NORBIT

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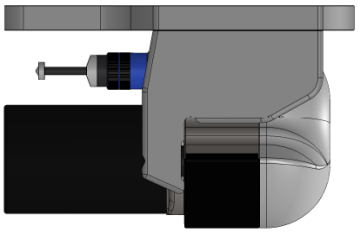
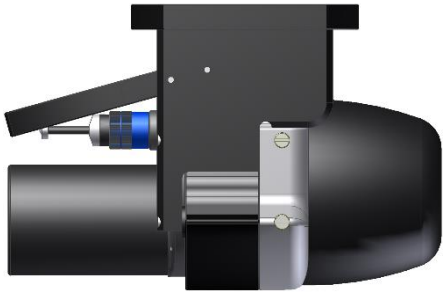
User and Technical Manual

TN-140075-6.2.2 WBMS Bathy Manual

10.3.6 Release





WBMS

iWBMSc/
iWBMSe

iWBMSh/
iWBMS

Edited: 22 January 2019

NORBIT Subsea AS

10.3.6 Release

This manual is including the following kit numbers

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

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NORBIT

Attention:

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.

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.

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Contents

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

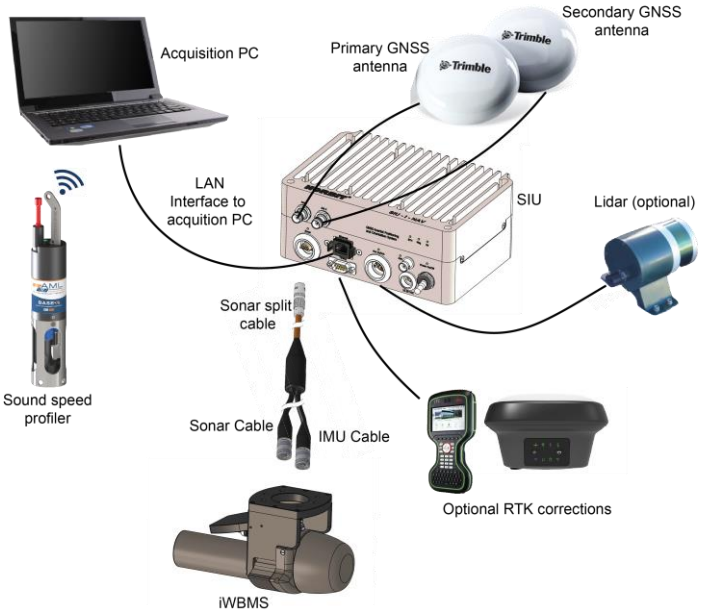
The NORBIT Wide Band Multibeam Sonar (WBMS) is the most compact, high resolution, wide-swath multibeam sonar available. With a dry-weight of less than 4.5kg (10lbs), beam widths of only 0.9° at 400kHz, and low power consumption, the stand-alone multibeam sonar easily mounts to a survey platform of any 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 centred 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 – 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 mould 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.

1) Unlike a flat array, bottom detections from a cylindrical array are much less susceptible to surface sound speed errors.

2) 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).

3) At all frequencies, the WBMS provides increased swath coverage with a smaller beam footprint for a fixed aperture.

4) 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.

5) 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 centres are fixed and predefined within the system setup. The user need only measure from top-centre 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://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 U.S- 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 Weight & Dimensions

Each NORBIT system (including all components) are shipped in a single, lightweight Pelican case that meets airline baggage guidelines. The table below lists dimensions and weights of each kit. If you do not see your kit in the following list please contact NORBIT Support for assistance

System	Case Dimensions		Weight
12003 WBMS	Length:	0.55m (1.80ft)	14kg (31lbs)
	Width:	0.35m (1.15ft)	
	Depth:	0.24m (0.79ft)	
12006 iWBMSe 12005 WBMSc	Length:	0.56m (1.84ft)	18kg (39.6lbs) 24kg (52.8)
	Width:	0.45m (1.48ft)	
	Depth:	0.26m (0.85ft)	
12004 iWBMS 12007 iWBMSh	Length:	0.63m (2.07ft)	27kg (66lbs)
	Width:	0.50m (1.64ft)	
	Depth:	0.30m (0.98ft)	

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: Always Protect Sonar .

The longer (months) the sonar is left submerged (especially in warm salty water), the greater the chance it will be heavily fouled (barnacles, etc.) or 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 more 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.

To protect the system from corrosion, take extra care when handling to not scratch the anodized aluminium housing (not a concern for titanium housing). It is also a good practice to rinse off the sonar after use, especially if used in salt water, 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 aluminium housing during installation. Spare anodes can be purchased directly from NORBIT.

CAUTION: Do not connect/disconnect any cables while the system is powered on. To prevent damage to system electronics always turn off power before disconnecting or swapping cables.

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.

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 requires 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. 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 call back 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.

1.11. Delivery Contents

Each new sonar kit delivery from the NORBIT factory includes the following items:

Name	Part number	Description
12003 WBMS:		
iWBMS Bathy	24003	Sonar transducers with dust caps
SIU-I	29024	Top-side sonar interface unit (SIU), with protective caps
AC/DC Power Supply	23008	90-264VAC, 47-63Hz with LEMO 1E connector
Accessories/Spares	35036	WBMS Mounting/Spare Parts
WBMS Interface Cable	33029	WBMS interface cable and protective caps
LAN Cable	33072	2.5m ethernet cable
SIU Power Pigtail	33111	LEMO 1E connectors to DC power
User Manual	TN-140075	Hard-copy of user manual, Sonar Declaration of Conformity
WBMS GUI and digital documents		USB drive containing digital copy of user manual, WBMS GUI
12006 iWBMSe:		
iWBMS Bathy	24003	Sonar transducers with dust caps
iWBMS IMU (SurfMaster)	(integrated)	Integrated Applanix IMU
2 x Trimble Antennas	540AP	GNSS antennas
SIU-I-NAV	29028	Top-side sonar interface unit (SIU), with protective caps
AC/DC Power Supply	23008	90-264VAC, 47-63Hz with LEMO 1E connector
Accessories/Spares	35031	WBMS Mounting/Spare Parts
WBMS Compact Cable	33088	WBMS/IMU interface cable and protective caps
GNSS Cables (x2)		GNSS TNC cables (10m)
LAN Cable	33072	2.5m ethernet cable
SIU Power Pigtail	33111	LEMO 1E connectors to DC power
User Manual	TN-140075	Hard-copy of user manual, Sonar Declaration of Conformity
WBMS GUI and digital documents		USB drive containing digital copy of user manual, WBMS GUI
12005 iWBMSc:		
iWBMS Bathy	24005	Sonar transducers with dust caps
iWBMS IMU (STIM300)	(integrated)	Integrated Applanix IMU
2 x NovAtel Antennas	GPS702GGL	GNSS antennas
SIU-I-NAV-Compact	29029	Top-side sonar interface unit (SIU), with protective caps
AC/DC Power Supply	23008	90-264VAC, 47-63Hz with LEMO 1E connector
Accessories/Spares	35031	WBMS Mounting/Spare Parts
WBMS Compact Cable	33088	WBMS/IMU interface cable and protective caps
LAN Cable	33072	2.5m ethernet cable
SIU Power Pigtail	33111	LEMO 1E connectors to DC power

User Manual WBMS GUI and digital documents	TN-140075	Hard-copy of user manual, Sonar Declaration of Conformity USB drive containing digital copy of user manual, WBMS GUI

12004 iWBMS:		
iWBMS Bathy	24003	Sonar transducers with dust caps
iWBMS IMU (WaveMaster)	24006	Integrated Applanix IMU
Trimble Antennas (x2)	540AP	GNSS antennas
SIU-I-NAV	29028	Top-side sonar interface unit (SIU), with protective caps
AC/DC Power Supply	23008	90-264VAC, 47-63Hz with LEMO 1E connector
Accessories/Spares	35031	WBMS Mounting/Spare Parts
WBMS Split Cable	33129	WBMS/IMU interface cable and protective caps
LAN Cable	33072	2.5m ethernet cable
SIU Power Pigtail	33111	LEMO 1E connectors to DC power
GNSS Cables (x2)		GNSS TNC cables (10m)
User Manual WBMS GUI and digital documents	TN-140075	Hard-copy of user manual, Sonar Declaration of Conformity USB drive containing digital copy of user manual, WBMS GUI

12007 iWBMSh:		
iWBMS Bathy	24003	Sonar transducers with dust caps
iWBMS IMU (OceanMaster)	24006	Integrated Applanix IMU
2 x Trimble Antennas	540AP	GNSS antennas
SIU-I-NAV	29028	Top-side sonar interface unit (SIU), with protective caps
AC/DC Power Supply	23008	90-264VAC, 47-63Hz with LEMO 1E connector
Accessories/Spares	35031	WBMS Mounting/Spare Parts
WBMS Split Cable	33129	WBMS/IMU interface cable and protective caps
GNSS Cables (x2)		GNSS TNC cables (10m)
LAN Cable	33072	2.5m ethernet cable
SIU Power Pigtail	33111	LEMO 1E connectors to DC power
User Manual WBMS GUI and digital documents	TN-140075	Hard-copy of user manual, Sonar Declaration of Conformity USB drive containing digital copy of user manual, WBMS GUI

12002 WBMS FLS		
iWBMS Bathy	24002	Sonar transducers with dust caps
SIU-I	29024	Top-side sonar interface unit (SIU), with protective caps
AC/DC Power Supply	23008	90-264VAC, 47-63Hz with LEMO 1E connector
Accessories/Spares	35036	WBMS Mounting/Spare Parts
WBMS Interface Cable	33029	WBMS interface cable and protective caps
LAN Cable	33072	2.5m ethernet cable
SIU Power Pigtail	33111	LEMO 1E connectors to DC power
User Manual WBMS GUI and digital documents	TN-140075	Hard-copy of user manual, Sonar Declaration of Conformity USB drive containing digital copy of user manual, WBMS GUI

1.12. Options and Upgrades

If necessary, NORBIT offers the following affordable upgrades:

- Custom cable lengths. Please specify length with order. Maximum is 50m.
- Bathymetric/Hydrographic survey data acquisition & processing software
  - Hypack & Hysweep
  - QINSy & Fledermaus
  - EIVA
  - CARIS (processing only)
  - Triton
- GNSS RTK Base Station Kit. Simple to use RTK base station with/without FCC license free radios.
- Post Processed Kinematic Software. Offers centimetre positioning even with GNSS outages.
  - For Compact: Waypoint Inertial Explorer (NovAtel)
  - For iWBMS: Applanix POS 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)*

Phone: +1 929 226 7248 (UTC -7)*

E-mail: subsea_support@norbit.com

*UTC time offsets above may be ±1hr off due to daylight savings time

2. Hardware Introduction, Installation and Offset Determination

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 orange warning boxes may not cover all critical notices.

CAUTION: Properly Seal Wet Connection.

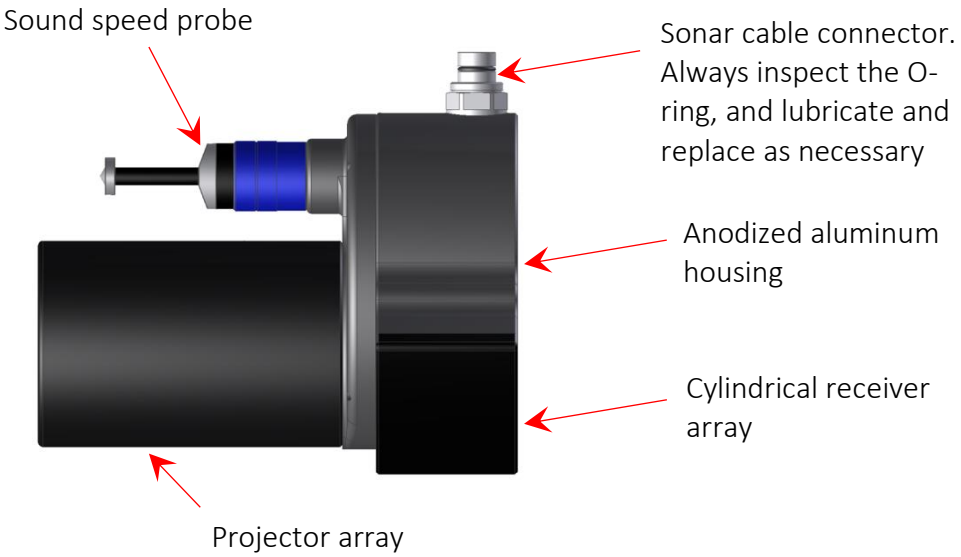
Inspect O-Ring each time before connecting wet-cable – replace as needed. Apply a *thin* coat of synthetic grease (e.g. Molykote 55) to the O-Rings. Strongly hand-tighten wet-connector (push in & tighten repeatedly until firmly connected). If connector sticks when tightening, apply a very thin coat of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

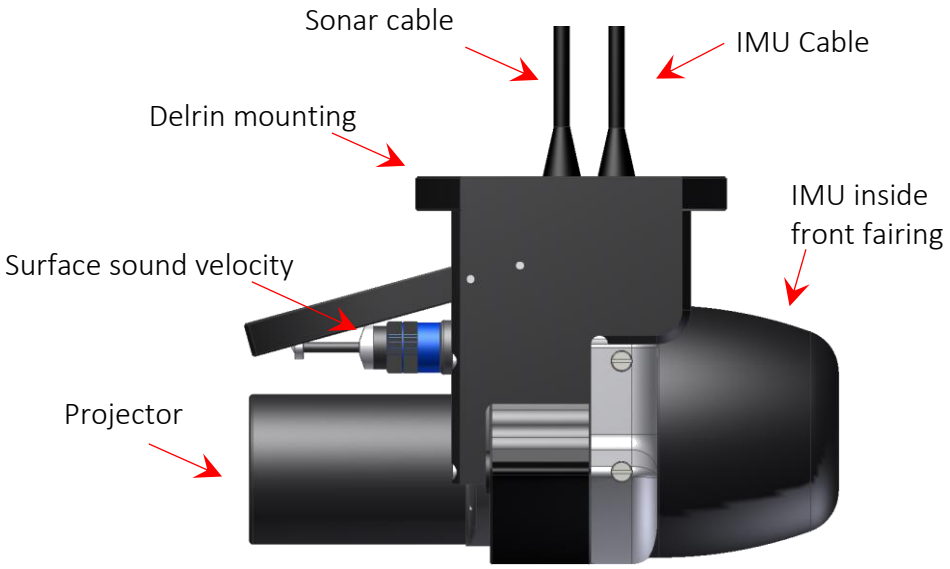
2.1. WBMS Wet-end Overview

The WBMS sonar is comprised of a cylindrical receiver array and a cylindrical transmitter 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.



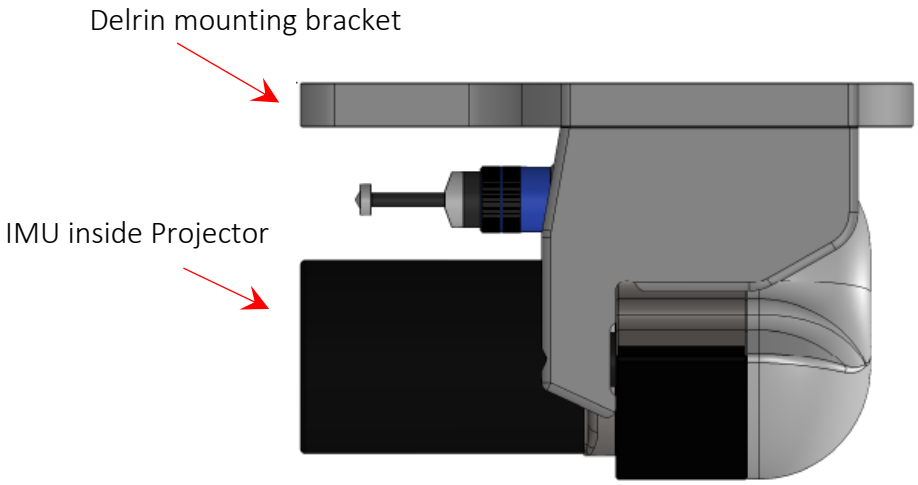
2.2. iWBMS(x) and STX Wet-end Overview

The iWBMSe, iWBMS, iWBMSh and the STX contain the well-known Applanix GNSS/INS systems. The iWBMS(x) systems are equipped with either a MEMS-based or one of two FOG IMUs. The systems are optionally available with POS MV MMS (POSPac) 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 Sensonor 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 Applanix MMS or Waypoint Inertial Explorer for full positioning and attitude PPP or PPK solutions.



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 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 10.3.6. 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. The Dry-End (Topside)

All WBMS systems include a compact topside sonar interface unit 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:

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.

CAUTION: Cover all Connection Ports.

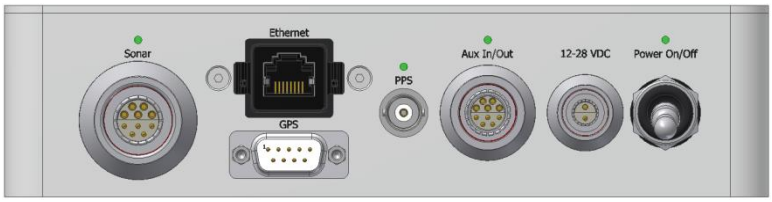
When operating in open environments, all connection ports on the topside should be tightly sealed either with the NORBIT supplied cables or, if the port is unused, with the port covers provided with the system.

2.3.1. 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.

2.3.2. Topside – WBMS Sonar Interface Unit (SIU)



Connector	Description
Sonar LEMO	Interface cable to the sonar.
GPS RS232	ZDA Timing input

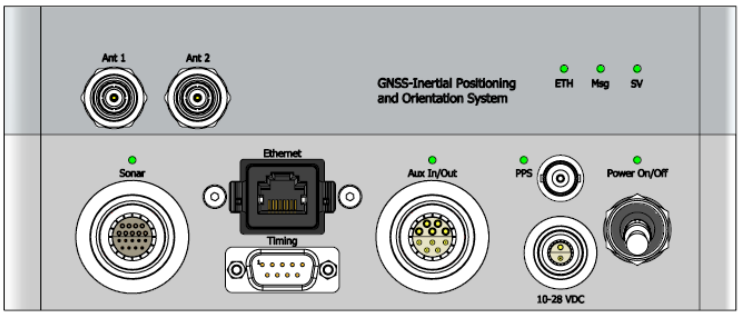
	PPS BNC	1 PPS input for external sensor (not typ. used)
	Ethernet RJ45	For communication between topside PC and sonar. SAMTEC Part# RCE-01-G-05.00-D
	AUX LEMO	For communication with auxiliary devices
	Power LEMO FUSE SOCKET*	Input DC voltage. Rear; 6A slow-blow

*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 topside will work with all WBMS Bathy and FLS systems. The iWBMSe and iWBMSc will 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.

2.3.3. Topside – Integrated WBMS Family – Integrated Sonar Interface Unit



Connector	Description
Sonar LEMO	18-pin interface to sonar and IMU.
Ant1 TNC	Primary GNSS antenna. Antenna closest to IMU
Ant2 TNC	Secondary GNSS antenna
GPS RS232	GNSS corrections input (RTK/DGPS).
PPS BNC	1 PPS output for external sensor (not typ. 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; 8A slow-blow

*Please note that SIU-I-NAV and SIU-I-Compact-NAV models 29028-5, 29029-3 and newer will not have the 6A 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.

2.3.4. LED Status Indicators & Description

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

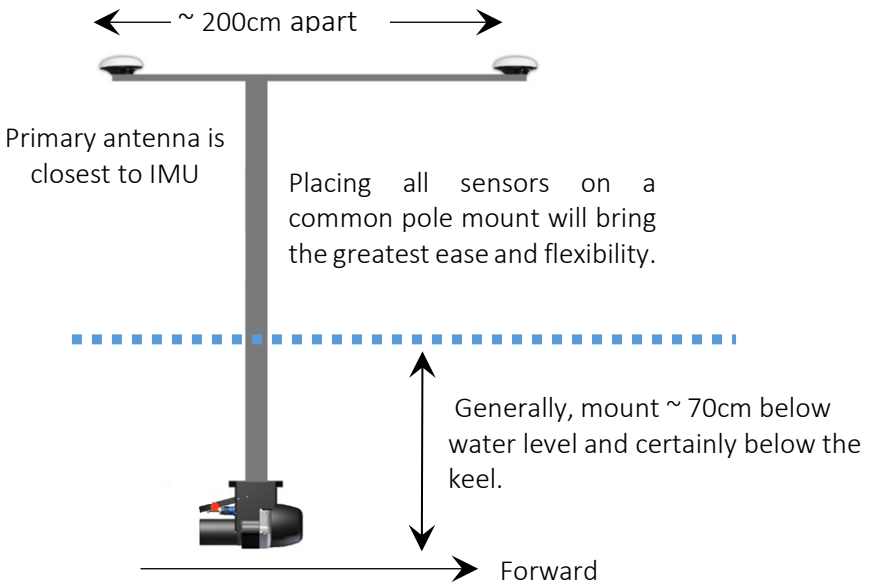
Indicator	Pattern	Description
Sonar LED	Off Led Blinking (ISO) 1Hz Blinking 1Hz Green steady Blinking 5Hz	Sonar Off Sonar Booting Sonar Stand By Sonar pinging Sonar Over Current Failure
PPS LED	Orange blinking (1Hz) Orange blinking (5Hz) Off On, steady	Sync/timing ok No sync, NMEA missing No sync, NMEA and PPS missing No sync, PPS missing
AUX LED	Always OFF	Not in use at this time
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

2.3.5. SIU Aux Port

The 10-pin Aux port on the integrated SIU allows users to expand WBMS capabilities by integrating additional sensors. For full pin description, refer to the Appendix. 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. Make an Installation Plan

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 mate-able!

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

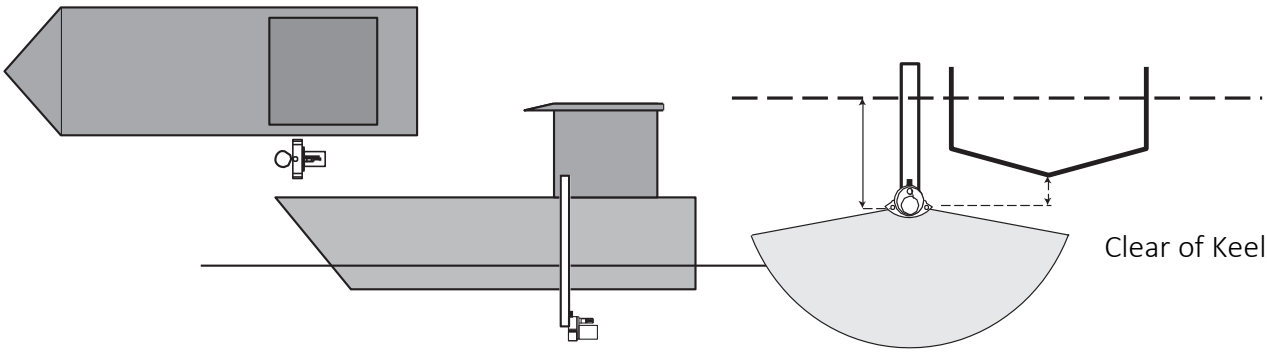
Prior to installation, always inspect cables for nicks and sheath wear. If there are any hazards that may expose cables to abrasion, it is advised that a chafing guard to protect the cable be made such as adding rubber tape around the cable at the point of concern. Ensure pins are not bent and that they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

2.5. Sonar Placement

Generally, the sonar 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

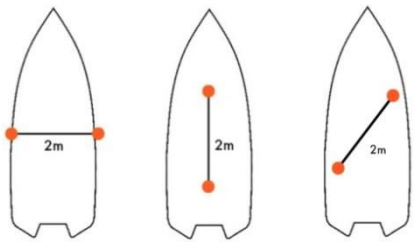
out a strong reflection). Additional sonar draft may be required depending on the characteristics of the vessel hull which may create bubbles during vessel motion, especially as sea state worsens. It is critical that the sound speed sensor on the WBMS has clean bubble-free water.

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.



2.6. GNSS Antenna Placement

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.

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 centreline.

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

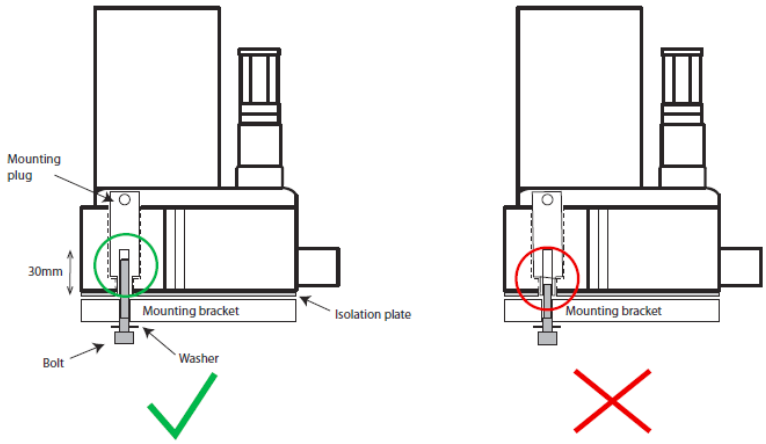
2.7. Mounting the WBMS

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 centreline 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 salt water 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 the hull mounting section in the appendix.



CAUTION: Electrically isolate the 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.

2.8. Mounting the integrated WBMS

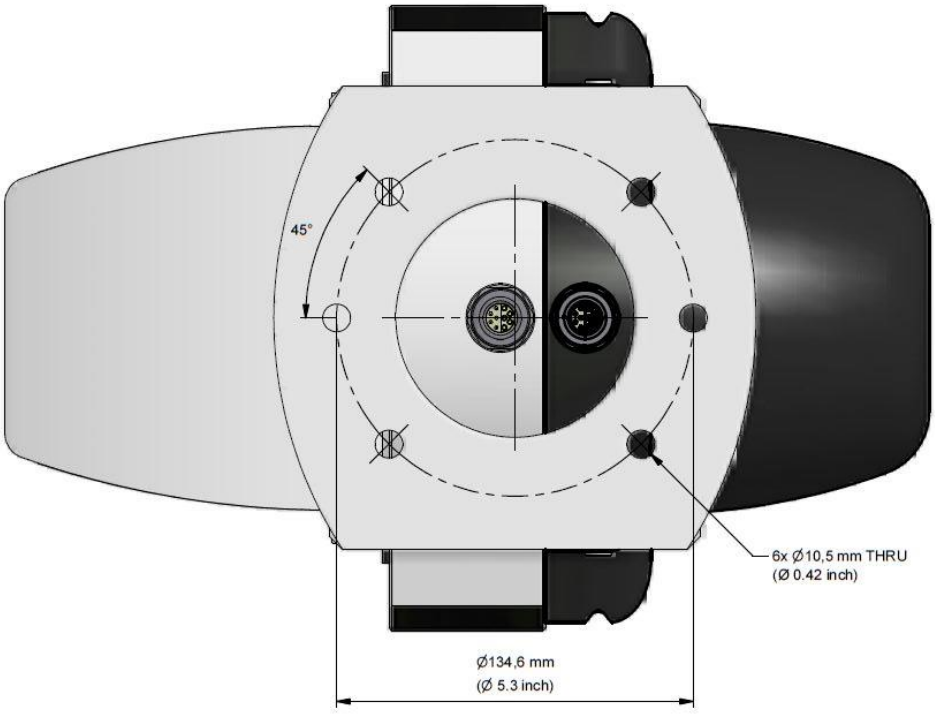
As noted in the section above, the sonar must be mounted with the transmitter (projector) pointing aft. Mount the sonar in line with the keel or centreline of the survey platform to within 0.5°. This is not so critical when the entire assembly is mounted to a single survey pole.

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

CAUTION: Wet-end cables must be run through the centre of the iWBMS(x) bracket.

The mounting bracket requires that wet-end cables be run through the top centre 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 salt water 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 centred 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.

3. Reference Points and Lever-Arm Offsets

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 misalignment should be measured and input into the acquisition/processing software.

Each sensor will have a well-defined measurement location. This is the point to which the output data is referenced. A GNSS antenna measurement point is known as the phase centre. The measurements in this section also reference the Top Centre Bracket (TCB).

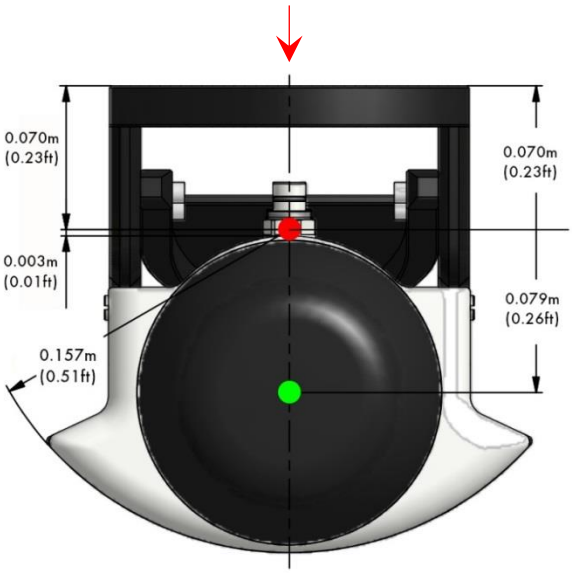
CAUTION: Taking full advantage of 10.3.6 requires Applanix Firmware 9.03 or newer.

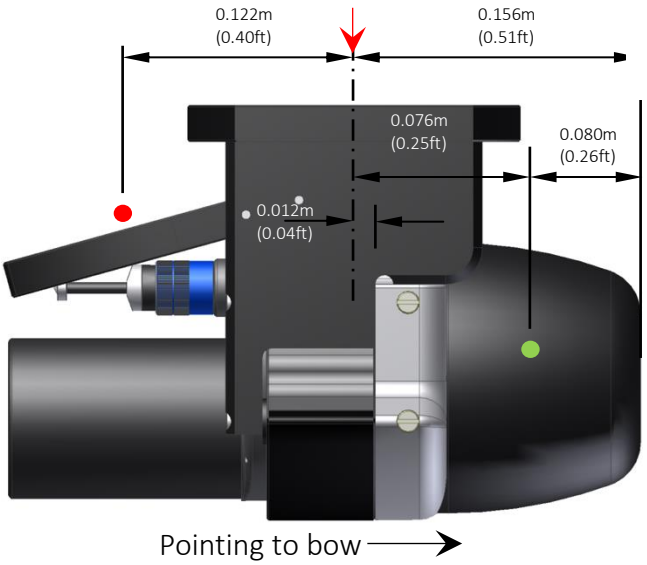
For iWBMSe, iWBMS and iWBMSh, the integrated Applanix must have at least 9.03 firmware. This enables the NORBIT GUI to take control of the system and automate many of the setup parameters. Users of older firmware versions are encouraged to contact NORBIT Support for upgrading.

3.1. Lever-Arm Offset Reference Location – 12004 & 12007 iWBMS & h 1.9° Tx

Kit part number: **12004**-X-X-**ACDB**-FXXX & **12007**-X-X-**ACDB**-FXXX

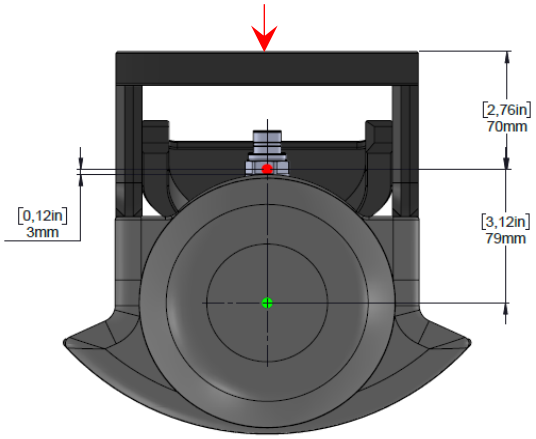
In the images, the red dot locates the sonar measurement point (same location as for WBMS only systems) while the green dot locates the IMU measurement point. These measurement points are fixed locations and are easily measured from the Top Centre of the sonar mounting Bracket (TCB). The red arrow points to the top centre of the bracket. Generally, the user need not concern themselves with the IMU reference point (green dot)





Sonar Reference (red dot) is 3mm above top of sonar housing and 70mm below top of iWBMS bracket. Green dot is the IMU sensing center which is forward 0.198m and down 0.079m from sonar ref point (red dot). For different configurations, it may be referenced 8cm aft from the front ('nose') of the fairing.

The iWBMS includes an Inertial Motion Unit that is rotated 90° about the x-axis (fore-aft axis) and 90° about the z-axis (up-down axis). For simplicity, this rotational offset is programmed into the 10.3.6 GUI so user intervention is not required.

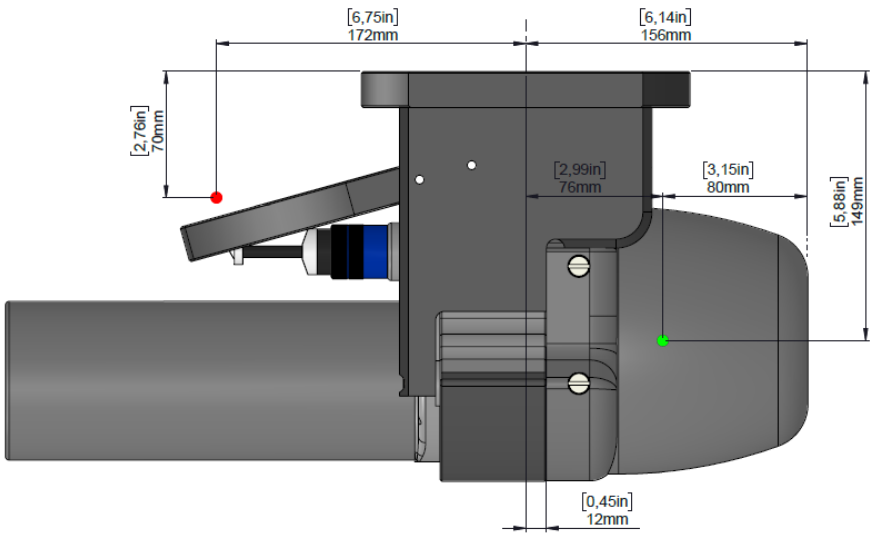


For a conventional installation where the sonar and IMU remain coupled and the top center of the sonar bracket used as the "measure point", the following offsets will be employed. Please note that the Forward offsets will vary if the system has a 1° projector. The only instances where the user will have to know these values are if a custom installation is being used, or if the Applanix firmware is older than 9.03 and all offsets are entered manually in POSView.

Lever Arms	+Fwd (m)	+Stbd (m)	+Dwn (m)
WBMS Ref. Point to IMU Ref. Point	0.198 (0.248) *	0.000	0.079
WBMS Ref. Point to Measure Point	-0.122 (-0.172) *	0.000	0.070

*Values in parentheses indicate offsets with a 1° projector.

3.2. Lever-arm Offset Reference Location – 12004 & 12007 iWBMS &h 0.95° Tx



Kit part number: **12004 (&7)**-X-X-A**B**DB-F400

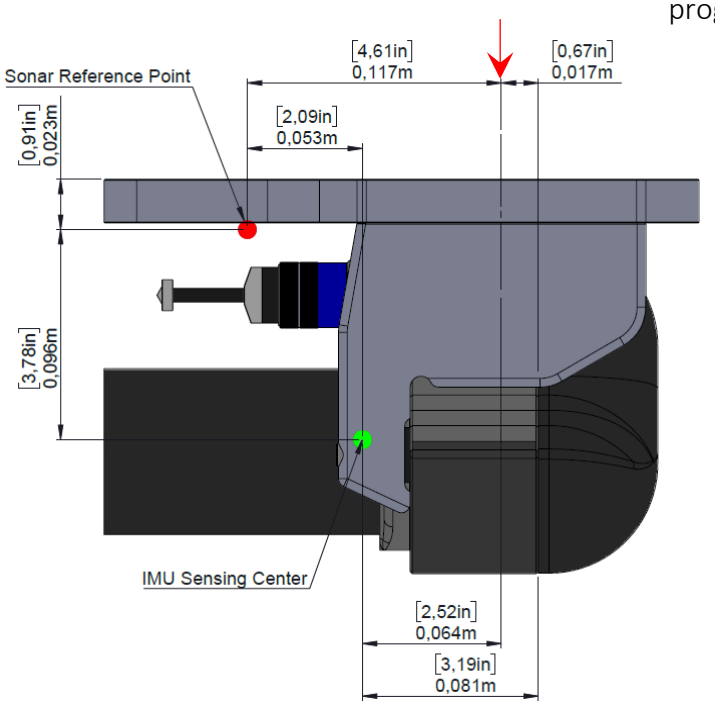
Users of the 0.95° Tx array with either the WaveMaster II or OceanMaster will use the tabulated offsets - distance from the top centre bracket to the sonar reference point. Users taking full advantage of 10.3.6 will not need to enter in these additional offsets.

Sonar Reference (red dot) is 3mm above top of sonar housing and 70mm below the top of the bracket. The green dot is the IMU reference center which is forward 0.248m and down 0.079m from sonar reference (red dot). For different configurations, it may be referenced 8cm aft from the front fairing. Please note that the offsets change depending on the projector because it affects the IMU placement inside the sonar. These distances have been programmed into the WBMS GUI 10.3.6 so the user does not have to input them if taking full advantage of 10.3.6 firmware.

Lever Arm	+Fwd (m)	+Stbd (m)	+Dwn (m)
WBMS Ref. Point to IMU Ref. Point	0.248	0.000	0.079
WBMS Ref. Point to Measure Point	-0.172	0.000	0.070

3.3. Lever-Arm Offset Reference Location – 12006 iWBMSe

In the image, the red dot locates the sonar measurement point, while the green dot represents the IMU measurement point. In the 10.3.6 firmware, this fixed distance has already been programmed into the interface so this need not be measured. The red arrow points to the top centre of the bracket.



The iWBMSe includes an Inertial Motion Unit that is rotated 180° about the Z-axis (up-down axis) and this is also programmed into the integrated user interface.

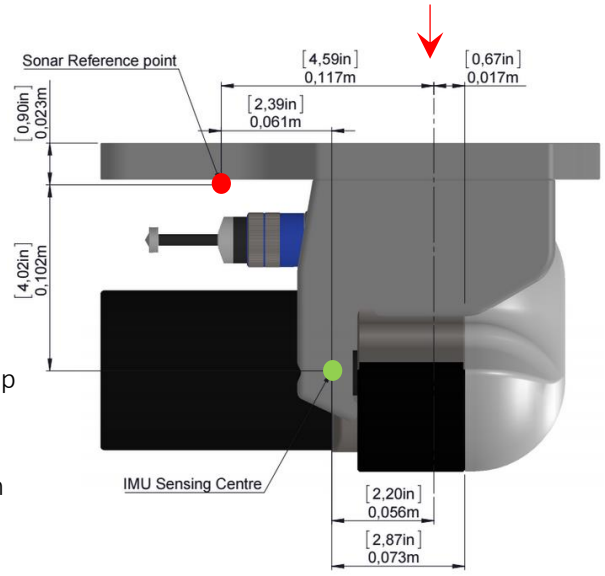
The offset measurements from Ref. to Antenna 1 (Primary) are to be measured to the top centre of the iWBMSe mounting bracket to the bottom of the primary antenna then the following additional offsets shall be factored in automatically:

Lever Arm	+Fwd (m)	+Stbd (m)	+Dwn (m)
IMU to Sonar Ref.	0.053	0.000	0.096
WBMS Ref. Point to Measure Point	-0.117	0.000	0.023

3.4. Lever-Arm Offset Reference Location – 12005 iWBMSc

Kit part number: **12005**-X-X-**ACDB**-FXXX

In the image, the red dot locates the sonar measurement point (same location as for WBMS only systems) while the green dot locates the IMU measurement point. These measurement points are fixed locations and are easily measured from the top centre of the sonar mounting bracket. The red arrow points to the top centre of the bracket.



Sonar Reference (red dot) is 3mm above top of sonar housing and 23mm below top of bracket. Green dot is IMU sensing center which is forward 0.061m and down 0.102m from sonar ref point (red dot).

To simplify the configuration, fixed offset values of the INS measurement point to sonar measurement point are accounted for in the NovAtel MarineSPAN system. This will then allow the INS data to be recalculated and output at the same location as the sonar measurement point. Therefore, the sonar and INS will then share the same offsets from the vessel Centre of Rotation (COR) when using acquisition and processing software such as QINSy, Hypack, CARIS, etc.

Lever Arm	+Fwd (m)	+Stbd (m)	+Dwn (m)
WBMS Ref. Point to IMU Ref. Point *	-0.061	0.000	0.102
WBMS Ref. Point to Measure Point	-0.056	0.000	-0.125

**For older iWBMSc systems, IMU to sonar reference offsets are -0.011m, 0.022m, -0.172m in the Fwd, Stbd, Up directions respectively. For images of the full kit and bracket, refer to the Appendix.*

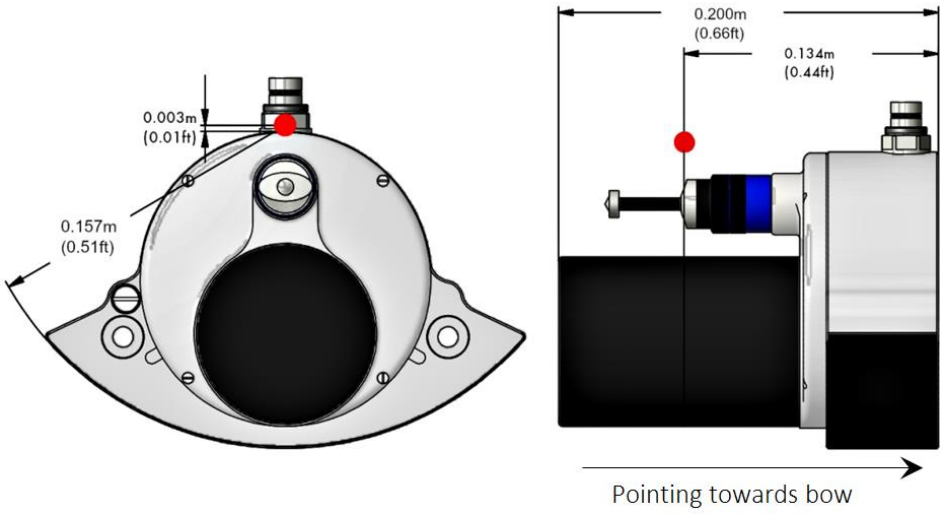
For the NovAtel MarineSPAN configuration, the offset measurements from the IMU to Antenna 1 and IMU to Antenna 2 must be measured. Measure from the top centre of the Compact bracket and add the offsets below to adjust to the IMU location, listed in the table above.

For detailed instructions on setting up the NovAtel MarinSPAN INS please go to Compact Configuration.

3.5. Lever-Arm Offset Reference Location – 12003 WBMS (1° and 2°)

Kit part number: 12003-X-X-ACDB-FXXX

For custom installations, the sonar reference point (red dot in images below) is located 3mm vertically above the top of sonar housing curvature and 134mm behind the forward flat face of the unit. The image below shows dimensions for a WBMS with a 2° projector. A WBMS with a 1° projector will add 100mm to the length of the system; the length will be 0.3m instead of 0.2m as shown below. The distance of the acoustic center from the forward flat face will be 0.184m instead of the 0.134m shown below.



3.6. STX Lever-Arm Offset Reference Location – 24016/24017 (400/200kHz STX)

The STX comes in two models – 200kHz and 400kHz The dimensions of the STX projector will be identical to that of the iWBMS with 1°Tx. The STX provides a versatile bathymetric tool – it can be used as a forward-looking sonar or operated as a conventional multibeam bathymetric sonar, for instance. 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. Please note that for such a setup, a second SIU will be required; a single SIU-I-NAV cannot adequately power both an STX and a second sonar. The STX can be controlled via the WBMS GUI 10.3.6 – the same interface controlling all NORBIT sonar systems. Detailed descriptions of the GUI can be found in the next section. Like the iWBMS systems, the STX is integrated with an inertial measurement unit (Applanix WaveMaster II or OceanMaster) and the related offsets are shown in the table below.

Lever Arm	+Fwd (m)	+Stbd (m)	+Dwn (m)
WBMS Ref. Point to IMU Ref. Point	0.234	0.000	0.079
WBMS Ref. Point to Measure Point	0.158	0.000	-0.07

4. WBMS GUI Installation

For the iWBMSe, iWBMS and iWBMSh the POSView GUI is no longer required, provided the Applanix firmware is at least 9.03. If in doubt, please contact NORBIT with the product serial numbers (topside and wet-end) 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 will install the WBMS Graphical User Interface (GUI) and copy the firmware to the PC. Upon connection to the sonar after GUI installation a check of firmware compatibility will be preformed. If there is a firmware mismatch a prompt will appear and ask if a firmware update should be preformed. If desired click preformed update. It is very important that power be maintained to the sonar during the update procedure.

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 8.1 (Fully Updated) or above; Windows 10 Pro is recommended Windows XP/Vista/7* - Unsupported (Windows XP is untested but might work if Windows Installer 4.5 Redistributable is installed prior)
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. iWBMSc – (Compact) INS GUI Install

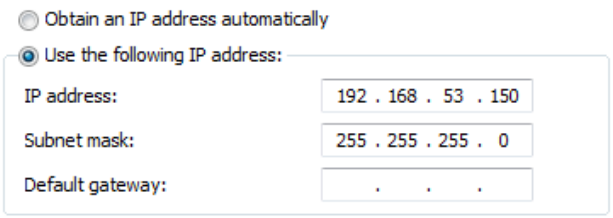
If operating the Compact, be certain that the included NovAtel Connect software is installed. Only version 1.8 and later should be used with the Compact. Navigate to the NovAtelConnect_Setup.exe provided by NORBIT and follow the prompts.

For detailed instructions on setting up and utilizing NovAtel Connect please go to Connecting INS to Connect.

4.2. 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 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 preconfigured with an IP address of 192.168.53.101. The IP address of the sonar will always be 192.168.53.XX where XX are 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. A good IP address to use would be 192.168.53.150 is it will not conflict with any system



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.

4.2.1. WBMS DHCP Connection

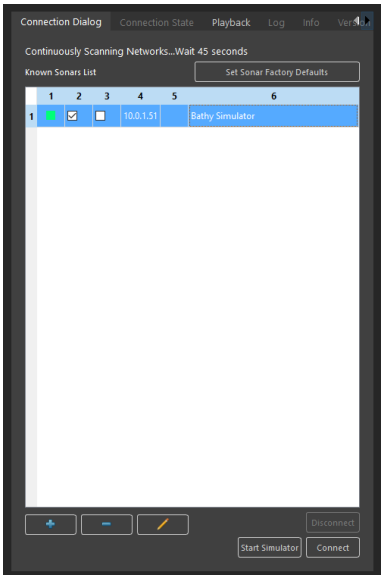
Unless otherwise required, please make sure that DCHP servers are not running on the same network as the sonar. During boot up, this will cause an automatic assignment of IP address. If this occurs, and a DHCP network is not desired, then power off the SIU, assign a static IP address to the computer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

5. WBMS Operation via GUI

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.

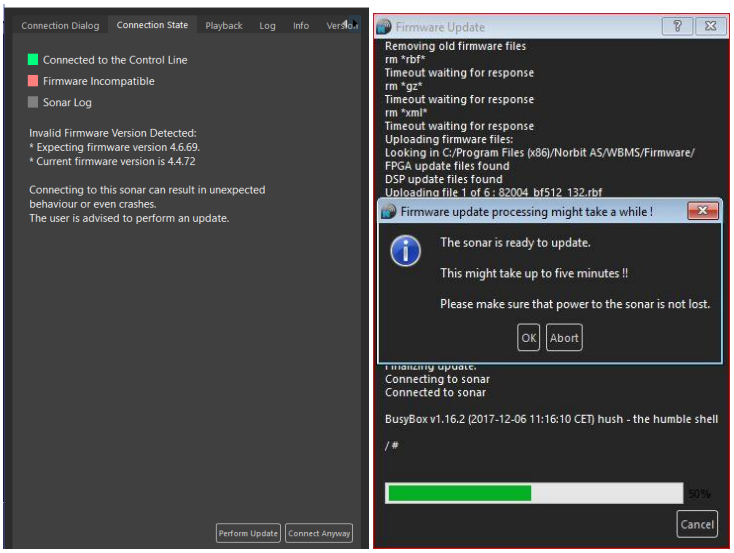
5.1. WBMS GUI Connection Window

Upon opening the GUI the connection dialog will be displayed. If a sonar is active and on the network a green box will appear next to the sonar. This indicates that the sonar is online. A red box indicates that it is not online. If the red box is shown next to the expected sonar, and the sonar is on check the network settings. Once a green box is displayed click on the sonar to highlight it blue and then click connect at the bottom of the window. If this is not the first time you have connected to the sonar then the GUI may automatically connect to the sonar.



Once connected a system check is performed that ensures the firmware is compatible. If it is not, a red warning LED, will indicate that the system firmware version is incompatible. To fix this, click "Perform Update" and follow the on-screen instructions to complete the process. *Please note that it is unsafe to turn off power to the sonar once the upgrade process displays the notification shown below – doing so will risk corrupting system configuration*. Operating a firmware and GUI with mismatching versions can produce unstable operation. For questions about the firmware or software, please contact NORBIT support.

Once the upgrade had been preformed follow the connection procedures discussed above.



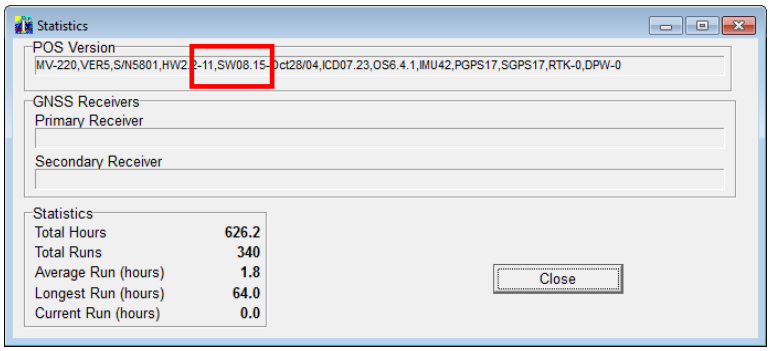
The GNSS/INS systems in the iWBMS, iWBMSh & iWBMSe can now be controlled with the new WBMS GUI (discussed later in this section). Once the system is connected, the GUI will commence logging raw GNSS/INS data. However, GNSS/INS logging will terminate if "Set Sonar Factory Defaults" is selected. The GUI will open a new INS logging file after a factory reset.

5.2. iWBMS, iWBMSh & iWBMSe INS Configuration

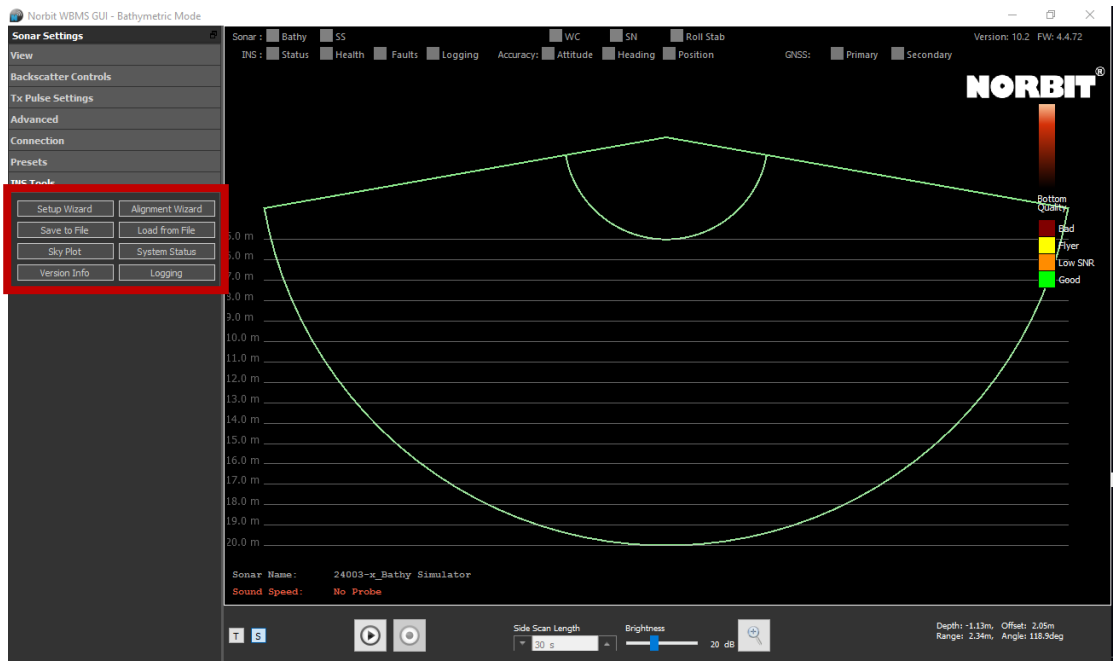
This section only valid for users with an integrated Applanix system.

NORBIT has integrated Applanix functionality into the NORBIT GUI; both INS and sonar may be configured and controlled from one simple interface. The user may still apply custom settings by selecting "Custom" for any of the settings described below.

In the NORBIT GUI, on the left hand side at the bottom, the INS tool can be found. For non-integrated/iWBMSc users most options will be greyed out. To use this feature of the NORBIT GUI the Applanix firmware must be version 9.03 or latter. For older firmware, please contact NORBIT Support with a screen shot of the View – Statistics window from POSView for the latest applicable version (example image here shows firmware version 8.15).



NOTE: For some users, firmware upgrades may incur additional cost from Applanix. To find out if this applies to your system contact NORBIT support with a screen shot of Applanix statistics window.



5.2.1. INS Setup Wizard

NORBIT advises prior to every new setup to apply factory default to ensure that there are no hidden issues from prior setups.

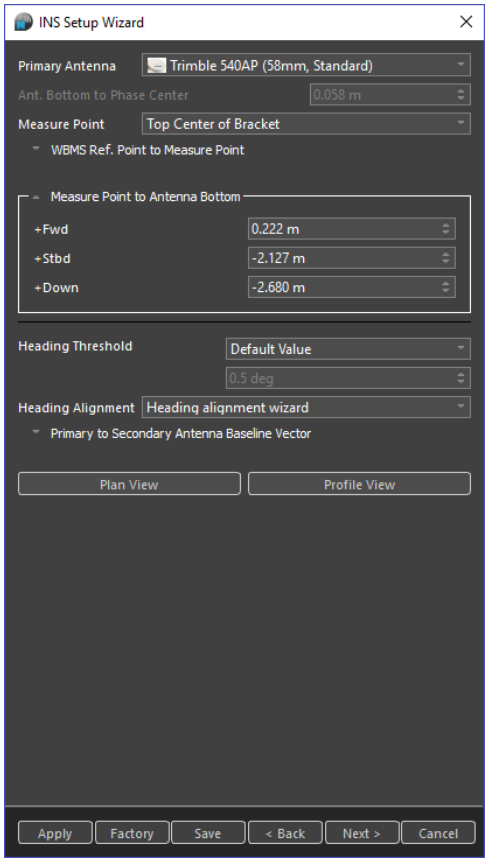
The Factory button will reset and apply factory default settings to the Applanix INS only. This will not affect sonar configuration. Applying Factory default values will configure Ethernet Real-time to output Groups 1, 3, 7, 10, 11, 20, 102, 103, 111, 112, and 113; ethernet logging to record groups 1, 2, 4, 5, 9, 10, 99, 102, 110, 111, 112, 113, 10001, 10007, 10008, 10009, 10011, 10012, 20000 Diagnostics, Applanix Diagnostics as well as ZDA and PPS for sonar timing.

Window one of the setup wizard will detect your sonar type in the System dropdown and will apply the static offsets and IMU rotations. To view these offsets click the arrow next to the configuration setting.

If a custom setting is desired click the down arrow next to the system type and choose custom.

5.2.1.1. Applanix Offset input

Offsets for the Applanix system are input in on screen two in the INS setup wizard. The



In the drop-down menu, next to Primary Antenna, select the correct antenna model, e.g. Trimble 540AP as shown below.

Carefully measure the distance from Antenna Bottom to Measure Point (top centre of wet-end bracket) and enter the correct values paying close attention to sign convention.

Should a positive value be entered for the down offset value a warning box will appear informing you that a positive number will place the sonar above the antennas. You will then be asked if you wish to change the value to a negative. If you have a special mounting and a positive number is correct, then you may cancel this warning.

The default thresholds for the heading alignment wizard will work for most users. It may be necessary to change the heading threshold value, e.g. if operating a large vessel and aggressive manoeuvring is not feasible. If heading calibration does not start within 30 minutes, change Heading Threshold option from Default Value to Custom and increase the threshold in 0.5º increments until the calibration starts successfully. Every time a heading alignment calibration is performed a patch test MUST also be conducted afterwards.

Select Heading alignment wizard to populate the fields in “Primary to Secondary Antenna Baseline Vector” with 0’s initially. Correct values will update once the Heading Alignment Wizard completes (described later in the section). If desired custom values can be added by changing the heading alignment from “heading alignment wizard’ to custom.

Open Plan View and/or Profile View to display schematics of antenna positions with respect to sonar reference. This can be used for a visual check of the system layout/offsets.

5.2.1.2. SBAS/Marine star settings

The Integrated GNSS page allows users to specify the desired satellite GNSS correction service. For instance, Satellite Based Augmentation Service type may be specified here. This is a correction source that is regional and free. Or, MarineStar paid subscription may be enabled and configured. Once complete, click Next to continue.

For info on setup of Marine star subscription please see the description of version info further down in this manual.

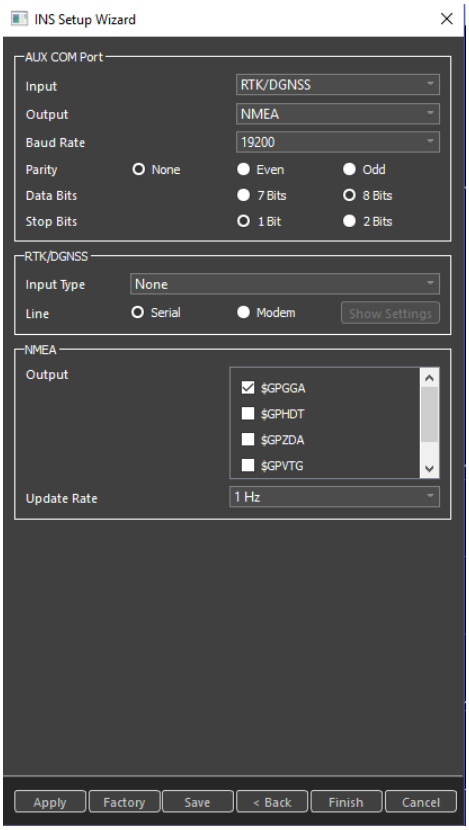
5.2.1.3. RTK/Aux GNSS input

If no RTK or Aux GNSS is being used then select “None” in the dropdown next to input.

Select the type on “Input”, for instance RTK or AUX GNSS receiver.

Unless otherwise required, leave the RTK settings as shown here. The incoming radio or NTRIP baud rates must match.

Select correct RTK input type (CMR, CMR+, CMRx, RTCM, etc.) as well as the RTK input type; serial (typical) or modem. Please note that if input type other than None is selected, POSView will only use GPS satellites so it will likely result in fewer satellite vehicles being detected. Selecting “None” enables Applanix to use additional satellites from other constellations such as GLONASS.



Select the desired NMEA output messages. For most users, the settings shown in the image should suffice.
If using a radio link for GNSS corrections, you may need to set the output to NONE to avoid issues with the radio.

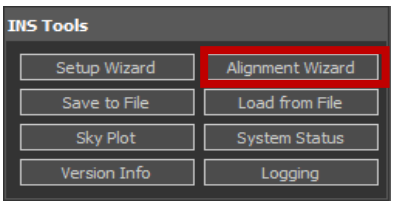
For users of an AUX GNSS. When an input of AUX is selected a new section will appear that will allow you to enter in the offsets to the AUX GNSS antenna. It is important to note that these offsets need to be from SONAR REFERENCE to PHASE CENTER of the aux GNSS antenna.

Click finish to complete INS configuration. If Heading Alignment Wizard was selected clicking finish now will automatically bring up the Heading Alignment Wizard. If preforming a heading alignment calibration is not possible at this time you may click cancel, with no loss of input values, and preform the calibration at a later time.

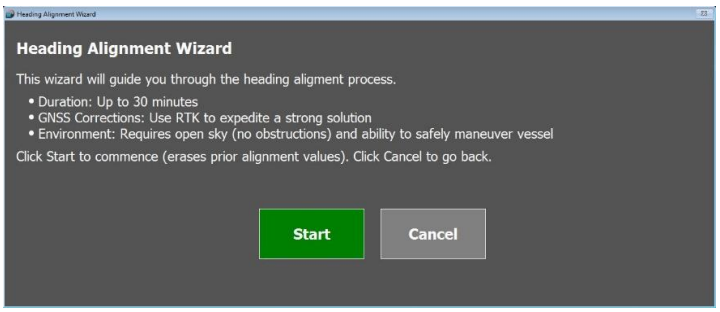
5.2.2. Heading Alignment Wizard

When first installing the iWBMS(x) or if the IMU or either of the two antennas is moved, it is necessary to perform a new heading alignment calibration to ensure proper alignment of the IMU with the GNSS antenna pair. A heading alignment calibration should be conducted in an area with clear view of the sky and away from tall structures that may impede GNSS performance.

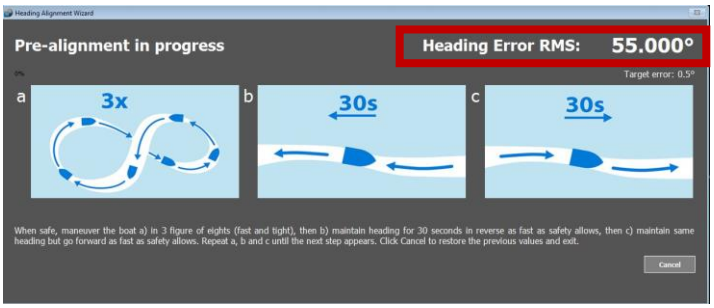
If a heading alignment calibration was not performed at the end of the INS setup the click the Alignment wizard in INS tools and follow the directions.



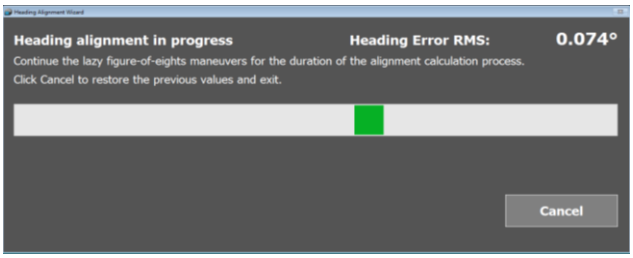
The first window in the heading alignment wizard will prompt users to click Start to begin the calibration process when ready. It is recommended that RTK is used to expedite the process. Be ready to manoeuvre the vessel before clicking start.



When the antennas have a clear view of the sky and users are ready to make fast maneuvers with the boat, click Start. Remember, the antennas must not be flexing or wobbling at the end of a flimsy pole. Make it stout, measure it well, then run the heading alignment!



Follow the recommended maneuvers shown, the Heading Error RMS will decrease. Once this value drops to or below the defined threshold ("Target error") and stays at this level for about 2 minutes, the next screen will appear. Continue to maneuver the vessel until this occurs.



Follow the instructions on this screen and continue to perform figure-of-eight manuvers until the final screen appears.

The example "GAMS Online" screen displays values obtained from the installation on a NORBIT field-testing vessel. The baseline vector values calculated by the Alignment Wizard should closely reflect the manually measured separation between primary and secondary antennas. If the values appear to be correct, click Commit and move on to sonar settings. We recommend that a patch test be performed soon after a Heading Alignment.

5.2.2.1. Understanding Heading Alignment Calibration results.

Understanding the alignment results will enable users to collect high quality data and properly verify offsets and mounting. The alignment results are the distances of separation from the primary antenna to the secondary antenna in the IMU reference frame in the *x*, *y* and *z* axes.

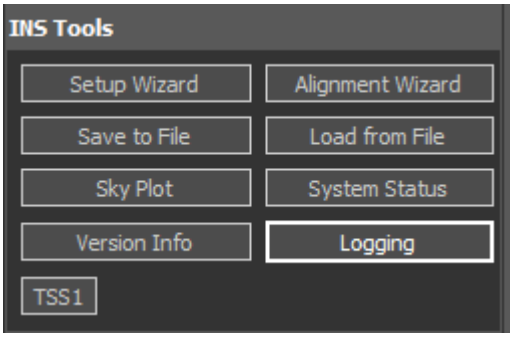
For instance, in the sonar-antenna configuration shown in the image. The *x*, *y* and *z* components of the vector from primary to secondary should closely match the measured values.

The *Y* component can be used to indicate if the iWBMS is in alignment with the antennas. A small value in the Y component indicates that the iWBMS is closely in line with the antenna orientation. A larger value would indicate 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 in alignment either by adjusting the mounting angle of the WBMS in the *Z* axis or 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.

If the antennas are mounted perpendicular to the sonar (in a *T*-formation) the explanations for *X* and *Y* will be reversed.

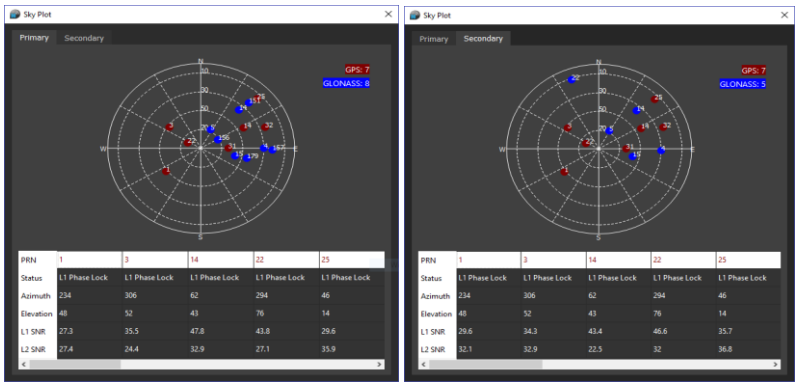
5.2.3. Save to/Load from File



The INS configuration may be saved to disk for future reference by clicking the Save to File button. Please note that this can be done inside the Setup Wizard also. The configuration will be saved as an .nvm file to a user-defined directory.

Similarly, to load a saved INS configuration (.nvm), click Load from File and navigate to the correct directory and click Open.

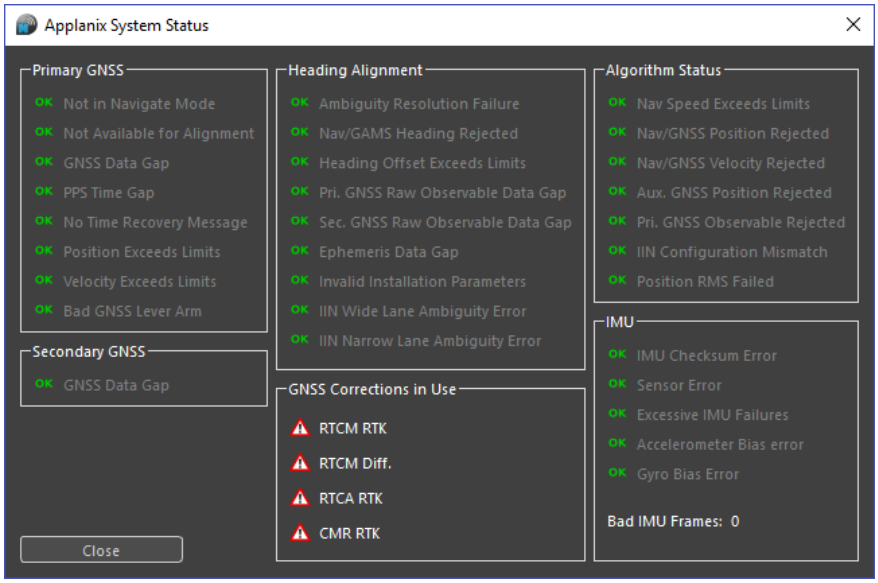
5.2.4. Sky Plot



The Sky Plot button opens a window (see associated images) to visualize detected satellites on the primary and secondary antennas, if connected.

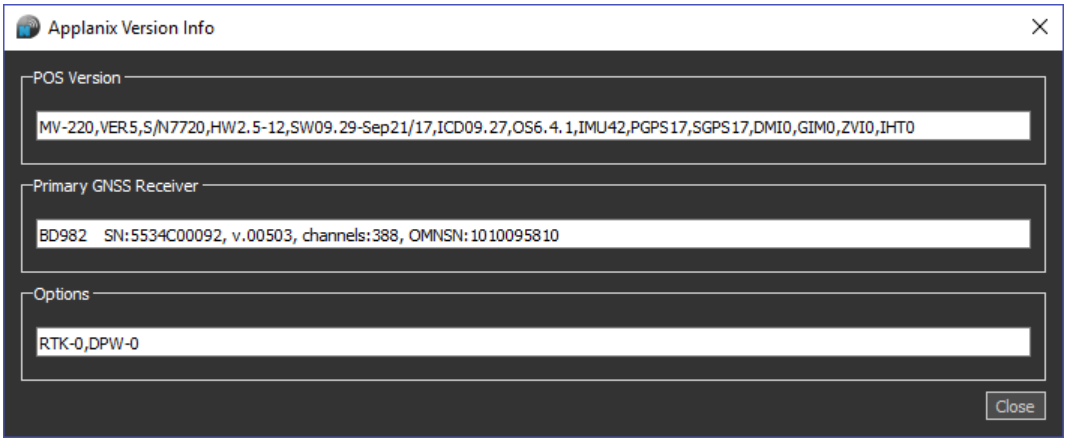
5.2.5. System Status

System Status will open a window showing a list of INS error codes. Check this window if the faults indicator in the GUI status bar is red. The image below shows a system without any errors. This window may serve as an important diagnostic and trouble-shooting indicator.



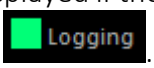
5.2.6. Version Info

Version Info displays all Applanix related hardware, software and firmware version information. For users requiring an authorization code to upgrade the Applanix firmware, for instance, NORBIT support may ask for a screenshot of this display. The image below shows an example of this window.



To subscribe to Marinestar submit the OMNSN number found in the Applanix version info to http://www.fugromarinestar.com/Order_form

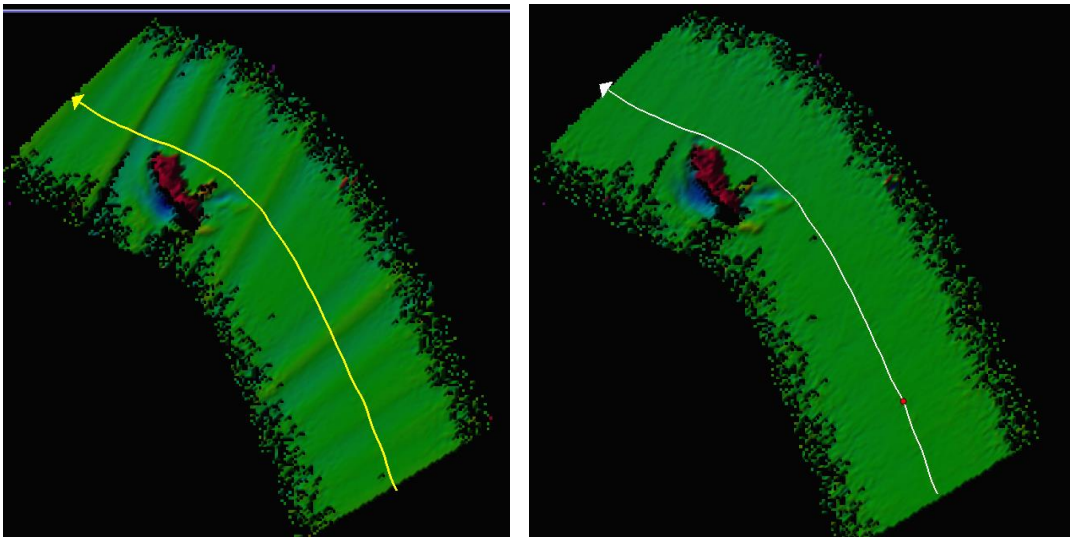
5.2.7. Logging

By default, the NOTBIT GUI will begin logging the Applanix RAW ins/Trueheave data as soon as the GUI is opened, there is no additional input needed from the user. NORBIT recommends that users do not disable the Logging button. When activated (default state) this commands the interface to record INS data as a binary file (*.000) defined by Applanix. The location of the saved *.000 file will be displayed if the mouse pointer is hovered over the INS: Logging box at the top of the GUI display: 

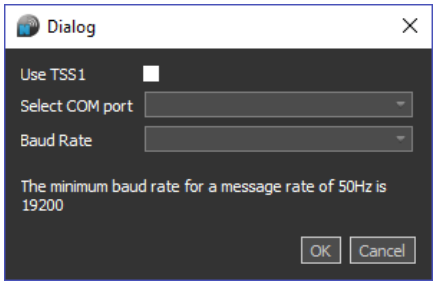
.

If deactivated, the Logging box will turn red. Logging of INS data may be restarted by clicking the Logging button, in INS tools, again.

The *.000 file serves a dual purpose – first, it may be applied as “True Heave” in post-processing (in QINSy for example) to drastically reduce heave artefacts, all without having to purchase additional proprietary licenses. The attached images show the difference in bathymetric data when True Heave is applied (image on right). Secondly, the *.000 files can be processed in POSMMS for the application of PPK data.



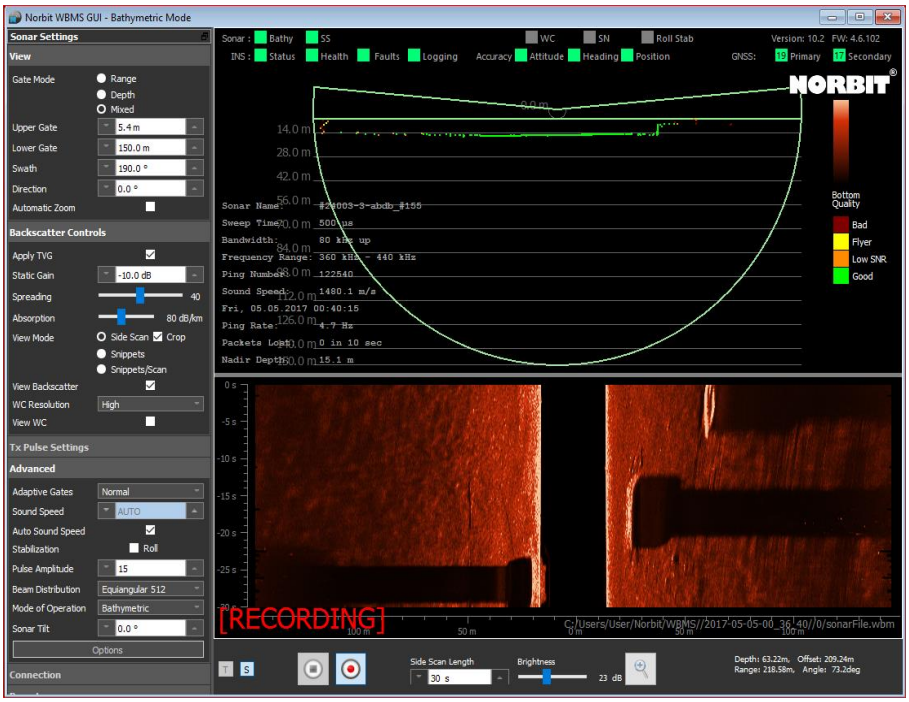
5.2.8. TSS1



For non integrated systems a TSS1 message can be used for roll compensation. The TSS1 message should be brought into the computer via COM port. In the TSS1 setup select the computer COM port and the proper baud rate.

5.3. Main WBMS GUI Screen

Once the GUI has established connection with the sonar, it will start logging automatically. The image below is an example of the main window while both GNSS/INS and sonar data is being logged.



The middle of the screen will display the sonar wedge and side-scan image, if selected. The wedge shows a single ping that will become a swath of data (multiple pings). Use this screen to assess data quality and swath coverage. Within the wedge area will be a list showing an overview of the sonar settings and measurements. The current firmware version is displayed in the top right corner of the main GUI display.

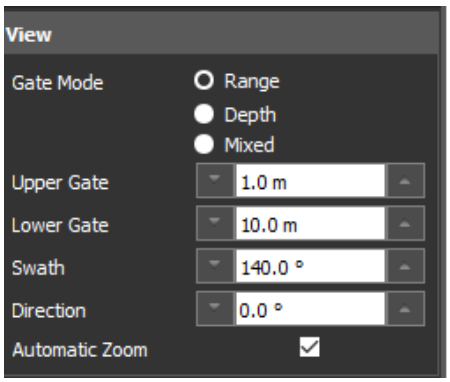
5.4. Sonar Settings Menus

The left column, as seen in the above image, contains various tabs each with user selectable options. The user may click on each tab title (light grey area) to view or hide the contents. For normal operation with default settings, only the first tab, View Field, need be made visible.

5.4.1. View Field

Most sonar control features can be found in the View tab. Here, the user may specify Gate Mode, the Upper and Lower Gates, Swath angle and swath pointing Direction.

The table below describes the functionality of each control in this tab.



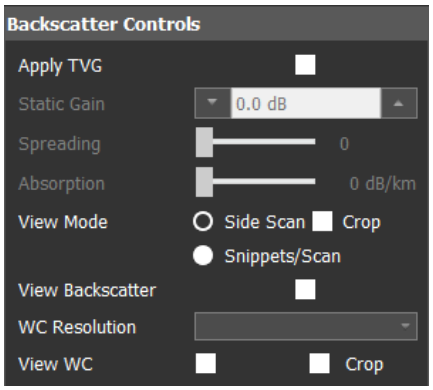
Function	Description
Gate Mode	Allows for selection of manual gates by upper and lower depth (Depth mode), by upper and lower range (Range mode) or by lower range and upper depth (Mixed mode). Depth gates will be used in most environments. Range gates are ideally used for shallow water bank to bank surveys or when changing the pointing direction. If Adaptive Gates are turned off, a depth point is picked within the Upper Gate and Lower Gate independently for each beam. When in Depth mode, changing the pointing direction, or operating with a physically tilted head may drastically reduce the ping rate. To avoid this, switch to Range or Mixed mode.
Upper Depth Gate	Manual gate. This sets the upper limit (minimum depth) for bottom detections. Change values by entering a number using keyboard and hit Enter, by using up/down arrows next to the corresponding control bar, or by placing cursor over yellow Upper Depth Gate and dragging to desired depth location. Minimum Value: 0.1m Maximum Value: 599m
Lower Depth Gate	Manual gate. Maximum depth for calculating bottom detections. Change values by entering a number using the keyboard and hit Enter, by using up/down arrows next to the corresponding control bar, or by placing cursor over yellow Lower Depth Gate and dragging to desired depth location. Minimum Value: 1.0m Maximum Value: 600m
Swath	User-defined total angular swath coverage. For typical harbour dredge surveys, this value is nominally 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 angle. Next select the desired pointing direction and last select the final desired overall swath angle. 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 allows the user to make the GUI as small as possible and to see greater detail. This is most effective when using Adaptive Ping Rate with a large lower depth/range gate.

CAUTION: Beam distribution fixes swath width and pointing direction when ED

Swath width cannot be increased such that any part of the swath exceeds an 80° pointing angle (so, a 160° swath with 0° rotation or a 120° swath pointed 20° is the maximum).

Sonar range setting is a function of the lower depth 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 the water being surveyed.

5.4.2. Backscatter Controls



The Backscatter Controls allow the user to change the data dynamics and apply gain to the data to fit in the dynamic range of the output data format (s7k). Sonar hardware has a limited time varied gain (TVG) which will operate 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", when checked, will remove this native sonar TVG that is applied in sonar hardware and instead apply the user specified TVG described by the mathematical formula:

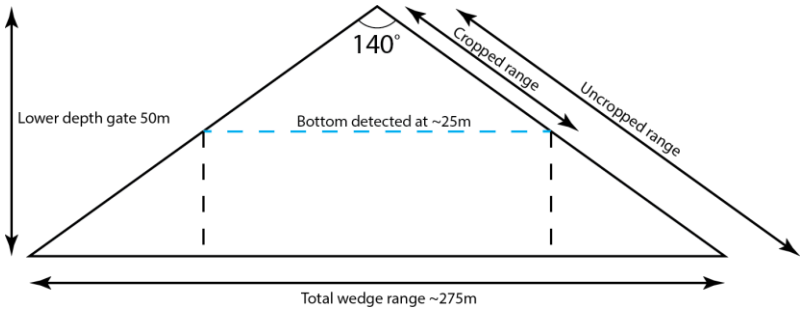
$$TVG = Spreading^* \log_{10}(R) + 2^*Absorption^*R/1000 + Gain.$$

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: Sidescan, Snippets, Water-column (WC), Snippet-Sidescan and Backscatter. For most cases, a gain of -20, spreading 40 and absorption of 80 will sufficiently scale the data.

If the signal gets saturated, the SS/WC/SN indicator will turn red on the main GUI display (see section 5.6). This can be fixed by adjusting the Static Gain. 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 "Apply TVG" is unchecked the native sonar TVG is not removed and no additional digital gain is applied to the data. Therefore, it's prudent to always select "Apply TVG"

Checking/selecting Side Scan displays the side scan data in the GUI. Even if it is not displayed in the GUI, side scan data is still sent to the acquisition software if properly requested.

Selecting Crop, with Side Scan, will command the GUI to restrict side scan to the maximum *range* of bottom detections. For example, setting the lower depth gate to 50m with a 140° swath, will result in a wedge range of ~275m (see diagram for illustration). If bottom detections are at ~25m, and side-scan is not cropped, side-scan will display data from the total wedge. If cropped, side-scan range will be limited to the cropped range. With water column and snippets deactivated, side-scan will be acquired at the current ping rate.



Checking the view WC check box will allow for the viewing of water column data within the NORBIT GUI. Water column data collection is limited to 5Hz.

Unchecking the Cropped box next to Water Column will enable acquisition of full water column data. This box should be unchecked for applications such as wreck investigations where users may want to see soundings below a given detection point. Water column data is output on record 7042. The Water Column (WC) Resolution control will set the resolution of data collected. It is advised to keep the resolution low when computational resources are scarce

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 in snippets mode, Snippet Side-scan will be activated so that (unlike regular side scan) a correctly positioned side scan can be derived from snippets data.

When surveying with an STX, 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

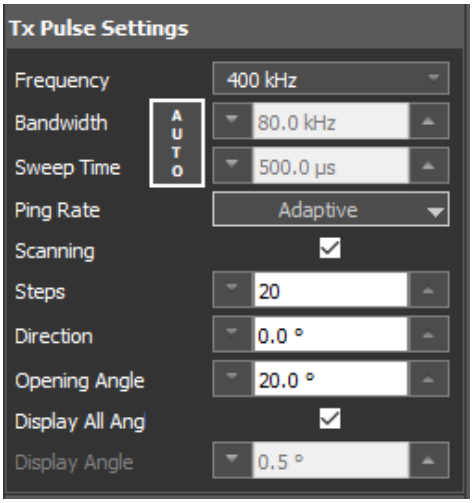
NOTE:
Snippets is data intensive. To ensure proper data collection make sure that the acquisition PC is not near its maximum CPU load. If CPU load it too great artefacts may appear in the snippets record.

5.4.3. Tx Pulse Settings

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

If the GUI detects an STX, this menu will activate the options below and including Scanning. These controls will not be visible if a standard WBMS is detected. All the functions are explained in the table below.

For additional information on STX usage please refer to the STX usage section further along in this manual.



Function	Description
Frequency	Sets centre frequency of transmitted pulse. The WBMS is optimized for a centre frequency of 400kHz for standard systems and 200kHz for the deep/long range systems. For a given depth, higher frequencies will theoretically have higher bottom detection resolution but also higher signal attenuation, especially in the presence of sediments. For most applications, however, we recommend maintaining a frequency closer to the centre frequency of that system (200 or 400kHz).

	Standard Systems: 200kHz – 700kHz Deep Range Systems: 160 kHz – 400kHz
Bandwidth	Frequency bandwidth of the sweep. Generally, for FM mode, set to 80kHz. Decrease the bandwidth in deeper waters or use automatic settings. For CW mode, set to 0kHz for constant frequency transmission. However, the system is designed from conception as an FM system and will perform optimally in this mode and yield highest resolution regardless of depth. Range is 0 – 80 kHz. To set a negative BW add a minus sign to the selection; e.g. -80kHz would set the system to sweep down
Sweep Time	Pulse duration of the signal transmission. For FM, long transmission duration of about 500µs is ideal. Only for very shallow waters (less than 5m) would it be necessary to reduce this value to about 200µs. Decreasing sweep time increases effective ping rate. For CW mode, the duration of the signal transmission directly reduces bottom detection quality yet increases range performance. It is best to use FM for most all surveys. Range is 0 to 500µs.
Automatic Bandwidth (Auto)	Adjusts bandwidth and pulse length 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, turn off Auto (below) and set bandwidth to 80kHz and sweep time to 500 µs 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 sent out. Certain factors like 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/hydrophone are longer. Sweep time will also affect ping rate. The system will automatically set sweep time to 200µs in shallow waters so that users may obtain highest ping rates.
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 Gates. 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 Depth 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 (ex. on AUV's). While operating in this mode, sonar bandwidth and sweep time are determined by the lower depth gate. If surveying in shallow waters the Lower Depth Gate should not be set too deep unless Auto Transmit Pulse Settings is not enabled.
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 (Swath Width, Lower Depth Gate, Swath Direction).
Ping Rate: External	Not typically used by most customers. 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 centre 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.
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

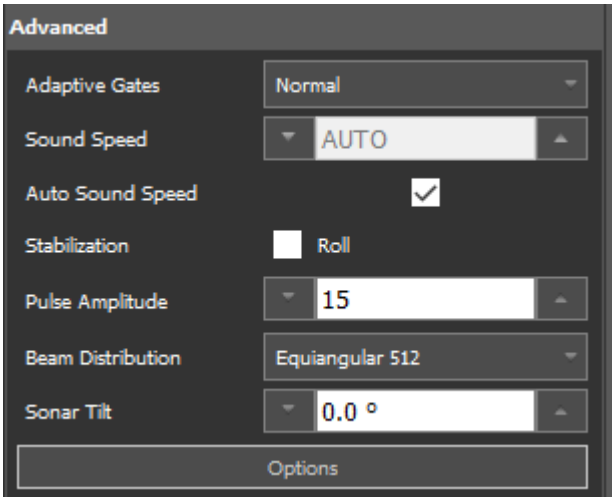
High quality sonar data requires excellent Signal to Noise (SNR). Therefore, the sonar Tx Pulse Settings directly impacts final data quality. For most conditions (temperature & salinity dependent) keep 80kHz bandwidth and 500µs sweep time. If useable swath width becomes narrow (noisy outer beams) then gradually degrease the bandwidth. If in doubt use Automatic Bandwidth selection.

CAUTION: For Bottom classification surveys using Snippets

If the primary purpose of the survey is for sidescan/snippets, then deactivate *Auto* and manually define sweep time and bandwidth. 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 sweep time. In general a 500µs will suffice however this will limit ping rate to a max of 20Hz if a faster ping rate is needed then reduce the sweep time.

5.4.4. Advanced

The Advanced tab contains controls that need not be modified during typical surveys. It is prudent for the sonar operator to understand these settings in the rare event that they need to be changed. If a NORBIT STX system is utilized then an additional checkbox will appear that will activate pitch stabilization. Pitch stabilization should not be used with scanning active.



Function	Description
Adaptive Gates	It is advisable to use Adaptive Gates in nearly all environments. If Adaptive Gates are too narrow, bottom detections may be noisy for large depth changes. In areas with steep gradients it is recommended that Adaptive Gates be turned Off. If Adaptive 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 associated 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 adaptive gates may need to be set wider to avoid cutting out data during large roll events.
Sound Speed	This tab controls how the surface sound speed is applied. If Auto Sound Speed is checked (recommended) the sonar will only take in values from the senor near the projector. If this sound speed probe fails, users can uncheck the Auto option and manually input the speed, based on a sound speed profiler for instance. An incorrect surface sound speed will irreparably compromise the beam pointing direction resulting in bad data. Min value

<table>
<tr><td></td><td>is 1300m/s, max is 1700m/s. When Auto Sound Speed is unchecked the last value at the head will be used to populate the SV value. Please note that this range reflects default hardware capabilities. For marine conditions requiring a bigger range, other models of the sound speed probe are available; please contact NORBIT for more information.</td></tr>
<tr><td>Auto Sound Speed</td><td>If this option is checked the speed of sound is read from the probe at the sonar. 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 de-selected, and the value set manually. If the sonar is on and out of the water or there are excessive bubbles, the GUI will display a warning stating that the sonar is out of water. If the sonar is pinging out of water, it will automatically take measures to prevent damage due to overheating. If the sonar temperature exceeds 65°C it will shut down automatically as a safety measure.</td></tr>
<tr><td>Beam Distribution</td><td>There are 4 modes to select from:
<u>Equiangle 512 or 256</u>: The angular swath coverage set above 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.
<u>Equidistant 512 or 256</u>: 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.</td></tr>
<tr><td>Stabilization</td><td>Roll stabilization will allow for a wider swath width in more dynamic sea states.
To use roll stabilization, ensure that Group 1 is selected on POS ethernet real-time with output at 50 Hz. Roll stabilization will compensate up to ±10º of roll and is limited to 160º swath angle. Currently roll stabilization is only available for the iWBMS (e&h) and WBMS users with Applanix systems.</td></tr>
<tr><td>Pitch Stabilization (STX only)</td><td>When activated, pitch stabilization allows for pitch compensated transmitted beams for a more even along-track coverage with minimal loss. STX scanning should be deactivated prior to using.</td></tr>
<tr><td>Pulse Amplitude</td><td>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</td></tr>
<tr><td>Sonar Tilt</td><td>Not typically used. This specifies the tilting angle in special mounting configurations such as dual head when the sonar is mounted at an angle. Allows the user to see a horizontal bottom in the GIU.</td></tr>
<tr><td>Options – Display Preferences, Timing and Triggering (See image below)</td><td>This allows user to specify display preferences and configure timing and triggering. The user preference options are described below.

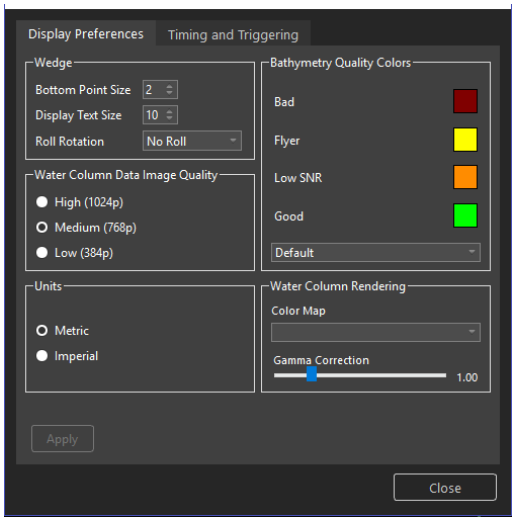
<table>
<tr><td>Bottom Point Size</td><td>Allows user to change the point size within the wedge. Adjustable from 1-10</td></tr>
<tr><td>Display Text Size</td><td>Allows the user to change the text size on the wedge area. Adjustable from 1-12</td></tr>
<tr><td>Roll Rotation</td><td>Viewing options to show the roll stabilized wedge.</td></tr>
<tr><td>Water Column Data Image Quality</td><td>This 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.</td></tr>
<tr><td>Units</td><td>Allows users to select the display units in the GUI to be either metric or imperial</td></tr>
<tr><td>Bathymetry Quality Colours</td><td>Changes colour palette of bottom detection quality flags</td></tr>
</table>

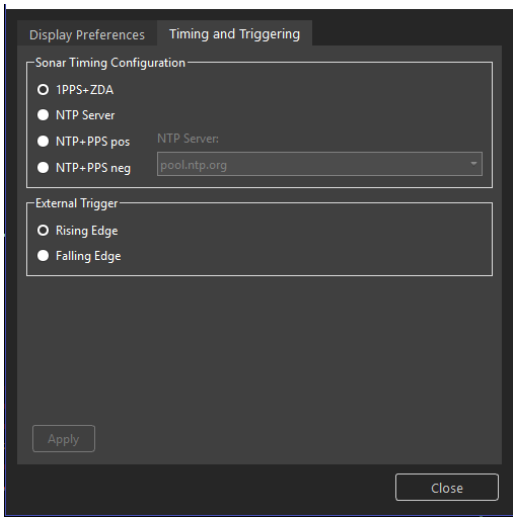
Colour Map offers different colour settings for visualizing the swath intensity data.

Gamma Correction slider bar will change 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:
User can specify method for sending timing to the sonar in this window. For most survey applications, it should be left at 1pps+ZDA; the GNSS signal provides the time stamp and the PPS signal derived from that. If GNSS signal is unavailable an NTP server, such as Meinberg may be used (but not recommended) for timing; to do so, select NTP Server and specify the name of the server in the NTP Server box. If timing error is more than 10milliseconds, sonar will discard timing. Select</td></tr>
</table>

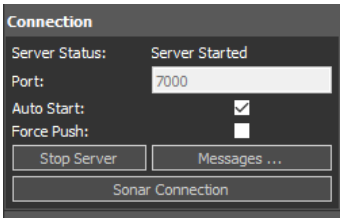
	NTP+PPS pos/neg if using time from an NTP server to provide PPS; "pos" and "neg" refer to a positive and negative signal spike respectively. In NTP+PPS setting, an error of more than 100milliseconds will render the data unusable. More advanced users can use an external signal to trigger the sonar; the External Trigger box provides a way to control whether the rising or falling edge is used to do so. **NOTE: For integrated systems triggering via the BNC connector is not possible. Inputting any voltage into the BNC of an integrated SIU can cause damage to the internal electronics**





5.4.5. Connection

The WBMS operates in a native data format. To ensure compatibility with other data acquisition and processing software, the WBMS includes a proxy that translates native WBMS data to an s7k data format. The proxy is therefore run from the WBMS GUI and is initiated automatically. The option allows the user to reset the connection should a conflict arise. Should it be needed, to avoid conflict with other equipment, the port number can also be changed.

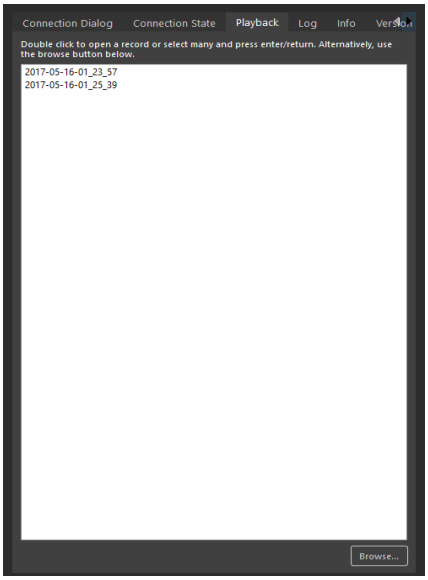


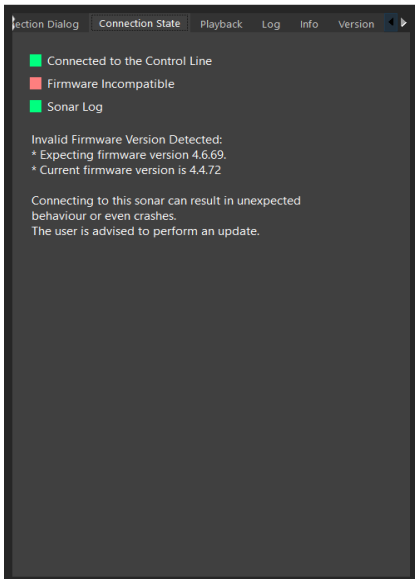
For dual head users the port numbers for each sonar are changed as follows. Only one selection of port number will be visible. With both sonars connected in the GUI if the port is changed to 17000 then the port fir the secondary head will be 17001. The second head will always be one grater than the primary.

NOTE: PDS2000 & EIVA Users

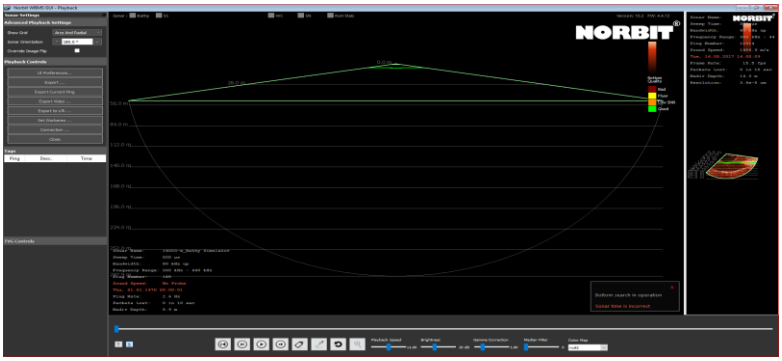
To receive data into PDS2000 or EIVA, the NORBIT GUI must be set to force push the desired records. Only selected records under the Tx settings will be transferred to the acquisition software. For example, the View Sidescan box MUST be checked in the GUI while collecting sidescan data.

The Sonar Connection button will open the Connection Dialog box (described in 5.1) as shown below. From here, users may navigate to the Connection State, Playback, Log, Info, and Version tabs. The connection state tab contains basic information regarding the connection to the sonar. If any of the squares/LEDs are red they indicate an error. Such is the case in the image on the right, indicating that the sonar is not loaded with the firmware expected by the GUI. To shut down and disconnect the sonar, click Disconnect from sonar.





The Playback tab displays all detected GUI recordings. If there are GUI recordings in other folders, USB drives, etc. please click on Browse and navigate to the correct folder. To play back a recording double-click on the file name. This will open a second display to the right of the live swath showing the recorded data. The GUI recording files are saved in the folder C:\Users\user\Norbit\WBMS\.



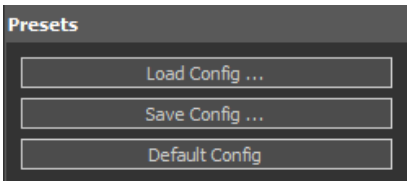
Users may click and drag the boundary to resize the Playback window (shown on right side of an active wedge) to a desired size as shown below. On the left are the Playback Settings and Controls. Users can change the sonar orientation by adjusting the Sonar Orientation control bar. To export current ping or a series of pings, use the Export Current Ping and Export buttons. At the bottom of the main display are the playback controls: go back to beginning of recording  , rewind by 1 ping  , play/stop  /  , forward 1 ping  , insert tag/comment/descriptor to recording  .

Other options including s7k export are shown on the left hand side of the GUI

The Log tab contains a record of all changes made to the sonar. This can be extremely useful during troubleshooting and NORBIT support may ask for a copy in certain support cases.

The Version tab will display the current WBMS GUI version as well as the current version of the firmware installed on the sonar.

5.4.6. Presets



These controls allow users to save preferred sonar configurations (Save Config) to a file that can be loaded (Load Config) into the GUI at the user's discretion. The saved configuration files are in the folder C:\Users\admin\AppData\Roaming\Norbit\PredefinedSonarSettings. Users may transfer these files to another computer to load desired presets to a different system.

When a configuration in loaded into the GUI it will create a single button that will allow for rapid changes in sonar settings. For example a setting can be made for looking to the port side, the setting would contain not only the direction but also so change in gate mode.

5.5. Upper GUI status lights.

The first row (***Sonar***) in the GUI status bar contains LEDs that indicate the specific sonar data that is being requested by an acquisition software. If none of the fields in the first row are requested, the LEDs in this row will remain greyed out as shown above. If requested by an acquisition software, only the related LED(s) will turn red ■ /green■ . A green LED indicates successful subscription of the data packet. If any of the lights are red, hover over the box to generate a popup providing further information. This is most likely to occur if the acoustic sensors are saturated. To fix this, simply change the TVG settings under Backscatter controls to reach a stable green indicator.

The ***Bathy*** LED in the row refer to bathymetric data that is output by the GUI. The ***SS***, ***WC*** and ***SN*** LEDs refer to side-scan, water column and snippets respectively. ***Roll Stab*** refers to the roll stabilization command under the Advanced tab in sonar settings.

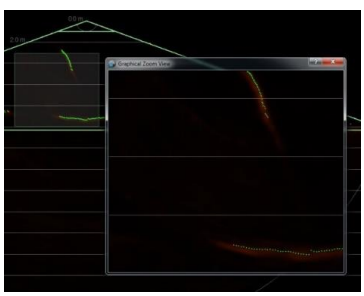
The second row of indicators (***INS***) in the GUI relate to the function and health of the Applanix INS system. If any indicators are red hover over them to see information related to the issue. If only SBAS is used, and RTK is not, the ***Status*** indicator will be orange. If SBAS is also unavailable, the LED will be red. The GNSS indicators – ***Primary*** and ***Secondary*** will be green if the GNSS antennas are connected and red if they are not, or if GNSS signal is bad. These two indicators also show the number of satellites that each antenna is tracking. Be aware that if using SBAS the primary antenna will always show 1 or 2 satellites more than the secondary.

5.6. Lower WBMS Viewer GUI Bar

By default, the sonar will start pinging once connected to the user interface. The Play  /Stop  button (to start/stop sonar pinging) is in the lower GUI display control bar. Once stopped, the Stop button changes to a Play button which can be clicked at any time to restart pinging.

Users may also set the Side-Scan Length and adjust display brightness using the buttons here. The ***Brightness*** control bar only adjusts the wedge intensity displayed on the GUI; it does *not* affect the data. This is useful to effectively increase the illumination of all acoustic data received. Applying too much brightness will saturate the image of the more reflective areas of the acoustic display, may cause the entire wedge to be nearly all black (lowest brightness) or all white (highest brightness).

To the right of the Brightness control is the Zoom tool. Clicking on the zoom tool will bring up an adjustable pop-up window in the main GUI display on the swath wedge. The user can drag the window to any location on the wedge to magnify any segment of the swath of interest. The zoom pop-up window will remain on top of all open windows.



Users can bring up further data visualization options using the two buttons: 

will display a time trace for each beam separately when the water column is active. Right clicking in the time trace window will allow the user to zoom into the trace. Left clicking zooms back to default. Channels can be selected by using the arrows at the bottom of the time trace window. A graphical channel selection will appear in the sonar wedge.

allows the user to hide/unhide the sonar settings menu. The user still has control of the static gates and therefore the sonar range by simply click and drag the upper and lower gate to a desired location.

The Record button  is for recording raw sonar data in native NORBIT format. Once recorded, this data can be played back at any time (even during real time sonar operation and recording). NORBIT Support may request this raw data for troubleshooting. The GUI recording files are saved in the folder C:\Users\user\Norbit\WBMS\. Each recording session will generate a folder with the naming convention YYYY-MM-DD-HH_MM_SS and the data will be stored inside this folder. If asked to send data to NORBIT please compress and send this folder or the relevant files.

5.6.1. Native Data Format, Conversion to s7k, Customization

As mentioned in the preceding section, users may record bathymetry data –no motion and navigation data – in native NORBIT format with extension .wbm. However, the Playback tab has an option to convert *.wbm files to s7k format which has a publicly available data format definition (DFD). If requested, NORBIT Support can provide documentation on the DFD, and in special cases, unofficial tools to help process a batch of *.wbm files to *.s7k.

5.6.2. Optimizing Side Scan within the GUI

Tuning the display brightness and Gamma Correction (in Options) in the GUI will not have any impact on the data and is only used to adjust the display. However, the TVG setting will be applied to output data. See TVG description for details.

To optimize side-scan images visually,

1) adjust brightness in the display control bar
2) go to Sonar Settings>Backscatter Controls and make sure Apply TVG is checked, then
3) adjust the values for **Static Gain**, **Spreading** and **Absorption** until the side-scan image appears unsaturated and that no red LED (saturation warning) appears for the backscatter options

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

6. WBMS Theory of Operation

To operate the sonar effectively, users should be aware of certain basic principles of sonar signal processing. This knowledge will help users trouble-shoot problems in the field with minimal assistance and tune sonar parameters to obtain high-quality data.

6.1. 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 is in shallow waters, reduce the sweep time to maximize the ping rate.

The NORBIT WBMS has been tested to 175m using 80kHz bandwidth. It is recommended that for most scenarios users use auto bandwidth.

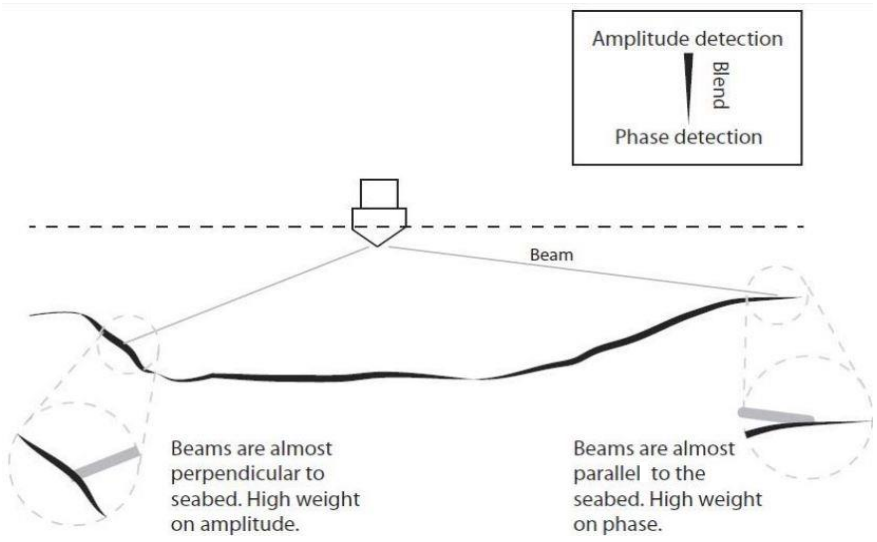
6.2. Bottom Detection

The WBMS seamlessly utilizes three methods for bottom detection:

WBMS Bottom Detections
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.

7. iWBMS Dual Head

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

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.

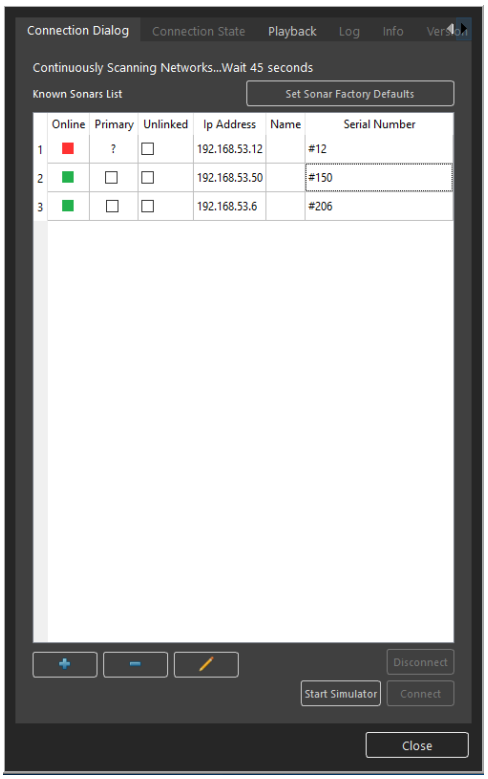
However, if *two* SIU-I (stand-alone SIU, part no. 29024) are used with a third party IMU, the primary sonar should connect to one SIU and the other sonar should connect to the second. Please note that if two SIU-I are used, timing in the form of a ZDA message and PPS over BNC must be supplied to both 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 Appendix 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.

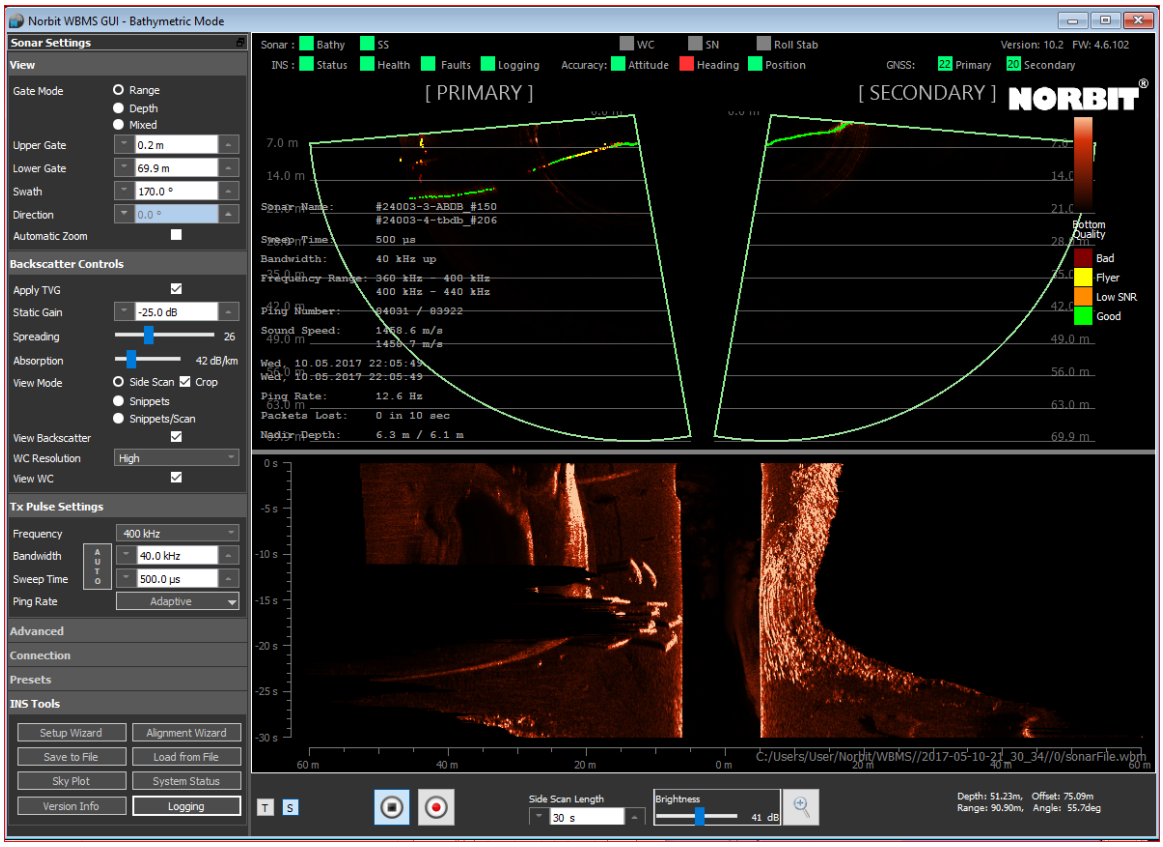
When setting up an iWBMS in a dual head configuration IMU rotations and offsets will change. For further information on this please refer to the NORBIT tilted sonar manual. If you do not have this manual, please contact NORBIT support.

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 2.7. 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 sufficient 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 10.3.6 and with the SIU powered on, run the GUI to detect and communicate with the sonars. On the Connection Dialog box, select the two sonars and check the "Primary" box to set one sonar as the primary. Then click Connect. For example, the image below 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 would be required to click on the two detected systems, then check the Primary box on the desired system and then hit Connect.
7) ***Sonar controls:*** once connected, two swaths will appear in the main GUI window with the primary sonar appearing on the left, as shown in the example below. Thus, visualization will be more intuitive if the primary sonar is installed on the port-side of the boat. The primary and secondary swaths will be labelled as such. If side-scan is turned on, as in the example below, the image displayed will be that from the two sonar systems combined. Adjust sonar parameters as needed and start collecting data. Any changes made in the sonar settings menu will apply to both systems. The controls for dual-head remain the same as for single-head. For more detailed explanations of all sonar settings functions and controls, please refer to section 5.3. 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. This can be done by opening the Tx Pulse Settings tab, turning off Auto and typing in 40kHz.



NOTE: In the acquisition software the port numbers will be as followes. Port 7000 will be the primary head and port 7001 will be the secondary head. If the port numbers are changes the secondary head will always add one to the port number of the primary head. In addition do some softwares give you the option to select one head as primary and one as secondary. In this case both heads will be primary heads.



7.1. Dual head 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 will automatically apply a frequency separation to the sonars. This separation is determined in the following way. When a centre frequency is selected that GUI will choose a bandwidth, by default, of 40kHz. For instance, when 400kHz is used with the default bandwidth of 40 then the sonars will 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 from each other.

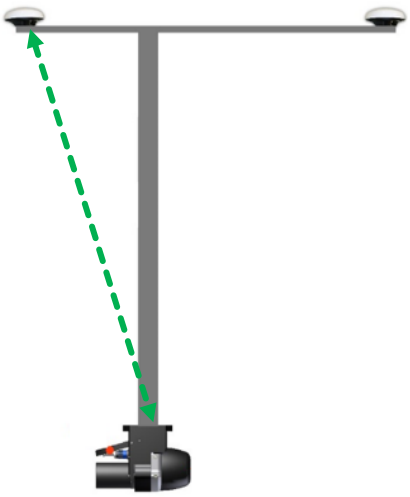
If you wish to change the frequency spread, you can do this by simply adjusting the bandwidth. The closer you put the bandwidth to 80kHz the more frequency overlap will occur. If you desire to operate the sonars individually you can simply unlink them. To control a sonar, click on the wedge associated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

Quick Start

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 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 centre of sonar bracket to base of primary antenna* (closest to sonar reference).



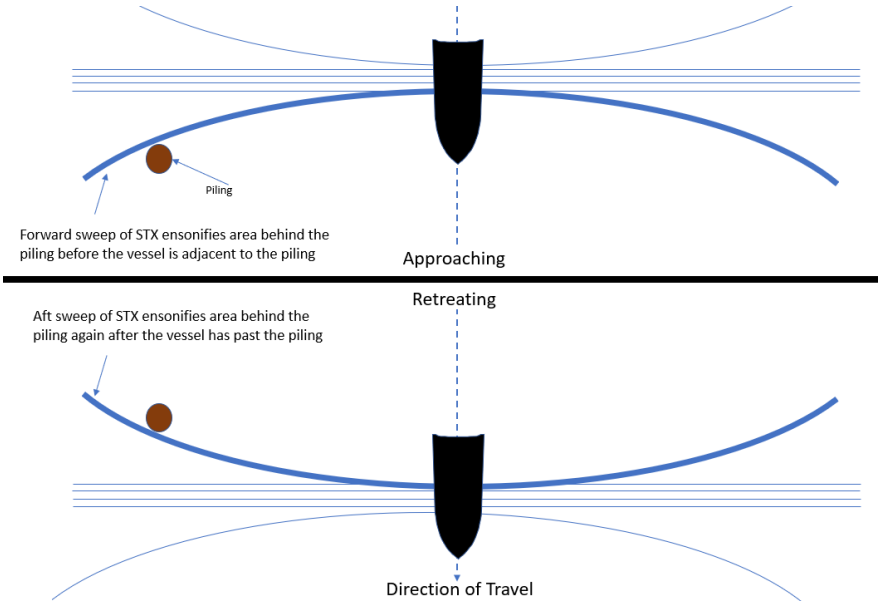
8. ***Power:*** Ensure power source is clean. Be aware of batteries that are under powered or cheap inverters.
9. ***Software:*** On the control and acquisition PC, install the WBMS GUI version 10.3.6. For iWBMSc users, also install NovAtel Connect. With all hardware connected to the SIU, power it on and open WBMS 10.3.6. 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 Sonar Settings menu and open Setup Wizard. For the default and recommended setup, simply follow the prompts in the setup wizard and have the measured offsets, from top centre of bracket to

base of primary antenna, at hand. For the baseline vector, select Alignment Wizard. This way, the Alignment 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 appendix of this manual for setup instructions.

11. ***Separate INS software:*** Not applicable for iWBMe, iWBMS & iWBMSh users running Applanix firmware >9.03 and sonar 10.3.6. 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 COG in to 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 centre of rotation. The driver for the WBMS will be the Reson 7125 or 71xx. Newer software, the driver will be 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!

STX Usage

The NORBIT STX is a steerable transmitter system that allows for 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, suck as behind pilings. This feature better aids in conducting inspection surveys by giving a more complete picture of the survey area.



When scanning is activated the STX will begin steering the transmit beam. For best results it is advised that speed be as slow as is safely possible. In addition, it is recommended that two passes be conducted. One pass as close as is safe to the structure and a second pass standing a bit off. This will ensure that maximum coverage is achieved.

The STX can also be utilized to fully develop an object on the sea floor such as a wreak. When used in that application the steering of the transmit beam allows for multiple hits, at varying angles, on the object in a single pass.

Timing

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” db-9 connector on SIU (pin 9 for pulse & pin 5 for ground)

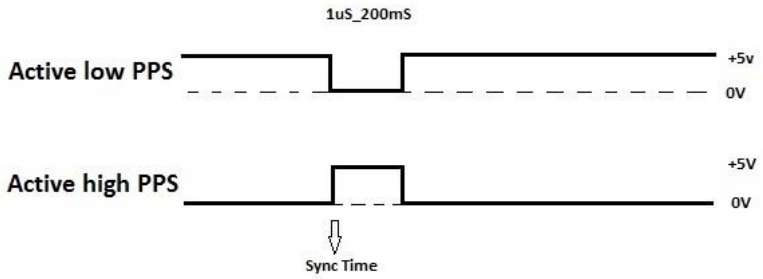
The PPS signal can be either active low or active high. The SIU synchronizes to the falling edge of an active low signal, or the rising edge of an active high signal. The voltage on the PPS should not exceed 5V, doing so may cause unwanted issues. In addition, the time duration should be 1µ-200ms.

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: Do not connect an active PPS cable to SIU for integrated systems!

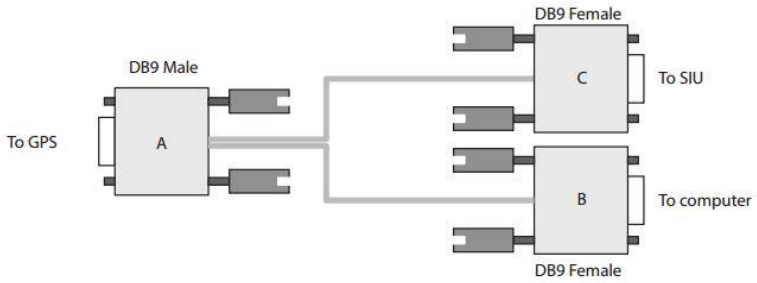
The integrated versions of the SIU outputs PPS pulses. Attaching an active PPS cable to this port will damage internal electronics and void the warranty.



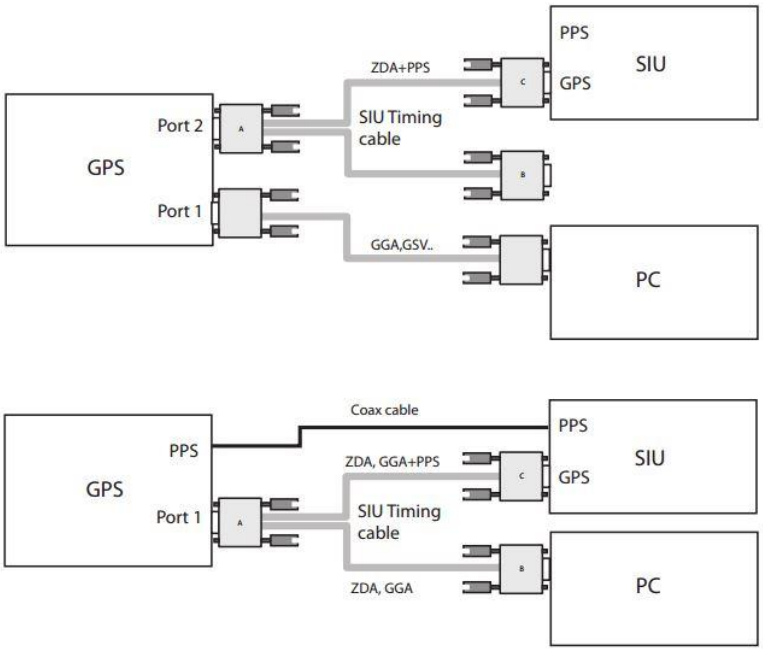
The timing cable pin-outs are as follows:

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.



NORBIT Operation without GUI (Headless/Passive mode)

Some setup of the NORBIT WBMS, such as AUV/ROV may require use of the system without the NOTBIT 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 enabled in the NORBIT GUI. This will allow the sonar state to be monitored by the GUI but will allow for other means on sonar control, such as custom software etc.

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

Additional Applanix information

While NOTBIT has integrated many features of the Applanix into the NOTBIT GUI some features were not included so as 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 NOTBIT GIU POSView must be in the monitor state and not in the connected state.

CAUTION:
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 system.

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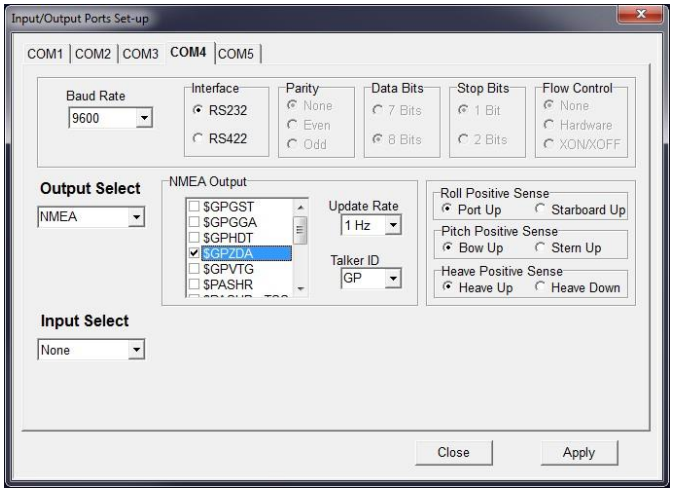
Alternate COM port setup

Some scenarios may require an alternate setup of the POSMV 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 Mountings tab 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 POSMV and set NTRIP service to a static position and input a position preferably located in the centre of the survey area.
I have a GPS receiver tied to my satellite corrector subscription service and need to bring it into the POSMV on the WBMS.	Under Lever Arms and Mounting Angles, Sensor Mountings tab enter in 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 will allow the POS to base its positions off the more accurate position obtained from the auxiliary GPS receiver

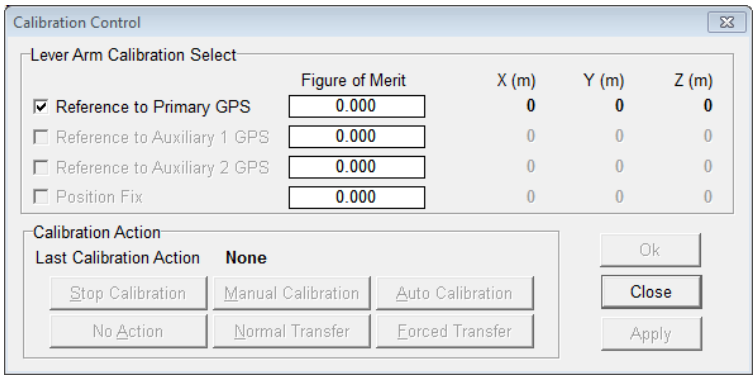
Running Installation Calibration Control

When offset measurements from IMU sensing centre to antenna phase centre are 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 for offset determination.

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 and choose Installation Calibration Control. This opens the dialogue window shown below. Check the box for Reference to Primary GPS then click on Auto Calibration, then hit 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 click the Normal Transfer button to copy these values into the Ref. To Primary GPS Lever-Arm. Then 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 centre of the IMU, then apply the additional offsets to the derived values. Following this procedure, run a GAMS calibration.



Applanix POS MV Nav Status

The Applanix POS MV vs. 8.63 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 will require 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 will not be 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.

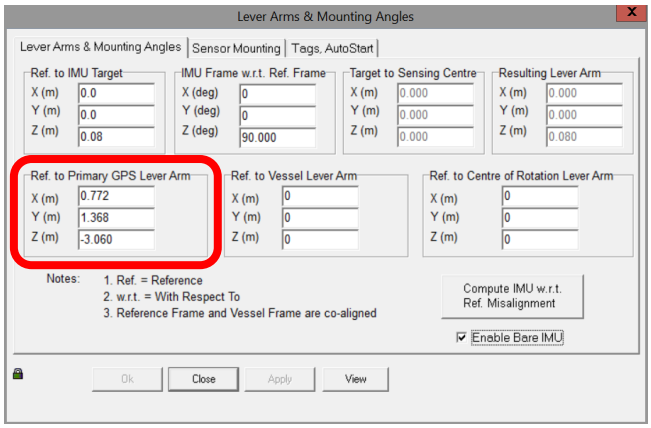
For mounting the IMU, NORBIT provides an optional mounting plate that will mount the IMU (shown in the appendix) in its NORBIT housing, with the connector facing towards the bow of the survey vessel. In this mounting configuration there will be a +90° Z axis rotation.

Should the user opt to mount the IMU without the optional NORBIT mounting plate the dowel nuts can be used. This will require that the IMU be secured to a mounting location that facilitates tightening the mounting screw from underneath. The screws used should be M6

and sufficient 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 sonar phase center will have to be input to the chosen acquisition software. If the IMU is at not the COR/vessel reference point, then the IMU offsets will also have to be measured and specified 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 will be 0.08m below the top of the fairing. This value will be the Ref to IMU target. Offsets highlighted in red need to be entered based on vessel offsets.



Two cables will be 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/can not be utilized then the offset from sonar reference point to vessel center of rotation should be input into the Applanix PosMV. At this time the ability to add this offset is not built into the NORBIT GUI, therefor POSView will need to be used. Inputting this offset greatly aids the Applanix in properly computing both realtime 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 in the offset values will result in improper heave calculations that will negatively impact your data.

WARNING: Mistakes in Ref to COR offsets can not be fixed in post-processing. Extreme care must be taken when entering in offset values. Thoroughly review values prior to surveying

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 382AP Antenna: 66mm (0.217ft)

Trimble 540AP Antenna: 58mm (0.190ft)

Compact WBMS (iWBMSc) NovAtel MarineSPAN Setup & Configuration

Co-location of the IMU and sonar ensures that what motion the sonar experiences is measured and used to produce highly accurate bottom detections regardless of survey platform flexing (provided that no flexing occurs between the IMU and GNSS antennas). Integration efforts of the Compact is also greatly simplified due to the co-located sonar and IMU.

Invest time in orienting the Compact wet-end accurately to be in-line (pointing forward) with the vessel keel as all offsets entered into the integrated INS (NovAtel Connect) will be with respect to the IMU orientation.

To simplify initial setup NORBIT provides a default batch configuration file. This batch file will have the INS offsets to sonar measurement point already entered. The only offsets that will need to be provided by the user will be the IMU to Antenna 1 and IMU to Antenna 2. It is best to save the new settings with a different file name than the default batch file. The system may also be configured using separate Wizards found in NovAtel Connect. However, the batch file method is more secure to ensure correct setup.

CAUTION: Use only the GNSS antennas and cables provided with the NORBIT system. Other antenna types may cause unexplained issued with the system.

For information on the operation and theory of NovAtel MarineSPAN™ not described in this Appendix refer to the NovAtel support website. The MarineSPAN system integrated into the Compact contains OEM628 and OEM615 GNSS receiver cards.

Compact Configuration – NovAtel MarineSPAN with STIM300

A STIM-300 IMU is integrated directly inside the sonar projector. The Compact system not only delivers quality INS data but is also the smallest fully integrated high resolution multibeam system ever built.

NovAtel OEM628 and OEM615 GNSS receiver cards are installed inside the iSIU topside. The job of the OEM cards is detailed below:

Rx Card	Model & Purpose
OEM638	Model D2L-R0R-TTR-W1 (GPS+GLONASS, RTK, SBAS, L-Band)
	Primary GNSS receiver card connects to Antenna 1
	Connects to OEM615 for ALIGN computations for heading aiding
	Connects to STIM-300 IMU
	Calculates complete MarineSPAN Inertial Navigation Solution
	Configures to serial port on SIU for GNSS corrections input
	Provides Pulse Per Second (PPS) output to WBMS

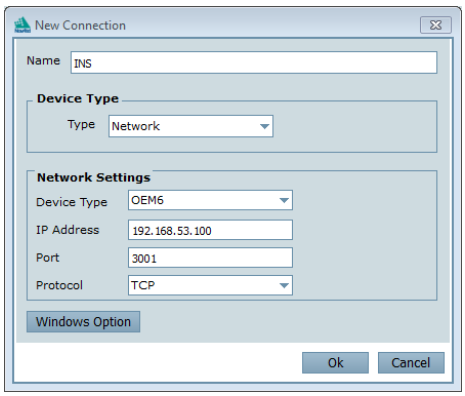
OEM615	Model D2S-Z0G-050 (GPS+GLONASS, SBAS ALIGN Hdg Only)
	Secondary GNSS receiver card connects to Antenna 2.
	Connects to OEM628 for ALIGN computation of heading aiding
	Provides GPZDA ASCII output to WBMS

Internal wiring provides timing information directly to the WBMS.

The Compact features a single cable between the wet-end and the topside Integrated Sonar Interface Unit (iSIU).

Connecting INS to NovAtel Connect

Interfacing with the Inertial Navigation System (INS) of the Compact is accomplished using NovAtel Connect software. All navigation parameters and navigational performance can be configured, monitored and assessed in the Connect software. To connect to the INS in Connect open NovAtel Connect GUI. Click on Device menu and Add Connection, use the default network IP address of **192.168.53.100. port 3001, TCP.**



Compact Lever-Arm Offsets & MarineSPAN Configuration Quick Steps

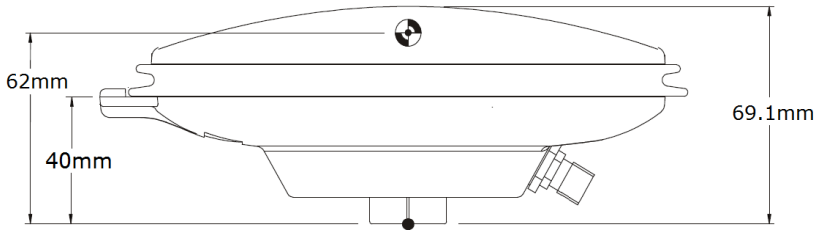
For the Compact the only measurements required are from the sonar bracket (top centre of bracket) to the primary antenna phase centre (± 0.5cm) and again to the secondary antenna phase centre (± 0.5cm). The fixed offsets from the top centre of the sonar bracket to the IMU are then added.

The Compact will always operate and output the Inertial Navigation Solution positioning, attitude and heading data with respect to the IMU frame. This IMU frame is closely aligned with the sonar. Therefore, the antenna location offsets are with respect to the IMU frame. If the Compact wet-end is not aligned to the vessel frame (not parallel to the keel, for example) then care must be taken that the antennas are measured along the x, y and z axis of the IMU (sonar) and not the vessel otherwise a positioning error will occur by the rotational offset.

Lever arm sign convention	**+Y Forward, +X Starboard, +Z Up**
Rotational sign convention	**+Bow Up, +STBD Up, +Clockwise**

Step 1: Measure from top centre of Compact sonar bracket to bottom of primary and secondary antennas in all three planes to nearest half centimetre. (Ensure that Antenna 1 is horizontally closest to the IMU). Then, include the additional offsets from top centre of sonar bracket to the IMU measurement point in addition to the vertical offset from bottom of antenna to phase centre as shown below (verify additional measurement on bottom of antenna as some kits have different antenna models):

GPS-702-GGL



From Top Centre Bracket (TCB) To IMU

	+Y Fwd	+X Stbd	+Z Up
From TCB	-0.056m	0.000m	-0.125m

Final values are then input into the "IMUToAntennaOffset" for Antenna 1 and "IMUToAntennaOffset2" for Antenna 2 as detailed below.

For example, if distances measured from top centre of sonar bracket to bottom of antenna 1 & 2 are:

Sensor	+Y Fwd	+X Stbd	+Z Up
Antenna1	+1.020m	-0.110m	+2.100m
Antenna2	-0.980m	+0.020m	+2.130m

Then the final offsets with the addition of the sonar and antenna phase centres would compute as follows:

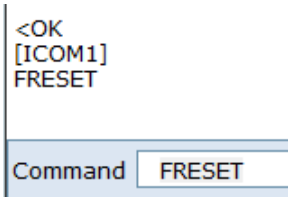
Sensor	+Y Fwd	+X Stbd	+Z Up
IMU To Ant1	+1.076m	-0.110m	+2.287m
IMU To Ant2	-0.924m	+0.020m	+2.317m

These offsets must then be input into the batch file. It is helpful for the MarineSPAN algorithm to know how well the offsets are known. Including the uncertainty in x, y and z aides the algorithm:

SETIMUTOANTOFFSET -0.110 1.076 2.287 0.03 0.03 0.03
SETIMUTOANTOFFSET2 0.020 -0.924 2.255 0.05 0.05 0.05

Details on the batch file are provided in a section below.

Step 2: Modify configuration batch file and import to system as shown in section below. The simplest way to manage the MarineSPAN configuration is via a batch file edit and import. For this, it is best to clear the system of its prior settings by forcing a Factory Reset for a clean configuration prior to importing the batch file. Do this by entering FRESET into the Console Window as shown using the network connection:
This will stop the SIU from outputting data on COM 3. The system will erase the system configuration, except for the IP address setup, and then the system will restart.



Once the FRESET is complete load the batch file. At this point the batch file will not completely load. After running the batch file while connected to serial, reconnect to the SIU using network and load the batch file again. At this point the system will be ready for use.

Inputting Lever Arms and Mounting Angles into NovAtel Connect™ (iWBMSc)

Once the measurements to antenna 1 & 2 have been determined the offsets must be input into the MarineSPAN system for the navigation solution to be correct. Not doing so will degrade data quality.

CAUTION: Record the offsets used in NovAtel MarineSPAN in project survey log.

Offsets in NovAtel MarineSPAN cannot be changed once the data is collected unless raw INS data is recorded and processed using Waypoint Inertial Explorer software. Therefore, it is important to know the offsets used in the MarineSPAN when troubleshooting data. It is best to only input changes to the NovAtel MarineSPAN using the batch file and then saving this file with survey project log.

NovAtel MarineSPAN Primary Default Batch File

NORBIT provides a default batch file for quick setup. This file must be modified for each new installation before being imported into the system. Individual commands may also be entered directly into the Console Window.

CAUTION: Manage processor load of NovAtel SPAN.

To ensure that unnecessary solution computations and output are not saved to the system, close all windows in NovAtel Connect except for the Console Window before sending a SAVECONFIG command. Each time a window is opened (ex. Position, Constellation, INS) instructions are sent to MarineSPAN to compute and then output these records. Saving too many of these into configuration puts an unnecessary burden on the SPAN processor.

This section describes the commands of the default batch file and highlights in green the changes required for each new installation.

Command	Description
UNLOGALL	Clears any configured data outputs.
ETHCONFIG ETHA AUTO AUTO AUTO AUTO	Programs Ethernet conditions
IPCONFIG ETHA STATIC 192.168.53.100 255.255.255.0	Sets MarineSPAN IP address
SAVEETHERNETDATA ETHA	Saves Ethernet settings even if FRESET command is issued.
CONNECTIMU COM1 IMU_STIM300	Sets IMU type and connection port (internal to iSIU)
SETIMUORIENTATION 5	Sets IMU orientation (5 is default orientation)
ALIGNMENTMODE AIDED_TRANSFER	Dual-Antenna Alignment Mode
SETINSOFFSET 0.00055 -0.06115 0.1025	Outputs INS solution to sonar measurement point
VEHICLEBODYROTATION 0 0 0	Rotates vehicle body to IMU frame
APPLYVEHICLEBODYROTATION ENABLE	Applies rotation values to vehicle body frame.
SETIMUTOANTOFFSET -0.110 1.020 2.100 0.03 0.03 0.03	+Stbd, +Fwd, +Up from IMU to Antenna 1 (closest Ant.) in meters. Last three digits are measurement uncertainty.
SETIMUTOANTOFFSET2 0.020 -0.947 2.302 0.05 0.05 0.05	+Stbd, +Fwd, +Up from IMU to Antenna 2 (farthest Ant.) Last three digits are measurement uncertainty.
HEAVEFILTER ENABLE	Enables heave calculation and output

SETHEAVEWINDOW 25	Real-time heave bandwidth. Multiply heave period by 5 and enter here. Default is 5 seconds wave period, so set to 25.
EVENTOUTCONTROL MARK1 ENABLE NEGATIVE 1000000 999000000	PPS control. Sets a negative 1µs pulse to sync with each second.
UNDULATION USER 0	Sets heights to be referenced to WGS84 instead of default EGM96
RTKTIMEOUT 20	Sets duration in seconds for marine environment that a delayed RTK correction is good for (60 seconds is default).
SERIALCONFIG COM3 19200 N 8 1 N OFF	Configures COM3 (serial connector on iSIU) communication parameters for GNSS corrections input
INTERFACEMODE COM3 AUTO NOVATEL OFF	Instructs MarineSPAN to automatically detect and use an incoming GNSS corrector (RTK) attached to iSIU serial port. Will automatically decode CMR, CMR+, RTCM2.3, RTCM3 and NovAtel messages
LOG COM3 GPGGA ONTIME 1	Outputs a GPGGA @ 1Hz to iSIU serial port for NTRIP local base.
LOG ICOM2 INSPVASB ONTIME 0.02	Hypack/QINSy Port3002: INS solution (position & attitude)
SBASCONTROL ENABLE AUTO	SBAS corrections will be used automatically unless a better GNSS correction input is provided.
LOG ICOM2 TIMEB ONTIME 1	Hypack/QINSy Port3002: Time message for sync.
LOG ICOM2 BESTPOSB ONTIME 0.2	Hypack/QINSy Port3002: Solution quality information
LOG ICOM2 HEAVEB ONNEW	Hypack/QINSy Port3002: Real-time & delayed time heave
LOG ICOM3 INSPVASB ONTIME 0.02	Hysweep Port 3003: INS Solution
LOG ICOM3 HEAVEB ONNEW	Hysweep Port 3003: Heave data
LOG ICOM3 TIMEB ONTIME 1	Hysweep Port 3003: Time message for sync.
SAVECONFIG	Saves configuration until FRESET command is issued.

Changing the IP address of the NovAtel INS

The IP address of the INS system can be changes should the need arise. To change the IP address please change the IP address in the batch file (highlighted in blue above) to the desired address. Next, connect to the INS via Connect using the default address. Once connected, follow the previously given steps to load the batch file. Depending on the address chosen the IP address of the computer may need to be adjusted. Also be aware that if the first 3 octets were changed the IP address of the sonar may also need to be changed.

NovAtel MarineSPAN Secondary Default Batch File

A secondary batch file is provided in the RARE event that the secondary GNSS receiver card needs reprogramming. If this is required then connection to the "AUX" port of the iSIU must be made to a computer via the LEMO to Serial debug cable provided with the system.

It is unlikely that this connection need be made and contact with NORBIT Support should be attempted first.

Command	Description
UNLOGALL	Clears any configured data outputs.
INTERFACEMODE USB1 NONE NONE	Programs internal USB port
INTERFACEMODE USB3 NONE NONE	Programs internal USB port
INTERFACEMODE USB2 NONE NONE	Programs internal USB port
MARKCONTROL MARK1 DISABLE	Sets to not output pulse
INTERFACEMODE COM3 NOVATEL NOVATEL	Programs internal serial port parameters
LOG COM3 GPZDA ONTIME 1	Output of GPZDA to WBMS for timing
SAVECONFIG	Saves configuration

Running a Boresight calibration.

CAUTION: Do not start logging raw INS data until <u>**AFTER**</u> completing a calibration. At the completion of the INS calibrate, data logging is terminated and users may not be notified of the termination

This calibration will solve for any misalignment between the INS measurement frame and the dual antenna measurement frame. To complete the calibration, follow the below instructions.

1. Allow the system to align and a solution good message to appear in the INS window in connect. For this to happen the vessel will have to have some dynamics applied preferably by doing some figure eights.

2. Once the above has occurred send the following command using the console window, **LOG INSOFFSETS ONNEW.** The command will output the INS offsets for the calibrations.

3. Enter the command **INSCALIBRATE BORESIGHT ENABLE 0.3** The value 0.3 indicates the standard deviation (in degrees) at which the calibration can stop. Once started steer the vessel in a straight line until the calibration has completed. As shown below, this will change the status from FROM_DUAL_ANT to CALIBRATING.

```
...
<  9
<  5 0.0000000000000000 0.0000000000000000 180.0000000000000000 15.0000000000000000 15.0000000000000000 15.0000000000000000 FROM_COMMAND RBV
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
<  5 0.0000000000000000 0.0000000000000000 -180.0000000000000000 0.0000000000000000  0.0000000000000000 39.0544592885569770 CALIBRATING BORESIGHT
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
```

4. When the status changes again to CALIBRATED BORESITE the calibration is complete. In the below example the calibrated boresight is -176.350deg with a standard deviation of 0.230. After the calibration is complete type in SAVECONFIG into the console window so that the calibration will be saved.

```
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
<  5 0.0000000000000000 0.0000000000000000 -176.3495099530403536 52.4937612737173538 0.0000000000000000 0.2295434901718268 CALIBRATED BORESIGHT
<  0 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 NONE INVALID
```

To include the calibrated value into the batch file (using the above example) include the following lines in the batch. To comply with NovAtel's sign convention, change plus/minus to minus/plus. There is no change of sign on the standard deviation value.

EXTHDGOFFSET (field 4*-1) (Field 7)
Using the above example
EXTHDGOFFSET 176.345 0.230

CAUTION: NORBIT advises NOT to run NovAtel RVB Calibration

Due to the unique mounting options that the iWBMSc is capable of NORBIT advises that the RVB calibration not be conducted. For further information on this contact NORBIT Support.

NovAtel MarineSPAN Raw Logging Default Batch File

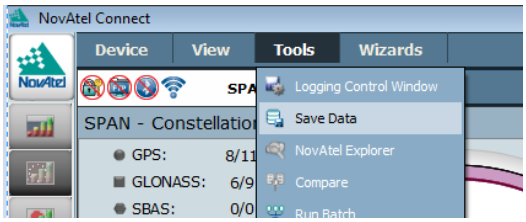
Logging raw INS data allows for Precise Point Positioning (PPP) or Post Processed Kinematic (PPK) navigation solutions allows for further processing to increase INS accuracy as required.

Logging raw data further allows for troubleshooting should an error occur during the survey. For example, if local GNSS base data was available during a survey then the INS solution may likely be increased to (depending on vessel dynamics and environmental conditions):

GNSS Outage	Mode	Position Accuracy (m) RMS		Attitude Accuracy		
		Hz	Vt	Roll	Pitch	Heading
0 seconds	RTK	0.02	0.03	0.015	0.015	0.08
	PP	0.01	0.02	0.015	0.015	0.08
10 seconds	RTK	0.27	0.14	0.025	0.025	0.095
	PP	0.02	0.02	0.015	0.015	0.08
60 seconds	RTK	6.61	1.46	0.044	0.044	0.13
	PP	0.23	0.03	0.017	0.017	0.081

Contact NORBIT Support at subsea_support@norbit.com for further information on the purchase of INS post processing software.

To log raw data, click on Save Data under the Tools menu pull-down:



Then send a batch file containing the below data logging commands to the MarineSPAN system by clicking on Run Batch under the Tools menu pull-down. The logging commands that should be populated in the batch file will include the below:

```
LOG VERSIONA ONCE
LOG RXSTATUS ONCE
LOG RAWEPHEMB ONCHANGED
LOG RANGECMPB ONTIME 1
LOG BESTPOSB ONTIME 1
LOG BESTGNSSPOSB ONTIME 1
LOG HEADINGB ONCHANGED
LOG HEAVEB ONNEW
LOG DELAYEDHEAVEB ONTIME 0.1
LOG DELAYEDHEAVEA ONTIME 0.1
LOG RAWIMUSXB ONNEW
LOG INSPVASB ONTIME 0.05
LOG INSUPDATEB ONCHANGED
LOG INSCOVSB ONTIME 1
LOG IMUTOANTOFFSETSB ONTIME 60
LOG VEHICLEBODYROTATIONB ONTIME 60
LOG GLOEPHEMERISB ONCHANGED
LOG RXCONFIGA ONCE
```

CAUTION: Closing NovAtel Connect GUI terminates raw data logging.

If NovAtel MarineSPAN has been configured for raw data logging, then the Connect GUI program must remain connected and active throughout.

Data logging should commence in excellent GNSS conditions with vessel movement for at least 5 minutes before and after the window of required data.

The above steps will produce a *.GPS file. If the default logging batch file was used, it can be applied to the data for delayed heave. NORBIT advises using delayed heave as it frees the user from having to constantly change the heave bandwidth with changing conditions and will

provide a better heave solution. Most processing software will allow the application of delayed heave by having a feature that will allow the *.GPS files to be selected. There is no need for additional post processing software to use delayed heave. Currently all processing software only accepts the ASCII delayed heave format, this will be changing soon. In preparation for that change both the binary and ASCII delayed heave formats are in the logging batch.

Due to the lower grade nature of the STIM300 IMU it is necessary to have vessel motion during the alignment process. This can be done by rocking the boat at the dock or by maneuvering the boat on the water or trailer until NovAtel Connect indicates “Solution Good.” Insufficient motion may cause a wrong heading to be computed by the system.

Delayed heave is post calculated 5min after real-time heave. To ensure that delayed heave fully covers collected data, start logging at least 5min before starting the actual survey and continue logging until 5min after the end of the last line.

CAUTION: If in doubt, log raw NovAtel data.

Even if user doesn’t own or use Waypoint Inertial Explorer software, it is recommended that for critical surveys this raw data is logged. Then, if positioning correction and/or GNSS outages are encountered the data may still be salvaged either by purchasing the additional software or by hiring this service (contact NORBIT).

Hypack Configuration for WBMS and iWBMS(x)

For sensors *not* supplied by NORBIT please contact vendor for integration instructions. The following sections show only one of many possible methods for configuring the acquisition software for the WBMS/iWBMSc. 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.

Lever-Arm Offsets

For the integrated systems, the INS is set to recalculate the navigation solution to the sonar reference point. Therefore, the INS and WBMS will share the same offset from COR - measure from the sonar reference point to the vessel COR to the nearest 5cm on the horizontal plane. Pay attention to the coordinate convention of the software to avoid errors. Hypack coordinate conventions are positive forward, positive to starboard, and positive down. 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, the sonar and INS share the 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.

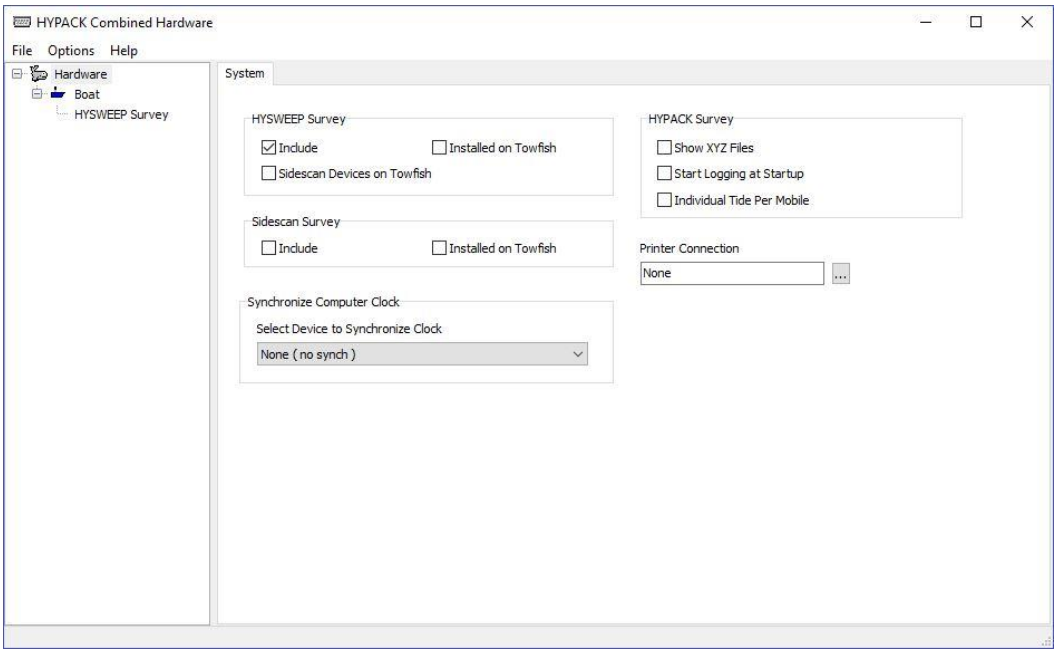
About the COR: The COR, for larger commercial vessels, will be documented and included with the vessel design plans. For other vessels, this point at which the vessels' roll and pitch axes intersect will need to be determined. This is a tricky measurement as the vessel COR may change from day to day and even during the day. Generally, choose a COR location that is about ¾ distance from bow to stern cantered on the keel and located at about the water level. Especially for smaller vessels, the COR will move 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 centreline 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 will allow of 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.

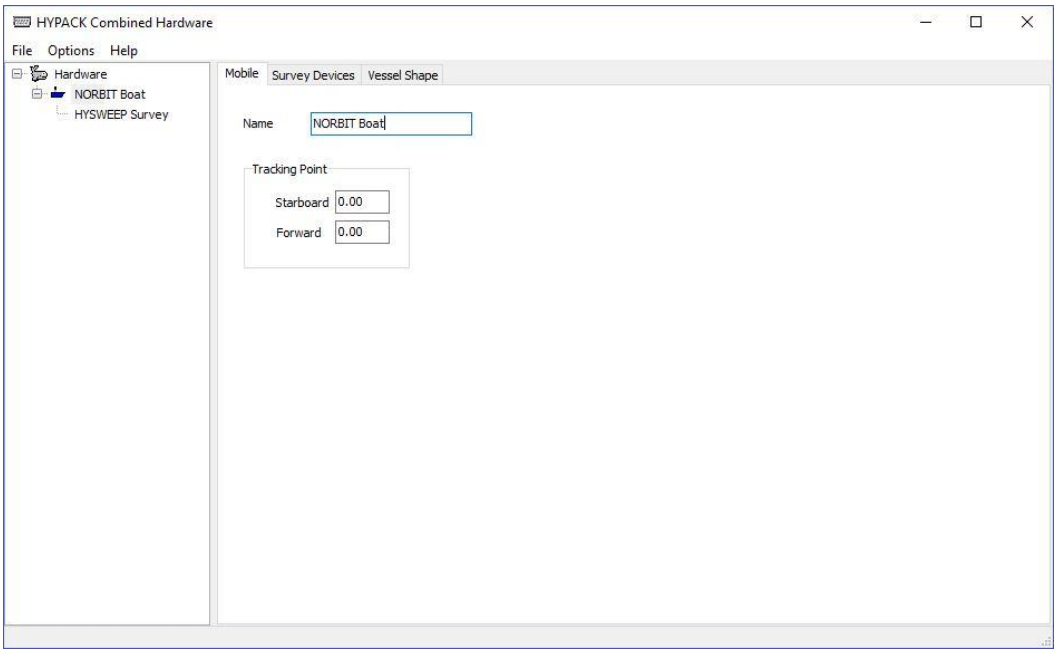
The offsets shown will be different for every vessel. For this example, Hypack2017 is used. The Hypack sign convention is +forward, +starboard, +down (even when "Elevation Mode" is selected in Geodetic Parameters.)

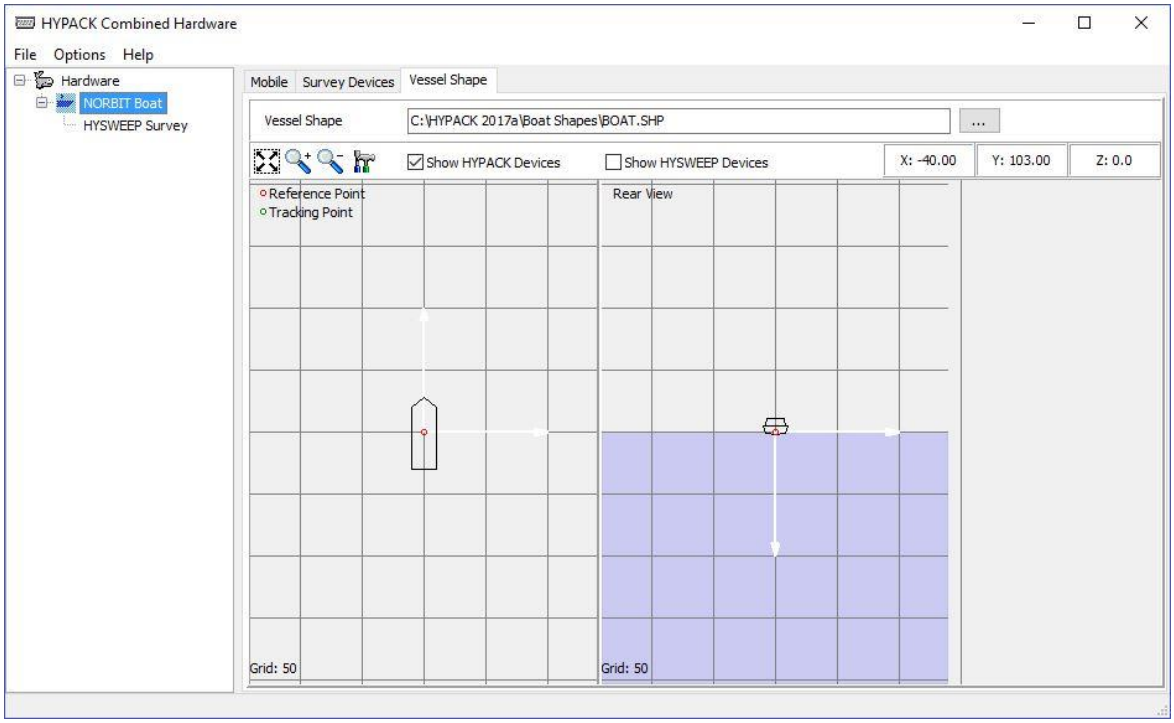
Hypack 2017 configuration combines both Hypack Hardware and Hysweep hardware into one interface. However, both sections must still be populated with the same drivers as prior versions.

Check “Include” under Hysweep Survey. This will allow devices to be populated for multibeam surveys.

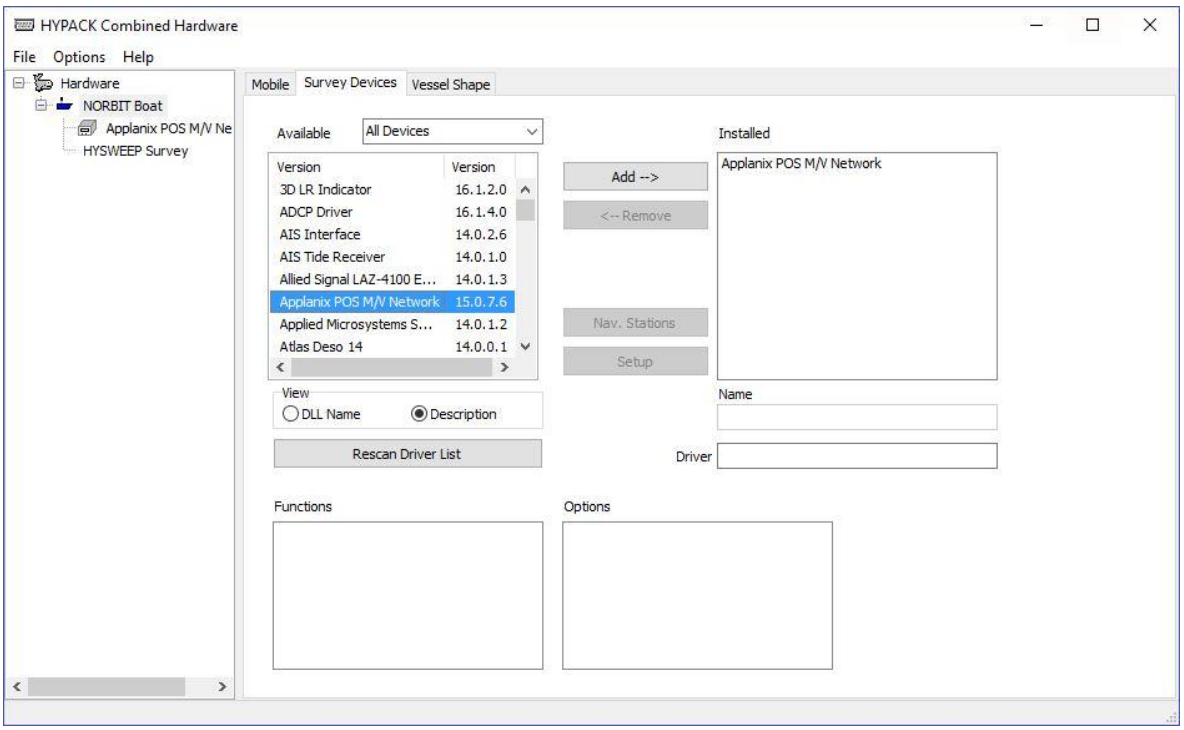


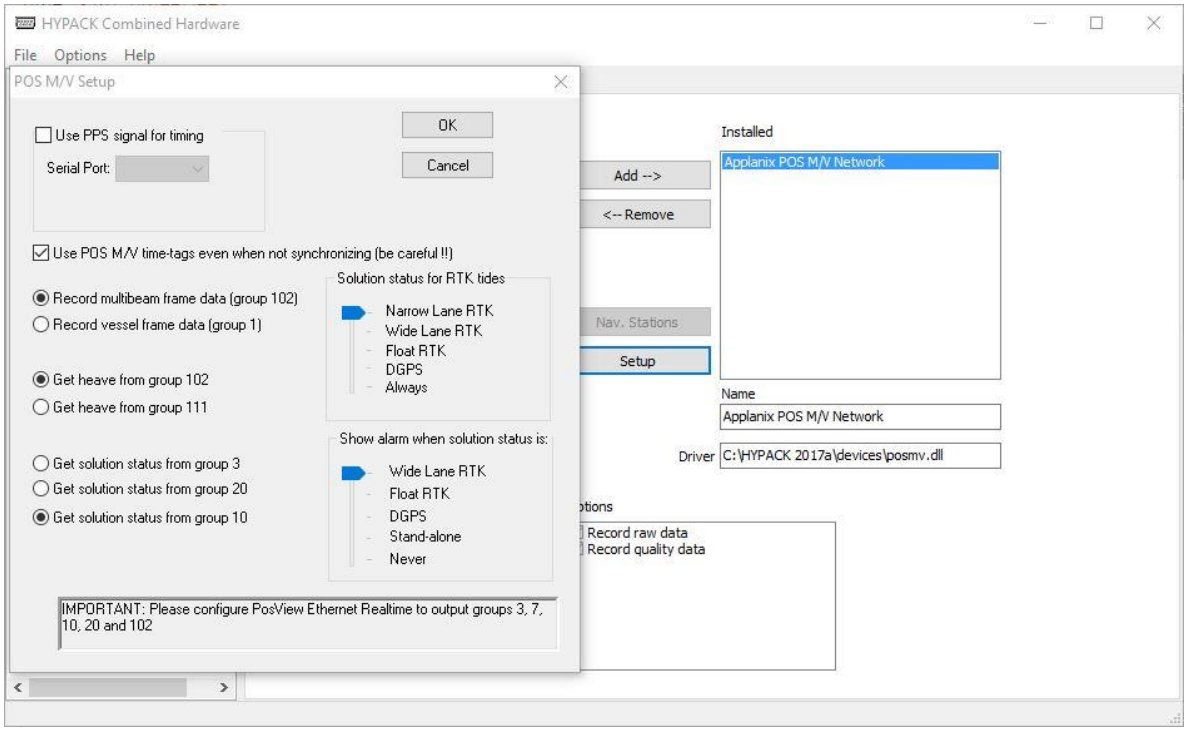
Next, select “Boat” and give it a name if desired. For more intuitive visualization, add a tracking point – preferably to the sonar reference (for standard installations). Edit Vessel Shape as appropriate.

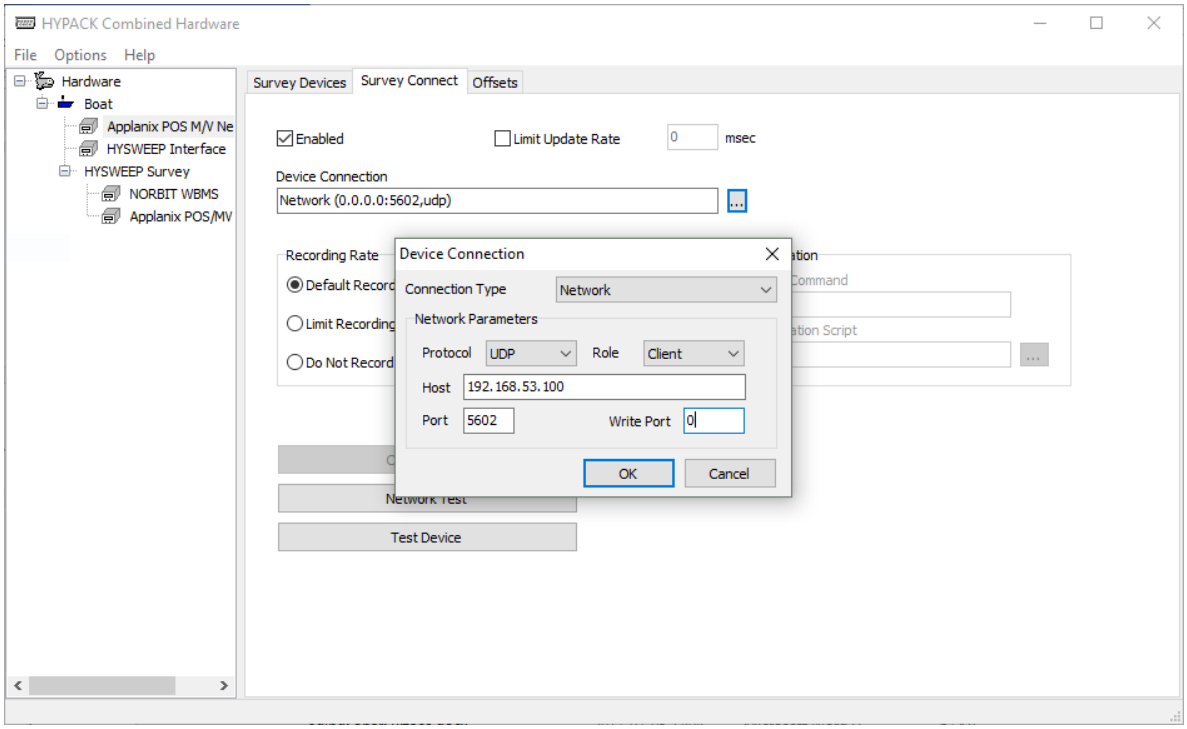


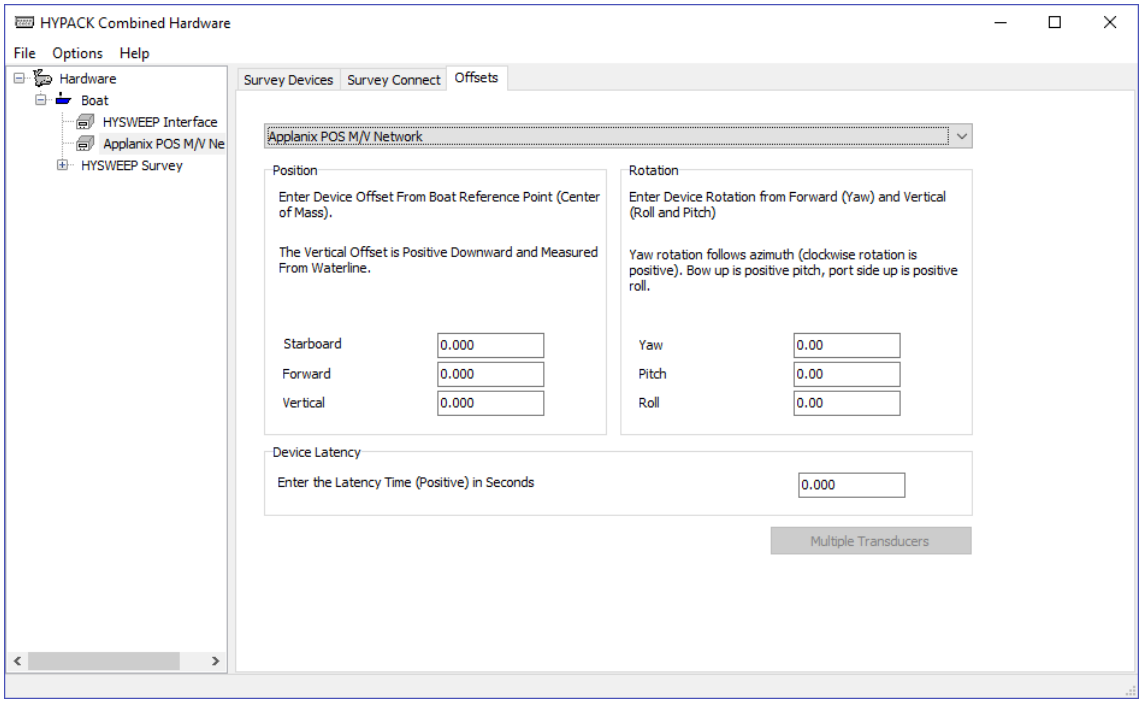


In Survey Devices, add the Applanix (or NovAtel for iWBMSc users) and configure as shown below.

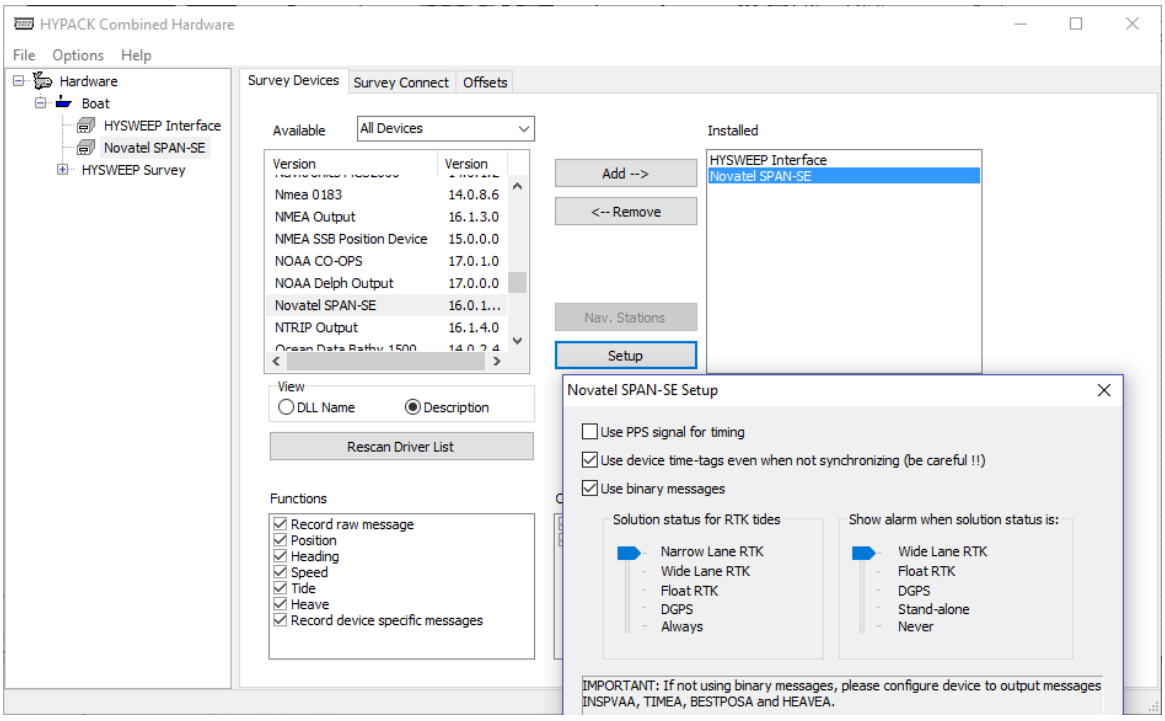


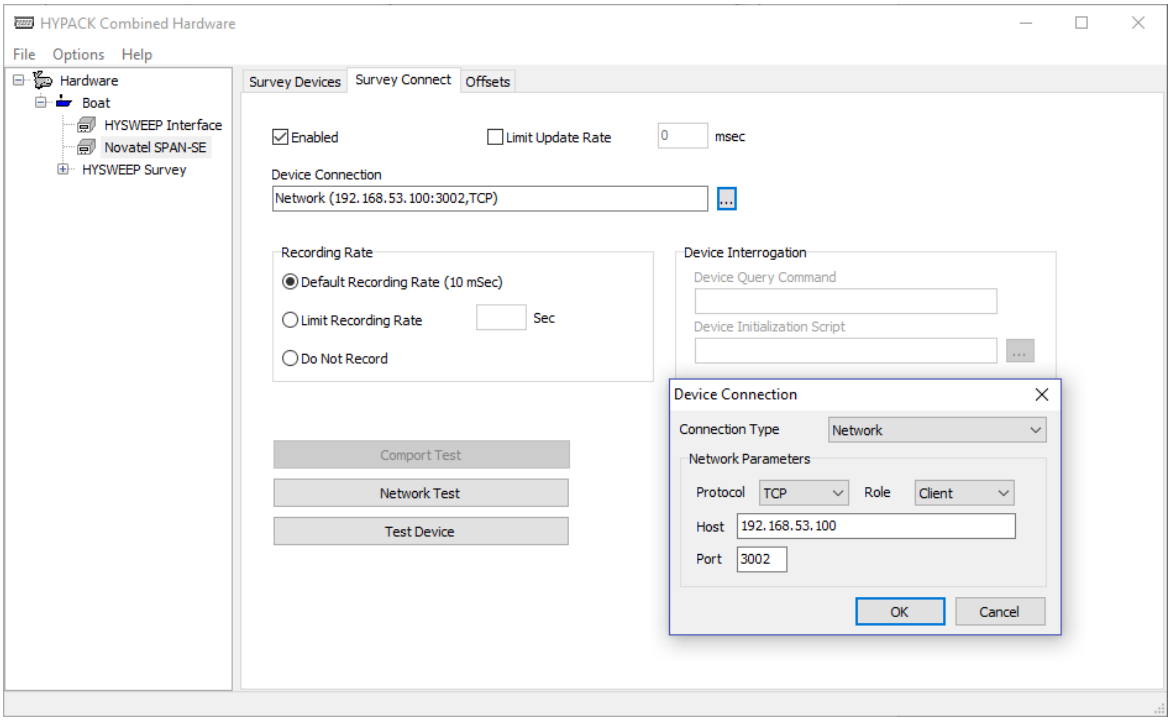

HYPACK Combined Hardware
File Options Help
POS M/V Setup
Use PPS signal for timing
Serial Port:
OK
Cancel
Use POS M/V time-tags even when not synchronizing (be careful !!)
Record multibeam frame data (group 102)
Record vessel frame data (group 1)
Get heave from group 102
Get heave from group 111
Get solution status from group 3
Get solution status from group 20
Get solution status from group 10
Solution status for RTK tides
Narrow Lane RTK
Wide Lane RTK
Float RTK
DGPS
Always
Show alarm when solution status is:
Wide Lane RTK
Float RTK
DGPS
Stand-alone
Never
IMPORTANT: Please configure PosView Ethernet Realtime to output groups 3, 7, 10, 20 and 102
Installed
Applanix POS M/V Network
Add -->
<-- Remove
Nav. Stations
Setup
Name
Applanix POS M/V Network
Driver
C:\HYPACK 2017a\devices\posmv.dll
Record raw data
Record quality data

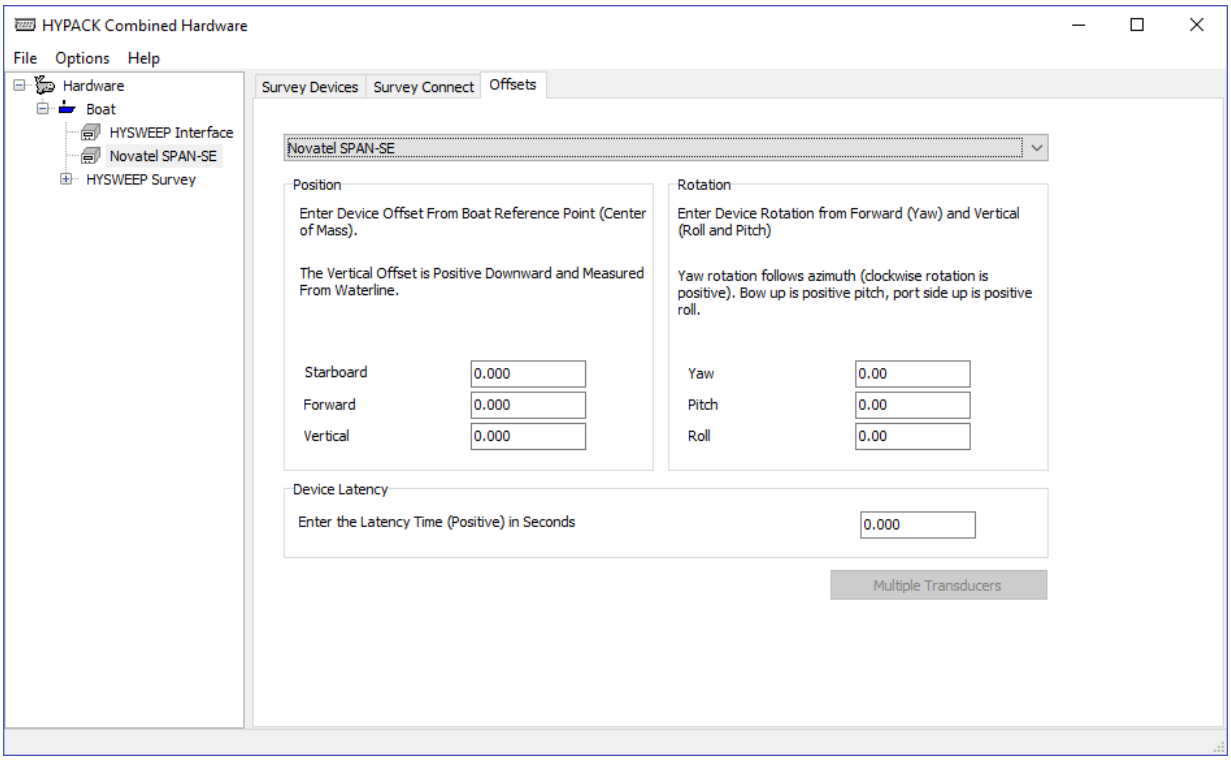

HYPACK Combined Hardware
File Options Help
Hardware
Boat
Applanix POS M/V Ne
HYSWEEP Interface
HYSWEEP Survey
NORBIT WBMS
Applanix POS/MV
Survey Devices
Survey Connect
Offsets
Enabled
Limit Update Rate
0
msec
Device Connection
Network (0.0.0.0:5602,udp)
Recording Rate
Default Record
Limit Recording
Do Not Record
Device Connection
Connection Type
Network
Network Parameters
Protocol
UDP
Role
Client
Host
192.168.53.100
Port
5602
Write Port
0
OK
Cancel
Test Device



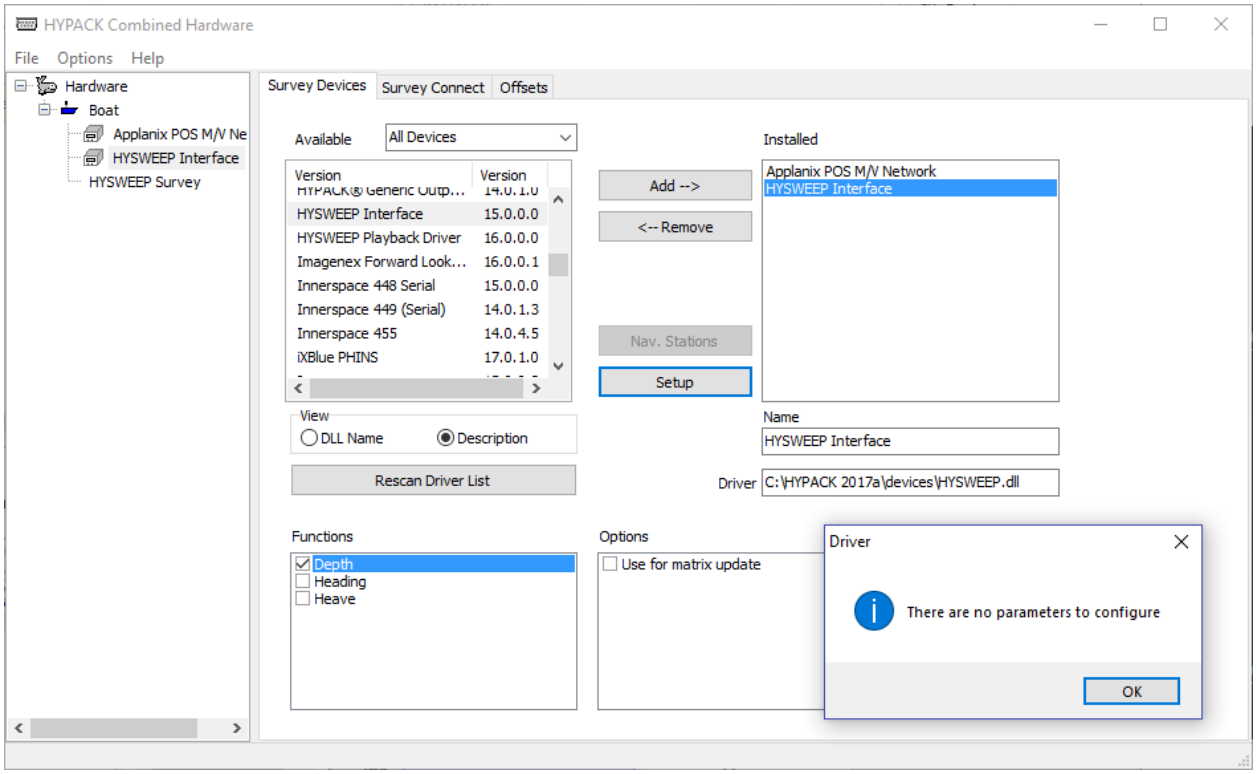
iWBMSc users will have to configure the NovAtel as follows:

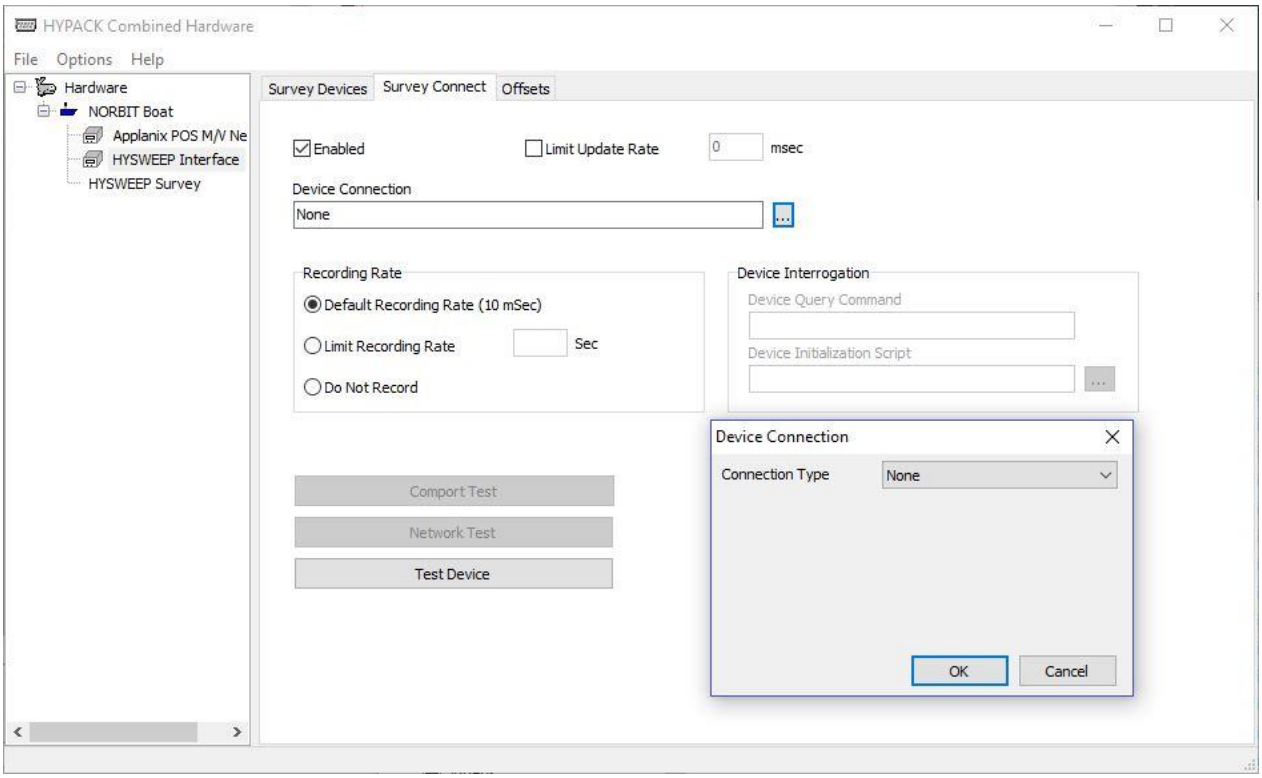


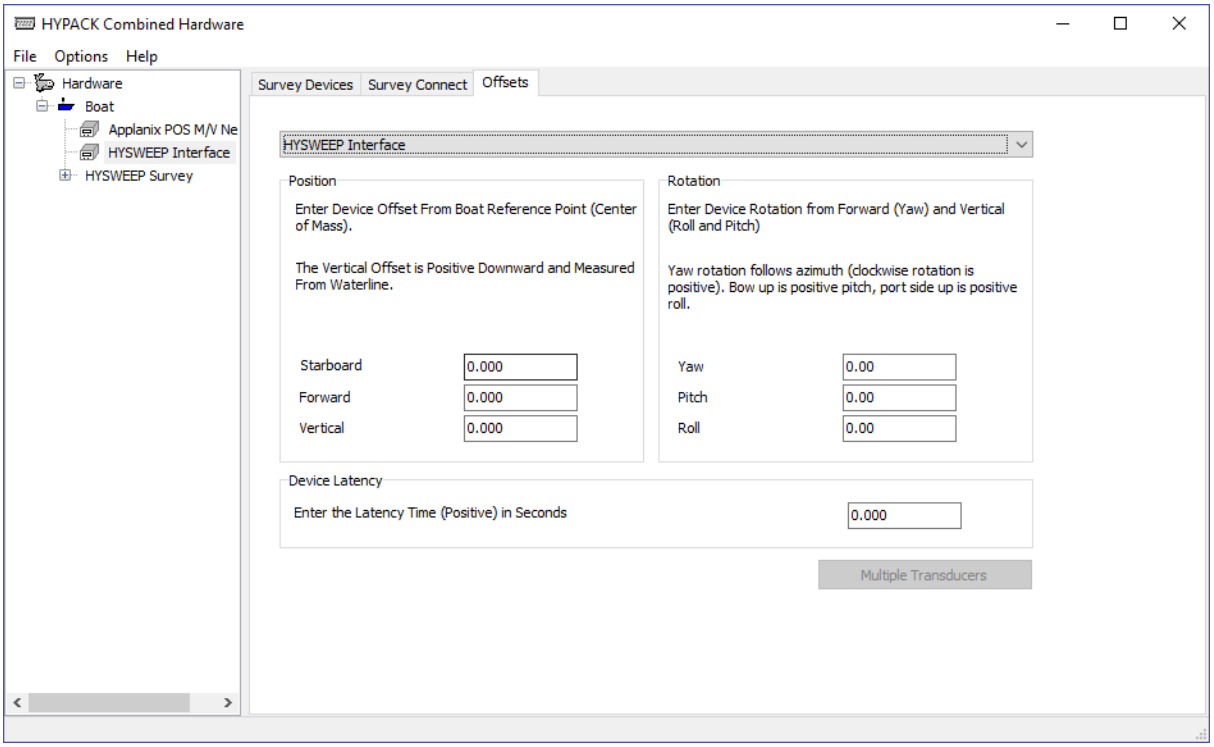

HYPACK Combined Hardware
File Options Help
Hardware
Boat
HYSWEEP Interface
Novatel SPAN-SE
HYSWEEP Survey
Survey Devices
Survey Connect
Offsets
Enabled
Limit Update Rate
0
msec
Device Connection
Network (192.168.53.100:3002,TCP)
Recording Rate
Default Recording Rate (10 mSec)
Limit Recording Rate
Sec
Do Not Record
Device Interrogation
Device Query Command
Device Initialization Script
Comport Test
Network Test
Test Device
Device Connection
Connection Type
Network
Network Parameters
Protocol
TCP
Role
Client
Host
192.168.53.100
Port
3002
OK
Cancel


HYPACK Combined Hardware
File Options Help
Hardware
Boat
HYSWEEP Interface
Novatel SPAN-SE
HYSWEEP Survey
Survey Devices
Survey Connect
Offsets
Novatel SPAN-SE
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

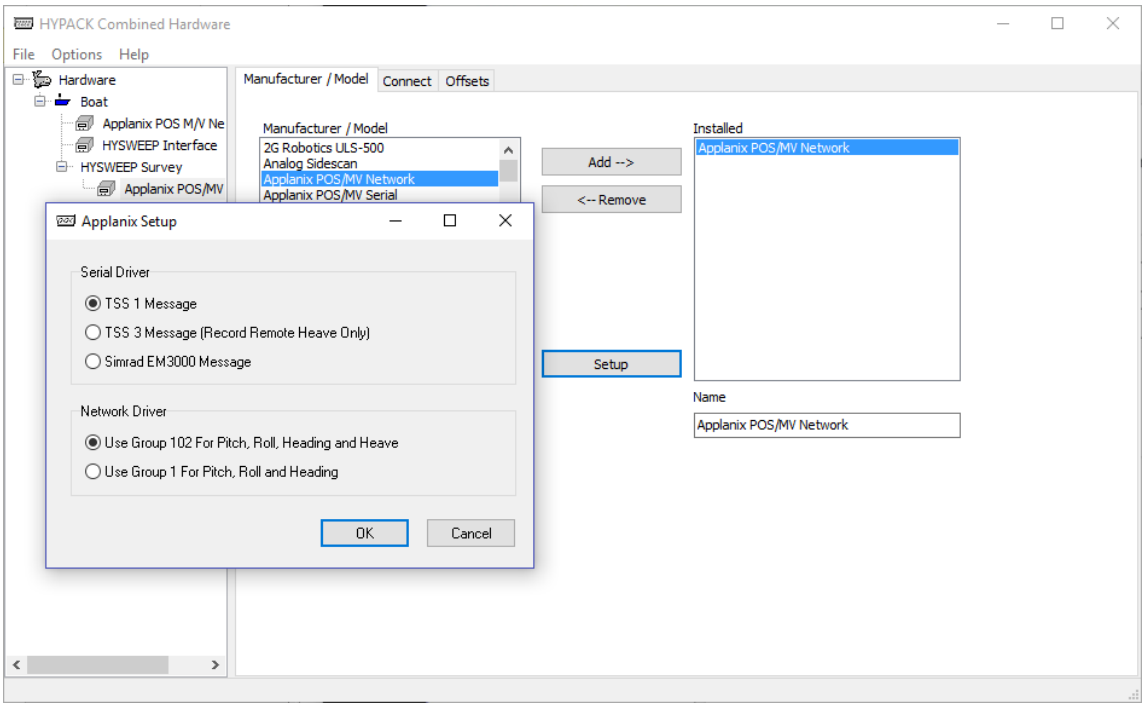
Then add and configure HYSWEEP Interface, checking only the Depth function under Functions:

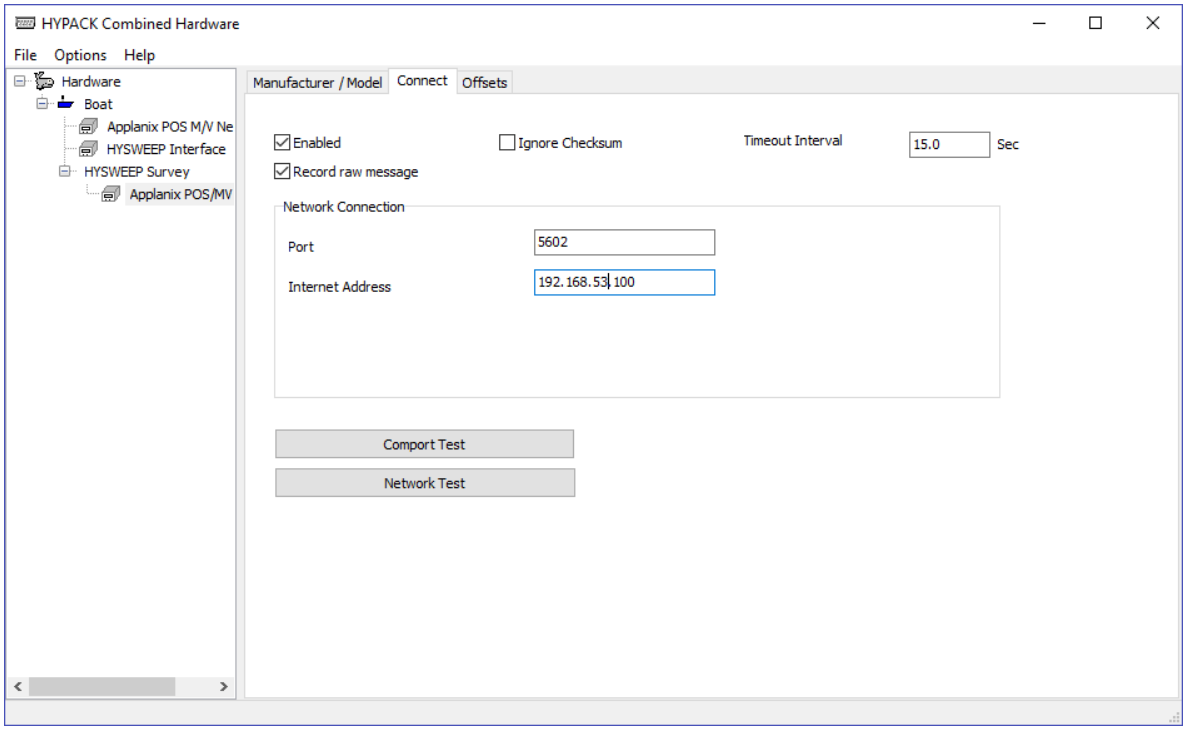


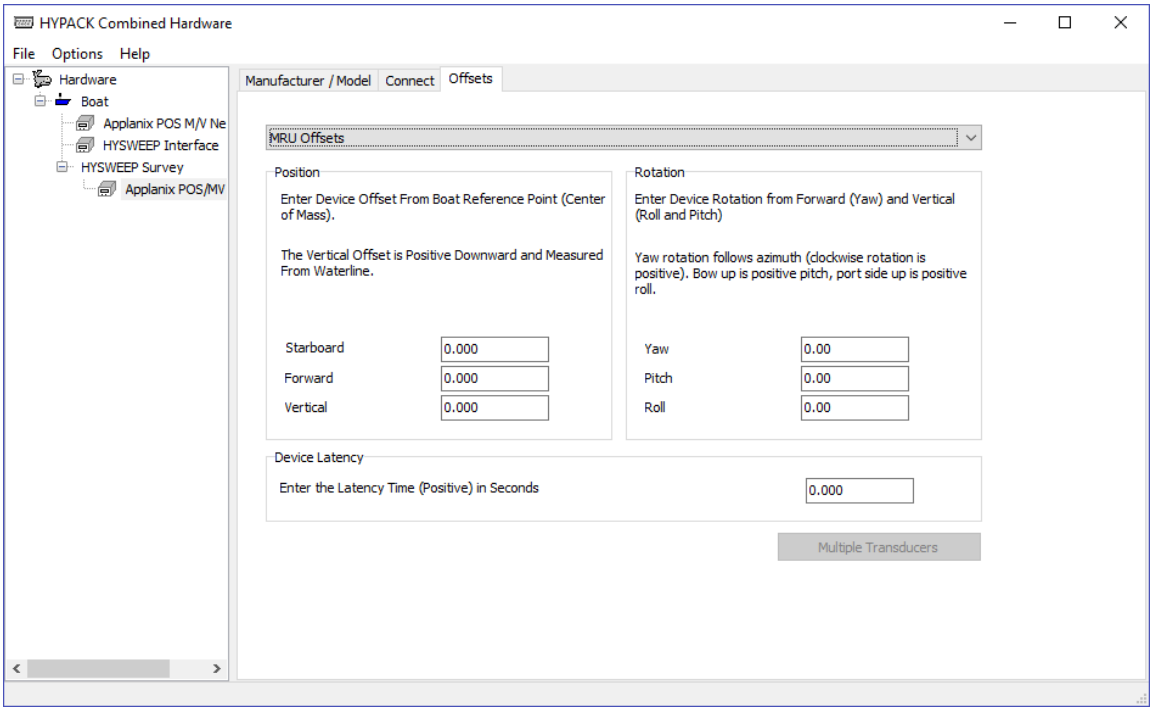




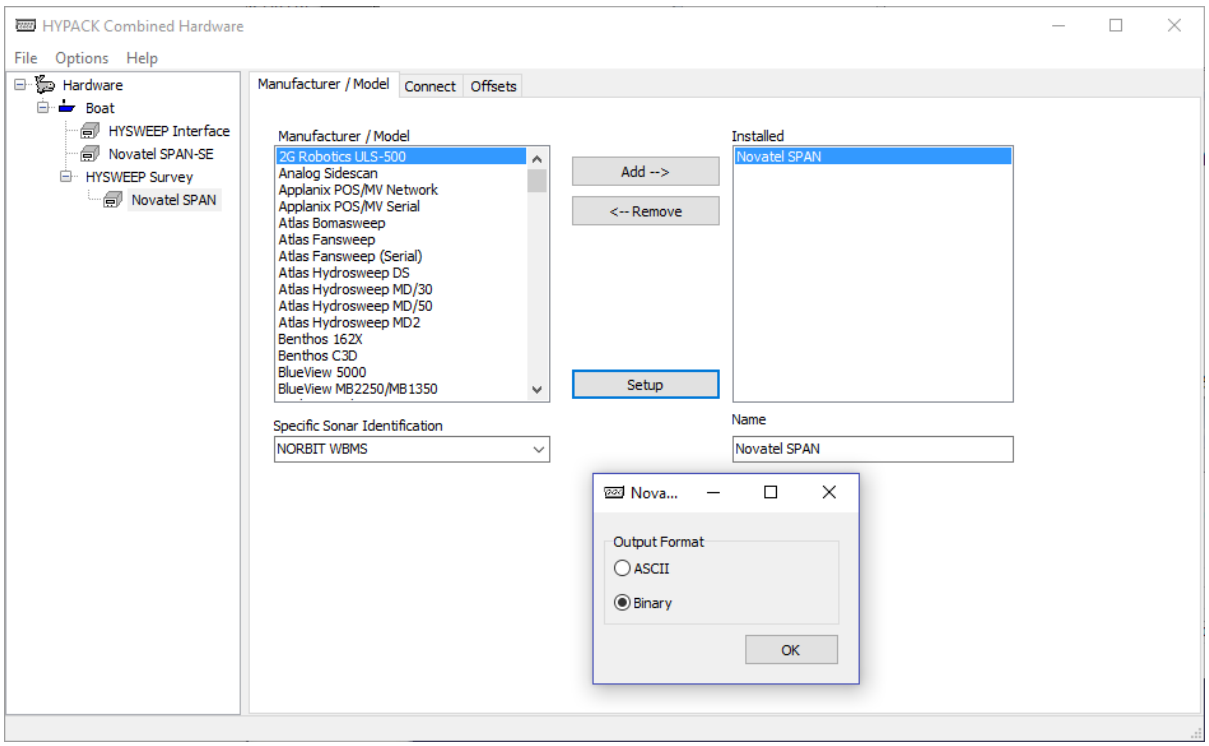
In HYSWEEP Survey, Manufacturer/Model add Applanix POS MV/Network (NovAtel for iWBMSc users) and Norbit WBMS and configure them as shown below:

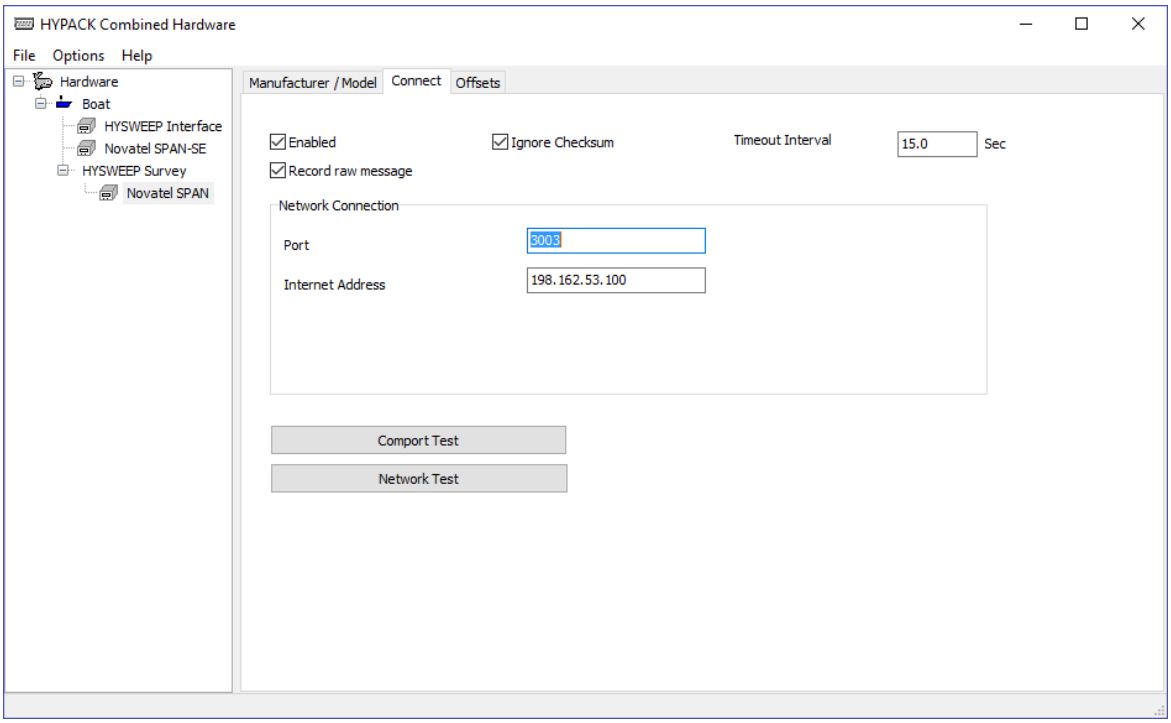


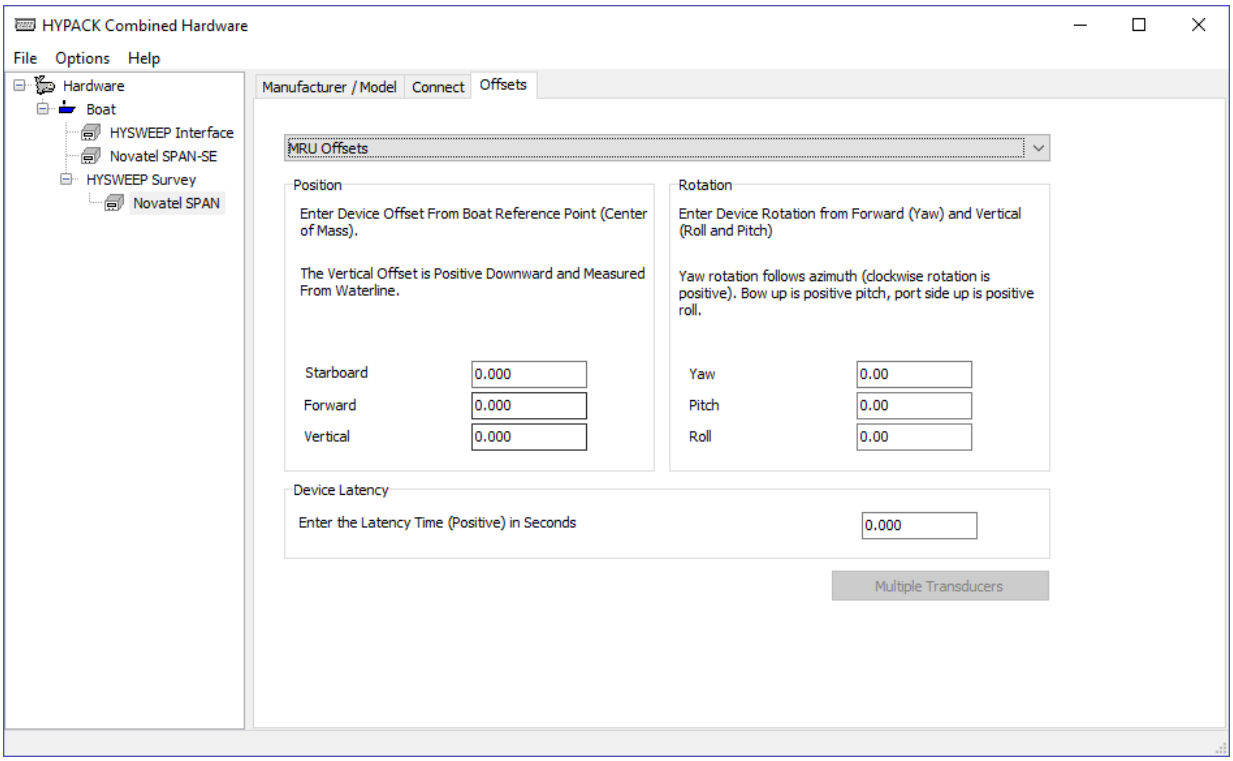

HYPACK Combined Hardware
File Options Help
Hardware
Boat
Applanix POS M/V Ne
HYSWEEP Interface
HYSWEEP Survey
Applanix POS/MV
Manufacturer / Model
Connect
Offsets
Enabled
Ignore Checksum
Timeout Interval
15.0
Sec
Record raw message
Network Connection
Port
5602
Internet Address
192.168.53.100
Comport Test
Network Test


HYPACK Combined Hardware
File Options Help
Hardware
Boat
Applanix POS M/V Ne
HYSWEEP Interface
HYSWEEP Survey
Applanix POS/MV
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

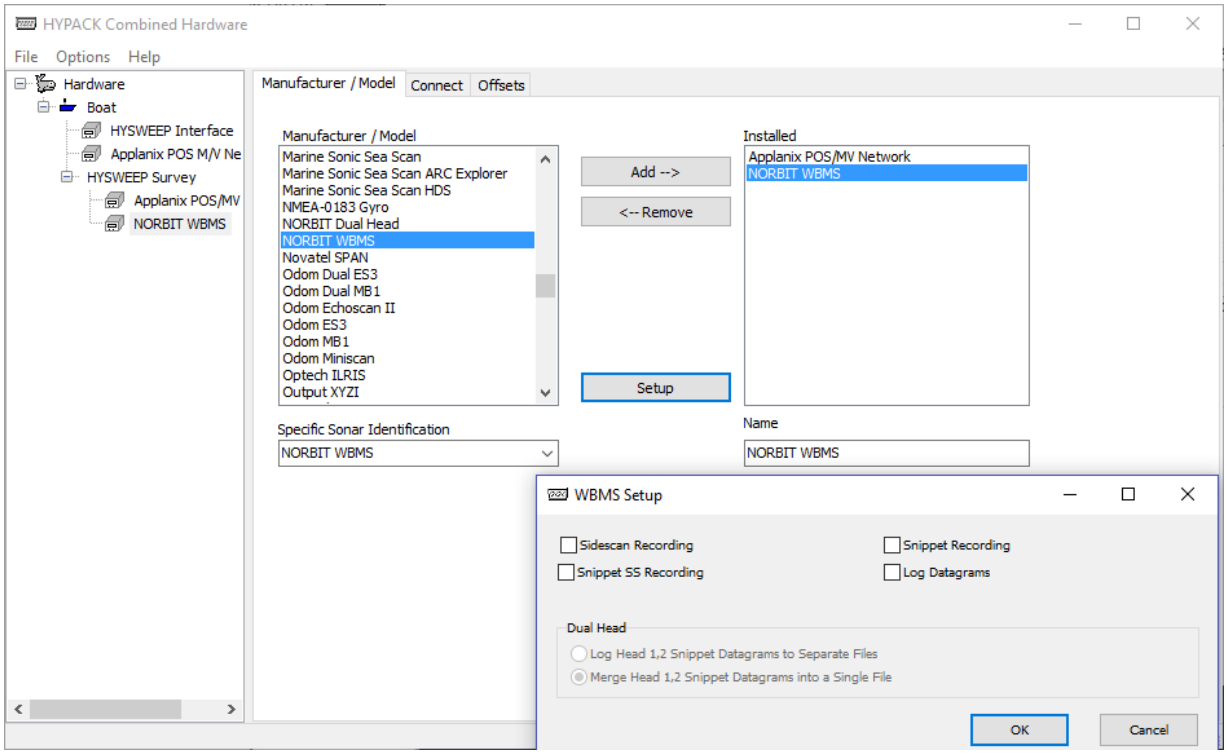
iWBMSc users will have to configure the NovAtel instead of the Applanix, as shown below:

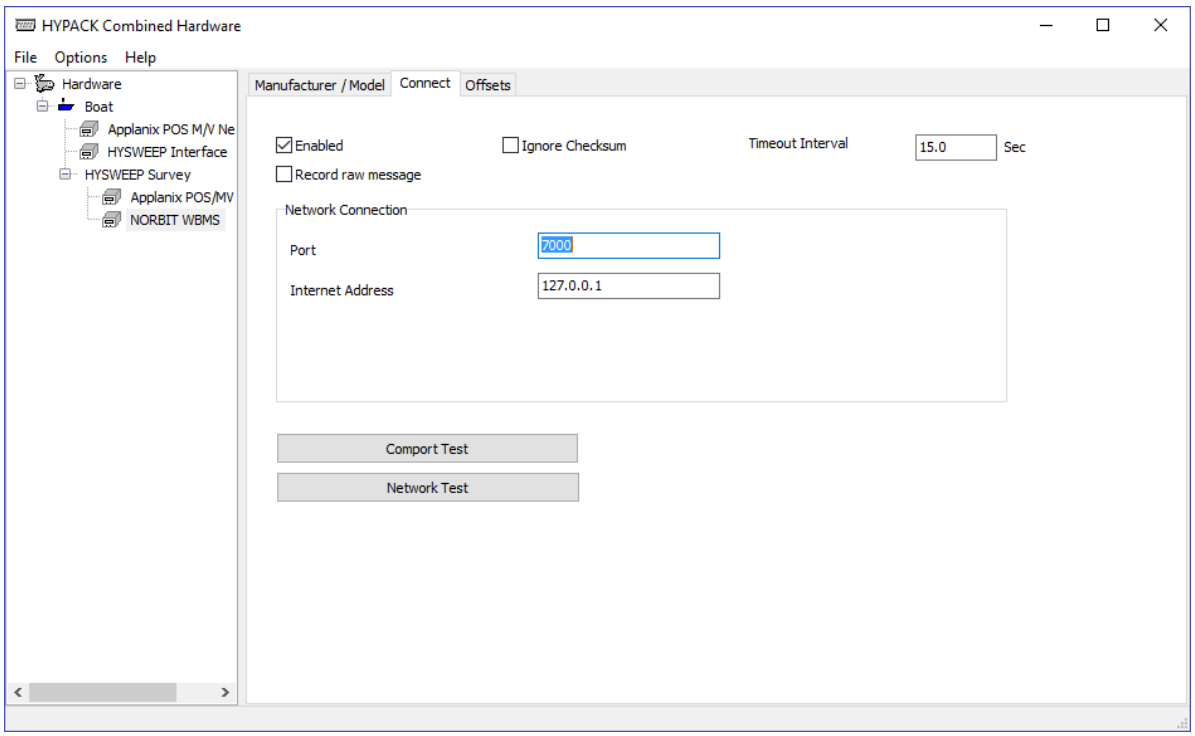


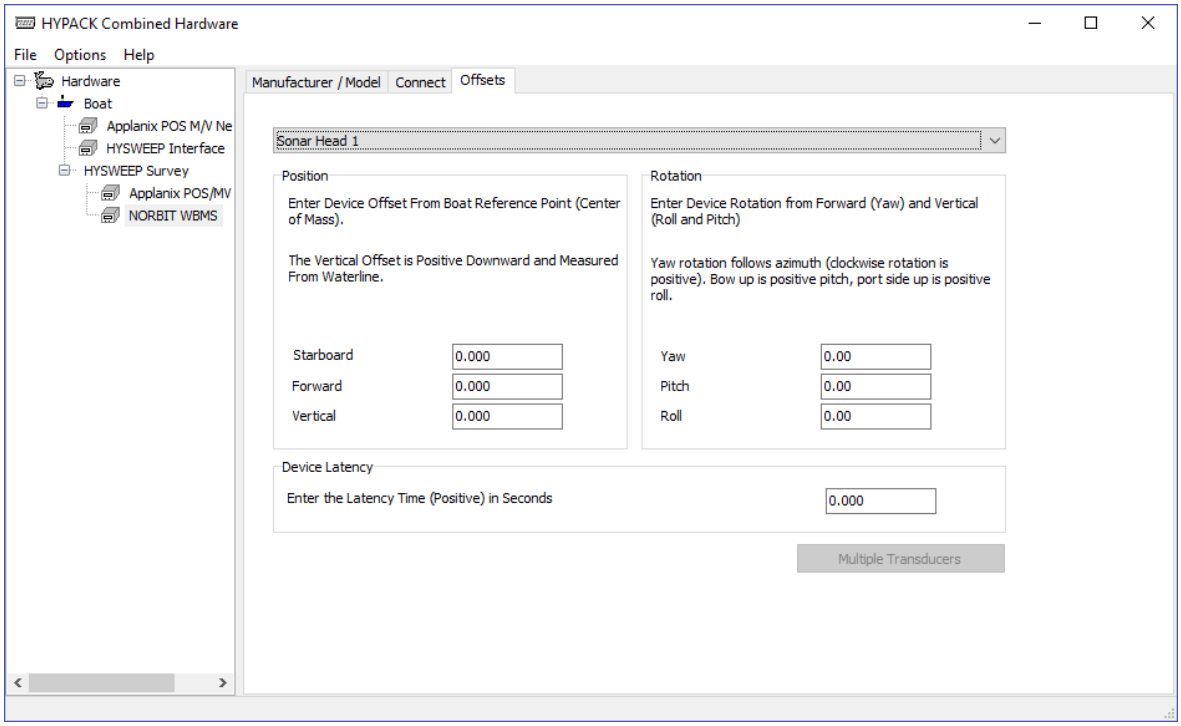




Next, go to HYSWEEP Survey, Manufacturer/Model and select NORBIT WBMS as shown below. In WBMS Setup, select “Sidescan Recording” for recording sidescan only; “Snippet SS Recording” for snippet-sidescan; “Snippet Recording” for logging snippets. If snippet data is requested at all, users must check “Log Datagrams.”




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

QINSy Configuration for WBMS, iWBMSc and all other iWBMS(x)

For sensors *not* supplied by NORBIT please contact vendor for integration instructions. The following sections show recommended configurations of the acquisition software for the WBMS/iWBMSc. 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 the first section of the Appendix.

Lever-Arm Offsets

For the integrated systems, the INS is set to recalculate the navigation solution to the sonar reference point. Therefore, the INS and WBMS will share the same offset from COR - measure from the sonar reference point to the vessel COR to the nearest 5cm on the horizontal plane. Pay attention to the coordinate convention of the software to avoid errors. QINSy coordinate conventions are positive forward, positive to starboard, and positive up. 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.

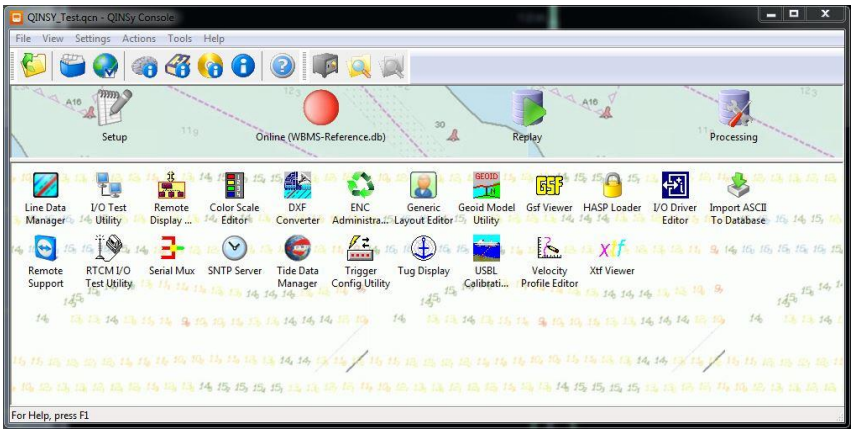
CAUTION: For integrated systems, the sonar and INS share the same offset.

If the INS was setup as recommended in this manual, then offsets from COR are required. Referencing data to the COR reduces heave measurement inaccuracies by replacing the vertical motion from the heave sensor with attitude-induced lever arm corrections.

About the COR: The COR, for larger commercial vessels, will be documented and included with the vessel design plans. For other vessels, this point at which the vessels' roll and pitch axes intersect will need to be determined. This is a tricky measurement 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 cantered on the keel and located at about the water level. Especially for smaller vessels, the COR will move 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 centreline 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.

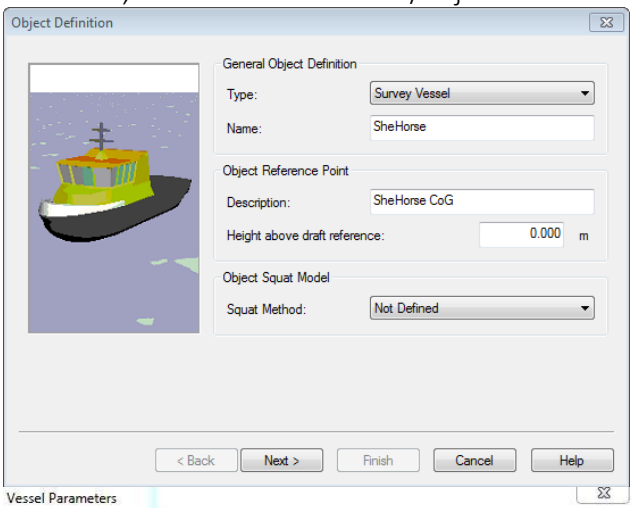
This example configuration places the INS reference at the sonar reference - i.e. the INS was configured to output values to the sonar reference location. If users want to base bathymetric measurements referenced to the water level, the only other offset required is a water level correction. This will allow of 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.

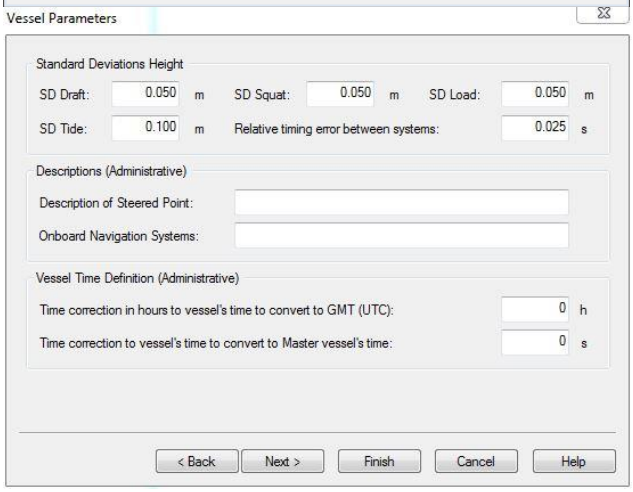
QINSy structures all data in a native database format. This means all data and hardware settings including, offsets are saved to a database file. The setup locates all sensors relative to an object, usually the survey vessel. The offsets from the object to the system (vessel) COR are entered as a node.



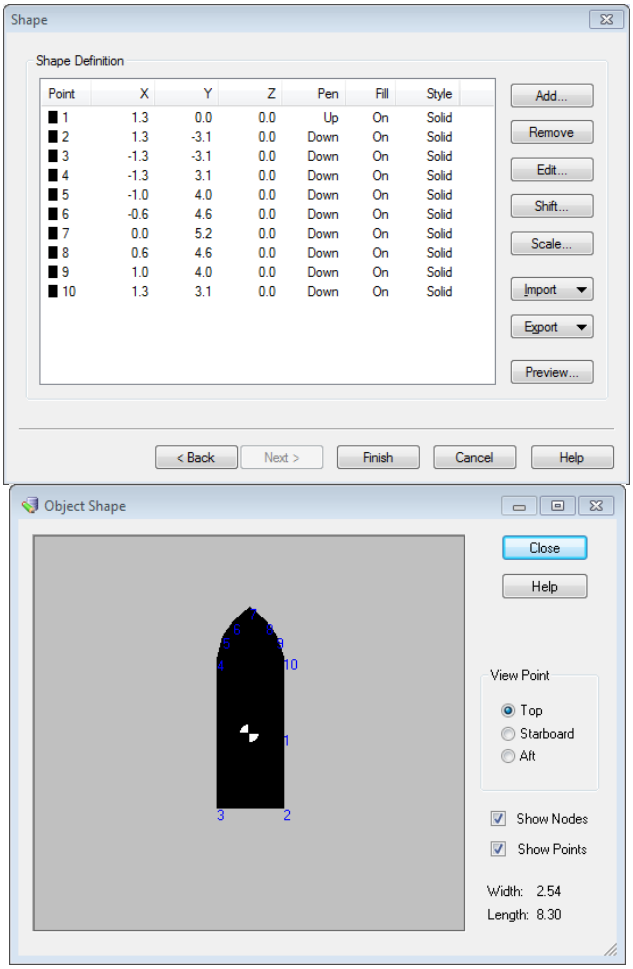
To start creating the database, go to QINSy>Setup>New Database. First go through and fill out all relevant Datum Parameters fields, i.e. specify project geodesy.

Next, complete all relevant fields in the Object Definition section. This will allow users to specify the shape of the vessel, location of the vessel/object reference point, etc.





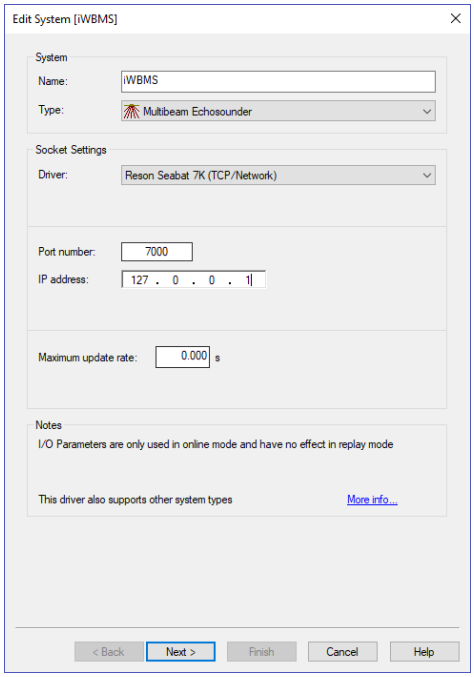
Should the user desire a vessel shape, it can be created and previewed in this section.

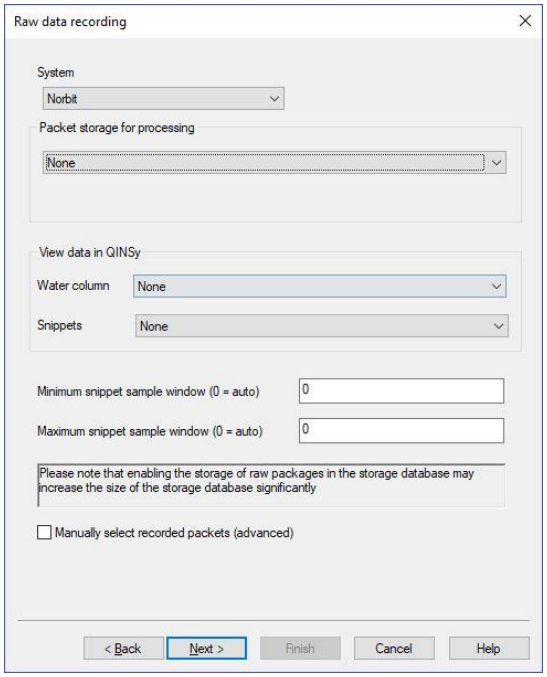


Multibeam Systems Setup

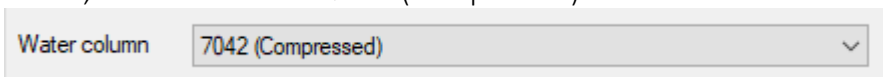
Once the project geodesy and vessel shape have been specified, instruments/sensors can now be added for data acquisition. The WBMS will be the first instrument that is entered.

The system will require a name and a type. The name can be user defined, e.g. NORBIT and the system type, chosen from the drop-down menu will be **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.

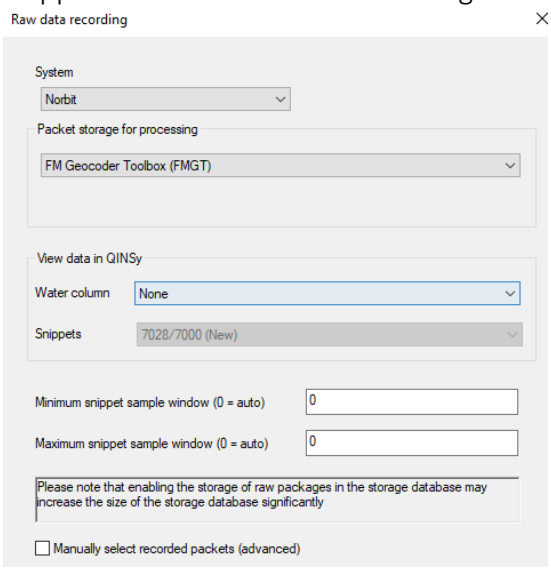


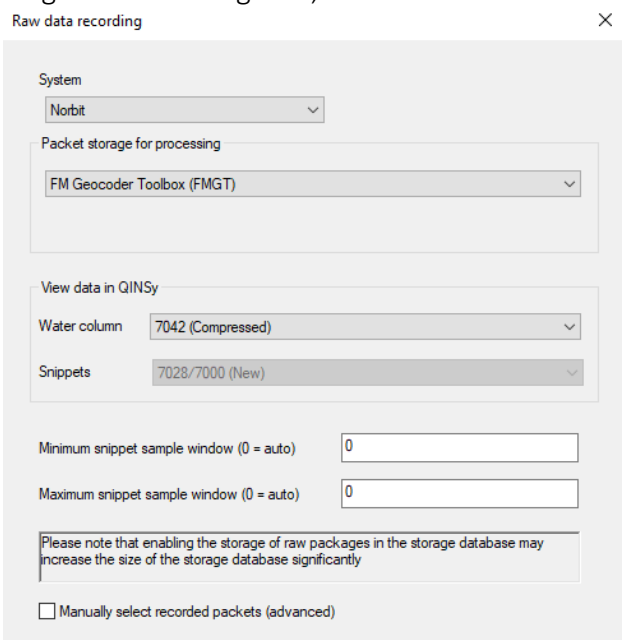


In the next window - Raw Data Recording – for standard bathymetric data collection, select Norbit under System, None under Packet Storage, Water Column and Snippets. To collect water column, users must select 7042 (Compressed) next to water column .

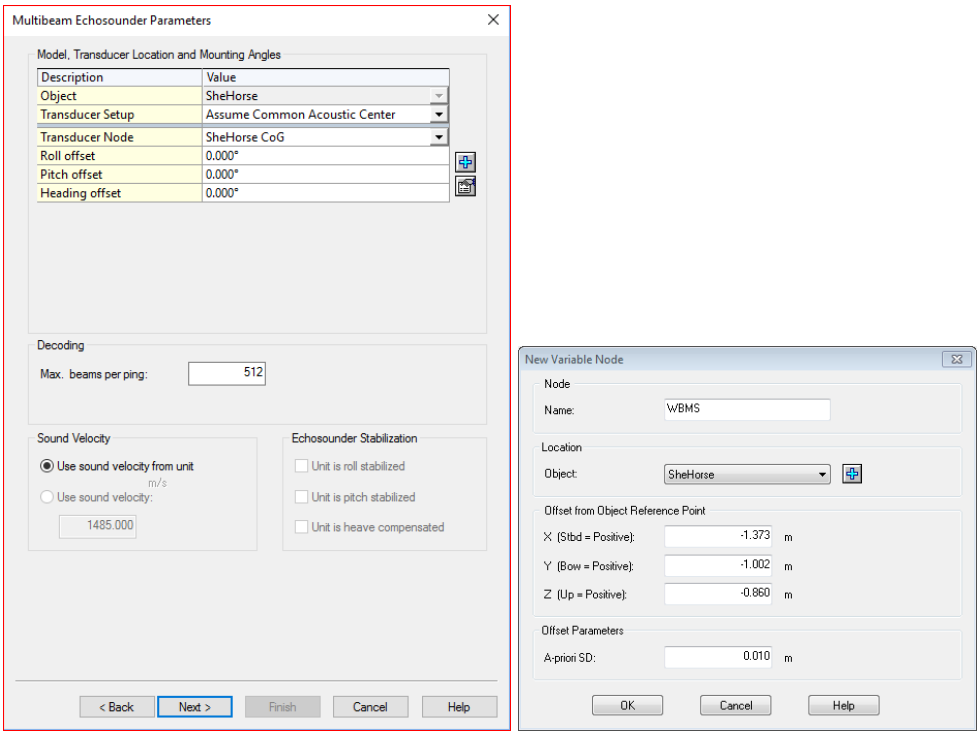


To collect snippets but no water column, configure the system as shown below on the left; for snippets and water column see image on the right. Once configured, click Next.

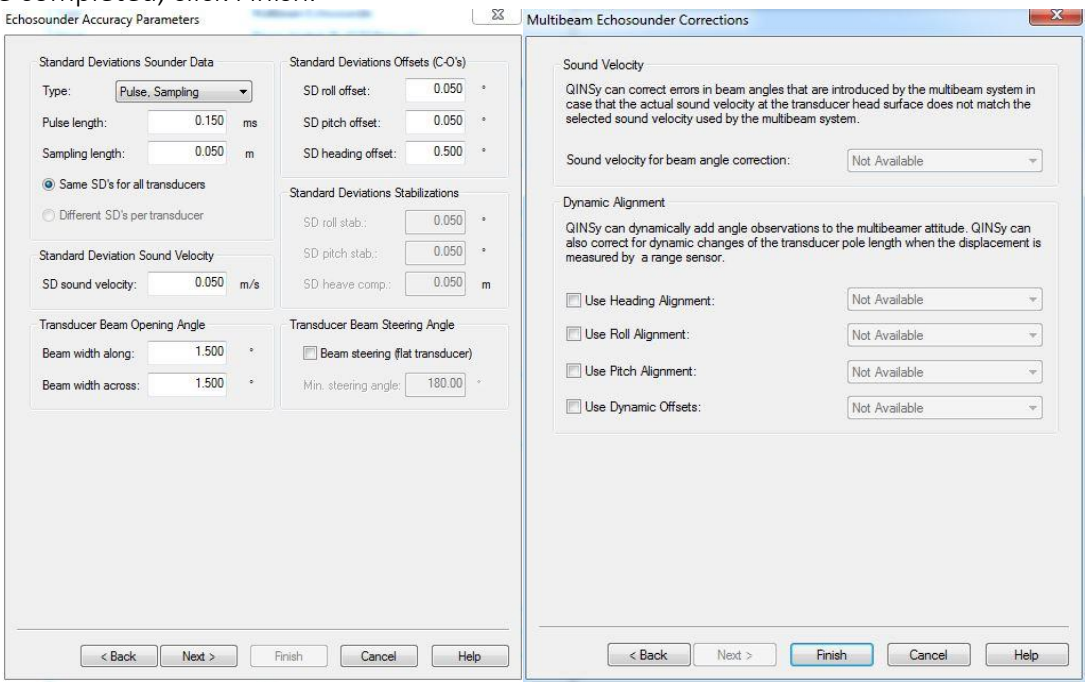




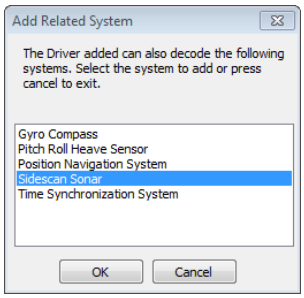
Offsets are specified in the Multibeam Echosounder Parameters window. Click on the + sign and create a new node called WBMS. Patch test values – roll, pitch and heading offsets, if known already, can be entered here. Enter 512 under max beams per ping.



NORBIT recommends that users keep the default values in the Echosounder Accuracy Parameters and Multibeam Echosounder Corrections. These two windows are shown below. Once completed, click Finish.

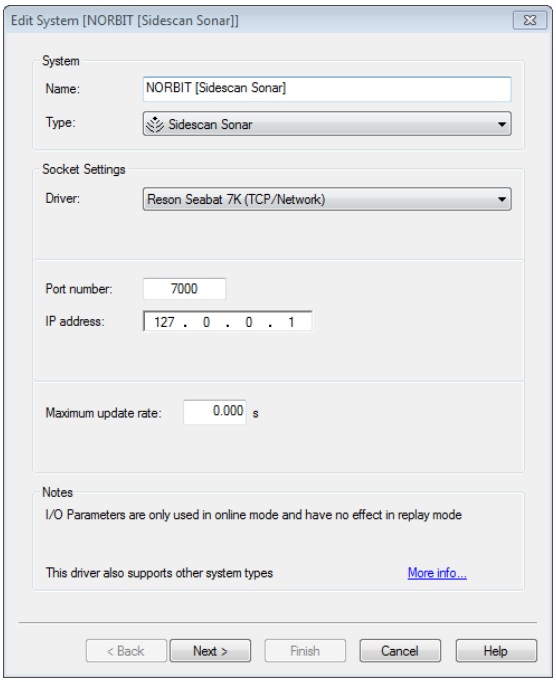


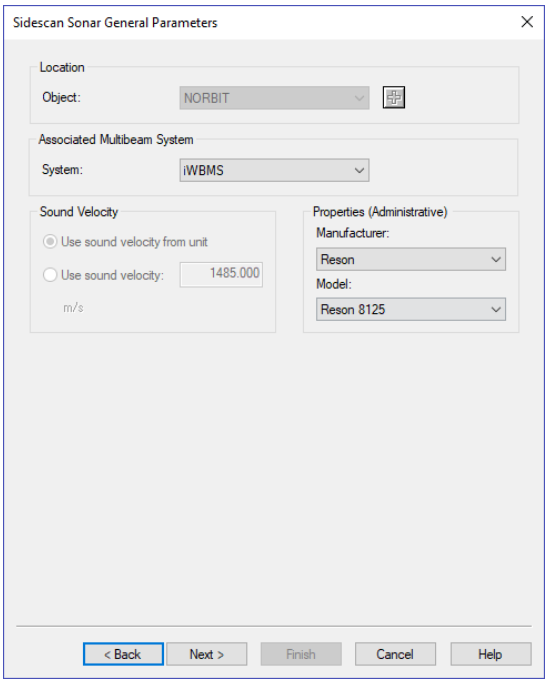
Another window will pop up to allow users to configure another sensor. If required, include Sidescan.

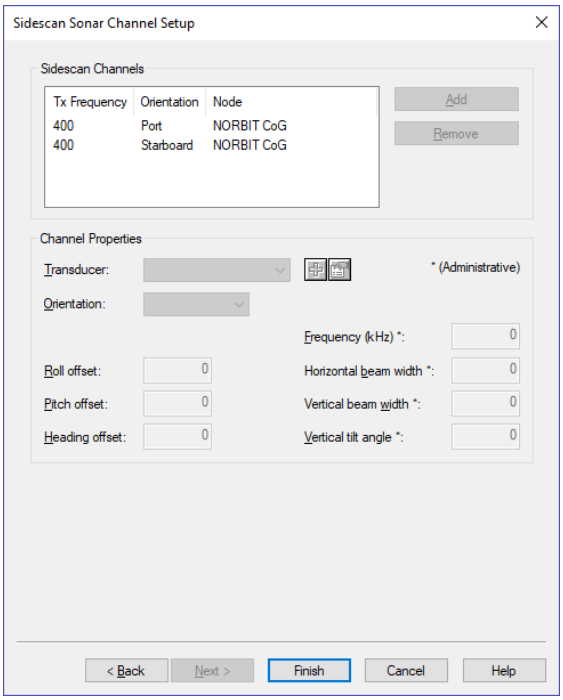


To set up the NORBIT sidescan in QINSy configure the Edit System page, Sidescan Sonar General Parameters and Sidescan Sonar Channel Setup as shown below.

A port and starboard channel will have to be added and QINSy will need to be informed of 400 kHz Frequency. Items marked with an asterisk (*) will not impact the data and are only for record keeping. Click Finish to complete configuring the side scan.

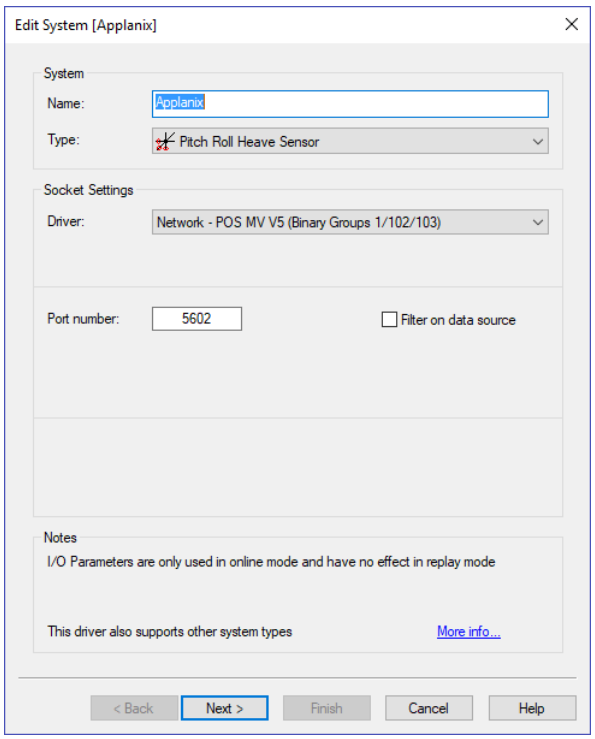


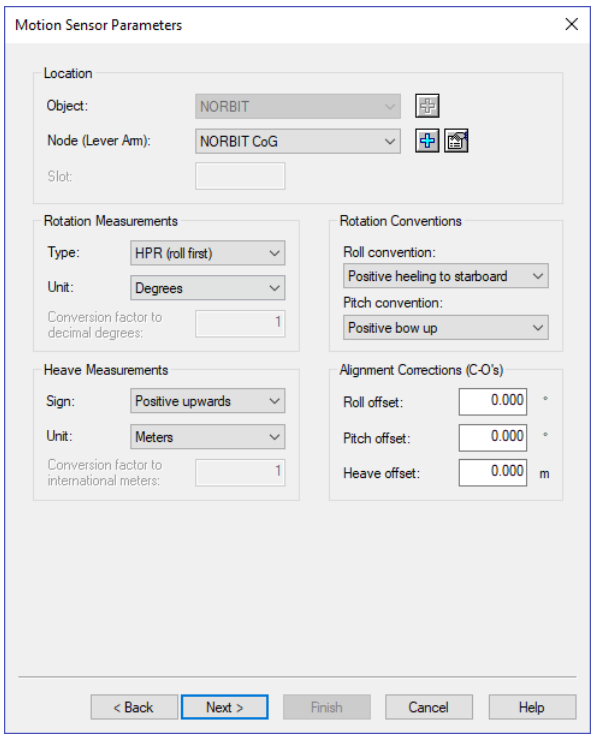


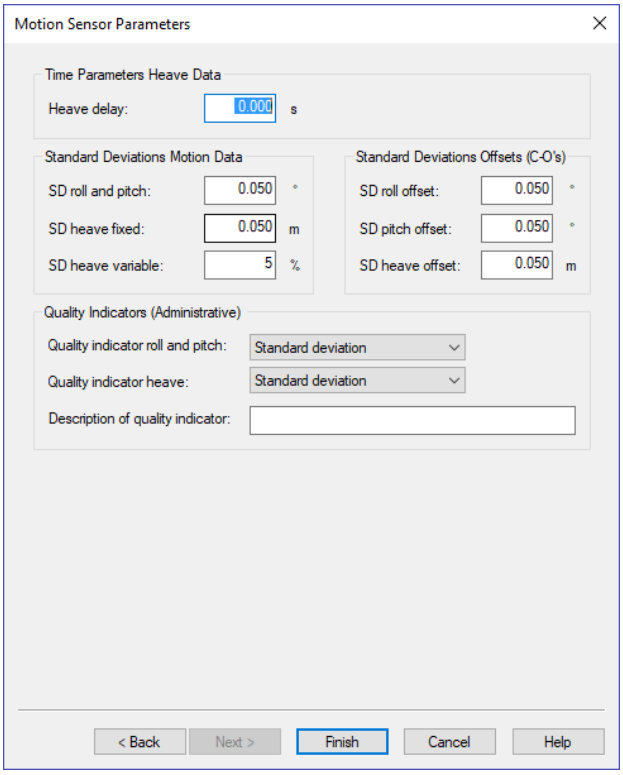


To integrate the (NovAtel or Applanix) INS with QINSy each function – attitude, heading, gyro, positioning - must be configured individually.

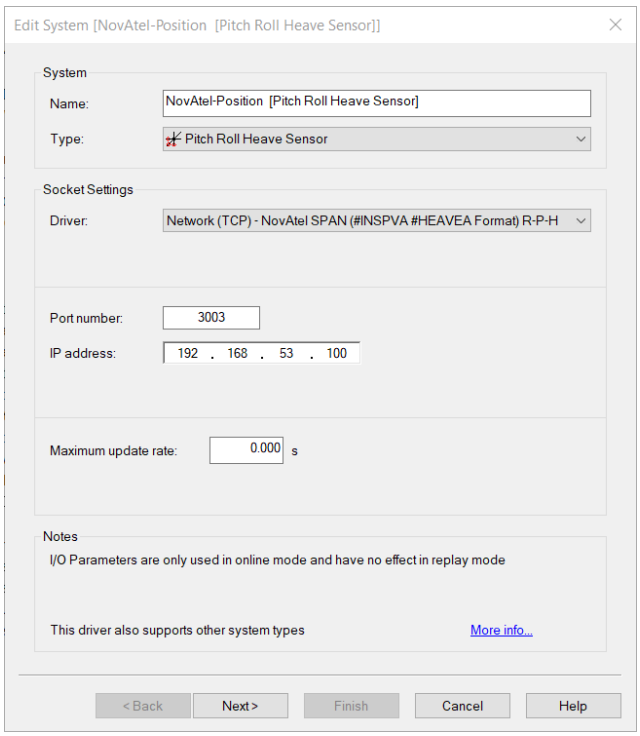
From the Database Setup Program right-click System, click New System. While the order of operations does not matter, this example will start with Pitch, Roll, Heave sensor. iWBMS users with Applanix INS will set up the Pitch, Roll, Heave as follows.

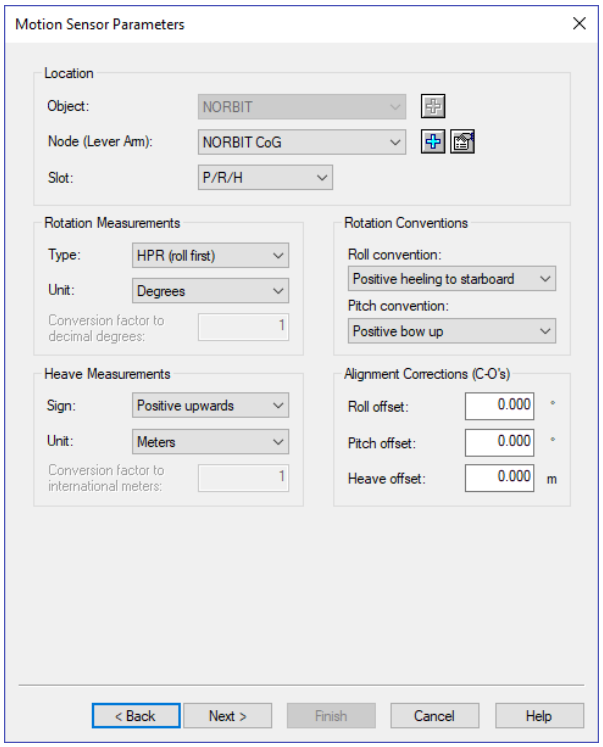


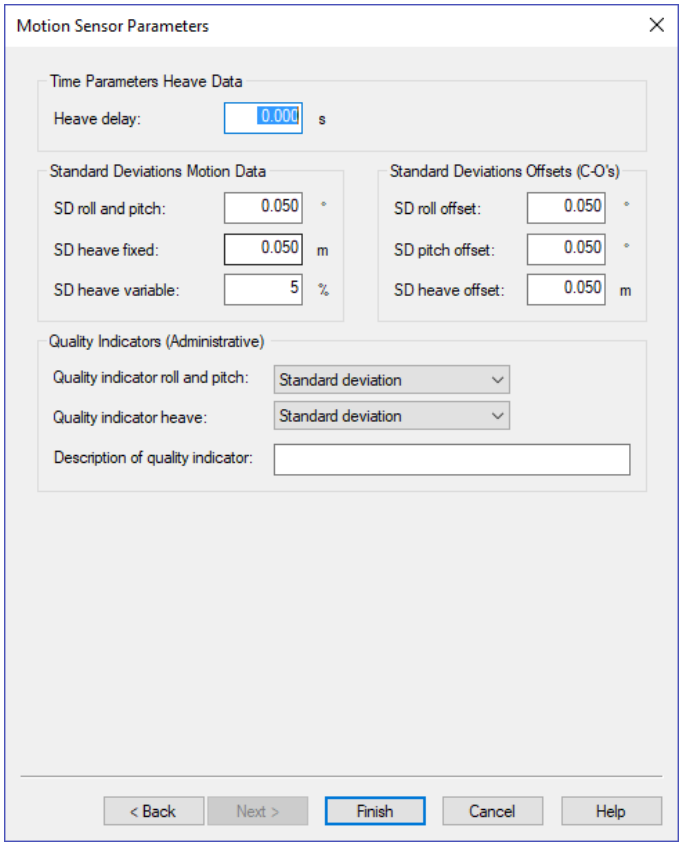




iWBMSc users will configure the Roll, Pitch, Heave as follows:

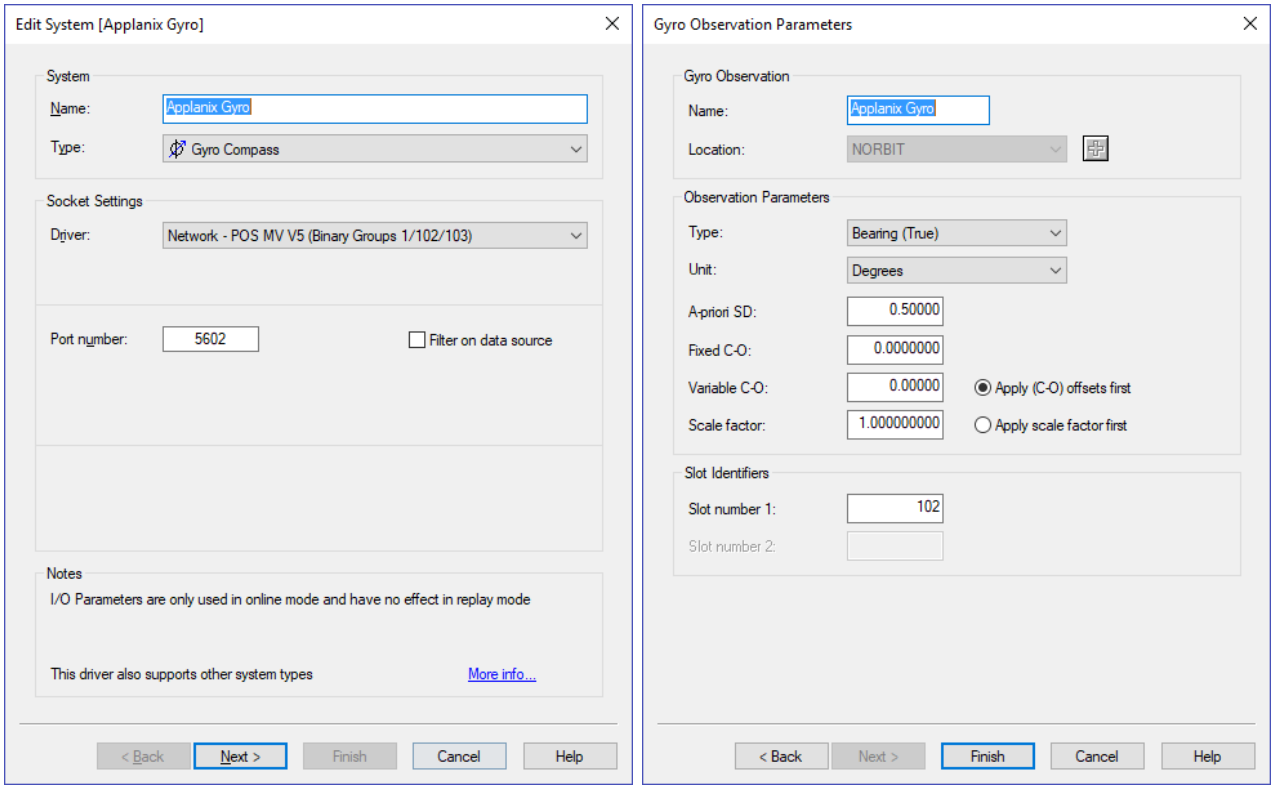




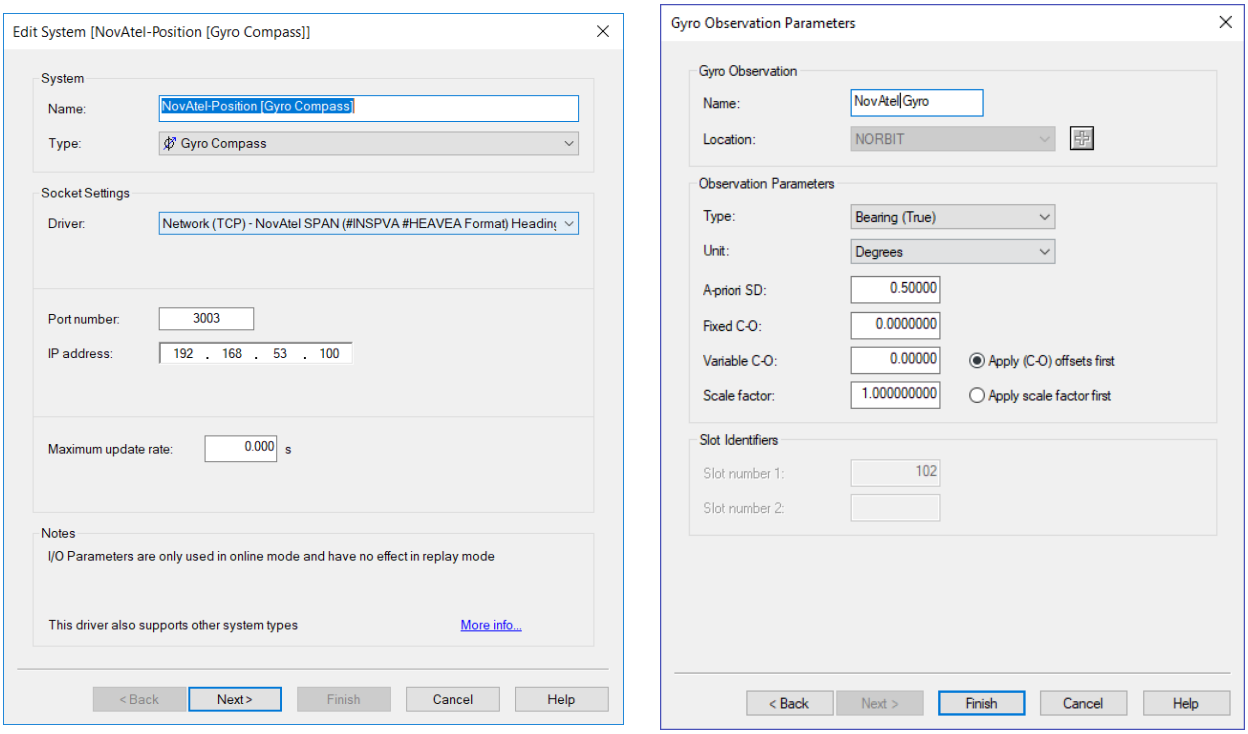


Once complete, click Finish.

iWBMS users with Applanix INS will configure the Gyro as follows:

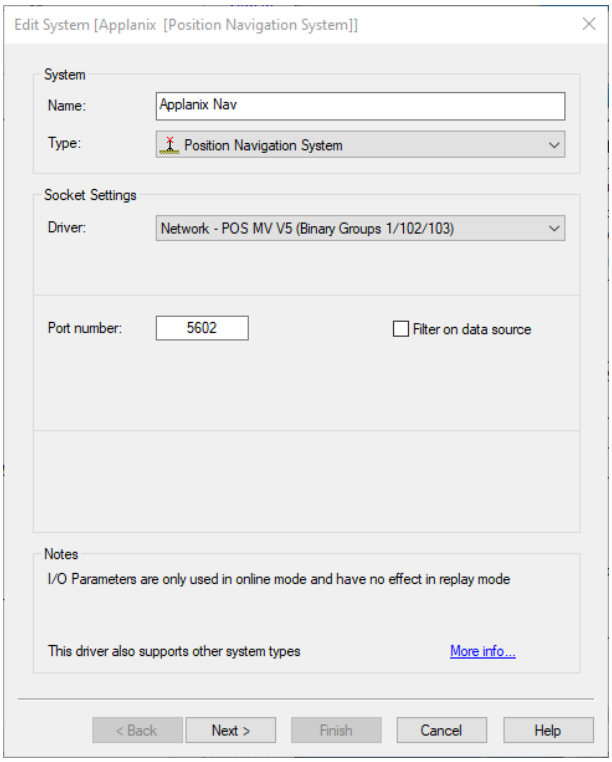


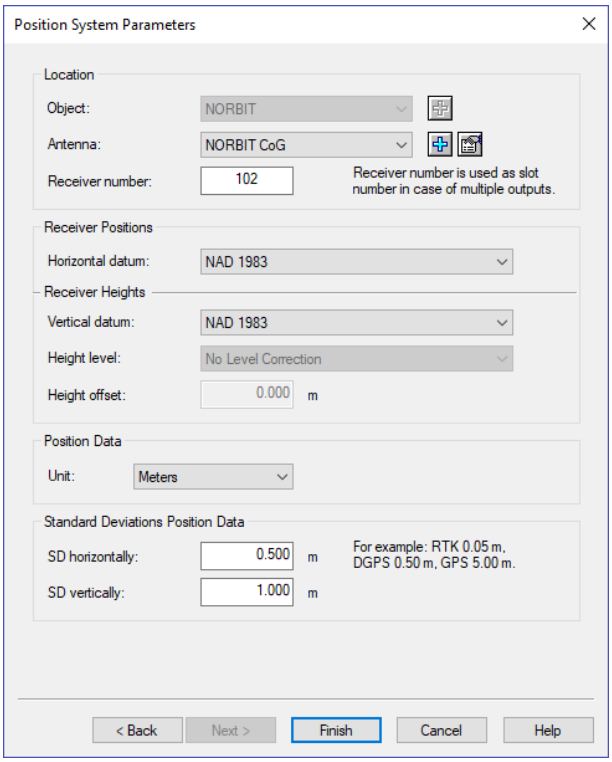
iWBMSc users with the NovAtel INS will configure the Gyro as follows:



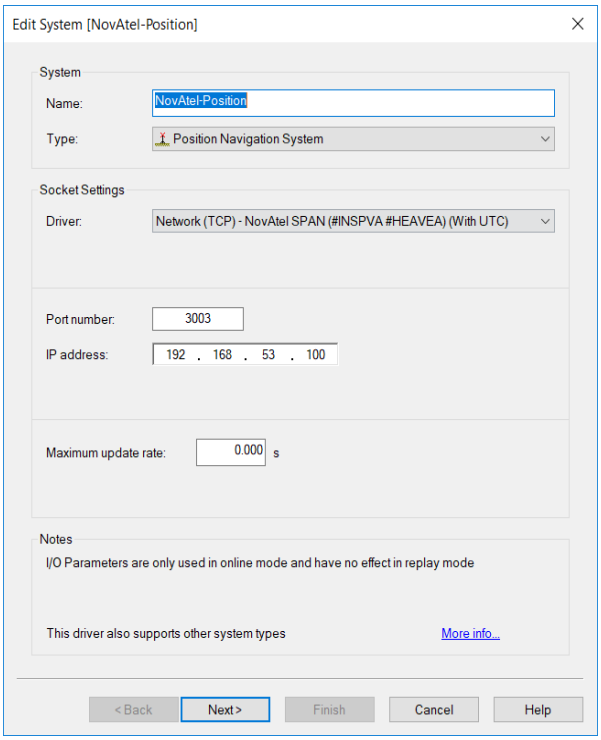
Click Finish and configure the next system.

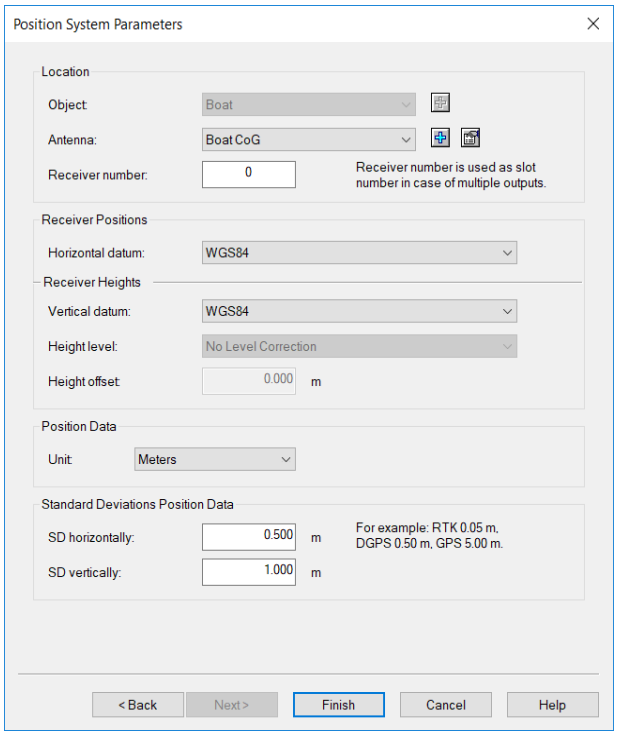
iWBMS users with Applanix INS will configure the Position Navigation System as follows. The Horizontal and Vertical datum will obviously depend on project specifications.



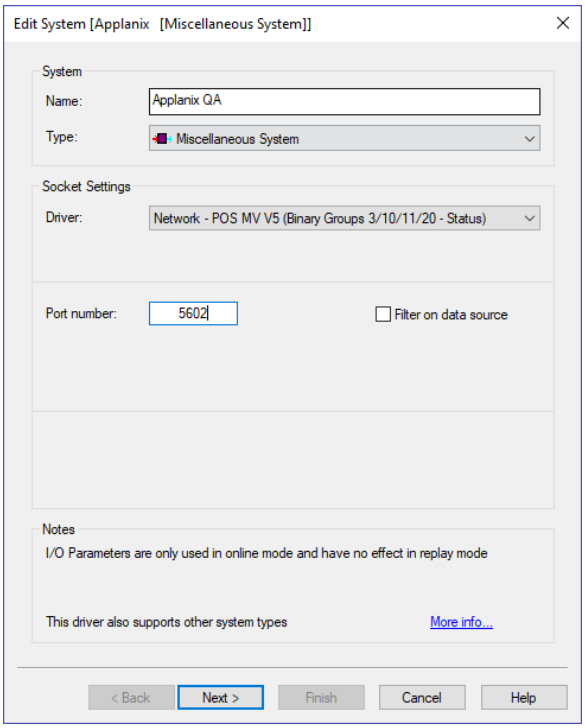


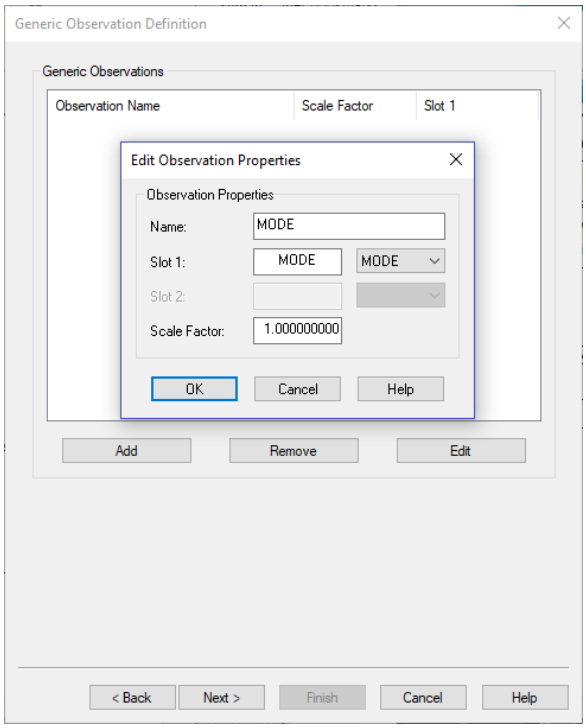
iWBMSc users will configure the Position Navigation System as shown below.

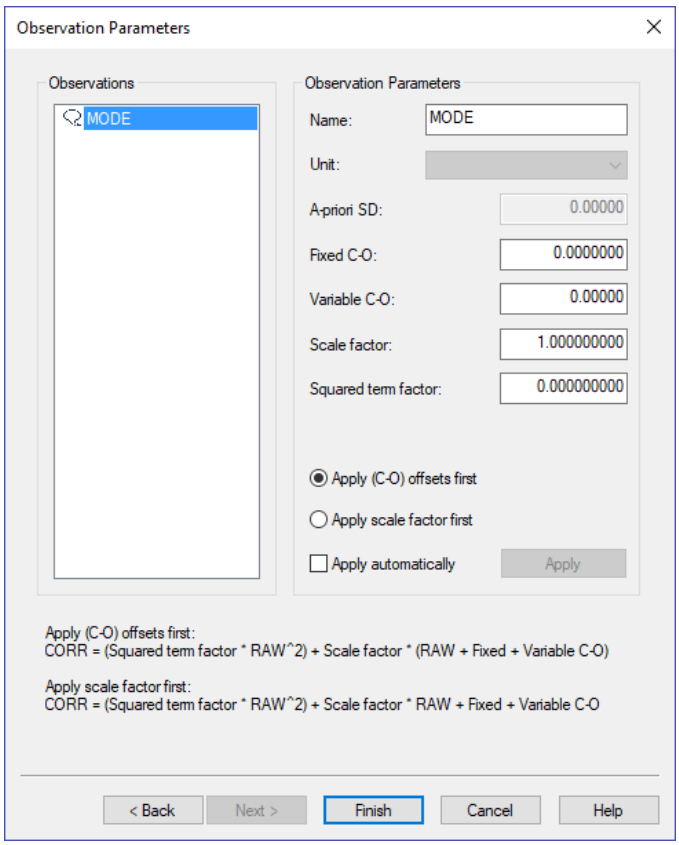




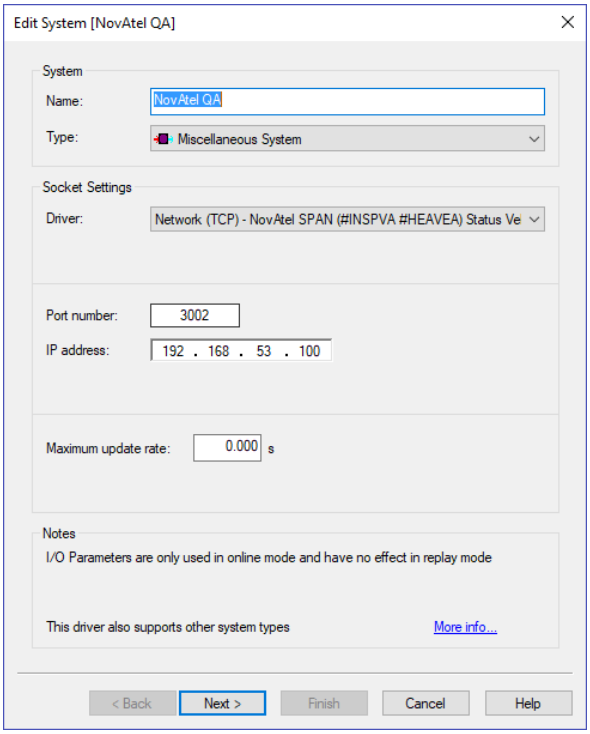
To configure the iWBMS (with Applanix) to output quality information, follow the steps shown below.

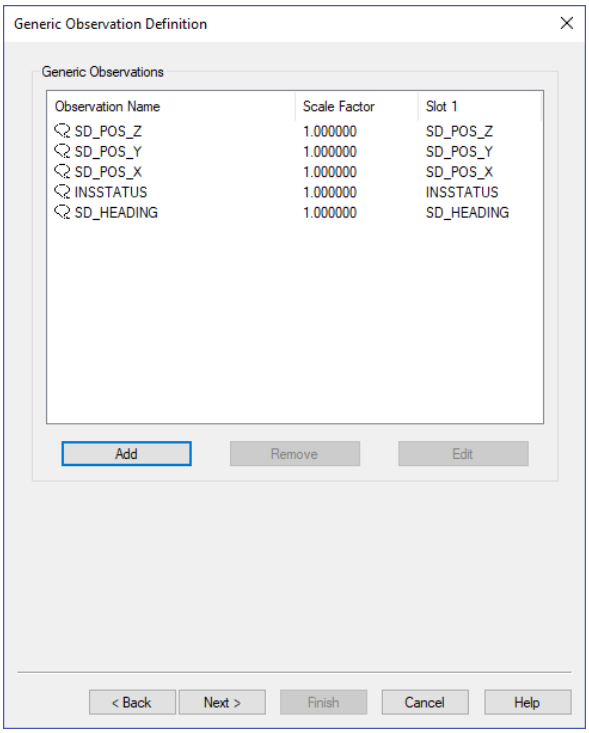


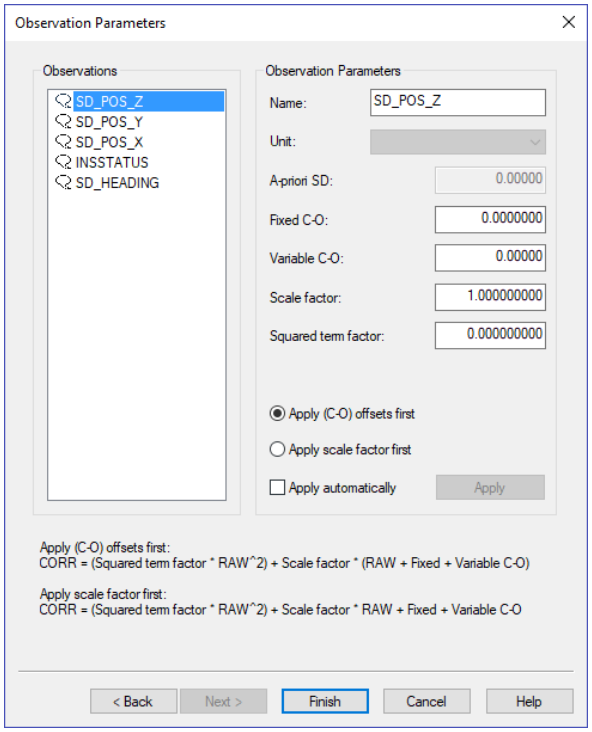




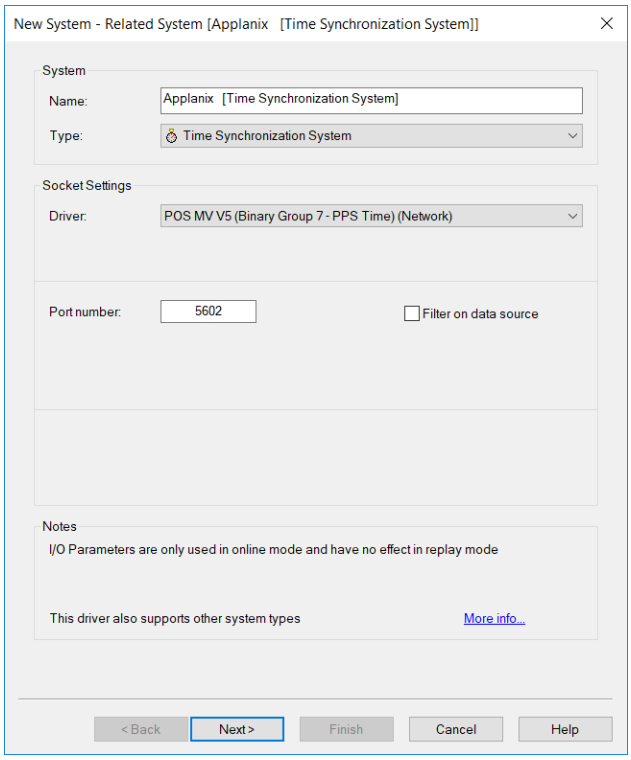
iWBMSc users will configure the NovAtel quality output as shown below.

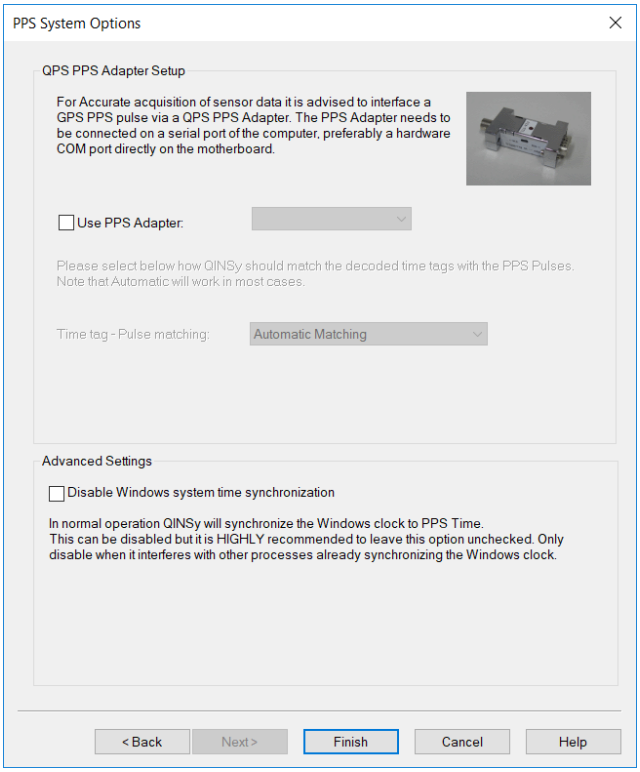






A time synchronization driver also needs to be added to the QINSy database setup. Use bianary group 7 without a PPS box.





Known issues with QINSy

1) If QINSy crashes during data acquisition, it may fail to close the Seabed 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.

The WBMS GUI Version 10 Hotfix requires that Force Push be enabled in the Connection tab. Please see Section 5.5.4 of the manual for further information on its functionality.

General instructions are provided for integrating NORBIT sensors (WBMS and iWBMS). For sensor not supplied by NORBIT then additional integration is required and is not explained here. The following sections show only one of many possible methods for configuring the WBMS. As with many sensor suite setups, this is certainly not the only method. The examples assume that an iWBMS was installed with the INS reference location moved to the sonar reference location in that system.

PDS2000 axes sign convention is positive in the up direction; this is different than the POS MV on the iWBMS. Incorrect entry of the sign may corrupt data.

The POS MV Ethernet real-time must be configured to output the following packets that are required by PDS200, 1,3,7,10,11,20,102,103,111,113. For information on how to configure Ethernet real-time in the POSView software refer to the POSView setup Appendix of the WBMS and iWBMS manual.

Lever-Arm Offsets

For the integrated systems, the INS is set to recalculate the navigation solution to the sonar reference point and a centre of rotation was applied to improve heave calculations. The integrated systems do not require additional offsets to be entered into the acquisition software. Should sonar data need to be referenced to water surface a draft value may be needed. This should be confirmed with a bar check.

When needing to reference the water level (if water level corrections are required or if data must be with respect to water level) then a sonar draft value may need to be entered and verified by carrying out a draft check (bar check).

CAUTION: For integrated systems, the sonar and INS share the same offset.

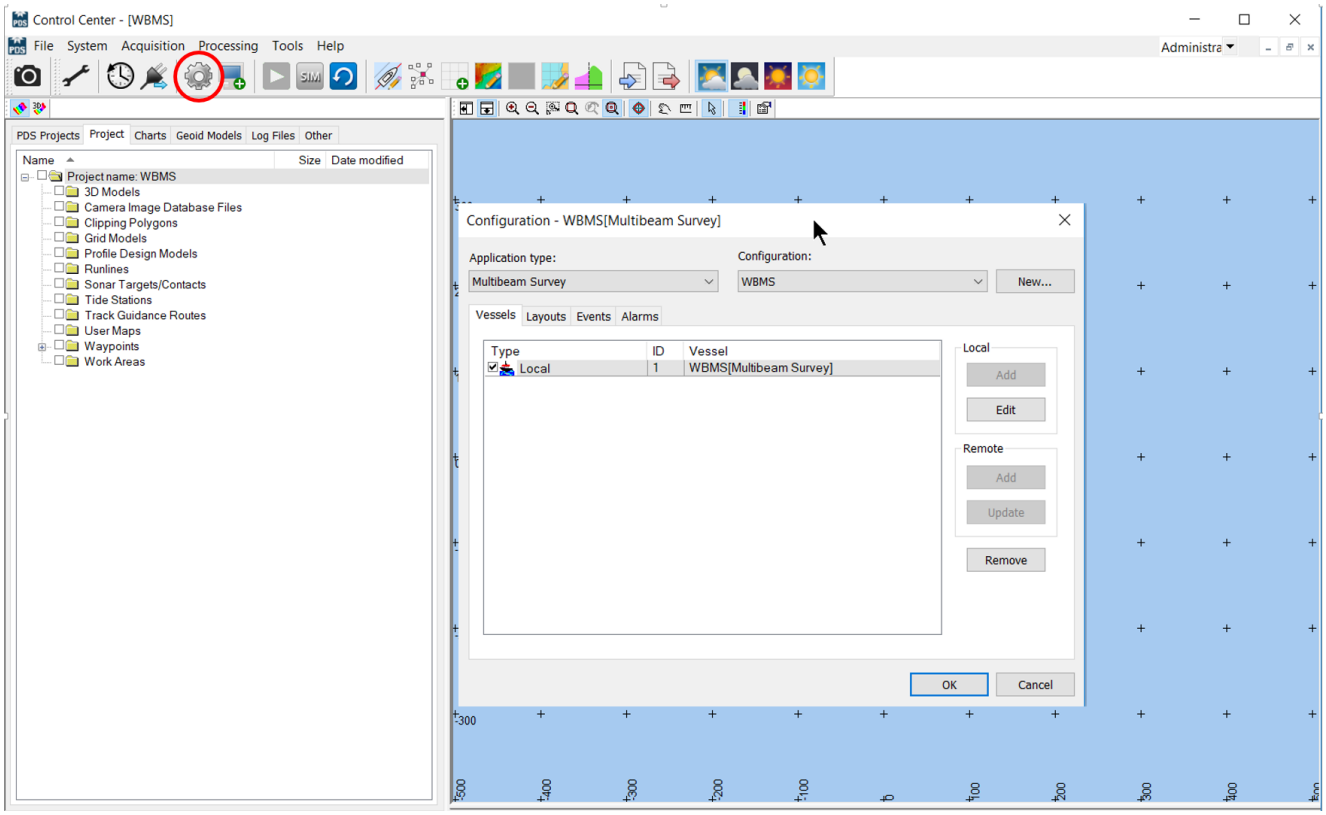
If the INS was setup as recommended in this manual then offsets from COR are required. Referencing data to the COR reduces heave measurement inaccuracies by replacing the heave sensor vertical motion data with attitude-induced lever arm corrections.

About the COR: The Centre of Rotation location depends on many factors however we will keep the discussion simple. The COR, for larger commercial vessels, will be documented and included with the vessel design plans. For other vessels, this point at which the vessels' roll and pitch axis meet will need to be determined. This is a tricky measurement as the vessel COR may change from day to day and even during the day. Very generally, choose a COR location that is about ¾ distance from bow to stern centred on the keel and located at about the water level. Especially for smaller vessels, the COR will move depending on fuel stowage and distribution of personnel body weight. For example, two people sitting on the starboard rail of a 6m craft will move the COR from the keel centreline a distance towards the starboard rail. Choose a location and attempt to keep the weight evenly distributed through the survey. If in doubt on the location then take the boat out into open water and observe its movements in waves while passing over waves in different directions.

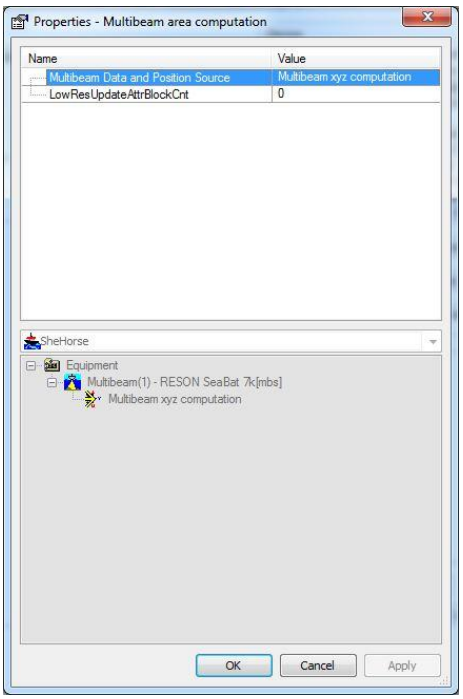
This example software configuration considers that both the INS and the sonar share the same measurement location (i.e. the INS was configured to output values to the sonar reference location). The only additional offset adjustment required is for a water level correction as we want to reference our data to a water level so we can choose to apply tide station water level corrections if required. Therefore, the COR will need to be moved up/down to the water level and confirmed via bar check.

Vessel Setup

In PDS200 all configurations are attached to a vessel. To start a new vessel configuration, click on the configuration button at the top of the control center window. A window will appear that will allow users to configure the vessel.



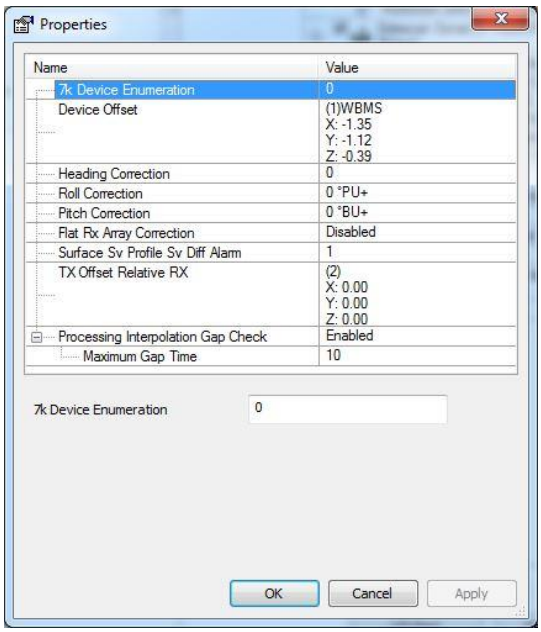
Clicking the Add button Prompt users to add a name for the vessel. Users can add the offset from COR to the WBMS in this section. If the POS MV was configured according to this manual then no offsets will be entered between COR and the WBMS. To start adding equipment to the double click on vessel and then the equipment tab.

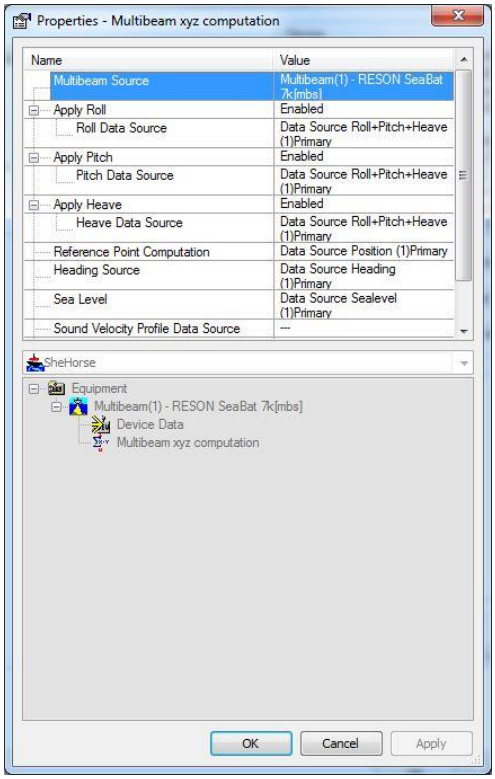


On the left side of the window are the equipment groups. When a group is clicked the associated drivers for the various systems will pop up. The first item that we will add is the WBMS. select the multibeam group and select the NORBIT using Reson 7k protocol driver and click the add button to add it to the right-hand window.

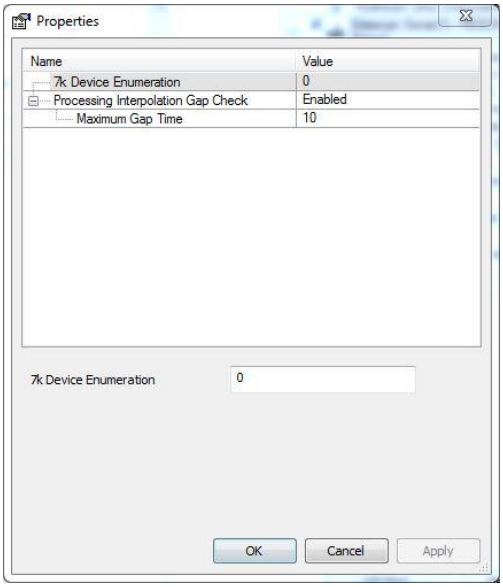
Click on I/O Port under the device window. This is where the network address for the sonar will be configured. Name the port WBMS the address will be 127.0.0.1 and the protocol will be TCP/IP. To associate the network address with a driver, click on the I/O port button and select the desired network configuration. The port name will be displayed beside the driver in the devices window. Be sure to select the WBMS network for both the multibeam and the sidescan.

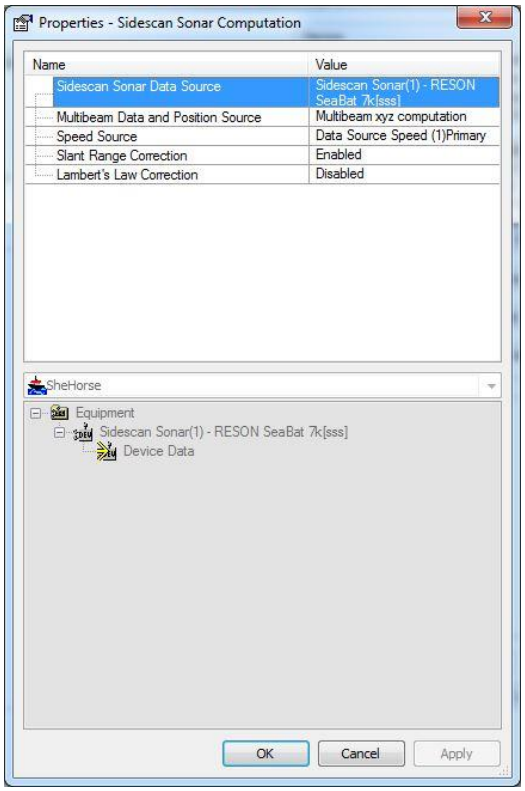
Click on multibeam at the top of the stack and click edit. Click on device offset and set it to the WBMS offset that was previously configured. From there go down the stack setting them up as follows.





To add Sidescan click on sidescan sonar under groups and add the RESON SeaBat 7k driver. As with the multibeam driver, configure step-by-step down the stack and configure the windows as shown.



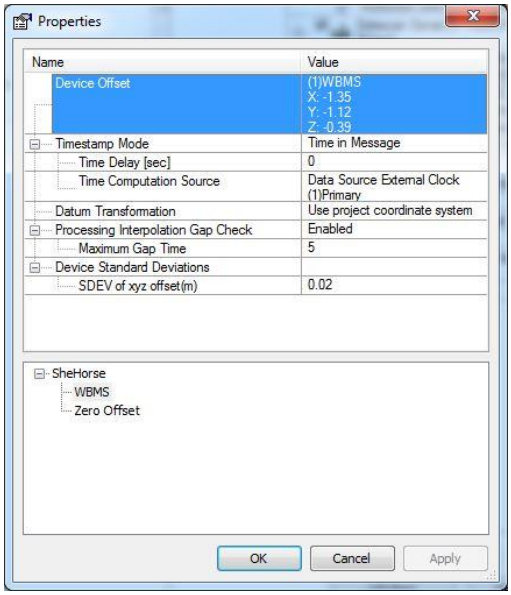


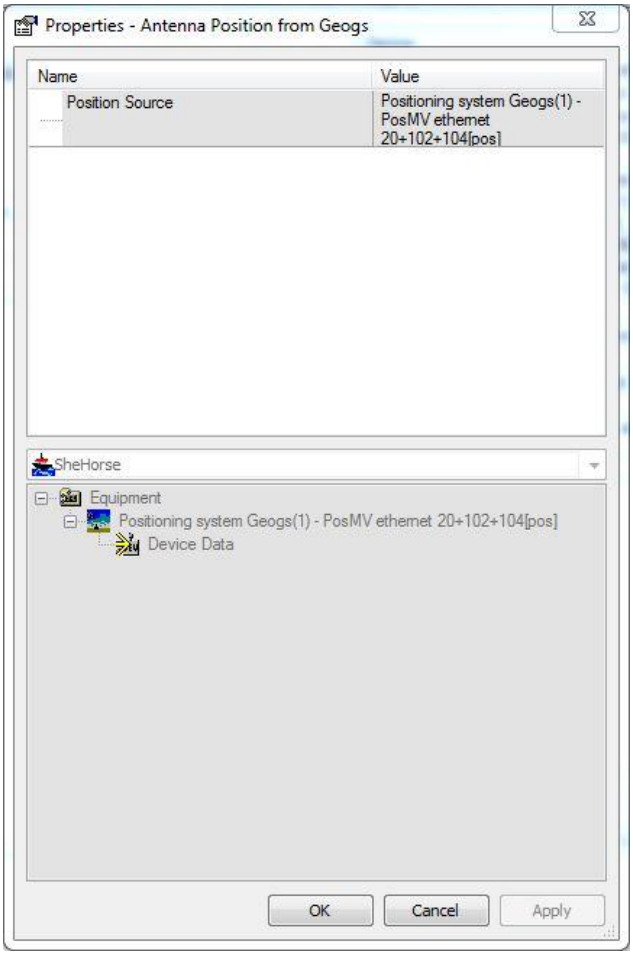
POS MV Setup (for iWBMS systems only)

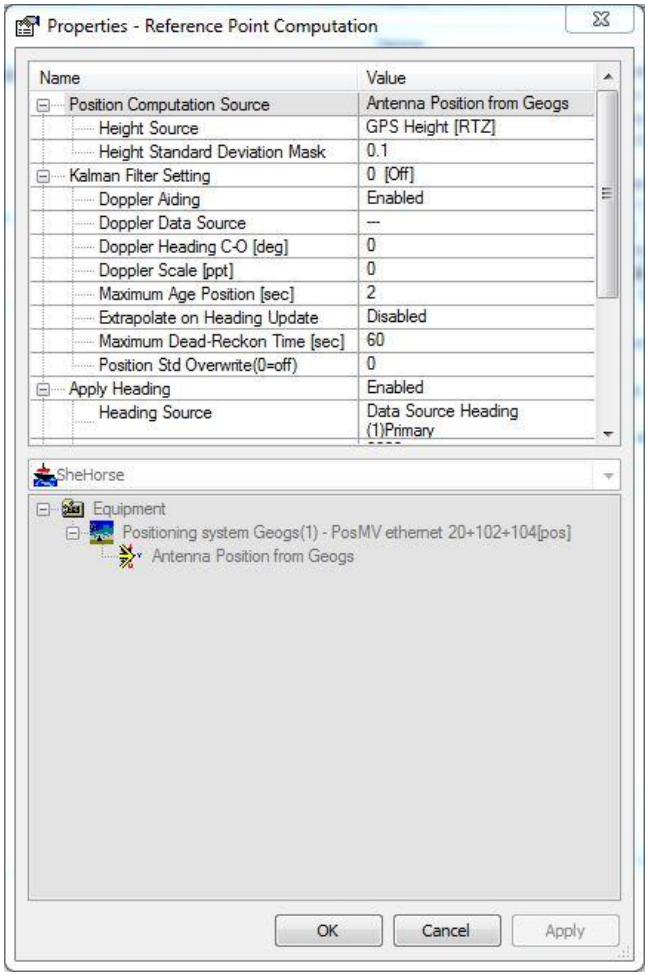
To integrate the INS with PDS2000 each function of the INS must be brought in individually. Therefore, a separate system must to be installed for attitude, heading/gyro, and positioning.

Click on I/O Port under the device window. This is where the network address for the PosMV will be configured. Name the port PosMV the address will be 192.168.53.100 port 5602 the protocol will be UDP/IP be sure to click check host address. To associate the network address with a driver, click on the I/O port button and select the desired network configuration. The port name will be displayed beside the driver in the devices window. Be sure to select the PosMV network for all drivers except the sonar.

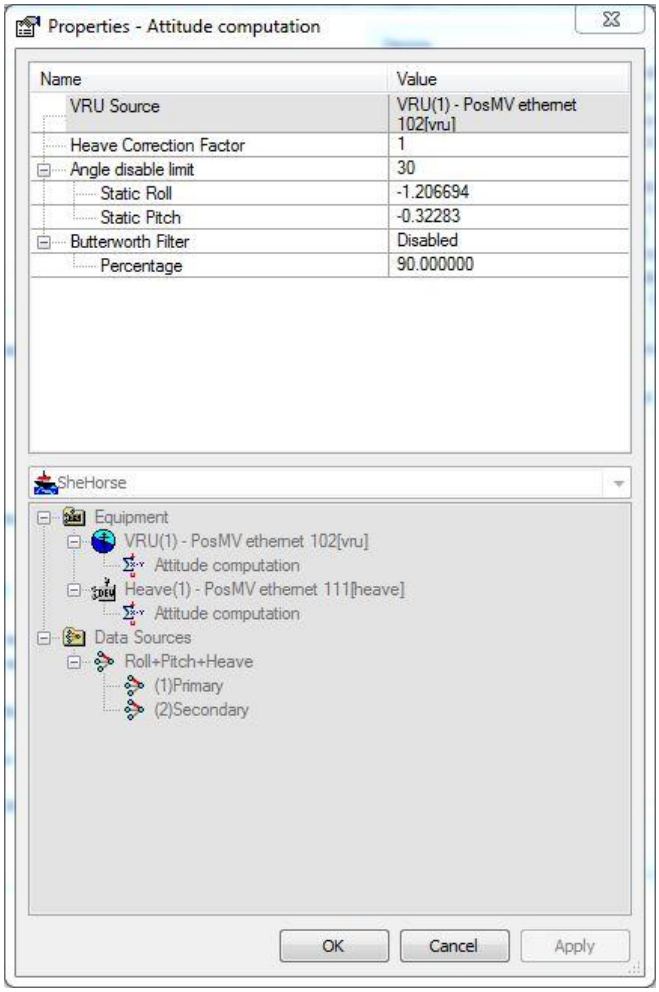
To add positioning from the POS M/V click on positioning system geogs and add the PosMV Ethernet 20+102+104 driver. Go down the stack configuring as shown in the following images.

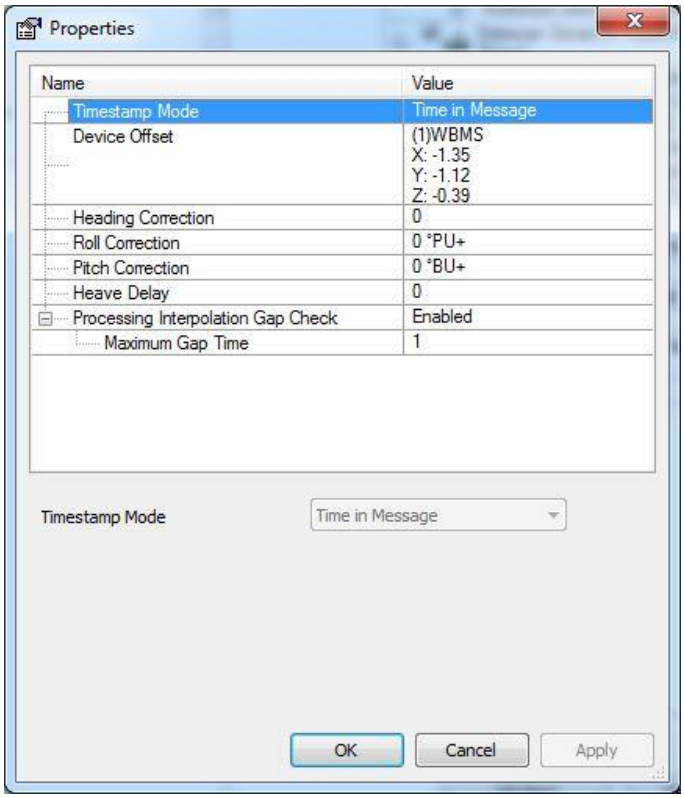




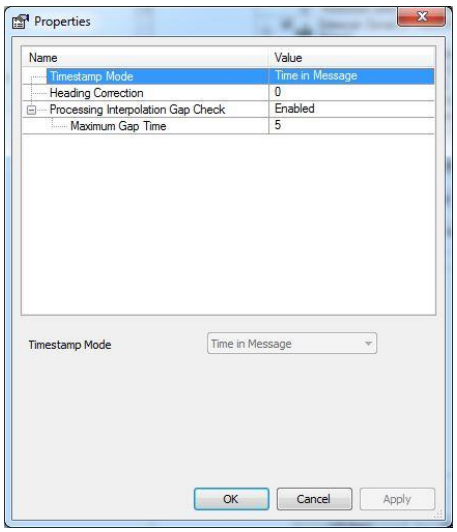


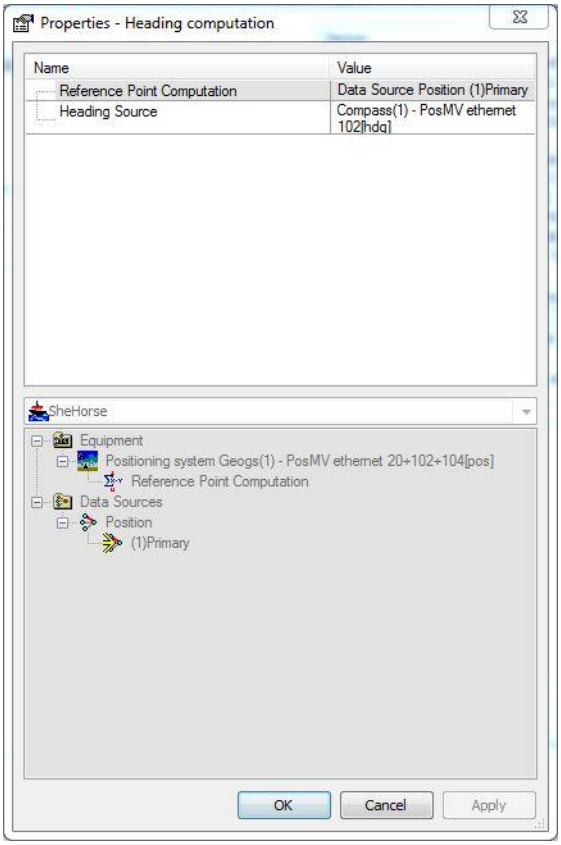
To add motion data from the POS click on the VRU group and add PosMV ethernet 102. Setup as shown in the following images.



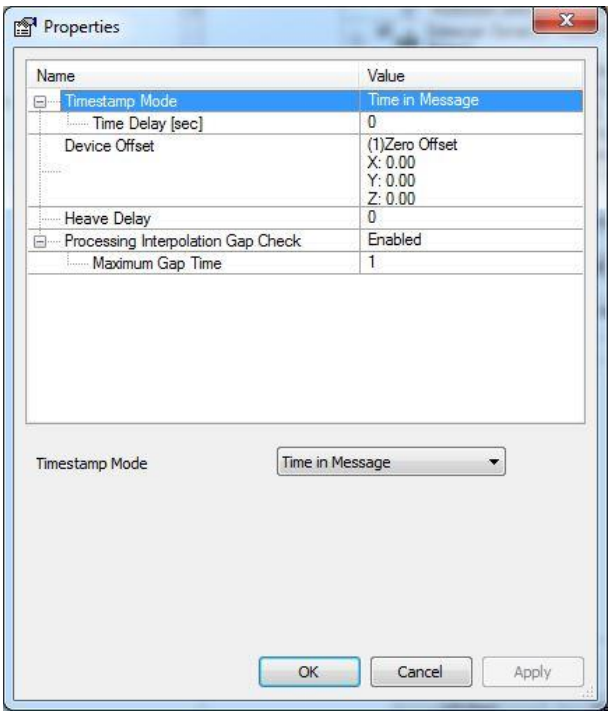


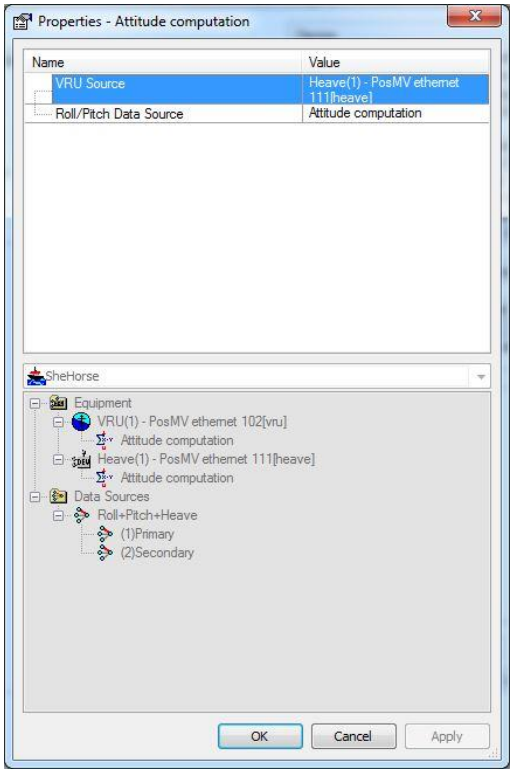
To add heading data, click on compass group and add PosMV ethernet 201 driver and set up as follows.





To add heave, click on heave group and add the PosMV ethernet 111. Setup as follows.





EIVA Software Configuration for WBMS & iWBMS

General instructions are provided for integrating NORBIT sensors (WBMS and iWBMS). For sensor not supplied by NORBIT then additional integration is required and is not explained here. The following sections show only one of many possible methods for configuring the WBMS. As with many sensor suite setups, this is certainly not the only method. The examples assume that an iWBMS was installed with the INS reference location moved to the sonar reference location in that system.

The EIVA axes sign convention is positive in the up direction; this is different than POS MV. Using the incorrect sign will degrade the data.

The POS MV Ethernet real-time must be configured to output the following packets that are required by EIVA, 1,3,7,10,11,20,102,103,111,113. For information on how to configure Ethernet real-time in the POSView software refer to the POSView setup Appendix of the WBMS and iWBMS manual.

Lever-Arm Offsets

For the integrated systems, the INS is set to recalculate the navigation solution to the sonar reference point and a centre of rotation is applied to improve heave calculations. For the integrated NORBIT systems, lever-arm offsets are not required in Hypack. Should sonar data need to be referenced to water surface a draft value may be needed. This should be confirmed with a bar check.

CAUTION: For integrated systems, the sonar and INS share the same offset.

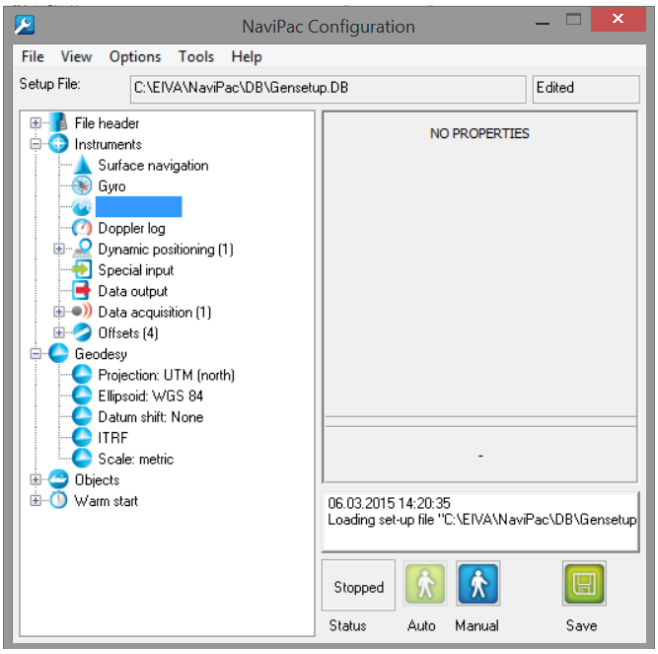
If the INS was setup as recommended in this manual then offsets from COR are required. Referencing data to the COR reduces heave measurement inaccuracies by replacing the heave sensor vertical motion data with attitude-induced lever arm corrections.

About the COR: The Centre of Rotation location depends on many factors however we will keep the discussion simple. The COR, for larger commercial vessels, will be documented and included with the vessel design plans. For other vessels, this point at which the vessels' roll and pitch axis meet will need to be determined. This is a tricky measurement as the vessel COR may change from day to day and even during the day. Very generally, choose a COR location that is about ¾ distance from bow to stern cantered on the keel and located at about the water level. Especially for smaller vessels, the COR will move depending on fuel stowage and 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 centreline a distance towards the starboard rail. Choose a location and attempt to keep the weight evenly distributed through the survey. If in doubt on the location then take the boat out into open water and observe its movements in waves as pass over waves in different directions.

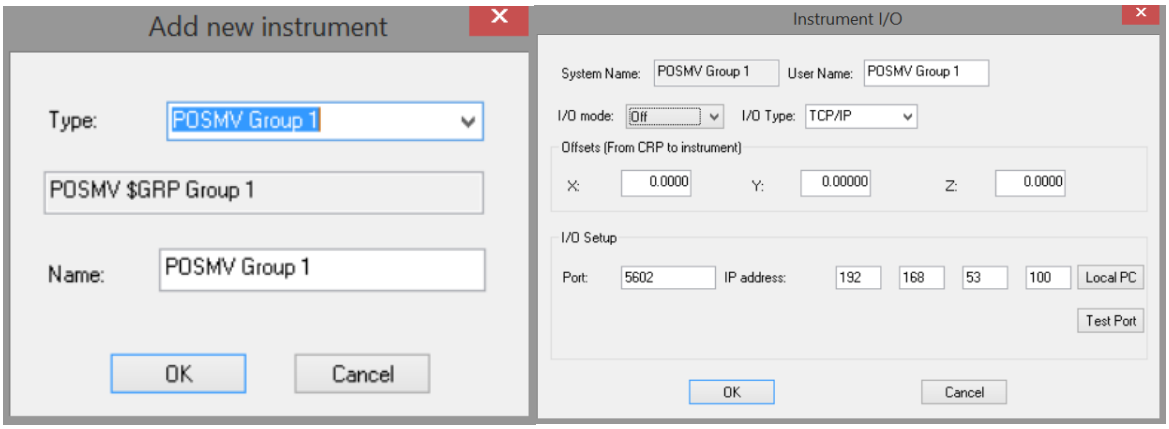
This example software configuration considers that both the INS and the sonar share the same measurement location (i.e. the INS was configured to output values to the sonar reference location). The only additional offset adjustment required is for a water level correction as we want to reference our data to a water level so we can choose to apply tide station water level corrections if required. Therefore, the COR will need to be moved up/down to the water level and confirmed via bar check.

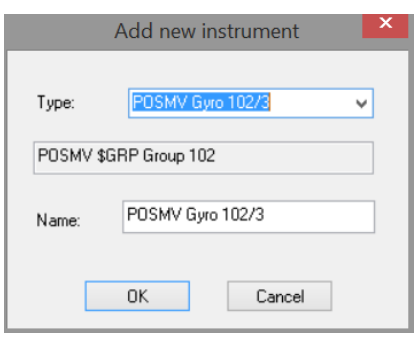
NaviPac is required in order to conduct a survey with EIVA. NaviPac is utilized by the helm display. Some additional information is shared with NaviScan.

The NaviPac configuration screen is where all information required for NaviPac will be entered. The only device that will be added to NaviPac will be the Applanix PosMV. Additional survey information can also be configured here. Quick start will only address equipment setup.

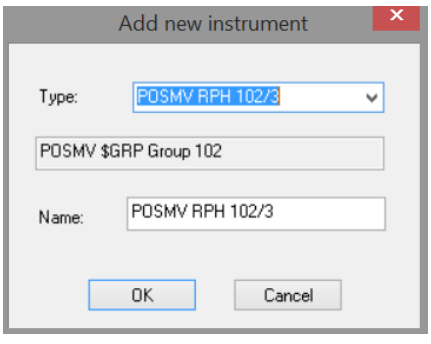


Under instruments right click surface navigation and add new item. Select POSMV group 1 from the dropdown list. The network settings will be the same for all POSMv functions. IP address 192.168.53.100 port 5602





The next function to be configured is gyro. Select POSMV Gyro 102\3. Under motion select POSMV RPH 102\3



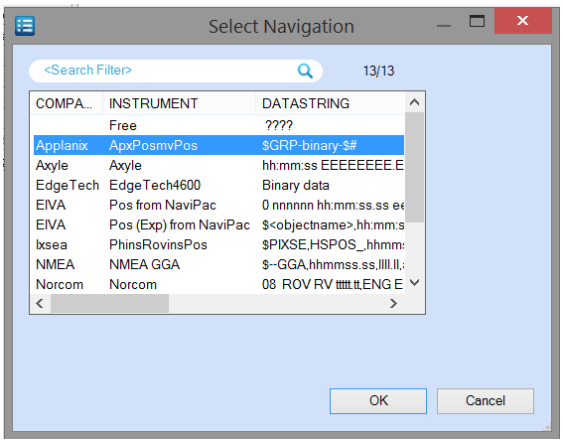
NaviScan Configuration

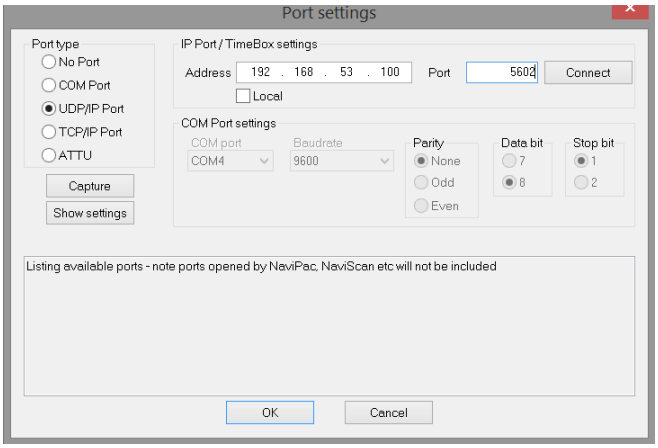
Sensors will be added to NaviScan under the equipment, add sensor drop down menu. For the Applanix all functions of the PosMV, navigation, HPR and heading must be brought in separately.

Applanix Setup

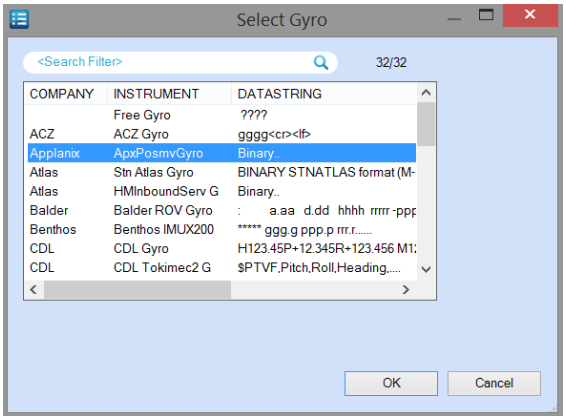
To integrate the INS with EIVA each function of the INS must be brought in individually. Therefore, a separate system must to be installed for attitude, heading/gyro, and positioning.

The first sensor to add will be a position sensor. After selecting position sensor add Applanix PosMV and configure with the following network settings.

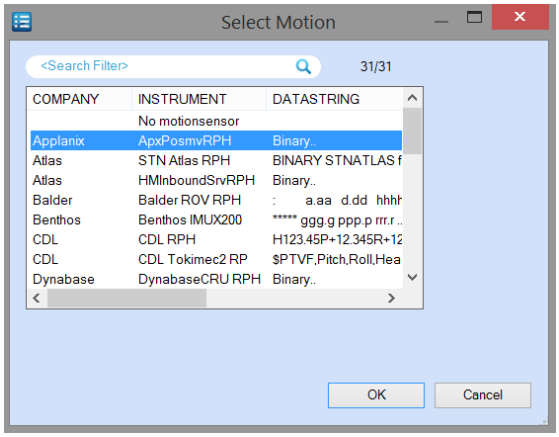




Next the gyro function of the Applanix will be added. Under add sensor select Gyro and select Applanix. The network settings will be the same as above.

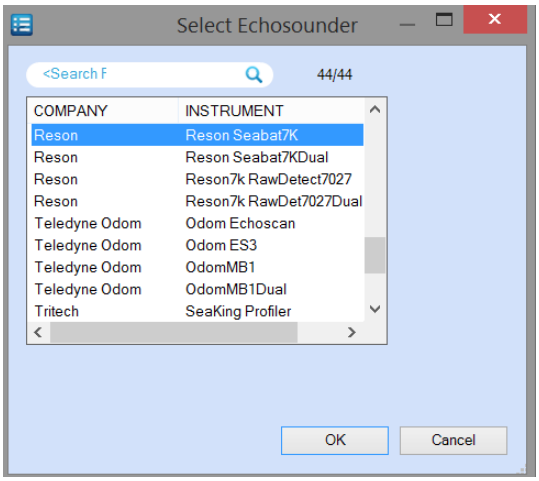


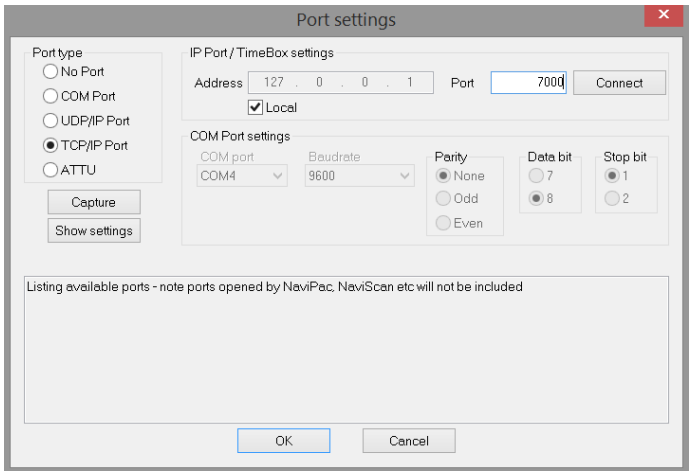
Next the motion function of the Applanix will be added. Under add sensor select Gyro and select Applanix. The network settings will be the same as previously stated.



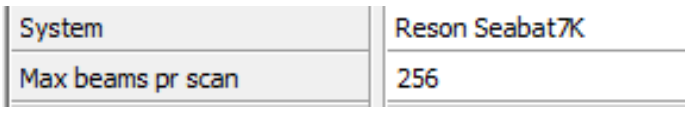
WBMS Integration.

To integrate the WBMS, start by going to add sensor and choose echosounder. Select the Reson Seabat 7k driver. Use TCP, click local host and port 7000

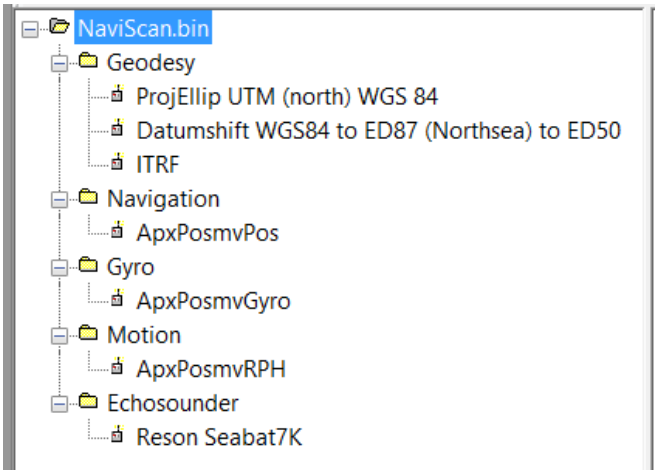




Click on the Reson Seabat 7k under multibeam in the project tree. To the right of the project tree under max beams per scan enter in 256.

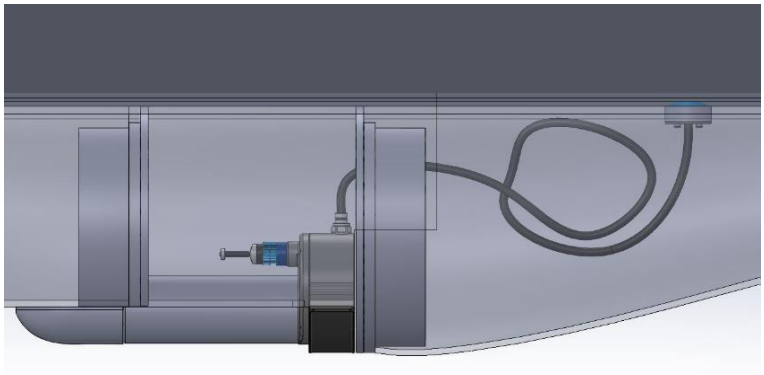


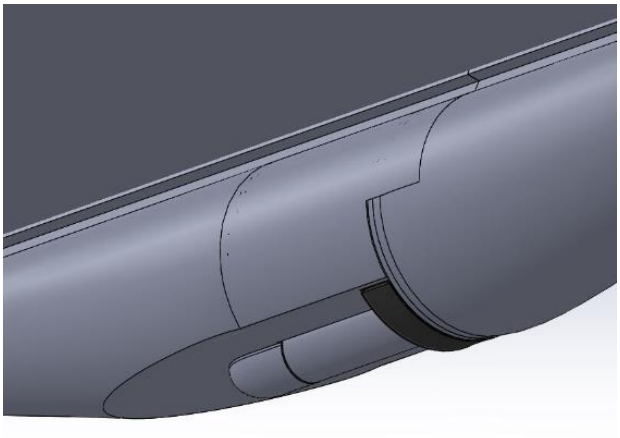
The final NaviScan project tree should look like the following image.



Hull mounting the WBMS

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_supoort@norbit.com.

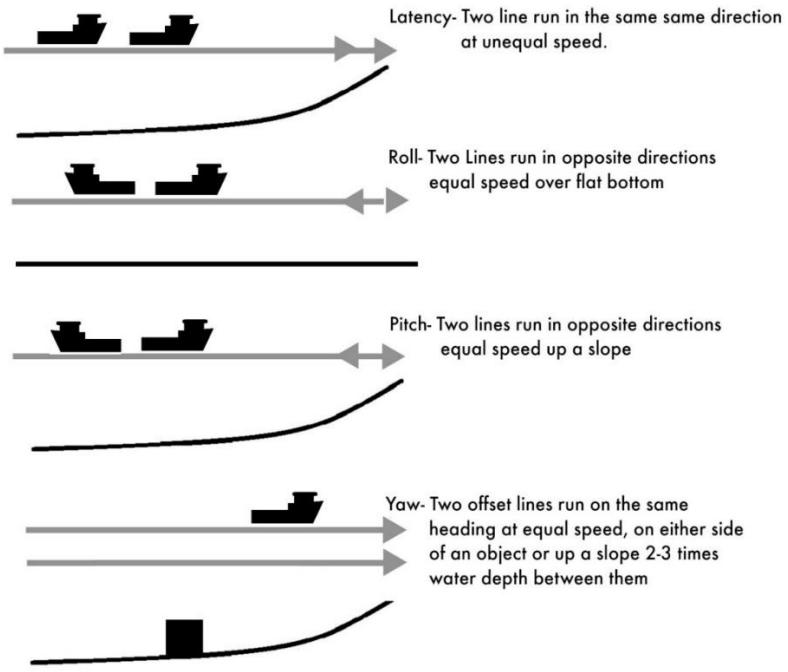
Survey System Calibration & Checks

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.

Patch Test

The Patch test resolves small misalignments between the sonar and the navigational system. Failure to NOT resolve these misalignments will result in inaccurate depth measurements. A patch test is conducted by running a series of reciprocal lines at varying speeds, depths and bottom terrain. A patch test should be conducted over an area with a slope or prominent features. This feature will be used to determine the corrections for the sonar and IMU misalignment. It is recommended that a patch test be performed whenever the sonar is remounted, 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.



Bar check

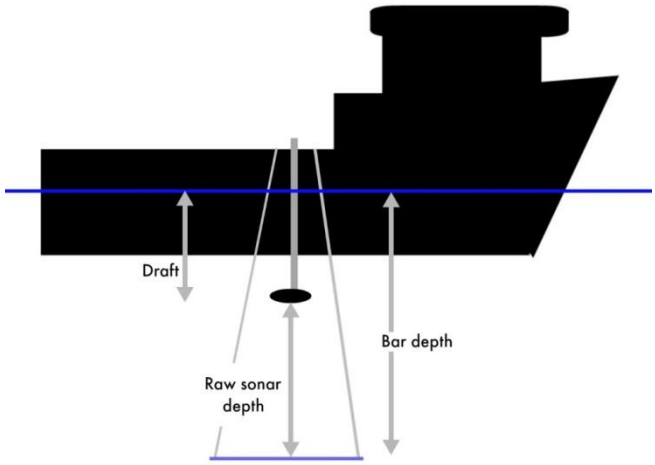
The bar check is a simple test that is used to verify that the draft corrections are holding constant. Periodic bar checks will help ensure that the system is stable and help account for changes in vessel loading. Bar checks are typically carried out using the Nadir beams to reduce the influence of ray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

For best bar check results, NORBIT recommends that the WBMS be set up in the following way.

Adaptive gates should be off
Set the ping rate to 3Hz

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.



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.

Troubleshooting

Tools to use for troubleshooting

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

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 10.3.6 for instructions on using PuTTY

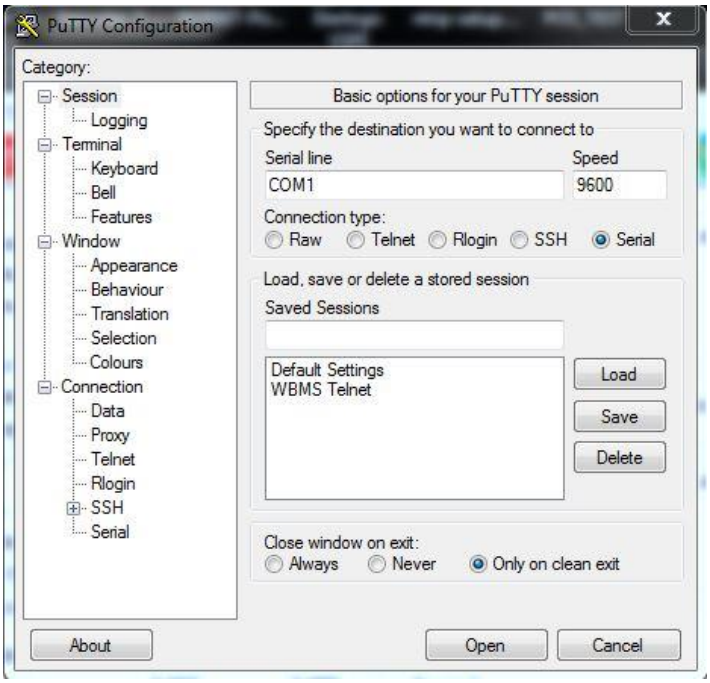
For network troubleshooting: the most common tool needed for the NORBIT will be the "ping" command executed using a command prompt. This command will ping or check the the IP address given and test if there is a connection. This is handy to verify whether NORBIT is communicating with the PC and that the issue 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 C:\HYPACK 2014\Support\Utilities.

To use the ping command: open a Command Prompt window by typing "cmd" into the Windows search bar. Once the window is open, type in: "ping 192.168.53.53." This example shows how to verify the connection of the sonar to the computer. Keep in mind that the last 2 digits will correspond to the serial number of the unit in question. This will also work for the POS by typing "ping 192.168.53.100".

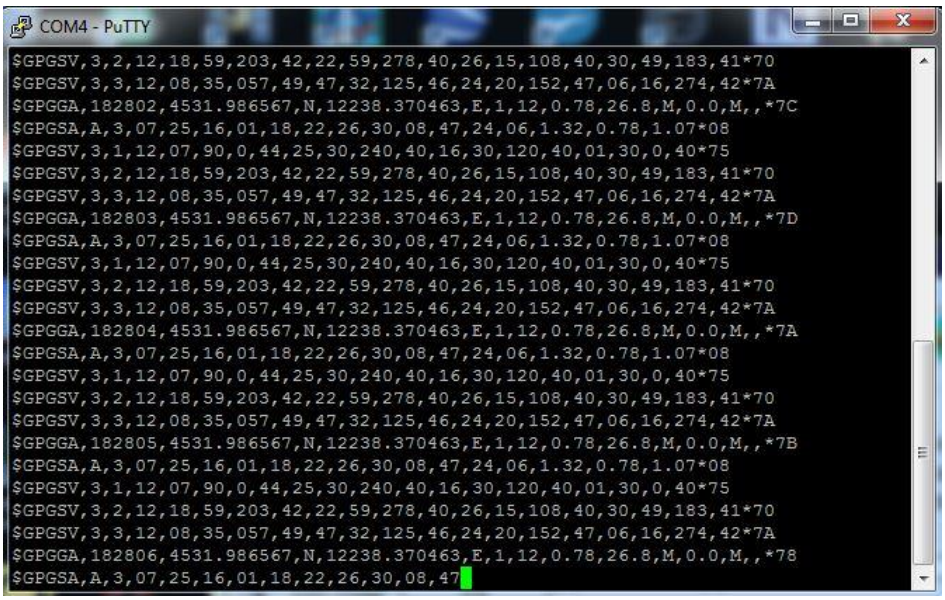
To troubleshoot hardware issues, it is recommended that users have a digital multimeter on hand. Multimeters are inexpensive and can be purchased at a number of locations. Please make sure that it includes a continuity test function. Some units will have an audio indication for this test. Among the many reasons to have a multimeter, the two most often used for troubleshooting sonars are the "continuity test" and "voltage" indicators. The continuity test will help identify a broken cable or connection and the voltage indicator will help identify power related issues the unit may be experiencing.

Setting up PuTTY for serial interrogation

Once PuTTY is open, change the connection type to serial. Type in the COM port being examined and the expected baud rate, referred to as Speed in PuTTY. Once the connection parameters have been entered click open.



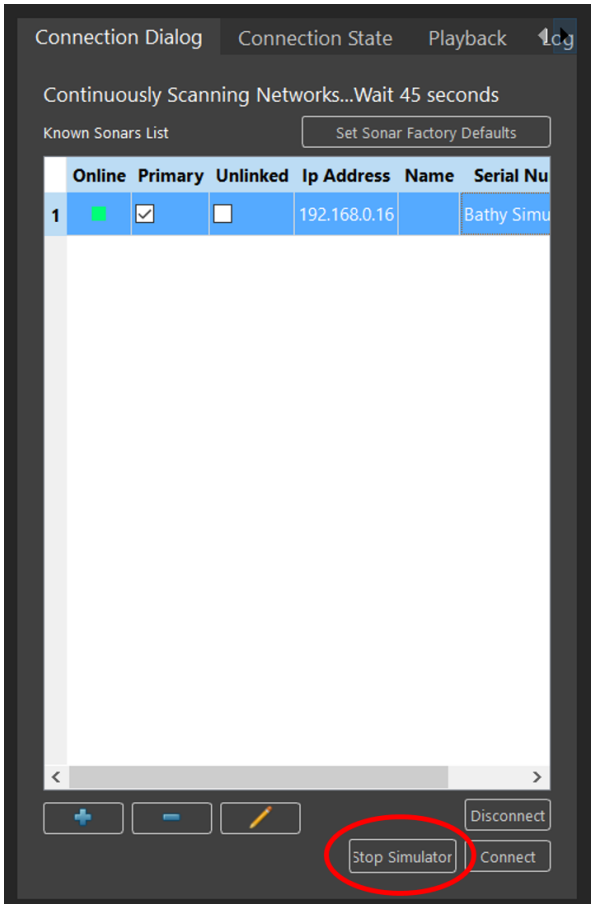
Once open PuTTY will open another window and display any data coming through the selected port.



Sonar Simulator

For training and certain troubleshooting scenarios NORBIT provides a sonar simulator that will send simulated data to the standard install GUI. The simulator is currently only for sonar data and *will not output simulated navigational data*.

The simulator is accessible in the connection window of the GUI in the lower right-hand corner is the start simulator button. Once started highlight the bathy simulator and connect to it as you would a standard sonar. You may receive an incompatible firmware warning, simply hit connect anyway ignoring the warning.



Once connected treat the simulator as a normal sonar. To start the simulated sonar data, click the play button. The simulator data can be used in acquisition software for testing/troubleshooting purposes. The simulator will not output a 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 your sonar then you can go back to the connection dialog and select your sonar to connect to.

Problems and potential solutions

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 – see section in document. • 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.
WBMS GUI rePlease note that if a SIU-I-NAV is useds to start after a new installation.	• For early versions, it may be necessary to remove orphaned files after an uninstallation. To do this, use Windows Explorer and in the address bar type: %appdata%\norbit\ then enter - delete everything inside of this location. Next, type %programdata%\norbit\ and enter – delete everything inside this folder. Now re-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 bio-fouling. 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.
PosView Shows IMU Warning/Failure	• 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>Advanced>Options>Timing and Triggering, select NTP+PPS pos and 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 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 PDS200 or Eiva	• Ensure that force push is checked in data output tab on 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.

Grounding the SIU

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.

Change the IP address of the sonar:

Log onto sonar with telnet:
Windows: Run → cmd
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 (will print to screen all ip_addr parameters)

fw_setenv ip_fallback 192.168.53.99 (will set the ip to 99 if no DHCP server is on the network.)

fw_setenv ip_addr 192.168.53.99 (will set the static ip to 99 regardless of DHCP)

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.

Data quality control checklist

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

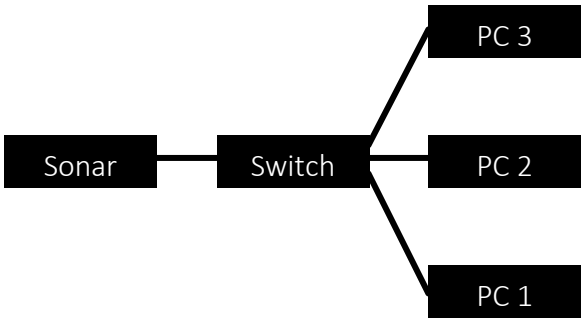
Checklist to improve data quality:

1. ***Review the hardware installation*** – ensure that the two antennas remain fixed in place relative to each other; otherwise there will be heading errors. Similarly, the position of the primary antenna relative to the IMU should not change; such motion will cause position errors in the 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 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 centreline (keel). Agreement to within ±0.5° is ideal if sonar and IMU are within 5m from one another.
5. ***COR*** - if the IMU is not mounted at the COR then 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 base station. DGNSS is accurate only to about 60cm horizontally. The ideal scenario is to use a post-processed kinematic solution. There are different options depending on the GNSS equipment used during the survey.

7. ***Sound speed*** - this may differ greatly in the upper 1m surface layer of the water column. If this difference exists in the survey area (check with a profiler) then lower the sonar below this layer boundary if possible but not so deep that the sonar pole cannot be controlled. Generally, 1m is the limit. Compare surface sound speed from WBMS with 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 needed. 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 may have 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 will 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.

Interfacing with Multiple PCs

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 the acquisition software like Hypack or QINSy. The only extra pieces of hardware for this will be 1) a network switch and 2) one 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. Set up this first, controlling PC as described in Section 4.2, noting the IP address of this computer. Install the WBMS GUI and configure as described above. Start GUI and sonar.

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 will have at least two options of interfacing with the sonar. First, the user may communicate with the sonar 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 box and users may connect to it as usual. Another option is to connect 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 will configure the acquisition program to request data from the GUI running in the first PC.

7k Records Output

Currently the NORBIT GUI supports streaming 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 7k records output by the Proxy Server contained in the NORBIT GUI.

Record	Description
7000	Sonar settings
7004	Beam Geometry
7006	Bottom detection results (bathymetric data)
7007	Side-scan data
7027	Raw bathymetry
7028	Snippet
7042	Compressed water column data
7500	7k remote control with ID 1051
7501	7k remote control acknowledge
7502	7k remote control not acknowledge

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

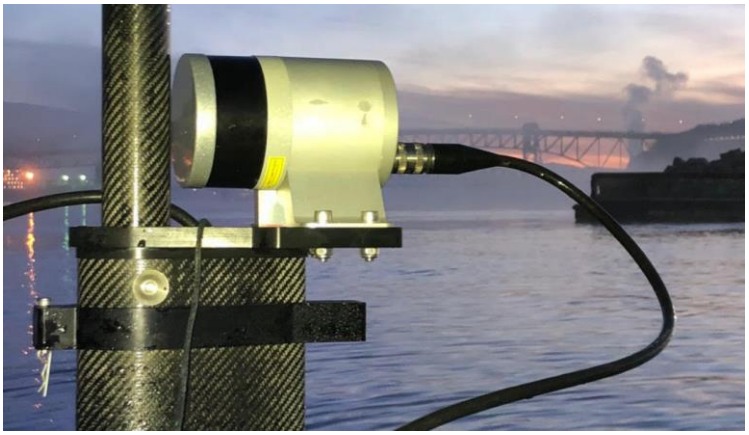
	Bathy	POS	WC	SS	SN	SNS	Data rate
Ping 50Hz	✓	✓	✗	✗	✗	✗	5Mbps
Ping 50Hz	✓	✓	✓	✓	✗	✗	13Mbps
Ping 50Hz	✓	✓	✓	✓	✓	✗	13Mbps
Ping 50Hz	✓	✓	✗	✗	✗	✓	11Mbps

Optional Enhancements for Integrated NORBIT Systems.

While the integrated family of NORBIT iWBMS systems is already highly capable, NORBIT offers other products that will further enhance the capabilities of the core sonar systems. These optional enhancements can be easily integrated into the existing iWBMS(x) systems. For additional information on these enhancement systems please contact NORBIT.

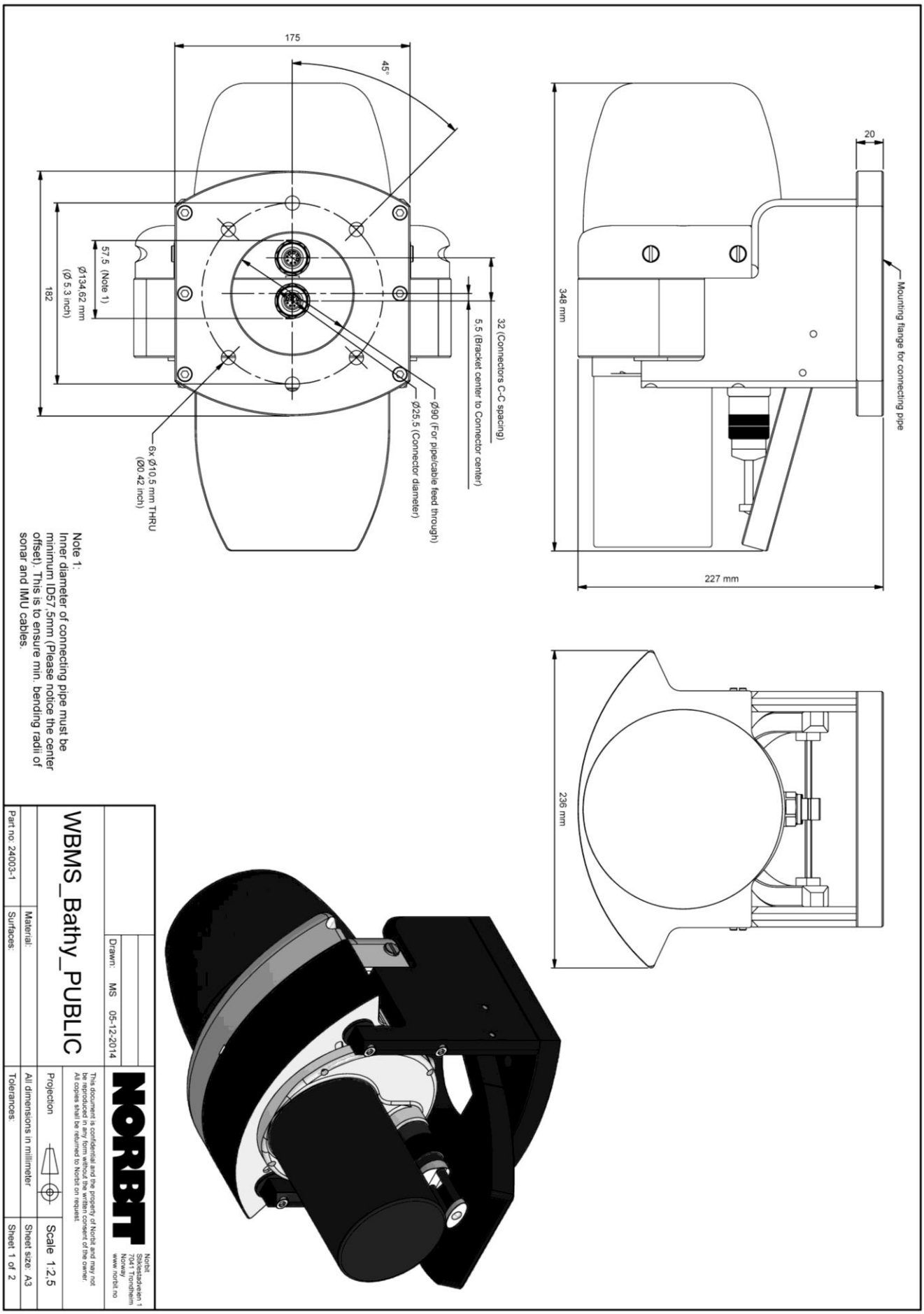
Obstacle Avoidance Forward Looking Sonar (FLS)

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 setup. Please contact NORBIT if to learn more about the FLS.

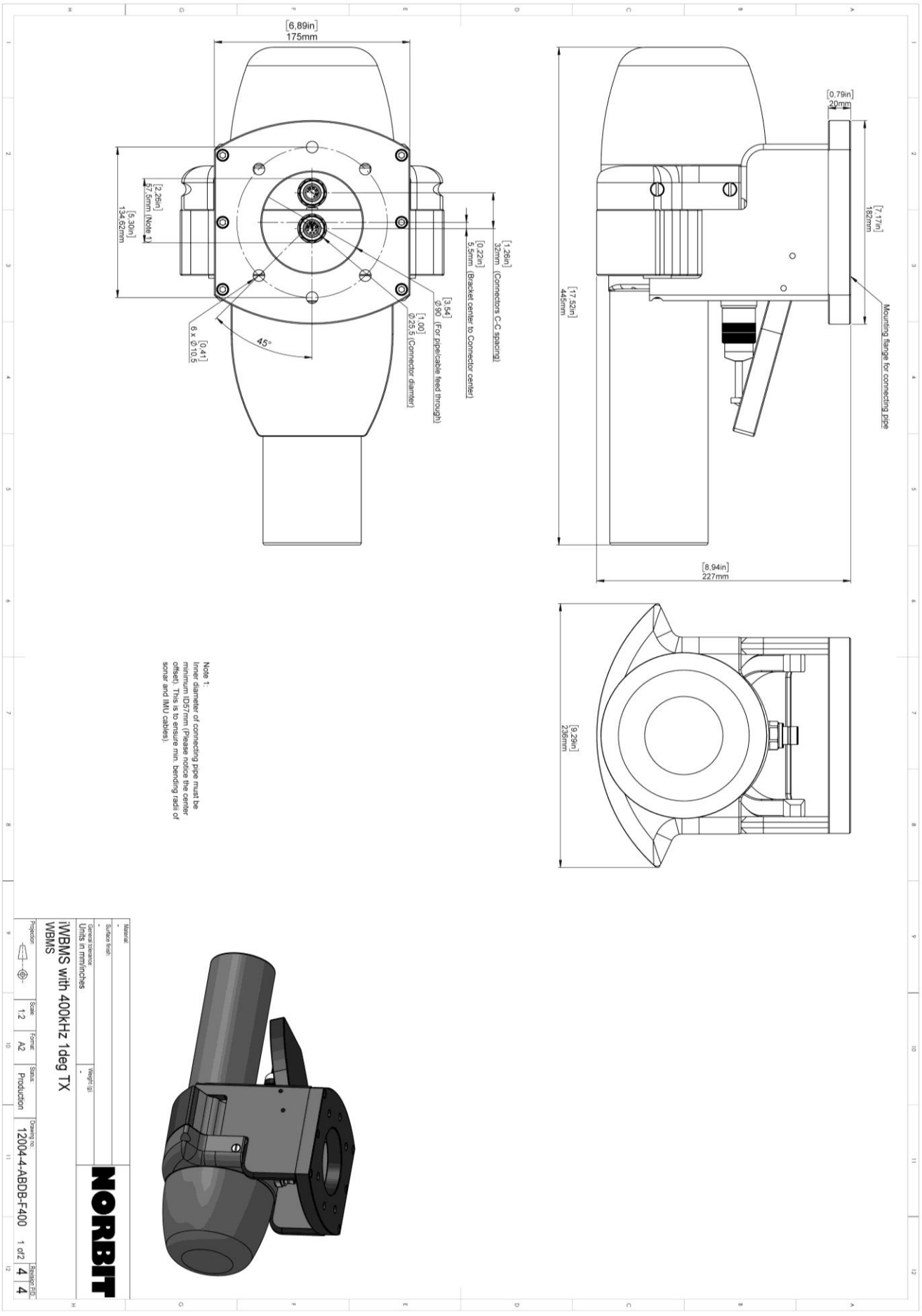


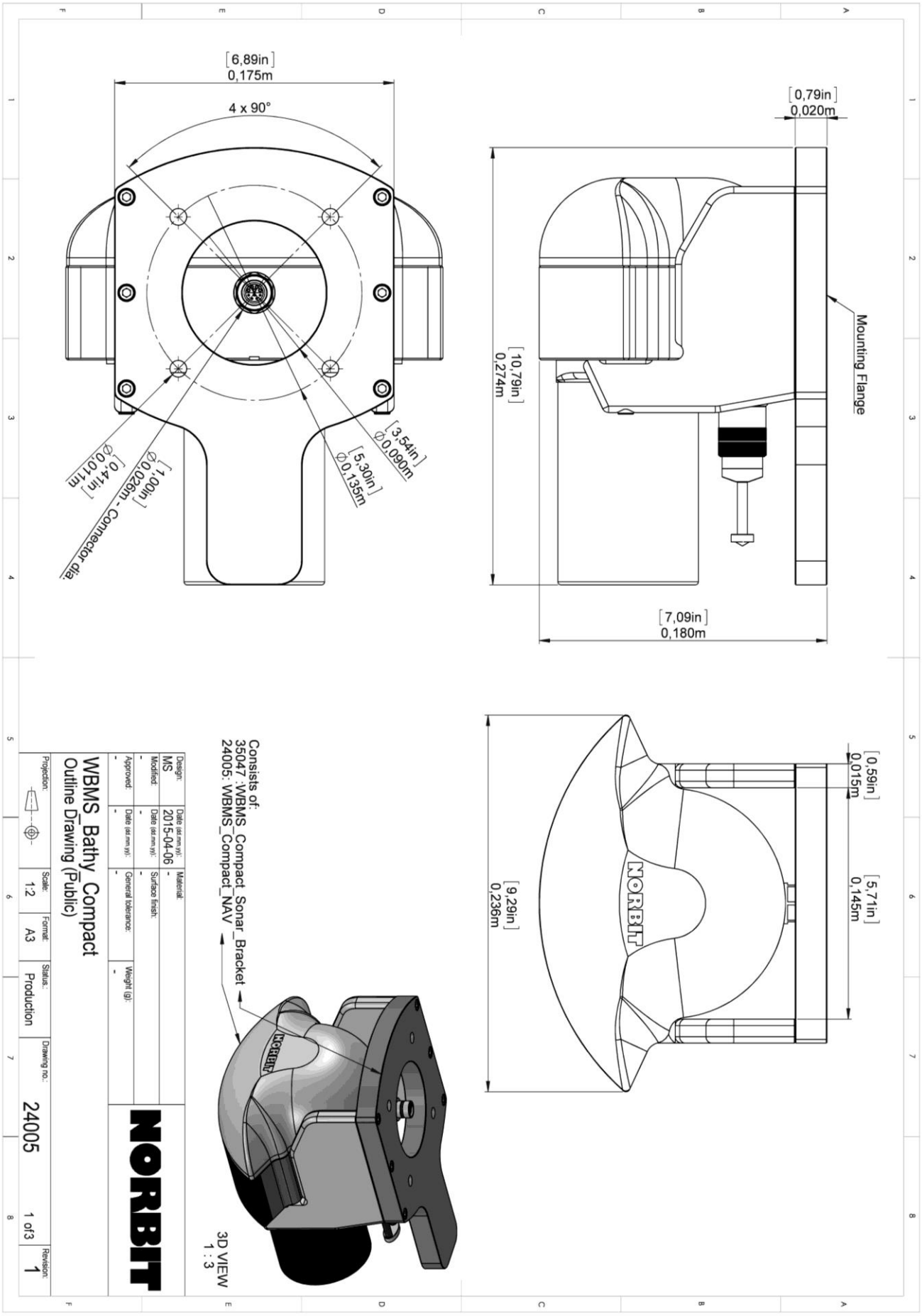
For users that require topographic data to be acquired in conjunction with multibeam data NORBIT offers the iLIDAR. The iLIDAR plugs into the AUX port of the iSIU. Like the iWBMS systems all timing and power is handled internally eliminating the need for additional cables. The LIDAR is as close to plug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

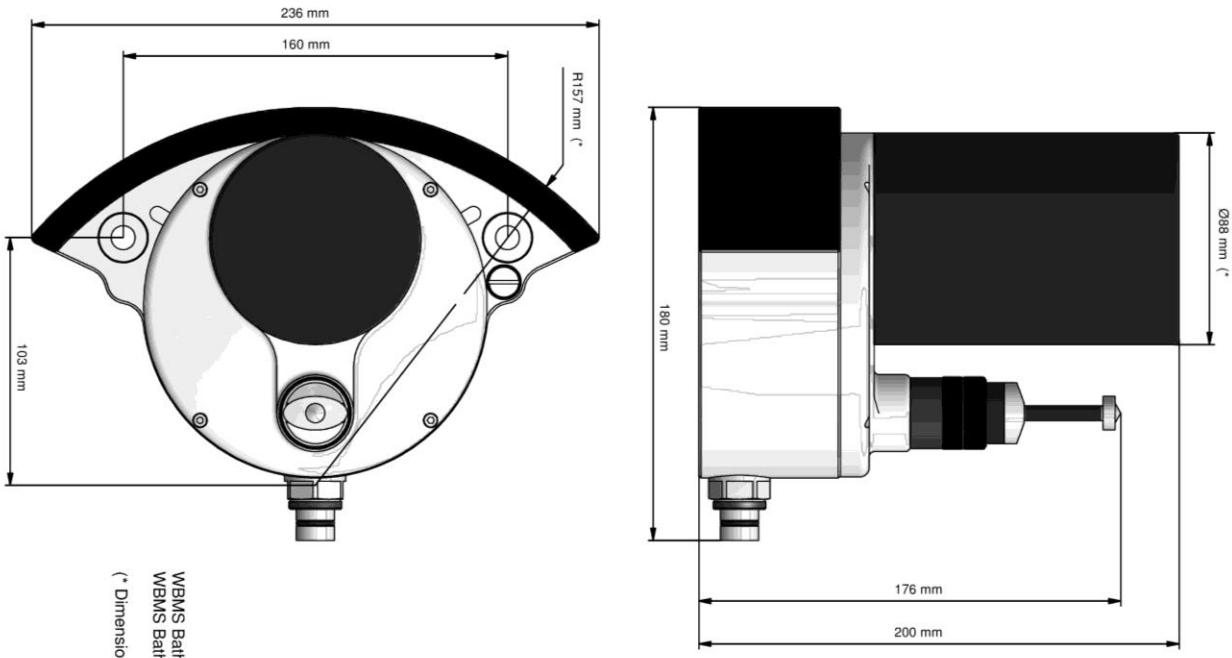
12004 iWBMS/12007 iWBMSh – Wet-end Dimensions



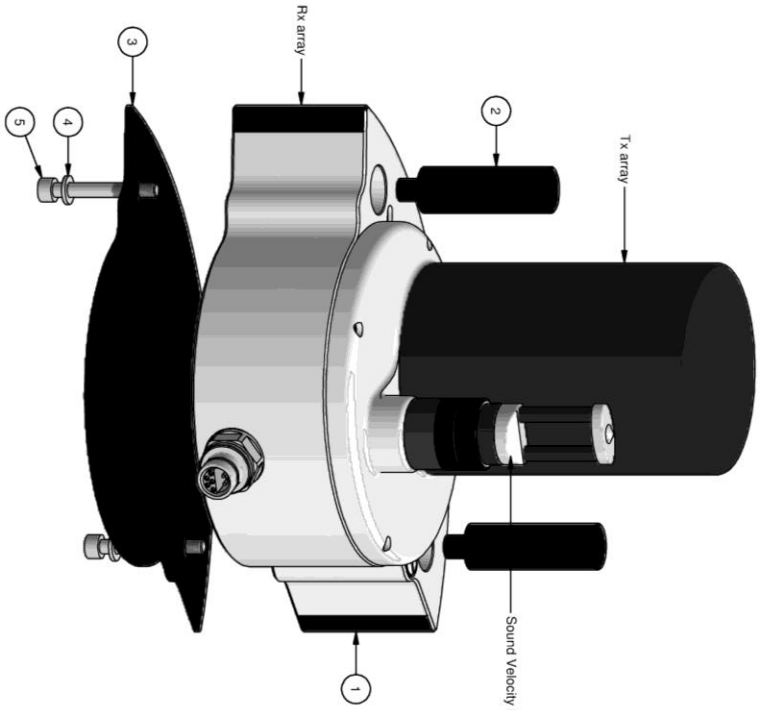
12004 iWBMS/12007 iWBMSh with 0.95° Tx – Wet-end Dimensions




[6,89in]
0,175m
4 x 90°
[0,79in]
0,020m
[10,79in]
0,274m
Mounting Flange
[7,09in]
0,180m
[3,54in]
Ø0,090m
[5,30in]
Ø0,135m
[1,00in]
Ø0,026m - Connector dia.
[0,4in]
Ø0,011m
[0,59in]
0,015m
[5,71in]
0,145m
[9,29in]
0,236m
NORBIT
Consists of:
35047: WBMS_Compact_Sonar_Bracket
24005: WBMS_Compact_NAV
3D VIEW
1 : 3
WBMS Bathy Compact
Outline Drawing (Public)
Design: MS
Date (dd.mm.yy): 2015-04-06
Material: -
Modified: -
Surface finish: -
Approved: -
General tolerance: -
Weight (g): -
Projection:
Scale: 1:2
Format: A3
Status: Production
Drawing no.: 24005
1 of 3
Revision: 1
NORBIT



WBMS Bathy weight in air: 4.2 kg
WBMS Bathy weight in water: 1.9 kg
(* Dimensions on Rx and Tx array my be changed.



Pos	Qty	Part number	Description	Material
5	2	M6x45 Socket Head Cap	M6x45 Socket Head Cap DIN 912	A4
4	2	M6 Washer DIN 125	M6 Washer DIN 125	A4
3	1	45459-1	WBMS_Protection_Plate	PEHD-1000, Black
2	2	45193-3	WBMS_Nut	POM, Black
1	1	24003-1	WBMS_Bathy	Generic

Parts List

NORBIT

Norbit
Strindveien 4
7041 Trondheim
Norway
www.norbit.no

Drawn: hr 09-05-2014

WBMS_Bathy_PUBLIC

Projection

Scale 1:2

All dimensions in millimeter

Sheet size: A3

Sheet 1 of 1

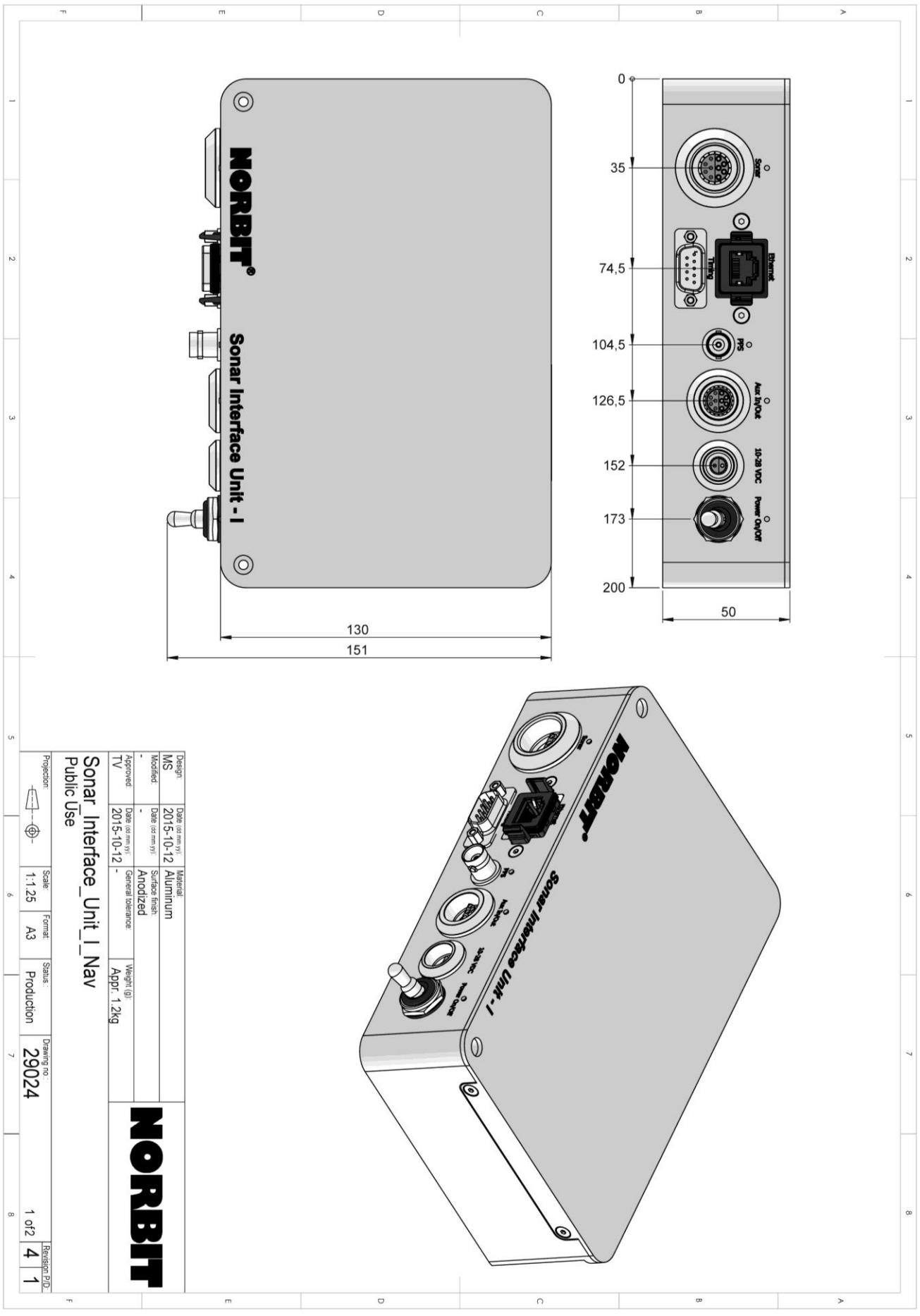
Material:

Surfaces:

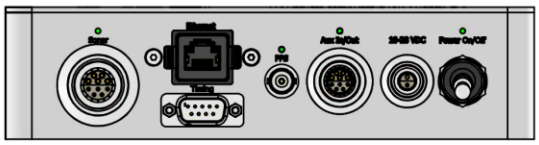
Tolerances:

Part no: 24003-1

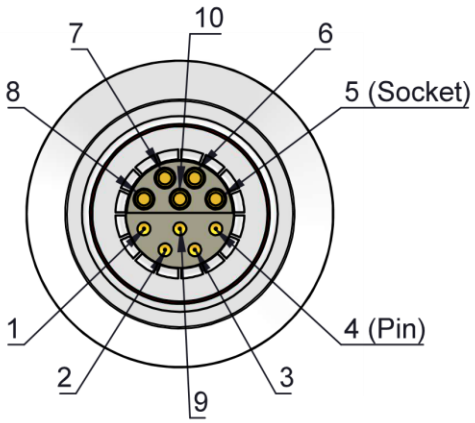
WBMS Sonar Interface Unit (SIU) Dimensions



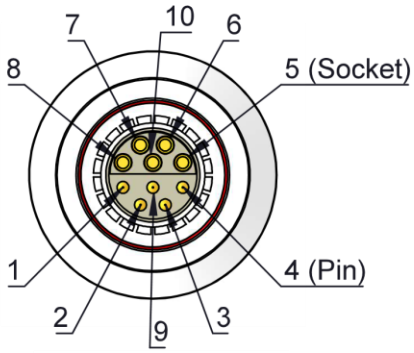
WBMS SIU Socket Pin Description



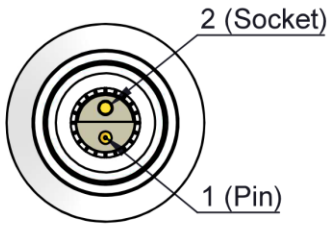
SIU-I
Part No: 29024-4



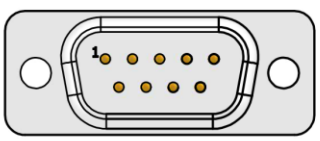
Sonar Socket	
No.	WBMS Function
1	LAN TX +
2	LAN TX -
3	LAN RX +
4	LAN RX -
5	RS-232 Tx/Trig Out
6	RS-232 Rx/Trig In
7	1PPS/IRIG-B
8	IRIG-B/RS-232 GND
9	PWR GND
10	PWR +24V



AUX In/Out Socket	
No.	WBMS Function
1	Not Connected
2	Not Connected
3	RS-232 Debug/Trig Out
4	RS-232 Debug/Trig In
5	Not Connected
6	Not Connected
7	Not Connected
8	Not Connected
9	PWR GND
10	Not Connected



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



GPS Socket & BNC	
No.	WBMS Function
2	RS-232 Tx/Trig Out
3	RS-232 Rx/Trig In
5	PWR GND
9 / BNC	PPS In

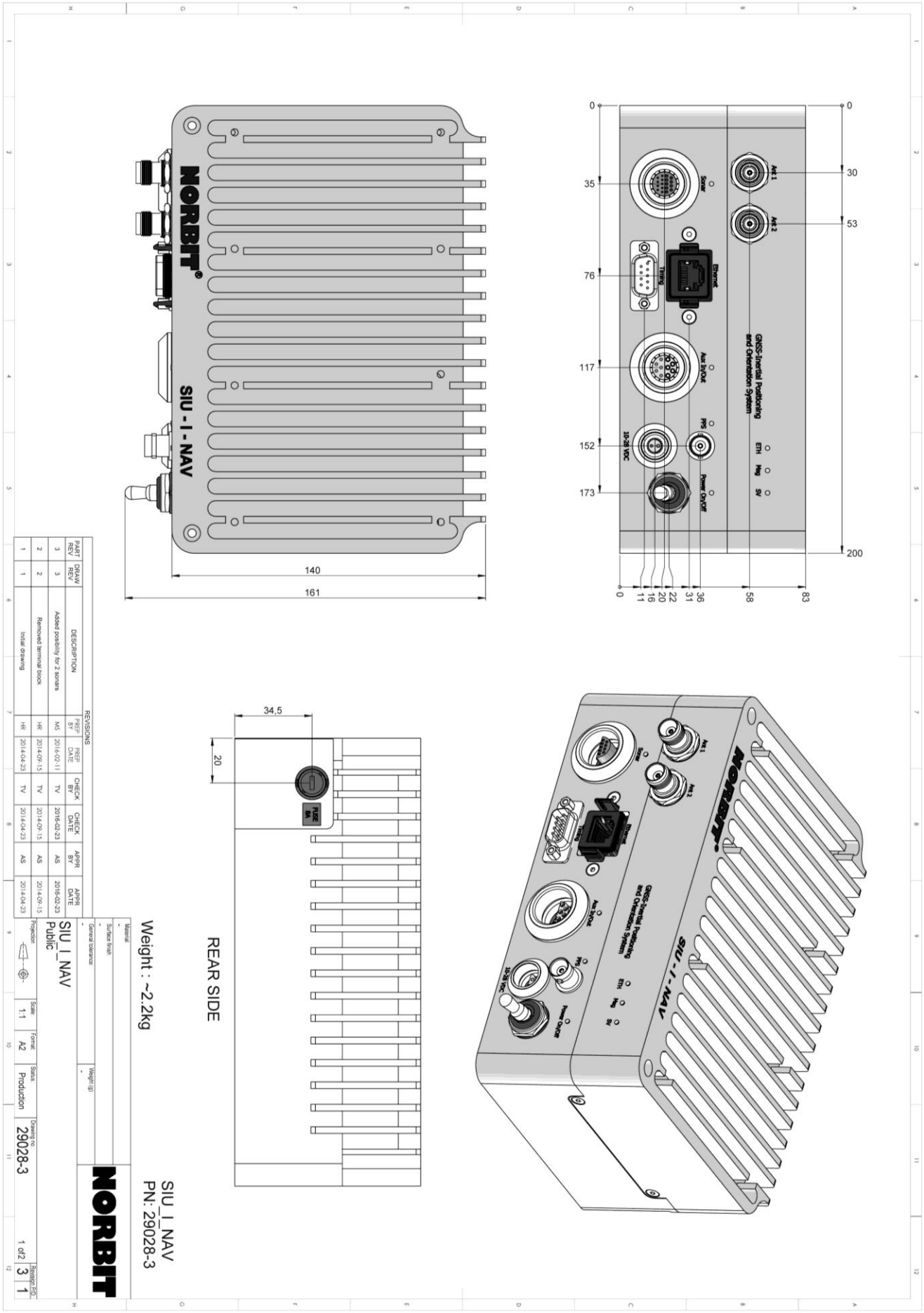
Design: MS	Date (dd.mm.yy): 2015-10-12	Material: Aluminum	
Modified: -	Date (dd.mm.yy): -	Surface finish: Anodized	
Approved: TV	Date (dd.mm.yy): 2015-10-12	General tolerance: -	Weight (g): Appr. 1.2kg

NORBIT

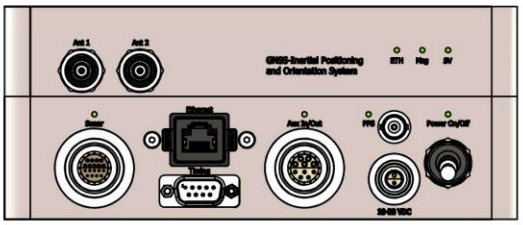
Sonar_Interface_Unit_I_Nav
Public Use

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

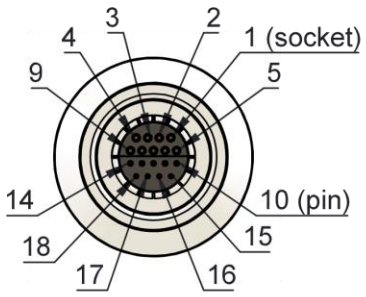
iWBMS Integrated Sonar Interface Unit (iSIU) Dimensions



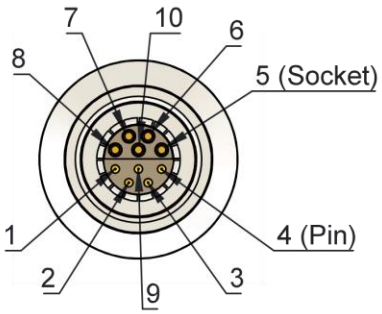
iSIU Socket Pin Description



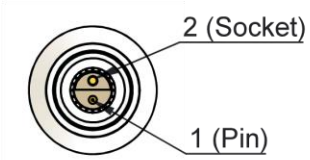
SIU_I_NAV
PN: 29028-3



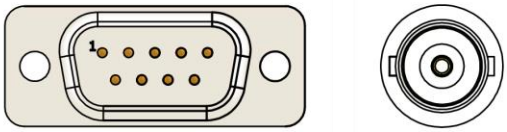
Sonar Socket	
No.	**WBMS function**
1	GND
2	GND
3	24 VDC
4	24 VDC
5	IMU COMM1
6	IMU COMM2
7	LAN, TX+
8	LAN, RX+
9	IRIG-B
10	IMU COMM3
11	IMU COMM4
12	LAN, TX-
13	LAN, RX-
14	Signal GND (IRIG-B, RS232)
15	RS-232 Tx/Trig Out
16	RS-232 Rx/Trig In
17	IMU COMM8
18	IMU COMM9



AUX In/Out Socket	
No.	**WBMS Function**
1	LAN TX+
2	LAN TX-
3	LAN RX+
4	LAN RX-
5	RS-232 Tx/Trig Out
6	RS-232 Rx/Trig In
7	1PPS/IRIG-B
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	RS-232 Tx/Trig Out
3	RS-232 Rx/Trig In
5	PWR GND
9 / BNC	PPS Out

Design: MS	Date (dd.mm.yy): 2016-02-16	Material: -			
Modified: -	Date (dd.mm.yy): -	Surface finish: -			
Approved: -	Date (dd.mm.yy): -	General tolerance: -	Weight (g): -		

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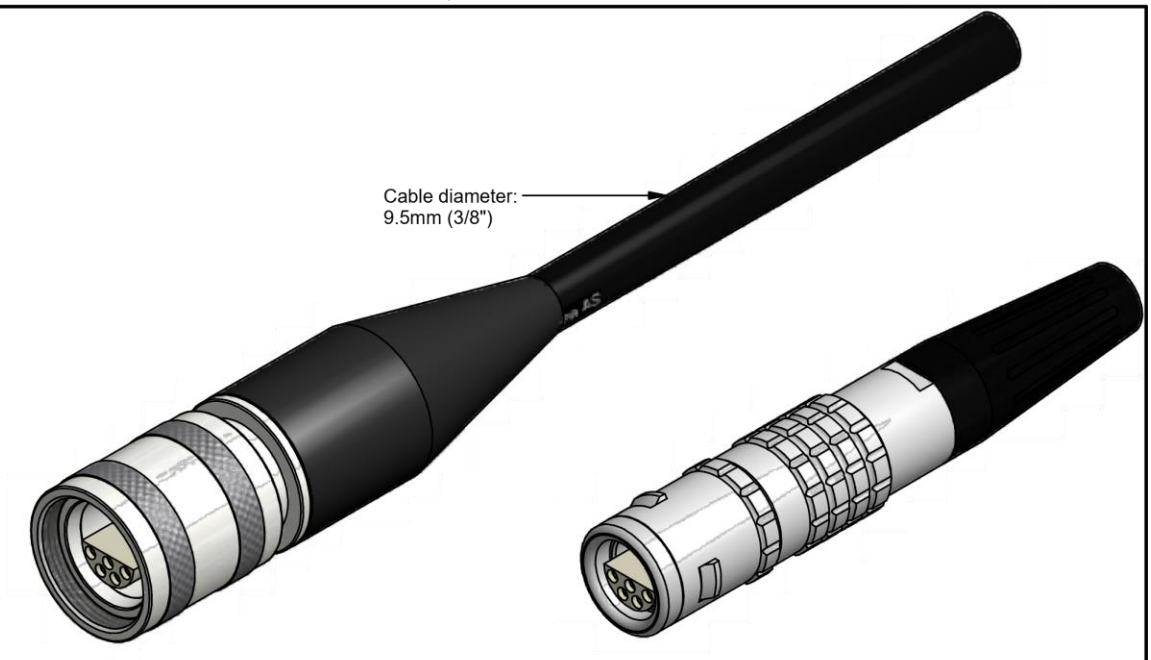
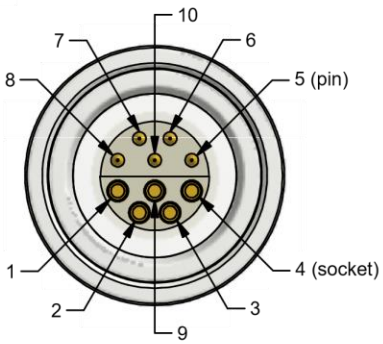
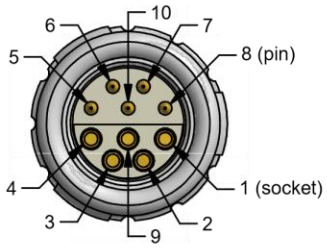
SIU_I_NAV (Socket)
Public

Projection:	Scale:	Format:	Status.:	Drawing no.:		Revision P/D:
	1:2	A4	Production	29028-3	2 of2	3 | 1

WBMS Interface Cable Pin Description





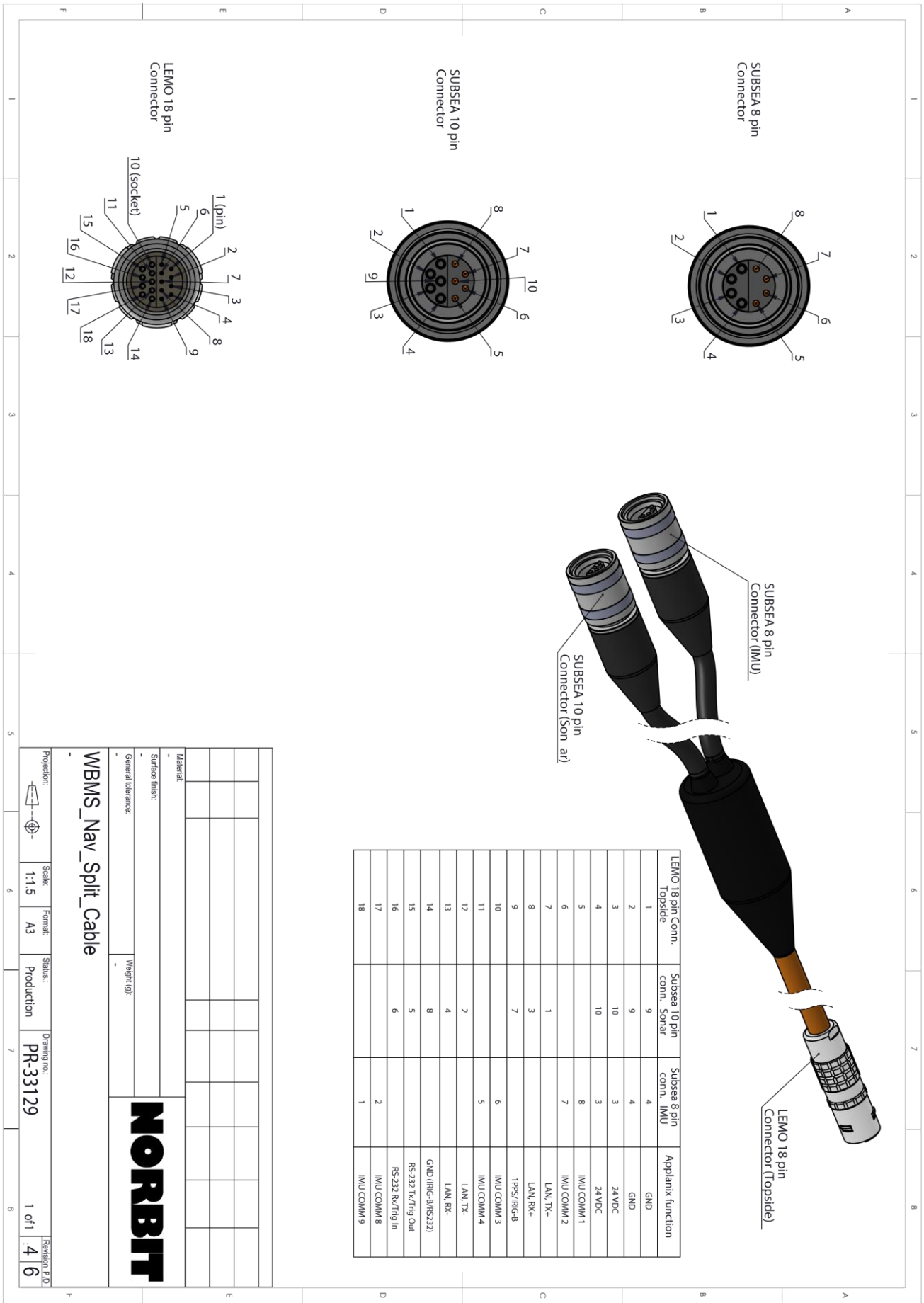


WBMS Interface Cable		
No. Subsea side	Description	No. Top side
1	Tx +	1
2	Tx -	2
3	Rx +	3
4	Rx -	4
5	RS232 Tx/Trig Out	5
6	RS232 Rx/Trig In	6
7	1PPS/IRIG-B	7
8	Signal GND	8
9	PWR GND	9
10	PWR +24 VDC	10

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

	Drawn: TV 2017-02-16		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

iWBMS Split Cable Pin Description



LEMO 18 pin Conn. Topside	Subsea 10 pin conn. Sonar	Subsea 8 pin conn. IMU	Applanix function
1	9	4	GND
2	9	4	GND
3	10	3	24 VDC
4	10	3	24 VDC
5		8	IMU COMM 1
6		7	IMU COMM 2
7	1		LAN, TX+
8	3		LAN, RX+
9	7		1PPS/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		RS-232 Tx/Trig Out
16	6		RS-232 Rx/Trig In
17		2	IMU COMM 8
18		1	IMU COMM 9

Material: -
Surface finish: -
General tolerance: -
Weight (g): -

WBMS_Nav_Split_Cable
-

Projection:	Scale:	Format:	Status:	Drawing no.:		Revision P.O
	1:1.5	A3	Production	PR-33129	1 of 1	4 6

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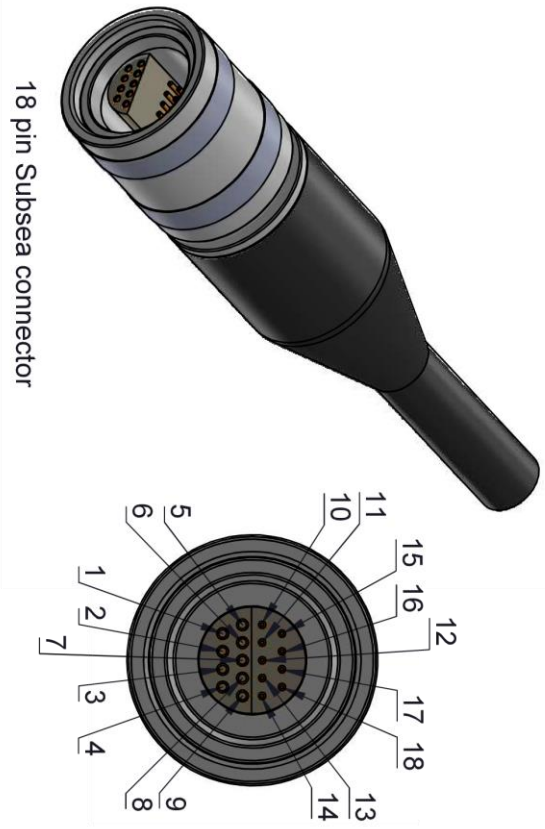
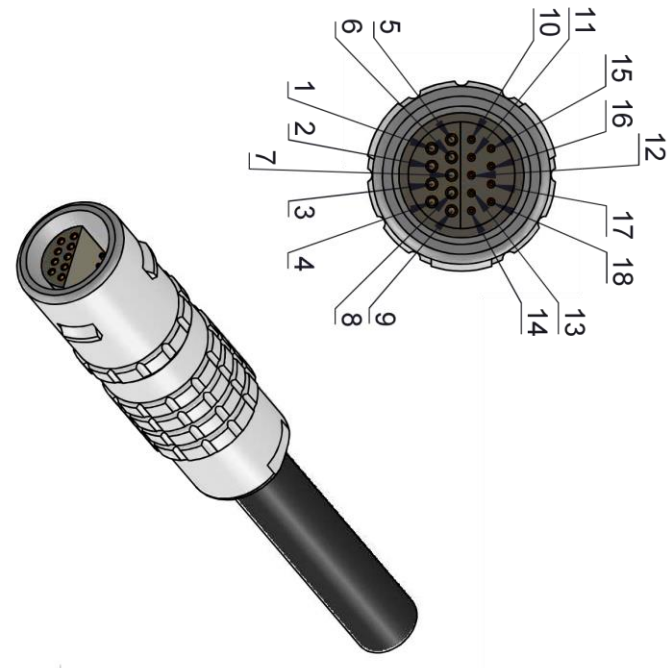
iWBMSc Interface Cable Pin Description

Subsea & Lemo connector pin no.	Function
1	GND
2	GND
3	24 VDC
4	24 VDC
5	628 Com1 RX (IMU)
6	628 Com1 TX (IMU)
7	LAN, TX+
8	LAN, RX+
9	1PPS/IRIG-B
10	628 Com1 GND (IMU)
11	IMU, TBD
12	LAN, TX-
13	LAN, RX-
14	GND (IRIG-B/RS232)
15	0 V (IMU)
16	24 V (IMU)
17	RS-232 Tx/Trig Out
18	RS-232 Tx/Trig In





Design: MS	Date (dd.mm.yy): 2015-10-05	Material: -	
Modified: -	Date (dd.mm.yy): -	Surface finish: -	
Approved: -	Date (dd.mm.yy): -	General tolerance: -	Weight (g): -

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WBMS_Compact_Interface_Cable
Wiring Diagram - Pin out

Projection:	Scale:	Format:	Status.:	Drawing no.:	Revision P/D:
	1:1	A4	Production	33088 1 of1	2 2

WBMS Bulkhead Pinout

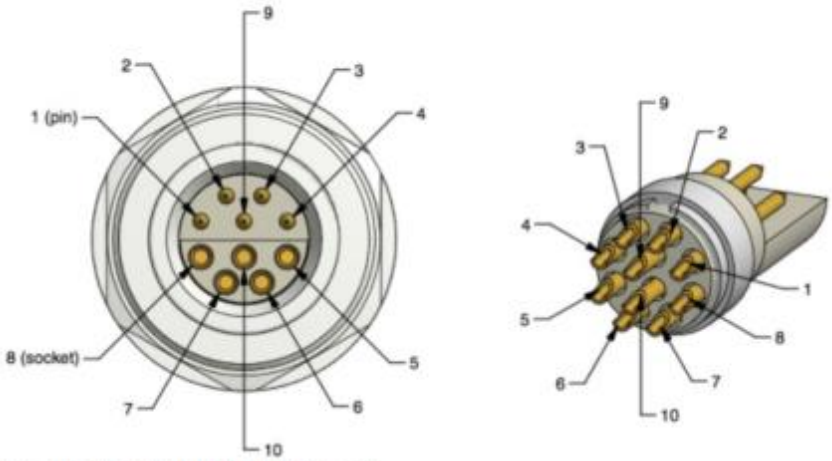


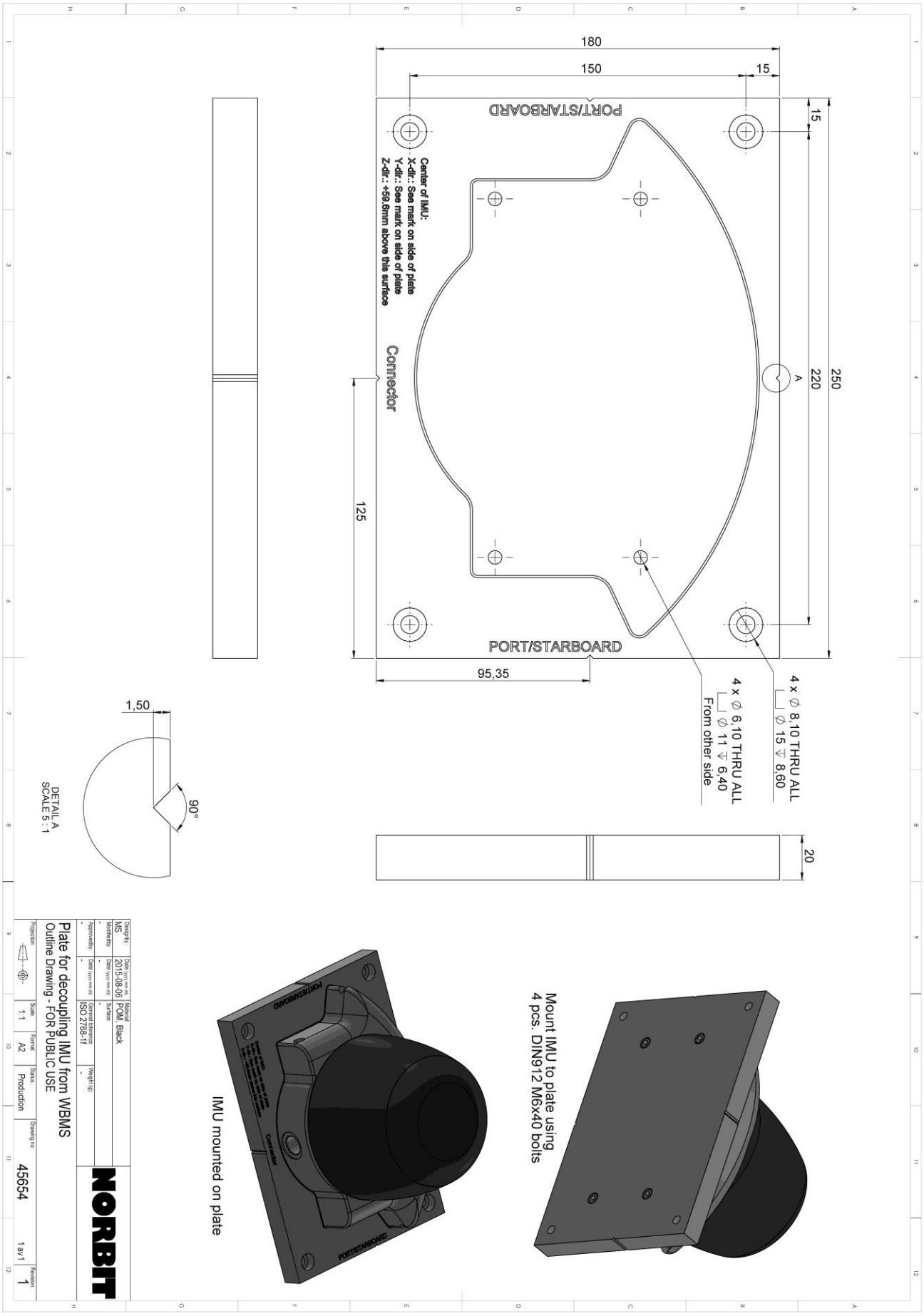
Figure 1: J1, WBMS Bulkhead.

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)

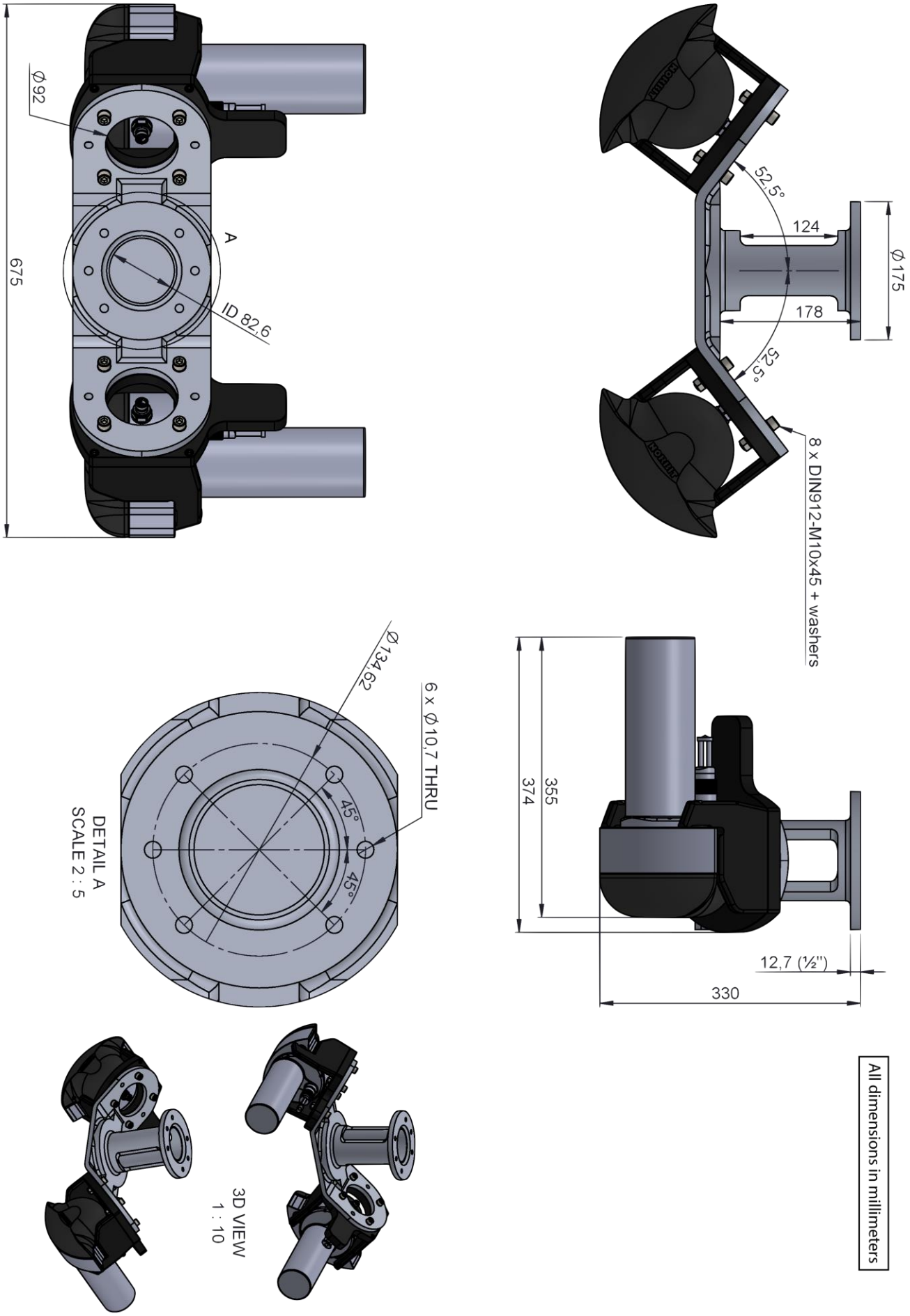
Pin	WBMS function	Electrical spec	Maximum Rating	Comment
1	LAN, TX+	100Base-T	1500 Vrms	Twisted Pair
2	LAN, TX-	100Base-T	1500 Vrms	
3	LAN, RX+	100Base-T	1500 Vrms	Twisted Pair
4	LAN, RX-	100Base-T	1500 Vrms	
5	RS232 Tx/Trig OUT	RS232	-15V to +15V	Debug/trigger. V_{low}=-6.1V V_{high}=6.6V
6	RS232 Rx/ 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.

Decoupled IMU Mounting Bracket

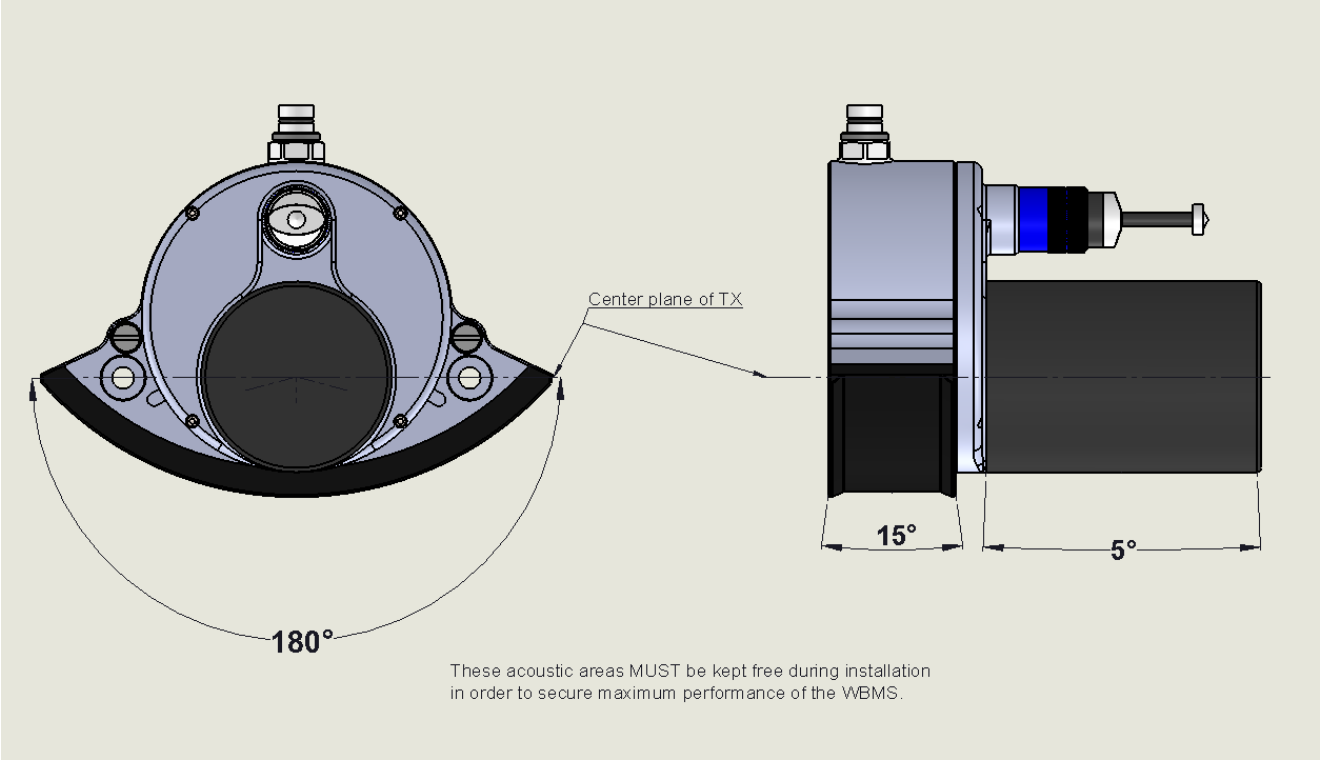


Dual-head Bracket



WBMS Keep-out 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.



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Sonar Offsets and Mounting Angles

	Name in GUI	Sonar Part No. (* denotes values that may be ignored for this purpose)	Sonar Acoustic Center to IMU Reference Point (+FWD, +STBD, +DWN)	IMU Mounting Angles (+Port up, +Bow up, +Clockwise)	Sonar Acoustic Center to Top Center of Bracket (+FWD, +STBD, +DWN)
12004 iWBMS, 400kHz (Applanix WaveMaster), Bracket PN: 35021	iWBMS-0.9x1.9deg	24003-*-**C**** 24003-1b (legacy)	0.198, 0, 0.079	90, 0, -90	0.122,0, -0.07
12004 iWBMS, 200kHz (Applanix WaveMaster), Bracket PN: 35021	iWBMS-1.9x1.9deg	24007-*-**C****	0.241, 0, 0.078	90, 0, -90	0.170, 0, -0.07
12004 iWBMS, 400kHz (Applanix WaveMaster) Bracket PN: 35021	iWBMS-0.9x0.9deg	24003-*-**B****	0.248, 0, 0.079	90, 0, -90	0.172, 0, -0.07
12004 STX, (Applanix WaveMaster) Bracket PN: 35021	iSTX-0.9x0.9deg	24016-*-**B***B	0.234, 0, 0.079	90, 0, -90	0.158, 0, -0.07
12005 iWBMSc, 400kHz NAV Kit (Novatel) Bracket PN: 35047	iWBMSc-0.9x1.9deg	24005-*-**C****	0.061, 0.022, 0.102	90, 0, -90	0.117, 0, -0.023
12006 iWBMSe, (Applanix SurfMaster) Bracket PN: 35047	iWBMSe-0.9x1.9deg	24018-*-**C****	0.053, 0, 0.096	0, 0, 180	0.117, 0, -0.023

12006 iWBMSe, (Applanix SurfMaster) Bracket PN: 35047	iWBMSe-0.9x0.9deg	24018-*-**B****	0.103, 0, 0.095	0, 0, 180	0.167, 0, -0.023
12006 iWBMSe, 200kHz (Applanix SurfMaster) Bracket PN: 35047	iWBMSe-1.9x1.9deg	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-0.9x1.9deg	24003-*-**C****	0.198, 0, 0.079	90, 0, -90	0.122,0, -0.07
12007 iWBMS (Applanix OceanMaster), 400kHz Bracket PN: 35021	iWBMS-0.9x0.9deg	24003-*-**B****	0.248, 0, 0.079	90, 0, -90	0.172, 0, -0.07
12007 STX (Applanix OceanMaster) Bracket PN: 35021	iSTX-0.9x0.9deg	24016-*-**B***B	0.234, 0, 0.079	90, 0, -90	0.158, 0, -0.07
12005 iWBMSc, 400kHz (Novatel) Bracket PN: 35027	iWBMSc-0.9x1.9deg	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-0.9x0.9deg	24003-*-**C****	0.175, 0, 0.079	90, 0, -90	0.122,0, -0.07