doi: 10.25923/hhvn-7d52

NOAA Ship *Okeanos Explorer*

MAPPING SYSTEMS READINESS REPORT 2015

Report Contributors:
PS Meme Lobecker[1]
PS Derek Sowers[1]
PS Lindsay McKenna[1]
LT Emily Rose[2]

[1]Physical Scientist, *Okeanos Explorer* Program, NOAA Office of Exploration and Research,
[2] Operations Officer, NOAA Ship *Okeanos Explorer*

NOAA Office of Ocean Exploration and Research
1315 East-West Hwy, SSMC3, #10210
Silver Spring, MD 20910

NOAA Office of Marine and Aviation Operations (Atlantic)
439 West York Street
Norfolk, VA 23510-1145
Telephone: (757) 441-6776
Fax: (757) 441-6495

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

1. Introduction ... 2
2. Purpose ... 4
2. Vessel General Specifications ... 5
3. Mapping Hardware ... 6
   Multibeam Echo Sounder (MBES) ... 8
   Water Column Singlebeam Echosounder ... 10
   Sub-bottom Profiler (SBP) ... 11
   Sonar Closet Cooling ... 11
   Positioning and Orientation Equipment ... 13
      POS/MV ... 13
      C-NAV ... 13
   Vertical Sound Speed Profiling ... 15
   Sound Speed at the Multibem Sonar Head ... 16
   SBE 32 Carousel (Water Sampler) ... 18
   Scientific Seawater Measurement System (including backup surface sound speed) ... 18
   Bridge Dynamic Positioning System ... 22
4. Static Vessel Offsets ... 23
   Center of Roll and Pitch ... 23
   Mapping sensor specific offsets ... 23
   IMU and Antenna Offsets ... 24
   Static draft measurement ... 24
   Dynamic Draft ... 25
5. System Calibrations and Performance Evaluations ... 25
   GAMS Calibration ... 25
   EM 302 Patch Test ... 26
   Timing and Pitch Offset ... 26
   Roll Offset ... 26
   Heading Offset ... 26
   EM 302 Crossline Analysis ... **Error! Bookmark not defined.**
   Sound Velocity Sensor Comparisons ... 28
6. Data Processing ... 30
   Bathymetric Data Processing ... 30
   Bottom Backscatter Data Processing ... 31
   Water Column Data Processing ... 31
   Subbottom Data Processing ... 31
   Sound Speed Cast Processing ... 31
   Additional Mapping Processing Software ... 31
7. Data Management and Archival Procedures ... 32
8. Appendices ... 33
   Appendix A: Drawings of arrangement and location of deck hardware and transducer fairing ... 34

Appendix B: CARIS HIPS Vessel Configuration File (VCF) for NOAA Okeanos Explorer April, 2009 ... 36
Appendix C: Details of 2015Deep Water Patch Test Results ... 37
Appendix D. Mapping Software ... 37
Appendix E. List of Acronyms ... 39
Appendix F. References available ... 40
Appendix G: EM 302 Built In System Test ... 41
Appendix H. Retired equipment ... 51
Singlebeam Echo Sounder (SBES) EA 600 ... 51
Items in Development ... 52
J-Frame ... 52
A-Frame ... 52
Cranes ... 52
Winches ... 52

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 2015. 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 2015 field season of the *Okeanos Explorer*.

2. 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 (last accessed 2/9/15).

The following information is also available online at http://www.moc.noaa.gov/oe/Specs/General%20Specifications.pdf (last accessed 2/9/2015)

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	17
Length (LOA)	68.3 m (224 feet)	Scientists	20
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.

3. 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:03P5001, 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)~~ *Uninstalled 2011, replaced with 18 kHz xucer for EK 60*	~~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, 05106/61202V, 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	5.1.18	C-NAV unit: 5164 Display unit: 10338

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

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 / 200°	2-3 ft / 10°	5.6	5.6
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.

Prior to the 2015 field season shakedown cruise the MBES transducers were inspected by divers. The transducer faces were almost completely clear of bio fouling and any that was present was removed by the divers. The anti fouling paint was in very good condition and there was no noticeable deformation to the epoxy surrounding the transducers.

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.

Prior to the 2015 field season shakedown cruise the transducer was inspected by divers. The transducer faces were almost completely clear of bio fouling and any that was present was removed by the divers. The anti fouling paint system was in very good condition.

Figure 2. EK 60 (bottom) / EA 600 (top) (disconnected) GPTs.

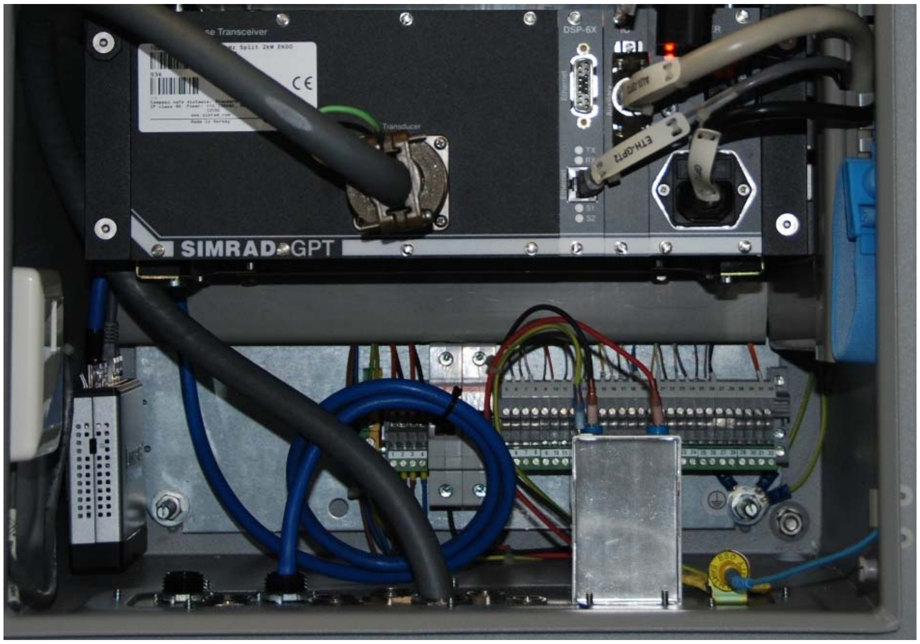


Figure 3. EK 60 GPT cabling detail.

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.

Sonar Closet Cooling

During the 2014/2015 winter in-port, the sonar closet was outfitted with two air conditioning units to isolate the space from the ship's overall ventilation system. Each unit provides 12,000 BTU.

Figure 4. Sonar closet AC unit installed 2015. 1 of 2 units.

Figure 5. Sonar closet AC unit installed 2015. 2 of 2 units.

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 6. Photos: From left: IMU and granite block, IMU, IMU under protective housing.

During the 2014/2015 winter in-port the POS MV antennas were raised to bring them above a light shield that was installed in the antenna farm to better allow bridge night watchstanders to maintain night vision. The updated xyz values were input in the POS controller in January 2015.

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

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.

Figure 8. Photos: XBT launch from the aft deck (left). Deck unit for XBT in red (right)

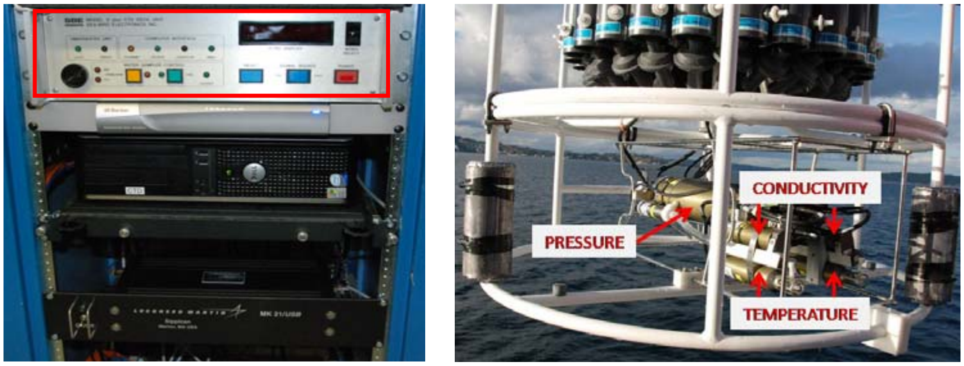


Figure 9. Photos: (Left) Deck Unit (SBE 11) for acquisition of real time sound speed profile from SBE 9 plus CTD (Right) Horizontally mounted CTD with dual Temperature and Conductivity sensors and SBE 32 Carousel for 24-bottle water sampling.

The primary Sea-Bird CTD sensor for the 2015 field season is SBE-9Plus CTD SN 0905. The calibration report SBE9plus P0905 19Jun13.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.

Sound Speed at the Multibem Sonar Head

The primary surface sound speed sensor is 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. The sensor is inspected during hull dives along with all major transducers. One spare is available on board.

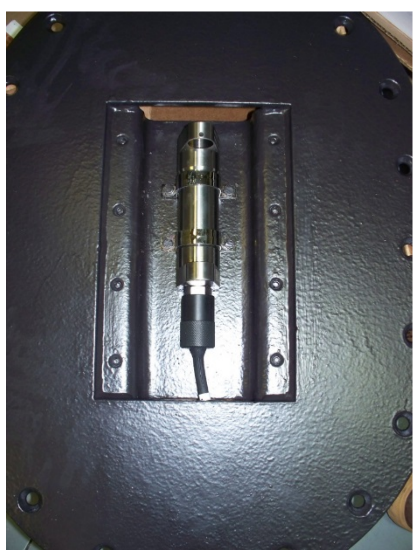


Figure 10. Photo showing the Reson SVP-70 probe attached to the access cover on the hull.

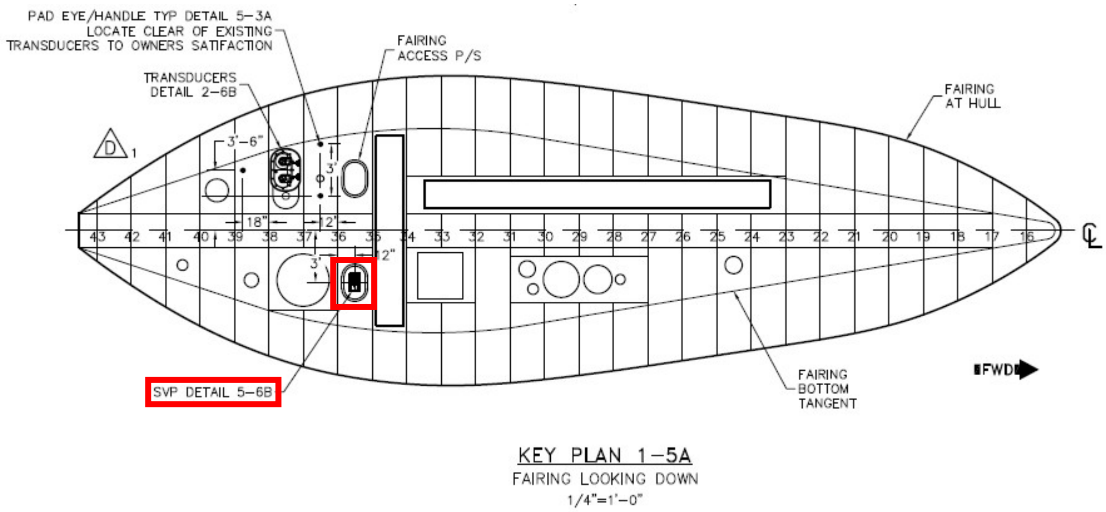


Figure 11. Line drawing showing the placement of the SVP probe on the transducer fairing.

The backup surface sound speed system is the thermosalinograph. The TSG collects temperature and conductivity readings, and is capable of deriving salinity and sound velocity data in real time. The value is computed by the system, fed into SCS and the multibeam acquisition computer. More information is provided below in the Scientific Seawater Measurement System section.

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. The system has demonstrated the ability to maintain 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’.

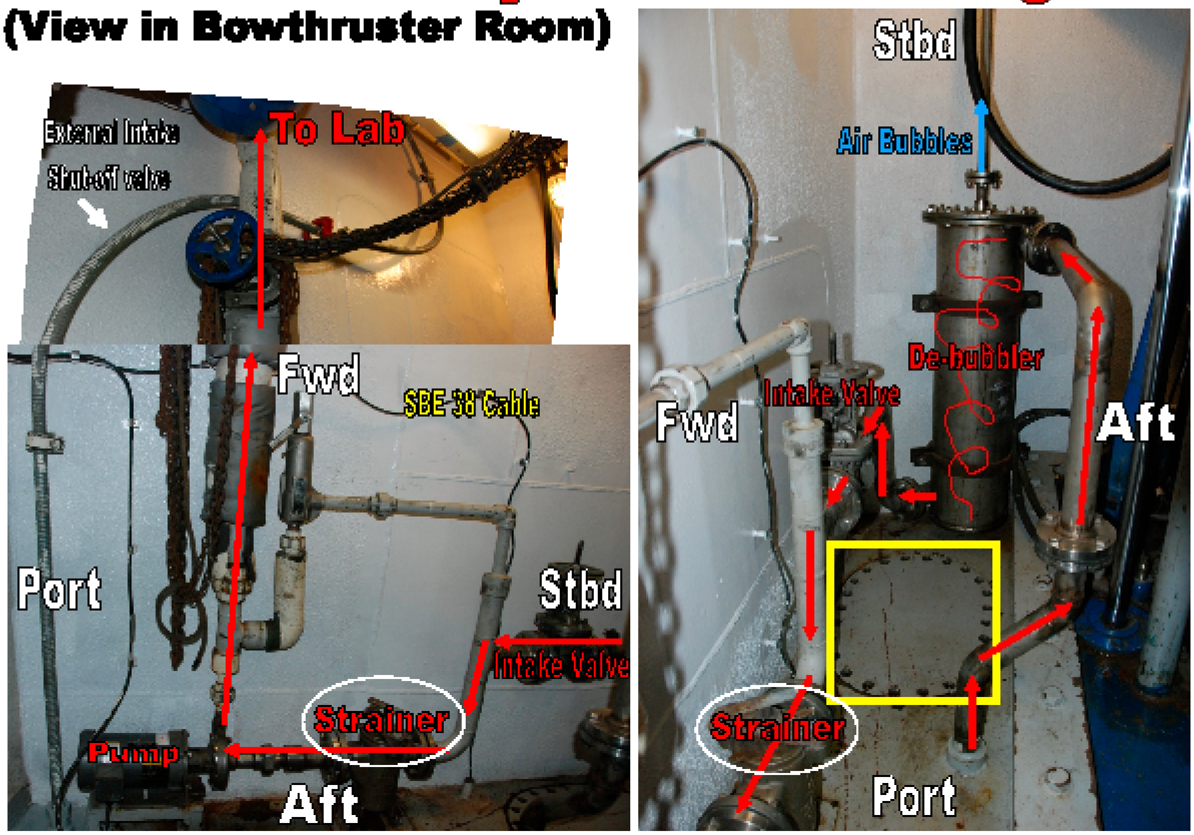
Figure 12. Photo showing depth of TSG intake location on the hull, approximately 13 feet below the water line.

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.

EX Seawater System Flow Diagram

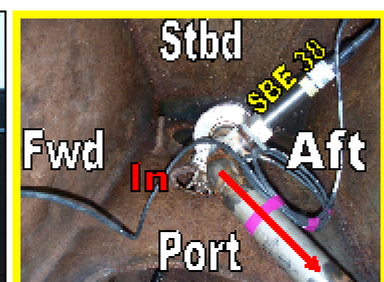
(View in Bowthruster Room)



In 2011 Drydock a new seawater intake was installed. The new intake was located lower on the bow to prevent the system from catching air bubbles while the ship rides large seas. The intake is now at a depth of 13 feet below the design water-line.

The intake is located in a cofferdam between the bow thruster room and the hull, with the SBE 38 approx. 2 feet above the intake. Water travels from the intake, through the SBE 38 sensor (horizontally mounted), up into the bow thruster room, through a de-bubbler, (where air is removed), past the intake valve, through the strainer, past the pump and up towards the labs.

There is a remote shut-off for the second intake valve, located in the cofferdam. (Official drawings can be made available when completed).



Looking downward from Man-hole cover in bow thruster room into cofferdam between the outer hull and bow thruster room.

(Arrows indicate direction of flow.)

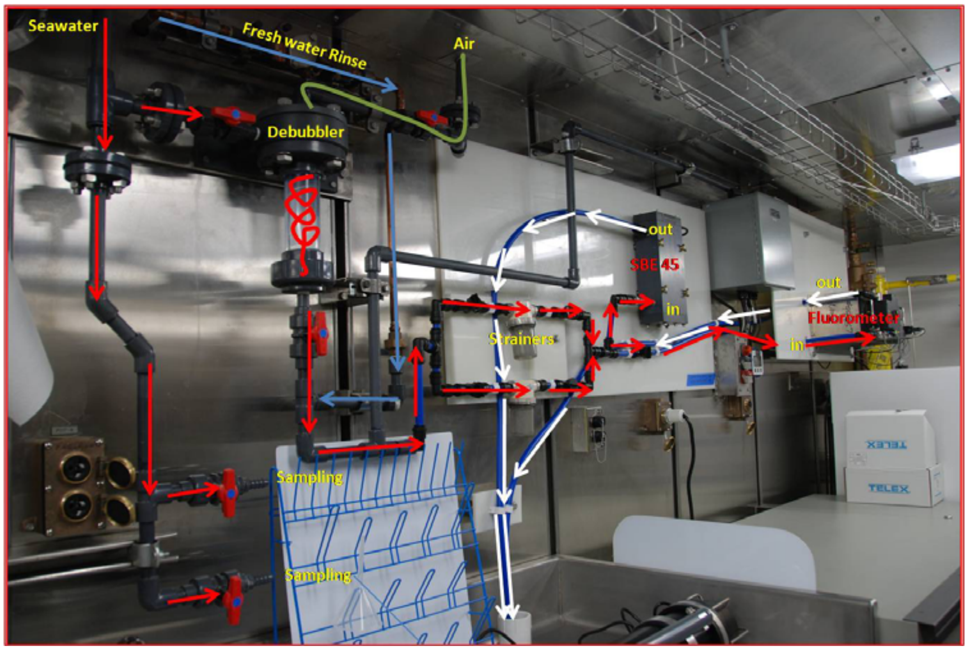


Figure 13. Photo showing intake configuration of the Scientific Seawater System, located in the bow thruster room (left). Flow diagram of Scientific Seawater System components in the wet lab, including TSG. Note: the flourometer has been removed from the system.

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 meter-level accuracy 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.

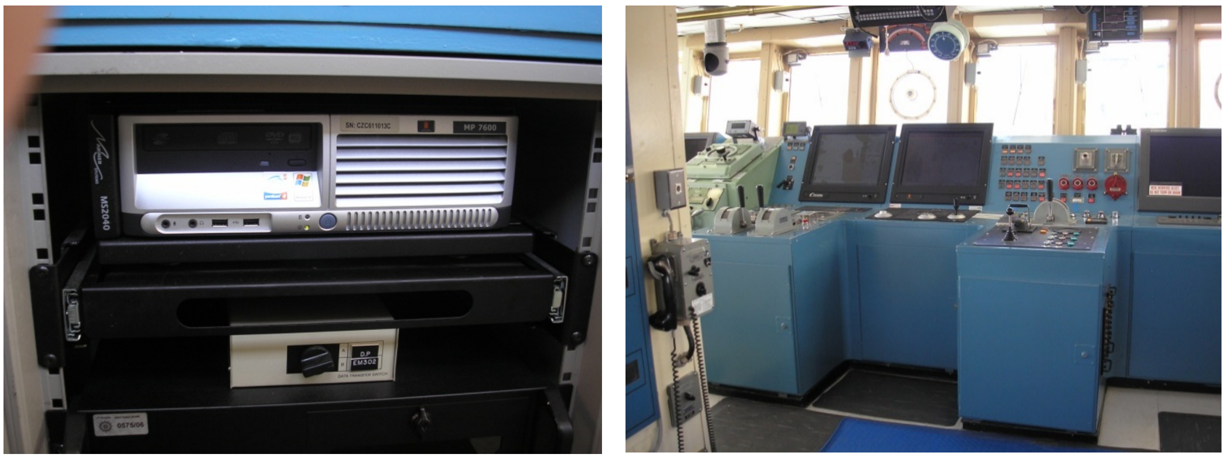


Figure 14. Bridge DP system installed on Okeanos Explorer (right) showing different controls and the USB drive (left) for inputting electronic files for the way point table.

4. 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

Table 8. Offsets: POS-MV antennas and IMU offsets to granite block.

DESCRIPTION	NORTHING (X)	EASTING (Y)	ELEVATION (Z)
Granite Block	0.000	0.000	0.000
IMU	0.734	0.008	-0.022
STAR GPS	8.239	3.577	-17.073
PORT GPS (PRIMARY)	8.232	1.275	-17.060

Table 9. Offsets: POS-MV antennas and granite block offsets to IMU.

DESCRIPTION	NORTHING (X)	EASTING (Y)	ELEVATION (Z)
Granite Block	-0.734	-0.008	0.022
IMU	0.000	0.000	0.000
STAR GPS	7.505	3.569	-17.051
PORT GPS	7.498	1.267	-17.038

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 EX1401 were as follows:

Beginning draft 02/9/2015	Forward 15', Aft 14' 3"
Ending draft 02/11/2015	Forward 15', Aft-13' 11"

Dynamic Draft

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

5. System Calibrations and Performance Evaluations

GAMS Calibration

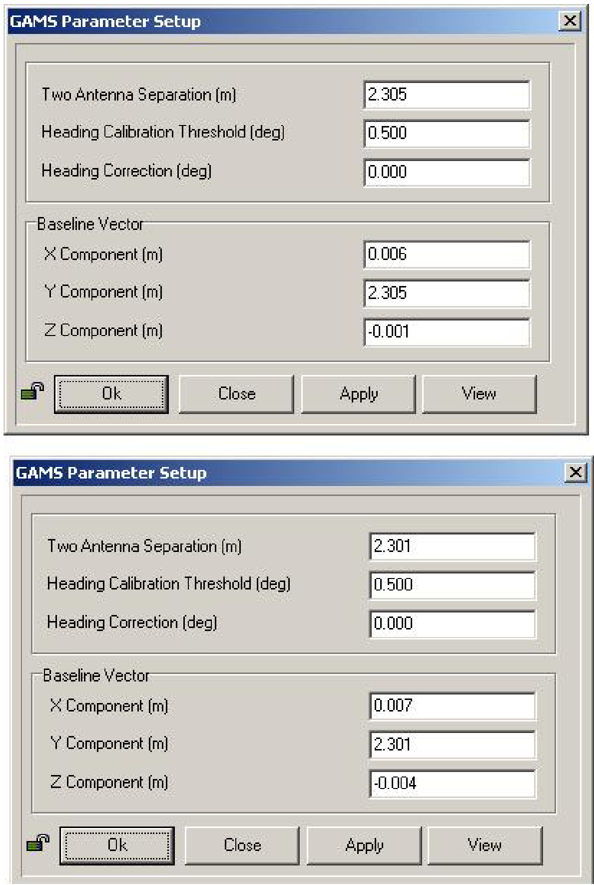


Figure 15. GAMS calibration results 08 January 2015.

EM 302 Patch Test

During EX1502L1, a multibeam patch test was conducted on the shelf near St. Croix Island in the Caribbean Sea. The timing, pitch, and roll lines were conducted in deep water >4000 m. The heading lines were conducted over a canyon feature in shallower water, 2200 m. 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 for timing, roll, and pitch were determined to have not changed from previous years' patch test results. The offset for heading changed compared to the previous years' heading test results. The POSMV antennas were raised during winter in-port, so this is an expected change.

Table 10. 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	0.2

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 feature with slopes of up to 25°. 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 4400 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 4.5 kilometers. The lines each ensonified the steep sides of a turbidity flow feature 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 a positive 0.2 degree heading offset in the installation.

EM 302 Crossline Analysis

Crossline analysis was conducted using surface differencing in Caris. Two reference surfaces were computed, the first using the lines that are run in the N/S direction. The second using the line oriented E/W, see figure 16. The two surfaces were differenced, and statistics were computed based on the differences. The attribute value bin sized used for the differencing was 1 m.

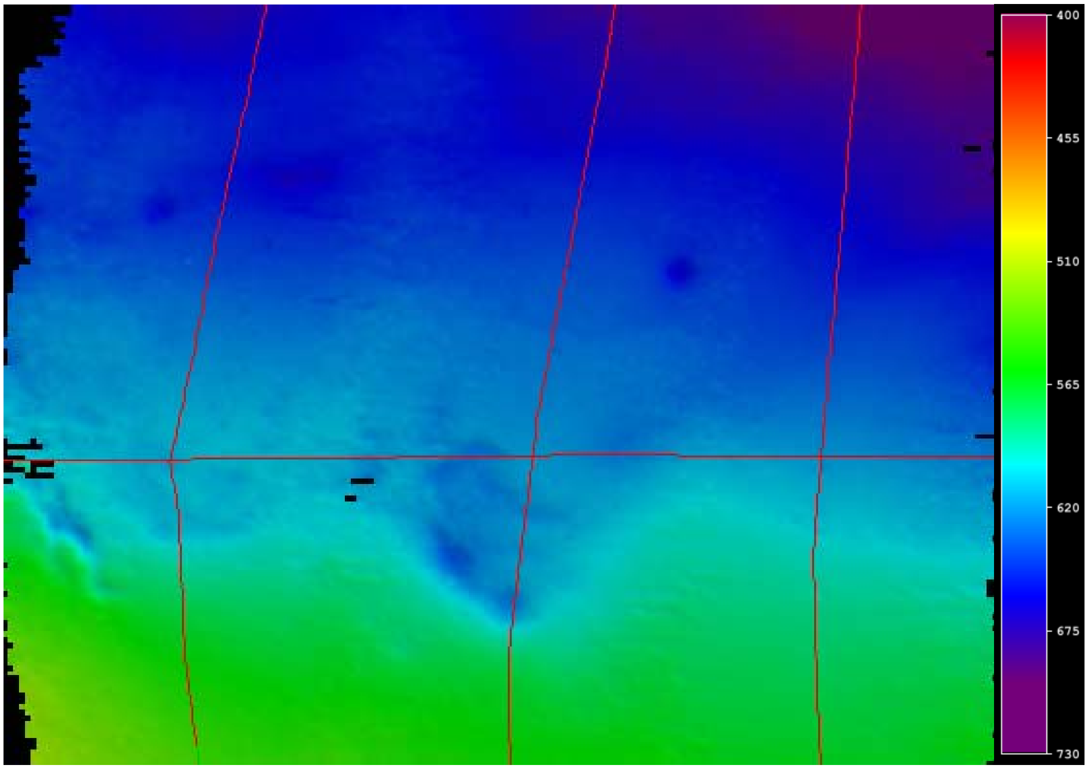


Figure 16. Reference surface and lines used in cross-line analysis. Depths are in meters.

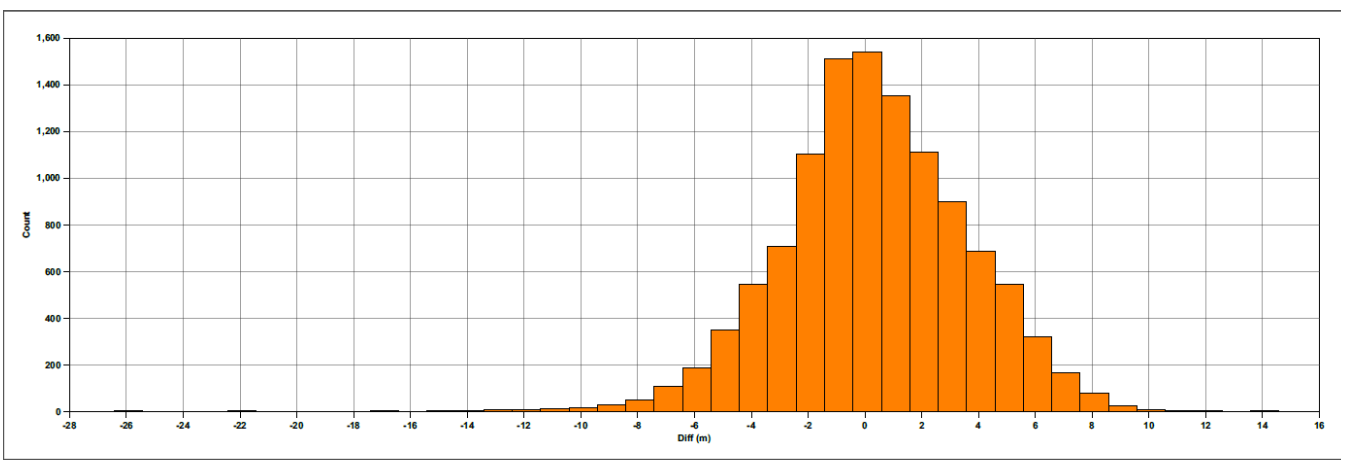


Figure 17. Difference histogram. The water depth of the cross-line analysis ranged from 500 m to 600 m. Statistics of the differencing are shown in Table 11.

Table 11. Differencing statistics.

Differencing Statistics	
Minimum (m)	-26.28
Maximum (m)	14.4
Mean (m)	0.34
Standard Deviation (m)	3.25
Total Count	11,377

Sound Velocity Sensor Comparisons

On 8 March 2015, a sound velocity comparison cast was conducted in the survey mapping area South of St. Croix. The sound speed comparison showed good agreement between data acquired via the SeaBird19+ CTD and the Sippican Deep Blue XBT probe, as seen in figure 18.

Raw file names: EX1502L1_XBT043_150308.EDF (XBT)
EX1502L1_CTD001_150308.hex (CTD)

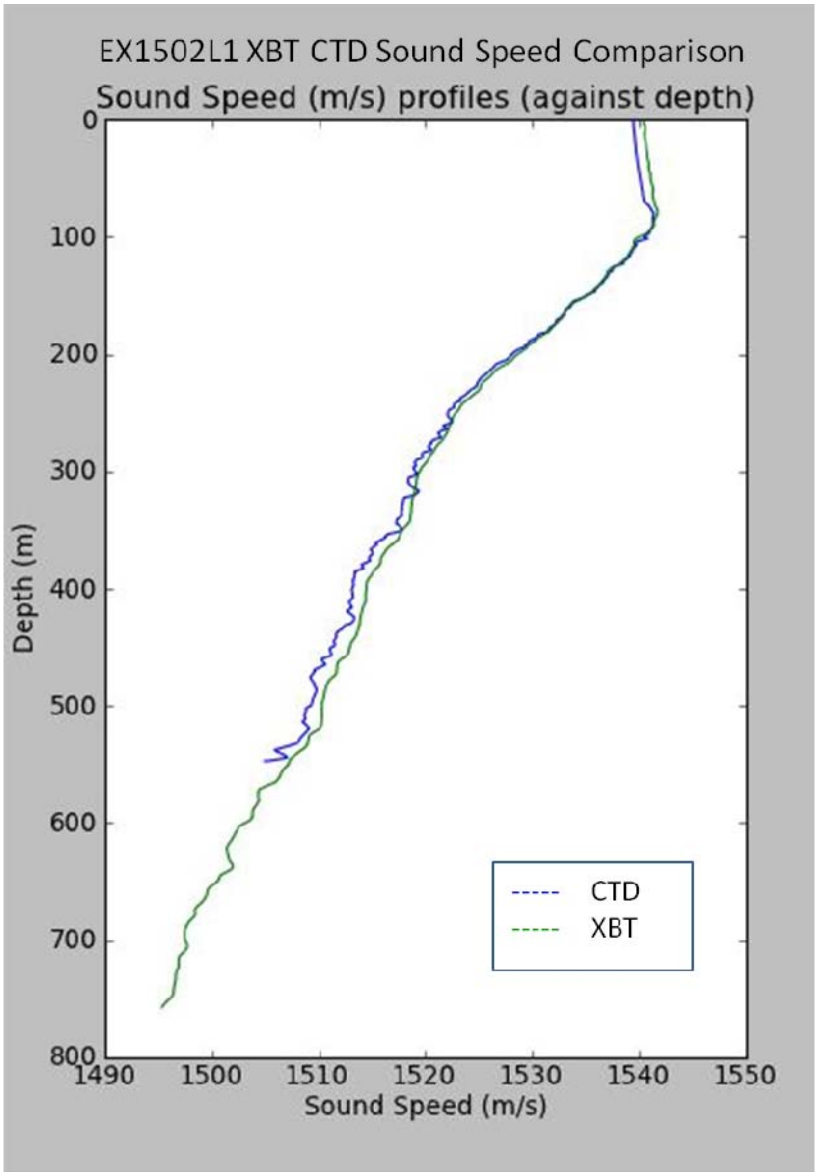


Figure 18. Results of comparison cast between Seabird SBE09Plus S/N 09P47490-0906 (shown in blue) and Sippican Deep Blue XBT probe (shown in green).

Data from CTD cast is incomplete for reasons unknown to acquisition watch. Maximum depth of XBT cast was 760m, and is reflected in figure 18. Maximum depth of CTD cast was 2430m, but data greater in depth than approximately 550m did not come through in the analysis. Several potential factors include: limited knowledge of the CTD system arrangement of both hardware and software on the *Explorer*, a speedily repaired sea cable with two repairs made less than 48 hours prior to cast, and a generally large seas (swells averaging 4-6ft). Even though the CTD data is cut short, there is enough to accept this analysis as a sound comparison.

Data from the thermosalinograph and Reson SVP 70 probe were compared and are shown in Figure 19. CTD data was not available. The results of the comparisons were favorable, showing less than 0.8 m/s differences, and are shown below.

The files recorded by the ship's Scientific Computer System (SCS) compared were:
Reson SVP 70: Sound-Velocity-Probe_20150308-000001.Raw
Thermosalinograph: TSG-RAW_20150308-000001.Raw

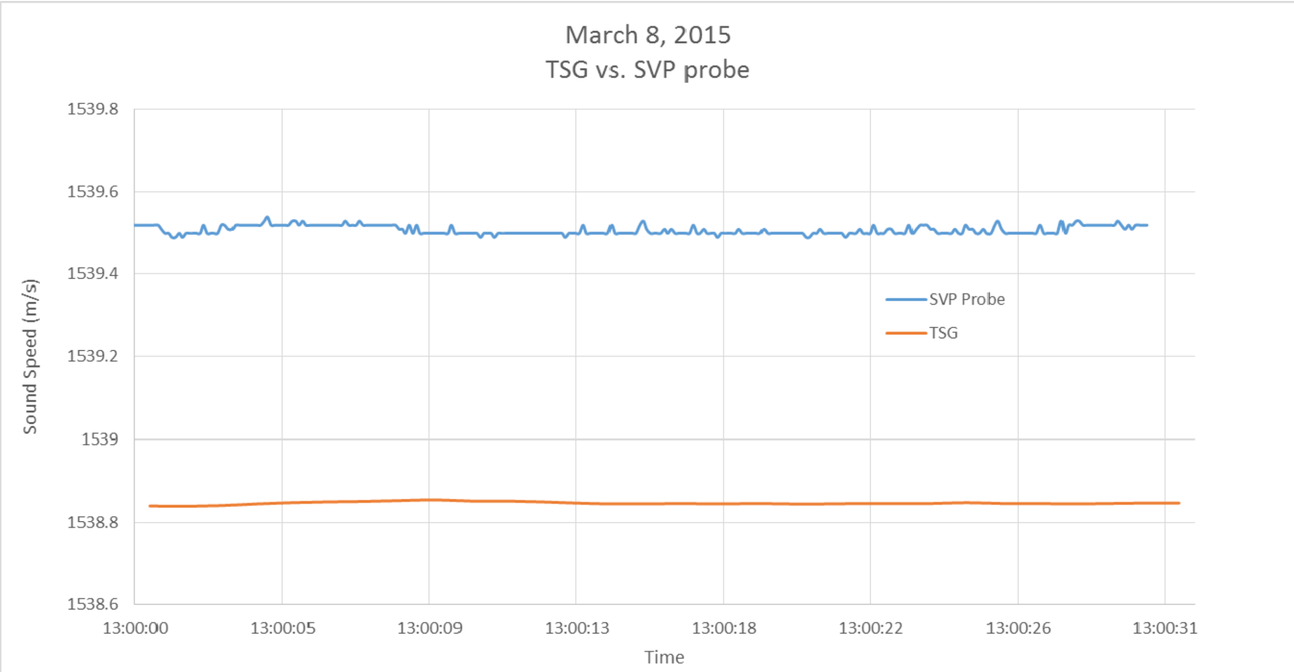


Figure 19. Results of comparison cast between Reson SVP probe (shown in blue) and thermosalinograph (shown in green).

6. 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 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 QPS Fledermaus for 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) and heading. Offsets determined during annual patch testing are applied in realtime with SIS. 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 CARIS vessel configuration file (VCF) for *Okeanos Explorer* contains zeros offsets, and the motion and sound velocity data are not required to be applied during post processing.

Bottom Backscatter Data Processing

The QPS Fledermaus FM Geocoder Toolbox software package used for processing EM 302 bottom backscatter data. This version of FMGeocoder is installed when as part of the QPS install.

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 02/09/2015).

It possible to produce the following SD objects using FM MidWater: beam fan, beam line, volume, and track line.

Subbottom Data Processing

Chesapeake Technology Sonar Wiz is available onboard for processing the SEG-Y files generated by the Knudsen 3260 subbottom profiler.

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.

7. Data Management and Archival Procedures

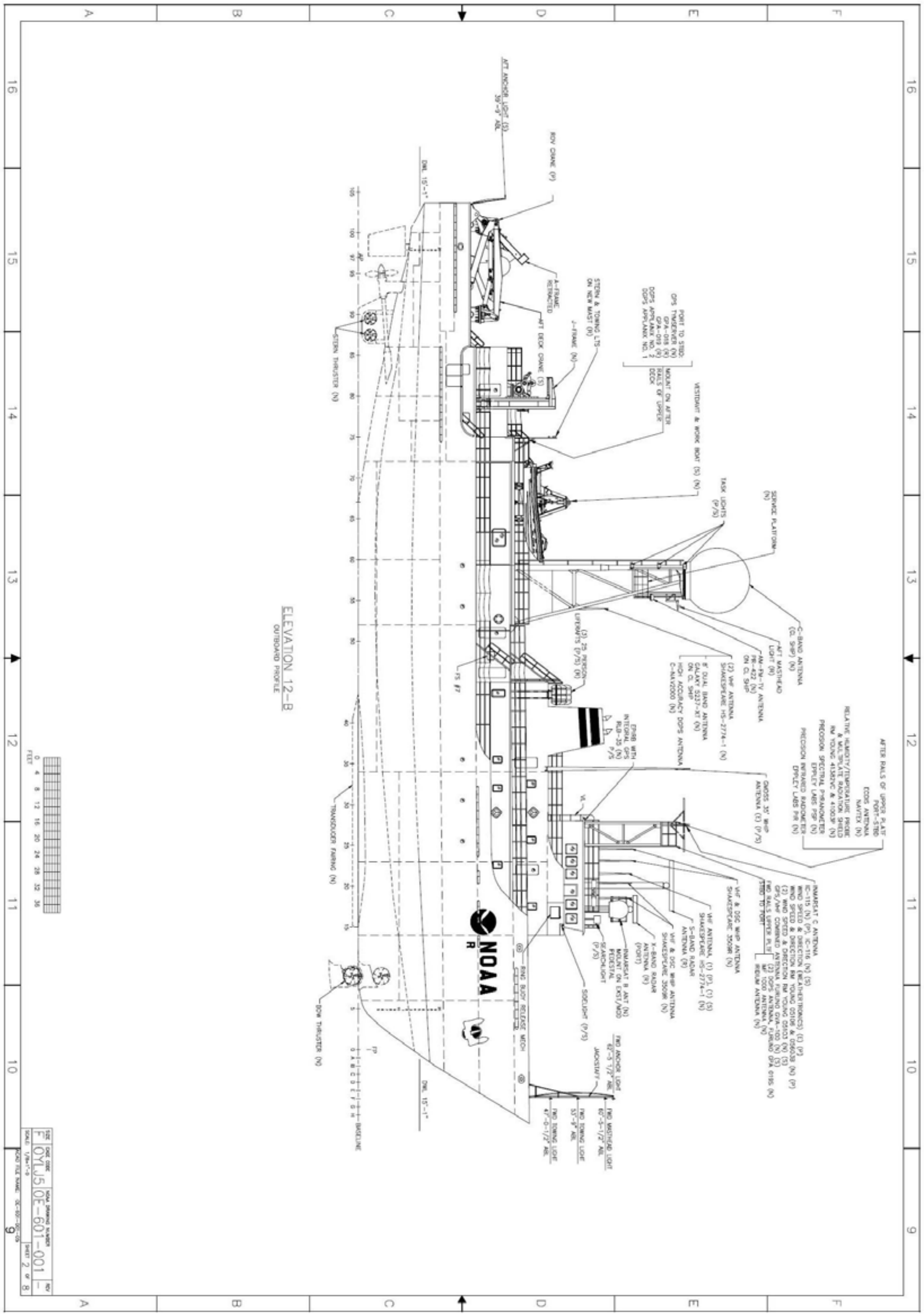
The National Coastal Data Development Center (NCDDC) co-manages the mapping data in close partnership with the mapping team. All data collected by the NOAA Ship *Okeanos Explorer* is made publically available through the public archives hosted by the National Geophysical Data Center and the National Oceanographic Data Center. The data is available in raw and processed formats that are readable by several free software packages. An annual data management plan is produced by NCDDC and is available by contacting oer.data.mgmt@noaa.gov.

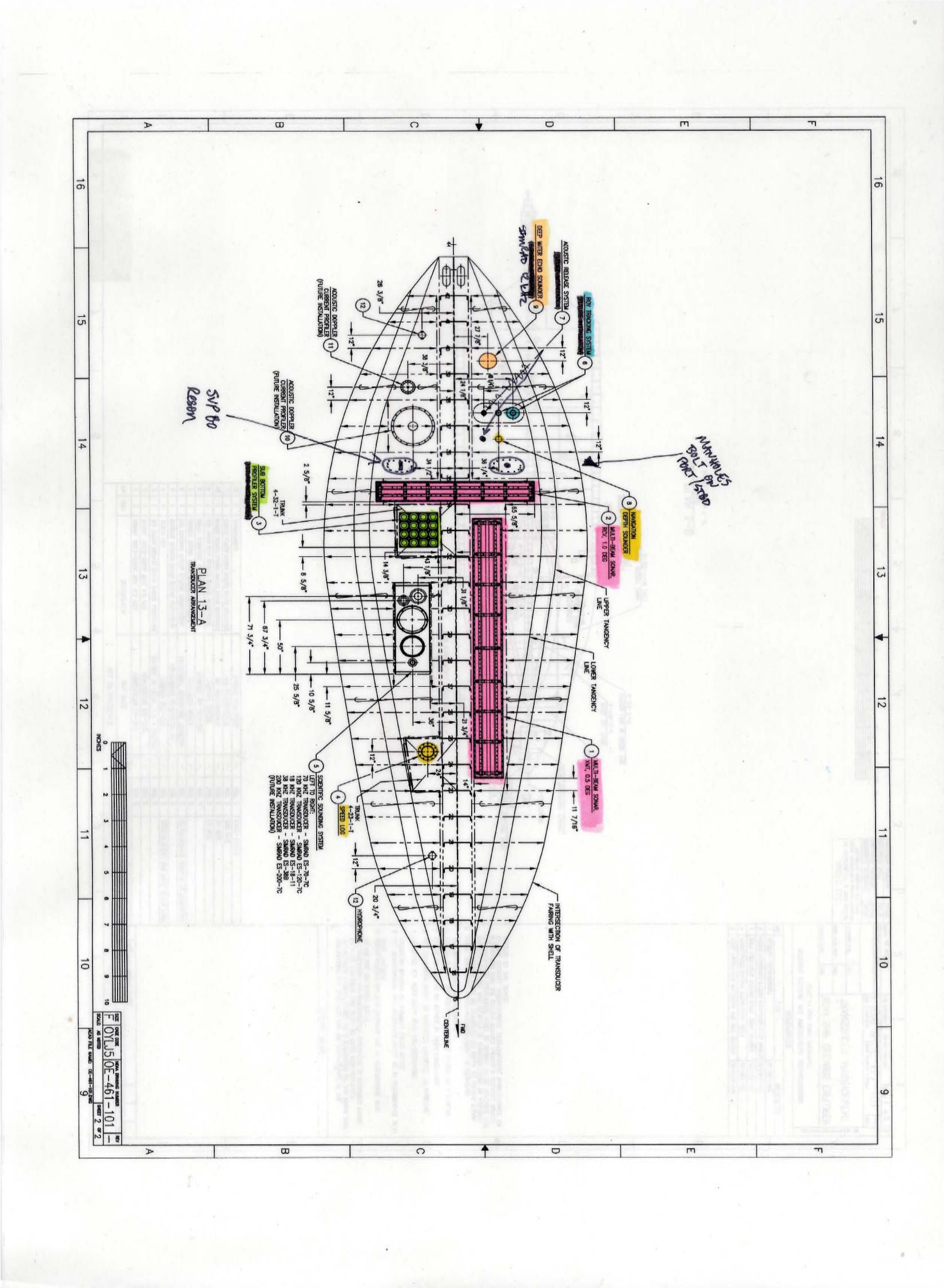
A mapping data report is produced by the mapping department for every cruise, and is archived alongside the data in the national archives and in the NOAA Central Library. The report describes the data acquisition and processing routines in place during the cruise. The mapping data report aims to promote 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.

8. 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.




PLAN 13-A
TRANSDUCER ARRANGEMENT
MULTI-BEAM SONAR
SUB BOTTOM PROFILER SYSTEM
SPEED LOG
HYDROPHONE
UPPER TANGENCY LINE
LOWER TANGENCY LINE
INTERSECTION OF TRANSDUCER FAIRING WITH SHELL
CENTERLINE

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

File: EXApril09.hvf


```xml
<?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 C: Details of 2015Deep Water Patch Test Results

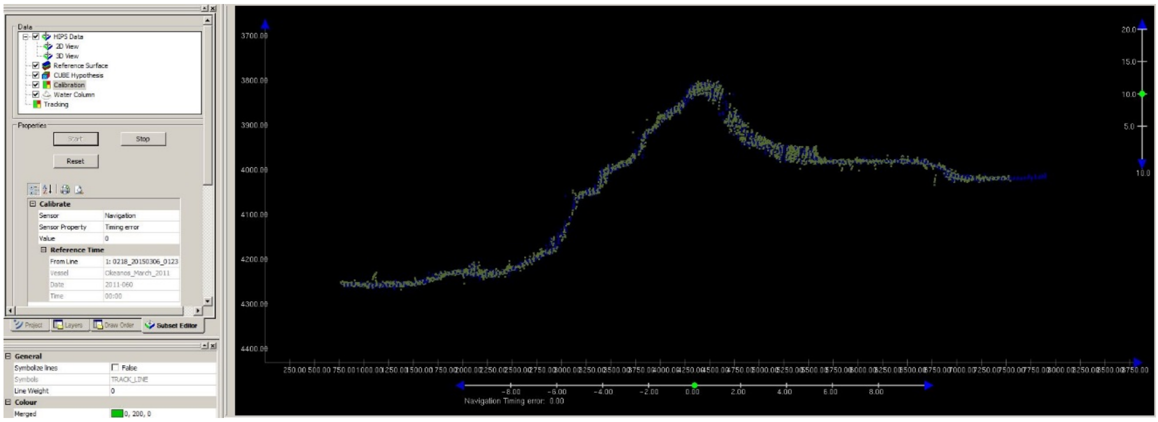


Figure 21. Screenshot of CARIS 8.1 Calibration Tool. Timing offset lines 0218, run at 8 knots, and 0220, run at 4 knots, verifying zero timing offset.

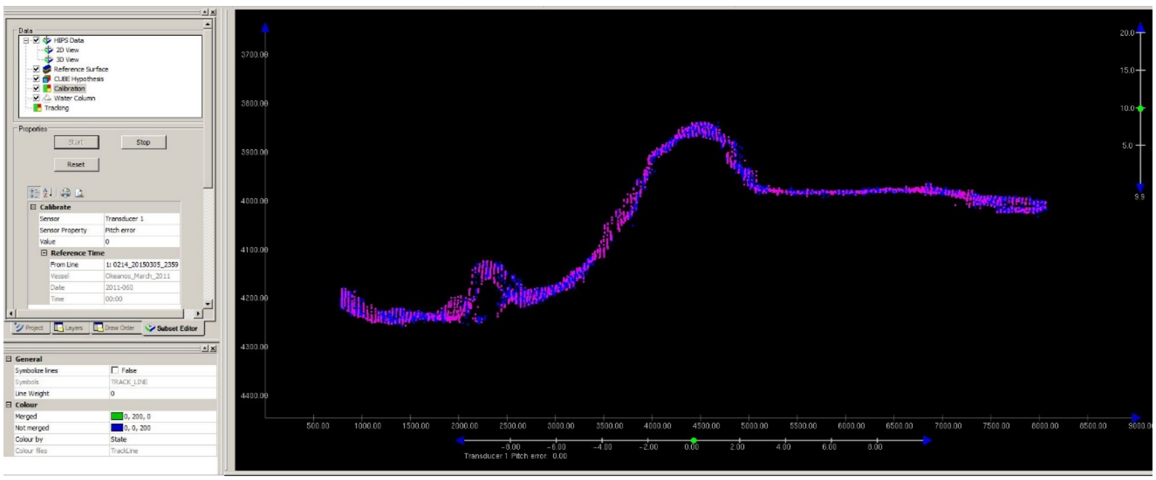


Figure 22. Screenshot of CARIS 8.1 Calibration Tool. Pitch lines were run with known offset -0.725 degree applied. Pitch lines 0216 and 0218 shown, verifying no adjustment to known offset is necessary.

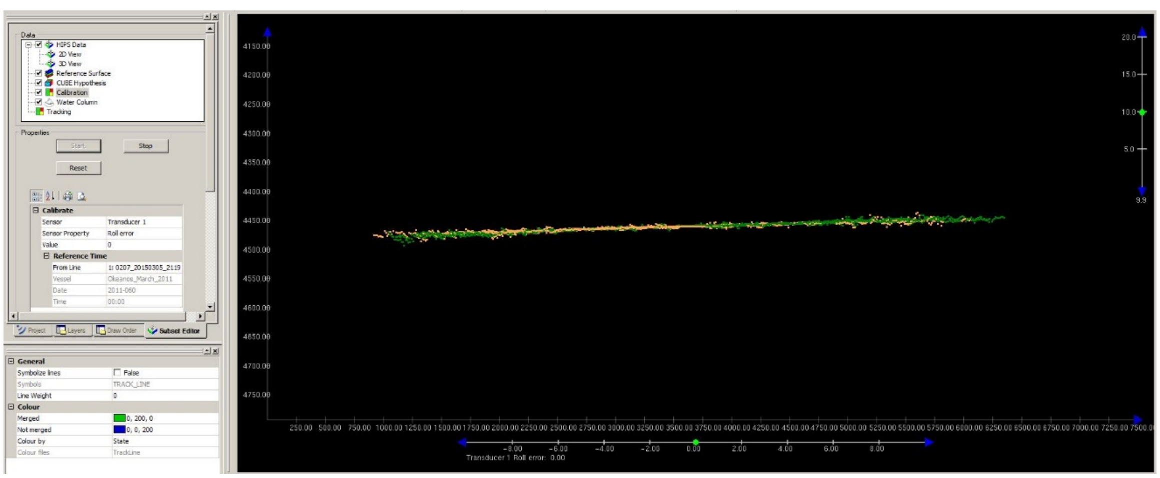


Figure 23. Screenshot of CARIS 8.1 Calibration Tool. Roll lines 0205 and 0207 are shown, verifying zero heading offset.

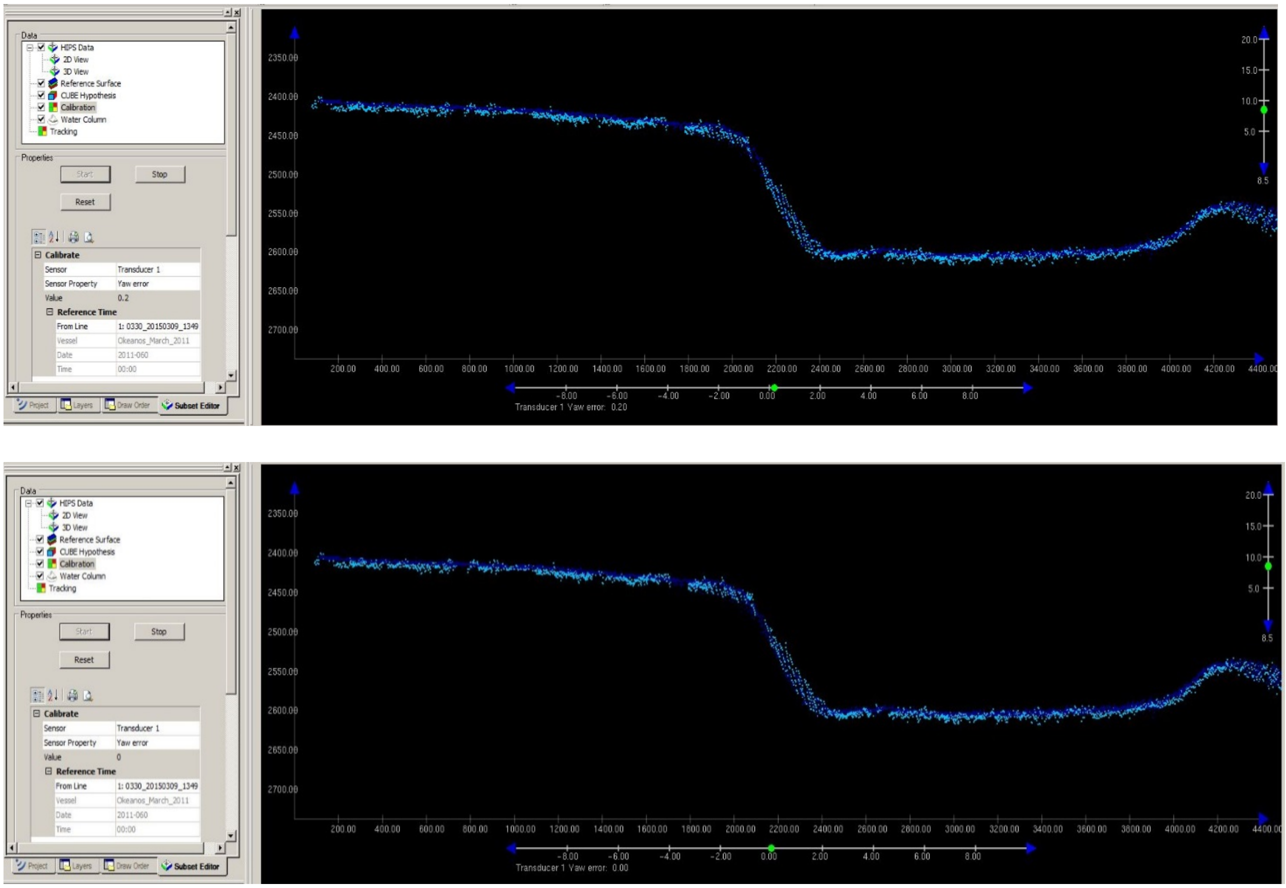


Figure 24. Screenshot of CARIS Calibration tool. Heading lines 0307 and 0309 shown. The top image shows the new +0.2 degree offset heading offset. The bottom picture shows a zero offset.

Appendix D. Mapping Software

Table 12. Mapping software in use during the 2015 field season.

Software	Version	Computer
SIS EM 302	4.1.3	Multibeam
Velocipy	13.2 (r4441)	CTD
POS Controller/Applanix	POS MV V4 Firmware v5.08 and POSView v4.0.2.0 SN# 2572	Wetlab
Caris HIPS	8.1.11	MBPROC1
	8.1.11	MBPROC2
	build 2014-12-11_19-30-23	

Fledermaus (IVS 3D)	7.4.2a build 114	MBPROC2
	7.4.2a build 114	MBPROC3
	7.4.2a	MBPROC1
KAP Converter	4.0.0.10	N/A
Pydro	13.2m (r4441)	CTD
Hypack (ROV)	14.0.023	EX-Hypack
Hypack (survey)	15.0.1.1	EXPlanning
Seasave 7	7.23.2	CTD & Hydrophone
SCS	v4.9.0.2769	SCS-A
C-NAV Unit Display Unit	Firmware: 5.1.18 Display software: 7.07	N/A
Knudson SBP, Sounder Suite Echo Control Server and Client	Client: V.271 Server: V.2.73	Knudsen SBP
SEG-Y JP2 & Viewer	1	EXSCSCL2
SonarWiz	5.04.0006	EXSCSCL2
ESRI ArcMap	10.3	EXSCSCL2
Global Mapper	16.1 (B021115)	EXSCSCL2
SIMRAD ER60	2.4.0	EK60
FileZilla		SCS Server A

Table 13. Mapping software in use during the 2015 field season.

Appendix E. 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
OER – NOAA Office of Ocean Exploration and Research
SAT – Sea Acceptance Test
SBES – singlebeam echosounder
SBP – sub-bottom profiler
SCS – Scientific Computer System
SVP – sound velocity profile
TRU – transreceiver unit
TSG - thermosalinograph
XBT – expendable bathythermograph

Appendix F. References available

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

- 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
- Knudsen chirp 3260 acceptance test report, 2008. D101-04819-Rev 1.
- Current Sea-Bird sensor calibration reports
- Ship Drawings

Appendix G: EM 302 Built In System Test

Saved: 2015.02.10 02:33:59

Sounder Type: 302, Serial no.: 101

Date   Time   Ser. No.   BIST Result

2015.02.10 01:51:36.535 101   0 OK
Number of BSP67B boards: 2
BSP 1 Master 2.2.3 090702 4.3 070913 4.3 070913
BSP 1 Slave 2.2.3 090702 4.4 070911
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 2.2.3 090702 4.3 070913 4.3 070913
BSP 2 Slave 2.2.3 090702 4.4 070911
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

2015.02.10 01:51:39.418 101   1 OK
High Voltage Br. 1

TX36   Spec: 90.0 - 145.0
0-1   121.7
0-2   121.3
0-3   120.9
0-4   121.3
0-5   121.3
0-6   121.3
0-7   120.5
0-8   120.1
0-9   121.3
0-10   121.7
0-11 120.5
0-12 120.9
0-13 120.5
0-14 122.1
0-15 120.9
0-16 121.7
0-17 120.1
0-18 120.9
0-19 121.7
0-20 120.9
0-21 120.9
0-22 120.9
0-23 121.3
0-24 119.7

High Voltage Br. 2

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

Input voltage 12V

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

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 30.4
0-2 28.4
0-3 28.8
0-4 28.0
0-5 28.4
0-6 29.6
0-7 30.0
0-8 30.4
0-9 29.6
0-10 27.2
0-11 26.8
0-12 28.0
0-13 30.4
0-14 28.8
0-15 30.0
0-16 29.2
0-17 30.0
0-18 29.6
0-19 30.8
0-20 31.2
0-21 30.4
0-22 29.6
0-23 30.8
0-24 31.6

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 0.6
0-7 0.5
0-8 0.5
0-9 0.5
0-10 0.5
0-11 0.5
0-12 0.5
0-13 0.5
0-14 0.6
0-15 0.6
0-16 0.5
0-17 0.5
0-18 0.8
0-19 0.5
0-20 0.7
0-21 0.6
0-22 0.6
0-23 0.7
0-24 0.5

TX36 power test passed

IO TX PPC Embedded PPC Download
2.11 1.14 Mar 5 2007/1.07 May 7 2013/1.11

TX36 unique firmware test OK

2015.02.10 01:51:54.186 101 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 2.5

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 34.0
7-2 36.0
7-3 36.0
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 0.6

Input Current 6V

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

RX32 power test passed

IO RX MB Embedded PPC Embedded PPC Download
1.12 1.14 May 5 2006/1.06 May 5 2006/1.07 Feb 18 2010/1.11

RX32 unique firmware test OK

2015.02.10 01:51:54.319 101 3 OK
High Voltage Br. 1

TX36 Spec: 90.0 - 145.0
0-1 121.7
0-2 121.3
0-3 120.9
0-4 121.3
0-5 121.3
0-6 121.3
0-7 120.5
0-8 120.1
0-9 121.3
0-10 121.3
0-11 120.5
0-12 120.9
0-13 120.5
0-14 122.1
0-15 120.9
0-16 121.7
0-17 120.1
0-18 120.9
0-19 121.7
0-20 120.9
0-21 120.9
0-22 120.9
0-23 121.3
0-24 119.7

High Voltage Br. 2

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

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 11.8
0-7 11.8
0-8 11.8
0-9 11.8
0-10 11.9
0-11 11.8
0-12 11.8
0-13 11.8
0-14 11.8
0-15 11.9
0-16 11.9
0-17 11.8
0-18 11.8
0-19 11.8
0-20 11.8
0-21 11.9
0-22 11.8
0-23 11.8
0-24 11.8

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

TRU power test passed

2015.02.10 01:51:54.502 101 4 OK
EM 302 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage: 18.00 PASSED
Test Voltage:40.00 Measured Voltage: 38.00 PASSED
Test Voltage:60.00 Measured Voltage: 58.00 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: 119.00 PASSED
Test Voltage:120.00 Measured Voltage: 119.00 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

2015.02.10 01:54:30.362 101 5 OK

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

2015.02.10 01:54:35.829 101 6 OK
Receiver impedance limits [600.0 1000.0] ohm

Board	1	2	3	4
1:	867.5	863.3	832.3	856.9
2:	843.4	856.4	839.7	860.5
3:	831.5	859.7	863.5	855.6
4:	851.2	847.5	860.0	852.2
5:	855.8	859.6	793.4	864.7
6:	862.5	864.7	845.0	866.4
7:	852.3	862.3	847.8	870.8
8:	851.6	853.3	860.4	846.5
9:	373.8*	855.5	856.4	839.4
10:	830.9	862.3	804.9	854.1
11:	850.5	849.6	851.6	838.6
12:	858.6	823.0	845.2	852.4
13:	856.9	851.7	838.3	851.4
14:	841.1	852.0	871.6	854.9
15:	834.5	848.2	853.7	849.9
16:	858.7	843.9	861.4	844.7
17:	834.9	936.9	859.1	852.9
18:	852.8	843.9	865.1	860.7
19:	827.0	848.5	842.6	848.1
20:	840.9	873.9	858.4	855.0
21:	866.3	854.3	884.7	859.0
22:	883.9	854.8	845.9	858.7
23:	876.2	869.3	861.5	858.7
24:	884.4	886.5	876.1	868.9
25:	849.4	861.1	859.0	859.9
26:	855.0	846.3	857.5	854.3
27:	839.3	849.2	857.1	856.0
28:	830.3	846.3	830.5	854.7
29:	829.1	864.3	848.7	855.4
30:	862.8	840.5	849.4	857.4
31:	839.7	836.3	853.9	846.3
32:	858.3	878.9	858.5	859.9

Transducer impedance limits [250.0 2000.0] ohm

Board	1	2	3	4
1:	347.5	365.8	362.6	373.9
2:	362.9	376.1	372.8	378.7
3:	351.4	352.6	379.2	365.6
4:	358.6	364.8	381.6	364.0
5:	344.5	366.7	391.4	357.1
6:	338.4	356.9	365.9	372.7

7: 349.5 359.9 399.0 369.4
8: 336.8 352.5 374.9 375.0
9: 158.3* 371.4 383.5 368.7
10: 367.4 358.4 384.7 375.7
11: 342.9 370.2 368.0 374.5
12: 357.6 380.1 383.2 356.8
13: 347.3 356.1 387.0 359.6
14: 382.7 355.6 390.4 356.2
15: 348.4 355.4 377.9 357.6
16: 345.0 369.1 386.2 344.7
17: 344.0 389.9 360.2 367.6
18: 350.5 370.2 375.5 371.3
19: 366.5 371.8 372.8 371.0
20: 363.4 357.9 373.0 358.1
21: 363.8 366.9 377.7 372.4
22: 366.3 371.1 378.8 359.9
23: 378.1 356.1 382.2 370.5
24: 376.9 379.2 357.2 355.7
25: 356.0 375.6 371.7 362.9
26: 357.9 389.5 371.1 372.0
27: 352.5 367.5 381.4 369.1
28: 367.3 382.4 379.7 350.8
29: 362.6 379.9 386.1 376.3
30: 346.1 357.9 364.5 376.4
31: 358.6 376.2 380.2 368.8
32: 342.8 373.9 371.3 380.3

Receiver Phase limits [-50.0 20.0] deg
Board 1 2 3 4
1: -2.1 1.9 4.7 2.1
2: 1.4 -1.3 3.0 0.8
3: 3.4 -3.1 -1.8 0.1
4: -0.2 1.5 -0.7 0.5
5: -0.8 -0.2 8.5 -0.9
6: -3.4 -3.2 0.0 -1.7
7: 0.6 -0.8 2.8 -1.0
8: -1.7 0.1 -3.5 0.9
9: -0.7 2.3 0.0 2.0
10: 3.4 -2.4 6.8 -0.1
11: -3.3 1.5 -2.7 3.3
12: -1.6 4.7 -0.4 -0.8
13: 0.0 -0.2 3.0 -0.6
14: 1.9 -1.1 -1.7 -1.6
15: 1.3 -2.4 -0.4 0.3
16: -2.3 2.0 -2.2 -1.5
17: 0.9 -2.9 -1.9 1.6
18: -2.6 4.2 -2.9 -1.9
19: 2.3 2.6 -1.3 2.5
20: 2.1 -2.1 -1.0 0.9
21: 0.0 2.5 -4.4 -1.9
22: -1.8 -0.7 1.4 -1.4
23: 0.8 -2.6 0.1 -2.0
24: -1.6 -2.3 -3.1 -3.1
25: 0.0 -0.5 0.6 0.5
26: -1.4 4.0 -3.4 -0.1
27: 1.7 -1.8 -0.9 -0.4
28: 5.6 -1.0 1.7 -1.3
29: 2.7 0.9 0.8 0.3
30: -3.0 1.1 0.0 1.7
31: 1.3 2.8 -0.1 3.2
32: -2.9 -3.3 -0.8 -0.5

Transducer Phase limits [-100.0 0.0] deg
Board 1 2 3 4
1: -36.1 -39.6 -35.8 -36.5
2: -36.6 -37.6 -33.4 -41.0
3: -32.8 -43.3 -36.5 -39.5
4: -37.1 -36.7 -38.3 -32.4
5: -39.4 -42.0 -38.2 -36.0
6: -36.9 -36.5 -36.7 -35.6
7: -34.9 -41.0 -36.2 -37.9
8: -37.4 -40.5 -41.0 -36.6
9: -38.2 -36.8 -36.6 -37.6
10: -41.1 -38.6 -28.7 -32.4
11: -38.6 -39.3 -43.1 -35.7
12: -35.3 -35.8 -43.8 -36.1
13: -36.1 -43.2 -34.6 -39.8
14: -37.1 -44.8 -36.7 -36.6
15: -31.9 -47.0 -39.0 -29.4
16: -38.7 -41.1 -36.8 -35.3
17: -31.5 -38.4 -42.4 -34.4
18: -34.9 -35.6 -40.7 -37.1
19: -37.4 -37.2 -37.9 -34.6
20: -33.8 -40.9 -42.4 -35.4
21: -35.0 -39.0 -37.7 -35.4
22: -36.7 -40.6 -33.4 -35.7
23: -37.3 -42.9 -36.3 -34.2
24: -37.7 -39.0 -41.2 -30.8
25: -31.7 -38.2 -39.5 -35.5
26: -41.0 -37.3 -36.3 -38.3
27: -33.7 -39.0 -38.7 -37.4
28: -37.3 -39.2 -34.3 -34.5
29: -38.3 -42.3 -38.7 -33.6
30: -35.3 -38.7 -38.9 -30.6
31: -40.5 -41.8 -35.5 -29.2
32: -40.3 -41.0 -36.5 -36.4
Rx Channels test passed

2015.02.10 01:55:03.998 101 7
OK
Tx Channels test passed

2015.02.10 01:57:44.991 101 8
OK
RX NOISE LEVEL

Board No: 1 2 3 4

0: 55.4 55.0 58.4 57.9
dB
1: 54.9 54.5 58.3 58.3
dB
2: 54.3 53.3 58.0 58.5
dB
3: 54.7 54.0 57.9 58.4
dB
4: 55.1 53.9 57.9 58.4
dB
5: 54.9 52.9 58.2 57.6
dB
6: 55.0 53.8 58.1 56.8
dB
7: 54.9 52.8 58.0 55.7
dB
8: 52.4 53.7 57.9 55.5
dB
9: 55.8 53.1 58.9 55.2
dB
10: 54.9 53.6 58.4 54.8
dB
11: 55.5 52.4 58.3 54.0
dB
12: 55.8 51.8 58.6 54.1
dB
13: 56.3 53.0 58.6 54.5
dB
14: 55.3 53.5 58.3 54.2
dB
15: 56.0 55.1 59.3 53.5
dB
16: 54.5 55.6 58.9 54.0
dB
17: 54.2 54.6 58.6 54.6
dB
18: 53.8 55.0 58.7 55.1
dB
19: 54.7 55.6 58.3 57.4
dB
20: 54.2 55.7 59.9 57.9
dB
21: 54.1 55.7 60.3 57.3
dB
22: 54.4 56.0 60.4 57.1
dB
23: 54.3 56.5 59.3 56.2
dB
24: 54.3 56.6 58.8 55.4
dB
25: 53.9 56.5 58.2 55.0
dB
26: 53.4 56.6 57.4 55.4
dB
27: 53.4 56.5 57.5 54.2
dB
28: 53.7 56.9 57.3 54.6
dB
29: 53.9 57.2 56.8 55.1
dB
30: 54.0 57.1 56.5 54.9
dB
31: 55.0 58.2 57.2 55.1
dB

Maximum noise at Board 3 Channel 22
Level: 60.4 dB

Broadband noise test

Average noise at Board 1 54.7 dB OK
Average noise at Board 2 55.2 dB OK
Average noise at Board 3 58.4 dB OK
Average noise at Board 4 56.1 dB OK

2015.02.10 01:57:51.825 101 9
OK
RX NOISE SPECTRUM

Board No: 1 2 3 4

26.1 kHz: 65.6 65.7 59.0
55.6 dB
26.3 kHz: 65.1 64.8 59.1
56.2 dB
26.5 kHz: 64.7 64.5 59.1
56.4 dB
26.7 kHz: 63.2 63.7 58.9
56.1 dB
26.9 kHz: 62.1 62.6 58.0
55.5 dB

27.1 kHz: 61.4 61.0 57.5
55.3 dB
27.3 kHz: 60.8 59.3 55.6
54.4 dB
27.5 kHz: 58.9 57.0 54.7
53.2 dB
27.7 kHz: 56.0 54.2 53.7
53.0 dB
27.9 kHz: 53.8 53.0 53.4
53.4 dB
28.1 kHz: 54.4 53.9 52.3
52.7 dB
28.3 kHz: 56.5 56.0 52.8
52.5 dB
28.5 kHz: 58.1 58.3 54.3
52.7 dB
28.7 kHz: 59.4 59.1 55.2
52.8 dB
28.9 kHz: 60.6 59.1 55.4
53.3 dB
29.1 kHz: 61.1 60.2 55.6
54.6 dB
29.3 kHz: 61.6 60.7 55.9
54.5 dB
29.5 kHz: 61.7 60.7 55.8
54.8 dB
29.7 kHz: 61.0 60.4 56.6
54.7 dB
29.9 kHz: 60.0 59.7 58.1
55.7 dB
30.1 kHz: 60.1 59.4 57.9
55.0 dB
30.3 kHz: 58.9 59.5 56.9
54.8 dB
30.5 kHz: 58.3 59.4 57.9
55.5 dB
30.7 kHz: 60.8 67.7 66.7
59.3 dB
30.9 kHz: 58.9 60.7 58.0
55.7 dB
31.1 kHz: 58.7 60.6 57.7
54.6 dB
31.4 kHz: 58.5 60.3 57.2
52.6 dB
31.6 kHz: 57.8 60.4 57.2
50.4 dB
31.8 kHz: 58.8 59.9 58.3
52.6 dB
32.0 kHz: 61.4 61.3 60.1
55.3 dB
32.2 kHz: 61.4 61.2 59.9
56.0 dB
32.4 kHz: 62.3 61.8 60.8
58.3 dB
32.6 kHz: 67.0 65.7 64.9
63.5 dB
32.8 kHz: 70.3 68.4 68.1
67.5 dB
33.0 kHz: 70.1 68.3 69.3
67.7 dB
33.2 kHz: 68.2 67.1 67.8
65.9 dB
33.4 kHz: 64.8 63.4 63.9
62.0 dB
33.6 kHz: 59.3 60.3 58.4
56.4 dB
33.8 kHz: 61.2 61.3 59.7
57.8 dB
34.0 kHz: 60.4 60.8 58.3
56.9 dB

Maximum noise at Board 1 Frequency
32.8 kHz Level: 70.3 dB

Spectral noise test

Average noise at Board 1 62.9 dB OK
Average noise at Board 2 62.5 dB OK
Average noise at Board 3 61.0 dB OK
Average noise at Board 4 58.9 dB OK

2015.02.10 01:57:58.658 101 10
OK
CPU: KOM CP6011
Clock 1795 MHz
Die 32 oC (peak: 33 oC @ 2015-02-10
- 00:27:15)
Board 30 oC (peak: 31 oC @ 2015-02-
10 - 00:26:39)
Core 1.33 V
3V3 3.30 V
12V 12.11 V
-12V -12.04 V
BATT 0.00 V
Primary network:
157.237.14.60:0xffff0000
Secondary network:
192.168.2.20:0xffffff00

2015.02.10 01:57:58.725 101 15
OK
EM 302
BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.5.7 140129
DDS: 3.5.9 130926
DSV: 3.1.6 130104
RX32 version : Feb 18 2010 Rev 1.11
TX36 LC version : May 7 2013 Rev 1.11
VxWorks 5.5.1 Build 1.2/2-IX0100 May
16 2007, 11:31:17

Saved: 2015.02.10 02:33:59

Sounder Type: 302, Serial no.: 101

Date Time Ser. No. BIST
Result

2015.02.10 01:51:36.535 101 0
OK
Number of BSP67B boards: 2
BSP 1 Master 2.2.3 090702 4.3 070913
4.3 070913
BSP 1 Slave 2.2.3 090702 4.4 070911
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 2.2.3 090702 4.3 070913
4.3 070913
BSP 2 Slave 2.2.3 090702 4.4 070911
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

2015.02.10 01:51:39.418 101 1
OK
High Voltage Br. 1

TX36 Spec: 90.0 - 145.0
0-1 121.7
0-2 121.3
0-3 120.9
0-4 121.3
0-5 121.3
0-6 121.3
0-7 120.5
0-8 120.1
0-9 121.3
0-10 121.7
0-11 120.5
0-12 120.9
0-13 120.5
0-14 122.1
0-15 120.9
0-16 121.7
0-17 120.1
0-18 120.9
0-19 121.7
0-20 120.9
0-21 120.9
0-22 120.9
0-23 121.3
0-24 119.7

High Voltage Br. 2

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

Input voltage 12V

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

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 30.4
0-2 28.4
0-3 28.8
0-4 28.0
0-5 28.4
0-6 29.6
0-7 30.0
0-8 30.4
0-9 29.6
0-10 27.2
0-11 26.8
0-12 28.0
0-13 30.4
0-14 28.8
0-15 30.0
0-16 29.2
0-17 30.0
0-18 29.6
0-19 30.8
0-20 31.2

0-21 30.4
0-22 29.6
0-23 30.8
0-24 31.6

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 0.6
0-7 0.5
0-8 0.5
0-9 0.5
0-10 0.5
0-11 0.5
0-12 0.5
0-13 0.5
0-14 0.6
0-15 0.6
0-16 0.5
0-17 0.5
0-18 0.8
0-19 0.5
0-20 0.7
0-21 0.6
0-22 0.6
0-23 0.7
0-24 0.5

TX36 power test passed

IO TX PPC Embedded PPC Download
2.11 1.14 Mar 5 2007/1.07 May 7 2013/1.11

TX36 unique firmware test OK

2015.02.10 01:51:54.186 101 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 2.5

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 34.0
7-2 36.0
7-3 36.0
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 0.6

Input Current 6V

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

RX32 power test passed

IO RX MB Embedded PPC Embedded PPC Download
1.12 1.14 May 5 2006/1.06 May 5 2006/1.07 Feb 18 2010/1.11

RX32 unique firmware test OK

2015.02.10 01:51:54.319 101 3 OK
High Voltage Br. 1

TX36 Spec: 90.0 - 145.0
0-1 121.7
0-2 121.3
0-3 120.9
0-4 121.3
0-5 121.3
0-6 121.3
0-7 120.5
0-8 120.1
0-9 121.3
0-10 121.3
0-11 120.5
0-12 120.9
0-13 120.5
0-14 122.1
0-15 120.9
0-16 121.7
0-17 120.1
0-18 120.9
0-19 121.7
0-20 120.9
0-21 120.9
0-22 120.9
0-23 121.3
0-24 119.7

High Voltage Br. 2

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

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 11.8
0-7 11.8
0-8 11.8
0-9 11.8
0-10 11.9
0-11 11.8
0-12 11.8

0-13 11.8
0-14 11.8
0-15 11.9
0-16 11.9
0-17 11.8
0-18 11.8
0-19 11.8
0-20 11.8
0-21 11.9
0-22 11.8
0-23 11.8
0-24 11.8

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

TRU power test passed

2015.02.10 01:51:54.502 101 4
OK
EM 302 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage: 18.00 PASSED
Test Voltage:40.00 Measured Voltage: 38.00 PASSED
Test Voltage:60.00 Measured Voltage: 58.00 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: 119.00 PASSED
Test Voltage:120.00 Measured Voltage: 119.00 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

2015.02.10 01:54:30.362 101 5
OK

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

2015.02.10 01:54:35.829 101 6
OK
Receiver impedance limits [600.0 1000.0] ohm

Board	1	2	3	4
1:	867.5	863.3	832.3	856.9
2:	843.4	856.4	839.7	860.5
3:	831.5	859.7	863.5	855.6
4:	851.2	847.5	860.0	852.2
5:	855.8	859.6	793.4	864.7
6:	862.5	864.7	845.0	866.4
7:	852.3	862.3	847.8	870.8
8:	851.6	853.3	860.4	846.5
9:	373.8*	855.5	856.4	839.4
10:	830.9	862.3	804.9	854.1
11:	850.5	849.6	851.6	838.6
12:	858.6	823.0	845.2	852.4
13:	856.9	851.7	838.3	851.4
14:	841.1	852.0	871.6	854.9
15:	834.5	848.2	853.7	849.9
16:	858.7	843.9	861.4	844.7
17:	834.9	936.9	859.1	852.9
18:	852.8	843.9	865.1	860.7
19:	827.0	848.5	842.6	848.1
20:	840.9	873.9	858.4	855.0
21:	866.3	854.3	884.7	859.0
22:	883.9	854.8	845.9	858.7
23:	876.2	869.3	861.5	858.7
24:	884.4	886.5	876.1	868.9
25:	849.4	861.1	859.0	859.9
26:	855.0	846.3	857.5	854.3
27:	839.3	849.2	857.1	856.0
28:	830.3	846.3	830.5	854.7
29:	829.1	864.3	848.7	855.4
30:	862.8	840.5	849.4	857.4
31:	839.7	836.3	853.9	846.3
32:	858.3	878.9	858.5	859.9

Transducer impedance limits [250.0 2000.0] ohm

Board	1	2	3	4
1:	347.5	365.8	362.6	373.9
2:	362.9	376.1	372.8	378.7
3:	351.4	352.6	379.2	365.6
4:	358.6	364.8	381.6	364.0
5:	344.5	366.7	391.4	357.1
6:	338.4	356.9	365.9	372.7
7:	349.5	359.9	399.0	369.4
8:	336.8	352.5	374.9	375.0
9:	158.3*	371.4	383.5	368.7
10:	367.4	358.4	384.7	375.7
11:	342.9	370.2	368.0	374.5
12:	357.6	380.1	383.2	356.8
13:	347.3	356.1	387.0	359.6
14:	382.7	355.6	390.4	356.2
15:	348.4	355.4	377.9	357.6
16:	345.0	369.1	386.2	344.7
17:	344.0	389.9	360.2	367.6
18:	350.5	370.2	375.5	371.3
19:	366.5	371.8	372.8	371.0
20:	363.4	357.9	373.0	358.1
21:	363.8	366.9	377.7	372.4
22:	366.3	371.1	378.8	359.9
23:	378.1	356.1	382.2	370.5
24:	376.9	379.2	357.2	355.7
25:	356.0	375.6	371.7	362.9
26:	357.9	389.5	371.1	372.0
27:	352.5	367.5	381.4	369.1
28:	367.3	382.4	379.7	350.8
29:	362.6	379.9	386.1	376.3
30:	346.1	357.9	364.5	376.4
31:	358.6	376.2	380.2	368.8
32:	342.8	373.9	371.3	380.3

Receiver Phase limits [-50.0 20.0] deg

Board	1	2	3	4
1:	-2.1	1.9	4.7	2.1
2:	1.4	-1.3	3.0	0.8
3:	3.4	-3.1	-1.8	0.1
4:	-0.2	1.5	-0.7	0.5
5:	-0.8	-0.2	8.5	-0.9
6:	-3.4	-3.2	0.0	-1.7
7:	0.6	-0.8	2.8	-1.0
8:	-1.7	0.1	-3.5	0.9
9:	-0.7	2.3	0.0	2.0
10:	3.4	-2.4	6.8	-0.1
11:	-3.3	1.5	-2.7	3.3
12:	-1.6	4.7	-0.4	-0.8
13:	0.0	-0.2	3.0	-0.6
14:	1.9	-1.1	-1.7	-1.6
15:	1.3	-2.4	-0.4	0.3
16:	-2.3	2.0	-2.2	-1.5
17:	0.9	-2.9	-1.9	1.6
18:	-2.6	4.2	-2.9	-1.9
19:	2.3	2.6	-1.3	2.5
20:	2.1	-2.1	-1.0	0.9
21:	0.0	2.5	-4.4	-1.9
22:	-1.8	-0.7	1.4	-1.4
23:	0.8	-2.6	0.1	-2.0
24:	-1.6	-2.3	-3.1	-3.1
25:	0.0	-0.5	0.6	0.5
26:	-1.4	4.0	-3.4	-0.1
27:	1.7	-1.8	-0.9	-0.4
28:	5.6	-1.0	1.7	-1.3
29:	2.7	0.9	0.8	0.3
30:	-3.0	1.1	0.0	1.7
31:	1.3	2.8	-0.1	3.2
32:	-2.9	-3.3	-0.8	-0.5

Transducer Phase limits [-100.0 0.0] deg

Board	1	2	3	4
1:	-36.1	-39.6	-35.8	-36.5
2:	-36.6	-37.6	-33.4	-41.0
3:	-32.8	-43.3	-36.5	-39.5
4:	-37.1	-36.7	-38.3	-32.4
5:	-39.4	-42.0	-38.2	-36.0
6:	-36.9	-36.5	-36.7	-35.6
7:	-34.9	-41.0	-36.2	-37.9
8:	-37.4	-40.5	-41.0	-36.6
9:	-38.2	-36.8	-36.6	-37.6
10:	-41.1	-38.6	-28.7	-32.4
11:	-38.6	-39.3	-43.1	-35.7
12:	-35.3	-35.8	-43.8	-36.1
13:	-36.1	-43.2	-34.6	-39.8
14:	-37.1	-44.8	-36.7	-36.6
15:	-31.9	-47.0	-39.0	-29.4
16:	-38.7	-41.1	-36.8	-35.3
17:	-31.5	-38.4	-42.4	-34.4
18:	-34.9	-35.6	-40.7	-37.1
19:	-37.4	-37.2	-37.9	-34.6
20:	-33.8	-40.9	-42.4	-35.4
21:	-35.0	-39.0	-37.7	-35.4
22:	-36.7	-40.6	-33.4	-35.7
23:	-37.3	-42.9	-36.3	-34.2

24: -37.7 -39.0 -41.2 -30.8
25: -31.7 -38.2 -39.5 -35.5
26: -41.0 -37.3 -36.3 -38.3
27: -33.7 -39.0 -38.7 -37.4
28: -37.3 -39.2 -34.3 -34.5
29: -38.3 -42.3 -38.7 -33.6
30: -35.3 -38.7 -38.9 -30.6
31: -40.5 -41.8 -35.5 -29.2
32: -40.3 -41.0 -36.5 -36.4
Rx Channels test passed

2015.02.10 01:55:03.998 101 7 OK
Tx Channels test passed

2015.02.10 01:57:44.991 101 8 OK
RX NOISE LEVEL

Board No: 1 2 3 4

0: 55.4 55.0 58.4 57.9 dB
1: 54.9 54.5 58.3 58.3 dB
2: 54.3 53.3 58.0 58.5 dB
3: 54.7 54.0 57.9 58.4 dB
4: 55.1 53.9 57.9 58.4 dB
5: 54.9 52.9 58.2 57.6 dB
6: 55.0 53.8 58.1 56.8 dB
7: 54.9 52.8 58.0 55.7 dB
8: 52.4 53.7 57.9 55.5 dB
9: 55.8 53.1 58.9 55.2 dB
10: 54.9 53.6 58.4 54.8 dB
11: 55.5 52.4 58.3 54.0 dB
12: 55.8 51.8 58.6 54.1 dB
13: 56.3 53.0 58.6 54.5 dB
14: 55.3 53.5 58.3 54.2 dB
15: 56.0 55.1 59.3 53.5 dB
16: 54.5 55.6 58.9 54.0 dB
17: 54.2 54.6 58.6 54.6 dB
18: 53.8 55.0 58.7 55.1 dB
19: 54.7 55.6 58.3 57.4 dB
20: 54.2 55.7 59.9 57.9 dB
21: 54.1 55.7 60.3 57.3 dB
22: 54.4 56.0 60.4 57.1 dB
23: 54.3 56.5 59.3 56.2 dB
24: 54.3 56.6 58.8 55.4 dB
25: 53.9 56.5 58.2 55.0 dB
26: 53.4 56.6 57.4 55.4 dB
27: 53.4 56.5 57.5 54.2 dB
28: 53.7 56.9 57.3 54.6 dB
29: 53.9 57.2 56.8 55.1 dB
30: 54.0 57.1 56.5 54.9 dB
31: 55.0 58.2 57.2 55.1 dB

Maximum noise at Board 3 Channel 22 Level: 60.4 dB

Broadband noise test

Average noise at Board 1 54.7 dB OK
Average noise at Board 2 55.2 dB OK
Average noise at Board 3 58.4 dB OK
Average noise at Board 4 56.1 dB OK

2015.02.10 01:57:51.825 101 9 OK
RX NOISE SPECTRUM

Board No: 1 2 3 4

26.1 kHz: 65.6 65.7 59.0 55.6 dB
26.3 kHz: 65.1 64.8 59.1 56.2 dB
26.5 kHz: 64.7 64.5 59.1 56.4 dB
26.7 kHz: 63.2 63.7 58.9 56.1 dB
26.9 kHz: 62.1 62.6 58.0 55.5 dB
27.1 kHz: 61.4 61.0 57.5 55.3 dB
27.3 kHz: 60.8 59.3 55.6 54.4 dB
27.5 kHz: 58.9 57.0 54.7 53.2 dB
27.7 kHz: 56.0 54.2 53.7 53.0 dB
27.9 kHz: 53.8 53.0 53.4 53.4 dB
28.1 kHz: 54.4 53.9 52.3 52.7 dB
28.3 kHz: 56.5 56.0 52.8 52.5 dB
28.5 kHz: 58.1 58.3 54.3 52.7 dB
28.7 kHz: 59.4 59.1 55.2 52.8 dB
28.9 kHz: 60.6 59.1 55.4 53.3 dB
29.1 kHz: 61.1 60.2 55.6 54.6 dB
29.3 kHz: 61.6 60.7 55.9 54.5 dB
29.5 kHz: 61.7 60.7 55.8 54.8 dB
29.7 kHz: 61.0 60.4 56.6 54.7 dB
29.9 kHz: 60.0 59.7 58.1 55.7 dB
30.1 kHz: 60.1 59.4 57.9 55.0 dB
30.3 kHz: 58.9 59.5 56.9 54.8 dB
30.5 kHz: 58.3 59.4 57.9 55.5 dB
30.7 kHz: 60.8 67.7 66.7 59.3 dB
30.9 kHz: 58.9 60.7 58.0 55.7 dB
31.1 kHz: 58.7 60.6 57.7 54.6 dB
31.4 kHz: 58.5 60.3 57.2 52.6 dB
31.6 kHz: 57.8 60.4 57.2 50.4 dB
31.8 kHz: 58.8 59.9 58.3 52.6 dB
32.0 kHz: 61.4 61.3 60.1 55.3 dB
32.2 kHz: 61.4 61.2 59.9 56.0 dB
32.4 kHz: 62.3 61.8 60.8 58.3 dB
32.6 kHz: 67.0 65.7 64.9 63.5 dB
32.8 kHz: 70.3 68.4 68.1 67.5 dB
33.0 kHz: 70.1 68.3 69.3 67.7 dB
33.2 kHz: 68.2 67.1 67.8 65.9 dB
33.4 kHz: 64.8 63.4 63.9 62.0 dB
33.6 kHz: 59.3 60.3 58.4 56.4 dB
33.8 kHz: 61.2 61.3 59.7 57.8 dB
34.0 kHz: 60.4 60.8 58.3 56.9 dB

Maximum noise at Board 1 Frequency 32.8 kHz Level: 70.3 dB

Spectral noise test

Average noise at Board 1 62.9 dB OK
Average noise at Board 2 62.5 dB OK
Average noise at Board 3 61.0 dB OK
Average noise at Board 4 58.9 dB OK

2015.02.10 01:57:58.658 101 10
OK
CPU: KOM CP6011
Clock 1795 MHz
Die 32 oC (peak: 33 oC @ 2015-02-10 - 00:27:15)
Board 30 oC (peak: 31 oC @ 2015-02-10 - 00:26:39)
Core 1.33 V
3V3 3.30 V
12V 12.11 V
-12V -12.04 V
BATT 0.00 V
Primary network:
157.237.14.60:0xffff0000
Secondary network:
192.168.2.20:0xffffff00

2015.02.10 01:57:58.725 101 15
OK
EM 302
BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.5.7 140129
DDS: 3.5.9 130926
DSV: 3.1.6 130104
RX32 version : Feb 18 2010 Rev 1.11
TX36 LC version : May 7 2013 Rev 1.11
VxWorks 5.5.1 Build 1.2/2-IX0100 May 16 2007, 11:31:17

Appendix H. Retired equipment

Singlebeam Echo Sounder (SBES) EA 600

The transducer for the system was removed in 2011 to make room for the new EK 60 18 kHz transducer. The following information remains 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.

Items in Development

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

J-Frame


Figure 19. Photos of starboard side CTD deck showing J-Frame (left) and CTD Winch (right).

A-Frame

Cranes

Winches