SERIES 4900 SONAR SYSTEM

Operations and Maintenance Manual

P/N 11210091, Rev. 02

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WARNING

Klein Marine Systems, Inc. recommends all troubleshooting be done by a trained technician. Some circuits in the Sonar Transceiver and Processing Unit have voltages as high as 240 volts, and some circuits in the sonar towfish have 1500 volts. You should familiarize yourself with the location of these voltages before you attempt any troubleshooting. Failure to observe these warnings could result in injuries to personnel.

CAUTION

Serious damage to the sonar electronics may occur if the sonar towfish is operated out of the water for periods longer than 15 minutes. Let the sonar cool 15 minutes or longer between operations. Protect the sonar towfish from direct exposure to the sun prior to and during operation in high temperature climates.

CAUTION

The depth rating on the transducers is 300 meters (984 ft). Operations at depths greater than 300 meters may damage the transducers.

CAUTION

When the towfish is close to the sea floor, the 900-kHz bottom tracking (altitude) performance is *not* exact. Klein Marine Systems, Inc. advises extreme caution when operating the towfish at altitudes of less than 4 meters (13 feet).

CAUTION

The system can be operated safely in harsh environments; however, the combination of speed, tow cable length and sea state can have a negative impact on towfish flight which may adversely affect the image performance.

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Sonar System Warranty

What Is Covered

LIMITED WARRANTY Subject to the conditions set forth below, equipment sold by Seller is warranted against defects in materials and workmanship, and Seller will repair or exchange any parts proven to be malfunctioning under normal use for one year (12 months) from the date of Delivery as follows:

a) **SONAR** and other associated manufactured products, with the following exceptions:

b) All third party accessories, winches, magnetometers, Sonar Laptops or PCs, and peripherals/accessories and third party software packages related to the Sonar Product Line are limited to the warranty provided by original manufacturer.

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b) A suitable proof of purchase, such as, a paid commercial invoice, an installation certificate signed by Seller or an authorized agent must be made available to Seller or Seller's authorized servicing agent at the time of the Warranty Service.

c) The warranties stated herein are in lieu of all other warranties, expressed or implied, and of all other obligations or liabilities on the part of Seller. Seller neither assumes nor authorizes any other person to assume for it any other liability. The Buyer expressly waives any right, claim or cause of action that might otherwise arise out of the purchase and use of Seller's products or service.

d) Warranty is not transferable and only applies to the original Buyer.

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f) Except where Seller has performed the installation of specific equipment, Seller assumes no responsibility for damage incurred during installation of equipment or by damage caused by no fault of the Seller.

g) This warranty does not cover routine system checkouts or alignment/calibration, unless required by replacement of part(s) in the area being aligned.

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Preface

The Series 4900 Sonar System is a towed single beam sonar comprising a towed underwater vehicle and topside equipment.

What's in This Manual

This operations and maintenance manual provides information pertaining to the setup and deployment, operation, general maintenance, and troubleshooting of the Series 4900 Sonar System. The manual is divided into the following five main chapters and three appendices:

Chapter 1: Overview. Presents an overview of the Series 4900 Sonar System components, including both functional and physical descriptions of the system.

Chapter 2: Specifications. Provides detailed physical and performance specifications for the main components of the Series 4900 Sonar System.

Chapter 3: Setup and Test. Provides instructions for unpacking, setting up and testing the Series 4900 Sonar System components. It also includes descriptions of all the connectors and operator controls and indicators.

Chapter 4: Equipment Maintenance. Provides checklists for daily, weekly, and long term inspection and service of the Series 4900 Sonar System components along with instructions for disassembling and reassembling the towfish and removing and installing the transducers.

Chapter 5: Technical Description. Provides and overall description of the Series 4900 Sonar System electronics to assist in troubleshooting, repair or adding optional equipment.

Appendix A: Notes on Handling Tow Cables. Contains information on tow cable handling.

Appendix B: Configuring and Updating the SP-III TPU. Provides instructions on how to use Linux TPU Updater to configure and update the SP-III TPU software.

Appendix C: Compass Calibration. Provides the procedure for calibrating the 14106073 MTI3 compass.

Appendix D: Rigging Guide. Provides towfish rigging guides for a towfish without an optional K-wing depressor and for a towfish with a K-wing I or K-wing II depressor.

Appendix E: Drawings. Provides outline drawings for reference purposes.

Appendix F: Towfish Towing Characteristics. Describes the towing characteristics of the towfish as graphical plots of the towfish depth verses tow cable length for various towfish speeds.

Appendix G: System Setup Diagram with Acoustic Positioning System. Provides the system setup diagram for installations with an acoustic positioning system.

Note, Warning and Caution Notices

Where applicable, note, warning and caution notices are included throughout this manual as follows:

NOTE *Recommendations or general information that is particular to the material being presented or a referral to another part of this manual or to another manual.*

WARNING *Identifies a potential hazard that could cause personal injury or death to yourself or to others.*

CAUTION *Identifies a potential hazard that could be damaging to equipment or could result in the loss of data.*

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CHAPTER 1: OVERVIEW

The Series 4900 Sonar System is a dual simultaneous frequency, very high resolution, long range side scan sonar system that is ideally suited for search and recovery (SAR) missions and coastal surveys requiring high accuracy in shallow water environments. The system employs both chirp and continuous wave (CW) technologies and is ruggedly constructed, light in weight, and configured for simple setup and operation from a small boat.

1.1 Main Features

The Series 4900 Sonar System has the following main features:

- Dual simultaneous frequency operation at 455 kHz and 900 kHz for ranges up to 200 meters and 75 meters, respectively.
- Advanced electronics and transducers that produce superior high resolution imagery.
- 12-bit digital multiplexer for transmission of sonar and control data over a single coaxial cable.
- A compass and pitch, roll, pressure, and temperature sensors.
- Interfaces for an optional magnetometer and responder.
- PC based operation using SonarPro.
- Small, lightweight and simple to operate and maintain.
- Interfaces to third party processors and LAN networks.
- Standard operating depth of 300 meters.
- Compatible with all Klein Marine Systems towing accessories and lightweight cables.

1.2 Equipment

The main components of the Series 4900 Sonar System equipment are a towfish; a Splashproof Transceiver and Processing Unit (SP-III TPU) and a laptop computer, or a Rack Mount Transceiver and Processing Unit (Rack Mount TPU) and a SonarPro Workstation; and a 50-meter tow cable.

1.2.1 Towfish

The towfish, which is shown in Figure 1-1, consists of a negatively buoyant stainless steel housing with attached port and starboard sonar transducers, a nose cone and a tail cone with stabilizing fins. The housing contains the sonar electronics, a downlink demultiplexer for control signals and an uplink multiplexer for sonar and sensor data. Internal sensors include a compass and motion sensor which provide heading, pitch and roll; a pressure transducer which provides water pressure for calculating depth; and a temperature sensor which provides water temperature. The downlink control signals and the uplink sonar and sensor data are multiplexed onto a single conductor coaxial tow cable. An electro-mechanical termination is provided on the towfish end of the tow cable, where a shackle provides a strong, reliable mechanical termination to the towfish tow bracket, and an underwater connector connects to a jumper cable on the towfish. Four carrying handles, two forward and two aft, are included for lifting and transporting the towfish, and a safety cable tab is provided for connecting the safety cable to the tow cable.

1.2.2 Splashproof Transceiver and Processing Unit (SP-III TPU)

The Splashproof Transceiver and Processing Unit (SP-III TPU) contains the electronics for processing the sonar data and powering and communicating with the towfish. The SP-III TPU is shown in Figure 1-2. The SP-III TPU is built into a rugged, lightweight splashproof case and contains the electronics for powering the towfish, downlink multiplexing the control signals to the towfish, uplink demultiplexing the sonar and sensor data from the towfish, and communicating with the laptop computer. The SP-III TPU also provides a navigation input. All of the connectors, indicators and switches are splashproof and are located on a panel on the side of the unit. The SP-III TPU is powered from either an AC or DC power source.

CAUTION *Do not submerge the SP-III TPU in water, as it is not designed for continuous immersion.*

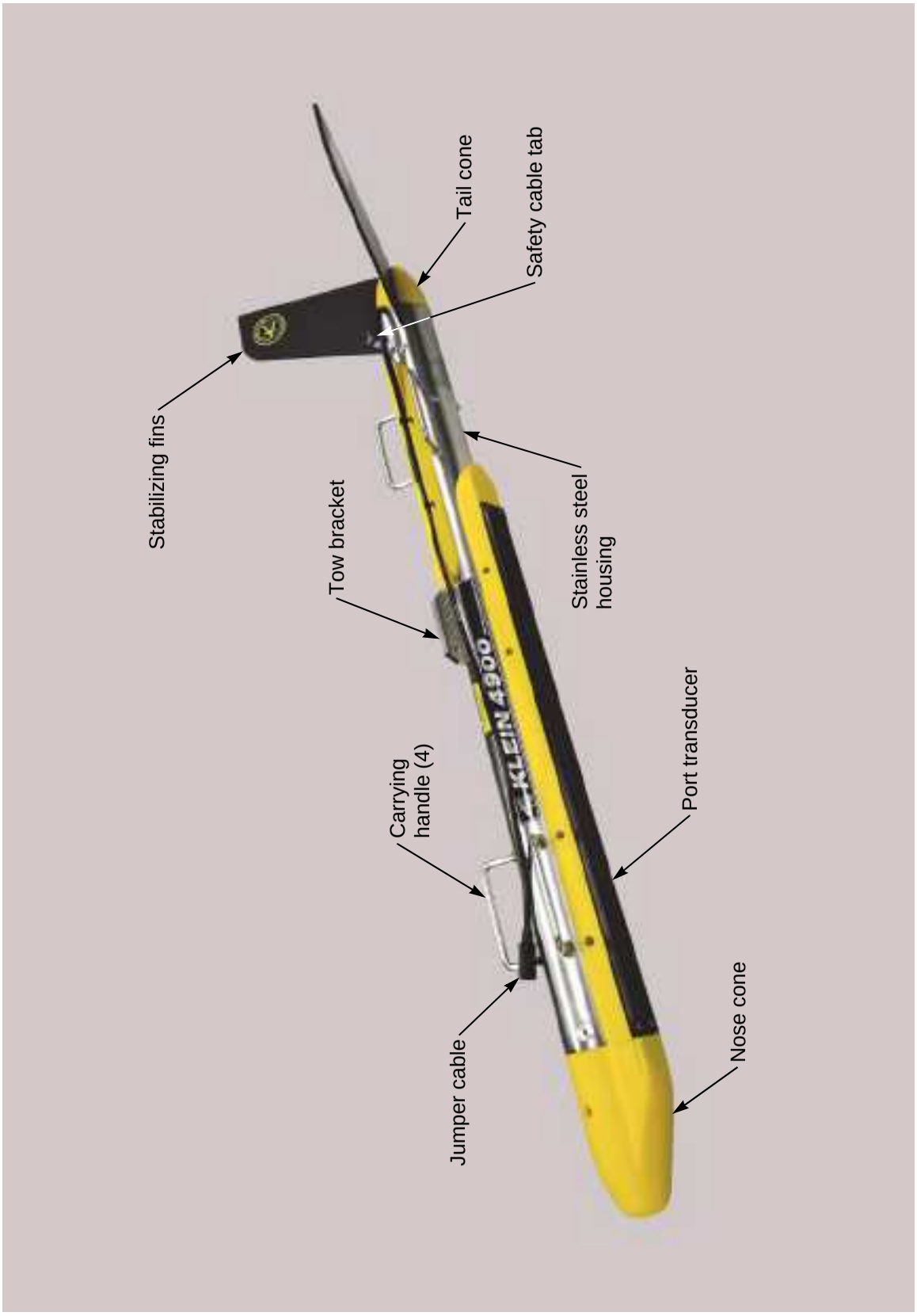


Figure 1-1: *Towfish*

Figure 1-2: *SP-III TPU*

1.2.3 Laptop Computer

The laptop computer, which includes the Windows operating system and SonarPro installed, is the control and display interface. The computer is set up in a client-server format, allowing for flexible and expandable system configurations with multiple computers connected over a TCP/IP fast Ethernet network, all sharing the sonar data.

1.2.4 Rack Mount Transceiver and Processing Unit (Rack Mount TPU)

The Rack Mount Transceiver and Processing Unit (Rack Mount TPU) is optionally available and is shown in Figure 1-3. This TPU is housed in a 19-inch rack mountable 2U chassis and connects to the towfish directly using an optional coaxial tow cable, or to an optionally supplied winch using the supplied deck cable, where the winch connects to the towfish using a tow cable. The deck cable can also be used to connect the TPU directly to the towfish for testing. The TPU receives and demultiplexes the sonar and sensor data from the towfish and transfers the data to the laptop computer over an Ethernet connection. The TPU can also input standard National Marine Electronics Association (NMEA) 0183 message sentence formats from a connected GPS, and a 1PPS input is provided which inputs 1PPS (one pulse per second) signals from the GPS. This signal is

Figure 1-3: *Rack Mount TPU*

used in conjunction with a NMEA $ZDA message input to add an accurate time stamp to the data. The TPU provides power and downlink commands to the towfish by combining 200 VDC with FSK control signals for transmission over the coaxial conductor in the tow cable. In addition, the TPU initiates each ping cycle to the side scan sonar and provides a trigger signal simultaneously with the responder trigger generated in the towfish for use with an acoustic positioning system.

1.2.5 SonarPro Workstation

The SonarPro Workstation is optionally available and is shown in Figure 1-4. It is an industrial grade Intel Pentium Dual Core based computer housed in a 19-inch rack mountable 2U chassis that inputs processed and time tagged sonar and sensor data from the TPU over an Ethernet 10/100/1000baseT connection. A SATA hard drive is included with the Microsoft Windows operating system and SonarPro installed. SonarPro is a comprehensive Windows based software program that provides multiple displays of real-time or saved sonar and sensor data and towfish status. SonarPro also allows you to record all acquired sonar and sensor data. The SonarPro Workstation also includes a high resolution 27-inch 2560 x 1440 monitor, a keyboard and a mouse.

Figure 1-4: *SonarPro Workstation*

1.2.6 Tow Cable

The standard tow cable is 50 meters long, Kevlar reinforced and includes a single coaxial conductor. It is used to tow and to provide power to the towfish, to transmit commands from the SP-III TPU to the towfish, and to transmit sonar and sensor data from the towfish to the SP-III TPU. Cable lengths longer than 50 meters are available.

CHAPTER 2: SPECIFICATIONS

This chapter includes the physical and performance specifications for the main components of the Series 4900 Sonar System.

NOTE *Specifications are typical and subject to change without notice.*

2.1 Sonar System

Beams:	1 port and 1 starboard
Sonar channels:	4
Sonar frequencies:	455 kHz and 900 kHz; dual simultaneous
Transmission pulse:	Chirp and CW; independent pulse controls for each frequency
Maximum range:	Up to 75 m per side at 900 kHz and 200 m per side at 455 kHz
Horizontal beam width:	0.3
Vertical beam width:	45
Tilt angle:	20 down from horizontal
Swath width:	150 m maximum at 900 kHz 400 m maximum at 455 kHz
Across track resolution:	1.2 cm at 900 kHz 2.4 cm at 455 kHz
Depth limit:	300 m (984 ft)
Operating temperature:	-2–32 C (28–90 F)
Data acquisition software:	SonarPro
Data output format:	Sonar Data Format (SDF) or Extended Triton Format (XTF) or both

Range:	10, 15, 20, 25, 30, 40, 50, 60, 75, 100, 120, 150, and 200 meters at 455 kHz 10, 15,20, 25,30, 40, 50, 60, and 75 meters at 900 kHz
Near nadir coverage:	25% of altitude per side

2.2 SP-III TPU

Size:	50.24 cm (19.78 in.) wide 17.1 cm (6.72 in.) high 32.7 cm (12.89 in.) deep
Weight:	6.8 kg (15.0 lb)
Ingress protection:	Designed to IP-65
Outputs:	100BaseTx, Ethernet LAN, RS-232 serial ports (2)
Output data format:	Selectable Sonar Data Format (SDF), Extended Triton Format (XTF), or both
Operating system:	Linux
Navigation input:	NMEA 0183
Input voltage:	88–264 VAC, 47–63 Hz or 12 VDC
Power consumption:	75 w (nominal)
Operating temperature:	0–40°C

2.3 Rack Mount TPU

Size:	8.9 cm (3.5 in.) H 48.3 cm (19.0 in.) W 35.6 cm (14.0 in.) D
Weight:	7.6 kg (17 lb)
Chassis type:	2U, 19-inch rack mount
Input voltage:	88–264 VAC, 47–63 Hz

2.4 Laptop Computer

Size:	39.0 cm (15.6 in.) wide 3.8 cm (1.5 in.) high 30.0 cm (11.8 in.) deep
Weight:	3.2 kg (7.0 lb)
Operating system:	Windows
Applications software:	SonarPro

2.5 SonarPro Workstation

Size:	8.9 cm (3.5 in.) H 48.3 cm (19.0 in.) W 43.2 cm (17.0 in.) D
Weight:	22.8 kg (50 lb)
Chassis type:	2U, 19-inch rack mount
CPU:	Intel Pentium Dual Core
Memory:	8 GB
Storage:	SATA hard drive DVDRW optical drive
I/O ports:	(2) Ethernet 10/100/1000baseT (6) USB 2.0 (2) RS-232 (1) VGA (1) DVI (dual display support)
Operating system:	Windows
Monitor:	21.5-inch diagonal 2560 x 1440 resolution 16:9 aspect ratio
Operator I/O:	Keyboard and mouse

2.6 Towfish

2.6.1 General

Construction:	316 stainless steel, passivated
Size:	8.9 cm (3.5 in.) dia by 142 cm (56 in.) long

Power requirements:	Provided from SP-III TPU or Rack Mount TPU
Weight in air:	24.7 kg (54.5 lb)
Weight in water:	13.5 kg (29.7 lb)

2.6.2 Sensors

Compass

Heading accuracy, level:	±0.5 RMS
Heading accuracy, tilted:	±1.0 RMS, <±30 tilt ±1.5 RMS, ±30 to ±60 tilt
Heading resolution:	0.1
Pitch range:	±90
Roll range:	±180
Pitch and roll accuracy:	±1 at <±30 tilt

Pressure sensor

Pressure range:	0–450 psi
Pressure accuracy:	1.0% of full scale

Temperature sensor

Temperature range:	-40–125°C

2.7 Tow Cables

Both lightweight and armored coaxial tow cables are available. A 50-meter lightweight coaxial tow cable is included with an SP-III TPU.

2.7.1 Lightweight Coaxial Tow Cable

Type:	Polyurethane jacketed coaxial, Kevlar reinforced
Conductors:	Coaxial copper
Diameter (OD):	1.156 cm (0.455 in.)
Breaking strength:	2270 kg (5000 lb)
Working load:	454 kg (1000 lb)
Operational length:	2000 m maximum
Voltage rating:	600 VDC

2.7.2 Armored Coaxial Tow Cable (0.322-inch)

Type:	Double layer, counter helical, galvanized improved plow steel (GIPS)
Conductors:	Coaxial copper
Diameter (OD):	8.2 mm (0.322 in.)
Breaking strength:	42.7 kN (9600 lbf)
Working load:	10.7 kN (2400 lbf)
Operational length:	1500 m (4920 ft) maximum
Voltage rating:	1200 VDC
Termination:	Stainless steel shackle at towfish end

2.7.3 Armored Coaxial Tow Cable (0.40-inch)

Type:	Double layer, counter helical, galvanized improved plow steel (GIPS)
Conductors:	Coaxial copper
Diameter (OD):	10.2 mm (0.40 in.)
Breaking strength:	48.9 kN (11,000 lbf)
Working load:	12.2 kN (2750 lbf)
Operational length:	1800 m (5950 ft) maximum
Voltage rating:	1200 VDC
Termination:	Stainless steel shackle at towfish end

CHAPTER 3: SETUP AND TEST

This chapter provides instructions for unpacking the Series 4900 Sonar System, connecting its components and a navigation system, and testing the system both on deck and at sea. Descriptions of all the connections and the operator controls and indicators on the SP-III TPU or Rack Mount TPU are also included.

3.1 Unpacking and Inspection

The towfish and the topside system components, including associated cables and documentation, are shipped in multiple shipping cases. Unpack all of the cases and verify that all of the items listed on the packing list have been received. If any items are damaged or missing, immediately contact Klein Marine Systems, Inc. or your KMS sales representative. In addition, record the serial numbers for the towfish, the SP-III TPU or Rack Mount TPU, and the laptop or SonarPro Workstation. The towfish serial number can be found on the towfish tow bracket. Refer to Figure 1-1 on page 1-3 for the location of the tow bracket. The serial numbers for the SP-III TPU or Rack Mount TPU and the laptop or SonarPro Workstation can be found on the rear panel of each. The Series 4900 Sonar System typically includes the following items:

- Towfish
- SP-III TPU or Rack Mount TPU
- Laptop or SonarPro Workstation
- Tow cable
- Cable kit containing:

  AC power cord
  DC power cord
  Ethernet cable
  Null modem cable
  GPS cable (customer GPS)

- Accessory tool kit
- Safety cable
- Thumb drive with manuals and software

3.2 Locating the Topside System Components

The SP-III TPU or Rack Mount TPU and the laptop computer or SonarPro Workstation should be located in an area that is protected from weather and spray and where the temperatures are consistently between 0°C and 35°C (32°F and 95°F). The SP-III TPU is partially sealed against spray and inclement weather. However, for equipment longevity, it is best to locate it in a sheltered area. The location should also be near the towfish launch point or be adequately equipped with devices for communicating with launch personnel. If separately mounting components in a 19-inch rack, ensure that the rack is properly secured and that there is ample room behind it for connecting the cables. A thick layer of foam should also be placed under the rack for shock isolation, and the back of the rack should be left open for proper air flow. Support the units inside the rack using appropriate mounting brackets, shelves or slides as needed and secure the front panels to the front of the rack where possible using standard 19-inch rack front panel mounting hardware

3.3 Power Requirements

The SP-III TPU requires 88–264 VAC, 47–63 Hz or 12 VDC to operate. For the laptop computer, refer to its documentation for the power requirements. The Rack Mount TPU and the SonarPro Workstation require 100–125 or 200–250 VAC, 50–60 Hz power to operate. The Series 4900 Sonar System is designed to protect against over and under voltage and transient spikes. However, it is always best to check the power source carefully using a voltmeter or oscilloscope before operating the equipment.

CAUTION *Application of improper AC power may damage the Series 4900 Sonar System. Do not turn the equipment on until the supply voltage and frequency have been checked.*

Since a variety of power connectors are in use throughout the world, it may be necessary to use an adapter or to cut off the US-type plug on the AC power cord and re-terminate it with a new plug. Should this modification be required, the wires should be connected in accordance with Table 3-1.

Table 3-1: *Power Cord Wiring*

COLOR	FUNCTION
Green	Ground (earth)
Blue or white	Neutral
Brown or black	Hot

3.3.1 Grounding

It is important that the Series 4900 Sonar System be well grounded to minimize potential hazards to the operator and electrical interference from other equipment. A good ground for the system is a low impedance, well conducted path to sea water. Always check the quality of the electrical ground by verifying that the AC power source ground has no voltage potential with respect to the vessel hull.

3.3.2 Rack Mount TPU and SonarPro Workstation Circuit Breakers

The main AC power input line is protected by a switch/circuit breaker in both the Rack Mount TPU and the SonarPro Workstation. The one on the Rack Mount TPU is located on the front panel on the far right as shown in Figure 3-4 on page 3-16. The one on the SonarPro Workstation is located on the back panel just to the right of the AC INPUT connector as shown in Figure 3-3 on page 3-10. To reset a switch/circuit breaker, switch it to ON.

3.4 Towfish Setup

Towfish setup encompasses attaching the stabilizer fins and connecting the tow cable. Before connecting the tow cable to the towfish, check that the retaining bolts securing the towfish nose cone and tail cone are tight.

3.4.1 Attaching the Stabilizer Fins

To attach the stabilizer fins:

1. Using a 17-mm box wrench, loosen the tail cone retaining bolt.
2. Pull the tail cone slightly away from the towfish housing.
3. Insert the two stabilizer fins into the slots in the tail cone.
4. Tighten the tail cone retaining bolt.

3.4.2 Connecting the Tow Cable to the Towfish

When connecting the tow cable to the towfish, refer to APPENDIX D: “Rigging Guide” for instructions. Instructions are provided for a towfish without an optional K-wing depressor and for a towfish with a K-wing I or K-wing II depressor.

WARNING *Before connecting the tow cable, verify that the SP-III TPU or Rack Mount TPU is turned off and that its power cord is disconnected. Failure to follow this practice may result in personal injury or damage to the towfish or the SP-III TPU/Rack Mount TPU electronics, or to both. For the location of the power switches, refer to “Topside System Controls and Indicators” on page 3-15.*

CAUTION *When connecting or disconnecting the connectors, do not bend them back and forth, as doing so may damage them. Use a straight down or up movement and push or pull on the connectors, not the cables.*

NOTE *Use of a lightweight cable with a K-Wing II depressor is not recommended. Only a K-Wing I depressor can be used with this cable.*

3.4.3 Disconnecting the Tow Cable from the Towfish

If possible, it is best to keep the tow cable connected to the towfish while on deck. If the tow cable is disconnected, however, it is very important that the connectors be properly maintained. Connectors must be kept clean and must remain out of the way of traffic while on deck. After disconnecting the tow cable from the towfish, install a dummy plug into each of the exposed connectors.

WARNING *Before disconnecting the tow cable, verify that the SP-III TPU or Rack Mount TPU is turned off and that its power cord is disconnected. Failure to follow this practice may result in personal injury or damage to the towfish or the SP-III TPU/Rack Mount TPU electronics, or to both. For the location of the power switches, refer to “Topside System Controls and Indicators” on page 3-15.*

To disconnect the tow cable:

1. Verify that the SP-III TPU or Rack Mount TPU is switched off and that its power cord is disconnected.

2. Grasp the body of each connector at the towfish and gently pull them apart. Do not pull on the cables to separate the connectors. Always hold the body of the connectors. After separating the connectors, put a thin coating of silicone grease on the rubber section of the connector pins.
3. Disengage the shackle from the tow bracket.
4. Install a dummy plug into each of the exposed connectors.

3.5 Topside System Connections

All of the topside system components connect together using the supplied cables. User supplied cables are required for connecting to a GPS and to other equipment.

3.5.1 SP-III TPU Connections

All the connections to the SP-III TPU are made to connectors on the side panel which is shown in Figure 3-1.

The SP-III TPU connectors are the following:

TOWFISH: 8-pin female bulkhead connector that connects to the towfish using the tow cable.

LAN: RJ-45 connector that connects to the Ethernet port of the laptop computer. The SP-III TPU uses a 100BaseTx Ethernet connection.

T/F TRIG: BNC connector that connects to an external sonar system and is used to trigger the sonar of that system at the start of each ping cycle. Provides a TTL compatible, 1-msec wide output pulse.

RESP TRIG: BNC connector that connects to an ultra short baseline navigation system (USBL). Provides a TTL compatible, 1-msec wide output pulse with each trigger of the optional responder.

EXT TRIG IN: Not supported for this system.

1PPS: BNC connector that connects to a GPS and is used to input 1PPS (one pulse per second) signals.

MAG: DB9 female connector that connects to a serial port of the magnetometer control computer. The baud rate is 9600.

DEBUG: DB9 female connector that connects to a serial port of a computer and is available for factory use and troubleshooting purposes. The baud rate is 115200.

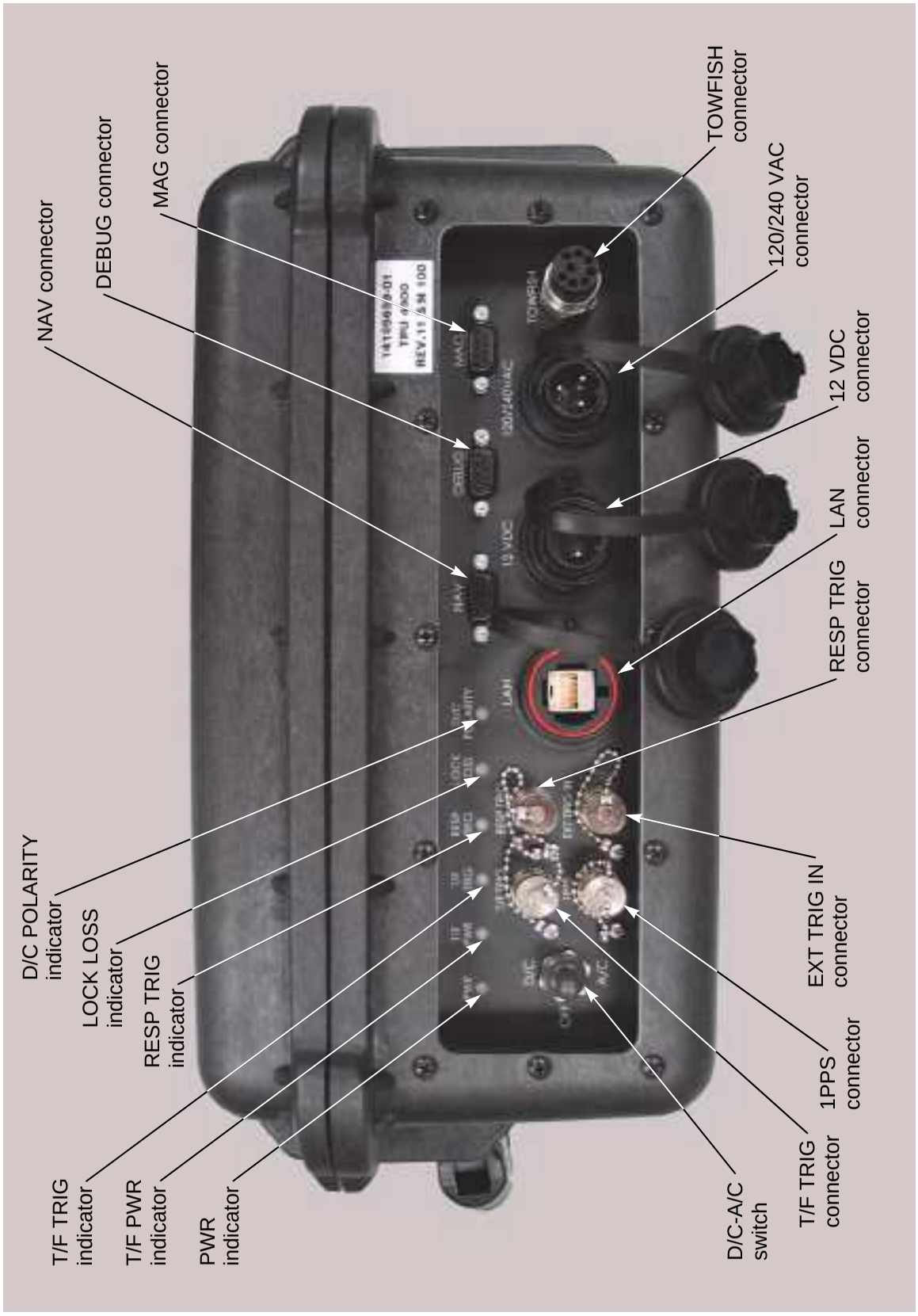


Figure 3-1: *SP-III TPU Side Panel*

NAV: DB9 male RS-232 serial port connector that connects to a shipboard navigation system and inputs NMEA 0183 message sentence formats. The baud rate is 4800.

120/240 VAC: 3-pin bulkhead connector that connects to an 88–264 VAC, 47–63 Hz power source.

12 VDC: 4-pin bulkhead connector that connects to a 12 VDC power source.

3.5.2 Rack Mount TPU Connections

All the connections to the Rack Mount TPU are made to connectors on the back panel which is shown in Figure 3-2.

The Rack Mount TPU connectors are the following:

ETHERNET: RJ-45 connector that connects to the ETHERNET connector on the SonarPro Workstation.

COM A: DB9 male RS-232 serial port connector that is for factory use only.

COM B: DB9 male connector that connects to a serial port of the magnetometer control computer. The baud rate is 9600.

COM C: DB9 male RS-232 serial port connector that is available as a spare and is not used.

NAV: DB9 male RS-232 serial port connector that connects to a shipboard navigation system and inputs NMEA 0183 message sentence formats.

EXT TRIG IN: Not supported for this system.

T/F TRIG: BNC connector that connects to an external sonar system and is used to trigger the sonar of that system at the start of each ping cycle. Provides a TTL compatible, 1-msec wide output pulse.

TRIG A: BNC connector that connects to an ultra short baseline navigation system (USBL). Provides a TTL compatible, 1-msec wide output pulse with each trigger of the optional responder.

1PPS IN: BNC connector that connects a GPS and is used to input 1 PPS (one pulse per second) signals.

TOWFISH: Type N coaxial connector that connects to the towfish or to the slip rings of the optional winch.

AC INPUT: IEC type connector that connects to the AC power source.

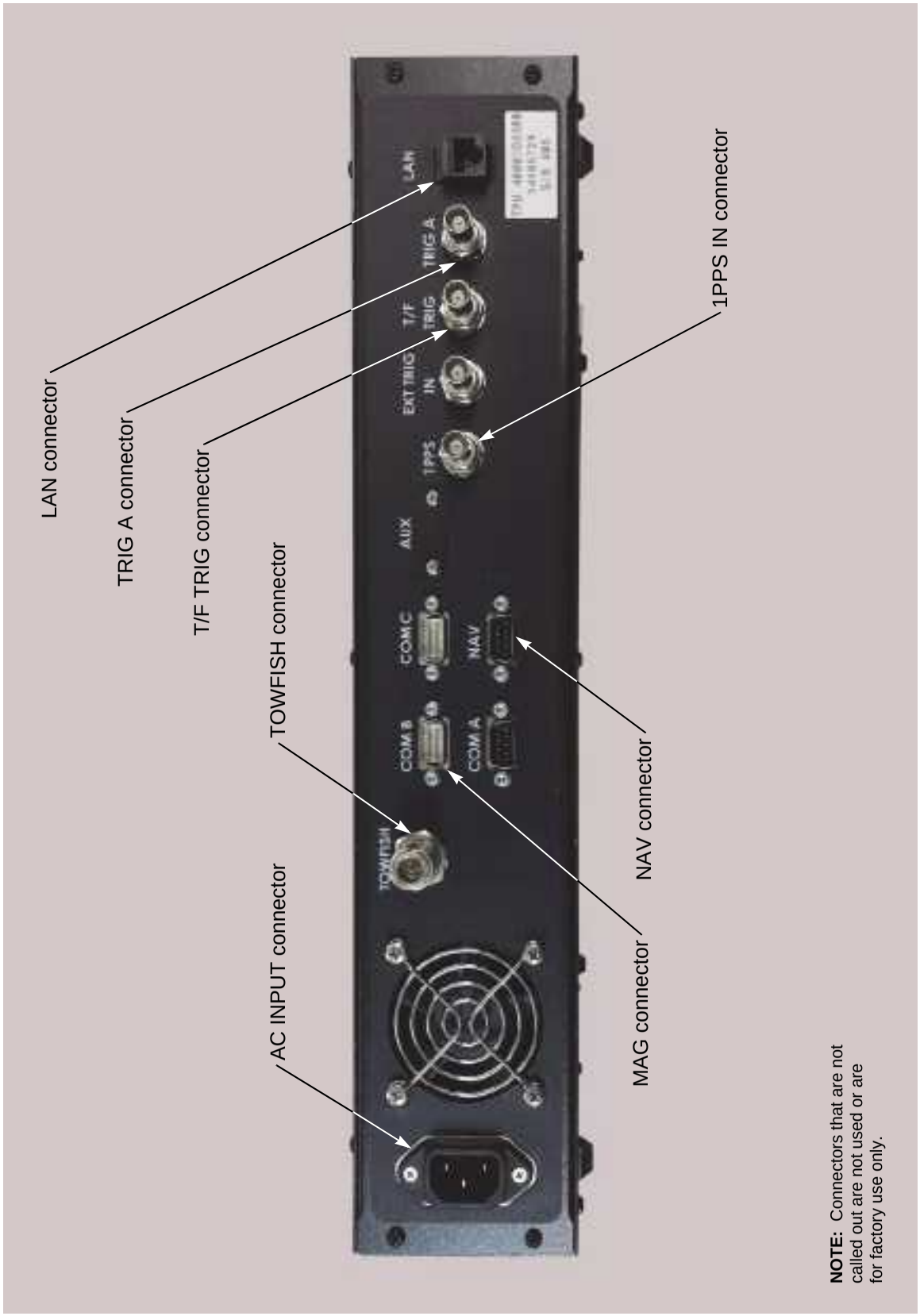


Figure 3-2: *Rack Mount TPU Back Panel*

3.5.3 SonarPro Workstation Connections

All the connections to the SonarPro Workstation are made to connectors on the back panel which is shown in Figure 3-3.

The SonarPro Workstation connectors are the following:

USB:	USB connectors (4, plus 2 on the front panel). Any two connect to the keyboard and the mouse. The front panel USB connectors are shown in Figure 3-5 on page 3-19.
DVI:	DVI connector that connects to the monitor.
ETHERNET:	RJ-45 connectors (2). Any one connects to the ETHERNET connector on the SP-III TPU or Rack Mount TPU.
AC INPUT:	IEC type AC input connector that connects to the AC power source.

3.6 Connecting the Topside System Components

The topside system components are connected using KMS or user supplied cables. Two system configurations are included, one that includes the SP-III TPU and the laptop computer, and the other that includes Rack Mount TPU and the SonarPro Workstation.

3.6.1 Connecting the SP-III TPU and the Laptop Computer

The following supplied cables are used to connect the SP-III TPU and the laptop computer:

- Ethernet crossover cable
- DC power cable
- AC power cable
- Tow cable

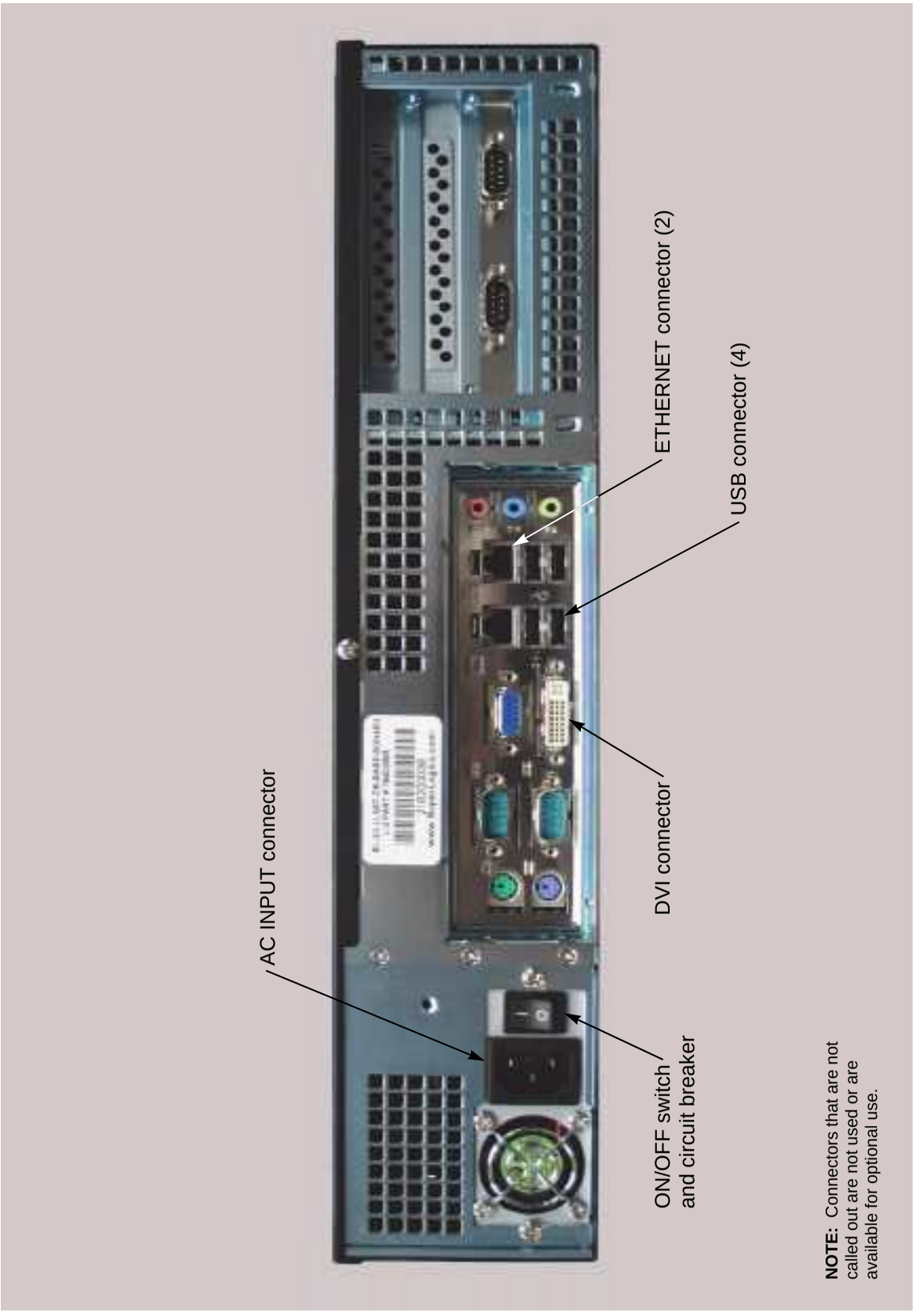
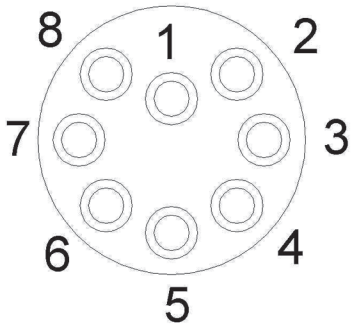


Figure 3-3: *SonarPro Workstation Back Panel*

For the connector pinouts and pin orientations for each of the connectors on the SP-III TPU side panel, refer to Table 3-3 through Table 3-8. For the connector pinout and orientation of the towfish jumper cable connector, refer to Table 3-2.

Table 3-2: *Towfish Jumper Cable Connector Pinout*

PIN	FUNCTION
1	200 VDC Power and Telemetry
2	Shield



WARNING *Before connecting the topside system components, verify that the SP-III TPU is turned off and that its power cable is disconnected. Failure to follow this practice may result in personal injury or damage to the towfish or the SP-III TPU electronics, or to both. For the location of the power switch, refer to "Topside System Controls and Indicators" on page 3-15.*

To connect the SP-III TPU and laptop computer:

1. Connect the Ethernet crossover cable to the LAN connector on the SP-III TPU and to the Ethernet port of the laptop computer.
2. Connect a GPS to the NAV connector on the SP-III TPU. A user supplied RS-232 serial cable is required where one end is terminated with a DB9 female connector and the other end is as required by the navigation system
3. Verify that the GPS is outputting NMEA-0183 formatted data strings at 4800 baud, no parity, 8 data bits, and 1 stop bit. In addition, the GPS should be outputting the following messages:
   - GLL or GGA
   - VTG
   - RMC (optional)

NOTE *If 4800 baud is not available from the GPS, contact KMS customer service for instructions on how to reconfigure the system to accept a different baud rate. Refer to "Customer Service" on page xvi for information on how to contact KMS customer service.*

Table 3-3: *LAN Connector Pinouts*

PIN	FUNCTION
3	TX+
6	TX-
1	RX+
2	RX-

Table 3-4: *12 VDC Connector Pinouts*

PIN	FUNCTION
1	Return
2	+12 VDC

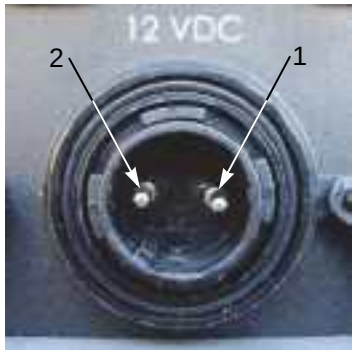


Table 3-5: *120/240 VAC Connector Pinouts*

PIN	FUNCTION
1	Neutral
2	GND
3	Line

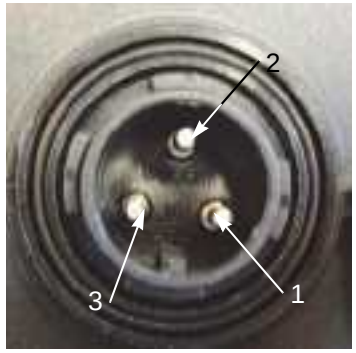


Table 3-6: *TOWFISH Connector Pinouts*

PIN	FUNCTION
1	200 VDC Power and Telemetry
2	Shield

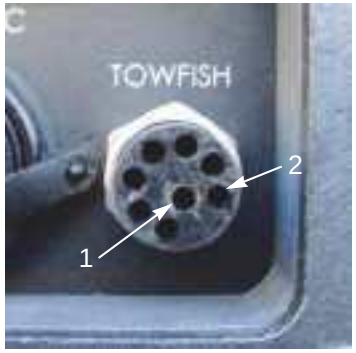


Table 3-7: *NAV, DEBUG and MAG Connector Pinouts*

PIN	FUNCTION
3	TX
2	RX
5	GND

Table 3-8: *T/F TRIG, RESP TRIG, 1PPS, and EXG TRIG IN Pinouts*

PIN	FUNCTION
Center	Signal
Shield	GND

4. Connect the tow cable to the TOWFISH connector on the SP-III TPU.
5. Connect the AC power cable to the 120/240 VAC connector on the SP-III TPU and to the AC power source, or connect the DC power cable to the 12 VDC connector on the SP-III TPU and to a 12 VDC power source, or both.
6. To run the laptop computer from AC power, connect it to its power supply and connect the power supply to the AC power source.

The following connections are optional:

7. Connect the 1PPS IN connector on the SP-III TPU to the 1PPS output of the shipboard GPS. A user supplied BNC-to-BNC cable is required.
8. Connect the T/F TRIG connector on the SP-III TPU to the trigger input of an external sonar system. A user supplied BNC-to-BNC cable is required.
9. Connect the RESP TRIG connector on the SP-III TPU to the trigger input of a USBL system. A user supplied BNC-to-BNC cable is required.

3.6.2 Connecting the Rack Mount TPU and the SonarPro Workstation

The following supplied cables are used to connect the Rack Mount TPU and the SonarPro Workstation:

- Ethernet crossover cable
- AC power cords (2)
- Deck cable

WARNING *Before connecting the topside system components, verify that the Rack Mount TPU is turned off and that its power cord is disconnected. Failure to follow this practice may result in personal injury or damage to the towfish or to the Rack Mount TPU electronics, or to both. For the location of the power switch, refer to “Topside System Controls and Indicators” on page 3-15.*

To connect the Rack Mount TPU and the SonarPro Workstation:

1. Connect the Ethernet crossover cable to the ETHERNET connector on the Rack Mount TPU and to either one of the two the ETHERNET connectors on the SonarPro Workstation.
2. Connect the monitor to the DVI connector on the SonarPro Workstation and connect the monitor power supply to the AC power source.
3. Connect the keyboard and the mouse to any two of the six USB connectors on the SonarPro Workstation.

4. Connect a GPS to the NAV connector on the Rack Mount TPU. A user supplied RS-232 serial cable is required where one end is terminated with a DB9 female connector and the other end is as required by the navigation system.
5. Verify that the GPS is outputting NMEA-0183 formatted data strings at 4800 baud, no parity, 8 data bits, and 1 stop bit. In addition, the GPS should be outputting the following messages:
   - GLL or GGA
   - VTG
   - RMC (optional)

NOTE *If 4800 baud is not available from the GPS, contact KMS customer service for instructions on how to reconfigure the system to accept a different baud rate. Refer to "Customer Service" on page xvi for information on how to contact KMS customer service.*

6. Connect the deck cable to the TOWFISH connector on the Rack Mount TPU and to the slip rings of the optional winch.

NOTE *For the predeployment checks, the deck cable can be temporarily connected to the TOWFISH connector on the Rack Mount TPU and to the towfish.*

7. Connect an AC power cable to the AC INPUT connectors on the Rack Mount TPU and the SonarPro Workstation and to the AC power source.

The following connections are optional:

8. Connect the 1PPS IN connector on the Rack Mount TPU to the 1PPS output of the shipboard GPS. A user supplied BNC-to-BNC cable is required.
9. Connect the T/F TRIG connector on the Rack Mount TPU to the trigger input of an external sonar system. A user supplied BNC-to-BNC cable is required.
10. Connect the TRIG A connector on the Rack Mount TPU to the trigger input of a USBL system. A user supplied BNC-to-BNC cable is required.

3.7 Topside System Controls and Indicators

The SP-III TPU includes controls and indicators on the side panel. The Rack Mount TPU and the SonarPro Workstation include controls and indicators on the front panels. The SonarPro Workstation also has its power switch on the back panel.

3.7.1 SP-III TPU Controls and Indicators

All of the controls and indicators are located on the side panel of the SP-III TPU as shown in Figure 3-1 on page 3-6. They are the following:

PWR: Green indicator that is illuminated when either AC or DC power is on.

A/C-D/C: 3-position switch that when switched to A/C, selects AC power to power the SP-III TPU, and when switched to D/C, selects DC power. With the switch in the center OFF position, power is disconnected.

T/F PWR: Blue indicator that is illuminated when 200 VDC is being applied to the towfish.

T/F TRIG: Yellow indicator that flashes when the sonar pings.

RESP TRIG: Yellow indicator that flashes when a responder trigger pulse is output.

LOCK LOSS: Red indicator that illuminates when the telemetry link with the towfish is interrupted or lost.

D/C POLARITY: Red indicator that illuminates when the polarity of the DC input power is reversed.

3.7.2 Rack Mount TPU Controls and Indicators

All of the Rack Mount TPU controls and indicators are on the front panel which is shown in Figure 3-4.

The Rack Mount TPU controls and indicators are the following:

POWER switch: Rocker switch/circuit breaker that turns the Rack Mount TPU on or off and provides AC input current protection. Should the breaker trip, the switch/ circuit breaker will switch to the OFF position. To reset it, switch it to the ON position.

POWER: Green LED that is on when the Rack Mount TPU is powered.

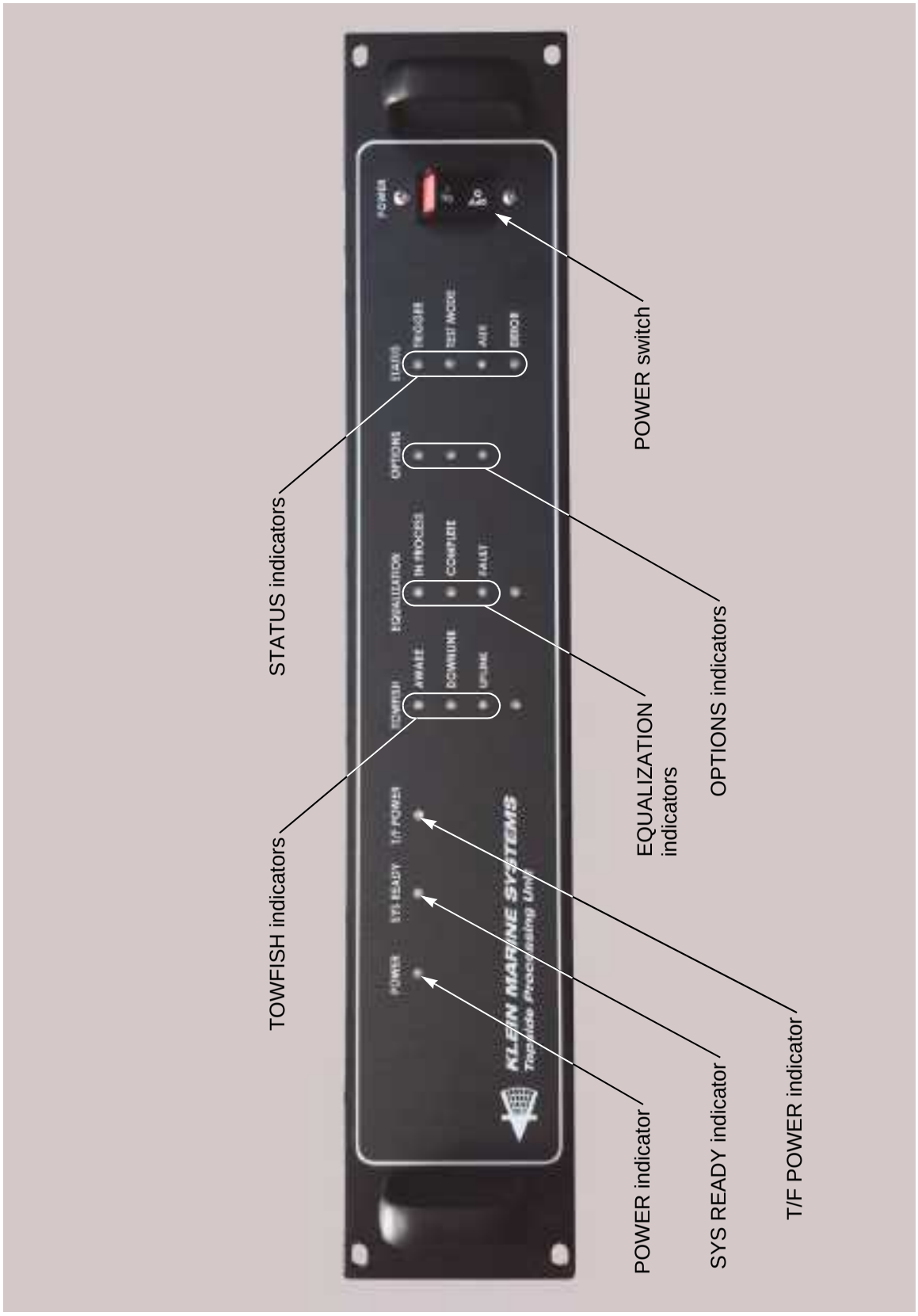


Figure 3-4: *Rack Mount TPU Front Panel*

SYS READY:	Green LED that will flash while the Rack Mount TPU and the towfish are powering up and then remain on when the Rack Mount TPU is ready to link with SonarPro on the SonarPro Workstation.
T/F POWER:	Blue LED that is on when power is being output to the towfish.
TOWFISH AWAKE:	Green LED that is on when the towfish is powered and is acquiring data.
TOWFISH DOWNLINK:	Green LED that is on when commands are being transfered from the Rack Mount TPU to the towfish.
TOWFISH UPLINK:	Green LED that is on when data are being transfered from the towfish to the Rack Mount TPU.
EQUALIZATION IN PROCESS:	Green LED that is on when cable equalization is being executed.
EQUALIZATION COMPLETE:	Green LED that is on when cable equalization has completed successfully.
EQUALIZATION FAULT:	Red LED that is on when cable equalization does not complete successfully. When proper operation is established, it will flash if telemetry errors are detected.
STATUS TRIGGER:	Yellow LED that flashes when the sonar on the towfish transmits.
STATUS TEST MODE:	Green LED that is on when internal system tests are being performed.
STATUS AUX:	Blue LED that is on when power is applied to optional components.
STATUS ERROR:	Red LED that flashes if system errors are detected

3.7.3 SonarPro Workstation Controls and Indicators

Most of the SonarPro Workstation controls and indicators are on the SonarPro Workstation front panel which is shown is Figure 3-5. Also shown is the location of the DVDRW optical drive.

The SonarPro Workstation controls and indicators are the following:

ON/OFF switch: Rocker switch/circuit breaker that switches AC power to the SonarPro Workstation and provides AC input current protection. This switch/circuit breaker, which is on the back panel and is shown in Figure 3-3 on page 3-10, should be left in the ON position. Should the breaker trip, the switch/circuit breaker will switch to the OFF position. To reset it, switch it to the ON position.

HARD DRIVE ACTIVITY: Green LED that flashes when the hard drive is being accessed.

ETHERNET: Green LED that flashes when there is activity on Ethernet port.

POWER: Blue LED that is on when the SonarPro Workstation is on.

POWER switch: Push button switch that turns the SonarPro Workstation on or off.

RESET switch: Push button switch that resets the SonarPro Workstation.

3.8 System Activation and Test

The Series 4900 Sonar System should be activated and tested on deck and at sea before starting an actual survey.

NOTE *Should it be required to change the IP address, edit the startup.ini file or update the software of the SP-III TPU, refer to APPENDIX B: "Configuring and Updating the SP-III TPU"*

3.8.1 Activating and Testing the System on Deck

To activate and test the system on deck:

1. Verify that the towfish has been properly set up and the system components connected.
2. Turn on the navigation system and let it acquire its location.

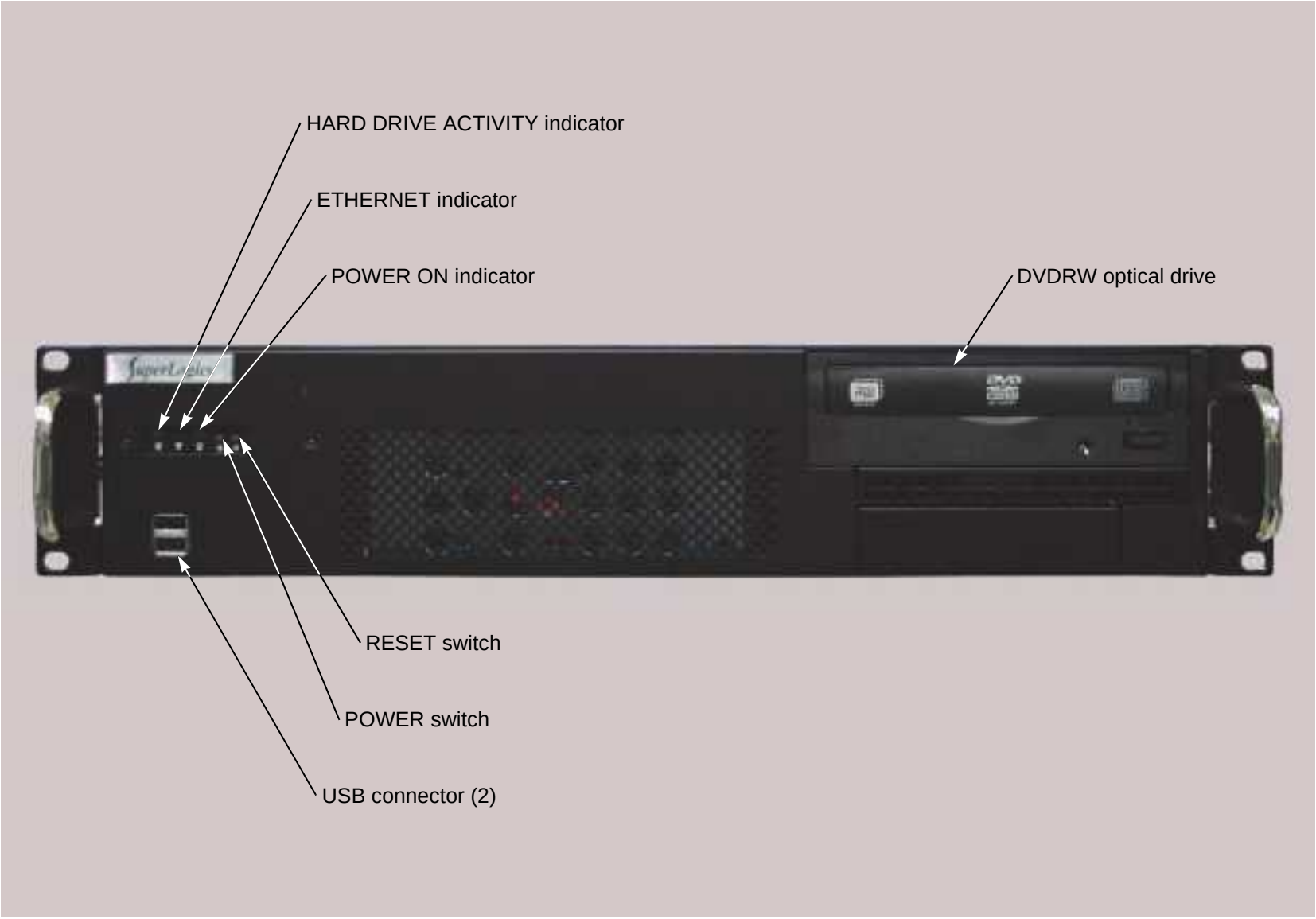


Figure 3-5: *SonarPro Workstation Front Panel*

3. Verify that the tow cable is connected to the SP-III TPU or Rack Mount TPU and the towfish.

4. Turn on the laptop computer or the SonarPro Workstation and wait for the Windows desktop to appear.

NOTE *For an SP-III TPU, should the DC power cord be connected with the polarities reversed, the D/C POLARITY indicator will illuminate when the A/C-D/C switch is switched to D/C. Should this situation occur, reverse the connection.*

CAUTION *Serious damage to the towfish electronics may occur if the towfish is operated on deck for periods longer than fifteen minutes. Between periods of operation, let the sonar cool for fifteen minutes. In high temperature climates, protect the towfish from direct exposure to the sun prior to and during operation.*

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5. Do one of the following:

   - Turn on the SP-III TPU by switching the A/C-D/C switch to A/C for AC operation or to D/C for DC operation. The PWR indicator should flash, and the LOCK LOSS indicator should illuminate. After approximately 1 minute, the T/F PWR indicator should turn on. After an additional 15 seconds, the LOCK LOSS indicator should turn off, and the PWR indicator should stop flashing and remain on.
   - Turn on the Rack Mount TPU. The POWER and EQUALIZATION IN PROCESS indicators should illuminate, and the SYS READY indicator should flash. Then after approximately 1 minute, the EQUALIZATION IN PROCESS indicator should turn off, the EQUALIZATION COMPLETE and T/F POWER indicators should turn on, the SYS READY indicator should stop flashing and remain on, and the STATUS TRIGGER indicator should begin flashing at the ping rate of the sonar.

6. Start SonarPro and observe that the towfish is transmitting by viewing the output pulse in the Sonar Viewer window. Also check that navigation data are being displayed in the Information window.

7. If a GPS is connected, check that navigation data are being displayed in the Information window.

8. Select the 150-range and select the 455-kHz operation. Allow the TVG to normalize; it will take about two minutes.

9. Perform a rub test on the port and starboard transducers to confirm that the receiver mode is operating properly. Do this test by vigorously rubbing each transducer, one at a time, while observing the Sonar Viewer window in SonarPro for returns.
10. Exit SonarPro and turn off the laptop computer and the SP-III TPU or the SonarPro Workstation and the Rack Mount TPU.

3.8.2 Activating and Testing the System at Sea

To activate and test the system at sea:

1. Verify that the towfish has been properly set up and the system components connected.
2. Turn on the navigation system and let it acquire its location.
3. Verify that the tow cable is connected to the SP-III TPU or Rack Mount TPU and the towfish.
4. Turn on the laptop computer and wait for the Windows desktop to appear.

NOTE *Should the DC power cord be connected with the polarities reversed, the D/C POLARITY indicator will illuminate when the A/C-D/C switch is switched to D/C. Should this situation occur, reverse the connection.*

CAUTION *Serious damage to the towfish electronics may occur if the towfish is operated on deck for periods longer than fifteen minutes. Between periods of operation, let the sonar cool for fifteen minutes. In high temperature climates, protect the towfish from direct exposure to the sun prior to and during operation.*

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5. Do one of the following:
   - Turn on the SP-III TPU by switching the A/C-D/C switch to A/C for AC operation or to D/C for DC operation. The PWR indicator should flash, and the LOCK LOSS indicator should illuminate. After approximately 1 minute, the T/F PWR indicator should turn on. After an additional 15 seconds, the LOCK LOSS indicator should turn off, and the PWR indicator should stop flashing and remain on.

- Turn on the Rack Mount TPU. The POWER and EQUALIZATION IN PROCESS indicators should illuminate, and the SYS READY indicator should flash. Then after approximately 1 minute, the EQUALIZATION IN PROCESS indicator should turn off, the EQUALIZATION COMPLETE and T/F POWER indicators should turn on, the SYS READY indicator should stop flashing and remain on, and the STATUS TRIGGER indicator should begin flashing at the ping rate of the sonar.

6. Start SonarPro and observe that the towfish is transmitting by viewing the output pulse in the Sonar Viewer window. Also check that navigation data are being displayed in the Information window.

7. If a GPS is connected, check that navigation data are being displayed in the Information window.

8. Deploy the towfish.

CAUTION *When the towfish is close to the sea floor, the bottom tracking (altitude) performance is less accurate. Exercise extreme caution when operating the towfish at altitudes of less than 4 meters (13 feet).*

9. Adjust the towfish within the water column so that it is at a safe altitude off the bottom and under the boat wake (about 15 percent of range). A good starting vessel speed is 4–5 knots. Check for the following:

   - The image is satisfactory for both the 455-kHz and 900-kHz channels.
   - Pitch, roll, depth, and altitude are being displayed.
   - Speed and heading are being displayed from the navigation system.

10. Refer to the SonarPro User Manual (P/N 11210093) for instructions on how to operate SonarPro to acquire, display and record sonar data.

CHAPTER 4: EQUIPMENT MAINTENANCE

This chapter provides instructions for maintaining the Series 4900 Sonar System on a daily, weekly and long term basis. In addition, instructions are provided for disassembling and reassembling the towfish and removing and installing the transducers.

4.1 Maintenance General Comments

Equipment used at sea is subjected to severe environmental and handling conditions. While the Series 4900 Sonar System is designed to operate in such conditions, a certain amount of routine maintenance is necessary to ensure trouble free, long term operation.

Keep a maintenance log. This provides assistance in tracking what has or has not been done with the system. A log is useful when tracking problems, if they do occur, and is especially important if more than one TPU, laptop computer or towfish is used in a large survey operation. Inventory the system, related spares and accessories carefully. Record the serial numbers of the major components, such as the SP-III TPU or Rack Mount TPU, the laptop computer or the SonarPro Workstation, and the towfish. Store the shipping boxes in a safe place so they can be reused when needed. A small amount of regular maintenance and care makes the critical difference in a successful field operation. The following pages contain the recommended routine checking and maintenance schedules for a daily, weekly, and long term basis.

4.2 Maintenance Checklists

4.2.1 Daily Maintenance Checklist

Perform the following maintenance steps at the end of each day's operation:

1. Turn off the power to the SP-III TPU and the laptop computer, or the Rack Mount TPU and the SonarPro Workstation.
2. Verify that all cables and connectors are secure and tightened.
3. If fresh water is available, wash down the towfish and the towing equipment. Cover them while not in use to protect against salt water spray and to minimize corrosion.

4. Keep the tow cable plugged into the towfish, or use dummy plugs on the tow cable and towfish to keep the connectors from exposure to the salt atmosphere. Remember to put a thin film of silicone grease, such as Dow-Corning 4, on the rubber portion of the underwater connector every time the towfish is disconnected. Avoid getting too much grease on the metal pins of the connector; a very light coating is sufficient.
5. Check that all of the screws on the towfish are tight.

4.2.2 Weekly Maintenance Checklist

Perform the following maintenance steps at the end of each week's operation:

1. Turn off the power to the SP-III TPU and the laptop computer, or the Rack Mount TPU and the SonarPro Workstation.
2. Check all cables for abrasion and damage. If any wear spots are noticed, clean them with fresh water, dry them, and wrap them carefully with electrical tape, such as Scotch #88 or #33. If there is wear or fraying in any of the cables in an area subject to high tension, repair or replace the cable.
3. Inspect and clean the system plugs and jacks.
4. Inspect the towfish for signs of corrosion or other damage.
5. Check the underwater connectors on the towfish. The contacts should be clean and shiny. Contacts may be cleaned with a rubber pencil eraser or very fine emery paper.

4.2.3 Long Term Maintenance Checklist

Perform the following maintenance steps at six month intervals, or more frequently when continued long term usage is occurring.

1. Turn off the power to the SP-III TPU and the laptop computer, or the Rack Mount TPU and the SonarPro Workstation.
2. Thoroughly clean the SP-III TPU or Rack Mount TPU, cables and towing equipment. Clean the top and outside surfaces of the SP-III TPU or Rack Mount TPU using a cloth dampened with fresh water. Use a small amount of detergent if necessary. Do not let dirt and salt deposits accumulate on the SP-III TPU or Rack Mount TPU.
3. Remove the nose and tail cones of the towfish and check that the connectors are firmly seated. Use a thin film of silicone grease on all external connectors. Make sure the transducer leads are free from cuts or abrasion.
4. Follow the instructions in the manufacturer's manual for any necessary cleaning and maintenance of the laptop computer.

4.3 Disassembling and Reassembling the Towfish

For troubleshooting purposes and for repair, it may be required to remove and replace major components of the towfish. Instructions are provided in the following pages for the disassembly of the towfish and the removal of the towfish electronics chassis and the transducers.

The following tools are recommended:

- 4-mm hex key
- 5-mm hex key
- 8-mm hex key
- Tail cone retaining bolt (to be removed from towfish during disassembly)
- 17-mm box wrench
- Phillips screw driver
- Lint-free cloth or paper towels
- Silicone grease, such as Dow-Corning DC4

4.3.1 Disassembling the Towfish

To disassemble the towfish:

1. Turn off the SP-III TPU or Rack Mount TPU.
2. Disconnect the tow cable from the towfish and set the towfish on a clean flat surface such that the carrying handles face up.
3. Using the 17-mm box wrench, loosen the tail cone retaining bolt, and then unscrew it by hand until it is free.

Figure 4-1: *Loosening the Tail Cone Retaining Bolt*

4. Pull the tail cone away from the towfish housing, and then reach inside the housing and disconnect the jumper cable.

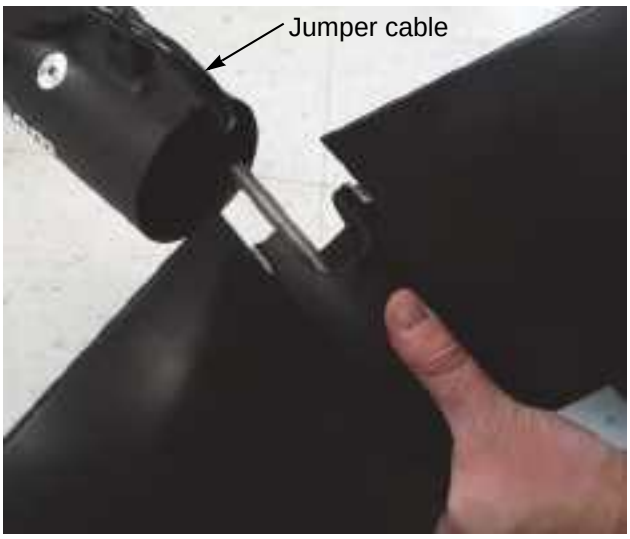


Figure 4-2: *Removing the Tail Cone*

5. Set the tail cone aside, and then remove the tail cone retaining bolt which is shown in Figure 4-3.

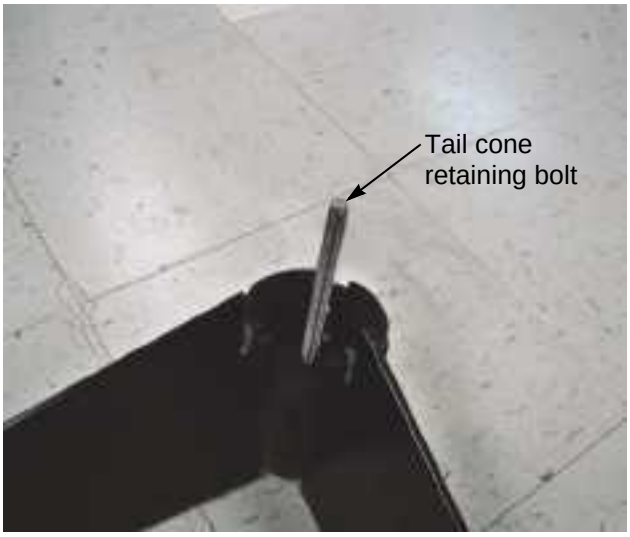


Figure 4-3: *Tail Cone Removed from the Towfish Housing*

6. Using the 8-mm hex key, loosen the nose cone retaining bolt and remove the nose cone. The bolt is accessed from the tip of the nose.

Figure 4-4: *Removing the Nose Cone*

7. Disconnect the two transducer cables.

Figure 4-5: *Disconnecting the Transducer Cables*

8. Using the 5-mm hex key, *tighten* the three locking screws in the towfish housing forward end cap.

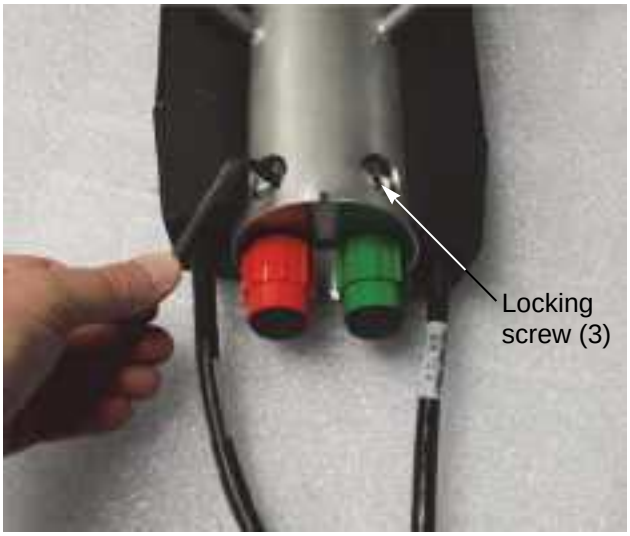


Figure 4-6: *Tightening the Locking Screws in the Towfish Housing Forward End Cap*

9. Screw the tail cone retaining bolt into the threaded hole in the middle of the forward end cap.

Figure 4-7: *Screwing the Tail Cone Retaining Bolt into the Forward End Cap*

10. Grasp the tail cone retaining bolt and carefully pull the forward end cap out of the towfish housing.

Figure 4-8: *Pulling the Forward End Cap out of the Towfish Housing*

11. Set the forward end cap aside as shown in Figure 4-9.

Figure 4-9: *Forward End Cap Removed from the Towfish Housing*

12. Using the 5-mm hex key, *tighten* the three locking screws in the towfish housing aft end cap.

Figure 4-10: *Tightening the Locking Screws in the Towfish Housing Aft End Cap*

13. Screw the tail cone retaining bolt into the threaded hole in the middle of the aft end cap.
14. Grasp the tail cone retaining bolt and carefully pull the electronics chassis completely out of the towfish housing. Be careful not to scratch the O-ring surface inside the housing.
15. Lay the electronics chassis on a clean, flat, dry surface.

Figure 4-11: *Pulling the Electronics Chassis out of the Towfish Housing*

4.3.2 Reassembling the Towfish

To reassemble the towfish:

1. Verify that the O-rings on both the forward and aft end caps are clean and free of dirt or scratches. Also use a lint-free cloth or paper towel to clean the O-ring surfaces inside the towfish housing and apply a *light* coat of silicone grease to these surfaces.

   If dirt or scratches are present on an O-ring, replace it. When replacing an O-ring, first clean the O-ring surface inside the towfish housing and the O-ring groove in the end cap using a lint-free cloth or paper towel, and then apply a *light* coat of silicone grease to the O-ring before installing it.
2. Insert the chassis into the aft end of the towfish housing, aligning the three locking screws with the three holes in the towfish housing.
3. *Loosen* the three locking screws until the heads of the screws are flush with the outside surface of the housing.
4. Connect the jumper cable to the connector on the aft end cap.
5. Slide the tail cone into the towfish housing, aligning the locator pin under the tail cone with the slot in the housing and threading the tail cone retaining bolt into the aft end cap.
6. Tighten the tail cone retaining bolt.
7. Inspect the two connectors on the Transition board to ensure that there are no bent pins. The Transition board is shown in Figure 4-12.
8. While aligning the three locking screws with the three holes in the towfish housing as shown in Figure 4-13 on page 4-10, carefully insert the forward end cap into the forward end of the towfish housing until it bottoms out.

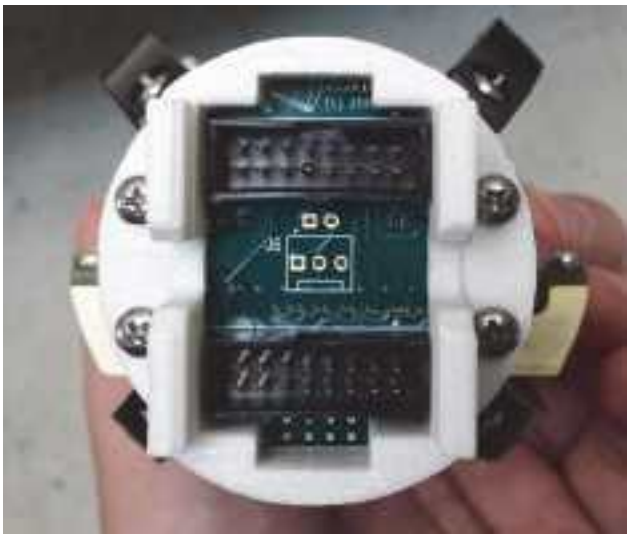


Figure 4-12: *Transition Board*

9. *Loosen* the three locking screws until the heads of the screws are flush with the outside surface of the housing.
10. Connect the two transducer cables, matching the colors with the connectors on the forward end cap.

Figure 4-13: *Aligning the Locking Screws before Inserting the Forward End Cap*

11. Slide the nose cone into the towfish housing, aligning the locator pin on the nose cone with the slot in the housing and threading the nose cone retaining bolt into the forward end cap as shown in Figure 4-14.
12. Tighten the nose cone retaining bolt.

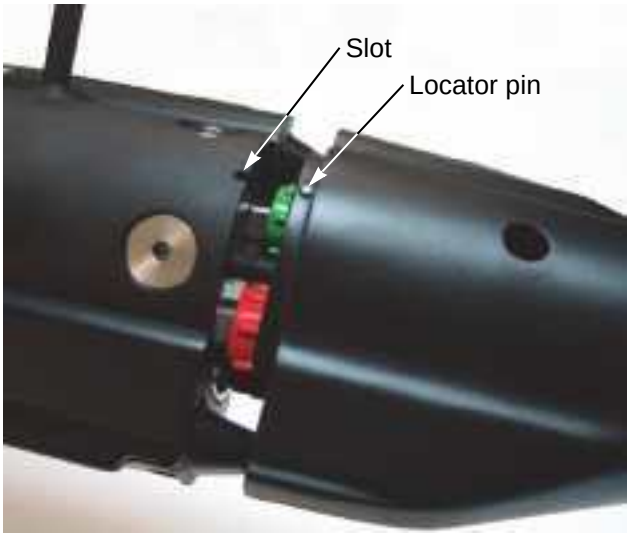


Figure 4-14: *Aligning the Locator Pin in the Nose Cone with the Slot in the Towfish Housing*

4.3.3 Removing the Transducers

To remove the transducers:

1. Perform Steps 1 through 4 in “Disassembling the Towfish” on page 4-3.
2. Using the 4-mm hex key, remove the eight socket head cap screws securing either transducer assembly to the towfish housing.

Figure 4-15: *Removing the Eight Socket Head Cap Screws Securing a Transducer Assembly*

3. Carefully separate the transducer assembly from the towfish housing.

Figure 4-16: *Separating a Transducer Assembly from the Towfish Housing*

4. Set the transducer assembly down with the transducer facing up.
5. Using the 4-mm hex key, remove the four socket head cap screws on the face of the transducer, two on each end.

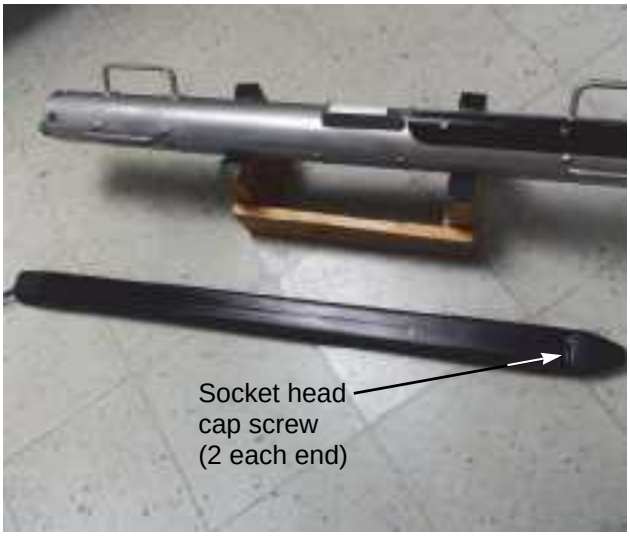


Figure 4-17: *Location of the Four Socket Head Cap Screws on the face of a Transducer*

6. Turn the transducer assembly over, and using the Phillips head screwdriver, remove the eight screws securing the transducer to the transducer assembly.
7. Separate the transducer from the transducer assembly.
8. Repeat Steps 2 through 7 to remove the other transducer.

Figure 4-18: *Removing the Eight Phillips Head Screws Securing the Transducer*

4.3.4 Installing the Transducers

To install the transducers:

1. Reverse Steps 2 through 7 in “Removing the Transducers” on page 4-11 for each transducer.
2. Connect the two transducer cables, matching the colors with the connectors on the forward end cap.
3. Slide the nose cone into the towfish housing, aligning the locator pin on the nose cone with the slot in the housing and threading the nose cone retaining bolt into the end cap as shown in Figure 4-12 on page 4-9.
4. Tighten the nose cone retaining bolt.

CHAPTER 5: TECHNICAL DESCRIPTION

This chapter provides an overall technical description of the Series 4900 Sonar System towfish, the SP-III TPU and the Rack Mount TPU electronics. This information, which includes block diagrams, printed circuit board descriptions, and chassis photos with callouts, is useful when performing any troubleshooting tasks and when installing optional equipment.

5.1 Towfish

The towfish transmits and receives the sonar signals, processes them and outputs the processed sonar and sensor data to the SP-III TPU or Rack Mount TPU over the tow cable. The primary active components of the towfish are the sonar electronics and the two transducer arrays. An optional magnetometer and responder can also be included. The compass and the pressure and temperature sensors are located on the electronics chassis.

5.1.1 Sonar Electronics

A block diagram depicting the functional relationships of all of the printed circuit boards in the sonar electronics is shown in Figure 5-1. All the boards are located on the towfish electronics chassis which is shown in Figure 5-2.

The printed circuit boards, along with their corresponding part numbers, that make up the towfish electronics are the following:

- **Control Sensor Interface (CSI) board** **14105398**
- **Transmitter board** **14105393-01**
- **Receiver board** **14105630-02**
- **Transition board** **14105645**
- **12 VDC Power Supply board** **11700092**
- **24 VDC Power Supply board (optional)** **11700093**
- **Power Filter board 12 VDC** **14105397**
- **Power Filter board 24 VDC (optional)** **14105397**
- **Subsea Telemetry board** **14105647-02**
- **Compass board** **14106073**

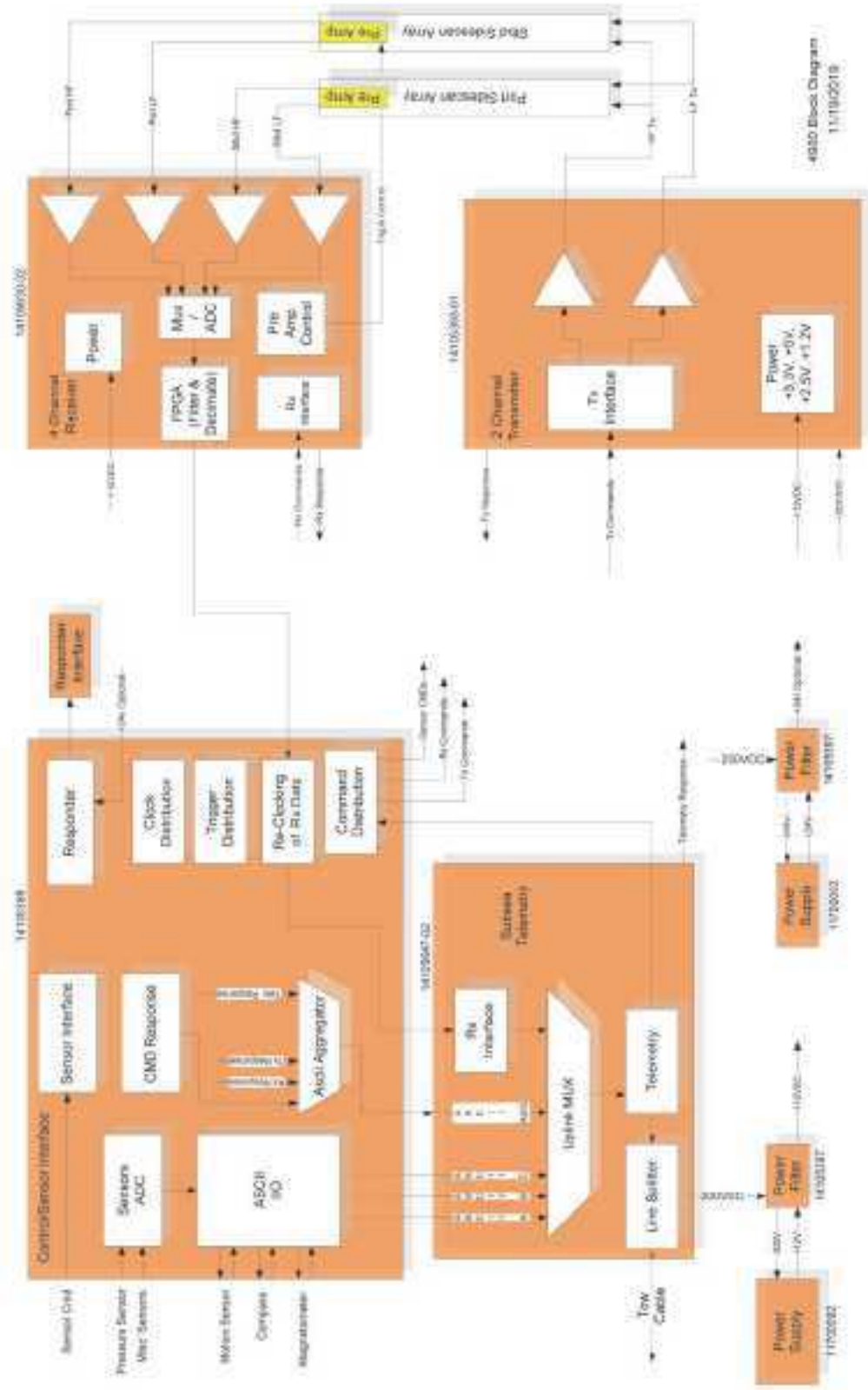


Figure 5-1: *The Series 4900 Sonar System Towfish Electronics Block Diagram*

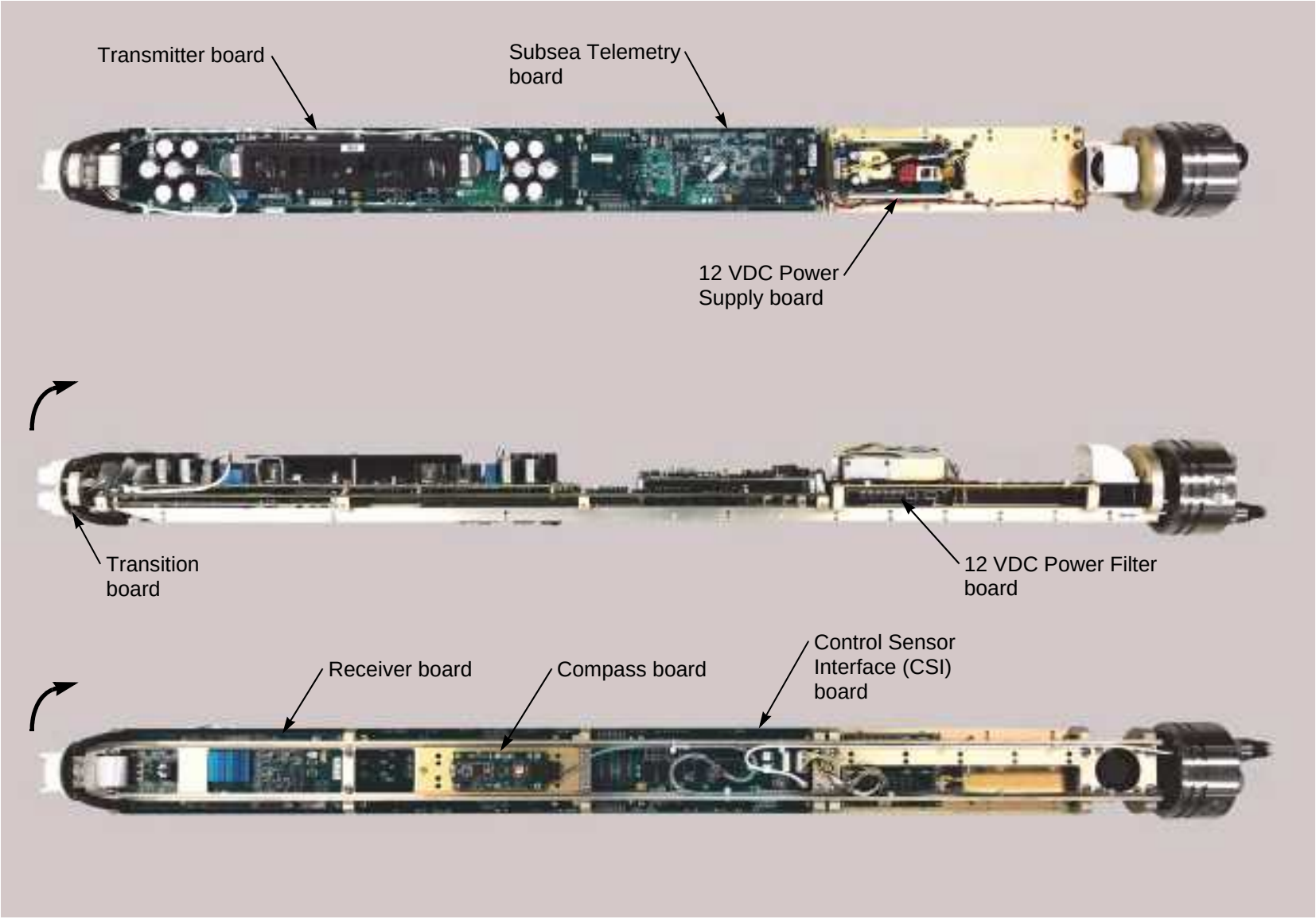


Figure 5-2: *The Series 4900 Sonar System Towfish Electronics Chassis*

Control Sensor Interface (CSI) board. The CSI board interconnects the Transmitter board, the Receiver board, the Telemetry board, the sensors, and the ASCII I/O ports. Specifically, the CSI board performs the following functions:

- Provides a central connection point for various system command interconnects.
- Generates the synchronization signals.
- Provides synchronized timing for the Transmitter board.
- Provides re-clocking of data from the Receiver board to the telemetry uplink multiplexer.
- Provides the controls for the ASCII uplink ports, including those for the motion sensor, the compass, the magnetometer, and the pressure sensor.
- Provides the command parser for the sensor interface.
- Provides the responder interface.
- Provides the serial EEPROM for the board identification.
- Multiplexes data into ASCII aggregate uplinks.
- Drives the SPI bus interface for sensors, including power, pressure, water/air temperature, and leak detection.
- Forwards downlink commands to sensors.
- Provides debug features.

Transmitter board. The Transmitter board includes two independent transmitters, each of which outputs a chirp transmit waveform to a transducer array during each ping cycle in accordance with a trigger signal from the CSI board. The chirp waveform, frequency sweep and pulse width for each cycle are generated by the Transmitter board for each transmitter in accordance with command and control and clock inputs from the CSI board. The Transmitter board is powered with 12 VDC and 200 VDC from the CSI board.

Receiver board. The Receiver board includes eight broad band, low power differential input receivers which input and amplify the sonar signals from preamplifiers in the transducer arrays. The amplified signals are output to a high speed 16-bit analog-to-digital converter (ADC), one for each receiver, and the digitized sonar data are processed, downsampled and output to the CSI board in accordance with command and control and clock signals from the CSI board. The Receiver board is powered with 12 VDC from the CSI board and supplies power and a time varying gain (TVG) trigger to the preamplifiers in the transducer arrays. The Receiver board also provides an enable signal that switches on a fixed gain in the preamplifiers. This gain is in addition to the TVG and is operator selectable.

Transition board. The Transition board provides the means to connect the large gauge wires from the RX PORT and RX STBD bulkhead connectors on the end cap to the Receiver board's 50 pin ribbon cable and to the Transmitter board's 3-pin connectors. Two additional connectors, one 2-pin and one 3- pin, are for future options.

+12 VDC Power Supply board. The +12 VDC Power Supply board inputs 100–240 VDC on connector P1 from the Power Filter board's connector JP1. The +12 VDC output from the Power Supply board on P2 is also connected to connector JP1 of the Filter board.

24 VDC Power Supply board. The +24 VDC Power Supply board inputs 100–240 VDC on connector P1 from the Power Filter board's connector JP1. The +24 VDC output from the Power Supply board on P2 is also connected to connector JP1 of the Filter board.

Power Filter board 12 VDC. Voltages are filtered by the Power Filter boards to and from the CSI board. The interconnection is from JP2 of the Power Filter board to JP18 (12 V) of the CSI board.

Power Filter board 24 VDC. Voltages are filtered by the Power Filter boards to and from the CSI board. The interconnection is from JP2 of the Power Filter board to JP19 (24 V) of the CSI board.

Subsea Telemetry board. The Subsea Telemetry board provides the cable interface for the towfish. Specifically, the Subsea Telemetry board performs the following functions:

- Separates the uplink data signals, the downlink command signals and the towfish power.
- Acquires sonar and sensor data from the CSI board and transmits the combined data to the SP-III TPU or Rack Mount TPU.
- Receives and interprets command and timing signals from the SP-III TPU or Rack Mount TPU.
- Matches the time references at the tow fish and the SP-III TPU or Rack Mount TPU.

5.1.2 Transducer Arrays

The transducer arrays contain transducer elements that both transmit and receive the acoustic signals. They also include two 2-channel embedded preamplifiers each which are powered from the Receiver board. The preamplifiers provide filtering and both 12 dB of fixed gain and 48 dB of TVG to the received sonar signals where the TVG is triggered from the Receiver board. The 12 dB of fixed gain is on or off operator selectable. Along with the TVG to compensate for the acoustic spreading loss, the preamplifiers increase the signal-to-noise ratio of the received signals before they are output to the Receiver board.

5.2 SP-III TPU

The SP-III TPU provides signal processing along with the system control and data telemetry functions. The printed circuit boards, along with their corresponding part numbers, are the following:

- **Demux board** **14105208-04**
- **CPU board** **14105873**
- **Topside Telemetry board** **14105646-02**
- **Power Integration board** **14105210-02**
- **Panel Interconnect board** **14105209**
- **Power Supply** **11700094**
- **Fan** **14105343**

All of these components are shown in Figure 5-4, and a block diagram of the SP-III TPU electronics is shown in Figure 5-3.

Demux board. The Demux board functions as a data and power interface between the towfish and the CPU. DC power and telemetry commands are transported down to the towfish, while sonar and sensor data transported up from the towfish are decoded and passed along to the CPU.

CPU board. The CPU board functions as the command and data interface between the laptop computer running SonarPro and the tow fish. It executes a real-time data server which outputs sonar and sensor data to and receives commands from an external client, such as SonarPro.

Topside Telemetry board. The Topside Telemetry board provides the cable interface for the SP-III TPU. Specifically, the Topside Telemetry board performs the following functions:

- Separates the uplink data signals, the downlink command signals and the towfish power.
- Acquires sonar and sensor data and reformats the data as required for the Demux board.
- Generates command and timing signals for the towfish.
- Matches the time references at the tow fish and the SP-III TPU.

Power Integration board. The Power Integration board provides 200 VDC to the towfish from either a 12 VDC or a 88–264 VAC, 47–63 Hz source. It also provides filtering, reverse polarity protection, and fusing of the input power.

Panel Interconnect board. The Panel Interconnect board facilitates a simple mechanical cable interface to the various external connectors in the system.

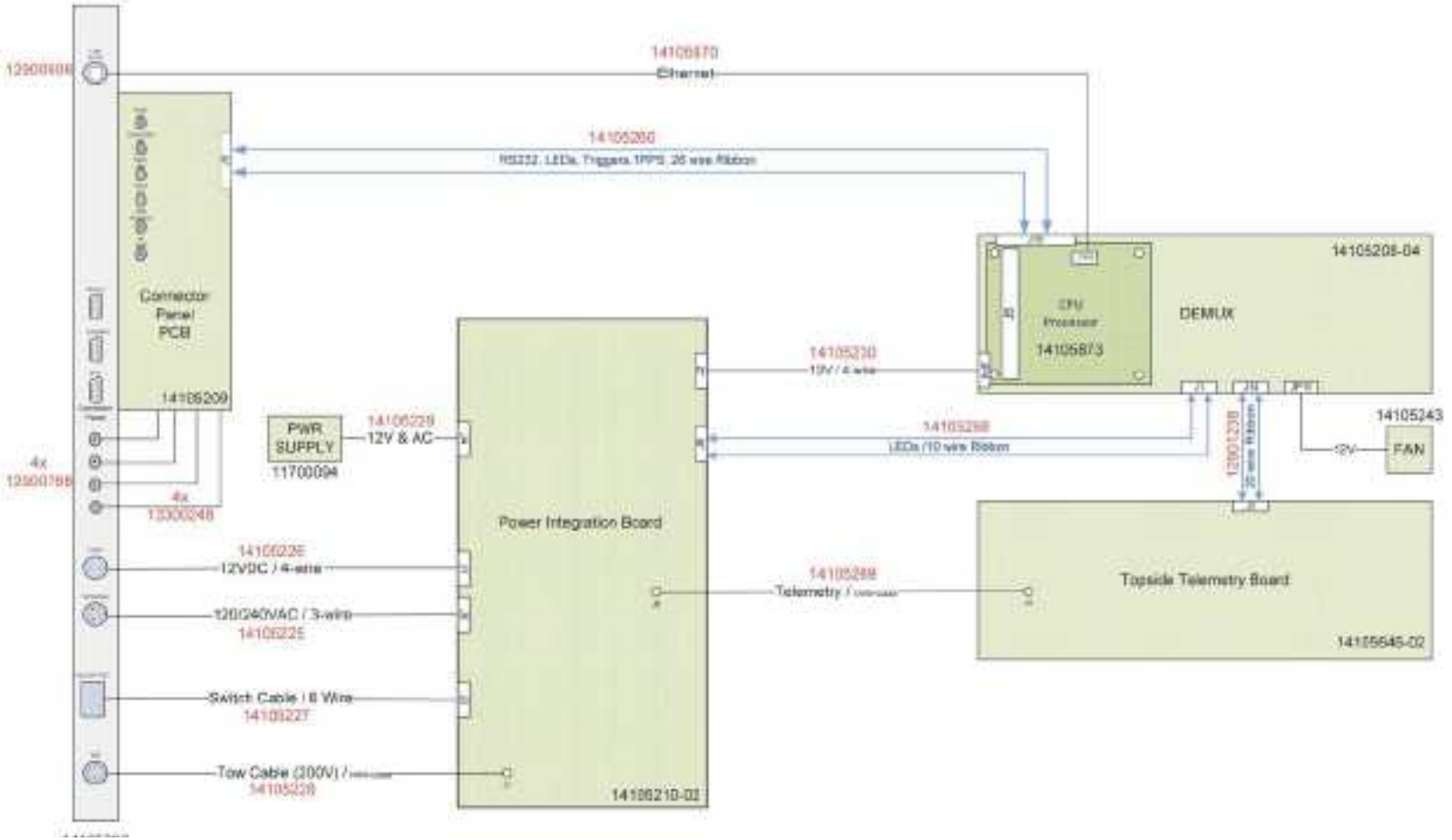


Figure 5-3: *SP-III TPU Electronics Block Diagram*

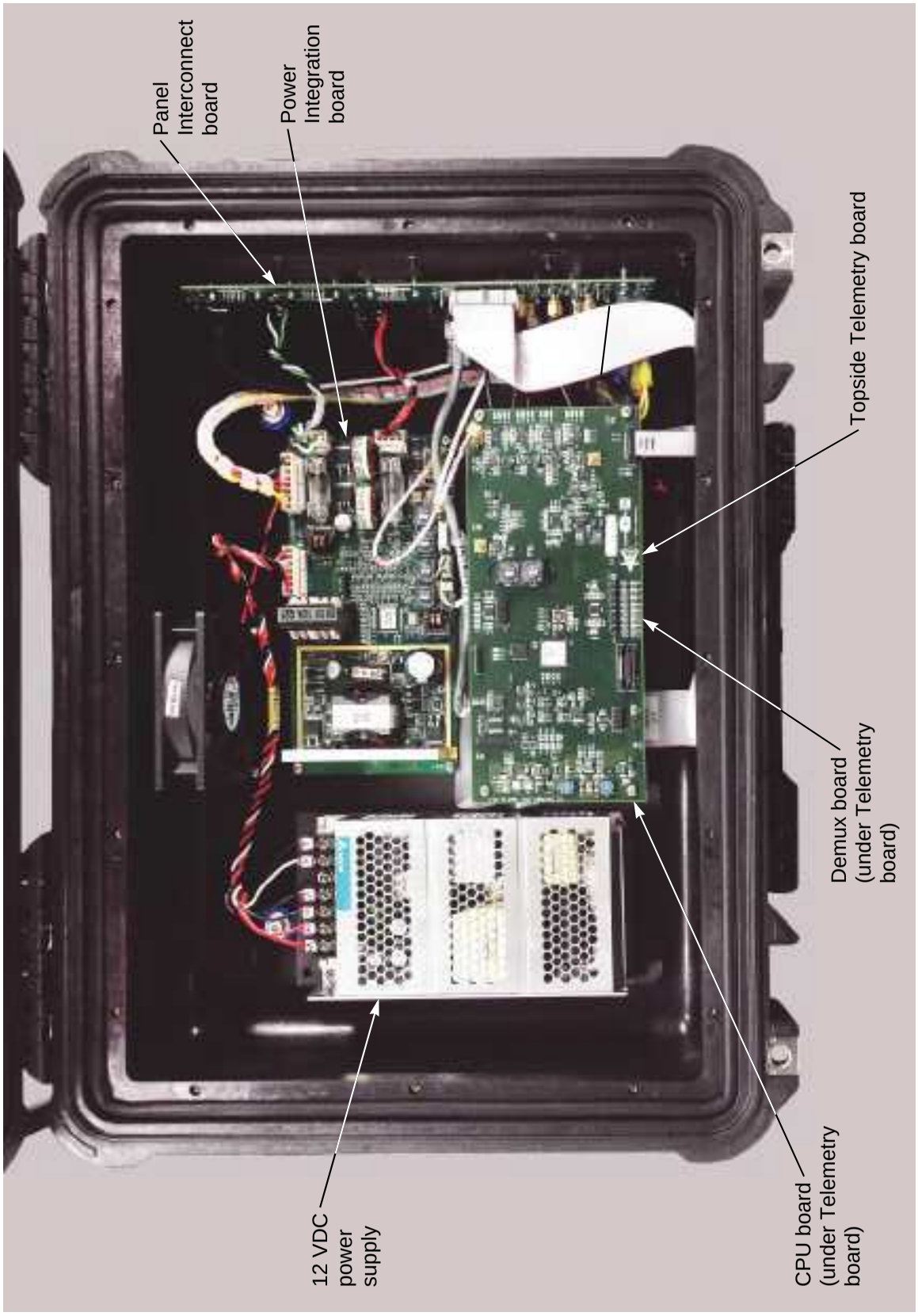


Figure 5-4: *SP-III TPU Electronics*

5.3 Rack Mount TPU

A block diagram depicting the functional relationships of all of the printed circuit boards in the Rack Mount TPU electronics is shown in Figure 5-5. These boards are located in the Rack Mount TPU electronics chassis as shown in Figure 5-6. The printed circuit boards, along with their corresponding part numbers, are the following:

- **Demultiplexer board** **14105785-03**
- **CPU board** **14105873**
- **High Voltage Power Supply board** **11700098**
- **200V Power Filter board** **14104980**
- **Topside Telemetry board** **14105646-02**
- **12V Power Filter board** **14105397**
- **12V Power Supply board** **11700092**
- **LED board** **14105464**

Assembled into a single rack mountable 3U enclosure, the Rack Mount TPU connects to the towfish directly or by way of an optionally supplied winch. It also connects to the SonarPro Workstation over an Ethernet connection and to customer supplied equipment, such as a GPS and an acoustic positioning system.

Demultiplexer board. The Demultiplexer board demultiplexes the uplink sonar and sensor data from the towfish and outputs FSK downlink commands along with 200 VDC power to the towfish while providing all of the external input and output signal and data connections for the Rack Mount TPU. It also provides the required recovery of signal and clock, detects trigger inputs and 1-PPS signals, generates the trigger outputs, inputs NMEA 0183 data, time stamps all of the data, and outputs the data to the SonarPro Workstation over the Ethernet connection. 200 VDC power is input to the Demultiplexer board from the 200V Power Filter board, and 12 VDC power is input from the 12V Power Filter board. The Demultiplexer board also provides front panel indicator outputs which drive the front panel LEDs on the LED board.

CPU board. The CPU board functions as the command and data interface between the laptop computer running SonarPro and the tow fish. It executes a real-time data server which outputs sonar and sensor data to and receives commands from an external client, such as SonarPro.

High Voltage Power Supply board. The High Voltage Power Supply board provides 200 VDC which is output to the towfish to power it.

200V Power Filter board. The 200V Power Filter board provides noise filtering of the 200 VDC power for transmission to the towfish over the coaxial tow cable. The filtered 200 VDC power is output to the Demultiplexer board where it is combined with the FSK control signals and output to the towfish.

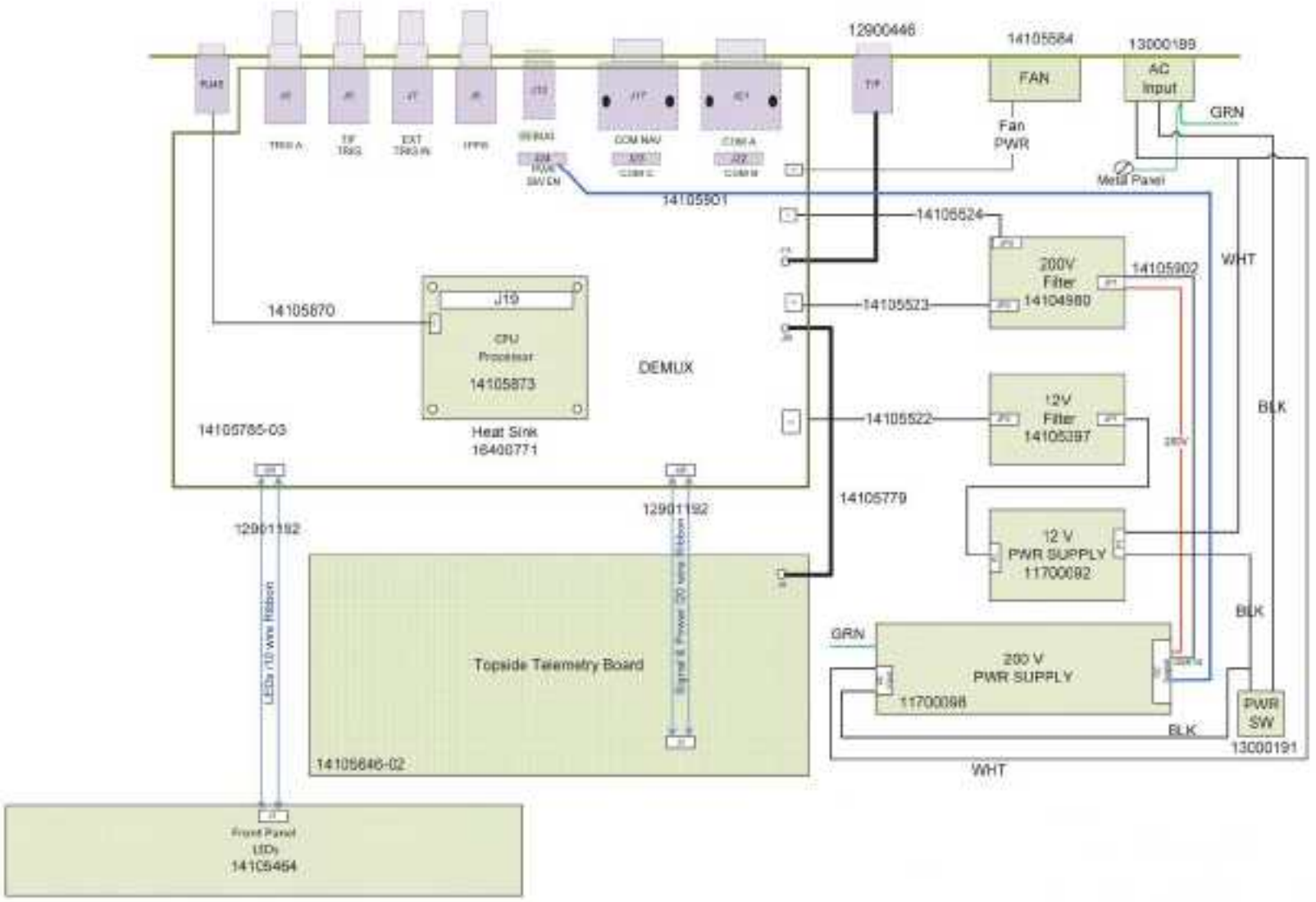


Figure 5-5: *The Series 4900 Sonar System Rack Mount TPU Electronics Block Diagram*

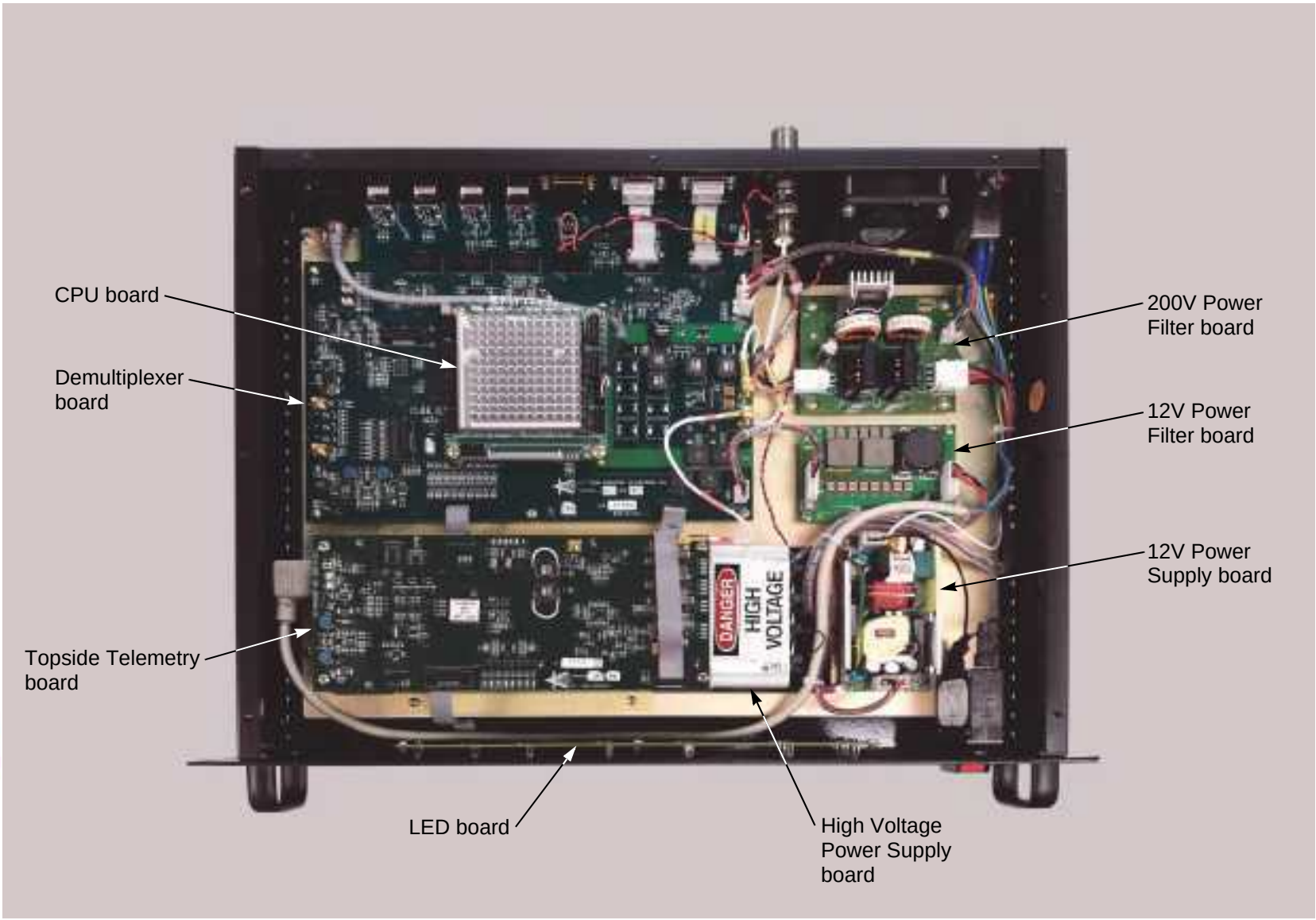


Figure 5-6: *The Series 4900 Sonar System Rack Mount TPU Electronics Chassis*

Topside Telemetry board. The Topside Telemetry board provides the cable interface for the Rack Mount TPU. Specifically, the Topside Telemetry board performs the following functions:

- Separates the uplink data signals, the downlink command signals and the towfish power.
- Acquires sonar and sensor data and reformats the data as required for the Demultiplexer board.
- Generates command and timing signals for the towfish.
- Matches the time references at the tow fish and the Rack Mount TPU.

12V Power Filter board. The 12V Power Filter board provides noise filtering of the 12V power supply for the Demultiplexer board.

12V Power Supply board. The 12V Power Supply board inputs 100–125 or 200–250 VAC and outputs 12 VDC to the 12V Power Filter board.

LED board. The LED board contains all of the front panel LED indicators. It mounts directly to the back of the front panel and connects to the Demultiplexer board over a single cable.

APPENDIX A: NOTES ON HANDLING TOW CABLES

A few methods on how to safely unreel tow cables are provided in this appendix. In addition, how cable kinking can occur is identified along with what can result from this condition.

A.1 Unreeling Tow Cable

The reel should be revolved and the rope taken off the way it was put on the reel as shown in Figure A-1 for two effective methods. Place a shaft through the reel center and jack it up so that the reel revolves freely. Pull the cable straight ahead, keeping it taut, to prevent the cable from becoming loose on the reel. A board held against a flange may be used as a brake to prevent the reel from revolving too fast.

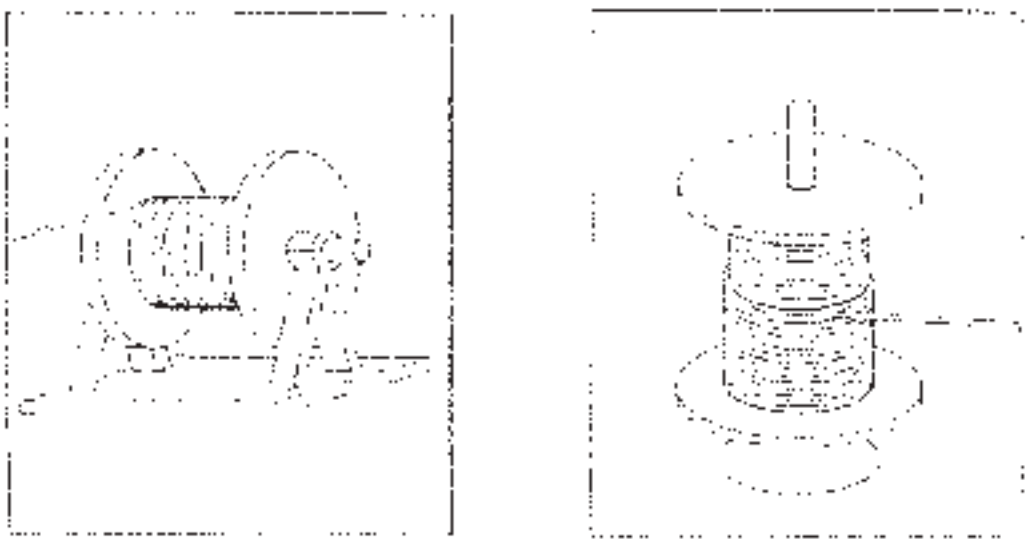


Figure A-1: *Correct Methods to Unreel Tow Cable*

A.2 Uncoiling Tow Cable

Remove ties and roll the coil along the ground so the rope lies straight. There will be no twist or kink in the cable if these instructions are followed.

CAUTION *If the reel and coil do not revolve freely, it will cause the cable to twist as each turn is taken off. Kinking will result if the twist is not removed and the cable straightened out before being placed under tension.*

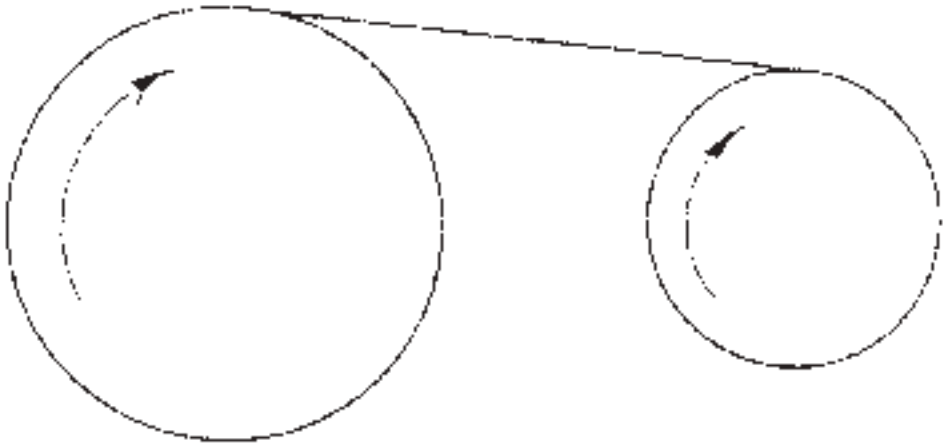


Figure A-2: *Spooling Real to Drum*

A.3 Cable Kinking

Cable kinking can be prevented if the cable is properly handled and installed. The cause, the effect and the result of cable kinking are discussed below.

A.3.1 Cause of Cable Kinking

Kinking is caused when the cable takes a spiral shape as the result of an unnatural twist. One of the most common causes of twisting is improper unreeling and uncoiling. A cable loop and a cable kink are shown in Figure A-3. At the loop stage no damage will occur if the loop is immediately straightened out before it causes a kink.

Cable Loop Cable Kink

Figure A-3: *Cable Loop and Kink*

A.3.2 Effect of Cable Kinking

The effect of kinking is shown in Figure A-4. The cable is permanently damaged

Figure A-4: *Damaged Cable*

A.3.3 Result of Cable Kinking

The result of cable kinking is that strands and wires are displaced, creating uneven tension which causes excessive wear at the point of the kink. The kink can be straightened out so that the damage appears slight; however, since the relative adjustment between strands has been disturbed, the cable cannot give maximum service.

APPENDIX B: CONFIGURING AND UPDATING THE SP-III TPU

SP-III TPU is configured at the factory. However, should changes be required, configuring and updating the SP-III TPU can be performed using Linux Updater. This program is automatically installed when installing SonarPro 12.1 and can be used to perform the following tasks:

- Query or change the IP address of the SP-III TPU.
- Edit the startup file of the SP-III TPU.
- Download and install software updates to the SP-III TPU.

B.1 Starting Linux TPU Updater

Linux TPU Updater is started by double-clicking the Linux TPU Updater icon on the Windows desktop. The *Klein Linux TPU Updater* dialog box will open as shown Figure B-1.

Figure B-1: *The Klein Linux TPU Updater Dialog Box*

B.2 Querying or Changing the SP-III TPU IP Address

The SP-III TPU IP address is set up at the factory. However, should a different address be required, it can be changed.

To change the SP-III TPU IP address:

1. Connect the supplied null modem cable to the NAV connector of the SP-III TPU and to an available serial port on the laptop computer using the USB/RS-232 converter supplied with the computer.
2. Turn on the laptop computer and wait for the Windows desktop to appear.
3. Turn on the SP-III TPU by switching the A/C-D/C switch to A/C for AC operation or to D/C for DC operation.
4. Start Linux TPU Updater.

   The *Klein Linux TPU Updater* dialog box opens.
5. Click **Read TPU IP Address**.

   The *Select RS-232 Port* dialog box shown in Figure B-2 opens.

Figure B-2: *The Select RS-232 Port Dialog Box.*

6. From the **Port** drop-down list box, select the serial port on the laptop computer to which the SP-III TPU is connected.
7. From the **Rate** drop-down list box, select the baud rate of the SP-III TPU's NAV serial port, or select *Determine Automatically* to have Linux TPU Updater find the rate.

   The *Klein Linux TPU Updater* dialog box opens with the current IP address displayed in the **TPU IP Address** text box as shown in Figure B.3.

Figure B-3: *The Klein Linux TPU Updater Dialog Box with Current TPU IP Address Displayed*

8. Enter the new address in the **Enter New IP Address** text box, and then click **Set TPU IP Address**.

   A window opens confirming the change:

B.3 Editing the SP-III TPU Startup File

The startup file for the SP-III TPU is startupCdi3000.ini.

To edit the startup file:

1. Connect the supplied Ethernet cable to the LAN connector of the SP-III TPU and to the Ethernet port of the laptop computer.
2. Turn on the laptop computer and wait for the Windows desktop to appear.
3. Turn on the SP-III TPU by switching the A/C-D/C switch to A/C for AC operation or to D/C for DC operation.
4. Start Linux TPU Updater.

   The *Klein Linux TPU Updater* dialog box opens.

5. Enter the SP-III TPU IP address in the **Enter TPU IP Address** text box if it is different than the default address, or click **Default Addr** if it is the default. The default address is 192.168.0.81. The address will already be displayed if it was queried or changed as described in “Querying or Changing the SP-III TPU IP Address” on page B-2.
6. Click **Edit startup.ini**.

   Windows Notepad opens with the contents of the startupCdi3000.ini file displayed.
7. Make the required changes to the startupCdi3000.ini file as required, and then exit Notepad.

   Notepad exits and the changed file is saved. The SP-III TPU software restarts and a window opens confirming the file update:

B.4 Updating the SP-III TPU Software

Updates to the SP-III TPU software are supplied as compressed archive files and must reside on the laptop computer.

To update the SP-III TPU software:

1. Connect the supplied Ethernet cable to the LAN connector of the SP-III TPU and to the Ethernet port of the laptop computer.
2. Turn on the laptop computer and wait for the Windows desktop to appear.
3. Turn on the SP-III TPU by switching the A/C-D/C switch to A/C for AC operation or to D/C for DC operation.
4. Start Linux TPU Updater.

   The *Klein Linux TPU Updater* dialog box opens.
5. Enter the SP-III TPU IP address in the **Enter TPU IP Address** text box if it is different than the default address, or click **Default Addr** if it is the default. The default address is 192.168.0.81. The address will already be displayed if it was queried or changed as described in “Querying or Changing the SP-III TPU IP Address” on page B-2.

6. Click **Update TPU Software**.

   An dialog box opens that enables file selection.

7. Select and open the update file to download and install.

   The file is downloaded to the SP-III TPU and installed, and the SP-III TPU software restarts. In about one minute a window opens confirming the software update:

APPENDIX C: COMPASS CALIBRATION

This appendix provides the procedure for calibrating the 14106073 MTI3 compass.

C.1 Overview

In this procedure SonarPro is used to control a calibration procedure once the compass is completely installed in the towfish. The procedure may be performed in the factory or in the field.

C.2 Required Items

The following items are required for the compass calibration:

- Towfish with MTI3 compass installed.
- PC with SonarPro 14.1 or 14.2 installed.
- The TPU Updater software must be available (it is normally installed as a part of the SonarPro installation).
- An SP-III or Rack Mount TPU to provide power and communications between SonarPro and the towfish.

C.3 Procedure

1. Connect the PC to the TPU using an Ethernet cable.
2. Connect the TPU to the towfish.
3. Turn on the TPU and allow it to establish communication with the towfish.
4. Start SonarPro and connect to the TPU as the master.
5. Open the Towfish Setup window.
6. Select the Towfish Diagnostics tab.
7. Enter the following command to set up the serial uplink

   $SI:AMC5
8. Enter the following command to set up the serial downlink

   $SI:MC5

9. Enter the following command to start the calibration process.

   $SI:SMC1$CCB

10. Perform the calibration movements:

    - Make sure the towfish is as far away from large metal objects and power wiring as possible.
    - Move the towfish to point in as many locations as possible for approximately three minutes. The manufacturer's instructions (Xsens document MT0202P) suggests that it might be helpful to picture trying to paint the inside of a balloon with the nose of the towfish to visualize the motions needed).
    - At some point, the towfish should move through all horizontal orientations (a full 360 degree circle).

11. Enter the following command to end the calibration process:

    $SI:SMC1$CCE

12. Start the TPU Updater software.
13. Enter the appropriate (usually the default) TPU address and select View TPU Log File / TPU Serial Log.
14. Scroll to the bottom of the Notepad window.
15. Search up for lines containing four stars "****" and look for lines like these:

    ***** IMU response #CCE

    ***** IMU response #ICCSTAT: 0

    ***** IMU response #DDT: 1.0

16. Determine if the result is successful. To do this, first look at the ICCSTAT entry and then refer to Table C-1. A successful calibration will return the value 0. Any other number represents a failure and it will be necessary to return to step 9 and repeat the calibration process. If the ICCSTAT value is zero, examine the DDT value. A perfect score is 1.0 and the objective is to get that or a result close to it. If the number is high, it is advised to proceed to step 9 and repeat the process.

NOTE *As experience is gained, the procedure may be updated to show a numeric range that is acceptable. The intent of calibration is to get as close to 1.0 as is possible. This may be affected by the electromagnetic noise environment in which the calibration is performed.*

Table C-1: *ICCSTAT Result Codes*

ICCSTAT	RESULT
0	Successful calibration
1	Too much disturbance (noise)
2	Not enough data
3	Both 1 and 2 above

17. If the calibration is successful, enter the following command to write the results to the sensor memory:

$SI:SMC1$CCS

APPENDIX D: RIGGING GUIDE

This appendix includes the towfish rigging guides for a towfish without an optional K-wing depressor and for a towfish with a K-wing I or K-wing II depressor.

GENERAL RIGGING GUIDE FOR THE 4XXX & MA-X TOWFISH

ACCESSORY KIT, 4XXX & MA-X TOWFISH, P/N:14105742

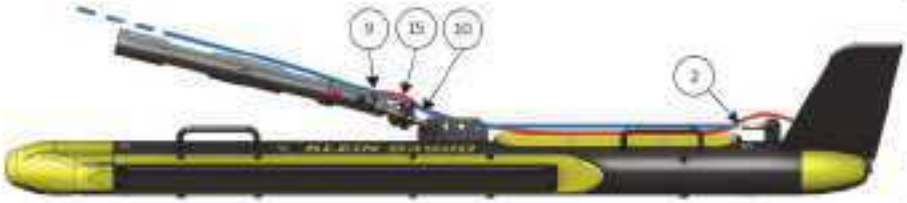
11 **SAFETY CABLE**, 16902031-23 (NOT PICTURED).

TOWFISH JUMPER, 12900850-25 (NOT PICTURED).

S4XXX & MA-X CONFIGURATION FOR LIGHTWEIGHT TOW CABLE

- ATTACH THE STAINLESS STEEL PIN SIDE OF ITEM No.10 TO THE LIGHTWEIGHT TOW CABLE THIMBLE.
- **S4900** – USE THE BLACK PLASTIC BOLT OF ITEM No.10 TO ATTACH THE TOW CABLE TO THE **FORWARD MOST** HOLE ON THE TOW FLANGE.
  S4000 & MA-X - USE THE BLACK PLASTIC BOLT OF ITEM No.10 TO ATTACH THE TOW CABLE TO THE **2ND** HOLE ON THE TOW FLANGE.
- USE THE 12900850-25 (**TOWFISH JUMPER**), SUPPLIED WITH TOWFISH, TO ATTACH THE TOWFISH AFT END CAP TO THE TOW CABLE.
- ATTACH ITEM No.11 (**SAFETY CABLE**) TO THE TOWFISH WITH ITEM No. 2 AND THE STAINLESS STEEL SIDE OF ITEM No.10 WITH ITEM No.15.
- SECURE BOTH CABLES TO THE REAR FAIRING WITH CABLE TIES.

S4XXX & MA-X CONFIGURATION FOR ARMORED TOW CABLE



- THE TOW CABLE TERMINATION IS ATTACHED TO THE TOWFISH BY ITEM No.9 AND No.10. THE STAINLESS STEEL PIN OF ITEM No.10 SHOULD BE USED TO ATTACH TO ITEM No.9.
- **S4900** - ATTACH THE BLACK PLASTIC BOLT END OF ITEM No. 10 TO THE **FORWARD MOST** HOLE ON THE TOW FLANGE.
  S4000 & MA-X - ATTACH THE BLACK PLASTIC BOLT END OF ITEM No. 10 TO THE **2ND** HOLE ON THE TOW FLANGE
- ATTACH THE TOW CABLE VIA A 12900850-40 (**TOWFISH JUMPER**) TO THE TOWFISH AFT END CAP.
- ATTACH A 16902031-30 (**SAFETY CABLE**) TO THE TOWFISH WITH ITEM No. 2 AND THE TOW CABLE SAFETY CABLE ATTACHMENT POINT WITH ITEM No.15.
- SECURE BOTH CABLES TO THE REAR FAIRING WITH CABLE TIES.

ALWAYS SECURE SHACKLE AND SWIVEL PINS WITH A MARINE GRADE CABLE-TIE (12700510). TRIM THE EXCESS CABLE-TIE BEFORE DEPLOYMENT.

KLEIN PART NO. 11603234 REV 01

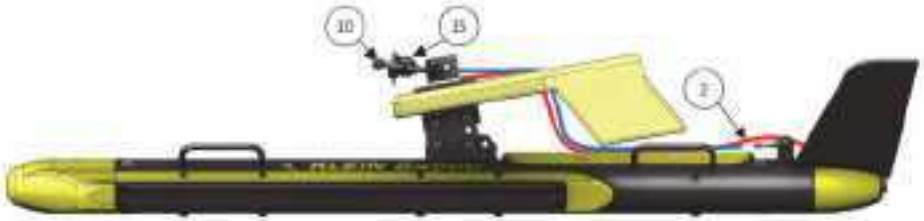
GENERAL RIGGING GUIDE FOR THE KLEIN 4XXX & MA-X TOWFISH WITH K-WING I

ACCESSORY KIT, 4XXX & MA-X TOWFISH, P/N:14105742

(11) SAFETY CABLE, 16902031-23 (NOT PICTURED).

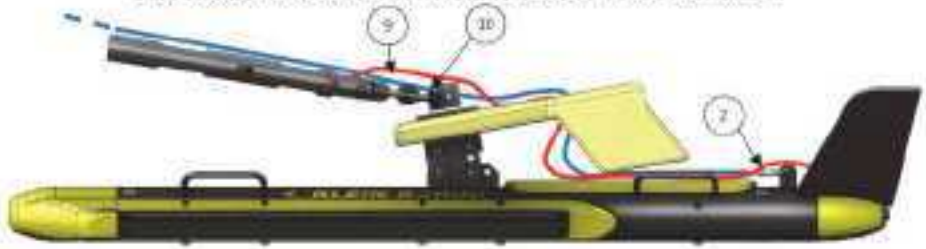
TOWFISH JUMPER, 12900850-25 (NOT PICTURED).

S4XXX & MA-X CONFIGURATION WITH LIGHTWEIGHT TOW CABLE & K-WING 1



- ATTACH THE K-WING TO THE TOW FLANGE, USING THE SUPPLIED HARDWARE FROM THE K-WING 1 KIT TO THE 1ST AND 3RD HOLES ON THE TOW FLANGE.
- ATTACH THE TOW CABLE VIA ITEM No. 10 TO THE TOW FLANGE ON TOP OF THE K-WING. USE THE STAINLESS STEEL PIN TO THE TOW CABLE AND THE BLACK PLASTIC PIN THROUGH THE TOW FLANGE. IT IS NOT NECESSARY TO USE THE BLACK PLASTIC WASHERS PROVIDED WITH ITEM No.10.
- USING THE 12900850-40 (TOWFISH JUMPER) SUPPLIED WITH THE K-WING 1 KIT, ATTACH THE TOW CABLE TO THE TOWFISH AFT END CAP.
- ATTACH THE 16902031-27 (SAFETY CABLE), SUPPLIED WITH THE K-WING 1 KIT, TO THE TOWFISH WITH ITEM No. 2 AND THE STAINLESS STEEL SIDE OF ITEM No.10 WITH ITEM No.15.
- SECURE BOTH CABLES TO THE REAR FAIRING WITH CABLE TIES

S4XXX CONFIGURATION WITH ARMORED CABLE & K-WING 1



- ATTACH THE K-WING TO THE TOW FLANGE, USING THE SUPPLIED HARDWARE FROM THE K-WING 1 KIT TO THE 1ST AND 3RD HOLES ON THE TOW FLANGE.
- ATTACH THE TOW CABLE VIA ITEM No. 9 AND 10 TO THE TOW FLANGE ON TOP OF THE K-WING. THE STAINLESS STEEL PIN OF ITEM No.10 SHOULD BE CONNECTED TO THE CABLE SAFETY CABLE ATTACHMENT POINT AND THE BLACK PLASTIC PIN THROUGH THE TOW FLANGE. IT IS NOT NECESSARY TO USE THE BLACK PLASTIC WASHERS PROVIDED WITH ITEM No.10.
- USING THE 12900850-40 (TOWFISH JUMPER), SUPPLIED WITH THE K-WING 1 KIT, ATTACH THE TOW CABLE TO THE TOWFISH.
- ATTACH THE 16902031-50 (SAFETY CABLE) TO ITEM No. 2 AND THE TOW CABLE SAFETY CABLE ATTACHMENT POINT WITH ITEM No.15 (NOT PICTURED).
- SECURE BOTH CABLES TO THE REAR FAIRING WITH CABLE TIES
- SECURE SAFETY CABLE TO THE TERMINATION AND TOW CABLE WITH VYNIL TAPE EVERY 500mm.

ALWAYS SECURE SHACKLE AND SWIVEL PINS WITH A MARINE GRADE CABLE-TIE (12700510). TRIM THE EXCESS CABLE-TIE BEFORE DEPLOYMENT.

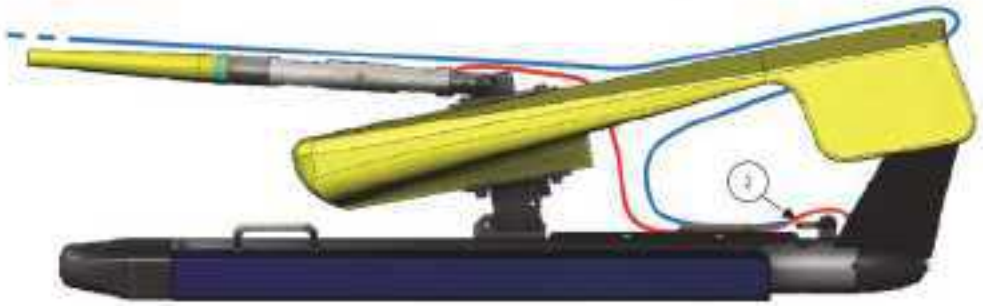
KLEIN PART NO. 11603234-01 REV 01

KLEIN MARINE SYSTEMS

GENERAL RIGGING GUIDE FOR THE KLEIN 4XXX & MA-X TOWFISH WITH K-WING II

ACCESSORY KIT, 4XXX & MA-X TOWFISH, P/N:14105742

S4XXX & MA-X CONFIGURATION WITH ARMORED TOW CABLE & K-WING 2



- ATTACH THE K-WING TO THE TOW FLANGE, USING THE SUPPLIED HARDWARE FROM THE K-WING 2 KIT TO THE 2ND AND 4TH HOLES ON THE TOW FLANGE.
- ATTACH THE TOW CABLE TO THE TOW FLANGE ON TOP OF THE K-WING.
- USING THE 12900850 (TOWFISH JUMPER), ATTACH THE TOW CABLE TO THE TOWFISH. ROUTE THE JUMPER CABLE THROUGH THE K-WING DRAIN HOLE NEAR THE TOW POINT.
- ATTACH THE 16902030 (SAFETY CABLE), TO THE TOWFISH WITH ITEM No. 2 11900078 (SHACKLE) LOCATED IN ACCESSORY KIT, AND THE TOW CABLE SAFETY CABLE ATTACHMENT POINT ON THE TOW CABLE WITH A 11900214, SUPPLIED WITH THE K-WING 2 KIT (NOT PICTURED). DO NOT ROUTE THE SAFETY CABLE THROUGH THE K-WING DRAIN HOLE.
- SECURE BOTH CABLES TO THE REAR FAIRING WITH CABLE TIES.
- SECURE SAFETY CABLE TO THE TERMINATION AND TOW CABLE WITH VINYL TAPE EVERY 500mm.

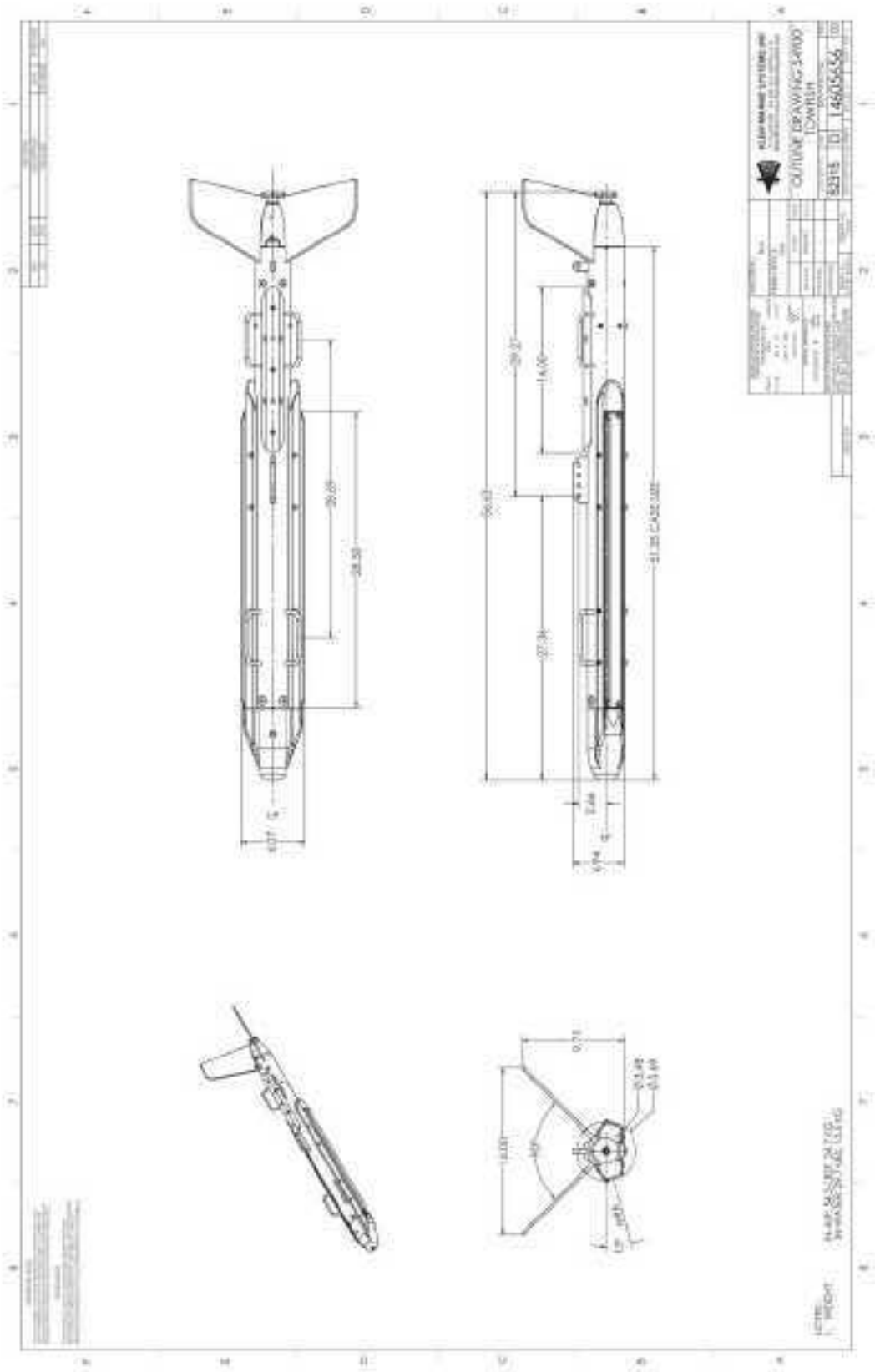
ALWAYS SECURE SHACKLE AND SWIVEL PINS WITH A MARINE GRADE CABLE-TIE (12700510). TRIM THE EXCESS CABLE-TIE BEFORE DEPLOYMENT.

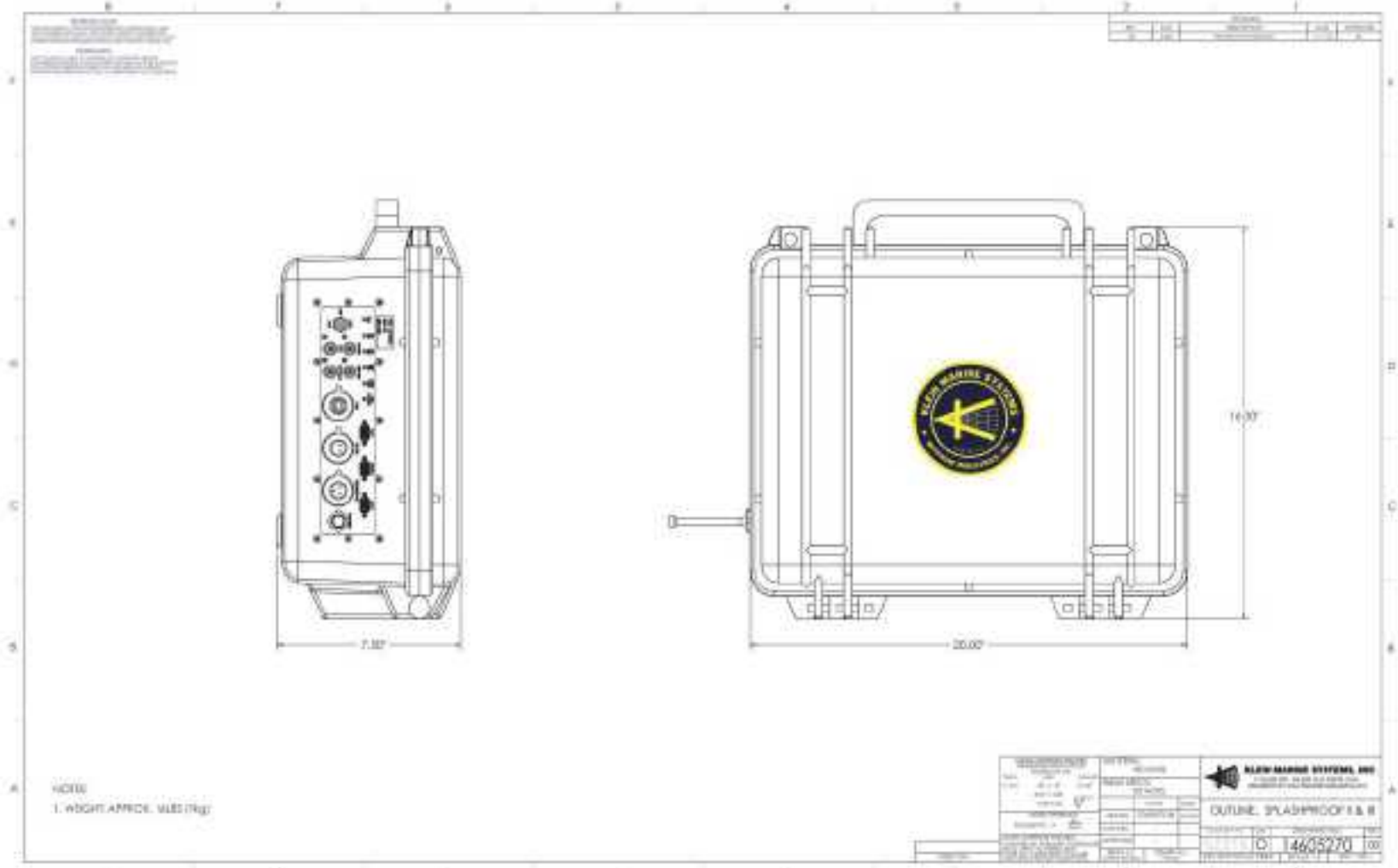
KLEIN PART NO. 11601234-02 REV 00

APPENDIX E: DRAWINGS

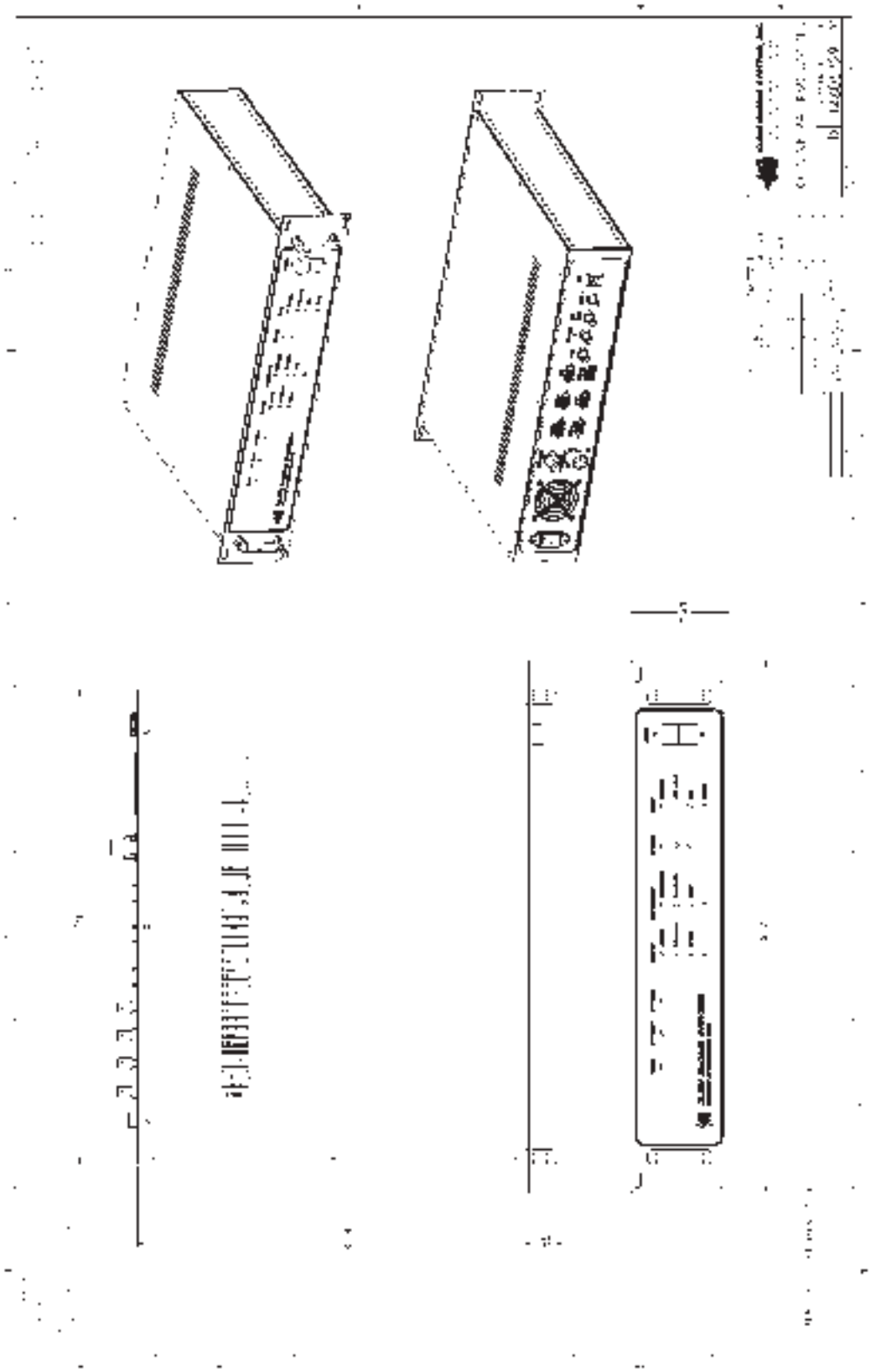
This appendix includes the following outline drawings. They are provided for reference purposes.

Drawing 14605656:	Outline, S4900 Towfish
Drawing 14605270:	Outline, Splashproof II and III
Drawing 14605729:	Outline, Rack Mount TPU


OUTLINE DRAWING 5490
TOWFISH
8315
14605656

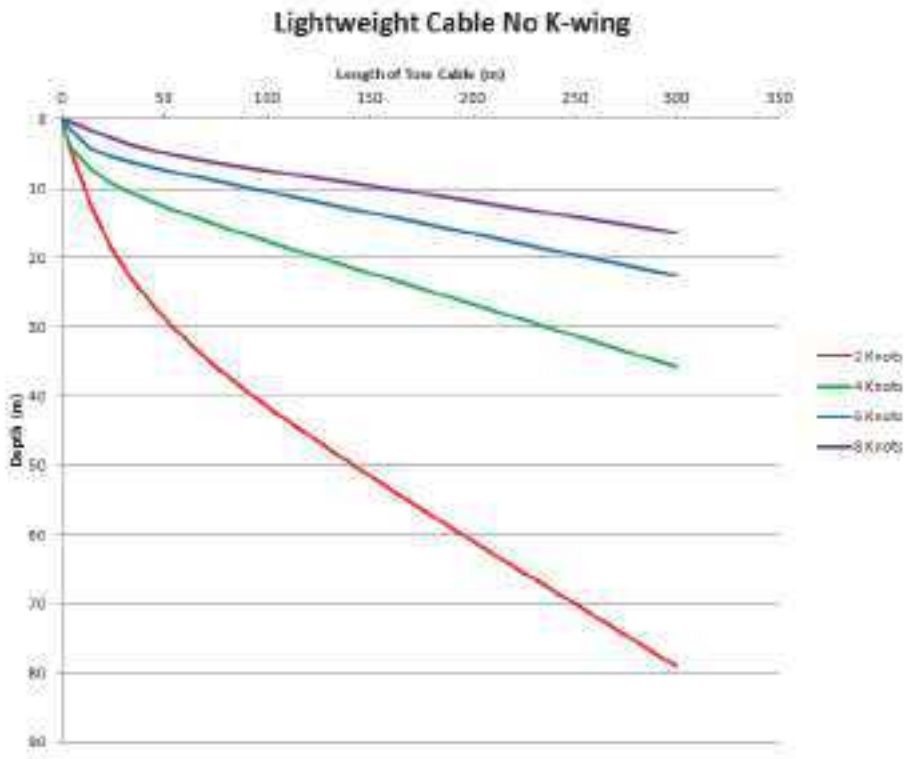


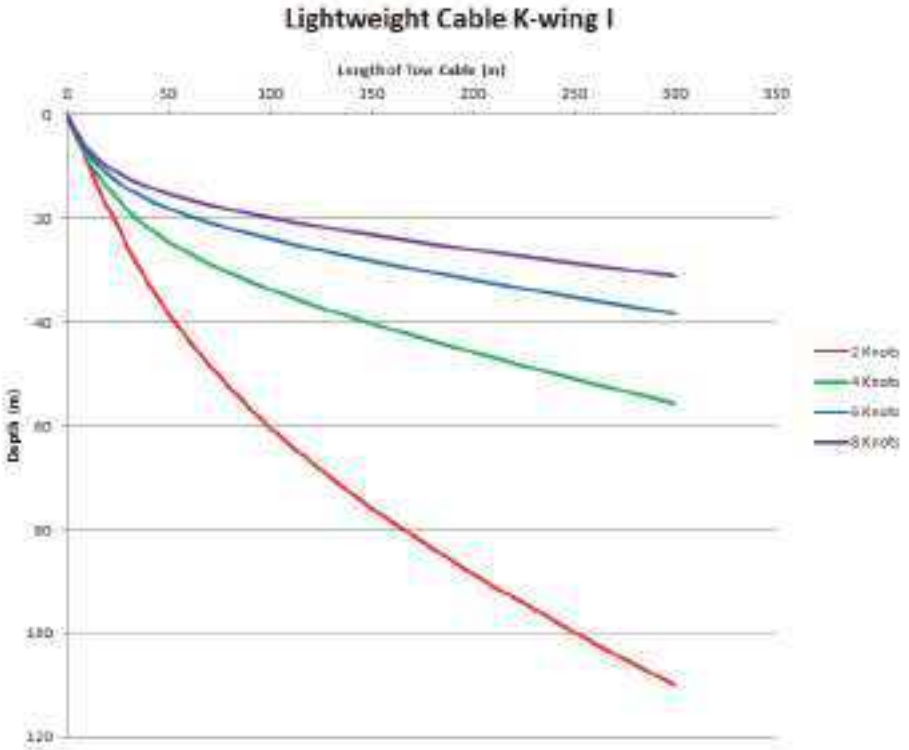
KLEIN MARINE SYSTEMS

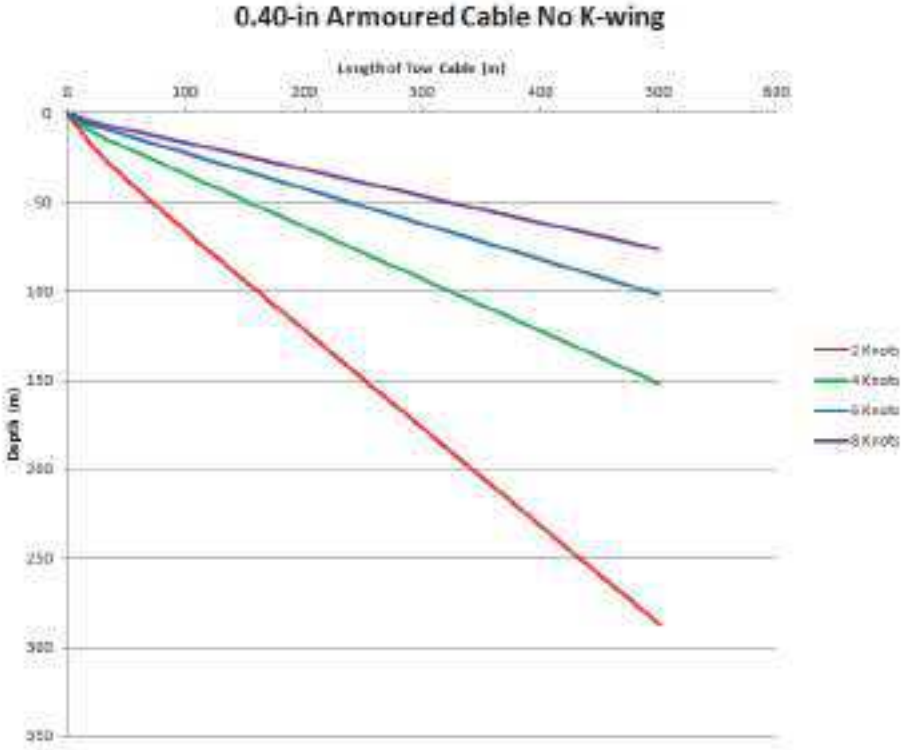


APPENDIX F:TOWFISH TOWING CHARACTERISTICS

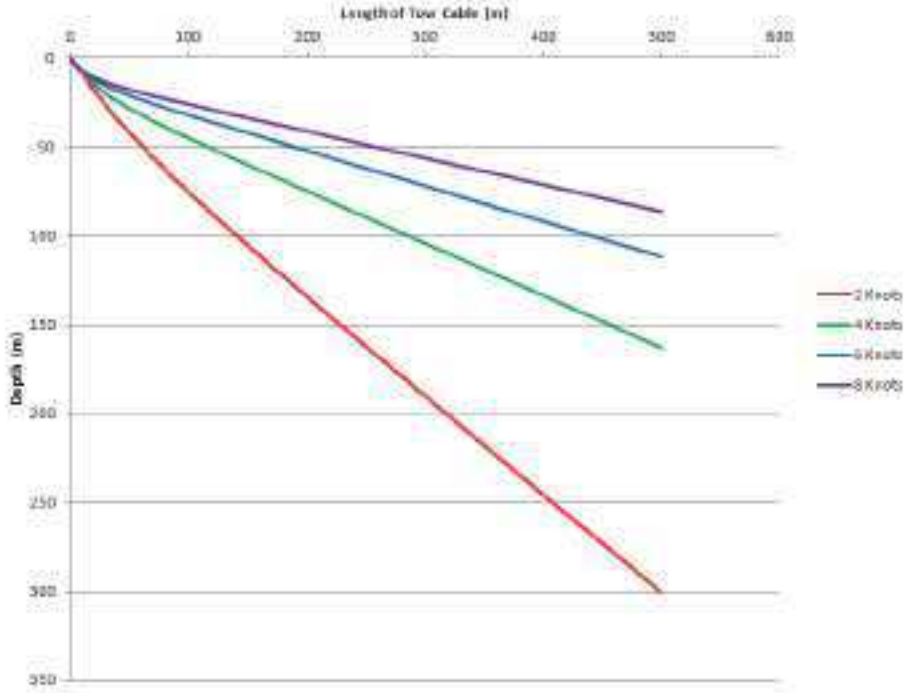
This appendix describes the towing characteristics of the towfish as graphical plots of the towfish depth versus tow cable length for various towfish speeds.



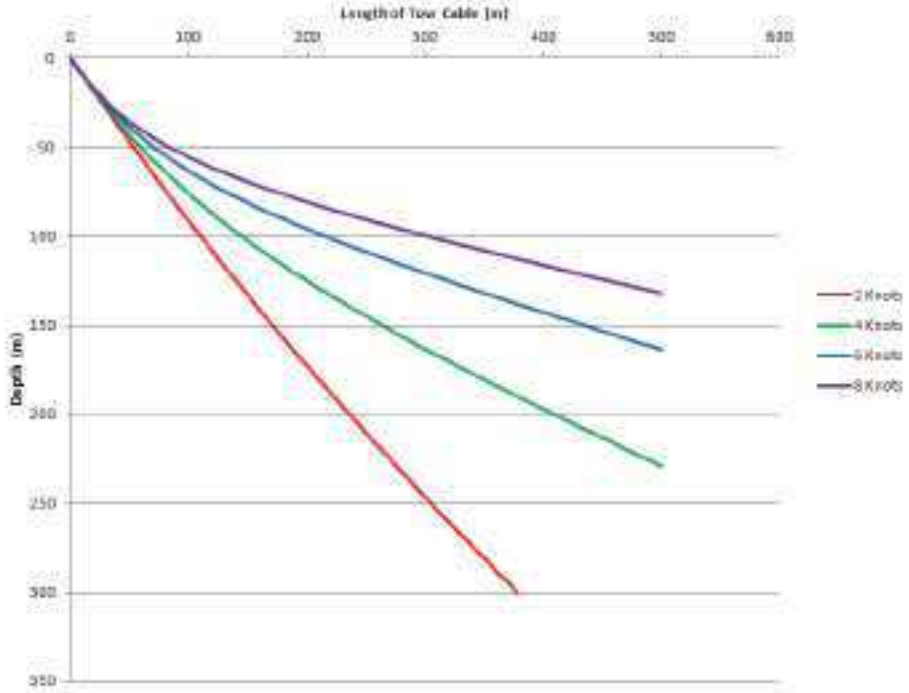

Lightweight Cable K-wing I
Length of Tow Cable (m)
0
50
100
150
200
250
300
350
Depth (m)
0
20
40
60
80
100
120
2 Knots
4 Knots
6 Knots
8 Knots

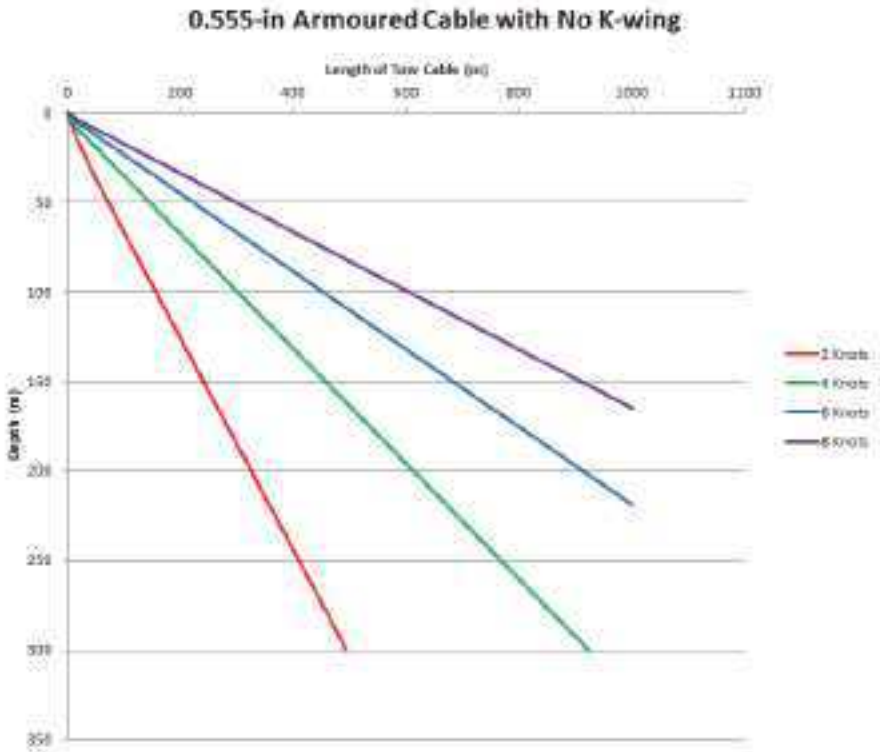

0.40-in Armoured Cable No K-wing
Length of Tow Cable (m)
0
100
200
300
400
500
600
Depth (m)
0
50
100
150
200
250
300
350
2 Knots
4 Knots
6 Knots
8 Knots

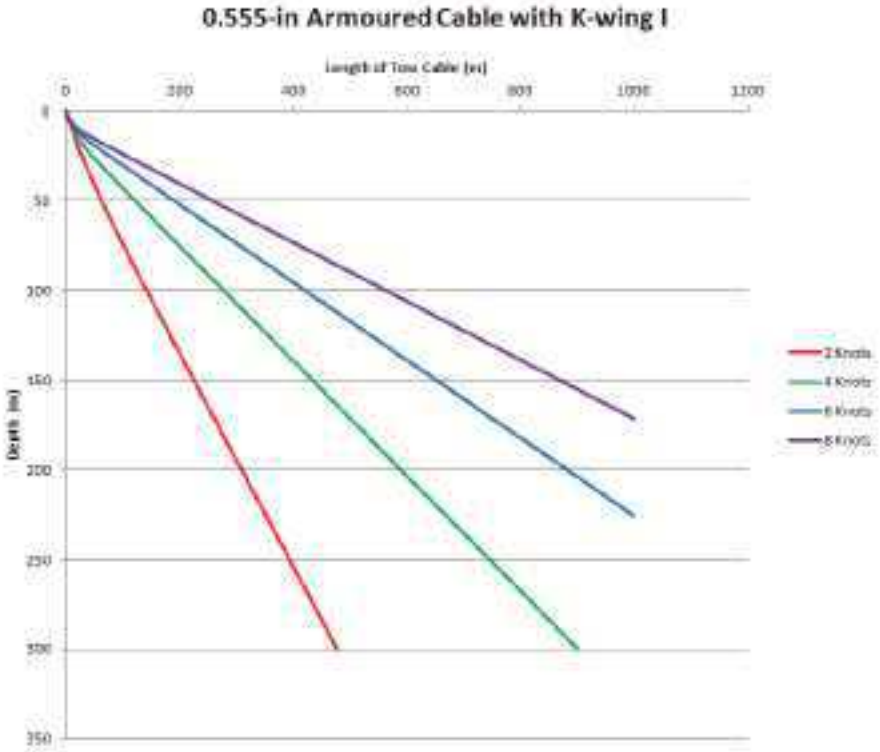
0.40-in Armoured Cable with K-wing I



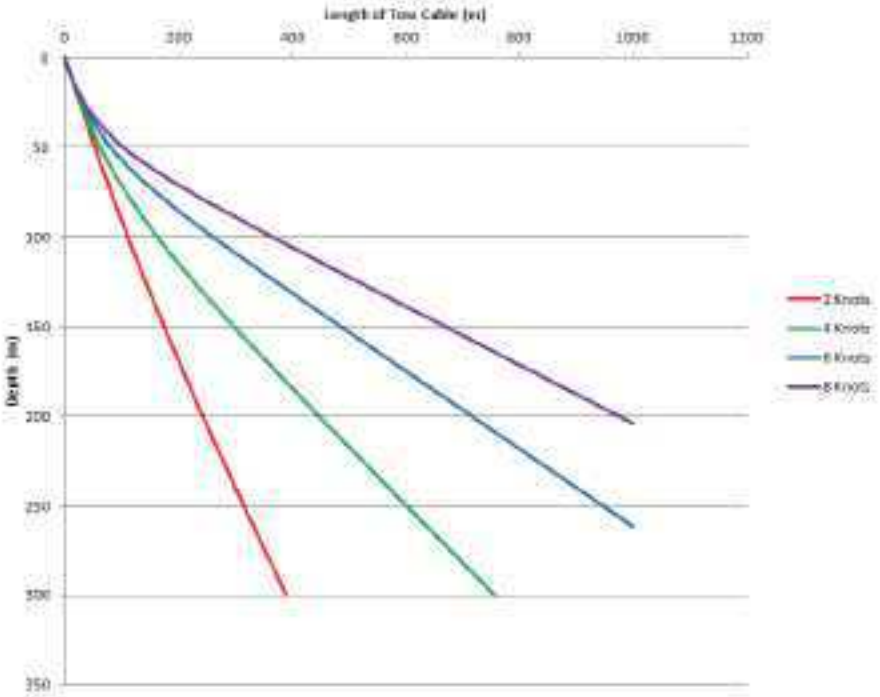
0.40-in Armoured Cable with K-wing II



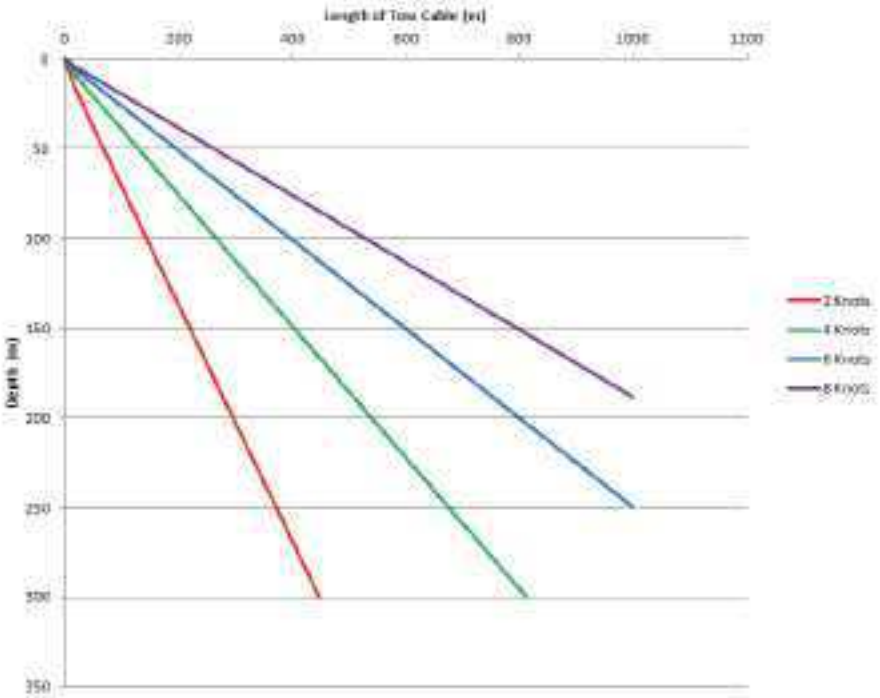

0.555-in Armoured Cable with No K-wing
Length of Tow Cable (m)
0
200
400
600
800
1000
1200
0
50
100
150
200
250
300
350
Depth (m)
2 Knots
4 Knots
6 Knots
8 Knots

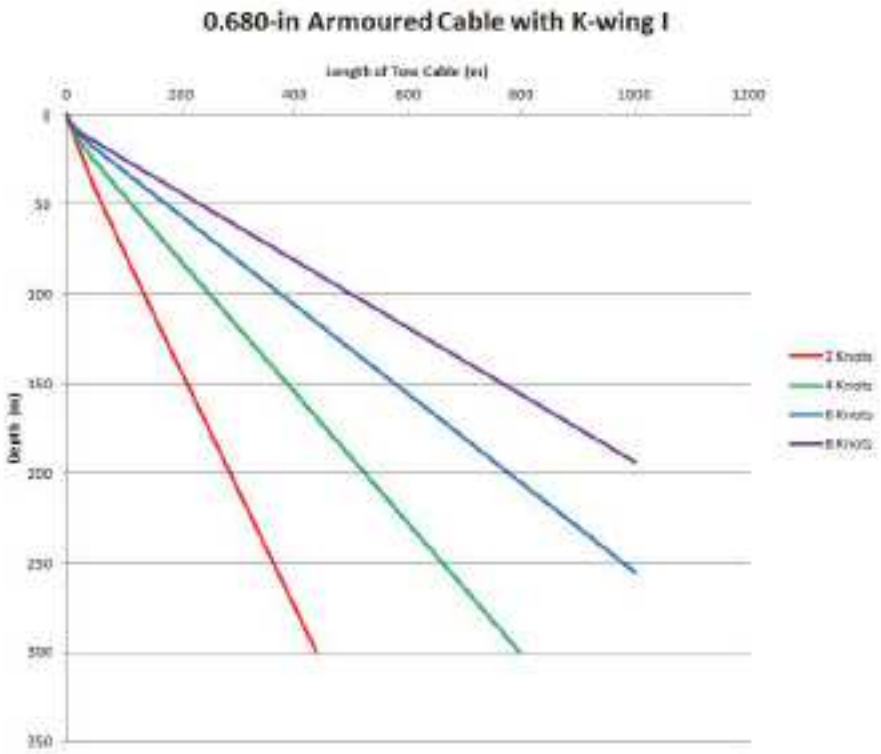

0.555-in Armoured Cable with K-wing I
Length of Tow Cable (m)
0
200
400
600
800
1000
1200
0
50
100
150
200
250
300
350
Depth (m)
2 Knots
4 Knots
6 Knots
8 Knots

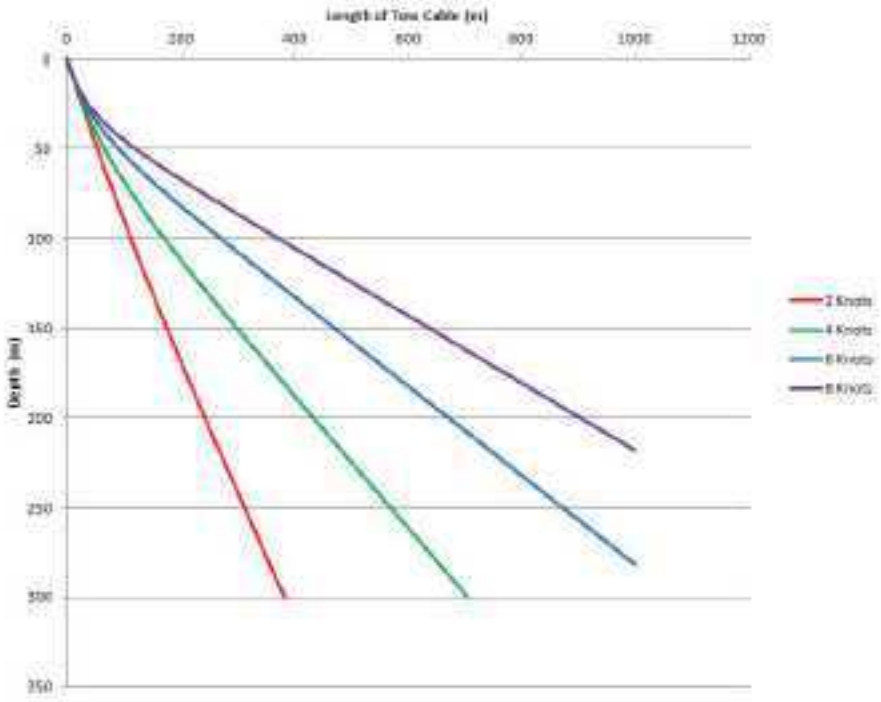
0.555-in Armoured Cable with K-wing II

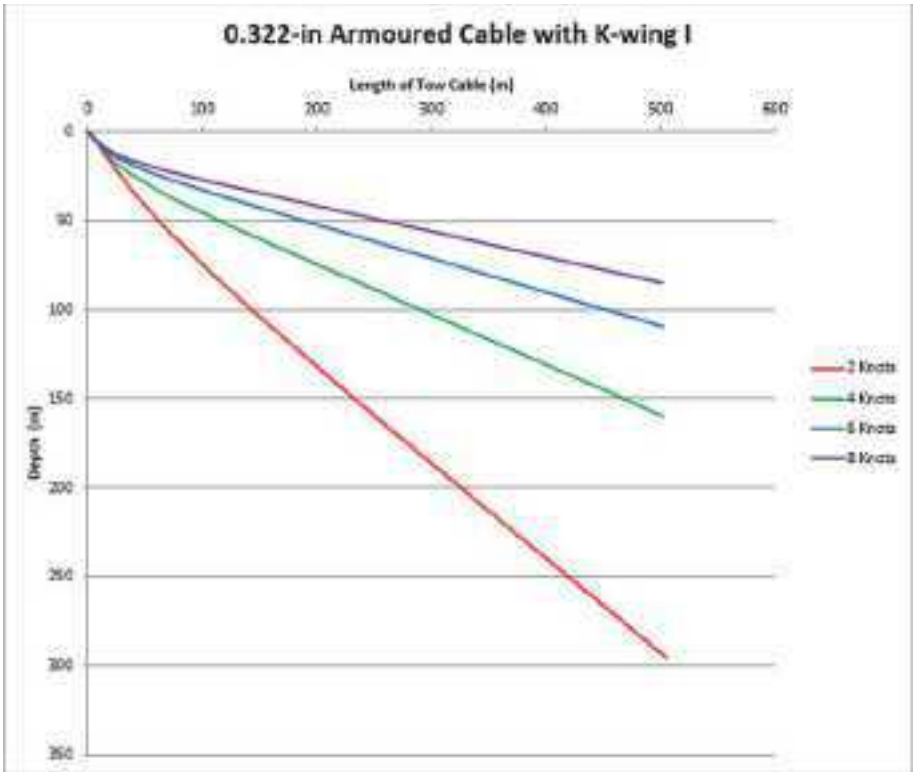


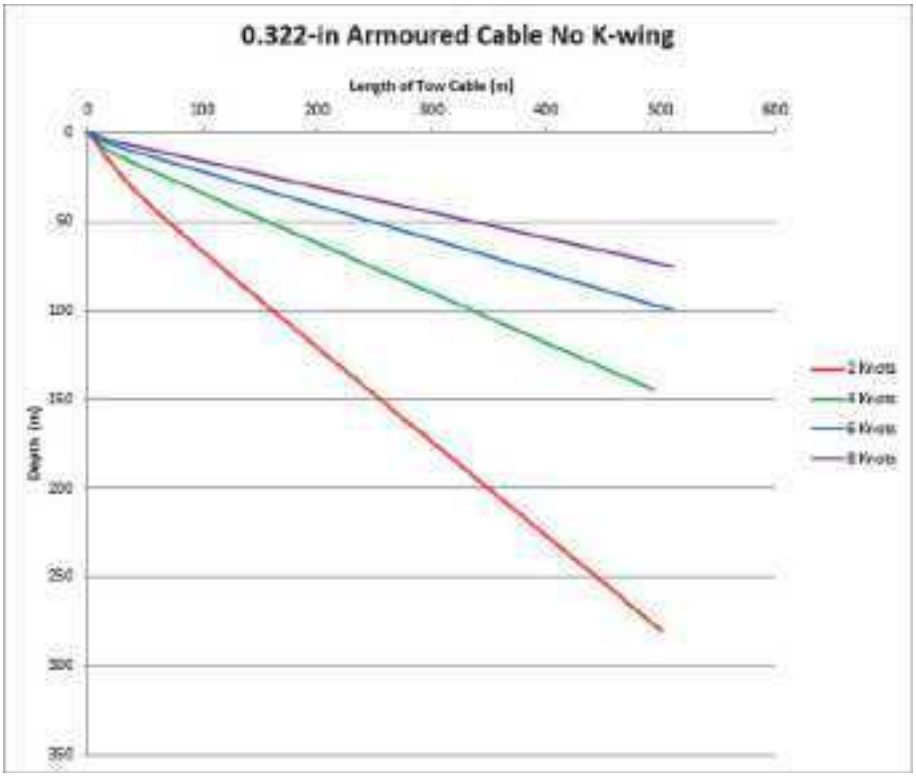
0.680-in Armoured Cable with No K-wing




0.680-in Armoured Cable with K-wing I
Length of Tow Cable (m)
0
200
400
600
800
1000
1200
0
50
100
150
200
250
300
350
Depth (m)
2 Knots
4 Knots
6 Knots
8 Knots


0.680-in Armoured Cable with K-wing II
Length of Tow Cable (m)
0
200
400
600
800
1000
1200
0
50
100
150
200
250
300
350
Depth (m)
2 Knots
4 Knots
6 Knots
8 Knots


0.322-in Armoured Cable with K-wing I
Length of Tow Cable (m)
0
100
200
300
400
500
600
Depth (m)
0
50
100
150
200
250
300
350
2 Knots
4 Knots
6 Knots
8 Knots


0.322-in Armoured Cable No K-wing
Length of Tow Cable (m)
0
100
200
300
400
500
600
Depth (m)
0
50
100
150
200
250
300
350
2 Knots
4 Knots
6 Knots
8 Knots

APPENDIX G: SYSTEM SETUP DIAGRAM WITH ACOUSTIC POSITIONING SYSTEM

This appendix comprises the system setup diagram shown in Figure G-1 for installations with an acoustic positioning system.

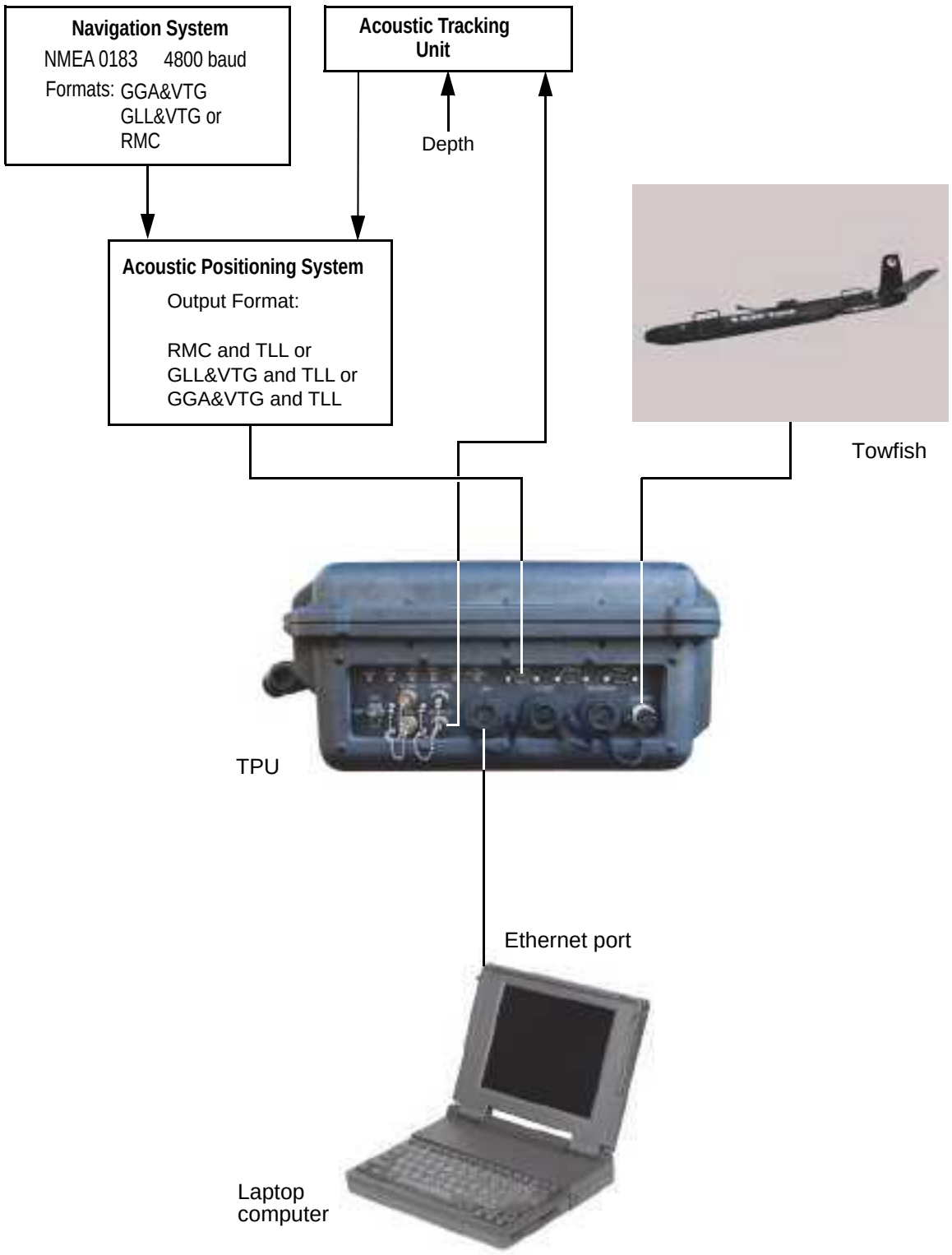


Figure G-1: *System Setup Diagram with Towfish, Navigation, Acoustic Positioning System, and Laptop Computer Connections*