DRAFT Memorandum

To: Thunder Bay National Marine Sanctuary

From: Brent Johnston

Date: May 9, 2019

Subject:Installation and integration of Kongsberg EM2040C Multibeam Echosounder on NOAA vessel R/V Storm

An installation and integration of a Kongsberg EM2040C Multibeam Echo Sounder (2040C) was requested by the NOAA Thunder Bay National Marine Sanctuary (TBNMS) of Brent Johnston for the purposes of hydrographic survey and backscatter data collection on the R/V Storm (refer to Figure 1). The Storm is maintained and operated by Great Lakes Environmental Research Laboratory (GLERL) out of Muskegon, Michigan. R/V Storm is 50 foot, aluminum survey platform. Installation was commenced near the TBNMS facilities on May 03, 2019 in Alpena, Michigan. A moonpool and mount for the 2040C had been previously installed and were found to be in good working order. The moonpool on the R/V Storm is below decks forward on the port side, directly below an aluminum hatch in the floor of the wheelhouse. An Applanix POS/MV 320 V4 navigation system was already installed as well with the IMU mounted conveniently below decks very near the multibeam moonpool.

Figure 1 R/V Storm

It was determined on May 03 that a computer suitable to run Kongsberg Seafloor Information System (SIS) had not been provided with the EM2040C transducer and topside. Attempts were made to utilize existing computers that TBNMS had on hand but none were found that were suitable and on May 04 the

decision was made to procure a suitable new computer. The computer was delivered on May 05 and installation was performed and the system was tested and found to be complete. The vessel and crew departed Alpena, Michigan the afternoon of May 05 for transit to the project site in Rogers City Michigan. During the transit the multibeam system was configured and tested and found to be in good working order. Kongsberg includes a Built In Self Test (BIST) in SIS that tests communications and system hardware after installation was complete the BIST was performed and all tests were passed successfully. Results from the BIST are presented below in Figure 2.

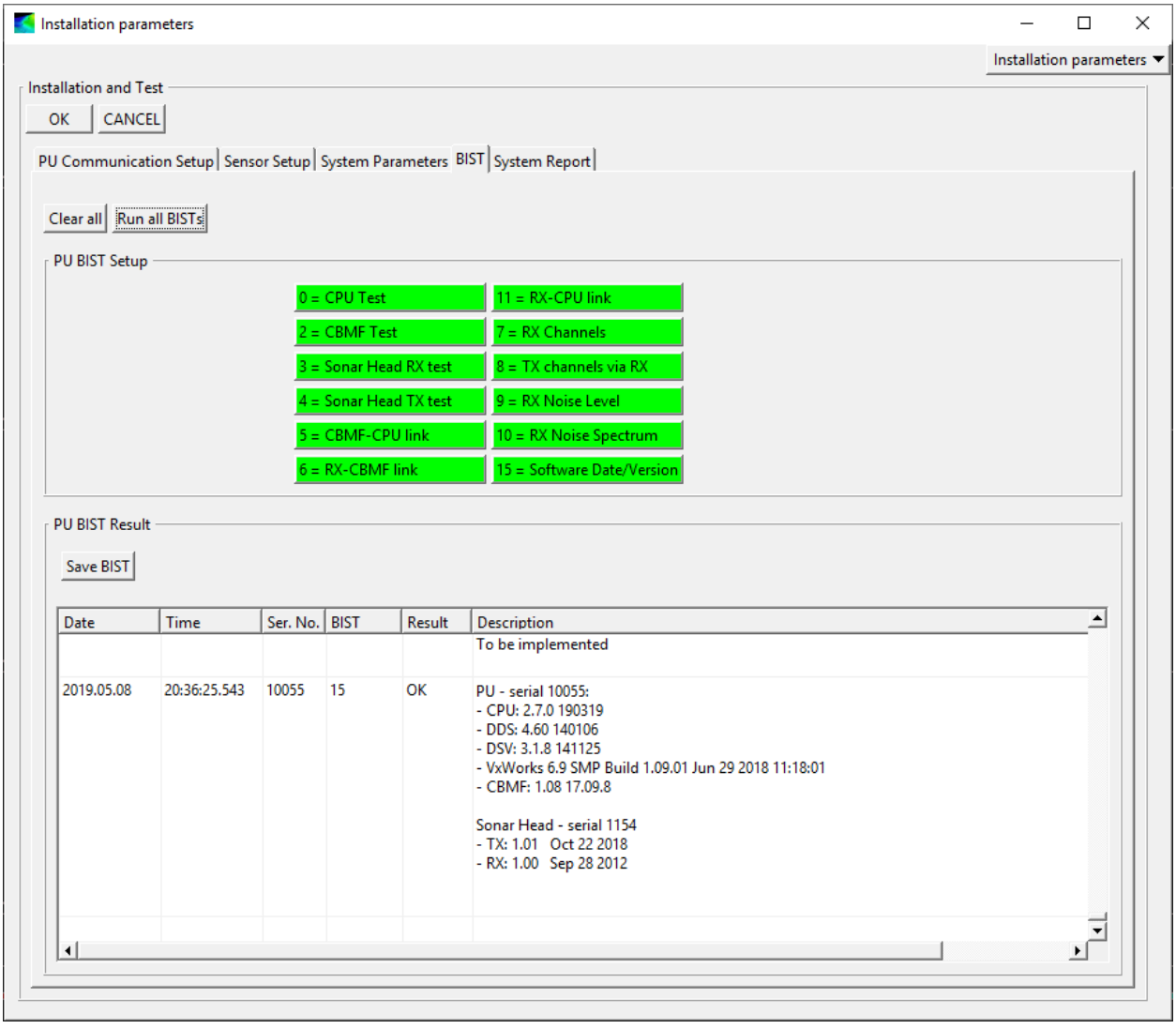

Figure 2 Kongsberg SIS BIST results, green indicates a positive test result.

Offsets from a June 2018 dockside offset survey (refer to Table 1 below) were confirmed via tape measure and found to be sufficient.

	Alongship (Fwd +)	Acrossship (Stbd +)	Vertical (Down +)
EM2040C Transducer	1.005	-0.873	1.815

Table 1 Horizontal EM2040C Transducer Offsets units in meters

On May 06, a shallow depth (approximately 25 meters) multibeam calibration or “patch” test was performed on a target of opportunity and processed (refer to Figure 3 below). Derived angular offset values were found to be similar to previous values (refer to Table 2 below).

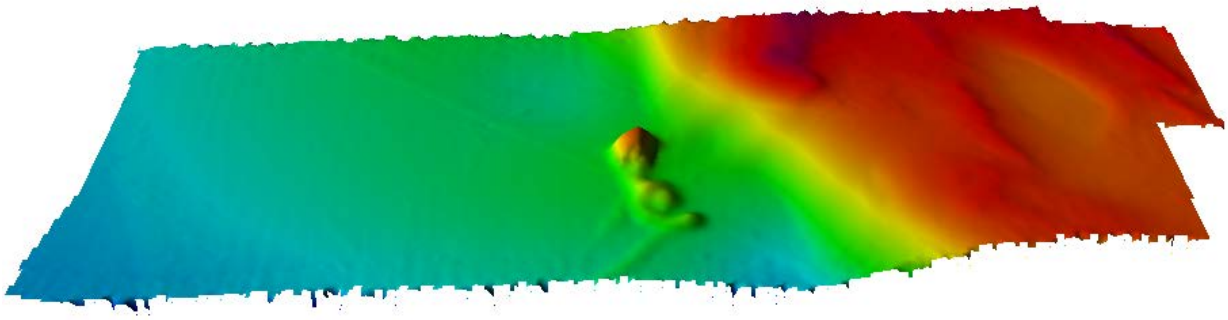

Figure 3 Processed Patch Test Results Surface

	Latency (Sec)	Pitch (Bow Up +)	Roll (Port up +)	Yaw (CW +)
EM2040C Transducer	0.0	2.8	2.35	-4.9

Table 2 Angular EM2040C Transducer Offsets Units in degrees

A follow up field effort is scheduled for July 2019 at that time interface cabling will be tidied and labelled and any further optimization of the system will be performed should it prove necessary.

Utilizing three days of project data collection as a reference, the system was found to be reliable and self-consistent. One item of note, a four-port network card was added to the SIS collection computer to facilitate a second network connection. The second network connection allows for data transfer, SIS integration with Hypack and Synergy (software that allows a single mouse and keyboard to control both the Hypack and SIS computers). Twice this second network card failed to initialize when the computer was started. The workaround for this issue was to shut down the computer, remove, then reseat the network card in the computer and restart the computer. The network card was procured from the vessel spare computer parts, as it was convenient. In the future a different network card could be installed should the issue become problematic.

A deeper water patch test was not necessary to achieve satisfactory angular offset values and project multibeam data acquisition time was deemed more valuable, further refinement of patch values might be achieved with a patch test conducted on a good target in 40-70 meters water depth.

Current vessel horizontal offsets have generally sufficient for survey data collection. However, vessel data quality would likely be further improved if a total station or tape measure and level survey could be performed with survey equipment installed while the vessel was stored on land.

Currently the surface sound speed sensor for the Storm is deployed off a pole mounted to the starboard side of the vessel. Ideally this sensor would be mounted directly adjacent to the multibeam transducer on the underside of the ship’s hull on a retractable mount. This would more precisely reflect sound speed at the sonar transducer and would also negate the need to always dock the vessel on the port side when the system is deployed.

Two items that are not necessary for quality data collection but would make it more acquisition more convenient and safer are an additional monitor for the Hypack station that has comparable specification to the vessel helm monitor. This would allow the sonar operator to see what is being displayed on the vessel helm display without having to leave their station. The other is a three to five port USB 3.0 hub for the Hypack station so that the Hypack license key and portable hard drives for data transfer can be conveniently plugged in on the desktop rather than on the top face of the Hypack computer where they are exposed to damage at an inconvenient knee level. Should TBNMS desire to add either of these, they could both be installed during the scheduled July 2019 field effort.

At the request of the NOAA data collection crew, offsets and adjustments, to the extent possible, were applied in the Caris vessel file rather than in Kongsberg SIS or the Applanix POS/MV firmware so that adjustments could be made in the future should they prove necessary. Screen captures of software and firmware settings for the Applanix POS/MV, Kongsberg SIS and Hypack are presented below.

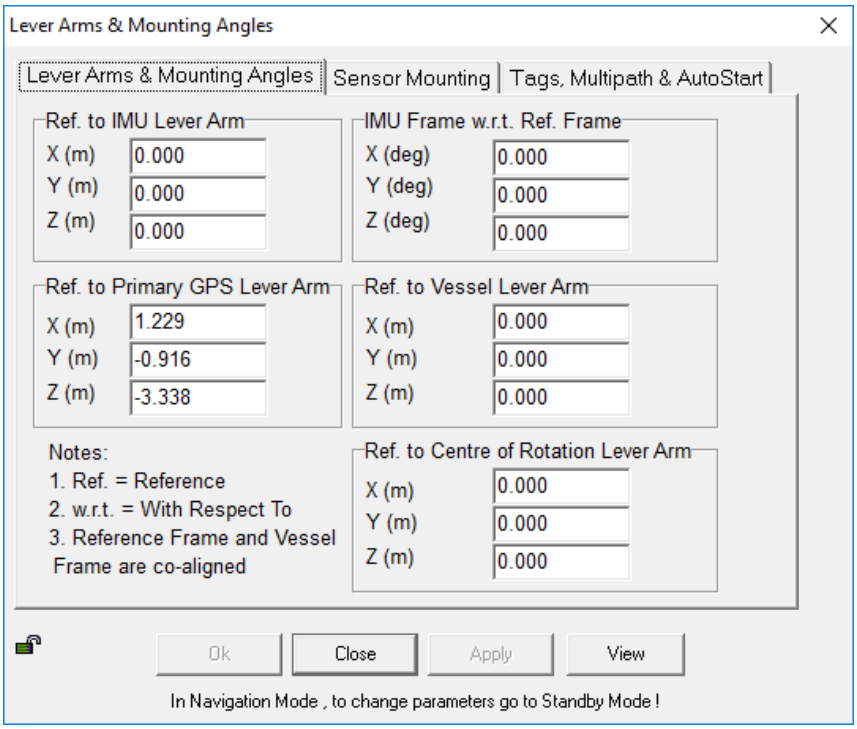

Figure 4 POS/MV Lever arms and mounting angles

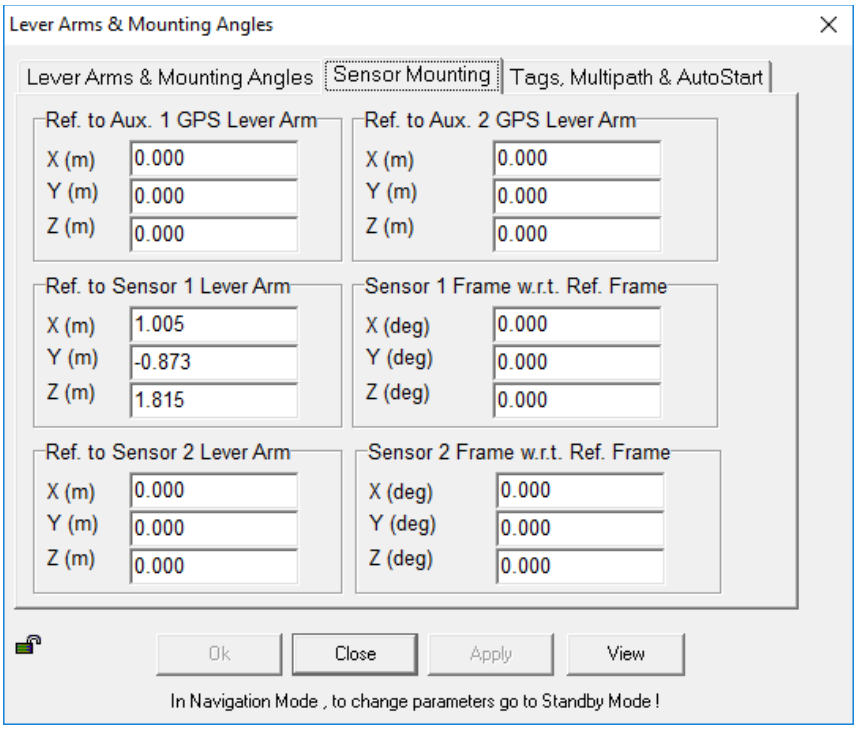

Figure 5 POS/MV Senor mounting

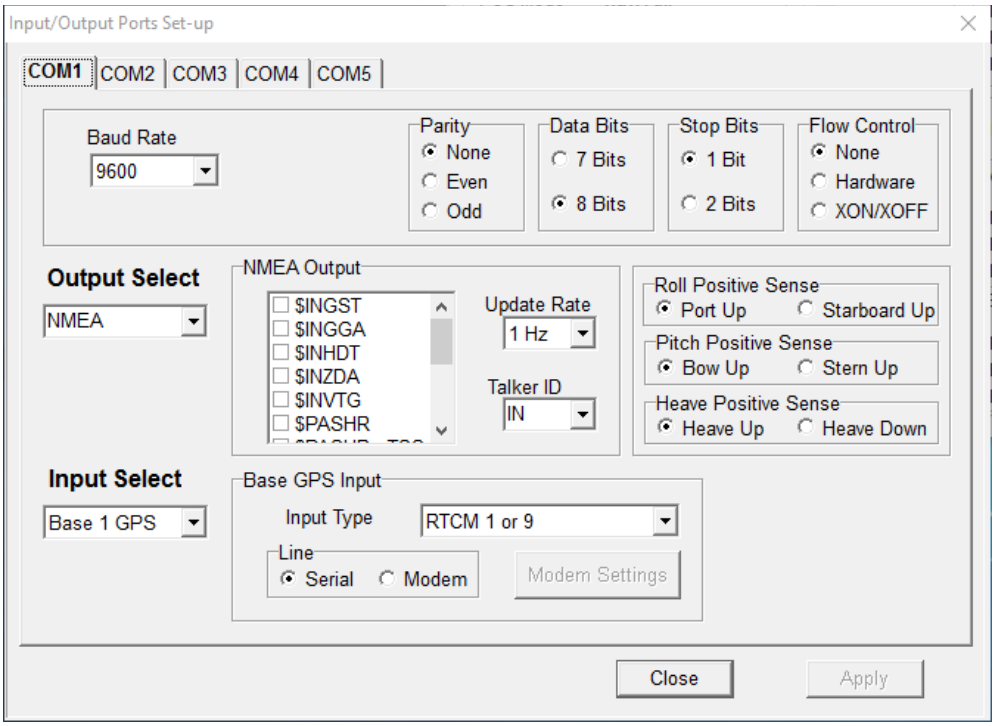

Figure 6 POS/MV Input Com1 RTCM 1 or 9 (DGPS Corrections) from the Trimble AG132 DGPS

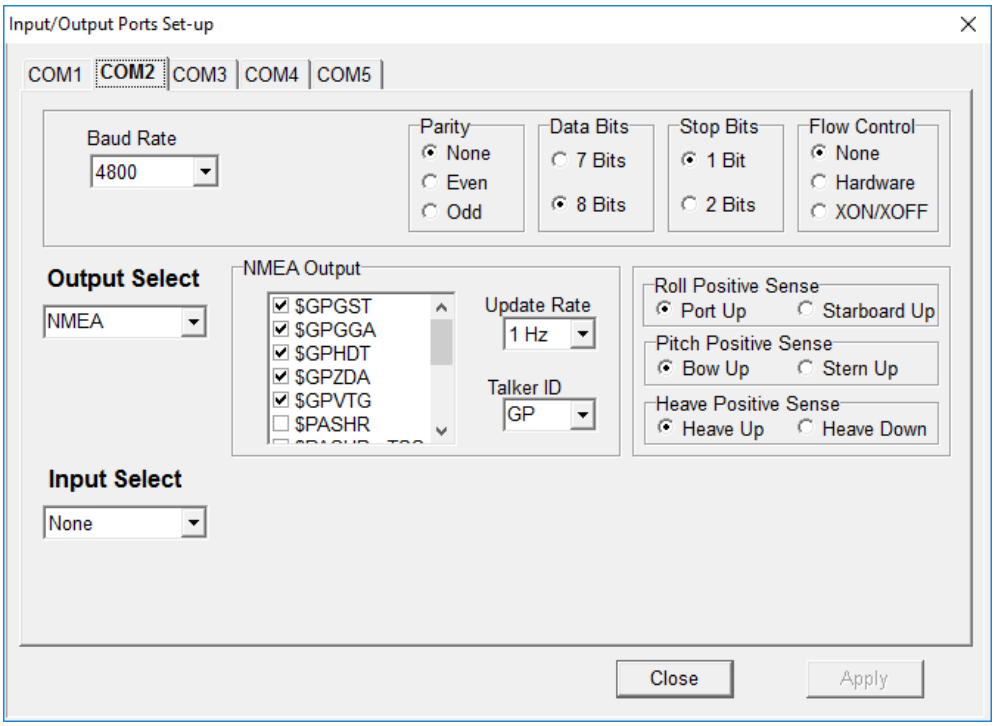

Figure 7 POS/MV Output Com2, GPGST, GPGGA, GPHDT, GPZDA, and GPVTG for output to Klein 3000 position and timing

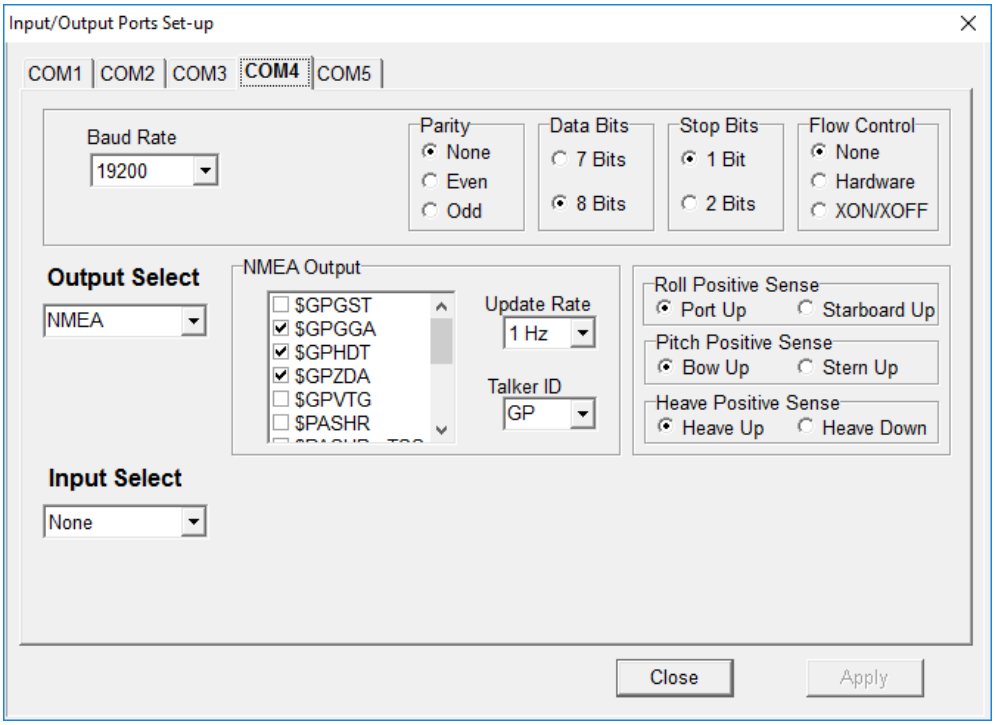

Figure 8 POS/MV Output Com4 GPGGA, GPHDT, GPZDA, and GPGGK for output to the Kongsberg EM2040C TPU for position, heading and timing

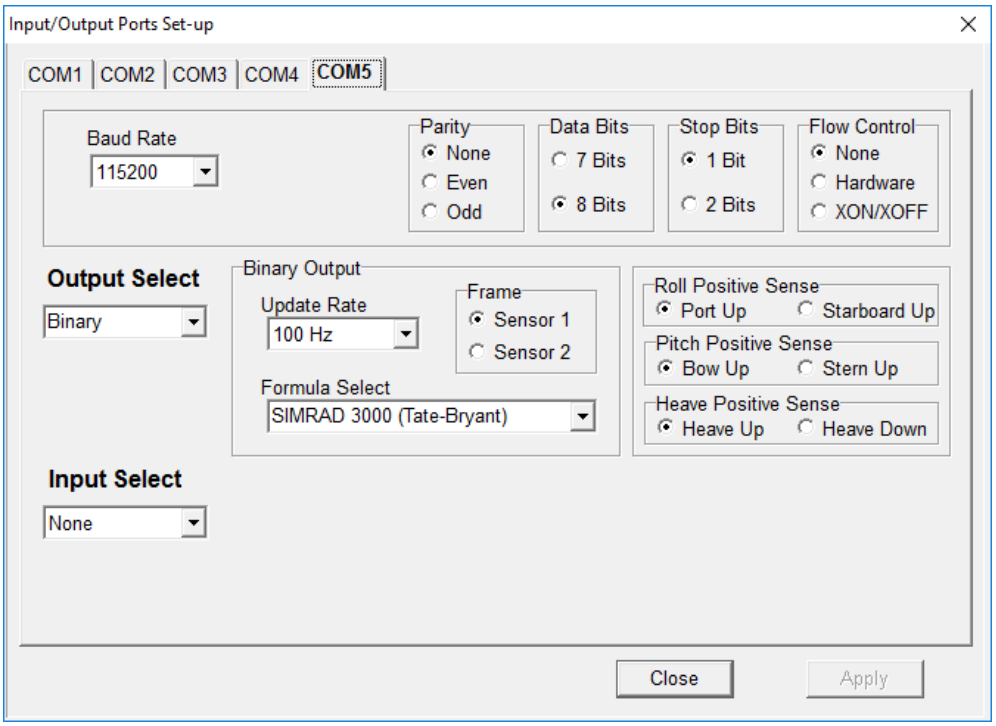

Figure 9 POS/MV Output Com5, SIMRAD 3000 is output for Sensor1 motion into Kongsberg SIS

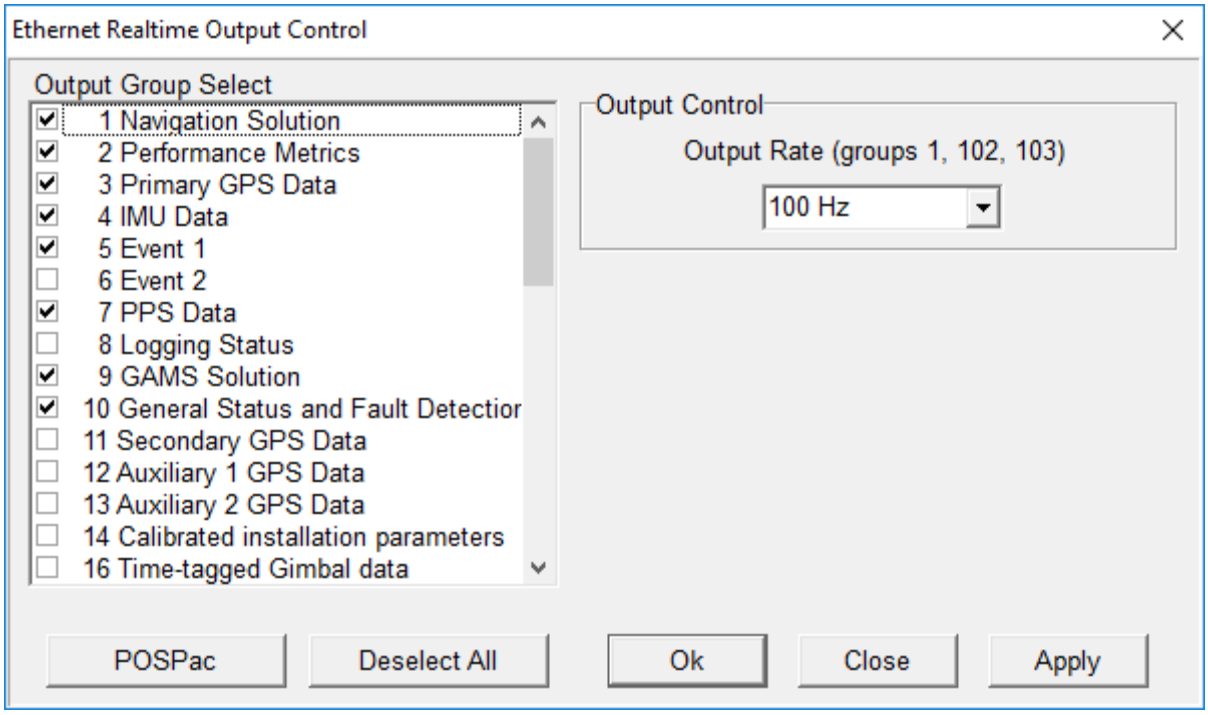

Figure 10 POS/MV Ethernet realtime output Group 103 is checked to supply Attitude/Velocity to Kongsberg SIS

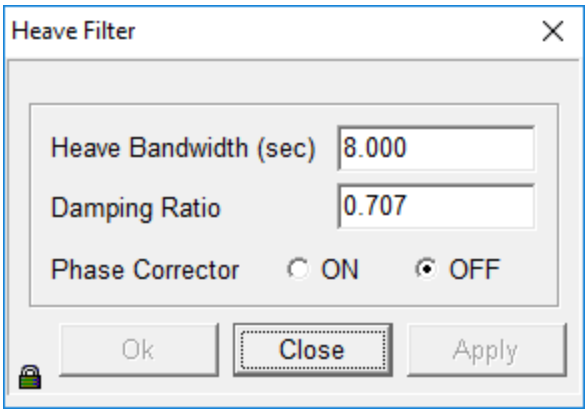

Figure 11 Applanix POS/MV Heave Filter settings

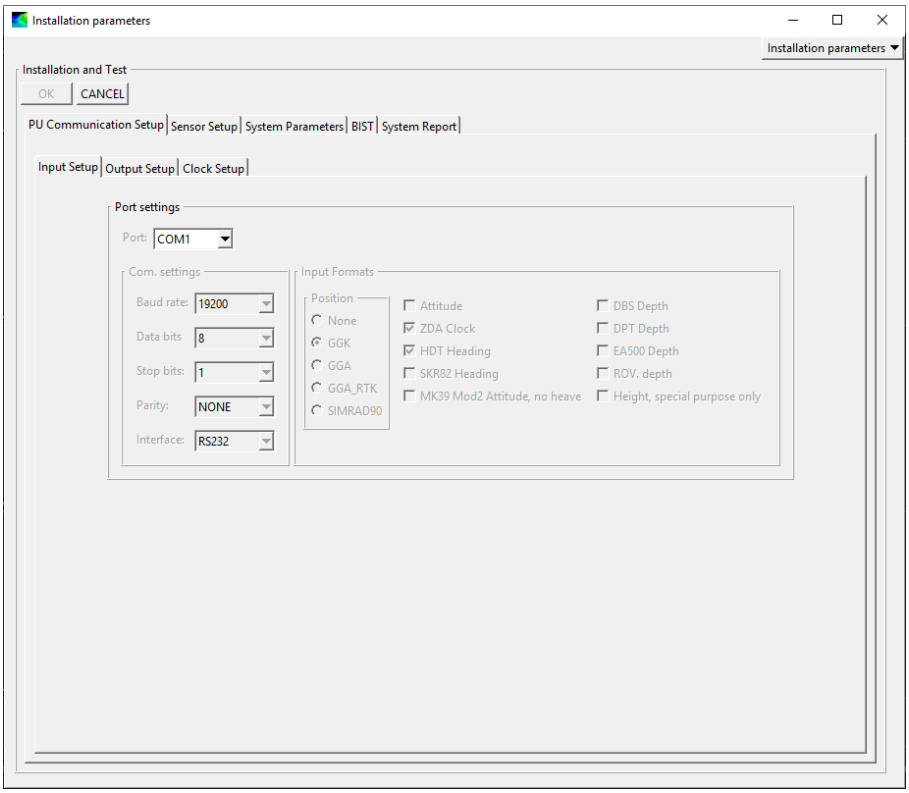

Figure 12 Kongsberg SIS COM1 Input of position GGK and time ZDA and heading HDT from the POS/MV

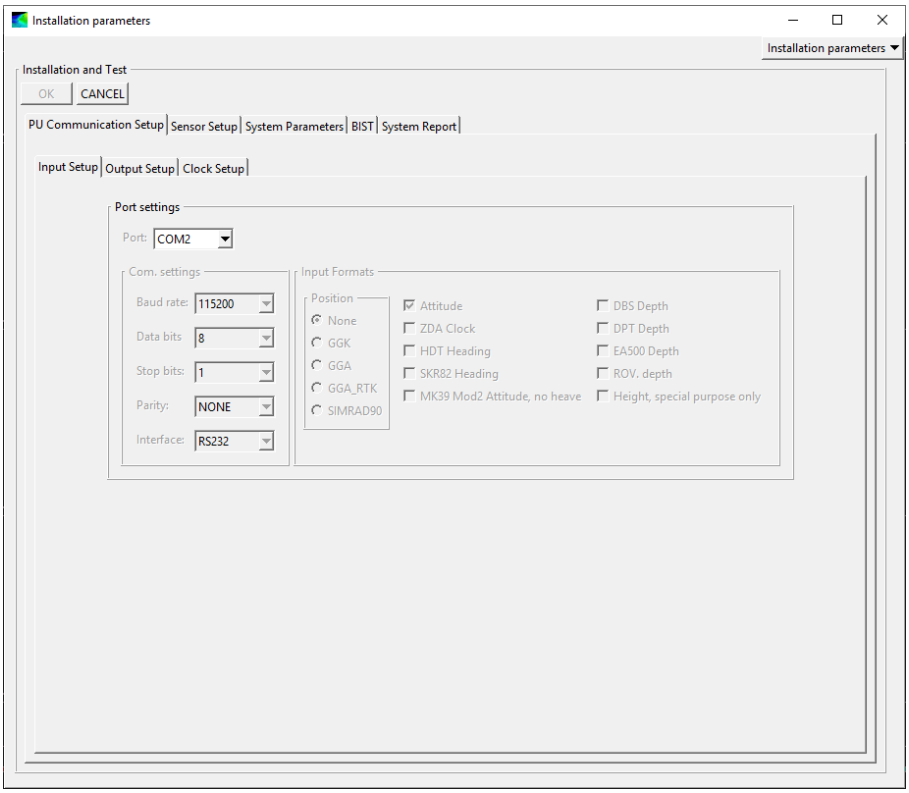

Figure 13 Kongsberg SIS COM2 Input of Attitude from the POS/MV

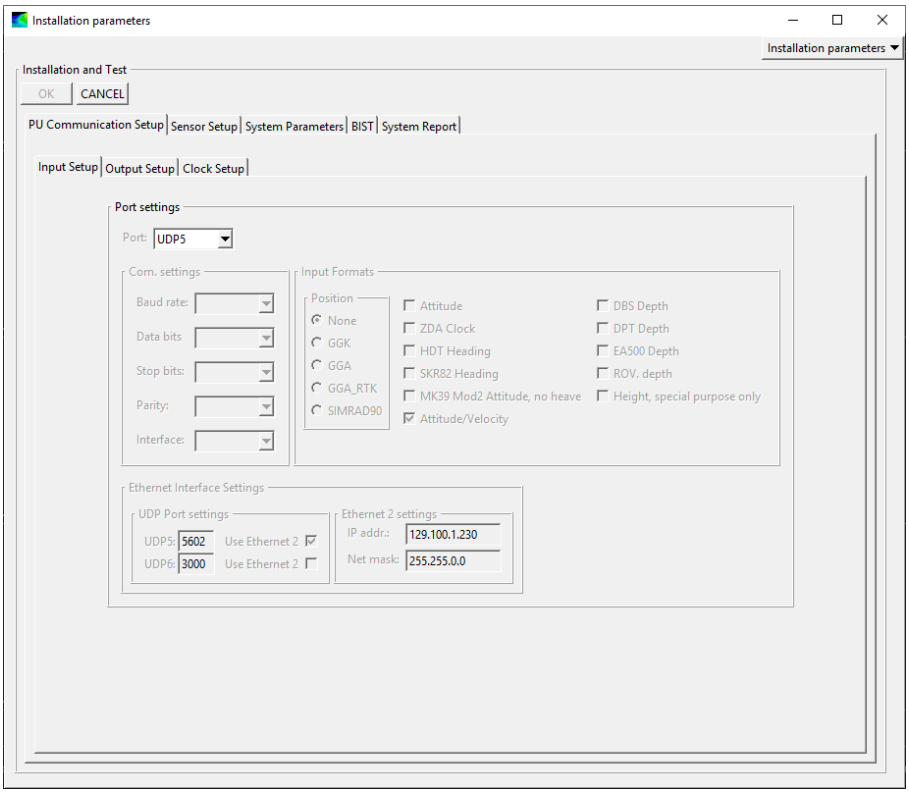

Figure 14 Kongsberg SIS UDP5 Input of Attitude/Velocity from the POS/MV

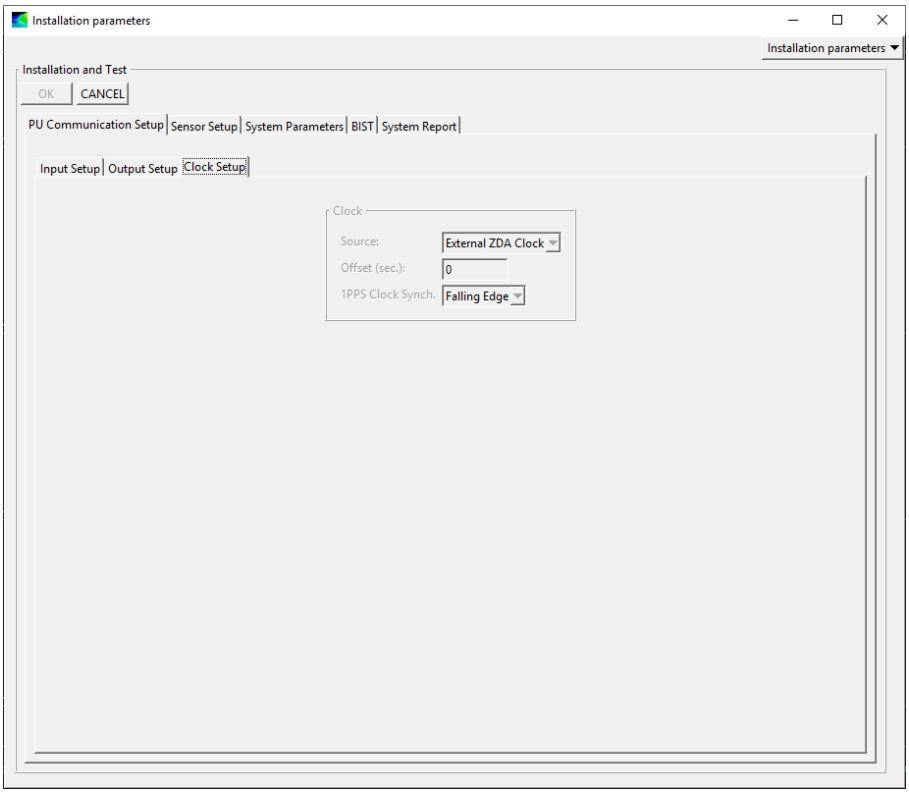

Figure 15 Kongsberg SIS clock setup synchronizing to the POS/MV

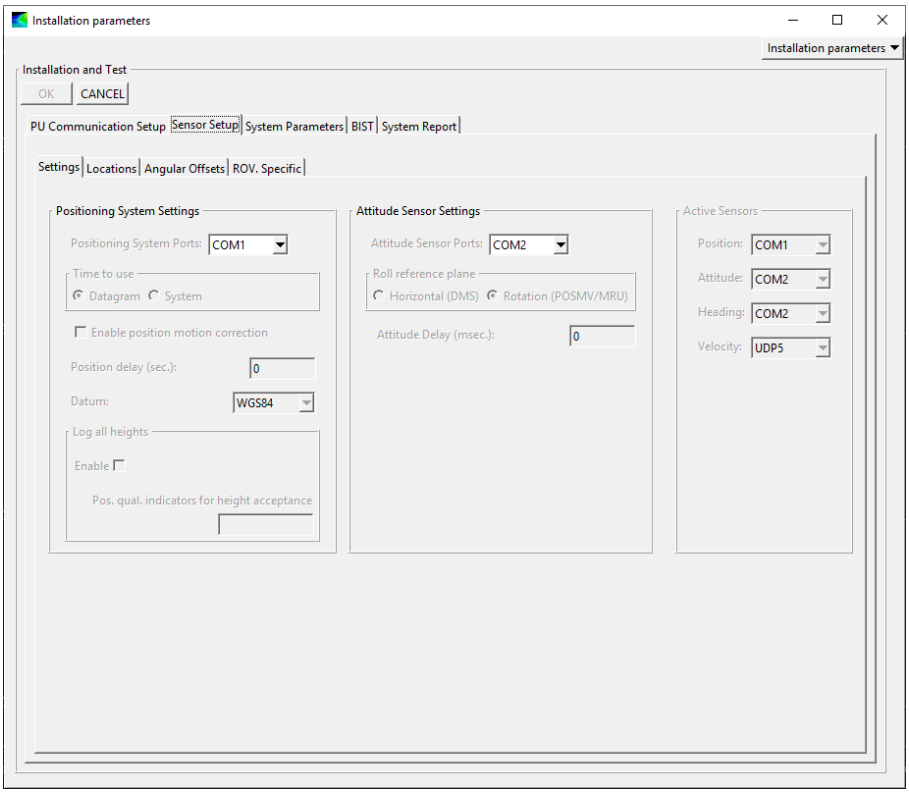

Figure 16 Kongsberg SIS sensor setup

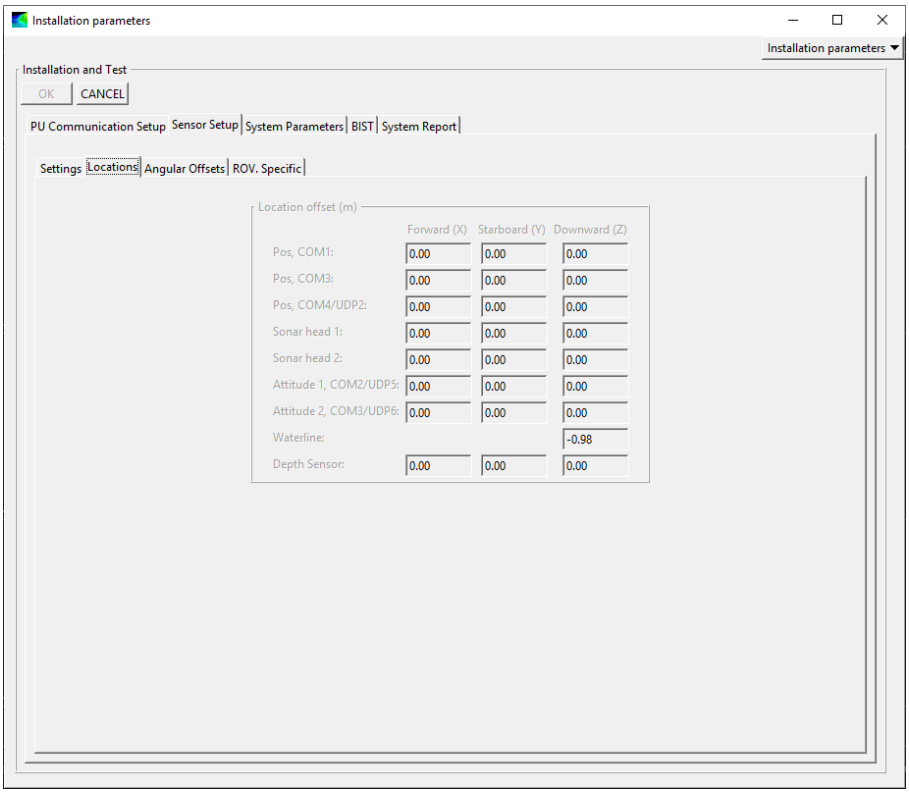

Figure 17 Kongsberg SIS Sensor Setup locations

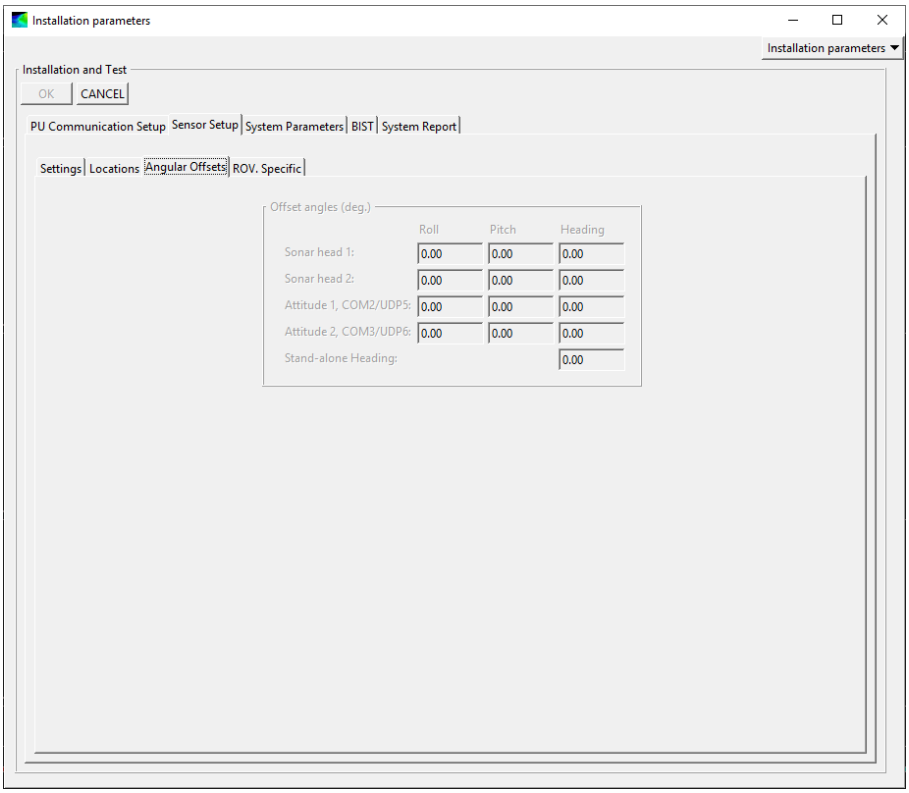

Figure 18 Kongsberg SIS Sensor Setup angular offsets

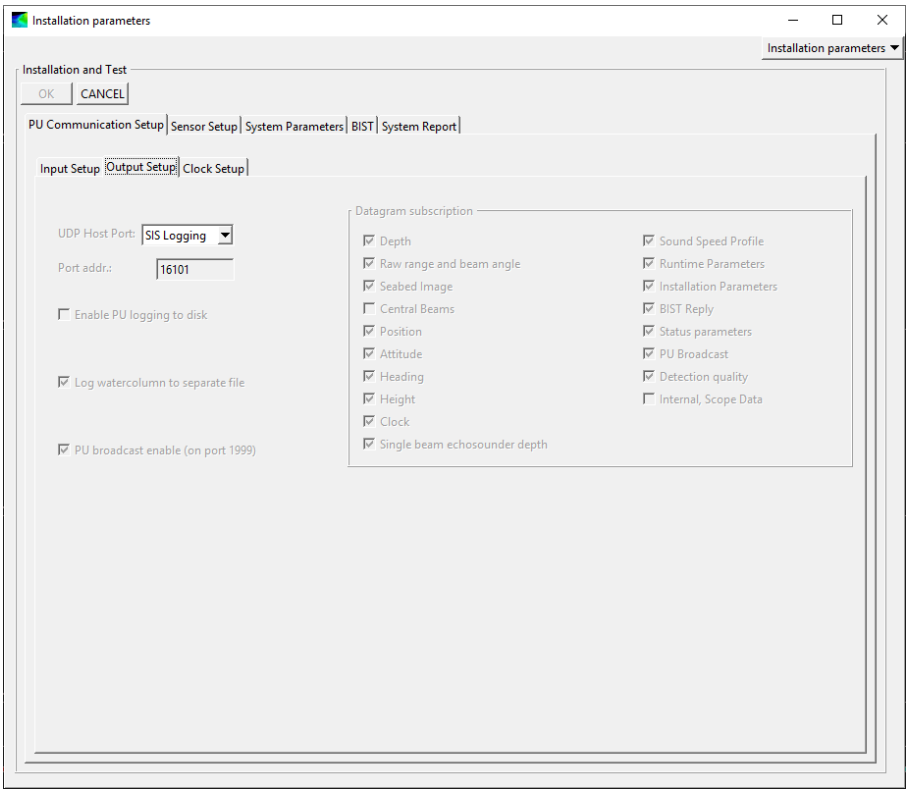

Figure 19 Kongsberg SIS local output for .ALL logging

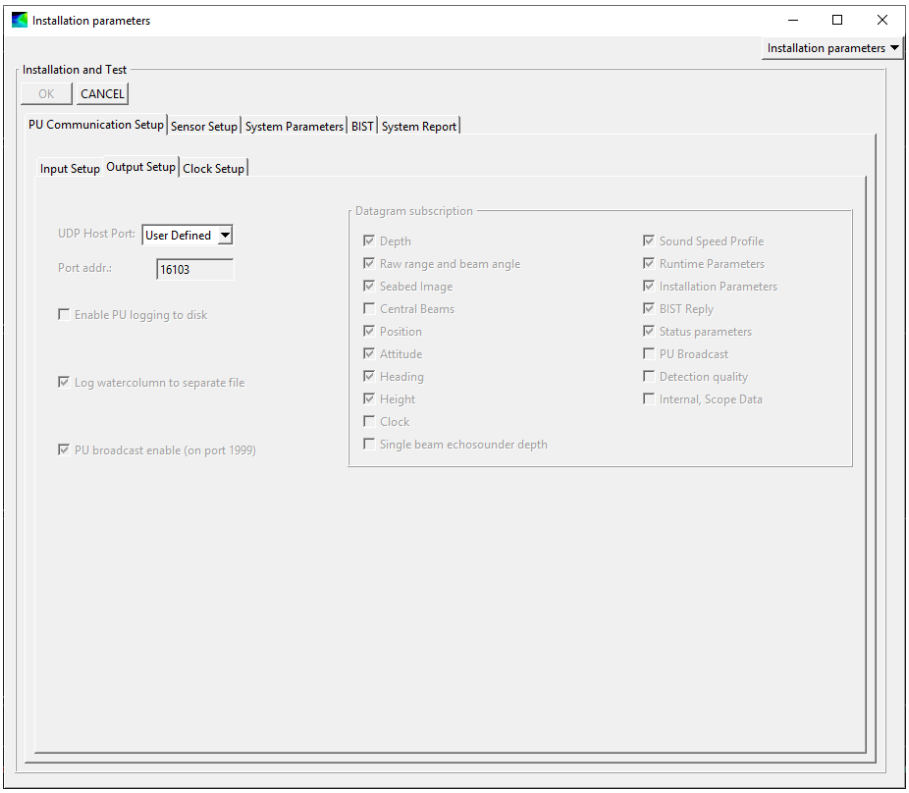

Figure 20 Kongsberg SIS output for swath display in Hypack

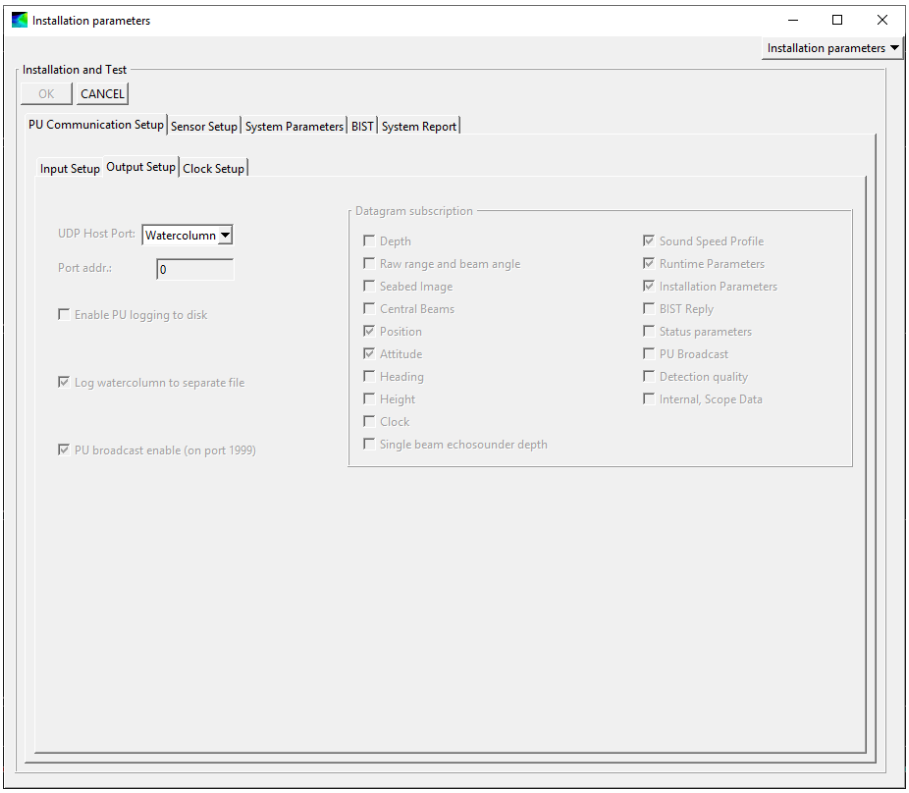

Figure 21 Kongsberg SIS output for local watercolumn logging

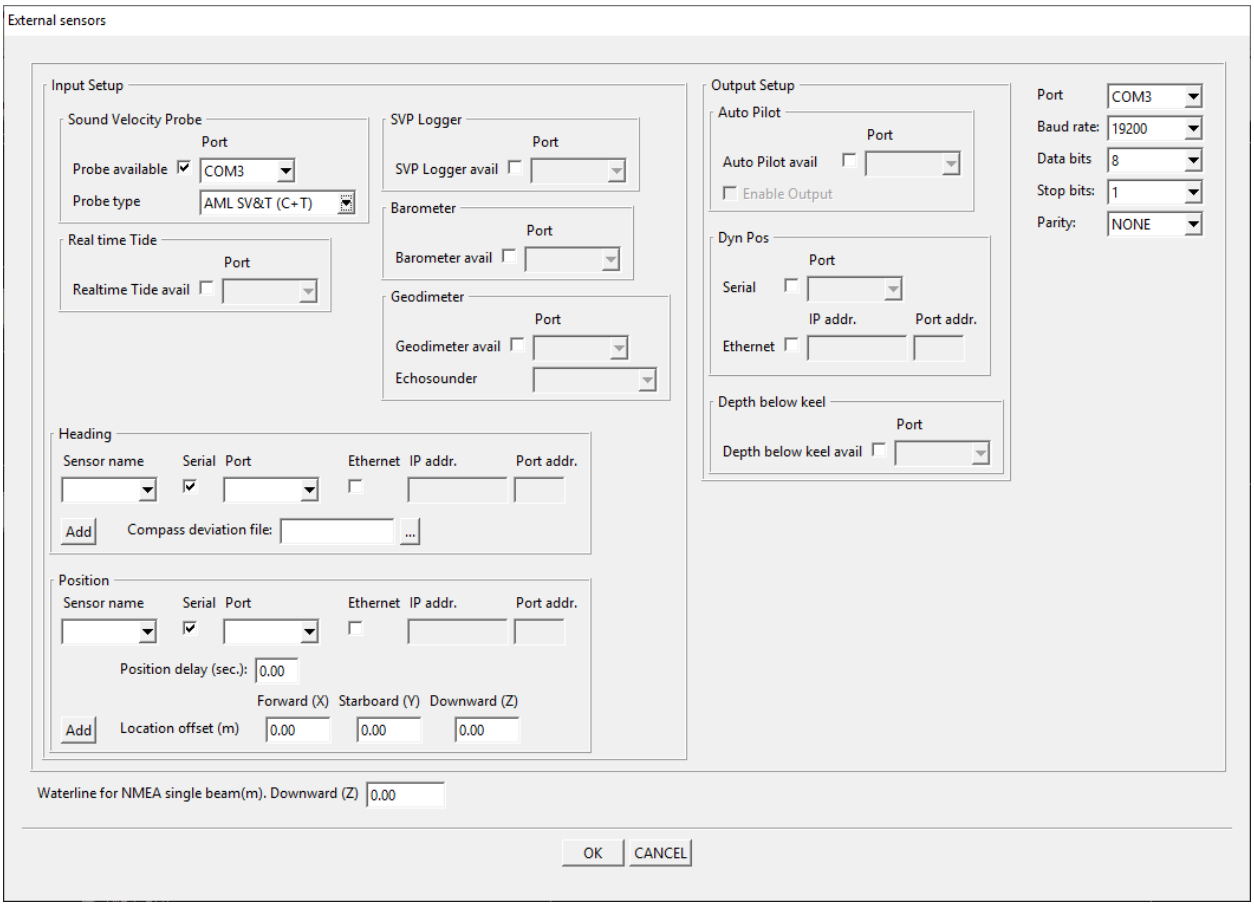

Figure 22 Kongsberg SIS External Sensors for input of transducer sound velocity probe

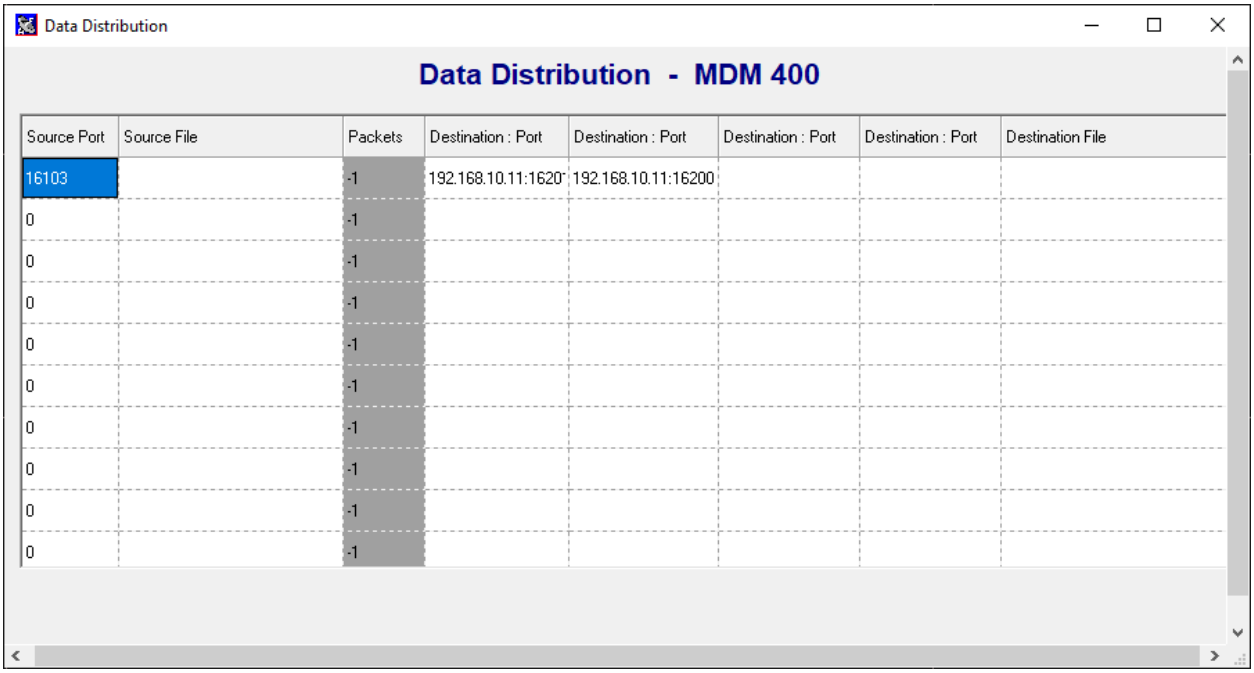

Figure 23 Kongsberg SIS data distribution for output of sonar data to Hypack

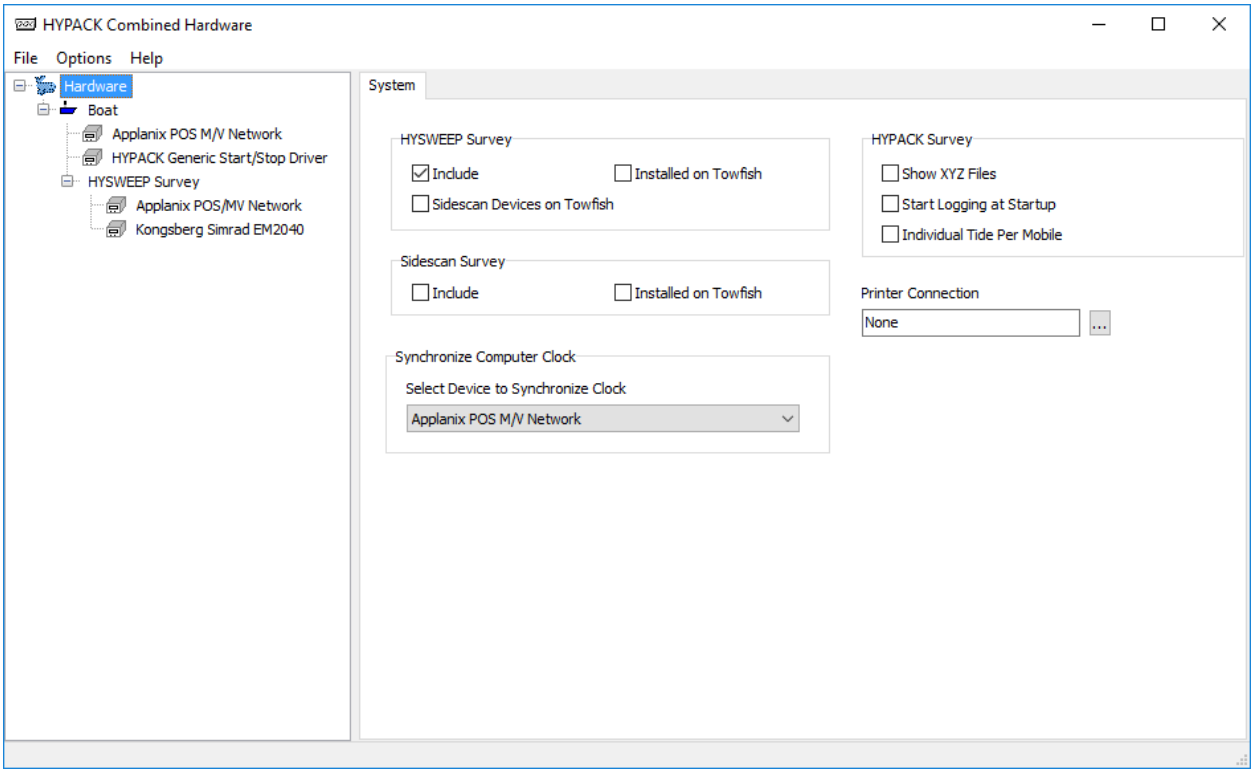

Figure 24 Hypack Hardware Configuration

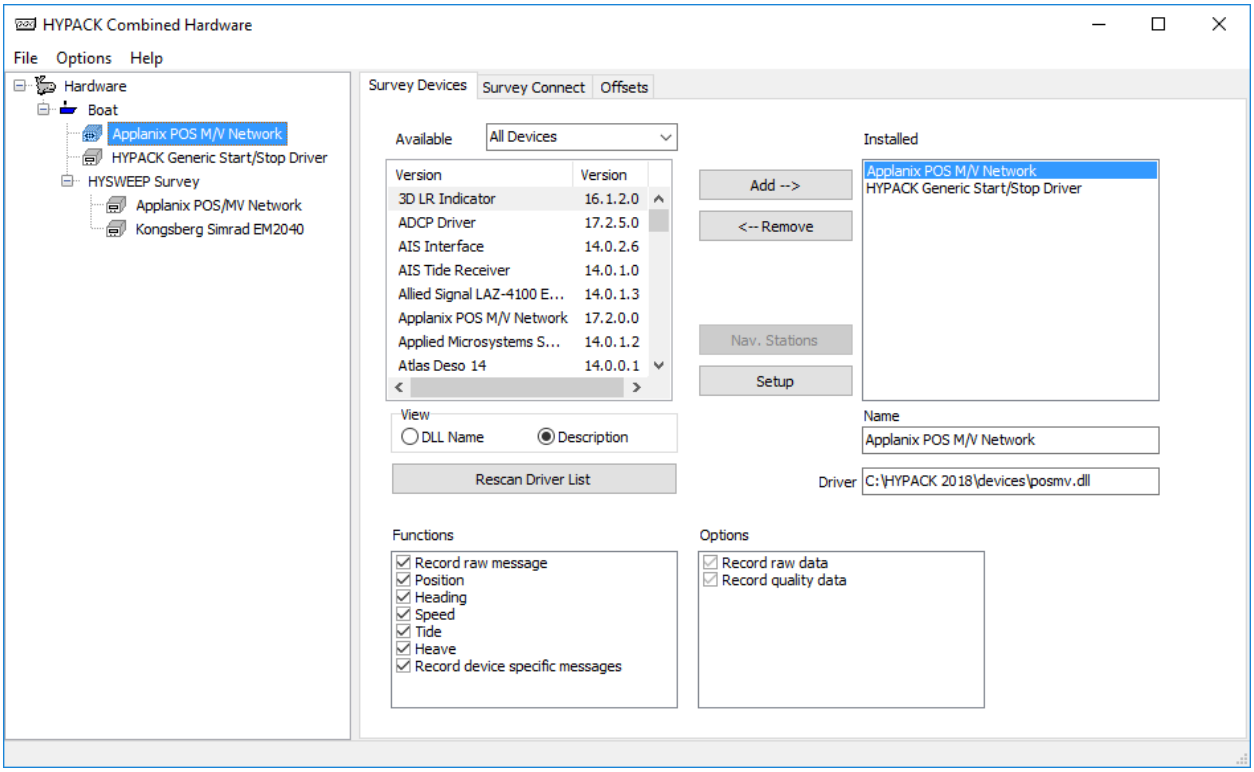

Figure 25 Hypack Applanix POS/MV driver configuration

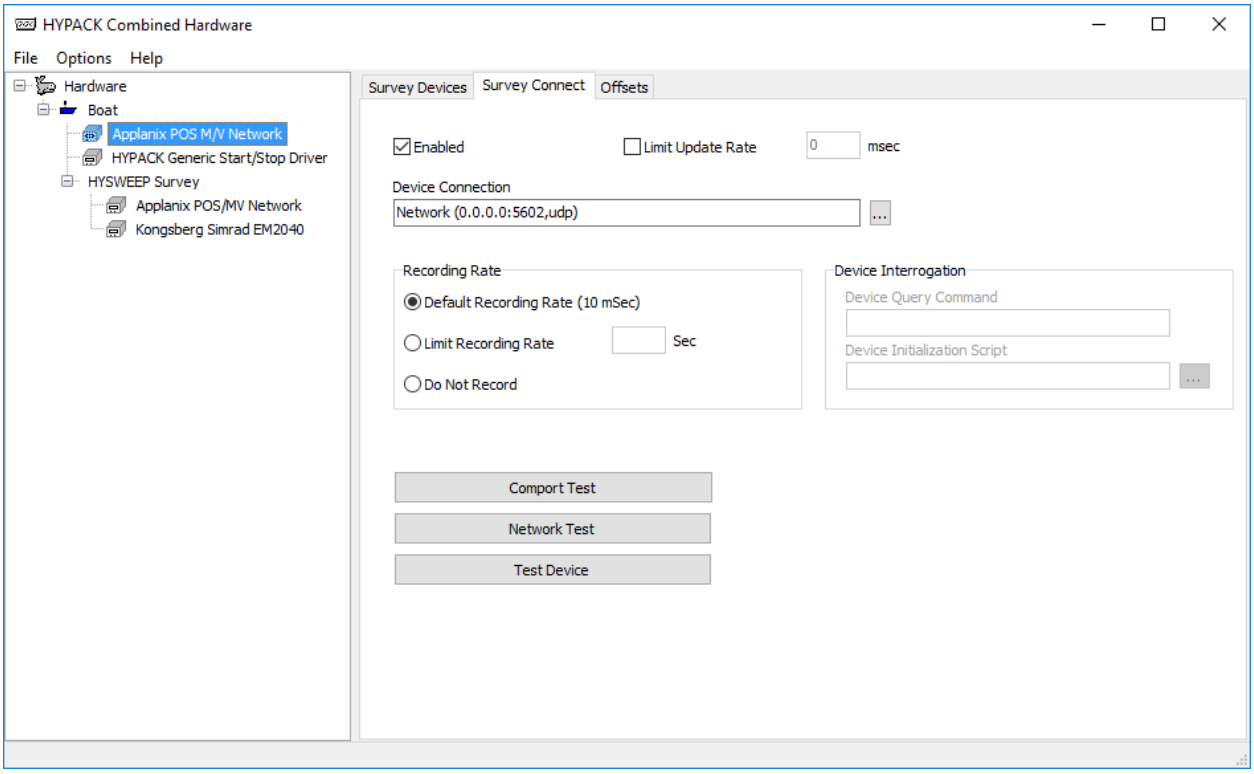

Figure 26 Hypack Applanix POS/MV connection pararmeters

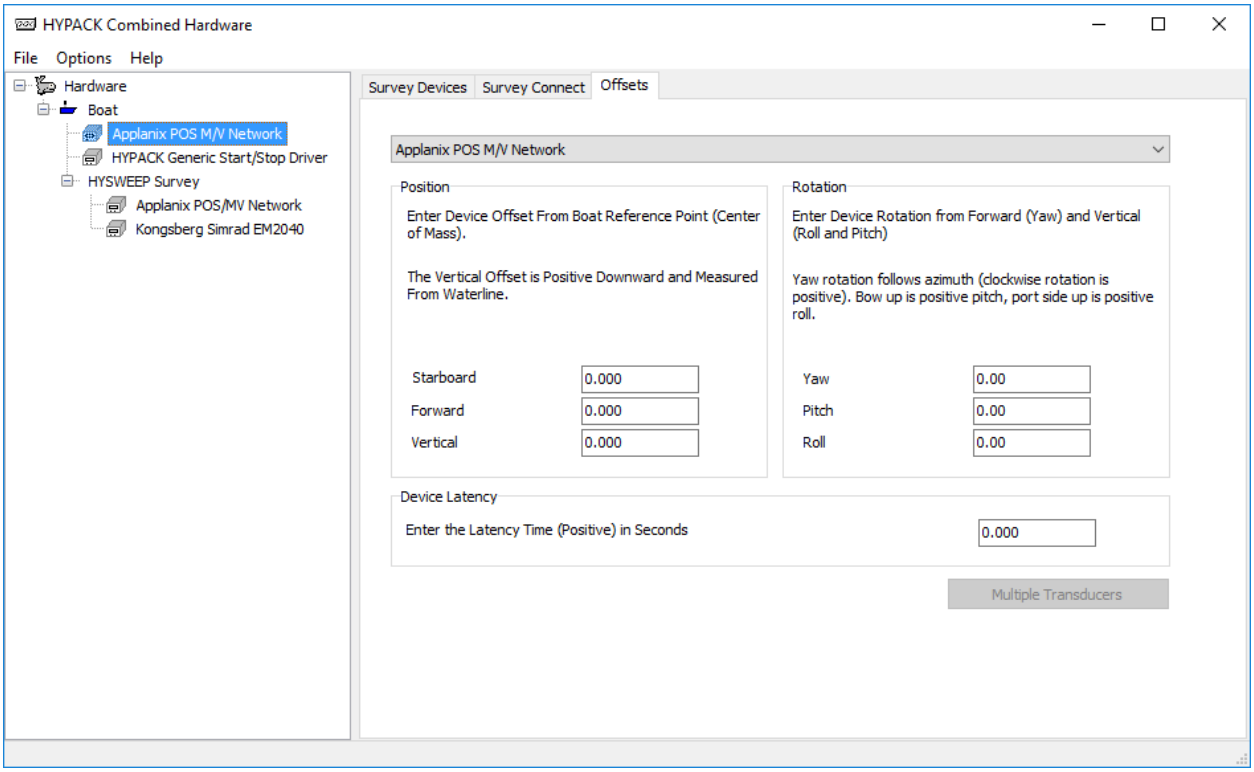

Figure 27 Hypack Applanix POS/MV offsets

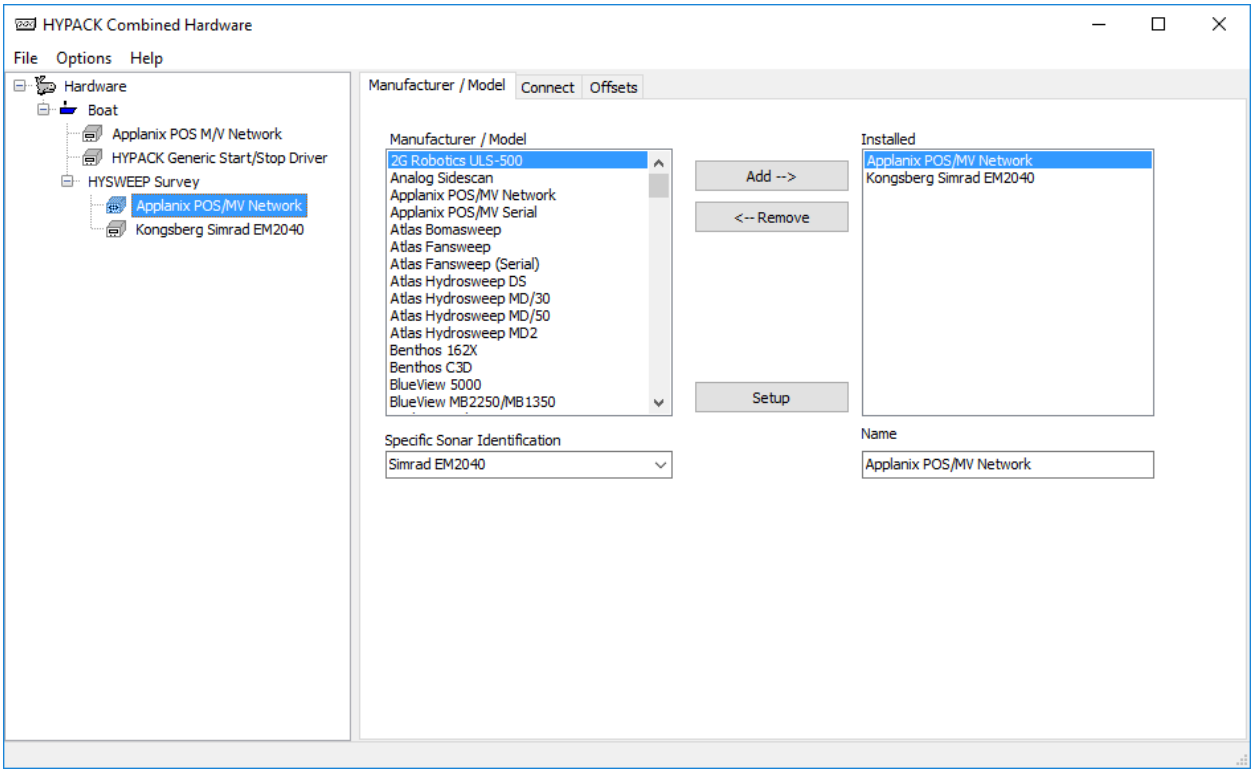

Figure 28 Hysweep Applanix POS/MV driver configuration

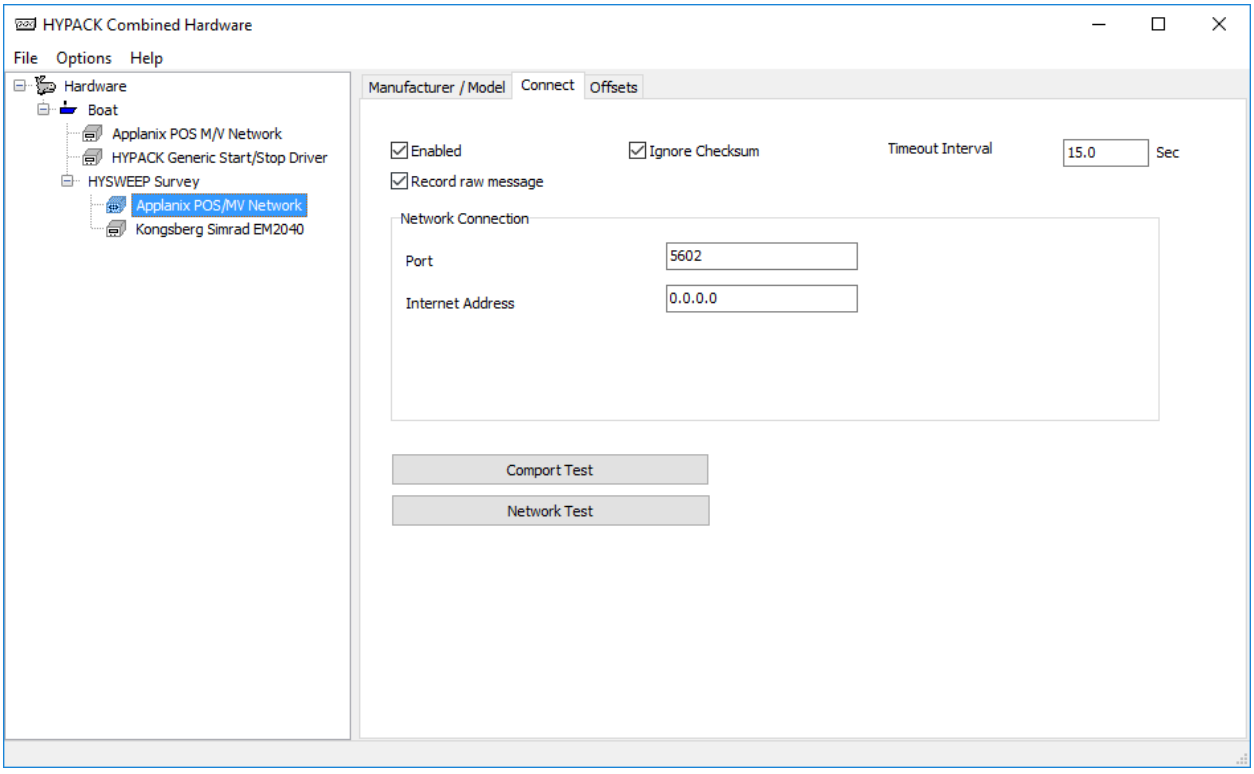

Figure 29 Hysweep Applanix POS/MV connection parameters

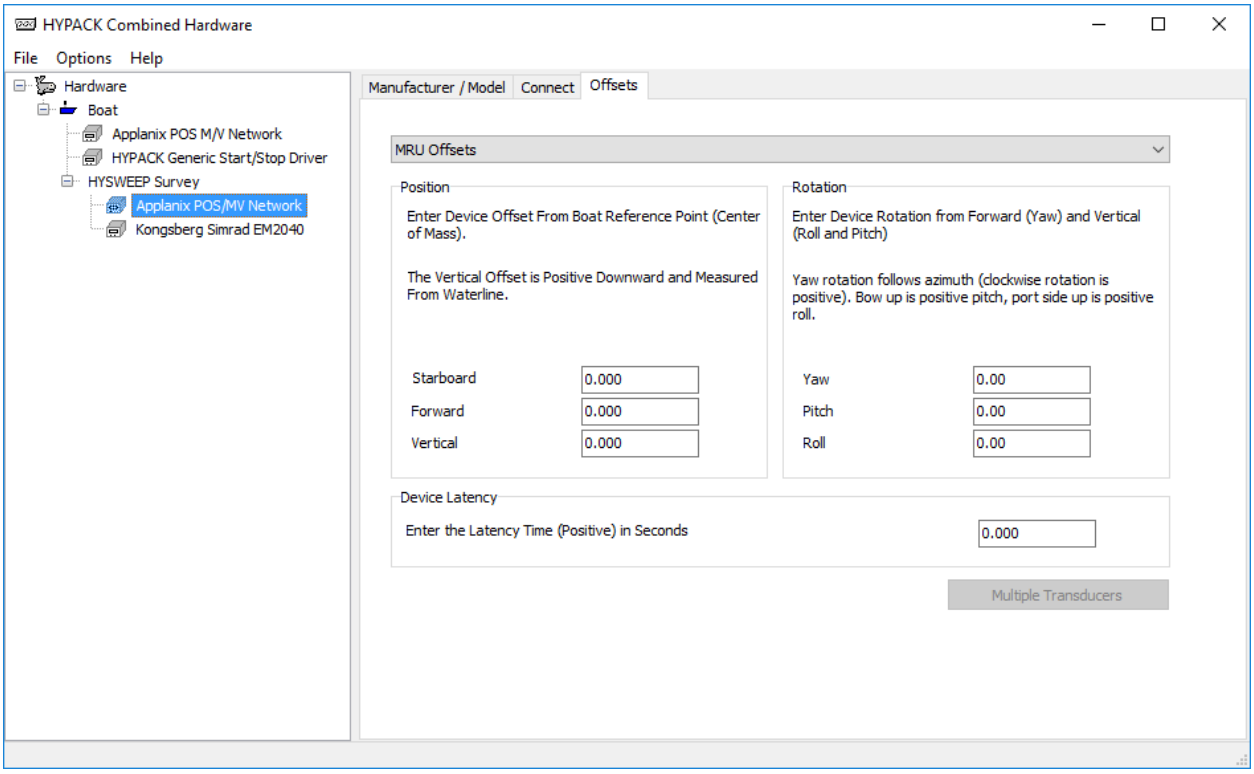

Figure 30 Hysweep Applanix POS/MV offsets

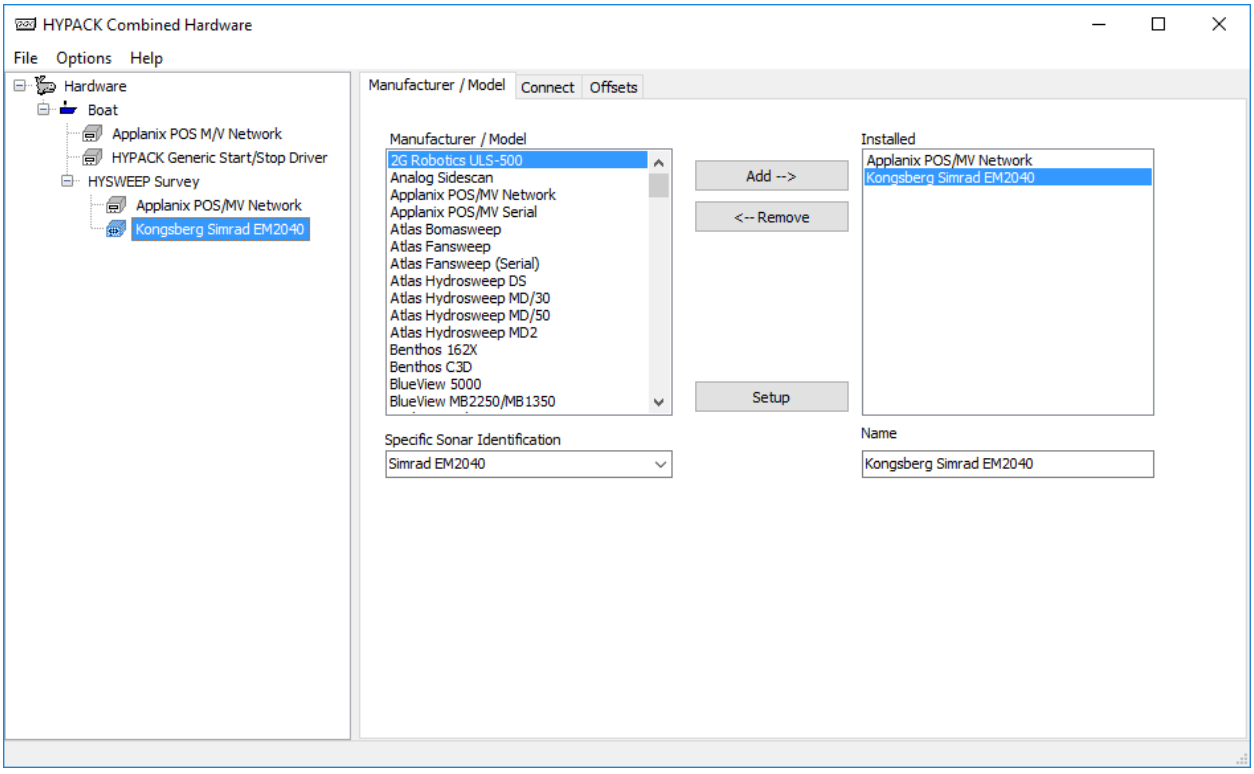

Figure 31 Hysweep Kongsberg EM2040C driver configuration

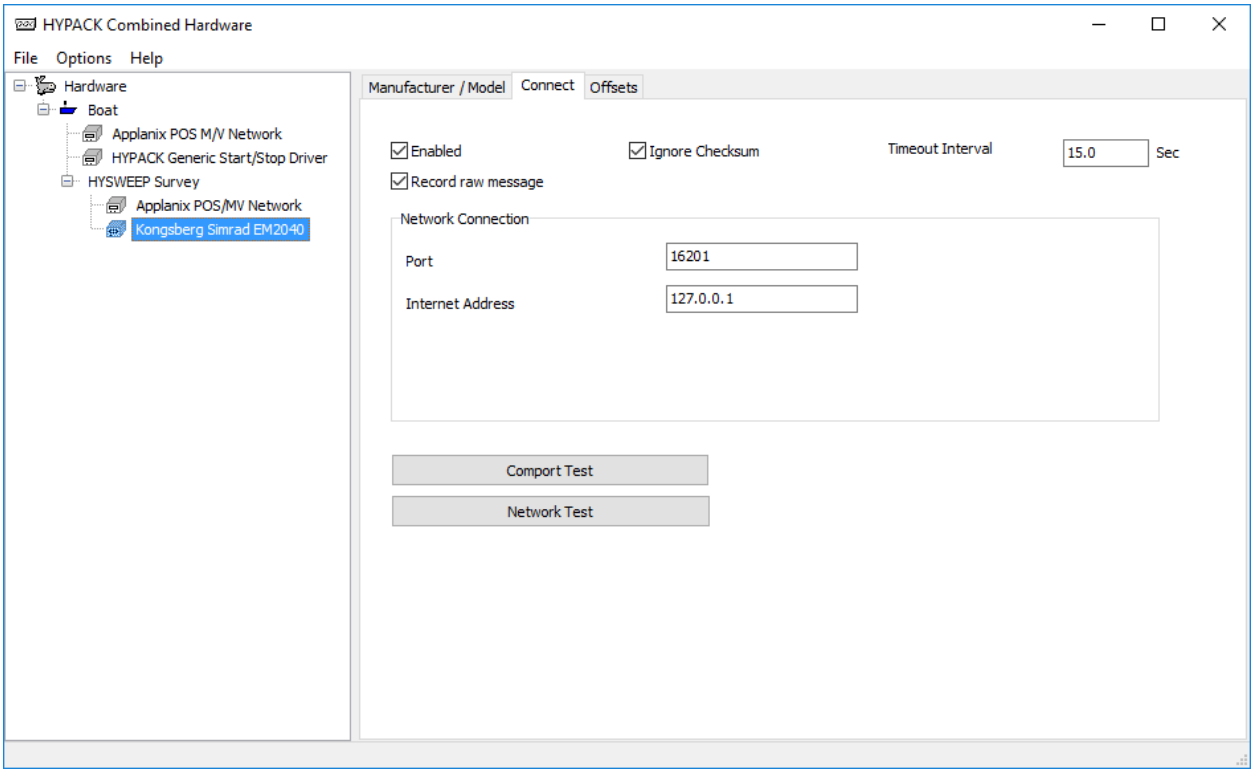

Figure 32 Hysweep Kongsberg EM2040C connection parameters

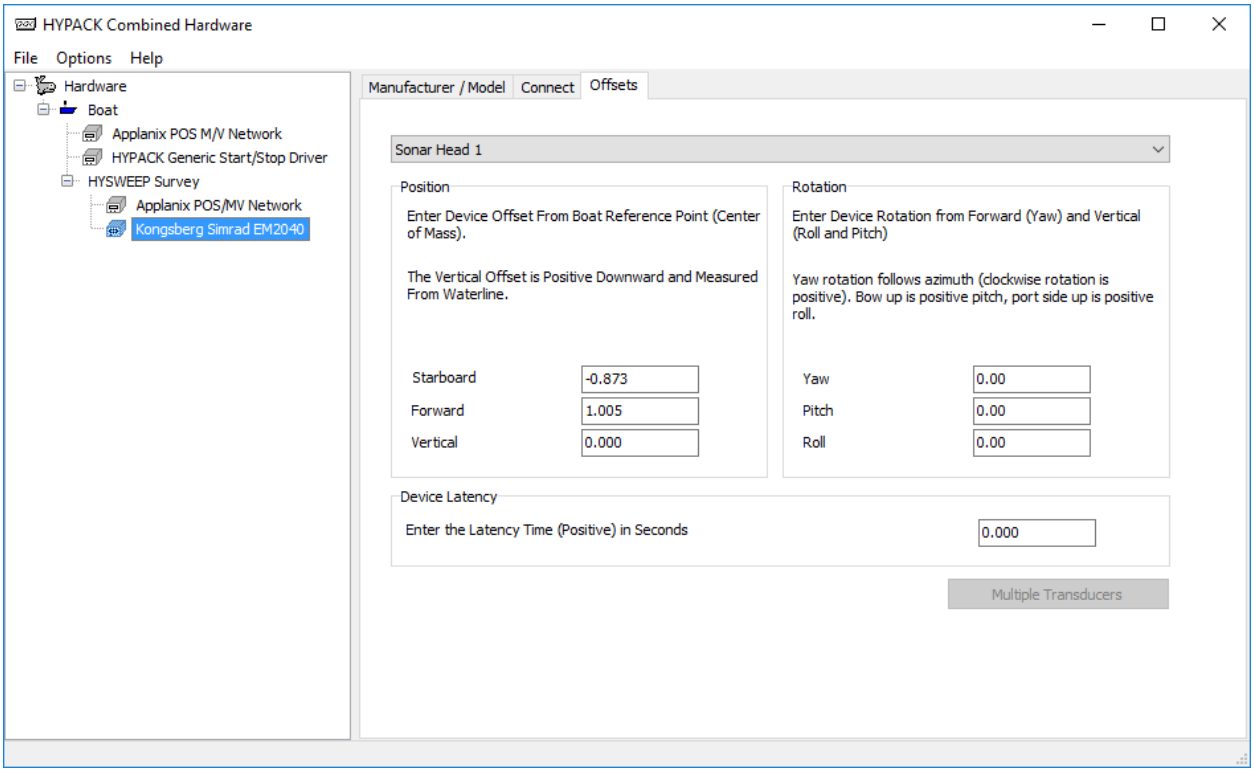

Figure 33 Hysweep Kongsberg EM2040C offsets