GeoEel/P-Cable Operator's Manual and Reference

Version 2.1
GeoEel Software V. 5.851
GeoEel Tester V. 20.9.0.0

GEOMETRICS

About This Manual

This manual is intended to be a useful field reference for the GeoEel, including its 3D configuation, the P-Cable. Every attempt has been made to cover all aspects of the system, in consideration of the fact that the system will often be used in parts of the world where communcation with Geometrics Support may be impossible. As such, it is quite long. While having a printed version can be handy, you will find this manual to be most useful in its electronic form. It is fully-searchable, with many hotlinks.

We welcome your input. Please send any suggestions for improvement to seismicsales@geometrics.com.

by Craig Lippus

GeoEel / P-Cable Operator's Manual

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Part I

1 System Overview

The GeoEel™ is a highly-flexible, modular marine Streamer system and consists of a variety of components, analog and digital, dry and wet. It can be deployed in a 2D or 3D fashion. The 3D version is called the "P-Cable"™. Schematics of each are shown below.

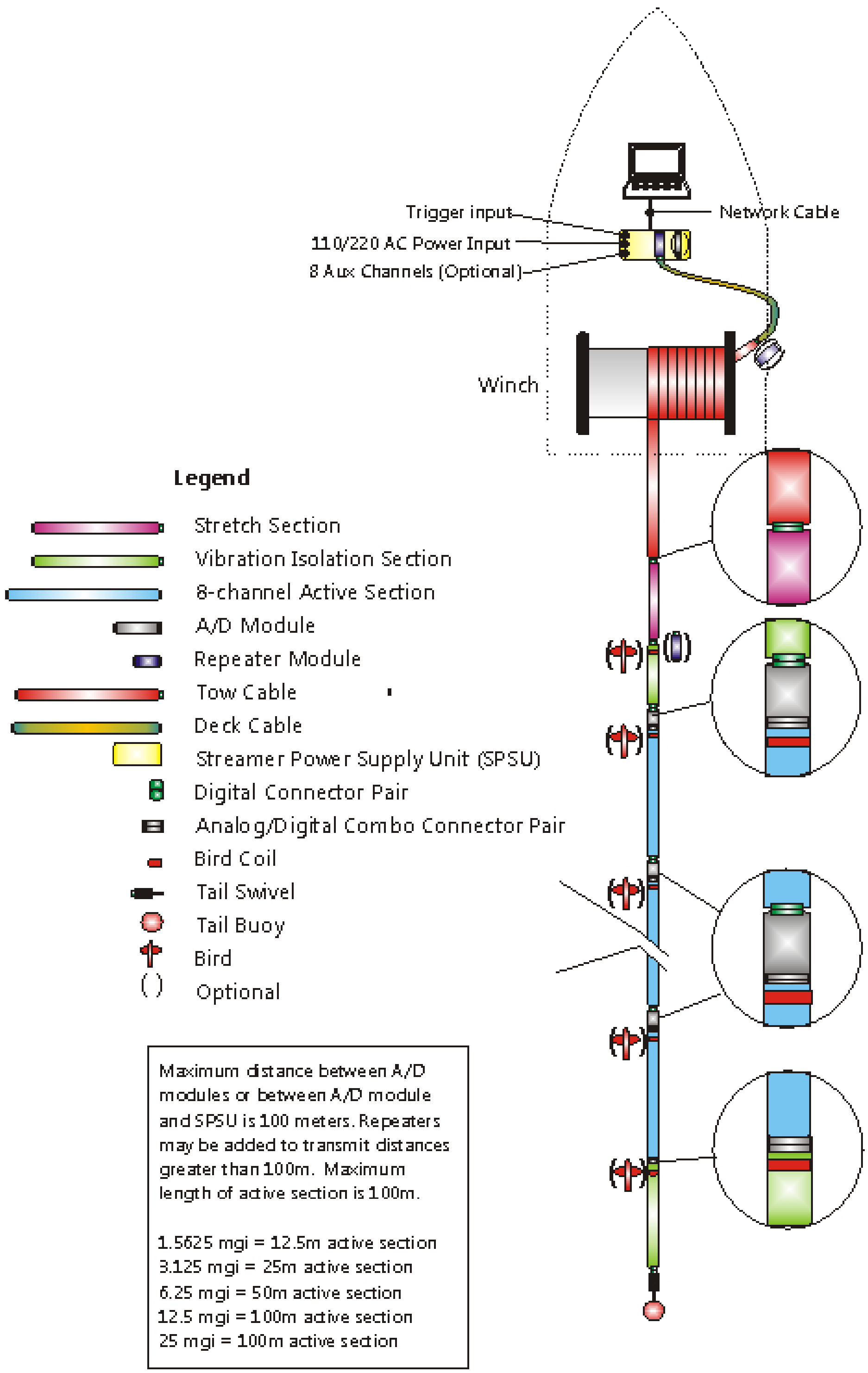


Figure 1: 2D GeoEel Schematic

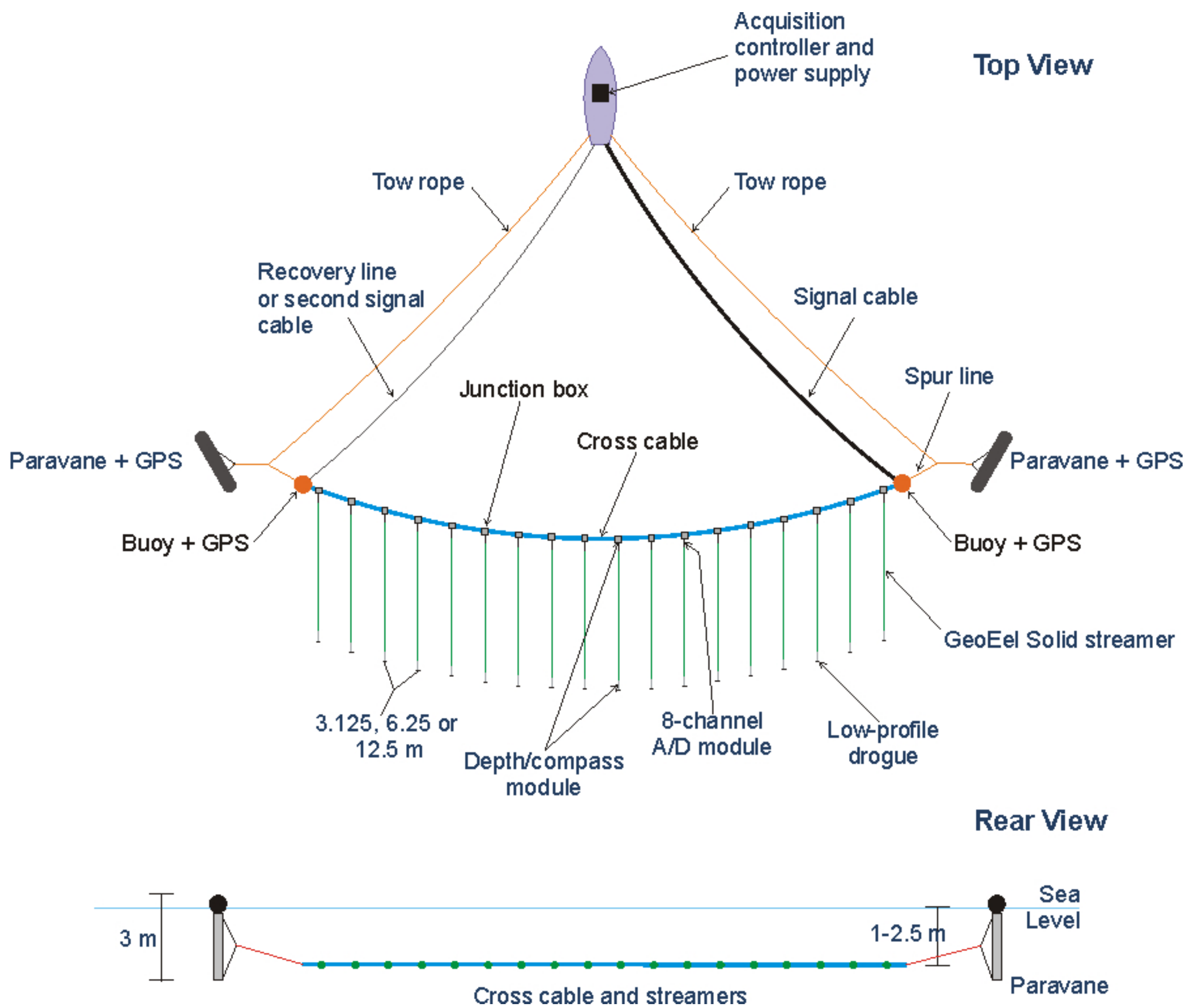


Figure 2: 3D P-Cable Schematic

1.1 Top-side Basic Components

- **PC with CNT-2 Marine Controller** – Windows-based, multi-threaded user interface, data storage.
- **Streamer Power Supply Unit (SPSU)** – Main hardware control unit, also called the “Deck Unit”. The Deck Unit provides power to the in-water components, accepts inputs from a shot controller,

supplies a gun control output signal, and all the necessary signals for the Streamer. It also contains eight auxiliary channels. The PC is connected via a standard CAT-5 RJ-45 Ethernet cable. The Deck Unit receives data from in-water components and passes them through to CNT-2 Controller.

- **Deck Cable** – Connects Deck Unit to Tow Cable.
- **Repeater** – Receives and re-transmits Ethernet packets. Required every 100m.

1.2 Wet-end Basic Components

- **Tow Cable** – Connects Deck Cable to Stretch or Vibration Isolation Section.
- **Vibration Isolation Section** – Fluid-filled or solid section, generally placed at inboard and outboard ends of active portion of Streamer.
- **Stretch Section** – Fluid- or gel-filled section, generally placed at inboard end of active portion of Streamer. Stretches to 110% of total length.
- **Digitizer** – Titanium module; contains 8-channel A/D circuitry.
- **Active Streamer Section** – Fluid-filled or solid section containing hydrophones.
- **Tail Swivel** – Attaches to end of last section in Streamer; provides tie-point for tail buoy.

Part II

2 Hardware

This section describes the various components that make up the GeoEel system. All of these components are used in both 2D and 3D P-Cable configurations, with a few minor exceptions and caveats.

2.1 General Hardware

2.1.1 Controller PC

The Controller PC runs the CNT-2 Marine Controller and can range from a simple laptop to a very powerful PC equipped with a RAID, tape drives, and multiple monitors. What you use depends on your application, size/type of vessel, shooting rate, etc.

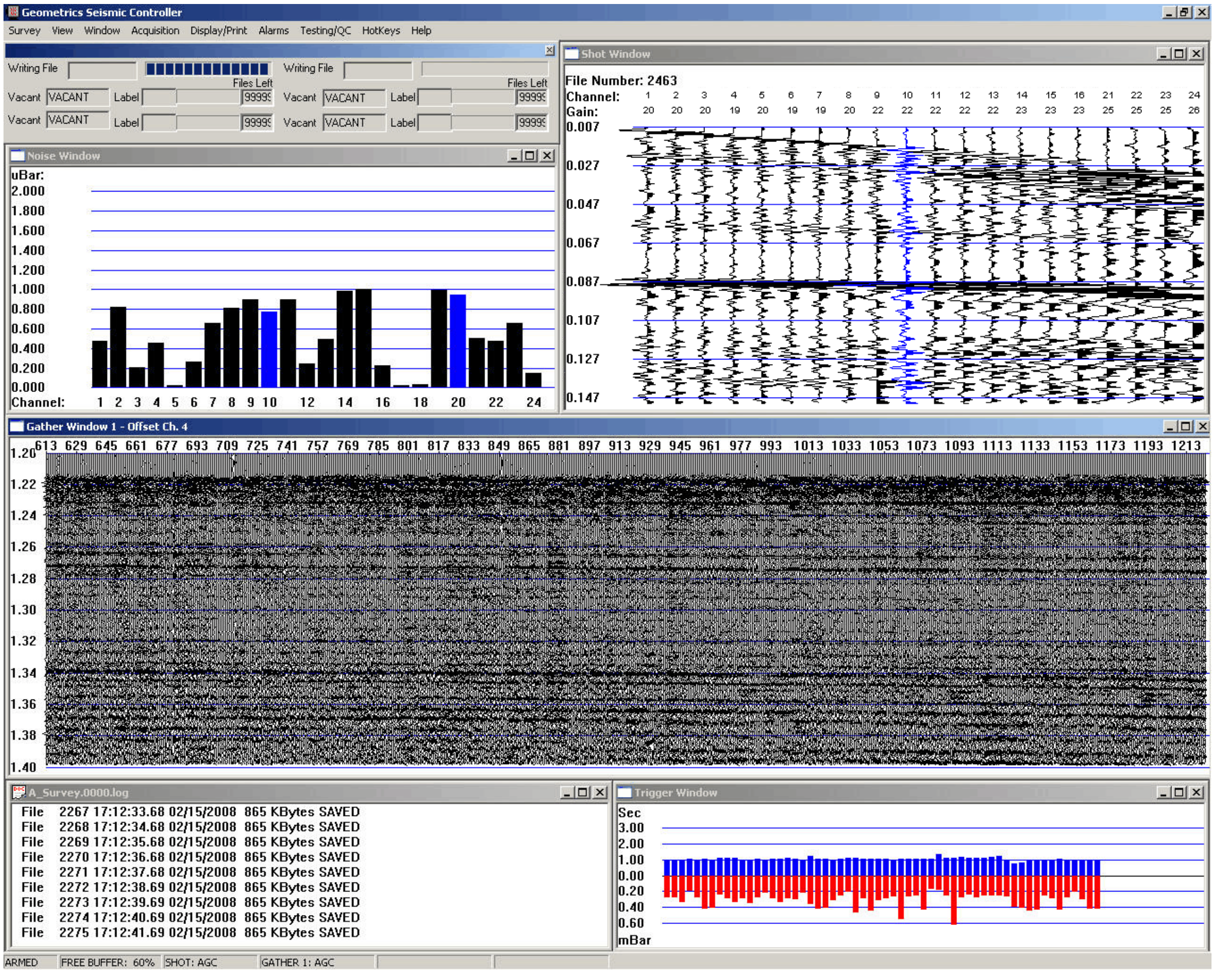


Figure 3: The CNT-2 GeoEel Controller.

Note: *It is highly recommended that Geometrics supply the Controller PC, particularly for larger systems or for systems intended for use in remote areas.*

2.1.2 Storage Media

The CNT-2 Marine Controller is compatible with all modern storage media including SCSI and serial tape drives, RAID, NAS, USB hard disks, etc. It is capable of writing to tape and hard disk simultaneously, and will automatically switch from one tape drive to another when a tape becomes full or if a tape drive fails. Simultaneous dual tape writing is also possible, switching between paired tape drives, while also writing to hard disk or RAID. It is also possible to write to two separate hard drives simultaneously.

Figure 4: Various types of storage media compatible with the CNT-2 Controller.

2.1.3 Power Supply

A third-party power supply of some make and model is supplied with the Deck Unit. It accepts 110 – 220 VAC input, 50 or 60 Hz. Typical capacity is 60VDC/10A, but larger capacity may be required for larger systems. Three typical power supplies are shown below. The necessary documentation is supplied with whichever power supply is provided.

Figure 5: Kepco (rack mountable), Sorensen (rack mountable) and Xantrex (portable) power supplies.

2.1.4 Deck Unit (SPSU, 2D)

The Deck Unit, or Streamer Power Supply Unit (SPSU), serves as the main panel for connections to the GeoEel, and typically runs on 60 VDC. Portable and rack-mount versions of the Deck Unit are available.

The Deck Unit serves several functions, including:

- Provides power to and communication with Digitizers, Junction Boxes, and other in-water electronics.
- Accepts trigger signal from external source (usually a source controller).
- Optionally provides a trigger output to fire a source.
- Provides interface between bird control system and birds.
- Provides auxiliary recording channels.
- Provides system leakage, voltage, and current measurements.

Figure 6: Portable Deck Unit Front Panel.

Figure 7: Rack-mount Deck Unit.

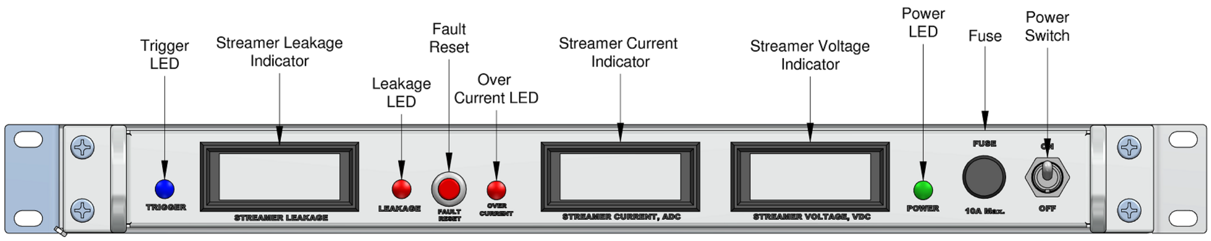


Figure 8: Rack-mount Deck Unit, front.

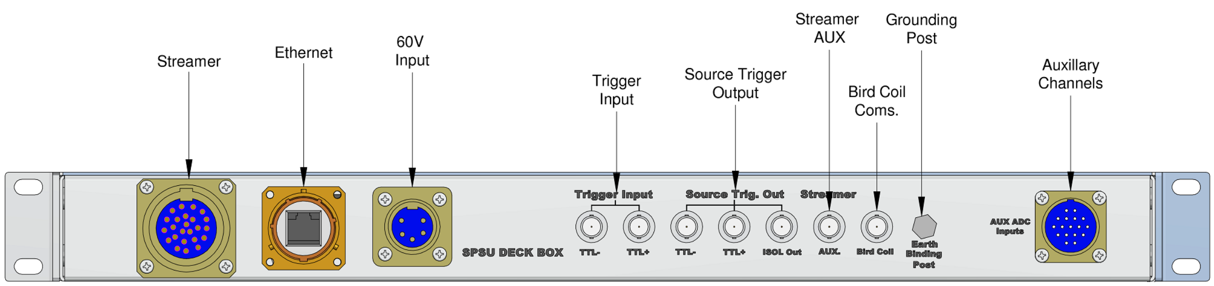


Figure 9: Rack-mount Deck Unit, rear.

- **Power Switch –** Controls power to Deck Unit.
- **Power LED** – Will be lit when power is on.
- **Fuse** – Check this 10A fuse if the Deck Unit will not power up; replace if necessary.
- **60V input –** Connector for supplied DC power supply.
- **Streamer** – Connector for GeoEel Deck Cable. Provides power to and digital communications with the GeoEel or P-Cable System.
- **Bird Coil** – Provides communication with the bird coils in the GeoEel hydrophone sections.
- **Streamer AUX** – The GeoEel has an extra pair of wires that runs the length of the Streamer, generally used to provide power to the tail buoy.
- **Fault** – Clears the Over Current and/or Leakage LED.
- **Streamer Voltage, VDC** – Numeric output showing the DC voltage supplied from the external

power supply. Typical is 60V. Deck Units for larger systems may include a voltage regulator to supply output voltage as high as 90V.

- **Over Current LED** – Illuminates if there is a short in the cable that causes current flow in excess of preset limits. Typically accompanied by a higher-than-normal leakage reading.

- **Streamer Current, ADC** – Numeric output showing current draw of GeoEel or P-Cable system. Useful in determining whether all sections are connected and powered up, and for assessing the severity of a leakage indication.

- **Leakage LED** – Illuminates when Leakage exceeds a preset value. Sensitive to short spikes in leakage that may not show up on LCD display. Readings above 500 will cause the red LED to be lit. Pressing the **Fault** button will reset he indicator.

- **Streamer Leakage Indicator** – Indicates current leakage to an unused wire in the GeoEel wire harness. Since no current is expected on this wire, the presence of a reading on this meter indicates the presence of electrical leakage somewhere in the system. See the section on leakage in the Troubleshooting section for conversion from the LCD reading to resistance.

- **Trigger LED** – Will blink briefly each time a trigger signal is received.

- **Trigger Input** – The GeoEel will trigger on a TTL+, TTL–, or contact closure. If you are using a closure, you should use the TTL– connector.

- **Source Trigger Out** – The Deck Unit is capable of providing a trigger to fire the source. It can be time-based, caused by an internal trigger in the Deck Unit, or the Deck Unit can receive a trigger signal from an external source and output a trigger. The Deck Unit will output a TTL+, TTL–, or isolated contact closure, all 1 ms in duration. If triggering is provided by the Deck Unit, the trigger timing is set in the CNT-2 Controller.

  Note: *An isolated trigger is a differential output signal, not referenced to the Deck Unit ground. It is a transistor-driven 1ms closure, useful if a floating trigger output is required. It also may reduce interference from the source. 50 Ohm impedance, +/- 10 volt maximum.*

  Note: *If you are using a TTL trigger, be sure to use the correct input on the Deck Unit. Failure to do so can result in early or late triggers. For instance, if you are using a positive TTL of 200ms duration, and you use the* ***negative*** *TTL input, the system will trigger on the falling edge of the TTL, and your trigger will be 200ms late.*

  Note: *In most cases, the Deck Unit is passive, and the master trigger signal comes from the navigation system. It is usually best to split the master trigger signal and send it to the gun controller and Deck Unit in parallel. If you do choose to use the Deck Unit to trigger the gun controller, be aware that some gun controllers require a trigger signal longer that 1 ms in duration.*

- **Ethernet** – Connects to Ethernet input on Controller PC; provides digital communications between a Deck Unit and CNT-2 Controller.

- **AUX ADC Inputs** – This is an analog input for recording auxiliary signals such as confirmation time break, source hydrophone, etc. Your system was delivered with an Auxiliary Channel Input Cable terminated with BNC connectors.

- **Earth Binding Post** – Connect to a good ground, either the hull or the sea itself.

Electronics
Wiring Diagram

2.1.5 Auxilliary Channel Input Cable

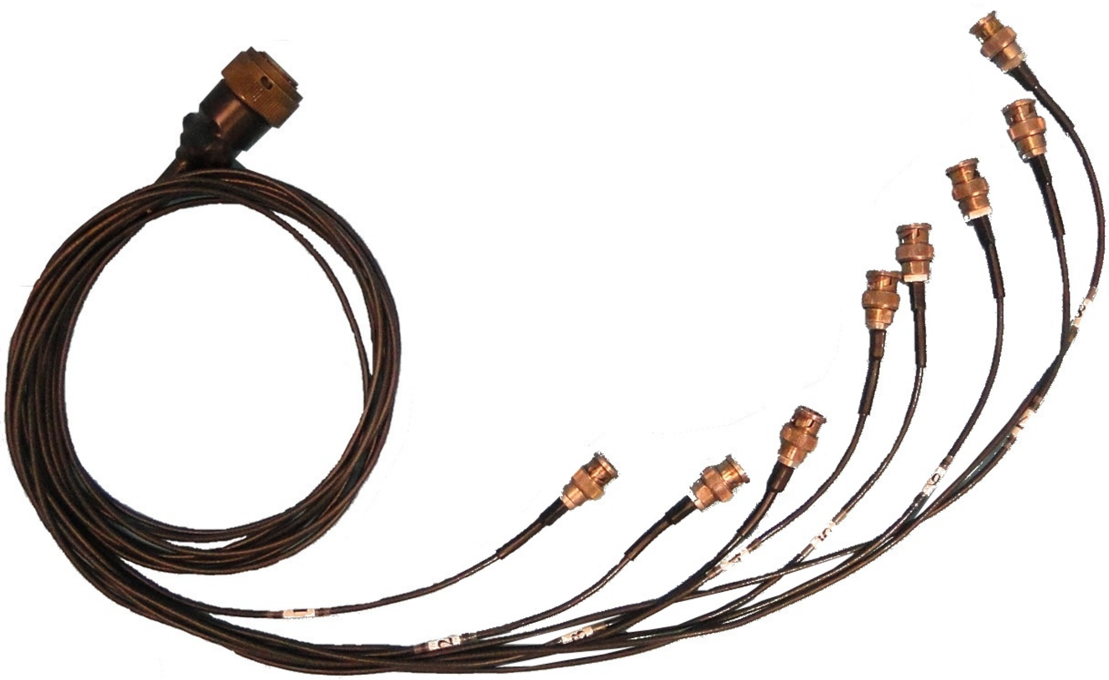


Figure 10: Eight-channel AUX Input Cable.

The Auxiliary Channel Input Cable is terminated with up to eight BNC connectors, and allows you to plug up to eight analog input signals into the 8-channel AUX board on the Deck Unit.

Wiring Diagram

2.1.6 Deck Cable

The Deck Cable connects the Deck Unit to the Tow Cable or the P-Cable Signal Cable. It can be up to 100m in length, and generally runs from the recording lab to winch, where it connects either directly to the Tow/Signal Cable or via a slip-ring and/or Repeater. As such, it is not designed for immersion. Deck Cables exceeding 100m can be constructed using multiple Deck Cables with Repeaters.

Figure 11: Deck Cable.

Wiring Diagram, 2D (scoop-proof Glenair connector)

[Wiring Diagram, 2D](#) (non scoop-proof Glenair connector)
[Wiring Diagram, P-Cable](#) (scoop-proof Glenair connector)

2.1.7 Repeater Module

Repeaters amplify and re-transmit Ethernet packets, and are required every 100m. Digitizers and the Deck Units each function as Repeaters. Also, the Tension Gauge and the In-line Depth/Compass modules both include Repeater circuitry. Generally one Repeater is required between the Deck Cable and the Tow Cable, as their combined length, along with the length of the inboard Stretch or Vibration Isolation Section, is usually greater than 100m. In normal deployments, Repeaters are not needed aft of the first Digitizer.

Note: *A missing Repeater will cause unreliable operation. Some communications will be possible, but the operation will be problematic and difficult to troubleshoot.*

Figure 12: In-line Repeater module.

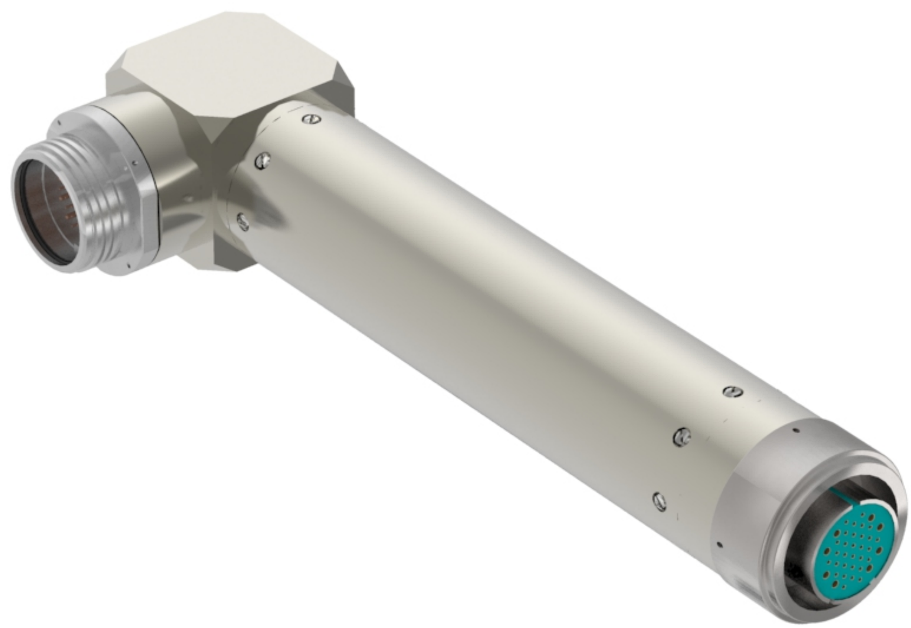


Figure13: Right-angle Repeater module.

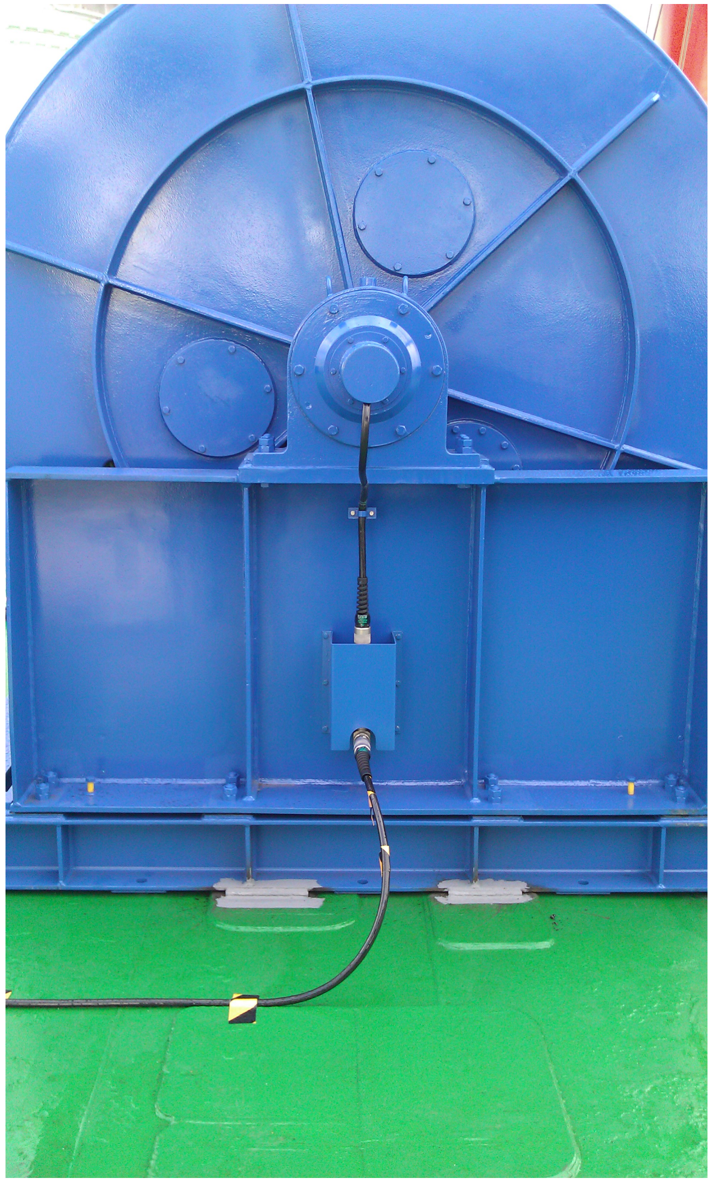


Figure 14: Right-angle Repeater installed on a winch between Deck Cable and Tow Cable.

Wiring Diagram (scoop-proof Glenair connector)
Wiring Diagram (non scoop-proof Glenair connector)

2.1.8 Tension Gauge Module

The Tension Gauge module is typically installed between the Tow Cable and a Vibration Isolation or Stretch Section. It will measure and report cable tension in real time to the CNT-2 Controller.

Figure 15: Tension Gauge/Repeater module.

Wiring Diagram (scoop-proof Glenair connectors)

2.1.9 In-line Depth Module

Figure 16: In-line Depth Module.

Wiring Diagram (scoop-proof Glenair connector)
Wiring Diagram (non scoop-proof Glenair connector)

2.1.10 Slip-ring

The slip-ring allows for communication with the system during deployment. This is very handy for trouble-shooting, especially with the P-Cable. The slip-ring is typically placed between the Deck Cable and Tow Cable or Signal Cable.

Figure 17: Slip-ring.

Wiring Diagram (Ethernet, 2D) (scoop-proof Glenair connectors)
Wiring Diagram (COAX, P-Cable) (scoop-proof Glenair connectors)

2.1.11 Tow Cable

The Tow Cable connects the Deck Cable to the first in-water component. At least one end, and optionally both, is submersible. Some earlier tow cables have a "Flex-tow" design which included 10m of fluid-filled section with a bird coil installed. This allows a lead bird, which must work the hardest to hold the Streamer at depth, to be placed well ahead of the first hydrophone, significantly reducing bird noise. This is accomplished in the current design with a separate Vibration Isolation Section. The maximum length of the Flex-tow design is 100m. The maximum length of the current design is 90m; 100m offset is achieved with the addition of a 10m Vibration Isolation Section. Longer offsets can be achieved by using multiple Tow Cables with Repeaters.

Figure 18: Tow cable.

Wiring Diagram (scoop-proof Glenair connectors)

2.1.12 Vibration Isolation Section

The Vibration Isolation Section is either solid or liquid-filled, up to 50m in length, and includes a bird coil and (optional) integrated depth sensor (liquid version only). It is similar to an Active Section, but contains no hydrophones. It helps to dampen Tow Cable strumming noise, and is generally mounted between the Tow Cable and the first Digitizer and the last Digitizer and tail buoy. It can be used in conjunction with a Stretch Section.

Figure 19: Vibration Isolation Section (liquid-filled).

Figure 20: Vibration Isolation Section (solid).

Wiring Diagram (scoop-proof Glenair connectors)
Wiring Diagram (non scoop-proof Glenair connectors)

2.1.13 Stretch Section

The Stretch Section is similar in construction to the liquid-filled Vibration Isolation Section, except that it has a green nylon stretch member and is gel-filled. It can be up to 50m long and stretches up to 10% of its length. It does not contain a bird coil or depth sensor. It is particularly useful in isolating the Active Section from heave effects in rough seas. A Stretch Section, if used, is generally mounted between the Tow Cable and the first Digitizer, and last Active Section and tail buoy. It can be used in conjunction with a Vibration Isolation Section. In general, shorter Streamers do not require Stretch Sections.

Figure 21: Stretch Section (gel-filled).

Wiring Diagram (scoop-proof Glenair connectors)
Wiring Diagram (non scoop-proof Glenair connectors)

2.1.14 Digitizer Module

The 8-channel Digitizer is made of titanium and contains the A/D circuitry. One Digitizer is mounted at the ship-end of every Active Section. It takes eight analog inputs and delivers digital data via TCP/IP on an Ethernet cable. It also re-transmits Ethernet packets, and as such, functions as a Repeater. There are two versions of the Digitizer; the 2D version (below) and the lead Digitizer in a P-Cable system. The latter uses a wet-mate Subconn or Titan Jumper Cable to connect to the Junction Box.

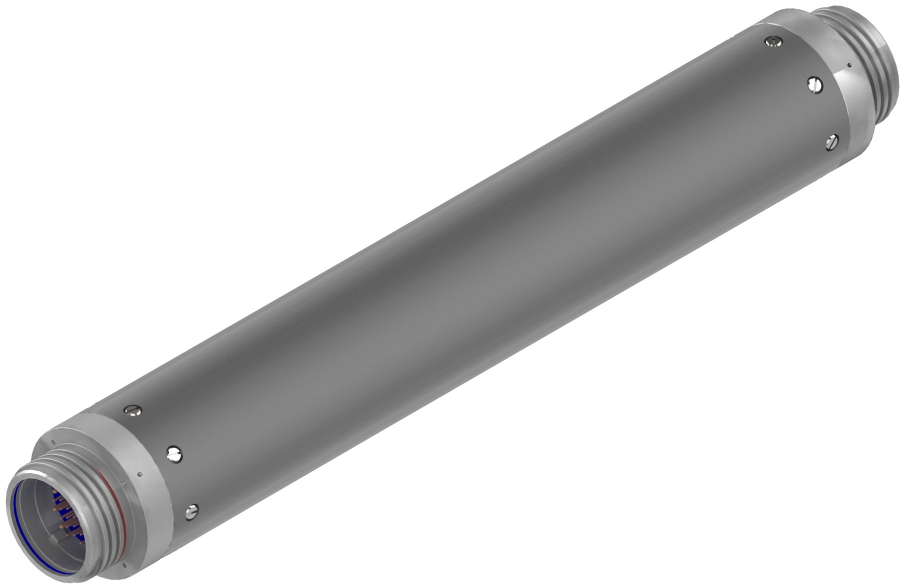


Figure 22: 2D/3D Digitizer.

The Digitizer contains 3 boards:

1. Ethernet Board
2. DSP Board
3. Analog Board

Wiring Diagram (scoop-proof Glenair connectors)
Wiring Diagram (non scoop-proof Glenair connectors)
Technical Data

2.1.15 Active Section

The Active Section contains hydrophones and can be 12.5, 25, 50, or 100m in length. It is either liquid-filled or solid polyurethane. It can include a bird coil and (optional) an integrated depth sensor (liquid version only). There are eight channels per section. In the liquid version, hydrophones are evenly-spaced at 0.78125m (128 per 100m), and the number of hydrophones per group varies with the group interval. In the solid version, there are 6 hydrophones per group in 100m and 50m Streamers, and 4 hydrophones per group in 25m and 12.5m (these are the standards; up to 12 hydrophones per group are available). Native group intervals from 1.5625m, 3.125m, 6.25m and 12.5m. See summary in tables below.

Figure 23: GeoEel Liquid-filled Active Section.

Figure 24: GeoEel Solid Active Section (with Digitizer installed).

	Liquid-filled	Solid
Available lengths (m)	12.5, 25, 50, 100	12.5, 25, 50, 100
Hydrophone spacing	78 cm	11.5 cm
Hydrophones per group (standard)	2, 4, 8, 16 (depends on group interval, see table below)	4-6 (depends on group interval, see table below)
Available group intervals (standard)	1.5625, 3.125, 6.25, 12.5	1.5625, 3.125, 6.25, 12.5 (custom intervals available)
Bird coils (standard)	2	1 (standard) or 2
Optional integrated depth sensor	1	NA (separate module)

Table 1: Summary of standard Active Section specifications.

	Hydrophones per group	
Group interval (m)	**Liquid-filled**	**Solid**
1.5625	2	4
3.125	4	4
6.25	8	6
12.5	16	6

Table 2: Standard hydrophone group specifications.

Wiring Diagram (Liquid) (non scoop-proof Glenair connectors)
Wiring Diagram (Solid) (scoop-proof Glenair connectors)

Technical Data (Liquid)
Technical Data (Solid)

2.1.16 Tail Depth/Compass Module

The Tail Depth/Compass modules are installed at the aft ends of Streamers in either 2D or 3D configurations. Standard units include an Ethernet switch and a depth sensor; a Digital Compass Heading Sensor can be included for positioning purposes. The compass and depth sensors communicate with the GeoEel Controller over the Ethernet lines.

Figure 25: Tail Compass/Depth module with carabiner for connecting Drogue or tail buoy.

Wiring Diagram (scoop-proof Glenair connector)
Wiring Diagram (non scoop-proof Glenair connector)

2.1.17 Tail Piece

The Tail Piece connects to the tail-end of the Streamer and provides a tie-point for a tail buoy.

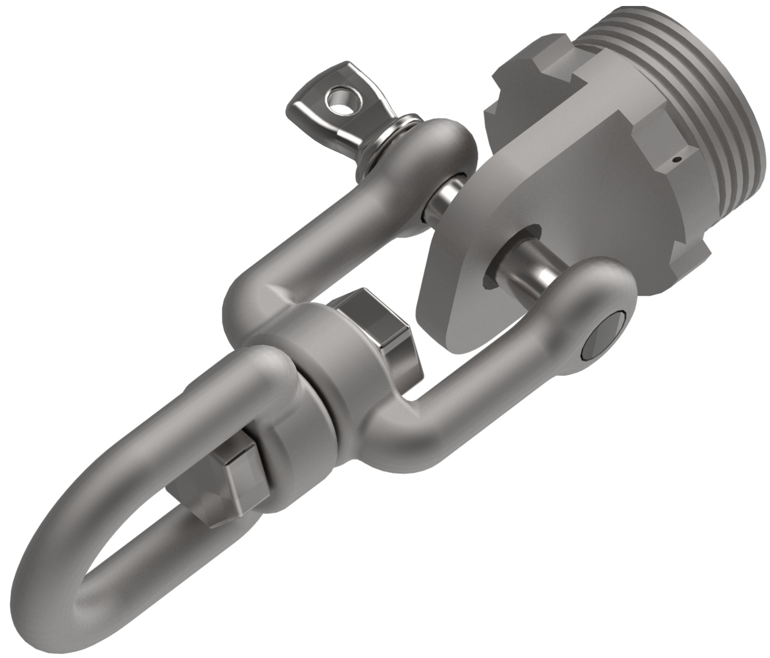


Figure 26: Tail Piece.

2.1.18 Tail Swivel With Power Output

The Tail Swivel, made by Concord Marine Systems, uses slip-ring technology to pass power from the Streamer through to the tail buoy. This is useful if the tail buoy does not have an turbine.

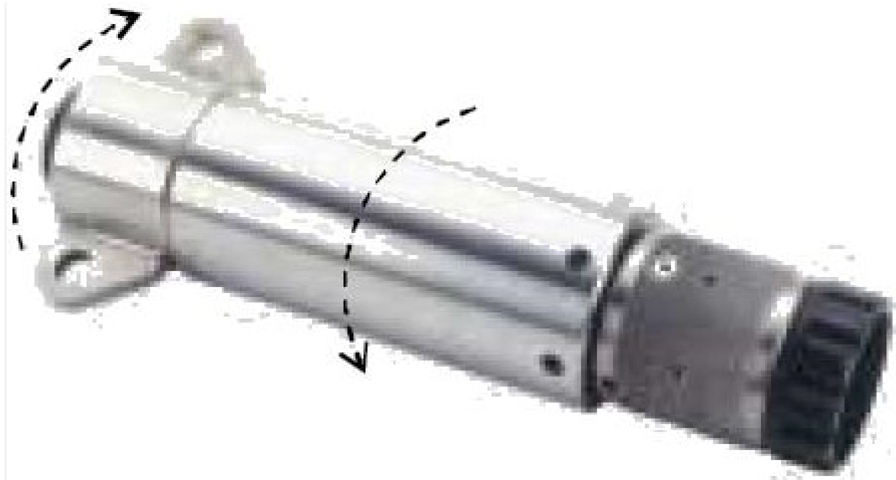


Figure 27: Concord Marine Systems Tail Swivel with power output for tail buoy.

Wiring Diagram and Brochure

2.1.19 Test Cable - Deck Unit to 2D Digitizer

This short Test Deck Cable allows direct connection between the Deck Unit and a Digitizer, Tow Cable, Vibration Isolation section and Stretch section, for troubleshooting purposes. Allows bypass of any one of the aforementioned components.

Figure 28: Deck Test Cable; allows easy bypass of selected in-water components for troubleshooting purposes.

Wiring Diagram (scoop-proof Glenair connector)
Wiring Diagram (non scoop-proof Glenair connector)

2.1.20 Digitizer Floats

Digitizers are negatively buoyant, weighing about 0.52 kg in water. If you are using Streamer birds, it is generally not necessary to use Digitizer Floats. Nor are they typically used in P-Cable systems. However, if you are doing 2D work and are not using Streamer birds, Digitizer Floats may be necessary. Installation instructions can be found in the Appendix. Digitizer Floats neutralize Digitizers, having a buoyant force of 0.52 kg.

Figure 29: Digitizer Float.

2.1.21 Ballasting Weights

Active Sections sink in fresh water. If necessary, you can install Digitizer Floats to help them float.

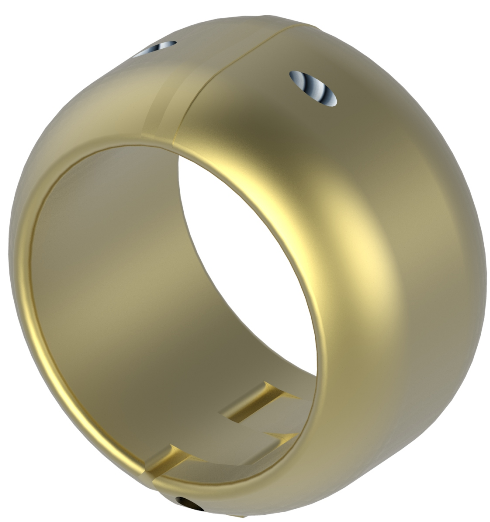


Figure 30: Ballasting Weight (0.4 Kg).

Active Sections are buoyant in salt water (1.025 g/cm^3); the longer the section, the more buoyant it is. When Streamer balancing is critical, as it is in P-Cable surveys, weights can be used to achieve neutral buoyancy. Each weight is 0.4 kg. Nominal Solid Active Section weights in salt and fresh water are as follows:

Section Length (m)	Weight in Salt Water (kg)	Weight in Fresh Water (kg)
25	-0.017	0.941
50	-0.875	1.039
100	-2.033	1.831

Table 3: Nominal Solid Active Section weights in salt and fresh water. Positive numbers indicate sinking; negative numbers indicate floating.

The actual water weight of Active Sections depends on variables including the number of hydrophones per group and actual water density (which depends on temperature and salinity). As such, some trial and error is generally required to get the desired buoyancy, depending on how accurate you are trying to be. The above values should be used as starting points.

2.1.22 Digitizer Clamp

The Digitizer Clamp is useful for changing out components when using longer Streamers. It allows components to be replaced without retrieving the entire Streamer. See the Appendix for instructions.

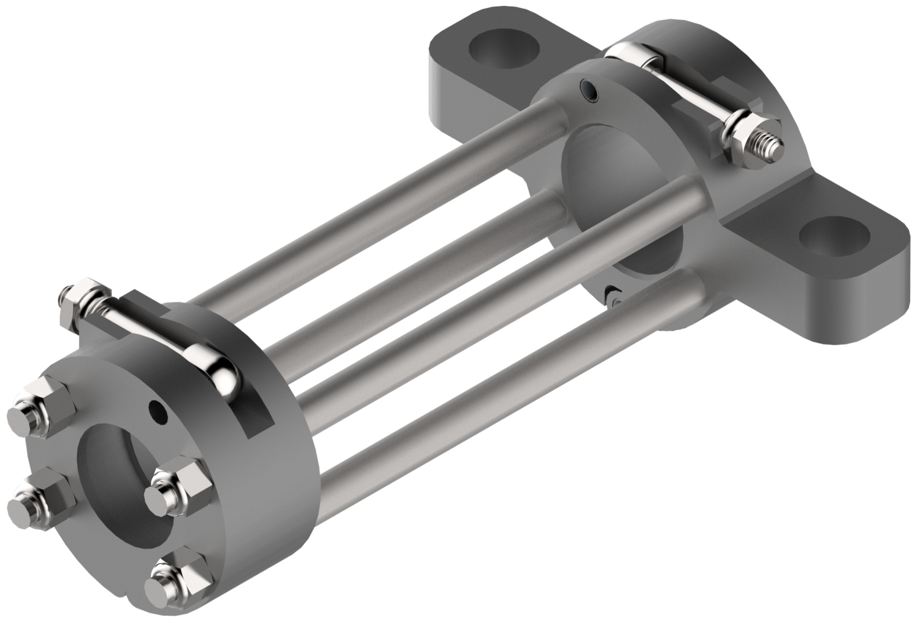


Figure 31: Digitizer Clamp.

2.1.23 Bird Collar Covers

The Bird Collar Covers fit over the bird collars to prevent damage to the Streamer when it is wound onto the winch under tension.

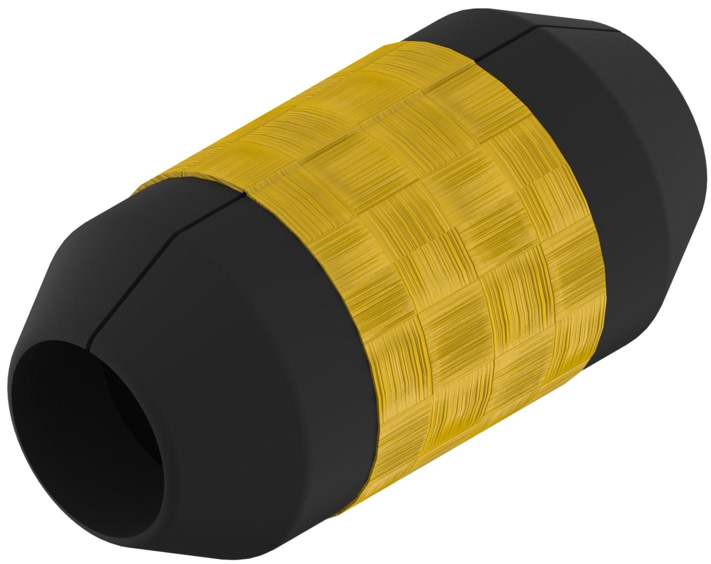


Figure 32: Bird Collar Cover.

2.2 P-Cable-specific Hardware

The P-Cable system is the name of the 3D configuration of the GeoEel. In addition to components unique to the P-Cable, it consists of the same general hardware as a 2D system, some of which has been slightly modified. The main distinguishing feature of the P-Cable system is the Cross Cable. The Cross Cable consists of four components: Junction Boxes, Junction Box Interconnect Cables, Jumper Cables, and the Cross Cable Strength Member. The Signal Cable replaces the Tow Cable, the Deck Cable is slightly different than the 2D version, and the 3D version of the Deck Unit includes a COAX modem.

2.2.1 Deck Unit (SPSU, P-Cable)

The 3D version of the Deck Unit is identical to the 2D version, except that it includes a modem. For large P-Cable systems, it may also include a voltage regulator. The unit shown below is rack-mountable.

Figure 33: Rack-mount Deck Unit.

[Wiring Diagram]

2.2.2 Deck Cable (P-Cable)

The 3D version of the Deck Cable is very similar to the 2D version, except that it uses COAX cable rather than CAT-5 Ethernet to transmit data.

Figure 34: P-Cable Deck Cable.

Wiring Diagram

2.2.3 Lead Digitizer (P-Cable)

The Lead Digitizer in a P-Cable system (i.e., the one that connects to the Junction Box) is terminated at the ship-end with a Subconn or Titan wet-mateable connector and is equipped with a bale to connect physically to a shackle on the Cross Cable.

Figure 35: Lead Digitizer module for P-Cable (shown with Subconn connector).

Wiring Diagram (Subconn and scoop-proof Glenair connectors)
Wiring Diagram (Titan and scoop-proof Glenair connectors)

2.2.4 Low-profile Drogue

A small low-profile Drogue is used at the tail of each P-Cable hydrophone Streamer to supply about 5 kg of tension at 5 knots. This helps keep the Streamers straight while under tow.

Figure 36: Low-profile Drogue.

2.2.5 Signal Cable

The Signal Cable comes in either 300m or 400m lengths and includes a single-end strength termination. It provides power to and communications with all in-water components. The Signal Cable's communications are performed over a COAX line rather than the standard Ethernet lines used in 2D systems. The COAX Modem installed in the termination, and another in the 3D version of the Deck Unit, allows for cable length up to 600M without the need of a Repeater. Typical Signal Cables come installed with braided haired fairing to reduce strumming during operations. An armored version is available, and highly recommended.

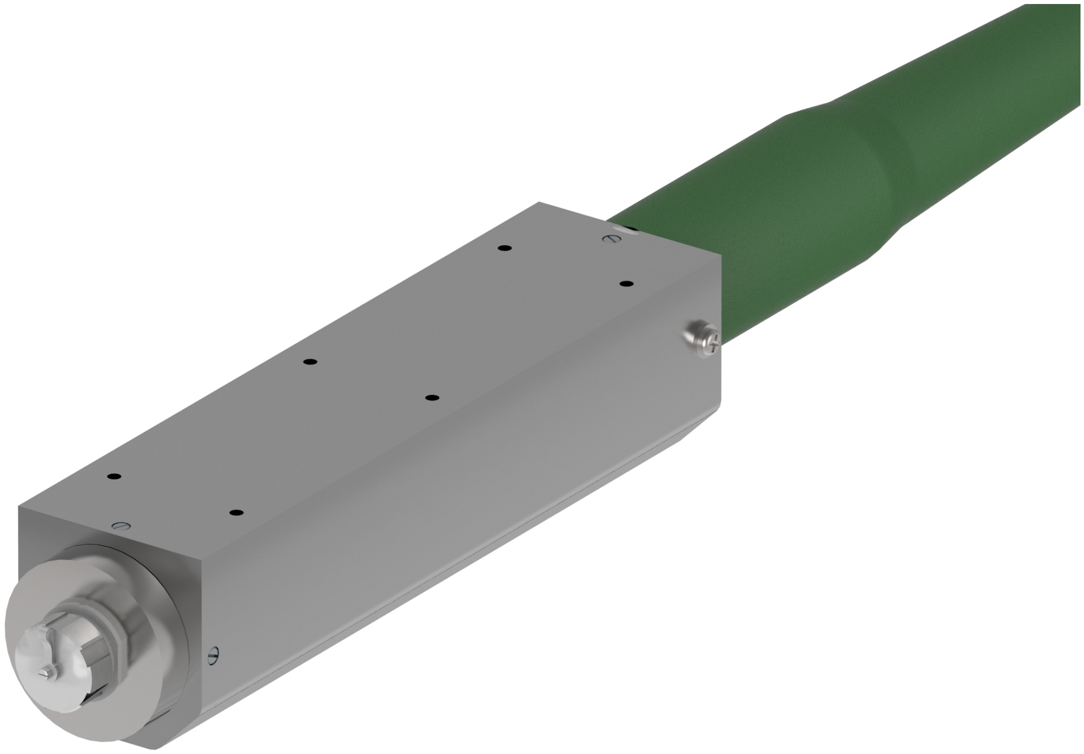


Figure 37: Signal Cable (wet-end).

Wiring Diagram (scoop-proof Glenair connectors)
Technical Specifications

2.2.6 Test Cable - Deck Unit to P-Cable Digitizer

This short test cable allows direct connection between the Deck Unit and a Lead P-Cable Digitizer, bypassing the P-Cable Deck Cable, Signal Cable, Cross Cable Interconnect Cable, and Junction Box.

Figure 38: Test Cable; Deck Unit to P-Cable Digitizer (Subconn version).

Figure 39: Test Cable; Deck Unit to P-Cable Digitizer (Titan version).

Wiring Diagram (Bendix and Subconn connectors)
Wiring Diagram (Bendix and Titan connectors)

2.2.7 Test Cable - Deck Unit to Junction Box

This short test cable allows direct connection between the Deck Unit and a Junction Box, bypassing the P-Cable Deck Cable, Signal Cable, and Cross Cable Interconnect Cable.

Figure 40: Test Cable; Deck Unit to Junction Box (Glenair version; Birns version not shown).

Wiring Diagram (Bendix and Glenair connectors)
Wiring Diagram (Bendix and Birns connectors)

2.2.8 Underwater Turbine

Paravanes generally have a GPS unit mounted on them, which are powered by a turbine combined with a battery and charging circuit.

Figure 41: Underwater turbine.

Figure 42: Turbine mounted on paravane.

2.2.9 Paravane-Mounted GPS

Figure 43: Paravane-mounted GPS.

2.2.10 Cross Cable

The Cross Cable enables the towing of a large number of parallel Active Sections from a small number of winches. It consists of a 25mm strength member, with Junction Boxes connected by Interconnect Cables.

Figure 44: Cross Cable showing Junction Box, Interconnect Cable, Lead Digitizer, and Active Section.

2.2.10.1 Junction Box

The P-Cable Junction Box provides a breakout along the Cross Cable where Digitizers and Active Sections are attached. Each Junction Box contains:

- 100 Mbps Ethernet Switch
- Depth Sensor
- Digital Compass Heading Sensor (Optional)
- Streamer Port (Subconn or Titan connector)
- Cross Cable Interconnect Cable port (Glenair or Birns connector)

Depending on the vintage of your system, your Junction Box will look like one of the following:

Figure 45: Junction Box (Titan and Birns connectors, left; Subconn and Glenair connectors,middle; Titan and Glenair connectors, right).

Wiring Diagram (Titan and Birns connectors)
Wiring Diagram (Subconn and scoop-proof Glenair connectors)
Wiring Diagram (Titan and scoop-proof Glenair connectors)

2.2.10.2 Cross Cable Interconnect Cable

Junction Boxes are linked with an Cross Cable Interconnect Cable which provides power and transmits trigger and data. Each cable is fitted with two waterproof Glenair or Birns connectors.

Figure 46: Cross Cable Interconnect Cable (shown here with Glenair connectors).

Face View of Connector
Wiring Diagram (scoop-proof Glenair connectors)

2.2.10.3 Jumper Cable

The Jumper Cable connects the P-Cable Lead Digitizer to the Junction Box. Depending on the vintage of your system, your Jumper Cables may be terminated with either Titan or Subconn wet-mateable connectors.

Figure 47: Titan Jumper Cable.

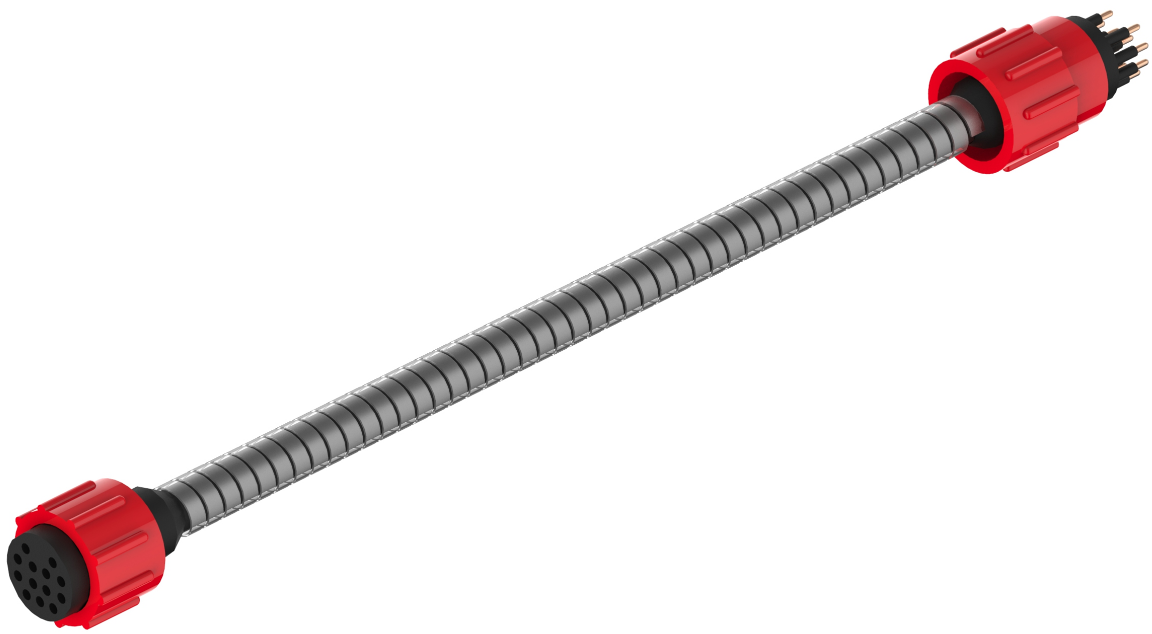


Figure 48: Subconn Jumper Cable.

See the Maintenance section for instructions on maintaining the Subconn Jumper Cables.

Wiring Diagram (Subconn connectors)
Wiring Diagram (Titan connectors)

2.2.11 Rigging

All ropes used in the P-Cable -- Tow Ropes, Recovery Line, Spur Lines, and Cross-Cable Strength Member -- are of Samson Amsteel-Blue.

Figure 49: Samson Amsteel-Blue rope.

2.2.11.1 Tri-point Assembly

The Tri-point assembly forms the junction of the Signal Cable, Cross-Cable, and Spur Line. The Signal Cable is attached to the swivel arm, allowing the angle between the Signal Cable and Cross Cable to change as the system is deployed.

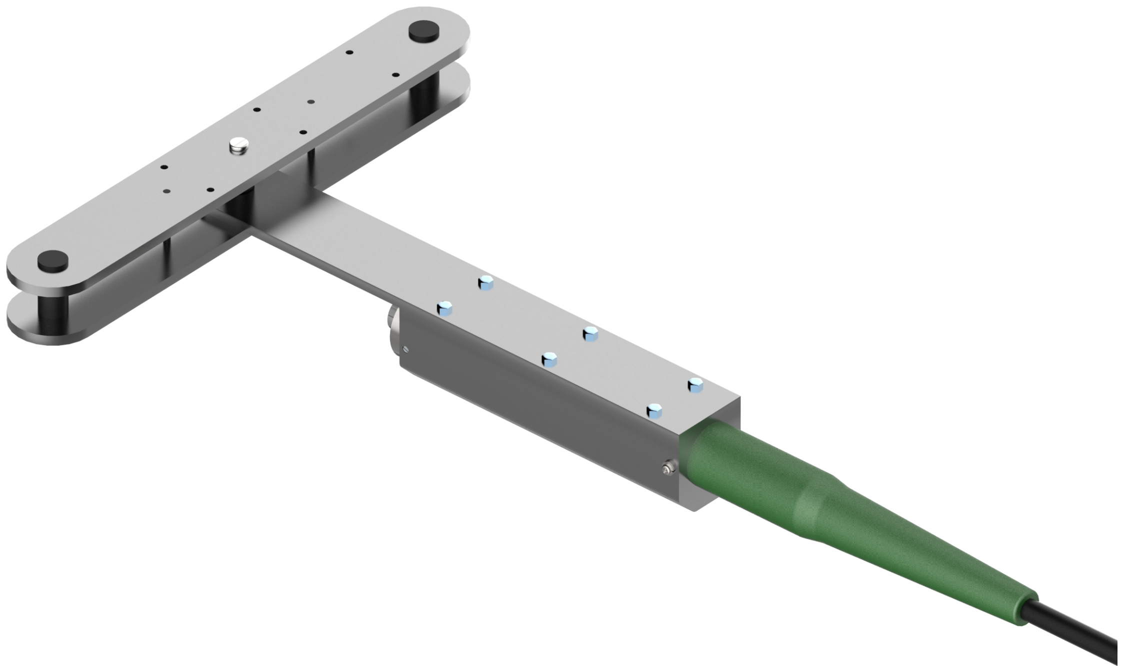


Figure 50: Tri-point assembly with Signal Cable attached.

2.2.11.2 Spur Line

The Spur Line connects the Tri-point to the Paravane bridle. It is made of 25mm Samson Amsteel-Blue rope.

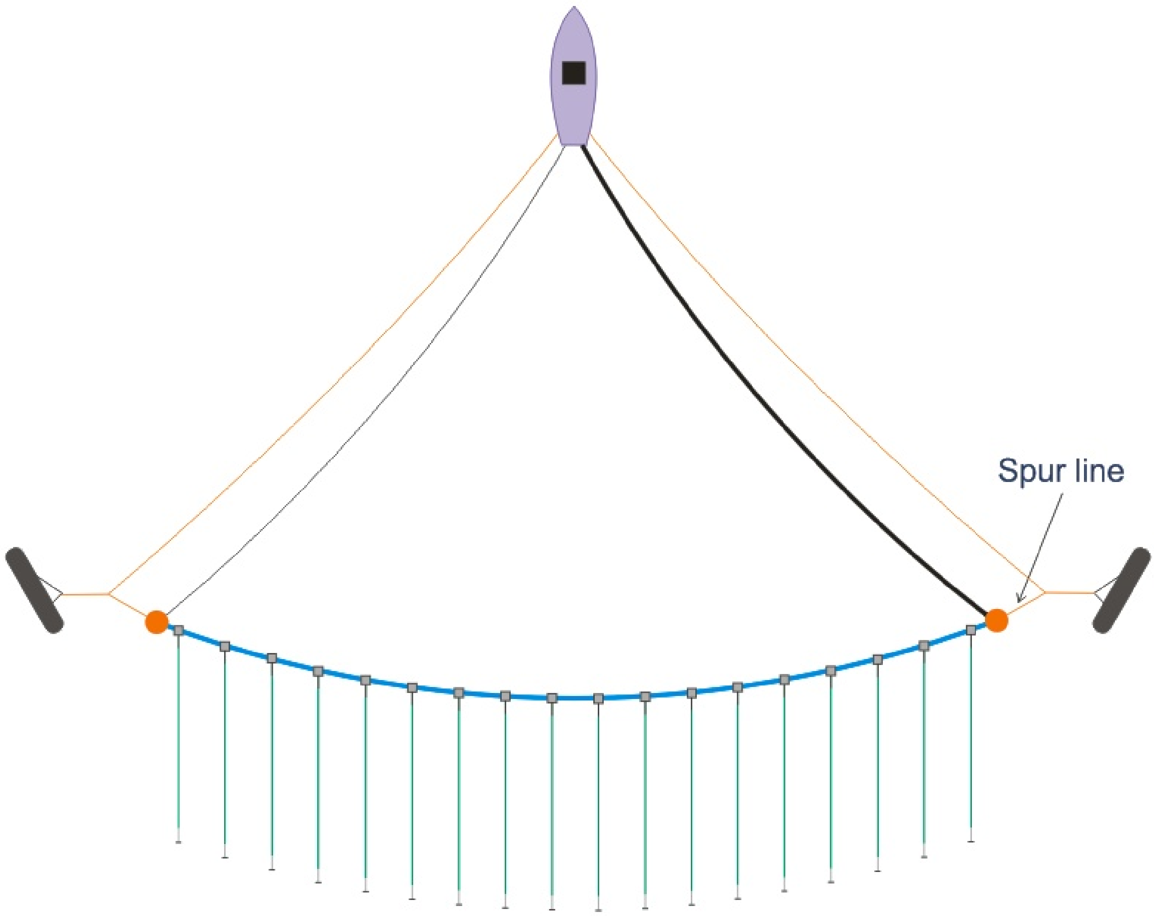


Figure 51: Spur Line.

2.2.11.3 Tow Rope

The Tow Rope connects from the paravane winch to the Spur Line (via eye-splice). It is used to deploy and recover the paravanes, and carries most of the load. It is made of 20mm Samson Amsteel-Blue rope.

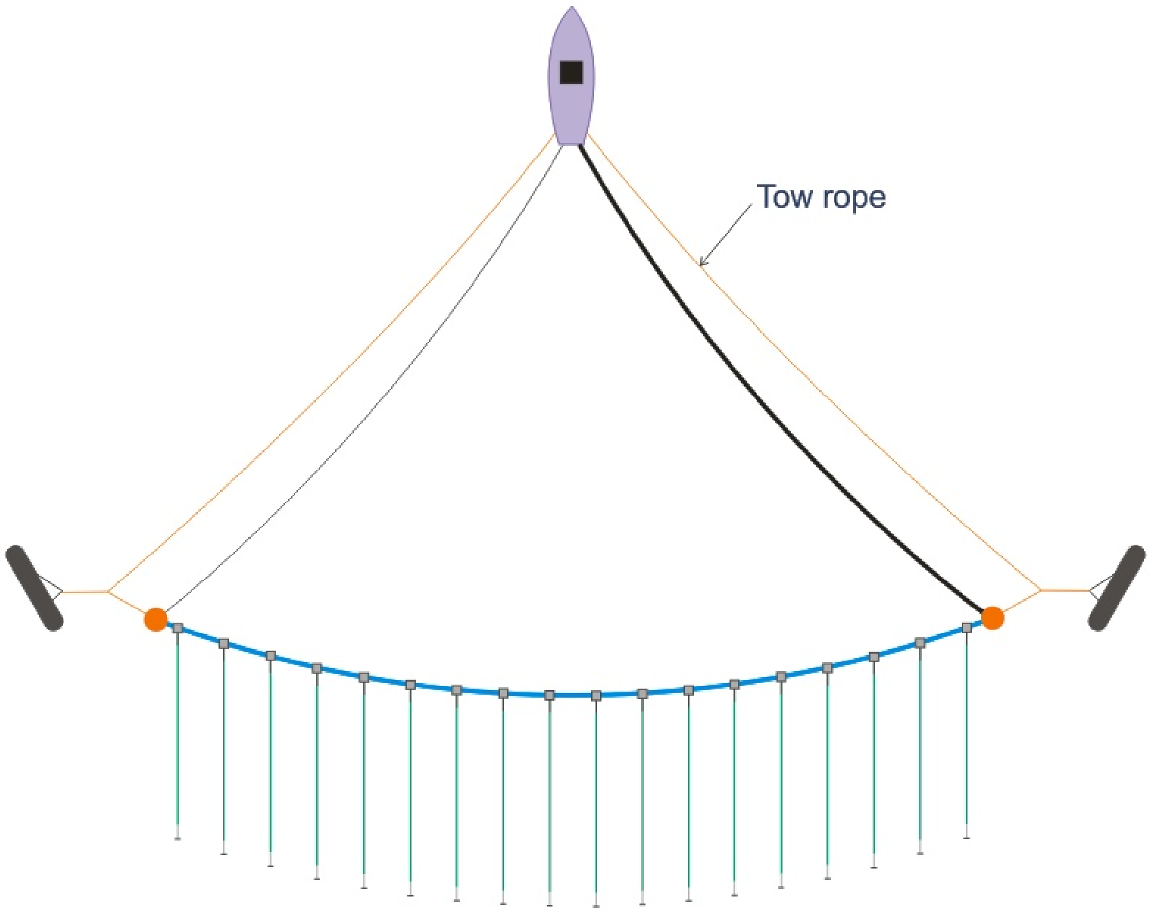


Figure 52: Tow Rope.

2.2.11.4 Recovery Line

The Recovery Line is typically stored under the Cross Cable on the Cross Cable winch. It connects to the Tri-point, and is used to recover the Port end of the Cross Cable. In this sense, it performs the same function as the Signal Cable. In fact, the Recovery Line can be a second, redundant Signal Cable. It is made of 16mm Samson Amsteel-Blue rope.

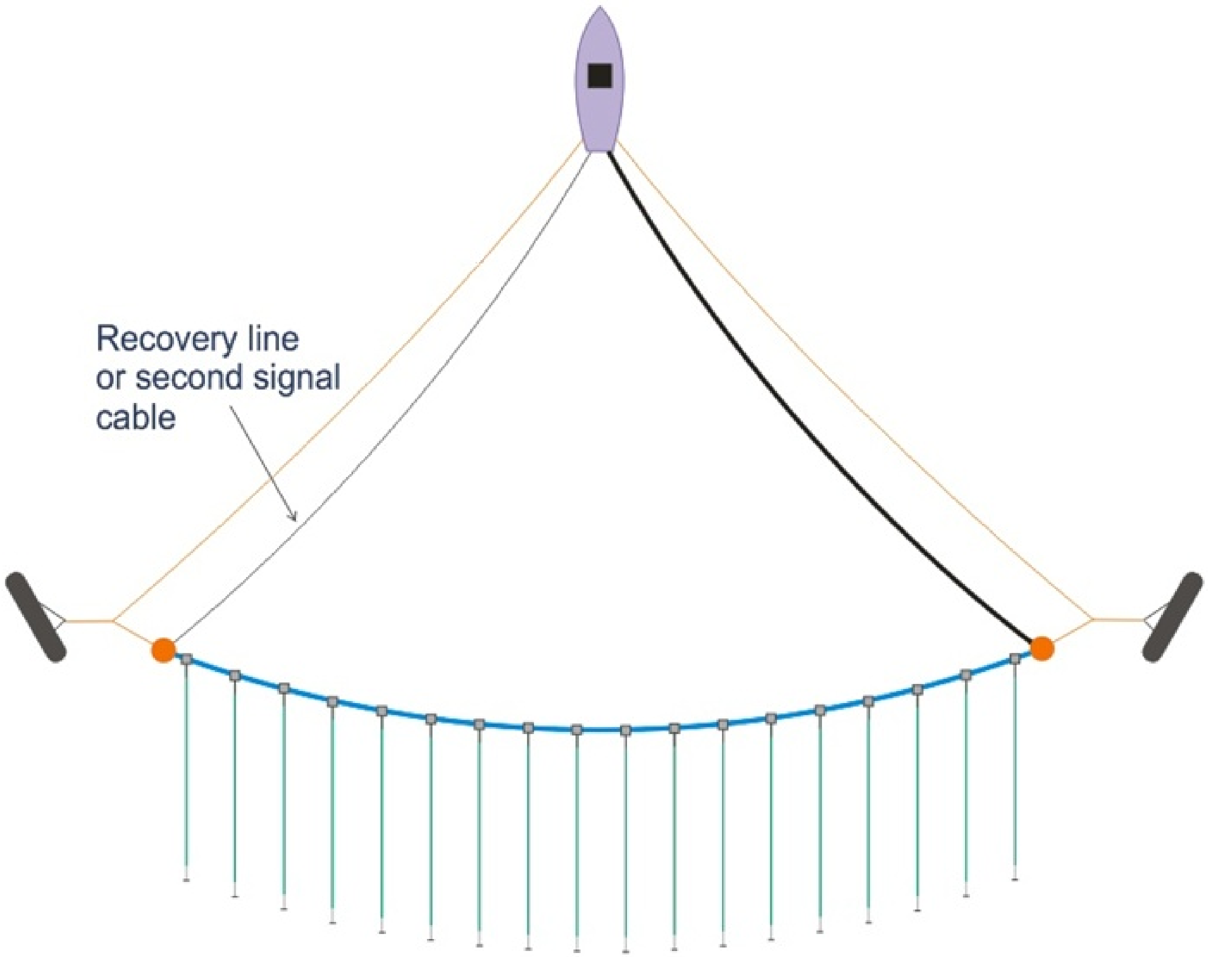


Figure 53: Recovery Line.

2.2.11.5 Cross Cable Strength Member

The Cross Cable Strength Member is 25mm Samson Amsteel-Blue rope, having an average strength of 100,000 lbs. The rope is constructed with eye splices on each end for easy connection to the Spur Lines and Signal Cable. The Junction Boxes are mounted to the Cross Cable Strength Member with bushings that go through the rope to ensure that the boxes do not move during operation.

It is recommended that you monitor the splices of the Cross Cable Strength Member just as any other rope. If excessive wear occurs it is recommended to replace or re-splice the eyes.

Splicing Instructions

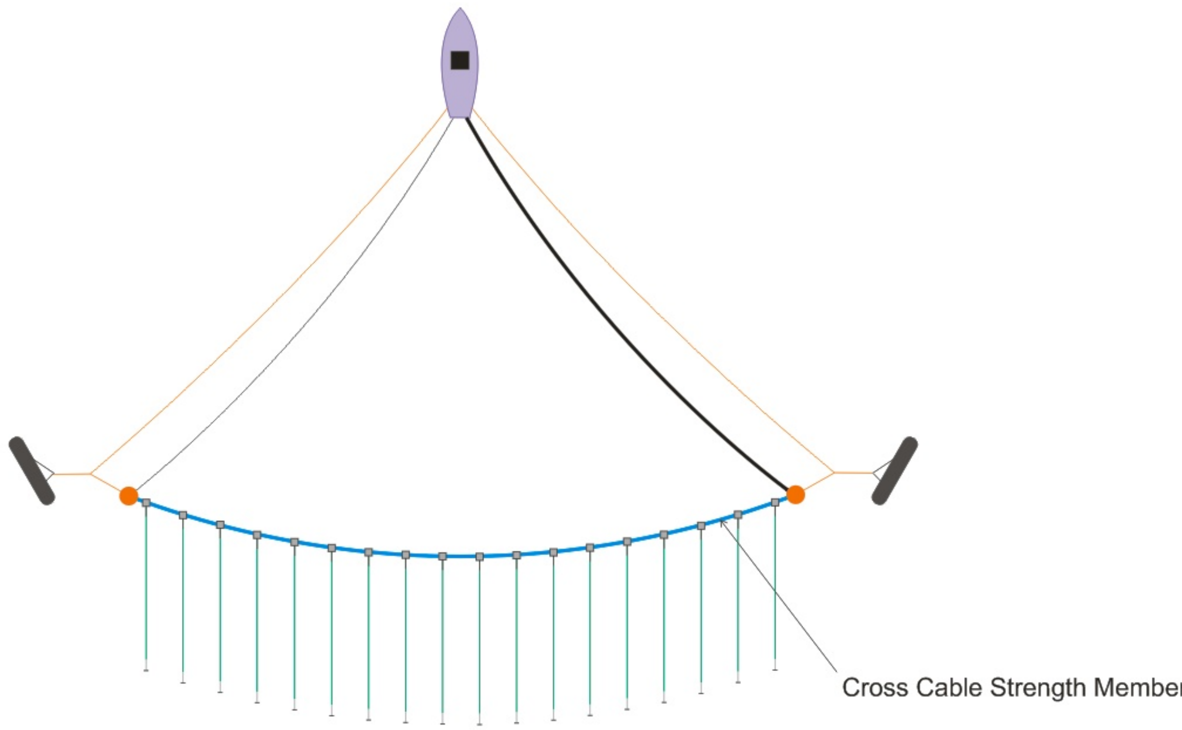


Figure 54: Cross Cable Strength Member.

Part III

3 Software

Enter topic text here.

3.1 CNT-2 Marine Controller

The CNT-2 Marine Controller is a multi-threaded acquisition package that provides control and setup of the GeoEel, provides various quality control tools, and ensures uninterrupted surveying and redundant data storage.

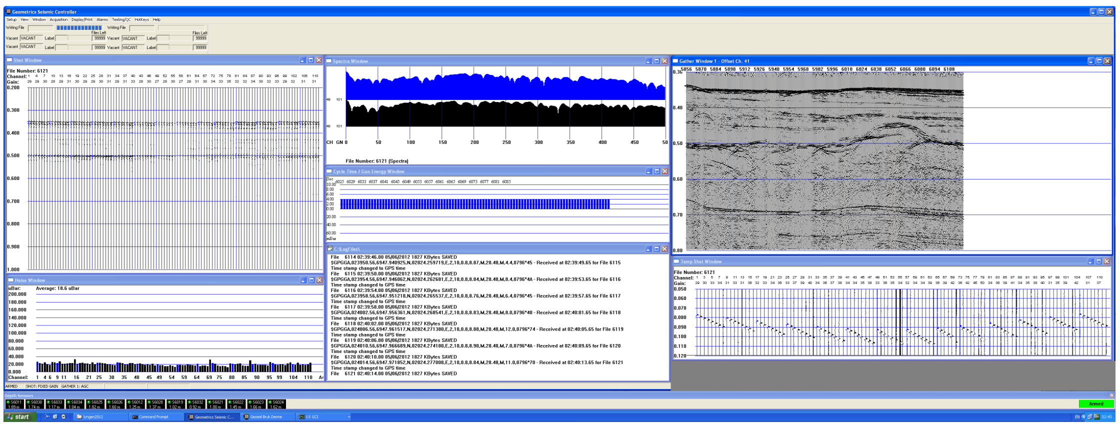


Figure 55: CNT-2 Marine Controller display.

The program will:

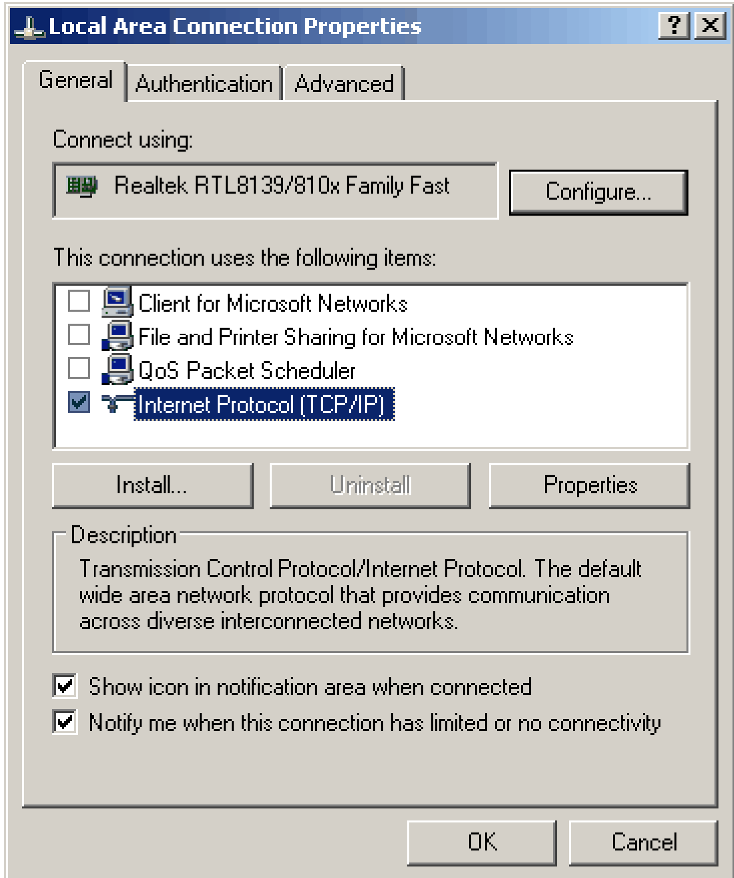
- Set up and configure Digitizers, display data and various QC windows, and write data to disk and/ or tape.
- Keep track of survey parameters, allowing previous surveys to be continued with minimal setup.
- Record and display a log of all shots, including file number, time, tape number, operator comments and other pertinent information.
- Display each shot as it is acquired. Multiple Shot windows can be opened to provide various views.
- Display and optionally print a user-definable single-trace gather during acquisition.
- Format data into SEG-D, SEG-Y, or SEG-2 and write to disk and/or other storage media during acquisition.
- Toggle between up to four tape drives, automatically switching between drives as tapes become full. Also can write to two tape drives at once, switching between pairs, providing an instant tape backup.
- Monitor shot time intervals and the energy on the time break hydrophone to ascertain proper source operation.

- Provide for minimum cycle times and maximum performance.
- Record external data from serial devices such as GPS, navigation, source controller, compasses and depth transducers and display and store them in the SEG-D header associated with each shot and in a separate serial log file.
- Display a real-time noise bar graph based on a user-selected portion of the shot record.
- Provide visual/audio alarms when error conditions occur during data acquisition.

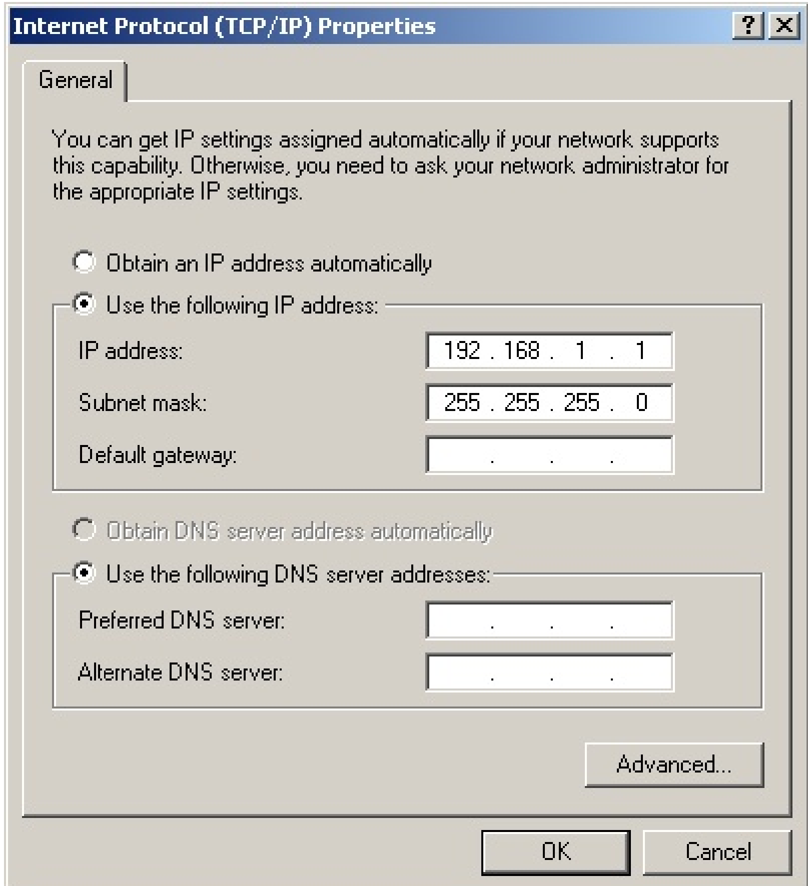
3.1.1 PC Network Configuration

The Controller PC must have a dedicated Ethernet interface to connect to the Deck Unit. If the Controller PC was supplied by Geometrics, this should already be configured. If not, you will need to configure the network.

Using the **Network Connections** item in the Windows **Control Panel**, choose the connection to be dedicated to the acquisition system. It is recommended that the only network protocol left enabled on this interface is TCP/IP, as shown below:



Click on **Properties** to bring up the following dialog:



The IP address of this NIC must be set to 192.168.1.1, with a subnet of 255.255.255.0, as shown above.

Using the CAT5 network cable supplied with the system, connect the Controller PC to the Ethernet connection on the Deck Unit.

3.1.2 Power Up Sequence

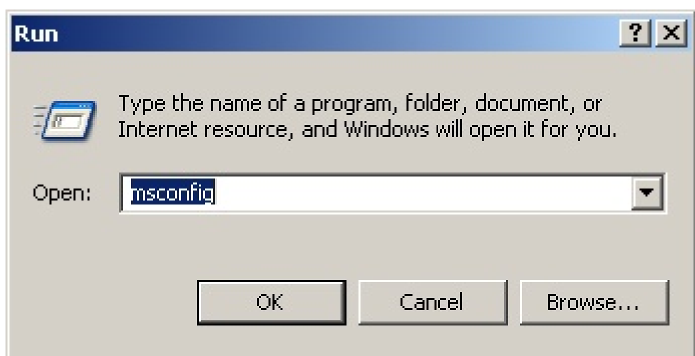
If you are using tape drives, power these up first. Turn on the power supply to the Deck Unit. Next, power up the Deck unit; this will in turn power up all the components in the Streamer. Do not start the software until 30 seconds after powering-up the Deck Unit. You should see the current LCD stabilize; this means that the Digitizer boards are finished booting.

Note: *The GeoEel Digitizers were not designed to function in high temperature environments. If you are powering the GeoEel while it is lying on deck or on the winch, they may overheat if left on for an extended period of time in direct sun or if insulated by an Digitizer Float. This will not damage the A/D electronics, but they may behave erratically and errors may be reported by the CNT-2. If this happens, power down the GeoEel and allow the components to cool.*

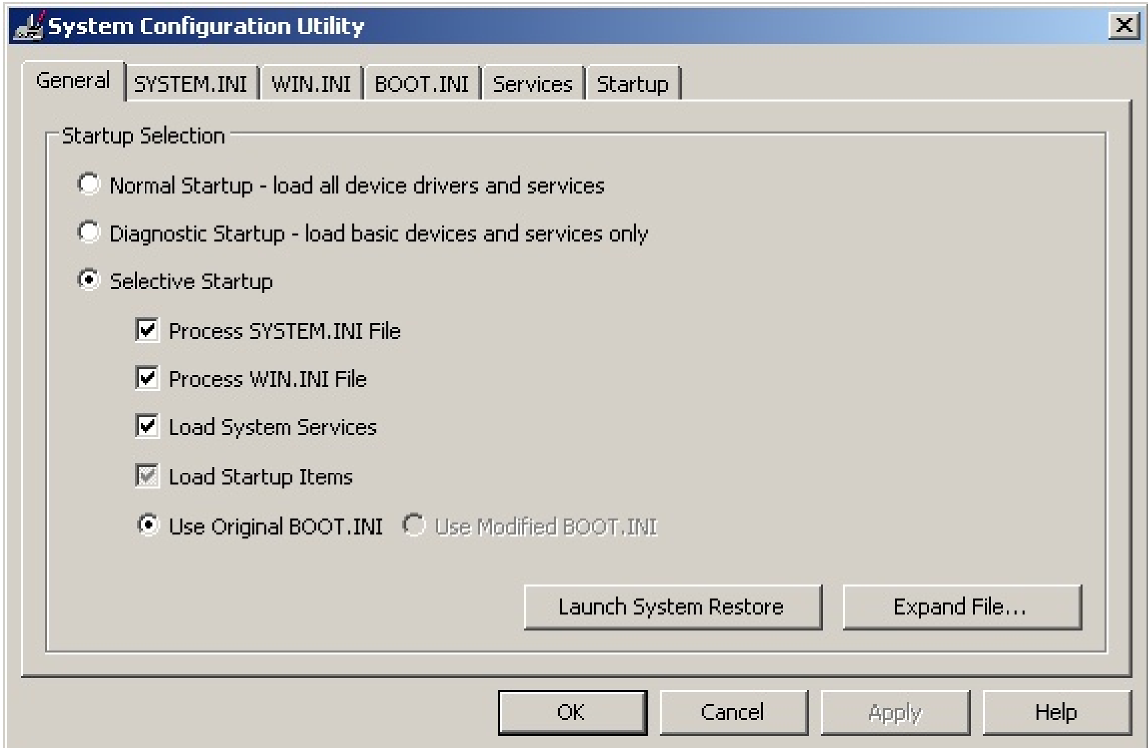
Start the software by double-clicking the GeoEel Controller shortcut on your desktop:

Note: *We highly recommend disabling all programs that might load automatically on boot-up and run in the background, such as virus protection software. These programs will sometimes take control of the network without warning. If this happens during data acquisition, shots may be missed. Background programs can usually be seen in the lower right-hand corner;*

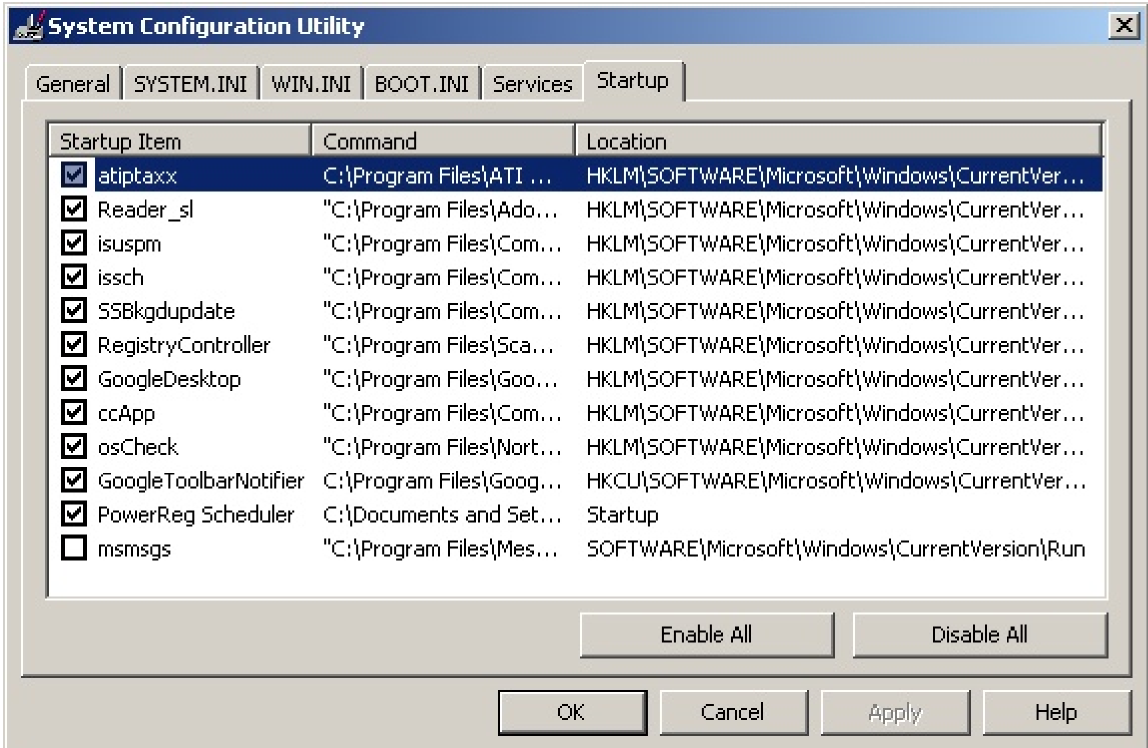
right-clicking and choosing "exit" or "quit" will shut them down. These can be precluded from loading upon boot-up of the Controller PC by clicking on Start *and* Run *(in Windows Vista or later, access **Run** by typing "run" in the text box that appears after clicking the Start Menu), and then typing* msconfig *into the dialog box:*



*Press **Ok** to bring up the following:*



Next, choose the Startup *tab:*

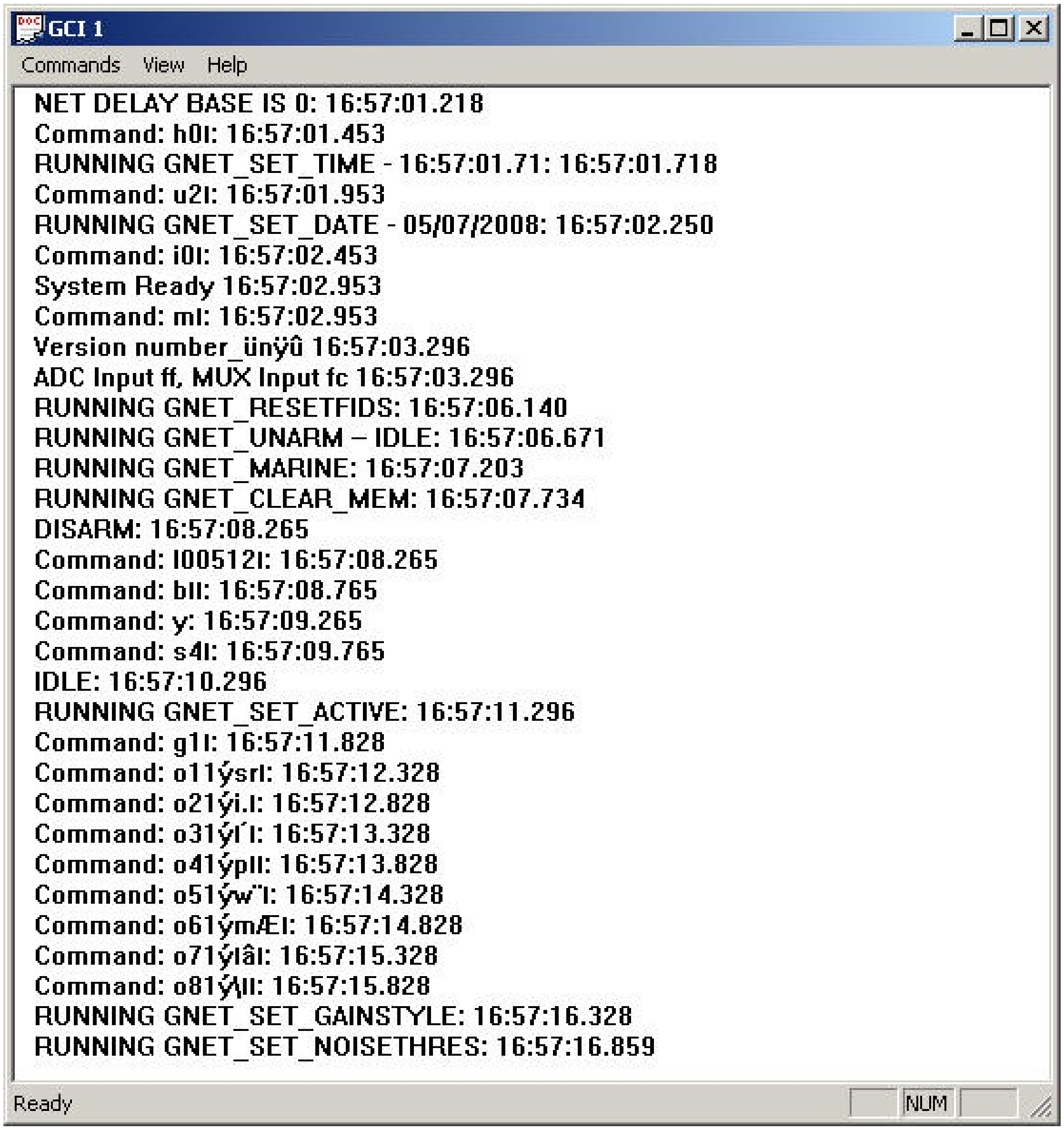


Deselect all applications that are not needed while doing a survey. Future boot-ups will only load the programs selected in the Startup *list.*

3.1.3 Auxiliary Programs Launched on Startup

Each in-water 8-channel Digitizer communicates with a program running on the Controller PC, called the GeoEel Controller Interface (GCI.exe). These programs, in turn, communicate with the main acquisition program, GeoEel.exe. One instance of GCI.exe is launched for each 8-channel Digitizer. The programs are called GCI 1, GCI 2, and so on, and are visible in the system tool bar at the bottom of the screen:

You may look at the GCI windows by clicking on their respective icons in the Task Bar. You will see various messages logging the communication of this program with GeoEel.exe. An example is shown below:



This window may be helpful in troubleshooting the system. The CNT-2 Controller automatically starts and stops these programs.

3.1.4 Starting a Survey

The CNT-2 Marine Controller is an extension of the CNT-1, which has been powering our marine seismic systems since 1996. It is a multi-threaded program that prioritizes safe data storage over all else. Displays include:

- **Survey Log window** – Displays the following information in the operator's log: shot number, date and time, RS-232 data, operator's messages, and data storage information.

- **Shot window** – Displays the current shot record.

- **Spectra window** – Displays the current shot record in the frequency domain.
- **Gather window** – Displays a single-trace (common offset) gather. Selected trace may be changed at any time. Gather is written to a file for off-line printing.
- **Cycle Time/Source Energy window** – Displays the time between triggers, and the rms energy of each shot as measured by a user-selected (usually near-field) hydrophone. This window shows at a glance if a shot was missed, or if the source(s) did not fire.
- **Tape Status window** – Shows the status of up to four tape drives, the amount of space left on each tape, the status of each tape, and whether any errors have occurred.
- **Real-time Noise window** – Displays noise measured in user-defined section of the shot record (usually the water column) in bar graph form. Continuously updated.
- **Tension window** – Displays tension on Tow Cable (if Tension Gauge module is installed).

When writing to tapes, data is buffered so that in the event of tape drive failure, acquisition can continue uninterrupted until the problem is fixed, at which point the shot records are automatically written to the tape in the proper order.

This section describes the CNT-2 Marine Controller on a menu item-by-menu item basis.

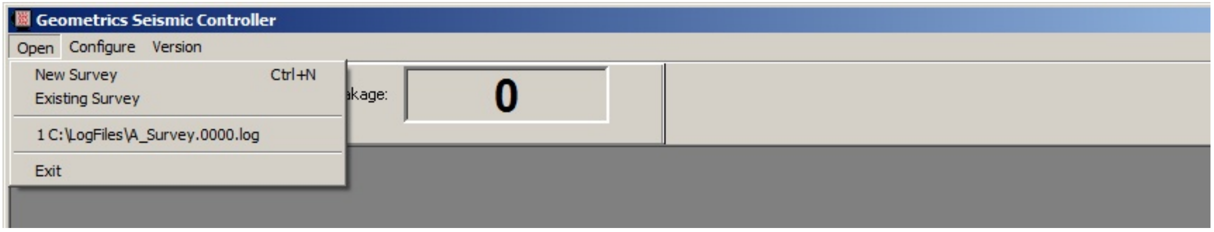
Note: *GeoEel.exe must be run as Administrator.*

Starting the software will bring up the initial configuration menu (the Tape Status or Tension and Leakage Status may or may not be visible at this point):

We'll discuss the menus in order from left to right; however, note that the Configure menu will often be the first one you will have to visit.

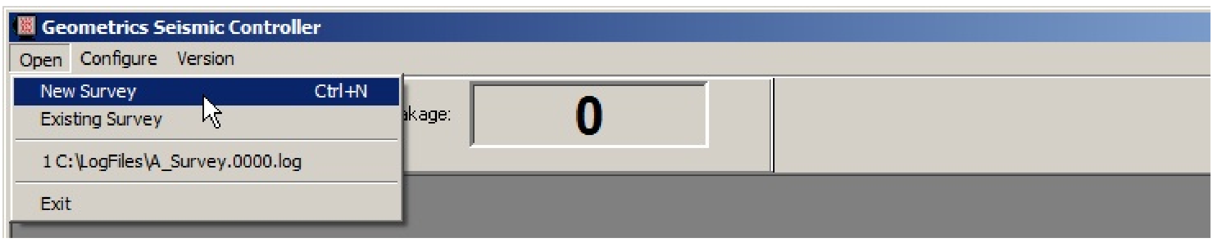
3.1.4.1 Open Menu

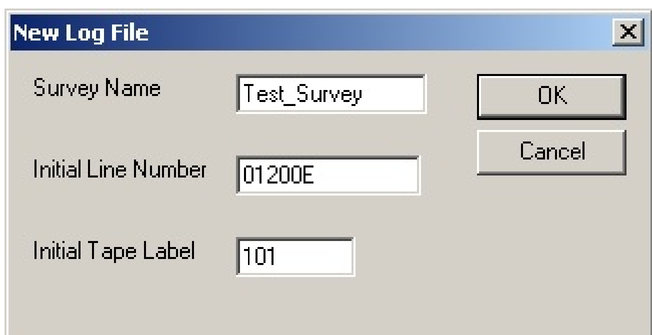
From the Open menu, you may do three things: open a new survey, open an existing survey, or exit the program.



3.1.4.1.1 New Survey Menu

If you are starting a fresh survey, choose New Survey:

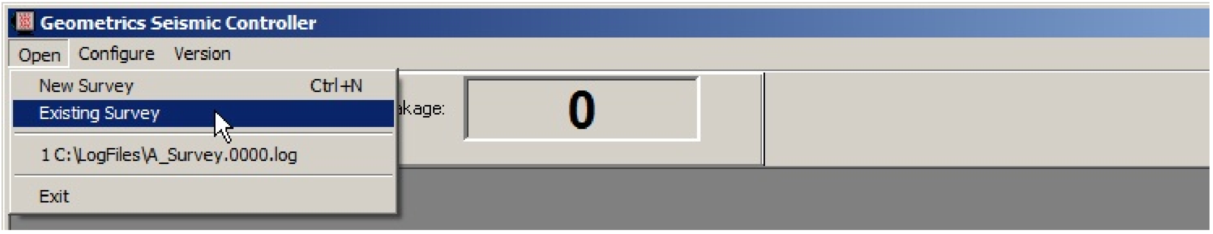


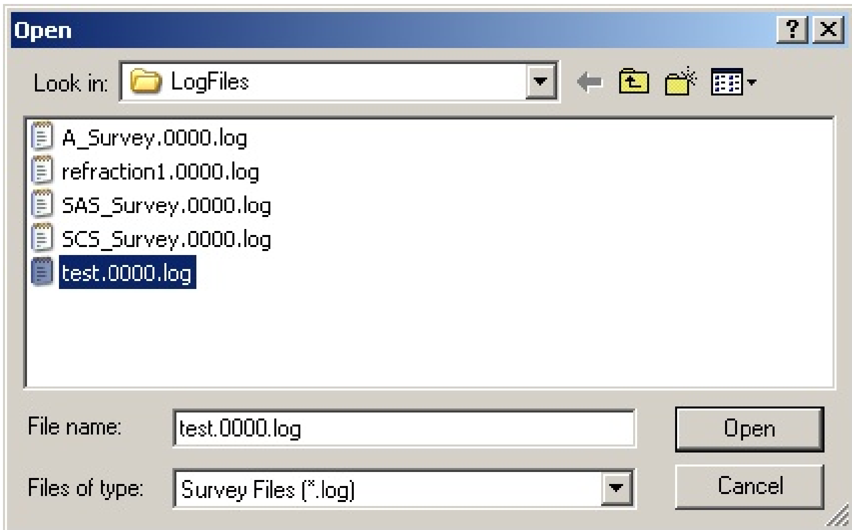


The dialog box shown above is the first in a wizard that will prompt you for survey parameters such as sample interval, record length, preamp gains, etc. We will discuss the various dialog boxes in more detail in subsequent sections.

3.1.4.1.2 Existing Survey

If you wish to continue an existing survey, click on Existing Survey and choose the desired survey from the list of surveys in the Logfiles folder:





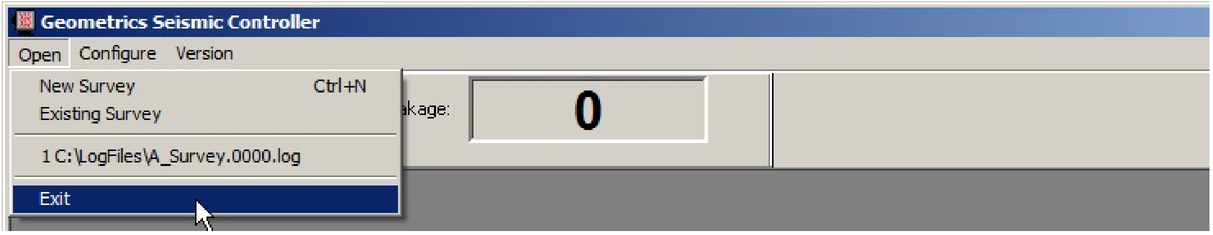
Note: *The Logfiles folder is automatically created in the root of the drive you install the CNT-2 Marine Controller on. For instance, if you install the software on the C: drive, the logfiles will be located in C:\Logfiles. It is recommended that you copy a shortcut to the Logfiles folder onto your desktop. This folder will contain parameter files and also the Survey, Navigation, Depth, and Tension logs.*

This allows you to pick up where you left off on a particular survey. Acquisition parameters such as preamp gain, sample interval, and record length will be read from that survey's parameters (.prm) file. The Survey Log will be opened and appended to.

Note that the last four surveys opened are displayed in the drop-down menu itself; you may also open an existing survey by choosing it from here if it is displayed.

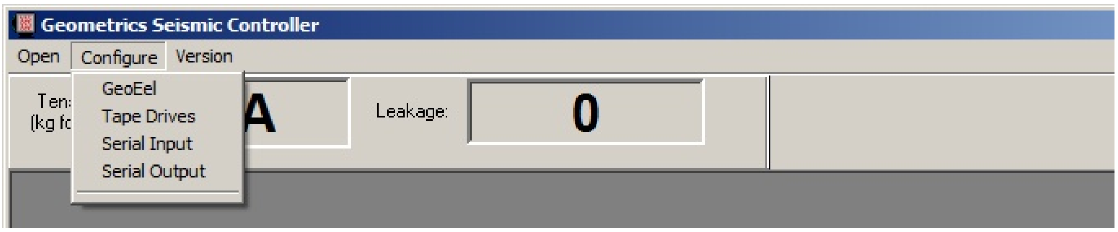
3.1.4.1.3 Exit

Choosing Exit will close the survey and shut down the CNT-2 Controller. You can accomplish the same thing by clicking on the **X** in the upper right-hand corner of the window. If you are using tape drives, closing the survey may take a few minutes, as the tape drives may have to rewind, so please be patient.



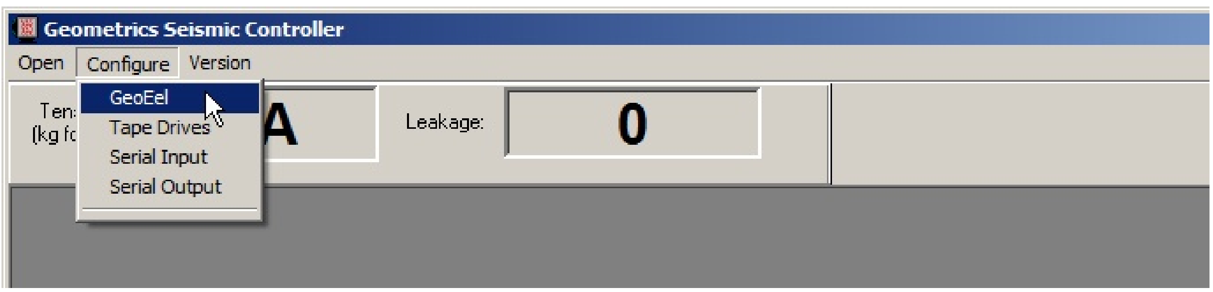
3.1.4.2 Configure Menu

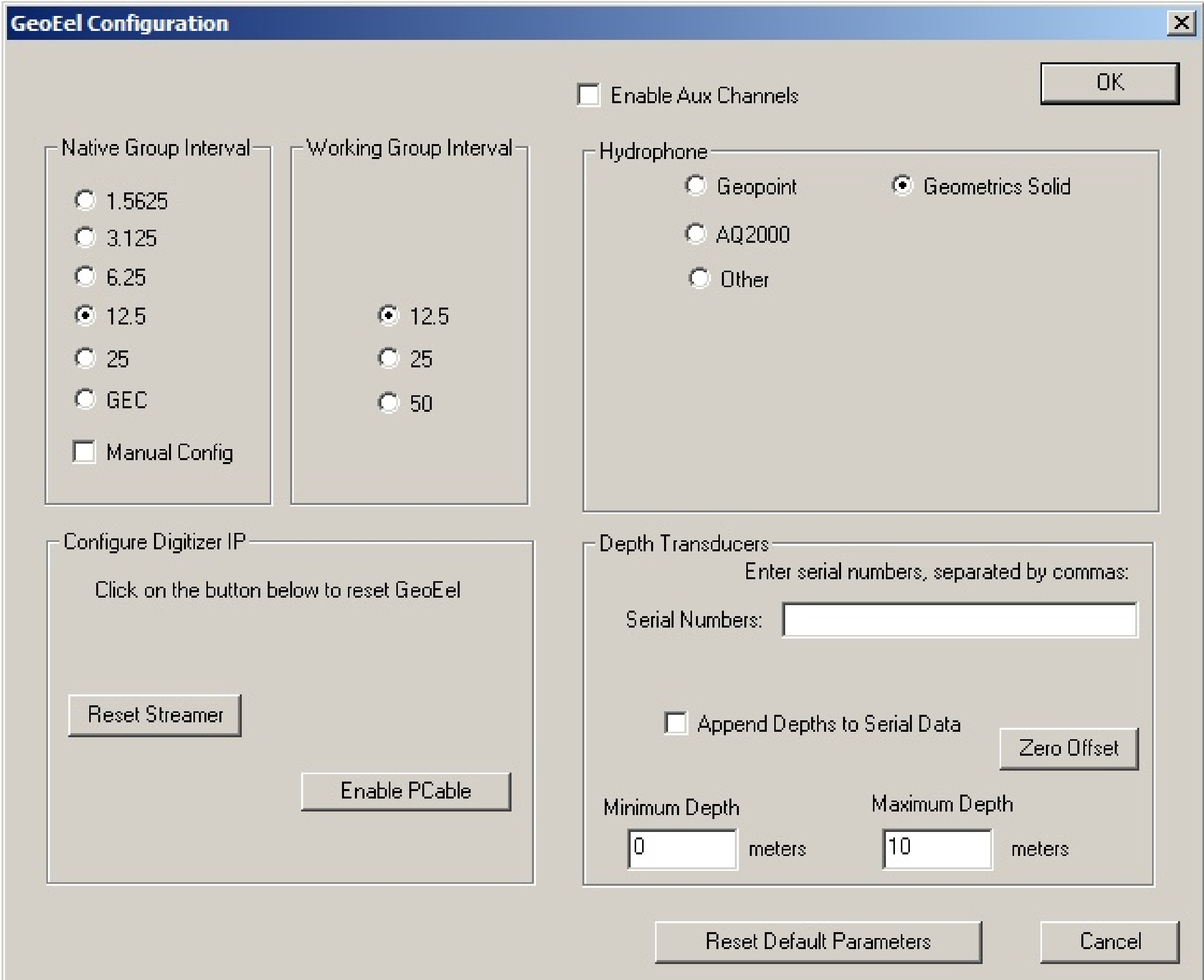
The Configure menu allows you to set up global parameters that cannot be changed during the survey -- the survey must be closed and re-started in order to get back to the Configure menu. If you visit the Configure menu, but make no changes, press **Cancel** to exit without being required to re-start the CNT-2 Controller.



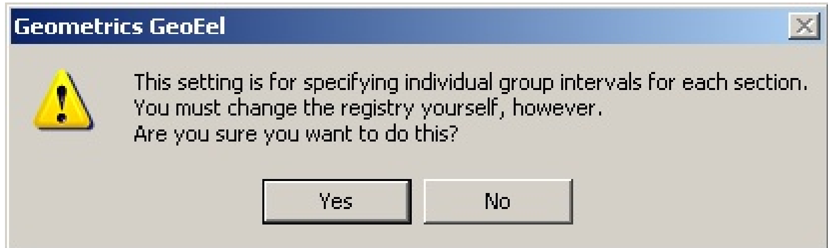
3.1.4.2.1 GeoEel

The first item in the Configure menu is GeoEel.

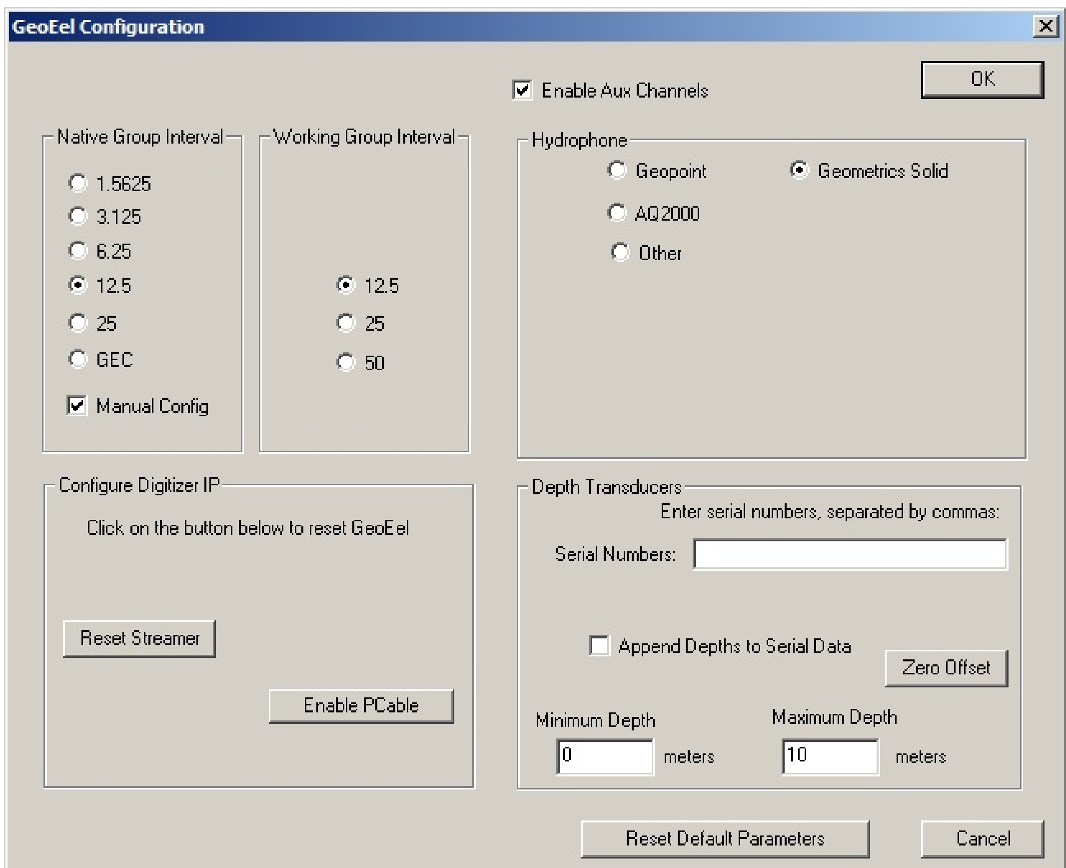




- Enable AUX channels – Enables/disables auxiliary channels. AUX channels are contained in the Deck Unit. The default number of AUX channels is 4, but you can record up to 8. To enable more than 4 AUX channels, see Registry Settings in the Appendix.
- Native Group Interval – Refers to the hard-wired group interval of the GeoEel (GEC only applies if you are using a GeoEel convertible with a third-party Streamer).
- Working Group Interval – The GeoEel (as well as any third-party Streamer) can be digitally reconfigured to a group interval larger than the Native Group Interval by setting a larger Working Group Interval. Each doubling of the Working Group Interval halves the number of channels. For instance, if your Native Group Interval is 6.25 and you set a Working Group Interval of 12.5, the total number of channels will be halved, and channels 1-2, 3-4, 5-6, etc. will be digitally averaged.
    - Manual Config - If you would like to specify the Working Group Interval for each section individually, you may do so. In order to do this, first click on the Manual Config check box in the dialog. You will be asked to confirm this choice as shown below:



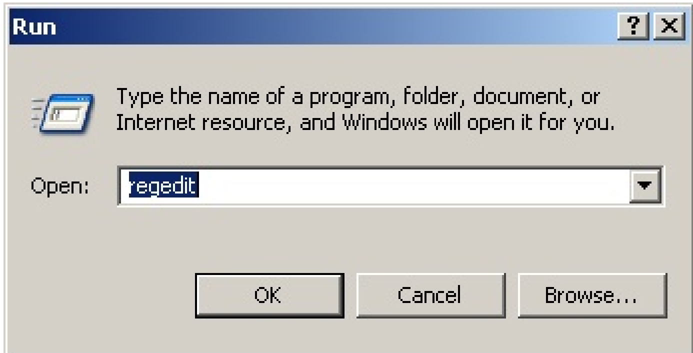
If you agree, the box will be checked:



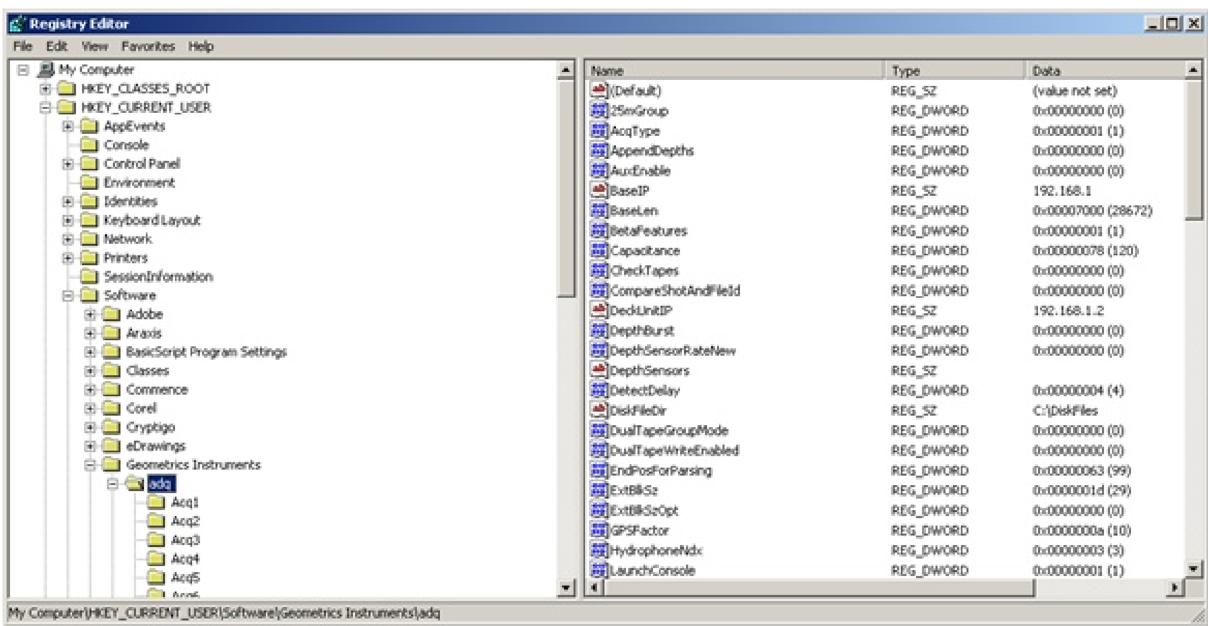
Click on **OK** to close this dialog box, and then the program will close.

Next, open the registry editor by choosing Start / Run in Windows, and typing "regedit".

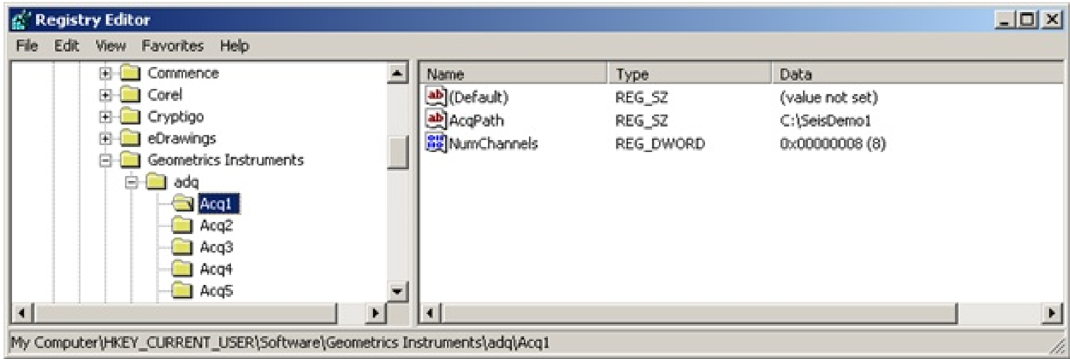
Note: *This operation should be undertaken only by those familiar with editing the* *registry. You can completely paralyze Windows by making the wrong changes.*



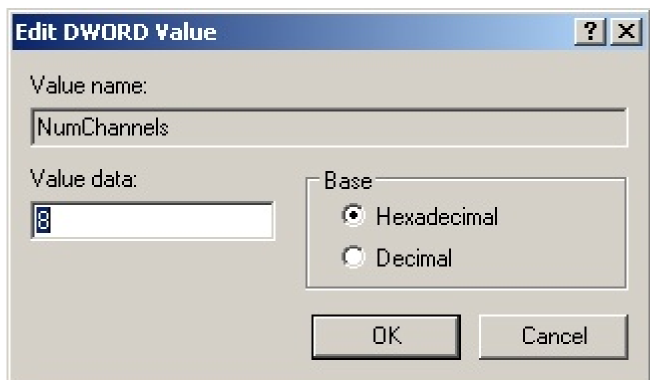
Browse to the HKEY_CURRENT_USER / Software / Geometrics Instruments keys, and choose the Adq key, as shown below:



Under the Adq key on the left view, you will see listed Acq1, Acq2, and so on. These are keys corresponding to the first section of the Streamer, 2nd section, and so forth. Selecting any of these will bring up the following:



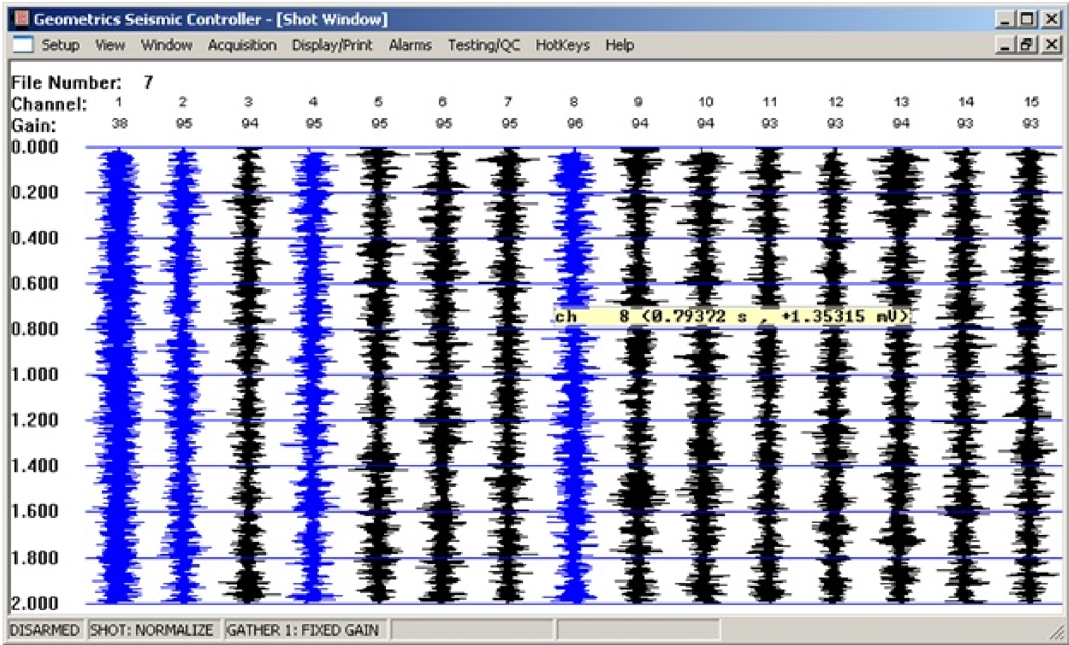
On the right-hand window pane, you may double-click the NumChannels key and change its value:



The default value is 8, meaning there are 8 channels in this section (which is Geometrics' standard). You may specify 1, 2, 4, or 8 channels. If you specify 1, then all 8 channels in the section will be averaged together into a single channel. Entering 2 will result in the first four channels being averaged into one channel, and the second four channels into a second channel.

Then select any other Acq# key and change its NumChannels value to specify a different grouping for other sections.

Once you restart the GeoEel.exe program, the settings used in the registry will take effect. The Shot window will display the first channel of each section in blue. For example, if you have 4 sections and enter 1 for the first section, 2 for the second section, 4 for the third section, and 8 channels for the fourth section, the Shot window will look as follows:



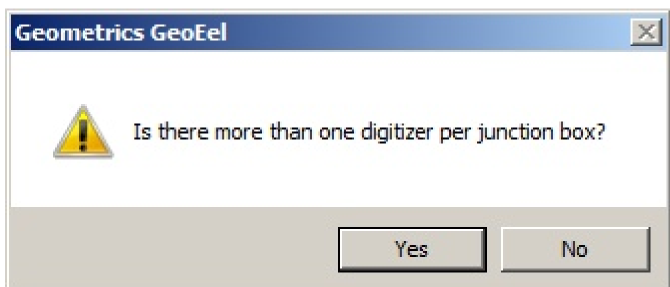
If you forget to select the Manual Config check box before making the changes in the registry, you will get the following message when you start the GeoEel software:

This will overwrite your changes in the registry with the default values, and you will have to go through the above process again. This is tedious, but we expect this feature to be rarely used. The program by default treats individual settings for the Streamer section as an error, and it attempts to fix it. The Manual Config check box overrides this.

Note*: Hydrophone leakage, hydrophone capacitance, and analog performance tests will all be adversely affected by these changes. For these test results to be accurate, you must disable the Manual Configuration settings. To accomplish this, simply uncheck the* Manual Config *box, press* **OK**, *and restart the software.*

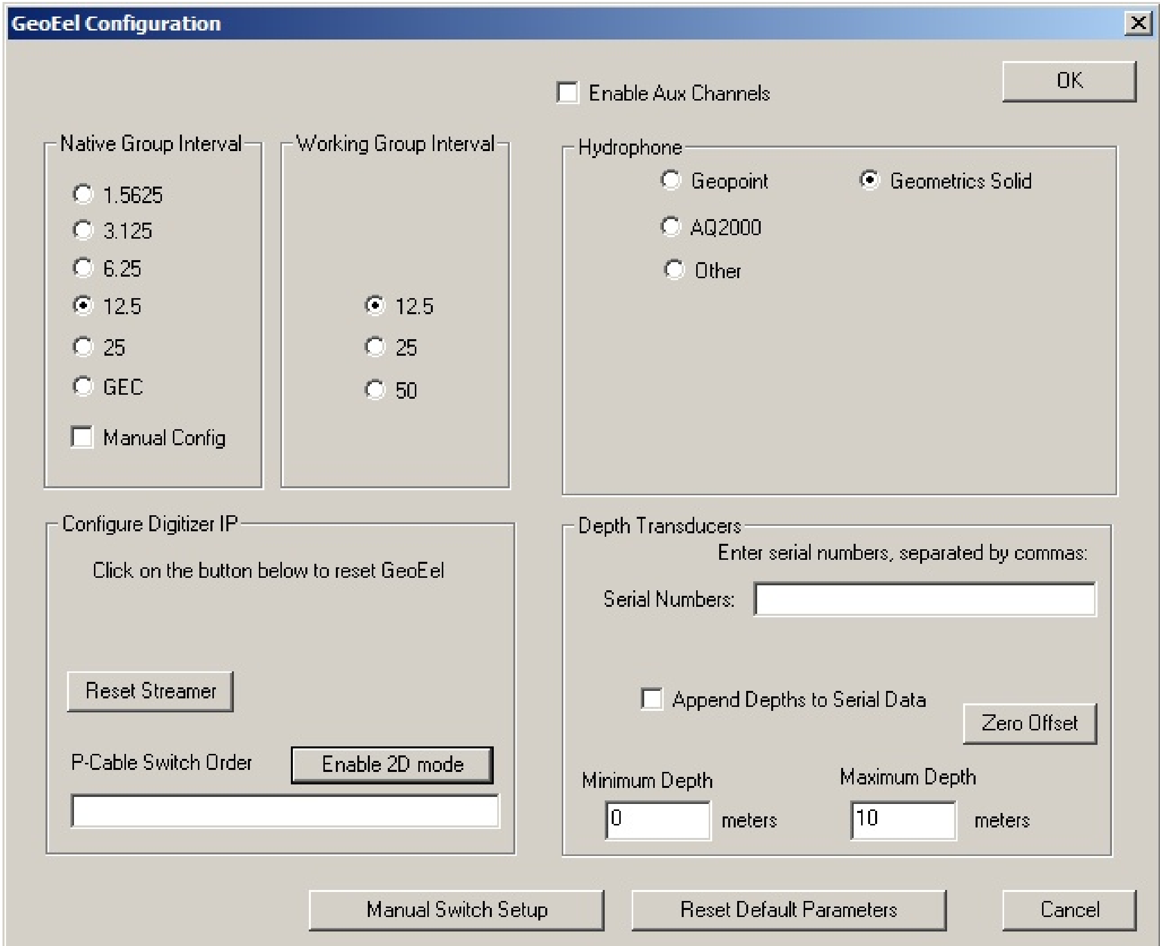
- Hydrophone – If you have a liquid or gel-filled GeoEel, Hydrophone should be set to either GeoPoint or AQ2000, depending on which hydrophones you requested in your Streamer (most Streamers come with GeoPoint hydrophones). If you have a Solid GeoEel, just click Geometrics Solid. It is important that the correct model is chosen here to ensure proper reporting of noise and the correct calculation of expected capacitance per channel. If you are not sure, please contact Geometrics. Other only applies when you are using the GEC and a third-party Streamer, and provides entries for Hydrophone Group Sensitivity and Expected Capacitance.
- Reset Streamer – Pressing the **Reset Streamer** button will send a 250 ms pulse down the trigger line, which will reset all the 8-channel boards in the Digitizers to an identical IP address (192.168.1.254).

  Note: *Once a survey has been opened, the IP addresses of the Digitizers are locked. This prevents accidental resets due to extraneous noise on the trigger line that might occur during surveying. To unlock the Digitizers, **you must cycle the power**. Reset Streamer will not work unless power is cycled first.*
- Enable P-Cable – Pressing the **Enable P-Cable** button will display the following message:



Most often, there is only one Digitizer (one 8-channel Active Section) connected to each Junction Box. If this is the case, press **No**. This will prevent the Detect Sections step from looking for additional Digitizers on the same Junction Box after it has found the first one, saving significant time in initializing the system. Otherwise, press **Yes**.

Either answer will modify the dialog box slightly:



- P-Cable Switch Order – The CNT-2 software needs to know the order of the Switches (Junction Boxes) on the Cross Cable. These numbers can be found engraved on the Junction Boxes themselves, and double as the serial numbers. Type them in, starting on the Starboard end, separated by a comma. This information will be written to the registry. **It is imperative that these are ordered correctly, or the traces from the individual Streamers will be out of order.**

  Note: *This step can also be accomplished in the Switch Tests module in the GeoEel Tester utility. In fact, it is preferable, because the Switch order can be determined automatically, eliminating the possibility of transcription errors.*

- **Detect Sections** – This button will appear after a Streamer reset. When **Detect Sections** is pressed, the Digitizers will be detected (based on their IP addresses of 192.168.1.254, see above discussion of the **Reset Streamer** command) in their physical order on the network, and assigned sequential IP addresses (192.168.1.3, 192.168.1.4, 192.168.1.5, etc.). Channels are then numbered by the CNT-2 Controller according to the location of the Digitizer in the Streamer or P-Cable array. For instance, the first Digitizer, 192.168.1.3, is set to channels 1-8. The Deck Unit has a fixed IP address of 192.168.1.2.

Note: *If it is a P-Cable system, you must provide the P-Cable Switch order prior to detecting sections.*

Note: *Holding the CTRL key down while pushing* **Reset Streamer** *will cause it to detect sections automatically after resetting.*

You will see the following messages during the process of detection and numbering sections. Those in italics are P-Cable only.

- **Looking for SPSU Comm Board** - The computer is connecting to the Ethernet board on the Deck Unit's main board stack.
- ***Preparing Cross Cable Switches*** *- An RS-485 broadcast command is sent over the AUX line to disable the Streamer Ethernet ports in all of the Junction Boxes to prevent communications with the Digitizers.*
- ***Making sure Cross Cable is Reset*** *- The computer is attempting to locate components with IP address 192.168.1.254; i.e., it is looking for Digitizers. If the Streamer ports were disabled successfully (above), it will not be able to detect any Digitizers, which is the idea. If Digitizers are detected, the preceding step will be repeated, followed again by this step.*
- ***Enabling Switch Position #___*** *- An RS-485 command is sent over the AUX line to enable the Streamer Ethernet port in Junction Box serial # YYYY (IP address 192.168.30.XX, where XX = YYYY - 7100) so that communication with the first Digitizer connected to that Junction Box can be established. You should see the message "Found Switch # ___ - Looking for Eels". This means it has found the Switch it was looking for and will now look for a Digitizer(s) connected to that Junction Box.*
- **Detecting A/D Module** - It is looking for the next Digitizer (IP address 192.168.1.254) in the network. When it finds one, you will see
  - A/D Module # ___ found. Then you will see one of the following:
    - Failed to establish new IP address,

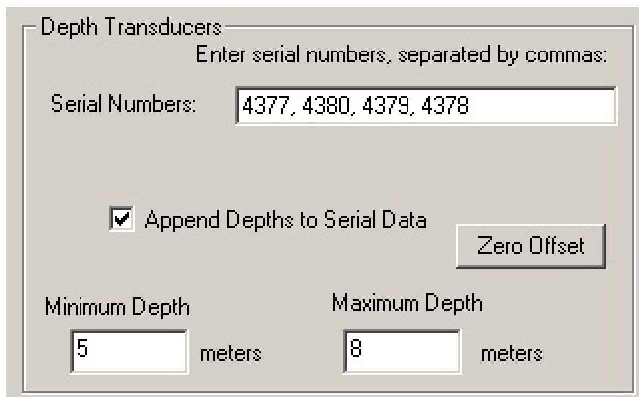
      or
    - IP changed to 192.168.1.___ OK.

In a 2D system, the **Detecting A/D Module** step will be repeated until no other Digitizers can be found. In the case of a P-Cable, the messages **Enabling Switch Position # ___** and **Detecting A/D Module** steps will be repeated until all Switches have been enabled and no other Digitizers can be found.

Note: *When this process has been completed, you should confirm that all Digitizers have actually been detected by the software. The software does not have a priori knowledge of their existence, so if they are not detected, the software assumes they do not exist.*

Note: *Resetting the Streamer takes about 15-20 seconds, regardless of the number of channels. The time required for detecting sections depends on the number of channels. In general, each 8-channel Digitizer requires about 25 seconds to be detected and be assigned an IP address.*

- Depth Transducers – These are optional and may be installed in your GeoEel (liquid-filled only) or provided as separate modules (solid or liquid-filled). If so, you must enter the serial numbers of the sections they are installed in or, in the case of a separate module, the serial number of the module itself. In the liquid-filled case, the serial number can be found at one or both ends of the section. Enter the 4-digit numbers with a comma in between, as shown below. They should be entered in the order the sections/modules are placed in the Streamer, inboard section first.

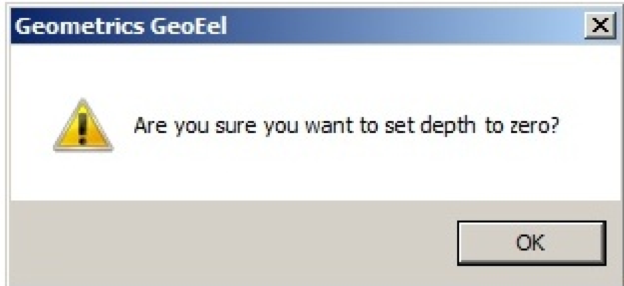


- Append Depths to Serial Data – If enabled, and if you are logging serial data, depth readings will be concatenated to the serial string before the string is written to the Survey Log and the SEG-D header. For example, if you are logging NMEA strings from a navigation system, a string containing the depth information will be appended to the navigation string, and the entire string written to the Survey Log and the SEG-D header. The depth data will also be written to the Depth Log.

- Minimum Depth/Maximum Depth – If any sensor depth exceeds these limits, it will be indicated on the depth sensor display. These limits can also be set from the Geometry Setup dialog.

  Depth sensors will be interrogated according to the settings in the Depth Sensor dialog box. Depth information will be written to the following file: [drive]:\Logfiles *[Survey_Name.Line_Number]*.depth.txt.

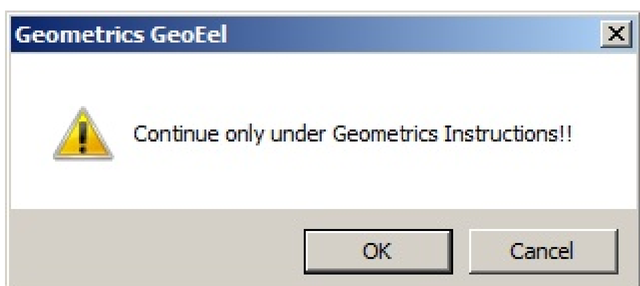
- Before deploying a system with depth sensors, you should calibrate them. Pressing **Zero Offset** will bring up the following message:



Press **OK** to calibrate all depth sensors.

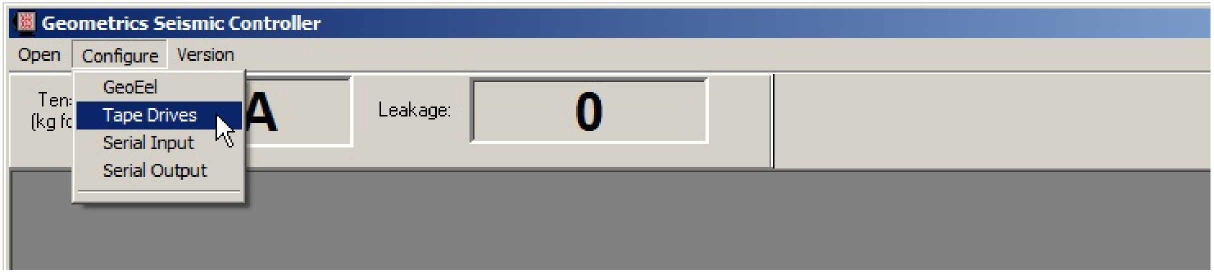
If it is a P-Cable system, there are depth sensors in the Junction Boxes, and the serial numbers of these are the serial numbers of the Junction Boxes themselves. In addition, there is typically a separate depth or depth/compass module at the tail of each Streamer. Best practice is to enter the serial numbers from Starboard to Port and from fore to aft.

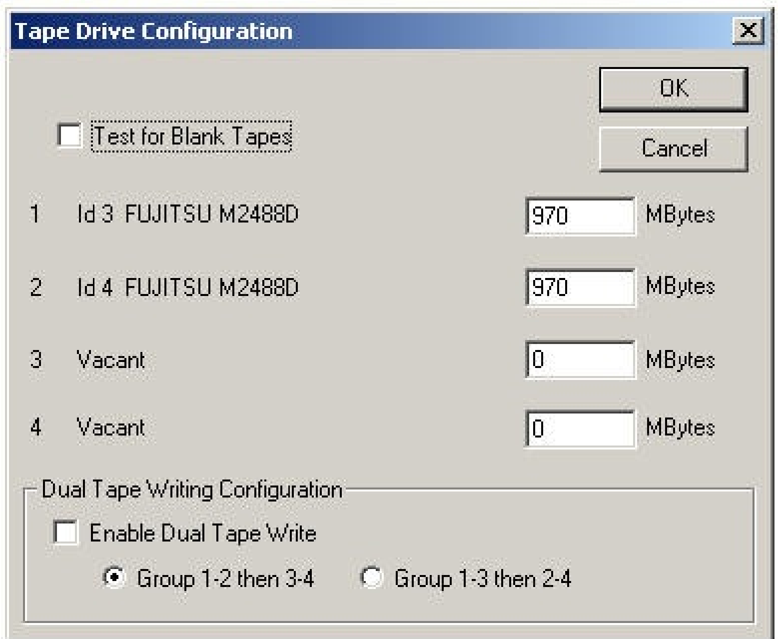
- **Enable 2D Mode** – This simply converts back to 2D mode, removing all references to the P-Cable.
- **Manual Switch Setup** – This tool is for configuring the Switches themselves. **This is something that is normally set at the factory and you should NOT enter this module unless you are on the phone with Geometrics Support.** You will see the following message:



3.1.4.2.2 Tape Drives

If you are using tape drives, open the Configure menu and choose Tape Drives:





The CNT-2 Marine Controller will control up to four tape drives, automatically switching when tapes get full or if a tape drive malfunctions. As mentioned earlier, SCSI tape drives must be turned on prior to starting the Controller PC in order to be recognized. The above dialog box will usually display the model name and number of the tape drive plugged into each port. Those ports not used will be labeled as "Vacant".

Note: *Only SCSI ID numbers 2 through 6 may be used for tape drives. Each drive must be set to a different number. Some systems may have a SCSI CD-ROM or hard disk attached, which will occupy one of the SCSI IDs. Watch the screen when the CNT-2 boots; it should report the SCSI ID of the CD-ROM or hard drive.*

Note: *The system searches for the first drive that is ready, starting with the lowest SCSI ID number. Therefore, the system will normally toggle between the first two drives, even if more are connected (unless dual tape write is enabled, see below). The other drives may be used in case of a drive error on one of the first two drives.*

Enter the amount of data in Mb to write to each tape before switching. When the amount of data written to a tape reaches the amount specified, that tape will be automatically ejected and the CNT-2 Controller will automatically switch over to a new tape drive. If the specified amount is larger than the capacity of the tape, it will still switch automatically, and no data will be lost. The purpose of this menu option is primarily to allow you to write less than the tape capacity if you so desire.

Note: *If the amount of data specified exceeds the tape capacity, switching may take slightly longer than normal. This is because the system must advance and actually reach the end of the tape in order to realize that the capacity has been reached. In the interim, some data may be buffered, and you may see messages in the Survey Log to this effect. This is not reason for panic. Once the system does switch over to a new tape drive, all data that were buffered during the switch will be written to the new tape in the proper order. Further note that this eventual writing to tape may not be accurately reflected in the real-time view of the Survey Log, but if you open the Survey Log in a text editor such as Notepad, you will see confirmation of this.*

- Test for Blank Tapes – If enabled, the system will check whether there are data on the tape prior to writing to it. If data is detected, you will be given the option to overwrite or append.

Note: *Checking the* Test for Blank Tapes *box may result in delays during the tape-switching process, as described in the note above. However, no shots will be missed.*

Note: *Since seismic data is so important, you should not rely solely on this program to check your tapes. It may be fooled in some conditions. This feature is meant as a backup measure only. The best thing to do is label each tape as it is ejected from a tape drive, set the write-protect tab, and remove it from the acquisition room.*

- Enable Dual Tape Write – If you have four tape drives plugged in, you may write to two tapes simultaneously, creating an instant backup, and switching between tape *pairs*. Check the box, and then define the tape pairs by clicking one of the radio buttons.

  When in dual tape write mode, paired tape drives will operate in tandem. If one tape drive of a pair malfunctions for some reason, forcing a switch to its counterpart in the other pair, *both* tape drives will eject their tapes, and control will switch over to the other pair. This ensures that all tape pairs have identical data content.

  Press **Ok** to apply the settings and close the menu. You will be prompted to re-start the software:

If you have only visited the menu, and have not made any changes, close it by pressing the **Cancel** button or by clicking on the **X** in the upper right-hand corner. Closing the menu in this manner will avoid the prompt to restart.

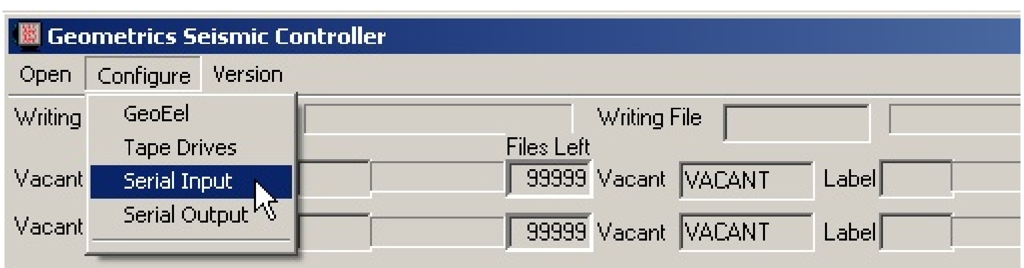
Note: *It takes a few seconds for the CNT-2 Controller to completely shut down. If you try to restart it too soon, you will see the following message:*

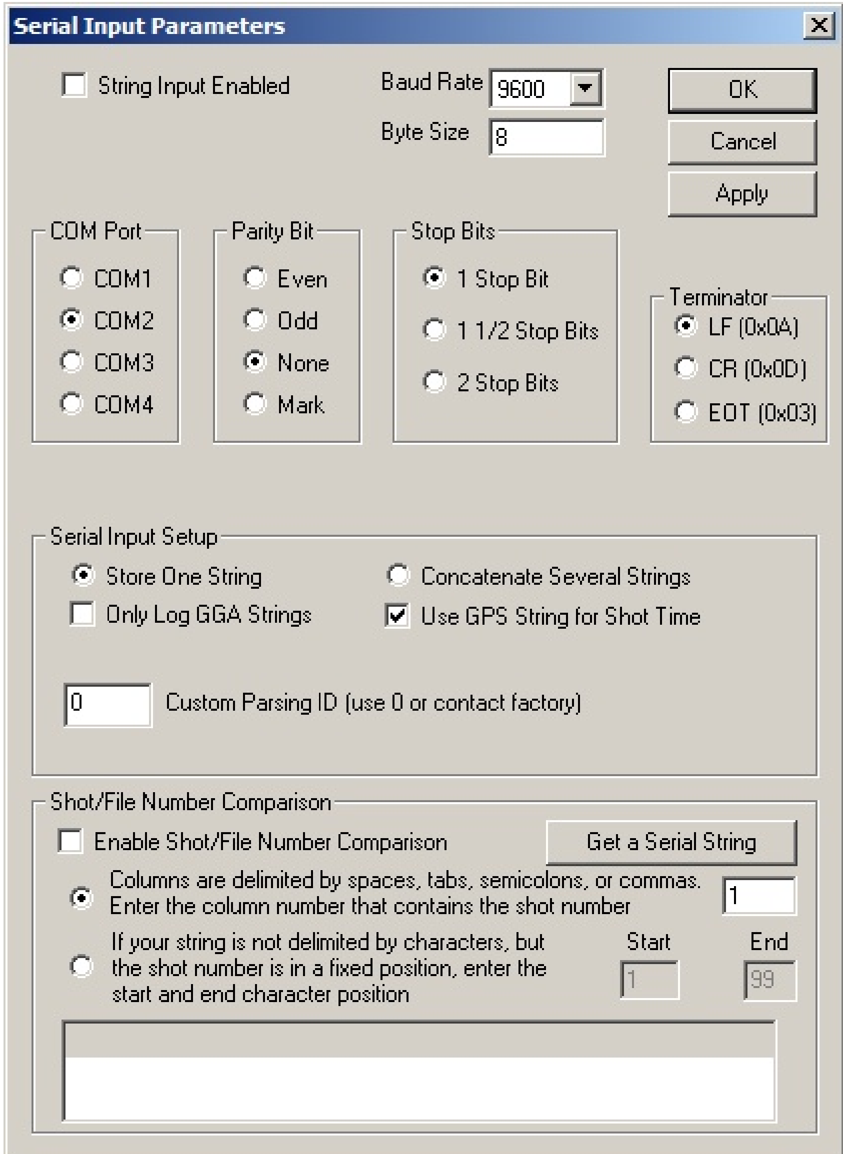
Just press **Yes** *and it will automatically retry after 10 seconds. In general, it's best to wait about 10 seconds after shutting down before restarting.*

Note: *If the program was terminated abnormally, some threads will still be running in the background and cause this message to be shown every time you start the Controller software. In this case, you should shut down the system and re-start (Start / Shut Down / Shut Down and Restart).*

3.1.4.2.3 Serial Input

The CNT-2 Marine Controller has the ability to accept data on a serial port or via the LAN and write it to the SEG header and the Survey Log. Most commonly this feature is used to log a navigation string. To set this up, choose Serial Input from the Configure menu:





- Serial Input Enabled – Check this box to enable serial input.

  Unless you are using UDP input (see below), carefully set the transmission protocol to match that of your serial (RS-232) device (i.e., GPS, navigation system, source controller).

  - Set the COM port to whichever one the serial cable is connected to.
  - Choose a Baud Rate from the drop-down list.
  - Byte Size, Parity Bit, and Stop Bits are generally as shown above, and these are the defaults.

  Indicate whether the incoming string is terminated with a:

  - Line Feed (LF, 0x0A)

- Carriage Return (CR, 0x0D), or
- EOT (end-of text; 0x03).

Note: *It is important to set this parameter correctly. If you don't, you may not get any strings at all. Always run a test prior to starting the survey.*

Many systems will send several different strings in a burst, delimited by a CR, LF, or EOT.

- Store One String – Will store only the first string to arrive and ignore the others.
- Concatenate Several Strings – Will concatenate and store all of the strings in a burst.

If you are logging a navigation string, it is most likely some sort of NMEA string. There are several different types, all containing different and overlapping data. The most commonly logged version is called a "GGA" string. If you are running a full navigation system – GPS plus a PC running NaviPac or other 3rd-party navigation software – you can generally specify which string to send out the serial port or over the LAN. However, if you have just connected a GPS unit directly to the CNT-2 Controller, you may not have any control over the type of serial string, and in this case, it is common for the GPS unit to send many different varieties at once.

- Only Log GGA Strings – Only GGA strings will be stored; others will be ignored. This setting overrides the radio buttons above – it will not concatenate several navigation strings if this option is enabled.

Normally, records are time-stamped (trigger time in header) based on the DOS clock. If you are logging GPS strings, you can elect to have this DOS time replaced with UTC Time, which is included in most if not all flavors of GPS strings. This is generally recommended.

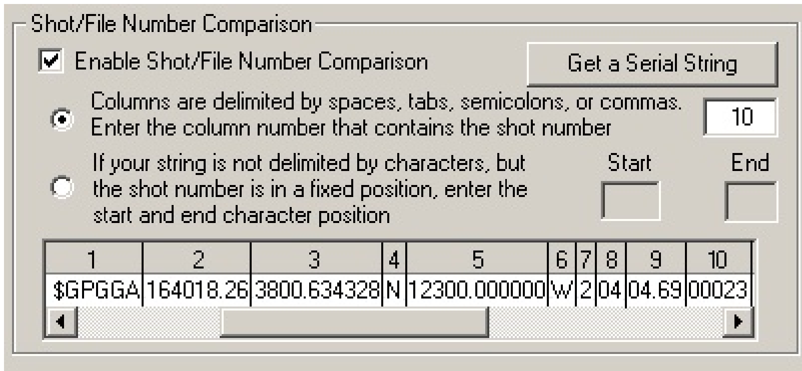
- Use GPS String for Shot Time – DOS trigger time in record will be replaced with UTC Time from GPS string.

Note: *Regardless of the SEG format you choose for the data, the first 96 characters are also written to the Survey Log, next to the appropriate FFID (shot file name, such as 1437.SGD) generated by the CNT-2 Controller. The* ***entire*** *string is written to a file named [drive]:\Logfiles\[Survey_Name.Line_Number].Nav.txt.*

- Custom Parsing ID – Contact the factory if you have special parsing needs.

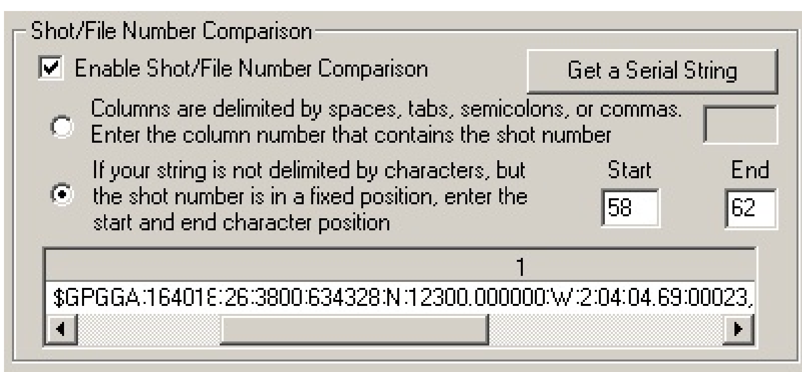
- Shot/File Number Comparison – When using a navigation system and/or source controller to trigger the system, it is common for a sequential "shot number" to be generated. This can generally be included in the serial string. If it is, it can serve as a useful QC tool to detect if the seismograph fails to trigger when the source is fired, or if the seismograph triggers on its own between firings of the source. The CNT-2 Controller generates an automatically-incremented FFID# for each shot file (the FFID# is the file name of the shot record). So long as the recording system and trigger source stay in sync with each other, the difference between these two numbers should stay constant. If they change, something failed to fire or fired out of turn. Enabling the Shot/File Number Comparison feature causes this difference to be calculated each time a trigger is received. If the difference changes, an alarm will sound (if enabled; more on alarms here).

For this comparison to take place, the CNT-2 Controller must be told which number within the received serial string represents the shot number. There are two ways to do this. Send a string to the CNT-2 Controller from your peripheral device. Then press the **Get a Serial String** button, and the string should be displayed in the window:



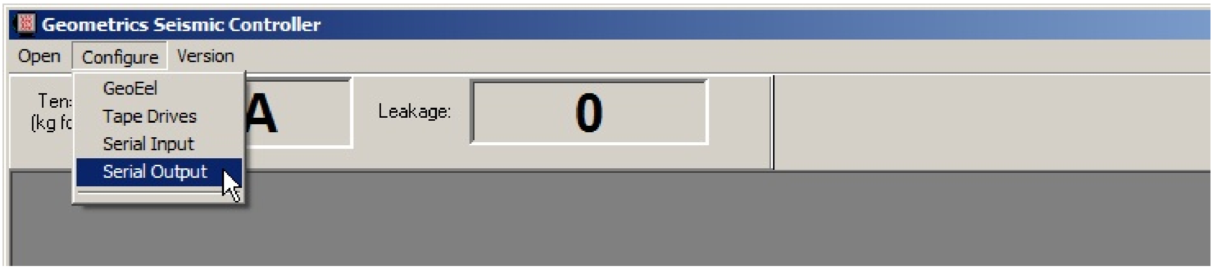
If the string is delimited with one of the delimiters the CNT-2 recognizes – space, tab, semicolon or a comma – then it will be divided into numbered columns as shown above. Click the upper radio button, identify which column contains the shot number, and enter that column number in the box.

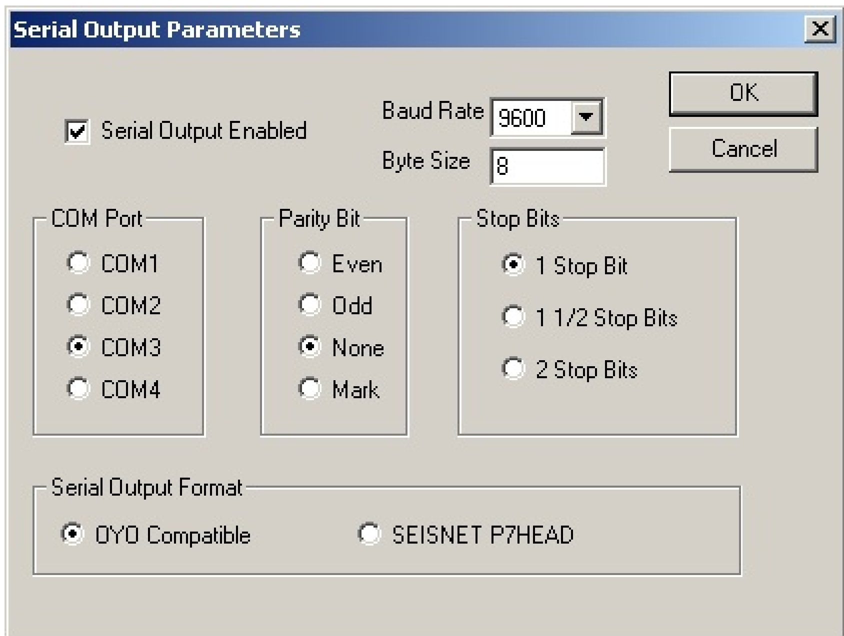
If the string is not delimited, or delimited with characters other than those listed above, then click the lower radio button, and count characters from left to right to determine the beginning and ending positions of the shot number. Enter these in the boxes to the right:



3.1.4.2.4 Serial Output

The CNT-2 Controller can also output a serial string for logging on a peripheral device, such as the navigation computer. Choose Serial Output from the Configure menu:





As in Serial Input, you must set the transmission protocols to match the peripheral device you are communicating with.

There are two formats to choose from for the output serial string.

- Oyo Compatible format. This format writes the FFID#, tape number, and number of active channels. Each field is right-justified and is 7 characters wide. The string is terminated with CRLF (0x0D 0x0A).

  Example:

  1 101 60

- SEISNET P7HEAD format follows the P7Header format. This string is terminated with LF (0x0A).

  Example (all on one line in reality):

  HDR 0000 195LOG 01200075DATE01210011TIME01340008UNIT01460001

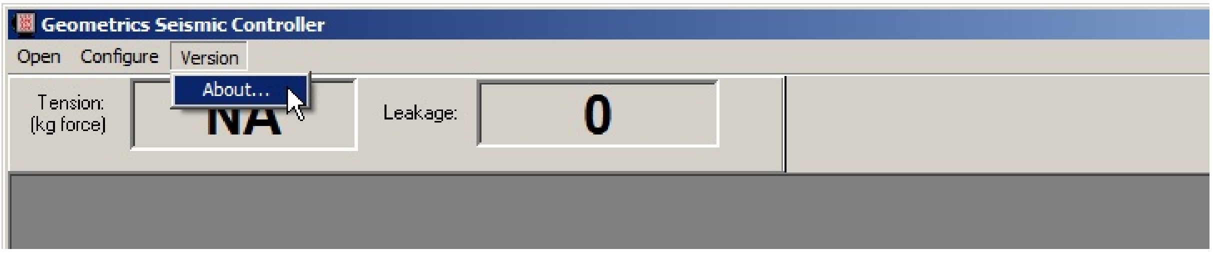
REEL01510009FILE01610011SHOT01730005BUF 01800001TAPE01830013

4:09:38 2 101 4 4

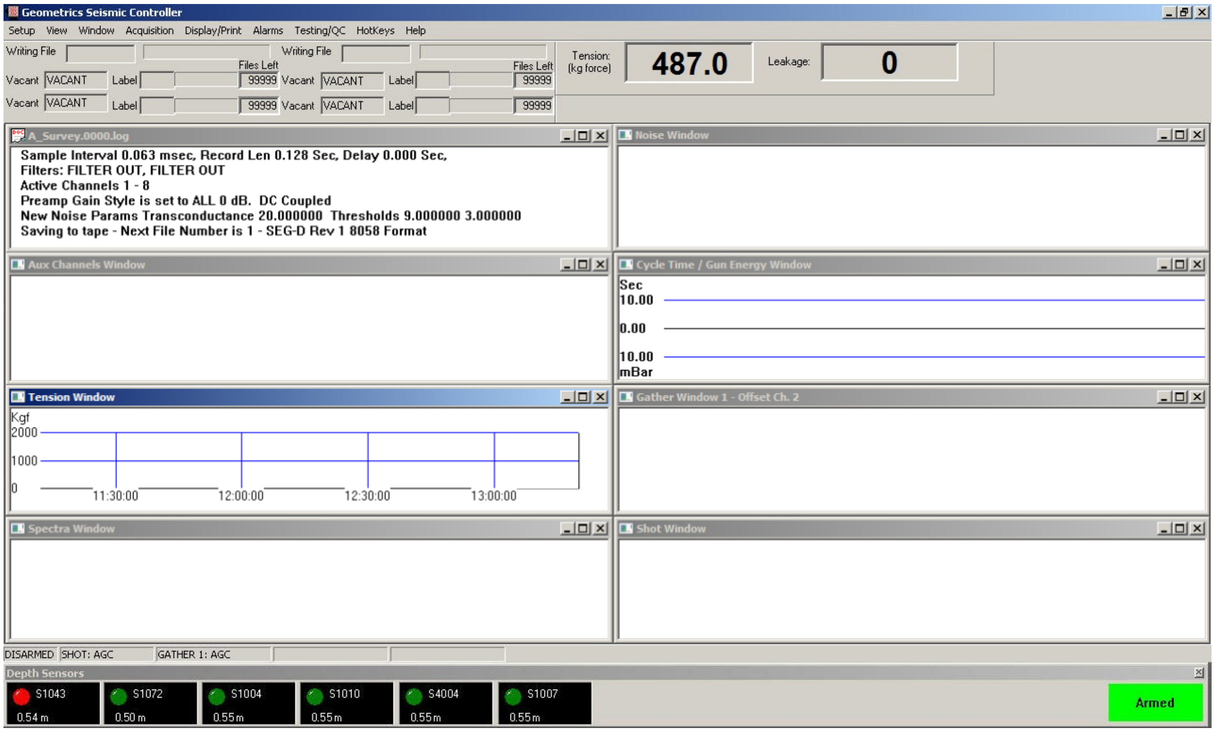
Note: You may enable Serial Input *and* Serial Output *at the same time, but you must use two separate serial ports.*

3.1.4.3 Version Menu

The Version menu displays the software version information, along with phone numbers and contact names for technical and field support:



3.1.4.4 Displays



After you have started a new survey or opened an existing one, you will be presented with the Main Program screen (above). The main menu items are across the top, followed by the Tape Status and Leakage and Tension windows. There are seven graphics windows shown on the main screen. They are: Shot window, Spectra window, AUX Channels window, Survey Log window, Gather window, Noise window, and Cycle Time/Source Energy window. If you have depth sensors and have activated them by entering their serial numbers in the GeoEel Configure menu, you will see a docked window showing the output of each sensor. You will also see a color-coded indication of the ready status of the system (red for disarmed, green for armed). Finally, a status line is shown at the bottom.

The first thing you should do is arrange the windows to fit your needs. The Tape Status and Tension and Leakage displays are "docked" windows. A docked window may be disconnected from the main frame by double-clicking on a blank area, as shown by the cursor arrow below:

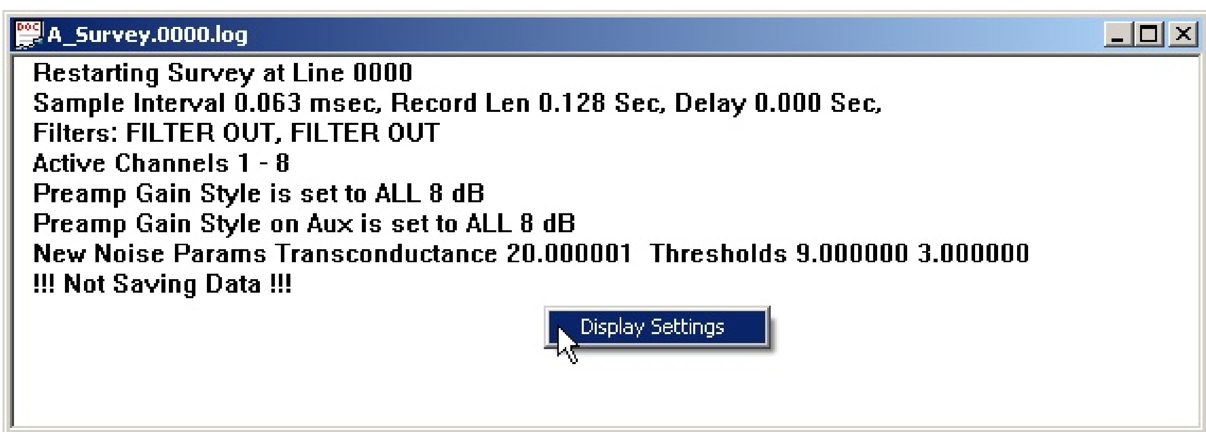
It may then be positioned anywhere you please. It can also be removed by pressing the **X** in the upper right-hand corner. To bring it back, visit the View menu.

The Depth Sensor display will appear automatically if their serial numbers are entered in the GeoEel configuration menu. This display cannot be removed; but it can be moved to the top, bottom, or sides of the screen.

Some of the displays may not be desired during surveying; if so, you can minimize them to save space. If you need more than four active, you might want to consider using two or even three monitors.

Note: *The windows will be restored to their previous configuration when you re-start the CNT-2 Controller.*

Note: *Right-clicking in any of the graphics windows above will bring up a display parameters menu for that window:*

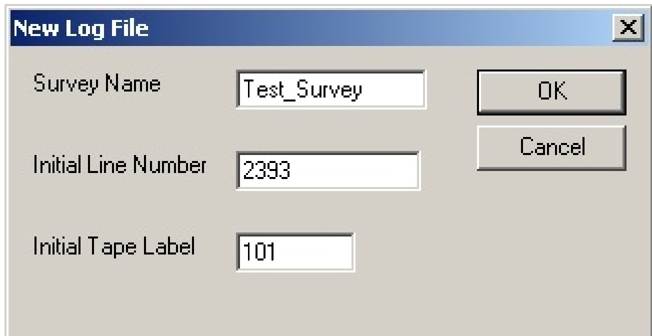


We will now discuss in detail the main menus and sub-menus. In the course of this, we will describe each of the displays mentioned above. These descriptions can be found primarily in the discussions of the View and Display/Print menus, where we describe the user-selectable display parameters.

3.1.4.5 Survey Setup Wizard

As mentioned earlier, choosing New Survey in the Open menu results in a series of prompts. Each is described briefly below; a full discussion of each dialog box can be found in the next section.

{Prompt} New Log File



Provide a Survey Name. This will be the root name given to the ASCII Survey Log file and all associated parameter files for this survey.

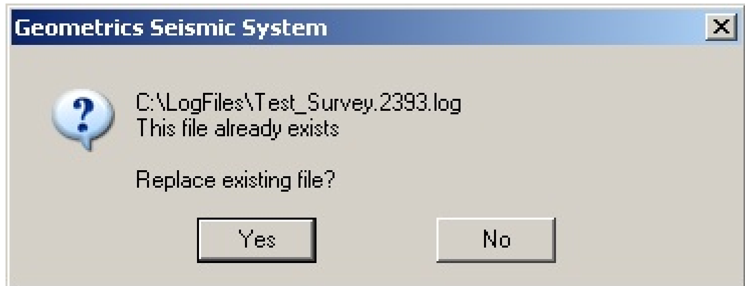
The Initial Line Number will be written to the Survey Log. This parameter can be alphanumeric and up to 15 characters. This will also be part of the Survey Log file name.

For the above Survey Name and Initial Line Number, eight files will be created under <drive>: Logfiles:

- **Test_Survey.2393.log** – ACSII Survey Log.
- **Test_Survey.2393.Gather1.dat** – Common-offset gather file – Geometrics-proprietary format (up to two additional Gather windows can be opened; their extensions will be “Gather2.dat” and “Gather3.dat”).
- **Test_Survey.2393.Gather1.SGY** – Common-offset gather file – SEG-Y format (up to two additional Gather windows can be opened; their extensions will be “Gather2.SGY” and “Gather3.SGY”).
- **Test_Survey.prm** – Survey parameters such as record length, sample interval, gains, etc. (binary format).
- **Test_Survey.2393.Nav.txt** ASCII navigation data log (only if Serial Input is enabled; will be empty if no GPS string is detected).
- **Test_Survey.2393.Depth.txt** ASCII depth data log (only if Depth Sensor serial numbers are entered in the Depth Transducers Serial Numbers line).
- **Test Survey.0000.ten** Tension logging parameters (binary format, only if Tension Gauge is detected).
- **Test Survey.2393.Tension.txt** ASCII Streamer tension log. (will be empty if no Tension Gauge is detected).
- **Test Survey.2393.trg** Trigger parameters log (binary format).

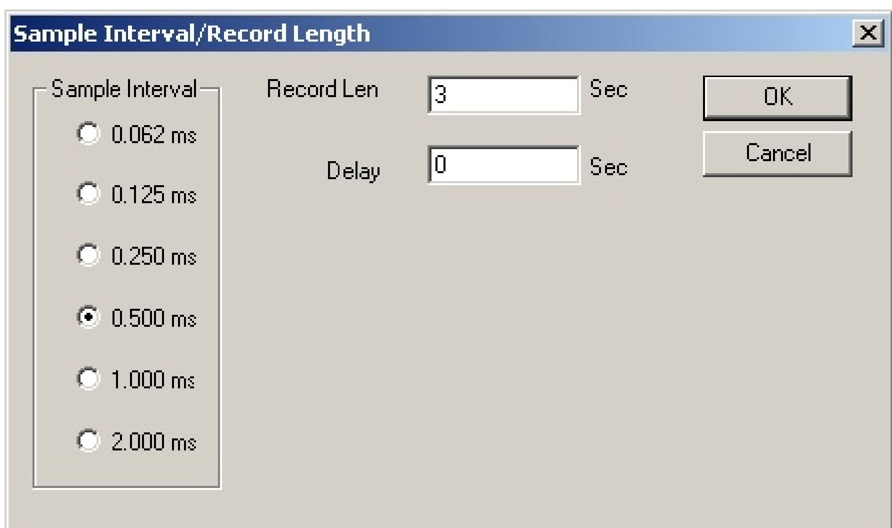
If you are writing to tape, the Initial Tape Label will be written to the Survey Log and incremented automatically each time the system switches to a new tape.

Note: *If you type in a* New Survey *name that already exists, you will see the following message:*



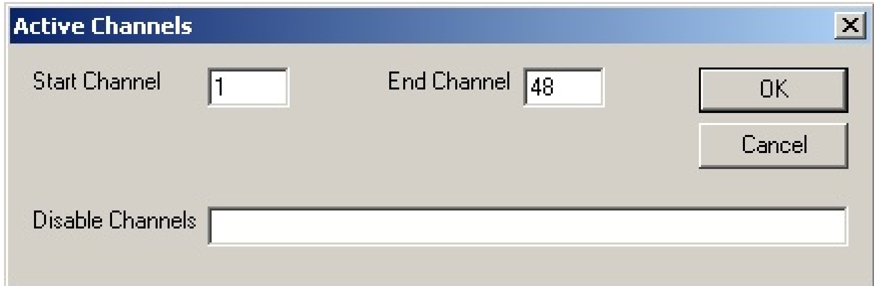
Choosing **Yes** *will cause the existing Survey Log file to be overwritten and* ***irretrievably lost.***

{Prompt} Sample Interval/Record Length



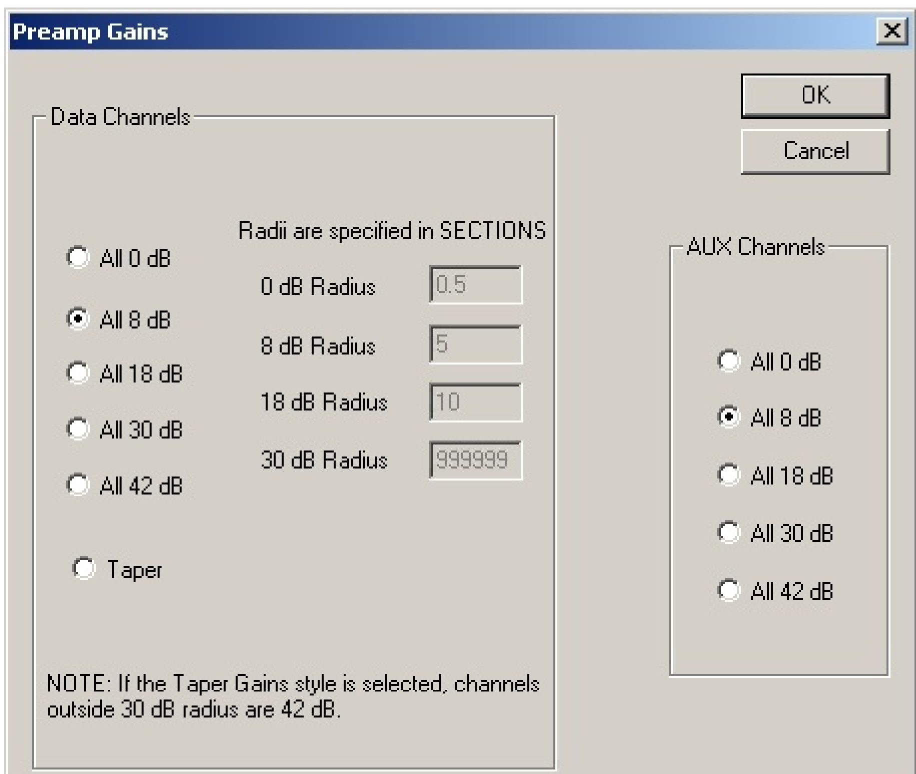
Set your Sample Interval, Record Length, and (if desired) a water-column Delay.

{Prompt} Active Channels



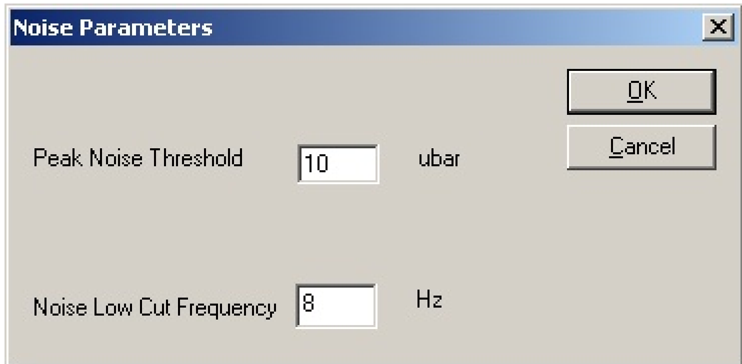
Set the range of active channels by setting a Start Channel and an End Channel. This can be a subset of the total number of channels. You may Disable Channels within the channel range by typing in their numbers separated by commas or dashes.

{Prompt} Preamp Gains



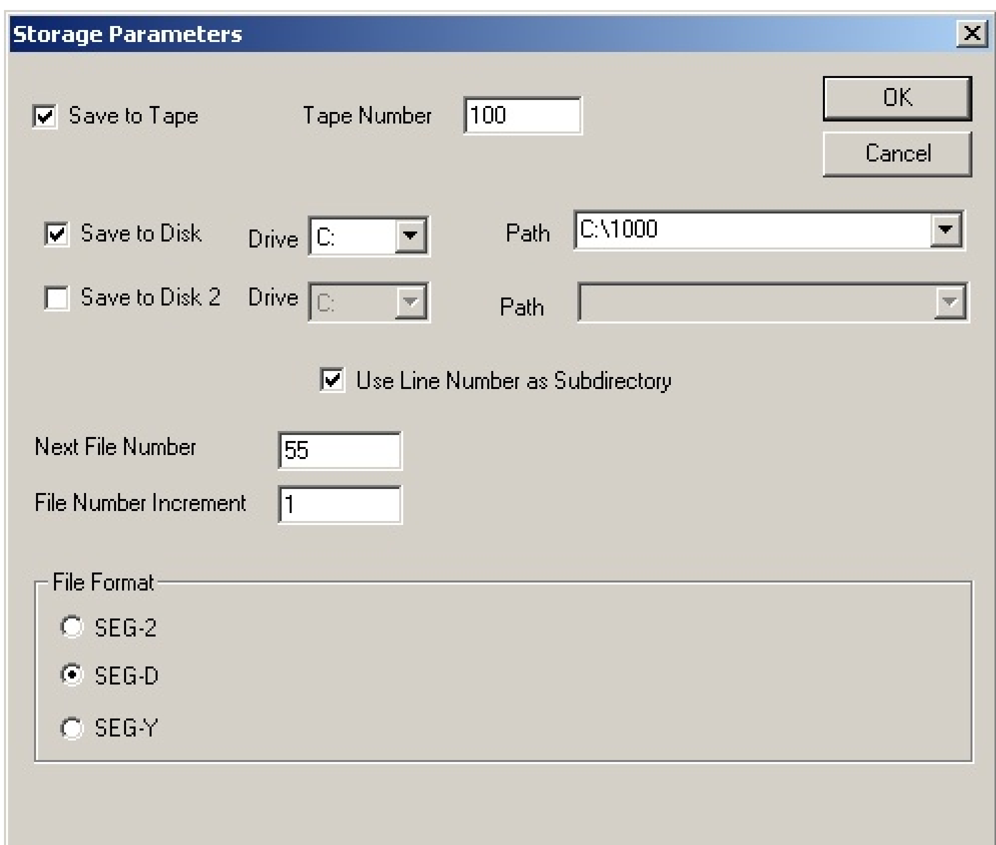
Set the preamp gains for your data and auxiliary channels.

{Prompt} Noise Parameters

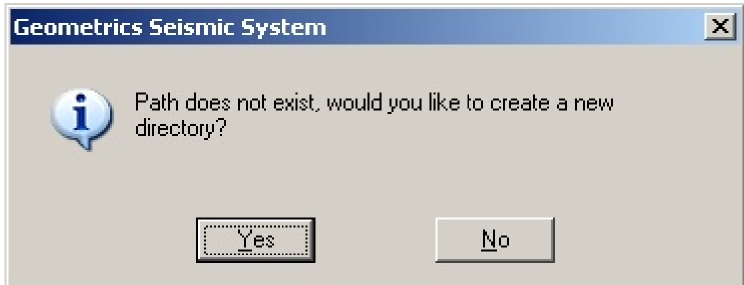


Set the Peak Noise Threshold and the Noise Low Cut Frequency. This is the filter that will be applied to the record prior to calculating and displaying the noise. If the threshold is exceeded, an alarm will appear (if enabled).

{Prompt} Storage Parameters

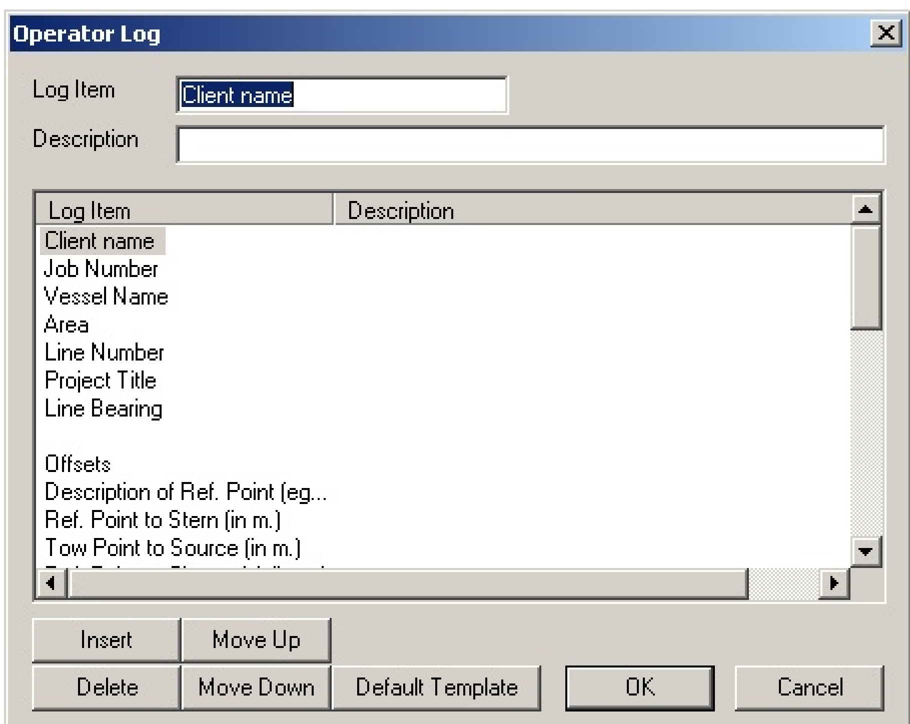


Enter the storage parameters for your survey, including storage media and SEG format. If you enter a path that does not exist, the following message will be displayed:



Pressing **Yes** will cause the path to be created.

{Prompt} Operator Log



Customize and fill in the Operator Log as necessary.

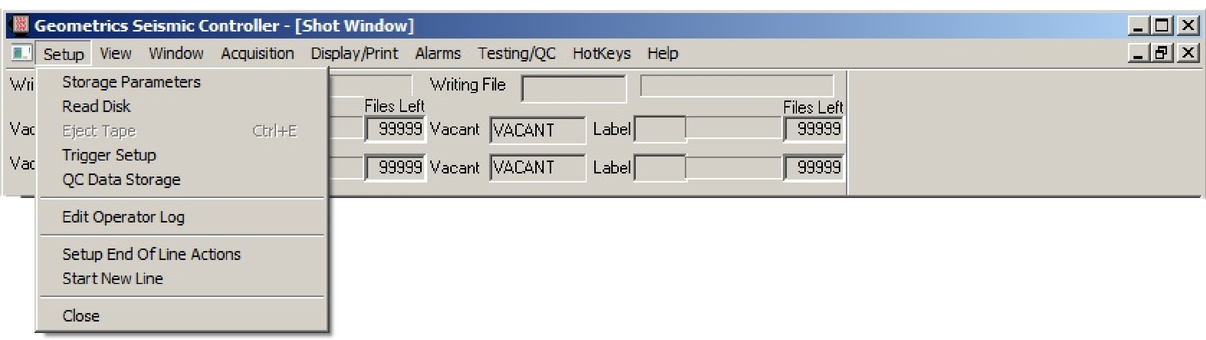
Note: All of the above dialog boxes can be accessed independent of the wizard, and are discussed in detail beginning here.

3.1.4.6 Detailed Discussion of Main Menu Items

The main menu bar is displayed below:

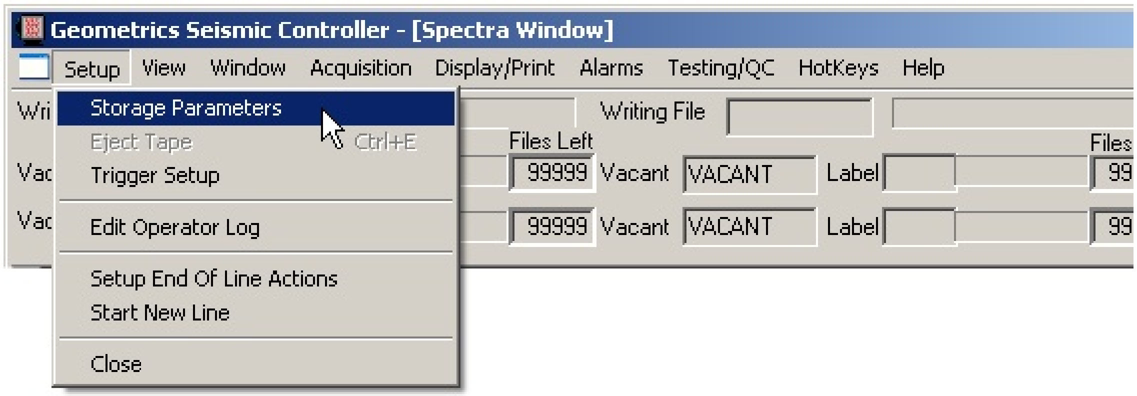
We will discuss the contents and functions of each item, working from left to right.

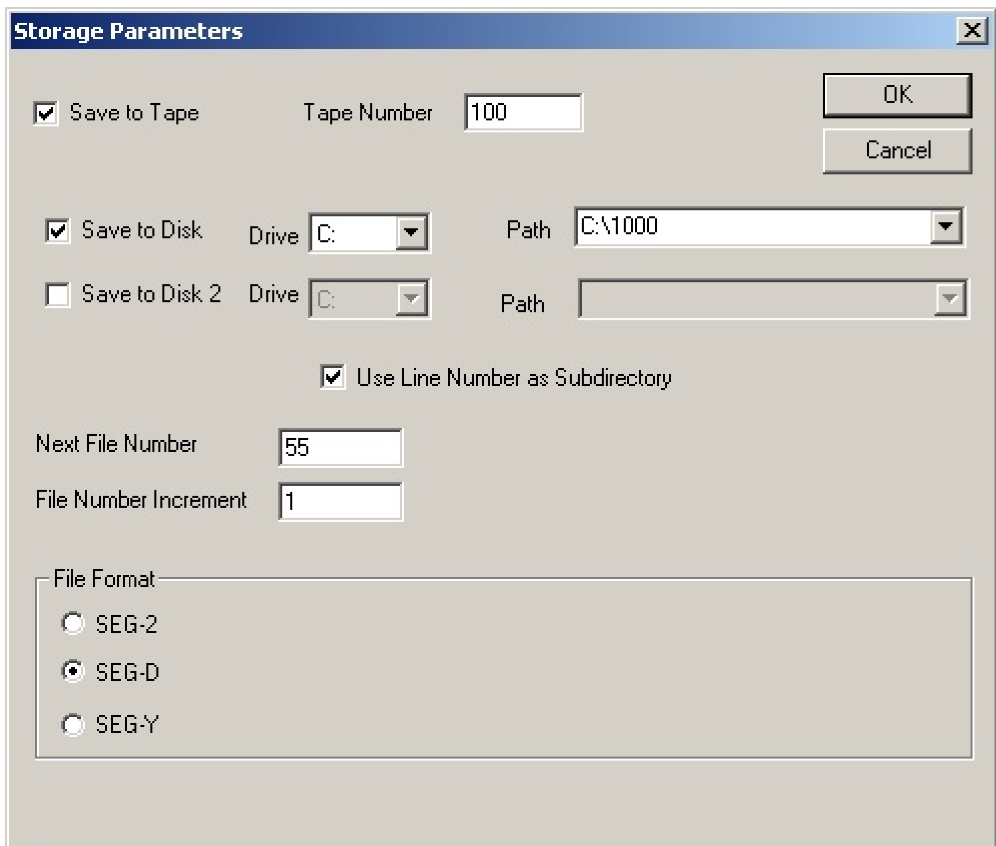
3.1.4.6.1 Setup Menu



3.1.4.6.1.1 Storage Parameters

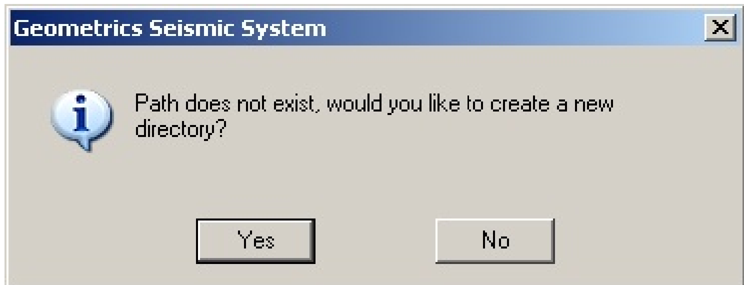
The first item in the Setup menu is Storage Parameters:





- Save to Tape – Enables write to tape. The CNT-2 Marine Controller supports most SCSI-based tape drives such as 3480, 3490, 3590 3592, DLT, Ultrium, etc.
- Tape Number – This will be the beginning tape number and will be displayed in the Tape Status window. This number will be automatically incremented by one each time control switches to a new tape drive. The tape number that each file is written to will be written to the Survey Log.
- Save to Disk – Enables write to disk. This may be an internal IDE or SCSI drive, external SCSI or USB drive, local RAID storage system, or NAS.

- Drive – Choose a drive to save your data to.
- Path – You can either choose a path from the drop-down list or type in a new one. If you enter a new path, you will see the following message:



Press **Yes** to create the new path.

Note: *Only top-level sub-directories from each drive are available in the drop-down list.*

- Save to Disk 2 – Enables writing to a second hard drive. You may write to two hard drives simultaneously, but you may not use the same path.

Note: *You may also write to tape and disk simultaneously.*

- Use Line Number as Sub directory – Creates a second-level directory within the main path automatically, and the name of the directory will be the same as the current Line Number. A new secondary directory will be created each time the Line Number increments. This allows you to store the data from each line in their own specific directories, named after the line numbers themselves.

Note: *Line number must be numeric.*

- Next File Number – This must be a positive integer and can have up to eight digits. This will be the FFID# of the next file saved.
- File Number Increment – The FFID# will be automatically incremented by this value, which may be any non-zero integer.

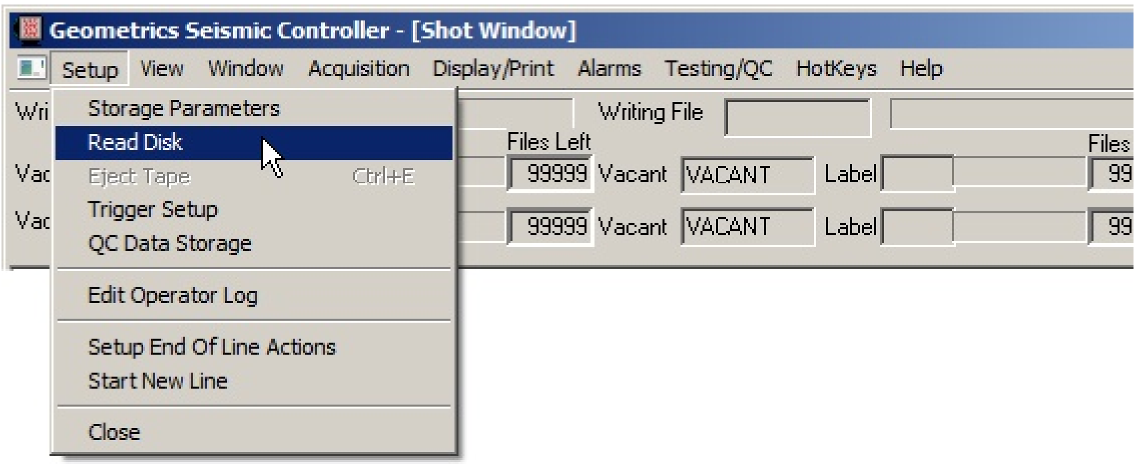
Note: *If you enter a negative value, be sure that the* Next File Number *is large enough that the file number itself will not go below 1 before you finish your survey line. Non-positive file numbers are not allowed, and will result in the software assigning positive file numbers in the following fashion: 3, 2, 1,* ***99999, 99998, 99997****....*

- SEG-2/SEG-D/SEG-Y – The CNT-2 Controller supports these three most popular SEG formats. Which format you choose depends on the storage medium, whether you plan to integrate navigation data into the header, and compatibility with the processing software to be used.

Note: *If Promax will be used to process SEG-D data, please see the section on Promax Compatibility in the Appendix.*

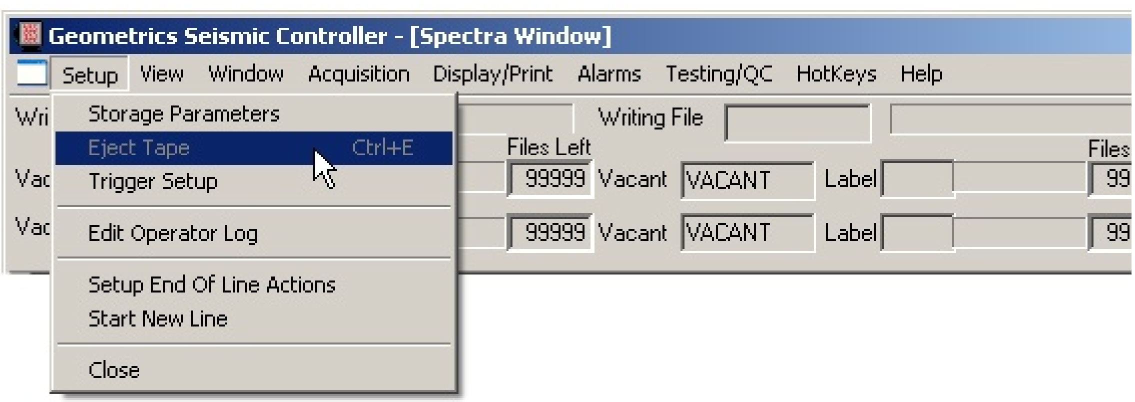
Note: *If you wish to integrate serial data into the file header, you must record SEG-D or SEG-Y format. SEG-2 does not support this feature. Regardless of which tape format you write, the GPS string will be written to the Navigation Log. Both are found in the Logfiles folder.*

3.1.4.6.1.2 Read Disk



The Read Disk command will read in and display, in the Shot window, any shot record. It is identical to right-clicking on an Optional Shot Window.

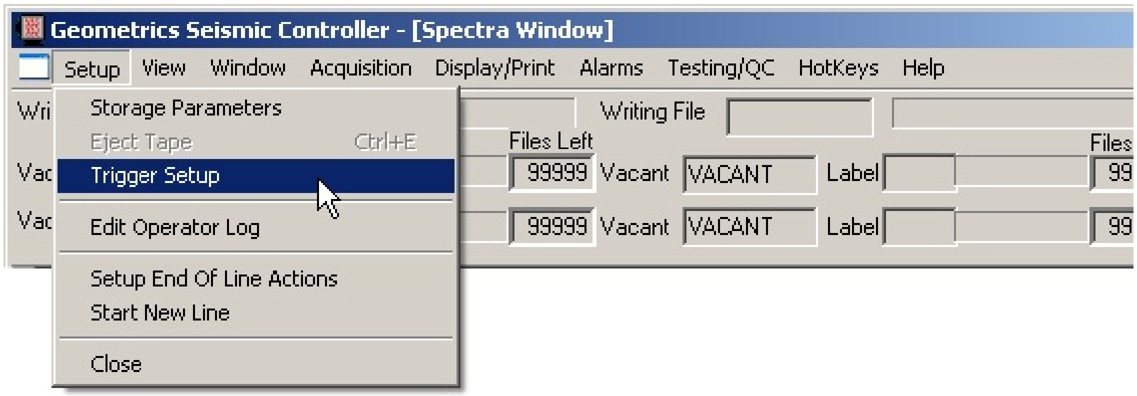
3.1.4.6.1.3 Eject Tape

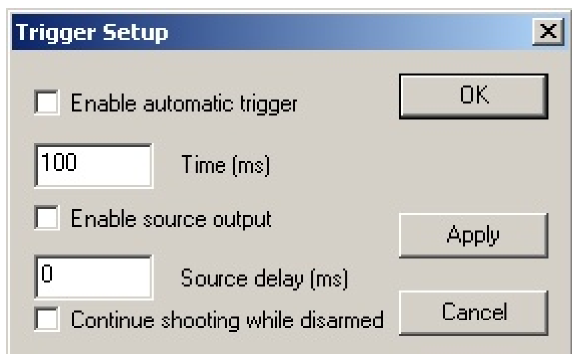


The Eject Tape option is useful on rare occasions when a tape drive gets into a state where it does not respond to a push of the **EJECT** button on the drive itself. This condition can often be overridden by choosing Eject Tape from the Setup menu.

Note: *The* Eject Tape *command can also be executed by pressing CTRL+E simultaneously.*

3.1.4.6.1.4 Trigger Setup



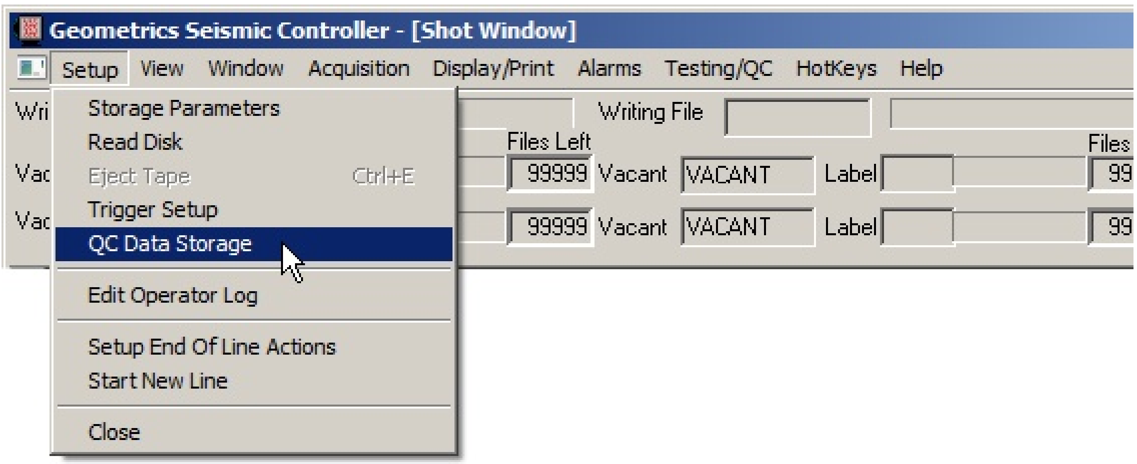


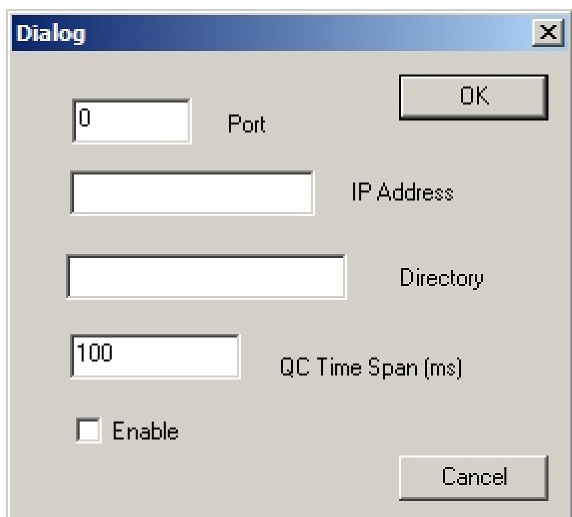
The GeoEel can be set up to trigger itself and optionally, the source, based on time.

- Enable automatic trigger – Check this box if you wish the system to trigger itself (as opposed to being triggered by an external device such as a source controller or navigation system). Set the time between triggers in ms.
- Enable source output – Check this box if you would like the GeoEel to trigger the source as well as itself.
- Source delay (ms) – If the above is enabled, and you would like to delay the source relative to the GeoEel trigger, indicate the delay in ms. The source trigger will lag the system trigger by this amount.
- Continue shooting while disarmed – If this box is checked, the system will ignore the ARM/ DISARM command (**F1** key). This is only recommended for troubleshooting purposes, and should be disabled during surveying.

Note: The Time (ms) *value in the above dialog box must be at least 100 ms greater than the record length. It will automatically revert to this if you set it to a smaller value. For instance, if your record length is 2 seconds, and you set a* Time *of 2000 ms, it will revert* *to 2100 ms when you press* **Ok** *or* **Apply**.

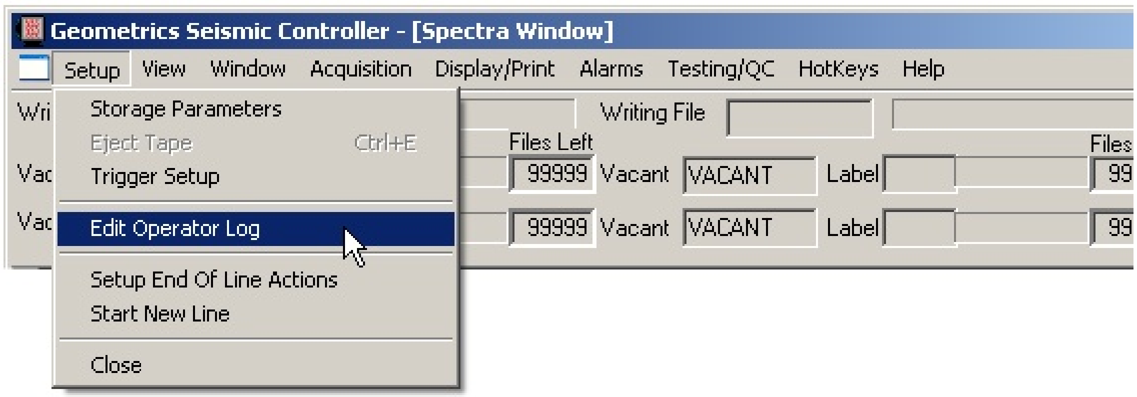
3.1.4.6.1.5 QC Data Storage

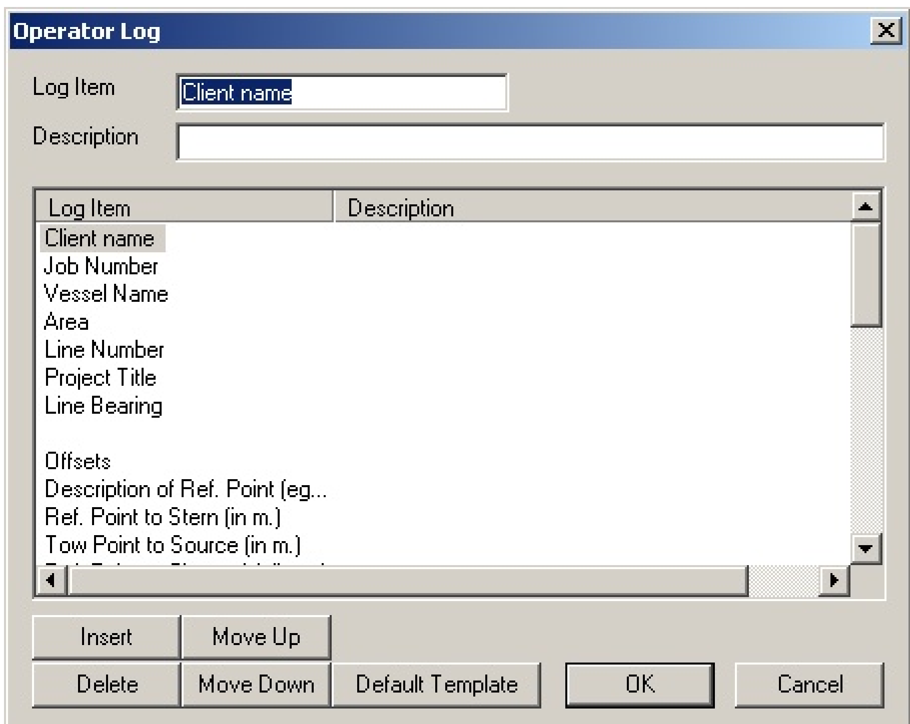




This feature allows you to write a user-specified segment of a SEG-Y file to a separate directory for QC purposes. The name of that file is then sent via a UDP socket so third-party QC software can open the file and read the data. It is especially handy for real-time positioning of a P-Cable using first breaks.

3.1.4.6.1.6 Edit Operator Log





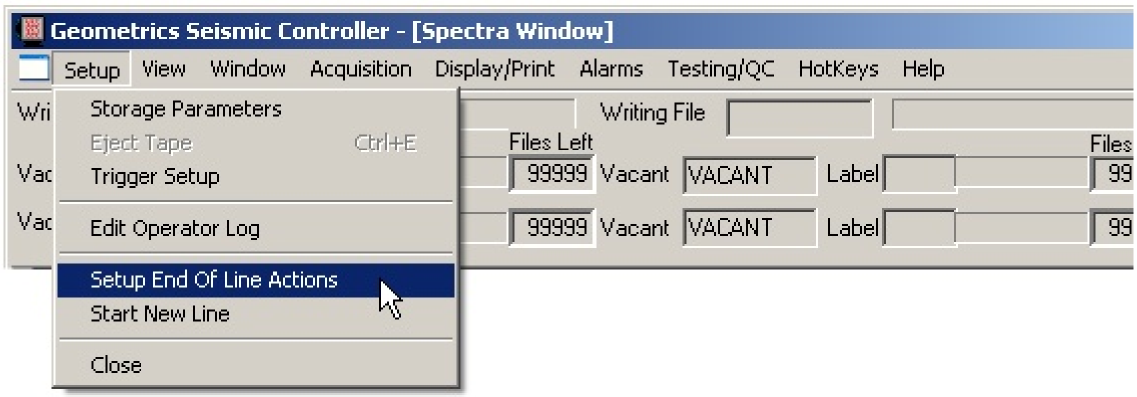
The Operator Log is a fully-customizable, optional template that you can choose to fill out at the beginning of the survey and edit at any time during the survey. When you open a new survey, it is one of the dialog boxes presented by the wizard.

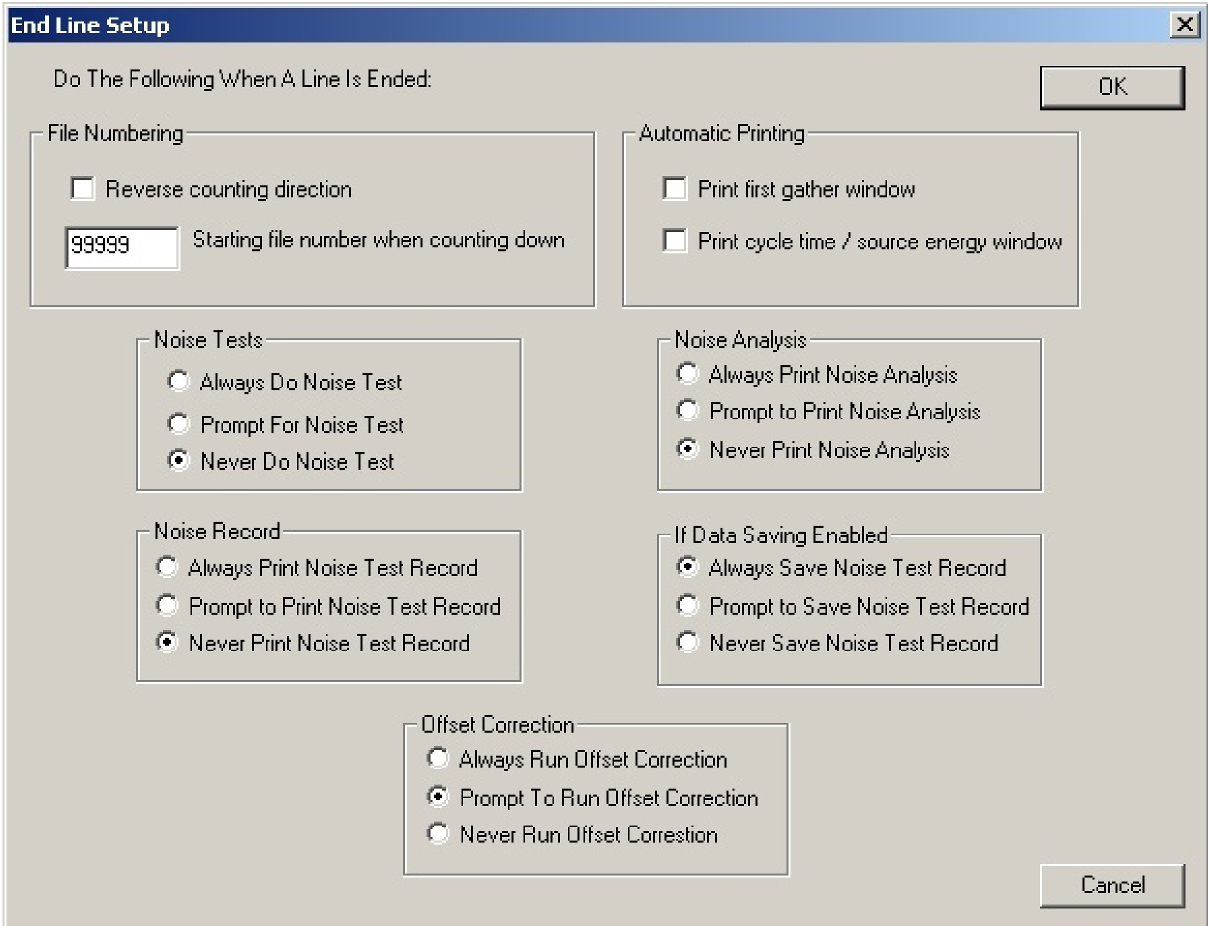
The Log Item column is fully user-definable. If you wish to change an existing item, just click on it and then type the new name in the box for Log Item at the top. Clicking off of it will enact the change. Use the **Insert** and **Delete** buttons to add and remove lines, and use the **Move Up** and **Move Down** buttons to move lines relative to each other. Pressing the **Default Template** button will load the default log.

To fill in the Description column, click on the Log Item you wish to describe, and then type in the description in the Description box at the top.

Pressing **Ok** will close the window and write the Operator Log to the Survey Log.

3.1.4.6.1.7 Setup End-of-Line Actions





Whenever you start a new line (discussed below), you automatically end the current one. The above menu allows you to determine what happens when the current line is ended and a new one is started.

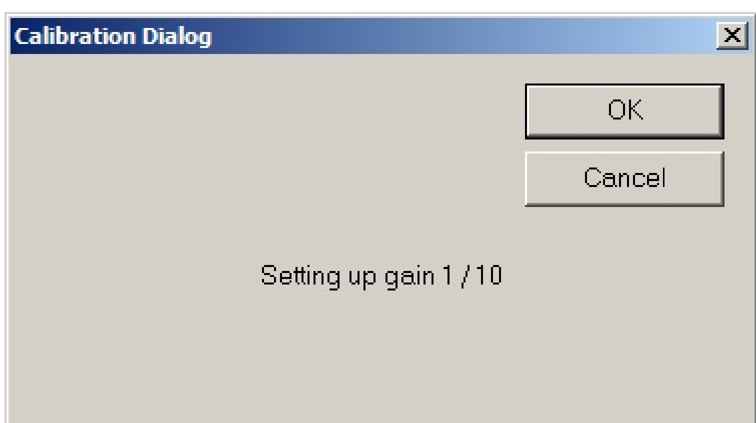
- Reverse Counting Direction – This reverses the sign of the file Increment each time you change lines. If you are doing a serpentine survey of multiple lines, this will ensure that the file numbers increase in the same direction on all lines, which is what some practitioners prefer. Be sure that the starting file number is large enough that it won't go to zero when counting down. Non-positive file numbers are not allowed, and in this eventuality the software will assign positive file numbers automatically.

- Print First Gather window – The Gather (or Brute Stack, if it exists) can be set to print automatically when a new line is started. Note that this only applies to Gather window 1.
- Print cycle time/source energy window – Like the Gather, this window can also be printed automatically when the line ends.
- Always/Prompt For/Never Do Noise Test – If you elect to do a noise test (either automatically or via prompt), a noise record will be taken, the record will be analyzed, and the results written to the Survey Log.
- Always/Prompt to/Never Print Noise Analysis – If you do a noise test, you can have the analysis printed automatically in addition to being written to the Survey Log.

- Always/Prompt to/Never Print Noise Test Record – Likewise, you can print the noise record itself (from which the analysis was made).

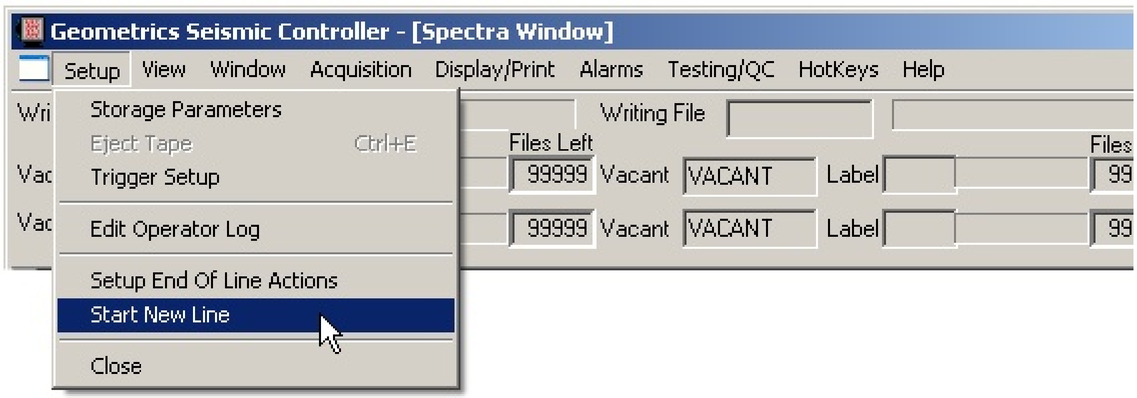
- Always/Prompt to/Never Save Noise Test Record – In addition to printing, you can save the noise test record to your storage media. Note that this only applies if Save to Disk or Save to Tape is enabled in the Storage Parameters dialog box. Noise files will be labeled as such in the Survey Log, but they are not given special file names and they are saved to the same location that your data is being saved to.

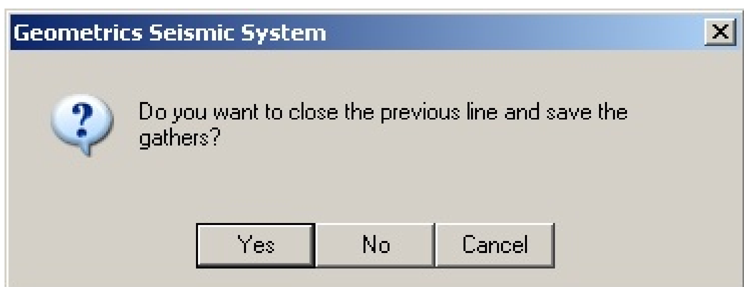
- Always/Prompt to/Never Run Offset Correction – Of all of the things you can automatically do at the end of a line, this is probably the most useful. The offset correction only takes about 30 seconds or so and is generally a good idea – it will remove any DC offset that might have drifted in during the line. The following dialog box will be displayed during the correction:



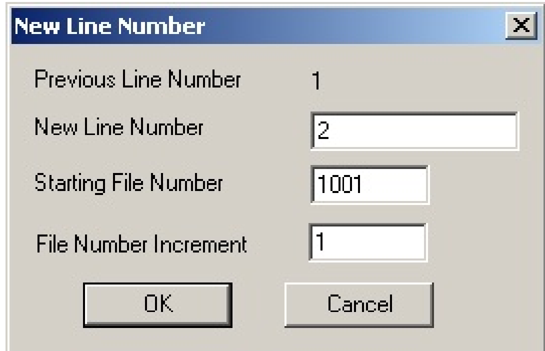
3.1.4.6.1.8 Start New Line

You can start a new line at any time in the survey. Depending on the settings discussed in the previous section, you may be prompted for various actions.





The difference between a yes and no answer here is whether or not the SEG-Y gather files are saved (the proprietary-format files are always saved). The previous line will be closed either way, and the end-of-line tasks discussed in the previous section will be performed. If you don't want to close the line, just hit **Cancel**. Otherwise, you will be presented with the following:



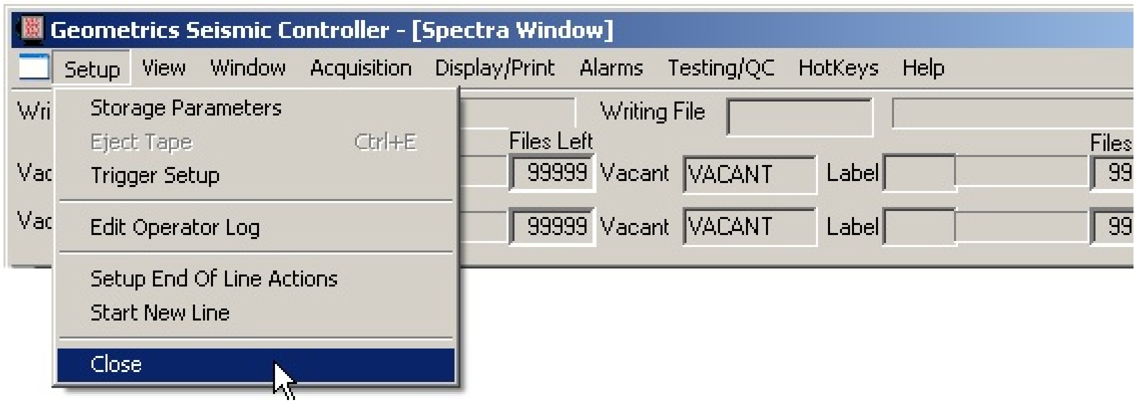
- New Line Number – A new Survey Log will be started having the same root name followed by the new line number. For instance, in the wizard we set a File Name of Test_Survey and an Initial Line Number of 2393. The resulting Survey Log file name was Test_Survey.2393.log. Putting in a New Line Number of 2394 would result in a new Survey Log file named Test_Survey.2394.log.
- Starting File Number – You may reset the Starting File Number within this dialog box. This is the same as the Next File Number setting found in the Storage Parameters menu. It is repeated here for convenience in the event that you wish to begin a new series of FFIDs commensurate with the beginning of a new line.

Note: *If you close a line accidentally, you may read it back in and continue. Shut down the program, restart, click on* Open>>Existing Survey*, and read in the appropriate Survey Log file.*

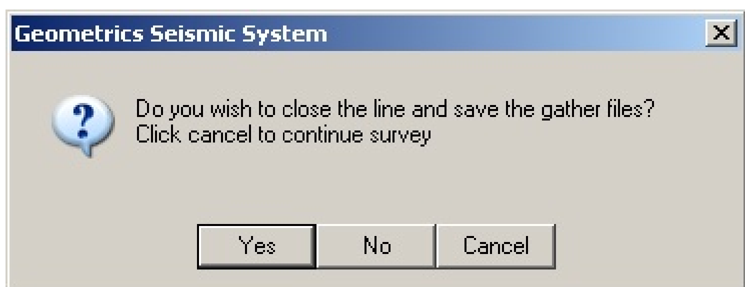
Note: *Some practitioners like to increment the line numbers but use the same FFID numbers over and over. For instance, after completing a line from south to north, beginning with FFID 1001 and ending with 2500, you might wish to start the north end of the next line with FFID 2500 and decrement (by setting a* File Number Increment *of -1) back down to 1001 as you move south. This is fine if you are writing tapes – tapes don't care if you write the same file name multiple times. However, if you are writing to disk, there will be file name conflicts. If you wish to work in this manner while writing to disk, we recommend that you create a separate folder for each line. This can be done manually or automatically. Reversing the shot number increment can be automated by checking the* Reverse Counting Direction *box in the* Setting End of Line Actions *dialog box. Note that if there are file name conflicts, data will still be saved – no files will be overwritten. A message will be recorded in the Survey Log that a duplicate file name was used, and a prefix will be added to the file name prior to saving.*

Note: *If you choose to work in the fashion described above, decrementing the file name as you return to the "low" end of the line, choose an initial file number for the low end that is high enough that there is no chance of the file number going below 1 on the return trip. If you do not do this, the software will assign new file names starting with 99999 after 1 is reached.*

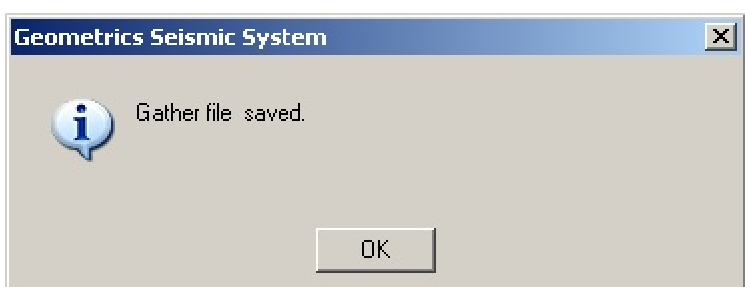
3.1.4.6.1.9 Close



Select **Close** to end the line and close the survey and CNT-2 Controller. This process may take a few minutes if you are writing to tape, so have patience. You will be prompted to confirm that you wish to close the line and save the gather file:



If you press **Yes**, the end-of-line functions as specified here will be performed, and the gather will be saved as a SEG-Y file in [drive:]\Logfiles:*[SurveyName.Line#]*.Gather*[X]*.sgy.

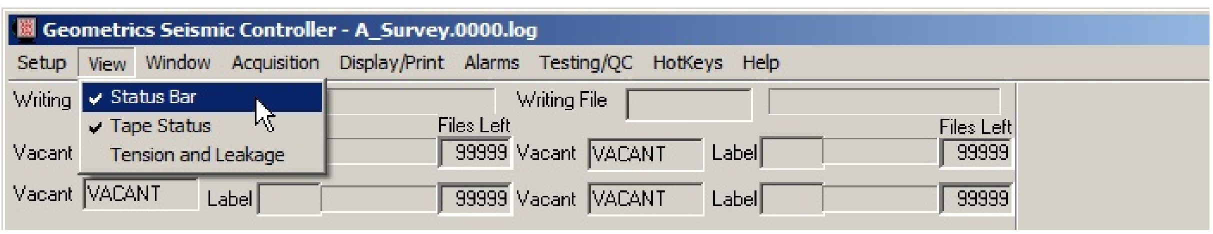


If you press **No**, the program will simply close; end-of-line tasks will not be performed and the SEG-Y gather will not be saved. (But the gather is always saved in Geometrics' internal format – see here. If later you wish that you had ended the line, you can re-open the survey, and then close it again [this time choosing **Yes**] to run the end-of-line tasks).

3.1.4.6.2 View Menu

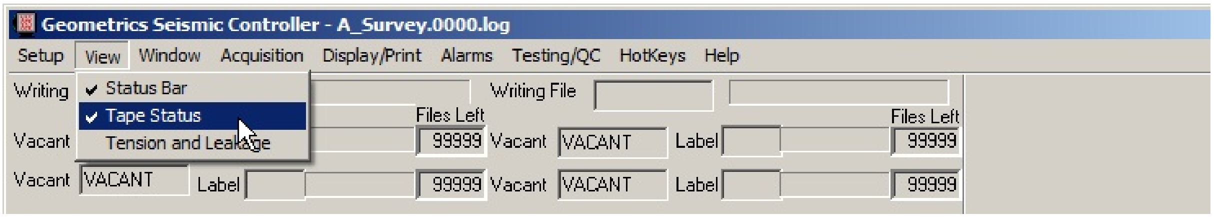
The View menu allows you to enable/disable the Tape Status window, the Status Bar, and the Tension and Leakage displays. This is an appropriate time to discuss these non-graphics displays, as they are not controlled in the Display/Print menu and hence are not included in the discussion there.

3.1.4.6.2.1 Status Bar



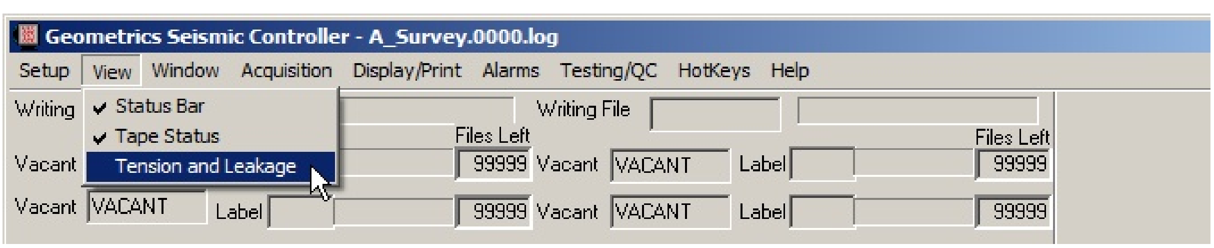
The Status Bar displays at a glance whether the system is armed or disarmed, and the display gain type used in the shot and gather records.

3.1.4.6.2.2 Tape Status



For each connected and powered tape drive, the drive's status ("VACANT", "READY", "ACTIVE", "REWINDING", OR "EJECTED"), make and model, label (tape number), and number of files left are displayed. In addition, the FFID# of the current file being written, along with a progress bar, are displayed. Since two tapes can be written to simultaneously, two Writing File boxes are shown, along with two progress bars. If you are not writing your data to tapes in real time, you should disable this display by de-selecting it in the View menu.

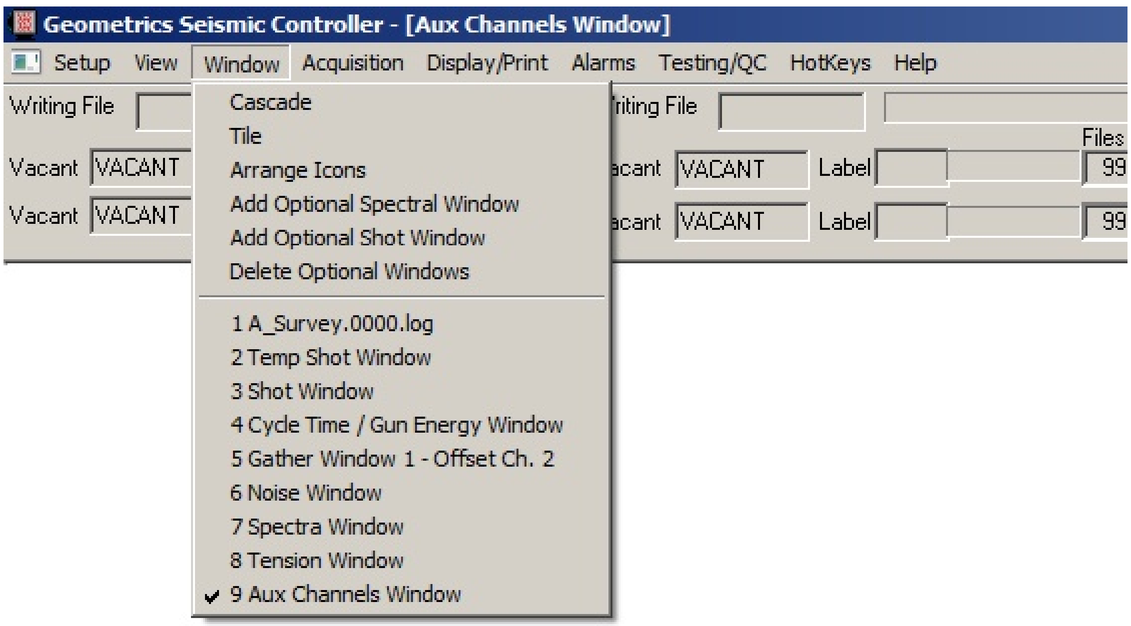
3.1.4.6.2.3 Tension and Leakage



If there is a Tension Gauge installed, you will see a number in the Tension box. In addition, a running graph is displayed in the Tension window, and tensions are written to the Tension Log.

The Leakage box reports the same leakage value displayed on the Deck Unit.

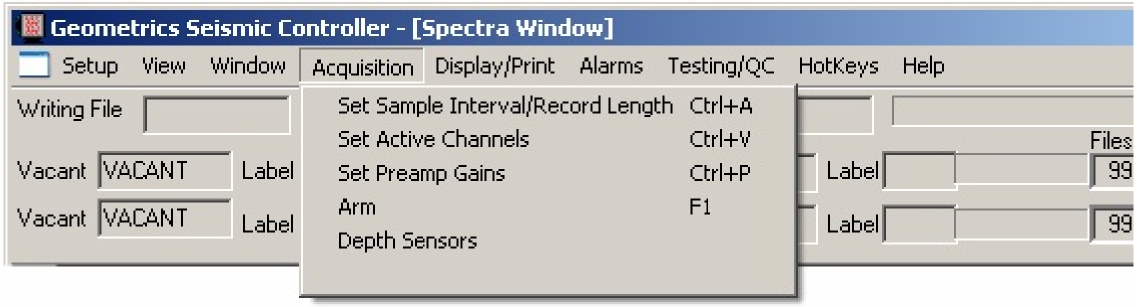
3.1.4.6.3 Window Menu



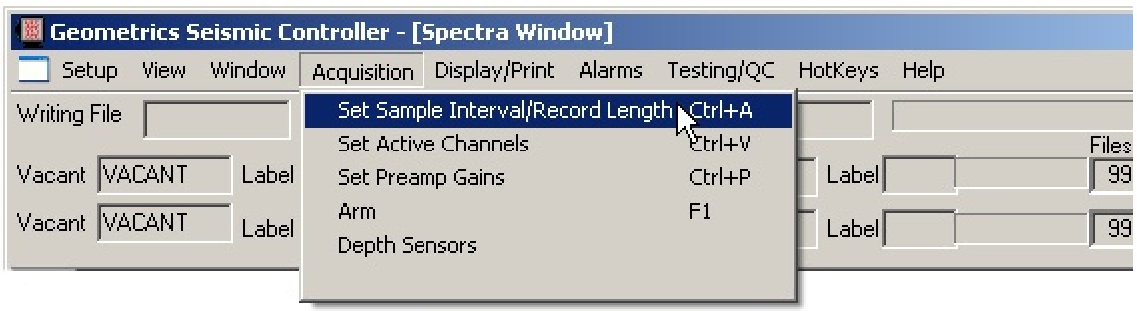
This is standard Windows fare for the most part, allowing you to tile and cascade windows, and bring back windows that have been minimized. You can also use this menu to create and delete Optional (additional) Shot and Spectra windows, which are discussed in the Optional Windows section.

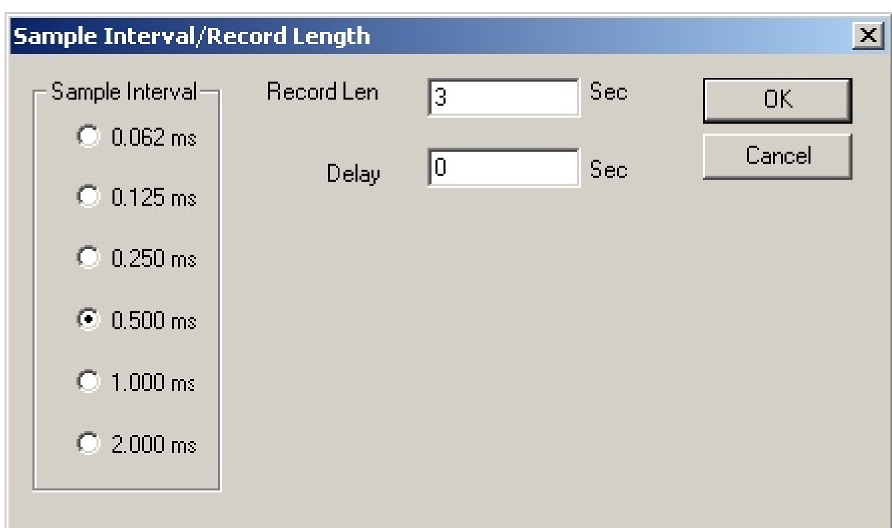
3.1.4.6.4 Acquisition Menu

The Acquisition menu is where you set all of the parameters that actually affect the data you acquire. As such, these are the most important parameters you can set. Please use extra care in setting these parameters.



3.1.4.6.4.1 Set Sample Interval/Record Length





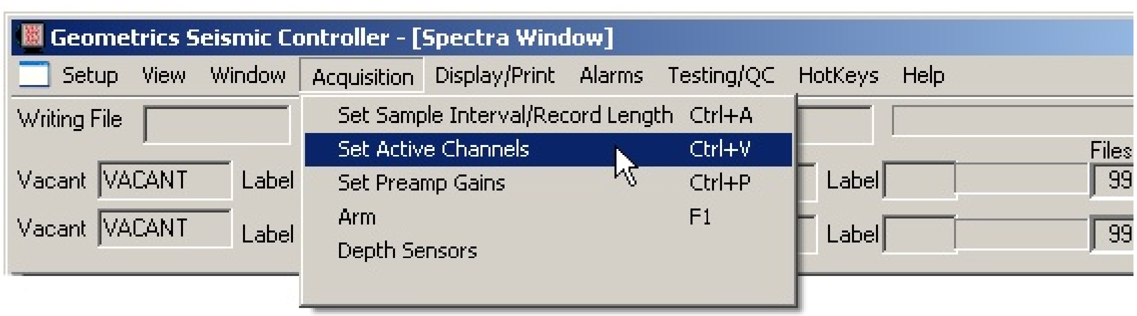
Note: The Set Sample Interval/Record Length *dialog box can also be accessed by pressing CTRL+A simultaneously.*

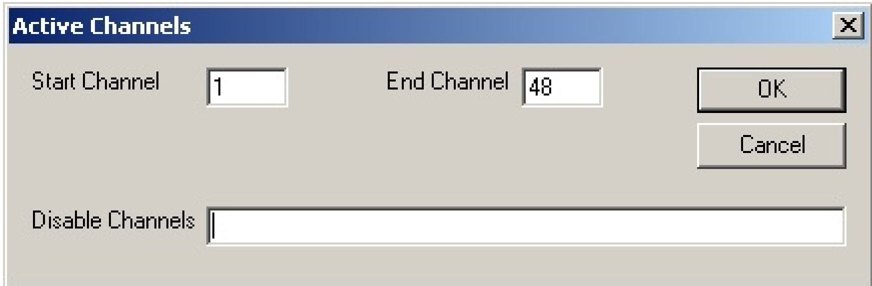
- Sample Interval – Choose a Sample Interval at which to digitize the hydrophone output. Your sample interval should be chosen at least partly on the basis of the frequencies you hope to obtain. The smaller the sample interval, the finer the sampling, and the higher the frequencies you can record.
- Record Length – Set a Record Length in seconds. The record must be between 256 and 16,000 samples long (but see the section on registry settings in the Appendix). If your combination of sample interval and record length (in seconds) falls outside of this range, you will see a message similar to the following:

The actual bounds shown above are in seconds and will depend on the sample interval you have chosen.

If you are in deep water, you may wish to set a water column Delay.

3.1.4.6.4.2 Set Active Channels





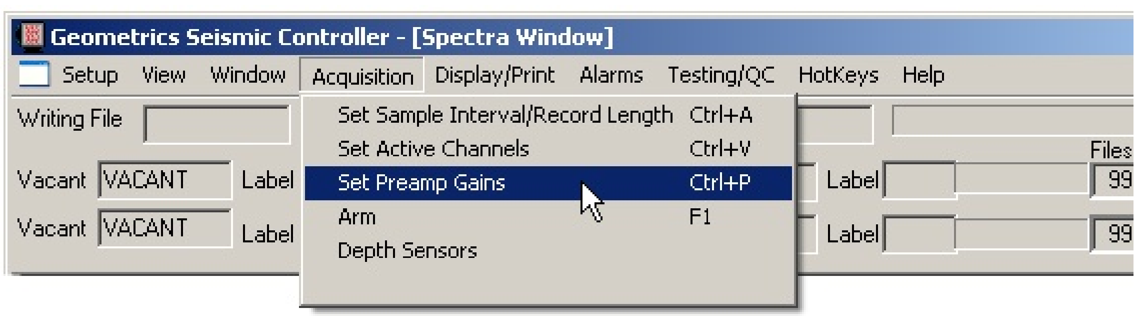
Note: *The* Set Active Channels *dialog box can also be accessed by pressing CTRL+V simultaneously.*

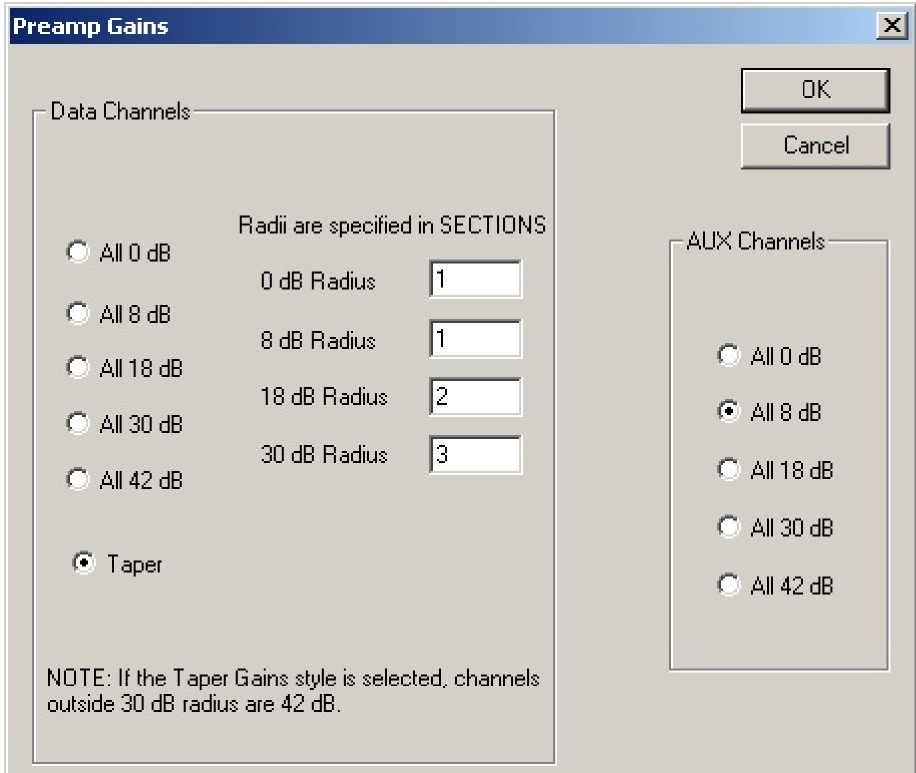
It is not necessary to record on all available data channels.

- Start/End Channel – Set the channel range by entering a Start Channel and an End Channel.
- Disable Channels – If you wish to disable any channels within the enabled range, type the channel numbers into the Disable Channels box, separated by commas. A range of channels can be specified with a beginning and ending channel separated by a dash. For instance, if you wish to disable channels 6, 9, 24, 25, 26, 27, 28, and 40, you would enter

  6,9,24-28,40

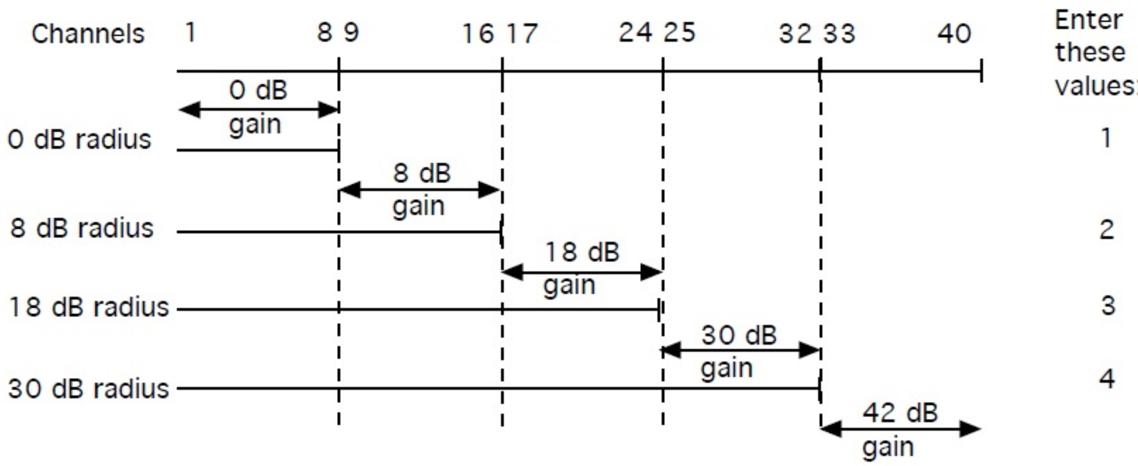
3.1.4.6.4.3 Set Preamp Gains

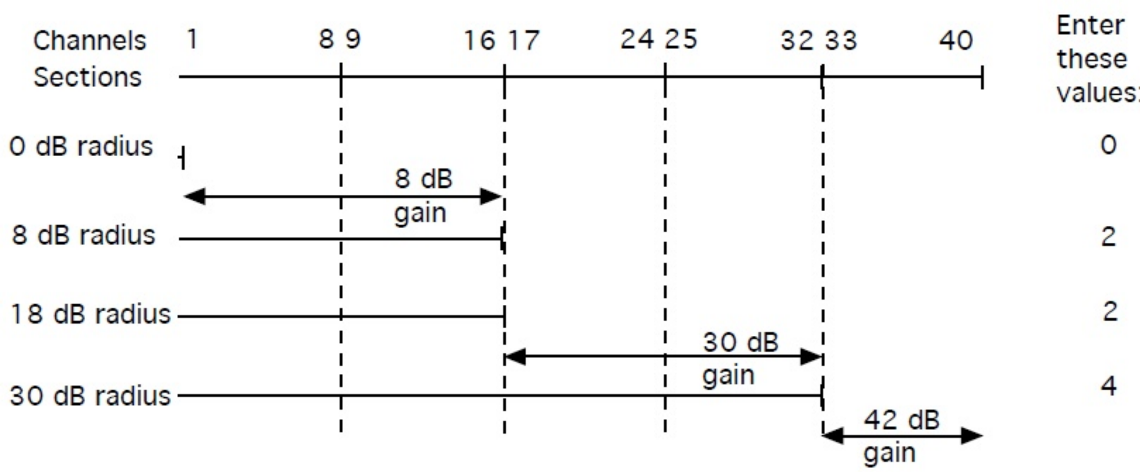




Note: *The* Set Preamp Gains *dialog box can also be accessed by pressing CTRL+P simultaneously.*

- All X dB – If your offset is large enough, data channel preamp gains can generally all be set to the same value.
- Taper – If your offset is small, you may need to set a tapered gain.
- X dB Radius – The radius assigned to each gain value determines the shape of the taper, and must increase with the gain value. Gain radii are set in units of 8-channel sections. In the dialog box above, the first 8 channels will be set to 0 dB, no channels will be set to 8 dB, channels 9-16 will be set to 18 dB, channels 17-24 will be set to 30 dB, and all channels beyond channel 24 will be set to 42 dB. A couple of additional examples are illustrated in the diagram below.





Preamp gains for AUX channels are the same for all.

The scaling factors for the various preamp gain settings are as follows:

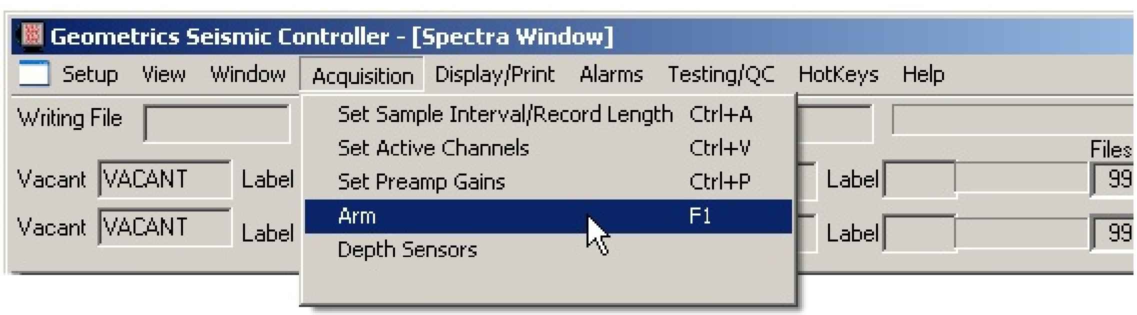
Gain	Descaling Factor
0 dB	4.01528×10^{-4}
8 dB	1.60611×10^{-4}
18 dB	4.72386×10^{-5}

Gain	Descaling Factor
30 dB	1.18096×10^{-5}
42 dB	2.85933×10^{-6}

Table 4: GeoEel analog gain settings and equivalent descaling factors

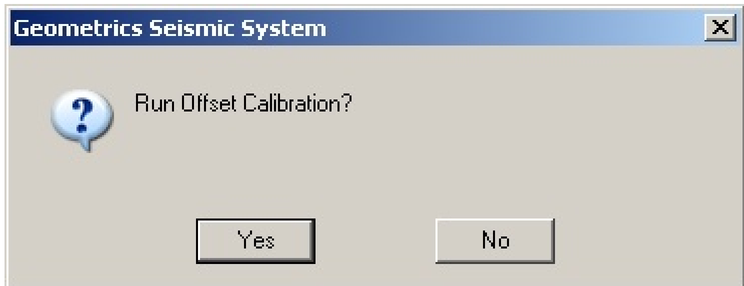
Note: *In choosing preamp gains, particularly for data channels, the goal should be to use the highest gain you can get away with. By "get away with", we mean without over-driving or "clipping" the A/D converters. In a shot record, over-driven channels will be displayed in red, and if enabled, an alarm will sound. An "over-driven channels" message will be written to the Survey Log. If you see red traces, reduce the gain on the offending channels. See the Noise Parameters section and also the Troubleshooting section.*

3.1.4.6.4.4 Arm



The system must be armed in order to respond to a trigger signal. You may toggle between an armed and disarmed state by pressing the F1 key. Which state it is in at any given time is displayed at the left end of the task bar:

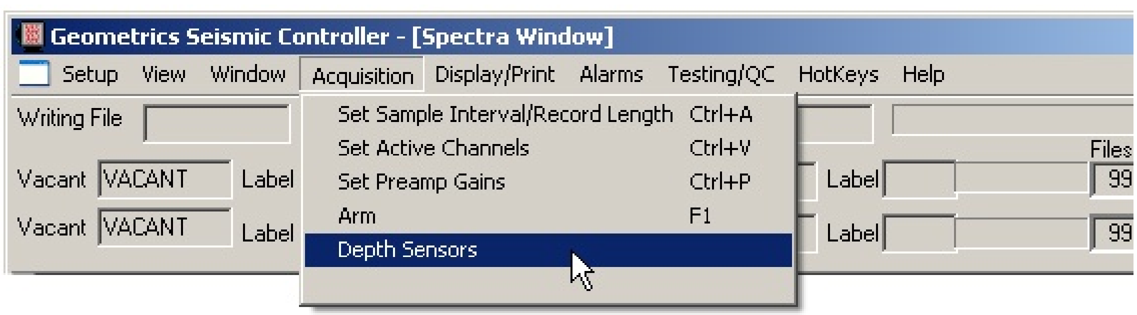
Depending on when the last time was that you ran an offset correction, you may be presented with the following prompt when arming the system:

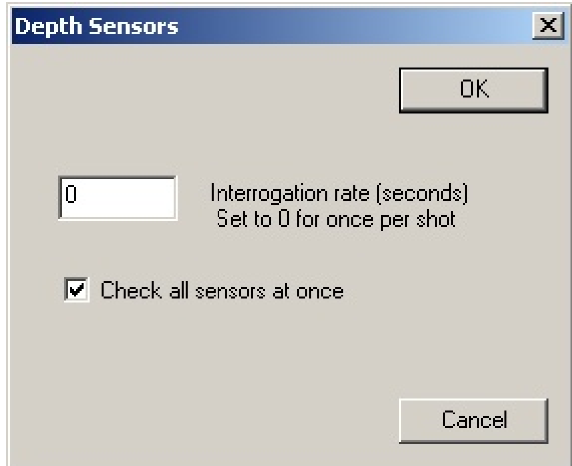


It never hurts to do an offset correction if you have the time; it will take about 30 seconds.

3.1.4.6.4.5 Depth Sensors

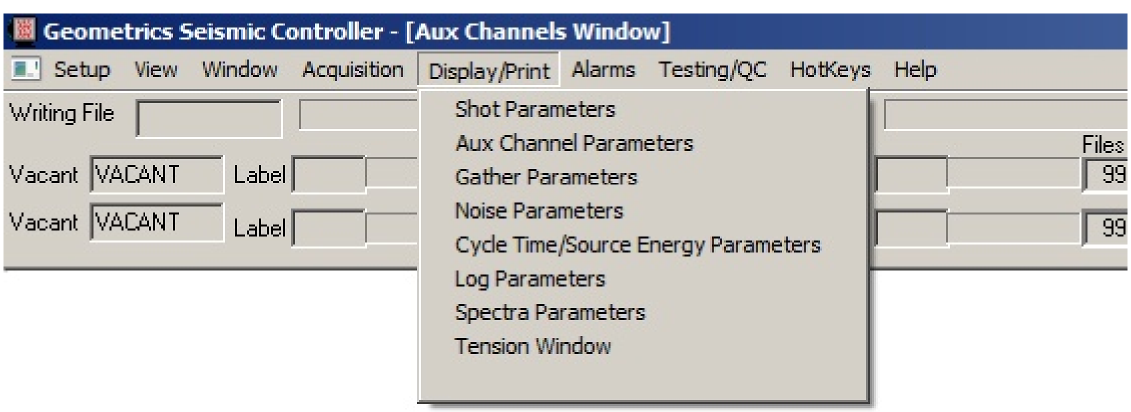
Your system may be equipped with depth sensors. If so, and if they have been enabled in the Configure menu, use the Depth Sensors dialog box to set them up:





- Interrogation Rate – The default (and recommended) sample rate is once per shot, all sensors simultaneously.
- Check all sensors at once – If you uncheck the Check all sensors at once box, the sensors will report in a serial fashion. Depth data will be written to the Depth Log, called [drive]:\Logfiles\[*Survey_Name.Line_Number*].depth.txt. An example Depth Log is shown here.

3.1.4.6.5 Display/Print Menu



The Display/Print menu allows you to control all of the display parameters used in the various graphics windows discussed earlier. Nothing you do in the Display/Print menu will affect the data actually stored to tape or disk. Changes to display parameters can be made at any time during the survey.

Note: *Any of the dialog boxes listed in the Display/Print menu shown above can be accessed by right-clicking on the appropriate graphics window.*

Note: *While changing display parameters during the survey is possible, this should only be done when necessary. Excessive interaction with the software during recording should be avoided to the degree feasible to minimize the chances of an interruption in data acquisition.*

3.1.4.6.5.1 Shot Parameters

The Shot Parameters dialog controls the appearance of the Shot window. An example is shown below:

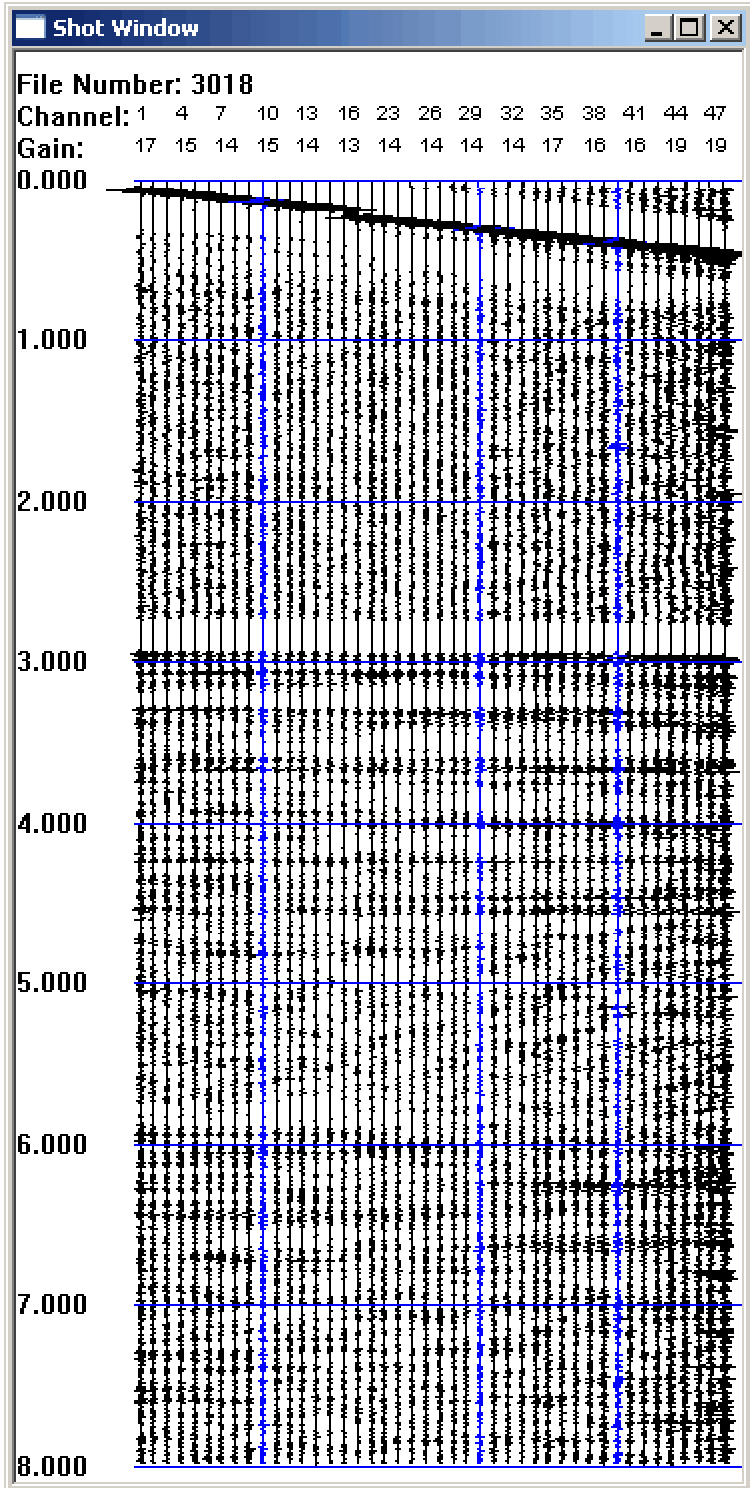


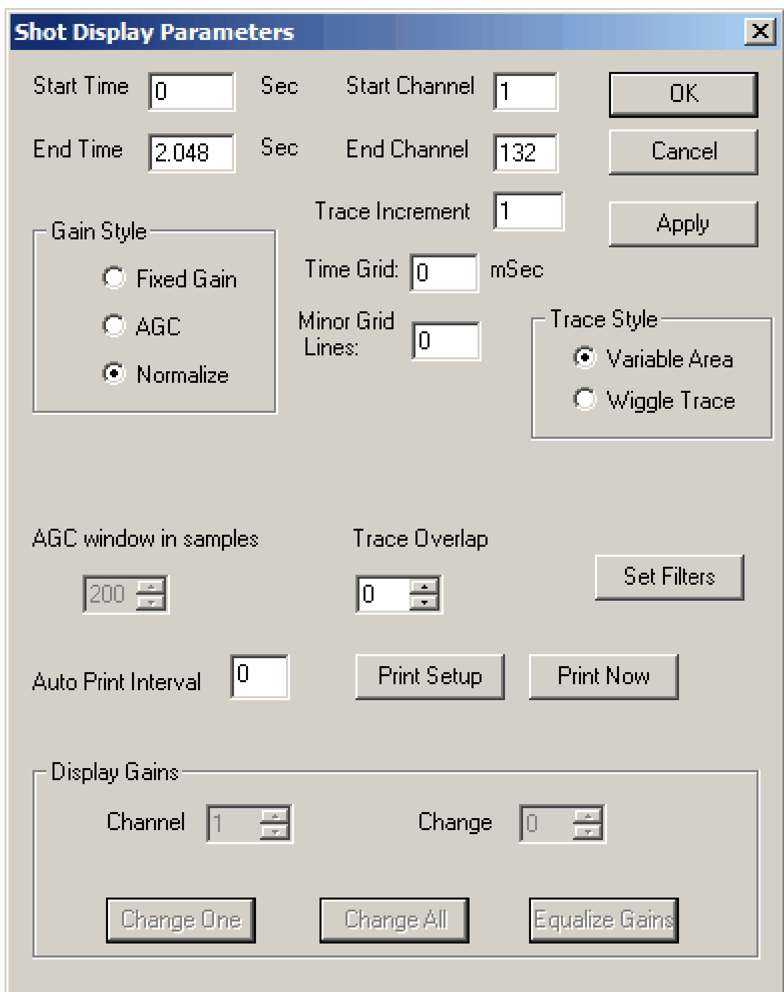
Figure 56: Example shot record.

The Shot window displays the most recent shot record in the time domain. The vertical axis is time in seconds. The FFID# is shown at the top. The top row of numbers represents channel number; since there is usually not enough room to label each channel, every 10^{th} channel is shown in blue. The second row of numbers represents display gain in dB. You have complete flexibility and control over how the data is displayed. You can control the time window, the time scale, the range of channels, the type of display gain used, playback filters, etc. The display parameters are controlled from the Shot Parameters dialog box in the Display/Print menu.

Note: *A red trace indicates that the channel has been over-driven or "clipped". Reducing the gain should alleviate this.*

Note: *The best way to learn how to optimize a shot display is to practice. Some good data files can be found here. If you have trouble downloading, contact Geometrics.*

They can also be found on the CNT-2 installation disk. Go here to learn how to read in data files. Also see here.



- Start/End Time – You can control the time scale of the shot record by choosing a Start Time and End Time. This will often be a subset of the total record length, especially when working in deep water and not using a water column delay.

  Note: *You may open several separate Shot windows, and use different display parameters in each.*

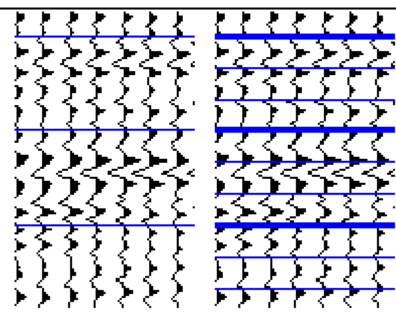
- Start/End Channel – You may also display a subset of the data channels. For instance, setting a Start Channel of 5 and an End Channel of 16 will result in only those 12 channels being included in the displayed shot record.

  Note: *Depending upon the number of active channels and the width of the Shot window, some of the traces may not be displayed. There is a minimum spacing between the traces that the program allows.*

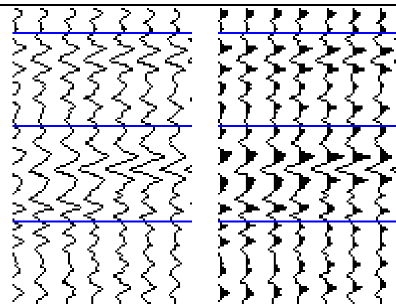
- Trace Increment – A subset of the total record also results by choosing a Trace Increment larger than one. For instance, setting a Trace Increment of 3 will result in the plotting of every third trace.

- Time Grid – You can control the Time Grid that is superimposed on the seismic data. If you leave this parameter set to zero, the software will choose one automatically.

- Minor Grid Lines – You can also insert any number of Minor Grid Lines between the main grid lines. For instance, setting this parameter to three will result in the main grid lines being shown in bold, and two secondary grid lines following each main grid line.



- Wiggle Trace/Variable Area – Data can be shown in Wiggle Trace or Variable Area form. Variable area fills in the positive peaks, making reflection events more apparent, and is the most common trace style used in marine reflection surveys.



The CNT-2 Controller provides three different types of display gains:

- Fixed Gain – Applies the same gain multiplier to the entire length of an individual trace (but not necessarily the same gain to all traces). This is most often the gain style of choice in refraction surveys.

- AGC (Automatic Gain Control) – This is a method used commonly for viewing signals that decay rapidly, like those in reflection surveys. It strives to equalize the amplitudes of early as well as late events in the seismic trace. This technique divides the total record length by the time associated with the number of samples you specify (in AGC Window, described below) to get the number of regions. For each region, it computes the average signal, and then divides every measurement in this region by this average and plots the result. For smaller signals, this has an amplifying effect because the signal is lower, but the average is also lower.

  This gain style is very useful in displaying seismic reflection data. If AGC is enabled, you must specify an AGC Window. The optimum choice will depend on the data and in particular the period of the seismic wavelets in the data. The number entered should be in data samples between 2 and 1000. The best choice is empirically determined, but need not be particularly precise. A wide range of values will give acceptable results. Windows that are too short will distort the waveforms; those too long will obscure some reflections. Since only the display is affected, experiment with different displays for a particular data set to see which gives the best records. When in doubt, start with 250.

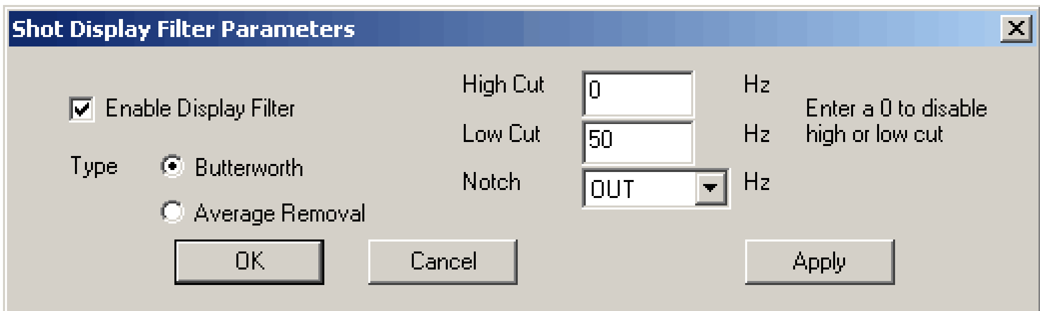
- Trace Overlap – To control the overall trace amplitudes when using AGC, you must specify a Trace Overlap. This is simply a scale factor, applied after the AGC is performed, that determines the display gain of each trace expressed in terms of how much the traces overlap each other. It is similar to Display Gains (discussed below) except that the display gain of each trace is the same. In most cases where you would use AGC, particularly reflection surveys, it is usually desirable to scale each trace identically after AGC has been applied.

  Experiment with the AGC Window and Trace Overlap parameters to get a feel for their effects on the display.

- Normalize – Takes the maximum amplitude of each trace and scales the entire trace proportionally by this value. This option is a good way of setting the gain on each channel so that you can view them all equally (e.g. in terms of the maximum value obtained) for each channel. As in AGC, the Trace Overlap value is used to set the amplitudes of the traces when they are normalized. It also applies to Fixed Gain mode, limiting the overlap of adjacent traces regardless of the Trace Size setting (below).

Note: *The most common gain style used in marine reflection applications is AGC.*

The GeoEel is equipped with digital display filters. Pressing the **Set Filters** button will bring up the Shot Display Filters Parameters dialog box:

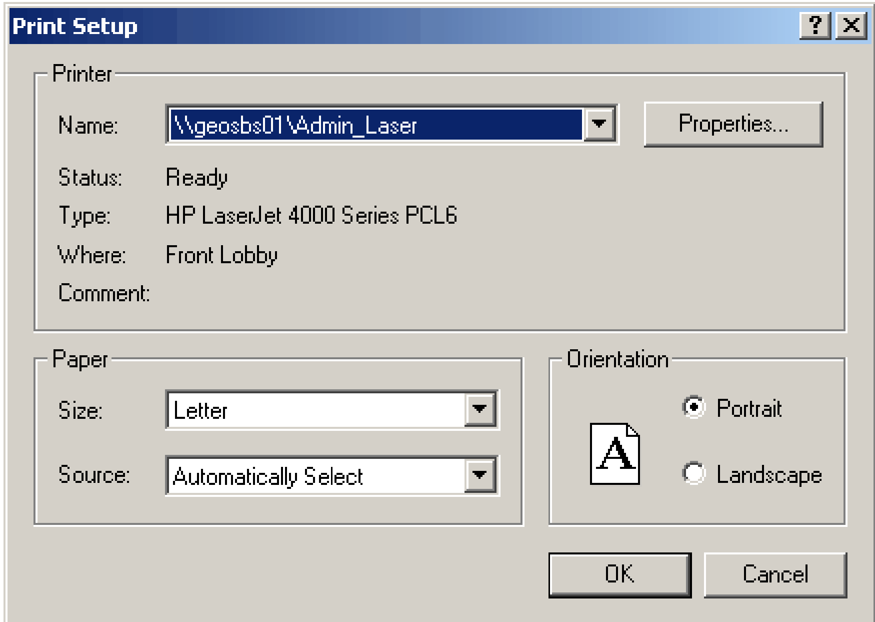


Display filters act only on the data display, and do not affect the data stored to tape or disk. The program offers High Cut, Low Cut and Notch filters.

- Enable Display Filters – Check the Enable Display Filter box to enable the filters.
- Butterworth/Average Removal – You may choose between a standard 24 dB/octave Butterworth filter and an "Average Removal" filter designed by Geometrics. With the latter, a moving average over a window centered on a particular data point is subtracted from the value of that data point. The filter is therefore non-causal (which means data values in the future affect the current output). For low cut filtering, we have found this method of filtering to be superior to that of a standard Butterworth filter.

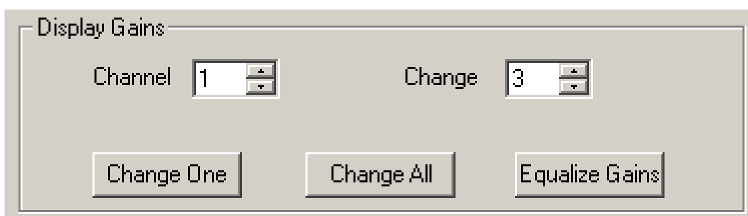
  Type in a corner frequency (a value of "0" disables the filter) and/or choose a notch frequency from the drop-down menu.
- High Cut/Low Cut/Notch – In the case of the Average Removal filter, the corner frequency determines the width of the moving average window. Notch and High cut do not apply to the Average Removal filter.
- Auto Print Interval – You may print your shot records to any Windows-based printer. Since marine surveys are generally typified by large volumes of data, it is usually desirable to print every *n*th shot record rather than every single one. This is controlled by the Auto Print Interval. Leaving this parameter set to zero disables the auto print feature. If you set the Auto Print Interval to, say, five, every fifth shot record will be printed.

Pressing the **Printer Setup** button brings up a print configuration dialog box:



Select the appropriate printer from the drop-down list and configure the printer properties as desired.

You may print the current shot record by simply pressing the **Print Now** button.



If you are using fixed gain, you may use the Display Gains dialog (above) to control the trace amplitudes.

Pressing the **Change One** button will change the display gain of the selected Channel by the number of dB in the Change box. Use the up/down controls or type in the values directly. Repeated presses of the button will change the gain by one Change increment for each press.

Pressing the **Change All** button will change *all* display gains by the Change value. Again, gains will increment with each press of the button.

Pressing **Equalize Gains** will set all gains equal to whatever the display gain of channel 1 happens to be at the time.

3.1.4.6.5.2 Aux Channel Parameters

The AUX Channels window displays any auxiliary channels that may be enabled. You have the same control over the display of AUX channels that you do regular data channels.

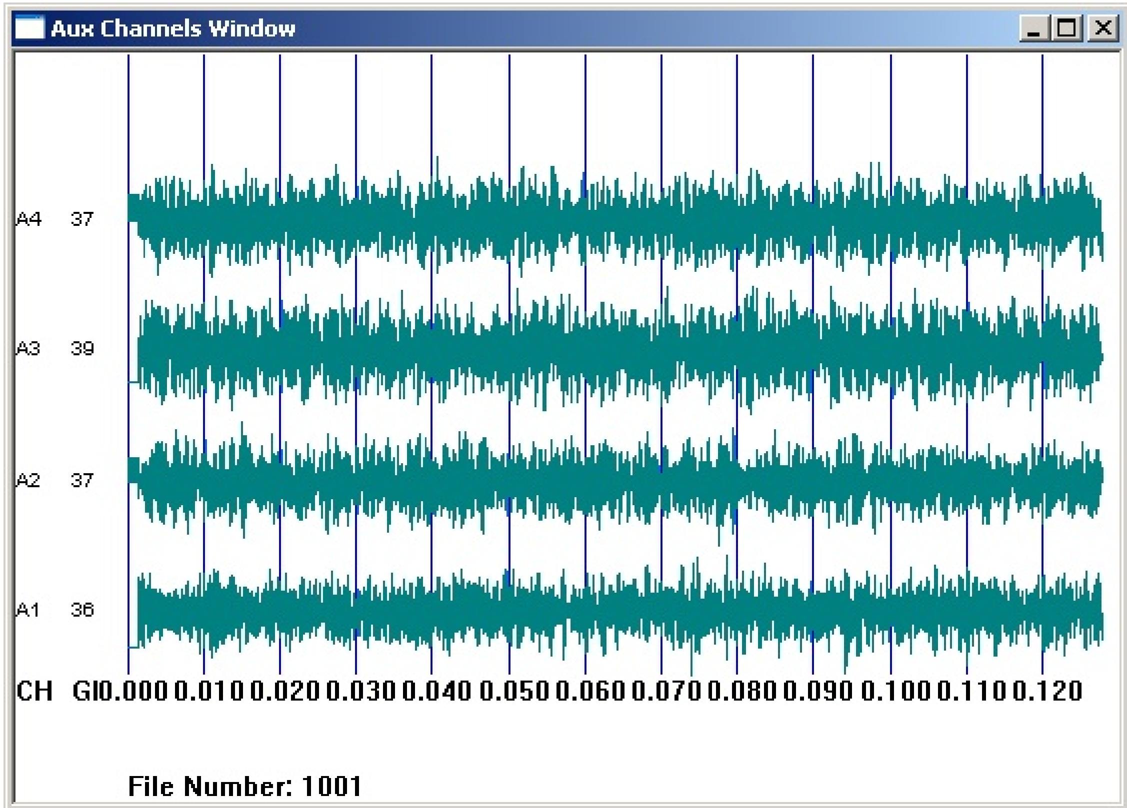
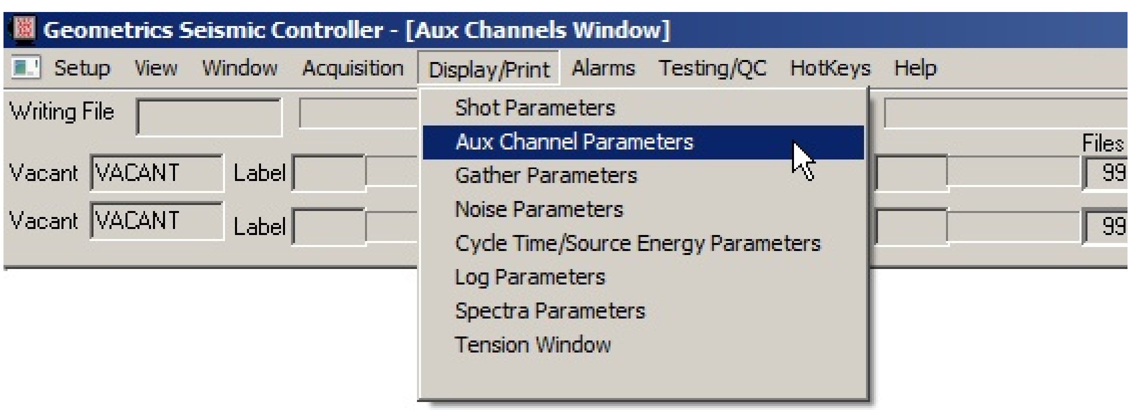
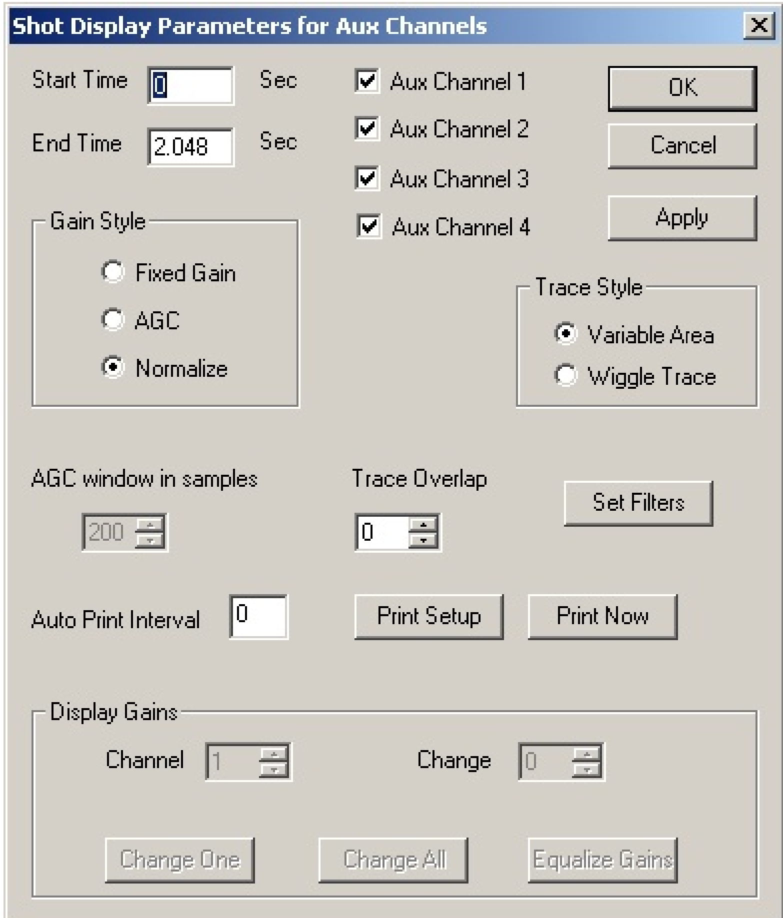


Figure 57: Auxiliary channel display.





The display parameter controls for AUX channels are identical to those for data channels, with the exception that you may here choose which AUX channels to display or not to display.

3.1.4.6.5.3 Gather Parameters

The Gather window displays a single user-specified trace from each shot record to build up a common-offset gather. It is left-scrolling and continuously updated. Depending on the survey area, the common offset gather (or "near trace gather") can rival a brute stack in quality and is a useful tool for monitoring data quality during the survey. An example is shown below:

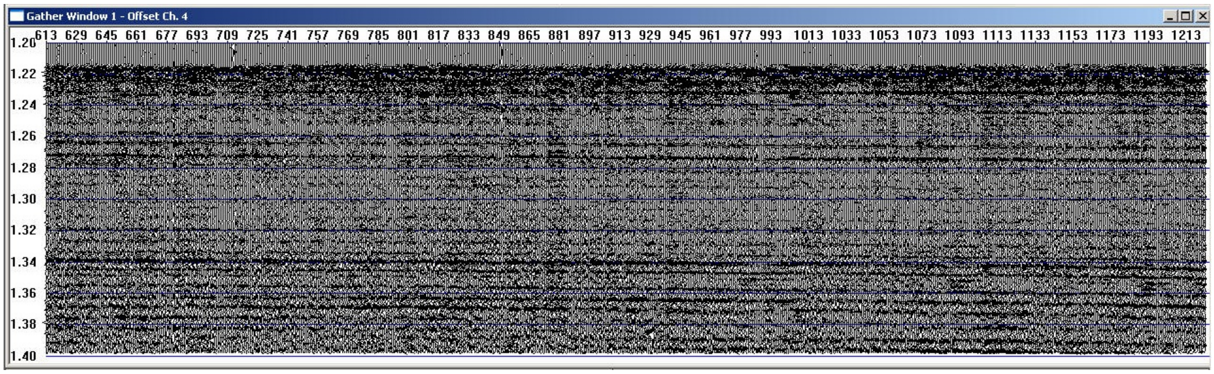
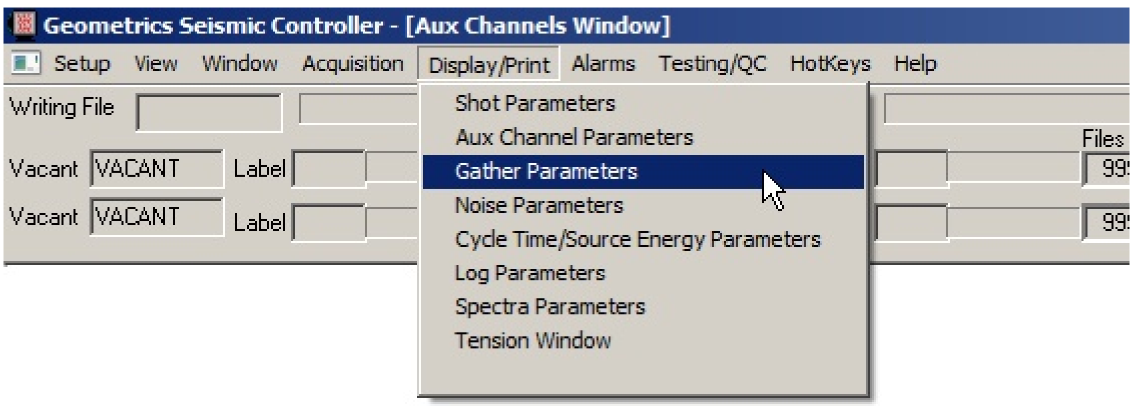
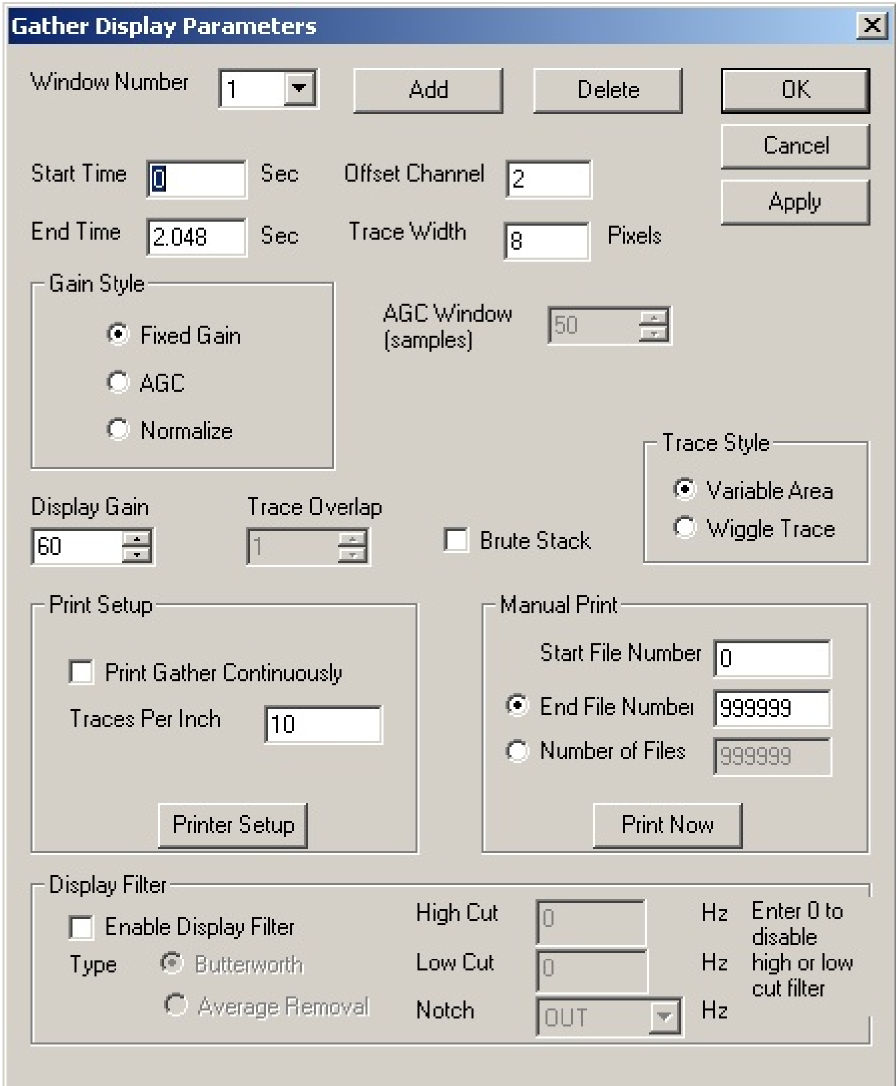


Figure 58: Example of common offset (near-trace) gather.





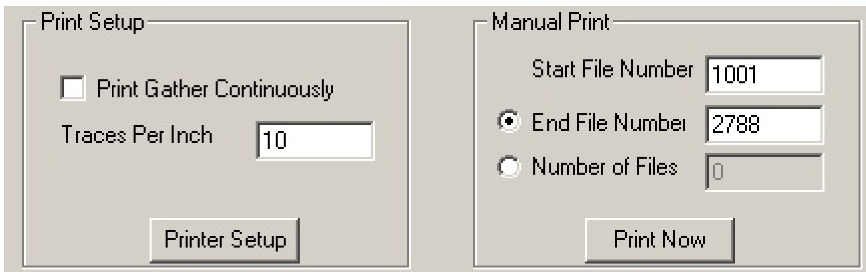
The gather display parameters are also very similar to those for data and AUX channel displays. We will discuss only those unique to the Gather Display Parameters dialog box. See the discussion of the Shot Display Parameters menu for items not covered here.

- Window Number – You may open as many as three Gather windows. Simply press the **Add** button to add Gather windows. Choose the appropriate Window Number before setting your gather display parameters. Pressing the **Delete** button will delete the gather number displayed in the Window Number box.
- Offset Channel – This is the channel that will be stripped from each shot record and added to the gather. This is usually one of the channels closest to the source.
- Trace Width – This sets the horizontal space allotted for each trace in pixels. The smaller this number, the closer together the traces will be in the gather.
- Brute Stack – If you have 24 channels or more, you might consider doing a “brute stack”

rather than a single-trace gather. This is enabled by checking the Brute Stack box. Checking this box will enable the Velocity Analysis and Geometry Setup options in the Testing/QC menu. A complete discussion of the brute stack feature is discussed in the Appendix.

There are two ways to print the gather:

- Print Gather Continuously – Check this box if you wish to print the gather continuously, in near real-time.



- Start/End File Number/ Number of Files – When printing the gather manually, choose a Start File Number and either an End File Number or a Number of Files. "Files" in this context means "traces" – there is one trace stripped out of every shot file. In the example above, the printed gather would have 1,787 traces (assuming the File Number Increment was 1 throughout the entire line).

- Traces Per Inch – This parameter is the same as Trace Width discussed above, expressed in different units. It simply determines how close together the traces will be to each other in the printed gather. This is independent of the Trace Width setting, which only affects the screen display.

To print manually, press the **Print Now** button.

Note: *Since the gather is displayed on the screen during the survey, it is generally recommended that you print the gather all at once at the end of the survey line, and use the printer for printing QC shot records.*

3.1.4.6.5.4 Noise Parameters

The noise parameters control the noise bar graph, shown below. This bar graph plots the rms noise amplitude for each channel. Channels exceeding user-specified noise thresholds are shown in red.

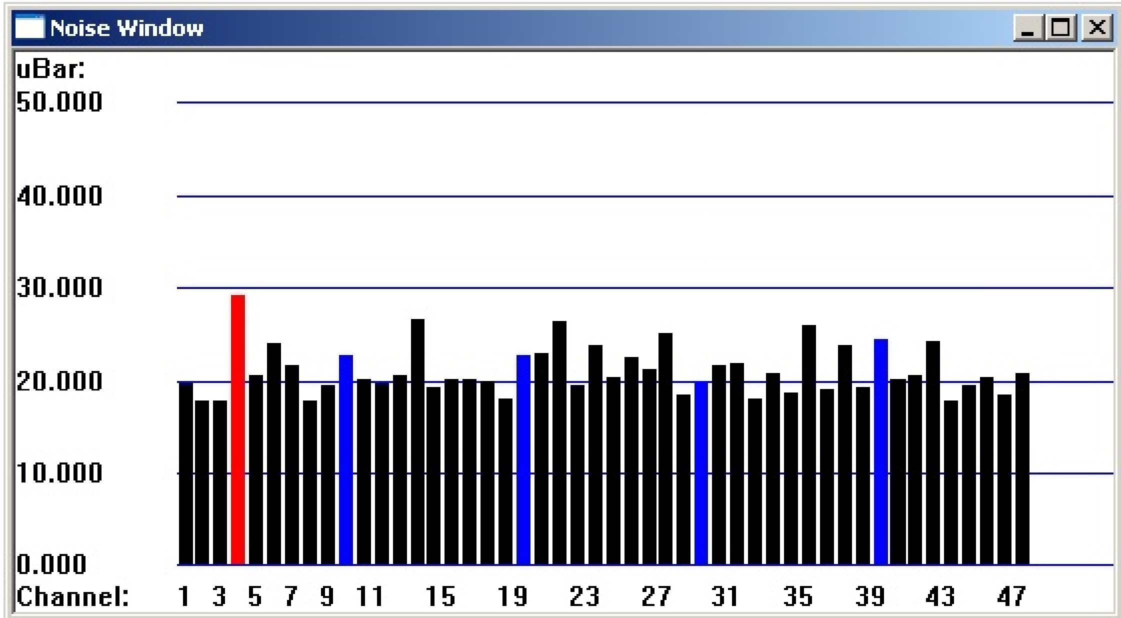
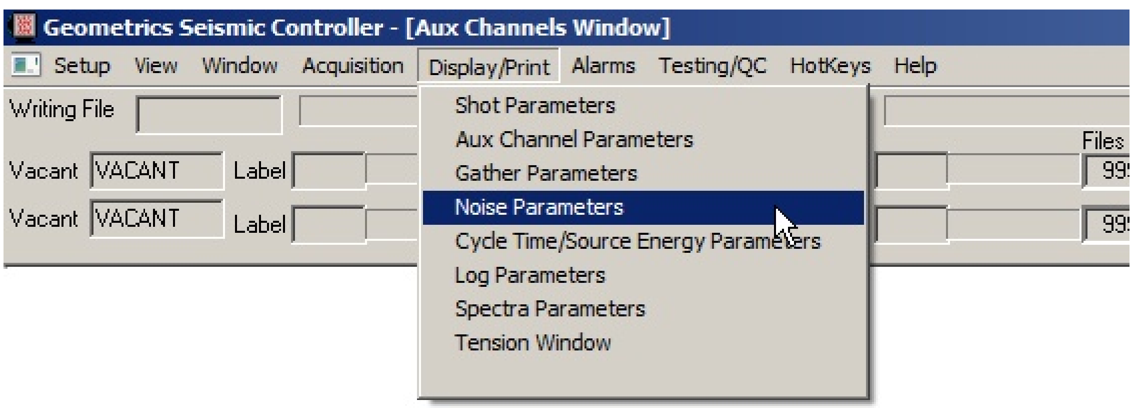
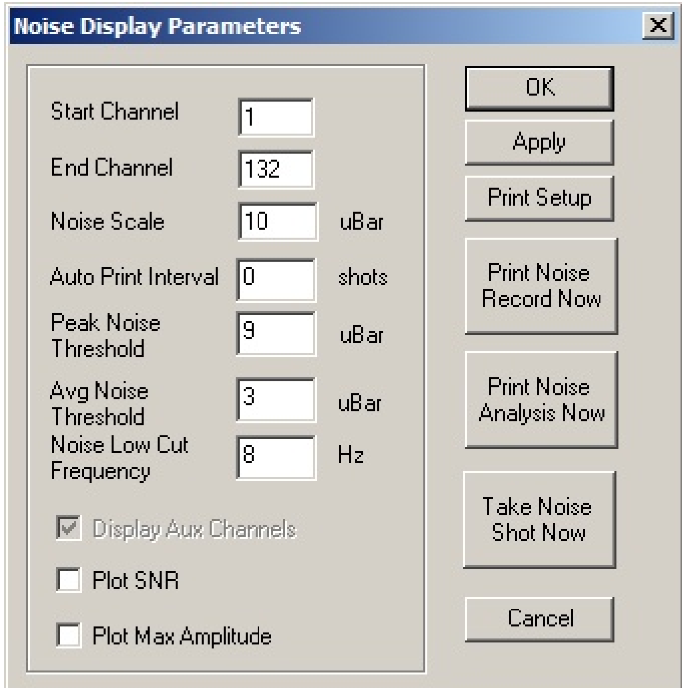


Figure 59: Noise bar graph.





Note: *There are two levels of noise testing offered by the CNT-2 Controller:*

1) ***Real-time "snapshot" bar graph*** *– A user-designated portion of the record (usually the water column) is examined for each shot, and the rms noise values for that record are calculated and shown in bar graph form. This plot is continuously updated. No summary table or noise records are generated; the noise values are not recorded.*

2) ***Complete noise analysis*** *– A record is taken without firing the source, and the entire record is evaluated. A table of rms values for each channel is written to the Survey Log and can be optionally printed, along with the bar graph. The noise record itself can be optionally saved and printed as well.*

There are various parameters you can set to customize the way noise reporting works.

- Start/End Channel – Set the Start Channel and End Channel to control which channels are included in the analysis (generally all).
- Noise Scale – The Noise Scale controls the scale of the vertical axis of the noise bar graph.
- Auto Print Interval – The Auto Print Interval allows you to print every *n*th noise bar graph. Leaving this parameter set to zero disables the auto print feature.
- Peak Noise Threshold – This is the maximum noise that is tolerable; the bar for any channel exceeding this level will be plotted in red.

- Average Noise Threshold – Not used.
- Noise Low Cut Frequency – This is the corner frequency of the low cut filter applied to the record prior to calculating the noise on each channel. This is often referred to as the "Swell Filter".
- Display AUX channels – In general, AUX channels are not included in a noise analysis, but you may elect to do so if necessary.
- Plot SNR – Check the Plot SNR box if you want to plot signal-to-noise ratio (SNR) rather than just the noise levels themselves.

A complete noise analysis (bar graph and table of rms noise values) is conducted when you press the **Take Noise Shot Now** button. Generally this is done at the beginning and/or end of a line. A noise record is taken, the noise is measured on each trace, and a bar graph and table (the "analysis") are generated.

Test_Survey.2393.log

Noise Test (File 1001)...
Noise Test (File Number: 1001)
Survey: Test_Survey
Line: 3
Date: 12/05/2007
Time: 17:20:42.15

Channel	001	002	003	004	005	006
Preamp (dB)	030	030	030	030	030	030
Noise (uBar)	19.40	17.52	17.65	28.98	20.30	23.75
	007	008	009	010	011	012
	030	030	030	030	030	030
	21.51	17.56	19.35	22.48	20.00	19.53
	013	014	015	016	017	018
	030	030	030	030	030	030
	20.41	26.41	19.11	20.04	19.89	19.71
	019	020	021	022	023	024
	030	030	030	030	030	030
	17.70	22.53	22.72	26.14	19.35	23.52
	025	026	027	028	029	030
	030	030	030	030	030	030
	20.07	22.39	20.99	24.91	18.29	19.45
	031	032	033	034	035	036
	030	030	030	030	030	030
	21.38	21.56	17.67	20.63	18.51	25.66
	037	038	039	040	041	042
	030	030	030	030	030	030
	18.77	23.56	19.10	24.28	19.86	20.28
	043	044	045	046	047	048
	030	030	030	030	030	030
	24.04	17.49	19.39	20.26	18.14	20.54

Average Noise RMS: 20.89 uBar

Table5: Noise analysis as written to the Survey Log.

The table is automatically written to the Survey Log. Similar buttons are provided for manually printing the noise record and noise analysis. Go here for information on automating this and other processes.

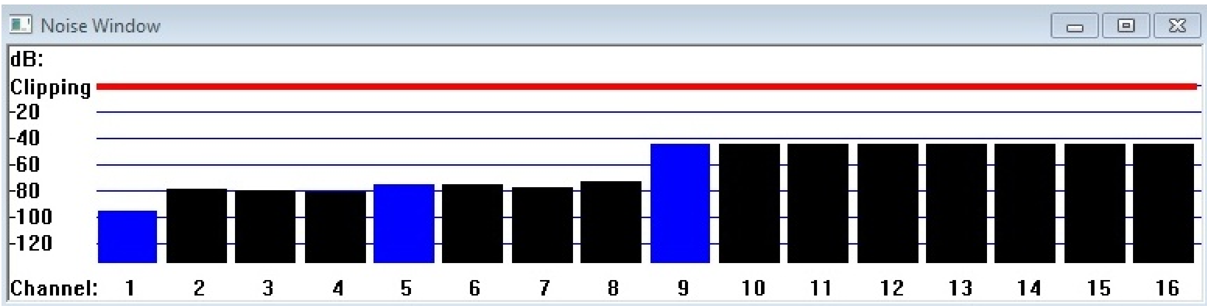
Note: *An offline noise test can be done at any time by pressing CTRL+T. It is not necessary to arm the system.*

Note: *The* **Print Noise Analysis Now** *and* **Print Noise Record Now** *buttons are only active when a noise record is in the buffer. Once a shot record is taken, these buttons will be grayed* *out.*

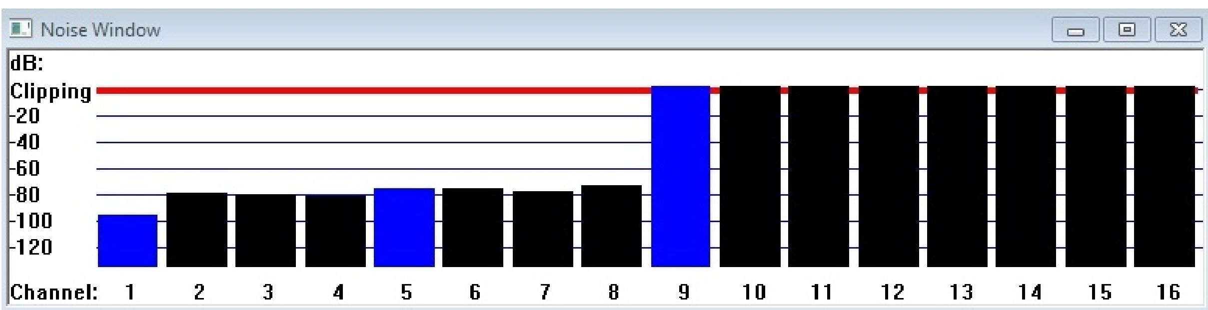
All of the items on the left side of the Noise Display Parameters menu apply to the snapshot; all except Auto Print Interval and Plot SNR apply to offline noise tests. The items in the center and on the right apply only to offline noise tests.

Please see the discussion on designation of signal and noise portions of a record here.

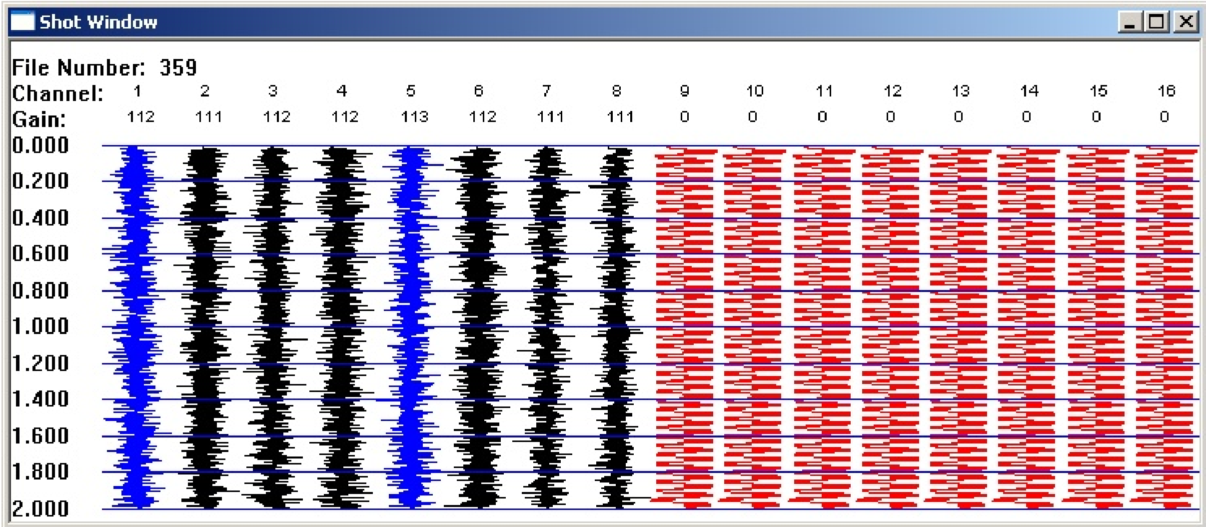
The Plot Max Amplitude feature allows you to determine how much of the full-scale range of the Digitizers is being used. Checking this box changes the Noise window to the following:



This shows the maximum amplitude from each shot on a dB scale. The A/D clipping threshold is shown by the red line. Take a test shot record. If the maximum signal levels are well below the clipping line, you may wish to increase the preamp gains for those channels. This will adjust the bars on the graph to reflect the effect of the new gains. If any of the bars reach the clipping threshold (below),



the traces will be shown in red in the Shot window:



The Maximum Amplitude is a handy way of making sure you are making full use of the dynamic range of the system. This calculation is not affected by any filters that are set for any other display windows. It is also not affected by the low cut filters used for the noise calculation.

3.1.4.6.5.5 Cycle Time / Source Energy Parameters

As the name indicates, the Cycle Time/Source Energy window displays two parameters:

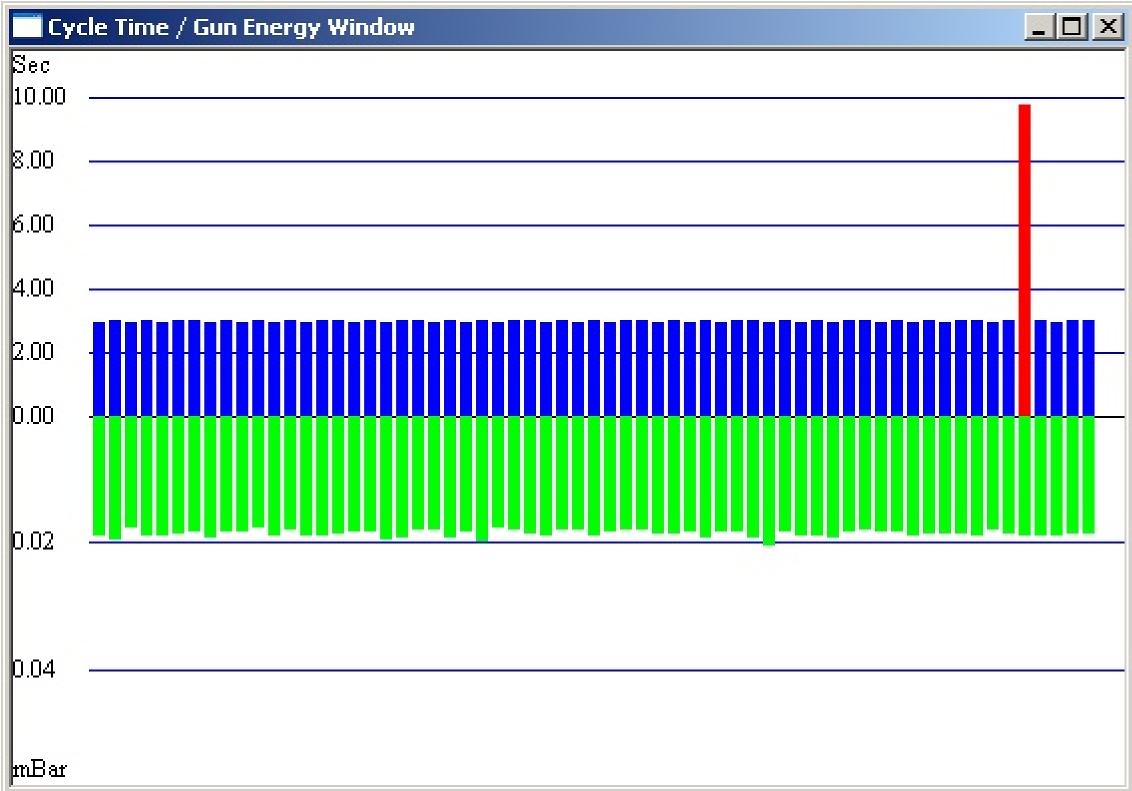
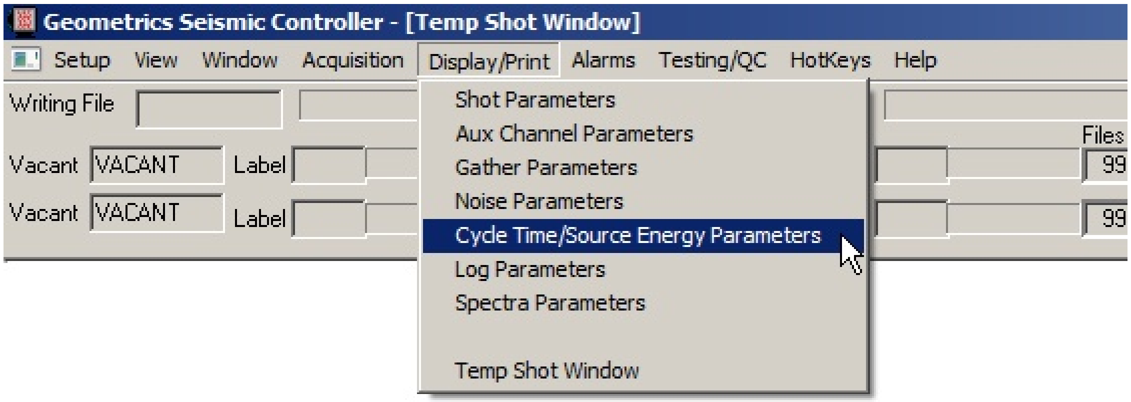


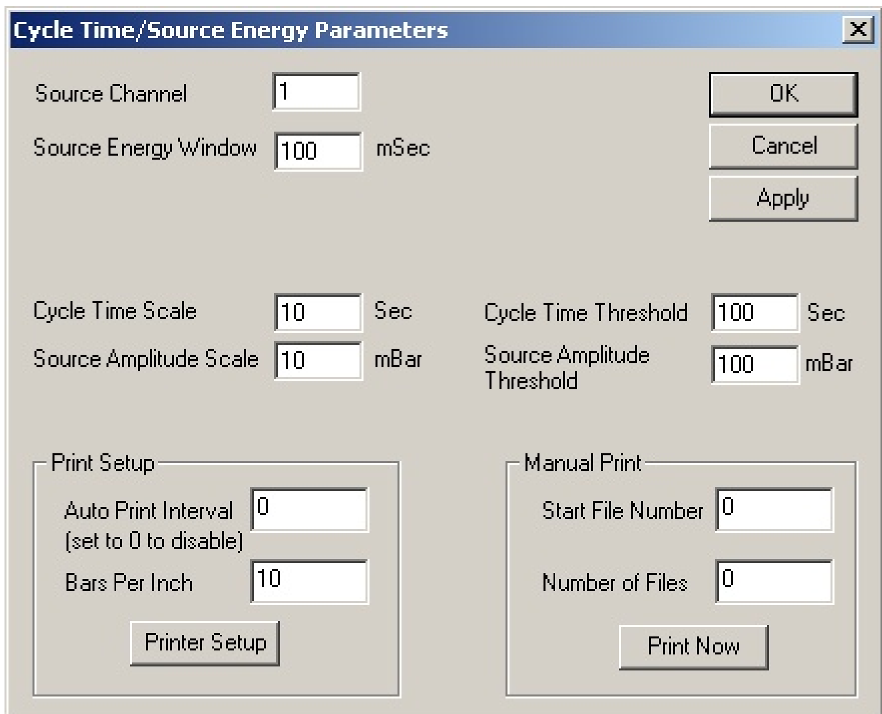
Figure 60: Cycle time/gun energy display.

The top bar graph indicates the time between triggers of the GeoEel. This is useful for catching missed or spurious triggers. A threshold can be set which, if exceeded, can cause an alarm to be sounded and the bar for that shot to be shown in red.

The bottom bar graph represents the rms amplitude of the near-field hydrophone. This can provide a crude check on source function; the idea is that the energy will not change much from shot to shot if the source(s) is firing consistently. You may set a threshold which, *if not reached or exceeded*, can cause an alarm to be sounded and the bar for that shot to be shown in red. This is generally used only when a sophisticated source controller is not available. If you are using a good source controller, this feature will be superfluous.

Both graphs are continuously-updating and left-scrolling.





- Source Channel – This is generally the channel connected to the near-field hydrophone to monitor the source. This will often be an AUX channel. If so, you must enter its channel number. AUX channels begin where data channels leave off. For instance, on a 48-channel system, the AUX channels will be channels 49, 50, 51, etc.

- Source Energy Window – This is set in ms and defines the length of the time window used in calculating the rms amplitude. This window begins at the start of the record and should be long enough to include the firing of the source. Since you are looking at shot-to-shot variations, the absolute amplitude is not important and this window can generally be left at 100 ms. If you are using a source delay of more than 100 ms, you might want to lengthen this window to ensure that it captures the source firing.

- Cycle Time Scale – Set to a value appropriate for your shooting rate. If you are shooting on distance, there will inevitably be some variation in the trigger time due to variations in vessel speed. Calculate the ideal trigger time based on your target speed and shot interval in distance, and set a Cycle Time Scale that is slightly larger. For instance, if you intend to shoot every 12.5 meters at 5 knots, your nominal shooting interval will be 4.86 seconds. A good setting would be about 5.5 or 6 seconds.
- Source Amplitude Scale – Set this parameter experimentally. It will depend on the source size and the offset between the source and the Source Channel.
- Cycle Time Threshold – This should be set to a value that, if exceeded, would indicate a possible problem. A good way to choose this threshold is to observe the cycle times for the first 20-30 shots, see what the maximum is, and set the threshold just slightly higher than the maximum.
- Source Amplitude Threshold – This should be determined in a manner similar to that for the Cycle Time Threshold. Remember, however, that in this case, you are setting a *minimum* value.
- Auto Print Interval – Printing is similar to printing a shot record and gather. You can print manually or automatically. To print automatically, set an Auto Print Interval other than zero. If you wish to print manually, enter a Start File Number and Number of Files, then press **Print Now**.
- Bars Per Inch – Determines this density of bars on the bar graph. Applies to both printing modes.

3.1.4.6.5.6 Log Parameters

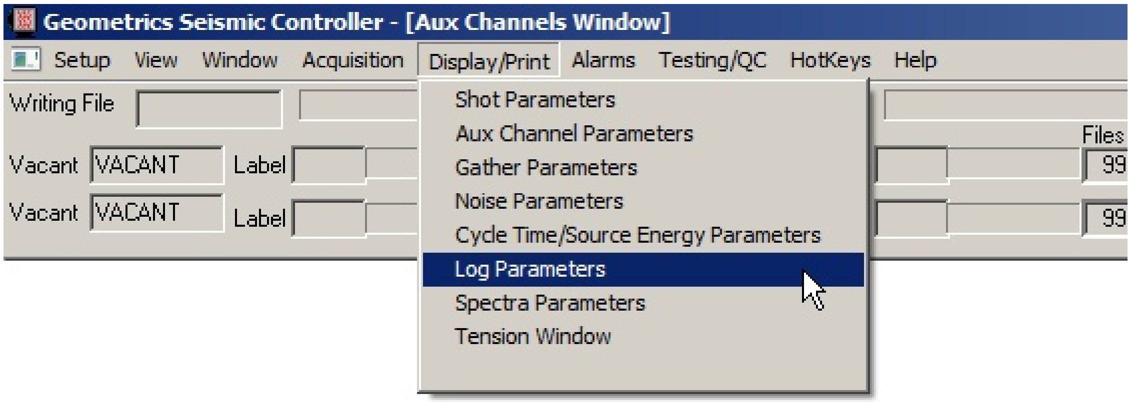
The Survey Log window displays a real-time, continuously-updated display of all important events that occur during the survey, including changes to acquisition parameters, data storage information, observer notes, and alarms:

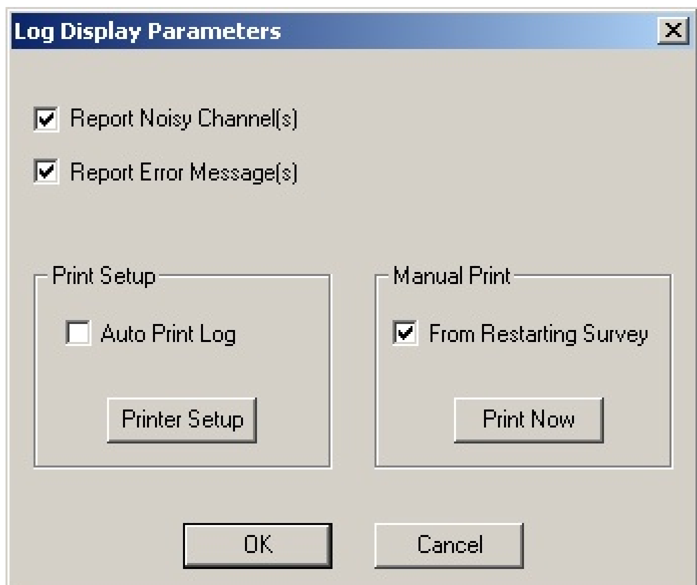
```
Test_Survey.2393.log

New Survey
Sample Interval 0.250 msec, Record Len 2.000 Sec, Delay 0.000 Sec,
Filters: FILTER OUT, FILTER OUT
Active Channels 1 - 48
Preamp Gain Style is set to ALL 30 dB
Preamp Gain Style on Aux is set to ALL 0 dB
New Noise Params Transconductance 20.000001  Thresholds 27.000000 3.000000
Saving to disk - Next File Number is 1001 - Data Dir is C:\Test - SEG-D Rev 1 8058 Format
File    1001 18:00:52.55 12/05/2007 1666 KBytes SAVED
File    1002 18:00:55.55 12/05/2007 1666 KBytes SAVED
File    1003 18:00:58.55 12/05/2007 1666 KBytes SAVED
File    1004 18:01:01.55 12/05/2007 1666 KBytes SAVED
File    1005 18:01:04.55 12/05/2007 1666 KBytes SAVED
File    1006 18:01:07.55 12/05/2007 1666 KBytes SAVED
ALARM: Trigger time threshold exceeded.  18:01:21
File    1007 18:01:19.70 12/05/2007 1666 KBytes SAVED
File    1008 18:01:22.69 12/05/2007 1666 KBytes SAVED
File    1009 18:01:25.70 12/05/2007 1666 KBytes SAVED
File    1010 18:01:28.69 12/05/2007 1666 KBytes SAVED
File    1011 18:01:31.69 12/05/2007 1666 KBytes SAVED
File    1012 18:01:34.69 12/05/2007 1666 KBytes SAVED
ALARM: Trigger time threshold exceeded.  18:01:49
File    1013 18:01:47.07 12/05/2007 1666 KBytes SAVED
File    1014 18:01:50.06 12/05/2007 1666 KBytes SAVED
File    1015 18:01:53.06 12/05/2007 1666 KBytes SAVED
File    1016 18:01:56.06 12/05/2007 1666 KBytes SAVED
ALARM: Gun amplitude threshold exceeded.  18:01:58
Preamp Gain Style is set to ALL 18 dB
Preamp Gain Style on Aux is set to ALL 0 dB
File    1017 18:02:35.55 12/05/2007 1666 KBytes SAVED
File    1018 18:02:38.55 12/05/2007 1666 KBytes SAVED
File    1019 18:02:41.54 12/05/2007 1666 KBytes SAVED
File    1020 18:02:44.55 12/05/2007 1666 KBytes SAVED
File    1021 18:02:47.54 12/05/2007 1666 KBytes SAVED
Note: Man overboard -- retrieved streamer and rescued swimmer. at 18:07:14 12/05/07
```

Figure 61: Sample Survey Log.

When this window is active, you may scroll this display using the **Page Up**, **Page Down**, **Home**, or **End** keys.





In the above dialog box, you may configure the way the Survey Log is shown on the screen, and whether or not it is sent to the printer port in real time.

- Report Noisy Channel(s) – If this box is checked, any channels exceeding the user-set peak noise threshold will be displayed in the log along with their rms noise value.
- Report Error Message(s) – If any errors or alarms occur during the survey, such as a missing serial string or a missed shot, they will be shown in the Survey Log.

  Note: *Even if the above two options are disabled, the full Survey Log stored on the disk drive will still show the messages, but they will not be displayed in real time.*

  Note: *It is generally recommended that* Report Noisy Channel(s) *be left unchecked in* *order to avoid a cluttered real-time display.*

- Auto Print Log – If enabled, the log will be printed automatically as it is generated. To manually print at any time, just press the **Print Now** button.
- From Restarting Survey – You may print the entire log, or check the box to print only the portion of the log generated since you reopened an existing survey.

Note: *Since the input serial string may be long, only the first 96 characters of the first string for each shot is displayed in the Survey Log. This is meant only as a QC measure so that you know you are receiving the serial string. However, the entire navigation string is written to the Navigation Log.*

3.1.4.6.5.7 Spectra Parameters

The Spectra window displays the most recent shot record in the frequency domain:

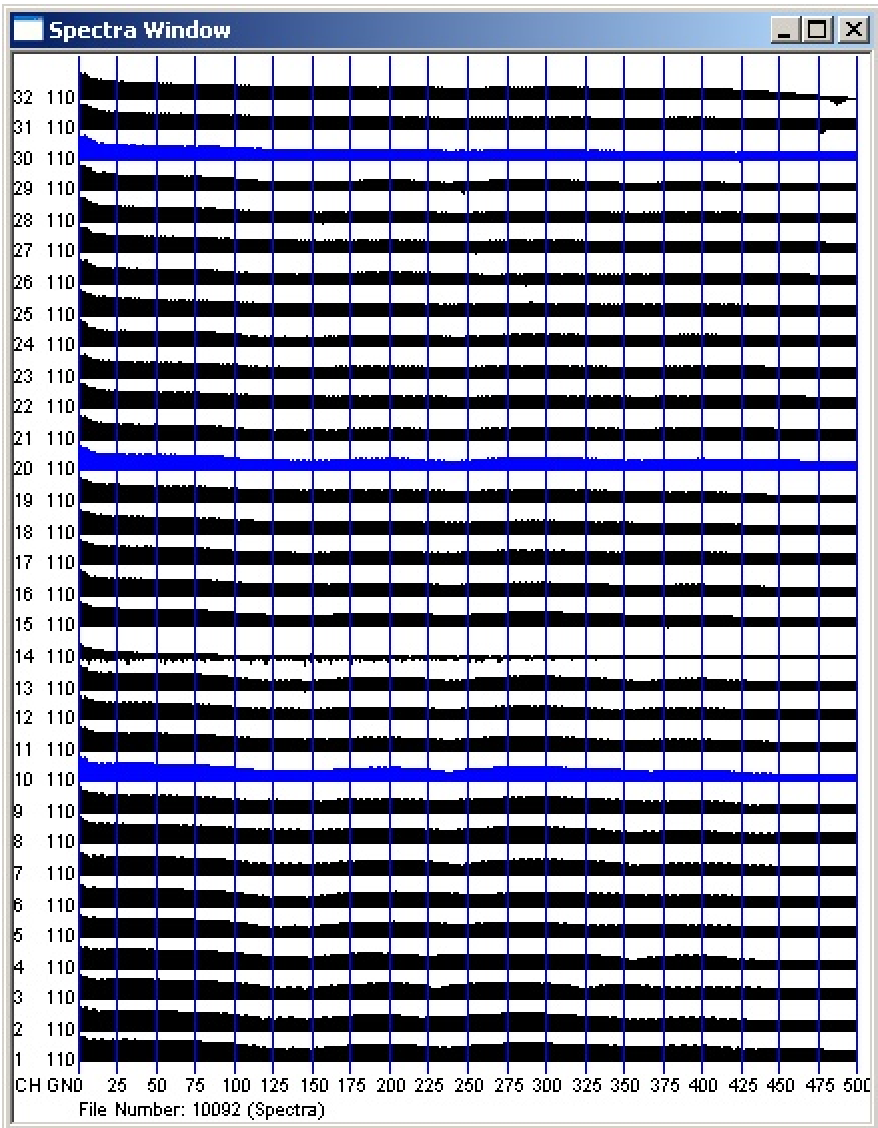
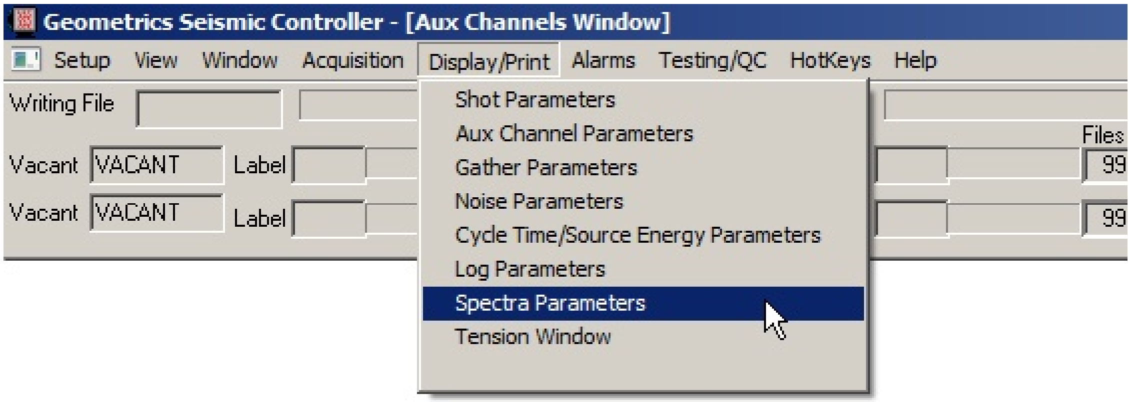
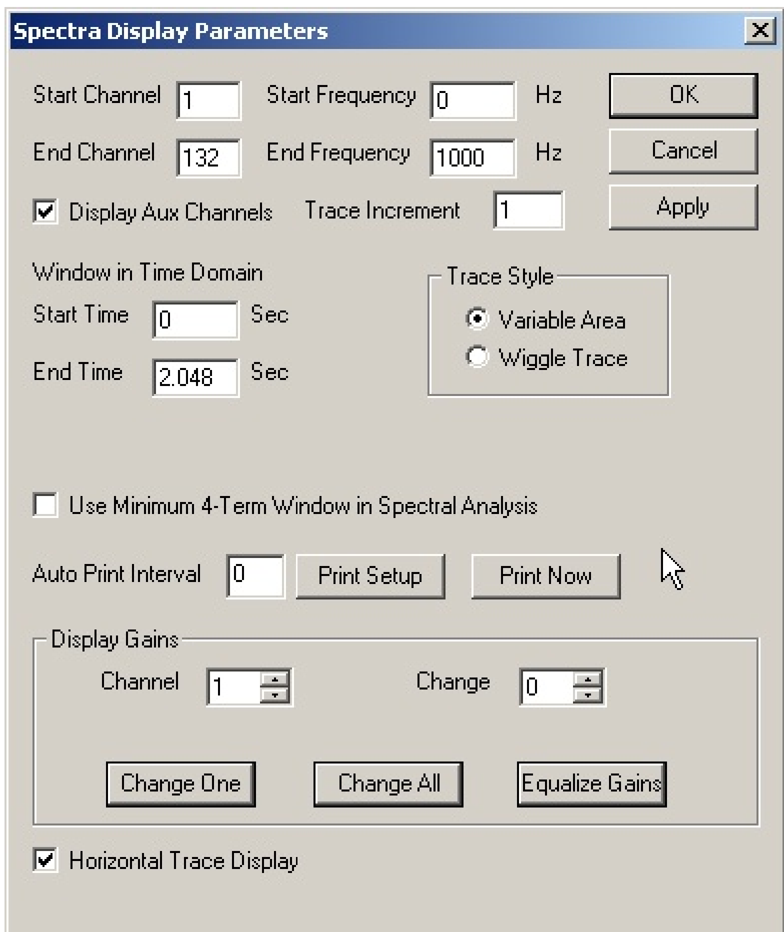


Figure 62: Example shot record spectra display.

The left column of numbers denotes the channel number, and the right column the relative scale factor ("trace size") applied to that trace. The horizontal axis is frequency in Hz.

The display parameters for the Spectra window are similar to those for the Shot window:





- Start Frequency/End Frequency – For the display scale, instead of providing a start and end *time*, you must provide a Start Frequency and an End Frequency.

- Display AUX Channels – Check this box if you would like to include AUX channels in the frequency plot.
- Start Time/End Time – If you wish to focus on a specific time slice of the shot record, you can set the Start Time and End Time. The Fourier analysis will be confined to this portion of the record.
- Use Minimum 4-term Window in Spectral Analysis – This will minimize the side lobes in the frequency domain plot.
- Horizontal Trace Display – Check this box if you would like the traces displayed horizontally rather than vertically.

3.1.4.6.5.8 Tension Window

The Tension window displays a continuously-scrolling bar-graph of the output of the Tension Gauge.

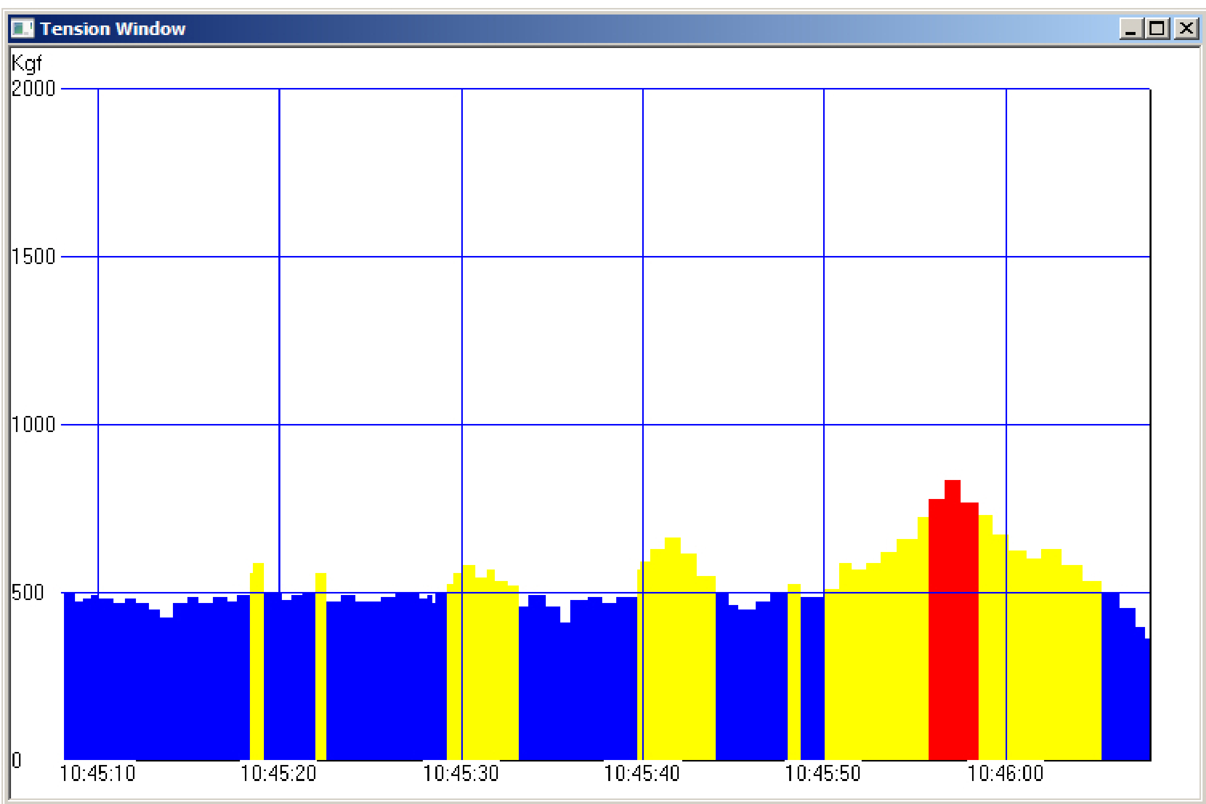
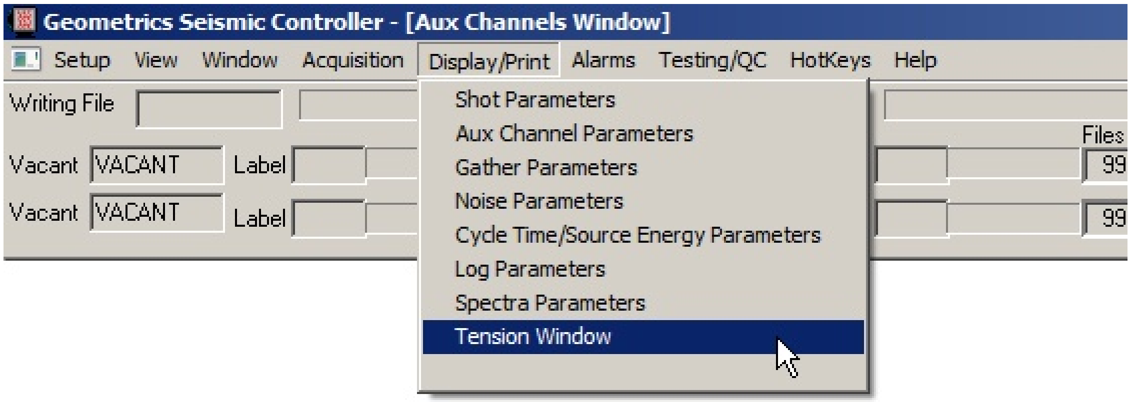
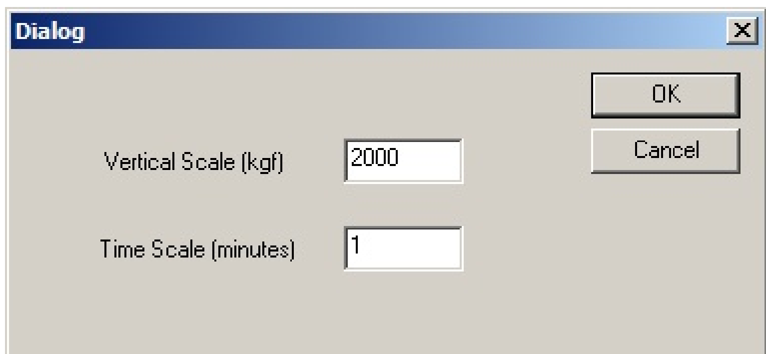
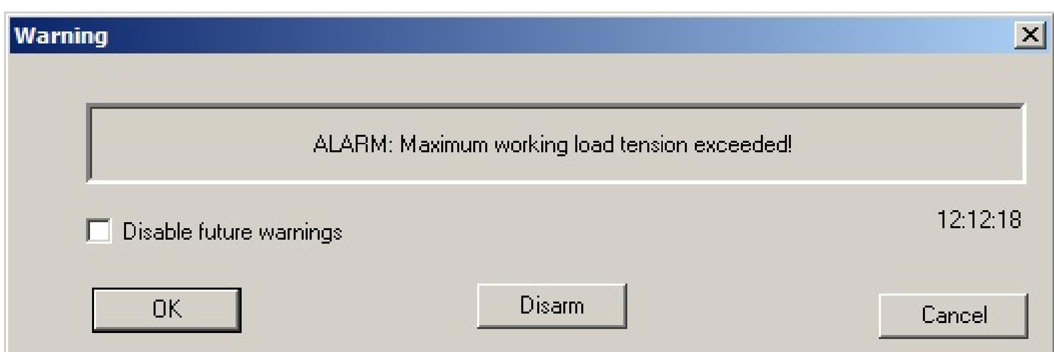


Figure 63: Example tension display. Yellow indicates warning levels, red indicates over-tension.





You may control the tension and time scales. If the maximum working load of the Tow Cable is exceeded, the tension value will be shown in red in the above graph, and the following alarm will appear:



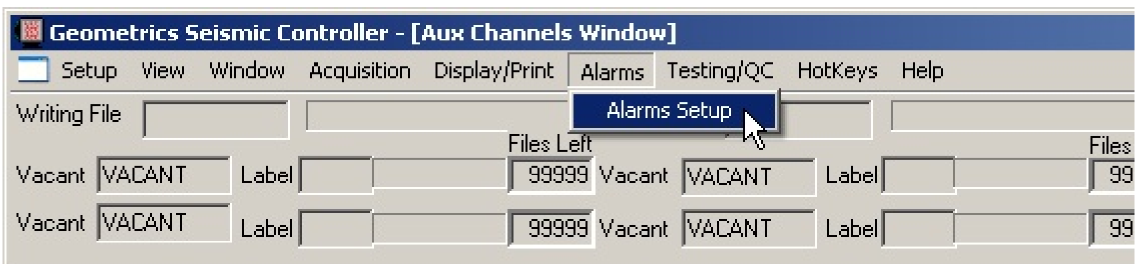
If this happens, the best immediate response is to slow the vessel down.

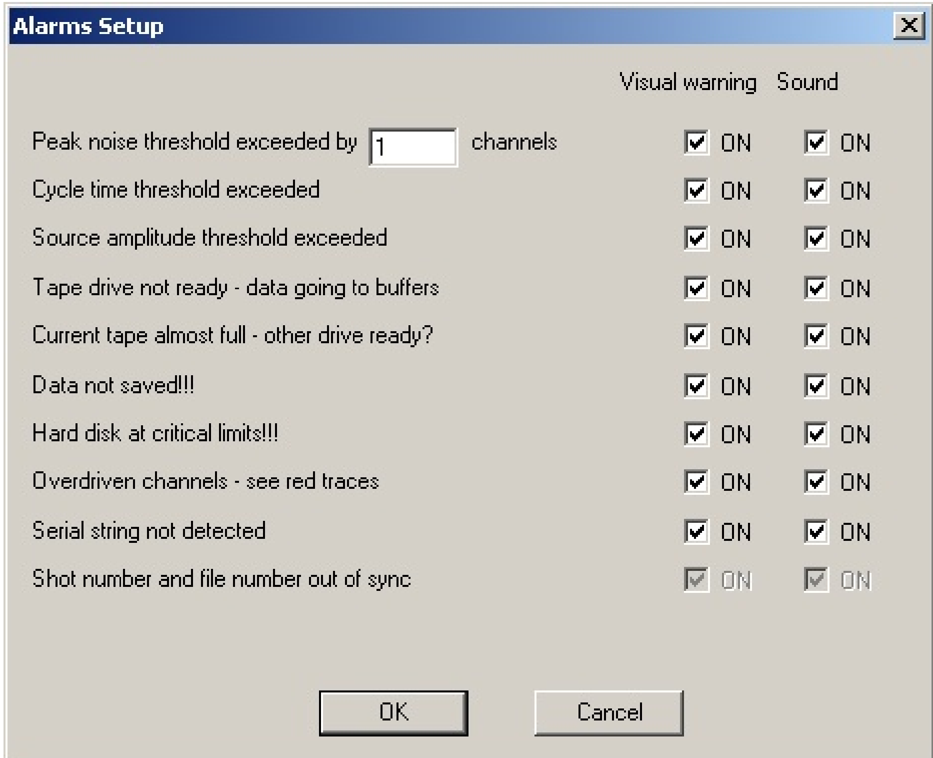
Tensions are recorded in the Tension Log.

3.1.4.6.6 Alarms Menu

You may set various audio and/or visual alarms to get the operator's attention when certain events occur. And example of a visual alarm is shown below:

Figure 64: Example alarm message.





Each of the above alarm conditions are described below:

- Peak noise threshold exceeded by X channels – Recall that the Peak Noise Threshold is set in the Noise Display Parameters dialog box. You may have the system activate an alarm whenever a user-specified number of channels exceeds that threshold.
- Cycle time threshold exceeded – Enable this alarm if you wish to be notified if the trigger time threshold set in the Trigger Time/Source Energy dialog box is exceeded.
- Source amplitude threshold exceeded – Enable this alarm if you wish to be notified if the Source Amplitude Threshold set in the Trigger Time/Source Energy dialog box is *not* reached.
- Tape drive not ready – data stored in buffers – If the tape drive is not ready for some reason – for instance, if there is no tape inserted – data will be buffered in memory and/or hard disk. When the tape drive becomes ready, data will be transferred to tape. Files will be stored on the tape in order and no data will be lost. It is highly recommended that this alarm be enabled.
- Current tape almost full – other drive ready? – You can avoid the alarm condition immediately above by making it a habit to always insert a fresh tape whenever a tape is removed from a tape drive. To help you remember this, enable this alarm. You will be warned when there is room for 10-15 more files on the current tape, and that a tape switch is imminent.
- Data not saved!!! – Note that it is not necessary to select a storage medium in the Storage Parameters dialog – *saving data is not mandatory*. This can be useful when doing practice or

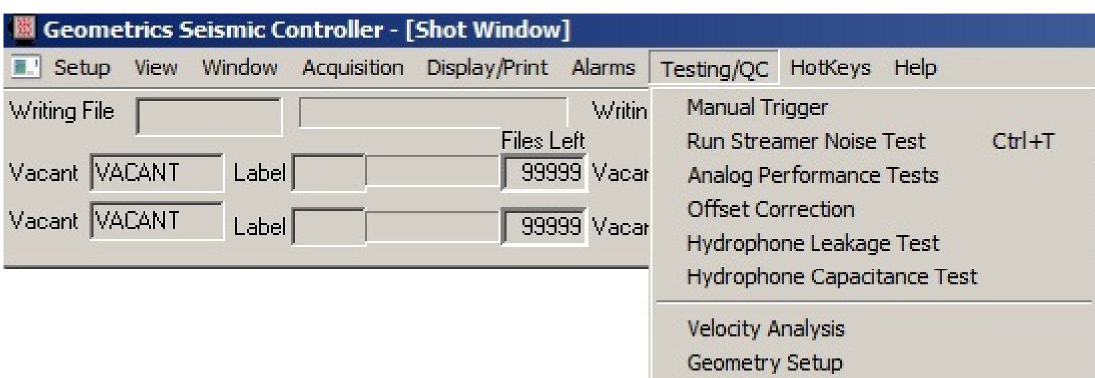
test shots prior to coming on a survey line. However, this brings with it the risk of failing to store data when you need to. If you make a habit of disabling data storage for doing test shots, enable this alarm to avoid losing data.

- Hard disk at critical limits!!! – This alarm will sound when the hard disk is down to 50 Mb of storage space. This is important if you are writing data to hard disk. It is also important if data is being buffered. If you run out of hard disk space, and something goes wrong with a tape drive, you risk losing data. This alarm is highly recommended.
- Over-driven channels – see red traces – If a channel is over-driven or "clipped", it will be displayed in red on the shot record. If you would like additional notification, enable this alarm.
- Serial string not detected – If you are logging a serial string, this alarm is highly recommended. It will sound if the serial string stops arriving for any reason.
- Shot number and file number out of sync – In the Serial Input dialog, recall that if you enable the Shot/File Number Comparison, the shot number generated by the triggering system can be included in the serial string and compared to the FFID# generated by the CNT-2 Controller. If you have elected to monitor this, you should enable this alarm.

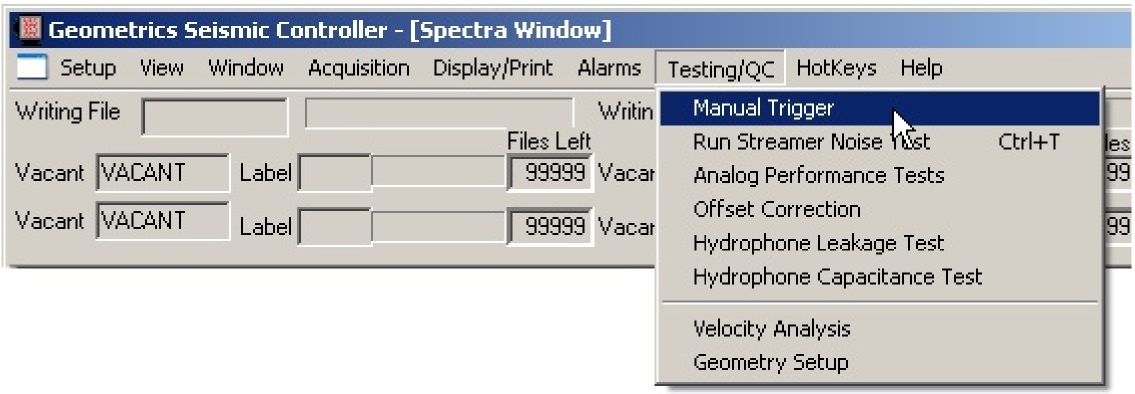
Note: *If an alarm condition occurs, this will be noted in the saved Survey Log regardless of whether or not the alarm was enabled. It will not be included in the version of the Survey Log displayed by the CNT-2 Controller in real time.*

3.1.4.6.7 Testing/QC Menu

The GeoEel offers several different test options to ascertain that the system is performing to published specifications. All of these tests can be found in the Testing/QC menu.

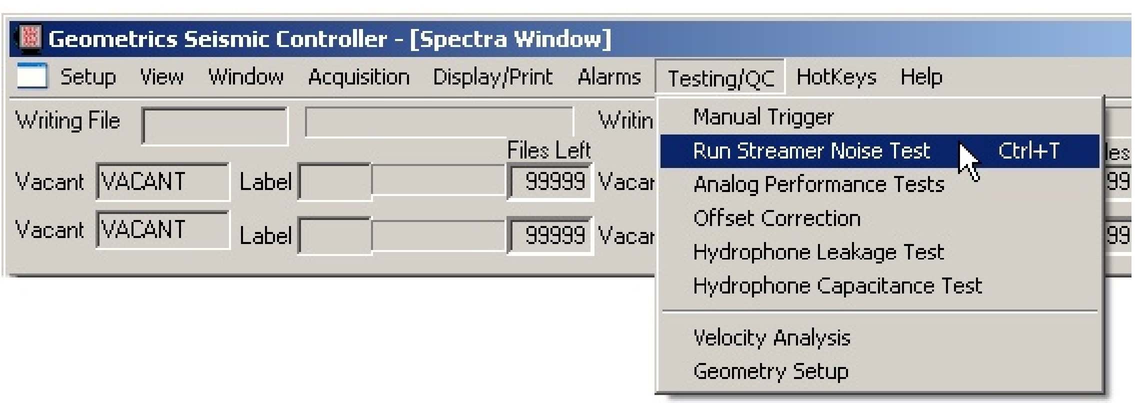


3.1.4.6.7.1 Manual Trigger



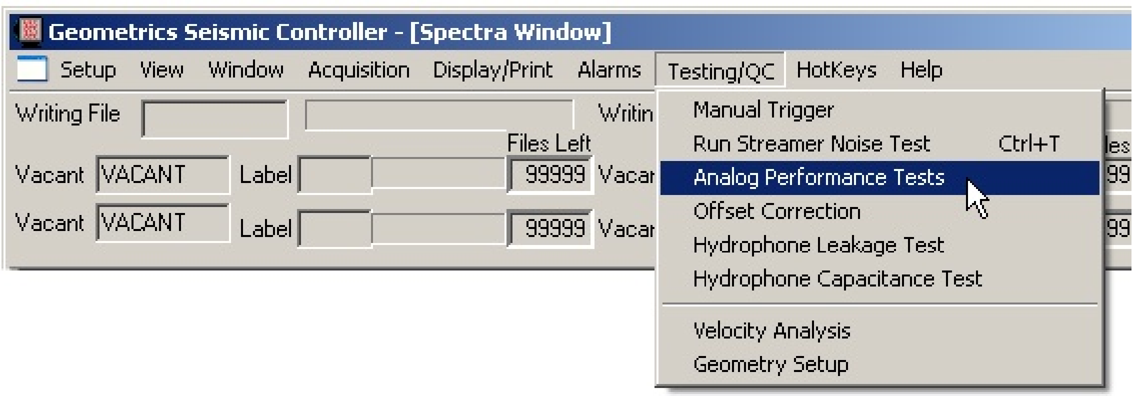
You can trigger the system at any time by simply choosing Manual Trigger in the Testing/QC menu. This can be useful in testing and troubleshooting. It is identical to a noise test, except that no noise analysis is done. The noise bar graph will be updated, but the only portion of the record it will represent will be the user-specified portion, rather than the entire record. As such, doing a manual trigger should not be a substitute for taking a noise record.

3.1.4.6.7.2 Run Streamer Noise Test (Hotkey: CTRL+T)

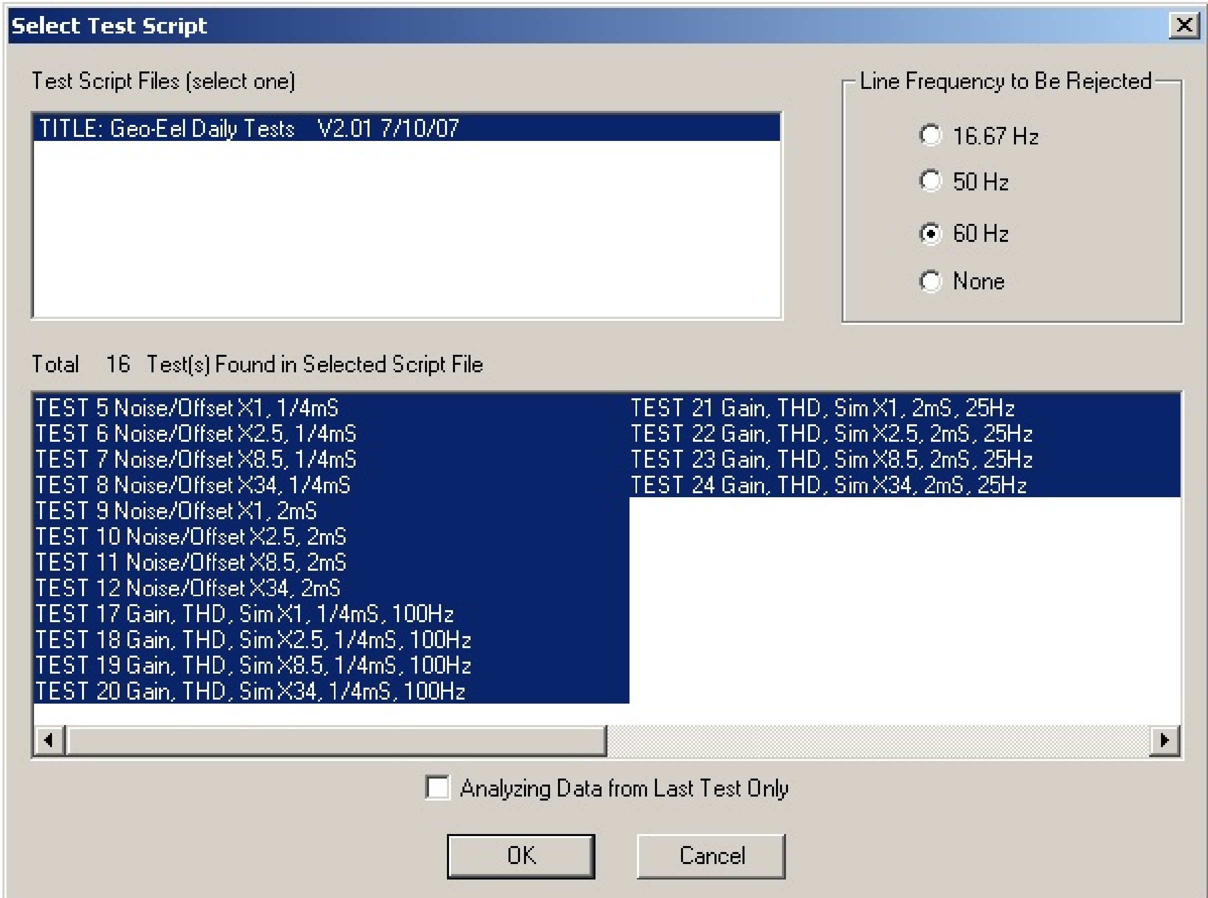


You may do a noise test at any time. It is not necessary to arm the system. The system will trigger and take a record, the noise bar graph will be updated, and a table will be created and written to the Survey Log. The noise *record* can be optionally saved, and the table, graph and noise record can be optionally printed, depending on the settings in the Noise Parameters dialog.

3.1.4.6.7.3 Analog Performance Tests



This will run the GeoEel self-test. This is a comprehensive performance test for daily, weekly or monthly use. The following dialog box will appear when Analog Performance Tests is selected:



Following is a detailed summary of the test that will be done:

1. Noise/Offset
   a. Noise
      i. Filter the first 4 harmonics of the power line frequency. (i.e. 50 or 60 Hz).
      ii. Measure the AC rms in mV. This is a time-domain rms calculation, without any filtering being applied.
      iii. Compare with Pass/Fail limit.
   b. Offset
      i. Filter the first 4 harmonics of the power line frequency. (i.e. 50 or 60 Hz)
      ii. Measure the DC offset in mV.

iii. Compare with Pass/Fail limit.

2. Gain/ THD (Total Harmonic Distortion)

   a. Gain

      i. A 100Hz, 2200mV sine wave is input into all channels.

      ii. Compare input signal to recorded signal. (Gain Accuracy).

      iii. Compare recorded signal on each channel to the average of that Digitizer's 8 channels. (Gain Similarity).

      iv. Compare with Pass/Fail limit.

   b. THD

      i. A 100Hz, 2200mV sine wave is input into all channels.

      ii. Sum together the amplitudes of the first 6 harmonics of the input signal.

         1. ***Note:*** *First 4 harmonics are summed on 30dB preamp gains.*

      iii. Compare if the ratio of the harmonics amplitudes to the fundamental is less than the Pass/Fail limit.

   c. Phase

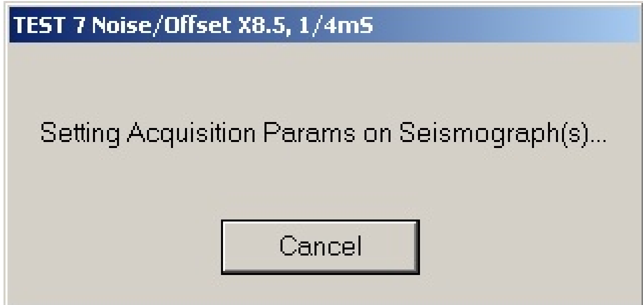
      i. Measure the phase difference between each channel and all other channels on that Digitizer (Phase Similarity). Note that the internal test oscillator does not have an absolute timing reference, so there is not internal absolute phase accuracy test. That type of test must be done with an external pulse generator.

      ii. Compare with Pass/Fail limit.

You may select the test script file to be run from the upper window, such as daily or monthly tests (only one test script is shown in the above dialog box), and select individual tests in the lower window if desired.

You may also select which line frequency is to be rejected in the test data analysis.

Data will be collected automatically, written to tape or hard disk (following the current settings in the Storage Parameters dialog), and the data analyzed. During the test, you will see the following message, which will show the progress of the test:

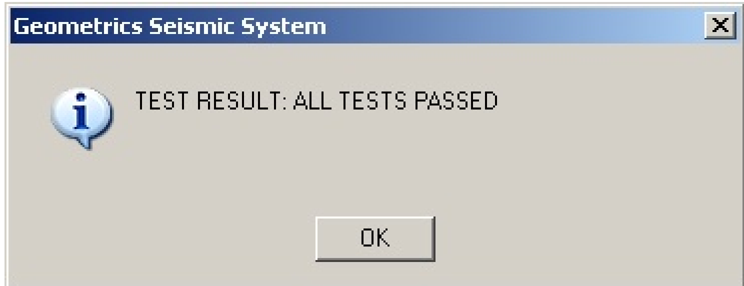


The Survey Log will document the process and identify the various test files:

```
C:\LogFiles\Test_Survey.01400E.log
!!! AUTO TEST BEGINS !!!
TEST DATA SAVED TO DISK (C:\TEST_DIR)
TITLE: Geo-Eel Daily Tests    V2.01 7/10/07
TEST 5 Noise/Offset X1, 1/4mS
File    2011 10:49:52.75 12/06/2007  428 KBytes SAVED
TEST 6 Noise/Offset X2.5, 1/4mS
File    2012 10:50:17.23 12/06/2007  428 KBytes SAVED
TEST 7 Noise/Offset X8.5, 1/4mS
File    2013 10:50:41.69 12/06/2007  428 KBytes SAVED
TEST 8 Noise/Offset X34, 1/4mS
File    2014 10:51:06.19 12/06/2007  428 KBytes SAVED
TEST 9 Noise/Offset X1, 2mS
File    2026 10:51:32.53 12/06/2007  428 KBytes SAVED
TEST 10 Noise/Offset X2.5, 2mS
File    2027 10:52:00.52 12/06/2007  428 KBytes SAVED
TEST 11 Noise/Offset X8.5, 2mS
File    2028 10:52:28.51 12/06/2007  428 KBytes SAVED
TEST 12 Noise/Offset X34, 2mS
File    2029 10:52:56.51 12/06/2007  428 KBytes SAVED
TEST 17 Gain, THD, Sim X1, 1/4mS, 100Hz
File    1011 10:53:24.39 12/06/2007  428 KBytes SAVED
TEST 18 Gain, THD, Sim X2.5, 1/4mS, 100Hz
File    1012 10:53:51.28 12/06/2007  428 KBytes SAVED
TEST 19 Gain, THD, Sim X8.5, 1/4mS, 100Hz
File    1013 10:54:18.18 12/06/2007  428 KBytes SAVED
TEST 20 Gain, THD, Sim X34, 1/4mS, 100Hz
File    1014 10:54:45.07 12/06/2007  428 KBytes SAVED
TEST 21 Gain, THD, Sim X1, 2mS, 25Hz
File    1026 10:55:13.84 12/06/2007  428 KBytes SAVED
TEST 22 Gain, THD, Sim X2.5, 2mS, 25Hz
File    1027 10:55:44.47 12/06/2007  428 KBytes SAVED
TEST 23 Gain, THD, Sim X8.5, 2mS, 25Hz
File    1028 10:56:15.10 12/06/2007  428 KBytes SAVED
TEST 24 Gain, THD, Sim X34, 2mS, 25Hz
File    1029 10:56:45.95 12/06/2007  428 KBytes SAVED
!!! DATA ACQUISITION COMPLETE !!!
```

Figure 65: Accounting of analog test files in Survey Log.

Hopefully you will see the following message when the test is completed:



Two test files are written to the Logfiles folder; LONG.RPT is comprehensive, while SHORT.RPT is a summary. A summary is also written to the Survey Log:

```
C:\LogFiles\Test_Survey.01400E.log
TEST REPORT
DATE: 06/Dec/07   TIME: 10:56:51
TOTAL 48 OUT OF 84 CHANNELS TESTED

TITLE: Geo-Eel Daily Tests    V2.01 7/10/07

TEST 5 Noise/Offset X1, 1/4mS

FILE 2011
File    2011 10:49:52.00 12/06/2007
DC OFFSET SPECIFICATION [ < 1.000000 mV ]                    PASSED
AC RMS SPECIFICATION [ < 0.037500 mV ]                      PASSED

TEST 6 Noise/Offset X2.5, 1/4mS

FILE 2012
File    2012 10:50:17.00 12/06/2007
DC OFFSET SPECIFICATION [ < 0.400000 mV ]                    PASSED
AC RMS SPECIFICATION [ < 0.016000 mV ]                      PASSED

TEST 7 Noise/Offset X8.5, 1/4mS

FILE 2013
File    2013 10:50:41.00 12/06/2007
DC OFFSET SPECIFICATION [ < 0.120000 mV ]                    PASSED
AC RMS SPECIFICATION [ < 0.004500 mV ]                      PASSED

TEST 8 Noise/Offset X34, 1/4mS

FILE 2014
File    2014 10:51:06.00 12/06/2007
DC OFFSET SPECIFICATION [ < 0.035000 mV ]                    PASSED
AC RMS SPECIFICATION [ < 0.001400 mV ]                      PASSED

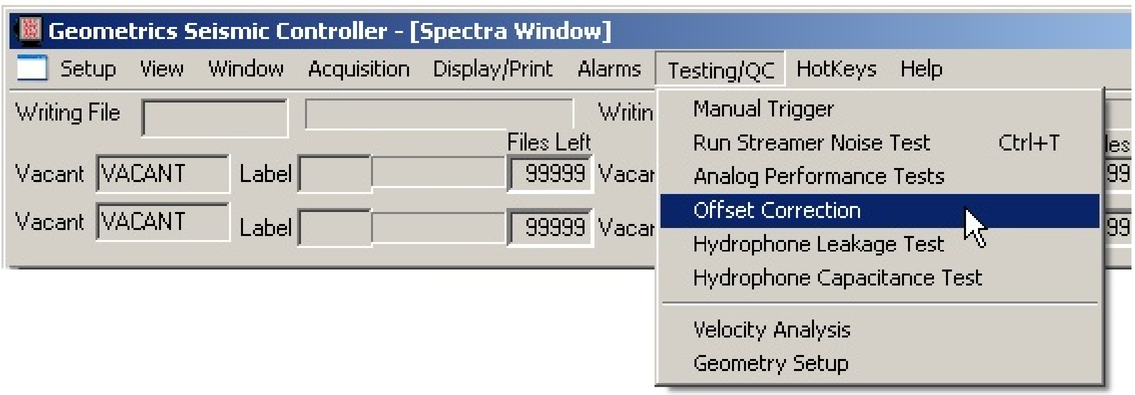
TEST 9 Noise/Offset X1, 2mS
```

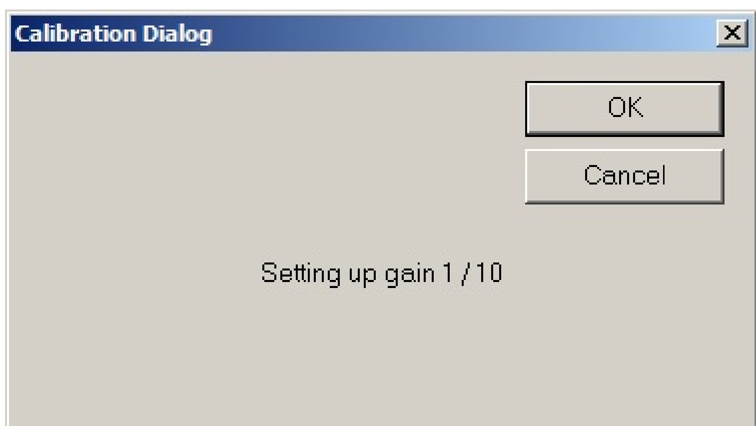
Figure 66: Short form analog test results written to Survey Log.

See examples of short- and long-form reports in the Appendix.

3.1.4.6.7.4 Offset Correction

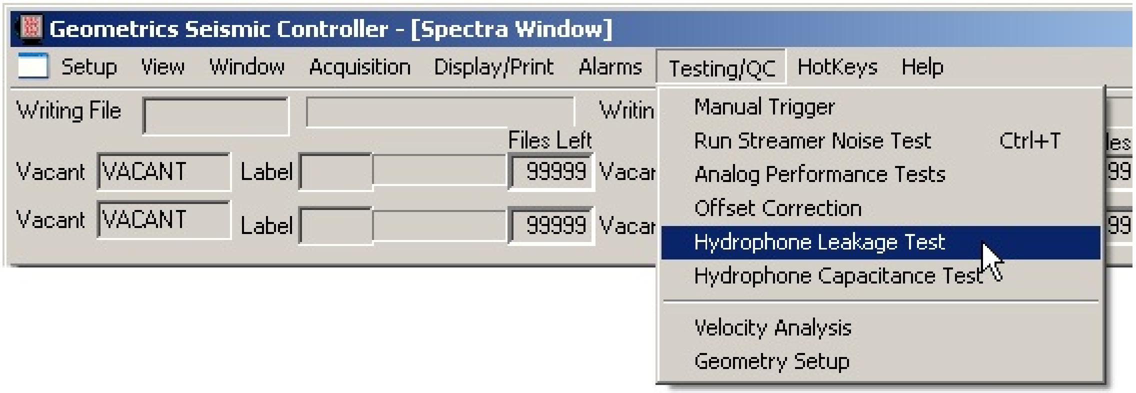
This function measures and corrects for the DC offset on each channel. About 30 seconds are required to perform the correction. You will see the following message while the test is being conducted:





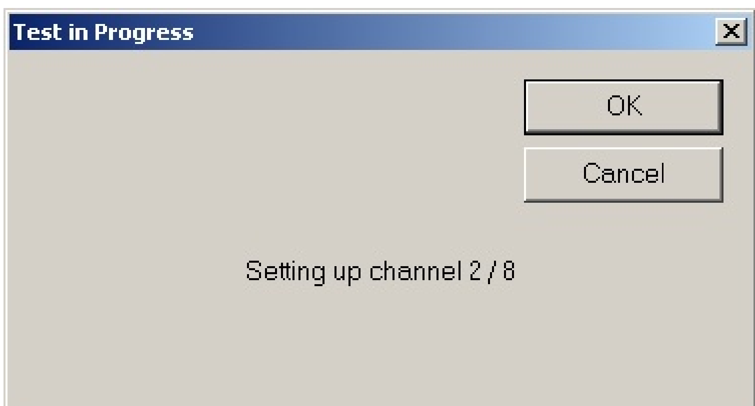
This correction should be performed after the temperature of the Digitizers has stabilized, or whenever DC offsets are suspected to be too large. You may be prompted after certain actions, such as arming the system or starting a new line, to run an offset correction.

3.1.4.6.7.5 Hydrophone Leakage Test



Note: *You should do an* Offset Correction *prior to running a* Hydrophone Leakage Test*; otherwise, the measured leakage values may be erroneous.*

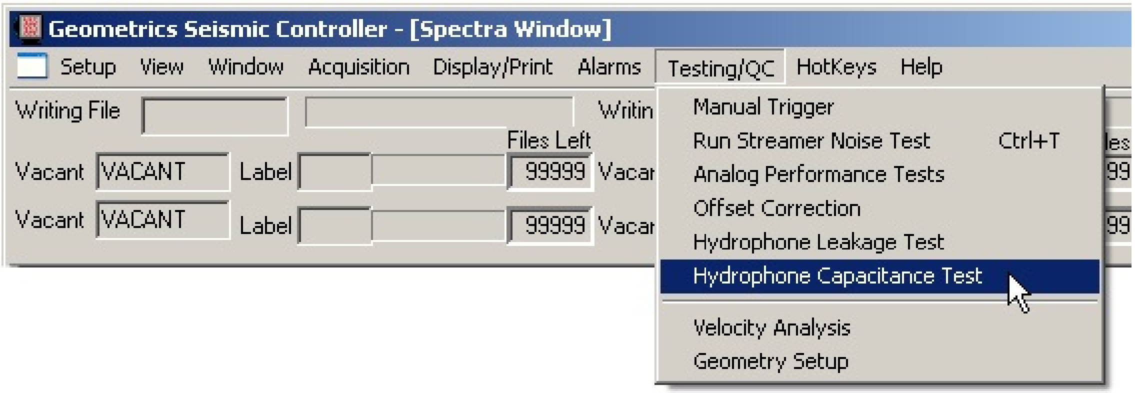
The Hydrophone Leakage Test performs a resistance test across the analog inputs. The following message will be displayed while the test is running:



The results of the test will be reported in the Logfiles folder, using the survey name, followed by the line number, and "LeakTest.htm". A sample report is shown in the Appendix.

Note: *You should not expect all resistances to be identical. What you see in the sample report in the Appendix is normal variation, due to variations in resistor values on the front ends of the analog inputs. We do not hold these resistor values to the tolerances necessary to accurately measure high values of resistance in parallel with the input resistance of the modules. The intention of the leakage test is to detect* ***anomalies.*** *It is not intended to accurately measure whether the resistance is 12 kOhm or 10 kOhm, but rather to help troubleshoot a section or Digitizer if a channel seems to be consistently recording bad data. An anomalous resistance does not necessarily mean the channel is bad, but if you do have a bad channel, an anomalous resistance may yield clues as to why. The pass/fail limit for this test is set to 1000 kOhm.*

3.1.4.6.7.6 Hydrophone Capacitance Test

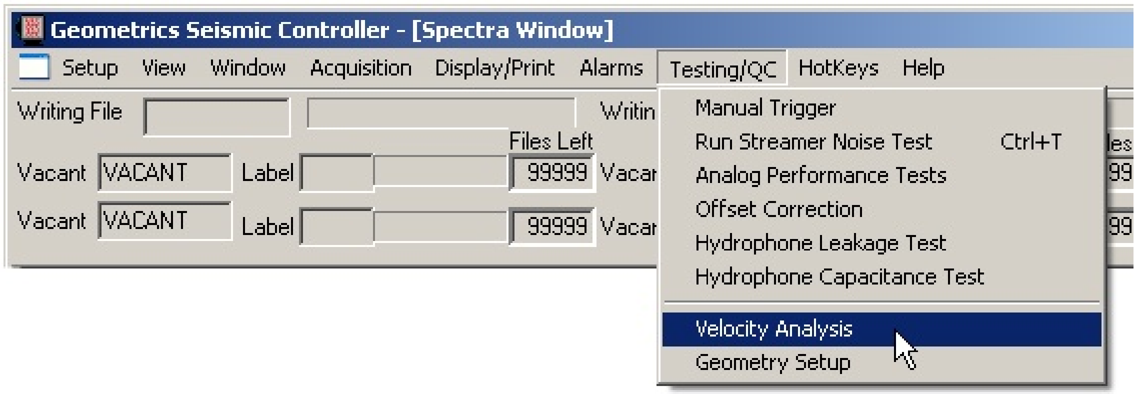


The Hydrophone Capacitance Test will perform a capacitance measurement across the analog inputs of each channel and compare the result to the expected capacitance, which is calculated on the basis of the Native Group Interval and Hydrophone model indicated in the GeoEel Configuration menu. The results of the test will be reported in the Logfiles folder, using the survey name, followed by the line number, and "CapTest.htm". A sample report is shown in the Appendix.

Note: *The purpose of this test is to detect bad or disconnected hydrophones in each group. If you are using a liquid GeoEel, which contains hydrophones manufactured by Titan/Benthos, it is a rather crude test, based on the knowledge of the number of hydrophones per group and the capacitance of each hydrophone. Theoretically, we know what the capacitance of the hydrophone group should be, because we know the capacitance of each hydrophone. In reality, however, the capacitance of each Titan/Benthos hydrophone can vary by up to ± 20%. For this reason, you will likely notice a significant channel-to-channel capacitance variation in the capacitance report, even if there are no problems with the Streamer. This is normal and should be expected. What you should* ***not*** *see are marked changes in capacitance on any given channel over time. For this reason, it is a good idea to do a capacitance test of each Active Section upon delivery of your Streamer and keep it as a reference. You should annotate the report with the serial numbers of the Active Sections, since these are not automatically detected or reported by the test. Capacitance tests should be conducted periodically and compared to this "standard". If you are using a solid GeoEel, the hydrophones are of Geometrics manufacture and the capacitance is better controlled. But the same advice applies – measure the baseline capacitance prior to your first survey and keep it as a record.*

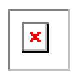
3.1.4.6.7.7 Velocity Analysis

This item applies only when you are doing a brute stack. See the Appendix for a complete discussion.

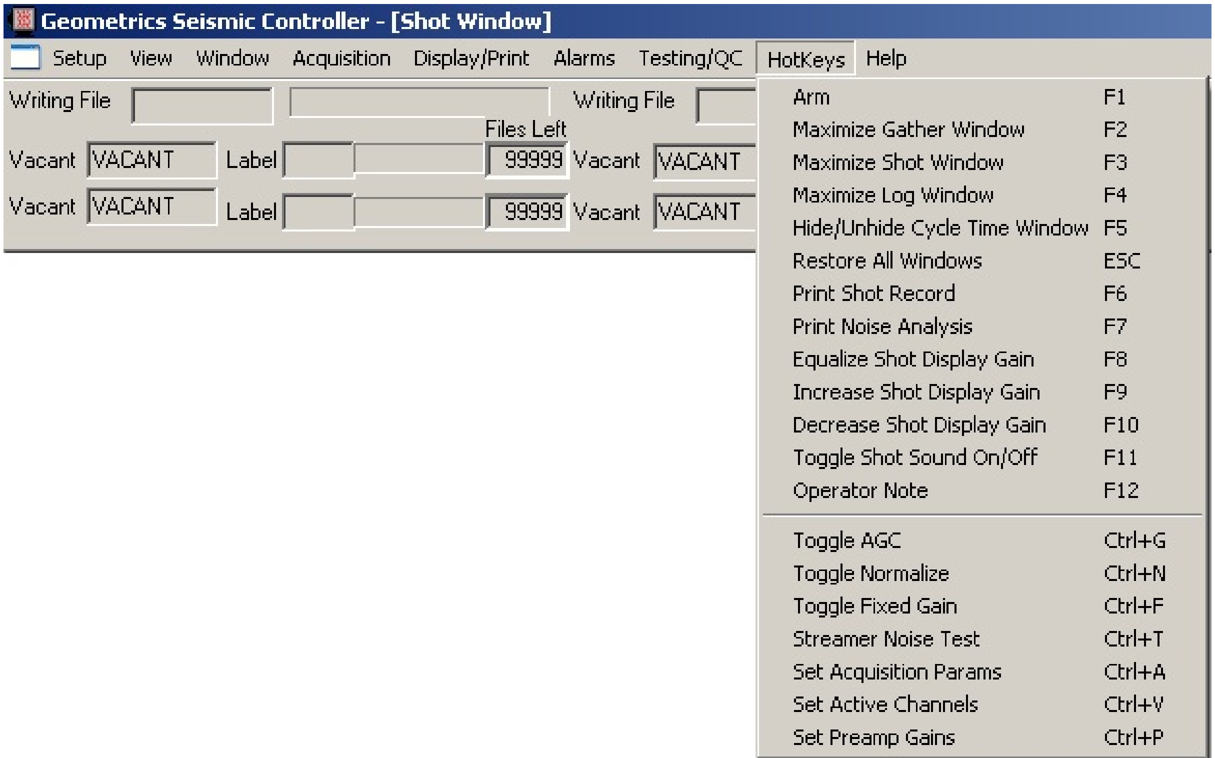


3.1.4.6.7.8 Geometry Setup

This item applies only when you are doing a real time brute stack. See the Appendix for a complete discussion.



3.1.4.6.8 Hotkeys Menu



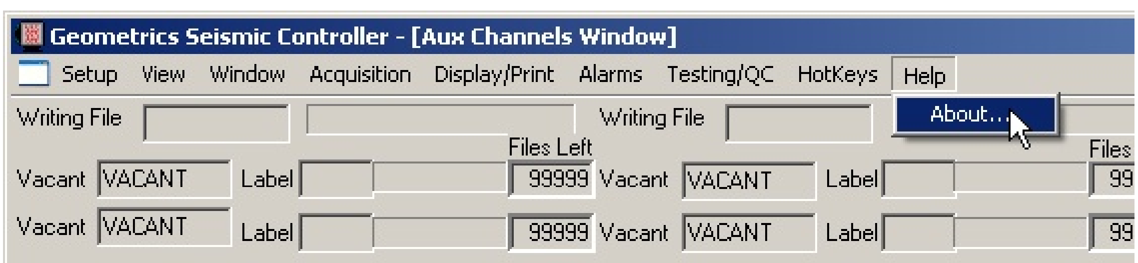
The CNT-2 Marine Controller offers many convenient “Hotkeys” that are worth memorizing and/or printing out for easy access. The functions of most of those shown in the menu above are self-evident; however some pointers are useful:

- The **F1** key is actually a toggle switch; it toggles between ARM and DISARM.
- The **ESC** key restores the view to your normal layout after you have maximized the gather, shot or log windows.
- **Equalize Shot Display Gain** applies only in fixed gain mode; when pressed, all display gains will be set to that of channel 1.
- Increasing or decreasing the display gains will change them by 3 dB per click (if in fixed gain mode) or by a Trace Overlap of 1 (if in AGC or normalize mode).
- The CNT-2 Controller will beep each time the system triggers. You may toggle this feature using the **F11** key.
- Pressing the **F12** key brings up the following dialog box:

Figure 67: Operator note entry box.

You may type in a time-stamped note of 80 characters, and it will be written to the Survey Log.

3.1.4.6.9 Help Menu



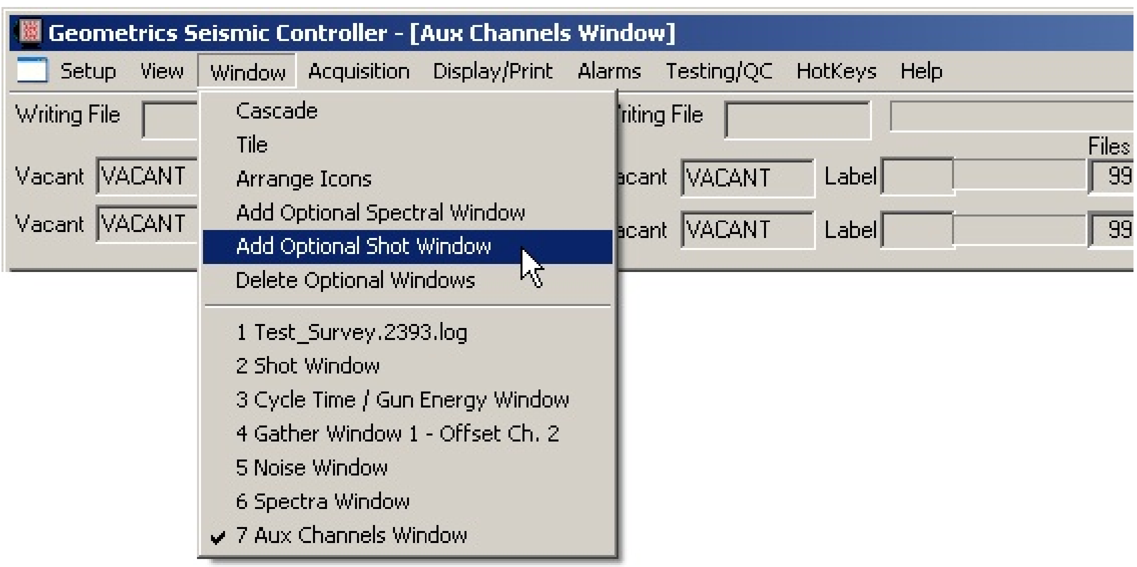
Clicking on Help>>About will display the above splash screen, which displays the software version and support details.

3.1.4.7 Other Program Features

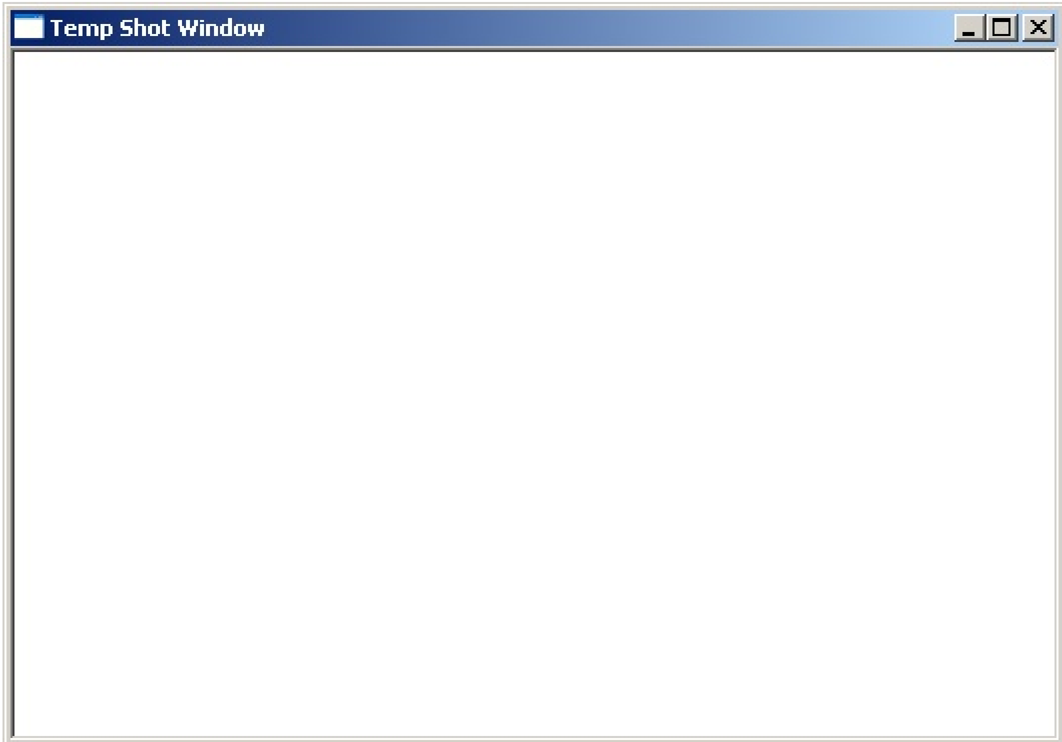
3.1.4.7.1 Optional Windows

You may open multiple Shot and Spectra windows. For instance, you may have one Spectra window focused on the shallower portion of the record, and another focused on the deeper portion. Multiple Shot windows can be used to break up a record into different time chunks or to display filter panels.

To open an Optional Shot window, open the Window menu and choose Add Optional Shot Window:



A blank Shot window will appear:



The data from the next shot will be displayed when the system triggers.

You may open up to seven separate Shot windows, and set the display parameters differently in each. For instance, you might display the entire record in one panel, and then break the record up into three different time chunks to better see the data:

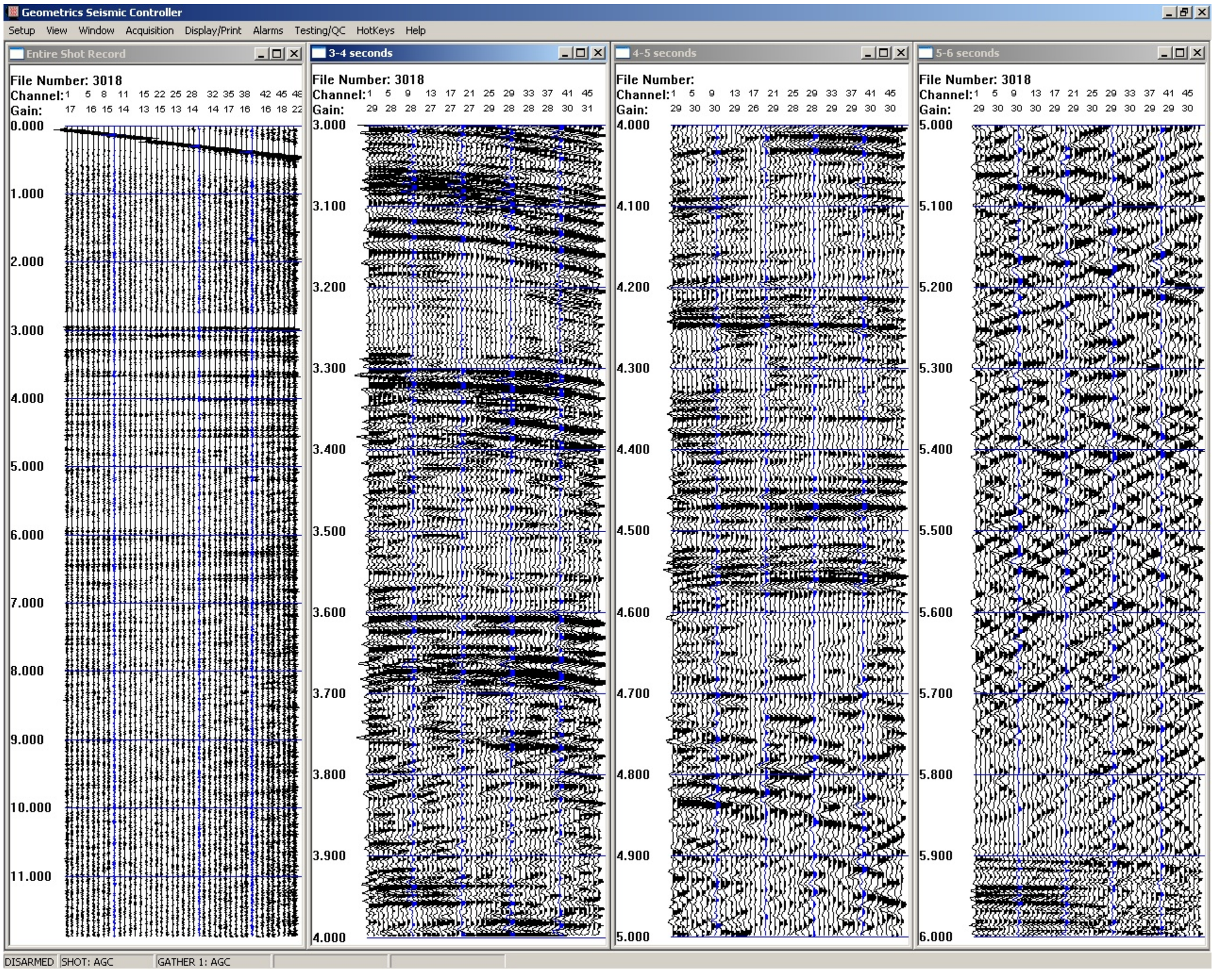
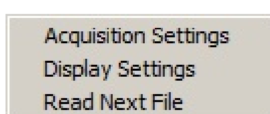


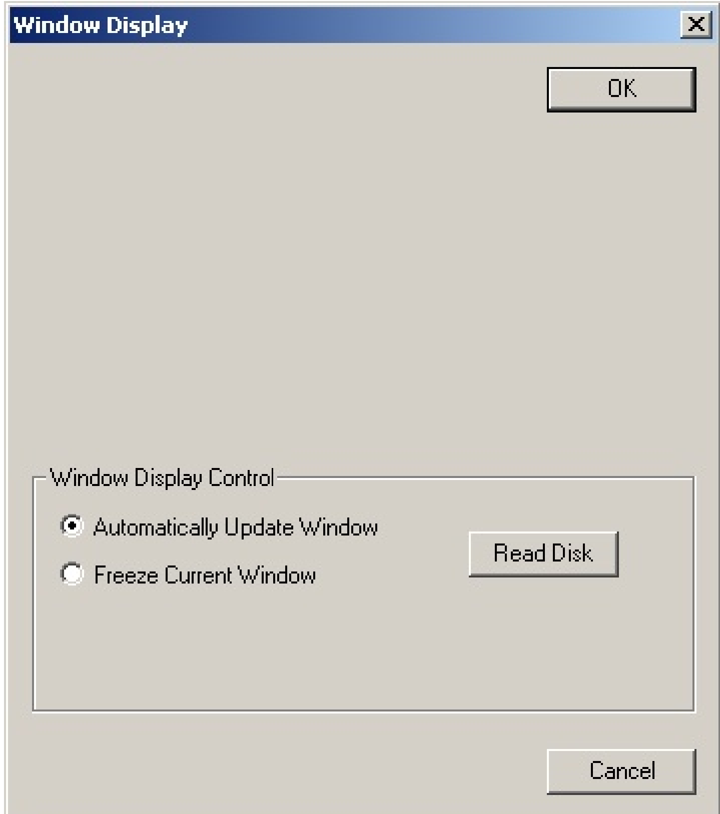
Figure 68: Multiple shot display showing shot record in entirety and in segments.

The figure above shows a 12-second record (left) and three separate but time-contiguous windows (left to right) of 1 second each.

Right-clicking in any Optional Shot window will display the following menu:

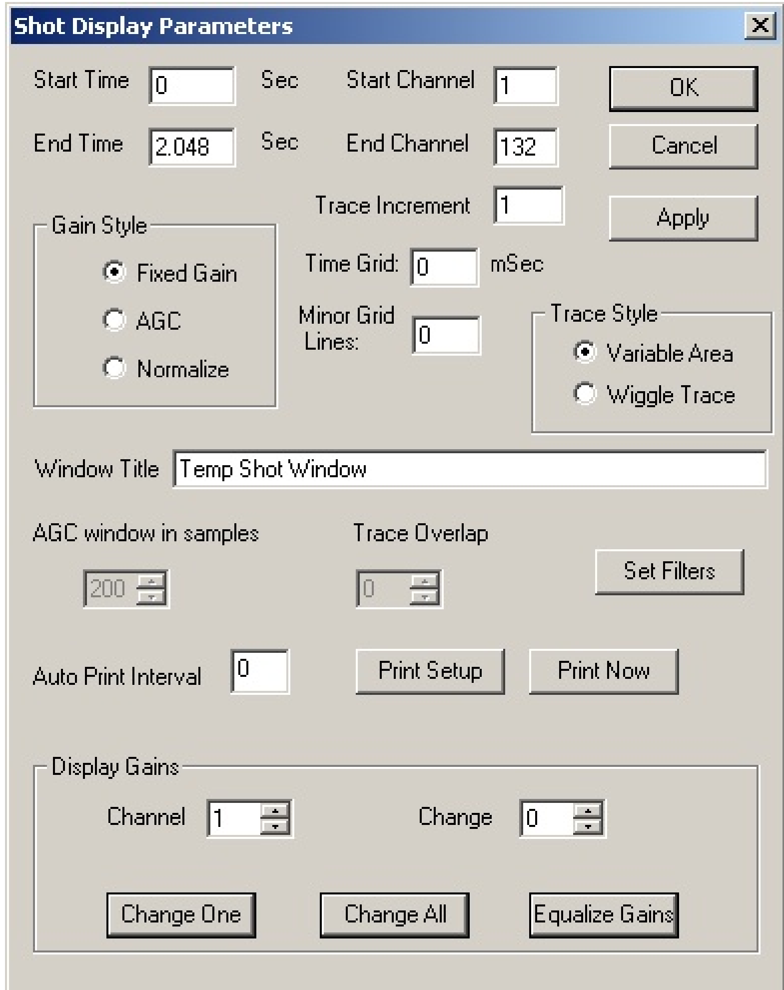


Choosing Acquisition Settings will bring up the following dialog:



If you click the Automatically Update Window radio button, this window will operate like the main shot display window. If you choose Freeze Current Window, it will no longer update the display after each shot, but will instead continue to display whatever data were there when freeze was chosen.

Choosing Display Settings will bring up the normal Shot Display Parameters dialog box:



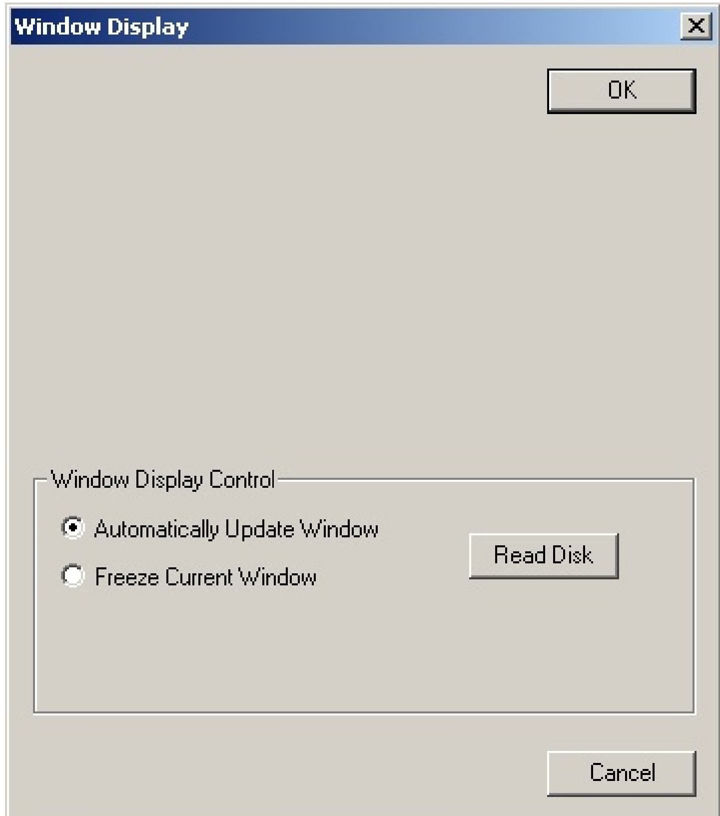
Whatever you type in for Window Title will be displayed at the top of the Optional Shot window. Each Optional Shot window can be given a unique descriptive name.

Note: *Parameters set in this dialog will apply to this specific Shot window only; you must set parameters separately for each Shot window.*

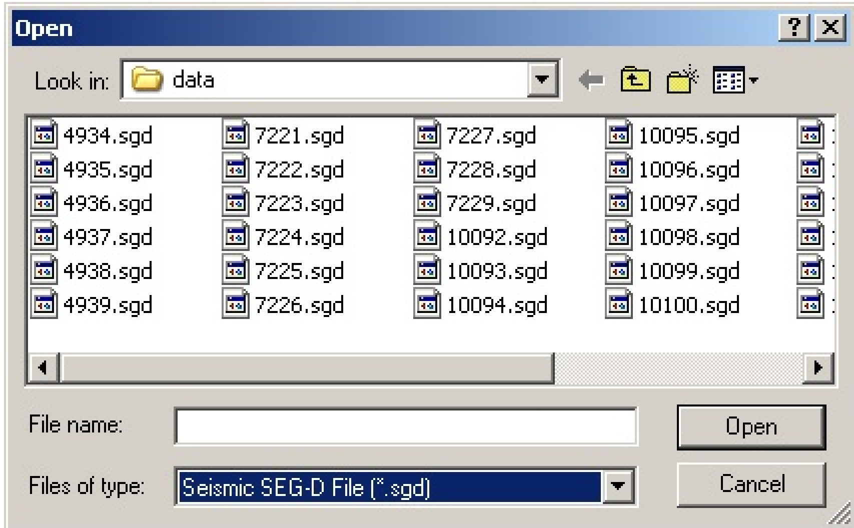
Choosing Read Next File will read the next file number.

3.1.4.7.2 Reading in a Shot Record

On any Optional Shot window, right-click and choose Acquisition Settings to bring up the following dialog:



Press the **Read Disk** button:



Choose the path and file name of the shot record you'd like to read in and display. Once a record has been read in, the display parameters may be adjusted in the same way as those for a new record.

Note: *This feature may only be used to read data from disk, not from tape. To read and display data from tape, see the section on the Tape Utility.*

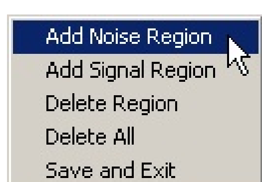
Note: *Also see here.*

3.1.4.7.3 Defining the Noise and Signal Regions

In order to make effective use of the real-time noise monitor, you must define a portion of the record that is dominated by noise. Usually, if the water is deep enough, the best place for this is between the first breaks and the water bottom reflection.

On the **main** Shot window, right-click to bring up the following menu:

Choose Edit Noise Regions, then *right-click again*:



Add Noise Region. Define a polygon around the portion of the record you wish the noise to be calculated from by left-clicking on the vertices. The polygon may have up to 10 vertices, and multiple polygons may be drawn. Be sure to close the polygon by re-clicking on the first vertex:

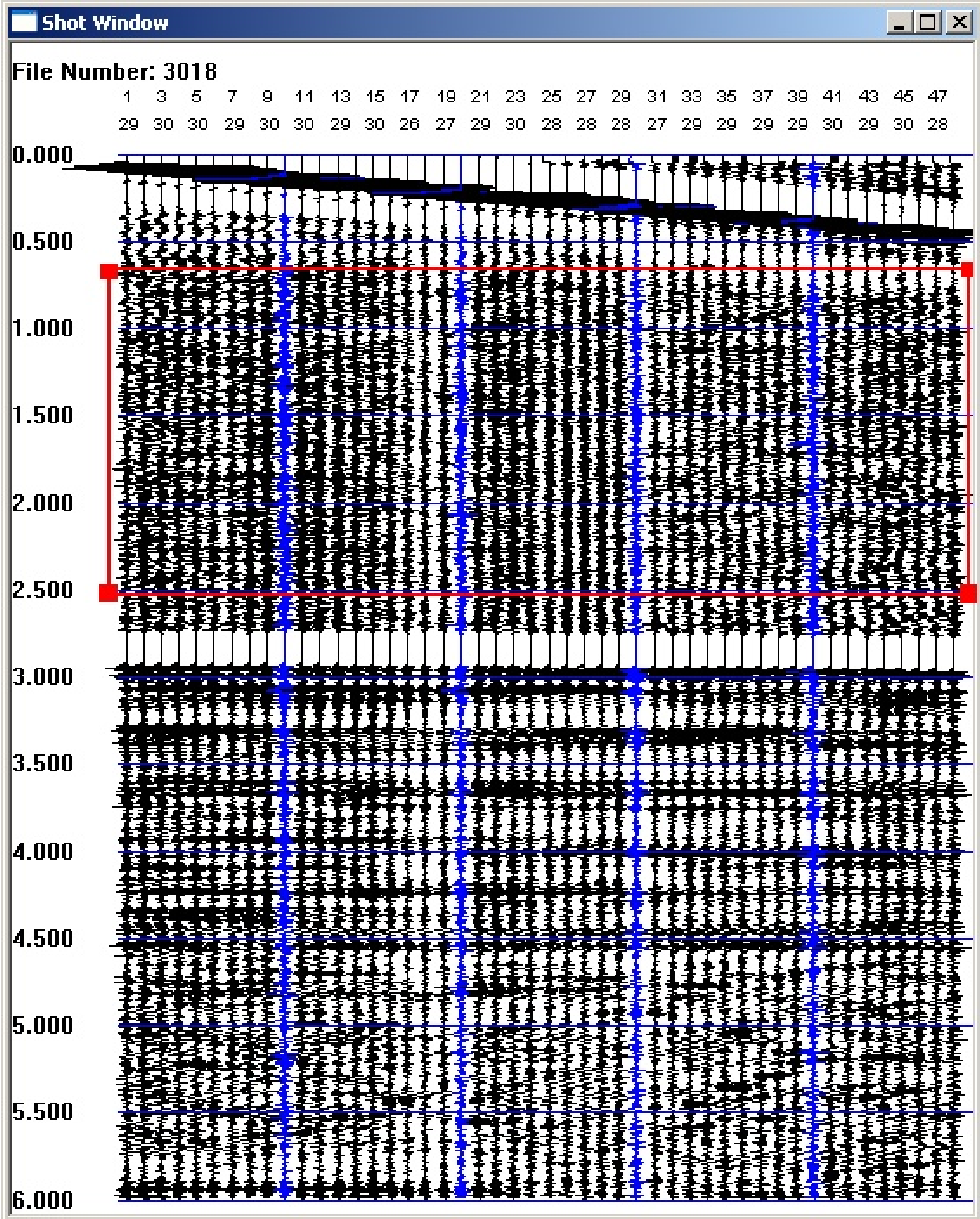


Figure 69: Defining the noise region in a shot record.

In the record above, the region selected for noise calculation after each shot is the zone between the first break and the water bottom reflection. Each time a record comes in, the rms amplitude of each channel will be calculated within this time window and the noise bar graph will be updated:

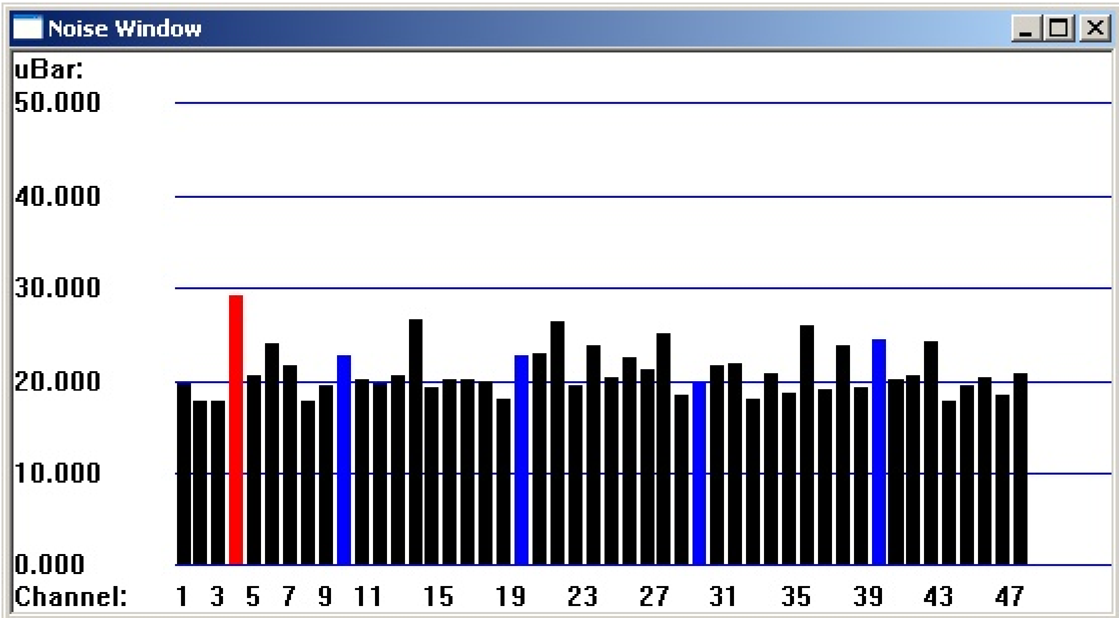


Figure 70: Bar graph showing rms amplitudes calculated in user-defined noise region between first breaks and water-bottom reflection.

If you use the region between the first breaks and the water-bottom reflection to calculate the noise, the position of the defined noise region may need to be adjusted periodically if the water depth changes significantly. Including the water-bottom reflection within the noise region will result in erroneously high noise calculations.

If you have enough offset, it might be better to calculate the noise in the region before the first breaks:

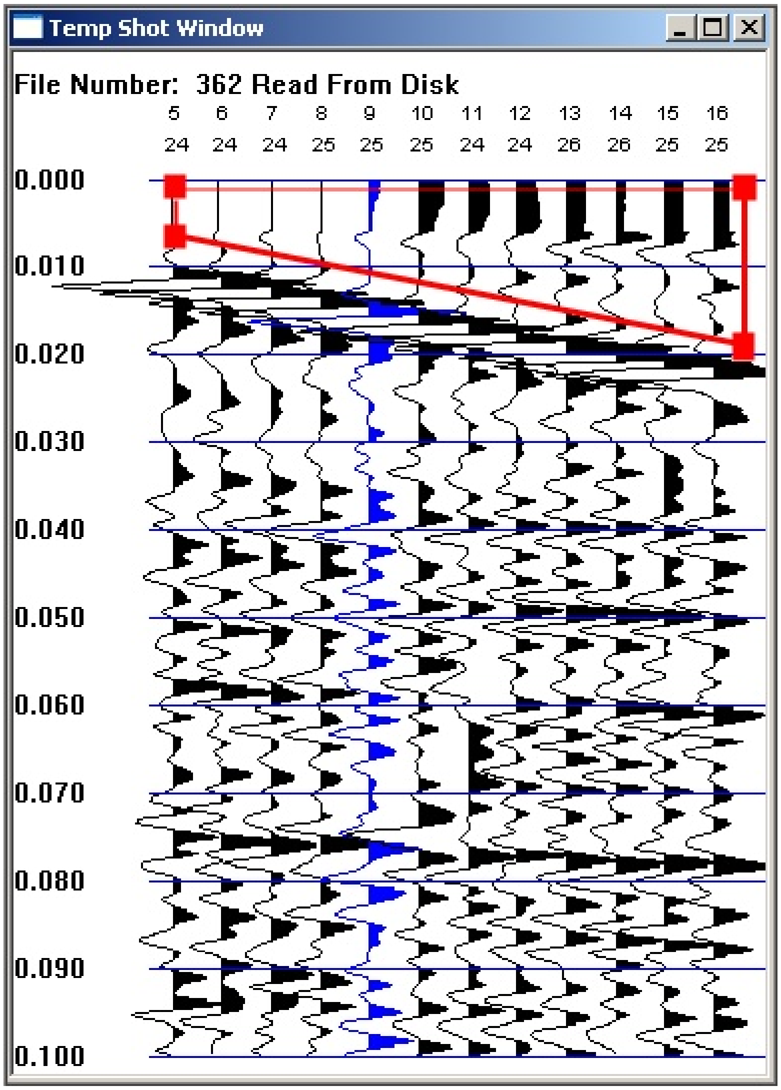
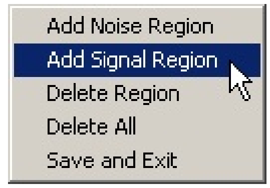


Figure 71: Bar graph showing rms amplitudes calculated in user-defined noise region prior to the first-arrivals.

If you wish to calculate a signal-to-noise ratio, choose Add Signal Region and define it in the same way:


Add Noise Region
Add Signal Region
Delete Region
Delete All
Save and Exit

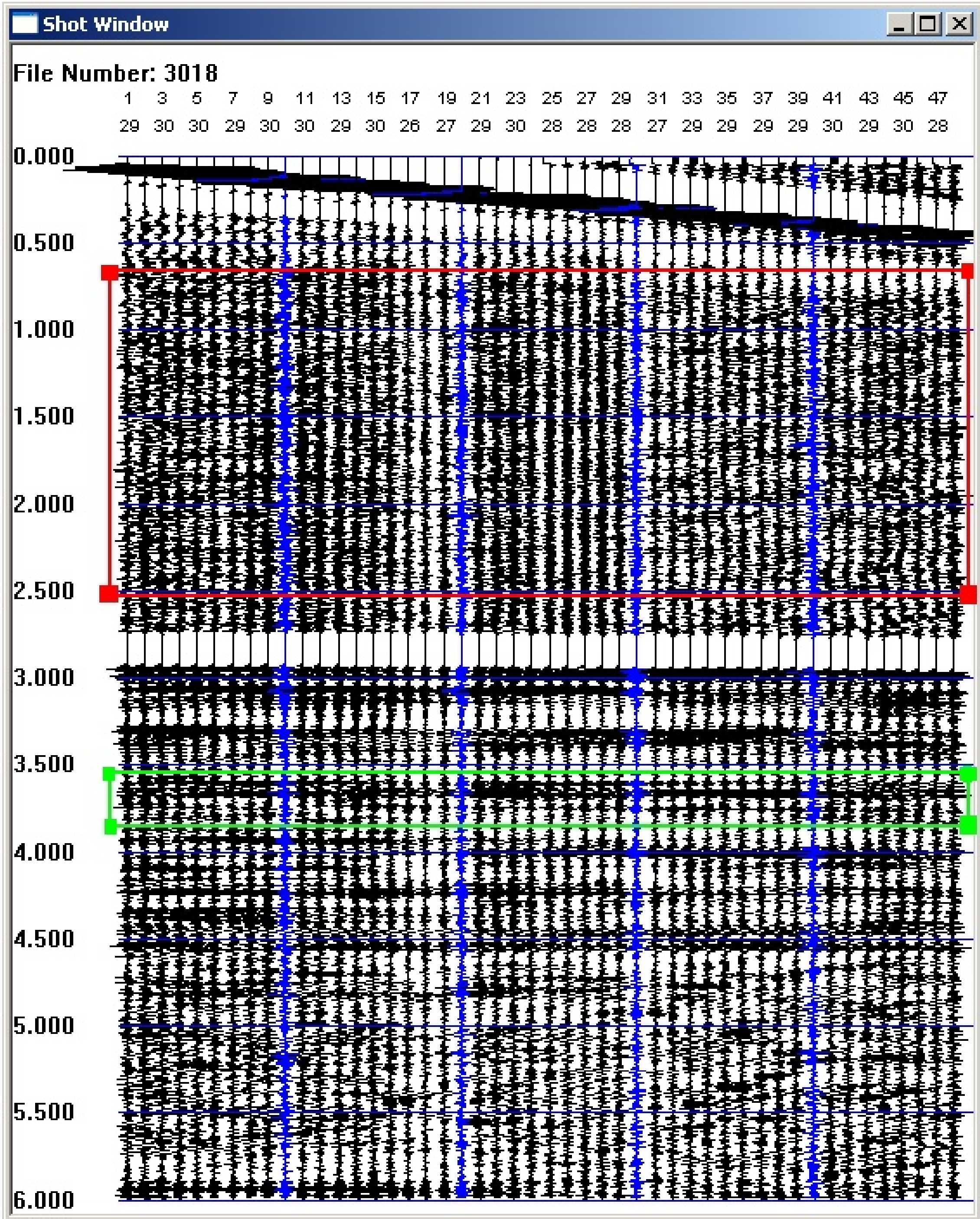


Figure 72: Defining the signal region in a shot record.

Note: *Do not overlap noise and signal polygons.*

To plot the signal-to-noise ratio, open the Noise Display Parameters dialog and check the Plot SNR box:

The noise bar graph will plot the ratio of the rms amplitude in the signal polygon to the rms amplitude in the noise polygon for each channel.

To delete a previously-defined signal or noise region, highlight the region in question, right-click and choose Delete Region:

To delete all previously-defined noise and signal regions, right-click and choose Delete All:

Note that changes made in the mode will only be preserved when you choose Save and Exit (which is the only way to exit this mode).

3.1.4.7.4 Depth Sensors

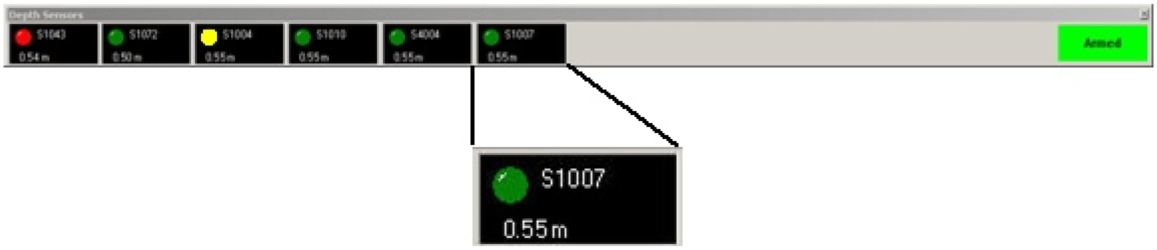


Figure 73: Depth sensor output display.

If you have entered the depth sensor serial numbers in the GeoEel Configure menu, you will see the above depth sensor display. The output of each sensor is in order from left to right, according to the order they were entered in the Configure menu. If they were entered as directed, the far left box will display the output of the sensor nearest the vessel. The depth sensor display can be placed at the bottom, top, or either side of the screen, depending on your preference.

Each box displays a colored circle indicating the sensor status. Green means the sensor is functioning. Red means no signal has been received from that sensor in the time expected, and may indicate a malfunction. Yellow indicates that the sensor has reported a depth that is outside the min/max set in the Geometry Setup menu.

In addition to depth sensor output, the ready status of the GeoEel will be displayed on the far right.

Depths will be logged in a file called [drive]:\Logfiles*[Survey_Name.Line_Number]*.depth.txt. An example Depth Log can be viewed here.

3.2 GeoEel Tester Utility

The GeoEel Tester program, designed primarily for the P-Cable, is designed to make tracking down leakage and faulty components easier. The program can be exercised in a more repetitive manner than running various functions using the GeoEel Controller, as components can be switched on and off individually. It also includes useful utilities, like resetting Digitizers and assigning new IP addresses.

Some necessary functions are not performed automatically. As an example, saving the Switch list to the registry after running **Determine Switch Order** requires confirmation. This is because the tool *does not assume that the result of the function is correct.* For instance, perhaps there are 8 Switches and only seven were found. If a Switch isn't found for some reason, the software has no idea of its existence. The operator must confirm the result and decide whether to save the configuration.

Because this tool allows the disabling of various functions and cutting power to components, care must be taken when using it. It is possible to leave the system in a state in which further operation of the system will be impaired if it is forgotten that this occurred.

Some functions take time to execute. For instance, the power up of all Switches takes several minutes. A Digitizer requires about 40 seconds to completely boot. The system can become unstable if the operator tries to connect to components while they are still booting. The operator must carefully observe the current fluctuations on the Deck Unit. Once the current has stabilized at the correct value, the system is ready. THIS MAY TAKE SEVERAL MINUTES.

YOU SHOULD FAMILIARIZE YOURSELF WITH THIS PROGRAM WITH A KNOWN GOOD SYSTEM BEFORE USING IT TO TROUBLESHOOT.

The executed commands are stored in the file C:\Geometrics\GeoEel\GeoEel Tester.log. This file is never overwritten by the program. You can save different versions by renaming the file, and a new one will be started. This file can be very useful, particularly if you contact Geometrics for support, because it gives a complete record of what you have tried and what the results were.

Some review of the GeoEel/P-Cable nomenclature and network conventions will be helpful before we discuss the capabilities of the GeoEel Tester.

Note: *The P-Cable components communicate via Ethernet. If you intend to connect the system to the ship's or any other network, you may experience IP address conflicts. Please contact Geometrics well ahead of time if you intend to connect the system to an existing network.*

- The terms "Streamer", "GeoEel", "Section" and "Digitizer" are used somewhat interchangeably in the context of troubleshooting. Likewise "Junction Box" and "Switch".

- The GeoEel Controller PC and the Deck Unit are on the .1 subnet (this is the third number in the IP address). Their addresses are set at the factory to 192.168.**1**.1 and 192.168.**1**.2, respectively (if you are supplying your own Controller PC, you must set its IP address to 192.168.1.1).

- All Digitizers are also on the .1 subnet. Their IP addresses are set either automatically by the **Detect Sections** command in the GeoEel Controller (the safest but more time-consuming method), or manually using the GeoEel Tester program (faster, but you must be careful to set it correctly). Digitizer #1 (closest topologically to Deck Unit) must be set to 192.168.1.3, #2 to 192.168.1.4, and so on. *This order is crucial, as it determines the numbering of the channels.* If the **Detect Sections** command in the GeoEel Controller is used to assign the IP addresses, this is done automatically, and there is less chance of error.

- The **Reset** command in the GeoEel Controller and in the GeoEel Tester tool resets the IP addresses of all of the Digitizers to 192.168.1.254. This is the IP address that the **Detect Sections** command searches for when assigning IP addresses. The **Detect Sections** command will ignore anything without this IP address. For instance, if for some reason the **Reset** command fails to reset a Digitizer, that Digitizer's IP address will not be set correctly by the **Detect Sections** command. It is therefore important to ensure a successful reset prior to running the **Detect Sections** command. This can be done using a program like IP Inspector or by pinging the previous IP addresses and making sure none of them respond.

- Digitizers are numbered according to their order on the Cross Cable. The Digitizer closest to the Signal Cable (192.168.1.3) is referred to as Digitizer #1. Digitizer #2 (192.168.1.4) is next in line, and so on.

- A schematic of a Cross Cable Junction Box (or Switch) is displayed below. Only those items pertinent to troubleshooting are shown. Each Junction Box includes a multi-port Ethernet switch, a depth sensor, and an optional digital compass. Each Junction Box includes trigger in/out, power in/out, and network in/out. In addition, there are switches that enable/disable the network connection to the Streamer, that disable the trigger to the rest of the array, and that control power to the associated Streamer (3) and, separately, to the rest of the array (4).

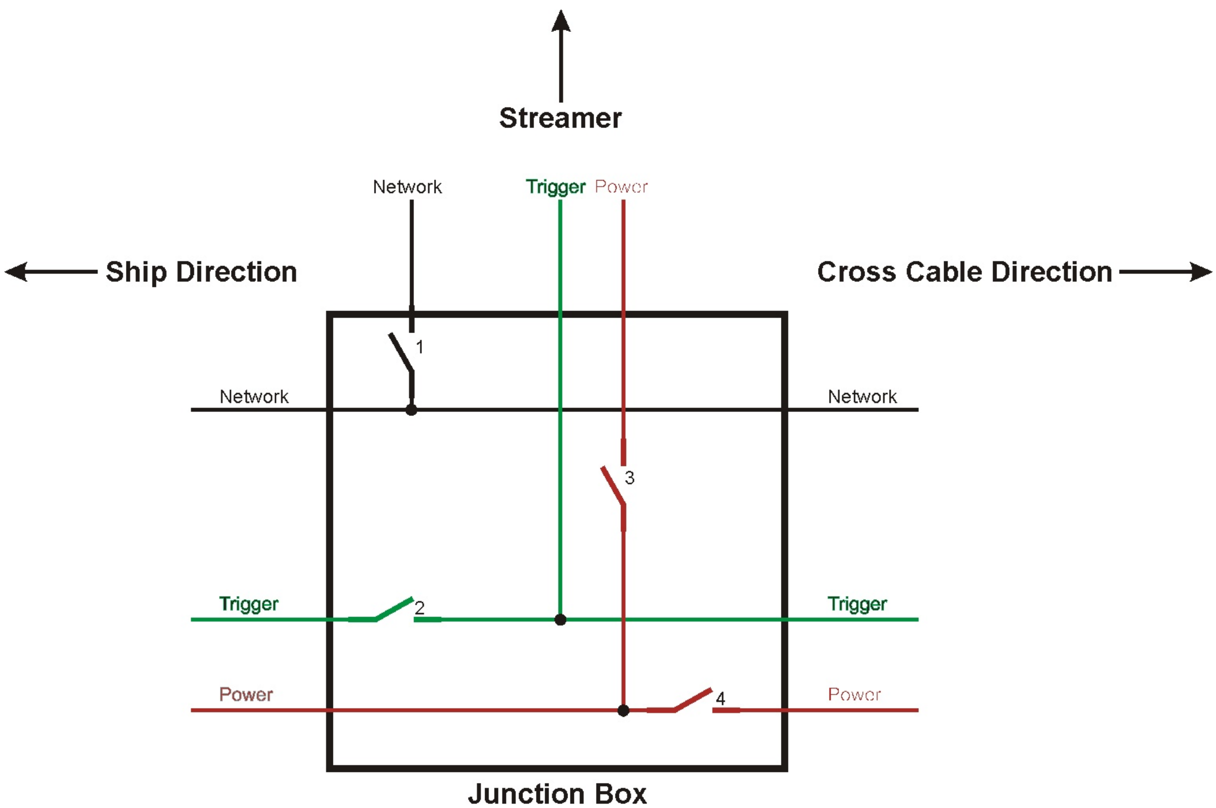


Figure 74: Schematic of switches in P-Cable Junction Box.

- The Junction Boxes are on the .2 subnet. Their IP addresses are set at the factory and are based on their serial numbers, which you can find stamped on the outside of the Junction Boxes. The last two digits of their IP address is the serial number minus 7100. For instance, a Junction Box with serial number 7137 has an IP address of 192.168.2.37.

- The Junction Boxes do not need to be on the Cross Cable in any particular order, and there is never any reason to change their IP addresses (although see comment above about connecting to existing networks). However, *it is important that the order be known by the software*. This is achieved either by manually entering the Junction Box serial numbers in the GeoEel Configuration dialog (the hard way), or using the **Determine Switch Order** command to interrogate the Junction Boxes for their serial numbers and then writing them to the registry (the easy way, and less prone to error). If Geometrics supplies the GeoEel Controller PC, which is highly recommended, this should already be set up correctly.

- By convention, Junction Boxes are numbered according to their order on the Cross Cable. The Junction Box closest to the Signal Cable is referred to as Junction Box #1.

- If the outputs of the depth sensors are to be logged by the GeoEel Controller, their serial numbers must be entered in the GeoEel Configuration menu. These are the same as the serial numbers of the Junction Boxes themselves, so they can simply be cut and pasted from the Junction Box serial number list in the same dialog. If the depths are being logged by a third-party system, such as Navpoint Trawler, they need not be visible to the GeoEel Controller, and, in fact, probably will not be, due to communication protocol conflicts (UDP vs. TCP). In this case there is no need to enter this information in the GeoEel Controller.

- The Tail Modules are on the .2 subnet. They are similar to the Junction Boxes in that their IP address is set at the factory, their order on the Cross Cable is not important, and there should be no need to change their IP addresses, which are set to the serial number minus 8000. These also contain a depth sensor and optional compass. Like the Junction Boxes, the GeoEel Controller only needs to know their order if the depths are to be logged by the GeoEel Controller.

- As of this writing, the GeoEel Controller software does not communicate with the digital compasses. These are utilized only by NavPoint Trawler.

The above is summarized in the schematic of a 6-Streamer P-Cable array shown below:

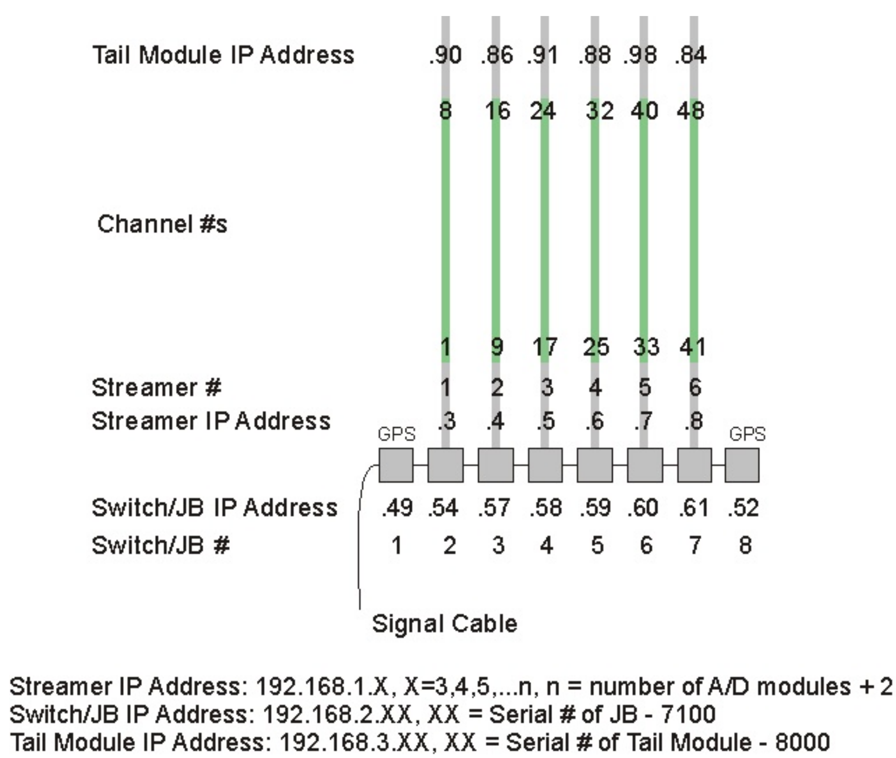
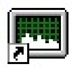
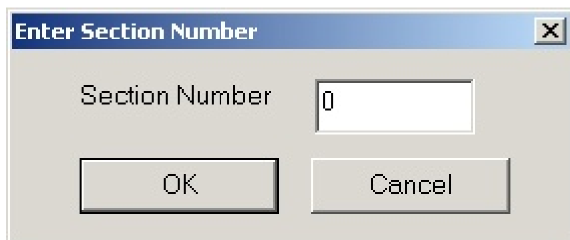


Figure 75: Schematic of P-Cable array showing IP addressing conventions.

The GeoEel Tester tool is organized into two broad categories: commands that communicate with Digitizers and commands that communicate with Switches. The section focused on Switches also includes Digitizer and Switch groupings to facilitate deployment and leakage isolation. We will focus on the Digitizers section first.

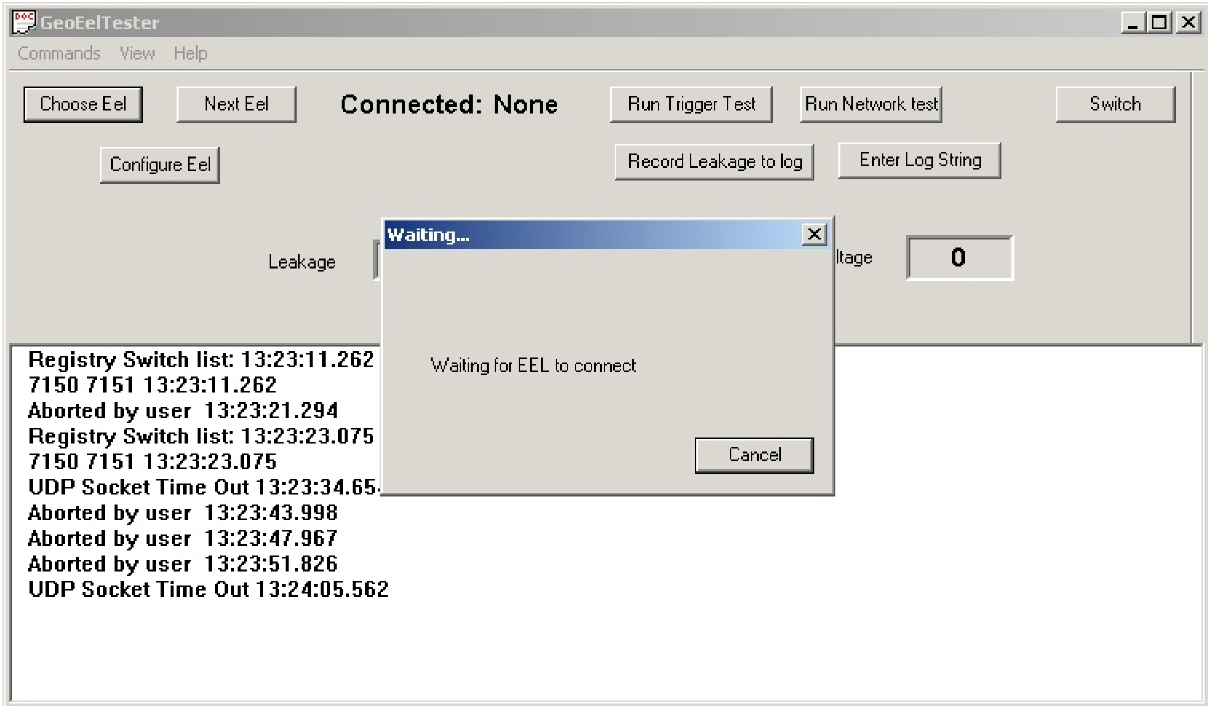
3.2.1 Digitizer Tests

Run the GeoEel Tester  program and the following dialog will appear:



If you would like to connect to and communicate with a particular section's Digitizer, enter its number (NOT its IP address) here. Section Number "0" refers to a Digitizer that has been reset and has an IP address of 192.168.1.254. As explained above, the sections are numbered 1, 2, 3, and so forth, according to their order on the Cross Cable. If you press the **Cancel** button, the program will not attempt to connect to a Digitizer yet. This is useful if you wish to perform functions relating to the Junction Boxes.

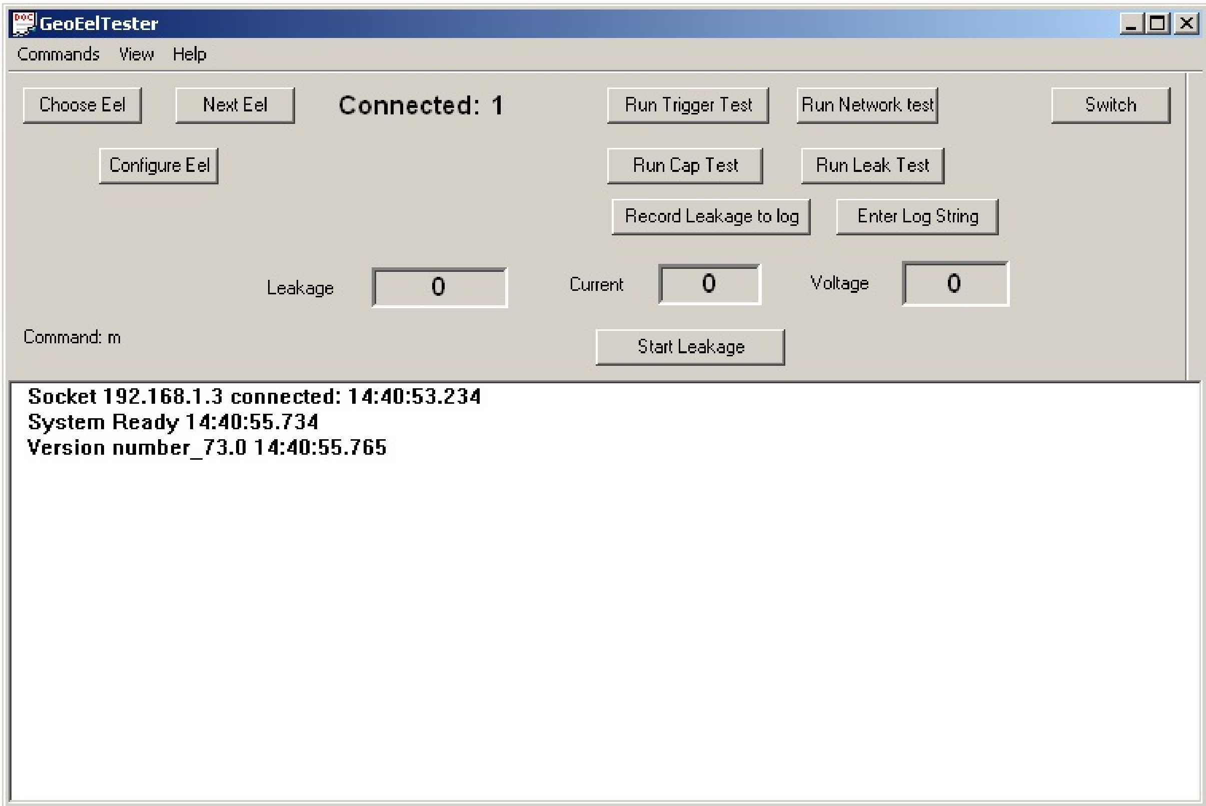
If you press **OK**, the following will appear:



If the Digitizer you specify is connected to the Cross Cable and powered up, the "Waiting for EEL to connect" dialog should disappear.

However, if the system is not connecting, you may choose **Cancel**. You will see the following dialog box. You may press the **Choose Eel** button to select another Digitizer.

If you connect to a Digitizer, you will see "Connected" and the Digitizer number, along with some additional information and buttons:

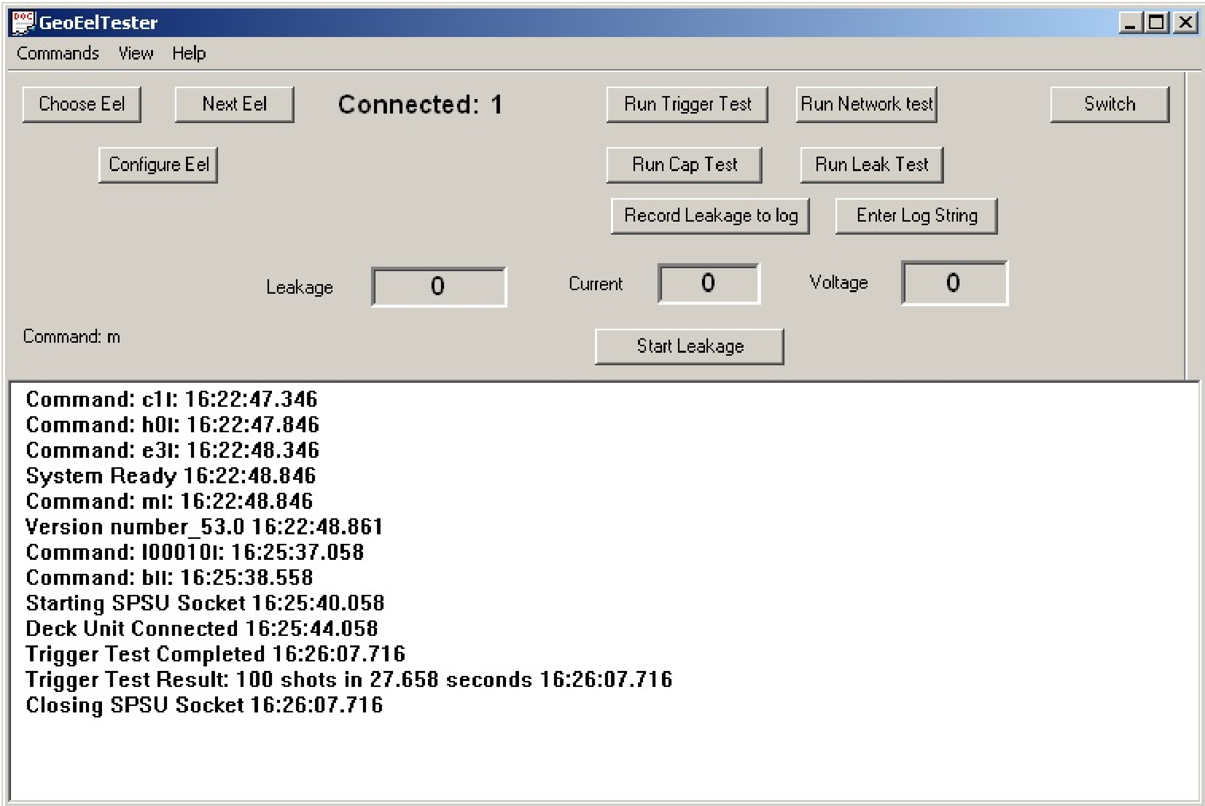


Note: *"Connected" in this context refers to a network connection.*

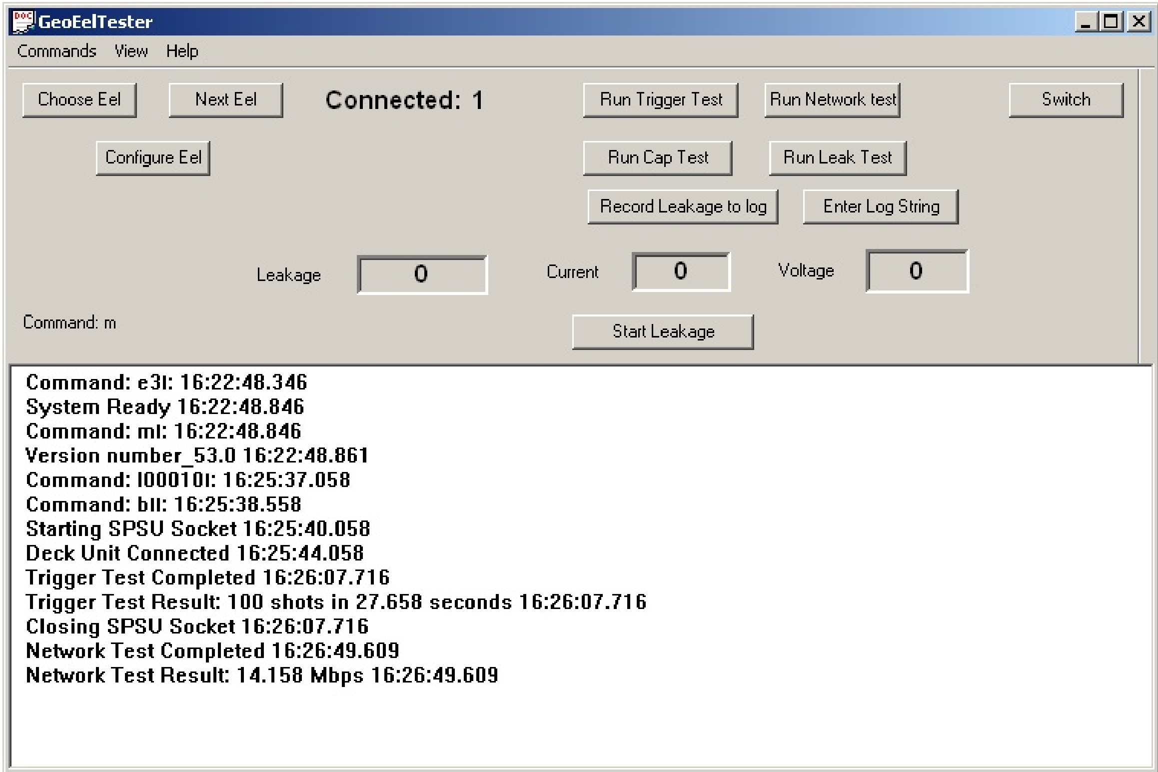
Following is a summary of the functions of the other buttons in the above dialog box.

- **Next Eel**: This function will disconnect from the present Digitizer, and connect to the next Digitizer in line. If you are currently connected to Eel (Digitizer)1, pressing **Next Eel** will close the network connection to Eel 1 (it will not power it down) and connect to Eel 2.

- **Run Trigger Test:** This tests the trigger circuit by measuring the time required to send 100 trigger commands to the Digitizer. This process should take 25-35 seconds.



- **Run Network Test**: This tests the network integrity by measuring the time required to transmit a set amount of data. The reported network speed should be 13.5 - 14 Mbps.



Note: *If you hold the CTRL key down while pressing* **Run Network Test**, *the test will run continuously until you press* **Cancel**.

- **Run Cap Test:** This works just like Hydrophone Capacitance Test in the Controller software, but it only works on the section physically connected to the Digitizer you are connected to.

- **Run Leak Test:** This works just like Hydrophone Leakage Test in the Controller software, but it only works on the section physically connected to the Digitizer you are connected to.

- **Record Leakage to Log**: The GeoEel Tester writes a continuous log of test results to a file called GeoEel Tester.log. You will find it in the Geometrics\GeoEel directory. Pressing this button will write the current leakage value to the log.

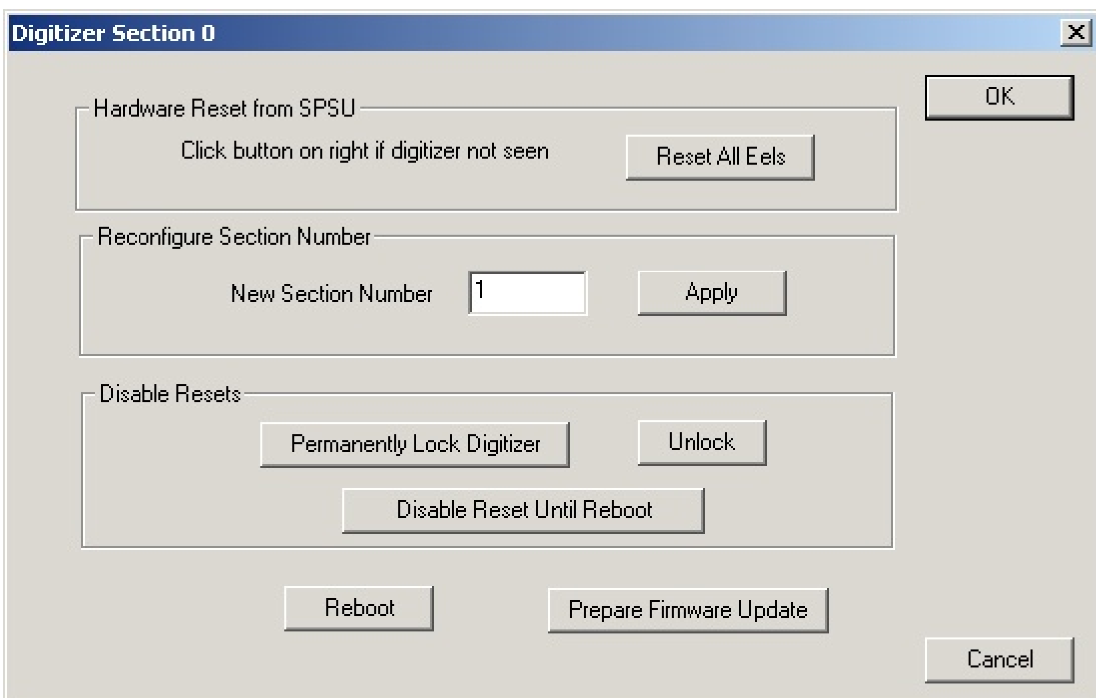
- **Enter Log String**: This allows the observer to enter a comment in the log. It is good practice to use this when troubleshooting. One of the first things you will be asked to do by Geometrics Support will be to email us the GeoEel Tester.log file.

- **Start Leakage:** This is a toggle switch that allows enabling/disabling the leakage, current, and voltage to be displayed and continuously updated in the boxes immediately above the button. These are the same values that are reported on the front panel of the Deck Unit.

- **Configure Eel:** This button brings up a configuration dialog with many functions. You must be careful when using these tools:

*Note: This tool is generally meant to be used to troubleshoot a **single** Digitizer that is connected directly to the Deck Unit with a test cable. It can be used when connected to the Cross Cable, but extreme caution should be used as you risk reconfiguring a Digitizer you did not intend to configure.*

Press **Yes** if you want to reconfigure the Digitizer you have connected to. You will be presented with the following:



From here, you may:

- **Reset All Eels**: This will perform a reset on ALL Digitizers connected to the Deck Unit and powered up, NOT ONLY THE ONE THIS SOFTWARE TOOL IS CONNECTED TO!!! This is the same function as the **Reset** button in the GeoEel Controller. *This is intended to be used only if there is a single Digitizer attached.*

- **Reconfigure Section Number:** This allows you to change the section number (i.e., the IP address) of a single Digitizer. For instance, if you have connected to Digitizer #6 (a Digitizer with IP address 192.168.1.8), and you wish to reconfigure it to be Digitizer #1 (192.168.1.3), you would enter "1" here and press **Apply**. You would then see the following:

After doing this, you must re-connect to the newly-configured Digitizer for further testing, using the **Choose Eel** button. See the section on changing out a Digitizer.

- **Permanently Lock Digitizer**: You must be especially careful when utilizing this feature. To avoid accidents, you must hold down the CTRL and SHIFT keys while clicking on this button for it to work. This function will "lock" this Digitizer, disabling resets. While locked, it will ignore all reset commands. This function only takes effect after the Digitizer is rebooted, either by using the **Reboot** button or by cycling the power on the Deck Unit.

- **Unlock**: This undoes the above, re-enabling resets of the Digitizer. Again, the Digitizer must be rebooted for this command to actually take effect.

  Note: *You can only permanently lock and unlock Digitizers one at a time, using the* ***Choose Eel*** *or* ***Next Eel*** *buttons. You cannot lock or unlock all of the Digitizers on the Cross Cable at once. However, you do not need to reboot them all individually; you can simply cycle the power on the Deck Unit once each Digitizer has been locked or unlocked.*

- **Disable Reset Until Reboot:** This command will *temporarily* disable resets on this Digitizer until it is rebooted, either through cycling the power on the Deck Unit or pressing the **Reboot** button.

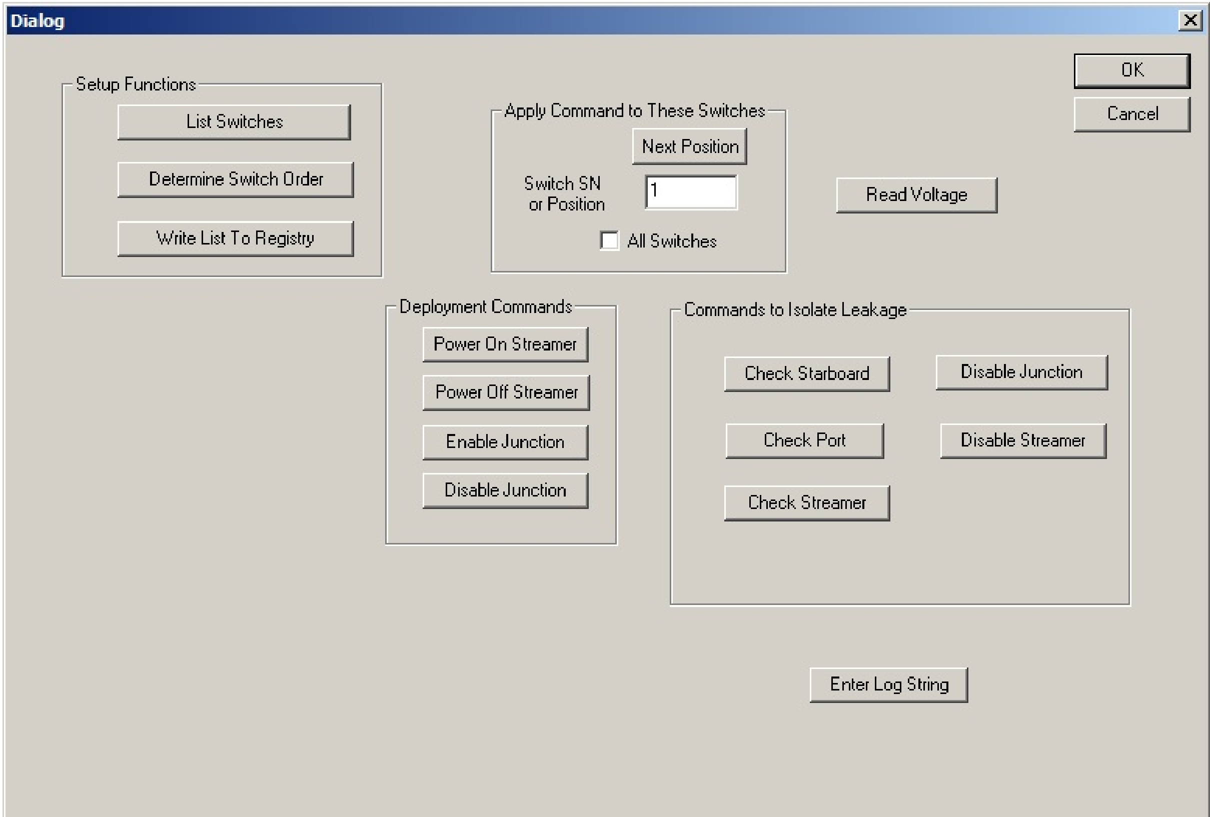
Note: *There is a subtle difference between "permanently" and "temporarily" locking a Digitizer. In the former, the Digitizer will not be resettable after merely* *rebooting; you must first use the **Unlock** command. In the latter, simply rebooting or cycling the power will unlock the Digitizer and allow it to be reset.*

***Note:** When you open a survey in the GeoEel Controller, the Digitizers will all be locked **temporarily**. This avoids accidental resets during the survey that might be caused by a noise spike on the trigger line. If you wish to reset any of these Digitizers later, they must first be rebooted.*

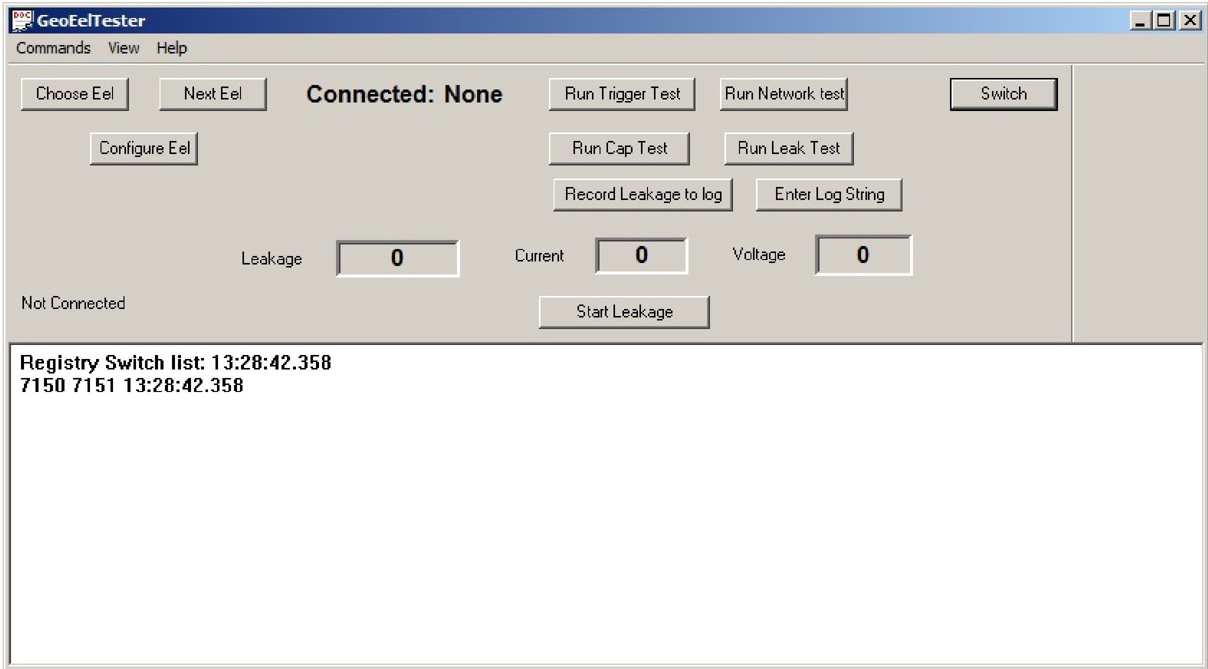
- **Reboot:** This will reboot the Digitizer you are currently connected to.
- **Prepare Firmware Update**: If you would like to update your firmware, please contact Geometrics.

3.2.2 Switch Tests

Pressing the **Switch** button brings up the following dialog:



If you move this dialog aside, you will see in the Log window the Switch list that is currently stored in the registry (registry key: PCableSwitches; in this case, we have two Switches, 7150 and 7151):



The **All Switches** function will apply to this list of Switches.

A description of the function of each button in this dialog follows:

Setup Functions

- **List Switches**: This queries the network and finds which Switches are attached. This command will not cause any settings to be changed. This command does not necessarily list the Switches in order.

- **Determine Switch Order**: This command will further interrogate the system to determine the order in which the Switches are connected. *Running this command by itself does not make any changes to any settings – it simply lists the Switch order on the screen and writes it to the GeoEel Tester log.*

  Note: *If the* **Determine Switch Order** *function does not complete, IT WILL LEAVE THE SYSTEM IN AN UNUSABLE STATE, UNTIL THE POWER IS CYCLED OR THE DETERMINE SWITCH ORDER FUNCTION IS RUN SUCCESSFULLY.*

- **Write List to Registry**: This will write the Switch list to the registry, in order, as determined by the **Determine Switch Order** command discussed above. This accomplishes the same thing as typing the Switch serial numbers into the P-Cable Switch Order box in the Configure>GeoEel dialog of the GeoEel Controller. Using the GeoEel Tester software to do this is easier and not prone to data entry errors. However, YOU MUST CONFIRM that the switch order, as determined by the **Determine Switch Order** command, is correct.

Apply Command to These Switches

- **Switch SN or Position:** Some Switch commands can be executed on a single Switch or on all of the Switches at once. To issue a command to a single Switch, type in either the Switch position or its serial number. To issue the command to all of the Switches simultaneously, check the **All Switches** box.

  Note*: This function works on the Switch list read from the registry or, if executed, the Switches identified by the* **Determine Switch Order** *command. Even if this listing is incorrect, this is the list that will be used when entering a position number. If you are in doubt, be sure to run the* **Determine Switch Order** *command before attempting to manipulate Switches.*

- **Next Position**: This increments the targeted position by 1. This is a more convenient method of entering the next position than entering a new number in the entry box. It works best if you work with Switch positions (which always increment by 1), rather than serial numbers, unless your Junction Boxes are on the Cross Cable in order of serial number and if there are no serial number gaps.

- **Read Voltage**: You may interrogate the Switches individually or all at once for their voltage. This can be a good diagnostic tool when troubleshooting the array. The voltages should decrease with position along the Cross Cable. Minimum recommended voltage is 45V; maximum is 70V.

Deployment Commands

- **Power On Streamer**: This command powers-up the Streamer (Digitizer), enables the trigger to the Streamer and the Interconnect Cable, and enables the Ethernet at the selected position(s). *The Interconnect Cable power is left unchanged from its previously existing state.*

- **Power Off Streamer**: This command kills power to the Streamer at the selected position. *The trigger and Ethernet ports are left enabled.*

- **Enable Junction**: Enables power to the Streamer and Interconnect Cable, and enables trigger and Ethernet on the selected position.

- **Disable Junction**: Reverses effects of **Enable Junction** above.

The deployment commands are intended to be used during system deployment. While the system has no Streamers physically connected, power on the Deck Unit, and do the following:

1) Press **Power off Streamer** with the **All Switches** box checked. This will disconnect power from all of the Streamer ports on all of the Junction Boxes.

2) Uncheck the **All Switches** box.

3) Connect the first Streamer to the first Junction Box. Press **Switch**, type in the Junction Box number (in this case, #1, or you can type in the actual serial number), and press **Power on Streamer**. Watch the current on the Deck Unit; it should increase by about 0.12 A, then fluctuate as the Digitizer boots, then settle. Wait for the current to settle, which takes about 35 seconds.

4) Close the Switch dialog box, click on **Choose Eel**, and enter the Eel number (1). Then run **Trigger Test** and **Network Test**.

5) Attach the next Streamer to the next Junction Box. Press **Switch**, press **Next Position,** and then press **Power on Streamer.** Observe the current on the Deck Unit; it should increase by about 0.12 A.

6) Close the Switch dialog box, and click on **Next Eel**. Then run **Trigger Test** and **Network Test**.

7) Continue this process until all Streamers have been installed on the Cross Cable.

Note: *DO NOT use the* ***Enable Junction*** *or the* ***Disable Junction*** *functions during this process. Enabling a Junction Box that was previously disabled will turn on all power, including Streamers, for the rest of the Cross Cable. This is because each Junction Box reboots during its power up stage, enabling all ports.*

Commands to Isolate Leakage

Isolating leakage, when it occurs, is a complicated process, made easier by this testing tool. Assuming that leakage is occurring when the system is completely powered up, we wish to turn on the system position by position, component by component, and determine when the leakage first appears. The function of each command is described below, followed by the procedure you should follow to isolate leakage.

- **Check Starboard:** Turns *off* power to all portions of the Cross Cable after selected position (i.e., everything to the *Port* side), including the Streamer at the selected position.
- **Check Port:** Turns *on* power to the Port side of the selected Junction Box. Turns *off* power (except Starboard power) at next Junction Box (*n+1*)
- **Check Streamer:** Powers on the Streamer at the current user-selected position, and enables the trigger line.
- **Disable Junction:** Disables Port-side power, trigger, and network at Position *n-1*, where *n* is the current user-selected position. The shuts down position *n*.
- **Disable Streamer:** Powers down the Streamer at the current position.

Leakage Isolation Procedure

Note: *The following assumes that the Tri-point is on the Starboard-side of the vessel, which is standard.*

Below is a portion of the Tri-point (Starboard) side of a P-Cable array. This will be used to illustrate the following leakage isolation procedure.

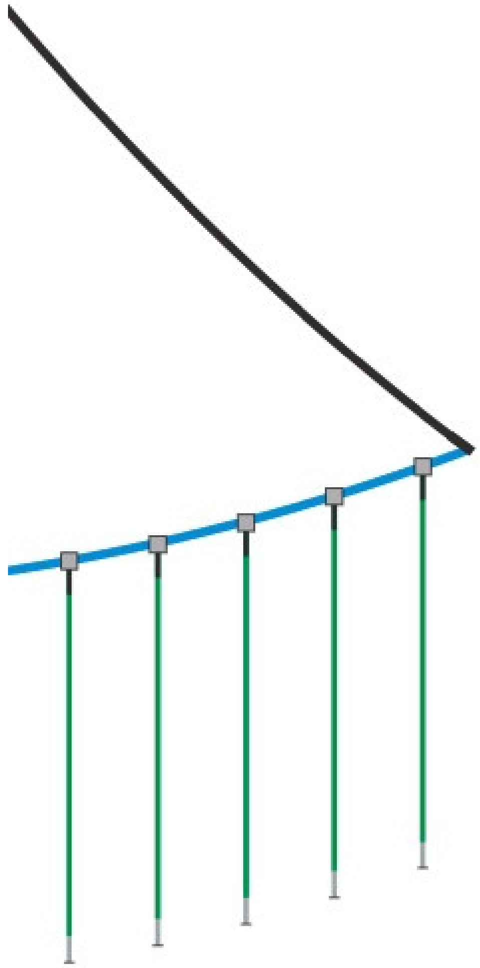


Figure 76: All components powered down.

1. power up the system at the Deck Unit. Presumably, the leakage shown on the Deck Unit is at some undesired value.

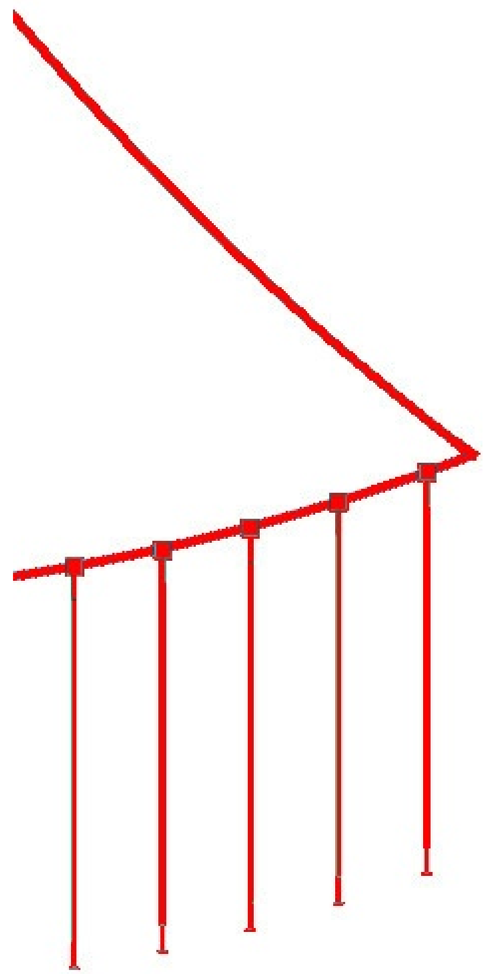


Figure 77: All components powered up.

2. Choose the position in the Cross Cable you wish to start at by typing it into the **Switch SN or Position** entry box (if you are just starting, this will be Position 1).

Note: *If you are restarting this process, you may choose any position on the Cross Cable to begin. If you start in the middle, and leakage goes away after Step 3, below, you are safe to continue. Otherwise, you need to choose an earlier position and perform Step 3 again.*

3. Click on **Check Starboard**. This turns *off* power to all components of the Cross Cable *after the Starboard side* of Position 1 (i.e, everything Port of Position 1), including Streamers. If the leakage remains, it is in the Signal Cable, the first Interconnect Cable (between the Signal Cable and first Junction Box), or the Starboard side of the first Junction Box.

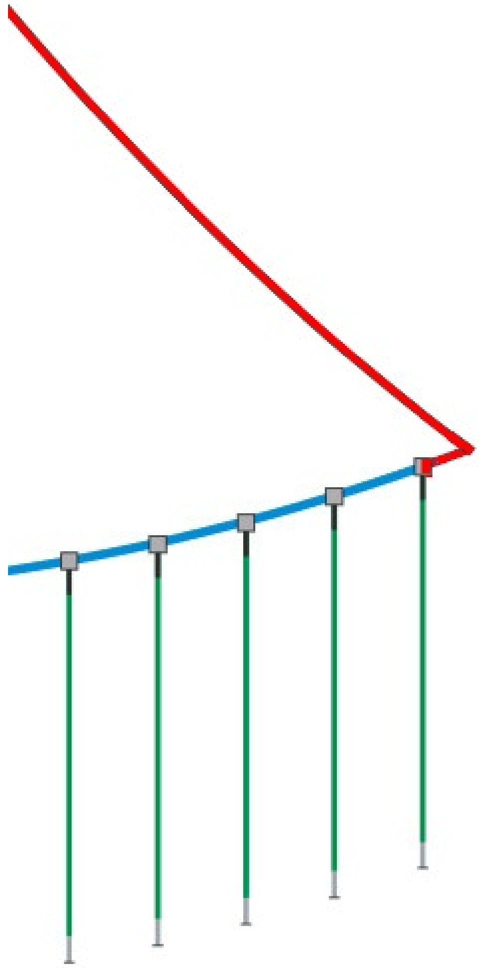


Figure 78: Power limited to Signal Cable, first Interconnect Cable, and Starboard-side of Junction Box 1.

If, after clicking **Check Starboard**, the leakage goes away,

4. Click on **Check Port**. This turns *on* power to the Port-side of the selected Junction Box, and turns *off* Port-side and Streamer power at the next Junction Box (*n+1*).

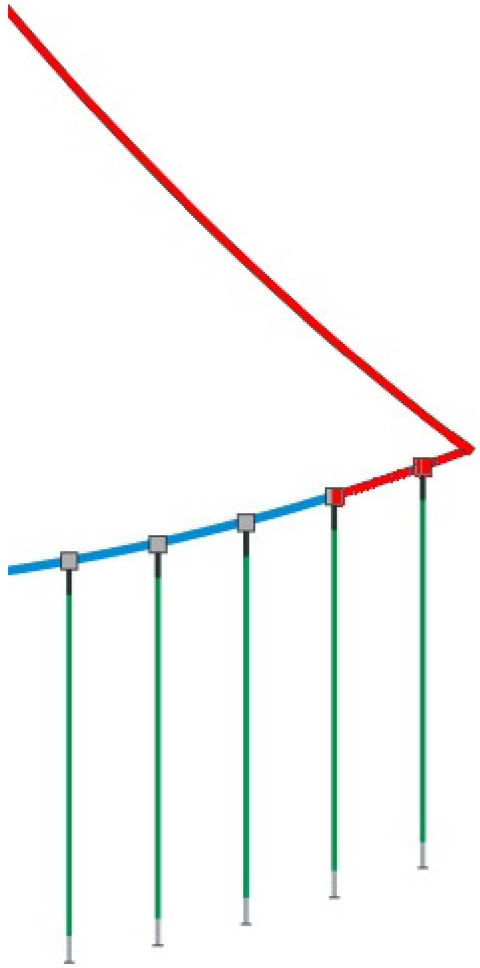


Figure 79: Power limited to Signal Cable, first Interconnect Cable, first Junction Box, second Interconnect Cable, and Starboard-side of Junction Box #2.

5. If the leakage value increases, it is in either a) the Port-side of the selected Junction Box, b) the Starboard-side of the next Junction Box, or c) the Interconnect Cable in between. Clicking on **Disable Junction** (this turns off the Port-side port) should make the leakage go away. The leakage should come and go as you alternate between the **Check Port** and **Disable Junction** buttons.

6. If, after pressing the **Check Port** button, no leakage appears, click on **Check Streamer**. This powers-up the Streamer at the selected Junction Box.

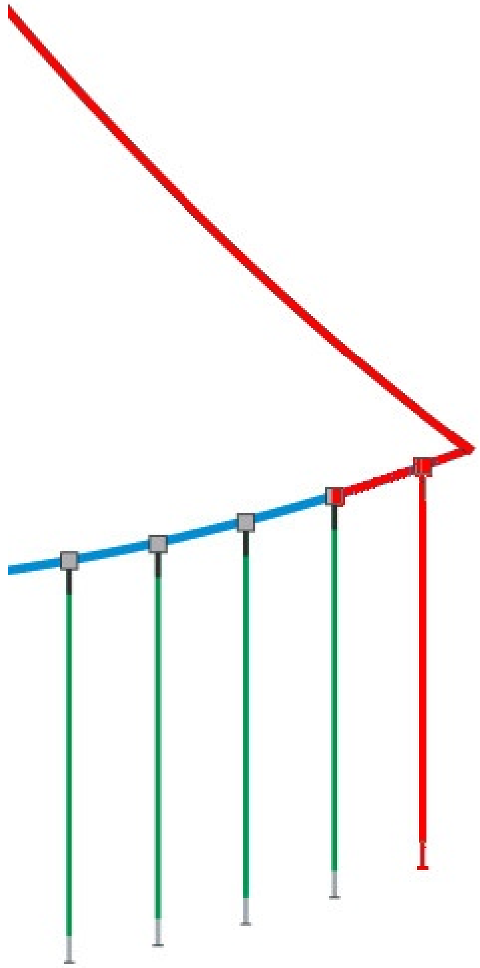


Figure 80: Power limited to Signal Cable, first Interconnect Cable, first Junction Box, second Interconnect Cable, Starboard-side of Junction Box #2, and Streamer #1.

7. If the leakage value increases, it is in the Streamer or in the Interconnect Cable between positions *n* and *n+1*. Next click **Disable Streamer**. This undoes the **Check Streamer** command, and the leakage should go away. This will confirm the location of the leakage, in case the leakage is intermittent. It should come and go as you alternate between the **Check Streamer** and **Disable Streamer** buttons.

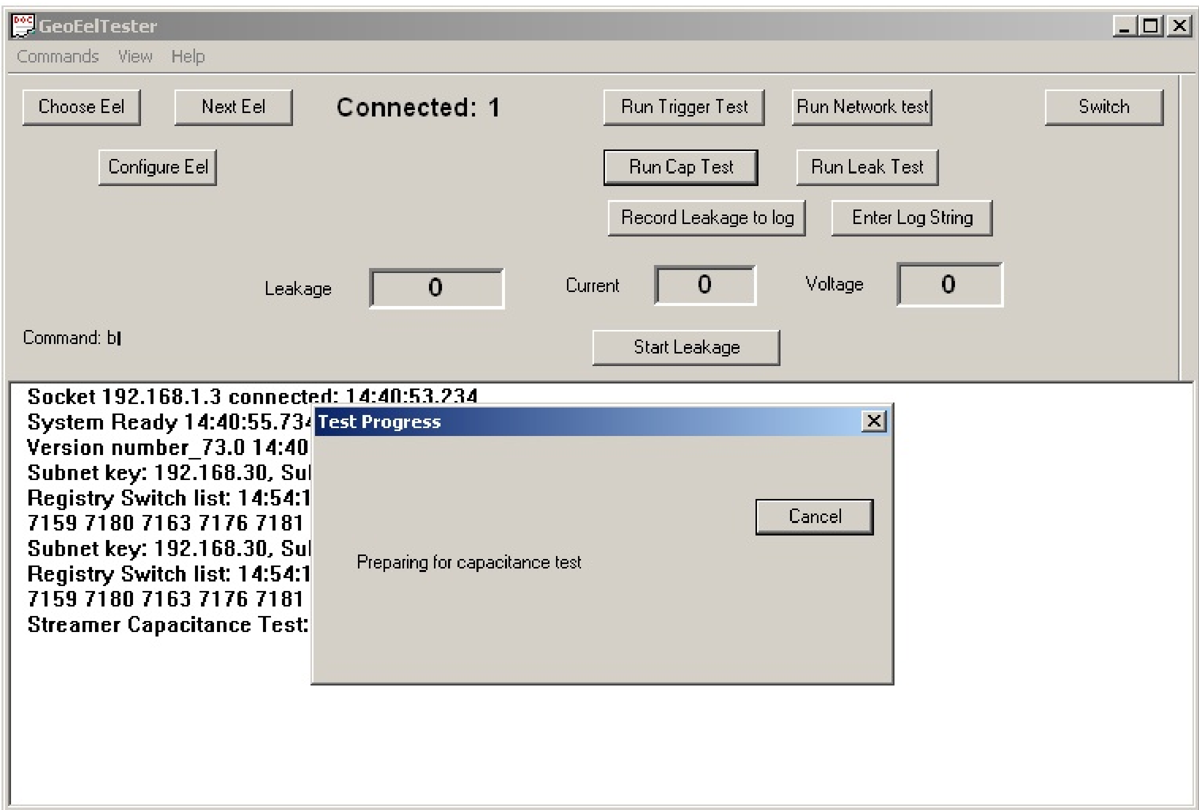
Note: *After clicking on* **Disable Streamer**, *it is safe to disconnect and re-connect components on that Streamer port. It is not powered on. Once the components have been replaced, you can click on* **Enable Streamer** *to check if the problem has been fixed with the new components.*

8. Click **Next Position**. This will index to the next Junction Box. Repeat steps 4-6 until the entire

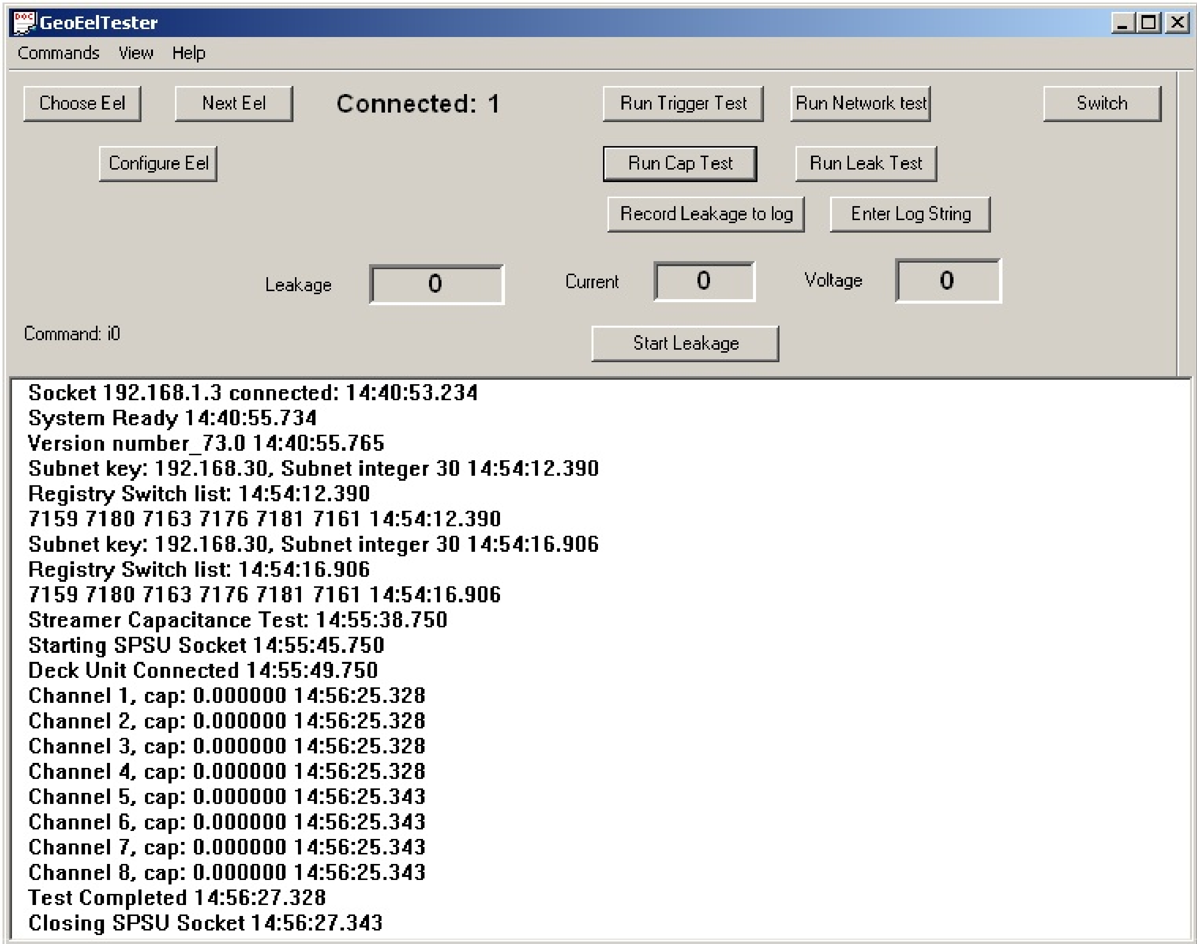
array has been checked.

3.2.3 Capacitance Test

You can test the capacitance of the hydrophone groups by pressing the **Run Cap Test** button. This is the same test that is done by the CNT-2 Controller capacitance test, except that rather than testing all of the GeoEels on the array, it is restricted to the single GeoEel that you are currently connected to. You will see series a messages like the one shown below,



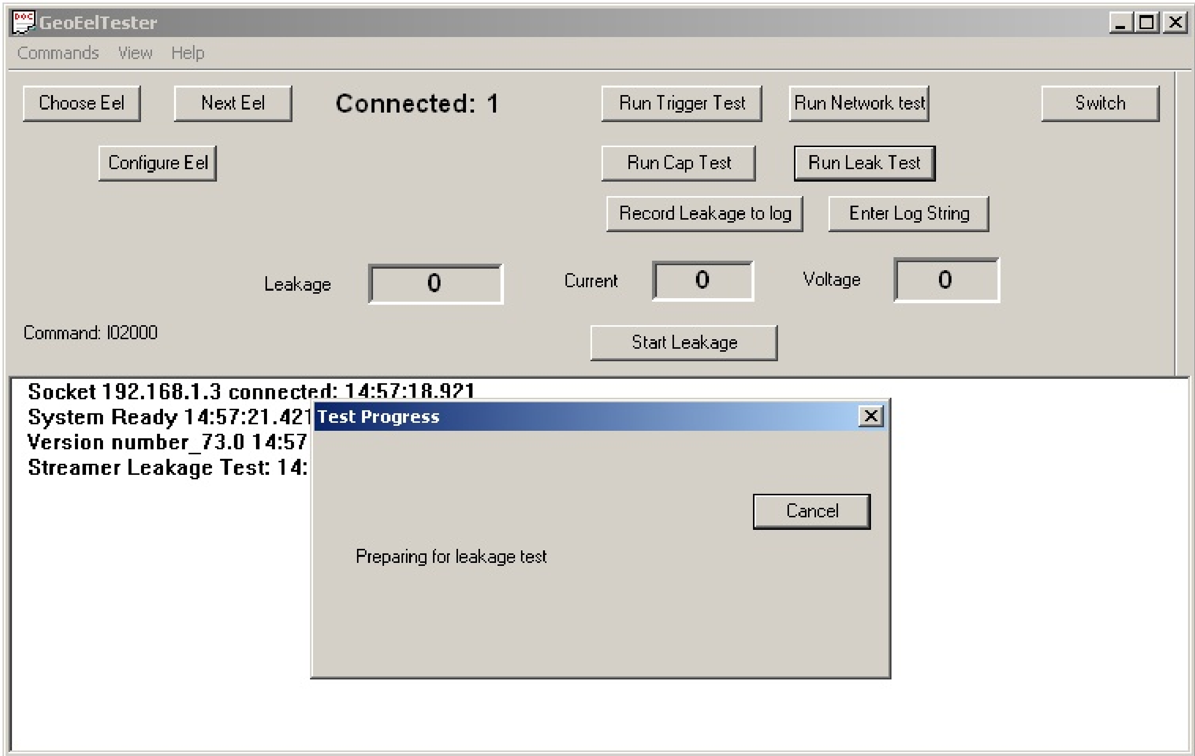
followed by a display of the results:



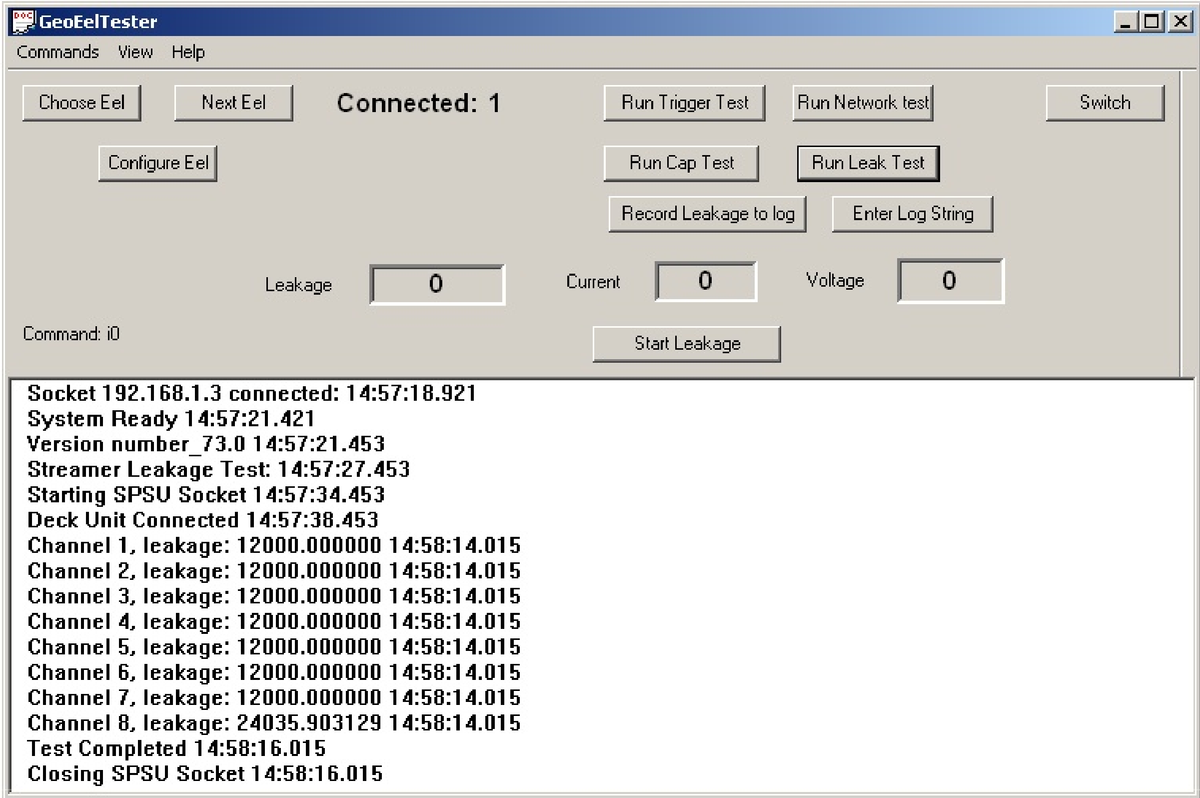
Unlike the test in the CNT-2 Controller, the test results are not written to a log.

3.2.4 Leakage Test

You can test the hydrophone group leakage by pressing the **Run Leak Test** button. This is the same test that is done by the CNT-2 Controller leakage test, except that rather than testing all of the GeoEels on the array, it is restricted to the single GeoEel that you are currently connected to. You will see series a messages like the one shown below,



followed by a display of the results:

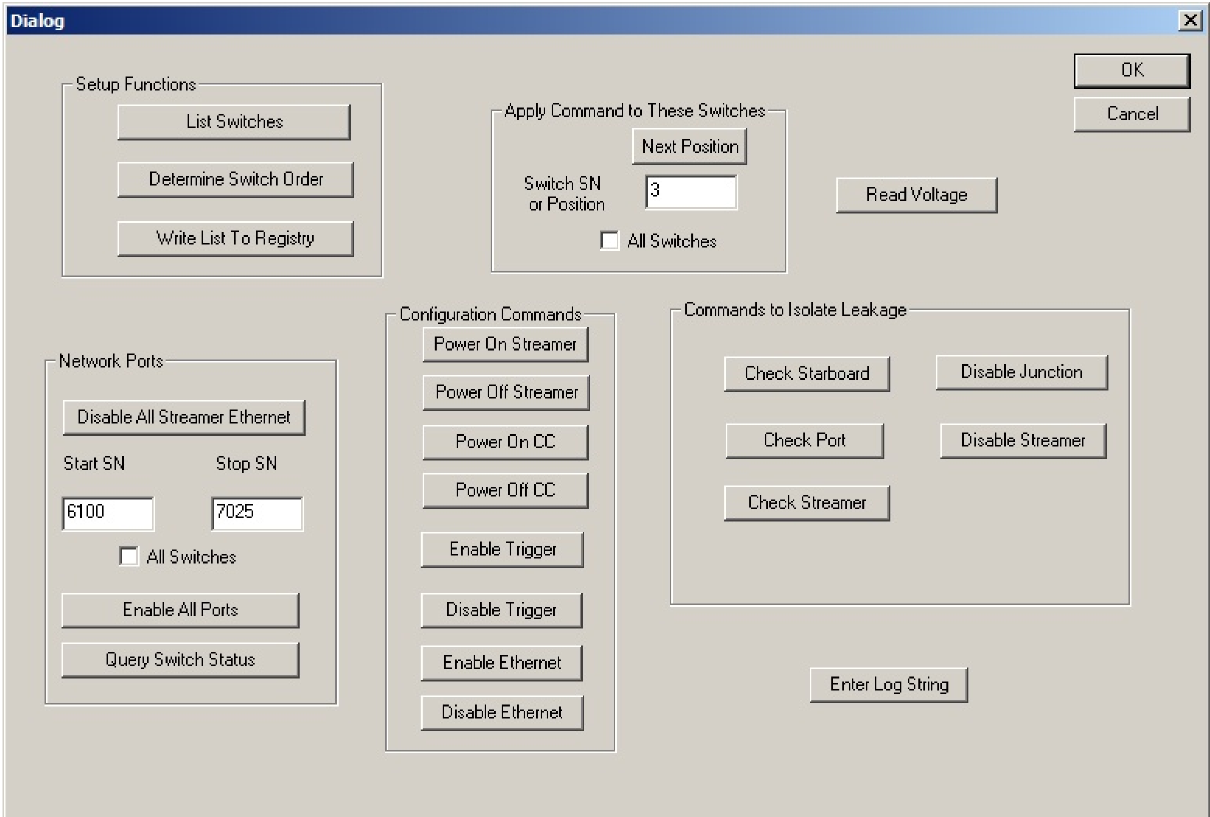


Unlike the test in the CNT-2 Controller, the test results are not written to a log.

3.2.5 Expert Mode

WARNING: THESE FUNCTIONS ARE TO BE USED UNDER THE DIRECT SUPERVISION OF GEOMETRICS ONLY!!!

If the CTRL key is held down while pressing the **Switch** button, the following dialog appears:



The following *additional* functions are available in Expert mode:

Network Ports Functions

The functions in this box utilize the serial line communication to the Switches to send configuration commands. Generally speaking, these commands SHOULD NOT BE USED. They are useful only if the network is not working properly. The **Power on/off** commands should be used instead.

Disable All Streamer Ethernet: This command is not safe. This will turn off all Switches' Streamer ports. Until a reset / detect sections is done from the GeoEel program, or the **Enable All Ports** function is chosen, no communication will be possible to the Streamers.

Start SN, Stop SN, All Switches: These determine which Switches the commands below will be sent to. Selecting **All Switches** will send commands to the all of the Switches stored in the registry, or determined by the **Determine Switch Order** function. Choosing a beginning and ending serial number string may be used if the **Determine Switch Order** command, which uses the network, is not working properly.

Enable All Ports: This will enable the Streamer ports using the range of serial numbers entered. This will re-enable communication to the Streamers.

Query Switch Status: This will query for the presence of the Streamer ports using the range of serial numbers entered.

Configuration Functions

Power On CC: This command will turn on the power to the selected downstream Cross Cable ports.

Power Off CC: This will disable power to the selected downstream Cross Cable ports.

Enable Trigger: This command will turn on the trigger on the selected Switch positions. This controls trigger to both the Streamer and the downstream Cross Cable port.

Disable Trigger: This command will turn off the trigger on the selected Switch positions. This controls trigger to both the Streamer and the downstream Cross Cable port.

Enable Ethernet: This command will enable Ethernet communication to the selected Streamer ports.

Disable Ethernet: This command will disable Ethernet communication to the selected Streamer ports.

3.3 TAPE Utility

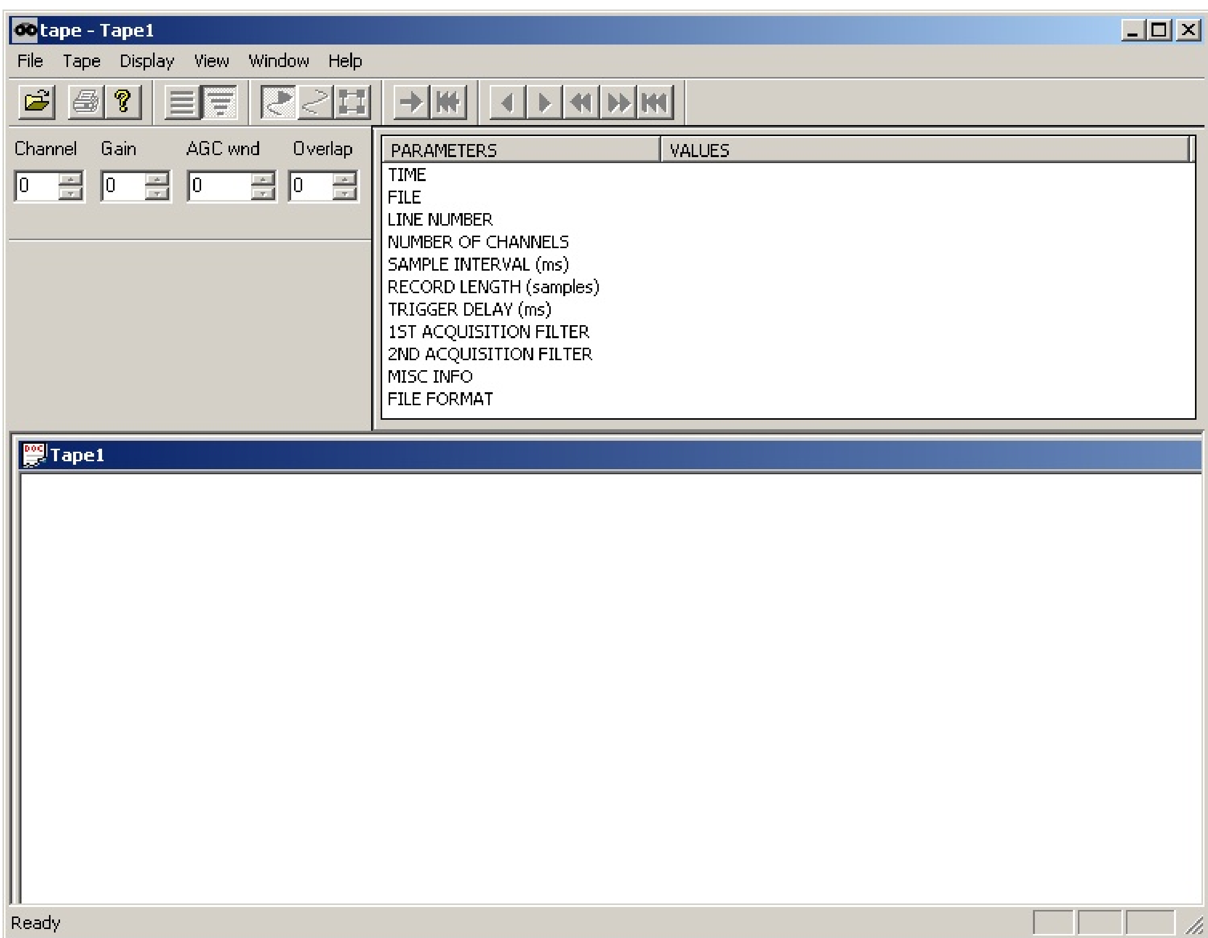
The Tape Reader is a utility that allows the user to read data from tapes. Its main purpose is simple tape verification and positioning. However, it can also be used to read, display and print data stored on disk. Other useful tools include the ability to transfer data from tape to disk and vice versa, make backup copies of tapes, convert any SEG file to an ASCII columnar format, and convert between SEG formats. There are no filters available on the Tape Reader, so if you wish to read and display/print previously saved data in filtered form, it is best to use the CNT-2 Controller. See here and here.

Note: *The CNT-2 Controller cannot read tapes directly. If you wish to optimize and display/ print files stored on tape, you should use the Tape Reader to transfer them to disk, then use the CNT-2 Controller to read, optimize, and print.*

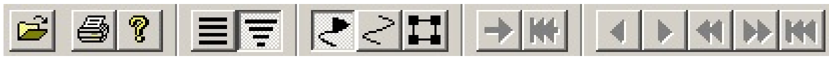
Start the software by double-clicking the Tape Reader shortcut on your desktop:

Note: *If there is no* Tape Reader *icon on your desktop, it can be found in the Geometrics \GeoEel folder on the drive where you installed the CNT-2 Controller. The file name is "tape.exe".*

This will bring up the following display:

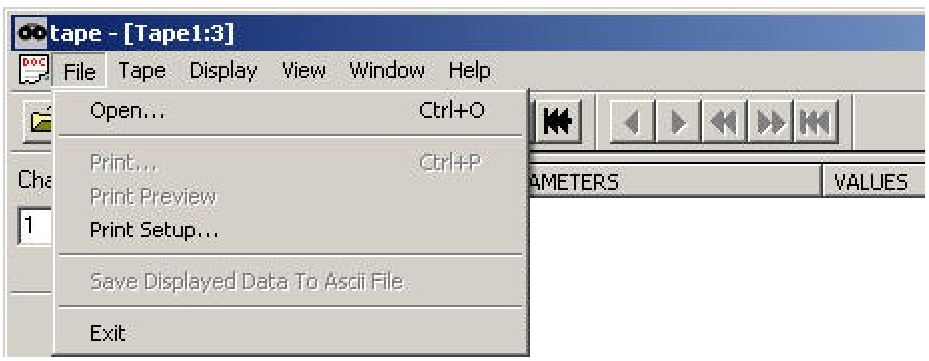


The Tape Reader features a tool bar that includes buttons for convenient access to certain commands in the dialog boxes:



Depending on the media you are reading from and the SEG format, some of the buttons on the right half of the tool bar will be grayed out. The function of each button will be apparent in the discussion below by its placement next to the appropriate menu item. Items that have hotkeys will also be indicated in section headings.

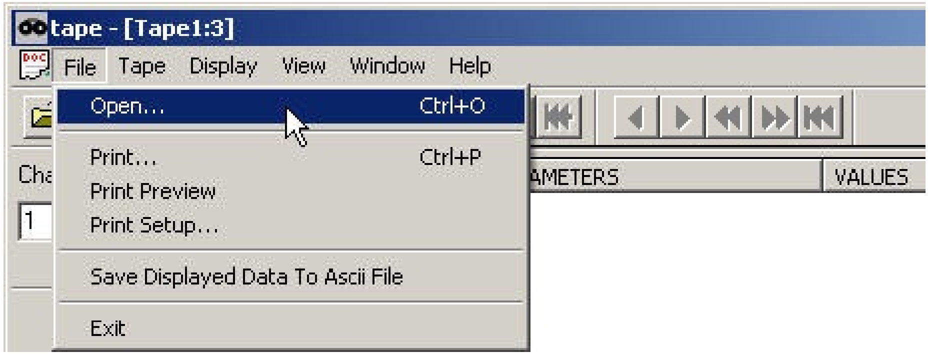
3.3.1 File Menu

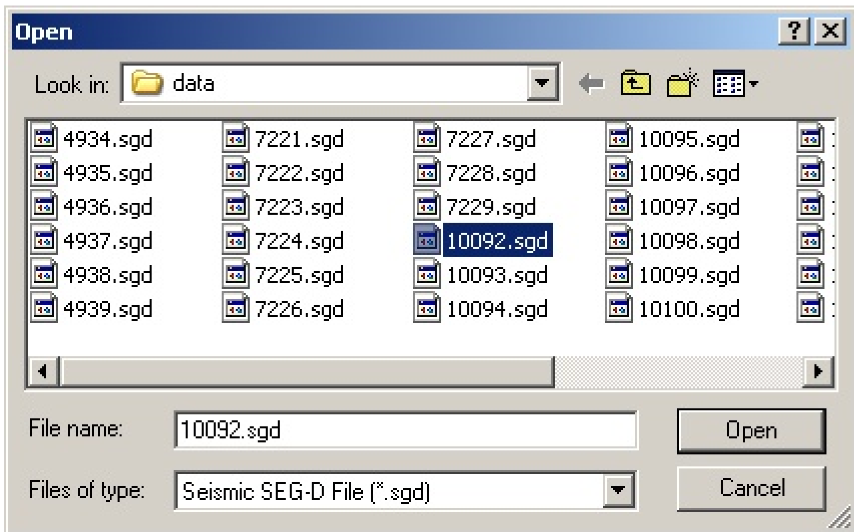


The File menu applies to files on disk only.

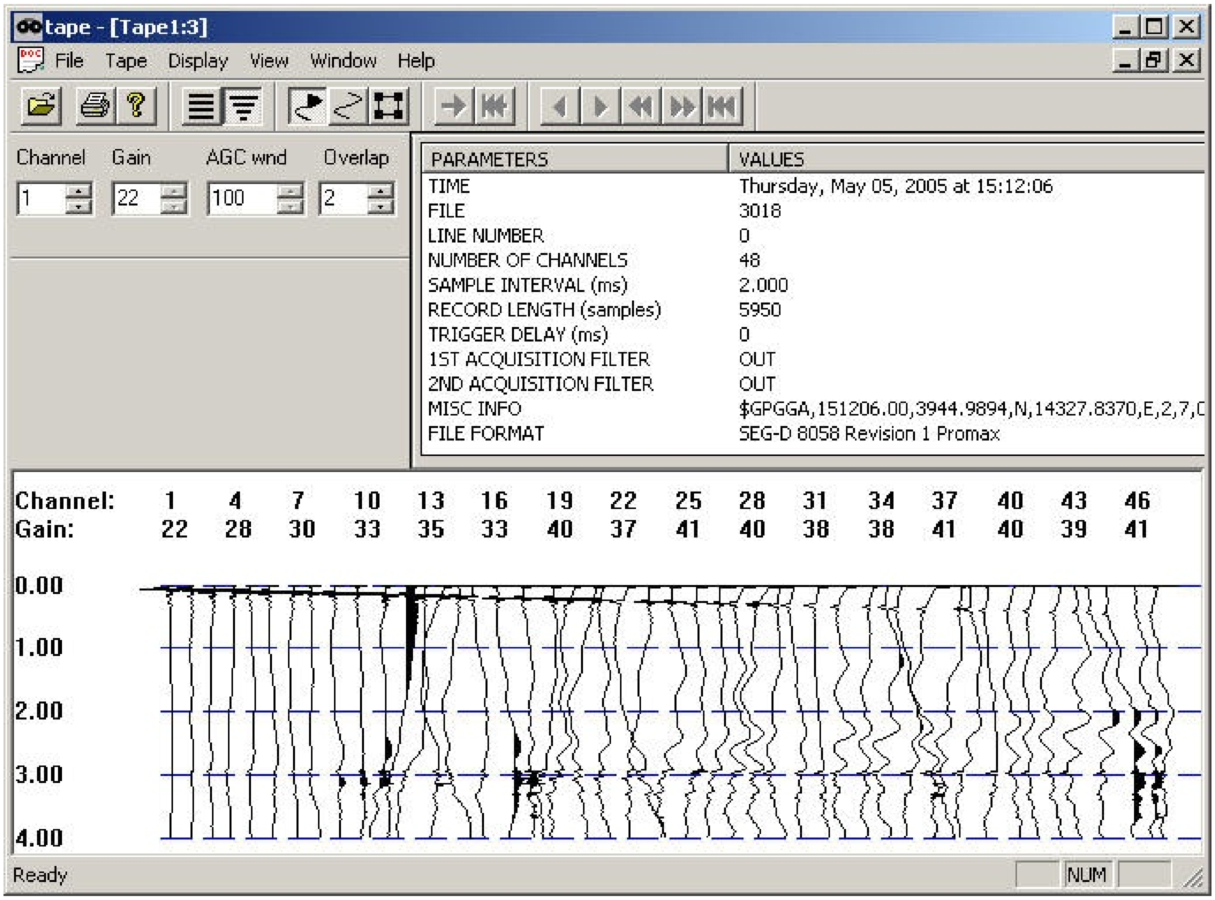
3.3.1.1 Open (Hotkey: CTRL+O)

Use the Open command to open a file previously stored on disk:



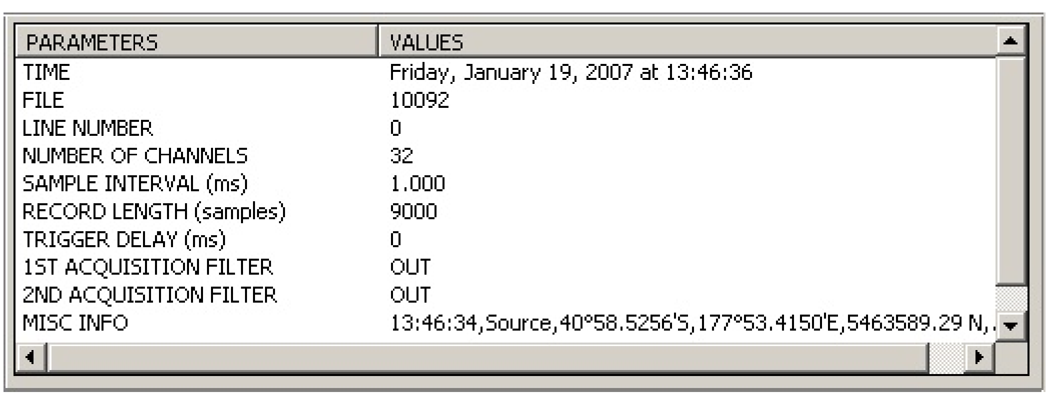


Your data will be displayed as shown below:



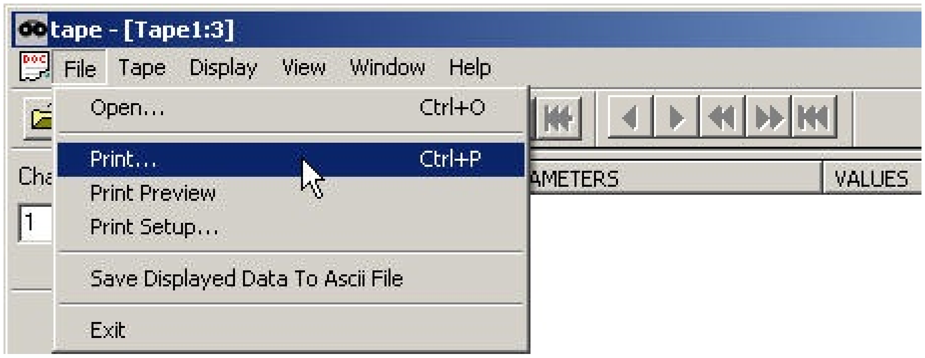
If it is a SEG-Y file, these tool buttons will be enabled on the tool bar:  They are discussed [here]() and [here]().

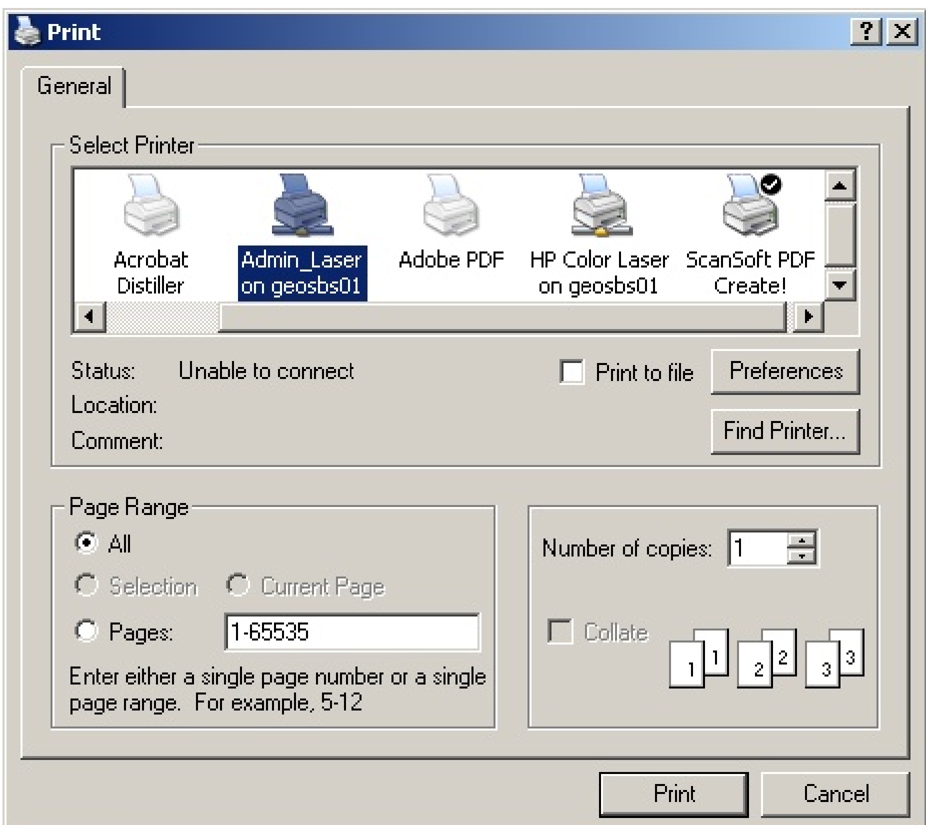
Information from the header will also be displayed, reproduced here for clarity:



PARAMETERS	VALUES
TIME	Friday, January 19, 2007 at 13:46:36
FILE	10092
LINE NUMBER	0
NUMBER OF CHANNELS	32
SAMPLE INTERVAL (ms)	1.000
RECORD LENGTH (samples)	9000
TRIGGER DELAY (ms)	0
1ST ACQUISITION FILTER	OUT
2ND ACQUISITION FILTER	OUT
MISC INFO	13:46:34,Source,40°58.5256'S,177°53.4150'E,5463589.29 N,.

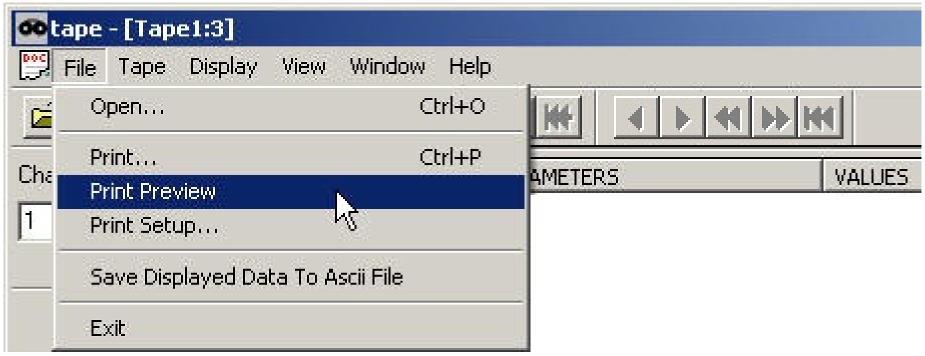
3.3.1.2 Print (Hotkey: CTRL+P)



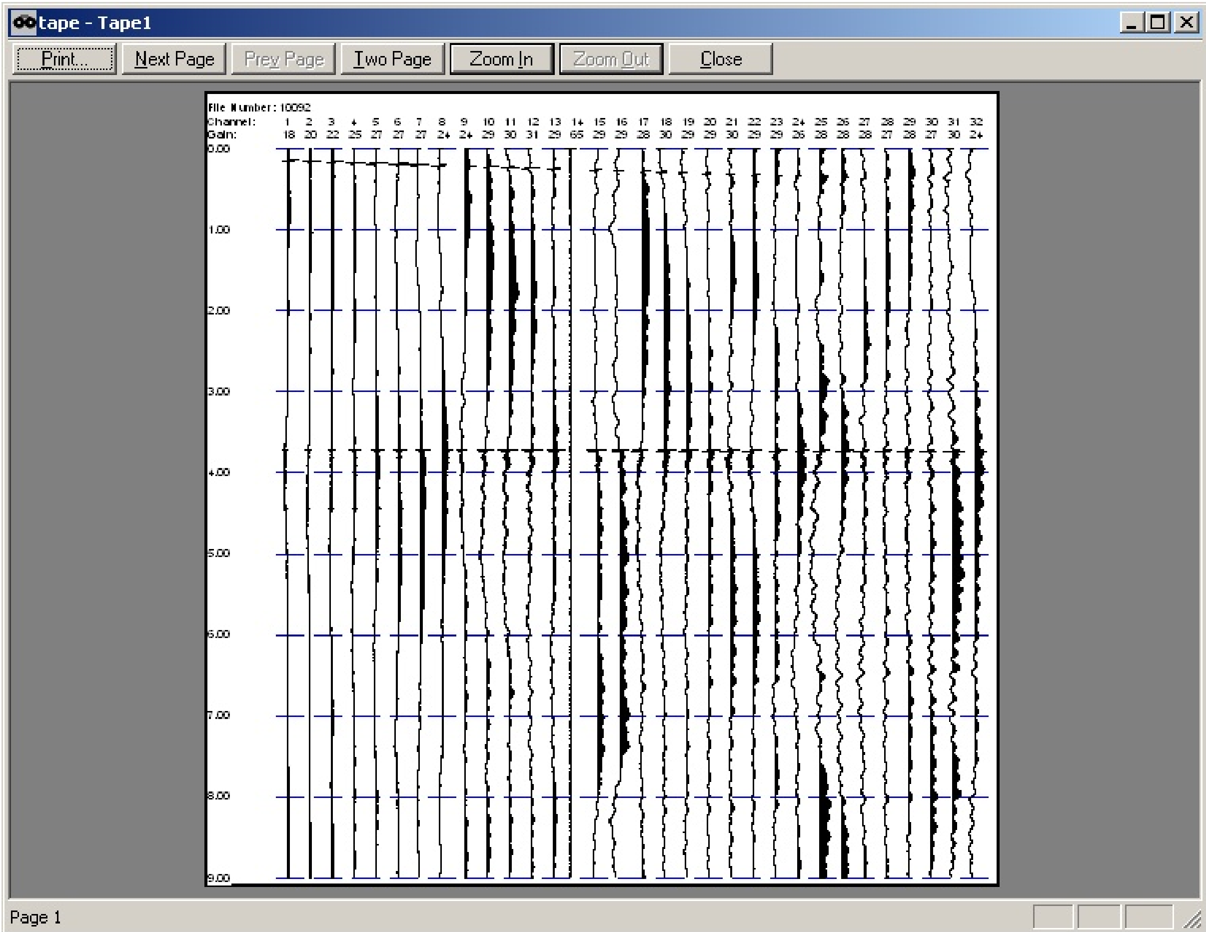


Choosing the Print option will open the above printing dialog. Choose you printer settings and press **Print**.

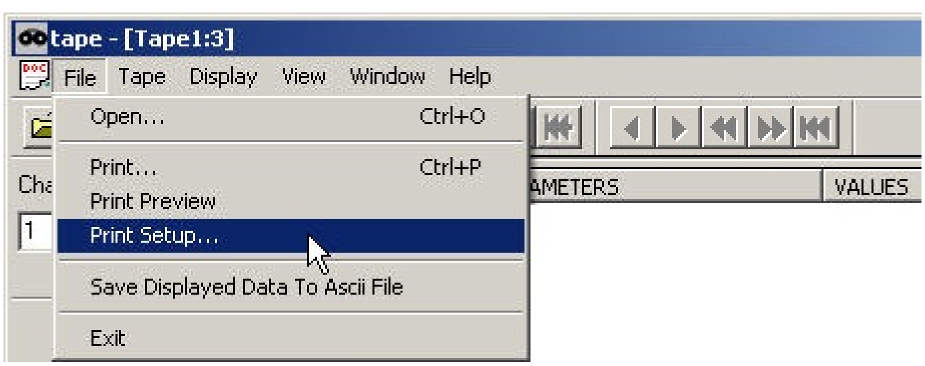
3.3.1.3 Print Preview

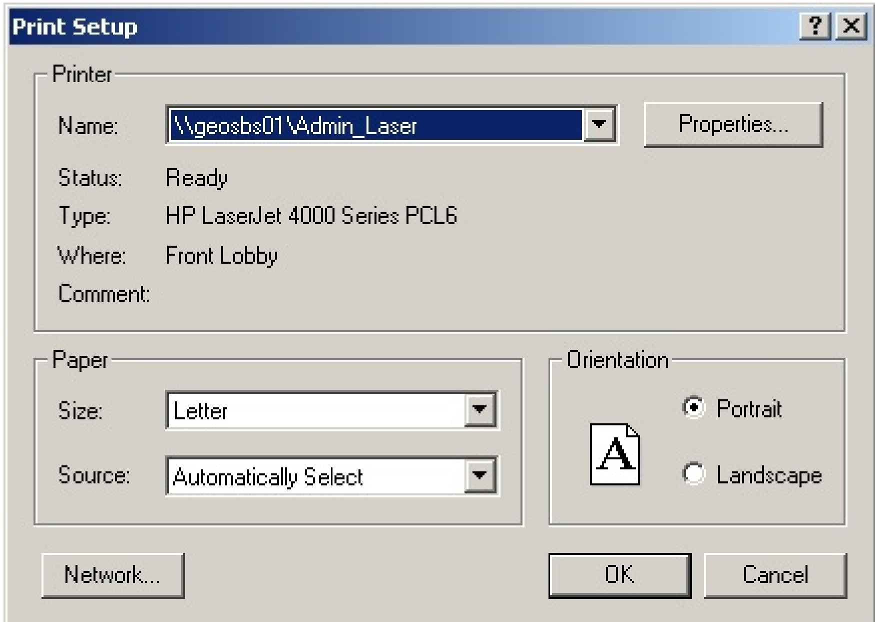


Choosing Print Preview will display the data as it will appear in printed form, according to your print settings:



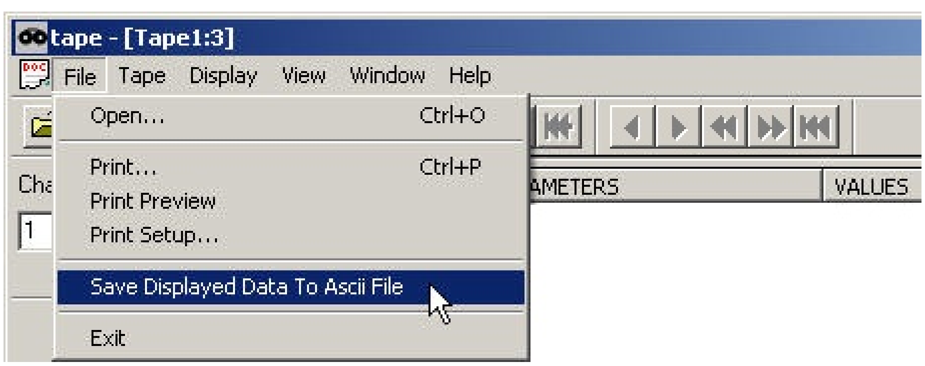
3.3.1.4 Print Setup



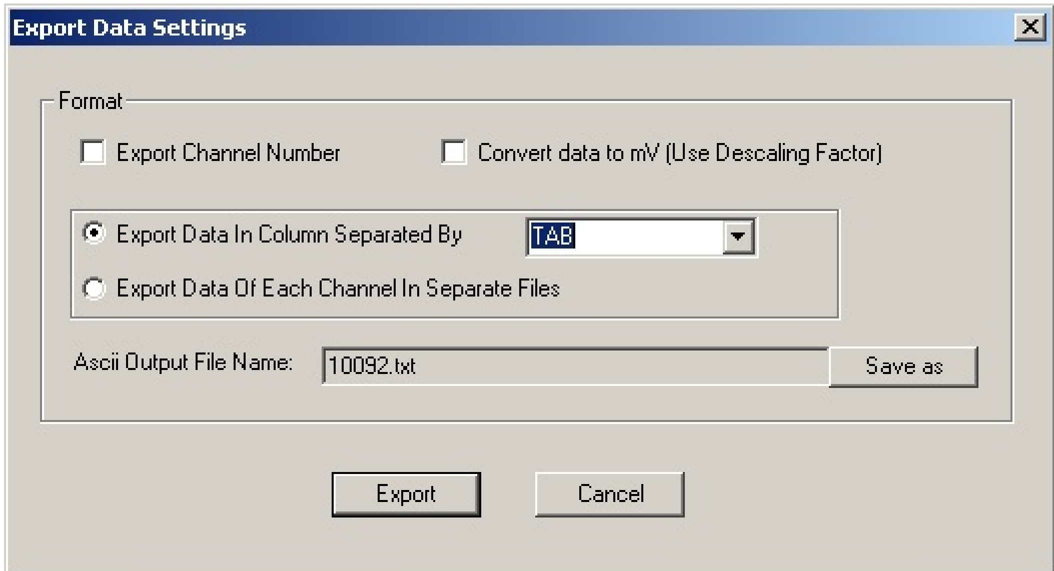


Selecting Print Setup displays the above standard setup menu.

3.3.1.5 Save Displayed Data to ASCII File



The Tape Reader can be used to convert a SEG file to an ASCII-columnar file.



Check the Export Channel Number box if you wish the channel number to appear above each column in the ASCII file. It is highly recommended that you check the Convert data to mV (Use Descaling Factor) box. This will account for the effects of different gains having been applied to different channels.

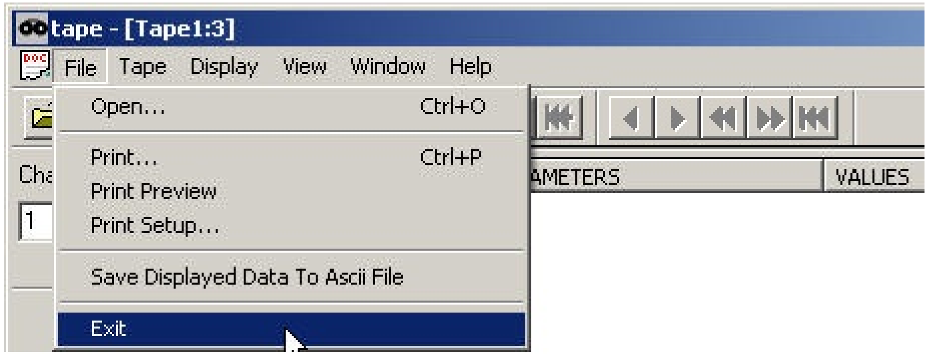
If you would like all of the data written to a single file, check the Export Data in Column Separated By radio button, and choose whether to delimit columns by a COMMA, SPACE or TAB.

If you would like each channel written to its own file, choose Export Data of Each Channel in Separate Files.

Click on **Save as** to set the file name and path. If you are exporting all channels to a single file, the file name will default to the FFID# of the SEG file with an extension of ".txt". For instance, the ASCII version of file "10092.SEG" will be "10092.txt". A suffix indicating the channel number will be added if you choose to export each channel to its own file. For instance, the name of the ASCII file containing channel 12 of file 10092.SEG will be "10092.txt.12".

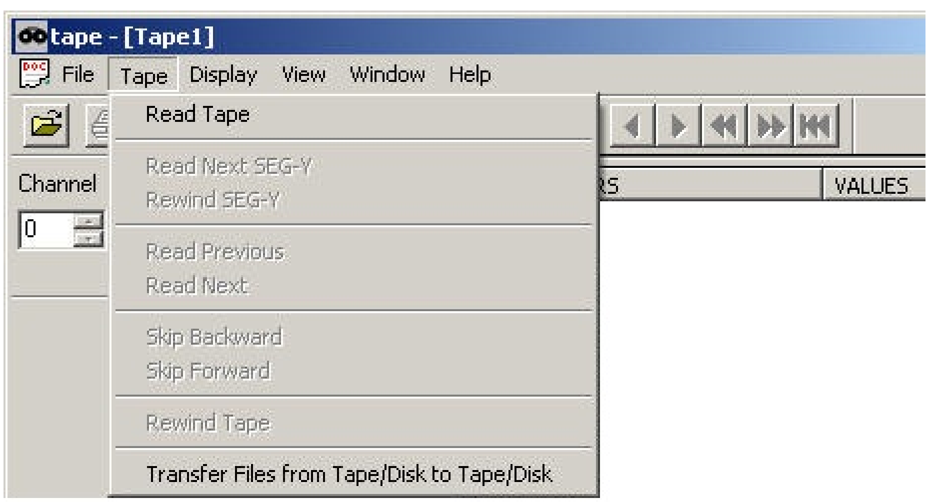
When you have chosen the particulars of the ASCII file, press **Export**.

3.3.1.6 Exit



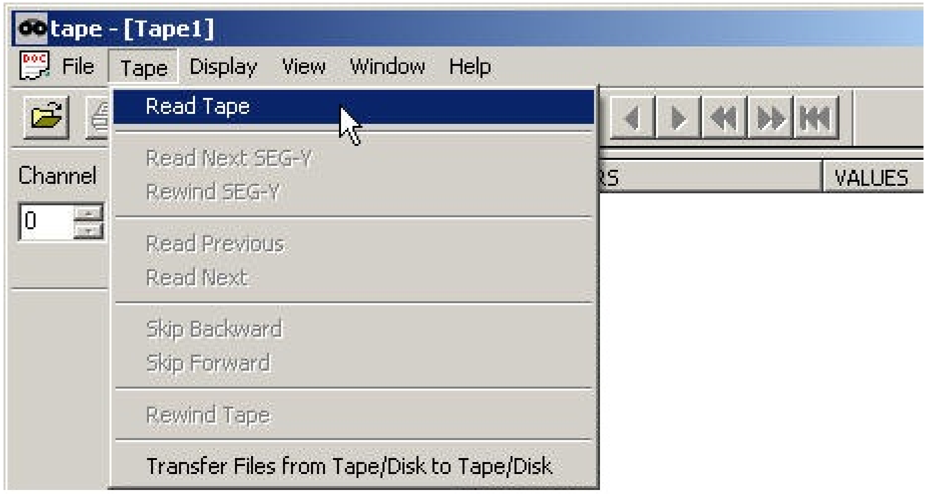
Choosing Exit will close the program. You can also click on the **X** in the upper right-hand corner.

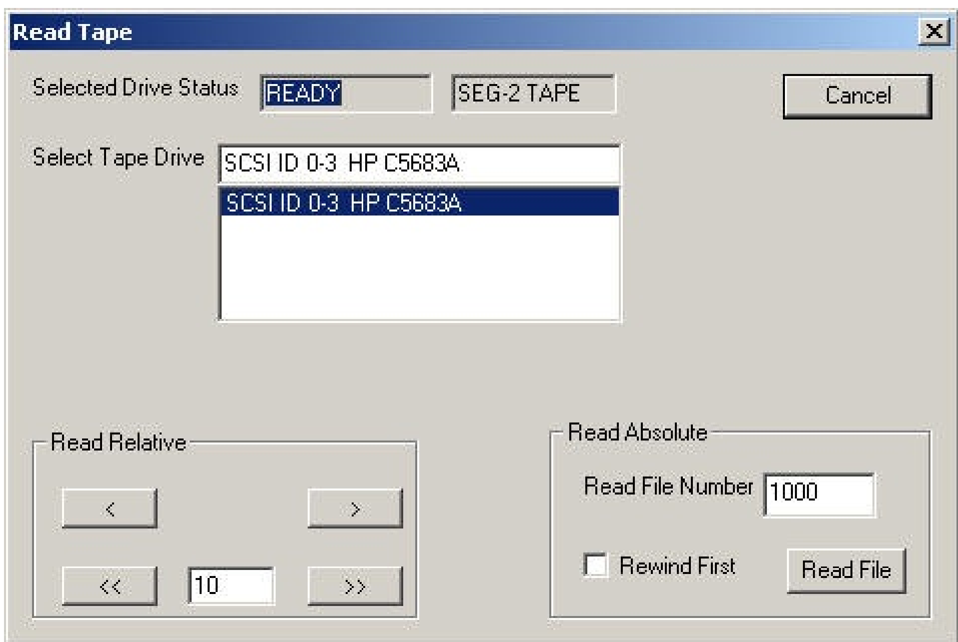
3.3.2 Tape Menu



The Tape menu allows you to navigate a tape for verification purposes or for transferring data to disk or another tape. If you have data on disk, you can use this menu to transfer it to tape. It also has functionality for stepping through SEG-Y files holding multiple shot records.

3.3.2.1 Read Tape





If more than one tape drive is connected, the above dialog box will display all tape drives with their SCSI ID numbers, vendor names, and model numbers in the Select Tape Drive list. Double-click the tape drive you would like to read data from. This operation will initialize the selected tape drive and display the status in the Selected Drive Status box. If there is no tape in the tape drive or if something is wrong with the tape drive, an error message will be displayed. Otherwise, the status will show READY and the SEG format found on the tape. You have two options to read tape files: Read Relative and Read Absolute. They are explained as follows:

- Read Relative – This operation reads a file relative to the current tape head position. Clicking on > reads the next file. Clicking on < reads the previous file. Clicking on >> or << reads the *n*th file relative to the current file forwards or backwards. Enter *n* in the box between the two buttons. The two sets of tape operations will be exactly the same if the entered number is 1.

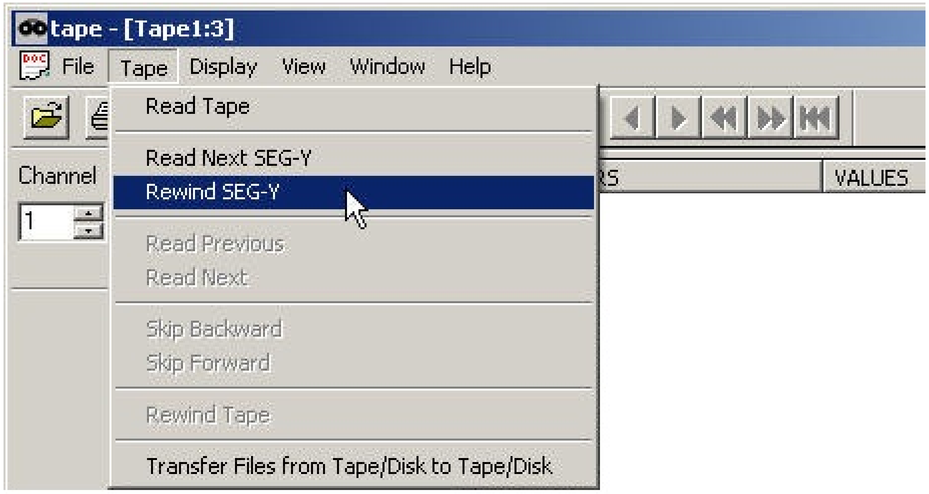
- Read Absolute – When you push the **Read File** button, this operation searches *forward* for the file name you enter in the Read File Number box. If Rewind First is checked, it will rewind the tape to the beginning before the search starts. This is necessary if the tape position is already past the file you wish to read.

All Read Relative operations can be also executed from the tool bar, or from the Tape menu shown below:

3.3.2.2 Read Next SEG-Y

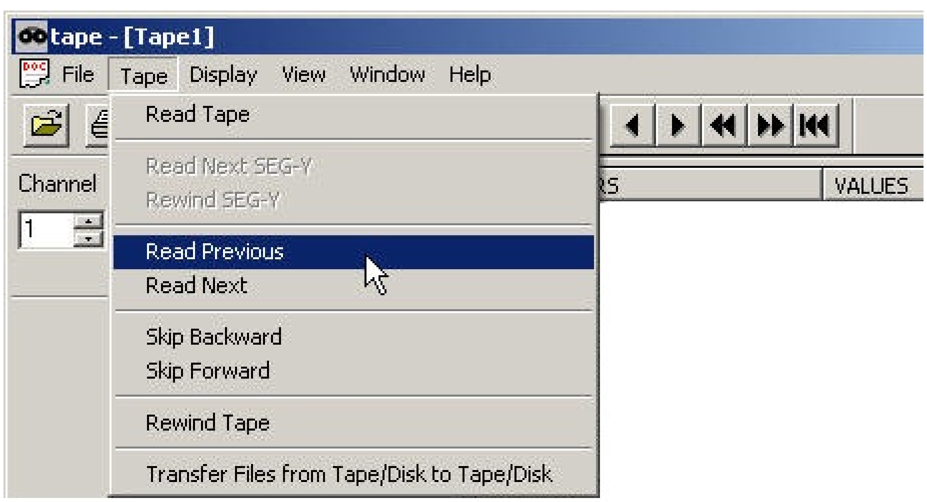
This function is exclusive to SEG-Y files *read from disk*. SEG-Y files are unique in that the same header is used for all shots taken with the same acquisition parameters; the header is only written once unless changes to acquisition parameters are made. Because of the way data is stored on disk (as opposed to tape), SEG-Y files are different from SEG-D or SEG-2 files. When writing SEG-D or SEG-2 to disk, a separate file is created for each shot. When writing SEG-Y to disk, *a single file is created containing many shots.* The Read Next SEG-Y command (and associated tool button) allows you to read in successive shot records after using the File >> Open command to read in a SEG-Y file.

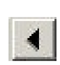
3.3.2.3 Rewind SEG-Y



Like the Read Next SEG-Y function, Rewind SEG-Y (and its associated tool button) is exclusive to SEG-Y files read from disk, and returns control to the first shot record in the file.

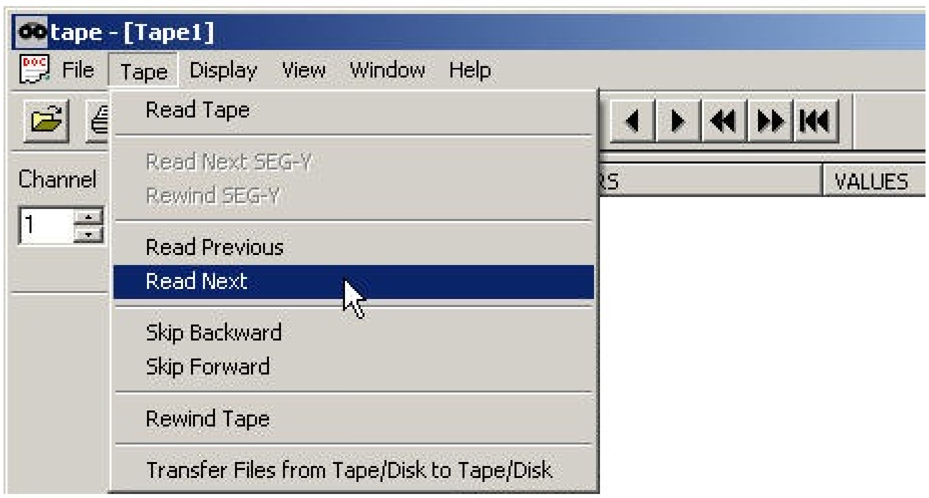
3.3.2.4 Read Previous





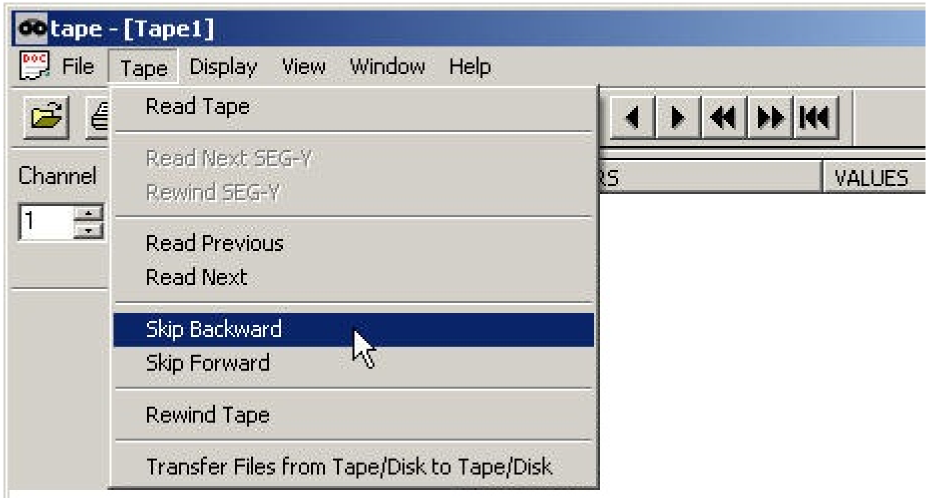
Same function as the  key in the Read Tape dialog; reads the next file relative to current tape position.

3.3.2.5 Read Next



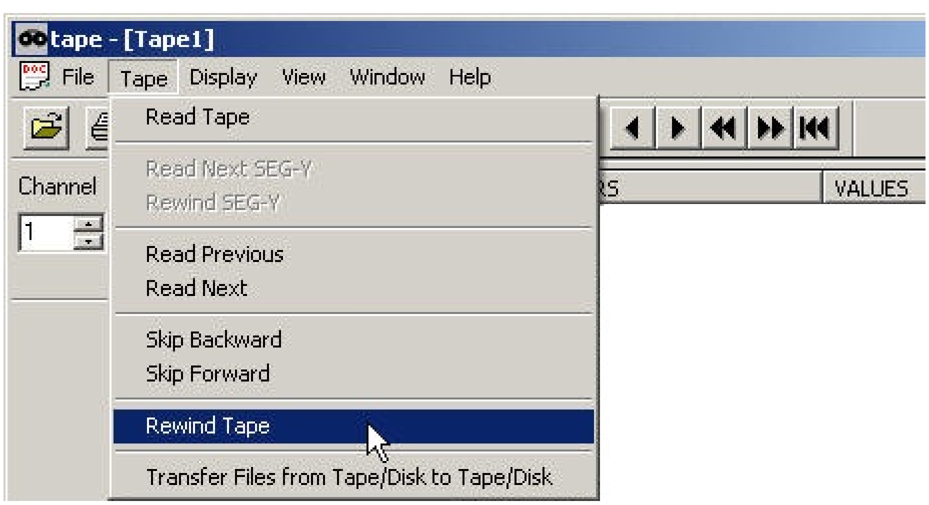
Same function as the  button in the Read Tape dialog.

3.3.2.6 Skip Backward



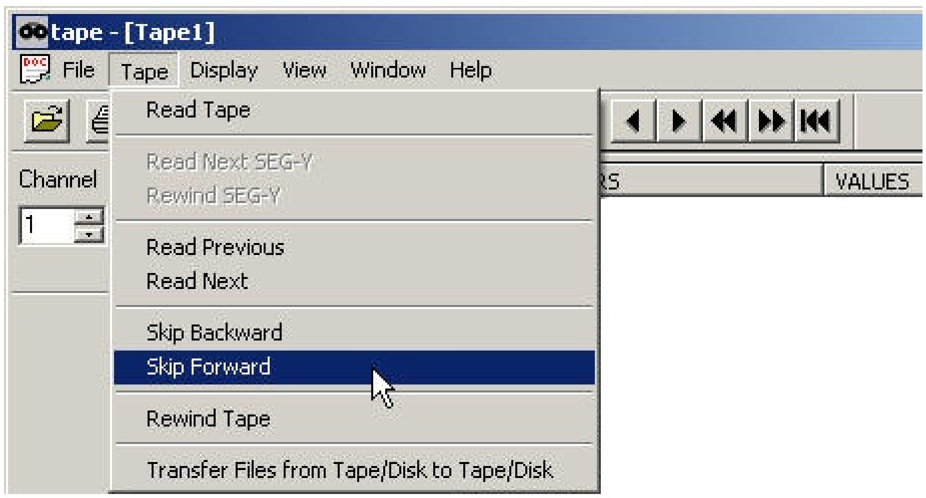
Same function as the  button in the Read Tape dialog.

3.3.2.7 Rewind Tape



Rewinds the tape to the beginning.

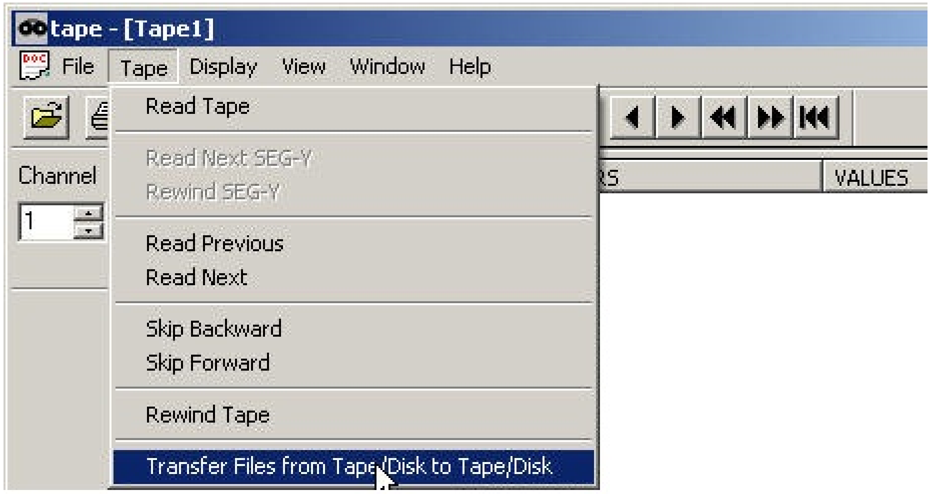
3.3.2.8 Skip Forward

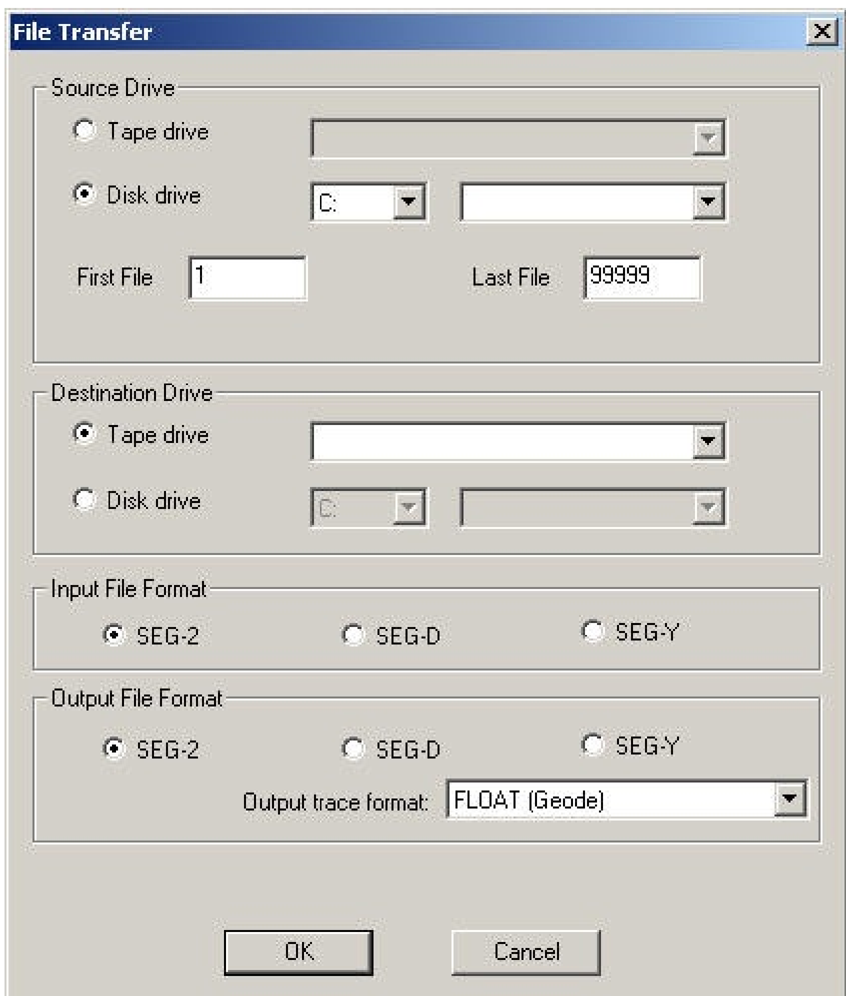


Same function as the 

key in the Read Tape dialog.

3.3.2.9 Transfer Files from Tape/Disk to Tape/Disk

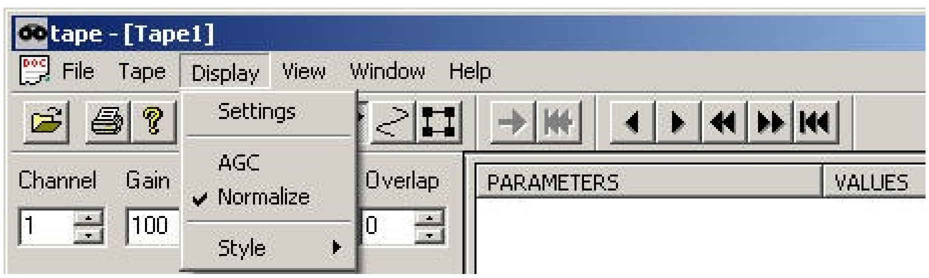




The Tape Reader can be used to transfer files between storage media, and to convert from one SEG format to another in the process. Indicate whether the Source Drive and Destination Drive are a Tape drive or a Disk drive. If it is a tape drive, indicate which one (if more than one are connected). If it is a disk drive, indicate the drive letter and path. Finally, indicate the Input File Format (the format of the existing data) and the Output File Format (the desired format of the data to be written to the destination drive). For SEG-2 and SEG-Y, you can choose an Output trace format of FLOAT or INTEGER. For SEG-D, choose 8058 rev 0 or 8058 rev 1 (recommended).

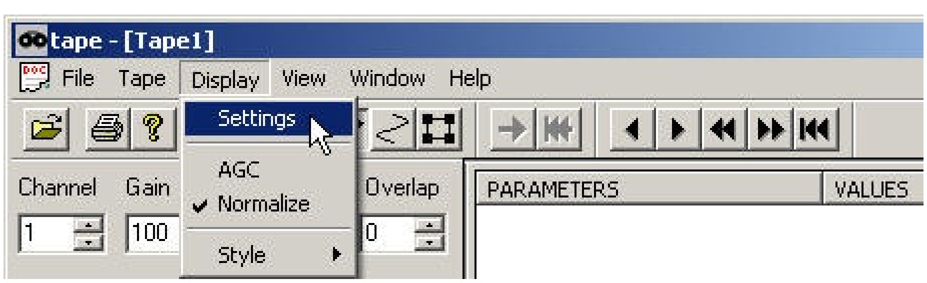
Note: *If you convert between formats,* ***do not*** *delete your original data. Some parameters do not transfer between formats, and depending upon the processing software you intend to use, incompatibilities may arise. The best practice is to* ***always keep*** *the original data files.*

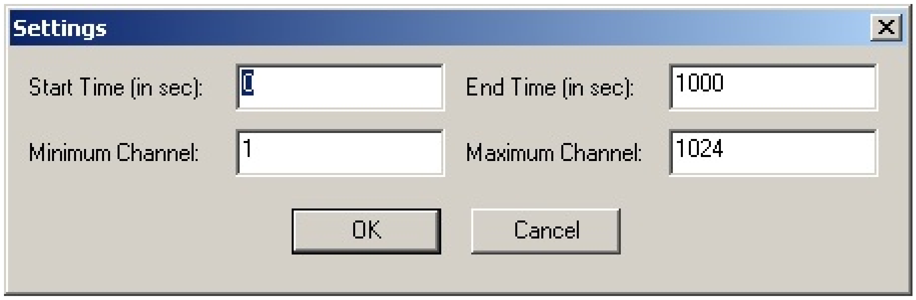
3.3.3 Display Menu



You may modify the shot display in a manner similar to that in the CNT-2 Controller.

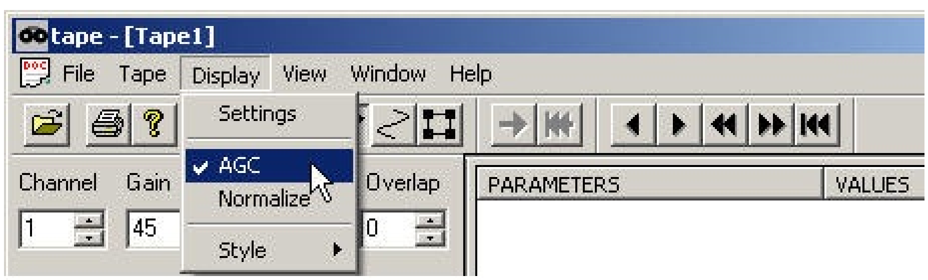
3.3.3.1 Settings





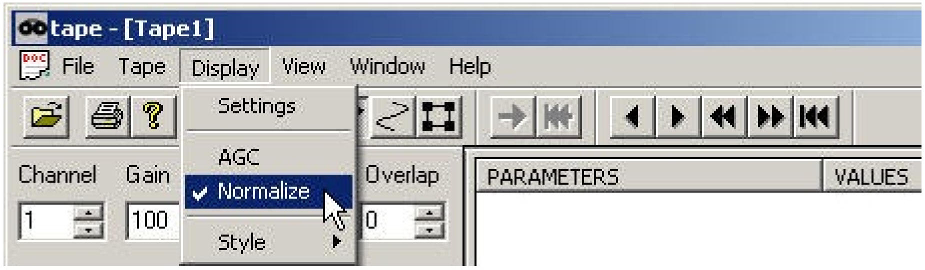
Set the time range and channel range that you wish to display in the Settings dialog.

3.3.3.2 AGC



AGC toggles automatic gain control on/off.

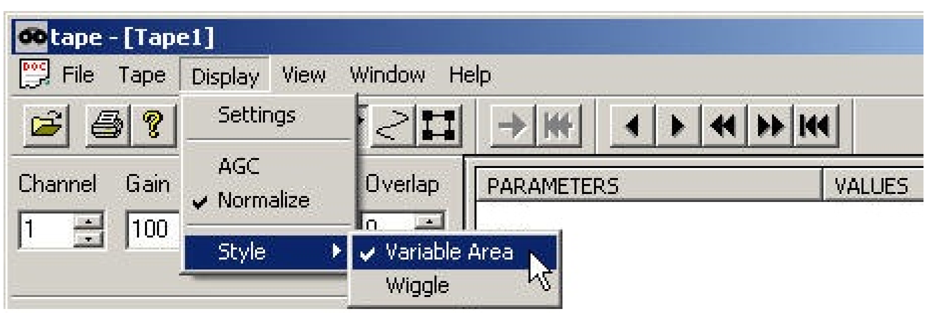
3.3.3.3 Normalize

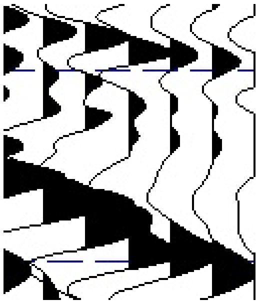


Normalize toggles trace normalization on/off.

Note: *If neither* AGC *nor* Normalize *is enabled, the software will revert to fixed gain. This is accomplished by clicking on the enabled gain style in the above menu or its corresponding tool bar button. For instance, if* Normalize *is enabled, clicking on it again will disable it but will not enable* AGC*. Instead, it reverts to fixed gain by default.*

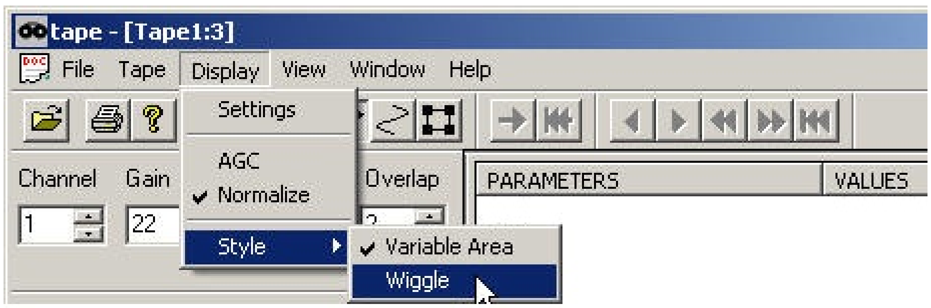
3.3.3.4 Style>>Variable Area

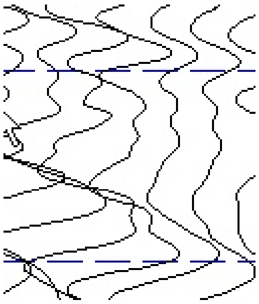


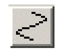


Variable Area displays data in the variable area trace style.

3.3.3.5 Style>>Wiggle

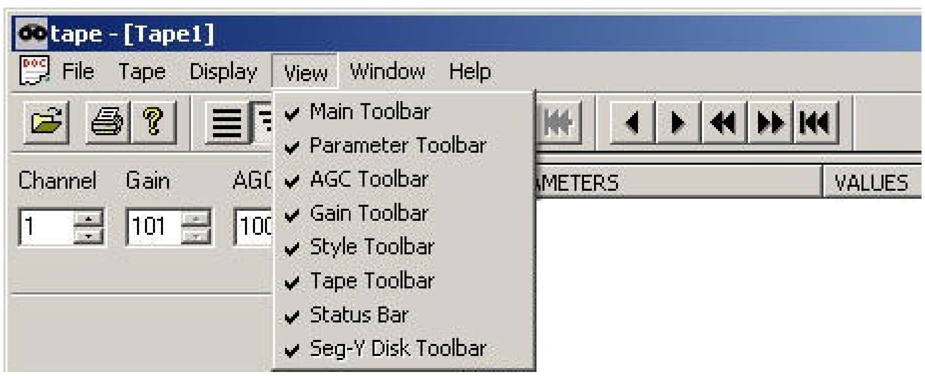






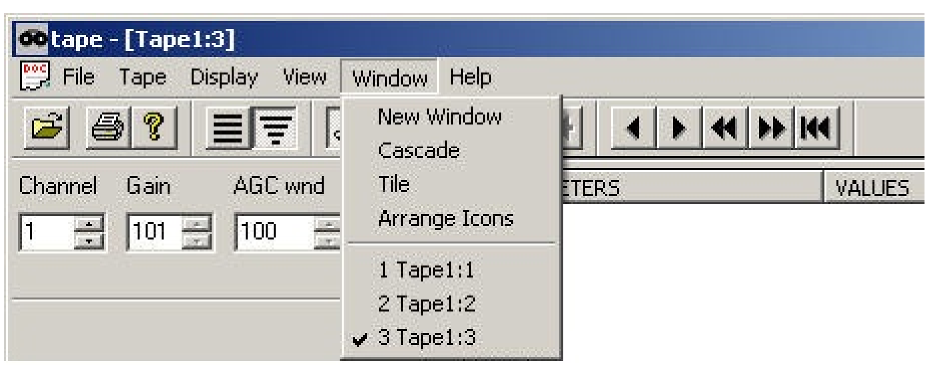
Wiggle displays data in the wiggle trace style.

3.3.4 View Menu



View toggles display of the various tool bars.

3.3.5 Window Menu



The Window menu contains standard Windows operations. New Window allows you to open multiple Shot windows.

3.3.6 Help Menu

Help displays the software version number.

Part IV

4 Troubleshooting

Note: *Avoid using the "reset/detect" command when troubleshooting. If used in the wrong instance, it can make a very simple problem much worse.*

4.1 Typical Issues

4.1.1 Leakage indicator LED is on / Leakage Reading over 200

Electrical leakage refers to current flowing where it is not supposed to (an electrical short). It can range from minor and to be ignored to major and disruptive to data acquisition. In the GeoEel and P-Cable systems, electrical leakage is most often caused by moisture or water ingress at connectors. The water provides a conductive medium though which current can flow, causing a short between conductors that are normally electrically isolated. Depending on the amount of current flow, corrosion may develop at the short. If not tended to, this will eventually ruin the connector. In the case of severe water ingress, false triggers or other phenomena can occur that may disrupt acquisition.

The leakage circuit inside the Deck Unit helps identify when there is water intrusion in the GeoEel or P-Cable system. It is very sensitive to extremely small amounts of moisture in the connectors. The LCD leakage indicator is on the front panel of the Deck Unit. There is also a red LED leakage light. The leakage light is sensitive to short-term spikes in resistance, such as what might occur if you make or break a powered connection somewhere in the system (not recommended). If the leakage light comes on, check the leakage LCD. If it is not showing significant electrical leakage, simply press the **Reset** button to turn off the LED.

The leakage number is displayed on the front panel of the Deck Unit and can range from -700 to 1300. **Typical leakage values range between 0 and 50. However, leakage values between -300 and 200 are usually acceptable for continuing operations as long as the current draw (amperage) does not increase significantly.** If the leakage increases steadily to 700 or more, this is indicative of water intrusion, and the problem should generally be dealt with to prevent undue damage to the leaking hardware, especially if accompanied by an increase in current draw. However, even at this point, it is not necessary to stop the survey unless data acquisition is being effected. Given the contrast between connector cost and vessel cost, leakage, unless severe, should be tracked down and corrected during acquisition down-time, such as during turns or weather delays, whenever possible. In some cases, depending on the severity and the components involved, you may even decide to sacrifice a connector or two rather than stop the survey. This is especially true in P-Cable deployments, where tracking down and mitigating leakage may take several hours.

At any rate, the main things to understand about the leakage indicator are:

- It is a diagnostic tool. If the system begins to malfunction in some way, and you have abnormally high leakage values, the problem is probably being caused by the leakage. If so, isolating and correcting the leakage will solve the problem.
- A high leakage indication is rarely a good reason to interrupt production. *It will only affect data quality if the leakage is at the analog inputs on the Active Sections, and water leakage here is*

relatively uncommon. So long as it is not affecting the data, it is often less costly in the long haul to live with it until you are down for weather or for some other reason. It almost never makes sense to stop and deal with it in the middle of a line -- wait until you get in a turn. Obviously, if it gets bad enough to affect system function, it must be dealt with immediately. Unless it involves the DC power circuit, which would be accompanied by an increase in current draw, it will probably not cause damage to the system.

You can convert the leakage indication to resistance in kOhm by the following formula:

$$R = \left(\frac{V}{90}\right) 70{,}000\ |L|^{-1.73}$$

The equation is graphed for three different voltages below (typical voltage is 60VDC).

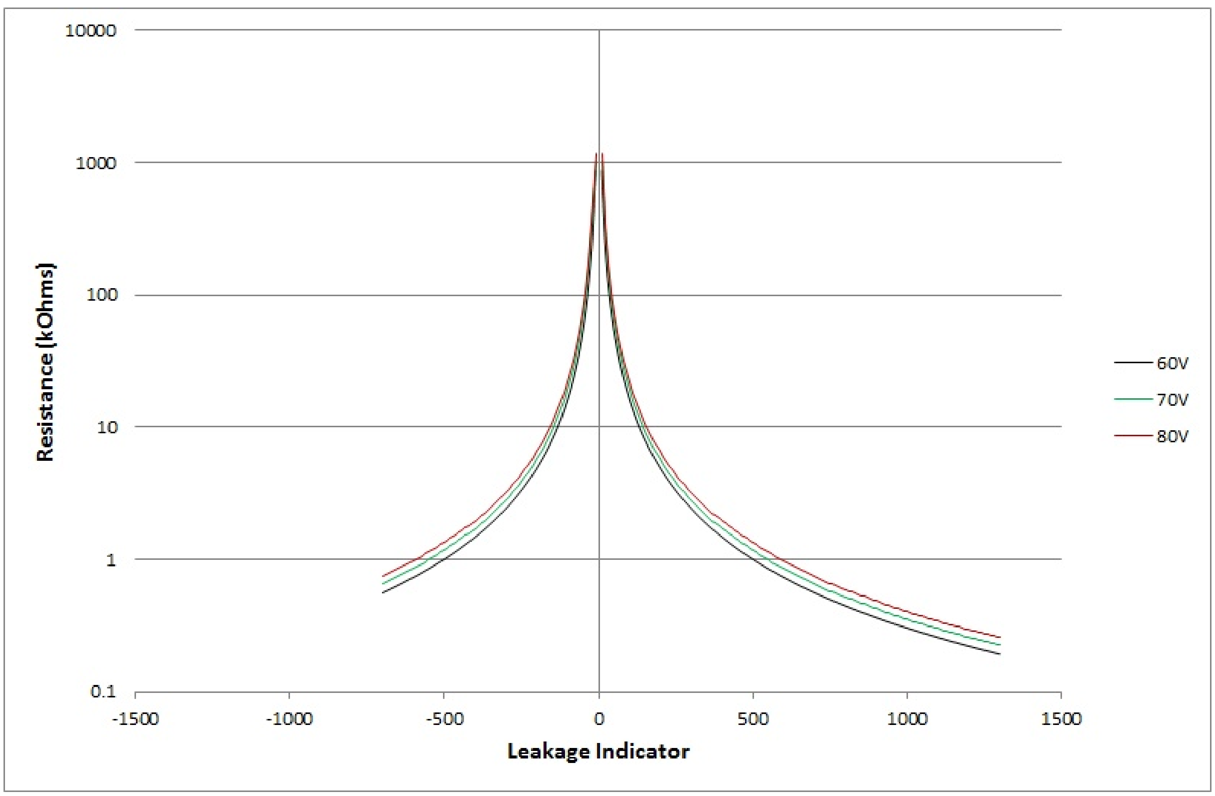


Figure 81: Converting the leakage indication to resistance.

4.1.2 Isolation and Mitigation of Leakage

Electrical leakage can be caused by several things:

- Damaged O-ring
- Water splash on an open connector
- Foreign matter in connector
- Incomplete connection
- Condensation, especially when air is warm and water is cold
- A short between wires somewhere, such as in a crushed Interconnect Cable.
- Moisture beneath the blue rubber pin-identifier in the male Glenair connector.

Most often, water is involved. In any case, often the most time-effective way of addressing a leaking component is to replace it with a spare and then solve the leakage problem in the lab.

Isolating leakage in a 3D system can be trickier, so 2D and 3D systems are discussed separately. Be sure to read the section on 2D systems, as much of it applies to 3D systems as well.

4.1.2.1 2D System

Possible Causes and Remedies:

1) There is a water leak somewhere. The location of a water leak can be difficult to isolate, but it is almost always at a connection. First, run a leakage test on the Controller. If all channels pass, that is an indication that it is not water intrusion inside a Streamer. Retrieve the Streamer slowly, stopping for a few moments as each connection comes on board, and watching the leakage LCD. When the leaking connection exits the water, you should observe a slow decrease in the reported leakage value. Re-submerging should cause the value to go back up. Once you have identified the leaking connection, disassemble and make sure that the O-ring is intact. If not, put one in (see section on connecting sections together in the Appendix). If so, remove, rinse the connection with distilled water, blow out with compressed air, re-grease or replace the O-ring, and reassemble. Submerge and test. If leakage persists, disassemble and *carefully* remove the blue rubber spacer (below) in the bottom of the connector (a toothpick is a good tool for this). Rinse, dry, and reassemble.

2) There is a dead short to the seawater. This is uncommon, but might happen if a piece of metal (perhaps a ball of solder) becomes lodged between a connector pin and the barrel or bulkhead. As opposed to a water leak described above, a short will be characterized by an instantaneous indication of a large leakage number. The best way to locate the problem is to disconnect components successively until the leakage goes away. *Note that you should power down the system prior to disconnecting and reconnecting components.* Once you have identified the problem component, inspect the connector for any foreign matter. If the cause isn't obvious, change out the component with a spare.

3) Some water simply splashed into the connector at some point, causing leakage between two pins. Rinse the connector in distilled water, dry it out with compressed air, and reassemble. If leakage persists, disassemble and *carefully* remove the blue rubber spacer (below) in the bottom of the connector. Rinse, dry, and reassemble.

Note: *When blowing out a connector with compressed air, take care not to dislodge the O-ring or the blue rubber spacer.*

If leakage varies up and down and does not remain a constant number there is a good chance that there is a problem with a hydrophone section. This will happen if there is a problem with a ground or power wire. This may also manifest itself as noise in the shot record. Run a leakage test; all sections should pass. Next, run a capacitance test. Make sure every channel is 230 ±20 nF. If one section reports low capacitance, there is a good chance it is causing the problem. Remove that section and see if the leakage disappears.

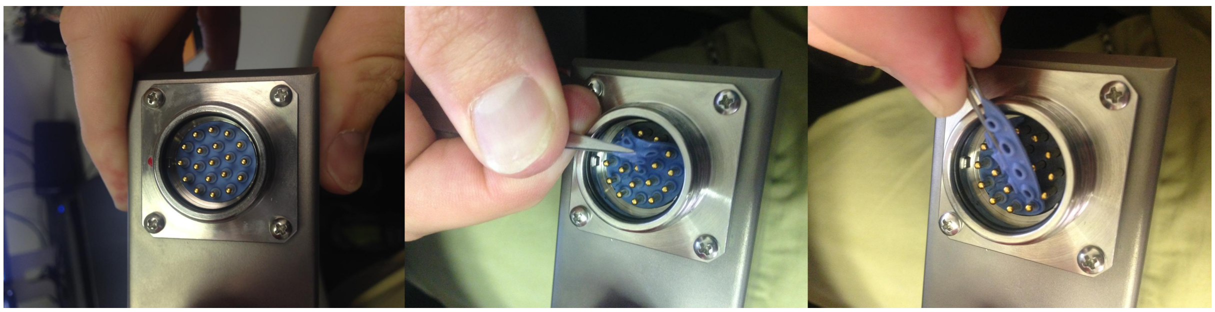


Figure 82: Removing the blue spacer in a Glenair connector.

4.1.2.2 P-Cable System

See the discussion on leakage isolation in the Switch Tests section of the GeoEel Tester chapter.

4.1.3 I am getting partial records

Partial records can occur if you have a bad trigger or network line. In either case, you must track down and replace the offending Digitizer or Active Section.

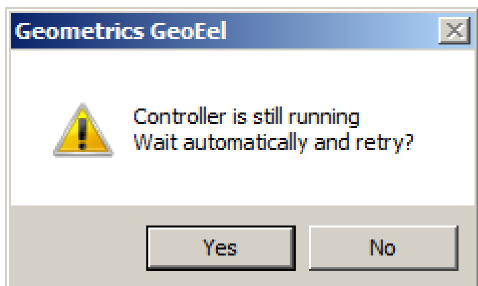
Partial records can also occur if you are shooting too fast. Digitizers do not all run at the exact same speed; some are inevitably slower than others. Before changing out sections, try slowing the shooting rate a little.

4.1.4 Deck Unit over-current light is on

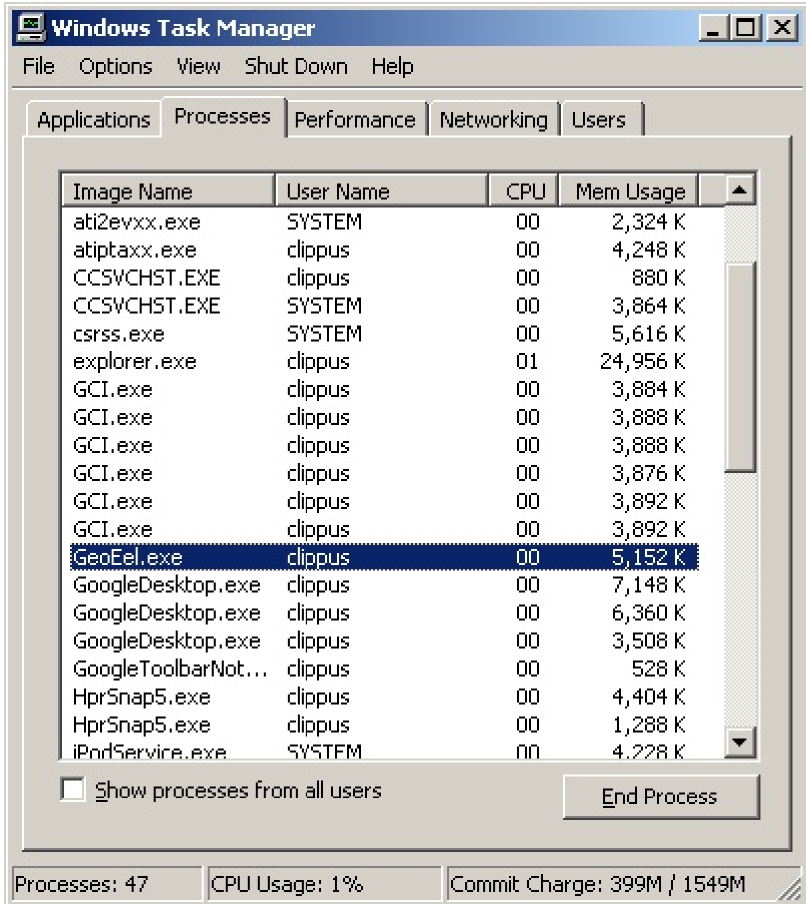
The over-current circuit, which includes the over-current LED, was designed to allow for a settable current indicator. The over-current LED is only an indicator that the current has surpassed a set value.

It does not prevent damage to the Deck Unit board set or any other electronics. The fuse inside the Deck Unit and the maximum current values are used in conjunction to provide the current limiting functions of the Deck Unit. These values are set at factory limits of a 10A fuse in the Deck Unit and a maximum current output from the provided power supply of 8A. For large systems, requiring higher currents, the over-current light is disabled as the circuit was not originally designed for it. Due to upgrades and other design changes the Deck Unit can be modified to allow for these large systems to operate safely and reliably, but the over-current circuit is unable to be modified due to the fact it is embedded in the boards. In other words, the over-current circuit is not useful in a modified Deck Unit.

4.1.5 "Controller is still running" message



When you shut down the CNT-2, it takes a few seconds for all of the threads to close. This is especially true if you are using tape drives. This message will come up if you start the CNT-2 too soon after shutting it down.   Choosing **Yes** will generally cause the program to launch and the above message will disappear. However, if you power down the Deck Unit before shutting down the CNT-2, the software may not shut down completely, and the above message will keep coming back every time you press **Yes**. If this happens, you must kill the GeoEel and GCI processes using the Task Manager. Press CTRL-ALT-DEL to bring up the Task Manager:



Under the Processes tab, Click on GeoEel.exe and choose End Process. Do the same for all occurrences of GCI.exe. You should now be able to restart the CNT-2.

4.1.6 "Deck unit not responding!" message

Possible causes and remedies:

1) The Deck Unit is not powered up. Shut down the software, power up the Deck Unit, wait 90 seconds, and restart the software.
2) The CNT-2 was started too soon after the Deck Unit was powered up. Wait 60 seconds and try again.
3) The network cable is disconnected or bad. Check and replace if necessary (the switch in the Deck Unit is auto-sensing; this can be a straight-through or crossover cable).
4) The IP address of the Controller PC is wrong. It should be set to 192.168.1.1.
5) The Deck Unit is in an unstable state. Shut down the software, cycle the power on the Deck Unit, wait 90 seconds, and restart the CNT-2.
6) The Deck Unit is connected to the wrong Ethernet port on the Controller PC. If you have more than one Ethernet port, you must make sure that the Deck Unit is connected to the one set to IP address 168.192.1.1.

4.1.7 "No sections detected" message

Possible causes and remedies:

1) The CNT-2 was started too soon after the Deck Unit was powered up. Close the Controller, wait 90 seconds and try again.
2) The network cable is disconnected or bad. Check and replace if necessary (the switch in the Deck Unit is auto-sensing; this can be a straight-through or crossover cable).
3) The IP address of the Controller PC is wrong. It should be set to 192.168.1.1.
4) The Deck Cable is not plugged into Deck Unit, or into the Tow Cable or slip-ring at the winch.
5) There is a problem with the slip-ring. Connect the Tow or Signal Cable directly to the Deck Cable.
6) There is a break in the cable somewhere before the first Digitizer unit. Make sure all connections are tight (see section in Appendix on connecting sections together).

4.1.8 "Eel(s) not responding with status" message

Possible causes and remedies:

1) There is a break in the cable somewhere. Make sure all connections are tight (see section in Appendix on connecting sections together). If you removed sections and wish to record on fewer channels, you must reset and detect sections.

2) One or more Digitizers were changed out and have the wrong IP address. Reset and detect sections.

3) One or more Digitizers are overheated (see note in section on powering up the system). Power down the Deck Unit and allow Digitizers to cool.

Note: *If you are testing the system functionality or communication with other systems, it may not be convenient to shut down all of the hardware, because you need at least one functioning A/D board for the system to be 100% functional. In this event, you can shut down all but the AUX channels, which are installed in the Deck Unit and are not disposed to overheating. This will allow you to continue testing of things like serial communication, writing data to tape or RAIDS, triggering the system with the navigation system or gun controller, etc., without the headache of the system continually overheating. To do this, shut down the CNT-2 Controller and set the* nAcqs *registry key to 1 (see section in Appendix on registry settings). Restart the CNT-2, and only the AUX channels will come on. When testing is complete, simply set the registry key back to the original number. The other way to accomplish this would be to shut down the Deck Unit, unplug the Streamer, and power up the Deck Unit. Only the AUX channels will be found, and testing can continue as discussed above.*

4.1.9 System hangs upon reset

Possible causes and remedies:

Try rebooting the Controller PC.

4.1.10 Shot display shows fewer channels than expected

Possible causes and remedies:

1) The Start Channel and End Channel display parameters are inconsistent with the current GeoEel configuration. Go to the Display/Print >> Shot Parameters menu and update these parameters.

2) The Start Channel and End Channel acquisition parameters are inconsistent with the current GeoEel configuration. Go to the Acquisition >> Active Channels menu and update these parameters.

3) The Working Group Interval is larger than it should be. You will have fewer channels displayed if the Working Group Interval is larger than the Native Group Interval. In general,

# of channels = (# Digitizers)(8)* (Native Group Interval / Working Group Interval)*

4) Some Digitizers were not detected and assigned IP addresses during the Detect Sections process. Alternatively, changes were made to the Streamer (Digitizers replaced or moved), and their IP addresses don't match their position in the Streamer. Go to the Configure>>GeoEel menu and press **Reset** and then **Detect Sections.**

4.1.11 Blocks of data appear out of order on the shot record

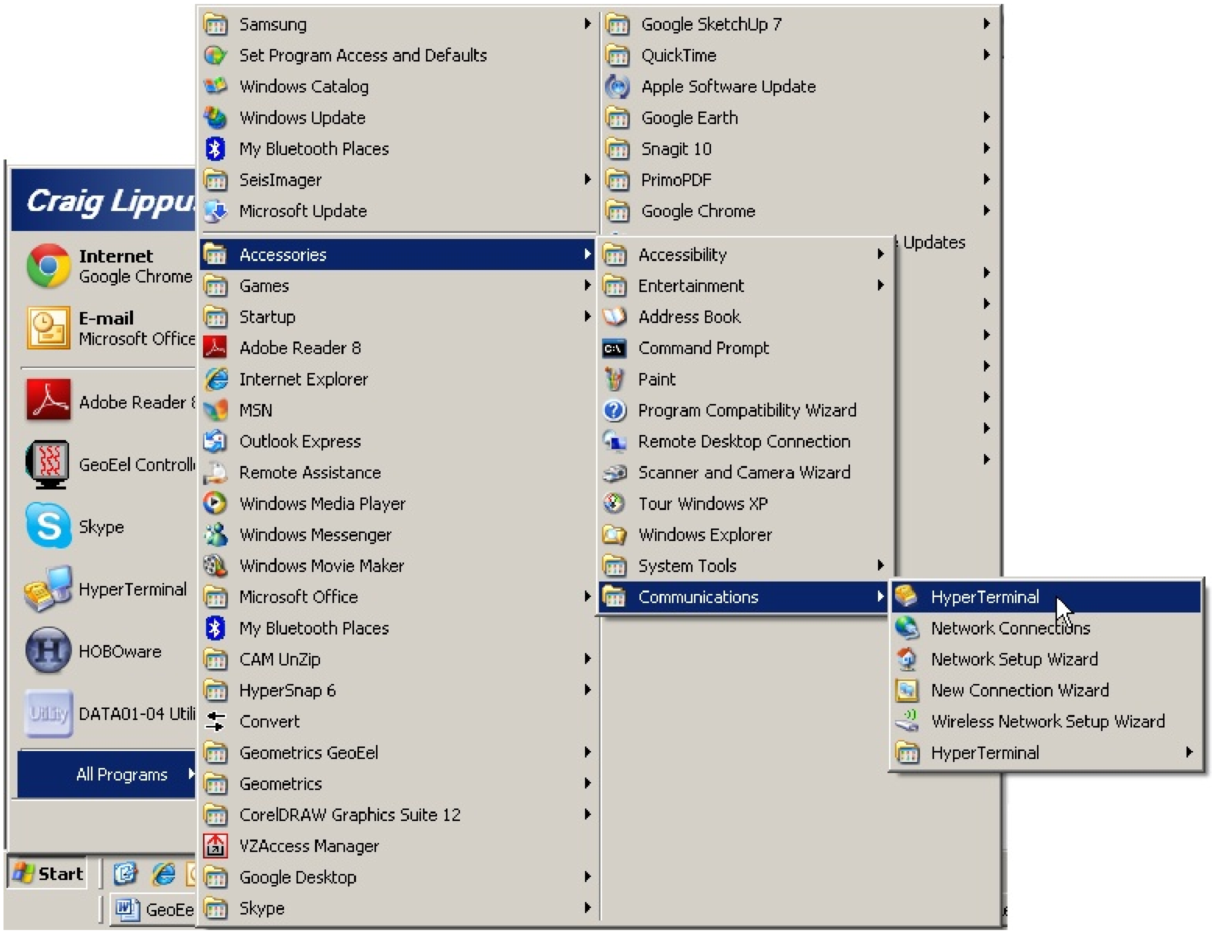
Possible causes and remedies:

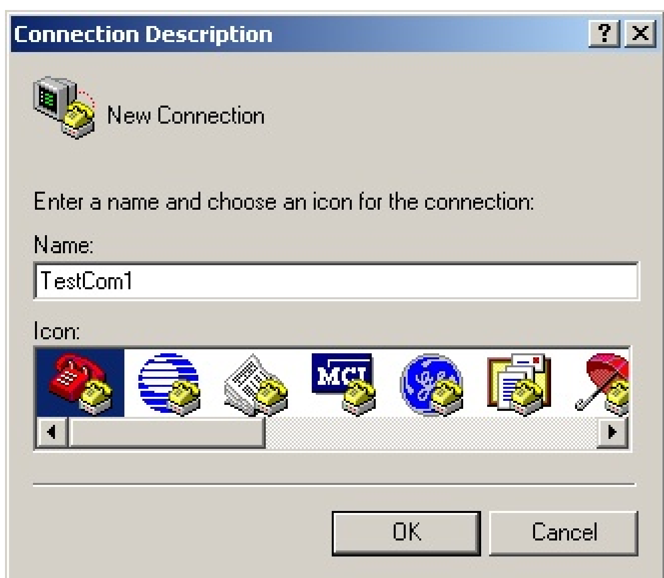
Two or more Digitizers are out of order in the Streamer. This can happen if you Detect Sections and then switch the locations of Digitizers. Either put them back to where they were or go to the Configure>>GeoEel menu and press **Reset** and then **Detect Sections.**

4.1.12 "No serial string detected" warning is displayed

Possible causes and remedies:

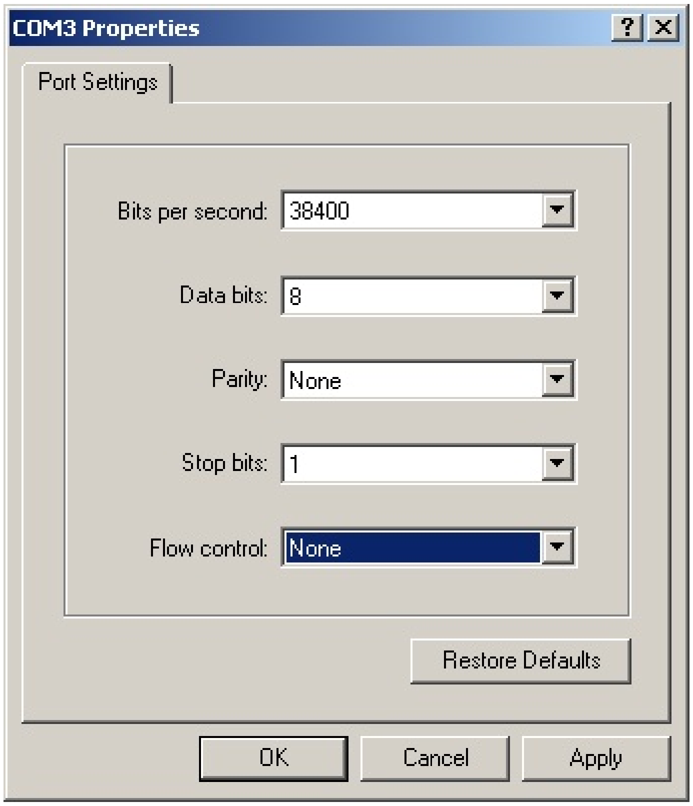
The first thing to check is whether or not the serial string is being received by the Controller PC. For this, use the Hyperterminal tool in the Accessories menu:


Craig Lippu
Internet
Google Chrome
E-mail
Microsoft Office
Adobe Reader
GeoEel Controll
Skype
HyperTerminal
HOBOware
DATA01-04 Utili
All Programs
Start
GeoEe
Samsung
Set Program Access and Defaults
Windows Catalog
Windows Update
My Bluetooth Places
SeisImager
Microsoft Update
Accessories
Games
Startup
Adobe Reader 8
Internet Explorer
MSN
Outlook Express
Remote Assistance
Windows Media Player
Windows Messenger
Windows Movie Maker
Microsoft Office
My Bluetooth Places
CAM UnZip
HyperSnap 6
Convert
Geometrics GeoEel
Geometrics
CorelDRAW Graphics Suite 12
VZAccess Manager
Google Desktop
Skype
Google SketchUp 7
QuickTime
Apple Software Update
Google Earth
Snagit 10
PrimoPDF
Google Chrome
Updates
Accessibility
Entertainment
Address Book
Command Prompt
Paint
Program Compatibility Wizard
Remote Desktop Connection
Scanner and Camera Wizard
Tour Windows XP
Windows Explorer
System Tools
Communications
HyperTerminal
Network Connections
Network Setup Wizard
New Connection Wizard
Wireless Network Setup Wizard
HyperTerminal


Connection Description
New Connection
Enter a name and choose an icon for the connection:
Name:
TestCom1
Icon:
MCI
OK
Cancel

Type in a name and press **Ok**:

Choose the appropriate COM port for the drop-down list and press **Ok**:



Set the serial protocols and press **Ok** ("flow control" should be set to NONE).

If the Controller PC is receiving serial strings on that COM port, and if you have the serial protocols set to match those of your serial output device, you should see the strings coming in the Hyperterminal window. If not:

Possible causes and remedies:

1) The serial cable is disconnected or bad. Check and replace if necessary.
2) The serial cable is connected to the wrong port on the Controller PC. Make sure it is plugged into the port indicated in the Serial Input dialog box. Conversely, make sure that you have chosen the right port number.
3) The serial input parameters entered in the Serial Input dialog box are inconsistent with those of the serial device.
4) The serial port is being used by another device. Try a different port.
5) The serial string is not being sent. Double-check your serial device.

If Hyperterminal indicates that the PC *is* receiving serial stings, but the CNT-2 software is still not receiving them, the most likely cause is that the Time Window is too small. Set the TimeWindow registry key to a larger number and try again.

Note: *If, as indicated by Hyperterminal, a serial string is being received by the PC, you will receive a string with the Get a Serial String command. However, this does not necessarily mean that a string will be received when you are triggering and recording data. The above command simply grabs the last serial string in the RS-232 buffer, no matter how old it is. In production, a serial string is only recorded if it arrives close enough in time to the trigger time (as set by the Time Window).*

Note: *For current versions of Windows, you will have to purchase Hyperterminal. It no longer is supplied with Windows.*

4.1.13 Serial strings appears corrupted

Possible causes and remedies:

This is generally caused by having one or more of the following parameters set incorrectly in the Serial Input dialog box: Baud Rate, Byte Size, Parity Bit, Stop Bits. These parameters must match those of the serial device you are using.

4.1.14 Serial strings are intermittent

Possible causes and remedies:

The most likely cause is that the Time Window is not quite long enough, resulting in some strings getting through and others being rejected. Set the TimeWindow registry key to a larger number and try again (see section on registry settings).

4.1.15 Software is unstable or behaving strangely

Possible causes and remedies:

The registry is corrupted. Shut down the software, delete the .prm files in the [drive]:\Logfiles folder, and delete the registry key. Restart the software. The registry keys will be re-created. Note that any registry settings you have made manually, such as TimeWindow or nAcqs, will need to be updated.

4.1.16 Tape drive not seen

Possible causes and remedies:

1) The tape drive is not powered up, or was powered up after the Controller PC; it must be powered up before the Controller PC.
2) There is a problem with the SCSI cable. Make sure it is plugged in correctly. Carefully check the connector pins, as they are easily bent.
3) Make sure a terminator is installed on the last tape drive in the chain. Check the pins on the terminator as well.
4) The tape drive is set to the wrong SCSI address. Each drive must have a unique SCSI ID setting; it should be either, 2, 3, 4, 5 or 6. Often, tape drives require that they be shut off and turned back on before the change in ID setting takes effect.

Regardless of the reason, if a tape drive is not seen by the Controller PC, you must take the following steps once the problem has been solved:

1) Turn off the tape drive.
2) Shut down the CNT-2 Controller.

3) Power down the Controller PC.

4) Power up the tape drive(s).

5) After 30 seconds, power up the Controller PC.

As the system boots, you will see the visible SCSI devices reported (this is the text that scrolls by during the boot process; you may see a SCSI hard disk listed, then you should see the tape drives.)

4.1.17 Trigger is late

Possible causes and remedies:

There are two trigger inputs on the Deck Unit. If you are using a TTL trigger, you must make sure to plug into the correct TTL connector. A TTL trigger is like a boxcar function; a positive TTL (TTL+) has a rising leading edge, while a negative TTL (TTL-) has a falling leading edge:

Figure 83: Positive and negative TTL pulses.

The TTL signal will have a time duration of *t* (usually 10-200ms). The TTL+ connector on the Deck Unit will trigger the system upon arrival of the rising edge, and the TTL- will trigger on the falling edge. If you plug a TTL+ signal into the TTL- connector, the system will trigger on the *falling* edge, which arrives at a time *t* after the rising edge; your trigger will be “late” by a time equal to the width of the TTL pulse. Likewise, if you plug a TTL- signal into the TTL+ trigger, the system will trigger on the *rising* edge, which again is late by time *t*. Either way you end up with a late trigger.

4.1.18 System doesn’t trigger

Possible causes and remedies:

1) System is not armed. Press the **F1** key to arm.
2) Trigger cable is disconnected or bad. Check and replace if necessary.
3) You are using a contact closure to trigger and you are plugged into the TTL+ connector on the Deck Unit. Plug the trigger into the TTL- connector.
4) A trigger signal is not being received. Test your triggering device with an oscilloscope, or by connecting the trigger signal to an AUX channel, triggering the GeoEel manually, and then triggering the triggering device while the GeoEel is recording.
5) There is something wrong with the trigger circuit on the Deck Unit. Use a paperclip to short the TTL- connector on the Deck Unit. If this triggers the system, then a contact closure into the TTL- connector should work.

4.1.19 We are missing shots

Possible causes and remedies:

This usually happens when you are firing too fast. Try reducing the firing rate. The time between triggers should be greater than the record length.

4.1.20 Data are excessively noisy

Possible causes and remedies:

1) If the noise is low frequency, the most common cause is cable strumming. This will be concentrated at the inboard end of the Streamer (low-numbered channels) and usually be of 10 Hz or less. It can be mitigated by installing fairing on the Tow Cable and/or applying low cut filters (see section on shot display parameters).

2) Another cause may be that the Streamer is too heavy, requiring a large bird wing angle to keep the Streamer at the desired depth, causing turbulent flow around the wings and putting noise into the channels nearest the bird. Be sure to install floats on the birds and Digitizers as necessary. See section in Appendix on Streamer deployment for advice on optimal Streamer deployment.

3) The seas are extreme. Depending on the situation, you may have to simply shut down and wait for better conditions. If this is not an option, then a combination of low cut filters (see section on shot display parameters) can be tried. A Stretch Section will minimize the effects of heave. Also try towing the Streamer at a greater depth.

4) If the noise is concentrated in the first few channels, the leading bird may be requiring an extreme wing angle to keep the Streamer at the desired depth, causing turbulent flow around the wings and putting noise into the channels nearest the bird. In the case of a long Tow Cable and/or low tow point, the bird could be struggling to keep the Streamer afloat. In this case, a small buoy on the Tow Cable will be helpful. In the case of a shorter Tow Cable and/or a high tow point, the bird may be doing just the opposite – struggling to keep the Streamer at depth. In this case, adding weight to the Tow Cable will help. This is usually done with weighted rope or lead tape.

4.1.21 Overdriven channels (as indicated by red traces)

Possible causes and remedies:

1) The source is too powerful for the offset and/or preamp gains you are using. This problem will be concentrated on the near channels, and won't appear when you do a noise test. Adjust shot offset and/or preamp gains as necessary.

2) The sea state is extreme. The problem will occur generally throughout the length of the Streamer and will be apparent on a noise test. Turn down the preamp gains.

3) There is excessive strumming of the Tow Cable. In this case, clipped traces will be concentrated at the inboard end of the Streamer and will be apparent on a noise test. The best remedy is to install fairing on the Tow Cable.

4.2 Networking

The following table summarizes the IP addresses of the various components in the system.

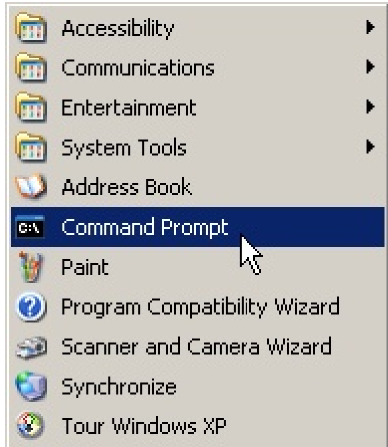
Ethernet IP Addresses	
Controller PC	192.168.1.1 (with subnet mask 255.255.255.0; this must be set by the user (fixed).
Deck Unit	192.168.1.2 (fixed).
Deck Unit depth option	192.168.1.251 (fixed).

Ethernet IP Addresses	
Digitizer (immediately after reset)	192.168.1.254 (dynamic, set when Reset command is executed).
Digitizer (during survey)	192.168.1.XX, where XX is the place of the Digitizer in line +2, i.e. Digitizer #1 is 192.168.1.3 (dynamic, set automatically by Detect Sections function).
AUX channels board	192.168.1.253 (fixed).
Junction Box (P-Cable only)	192.168.1.XX, where XX = serial # of Junction Box minus 6100 (no power relays in Junction Boxes). OR 192.168.3.XX, where XX = serial # of Junction Box minus 7100 (power relays in Junction Boxes).
Tail Compass/depth module	192.168.2.XX, where XX = serial # of Tail Module minus 8000

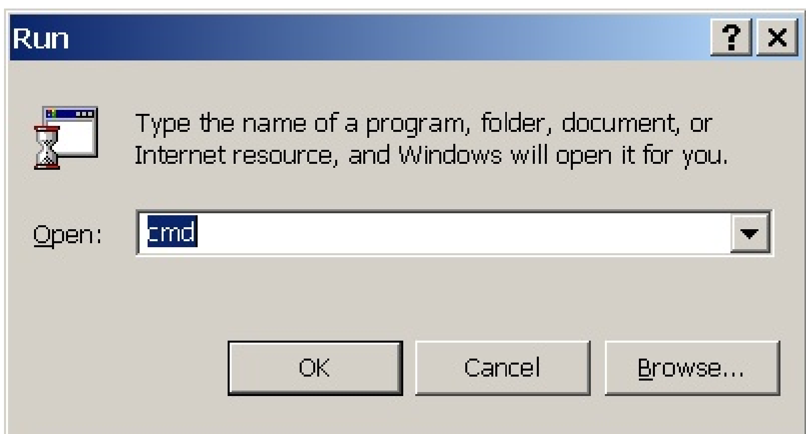
Table 6: IP addresses used in various GeoEel and P-Cable components.

4.3 Testing Using the Command Prompt

It is often useful to use the command prompt to check communication with various components of the system. The command prompt can usually be found in the Windows Accessories menu, and looks like this:



An alternate way to open the command prompt is to click on Start >>Run; type “cmd” in the Run dialog box; and click on the **Ok** button as shown below.



To ping an IP address, type “ping xxx.xxx.x.x” at the command prompt:

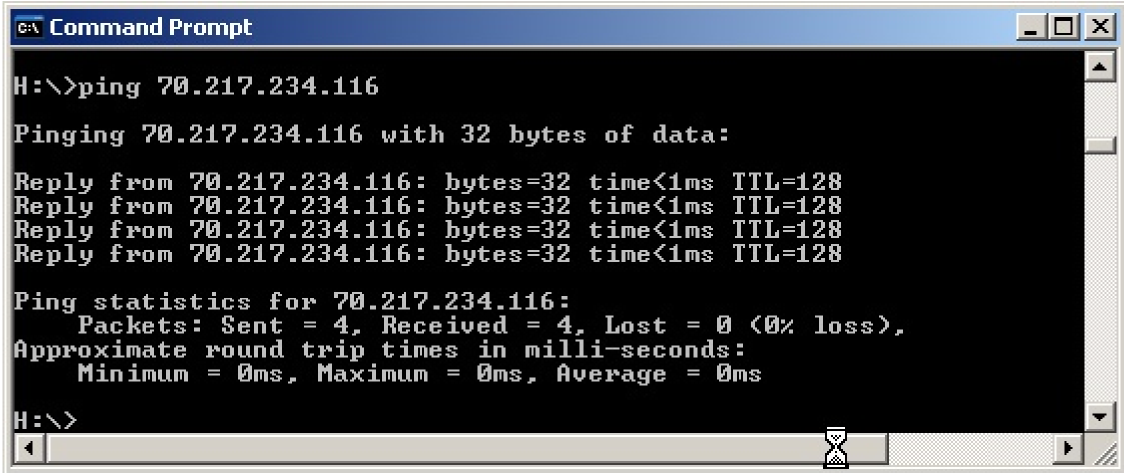


Figure 84: Successfully pinging an IP address in the command prompt window.

If you get replies like those shown above (the actual IP address shown is just an example), you have communication with that IP address. If you do not have a connection, you will see something like the following:

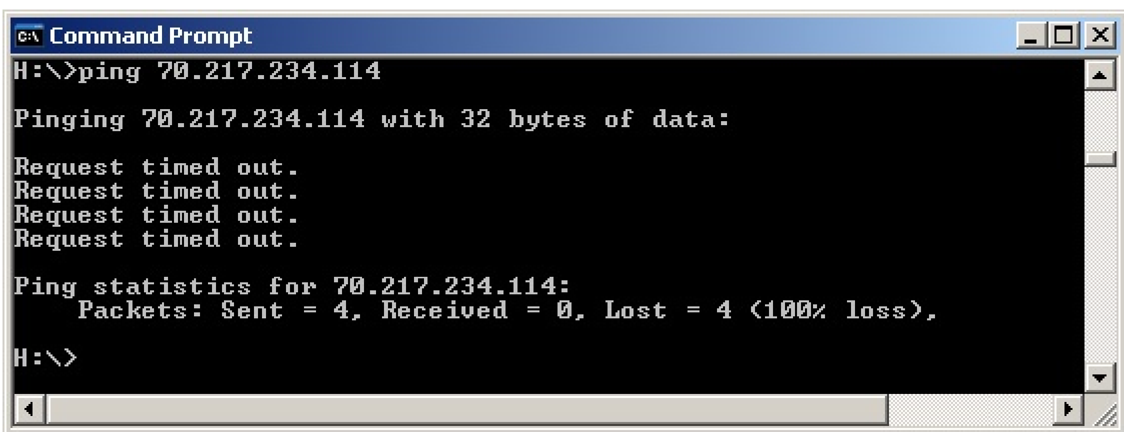


Figure 85: Failed ping attempt.

You can determine whether your IP configuration is correct or not by typing “ipconfig” at the command prompt. You should see something like the following:

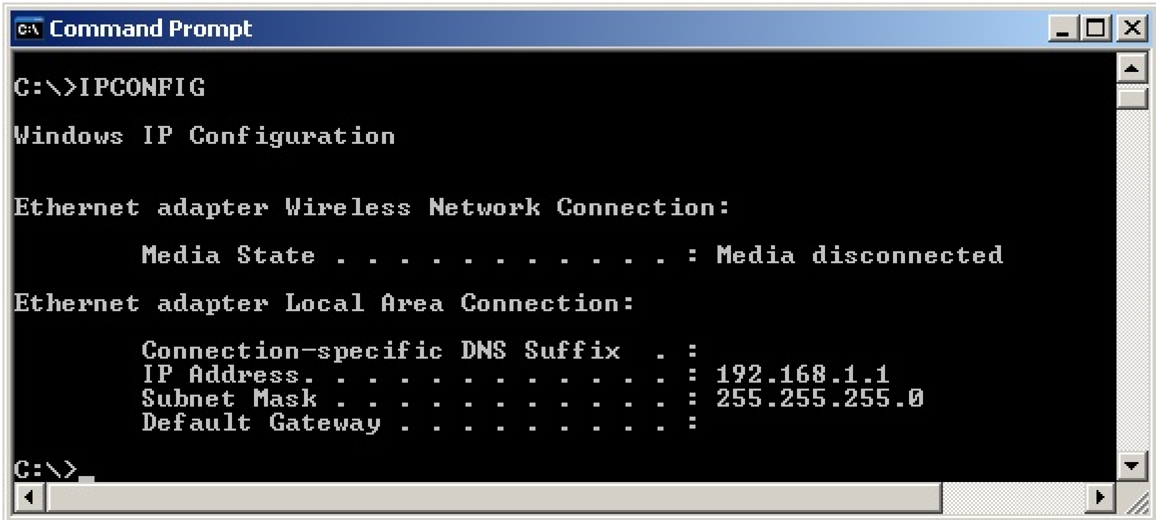


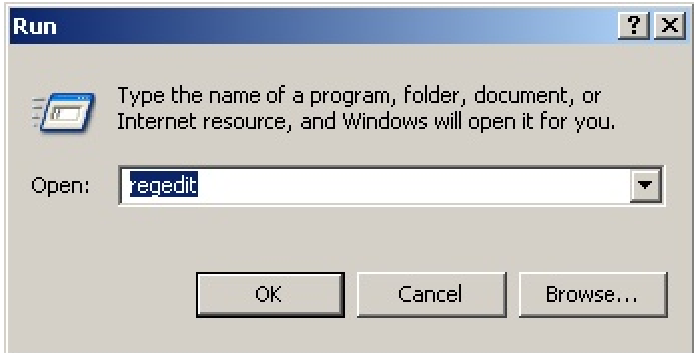
Figure 86: Confirming IP configuration of Controller PC using "ipconfig" command at the command prompt.

4.4 Deleting a Registry Key

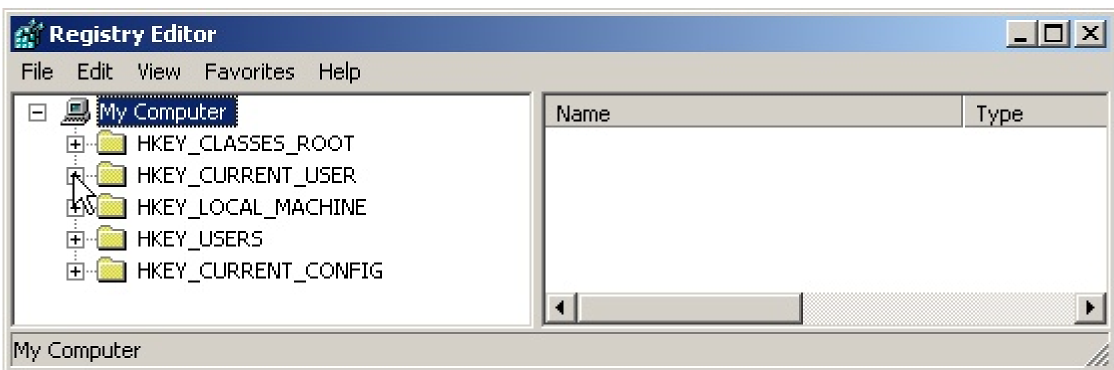
The CNT-2 Marine Controller uses registry keys to store information about the system and about some program behavior. It uses .prm files to store specific information about a particular survey. Should the program behave in an unpredictable manner, it can be helpful to delete the .prm files and the registry key after the program closes and before it is started again. The .prm files are stored in [drive:]\Geometrics\GeoEel and [drive:]\Logfiles.

To delete the registry key, click on the Windows Start button, 

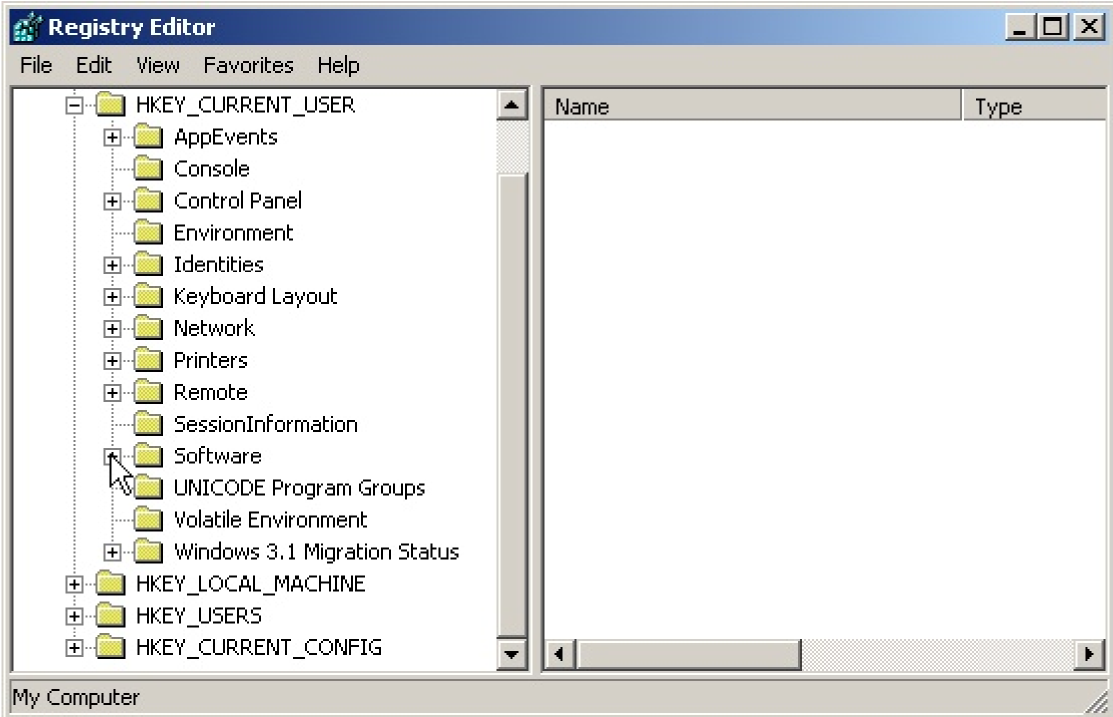
choose Run, and type in "regedit":



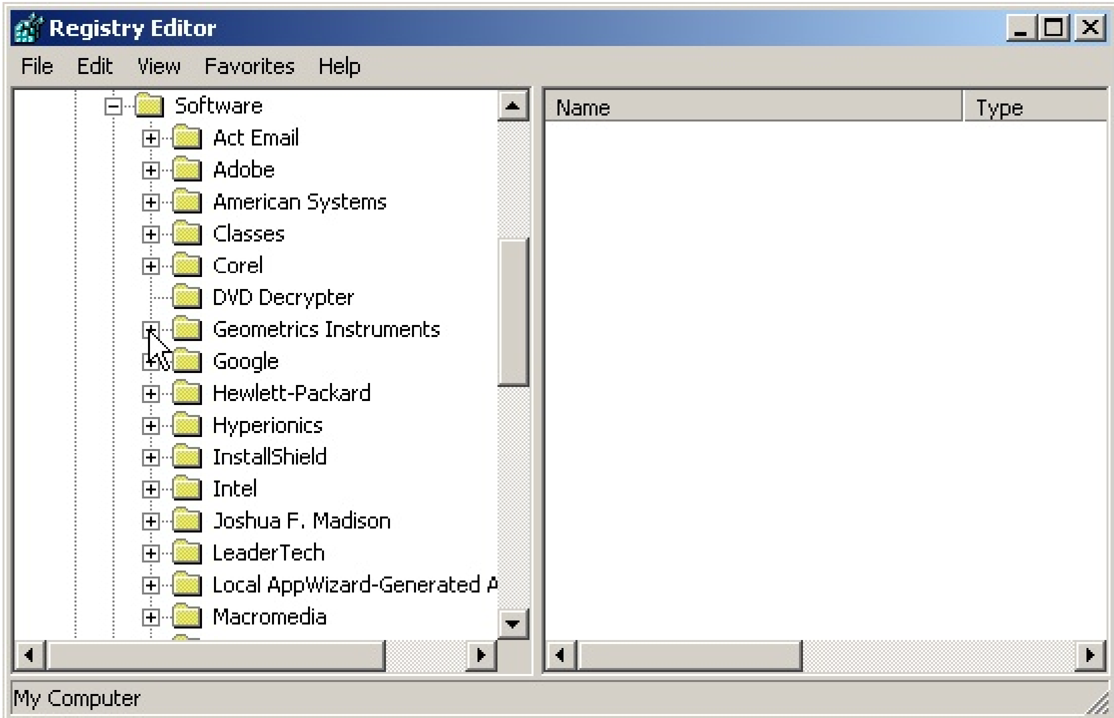
Next, click on the "+" next to HKEY_CURRENT_USER,



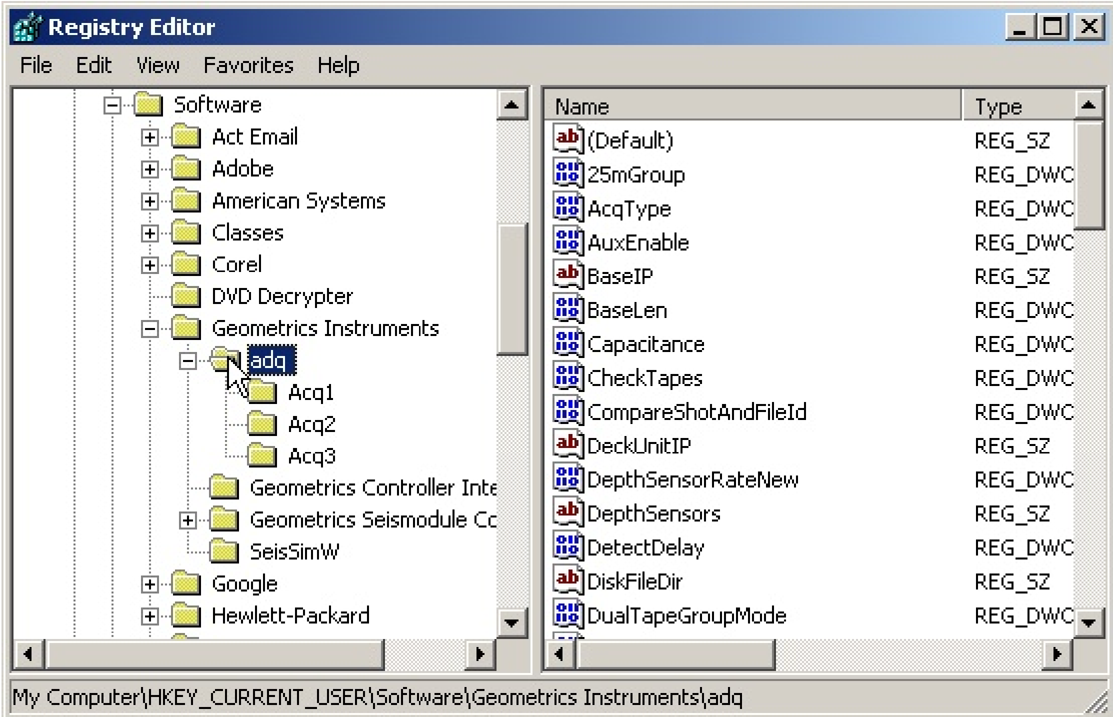
then on the "+" next to Software,



Geometrics Instruments,



and you should see a folder called adq. Click on this folder to display its contents:



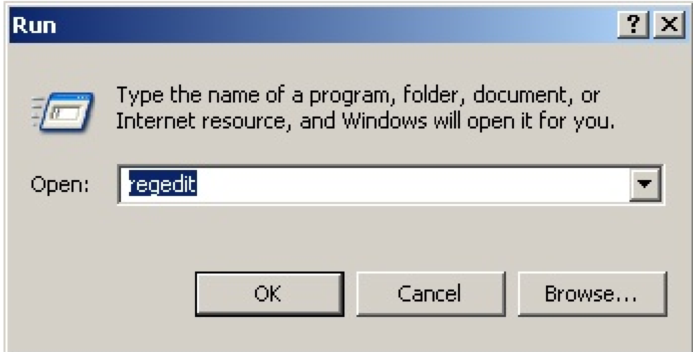
Highlight the adq folder and press the delete key. Deleting this registry key before the program starts, along with the .prm files, will return the program to factory settings.

4.5 Registry Settings

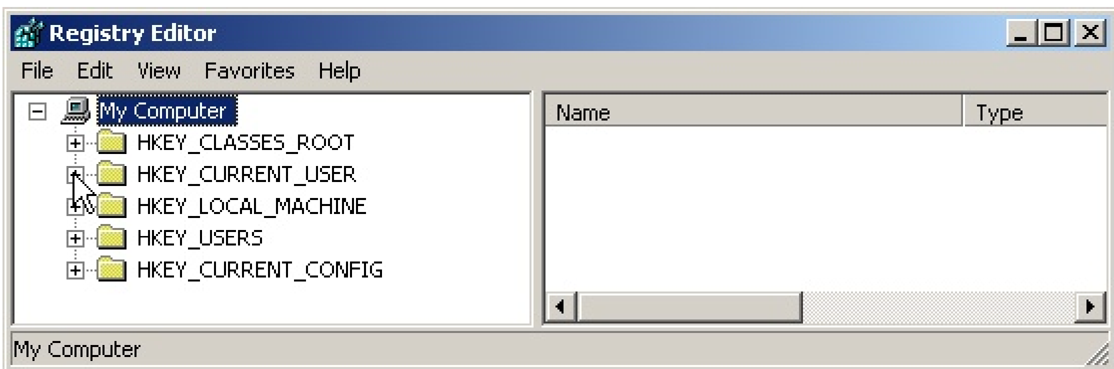
Some parameter settings are usually best left alone, and are therefore not available in the menus. Nevertheless, if necessary, and with *extreme care*, you can make changes to certain parameters at the registry level. To do so, follow the instructions below ***exactly.*** Any deviation could cause significant problems with Windows.

To get to the GeoEel section of the registry, do the following.

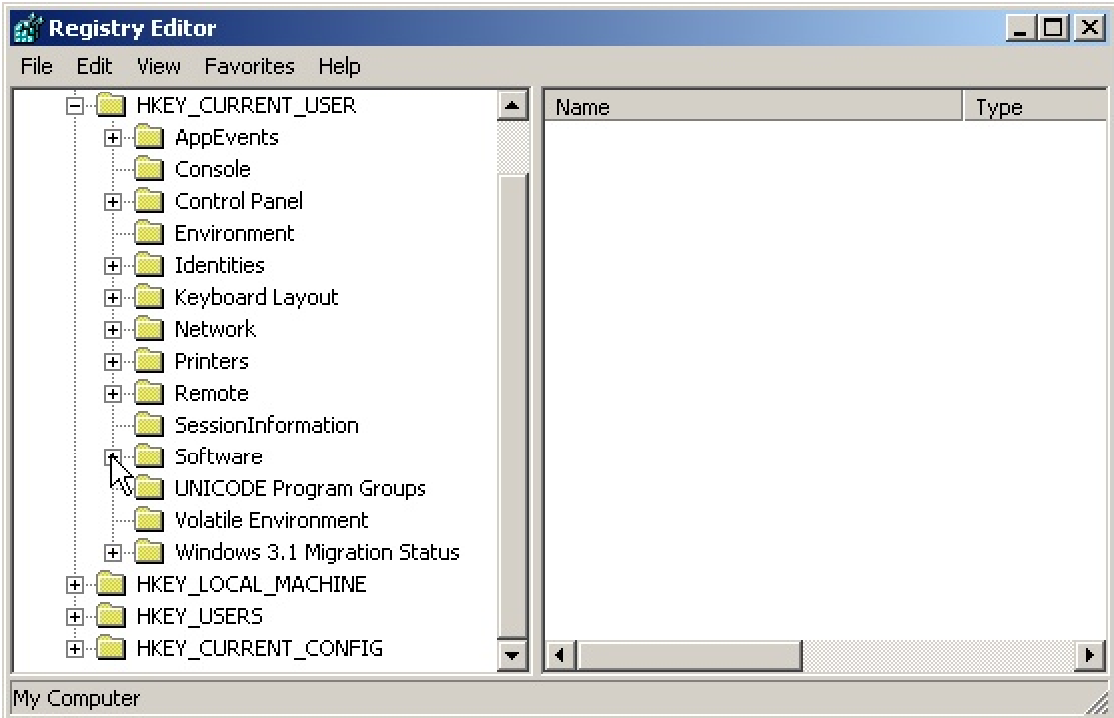
Click on the Windows Start button,  choose Run, and type in “regedit”:



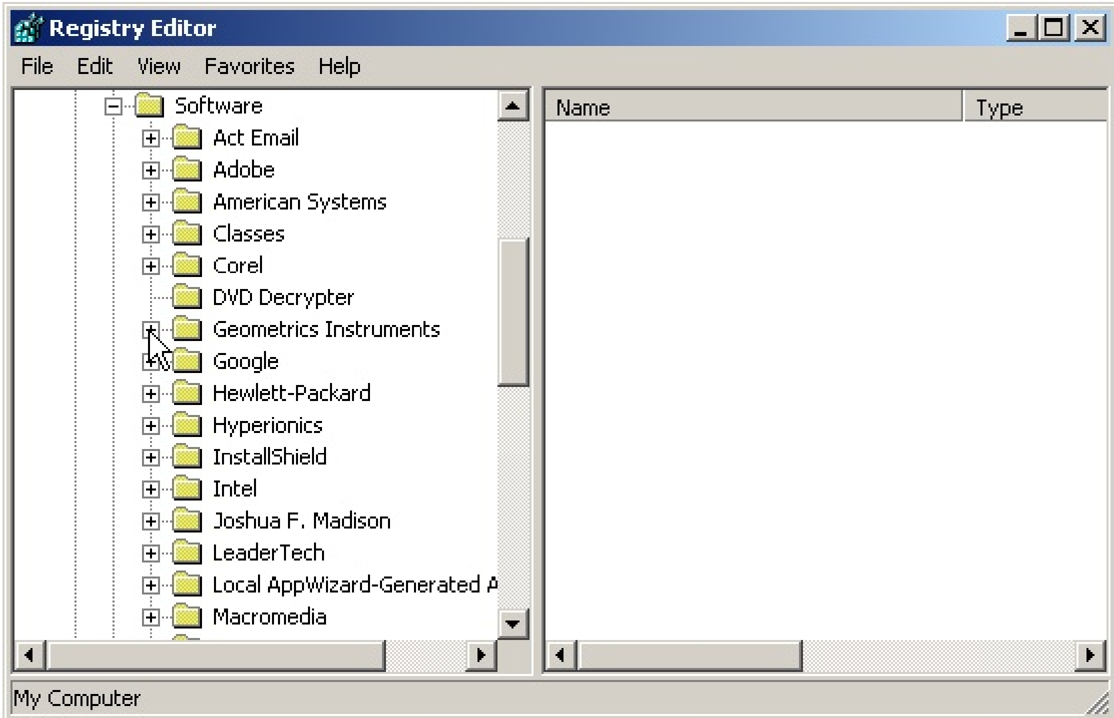
Next, click on the "+" next to HKEY_CURRENT_USER,



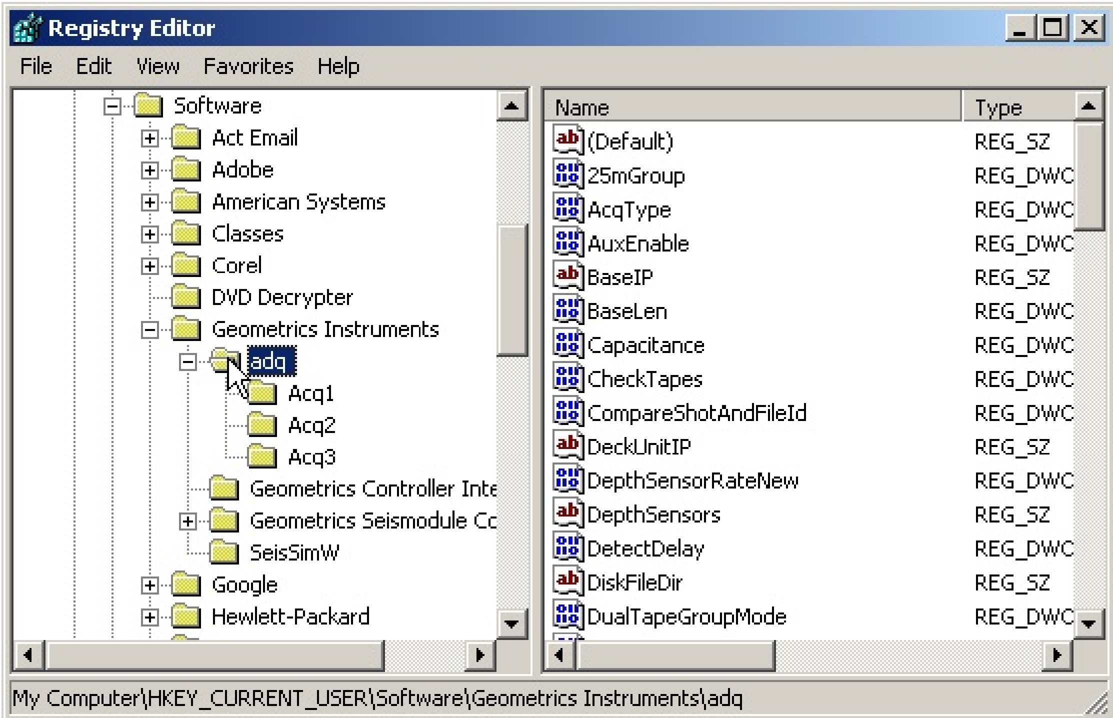
then on the "+" next to Software,



Geometrics Instruments,

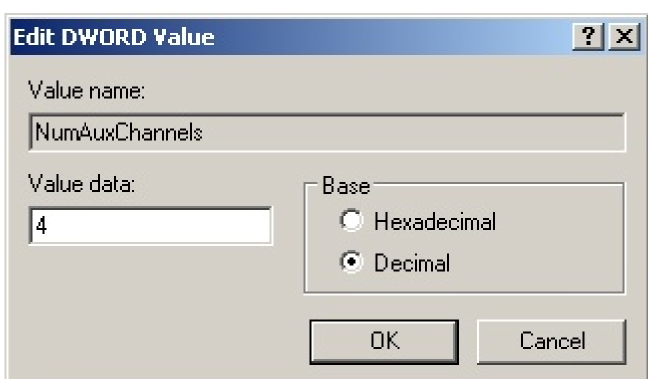


and you should see a folder called adq. Click on this folder to display its contents:



You will see a list of registry keys on the right. Most of these refer to parameters that can be accessed from the CNT-2 menu structure. Those few that are not, and that are useful to know about, are discussed below.

Note: *To edit a registry key, double-click on it, and you will see something like the following:*



Click the Decimal *radio button, type in the new value, and press* **OK**.

- BaseLen: The default maximum record length is 16,384 samples per trace. This is more than long enough for most standard applications; keeping it to this level avoids wasting memory needlessly. However, the maximum record length possible is actually 32,768 samples/trace. If you need a longer record length than 16,384, edit the BaseLen key appropriately.
- nAcqs: This key refers to the number of Digitizer boards in the system, including the AUX board in the Deck Unit. For instance, a 48-channel system would have an nAcqs value of seven. Sometimes it is useful to be able to change this setting temporarily (for instance, see Eel(s) Not Responding With Status error in the Troubleshooting section).
- NumAuxChannels: There are eight AUX channels in most Deck Units. However, it is rare to use more than four. As such, the default is four. However, in the event you need to use more than four, you can change it here. Valid values are either 4 or 8.
- Simulating: The CNT-2 may be run without a GeoEel or Deck Unit attached. However, this requires it to be in "Simulator" mode. In this mode, most, but not all, (such as arming and triggering) software functions will be available. To enable simulator mode, set the Simulating registry key to 1. For production mode, it should be set to 0.
- TimeWindow: When logging serial data, the CNT-2 Controller will accept, for each record, any string that arrives within 1000 ms (by default) after the trigger. All other strings are ignored. Most navigation and source control systems send their serial string within this time. However, if the string lags the trigger by more than 1 second, you may need to increase this time window.

Note: *If in the process if changing registry settings you accidentally corrupt the GeoEel portion of the registry, the CNT-2 will become unstable and may crash. In this event, see the section on deleting a registry key in the Appendix.*

4.6 Replacing a Junction Box (P-Cable)

Replacing a Junction Box is simple. After physically installing, check to see if you can ping it. Its address should be 192.168.1.XX or 192.168.3.XX (most likely), with XX being the last two digits of the serial number. Then open the GeoEel Controller, go to the Configure>>GeoEel dialog and make sure you replace the serial number of the old one with that of the new.

4.7 Replacing a Digitizer Module (P-Cable)

The new module must have the same IP as the old one, 192.168.1.XX. XX starts at 3. i.e., the first Digitizer in the system (closest to Cross Cable) is 192.168.1.3. Second Digitizer is 192.168.1.4, and so on. GETTING THIS RIGHT IS EXTREMELY IMPORTANT.

There are two ways to do this:

Quick and easy, but dangerous if you are not careful

- Use the spare computer and spare Deck Unit.
- Make sure the Deck Unit is powered down.
- Plug the Digitizer module into the Deck Unit using the test cable.
- Power up the Deck Unit.
- Power up the Controller PC.
- After the current indicator on the Deck Unit settles, start the GeoEel Tester.
- Click on **Configure GeoEel**.
- Choose **Reset All Eels**.
- Press **Cancel**.
- Press **Choose GeoEel**.
- Choose GeoEel 0.
- Click on **Configure GeoEel**.
- Type in the new section number and press **Apply**. THIS IS WHERE YOU MUST BE CAREFUL. MAKE SURE YOU TYPE IN THE RIGHT SECTION NUMBER. THEY ARE NUMBERED IN SEQUENCE, STARTING AT 1, FROM THE SIGNAL CABLE END OF THE CROSS CABLE. IF IT IS THE THIRD GEOEEL FROM THE SIGNAL CABLE, IT IS SECTION #3.
- Press **Reboot**.
- Run a trigger test, make sure it triggers 100 times in 25-35 seconds.
- Run a network test, make sure the network speed reported is 13 Mbps or greater.
- Make sure the Junction Box is powered down. When doing something like this, it is generally best to just kill power at the Deck Unit and power down the entire array.
- Plug Digitizer into Junction Box.
- Power up the Deck Unit. You should be good to go.

More time consuming, but safer

- Kill power to the array at the Deck Unit.
- Plug the replacement Digitizer into the array.
- Power up the array, wait for everything to boot.
- Start up the GeoEel Controller.
- Choose Configure>GeoEel.
- Choose **Reset**.
- Choose **Detect**.
- Wait for the system to detect and assign IP addresses to all Digitizers.
- You should be good to go.

4.8 Replacing a Tail Depth/Compass Module

To replace a Tail Depth/Compass module, simply replace it physically, then open the Configuration>>GeoEel menu and replace the old serial number with the new serial number.

4.9 Installing an Interconnect Cable

The Cross Cable Interconnect Cables connect the Junction Boxes to each other on the Cross Cable. Their proper assembly onto the Strength Member (rope) of the Cross Cable is critical to the proper performance of the system. Improperly wrapped Interconnect Cables can result in:

- Ethernet failures
- False Triggers
- Leakage
- Unpredictable and adverse towing characteristics

The following instructions document how to replace a Cross Cable Interconnect Cable.

1. Remove the bad cable, **noting the wrap direction**.

2. Leave the bottom layer of friction tape if still usable. Otherwise re-tape the rope and re-mark the tape with the correct location as marked on the rope, seen in the figure below. **It is important to ensure that the mark on the tape is in the same location as the mark on the rope.**

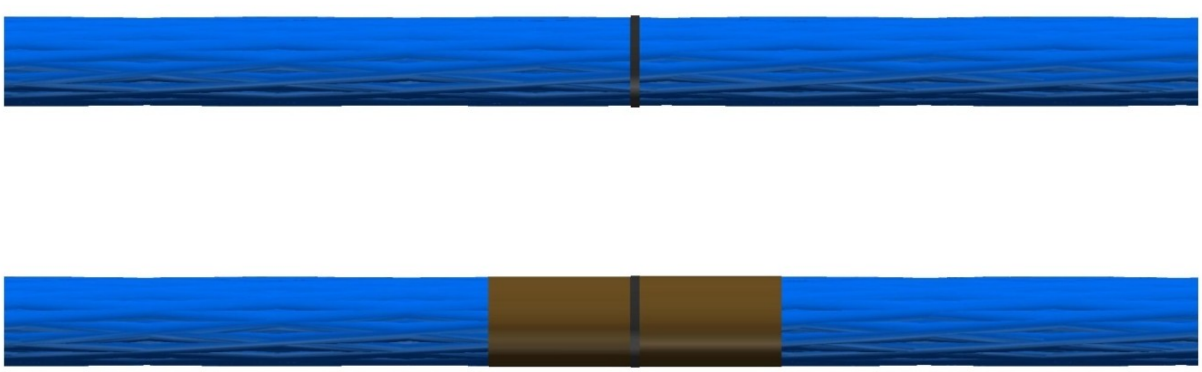


Figure 87: Rope markings for Interconnect Cable installation.

3. Tension the Cross Cable to a minimum 250kg.
    a. If possible, it is best to wrap the entire section at one time while under tension.
    b. If it is not possible to wrap the entire section, wrap as much as possible and move it onto the winch. Finish wrapping the rest at the longest length possible.
4. Align the first marks on the rope and the Interconnect Cable as shown in the figure below:

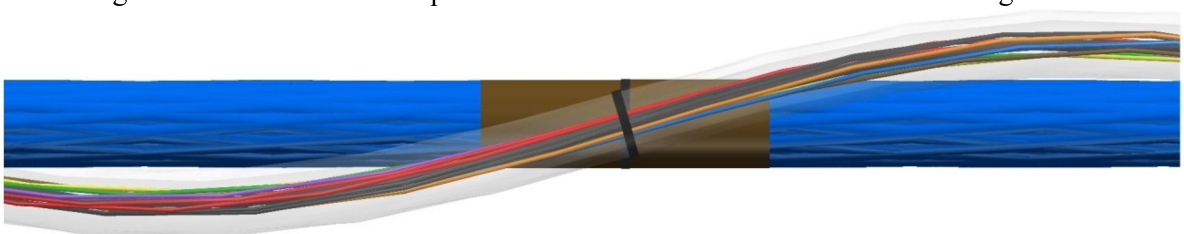


Figure 88: Alignment of Strength Member mark and Interconnect Cable mark.

5. Wrap friction tape around both the Interconnect Cable and the rope:

Figure 89: Friction tape installed over Interconnect Cable and Strength Member.

6. Wrap the Interconnect Cable along the length of the rope for one complete revolution (360^o) until the next mark on the cable and rope are close. **Remember: The Interconnect Cable MUST be installed in the same wrap direction as the one it is replacing.**
7. Align the marks as above and apply friction tape.
8. Continue to wrap the cable along the entire length of the rope, carefully aligning all marks.

    Note: *It is important that the Interconnect Cable only makes 360^o of revolution between the two tape locations. In addition, the cable should make contact with the Strength Member in the same orientation at each mark, as shown in the figure below:*

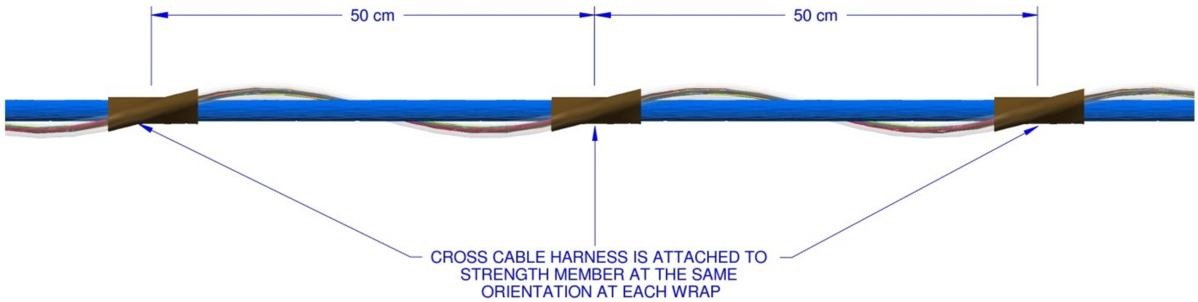


Figure 90: Interconnect Cable properly attached at same orientation on each wrap.

9. At the final alignment location, tape the Interconnect Cable and rope together -- **but do not wrap the cable and rope between the final tape location and the Junction Box**. This will allow the Interconnect Cable to stretch more effectively at the Junction Box.

10. Install a zip tie over each of the friction tape locations, securing it tightly and removing any excess.

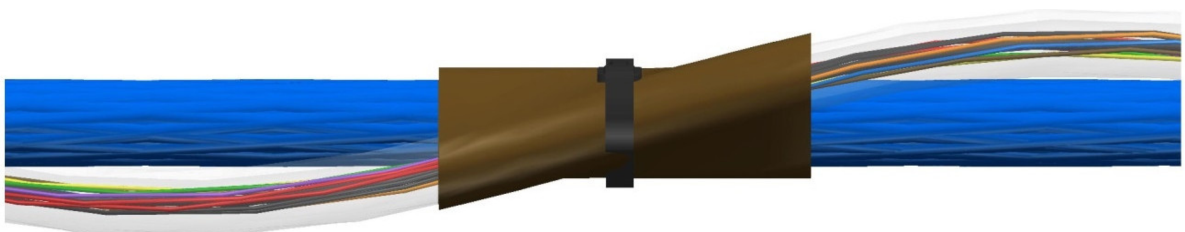


Figure A 91: Zip tie installed on Cross Cable.

11. Install plastic tape over each of the zip ties. Use the "pull-through" method to secure the plastic tape from unraveling.

Figure 92: Plastic tape installed and secured with the " pull-through" method.

12. After installation of the plastic tape, the Cross Cable assembly should look similar to that shown in the figure below:

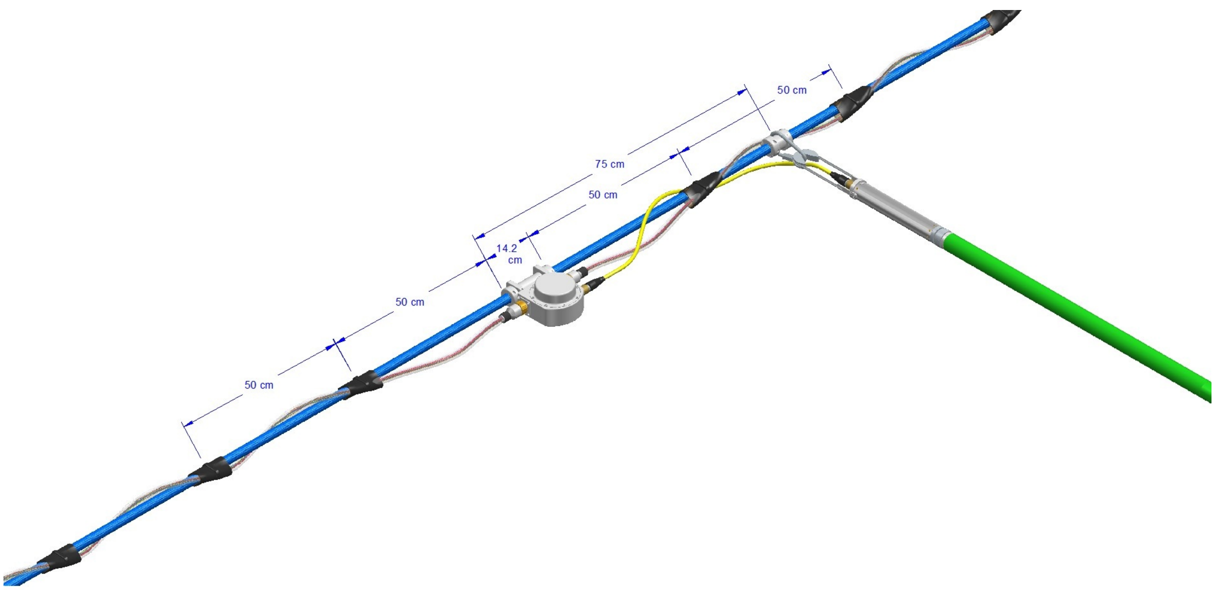


Figure 93: Fully-installed Interconnect Cable.

Additional Notes:

1. The Cross Cable Interconnect Cable is shipped with a mark on the tubing at 52.9 cm intervals. This interval is important to keep when wrapping the Cross Cable.

2. The Strength Member is marked at intervals of 50cm.

3. Junction Boxes are spaced either 7.07 or 14.14m from center-to-center at 250 kg tension. This provides a distance of either 7 or 14m between Junction Boxes where the Interconnect Cable needs to be wrapped.

4. There are either 14 or 28 Interconnect Cable wraps between each Junction Box.

5. Each Interconnect Cable should be wrapped in the opposite direction of the adjacent ones. For example, if #2 is wrapped in a clockwise orientation, #1 and #3 should be wrapped in a counterclockwise direction. A corollary to this is that a replacement section should be wrapped in the same direction as the one it is replacing. This is very important from a hydrodynamic standpoint.

Part V

5 Appendices

5.1 Optimizing a Shot Record

One of the most important skills for an observer to perfect is optimizing the shot record, which is done by optimizing display parameters like display gain, AGC window, time window, and filters. These settings do not affect the data saved to storage – these are display settings only – but a poorly optimized record does not allow a good assessment of data quality; indeed, it can lead to false conclusions and lots of confusion. Optimizing a shot record takes practice, and is best illustrated by example.

Below is a complete 48-channel, 8-second shot record taken in about 2,200m of water:

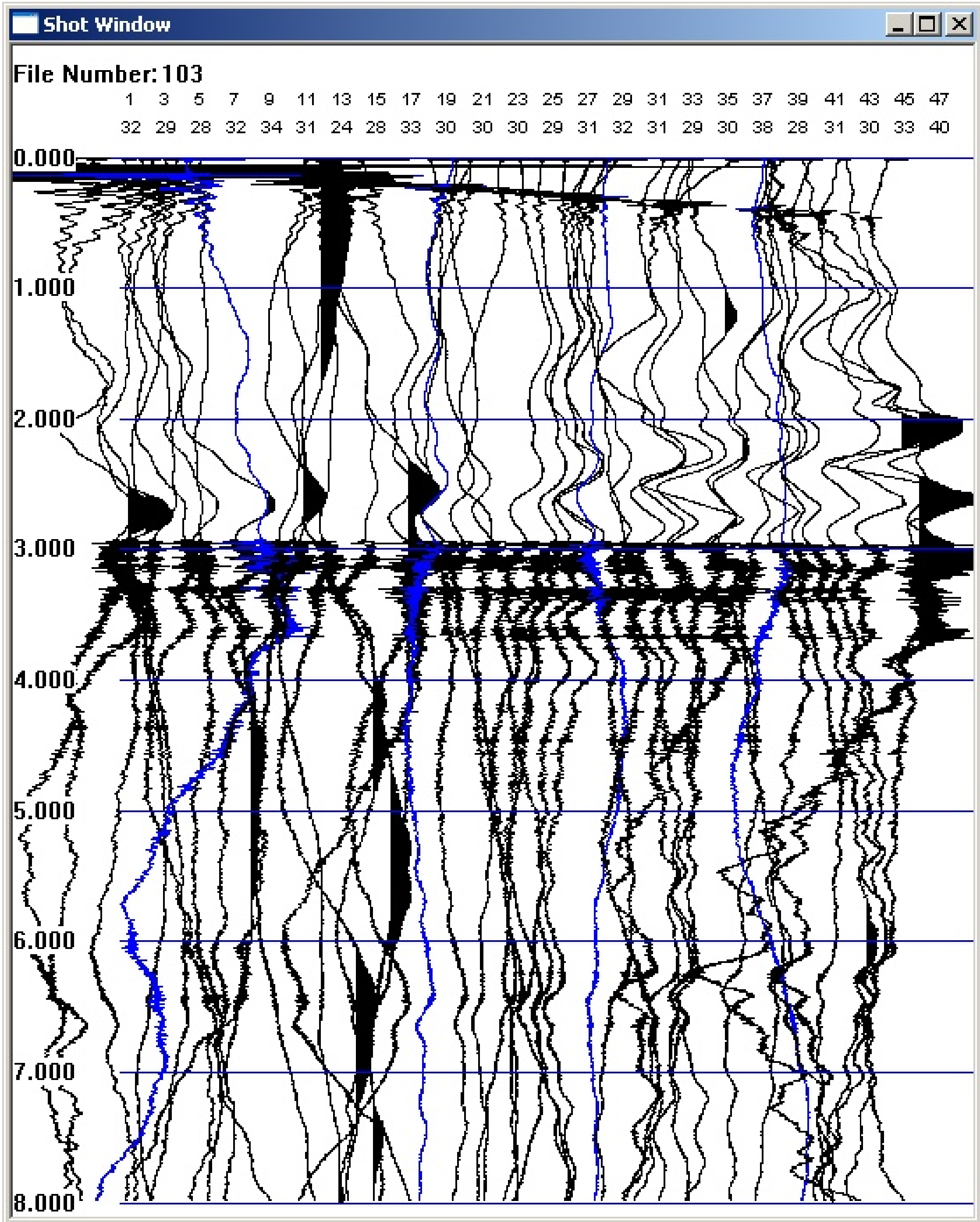


Figure A94: Example raw shot record.

Traces are displayed in fixed gain, and all filters are disabled. In this "raw" state, we can see mostly swell noise; however, the first breaks, the water-bottom reflection, and a reflective zone from about 3-5 seconds are apparent. Any events below 6 seconds are likely to be mostly multiples.

Let’s enable a 10 Hz low cut filter to eliminate the swell noise:

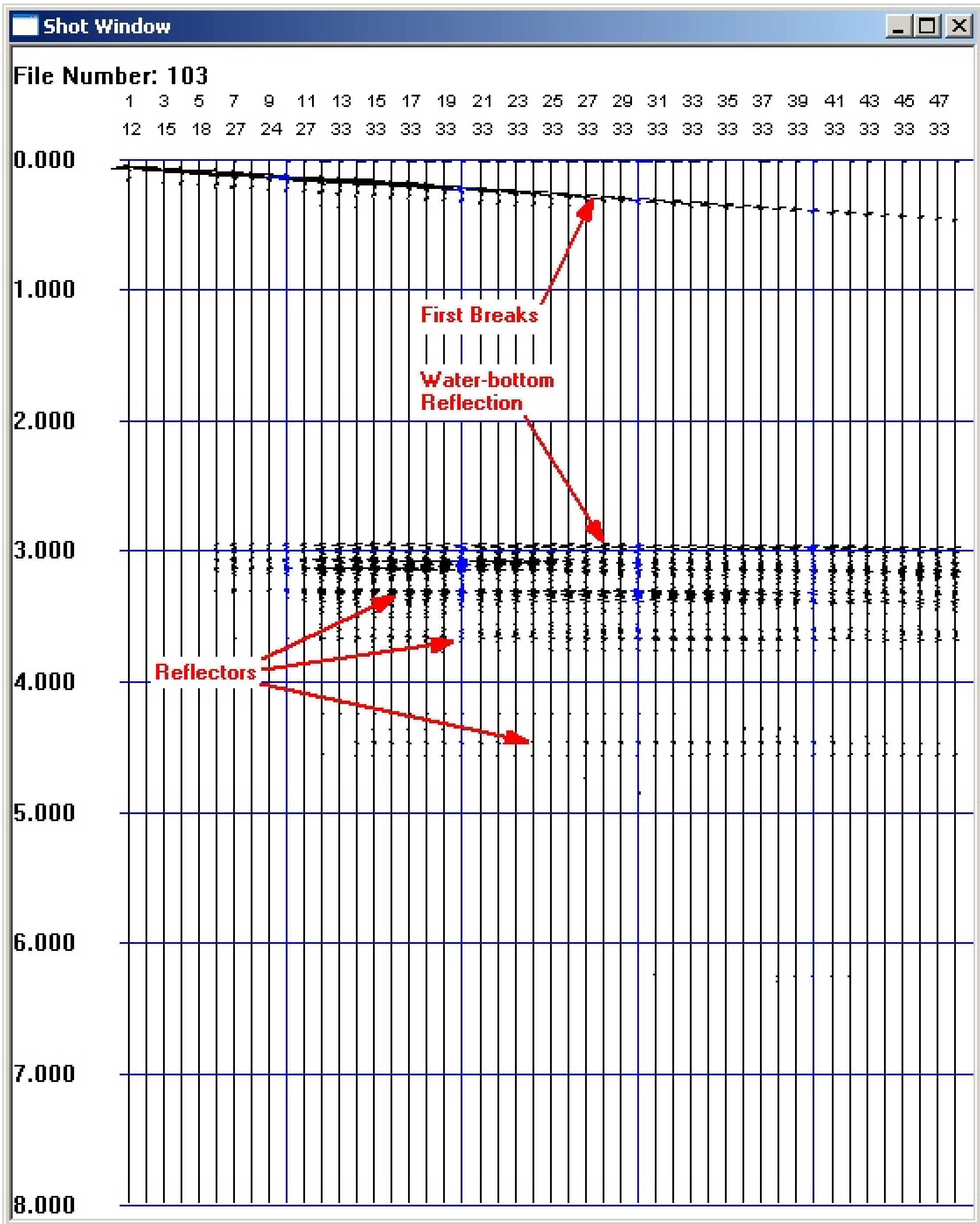


Figure A95: Example shot record after applying a 10 Hz low cut filter.

The swell noise has disappeared, and the first breaks and reflected events are greatly enhanced. Next, we’ll enable AGC and adjust the trace overlap:

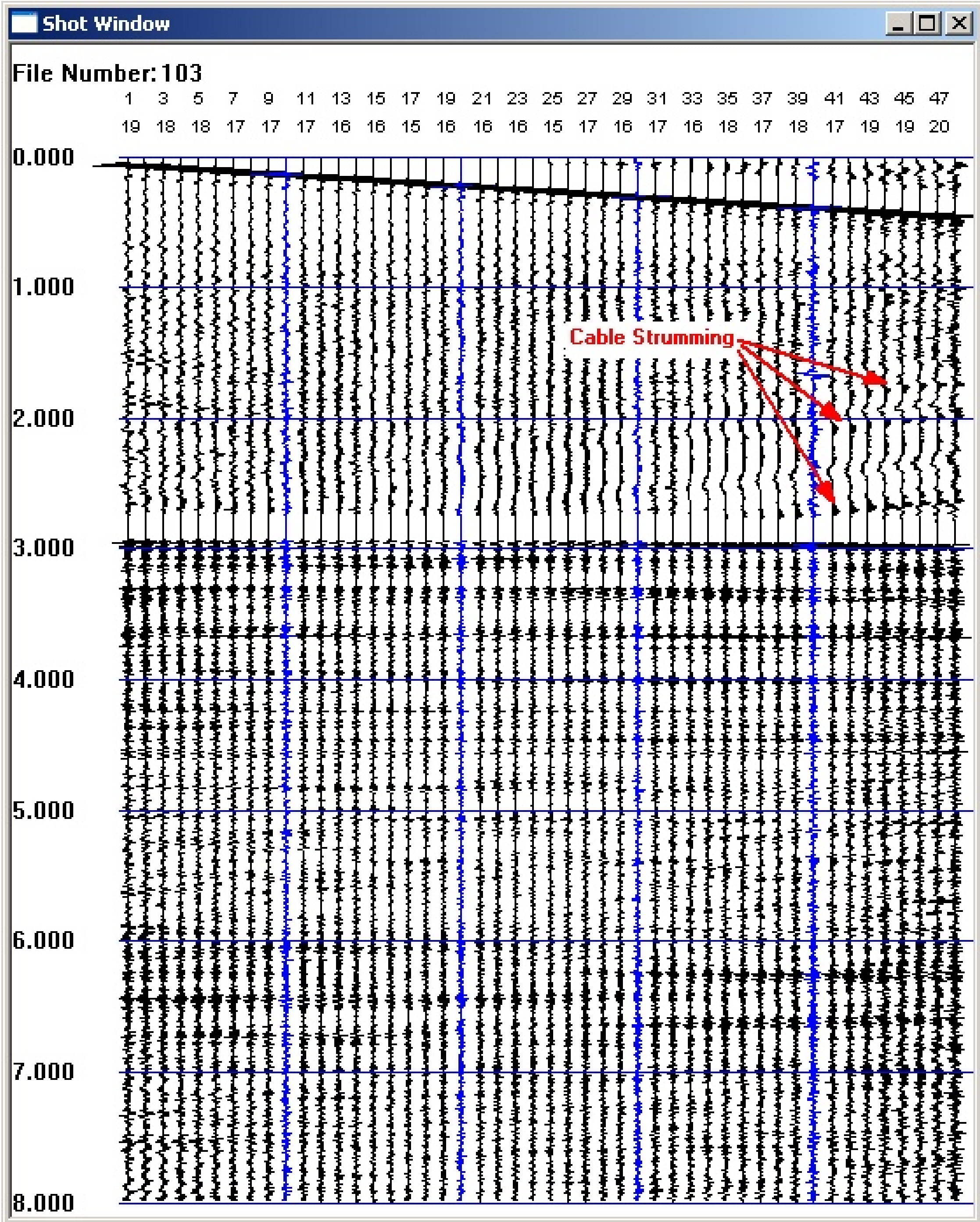


Figure A96: Example shot record after applying a 10 Hz low cut filter and AGC.

AGC reveals a small amount of what is probably strumming noise (this is caused by strumming of the Tow Cable where it makes contact with the water on an angle, and can usually be all but eliminated with the installation of haired fairing). Strumming noise is usually in the 10-20 Hz range. Setting the low cut filter to 50 Hz eliminates this, without a visible impact on the reflective zone:

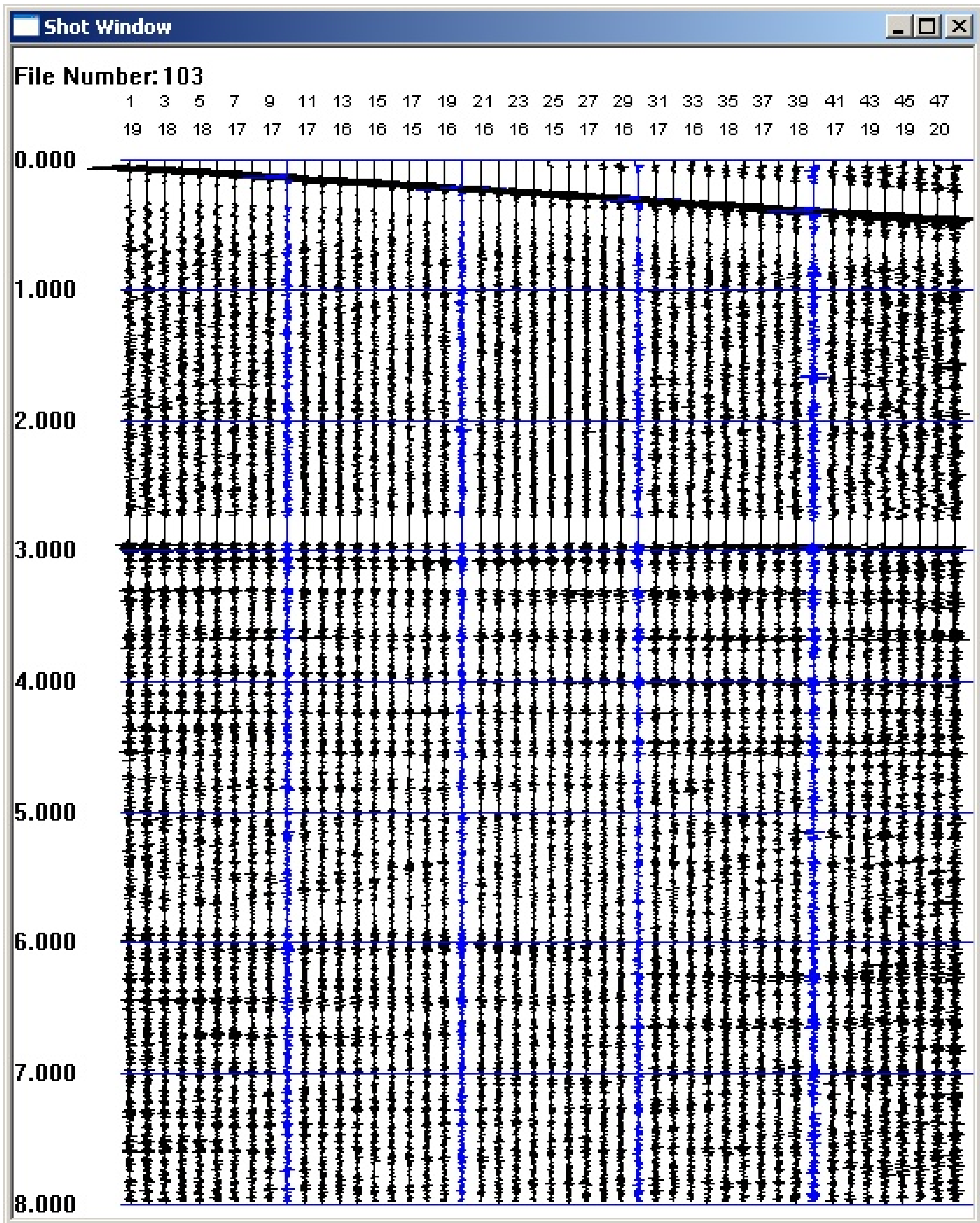


Figure A97: Example shot record after increase of low cut corner frequency to 50 Hz.

Anything of geological interest will be below about 3 seconds, so let’s eliminate the water column:

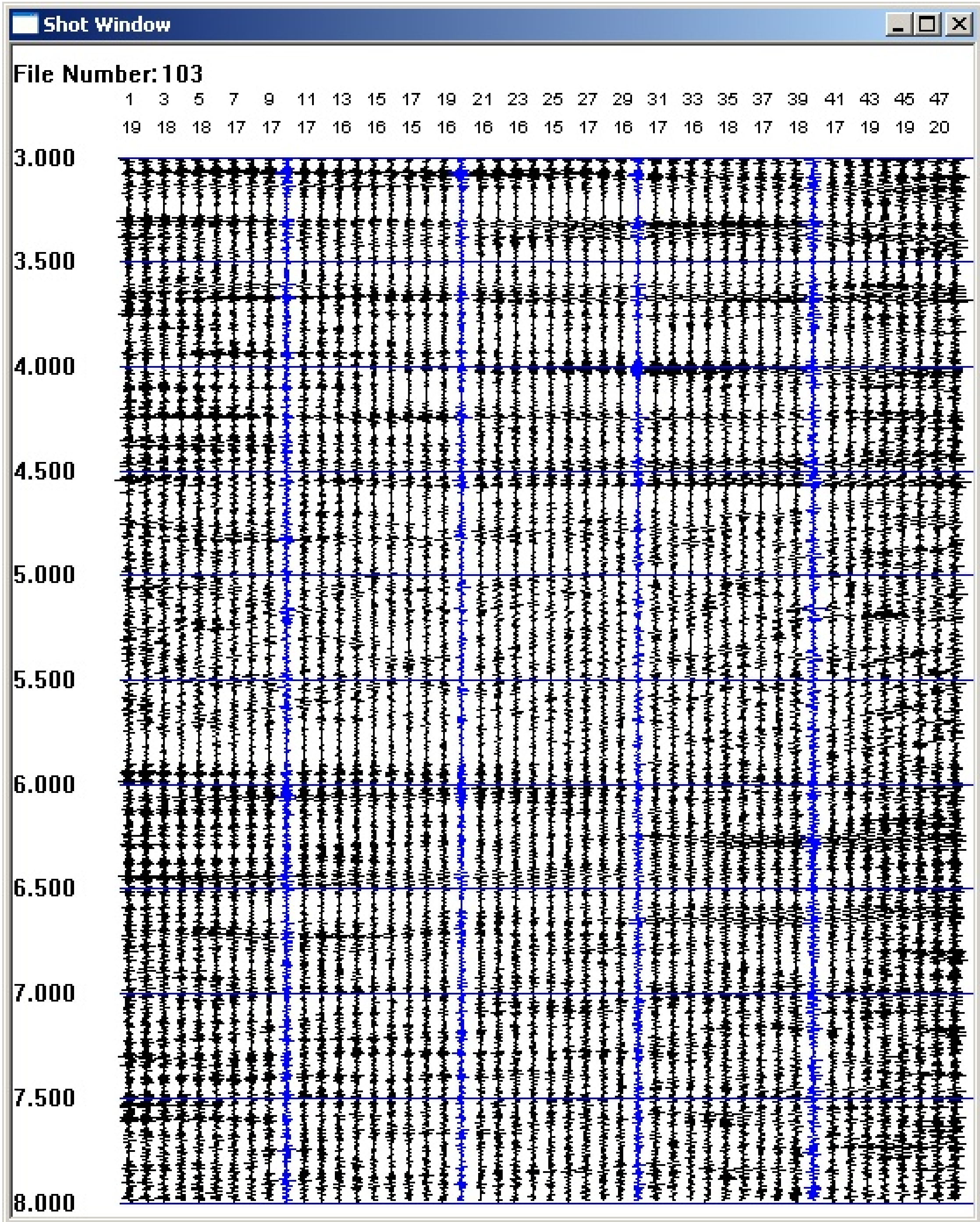


Figure A98: Example shot record after eliminating water column from display.

We are now beginning to see some reflector detail. Finally, zooming in on the first second below the sea bottom, we get:

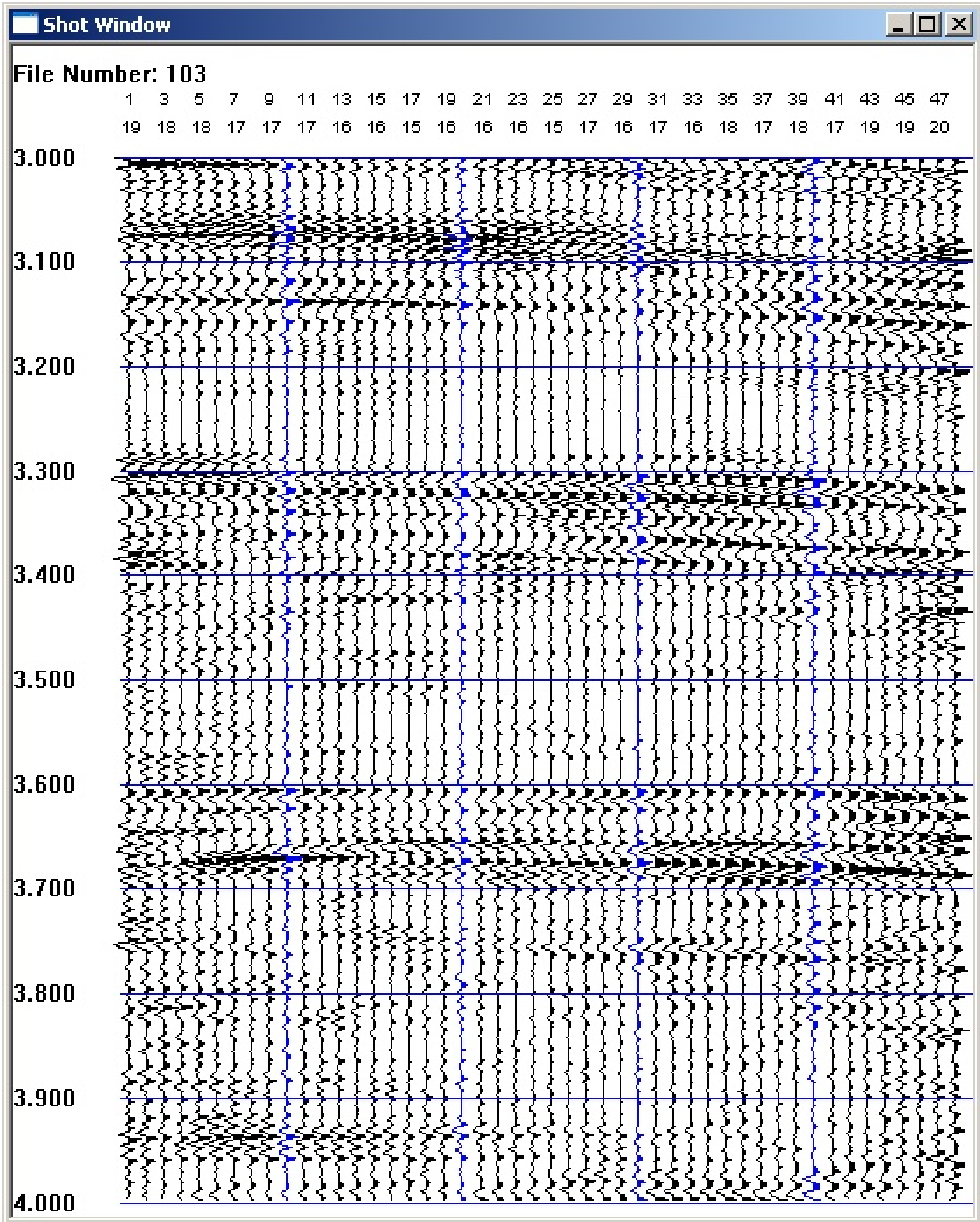


Figure A99: Example shot record focused on first second of data below seabed.

There is no "right" way to display seismic data. The main point here is that what you see is highly dependent on the display settings and even how you size the window. Don't panic if you see "nothing" in the first few shot records. The display settings are rarely set appropriately at the outset of a survey, and almost always need adjustment. Below are two views of the same shot record. The record on the left is in its raw state – unfiltered, no AGC, and most of what is visible is water column. The record on the right has been optimized through filtering, AGC, and time windowing to view the reflectors of interest just below the water-bottom reflection.

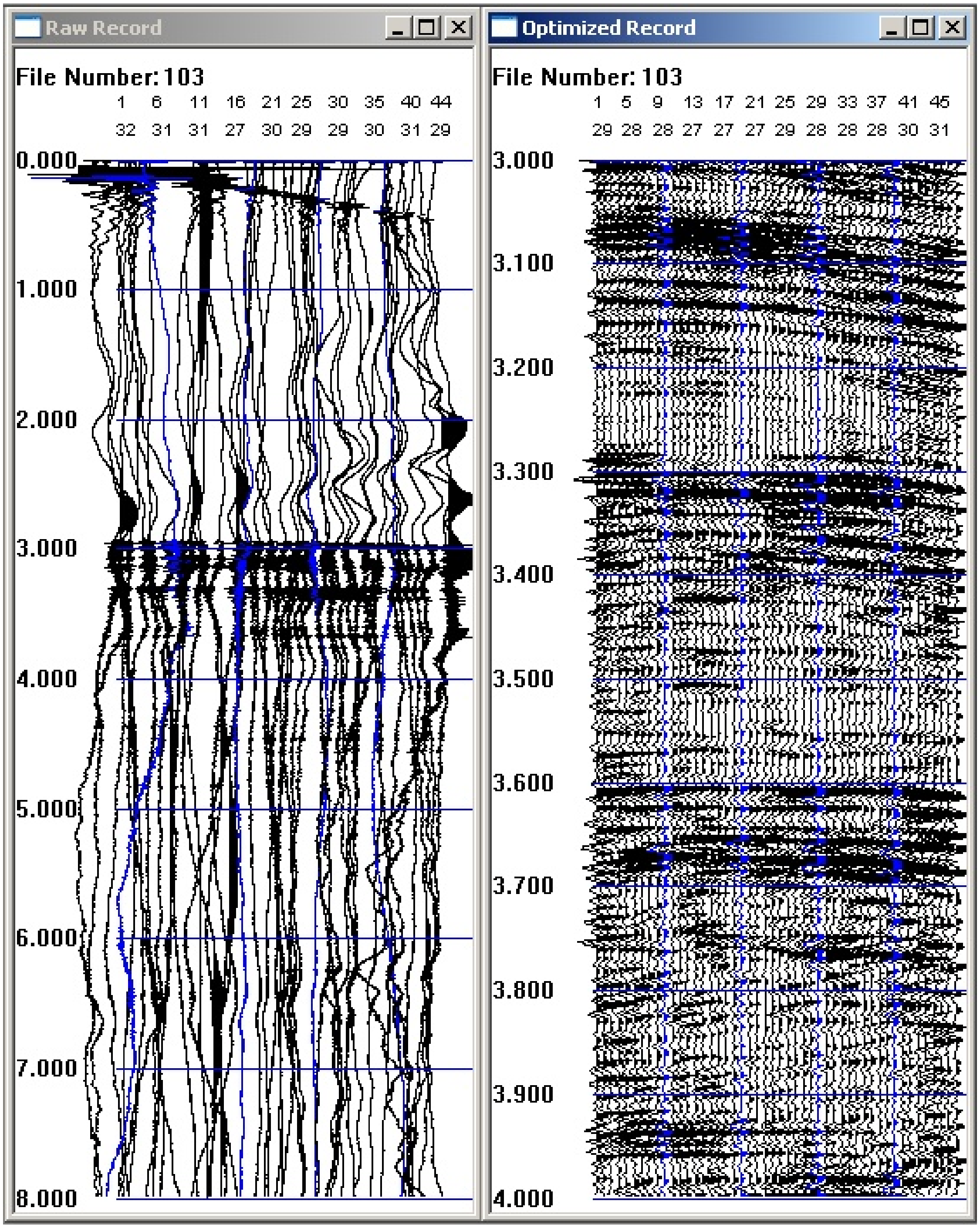


Figure A100: Raw vs. optimized shot record.

As a general rule of thumb, the recommended starting parameters are:

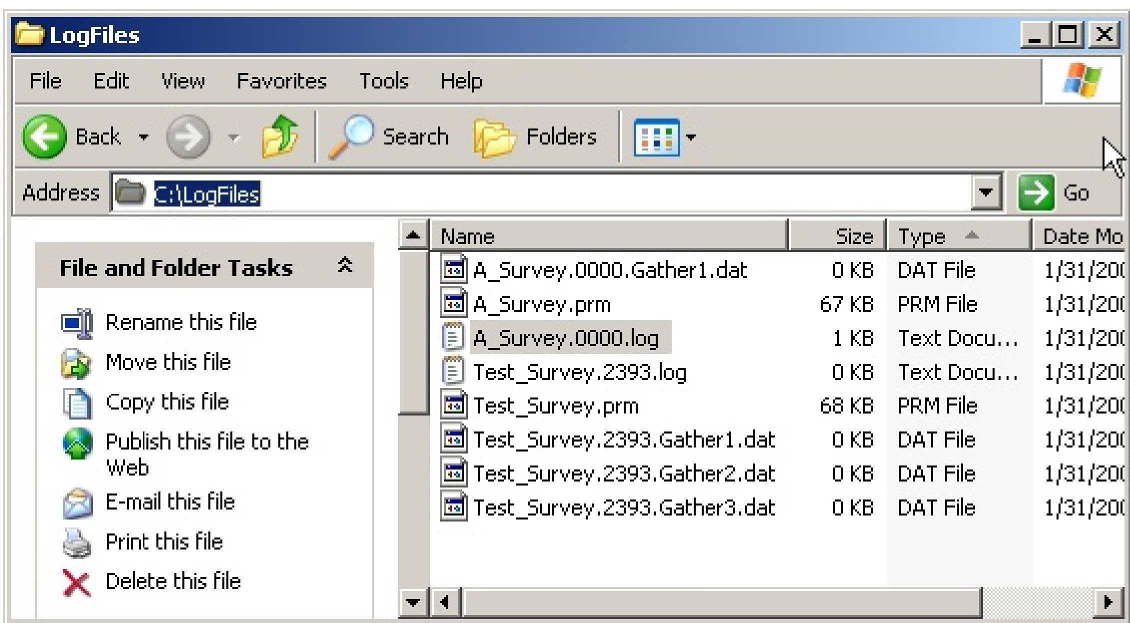
- **Display Gain:** AGC enabled, 200-sample window
- **Filter:** 20 Hz low cut

- **Trace Overlap:** 2
- **Trace Style:** Variable area
- **Time Window:** 0.5 – 1.0 seconds, starting just above the water-bottom reflection.

Using the above settings at the outset will generally result in a passable shot record; once you can see and identify reflection events, you can fine-tune to your taste. The best way to learn how to optimize a shot record is to practice. Some good practice records can be found here. If you have trouble downloading, contact Geometrics.

5.2 Working With Gathers/Brute Stacks

Gather and brute stack files are stored in a Geometrics-proprietary format in the [drive:]\Logfiles folder. The file name is of the format *[SurveyName.Line#]*.Gather*[X]*.dat. For instance, the first gather for line #2393 in a survey named "Test_Survey" would be Test_Survey.2393.Gather1.dat. Since you can create as many as three separate Gather windows simultaneously, you may also have gathers named Test_Survey.2393.Gather2.dat and Test_Survey.2393.Gather3.dat.



Note: *The internal format gather files are always saved, and when you open an existing survey, the gather(s) for that survey are read in automatically and appended to.*

To view an existing gather, open the appropriate survey. You will be prompted to read the existing gather into memory. The Gather window will still be blank, but you can scroll back in time using the **Page Up** key. Pressing the **Page Down** key will scroll forward in time. **Home** and **End** will scroll to the beginning and end, respectively. You may print following the procedure outlined in the section on gather parameters.

Gathers can also be optionally saved in SEG-Y format in the same folder. The file name is *[SurveyName.Line#]*.Gather*[X]*.sgy.

Note: *If you mistakenly neglect to save the SEG-Y gather when closing the survey, you may reopen the survey (automatically reading in the Geometrics-format gather), then re-close the survey, this time choosing* **Yes** *when prompted whether or not to save the SEG-Y version.*

5.3 Creating a Brute Stack

Note: *The following discussion assumes that the reader is familiar with basic seismic reflection data processing.*

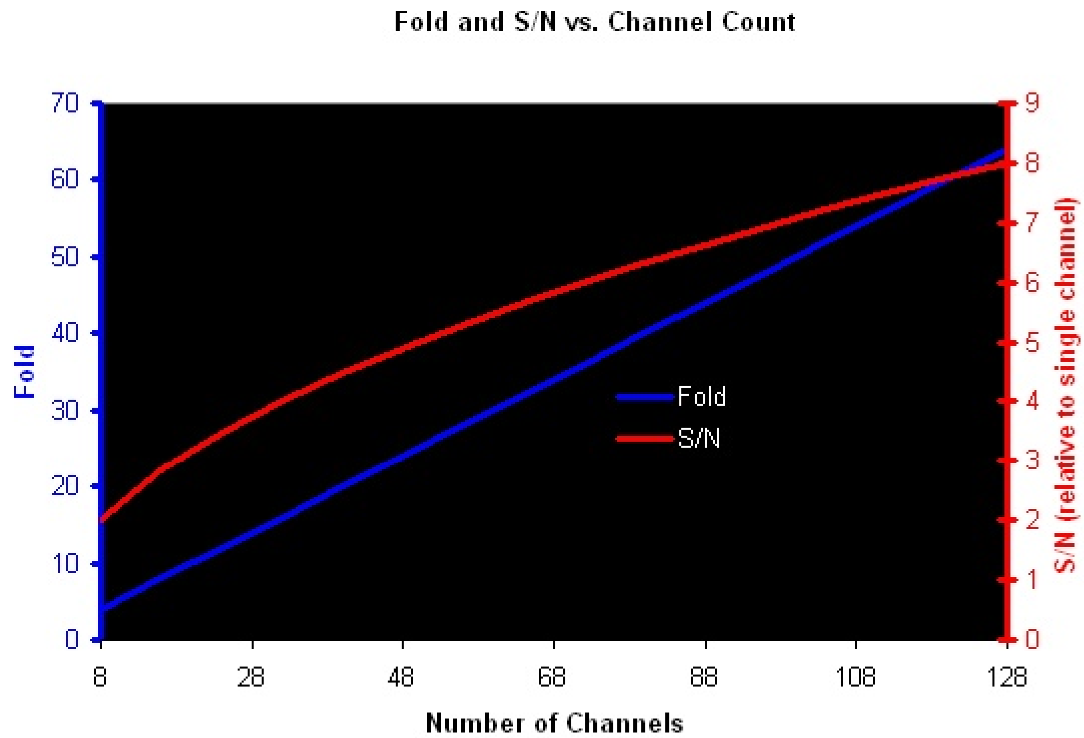
One of the main advantages of multichannel seismic recording is the ability to construct a stacked section. The CNT-2 Controller offers a “brute stack” feature which, if supplied with accurate velocity and shooting geometry information, can produce a real-time stacked section of significantly higher signal-to-noise (S/N) ratio than a single-trace, common-offset gather. The steps taken to produce the stack are:

1) Conducting a common-midpoint (CMP) sort, producing CMP gathers.
2) Correcting the CMP gathers for normal moveout (NMO) by applying a user-supplied stacking velocity function.
3) Summing (“stacking”) the corrected traces in each gather to form a single trace associated with that midpoint.
4) Plotting the summed traces side-by-side to produce a stacked section.

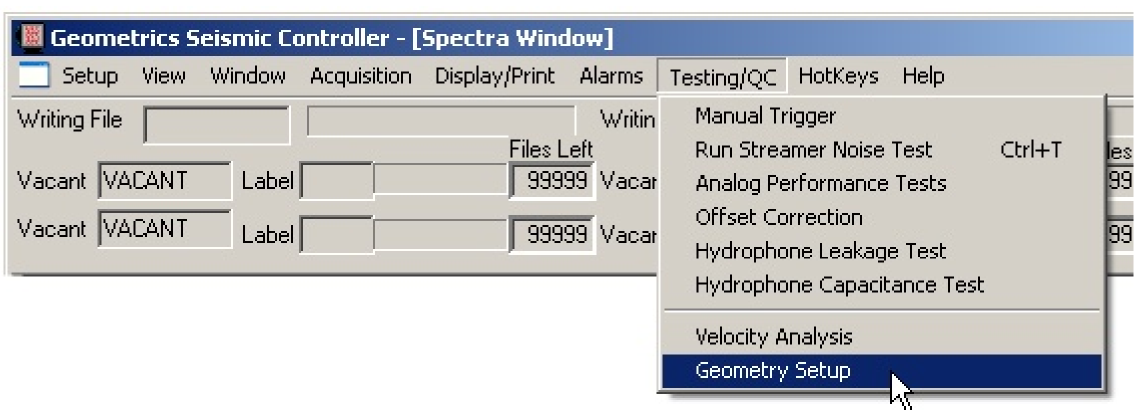
All of the above items are done automatically by the software. The final result is a “brute” stack in the sense that no pre-stack or post-stack steps such as deconvolution, migration, etc. are performed.

Assuming the shot interval is equal to the hydrophone spacing, the number of traces per CMP gather will be ½ the number of recording channels. This is referred to as the “fold”. Shooting at the hydrophone interval with a 96-channel system results in a 48-fold stack; each trace in the stacked section is the sum of 48 individual traces.

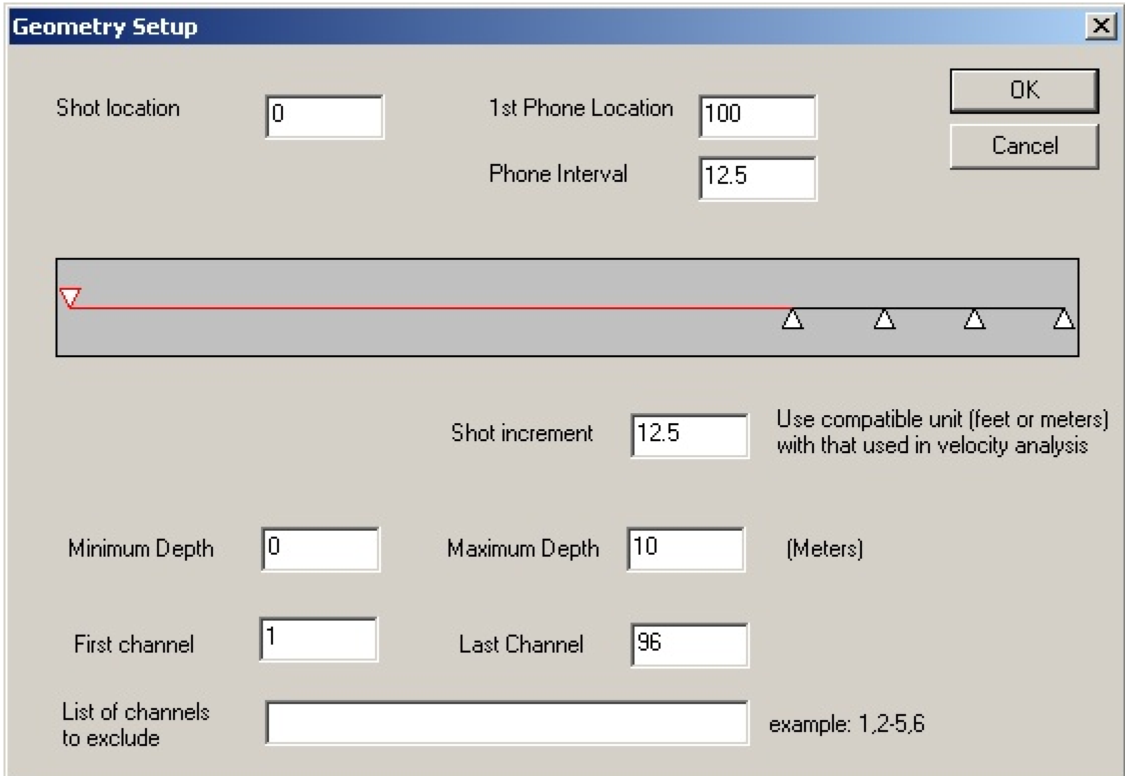
Assuming all noise is random, all signal is coherent, and the velocity function is accurate, the summing of the traces results in an increase in the S/N ratio proportional to the square root of the fold. Therefore, four traces per CMP (8 recording channels) results in a doubling of the S/N ratio compared to a single trace. Sixty-four traces (128 channels) results in an 8x improvement (refer to the graph below).



In order to do a brute stack, the correct acquisition geometry must be provided. In the Testing/QC menu, select Geometry Setup:



You will see the following dialog box:

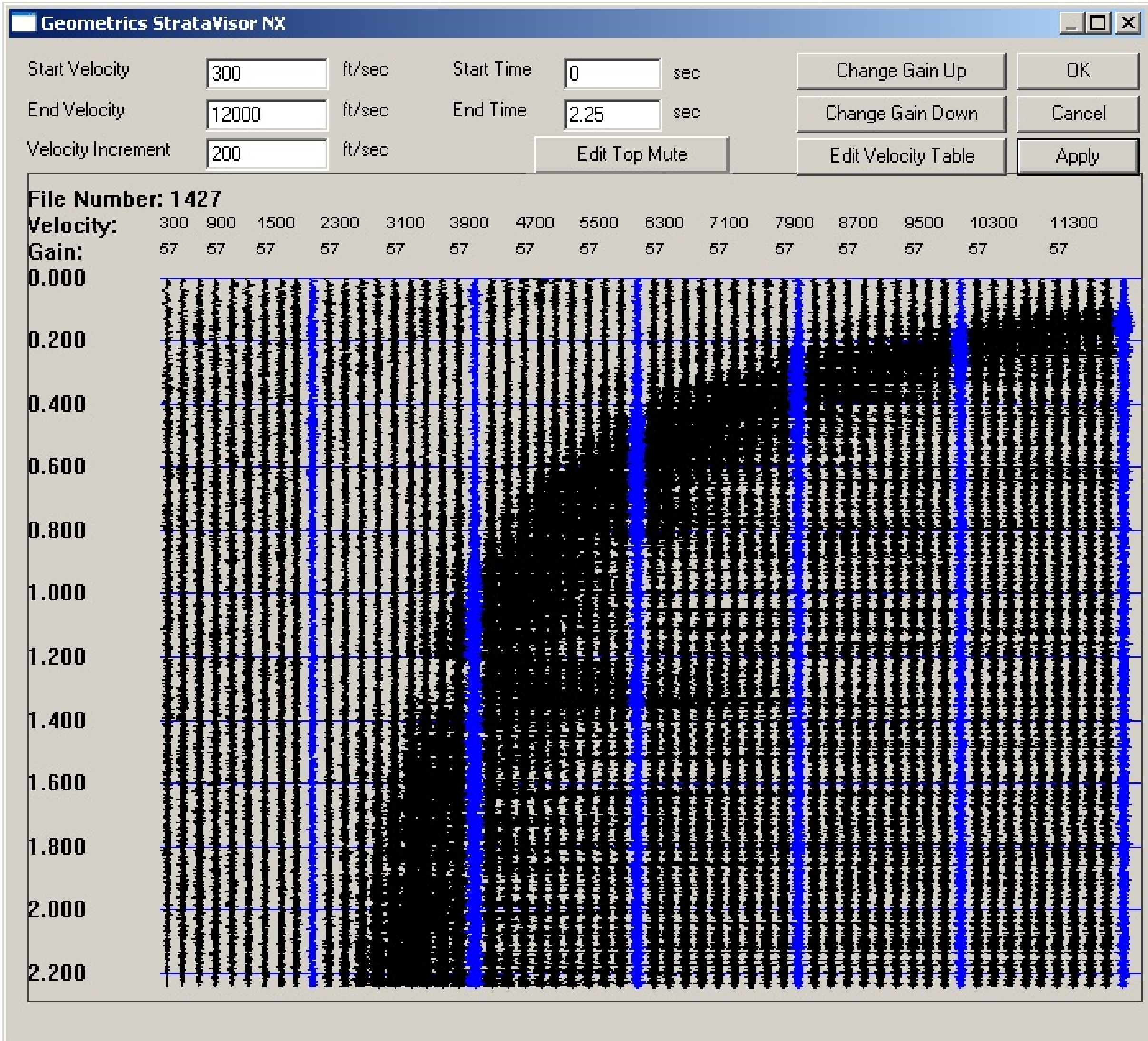


All of the geometry information is relative – you are simply defining the acquisition geometry, which should be constant throughout the survey. Enter the Shot Location, the 1st Phone Location (relative to the shot), Group Interval, and Shot Interval. The shot interval must be an even multiple/divisor of the group interval (which is typical) for the brute stack algorithm to work properly. For instance, if the group interval is 12.5m, the shot interval should be 6.26, 12.5, 25m, etc.

Minimum Depth and Maximum Depth set the limits at which the depth sensors display indicates an out-of-range value.

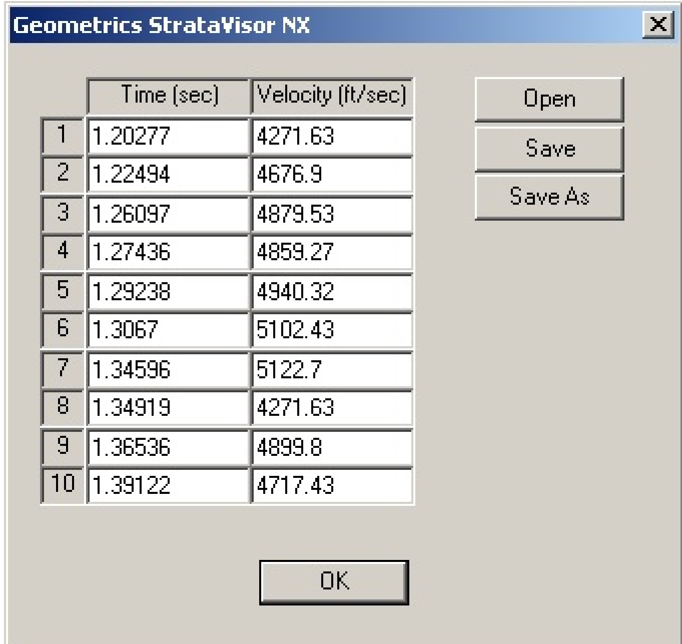
Indicate the range of channels you wish to include in the brute stack (typically all channels), and any bad or noisy channels you wish to exclude.

In the Gather Parameters dialog, check the Brute Stack box to enable the **Velocity Analysis** button. Press the button to open the velocity dialog:

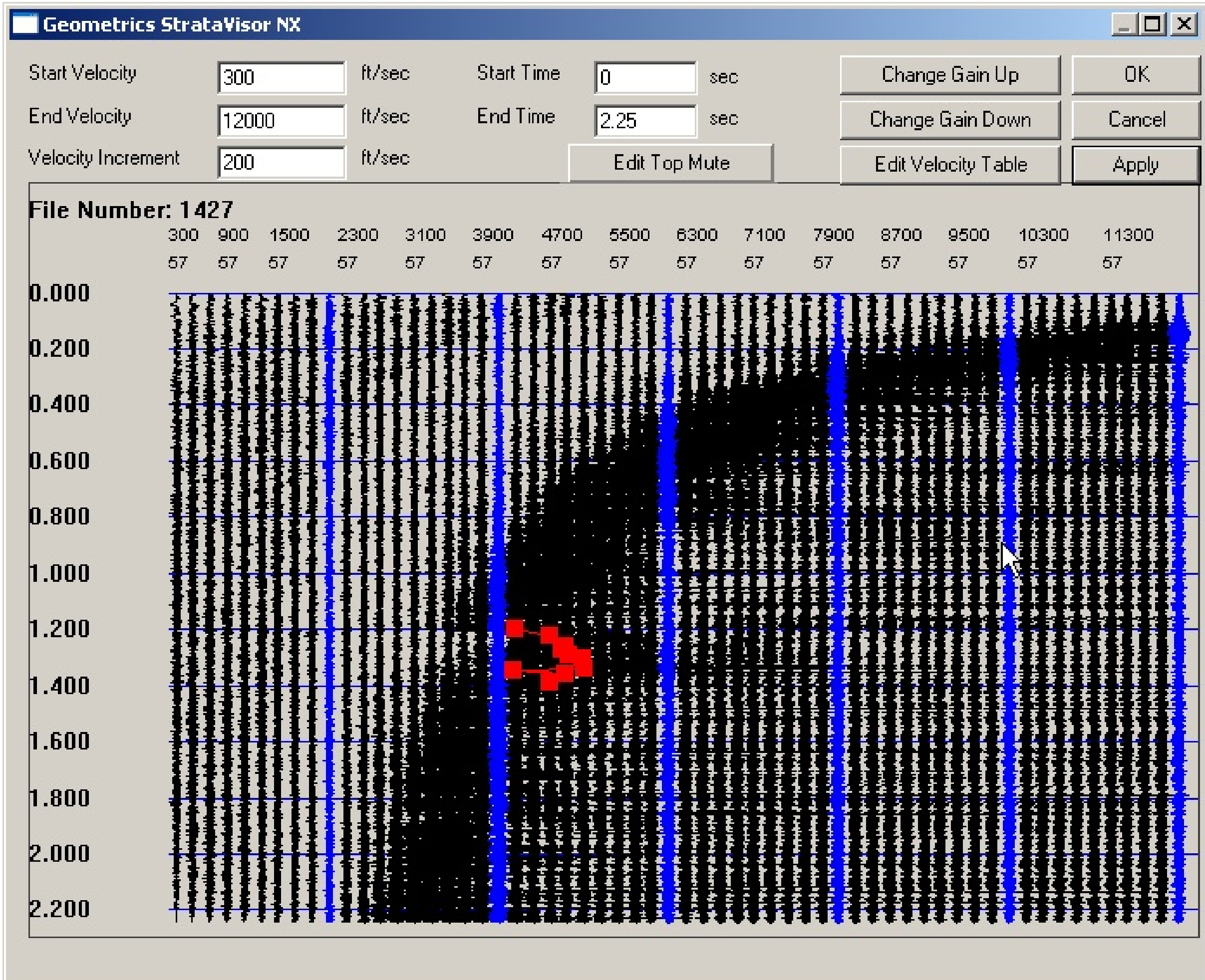


A semblance plot is generated automatically using default parameters. We will return to this directly.

If you already have an existing stacking velocity function, press the **Edit Velocity Table** button and type it in.



You may enter up to 10 time/velocity pairs. Press **Save As** to save the velocity-time function as an ASCII file in the C:\Logfiles folder. When finished, press **OK**. Your velocity function will be displayed on the semblance plot:

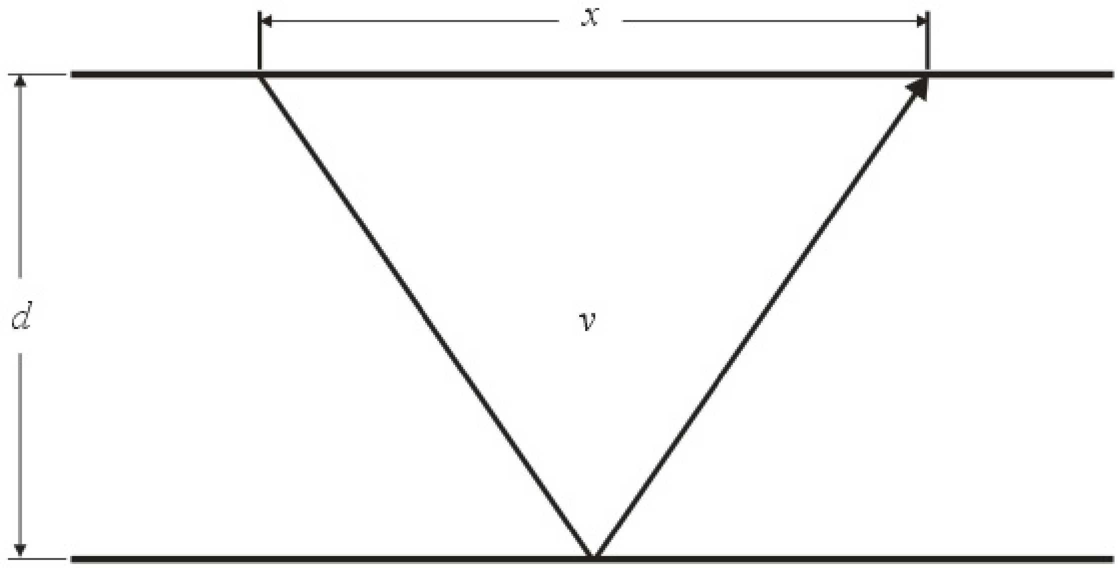


Velocities have only been assigned to the zone of interest, located at 1.2 to 1.4 seconds. Press **OK** to close the velocity dialog. The program now has everything it needs to construct a brute stack as data is acquired.

What is a Semblance Plot?

If you do not have a pre-existing stacking velocity function, you can determine one from the data by means of a “semblance” analysis. Understanding what a semblance plot is will be useful when optimizing it and picking stacking velocities.

Refer to the following figure:



For a given horizontal reflector, the increase of reflection time as a function of offset is hyperbolic and expressed by the following equation:

$$t = \frac{2\sqrt{d^2 + \left(\frac{x}{2}\right)^2}}{v}$$

or

$$t^2 = \frac{4d^2 + x^2}{V^2}$$

where t = the two-way reflection time, d = the depth to the reflector, and x = the source-receiver offset.

This change of reflector time with offset is called "normal moveout" (NMO) and must be corrected for prior to summing the traces in the CMP gather. We need an expression for the correction that must be applied to affect this.

Taking two points on the reflector and differencing them, we get

$$t_2^2 - t_1^2 = \frac{4d^2 + x_2^2 - 4d^2 - x_1^2}{v^2} = \frac{x_2^2 - x_1^2}{v^2}.$$

Solving for *v* shows that given two points on a reflector, we can calculate the average velocity above that reflector (the “stacking” velocity):

$$v = \sqrt{\frac{x_2^2 - x_1^2}{t_2^2 - t_1^2}}.$$

Setting x_1 to zero and rearranging, we see that

$$t_2^2 = \frac{x_2^2}{v^2} + t_1^2.$$

It follows that the increase of reflection time with offset is

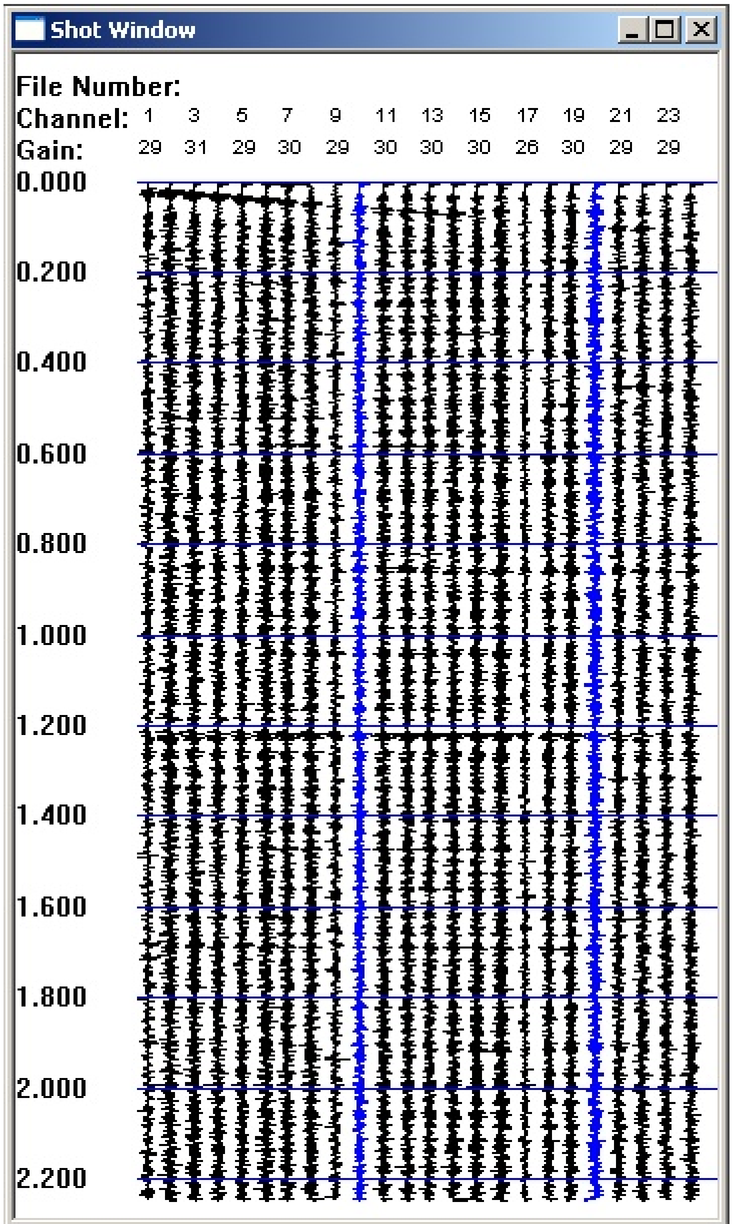
$$\sqrt{\frac{x^2}{v^2}}\ .$$

This is the value we must subtract from each reflection time in the CMP gather to remove the effect of moveout prior to summing the traces. In a nutshell, this is what the brute stack function does.

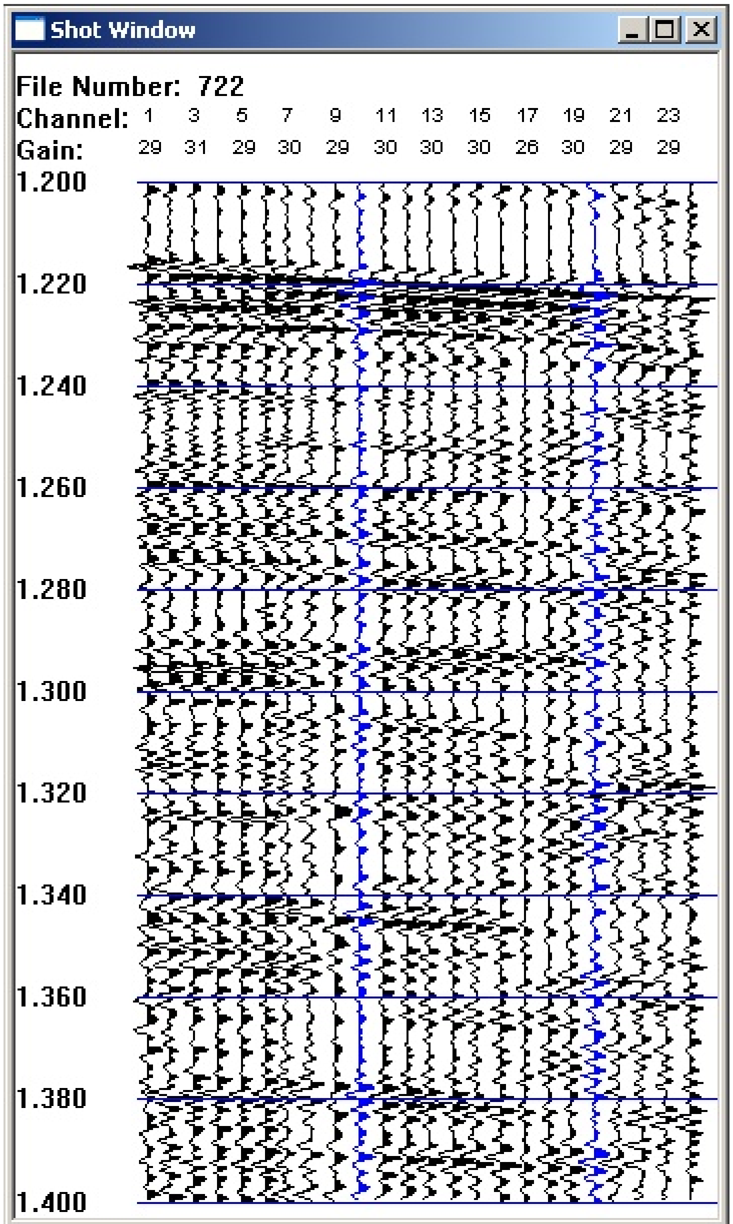
Most marine reflection records will have numerous reflectors, all of which may be defined by a unique stacking velocity. This means that the correction applied must change as a function of time. A correction that flattens a reflector having a moveout velocity of 3,000 m/sec will not flatten one with a velocity of 3,700 m/sec.

A semblance plot corrects and stacks the same CMP gather numerous times using a range of velocities, and plots the resulting stacked traces side by side. On any given trace, the amplitude will be a maximum wherever the NMO correction flattens a reflector the best (because the coherency will be at a maximum). Identifying zones of high coherence on the semblance plot allows you to build a stacking velocity function. This is best illustrated by example.

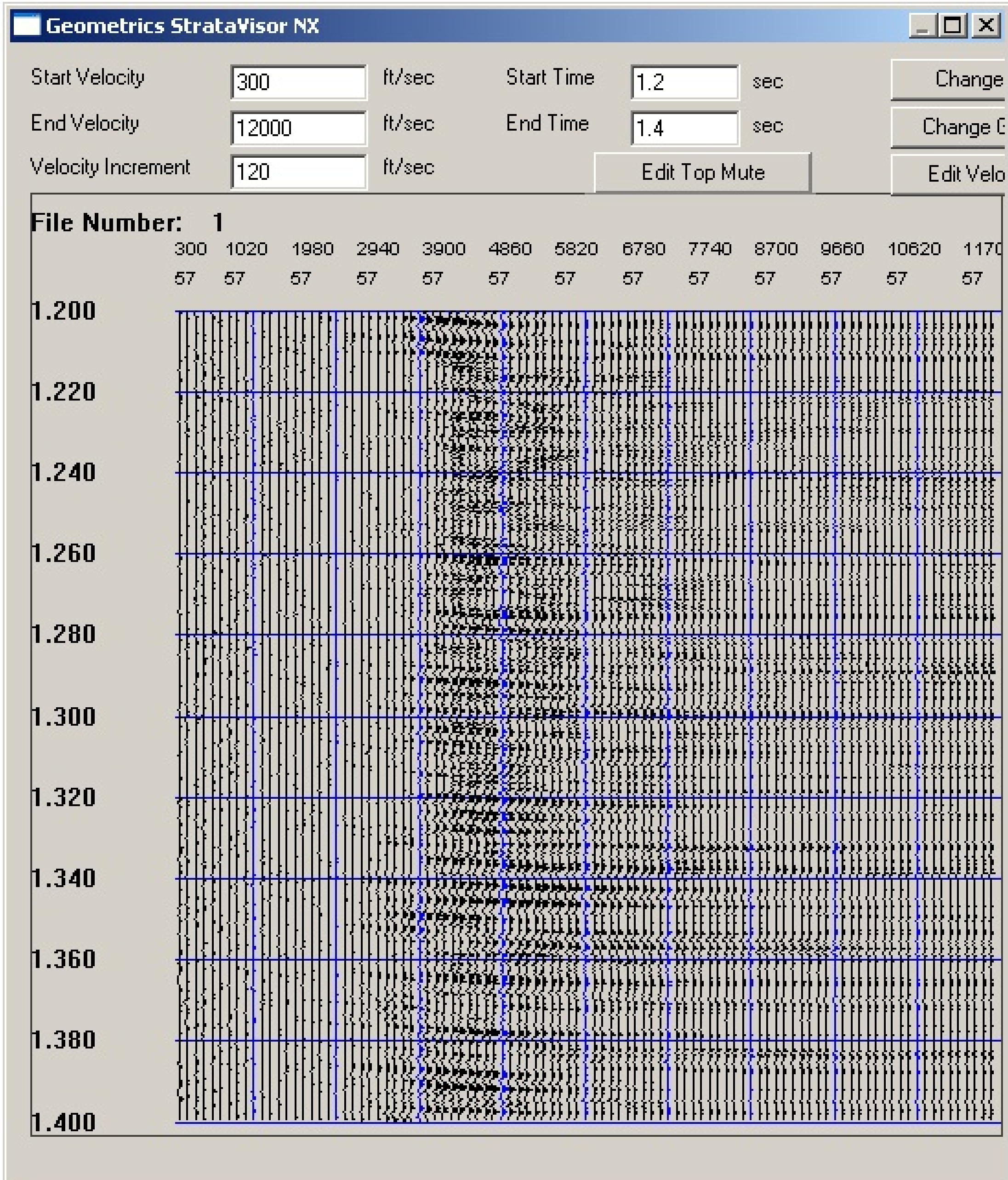
Our sample shot record is displayed in its entirety below:



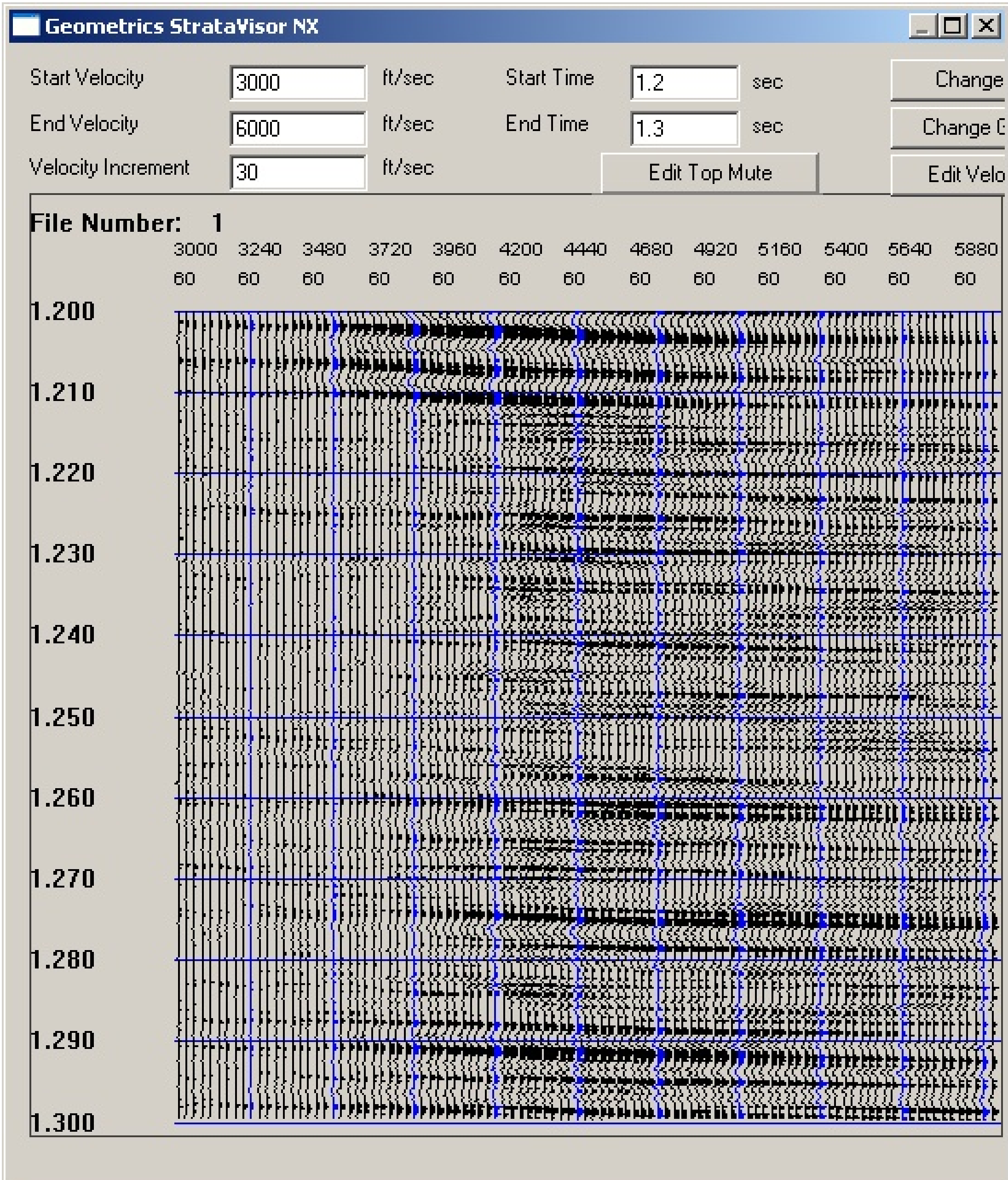
Optimize the record by applying steps described in the Appendix. In our example, the water-bottom reflection is at about 1.2 seconds. Further examination of the record reveals a zone of interest between about 1.2 and 1.4 seconds. Our optimized record is shown below:



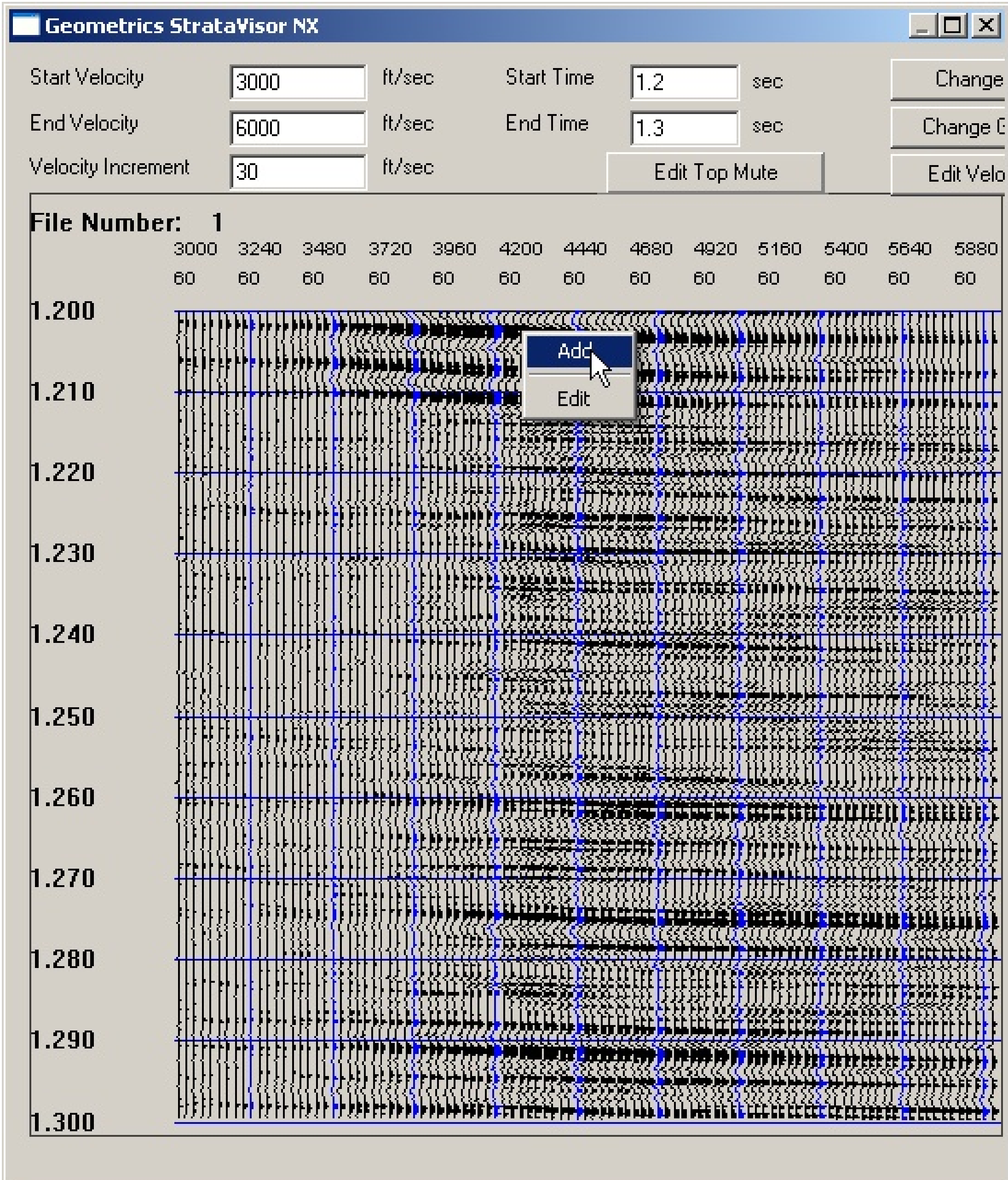
Open the velocity analysis dialog and set a wide velocity range to start with. Set the Start Time and End Time to focus on the zone of interest:



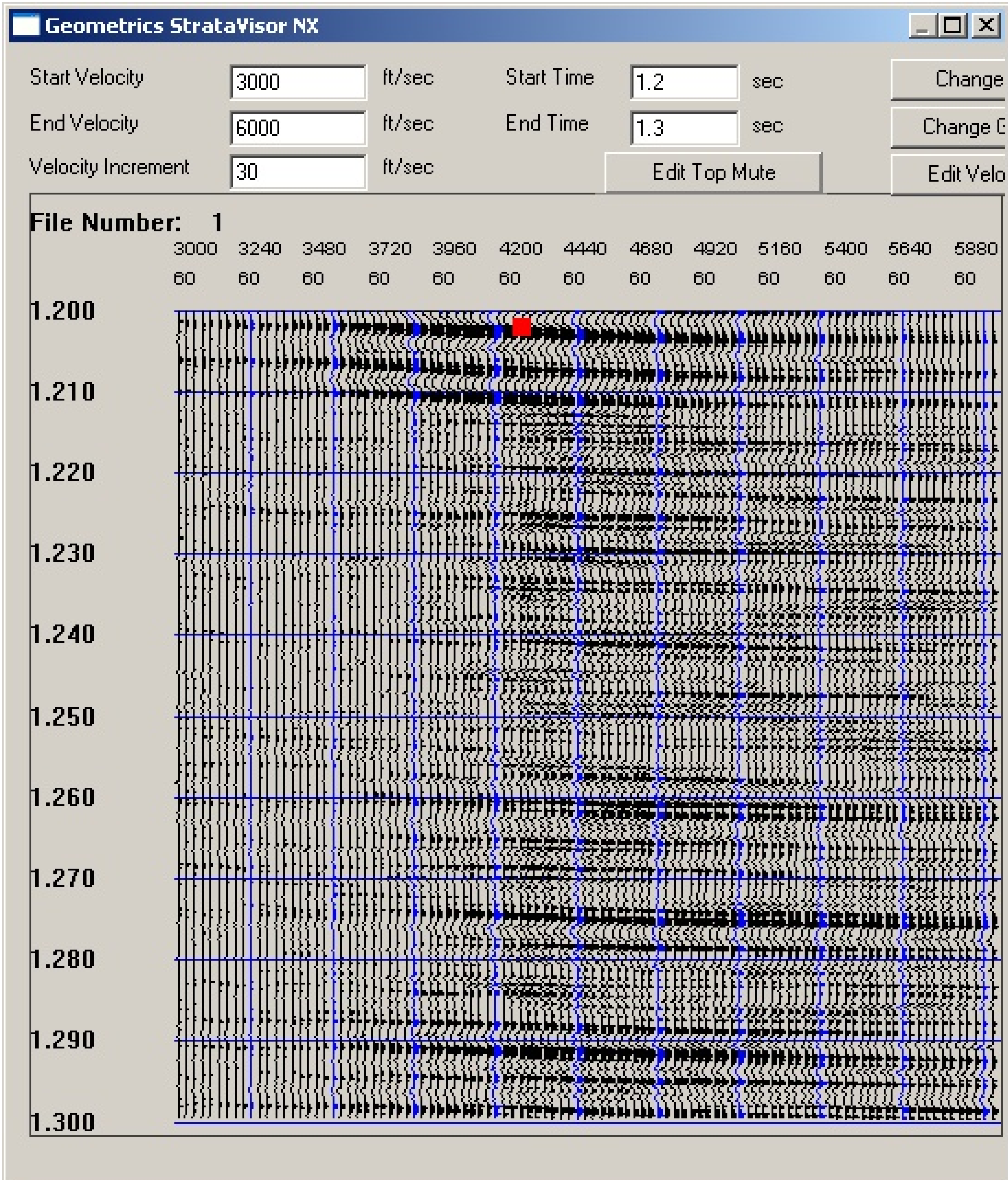
The vertical axis is time, and the horizontal axis is velocity. The upper row of numbers across the top represents velocity, and the bottom row represents display gain. Each trace represents a stacked *shot* record that has been corrected with a specific velocity. The zone of coherence appears to be confined between about 3,000 and 6,000. Let's focus closer by changing the velocity and time limits:



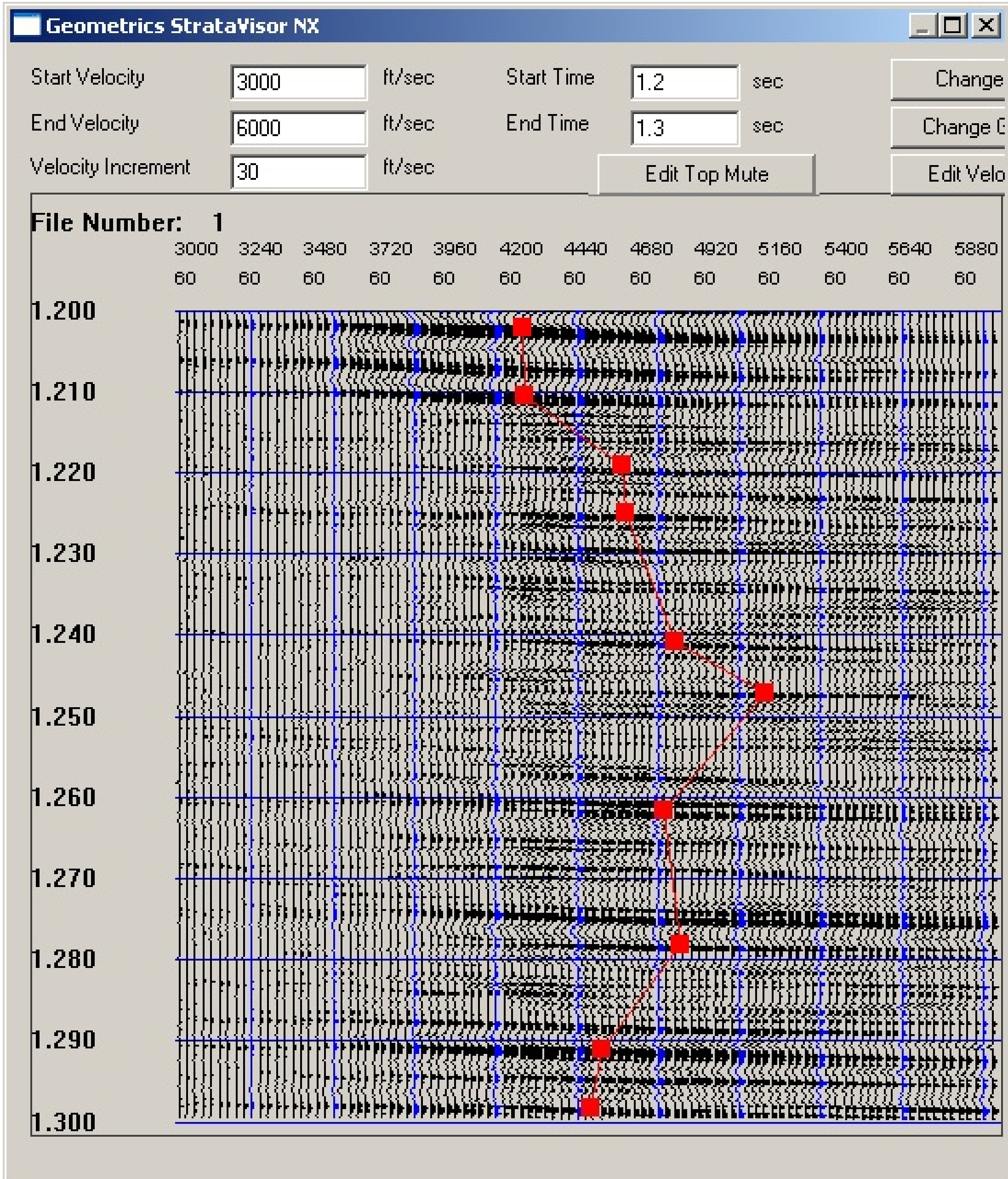
We'll pick velocities in two steps, 100 ms at a time. We point our mouse at the point at which we want to assign a velocity and right-click:



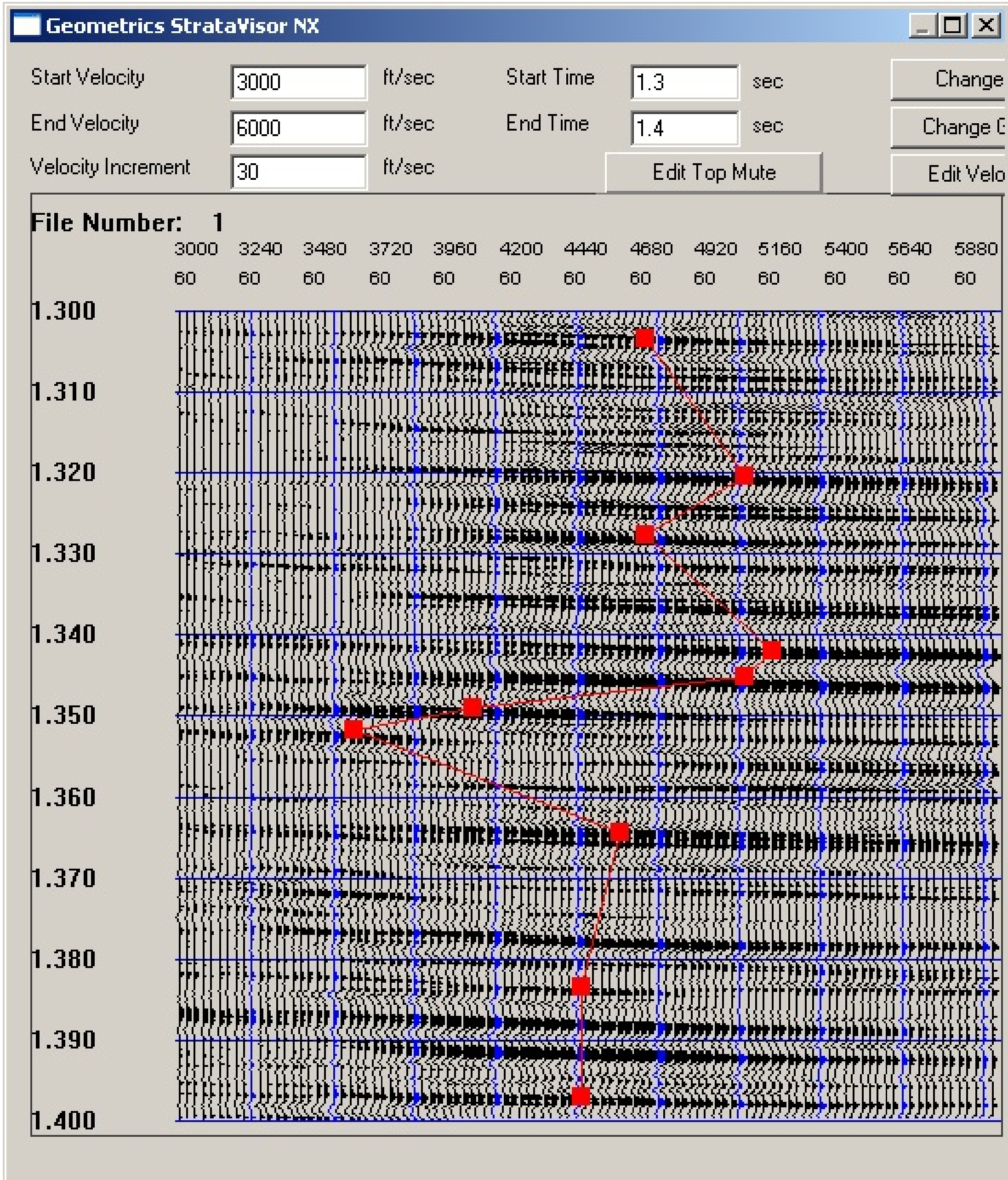
Choose Add to pick the velocity:



Assign velocities throughout in a similar fashion:

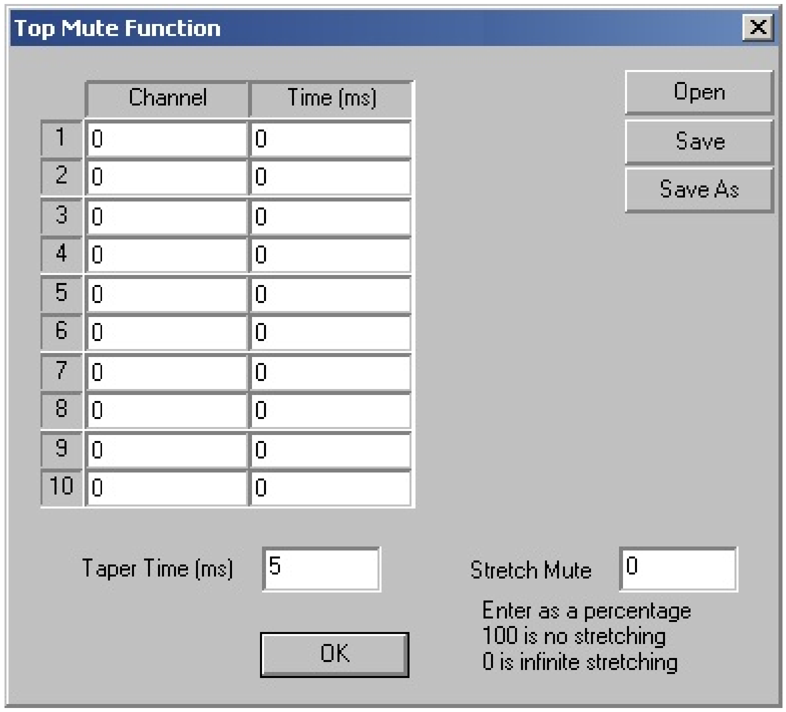


Change the time window to 1.3-1.4 seconds and repeat:



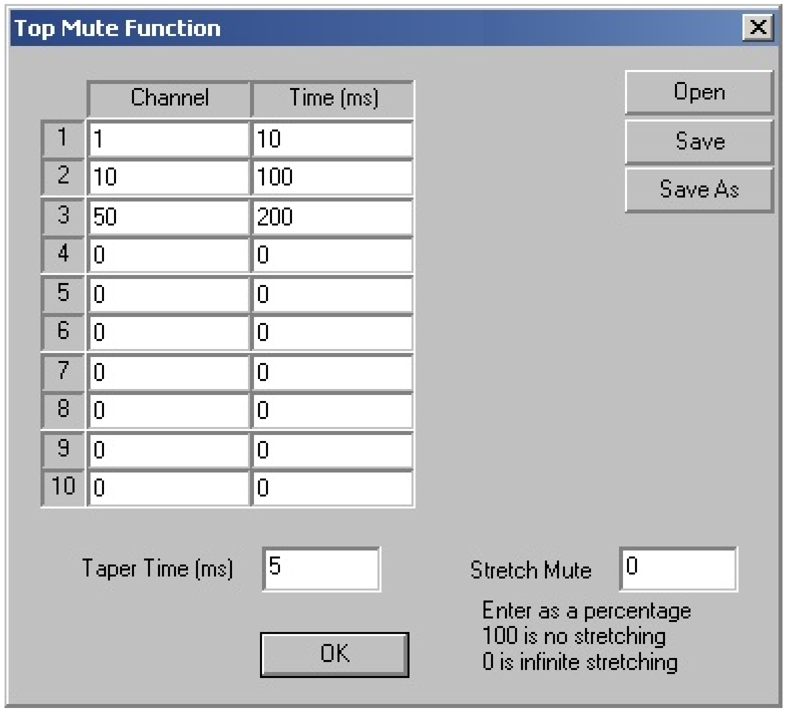
You may delete an assigned velocity by right-clicking, choosing Edit, and then choosing Delete. You may edit an assigned velocity by right-clicking, choosing Edit and typing in the value, or by left-clicking and dragging it to the new location, and pressing **OK.**

Pressing the **Edit Top Mute** button will bring up the following dialog:



In this dialog box, you may enter the top mute parameters and the stretch mute limits.

The channel/time pairs entered in the table define a series of line segments which limit the data used in the brute stack. All data prior to the time limit set by the line segments are muted prior to calculating the brute stack. For example:



Using the settings shown in the above dialog box, a line will be drawn from Channel 1, 10 ms (1,10) to Channel 10, 100 ms (10,100), then to Channel 50, 200 ms (50,200). Samples above this time line will be ignored in the brute stack calculation.

A linear taper is used to smooth the transition between data that is muted and data that is not. Enter the Taper Time in ms.

A stretch mute may also be specified. A Stretch Mute setting of 0 means the mute is not applied. The muting is applied when the time stretch is greater than 100 / number entered. For instance, a stretch mute setting of 50 means that data that have been stretched by more than a factor of two (by the NMO correction) will be left out of the brute stack calculation. The stretch and top mutes operate simultaneously, and data is muted if either the top mute or stretch mute applies.

You may save or open a top mute file by clicking on **Open**, **Save**, or **Save As**. This is useful if the top mute is complicated and you do not want to enter it with each new survey. Note also that the table shown in the dialog is always saved with the survey parameters.

We're now ready to conduct the survey. Note that the stacking velocity function may need to be updated from time to time as the survey progresses.

The brute stack will build up and scroll to the left, exactly the same way a near-trace gather does. All of the discussions on near trace gathers here and here apply equally to brute stack.

If your velocities are accurate enough, you should see a better result with a brute stack than with the single-trace gather. A typical comparison is provided below.

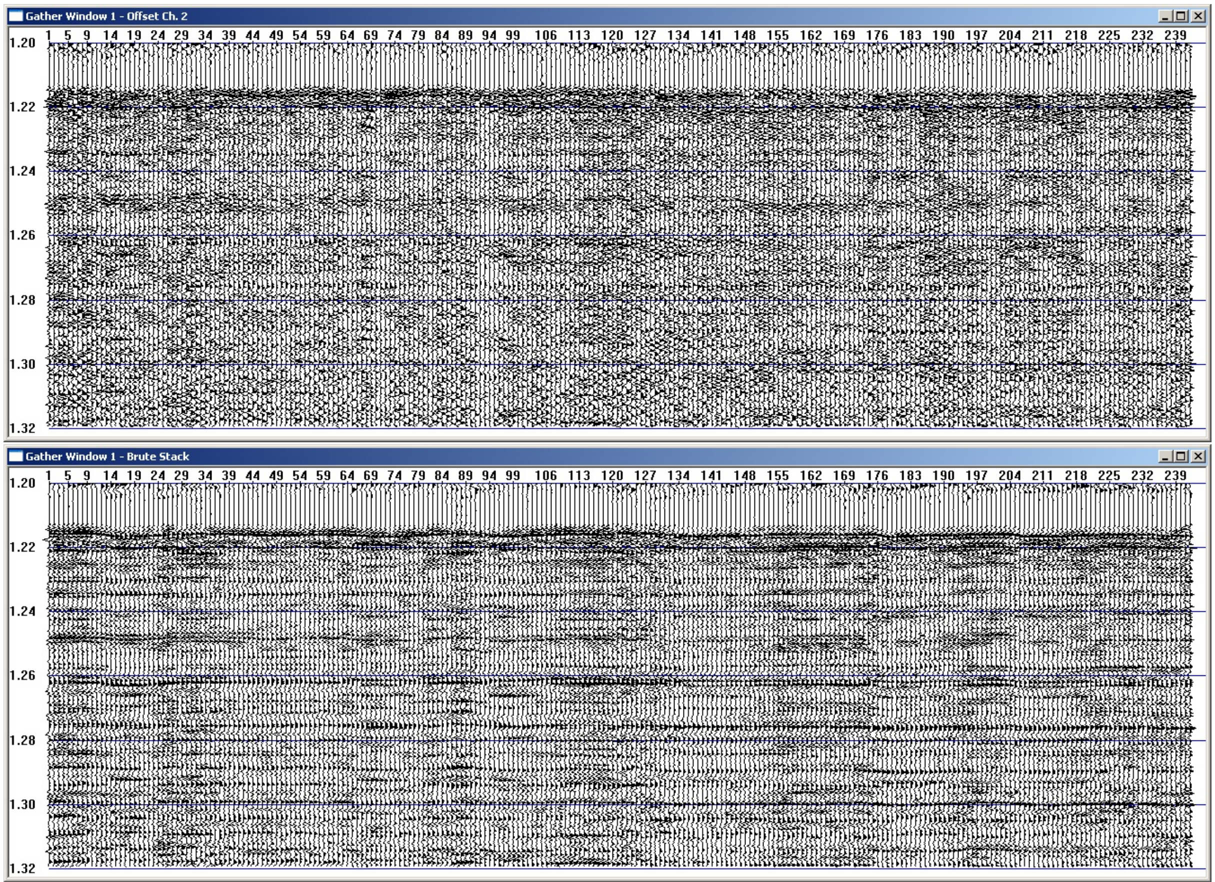


Figure A101: Single-trace gather (top) and brute stack (bottom).

5.4 Plotting a Reference Trace

If you wish, you may include a reference trace on a noise record by using the following procedure:

1) Make sure seismograph is disarmed (**F1** key).
2) Set all of the preamp gains to an identical value, including those of the AUX channels if you have them.
3) Go to the task bar at bottom, and open a GCI window (if you are recording AUX channels, we recommend that you open the GCI window that pertains to the AUX channels, which will be the highest-numbered GCI window. For instance, if you have a 48-channel system, you will have a GCI window for each A/D board (6), plus a 7th GCI window for the AUX channels. Open GCI7.).

4) Open the Commands menu, select Choose Input, and press **Test Oscillator**.

5) Open the Commands menu, select DAC Level, and set to 80. This will put ~50 µV (2.5 µbar), 100 Hz sine wave on the four AUX channels (or the 8 channels of whichever GCI window you used). This is your reference trace.

6) Press **OK**.

7) Minimize the GCI Window.

8) Arm the system (**F1** key).

9) Open the Testing/QC menu, select Manual Trigger. The system will take a record.

10) Right-click on the Shot window, select Display Settings.

11) Make sure that you display all the channels, including AUX channels. If you have a 48-channel system with AUX channels, you would want to display channels 1-49 (this will include one of the four AUX channels; including 50-52 would be redundant). Set the gain to Fixed Gain, and then press **Equalize Gains**. Depending on your goal, you might also wish to set a low cut filter – most practitioners use 5-8 Hz to eliminate swell noise. Next, increase/decrease all the display gains together until you get something that looks something like the picture below:

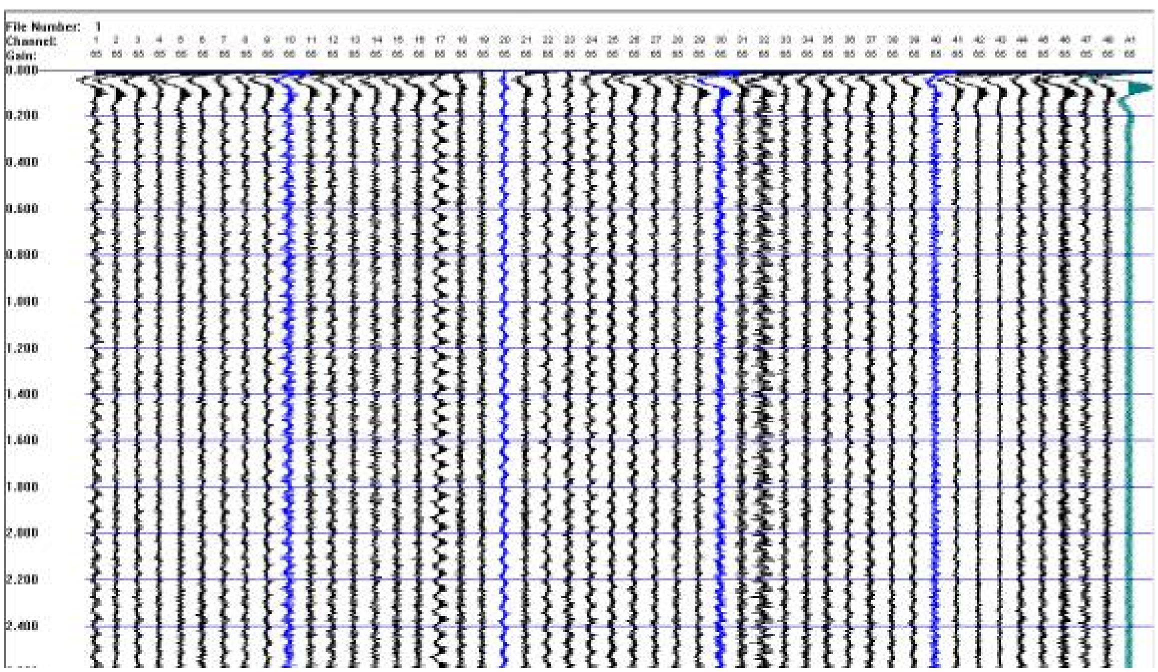


Figure A102: Noise record with reference trace.

In the above noise record, the green trace is the reference trace and is an AUX channel. An 8 Hz low cut filter was used to eliminate swell effects. The rms amplitude of the reference trace is ~2.5 µbar.

If your system does not have AUX channels, we recommend doing two noise tests using GCI window 1 the first time and GCI window 2 the second time. In this case you'll be using channels 1-8 as your reference for the first noise test, and channels 9-16 for your second test.

To turn the oscillator off, choose Input and click on Phone Signal.

5.5 File Formats

A "file" or "record" is the data from a seismic record recorded onto the disk or tape. The formats available on the GeoEel are SEG-D (8058, rev. 1), SEG-2 and SEG-Y, the standards for seismic data files established by the Society of Exploration Geophysicists'. Most third-party software developers have also standardized on one or more of these formats. The complete standards are available from the Society of Exploration Geophysicists.

The following sections describe the SEG-D, SEG-2 and SEG-Y formats used in the GeoEel.

5.5.1 SEG-D 8058 File Structure

Note: *If Promax will be used to process SEG-D data, please see the section on Promax compatibility in the Appendix.*

The following section describes the SEG-D[2] format used in the CNT-2 Marine Controller. The complete standard is available from the SEG.

Two general header blocks, scan type header, external header blocks if any user supplied string, and demux trace header are used in SEG-D format to store trace information. The following are the fields used in each header block:

General header, block #1

Byte 1-2: File Number (if number is less than 10000 or = FFFF if greater than 9999),

Byte 3-4: Format Code (= 8058),

Byte 11: Year,

Byte 12 (upper 4 bits): # Blks in Gen Hdr (= 1),

Byte 12 (lower 4 bits) - 13: Day,

Byte 14: Hour,

Byte 15: Minute,

Byte 16: Second,

Byte 23: Base Scan Interval,

Byte 26 (upper 4 bits): Record Type,

Byte 26 (lower 4 bits) - 27: Record Length (= FFF, use extended record length),

Byte 28: Scan Types/Record (= 1),

Byte 29: Chan Sets/Scan Type (= 2),

Byte 32: External Header Block Length (= length needed to record external string).

General header, block #2

Byte 1-3: Expanded File Number (if number is greater than 9999),

Byte 11-12: SEG-D Revision Number (= 1),

Byte 15-17: Extended Record Length,

Byte 13-14: Gen. Header Block # (= 2),

Byte 29-32: Descaling Factor.

1st Scan type header

Byte 1:Scan Type Number (= 1),

Byte 2: Channel Set Number (= 1),

Byte 3-4: Channel Set Start Time,

Byte 5-6: Channel Set End Time,

Byte 9-10: Number of Channels,

Byte 11 (upper 4 bits): Channel Type (= 1 for data channel),

Byte 12 (lower 4 bits): Channel Gain (= 3, always fixed gain),

Byte 13-14: Alias Filter Frequency (if any*),

Byte 15-16: Alias Filter Slope (if any*),

Byte 17-18: Low cut Filter (if any*),

Byte 19-20: Low cut Filter Slope (if any*),

Byte 21-22: First Notch Filter (if any*),

Byte 23-24: Second Notch Filter (if any*),

Byte 30: Vertical Stack.

2nd Scan type header

Byte 1:Scan Type Number (= 1),

Byte 2: Channel Set Number (= 2),

Byte 3-4: Channel Set Start Time,

Byte 5-6: Channel Set End Time,

Byte 9-10: Number of Channels,

Byte 11 (upper 4 bits): Channel Type (= 7 for pilot or aux. channel),

Byte 12 (lower 4 bits): Channel Gain (= 3, always fixed gain),

Byte 13-14: Alias Filter Frequency (if any*),

Byte 15-16: Alias Filter Slope (if any*),

Byte 17-18: Low cut Filter (if any*),

Byte 19-20: Low cut Filter Slope (if any*),

Byte 21-22: First Notch Filter (if any*),

Byte 23-24: Second Notch Filter (if any*),

Byte 30: Vertical Stack.

External header block(s)

This field stores user supplied information, such as GPS NAV string coming from serial port at each shot.

For each channel:

Demux trace header

Byte 1-2: File Number (if number is less than 10000 or = FF if greater than 9999),

Byte 4: Channel Set Number,

Byte 5-6: Trace Number,

Byte 11: Sample Skew,

Byte 18-20: Extended File Number (if number is greater than 9999).

Note: *All fields that are not used will be recorded as zero. The data followed by each demux trace header and trace header extension has 8058 data format that stands for 32-bit IEEE demultiplexed.*

[1]Pullan, S. E., 1990, Recommended Standard for Seismic (Radar) Data Files in the Personal Computer Environment: Geophysics, Vol. 55, No. 9, September 1990, pp. 1260-1271.

[2]SEG Subcommittee on Field Tape Standards, Digital Field Tape Format Standards - SEG-D, REVISION 1: Geophysics, Vol. 59, No. 4, April, 1994, pp. 668-684.

[3]ANSI/IEEE Std 754-1985.

* If there is no filter selected, all of these fields will be recorded as zero. High cut filter is recorded in Alias Filter Frequency and Alias Filter Slope. If both filters are high cut filters, the one with lower frequency is recorded. Similarly, if both filters are low cut filters, the one with higher frequency is recorded.

5.5.2 SEG-2 File Structure

The file is organized on the disk as blocks: a File Descriptor Block, followed by a sequence of Trace Descriptor Blocks and Data Blocks.

{beginning of file)

FILE DESCRIPTOR BLOCK
TRACE DESCRIPTOR BLOCK 1
DATA BLOCK 1
TRACE DESCRIPTOR BLOCK 2
DATA BLOCK 2
....

....

The *File Descriptor Block* contains information common to all the traces in the file, plus it provides information required to parse the rest of the overhead data. Another name for this block is the "File Header".

Each *Trace Descriptor Block* provides location, format, and other information pertinent to its corresponding Data Block (containing the data from a trace). Another name for this block is "Trace Header".

The *Data Block* consists of fixed point or floating point numbers as specified by their corresponding Trace Descriptor Block. This block contains the data from one channel (or one trace) of the seismograph.

There is a Trace Descriptor Block for each Data Block (in other words, there is a trace header for each block of data from one trace). The blocks are arranged in numerical order.

Pointers are written in the file blocks to indicate locations of the blocks with respect to the beginning of the file. Pointers are always long integers (32 bits). All addressing is to byte boundaries. All blocks start on double word (32 bit) boundaries.

Integers are 16-bit numbers written *low byte first* to conform to the Intel processors used with our software. Long integers are 32-bit numbers, also written low byte first. Hexadecimal number 4547 would be written 47 45 in the file. A 32-bit (4-byte) data sample, such as 0001D340 would be written 40 D3 01 00.

A typical file is shown later in an example, with interpretable characters shown in the right side column. Referring to this example will be helpful in understanding the following descriptions of the data format.

File Descriptor Block

The first block in the file is the File Descriptor Block. The construction of the File Descriptor Block is:

Byte	
0-1	3a55 (File Descriptor Block ID)
2-3	REVISION NUMBER
4-5	SIZE OF TRACE POINTER SUB-BLOCK (M)
6-7	NUMBER OF TRACES IN FILE (N)
8	SIZE OF STRING TERMINATOR
9	FIRST STRING TERMINATOR CHARACTER
10	SECOND STRING TERMINATOR CHARACTER
11	SIZE OF LINE TERMINATOR
12	FIRST LINE TERMINATOR CHARACTER
13	SECOND LINE TERMINATOR CHARACTER
14-31	RESERVED
32-35	POINTER TO TRACE DESCRIPTOR BLOCK 1
36-39	POINTER TO TRACE DESCRIPTOR BLOCK 2

```
----  ----------------------------------
----  POINTER TO TRACE DESCRIPTOR BLOCK N
33+M  STRING 1
      STRING 2
      .........
 M    STRING Z
```

This block holds information common to all traces in the file and pertaining to the structure and interpretation of the file. It consists of:

- 32 bytes providing the block identifier, the revision number, the size of the Trace Pointer sub-block, the number of traces in this file, and the string and line terminator,
- a Trace Pointer sub-block giving pointers to the start of each Trace Descriptor Block in the file, and
- optional strings with information related to the *entire* file such as date, time, delay, constant, high cut filter frequency, line number, low cut filter frequency, notch filter frequency, sample interval, shot coordinate, shot interval, shot map, and shot offset.

The *File Descriptor Block ID* (bytes 0 and 1 of this block and of the file) contains the integer 3a55 (in hexadecimal). This integer identifies the file as a seismic data file following this standard and identifies this block as the Record Descriptor Block (55 appears first, since it is the low byte).

The *File Standard Revision Number* (bytes 2 and 3) appear next.

Bytes 4 and 5 contain an integer giving the *size of the Trace Pointer Sub-block* in bytes (see below). All blocks start on double-word boundaries and are divisible by four.

Bytes 6 and 7 contain the *number of traces in this file*.

The *String Terminator* is one or two non-printable ASCII characters (decimal ASCII codes 0 through 31) used to separate the strings that hold the information in character string form in this (the File Descriptor) block, and the Trace Descriptor Blocks. Byte 8 is 01 (hex) and bytes 9 and 10 are 00 (hex) indicating the string terminator used by the GeoEel is the NULL character.

The *Line Terminator* is one or two ASCII characters used to separate the lines of text in the Notes Block. In the GeoEel, 01 (size of line terminator, 01 hex), byte 12 is 0A (line terminator character), and byte 13 is 00 (hex) indicating that the Line Terminator used by the GeoEel is the Linefeed (0A) character.

Bytes 14 through 31 are reserved and written as 00.

The *Trace Pointer Sub-block* starts at byte 32, and contains pointers (unsigned long integers) to the start of each Trace Descriptor Block in the file. The length of this sub-block in bytes is specified in bytes 4 and 5, and the number of pointers (corresponding to the number of traces) contained in the sub-block is specified in bytes 6 and 7 (see above).

Following the Trace Pointer Sub-block is a free format section containing strings to provide optional information common to all traces in the file (the acquisition parameters, date and time, line geometry, etc.). Each string starts with an integer giving the length of the string (the offset to the next string), followed by a key word naming the parameter in the string, followed by the value (in ASCII), and terminated by the null character string terminator (indicated in bytes 8, 9, and 10 above). A list of key words used in the descriptor blocks will be found later in this appendix.

Trace Descriptor Block

The Trace Descriptor Block contains information relative to an individual trace (seismograph channel). Each Trace Descriptor Block is followed by a Data Block containing the data for that trace. The construction of the Trace Descriptor Block is:

Byte	
0-1	4422 (Trace descriptor block ID)
2-3	SIZE OF THIS BLOCK IN BYTES (X)
4-7	SIZE OF FOLLOWING DATA BLOCK IN BYTES (Y)
8-11	NUMBER OF SAMPLES IN DATA BLOCK
12	DATA FORMAT CODE

13-31	RESERVED
32	STRING 1
	STRING 2
	. . . .
X	STRING Z

The actual byte number for the start of the Trace Descriptor Block varies with the length of the Record Descriptor Block. The optional strings follow with information pertinent to that block (channel number, descaling factor, geophone group location, number of stacks, etc.).

The *Trace Descriptor* (bytes 0 and 1) contains the integer 4422 (hex) to identify this block as a Trace Descriptor Block.

The *Block size* (bytes 2 and 3) contains the integer giving the size of this block in bytes.

The *Size of Data Block* (bytes 4 through 7) contains the long (32-bit) integer giving the size of the following Data Block corresponding to this Trace Descriptor Block.

The *Number of Samples in Data Block* (bytes 8 through 11) contains the integer giving the size of the Data Block in samples.

The *Data Format Code* (bytes 12) specifies the data format in the following data block according to the following table:

Byte value	Data Format
01	16-bit fixed point
02	32-bit fixed point
03	20-bit floating point (SEG convention)
04	32-bit floating point (IEEE standard)
05	64-bit floating point (IEEE standard)

The GeoEel presently offers data recording in code 02, 32-bit fixed point data. Contact the factory regarding 32 bit floating point (04).

The next twenty bytes (bytes 13 through 31) are a series of zeros. This space is reserved.

The rest of the Trace Descriptor Block contains a series of strings. The string format and convention is the same as that used in the File Descriptor Block.

Data Block

A data block follows each Trace Descriptor Block. This is the data for the corresponding trace in the selected format. Except for the last trace (or a single channel record), the Data Block will be followed by the Trace Descriptor Block for the next trace.

String Format

The Record and Trace Descriptor Blocks contain strings that provide information about the survey or the specific trace. Each string starts with an integer giving the length of the string, followed by a key word that names the parameter in the string, then the value (in ASCII format) corresponding to that word, and then ends with the string terminator (null character). Key words can not have embedded spaces (use _ for space, decimal ASCII code 95). The key word and the associated data is separated by one or more spaces or tabs. To assist application program string searches, all strings are ordered alphabetically according to the key word, and all alpha characters are uppercase.

Numeric values may be decimal integers or decimal floating point numbers. Negative decimal numbers are preceded by a minus sign "-". Decimal floating point numbers may use an "E" to express the number in scientific notation. Decimal points must be followed by a numeric character. The numbers in the following list are allowable numeric expressions. Unless stated otherwise, integers must have magnitude less than 32,000 (16 bits).

12, -3, -12.657, -34.6, -1.345E24, -2.3E6, -5.6E-11, -2.0E-9

Some values like time and date are expressed in the special indicated format.

Key Words Used in File Descriptor Block

The File Descriptor Block normally contains the following strings. Other strings may be added later. Not all strings supported by the SEG standard are used by the GeoEel.

ACQUISITION_DATE

The date the data were acquired, in dd/mmm/yyyy format. For example April 1, 1988 would be stored as 01/APR/1988.

ACQUISITION_TIME

The time of day the data were acquired. The format is 24-hour time stored in hh:mm:ss format. For example 3:30PM would be stored as 15:30:00.

GENERAL_CONSTANT

A positive decimal number of 12 or fewer digits, entered by the operator as a general purpose number.

INSTRUMENT_GEOMETRICS_GeoEel

Identifies instrument used to collect the data.

TRACE_SORT

Identifies the trace sort. "As Acquired" is used for normal field records.

UNITS

Identifies measuring system, e.g. feet, meters. NONE is written to designate that system does not differentiate between systems.

NOTE

This string appears as the last string and contains notes and parameters not defined in the standard.

Key Words Used in Trace Descriptor Blocks

CHANNEL_NUMBER

The channel number is a positive integer identifying the seismograph channel (or trace).

DELAY

The delay value is a floating point number expressing the time (in seconds) elapsed from the start pulse to recording the first sample in the Data Block.

DESCALING_FACTOR

A floating point number used to determine the true amplitude of the input signal. To convert from a data sample value to the actual input voltage (in mV) to the seismograph from the geophone, the formula is:

input voltage due to one shot = data point * DESCALING_FACTOR

On the GeoEel system, the scaling factor will be different for different preamp gains (see table in section on setting preamp gains).

HIGH_CUT_FILTER

The HIGH_CUT_FILTER values are positive decimal integers expressing the high cut filter 3 dB frequency in Hz and slope in dB per octave. A value of 0 for the frequency indicates the filter was not implemented.

LINE_NUMBER

The line ID is a collection of printable ASCII characters.

LOW_CUT_FILTER

The LOW_CUT_FILTER values are positive decimal integers expressing the low cut filter 3 dB frequency in Hz and slope in dB per octave. A value of 0 for the frequency indicates the filter was not implemented.

NOTCH_FREQUENCY

The NOTCH_FREQUENCY value is a positive decimal integer or floating point number expressing the notch filter frequency in Hz. A value of 0 indicates a notch filter was not implemented.

RECEIVER_LOCATION

This is the location of the geophone group for the particular trace. It is the dimension along the line, using the same linear coordinate system as the SOURCE_LOCATION.

In the file, each geophone group will have a location specified in the Trace Descriptor Block, as does the shot point in the Record Descriptor, providing that the operator has correctly entered the information in the geometry menu during data acquisition. Note however, that use of file storage for location is optional, that the operator's log may contain the same information, and that the files may be edited later to insert or correct this information.

SAMPLE_INTERVAL

The value is a floating point number expressing the time between samples in seconds.

SOURCE_LOCATION

This is the location of the shot. This value is a linear coordinate specifying location along the survey line relative to some reference. May specify depth in a drill hole.

STACK_COUNT

This stack count is a positive integer indicating the number of times data were stacked into an individual trace. This number may be different for each channel (trace).

5.5.3 SEG-Y File Structure

The following are the fields filled in SEG-Y header:

Reel header part 1 (EBCDIC):

Number 2:	LINE x
Number 4:	INSTRUMENT Geometrics GeoEel
Number 5:	TRACE/RECORD xxxxxxxxx
Number 6:	SAMPLE INTERVAL xxxxxxxxx µsec RECORD LEN xxxxxxx
Number 10:	FILTERS LOW CUT xxxx HZ HIGH CUT xxxxxx HZ NOTCH xxx HZ

Reel header part 2 (binary):

Byte 3205-3208:	Line number
Byte 3213-3214:	Number of traces
Byte 3217-3218:	Sample Interval
Byte 3221-3222:	Number of Samples
Byte 3225-3226:	Data sample format code (2 = 4 bytes fixed points)
Byte 3255-3256:	Measurement system (2 = feet)

Trace header (binary):

Byte 9-12:	Field record number
Byte 13-16:	Trace number
Byte 29-30:	Trace ID code (1 = seismic data)
Byte 31-32:	Number of vertical stacks
Byte 33-34:	Number of horizontal stacks (1)
Byte 71-72:	Scalar (1)
Byte 73-76:	Source coordinate - X
Byte 81-84:	Group coordinate - X
Byte 115-116:	Number of Samples
Byte 117-118:	Sample Interval
Byte 145-146:	Notch filter frequency
Byte 147-148:	Notch filter slope
Byte 149-150:	Low cut filter frequency
Byte 151-152:	High cut filter frequency
Byte 153-154:	Low cut filter slope
Byte 155-156:	High cut filter slope
Byte 157-158:	Year data
Byte 159-160:	Day of year
Byte 161-162:	Hour
Byte 163-164:	Minute
Byte 165-166:	Second

Byte 167-168: Time base code (1 = local)

Note: *Value inside parenthesis is the default value in that field. All filter information, if not used, will record as all zeros.*

5.5.4 SEG-D Promax Compatibility

There is some room for interpretation with this standard (8058, Rev 1) in regards to the exact number of samples written for each trace. The general header specifies a record length in ms. The scan type header specifies a start and end time in 2 ms increments.

Geometrics normally uses the general header (block 2, bytes 15-17) to specify the record length time. We then write (extended record length / base scan interval) number of samples in each trace. If the delay were zero and the record length one second, for example, we would write the start time in the scan type header to be zero (the start of the record) and the end time to be one second. If the base scan interval were one ms, we would write 1000 samples of data.

Promax, however, expects something a bit different. By default, it uses the scan type header information. It expects (end time – start time) / sample rate + 1 samples per trace. From this perspective, we write one less sample than would be calculated using the end time and start time we write in the scan type header. Users of Promax should adjust the import settings to adjust for this discrepancy.

5.6 Sample Reports and Logs

The CNT-2 Controller creates several different logs and reports. These are summarized in the following sections.

5.6.1 Example Depth Log

If depth sensors are present, a Depth Log will be created containing the depth recorded at each sensor for each file.

Note: *The sensors work one at a time; only one sensor gets updated after each shot. The values written for sensors that were not updated are just repeated from the previous shot.*

The name of the Depth Log will be [drive]:\Logfiles*[Survey_Name.Line_Number]*.depth.txt. A sample Depth Log is shown below.

File: 1, Depths: 1043: -0.43m 1072: 0.49m
File: 2, Depths: 1043: -0.43m 1072: 0.49m
File: 3, Depths: 1043: -0.43m 1072: 0.49m
File: 4, Depths: 1043: -0.43m 1072: 0.49m
File: 5, Depths: 1043: -0.43m 1072: 0.49m
File: 6, Depths: 1043: -0.43m 1072: 0.49m
File: 7, Depths: 1043: -0.43m 1072: 0.50m
File: 8, Depths: 1043: -0.43m 1072: 0.50m
File: 9, Depths: 1043: -0.43m 1072: 0.49m
File: 10, Depths: 1043: -0.43m 1072: 0.49m
File: 11, Depths: 1043: -0.43m 1072: 0.50m
File: 12, Depths: 1043: -0.43m 1072: 0.50m
File: 13, Depths: 1043: -0.43m 1072: 0.49m
File: 14, Depths: 1043: -0.43m 1072: 0.49m
File: 15, Depths: 1043: -0.43m 1072: 0.49m
File: 16, Depths: 1043: -0.43m 1072: 0.49m
File: 17, Depths: 1043: -0.43m 1072: 0.49m
File: 18, Depths: 1043: -0.43m 1072: 0.49m
File: 19, Depths: 1043: -0.43m 1072: 0.49m
File: 20, Depths: 1043: -0.43m 1072: 0.49m
File: 21, Depths: 1043: -0.43m 1072: 0.49m
File: 22, Depths: 1043: -0.43m 1072: 0.49m
File: 23, Depths: 1043: -0.43m 1072: 0.49m
File: 24, Depths: 1043: -0.43m 1072: 0.49m
File: 25, Depths: 1043: -0.43m 1072: 0.49m
File: 26, Depths: 1043: -0.44m 1072: 0.49m
File: 27, Depths: 1043: -0.44m 1072: 0.49m
File: 28, Depths: 1043: -0.43m 1072: 0.49m
File: 29, Depths: 1043: -0.43m 1072: 0.50m
File: 30, Depths: 1043: -0.43m 1072: 0.50m
File: 31, Depths: 1043: -0.43m 1072: 0.49m
File: 32, Depths: 1043: -0.43m 1072: 0.49m
File: 33, Depths: 1043: -0.43m 1072: 0.49m
File: 34, Depths: 1043: -0.44m 1072: 0.49m
File: 35, Depths: 1043: -0.44m 1072: 0.49m
File: 36, Depths: 1043: -0.44m 1072: 0.49m
File: 37, Depths: 1043: -0.44m 1072: 0.49m
File: 38, Depths: 1043: -0.44m 1072: 0.49m
File: 39, Depths: 1043: -0.44m 1072: 0.49m
File: 40, Depths: 1043: -0.43m 1072: 0.49m
File: 41, Depths: 1043: -0.43m 1072: 0.50m

5.6.2 Example Navigation Log

Below is a sample navigation file ([drive]:\Logfiles*[Survey_Name.Line_Number]*.Nav.txt) showing the FFID generated by the CNT-2 Controller followed by a standard GPGGA string received on the serial port.

```
1001,$GPGGA,165443.06,3802.159312,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*49
1002,$GPGGA,165444.27,3802.160934,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*49
1003,$GPGGA,165445.29,3802.162556,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4C
1004,$GPGGA,165446.86,3802.164178,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*44
1005,$GPGGA,165446.85,3802.165801,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*41
1006,$GPGGA,165448.16,3802.169045,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*41
1007,$GPGGA,165449.11,3802.170668,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*46
1008,$GPGGA,165450.34,3802.172296,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*48
1009,$GPGGA,165451.39,3802.173912,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*44
1010,$GPGGA,165452.87,3802.175535,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4D
1011,$GPGGA,165501.27,3802.191758,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*43
1012,$GPGGA,165502.48,3802.193386,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4A
1013,$GPGGA,165503.51,3802.195003,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4D
1014,$GPGGA,165504.51,3802.196625,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4B
1015,$GPGGA,165505.27,3802.198247,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*45
1016,$GPGGA,165506.11,3802.199876,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4C
1017,$GPGGA,165507.48,3802.201492,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*43
1018,$GPGGA,165508.49,3802.203114,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*44
1019,$GPGGA,165509.51,3802.204737,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4C
1020,$GPGGA,165510.92,3802.206359,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*45
1021,$GPGGA,165511.95,3802.207981,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4D
1022,$GPGGA,165512.57,3802.211226,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*41
1023,$GPGGA,165513.30,3802.212848,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*40
1024,$GPGGA,165514.71,3802.214471,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*42
1025,$GPGGA,165515.51,3802.216093,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4B
1026,$GPGGA,165516.13,3802.217716,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*46
1027,$GPGGA,165518.36,3802.220966,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*47
1028,$GPGGA,165519.28,3802.222582,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4B
1029,$GPGGA,165520.68,3802.224204,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4A
1030,$GPGGA,165521.59,3802.225827,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*43
1031,$GPGGA,165522.68,3802.227449,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*44
1032,$GPGGA,165524.33,3802.230694,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*48
1033,$GPGGA,165525.79,3802.232316,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*4A
1034,$GPGGA,165525.24,3802.233938,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*45
1035,$GPGGA,165526.53,3802.235561,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*40
1036,$GPGGA,165527.05,3802.237183,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*48
1037,$GPGGA,165529.73,3802.240428,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*43
1038,$GPGGA,165530.66,3802.242056,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*46
1039,$GPGGA,165531.88,3802.243672,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*40
1040,$GPGGA,165532.23,3802.245295,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*49
1041,$GPGGA,165533.97,3802.246917,N,12300,W,2,4,4.69,23,M,-28,M,3.65,0000*45
```

5.6.3 Example Survey Log

Below is a sample Survey Log ([drive]:\Logfiles*[Survey_Name.Line_Number].log*):

New Survey
Sample Interval 0.250 ms, Record Len 1.500 Sec, Delay 0.000 Sec,
Filters: FILTER OUT, FILTER OUT
Active Channels 1 - 48
Preamp Gain Style is set to ALL 30 dB
New Noise Params Transconductance 20.000001 Thresholds 9.000000 3.000000
Saving to disk - Next File Number is 1 - Data Dir is C:\7SIV1A - SEG-D Rev 1 8058 Format

Client name : Shell
Vessel : Henry Christofferson
Project Title : Summer 2007 Beaufort Sea Shallow Hazard Survey
Prospect : Sivulliq
Well Numbers : 1A, 1B, 2A, 4B
Recording System : Geometrics GeoEel
Channels : 48
Hydrophone Group Interval (m) : 6.25
Total Active Section (m) : 300
Tow Point to Source (m) : 15
Near Offset (m) : 25
Shot Interval (m) : 6.25
Tow Depth (m) : 3
Array Volume (cu. in.) : 250
Water Depth (m) : 20-40

Leakage Test Passed
Capacitance test failed on 48 channels
Noise Test (File 1)...
Noise Test (File Number: 1)
Survey: Sivulliq
Line: 1200E
Date: 02/01/2008
Time: 15:30:25.15

Channel	001	002	003	004	005	006
Preamp (dB)	030	030	030	030	030	030
Noise (µBar)	0.68	0.65	0.85	0.84	0.81	0.98
	007	008	009	010	011	012
	030	030	030	030	030	030
	0.39	0.52	0.69	0.64	0.61	0.68
	013	014	015	016	017	018
	030	030	030	030	030	030
	0.74	0.88	1.10	1.31	0.99	1.25
	019	020	021	022	023	024
	030	030	030	030	030	030
	0.55	0.81	0.75	0.79	0.66	0.89
	025	026	027	028	029	030
	030	030	030	030	030	030
	0.57	0.58	0.55	0.79	0.52	0.84
	031	032	033	034	035	036
	030	030	030	030	030	030

1.05	0.51	0.62	0.58	0.50	0.68
037	038	039	040	041	042
030	030	030	030	030	030
0.78	0.71	0.98	1.19	0.64	0.63
043	044	045	046	047	048
030	030	030	030	030	030
0.49	0.58	0.50	0.74	0.97	0.74

Average Noise RMS: 0.75 µBar
Saving to disk - Next File Number is 2 - Data Dir is C:\7SIV1A - SEG-D Rev 1 8058 Format
File 2 15:32:23.19 02/01/2008 1154 KBytes SAVED
File 3 15:32:25.20 02/01/2008 1154 KBytes SAVED
File 4 15:32:27.20 02/01/2008 1154 KBytes SAVED
File 5 15:32:29.19 02/01/2008 1154 KBytes SAVED
File 6 15:32:31.19 02/01/2008 1154 KBytes SAVED
File 7 15:32:33.20 02/01/2008 1154 KBytes SAVED
File 8 15:32:35.20 02/01/2008 1154 KBytes SAVED
File 9 15:32:37.19 02/01/2008 1154 KBytes SAVED
File 10 15:32:39.20 02/01/2008 1154 KBytes SAVED
ALARM: Gun amplitude threshold exceeded. 15:32:42
File 11 15:32:41.20 02/01/2008 1154 KBytes SAVED
File 12 15:32:43.19 02/01/2008 1154 KBytes SAVED
File 13 15:32:45.19 02/01/2008 1154 KBytes SAVED
File 14 15:32:47.20 02/01/2008 1154 KBytes SAVED
File 15 15:32:49.19 02/01/2008 1154 KBytes SAVED
File 16 15:32:51.19 02/01/2008 1154 KBytes SAVED
File 17 15:32:53.20 02/01/2008 1154 KBytes SAVED
File 18 15:32:55.20 02/01/2008 1154 KBytes SAVED
File 19 15:32:57.19 02/01/2008 1154 KBytes SAVED
File 20 15:32:59.19 02/01/2008 1154 KBytes SAVED
File 21 15:33:01.20 02/01/2008 1154 KBytes SAVED
File 22 15:33:03.20 02/01/2008 1154 KBytes SAVED
File 23 15:33:05.19 02/01/2008 1154 KBytes SAVED
File 24 15:33:07.20 02/01/2008 1154 KBytes SAVED
File 25 15:33:09.20 02/01/2008 1154 KBytes SAVED
File 26 15:33:11.19 02/01/2008 1154 KBytes SAVED
ALARM: Noise Threshold exceeded by 2 channels. 15:33:14
File 27 15:33:13.19 02/01/2008 1154 KBytes SAVED
File 28 15:33:15.20 02/01/2008 1154 KBytes SAVED
File 29 15:33:17.20 02/01/2008 1154 KBytes SAVED
File 30 15:33:19.19 02/01/2008 1154 KBytes SAVED
File 31 15:33:21.20 02/01/2008 1154 KBytes SAVED
File 32 15:33:23.20 02/01/2008 1154 KBytes SAVED
File 33 15:33:25.19 02/01/2008 1154 KBytes SAVED
File 34 15:33:27.19 02/01/2008 1154 KBytes SAVED
File 35 15:33:29.20 02/01/2008 1154 KBytes SAVED
File 36 15:33:31.20 02/01/2008 1154 KBytes SAVED
File 37 15:33:33.19 02/01/2008 1154 KBytes SAVED
File 38 15:33:35.20 02/01/2008 1154 KBytes SAVED
File 39 15:33:37.20 02/01/2008 1154 KBytes SAVED

File 40 15:33:39.20 02/01/2008 1154 KBytes SAVED
File 41 15:33:41.19 02/01/2008 1154 KBytes SAVED
Noise Test (File Number: 42)
Survey: Sivulliq
Line: 1200E
Date: 02/01/2008
Time: 15:34:08.88

Channel	001	002	003	004	005	006
Preamp (dB)	030	030	030	030	030	030
Noise (µBar)	0.60	0.61	0.71	0.77	0.76	0.94
	007	008	009	010	011	012
	030	030	030	030	030	030
	0.35	0.49	0.62	0.57	0.55	0.63
	013	014	015	016	017	018
	030	030	030	030	030	030
	0.65	0.82	1.05	1.26	0.94	1.19
	019	020	021	022	023	024
	030	030	030	030	030	030
	0.49	0.76	0.68	0.72	0.60	0.85
	025	026	027	028	029	030
	030	030	030	030	030	030
	0.55	0.53	0.49	0.75	0.49	0.78
	031	032	033	034	035	036
	030	030	030	030	030	030
	0.98	0.47	0.60	0.52	0.51	0.65
	037	038	039	040	041	042
	030	030	030	030	030	030
	0.71	0.67	0.95	1.15	0.61	0.59
	043	044	045	046	047	048
	030	030	030	030	030	030
	0.47	0.52	0.49	0.70	0.96	0.70

Average Noise RMS: 0.70 µBar
File 42 15:34:08.88 02/01/2008 1154 KBytes SAVED
End of Line 1200E

List of error(s):
Noise Threshold exceeded: 1
Gun amplitude threshold exceeded: 1

Average RMS noise: 0.65 µBar
Peak RMS noise: 1.19 µBar

5.6.4 Example Tension Log

Below is a sample Tension Log ([drive]:\Logfiles*[Survey_Name.Line_Number].Tension*.txt):

01/20/15 16:41:00.00 350.0
01/20/15 16:41:10.00 384.0
01/20/15 16:41:20.00 419.0
01/20/15 16:41:30.00 453.0
01/20/15 16:41:40.00 486.0
01/20/15 16:41:50.00 517.0
01/20/15 16:42:00.00 547.0
01/20/15 16:42:10.00 575.0
01/20/15 16:42:20.00 601.0
01/20/15 16:42:30.00 624.0
01/20/15 16:42:40.00 644.0
01/20/15 16:42:50.00 661.0
01/20/15 16:43:00.00 676.0
01/20/15 16:43:10.00 687.0
01/20/15 16:43:20.00 694.0
01/20/15 16:43:30.00 699.0
01/20/15 16:43:40.00 699.0
01/20/15 16:43:50.00 697.0
01/20/15 16:44:00.00 690.0
01/20/15 16:44:10.00 681.0
01/20/15 16:44:20.00 668.0
01/20/15 16:44:30.00 652.0
01/20/15 16:44:40.00 632.0
01/20/15 16:44:50.00 610.0
01/20/15 16:45:00.00 586.0
01/20/15 16:45:10.00 559.0
01/20/15 16:45:20.00 530.0
01/20/15 16:45:30.00 499.0
01/20/15 16:45:40.00 467.0
01/20/15 16:45:50.00 433.0
01/20/15 16:46:00.00 399.0
01/20/15 16:46:10.00 364.0
01/20/15 16:46:20.00 329.0
01/20/15 16:46:30.00 294.0

5.6.5 Analog Test Results - Short Form

```
TEST REPORT
DATE: 01/Feb/08   TIME: 15:00:15
TOTAL 48 OUT OF 48 CHANNELS TESTED

TITLE: Geo-Eel Daily Tests    V2.01 7/10/07

TEST 5 Noise/Offset X1, 1/4mS
```

```
FILE 2011
DC OFFSET SPECIFICATION ( < 1.000000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.037500 mV )
PASSED

TEST 6 Noise/Offset X2.5, 1/4mS

FILE 2012
DC OFFSET SPECIFICATION ( < 0.400000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.016000 mV )
PASSED

TEST 7 Noise/Offset X8.5, 1/4mS

FILE 2013
DC OFFSET SPECIFICATION ( < 0.120000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.004500 mV )
PASSED

TEST 8 Noise/Offset X34, 1/4mS

FILE 2014
DC OFFSET SPECIFICATION ( < 0.035000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.001400 mV )
PASSED

TEST 9 Noise/Offset X1, 2mS

FILE 2026
DC OFFSET SPECIFICATION ( < 1.000000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.002000 mV )
PASSED

TEST 10 Noise/Offset X2.5, 2mS

FILE 2027
DC OFFSET SPECIFICATION ( < 0.400000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.001000 mV )
PASSED

TEST 11 Noise/Offset X8.5, 2mS

FILE 2028
DC OFFSET SPECIFICATION ( < 0.120000 mV )
PASSED
```

```
AC RMS SPECIFICATION ( < 0.001200 mV )
PASSED

TEST 12 Noise/Offset X34, 2mS

FILE 2029
DC OFFSET SPECIFICATION ( < 0.035000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.008000 mV )
PASSED

TEST 17 Gain, THD, Sim X1, 1/4mS, 100Hz

FILE 1011
GAIN ACCURACY SPECIFICATION ( <  2.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED
HARMONIC DISTORTION SPECIFICATION ( <  0.00120 % )
PASSED

FILE 1011
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

TEST 18 Gain, THD, Sim X2.5, 1/4mS, 100Hz

FILE 1012
GAIN ACCURACY SPECIFICATION ( <  2.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED
HARMONIC DISTORTION SPECIFICATION ( <  0.00120 % )
PASSED

FILE 1012
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

TEST 19 Gain, THD, Sim X8.5, 1/4mS, 100Hz

FILE 1013
GAIN ACCURACY SPECIFICATION ( <  2.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED
HARMONIC DISTORTION SPECIFICATION ( <  0.00150 % )
PASSED

FILE 1013
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED
```

```
TEST 20 Gain, THD, Sim X34, 1/4mS, 100Hz

FILE 1014
GAIN ACCURACY SPECIFICATION ( <  6.25000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  3.00000% )
PASSED
HARMONIC DISTORTION SPECIFICATION ( <  0.00700 % )
PASSED

FILE 1014
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

TEST 21 Gain, THD, Sim X1, 2mS, 25Hz

FILE 1026
GAIN ACCURACY SPECIFICATION ( <  2.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED
HARMONIC DISTORTION SPECIFICATION ( <  0.00120 % )
PASSED

FILE 1026
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

TEST 22 Gain, THD, Sim X2.5, 2mS, 25Hz

FILE 1027
GAIN ACCURACY SPECIFICATION ( <  2.60000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED
HARMONIC DISTORTION SPECIFICATION ( <  0.00120 % )
PASSED

FILE 1027
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

TEST 23 Gain, THD, Sim X8.5, 2mS, 25Hz

FILE 1028
GAIN ACCURACY SPECIFICATION ( <  2.10000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED
HARMONIC DISTORTION SPECIFICATION ( <  0.00120 % )
PASSED
```

```
FILE 1028
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

TEST 24 Gain, THD, Sim X34, 2mS, 25Hz

FILE 1029
GAIN ACCURACY SPECIFICATION ( <  6.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  3.00000% )
PASSED
HARMONIC DISTORTION SPECIFICATION ( <  0.00300 % )
PASSED

FILE 1029
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED
```

TEST RESULT ALL TESTS PASSED

5.6.6 Analog Test Results - Long Form

```
TEST REPORT
DATE: 01/Feb/08   TIME: 15:00:15
TOTAL 48 OUT OF 48 CHANNELS TESTED
INTERNAL TEST SYSTEM  Analysis Version ( 2.10 )
60Hz power line frequencies rejected
*** indicates channels out of specification

TITLE: Geo-Eel Daily Tests    V2.01 7/10/07

--------------------------------------------------------------------------
-----
TEST 5 Noise/Offset X1, 1/4mS

FILE 2011
File Date: Feb/01/08   Time: 14:55:03
Sampling Rate:    250 µsec   Record Length:  0.512 sec   Delay:    6 ms
Preamp Gain: 0 dB     Acquisition Filters: OUT  OUT

ANALYSIS NOISE 4 1.0 0.0375
CHAN          DC OFFSET (mV)       AC RMS (mV)
  1             -0.010877           0.022725
  2             -0.006149           0.021544
  3             -0.008080           0.022903
  4             -0.002654           0.023239
  5             -0.001393           0.020597
  6             -0.003089           0.021829
  7             -0.004388           0.021094
```

```
 8             -0.008312          0.022837
 9             -0.008768          0.019837
 10            -0.009205          0.019225
 11            -0.009418          0.019796
 12            -0.006810          0.021106
 13            -0.013231          0.020799
 14            -0.008022          0.021231
 15            -0.010073          0.019872
 16            -0.007855          0.020882
 17            -0.004921          0.020450
 18             0.003917          0.022353
 19            -0.000153          0.022477
 20            -0.000238          0.021461
 21            -0.012506          0.022236
 22            -0.004903          0.023501
 23             0.000758          0.024407
 24             0.002642          0.021642
 25            -0.008055          0.022074
 26            -0.007367          0.021670
 27            -0.010725          0.018897
 28            -0.006897          0.022606
 29            -0.006189          0.021066
 30            -0.004790          0.021905
 31            -0.009525          0.021416
 32            -0.007592          0.022696
 33            -0.007789          0.022526
 34            -0.006094          0.020516
 35            -0.000214          0.022489
 36            -0.003806          0.023266
 37            -0.012157          0.021684
 38            -0.009681          0.023402
 39            -0.001377          0.021445
 40            -0.005460          0.023533
 41            -0.006635          0.021162
 42            -0.011343          0.019868
 43            -0.010972          0.020357
 44            -0.011226          0.023823
 45            -0.004937          0.020173
 46            -0.011229          0.018531
 47            -0.011804          0.019717
 48            -0.013047          0.019438
 ABSOLUTE MEAN:  0.007026          0.021506
WORST CASE CHN:      13                 23
DC OFFSET SPECIFICATION ( < 1.000000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.037500 mV )
PASSED

--------------------------------------------------------------------------
-----
TEST 6 Noise/Offset X2.5, 1/4mS

FILE 2012
```

```
File Date: Feb/01/08   Time: 14:55:20
Sampling Rate:    250 µsec   Record Length:  0.512 sec   Delay:    6 ms
Preamp Gain: 8 dB     Acquisition Filters: OUT  OUT

ANALYSIS NOISE 4 0.4 0.016
CHAN          DC OFFSET (mV)       AC RMS (mV)
  1             -0.003488           0.008756
  2             -0.001943           0.008820
  3             -0.001389           0.009064
  4              0.002707           0.009742
  5             -0.002020           0.008545
  6              0.000291           0.009035
  7              0.000688           0.008451
  8             -0.002730           0.009081
  9             -0.004914           0.008126
 10             -0.003740           0.007421
 11             -0.002307           0.007725
 12             -0.001508           0.008696
 13             -0.005950           0.007930
 14             -0.003513           0.008408
 15             -0.003582           0.008203
 16             -0.002144           0.008279
 17             -0.003410           0.007935
 18             -0.001226           0.008529
 19             -0.004574           0.008535
 20             -0.003142           0.009078
 21             -0.004755           0.008650
 22             -0.003667           0.008586
 23             -0.004087           0.009053
 24             -0.005186           0.009058
 25             -0.004236           0.008893
 26             -0.002180           0.007987
 27             -0.002039           0.007619
 28             -0.001060           0.008960
 29             -0.003689           0.008431
 30             -0.001181           0.008076
 31             -0.001484           0.008805
 32              0.000732           0.008686
 33             -0.002504           0.008951
 34             -0.002909           0.008171
 35             -0.001021           0.008410
 36             -0.001821           0.009088
 37             -0.003535           0.008870
 38             -0.003681           0.009157
 39             -0.000602           0.008460
 40             -0.001658           0.009316
 41             -0.003537           0.008464
 42             -0.001327           0.008246
 43              0.000014           0.008014
 44             -0.001020           0.009034
 45             -0.001106           0.008613
 46             -0.000437           0.007507
 47              0.001000           0.007738
```

```
 48               0.004779           0.008163
 ABSOLUTE MEAN:  0.002511           0.008528
WORST CASE CHN:      13                  4
DC OFFSET SPECIFICATION ( < 0.400000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.016000 mV )
PASSED

--------------------------------------------------------------------------
-----
TEST 7 Noise/Offset X8.5, 1/4mS

FILE 2013
File Date: Feb/01/08   Time: 14:55:38
Sampling Rate:    250 µsec   Record Length:  0.512 sec   Delay:    6 ms
Preamp Gain: 18 dB     Acquisition Filters: OUT  OUT

ANALYSIS NOISE 4 0.12 0.0045
CHAN           DC OFFSET (mV)       AC RMS (mV)
  1              -0.002587           0.002706
  2              -0.002127           0.002685
  3              -0.001877           0.002617
  4              -0.001382           0.002910
  5              -0.001218           0.002500
  6              -0.001424           0.002810
  7              -0.000617           0.002650
  8              -0.001369           0.002893
  9              -0.000934           0.002374
 10              -0.001239           0.002129
 11              -0.000983           0.002303
 12              -0.000794           0.002524
 13              -0.001066           0.002452
 14              -0.001079           0.002504
 15              -0.001024           0.002431
 16              -0.001132           0.002543
 17              -0.001783           0.002339
 18              -0.000635           0.002736
 19              -0.001309           0.002804
 20              -0.000754           0.002522
 21              -0.001049           0.002582
 22              -0.001305           0.002676
 23               0.001024           0.002954
 24              -0.000837           0.002475
 25               0.000072           0.002699
 26              -0.000038           0.002519
 27              -0.000447           0.002202
 28              -0.000235           0.002645
 29               0.000153           0.002419
 30               0.000099           0.002423
 31              -0.000106           0.002568
 32               0.000091           0.002750
 33              -0.001969           0.002734
 34              -0.001428           0.002395
```

```
 35            -0.000451          0.002536
 36            -0.000784          0.002640
 37            -0.001557          0.002658
 38            -0.002229          0.002495
 39            -0.000654          0.002564
 40            -0.001181          0.002650
 41            -0.002077          0.002446
 42            -0.001976          0.002307
 43            -0.002075          0.002430
 44            -0.001916          0.002638
 45            -0.001353          0.002434
 46            -0.002480          0.002335
 47            -0.002137          0.002199
 48            -0.002270          0.002468
 ABSOLUTE MEAN:  0.001194          0.002547
WORST CASE CHN:       1                 23
DC OFFSET SPECIFICATION ( < 0.120000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.004500 mV )
PASSED

-------------------------------------------------------------------------
-----
TEST 8 Noise/Offset X34, 1/4mS

FILE 2014
File Date: Feb/01/08   Time: 14:55:55
Sampling Rate:    250 µsec   Record Length:  0.512 sec   Delay:    6 ms
Preamp Gain: 30 dB     Acquisition Filters: OUT  OUT

ANALYSIS NOISE 4 0.035 0.0014
CHAN          DC OFFSET (mV)       AC RMS (mV)
  1             0.000083          0.000725
  2            -0.000890          0.000757
  3            -0.000688          0.000747
  4            -0.000098          0.000764
  5             0.000457          0.000681
  6             0.000320          0.000754
  7            -0.000104          0.000676
  8            -0.000128          0.000716
  9             0.000143          0.000674
 10            -0.000123          0.000635
 11             0.000170          0.000646
 12             0.000168          0.000700
 13             0.000138          0.000692
 14            -0.000228          0.000702
 15            -0.000188          0.000686
 16            -0.000118          0.000697
 17            -0.000886          0.000669
 18            -0.000375          0.000737
 19            -0.000361          0.000760
 20             0.000034          0.000677
 21             0.000017          0.000736
```

```
 22              -0.000345          0.000740
 23               0.002251          0.000772
 24              -0.000069          0.000692
 25               0.000495          0.000704
 26               0.000327          0.000750
 27              -0.000063          0.000614
 28              -0.000290          0.000732
 29               0.000473          0.000680
 30              -0.000182          0.000708
 31              -0.000042          0.000708
 32              -0.000284          0.000738
 33               0.000030          0.000742
 34               0.000000          0.000639
 35              -0.000031          0.000705
 36               0.000088          0.000726
 37               0.000578          0.000756
 38              -0.000076          0.000722
 39              -0.000128          0.000692
 40               0.000317          0.000717
 41              -0.000619          0.000684
 42              -0.000396          0.000675
 43              -0.000230          0.000688
 44              -0.000298          0.000693
 45              -0.000320          0.000671
 46              -0.000597          0.000685
 47              -0.000361          0.000644
 48              -0.000282          0.000737
 ABSOLUTE MEAN:   0.000310          0.000705
WORST CASE CHN:       23                 23
DC OFFSET SPECIFICATION ( < 0.035000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.001400 mV )
PASSED

-------------------------------------------------------------------------
-----
TEST 9 Noise/Offset X1, 2mS

FILE 2026
File Date: Feb/01/08   Time: 14:56:14
Sampling Rate:   2000 µsec   Record Length:  4.096 sec   Delay:   48 ms
Preamp Gain: 0 dB     Acquisition Filters: OUT  OUT

ANALYSIS NOISE 4 1.0 0.002
CHAN            DC OFFSET (mV)       AC RMS (mV)
  1              -0.030797          0.001156
  2              -0.018289          0.001178
  3              -0.019490          0.001178
  4              -0.012157          0.001183
  5              -0.012634          0.001558
  6              -0.019424          0.001182
  7              -0.014264          0.001389
  8              -0.021341          0.001200
```

```
  9             -0.023696           0.001226
 10             -0.015772           0.001169
 11             -0.013185           0.001195
 12             -0.010278           0.001110
 13             -0.028353           0.001355
 14             -0.016250           0.001193
 15             -0.015931           0.001202
 16             -0.011282           0.001288
 17             -0.011155           0.001192
 18             -0.003204           0.001155
 19             -0.010993           0.001224
 20             -0.008556           0.001177
 21             -0.014724           0.001200
 22             -0.014502           0.001229
 23             -0.013324           0.001290
 24             -0.006714           0.001278
 25             -0.015959           0.001177
 26             -0.009511           0.001290
 27             -0.011495           0.001342
 28             -0.004471           0.001156
 29             -0.013898           0.001251
 30             -0.007510           0.001162
 31             -0.009386           0.001190
 32             -0.002351           0.001199
 33             -0.021852           0.001273
 34             -0.017125           0.001208
 35             -0.007634           0.001190
 36             -0.011930           0.001134
 37             -0.024632           0.001239
 38             -0.025117           0.001211
 39             -0.011180           0.001327
 40             -0.014441           0.001435
 41             -0.015129           0.001144
 42             -0.019174           0.001177
 43             -0.023842           0.001153
 44             -0.019538           0.001131
 45             -0.009300           0.001206
 46             -0.023947           0.001251
 47             -0.024550           0.001229
 48             -0.028442           0.001257
 ABSOLUTE MEAN:  0.015390           0.001226
WORST CASE CHN:       1                  5
DC OFFSET SPECIFICATION ( < 1.000000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.002000 mV )
PASSED

------------------------------------------------------------------------------
TEST 10 Noise/Offset X2.5, 2mS

FILE 2027
File Date: Feb/01/08   Time: 14:56:35
```

```
Sampling Rate:   2000 µsec   Record Length:  4.096 sec   Delay:   48 ms
Preamp Gain: 8 dB     Acquisition Filters: OUT  OUT

ANALYSIS NOISE 4 0.4 0.001
CHAN           DC OFFSET (mV)        AC RMS (mV)
  1              -0.006576             0.000471
  2              -0.001518             0.000501
  3              -0.000807             0.000478
  4               0.003338             0.000490
  5              -0.003625             0.000620
  6              -0.000255             0.000433
  7               0.004022             0.000572
  8              -0.000629             0.000474
  9              -0.007228             0.000493
 10              -0.006244             0.000485
 11              -0.005373             0.000497
 12              -0.004517             0.000476
 13              -0.009160             0.000568
 14              -0.005712             0.000497
 15              -0.006485             0.000497
 16              -0.005295             0.000524
 17              -0.004670             0.000519
 18              -0.002298             0.000486
 19              -0.007488             0.000497
 20              -0.005042             0.000466
 21              -0.005094             0.000477
 22              -0.005102             0.000491
 23              -0.007053             0.000546
 24              -0.006575             0.000526
 25              -0.006728             0.000488
 26              -0.004657             0.000519
 27              -0.004072             0.000556
 28              -0.002605             0.000468
 29              -0.006036             0.000508
 30              -0.004220             0.000487
 31              -0.004601             0.000471
 32              -0.002692             0.000491
 33              -0.007374             0.000517
 34              -0.009143             0.000493
 35              -0.005630             0.000483
 36              -0.006137             0.000489
 37              -0.007782             0.000530
 38              -0.010648             0.000496
 39              -0.006836             0.000553
 40              -0.008038             0.000617
 41              -0.004970             0.000479
 42              -0.003050             0.000484
 43              -0.001944             0.000476
 44              -0.000363             0.000444
 45              -0.002472             0.000473
 46              -0.003206             0.000519
 47              -0.000176             0.000448
 48               0.001191             0.000504
```

```
 ABSOLUTE MEAN:  0.004764           0.000502
WORST CASE CHN:      38                   5
DC OFFSET SPECIFICATION ( < 0.400000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.001000 mV )
PASSED

--------------------------------------------------------------------------
-----
TEST 11 Noise/Offset X8.5, 2mS

FILE 2028
File Date: Feb/01/08   Time: 14:56:57
Sampling Rate:   2000 µsec   Record Length:  4.096 sec   Delay:   48 ms
Preamp Gain: 18 dB     Acquisition Filters: OUT  OUT

ANALYSIS NOISE 4 0.12 0.0012 0.0004
CHAN          DC OFFSET (mV)       AC RMS (mV)
  1             -0.002967           0.000184
  2             -0.002867           0.000183
  3             -0.002719           0.000185
  4             -0.001248           0.000179
  5             -0.000612           0.000220
  6             -0.001377           0.000186
  7             -0.001443           0.000201
  8             -0.002343           0.000189
  9             -0.002374           0.000194
 10             -0.002362           0.000187
 11             -0.001692           0.000185
 12             -0.001696           0.000184
 13             -0.002333           0.000220
 14             -0.002098           0.000194
 15             -0.001990           0.000187
 16             -0.002181           0.000199
 17             -0.001634           0.000185
 18             -0.000291           0.000184
 19             -0.000953           0.000183
 20             -0.000369           0.000182
 21             -0.001178           0.000181
 22             -0.001131           0.000183
 23              0.001330           0.000276
 24              0.000065           0.000174
 25             -0.000938           0.000185
 26             -0.000737           0.000199
 27             -0.001016           0.000196
 28             -0.000897           0.000186
 29             -0.000662           0.000199
 30             -0.001230           0.000182
 31             -0.001192           0.000183
 32             -0.001084           0.000191
 33             -0.001983           0.000189
 34             -0.001708           0.000182
 35             -0.000658           0.000185
```

```
 36              -0.000873           0.000191
 37              -0.001692           0.000185
 38              -0.002583           0.000187
 39              -0.000977           0.000196
 40              -0.001191           0.000213
 41              -0.002549           0.000183
 42              -0.002479           0.000188
 43              -0.002491           0.000202
 44              -0.001907           0.000180
 45              -0.001518           0.000186
 46              -0.002890           0.000196
 47              -0.002503           0.000196
 48              -0.002226           0.000206
 ABSOLUTE MEAN:  0.001609            0.000192
WORST CASE CHN:        1                 23
DC OFFSET SPECIFICATION ( < 0.120000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.001200 mV )
PASSED

-------------------------------------------------------------------------
-----
TEST 12 Noise/Offset X34, 2mS

FILE 2029
File Date: Feb/01/08   Time: 14:57:18
Sampling Rate:   2000 µsec   Record Length:  4.096 sec   Delay:   48 ms
Preamp Gain: 30 dB     Acquisition Filters: OUT  OUT

ANALYSIS NOISE 4 0.035 0.008 0.0003
CHAN           DC OFFSET (mV)       AC RMS (mV)
  1               0.000080           0.000126
  2              -0.000997           0.000123
  3              -0.000654           0.000122
  4              -0.000024           0.000115
  5               0.000566           0.000120
  6               0.000431           0.000124
  7               0.000172           0.000122
  8              -0.000068           0.000128
  9              -0.000031           0.000121
 10              -0.000236           0.000127
 11               0.000359           0.000130
 12               0.000035           0.000116
 13               0.000058           0.000134
 14              -0.000345           0.000126
 15              -0.000129           0.000124
 16              -0.000007           0.000127
 17              -0.001078           0.000123
 18              -0.000384           0.000126
 19              -0.000443           0.000123
 20               0.000098           0.000116
 21               0.000204           0.000135
 22              -0.000333           0.000121
```

```
 23             0.002151          0.000192
 24             0.000083          0.000119
 25             0.000729          0.000124
 26             0.000449          0.000124
 27             0.000025          0.000122
 28            -0.000088          0.000125
 29             0.000695          0.000131
 30            -0.000222          0.000123
 31            -0.000156          0.000120
 32            -0.000223          0.000127
 33            -0.000002          0.000120
 34            -0.000089          0.000117
 35            -0.000052          0.000120
 36             0.000097          0.000120
 37             0.000757          0.000135
 38            -0.000098          0.000124
 39            -0.000180          0.000125
 40             0.000297          0.000139
 41            -0.000706          0.000127
 42            -0.000413          0.000126
 43            -0.000284          0.000137
 44            -0.000105          0.000128
 45            -0.000324          0.000130
 46            -0.000969          0.000127
 47            -0.000442          0.000127
 48            -0.000215          0.000130
 ABSOLUTE MEAN:  0.000346          0.000126
WORST CASE CHN:      23                23
DC OFFSET SPECIFICATION ( < 0.035000 mV )
PASSED
AC RMS SPECIFICATION ( < 0.008000 mV )
PASSED

--------------------------------------------------------------------------
-----
TEST 17 Gain, THD, Sim X1, 1/4mS, 100Hz

SIGNAL_TYPE SINE 100.000000 800.000000 0.000000 8

FILE 1011
File Date: Feb/01/08   Time: 14:57:39
Sampling Rate:    250 µsec   Record Length:  0.512 sec   Delay:    6 ms
Preamp Gain: 0 dB     Acquisition Filters: OUT  OUT

ANALYSIS GAIN 2.0 2.0
INPUT PEAK AMPLITUDE IS    800.000 mV
CHAN    TEST      PEAK AMPLITUDE  ACCURACY     SIMILARITY
 NO.    FREQ          ( mV )         (%)           (%)
  1    100.000       796.057     -0.49291        0.08895
  2    100.000       795.813     -0.52338        0.05830
  3    100.000       794.885     -0.63931       -0.05831
  4    100.000       796.137     -0.48293        0.09899
  5    100.000       789.824     -1.20       -0.69470
```

```
  6    100.000       797.810     -0.27381        0.30933
  7    100.000       793.443     -0.81964       -0.23969
  8    100.000       794.290     -0.71371       -0.13314

  9    100.000       800.756      0.09447        0.01306
 10    100.000       801.206      0.15071        0.06925
 11    100.000       800.582      0.07280       -0.00860
 12    100.000       800.719      0.08992        0.00851
 13    100.000       800.103      0.01292       -0.06843
 14    100.000       801.815      0.22685        0.14533
 15    100.000       800.343      0.04292       -0.03846
 16    100.000       800.583      0.07290       -0.00850

 17    100.000       795.332     -0.58347       -0.32996
 18    100.000       801.456      0.18194        0.43740
 19    100.000       800.659      0.08237        0.33757
 20    100.000       800.465      0.05812        0.31327
 21    100.000       794.007     -0.74915       -0.49607
 22    100.000       797.299     -0.33759       -0.08346
 23    100.000       798.631     -0.17111        0.08345
 24    100.000       796.896     -0.38804       -0.13403

 25    100.000       798.012     -0.24844       -0.59769
 26    100.000       803.263      0.40791        0.05636
 27    100.000       803.280      0.41001        0.05846
 28    100.000       805.083      0.63542        0.28308
 29    100.000       803.904      0.48797        0.13614
 30    100.000       797.763     -0.27956       -0.62870
 31    100.000       799.771     -0.02862       -0.37864
 32    100.000       802.358      0.29480       -0.05635

 33    100.000       799.145     -0.10692        0.43270
 34    100.000       793.830     -0.77126       -0.23523
 35    100.000       795.926     -0.50929        0.02815
 36    100.000       800.062      0.00773        0.54797
 37    100.000       794.961     -0.62983       -0.09304
 38    100.000       795.478     -0.56530       -0.02816
 39    100.000       801.830      0.22881        0.77024
 40    100.000       794.692     -0.66346       -0.12685

 41    100.000       796.857     -0.39285       -0.07112
 42    100.000       797.344     -0.33204       -0.01011
 43    100.000       797.505     -0.31188        0.01011
 44    100.000       802.665      0.33317        0.65724
 45    100.000       797.771     -0.27866        0.04344
 46    100.000       796.606     -0.42421       -0.10258
 47    100.000       795.488     -0.56396       -0.24279
 48    100.000       800.478      0.05978        0.38297
            MEAN:    798.400     -0.20004
WORST CASE CHN:                     5               39
GAIN ACCURACY SPECIFICATION ( <  2.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
```

```
PASSED

ANALYSIS HARMONIC_DISTORTION 6 0.0012
CHAN  FNDMTL            FIRST FIVE HARMONIC CONTENT (%)          RMS
TOTAL (%)
 NO.   FREQ       2          3          4          5          6
  1  100.000   0.00017   0.00010   0.00009   0.00012   0.00008   0.00028
  2  100.000   0.00022   0.00015   0.00009   0.00013   0.00010   0.00034
  3  100.000   0.00016   0.00012   0.00013   0.00012   0.00011   0.00031
  4  100.000   0.00022   0.00011   0.00010   0.00009   0.00009   0.00031
  5  100.000   0.00018   0.00017   0.00009   0.00009   0.00011   0.00032
  6  100.000   0.00021   0.00016   0.00009   0.00008   0.00009   0.00031
  7  100.000   0.00021   0.00020   0.00011   0.00014   0.00007   0.00036
  8  100.000   0.00021   0.00012   0.00009   0.00010   0.00009   0.00030
  9  100.000   0.00019   0.00016   0.00013   0.00014   0.00013   0.00034
 10  100.000   0.00013   0.00017   0.00013   0.00012   0.00012   0.00031
 11  100.000   0.00015   0.00015   0.00012   0.00013   0.00013   0.00030
 12  100.000   0.00014   0.00018   0.00008   0.00015   0.00011   0.00031
 13  100.000   0.00021   0.00016   0.00012   0.00022   0.00025   0.00048
 14  100.000   0.00018   0.00023   0.00015   0.00023   0.00012   0.00042
 15  100.000   0.00018   0.00019   0.00011   0.00010   0.00009   0.00032
 16  100.000   0.00015   0.00015   0.00010   0.00011   0.00010   0.00029
 17  100.000   0.00023   0.00014   0.00012   0.00013   0.00008   0.00036
 18  100.000   0.00022   0.00013   0.00017   0.00014   0.00014   0.00040
 19  100.000   0.00021   0.00012   0.00013   0.00017   0.00012   0.00037
 20  100.000   0.00022   0.00015   0.00018   0.00015   0.00011   0.00039
 21  100.000   0.00024   0.00013   0.00013   0.00016   0.00012   0.00039
 22  100.000   0.00024   0.00013   0.00014   0.00017   0.00010   0.00039
 23  100.000   0.00020   0.00013   0.00014   0.00018   0.00011   0.00038
 24  100.000   0.00019   0.00016   0.00012   0.00016   0.00010   0.00035
 25  100.000   0.00007   0.00013   0.00015   0.00015   0.00016   0.00033
 26  100.000   0.00008   0.00008   0.00014   0.00019   0.00015   0.00032
 27  100.000   0.00007   0.00014   0.00014   0.00020   0.00013   0.00035
 28  100.000   0.00007   0.00010   0.00017   0.00018   0.00015   0.00035
 29  100.000   0.00007   0.00009   0.00014   0.00019   0.00014   0.00033
 30  100.000   0.00011   0.00013   0.00015   0.00019   0.00015   0.00037
 31  100.000   0.00015   0.00013   0.00015   0.00019   0.00014   0.00036
 32  100.000   0.00008   0.00017   0.00015   0.00018   0.00019   0.00038
 33  100.000   0.00010   0.00008   0.00015   0.00016   0.00011   0.00028
 34  100.000   0.00010   0.00010   0.00013   0.00015   0.00011   0.00027
 35  100.000   0.00009   0.00011   0.00014   0.00013   0.00009   0.00027
 36  100.000   0.00008   0.00011   0.00009   0.00019   0.00011   0.00029
 37  100.000   0.00006   0.00009   0.00016   0.00009   0.00008   0.00027
 38  100.000   0.00011   0.00011   0.00015   0.00017   0.00011   0.00031
 39  100.000   0.00005   0.00011   0.00014   0.00013   0.00012   0.00027
 40  100.000   0.00006   0.00006   0.00014   0.00016   0.00009   0.00027
 41  100.000   0.00013   0.00014   0.00012   0.00018   0.00009   0.00034
 42  100.000   0.00018   0.00013   0.00011   0.00016   0.00011   0.00032
 43  100.000   0.00014   0.00014   0.00013   0.00023   0.00007   0.00036
 44  100.000   0.00012   0.00011   0.00013   0.00017   0.00006   0.00030
 45  100.000   0.00012   0.00014   0.00014   0.00017   0.00008   0.00032
 46  100.000   0.00020   0.00014   0.00016   0.00019   0.00008   0.00038
 47  100.000   0.00016   0.00014   0.00011   0.00020   0.00007   0.00033
```

```
 48  100.000   0.00015   0.00014   0.00011   0.00019   0.00006   0.00032
                                                        MEAN:   0.00033
                                              WORST CASE CHN:     13
HARMONIC DISTORTION SPECIFICATION ( <  0.00120 % )
PASSED

FILE 1011

ANALYSIS PHASE 0.1
CHAN    TEST FREQ   SIMILARITY
          (HZ)       (DEGREE)
WORST CASE CHN:        13
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

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-----
TEST 18 Gain, THD, Sim X2.5, 1/4mS, 100Hz

SIGNAL_TYPE SINE 100.000000 800.000000 0.000000 8

FILE 1012
File Date: Feb/01/08   Time: 14:57:58
Sampling Rate:    250 µsec   Record Length:  0.512 sec   Delay:    6 ms
Preamp Gain: 8 dB     Acquisition Filters: OUT  OUT

ANALYSIS GAIN 2.0 2.0
INPUT PEAK AMPLITUDE IS    800.000 mV
CHAN    TEST      PEAK AMPLITUDE  ACCURACY     SIMILARITY
 NO.    FREQ          ( mV )         (%)           (%)
  1    100.000       800.847      0.10587       0.22803
  2    100.000       800.068      0.00844       0.13048
  3    100.000       795.504     -0.56194      -0.44059
  4    100.000       801.168      0.14598       0.26819
  5    100.000       795.737     -0.53290      -0.41151
  6    100.000       803.784      0.47295       0.59557
  7    100.000       797.982     -0.25221      -0.13048
  8    100.000       797.891     -0.26357      -0.14185

  9    100.000       804.476      0.55953       0.01688
 10    100.000       804.045      0.50561      -0.03675
 11    100.000       804.883      0.61041       0.06749
 12    100.000       804.205      0.52558      -0.01688
 13    100.000       803.280      0.41002      -0.13182
 14    100.000       805.167      0.64589       0.10277
 15    100.000       800.221      0.02760      -0.51218
 16    100.000       805.676      0.70946       0.16600

 17    100.000       802.938      0.36730      -0.00274
 18    100.000       806.726      0.84074       0.46894
 19    100.000       802.612      0.32652      -0.04338
 20    100.000       806.528      0.81599       0.44429
 21    100.000       798.371     -0.20358      -0.57152
```

```
 22    100.000       804.854     0.60677        0.23584
 23    100.000       802.982     0.37281        0.00274
 24    100.000       797.913    -0.26083       -0.62856

 25    100.000       803.243     0.40533       -0.39497
 26    100.000       805.906     0.73824       -0.06472
 27    100.000       809.290     1.16131        0.35498
 28    100.000       806.950     0.86871        0.06472
 29    100.000       809.797     1.22464        0.41781
 30    100.000       802.021     0.25266       -0.54643
 31    100.000       803.432     0.42906       -0.37143
 32    100.000       807.994     0.99924        0.19420

 33    100.000       795.952    -0.50602       -0.44450
 34    100.000       798.087    -0.23907       -0.17739
 35    100.000       804.272     0.53402        0.59618
 36    100.000       804.759     0.59485        0.65705
 37    100.000       797.547    -0.30661       -0.24497
 38    100.000       800.924     0.11549        0.17739
 39    100.000       804.945     0.61818        0.68039
 40    100.000       797.703    -0.28712       -0.22547

 41    100.000       795.409    -0.57385        0.01131
 42    100.000       795.229    -0.59635       -0.01132
 43    100.000       790.143    -1.23208       -0.65079
 44    100.000       799.389    -0.07633        0.51176
 45    100.000       796.526    -0.43422        0.15177
 46    100.000       792.418    -0.94779       -0.36483
 47    100.000       791.345    -1.08189       -0.49971
 48    100.000       797.457    -0.31790        0.26877
          MEAN:      801.221     0.15260
WORST CASE CHN:                     43             39
GAIN ACCURACY SPECIFICATION ( <  2.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED

ANALYSIS HARMONIC_DISTORTION 6 0.0012
CHAN  FNDMTL             FIRST FIVE HARMONIC CONTENT (%)         RMS
TOTAL (%)
 NO.   FREQ       2         3         4         5         6
  1  100.000  0.00013  0.00007  0.00017  0.00013  0.00017  0.00032
  2  100.000  0.00013  0.00006  0.00015  0.00012  0.00015  0.00029
  3  100.000  0.00015  0.00004  0.00014  0.00012  0.00014  0.00030
  4  100.000  0.00018  0.00005  0.00015  0.00013  0.00014  0.00032
  5  100.000  0.00012  0.00006  0.00015  0.00013  0.00015  0.00030
  6  100.000  0.00013  0.00007  0.00017  0.00013  0.00015  0.00031
  7  100.000  0.00012  0.00006  0.00017  0.00012  0.00016  0.00031
  8  100.000  0.00012  0.00007  0.00015  0.00013  0.00016  0.00030
  9  100.000  0.00019  0.00018  0.00015  0.00013  0.00010  0.00035
 10  100.000  0.00021  0.00018  0.00016  0.00011  0.00011  0.00037
 11  100.000  0.00023  0.00017  0.00015  0.00012  0.00011  0.00037
 12  100.000  0.00024  0.00016  0.00015  0.00012  0.00010  0.00037
```

13	100.000	0.00017	0.00021	0.00018	0.00013	0.00010	0.00038
14	100.000	0.00016	0.00020	0.00015	0.00011	0.00011	0.00035
15	100.000	0.00019	0.00014	0.00015	0.00010	0.00010	0.00032
16	100.000	0.00019	0.00018	0.00015	0.00011	0.00010	0.00035
17	100.000	0.00007	0.00010	0.00010	0.00012	0.00013	0.00025
18	100.000	0.00009	0.00009	0.00011	0.00011	0.00013	0.00026
19	100.000	0.00014	0.00009	0.00010	0.00012	0.00012	0.00027
20	100.000	0.00017	0.00008	0.00011	0.00012	0.00011	0.00028
21	100.000	0.00007	0.00008	0.00010	0.00011	0.00015	0.00024
22	100.000	0.00008	0.00010	0.00011	0.00009	0.00014	0.00025
23	100.000	0.00009	0.00009	0.00009	0.00011	0.00013	0.00024
24	100.000	0.00012	0.00008	0.00009	0.00010	0.00014	0.00025
25	100.000	0.00013	0.00018	0.00010	0.00019	0.00008	0.00033
26	100.000	0.00008	0.00018	0.00011	0.00017	0.00008	0.00032
27	100.000	0.00008	0.00016	0.00010	0.00019	0.00008	0.00031
28	100.000	0.00007	0.00018	0.00011	0.00019	0.00010	0.00032
29	100.000	0.00012	0.00018	0.00010	0.00018	0.00008	0.00032
30	100.000	0.00015	0.00017	0.00012	0.00020	0.00010	0.00035
31	100.000	0.00014	0.00017	0.00011	0.00018	0.00009	0.00033
32	100.000	0.00009	0.00016	0.00010	0.00019	0.00008	0.00031
33	100.000	0.00021	0.00022	0.00012	0.00019	0.00012	0.00042
34	100.000	0.00023	0.00019	0.00012	0.00021	0.00011	0.00042
35	100.000	0.00024	0.00020	0.00011	0.00020	0.00012	0.00042
36	100.000	0.00030	0.00025	0.00011	0.00020	0.00012	0.00049
37	100.000	0.00024	0.00021	0.00011	0.00019	0.00012	0.00043
38	100.000	0.00022	0.00022	0.00011	0.00020	0.00012	0.00042
39	100.000	0.00023	0.00019	0.00012	0.00021	0.00013	0.00043
40	100.000	0.00024	0.00021	0.00010	0.00021	0.00012	0.00043
41	100.000	0.00019	0.00004	0.00016	0.00011	0.00005	0.00028
42	100.000	0.00017	0.00007	0.00015	0.00010	0.00005	0.00027
43	100.000	0.00014	0.00005	0.00015	0.00009	0.00005	0.00025
44	100.000	0.00012	0.00006	0.00014	0.00010	0.00006	0.00024
45	100.000	0.00015	0.00009	0.00016	0.00010	0.00005	0.00028
46	100.000	0.00016	0.00007	0.00015	0.00012	0.00005	0.00028
47	100.000	0.00015	0.00009	0.00016	0.00009	0.00005	0.00027
48	100.000	0.00014	0.00006	0.00015	0.00010	0.00008	0.00026
						MEAN:	0.00032
						WORST CASE CHN:	36

HARMONIC DISTORTION SPECIFICATION (< 0.00120 %)
PASSED

FILE 1012

ANALYSIS PHASE 0.1
CHAN TEST FREQ SIMILARITY
(HZ) (DEGREE)
WORST CASE CHN: 36
PHASE SIMILARITY SPECIFICATION (< 0.100 DEG)
PASSED

TEST 19 Gain, THD, Sim X8.5, 1/4mS, 100Hz

```
SIGNAL_TYPE SINE 100.000000 225.470642 0.000000 8

FILE 1013
File Date: Feb/01/08   Time: 14:58:18
Sampling Rate:    250 µsec   Record Length:  0.512 sec   Delay:    6 ms
Preamp Gain: 18 dB     Acquisition Filters: OUT  OUT

ANALYSIS GAIN 2.0 2.0
INPUT PEAK AMPLITUDE IS    225.471 mV
CHAN    TEST      PEAK AMPLITUDE  ACCURACY     SIMILARITY
 NO.    FREQ         ( mV )          (%)          (%)
  1    100.000       224.942     -0.23443        0.34350
  2    100.000       224.137     -0.59146       -0.01559
  3    100.000       222.799     -1.18472       -0.61229
  4    100.000       224.207     -0.56045        0.01560
  5    100.000       222.980     -1.10457       -0.53167
  6    100.000       225.352     -0.05251        0.52648
  7    100.000       223.733     -0.77061       -0.19578
  8    100.000       224.303     -0.51774        0.05856

  9    100.000       225.875      0.17919       -0.02734
 10    100.000       226.310      0.37215        0.16522
 11    100.000       226.074      0.26747        0.06076
 12    100.000       225.756      0.12653       -0.07989
 13    100.000       225.489      0.00830       -0.19788
 14    100.000       225.998      0.23397        0.02733
 15    100.000       224.187     -0.56920       -0.77419
 16    100.000       226.100      0.27923        0.07249

 17    100.000       225.754      0.12565        0.07459
 18    100.000       226.322      0.37766        0.32646
 19    100.000       225.417     -0.02361       -0.07459
 20    100.000       226.166      0.30828        0.25712
 21    100.000       224.188     -0.56895       -0.61966
 22    100.000       226.038      0.25141        0.20028
 23    100.000       225.089     -0.16949       -0.22040
 24    100.000       223.513     -0.86816       -0.91872

 25    100.000       225.096     -0.16607       -0.67394
 26    100.000       227.191      0.76291        0.25032
 27    100.000       227.406      0.85819        0.34511
 28    100.000       226.764      0.57353        0.06190
 29    100.000       227.432      0.87004        0.35690
 30    100.000       225.375     -0.04255       -0.55104
 31    100.000       225.019     -0.20020       -0.70790
 32    100.000       226.483      0.44909       -0.06190

 33    100.000       223.810     -0.73660       -0.27566
 34    100.000       223.761     -0.75838       -0.29754
 35    100.000       226.061      0.26190        0.72748
 36    100.000       225.857      0.17132        0.63648
 37    100.000       223.933     -0.68199       -0.22080
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 38    100.000       224.693     -0.34505        0.11771
 39    100.000       225.785      0.13947        0.60447
 40    100.000       224.164     -0.57938       -0.11771

 41    100.000       225.680      0.09286        0.06929
 42    100.000       225.367     -0.04576       -0.06930
 43    100.000       223.441     -0.90037       -0.92370
 44    100.000       226.229      0.33629        0.31266
 45    100.000       226.480      0.44771        0.42406
 46    100.000       223.659     -0.80333       -0.82668
 47    100.000       224.159     -0.58189       -0.60530
 48    100.000       226.695      0.54280        0.51913
          MEAN:      225.235     -0.10461
WORST CASE CHN:                     3              43
GAIN ACCURACY SPECIFICATION ( <  2.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED

ANALYSIS HARMONIC_DISTORTION 6 0.0015
CHAN  FNDMTL             FIRST FIVE HARMONIC CONTENT (%)          RMS
TOTAL (%)
 NO.   FREQ       2          3          4          5          6
  1  100.000   0.00029   0.00024   0.00044   0.00022   0.00023   0.00093
  2  100.000   0.00034   0.00024   0.00045   0.00023   0.00021   0.00091
  3  100.000   0.00037   0.00025   0.00045   0.00022   0.00022   0.00094
  4  100.000   0.00040   0.00024   0.00044   0.00023   0.00022   0.00096
  5  100.000   0.00035   0.00023   0.00045   0.00024   0.00023   0.00095
  6  100.000   0.00033   0.00025   0.00044   0.00021   0.00021   0.00093
  7  100.000   0.00034   0.00023   0.00046   0.00023   0.00021   0.00094
  8  100.000   0.00034   0.00024   0.00044   0.00023   0.00021   0.00093
  9  100.000   0.00032   0.00046   0.00030   0.00029   0.00020   0.00088
 10  100.000   0.00036   0.00044   0.00030   0.00031   0.00017   0.00088
 11  100.000   0.00038   0.00044   0.00030   0.00030   0.00019   0.00089
 12  100.000   0.00040   0.00046   0.00030   0.00031   0.00019   0.00091
 13  100.000   0.00032   0.00045   0.00030   0.00031   0.00018   0.00088
 14  100.000   0.00030   0.00044   0.00028   0.00029   0.00018   0.00084
 15  100.000   0.00031   0.00045   0.00030   0.00032   0.00019   0.00089
 16  100.000   0.00036   0.00045   0.00030   0.00030   0.00018   0.00089
 17  100.000   0.00024   0.00019   0.00021   0.00042   0.00041   0.00076
 18  100.000   0.00025   0.00017   0.00021   0.00042   0.00040   0.00073
 19  100.000   0.00024   0.00018   0.00020   0.00041   0.00039   0.00073
 20  100.000   0.00025   0.00017   0.00022   0.00040   0.00041   0.00073
 21  100.000   0.00024   0.00016   0.00021   0.00039   0.00041   0.00072
 22  100.000   0.00024   0.00016   0.00020   0.00041   0.00044   0.00075
 23  100.000   0.00023   0.00017   0.00021   0.00043   0.00042   0.00074
 24  100.000   0.00024   0.00018   0.00022   0.00042   0.00041   0.00075
 25  100.000   0.00025   0.00036   0.00071   0.00033   0.00030   0.00106
 26  100.000   0.00029   0.00036   0.00069   0.00035   0.00030   0.00105
 27  100.000   0.00028   0.00037   0.00070   0.00033   0.00030   0.00107
 28  100.000   0.00027   0.00037   0.00071   0.00032   0.00030   0.00105
 29  100.000   0.00026   0.00038   0.00070   0.00035   0.00028   0.00106
 30  100.000   0.00026   0.00039   0.00072   0.00033   0.00028   0.00107
```

31	100.000	0.00024	0.00036	0.00070	0.00034	0.00030	0.00106
32	100.000	0.00028	0.00036	0.00071	0.00034	0.00030	0.00108
33	100.000	0.00031	0.00043	0.00044	0.00033	0.00039	0.00103
34	100.000	0.00027	0.00043	0.00044	0.00032	0.00037	0.00101
35	100.000	0.00030	0.00042	0.00046	0.00033	0.00039	0.00102
36	100.000	0.00024	0.00047	0.00044	0.00031	0.00039	0.00101
37	100.000	0.00032	0.00043	0.00047	0.00031	0.00039	0.00103
38	100.000	0.00030	0.00042	0.00044	0.00032	0.00037	0.00099
39	100.000	0.00028	0.00044	0.00047	0.00031	0.00040	0.00103
40	100.000	0.00027	0.00043	0.00046	0.00031	0.00037	0.00100
41	100.000	0.00041	0.00041	0.00042	0.00058	0.00031	0.00101
42	100.000	0.00048	0.00041	0.00040	0.00059	0.00032	0.00103
43	100.000	0.00049	0.00043	0.00040	0.00060	0.00032	0.00106
44	100.000	0.00057	0.00043	0.00041	0.00062	0.00029	0.00110
45	100.000	0.00043	0.00045	0.00041	0.00062	0.00033	0.00105
46	100.000	0.00043	0.00042	0.00040	0.00060	0.00032	0.00102
47	100.000	0.00048	0.00041	0.00041	0.00058	0.00030	0.00103
48	100.000	0.00056	0.00042	0.00042	0.00061	0.00032	0.00109
						MEAN:	0.00095
						WORST CASE CHN:	44

HARMONIC DISTORTION SPECIFICATION (< 0.00150 %)
PASSED

FILE 1013

ANALYSIS PHASE 0.1
CHAN   TEST FREQ   SIMILARITY
        (HZ)   (DEGREE)
WORST CASE CHN: 44
PHASE SIMILARITY SPECIFICATION (< 0.100 DEG)
PASSED

TEST 20 Gain, THD, Sim X34, 1/4mS, 100Hz

SIGNAL_TYPE SINE 100.000000 50.476589 0.000000 8

FILE 1014
File Date: Feb/01/08   Time: 14:58:38
Sampling Rate: 250 µsec   Record Length: 0.512 sec   Delay: 6 ms
Preamp Gain: 30 dB   Acquisition Filters: OUT OUT

ANALYSIS GAIN 6.25 3.0
INPUT PEAK AMPLITUDE IS 50.477 mV

CHAN NO.	TEST FREQ	PEAK AMPLITUDE (mV)	ACCURACY (%)	SIMILARITY (%)
1	100.000	48.198	-4.51391	0.51605
2	100.000	48.007	-4.89271	0.11729
3	100.000	47.857	-5.18962	-0.19526
4	100.000	47.894	-5.11555	-0.11730
5	100.000	47.405	-6.08509	-1.13790
6	100.000	48.028	-4.85185	0.16030

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  7    100.000        47.825     -5.25394        -0.26297
  8    100.000        48.355     -4.20321         0.84311

  9    100.000        48.442     -4.03100        -0.02552
 10    100.000        48.798     -3.32634         0.70856
 11    100.000        48.572     -3.77322         0.24303
 12    100.000        48.463     -3.98919         0.01804
 13    100.000        48.413     -4.08729        -0.08415
 14    100.000        48.449     -4.01762        -0.01157
 15    100.000        48.126     -4.65626        -0.67686
 16    100.000        48.460     -3.99541         0.01157

 17    100.000        48.432     -4.05050         0.35650
 18    100.000        48.370     -4.17263         0.22876
 19    100.000        48.535     -3.84659         0.56978
 20    100.000        48.213     -4.48538        -0.09835
 21    100.000        48.123     -4.66319        -0.28433
 22    100.000        48.307     -4.29732         0.09835
 23    100.000        48.208     -4.49354        -0.10688
 24    100.000        47.901     -5.10314        -0.74448

 25    100.000        48.017     -4.87200        -1.15051
 26    100.000        49.179     -2.57076         1.24077
 27    100.000        48.797     -3.32785         0.45406
 28    100.000        48.816     -3.28911         0.49432
 29    100.000        48.744     -3.43191         0.34593
 30    100.000        48.189     -4.53111        -0.79628
 31    100.000        47.991     -4.92385        -1.20438
 32    100.000        48.408     -4.09771        -0.34593

 33    100.000        48.530     -3.85661         0.81789
 34    100.000        47.699     -5.50301        -0.90855
 35    100.000        48.099     -4.70945        -0.07641
 36    100.000        48.288     -4.33645         0.31473
 37    100.000        48.076     -4.75683        -0.12609
 38    100.000        47.897     -5.10961        -0.49603
 39    100.000        48.173     -4.56371         0.07642
 40    100.000        48.368     -4.17803         0.48085

 41    100.000        49.815     -1.31138         0.69214
 42    100.000        49.339     -2.25413        -0.26975
 43    100.000        49.277     -2.37599        -0.39408
 44    100.000        49.482     -1.97041         0.01973
 45    100.000        50.077     -0.79116         1.22292
 46    100.000        49.076     -2.77403        -0.80021
 47    100.000        49.462     -2.00909        -0.01973
 48    100.000        50.096     -0.75333         1.26152
          MEAN:       48.485     -3.94567
WORST CASE CHN:                      5              48
GAIN ACCURACY SPECIFICATION ( <  6.25000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  3.00000% )
PASSED
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ANALYSIS HARMONIC_DISTORTION 4 0.007
CHAN  FNDMTL            FIRST FIVE HARMONIC CONTENT (%)          RMS
TOTAL (%)
 NO.   FREQ       2         3         4         5         6
  1  100.000   0.00219   0.00147   0.00144   0.00106
  0.00318
  2  100.000   0.00217   0.00148   0.00148   0.00106
  0.00319
  3  100.000   0.00219   0.00149   0.00146   0.00103
  0.00320
  4  100.000   0.00211   0.00149   0.00140   0.00107
  0.00313
  5  100.000   0.00216   0.00150   0.00142   0.00111
  0.00319
  6  100.000   0.00213   0.00147   0.00146   0.00110
  0.00317
  7  100.000   0.00212   0.00151   0.00148   0.00110
  0.00319
  8  100.000   0.00218   0.00148   0.00146   0.00116
  0.00323
  9  100.000   0.00177   0.00203   0.00151   0.00178
  0.00357
 10  100.000   0.00169   0.00205   0.00147   0.00188
  0.00357
 11  100.000   0.00169   0.00201   0.00150   0.00182
  0.00353
 12  100.000   0.00168   0.00202   0.00154   0.00190
  0.00359
 13  100.000   0.00179   0.00206   0.00149   0.00184
  0.00361
 14  100.000   0.00176   0.00199   0.00144   0.00178
  0.00351
 15  100.000   0.00175   0.00204   0.00146   0.00185
  0.00357
 16  100.000   0.00175   0.00199   0.00145   0.00186
  0.00355
 17  100.000   0.00127   0.00204   0.00152   0.00209
  0.00353
 18  100.000   0.00122   0.00202   0.00156   0.00205
  0.00349
 19  100.000   0.00140   0.00204   0.00154   0.00201
  0.00354
 20  100.000   0.00136   0.00204   0.00152   0.00206
  0.00354
 21  100.000   0.00133   0.00205   0.00153   0.00203
  0.00353
 22  100.000   0.00130   0.00202   0.00157   0.00210
  0.00356
 23  100.000   0.00133   0.00200   0.00155   0.00209
  0.00354
 24  100.000   0.00138   0.00204   0.00155   0.00207
  0.00357
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  25  100.000   0.00143   0.00208   0.00154   0.00081
   0.00306
  26  100.000   0.00139   0.00204   0.00150   0.00077
   0.00299
  27  100.000   0.00141   0.00202   0.00151   0.00088
   0.00302
  28  100.000   0.00144   0.00211   0.00151   0.00090
   0.00310
  29  100.000   0.00147   0.00205   0.00154   0.00089
   0.00309
  30  100.000   0.00142   0.00202   0.00149   0.00088
   0.00302
  31  100.000   0.00143   0.00206   0.00153   0.00086
   0.00306
  32  100.000   0.00143   0.00205   0.00146   0.00085
   0.00302
  33  100.000   0.00135   0.00273   0.00177   0.00076
   0.00361
  34  100.000   0.00131   0.00267   0.00177   0.00075
   0.00354
  35  100.000   0.00135   0.00271   0.00180   0.00072
   0.00360
  36  100.000   0.00131   0.00274   0.00172   0.00072
   0.00357
  37  100.000   0.00135   0.00269   0.00183   0.00070
   0.00360
  38  100.000   0.00130   0.00270   0.00174   0.00074
   0.00354
  39  100.000   0.00134   0.00270   0.00172   0.00071
   0.00355
  40  100.000   0.00134   0.00267   0.00178   0.00068
   0.00355
  41  100.000   0.00120   0.00110   0.00145   0.00208
   0.00302
  42  100.000   0.00120   0.00114   0.00146   0.00199
   0.00298
  43  100.000   0.00124   0.00112   0.00148   0.00203
   0.00302
  44  100.000   0.00125   0.00116   0.00140   0.00201
   0.00299
  45  100.000   0.00127   0.00115   0.00144   0.00203
   0.00302
  46  100.000   0.00120   0.00109   0.00146   0.00205
   0.00300
  47  100.000   0.00123   0.00114   0.00143   0.00201
   0.00298
  48  100.000   0.00123   0.00114   0.00140   0.00204
   0.00299
                                                         MEAN:  0.00332
                                                WORST CASE CHN:     33
 HARMONIC DISTORTION SPECIFICATION ( <  0.00700 % )
 PASSED
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FILE 1014

ANALYSIS PHASE 0.1
CHAN    TEST FREQ   SIMILARITY
          (HZ)       (DEGREE)
WORST CASE CHN:         33
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

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TEST 21 Gain, THD, Sim X1, 2mS, 25Hz

SIGNAL_TYPE SINE 25.000000 800.000000 0.000000 8

FILE 1026
File Date: Feb/01/08   Time: 14:59:00
Sampling Rate:   2000 µsec   Record Length:  4.096 sec   Delay:   48 ms
Preamp Gain: 0 dB     Acquisition Filters: OUT  OUT

ANALYSIS GAIN 2.0 2.0
INPUT PEAK AMPLITUDE IS    800.000 mV
CHAN    TEST      PEAK AMPLITUDE  ACCURACY     SIMILARITY
 NO.    FREQ          ( mV )        (%)            (%)
  1     24.999       799.383     -0.07719        0.08887
  2     24.999       799.137     -0.10786        0.05815
  3     24.999       798.208     -0.22397       -0.05816
  4     24.999       799.465     -0.06691        0.09916
  5     24.999       793.123     -0.85964       -0.69489
  6     24.999       801.142      0.14277        0.30919
  7     24.999       796.758     -0.40524       -0.23973
  8     24.999       797.611     -0.29868       -0.13300

  9     24.999       804.195      0.52436        0.01312
 10     24.999       804.647      0.58087        0.06935
 11     24.999       804.019      0.50236       -0.00877
 12     24.999       804.158      0.51978        0.00856
 13     24.999       803.536      0.44206       -0.06876
 14     24.999       805.261      0.65764        0.14572
 15     24.999       803.781      0.47259       -0.03839
 16     24.999       804.021      0.50256       -0.00856

 17     24.999       798.786     -0.15176       -0.32979
 18     24.999       804.936      0.61696        0.43755
 19     24.999       804.138      0.51728        0.33805
 20     24.999       803.944      0.49304        0.31385
 21     24.999       797.449     -0.31886       -0.49660
 22     24.999       800.758      0.09476       -0.08372
 23     24.999       802.100      0.26250        0.08372
 24     24.999       800.359      0.04492       -0.13347

 25     24.999       801.335      0.16682       -0.59779
 26     24.999       806.608      0.82598        0.05634
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 27      24.999       806.625      0.82816        0.05850
 28      24.999       808.436      1.05453        0.28314
 29      24.999       807.248      0.90606        0.13580
 30      24.999       801.084      0.13549       -0.62888
 31      24.999       803.099      0.38744       -0.37886
 32      24.999       805.700      0.71245       -0.05633

 33      24.999       802.708      0.33854        0.43291
 34      24.999       797.368     -0.32903       -0.23528
 35      24.999       799.473     -0.06583        0.02816
 36      24.999       803.629      0.45363        0.54811
 37      24.999       798.508     -0.18651       -0.09263
 38      24.999       799.023     -0.12209       -0.02816
 39      24.999       805.403      0.67534        0.77003
 40      24.999       798.234     -0.22079       -0.12694

 41      24.999       800.421      0.05260       -0.07160
 42      24.999       800.912      0.11404       -0.01023
 43      24.999       801.076      0.13452        0.01023
 44      24.999       806.261      0.78263        0.65753
 45      24.999       801.348      0.16850        0.04416
 46      24.999       800.175      0.02191       -0.10224
 47      24.999       799.055     -0.11817       -0.24215
 48      24.999       804.066      0.50829        0.38353
           MEAN:      801.848      0.23102
WORST CASE CHN:                      28              39
GAIN ACCURACY SPECIFICATION ( <  2.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED

ANALYSIS HARMONIC_DISTORTION 6 0.0012
CHAN  FNDMTL             FIRST FIVE HARMONIC CONTENT (%)          RMS
TOTAL (%)
 NO.   FREQ       2         3         4         5         6
  1   24.999   0.00021   0.00006   0.00003   0.00002   0.00004   0.00024
  2   24.999   0.00019   0.00007   0.00005   0.00003   0.00006   0.00023
  3   24.999   0.00017   0.00009   0.00005   0.00003   0.00006   0.00022
  4   24.999   0.00019   0.00009   0.00003   0.00003   0.00005   0.00023
  5   24.999   0.00017   0.00006   0.00004   0.00003   0.00004   0.00021
  6   24.999   0.00021   0.00007   0.00004   0.00003   0.00005   0.00025
  7   24.999   0.00021   0.00006   0.00004   0.00003   0.00005   0.00024
  8   24.999   0.00020   0.00007   0.00005   0.00003   0.00005   0.00024
  9   24.999   0.00015   0.00004   0.00006   0.00006   0.00004   0.00018
 10   24.999   0.00016   0.00003   0.00006   0.00005   0.00004   0.00019
 11   24.999   0.00014   0.00004   0.00006   0.00005   0.00004   0.00017
 12   24.999   0.00013   0.00005   0.00006   0.00006   0.00003   0.00017
 13   24.999   0.00018   0.00006   0.00007   0.00007   0.00006   0.00022
 14   24.999   0.00020   0.00005   0.00004   0.00005   0.00004   0.00022
 15   24.999   0.00017   0.00006   0.00005   0.00005   0.00004   0.00020
 16   24.999   0.00016   0.00004   0.00005   0.00006   0.00003   0.00018
 17   24.999   0.00014   0.00006   0.00005   0.00002   0.00002   0.00017
 18   24.999   0.00016   0.00008   0.00004   0.00004   0.00002   0.00020
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 19   24.999   0.00016   0.00008   0.00005   0.00002   0.00003   0.00019
 20   24.999   0.00016   0.00009   0.00003   0.00001   0.00003   0.00019
 21   24.999   0.00016   0.00006   0.00005   0.00003   0.00003   0.00019
 22   24.999   0.00018   0.00006   0.00004   0.00002   0.00003   0.00020
 23   24.999   0.00019   0.00010   0.00007   0.00005   0.00004   0.00024
 24   24.999   0.00020   0.00009   0.00005   0.00002   0.00003   0.00023
 25   24.999   0.00010   0.00007   0.00003   0.00006   0.00004   0.00015
 26   24.999   0.00010   0.00008   0.00004   0.00003   0.00005   0.00015
 27   24.999   0.00011   0.00006   0.00004   0.00004   0.00005   0.00015
 28   24.999   0.00009   0.00007   0.00004   0.00004   0.00004   0.00015
 29   24.999   0.00009   0.00010   0.00004   0.00004   0.00004   0.00016
 30   24.999   0.00013   0.00007   0.00003   0.00006   0.00005   0.00018
 31   24.999   0.00016   0.00006   0.00005   0.00006   0.00004   0.00020
 32   24.999   0.00013   0.00007   0.00005   0.00005   0.00004   0.00018
 33   24.999   0.00015   0.00006   0.00003   0.00004   0.00005   0.00018
 34   24.999   0.00017   0.00007   0.00004   0.00004   0.00004   0.00020
 35   24.999   0.00017   0.00006   0.00005   0.00004   0.00005   0.00020
 36   24.999   0.00018   0.00006   0.00004   0.00004   0.00005   0.00021
 37   24.999   0.00016   0.00005   0.00003   0.00005   0.00004   0.00019
 38   24.999   0.00019   0.00007   0.00005   0.00005   0.00005   0.00022
 39   24.999   0.00021   0.00007   0.00004   0.00004   0.00004   0.00024
 40   24.999   0.00017   0.00006   0.00004   0.00004   0.00004   0.00020
 41   24.999   0.00018   0.00004   0.00003   0.00002   0.00006   0.00020
 42   24.999   0.00019   0.00007   0.00006   0.00003   0.00007   0.00022
 43   24.999   0.00017   0.00006   0.00004   0.00003   0.00007   0.00021
 44   24.999   0.00019   0.00005   0.00004   0.00003   0.00007   0.00022
 45   24.999   0.00017   0.00006   0.00003   0.00003   0.00007   0.00021
 46   24.999   0.00020   0.00004   0.00004   0.00003   0.00005   0.00022
 47   24.999   0.00019   0.00006   0.00004   0.00002   0.00006   0.00022
 48   24.999   0.00018   0.00004   0.00003   0.00003   0.00005   0.00020
                                                            MEAN:  0.00020
                                                  WORST CASE CHN:       6
HARMONIC DISTORTION SPECIFICATION ( <  0.00120 % )
PASSED

FILE 1026

ANALYSIS PHASE 0.1
CHAN    TEST FREQ   SIMILARITY
          (HZ)        (DEGREE)
WORST CASE CHN:         6
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

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-----
TEST 22 Gain, THD, Sim X2.5, 2mS, 25Hz

SIGNAL_TYPE SINE 25.000000 800.000000 0.000000 8

FILE 1027
File Date: Feb/01/08   Time: 14:59:23
Sampling Rate:   2000 µsec   Record Length:  4.096 sec   Delay:   48 ms
```

Preamp Gain: 8 dB   Acquisition Filters: OUT OUT

ANALYSIS GAIN 2.6 2.0
INPUT PEAK AMPLITUDE IS   800.000 mV

CHAN NO.	TEST FREQ	PEAK AMPLITUDE (mV)	ACCURACY (%)	SIMILARITY (%)
1	24.999	804.354	0.54421	0.22803
2	24.999	803.570	0.44621	0.13034
3	24.999	798.989	-0.12643	-0.44050
4	24.999	804.677	0.58461	0.26830
5	24.999	799.226	-0.09680	-0.41097
6	24.999	807.305	0.91310	0.59576
7	24.999	801.478	0.18472	-0.13033
8	24.999	801.386	0.17328	-0.14173
9	24.999	807.937	0.99212	0.01689
10	24.999	807.503	0.93793	-0.03677
11	24.999	808.344	1.04301	0.06729
12	24.999	807.664	0.95802	-0.01689
13	24.999	806.733	0.84157	-0.13221
14	24.999	808.633	1.07918	0.10311
15	24.999	803.663	0.45789	-0.51219
16	24.999	809.141	1.14268	0.16599
17	24.999	806.321	0.79007	-0.00285
18	24.999	810.124	1.26547	0.46882
19	24.999	805.995	0.74940	-0.04319
20	24.999	809.928	1.24105	0.44459
21	24.999	801.734	0.21673	-0.57168
22	24.999	808.242	1.03021	0.23541
23	24.999	806.366	0.79580	0.00284
24	24.999	801.276	0.15955	-0.62840
25	24.999	806.564	0.82050	-0.39470
26	24.999	809.237	1.15458	-0.06465
27	24.999	812.634	1.57923	0.35489
28	24.999	810.284	1.28545	0.06464
29	24.999	813.147	1.64339	0.41827
30	24.999	805.336	0.66698	-0.54637
31	24.999	806.750	0.84374	-0.37174
32	24.999	811.329	1.41614	0.19376
33	24.999	799.380	-0.07751	-0.44430
34	24.999	801.523	0.19041	-0.17737
35	24.999	807.735	0.96693	0.59631
36	24.999	808.227	1.02832	0.65747
37	24.999	800.981	0.12257	-0.24495
38	24.999	804.372	0.54646	0.17737
39	24.999	808.412	1.05151	0.68058
40	24.999	801.139	0.14240	-0.22521
41	24.999	798.956	-0.13052	0.01126
42	24.999	798.776	-0.15302	-0.01126

```
 43     24.999       793.669     -0.79141       -0.65057
 44     24.999       802.957      0.36968        0.51218
 45     24.999       800.081      0.01008        0.15206
 46     24.999       795.953     -0.50593       -0.36468
 47     24.999       794.877     -0.64040       -0.49934
 48     24.999       801.016      0.12705        0.26920
          MEAN:      804.665      0.58313
WORST CASE CHN:                     29              39
GAIN ACCURACY SPECIFICATION ( <  2.60000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED

ANALYSIS HARMONIC_DISTORTION 6 0.0012
CHAN  FNDMTL             FIRST FIVE HARMONIC CONTENT (%)          RMS
TOTAL (%)
 NO.   FREQ       2         3         4         5         6
  1   24.999   0.00027   0.00005   0.00002   0.00003   0.00003   0.00029
  2   24.999   0.00028   0.00005   0.00002   0.00003   0.00002   0.00030
  3   24.999   0.00031   0.00003   0.00003   0.00004   0.00003   0.00032
  4   24.999   0.00035   0.00004   0.00003   0.00004   0.00003   0.00036
  5   24.999   0.00027   0.00006   0.00001   0.00004   0.00003   0.00029
  6   24.999   0.00028   0.00005   0.00002   0.00003   0.00003   0.00030
  7   24.999   0.00028   0.00005   0.00001   0.00003   0.00003   0.00029
  8   24.999   0.00029   0.00005   0.00002   0.00003   0.00003   0.00030
  9   24.999   0.00016   0.00007   0.00004   0.00004   0.00004   0.00019
 10   24.999   0.00017   0.00007   0.00004   0.00005   0.00004   0.00020
 11   24.999   0.00016   0.00007   0.00004   0.00005   0.00005   0.00020
 12   24.999   0.00018   0.00007   0.00004   0.00005   0.00004   0.00021
 13   24.999   0.00016   0.00008   0.00003   0.00005   0.00004   0.00020
 14   24.999   0.00017   0.00007   0.00004   0.00004   0.00004   0.00020
 15   24.999   0.00015   0.00007   0.00004   0.00005   0.00005   0.00019
 16   24.999   0.00016   0.00007   0.00005   0.00005   0.00004   0.00019
 17   24.999   0.00012   0.00006   0.00004   0.00006   0.00004   0.00017
 18   24.999   0.00013   0.00006   0.00004   0.00006   0.00005   0.00017
 19   24.999   0.00016   0.00005   0.00004   0.00006   0.00005   0.00020
 20   24.999   0.00020   0.00005   0.00004   0.00007   0.00004   0.00023
 21   24.999   0.00012   0.00006   0.00004   0.00007   0.00004   0.00017
 22   24.999   0.00014   0.00004   0.00005   0.00007   0.00004   0.00018
 23   24.999   0.00014   0.00005   0.00004   0.00007   0.00004   0.00017
 24   24.999   0.00014   0.00005   0.00005   0.00007   0.00004   0.00018
 25   24.999   0.00016   0.00008   0.00004   0.00002   0.00001   0.00018
 26   24.999   0.00019   0.00007   0.00003   0.00002   0.00002   0.00021
 27   24.999   0.00019   0.00008   0.00004   0.00002   0.00002   0.00022
 28   24.999   0.00023   0.00007   0.00004   0.00002   0.00001   0.00025
 29   24.999   0.00014   0.00008   0.00003   0.00002   0.00002   0.00017
 30   24.999   0.00014   0.00008   0.00003   0.00002   0.00001   0.00016
 31   24.999   0.00015   0.00008   0.00003   0.00002   0.00002   0.00018
 32   24.999   0.00017   0.00008   0.00003   0.00002   0.00001   0.00019
 33   24.999   0.00026   0.00005   0.00005   0.00007   0.00002   0.00028
 34   24.999   0.00028   0.00005   0.00006   0.00007   0.00002   0.00030
 35   24.999   0.00030   0.00004   0.00005   0.00007   0.00003   0.00032
 36   24.999   0.00037   0.00007   0.00005   0.00007   0.00002   0.00039
```

37	24.999	0.00025	0.00005	0.00005	0.00007	0.00002	0.00028
38	24.999	0.00026	0.00005	0.00005	0.00007	0.00002	0.00029
39	24.999	0.00027	0.00005	0.00005	0.00007	0.00003	0.00029
40	24.999	0.00029	0.00005	0.00006	0.00008	0.00002	0.00032
41	24.999	0.00025	0.00006	0.00004	0.00003	0.00004	0.00027
42	24.999	0.00025	0.00007	0.00004	0.00003	0.00004	0.00028
43	24.999	0.00027	0.00006	0.00004	0.00003	0.00004	0.00029
44	24.999	0.00030	0.00006	0.00005	0.00003	0.00004	0.00032
45	24.999	0.00025	0.00008	0.00004	0.00003	0.00004	0.00027
46	24.999	0.00025	0.00007	0.00004	0.00003	0.00004	0.00027
47	24.999	0.00026	0.00008	0.00004	0.00003	0.00004	0.00028
48	24.999	0.00031	0.00006	0.00004	0.00003	0.00004	0.00032
						MEAN:	0.00025
						WORST CASE CHN:	36

HARMONIC DISTORTION SPECIFICATION (< 0.00120 %)
PASSED

FILE 1027

ANALYSIS PHASE 0.1
CHAN TEST FREQ SIMILARITY
(HZ) (DEGREE)
WORST CASE CHN: 36
PHASE SIMILARITY SPECIFICATION (< 0.100 DEG)
PASSED

TEST 23 Gain, THD, Sim X8.5, 2mS, 25Hz

SIGNAL_TYPE SINE 25.000000 225.470642 0.000000 8

FILE 1028
File Date: Feb/01/08 Time: 14:59:46
Sampling Rate: 2000 µsec Record Length: 4.096 sec Delay: 48 ms
Preamp Gain: 18 dB Acquisition Filters: OUT OUT

ANALYSIS GAIN 2.1 2.0
INPUT PEAK AMPLITUDE IS 225.471 mV

CHAN NO.	TEST FREQ	PEAK AMPLITUDE (mV)	ACCURACY (%)	SIMILARITY (%)
1	24.999	225.920	0.19945	0.34346
2	24.999	225.112	-0.15925	-0.01576
3	24.999	223.769	-0.75480	-0.61217
4	24.999	225.183	-0.12778	0.01576
5	24.999	223.950	-0.67440	-0.53166
6	24.999	226.332	0.38209	0.52636
7	24.999	224.706	-0.33907	-0.19584
8	24.999	225.279	-0.08495	0.05865
9	24.999	226.838	0.60623	-0.02735
10	24.999	227.275	0.80007	0.16527
11	24.999	227.038	0.69500	0.06086

```
 12     24.999      226.719      0.55375       -0.07950
 13     24.999      226.449      0.43397       -0.19853
 14     24.999      226.962      0.66128        0.02735
 15     24.999      225.143     -0.14544       -0.77429
 16     24.999      227.065      0.70712        0.07290

 17     24.999      226.715      0.55194        0.07453
 18     24.999      227.286      0.80498        0.32636
 19     24.999      226.377      0.40217       -0.07453
 20     24.999      227.129      0.73558        0.25729
 21     24.999      225.142     -0.14589       -0.61999
 22     24.999      226.999      0.67773        0.19972
 23     24.999      226.047      0.25552       -0.22048
 24     24.999      224.465     -0.44615       -0.91882

 25     24.999      226.024      0.24540       -0.67408
 26     24.999      228.127      1.17828        0.25025
 27     24.999      228.343      1.27408        0.34516
 28     24.999      227.699      0.98820        0.06191
 29     24.999      228.369      1.28549        0.35647
 30     24.999      226.303      0.36924       -0.55137
 31     24.999      225.946      0.21101       -0.70815
 32     24.999      227.417      0.86323       -0.06192

 33     24.999      224.748     -0.32069       -0.27563
 34     24.999      224.698     -0.34273       -0.29769
 35     24.999      227.008      0.68189        0.72740
 36     24.999      226.804      0.59117        0.63664
 37     24.999      224.871     -0.26592       -0.22084
 38     24.999      225.634      0.07233        0.11756
 39     24.999      226.731      0.55899        0.60444
 40     24.999      225.104     -0.16269       -0.11756

 41     24.999      226.688      0.53991        0.06917
 42     24.999      226.375      0.40092       -0.06917
 43     24.999      224.439     -0.45736       -0.92342
 44     24.999      227.241      0.78500        0.31312
 45     24.999      227.492      0.89637        0.42396
 46     24.999      224.659     -0.36003       -0.82656
 47     24.999      225.161     -0.13736       -0.60493
 48     24.999      227.708      0.99251        0.51965
          MEAN:     226.198      0.32242
WORST CASE CHN:                    29              43
GAIN ACCURACY SPECIFICATION ( <  2.10000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  2.00000% )
PASSED

ANALYSIS HARMONIC_DISTORTION 6 0.0012
CHAN  FNDMTL            FIRST FIVE HARMONIC CONTENT (%)          RMS
TOTAL (%)
 NO.   FREQ       2         3         4         5         6
  1   24.999   0.00019   0.00010   0.00009   0.00012   0.00016   0.00034
```

2	24.999	0.00019	0.00010	0.00009	0.00011	0.00015	0.00034
3	24.999	0.00020	0.00010	0.00009	0.00013	0.00016	0.00036
4	24.999	0.00024	0.00010	0.00008	0.00012	0.00016	0.00037
5	24.999	0.00020	0.00010	0.00009	0.00013	0.00015	0.00035
6	24.999	0.00019	0.00010	0.00010	0.00012	0.00016	0.00035
7	24.999	0.00019	0.00010	0.00010	0.00012	0.00016	0.00034
8	24.999	0.00020	0.00010	0.00009	0.00012	0.00015	0.00034
9	24.999	0.00016	0.00017	0.00019	0.00014	0.00012	0.00037
10	24.999	0.00019	0.00016	0.00019	0.00014	0.00011	0.00038
11	24.999	0.00021	0.00017	0.00019	0.00015	0.00010	0.00039
12	24.999	0.00023	0.00016	0.00019	0.00017	0.00010	0.00040
13	24.999	0.00015	0.00017	0.00020	0.00016	0.00011	0.00037
14	24.999	0.00013	0.00017	0.00019	0.00014	0.00011	0.00035
15	24.999	0.00015	0.00017	0.00019	0.00015	0.00011	0.00036
16	24.999	0.00018	0.00017	0.00019	0.00016	0.00011	0.00038
17	24.999	0.00016	0.00018	0.00016	0.00016	0.00012	0.00038
18	24.999	0.00014	0.00018	0.00016	0.00016	0.00012	0.00037
19	24.999	0.00010	0.00018	0.00017	0.00017	0.00011	0.00037
20	24.999	0.00011	0.00018	0.00016	0.00016	0.00011	0.00036
21	24.999	0.00014	0.00019	0.00015	0.00017	0.00011	0.00038
22	24.999	0.00014	0.00018	0.00015	0.00017	0.00011	0.00038
23	24.999	0.00011	0.00018	0.00016	0.00017	0.00011	0.00036
24	24.999	0.00010	0.00018	0.00016	0.00017	0.00011	0.00036
25	24.999	0.00026	0.00017	0.00017	0.00020	0.00009	0.00044
26	24.999	0.00024	0.00018	0.00016	0.00020	0.00008	0.00043
27	24.999	0.00023	0.00018	0.00016	0.00020	0.00008	0.00043
28	24.999	0.00026	0.00017	0.00016	0.00020	0.00009	0.00043
29	24.999	0.00026	0.00018	0.00016	0.00019	0.00008	0.00043
30	24.999	0.00026	0.00018	0.00016	0.00019	0.00008	0.00044
31	24.999	0.00026	0.00018	0.00016	0.00020	0.00008	0.00044
32	24.999	0.00024	0.00018	0.00016	0.00019	0.00008	0.00043
33	24.999	0.00010	0.00010	0.00017	0.00013	0.00014	0.00032
34	24.999	0.00010	0.00010	0.00016	0.00013	0.00013	0.00032
35	24.999	0.00009	0.00011	0.00016	0.00013	0.00014	0.00032
36	24.999	0.00016	0.00011	0.00016	0.00014	0.00013	0.00035
37	24.999	0.00010	0.00009	0.00016	0.00013	0.00014	0.00032
38	24.999	0.00011	0.00010	0.00017	0.00014	0.00013	0.00033
39	24.999	0.00009	0.00010	0.00016	0.00013	0.00014	0.00032
40	24.999	0.00009	0.00010	0.00015	0.00013	0.00014	0.00032
41	24.999	0.00018	0.00019	0.00013	0.00013	0.00008	0.00035
42	24.999	0.00015	0.00020	0.00014	0.00013	0.00007	0.00034
43	24.999	0.00015	0.00019	0.00014	0.00013	0.00008	0.00034
44	24.999	0.00013	0.00019	0.00014	0.00013	0.00008	0.00032
45	24.999	0.00017	0.00021	0.00014	0.00013	0.00008	0.00035
46	24.999	0.00017	0.00020	0.00013	0.00013	0.00008	0.00034
47	24.999	0.00015	0.00020	0.00015	0.00014	0.00008	0.00034
48	24.999	0.00014	0.00020	0.00014	0.00014	0.00008	0.00034
						MEAN:	0.00037
						WORST CASE CHN:	25

HARMONIC DISTORTION SPECIFICATION (< 0.00120 %)
PASSED

FILE 1028

```
ANALYSIS PHASE 0.1
CHAN    TEST FREQ   SIMILARITY
          (HZ)        (DEGREE)
WORST CASE CHN:        25
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

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TEST 24 Gain, THD, Sim X34, 2mS, 25Hz

SIGNAL_TYPE SINE 25.000000 50.476589 0.000000 8

FILE 1029
File Date: Feb/01/08   Time: 15:00:10
Sampling Rate:   2000 µsec   Record Length:  4.096 sec   Delay:   48 ms
Preamp Gain: 30 dB     Acquisition Filters: OUT  OUT

ANALYSIS GAIN 6.0 3.0
INPUT PEAK AMPLITUDE IS     50.477 mV
CHAN    TEST      PEAK AMPLITUDE  ACCURACY     SIMILARITY
 NO.    FREQ          ( mV )         (%)           (%)
  1     24.999        48.410     -4.09462        0.51606
  2     24.999        48.218     -4.47526        0.11712
  3     24.999        48.067     -4.77310       -0.19504
  4     24.999        48.105     -4.69875       -0.11712
  5     24.999        47.613     -5.67364       -1.13888
  6     24.999        48.238     -4.43430        0.16005
  7     24.999        48.034     -4.83809       -0.26316
  8     24.999        48.567     -3.78238        0.84332

  9     24.999        48.660     -3.59796       -0.02557
 10     24.999        49.018     -2.89010        0.70852
 11     24.999        48.791     -3.33907        0.24291
 12     24.999        48.682     -3.55571        0.01825
 13     24.999        48.632     -3.65468       -0.08439
 14     24.999        48.667     -3.58450       -0.01162
 15     24.999        48.343     -4.22613       -0.67702
 16     24.999        48.679     -3.56210        0.01162

 17     24.999        48.640     -3.63887        0.35641
 18     24.999        48.578     -3.76158        0.22861
 19     24.999        48.743     -3.43389        0.56989
 20     24.999        48.420     -4.07532       -0.09814
 21     24.999        48.329     -4.25380       -0.28401
 22     24.999        48.515     -3.88686        0.09813
 23     24.999        48.415     -4.08350       -0.10666
 24     24.999        48.106     -4.69595       -0.74450

 25     24.999        48.224     -4.46234       -1.15058
 26     24.999        49.391     -2.15105        1.24083
 27     24.999        49.007     -2.91122        0.45432
```

```
 28     24.999        49.027     -2.87232        0.49456
 29     24.999        48.954     -3.01604        0.34586
 30     24.999        48.397     -4.11983       -0.79619
 31     24.999        48.198     -4.51433       -1.20436
 32     24.999        48.617     -3.68458       -0.34586

 33     24.999        48.734     -3.45300        0.81773
 34     24.999        47.899     -5.10626       -0.90866
 35     24.999        48.302     -4.30909       -0.07623
 36     24.999        48.491     -3.93440        0.31503
 37     24.999        48.277     -4.35725       -0.12652
 38     24.999        48.098     -4.71158       -0.49653
 39     24.999        48.375     -4.16308        0.07623
 40     24.999        48.571     -3.77542        0.48104

 41     24.999        50.028     -0.88843        0.69129
 42     24.999        49.550     -1.83503       -0.27040
 43     24.999        49.489     -1.95702       -0.39434
 44     24.999        49.694     -1.54944        0.01974
 45     24.999        50.292     -0.36569        1.22236
 46     24.999        49.287     -2.35700       -0.80070
 47     24.999        49.675     -1.58829       -0.01973
 48     24.999        50.312     -0.32705        1.26161
          MEAN:       48.695     -3.52958
WORST CASE CHN:                      5              48
GAIN ACCURACY SPECIFICATION ( <  6.00000% )
PASSED
GAIN SIMILARITY SPECIFICATION ( <  3.00000% )
PASSED

ANALYSIS HARMONIC_DISTORTION 4 0.003
CHAN  FNDMTL              FIRST FIVE HARMONIC CONTENT (%)          RMS
TOTAL (%)
 NO.   FREQ        2         3         4         5         6
  1   24.999   0.00037   0.00051   0.00037   0.00060
  0.00094
  2   24.999   0.00036   0.00050   0.00043   0.00060
  0.00096
  3   24.999   0.00037   0.00047   0.00042   0.00061
  0.00095
  4   24.999   0.00042   0.00048   0.00042   0.00060
  0.00097
  5   24.999   0.00040   0.00048   0.00042   0.00060
  0.00096
  6   24.999   0.00038   0.00052   0.00042   0.00060
  0.00097
  7   24.999   0.00035   0.00050   0.00041   0.00062
  0.00096
  8   24.999   0.00038   0.00047   0.00041   0.00063
  0.00096
  9   24.999   0.00094   0.00079   0.00065   0.00055
  0.00149
 10   24.999   0.00094   0.00076   0.00066   0.00055
```

```
 0.00148
11   24.999   0.00098   0.00078   0.00064   0.00054
 0.00151
12   24.999   0.00101   0.00080   0.00063   0.00054
 0.00153
13   24.999   0.00093   0.00078   0.00064   0.00054
 0.00147
14   24.999   0.00090   0.00078   0.00064   0.00053
 0.00146
15   24.999   0.00091   0.00080   0.00063   0.00053
 0.00146
16   24.999   0.00093   0.00077   0.00063   0.00053
 0.00147
17   24.999   0.00064   0.00038   0.00067   0.00074
 0.00124
18   24.999   0.00058   0.00039   0.00068   0.00074
 0.00122
19   24.999   0.00056   0.00037   0.00067   0.00074
 0.00120
20   24.999   0.00055   0.00040   0.00067   0.00073
 0.00120
21   24.999   0.00055   0.00038   0.00067   0.00075
 0.00120
22   24.999   0.00059   0.00037   0.00067   0.00074
 0.00121
23   24.999   0.00056   0.00037   0.00067   0.00075
 0.00121
24   24.999   0.00055   0.00036   0.00065   0.00075
 0.00119
25   24.999   0.00079   0.00032   0.00036   0.00062
 0.00111
26   24.999   0.00082   0.00033   0.00036   0.00061
 0.00114
27   24.999   0.00083   0.00033   0.00036   0.00061
 0.00114
28   24.999   0.00083   0.00031   0.00036   0.00061
 0.00114
29   24.999   0.00081   0.00033   0.00037   0.00062
 0.00113
30   24.999   0.00076   0.00032   0.00035   0.00061
 0.00108
31   24.999   0.00078   0.00031   0.00035   0.00062
 0.00110
32   24.999   0.00076   0.00032   0.00034   0.00064
 0.00109
33   24.999   0.00050   0.00052   0.00090   0.00048
 0.00125
34   24.999   0.00057   0.00048   0.00092   0.00044
 0.00126
35   24.999   0.00056   0.00050   0.00093   0.00047
 0.00129
36   24.999   0.00068   0.00056   0.00094   0.00046
 0.00137
```

```
 37   24.999   0.00057   0.00049   0.00092   0.00045
  0.00127
 38   24.999   0.00056   0.00050   0.00092   0.00048
  0.00128
 39   24.999   0.00054   0.00050   0.00093   0.00047
  0.00128
 40   24.999   0.00061   0.00050   0.00093   0.00044
  0.00129
 41   24.999   0.00058   0.00100   0.00057   0.00038
  0.00134
 42   24.999   0.00060   0.00100   0.00055   0.00039
  0.00135
 43   24.999   0.00060   0.00097   0.00056   0.00039
  0.00133
 44   24.999   0.00059   0.00100   0.00058   0.00039
  0.00135
 45   24.999   0.00060   0.00102   0.00056   0.00040
  0.00137
 46   24.999   0.00059   0.00097   0.00056   0.00038
  0.00132
 47   24.999   0.00059   0.00102   0.00055   0.00040
  0.00136
 48   24.999   0.00060   0.00098   0.00055   0.00038
  0.00133
                                                         MEAN:  0.00123
                                               WORST CASE CHN:     12
HARMONIC DISTORTION SPECIFICATION ( <  0.00300 % )
PASSED

FILE 1029

ANALYSIS PHASE 0.1
CHAN     TEST FREQ   SIMILARITY
           (HZ)        (DEGREE)
WORST CASE CHN:        12
PHASE SIMILARITY SPECIFICATION ( < 0.100 DEG )
PASSED

TEST RESULT                                                ALL TESTS
PASSED

TOTAL TIME: 348 SECONDS (327+21)
```

5.6.7 Noise Test

(From Survey Log, see example in Appendix).

Noise Test (File Number: 1)
Survey: Sivulliq
Line: 1200E
Date: 02/01/2008
Time: 15:30:25.15

Channel	001	002	003	004	005	006
Preamp (dB)	030	030	030	030	030	030
Noise (µBar)	0.68	0.65	0.85	0.84	0.81	0.98
	007	008	009	010	011	012
	030	030	030	030	030	030
	0.39	0.52	0.69	0.64	0.61	0.68
	013	014	015	016	017	018
	030	030	030	030	030	030
	0.74	0.88	1.10	1.31	0.99	1.25
	019	020	021	022	023	024
	030	030	030	030	030	030
	0.55	0.81	0.75	0.79	0.66	0.89
	025	026	027	028	029	030
	030	030	030	030	030	030
	0.57	0.58	0.55	0.79	0.52	0.84
	031	032	033	034	035	036
	030	030	030	030	030	030
	1.05	0.51	0.62	0.58	0.50	0.68
	037	038	039	040	041	042
	030	030	030	030	030	030
	0.78	0.71	0.98	1.19	0.64	0.63
	043	044	045	046	047	048
	030	030	030	030	030	030
	0.49	0.58	0.50	0.74	0.97	0.74

Average Noise RMS: 0.75 µBar

5.6.8 Leakage Report

Geometrics
Leakage Report

Survey:	Test_Survey
Line Number:	2393
Date:	02/01/2008
Time:	15:06:48.54

Leakage Test

Values (kOhms):

Channel:	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 4**	**Ch 5**	**Ch 6**	**Ch 7**	**Ch 8**
R (kOhm):	12000.0	12000.0	10327.4	10467.6	5495.5	12000.0	7694.0	9012.1
Result:	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed

Channel:	**Ch 9**	**Ch 10**	**Ch 11**	**Ch 12**	**Ch 13**	**Ch 14**	**Ch 15**	**Ch 16**
R (kOhm):	12000.0	12000.0	12000.0	12000.0	12000.0	12000.0	12000.0	12000.0
Result:	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed

Channel:	**Ch 17**	**Ch 18**	**Ch 19**	**Ch 20**	**Ch 21**	**Ch 22**	**Ch 23**	**Ch 24**
R (kOhm):	9548.8	12000.0	12000.0	12000.0	9309.4	11190.1	11235.9	7631.5
Result:	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed

Channel:	**Ch 25**	**Ch 26**	**Ch 27**	**Ch 28**	**Ch 29**	**Ch 30**	**Ch 31**	**Ch 32**
R (kOhm):	7662.3	12000.0	12000.0	12000.0	12000.0	8760.9	12000.0	12000.0
Result:	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed

Channel:	**Ch 33**	**Ch 34**	**Ch 35**	**Ch 36**	**Ch 37**	**Ch 38**	**Ch 39**	**Ch 40**
R (kOhm):	12000.0	8659.2	12000.0	12000.0	8127.8	12000.0	12000.0	10682.2
Result:	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed

Channel:	**Ch 41**	**Ch 42**	**Ch 43**	**Ch 44**	**Ch 45**	**Ch 46**	**Ch 47**	**Ch 48**
R (kOhm):	9853.8	9473.1	7067.6	12000.0	8762.6	8584.9	7171.1	12000.0
Result:	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed

Table A7: Example leakage test report.

5.6.9 Capacitance Report

Geometrics
Capacitance Report

Survey:	Test_Survey
Line Number:	2393
Date:	12/05/2007
Time:	18:25:20.80

Capacitance Test

Values (nF):

Channel:	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 4**	**Ch 5**	**Ch 6**	**Ch 7**	**Ch 8**
Cap (nF):	116.10	116.88	117.59	118.50	119.44	118.58	117.85	120.87
Result:	-9.30	-8.69	-8.14	-7.42	-6.68	-7.36	-7.93	-5.57

Channel:	**Ch 9**	**Ch 10**	**Ch 11**	**Ch 12**	**Ch 13**	**Ch 14**	**Ch 15**	**Ch 16**
Cap (nF):	126.62	124.70	122.17	120.89	124.38	121.60	121.30	124.09
Result:	-1.08	-2.57	-4.56	-5.56	-2.83	-5.00	-5.24	-3.06

Channel:	**Ch 17**	**Ch 18**	**Ch 19**	**Ch 20**	**Ch 21**	**Ch 22**	**Ch 23**	**Ch 24**
Cap (nF):	115.43	116.05	116.72	118.07	117.49	118.59	120.08	119.79
Result:	-9.82	-9.34	-8.81	-7.76	-8.21	-7.35	-6.19	-6.42

Channel:	**Ch 25**	**Ch 26**	**Ch 27**	**Ch 28**	**Ch 29**	**Ch 30**	**Ch 31**	**Ch 32**
Cap (nF):	120.07	120.75	120.96	121.82	119.90	122.28	122.85	124.28
Result:	-6.19	-5.66	-5.50	-4.83	-6.33	-4.47	-4.02	-2.91

Channel:	**Ch 33**	**Ch 34**	**Ch 35**	**Ch 36**	**Ch 37**	**Ch 38**	**Ch 39**	**Ch 40**
Cap (nF):	117.56	121.19	121.43	120.49	120.27	120.54	122.77	121.60
Result:	-8.16	-5.32	-5.14	-5.87	-6.04	-5.83	-4.09	-5.00

Channel:	**Ch 41**	**Ch 42**	**Ch 43**	**Ch 44**	**Ch 45**	**Ch 46**	**Ch 47**	**Ch 48**
Cap (nF):	125.58	127.15	141.33	133.36	135.49	142.46	141.60	143.26
Result:	-1.89	-0.67	10.41	4.19	5.86	11.30	10.63	11.92

Table A8: Example capacitance test report.

5.7 2D Deployment

As Streamers go, the GeoEel is relatively easy to deploy, owing to its small diameter and light weight. However, deployment is very important and the quality of the deployment can affect the quality of the data. Careless deployment can also cause loss of or damage to the Streamer. Keeping to the following guidelines will help ensure the safety of the Streamer and the quality of the data.

5.7.1 Streamer Assembly

Assembling the Streamer is simple, but each is unique in terms of number of channels, number of sections and combination of sections. You may or may not have Stretch or Vibration Isolation Sections, for instance. If you do have these, you may choose to install them at the inboard end, the outboard end, or at both ends of the Streamer. Typically, a Streamer consists, from front to back, of

- Deck Cable (inboard end connects to Deck Unit)
- Repeater (if necessary)
- Tow Cable
- Vibration Isolation Section (optional)
- Stretch Section (optional)
- Digitizer and Active Section (one of each for each 8 channels)
- Stretch Section (optional)
- Vibration Isolation Section (optional)
- Tail swivel
- Tail buoy

The Deck Cable will connect either directly to the Tow Cable on the winch or to a slip-ring. If the former, you should institute a procedure to preclude winch operation while the Deck Cable is connected to the Tow Cable to prevent damaging them.

Either a Digitizer or a Repeater is required at least every 100m along the Streamer. If a Repeater(s) is required, it will be somewhere inboard of the first Digitizer. For instance, if you have a 25m Deck Cable, a 70m Tow Cable, and a 25m Stretch Section, you will need a Repeater between the Tow Cable and the Stretch Section. If you have a 25m Deck Cable, a 100m Tow Cable, and a 25m Stretch Section, you will need two Repeaters: one between the Deck and Tow Cables, and one between the Tow Cable and Stretch Section.

If you have Vibration Isolation and/or Stretch Sections, these are generally installed between the Tow Cable and the first Digitizer, and between the last Active Section and the Tail Piece or Tail Swivel. Generally you have either a Stretch or a Vibration Section, not both; however, Stretch Sections do not have bird coils in them and a lead Vibration Isolation Section is often desired so that the first bird can be installed well ahead of the first Active Section. The lead bird commonly has to do the most work to keep the inboard end of the Streamer at the desired depth, and the large wing angles that are often required can put a substantial amount of noise into the Streamer. Having the lead bird far from the hydrophones is therefore desirable, and a short Vibration Isolation Section makes this possible.

If you only have a single Stretch Section, it should be installed at the inboard end of the Streamer; this is where the effect of heave is the greatest.

Finally, the Tail Piece or Tail Swivel is connected to the outboard end of the Streamer, to which the tail buoy is secured. You should use a sufficient length of rope such that the tail buoy does not lift the outboard end of the Streamer higher than the desired tow depth.

5.7.2 Connecting Sections Together

Connecting the sections together properly is critical. The Deck Cable, Tow Cable, Repeaters, Vibration Isolation Sections and Stretch Sections are male on one end and female on the other; hence they can only be connected one way. By contrast, Active Sections are hermaphroditic; either end can be inboard. Note, however, that some Active Sections may have only a single bird coil near one of the ends, so you should be mindful of where you want your birds to be before you connect these sections. The location of the bird coil in a liquid section can be ascertained by finding the three red spacers; see below.

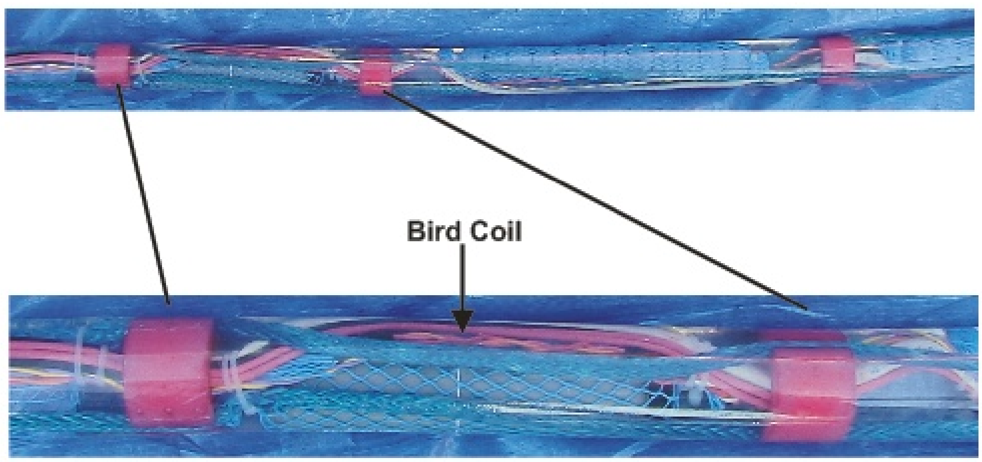


Figure A103: Red spacers and bird coil.

Solid Active Sections include a bird coil at each end, and these are marked by black band:

Figure A104: Location of bird coil in solid section, as indicated by black band.

Note: *Digitizers are physically hermaphroditic****, but not electronically so****. Even though the connectors on either end of the module are identical,* ***the knurled bulkhead must be inboard****. If it is not, neither that Digitizer nor any modules outboard of it will be seen by the CNT-2 Controller. See photograph below for proper Digitizer orientation.*

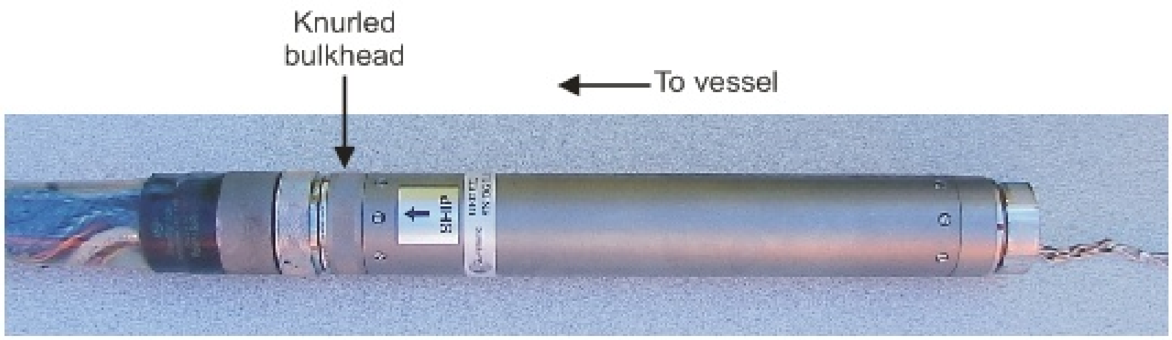


Figure A105: Digitizer configuration.

Before connecting components together, inspect to make sure that the O-rings are in-place. Only the male connectors have O-rings, and they are on the inside of the barrel. *There is only one O-ring per connection*:

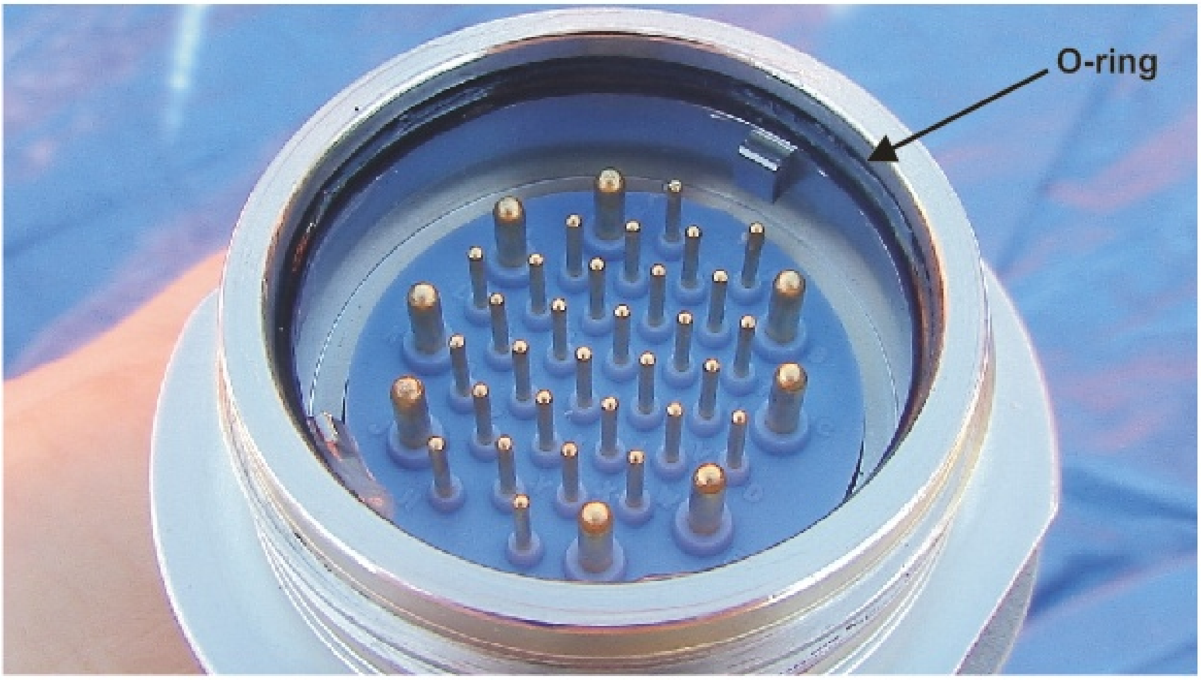


Figure A106: Location of O-ring in connector.

Make sure the connector is clean and dry. If necessary, flush with distilled water and dry with canned air. Also, inspect for any bent pins, and if necessary, straighten with a pair of small needle-nosed pliers.

Note: *With liquid sections, over time, a small amount of silicone oil may seep into the connector, especially on sections that have been overfilled. This may also be residual oil that seeped into the recesses of the connector during the original filling process. This is normal; if you remove the cap and find the connector damp, simply blow out the excess silicone oil with canned air. Getting the pins absolutely dry is not necessary; the pins and sockets will still make electrical contact.*

Note: *Contact cleaner is **not** recommended, as it tends to dry out the O-rings and the rubber seat (blue material inside connector). If contact cleaner must be used, use one of the pointed wooden sticks in the repair kit to gently remove the O-ring first. Flush the connector with distilled water, re-grease the O-ring **lightly** with silicone grease, and reassemble. O-rings should be checked and re-greased periodically. After greasing, remove any excess with a Q-tip.*

To connect,

1) Align the connector keys and slots:

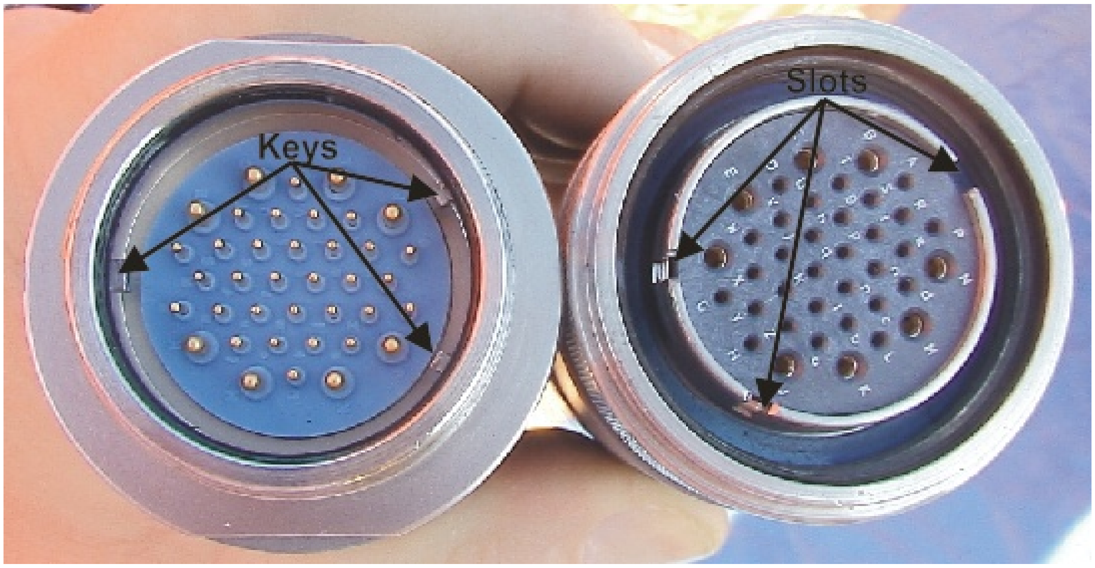


Figure A107: Connector alignment.

2) Twist the barrel clockwise until the red indicator on the male connector is no longer visible:

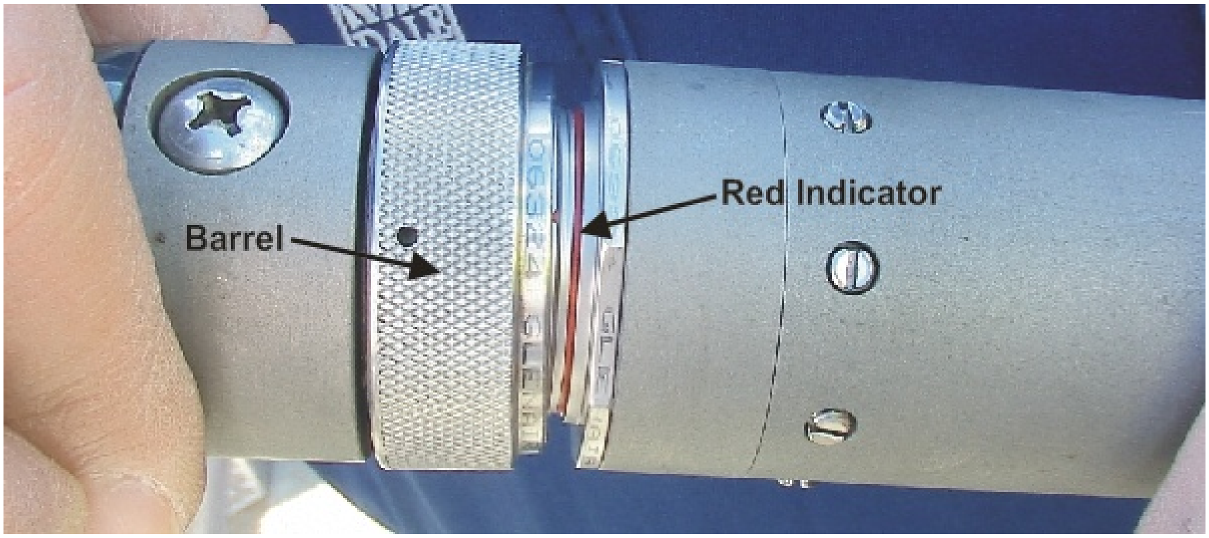


Figure A108: Making a connection.

3) Use the soft-jawed pliers to tighten:

Figure A109: Securing a connection with soft-jawed pliers.

4) Wrap tightly with black electrical tape or silver Streamer tape to prevent loosening:

Figure A110: Applying tape to connector to prevent loosening.

5) Follow with three or four wraps of brown friction (“bulldog”) tape:

Figure A111: Applying friction tape over electrical tape on connector.

6) Terminate friction tape by one of the methods described in the Appendix.

Note: *For best results, be sure to wrap very tightly and with no gaps. The friction tape is self-vulcanizing; if wrapped tightly, it will fuse to itself over time.*

Note: *This process applies to all connections between all components of the system.*

5.7.3 Installing Streamer Birds and Bird Collars

Each Active and Vibration Isolation Section contains at least a single bird coil at one end. It can be found by looking for the three red spacers in a liquid section, or a black band on a solid section. Before you can install a Streamer bird, you must install the bird collars. Although birds are made by different manufacturers (ION Geophysical, Concord, Western Geco), the collar and the means of attachment are very similar. In the discussion below, the birds and collars used are provided by ION Geophysical (formerly Digicourse) Model 5010.

Each bird requires two sets of inner and outer collars. A single set is shown below.

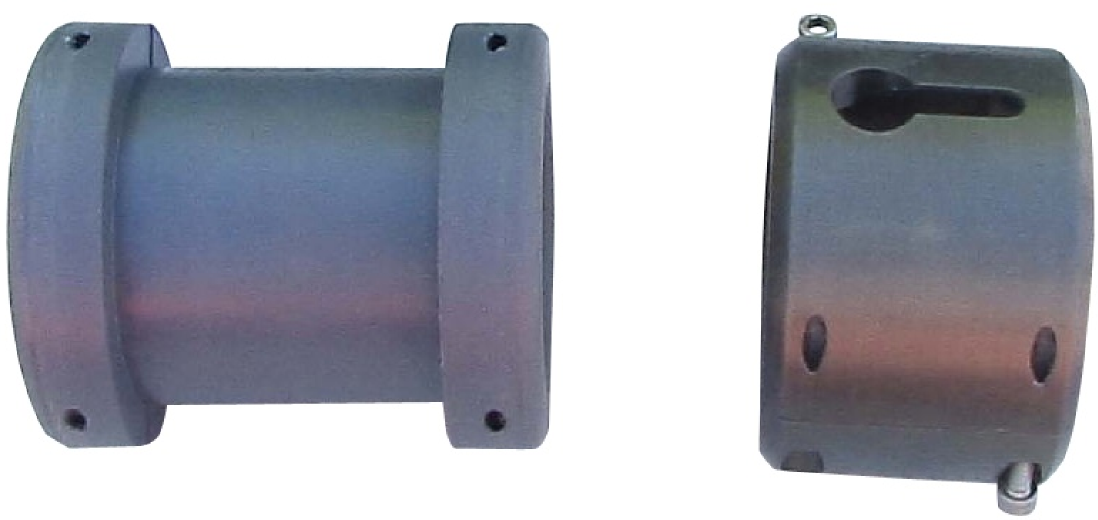


Figure A112: Inner (left) and outer (right) bird collars.

Each collar in turn consists of two pieces, joined together by four screws:

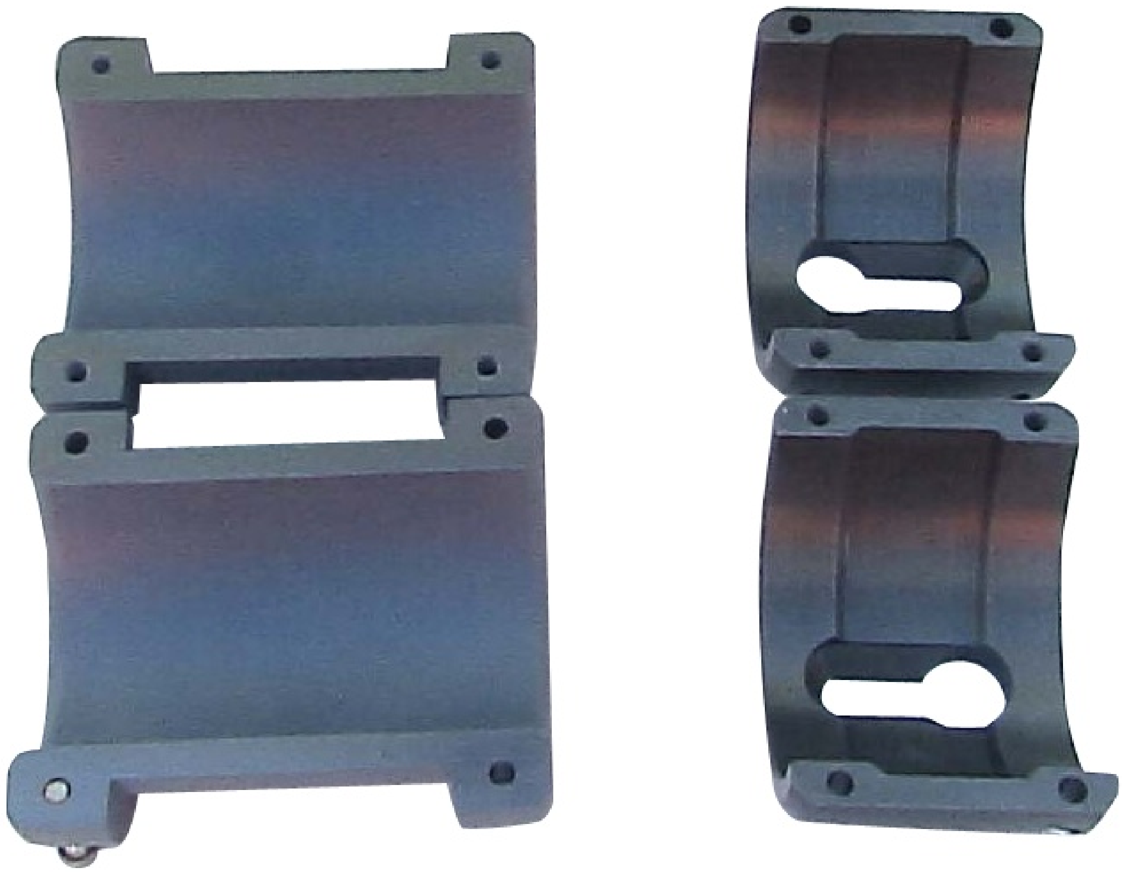


Figure A113: Disassembled bird collars.

Figure A114: Assembled bird collars (complete set).

The inner collars are generally made of plastic and mount directly to the Streamer. The outer collars are made of metal, fit around the inner collars, and attach to the bird. You should refer to the mounting instructions provided with your bird for details, but some helpful hints follow:

The bird must be mounted such that the coil in the bird is adjacent to the coil in the Streamer, as shown below. This alignment does not have to be perfect; a few cm either way is OK..

1) First, estimate the placement of the collars. Install ½ of an outer collar on the front and back of the bird, lay ½ of an inner collar in the outer collars, and then position the bird so that the coils line up:

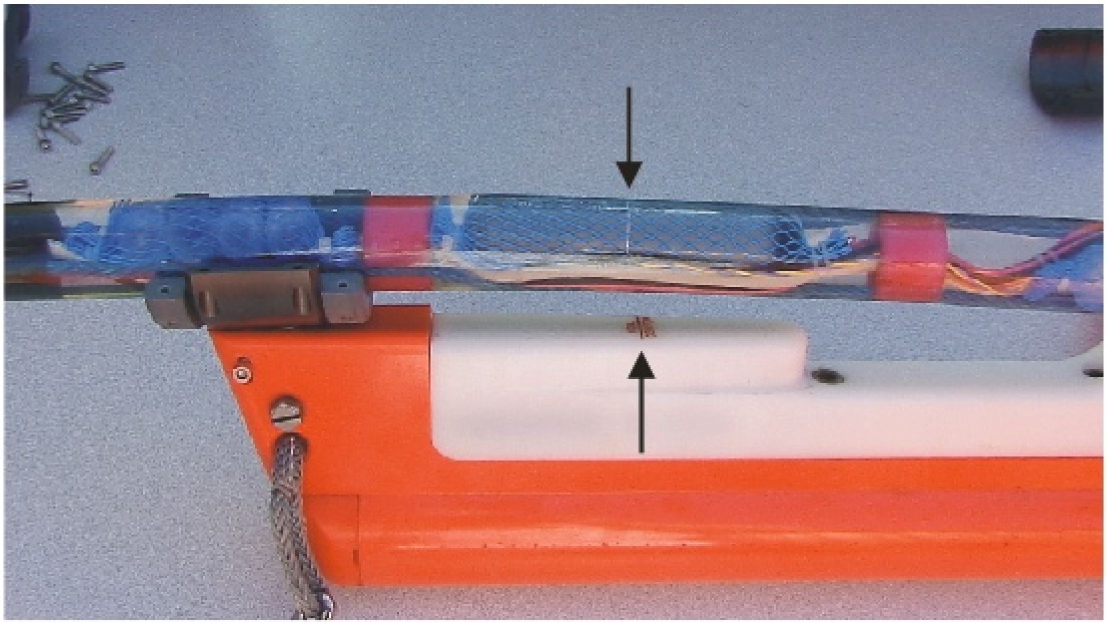


Figure A115: Aligning bird coils on liquid-filled section (only front collar is pictured here).

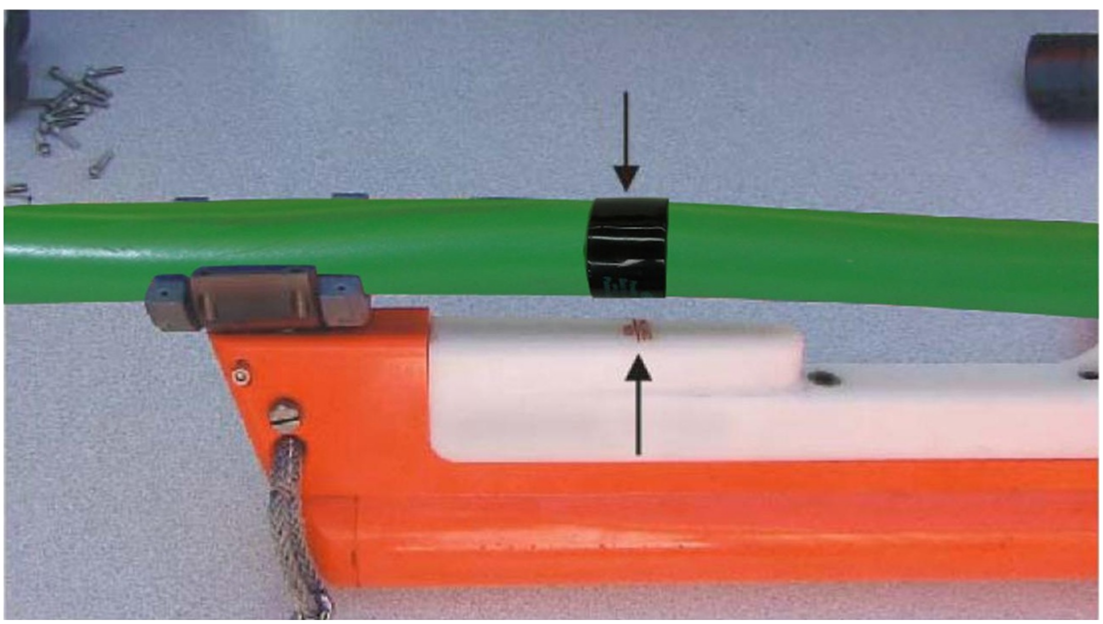


Figure A116: Aligning bird coils on solid section (only front collar is pictured here).

2) Mark the center point of the inboard and outboard collars on the Streamer.

3) Using about 50% overlap, and starting at the inboard end, apply 2-3 layers of friction tape in a band about four inches wide, centered on the marks you have made, for each collar:

Figure A117: Installing friction tape as part of collar installation.

4) Secure an inner collar to the approximate center of the *inboard* band of friction tape (which will attach to the front of the bird). The two halves of the collar should meet, but the collar should fit tight enough to the Streamer that it cannot slide or rotate. Adjust the amount of friction tape if necessary.

Figure A118: Bird collar installed.

Note: *It is very important that the two halves of the collar come together completely; otherwise the outer collar may not be free to rotate on the inner collar, and this is essential for proper bird function.   Do not over-tighten the screws or the collar may crack.*

5) Using 100% overlap, apply 4-5 turns of friction tape to the Streamer immediately aft of the collar. The will be further insurance against its sliding:

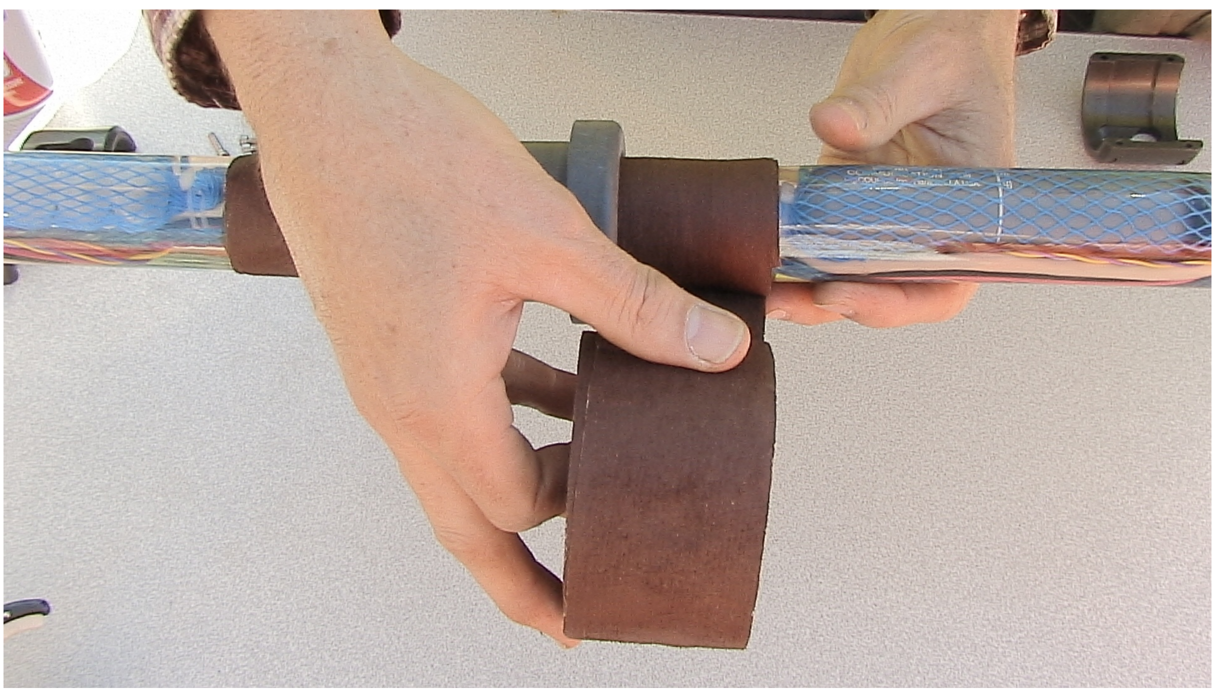


Figure A119: Installing friction tape behind bird collar to prevent sliding.

6) Secure by one of the methods demonstrated in the Appendix.

7) Place the bird so that the outer collar on the bird fits in the inner collar on the Streamer:

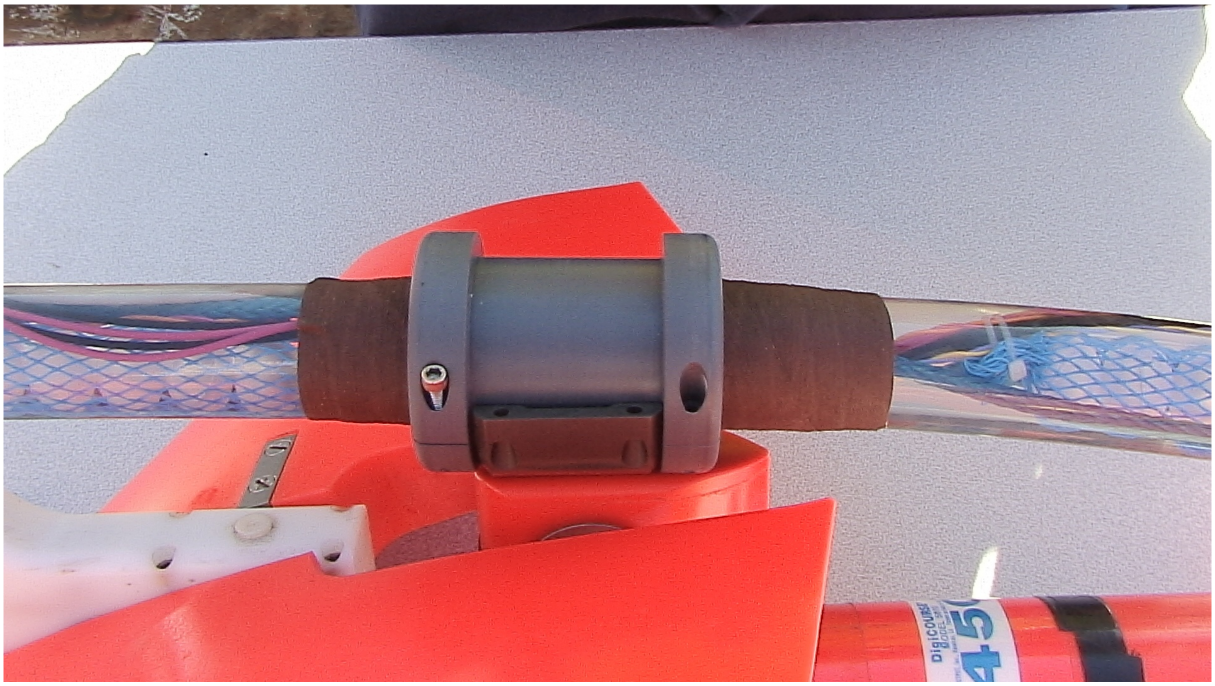


Figure A120: Aligning installed inboard collar to assist alignment of outboard collars.

8) Now position the outboard inner collar on the Streamer so that it lines up with the outboard outer collar on the bird:

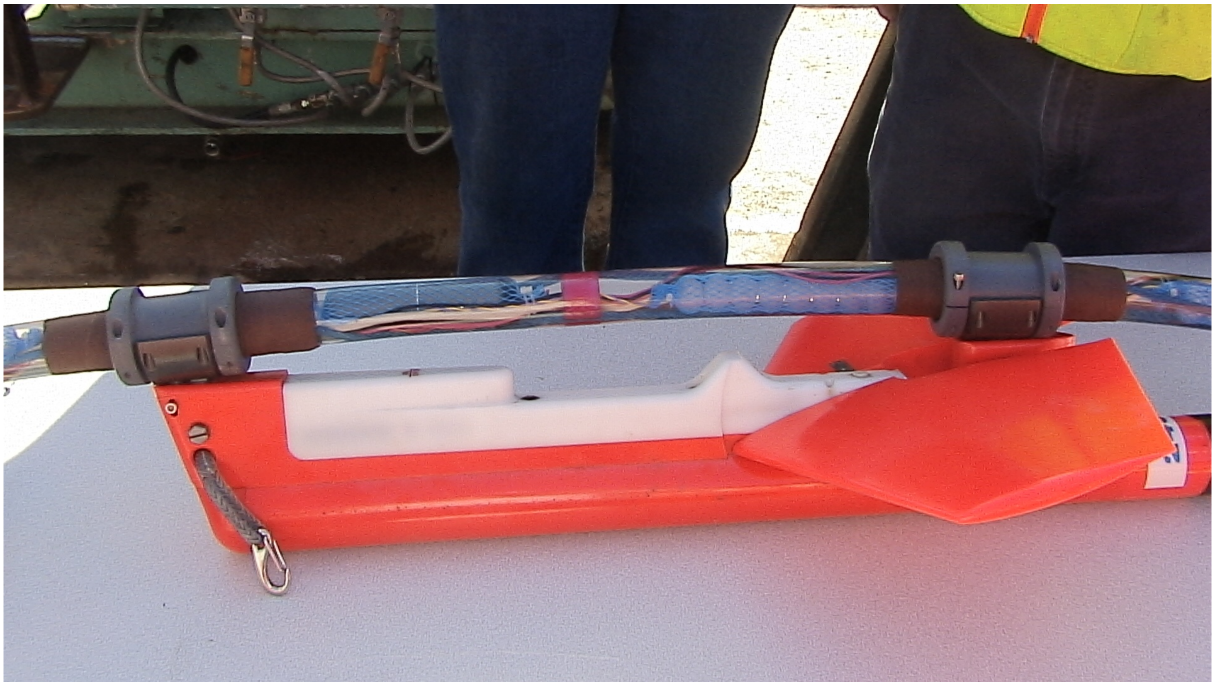


Figure A121: Outboard inner collar aligned with outer collar and ready for installation.

9) Install the outboard inner collar in the same fashion as before.

10) Install outer collars on inner collars:

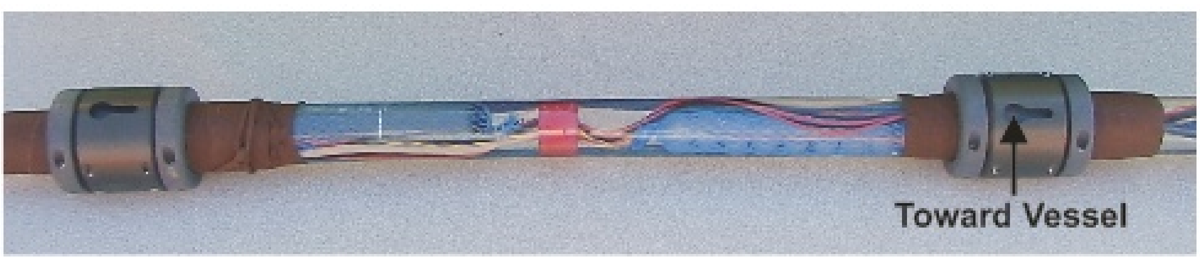


Figure A122: Complete set of collars installed on streamer.

Note: *The round end of the key slot should always be toward the inboard end of the Streamer.*

11) Install bird and bird float according to instructions provided by manufacturer:

Figure A123: Complete bird and bird float installation.

Again – the absolute positions of the collars is not critical; the coils do not need to line up perfectly. What matters most is that the collars are the right distance apart. The reason for this should become obvious when you install the birds.

Note: *Before deploying the Streamer, it is highly recommended that you flap the wings on the installed birds to confirm functionality. Follow the instructions in the bird manual.*

Note: *The wing angle on the birds should be neutral or positive during deployment. If it is negative, the Streamer will want to dive during deployment.*

5.7.4 Installing Digitzer Floats

The Digitizer weighs approximately 520g (1.1 lb) in water. Even if you have a bird mounted nearby, it is often desirable to offset this weight. The addition of the float will make the Digitizer neutral in salt water.

The float should fit snugly to the Digitizer, but apply a layer or two of friction tape if necessary. Secure at either end with zip ties, followed by a tight wrap of black electrical tape. The tape is important; it will prevent the sharp point of the zip tie from damaging the Streamer while on the winch.

Figure A124: Digitizer float secured to Streamer with tie wraps.

Figure A125: Tape applied over tie wraps to protect Streamer.

Finish up with friction tape to prevent unraveling. Secure by one of the methods demonstrated in the Appendix.

5.7.5 Using the Digitizer Clamp

The Digitizer Clamp was designed to allow changing out components while the rest of the system remains in the water under tow. It was designed to attached to *Digitizers only*. To use the Digitizer Clamp,

1. Retrieve the Streamer until the first Digitizer aft of the component to be replaced comes on board.
2. Attach the clamp to the Digitizer as shown in the figure below. DO NOT attach the clamp to a GeoEel Streamer or a Repeater. DAMAGE WILL RESULT.

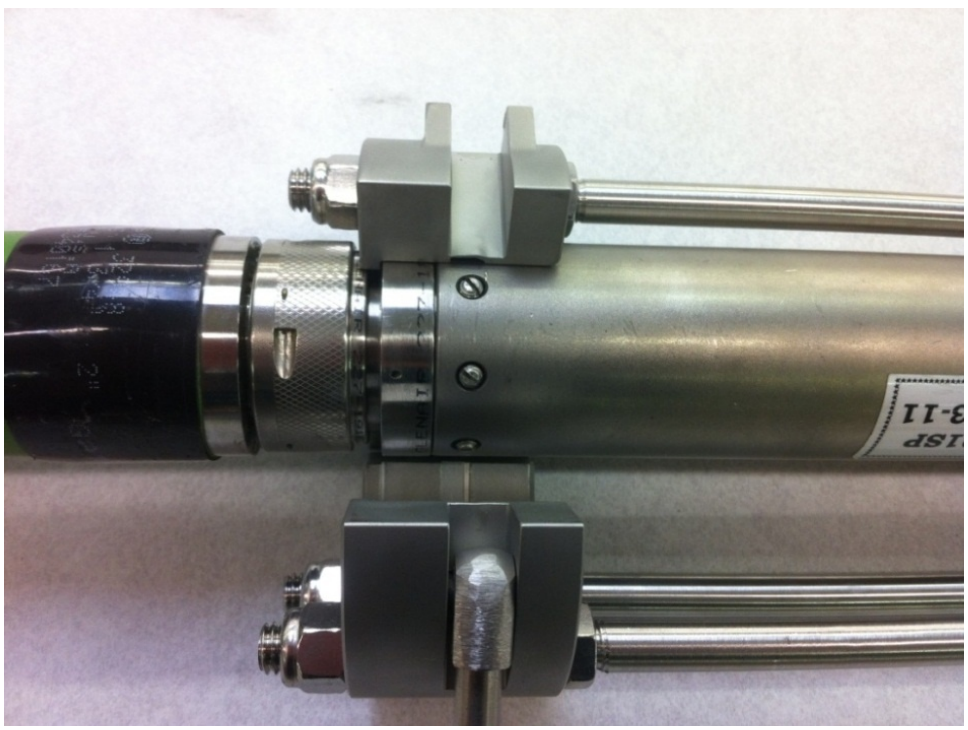


Figure A126: Digitizer Clamp.

3. Close the clamp and tighten the nuts. Attach shackles to the two forward tabs as shown in the figure below. Tie off connecting wires, ropes or chains at approximately the same length to keep the clamp in line with the Streamer.

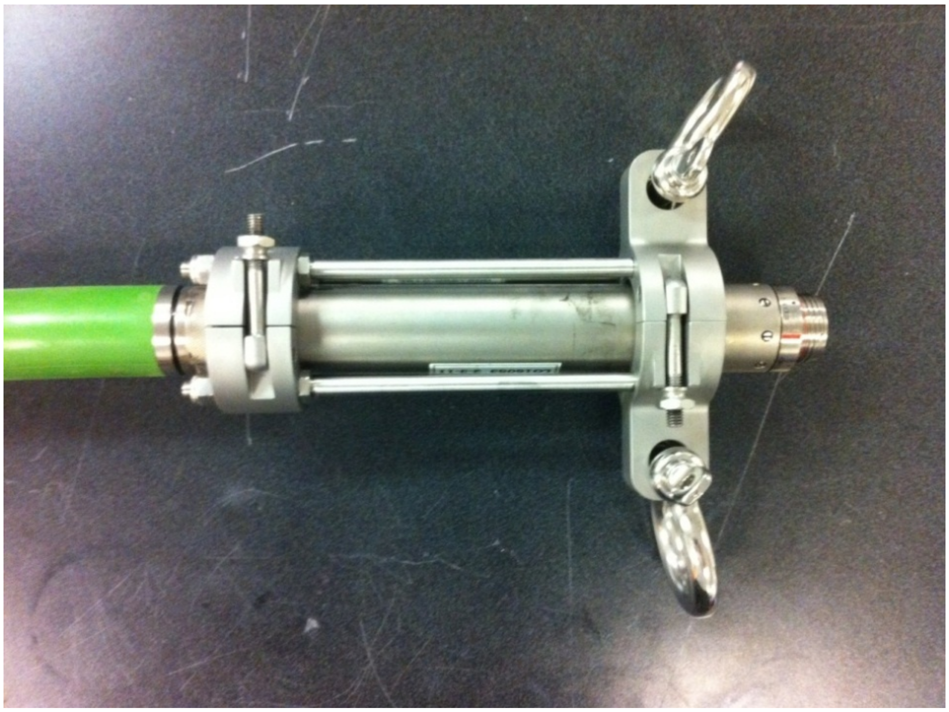


Figure A127: Digitizer Clamp installed.

4. With the clamp closed and tied off securely, slowly allow the clamp to take the tension of the Streamer left in the water until that on deck no longer has tension on it.
5. Remove and replace the suspect component.
6. Pull in the on-deck portion of the system until the tension is taken off of the clamp.
7. Remove the clamp from the Digitizer and redeploy.

5.7.6 Terminating Friction Tape to Prevent Unraveling

5.7.6.1 "Tie-off" Method

This is the most commonly-used method of terminating friction tape.

After wrapping, leave a 4-5 inch “tail”. Tear it in half longitudinally, and rub the two resultant pieces between your palms:

Figure A128: Preparing friction tape for tie-off.

Wrap the resulting “strings” around the Streamer and tie securely:

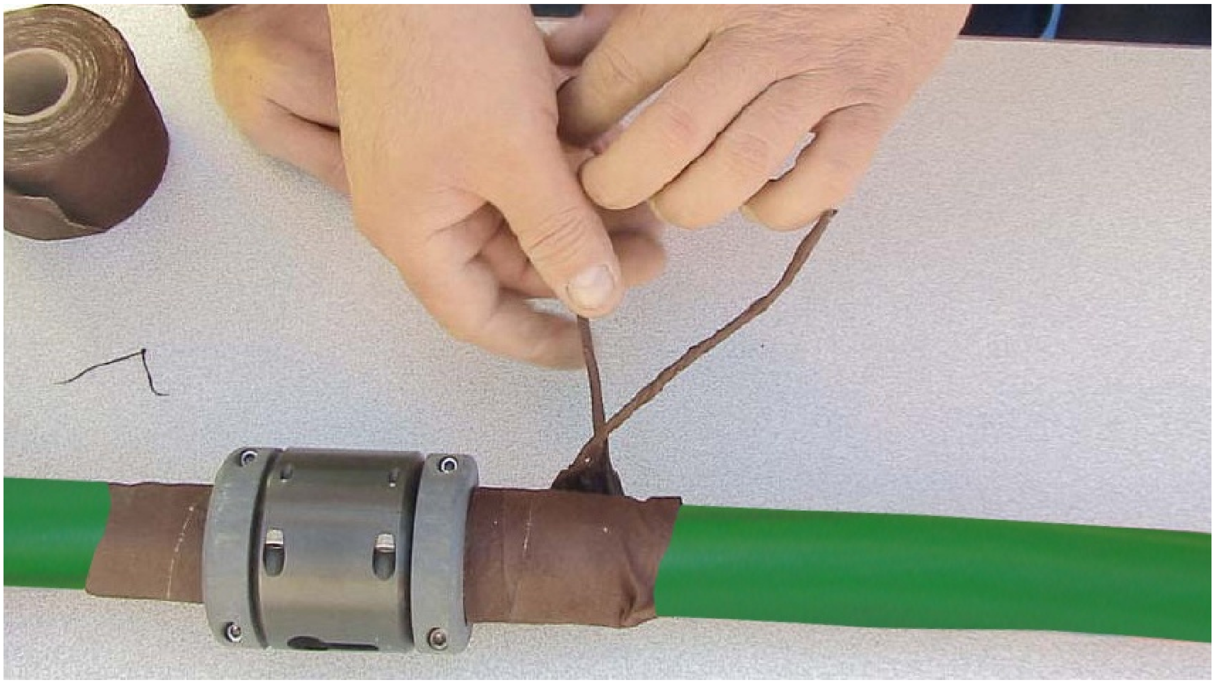


Figure A129: Tying off friction tape.

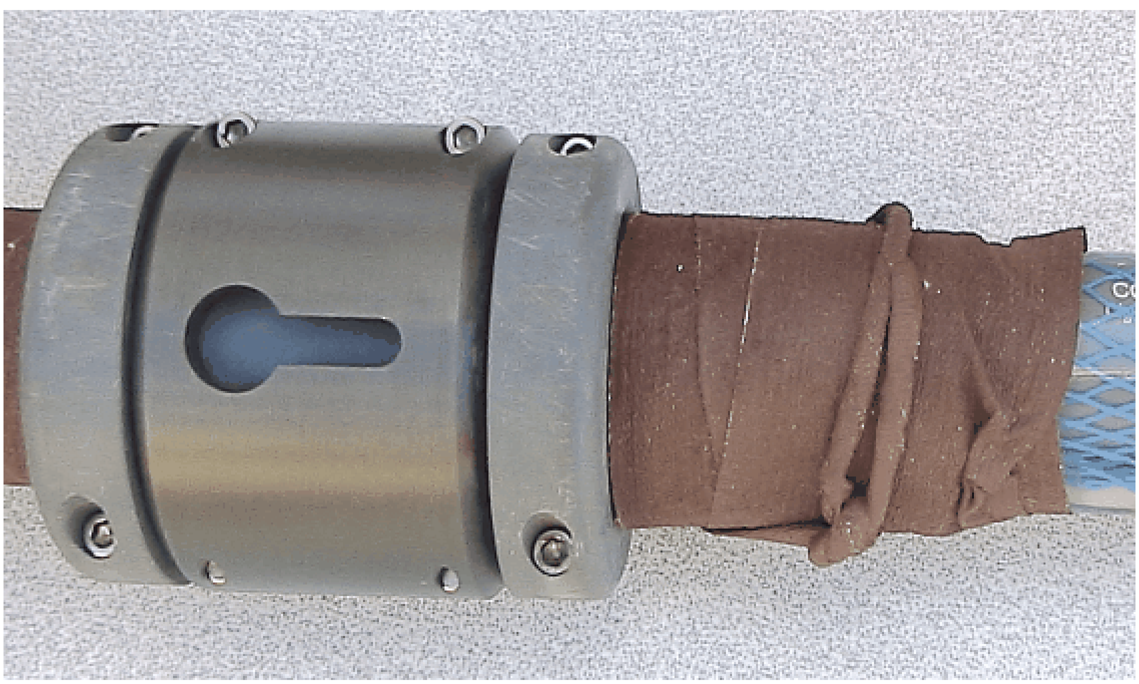


Figure A130: Tied off friction tape.

5.7.6.2 "Pull-through" Method

The following is a very robust method of securing friction tape.

1) Loop and attach a zip tie to a screwdriver, nail, welding rod, etc. as pictured below.

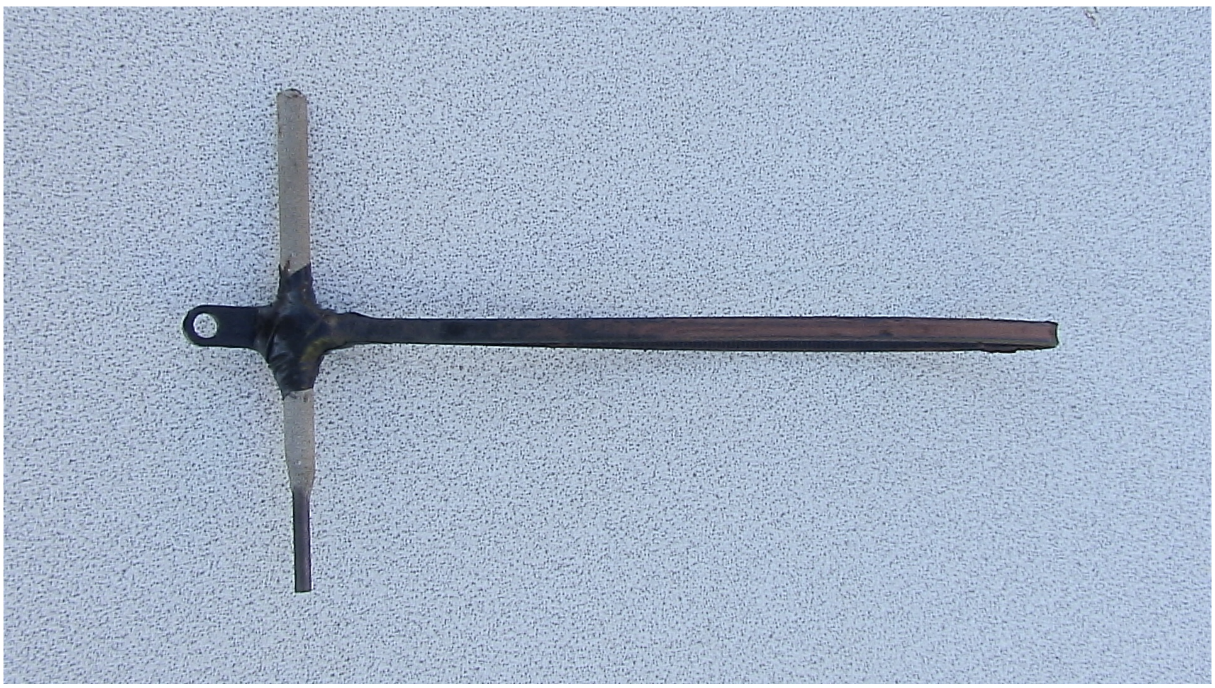


Figure A131: Simple tool fashioned out of welding rod and tie wrap.

2) After three or four wraps of tape, place the loop against the tape and wrap three times.

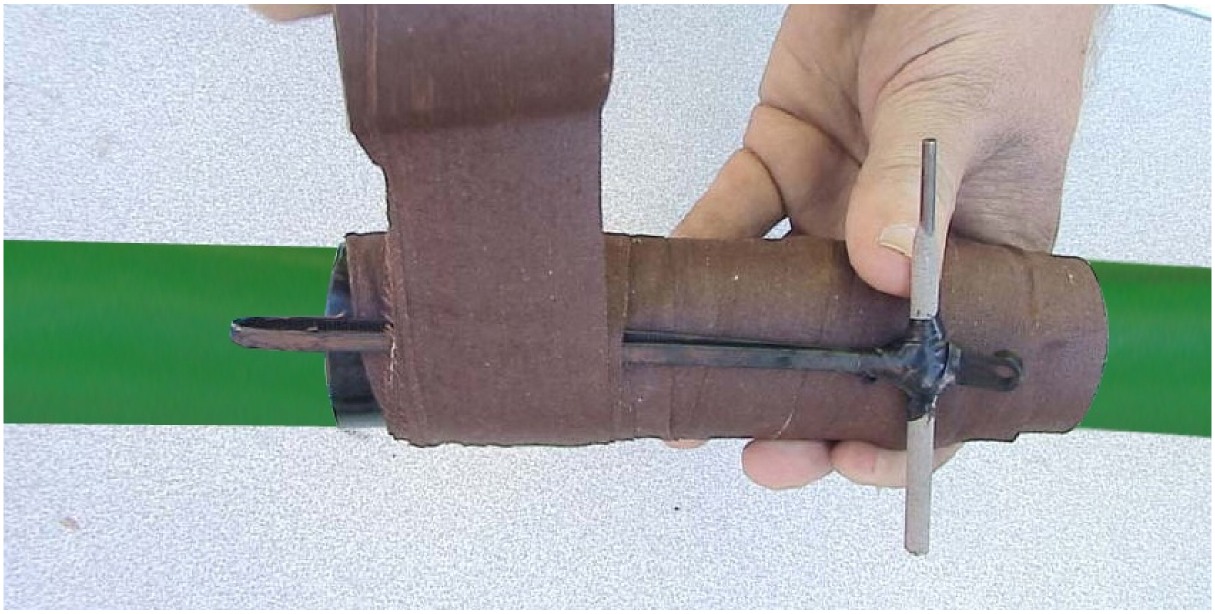


Figure A132: Wrapping friction tape over pull-tool.

3) Leave about four inches of extra tape, rub it between your palms, and put it through the loop.

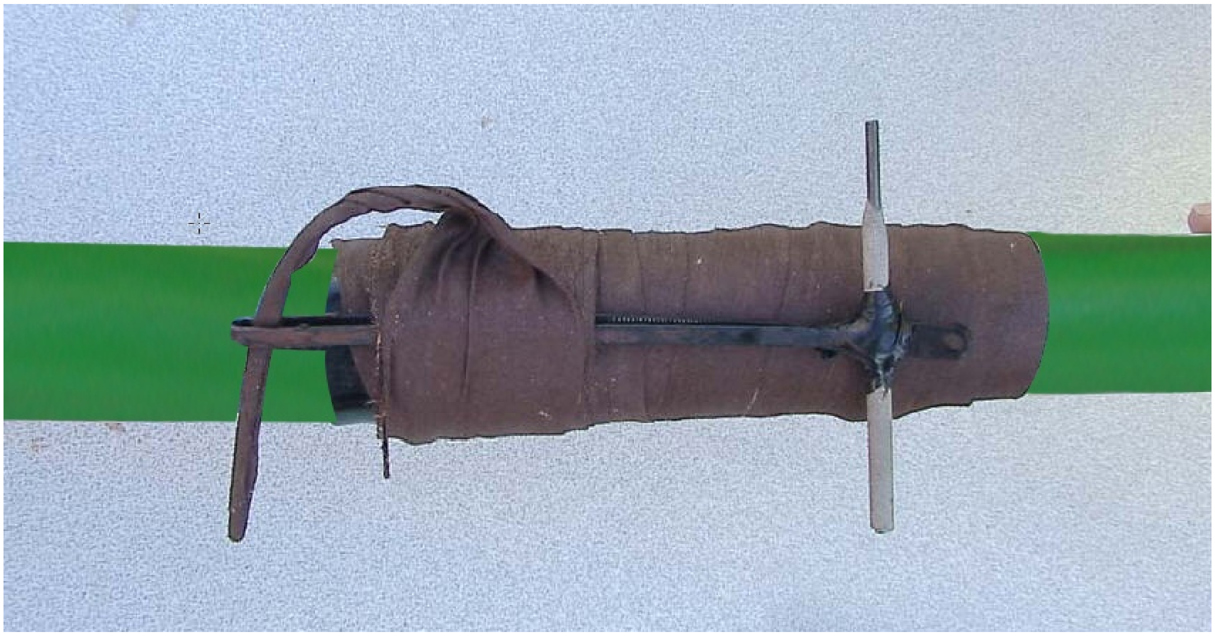


Figure A133: Friction tape "tail" ready to be pulled.

4) Pull the loop through, and cut off the excess.

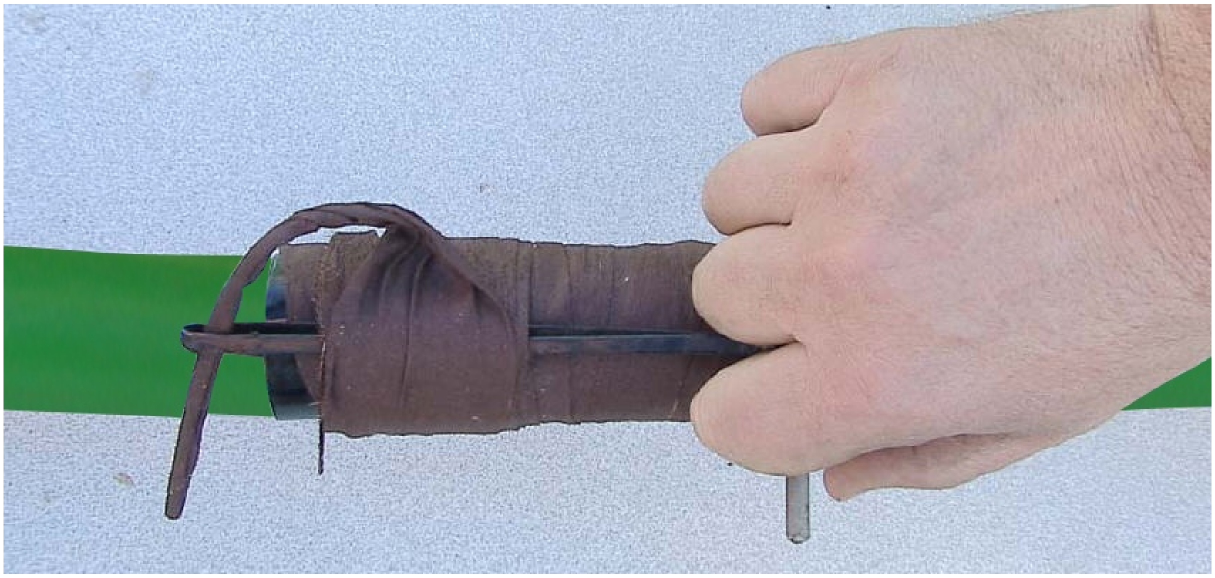


Figure A134: Preparing to pull friction tape through the loop..

Figure A135: Finish friction tape termination.

5.8 P-Cable Deployment and Retrieval

5.8.1 Back Deck Procedure

System deployment is the most crucial aspect of a P-Cable survey. As with any marine seismic system, it is during deployment and retrieval that system components are most likely to be damaged; as such, great care must be taken to follow the correct procedures.

There are many ways to deploy paravanes, depending on the ship's configuration. Geometrics makes no attempt to give instructions on vane deployment; it is assumed that paravane experts are on-board. It is highly recommended that testing of the vanes alone, and then with the Cross Cable only (no Active Sections), be done before attempting a full deployment of the system. Some items to keep in mind before deploying:

- *A slip-ring on the Signal Cable winch is highly recommended, as it will vastly simplify the deployment process.* ***If your Signal Cable winch does not have a slip-ring, be sure the Deck Cable is disconnected from the Signal Cable before operating the Signal Cable winch. Failure to do this will result in damage to the Deck Cable.***

- *The ship's through-the-water speed should be 2-3 knots during deployment.*

- *Prior to deployment, you should have some idea of the amount of paravane rope you will ultimately need to let out to achieve optimum array shape. You may find that, during deployment, you will need to let out more rope than you will actually use during surveying. Some practitioners let out extra Starboard Tow Rope during the deployment, and then pull some of it back in once the Port paravane has been deployed. The exact procedure will vary with vessel size, deck configuration, and array dimensions.*

The steps listed below should be used only as a guide, since every vessel and every deployment is different. They are not intended to be used as "cookbook" instructions, although they should be close.

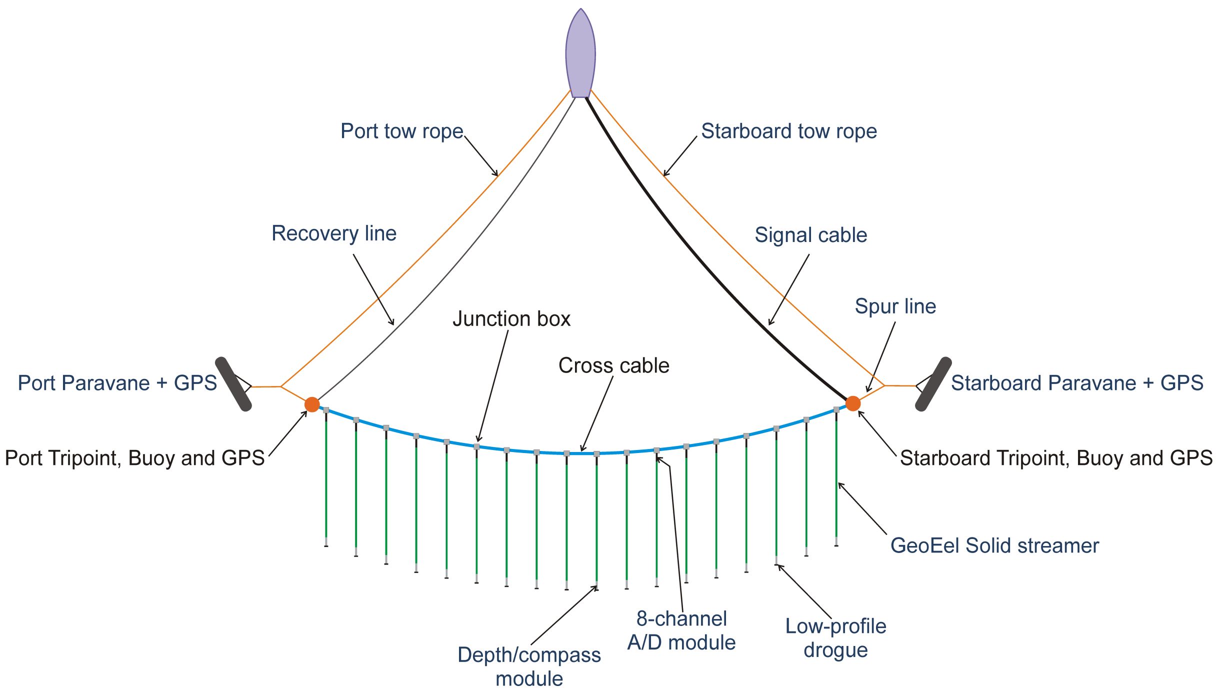


Figure A136: P-Cable system components.

Refer to the above figure for the following discussion.

Preparing for deployment

1) Attach the Tri-point assembly to the Signal Cable (see below).

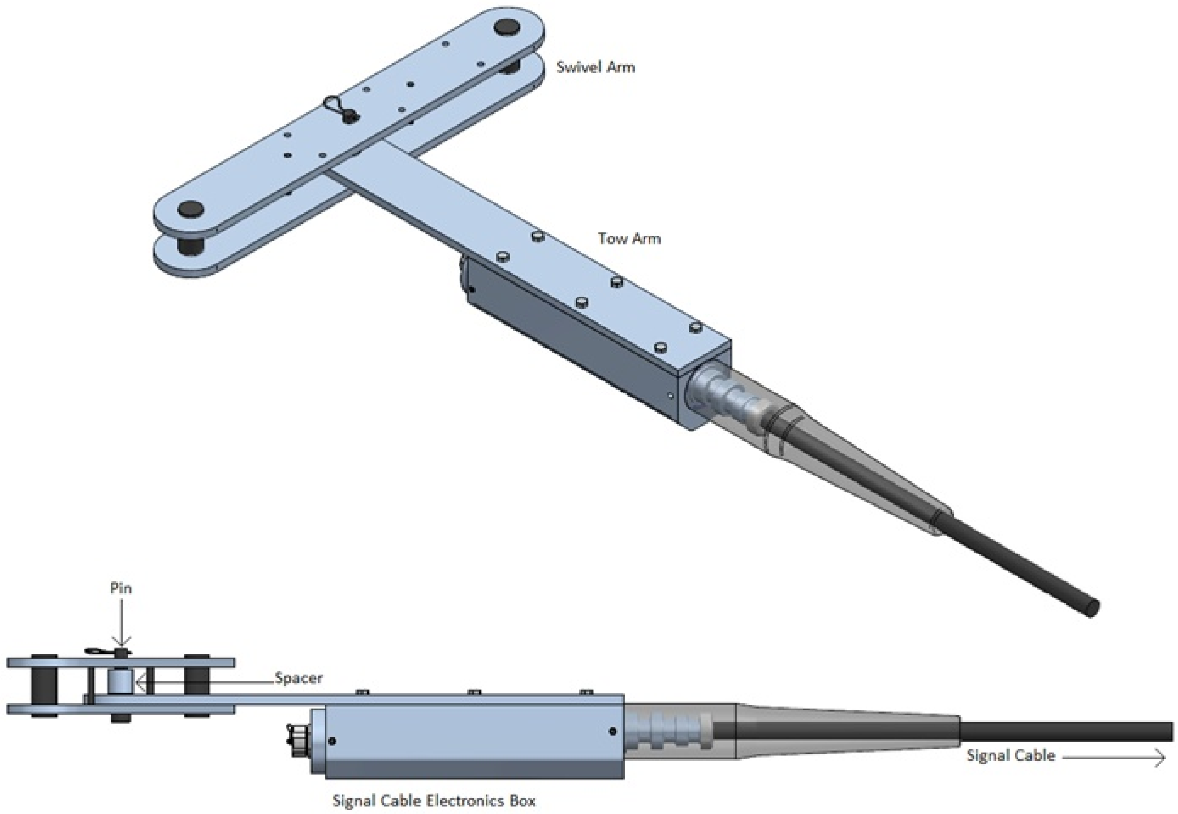


Figure A137: Tri-point and Signal Cable assembly.

2) Attach the Starboard Spur Line to the outboard end of the Tri-point swivel arm. Be sure that the Tri-point is oriented correctly, as shown above. The electronics box should be on the bottom, and the tow arm should connect to the bottom of the swivel arm as shown.

3) Attach the GPS buoy to the Tri-point. The rope length will determine the tow depth.

4) Secure the Cross Cable to the inboard end of the swivel arm and connect to the Signal Cable. At this point, you should have something like the following:

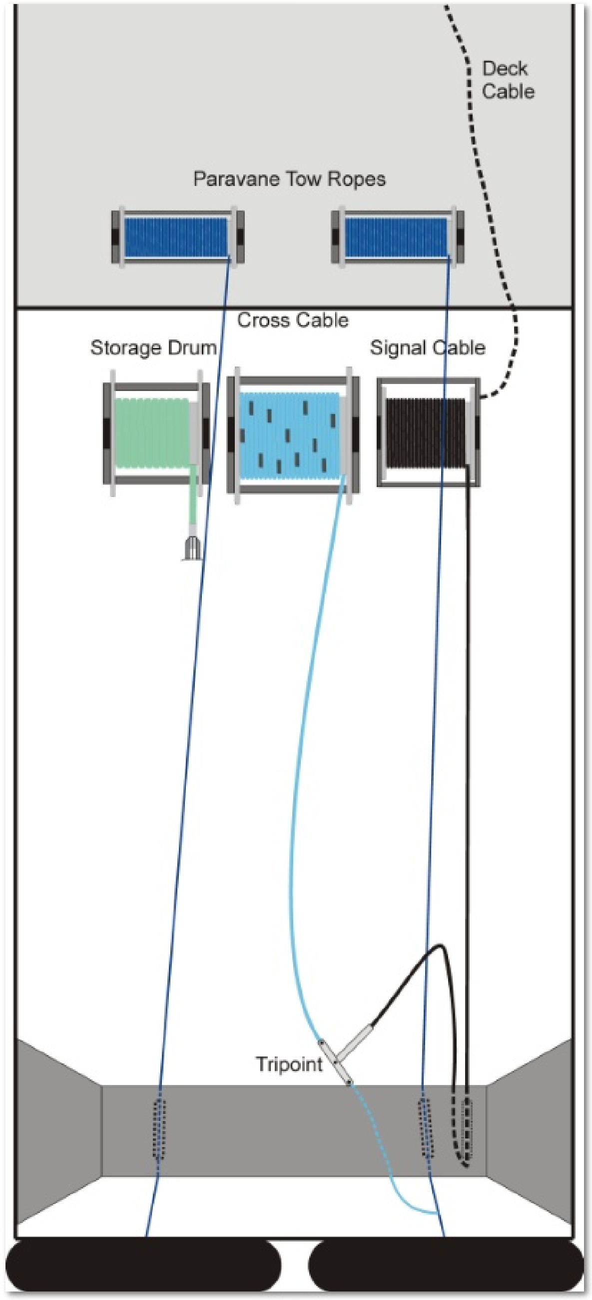


Figure A138: Deck configuration immediately prior to deployment.

Now you should test the Cross Cable to make sure all of the Junction Boxes are functioning and reporting accurate depths. If necessary, connect the Deck Cable to the Signal Cable. Power up the array via the Deck Box. Since there are no Digitizers attached yet, this will not take long. Once the current draw on the Deck Box has settled, start the GeoEel Tester Utility. Press **Switch** and follow the instructions to get their serial numbers written to the registry in the proper order (this may already have been done). Once the Switches have been recorded in the registry, close the utility and start the

CNT-2 Controller.

Note: *Make sure that the switch test found all of the Junction Boxes that are known to be in the system.*

Go through the startup procedure. You should see the Depth Sensor outputs at the bottom of the display. All status lights should be green or yellow. Red indicates a non-functioning Depth Sensor; this would be a good time to change out that Junction Box. Each sensor should be showing a depth of near zero -- if necessary, use this opportunity to calibrate the Depth Sensors.

Once you have ascertained that all of the Depth Sensors are functioning and calibrated, close the software and power down the system.

Balancing the Cross Cable

Prior to doing the first full deployment of the P-Cable system, the Cross Cable may require balancing. The Cross Cable is negatively buoyant, but there are hydrodynamic forces at work that are difficult to predict and that depend on many factors. It is therefore recommended that you do a deployment without Active Sections attached, assess the towing behavior of the Cross Cable, and balance with weights, floats, or tension adjustments if necessary. In general, the more tension on the Cross Cable, the straighter it tows in the water (in both the horizontal and vertical planes), as the tension overrides the vertical component of the hydrodynamic forces. For this reason, with respect to the shape of the array, high tension is better than lower tension. However, drag increases with paravane lift, potentially affecting vessel maneuverability and definitely affecting fuel consumption. We leave determining the optimum paravane settings to the experts.

Note: *The maximum working load of the Cross Cable is 9070 kg (20,000 lb).*

The Active Sections plus Digitizers are close to neutrally buoyant and tend to tow close to the same depth as the Cross Cable. Some flotation, or even a bird, might be required at the tail (tail buoys are not recommended). In general, adding Active Sections to the Cross Cable has a minimal effect on its tow behavior, although fine-tuning after Active Sections are installed is often necessary. In general, the horizontal drag applied by the Active Sections tends to improve (i.e., straighten in the vertical plane), the towing shape of the Cross Cable.

The balancing process is also a good opportunity to identify any leakage on the Cross Cable that might need mitigation.

1) Instrument room: Power on the system. Note the leakage reading; it should be a small number.

2) Streamer deck: When instructed by the instrument room, begin deploying the Starboard paravane and lowering the Tri-point and GPS buoy into the water by the Signal Cable. Typically the Tri-point is lowered by hand by the Signal Cable itself. Once the Tri-point is in the water, the buoy can be deployed. The details vary depending on the length of the buoy line and the height of the deployment deck.

3) Streamer deck: Continue deploying the Starboard paravane. While doing so, allow the Tri-point to pull out the Signal Cable and Cross Cable.

4) Instrument room: Keep an eye on leakage, paying particular attention each time a Junction Box

enters the water. If you get leakage, make a note of which Junction Box it is so you can fix it after the balancing process but before full deployment. You might want to use the GeoEel Tester software to confirm the location of the leak if you are not sure.

Note: *There should be tension on the Signal Cable at all times,* ***not to the point that the paravane is being towed by the Signal Cable****, but such that there is not excess Signal Cable in the water, allowing it to loop back behind the Tri-point. The Signal Cable should be kept sub-parallel to the Tow Rope, and between the Tow Rope and Cross Cable as much as possible.*

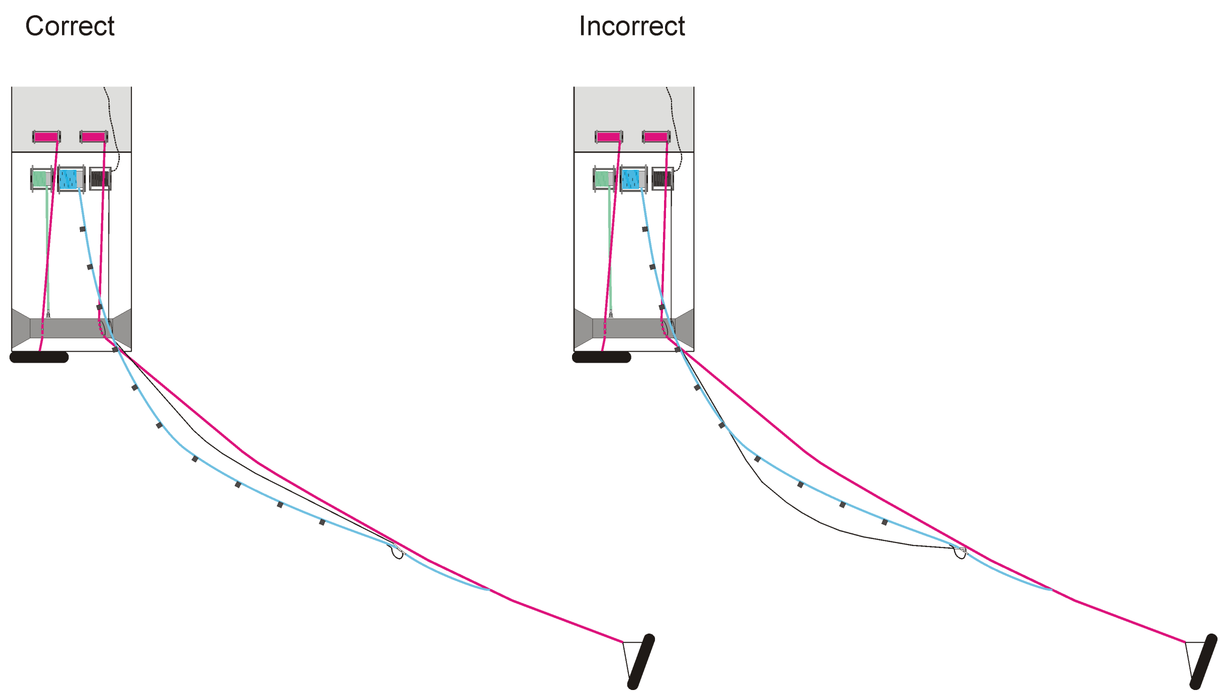


Figure A139: The right way and the wrong way to deploy the P-Cable. In this figure, the Tow Ropes have been colored magenta for better clarity.

5) Streamer deck: Continue until all of the Junction Boxes have been deployed and the Recovery Line (Port) Tri-point is reached on the Cross Cable winch (this is typically just a D-ring, unless you have a second Signal Cable on the Port side instead of a Recovery Line).

6) Streamer deck: Attach the Spur Line to the Recovery Line Tri-point.

7) Streamer deck: Deploy the Port paravane. When finished, your array should look like the following:

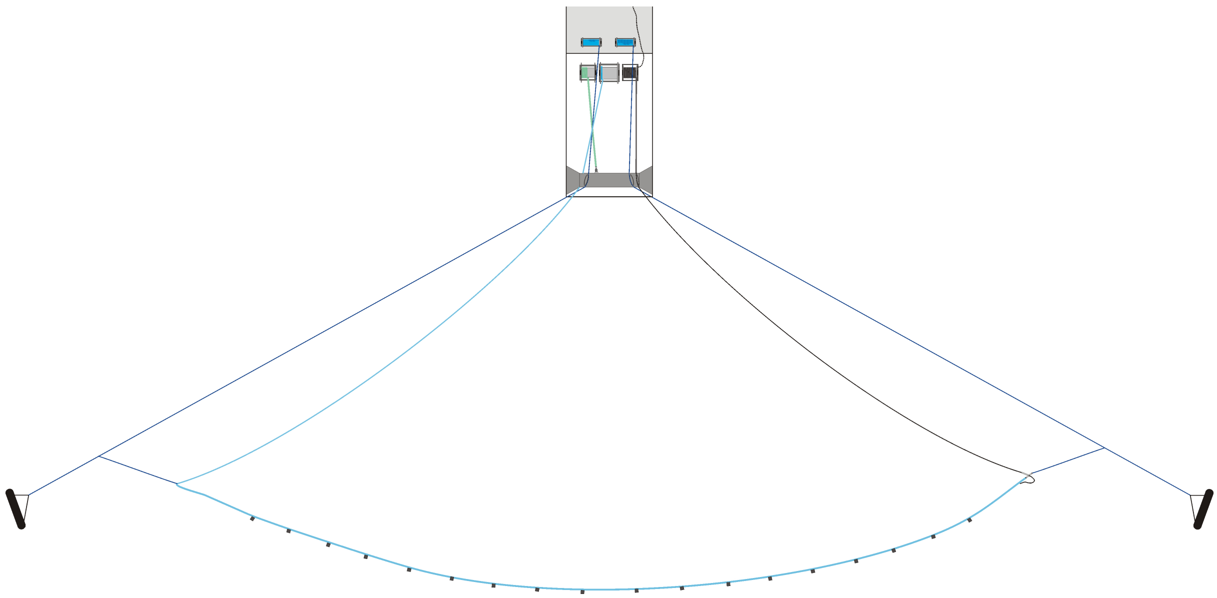


Figure A140: Fully-deployed Cross-Cable.

7) Instrument room: Start the CNT-2 Controller and look at the depth indicators. If there is enough tension, the Cross Cable should tow at a depth roughly the same as the Tri-point buoy rope lengths. If necessary, make note of the high and low spots, and instruct the streamer deck to recover the array, add tension, weights or floats as necessary, and redeploy. Once you have the Cross Cable towing within an acceptable depth range, you are ready to go ahead with full deployment.

Deploying the P-Cable System

The process of deploying the P-Cable system is very similar to the balancing process described above, except that you will be adding Active Sections to the Cross Cable as the Junction Boxes come off the winch, and there will be very close coordination with the instrument room. Some of the steps listed above are repeated here.

1) Connect a drogue to the end of the first Active Section on the storage drum by sliding it over the Tail Module and securing with a carabiner.

2) When instructed by the instrument room personnel, begin deploying the Starboard paravane and lowering the Tri-point and buoy into the water by the Signal Cable. Typically the Tri-point is lowered by hand by the Signal Cable itself. Once the Tri-point is in the water, the buoy can be deployed. The details vary depending on the length of the buoy line and the height of the deployment deck. Deploy the Cross Cable up to the point that the next Junction Box is off the Cross Cable winch and ready to go in the water. **Do not connect the Active Section yet.** Stand by; the operator will perform a series of tests, discussed in the next section.

3) When instructed by the instrument room, connect the Active Section to the Junction Box and deploy the Active Section tail-first. The drogue should help pull it off the stern. Once most of the Active Section is deployed and relatively straight, continue deployment of the Cross Cable until the next Junction Box is ready. The proper way to connect the Active Section is shown below:

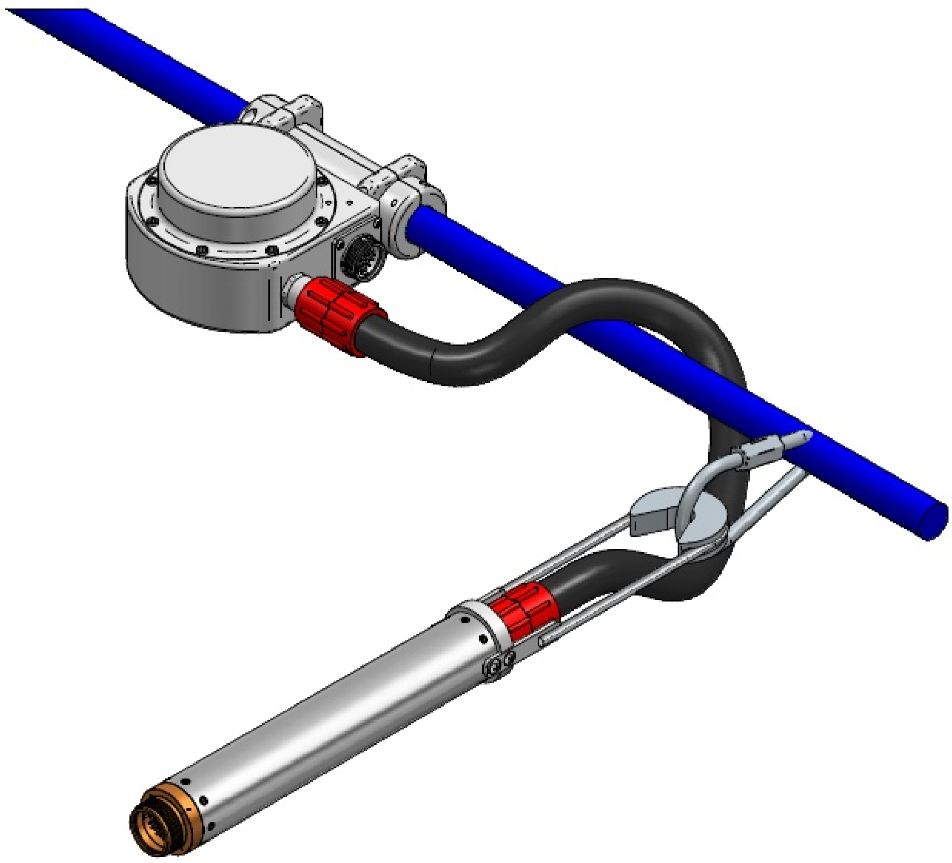


Figure A141: Proper way to connect Active Section to Cross Cable. Looping the Jumper Cable around the Cross Cable Strength Member as shown reduces strumming and minimizes wear.

4) Return to Step #1 and repeat until all Active Sections are deployed.

After installing two Active Sections, your array should look similar to the following:

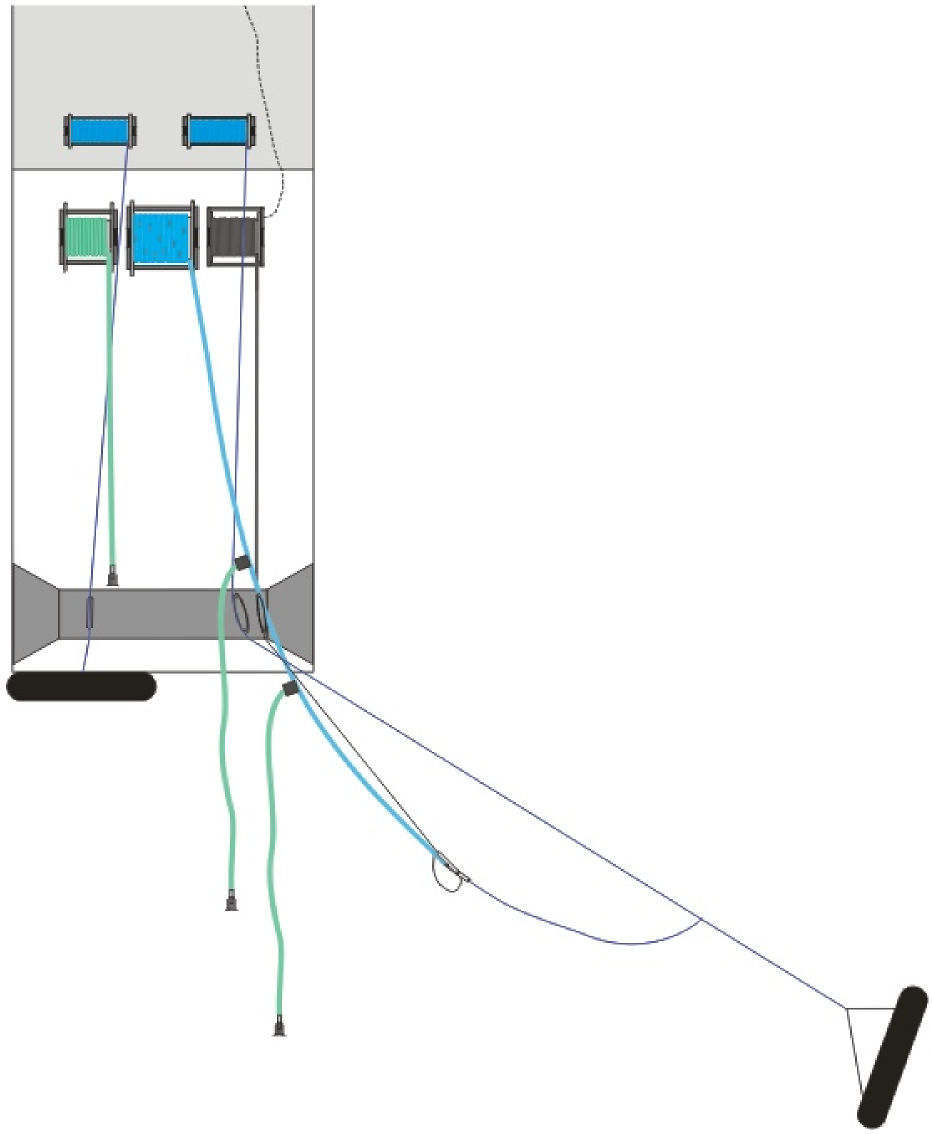


Figure A142: Partially-deployed P-Cable.

REMEMBER: While deploying, only let out as much Signal Cable as necessary, while keeping most of the paravane tension on the Two Rope. The bulk of the tension on the Signal Cable should be exerted by the water, NOT the paravane.

IMPORTANT: When deploying the Starboard paravane, let it out *slowly*. Letting it out too fast will allow it to drift behind the boat. This will cause the Cross Cable to become too parallel to the Active Sections, running the risk that some of the Active Sections will wrap around the Cross Cable. Strive to keep the paravane at least 45 degrees to Starboard, as shown below. This will maximize the angle between the Cross Cable and the Active Sections. Do not worry if Active Sections cross each other during deployment. This is common and does not result in tangling.

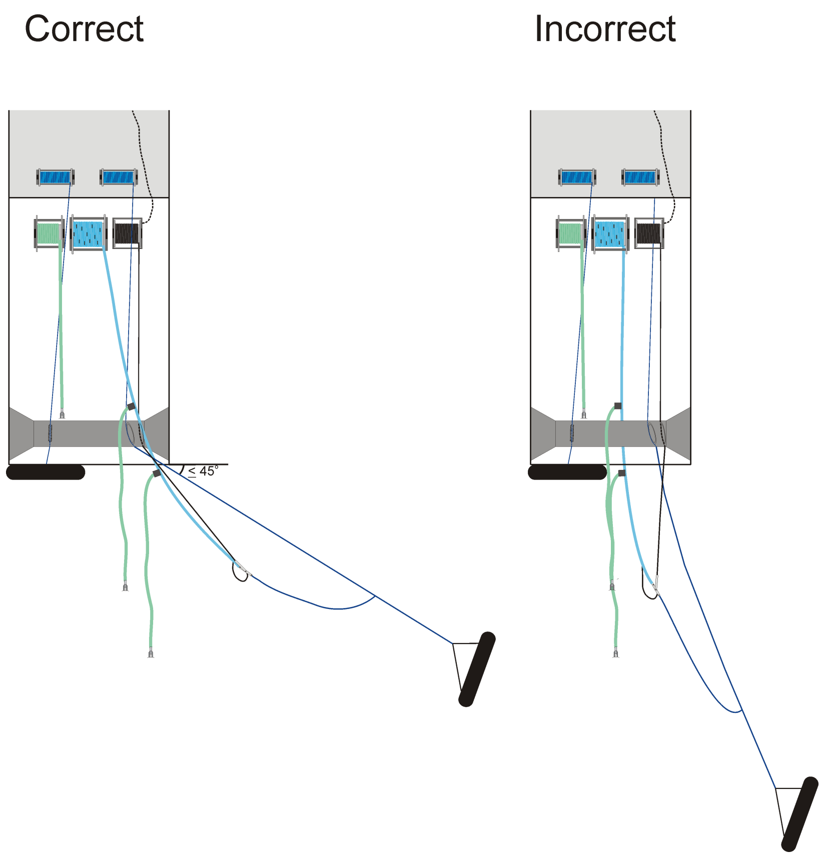


Figure A143: The right way and wrong way to deploy the Starboard paravane. The paravane should be let out slowly enough that the shown angle between the Cross Cable and the stern never exceeds 45 degrees.

Figure A144: Picture of array just prior to deployment of Port paravane.

5) Deploy the Port paravane, which will pull the Recovery Line off the Cross Cable winch. Follow the same procedure you did on the Starboard side, letting the Tow Rope carry most of the tension and only letting out as much Recovery Line as necessary.

6) Adjust Tow Rope lengths as necessary.

Once deployed, your array should look similar to the following:

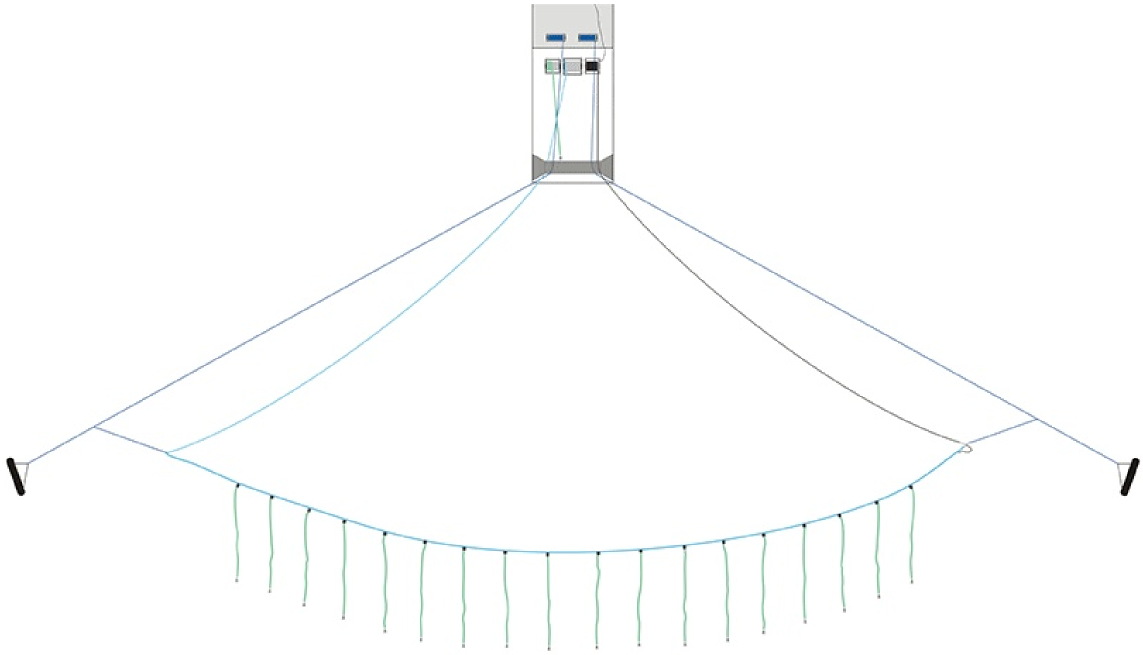


Figure A145: Fully-deployed P-Cable system.

Recommended survey speed is 4-5 knots through the water.

An animation of the deployment process can be found here: http://www.geometricspcable.com/deploymentanimat.html

A video can be found here (deployment starts at 3:00): https://www.youtube.com/watch?v=UIvVN2Y-LTg

5.8.2 Instrument Room Procedure

Deploying the P-Cable system is a simple process. It consists of connecting components to the Cross Cable Junction Boxes as they come off the winch and testing those components in the process. The important thing is to avoid connecting a Digitizer to the Junction Box while there is power on the Digitizer/Streamer port. The GeoEel Tester tool facilitates deployment by allowing you to control power to the Digitizer ports individually, obviating the need to power down the entire system. A *typical* deployment procedure for a P-Cable that includes Tail Modules is detailed below:

1. Print out the deployment checklist.

2. Power up the Deck Unit. This will power up all of the Junction Boxes on the Cross Cable.

3. Watch the current indicator on the Deck Unit front panel and wait until the current stabilizes. Record the current in the Deployment Checklist.

4. Start the GeoEel Tester software.

5. Query all Switches, making sure all Junction Boxes respond. Record in the Deployment Checklist.

6. Check the All Switches box.

7. Press **Power off Streamer**. This will cut power to the Digitizer ports (and only the Digitizer ports) on *all* Junction Boxes.

8. Uncheck the All Switches box.

9. Enter the Switch number (in the first instance, this is the first Junction Box that will have a Streamer attached to it.

10. Radio the streamer deck and ask them to begin deployment of the system. When the first Junction Box becomes available from the Cross Cable winch, have them stop and connect a Digitizer and Active Section to the Junction Box, and **radio confirmation of this**. After connection is confirmed, instruct the streamer deck to stand by.

11. Press **Power on Streamer**. This will enable power to the Digitizer port on *this Junction Box only*.

12. Watch the current indicator on the Deck Unit front panel, wait until current stabilizes, and record the current value in the Deployment Checklist.

13. Note the leakage value in the Deck Unit front panel and record in the Deployment Checklist.

14. Open a command prompt window.

15. Ping the Digitizer and record in the Deployment Checklist. Leave this command window open.

16. Open a second command window.

17. Ping the Tail Module and record in the Deployment Checklist. Leave this command window open.

18. Run a trigger test and record time required for 100 triggers in the Deployment Checklist.

19. Run a network test and record the network speed in Mbps in the Deployment Checklist.

20. Press **Next Position**. This will power up the next Junction Box

21. Radio the streamer deck and ask them to continue deployment of the system. When the next

Junction Box becomes available from the Cross Cable winch, have them stop and connect a Digitizer and Active Section to the Junction Box, and **radio confirmation of this**. After connection is confirmed, instruct the streamer deck to stand by.

22. Return to Step #11.

23. Repeat until all Active Sections have been deployed.

5.8.3 Deployment Checklist

A typical P-Cable Deployment Checklist is shown below:

P-Cable Deployment Checklist											
Date:											
Time:											
Project:											
Streamers:	24										
Length:	50 m										
Streamer Separation	12.5 m nominal										
Group Interval	6.25 m										
Observers:											
Streamer #	Switch SN	Query Switch	Digitizer IP Address	Pinged Digitizer	Tail Module IP Address	Pinged Tail Module	Current (A)*	Leakage	Trigger Test (sec)	Network Test (mbs)	Remarks
None	NA	NA	NA	NA	NA	NA	N/A	NA	NA	NA	Begin Deployment
1	7154	x	192.168.1.3	x	192.168.40.90	x	1.6	-004	35	13.7	14:40 UTC
2	7157	x	192.168.1.4	x	192.168.40.86	x	1.8	-004	32	13.9	
3	7158	x	192.168.1.5	x	192.168.40.91	x	1.9	-003	27	13.9	
4	7159	x	192.168.1.6	x	192.168.40.88	x	2.1	-005	35	13.9	
5	7160	x	192.168.1.7	x	192.168.40.98	x	2.2	-002	26	13.7	
6	7161	x	192.168.1.8	x	192.168.40.84	x	3.2	-002	28	13.9	
7	7162	x	192.168.1.9	x	192.168.40.2	x	2.4	000	27	13.8	15:05 UTC
8	7163	x	192.168.1.10	x	192.168.40.93	x	2.6	-001	28	13.7	
9	7164	x	192.168.1.11	x	192.168.40.5	x	2.7	000	28	13.9	
10	7165	x	192.168.1.12	x	192.168.40.3	x	2.8	002	27	14.0	
11	7166	x	192.168.1.13	x	192.168.40.6	x	3.0	002	28	13.8	
12	7167	x	192.168.1.14	x	192.168.40.8	x	3.2	004	27	13.7	15:35 UTC

Table A9: P-Cable deployment checklist.

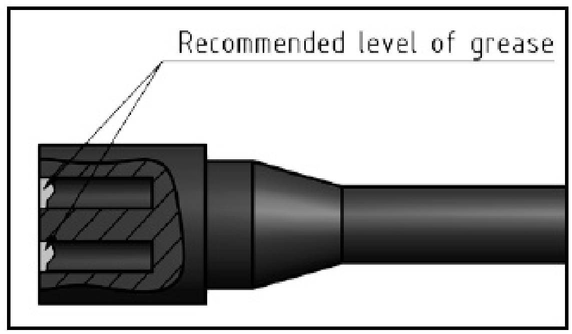
5.9 Maintenance

5.9.1 Subconn Jumper Cables

Handling

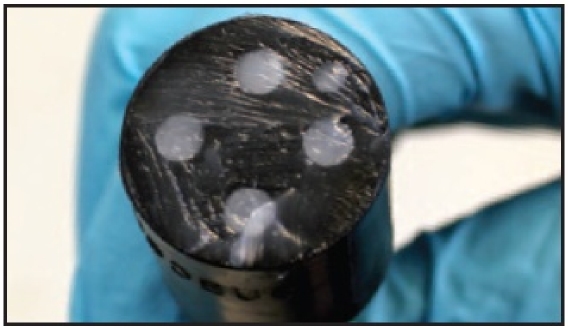
- Always apply grease before mating (see below).
- Disconnect by pulling straight, not at an angle.
- Do not pull on the cable and avoid sharp bends at cable entry.
- When using a bulkhead connector, ensure that there are no angular loads.
- Do not over-tighten the bulkhead nuts.
- SubConn connectors should not be exposed to extended periods of heat or direct sunlight. If a connector becomes very dry, it should be soaked in fresh water before use.

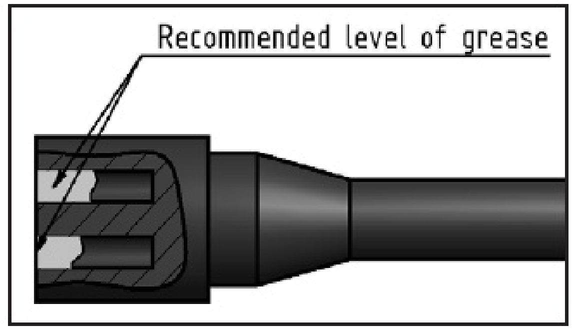
Greasing and mating above water (dry mate)



- Connectors must be greased with Molykote 44 Medium before every mating.
- A layer of grease corresponding to minimum 1/10 of socket depth should be applied to the female connector.
- The inner edge of all sockets should be completely covered, and a thin transparent layer of grease left visible on the face of the connector.
- After greasing, fully mate the male and female connectors in order to secure optimal distribution of grease on pins and in sockets.
- To confirm that grease has been sufficiently applied, unmate and check for grease on every male pin. Then re-mate the connectors.

Greasing and mating under water (wet mate)





- Connectors must be greased with Molykote 44 Medium before every mating.
- A layer of grease corresponding to approximately **1/3** of socket depth should be applied to the female connector.
- All sockets should be completely sealed, and transparent layer of grease left visible on the face of the connector.
- After greasing, fully mate the male and female connectors and remove any excess grease from the connector joint.

Cleaning

- General cleaning and removal of any accumulated sand or mud on a connector should be performed using spray contact cleaner (isopropyl alcohol).
- New grease must be applied again prior to mating.

Use of Loctite

- Always use Loctite 5910 to lock non-metallic (Peek) connectors.
- For locking metallic connectors, the use of Loctite 243 is recommended.

Also see http://macartney.com/support for videos of these processes.

5.9.2 Glenair Flange-mount Connectors

Suggested Glenair Geo-Marine® Handling Procedures

This procedure details the installation and maintenance requirements for square flange-mount connectors.

220-02 and 220-12 Square Flange-Mount

The procedure for the assembly and installation must be performed by personnel properly familiarized with the product and requirements. When in operation and in the fully-mated condition, no maintenance is required. For initial assembly and for any subsequent maintenance, Glenair recommends the following.

A. Before initial mating, visually inspect O-rings for any foreign contaminates, damage, or abnormalities. Verify installation of the O-rings and that they are properly lubricated as recommended in Glenair's Geo-Marine® Connector Catalog.

B. For maintenance, and before unmating of plug connector/cable assembly from the receptacle, ensure connectors are free of damage, any foreign contaminates, or abnormalities.

1. After unmating, visually check connector's contacts, O-ring and inter-facial seal (pin identifier) and note any damage or abnormalities.

2. Remove any grease, moisture or foreign particles from inside connector, contacts, O-ring and seals. Caution should be used to avoid damaging the O-ring's sealing surfaces. Do not use liquid cleaners as they may become entrapped, inhibiting the proper sealing function.

3. In the event the internal contact surfaces are contaminated or have been exposed to water, the receptacle connector should be flushed with distilled or deionized water and thoroughly dried.

4. The surface should be dried using a low-pressure (15-25psi) gas stream of dry nitrogen or filtered compressed air.

5. Electrically test the connector/cable assembly in accordance with the parameters of the connector and the system.

6. Apply a very thin film of appropriate silicone lubricant to O-ring prior to installation.

Note: *Replacement or spare O-rings, peripheral seals and inter-facial seals are available for each connector size. Consult the Geo-Marine catalog or the factory for information.*

7. To reassemble, properly align master key of plug connector/cable assembly to that of the receptacle, partially hand engage, and torque to recommended value as noted in Geo-Marine catalog.

5.9.3 Eye-splicing Instructions

The following instructions are from Samson Rope, the manufacturer of the rope used in the Tow Rope and the Cross Cable.

For more information, contact:

www.samsonrope.com
CustServ@SamsonRope.com
+1-360-384-4669

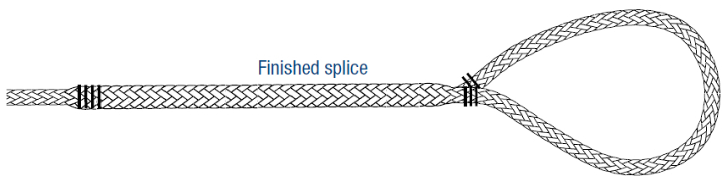
SAMSON SPLICING INSTRUCTIONS

12-Strand Class II Eye Splice

Class II ropes are made in whole or part from any of the following high modulus fibers: Dyneema®, Vectran®, Technora®, and Zylon®.

The eye splice is used to place a permanent loop in the end of a rope, generally for attachment purposes to a fixed point. An eye is also used to form the rope around a thimble, which is used to protect the rope, especially when it is to be attached to a shackle, chain, or wire rope.

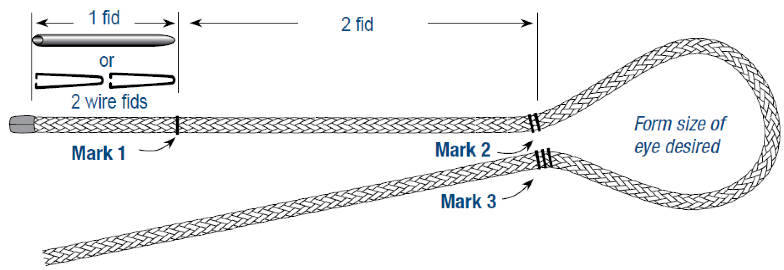
This eye splice may be performed on new or used rope. This is an all-purpose splice technique designed for people who generally splice used rope as frequently as new rope. By following the procedure below, the splice can retain from 90% to 100% of average new rope strength and in used rope up to the same proportion of residual used rope strength.



STEP 1 MEASURING

Tape end of line to be spliced and measure 1 tubular fid length (or 2 wire fid lengths) from taped end of line and make Mark 1.

From Mark 1 measure 2 tubular fid lengths (or 4 wire fid lengths) and make Mark 2. Now form size of eye desired and make Mark 3.

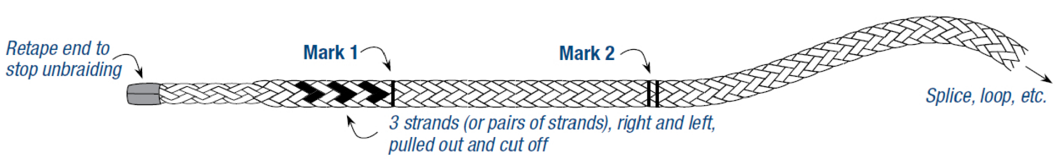


STEP 2 MAKING TAPER

From Mark 1, in the direction of the taped end of the line, mark every second right and left strand* for 3 strands.** Pull every marked strand out of line and cut (tape at end can cause resistance and may have to be removed in order to pull out cut strands.) Tapered end will now have only 6 strands remaining (or 4 strands for an 8-strand braid.) Tape tapered tail tightly to keep from unbraiding.

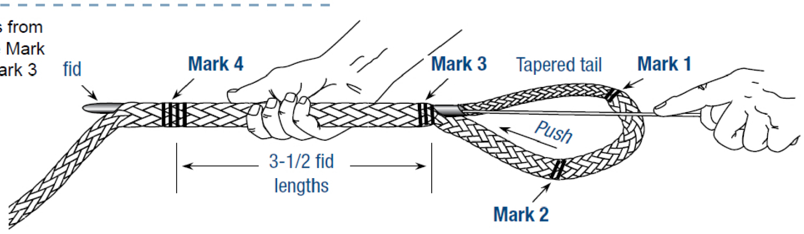
**Some rope diameters may have pairs of strands in right and left direction. In this case, treat the pairs of strands as a single strand, marking and cutting both in each direction as described above.*

***Some very small diameter ropes may be 8-strand. For an 8-strand construction, mark every 3rd left and right strand for 2 strands.*



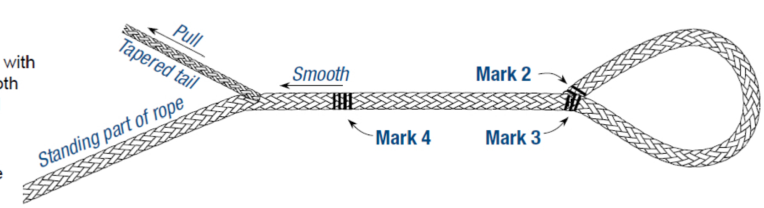
STEP 3 BURYING TAIL INTO STANDING PART OF LINE

Measure 3-1/2 tubular fid lengths from Mark 3 (7 wire fid lengths), make Mark 4. Insert fid and tapered tail at Mark 3 and bring fid out beyond Mark 4. Pull fid and tapered tail out. Do not let the line twist.



STEP 4 FINISHING BURYING

Remove fid. Pull hard on tapered tail with one hand. With the other hand, smooth bunched line towards eye splice until Marks 2 and 3 converge.



4A Remove the fid and any tape at the end of the tail. From the end of the tail, mark 3 consecutive strands, as shown. Pull them out of the

5.9.4 In-line Splicing Instructions

The following instructions are from Samson Rope, the manufacturer of the rope used in the Tow Rope and the Cross Cable.

For more information, contact:

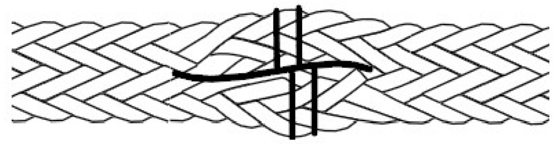
www.samsonrope.com
CustServ@SamsonRope.com
+1-360-384-4669

SAMSON SPLICING INSTRUCTIONS

12-Strand Class II End-for-End Splice Modified for Dirty, Used Rope

Class II ropes are made in whole or part from high modulus fibers: Dyneema®, Vectran®, Technora®, and Zylon®.

This splicing procedure is specifically for used, dirty ropes that require repair or re-splicing. By following the procedure below, the spliced rope can retain from 90% to 100% of the residual strength of the used rope strength.



Finished splice

STEP 1 SOAKING USED ROPE

Fill a large bucket with clean, warm water. Place the area of the rope that will be spliced in the bucket to soak.

STEP 2 CLEANING USED ROPE

Starting at one end of the rope, grab the rope and "birdcage" the rope while underwater. This means that you will slack and milk the rope while in the bucket to clean out the interior section of the rope.

2A As the water may be dirty after the first round of cleaning, you may need to dump the water out and start with a fresh bucket of water. Continue to refresh water and wash until the rope appears clean.

STEP 3 SQUEEGEEING WATER FROM ROPE

Using your hand or another small piece of rope, squeegee out as much water from the wet rope as you can.

SAMSON SPLICING INSTRUCTIONS

12-Strand Class II End-for-End Splice Modified for Dirty, Used Rope

STEP 4 MEASURING AND MARKING

Rope A

5.10 Electronics

Components that have electronics in them are as follows.

- Deck Unit
  - Deck Unit Board Stacks
  - Ethernet Board
  - DSP Board
  - Analog Board
  - RS-485 Depth Board
  - COAX Modem
- Digitizer
  - Ethernet Board
  - DSP Board
  - Analog Board
- Junction Box
  - Ethernet Switch
  - Compass
  - Depth Sensor
- Tail Module
  - Tail Compass Boards
  - Compass
  - Depth Sensor
- Repeater
  - Repeater Board Stack
  - Repeater with Depth/Compass Boards
  - Repeater with Tension Gauge
- Signal Cable
  - COAX Modem

5.10.1 Analog Board

The Analog Board is equipped with eight analog-to-digital converters and their associated preamplifiers. The Analog Board is responsible for the data acquisition of the hydrophone Streamer that it is attached to. After the data is acquired it is passed along to the DSP Board for processing.

Technical information can be found at: Digitizer Technical Data.

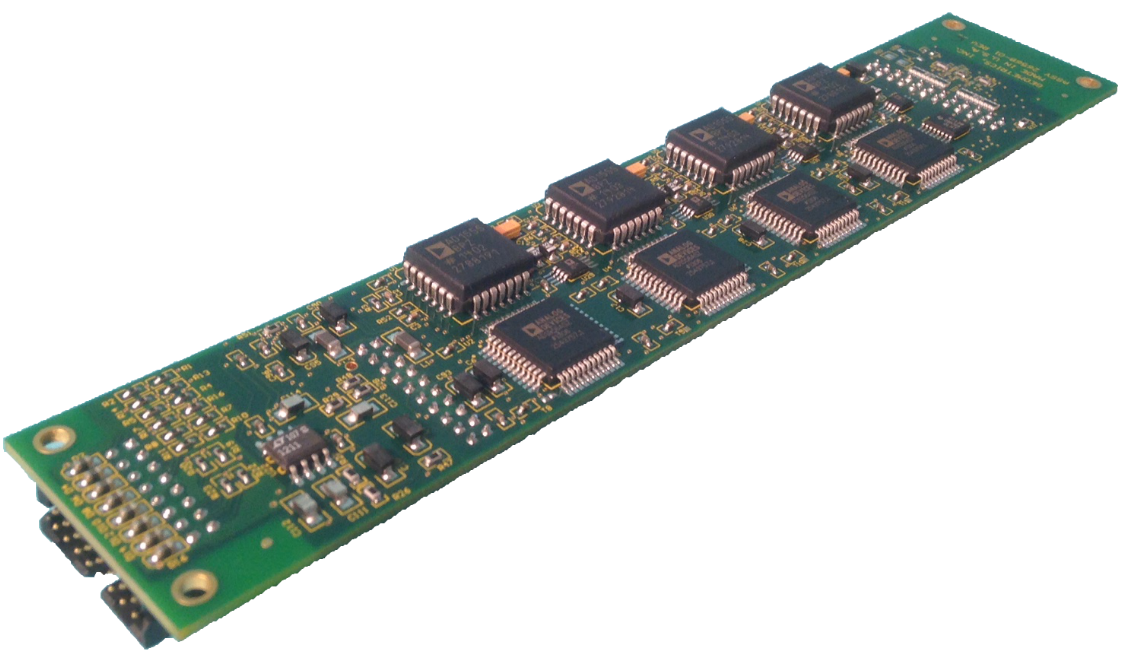


Figure A146: Analog Board.

5.10.2 Ethernet Board

The Ethernet Board is used in several locations in the GeoEel System:

- Deck Unit (2 or 3 Locations)
- Digitizers
- Repeaters

The Ethernet Board provides the interface for communication to the computer and GeoEel Controller software. Each board has the ability to change IP addresses based upon where it is located in the system. The IP addresses allow the GeoEel Controller to know where each component is located topologically and thus record data location properly. The Ethernet Board also contains the circuitry for the trigger, which tells the Analog Board and DSP Board when to record data. After the data is recorded the Ethernet Board packages the information and transmits it back to the GeoEel Controller via the Deck Unit.

Ethernet Board IP Addresses

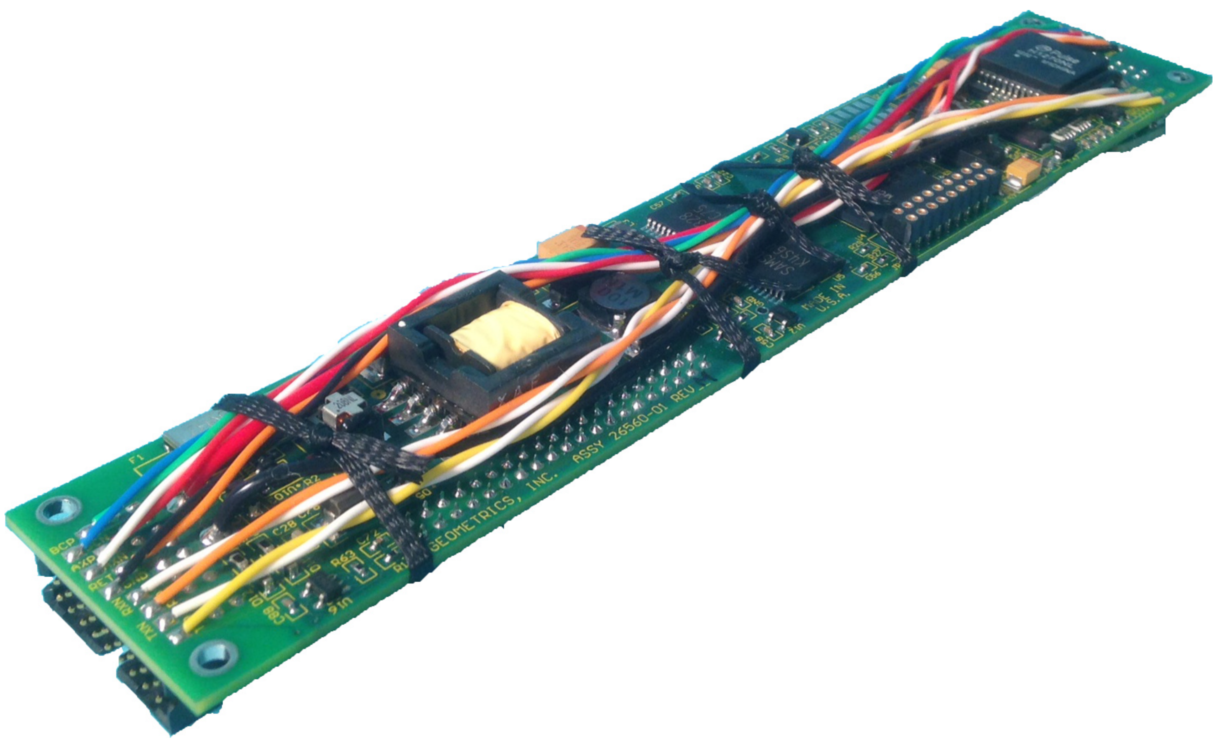


Figure A147: Ethernet Board.

5.10.3 DSP Board

The Digital Signal Processing (DSP) Board is responsible for processing the signal that is received from the Analog Board, buffering that signal, then passing the data to the Ethernet Board, where it is packaged and transmitted to the GeoEel Controller.

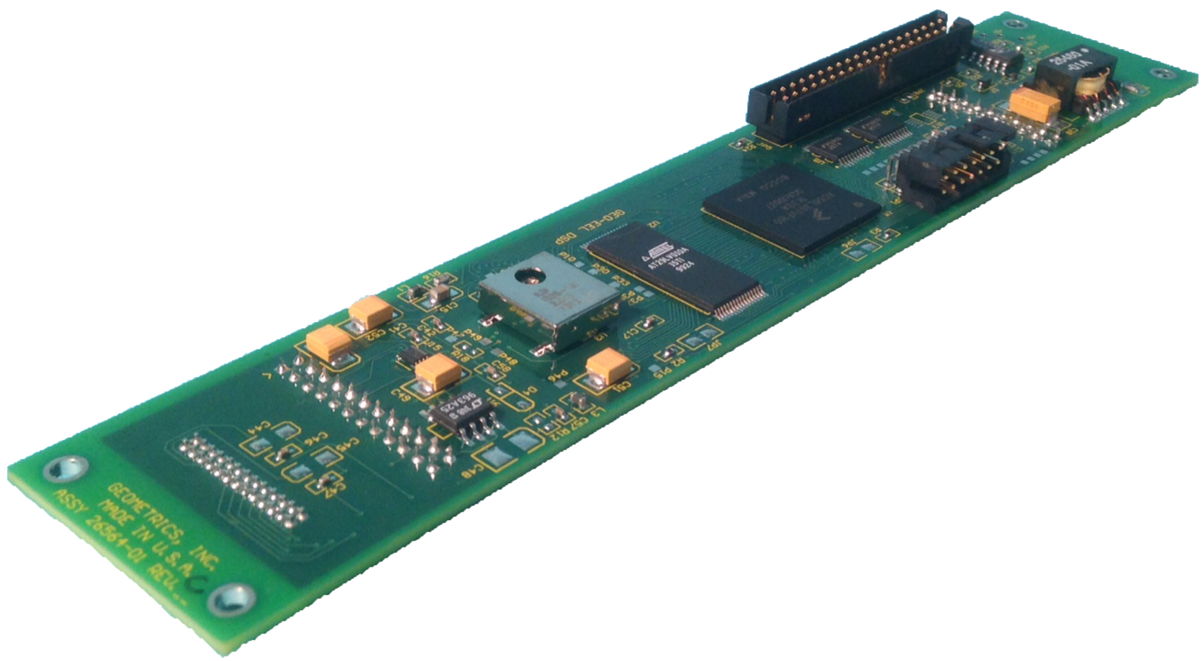


Figure A148: DSP board.

5.10.4 Deck Unit Board Stack

There are three board stacks that make up most Deck Units. They include the Main Deck Unit Board Stack, the AUX Channels Board Stack, and the optional Depth Board Stack. Each board set and its functions are described below.

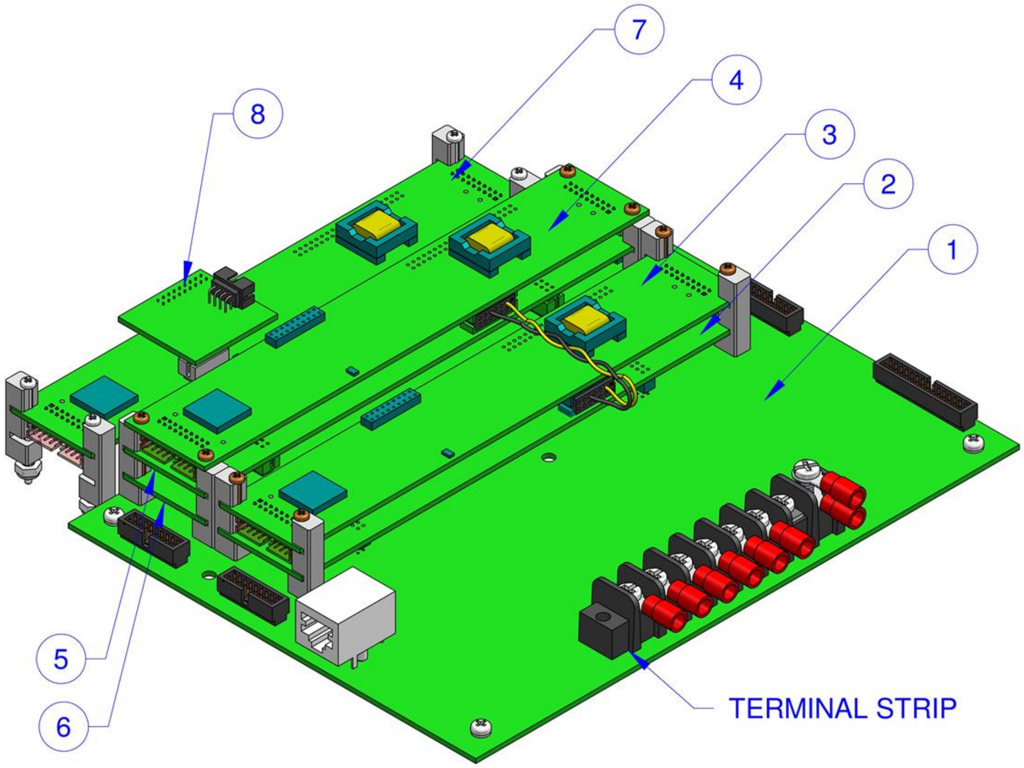


Figure A149: Annotated rendering of Deck Unit Board Stack.

Main Deck Unit Board Stack

1. Deck Unit Motherboard

The Motherboard contains the leakage circuit. The leakage circuit inside helps identify when there is water intrusion in the GeoEel or P-Cable system. The leakage number is displayed on the front panel of the Deck Unit and can range from -700 to 1300. For more technical information on Leakage visit the Troubleshooting section.

2. DSP Board

The Deck Unit DSP Board is the brains of the Deck Unit. It generates the signals such as the internal Trigger and Reset commands. The DSP Board parses commands for the trigger source, trigger timing, etc. and sends those commands to the rest of the system.

3. Ethernet Board

The Ethernet Board that is part of the Main Deck Unit Board Stack is set to a fixed IP address of 192.168.1.2. The Deck Unit Ethernet Board serves as the translator between the DSP board and the Ethernet communications. It is the board that is responsible for the communication between the GeoEel Controller and the AUX Channels Ethernet Board.

AUX Channels Board Stack

4. Ethernet Board

The Ethernet Board that is part of the AUX Channel Board Stack is set to a fixed IP address of 192.168.1.253. It is the board that is responsible for communications between the Ethernet board on the Deck Unit Mother Board and the Ethernet Board on the Depth Board Set (if installed) and the rest of the GeoEel System.

5. DSP Board

The AUX Channels DSP Board is responsible for processing the signal that is received from the Analog Board on the AUX channels installed inside the Deck Unit. It buffers the signal, then passes the data to the Ethernet Board, where it is packaged and transmitted to the Marine Controller. The DSP on the AUX Channels board is unique in that it doesn't have an internal clock and is thus slaved to the Deck Unit DSP. *Due to this uniqueness it cannot be easily swapped with other DSP boards in the GeoEel System.*

6. Analog Board

The Analog Board portion of the AUX channels is exactly the same as an Analog Board that is contained in the Digitizers.

Depth Board Stack

7. Ethernet Board

The Ethernet Board that is part of the Depth Board Stack is set to a fixed IP address of 192.168.1.251. It is the board that is responsible for communications between the AUX Channels and the COAX Modem (if installed) and the rest of the GeoEel System.

8. RS-485 Board

The RS-485 Depth Board is used to communicate with the Ethernet switches in the Junction Boxes.

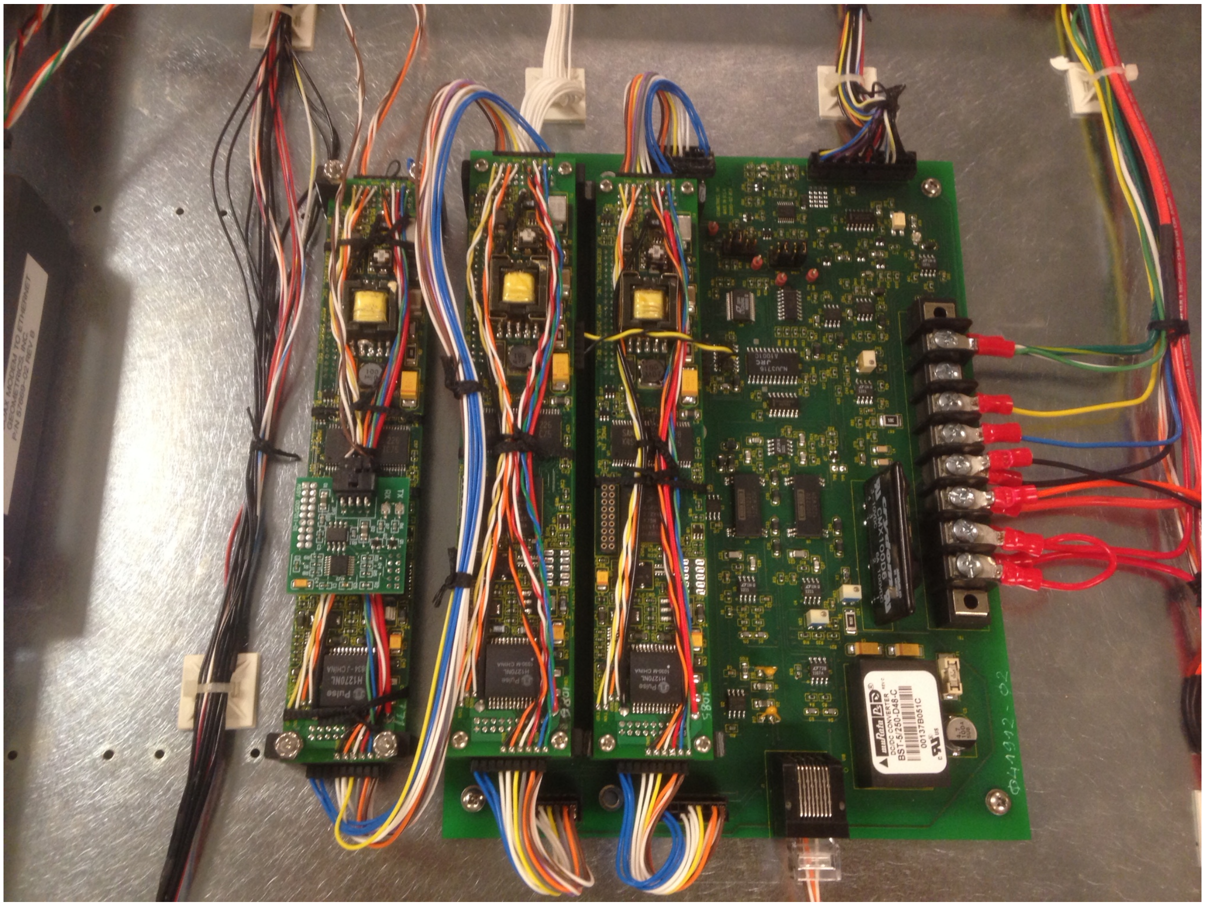


Figure A150: Deck Unit Board Stack.
Boards from left to right: Depth (optional), AUX Channels, DSP/Ethernet, Motherboard.

5.10.5 Repeater Board Stack

The Repeater board re-transmits the Ethernet signal for up to an extra 100M, and can be found in In-line Repeater modules, Right-Angle Repeater modules, In-line Depth modules, and Tension Gauge modules. Repeater boards without the Depth or Tension Gauge options do not have an IP address, and are invisible to the GeoEel Controller. Repeaters that include these features have an IP Address and can be communicated with through TCP/IP commands. Repeaters are typically used only in 2D GeoEel configurations.

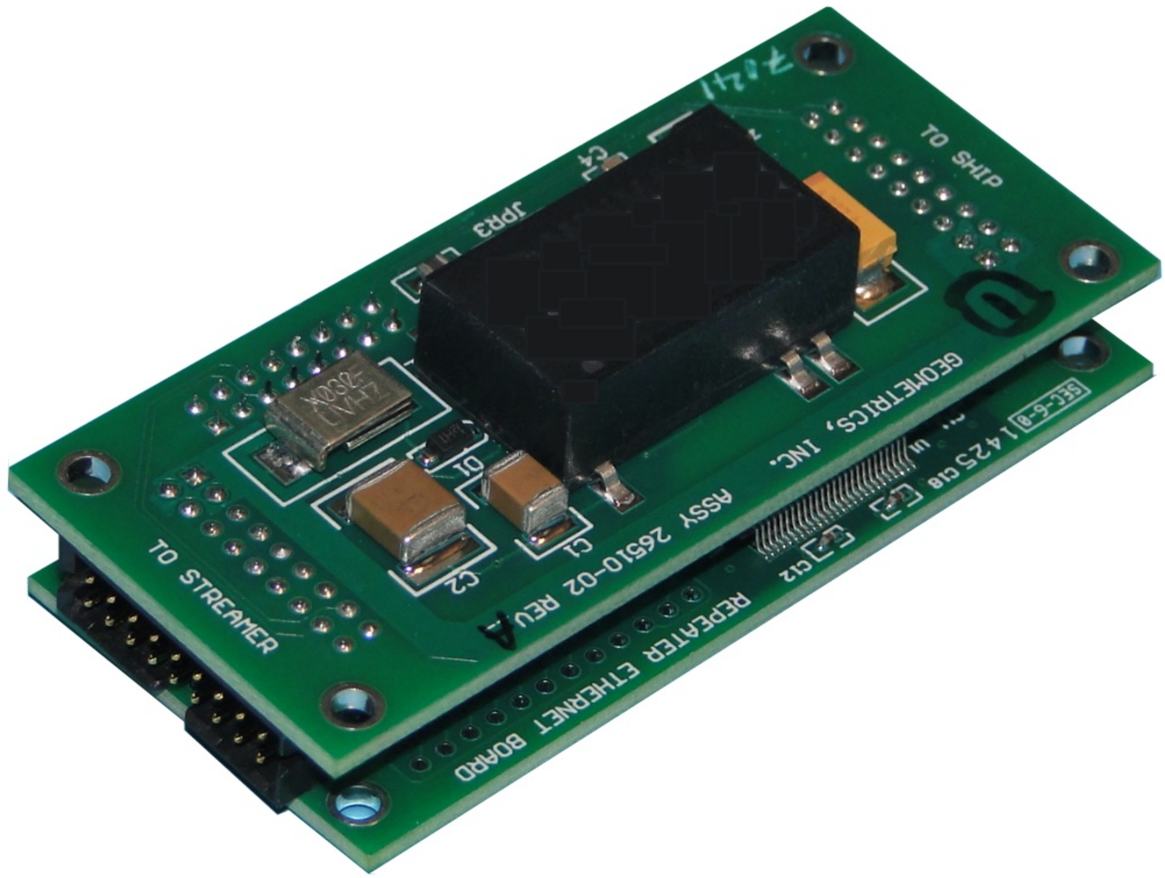


Figure A151: Repeater Board Stack.

5.10.6 Digitizer Board Stack

The Digitizer electronics set is comprised of an Ethernet Board, a Digital Signal Processing (DSP) Board, and an Analog-to-Digital Converter Board. These boards are stacked together as seen below in both the Digitizer module and in the Deck Unit.

Performance information can be found at Digitizer Technical Data.

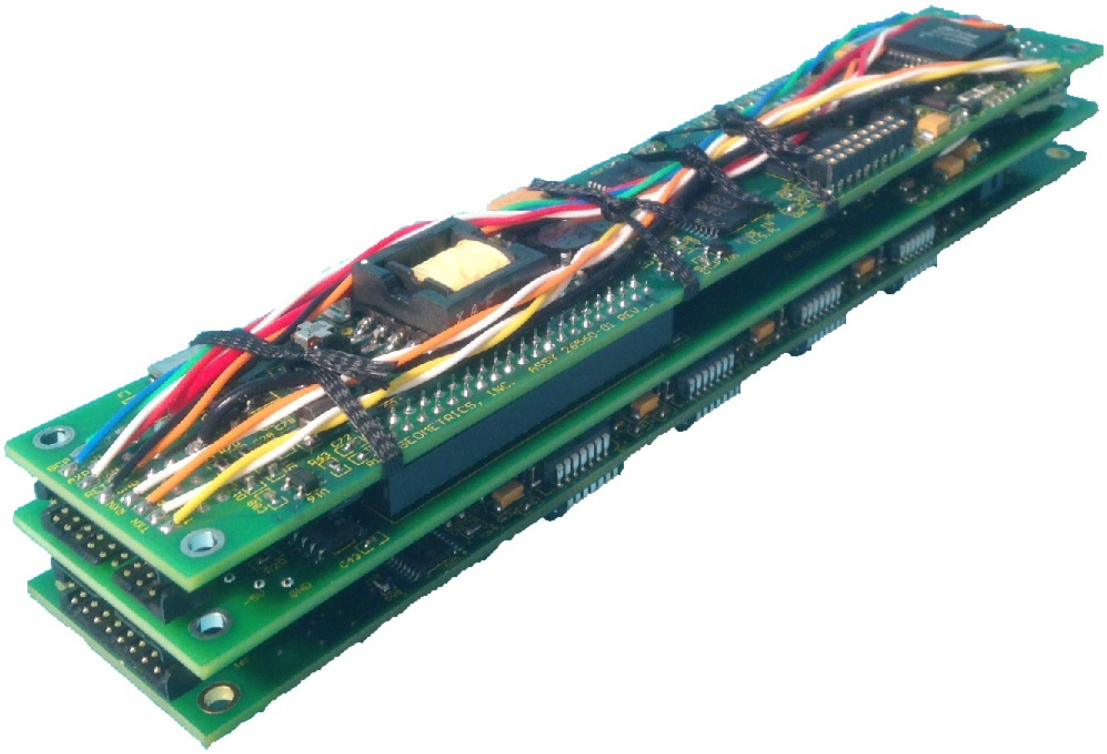


Figure A152: Digitizer Board Stack. Top: Ethenet. Middle: DSP. Bottom: Digitizer.

5.10.7 Depth/Compass Board Stack

Three boards combine to make up the Depth/Compass Board Set:

- Depth/Compass Board
- Lantronix Board
- I/F Board

Depth/Compass Board

The Depth/Compass Board provides the serial interface to both the Digital Compass and the Depth Sensors.

Lantronix Board

The Lantronix, WiPort NR, Serial to Ethernet Server embedded in the module provides a connection between the Ethernet and two serial data channels The Heading Sensor uses Channel 1 and the Pressure Sensor uses Channel 2. A specific sensor is selected using its unique address and port number. The Lantronix board allows for different settings on the two serial sensors at the same time configured on the same network. The IP address of the Lantronix board is typically based upon the serial # of the unit. If the IP address is unknown the GeoEel Tester can be used to determine the address.

I/F Board

The I/F Board is the interface board that transmits the Ethernet signal from the Lantronix Board. It acts as a Repeater an can transmit a signal up to 100M.

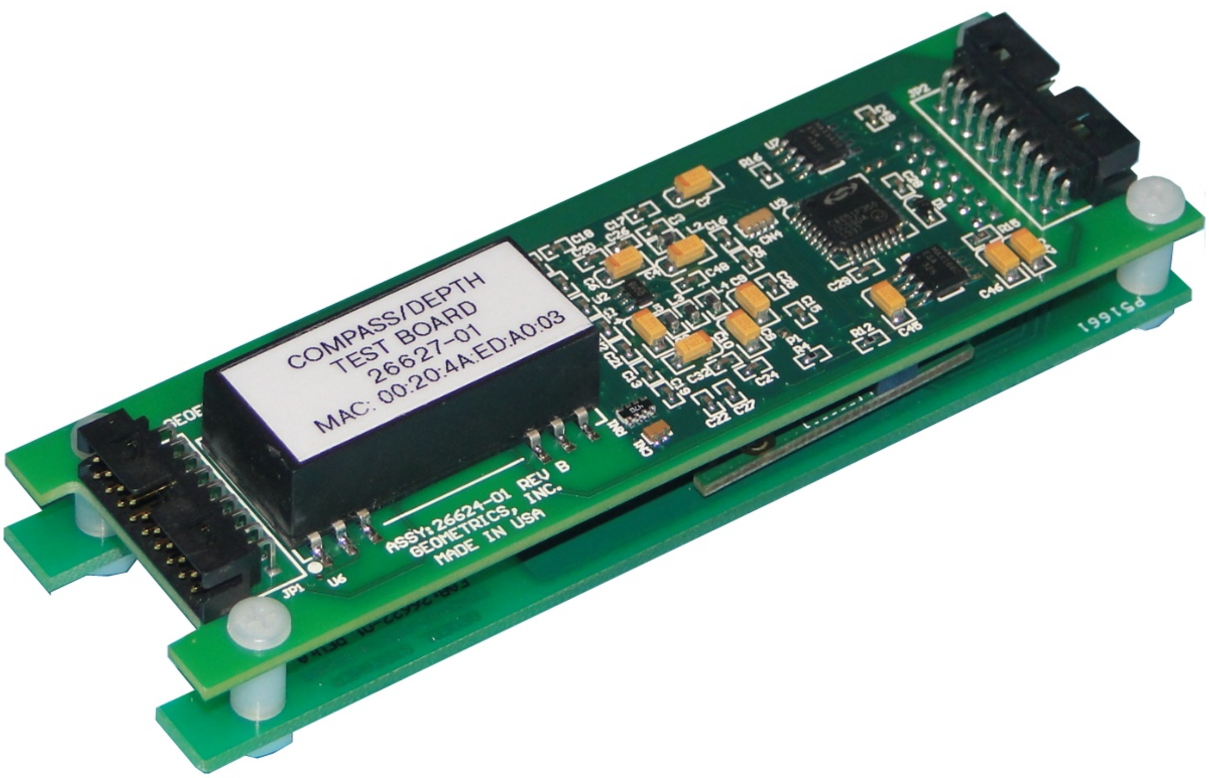


Figure A153: Depth/Compass Board Stack.

5.10.8 Ethernet Switch

The 5-Port Cross Cable Ethernet Switch is designed to be installed inside each Cross Cable Junction Box.

The latest version of the switch includes:

- 5-Port Configurable Ethernet Switch.
- Depth Sensor.
- Digital Compass heading sensor (optional).
- A voltage sensor.
- Solid state relays to monitor the 60V power bus voltage and control the power supplied to the attached Digitizer, and the downstream Junction Boxes.
- Trigger and Ethernet control.

The heading sensor, pressure sensor and voltage sensor communicate using an embedded Ethernet server while the Ethernet switch communicates over an RS-485 serial bus with an Ethernet-to-serial server in the Deck Unit.

Each Ethernet switch has a unique IP address which is assigned according to the serial number of the Junction Box of the unit. That unique serial number must be input into the GeoEel Controller to properly perform a Reset/Detect, Power Control and/or Ethernet Control functions.

IP addresses can be determined using the GeoEel Tester program or the Lantronix Device Installer program. It is important to ensure that the network interface card is configured properly to communicate with the information that is transmitted over the Ethernet.

Serial #	IP Address
6000-6099	No IP address (earliest systems)
6100-6250	192.168.1.XXX (where XXX is SN-6000) (no power control)
7100-7250	192.168.3. XXX (where XXX is SN-7100) (with power control)

Table A10: Junction Box IP addresses.

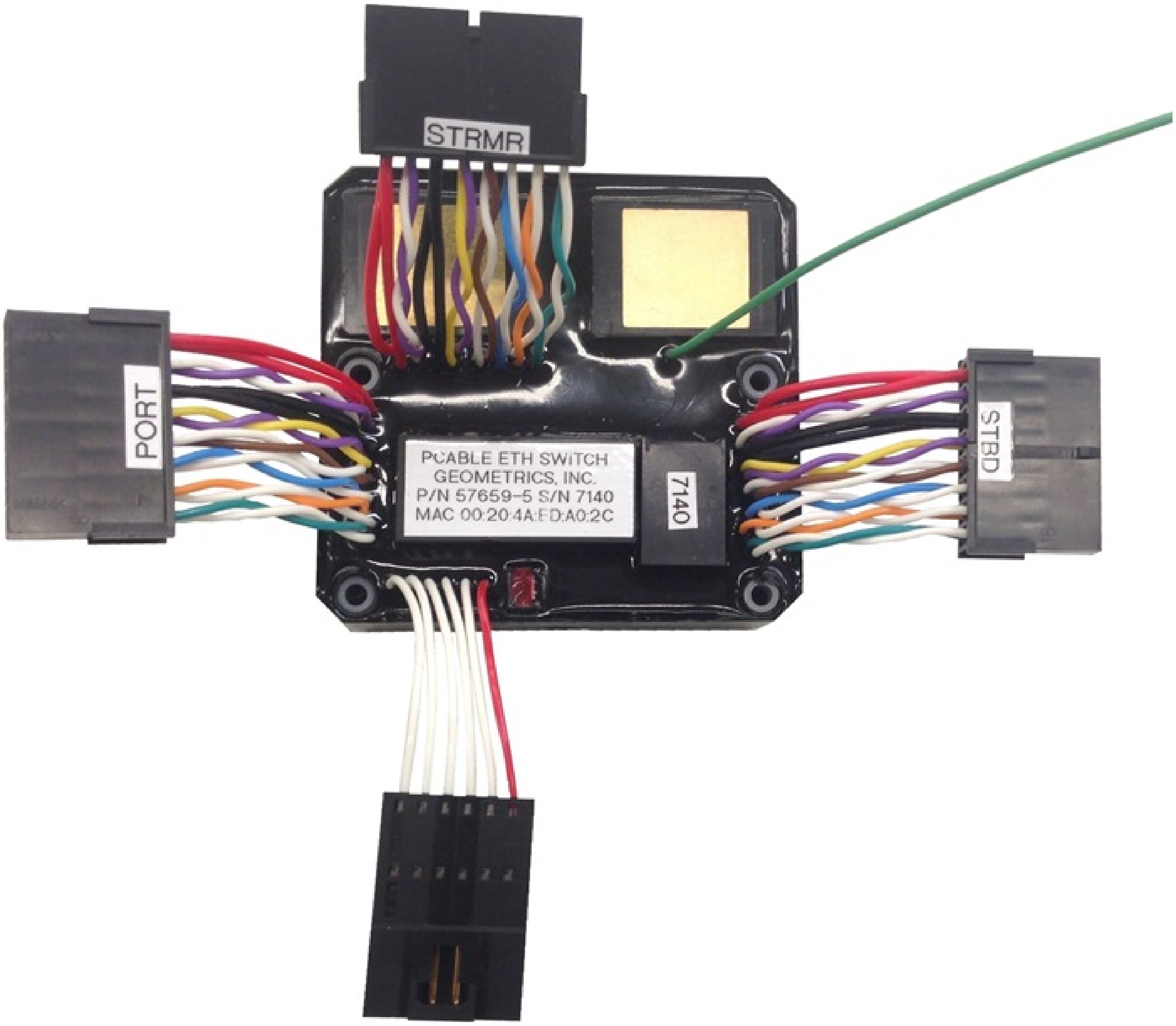


Figure A154: Five-port Ethernet Switch with power control capabilities.

5.10.9 Coax Modem

The communications pair in the Signal and P-Cable Deck Cables are COAXial cable rather than CAT5. This allows the Signal Cable to be up to 600m long without the need of a Repeater. A COAX modem in the wet-end of the Signal Cable, along with a second modem in the P-Cable Deck Unit, convert between standard Ethernet and Ethernet-over-COAX. The COAX modem includes one COAX connection and two Ethernet ports. All three connections inside the Deck Unit are used, while only two (one COAX, one Ethernet) are used in the Signal Cable.

The communication speed of the COAX modems can be tested using the TRENDnet Powerline

Utility.

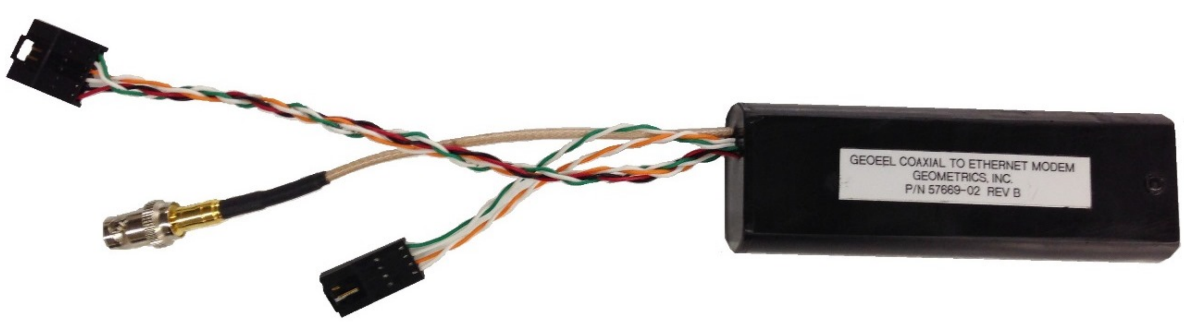


Figure A155: Coax/Ethernet Modem.

Wiring Diagram

5.10.10 Depth Sensor

A 100 psi depth sensor is used throughout both the 2D and 3D GeoEel configurations. Units with depth sensors include:

- Tail Depth/Compass modules
- P-Cable Junction Boxes
- In-line Repeater modules (optional)
- Tension Gauge (optional)

The depth sensor sends pressure data via TCP/IP which is converted to depth and displayed by the CNT-2 GeoEel Controller. Communication is via Channel 2 of the Lantronix Ethernet Server.

The Depth Sensor offset can be reset using the Configuration dialog in the GeoEel Controller. This is also where the Depth Sensor serial numbers are entered in the Controller software.

Note: *Only advanced users should change the communication protocol of the Depth Sensors.*

Depth Sensor Technical Data

Figure A156: Depth Sensor.

5.10.11 Digital Compass

The heading sensor sends compass headings at a programmable rate via Ethernet messages. The module includes a Sparton DC-4 or GEDC-6 Digital Compass.

Figure A157: Sparton GEDC-6 Digital Compass.

Technical Specifications

5.10.12 RS485 Board

The RS-485 board (Item 8 in figure below) is stacked on top of an Ethernet Board (Item 7) to make up the Depth Option in the Deck Unit. The RS-485 board is also used to communicate with the Ethernet switches in the Junction Boxes. The commands are sent from the GeoEel Controller to the Ethernet Board (set to IP 192.168.1.251), converted to a 4800-Baud RS-485 signal, then transmitted over the AUX pair in the attached cables.

The RS-485 is essential to the Ethernet Port Control Commands which are further described in the Ethernet Port Control Section.

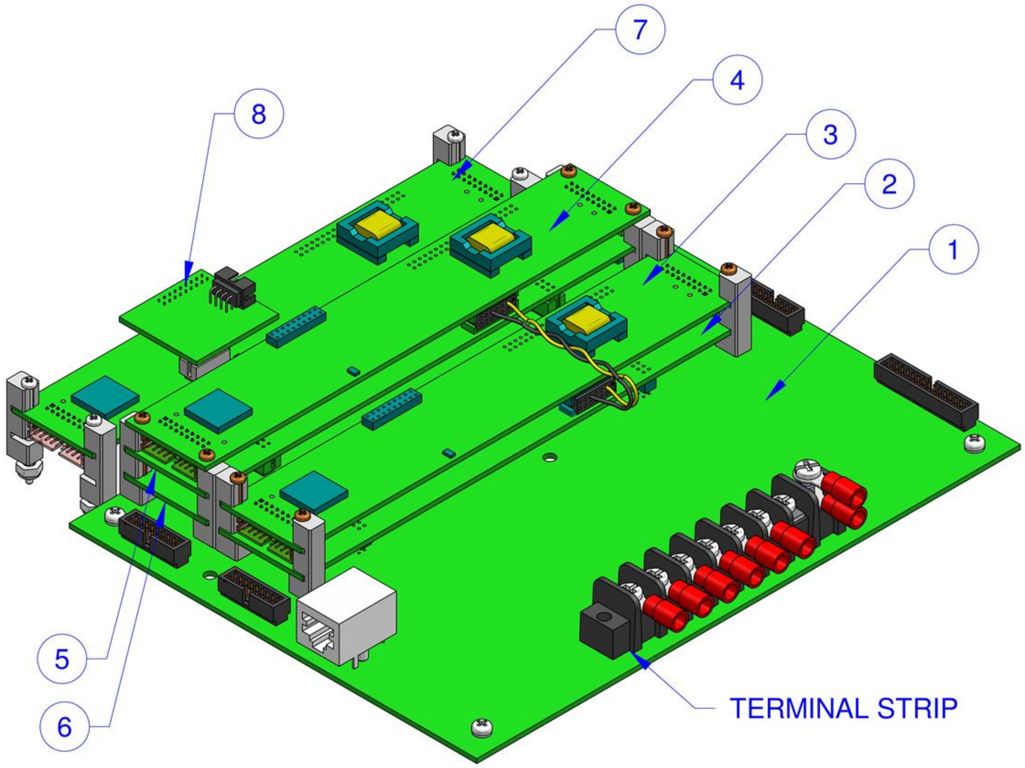


Figure A158: Deck Unit Board Stack showing Ethernet Board (7) and RS485 Depth Board (8).

5.11 Schematics and Wiring Diagrams

Note: *Several brands and styles of connectors have been used in the GeoEel and P-Cable systems during their evolutions. These include Bendix, Titan, Birns, Subconn, and Glenair. Further, there are two styles of Glenair connectors used historically on some components, "scoop-proof" and non "scoop-proof". In scoop-proof connectors (used currently), the barrel is slightly longer, making it much less likely that misalignment during connection/disconnection will result in bent pins.*

5.11.1 Deck Unit (2D and P-Cable)

A	+60V
B	+60V
E	+60V
F	+60V
C	+60V RET
D	+60V RET
G	+60V RET
H	+60V RET
J	TRG+
K	TRG-
L	AUX P
M	AUX N
N	BIRD P
P	BIRD N
R	ETH TX+
S	ETH TX-
T	ETH RX+
U	ETH RX-
X	COAX SIG
V	ANA GND
W	SIG GND

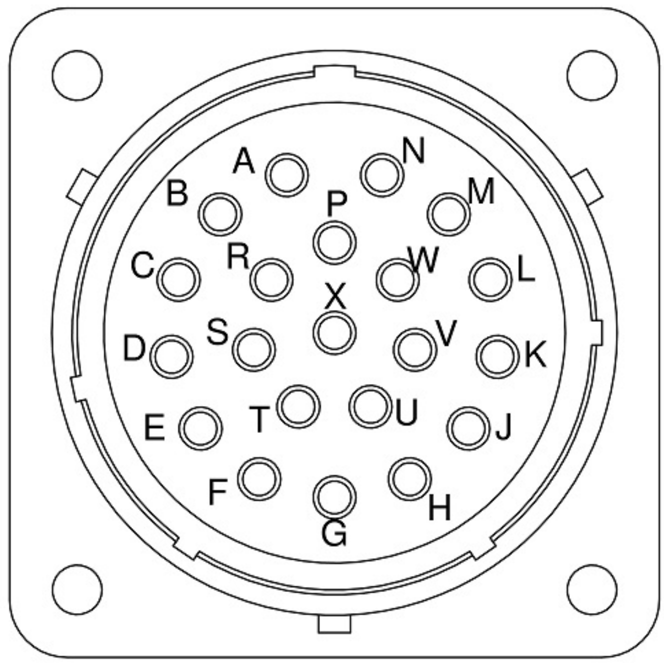


Figure A159: Deck Unit pin assignments.

5.11.2 Aux Channel Input Cable

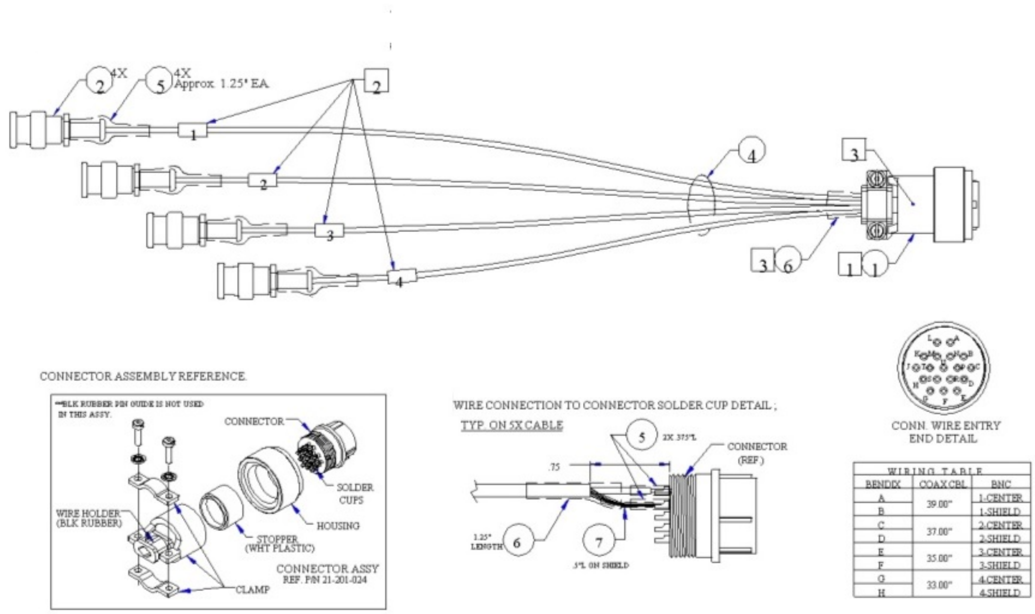


Figure A160: AUX Channel Input Cable wiring diagram (four channels).

5.11.3 Deck Cable (2D, Bendix and Scoop-proof Glenair Connectors)

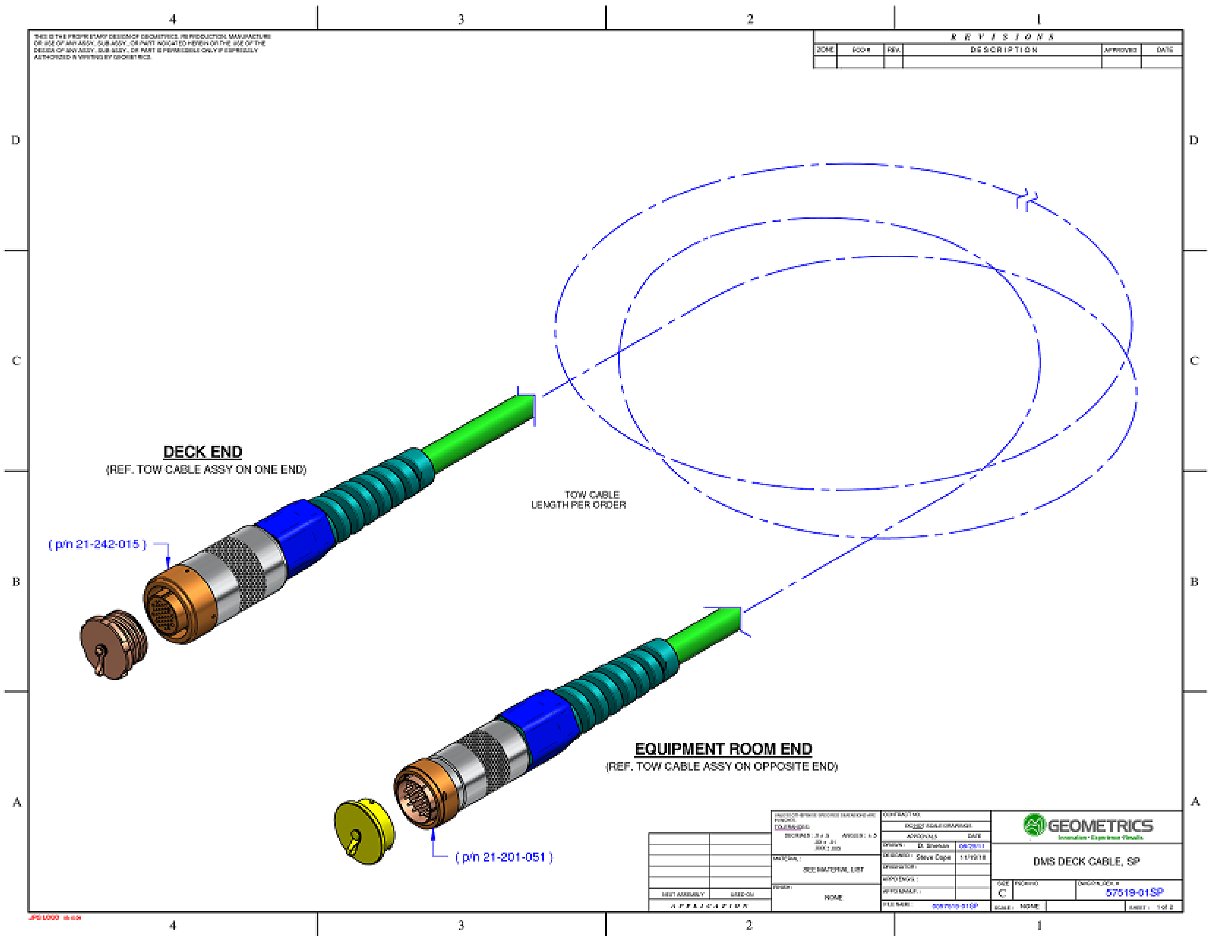
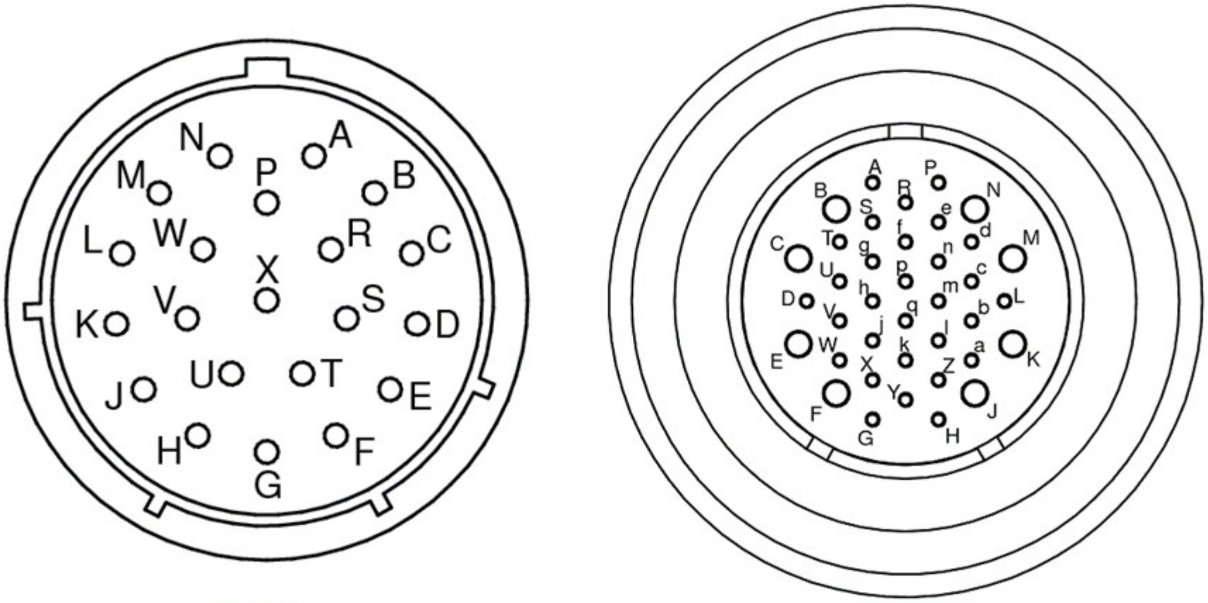


Figure A161: Schematic of 2D Deck Cable (scoop-proof).



21-201-051
Female Bendix

21-242-015
Female Glenair

Figure A162: Pin labels for Bendix (left) and Glenair (right) 2D Deck Cable connectors.

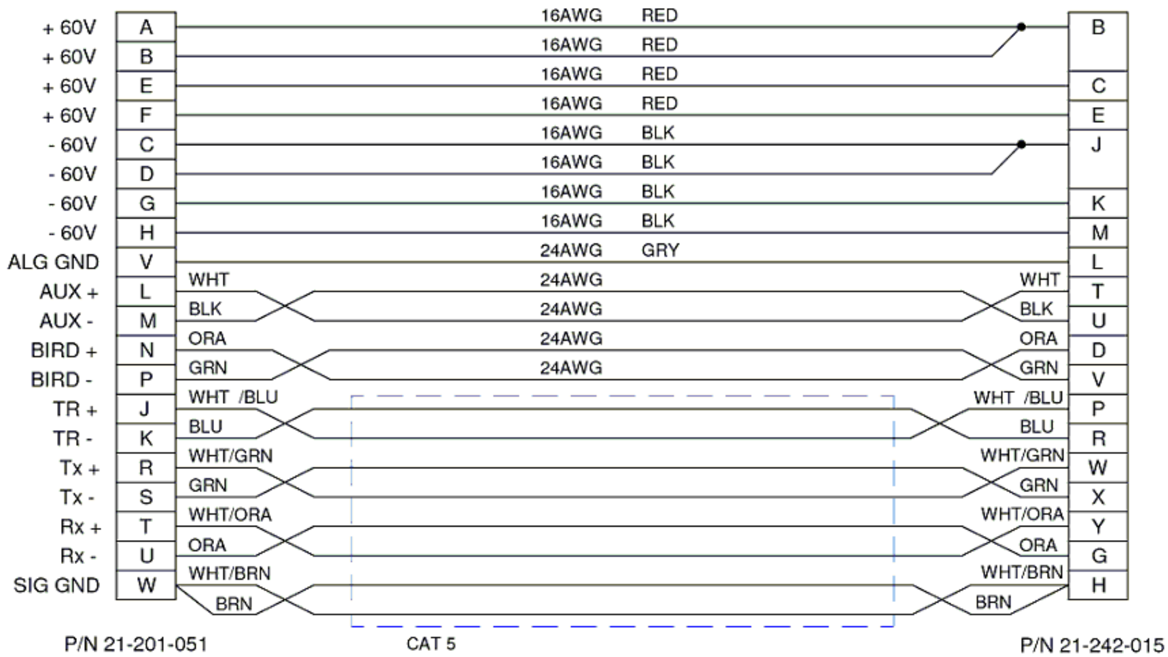


Figure A163: 2D Deck Cable wiring diagram (scoop-proof).

5.11.4 Deck Cable (2D, Bendix and Non Scoop-proof Glenair Connector)

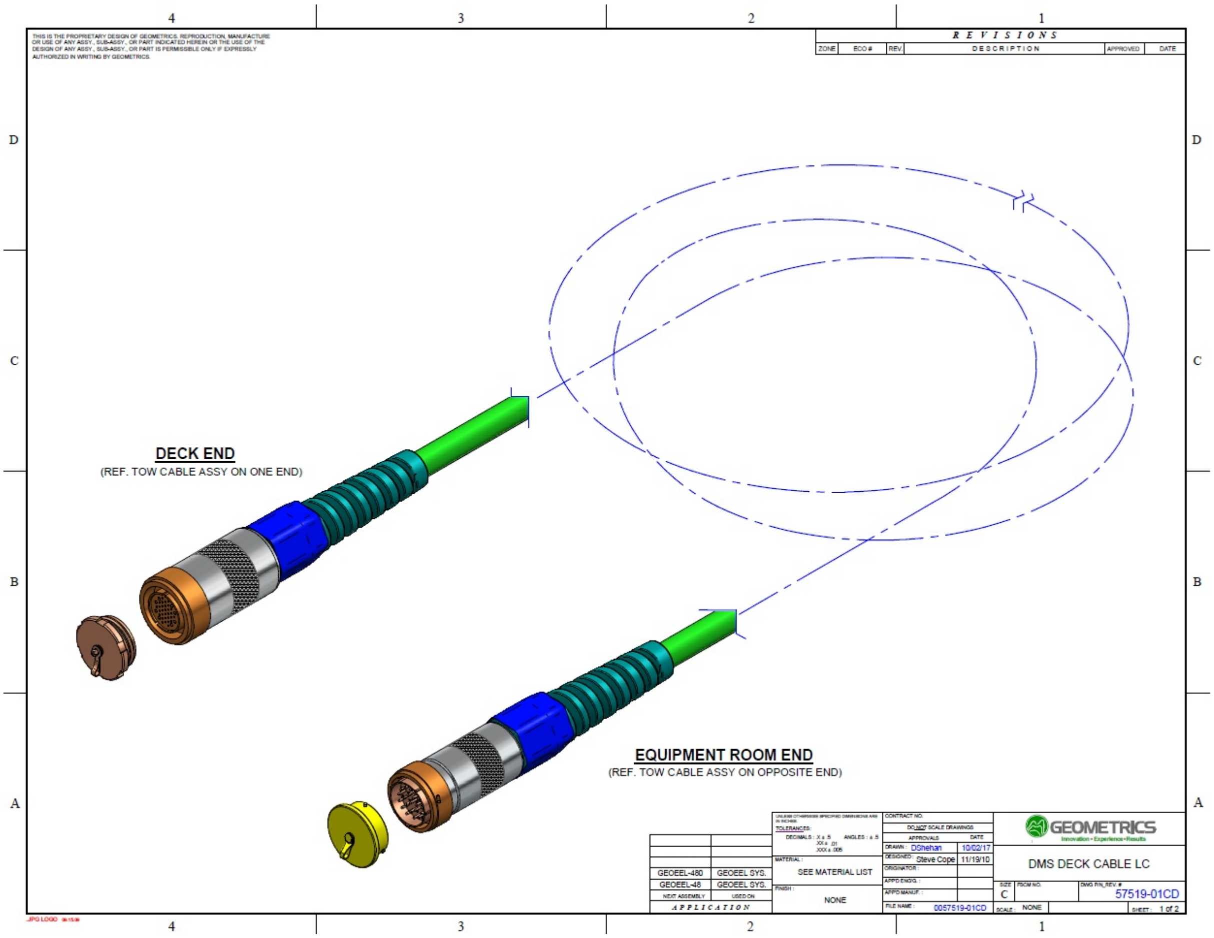


Figure A164: Schematic of 2D Deck Cable (non scoop-proof).

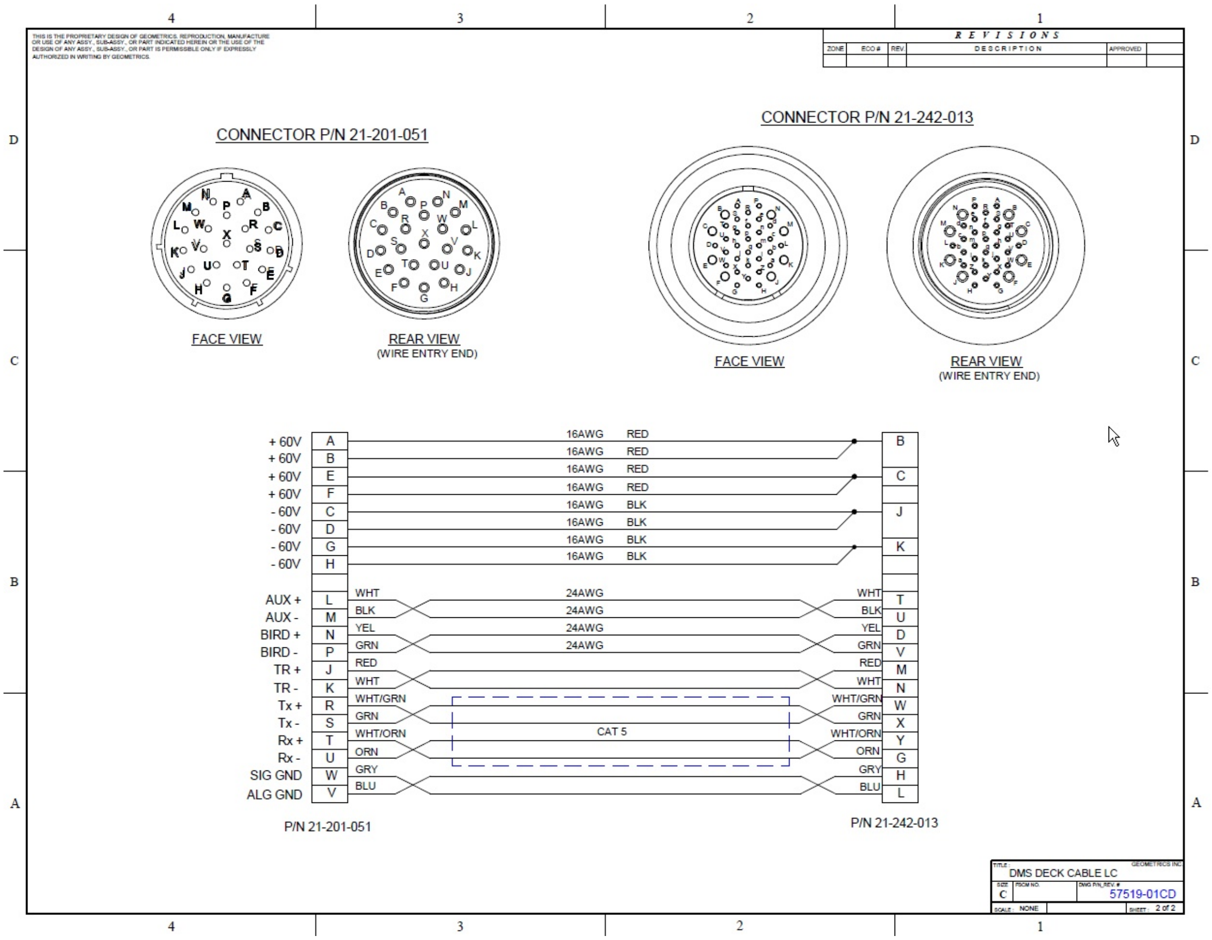


Figure A165: 2D Deck Cable wiring diagram (non scoop-proof).

5.11.5 Deck Cable (P-Cable)

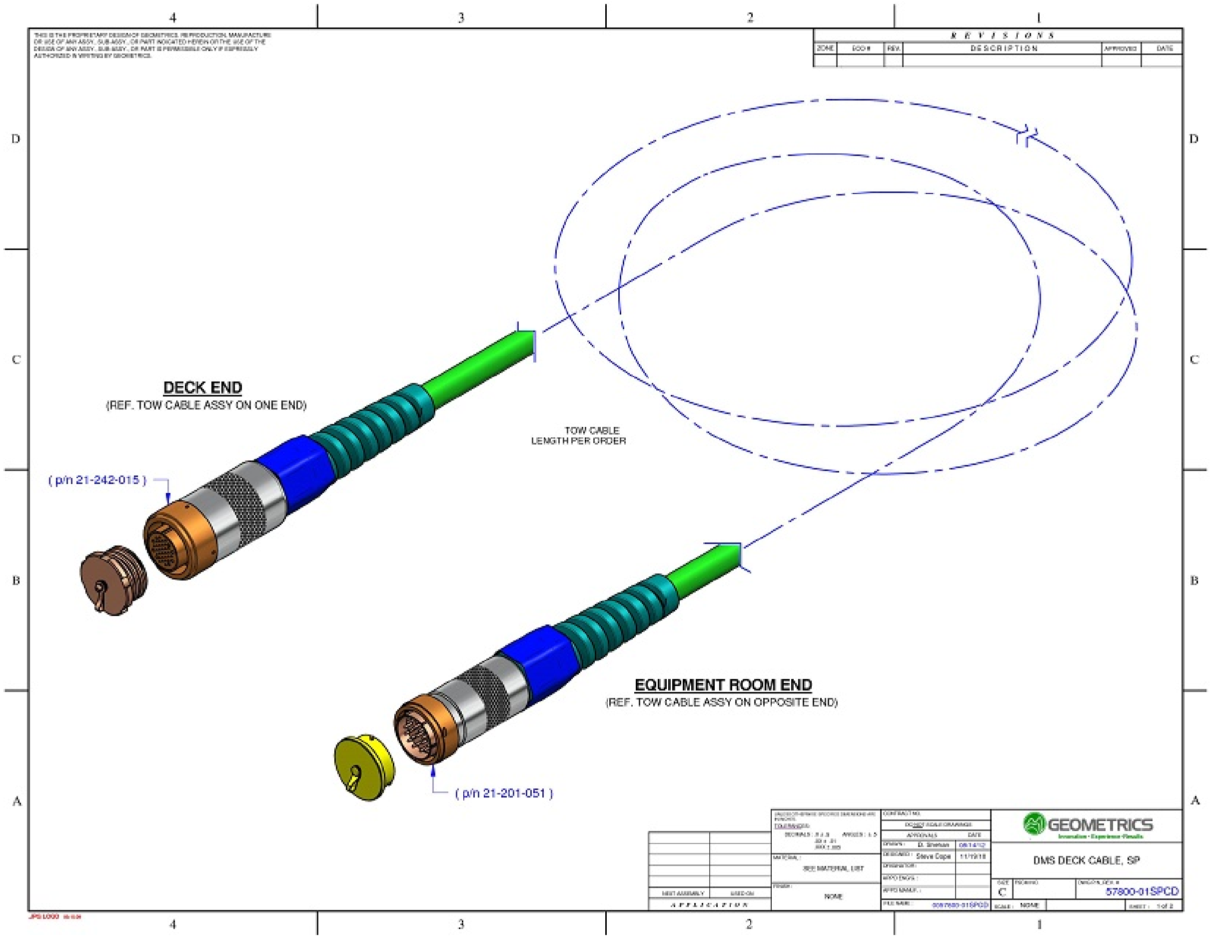


Figure A166: Schematic of P-Cable Deck Cable.

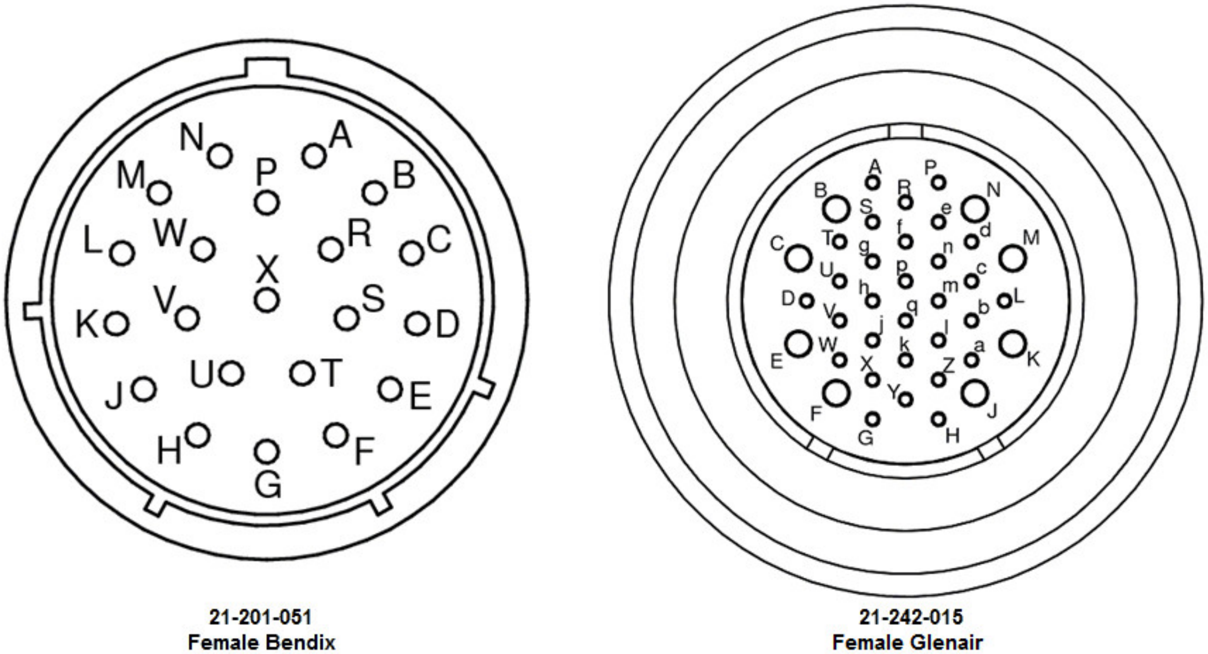


Figure A167: Pin labels for Bendix (left) and Glenair (right) 3D Deck Cable connectors.

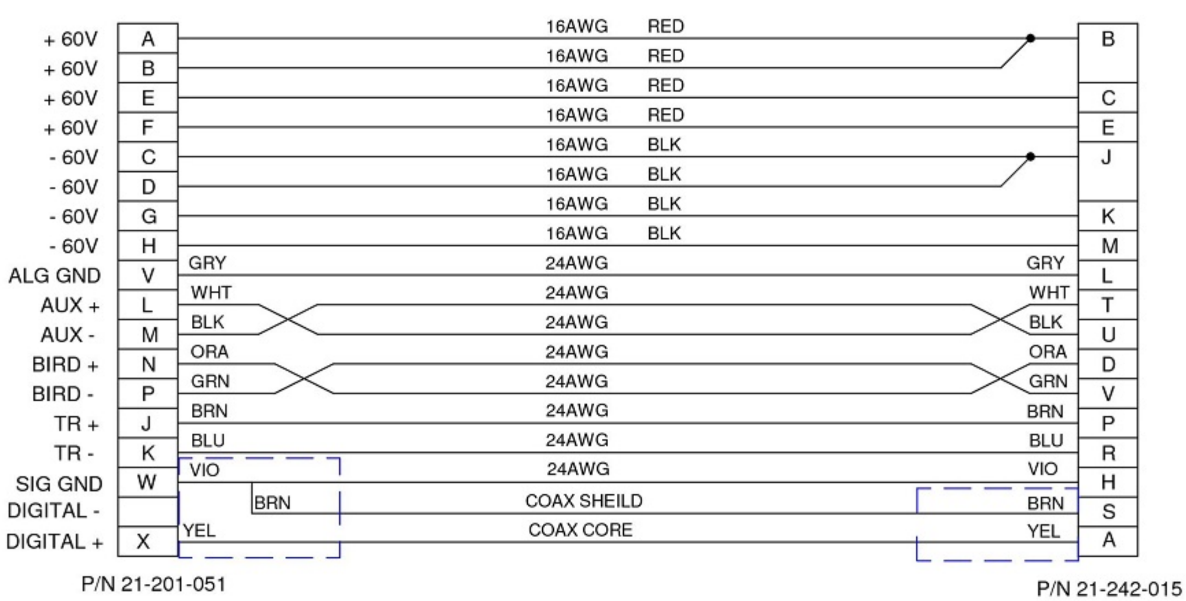


Figure A168: 3D Deck Cable wiring diagram.

5.11.6 Slip-ring (2D)

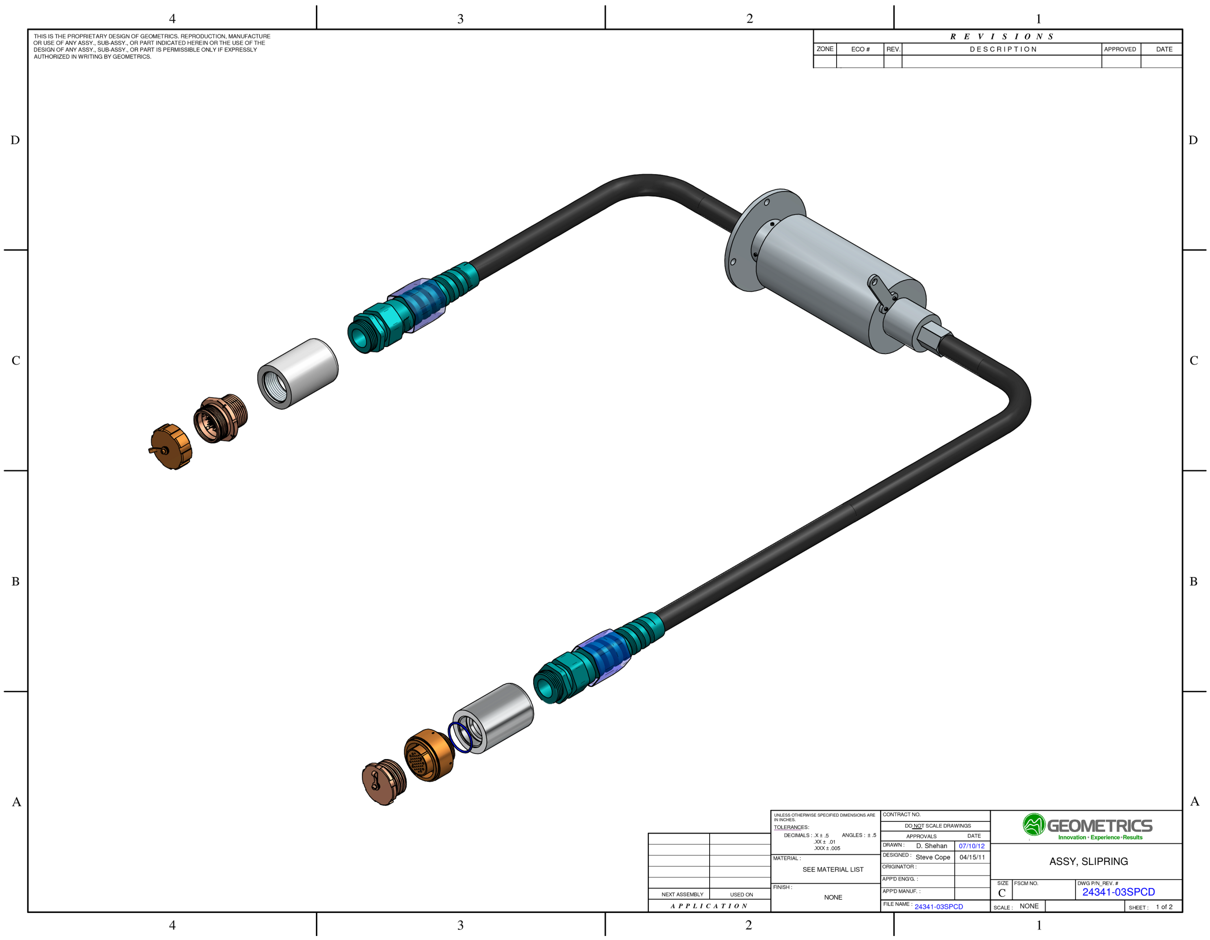
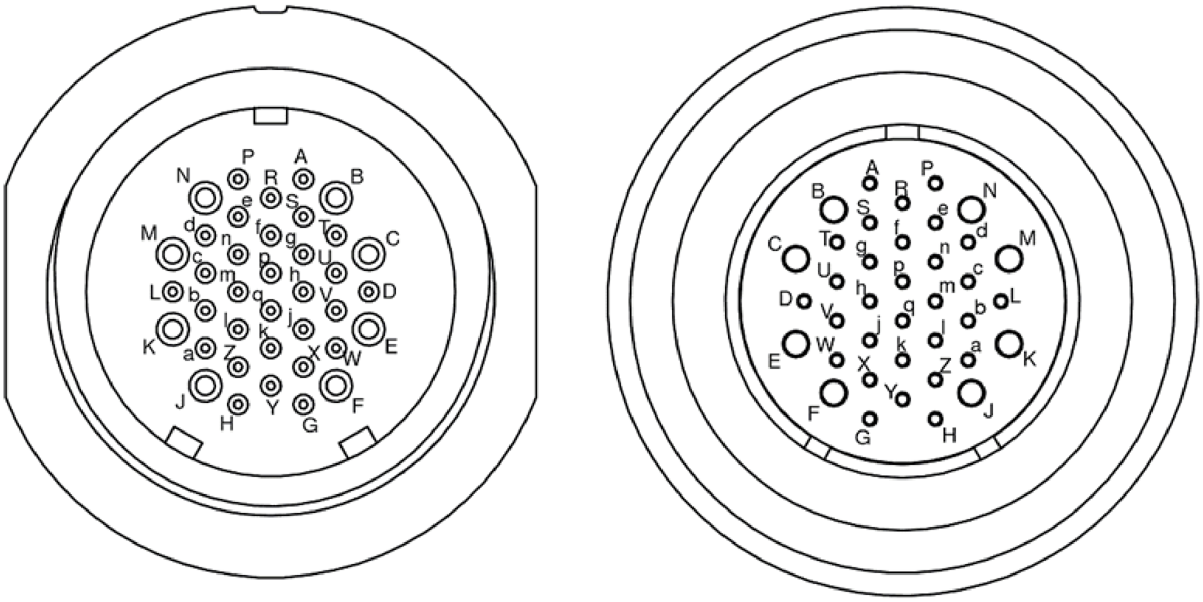


Figure A169: Schematic of 2D slip-ring.



P/N 21-242-016
Male Glenair

P/N 21-242-015
Female Glenair

Figure A170: Pin labels for male Glenair (left) and female Glenair (right) 2D slip-ring connectors.

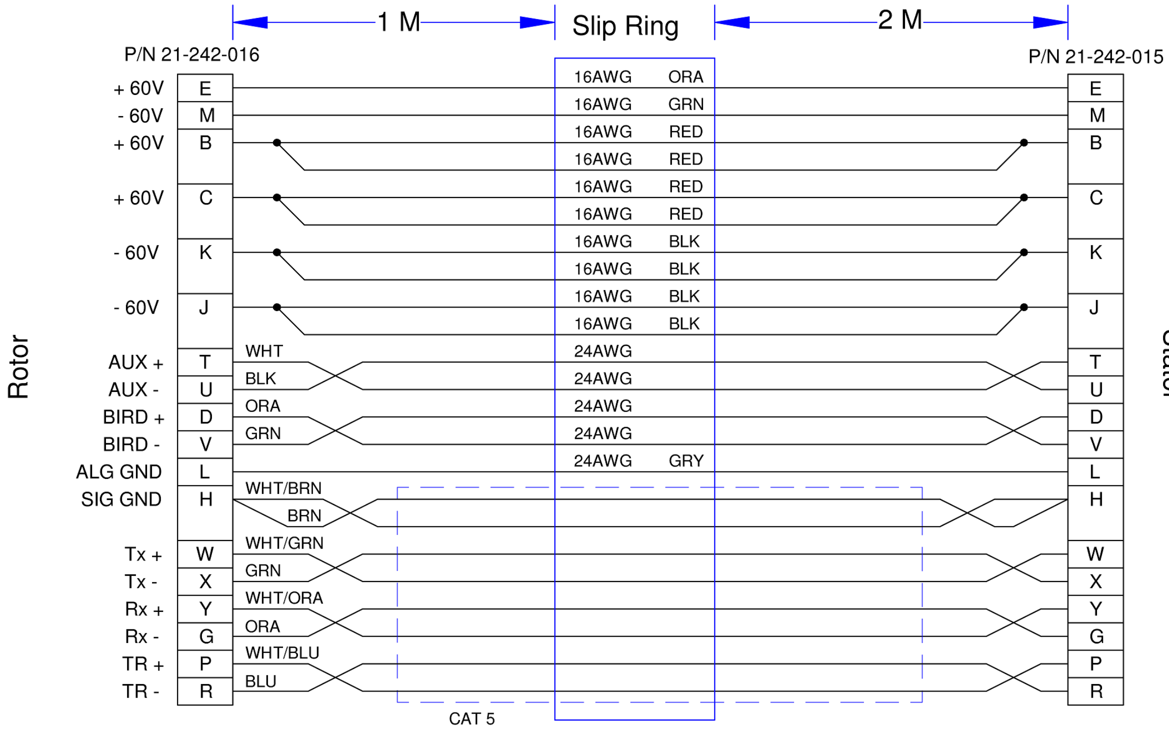


Figure A171: 2D slip-ring wiring diagram.

5.11.7 Slip-ring (P-Cable)

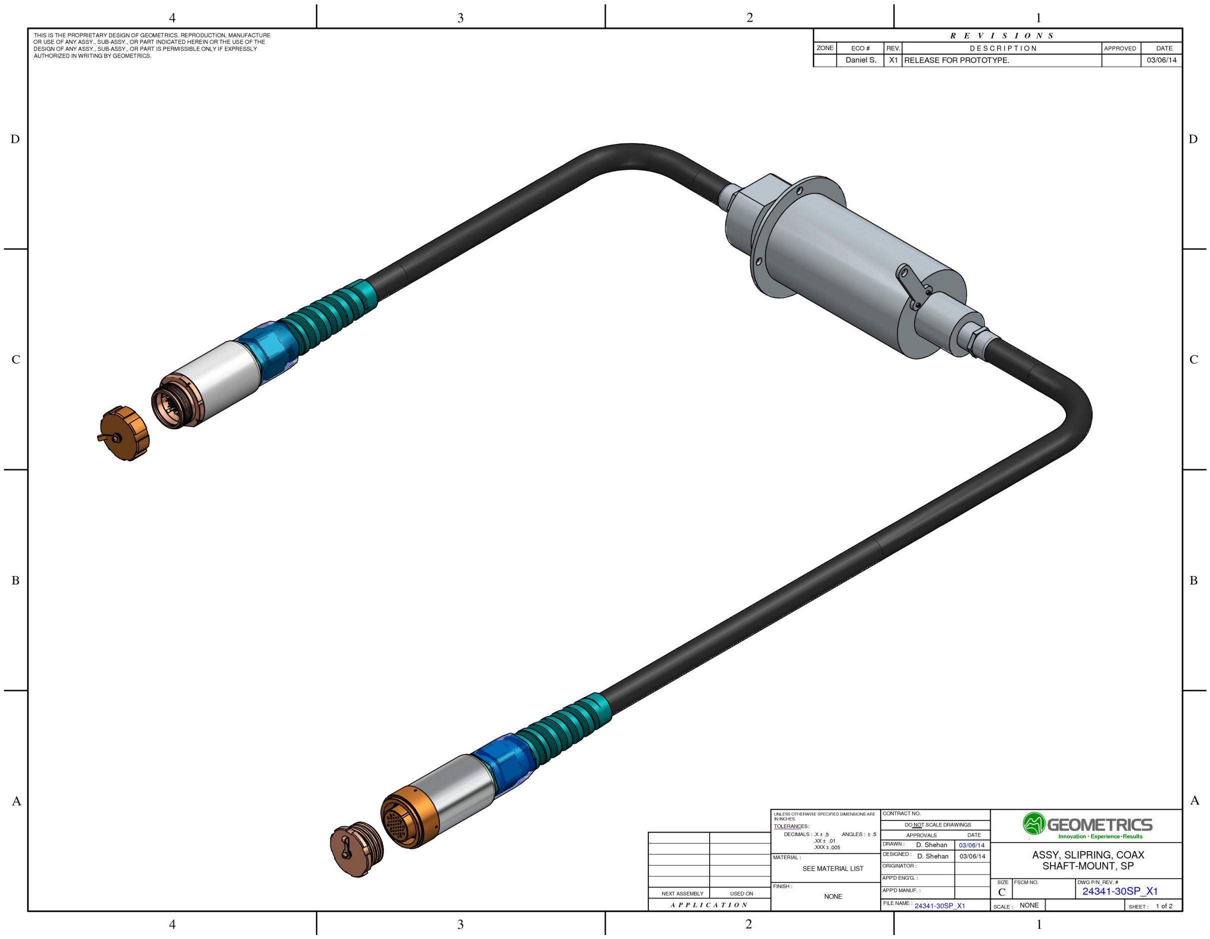


Figure A172: Schematic of P-Cable slip-ring.

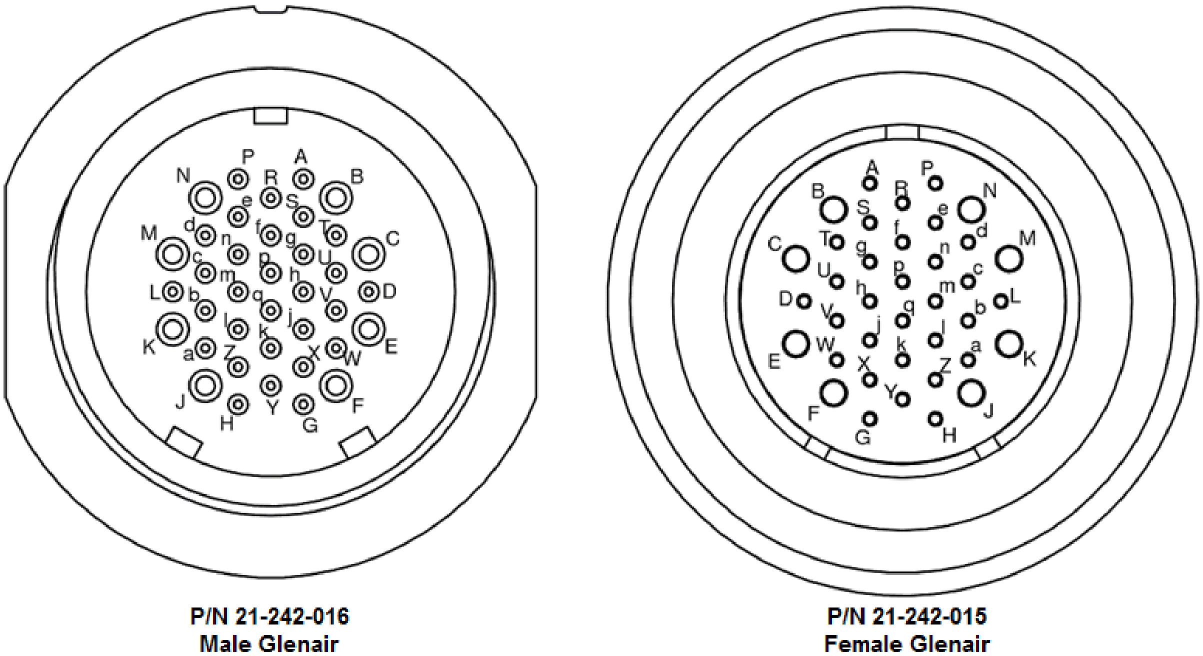


Figure A173: Pin labels for male Glenair (left) and female Glenair (right) P-Cable slip-ring connectors.

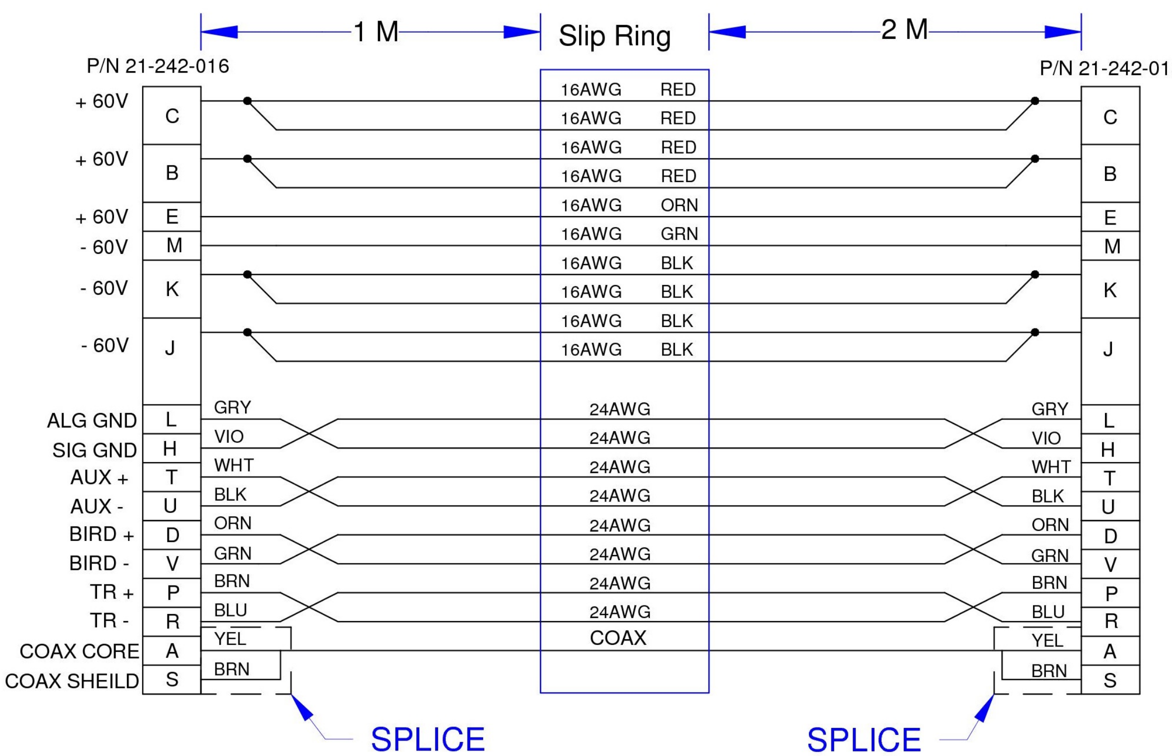


Figure A174: P-Cable slip-ring wiring diagram.

5.11.8 Coax Modem

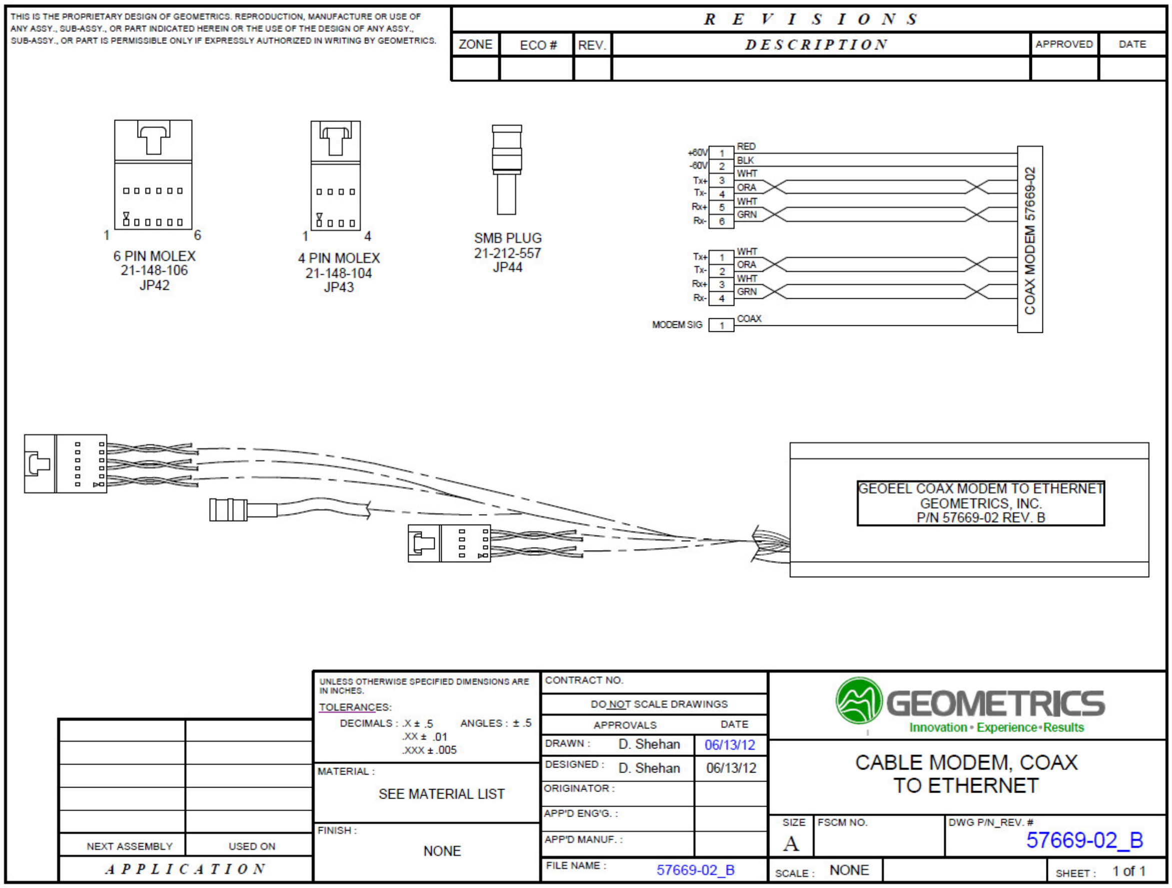


Figure A175: Wiring diagram for COAX modem.

5.11.9 Tow Cable (Scoop-proof Glenair Connectors)

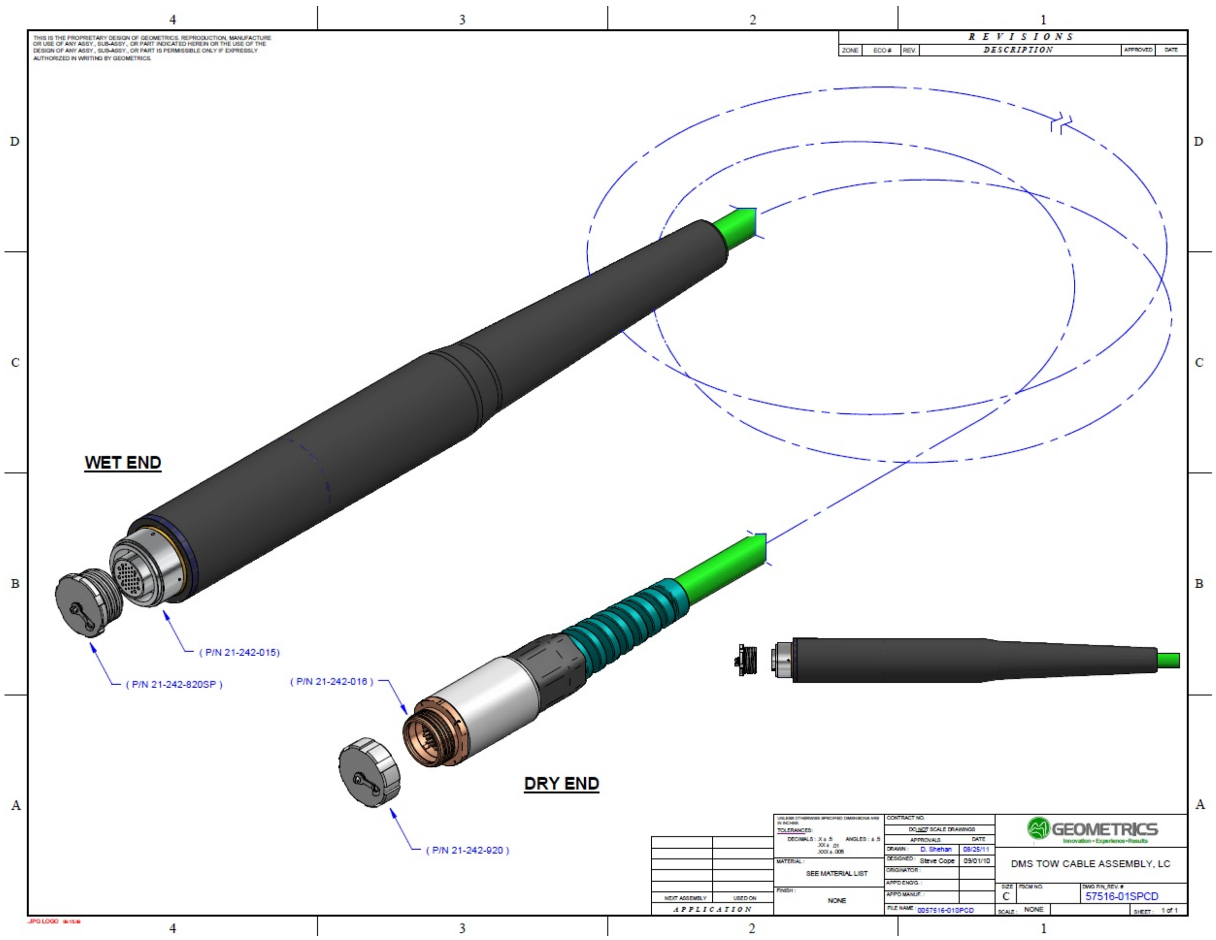


Figure A176: Tow Cable schematic (scoop-proof).

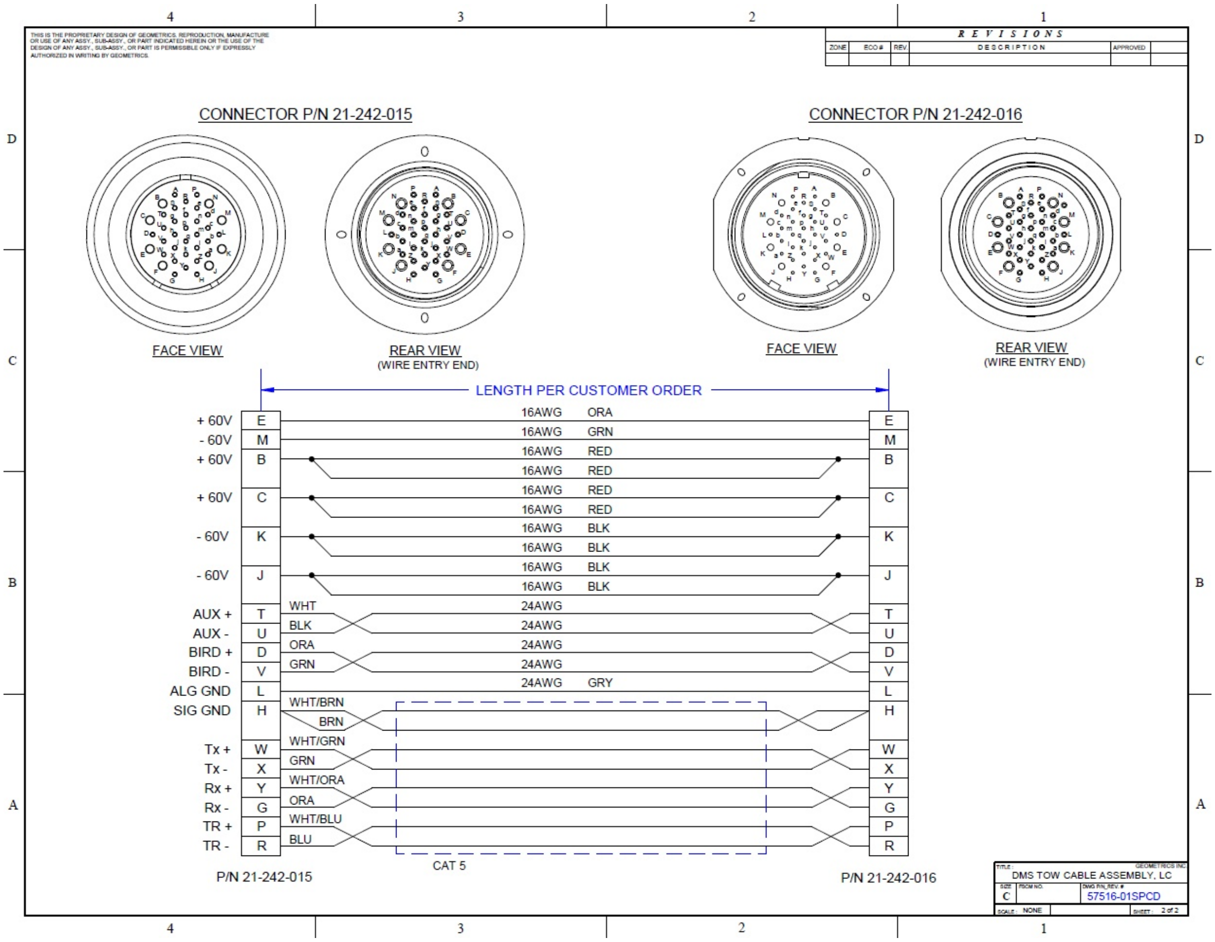


Figure A177: Tow Cable wiring diagram (scoop-proof).

5.11.10 Tow Cable (Non Scoop-proof Glenair Connectors)

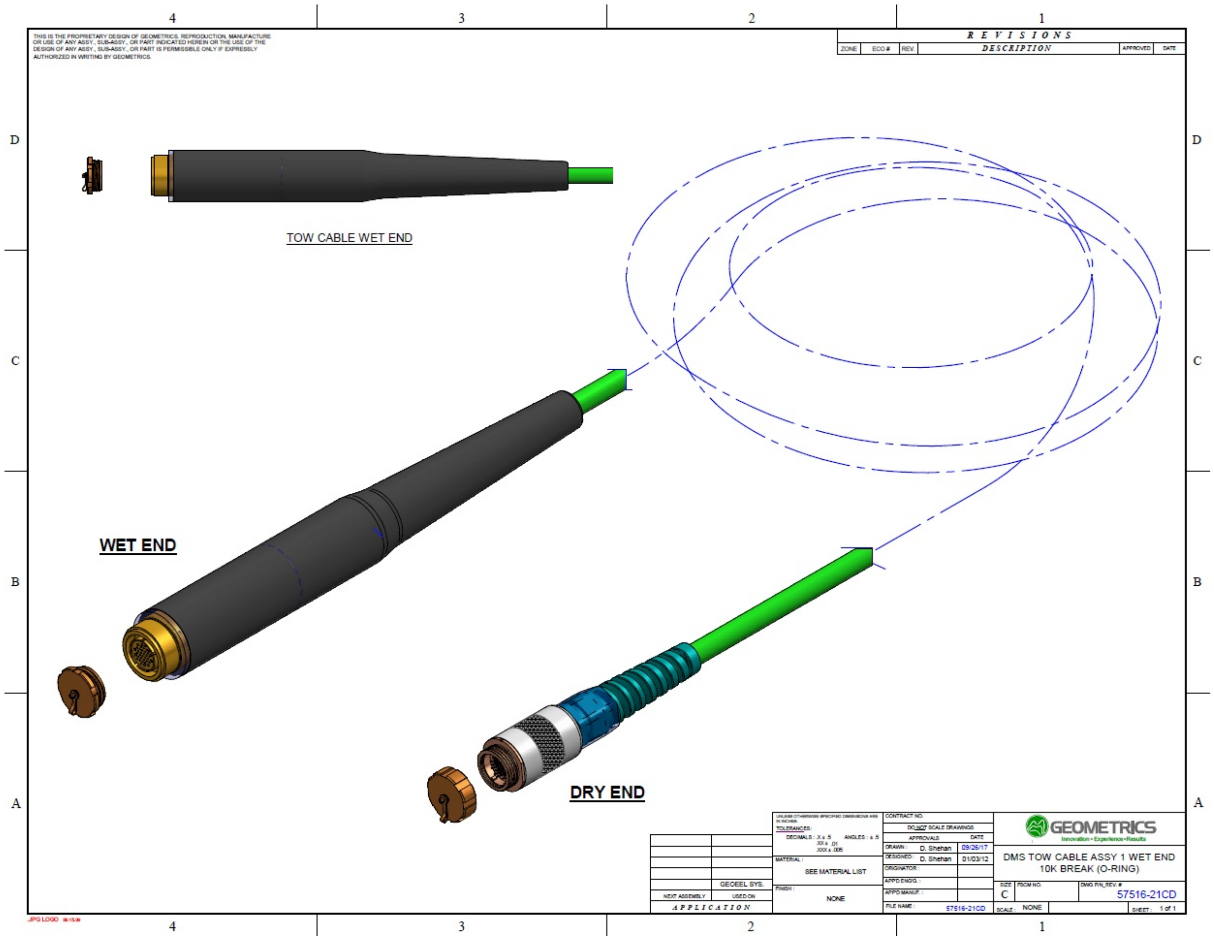


Figure A178: Tow Cable schematic (non scoop-proof).

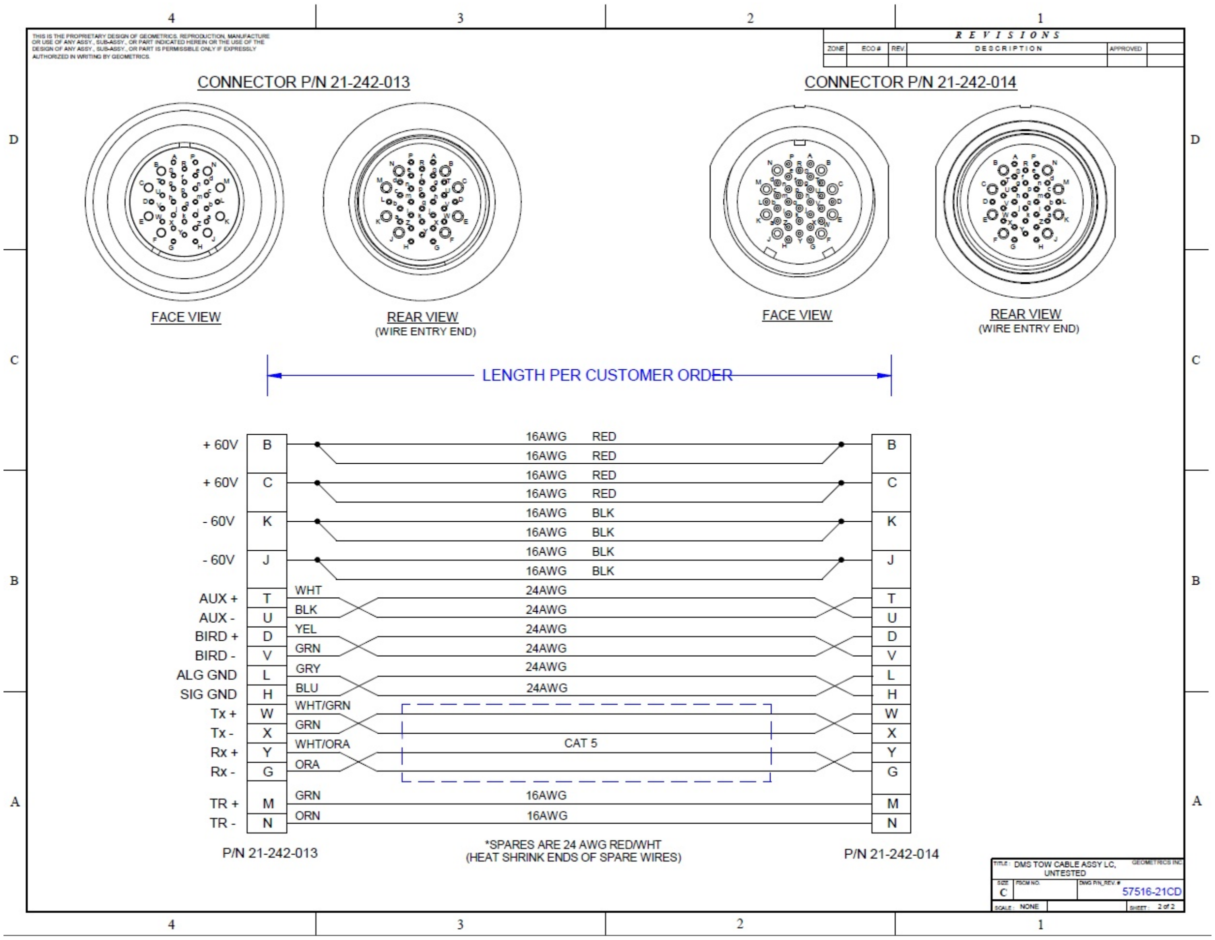


Figure A179: Tow Cable wiring diagram (non scoop-proof).

5.11.11 Repeater (Scoop-proof Glenair Connectors)

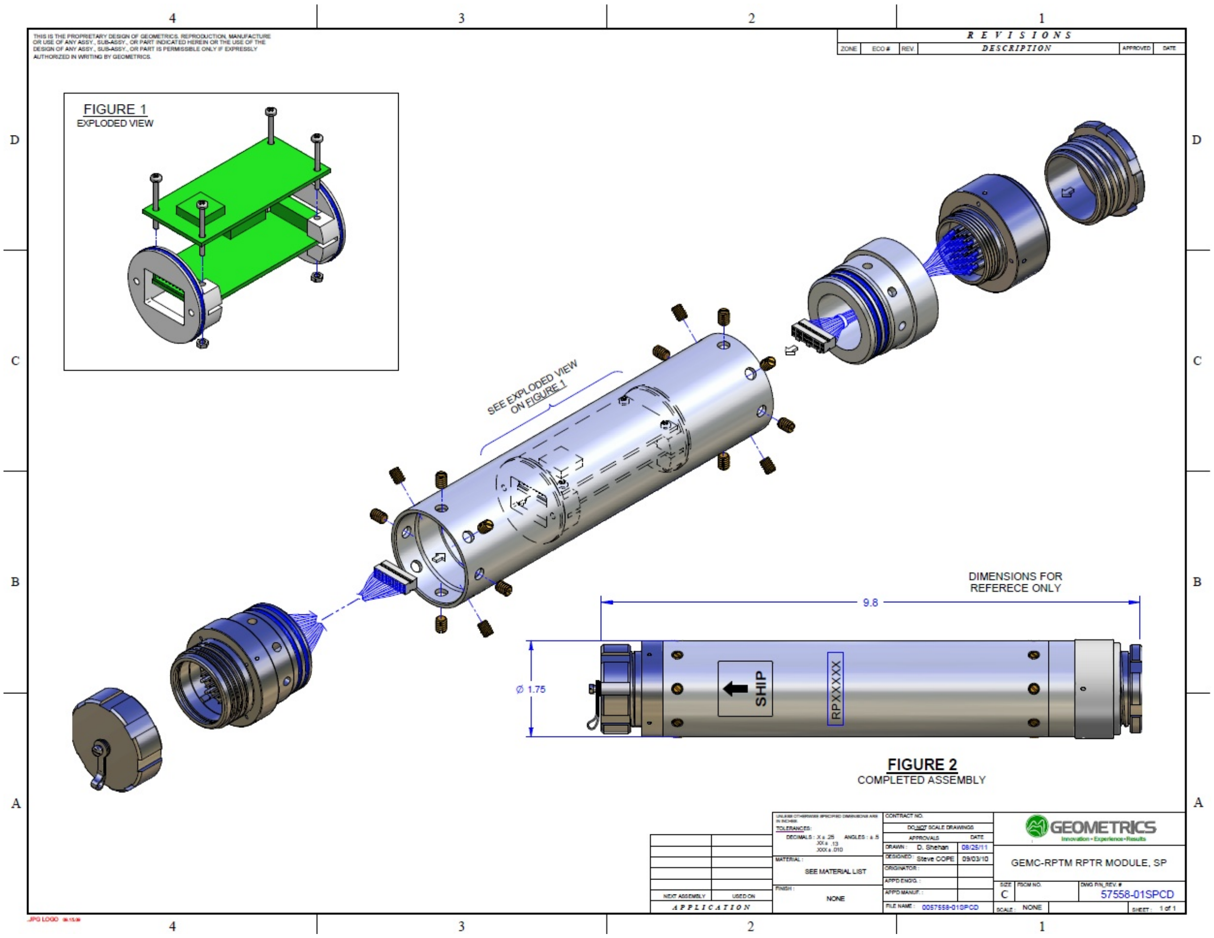


Figure A180: Exploded view of Repeater (scoop-proof).

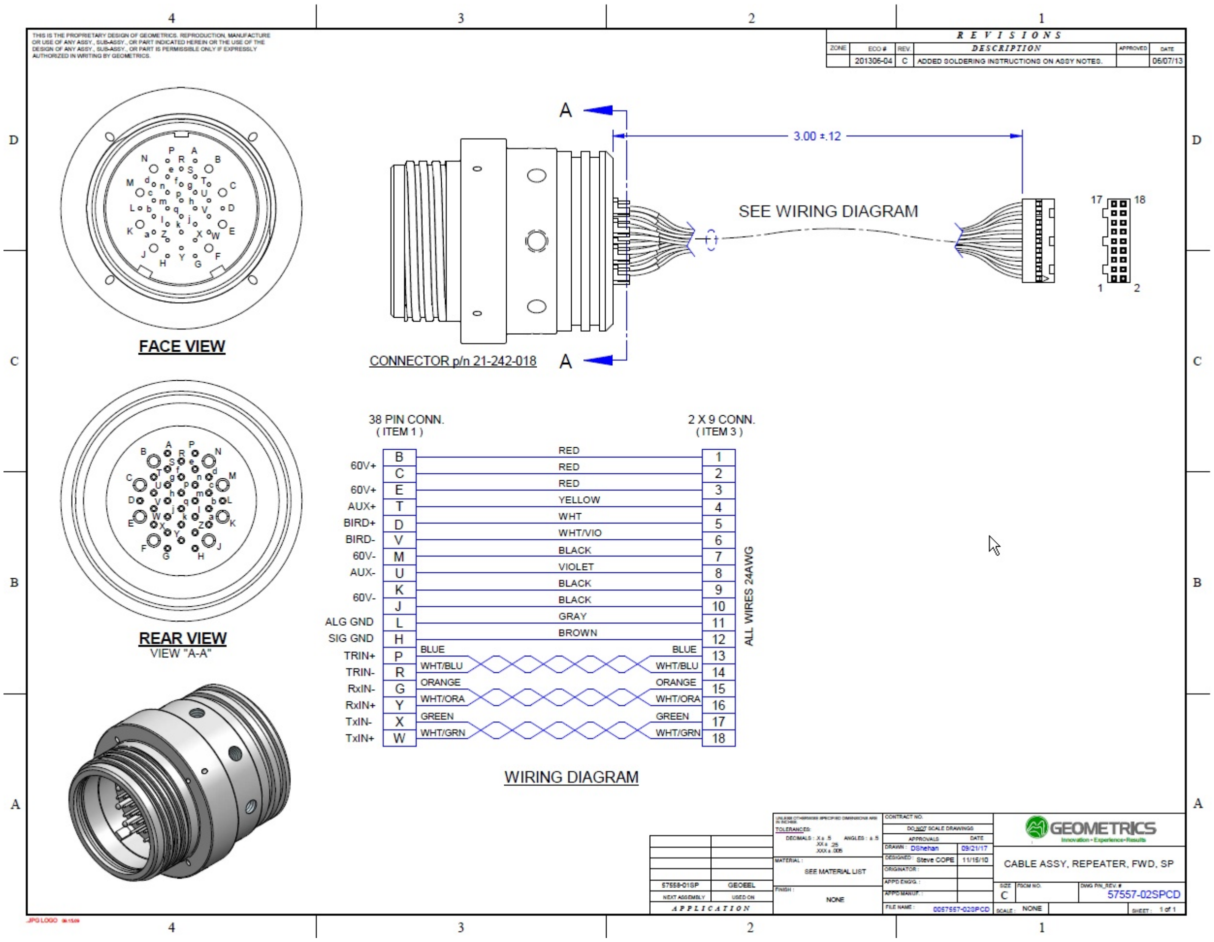


Figure A181: Wiring diagram for forward Repeater connector (scoop-proof).

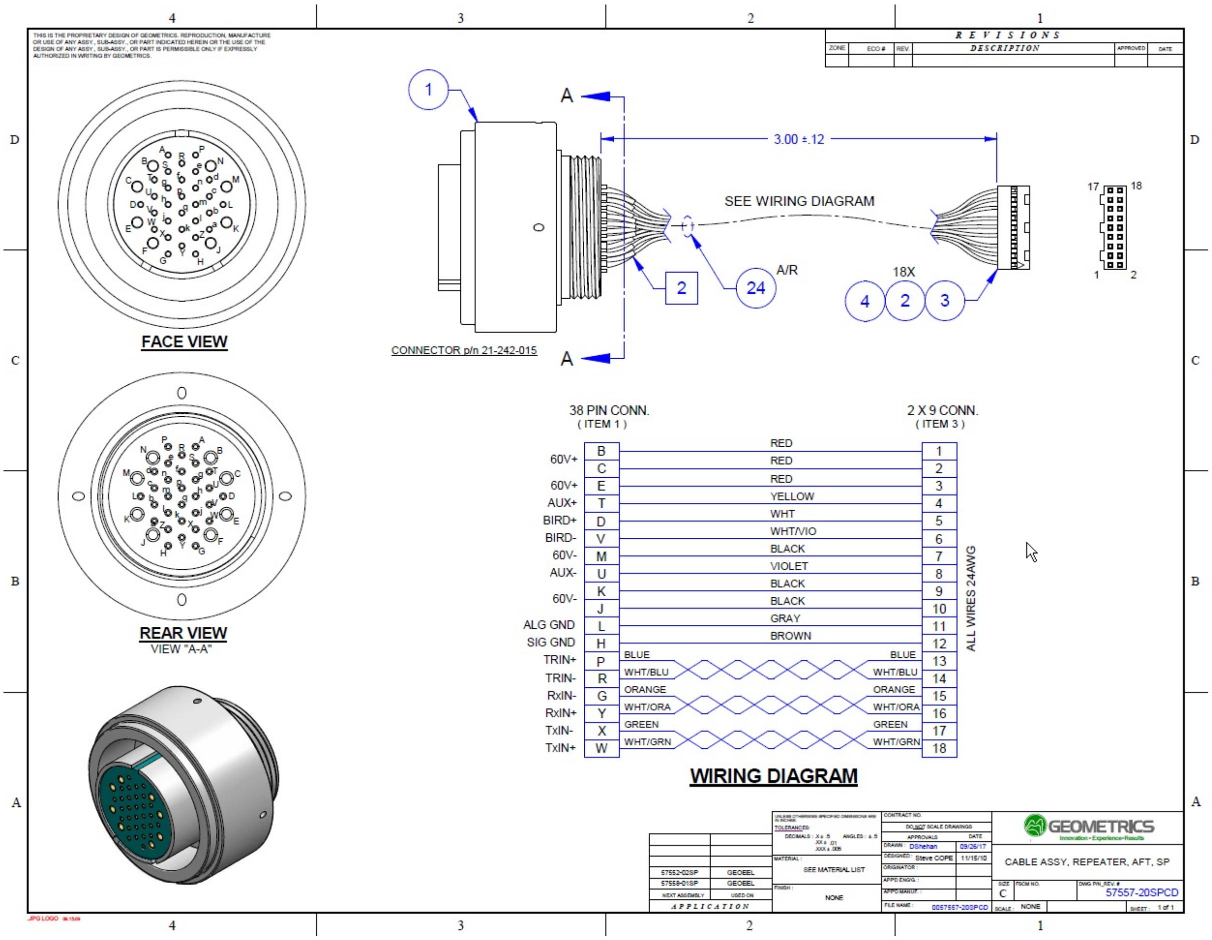


Figure A182: Wiring diagram for aft connector of Repeater (scoop-proof).

5.11.12 Repeater (Non Scoop-proof Glenair Connectors)

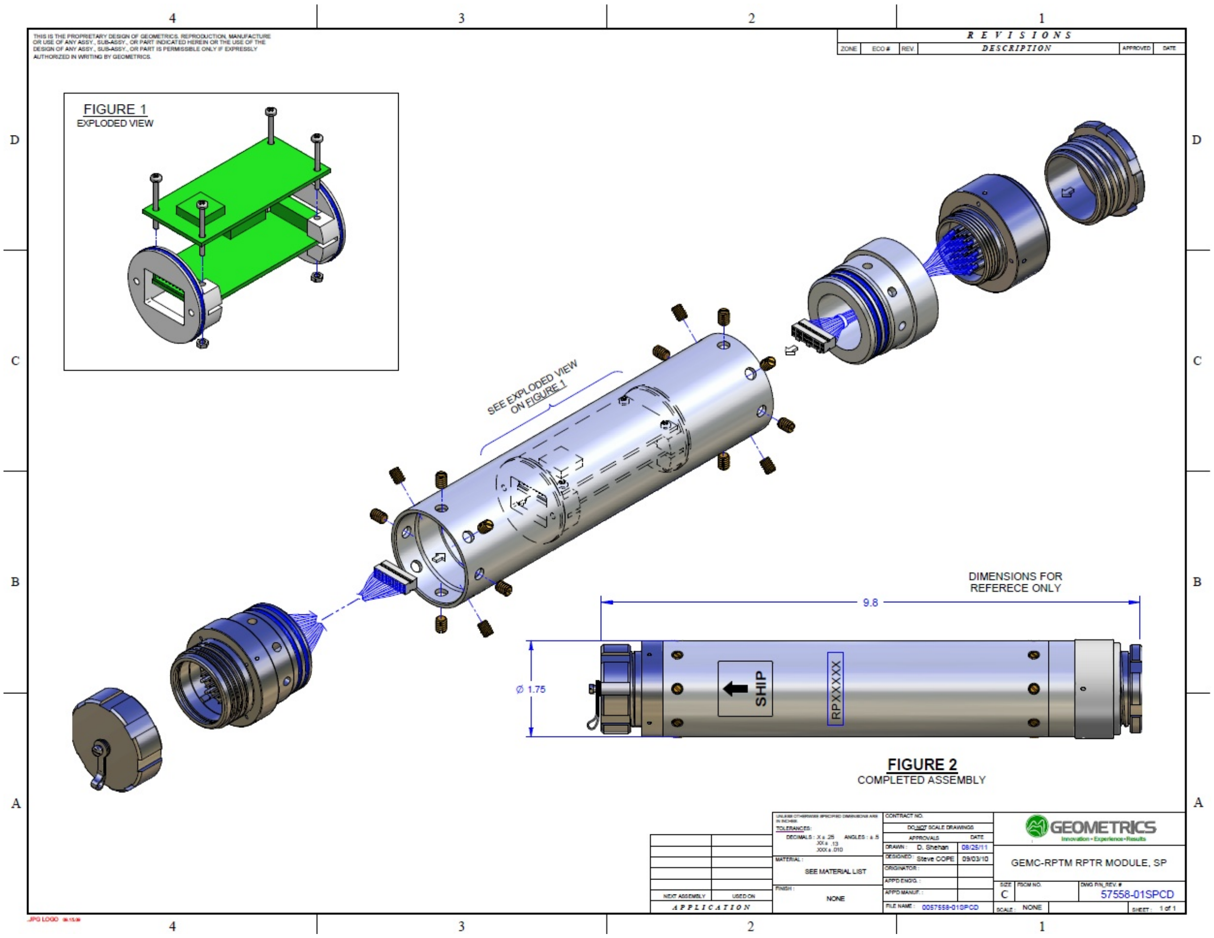


Figure A183: Exploded view of Repeater (Scoop-proof style shown).

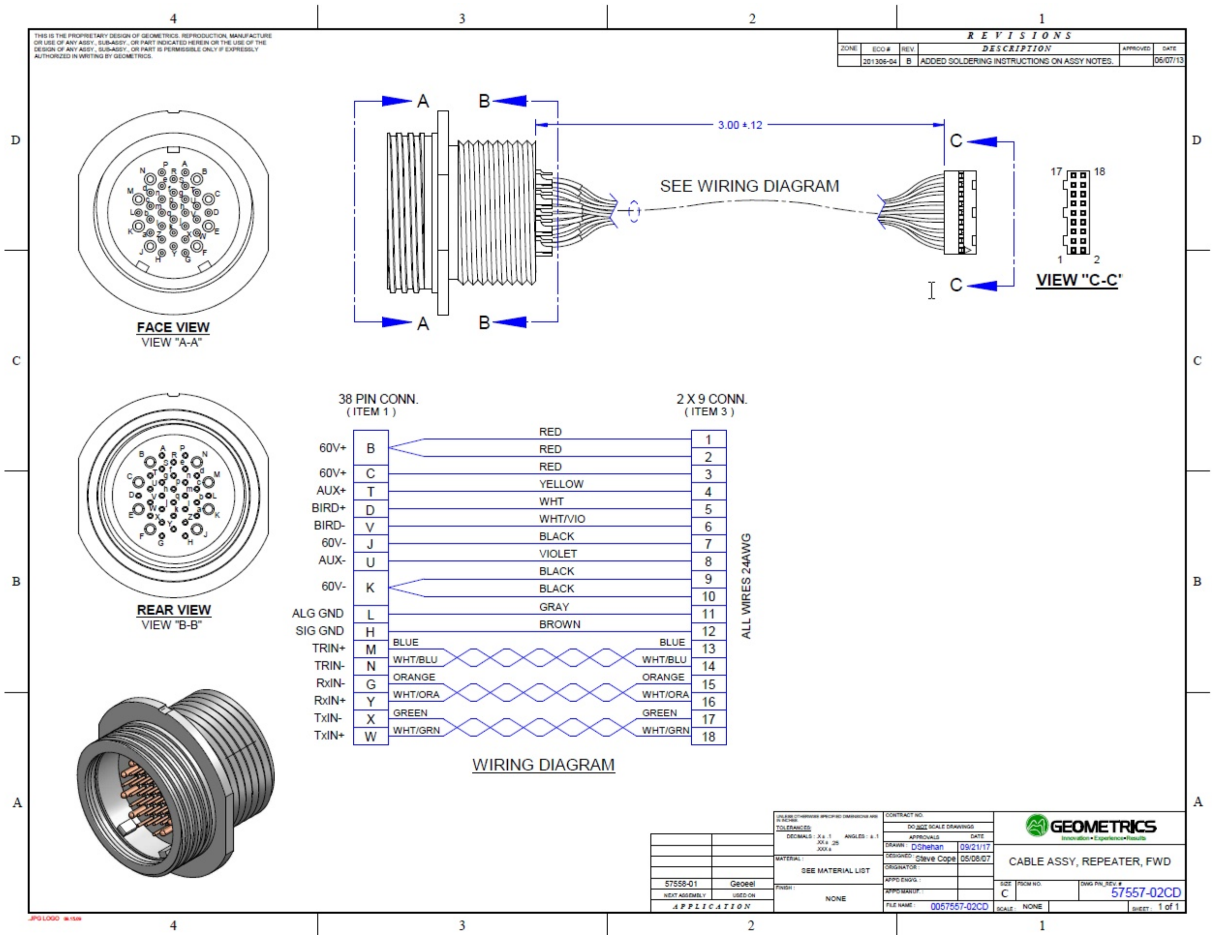


Figure A184: Wiring diagram for forward connector on Repeater (non scoop-proof).

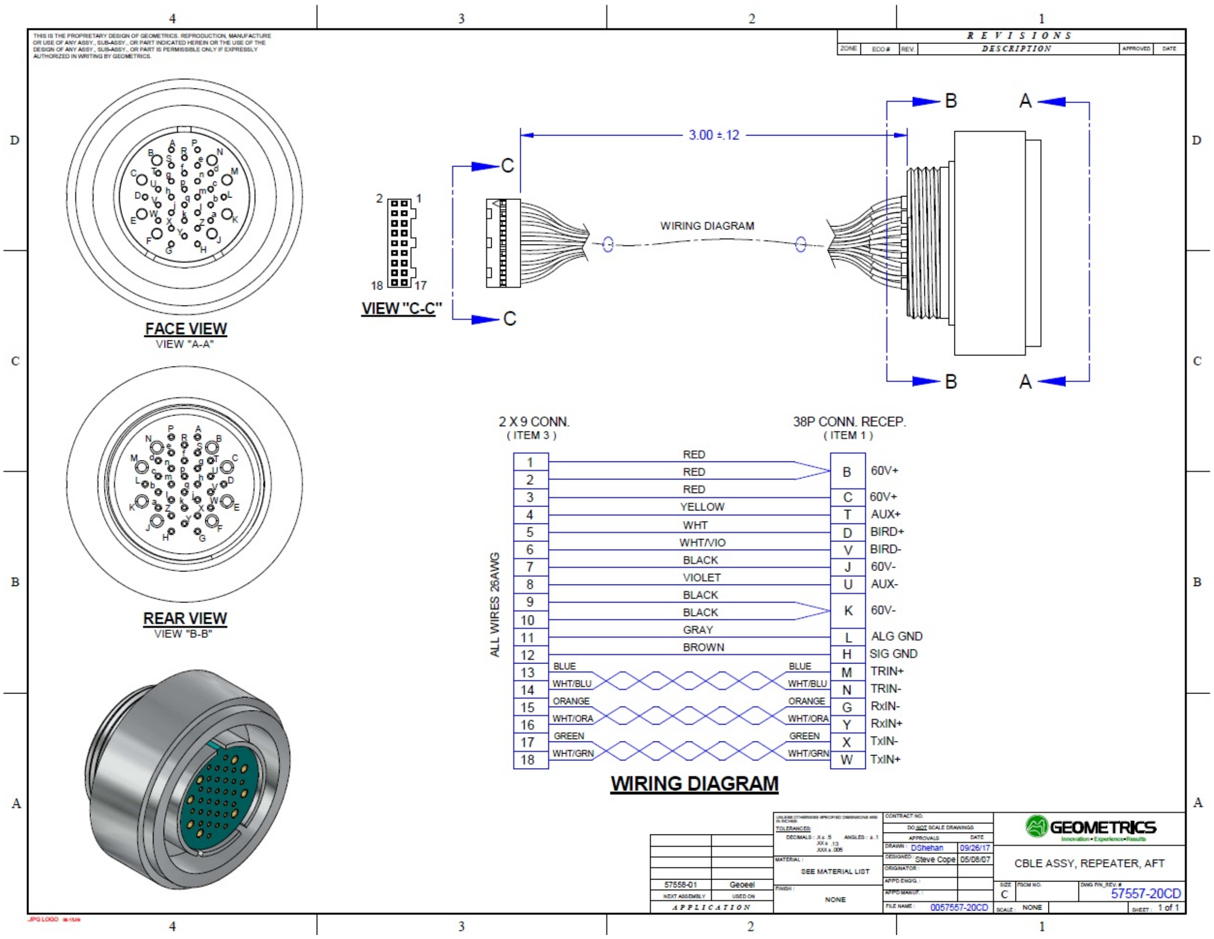
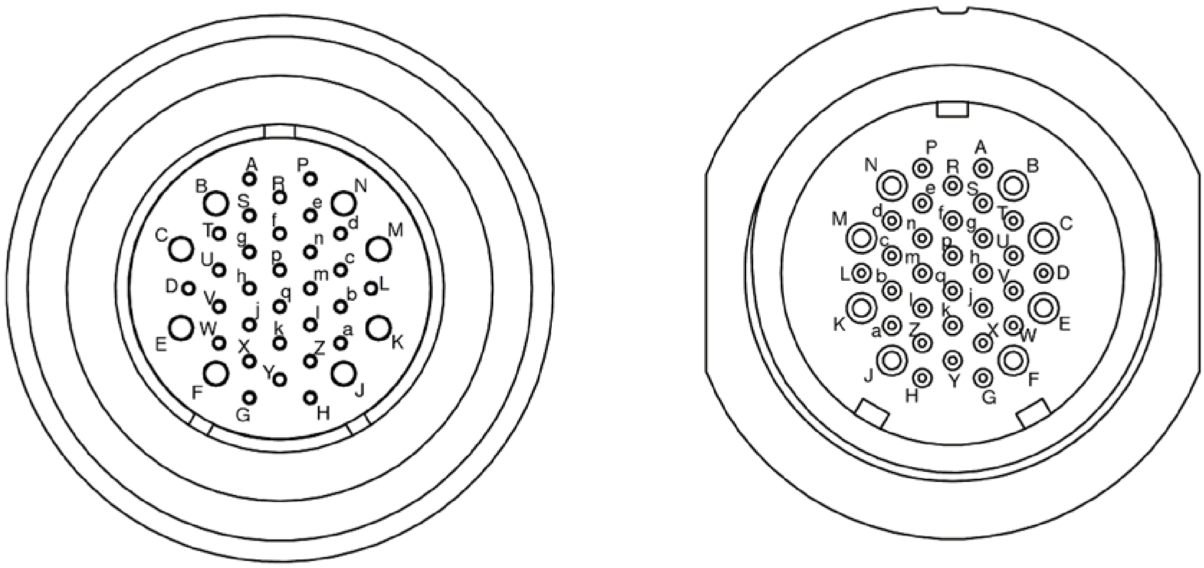


Figure A185: Wiring diagram for aft connector on Repeater (non scoop-proof).

5.11.13 Vibration Isolation/Stretch Section (Scoop-proof Glenair Connectors)



P/N 21-242-015
Female Glenair

P/N 21-242-016
Male Glenair

Figure A186: Pin labels for female Glenair (left) and male Glenair (right) Vibration Isolation and Stretch Section connectors (scoop-proof).

	Color	AWG	P/N 21-242-015	P/N 21-242-016	Remark
Trgger	RED	26	P (+)	P (+)	TP
	BROWN	26	R (-)	R (-)	
AUX	RED	26	T (+)	T (+)	TP
	YELLOW	26	U (-)	U (-)	
Positive power	RED/RED Q1	18	B (+)	B (+)	Quadruple twisted (1)
	RED/RED Q2	18	C (-)	C (-)	
Bird (inner pair shielded)	WHITE	22	D (+)	D (+)	Tripple twisted
	BLUE	22	V (-)	V (-)	
	DRAIN	24	L	L	
Power	RED/RED Q3	18	E (+)	E (+)	Quadruple twisted (2)
	BLACK/BLACK Q3	18	M (-)	M (-)	
CAT 5 (Blue)	WHITE	22	Y(+)	Y(+)	
	BLUE	22	G(-)	G(-)	
	DRAIN	24	L	L	
CAT 5 (Green)	WHITE	22	W(+)	W(+)	
	GREEN	22	X(-)	X(-)	
	DRAIN	24	L	L	
Negative power	BLACK/ BLACK Q1	18	K (+)	K (+)	Quadruple twisted (3)
	BLACK/BLACK Q2	18	J (-)	J (-)	
Signal ground	Black	26	H (+)	H (+)	TP
	Yellow	26	H (+)	H (+)	
Analog ground	RED	26	L	L	TP
	GREEN	26	L	L	

Figure A187: Vibration Isolation/Stretch Section wiring diagram (scoop-proof).

5.11.14 Vibration Isolation/Stretch Section (Non Scoop-proof Glenair Connectors)

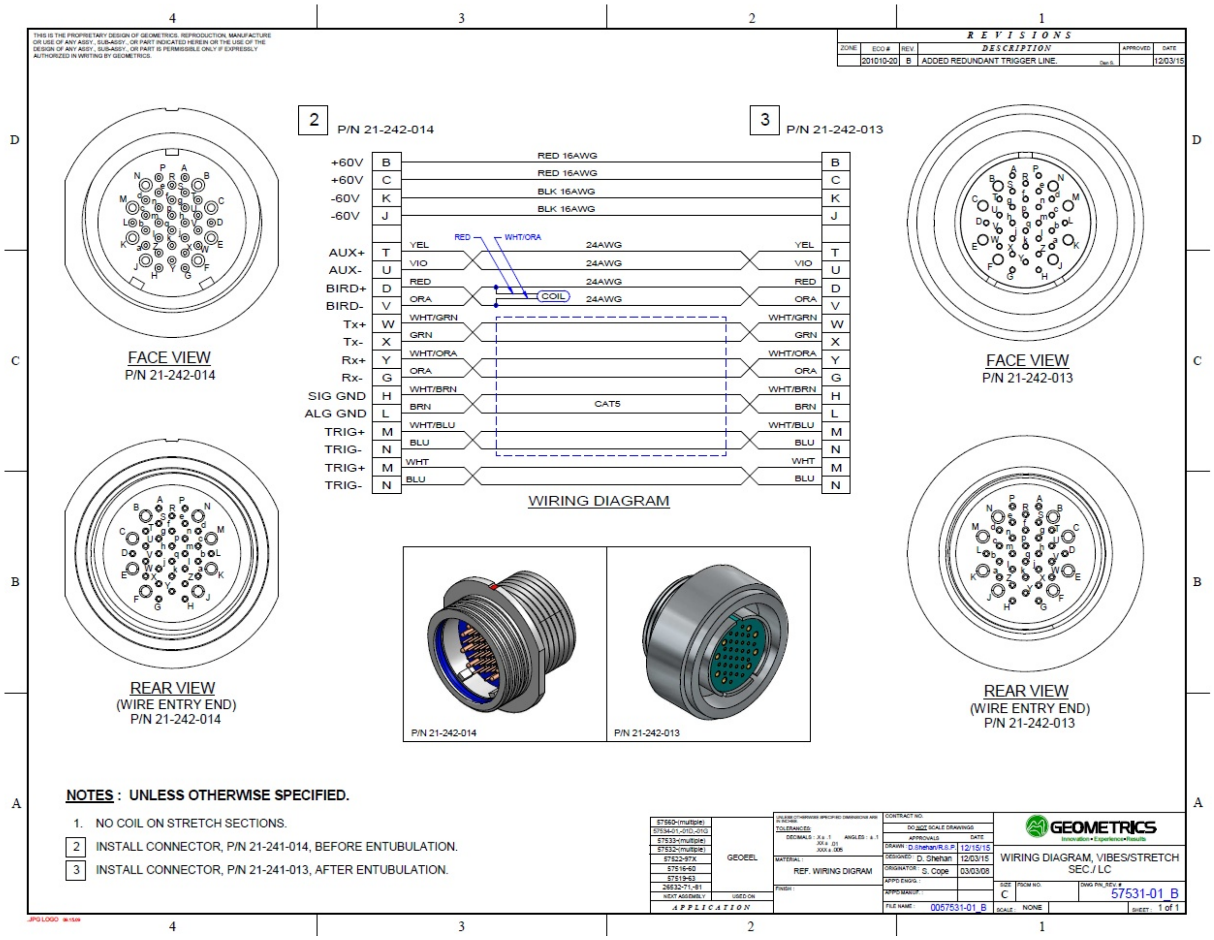


Figure A188: Vibration Isolation/Stretch Section wiring diagram (non scoop-proof).

5.11.15 Jumper Cable (Subconn Connectors)

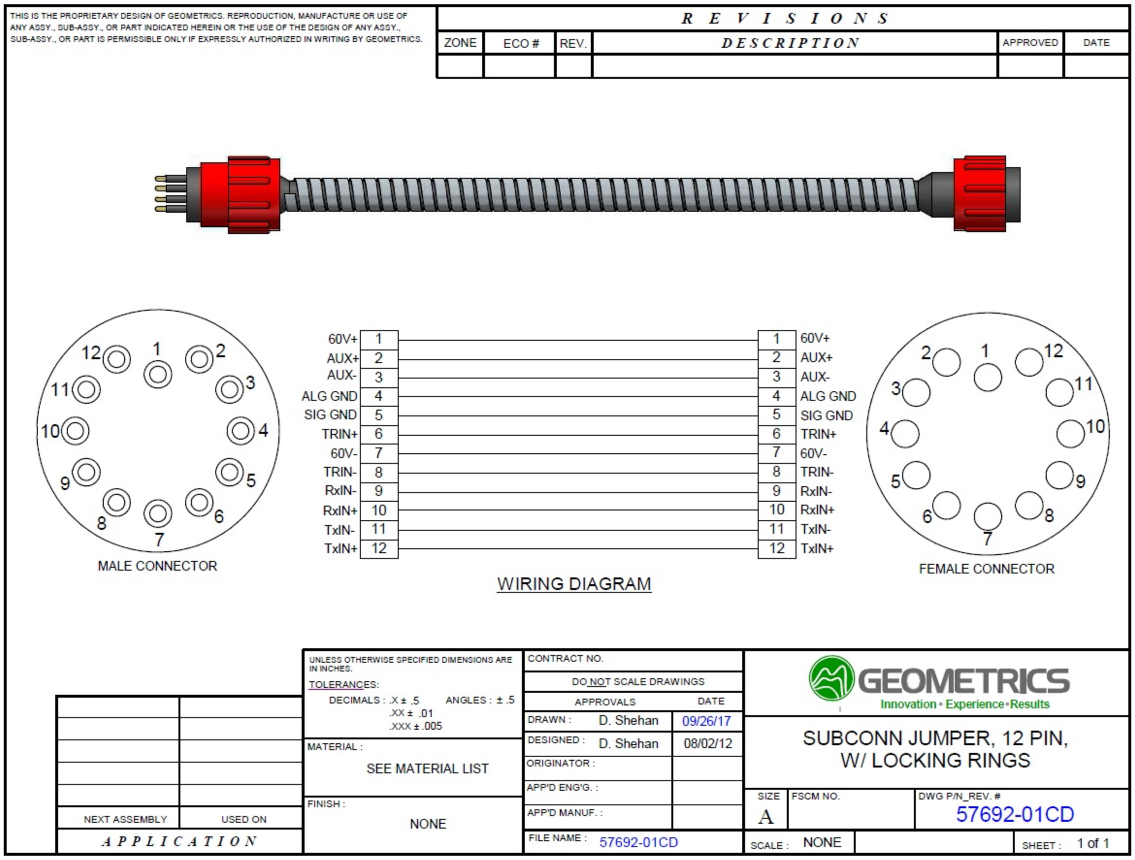


Figure A189: Wiring diagram for Subconn Jumper Cable.

5.11.16 Jumper Cable (Titan Connectors)

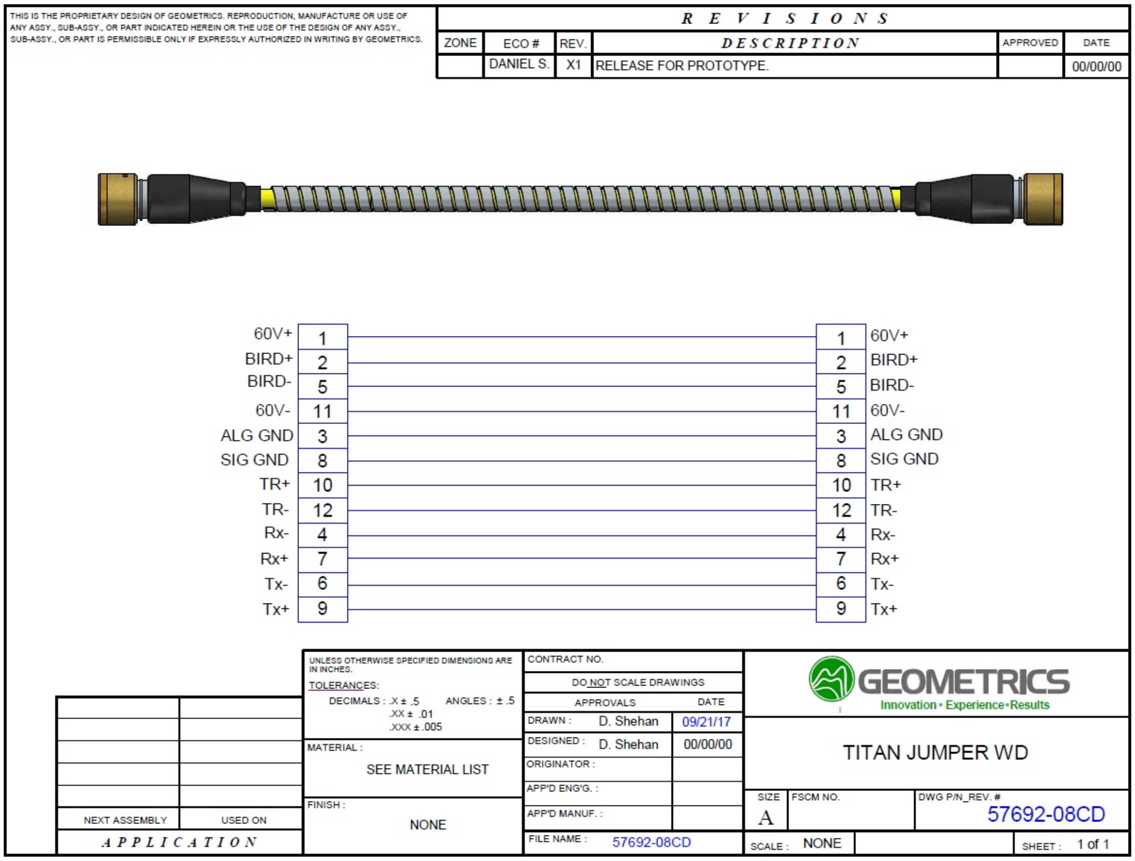


Figure A190: Wiring diagram for Titan Jumper Cable.

5.11.17 Digitizer (2D, Scoop-proof Glenair Connectors)

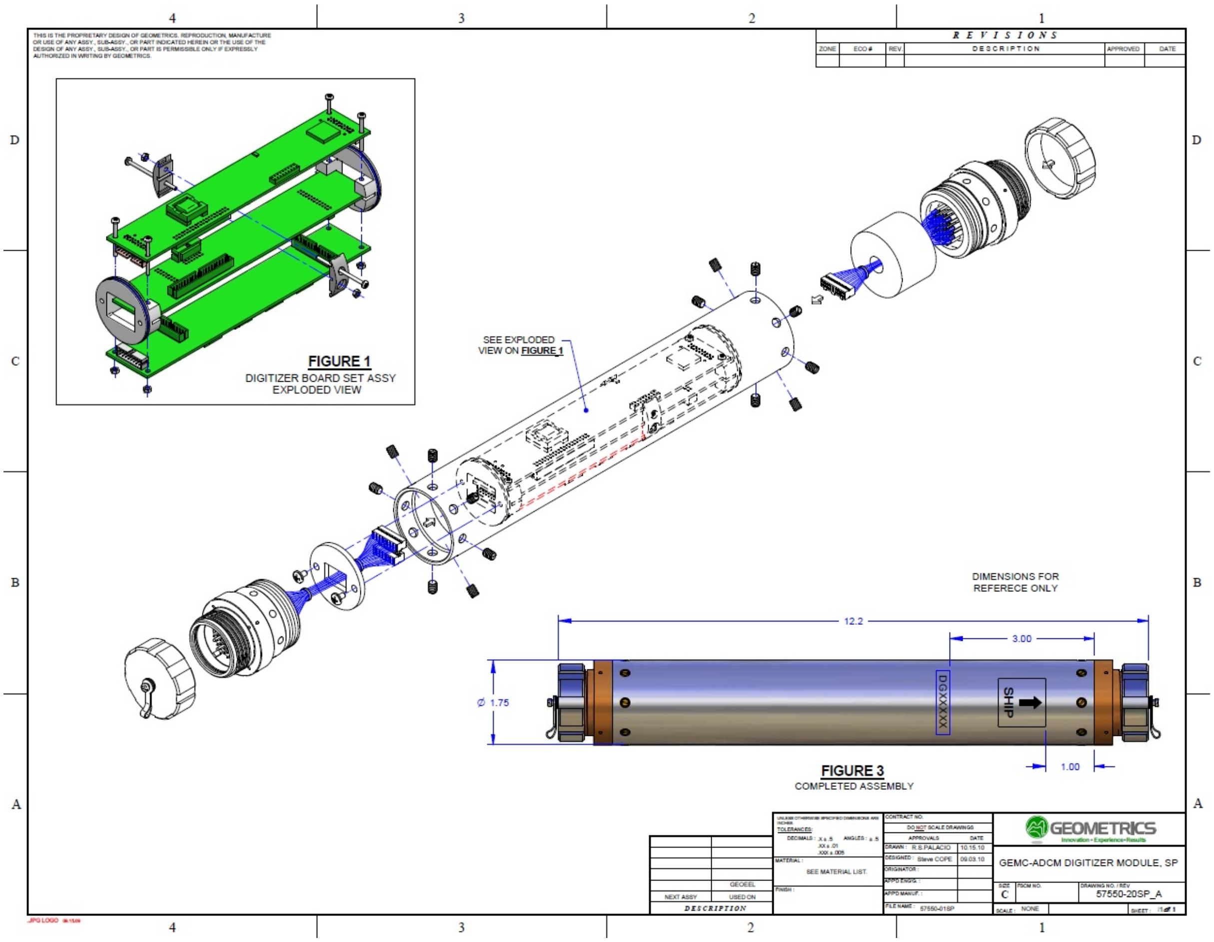


Figure A191: Exploded view of 2D Digitizer (scoop-proof).

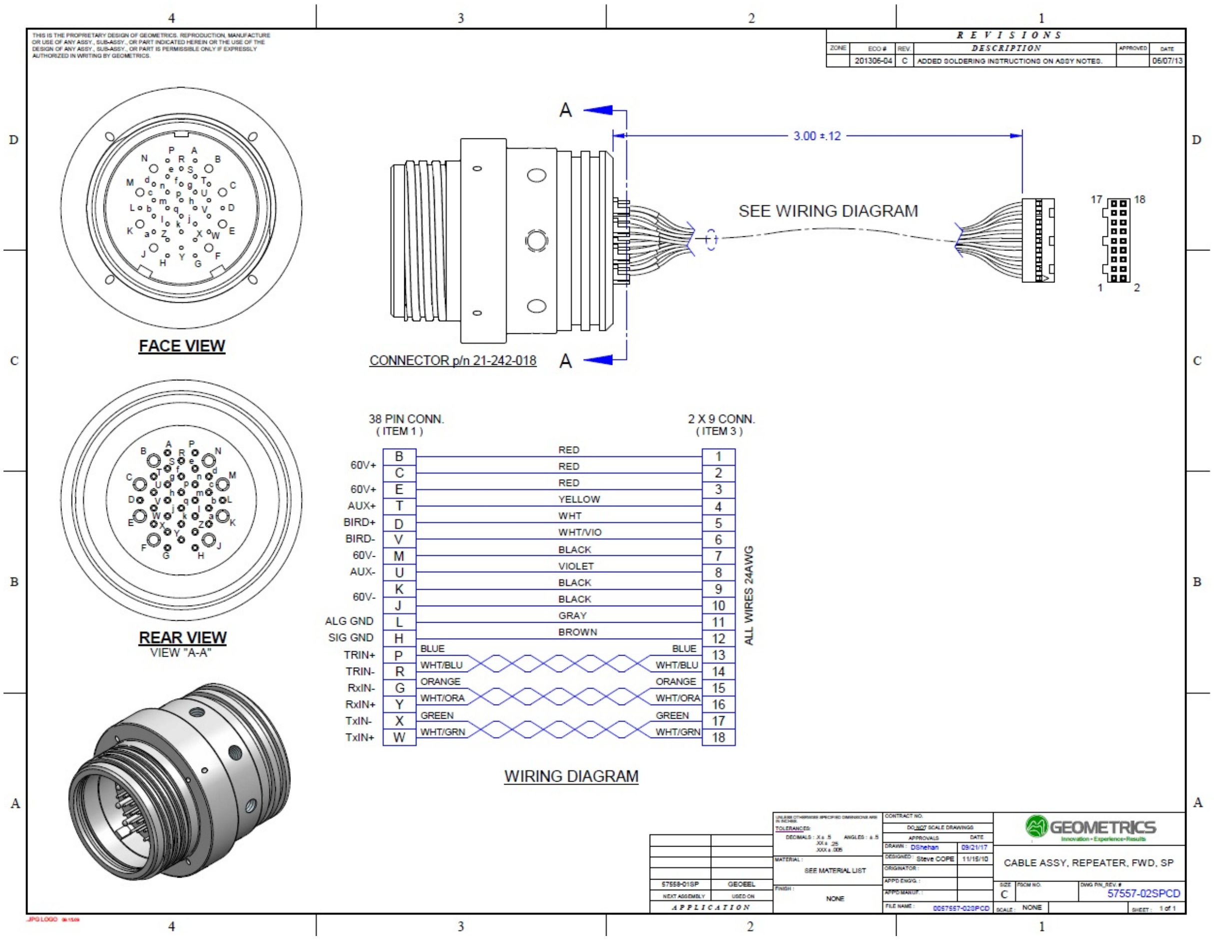


Figure A192: Wiring diagram for forward connector (scoop-proof).

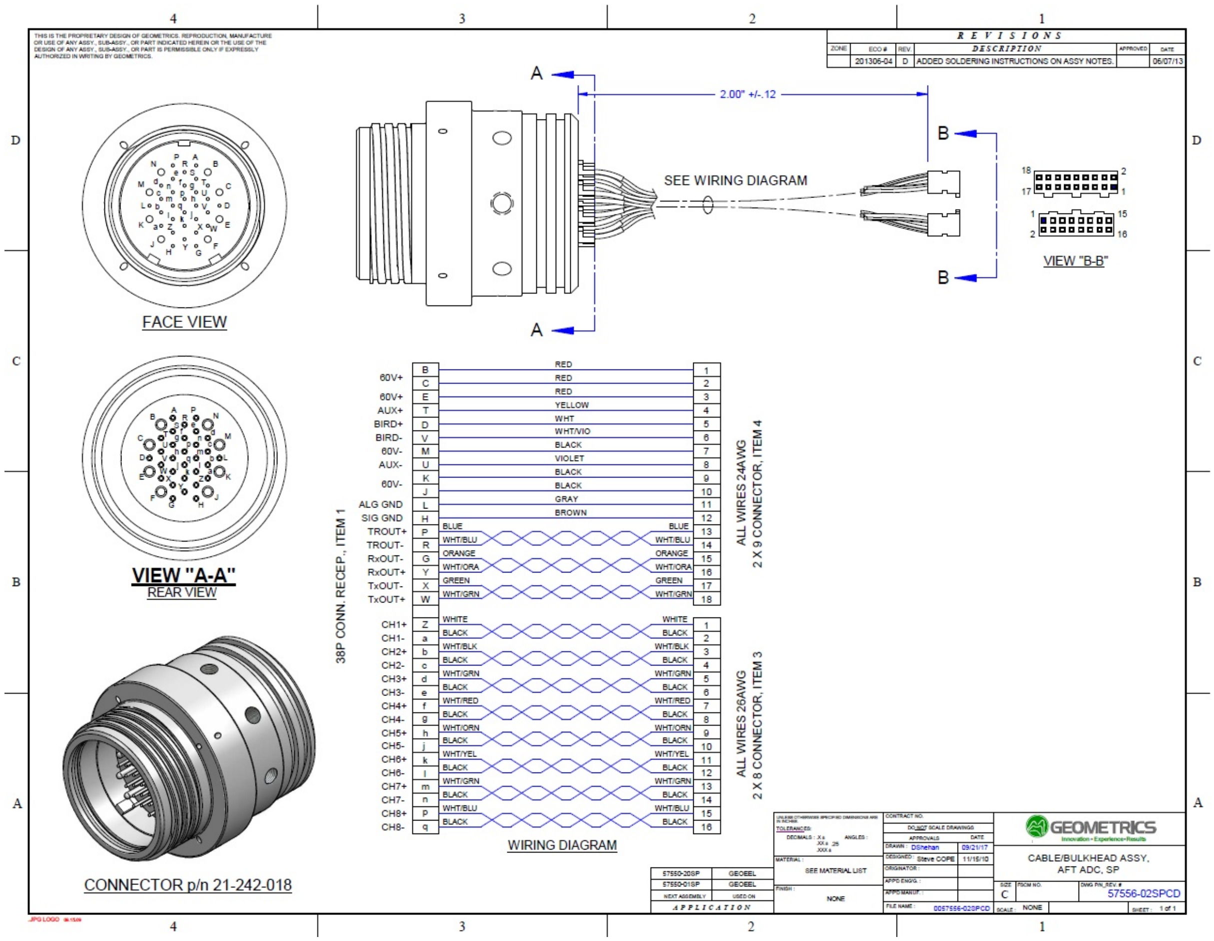


Figure A193: Wiring diagram for aft connector (scoop-proof).

5.11.18 Digitizer (2D, Non Scoop-proof Glenair Connectors)

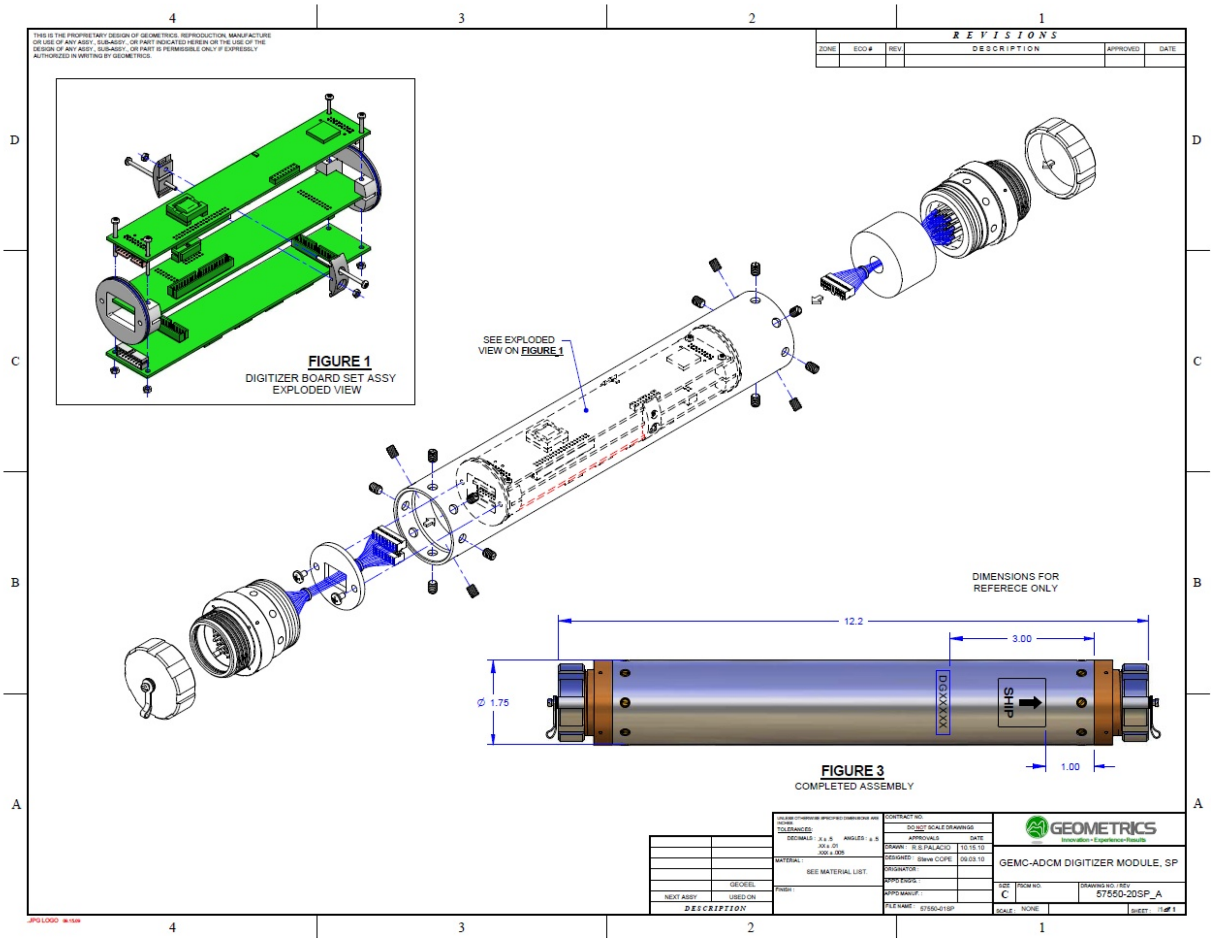


Figure A194: Exploded view of 2D Digitizer (scoop-proof shown).

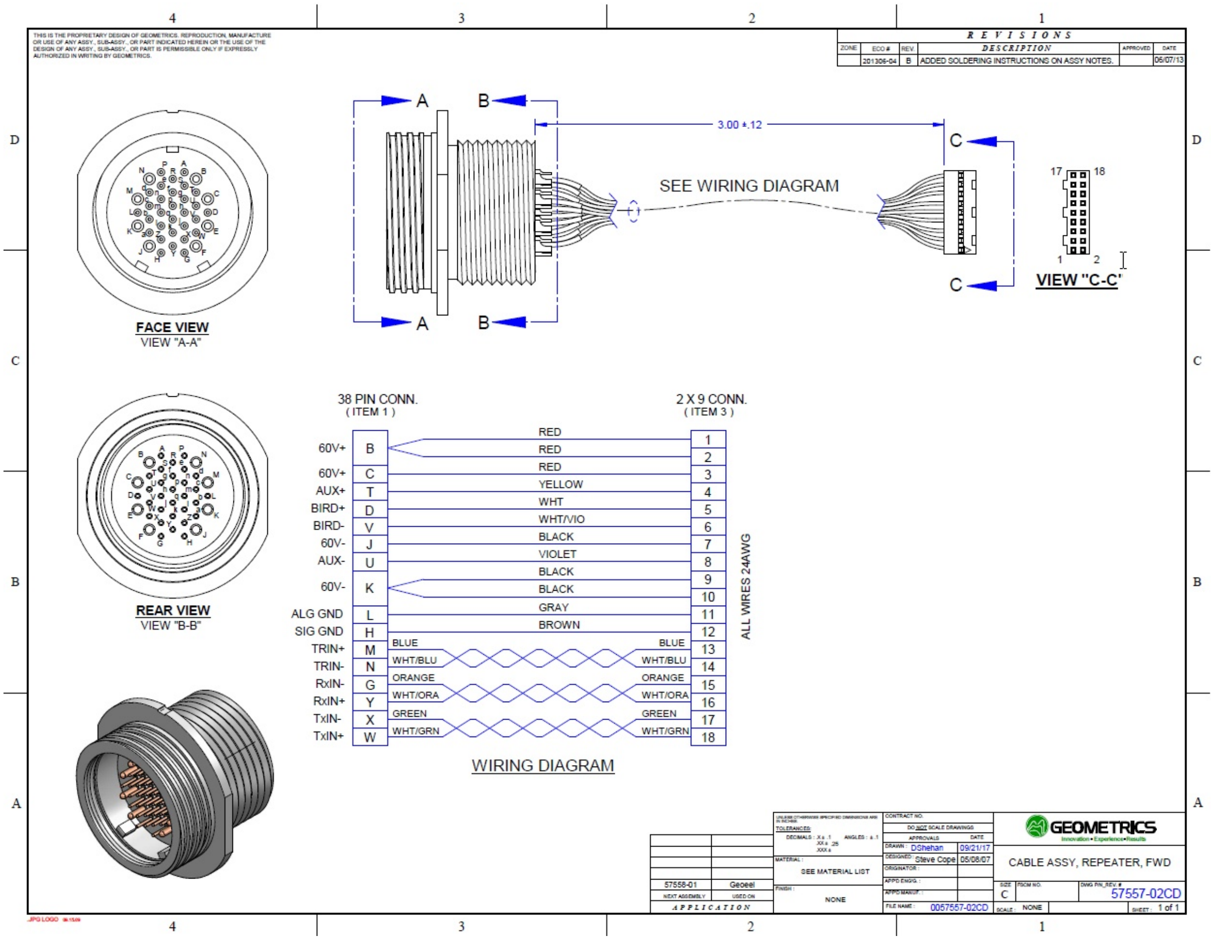


Figure A195: Wiring diagram for forward connector (non scoop-proof).

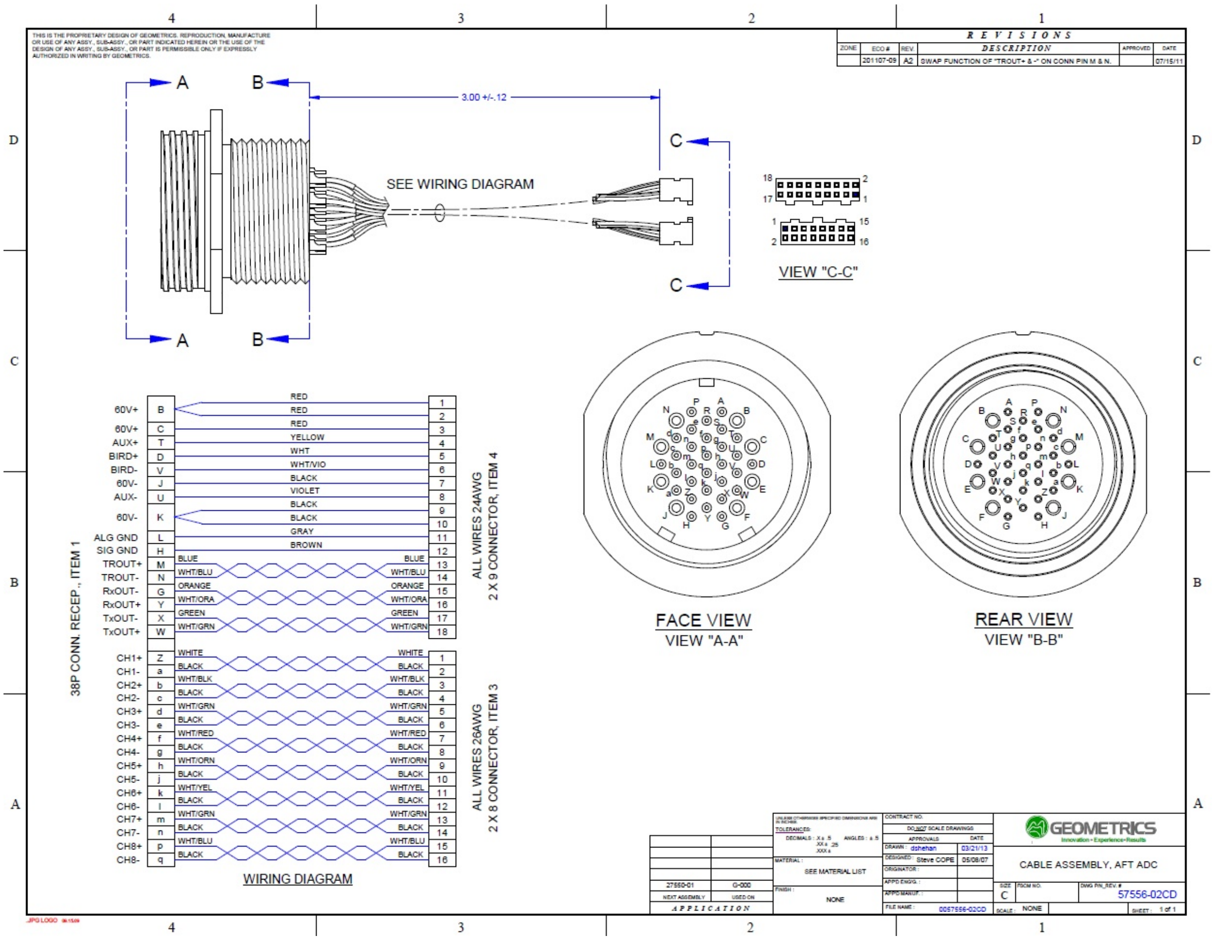


Figure A196: Wiring diagram for aft connector (non scoop-proof).

5.11.19 Digitizer (P-Cable, Subconn and Scoop-proof Glenair Connectors)

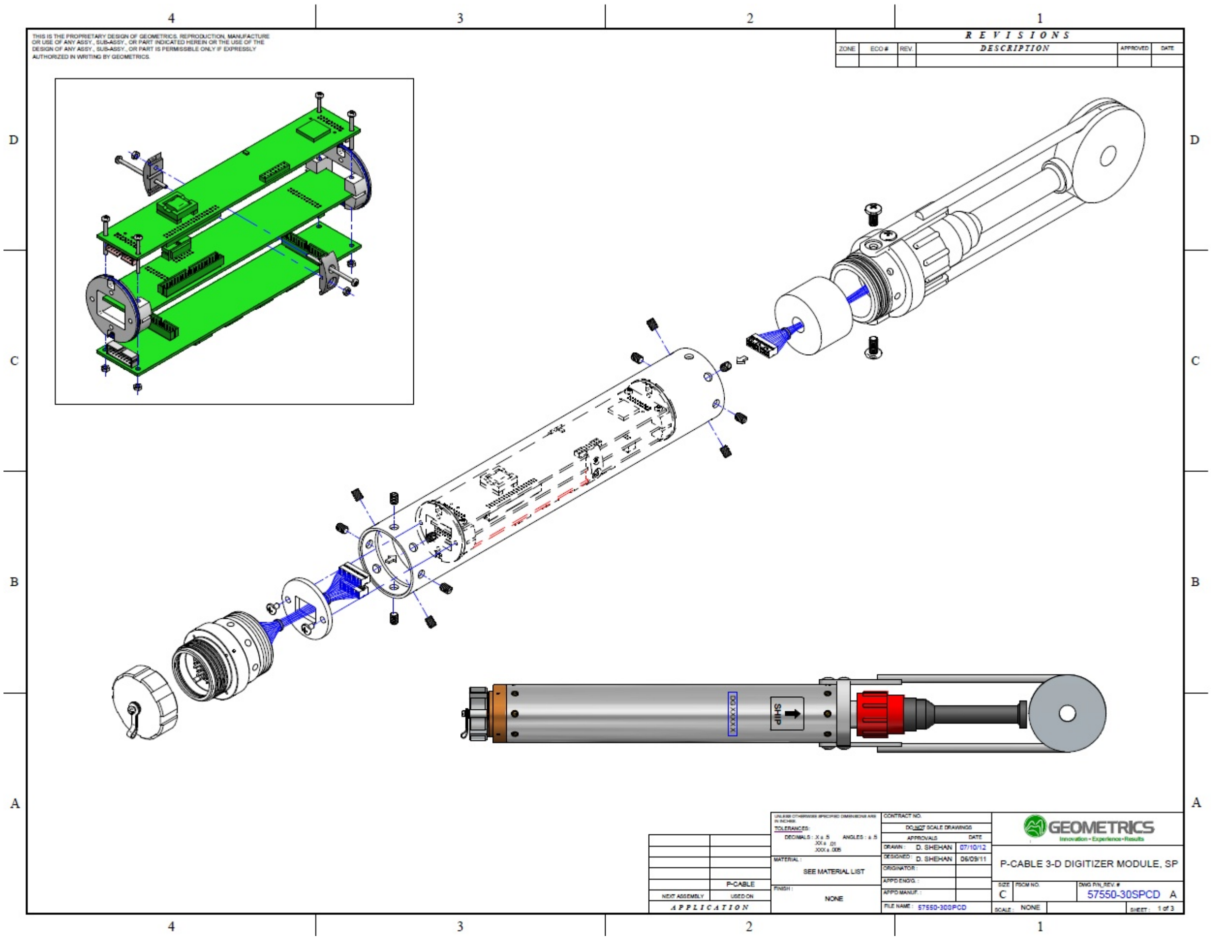


Figure A197: Exploded view of Lead Digitizer for P-Cable, Subconn.

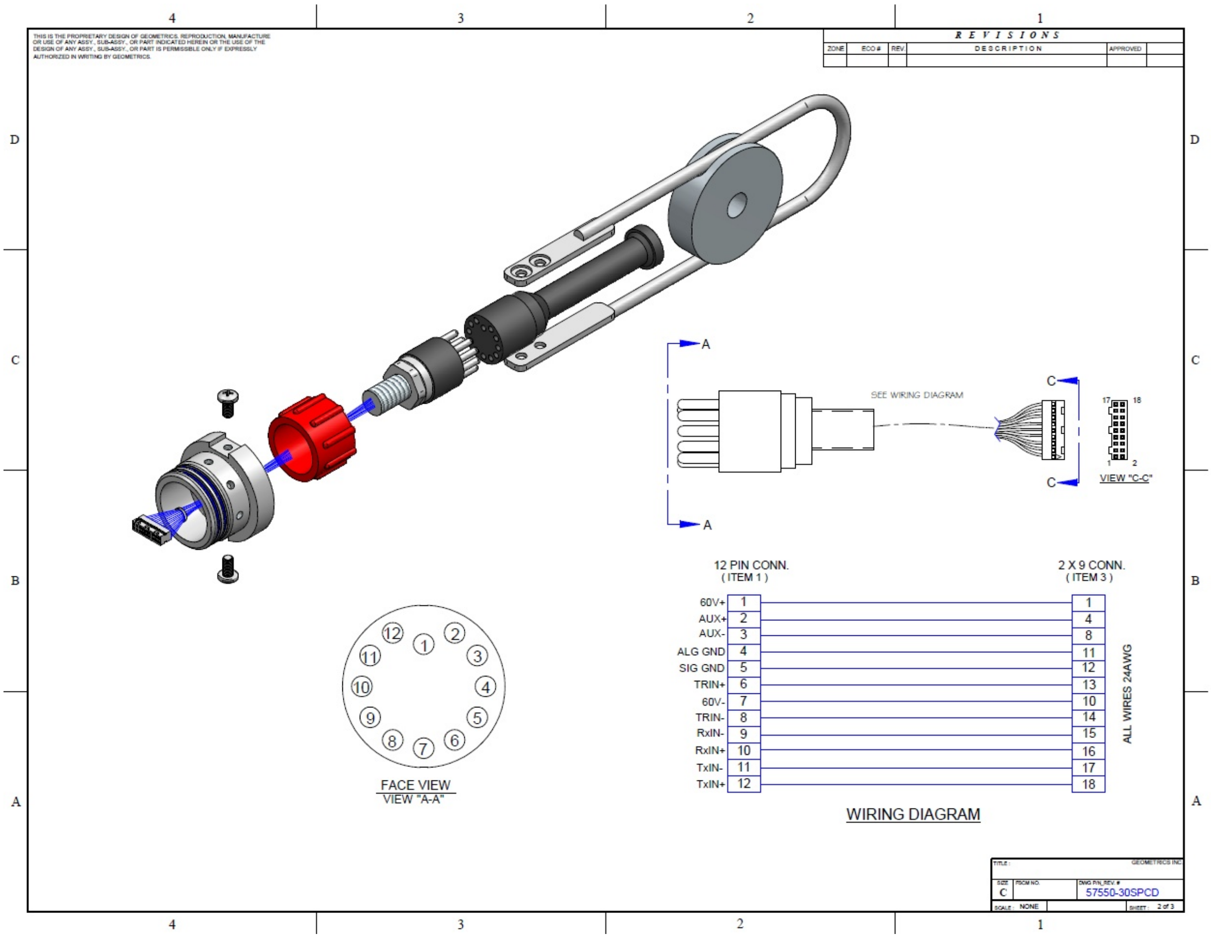


Figure A198: Wiring diagram for Subconn connector.

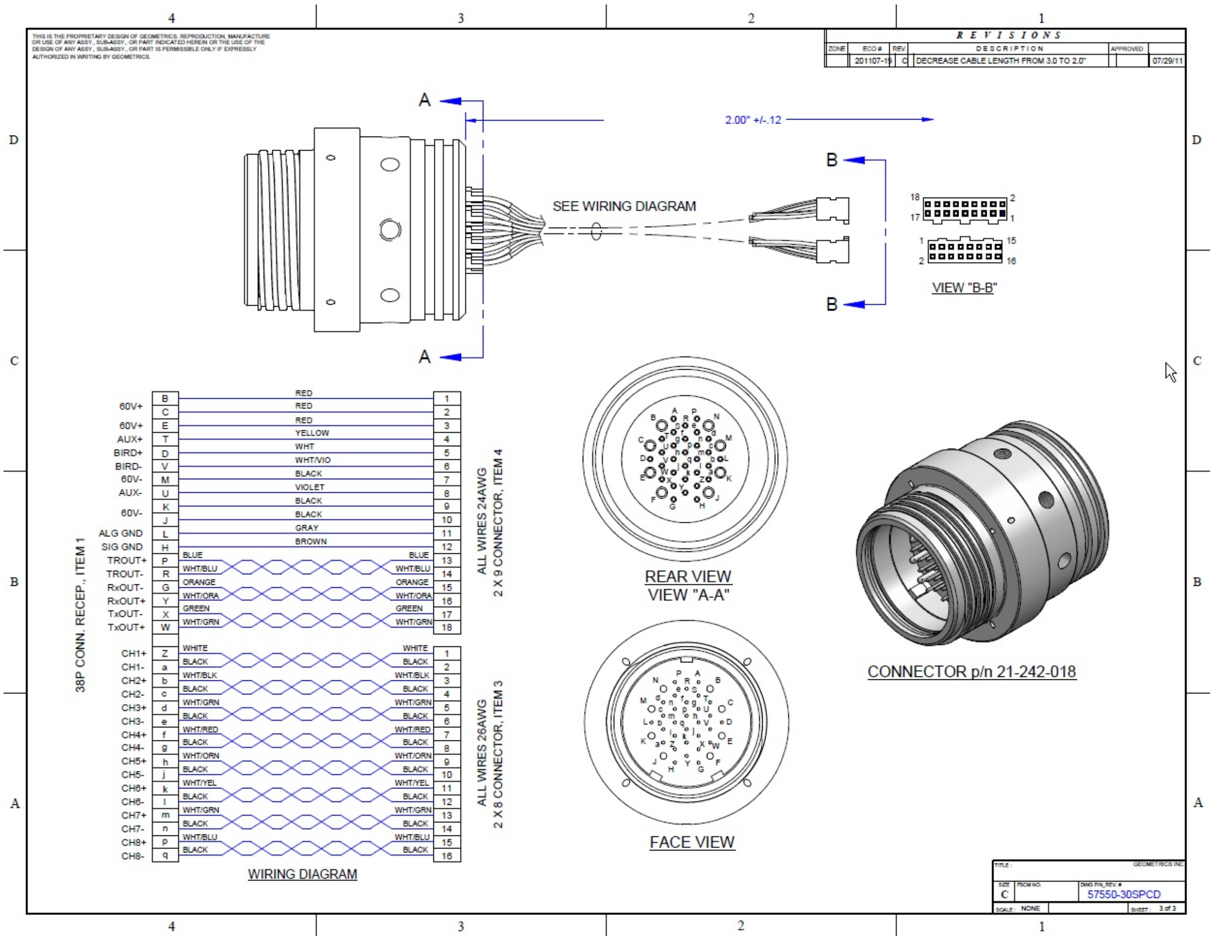


Figure A199: Wiring diagram for Glenair connector.

5.11.20 Digitizer (P-Cable, Titan and Scoop-proof Glenair Connectors)

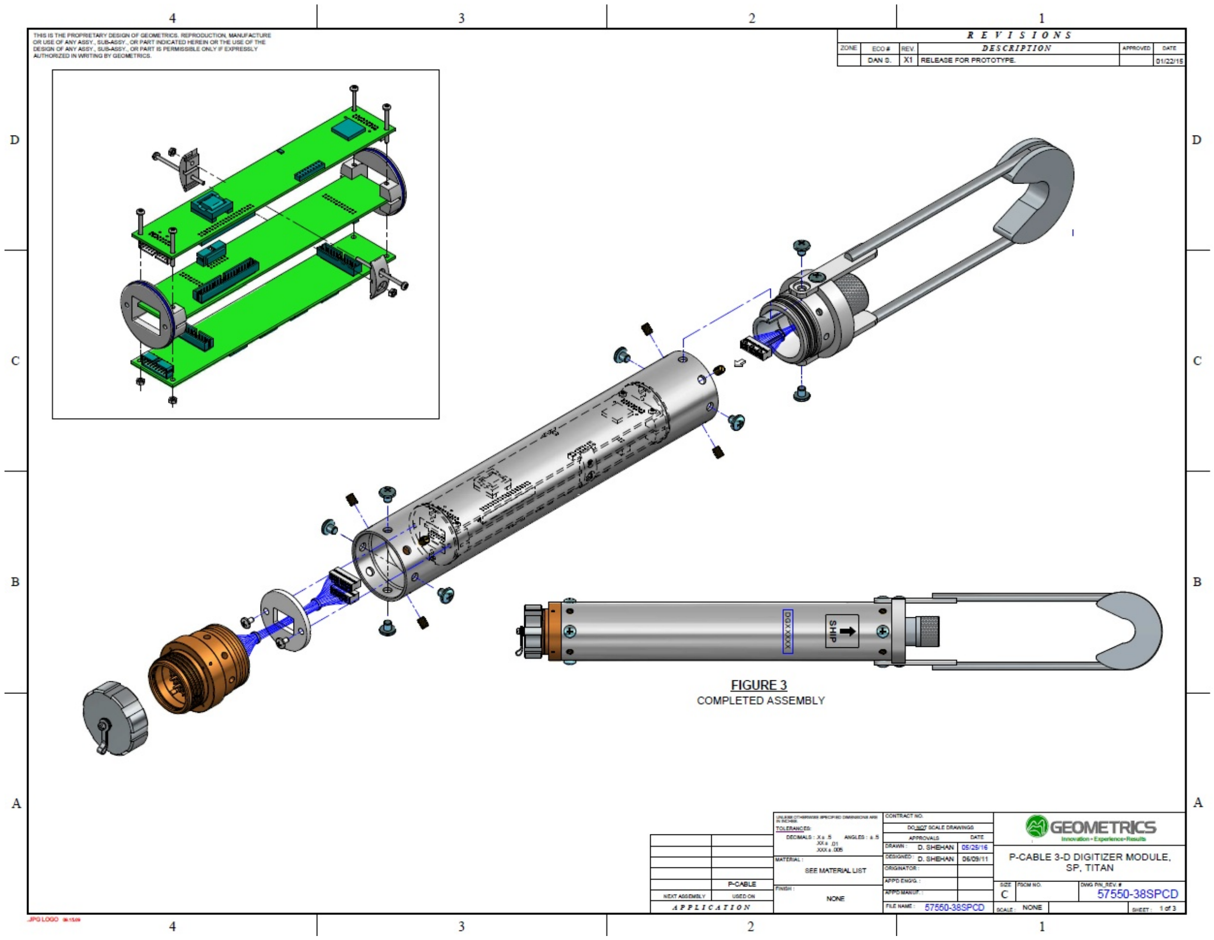


Figure A200: Exploded view of Lead Digitizer for P-Cable, Titan connector.

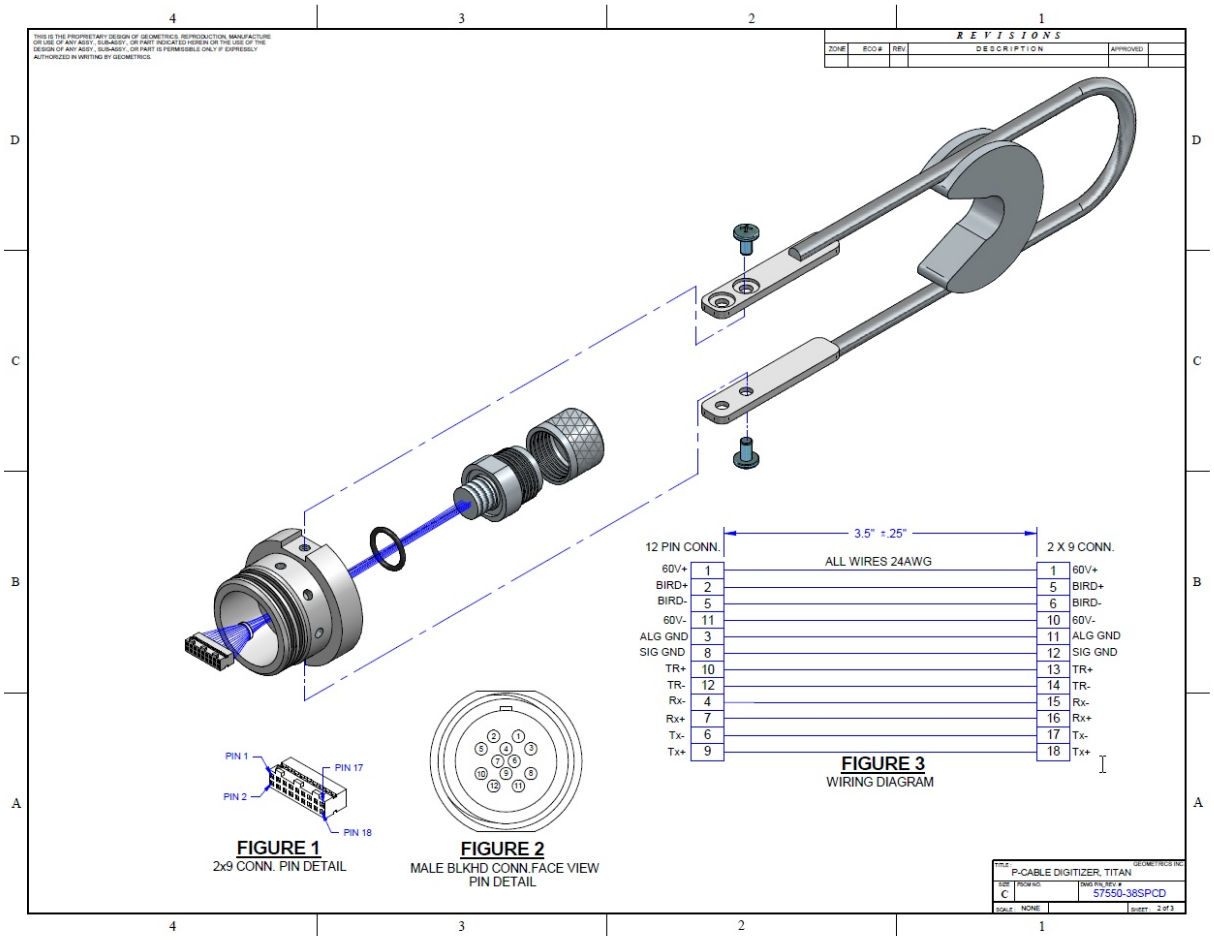


Figure A201: Wiring diagram for Titan connector.

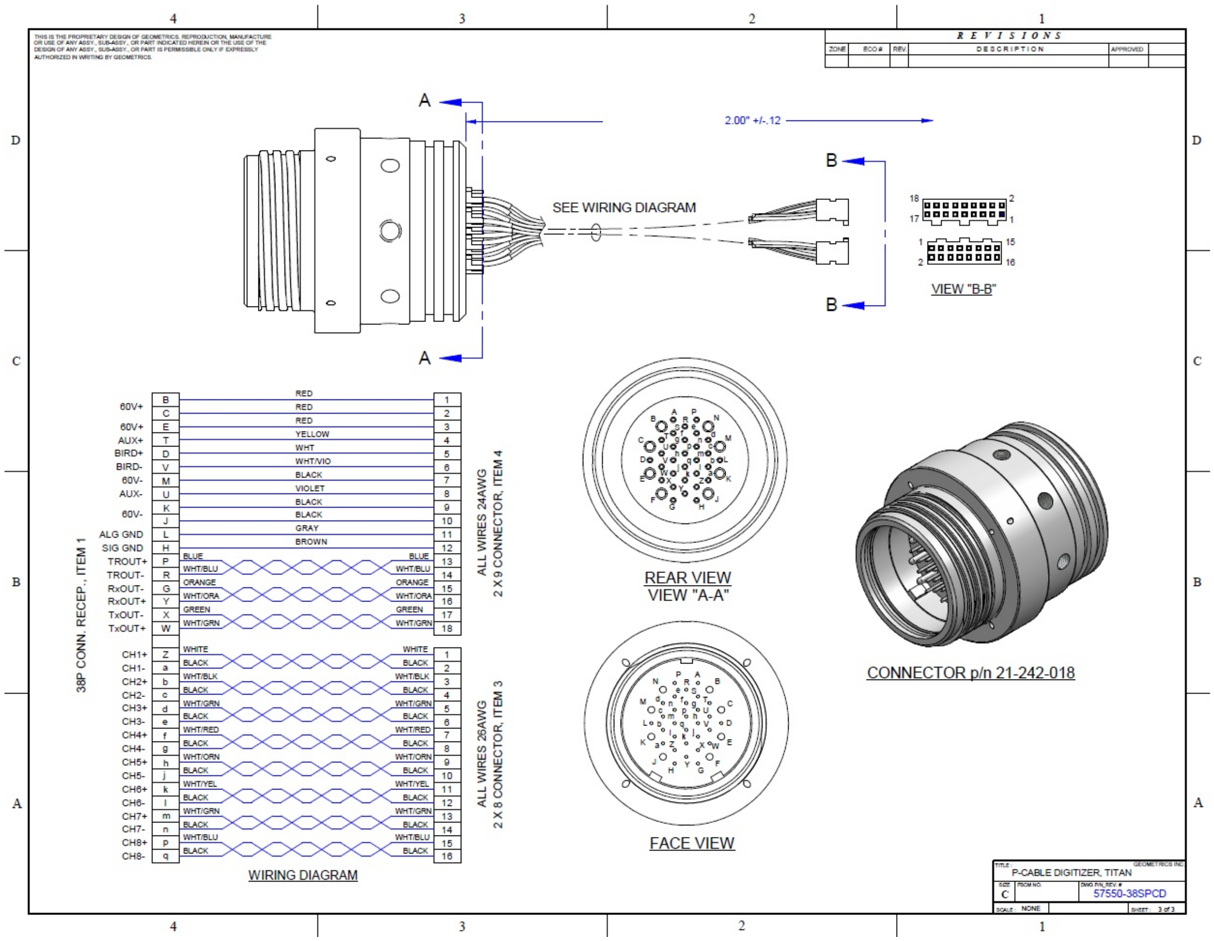
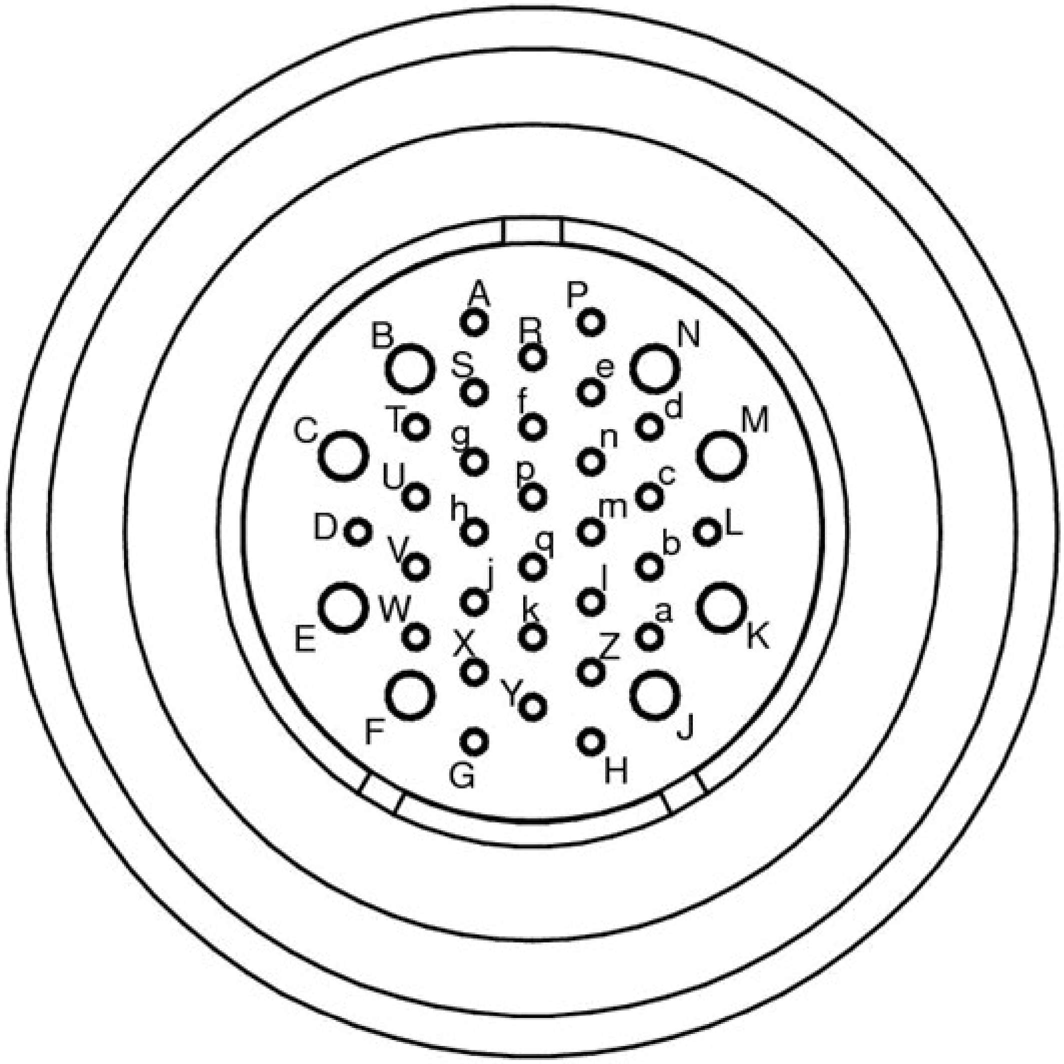


Figure A202: Wiring diagram for Glenair connector.

5.11.21 Active Section (Solid, Scoop-proof Glenair Connectors)



21-242-015
Female Glenair

Figure A203: Pin labels for female Glenair Solid Active Section connectors (scoop-proof).

	CHANNEL #	COLOR	AWG	HEAD CONN / POLARITY	12 PHONES + SWITCH ARRAY SIDE A	SIDE B	TAIL CONN	REMARK	
QUADRANT #1	7	WHITE	26	m (+)	CLEAR WIRE	CLEAR WIRE	b (+)	TP	
		BLACK	26	n (-)	WHITE WIRE	WHITE WIRE	c (-)		
	4	RED	26	f (+)	CLEAR WIRE	CLEAR WIRE	h (+)	TP	
		BLACK	26	g (-)	WHITE WIRE	WHITE WIRE	j (-)		
	3	GREEN	26	d (+)	CLEAR WIRE	CLEAR WIRE	k (+)	TP	
		BLUE	26	e (-)	WHITE WIRE	WHITE WIRE	l (-)		
	2	ORANGE	26	b (+)	CLEAR WIRE	CLEAR WIRE	m (+)	TP	
		RED	26	c (-)	WHITE WIRE	WHITE WIRE	n (-)		
	TRIGGER	RED	26	P (+)			P (+)	TP	
		BROWN	26	R (-)			R (-)		
QUADRANT #2	8	BLUE	26	p (+)	CLEAR WIRE	CLEAR WIRE	Z (+)	TP	
		BLACK	26	q (-)	WHITE WIRE	WHITE WIRE	a (-)		
	AUX	RED	26	T (+)			T (+)	TP	
		YELLOW	26	U (-)			U (-)		
	POSITIVE PWR	**RED/RED Q1**	**18**	**B (+)**			**B (+)**	QUADRUPLE TWISTED	
		RED/RED Q3	**18**	**C (+)**			**C (+)**		Q1
	BIRD (Inner Pair Shielded)	WHITE	22	D (+)			D (+)	TRIPLE TWISTED	
		BLUE	22	V (-)			V (-)		
		DRAIN	24	L			L		
QUADRANT #3	5	ORANGE	22	h (+)	CLEAR WIRE	CLEAR WIRE	f (+)	TP	
		BLACK	22	j (-)	WHITE WIRE	WHITE WIRE	g (-)		
	POWER	**RED/RED Q2**	**18**	**E (+)**			**E (+)**	QUADRUPLE TWISTED	
		BLK/BLK Q2	**18**	**M (-)**			**M (-)**		Q2
	CAT 5 (BLUE)	Rx (+) WHITE	24	Y (+)			Y (+)		
		Rx (-) BLUE	24	G (-)			G (-)		
		DRAIN	24	L			L		
	CAT 5 (GREEN)	WHITE	24	W (+)			W (+)		
		BLUE	24	X (-)			X (-)		
		DRAIN	24	L			L		
QUADRANT #4	6	GREEN	26	k (+)	CLEAR WIRE	CLEAR WIRE	d (+)	TP	
		BLACK	26	l (-)	WHITE WIRE	WHITE WIRE	e (-)		
	1	BROWN	26	Z (+)	CLEAR WIRE	CLEAR WIRE	p (+)	TP	
		BLACK	26	a (-)	WHITE WIRE	WHITE WIRE	q (-)		
	NEGATIVE PWR	**BLK/BLK Q1**	**18**	**K (-)**			**K (-)**	QUADRUPLE TWISTED	
		BLK/BLK Q3	**18**	**J (-)**			**J (-)**		Q3
	SIGNAL GND	BLACK	26	H (+)			H (+)	TP	
		YELLOW	26	H (+)			H (+)		
	ANALOG GND	RED	26	L	DRAIN WIRE (8X)	DRAIN WIRE (8X)	L	TP	
		GREEN	26	L			L		
	SPARE	RED	26					TP	
		WHITE	26						
	SPARE	RED	26					KV 8/26/10	
		BLUE	26						

Table A204: Solid Active Section wiring diagram (scoop-proof).

5.11.22 Tail Swivel With Power Output

Concord Tail Swivel

Streamer Tail Swivel Device


Tail Swivel Device

Features

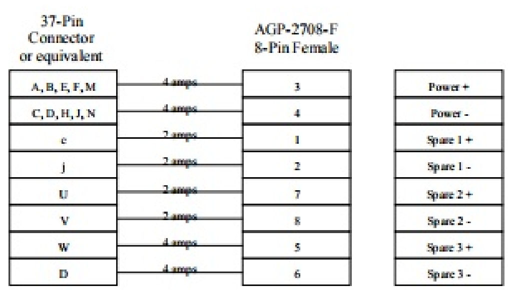
- Provides power and communication between streamer and tail-buoy via internal slip ring
- Prevents rotational stress and damage from streamer rotational coiling
- Rugged design provides superior in-water reliability
- Custom high power models available on request

GENERAL SPECIFICATIONS

Number of Internal Ring Circuits	24	maximum
Maximum Current circuit	2	Amperes per
Maximum Rated Voltage:	210	VDC (Note 1)
	240	VAC
Nominal Circuit Resistance (single circuit):	200	milli ohms (Note 2)
Electrical Noise (at 5 RPM, 6 VDC, 50 mamps current):	100	milli ohms max
Insulation Resistance (at 500 VDC):	1000	mega ohms (Note 3)
Dielectric Strength	500	VAC @ 60 Hz (Note 4)
Slip Ring Contact Material:	Gold	
Static Operating Load:	7000	pounds
Dynamic Operating Load:	4250	pounds
Recommended Maximum Operating Depth:	400	meters seawater
Seal Design Pressure Rating:	1000	PSIG (685 meters seawater)
Case Material:	6AL4V Titanium	
Operating Temperature Range:	-5° to 60°	Celsius
Storage Temperature Range:	-40° to 80°	Celsius

Notes:

1. *Circuits are suitable for low milli volt signals.*
2. *For paralleled circuits, divide 200 milli ohms by number of circuits.*
1. *Case is electrically isolated from any circuit*



Example: Tail Swivel Wiring

OYO GEOSPACE GROUP OF COMPANIES
OYO GEOSPACE • 7007 Pinemont • Houston, Texas, 77040 U.S.A. • www.geospacetech.com
Tel: 713 986-4444 • Fax: 713 986-4445

GEOSPACE TECHNOLOGIES GEOSPACE GEOSPACE OFFSHORE OYO INSTRUMENTS, LP

Regional Offices
OYO Geospace Canada, Inc. 2735-37 Avenue N.E. Calgary, Alberta, Canada T1Y 5R8 403 250-9600
OYO Geo-Impulse International LLC Kirovogradskaya, 36 Ufa, Bashkortostan, Russia 450001 011 (7) 3472 25 39 73
OYO Geospace China Room 700, 7th Floor, Lido Office Tower, Lido Place Jichang Road, Jiang Tai Road, Beijing, 100004, P.R.China 011 (86) 10 643 78 758
OYO Instruments, Europe Ltd. 83 Bramingham Business Park, Enterprise Way, Luton Bedfordshire LU3 4BU, England 011 44 (0) 1582 573 980

Concord Tail Swivel 07/2004

Figure A205: Wiring diagram and brochure for Concord Tail Swivel.

5.11.23 Signal Cable

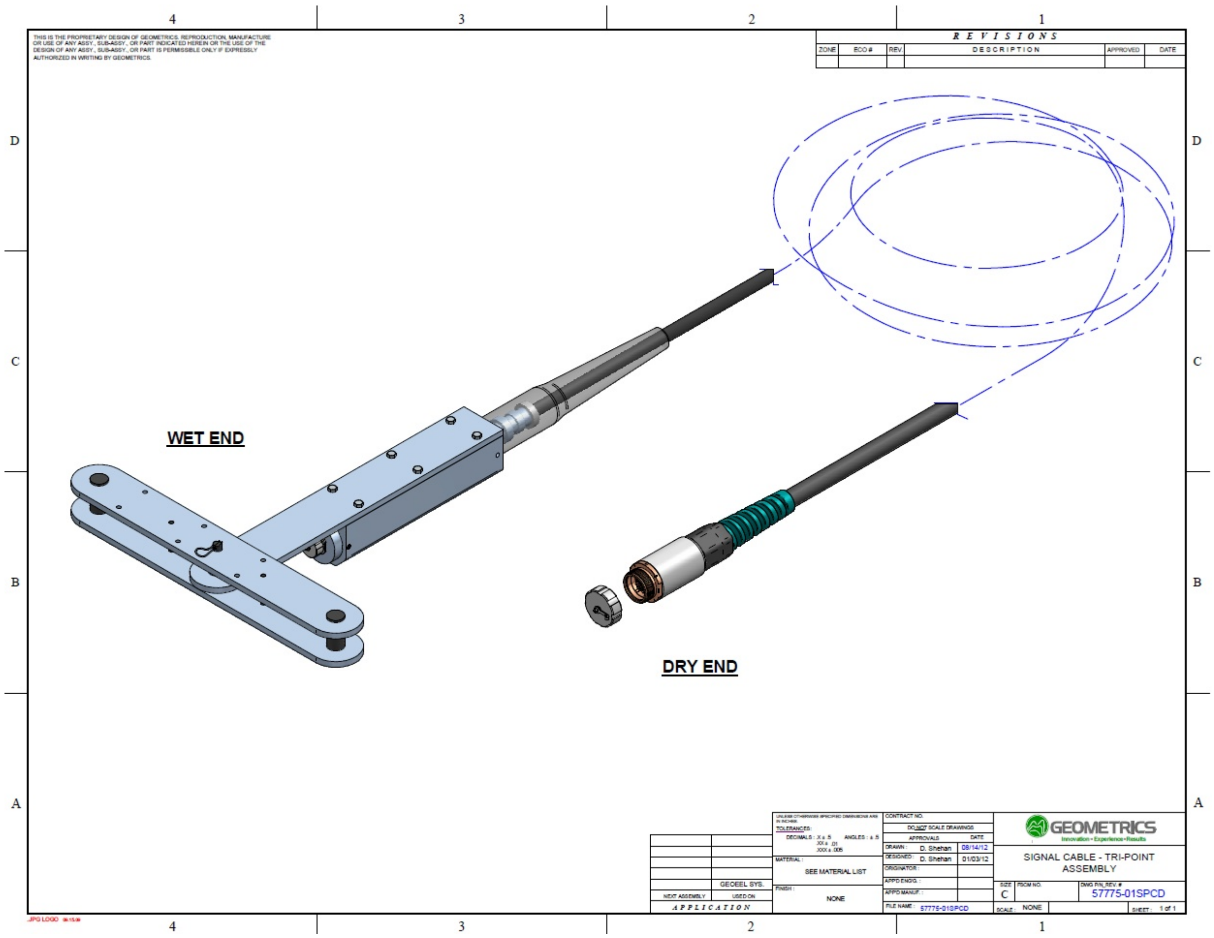


Figure A206: Schematic of Signal Cable.

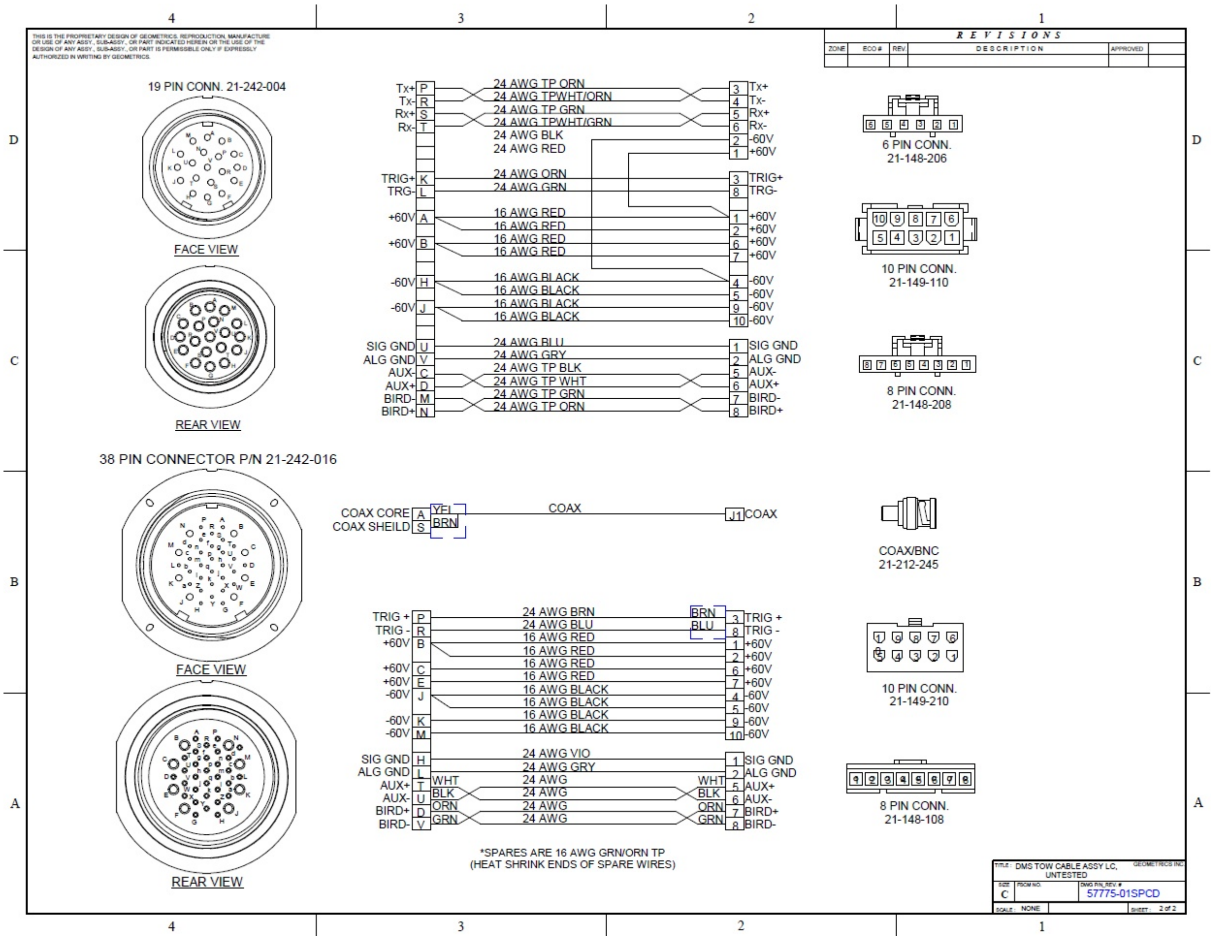


Figure A207: Wiring diagram for Signal Cable.

5.11.24 Cross-Cable Interconnect Cable (Glenair Connectors)

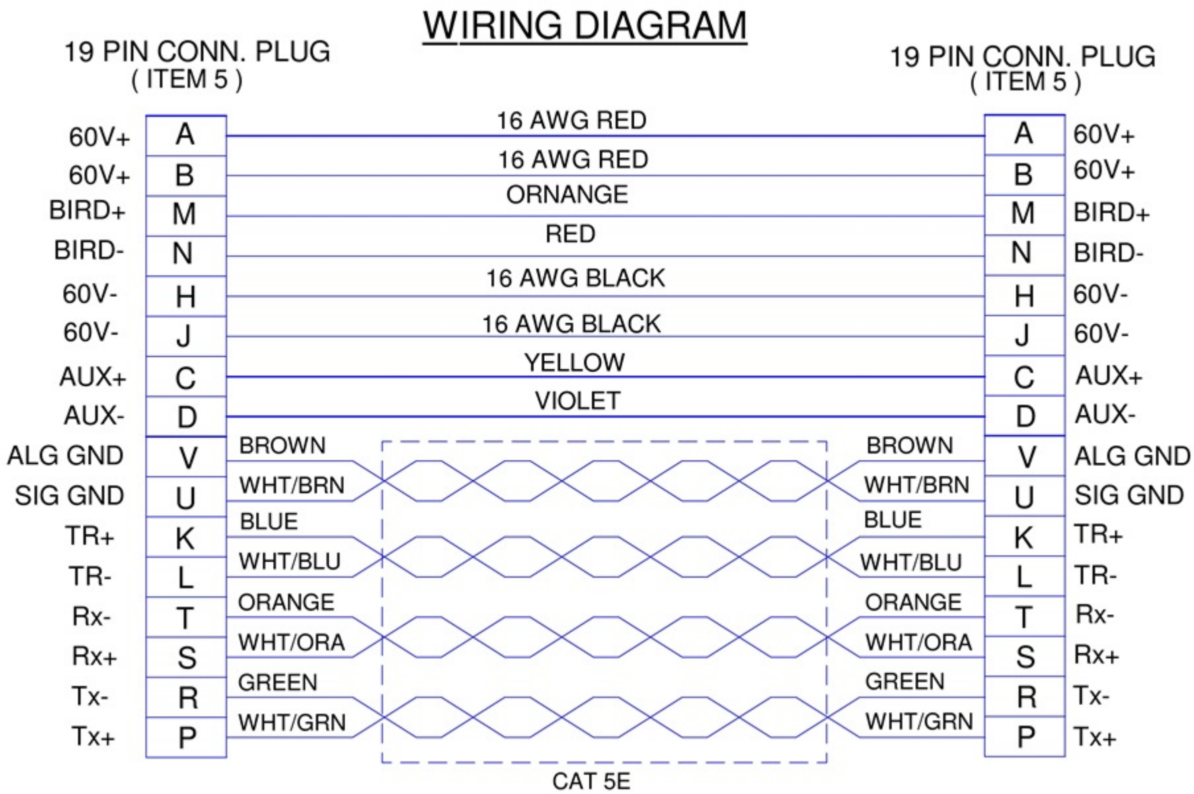


Figure A208: Cross Cable Interconnect Cable wiring diagram, Glenair connectors.

5.11.25 Junction Box (Glenair and Subconn Connectors)

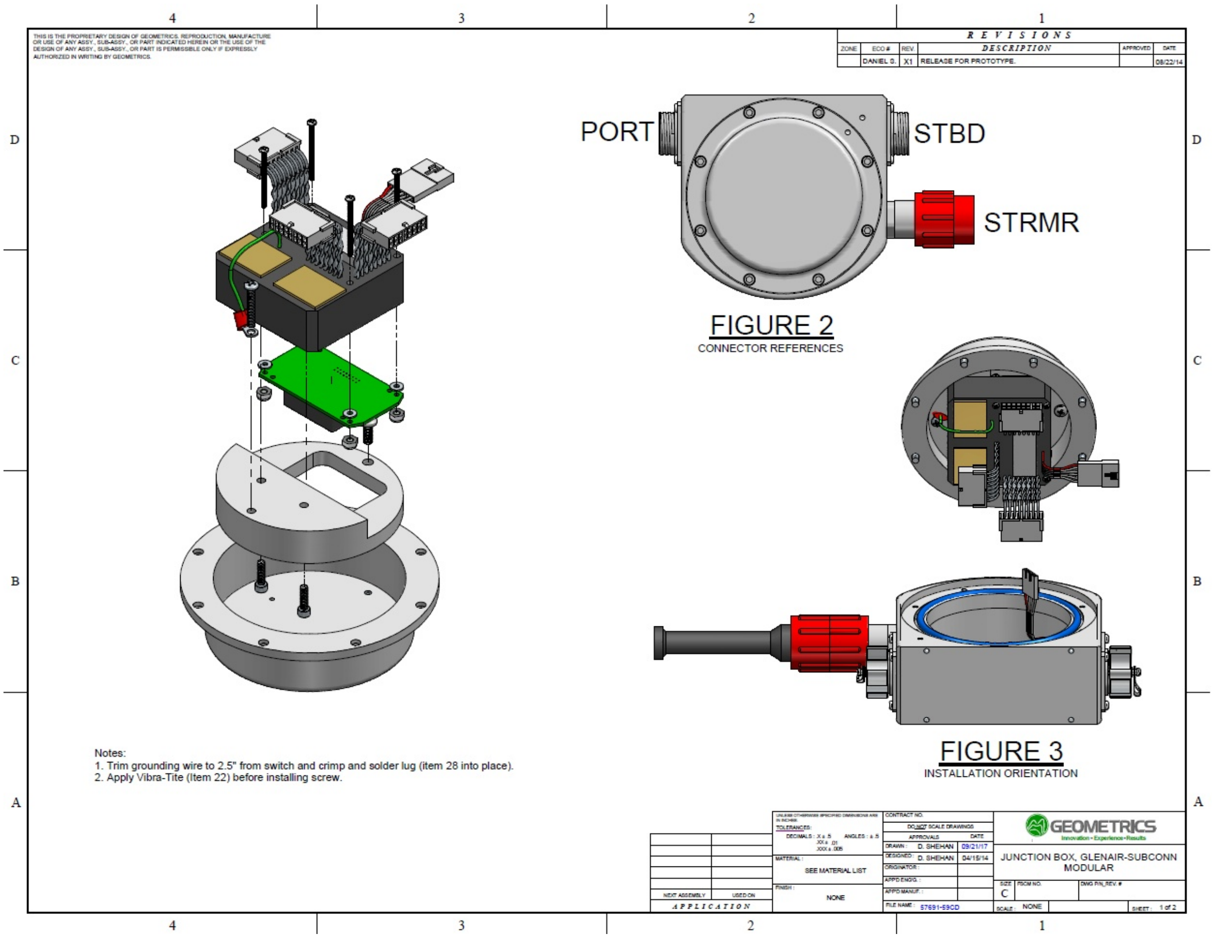


Figure A209: Exploded view of Junction Box (Glenair and Subconn).

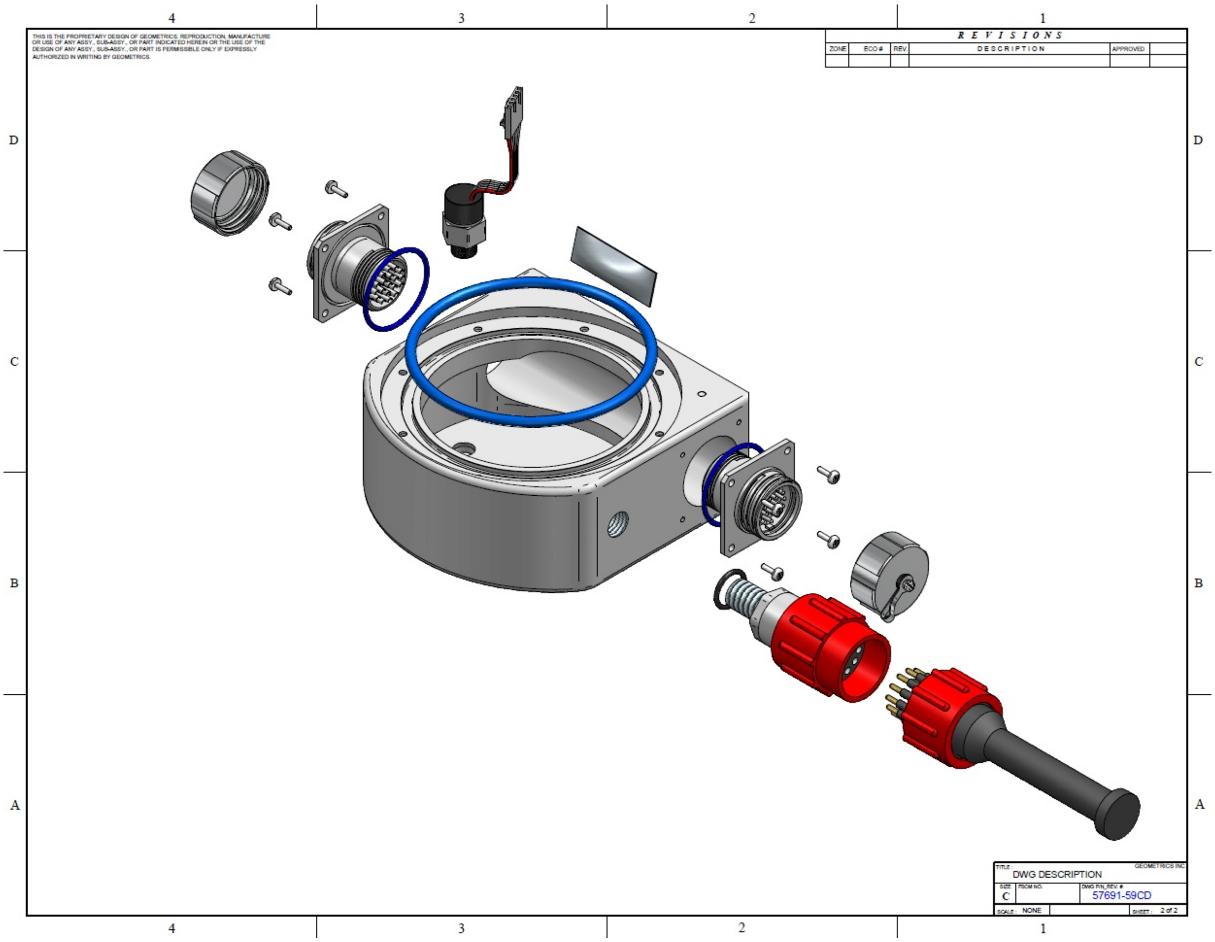


Figure A210: Exploded view of Junction Box shell.

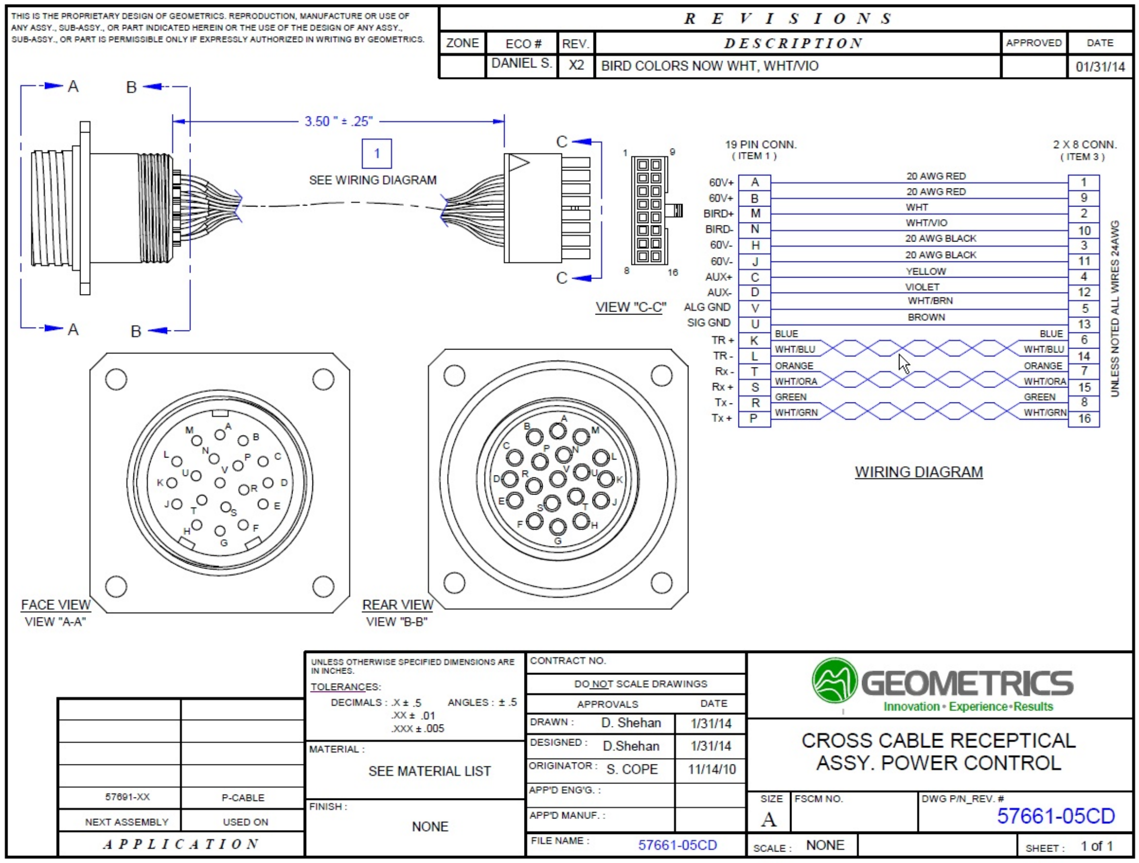


Figure A211: Wiring diagram for Glenair connector.

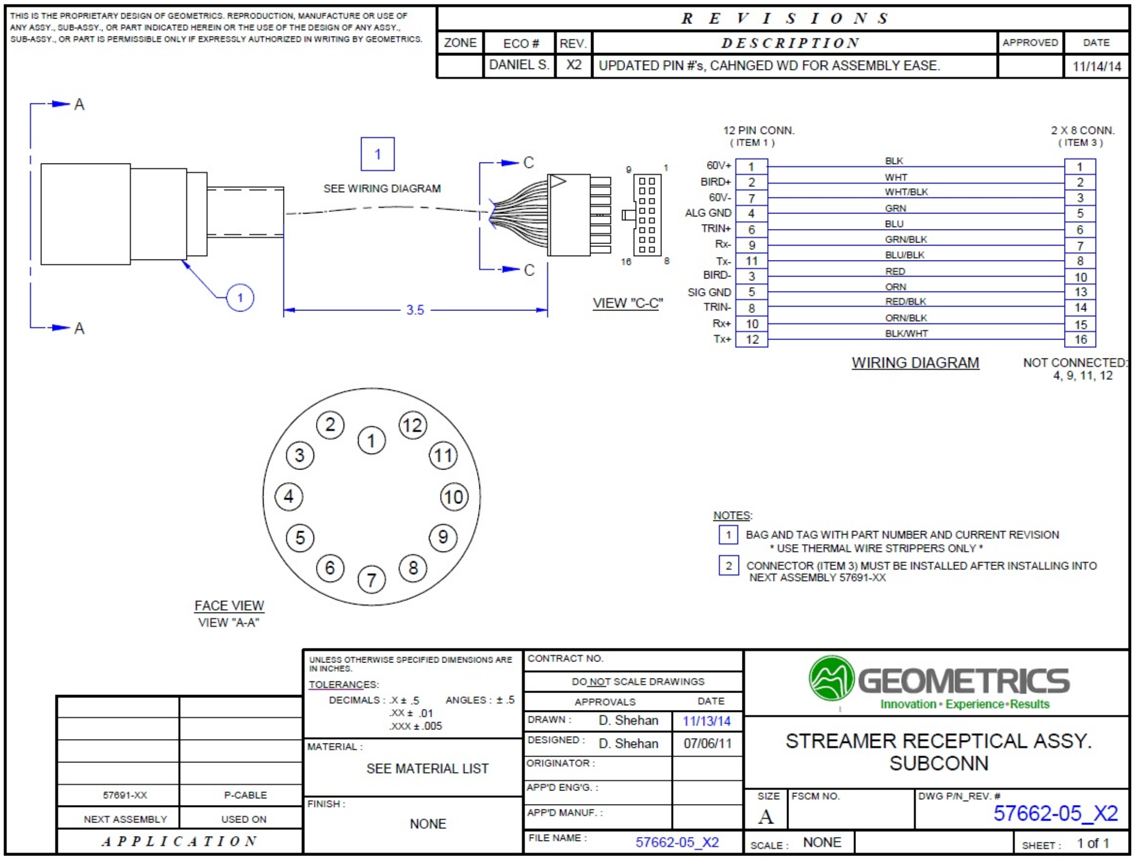


Figure A212: Wiring diagram for Subconn connector.

5.11.26 Junction Box (Glenair and Titan Connectors)

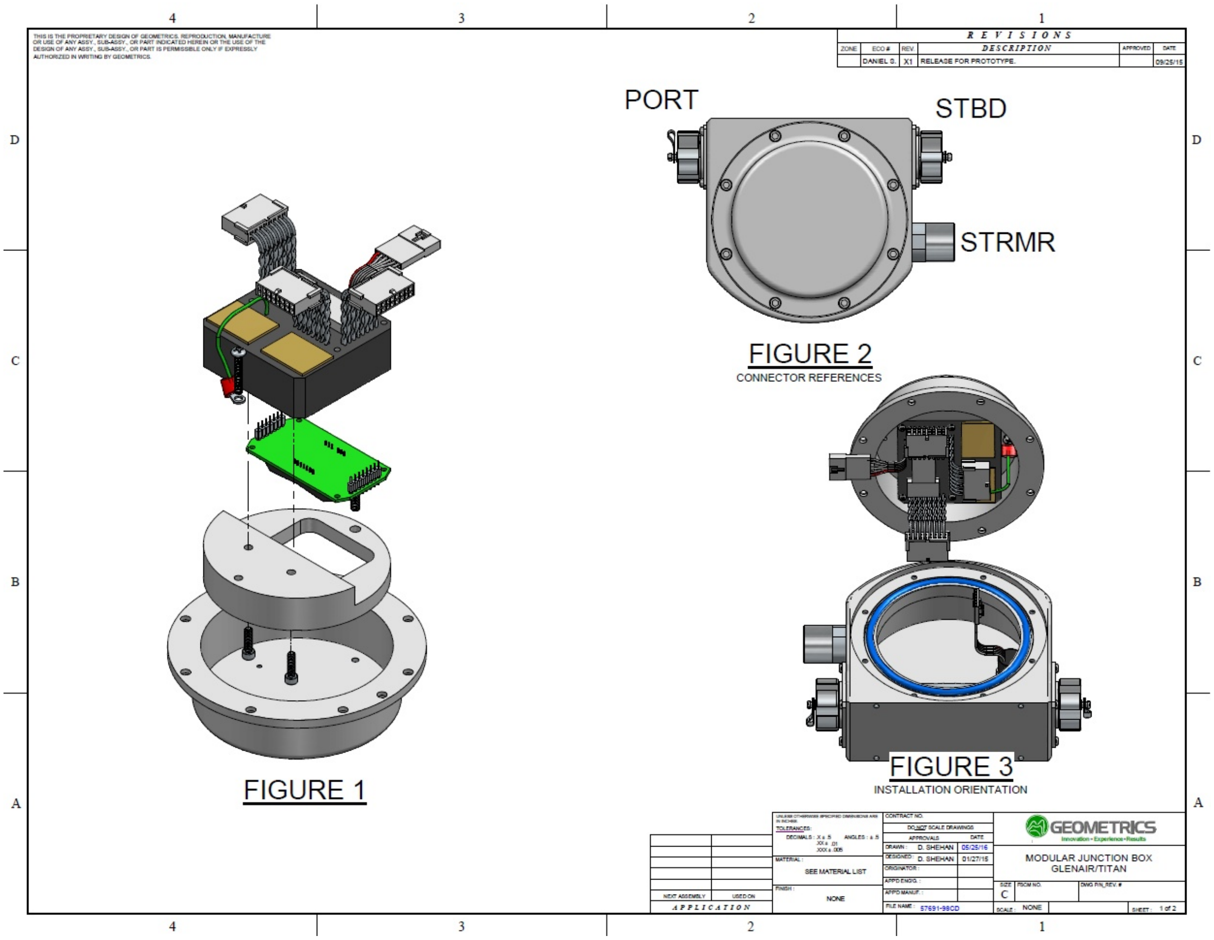


Figure A213: Exploded view of Junction Box (Glenair, Titan).

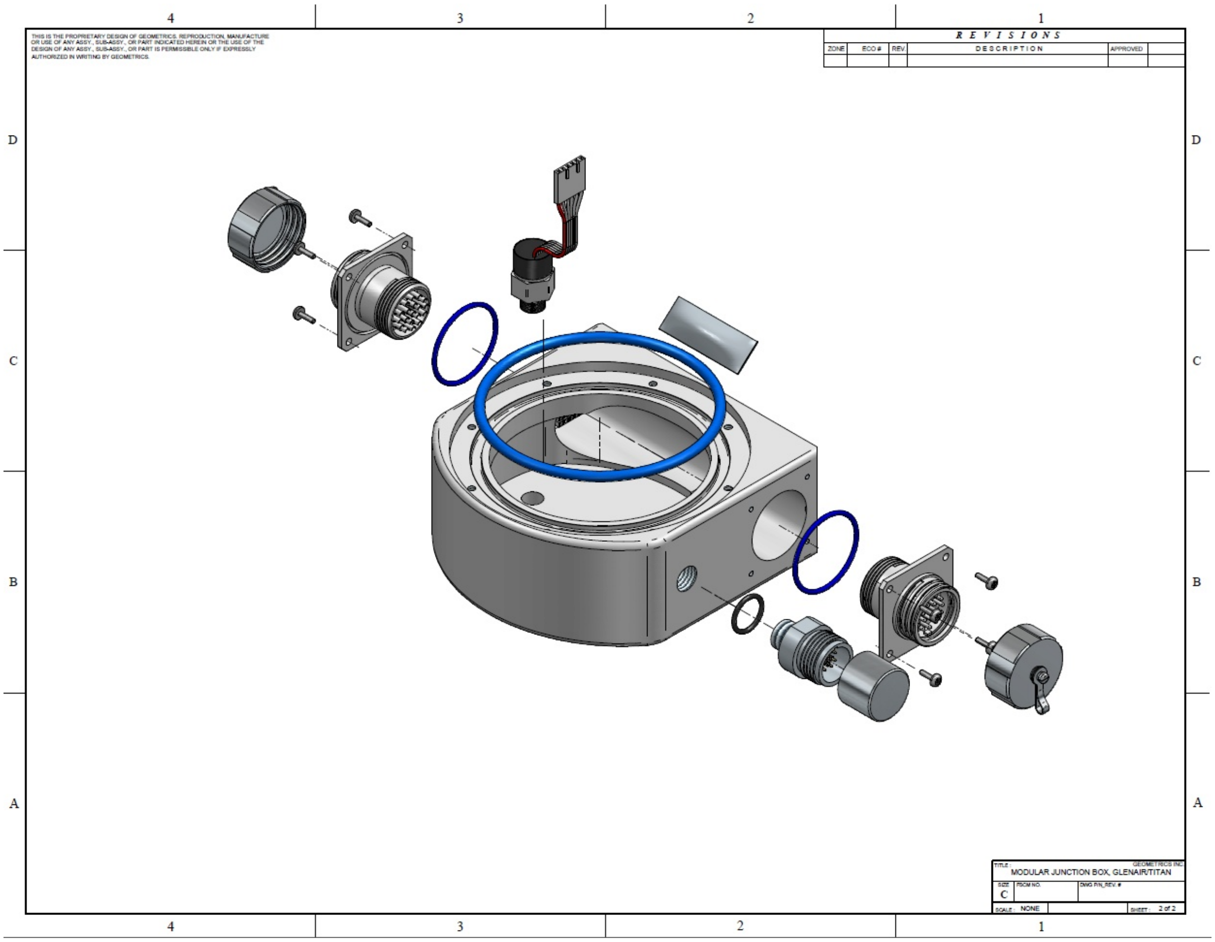


Figure A214: Exploded view of Junction Box shell.

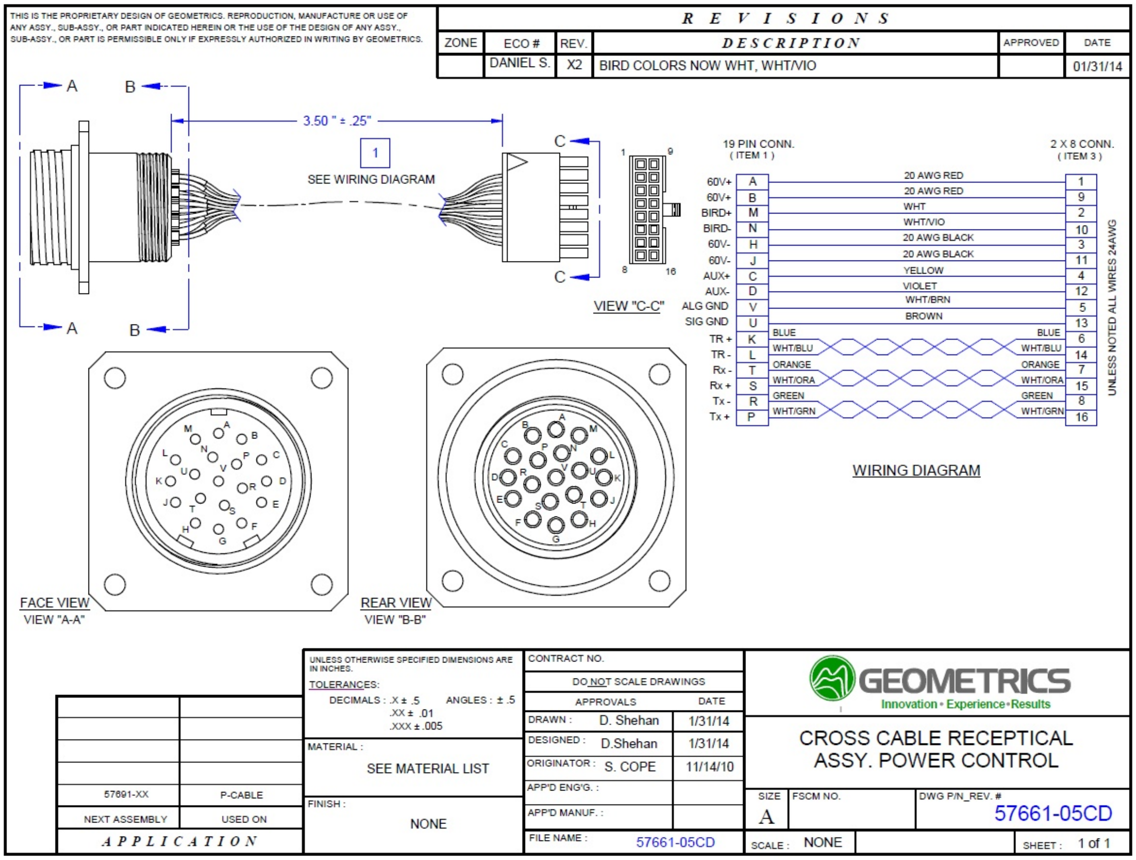


Figure A215: Wiring diagram for Glenair connector.

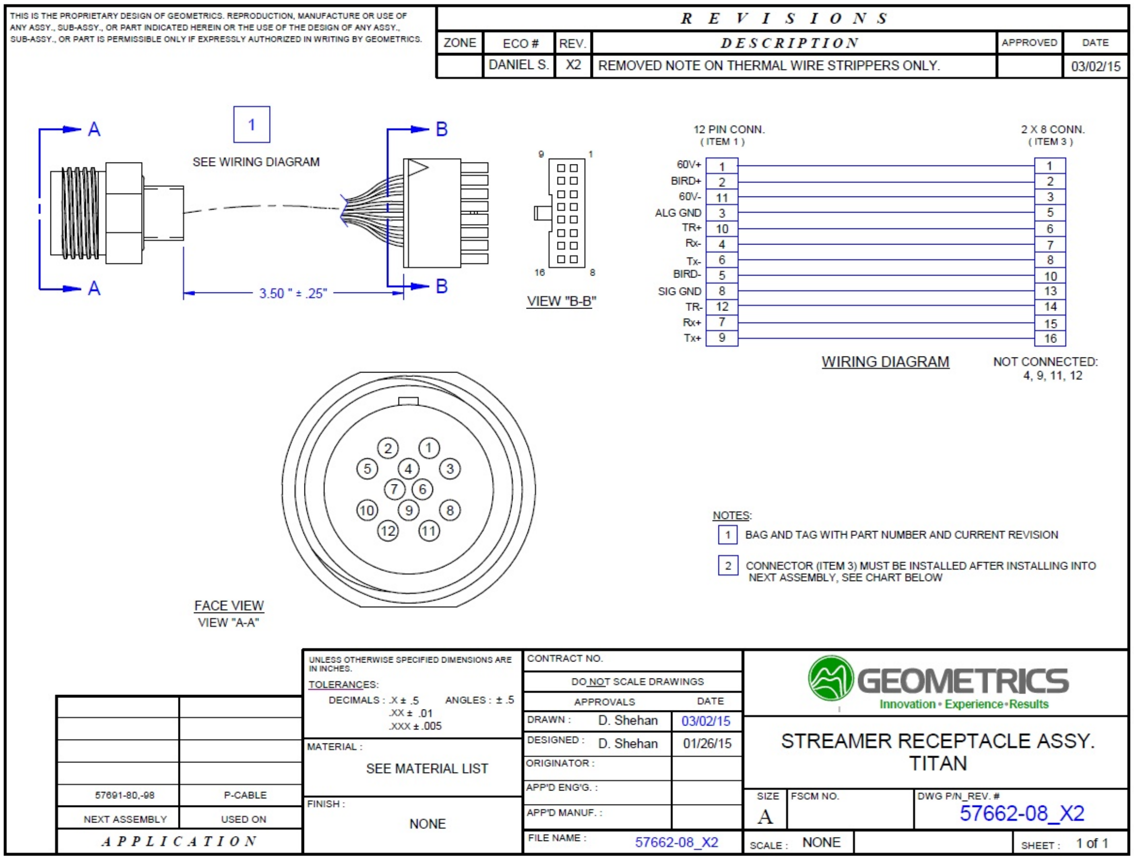


Figure A216: Wiring diagram for Titan connector.

5.11.27 Junction Box (Birns and Titan Connectors)

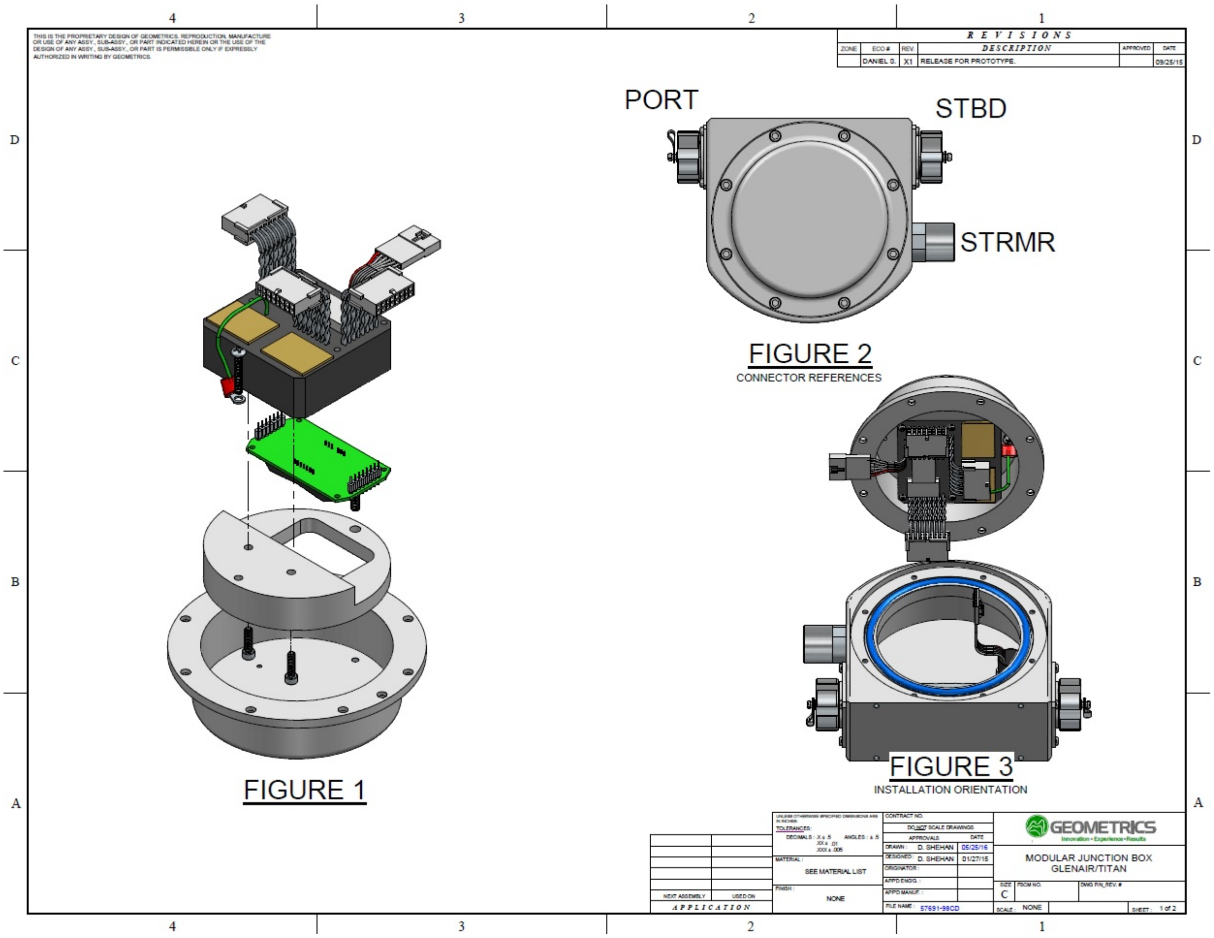


Figure A217: Exploded view of Junction Box (Birns, Titan).

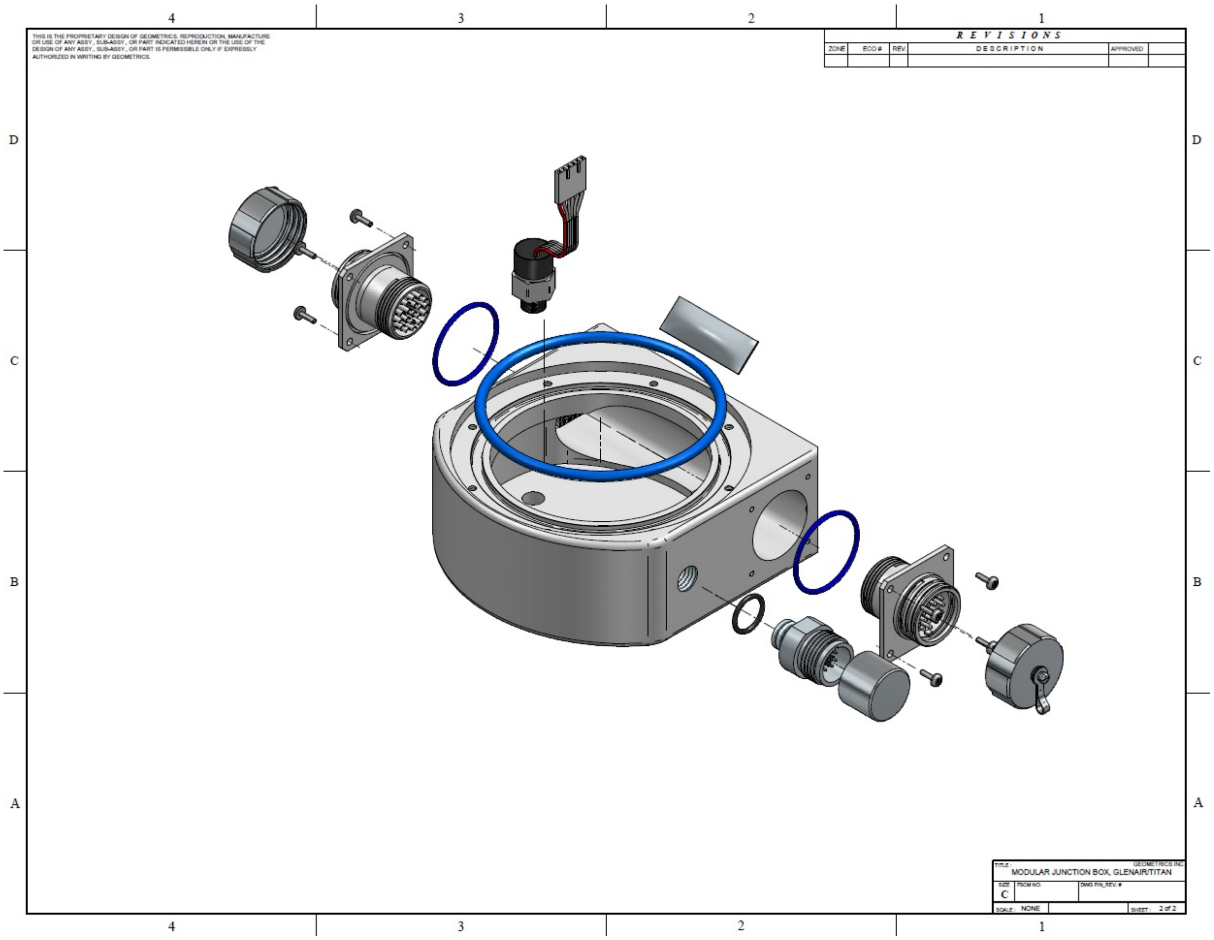


Figure A218: Exploded view of Junction Box shell.

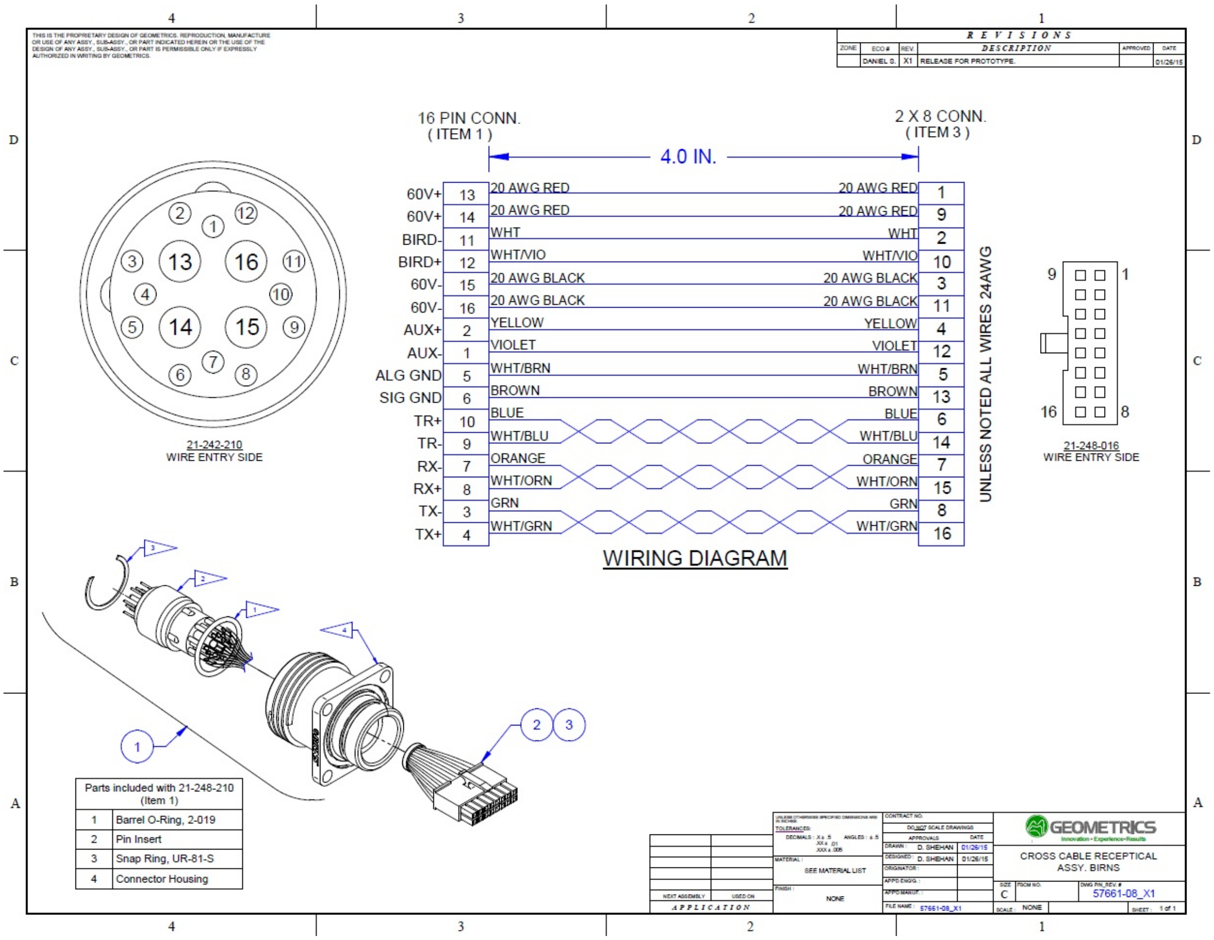


Figure A219: Wiring diagram for Birns connector.

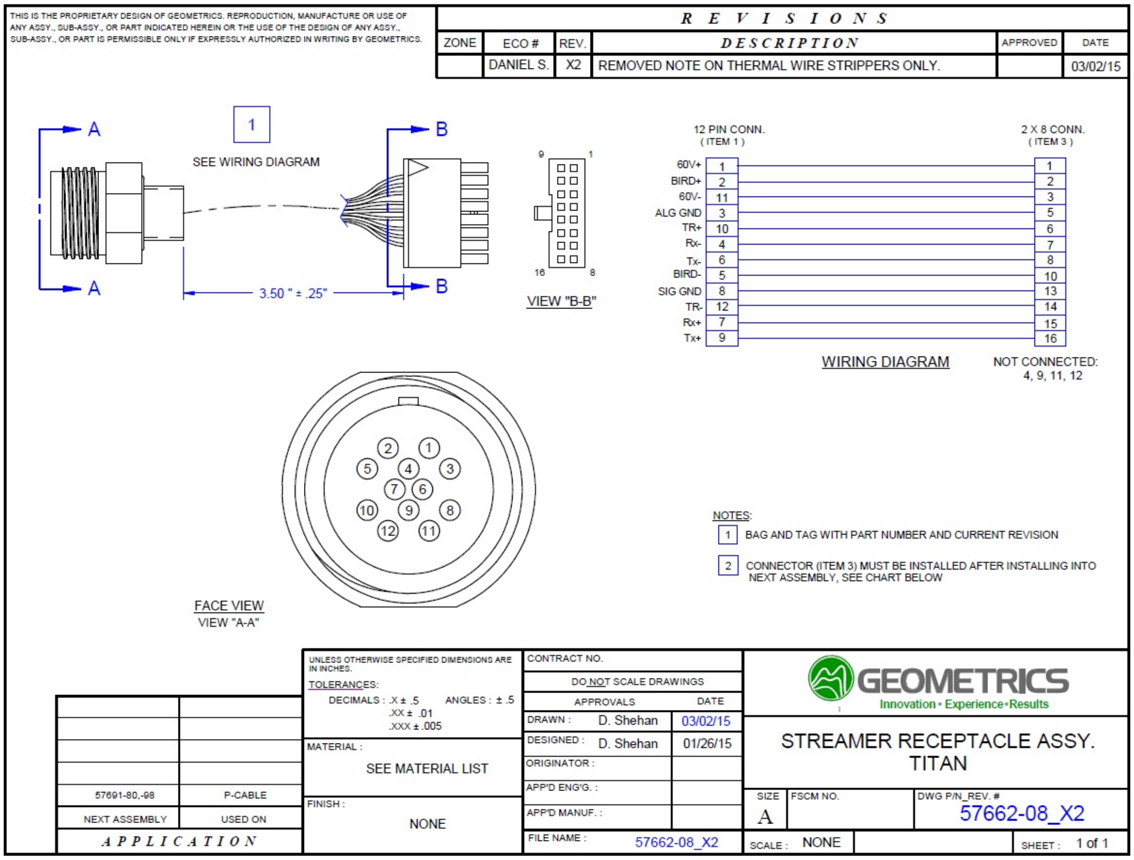


Figure A220: Wiring diagram for Titan connector.

5.11.28 Tension Gauge (Scoop-proof Glenair Connectors)

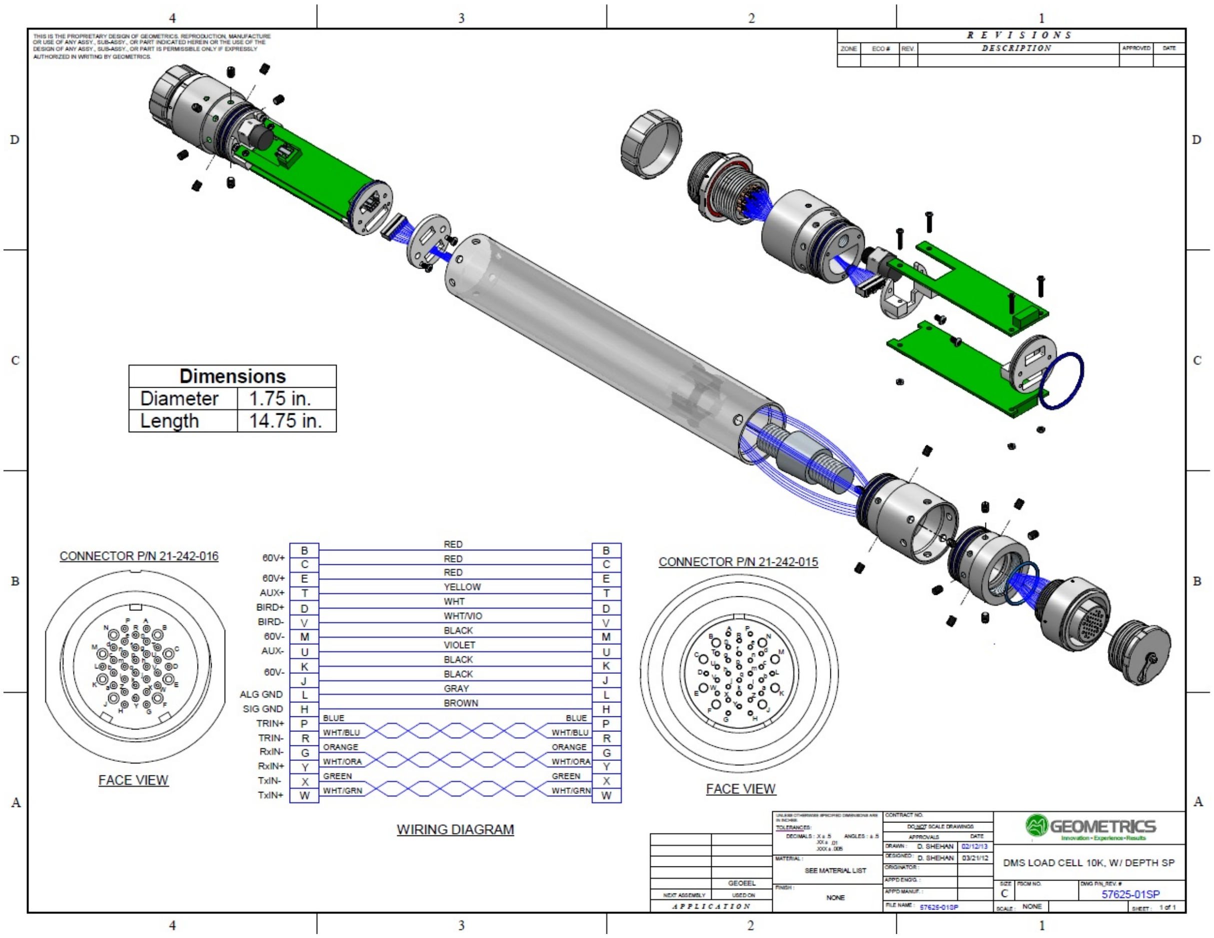


Figure A221: Exploded view of Tension Gauge.

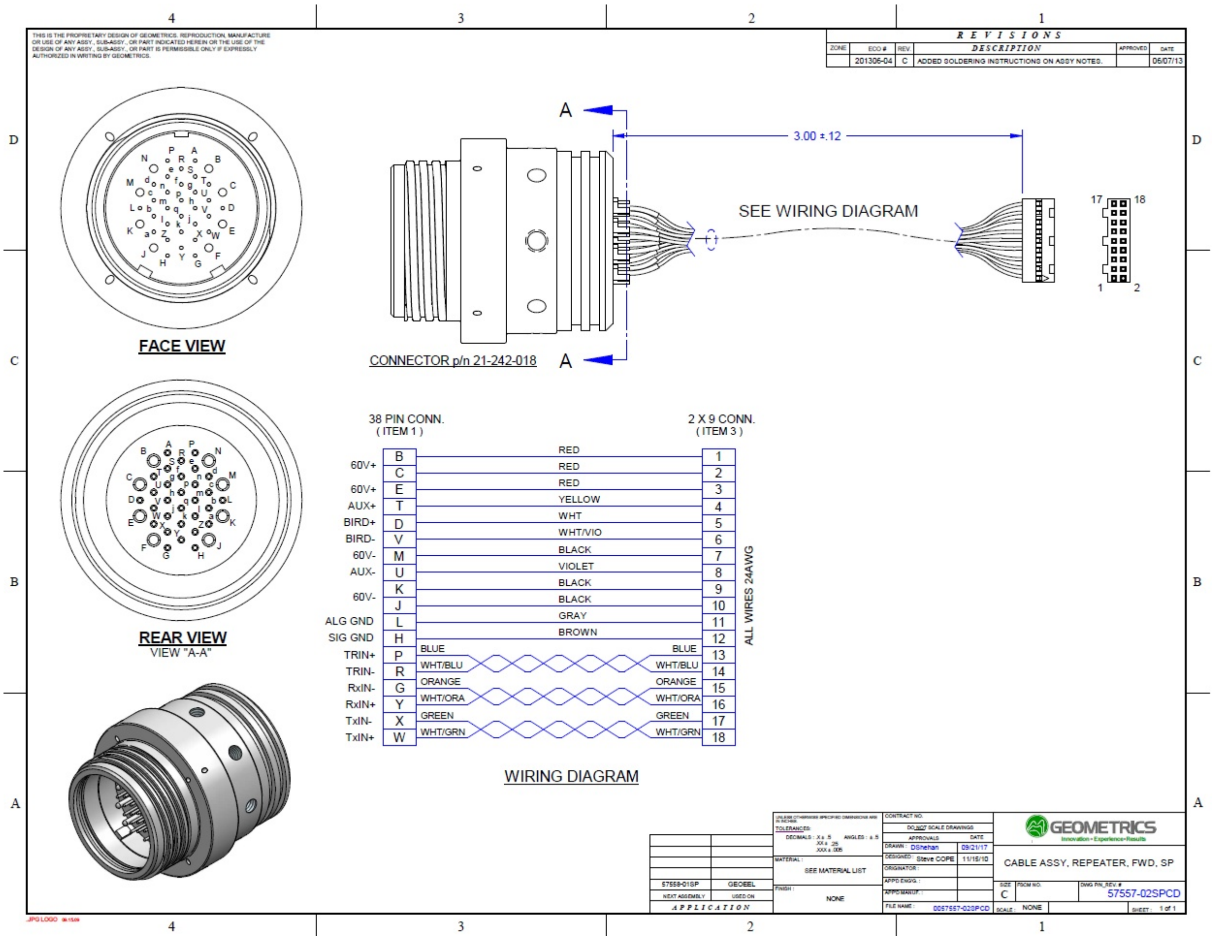


Figure A222: Wiring diagram for forward connector of Tension Gauge.

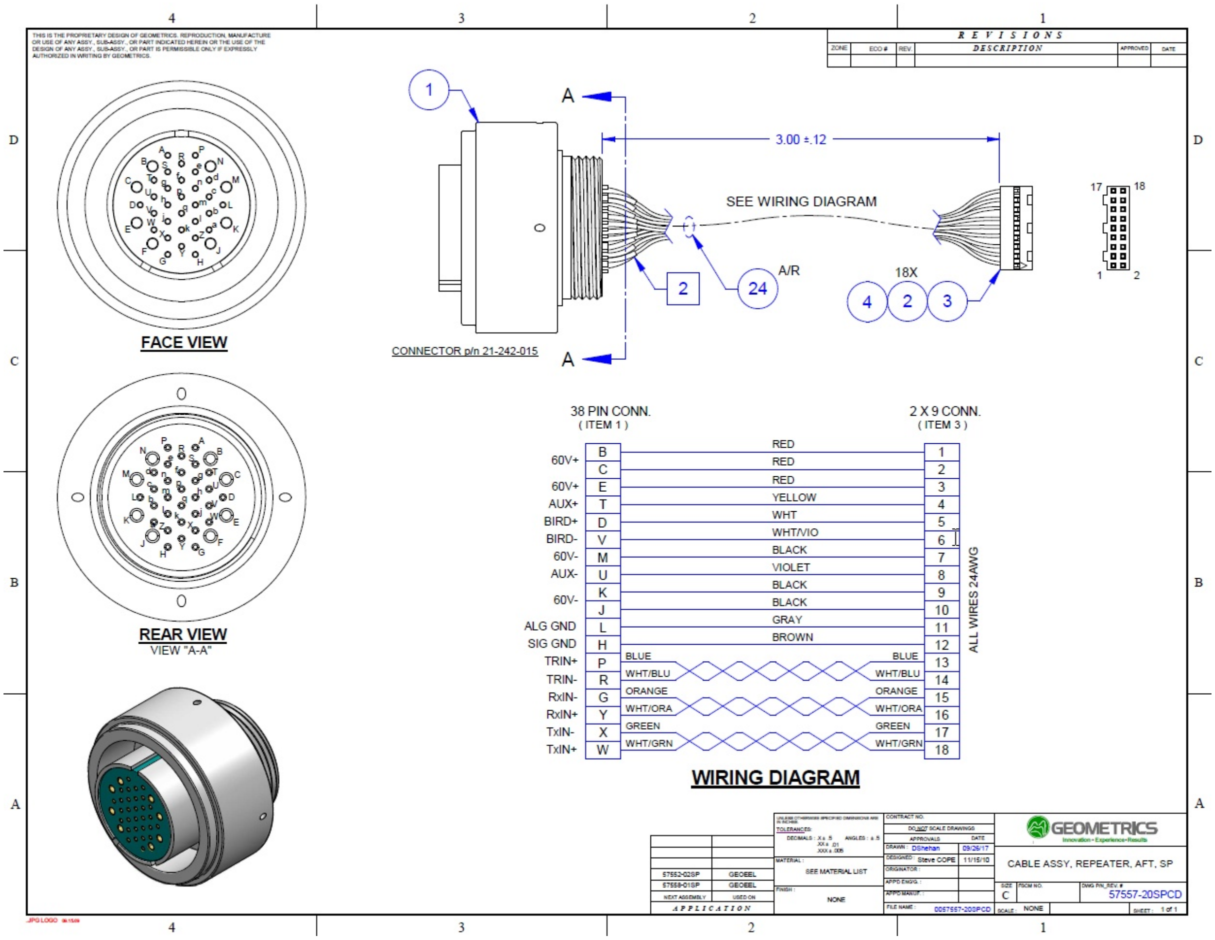


Figure A223: Wiring diagram for aft connector of Tension Gauge.

5.11.29 Tail Depth/Compass (Scoop-proof Glenair Connector)

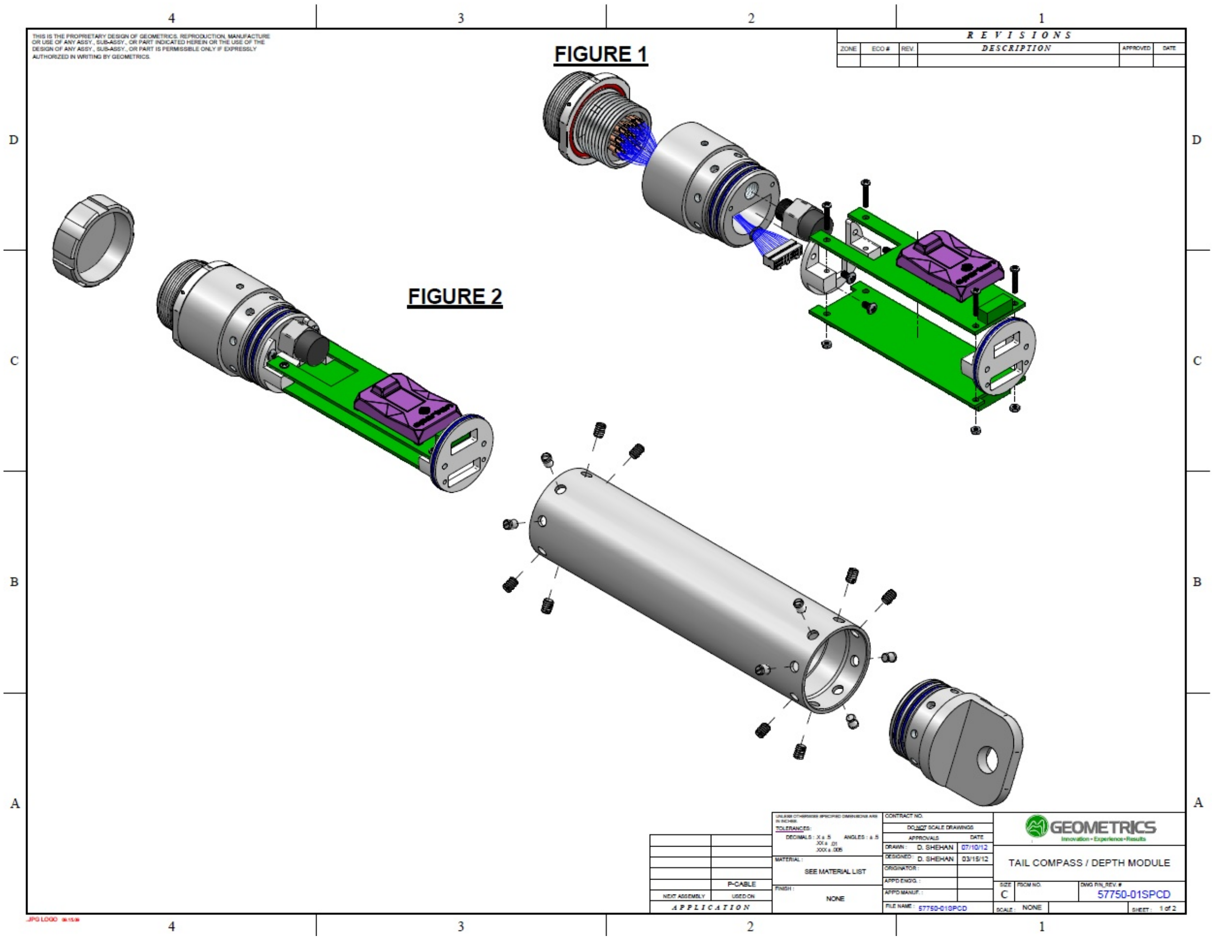


Figure A224: Exploded view of Tail Depth/Compass module (scoop-proof).

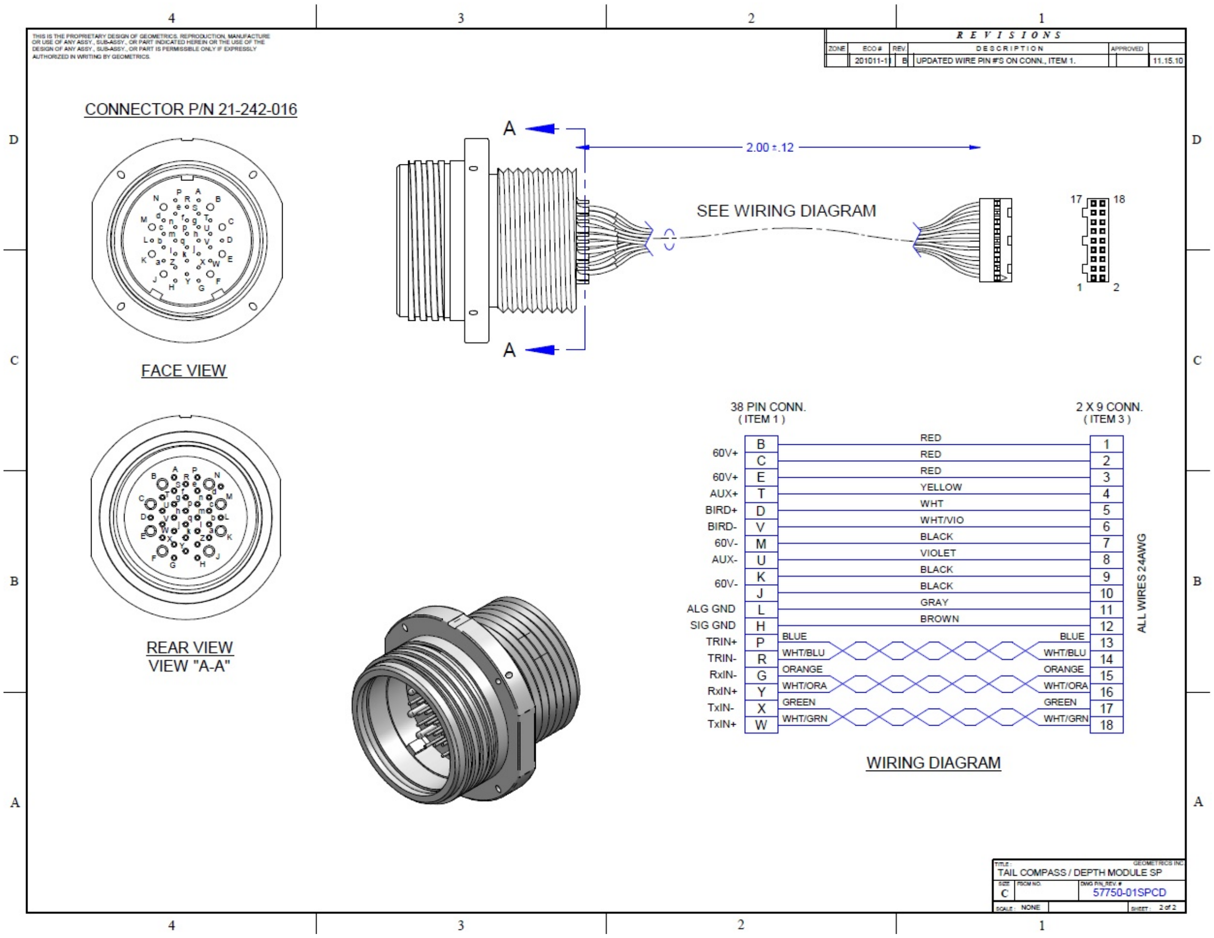


Figure A225: Wiring diagram for Tail Depth/Compass module (scoop-proof).

5.11.30 Tail Depth/Compass (Non Scoop-proof Glenair Connector)

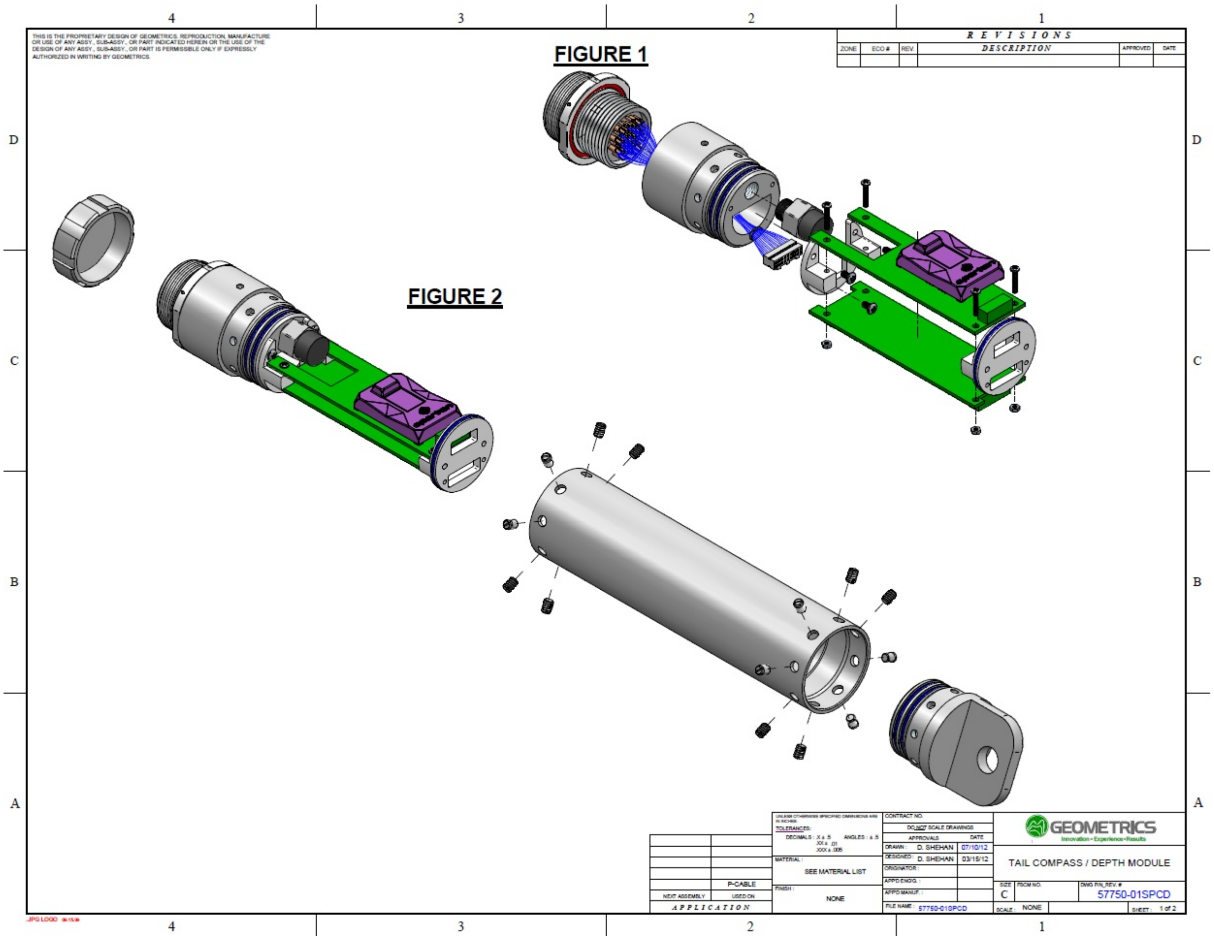


Figure A226: Exploded view of Tail Depth/Compass module (non scoop-proof).

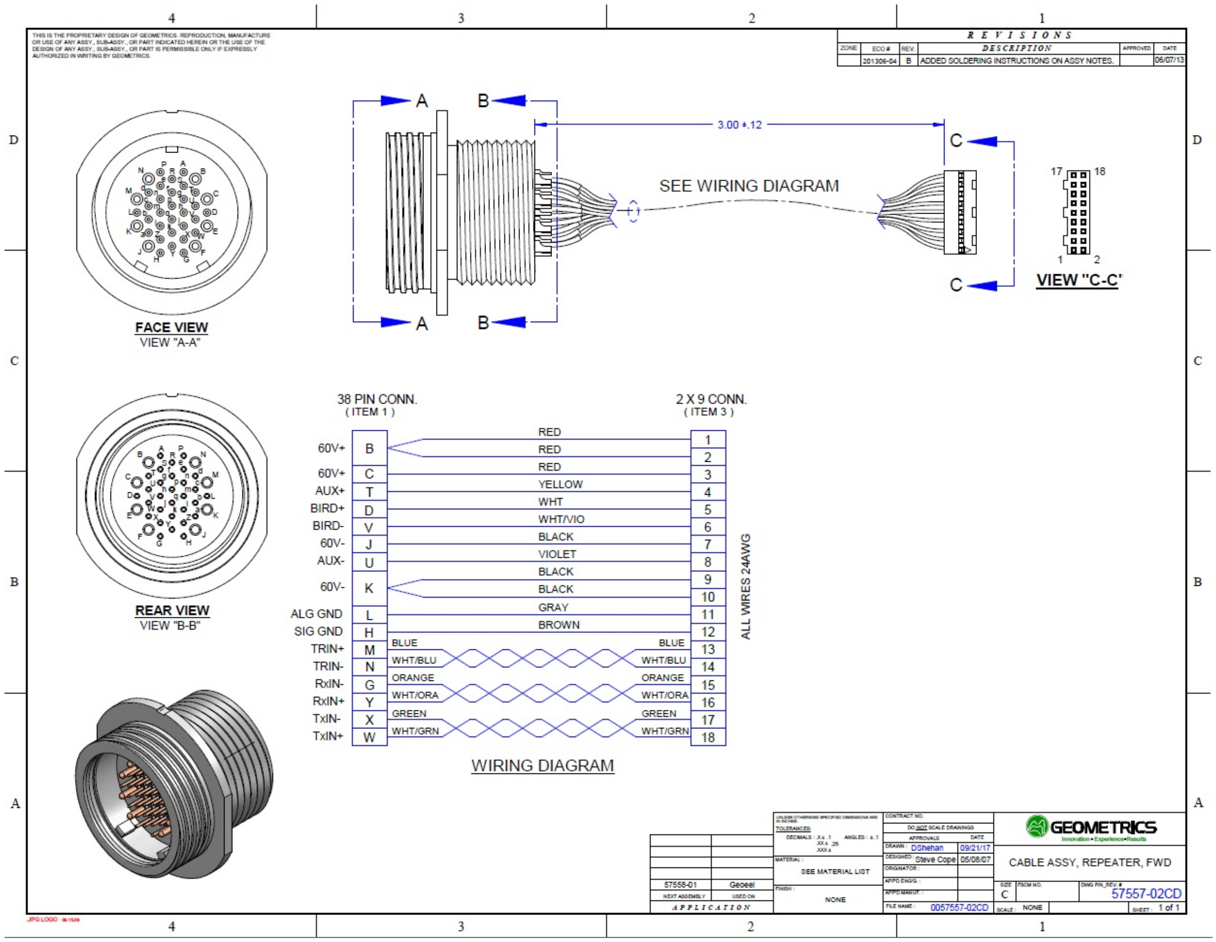


Figure A227: Wiring diagram for Tail Depth/Compass module (non scoop-proof).

5.11.31 Test Cable - Deck Unit to 2D Digitizer (Bendix and Scoop-proof Glenair Connectors)

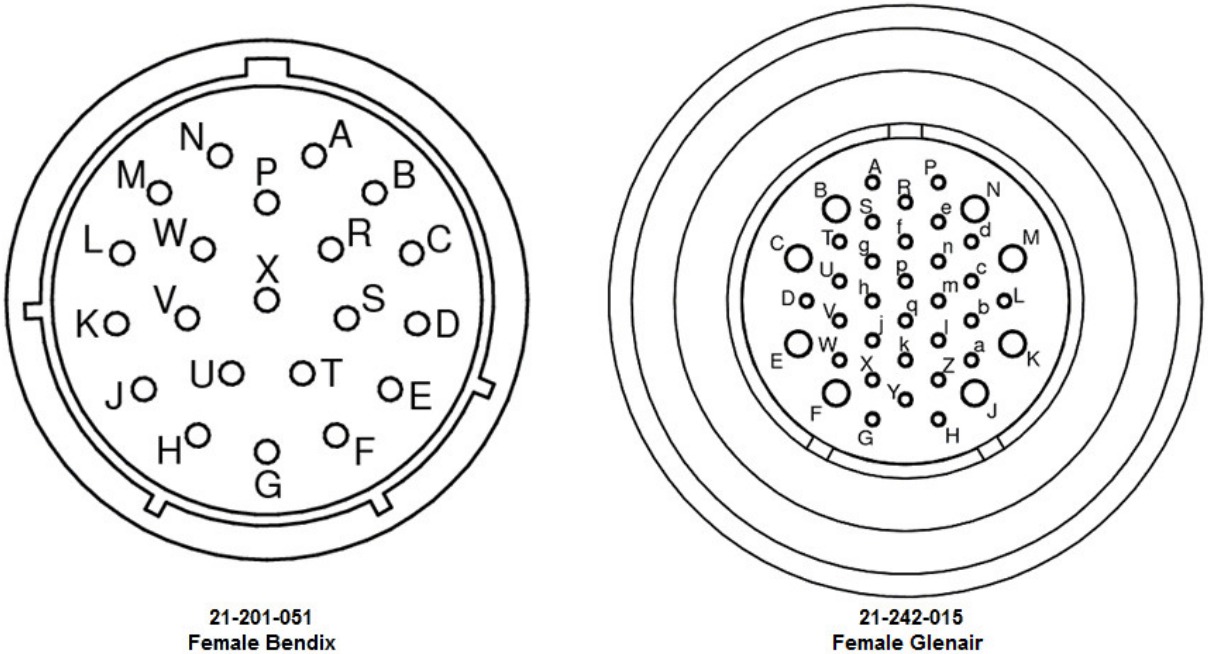


Figure A228: Pin labels for Bendix (left) and Glenair (right) 2D Test Deck Cable connectors (scoop-proof).

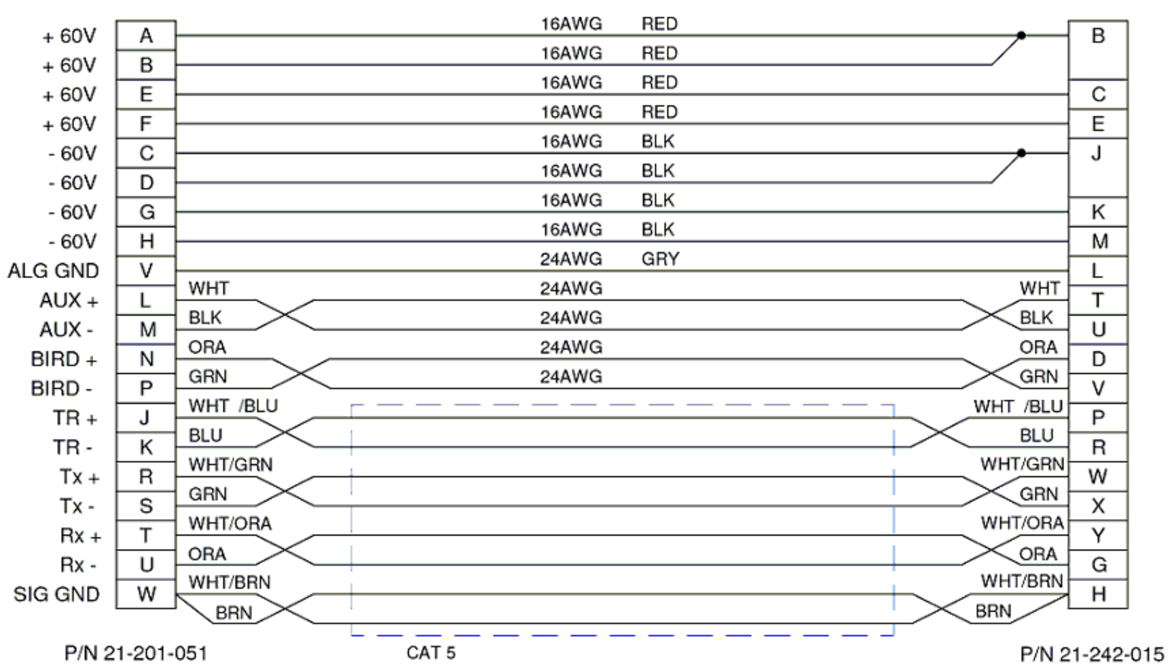


Figure A229: 2D Test Deck Cable wiring diagram (scoop-proof).

5.11.32 Test Cable - Deck Unit to 2D Digitizer (Bendix and Non Scoop-proof Glenair Connectors)

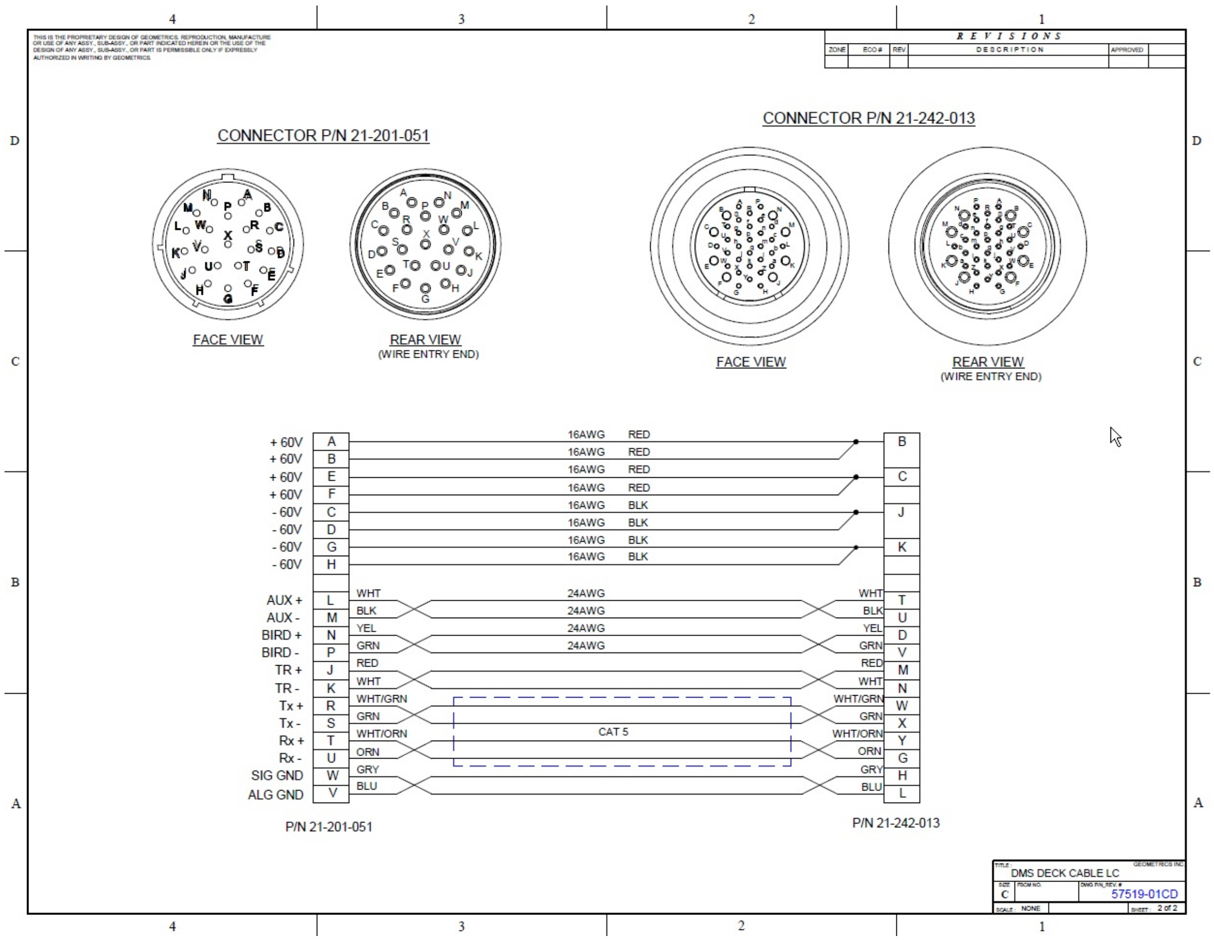


Figure A230: 2D Deck Test Cable wiring diagram (non scoop-proof).

5.11.33 Test Cable - Deck Unit to Junction Box (Bendix and Birns Connectors)

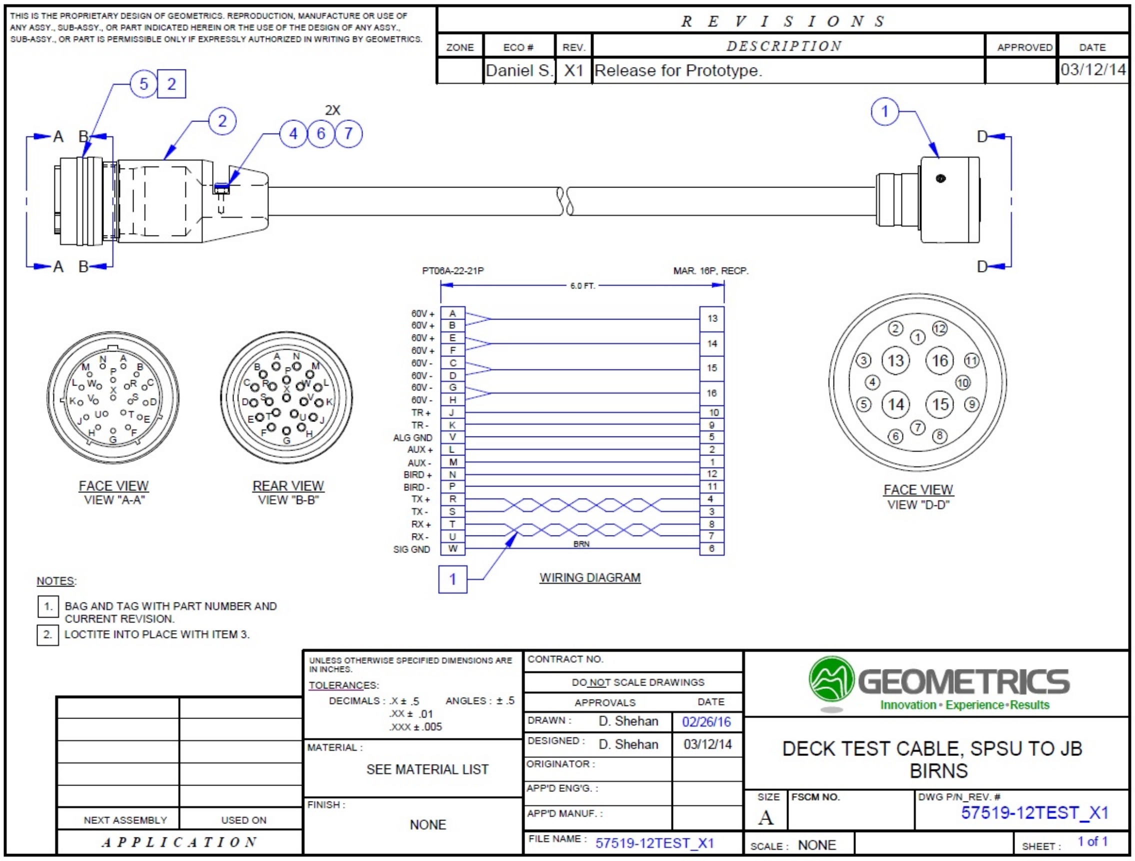


Figure A231: Wiring diagram for Deck Unit to Junction Box Test Cable, Birns.

5.11.34 Test Cable - Deck Unit to Junction Box (Bendix and Glenair Connectors)

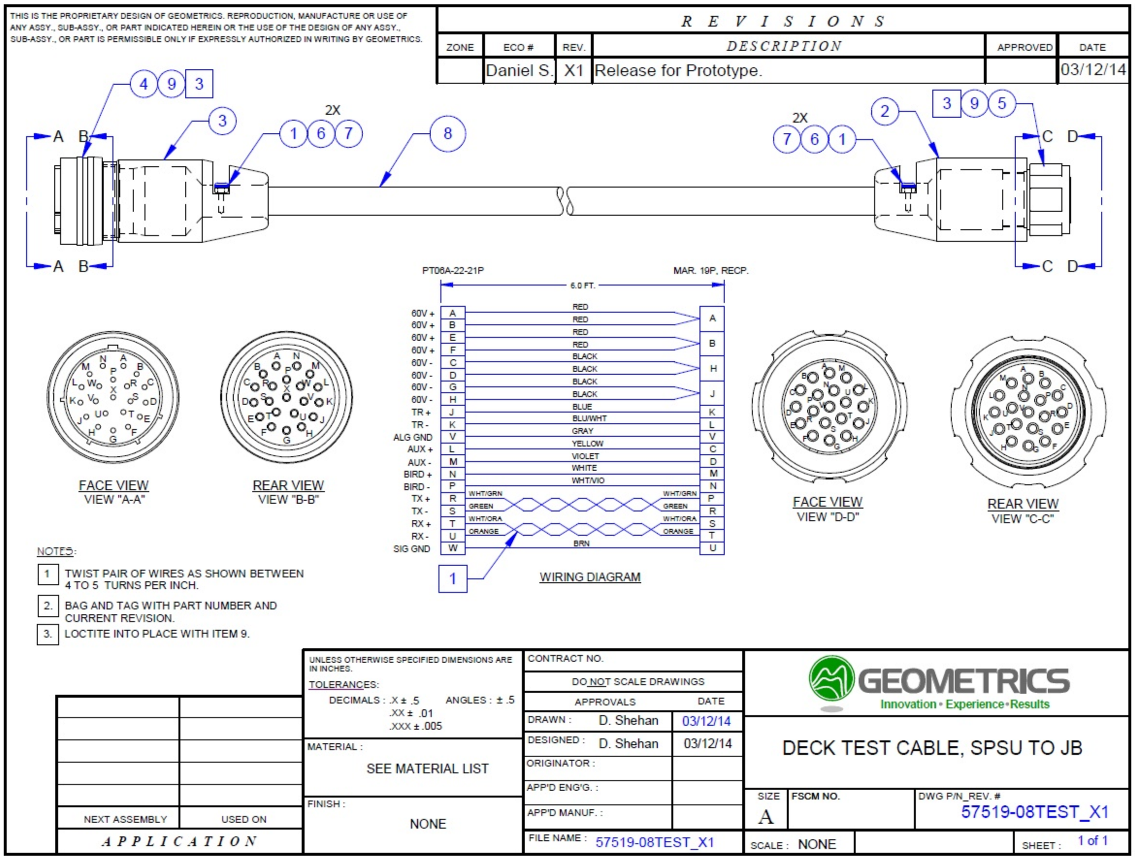


Figure A232: Wiring diagram for Deck Unit to Junction Box Test Cable, Glenair.

5.11.35 Test Cable - Deck Unit to P-Cable Digitizer (Bendix and Subconn Connectors)

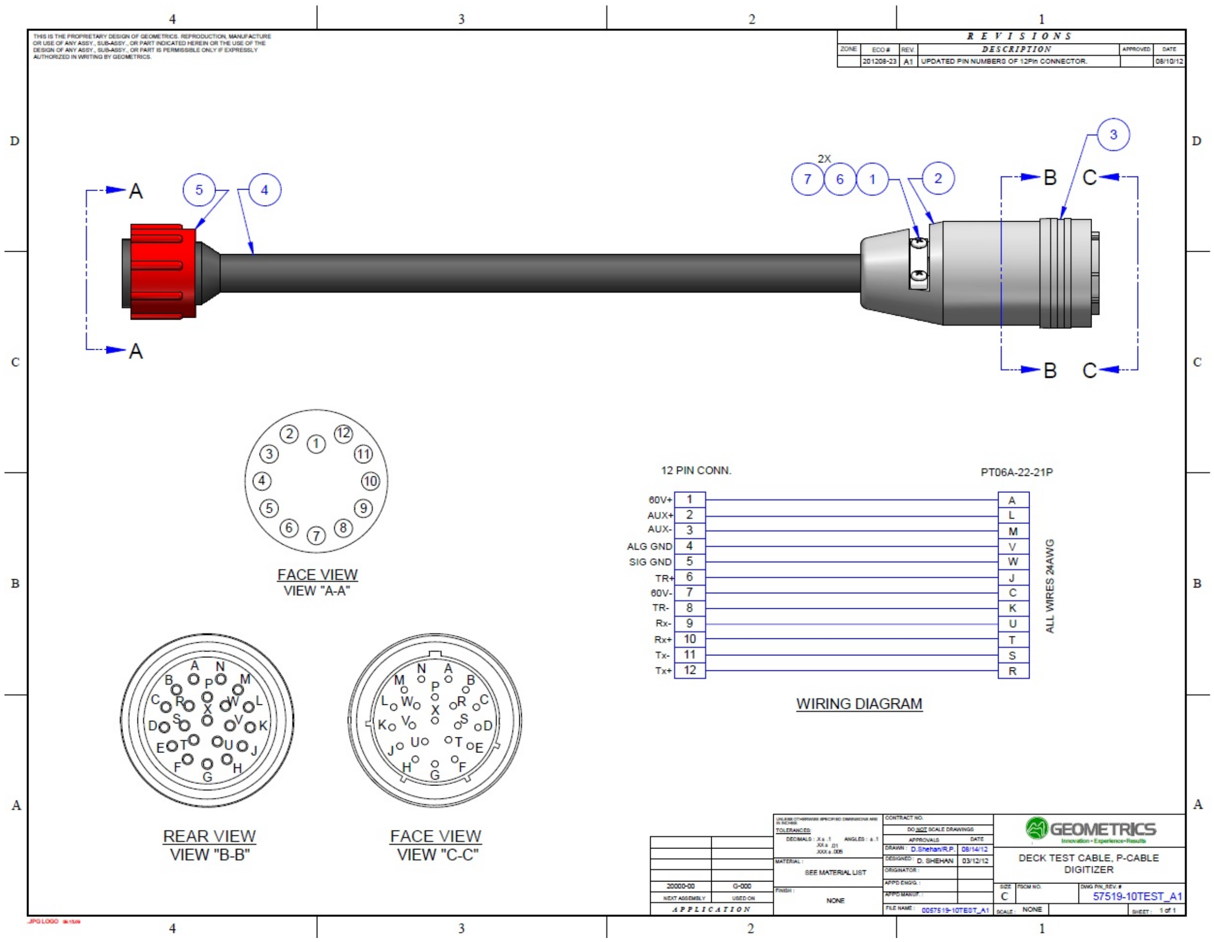


Figure A233: Wiring diagram for Deck Unit to P-Cable Lead Digitizer, Subconn.

5.11.36 Test Cable - Deck Unit to P-Cable digitizer (Bendix and Titan Connectors)

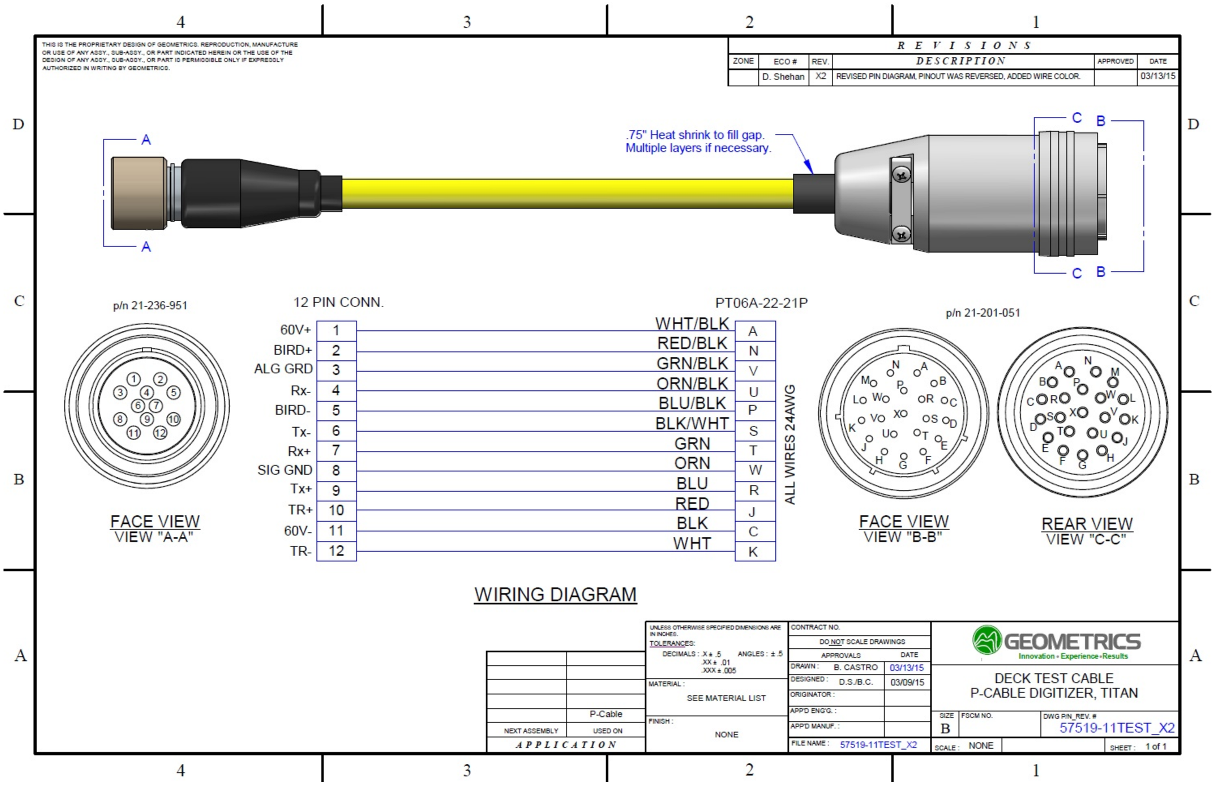


Figure A234: Wiring diagram for Deck Unit to P-Cable Lead Digitizer, Titan.

5.12 Technical Specifications of Selected Components

5.12.1 Digitizer and AUX channels

Channels per Module:	8
Sample Rates:	1/8 ms, 1/4 ms, 1/2 ms, 1 ms, 2 ms
Programmable Gains:	0 dB, 8 dB, 18 dB, 30 dB, 42 dB
Record Length:	Up to 30,000 samples/trace (>16,000 requires a registry edit)
Dead-time:	Up to 256 samples
I/O Communications:	100Base TX Fast Ethernet, IEEE 802.3 compliant
Dead Time Between Shots:	100ms
Anti-alias Filter:	-3 dB @ 81% of Nyquist, down 135 dB at stop band

Input Impedance:	126.8 KOhm, paralleled by 2.4 nF
Continuous Recording Mode:	Available with GPS synchronization
Test Oscillator:	10 Hz to 2 KHz, 1µV to 100 mV AC rms
QC Tests:	Noise, DC offset, total harmonic distortion, gain accuracy, gain similarity, phase similarity
Bandwidth:	DC to 2 KHz
Resolution:	24 bits including sign
Maximum Input Range:	±2.25V
Dynamic Range:	120 dB typical @ 1ms
Common-mode Rejection:	90 dB @ 1/4 ms, 190 Hz
Gain Accuracy:	±6.25% @ 1/4 ms, 30 dB, 100 Hz; ±6.0% @ 2ms, 30 dB, 25 Hz
Gain Similarity:	±3% @ 1/4 ms, 30 dB, 100 Hz; ±3.0% @ 2ms, 30 dB, 25 Hz
Phase Similarity:	$+0.1^{o}$ @ 1/4 ms, 30 dB, 100 Hz; $+0.1^{o}$ @ 2ms, 30 dB, 25 Hz
THD:	0.007% @ 1/4 ms, 30 dB, 100 Hz; 0.003% @ 2ms, 30 dB, 25 Hz
Crosstalk:	-105 dB @ 30 dB, 1/4 ms, 190 Hz
Noise Floor:	1.4 µV rms @ 30 dB, 1/4 ms; 0.2 µV rms @ 30 dB, 2ms
Power Consumption:	Approximately 100 mA at 48VDC (12.5 mA/channel)
Dimensions:	44 mm diameter x 330 mm long (1.75" by 11")
Weight in air:	900 grams (2.0 lbs)
Weight in water:	520 grams (1.1 lbs)
Packaging:	Titanium body

Table A11: Digitizer technical specifications

5.12.2 Tow Cable

Electrical Conductors:	7ea TP 24AWG, and 10ea 16AWG conductors
Strain Member:	Vectran
Break Strength:	4,500kg
Length:	Up to 100m
Diameter:	18.6 mm

Weight:	~21 kg (46 lbs) for 50 meters
Termination:	Water tight, Custom, 38-Pin connector
Bend Diameter:	46cm

Table A12: Tow Cable technical specifications.

5.12.3 Liquid-filled Active Section

Number of Channels:	8 per section
Group Interval:	1.5625, 3.125, 6.25, and 12.5 m
Section Length:	12.5, 25, 50, and 100 m
Hydrophones per Group:	Depends on group interval; see Table below.
Hydrophone Type:	Benthos RDA Geopoint or AQ-2000
Group Sensitivity:	Max 9 or 20 V/Bar, depends on group interval and hydrophone model; see graphs below
Jacket Material:	Clear polyurethane, 70 Duro, 3.18 mm (1/8 inch) wall thickness
Diameter:	41 mm (1.6 inches)
Ballast Fluid:	Inert, high-flashpoint, non-polluting silicone oil, 100 cSt to 3 cSt, depending on desired buoyancy Ballast Fluid information
Weight:	1.35 kg (3 lbs) / m
Strain Member:	Vectran
Break Strength:	2,200 kg (5000 lbs)
Typical Towing Noise:	<7 µbars at 4.5 knots, 8 Hz low cut filter, Beaufort 5-6 seas
Minimum Bend Radius:	750 mm (30 inches)
Compass/Bird Coil:	I/O Model 587 (one per section)
Depth Transducer:	One per section (optional)

Table A13: Active Section Technical specifications (liquid-filled).

Group Spacing (m)	1.5625	3.125	6.25	12.5
Channels/Section	8	8	8	8
Section Length (m)	12.5	25	50	100
Hydrophones/Group	2	4	8	16
Hydrophones/Section	16	32	64	128

Table A14: Relationship between group spacing, hydrophones/group, and Streamer length for liquid-filled sections.

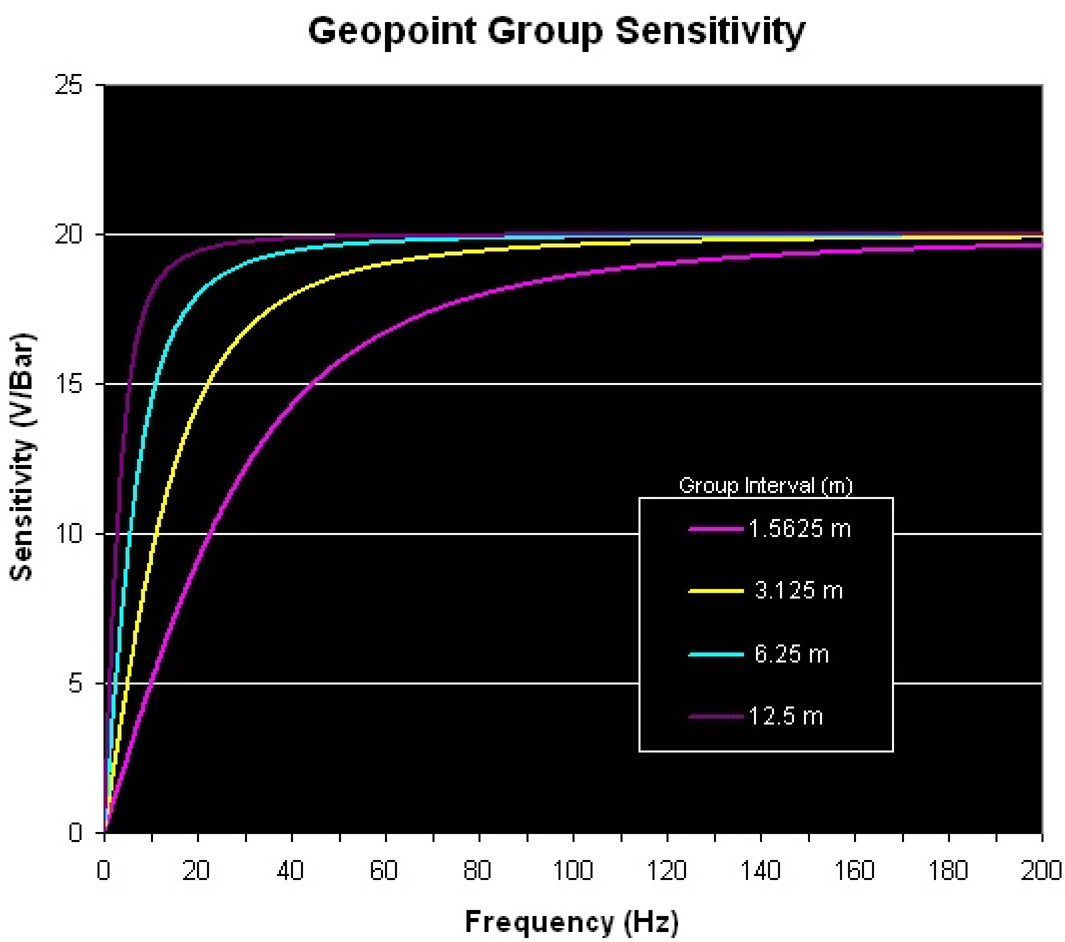


Figure A235: Group sensitivity for Geopoint hydrophones as a function of frequency (liquid-filled).

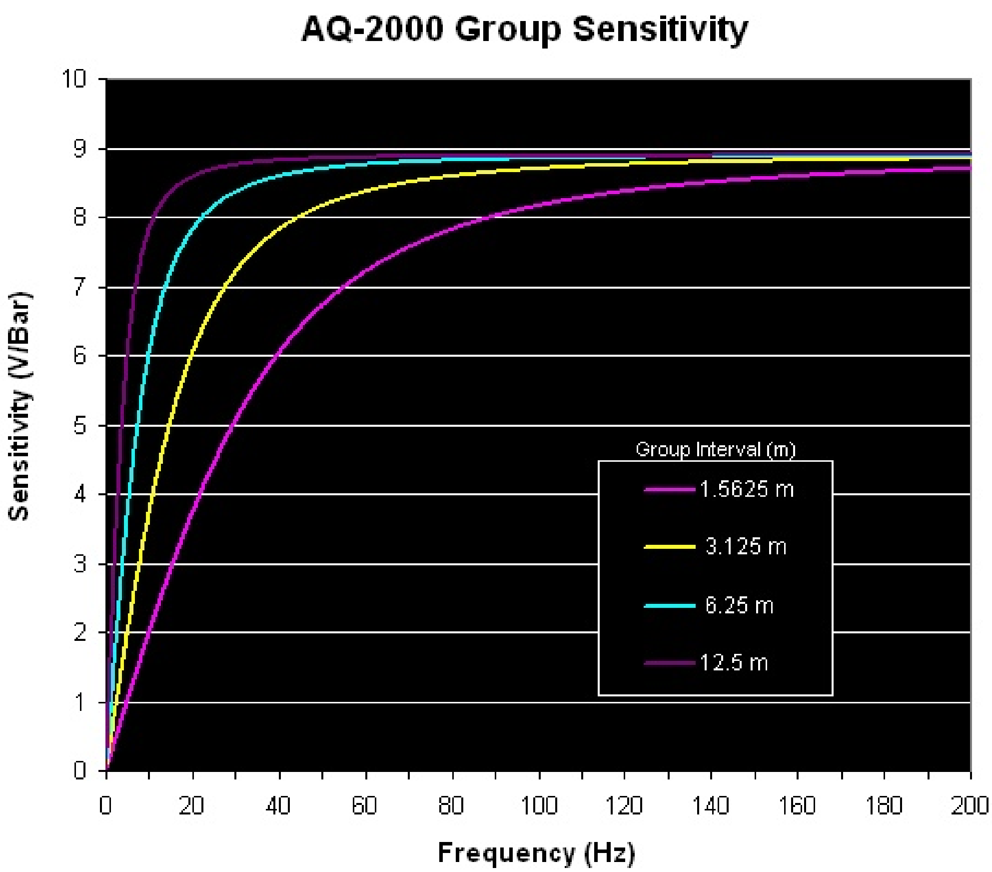


Figure A236: Group sensitivity for AQ-2000 hydrophones as a function of frequency (liquid-filled).

5.12.4 Solid Polyurethane Active Section

Number of Channels:	8 per section
Group Interval:	1.5625, 3.125, 6.25, and 12.5 m
Section Length:	12.5, 25, 50, and 100 m
Hydrophones per Group:	4-12
Hydrophone Type:	Geometrics proprietary hydrophone
Group Sensitivity:	Max 20V/Bar, see graphs below
Jacket Material:	Constructed of solid polyurethane
Diameter:	44.5 mm (1.75 inches)
Weight in air:	1.56 kg (3.4 lbs) / m
Strain Member:	Zylon
Break Strength:	2,200 kg (5000 lbs)
Typical Towing Noise:	<4 µbars at 4.5 knots, 8 Hz low cut filter, Beaufort 5-6 seas

Number of Channels:	8 per section
Minimum Bend Radius:	750 mm (30 inches)
Compass/Bird Coil:	Geometrics proprietary Bird Coil (I/O Model 587 equivalent)

Table A15: Active Section technical specifications (solid).

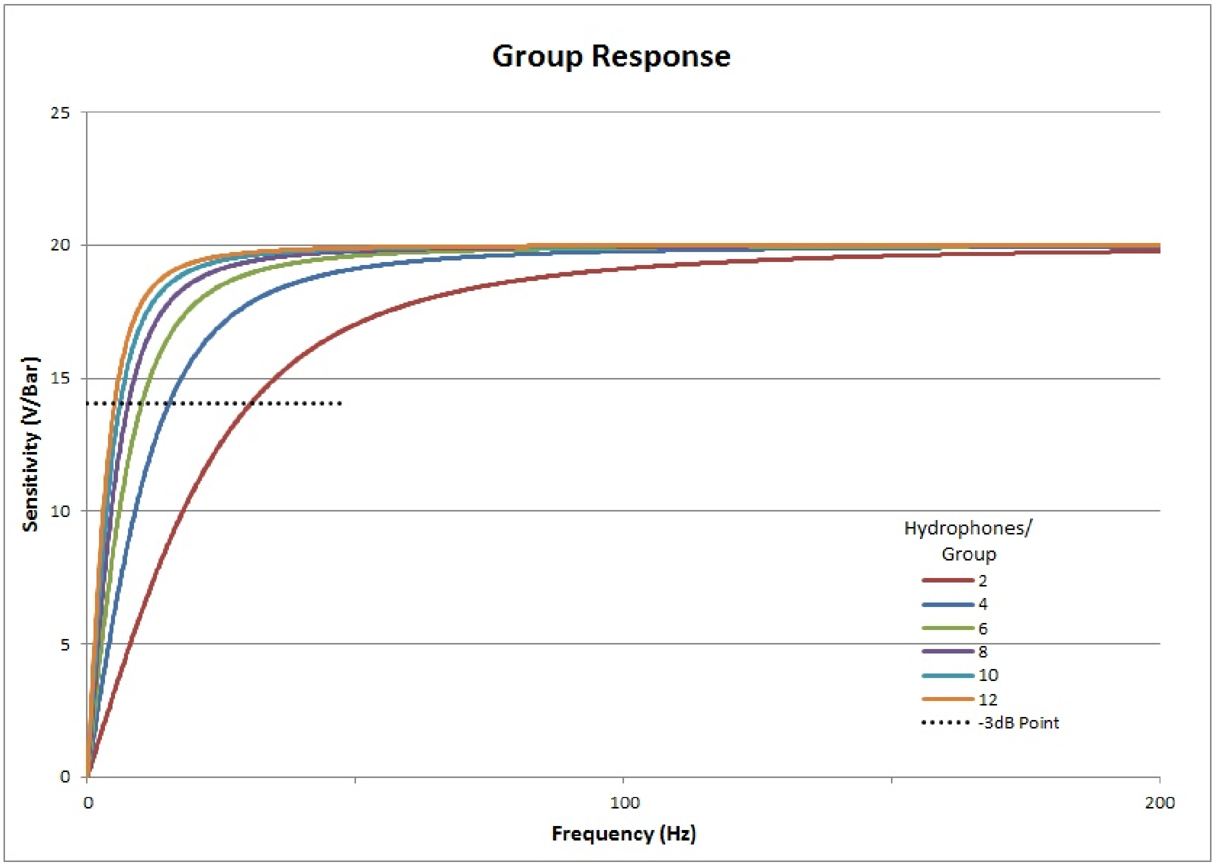


Figure A237: Group sensitivity for Geometrics GeoEel Solid hydrophones as a function of frequency and hydrophone quantity.

Hydrophones/ Group	- 3dB Point (Hz)
2	30.7
4	15.3
6	10.5
8	7.6
10	6.2
12	5.1

Table A16: Geometrics GeoEel Solid hydrophones -3dB Point.

Calculating the -3dB point can be done by understanding that as the number of hydrophones/group increases, capacitance increases, and the -3 dB frequency decreases, per the following equation:

$$\text{Sensitivity} = \frac{VR}{\sqrt{R^2 + \left[\frac{1}{2\pi fC}\right]^2}}$$

Where

V = sensitivity of single hydrophone
R = resistance
f = frequency
C = capacitance

It is also important to distinguish between signal-to-noise and frequency response. Signal-to-noise increases as the square root of the number of hydrophones/group, but the frequency response is controlled by the increased capacitance. The two measurements are independent of each other but coupled due to the change in the number of hydrophones/group; they are different effects arising from the same cause.

5.12.5 Signal Cable (P-Cable)

Electrical Conductors:	4ea TP 24AWG, 10ea 16AWG, 1ea COAX
Strain Member:	Vectran
Break Strength:	9,000 kg
Length:	Up to 600m
Diameter:	19.8 mm (without fairing)
Bend Diameter:	46cm

Table A17: Signal Cable technical specifications.

5.12.6 Digital Compass (P-Cable)

Dynamic Heading Accuracy	1.0° rms
Static Heading Accuracy	0.3° rms
Heading Repeatability	0.1° rms
Dynamic Pitch/Roll Accuracy	1.0° rms
Static Pitch/Roll Accuracy	0.2° rms
Pitch/Roll Repeatability	0.1° rms
Pitch/Roll Range	± 90°, ± 180°
Accelerometer Range	+/- 4g(+/- 1g)
Accelerometer Noise Density	126 µg/√Hz
Accelerometer Bias Stability	0.023 mg
Accelerometer Velocity Random Walk (VRW)	0.063 m/s
Gyro Dynamic Range	± 480 °/sec
Gyro Noise Density	0.03 dps/√Hz
Gyro Bias Stability	10.8 deg/hr
Gyro Angular Random Walk (ARW)	1.5 deg/√hr
Magnetic Range	±1.2 Gauss
Maximum Magnetic Inclination (Dip)	± 80°
Update Rate (Samples/Sec)	100
Baud Rate	9.6; 19.2; 38.4; 57.6; 115.2 kbaud
L x W x H	42 x 28 x 11 mm (1.66 x 1.11 x 0.43 inches)
Mass	16g
Encapsulated or Enclosure	Yes
Operating Temp	-40° to +85° C
Storage Temp	-40° to +85° C
Humidity Resistance	95%, 70° C, 240 hrs
	Meets MIL-STD-202G – Method 103A, Test Condition A
Shock Resistance	1500g, 1ms Pulse, Half-Sine Wave
	Meets MIL-STD-202G – Method 213B, Test Condition F
Vibration Resistance	.06 dB Power Spectral Density, 9.26 G rms
	Meets MIL-STD-202G – Method 214A, Test Condition I/C
Power Supply Input (Unregulated Voltage)	+4 to +10V DC

Input Power, Operating Mode (Typical @ 4V)	320 mW
Input Power, Sleep Mode (Typical @ 4v)	12 mW
3.3V Logic UART Interface	Yes
3-D In-Field Calibration	Yes
2-D In-Field Calibration	Yes
Able To Maintain Function When Inverted	Yes
Quaternion/Rotation Matrix Output	Yes
True North Heading Output	Yes
Includes World Magnetic Model	Yes
Pin Connectivity Gold Plating	Yes
RoHS Compliant	Yes

Table A18: Specifications of DC-4E Digital Compass (courtesy of Sparton Navigation and Exploration).

5.12.7 Depth Sensor

Depth accuracy	+/- 0.14m
Sample rate	Variable; up to 1 Hz
Max pressure rating	100 psi

Table A19: Depth Sensor technical specifications.

5.12.8 Tension Gauge

Maximum tension	2270 kgf
Sample rate	10 Hz
Accuracy	+/- 23 kgf

Table A20: Tension Gauge technical specifications.

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