SERIES 5000 V2 SONAR SYSTEM

Operations and Maintenance Manual

P/N 11214512, Rev. 04

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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 for the Series 5000 V2 Sonar System is 500 meters (1640 feet). Operations at depths greater than 500 meters may damage the transducers. For a Series 5000 V2 Sonar System with bathymetry option, the depth rating is 200 meters (656 feet). Operations at depths greater than 200 meters may damage the transducers.

STANDARDS

SAFETY: EN 60950

EMC: EN 60945

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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:

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c) This warranty does not apply to tow cables. If applicable, the manufacturer's warranty will be forwarded with the equipment.

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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.

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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.

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Preface

The Series 5000 V2 Sonar System is a towed multibeam sonar comprising a towed underwater platform and a topside system.

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 5000 V2 Sonar System. The manual is divided into the following four main chapters and four appendices:

Chapter 1: Overview. Presents an overview of the Series 5000 V2 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 system, including the acoustic transducers, the environmental and navigation sensors, and the available tow cables.

Chapter 3: Preparation for Use. Provides instructions for unpacking and setting up the Series 5000 V2 Sonar System components. It also includes a pre-survey checkout procedure.

Chapter 4: Maintenance and Troubleshooting. Provides instructions on how to perform maintenance and troubleshooting of the Series 5000 V2 Sonar System and how to replace the fixed tail cone assembly and remove, install and test the towfish electronics.

Chapter 5: Technical Description. Provides an overall technical description of the Series 5000 V2 Sonar System towfish and TPU electronics, including block diagrams, printed circuit board descriptions and chassis photos with call outs.

Appendix A: Sample Towing Characteristics. Provides towing characteristics charts which are helpful when planning survey equipment requirements.

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

Appendix C: Configuring and Updating the TPU. Provides instructions on how to configure and update the Series 5000 V2 Sonar System TPU.

Appendix D: Different Tow Cable Lengths and the Startup.ini File. Provides instructions on how to tune the Series 5000 V2 Sonar system for optimum performance versus various cable lengths and how to measure cable insertion loss.

Appendix E: Drawings and Parts Lists. Provides drawings and parts lists for reference and troubleshooting purposes.

Note, Warning, Caution, and Shock Hazard Notices

Where applicable, note, warning, caution, and shock hazard 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.*

SHOCK HAZARD *Identifies a potential electrical shock hazard that could cause personal injury or death to yourself or to others.*

Customer Service

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CHAPTER 1: OVERVIEW

The Series 5000 V2 Sonar System is a very high resolution, multibeam long range sonar system that is ideally suited for surface mine counter measure applications and hydrographic, geophysical, pipeline, and offshore surveys. The two primary drawbacks of conventional side-looking sonars, along-track resolution and towing speed limitation, have been addressed by simultaneously forming multiple dynamically focused beams per side, per ping. This allows greater towing speeds without the usual loss of bottom coverage while maintaining high resolution. The system employs operator selectable chirp and continuous wave (CW) technologies which, when coupled with KMS proprietary display algorithms, provides extraordinary sea floor images. In addition, rugged construction, low weight and simple setup enables operation from large or small vessels.

1.1 Main Features

The Series 5000 V2 Sonar System provides the following main features:

- High speed, high resolution, multibeam side scan sonar.
- 14-bit digital multiplexer for transmission of sonar and control data over a single coaxial cable.
- PC based operation using SonarPro and the Windows operating system.
- Operation at 455 kHz for ranges up to 150 meters.
- Flexible and expandable system configurations.
- Chirp and CW operating modes.
- 500-meter operating depth (200-meter with bathymetry option).
- Operation with up to 800 meters of coaxial 0.680-inch diameter armored tow cable.
- Heading, pitch, roll and pressure sensors.
- Optional interfaces for a responder, acoustic positioning system yaw rate sensor, and altimeter.
- Small, lightweight and simple to operate and maintain.

1.2 System Components

The main components of the Series 5000 V2 Sonar System are the towfish and the topside system. The towfish is the underwater component and is towed with an armored coaxial tow cable up to 800 meters in length. The topside system provides the power source for the towfish and receives, stores and processes data acquired by the towfish. The towfish connects to the topside system using an optionally supplied winch with slip rings and an armored coaxial tow cable. A terminated, light weight deck cable is optionally supplied for connecting to the winch or for connecting directly to the towfish for testing. The topside system is composed of two separate main components:

- Transceiver and Processing Unit (TPU)
- SonarPro Workstation

In addition, a K-Wing I or K-Wing II Depressor can be installed on the towfish which enables a greater towing depth with less cable deployed.

1.2.1 Towfish

The towfish, which is shown in Figure 1-1, consists of a negatively buoyant stainless steel towfish housing with attached port and starboard sonar transducer arrays, an altimeter, a nose cone, and a tail cone with stabilizing fins. Inside the towfish housing is a pressure housing containing the sonar electronics, a downlink demultiplexer for control signals, an uplink multiplexer for sonar and sensor data, a transmitter board for transmit pulses, receiver boards for receiving signals, and the compass, pitch/roll and pressure sensors. 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. The installed safety cable minimizes the chances of losing the towfish should it collide with an obstruction.

1.2.2 TPU

The 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 an optionally 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 SonarPro Workstation over an Ethernet connection. The TPU provides power and downlink

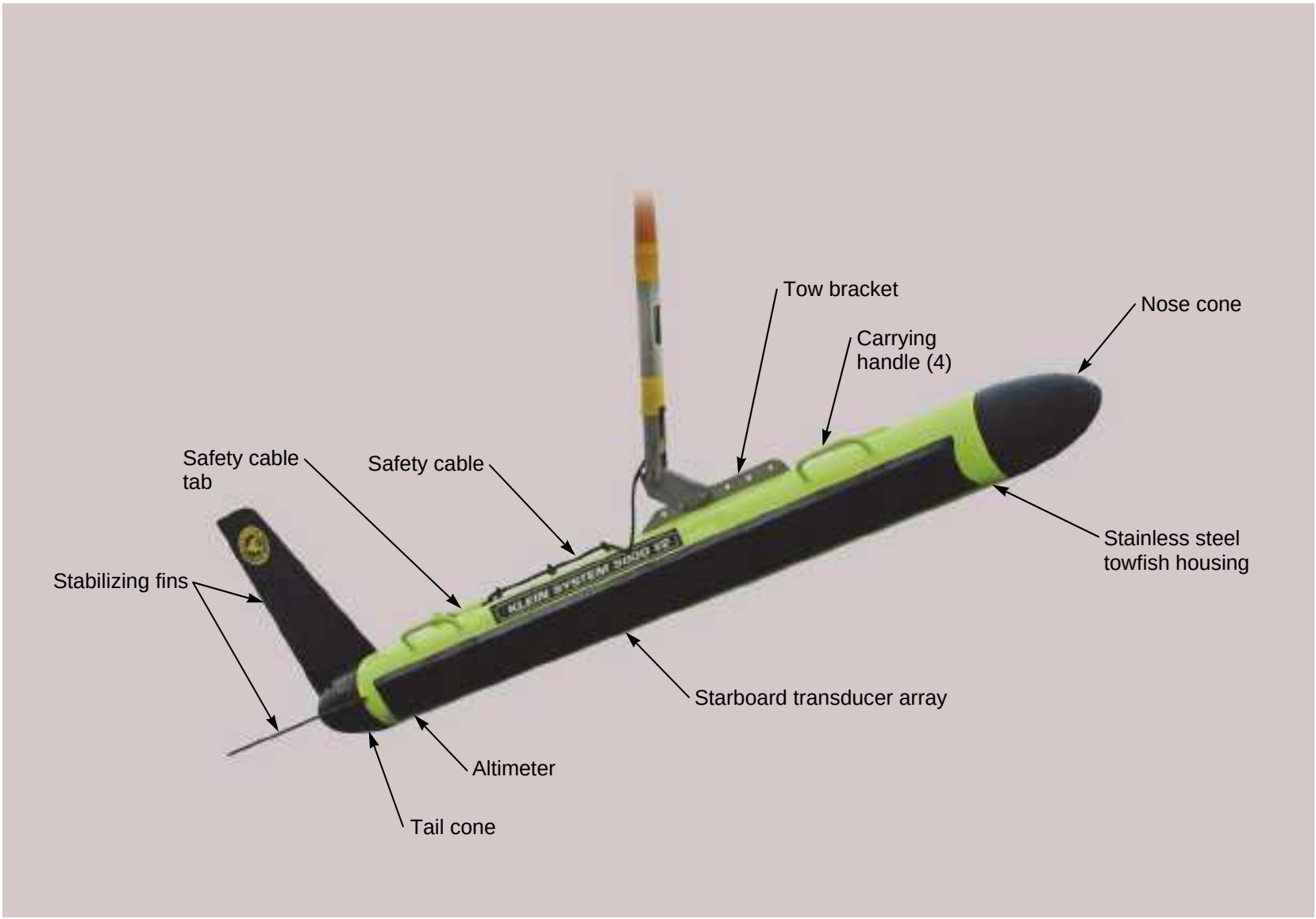


Figure 1-1: *Series 5000 Towfish*

Figure 1-2: *Series 5000 V2 Sonar System Topside System Main Components*

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. The TPU can also input standard National Marine Electronics Association (NMEA) 0183 message sentence formats from a connected GPS, and a 1 PPS input is provided which inputs 1 PPS (one pulse per second) signals from the GPS. This signal is used in conjunction with a NMEA $ZDA message input to add an accurate time stamp to the data.

1.2.3 SonarPro Workstation

The SonarPro Workstation is an industrial grade 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 100baseT connection. A SATA hard drive is included with the Windows operating system and SonarPro installed. SonarPro is a comprehensive Windows based software program that provides multiple displays of real-time or previously recorded sonar and sensor data. SonarPro also allows you to record all acquired sonar and sensor data. The SonarPro Workstation includes a high resolution 27-inch 2560 x 1440 monitor, a keyboard and a mouse.

CHAPTER 2: SPECIFICATIONS

This chapter includes the physical and performance specifications for the main components of the Series 5000 V2 Sonar System.

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

2.1 Sonar System

Beams:	5 port and 5 starboard
Sonar frequency:	455 kHz
Maximum range:	Up to 150 m per side (actual range varies with environmental conditions and pulse length)
Range scales:	50, 75, 100, and 150 m; 50 and 75 m are high resolution; 200 and 250 m reconnaissance mode
Swath width:	100 to 500 m (usable swath width varies with environmental conditions and pulse length)
Along track resolution:	10 cm @ 38 m, 20 cm @ 75 m and 36 cm @ 150 m
Across track resolution:	3.75 cm
Operating speed envelope:	2 to 10 knots at 150 m
Depth rating:	500 m (1640 ft) 200 m (656 ft) with bathymetry option
Operating temperature:	-2–35°C (14–95°F)

2.2 Topside System

The main topside components of the Series 5000 V2 Sonar System are the Transceiver and Processing Unit (TPU) and the SonarPro Workstation.

2.2.1 System Power Requirements

The system power requirements are 100–125 or 200–250 VAC, 50–60 Hz at 100 watts for the TPU and the towfish together.

2.2.2 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
I/O ports:	(1) LAN (4) RS-232 (4) BNC (1) RJ45 debug (1) N-Type

2.2.3 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:	27-inch diagonal 2560 x 1440 resolution 16:9 aspect ratio
Operator I/O:	Keyboard and mouse

2.3 Towfish

2.3.1 General

Body material:	Type 316 stainless steel
Nose/tail cone material:	Urethane (80 D Durometer)
Tail fin material:	Hard-coat anodized 6061 aluminum
Size:	203 cm (79.9 in.) long 16.8 cm (6.6 in.) diameter 30.5 cm (24 in.) wide, including tail fins 61.0 cm (24 in.) high, including tail fins
Weight in air:	70.5 kg (155 lb)
Weight in water:	47.7 kg (105 lb)

2.3.2 Transducers

Type:	Proprietary line array
Vertical beam angle:	40°
Depth limit:	500 m (1640 ft) 200 m (656 ft) with bathymetry option

2.3.3 Transmitter

Type:	Toneburst
Transmission pulse:	25, 50 and 100 µsec CW; 200 µsec 2-tone; 2, 4, 8 and 16 msec chirp

2.3.4 Receiver

Type:	High gain, tuned preamplifier with TVG
Noise figure:	1 dB nominal
TVG range:	80 dB

2.3.5 A/D Converter

Type:	Pipeline
Resolution:	14 bits
Quantization:	Linear
Sample rate:	Proprietary

2.3.6 Multiplexer

Modulation format:	Pulse code modulation (PCM)
Multiplexing format:	Time division multiplexing (TDM)
Number of channels:	32
Data rate:	29.12 Mbaud
Data format:	NRZ
Bit error rate:	Better than $1x10^{-8}$ (before correction)

2.3.7 Power

Input power:	Powered from the TPU; no additional power required

2.3.8 Heading Sensor

Accuracy level:	±0.5° RMS
Accuracy tilted:	±1.0° RMS
Resolution:	0.1°
Repeatability:	±0.1°

2.3.9 Pitch and Roll Sensor

Accuracy:	±0.2° RMS
Resolution:	0.1°
Repeatability:	±0.2°

2.3.10 Pressure Sensor

Pressure range:	0–750 psig
Accuracy:	±0.10%

2.4 Tow Cables

Electrically, the tow cable must be 50 ohms. The whole cable assembly, including the deck cable, the slip rings, the winch, the tow cable, and the connectors must be coax all the way from the TPU to the towfish.

2.4.1 Lightweight Coaxial Deck Cable

Type:	Polyurethane jacketed, coaxial Kevlar reinforced
Conductors:	Coaxial copper
Diameter (OD):	1.15 cm (0.455 in.)
Voltage rating:	600 VDC

2.4.2 Armored Coaxial Tow Cable (0.40)

Type:	Double layer, counter helical, galvanized improved plow steel (GIPS) Stainless steel can be a special order
Conductors:	Coaxial copper
Diameter (OD):	10.2 mm (0.40 in.)
Breaking strength:	4990 kg (11, 000 lb)
Working load:	1247 kg (2750 lb)
Operational length (including deck cable):	400 m max
Voltage rating:	1200 VDC
Termination:	Stainless steel shackle at towfish end

2.4.3 Armored Coaxial Tow Cable (0.68)

Type:	Double layer, counter helical, galvanized extra improved plow steel (GEIPS) Stainless steel can be a special order
Conductors:	Coaxial copper
Diameter (OD):	17.3 mm (0.68 in.)
Breaking strength:	18140 kg (40,000 lb)
Working load:	4535 kg (10,000 lb)

Operational length (including deck cable):	750 m max
Voltage rating:	3000 VDC
Termination:	Stainless steel shackle at towfish end

2.5 Towfish Options

The towfish can be equipped with the following options:

- Responder interface
- Transponder interface
- Magnetometer interface
- Yaw rate sensor
- Altimeter
- Depressor wings

2.6 Tow Cable Options

Two types of tow cables are available:

- Armored coaxial (0.40)
- Armored coaxial (0.68)

CHAPTER 3: PREPARATION FOR USE

This chapter provides instructions for unpacking the Series 5000 V2 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 controls and indicators for all the system components 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 TPU and the 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 TPU and the SonarPro Workstation or laptop can be found on the rear panel of each.

3.2 Locating the Topside System Components

The TPU and the 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 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 TPU and the SonarPro Workstation require 100–125 or 200–250 VAC, 50–60 Hz power to operate. The Series 5000 V2 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 5000 V2 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 cable 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: *TPU Power Cable Wiring*

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

3.3.1 Grounding

It is important that the Series 5000 V2 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 TPU and SonarPro Workstation Circuit Breakers

The main AC power input line is protected by a switch/circuit breaker in both the TPU and the SonarPro Workstation. The one on the TPU is located on the front panel on the far right as shown in Figure 3-3 on page 3-12. 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 3-2 on page 3-9. To reset a switch/circuit breaker, switch it to ON.

3.4 Towfish Setup

Before connecting the tow cable, make a general inspection of the towfish. Check that the retaining screws securing the towfish nose cone and tail section assemblies are tight. Check the tail fins and tow bracket assembly to be sure the retaining screws and bolts are secure. Also verify that the tail fins are straight and true.

3.4.1 Connecting the Tow Cable

WARNING *Before connecting the tow cable, verify that the power to the TPU is turned off. Also disconnect the TPU power cable from the power source. Failure to follow this practice may result in personal injury or damage to the towfish or the TPU electronics, or to both.*

SHOCK HAZARD *Do not connect or disconnect the tow cable from the towfish or the TPU when power is on. Failure to follow this practice may result in personal injury and will damage the towfish or the TPU electronics, or both.*

To connect the tow cable:

1. Remove the retaining ring from the beveled end of the tow pin and withdraw the pin from the tow bracket.
2. Align the tow shackle mounting hole with the upper mounting hole of the tow bracket, and then insert the beveled end of the tow pin through the holes in the tow cable shackle and the bracket and secure the pin with the retaining ring.
3. Remove the dummy plug from the connector on the towfish end of the tow cable and from the towfish jumper cable.

CAUTION *Always avoid putting excessive silicon grease on the Subcon male pins. Apply a light coat of grease, and never put grease into the female connectors.*

4. Apply a thin film of silicone grease to the pins of the male connector. Use a high quality, nonconducting grease such as Dow Corning DC-4.

CAUTION *When connecting or disconnecting the electrical connection, do not bend it back and forth. Use straight up action. Pull on the connector, not the cable.*

5. Align the male and female connectors and press the connectors together firmly. If necessary, use a *slight* side to side rocking motion while pressing on the connector, but do not bend the pins. When properly inserted there should be no gap between the surfaces of the two connectors.

6. Attach the shackle end of the safety cable to the bail grip loop on the tow cable near the tow cable shackle, and the clevis pin end to the safety cable tab on the top of the towfish near the tail. Refer to Figure 1-1 on page 1-3 for the location of the safety cable tab. The safety cable must be taut enough so that drag, or the likelihood of snagging, is not increased, but loose enough so that it does not interfere with the functioning of the tow shackle.

NOTE *The tow cable and not the safety cable must take up the strain of the tow load.*

7. If not already secured, use cable ties (7.5 x 0.185 in.), which are included in the towfish spares kit, to fasten the safety cable to the cable hold-down clips on the top of the towfish housing. Place a cable tie through the shackle pin hole and wrap around the shackle pin to prevent the shackle from loosening. Use electrical tape every 30 cm (12 in.) to secure the safety cable to the tow cable starting at the top of the tow shackle and up the bail grip loop. Move the tow shackle forward and backward to check for smooth operation.

3.4.2 Connecting the Tow Cable with the Optional K-Wing Depressor

The shackle on the tow cable connects mechanically to the towfish K-Wing depressor tow bracket using a tow pin. The depressor connects mechanically to the towfish. The waterproof connector on the towfish jumper cable connects to the waterproof connector on the tow cable. The towfish mechanical and electrical connection procedure is as follows:

1. Remove the retaining ring from the beveled end of the tow pin, withdraw the pin from the tow bracket and set it aside. Remove the two bolts and tow brackets from the welded-on six-hole towing flange. Take note of the location of the tow brackets for future reference.
2. Position the K-Wing depressor over the towing flange in the same location as where the tow brackets were previously connected. Secure the depressor to the towing flange with the fasteners provided.
3. Align the tow shackle mounting hole with the mounting hole of the K-Wing shackle on the tow depressor tow bracket. Insert the beveled end of the tow pin through the holes in the tow cable shackle and the bracket, and secure the tow pin with the retaining ring.
4. If the towfish was previously configured for towing without a depressor, it will be necessary to extend the free length of the towfish 100-inch jumper cable in order to reach the shackle connector. Do not extend more than is

needed to make the connection and to provide free rotation of the tow shackle. Remove the dummy plug from the connector on the end of the tow cable. Apply a thin film of silicone grease to the pins of the connector. Do not over grease. Align the male and female connectors, and press the connectors together firmly. If necessary, use a slight side-to-side rocking motion while pressing on the connector, but do not bend the pins. When properly inserted there should be no gap between the surfaces of the two connectors.

5. Attach the shackle end of the safety cable to the bail grip loop on the tow cable near the tow cable shackle, and the clevis pin end to the safety cable tab on the top of the towfish near the tail. Refer to Figure 1-1 on page 1-3 for the location of the safety cable tab. The safety cable must be taut enough so that drag, or the likelihood of snagging, is not increased, but loose enough so that it does not interfere with the functioning of the tow shackle.

NOTE *The tow cable and not the safety cable must take up the strain of the tow load.*

6. If not already secured, use cable ties (7.5 x 0.185 in.), which are included in the towfish spares kit, to fasten the safety cable to the cable hold-down clips on the top of the towfish housing. Place a cable tie through the shackle pin hole and wrap around the shackle pin to prevent the shackle from loosening. Use electrical tape every 30 cm (12 in.) to secure the safety cable to the tow cable starting at the top of the tow shackle and up the bail grip loop. Move the tow shackle forward and backward to check for smooth operation.

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 all the connectors be properly maintained. Connectors must be kept clean and must remain out of the way of traffic while on deck. Klein Marine Systems, Inc. supplies dummy connectors which can be used to protect the underwater connectors on the towfish and cable when they are not mated to each other.

WARNING *Before disconnecting the tow cable, verify that the 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 TPU electronics, or to both. For the location of the power switches, refer to "Topside System Controls and Indicators" on page 3-11.*

To disconnect the tow cable:

1. Verify that the TPU is switched off and that its power cord is disconnected.
2. Disconnect the safety cable from the bail grip loop. Remove the electrical tape securing the safety cable to the tow cable. Cable ties fastening the safety cable to the cable hold-down clips on the towfish housing may remain in place.
3. Separate the connectors by first loosening the locking sleeve. Then double check that the TPU is off and grasp the body of the connector and gently pull it out of the tow shackle connector. Do not pull on the wires to separate the connectors. Always hold the body of the connector. After separating the connectors, put a thin coating of silicone grease on the rubber section of the connector pins.
4. Remove the retaining ring from the tow pin and withdraw the pin. Disengage the tow cable shackle from the towfish or tow bracket. Replace the tow pin in the hole in the tow bracket, and secure it with the retaining ring.

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 TPU Connections

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

The TPU connectors are the following:

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

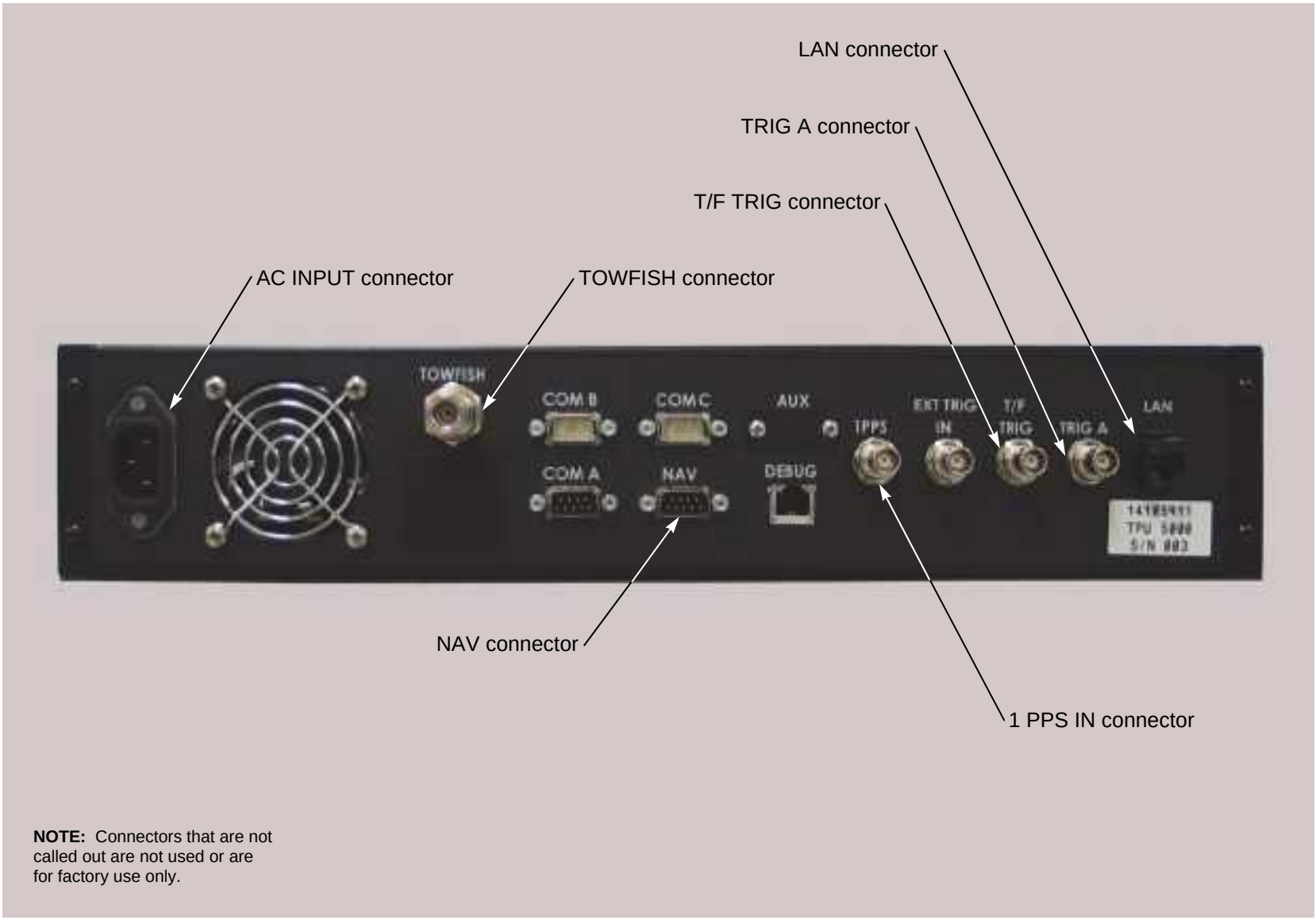
COM A: DB9 male RS-232 serial port connector that is for factory use only.

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

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.



NOTE: Connectors that are not called out are not used or are for factory use only.

Figure 3-1: *TPU Back Panel*

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, 100-µs wide output pulse.

TRIG A: BNC connector that connects to an ultra short baseline navigation system (USBL). Provides a TTL compatible, 100-µs wide output pulse with each trigger of the optional responder.

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

TOWFISH: Type N coaxial connector that connects to the towfish using a deck cable or a tow cable.

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

3.5.2 SonarPro Workstation Connections

All the connections to the SonarPro Workstation are made to connectors on the back panel which is shown in Figure 3-2.

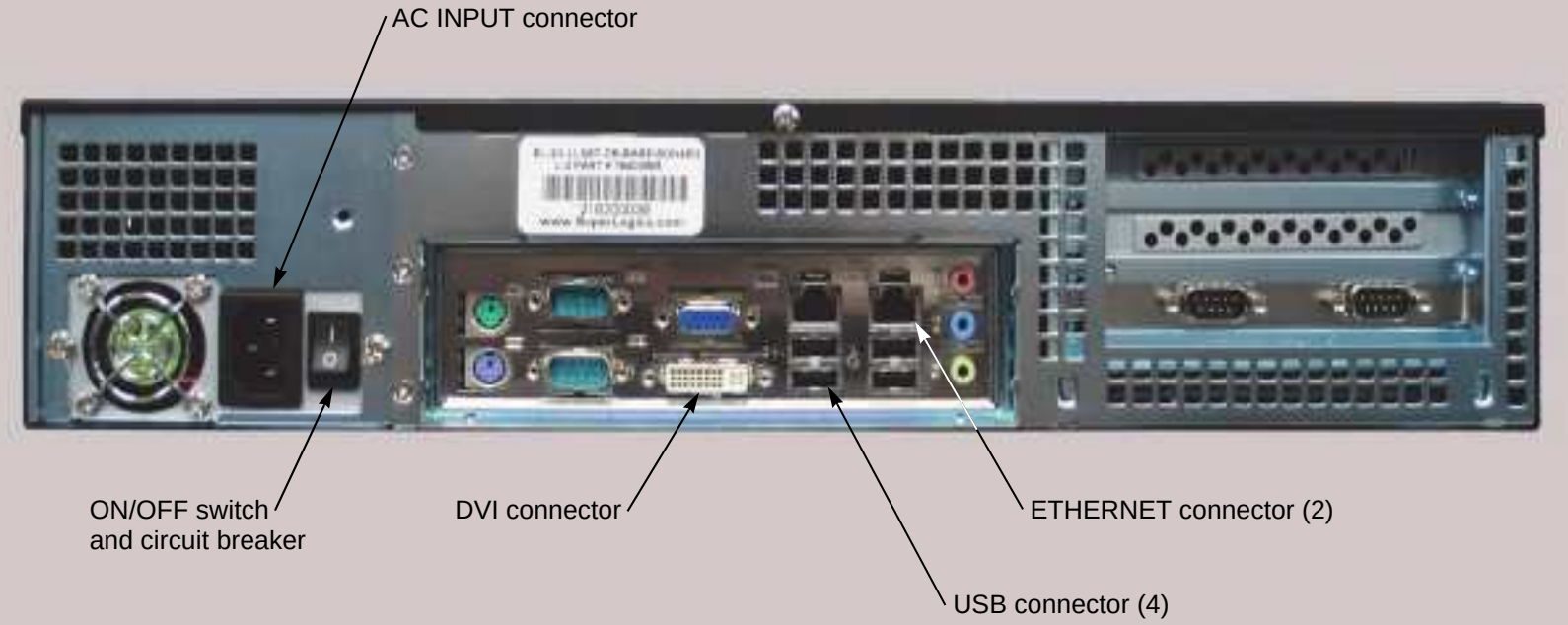
The SonarPro Workstation connectors are the following:

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 3-4 on page 3-14.

DVI: DVI connector that connects to the monitor.

ETHERNET: RJ-45 connectors (2). Any one connects to the LAN connector on the TPU.

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



NOTE: Connectors that are not called out are not used or are available for optional use.

Figure 3-2: *SonarPro Workstation Back Panel*

3.6 Connecting the Topside System Components

The following cables are required to connect the TPU and the SonarPro Workstation:

- Ethernet cable
- AC power cords (2)
- Deck cable or tow cable (deck cable is optionally supplied)

WARNING *Before connecting the topside system components, verify that the 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 TPU electronics, or to both. For the location of the power switches, refer to* *"Topside System Controls and Indicators" on page 3-17.*

To connect the TPU and the SonarPro Workstation:

1. Connect the Ethernet cable to the LAN connector on the 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 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.*

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6. Connect the optional deck cable or tow cable to the TOWFISH connector on the TPU.

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

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

The following connections are optional:

8. Connect the 1 PPS IN connector on the TPU to the 1 PPS source. A user supplied BNC-to-BNC cable is required.

9. Connect the T/F TRIG connector on the 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 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 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 TPU Controls and Indicators

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

The TPU controls and indicators are the following:

POWER switch: Rocker switch/circuit breaker that turns the 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 TPU is powered.

SYS READY: Green LED that will flash while the TPU and the towfish are powering up and then remain on when the TPU is ready to link with SonarPro on the SonarPro Workstation.

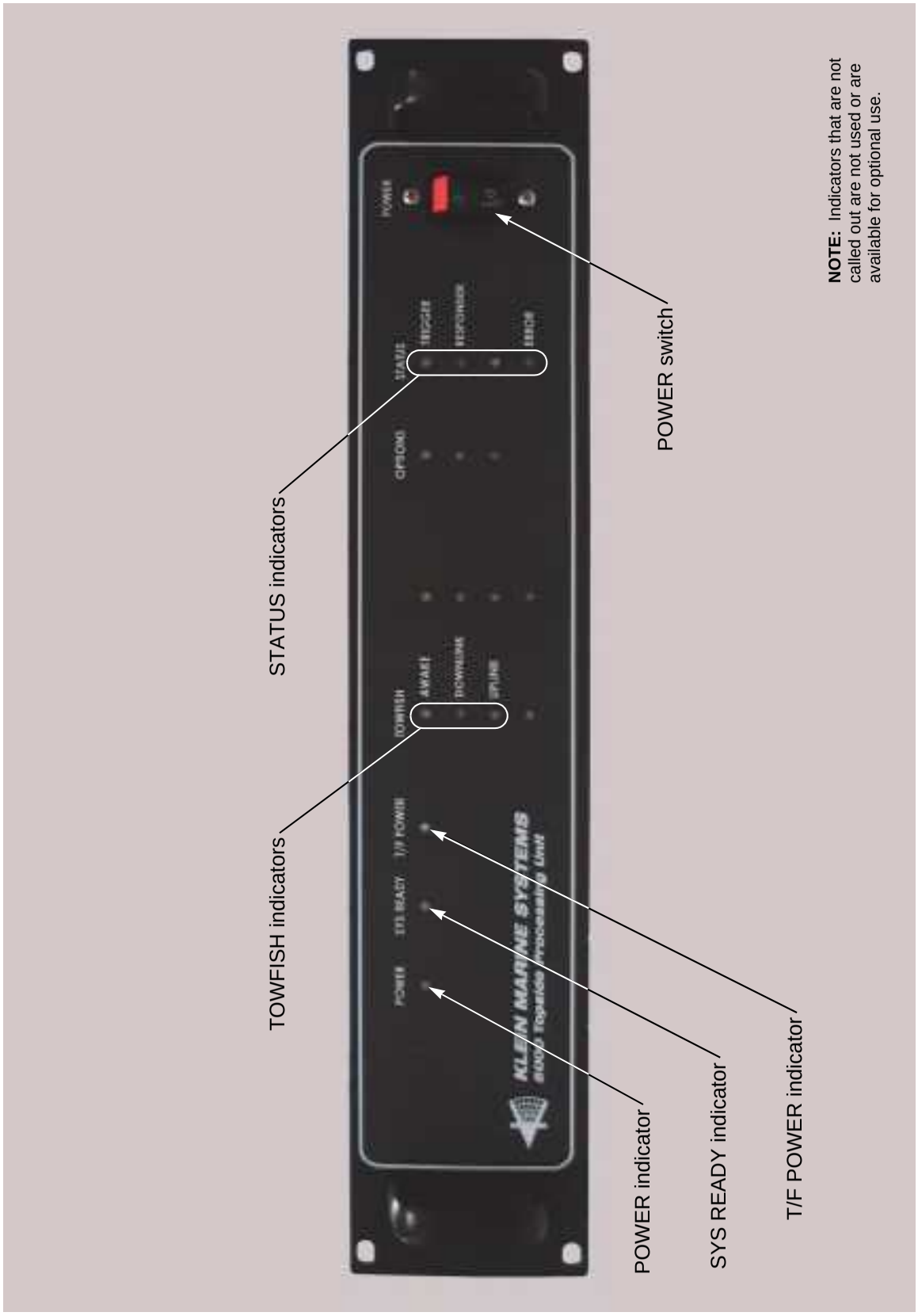


Figure 3-3: *TPU Front Panel*

T/F POWER: Blue LED that is on when power is being applied 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 TPU to the towfish.

TOWFISH UPLINK: Green LED that is on when data are being transfered from the towfish to the TPU.

STATUS TRIGGER: Yellow LED that flashes when the sonar on the towfish transmits.

STATUS RESPONDER: Yellow LED that flashes when a responder trigger is sent to the towfish.

STATUS ERROR: Red LED that flashes if system errors are detected.

3.7.2 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 3-4. 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 3-2 on page 3-9, 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.

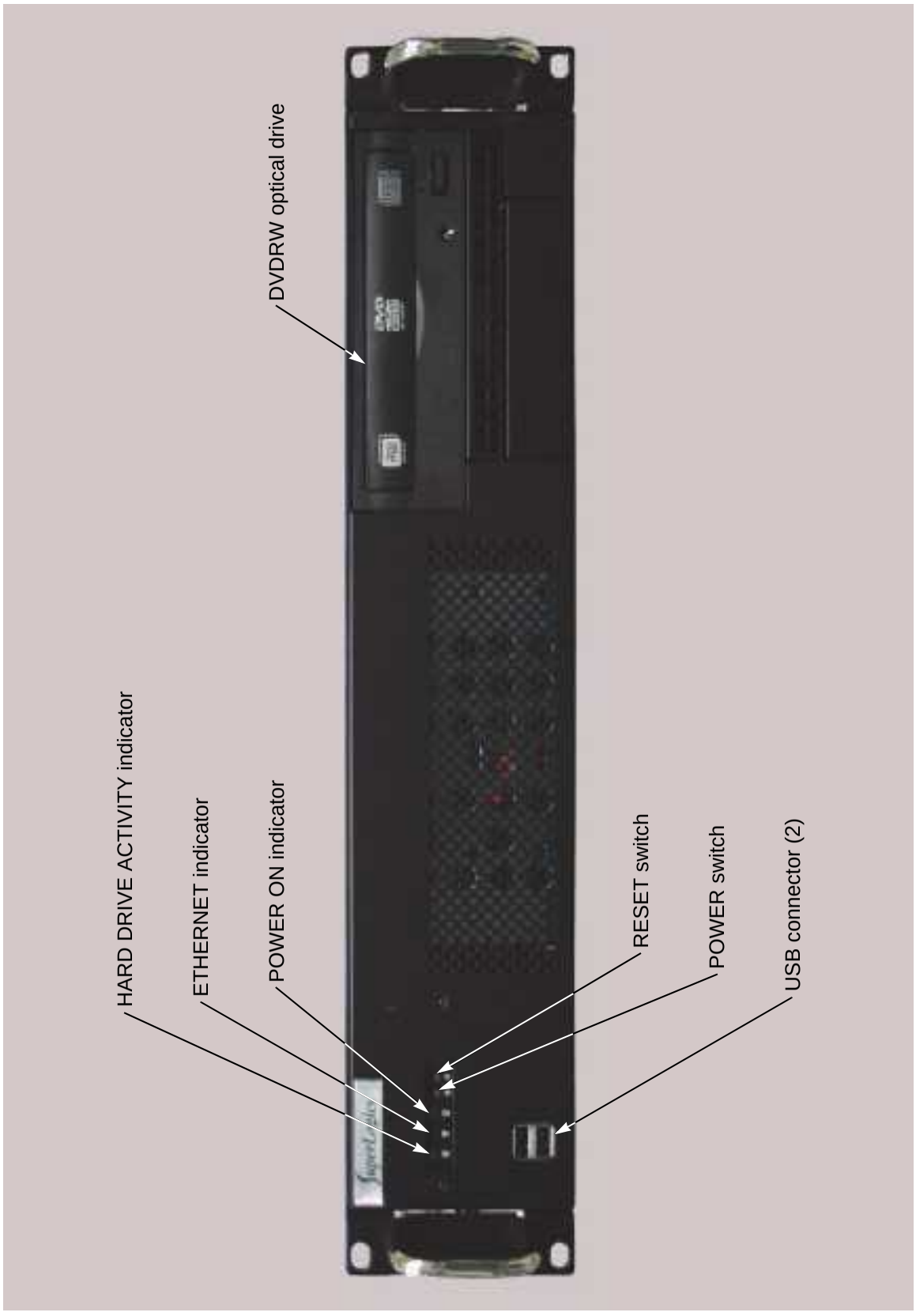


Figure 3-4: *SonarPro Workstation Front Panel*

3.8 System Activation and Test

The Series 5000 V2 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 TPU, refer to APPENDIX C: "Configuring and Updating the 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.
3. Verify that the tow cable is connected to the towfish and to the TPU or to the SP-III TPU.
4. Turn on the SonarPro Workstation or the laptop computer and wait for the Windows desktop to appear.
5. Turn on the TPU.

   After 10 seconds the POWER indicator should turn on and the SYS READY indicator should flash. After approximately 1 minute the SYS READY and AWAKE indicators should turn on, the DOWNLINK and TRIGGER indicators should flash, and the TF POWER should be on.

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.*

6. Start SonarPro and observe that the towfish is operational by viewing the waterfall sonar data in the Sonar Viewer window. Also check that sensor 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-meter range and 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 receivers are 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 SonarPro Workstation and the 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 towfish and to the TPU.
4. Turn on the SonarPro Workstation and wait for the Windows desktop to appear.
5. Turn on the TPU.

   After 10 seconds the POWER indicator should turn on and the SYS READY indicator should flash. After approximately 1 minute the SYS READY and AWAKE indicators should turn on, the DOWNLINK and TRIGGER indicators should flash, and the TF POWER should be on.

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.*

6. Start SonarPro and observe that the towfish is transmitting by viewing the output pulse in the Sonar Viewer window. Also check that sensor 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.
   - 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: MAINTENANCE AND TROUBLESHOOTING

This chapter provides instructions on how to perform maintenance and troubleshooting of the Series 5000 V2 Sonar System and includes guides for taking care of the equipment on a daily, weekly, and long term basis. In addition, instructions are provided on how to replace the fixed tail cone assembly and remove, install and test the towfish electronics.

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.*

4.1 General Maintenance Recommendations

Equipment used at sea is subjected to severe environmental and handling conditions. While the Series 5000 V2 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, SonarPro Workstation 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. 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 TPU and to 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 towing apparatus. 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 TPU and to 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 TPU and to the SonarPro Workstation.

2. Thoroughly clean the TPU, cables and towing equipment. Clean the top and outside surfaces of the 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 TPU cabinet.
3. Remove the screws securing the nose cone 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 SonarPro Workstation.

4.3 Replacing the Fixed Tail Cone Assembly

Figure 4-1: *Towfish Tail with Rear Center Pin in Place*

The following procedure describes how to install or replace the fixed tail cone assembly, P/N 14105284, used on the towfish. This assembly is installed on all new Series 5000 V2 towfish and can be retrofitted on older Series 5000 V2 towfish using the collision tolerant tail cone assembly.

The following tools and parts are required:

- 8-mm hex key with a shaft at least 6 in. (15 cm) long
- Medium flat bladed screwdriver
- Pliers
- Tail cone assembly (P/N 14105284)

Also refer to Drawing 15100952, Option Kit, .25" Tailfin, "T", System 5000 throughout the procedure.

To replace the fixed tail cone assembly:

1. Align rear center pin. This center pin is not part of the tail cone assembly and is used with both the older collision tolerant tail cone and the new fixed tail cone assembly.

2. With the large hole to the upper right, align the tail cone with the rear center pin and thread the rear tail cone bolt (7) into the rear center pin using the 8-mm hex key.

Figure 4-2: *Tail Cone being Aligned and Attached to Towfish*

3. Using the pliers, tighten the rear tail cone bolt (7). Do not overtighten.

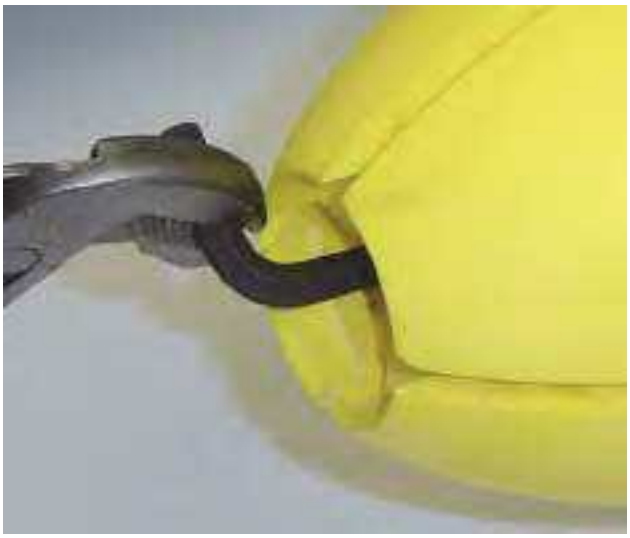


Figure 4-3: *Tail Cone Being Tightened with Hex Key*

4. Install the crossbar (4) into the large hole.

Figure 4-4: *Crossbar Used to Secure Tail Cone Parts*

5. Using the flat bladed screw driver, align the threaded hole in the crossbar (4) and screw the bolt (7) with the retaining cup (5) into the crossbar with the 8-mm hex key. Leave the retaining cup loose to accommodate the tail fins.

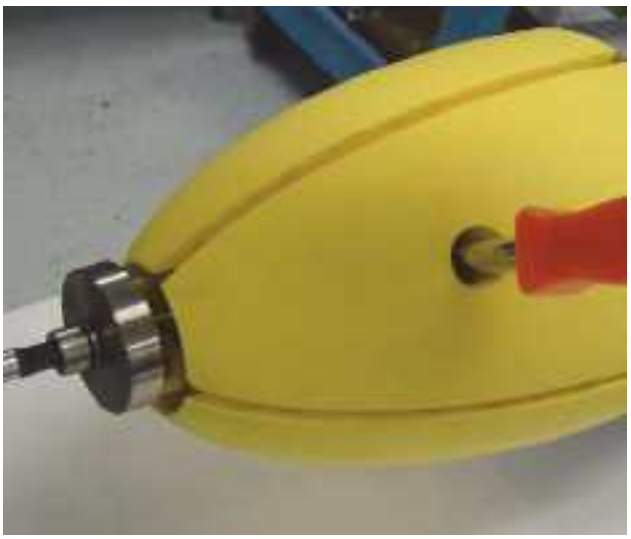


Figure 4-5: *Tail Cone Being Tightened With Screwdriver and Key*

6. Install the two horizontal tail fins (2) and the vertical tail fin (3) by inserting the forward slot into the towfish body. The rearward slot should be secured by the retaining cup.

Figure 4-6: *Tail Fins being Inserted into Tail Cone*

7. Tighten the retaining cup bolt (7) so that the tail fins are secured.

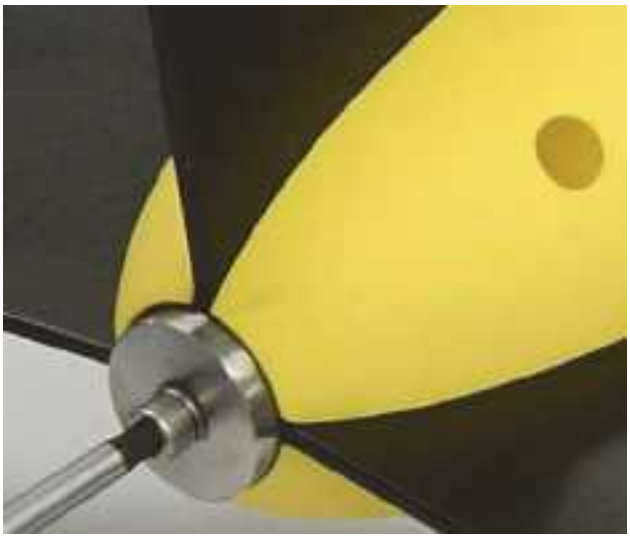


Figure 4-7: *Tail Fins being Secured to Tail Cone*

4.4 Removing the Fixed Tail Cone Assembly

Removal of the fixed tail cone assembly is the reverse of the installation procedure.

4.5 Removing the Towfish Electronics

To remove the towfish electronics:

1. Remove the towfish nose cone by unscrewing the socket head cap screw in the center with an 8-mm hex key or driver. Once you have the nose cone off you will find the push/pull assembly shown in Figure 4-8.

   This assembly is used to insert or remove the electronics from the pressure housing. Positioned one way the assembly screws into the end cap and extracts the electronics. When flipped over, the assembly pushes the electronics end cap into the pressure housing.

Figure 4-8: *Push/Pull Assembly*

2. Disconnect all the cables from the bulkhead connectors on the electronics housing end cap.
3. Position the post with the unthreaded hole to the top.
4. Study the jacking screw. You will notice the threads are off center. Locate the short, unthreaded side.
5. Insert the short end of the jacking screw, which is shown in Figure 4-9, through the post.
6. Thread the jacking screw into the electronics housing feed-thru.
7. Place the washer onto the jacking screw, thread the nut on and tighten the nut. This will extract the electronics housing.

Figure 4-9: *Jacking Screw*

4.6 Installing the Towfish Electronics

To install the towfish electronics:

1. Slide the electronics gently and carefully into the pressure bottle, aligning the alignment pin with the notch in the pressure housing.
2. Locate the bulkhead connectors on the electronics housing end cap. These connectors are shown in Figure 4-10.

Figure 4-10: *Electronics Housing End Cap Bulkhead Connectors*

CAUTION *Do not connect the altimeter cable to one of the transmit transducer bulkhead connectors (TX-STBD or TX-PORT). Doing so may damage the altimeter transducer when the side scan transmitters are operating. Connect the altimeter cable to the ALT bulkhead connector only.*

3. Reconnect the cables to the bulkhead connectors on the electronics housing end cap. The altimeter cable is marked with colored shrink tubing as shown in Figure 4-11. Connect this cable to the ALT connector only.

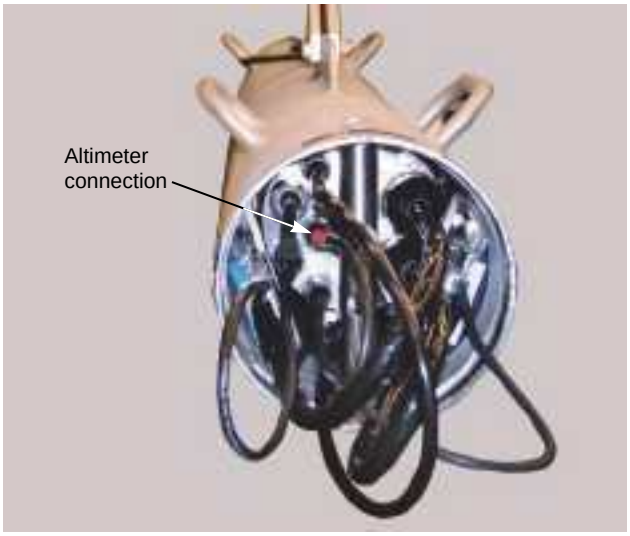


Figure 4-11: *Altimeter Cable Identified with Colored Shrink Tubing*

4. Position the post with the threaded hole to the top, and thread the jacking screw into the post with the long, unthreaded section entering the feed-thru.

CAUTION *When tightening the jacking screw as described below, do not over tighten.*

5. Tighten the jacking screw to push the electronics into the pressure housing. Stop when flush.
6. Thread the washer and nut onto the jacking screw and hand tighten.
7. Replace the nose cone.

4.7 Testing the Towfish Electronics

Remove the towfish electronics as described in “Removing the Towfish Electronics” on page 4-7 and place the electronics in a position so that you can reconnect the transducers. The towfish electronics is shown removed and ready for servicing in Figure 4-12.

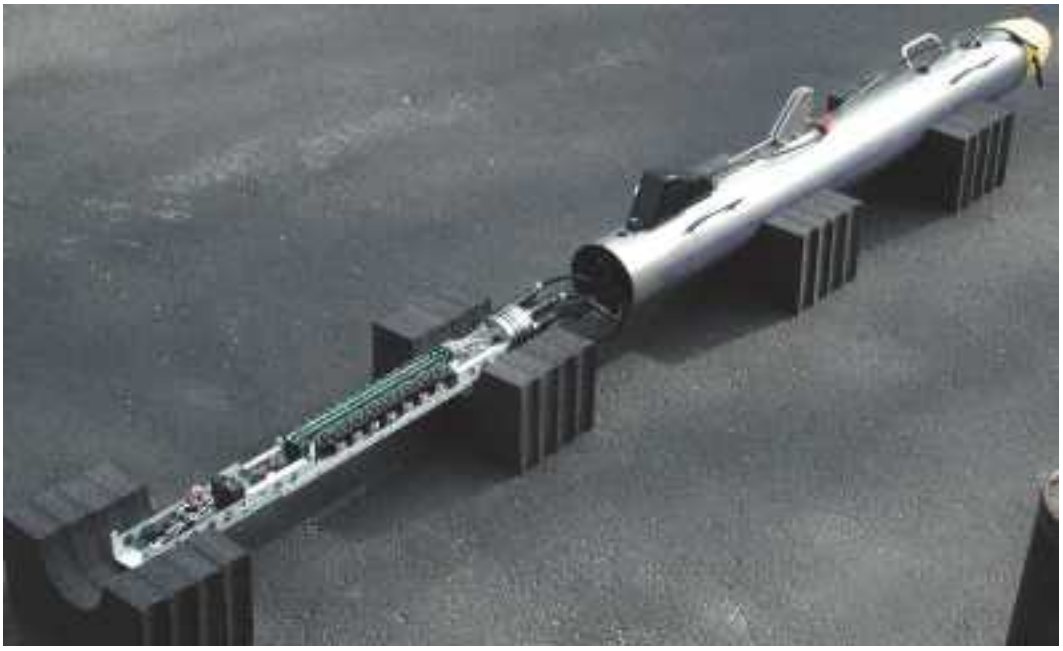


Figure 4-12: *Towfish Electronics Ready for Servicing*

4.7.1 Checking the Multiplexer Board

The Multiplexer board is shown Figure 5-2 on page 5-3. When checking voltages, unless otherwise noted, use TPGND1 as the ground reference. Reference designations are printed on the board.

To check the Multiplexer board, do the following:

- Verify that 200 VDC is present on JP8 and that orange LED D40 is illuminated.
- Verify that +5 VDC is present at L37 and that green LED D37 is illuminated.
- Verify that -5 VDC is present at L30 and that green LED D38 is illuminated.
- Verify that +3.3 VDC is present on the output side of L26 and that green LED D39 is illuminated.
- Verify that +28 VDC is present at TP25. Use TPGND8 as the ground reference.
- Verify that +2.5 VDC is present at TP9 and that green LED D9 is illuminated. The +2.5 VDC is generated from the +3.3 VDC.
- Verify that +1.2 VDC is present at TP10 and that green LED D11 is illuminated. The +1.2 VDC is generated from the +3.3 VDC.

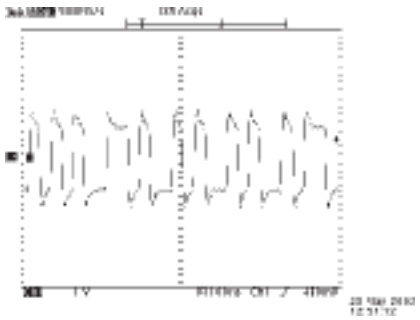
In addition, refer to Figure 4-14 for some applicable waveforms.

4.7.2 Checking the Transmitter Board

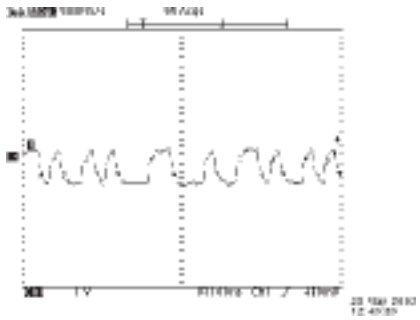
By probing on the Transmitter board you can check that the transmitters are working. Probe each transmitter output connector (J5-1, 2; J6-1, 2) to view the two transmitter outputs. These are floating differential output pairs, so the signal levels at pin 1 and 2 may be unequal. But all four pins should show transmitter outputs similar to that shown in Figure 4-14, and you should see a scope trace similar to the one shown in the figure. You can select different pulse lengths on the System 5000 Control tab of the *Sonar Interface* dialog box. Note that pulse lengths of 2 ms and greater are generated at a lower amplitude than shorter pulse lengths. The altimeter transmitter can be checked at J7-1.

4.7.3 Checking the Receiver Boards

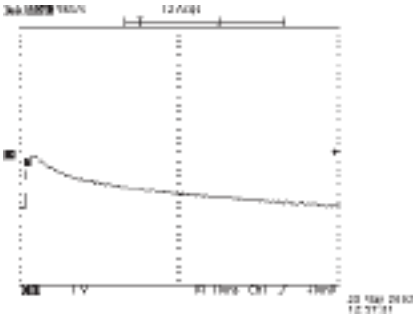
If your sonar image seems to be having problems on one side, this is an indication that you may have a receiver problem. Try swapping the receiver boards and see if the problem follows the board.



TP18 Telemetry



TP17



TP28 TVG curve

Figure 4-13: *Multiplexer Board Waveforms*

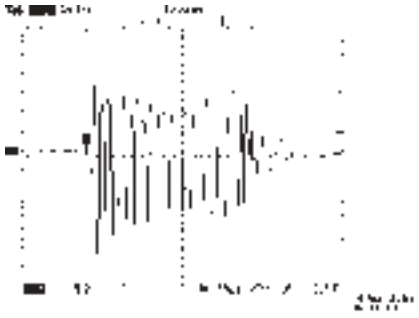


Figure 4-14: *Sample Transmit Waveform*

4.7.4 Checking the Sensors

Sensor readings can be read out directly in the Information window in SonarPro. Move the towfish in pitch, roll and heading and check to see if the readings change. If you have no sensor readings, check that the cable is properly plugged into the sensor interface board at JP5. Also check that the cable is properly connected at the compass board.

4.7.5 Calibrating the Optional Temperature Probe

The optional temperature probe adjustment is made on the Sensor Interface board. With the towfish open, turn the towfish on, and let the system boot up. Start SonarPro. With the towfish at ambient temperature, measure the ambient temperature with an accurate thermometer. Set the potentiometer on the Sensor Interface board, which is shown in Figure 4-15, to the current temperature. The temperature can be viewed in the Information window in SonarPro.

Figure 4-15: *The Sensor Interface Board*

4.7.6 Calibrating the Compass

The compass is calibrated using the Compass Calibration Wizard in SonarPro. To start the wizard, click **Run Compass Calibration Wizard** on the *Towfish Diagnostics* tab of the *Sonar Interface* dialog box. Follow the instructions and play the demonstration animation.

The compass calibration must be performed away from all magnetic and metal sources, most likely off the ship. You enable the towfish compass calibration mode and then rotate the towfish slowly 360 degrees in a circle (more than a minute). At the same time you must pitch and roll the towfish beyond its 20 degree limits, we suggest 45 degrees to be safe.

NOTE *Excellent calibration results have been obtained by enabling the compass calibration and towing the towfish in a series of three circles with the boat.*

NOTE *If trying the method mentioned in the note above, survey the area first making sure you have enough water to operate safely since the transmitters are turned off.*

The compass calibration can also be done by manually entering commands in the **Operator command** area of the *Towfish Diagnostics* tab. After entering a command, click **Send Command** to send the command to the towfish.

To calibrate the compass manually, enter the following commands in the order shown.

$TM0:	Turn off transducer transmitter.
$TA0:	Turn off altimeter transmitter.
$Ch:	Halt compass transmission.
$Cmpcal=d:	Disables compass multi-point calibration mode.
$Ccc:	Clears compass calibration table.
$Cmpcal=e:	Enables multi-point calibration.
$Cgo:	Starts compass for calibration. Rotate the towfish 360 degrees while rotating the towfish through the limits of pitch and roll. This should be done over a time frame of 1 minute.
$Ch:	Halt compass calibration.
$Cmpcal=d:	Disables compass multi-point calibration mode.
$Cgo:	Starts compass.
$TA1:	Turn on altimeter transmitter.
$TM3:	Turn on transducer transmitter.

Turn the towfish off and then on again and check that the compass is working.

CHAPTER 5: TECHNICAL DESCRIPTION

This chapter provides an overall technical description of the Series 5000 V2 Sonar System towfish and 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.

The Series 5000 V2 Sonar System departs from previous multibeam systems in that the swath forming process is implemented digitally using digital signal processing (DSP), rather than analog delay lines, phase shifters, or multipliers and adders. The primary advantage of this technique is a reduction in the size and weight of the towfish. This affords a accompanying reduction in the size of the required survey vessel and ancillary equipment, such as a winch and crane. Other advantages include more flexibility in the swath processing, allowing software control of operating parameters. Previously this would have required hardware changes.

5.1 Towfish

The towfish transmits and receives the sonar signals, processes them and outputs the processed sonar and sensor data to the TPU over the tow cable. The primary active components of the towfish are the sonar electronics and the two transducer arrays. Heading, pitch, roll, and pressure sensors are also included, and an optional responder and an altimeter can also be included.

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 on page 5-3.

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

	w/o bathymetry	w/bathymetry
• **Transmitter**	**14104530**	**14104530**
• **Receiver (2)**	**14104548**	**14104932-02**
• **Sensor Interface**	**14102038-01**	**14102038-01**
• **Multiplexer**	**14104941**	**14104941**
• **Power Supply**	**14104506**	**14104506**
• **Compass board**	**14104940**	**14104940**

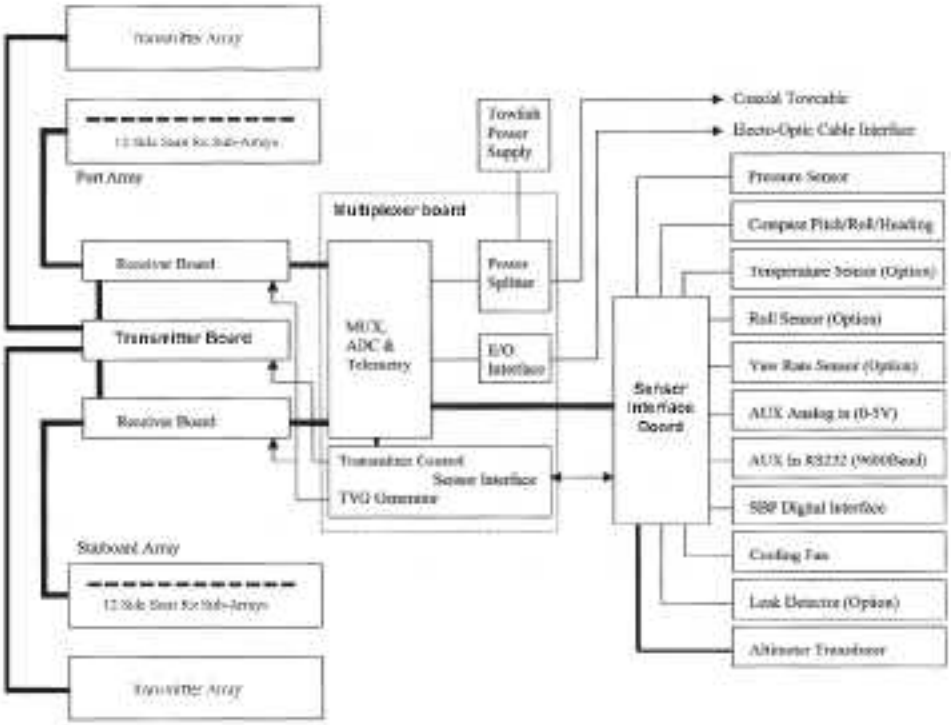


Figure 5-1: *Towfish Block Diagram—12 Sidescan Channels and 3 Bathymetery Channels*

Transmitter board. The Transmitter board produces a transmit pulse, at the start of a swath, that ensonifies the sea floor over a defined footprint. The Transmitter board is composed of two individual transmitting channels, one connected to the port array and the other connected to the starboard array. The transmitters operate at a center frequency of 455 kHz and support both CW and chirp waveform transmission. The Transmitter board also contains transmit and receive circuitry for the optional altimeter.

Receiver boards. The Receiver boards process the backscatter information by applying fixed gain, time varied gain (TVG) and frequency filtering to the input voltage signals received from the individual sub-arrays in the transducer arrays. There are two Receiver boards, one for the port array and one for the starboard array.

Each of the receiver channels is bandpass filtered with tightly matched filters providing a -3dB bandwidth of 20 kHz, centered at 455 kHz. The filtered signal is then output to the Multiplexer board for subsequent sampling.

Sensor Interface board. The Sensor Interface board conditions sensor data from the compass board, depth pressure sensor, altimeter, and optional devices for subsequent multiplexing and transmission to the TPU.

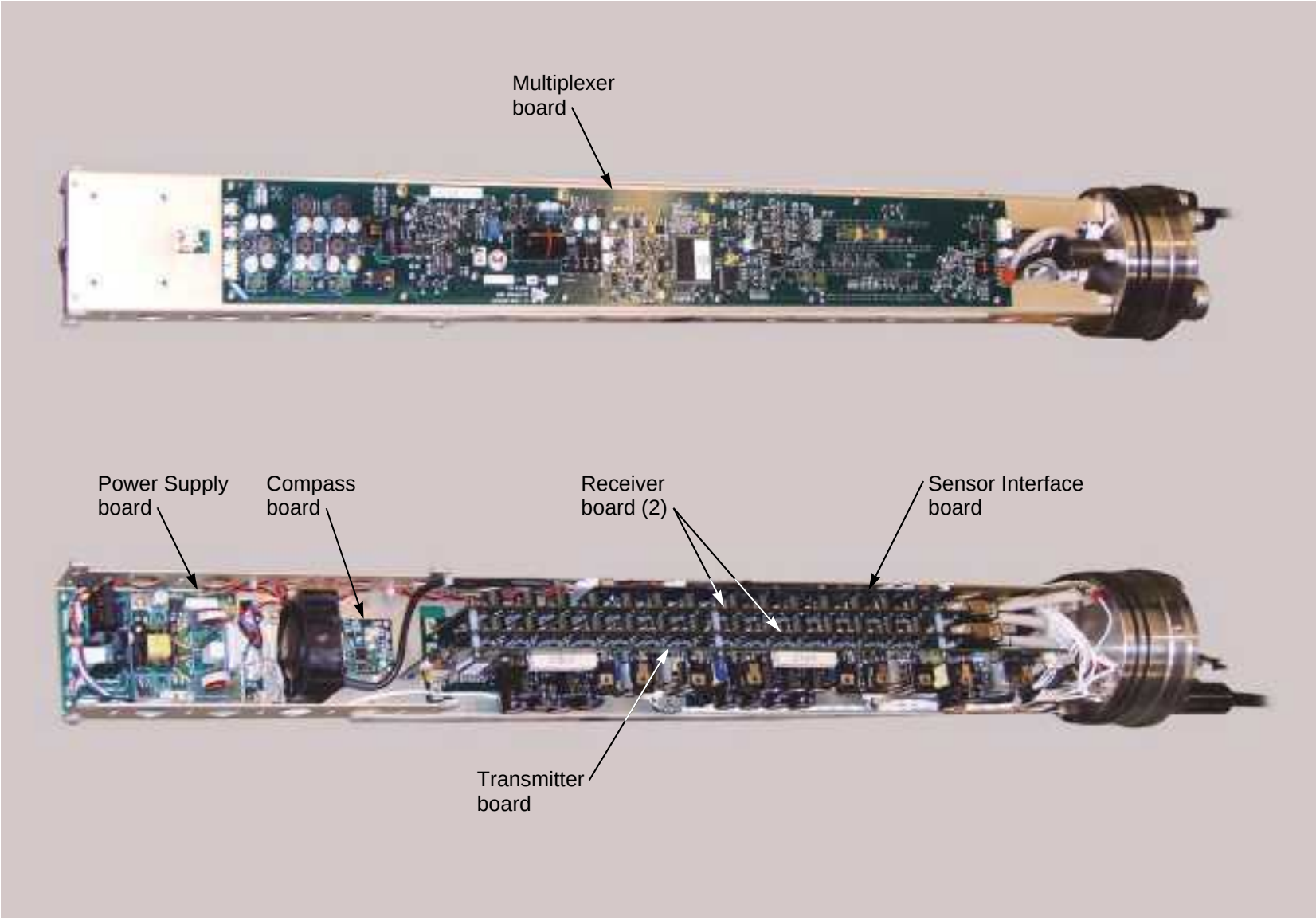


Figure 5-2: *The Series 5000 V2 Sonar System TPU Electronics Chassis*

Multiplexer board. The Multiplexer board digitizes the signals from each of the transducer sub-array channels along with the signals from the sensors, encodes the data, and transmits a high baud rate digital data stream to the TPU by way of the tow cable. The Multiplexer board also receives the trigger signal and command messages which instruct the Transmitter board to fire the arrays and configure aspects of towfish operation. The Multiplexer board also acts as a motherboard for the other boards providing the connections and distributing power.

In addition, the Multiplexer board performs the following functions:

- Receives the 200 VDC and telemetry from the TPU and separates out the telemetry from the 200 VDC.
- Routes the 200 VDC to the power supply, and then receives the converted ±12 VDC.
- Routes the 200 VDC to the Transmitter boards.
- Generates ±5 VDC, +3.3 VDC, and +28 VDC.
- Generates the time varied gain (TVG) curves for the received sonar signals from the transducers.
- Multiplexes all the data channels and transmits the telemetry to the TPU.
- Provides cable uplink and downlink interface.

A full duplex hybrid allows data transmission up the cable while simultaneously receiving the FSK trigger signals and power. The downlink signals are input to FSK demodulators, and the baseband outputs are routed to the Transmitter board, indicating when to fire the main array, and to a micro controller that handles towfish configuration.

Compass board. The compass board provides heading, pitch and roll.

5.1.2 Transducer Arrays

The two transducer arrays are each composed of 12 piezoelectric ceramic sub-arrays that operate as both transmit and receive elements. Each set of 12 sub-arrays is arranged into a continuous line array spanning an overall aperture of 1.2 meters. When the bathymetry option is present, 3 additional receive arrays are included that feed the additional channels of the receiver boards.

5.2 TPU

A block diagram depicting the functional relationships of all of the printed circuit boards in the TPU electronics is shown in Figure 5-3. These boards are located in the TPU electronics chassis as shown in Figure 5-4. The printed circuit boards, along with their corresponding part numbers, are the following:

- **Demultiplexer board** **14105785**
- **CPU board** **14105873**
- **High Voltage Power Supply board** **11700098**
- **200V Power Filter board** **14104980**
- **Topside Telemetry board** **14105841**
- **12V Power Filter board** **14105397**
- **12V Power Supply board** **11700092**
- **LED board** **14105464**

Assembled into a single rack mountable 3U enclosure, the 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 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 SonarPro Workstation 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.

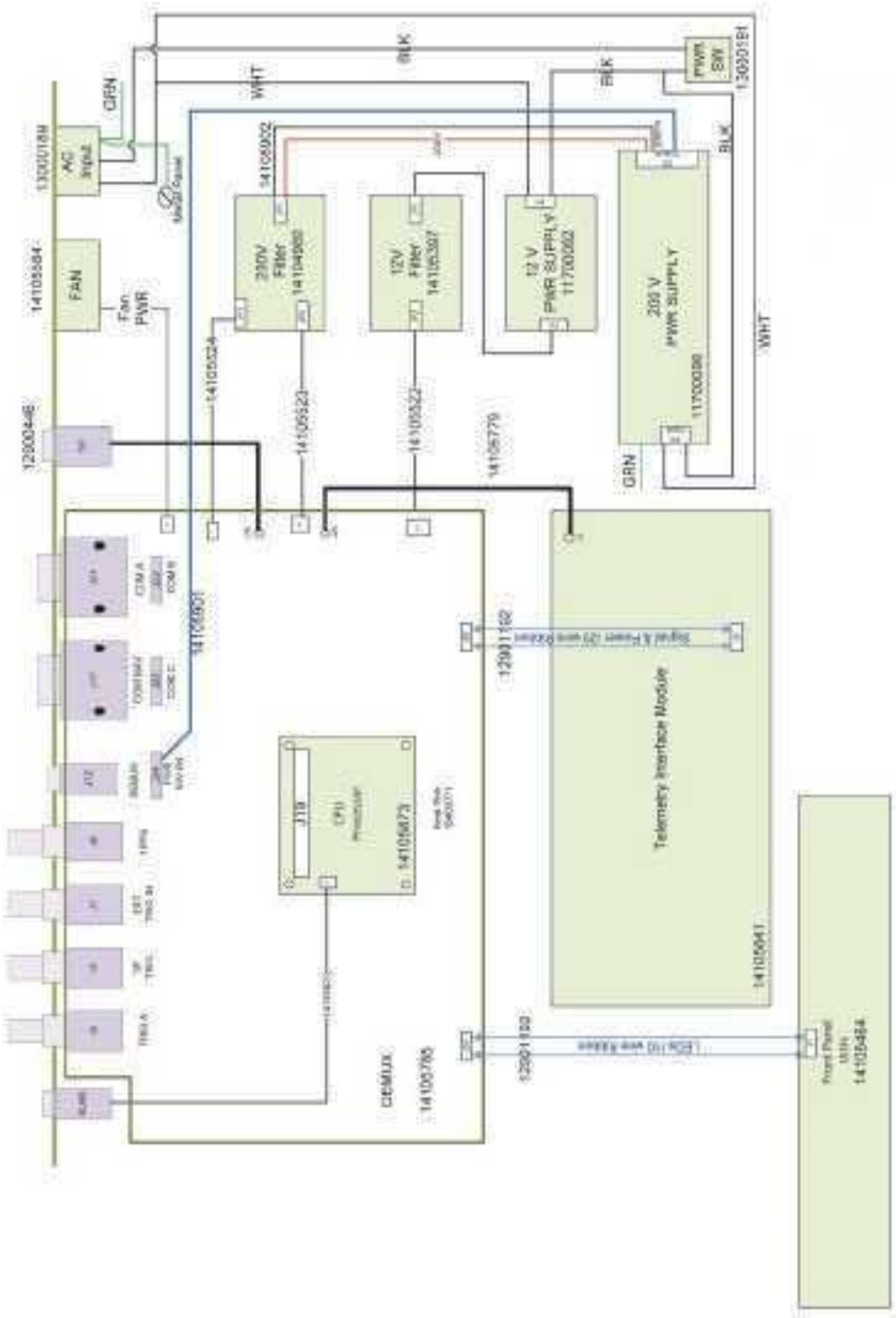


Figure 5-3: *The Series 5000 V2 Sonar System TPU Electronics Block Diagram*

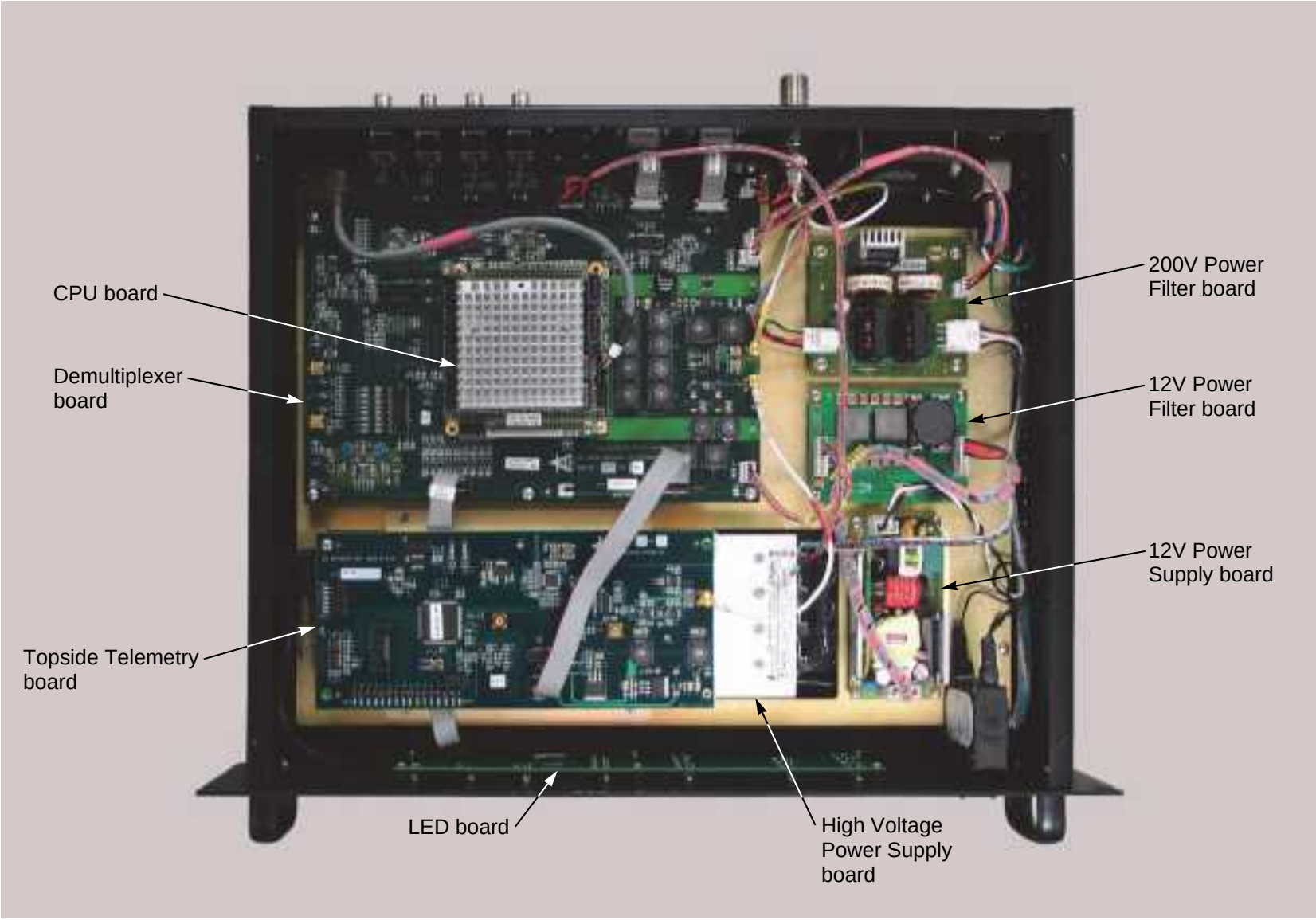


Figure 5-4: *The Series 5000 V2 Sonar System TPU Electronics Chassis*

Topside Telemetry board. The Topside Telemetry board provides the cable interface for the 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 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: SAMPLE TOWING CHARACTERISTICS

Five towing characteristic graphs are included in this appendix as Figure A-1 through Figure A-5. Two of the graphs were generated without any additional weight being added to the towfish, and the other two graphs were made with our K-Wing II Depressor attached to the towfish. We believe you will find these graphs helpful in planning your surveys and equipment requirements.

As with any projections of this type, certain conditions and assumptions were made in order to generate a reasonable quantity of data with some degree of accuracy. Read all the conditions below before you attempt to use the data.

Data. Data were computer generated using programs of known prediction accuracy in both military and commercial towing systems. At best this type of data provides "ballpark" values versus absolute values. These curves have been checked with field data wherever possible. At best the values are within 15% accurate with the greatest accuracy at towfish depths between 91 m (300 ft) and 914 m (3000 ft) and at tow speeds of 3 to 7 knots. They are least accurate at slow speeds and short cable lengths.

NOTE *Depressors have minimal effect at speeds of 2 knots or less. Boat motion plays a large role in shallow towing. For very deep towing, ocean currents can completely change the cable characteristics.*

Tow Cables. Tow cables having the characteristics below were used. Should you have a different cable, it could make a significant difference.

- 10.2 mm (0.40 in.) nominal diameter double armored, galvanized steel; weighing 353 kg per 1000 m (237 lb per 1000 ft) in air; 353 kN (11,000 lb) breaking strength.
- 17.3 mm (0.68 in.) nominal diameter double armored, galvanized steel; weighing 1030 kg per 1000 m (692 lb per 1000 ft) in air; 178 kN (40,000 lb) breaking strength.

Cable drag increases with increasing cable diameter. The drag increases as the velocity squared (V^2). As cable weight per unit length increases, the cable tows deeper.

Towfish. The Klein Model 5250 stainless steel towfish was used in all cases. It weighs 48 kg (105 lb) in water, is 16.8 cm (6.6 in.) in diameter and has a length of 203 cm (79.9 in.). Smaller or larger towfish will only make a difference when being towed on a cable of less than 60 m (200 ft) length at speeds slower than 2 knots.

Depressor. The Klein K-Wing II, Model 402A-002 was used to create the depressive forces in the calculations shown on three of the graphs. The K-Wing mounts directly to the towfish end.

Interpreting the Graphs. Pick the graph closest to your operating conditions. With a given speed and cable length, you can determine effective tow depth. You can also determine the cable length required to reach a specific depth at a given speed.

NOTE *The graphs were calculated with the equipment and conditions noted. The data can be used for different equipment and conditions by extrapolating the data from the graphs.*

More details on towing characteristics, such as tension, layback, etc., are available at Klein Marine Systems, Inc. We would be glad to help you meet your requirements. Your experiences in towing our side scan sonar under various conditions would be helpful in upgrading our data, and we respectfully solicit your comments.

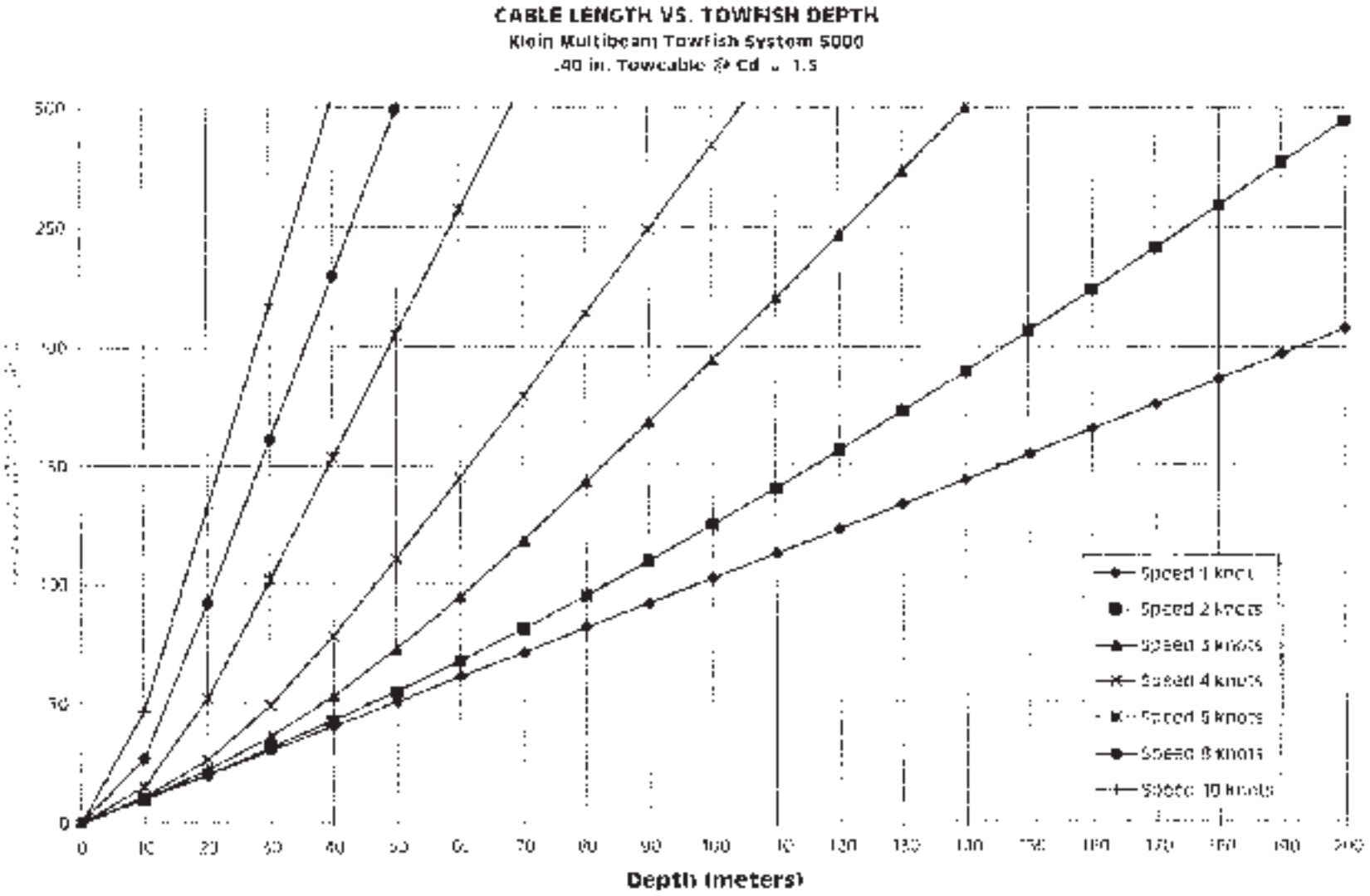


Figure A-1: *Cable Length vs. Towfish Depth Graph 1*

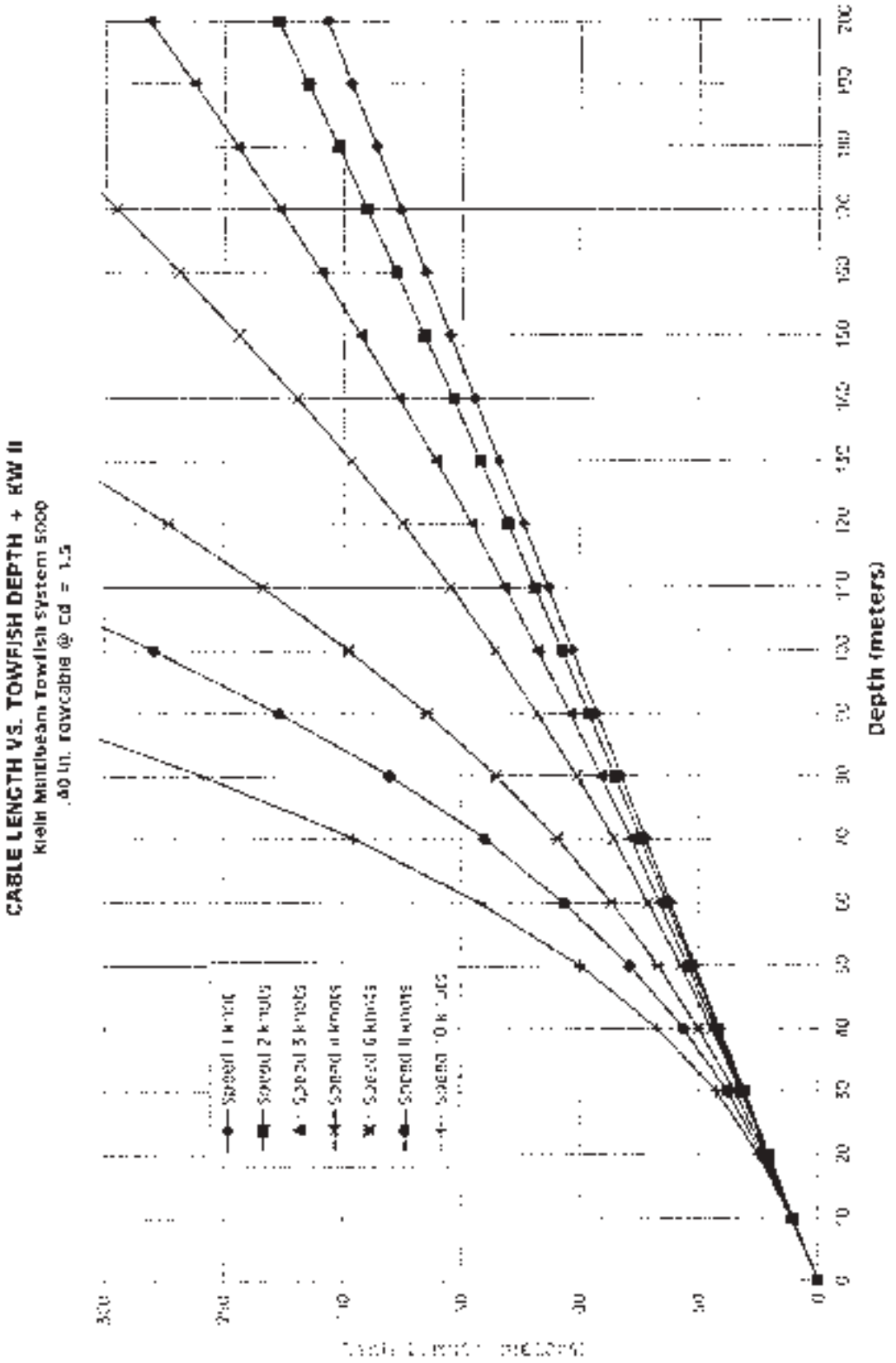


Figure A-2: *Cable Length vs. Towfish Depth Graph 2*

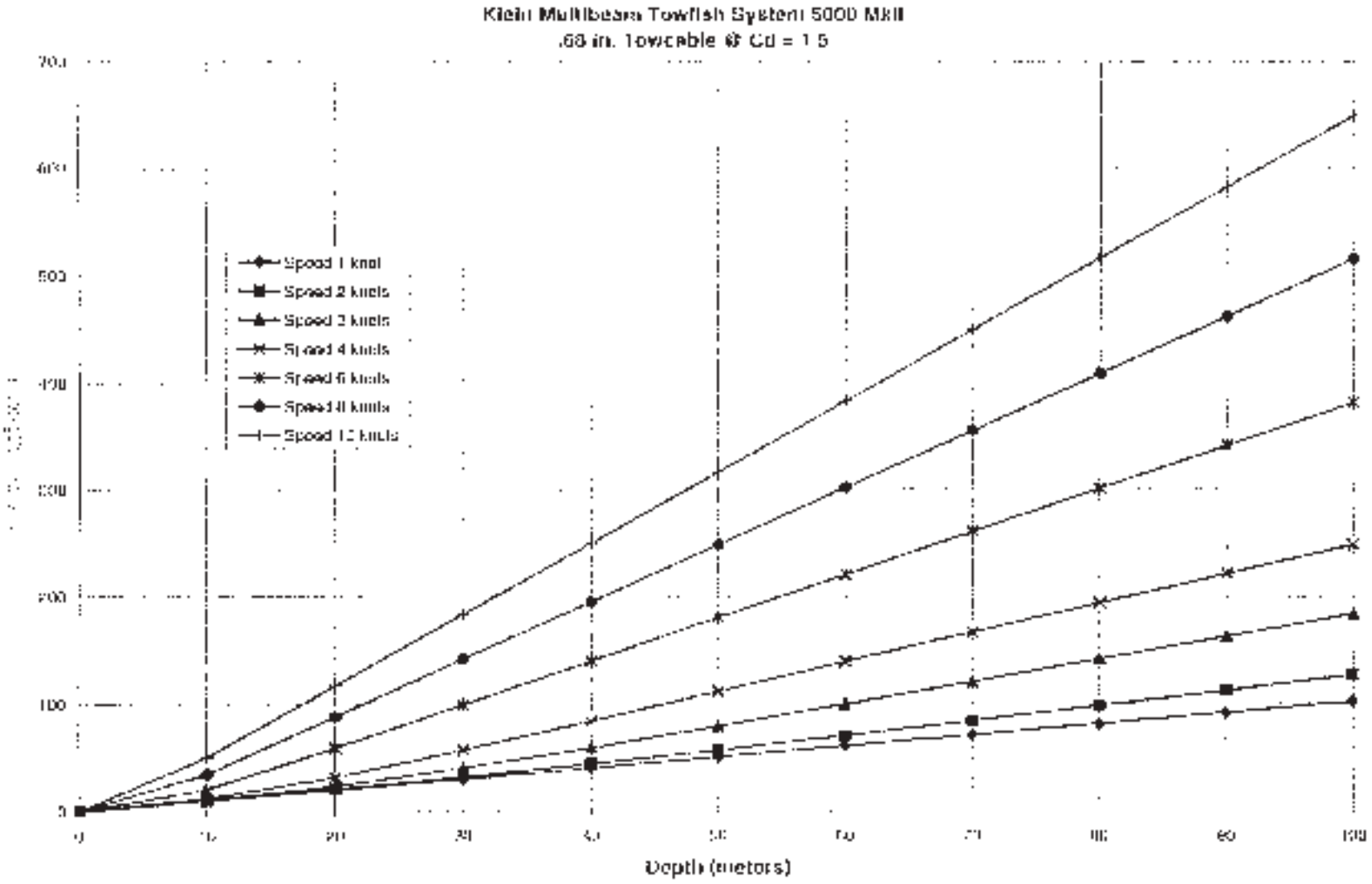


Figure A-3: *Cable Length vs. Towfish Depth Graph 3*

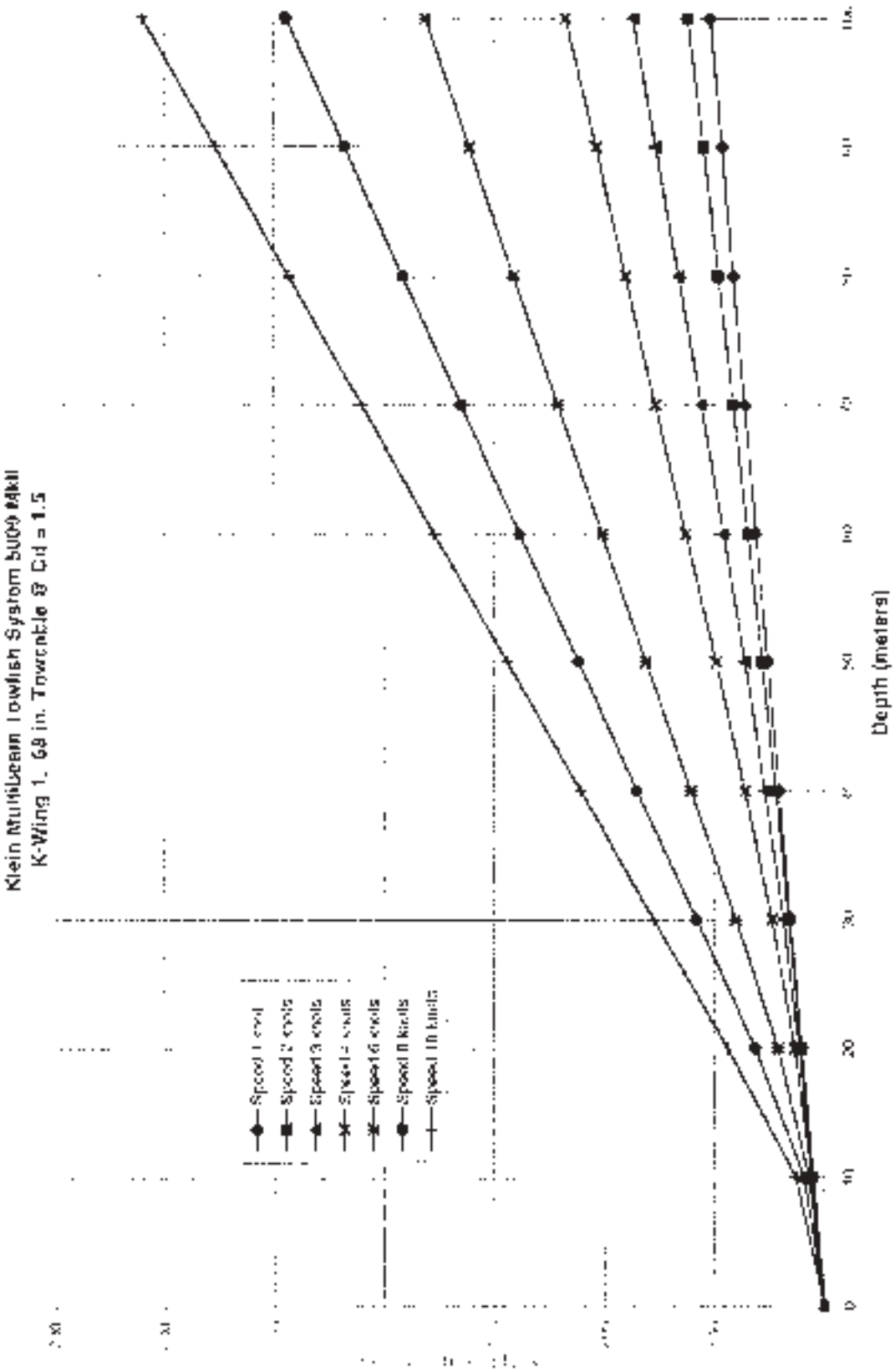


Figure A-4: *Cable Length vs. Towfish Depth Graph 4*

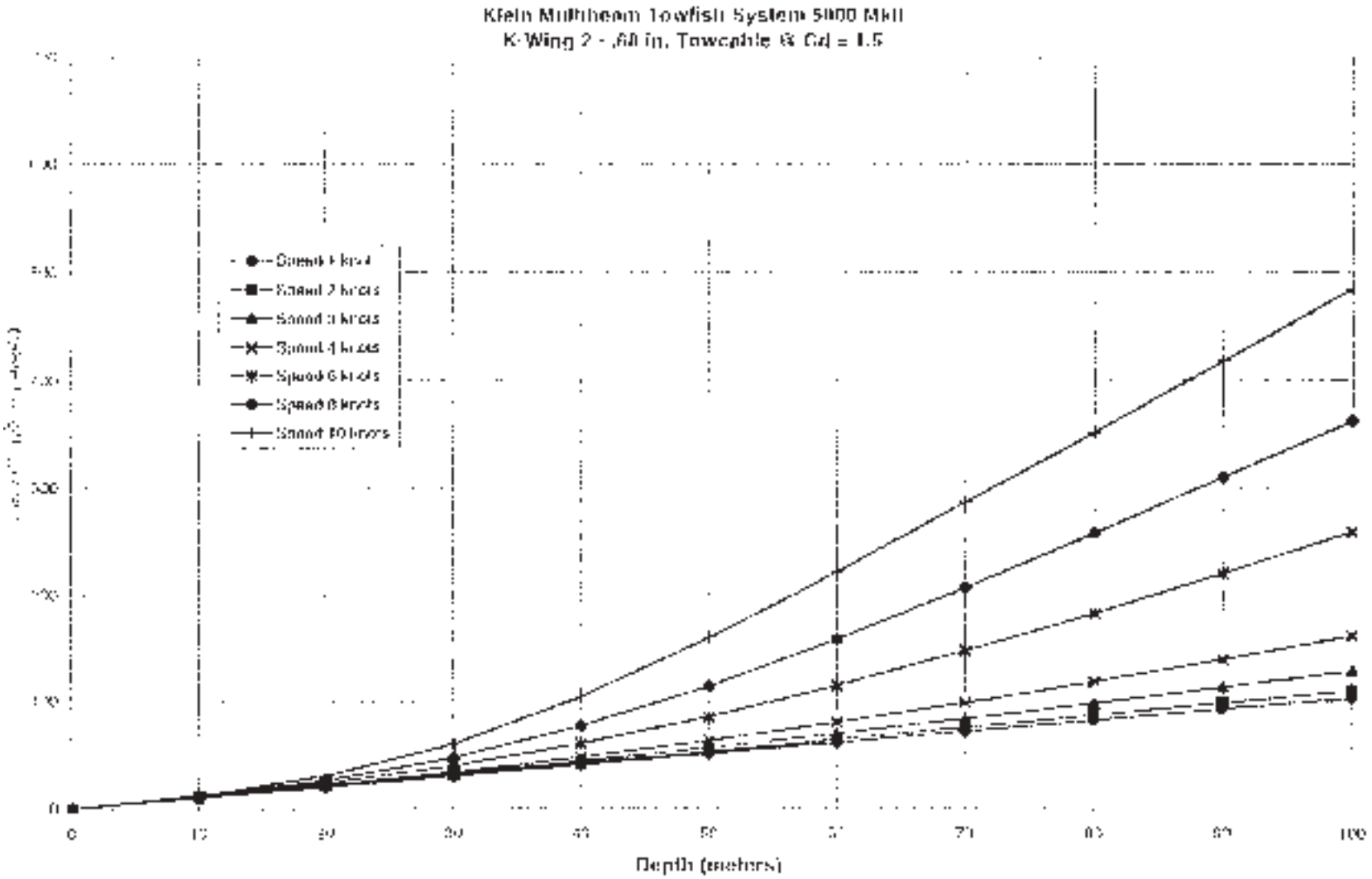


Figure A-5: *Cable Length vs. Towfish Depth Graph 5*

APPENDIX B: 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.

B.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 B-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.

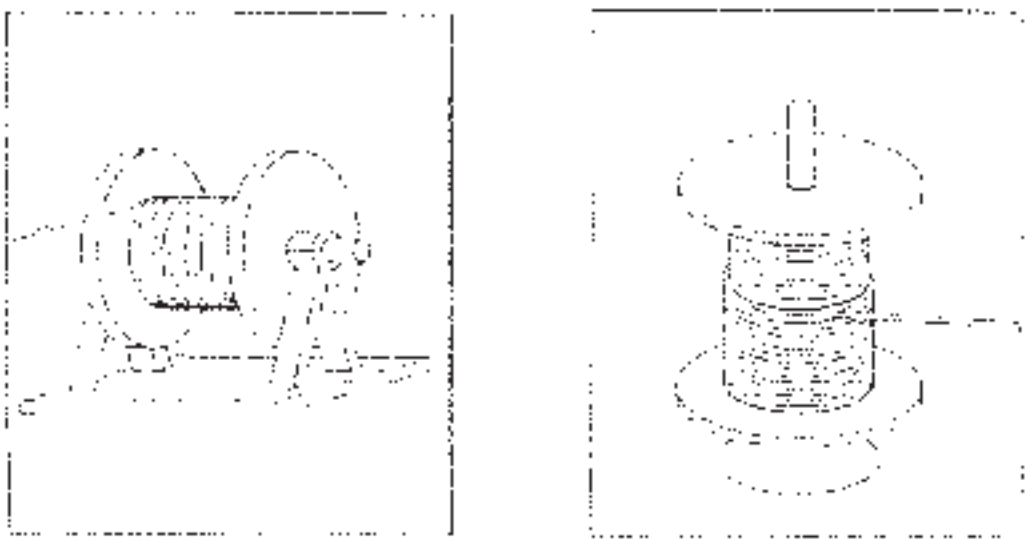


Figure B-1: *Correct Methods to Unreel Tow Cable*

B.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.*

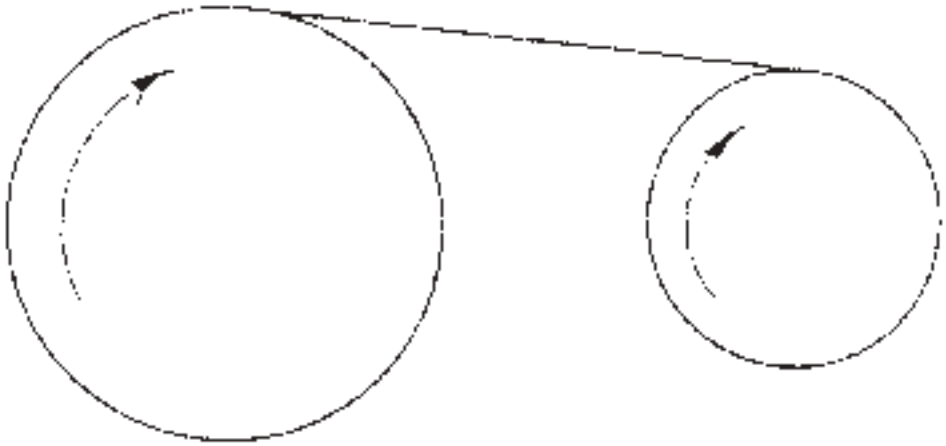


Figure B-2: *Spooling Real to Drum*

B.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.

B.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 B-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 B-3: *Cable Loop and Kink*

B.3.2 Effect of Cable Kinking

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

Figure B-4: *Damaged Cable*

B.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 C: CONFIGURING AND UPDATING THE TPU

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

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

C.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 C-1.

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

C.2 Querying or Changing the TPU IP Address

The TPU IP address is set up at the factory. The factory set default IP address is 192.168.0.81. However, should a different address be required, it can be changed.

To change the TPU IP address:

1. Connect the supplied null modem cable to the NAV connector of the TPU and to an available serial port on the SonarPro Workstation.
2. Turn on the SonarPro Workstation and wait for the Windows desktop to appear.
3. Turn on the TPU.
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 C-2 opens.

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

6. From the **Port** drop-down list box, select the serial port on the SonarPro Workstation to which the TPU is connected.
7. From the **Rate** drop-down list box, select the baud rate of the 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 C-3.

Figure C-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:

C.3 Editing the TPU Startup File

The startup file for the TPU is startupCdi3000.ini.

To edit the TPU startup file:

1. Connect the supplied Ethernet cable to the LAN connector of the TPU and to the ETHERNET connector of the SonarPro Workstation.
2. Turn on the SonarPro Workstation and wait for the Windows desktop to appear.
3. Turn on the TPU.
4. Start Linux TPU Updater.

   The *Klein Linux TPU Updater* dialog box opens.

5. Enter the 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 TPU IP Address” on page C-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 TPU software restarts and a window opens confirming the file update:

8. To ensure a clean start with the new update, in about 20 seconds, turn the TPU off and then on again.

C.4 Updating the TPU Software

Updates to the TPU software are supplied as compressed archive files and must reside on the SonarPro Workstation or the laptop computer.

To update the TPU software:

1. Connect the supplied Ethernet cable to the LAN connector of the TPU and to the ETHERNET connector of the SonarPro Workstation.
2. Turn on the SonarPro Workstation and wait for the Windows desktop to appear.
3. Turn on the TPU.
4. Start Linux TPU Updater.

   The *Klein Linux TPU Updater* dialog box opens.

5. Enter the 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 TPU IP Address” on page C-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 TPU and installed, and the TPU software restarts. In about two minutes, a window opens confirming the software update:

APPENDIX D: DIFFERENT TOW CABLE LENGTHS AND THE STARTUP.INI FILE

The Series 5000 V2 Sonar System operates at high data rates. For optimum performance, settings have been provided to tune the system's uplink for various cable lengths up to -24 dB of insertion loss. The adjustment settings are made in the Startup.ini file using the following two lines:

set PREEMPHISIS x

set LBOGAIN x

This file may be opened in any text editor such as Wordpad. After editing, save the file.

The adjustment parameters are as follows:

set PREEMPHISIS x	x = (0-7)	SonarPro Command $ML x
set LBOGAIN x	x = (0-3)	SonarPro Command $MG x

We recommend the following:

For a 15-meter cable,

set PREEMPHISIS 1

set LBOGAIN 0

For a 150-meter cable,

set PREEMPHISIS 3

set LBOGAIN 1

For cables around 600 meters,

set PREEMPHISIS 7

set LBOGAIN 2

For cables that are longer, experimentation with the above settings should be done. To do this, watch the yellow ERROR indicator on the TPU front panel. Vary the uplink parameters until error-free operation is achieved. We recommend running SonarPro and using the *Towfish Diagnostics* tab of the *Sonar Interface* dialog box.

For example, when testing a 1000-meter cable, from SonarPro the following command set yielded error-free operation: $MG2 and $ML7. Therefore the Startup.ini file would be adjusted to contain the following:

set PREEMPHISIS 7

set LBOGAIN 2

D.1 Measuring Cable Insertion Loss

To get an accurate assessment of your tow cable assembly, we suggest that you use a Hewlett Packard 4194A Impedance/Gain-Phase Analyzer or similar.

A sample plot is shown in Figure D-1.

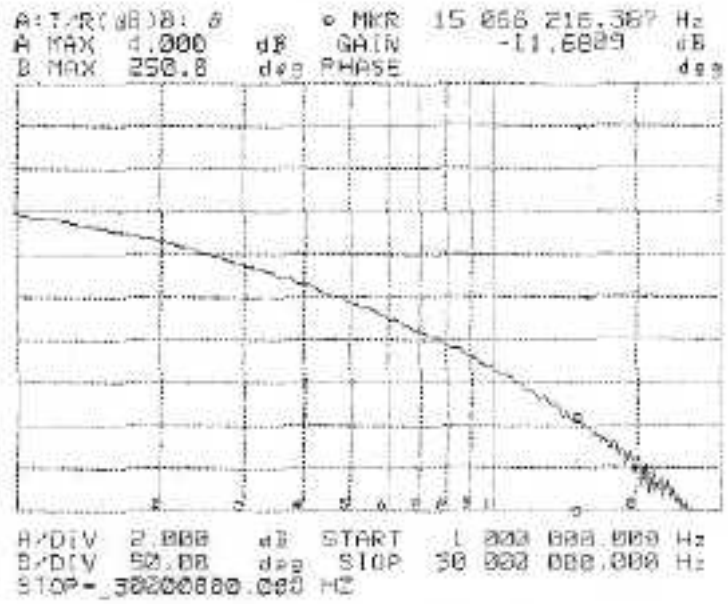


Figure D-1: *Sample Plot of Tow Cable Characteristics*

If you do not have access to a Hewlett Packard 4194A Impedance/Gain-Phase Analyzer, you can get a close reading by using a function generator, a 50-ohm terminator and an oscilloscope as shown in Figure D-2.

With the function generator and the oscilloscope connected to the cable, monitor input on the oscilloscope and input a 1 volt peak (2 volt peak-to-peak) sine wave of the specific frequency of interest. Measure the peak output at the other end of the cable on the scope through the 50-ohm termination.

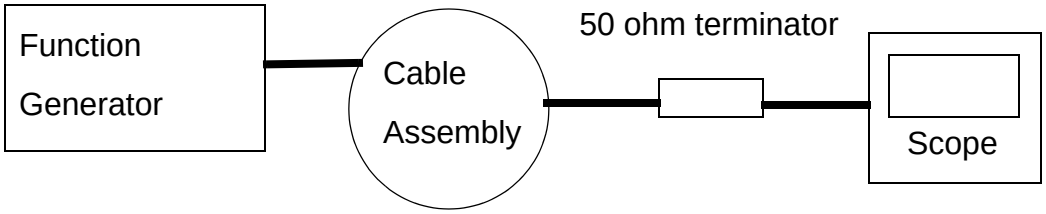


Figure D-2: *Setup for Measuring Tow Cable Characteristics using a Function Generator, Terminator and Oscilloscope*

Use the formula

dB = 20 log (Vout /Vin)

For example, if at 15 MHz, you get a reading of 160 mv, then

dB = 20 log (0.16/1.0) = 15.9 dB loss.

NOTE *The whole cable assembly must not exceed an attenuation of greater than 24 dB of insertion loss at 15 MHz. We suggest a working loss of 24 dB at 15 MHz.*

D.2 Spare Tow Cable

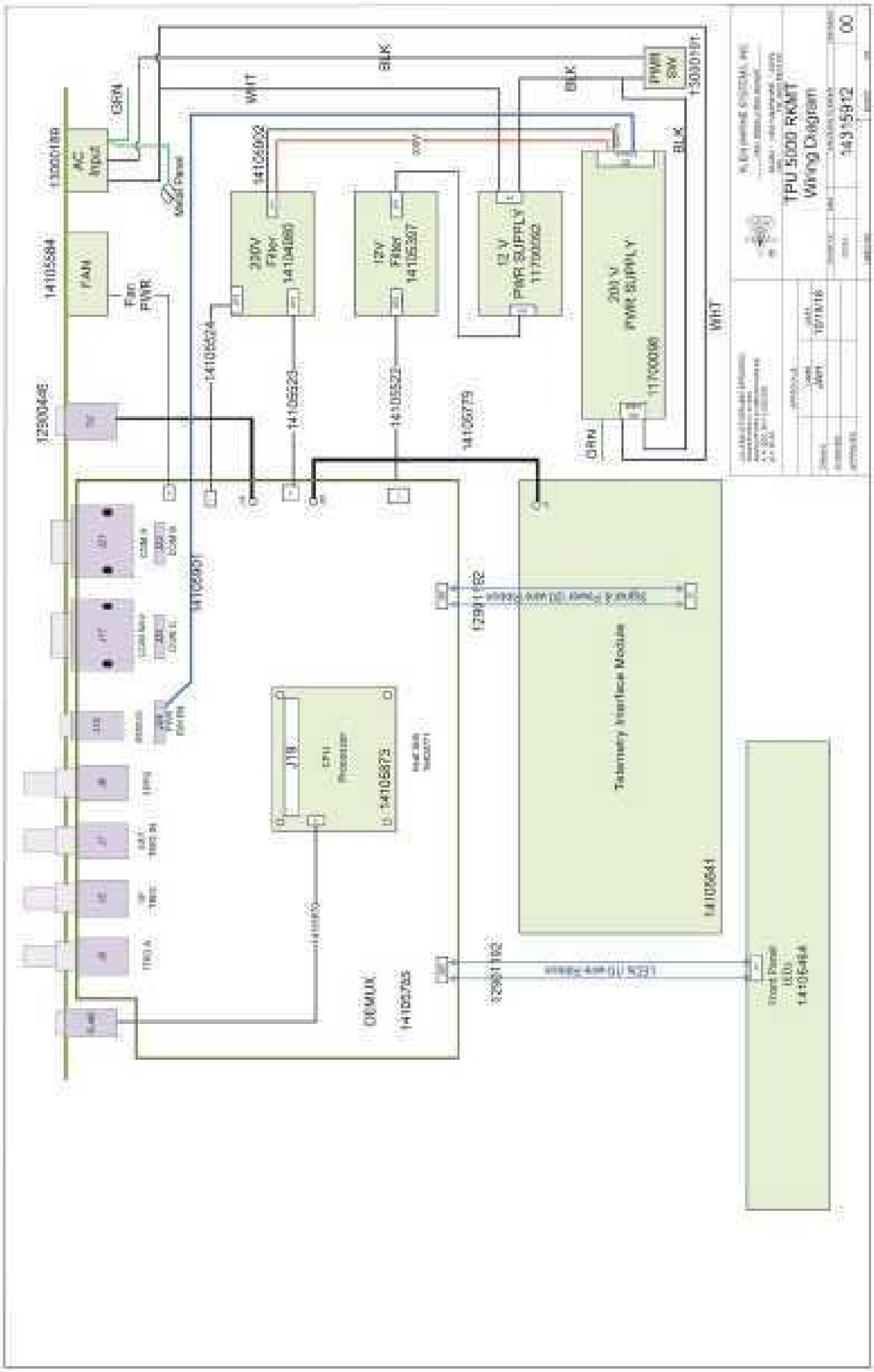
Given the nature of high speed towing, cable problems can occur. For troubleshooting purposes we suggest that you have on hand a lightweight Kevlar reinforced 150-meter (minimum length) tow cable. This extra cable will allow you to bypass your primary tow cable assembly and speed up fault isolation.

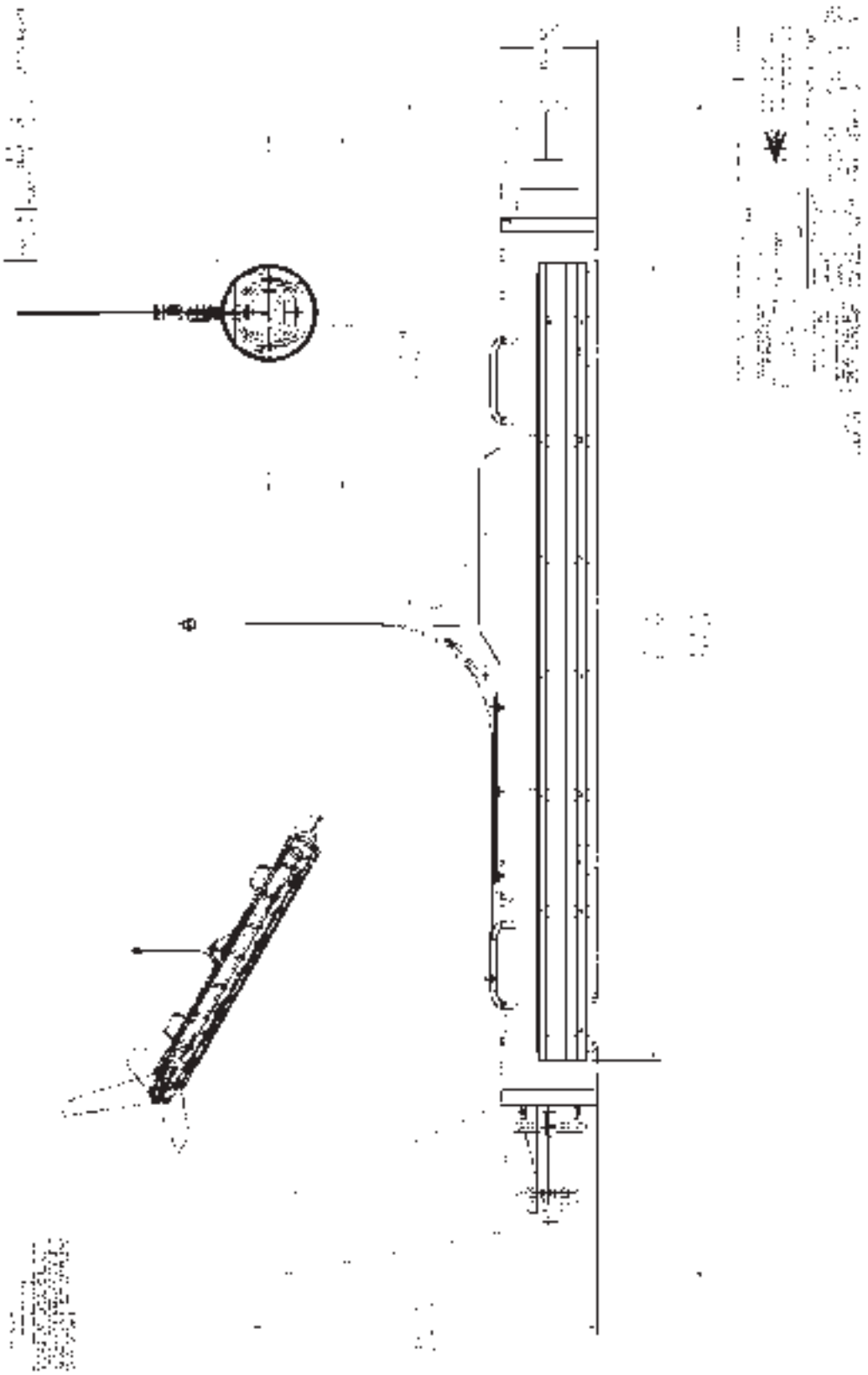
APPENDIX E: DRAWINGS AND PARTS LISTS

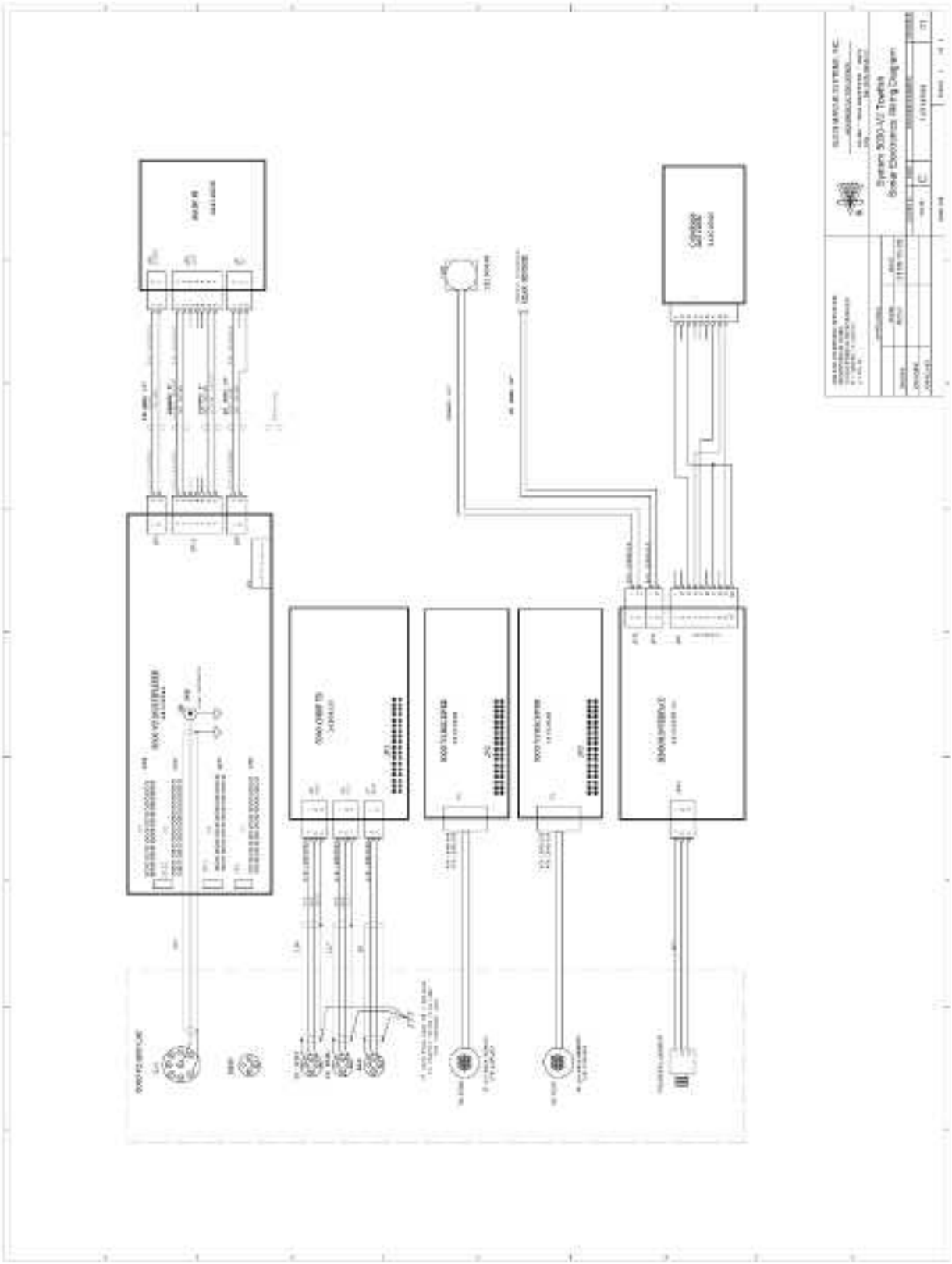
Listed in Table E-1 are the drawings and parts lists included in this appendix. They are provided for reference and troubleshooting purposes. Each assembly drawing is followed by its corresponding parts list.

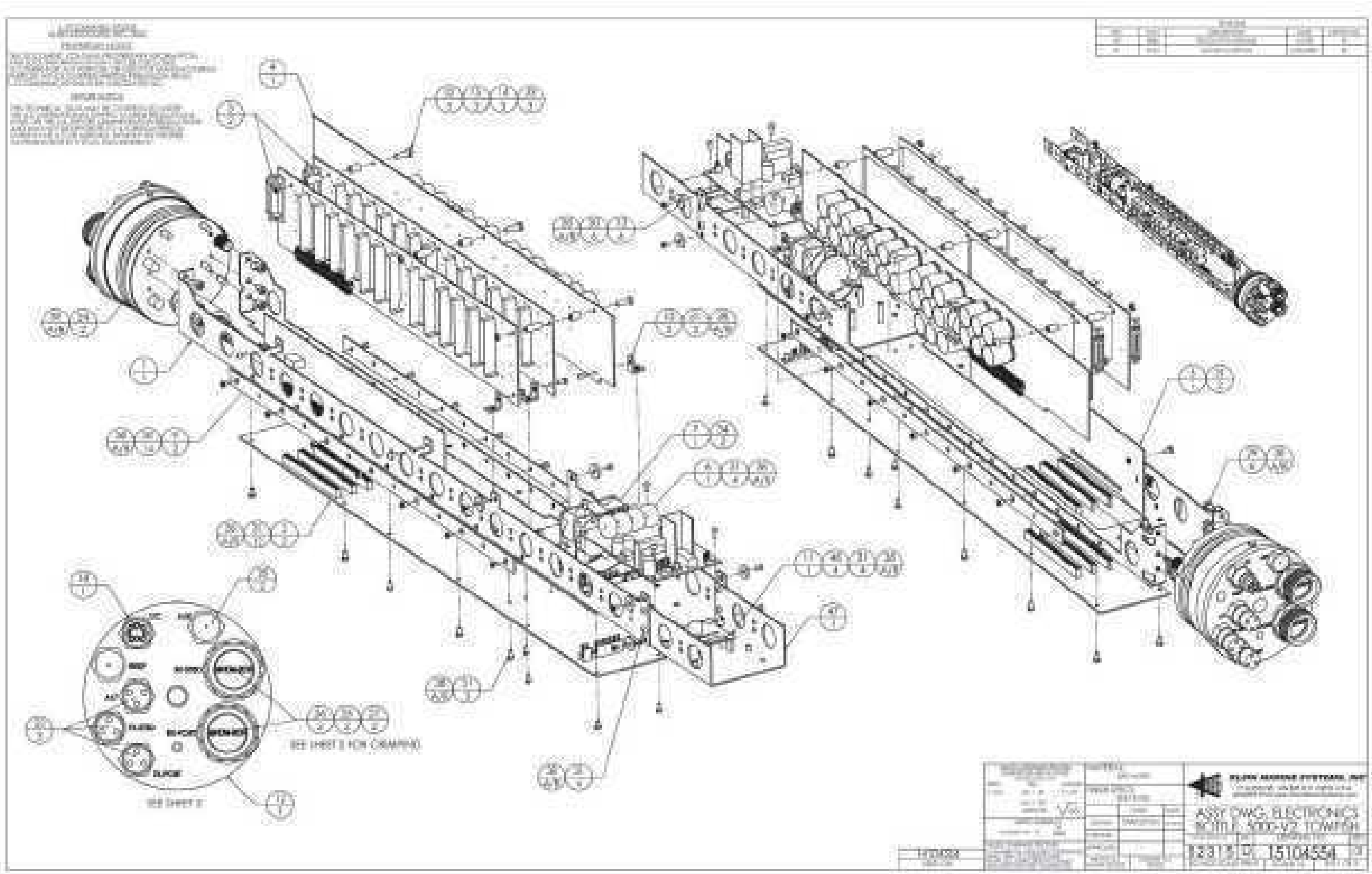
Table E-1: *List of Drawings and Parts Lists*

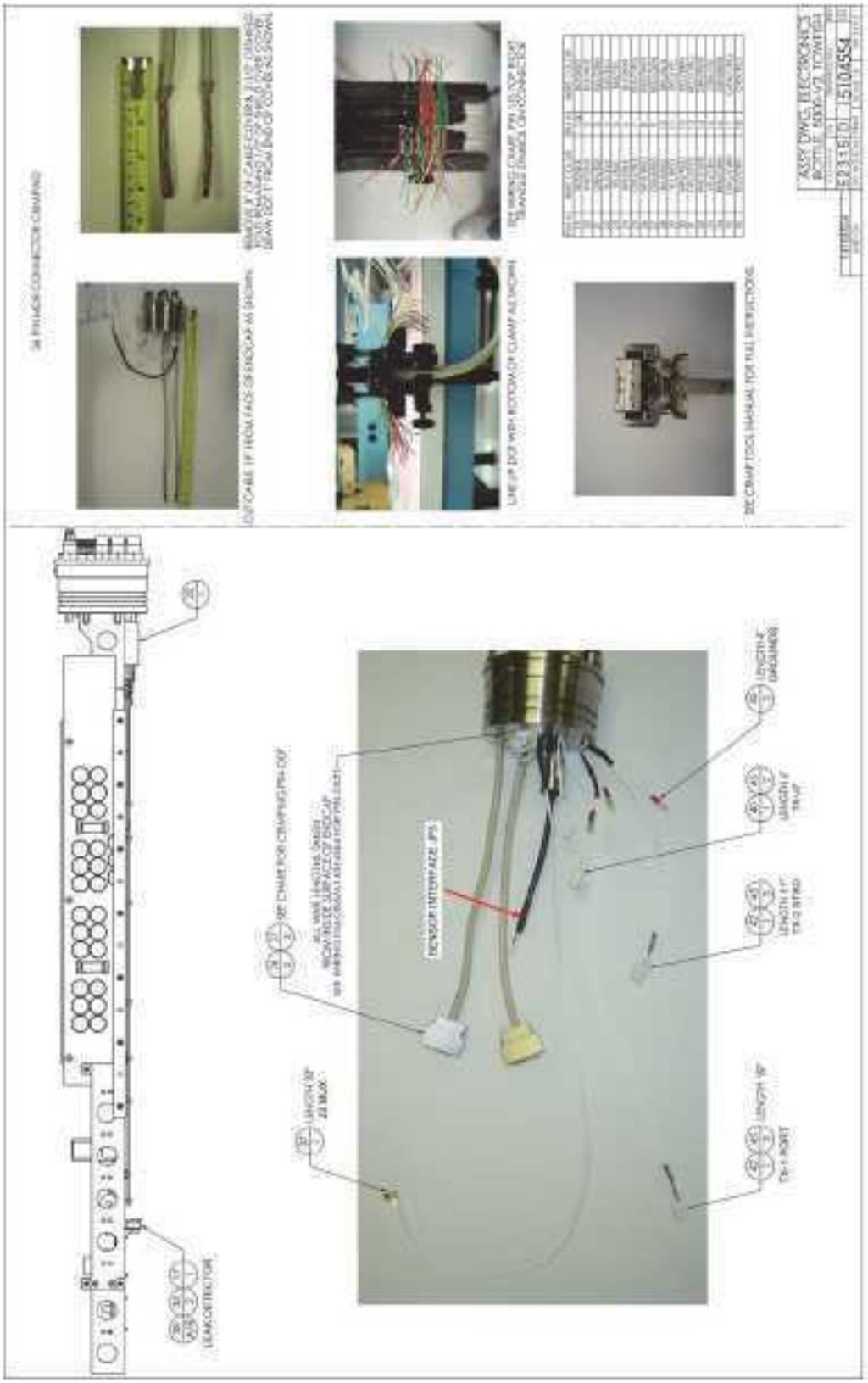
DRAWING NO.	PARTS LIST NO.	TITLE
14315912		Wiring Diagram, TP 5000 Rackmount
14600134		Outline Drawing, Towfish
14314554		Wiring Diagram, Chassis Electronics, Towfish, Series 5000 V2
15104554		Assembly Drawing, Electronics Bottle, Towfish, 5000 V2, Sheets 1 and 2
	14104554	Assembly, Electronics Bottle, Towfish, 5000 V2
15100952		Assembly Drawing, Option Kit .25” Tailfin, “T” Sys 5000
	14105284	Assembly, Spares Kit, Tailfins/Cone, 5000-V2
14315006		Wiring Diagram, Chassis Electronics, Towfish, Series 5000 V2 Bathy
15105006		Assembly Drawing, Electronics Bottle, Towfish 5000 V2 Bathy, Sheets 1 and 2
	14105006	Assembly, Electronics Bottle, Towfish 5000 V2 Bathy
15104917		Assembly Drawing, Nosecone DMB, Black
	14104917	Assembly, Nosecone DMB
15100963		Assembly Drawing, Cable Term, BHD Conn, Armored Coax
	14102919-100M	Assembly, Cable Term, BHD Conn, Armored Coax, .40
	14102967-100M	Assembly, Cable Term, BHD Conn, Armored Coax, .525
15101000		Assembly Drawing, Cable Term, BHD Conn, Armored Coax, 0.68"
	14103017	Assembly, Cable Term, BHD Conn, Armored Coax, 0.68"


12900446
14105584
FAN
Fan PWR
13000189
AC Input
GRN
Metal Panel
14105901
14105524
230V Filter 14104980
14105902
WHT
14105523
J19
CPU Processor
14105873
DEMUX
14105793
12V Filter 14105307
14105522
BLK
14105775
12901192
12 V PWR SUPPLY 11700092
BLK
GRN
Telemetry Interface Module
200 V PWR SUPPLY
11700098
PWR SW
BLK
13000101
14105641
WHT
Front Panel LED 14105464
TPU 5000 RKMT Wiring Diagram
14315912
00



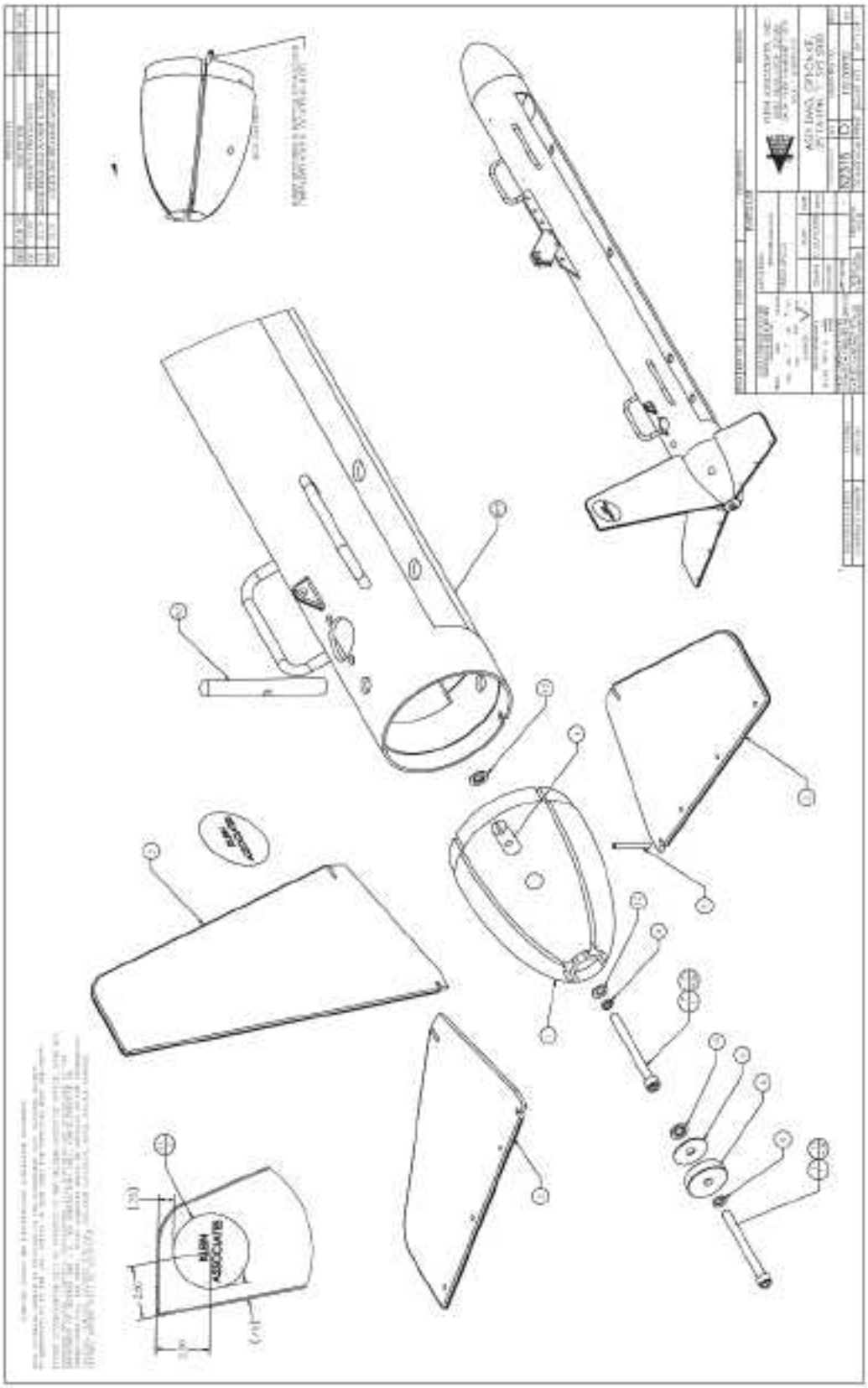



SEE SHEET 3 FOR CRIMPING
SEE SHEET 3
ASSY DWG, ELECTRONICS BOTTLE, 5000-V2, TOWFISH
15104554



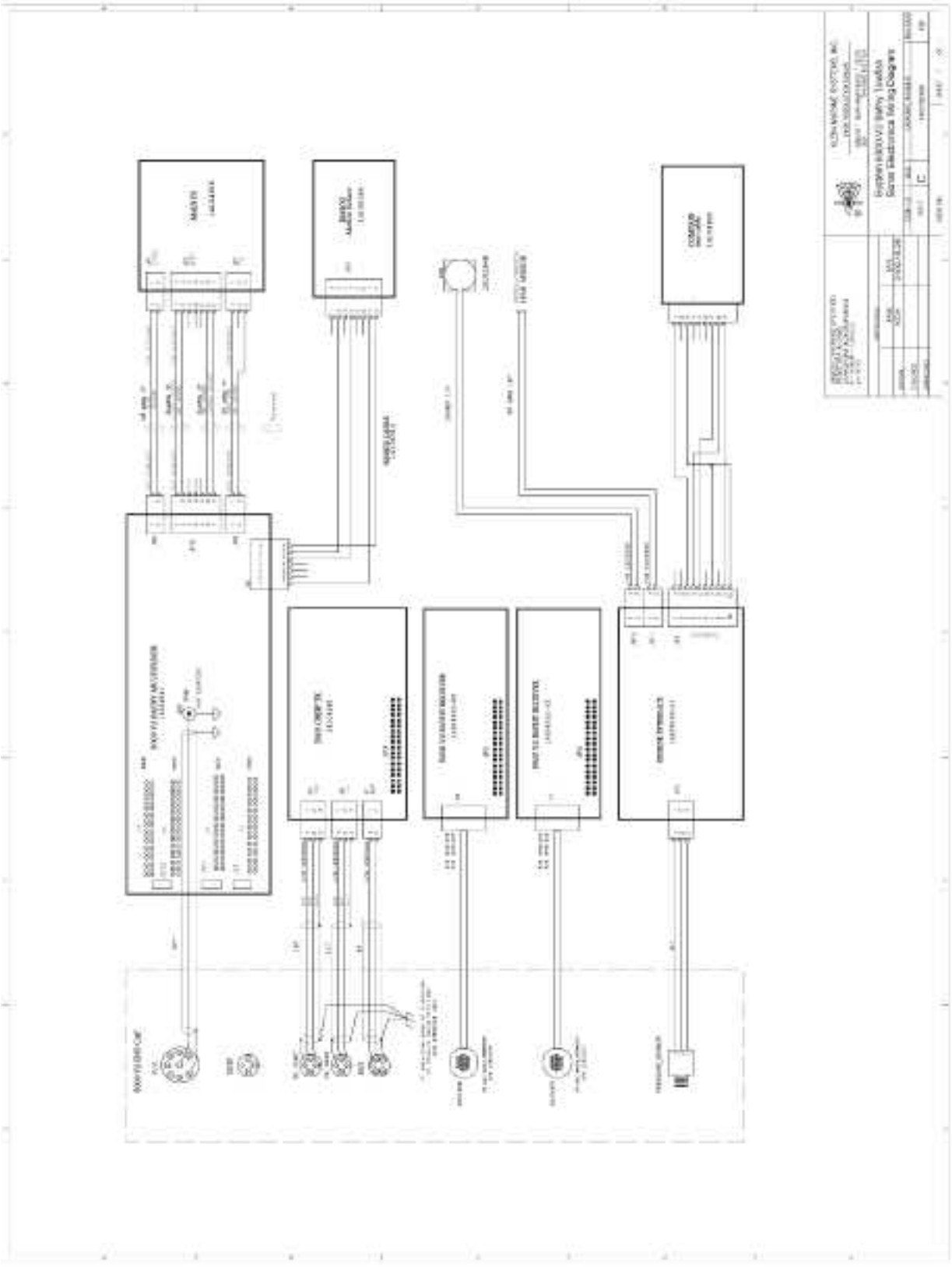
14104554
ASSY, ELECTRONIC BOTTLE, 5000-V2, T/F

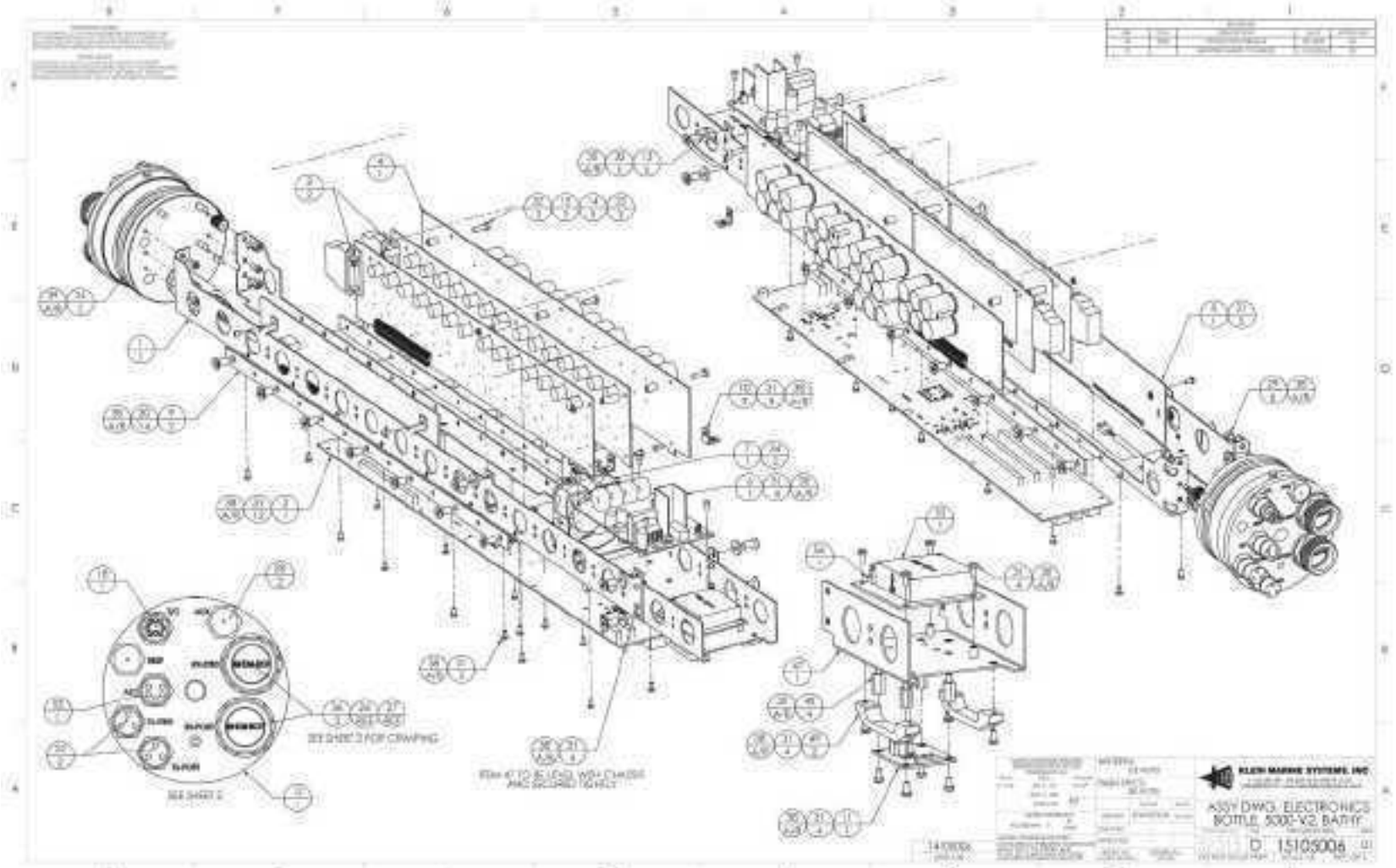
Item	Part Number	Description	Qty
1	14202677	CHASSIS, ELECTRONICS UNIT-V2	1
2	14104941	ASSY, PCB, MUX, 5000-V2, BATTY	1
3	14104548	ASSY, PCB, RECEIVER, SYS 5000-V2	2
4	14104540	ASSY, PCB, ASSEMBLY TRANSMITTER, 5000-V2	1
5	14102036-01	ASSY, PCB, SENSOR INTERFACE BOARD	1
6	14104506	ASSY, PCB,SYNCH PWR SUPPLY,SYS5000-V2	1
7	14102648	ASSY,FAN DMB	1
8	14201620	HOUSING,PRESSURE DMB	1
9	14201654	BRACKET,CHASSIS,UDF	2
10	14201622	BRACKET,ANGLE,PCB	3
11	14104540	ASSY,COMPASS, 5000-V2	1
12	14202670	ENDCAP, 5000-V2, TOWFISH, SS	1
13	12500764	WASHER,NYLON,.164X.500X.075	6
14	12501127	SPACER, CLEARANCE, M3 X 15MM, NYLON	3
15	12501120	SPACER, CLEARANCE, M3 x 9MM, NYLON	3
17	14104542	ASSY, LEAK DETECTOR, SYS 5000-V2	1
18	12900657	CONN,BHD,6 PIN MICRO,MALE 7/16-20,SS	1
22	12901015	CONN,BHD,3 PIN MICRO FEMALE,7/16-20,SS	3
24	15900030	O-RING,2-241	2
25	14104899	ASSY,PRESSURE SENSOR,150PSI,1-5V, 7/16-20	1
26	12901063	CONN, MDR PLUG 36POS IDC GOLD	2
27	12901064	CONN SHELL, 36P, MDR	2
28	14105100	ASSY,BLANKING,PLUG,7/16-20,2-014 ORING	2
29	12500887	SCREW, SHCS, M4X8 MM, 18 8 SS	6
30	12500711	SCREW,FH 90° M3X5 MM PHLPS 18-8	20
31	12500757	SCREW, PHMS M3X6MM PHILPS SS	22
32	12500726	SCREW, PHMS M3X35MM PHLPS SS	3
33	12500725	NUT,LOCK,NYLON INSERT M3 SS	3
34	12500736	SCREW, PHMS M3X20MM PHLPS SS	2
35	12500711	SCREW,PHMS M3X10MM PHLPS SS	2
36	12901057	CONN,RCPT,35PIN,METAL SHELL,MHDMI&T&T+OS	2
37	12900315	CONN, PLUG, SMB MINI COAX, RA	1
38	12700021	ADHESIVE,LOCTITE 242, BLUE	A/R
39	12700118	SILICONE GREASE,DC 4	A/R
40	12900556	CONN, HOUSING, 2 PIN MOLEX, 156" SPC	2
41	12900557	CONN, HOUSING, 7 PIN, 156" SPC	2
42	12900550	CONN,HOUSING,3 PIN MOLEX,W/POL,.156" SPC	2
43	12900549	CONN, HOUSING, 3 PIN, .100 SPC	2
44	13400045	TERM,RING TONGUE #8 RED	3
45	12900550	CONN, HOUSING, 2 PIN, .100 SPC	2
46	12900634	CONN, HOUSING, 4 PIN, USE W/RAMP	1
47	14202756	BRACKET, EXTENSION, 4", CHASSIS V2	1
48	12501074	STANDOFF, M3, HEX, 12MM, M/F	4
900	15104554	ASSY DWG, ELECT. BOTTLE, 5000-V2, T/F	REF
901	14514554	WIRING DIAG, ELECT BOTTLE, 5000-V2	REF

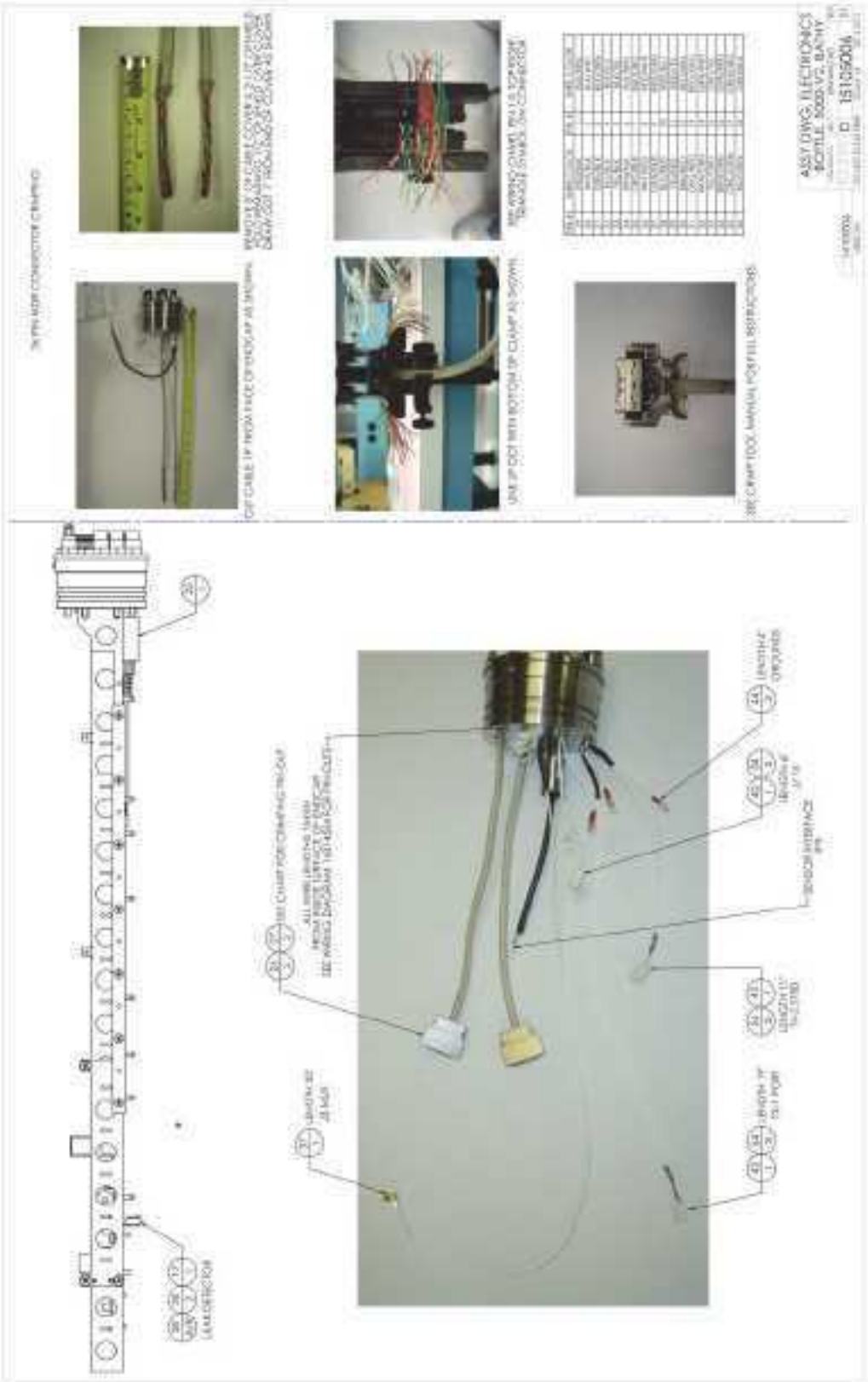


14105284
ASSY, SPARES KIT, TAILFINS/CONE, 5000-V2

Item	Part Number	Description	Qty
1	14202781	TAILCONE, 5000 V2, BLACK	1
2	14201795	TAILFIN,HORIZONTAL,2" X.25" THK,SYS 5000	2
3	14201796	TAILFIN,VERTICAL,20" X.25"THK,SYS 5000	1
4	14201797	CROSSBAR,.750DIA X 2.00",SCHSS	1
5	14201798	CUP RETAIN RG,2.00DIA X .50", 316SS	1
6	14201810	WASHER,FLAT, 4410x1.7000x 06,DELRIN,BLK	1
7	12500837	BOLT,SHCS,M10X110MM,316 SS	2
8	12500835	WASHER LOCK, M10, 316 SST	2
9	12500843	SCREW,SET,M6X50M,CUP PO NT,304 SS	1
10	12500836	WASHER, FLAT, M10, 316SS	1
11	11603236	LABEL, KLEIN MARINE SYSTEMS, 3.5 DIA	2
12	12700814	COMPOUND, NEVER SEIZE MARINE GRADE, 8OZ	A/R
13	12500846	WASHER, RETAINING, .375X.062 NYLON	2
900	15100952	ASSY DWG,OPT KIT .25" TAILFIN, T SYS5000	REF

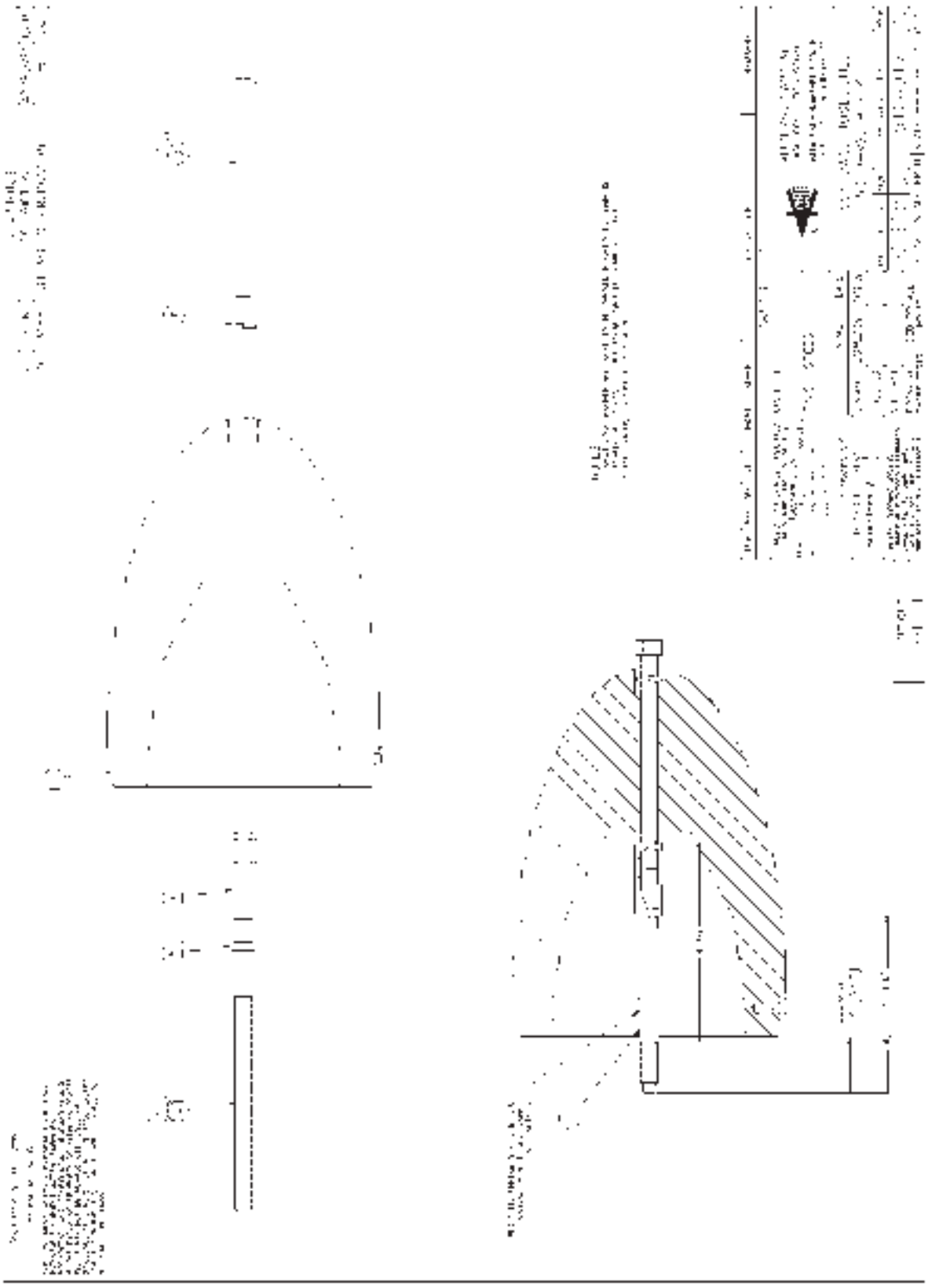



ASSY DWG, ELECTRONICS
BOTTLE, 5000-V2, BATHY
D 15105006



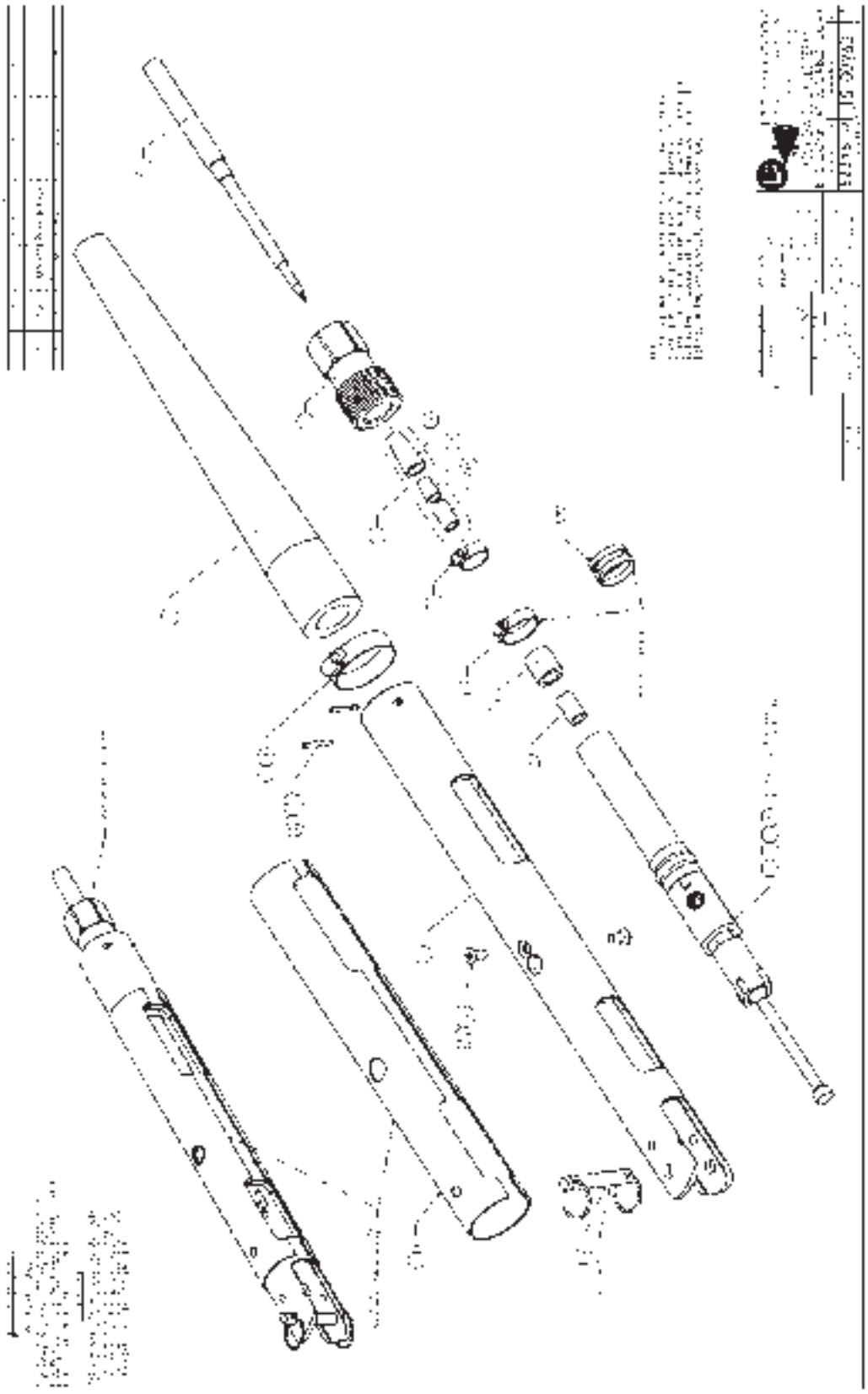
14105006
ASSY, CHASSIS ELECTRONICS, 5000-V2,BATHY

Item	Part Number	Description	Qty
1	14202577	CHASSIS, ELECTRONICS, 5000 V2	1
2	14104931	ASSY, PCB, MUX, 5000-V2, BATHY	1
3	14104932-02	ASSY, PCB, RECEIVER, 5000-V2, BATHY, TF	2
4	14104530	ASSY, PCB, TX, 455KHZ, 5000 V2	1
5	14102036-01	ASSY, PCB, SENSOR INTERFACE BOARD	1
6	14104506	ASSY, PCB,SWITCH PWR SUPPLY SYS5000 V2	1
7	14102549	ASSY,FAN,DMB	1
9	14201534	BRACKET,CHASSIS GUIDE	2
10	14201522	BRACKET,ANGLE PCB	3
11	14104910	ASSY,COMPASS,5000-V2	1
12	14202671	ENDCAP, 5000-V2, TOWFISH, SS	1
13	12500764	WASHER NYLON .TBAX 5000 O/S	6
14	12501177	SPACER, CLEARANCE, M3 X 15MM, NYLON	3
15	12501176	SPACER, CLEARANCE, M3 X 9MM, NYLON	3
17	14104562	ASSY, LEAK DETECTOR, SYS 5000-V2	1
18	12900557	CONN,BHD,8 PIN MICRO,MALE,7/16-20,SS	1
22	12901015	CONN,BHD,3 PIN MICRO,FEMALE 7/16-20,SS	2
24	15900030	O-RING, 2-211, BUNA-N, 70A	2
25	14104513	ASSY,PRESSURE SENSOR,300PSI 0-5V,7/16-20	1
26	12901053	CONN, MDR PLUG 36POS IDC GOLD	2
27	12901054	CONN SHELL, 36P, MDR	2
28	14100190	ASSY,BLANKING,PLUG,7/16-20,2-014 ORING	2
29	12500887	SCREW, SHCS, M4X6MM, BRASS	6
30	12500711	SCREW,FH 90, M3X5MM PHLPS 18-8	30
31	12500757	SCREW, PHMS M3 X 6MM PHLPS 18-8 SS	40
32	12500726	SCREW, PFHMS M3X45MM PHLPS SS	4
33	12500725	NUT,LOCK NYLON INSERT M3 SS	0
34	12500755	SCREW, PHMS M3 X 30MM PHLPS SS	2
35	12500771	SCREW, PHMS M3 X 10MM PHLPS SS	2
36	12901057	CONN, BHD 36-PIN,METAL SHELL,MHDM&16 PLUGS	2
37	12900315	CONN, PLUG SMB MINI COAX, RA	1
38	12700021	ADHESIVE LOCTITE #242, BLUE	A/R
39	12700418	SILICONE GREASE DC 4	A/R
40	12900536	CONN, HOUSING, 2 PIN MULTI, .156 SPC	2
41	12900537	CONN, HOUSING, 7 POS, .156 SPC	2
42	12900533	CONN,HOUSING 3 PIN W/POL .156 SPC	2
43	12900540	CONN, HOUSING, 3 PIN, .100 SPC	2
44	13500345	TERM, RING TONGUE #8 RED	3
45	12900550	CONN, HOUSING, 2 PIN, .100 SPC	2
46	12900614	CONN, HOUSING, 3 POS, .156 W/RAMP	1
47	14202736	CHASSIS EXTENSION, KMS 02	1
48	12501074	STANDOFF, M3, HEX, 12MM, M/F	4
49	14202950	RAIL, CHASSIS EXT, V2	2
52	12900700	CONN,BHD,5 PIN MICRO,FEMALE,7/16-20,SS, 1FT	1
53	14105355	ASSY,PCB MOTION SENSOR INTERFACE(KMS 02)	1
54	13500098	TERMINAL CRIMP (.156 SPC, MOLEX)	9
55	13300231	CABLE, 50 OHM COAX, RG-316/U	A/R
56	14105314	ASSY, CABLE, KMS 02 TO MUX, 5000 V2	1
300	15105006	ASSY DWG,TF,ELECTRONIC,SYS 5000-V2,BATHY	REF
301	14314554	WIRING DIAG, ELECT BOTTLE, 5000 V2	REF



14104917
ASSY,NOSECONE DMB, BLACK

Item	Part Number	Description	Qty
1	14702787	NOSECONE, 5000-V2, BLACK	1
2	14201613	ROD,THREADED,M10,316SS	1
3	12500758	BOLT,SHCS M10X130mm 316SS	1
4	14201630	NUT,COUPLING M10X38MM SS	1
5	12500751	NUT,HEX,JAM M10 316SS	2
6	12500752	WASHER,LOCK SPLIT 3/8 HI COLLAR SS	1
7	12700134	SLEEVING,SHRINK 3/4 IN BLACK	A/R
8	12700082	ADHESIVE,LOCTITE 277, RED	A/R
900	15104917	ASSY DWG,NOSECONE DMB,BLACK	REF

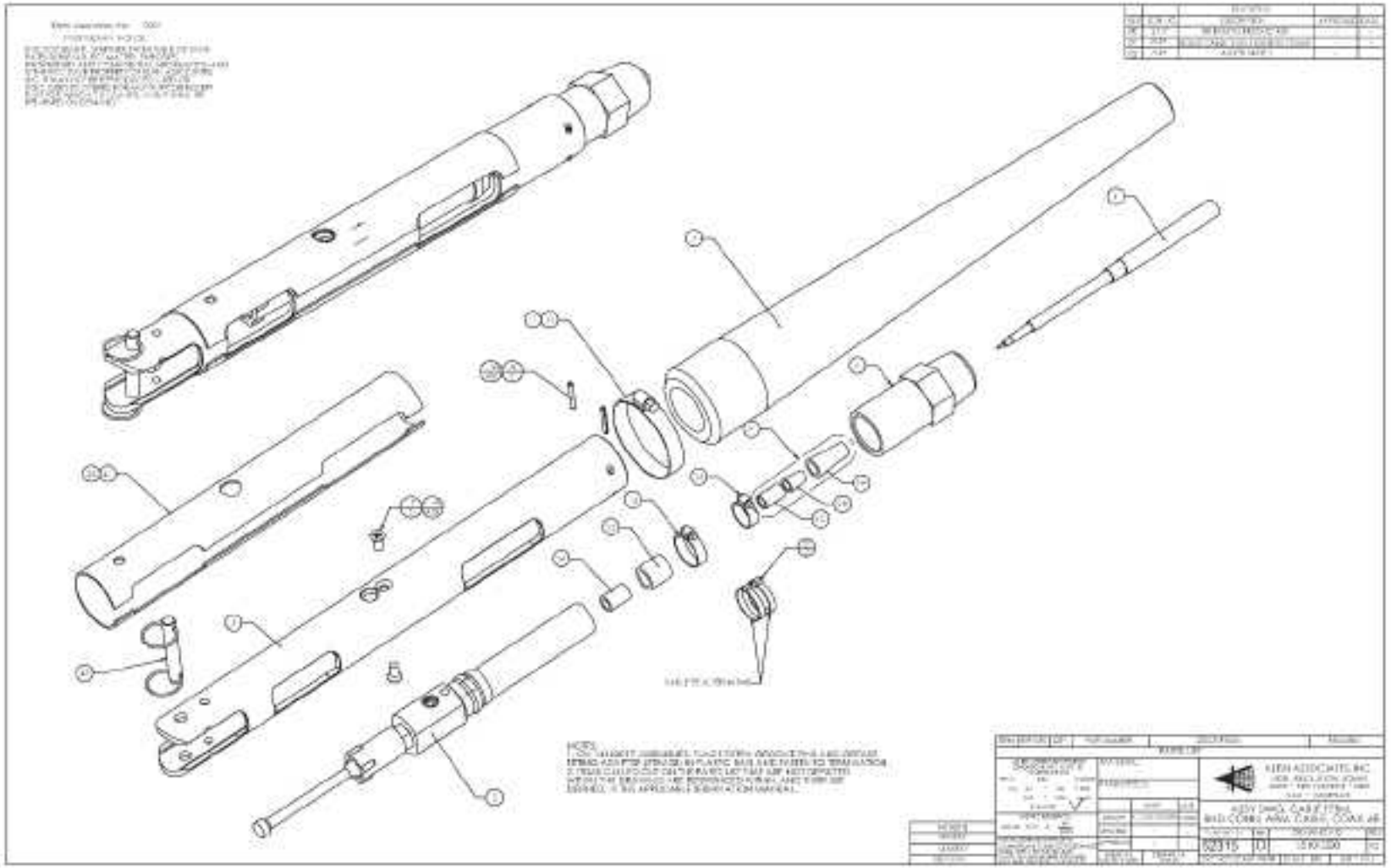


14102919-100M
ASSY,CABLE TERM,BHD CONN,ARMORD,COAX,.40

Item	Part Number	Description	Qty
1	13300043	CABLE,TOW ARM COAX .40 DIA (NOM)	100M
2	14102020	ASSY,BHD CONN&TUBE(3/4 ID),6 PIN MICRO	1
3	14000315	GRIP,CABLE .40-.50"DIA X36" THIMBLE,SS	1
4	14103031	ASSY STR REL, .50IDX1.75ODX12 T5,1.25HEX,	1
5	14201736	HOUSING,CABLE TERM BHD 1.7"	1
6	14201026	SLEEVE 7/16" 1.50 12 THREAD, 1.25" HEX	1
7	12500623	SCREW,FHMS M6X12MM PHLPS,316	2
8	16200025	PIN,GROOVE 1/8 X 1 IN TYPE 2	2
9	14000210	SET DUAL PLUG ARM CAB .4 DIA.(NOM)	1
11	14000273	CLAMP HOSE WORM-DRIVE,SMTH .47X1.5-2D SS	1
12	14000246	CLAMP HOSE,.31"WDX.50-.91DIA SS	1
13	14000284	CLAMP,HOSE,WORM 5/16"WD,11/16-1-1/4 D,SS	1
14	14000292	SPLICE,INSUL,CRIMP,22-12AWG,CLOSED END	3
15	14000112	SPLICE NON-INS PAR CRIMP 14 D	2
16	12700536	SPIRAL WRAP 1/2 IN BLACK	50FT
17	12700803	SHRINK SLVG,PVC 2",2:1,STD WALL,YLW 3"LG	1
22	12700510	TIE, CABLE 7.5X .185 IN BLACK	5
23	12700029	TIE CABLE 4 IN	5
24	12700509	TBG .25 DX.50 OD 50A DURO SILICONE TRANS	1
25	12700560	TBG,1/2 DX.75OD 50A DURO SILICONE TRANS	1
26	12700543	ADHESIVE,LOC 277(RED) 10ML BTL	A/R
27	12700591	GREASE LITHIUM,NLGI #2,3 OZ CARTRIDGE	1
28	13400046	ADAPTER FLUSH GREASE FITTING TIP 1/8NTPF	A/R
29	10800032	BAG ZIPLOCK 3X5 W/LOGO	1
30	14000290	CLAMP,HOSE,WORM .5WD 1.06-2 DIA,SS	1
31	12700558	BUSHING,PLASTIC ANTI-SHORT .35 IDX.394 OD	1
32	12700570	SLEEVING SHRNK, 3"ID 3:1,THK,ADH,POLYOL	A/R
33	12700024	SLEEVING SHRINK 3/8 IN BLACK	A/R
34	12700149	SLEEVING SHRINK 1/4 IN BLACK	A/R
36	13500020	TERM, RING TONGUE #8 BLUE	2
37	17500005	MSDS,HAZARD MAT'L LIT,LOCTITE 277	REF
38	17500015	MSDS GREASE LITHIUM MOBILITH AW-2	REF
39	17500008	MSDS, HAZARD MAT'L LIT LOCTITE 242	REF
40	12700001	ADHESIVE, LOCTITE #242, BLUE	A/R
41	14202032	COVER, CABLE TERMINATION HOUSING, 1.2"	1
42	14000296	CLAMP,HOSE WORM .31"WD X .22-.52DIA SS	2
43	16200013	TOW PIN,TOWFISH	1
900	11210070	MANUAL,CABLE TERM BHD CONN, ARMORED COAX	REF
901	14600133	OUTLINE DWG,CA TRM BHD CONN,ARM COAX	REF
902	15100963	ASSY DWG CAB TERM,BHD CONN ARM,COAX	REF

14102967-100M
ASSY,CABLE TERM,BHD CONN,ARM.,COAX,.625

Item	Part Number	Description	Qty
1	13300067	CABLE,COAX,ARMORED,SS,.625 OD, W/FA RING	100M
2	14102920	ASSY,BHD CONN&TUBE(3/4"ID) 6 PIN MICRO	1
3	14000315	GRIP CABLE,.40-.50"DIA X36" THIMBLE SS	1
4	14102875	ASSY STRAIN RELIEF,.56IDX1.75ODX12.75	1
5	14201786	HOUSING,CABLE TERM,BHD,17"	1
6	14201813	SLEEVE 5/16",1.50 X 12 THREAD 1.25" HEX	1
7	12500823	SCREW,FHMS,M6X12MM PHLPS,316	2
8	16200023	PIN GROOVE 1/8 X 1 IN TYPE 2	2
9	14000275	DUAL PLUG,AR CAB,325D,ME256AME253BME256C	1
11	14000273	CLAMP HOSE,WORM-DRIVE,SMTH,.47X1.5-2D SS	1
12	14000288	CLAMP,HOSE .31"WDX.50-.91DIA,SS	1
13	14000234	CLAMP HOSE,WORM 5/16"WD 11/16-1 1/4 D SS	1
14	14000202	SPLICE INSUL CRIMP,22-12AWG,CLOSED END	1
15	14000201	SPLICE NON-INS PAR CRIMP COPPER .21 ID	1
16	12700535	SPIRAL WRAP,1/2 IN BLACK	50FT
17	12700503	SHRINK SLVG PVC 2:1,3.1,STD WALL YLW 3"LG	1
22	12700510	TIE,CABLE 7.5X .105 IN BLACK	A/R
23	12700029	TIE CABLE 4 IN	A/R
24	12700589	TBG .31IDX.50OD,STD DURO,MED 65,SIL CLR	1
25	12700590	TBG,1/2IDX.75OD,50A DURO,SILICONE TRANS	1
26	12700543	ADHESIVE,LOC 277(RED) 10ML BTL	A/R
27	12700591	GREASE,LITH LM NLGI #2 3 OZ CARTRIDGE	1
28	13400046	ADAPTER,FLUSH GREASE FITTING TIP 1/8NPT	A/R
29	13800032	BAG ZIPLOCK 3X5 W/LOGO	1
30	14000290	CLAMP HOSE WORM,.5WD 1.06-2 DIA SS	1
31	12700658	BUSHING PLASTIC ANTI SHORT.35 IDX.394 OD	1
32	12700570	SLEEVING,SHRNK .6" D.3 THK,ADH,POLYOL	A/R
33	12700302	SLEEVING,SHRINK 1/2 IN BLACK	A/R
34	12700149	SLEEVING,SHRINK 1/4 IN BLACK	A/R
36	13500020	TERM RING TONGUE #6 BLUE	2
37	17500008	MSDS,HAZARD MAT'L LIT LOCTITE 277	REF
38	17500013	MSDS,GREASE LITHIUM MOBILITH AW-2	REF
39	17500006	MSDS, HAZARD MAT'L LIT LOCTITE 242	REF
40	12700021	ADHESIVE,LOCTITE #242 BLUE	REF
41	14202032	COVER CABLE TERMINATION HOUSING 13"	1
42	14000296	CLAMP HOSE WORM,.31"WD X .22-.50DIA,SS	2
43	16200013	TOW PIN,TOWFISH	1
900	11210070	MANUAL CABLE TERM BHD CONN ARMORED,COAX	REF
901	14600193	OUTLINE DWG CA TRM BHD CONN ARM COAX	REF
902	15100963	ASSY DWG,CAB TERM,BHD CONN ARM,COAX	REF



14103017

ASSY,CABLE TERM,BHD CONN,ARMORED,COAX,.68

Item	Part Number	Description	Qty
1	13300045	CABLE,TOW ARM COAX .68 DIA	10CM
2	14102920	ASSY BHD CONN&TUBE(3/4"ID),8 PIN MICRO	1
3	14102771	ASSY,GRIP BAIL,MOG .56 TO .75 RANGE	1
4	14103024	ASSY STRAIN RELIEF,.75IDX2.50"ODX18" WW	1
5	14201768	HOUSING CABLE TERM BHD,17"	1
6	14200223	SLEEVE .680 ARM CABLE	1
7	12500923	SCREW,FHMS M6X12MM,PHLPS 316	2
8	16200023	PIN,GROOVE 1/8 X 1 IN TYPE 2	2
9	14200222	DUAL PLUG,ARM CABLE .680	1
11	14200291	CLAMP,HOSE SMOOTH 4TWD 1.3/4-2.3/4D,316	1
12	14200289	CLAMP HOSE .31 WDX .60-.91DIA SS	1
13	14200284	CLAMP,HOSE,WORM,5/16"WD,11/16-1-1/4 D SS	1
14	14200293	SPLICE,INSUL,CRIMP 8AWG,CLOSED END	1
15	14200261	SPLICE NON-INS PAR CRIMP,COPPER .21 ID	1
16	12700558	SP RAL WRAP,1/2 IN BLACK	5FT
17	12700615	SLVG,PVC,3/12"ID,STD WALL THK YLW,3"	1
22	12700510	TIE CABLE 7.5X .185 IN BLACK	20
23	12700025	TIE CABLE 4 IN	5
24	12710000	AID,TUBING .43IDX.62OD X 1" .50A, SILCN	1
25	12710001	AID,TUBING,.62IDX.75OD X 1".50A,SILCNE	1
26	12700542	ADHESIVE LOC 277(RED; 10ML BTL	A/R
27	12700391	GREASE LITHIUM NLGI #2 3 OZ CARTRIDGE	1
28	13400046	ADAPTER FLUSH GREASE FITTING TIP 1/8NTPF	A/R
29	13900032	BAG,ZIPLOCK 3X5 W/LOGO	1
30	14200290	CLAMP,HOSE WORM,.5WD 1.06-2 DIA SS	1
31	12700614	BUSHING ANTI SHORT .540" ID	1
32	12700570	SLEEVING SHRNK .5"ID 0.1 THK,ADH POLYOL	A/R
33	12700002	SLEEVING,SHRINK 1/2 IN BLACK	A/R
34	12700149	SLEEVING,SHRINK 1/4 IN BLACK	A/R
36	13500113	TERMINAL RING #10 YELLOW	2
37	17500002	MSDS HAZARD MAT'L LIT LOCTITE 277	REF
38	17500013	MSDS,GREASE LITHIUM MOBILITH AW-2	REF
39	17500004	MSDS HAZARD MAT'L LIT,LOCTITE 242	REF
40	12700541	ADHESIVE,LOC 242(BLUE; 5ML CPSL	A/R
41	14202032	COVER, CABLE TERMINATION HOUSING 12"	1
42	14200296	CLAMP HOSE WORM, .31"WD X .44-.78D 4 SS	2
43	16200013	TOW PIN TOWFISH	1
300	11210070	MANUAL,CABLE TERM,BHD CONN, ARMORED,COAX	REF
301	14600205	OUTLINE DWG CAB TERM BHD CON,ARMORED,COAX	REF
302	15101002	ASSY DWG CBLE TERM BHD CONN ARMORED COAX	REF