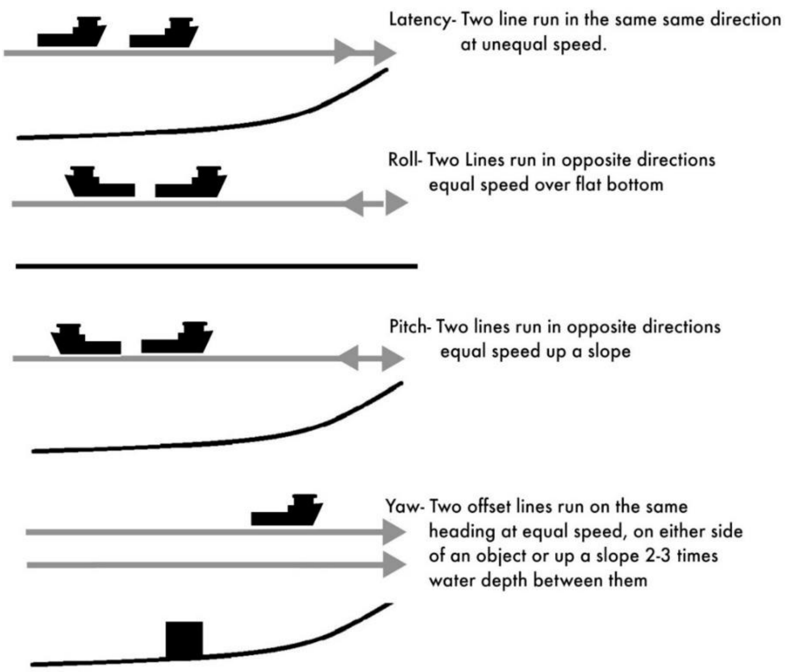
6 Survey Calibrations & Checks

Before starting a survey (or during longer surveys) it is best practice to regularly check the performance and alignment of the sonar system. The following procedures are vital in maintaining quality control of depth measurements.

6.1 Patch Test

The Patch test resolves small misalignments between the sonar and the navigational system. Failure to **not** resolve these misalignments results in inaccurate depth measurements. A patch test is performed by running a series of reciprocal lines at varying speeds, depths and bottom terrain. A patch test should be performed over an area with a slope or prominent features. It is recommended that a patch test be performed whenever the sonar is re-mounted, repositioned, or has been displaced in any way.

There are four tests that must be run for a patch test: latency, roll, pitch and Yaw. For best results, patch tests should be carried out when conditions are calm and vessel motion is at a minimum. It is important to have good vessel handling as the reciprocal lines need to be as close possible. Deeper water is preferred as the misalignment angles will be more apparent. Positioning should, at a minimum, be SBAS corrected. However, it is strongly recommended that RTK corrections be used as positional errors will decrease the repeatability of patch test measurements. For processing patch tests refer to the manual of the chosen acquisition or processing software.



6.2 Bar Check

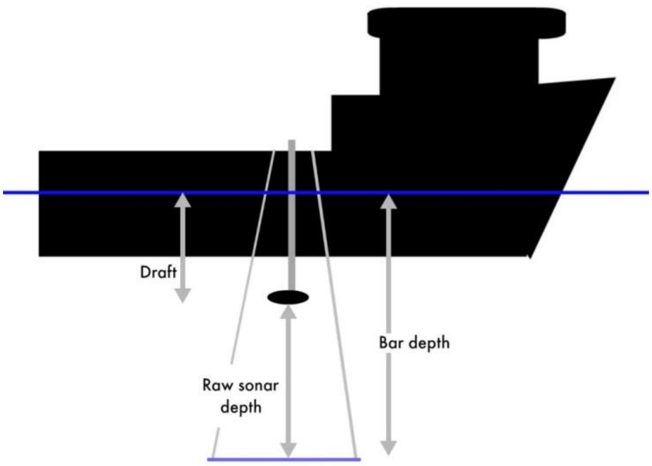
The bar check is a simple test that is used to verify that the draft corrections are holding constant. Periodic bar checks will help ensure that the system is stable and help account for changes in vessel loading. Bar checks are typically carried out using the Nadir beams to reduce the influence of ray bending due to sound velocity changes.

For best bar check results, NORBIT recommends that the WBMS be set up with the following configuration:

- Set **Adaptive Gates** to **Off**
- Set ping rate to **Fixed 3 Hz**

To conduct a bar check, an apparatus, that will reflect sound, must be lowered below the sonar to a known water depth. When the object becomes visible on the GUI a depth reading should be taken. This raw reading will be the depth below sonar head. The measurement should be corrected for the predefined draft of the sonar. For example, if the bar depth is 3m and the sonar head has a draft of 1m the depth below sonar head will be 2m and when the 1m draft is accounted for the multibeam measured depth will match the bar depth. If the corrected depth does not match the bar depth further investigation may be warranted.

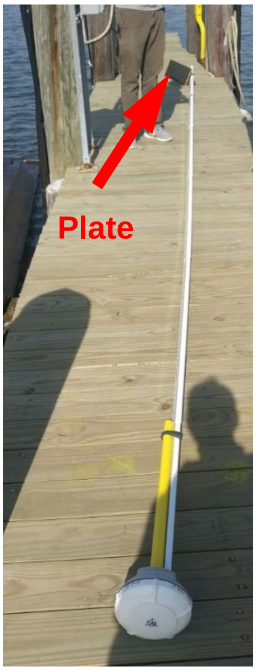
A bar check apparatus can be made from a metal plate secured so it will hang level in the water. The depth of the plate is measured from the face.



6.3 Surface Sound Speed Verification

It is good practice to periodically verify the reading from the surface sound speed probe. This can be completed by comparing the readings from the surface probe to the reading from another sound velocity probe. If comparing to a sound velocity cast be sure to select a reading that is as close to the draft of the sonar as possible. It should be expected that the two readings be within 1m/s of each other. Should this not be the case further investigations may be warranted.

6.4 GNSS Independent Plate Check



To ensure that all systems are operating properly and to verify offsets a Seahorse plate check was performed. The plate check consists of a metal plate attached to a fiberglass survey rod approximately 1m from the bottom of the rod.

The rod is then extended and an independent GNSS rover antenna is placed at the top. The measurement from the GNSS antenna to the plate is taken and placed as the antenna height in the rover. The rod with the attached plate and GNSS antenna is lowered into the water so that the plate is visible within the sonar wedge.

At the same time, GNSS measurements are taken from the rover and NORBIT data is recorded. The elevation of the rover shots and the final processed elevation of the soundings is then compared. If all sonar equipment is functioning properly and the offsets have been measured correctly then the final difference should be within 1-2cm and often better.

The elevation of the plate, determined by the GNSS rover, can use the same base station as the NORBIT. However, using a different base station can add another level of independence from the sonar system. This can even help check that the base station you are using for the sonar is sending out the proper corrections.

7 Dual Head Configuration

The WBMS systems provide high-resolution data in single-head mode. However, for shallow water applications where survey speed and efficiency need to be maximized, NORBIT provides a dual head solution that is extremely simple to set up and use. Especially in shallow waters, NORBIT's dual head solution will yield swath coverage of up to 25 times water depth enabling surveyors to collect data very quickly and efficiently. Alternatively, two heads may be employed in downward looking orientation where one head is mechanically or electronically pitch steered for a multi-ping operation for increased along track sounding density.

If a SIU-I-NAV (an integrated SIU, part no. 29028) is used, the secondary sonar can be connected to the same SIU via the auxiliary port. For SIU versions 29028-4 and older, the power supply unit will require an upgrade to power two sonars. Please contact NORBIT if you have questions about upgrading your system for dual-head readiness.

Example dual-head configuration with two iWBMSc 1° systems. Dual-head bracket and mounting pole sold separately

However, if **two** SIU-I (stand-alone SIU, part no. 29024) are used with a third party IMU, the primary sonar should connect to one SIU and the other sonar should connect to the second. Please note that if two SIU-I are used, timing in the form of a ZDA message and PPS over BNC must be supplied to both sonars. In addition, a TTL sync cable must be used between the two SIUs contact NORBIT support if you require this cable.

To set up a dual-head system the sonars can be mounted on a dual-head bracket, sold separately by NORBIT. Please refer to the Dual Head Bracket section for a detailed schematic or contact NORBIT Support for more information. Alternatively, each sonar can be attached to a single-head bracket and mounted over each side of the boat. While this configuration may be more difficult to implement than utilizing a dual-head bracket, the wider separation will provide additional coverage.

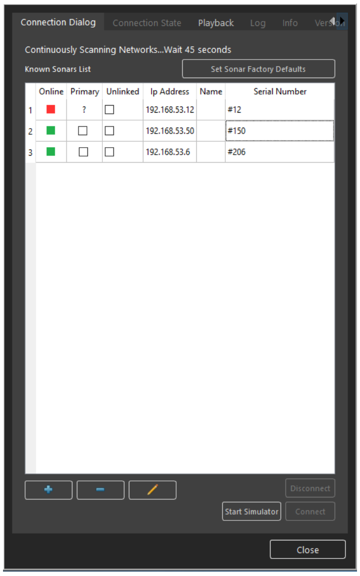
⚠ **NOTE: Dual Head Offsets**

When setting up an iWBMS in a dual head configuration IMU rotations and offsets will change. For further information on this please refer to the NORBIT tilted sonar technical note (document TN-190018) and/or the NORBIT Dual Head Quick Start Guide. If you do not have this document, please contact NORBIT support.

7.1 Installation Guide

The following guide provides instructions to set up a dual-head system.

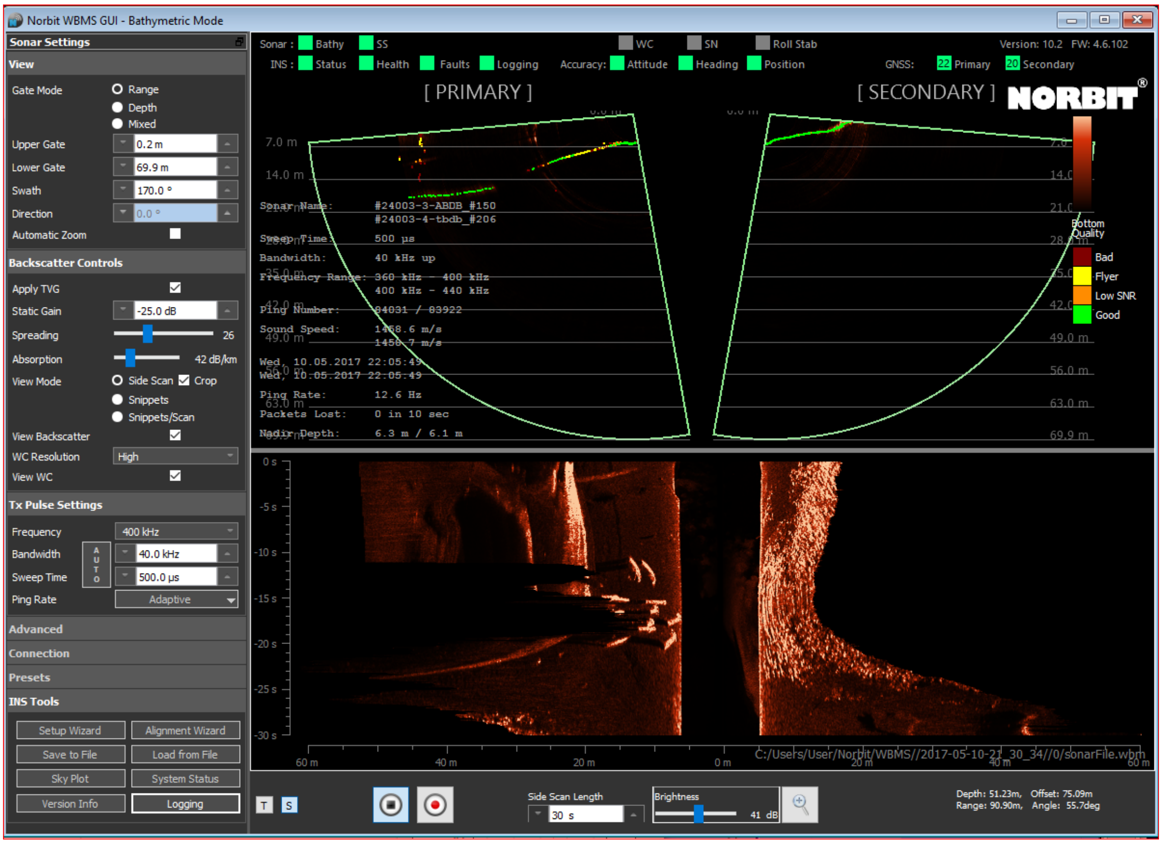
1. ***Bracket and Mount:*** Decide whether to use a dual-head bracket (sold separately) or two single head brackets mounted over the side of the boat. Make an installation plan as recommended in Section 2.5.1. Attach sonars to the desired bracket(s) and follow installation plan.
2. ***Power:*** If a SIU-I-NAV is used, it must be supplied with 24VDC. If two (stand-alone) SIU-I are used, each will need 12VDC. The standard power brick provided with a single head system does not provide enough power for a dual head configuration. Please contact NORBIT support should you require a larger power supply.
3. ***Antennas:*** As with the single-head, install antennas as recommended in 2.8
4. **Cables:** Secure, direct and connect all cables to the SIU, ideally located next to the acquisition and control computer. The sonar cable of the second system can plug into the Aux port of an iSIU.



5. ***SIU & PC:*** Connect the SIU to the control and acquisition PC via ethernet. Before powering the sonar set the IP address of the PC to **192.168.53.XXX** where XXX can be any number from 101 to 255 except 100 which is reserved for the GNSS/INS or the last two digits of the sonar serial number; set the subnet mask to 255.255.255.0.
6. ***GUI:*** Install the WBMS GUI and, with the SIU powered on, run the GUI to detect and communicate with the sonars. On the **Connection Dialog**, select the two sonars and select the **Primary** sonar. Click **Connect**. The example on this page shows an instance where the GUI detects two sonars (indicated by green LED) and has the IP address of a previously used, but disconnected system (indicated by red LED). In this example, the user must select the two detected systems, then check the **Primary** selection on the desired system, then select **Connect**.
7. ***Sonar Controls:*** Once connected, two swaths appear in the main GUI display with the primary sonar appearing on the left, as shown in the example. Thus, visualization is more intuitive if the primary sonar is installed on the port side. The primary and secondary swaths are labelled on the display as such. If side scan is enabled, the image displayed is that from the two sonar systems combined. Adjust sonar parameters as needed and start collecting data. Any changes made to the sonar settings menu apply to both systems. The controls for dual head remain the same as for single head. For more detailed explanations of all sonar functions and controls, please refer to section 4.6. It is highly recommended that users change the sonar Tx bandwidth to 40kHz (for each sonar) since they are optimized for a **total** bandwidth of 80kHz.

⚠ **NOTE: Port Number Assignments**

In the acquisition software, the port number is **7000** for primary and **7001** for secondary, by default. The secondary port is always one greater than the primary. Some software packages give the option to select one head as primary and one as secondary. In this case both heads will be primary.



7.2 Frequency Separation

For dual head sonar operation, the transmit frequencies of the two sonars must not overlap. When 2 sonars are selected the NORBIT GUI automatically applies a frequency separation to the sonars. This separation is determined in the following way. When a center frequency is selected that GUI will choose a bandwidth, by default, of 40kHz. For instance, when 400kHz is used with the default bandwidth of 40kHz, the sonars ping through a total frequency range of 360kHz-440kHz, with one sonar pinging a range of 360kHz to 400kHz, and the second sonar pinging from 400kHz to 440kHz. This allows the sonars to ping in sync without interference.

If you wish to change the frequency spread, you can do this by simply adjusting the bandwidth. The closer you put the bandwidth to 80kHz the more frequency overlap will occur. If you desire to operate the sonars individually you can simply unlink them. To control a sonar, click on the wedge associated with the desired sonar and adjust the settings as required.

8 Optional Enhancements

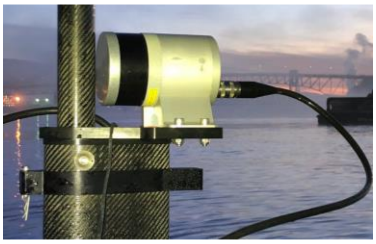
While the integrated family of NORBIT systems are already highly capable, NORBIT offers additional products that further enhance their capability. These optional enhancements can be easily integrated into the existing iWBMS(x) systems. For additional information, please contact NORBIT.

8.1 Obstacle Avoidance Forward Looking Sonar (FLS)

NORBIT's FLS is a wide beam angle sonar that can be mounted pointing up and looking forward. This configuration was developed to aid surveyors in obstacle avoidance and marine feature monitoring in especially difficult navigational conditions. The additional sonar is plugged into the AUX port on the SIU, simplifying the hardware setup. Please contact NORBIT to learn more about the FLS.

8.2 Integrated Topographic LiDAR (iLiDAR)

For users that require topographic data to be acquired in conjunction with multibeam data, NORBIT offers the iLiDAR. The iLiDAR plugs into the AUX port of the iSIU. Like the iWBMS systems, all timing and power is handled internally, eliminating the need for additional cables. The LiDAR is as close to plug and play as possible. The LiDAR uses 16 beams allowing for up to 300,000 points/sec to be collected simultaneously with multibeam data, while still only requiring a single network cable from the SIU to the acquisition PC.



8.3 Carbon Fiber Mounting Pole (PORTUS)

For users that frequently travel with their system and utilize vessels of opportunity, NORBIT offers the PORTUS Pole. This carbon fiber mount easily packs down into one hard ski case and can be checked with your NORBIT system onto nearly any commercial flight. The PORTUS easily mounts to nearly any small vessel of opportunity, and with known dimensions there is no need for the surveyor to worry about calculating offsets.

9 Troubleshooting

9.1 Troubleshooting Tools

For some troubleshooting, having the right tools greatly speed up the ability to solve the issue. For NORBIT systems, methods for interrogating serial and network connections are two of the most useful software tools.

For interrogating serial data, it is recommended to use 3rd party software. NORBIT recommends using PuTTY, a free 3rd party telnet and SSH implementation for Windows. See section 9.1.1 for instructions on using PuTTY

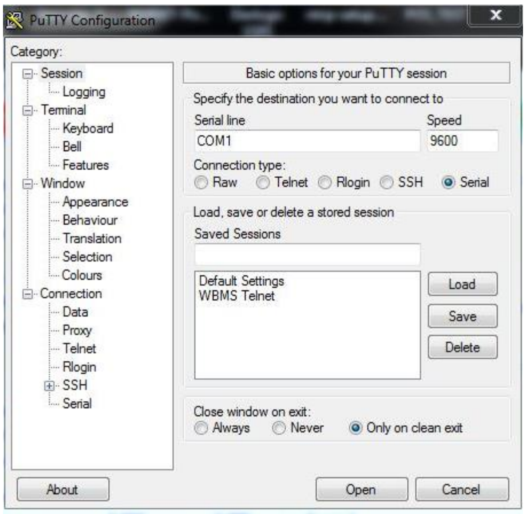
For Network Troubleshooting: The most common tool needed for the NORBIT is the "ping" command executed using Windows command prompt. This command pings or checks the input IP address and tests if a connection is present. This is useful for verifying whether NORBIT is communicating with the PC and indicates whether the problem may be somewhere else down the line. Should further investigation be needed, Wireshark is a good networking troubleshooting tool and can be downloaded for free. For HYPACK, users Wireshark can be found in: C:\HYPACK 2014\Support\Utilities\

To Use the Ping Command: Open Command Prompt window by typing `cmd` into the Windows search bar. In the command prompt type `ping 192.168.53.XX`. This example shows how to verify the connection of the sonar to the computer. Keep in mind that the last 2 digits correspond to the last 2 digits of the serial number of the unit in question. This also works for the internal Applanix INS by typing `ping 192.168.53.100`.

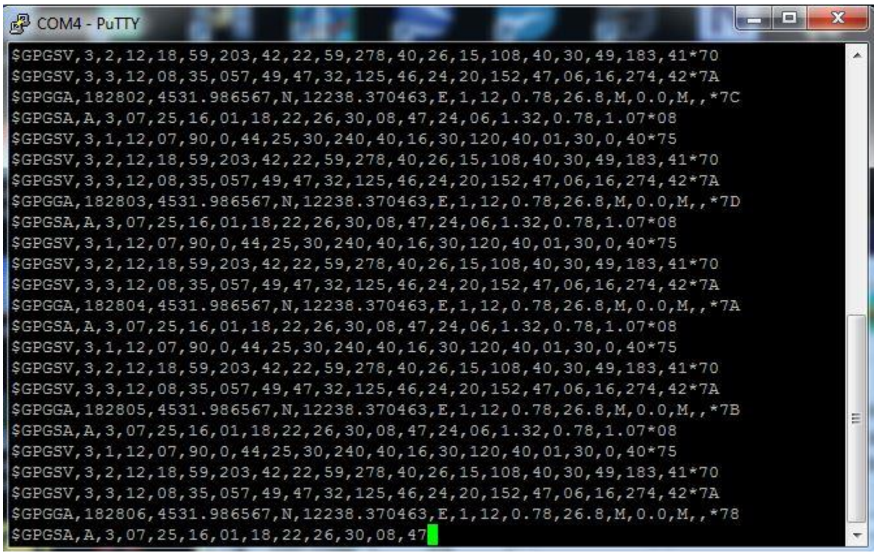
To troubleshoot hardware issues, it is recommended that users have a digital multimeter on hand. Multimeters are inexpensive and can be purchased at most electrical or hardware stores. Please make sure that it includes a continuity test function. Some units have an audio indication for this test. The two most useful functions for troubleshooting sonars are the continuity test and voltage indicator. The continuity test helps identify broken cables or connections, while the voltage indicator helps identify power related issues.

9.1.1 Configuring PuTTY for Serial Interrogation

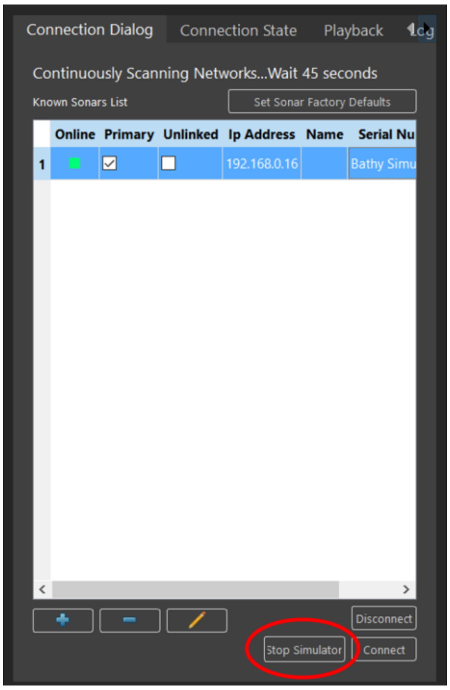
Begin by changing the connection type to serial. Type in the relevant COM port number and expected baud rate, referred to as **Speed** in PuTTY. Once the connection parameters have been entered, click **Open**.



PuTTY then opens a command-style window and displays any data incoming on the specified port. The example below shows several NMEA messages arriving on COM 4:



9.1.2 Sonar Simulator



For training and certain troubleshooting scenarios, NORBIT provides a sonar simulator that sends simulated data to the standard GUI. The simulator is currently only for sonar data and does not output simulated navigational data.

The simulator can be started via the Connection Dialog. Press **Start Simulator**. Once started, highlight the bathy simulator on the sonar list and click **Connect** as you would do with a standard sonar. You may receive an incompatible firmware warning; ignore this and click **Connect Anyway**.

To start the simulated sonar data, click the play button. The simulator data can be used in acquisition software for testing, training or troubleshooting purposes. The simulator does not output sound velocity, navigational or inertial data. Consequently, the simulated sonar data will not be time stamped.

To close the simulator, simply shut down the GUI. If you wish to switch back to a real sonar, return to the Connection Dialog and select it.

9.2 Symptoms & Suggested Actions

Following is a table that should facilitate troubleshooting of common problems:

Problem	Possible Solutions

Cannot connect to the sonar	• Verify the SIU is powered on • Check that cables connections are free from corrosion and are properly secured • Check for bent pins on sonar cable • Check for IP address conflicts. The network card on the PC should be configured to 192.168.53.XXX where XXX is neither 100 (INS) nor the sonar serial number. • If using a network switch, bypass the switch and connect directly to the computer to check for faults with the switch. • Reboot PC wait 30 seconds, then power-cycle the SIU. • Ping the sonar to check connection. • Try grounding the SIU
WBMS is connected but no IMU data is coming in	• Check cable connections and reseat if necessary • Check for bent sonar cable pins • Possible IP address conflict. Check network settings • Windows Firewall is preventing connection, allow POSView access through firewall. Can still be the problem if firewall is off. • Possible damages sonar cable • Try grounding the SIU
WBMS GUI does not match description in this manual or software not performing as described in manual	• Obtain the latest installation version from NORBIT support: subsea_support@NORBIT.com and install.
IMU is connected but there is no sonar connected	• Check cable connections reseat if necessary • Possible IP address conflict. Check network settings • The GUI and BathyProxy should be allowed in windows firewall. • Try grounding the sonar
Surface SV sensor is not connected or is showing bad values	• SV sensor is not tightly secured to the head leading to faulty connection; tighten up the SV probe to the head. • Trapped air bubbles are changing sound speed. Stop the vessel to allow bubbles to dissipate to see if reasonable values return. May need to adjust mounting to reduce bubble formation • Inspect the sensor for visible damage. Any distortion in the sensor may cause bad readings. • Check for foreign object stuck on sensor.
Sonar display is freezing, and data packets are being dropped	• May be due to heavy network traffic; run Task Manager to check if any unnecessary programs/processes are taking up excessive network bandwidth • Bad switch, hub or cable. Replace. • May need to manually update computer network card driver
Network disconnection errors occur or data from sonar and/or IMU is dead	• Check the sonar and/or IMU cables. Check that the connection at wet-end is tight. If it has loosened then remove connection, clean threads at both male and female fittings and apply a very small amount of grease (O-Ring grease mentioned in this manual works well) then re-tighten. If fingers are weak from cold, then use a tool but **do not overtighten!**
Unable to get RTK correctors	• Check COM port settings • Check cable connections • Verify IP address and mount point if using network solution • Check radio link • Try with Null Modem • Check on a different unit to see if data is legible

Soundings are being filtered out	• Adaptive gates are on Narrow and may need to be changed to a wider setting • May need to turn adaptive gates off.
Bottom detection quality is degraded	• Check sonar head for marine biofouling. Clean barnacles off gently. • Check that sonar cable connectors are clean, dry and properly seated.
Lower Gate is beyond expected depth but there is no bottom detected or soundings look like a large hump	• Try lowering the upper gate closer to the expected bottom.
Unable to get GAMS Calibration to lock in	• Check antenna connections ensure that the antennas are plugged into the correct primary/secondary sockets. • Verify offset measurements • Reset POS to factory defaults and start configuration over • Area/Time may have bad GNSS. Relocate and/or wait for better GNSS window
No GNSS Data in INS System	• Check cables and ensure that connection is tight on the SIU and antennas • Make sure that the antennas provided with the kit are used. Other antennas may cause issues • Make sure antennas have clear view of the sky and not obstructed by metallic objects, etc.
System status shows faults	• Check that cables are secure and tight • Check for bent pins on the cable and SIU • Low quality power supplies may cause this issue. Change the power source to see if this fixes issue. • Possible damaged sonar cable. • Try grounding the SIU
NovAtel Connect will not connect on port 3001	• Connect on a different port 3002 or 3003 and apply FRESET and reload the batch file.
NovAtel data not read in acquisition software or acquisition software crashes	• Check that there is not port interference. Connect and acquisition software should not be connecting on the same port number.
INS window in NovAtel connect displays no data or crashes connect when open	• Update video drivers on computer.
There is data in NORBIT GUI and INS GUI, but data is not coming into acquisition software	• Ensure that both sets of firewalls (Private and Guest or public networks) are turned off. • Check to see if acquisition software has correct ports specified.
There is no timing in the sonar. GUI timing line is red	• Check pins on cable and in SIU. If a pin is bent VERY gently bend it back. *This may result in damage so do so at own liability* • If cable is good check that INS is outputting ZDA and PPS pulse • Besides the onboard GNSS cards, users can obtain reliable NTP timing from the QINSy time server. Another recommended source of external, free third-party timing server is Meinberg. Another option is to use the QINSy SNTP server, which does not require license. Open

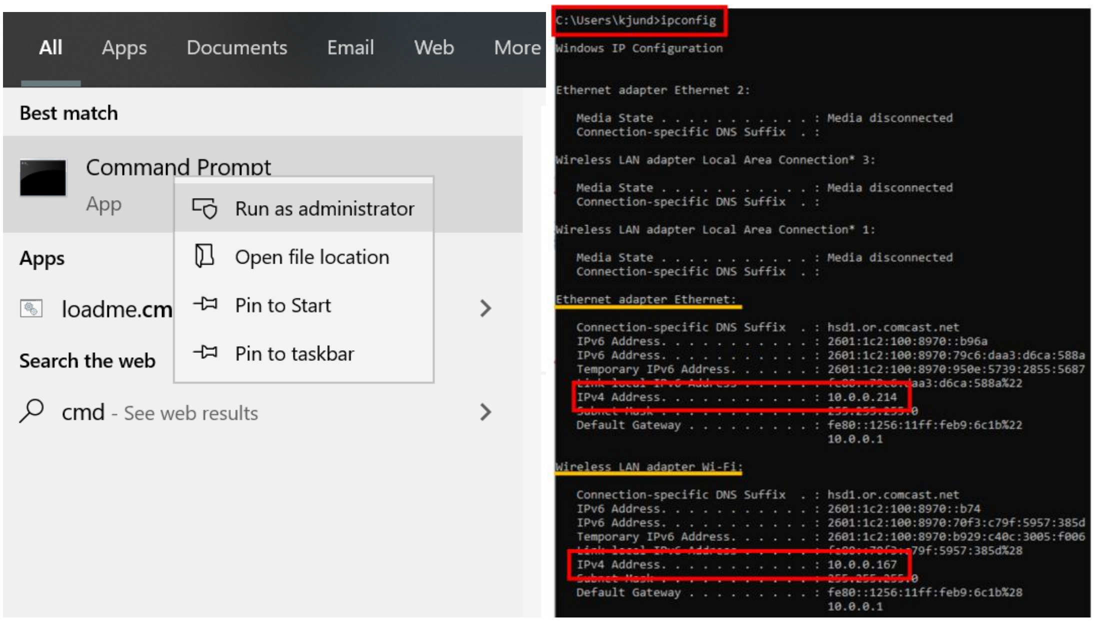
		QINSY, double-click SNTP Server – this should automatically start the server. If not, the user may have to change (UDP) port in the Options menu inside SNTP Server. Once server is running, go to the NORBIT GUI and go to **Advanced** > **Options** > **Timing and Triggering**, select **NTP+PPS pos**, select the proper IP and click **Apply**.
"Sonar timing incorrect" pop-up window remains even after antennas pick up satellites	•	This may happen sometimes if the POS MV reboots slower than the sonar. You can manually close the pop-up window in this case. If sonar timing is incorrect, the timing row in the main GUI display will remain red.
iWBMSc has incorrect heading after powering up	•	Restart the SIU. Make sure vessel has some motion during alignment process. See NovAtel section of this manual for further information.
No NORBIT data in PDS or EIVA	•	Ensure that force push is checked under **Connection** settings in GUI.
Smears appear in the snippets record	•	PC load is too high, and it is unable to properly process the high data load. Try reducing PC load by closing unused programs and non-critical windows in the acquisition software. Older slower computers may not be able to handle the data load and a newer computer may need to be used.
Text in GUI appears too cramped	•	In Windows, go to Change Display Settings, and change the Scale and Layout values; more specifically, change the value under "Change the size of text, apps, and other items"
INS Logging light it Red or Orange	• • •	Open **INS Setup Wizard** and apply **Factory** defaults Reboot PC Turn off firewalls.

9.3 SIU Grounding

In some cases, the SIU may need to be grounded for proper operation. Some symptoms of possible grounding issues are, IMU failures, sonar boot up issues. If you do not see a grounding screw on the SIU, NORBIT advises that you use the BNC connection. To ground the system, find a BNC cable and break off the pin inside the connector. On the other end expose the ground shielding, using the outer braid of wires and crimp a connection to them (see below image). Connect the BNC connection to the SIU and the other end to either a metal part of the vessel or a wire that is in the water.

9.4 Finding the Computer IP Address

To find the IP address of the PC operating the NORBIT GUI, open command prompt from the Windows Start Menu and then type `ipconfig` and press enter. Then search for the IPv4 IP address. Depending on what type of connection is present, either look for the wired or wireless IPv4 address. Note, you may need to run command prompt with administrator rights (right-click and select **Run as administrator**).



9.5 Change Sonar IP Address

Log onto the sonar with telnet. To do this, press **Windows+R** to open the **Run** dialog. Type `cmd` to open command prompt, then use the following commands:

`Telnet 192.168.53.XX` (where XX is the last two digits of sonar wet-end serial number)

Print to screen all u-boot parameters:

`fw_printenv`

Options:

`fw_printenv ip_addr` (print to screen all ip_addr parameters)

`fw_setenv ip_fallback 192.168.53.99` (sets IP to 99 if no DHCP server is on the network)

`fw_setenv ip_addr 192.168.53.99` (sets static IP to 99 regardless of DHCP)

9.6 Cable Covers

The sonar cables (and IMU cables for the integrated versions) include a protective cap affixed to the cable with an adjustable length cable. The length may be adjusted by grabbing one of the small collars and pulling on the cable.

9.7 Data Quality Control Checklist

The manual details procedures for optimizing NORBIT sonar performance. However, if some simple steps are skipped or not followed closely users may encounter data degradation. This section provides a brief checklist and options to enhance data quality.

Checklist to improve data quality:

1. ***Review Hardware Installation:*** Ensure that the two antennas remain fixed in place relative to each other; otherwise there heading errors are present. Similarly, the position of the primary antenna relative to the IMU should not change; such motion will cause position errors in soundings.
2. ***Primary Antenna:*** Ensure that the primary antenna is closest to the IMU and connected to the correct port.
3. ***Offsets:*** Measure offsets correctly to the nearest 1cm or better, and check that the signs are correct.
4. ***Alignment:*** Ensure that the sonar (and IMU if separate) is closely aligned with the vessel centerline (keel). Agreement to within ±0.5° is ideal if the sonar and IMU are within 5m from one another.
5. ***Center of Rotation:*** If the IMU is not mounted at the CoR, it is important that the processing software corrects for vertical motion using the CoR offset lever arm with roll and/or pitch tilt as the heave sensor is less accurate than this. The heave should only be used to determine the vertical displacement of the entire survey platform.
6. ***GNSS Corrections:*** Only Narrow Lane RTK is suitable for RTK tides. Position errors increase with distance from the base station. DGNSS is accurate only to about 60cm horizontally. Ideally use a post-processed kinematic solution. There are different options depending on the GNSS equipment used during survey.
7. ***Surface Sound Speed:*** This may differ greatly in the upper 1m surface layer of the water column. If this difference exists (check with a profiler) then, if possible, lower the sonar below this layer boundary, but not so deep that the sonar pole cannot be controlled. Generally, 1m is the limit. Compare surface sound speed from the WBMS with the sound velocity profile at the draft depth. These speeds should agree within 1-2m/s.
8. ***Sound Speed Profiles:*** Should be taken as often as the changing conditions dictate. For instance, once per day may be suitable in non-tidal areas of a river or lake while once every 500m, or 1-2 hours, may be required for some regions where water temperatures vary greatly.
9. ***Patch Test:*** Review multibeam roll, pitch, yaw and latency offset values. Repeat measurements as and when required. Generally, during a single installation, roll should not vary by more than ±0.02°, pitch by ±0.1° and heading by ±0.5°. Conduct a patch test every time the sonar and IMU are moved.
10. ***Swath Angle:*** Bathymetric soundings are most accurate if they are within a ±70° area from nadir (depending on water depth), or wider if the beam footprint and incidence angle are very small, e.g. when the swath is perpendicular to a steep shoreline sloping up from nadir. Soundings sloping down from nadir have a large footprint and incidence angle. It is always better to 'look' up a slope than down one and therefore survey lines should generally be parallel to the bottom contour.

9.8 Sonar System Diagnosis

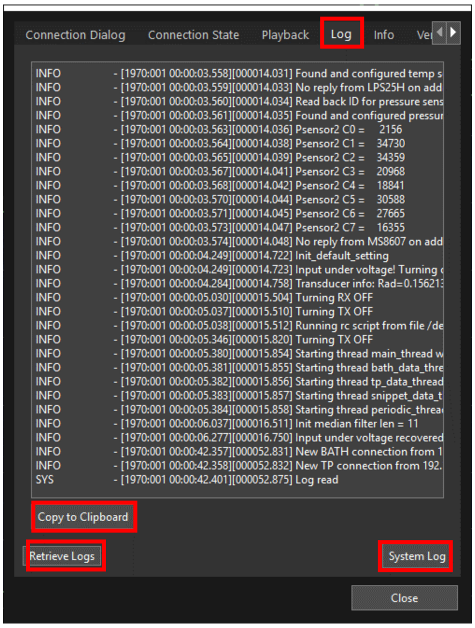
In case of technical difficulties with the iWBMS system, users should refer to the guidelines below. **If possible, please have TeamViewer (or similar remote desktop control application of choice) installed and ready to run, to allow NORBIT Support to control the system remotely.** This section explains how to diagnose sonar-related issues, while the following section discusses Applanix-related problems.

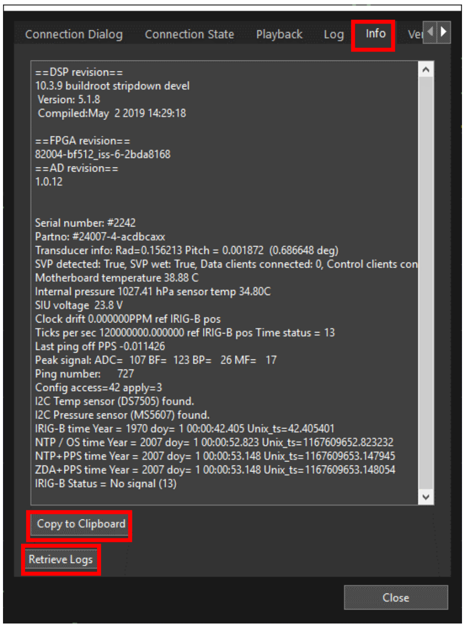
In case the sonar starts to function erratically, NORBIT support will advise the user to perform diagnostic checks, including, but not limited to the following:

1. ***Verify IP Address of Acquisition/Control PC*:** Should be 192.168.53.XXX, with XXX being greater than 100 and less than 255. The system subnet mask should be 255.255.255.0.
2. ***Verify Power Supply:*** If WBMS GUI fails to connect to or detect hardware, first check if the system is powered on. If so, check the power supply voltage with a voltmeter. Also,

depending on the power source, check the battery/inverter for failure. Check the sonar SIU LED and power supply to the SIU; a faulty power supply prevents proper connection to sonar, and/or IMU faults. If power is <12V or >28V the power LED will blink at 5Hz. It may be necessary to employ an alternative, preferably known power source to test the system, e.g. power the sonar from a wall outlet or fully charged battery. If this step is not possible, go to the next step.

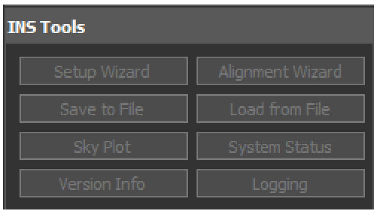
3. ***Command Line Ping:*** To test connectivity to the sonar, open Windows Command Prompt and type `ping 192.168.53.XX` (XX being the last 2 digits of the sonar serial number). This indicates whether the sonar is detectable by the acquisition PC
4. ***Factory Reset:*** If the sonar is detected in the GUI, go to **Connection** > **Sonar Connection** and click **Set Sonar Factory Defaults.** Wait a few minutes to see if the connection is re-established.
5. ***Socket Pins:*** Turn off power and check all cable and SIU sockets for bent pins.
6. ***NORBIT GUI Recording:*** For issues visible in the GUI display, send NORBIT Support a small recording that shows an example of the problem. Please enable water column ("View WC") in the NORBIT GUI and include it in the recorded display.
7. ***NORBIT Logs:*** If possible, send NORBIT Support the following information in an email or document:
   a. In the GUI, go to **Connection** > **Sonar Connection** > **Log**. Select **Retrieve Logs**, then **Copy to Clipboard,** and paste the contents to a document or email. Do the same for **System Log**.
   b. Go to **Connection** > **Sonar Connection** > **Info**, select **Copy to Clipboard** and paste the contents to a document or email and send it to NORBIT Support.





   c. Should the user see other error messages, whether in Windows or the GUI, screenshots should be taken, saved, and emailed to NORBIT support for reference.

9.9 Applanix INS Diagnosis

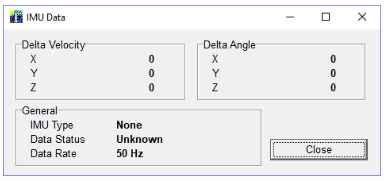


1. ***Check Timing:*** If there are no timing issues ignore steps 1-3. If timing is incorrect, check the Primary and Secondary GNSS indicators at the top of the GUI and go to **INS Tools** > **Sky Plot** to check if any satellites are detected, and if so, to what level of precision.
2. ***Confirm LED Status***: Check PPS LED on the SIU. If functioning correctly, it should blink at 1Hz. If satellites are detected but the PPS LED is not blinking at 1Hz, open POSView and check COM4 settings to check that it is outputting NMEA ZDA. For LED indicator statuses, refer to the table below.

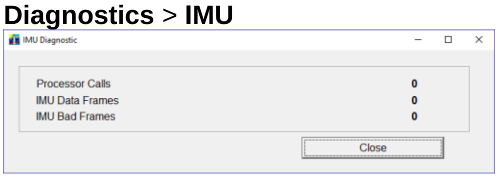
PPS LED Status	
Orange, blinking at 1Hz	Sync good
Orange, blinking at 5Hz	No sync, NMEA missing
Orange, steady	No sync, PPS missing
Off	No sync, NMEA and PPS missing

3. ***Inspect Pins:*** PPS LED is blinking at 1Hz, power off system and very carefully check for bent IMU cable and SIU socket pins. If you find bent pins, contact NORBIT Support for immediate instructions on how to fix them. If possible, please send pictures of the bent pins to NORBIT Support. Also check cable and SIU sockets for dirt and other unwanted materials that may interfere with the signal.
4. ***Physical Installation:*** For issues such as motion artefacts, let NORBIT support know if any changes were made to the physical setup (e.g. if sonar/antenna pole was moved). If possible, send pictures of the mounting configuration to NORBIT. The goal is to rule out any wobble in the physical setup. Also, ensure that primary and secondary antennas are no more than 2m apart. If they are not, heading accuracy may be compromised.
5. ***Check for Damaged Cable:*** If the check in #3 also passes, try gently turning and twisting the sonar cable to see if a damaged cable is causing the issues. If it is, the symptom may be reproduced by bending the cable at or near the damaged area.
6. ***Data Rate:*** In case of missing RTK signal:
   a. If using NTRIP, check the internet connection and the correct COM port to use in Windows Device Manager. Verify NTRIP login credentials, IP address, etc. Check Corrector type and verify that baud rates specified in NTRIP match baud rates in the NORBIT GUI **INS Setup Wizard**.
   b. If using a rover, if no RTK signals are received, check that the radio is transmitting, and that the receiver is tuned to the correct frequency and is functional. Verify that baud rates and corrector types match.
7. ***Screenshots:*** If the sonar is detected but the IMU is not, or an IMU Failure error is displayed, check cable sockets for bent pins. If all pins look fine, power the system on, open POSView and send screenshots of the main POSView display, as well as the following:

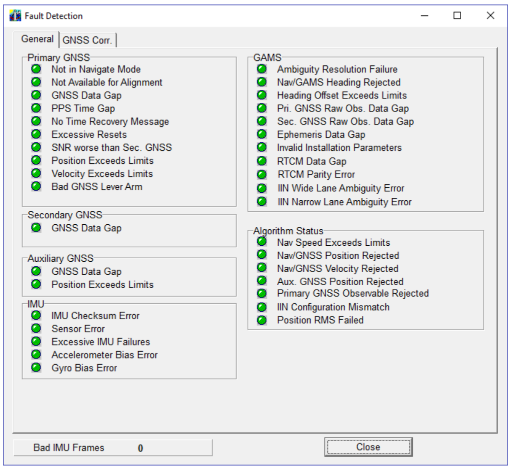
View > **IMU Data**



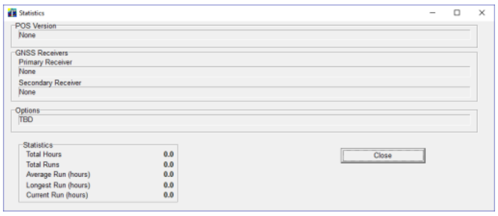
Diagnostics > **IMU**



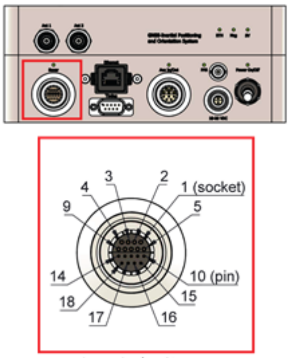
View > **Faults**



View > **Statistics**



8. ***Resistance/Continuity Test:*** If the IMU remains unresponsive or POSView shows IMU Failure, perform the "resistance test" to check the status of circuit components. A multimeter is required for the measurement of resistances across nine pairs of sonar socket pins. The illustration below shows the socket diagram and corresponding resistance when functioning correctly. Please measure the resistances and send the results to NORBIT Support.



Sonar Socket Pins

Pin A	Pin B	Ideal Resistance (Ω)
5	6	230
10	11	230
17	18	230
5	2	Between 10 and 100
6	2	Between 10 and 100
10	2	Between 10 and 100
11	2	Between 10 and 100
17	2	Between 10 and 100
18	2	Between 10 and 100

9. ***Factory Reset:*** For users of iWBMS(x) with Applanix inertial sensors, and NORBIT GUI 10.2 or later, if errors pertaining to the INS persist, attempt a Factory Reset. Go to **INS Tools** > **INS Setup Wizard** and select **Factory**. Then close the window.
10. ***Applanix/POSPac Recording:*** For motion, heading or position artefacts in the data, please send NORBIT Support a *.000 file for further diagnosis and troubleshooting.

10 Basic Acquisition Software Setup

10.1 HYPACK Setup for WBMS, iWBMS, iWBMSh, iWBMSe & iWBMSc

For sensors **not** supplied by NORBIT please contact vendor for integration instructions. The following sections show only one of many possible methods for configuring HYPACK 2017a for the NORBIT sonars. As with many sensor suite setups, this is certainly not the only method. The examples assume that the INS reference is collocated with the sonar reference location.

10.1.1 Offsets

By default, integrated NORBIT systems output all sonar and navigation data at the WBMS Reference Point (refer to the Offsets section for more details). Therefore, each device in HYPACK requires the same identical offset, that is the offset from Center of Rotation to WBMS Reference Point, assuming the CoR is chosen as the HYPACK reference point. If the optional iLiDAR is installed, this offset must be separately measured and applied.

Note that the HYPACK sign convention uses **+Forward**, **+Starboard**, and **+Down**. Incorrect entry of the sign may corrupt data. If depths need to be reported relative to the water level, please move the CoR height up/down to the appropriate level. Perform a draft or bar check to verify these values.

⚠ **CAUTION: For Integrated Systems, Sonar and INS Share Same Offset**
Offsets from CoR are required if the INS is setup as recommended in this manual. Referencing data to the CoR reduces heave inaccuracies by replacing the heave data with attitude-induced lever arm corrections.

About the COR: The COR, for larger commercial vessels, is documented in the vessel design plans. For other vessels, this point at which the vessel's roll and pitch axes intersect need to be determined. This is difficult to measure as the vessel CoR may change from day to day, and even during the day. Generally, choose a CoR location that is about ¾ distance from bow to stern, centered on the keel, and located at approximately water level. Especially for smaller vessels, the CoR moves depending on fuel stowage and even distribution of personnel body weight. For example, two persons sitting on the starboard rail of a 6m craft will move the CoR from the keel centerline a distance towards the starboard rail. Choose a location and attempt to keep the weight distribution constant throughout the survey. If in doubt, take the boat to open water and measure its motion while passing over waves in different directions.

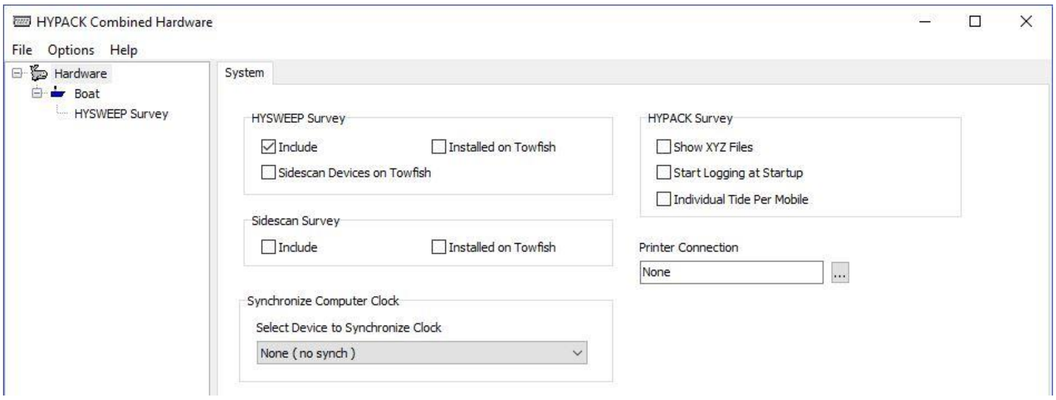
This example configuration places the INS reference at the sonar reference, i.e. the INS was configured to output values to the WBMS Reference Point. If users want to base bathymetric measurements referenced to the water level, the only other offset required is a water level correction. This allows the application of tide station water level corrections if required. The water level correction involves translating the CoR up/down to the water level and confirmed by a bar check.

The offsets shown will be different for every vessel. For this example, HYPACK2017 is used.

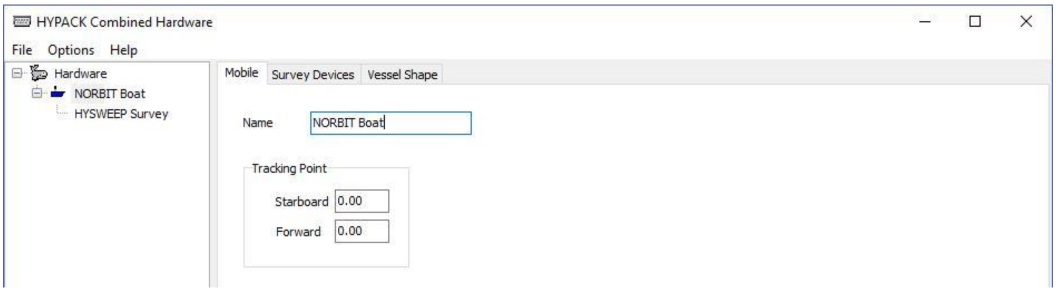
HYPACK 2017 configuration combines both HYPACK Hardware and HYSWEEP hardware into one interface. However, both sections must still be configured with the same drivers as in previous versions.

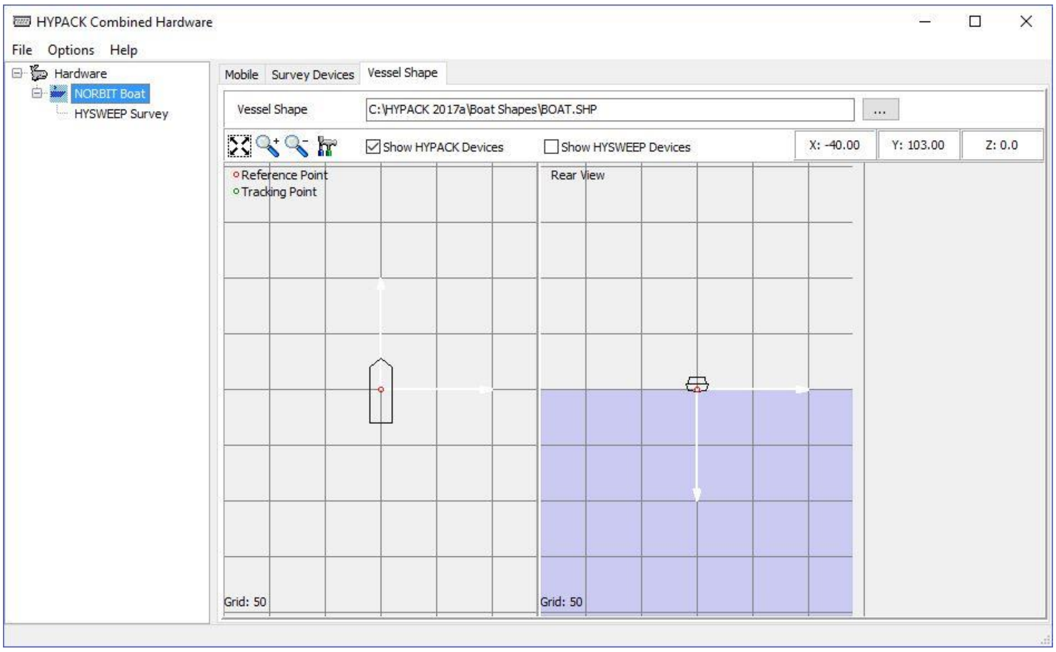
10.1.2 HYPACK Setup for WBMS, iWBMS, iWBMSh & iWBMSe

Step 1. Enable HYSWEEP Survey
Check **Include** under HYSWEEP Survey. This allows devices to be added for multibeam surveys.



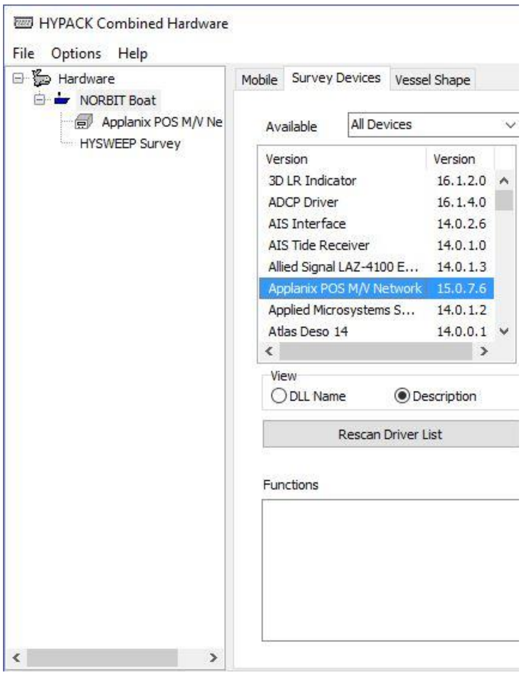
Step 2. Define Boat
Select **Boat** and give it a name. For more intuitive visualization, add a tracking point, preferably to the sonar reference point (for standard installations). Edit Vessel Shape as appropriate.

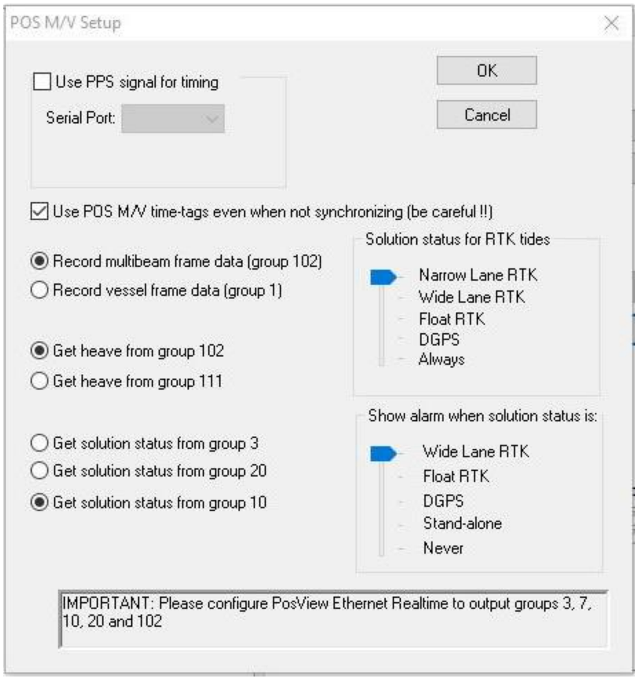


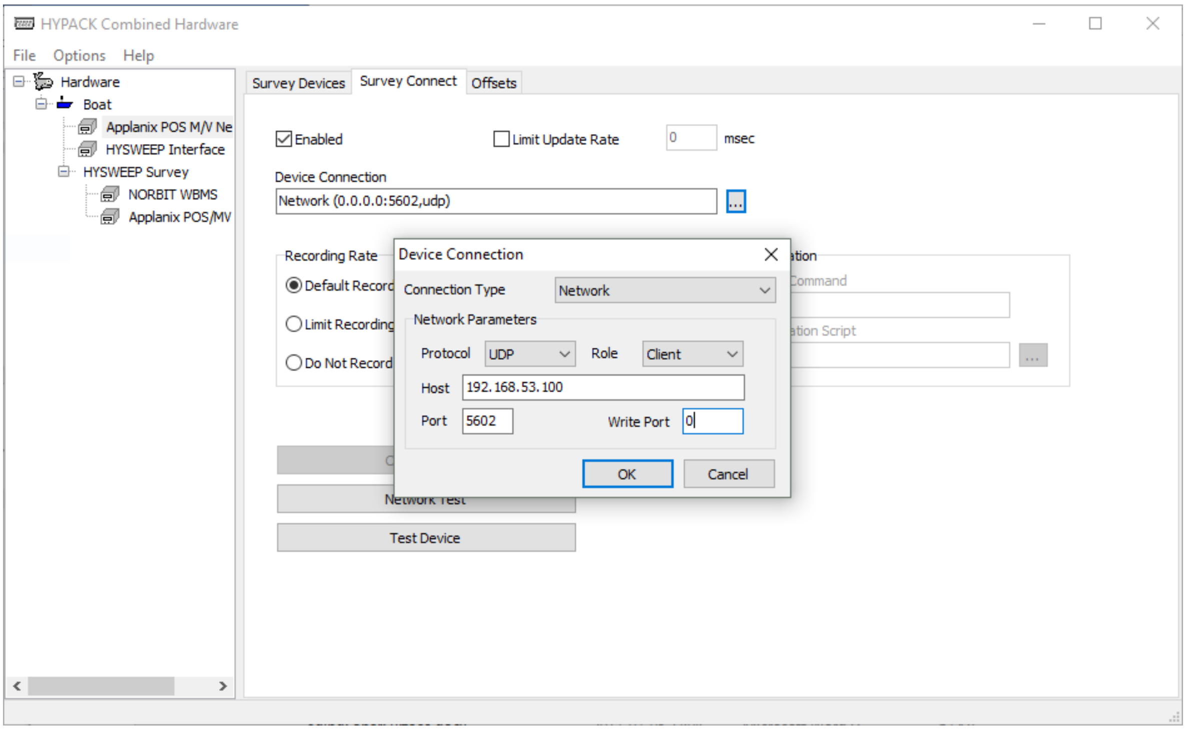


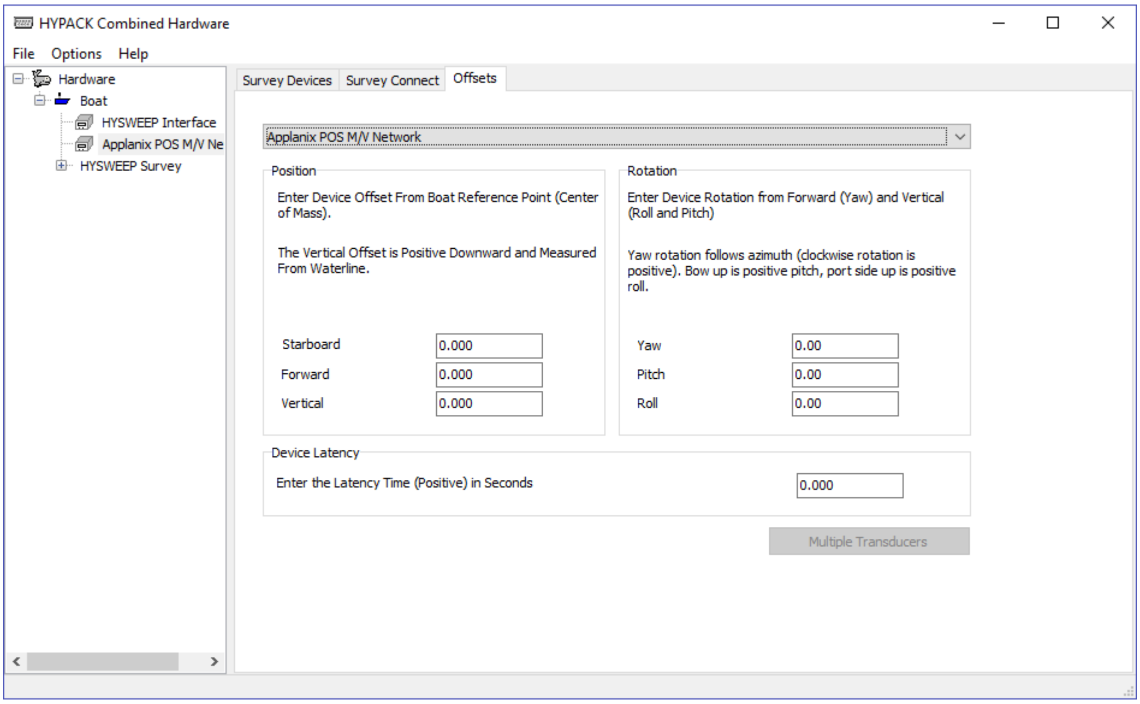
Step 3. Configure Position and Heading Device

In Survey Devices, add the Applanix POS M/V Network device and configure it as shown below.



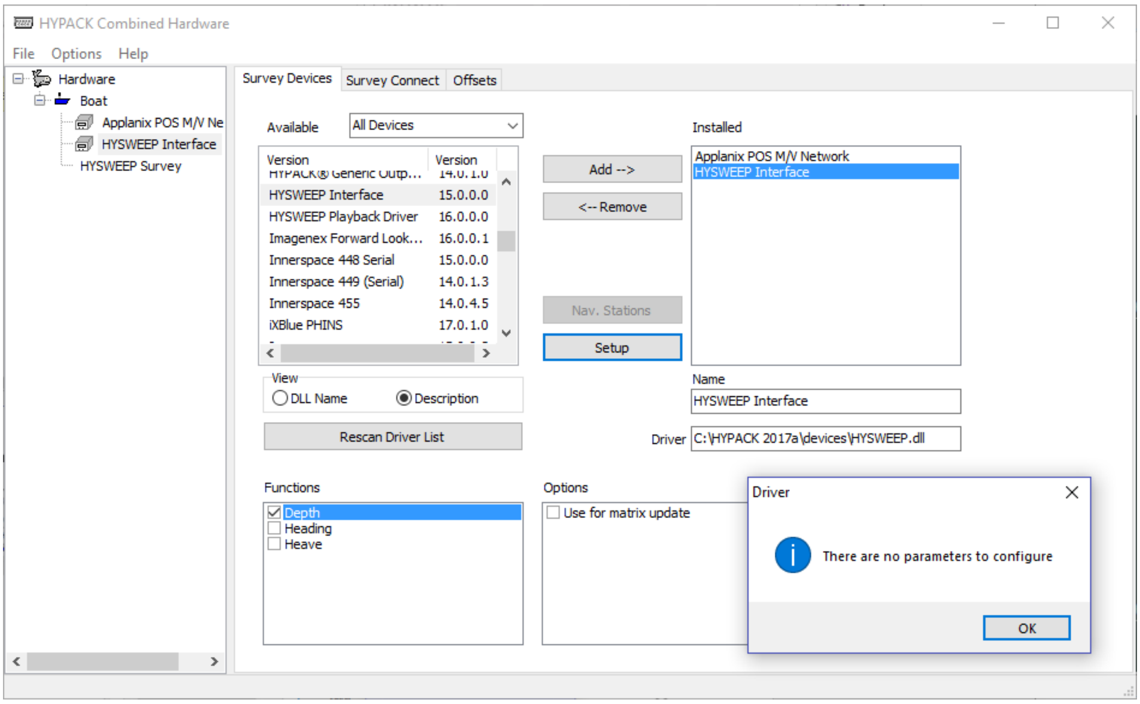


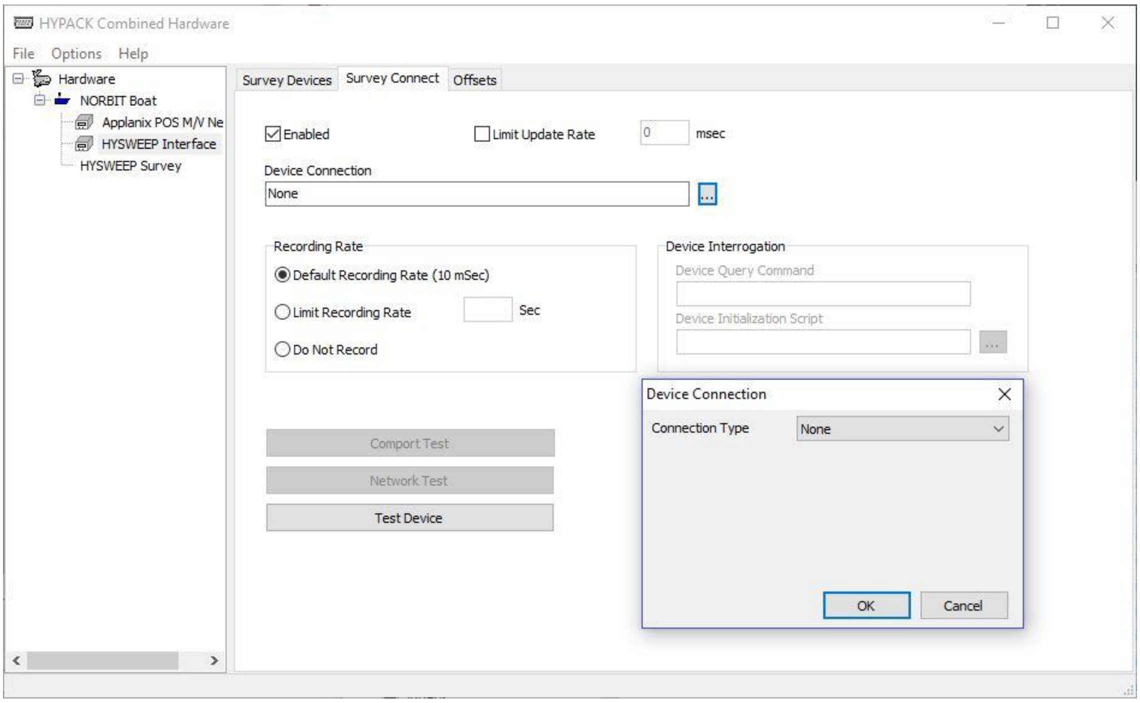


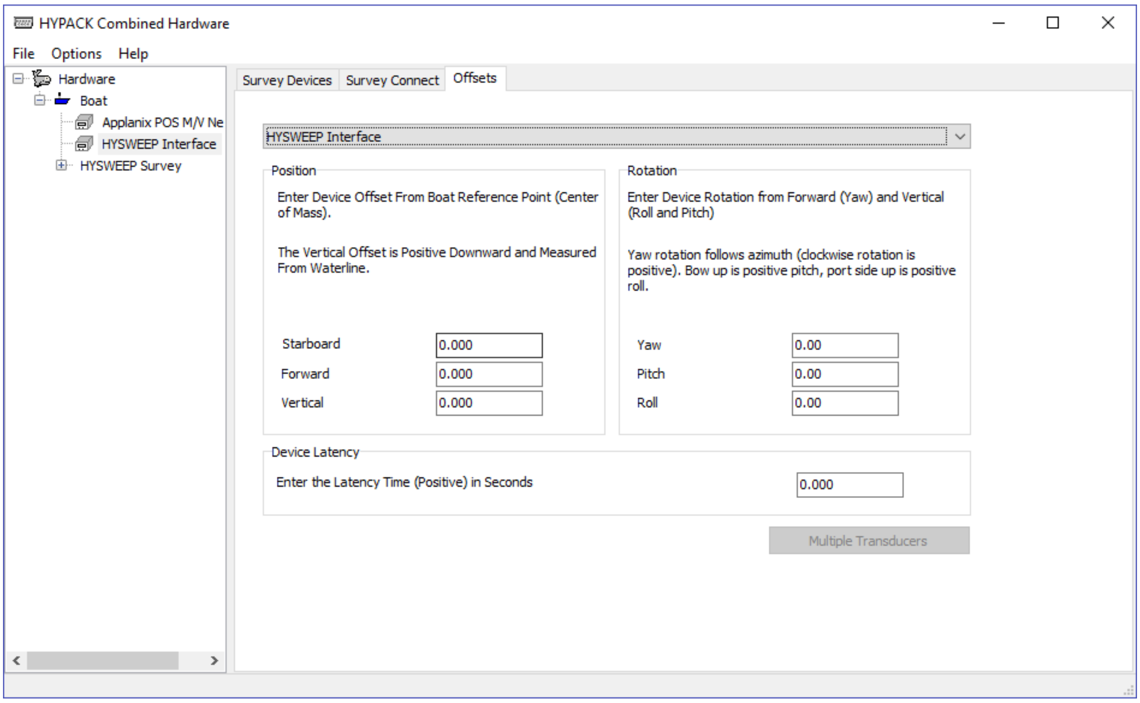


Step 4. Configure HYSWEEP Interface

Then add, and configure, HYSWEEP Interface, checking only the Depth function under Functions:

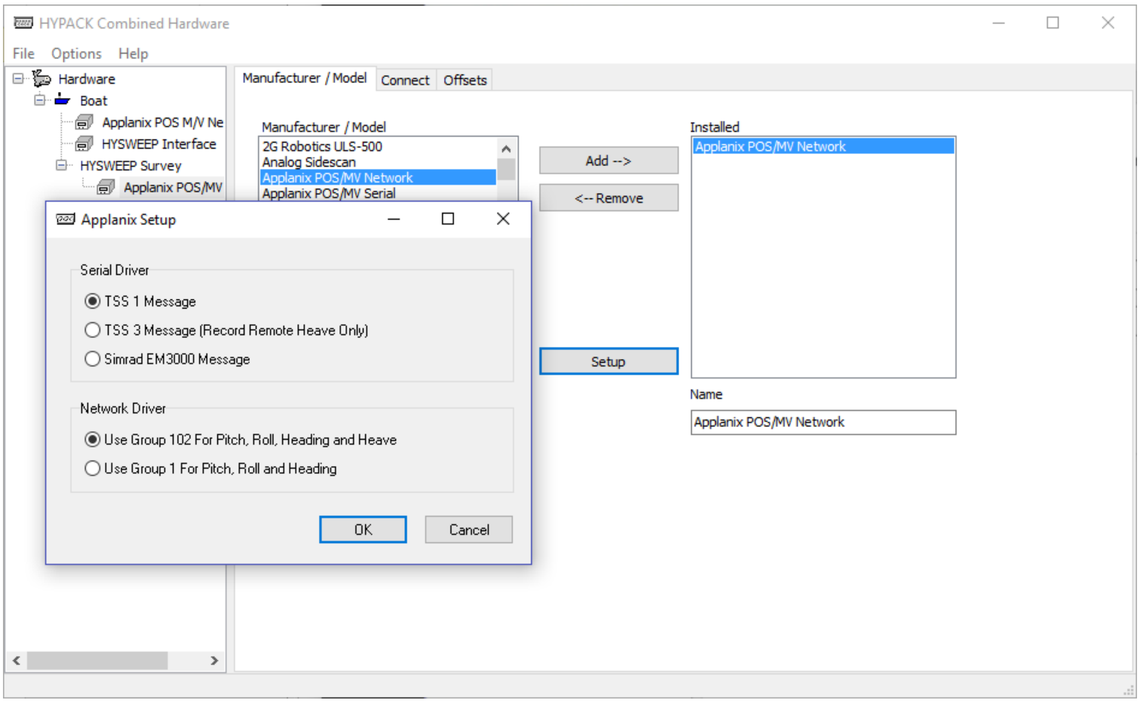


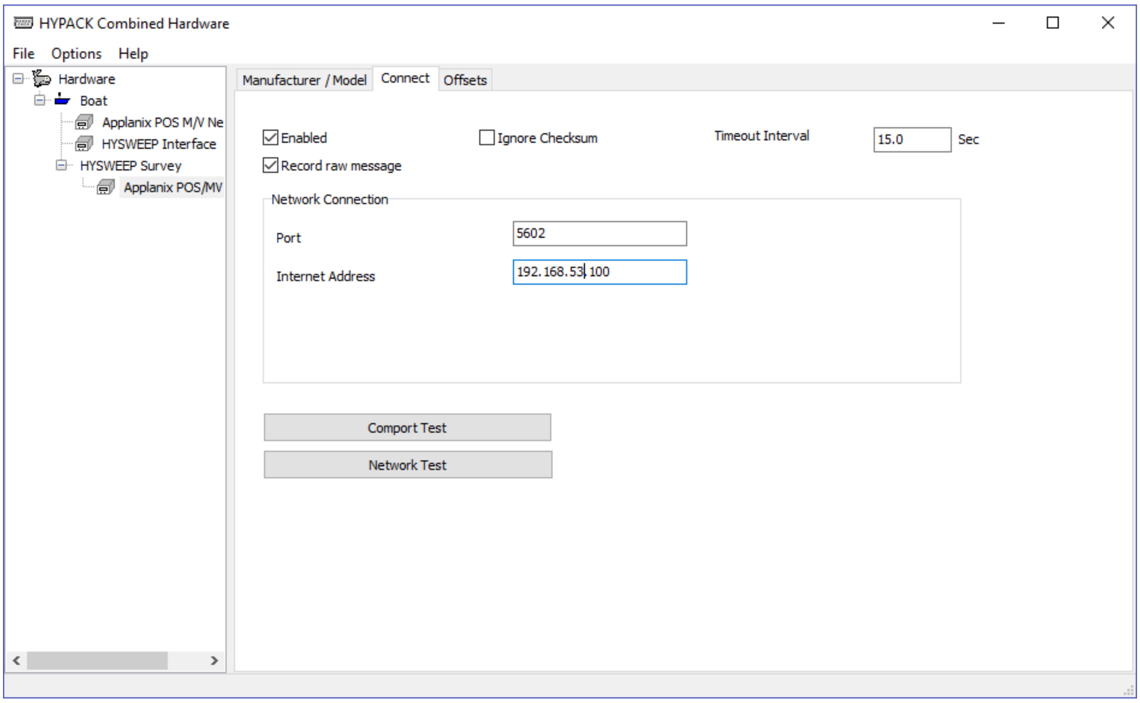

HYPACK Combined Hardware
File
Options
Help
Hardware
NORBIT Boat
Applanix POS M/V Ne
HYSWEEP Interface
HYSWEEP Survey
Survey Devices
Survey Connect
Offsets
Enabled
Limit Update Rate
0
msec
Device Connection
None
Recording Rate
Default Recording Rate (10 mSec)
Limit Recording Rate
Sec
Do Not Record
Device Interrogation
Device Query Command
Device Initialization Script
Comport Test
Network Test
Test Device
Device Connection
Connection Type
None
OK
Cancel

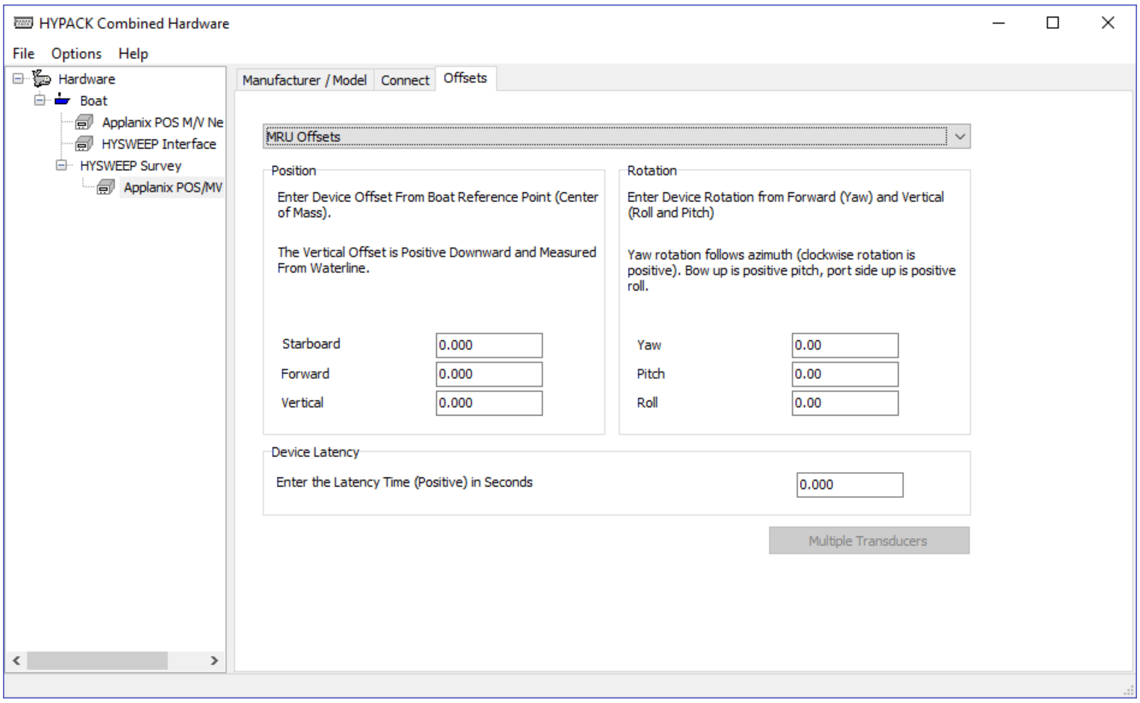

HYPACK Combined Hardware
File
Options
Help
Hardware
Boat
Applanix POS M/V Ne
HYSWEEP Interface
HYSWEEP Survey
Survey Devices
Survey Connect
Offsets
HYSWEEP Interface
Position
Enter Device Offset From Boat Reference Point (Center of Mass).
The Vertical Offset is Positive Downward and Measured From Waterline.
Starboard
0.000
Forward
0.000
Vertical
0.000
Rotation
Enter Device Rotation from Forward (Yaw) and Vertical (Roll and Pitch)
Yaw rotation follows azimuth (clockwise rotation is positive). Bow up is positive pitch, port side up is positive roll.
Yaw
0.00
Pitch
0.00
Roll
0.00
Device Latency
Enter the Latency Time (Positive) in Seconds
0.000
Multiple Transducers

Step 5. Configure Motion Device

In HYSWEEP Survey, add the Applanix POS/MV Network device and configure it as shown below:

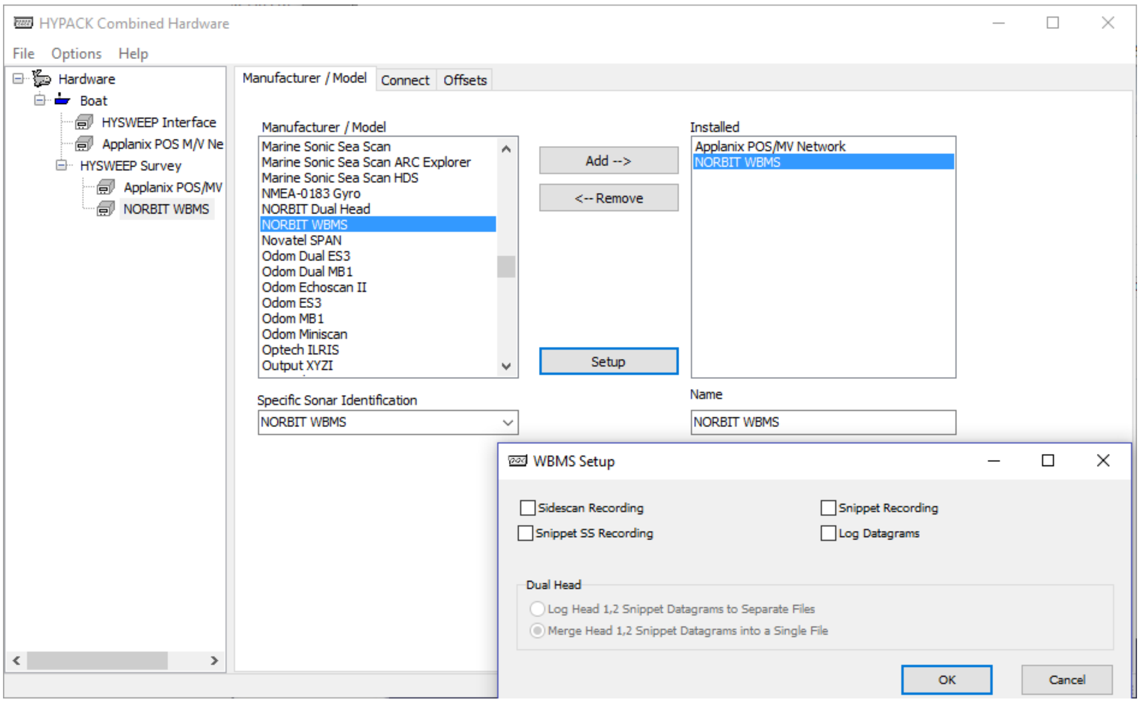


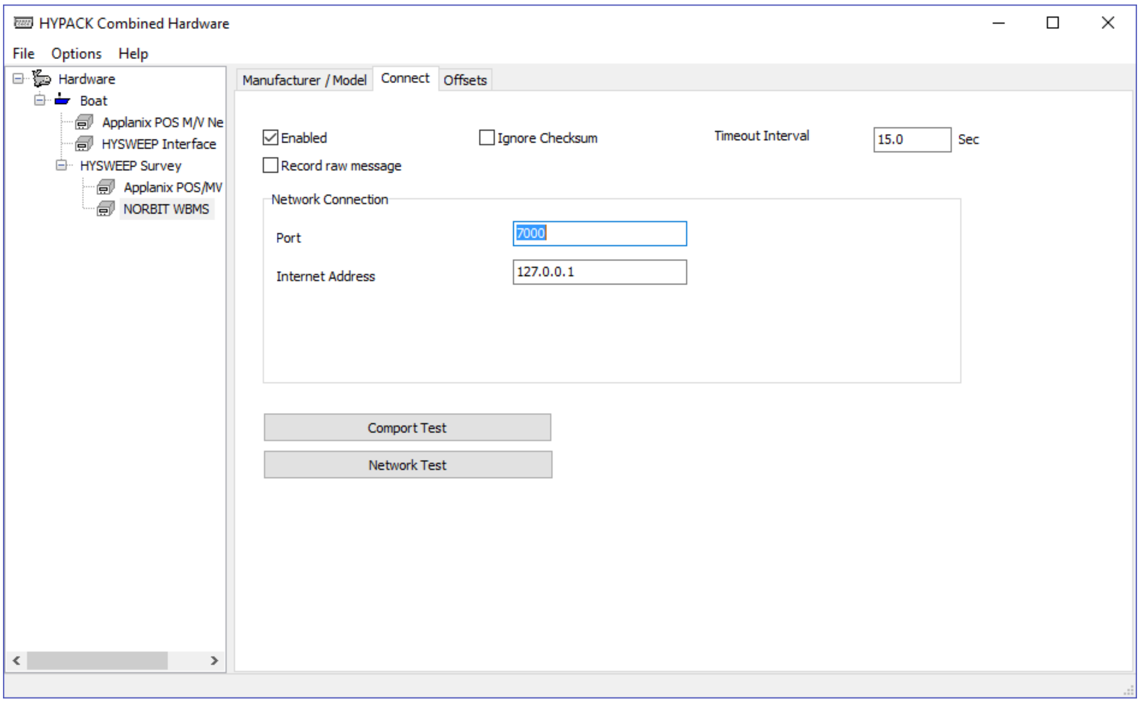


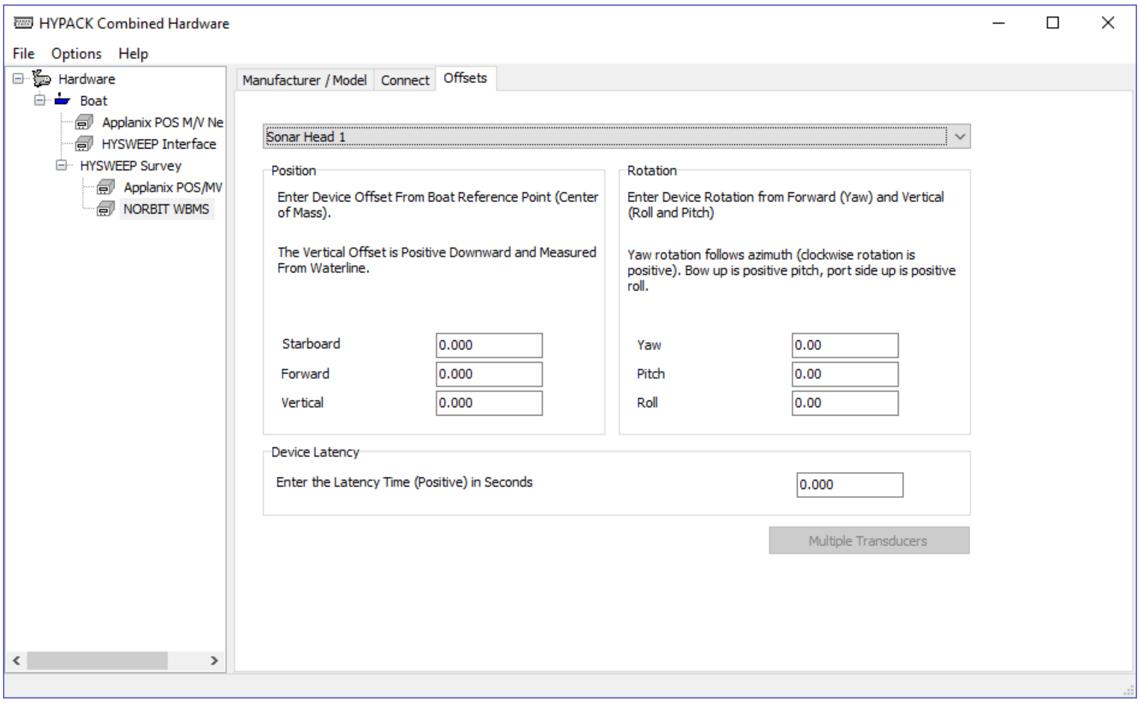


Step 6. Configure Multibeam Device

Next, go to HYSWEEP Survey and select NORBIT WBMS as shown below. In WBMS Setup, select **Sidescan Recording** for recording Sidescan only, or **Snippet SS Recording** for Snippet-Sidescan, or **Snippet Recording** for logging Snippets. If Snippet data is requested, users must also select **Log Datagrams**. Note that the bathymetry data automatically includes beam intensity values at the bottom detection point, which provides coarse backscatter, separate from side scan and snippets.




HYPACK Combined Hardware
File Options Help
Hardware
Boat
Applanix POS M/V Ne
HYSWEEP Interface
HYSWEEP Survey
Applanix POS/MV
NORBIT WBMS
Manufacturer / Model
Connect
Offsets
Enabled
Ignore Checksum
Timeout Interval
15.0
Sec
Record raw message
Network Connection
Port
7000
Internet Address
127.0.0.1
Comport Test
Network Test

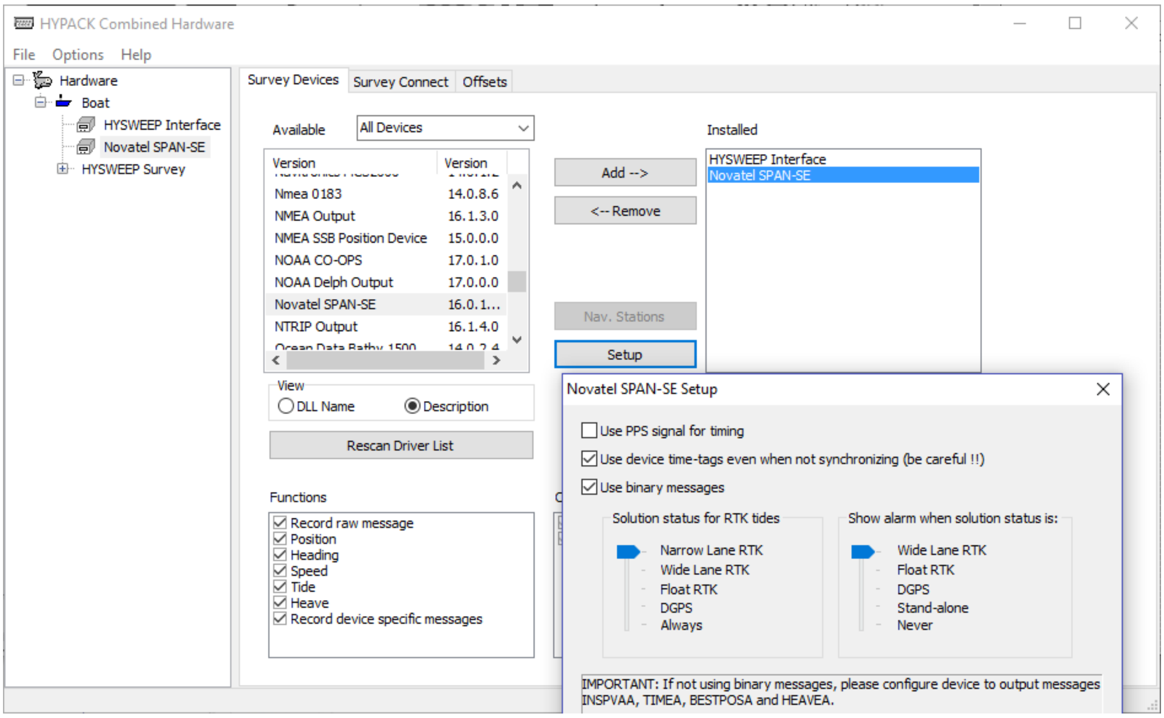

HYPACK Combined Hardware
File Options Help
Hardware
Boat
Applanix POS M/V Ne
HYSWEEP Interface
HYSWEEP Survey
Applanix POS/MV
NORBIT WBMS
Manufacturer / Model
Connect
Offsets
Sonar Head 1
Position
Enter Device Offset From Boat Reference Point (Center of Mass).
The Vertical Offset is Positive Downward and Measured From Waterline.
Starboard
0.000
Forward
0.000
Vertical
0.000
Rotation
Enter Device Rotation from Forward (Yaw) and Vertical (Roll and Pitch)
Yaw rotation follows azimuth (clockwise rotation is positive). Bow up is positive pitch, port side up is positive roll.
Yaw
0.00
Pitch
0.00
Roll
0.00
Device Latency
Enter the Latency Time (Positive) in Seconds
0.000
Multiple Transducers

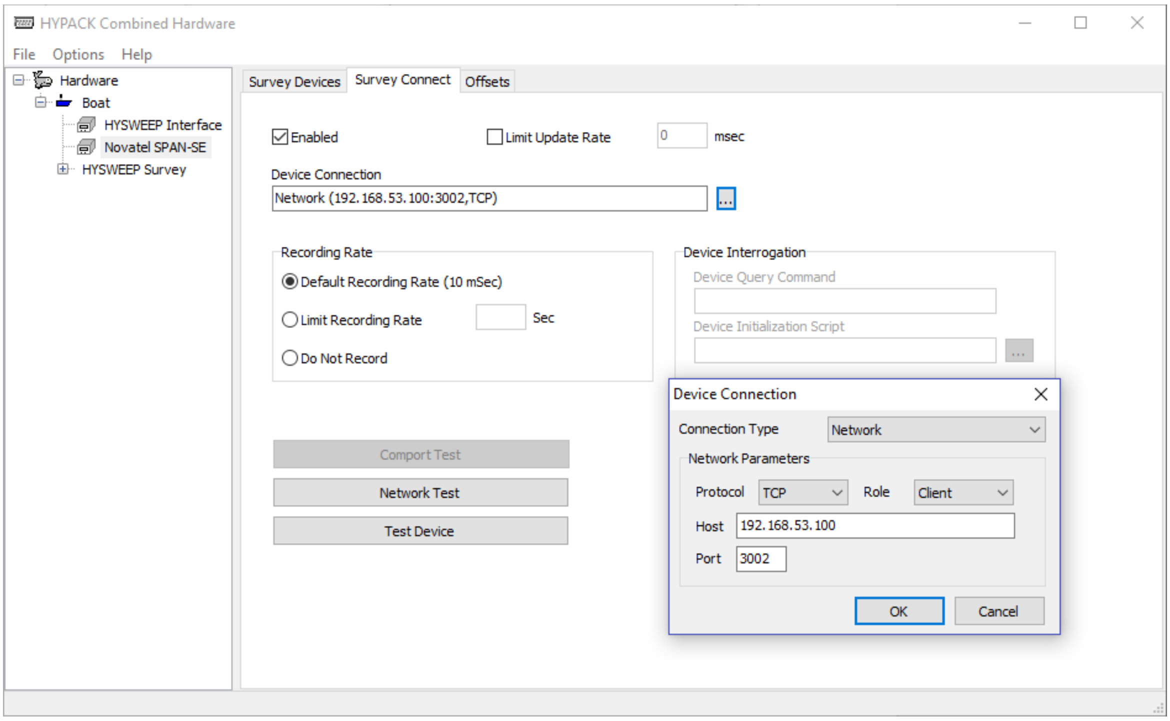
10.1.3 HYPACK Setup for iWBMSc

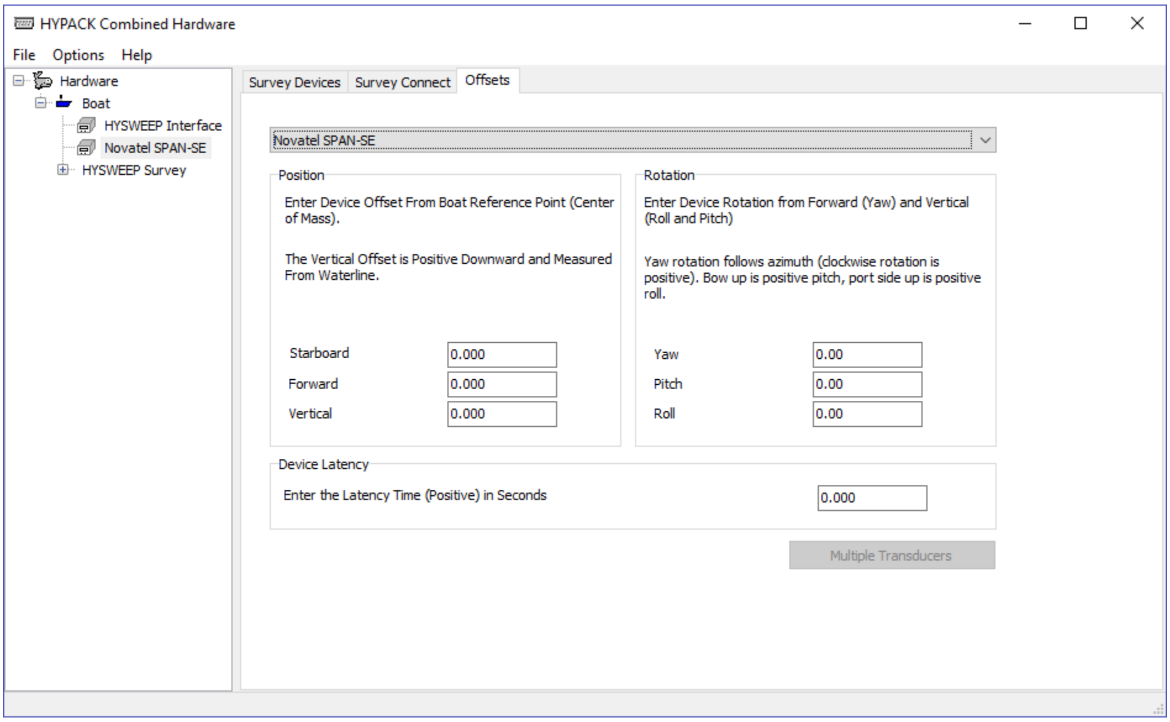
The procedure for iWBMSc users is the same as described in the previous section, except for the following differences in steps 3 and 5:

Step 3. Configure Position and Heading Device

In Survey Devices, add the Novatel SPAN-SE device and configure it as shown below.

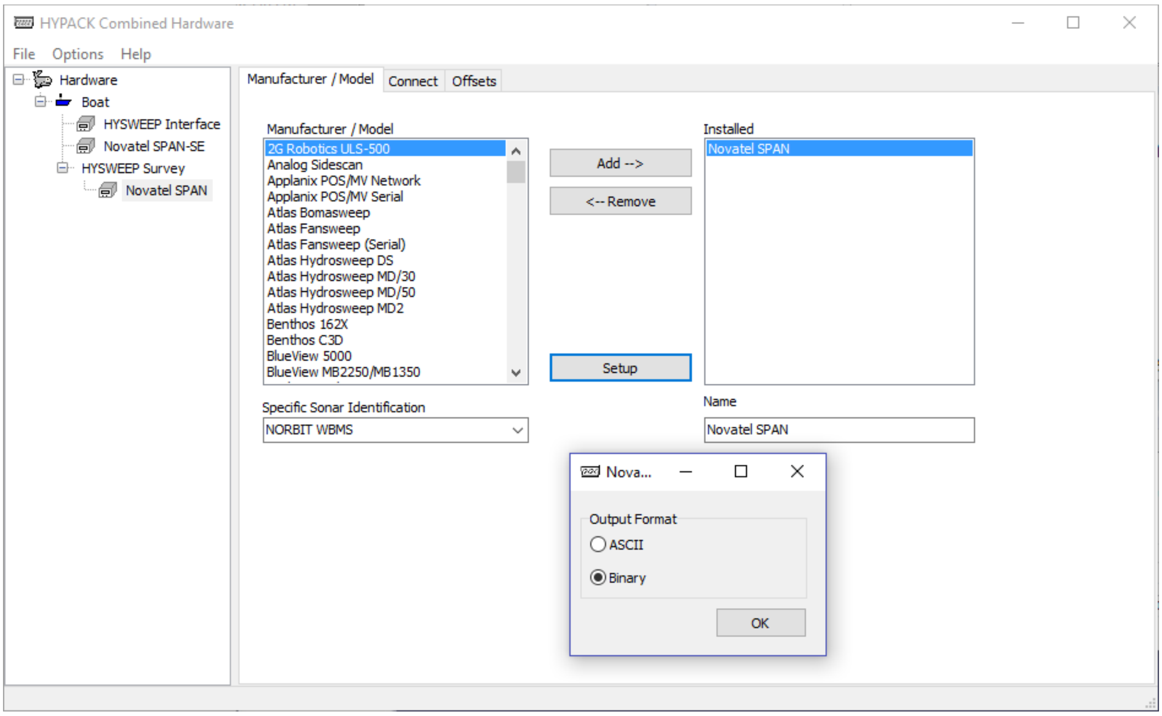


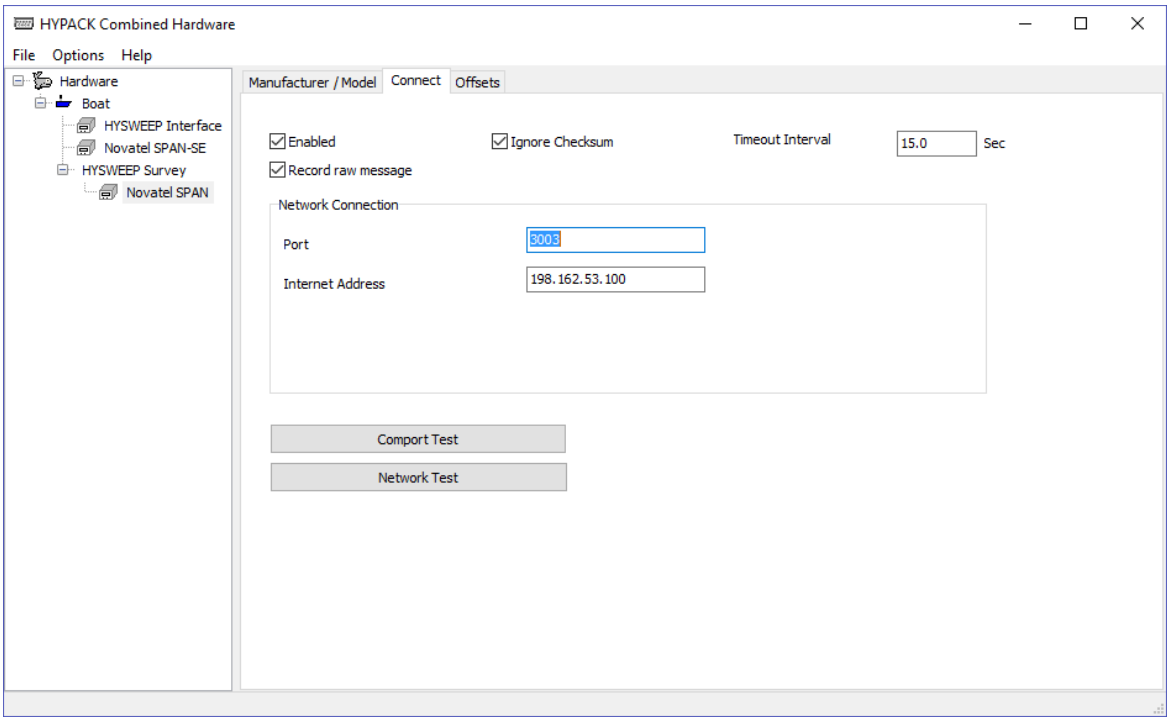


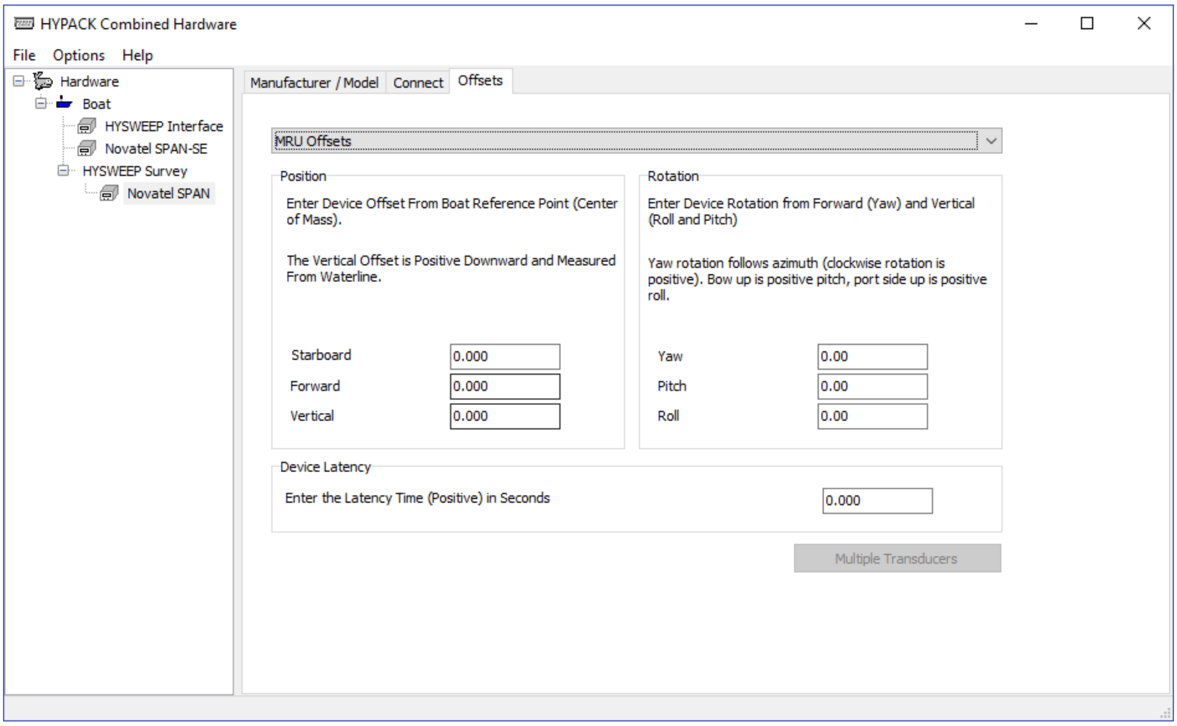


Step 5. Configure Motion Device

In HYSWEEP Survey, add the Novatel SPAN device and configure it as shown below:




HYPACK Combined Hardware
File Options Help
Hardware
Boat
HYSWEEP Interface
Novatel SPAN-SE
HYSWEEP Survey
Novatel SPAN
Manufacturer / Model
Connect
Offsets
Enabled
Ignore Checksum
Timeout Interval
15.0
Sec
Record raw message
Network Connection
Port
3003
Internet Address
198.162.53.100
Comport Test
Network Test


HYPACK Combined Hardware
File Options Help
Hardware
Boat
HYSWEEP Interface
Novatel SPAN-SE
HYSWEEP Survey
Novatel SPAN
Manufacturer / Model
Connect
Offsets
MRU Offsets
Position
Enter Device Offset From Boat Reference Point (Center of Mass).
The Vertical Offset is Positive Downward and Measured From Waterline.
Starboard
0.000
Forward
0.000
Vertical
0.000
Rotation
Enter Device Rotation from Forward (Yaw) and Vertical (Roll and Pitch)
Yaw rotation follows azimuth (clockwise rotation is positive). Bow up is positive pitch, port side up is positive roll.
Yaw
0.00
Pitch
0.00
Roll
0.00
Device Latency
Enter the Latency Time (Positive) in Seconds
0.000
Multiple Transducers

10.2 QINSy Setup for WBMS, iWBMS, iWBMSh, iWBMSe & iWBMSc

For sensors **not** supplied by NORBIT, please contact the vendor for integration instructions. The following sections show recommended configurations of QINSy v8.18 for all NORBIT sonars. The examples assume that the INS reference is collocated with the sonar reference.

iWBMSc users must configure the MarineSPAN output records to log the following:

```
LOG ICOM2 INSPVAA ONTIME 0.05
LOG ICOM2 TIMEA ONTIME 1
LOG ICOM2 BESTPOSA ONTIME 0.2
LOG ICOM2 HEAVEA ONNEW
```

For information on how to configure the NovAtel Connect software please refer to section **Error! Reference source not found.**.

10.2.1 Offsets

By default, integrated NORBIT systems output all sonar and navigation data at the WBMS Reference Point (refer to the Offsets section for more details). Therefore, each system in the QINSy database requires the same identical offset, that is the offset from Center of Rotation to WBMS Reference Point, assuming the CoR is chosen as the QINSy reference point. If the optional iLiDAR is installed, this offset must be separately measured and applied.

Note that the QINSy sign convention uses **Y+ Forward**, **X+ Starboard**, and **Z+ Up**. This is not the same as the integrated Applanix systems on NORBIT sonars. Incorrect entry of the sign may corrupt data. If depths need to be reported relative to the water level, please move the CoR height up/down to the appropriate level. Perform a draft or bar check to verify these values.

⚠ **CAUTION: For Integrated Systems, Sonar and INS Share Same Offset**
Offsets from CoR are required if the INS is setup as recommended in this manual. Referencing data to the CoR reduces heave inaccuracies by replacing the heave data with attitude-induced lever arm corrections.

About the COR: The COR, for larger commercial vessels, is documented in the vessel design plans. For other vessels, this point at which the vessel's roll and pitch axes intersect need to be determined. This is difficult to measure as the vessel CoR may change from day to day, and even during the day. Generally, choose a CoR location that is about ¾ distance from bow to stern, centered on the keel, and located at approximately water level. Especially for smaller vessels, the CoR moves depending on fuel stowage and even distribution of personnel body weight. For example, two persons sitting on the starboard rail of a 6m craft will move the CoR from the keel centerline a distance towards the starboard rail. Choose a location and attempt to keep the weight distribution constant throughout the survey. If in doubt, take the boat to open water and measure its motion while passing over waves in different directions.

This example configuration places the INS reference at the sonar reference, i.e. the INS was configured to output values to the sonar reference location. If users want to base bathymetric measurements referenced to the water level, the only other offset required is a water level correction. This allows the application of tide station water level corrections if required. The water level correction involves translating the CoR up/down to the water level and confirmed by a bar check.

10.2.2 Database Setup for WBMS, iWBMS, iWBMSh & iWBMSe

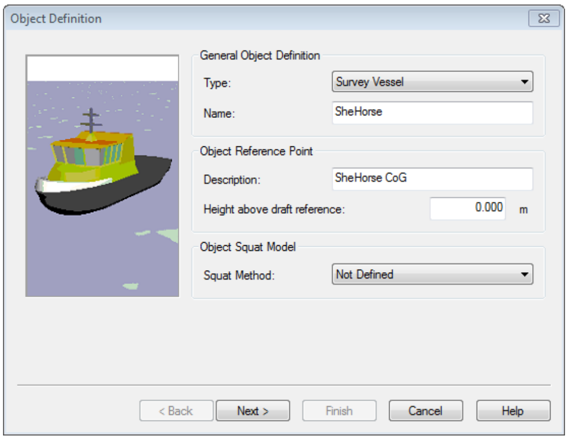
QINSy structures all data in a native database format. All data and hardware settings including offsets are saved to a database file. The setup locates all sensors relative to an object, usually the survey vessel. The offsets from the object to the system (vessel) CoR are entered as a node.

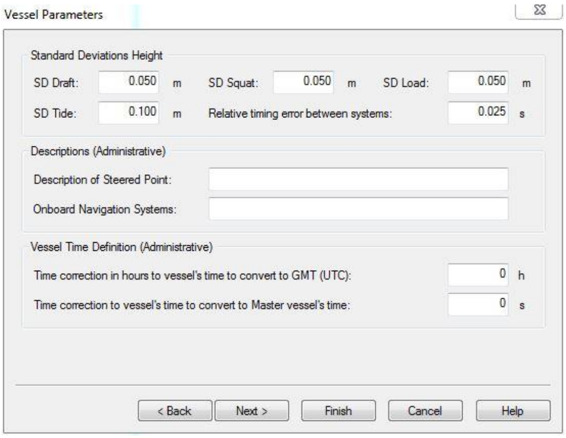
Step 1. Configure Geodesy

To start creating the database, go to **QINSy** > **Setup** > **New Database**. Go through and fill out the relevant Datum Parameters fields, i.e. specify the project geodesy.

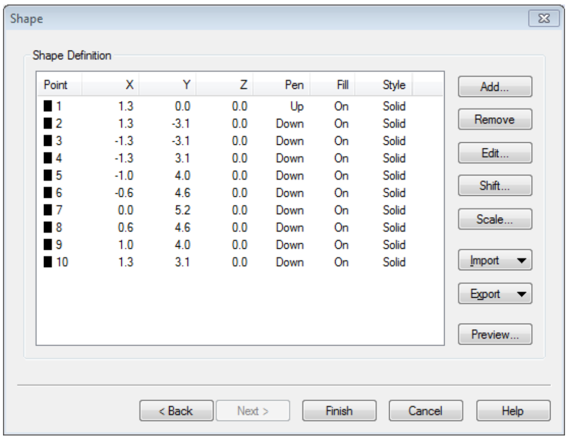
Step 2. Object Definition

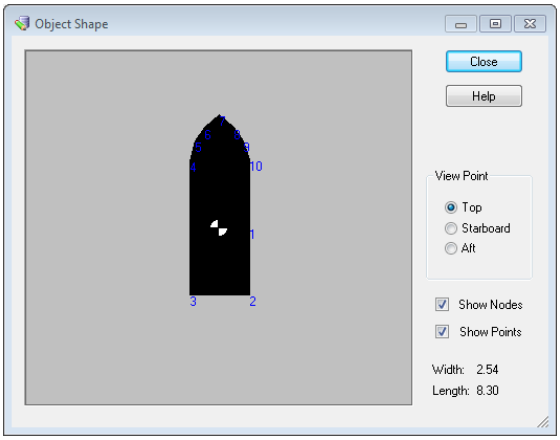
Complete all relevant fields in the Object Definition section. This allows users to specify the shape of the vessel, location of the vessel/object reference point, etc.





Should the user desire a vessel shape, it can be created and previewed in this section.

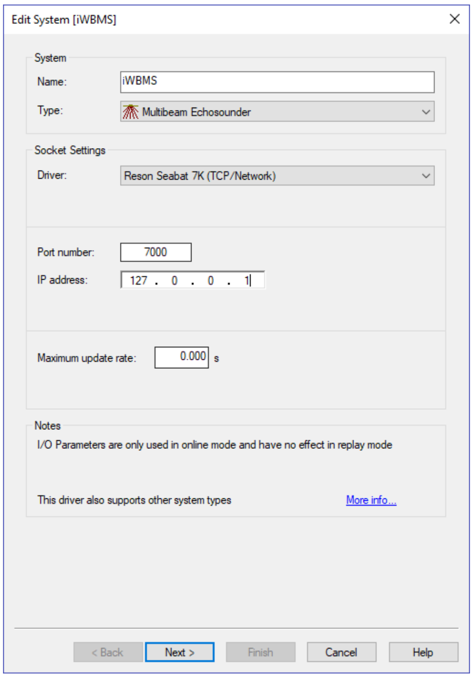


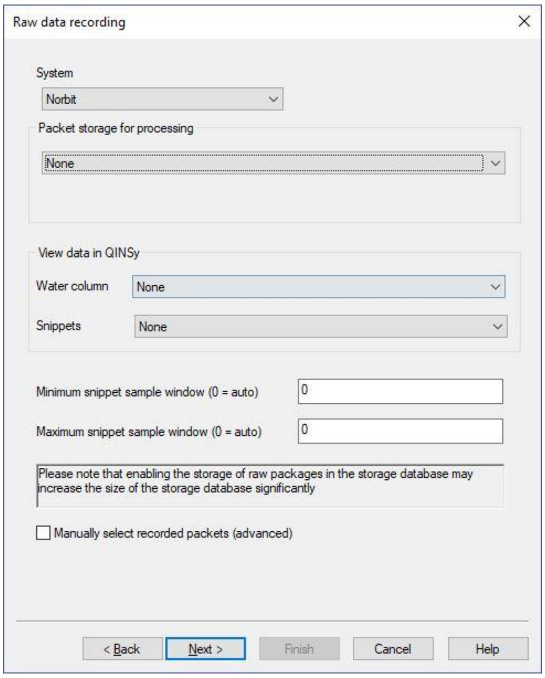


Step 3. Add Multibeam System

Once the project geodesy and vessel shape have been specified, instruments/sensors can now be added for data acquisition. The WBMS is the first instrument that is added.

The system requires a name and type. The name can be user defined, e.g. NORBIT and the system type, chosen from the drop-down menu is **Multibeam Echosounder.** Under socket settings select the **Reson SeaBat 7k (TCP/Network)** driver. The port number is **7000 and the IP address is 127.0.0.1**. Then click Next.

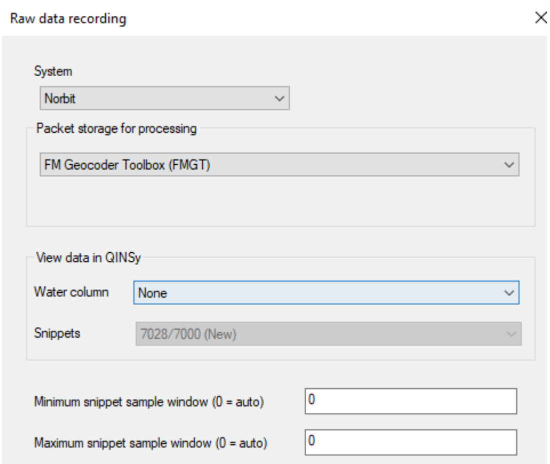


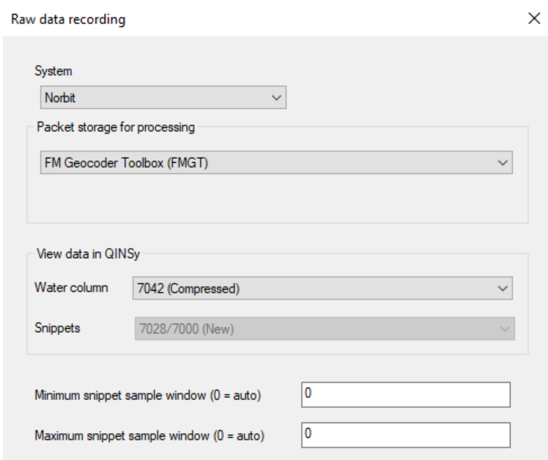


In the next window, Raw Data Recording, for standard bathymetric data collection select **NORBIT** under System, **None** under Packet Storage, Water Column and Snippets. Note that the bathymetry data automatically includes beam intensity values at the bottom detection point, which provides coarse backscatter, separate from side scan and snippets.

Step 4. Configure Snippets and/or Water Column Recording (Optional)

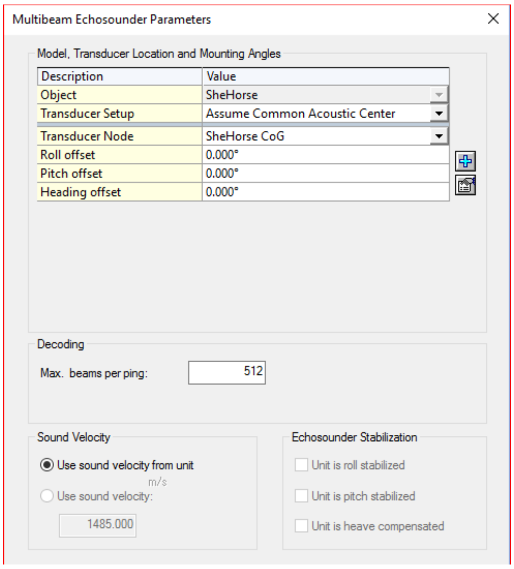
To collect water column, users must select the 7042 (Compressed) option. To collect snippets but no water column, configure the system as shown below on the left; for snippets and water column see image on the right. Once configured, click Next.

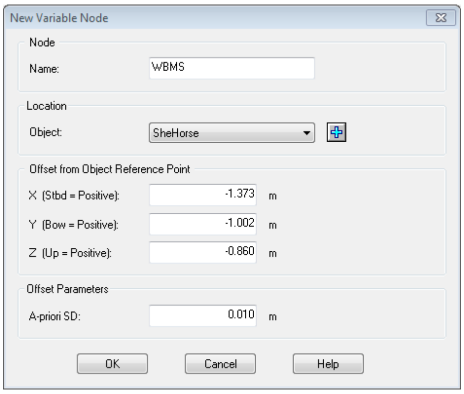




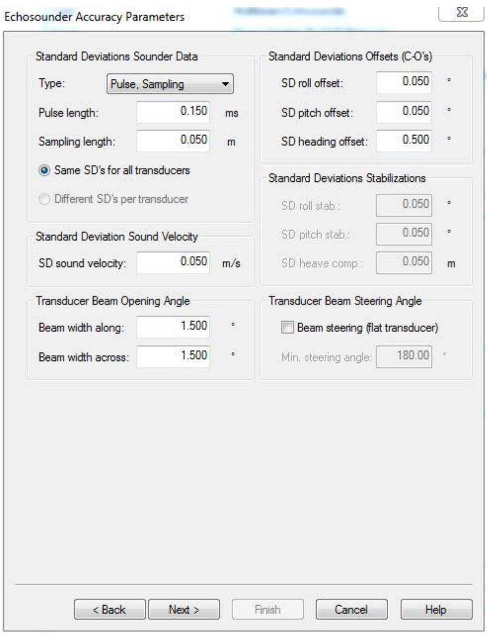
Step 5. Enter Offset to WBMS Reference Point

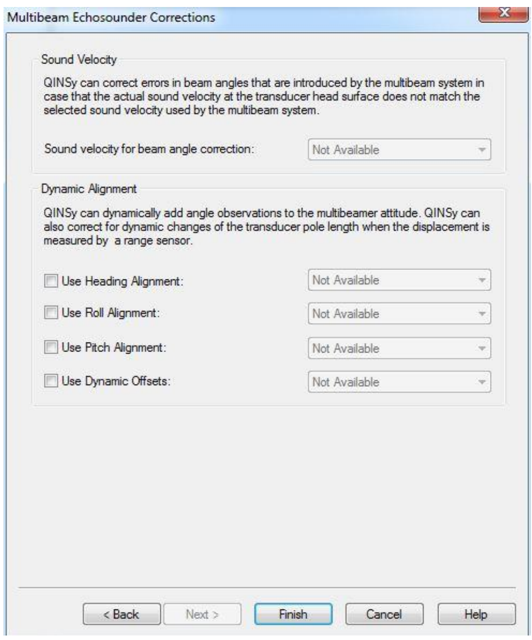
Offsets are specified in the Multibeam Echosounder Parameters window. Click on the **+** sign and create a new node called WBMS. Patch test values (roll, pitch and heading) may be entered if known. Enter 512 under max beams per ping.





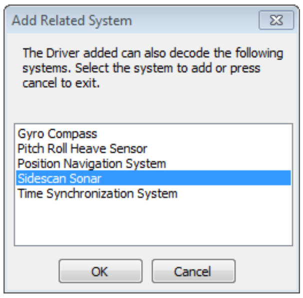
NORBIT recommends that users keep the default values in the Echosounder Accuracy Parameters and Multibeam Echosounder Corrections. Click Finish.



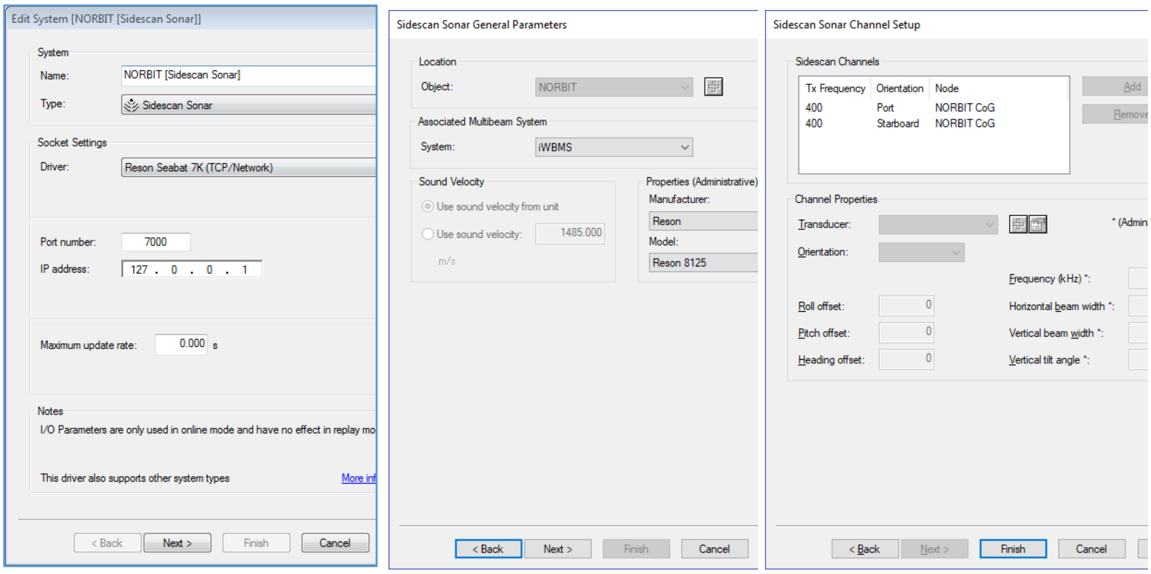


Step 6. Add Side Scan System (Optional)

After completing the previous step, the user is prompted to configure additional related systems. If side scan data is required, add it now.

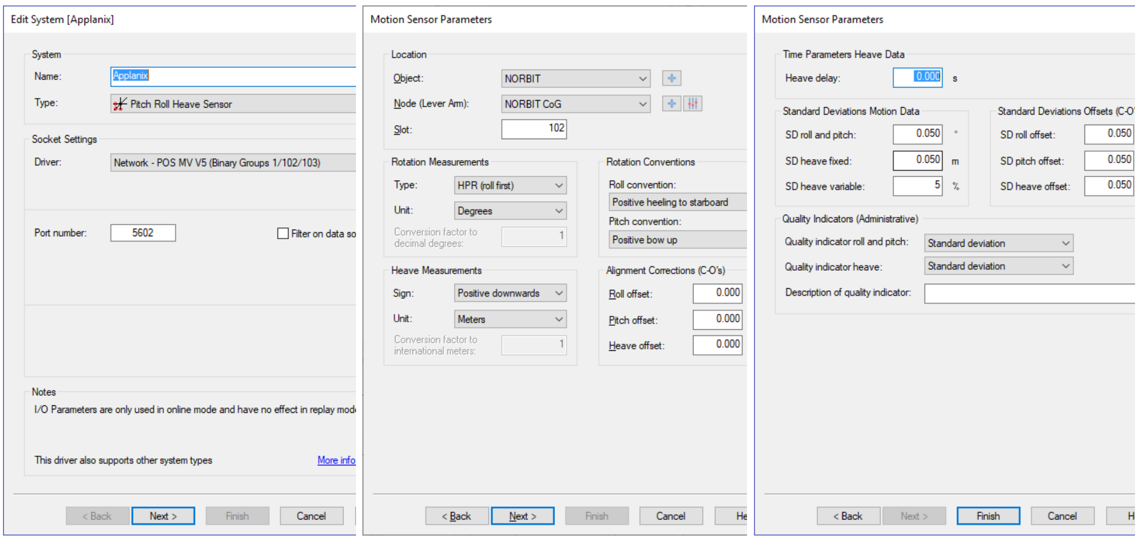


To set up the NORBIT side scan in QINSy configure the pages as shown below. A port and starboard channel must be added and specify the frequency. Items marked with an asterisk (*) will not impact the data and are only for record keeping. Click Finish when done.



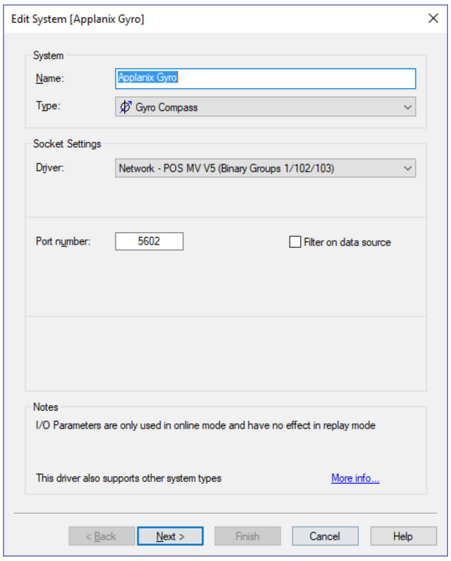
Step 7. Add Pitch/Roll/Heave System

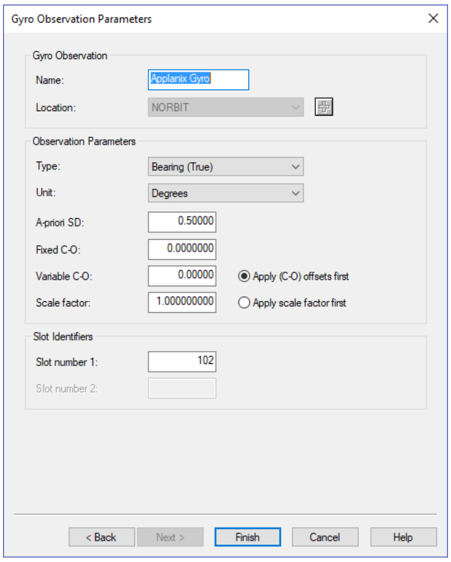
From the Database Setup window, right-click System, click New System and add a Pitch/Roll/Heave sensor. Please note that for Applanix POS MV systems, the sign convention is positive downwards:



Step 8. Add Gyro Compass System

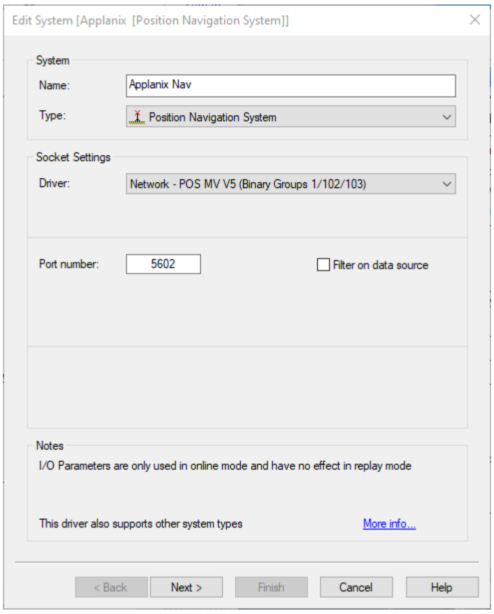
Repeat the previous step to add a new system, but this time add a Gyro Compass:

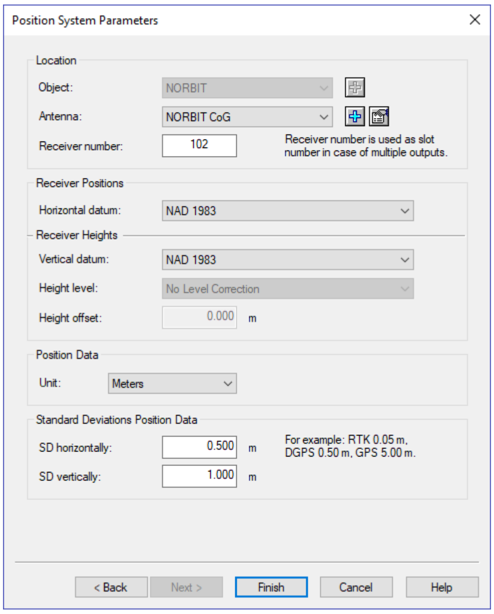




Step 9. Add Position Navigation System

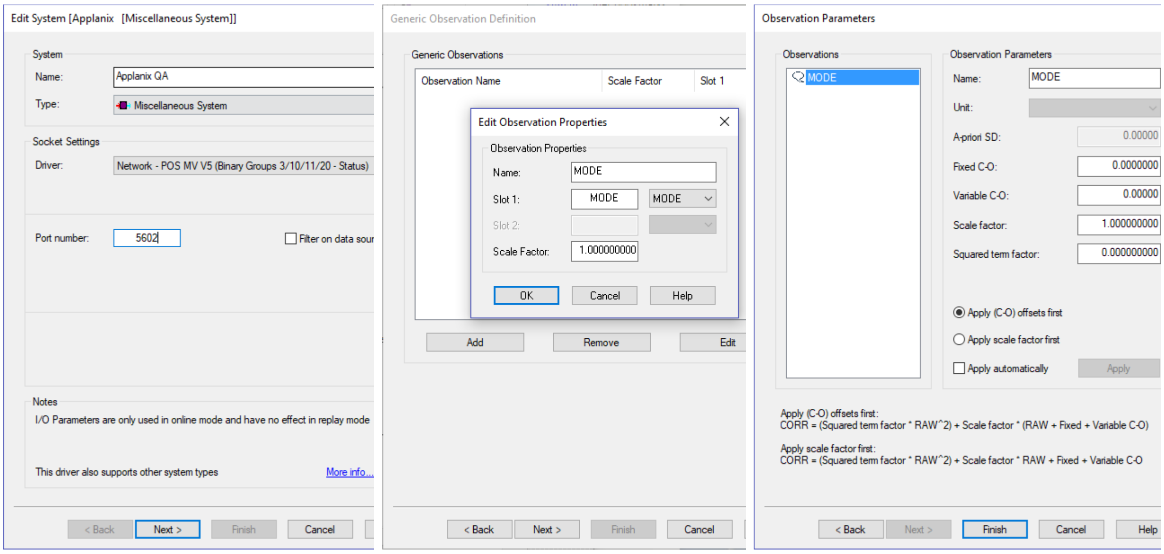
Repeat the previous step to add a new system, but this time add a Position Navigation System. The Horizontal and Vertical datum will obviously depend on project specifications.





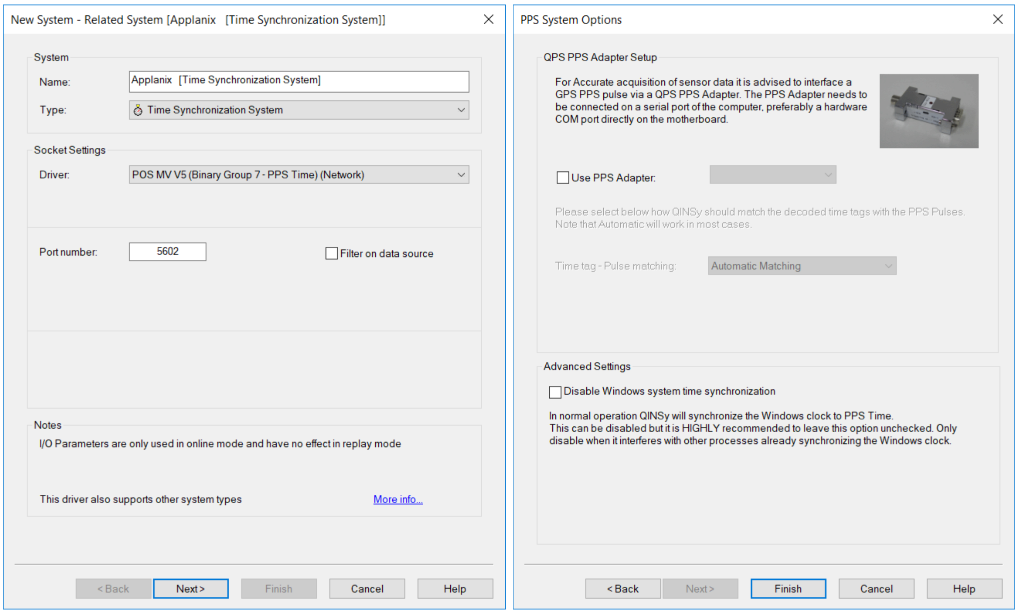
Step 10. Output Quality Information (Optional)

To configure the iWBMS, iWBMSh or iWBMSe (with Applanix) to output quality information, add a Miscellaneous system as per below:



Step 11. Add Time Synchronization System

A time synchronization system must be added. Use binary group 7 without a PPS box.

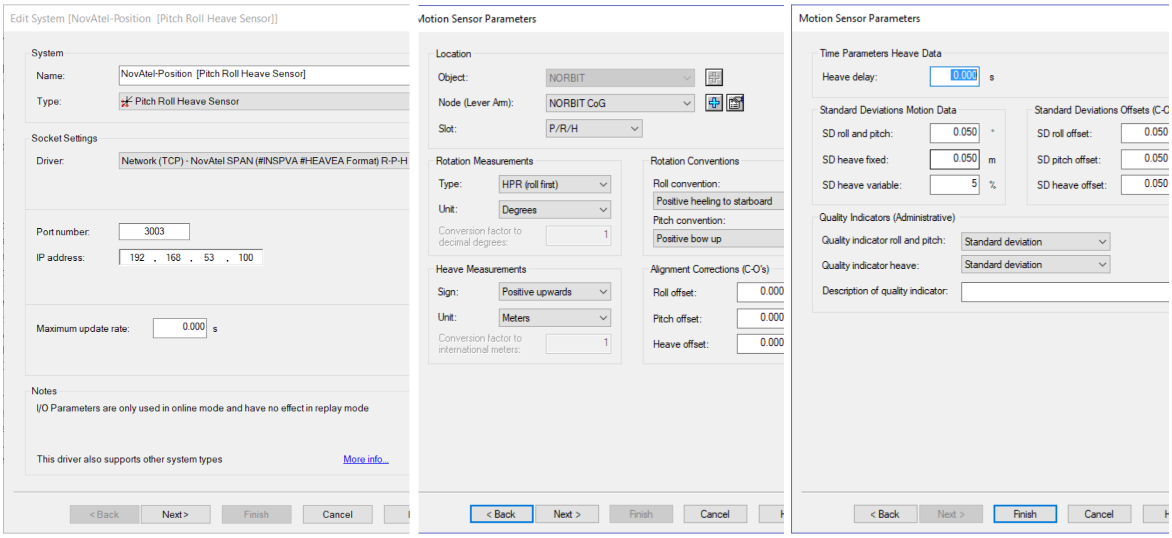


10.2.3 Database Setup for iWBMSc

The setup procedure is generally the same for iWBMSc users, but with the following differences in Steps 7-10.

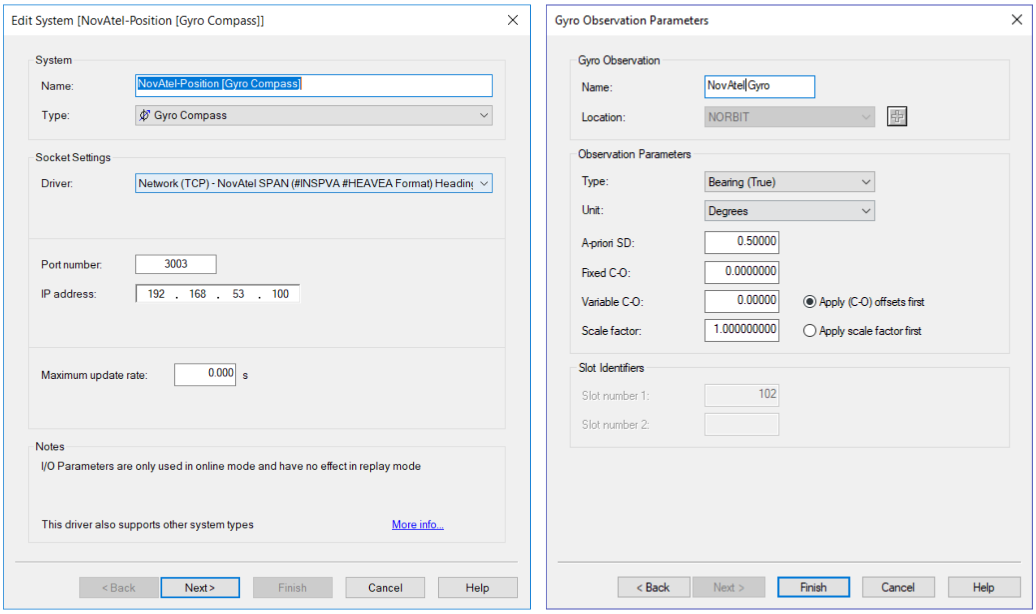
Step 7. Add Pitch/Roll/Heave System

iWBMSc users must configure the Pitch/Roll/Heave Sensor as follows:



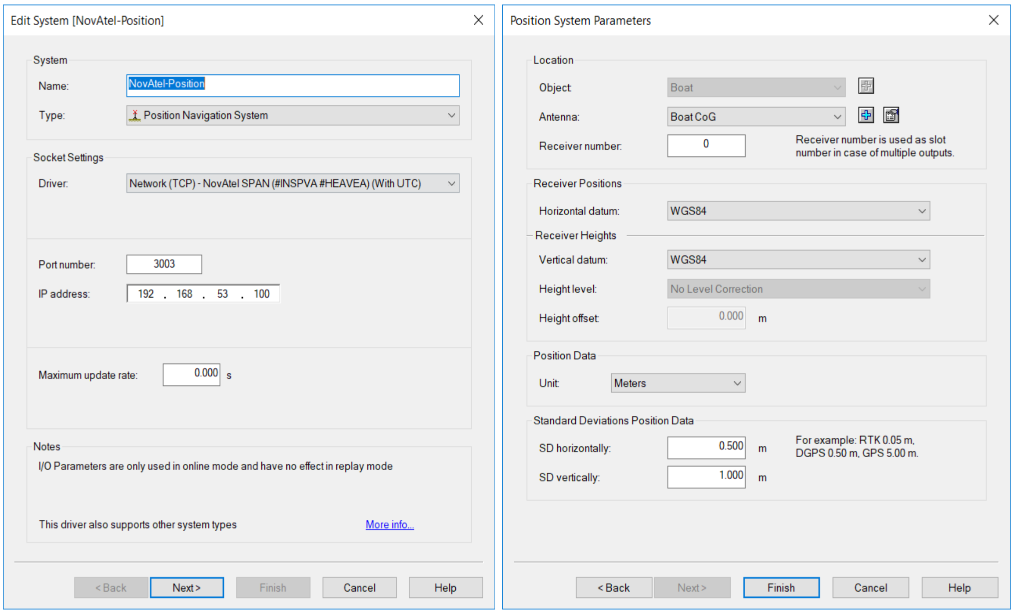
Step 8. Add Gyro Compass System

iWBMSc users with the NovAtel INS should configure the Gyro as follows:



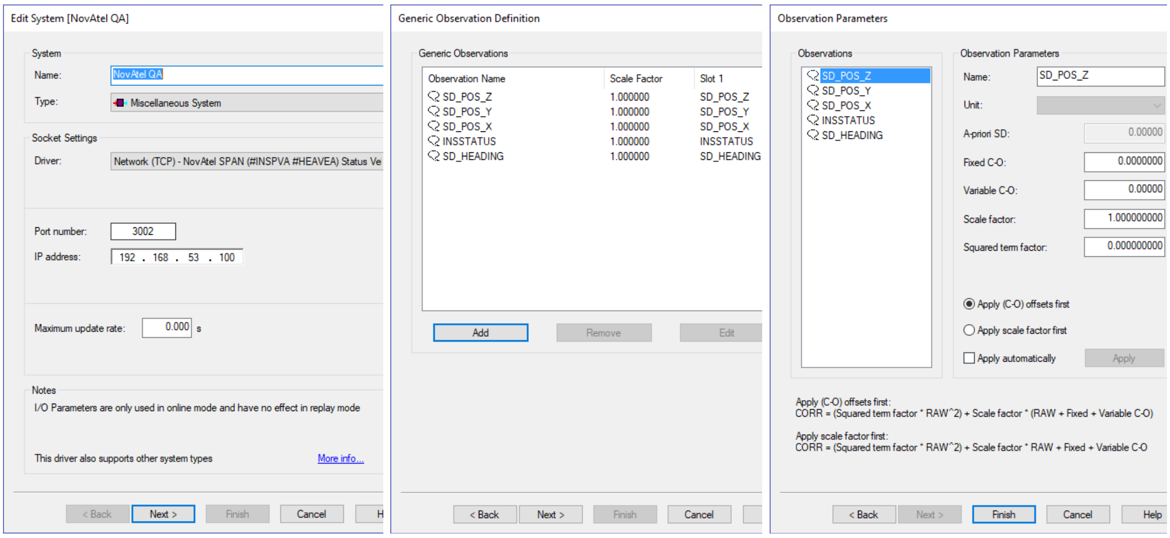
Step 9. **Add Position Navigation System**

iWBMSc users should configure the system as shown below:



Step 10. **Output Quality Information (Optional)**

iWBMSc users must configure the NovAtel quality output as follows:



10.2.4 Known Issues

1. If QINSy crashes during data acquisition, it may fail to close the SeaBat driver. If this is the case users may have to close the driver manually. To do so, open Windows Task Manager and close DrvSeabat7k.exe.
2. The QINSy dongle may block a COM port after a crash. This can also be checked by going into Task Manager with QINSy closed and the USB dongle removed. Look for sntlkeyssrvr.exe and/or sntlsrtsrvr.exe. Close both from Task Manager and try again.
3. Rates in the observation physics display for the NORBIT are incorrect. This may lead users to think that sonar is not pinging properly. This is not the case.

10.3 PDS Setup for WBMS, iWBMS, iWBMSh & iWBMSe

The WBMS GUI Version 10 Hotfix requires that **Force Push** be enabled in the WBMS GUI Connection settings in order to receive data in PDS. Refer to section 4.6.5 for more information on its functionality.

General instructions are provided for integrating NORBIT sensors. For sensors not supplied by NORBIT, additional integration steps may be required which are not explained here. The setup examples used in this section assume that an iWBMS, iWBMSh, or iWBMSe was installed in a standard configuration.

Note that the PDS sign convention uses **Y+ Forward**, **X+ Starboard**, and **Z+ Up**. This is not the same as the integrated Applanix systems on NORBIT sonars. Incorrect entry of the sign may corrupt data.

The Applanix Ethernet groups required by PDS are automatically configured on integrated NORBIT systems, thus no action is required. The required groups are: `1, 3, 7, 10, 12, 20, 102, 104, 111` and `113`.

10.3.1 Offsets

By default, integrated NORBIT systems output all sonar and navigation data at the WBMS Reference Point (refer to the Offsets section for more details). Therefore, PDS only requires the Sea Level offset, Center of Gravity offset, and LiDAR offset if the optional iLiDAR is installed.

The Sea Level offset is used when depths are reduced using tide and heave. When RTK heights are used for depth reduction, the Sea Level offset is only used for applying the sound velocity profile at the correct depth.

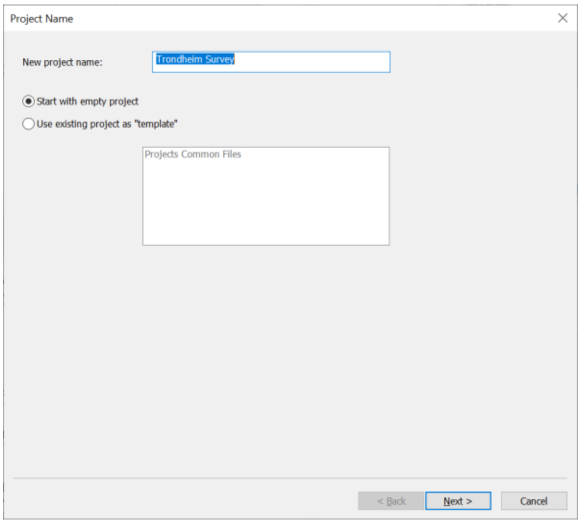
⚠ **CAUTION: For Integrated Systems, Sonar and INS Share Same Offset**
By default, integrated NORBIT systems output all sonar and navigation data at the WBMS Reference Point. Therefore, each device in the project setup should have the same offset.

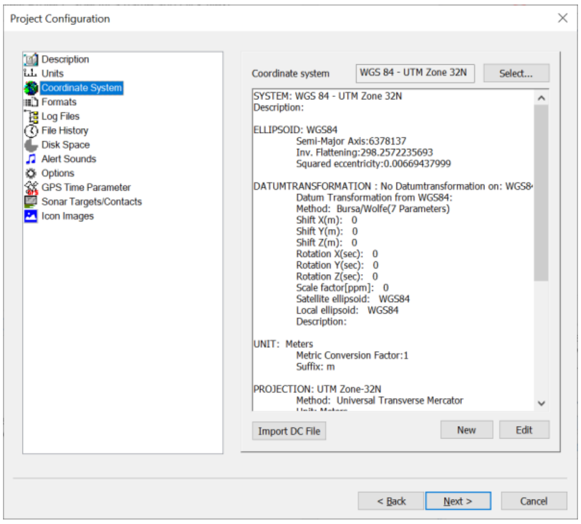
About the COR: The COR, for larger commercial vessels, is documented in the vessel design plans. For other vessels, this point at which the vessel's roll and pitch axes intersect need to be determined. This is difficult to measure as the vessel CoR may change from day to day, and even during the day. Generally, choose a CoR location that is about ¾ distance from bow to stern, centered on the keel, and located at approximately water level. Especially for smaller vessels, the CoR moves depending on fuel stowage and even distribution of personnel body weight. For example, two persons sitting on the starboard rail of a 6m craft will move the CoR from the keel centerline a distance towards the starboard rail. Choose a location and attempt to keep the weight distribution constant throughout the survey. If in doubt, take the boat to open water and measure its motion while passing over waves in different directions.

10.3.2 Setup Project

Step 1. Create New Project and Setup Geodesy

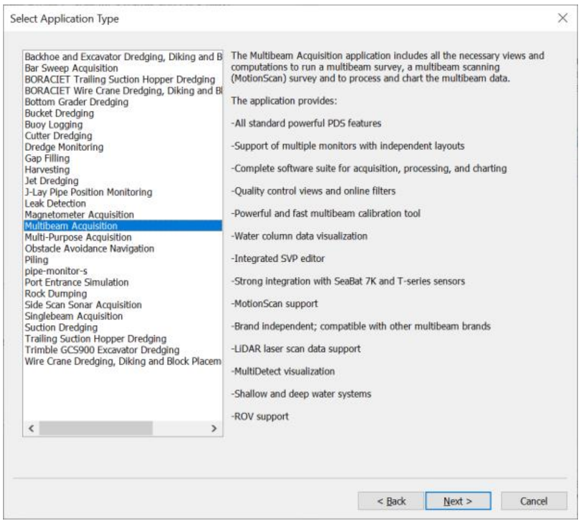
Create a new project in PDS Control Center via **File** > **New Project**. Specify a name for the project, and on the next page select a coordinate system from the geodatabase or define a new coordinate system according to the survey requirements.

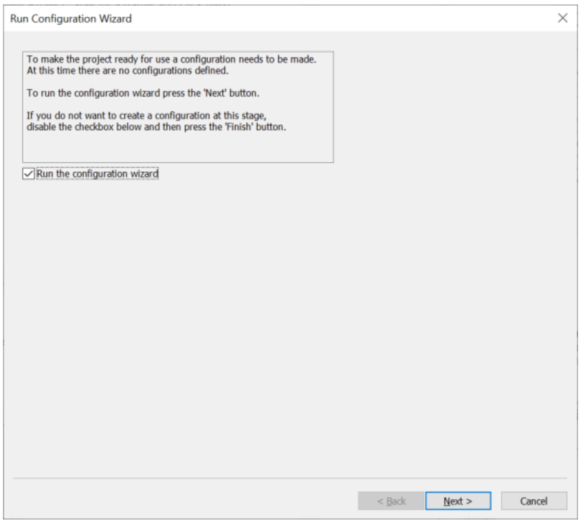




Step 2. Select Application Type and Run Configuration Wizard

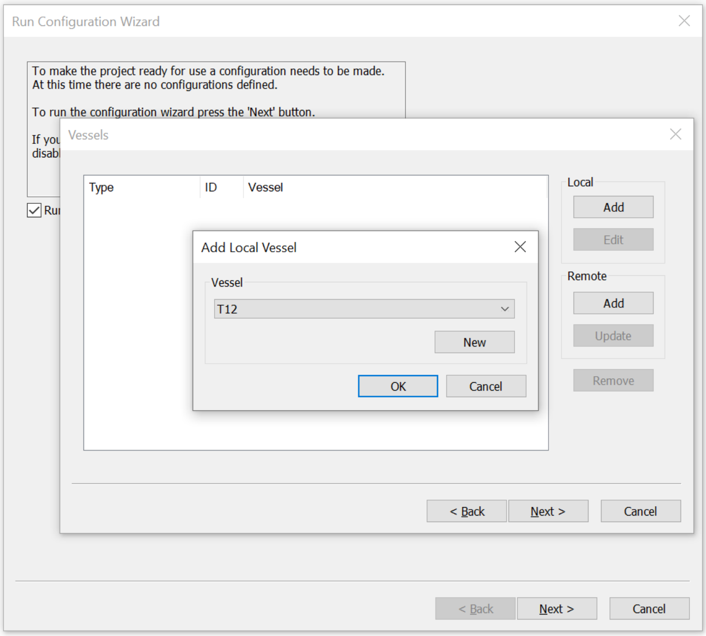
Select **Multibeam Acquisition** as the application type. Click **Next** and run the configuration wizard.





Step 3. Add New Vessel

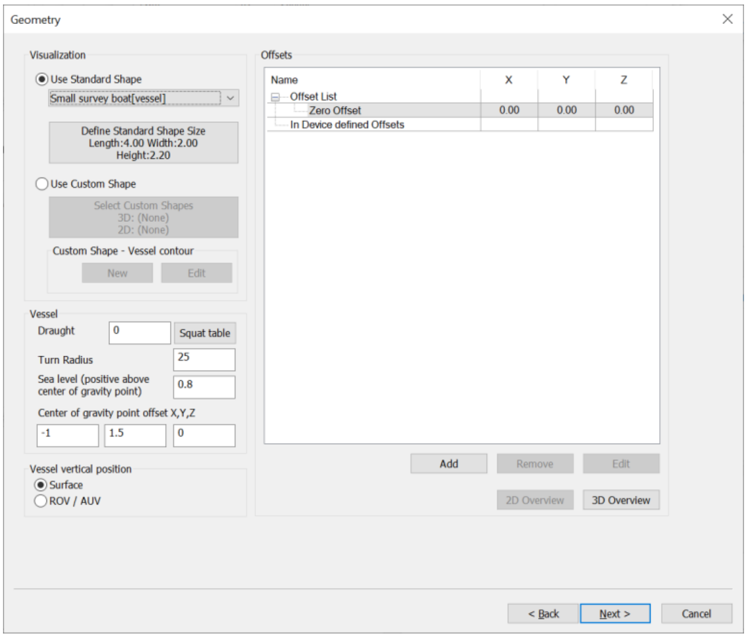
Specify a name for the configuration (e.g. "Survey Vessel Pole Mount") and on the next page add a Local vessel which will contain all drivers and offsets.



Step 4. Enter Offsets

On the Geometry page, define the shape of the vessel (only for display) and enter the Center of Gravity offset as measured from the WBMS Reference Point. Leave the CoG Z field zero to keep the setup simple, as the Sea Level offset is defined in relation to the CoG. Then enter the Sea Level offset relative to the WBMS Reference Point. This should be a positive value.

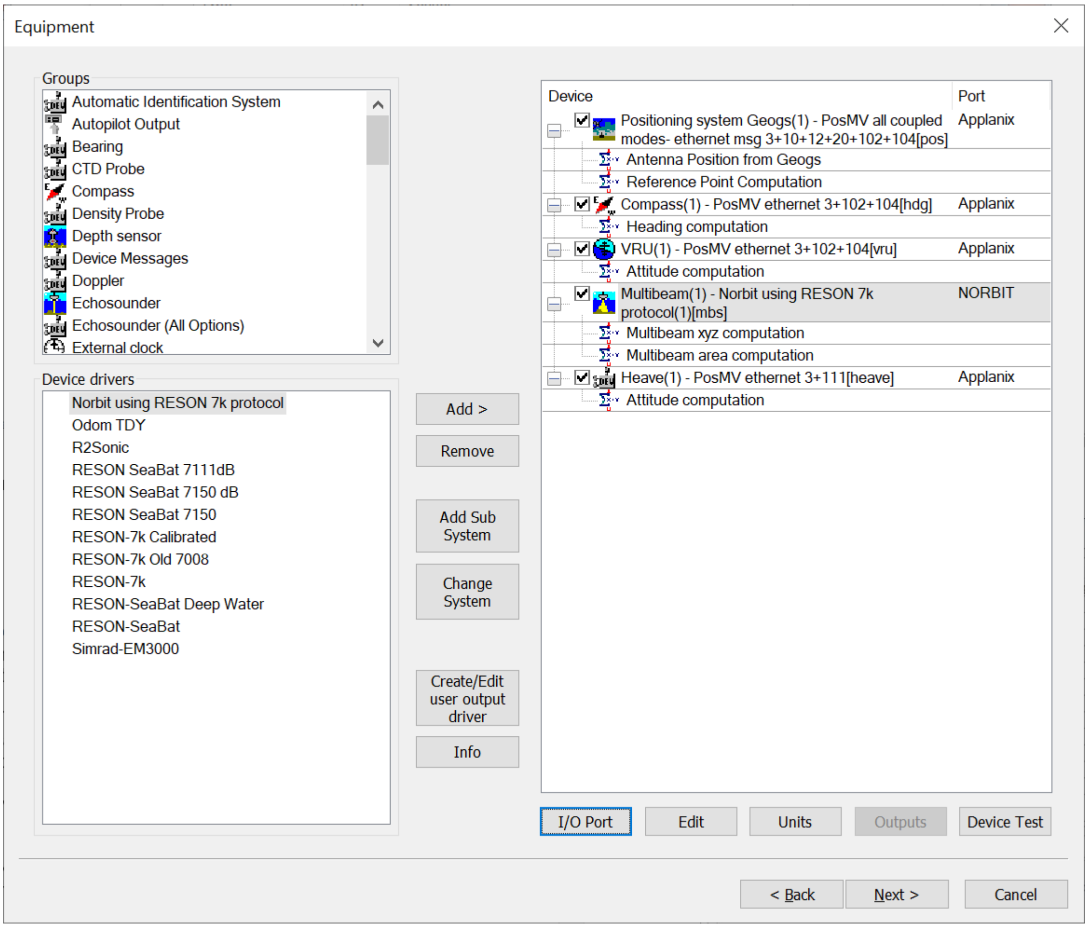
If the optional iLiDAR is installed, add its offset to the list. This is the measured offset from WBMS Reference Point to iLiDAR Reference Point. Refer to the iLiDAR manual for more details.



Step 5. Add Essential Devices

Devices for each data type are added on the Equipment list. On the left side, select the Group and then select the driver to add. As a minimum, the following drivers are required:

Group	Driver	I/O Port	Offset
Positioning system Geogs	PosMV all coupled modes- ethernet msg 3+10+12+20+102+104[pos]	192.168.53.100 UDP 5602	Zero Offset
Compass	PosMV ethernet 3+102+104[hdg]	192.168.53.100 UDP 5602	Zero Offset
VRU	PosMV ethernet 3+102+104[vru]	192.168.53.100 UDP 5602	Zero Offset
Multibeam	NORBIT using RESON 7k protocol (1) [mbs]	127.0.0.1 TCP 7000	Zero Offset



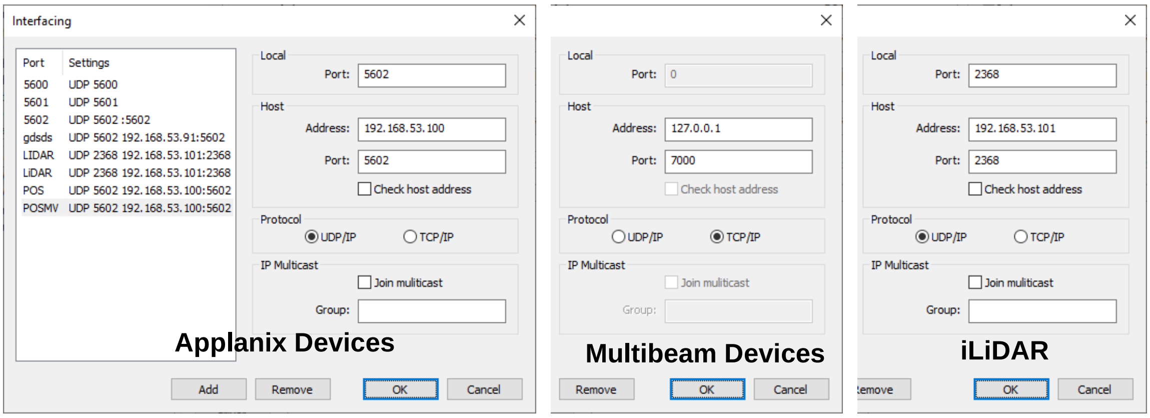
Step 6. Add Optional Devices

Optional drivers may be added for snippets or side scan data, true heave data, and LiDAR data:

Group	Driver	I/O Port	Offset
Snippets	NORBIT using RESON 7k protocol (1) [snp]	127.0.0.1 TCP 7000	Zero Offset
Sidescan Sonar	NORBIT using RESON-7k protocol (1) [sss]	127.0.0.1 TCP 7000	Zero Offset
Heave	PosMV ethernet 3+111[heave]	192.168.53.100 UDP 5602	Zero Offset
Laser Scan	Velodyne LiDAR VLP-16[laser-scan]	192.168.53.101 UDP 2368	iLiDAR

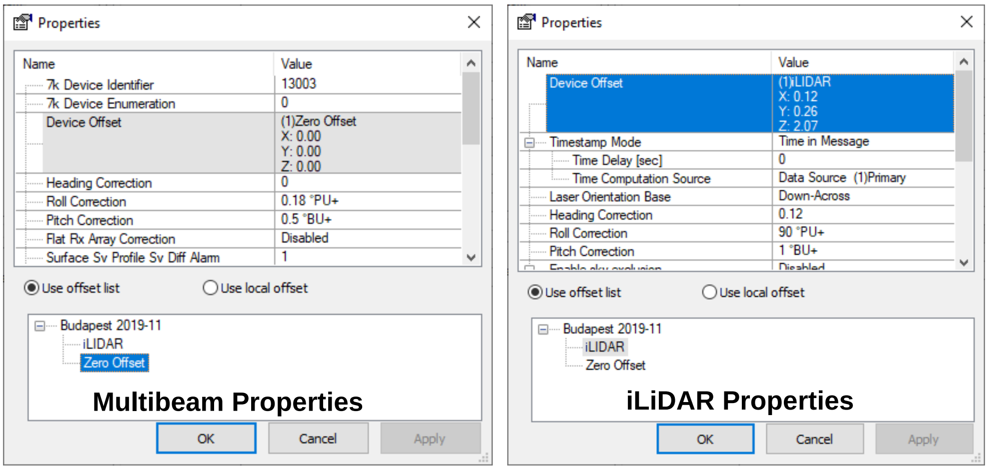
Step 7. Configure I/O Ports

Select each device on the Equipment list and click I/O Port to configure the interfacing parameters, as per the tables in the previous sections.



Step 8. Configure Device Properties and Apply Offsets

For each device on the Equipment list, click Edit to open the Device Properties. Here you must select the offsets to apply, as defined previously on the Geometry setup. Recall that all applied offsets should be zero, except the optional iLiDAR.



The patch test values, if known, may be entered in the device properties for the multibeam and optional iLiDAR. They should be entered in the **Roll Correction**, **Pitch Correction**, and **Heading Correction** fields.

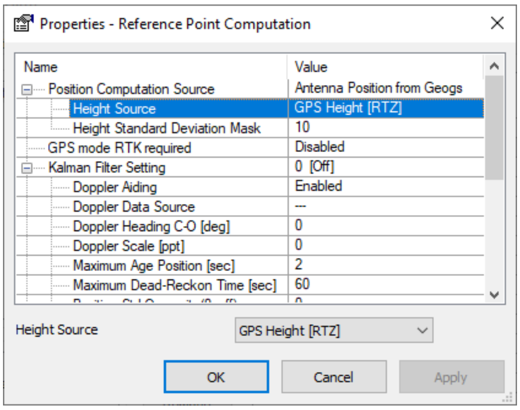
Step 9. Configure Optional LiDAR Properties

If the optional iLiDAR is installed, the orientation base must be set in device properties. This should be set to **Down-Across** assuming the scanner is installed in the standard configuration with connector aft. Refer to the PDS manual for more details.

Step 10. Configure Height Source

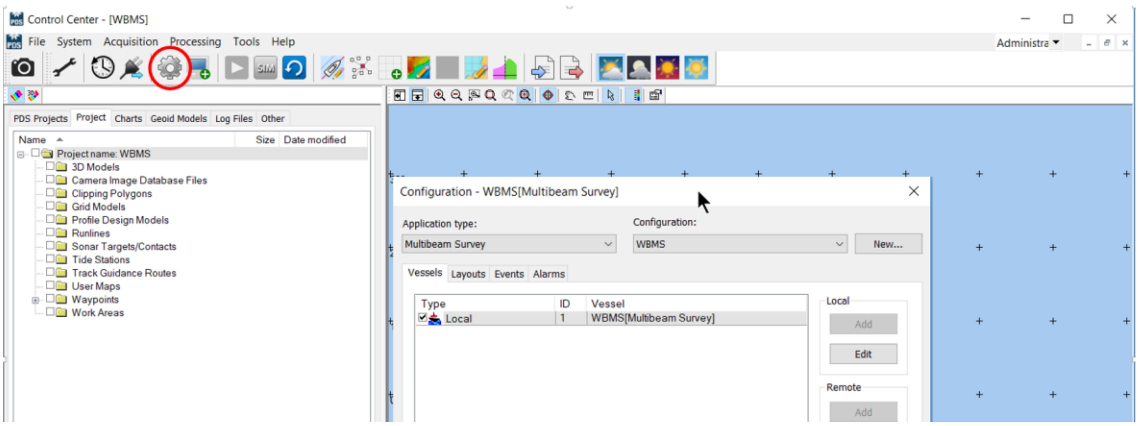
Select **Reference Point Computation** under the positioning device and double click, or press Edit. The height source can be set to **GPS Height [RTZ]** if RTK positioning is available, and if you wish for these heights to be used for depth reduction. Otherwise, set this to **None**.

Height Standard Deviation Mask is a user-defined quality threshold for utilizing RTK heights in the depth calculation. By default, it is set to 0.1m, which means that the GPS Height source will only be applied if the altitude quality reported by the sensor is <0.1m. To ensure that RTK heights are always used regardless of reported quality, set the deviation mask to a high value, e.g. 10m.



Step 11. Complete the Wizard

Now the essential steps are complete. The next pages of the wizard contain optional setup steps, details of which are available in the PDS manual. Finish the wizard to return to PDS Control Center. To return to these settings and modify the vessel configuration, click the gear icon on the toolbar.



10.4 EIVA Setup for WBMS, iWBMS, iWBMSh & iWBMSe

The WBMS GUI Version 10 Hotfix requires that **Force Push** be enabled in the WBMS GUI Connection settings in order to receive data in EIVA. Refer to section 4.6.5 for more information on its functionality.

General instructions are provided for integrating NORBIT sensors in EIVA. For sensors not supplied by NORBIT, additional integration steps may be required which are not explained here. The setup examples used in this section assume that an iWBMS, iWBMSh, or iWBMSe was installed in a standard configuration.

Note that the EIVA sign convention uses **+Up**. This is not the same as the integrated Applanix systems within NORBIT sonars. Incorrect entry of the sign may corrupt data.

The Applanix Ethernet groups required by EIVA are automatically configured on integrated NORBIT systems, thus no action is required. The required groups are: `1, 3, 7, 10, 12, 20, 102, 104, 111` and `113`.

10.4.1 Offsets

By default, integrated NORBIT systems output all sonar and navigation data at the WBMS Reference Point (refer to the Offsets section for more details). Therefore, each sensor in EIVA requires the same identical offset, that is the offset from Center of Rotation to WBMS Reference Point, assuming the CoR is chosen as the EIVA reference point. If the optional iLiDAR is installed, this offset must be separately measured and applied.

⚠ **CAUTION: For Integrated Systems, Sonar and INS Share Same Offset**
Offsets from CoR are required if the INS is setup as recommended in this manual. Referencing data to the CoR reduces heave inaccuracies by replacing the heave data with attitude-induced lever arm corrections.

About the COR: The COR, for larger commercial vessels, is documented in the vessel design plans. For other vessels, this point at which the vessel's roll and pitch axes intersect need to be determined. This is difficult to measure as the vessel CoR may change from day to day, and even during the day. Generally, choose a CoR location that is about ¾ distance from bow to stern, centered on the keel, and located at approximately water level. Especially for smaller vessels, the CoR moves depending on fuel stowage and even distribution of personnel body weight. For example, two persons sitting on the starboard rail of a 6m craft will move the CoR from the keel centerline a distance towards the starboard rail. Choose a location and attempt to keep the weight distribution constant throughout the survey. If in doubt, take the boat to open water and measure its motion while passing over waves in different directions.

This example configuration places the INS reference at the sonar reference, i.e. the INS was configured to output values to the sonar reference location. If users want to base bathymetric measurements referenced to the water level, the only other offset required is a water level correction. This allows application of tide station water level corrections if required. The water level correction involves translating the CoR up/down to the water level and confirmed by a bar check.

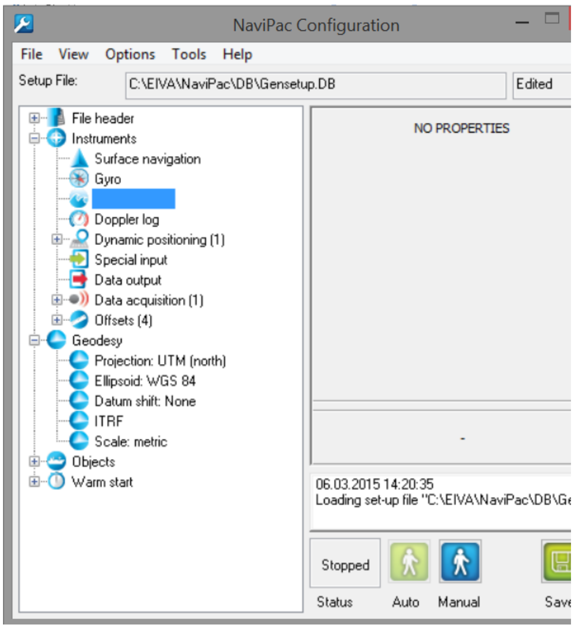
10.4.2 NaviPac Setup

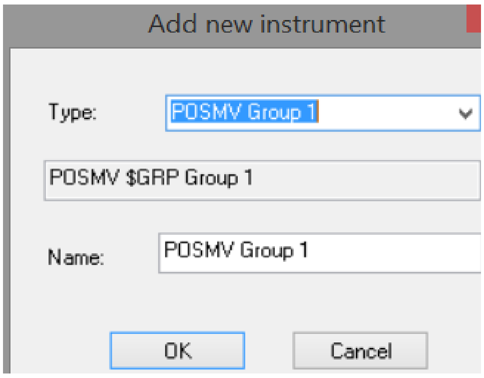
NaviPac is required to perform a multibeam survey with EIVA. It is utilized by the helmsman display, and some additional information is shared with the online recording module, NaviScan.

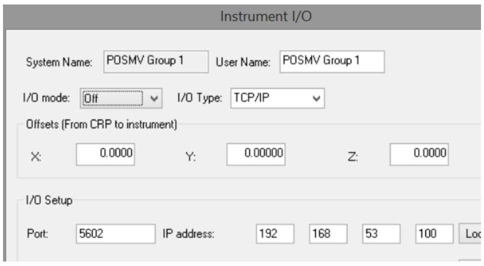
The configuration is performed via the NaviPac Configuration utility. Applanix POS MV is the only required device. Additional survey information may be configured here, but this guide only addresses the essential setup steps required to perform a survey.

Step 1. Add Surface Navigation Instrument

Under Instruments, right click Surface Navigation and add new item. Select POSMV Group 1 from the dropdown list. Enter the network communication parameters, as per below:

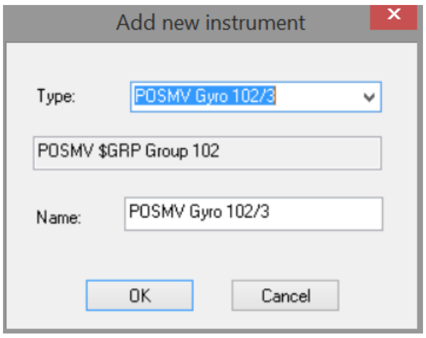


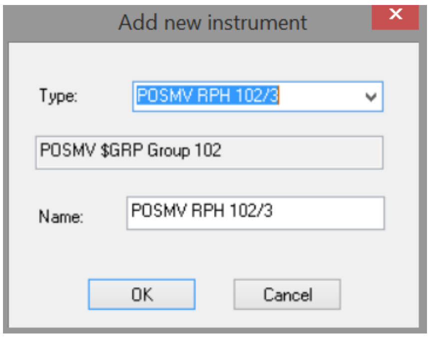




Step 2. Add Gyro and Motion Instruments

Add a Gyro instrument and select POSMV Gyro 102/3. For Motion, select POSMV RPH 102/3



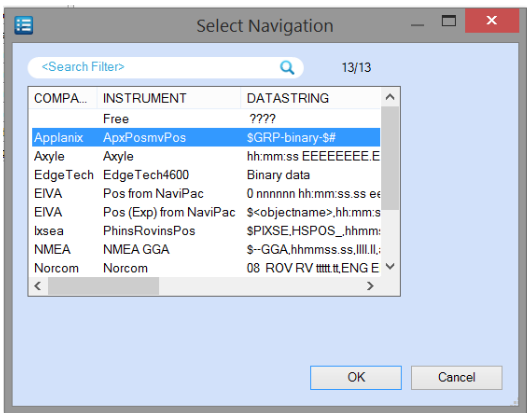


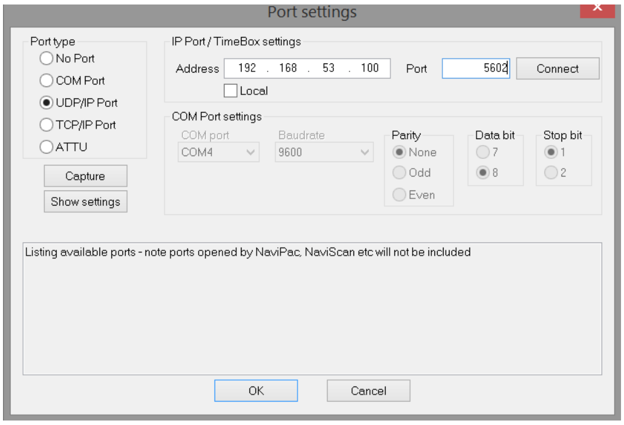
10.4.3 NaviScan Setup

The next step involves adding sensors to NaviScan under the equipment, add sensor drop down menu. To integrate the Applanix INS with EIVA each function must be brought in separately. Therefore, a separate system must be installed for attitude, heading/gyro, and positioning.

Step 3. Add Position Sensor

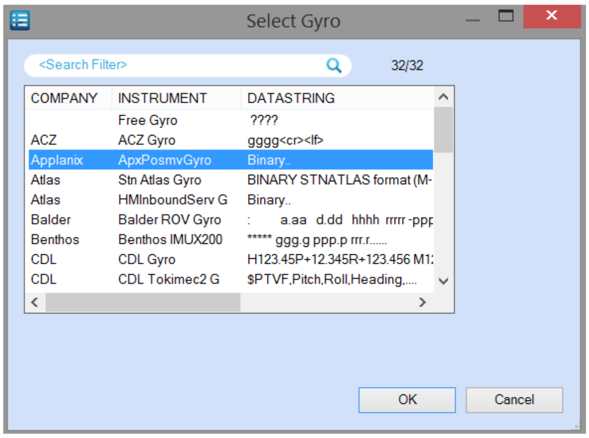
Begin by adding the position sensor. Select position sensor and add Applanix POS MV and configure the network settings to IP address 192.168.53.100, on UDP port 5602.

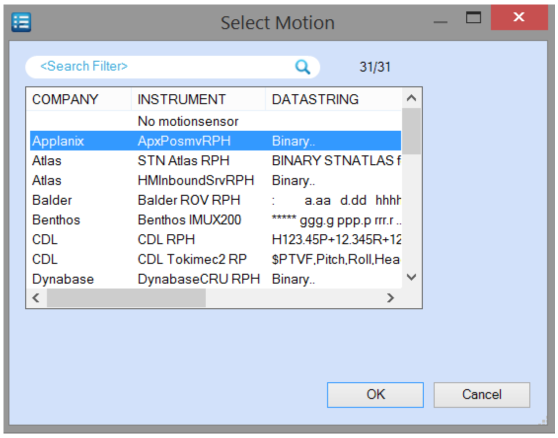




Step 4. Add Gyro Sensor and Motion Sensor

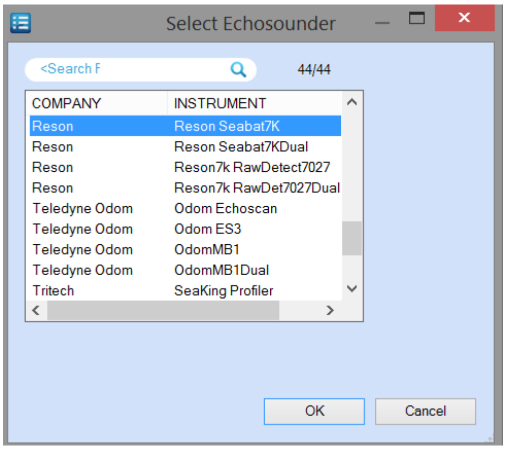
Repeat the previous step to add the Gyro sensor and the Motion sensor. Under add sensor, select Gyro and Motion, respectively, and in each case choose the Applanix option. Configure the network settings as per the previous step.

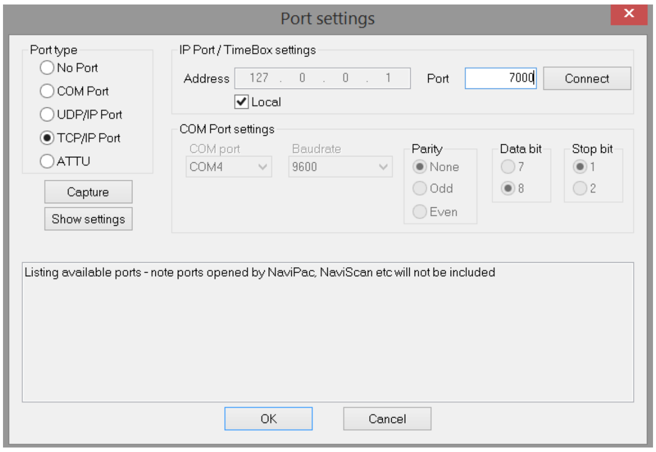




Step 5. Add Echosounder

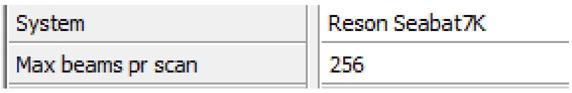
To integrate the WBMS, go to Add Sensor and choose Echosounder. Select the **Reson SeaBat 7k** driver. In the port settings select TCP/IP Port, enable Local, and use port 7000.



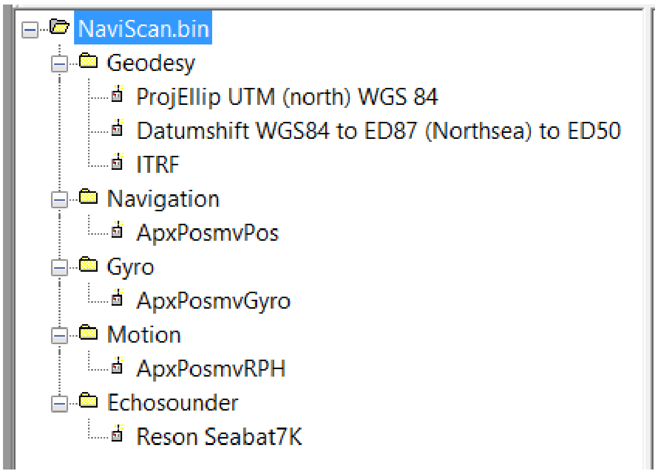


Step 6. Configure Max Beams

Click on Reson SeaBat 7k under multibeam in the project tree. To the right of the project tree, under enter **256** for Max beams per scan.



The final NaviScan project tree looks like the following:

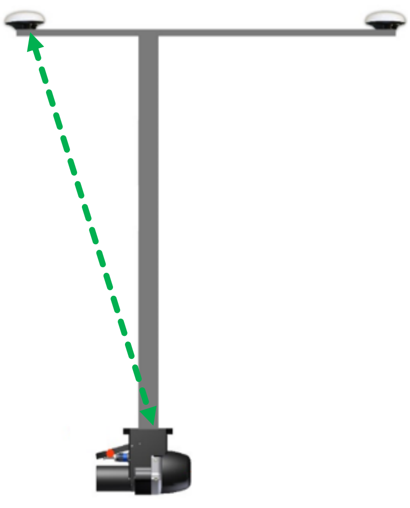


Appendix A: Quick Start Guide

Users are advised to refer to this section for a quick, basic installation guide without detailed descriptions of each operation. NORBIT recommends that users familiarize themselves with detailed descriptions of each operation/function before using this guide.

WBMS sonar-only users should skip sections related to INS configurations.

1. ***Unpack and Inspect:*** Unpack sonar system and inspect all cables and connectors for damage, dirt and moisture. Inspect the sonar for especially around the transducers for cuts or gouges.
2. ***Sonar Installation:*** Depending on vessel being used, make an installation plan. Follow this plan to mount sonar (ideally with NORBIT bracket) on the vessel and align unit to be parallel with the vessel keel with the projector pointing aft. Bolt sonar bracket to pole with minimum of 4 bolts. Use lock-washers and/or LOC-TITE especially for longer duration setups as nuts will vibrate and loosen over time. Users are advised to connect wet-end sonar and IMU cables before mounting the system. This simplify the process of securing cables.
3. ***Antennas:*** For GNSS/INS integrated WBMS: Mount GNSS antennas with 5/8" threaded bolts. While not necessary, it is helpful to align GNSS antennas to be parallel or perpendicular to vessel keel. The antenna closest to the WBMS is the primary. Select an antenna cable, label it at both ends (to prevent confusion) and use this to connect primary antenna to Ant1 on the SIU. Connect the secondary antenna to Ant2.
4. ***Cables:*** Run cables from sonar and antennas to SIU. Avoid sharp bends and be cautious of chafing. Handle cables with care – rough handling will bend connector pins in the cables and lead to loss of signal. Do not run cables next to high voltage lines – spread cable out to avoid RF interference.
5. ***SIU & PC:*** Connect the SIU to the control and acquisition PC via ethernet. Before powering the sonar set the IP address of the PC to 192.168.53.XXX where XXX can be any number from 101 to 255; set the subnet mask to 255.255.255.0
6. ***RTK:*** If RTK is being used, set it up as needed.
7. ***Offsets:*** For the default setup, measure offsets (green dotted line in image) from **Top Center of Bracket to base of primary antenna** (the antenna closest to the WBMS Reference Point).



8. ***Power:*** Ensure power source is clean. Be aware of batteries that are under powered or cheap inverters.
9. ***Software:*** On the control and acquisition PC, install the WBMS GUI version 10.4.0. For iWBMSc users, also install NovAtel Connect. With all hardware connected to the SIU, power it on and open WBMS 10.4.0. On the **Connection State** tab wait until the Control Line, Firmware and Sonar Log turns green. Then click on Connection Dialog and select the correctly detected sonar and click Connect. Once connected, the GUI should start logging GNSS/IMU data automatically.
10. ***INS Setup:*** In the GUI, navigate to **INS Tools** in the settings menu and open **INS Setup Wizard**. For the default and recommended setup, simply follow the prompts in the setup wizard and have the measured offsets, from top center of bracket to base of primary antenna, at hand. For the baseline vector, select **Alignment Wizard**. This way, the wizard will open automatically once the setup wizard is complete. The **Alignment Wizard** was known as the GAMS calibration in POSView. This process ensures agreement in the heading alignment between the GNSS and INS. For NovAtel users please refer to the NovAtel Setup information section of this manual for setup instructions.

11. ***Separate INS Software:*** Not applicable for iWBMSe, iWBMS & iWBMSh users running Applanix firmware >9.03 and sonar 10.4.0. Setup NovAtel Connect (Compact) or Applanix POSView (iWBMS). Enter in the measured offset to the primary antenna and separation distance to secondary antenna (POSView). Also enter the offsets from reference to CoR in the acquisition software. See below appendices.
12. ***Acquisition:*** Setup the acquisition software of choice, e.g. HYPACK, QINSy, etc. Offsets to be with respect to the vessel center of rotation. The driver for the WBMS will be the RESON 7125 or 71xx. Newer software, the driver is called NORBIT.
13. ***Tides:*** For verification that the INS system is ready for survey when using RTK, it is a good practice to use a time series graph of the tide values. As soon at the graph stabilizes on a narrow value range the system should be ready for survey.
14. ***Bar Check:*** Run a bar check to validate sonar draft.
15. ***Sound Speed:*** Verify the sound speed reported by the sensor on the sonar by comparing it to another sensor, e.g. a sound speed profiler.
16. ***Patch Test:*** Run a patch test each time the sonar is installed or moved from its previous location.
17. Have fun!

Appendix B: Advanced Applanix Setup

While NORBIT has integrated many features of the Applanix into the NORBIT GUI, some features were not included to keep operation clean and simple. The features not included are typically used by a small subset of NORBIT users. If you require a feature that is not found inside the NORBIT GUI you may have to utilize POSView. If an item is not found within this section, please refer to the Applanix user guide.

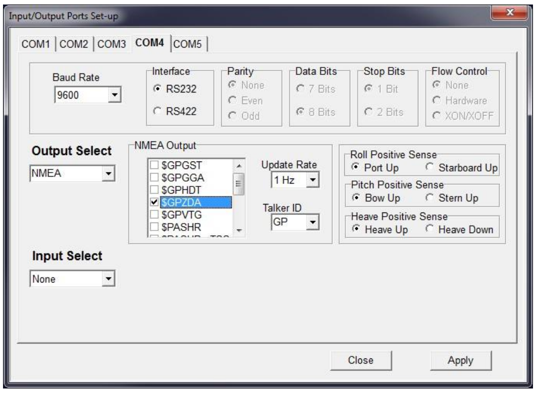
POSView can be used in conjunction with the NORBIT GUI. However, during INS setup in the NORBIT GUI, POSView must be in the monitor state and not in the connected state.

⚠ **CAUTION: Use Correct POSView Version**

Do not use a POSView version that is incompatible with POS firmware installed on the sonar system. Doing so can cause unexpected errors in the POS MV system.

Alternate COM port setup

Some scenarios may require an alternate setup of the POS MV Com ports. Refer to the table below for guidance on handling some of these special scenarios. If a desired setting is not shown in the table below, contact NORBIT support for assistance.



Scenario	Solution
A sensor in use requires heading in NMEA format. I am using an NTRIP service that required GPGGA	Obtain a DB9 Y splitter. Set COM 3 to output a GPGGA string required by NTRIP and select a GPHDT string required by the device. Set the baud rate and the update rate to a setting required by the device. Use one side of the Y splitter to connect to the computer for NTRIP and connect the other end to device. *If the baud rate is set high enough there should be no issue in outputting any number of NEMA strings from the iWBMS
A sensor in use requires the real-time heave calculated at its position on the vessel and I am using base station broadcasting RTK correctors.	Under, **Lever Arms & Mounting Angles** > **Sensor Mounting**, enter the XYZ offsets to the sensor in question. Under the COM 3 output select Binary and select the message string, and the device update rate. To the right of the update rate select Sensor 2. Under input, select Base 1 and select the type of correctors being used. Use a Y splitter to bring RTK corrections into the SIU and the Binary message to the desired device. In some applications a Null modem may be needed.

A sensor in use requires the real-time heave calculated at its position on the vessel and I am using NTRIP for RTK correctors	Follow the above steps for setting up the POS MV and set NTRIP service to a static position and input a position preferably located in the center of the survey area.
I have a GPS receiver tied to my satellite corrector subscription service and need to bring it into the POS MV on the WBMS.	Under **Lever Arms & Mounting Angles** > **Sensor Mounting**, enter the XYZ offsets to the auxiliary GPS receiver under the Ref to Aux 1 GPS. Under Input & Output Configure COM 3 Input to AUX 1 GPS. This allows the POS MV to base its positions off the more accurate position obtained from the auxiliary GPS receiver

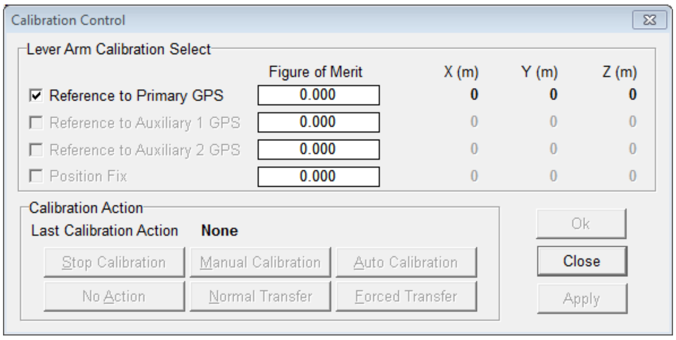
Running Installation Calibration Control

When offset measurements from the IMU sensing center to antenna phase center is not accurately measured or difficult to measure due to long measurement runs and around many bulkheads then it is possible to automatically calculate these offsets using POSView. This requires clear views to at least 6 GNSS satellites that are positioned in different orthogonal quadrants with at least one satellite (nearly) directly overhead and a strong RTK Fix positioning solution. Enter in the best measured offsets (determined from a mean of multiple calibrations) to the “Reference to Primary Antenna” in the Lever Arms window.

CAUTION: Installation Calibration Control Is Not Reliable

Use of the Installation Calibration Control routine should only be used if physical offset measurements cannot be performed. The routine should be run a minimum of 3 times and values averaged.

Go to **Settings** > **Installation** > **Installation Calibration Control**. This opens the dialogue window shown below. Select **Reference to Primary GPS**, then select **Auto Calibration** and **OK**. Immediately begin moving the vessel through tight figure-of-eight motions. The Figure of Merit will begin to count to 100 as solutions are determined. When complete, record the newly derived offsets on paper and run again. When the values remain steady to within 1cm, select **Normal Transfer** to copy these values to the **Ref. To Primary GPS Lever Arm**. Select **Save Settings** in the Settings pull-down. If the reference location in the POS MV is chosen to be a point other that the sensing center of the IMU, then apply the additional offsets to the derived values. Following this procedure, run a GAMS calibration.



Applanix POS MV Nav Status

Applanix POS MV v8.63 incorporates the following navigation status types. The Nav Status displays the source and quality of the GNSS sensors and the resulting mode of the navigation solution. These are listed below with those highlighted in green being the best solutions:

Nav Status	Description
DR (Dead Reckoning)	No GNSS input is available; navigation is using only the IMU data
RTCM DGNSS	Navigator is tightly coupled using the primary GNSS raw observables plus base GNSS corrections (RTCM 1 or 9)
CODE DGNSS	Navigator is tightly coupled using the primary GNSS raw observables plus base GNSS corrections (RTCM 18 and 19, CMR, CMR+)
FLOAT RTK	Navigator is tightly coupled using the primary GNSS raw observables plus base GNSS corrections (RTCM 18 and 19, CMR, CMR+)
FIXED RTK	Same as Float RTK but better accuracy
Pri. C/A	Navigator is closely coupled using the primary GNSS position data in C/A mode
Pri. DGNSS	Navigator is closely coupled using the primary GNSS position data in DGNSS mode
Pri. P Code	Navigator is closely coupled using the primary GNSS position data in P-CODE mode
Pri. FIXED / FLOAT RTK	Navigator is closely coupled using the primary GNSS position data in RTK mode
Aux. DGNSS	Navigator is loosely coupled using the auxiliary GNSS position data in DGNSS mode
Aux. P Code	Navigator is loosely coupled using the auxiliary GNSS position data in P-CODE mode
Aux. Float RTK	Navigator is loosely coupled using the auxiliary GNSS position data in Float RTK mode
Aux. WL RTK	Navigator is loosely coupled using the auxiliary GNSS position data in Wide Lane RTK mode
Aux. NL RTK	Navigator is loosely coupled using the auxiliary GNSS position data in Narrow Lane RTK mode

Decoupled IMU Mounting

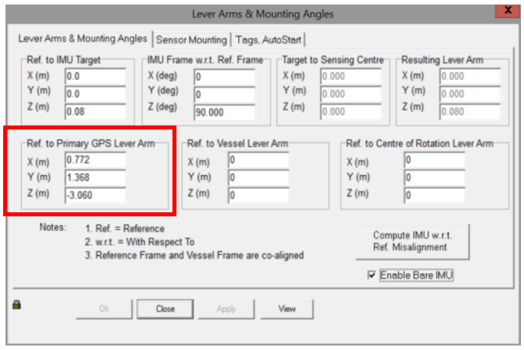
In some scenarios, it may be required that the IMU be decoupled from the sonar and mounted elsewhere on the survey vessel. This requires additional offsets that are not required for a typical iWBMS installation. Depending on the IMU mounting location, additional offsets may include IMU to vessel center of rotation (CoR) and CoR to sonar phase center. Should the user decide to use the IMU as the vessel reference then the IMU to CoR offset is not needed.

To decouple the WBMS from the IMU start by removing the four bolts at the back of the iWBMS bracket. This should be done with the iWBMS resting on a padded surface to reduce the chances of damage. Once the 4 bolts are removed carefully separate the IMU from the sonar taking care to not lose the dowel nuts located in the base plate of the IMU.

For mounting the IMU, NORBIT provides an optional mounting plate that mounts the IMU (shown in the appendix) in its NORBIT housing, with the connector facing towards the bow of the survey vessel. In this mounting configuration there is a +90° Z axis rotation.

Should the user opt to mount the IMU without the optional NORBIT mounting plate the dowel nuts can be used. This requires that the IMU be secured to a mounting location that facilitates tightening the mounting screw from underneath. The utilized screws should be M6 and of an enough length to extend 23mm from the top of the mounting plate for securing the IMU.

In the decoupled mounting configuration, offsets from the IMU/CoR to **WBMS Reference Point** must be applied in the chosen acquisition software. If the IMU is at not the CoR/vessel reference point, the IMU offsets also must be measured and applied in the acquisition program.



In the decoupled mounting configuration, the IMU offset should be measured from the vessel CoR to the center of the IMU fairing. The sensing center of the IMU is 0.08m below the top of the fairing. This value should be entered in **Ref. to IMU Target**. Offsets highlighted in red must be entered based on vessel offsets.

Two cables are required if operating the system in a decoupled configuration: the standard split cable for the IMU and a separate WBMS cable for the sonar.

For further information and assistance with this, please contact NORBIT support. Once POS starts receiving the Marinestar signal, the Nav Status will change to "Pri. Marinestar GPS" on the main POS MV display.

Ref to Center of Rotation Lever Arm

During surveys where RTK or PPK are not/cannot be utilized then the offset from WBMS Reference Point to vessel center of rotation should be entered to the Applanix POS MV. Applying these offset aids, the Applanix in properly computing both real-time heave as well as delayed heave. Extreme care must be taken when entering in these offsets as there is no way to correct incorrect offsets in post-processing. Failure to accurately enter the offsets results in incorrect heave calculation and degrades data quality.

⚠ **CAUTION: Mistakes Cannot Be Fixed in Post-Processing**

Mistakes in Ref to CoR offsets cannot be fixed in post-processing. Extreme care must be taken when entering in offset values. Thoroughly review values prior to surveying

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Antenna Offsets

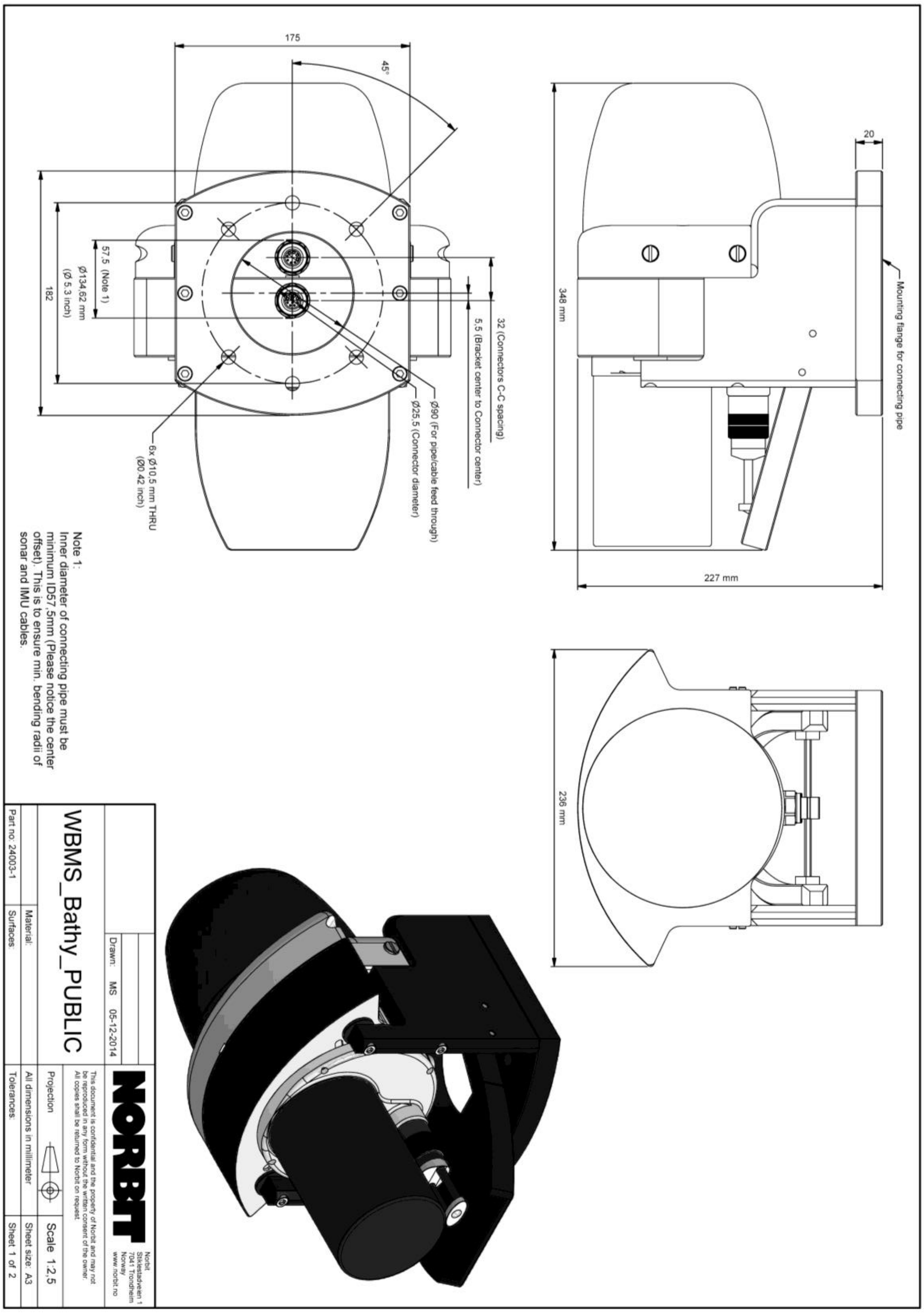
The GNSS antennas below are the most common antennas found with NORBIT KITS. The measurements shown are from base of the antenna to its phase center.

Trimble 540AP Antenna: 58mm (0.190ft)

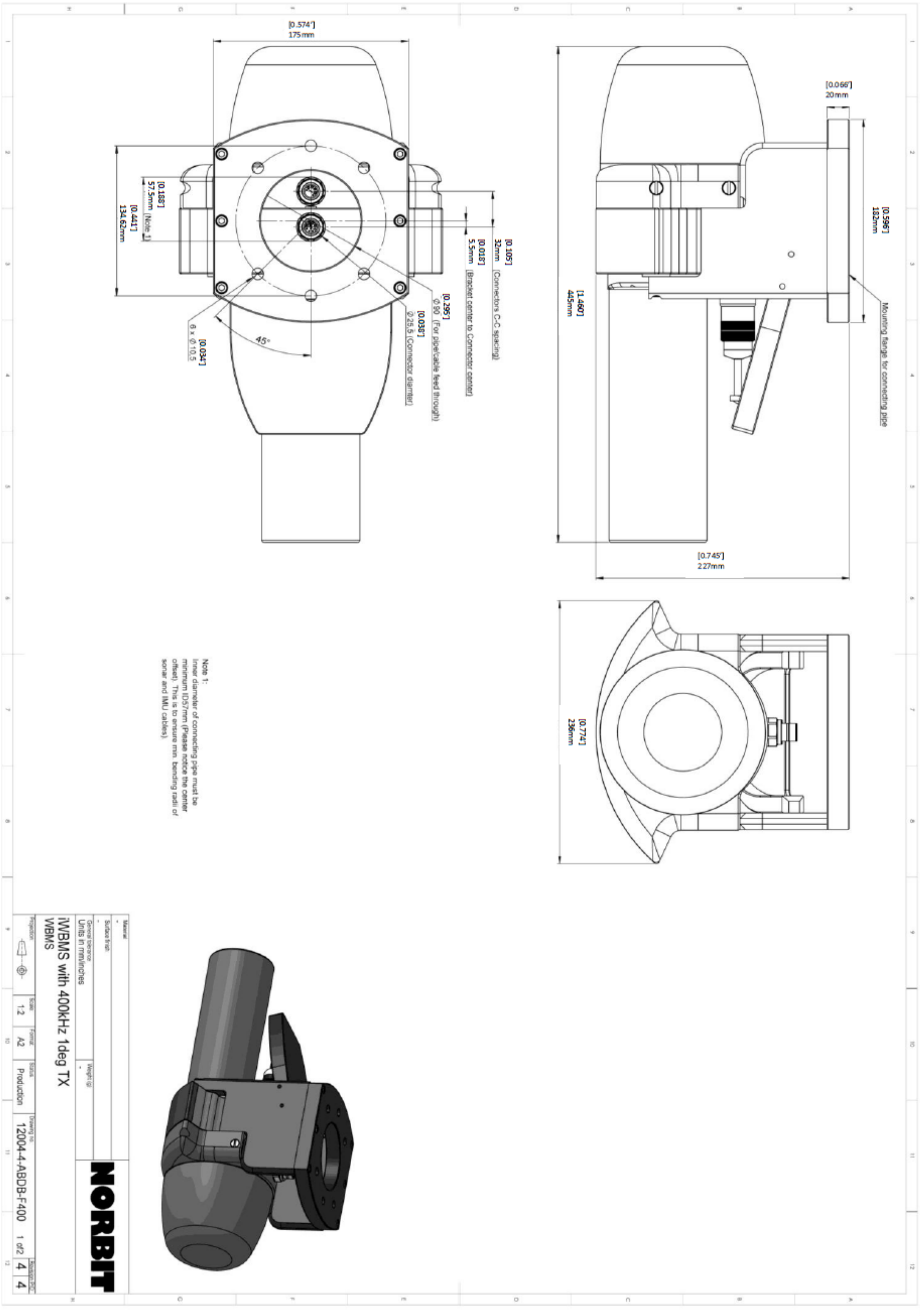
Trimble 382AP Antenna: 66mm (0.217ft)

Appendix C: Sonar Hardware Dimensions

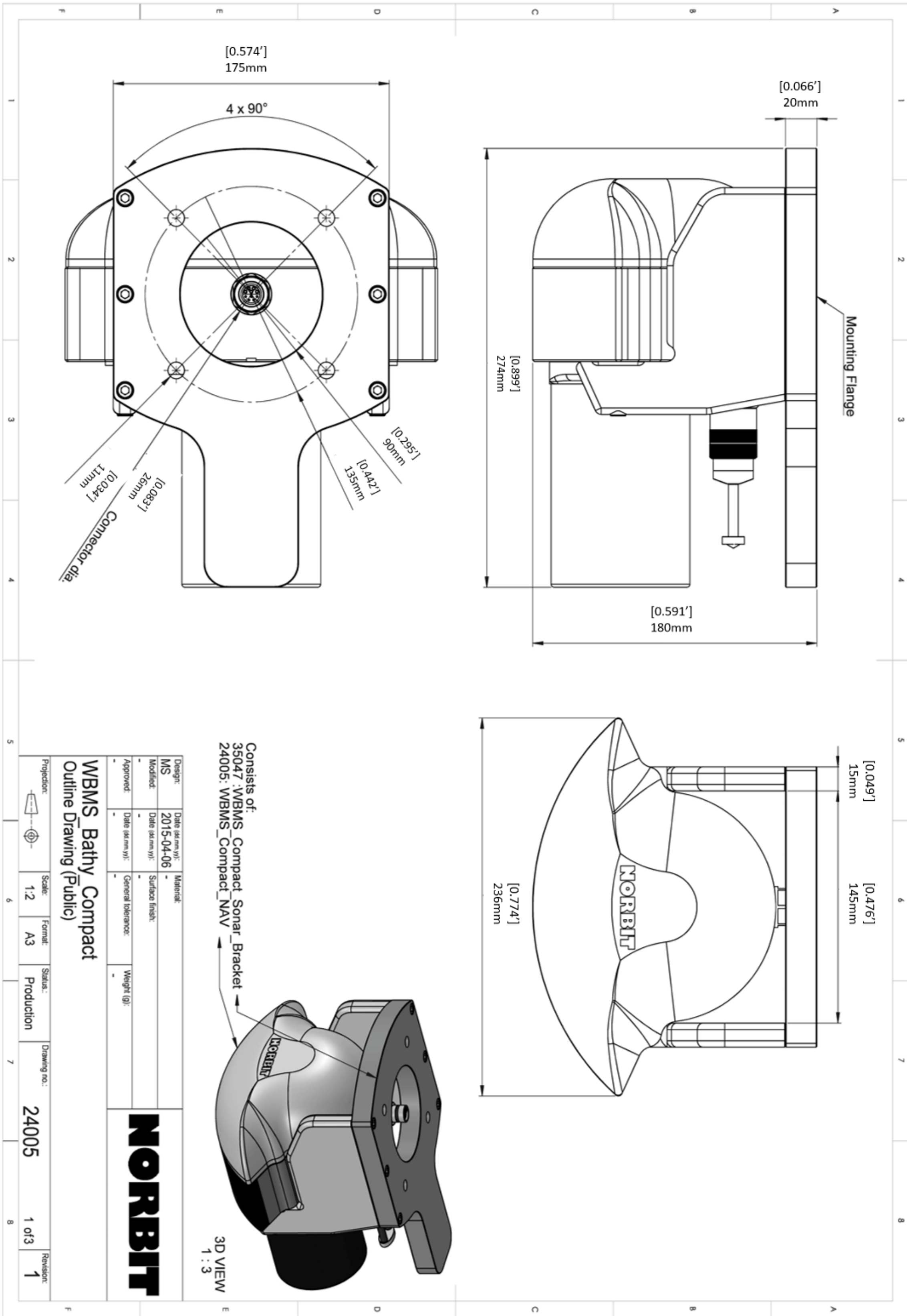
C1. 12004 iWBMS / 12007 iWBMSh – Wet-end Dimensions (PN 24003-ACDB)



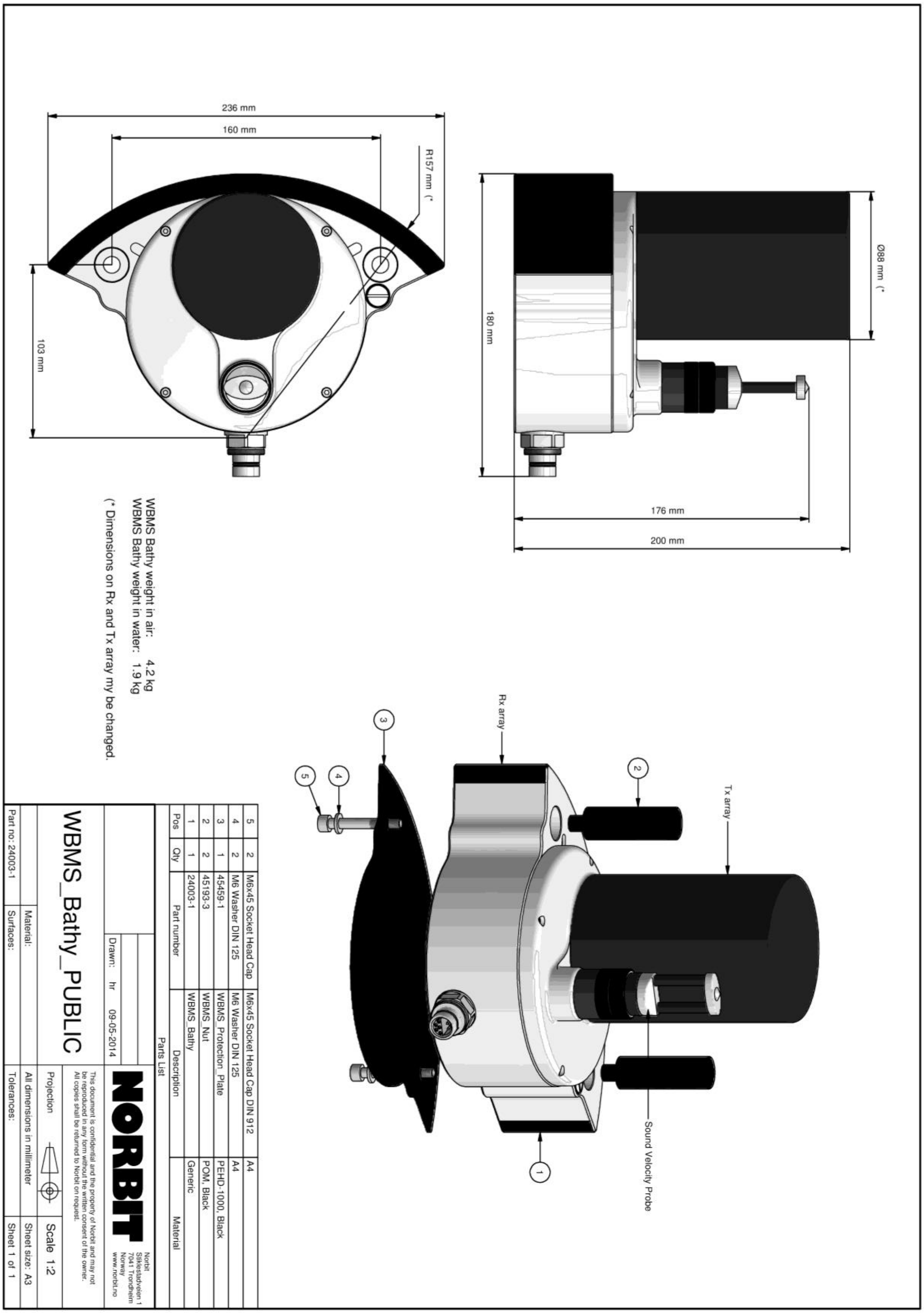
C2. 12004 iWBMS / 12007 iWBMSh 0.95°Tx Wet-end Dimensions (PN 24003-ABDB)



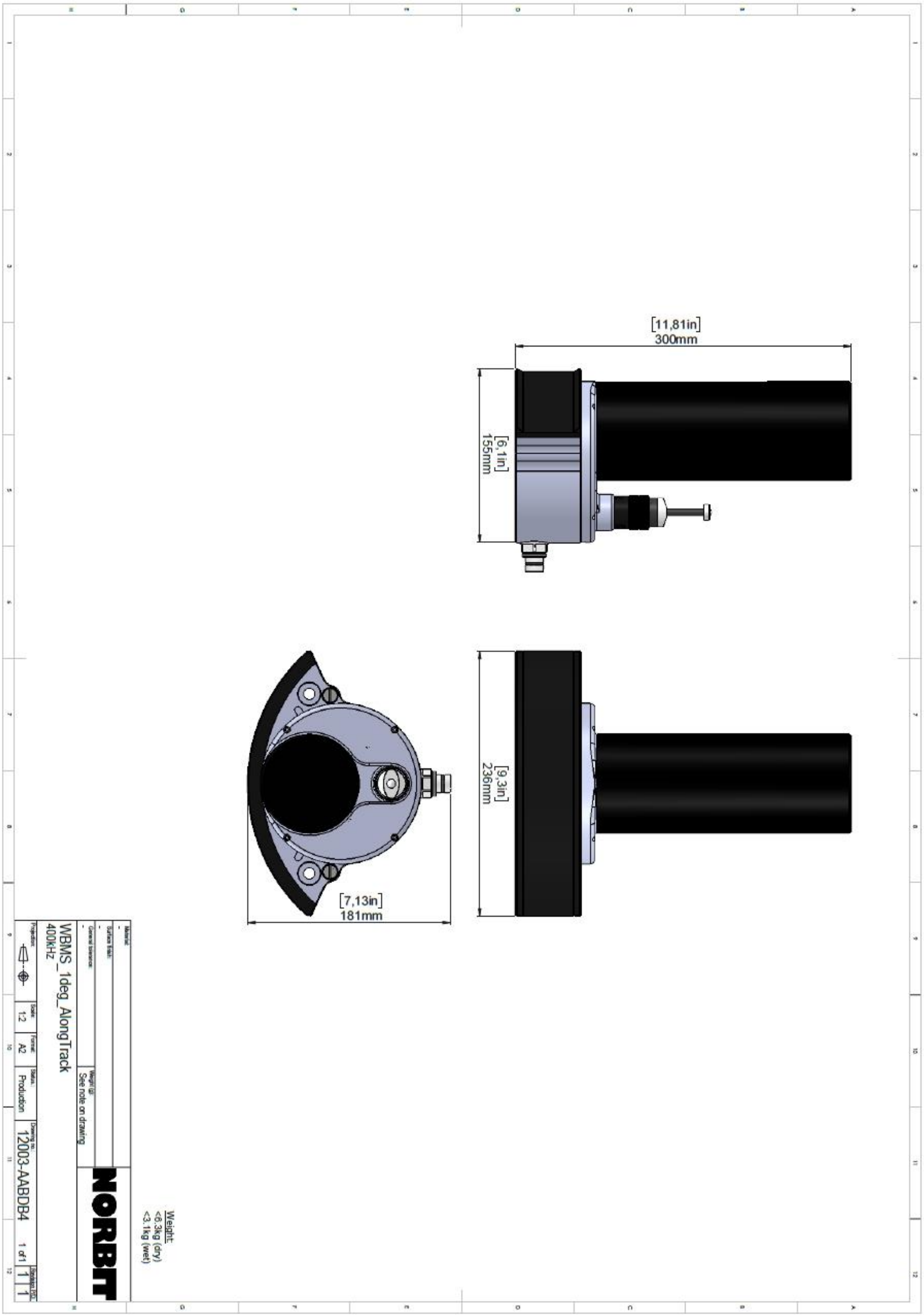
C3. 12005 iWBMSc / 12006 iWBMSe – Wet-end Dimensions – PN 24005/24018



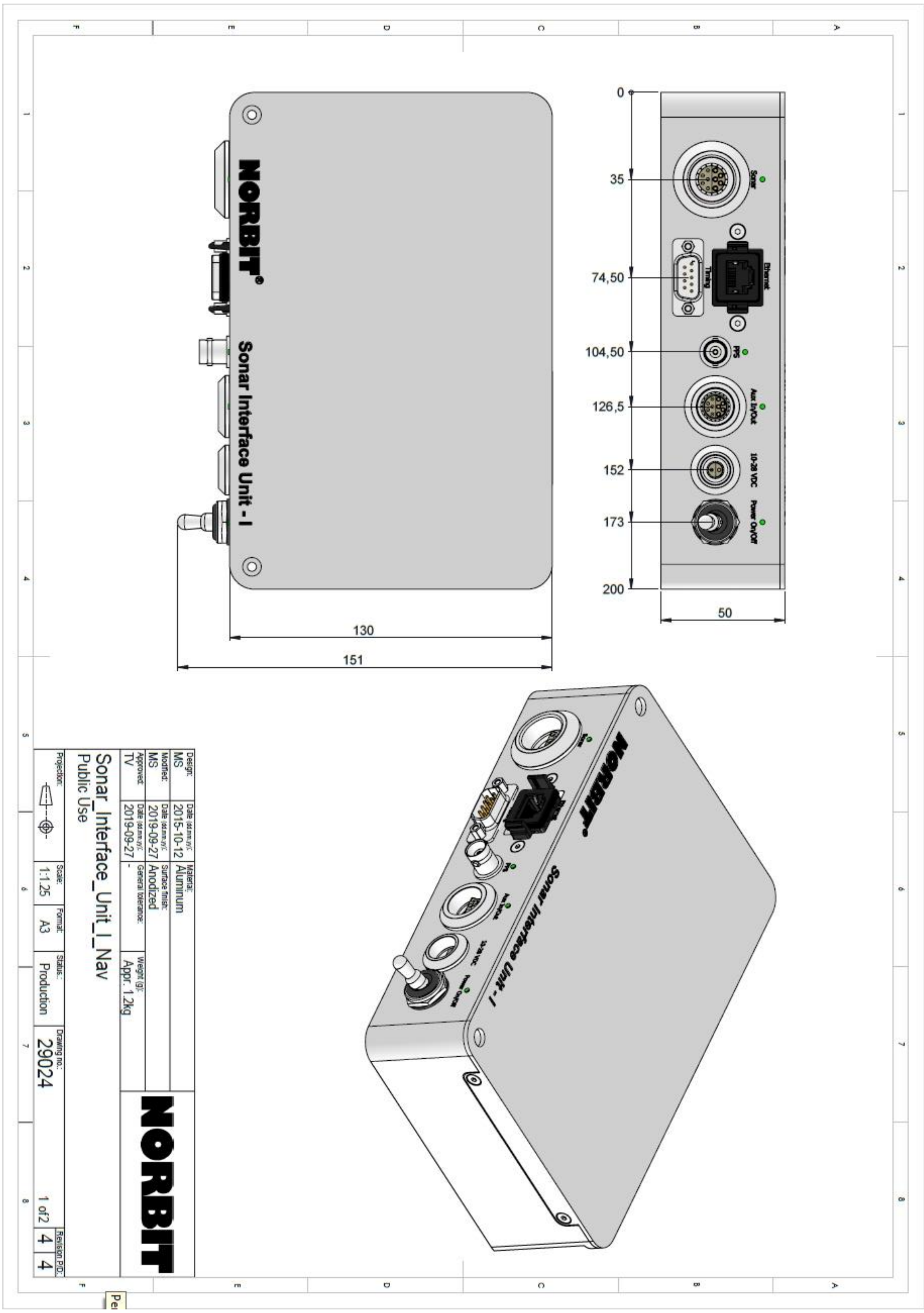
C4. 12003 WBMS – Wet-end Dimensions (PN 24003-ACDB)



C5. 12003 WBMS with 0.95° Tx – Wet-end Dimensions (PN 24003-ABDB)



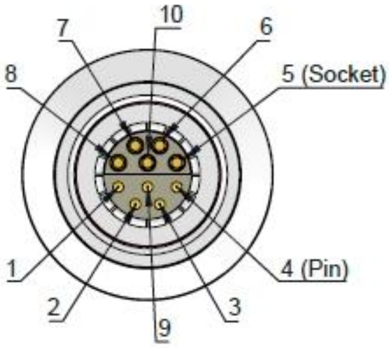
C6. WBMS Sonar Interface Unit (SIU) Dimensions (PN 29024)



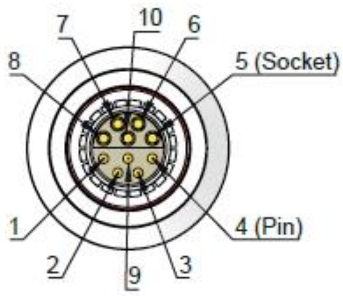
Appendix D: Cable Pinout Diagrams

D1. WBMS Sonar Interface Unit (SIU) Socket Pin Description (PN 29024)

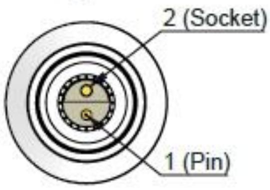
SIU-I
Part No: 29024-4



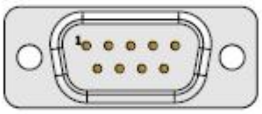
Sonar Socket	
No.	WBMS Function
1	LAN TX +
2	LAN TX -
3	LAN RX +
4	LAN RX -
5	RS-232 TX
6	RS-232 RX
7	IRIG-B
8	IRIG-B/RS-232 GND
9	PWR GND
10	PWR +24V



AUX In/Out Socket	
No.	WBMS Function
1	
2	
3	RS-232 TX
4	RS-232 RX
5	
6	
7	
8	
9	PWR GND
10	



12-28 VDC Socket	
No.	WBMS Function
1	PWR GND
2	PWR + 12-28 VDC



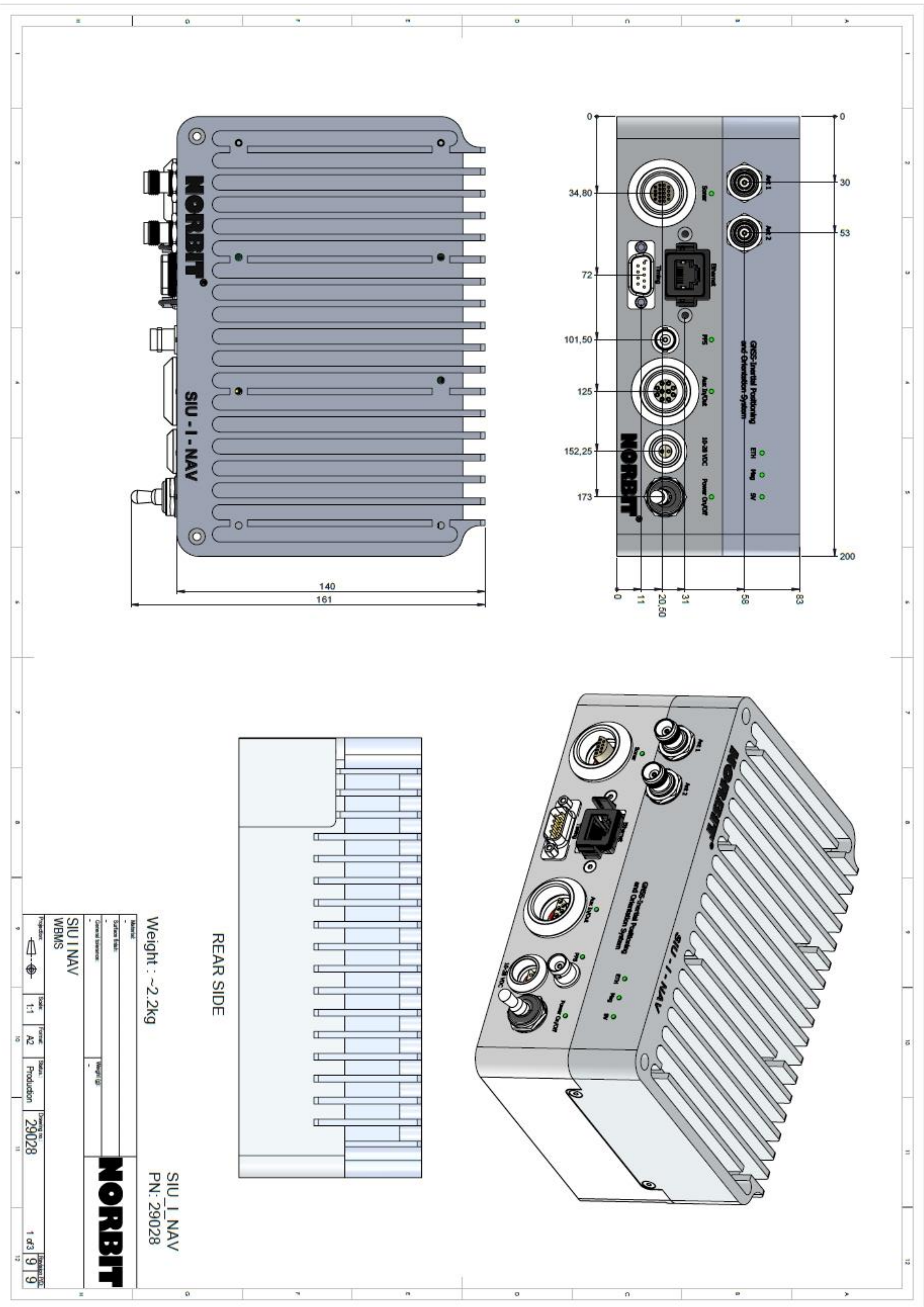
GPS Socket / BNC	
No.	WBMS Function
2	TIMING TX (RS-232)
3	TIMING RX (RS-232)
5	GND
9 / BNC	PPS

Design: MS	Date (dd.mm.yy): 2015-10-12	Material: Aluminum		NORBIT
Modified: MS	Date (dd.mm.yy): 2019-09-27	Surface finish: Anodized		
Approved: TV	Date (dd.mm.yy): 2015-10-12	General tolerance: -	Weight (g): Appr. 1.2kg	

Sonar_Interface_Unit_I_Nav
Public Use

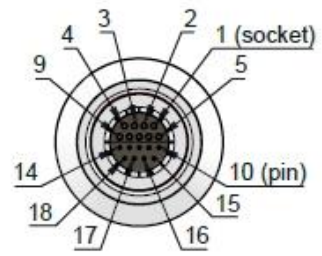
Projection:	Scale: 1.5:1	Format: A4	Status.: Production	Drawing no.: 29024	2 of2	Revision P/D: 4 4

D2. iWBMS Integrated Sonar Interface Unit (iSIU) Dimensions (PN 29028)

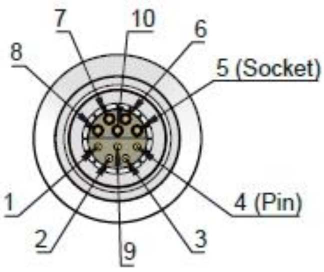


D3. iWBMS Integrated Sonar Interface Unit Socket Pin Description (PN 29028)

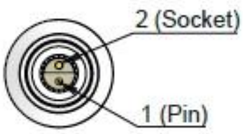
SIU_I_NAV
PN: 29028



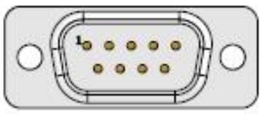
Sonar Socket	
No.	WBMS function
1	GND
2	GND
3	24 VDC
4	24 VDC
5	IMU COMM1
6	IMU COMM2
7	LAN, TX+
8	LAN, RX+
9	IRIG-B
10	IMU COMM3
11	IMU COMM4
12	LAN, TX-
13	LAN, RX-
14	Signal GND (IRIG-B, RS232)
15	RS232 TX
16	RS232 RX
17	IMU COMM8
18	IMU COMM9



AUX In/Out Socket	
No.	WBMS Function
1	LAN TX+
2	LAN TX-
3	LAN RX+
4	LAN RX-
5	RS232 TX
6	RS232 RX
7	Trigger/GPIO
8	RS232/Trig GND
9	PWR GND
10	PWR + 24 VDC



12-28 VDC Socket	
No.	WBMS Function
1	PWR GND
2	PWR + 12-28 VDC



GPS Socket / BNC	
No.	WBMS Function
2	Applanix COM3 TX
3	Applanix COM3 RX
5	GND
9 / BNC	PPS

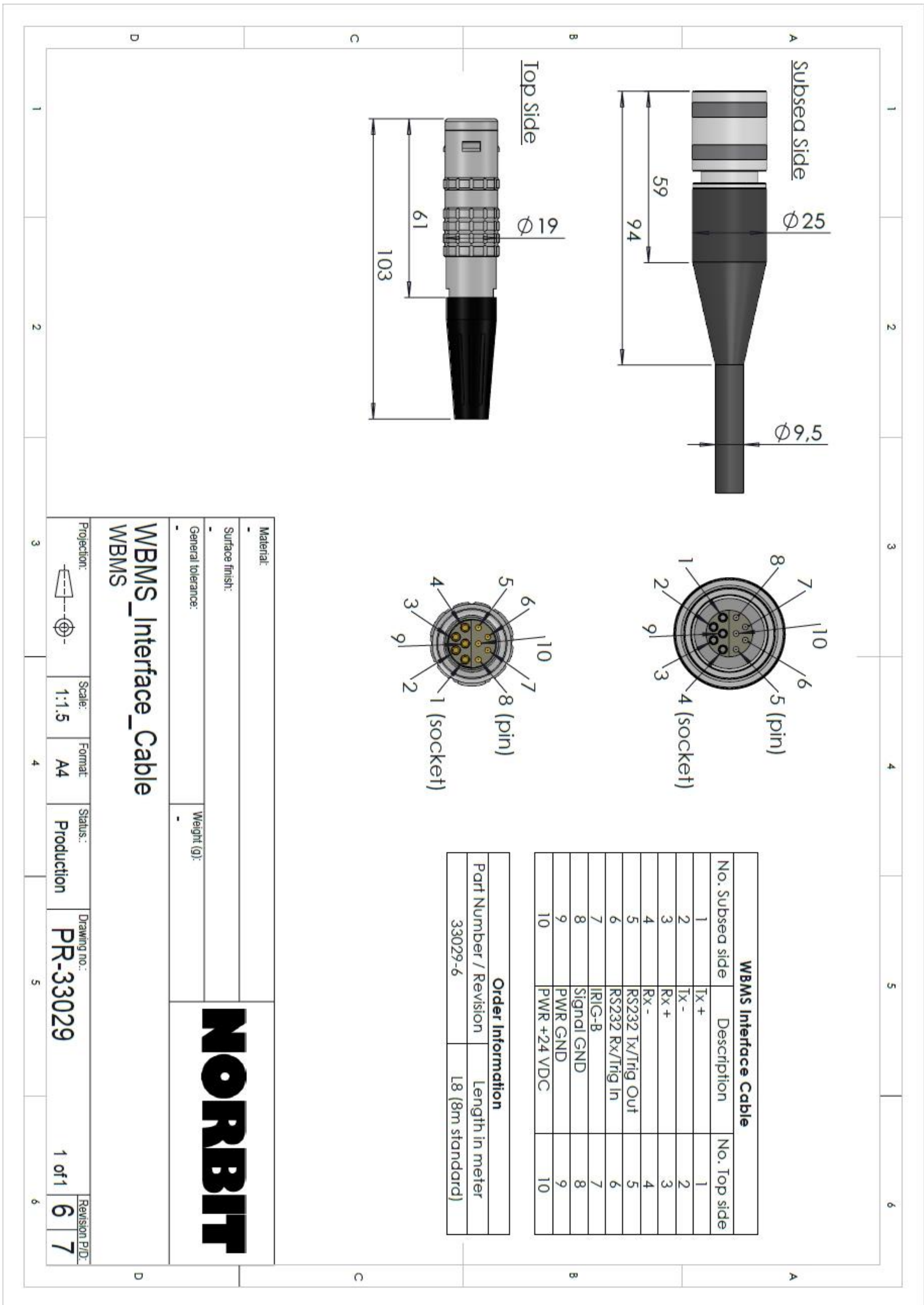
Design:	Date (dd.mm.yy):	Material:	
HR	2014-04-23	-	
Modified:	Date (dd.mm.yy):	Surface finish:	
MS	2019-09-27	-	
Approved:	Date (dd.mm.yy):	General tolerance:	Weight (g):
TV	2019-09-27	-	1452.44

NORBIT

SIU I NAV Socket
WBMS

Projection:	Scale:	Format:	Status.:	Drawing no.:	Revision P/D:
	1:2	A4	Production	29028 2 of3	9 9

D4. WBMS Interface Cable Pin Description (PN 33029)



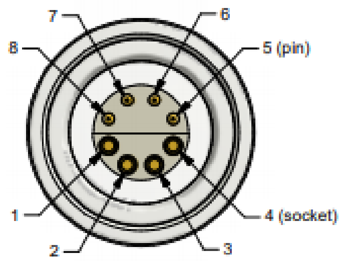
WBMS Interface Cable

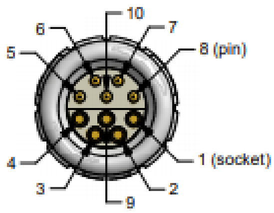
No. Subsea side	Description	No. Top side
1	Tx +	1
2	Tx -	2
3	Rx +	3
4	Rx -	4
5	RS232 Tx/Trig Out	5
6	RS232 Rx/Trig In	6
7	IRIG-B	7
8	Signal GND	8
9	PWR GND	9
10	PWR +24 VDC	10

Order Information

Part Number / Revision	Length in meter
33029-6	L8 (8m standard)

D5. WBMS Interface Cable Pin Description (PN 33075)





IMU Interface Cable	
No. Subsea side	Description
1	IMU_COMM9
2	IMU_COMM8
3	PWR +24 VDC
4	PWR GND
5	IMU_COMM4
6	IMU_COMM3
7	IMU_COMM2
8	IMU_COMM1

IMU Interface Cable	
WBMS function	No. Top side
IMU_COMM9	1
IMU_COMM8	2
NC	3
NC	4
IMU_COMM4	5
IMU_COMM3	6
IMU_COMM2	7
IMU_COMM1	8
PWR GND	9
PWR +24 VDC	10

Drawn: tv 2018-11-08

NORBIT

Norbit
Stiklestadveien 1
7041 Trondheim
Norway
www.norbit.no

WBMS_IMU_Interface Cable PUBLIC

Projection

Scale 1.5:1/1:1

Material:

All dimensions in millimeter

Sheet size: A4

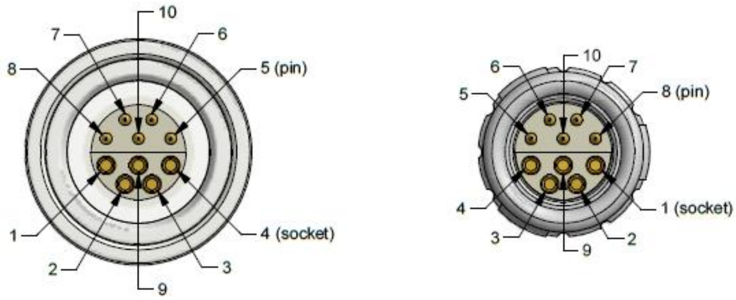
Part no: 33075-4

Surfaces:

Tolerances:

Sheet 1 of 1

D6. WBMS Interface Cable Pin Description (PN 33029)

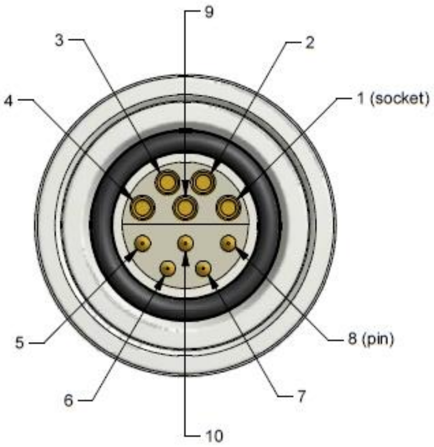


WBMS Interface Cable		
No. Subsea side	Description	No. Top side
1	Tx +	1
2	Tx -	2
3	Rx +	3
4	Rx -	4
5	RS232 Tx/Trig Out	5
6	RS232 Rx/Trig In	6
7	IRIG-B	7
8	Signal GND	8
9	PWR GND	9
10	PWR +24 VDC	10

Order information	
Part number/revision	Lenght in meter
33029-6	L8 (8m standard)

	Drawn: TV 2017-02-16	NORBIT	Norbit Stiklestadveien 1 7041 Trondheim Norway www.norbit.no
WBMS_Interface_Cable PUBLIC		This document is confidential and the property of Norbit and may not be reproduced in any form without the written consent of the owner. All copies shall be returned to Norbit on request.	
		Projection	Scale 1.5:1
	Material:	All dimensions in millimeter	Sheet size: A4
Part no: 33029-6-L8	Surfaces:	Tolerances:	Sheet 1 of 1

D7. WBMS Interface Pigtail Deepsea Cable Pin Description (PN 33095-x-Lx-D)



Front view

Pin out		
Pin	Description	Cable, Color
1	Tx +	24 AWG, white/orange
2	Tx -	24 AWG, orange
3	Rx +	24 AWG, white/green
4	Rx -	24 AWG, green
5	RS232 Tx/Trig Out	24 AWG, white/brown
6	RS232 Rx/Trig In	24 AWG, brown
7	PPS/IRIG-B	24 AWG, white/blue
8	Signal GND	24 AWG, blue
9	PWR GND	Black 0.5 mm2
10	PWR +24V	White 0.5 mm2

Order information	
Part number/revision	Lenght in meter
33095-3	L2 (2m standard)

Drawn: TV 2018-09-10

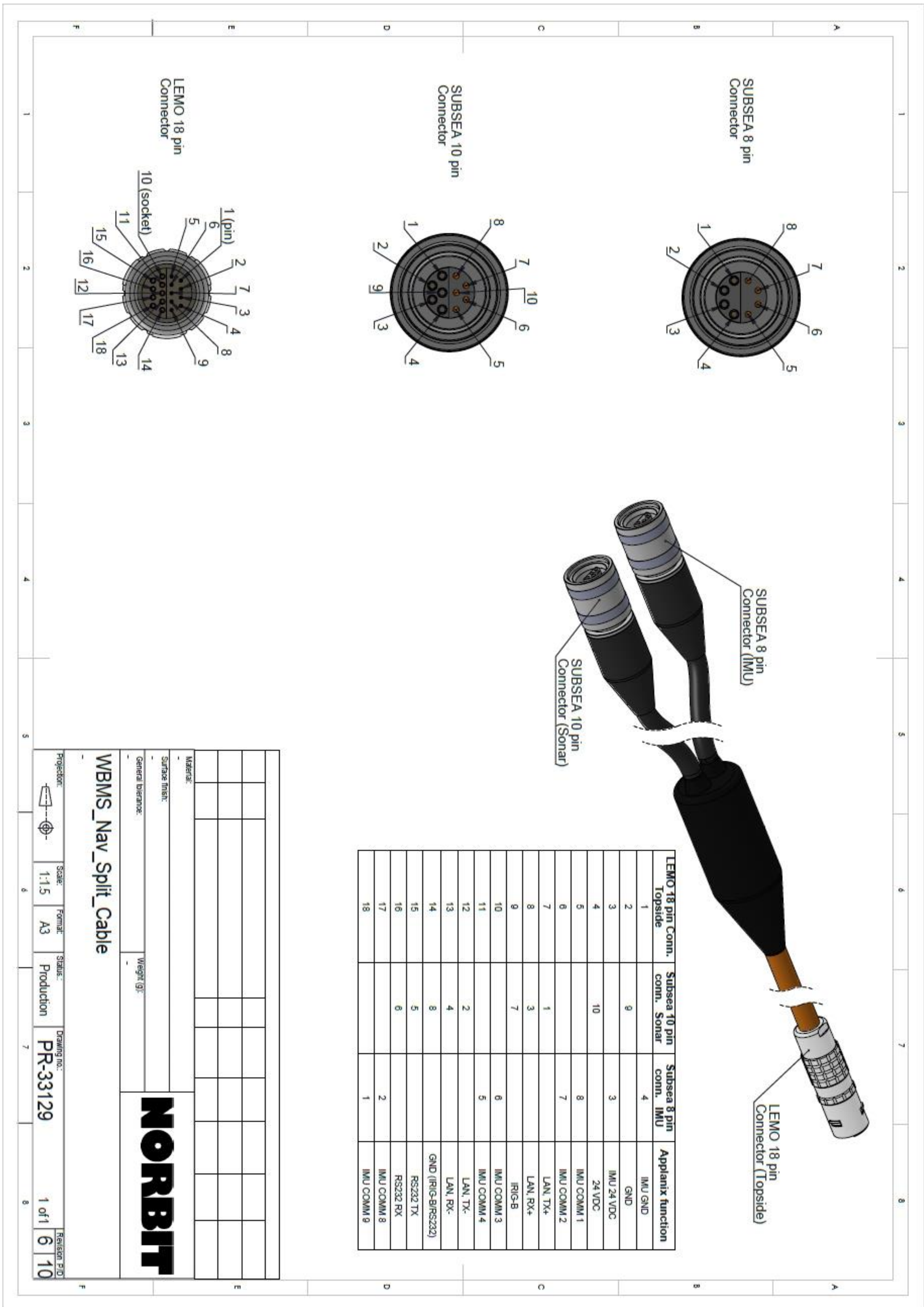
NORBIT

Norbit Subsea
Stiklestadveien 1
7041 Trondheim
Norway
www.norbit.no

WBMS Interface Pigtail Deepsea, PUBLIC

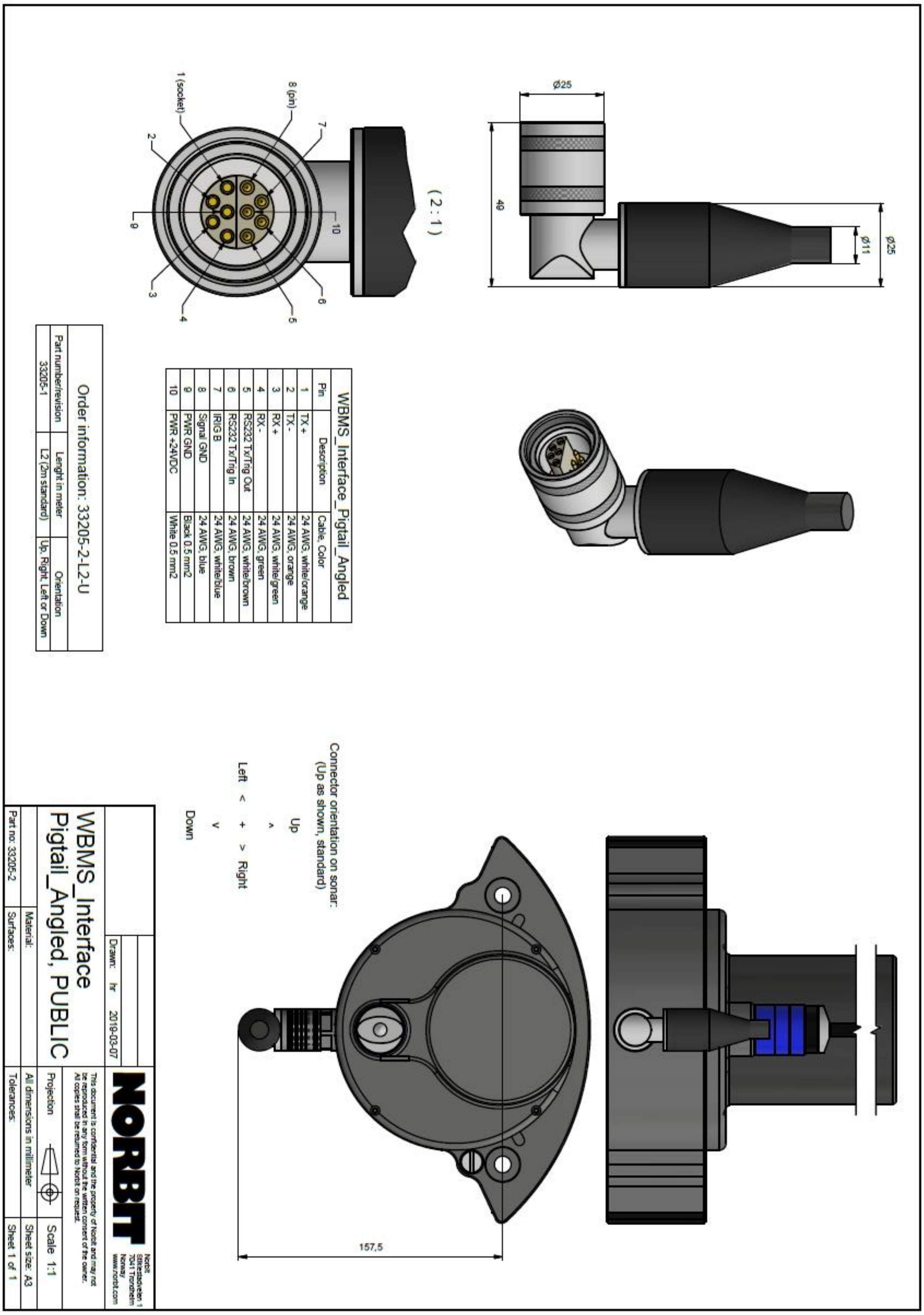
	Material: Titanium	Projection	Scale
		All dimensions in millimeter	Sheet size: A4
Part no: 33095-3-L2-D	Surfaces:	Tolerances:	Sheet 1 of 1

D8. iWBMS Split Cable Pin Description (PN 33129)



LEMO 18 pin Conn. Topside	Subsea 10 pin conn. Sonar	Subsea 8 pin conn. IMU	Applanix function
1		4	IMU GND
2	9		GND
3		3	IMU 24 VDC
4	10		24 VDC
5		8	IMU COMM 1
6		7	IMU COMM 2
7	1		LAN, TX+
8	3		LAN, RX+
9	7		IRIG-B
10		6	IMU COMM 3
11		5	IMU COMM 4
12	2		LAN, TX-
13	4		LAN, RX-
14	8		GND (IRIG-B/RS232)
15	5		RS232 TX
16	6		RS232 RX
17		2	IMU COMM 8
18		1	IMU COMM 9

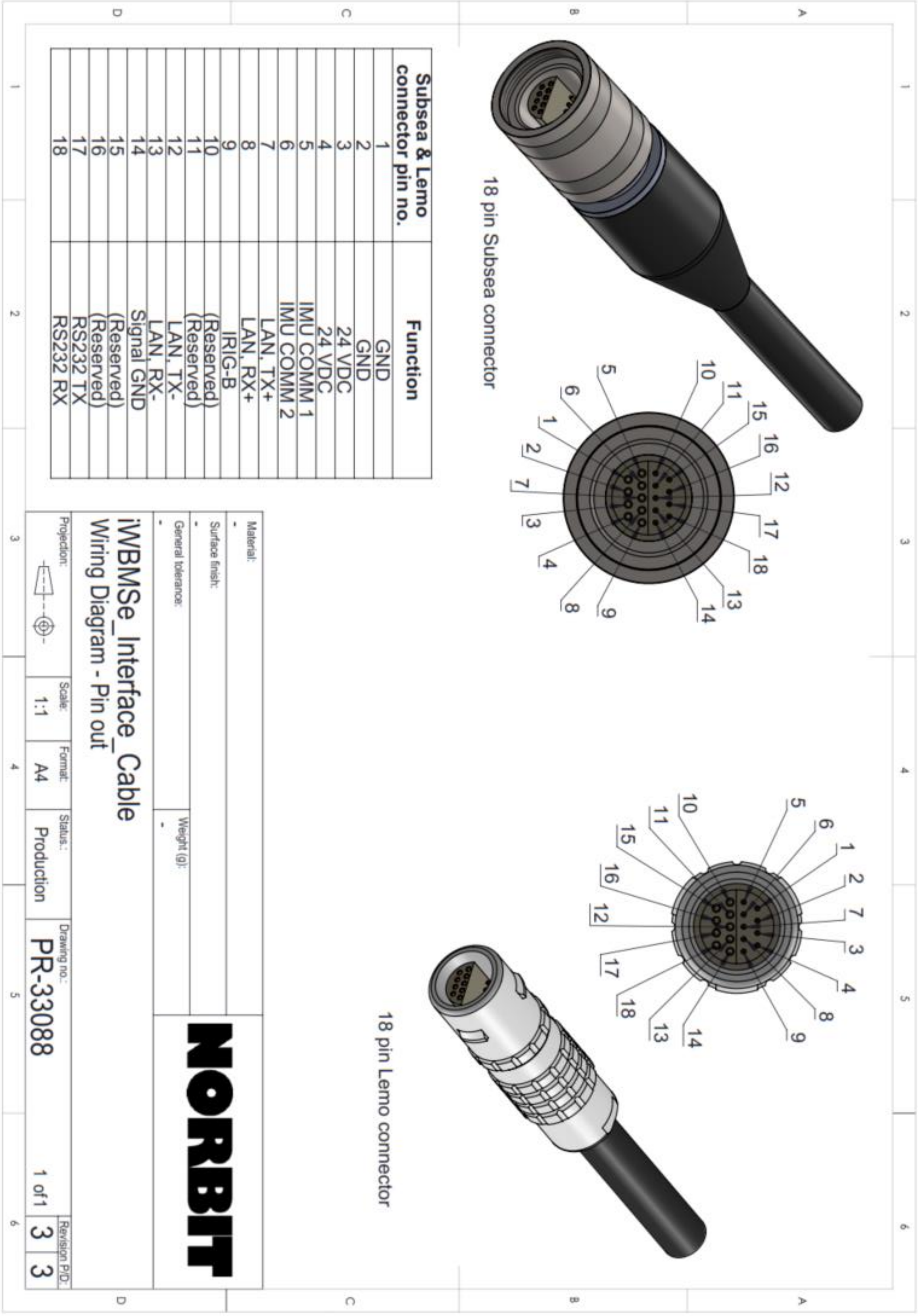
D9. WBMS Interface Pigtail Angled Pin Description (PN 33205)



WBMS_Interface_Pigtail_Angled

Pin	Description	Cable, Color
1	TX +	24 AWG, white/orange
2	TX -	24 AWG, orange
3	RX +	24 AWG, white/green
4	RX -	24 AWG, green
5	RS232 Tx/Trig Out	24 AWG, white/brown
6	RS232 Tx/Trig In	24 AWG, brown
7	IRIG B	24 AWG, white/blue
8	Signal GND	24 AWG, blue
9	PWR GND	Black 0.5 mm2
10	PWR +24VDC	White 0.5 mm2

D10. iWBMSc Interface Cable Pin Description (PN 33088)



Subsea & Lemo connector pin no.	Function
1	GND
2	GND
3	24 VDC
4	24 VDC
5	IMU COMM 1
6	IMU COMM 2
7	LAN, TX+
8	LAN, RX+
9	IRIG-B
10	(Reserved)
11	(Reserved)
12	LAN, TX-
13	LAN, RX-
14	Signal GND
15	(Reserved)
16	(Reserved)
17	RS232 TX
18	RS232 RX

D11. WBMS Bulkhead Pinout

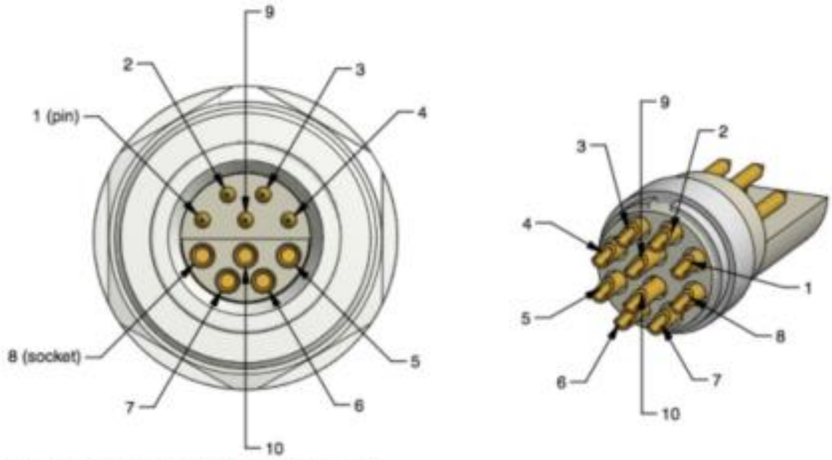


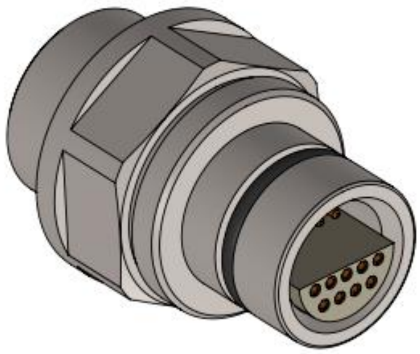
Figure 1: J1, WBMS Bulkhead.

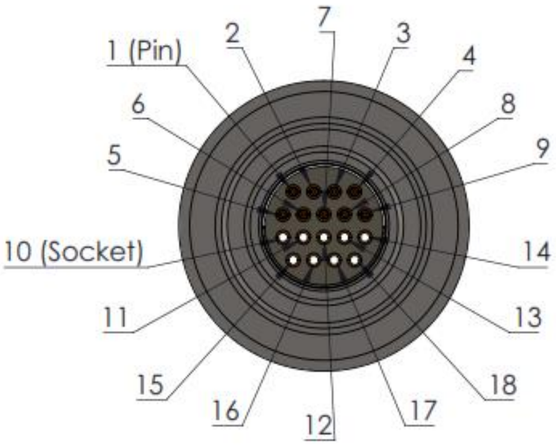
Connector type : Norbit 33049
Material : Titanium Grade 5
Insert : Lemo 10 pin
Endurance : > 5000 cycles IEC 60512-5 test 9a (ref: lemo, O-ring needs to be changed)
Pressure rating: 600 Bar (mated and unmated)

Pin	WBMS function	Electrical spec	Maximum Rating	Comment
1	LAN, TX+	100Base-T	1500 Vrms	Twisted Pair
2	LAN, TX-	100Base-T	1500 Vrms	
3	LAN, RX+	100Base-T	1500 Vrms	Twisted Pair
4	LAN, RX-	100Base-T	1500 Vrms	
5	RS232 Tx/Trig OUT	RS232	-15V to +15V	Debug/trigger. V_{low}=-6.1V V_{high}=6.6V
6	RS232 Rx/ Trig IN	RS232 (TTL comp.)	-25V to +25V	Debug/trigger. Trigger threshold 1.7±0.5Volt
7	IRIG-B	TTL 5V	-9V to +14V	Timing input. 3.3V and 5V TTL
8	Signal GND	GND	-	Shared ground for IRIG-B and RS232
9	GND	GND	-	Power ground
10	24VDC	24VDC	30V	Power input

Pinout Table.

D12. iWBMSe Bulkhead Pinout (PN 33169)





Pin out diagram	
Pin / Socket	WBMS function
1	GND
2	GND
3	24 VDC
4	24 VDC
5	IMU COMM1
6	IMU COMM2
7	LAN, TX+
8	LAN, RX+
9	IRIG-B
10	N/C
11	N/C
12	LAN, TX-
13	LAN, RX-
14	Signal GND
15	N/C
16	N/C
17	RS232 TX
18	RS232 RX

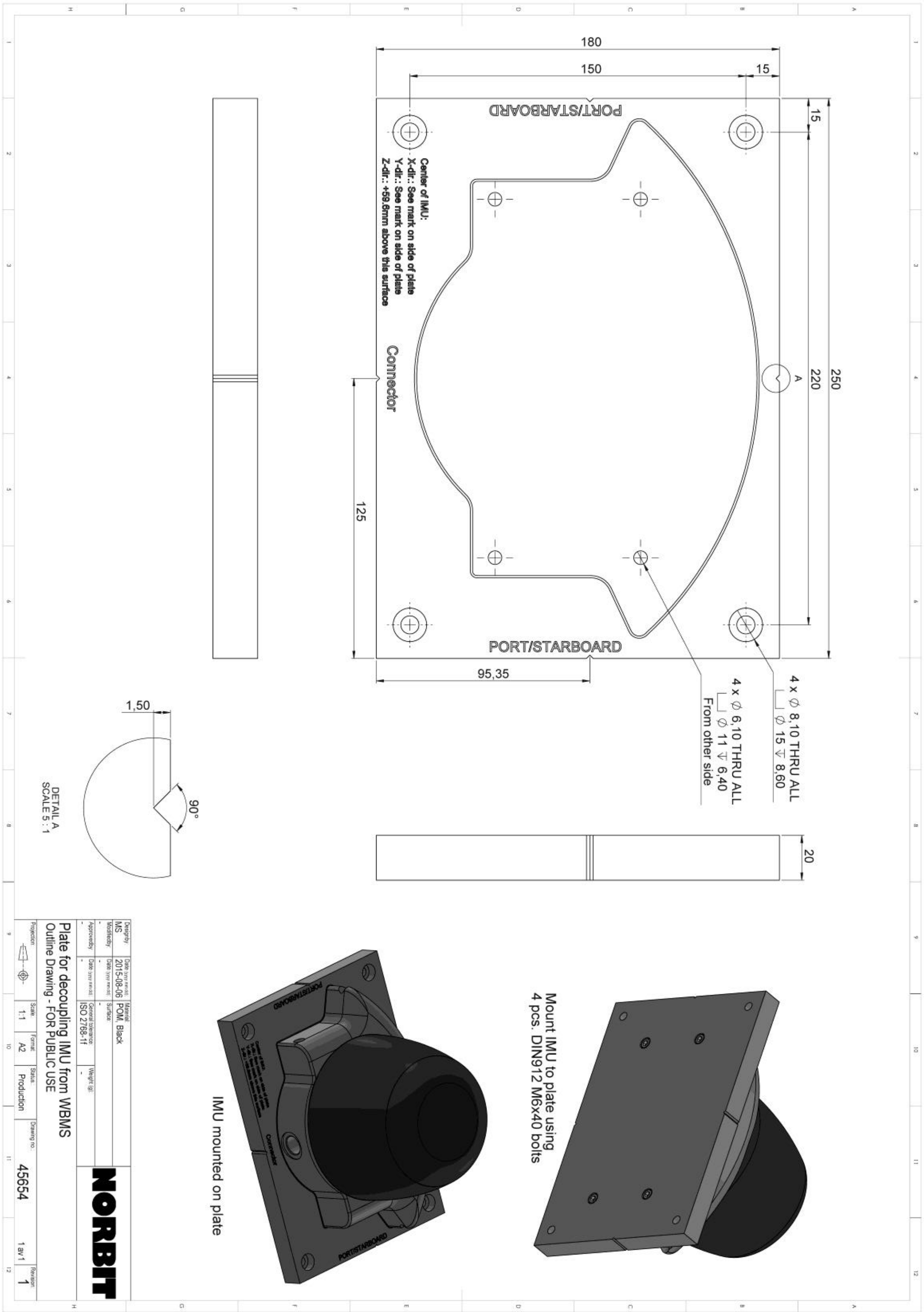
Design: MS	Date (dd.mm.yy): 2019-03-26	Material: Titan Gr. 5		NORBIT
Modified: MS	Date (dd.mm.yy): 2019-03-26	Surface finish: -		
Approved: TV	Date (dd.mm.yy): 2019-03-26	General tolerance: -	Weight (g): -	

iWBMSe Bulkhead
WBMS

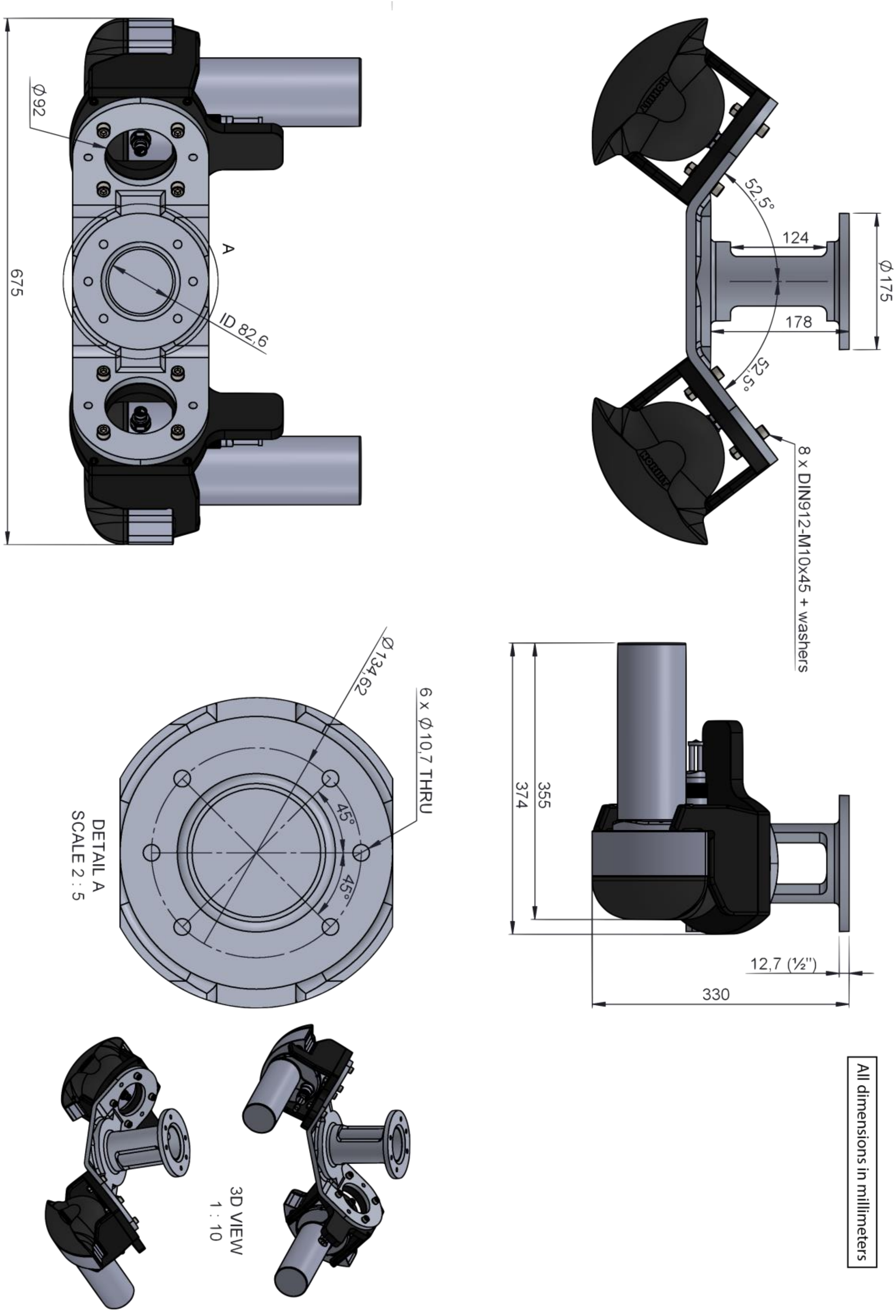
Projection:	Scale: 2:1	Format: A4	Status.: Production	Drawing no.: PR-33169	1 of 1	Revision P/D: 3 4

Appendix E: Mounting Bracket and Pole Dimensions

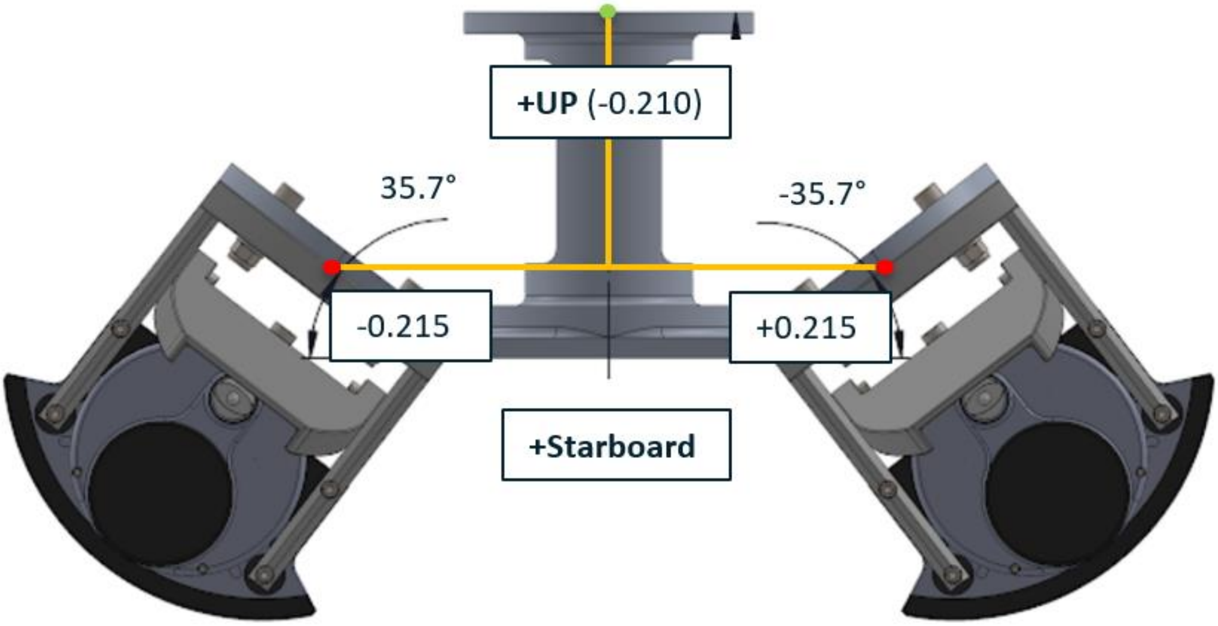
E1. Decoupled IMU Mounting Bracket (PN 45654)



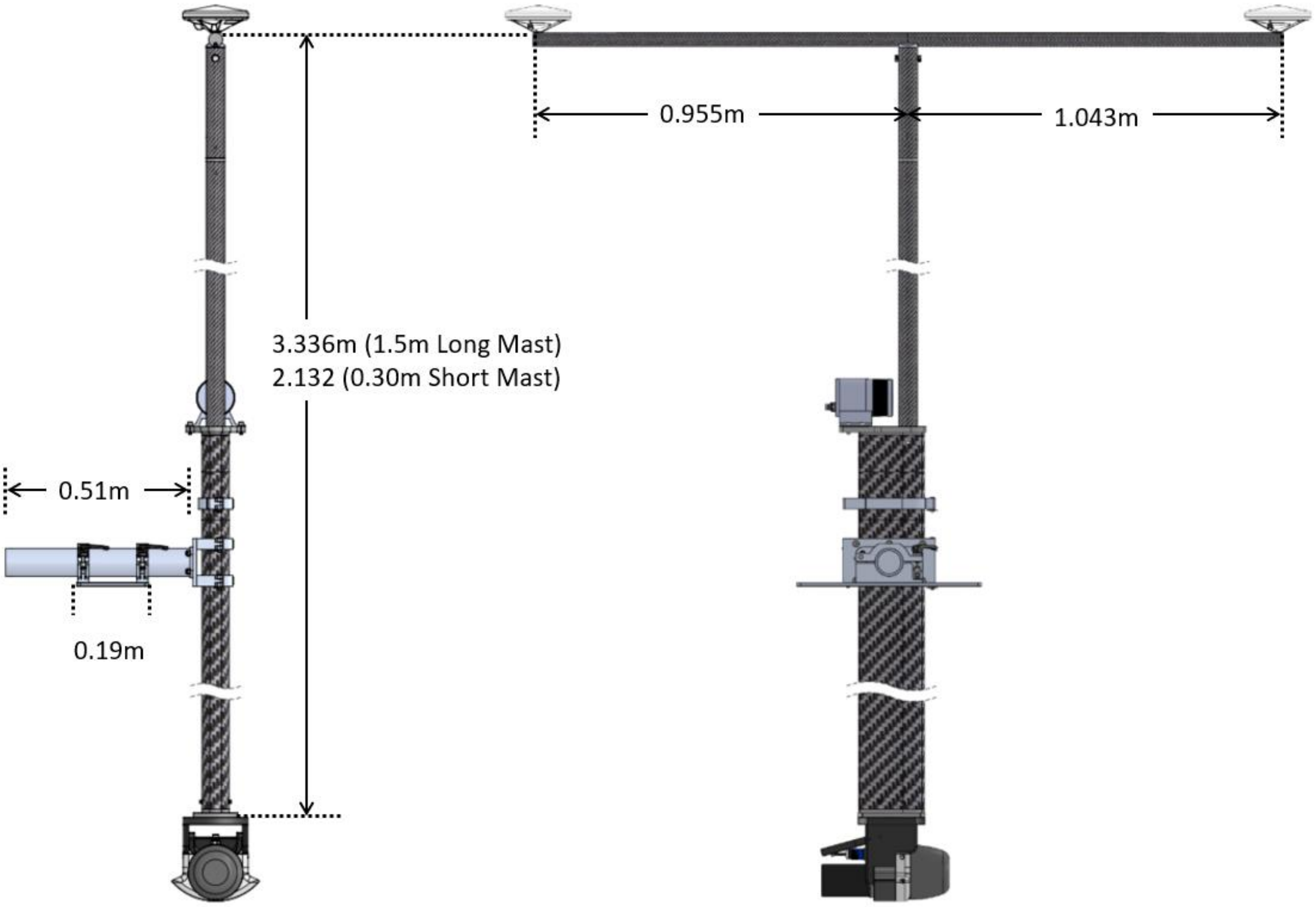
E2. Dual Head Bracket with iWBMSc / iWBMSe



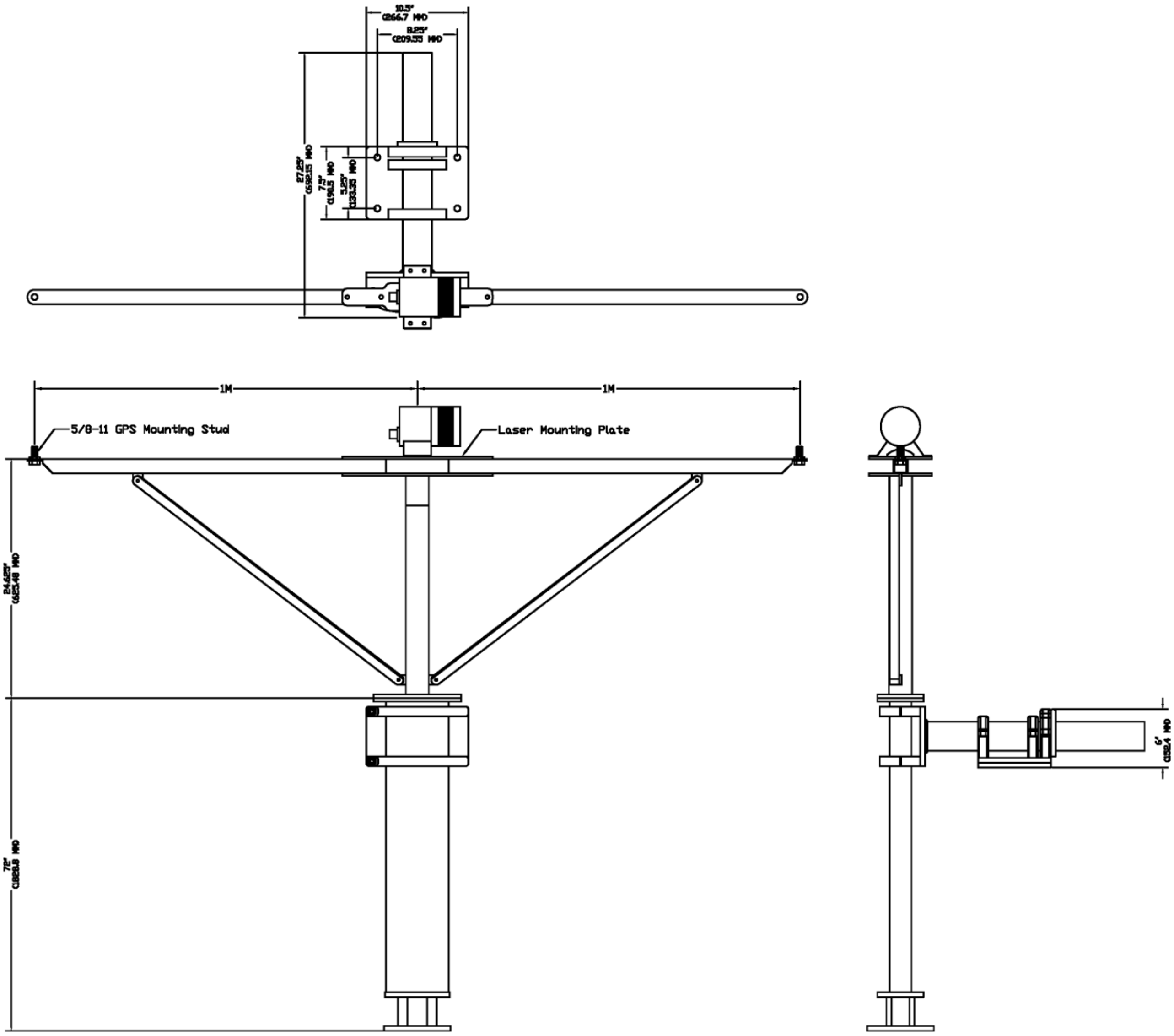
E3. Dual Head Bracket with iWBMS / iWBMSh



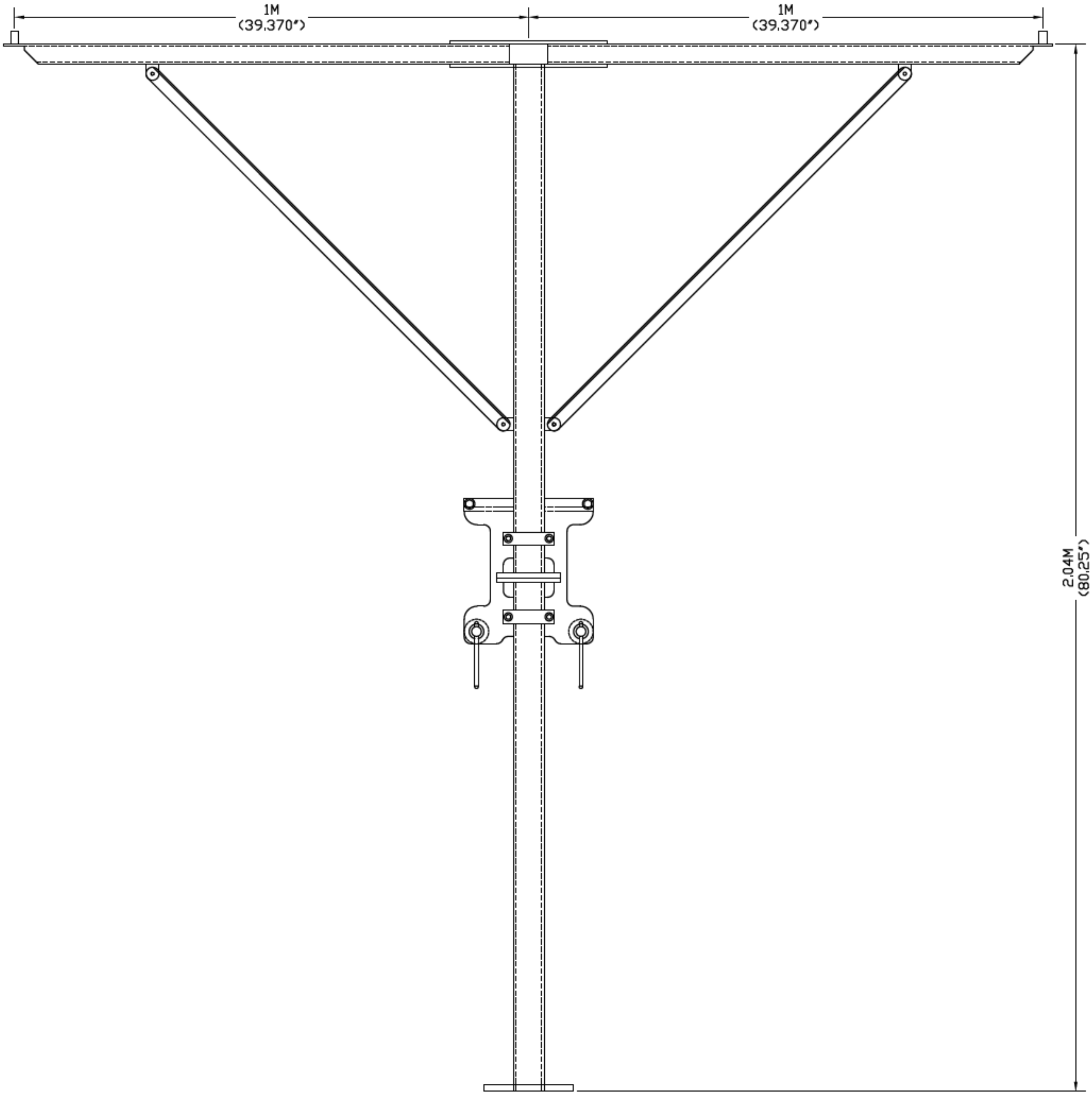
E4. NORBIT Carbon Fiber PORTUS Pole



E5. NORBIT Mini Mount Outline with Laser Stand



E6. NORBIT Travel Mount



Notes

Notes

Notes