



# GEOMETRICS

Innovation • Experience • Results

## **CESIUM-VAPOR MARINE MAGNETOMETER TELEMETRY/DECOUPLER**

**25584-0M**

**REV. D**

## *Operation Manual*

COPYRIGHT © 2014

### **GEOMETRICS, INC.**

2190 Fortune Drive, San Jose, CA 95131 USA

Phone: (408) 954-0522

Fax: (408) 954-0902

EMAIL: [sales@mail.geometrics.com](mailto:sales@mail.geometrics.com)



## TABLE OF CONTENTS

<b>TABLE OF CONTENTS .....</b>	<b>III</b>
<b>1 INTRODUCTION .....</b>	<b>1</b>
<b>2 SYSTEM COMPONENTS AND SPECIFICATIONS.....</b>	<b>2</b>
<b>3 SYSTEM INSTALLATION .....</b>	<b>5</b>
3.1 IDENTIFYING THE COMPONENTS.....	6
3.2 INSTALLATION OF THE POWER SUPPLY.....	7
3.3 POWER SUPPLY CONNECTIONS .....	8
3.4 DECK CABLE CONNECTION – INTERLOCK CONNECTION.....	9
3.5 SLIP-RING CONNECTION .....	9
3.6 TOW CABLE CONNECTION .....	9
3.7 TELEMETRY VESSEL CONNECTION .....	10
3.8 POWER SUPPLY SETTINGS.....	11
3.9 SYSTEM CHECKOUT.....	12
<b>4 TROUBLE-SHOOTING GUIDE.....</b>	<b>13</b>
<b>APPENDIX.....</b>	<b>15</b>
<b>A1 CIRCUIT DIAGRAMS.....</b>	<b>17</b>
<b>A2 – TOW CABLE RETERMINATION.....</b>	<b>23</b>
<b>A3 - THEORY OF OPERATION .....</b>	<b>27</b>
<b>A4. BLOCK DIAGRAM OF SYSTEM COMPONENTS .....</b>	<b>29</b>

### List of Figures

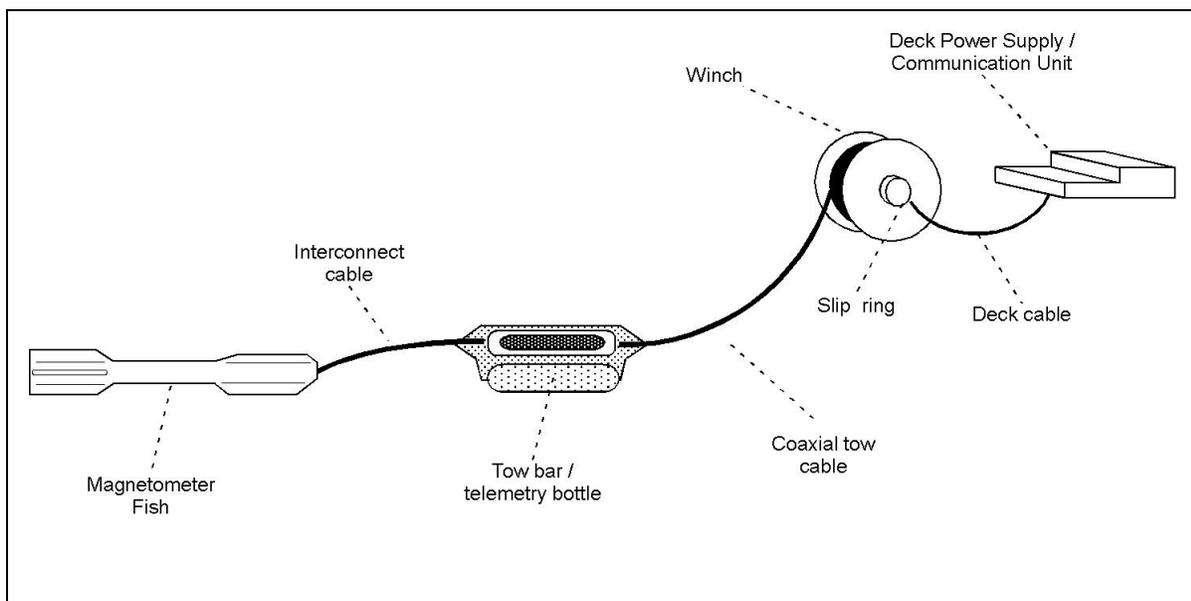
Figure 1. Simple telemetry system. ....	1
Figure 2. Block diagram of a long tow cable system.....	2
Figure 3. Standard telemetry components. ....	6
Figure 4. Xantrex Power Supply.....	7
Figure 5. Kepco Power Supply.....	8
Figure 6. On-Board Cable, interconnect cable, and typical Slip ring assembly. ....	9
Figure 7. 9 meter G-880 sensor-to-tow bar interconnect cable. ....	10
Figure 8. Tow bar / telemetry vessel assembly.....	11
Figure 9. Telemetry tow bar with interconnect and tow cables attached. ....	11

## List of Tables

Table 1. Specifications for telemetry system components. ....	3
Table 2. Steel coaxial cable specifications. ....	3
Table 3. Kevlar tow cable specification.....	4

## 1 INTRODUCTION

Geometrics marine magnetometers are powered by low-voltage (24v) sources and are equipped for two-way communication using an RS-232 serial data format. This power/communication method employs a 5 conductor tow cable and is limited by power and signal loss to cable lengths of 1000 ft (305m) or less. The low voltage/serial data scheme has several advantages but will not support operation on longer cables. To permit operation on cables longer than 1000 ft. Geometrics provides the telemetry system described in this manual. It is designed to provide power and data telecommunications for Geometrics' cesium-vapor marine magnetometer models G-880, G-881, and G-882 and will allow them to be operated on coaxial tow cable up to 10 km long. An illustration showing the major components comprising a typical system is shown in Figure 1.



**Figure 1. Simple telemetry system.**

A special low-noise, high-voltage power supply powers the telemetry system and includes an interlock system that provides operational safety for the ship's personnel. The power supply is usually connected to the tow cable via a deck cable, which is in turn connected to a slip ring mounted on the winch. This arrangement permits efficient operation through long, heavy coaxial tow cables. The telemetry system relies on the Frequency Shift Keying (FSK) communication technique, operating at a base frequency of 200 kHz for communication with a telemetry module housed in a pressure bottle at the wet end of the tow cable. This communication signal shares the coaxial cable with a high voltage direct current that powers the telemetry module. The telemetry module in turn provides 24 V power and RS-232 for communication with the magnetometer fish via a short 9 m non-magnetic interconnect cable. This deployment allows operation from long steel armored cable while avoiding magnetic interference from the steel armor. The telemetry bottle can supply regulated power to a single cesium-vapor magnetometer or multiple magnetometers making up a gradiometer array. The telemetry systems components are all conservatively

rated for operation at pressures up to 8,000 psi (18,000 ft or 5,600 m). The magnetometer is rated for operation at pressures up to 4,000 psi (8,850 ft. or 2,700 m).

Included in this manual are sections describing the system components, system installation, system operation, and a trouble-shooting guide. The appendix contains system specifications, basic hookup instructions, wiring diagrams, block diagrams, and specifications to aid in the proper configuration and installation of the system.

## 2 SYSTEM COMPONENTS AND SPECIFICATIONS

All system components and their electrical interconnection with the data-logging computer are shown in schematic form in figure 2. Many systems are shipped from Geometrics as an integrated package that includes all of the components show in Figure 2. In some cases the system will include only those items needed to upgrade the capability of an existing marine magnetometer system. If a coaxial cable designed for some other oceanographic system is used with the telemetry system it should have an attenuation of 60db or less at 200 khz.

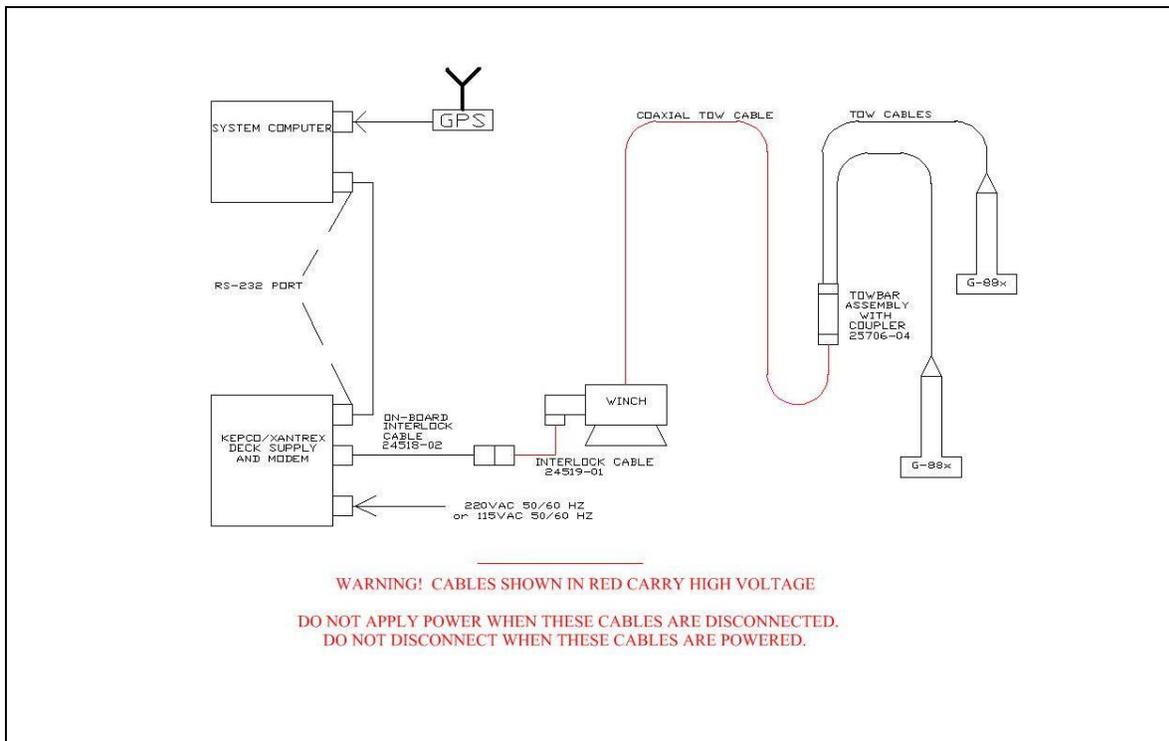


Figure 2. Block diagram of a long tow cable system.

Table 1 lists those items that will normally be provided with a telemetry system and gives their general specifications. Items shown in *italics* are sometimes supplied by the customer or a third party and their dimensions and weights should be obtained from the Original Equipment Manufacturer. Some systems utilize armored coaxial cable that was terminated for other oceanographic applications and in these cases a short adapter cable may be

necessary. This adapter cable would connect the wet end of the armored cable with Geometrics' telemetry bottle. Table 2 lists the specifications of the typical steel armored coaxial tow cable that is supplied with complete systems. For some applications unarmored Kevlar-reinforced coaxial cable is used. The specifications for the typical coaxial Kevlar cable used with the telemetry system are given in table 3.

**Table 1. Specifications for telemetry system components.**

<b>Component</b>	<b>Dimensions</b>	<b>Weight</b>	<b>Specification</b>
<i>All Telemetry sea going components rated at 5,000 psi minimum. Storage temperature -30 to +50 C. Operation temperature 0 to +30C</i>			
Power Supply / Communication Unit (Xantrex)	16.5" D x 17" W x 3.5" H (41.9 cm x 43.1 cm x 8.9cm)	21 lbs (10kg)	Input Voltage: 85 to 130 or 190 to 264 VAC, 47 to 63 Hz. Output Voltage: 15 to 150 VDC Opto-isolated Dual Frequency FSK modem
Deck Cable	Built to order	1 lb / ft (1.5kg/m)	Twisted Shielded Pair of number 14 AWG. Interlock wired with white wire (return) tied shield
<i>Tow cable</i>	See Tables 2 and 3		Double armored steel or Polyurethane covered aramid fiber. Coaxial, center conductor 18 gauge AWG. Attenuation: 7 db per 1000 meters or less.
<i>Winch / Cable Reel</i>	<i>Varies with installation; see manufacture's documentation.</i>		
<i>Slip Ring Assembly</i>	<i>Varies with installation; see manufacture's documentation.</i>		
Tow Bar			Solid aluminum frame, minimum fracture strength 5,000 Lbs. (2265 kg).
Telemetry Bottle	23" L x 3" O.D. 58.5 cm x 7.7 cm	11 lbs (5kg)	Input voltage 28 to 150 VDC. Output voltage: 28 VDC. Dual Frequency Send/Receive FSK modem.
Interconnect Cable	9 m (typical)	30 lbs (13.5)	Termination: 8-pin Subconn connector; attached via 0.675" dia. pin centered 0.750" from opening of clevis jaws. Clevis jaws accept plate 0.675" wide.

**Table 2. Steel coaxial cable specifications.**

P/N 60-203-022 <i>All sea going components rated at 5,000 psi minimum. Storage temperature -30 to +50 C. Operation temperature 0 to +30C</i>
---

Coaxial Element	Conductor	#14 AWG (19/.0142 in.) BC. 068in.
	Insulation	.055 inch Wall PE.178 inches
	Return	#28 AWG B.C..203 inches
	Belt	.0385 inch Wall PE.287 inches
Armor	First layer	24/.0375 inch GIPS .354 inches (O.D.)
	Second layer	24/.048 inch GIPS .450 inches (O.D.)
Physical	Weight in air	469 kg/km
	Weight in sea water	379kg/km
	Specific gravity	5.4
Mechanical	Breaking strength	16,000 lbs
	Maximum working strength	4,000 lbs
	Minimum bend radius	23cm
Electrical	Voltage rating	1,900 VDC
	Insulation resistance	3,048 M-ohms km
Resistance	Conductor	9.8 ohms/km
	Return	6.9 ohms/km
Characteristic Impedance	@ 1 MHz	40 ohms

**Table 3. Kevlar tow cable specification.**

P/N 60-453-100		
<i>All sea going components are rated at 5,000 poi minimum. Storage temperature -30 to +50 C. Operation temperature 0 to +30 C.</i>		
Capacitance	@ 1 KHz	131 pF/m
Attenuation	@ 0.5, 1, 3, and 5 Mhz	7.2, 10.5, 18, and 23.3 db/km
Coaxial Element	Conductor	#17 AWG elastic stranded T.C.
	Insulation	Polyethylene
Jacket	Polyurethane	04 “ thick
Strength member	Kevlar	Braided yarn
Physical	Weight in air	115 lbs / 1000 ft.
	Weight in sea water	20 lbs/ 1000’
	Specific gravity	~1.2
Mechanical	Breaking strength	10,000 lbs
	Maximum working strength	2,500 lbs
	Minimum Bend Radius	9 “
Electrical	Voltage rating	1500 V
	Insulation Resistance	3,048 Mohms km
Resistance	Conductor	6.1 ohms /M ft.
	Return	4.0 ohms/ft.
Characteristic Impedance	@ 1 Mhz	50 ohm
Capacitance	@ 1 KHz	30.7 pF/ft.
Attenuation	@ 0.5, 1, 3, and 5 Mhz	1.78db, 2.52 db, 4.37db, 5.64 db/1000 ft

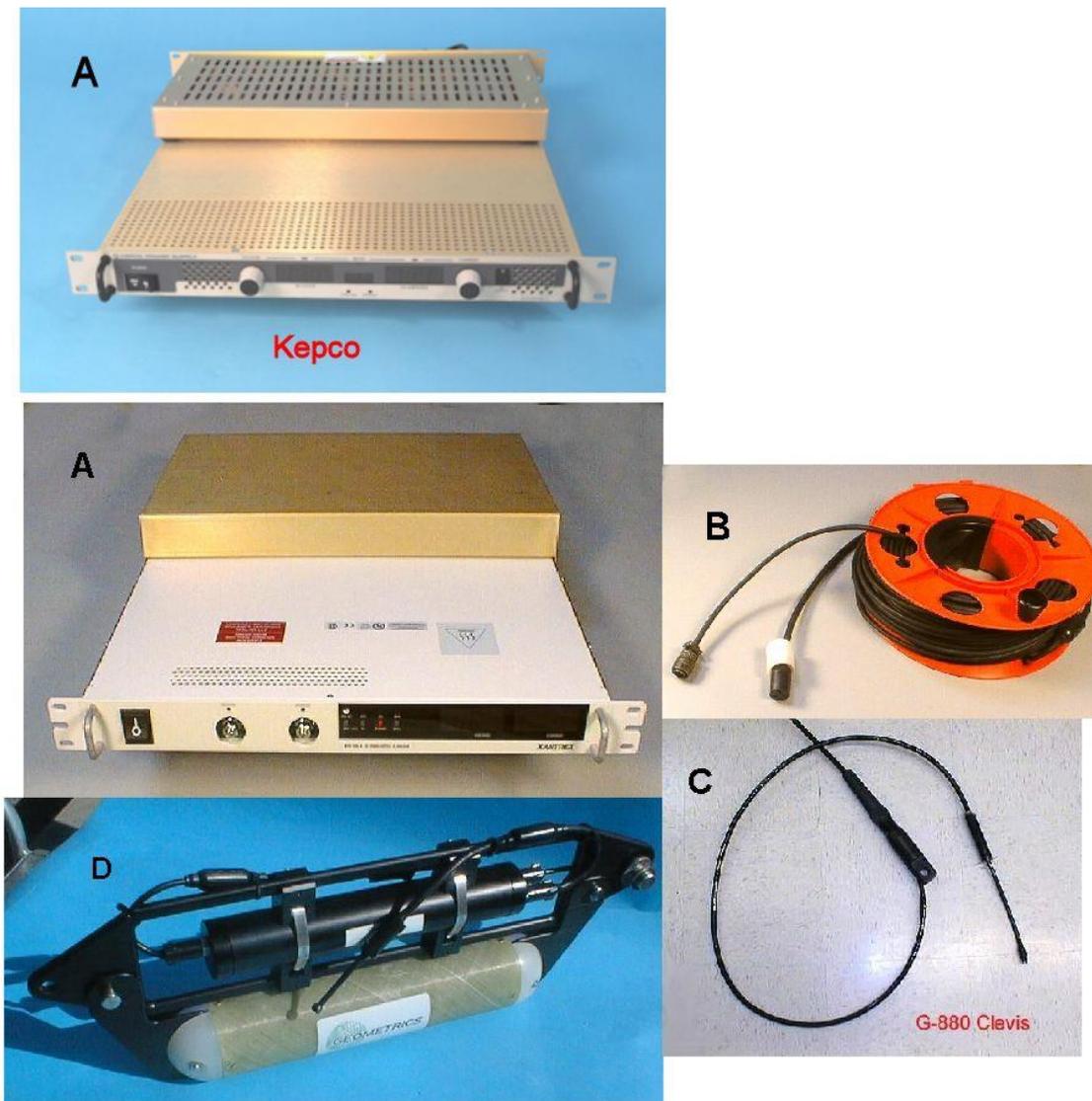
### 3 SYSTEM INSTALLATION

The assembly procedure of the system will depend upon its configuration (see System Block Diagram, Figure 2). The instructions that follow assume that the user has a basic knowledge of their system's configuration and the operation of the magnetometer fish. If this is not the case, please review the relevant operational manuals for this information. These are the G-880, G-881, or G-882 Operation Manuals and/or MagLogLite Operation Manual.

***WARNING: DURING OPERATION, THOSE COMPONENTS LYING BETWEEN THE ONBOARD INTERLOCK CABLE AND THE MULTICONDUCTOR MAGNETOMETER TOW CABLE(S) ARE CARRYING HIGH VOLTAGE DIRECT CURRENT. DO NOT DISCONNECT THESE COMPONENTS WHILE THEY ARE UNDER POWER. DO NOT APPLY POWER WHEN THESE COMPONENTS ARE DISCONNECTED. SEE FIGURE TWO FOR DETAILS.***

### 3.1 Identifying the components

As shown in Figure 1, the telemetry system comprises four (4) major components. These are the Xantrex or Kepco deck power supply with communications unit, the on-board deck interlock cable, the coaxial interconnect cable with clevis termination, and the tow bar / wet-end telemetry bottle. Photographs of these four components are shown in Figure 3. These images can be used to identify the components and their associated cables. If the telemetry system is provided by Geometrics as an integrated system and a coaxial tow cable is included, no splicing or other direct wiring will be required. However, if the user will be attaching the Telemetry System to a coax cable system not supplied by Geometrics, then the information provided in section 3.2 shows the correct method for connecting the coaxial cable to the deck and telemetry bottle cables.



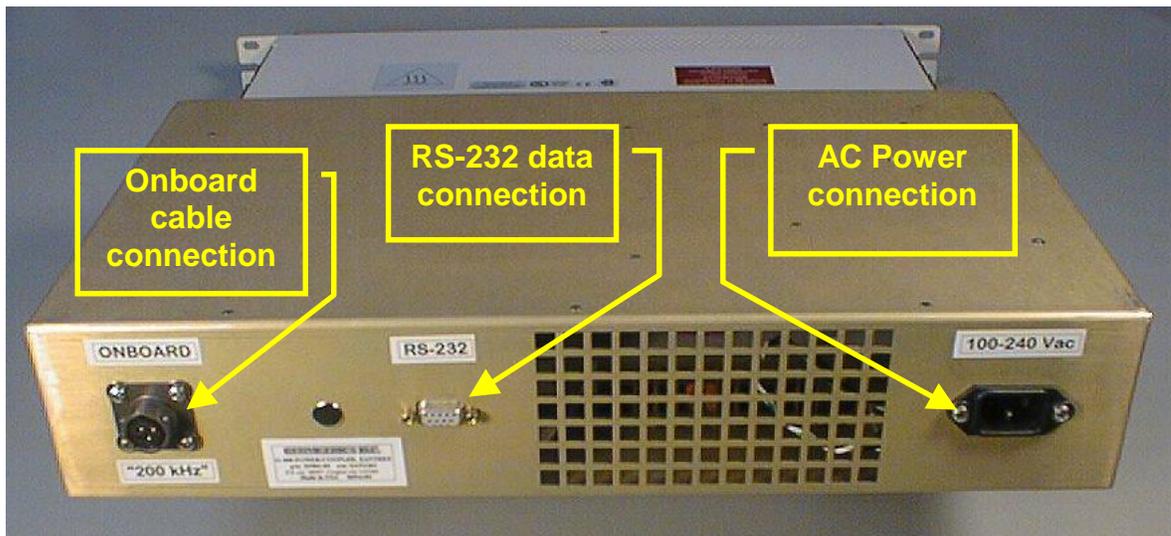
**Figure 3. Standard telemetry components.**

Clockwise from the upper left-hand figure these components are: A) Power supply / communications unit, B) On-board deck cable, C) Interconnect tow cable with clevis termination, and D) Tow bar / telemetry bottle with anti-rotation weight.

### 3.2 Installation of the Power Supply

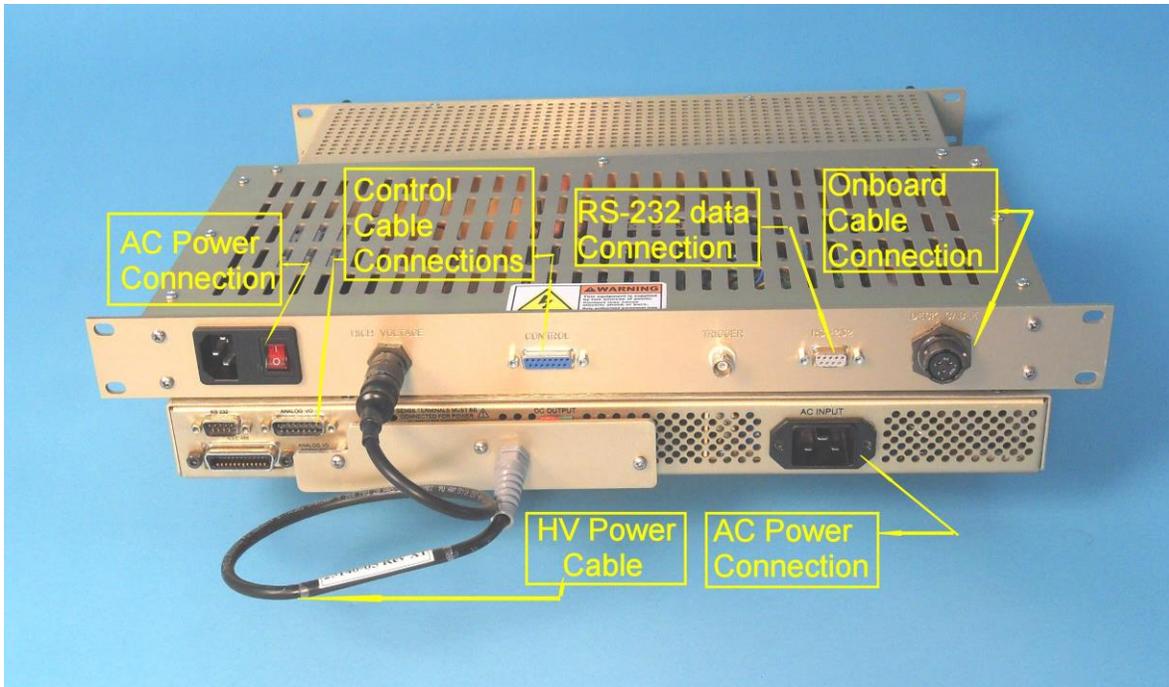
Typically, the power supply is located close to the logging computer in an instrument cabin. We recommend mounting the AC Power Supply in an enclosed area where it will not be subject to wet conditions but will be provided with adequate ventilation. The power supply is equipped for installation in a standard Western Union type instrument rack and Geometrics recommends installation in this type of ship-mounted rack cabinet. In any case, the power supply should be mechanically secured so that it remains immobile when exposed to the pitch and roll of the survey vessel. The mounting scheme should also permit initial access to the electrical connections located on the back panel of this component.

Geometrics systems are supplied with power supplies made by Xantrex and Kepco. The Xantrex model is the XFR 150-8. The Kepco model is the KLP150-16. These power supplies have been modified by Geometrics to perform their intended function. These units are automatic ranging: it will run on a supply voltage ranging from 85 to 130 VAC or 190 to 264 VAC at 47 to 63 Hz.



**Figure 4. Xantrex Power Supply.**

Rear view of rack-mountable unit showing connections on the component's back panel.



**Figure 5 Kepeco Power Supply**

Rear view of rack-mountable unit showing connections on the component's back pane

### 3.3 Power Supply Connections

The power supply has three connections on the rear panel. As shown in Figure 4 these are: Onboard interlock cable connection, the RS-232 data connection, and the AC power connection. Connect the Power Supply to the AC service but **do not turn it on at this time**. Connect the RS-232 serial port to the logging computer using the RS-232 data cable. Connect the on-board interlock cable to the power supply and run it to the winch drum. Pay special attention when routing the on-board cable to make sure that this cable will not be crushed or cut or cause a safety hazard.

Connect the on-board interlock cable to the Coaxial Tow Cable stored on the winch drum. On the winch, a slip ring assembly, like that shown in Figure 5, may be used as the connection point for the on-board cable. You may need to follow directions in section 3.6 for making a water-tight connection to a slip-ring assembly not supplied by Geometrics.



Figure 6. On-Board Cable, interconnect cable, and typical Slip ring assembly.

### 3.4 Deck cable connection – interlock connection

The power supply must be used with the on-board deck cable supplied with the system because the cable forms an interlock between the supply and the load. Using another type of cable will either not work, may damage equipment, and/or pose a safety hazard. The interlock system is designed to turn the power supply's output off if the on-board cable is unplugged at either the power supply or the winch-end interlock connection.

### 3.5 Slip-ring connection

Consult the documentation provided by the manufacturer of the slip ring and winch for information on the interconnection of these components. The electrical connection between the interconnect cable and tow cable is shown in Appendix Figure A1.

### 3.6 Tow cable connection

Many systems are supplied for use with the customer's steel or Kevlar coax cable (e.g. side-scan sonar cable). ***In these cases a 5 wire pigtail connector will be supplied and this should be spliced to the customer's tow cable This pigtail connector MUST have pin#4 connected to the tow cable center coax conductor and pin #5 connected the tow cable shield (screen).*** This pigtail connector will attach to connector J1 shown in the System Wiring Diagram in Appendix Figure 2). Any other pin connections will disable the Interlock circuit and the power supply will not supply power. A reverse-polarity circuit protects the input circuit of the Deck Power Supply Communication Unit. It will not function if the 5 wire input connector is wired incorrectly.

The voltage at the 5-pin connector is **DANGEROUS. Do not probe this connector with the deck supply turned on!** The best way to determine if the system is connected correctly is to refer carefully to the System Wiring diagram (Appendix Figure 2). The system will draw the correct factory-set current if it has been connected properly and the Deck Supply voltage is set high enough to compensate for the tow cable resistance. The Deck Supply voltage output will only rise high enough to keep the supply in constant current mode. These current and voltage values are given in section 3.8.

### 3.7 Telemetry vessel connection

The telemetry vessel has connections at both ends: one for the coaxial tow cable at its front end, and one or two at its back end for one or two magnetometer tow cable(s). The magnetometer tow cable is a multi-conductor cable with a Kevlar strength member, typically 9 meters or more in length. An example of this cable as used on the G-880 is shown in Figure 6. The cables that attach to the telemetry pressure vessel are configured so that they can only be connected to their proper receptacle. Make the mechanical connection of the coaxial cables clevis to the front of the tow bar using the clevis attachment pin as shown in Figure 7. Be sure to also secure the attachment pin with a stainless steel cotter pin. In the same manner attach the magnetometer tow cables to the back of the tow bar with their attachment pins.

*Note: Mechanical connection between the tow bar and a non-standard clevis is possible if the clevis jaw will accept the tow bar and clevis bolt hole is of equal or greater diameter than the matching bolt hole on the tow bar. It may be necessary to use appropriate bushings, shoulder washers and/or washers to obtain optimum attachment between the tow bar and a nonstandard clevis.*

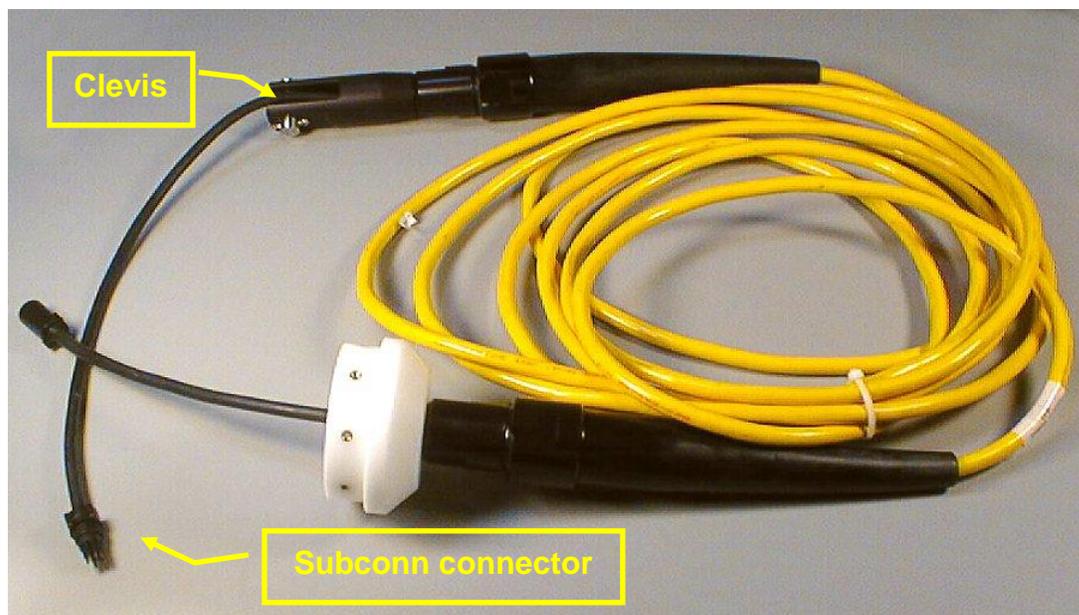
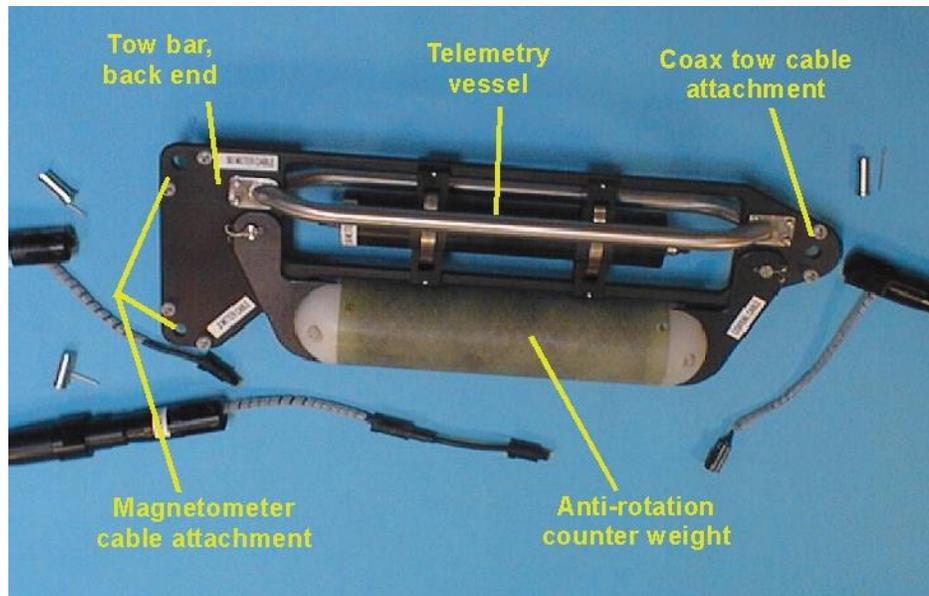


Figure 7. 9 meter G-880 sensor-to-tow bar interconnect cable.

Next, attach the Subconn connector on the coaxial tow cable to the matching connector on the front of the telemetry vessel. Make sure that the socket face and socket pins on these connectors have been coated with a small amount of silicone grease. Mate these connectors by pushing them together firmly until the connector faces meet and then secure the connection by hand tightening the screw-on locking sleeve. Repeat this process for the connection of the magnetometer(s) tow cable(s) at the back end of the pressure vessel. The system should now be contiguous from the Mag Sensor to the Logging Computer. At this point, the telemetry bottle, tow frame and cabling should appear as show in Figure 8.



**Figure 8. Tow bar / telemetry vessel assembly.**



**Figure 9. Telemetry tow bar with interconnect and tow cables attached.**

### **3.8 Power Supply Settings**

The Deck Power Supply is a constant current supply. It is factory set to output sufficient current to operate the G-880/881/882 magnetometer or gradiometer system through

different cable lengths. The power supply voltage output can range from about 15 Volts DC to about 150 Volts DC. The current output is approximately 1.3 to 1.6 amperes for a single sensor system and from 2.1 to 2.4 Amps for a gradiometer system. NO operator adjustment of the output current is allowed or provided.

### **3.9 System Checkout**

Once the system is completely connected, as described above, it should be powered up on-deck to verify performance. When working in a warm environment we recommend placing the tow bar assembly out of the direct sunlight in order to avoid overheating the telemetry bottle. To verify system performance:

- Move the magnetometer sensor approximately 3 feet (1 m) away from any large steel object. In the case of a steel deck, use a wooden crate or cardboard box to raise the sensor off the deck approximately 3 feet (1m).
- Turn on the Xantrex or Kepco Power Supply.
- Connect the output of GPS receiver that is configured to provide the NMEA 0183 data format to the logging computer. Note: two communications ports are required on the logging computer for proper survey operation; one for GPS input and one for the magnetometer input. If the computer is equipped with a USB port then connection may be made using a multi-serial port to USB adapter.
- Start the MagLogLite software and run the Survey Configuration Wizard or start the program using an existing survey configuration if one is available.
- Verify that the magnetometer and GPS receiver are communicating with the logging computer and observe the signal strength and character of the magnetometer data on the MagLogLite display.
- Verify the current and voltage values displayed for future reference.

Some users will prefer to perform the system checkout using Windows' HyperTerminal, Hypack, or some other logging software. Refer to instructions supplied with these programs to verify proper communications and magnetometer performance.

If communication cannot be established, or if they appear to be erratic, turn off the Xantrex or Kepco Power Supply and recheck all connections. If all connections are correct and there is still difficulty with communications or magnetometer performance, refer to the Trouble-shooting guide that follows.

## 4 TROUBLE-SHOOTING GUIDE

We at Geometrics pride ourselves on designing and building instrumentation of the highest possible quality, performance and reliability. If you are experiencing difficulties with the operation of the equipment, our goal is to get you up and running as quickly as possible. For that reason we supply the following troubleshooting guide. Please work through these suggestions before contacting Geometrics. It will help us serve you better and more quickly.

- 1) **Check all connections** - The cabling systems cannot be connected in any manner that will damage the electronics, due to the reverse polarity and over voltage protection circuitry, but there may be a loose connection or a bad connection. Check each underwater connector and Deck box connector for proper seating. Note: front panel knobs are not operational and have no effect. The deck cable contains an interlock circuit and must be connected properly to operate. *Before connecting or disconnecting any of the components carrying high voltage make sure that the power supply is turned off.*
- 2) **Simplify the System** - Test the magnetometer separately from the telemetry and Xantrex or Kepco power supply using the small white junction box and black box AC power supply. See the magnetometer manual for specific information regarding your model magnetometer. Verify the magnetometer communicates to your computer. Test the magnetometer using the short multi-conductor tow cable (typically 9 Meter length) which normally attaches to the telemetry bottle. Connect it directly to the DC data Junction box using the using the supplied test adapter.
- 3) **Check power** – If problems persist, Turn Off the power supply, disconnect the telemetry decoupler bottle from the tow cable. Connect a volt meter to the coaxial tow cable and leave the deck and tow cables connected to the power supply. Turn on the Xantrex or Kepco power supply: the voltage meter should read approximately 115 volts and the current meter should indicate “0” (zero) current with only the tow cable attached. Turn Off the power supply.
- 4) **Check power** – If problems persist, connect the telemetry decoupler bottle only, to the tow cable (no magnetometer). Turn on the power supply, the current indication meter on the deck Xantrex or Kepco supply should read between 1.3 to 1.6 Amps for single mag systems. For gradiometers the proper current is 2.1 to 2.4 Amps. Note that the Kepco Supply requires two AC outlets to function. The current limit indicator light should also be lit. Turn off the power supply.
- 5) **Check power** - Now connect the magnetometer to the telemetry decoupler bottle using the short multi-conductor tow cable. Turn on the power supply. The voltage indication should rise slightly from the previous measurement, and RS-232 communication should be established. If the magnetometer operation has been verified, and the cables checked,

and the voltage and current indication on the power supply appear to be correct, see next step below.

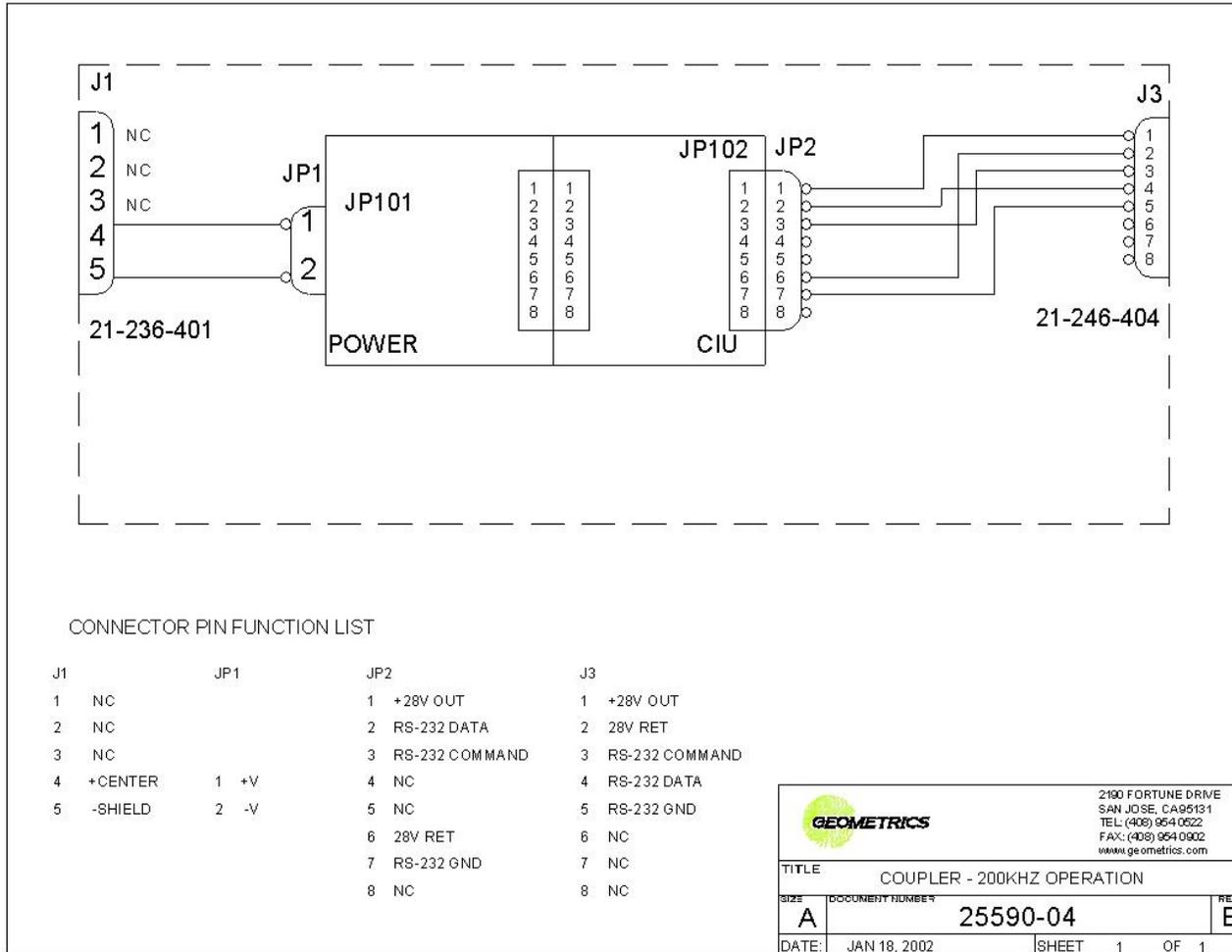
- 6) **Check Comm. port settings** - Many problems stem from improper Windows communication or port settings. We suggest that you shut down the MagLog or Hypack software programs and use Windows HyperTerminal program to troubleshoot communications problems. Using HyperTerminal (go to Start, Programs, Applications, Communications, HyperTerminal) start HyperTerminal (hypertrm.exe). Set up a new dial-up connection and select DIRECT TO PORT. Select the serial com port that is assigned to the magnetometer; also try the other com port that is connected to the GPS. Baud rate for serial transmission is up to 9600 for the magnetometer and 9600 or 4800 for the GPS. Note that the serial transmission rate of the magnetometer is faithfully reproduced at the topside, so that a magnetometer whose default is 4800 baud will also transmit 4800 baud to the logging software through the telemetry system. Click on DIAL and the HyperTerminal screen should show data streaming up the page.
- 7) **Serial port converter** - If communication cannot be established using HyperTerminal for either the GPS or Magnetometer serial transmissions, then the problem is most likely in the setup of the serial ports. Are you using USB to Serial Port converters? We have found that PCMCIA Serial Converters have better drivers especially for Windows ME and 2000 and XP. We suggest that you use local resources or call us if you cannot get either port to respond to either Magnetometer or GPS serial transmission.
- 8) **Restart the system** - If you have confirmed that the GPS receiver is sending data, but the magnetometer is not sending data, we suggest that you completely power down the system and restart to reset the microprocessor in the magnetometer.

**Temperature** - If the telemetry system has been run on deck it may have shut down due to an over heating condition. Turn power off and wait until the system's telemetry bottle has been cool to the touch for about 10 minutes. When the unit is cool repeat step number 2) and verify proper operation.

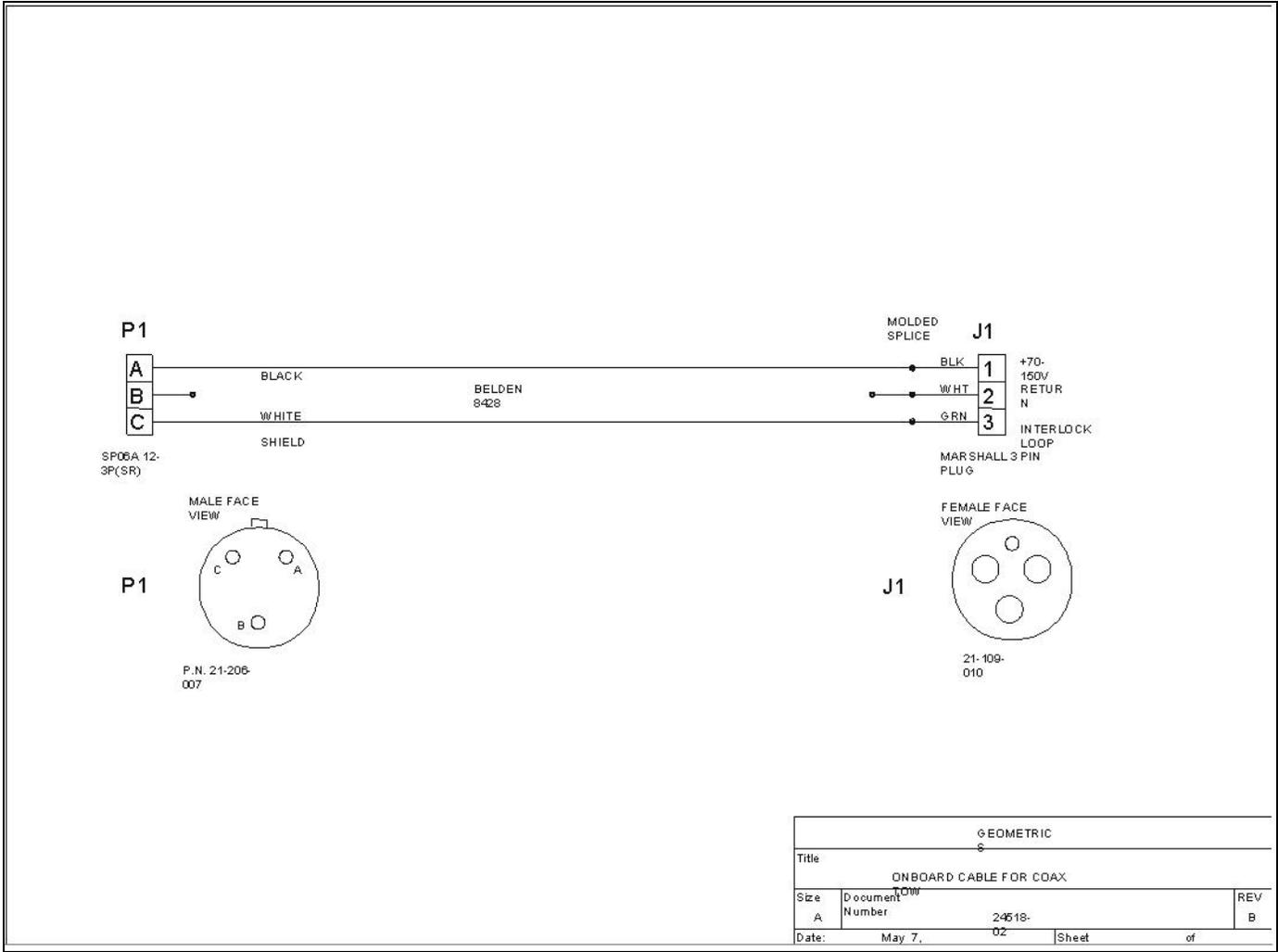
# APPENDIX



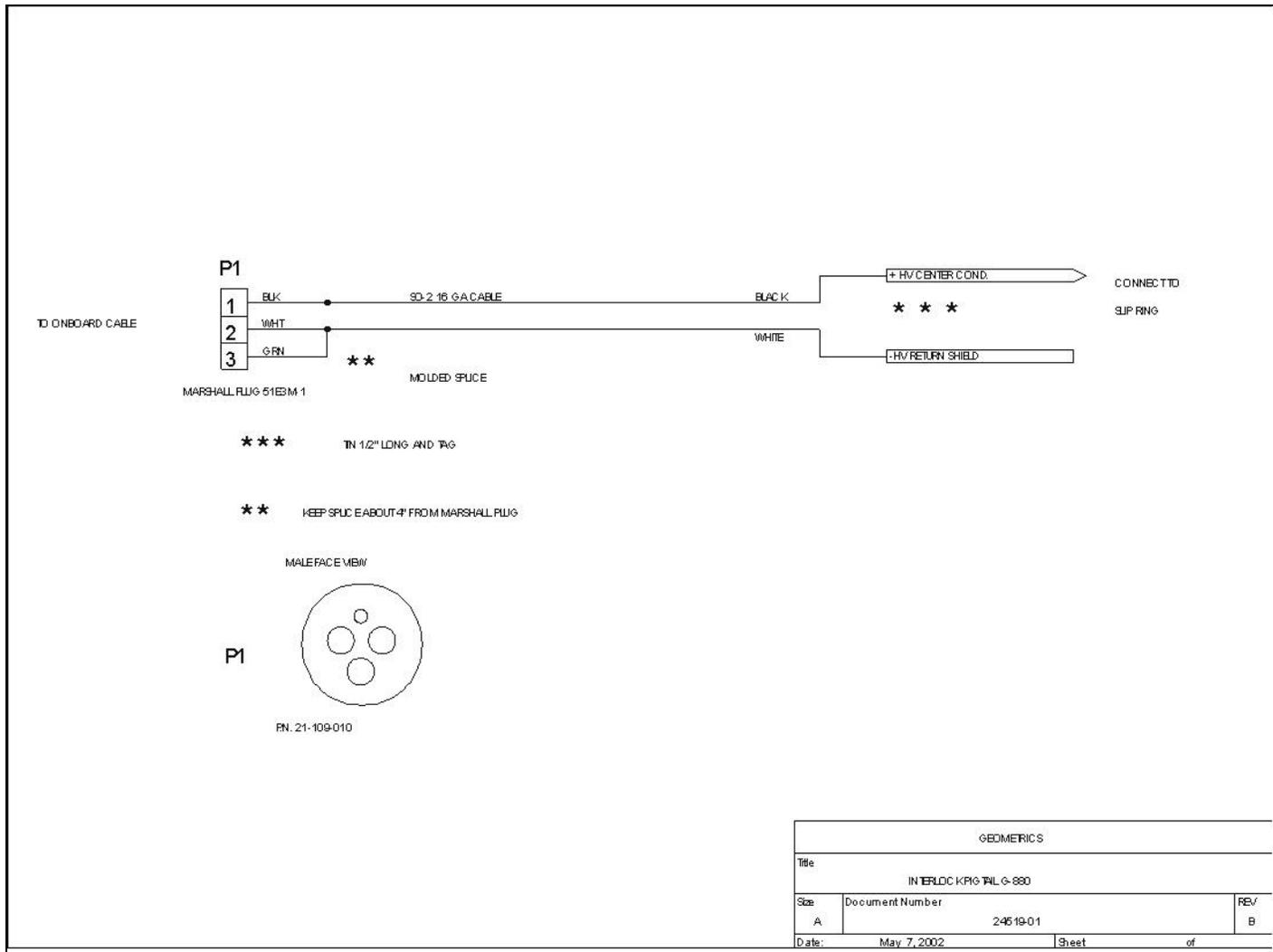
# A1 CIRCUIT DIAGRAMS



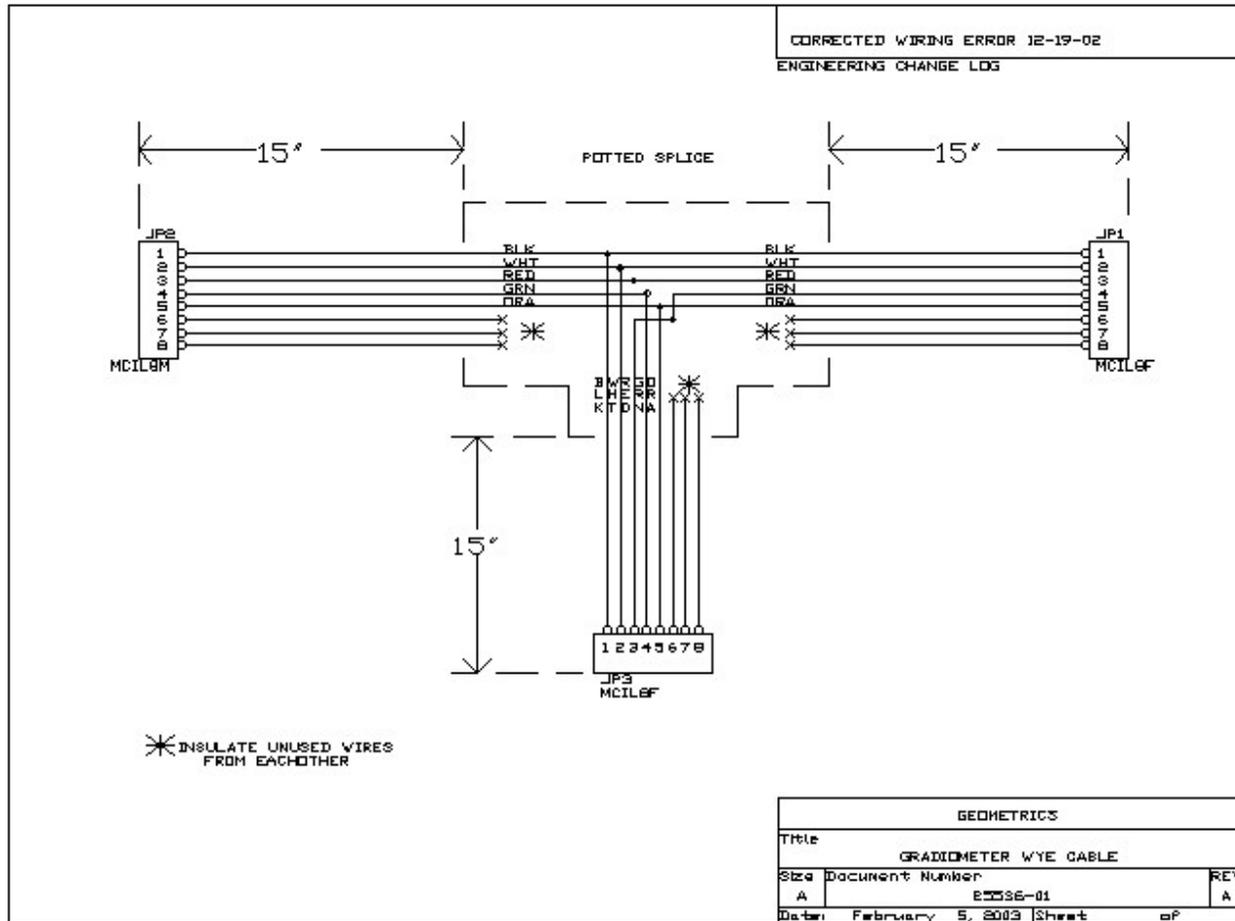
Appendix Figure 1. 200khz coupler.



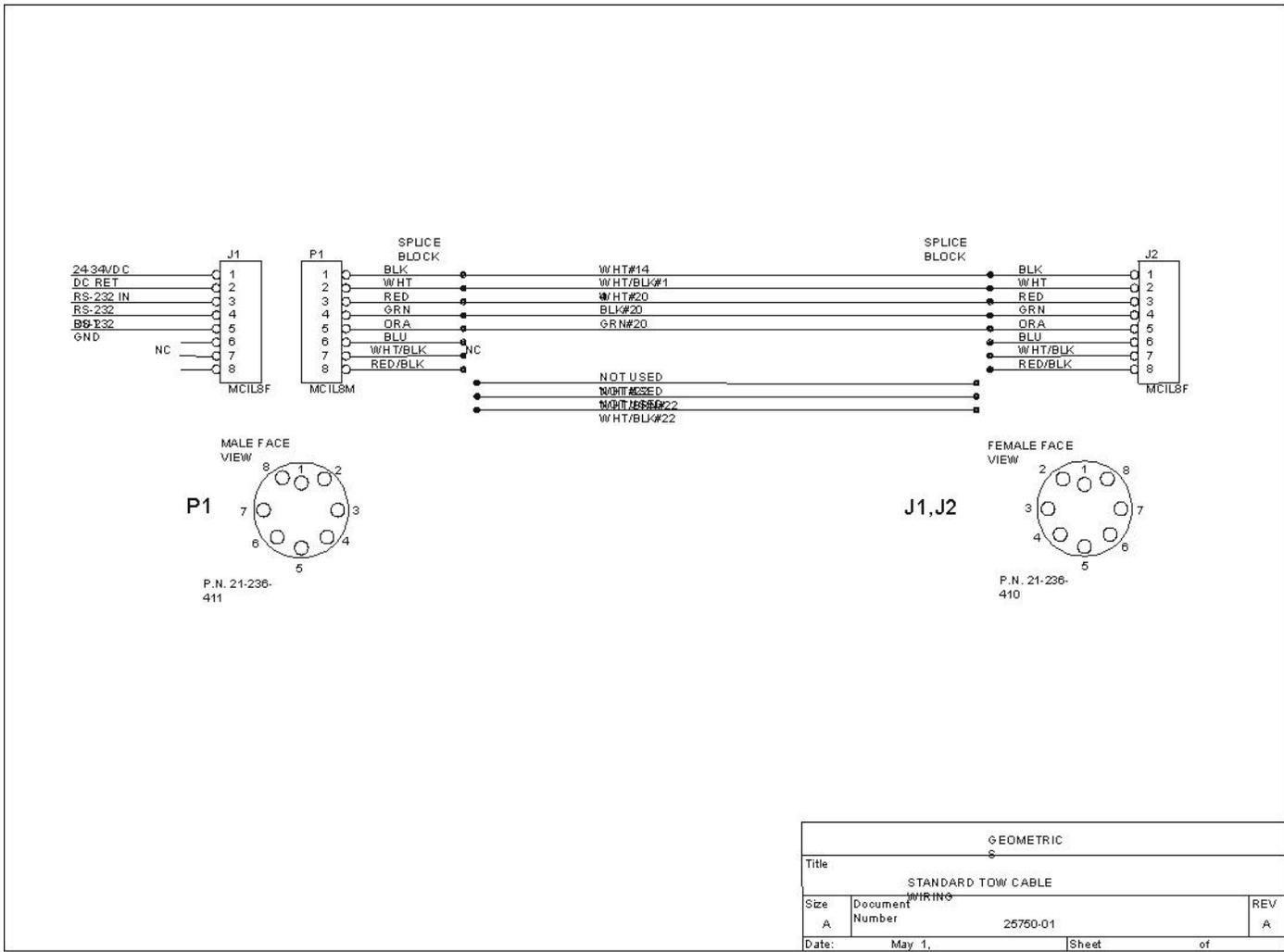
**Appendix Figure 2. Onboard Cable for Coaxial Tow cable.**



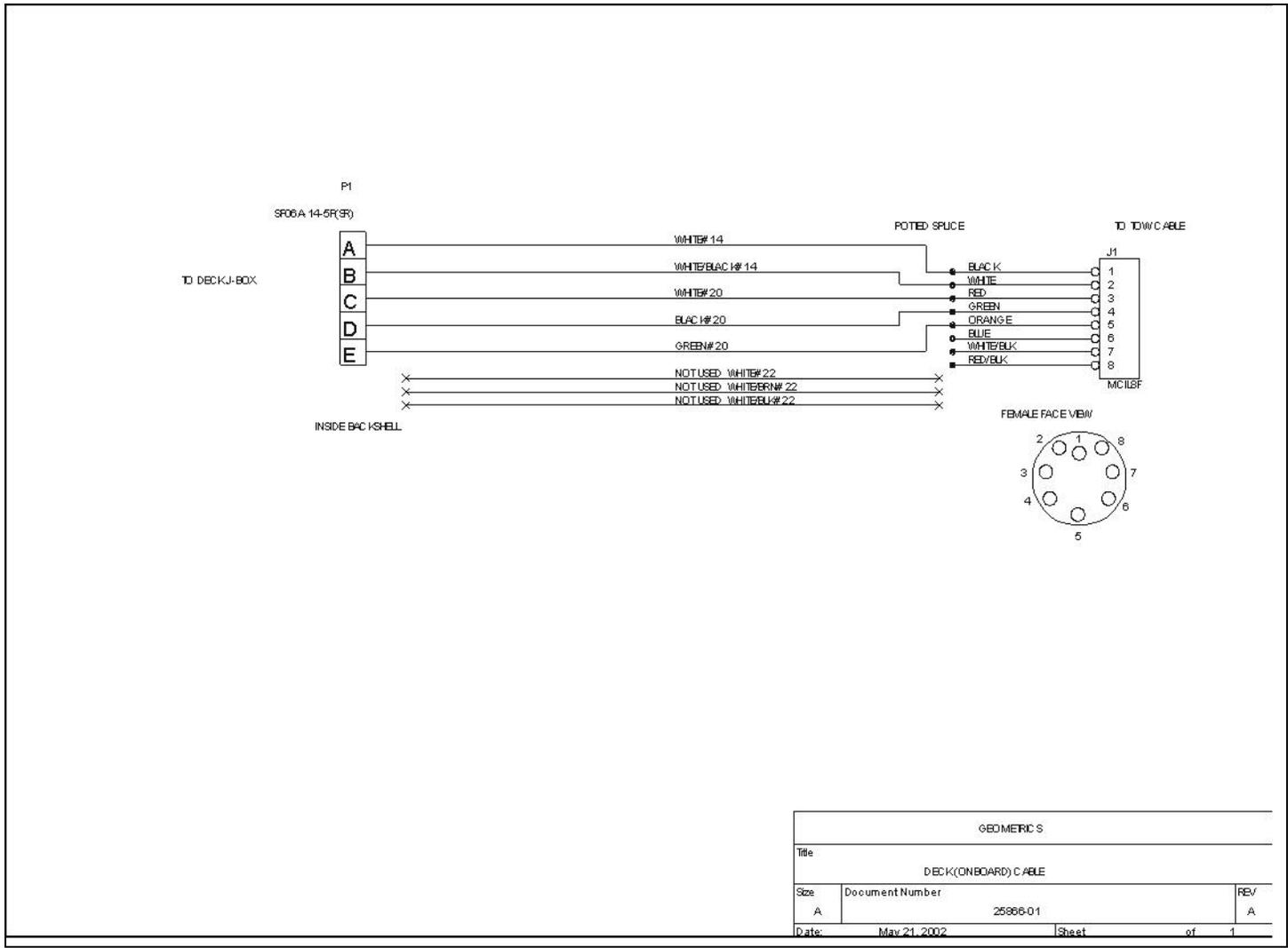
Appendix Figure 3. Interlock Pigtail Cable.



**Appendix Figure 4. Gradiometer Cable.**  
(For systems that do not include telemetry system.)



Appendix Figure 5. Standard (24 –33 volt) Tow Cable Wiring.



Appendix Figure 6. Deck Cable.

## A2 – TOW CABLE RETERMINATION

The section describes Geometrics' Procedure #50050-TI/02 for re-termination of Kevlar reinforced cable P/N 60-453-096 and requires a termination kit (P/N 50025-01). If this procedure is closely followed the termination will permit the maximum strength of the cable to be realized. This cable type has been pull tested to breaking and is now rated to break at about 3800 lbs. The working load rating on the cable is 700 lbs. Any other specifications for this cable are superceded by this document.

### Supplies And Tools Required:

Acetone or MEK  
Alcohol-Isopropyl or Denatured  
Ohm-meter or Megger  
Scalpel or X-Acto type knife and extra blades  
Wire cutters  
Needle nose pliers, with gripping teeth  
Rosin-core solder  
Soldering iron-50 watts  
Large bench vise with soft jaws  
6 inch ruler  
Plenty of paper towels or clean rag wipers  
Sharpie type marking pen  
Sharp scissors  
Sturdy work table

**Note:** Please read these instructions and check the parts supplied against the parts list before proceeding.

**CAUTION:** Do not smoke or eat while terminating cables. The solvents are flammable and the potting materials are not to be ingested.

**CAUTION:** Wear safety glasses to protect against any materials getting into the eyes.

**CLEAN** all of the metal parts with acetone or MEK, before doing any potting. This will aid in getting a good bond between parts. Do not get the solvent on the molded Bend Relief boot on p.n. 25890-01.

- 1 Locate the Esmet Bend Relief, p.n. 25890-01 and slide it down the tow cable a few feet out of the way. Be sure that the small tapered end goes on first!
- 2 Now, slide the Socket, p.n. 24585-02, down the cable about 2 feet. There is a key cemented into a keyway in the tapered bore. Take care that it does not become dislodged from the keyway.
- 3 Clamp the end of the tow cable in the vise, leaving about 1 foot above the jaws. Do not clamp too tightly, just enough to keep the cable from slipping out. Use towels or rags to protect it.
- 4 Use the marking pen to mark four evenly spaced lines about 4 inches long down the jacket, starting at the end of the cable. These will be slits cut into the jacket, so it can be stripped back from the inner core. Draw a circle around the cable, at the end of the lines. Draw another  $\frac{1}{4}$  inch down from the first one.

- 5 The jacket must be slit on the four lines to form flaps. This must be done very carefully, as the Kevlar strength member fibers are easily damaged. Start cutting at the end of the cable and guide the knife so it will not penetrate all of the way to the Kevlar. The cuts on the end of the cable can be somewhat deeper, since only the 2 inches closest to the bottom of the flaps will be in the potting resin. The rest will be trimmed away, later. It should be possible to aid the cutting by using the pair of pliers to grasp the jacket and help it separate at the cuts. Only cut two lines, opposite, so two wider flaps are formed. At this time, the cutting and pulling will expose the Kevlar and it will be seen that the jacket sticks to the Kevlar. Carefully tease the Kevlar away from the jacket, so it is not damaged. After the flaps reach the end of the lines, at about 4 inches, the other two lines can be cut down to the same length. The scissors can be used for this job.
- 6 Use some of the tape supplied to hold the jacket flaps down out of the way and use the hair brush to smooth out any snarls and tangles in the Kevlar. Remember-try not to break any Kevlar strands!
- 7 Bring the Socket up and stop it so the bottom ends of the flaps are just inside the projecting nipple on the bottom. The bottom-marked circle should just be showing below the nipple. Remember that the object is to capture as much of the jacket as possible and keep the ends of the cuts inside of the socket. Use the tape to stop off the bottom of the nipple, so no potting mixture can escape while pouring. Use only two wraps.
- 8 Drape the Kevlar strands out away from the wires in the center, so they can be first unwrapped and then cleaned of the water- blocking compound. The compound is somewhat like wax. It can be pulled off the wires as they are unwound from each other. Clean the wires with the alcohol only. First, soak a wiper the alcohol and then use it to wipe down each wire. Now, locate and cut the filler rod, just above the point where the jacket flaps bend over the sides of the Socket. The filler rod can be mistaken for the black jacketed wire, so be careful.
- 9 The wires should now be twisted back together, so the potting resin can be poured. Go back and smooth out the Kevlar with the hair brush and make sure that the strands are evenly distributed around the center conductors. Clamp the Assembly Jig, p.n. 50021-01, to the work table and set the Socket into the Fixture, so it is down on the stop. Hold it in place with a few wraps of the tape. Use tow more lengths of the tape to hold the cable down on the lower guides. The fixture is necessary, so the cable will be concentric with the socket, after potting.
- 10 The resin pack should now be readied for mixing. Be sure that the gloves are put on first. Now, use the pliers to pull the outer black plastic retainer from the resin pack. Then pull the inner rod out and start to mix the clear catalyst into the resin. Do not open the pack, until the resin has been mixed. Work the resin round and round to mix it completely. The mixing should proceed for about 45 seconds to a minute. Now, carefully cut one corner of the pack. There is excess resin, in the pack, but less than half of this is necessary for the potting.
- 11 Slowly pour the potting mixture into the top of the socket along one side the Socket. The resin will soak into the Kevlar, so keep pouring until it reaches the top flange of the socket. Try not to disturb the Kevlar after the pour, as the resin mix will start to set

up in about a half-hour after mixing. The assembly may become warm, but the pack will become quite warm, so be sure that it is on a sheet of waste, in case it starts to leak. The remaining resin will probably set before the resin in the socket, so it should be left alone overnight, if possible.

- 12 After the resin has completely set up, the excess Kevlar and the jacket flaps must be trimmed away. Do not use a knife to do this, as it might slip and cut either the operator or the cable! Use the wire cutters to “nibble” away at the excess.
- 13 The conductors may now be readied for connection to the Pigtail. There will normally be five of the eight wires connected. Follow the wiring diagram, 25750-01 included with the kit to be sure that the correct wires are connected together. First, cut the correct wires to about 2 inches in length. Prepare the wires, so that about  $\frac{3}{4}$  inch of each chosen wire has been stripped. Carefully solder each wire for the entire stripped length. Do not overheat the jacket, as it can melt. Then, slip a 1-inch piece of the fiberglass sleeving down over each wire. Form a hook in each wire, so it will form a good mechanical connection to the wires on the Pigtail. Leave about  $\frac{1}{2}$  inch of each tinned wire open. This will help to form a water-block at each conductor, after the final potting step.
- 14 Cut the pigtail to the correct length and strip the jacket off. About 2 inches of jacket should be removed. Be careful, when cutting the outer jacket, so the covering on each wire is not damaged. Remove any inner packing and unused wires with the wire cutters. Strip each selected wire about  $\frac{3}{4}$  inch and tin it with solder as was done on the tow cable conductors. Form a hook as above on the tow cable. After each wire has been connected and the hooked ends are crimped with the pliers, they can be soldered. Clean each wire with alcohol. Slide the tubing over each soldered wire. The fiberglass tubing is used, as it is porous and the Scotchcast will soak through to form a water block.
- 15 At this point, the cable wiring should be checked against the diagram. Test for both open and shorted conductors. A WORD OF CAUTION! When probing a watertight connector socket, such as the female connectors used on this cable, be very careful not to use a test probe larger than the pin diameter of a male connector. If a larger probe is forced into a female contact, it can be damaged, and will become intermittent. If there is a spare mating connector for each end of the cable, use it to connect to the ohm-meter or Megger. Wipe the jacket on the pigtail with the Acetone or MEK, for about 3 inches from the soldered connection area. Do not get Solvent into the potted tow cable end!
- 16 The next step is to take the Socket out of the Assembly Fixture and remove the tape from the nipple on the bottom of the Socket. Slide the Esmet Bend Relief, p.n. 22890-01 up until it nearly bottoms on the Socket. Mix a small amount of the 5 minute epoxy and apply it around the Socket, just under the top flange. Pull the Socket down, so the flange seats on the threaded end of the Esmet. Wrap about two wraps of tape at the point where the tow cable enters the Strain Relief.
- 17 Put this assembly in the vise and hold it vertical, with the vise clamped to the body of the Esmet. Use rags to protect the anodized finish. Wait for 5 minutes before moving to step 18.

- 18 Screw the threaded Adapter on to the Esmet. Tighten it hand tight. Locate the Scotchcast 2130 compound, p.n. 16-300-001. Open and mix it according to the instructions on the inner pack. It will mix in a similar way to the Socketfast Bi-Pack. Cut the bag on a corner, as before and pour it into a cup. This is then poured into the top of the Adapter, along one side of the cable pigtail. Pour slowly. It will run down around the cable until it fills up to the top of the Adapter. Check often, in case the potting needs topping off. The Pigtail should be supported, so it is centered over the hole in the Adapter. The assembly should now be left to cure at least overnight.
- 19 Perform electrical tests again, after the overnight cure.
- 20 Lubricate the female contact holes in the Pigtail with silicone grease. Use only a small, match head-sized amount in the mouth of each contact. If too much grease is packed into the female contacts, it may permanently spread the contact open and render it unusable.

### A3 - THEORY OF OPERATION

Geometrics Coaxial Cable Telemetry System uses a FSK ("Frequency Shift Keying") modem telemetry technology to send signals over long marine coax cable such as that used for Side Scan Sonar systems. Its primary purpose is to communicate and supply power to our marine magnetometer systems such as the G-880, G-881, and G-882.

The choice of the frequency used in an FSK system will determine the rate of data transmission as well as the attenuation of signal strength with distance for particular cable. If the frequency range is chosen correctly FSK technology allows data transmission through low loss coax cables over great distances. Geometrics telemetry system is centered on 200 kHz and can transmit over cables where the total attenuation of signal is less than 60db at 200 kHz. We use this frequency range because 200 kHz signals have much better propagation and less attenuation than higher frequency systems. Typical low loss cables may have losses in the range of 8 to 10 db per kilometer. This means that the Geometrics Telemetry System will be able to transmit bi-directional data over coaxial cables as long as 6 km.

The FSK method is often used to transmit logical signals over long distances. All signals are transmitted as sine waves at either of two particular frequencies that lie close to 200 kHz . One of these frequencies represents a logical "true" and the other frequency represents a logical "false".

FSK transmission of data has the advantage of being relatively immune to noise. Only noise that happens to have a frequency near one of the two frequencies can interfere with the data. This is important because electrical machinery used in and near the winch can produce large amounts of electrical noise at the mains frequency (50Hz or 60Hz) and its harmonics.

Tow cables do not have flat frequency responses. Higher frequencies tend to be attenuated and time-delayed more than lower frequencies. If a signal that contains a broad band of frequencies is transmitted on a cable, the wave shape will be very distorted when it gets to the other end. An FSK system is largely immune to this problem because of the narrow range of frequencies used.

Geometrics telemetry systems operate bi-directionally, meaning that commands can be sent to the magnetometer to change cycle rate, toggle analog channels, or data rates, and also receive data back from the magnetometer at the same time. Characters can be traveling in both directions simultaneously on the cable without interfering with each other. This is called "full-duplex" communication.

Full-duplex communication is important in high performance magnetometers, because the magnetometer is sending many characters of data per second. Without full-duplex

communications, commands would have to be sent very slowly to the magnetometer to fit them in between the characters of the data coming from the magnetometer. The FSK modem technology provides a transparent communication interface between the Logging Computer and the Magnetometer, both of which use RS-232 to communicate. The baud rates are faithfully recreated at the receiver end.

The selection of the frequencies used in the FSK system was based on several considerations. There must be a pair of frequencies for the down-going communication and a different pair for the up-coming communication. There must be enough difference between these two pairs of frequencies that the receiver circuit can detect them without interference from the signals being transmitted. There must be enough separation between the two frequencies in a pair to allow the receiver to quickly determine which frequency is being received.

The electrical noise on the fantail of the ship is usually stronger at lower frequencies than at higher frequencies. For this reason the higher pair of frequencies was selected for the up-coming communication.

Commands signals sent down the cable use frequencies of approximately 38 kHz and 58 kHz. Data signals coming up the cable use frequencies of approximately 150 kHz and 250 kHz.

The Telemetry System employs a sophisticated DC/DC converter, over-voltage, and Reverse-Voltage protection circuits. The Xantrex or Kepco Deck Power Supply produces a constant current at up to 150 VDC that is converted to a stable 28 VDC for the operation of the Magnetometer or Gradiometer system. Unlike most electrical systems, the Geometrics Power Supply system is a constant current design, rather than the more typical constant voltage design. This means that no more power than required is sent to the Wet-End Telemetry Bottle electronics. The voltage produced by the Deck Power Supply will increase when a longer cable is used or a magnetometer draws more power from the DC-to-DC converter in the Telemetry Bottle.

Another function of the telemetry vessel is to provide a transition point between the steel armored coaxial cable that is magnetic, and the non-magnetic Kevlar tow cable used to connect the Magnetometer to the Tow Bar Assembly. In this way we remove the effects of the steel cable that would otherwise be detected by the sensitive cesium magnetometer system.

#### A4. BLOCK DIAGRAM OF SYSTEM COMPONENTS

