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NOAA Ship *Okeanos Explorer*

MAPPING SYSTEMS READINESS REPORT 2012

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1. Introduction

The *Okeanos Explorer* Program

Commissioned in August 2008, the NOAA Ship *Okeanos Explorer* is the nation's only federal vessel dedicated to ocean exploration. With 95% of the world's oceans left unexplored, the ship's combination of scientific and technological tools uniquely positions it to systematically explore new areas of our largely unknown ocean. These exploration cruises are explicitly designed to generate hypotheses and lead to further investigations by the wider scientific community.

Using a high-resolution multibeam sonar with water column capabilities, a deep water remotely operated vehicle, and telepresence technology, *Okeanos Explorer* provides NOAA the ability to foster scientific discoveries by identifying new targets in real time, diving on those targets shortly after initial detection, and then sending this information back to shore for immediate near-real-time collaboration with scientists and experts at Exploration Command Centers around the world. The subsequent transparent and rapid dissemination of information-rich products to the scientific community ensures that discoveries are immediately available to experts in relevant disciplines for research and analysis

Through the *Okeanos Explorer* Program, NOAA's Office of Ocean Exploration and Research (OER) provides the nation with unparalleled capacity to discover and investigate new oceanic regions and phenomena, conduct the basic research required to document discoveries, and seamlessly disseminate data and information-rich products to a multitude of users. The program strives to develop technological solutions and innovative applications to critical problems in undersea exploration and to provide resources for developing, testing, and transitioning solutions to meet these needs.

Okeanos Explorer Management – a unique partnership within NOAA

The *Okeanos Explorer* Program combines the capabilities of the NOAA Ship *Okeanos Explorer* with shore-based high speed networks and infrastructure for systematic telepresence-enabled exploration of the world ocean. The ship is operated, managed and maintained by NOAA's Office of Marine and Aviation Operations, which includes commissioned officers of the NOAA Corps and civilian wage mariners. OER owns and is responsible for operating and managing the cutting-edge ocean exploration systems on the vessel (ROV, mapping and telepresence) and ashore including Exploration Command Centers and terrestrial high speed networks. The ship and shore-based infrastructure combine to be the only federal program dedicated to systematic telepresence-enabled exploration of the planet's largely unknown ocean.

Contents

2. Purpose

The purpose of this document is to describe the mapping system of the NOAA Ship *Okeanos Explorer*, and the performance evaluation undertaken in 2012. This report will provide a comprehensive listing of all system components, configuration, calibrations and system performance evaluations of equipment and software in use during the 2012 field season of the *Okeanos Explorer*.

3. Vessel General Specifications

From 2005 to 2008, the vessel underwent extensive refurbishment by Todd Pacific Shipyards Corporation and Fairhaven Shipyard, including adding mission space for the ROV hanger, bow and stern thrusters, fairings for mapping sensors, and bridge upgradation. The ship has been outfitted with a deep-water multibeam echo sounder (MBES), a singlebeam echo sounder (SBES), and a subbottom profiler (SBP), along with host of ancillary equipment. Detailed layouts of the all of the new, modified and relocated equipment can be accessed at http://www.moc.noaa.gov/oe/index.html. Videos of the conversion can be accessed at http://oceanexplorer.noaa.gov/okeanos/welcome.html.

The following information is also available online at http://www.moc.noaa.gov/oe/Specs/General%20Specifications.pdf (last accessed 2/10/2012)

Table 1. Vessel specifications

Vessel Specifications			
Hull Number	337	Cruising speed	10 knots
Call letters	WTDH	Mapping speed	8-10 knots
Builder	VT Halter Marine, Inc., Moss Point, MS	Berthing	46
Launched	Oct 28, 1988	Commissioned officers	6
Delivered to NOAA	Sept 10, 2004	Licensed engineers	3
Commissioned	Aug 14, 2008	Crew	18
Length (LOA)	68.3 m (224 feet)	Scientists	19
Breadth	13.1 m (43 feet)	Ambar RHIB	
Draft	5.18 m (17 feet)	Full Load displacement	2312 long tons
Range	9600 nm	Light ship displacement	1616 long tons
Endurance	40 days		
Main propulsion	2800 hp General electric DC drive motors	Power	4 Caterpillar D398 12 cylinder 800 HP diesel generators produce 240,000 watts at 600 vac.

4. Deck Equipment – *this section under development-*

J-Frame

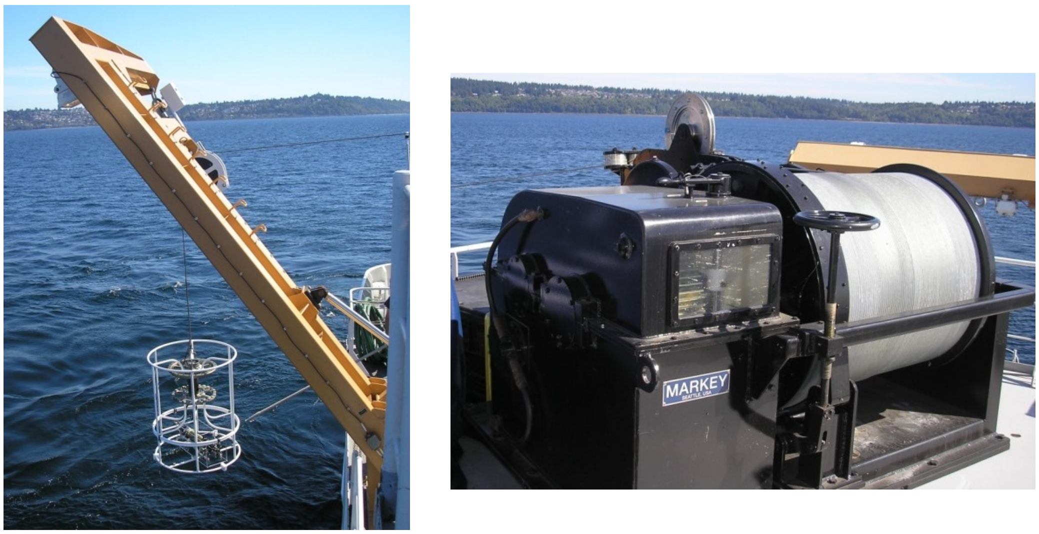


Figure 1. Photos of starboard side CTD deck showing J-Frame (left) and CTD Winch (right).

A-Frame

Cranes

Winches

5. Mapping Hardware

Table 2. Mapping hardware inventory.

Equipment	Install Date	Quantity	Manufacturer	Equipment name	Firmware version	Serial No.
30 kHz Multibeam Echosounder	3/2008	1	Kongsberg	EM 302	SIS v.3.6.4	1 (HWS 10 is 271)
18 kHz Singlebeam Watercolumn Echosounder	6/2011	1	Kongsberg	EK60	2.2.1	2097 (18 kHz transducer); 934 (GPT)
Inertial Measurement Unit	5/2008	1	Applanix	POS/MV	320 V. 4.0.2.0	2572
Gyrocompass	2008	1	SG Brown	TSS Meridian Gyrocompass		Unit 929060; S/N 5217
Pressure Sensor & Deck Unit	4/2011	2 each	Sea-Bird	SBE 9/11 Plus	N/A	09P47490-0905, 11P45414-0752; 09P47490-0906, 11P47490-0782
Temperature & Conductivity Sensors	4/2011	4 each	Sea-Bird	SBE 3Plus & 4C	N/A	Primary:03 P5001, 43449, Secondary: 03P5017, 43451; Primary: 03P5023, 43455, Secondary: 03P5026, 43456
Pump	4/2011	5	Sea-Bird	SBE 5T	N/A	Primary : 054928 Secondary : 054978; Primary: 054974, Secondary: 054975; Spare: 055056
Dissolved Oxygen (DO)	5/2011	2	Sea-Bird	SBE 43	N/A	432100
Light Scattering Sensor (LSS)	6/2011	1	Seapoint	Turbiditiy	N/A	12790

Light Scattering Sensor (LSS)	6/2011	1	Seapoint	Turbiditiy	N/A	12791
Oxidation Reduction Potential (ORP)	6/2011	1	PMEL	ORP	N/A	ORP4CTD-07
Altimeter + battery	6/2011	1	Kongsberg / PMEL	1007	N/A	1102141
Altimeter (spare) + battery (spare)	2/2012	1	Kongsberg / PMEL	1007	N/A	1102142
Carousel Rosette	7/2008	1	Sea-Bird	SBE 32	N/A	3247490-0674
Thermosalinograh (TSG)	4/20011	2	Sea-Bird	SBE 45	N/A	4540402-0149, 45414-0194
External Temperature Sensor	3/2011	2	Sea-Bird	SBE 38	N/A	3845414-0317, 3852209--442
~~Single beam echo sounder (12 kHz)~~	~~3/2008~~	~~1~~	~~Kongsberg~~	~~EA 600~~	~~V. 2.4.1~~	~~(GPT: 385)~~
Sub bottom profiler	4/2008	1	Knudsen	Chirp 3260	V. 1.61	K2K-07-0910
Met station (Temp/Relative Humidity, Wind/Pressure, Long wave/Short wave radiation	11/2007	1	Visala, RM Young, Eppley Laboratory	HMP45A, 05106/61202 V, PSP/PIR	V. 1.965	C4650041, WM82711/ BP05149, 36630F3/3382F3
Dynamic Positioning System	9/2007	1	Kongsberg	-	Product: K-Pos DP-11	Software: 7.0.3
Satellite Navigation System (C-NAV)	7/2007	1	C&C Technologies	2050G	N/A	5164

Multibeam Echo Sounder (MBES)

The *Okeanos Explorer* is equipped with a Kongsberg Maritime EM 302 multibeam sonar system. The sonar system was hull mounted by Todd Shipyard in Seattle during 2006/2007, and was completed in March 2008, and the installation was accepted after field tests in September 2008. The EM 302 receiver and transmit array are arranged in a Mills Cross formation on the transducer fairing. The fairing is installed between frame 15 and 42 (Figure 3). The topside electronics (trans-receiver unit – PU unit) for the EM 302 are located in an enclosed, temperature controlled closet in the ship's library (Figure 3). The EM 302 control and acquisition work station is located in the main mission space in the Control Room on the 01 deck. A PU remote on/off switch is located next to the work station. The software SIS (Seafloor Information System) computer is located in the rack room.

The nominal frequency of the EM 302 is 30 kHz. The system can be operated in two modes – CW (continuous waveform) or FM (frequency modulated) mode. The distinctive advantage of FM mode is that a larger swath can be achieved as compared to traditional deep water multibeam systems. In shallow water depths (less than 3300 meters), the sonar also utilizes multi-ping technology (dual swath) where two pings are simultaneously sent into the water, thereby increasing the sounding data density.

Figure 2. Photos: (Clockwise from left) EM 302 TRU unit, Transducer fairing, Elements of EM 302 being installed inside the fairing.

During the 2009-2010 winter in-port, the EM 302 TRU closet was refitted with a new air ventilation system and insulation. Thermometers were installed in the closet to monitor temperature control. During the 2012 shakedown cruise (EX1201), temperatures in the TRU closet were observed to remain below 85 degrees Fahrenheit at all times.

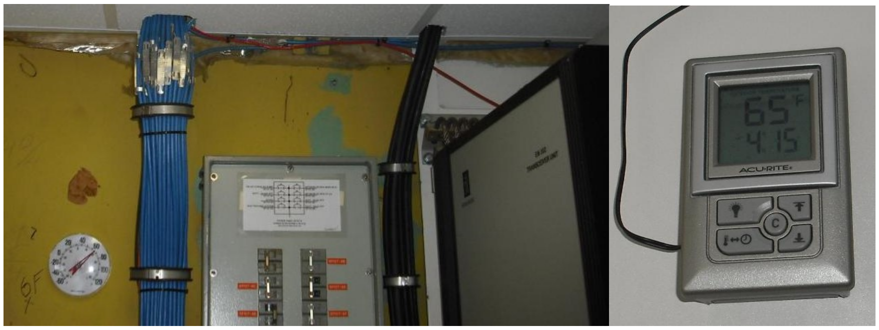


Figure 3. Photos of temperature gauges installed in the TRU closet 2009/2010 winter inport.

The following table is provided as a sample of observed swath widths from the 2011 and 2012 shakedown cruises. Coverage will vary based on ship speed, environmental conditions, and seafloor characteristics.

Table 3. Sample EM 302 swath coverage observed 2011.

Nadir Depth (m)	Vessel Speed (kts)	Ship Heading	Wind Speed / Direction	Swell Height / Direction	Swath Coverage	Coverage as a Function of Water Depth
4000	8.5	268°	10-12kts / 280°	8-10 ft / 280°	7.3km	1.8
4000	8	90°	10-12 kts / 280°	8 ft / 280°	7.5km	1.9
3000	7.5	268°	10-12kts / 280°	8-10 ft / 280°	6.9 km	2.3
3000	7.7	90°	10-15 kts / 310°	8 ft / 280°	7.3 km	2.4
2000	8	268°	10-12kts / 280°	8-10 ft / 280°	7km	3.5
2000	7.7	90°	10-15 kts / 310°	8 ft / 280°	7.7km	3.9
1000	7.7	268°	10-12kts / 280°	8-10 ft / 280°	4.2 km	4.2
1000	8.1	90°	10-15 kts / 310°	8 ft / 280°	5.5 km	5.5

Table 4. Sample EM 302 swath coverage observed 2012.

Nadir Depth (m)	Vessel Speed (kts)	Ship Heading	Wind Speed / Direction	Swell Height / Direction	Swath Coverage	Coverage as a Function of Water Depth
500	9	220°	33 kts / 10°	8-10 ft / 10°	2	4
1000	10	36°	13 ks /	2-3 ft / 10°	5.6	5.6

			200°			
1500	8	220°	10 kts / 230°	3-4 ft / 10°	6	4
2000	10	194°	10 kts / 0°	3-4 ft / 20°	6.6	3.3
2500	10	228°	16 kts / 30°	3-4 ft /30°	7.5	3

During the 2010/2011 winter in port, the EM 302 transducers were thoroughly and carefully cleaned, the epoxy around the fairing was removed, and a new coat of Belzona was applied, all based on direct advice obtained from Kongsberg engineers. The transducers were also coated with an anti-fouling paint, as recommended by the manufacturer.

Also during the 2010/2011 winter in port, the EM 302 TRU sub-rack was replaced by a Kongsberg engineer. During the 2009 / 2010 field seasons, TX36 slot #16 destroyed the high voltage bridges of several TX36 boards. The sub-rack replacement was done to address this, and was tested during the 2011 shakedown cruise (EX1101). As of May 2011, the sub-rack had not destroyed any additional transmit boards.

Prior to the 2012 shakedown cruise, video footage of the transducers was obtained by divers. The transducers were generally free of hard marine fouling where anti-fouling paint had been applied during the winter 2010/2011 in port. Algal growth was observed but was expected to be naturally removed when the ship got underway.

Water Column Singlebeam Echosounder

A Kongsberg EK 60 singlebeam water column sonar was incorporated on the ship in June 2011. The EA 600 12 kHz transducer was replaced with an 18 kHz transducer, and an EK 60 GPT was installed in the sonar closet. The system passed harbor acceptance test in San Diego, and was successfully field tested during the 2011 field season.

Figure 4. Photo of EA 600 / EK 60 RDS controller in the Dry Lab computer rack.

Figure 5. EK 60 / EA 600 (disconnected) GPTs.

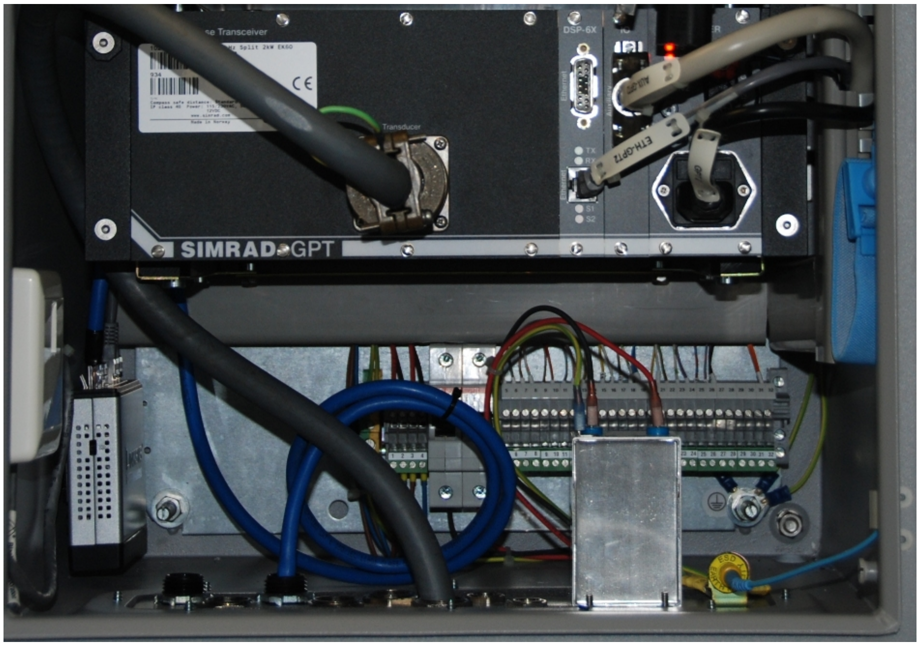


Figure 6. EK 60 GPT cabling detail.

Sub-bottom Profiler (SBP)

The *Okeanos Explorer* is outfitted with 3.5 kHz Knudsen Chirp 3260 sub-bottom profiler. The system is capable of collecting sub-bottom data at full ocean depths. The system was accepted by the ship in Nov 2008 after some initial checks using simulator mode. The 2008 acceptance report for the Knudsen 3260 is included in the appendices section of this report.

During the 2009 evaluation, a strong interference was observed between the Knudsen and the EM 302 / EA 600. Consequently, the SBP profiler was outfitted to accept an external trigger from the EM 302. During the 2011 shakedown cruise, the subbottom was run in tandem with the multibeam near San Juan Seamount in 4000 meters of water. No interference was observed.

During the 2011 ship shakedown, navigation data from the C-NAV was routed to the Knudsen rack unit via an amplifier. The navigation was updating in the Knudsen data collection software, and test files were collected in *.keb and *.kea format. The system prevents the collection of SEG-Y files at ranges greater than 2000 meters. The *.keb and *.kea files could not be examined, as the Chesapeake Technologies SonarWiz dongle could not be located on the ship.

Currently, attitude data is not provided to the Knudsen rack unit.

Singlebeam Echo Sounder (SBES)

The transducer for the system was removed in 2011 to make room for the new EK 60 1 kHz transducer. The following informaiton is left in this report for historical equipment tracking purposes. During field seasons 2008 – 2010, *Okeanos Explorer* was equipped with a Kongsberg Maritime EA 600 singlebeam sonar system (see figures below). The SBES system consists of 12 kHz transducer (Kongsberg 12-16/60) with 2 kilowatt transmit power that can collect data in up to 10000 m of water. The transceiver unit is connected to EA-RDS that provides the user interface to control the system settings. The transceiver unit is located in the closet in the ship's library on the main deck. Top side electronics including the controlling computer are located in dry lab on the 01 deck. The singlebeam sonar was tested to a depth of > 9000 m over the Mariana Trench in 2010 during cruises EX1003 and EX1005. The 2008 harbor and sea acceptance reports for the EA 600 are included in the appendices section of this report.

Figure 7. Photos showing EA600 TRU interior (left) and EA600 TRU outer casing (right). Note: this photo does not include the 2011 EK 60 GPT installation and shows the EA 600 cabling connected, though as of the time of writing this report, the EA 600 was disconnected (see figure above).

Positioning and Orientation Equipment

POS/MV

Okeanos Explorer is equipped with an Applanix POS MV 320, which provides position, heading, attitude and heave data for the vessel. The system includes a POS computer system (PCS), an inertial motion unit (IMU) and two GPS antennas. The IMU is located in the fan room in front of Ship's library (between frames 35-40). During the 2009-2010 winter in port, a protective case was secured around the IMU to protect it from contact damage.

Figure 8. Photos: Clockwise from top left: IMU and granite block, IMU, IMU under protective housing.

C-NAV

The ship is equipped with a C-NAV 2050. The figures below show the arrangement of miscellaneous antennas onboard, including the CNAV GPS antenna, and the POS M/V port and starboard antennas.

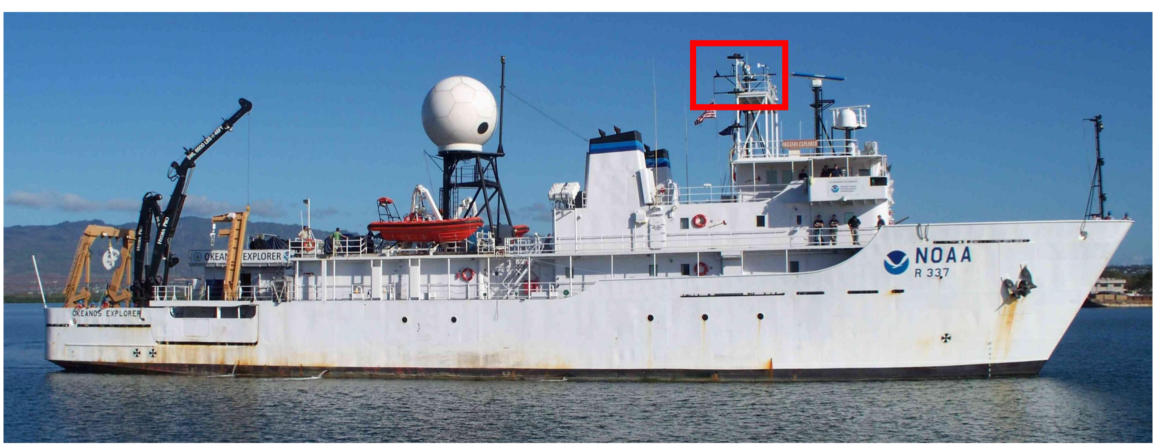


Figure 9. Starboard side of ship. Red box indicates location of survey related antennae.

TSS Gyrocompass

Two Teledyne Meridian Standard gyrocompasses are located on the bridge. The starboard side TSS (on the left in the photo below) provides heading to the EM 302 TRU. It is labeled GYRO #1. The unit is capable of following heading changes of up to 200° per second, and dynamic heading accuracy of 0.6°.

Figure 10. Photo of TSS gyrocompasses located on the bridge. Left hand unit is used for EM 302.

Vertical Sound Speed Profiling

Okeanos Explorer has two Sea-Bird electronics, Inc. (SBE) 9/11Plus CTDs, each with dual “3plus Temperature” and “4C Conductivity” sensors. “3plus Temperature” sensors are certified by Seabird to demonstrate temperature measurement drift of less than 0.001 °C and time measurement accuracy within 0.065 ± 0.010 seconds. “4 C Conductivity” sensors are ideally suited for obtaining horizontal data with towed systems or vertical data with lowered systems.

This unit is capable of collecting temperature, conductivity, and pressure in real time and depth, salinity and sound velocity are calculated in real time via SBE Seasave acquisition software. One complete package is used to collect data and the other is kept as a spare. The ship must hold station to conduct a CTD cast. The CTD is lowered through the water column at 60m/min.

The ship will be successfully tested Tow-Yo capabilities during the 2011 field season. Tow-Yos can be conducted in up to 2500 meters of water while the ship utilizes its dynamic positioning system to maintain precise Tow-Yo tracklines.

Lockheed Martin Sippican expendable bathy thermograph (XBT) casts are conducted on the aft deck with a portable launcher. The data are collected in real time with the WinMK21 acquisition software. The major difference between the CTD and XBT is that an XBT cast can be completed while the ship is underway. The mapping department stocks “Deep Blue” XBT probes, which can be launched at ship speeds of up to 20 knots, and collect data to a maximum depth of 760 m. Sound Velocity data from the CTD and XBT are viewed and processed using the in-house NOAA program Velocipy on the CTD computer. The sound speed computed by TSG is fed into SCS and the multibeam acquisition computer.

Figure 11. Photos: XBT launch from the aft deck (left). Deck unit for XBT in red (right)

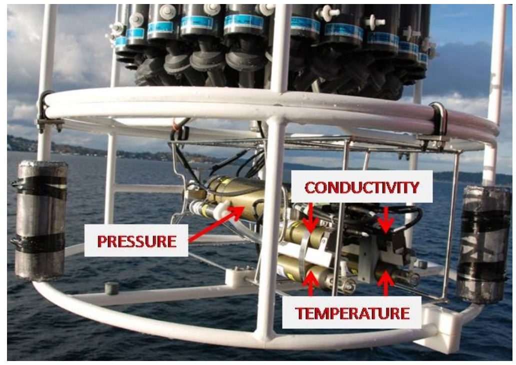


Figure 12. Photos: (Left) Deck Unit (SBE 11) for acquisition of real time sound speed profile from SBE 9 plus CTD (Right) Horizontally mounted CTD with dual Temperature and Conductivity sensors and SBE 32 Carousel for 24-bottle water sampling.

The primary Sea-Bird CTD sensor for the 2012 field season is SBE-9Plus CTD SN 09P47490-0906. The calibration report SBE9plusP090608Oct10.pdf for manufacturer calibration information and testing results is available by contacting the ship. During the shakedown cruise simultaneous comparison of CTDs, XBT and surface sound speed comparison showed a close agreement between CTD and XBT sound velocity profiles.

SBE 32 Carousel (Water Sampler)

SBE 9/11 plus CTD is connected to the SBE 32 Carousel. The SBE 32 is rigged with 24-2.5L water sampling bottles. The bottles can be fired to close at any depth during a cast through the Seasave acquisition software on CTD computer in the dry lab or control room.
In 2011, additional CTD sensors were acquired and installed on the CTD. These include Dissolved Oxygen, Light Scattering Sensor (LSS), Oxidation Reduction Potential (ORP) and an altimeter.

Scientific Seawater Measurement System (including backup surface sound speed)

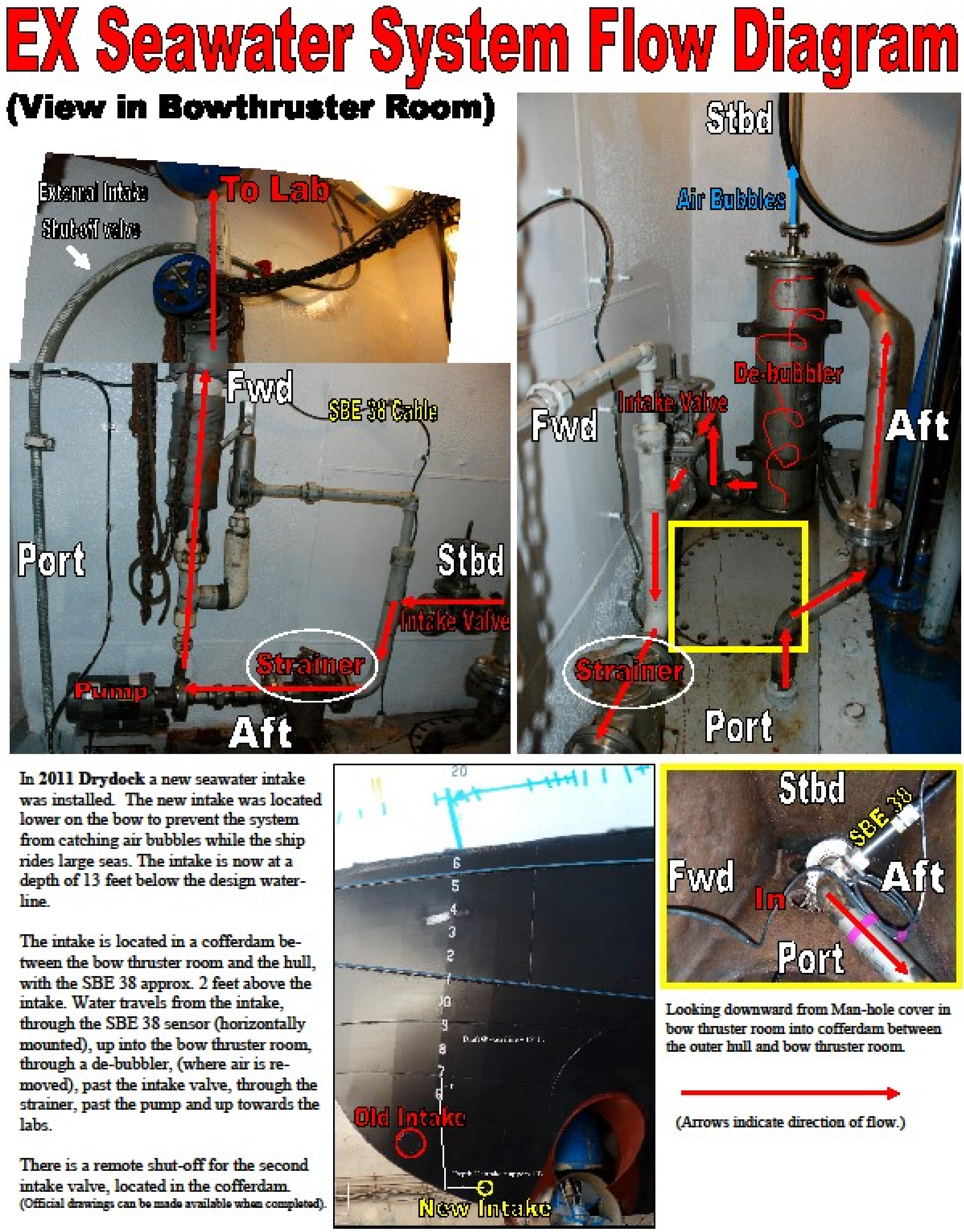
The scientific seawater system utilizes a SBE 45 Thermosalinograph (TSG) and an SBE 38, to collect continuous sea surface temperature and salinity data. Located in the Wet Lab, the TSG collects temperature and conductivity readings, and is capable of deriving salinity and sound velocity data in real time. The pump and the SBE 38 are located in the bow thruster room. During the 2010/2011 winter in port, a de-bubbler was installed between the intake and the pump to reduce susceptibility to air-intake during rough seas. During the 2011 shakedown cruise, the system maintained a steady flow during seas up to a 10-12 foot swell and winds of 40 knots without interruption.

The ship was not provided with drawings after the modifications were made, so the intake depth was measured with a photo of the bow showing the draft marks. The average draft at the bow is 15' 1". The distance between the bottom of a draft mark and the bottom of the next draft mark is 1'. Measuring downward, the depth of the intake below the sea surface is approximately 13'.

Figure 13. Photo showing depth of TSG intake location on the hull, approximately 13 feet below the water line.

The pump intakes water from eleven feet below the water line into the Bow Thruster Room, where a SBE 38 Remote Temperature Sensor acquires sea surface temperature. Afterwards, the water continues aft to the wet lab where it passes through the SBE 45 and is expelled on the port side below and a little forward of the wet lab.

The graphic below shows the flow of seawater from the point of intake on the hull to the wet lab. Official drawings are being produced by the ship.



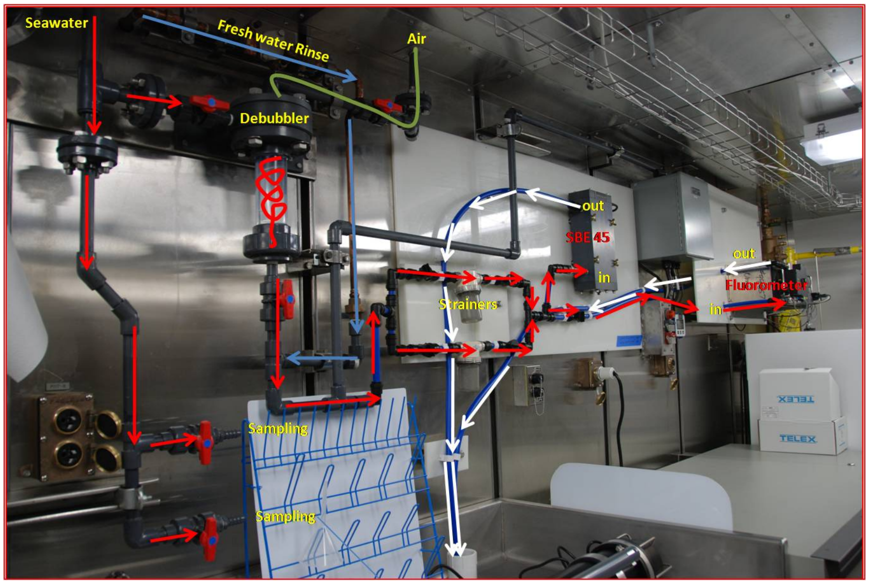


Figure 14. Photo showing intake configuration of the Scientific Seawater System, located in the bow thruster room (left). Flow diagram of Scientific Seawater System components in the wet lab, including TSG. Note: the flourometer has been removed from the system.

Surface Sound Speed – Reson SVP-70 Velocity Probe

A Reson Sound Velocity Probe (SVP-70) was installed during the 2010 drydock. It is located on the starboard side access cover on the transducer fairing, aft of the multibeam receive array. This is the primary sensor for surface sound speed measurement.

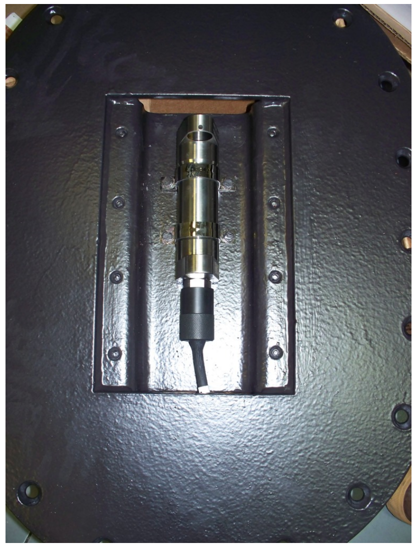


Figure 15. Photo showing the Reson SVP-70 probe attached to the access cover on the hull.

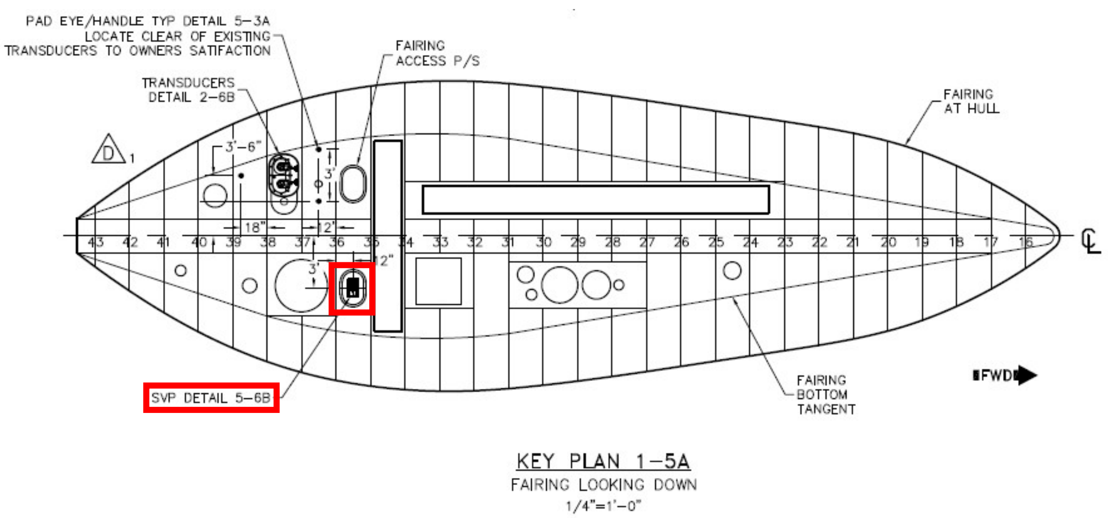


Figure 16. Line drawing showing the placement of the SVP probe on the transducer fairing.

Bridge Dynamic Positioning System

Okeanos Explorer is equipped with Kongsberg Dynamic position (DP) that has been integrated with the navigation system to help *Okeanos Explorer* maintain her position within a few meters during ROV operations using bow and stern thrusters. The DP system is also capable of running predefined track lines with minimal supervision.

During the 2012 performance evaluation, the bridge DP system was found to be performing satisfactorily, in particular capable of maintaining position and following predetermined track lines. The bridge DP system requires the track lines be input in a specific format, specifically as a series of way points. Lines created by the survey department in MapInfo and Hypack are converted via a MATLAB routine to be compliant with the bridge DP system. The DP system at present is not connected to ship's net-work and therefore way point files need to be manually fed to the DP system through a local USB port. An alternative work around is to manually input the way points into DP system via a key pad.

An example of a DP system compliant way point file is provided in the appendices section of this report.

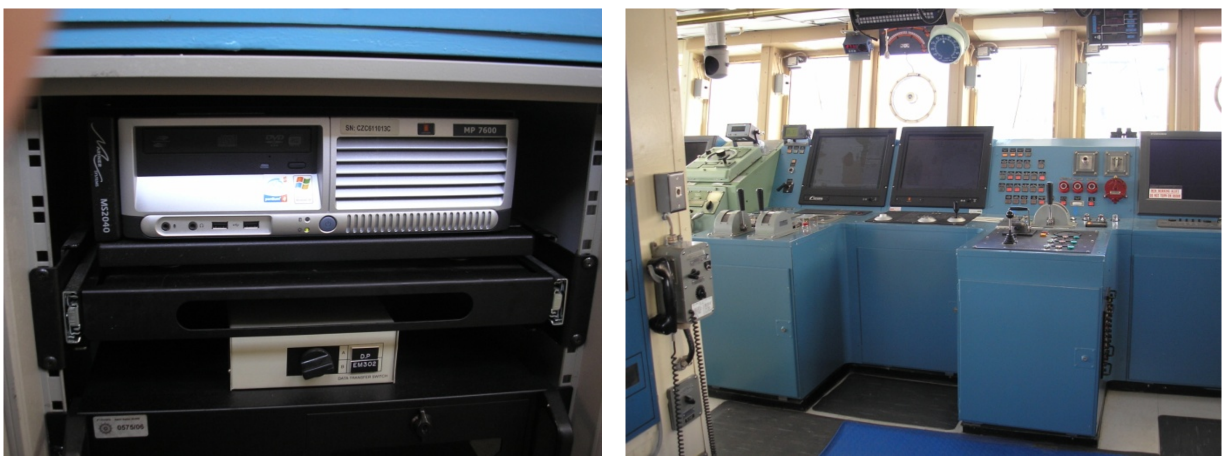


Figure 17. Bridge DP system installed on Okeanos Explorer (right) showing different controls and the USB drive (left) for inputting electronic files for the way point table.

6. Static Vessel Offsets

The sensors (IMU and GPS antennas), the sonar system, and permanent benchmarks were measured with respect to the vessel's reference point (RP), which is the granite block shown in Figure 7. The ship was surveyed by Westlake Consultants, Inc. The resultant preliminary report "Report of Sonar Systems and GPS Antennae as-builting on the NOAA *Okeanos Explorer*" March 18, 2008 [2] summarizes Westlake Consultant's survey methodology, defines the coordinate system and details the offsets measurements. All measurements described within the report are referred to the granite block and follow the coordinate system where all values--STBD (Y), FWD (X) and down (Z) of the granite block--as positive. Positive pitch is described as bow up and positive roll is described as STBD up.

Center of Roll and Pitch

The ship's center of gravity changes with ship loading conditions. The position of the center of the gravity was available from the records of the ship's inclining experiment done in 2008 [3]. To determine lever arm offsets, the center of gravity was assumed to be a reasonable approximation of the center of rotation. The position of the ship's center of gravity based on light conditions detailed in the Stability Test report [3], was measured to be 31.501 m aft of the forward perpendicular (frame 0), 0.0 m starboard of the center line, and 5.514 m above the keel base line. These values were transformed into the POS/MV reference frame with reference to the RP.

Table 5. Granite block (RP) to center of gravity (rotation) offsets

RP to center of gravity (rotation) (m)		
X	Y	Z
-7.896	2.487	0.825

Mapping sensor specific offsets

The GPS antenna to reference point lever arm is accounted for in the POS/MV controller. The sonar specific offsets such as roll mounts and sonar locations are entered directly into the Kongsberg Seafloor Information System (SIS) acquisition software. These figures are referenced to the granite block (RP).

Table 6. EM 302 specific offsets.

	Sonar coordinates (m)			Angular offsets (Degrees) after patch test		
	X	Y	Z	Roll	Pitch	Heading
EM 302 Transmit array	6.147	1.822	6.796	0.0	0.0	359.98
EM 302 Receiver array	2.497	2.481	6.790	0.0	0.0	0.03

EM 302 Water line	----	----	1.838	----	----	----
EA 600 / EK 60						
Knudsen SBP	3.967	3.500	6.746	----	----	----

IMU and Antenna Offsets

The offsets between the reference point and the GPS antenna were referenced to the primary antenna. The port antenna is primary.

Table 7. POS MV settings for offsets to primary GPS, aux GPS (C-NAV) and IMU.

POS /MV Coordinates			
	X	Y	Z
Primary GPS (Port Ant.)	8.265	1.335	-15.403
Ref to IMU	0.734	0.008	-0.022
Ref to Aux 1 GPS (C-NAV)	8.353	5.927	-15.396

Static draft measurement

The static draft is measured by the bridge before the start of each cruise and the information is included in every mapping cruise report. The bow draft is directly read off draft marks on the hull and the stern draft is measured and then calculated from a specific frame on the fantail. These draft measurement are then compared to and verified with the results from the ship's stability calculations.

Draft measurements taken during cruise EX1201 were as follows:

Beginning draft 02/14/2012	Fwd: 14' 05" Aft: 14'05"
Ending draft 02/23/2012	Fwd: 13' 9" Aft: 15' 01"

Dynamic Draft

Dynamic draft measurements have not been calculated for *Okeanos Explorer*.

7. System Calibrations and Performance Evaluations

The measured distance between the antennas [3, Westlake report], is 2.3001. POS MV manual (section 4) describes that the distance between the antennas calculated in GAMS calibration should be within 5 mm to actual distance. The GAMS calibration resulted in a distance between the antennas to be 2.297 m therefore the difference between actual antennas separation and GAMS solution antennas separation is 4 mm (< 5mm). Therefore the GAMS calibration seems to be done correctly.

GAMS did not appear to require calibration during the 2010 shakedown cruise, with the GAMS status consistently “online” or “ready online”. However, a GAMS calibration was run as a precautionary measure, resulting in no change of GAMS status or values. A GAMS calibration was not run during the 2012 shakedown cruise.

EM 302 Patch Test

During the EX1201 Shakedown cruise (Feb. 14 -23, 2012), a multibeam patch test was conducted over Veatch Canyon southeast of Rhode Island. The patch test was run with the previous year’s transducer offsets applied. The results of the patch test were analyzed in both SIS Calibration Mode and with the CARIS Calibration Tool. Screen grabs of all CARIS calibrations are provided in the appendices of this report. The offsets were determined to have not changed from previous years’ patch test results.

Table 8. Angular offsets for Transmit (TX) and Receive (TX) transducer and attitude sensor

	Roll	Pitch	Heading
TX Transducer	0.0	0.0	359.98
RX Transducer	0.0	0.0	0.03
Attitude	0	-0.725	0.0

Timing and Pitch Offset

The navigation time error and pitch biases were determined by running a single line in opposite directions at two speeds over a section of Veatch Canyon with slopes of up to 30°. It was determined there is no timing offset present in the navigation and timing system. The pitch offset was confirmed to be -0.0725.

Roll Offset

The roll bias was determined by running a single line at the same speed over a flat area in 2075 meters of water in opposite directions. It was confirmed there is no roll offset in the installation.

Heading Offset

The heading bias was determined by running a pair of parallel line offset from each other by 3.5 kilometers. The lines each ensonified the steep sides of Veatch Canyon in their outer beams. The lines were run in the same direction and at the same speed across the canyon. It was confirmed there is no heading offset in the installation.

EM 302 Crossline Analysis

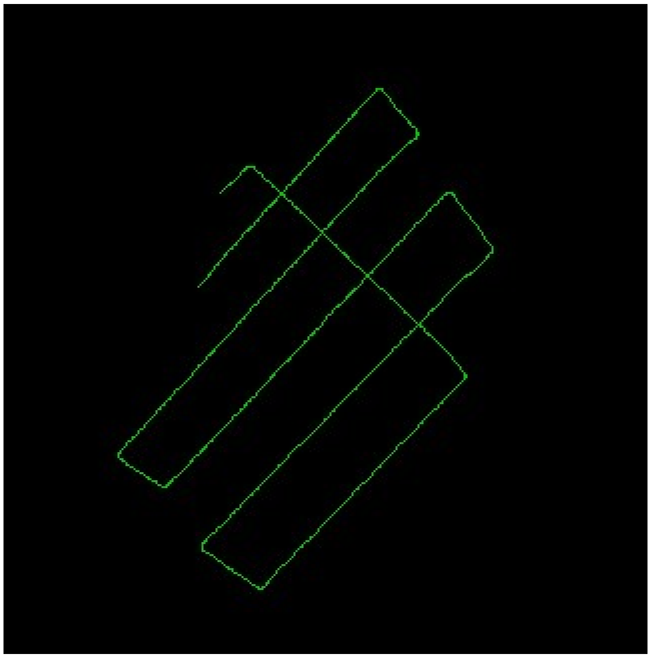


Figure 18. Screen shot (north up) taken in CARIS 7.1 showing lines used in crossline analysis.

Cross Line:
0068_20120219_203701_EX1201_MB

Main scheme Lines:
0064_20120219_123703_EX1201_MB
0065_20120219_143702_EX1201_MB
0066_20120219_163702_EX1201_MB
0067_20120219_183701_EX1201_MB

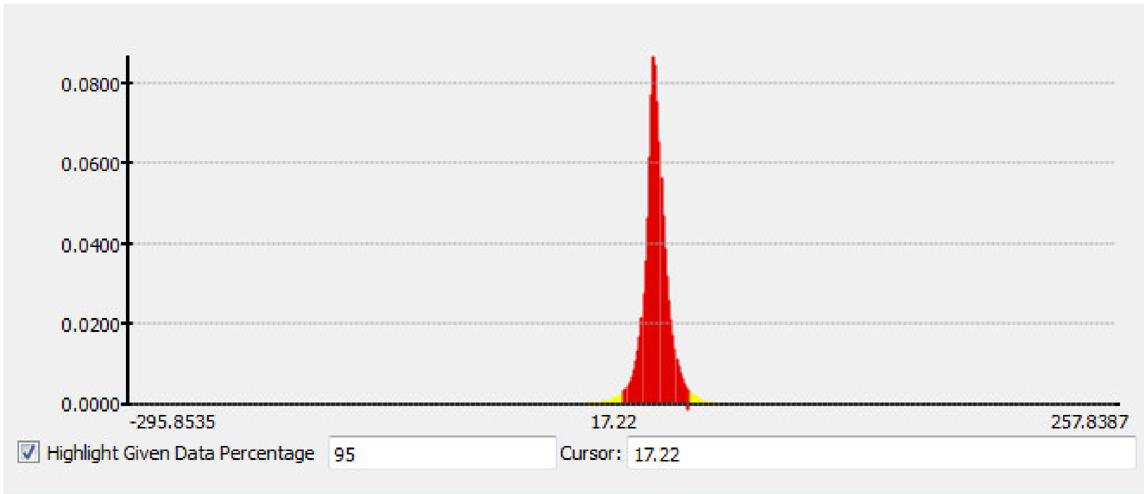


Figure 19. Screen grab showing Fledermaus CrossCheck results. Data falling within the 95% confidence level is highlighted in red.

The statistics from running the Fledermaus Crosscheck routine were as follows (values in meters):

-1802.206263 # Data Mean
-1801.884124 # Reference Mean
-0.322140 # Mean
-0.569490 # Median
11.176000 # Std. Deviation
-2643.80 -984.97 # Data Z - Range
-2490.55 -1022.37 # Ref. Z - Range
-295.85 257.84 # Diff Z - Range
22.673200 # Mean + 2*stddev
22.920555 # Median + 2*stddev

Sound Velocity Sensor Comparisons

Two sound velocity comparison casts were conducted. Both comparisons showed good agreement between the two sensor types.

CTD file EX1201_CTD01_20120215 was compared to Deep Blue XBT EX1201_XBT06_120215 file. The results are shown at left below.

CTD file EX1201_CTD02_20120215 was compared to Deep Blue XBT EX1201_XBT08_120215 file. The results are shown at right below.

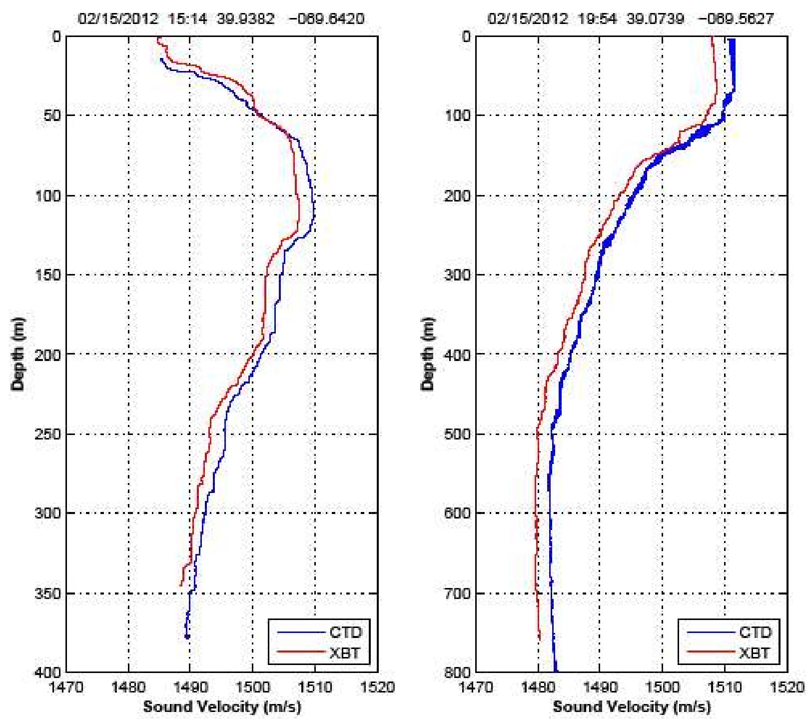
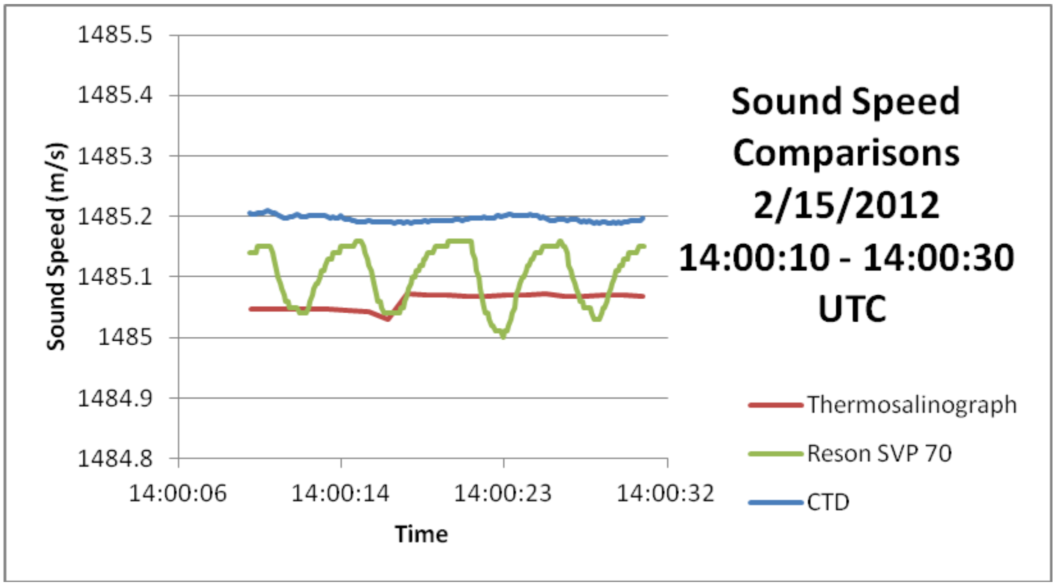


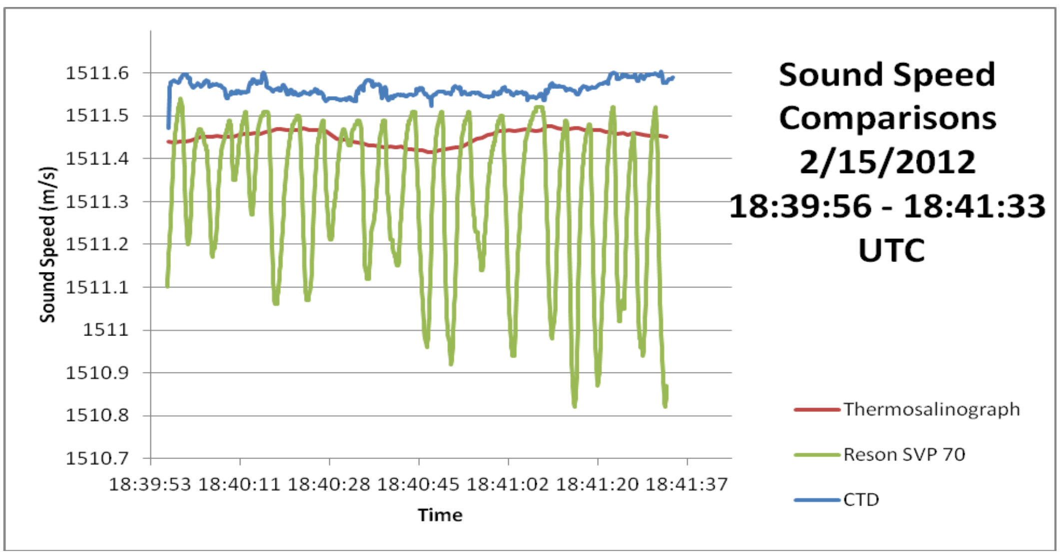
Figure 20. Results of comparison cast between Seabird SBE09Plus S/N 09P47490-0906 and Sippican Deep Blue XBT probe (shown in blue).

Two CTD casts were conducted to compare to the thermosalinograph and Reson SVP 70 probe. The CTD was held at the approximate depths of the sound velocity probe, or 4 to 4.5 meters. The results of the comparisons were favorable, showing less than 0.6 m/s differences, and are shown below.

The files recorded by the ship's Scientific Computer System (SCS) compared were:
CTD file (from SCS) CTD-RAW_20110325-000000.Raw
Reson SVP 70: Sound-Velocity-Probe_20120215-000000.Raw

TSG-RAW_20120215-000000.Raw





8. Data Processing

Detailed documentation is available in the form of standard operating procedures (SOPs) for all data collection and processing routines performed by the mapping team onboard *Okeanos Explorer*. The purpose of this data processing section is to describe the current status of a few data processing pipelines.

Bathymetric Data Processing

CARIS HIPS/SIPS v. 7.1.1 is used to edit the bathymetric data from the EM 302 multibeam. At present, an uncertainty model for the EM 302 is in development and therefore manual editing of bathymetric data has been the practice. Cleaned data is exported to ASCII text files and then imported to IVS Fledermaus v. 7.3.1a for further processing, visualization, quality control, and product generation.

The Kongsberg SIS system accounts for all the static offsets and biases during real time acquisition. The motion data from the POS MV is directly fed into SIS during data acquisition to account for ship motion (i.e. heave, roll, pitch). Yaw is provided by the TSS gyrocompases located on the bridge. Also the real time sound speed near the sonar head is fed into SIS and the most recently acquired sound speed profile is used in real time to correct soundings for sound speed corrections during data acquisition. Unless there are problems observed in the data, there is no requirement to apply these corrections during post processing in CARIS. As a result, the vessel configuration file (VCF) for *Okeanos Explorer* contains zeros offsets, and the motion data is not required to be applied during post processing. However, for the computation of uncertainty in CARIS HIPS, actual offsets are required along with standard deviations for miscellaneous sensors used. The HIPS VCF is provided as Appendix C.

Bottom Backscatter Data Processing

The QPS Fledermaus FMGT software package used for processing EM 302 bottom backscatter data. This version of FMGeocoder is installed when upgrading to the Fledermaus Version 7.1.0a, Build 481 from March 3, 2010.

Water Column Data Processing

The QPS Fledermaus MidWater software package is used to process EM 302 water column backscatter and EK 60 data and view the resulting Fledermaus SD objects. The programs are the best method available to the mapping department for water column data processing. The output SD objects are viewable via a free software iView4D available here http://www.qps.nl/display/fledermaus/iview (last accessed 02/19/2012).

It possible to produce the following SD objects using FM MidWater: beam fan, beam line, volume, and track line. These products are produced on an as-needed exploration operational basis.

Subbottom Data Processing

Sonar Wiz v. 4004.0034 is available for processing the SEG-Y files, and possibly the KEB and KEA files, generated by the Knudsen 3260 subbottom profiler. Complete testing of this data processing pipeline is in progress.

Sound Speed Cast Processing

Velocipy, a component of the larger survey Pydro developed by NOAA, is used for onboard sound velocity profile processing. Pydro is used within NOAA primarily by the hydrographic ships and the Office of Coast Survey. Velocipy reads raw XBT and CTD casts and converts to ASVP format, which is required by SIS. SIS is then used to extend profiles based on world average sound velocity profile data, and the profile is applied to correct the multibeam data for sound velocity effects in real time.

Additional Mapping Processing Software

Additional available mapping software including ArcMap, MapInfo, Hypack, and Global Mapper are available onboard. For a complete list of software available, see Table 7.

9. Data Management and Archival Procedures

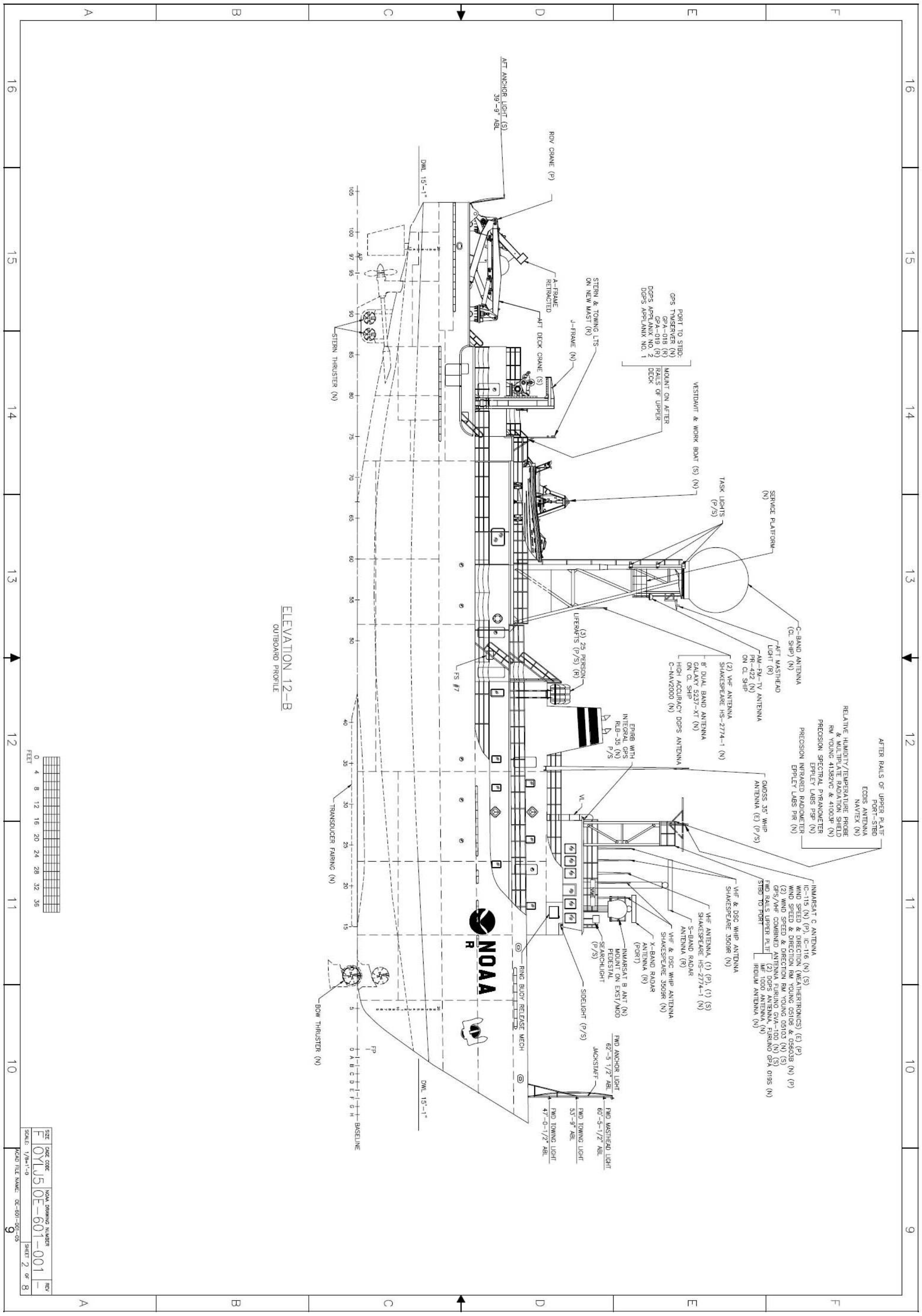
The 2012 *Okeanos Explorer* Data Management Plan,co- authored by the National Coastal Data Development Center and OER, is forthcoming as of February 2012. All data collected by the NOAA Ship *Okeanos Explorer* is made publically available through the public archives hosted by the National Geophysical Data Center and the National Oceanographic Data Center. The data is available in raw and processed formats that are readable by several free software packages.

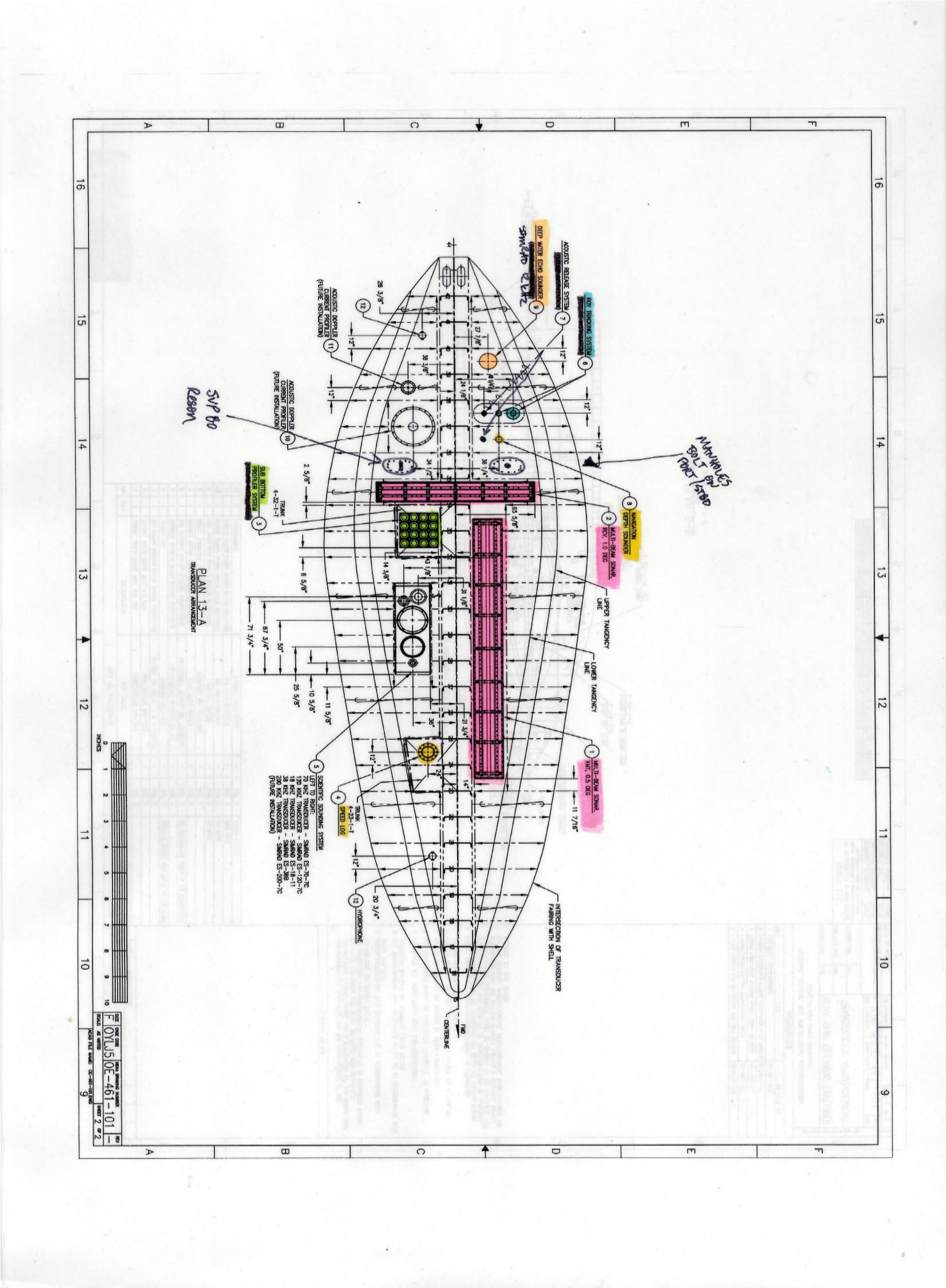
A mapping data report is produced by the mapping department for every cruise, and is archived alongside the data in the national archives and in the NOAA Central Library. The report describes the data acquisition and processing routines in place during the cruise. The mapping data report aims to promote understanding of the dataset collected during the cruise to promote ease of use of the data. This Readiness Report is intended to compliment the mapping data reports.

10. Appendices

Appendix A: Drawings of arrangement and location of deck hardware and transducer fairing

The two drawings below show the arrangement and location of deck hardware and transducer fairing after the completion of Okeanos Explorer conversion (Source: AMSEC LLC Naval Architect and Marine Engineers, Bremerton, Oakland, San Diego drawings 2005). The second drawing has been updated by hand based on fairing modifications completed during the 2010/2011 winter in-port.





Appendix B: Example of Dynamic Positioning (DP) system compliant way point table

```
CreateDate (UTC),Sunday, September 28, 2008 20:20:20
Version,4
TrackName,
NoOfWp,7
Datum,WGS84
WPFormat,WPId,WPHemisNS,WPLatDeg,WPLatMin,WPHemisEW,WPLonDeg,WPLonMin,WPLegType,WPHead,WPSpeed,WPTurnRad
WP,1,N,43,3.5609,W,126,40.3078,0,180,1.5433,200
WP,2,N,42,46.1603,W,126,49.2321,0,180,1.5433,200
WP,3,N,42,21.5328,W,127,15.5262,0,180,1.5433,200
WP,4,N,42,0.65965,W,127,14.6833,0,180,1.5433,200
WP,5,N,41,42.5906,W,127,22.0253,0,180,1.5433,200
WP,6,N,42,2.684,W,127,31.3482,0,180,1.5433,200
WP,7,N,42,16.7337,W,127,20.7283,0,180,1.5433,200
END
```

Appendix C: CARIS HIPS Vessel Configuration File (VCF) for NOAA Okeanos Explorer April, 2009

File: EXApril09.hvf


```
<?xml version="1.0"?>
<HIPSVesselConfig Version="2.0">
 <VesselShape>
  <PlanCoordinates>
   <Entry X="-5.500000" Y="-10.000000"/>
   <Entry X="7.500000" Y="-10.000000"/>
   <Entry X="7.500000" Y="40.000000"/>
   <Entry X="1.000000" Y="58.000000"/>
   <Entry X="-5.500000" Y="40.000000"/>
   <Entry X="-5.500000" Y="-10.000000"/>
  </PlanCoordinates>
  <ProfileCoordinates>
   <Entry Y="-10.000000" Z="4.000000"/>
   <Entry Y="-10.000000" Z="-6.000000"/>
   <Entry Y="40.000000" Z="-6.000000"/>
   <Entry Y="58.000000" Z="4.000000"/>
   <Entry Y="-10.000000" Z="4.000000"/>
  </ProfileCoordinates>
  <RP Length="10.000000" Width="7.500000" Height="6.000000"/>
 </VesselShape>
 <DepthSensor>
  <TimeStamp value="2006-276 00:00:00">
   <Latency value="0.000000"/>
   <SensorClass value="Swath"/>
   <TransducerEntries>
    <Transducer Number="1" StartBeam="1" Model="em300">
     <Offsets X="0.000000" Y="0.000000" Z="0.000000" Latency="0.000000"/>
     <MountAngle Pitch="0.000000" Roll="0.000000" Azimuth="0.000000"/>
    </Transducer>
   </TransducerEntries>
  </TimeStamp>
 </DepthSensor>
 <GyroSensor>
  <TimeStamp value="2008-252 00:00:00">
   <Latency value="0.000000"/>
   <ApplyFlag value="No"/>
  </TimeStamp>
 </GyroSensor>
 <HeaveSensor>
  <TimeStamp value="2008-252 00:00:00">
   <Latency value="0.000000"/>
   <ApplyFlag value="No"/>
   <Offsets X="0.000000" Y="0.000000" Z="0.000000" Heave="0.000000"/>
  </TimeStamp>
 </HeaveSensor>
 <NavSensor>
  <TimeStamp value="2008-252 00:00:00">
   <Latency value="0.000000"/>
   <Ellipse value="WG84"/>
   <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
   <Comment value="(null)"/>
   <Manufacturer value="(null)"/>
   <Model value="(null)"/>
   <SerialNumber value="(null)"/>
  </TimeStamp>
 </NavSensor>
 <PitchSensor>
  <TimeStamp value="2008-252 00:00:00">
   <Latency value="0.000000"/>
   <ApplyFlag value="No"/>
   <Offsets Pitch="0.000000"/>
  </TimeStamp>
 </PitchSensor>
 <RollSensor>
  <TimeStamp value="2008-252 00:00:00">
   <Latency value="0.000000"/>
   <ApplyFlag value="No"/>
   <Offsets Roll="0.000000"/>
   <Comment value="(null)"/>
   <Manufacturer value="(null)"/>
   <Model value="(null)"/>
   <SerialNumber value="(null)"/>
  </TimeStamp>
 </RollSensor>
 <TPEConfiguration>
  <TimeStamp value="2008-252 00:00:00">
   <Comment value=""/>
   <Latency value="0.000000"/>
   <Offsets>
    <MRUtoTransducer X="1.800000" Y="6.100000" Z="6.900000" X2="0.000000"
Y2="0.000000" Z2="0.000000"/>
    <NavigationToTransducer X="6.100000" Y="1.800000" Z="6.100000"
X2="0.000000" Y2="0.000000" Z2="0.000000"/>
    <Transducer Roll="0.000000" Roll2="0.000000"/>
    <Navigation Latency="0.000000"/>
   </Offsets>
   <StandardDeviation>
```

<Motion Gyro="0.000000" HeavePercAmplitude="5.000000" Heave="0.050000" Roll="0.020000" Pitch="0.020000" PitchStablized="0.000000"/>
<Position Navigation="0.500000"/>
<Timing Transducer="0.010000" Navigation="0.010000" Gyro="0.010000" Heave="0.010000" Pitch="0.010000" Roll="0.010000"/>
<SoundVelocity Measured="0.000000" Surface="0.000000"/>
<Tide Measured="0.000000" Zoning="0.000000"/>
<Offsets X="0.010000" Y="0.010000" Z="0.010000"/>
<MRUAlignment Gyro="0.010000" Pitch="0.010000" Roll="0.010000"/>
<Vessel Speed="0.250000" Loading="0.100000" Draft="0.100000" DeltaDraft="0.100000">
<StDevComment value="(null)"/>
</Vessel>
</StandardDeviation>
</TimeStamp>
</TPEConfiguration>
</HIPSVesselConfig>

Appendix D: Details of 2012 Deep Water Patch Test Results

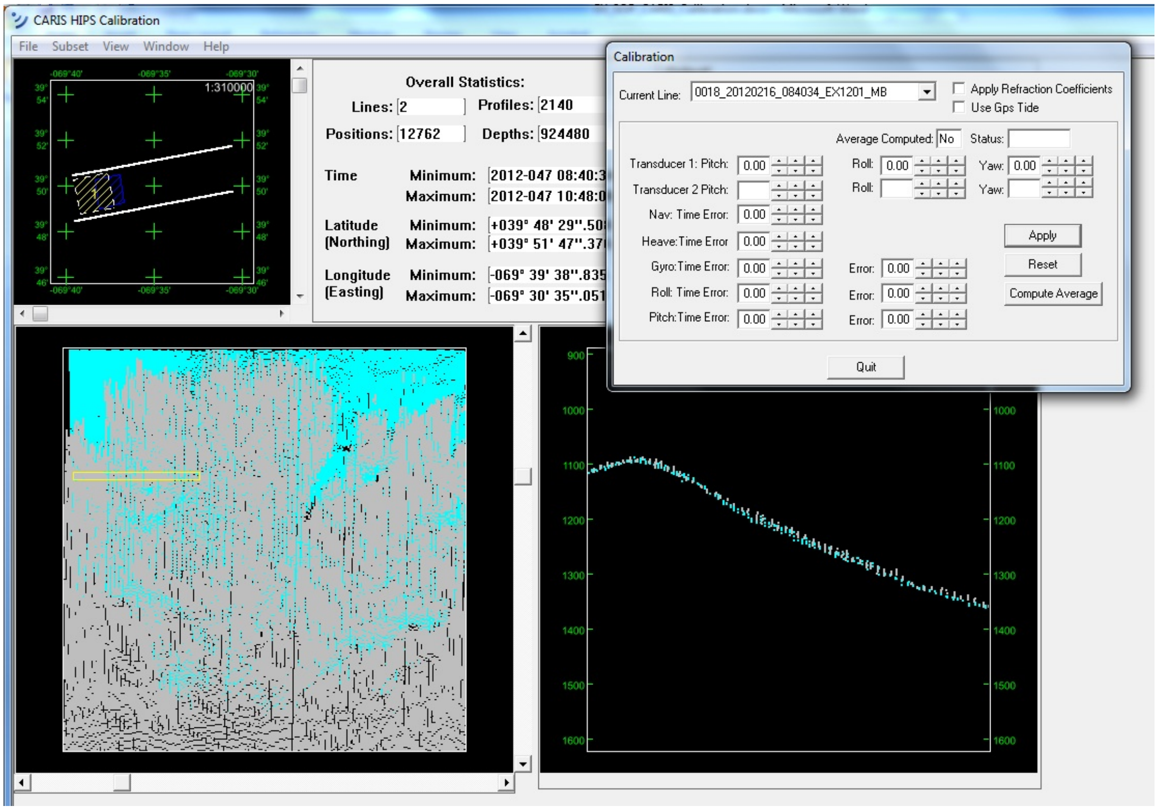


Figure 21. Screenshot of CARIS Calibration tool. Heading lines 0018, 0020 shown, verifying zero heading offset.

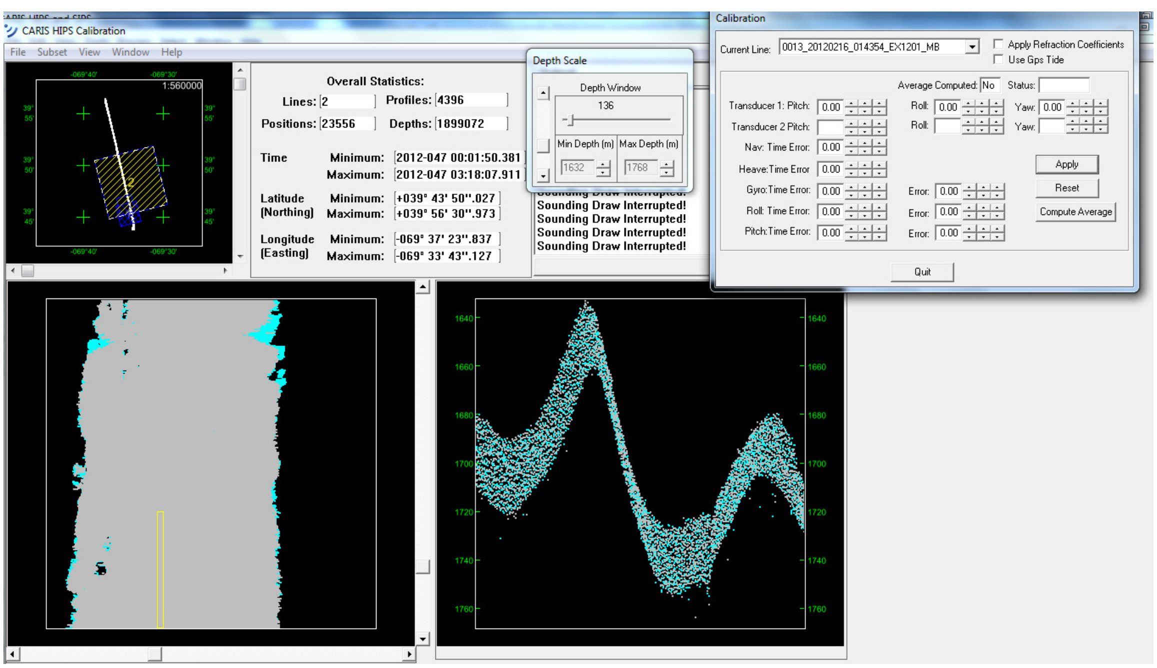


Figure 22. Screenshot of CARIS Calibration Tool. Pitch lines were run with known offset -0.725 degree applied. Pitch lines 0012 and 0013 shown, verifying no adjustment to known offset is necessary.

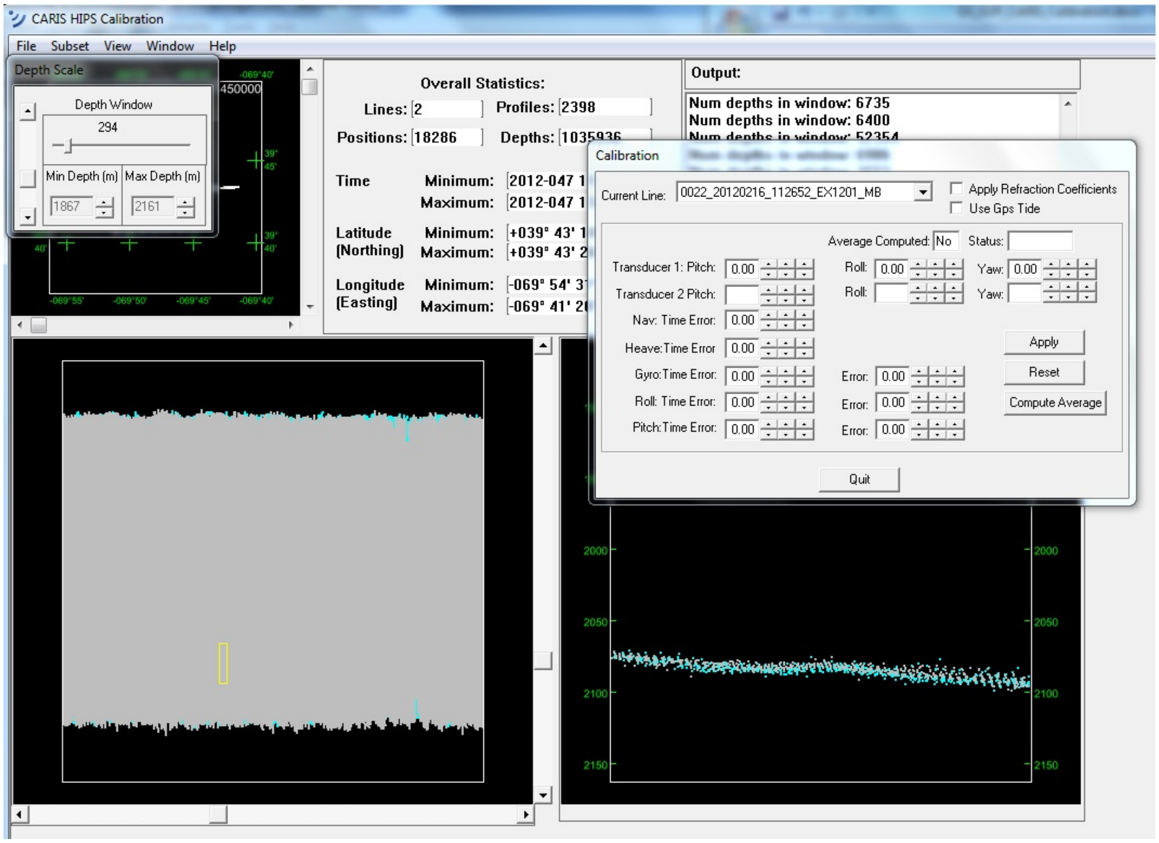


Figure 23. Screenshot of CARIS Calibration Tool. Roll lines 0022 and 0023 shown, verifying zero heading offset.

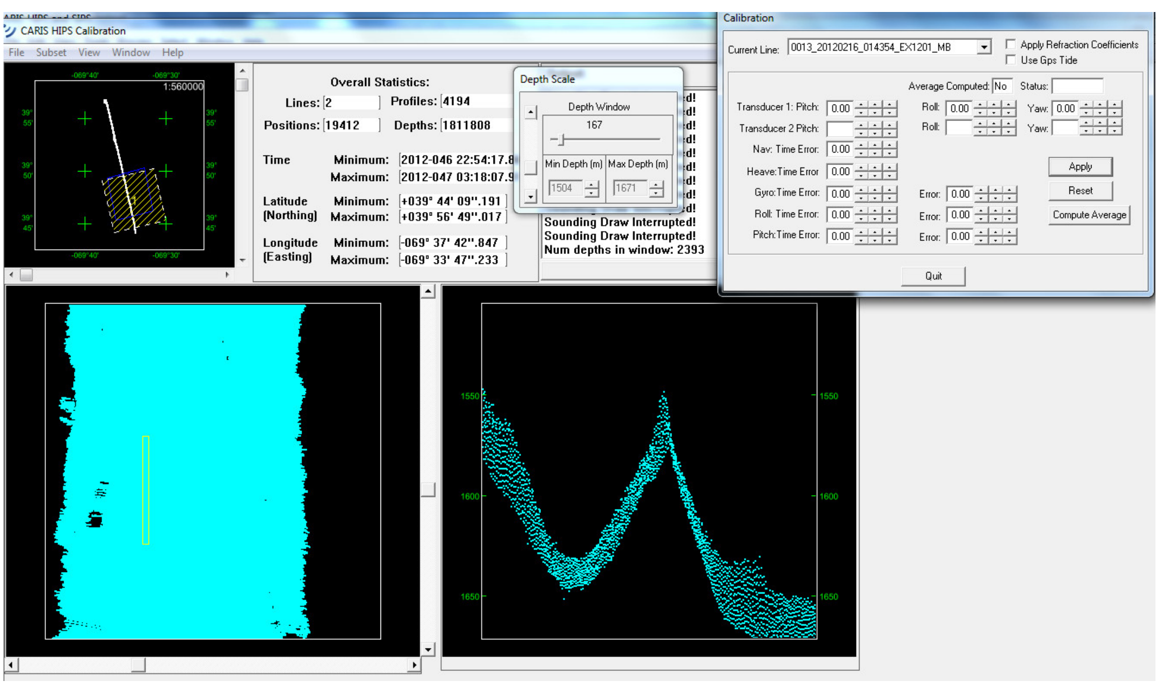


Figure 24. Screenshot of CARIS Calibration Tool. Timing offset lines 0011, run at 4 knots, and 0013, run at 8 knots, verifying zero timing offset.

Appendix E. Mapping Software

Table 9. Mapping software in use during the 2011 field season.

Appendix F. List of Acronyms

CTD – conductivity temperature and depth
GPS – global positioning system
HAT– Harbor Acceptance Test
IMU – inertial motion unit
MBES – multibeam echosounder
NCDDC – National Coastal Data Development Center
NGDC – National Geophysical Data Center
NOAA – National Oceanic and Atmospheric Administration
SAT – Sea Acceptance Test
SBES – singlebeam echosounder
SBP – sub-bottom profiler
SCS – Scientific Computer System
SVP – sound velocity profile
TRU – transreceiver unit
XBT – expendable bathythermograph

Appendix G. References available

The following documents are available by request to the ship (ops.explorer@noaa.gov).

- Knudsen chirp 3260 acceptance test report, 2008. D101-04819-Rev 1.
- Westlake Consultant report of Sonar Systems and GPS Antennae as-builting on the NOAA *Okeanos Explorer*. March 18, 2008.
- Ship inclining experiment report, 2008.
- Kongsberg EM 302 Sea Acceptance Test (SAT) report
- Kongsberg EA 600 Sea Acceptance Test (SAT) report
- Kongsberg EK 60 Harbor Acceptance Test (HAT) report
- Current Sea-Bird sensor calibration reports

Appendix H: Crane Load Diagrams

PORT

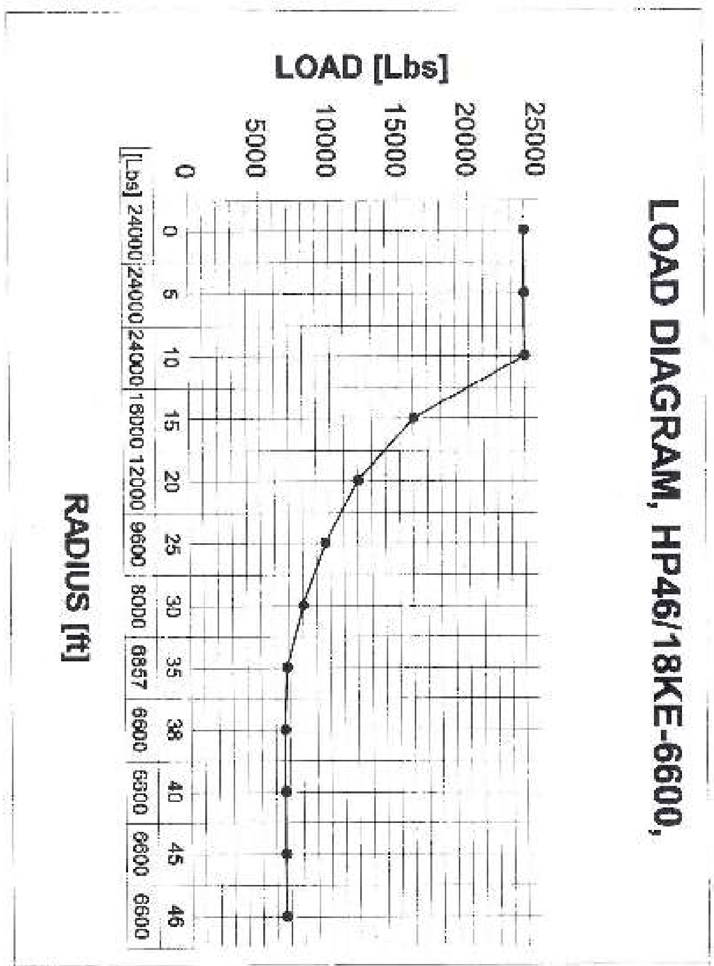


Figure 25. Port side crane load diagram.

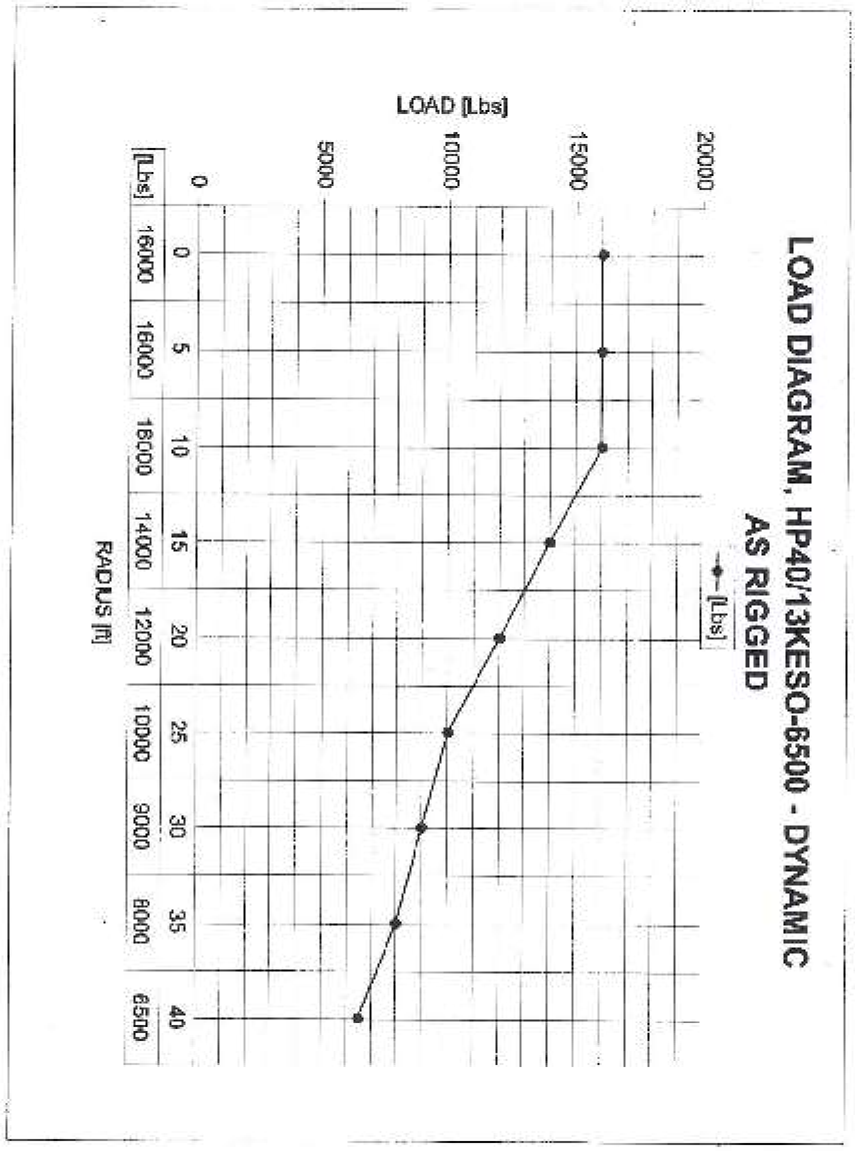


Figure 26. Starboard side crane load diagram.

Appendix I: EM 302 Built In System Test

Saved: 2012.02.23 08:25:43

Date Time Ser. No. BIST Result

2012.02.23 08:18:51.896 101 0 OK

Sounder Type: 302, Serial no.: 101

Number of BSP67B boards: 2

```
BSP 1 Master 2.3 090702 4.3 070913
4.3 070913
BSP 1 Slave 2.3 090702 6.0 080902
BSP 1 RXI FPGA 3.6 080821
BSP 1 DSP FPGA A 4.0 070531
BSP 1 DSP FPGA B 4.0 070531
BSP 1 DSP FPGA C 4.0 070531
BSP 1 DSP FPGA D 4.0 070531
BSP 1 PCI TO SLAVE A1 FIFO: ok
BSP 1 PCI TO SLAVE A2 FIFO: ok
BSP 1 PCI TO SLAVE A3 FIFO: ok
BSP 1 PCI TO SLAVE B1 FIFO: ok
BSP 1 PCI TO SLAVE B2 FIFO: ok
BSP 1 PCI TO SLAVE B3 FIFO: ok
BSP 1 PCI TO SLAVE C1 FIFO: ok
BSP 1 PCI TO SLAVE C2 FIFO: ok
BSP 1 PCI TO SLAVE C3 FIFO: ok
BSP 1 PCI TO SLAVE D1 FIFO: ok
BSP 1 PCI TO SLAVE D2 FIFO: ok
BSP 1 PCI TO SLAVE D3 FIFO: ok
BSP 1 PCI TO MASTER A HPI: ok
BSP 1 PCI TO MASTER B HPI: ok
BSP 1 PCI TO MASTER C HPI: ok
BSP 1 PCI TO MASTER D HPI: ok
BSP 1 PCI TO SLAVE A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE A3 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE B3 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE C3 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok
BSP 1 PCI TO SLAVE D3 HPI: ok
BSP 2 Master 2.3 090702 4.3 070913
4.3 070913
BSP 2 Slave 2.3 090702 6.0 080902
BSP 2 RXI FPGA 3.6 080821
BSP 2 DSP FPGA A 4.0 070531
BSP 2 DSP FPGA B 4.0 070531
BSP 2 DSP FPGA C 4.0 070531
BSP 2 DSP FPGA D 4.0 070531
BSP 2 PCI TO SLAVE A1 FIFO: ok
BSP 2 PCI TO SLAVE A2 FIFO: ok
BSP 2 PCI TO SLAVE A3 FIFO: ok
BSP 2 PCI TO SLAVE B1 FIFO: ok
BSP 2 PCI TO SLAVE B2 FIFO: ok
BSP 2 PCI TO SLAVE B3 FIFO: ok
BSP 2 PCI TO SLAVE C1 FIFO: ok
BSP 2 PCI TO SLAVE C2 FIFO: ok
BSP 2 PCI TO SLAVE C3 FIFO: ok
BSP 2 PCI TO SLAVE D1 FIFO: ok
BSP 2 PCI TO SLAVE D2 FIFO: ok
BSP 2 PCI TO SLAVE D3 FIFO: ok
BSP 2 PCI TO MASTER A HPI: ok
BSP 2 PCI TO MASTER B HPI: ok
BSP 2 PCI TO MASTER C HPI: ok
BSP 2 PCI TO MASTER D HPI: ok
BSP 2 PCI TO SLAVE A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok
BSP 2 PCI TO SLAVE A3 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE B3 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE C3 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok
BSP 2 PCI TO SLAVE D3 HPI: ok

Summary:
BSP 1: OK
BSP 2: OK


-----------------------------------------------------
------------------------------

2012.02.23 08:18:54.780  101        1
OK


High Voltage Br. 1
------------------
TX36   Spec: 90.0  - 145.0
0-1   121.7
0-2   121.7
0-3   121.3
0-4   121.3
0-5   121.3
0-6   120.9
0-7   121.3
0-8   120.1
0-9   121.3
0-10   121.7
0-11  121.7
0-12  120.5
0-13  122.1
0-14  121.3
0-15  122.1
0-16  122.1
0-17  120.9
0-18  121.7
0-19  120.9
0-20  121.3
0-21  121.3
0-22  122.1
0-23  120.5
0-24  121.3


High Voltage Br. 2
------------------
TX36   Spec: 90.0  - 145.0
0-1   121.3
0-2   121.3
0-3   121.3
0-4   120.9
0-5   120.9
0-6   120.9
0-7   120.5
0-8   120.9
0-9   121.7
0-10   121.3
0-11  121.3
0-12  120.9
0-13  120.1
0-14  121.7
0-15  121.7
0-16  121.7
0-17  121.3
0-18  121.3
0-19  120.9
0-20  121.3
0-21  121.7
0-22  121.7
0-23  121.3
0-24  121.3


Input voltage 12V
-----------------
TX36   Spec: 11.0  - 13.0
0-1    11.9
0-2    11.9
0-3    11.9
0-4    11.9
0-5    11.9
0-6    11.9
0-7    11.9
0-8    11.9
0-9    11.9
0-10    11.9
0-11   11.9
0-12   11.9
0-13   11.9
0-14   11.9
0-15   11.9
0-16   12.0
0-17   11.9
0-18   11.9
0-19   11.9
0-20   12.0
0-21   11.9
0-22   11.9
0-23   11.8
0-24   11.9


Digital 3.3V
------------
TX36   Spec:  2.8  -  3.5
0-1    3.3
0-2    3.3
0-3    3.3
0-4    3.3
0-5    3.3
0-6    3.3
0-7    3.3
0-8    3.3
0-9    3.3
0-10    3.3
0-11    3.3
0-12    3.3
0-13    3.3
0-14    3.3
0-15    3.3
0-16    3.3
0-17    3.3
0-18    3.3
0-19    3.3
0-20    3.3
0-21    3.3
0-22    3.3
0-23    3.3
0-24    3.3


Digital 2.5V
------------
TX36   Spec:  2.4  -  2.6
0-1    2.5
0-2    2.5
0-3    2.5
0-4    2.5
```

0-5 2.5
0-6 2.5
0-7 2.5
0-8 2.5
0-9 2.5
0-10 2.5
0-11 2.5
0-12 2.5
0-13 2.5
0-14 2.5
0-15 2.5
0-16 2.5
0-17 2.5
0-18 2.5
0-19 2.5
0-20 2.5
0-21 2.5
0-22 2.5
0-23 2.5
0-24 2.5

Digital 1.5V

TX36 Spec: 1.4 - 1.6
0-1 1.5
0-2 1.5
0-3 1.5
0-4 1.5
0-5 1.5
0-6 1.5
0-7 1.5
0-8 1.5
0-9 1.5
0-10 1.5
0-11 1.5
0-12 1.5
0-13 1.5
0-14 1.5
0-15 1.5
0-16 1.5
0-17 1.5
0-18 1.5
0-19 1.5
0-20 1.5
0-21 1.5
0-22 1.5
0-23 1.5
0-24 1.5

Temperature

TX36 Spec: 15.0 - 75.0
0-1 28.4
0-2 28.8
0-3 29.6
0-4 29.6
0-5 29.6
0-6 30.0
0-7 30.8
0-8 30.8
0-9 30.4
0-10 28.4
0-11 28.0
0-12 28.4
0-13 28.0
0-14 30.4
0-15 28.8
0-16 28.4
0-17 28.4
0-18 28.8
0-19 28.0
0-20 28.4
0-21 28.8
0-22 28.4
0-23 28.8
0-24 28.4

Input Current 12V

TX36 Spec: 0.3 - 1.5
0-1 0.6
0-2 0.5
0-3 0.5
0-4 0.5
0-5 0.5
0-6 0.5
0-7 0.6
0-8 0.5
0-9 0.6
0-10 0.5
0-11 0.6
0-12 0.6
0-13 0.6
0-14 0.6
0-15 0.6
0-16 0.5
0-17 0.8
0-18 0.7
0-19 0.6
0-20 0.6
0-21 0.7
0-22 0.5
0-23 0.5
0-24 0.6

TX36 power test passed

IO TX MB Embedded PPC Embedded PPC Download
2.11 One CPU1.13 Reduced Performance: 1 voice/Mar 5 2007/1.07 Jun 17 2008/1.11

TX36 unique firmware test OK

2012.02.23 08:19:09.547 101 2 OK

Input voltage 12V

RX32 Spec: 11.0 - 13.0
7-1 11.6
7-2 11.7
7-3 11.7
7-4 11.7

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

Digital 3.3V

RX32 Spec: 2.8 - 3.5
7-1 3.3
7-2 3.3
7-3 3.3
7-4 3.3

Digital 2.5V

RX32 Spec: 2.4 - 2.6
7-1 2.5
7-2 2.5
7-3 2.4
7-4 2.4

Digital 1.5V

RX32 Spec: 1.4 - 1.6
7-1 1.5
7-2 1.5
7-3 1.5
7-4 1.5

Temperature

RX32 Spec: 15.0 - 75.0
7-1 29.0
7-2 30.0
7-3 31.0
7-4 29.0

Input Current 12V

RX32 Spec: 0.4 - 1.5
7-1 0.7
7-2 0.7
7-3 0.7
7-4 0.7

Input Current 6V

RX32 Spec: 2.4 - 3.3
7-1 2.7
7-2 2.8
7-3 2.9
7-4 2.8

RX32 power test passed

IO RX MB Embedded PPC Embedded PPC Download
1.12 Generic1.14 GenericMay 5 2006/1.06 May 5 2006/1.07 Feb 18 2010/1.11

RX32 unique firmware test OK

2012.02.23 08:19:09.681 101 3
OK

High Voltage Br. 1

TX36 Spec: 90.0 - 145.0
0-1 121.7
0-2 121.3
0-3 121.3
0-4 121.3
0-5 120.9
0-6 120.9
0-7 121.3
0-8 120.1
0-9 121.3
0-10 121.7
0-11 121.7
0-12 120.5
0-13 122.1
0-14 121.3
0-15 122.1
0-16 122.1
0-17 120.9
0-18 121.7
0-19 120.9
0-20 121.3
0-21 120.9
0-22 121.7
0-23 120.5
0-24 121.3

High Voltage Br. 2

TX36 Spec: 90.0 - 145.0
0-1 121.3
0-2 121.3
0-3 120.9
0-4 120.9
0-5 120.9
0-6 120.9
0-7 120.5
0-8 120.5
0-9 121.3
0-10 121.3
0-11 120.9
0-12 120.9
0-13 120.1
0-14 121.7
0-15 121.7
0-16 121.7
0-17 120.9
0-18 121.3
0-19 120.9
0-20 121.3
0-21 121.7
0-22 121.7
0-23 120.9
0-24 121.3

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9
0-2 11.9
0-3 11.9
0-4 11.9
0-5 11.9
0-6 11.9
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.9
0-11 11.9
0-12 11.9
0-13 11.9
0-14 11.9
0-15 11.9
0-16 12.0
0-17 11.9
0-18 11.9
0-19 11.9
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.8
0-24 11.9

RX32 Spec: 11.0 - 13.0
7-1 11.7
7-2 11.7
7-3 11.7
7-4 11.7

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

TRU power test passed

2012.02.23 08:19:09.864 101 4
OK

EM 302 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage: 18.00 PASSED
Test Voltage:40.00 Measured Voltage: 39.00 PASSED
Test Voltage:60.00 Measured Voltage: 59.00 PASSED
Test Voltage:80.00 Measured Voltage: 79.00 PASSED
Test Voltage:100.00 Measured Voltage: 100.00 PASSED
Test Voltage:120.00 Measured Voltage: 121.00 PASSED
Test Voltage:120.00 Measured Voltage: 120.00 PASSED
Test Voltage:100.00 Measured Voltage: 106.00 PASSED
Test Voltage:80.00 Measured Voltage: 85.00 PASSED
Test Voltage:60.00 Measured Voltage: 65.00 PASSED
Test Voltage:40.00 Measured Voltage: 45.00 PASSED

11 of 11 tests OK

2012.02.23 08:21:45.724 101 5
OK

BSP 1 RXI TO RAW FIFO: ok
BSP 2 RXI TO RAW FIFO: ok

2012.02.23 08:21:51.224 101 6
OK

Receiver impedance limits [600.0 1000.0] ohm

Board	1	2	3	4
1:	843.8	837.5	803.8	839.3
2:	820.5	845.7	805.9	848.6
3:	797.4	835.4	836.4	809.8
4:	832.1	821.1	824.8	834.9
5:	832.4	828.1	774.9	837.1
6:	840.8	843.1	820.1	816.8
7:	819.8	841.5	816.5	833.6
8:	827.2	828.1	841.3	737.7
9:	822.0	831.9	809.7	860.7
10:	805.7	852.0	769.1	824.9
11:	825.2	822.9	822.4	841.5
12:	832.7	811.2	829.9	846.4
13:	827.8	821.3	803.6	818.4
14:	809.9	825.2	843.4	834.7
15:	810.1	842.3	837.4	809.3
16:	836.1	813.0	839.3	874.5
17:	807.8	878.6	837.4	844.9
18:	833.0	825.9	843.2	813.9
19:	797.8	825.2	821.8	825.9
20:	812.1	868.7	833.3	839.6
21:	842.6	825.0	871.1	867.1
22:	858.4	838.9	815.6	815.2
23:	851.6	855.6	838.0	845.1
24:	864.1	882.0	857.2	841.7
25:	827.3	823.7	827.3	860.0
26:	826.7	816.1	839.2	840.8
27:	811.6	826.0	829.3	845.4
28:	798.2	825.0	802.3	826.5

29:	797.4	837.1	824.0	828.5
30:	837.9	813.3	839.1	0.0*
31:	812.0	815.2	840.4	835.8
32:	835.1	865.9	848.1	860.5

Transducer impedance limits [250.0 2000.0] ohm

Board	1	2	3	4
1:	330.5	355.4	350.0	354.4
2:	347.0	358.5	359.7	347.1
3:	336.4	335.3	367.8	360.3
4:	343.1	354.8	378.0	357.6
5:	327.9	356.4	369.4	347.0
6:	324.8	344.1	352.7	381.7
7:	335.3	345.1	387.3	354.8
8:	325.2	338.0	360.2	390.2
9:	359.8	360.1	377.6	355.0
10:	355.2	347.5	384.4	364.6
11:	328.2	362.3	360.0	369.6
12:	340.3	367.6	360.9	387.8
13:	332.7	349.4	382.5	387.5
14:	367.3	347.4	369.5	402.6
15:	325.7	338.7	364.8	361.5
16:	329.1	363.7	379.3	357.9
17:	326.5	354.1	348.3	360.9
18:	337.7	350.5	362.5	364.9
19:	349.3	355.4	356.0	368.1
20:	345.8	341.6	363.2	350.6
21:	341.3	352.7	352.1	368.2
22:	352.9	356.8	365.6	369.6
23:	356.2	338.5	378.7	370.7
24:	357.7	358.7	351.7	345.4
25:	339.4	365.0	358.3	350.3
26:	344.1	374.9	362.0	362.4
27:	334.9	356.5	359.7	354.3
28:	354.8	369.9	374.8	353.8
29:	349.7	360.8	376.6	388.0
30:	330.0	349.1	353.6	0.0*
31:	344.6	368.5	361.4	390.7
32:	342.0	352.1	363.7	368.3

Receiver Phase limits [-50.0 20.0] deg

Board	1	2	3	4
1:	-2.1	2.4	4.3	-0.9
2:	0.5	-3.0	3.8	-4.5
3:	4.0	-1.5	-0.8	3.1
4:	-1.6	2.3	1.3	-1.9
5:	-1.2	1.7	6.4	0.4
6:	-3.4	-2.4	0.1	3.2
7:	1.7	-0.6	3.5	-0.2
8:	-1.5	0.9	-3.7	13.5
9:	-0.5	2.4	3.5	-3.2
10:	2.7	-4.0	7.1	-0.9
11:	-2.5	2.2	-1.2	0.0
12:	-1.2	2.5	-2.1	-2.3
13:	0.6	1.6	4.0	3.8
14:	2.4	0.3	-0.7	-0.6
15:	0.7	-5.0	-1.7	3.3
16:	-2.3	3.4	-2.2	-7.4
17:	1.0	-5.3	-2.1	0.2
18:	-3.2	3.0	-2.7	3.4
19:	2.5	2.6	-1.7	2.3
20:	2.3	-5.0	-0.6	1.0
21:	-0.4	3.5	-5.6	-2.8
22:	-1.5	-1.5	2.1	2.5
23:	0.3	-3.4	0.0	-0.2
24:	-2.4	-5.3	-3.4	-1.4
25:	-0.7	2.5	1.2	-4.3
26:	-0.7	4.7	-3.6	-1.7
27:	1.6	-0.8	-0.2	-4.2
28:	5.4	-0.6	2.0	1.0
29:	3.0	1.9	0.8	2.2
30:	-2.5	2.2	-2.6	203.4*
31:	1.4	2.4	-2.1	1.5
32:	-2.6	-4.2	-3.4	-4.8

Transducer Phase limits [-100.0 0.0] deg

Board	1	2	3	4
1:	-37.5	-39.5	-38.5	-44.1
2:	-39.1	-40.8	-34.5	-48.9
3:	-34.0	-44.2	-37.9	-44.0
4:	-41.5	-38.1	-39.8	-39.3
5:	-40.9	-42.2	-41.6	-40.6
6:	-40.3	-37.9	-38.5	-39.4
7:	-37.0	-41.9	-38.6	-42.5
8:	-39.9	-42.7	-45.0	-36.3
9:	-41.2	-38.2	-37.8	-48.6
10:	-44.7	-40.8	-31.7	-40.3
11:	-41.2	-39.9	-45.5	-44.8
12:	-38.0	-38.9	-48.8	-45.8
13:	-39.1	-44.3	-35.2	-46.1
14:	-39.6	-45.3	-39.5	-44.9
15:	-33.7	-50.3	-41.2	-36.7
16:	-41.1	-41.4	-38.3	-41.1
17:	-32.3	-39.9	-44.6	-39.9
18:	-36.1	-37.2	-42.8	-41.8
19:	-39.1	-38.1	-39.3	-42.7
20:	-36.2	-43.6	-45.8	-41.6
21:	-36.2	-39.9	-39.5	-41.4
22:	-38.4	-42.7	-33.8	-41.3
23:	-38.7	-46.4	-38.0	-38.8
24:	-40.5	-43.0	-43.2	-34.8
25:	-33.0	-37.3	-40.4	-41.3
26:	-43.4	-39.0	-37.8	-44.0
27:	-35.2	-39.7	-38.6	-44.1
28:	-39.8	-39.9	-36.0	-39.1
29:	-40.2	-43.4	-43.8	-38.3
30:	-36.0	-41.2	-41.6	114.7*
31:	-42.8	-45.2	-38.6	-34.8
32:	-42.9	-44.8	-41.8	-46.6

Rx Channels test passed

2012.02.23 08:22:19.426 101 7
OK

Tx Channels test passed

2012.02.23 08:25:00.536 101 8
OK

RX NOISE LEVEL

Board No:	1	2	3	4	
0:	51.8	51.3	46.7	46.3	dB
1:	51.8	50.4	47.5	45.9	dB
2:	51.0	50.6	45.1	46.8	dB
3:	51.2	49.7	46.2	45.9	dB
4:	51.5	50.1	47.5	46.9	dB
5:	51.4	50.2	47.6	46.6	dB
6:	51.8	50.1	49.0	47.0	dB
7:	51.6	49.1	46.7	47.5	dB
8:	52.2	49.8	45.9	48.0	dB
9:	51.3	49.1	45.1	47.6	dB
10:	51.3	48.4	46.8	48.7	dB
11:	52.1	48.7	45.7	48.3	dB
12:	51.6	49.4	46.9	48.9	dB
13:	51.2	47.8	46.3	49.1	dB
14:	51.6	48.3	46.0	49.3	dB
15:	50.3	49.1	45.8	48.7	dB
16:	49.5	47.6	44.8	46.6	dB
17:	50.5	46.8	42.7	45.5	dB
18:	52.4	47.4	44.6	47.2	dB
19:	51.7	46.4	43.9	46.6	dB
20:	50.3	46.5	48.9	48.5	dB
21:	54.5	47.0	56.5	48.9	dB
22:	52.1	46.3	53.7	49.0	dB
23:	55.7	47.8	55.9	49.3	dB
24:	55.0	46.3	52.4	49.5	dB
25:	57.5	46.7	52.1	48.3	dB
26:	62.4	46.1	52.1	48.9	dB
27:	60.1	45.7	46.5	49.0	dB
28:	58.7	46.6	47.3	50.1	dB
29:	63.1	46.1	45.9	61.7	dB
30:	56.8	46.1	47.4	50.1	dB
31:	53.0	46.4	47.5	49.8	dB

Maximum noise at Board 1 Channel 29 Level: 63.1 dB

Broadband noise test

Average noise at Board 1 55.3 dB OK

Average noise at Board 2 48.4 dB OK
Average noise at Board 3 49.3 dB OK
Average noise at Board 4 50.4 dB OK

2012.02.23 08:25:07.403 101 9
OK

RX NOISE SPECTRUM

Board No: 1 2 3 4

26.1 kHz: 50.9 52.1 59.0
63.9 dB
26.3 kHz: 50.6 52.0 58.9
57.6 dB
26.5 kHz: 50.7 52.5 58.2
57.4 dB
26.7 kHz: 50.8 52.1 57.5
56.9 dB
26.9 kHz: 51.5 52.2 57.6
56.7 dB
27.1 kHz: 51.3 51.7 57.1
56.0 dB
27.3 kHz: 51.0 51.6 57.1
56.8 dB
27.5 kHz: 51.2 52.0 57.3
56.8 dB
27.7 kHz: 50.9 51.4 57.1
57.6 dB
27.9 kHz: 51.2 51.4 57.5
58.0 dB
28.1 kHz: 50.5 51.7 57.8
58.5 dB
28.3 kHz: 51.7 52.3 58.0
59.4 dB
28.5 kHz: 51.4 52.1 58.2
59.5 dB
28.7 kHz: 51.4 52.3 58.4
60.0 dB
28.9 kHz: 52.1 52.6 59.0
59.2 dB
29.1 kHz: 51.4 51.7 58.7
59.5 dB
29.3 kHz: 51.2 52.1 58.7
59.0 dB
29.5 kHz: 51.9 52.8 59.1
58.2 dB
29.7 kHz: 52.0 52.0 59.0
57.9 dB
29.9 kHz: 51.6 52.2 59.1
57.6 dB
30.1 kHz: 52.1 52.8 59.5
58.3 dB
30.3 kHz: 51.7 52.7 60.0
57.7 dB
30.5 kHz: 52.0 53.6 60.1
57.3 dB
30.7 kHz: 52.6 54.0 60.5
58.3 dB
30.9 kHz: 51.8 52.8 60.3
57.0 dB
31.1 kHz: 51.3 52.3 59.9
56.1 dB
31.4 kHz: 51.7 52.2 59.7
56.6 dB
31.6 kHz: 51.0 51.5 59.1
55.9 dB
31.8 kHz: 51.3 51.5 58.8
56.1 dB
32.0 kHz: 51.3 51.2 58.2
56.3 dB
32.2 kHz: 51.2 51.0 57.8
55.5 dB
32.4 kHz: 50.1 50.5 57.0
55.7 dB
32.6 kHz: 49.9 51.0 56.3
55.8 dB
32.8 kHz: 50.5 50.1 55.6
55.9 dB
33.0 kHz: 50.1 50.1 55.0
56.2 dB
33.2 kHz: 49.5 49.8 54.2
56.2 dB
33.4 kHz: 49.1 49.8 53.7
56.3 dB
33.6 kHz: 48.7 49.5 53.2
56.2 dB
33.8 kHz: 48.1 49.1 52.5
55.9 dB
34.0 kHz: 48.1 48.2 51.8
55.7 dB

Maximum noise at Board 4 Frequency
26.1 kHz Level: 63.9 dB

Spectral noise test

Average noise at Board 1 51.0 dB OK
Average noise at Board 2 51.8 dB OK
Average noise at Board 3 58.1 dB OK
Average noise at Board 4 57.8 dB OK

2012.02.23 08:25:14.270 101 10
OK

CPU: KOM CP6011
Clock 1795 MHz
Die 29 oC (peak: 29 oC @ 2012-02-23 - 08:15:42)
Board 30 oC (peak: 30 oC @ 2012-02-23 - 08:21:07)
Core 1.36 V
3V3 3.28 V
12V 12.05 V
-12V -12.04 V
BATT 3.49 V
Primary network:
157.237.14.60:0xffff0000
Secondary network:
192.168.2.20:0xffffff00

2012.02.23 08:25:14.403 101 15
OK

EM 302

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.5.1 110322
DDS: 3.5.2 101013
RX32 version : Feb 18 2010 Rev 1.11
TX36 LC version : Jun 17 2008 Rev 1.11
VxWorks 5.5.1 Build 1.2/2-IX0100 May 16 2007, 11:31:17

Items in Development

- *Updated vessel / equipment offsets and wiring (simple) drawings.*