9940 Summers Ridge Road • San Diego, CA 92121-3091 • Telephone +1-858-546-8327 • Fax +1-858-546-8150 • www.sontek.com

Argonaut SL/SW/XR Firmware Version 11.8
ViewArgonaut Software Version 3.50

SonTek/YSI has released Argonaut SL/SW/XR firmware version 11.8. To take advantage of the new features, you should also update to *ViewArgonaut* software version 3.50 or later.

- Section 1 describes changes and new features available in v11.8.
- Section 2 gives information for updating your system to firmware v11.8.
  - Note: New systems shipped on or after May 7, 2007 already have v11.8 installed.
- Section 3 gives contact information for SonTek/YSI.

1. Changes and New Features in Version 11.8

1.1. New Argonaut-SL housing design

All Argonaut-SL housings have been completely redesigned and updated for improved performance, better reliability, and easier installation.

Low Profile SL500 Low Profile SL1500 Low Profile SL3000

- New housing designs for the 500-kHz, 1500-kHz, and 3000-kHz Argonaut-SL systems offer several significant improvements.
  - Better performance and reduced flow disturbance, particularly in shallow water and very narrow channels.
  - Features specifically designed for easier installation.
  - New underwater connector for the 1500 and 3000-kHz systems. (No changes were made to the connectors and cables used for the 500-kHz Argonaut-SL and the Argonaut-SW.)
- The new housings reduce flow disturbance near the instrument, allowing reduced minimum blanking distances.
  - Reduced blanking affects the minimum allowed values for Cell Begin, Cell End, and Blanking Distance (for multi-cell profiling). The reduced values are available for only the new low profile housings; values for the original housing remain the same.
  - Minimum values for both housing styles are shown in the following table.

Frequency	New Low-Profile Housing		Original Housing	
	Min Cell Begin / Blanking Distance	Min Cell End	Min Cell Begin / Blanking Distance	Min Cell End
500 kHz	1.5 m (4.9 ft)	5.5 m (18.0 ft)	1.5 m (4.9 ft)	5.5 m (18.0 ft)
1500 kHz	0.2 m (0.7 ft)	1.2 m (3.9 ft)	0.5 m (1.6 ft)	1.5 m (4.9 ft)
3000 kHz	0.1 m (0.3 ft)	0.6 m (2.0 ft)	0.2 m (0.7 ft)	0.7 m (2.3 ft)

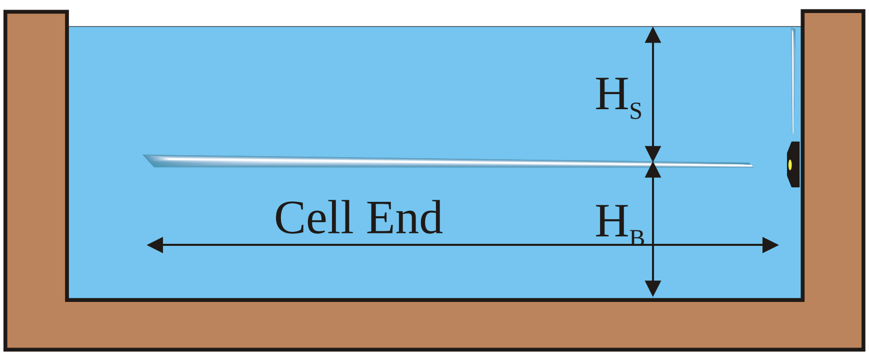
For more information on the Argonaut-SL improvements, see:

- Technical Note: Argonaut-SL New Features and Enhancements (April 2007): http://www.sontek.com/product/asl/sl-new0407.pdf
- Argonaut-SL Brochure/Specifications: http://www.sontek.com/download/brochure/arg-sl.pdf

1.2. *Improved vertical beam performance*

Vertical beam performance has been improved, particularly for the new housings in very shallow water.

- All vertical beam algorithms have been updated to provide improved reliability.
- The minimum depth for vertical beam operation for all systems using the new housings has been improved, allowing operation in shallower water.
  - **IMPORTANT**: Monitor the aspect ratio closely in shallow water to avoid possible measurement contamination from surface or bottom effects. Refer to the Argonaut-SL manual or contact SonTek/YSI for more information.



$$\text{If } H_S < H_B\text{, Aspect Ratio} = \text{Cell End} / H_S$$
$$\text{If } H_B < H_S\text{, Aspect Ratio} = \text{Cell End} / H_B$$

  - The table below shows the minimum vertical beam depth for all system configurations.
  - The reduced minimum depth for the 500 and 1500 kHz vertical beam is available for the new low profile housings only.

Frequency	New Low Profile Housing Min Vertical Beam Depth	Original Housing Min Vertical Beam Depth
500 kHz	0.20 m (0.65 ft)	0.40 m (1.30 ft)
1500 kHz	0.15 m (0.50 ft)	0.25 m (0.80 ft)
3000 kHz	0.10 m (0.30 ft)	0.10 m (0.30 ft)

2. Installing the Firmware Update

Note: All production systems shipped on or after May 7, 2007 have version 11.8 already installed and do not require you to update the firmware.

To install Argonaut firmware version 11.8:

- Contact SonTek to obtain the firmware hex file (**`arg118.hex`**) and the access code file (**`arg118ac.txt`**) for your system. Be sure to provide your name, organization, and system serial number.
- If applicable, download the latest version (4.00 or later) of *SonUtils* from the SonTek website (**www.sontek.com**). Look for the **Support – Downloads** page.
- Install *SonUtils* on your computer following the instructions provided.
- Connect the Argonaut to an available **COM** port of your computer.
- Run *SonUtils*. Select the correct **COM** port in the upper left portion of the *SonUtils* window.
- Click the **Break** icon to establish communications with the system. You should see a wake up message from the Argonaut in the *SonUtils* main window.
- Click **Instrument | Update Firmware**.
- Use the browse window to select the firmware hex file (**`arg118.hex`**).
- Enter the access code when prompted (**`arg118ac.txt`**). Use a transfer mode of **Binary** and be sure the **Verify new firmware** and **Use fast connection** boxes are selected. Click **Start** when ready.
- The software will show an updating display as the new firmware is loaded.
- We hope you find the latest enhancements to the Argonaut firmware useful in your applications. To take advantage of these new features, we encourage you to update to the latest version of the ViewArgonaut program (version 3.50 or later), available through our web site at: **www.sontek.com/product/sw/viewarg/viewargonaut.htm**.

3. Contact Information

We welcome any comments, questions, or suggestions you have regarding Argonaut firmware version 11.8.

SonTek/YSI Inc
9940 Summers Ridge Road
San Diego CA 92121-3091

Tel: +1 (858) 546-8327
Fax: +1 (858) 546-8150

E-mail: **support@sontek.com**
Web: **www.sontek.com**

6837 Nancy Ridge Dr., Suite A • San Diego, CA 92121 • Telephone (858) 546-8327 • Fax (858) 546-8150 • Internet: www.sontek.com

Argonaut SL/SW/XR Firmware Versions 11.6 and 11.7
ViewArgonaut Software Version 3.43

SonTek/YSI has released Argonaut SL/SW/XR firmware versions 11.6 and 11.7. To take advantage of the new features, you should also update to *ViewArgonaut* software version 3.43 or later. If you have any questions about these new features, please contact SonTek/YSI.

NOTE: This document mainly describes firmware version 11.6. Version 11.7 was released December 7, 2006 to correct a minor diagnostic issue discovered shortly after the release of v11.6

- Section 1 describes changes and new features available in versions 11.6 and 11.7.
- Section 2 gives information for updating your system to firmware version 11.7.
    - Note: All production systems shipped on or after December 7, 2006 have version 11.7 already installed and do not require you to update the firmware.
- Section 3 gives contact information for SonTek/YSI.

1. Changes and New Features in Version 11.6 and 11.7

1.1. Total volume criteria

Total volume calculations allow the Argonaut to determine the amount of water that has passed the system over a given span of time; new criteria allow the modification of this calculation.

- Total volume is the cumulative sum of flow rate multiplied by time. This represents the amount of water that has passed the system in a given amount of time.
- By default, total volume includes all flow past the system regardless of the magnitude or direction of the flow.
- New criteria modify the calculations to accumulate flow into total volume.
    - Total volume is only accumulated if the flow rate meets certain criteria:
        - Flow ≥ a user-specified threshold
        - Flow ≤ a user-specified threshold
        - Magnitude (absolute value) of flow ≥ a user-specified threshold
    - Total volume is only accumulated if the velocity meets certain criteria:
        - Velocity ≥ a user-specified threshold
        - Velocity ≤ a user-specified threshold
        - Magnitude (absolute value) of velocity ≥ a user-specified threshold
- These conditions are provided to calculate a modified total volume value (e.g., only accumulate flow in a certain direction) or to avoid the accumulation of small, residual flow values in stagnant water.

1.2. Change water level output to stage

All real-time data from the vertical beam (SL and SW systems) are now output as "stage" rather than "water level".

- Water level is the height above the water surface above the top of the system.
- Stage is water level plus the user-specified instrument elevation. This value thus reports water depth relative to a user-specified datum.
- All real-time data outputs (RS232, SDI-12, analog output, and Modbus) now output stage rather than water level.

1.3. Assorted Changes

The following list describes several minor changes and corrections.

- The Argonaut Flow Display can now be used during SDI-12 data collection.
- The maximum dimension of a trapezoid channel for flow calculations has been increased from 100 to 1000 m (328 to 3280 ft).
- The maximum reference for analog output signals proportional to flow rate has been increased (to allow the analog output signal to be used for flow on larger rivers). The maximum reference value is now ±1,000,000 m^3/s or ±10,000,000 ft^3/s.
- Ice detection algorithms have been improved to provide a more reliable indicator of ice coverage (Argonaut-SW).
- An error in flow calculations for multiple (divided) channels has been corrected. Previously only the flow in the first (or multiple) channels was calculated. The system now calculates flow in all channels.
- Flow calculations for the Argonaut-SW have been updated to correctly calculate flow when the SW is installed below the bottom of the channel (e.g., when the SW has been installed in a hole dug into the channel bottom).
- The 750-kHz Argonaut-XR now operates reliably with very small cell size settings. Previously, small cell size values settings could potentially affect velocity data.

2. Installing the Firmware Update

Note: All production systems shipped on or after December 7, 2006 have version 11.7 already installed and do not require you to update the firmware.

To install Argonaut firmware version 11.7:

- Contact SonTek to obtain the firmware hex file (**`Arg117.hex`**) and the access code for your system. Be sure to provide your name, organization, and system serial number.
- If applicable, download the latest version (4.00 or later) of *SonUtils* from the SonTek website (**www.sontek.com**). Look for the **Support – Downloads** page.
- Install *SonUtils* on your computer following the instructions provided.
- Connect the Argonaut to an available **COM** port of your computer.
- Run *SonUtils*. Select the correct **COM** port in the upper left portion of the *SonUtils* window.
- Click the **Break** icon to establish communications with the system. You should see a wake up message from the Argonaut in the *SonUtils* main window.
- Click **Instrument | Update Firmware**.
- Use the browse window to select the firmware hex file (**`Arg117.hex`**).
- Enter the access code when prompted. Use a transfer mode of **Binary** and be sure the **Verify new firmware** and **Use fast connection** boxes are selected. Click **Start** when ready.
- The software will show an updating display as the new firmware is loaded.
- We hope you find the latest enhancements to the Argonaut firmware useful in your applications. To take advantage of these new features, we encourage you to update to the latest version of the ViewArgonaut program (version 3.43 or later), available through our web site at: **www.sontek.com/product/sw/viewarg/viewargonaut.htm**.

3. Contact Information

We welcome any comments, questions, or suggestions you have regarding Argonaut firmware version 11.7.

SonTek/YSI, Inc.
6837 Nancy Ridge Dr, Ste A
San Diego CA 92121-3217

Tel: +1 (858) 546-8327
Fax: +1 (858) 546-8150

E-mail: **support@sontek.com**
Web: **www.sontek.com**

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SonTek/YSI Argonaut
Acoustic Doppler Current Meter
Technical Documentation

SonTek/YSI
6837 Nancy Ridge Drive, Suite A, San Diego, CA 92121 USA
Telephone (858) 546-8327 • Fax (858) 546-8150
E-mail: inquiry@sontek.com • Internet: www.sontek.com

A YSI Environmental Company

Getting Started with the Argonaut MD, SL, or XR

Thank you for your purchase. We are confident you will find the Argonaut powerful, accurate, reliable, and easy to use. If you have questions, comments, or suggestions, please let us know.

1) Suggested Reading

- We encourage you to read the *Argonaut Principles of Operation*. It provides valuable background information regarding theory, instrument use, and data analysis.
- Refer to the *Argonaut Operation Manual* and the *Argonaut Software Manual* as needed for specific information about using the Argonaut.
- See Section 2 of the *Argonaut Operation Manual* for more "Getting Started" instructions.

2) Software Installation

- Insert the Argonaut software CD into your computer's CD-ROM drive. Wait a moment for the SonTek Argonaut Software menu to appear. Note: If the menu does not appear, use either *Windows Explorer* or **Start | Run** to locate and run *Install.exe* from the CD.
- Use the **Read Me** option to learn more about the programs on the CD, and to review any last-minute information that may not be contained in the printed documentation.
- Windows-based Software: Use the program setup options (*e.g.*, **ViewArgonaut Setup**, **SonUtils Setup**) to install the individual Windows-based Argonaut programs. Follow the on-screen instructions. Note that you will be asked to enter *Name*, *Company*, and *Serial* information. For the *Serial* field, use the serial number of your instrument.
- DOS-based Software: Create a directory on your hard disk in which to store the Argonaut's DOS-based software. We recommend a directory name such as **`ArgDOS`**. Use the **Argonaut DOS Programs** option to manually copy the entire contents of this CD folder into the directory you created on your hard disk. Note that the subdirectory named **`SRC`** can also be copied to your computer. It contains source code for some of the DOS programs in case you wish to create your own data extraction and analysis programs.

3) Quick Start: Real-Time Data Collection with Windows Software

- Note: Steps 3 through 6 can also be done using DOS-based software. Refer to the *Argonaut Software Manual* for information on using the DOS-based software.
- Plug the power and communication cable into the Argonaut, plug the serial connector into COM1 on your computer, and connect the power supply to the instrument.
- Mount the instrument in a small tank with some seeding material in the water. (Testing can also be done in air, although the velocity data will be meaningless.)
- Start *ViewArgonaut* using **Start | Programs | SonTek Software | ViewArgonaut**.

- Click **Realtime** to start the real-time data collection software.
- Select a short averaging interval (10 seconds)
- Press **OK** to configure the Argonaut.
- Press the green play icon (►) to start data collection.
- Press the red record icon (●) to start recording to a file.
- Collect a few minutes worth of data, generating real currents if possible.

4) Quick Start: Post Processing with Windows Software

- Start *ViewArgonaut* using **Start | Programs | SonTek Software | ViewArgonaut**.
- Click **PostProcessing** to start the post processing software.
- Select **File | Open**.
- Select the file you recorded with the real-time software and click **OK**.
- Click **OK** when file statistics are shown to finish loading the data.
- Use the **Zoom** tool.
- Double click the axis to change the plot scale.
- Use the slide bar on the top to view tabular data for individual samples.
- Export data in ASCII format using **File | Export**.

5) Quick Start: System Diagnostics with Windows Software

- Mount the Argonaut in a small tank of water with a little seeding material, ideally with the instrument close to a boundary (20-30 cm / 8-12 in).
- Start *ViewArgonaut* using **Start | Programs | SonTek Software | ViewArgonaut**.
- Click **ArgCheck** to start the system diagnostic software.
- Refer to the *Argonaut Software Manual* for interpreting the software output.

6) Direct Command Interface with Windows Software

- The direct command interface allows you to “talk” directly to the Argonaut.
- Start *SonUtils* using **Start | Programs | SonTek Software | SonUtils**.
- Select **SonTermW** to start the terminal emulator software.
- Click the **BREAK** icon (or press **Alt+B**) to wake-up the instrument. You should see a wake-up response from the instrument.
- Use the **Show** icons to view all parameter settings.
- Type **`help`** and press <Enter> for assistance with the direct command interface.
- Refer to the *Argonaut Operation Manual* for more details.

Special Notice when Turning Computers On or Off

When many computers and data loggers are turned on or off, they send a signal out the serial port that can be interpreted as a BREAK. If the Argonaut is connected to the serial port, this can interrupt data collection or awaken the Argonaut from its sleep mode. This may cause the loss of data or the draining of batteries. Always disconnect the Argonaut from the computer or data logger before turning the computer/data logger on or off.

SonTek/YSI
6837 Nancy Ridge Drive, Suite A, San Diego, CA 92121 USA
Telephone (858) 546-8327 • Fax (858) 546-8150
E-mail: inquiry@sontek.com • Internet: http://www.sontek.com

A YSI Environmental Company

Argonaut
Acoustic Doppler Current Meter
Operation Manual
Firmware Version 7.9

WARRANTY, TERMS AND CONDITIONS

Thank you for purchasing a SonTek Acoustic Doppler Velocity sensor. The instrument was thoroughly tested at the factory and found to be in excellent working condition. If the shipping crate appears damaged, or if the system is not operating properly, please contact SonTek immediately.

The System you have purchased is covered under a one year limited warranty that extends to all parts and labor for any malfunction due to workmanship or errors in the manufacturing process. The warranty does not cover shortcomings that are due to the design, nor does it cover any form of incidental damage because of errors in the measurements.

In case your System is not functioning properly, first try to identify the source of the problem (refer to the appropriate section of the manual for a trouble shooting advice). If additional support is required, we encourage you to contact us immediately if a problem is detected and we will work to resolve the problem as quickly as possible. Most problems can be resolved without a system being returned to us.

In case the system needs to be shipped back to the factory, please contact SonTek to obtain a Return Merchandise Authorization (RMA) number. We reserve the right to refuse receipt of shipments without RMAs. We require the system to be shipped back in original shipping container using original packing material and all delivery cost to SonTek covered by the customer (including all taxes and duties). If the system is returned without appropriate packing, the customer will be required to cover the cost of new packaging crate and material.

INTRODUCTION

This manual is organized into the following sections:

Section 1. Argonaut Components, Terminology, and Sampling – Naming conventions and terms used in this manual, plus a general description of Argonaut sampling strategies.

Section 2. Getting Started – General instructions for collecting data with the Argonaut in the most common configurations.

Section 3. Direct Command Interface – Direct communication with the Argonaut, including command format, options, and output data format.

Section 4. Compass/Tilt Sensor Operation – Concerns and procedures relating to the internal compass and 2-axis tilt sensor.

Section 5. Argonaut Hardware – Description of Argonaut electronics, cables, connectors, and instructions for accessing system components.

Section 6. Operational Considerations – Concerns and procedures relating to power supply, instrument mounting, coordinate systems, maintenance, and troubleshooting.

Section 7. Autonomous Deployment – Instructions for initiating an autonomous deployment (using internal recording and battery power). This section also includes detailed information on Argonaut power consumption, and a general discussion of operating parameter selection.

Section 8. Argonaut Optional Features – Describes SonWave wave spectra collection package and external MicroCat CT sensor operation.

Section 9. Additional Support – Contact information for additional customer support.

Appendix 1. Argonaut Binary Data File Format

Appendix 2. Internal SDI-12 Support for Argonaut SL/XR

Appendix 3. Vertical Beam Support for Argonaut SL Systems

Appendix 4. Analog Output Option for Argonaut SL/XR Systems

TABLE OF CONTENTS

Section 1. Argonaut Components, Terminology, and Sampling

1.1. Argonaut Components

The Argonaut includes several components depending on the exact instrument configuration. The list below gives a brief description of all major system components and their function.

- Argonaut sensor - The sensor consists of two or three acoustic transducers (for 2D or 3D measurements) permanently mounted in the transducer head. The head is mounted to the pressure housing; the size and material used for construction vary with system configuration.
- Receiver electronics - The receiver electronics consist of a circuit board mounted directly to the inside of the transducer head. The receiver provides the primary conditioning of the return signals from the acoustic transducers.
- Argonaut processor - The Argonaut processor consists of two printed circuit boards inside the pressure housing. The processor is mounted on an internal mounting frame supported from the transducer head (§5.2). The processor sends and receives signals from the sensor, performs Doppler calculations to compute velocity, controls the operation of all other sensors, and outputs the data over the serial port and to the internal recorder.
- Power and communication cable - This cable carries DC input power and serial communication between the processor and the controlling computer. The Argonaut can be configured for RS232 serial communication for cable lengths to 100 m (300 ft) or RS422 for cable lengths to 1500 m (4500 ft).
- Splitter cable - This cable connects the Argonaut XR or SL to an external battery pack for autonomous operation. The cable has one connector to the Argonaut, a second to the battery pack, and a third to the power and communication cable (sealed with a dummy plug during deployment). See §5.5.2 for details.
- Temperature sensor - The temperature sensor, standard on all Argonaut systems, is mounted on a titanium pin in the Argonaut transducer head. Temperature data are used to automatically compensate for changes in sound speed; sound speed is used to convert Doppler shift to water velocity. See §6.6 for details on the temperature sensor.
- Compass/tilt sensor - This sensor measures magnetic heading and 2-axis tilt (maximum tilt ±50°). It comes standard with the Argonaut MD and XR, and is optional for the Argonaut SL. It allows the Argonaut to report velocity measurements in Earth coordinates (East / North / Up or ENU). The compass includes a built-in calibration feature to compensate for ambient magnetic fields. See Section 4 for more details.
- Pressure sensor - The pressure sensor (standard on the XR; optional on the MD and SL) is mounted in the Argonaut transducer head between the acoustic transducers. In addition to its more general function of measuring deployment depth and surface elevation, data from the pressure sensor can be used by the Argonaut XR to automatically adapt operation for changing water level. See §6.6 for more details on the pressure sensor, see §3.8 for more details about the Argonaut XR dynamic boundary adjustment.
- Battery power - The Argonaut can include battery power for autonomous deployment or to act as a backup in the event of shore power failure. For the Argonaut MD, the batteries are enclosed with the processor in a single pressure housing. For the Argonaut XR and SL, the batteries are housed in a separate underwater canister and are connected using a special splitter cable (§5.5.2). See Section 7 for details on autonomous operation from battery power.

1.2. Definitions and Terminology

This section defines terms commonly used when working with the Argonaut.

- Direct command interface - direct serial communication with the Argonaut to control system operation and retrieve data.
- BREAK - a serial communication signal that causes a hardware reset in the electronics and returns the Argonaut to command mode.
- Ping - a single estimate of the water velocity. A ping consists of each transducer sending an acoustic pulse, listening to the response, calculating the along beam velocity, and combining data from all beams to compute the 3D velocity.
- Sample - refers to the collection of a number of pings to produce a mean estimate of water velocity. The mean sample includes velocity, standard deviation, and signal strength data, as well as data from other sensors.
- Temperature - water temperature, in °C, is used for sound speed calculations. A default value is entered by the user, and another value is measured using an internal temperature sensor.
- Salinity - water salinity, in ppt; a user-supplied value is used for sound speed calculations.
- Sound speed - speed of sound in water, in m/s. This is used to convert the Doppler shift to velocity. Sound speed can be calculated either from user-specified temperature and salinity, or from measured temperature and user-input salinity (see **`TempMode`** in §3.8 for details). See *Argonaut Principles of Operation* regarding the effect of sound speed on velocity data.
- Measurement volume / sampling volume – the volume of water in which the Argonaut measures velocity. This volume is at a fixed location for the Argonaut MD, and is user-programmable for the Argonaut XR and SL.
- Cell begin – the location of the start of the measurement volume for the XR and SL. This is set by the user and is measured as distance along the axis of the instrument housing.
- Cell end – the location of the end of the measurement volume for the XR and SL. This is set by the user and is measured as distance along the axis of the instrument housing.
- Dynamic boundary adjustment – the automatic modification of the XR sampling volume based on data from the pressure sensor. This can be used to adapt operation to changing conditions in environments where surface elevation varies (*e.g.*, tide or river stage variations).
- Pinging rate - the number of pings per second, in Hz. The Argonaut is programmed to ping once per second.
- Sample time - the Argonaut records date and time from its internal clock with each sample. The recorded time represents the start of the averaging interval.
- Averaging interval - the period, in seconds, over which the Argonaut averages data before computing mean velocity.
- Sample interval - the time between sequential samples, in seconds. This is defined as the time from the start of one sample to the start of the next sample, and must be greater than or equal to the averaging interval or the averaging interval will take precedence.
- Burst sampling - this sampling method allows you to record a number of samples in rapid succession, and then place the Argonaut in a low-power state for an extended period. This obtains information about both the short- and long-term variation of water velocity without the power and memory required for continuous sampling.

- Burst interval - the time, in seconds, between each sampling burst (when burst sampling is enabled). This is measured from the start of one burst to the start of the next burst, and must be greater than the total time required for each burst.
- Samples per burst - the number of samples recorded during each burst.

1.3. Argonaut Sampling Strategies

Many of the terms defined in §1.2 are used to determine the sampling strategy used by the Argonaut. These include ping, averaging interval, sample interval, burst interval, and samples per burst. These terms and the sampling strategies used by the Argonaut are shown in Figure 1. The Argonaut supports three basic sampling strategies.

Continuous Sampling – Continuous sampling is used for real-time data collection when connected to shore power or for autonomous deployments without power or data limitations. For continuous operation, the Argonaut sample interval is set to the same value as the averaging interval, burst sampling is disabled, and the system continually collects data.

Reduced Duty Cycle Sampling – For many autonomous deployments, the Argonaut uses a reduced duty cycle where the sample interval is greater than the averaging interval. When the Argonaut is not collecting data, it enters a low power state where power consumption is less than 1 mW. Duty cycle is calculated as the ratio of the averaging interval to the sample interval. Battery life is extended by the inverse of the duty cycle. For example, an averaging interval of 5 minutes with a sample interval of 15 minutes gives a 33% duty cycle and extends battery life by a factor of three.

Burst Sampling – Burst sampling lets you obtain information about short-term flow variation without requiring continuous operation. In this mode, the Argonaut collects a number of samples in rapid succession and then enters a sleep mode to conserve power. Duty cycle during burst sampling is calculated by the following formula.

```
Duty cycle = (Samples_per_burst * Averaging_interval) / Burst_interval
```

See Section 7 for details about system power consumption, calculating battery life, and initiating autonomous deployments.

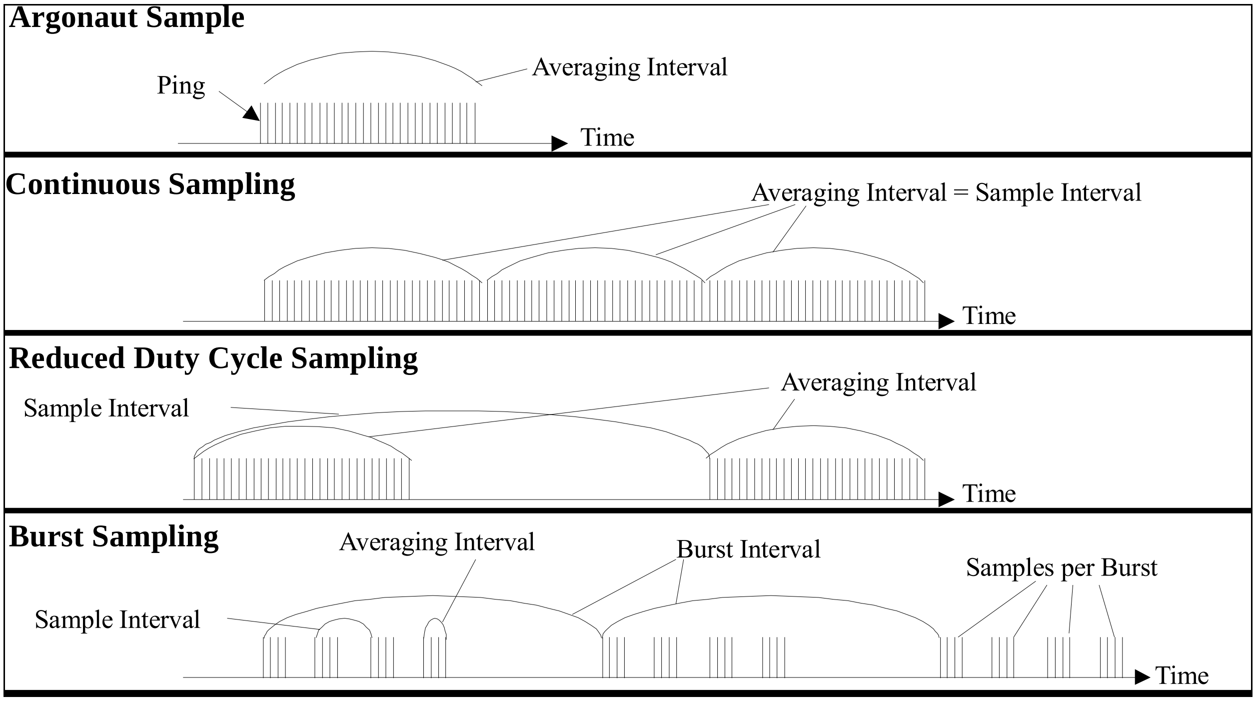


Figure 1 – Argonaut Sampling Strategies

Section 2. Getting Started

This section contains basic instructions for collecting data with the Argonaut in the three most common configurations. These instructions are not intended to be comprehensive, but should be sufficient to start collecting data for preliminary analysis.

Note that the testing described here can be done with the system in air without any damage to the Argonaut, although the velocity data from the instrument will be meaningless. We suggest you begin with some basic testing with the system in the air and then move to field tests (from a dock or small boat) to gain experience.

2.1. Real-Time Data Collection with SonTek Software

The easiest way to collect Argonaut data is to use the real-time data collection software, *ARGONAUT.EXE*. This software is described in detail in the *Argonaut Software Manual*. Basic instructions for collecting data using *ARGONAUT* are given below.

1. Copy all files from the software diskette to a directory on the controlling computer. Place the computer in a dedicated DOS mode (not a DOS prompt within Windows).
2. Connect the Argonaut power and communication cable from the instrument to COM1 of the controlling computer and to the external power supply included with the system.
3. Type **ARGONAUT** at the DOS prompt. The software will establish communication with the Argonaut and download the current system configuration.
4. Select the desired operating parameters from the setup menu. For initial testing, we recommend using a relatively short averaging interval (perhaps 15 seconds) to speed up the data collection process. Specify a file in which to capture data on the computer hard disk.
5. Select **Start Data Acquisition** from the setup menu. The software will configure the Argonaut and begin data collection. Allow the Argonaut to collect several minutes of data.
6. Stop data collection by pressing **Alt+F10**. After confirmation, the program will return to the setup menu. Select **Exit Data Acquisition** to return to the DOS prompt.
7. Use the *GARG*.EXE* or *EARG*.EXE* programs to convert the binary data file to ASCII format. See the *Argonaut Software Manual* for details on program operation.

2.2. Real-Time Data Collection using Serial Output Data

The Argonaut is often integrated with a variety of data collection systems using the direct command interface and serial output data. For this type of integration, it may be helpful to gain experience with the system using the terminal emulator *SonTerm* included with the Argonaut software. Basic instructions for getting started are given below. For more information on the direct command interface and output data format, see Section 3.

1. Copy all files from the software diskette to a directory on the controlling computer. Place the computer in a dedicated DOS mode (not a DOS prompt within Windows).
2. Connect the Argonaut power and communication cable from the instrument to COM1 of the controlling computer and to the external power supply included with the system.
3. Type **SONTERM** at the DOS prompt.
4. Capture all communication with the Argonaut to a file for future reference using the **Alt+F** option in *SonTerm*.
5. Press **Alt+B** to send a **BREAK** to the Argonaut and bring the system into command mode (the Argonaut command prompt is "**>**").

6. Begin using the direct command interface by typing **`Help`** at the command prompt. This will lead you into several menus displaying available commands.
7. Use the four "**`Show`**" commands ("**`Show Conf`**", "**`Show System`**", "**`Show Setup`**", and "**`Show Deploy`**") to display all Argonaut hardware and operating parameter settings.
8. Type "**`Compass CONT`**" to display data from the internal compass/tilt sensor (if present). Rotate and tilt the Argonaut to verify compass operation (§4.1). Press any key to stop data output.
9. Type "**`Sensor CONT`**" to display data from the temperature, pressure, and battery voltage sensors (§3.12 and §6.6). Press any key to stop data output.
10. Type "**`Dir`**" to view the contents of the internal recorder.
11. Select reasonable operating parameters for trial data collection. Use relatively small values for averaging interval and sample interval (15 seconds). Select the output format as ASCII.
12. Begin data collection immediately with the "**`Start`**" command.
13. Allow the Argonaut to output a number of samples, then exit *SonTerm* (Alt+X) and take a closer look at the output data in the log file specified earlier.

2.3. Autonomous Deployment

Autonomous deployments use the Argonaut internal recorder and battery power. Section 7 contains detailed instructions for initiating autonomous deployments. This section provides a brief overview of the steps used to collect a sample deployment from external power. It assumes you have already followed the steps in §2.2 and have a basic familiarity with the direct command interface.

1. Copy all files from the software diskette to a directory on the controlling computer. Place the computer in a dedicated DOS mode (not a DOS prompt within Windows).
2. Connect the Argonaut power and communication cable from the instrument to COM1 of the controlling computer and to the external power supply included with the system.
3. Type **`SONTERM`** at the DOS prompt.
4. Capture all communication with the Argonaut to a file for future reference using the **Alt+F** option in *SonTerm*.
5. Press Alt+B to send a **`BREAK`** to the Argonaut and bring the system into command mode (the Argonaut command prompt is "**>**").
6. Use the four **`Show`** commands (**`Show Conf`**, **`Show System`**, **`Show Setup`**, and **`Show Deploy`**) to display all Argonaut hardware and operating parameter settings.
7. Select relatively short values for averaging interval and sample interval (15 seconds) and disable burst sampling. Make sure the deployment start date and time are before the current date and time shown on the Argonaut internal clock. Specify a deployment name for the recorded data.
8. Begin autonomous data collection with the "**`Deploy`**" command.
9. Allow the Argonaut to output a number of samples, and then exit *SonTerm* (Alt+X).
10. Type **`SONREC 1`** at the DOS prompt to start the data retrieval software. When the directory is displayed, mark the file you have just generated using the spacebar and download by pressing the **`F3`** key. When the data file has been downloaded, exit *SonRec* by pressing **`Esc`**.
11. Use the GARG___.EXE or EARG___.EXE programs to convert the binary data file to ASCII format.

Section 3. Direct Command Interface

Before data collection, you must understand the basic communication protocol and set some operational parameters. This can be done using the direct command interface or the software provided with the Argonaut. This section describes the direct command interface using a terminal or terminal emulator (such as *SonTerm* or *SonTermW* supplied with the Argonaut software).

- Section 3.1 describes communication protocols and settings.
- Section 3.2 provides an overview of the operational modes of the Argonaut.
- Section 3.3 gives an important notice about cycling the Argonaut power source.
- Section 3.4 presents the syntax rules for the direct-command interface.
- Section 3.5 gives a summary of all available commands.
- Sections 3.6 through 3.15 describe each command in detail.
- Sections 3.16 and 3.17 describe data output formats.
- Appendix 2 provides support for Argonaut-SLs that have the vertical beam option.

3.1. Serial Communication Protocols and Settings

The Argonaut can communicate using several serial communication protocols (see §6.5 for additional information).

- RS232 – Single system operation with cable lengths to 100 meters (300 feet)
- RS422 – Single system operation with cable lengths to 1500 meters (4500 feet)
- SDI-12 – Single system operation with cable lengths to 100 meters (300 feet)

The protocol is set at the factory based on user requirements. The different protocols have the following effects on the direct-command interface.

- RS232 – Direct-command interface is described here in Section 3.
- RS422 – Direct-command interface is described here in Section 3.
- SDI-12 – This protocol uses a reduced direct-command interface, which is typically used in conjunction with RS232 for complete programming capabilities. See Appendix 2 for details on SDI-12 operation.

The default communication settings for all communication protocols are below.

- 9600 baud (§5.4 explains how to change baud rate settings)
- 8 data bits (fixed)
- No parity (fixed)
- 2 stop bits (fixed)

3.2. Modes of Operation

The Argonaut has five operational modes, each of which is described in this section:

- Command mode
- Data acquisition mode
- Deployment mode
- Sleep mode
- SDI-12 interface mode

3.2.1. Command Mode

- The Argonaut can send and receive commands related to all aspects of instrument operation.
- You can enter the command mode from any other mode by sending a **`BREAK`** (§3.4).
- You can enter the command mode from the data acquisition mode using the run-time command “**`+++`**” (§3.15).
- You can put the Argonaut into any other mode only from the command mode.
- To enter the data acquisition mode from the command mode, use the command **`Start`**.
- To enter the deployment mode from the command mode, use the command **`Deploy`**.
- To enter the SDI-12 interface mode from the command mode, use the command **`sdi12`**.
- To enter the sleep mode from the command mode, use the command **`PowerOff`**.
- If the Argonaut is left idle in the command mode for more than five minutes, it will enter the sleep mode to conserve power.

3.2.2. Data Acquisition Mode

- Data acquisition mode is used for real-time data collection for which you are typically connected to an external power supply and computer or data logger.
- Data acquisition mode is entered from command mode with the command **`Start`**. After the **`Start`** command, the Argonaut takes a few seconds to initialize and then begins data collection.
- In data acquisition mode, the Argonaut ignores the deployment parameters **`StartDate`** and **`StartTime`**.
- If the internal recorder has been enabled (**`Recorder ON`**), data are output both over the serial port and to the internal recorder. If the recorder has been disabled (**`Recorder OFF`**), data are sent only to the serial port.
- You can exit the data acquisition mode and return to the command mode by sending a **`BREAK`** (§3.4) or by using the run-time command “**`+++`**”.
- While in data acquisition mode, the Argonaut can enter a low-power state between pings and between samples. This state is similar to, although not the same as, the sleep mode. The Argonaut will enter the low-power state if the system command **`AutoSleep`** is set to **`ON`** (the default setting). See §3.7 regarding the **`AutoSleep`** command and §3.15 regarding the effects of the power saving state on the run-time commands.

3.2.3. Deployment Mode

- Deployment mode is used for autonomous data collection (internal recording, typically with battery power).
- Deployment mode is entered from command mode using the command **`Deploy`**.
- In deployment mode, the instrument starts data collection at the date and time specified by **`StartDate`** and **`StartTime`**. If the current date and time are after the specified start date and time, the system begins data collection immediately.
- In deployment mode, data are always stored to the internal recorder regardless of the **`Recorder ON/OFF`** parameter.
- In deployment mode, the Argonaut will always enter the low-power state between pings and between samples regardless of the **`AutoSleep`** parameter (**`AutoSleep`** is forced **`ON`**).
- Because of the power saving state, the run-time commands (§3.15) cannot be used.
- You can exit the deployment mode and enter the command mode by sending a **`BREAK`**.

3.2.4. Sleep Mode

- Sleep mode is used to conserve power when the Argonaut is not in use. In the sleep mode, the Argonaut consumes less than 1 mW of power.
- The sleep mode is entered from the command mode using the command `PowerOff`.
- You can exit the sleep mode and enter command mode by sending a **`BREAK`** or by sending the command "**`+++`**" (§3.15).
- When in sleep mode, the Argonaut will not respond to any other external commands. The exception is if system power is switched off and on (§3.3).
- If the Argonaut is left idle in command mode for more than five minutes, it will automatically enter the sleep mode to conserve power.

3.2.5. SDI-12 Mode

- SDI-12 mode is used with SDI-12 communication protocol to match data-logger requirements. For more information, see Appendix 2.
- SDI-12 mode is entered from command mode using the command `sdi12 ON`.
- In SDI-12 mode, the Argonaut first performs all setup requirements for data collection. It then enters a low-power mode, awaiting commands from an external data logger.
- In SDI-12 mode, the Argonaut collects one sample at a time on command from an external data-logger.

3.3. Special Notice when Changing Power Sources

When power to the Argonaut is turned off and on (e.g., when changing batteries or switching power supplies), the Argonaut enters the mode it was in before power was lost.

- If previously in command or sleep mode, the system enters command mode.
- If previously in data acquisition mode, the system immediately starts real-time data collection.
- If previously in deployment mode, the system starts a new deployment. `StartDate` and `StartTime` are ignored and the new deployment begins immediately. This is a safety feature to avoid data loss in the unlikely event of a problem with the system clock.
- If previously in SDI-12 mode, the system will again enter SDI-12 mode and wait for a command to begin a new sample.

To Avoid Draining the Batteries When the System is Not in Use

- Always power the system off before storing the system to prevent draining the batteries.
- The splash-proof configuration can be powered off using the switch on the front panel.
- All Argonaut configurations can be powered off by establishing direct communications using *SonTerm* and sending the command `PowerOff` (§3.7).

IMPORTANT:

- When some computers and data loggers are turned on or off, they send a signal out the serial port that can be interpreted by the Argonaut as a **`BREAK`** (§3.4).
- If the Argonaut is connected to the serial port, this can interrupt data collection or bring the Argonaut out of sleep mode and cause the loss of data or the draining of the batteries.
- Always disconnect the Argonaut from the computer or data logger **<u>before</u>** turning the computer on or off.

3.4. Command Syntax

Throughout this manual, we refer to a **BREAK** when discussing direct communications with the Argonaut. Definition of **BREAK**:

- The **BREAK** is a serial communication signal that causes a hardware reset and places the instrument in command mode. A **BREAK** consists of holding the data input line high for a period of at least 300 milliseconds. Most terminal emulators include the ability to send a **BREAK**; *SonTerm* (supplied with the Argonaut) uses **Alt+B**.

These are the basic rules for direct communication with the Argonaut.

1. The Argonaut can be brought into the command mode from any other mode by sending a **BREAK**.
2. All commands consist of a single keyword that may be followed by one or more ASCII parameters. The commands and parameters are <u>not</u> case sensitive.
3. When the Argonaut has completed a command and is ready to accept another command, it will send the prompt character "**>**".
4. Parameters may be numeric (either integer or floating point), alphanumeric, or a combination (*e.g.*, a date or time string).
5. Commands must be terminated by a carriage return – <CR>.
6. The Argonaut echoes every character as it is received (except for run-time commands received during data collection – see Section 3.15).
7. After receiving the <CR> that signals the end of the command string, the Argonaut echoes with an additional line feed character – <LF>.
8. If the Argonaut recognizes a command as valid it will transmit: <LF>**OK**<CR><LF>.
9. If a command is not recognized, the parameters are out of range, or the command cannot be executed in the present state, the Argonaut returns an error message followed by <CR><LF>.

IMPORTANT:

- When some computers and data loggers are turned on or off, they send a signal out the serial port that can be interpreted by the Argonaut as a **BREAK**.
- If the Argonaut is connected to the serial port, this can interrupt data collection or bring the Argonaut out of sleep mode and cause the loss of data or the draining of the batteries.
- Always disconnect the Argonaut from the computer or data logger <u>**before**</u> turning the computer on or off.

3.5. Direct Command Summary

The tables below summarize all direct commands that can be used with the Argonaut, including any abbreviations (shorter versions of the same command). These commands are split into different sections, and different tables, based on their function. Further details on individual commands are provided in the sections that follow. The following abbreviations are used for input parameters to the Argonaut.

- d Integer input (*e.g.*, 30)
- d.d Decimal real number input (*e.g.*, 0.33, 1.5)
- yy/mm/dd Date as year, month, and day (*e.g.*, 1996/05/20 or 96/05/20)
- hh:mm:ss 24-hour clock with hour, minute, and second (*e.g.*, 18:15:00)

Help Commands (Section 3.6)

Command	Short	Function
Help	H or ?	Available help categories
Help System	H/? System	General system commands
Help Setup	H/? Setup	Real-time data collection commands
Help Deploy	H/? Deploy	Autonomous deployment commands
Help Sdi12	H/? Sdi12	SDI-12 interface control commands (if applicable)
Help Recorder	H/? Recorder	Data recorder commands
Help Sensor	H/? Sensor	Peripheral sensor commands
Help Compass	H/? Compass	Compass/tilt sensor commands
Help Show	H/? Show	Commands to display system configuration

System Commands (Section 3.7)

Command	Short	Function	Parameters
Start	(none)	Starts real-time data collection (enters data acquisition mode)	
Deploy	(none)	Starts autonomous deployment (enters deployment mode)	
SaveSetup	(none)	Save current parameters to EEPROM	
Defaults	DEF	Sets all parameters to factory defaults	
Ver	(none)	Shows CPU firmware version	
DSPVer	(none)	Shows DSP firmware version	
BoardRev	(none)	Shows electronics board revision number	
SerNum	(none)	Shows Argonaut serial number	
Date <date>	(none)	Shows / sets system clock date	yy/mm/dd
Time <time>	(none)	Shows / sets system clock time	hh:mm:ss
PowerOff	(none)	Puts Argonaut in sleep mode	
AutoSleep <mode>	AS	If ON, Argonaut enters reduced power state during gaps in data collection	On / Off
OutMode <mode>	OM	Selects data output mode	Auto / Polled
OutFormat <format>	OF	Specifies output data format	Ascii, Binary, or SeaBird
Recorder <status>	(none)	Turns internal recording on or off	On / Off
RecMode <mode>	(none)	Sets recording mode (Buffer not enabled)	Normal/Buffer

Setup Commands (Section 3.8)

Command	Short	Function	Parameters
Temp <temperature>	(none)	Set default temperature (°C)	d.d
Sal <ppt>	(none)	Set default salinity (ppt)	d.d
AvgInterval <s>	AI	Set averaging interval (seconds)	d
SampleInterval <s>	SI	Set time between samples (seconds)	d
CellBegin	CB	Set start location of measurement volume (Argonaut XR and SL only)	d.d
CellEnd	CE	Set end location of measurement volume (Argonaut XR and SL only)	d.d
CoordSystem <system>	CY	Set coordinate system for velocities	BEAM, XYZ or ENU
TempMode <mode>	TM	Set temperature used for sound speed calculations	USER or MEASURED
DataFormat <format>	DF	Set output and stored data format	LONG or SHORT
ProfilingMode <mode>	PM	If installed, enable/disable profiling mode.	YES or NO
Ncells <number>	NC	If PM=yes, number of cells to record	d
CellSize <size>	CS	If PM=yes, length of range cell (m)	d.d
BlankDistance <dist.>	BD	If PM=yes, distance to start of first cell (m)	d.d
DynBoundaryAdj <mode>	DBA	Set dynamic boundary adjustment mode (XR and SL with a pressure sensor only)	YES or NO

Deployment Commands (Section 3.9)

Command	Short	Function	Parameters
Deployment <name>	(none)	Set deployment name (5 characters max.)	ASCII text
Comments	(none)	Enter deployment comments	ASCII text
StartDate <date>	SD	Set deployment start date	yy/mm/dd
StartTime <time>	ST	Set deployment start time	hh:mm:ss
AvgInterval <s>	AI	Set averaging interval (seconds)	d
SampleInterval <s>	SI	Set time between samples (seconds)	d
BurstMode <mode>	BM	Enable or disable burst sampling	YES or NO
BurstInterval <s>	BI	Set time between bursts (seconds)	d
SamplesPerBurst <number>	SB	Set number of samples per burst	d

SDI-12 Interface Commands (Section 3.10)

Command	Short	Function	Parameters
sdi12	(none)	Places the system in the SDI-12 mode	ON
sdi12address	(none)	Sets the SDI-12 interface address	d
sdi12format	(none)	Sets the SDI-12 output data format	SIDEKICK or SONTEK
?EXIT!	(none)	Exits the SDI-12 interface mode	

Recorder Commands (Section 3.11)

Command	Short	Function	Parameters
LD or Dir	(none)	List deployments currently on recorder	
Format	(none)	Erase all data from recorder	
RecStatus	(none)	Show recorder size and free space left	
Recorder <status>	(none)	Turns internal recording on or off	ON or OFF
RecMode <mode>	(none)	Sets recording mode (**BUFFER MODE IS NOT CURRENTLY ENABLED**)	NORMAL or BUFFER
OD <name>	(none)	Open deployment to access data	<deployment name>
CD	(none)	Return name of currently open deployment	
RC	(none)	Retrieve configuration information from currently open deployment	
RSA [N]	(none)	Retrieve next N samples from file, ASCII format	d
RSB [N]	(none)	Retrieve next N sample from file, binary format	d
FS	(none)	Go to first sample in deployment	
LS	(none)	Go to last sample in deployment	
GS <sample number>	(none)	Go to <sample number> in deployment	d
CS	(none)	Return current sample number	
NS	(none)	Return number of samples in deployment	

Sensor Commands (Section 3.12)

Command	Short	Function	Parameters
Sensor	(none)	Display most recent temperature, pressure, and battery voltage data	
Sensor CONT	(none)	Display continuous temperature, pressure, and battery voltage data	
PressOffset	(none)	Display pressure sensor calibration offset	
PressScale	(none)	Display pressure sensor calibration 1st order coefficient	
PressScale_2	(none)	Display pressure sensor calibration 2nd order coefficient	

Compass Commands (Section 3.13)

Command	Short	Function	Parameters
Compass	(none)	Display most recent heading, pitch, and roll data	
Compass CONT	(none)	Display continuous heading, pitch, and roll data	
Compass CAL	(none)	Perform a compass calibration	

Show Commands (Section 3.14)

Command	Short	Function
Show Conf	S Conf	Display hardware configuration parameters
Show System	S System	Display general system parameters
Show Setup	S Setup	Display real time data collection parameters
Show Deploy	S Deploy	Display autonomous deployment parameters

Run-Time Commands (Section 3.15)

Command*	Short	Function
+++	(none)	Return to command mode (stop data collection)
O	(none)	Transmit last sample
T	(none)	Transmit Argonaut date and time
C+	(none)	Adjust real-time clock +1 second
C-	(none)	Adjust real-time clock -1 second
A	(none)	Transmit time left in current averaging interval (seconds)

*These commands available only in data acquisition mode.

3.6. Help Commands

The Argonaut direct command interface contains several on-line help commands. These are designed such that, by starting with "Help", you are led through a series of menus that show all Argonaut commands. Several help commands display all commands you would normally use for any aspect of Argonaut operation.

- `Help` Listing of help menus available
- `Help System` General system commands
- `Help Setup` Real-time data collection commands
- `Help Deploy` Autonomous deployment commands
- `Help Sdi12` SDI-12 interface control commands
- `Help Recorder` Data recorder commands
- `Help Sensor` Peripheral sensor commands
- `Help Compass` Compass/tilt sensor commands
- `Help Show` Commands to display system configuration

The output of these commands is self-explanatory. For more details on individual commands, see the remaining portions of Section 3.

3.7. System Commands

System commands relate to general operation of the Argonaut.

- Starting data collection
- Displaying the serial number
- Setting the clock
- Data output and storage

Each command is shown with its full name, short name (if one exists), optional parameters (in brackets), and appropriate detailed information.

`Start`

- Starts real-time data collection, putting the Argonaut into data acquisition mode (§3.2.2).
- The system first saves all recently entered commands (i.e., does a **`SaveSetup`**).
- Data collection begins immediately (**`StartDate`** and **`StartTime`** are ignored).
- Burst sampling cannot be used (burst sampling parameters are ignored).
- The system enters a low-power state between samples if **`AutoSleep`** is **`ON`**.
- Run-time commands can only be used when **`AutoSleep`** is **`OFF`**.
- Data will be stored to the recorder if enabled (**`Recorder ON`**).

`Deploy` *(do not confuse with* **`Deployment`** *command, §3.9)*

- Starts autonomous data collection, putting the Argonaut into deployment mode (§3.2.3).
- The system first saves all recently entered commands (*i.e.*, does a **`SaveSetup`**).
- Data collection begins when the Argonaut clock reaches the specified **`StartDate`** and **`StartTime`**. If the current date/time is after the specified start date/time, data collection begins immediately.
- Argonaut data are stored to the recorder regardless of the **`Recorder`** setting.
- Instructs system to enter a low-power state between samples (**`AutoSleep`** is forced **`ON`**).

`SDI12 ON`

- The **`sdi12 ON`** command is used only with the SDI-12 serial interface.
- See Appendix 2 for a description of the SDI-12 interface.

`SaveSetup`

- Saves all current parameter settings to internal memory (EEPROM).
- This command must be sent before the system is shut down (or before a **`BREAK`** is sent); otherwise, any recently entered commands will be lost.
- Executed automatically as part of the **`Start`**, **`Deploy`**, and **`sdi12`** commands.

`Defaults` *or* **`DEF`**

- Sets all parameters (except baud rate) to the factory default values. The baud rate remains at the currently active value. To change the baud rate, see §5.4.
- See the individual command descriptions for default values.

`Ver`

- Outputs the version number of the CPU firmware.

DSPVer

- Outputs the version number of the DSP firmware.

BoardRev

- Outputs the revision number of the Argonaut processing electronics boards.

SerNum

- Returns the instrument serial number from memory (should match the serial number on the transducer head).

Date [yy/mm/dd]

- Without parameter: returns the date from the Argonaut clock.
- When given a date in the form "yy/mm/dd" where yy = year (2 or 4 digits), mm = month (2 digits), and dd = day (2 digits), it resets the date.
- Example: **Date 2001/09/08** or **Date 01/09/08** are equivalent commands setting the date to September 8, 2001.

Time [hh:mm:ss]

- Without parameter: returns the time from the Argonaut clock.
- When given a time in the form of "hh:mm:ss" (24-hour clock, where hh = hour (2 digits), mm = minute (2 digits), and ss = seconds (2 digits)), it resets the time.
- Example: **Time 16:24:08** sets the time to 16:24:08 (4:24:08 p.m.).

PowerOff

- Places the Argonaut into sleep mode (§3.2.4).
- We recommend placing the Argonaut in sleep mode whenever it is not in use.
- The Argonaut will automatically enter sleep mode if it is left idle in command mode for more than five minutes.

AutoSleep *or* **AS [ON|OFF]**

- Default parameter: **ON**
- Without parameter: returns its current setting.
- Determines whether the Argonaut enters a reduced power state during data collection.
- When **ON**, the Argonaut will enter the reduced power state between samples. Power consumption is less than 1 mW in the reduced power state.
- When **OFF**, the Argonaut electronics remain active even when not collecting data.
- Must be **OFF** to use the Run-Time commands (§3.15).
- In deployment mode, **AutoSleep** is forced **ON**.

OutMode *or* **OM [AUTO|POLLED]**

- Default parameter: **AUTO**
- Without parameter: returns its current setting.
- Determines whether data are sent over the serial port after the completion of a sample (**AUTO**) or only sent when a specific run-time command is received (**POLLED**).
- The run-time command "**O**" (Output) causes the output of the last sample from the buffer to be sent (§3.15).

OutFormat *or* **OF [BINARY|ASCII|SEABIRD|METRIC|ENGLISH]**

- Default parameter: **ASCII**
- Without parameter: returns its current setting.
- Determines the format of the data output through the serial port. Section 3.16 has a description of the output data formats (**BINARY**, **ASCII**, **SEABIRD**, **METRIC**, **ENGLISH**).
- Data stored on the internal recorder are always stored in binary format (§3.16).

Recorder [ON|OFF]

- Default parameter: **ON**
- Without parameter: returns its current setting.
- When **ON**, all data collected by the Argonaut will be stored on the internal recorder.
- When **OFF**, any data collected in data acquisition mode (via the **Start** command) will not be stored to the recorder (but will be output to the serial port).
- When in deployment mode (via the **Deploy** command), data are always stored on the internal recorder.

RecMode [NORMAL|BUFFER]

- This command is not enabled in this version of the firmware.

3.8. Setup Commands

Setup commands affect the primary data collection parameters of the Argonaut.

- Temperature
- Salinity
- Averaging interval
- Sample interval
- Velocity Range
- Coordinate system
- Data format
- Cell begin
- Cell end
- Profiling mode
- Number of cells
- Cell size
- Blanking distance
- Dynamic boundary adjustment

Note that the timing commands **`AvgInterval`** and **`SampleInterval`** are also listed under deployment commands (§3.9).

Each command is shown with its full name, short name (if one exists), optional parameters (in brackets), parameter range (if appropriate), and detailed information.

`Temp [d.d]`

- Default parameter: **`20.0`** (°C)
- Parameter range: **`-5.0`** to **`60.0`** (°C)
- Without parameter: returns its current setting.
- When used with a valid input parameter, the user-specified temperature is set to this value.
- This temperature value is used to calculate sound speed if **`TempMode`** is set to **`USER`**.
- See the *Argonaut Principles of Operation* for the effect of sound speed on velocity data.

`Sal [d.d]`

- Default parameter: **`34.5`** (ppt)
- Parameter range: **`0.0`** to **`60.0`** (ppt)
- Without parameter: returns its current setting.
- When used with a valid input parameter, the salinity is set to this value.
- This salinity value is used to calculate sound speed.
- See the *Argonaut Principles of Operation* for the effect of sound speed on velocity data.

`AvgInterval` *or* **`AI [d]`**

- Default parameter: **`120`** (s)
- Parameter range: **`10`** to **`3600`** (s; maximum is equivalent to 60 minutes)
- Without parameter: returns its current setting (in seconds).
- When used with a valid integer parameter, the averaging interval is set to this value.

`SampleInterval` *or* **`SI [d]`**

- Default parameter: **`1200`** (s; 20 minutes)
- Parameter range: **`10`** to **`43200`** (s; maximum is equivalent to 12 hours)
- Without parameter: returns its current setting (in seconds).
- When used with a valid integer parameter, the sample interval is set to this value.
- Sample interval is the time between the start of successive samples (§1.2 and §1.3).
- If **`AvgInterval`** > **`SampleInterval`**, then **`AvgInterval`** takes precedence.

`CoordSystem` *or* **`CY [BEAM|XYZ|ENU]`**

- Default parameter: **`ENU`** (for MD and XR); **`XYZ`** (for SL)
- Without parameter: returns its current setting.
- When used with a valid parameter, sets the coordinate system to this value.
- **`BEAM`** causes velocity data to be stored and output as along-beam velocities.
- **`XYZ`** causes velocity data to be recorded and output in the Cartesian coordinate system relative to the Argonaut.
- **`ENU`** causes the Argonaut to use the compass/tilt sensor (if installed) data to transfer velocity data in Earth (East-North-Up) coordinates.
- See §6.4 for coordinate system details.

`TempMode` *or* **`TM [USER|MEASURED]`**

- Default parameter: **`MEASURED`**
- Without parameter: returns its current setting.
- When used with a valid parameter, sets the temperature mode to this value.
- Determines whether the user-input temperature (**`USER`**), or the value from the temperature sensor (**`MEASURED`**), is used for sound speed calculations.
- The temperature sensor is specified as accurate to ±0.1°C. We recommend using **`MEASURED`** unless there is reason to suspect the temperature sensor has been damaged.
- See *Argonaut Principles of Operation* for the effect of sound speed on velocity data.

`DataFormat` *or* **`DF [LONG|SHORT]`**

- Default parameter: **`LONG`**
- Without parameter: returns its current setting.
- When used with a valid parameter, sets the data format to this value.
- Determines the format of data output over the serial port and to the internal recorder. **`LONG`** format includes all available diagnostic data and requires 33 bytes of data storage per sample (binary format). **`SHORT`** includes only minimal diagnostic data and requires 20 bytes of storage per sample (binary format). **`SHORT`** is intended only for autonomous deployments with large data storage requirements.
- See §7.2 regarding the calculation of data storage requirements.

`CellBegin` *or* **`CB [d.d]`** *(used in* **`XR`** *and* **`SL`** *systems only)*

- Default parameter: **`2.0`** (meters)
- Parameter range: **`0.5`** to **`14.8`** (for 1.5-MHz XR and SL systems)
`0.2` to **`5.8`** (for 3.0-MHz XR and SL systems)
- Without parameter: returns its current setting (in meters).
- When used with a valid parameter, sets the starting location of the measurement volume to this value in meters. The measurement volume location is specified as the vertical (XR systems) or horizontal (SL systems) distance from the transducer head.
- The measurement volume size (the difference between **`CellBegin`** and **`CellEnd`**) must be at least 0.5 meters.
- See *Argonaut Principles of Operation* for the effect of sound speed on velocity data.

`CellEnd` *or* **`CE [d.d]`** *(used in* **`XR`** *and* **`SL`** *systems only)*

- Default parameter: **`2.0`** (meters)
- Parameter range: **`0.7`** to **`15.0`** (for 1.5-MHz XR and SL systems)
  `0.4` to **`6.0`** (for 3.0-MHz XR and SL systems)
- Without parameter: returns its current setting (in meters).
- When used with a valid parameter, sets the ending location of the measurement volume to this value in meters. The measurement volume location is specified as the vertical (XR systems) or horizontal (SL systems) distance from the transducer head.
- The measurement volume size (the difference between **`CellBegin`** and **`CellEnd`**) must be at least 0.5 meters.
- See *Argonaut Principles of Operation* for the effect of sound speed on velocity data.

`ProfilingMode` *or* **`PM [YES|NO]`** *(used in* **`XR`** *and* **`SL`** *systems only)*

- This command is only available in XR and SL systems that have the optional Profiling Mode feature installed. **`ProfilingMode`** allows you to collect a "profile" of data from a series of range cells. This differs from the standard Argonaut method of collecting data within just one range cell.
- Default parameter: **`NO`**
- Without parameter: returns its current setting.
- When used with a valid parameter, enables (**`YES`**) or disables (**`NO`**) the profiling mode feature. Setting **`PM`** to **`YES`** requires you to enter values for the number of cells (**`Ncells`**; **`NC`**), cell size (**`CellSize`**; **`CS`**), and blanking distance (**`BlankDistance`**; **`BD`**). Data for each cell is collected and output in the format described in §3.17.

`Ncells` *or* **`NC [d]`** *(used in* **`XR`** *and* **`SL`** *systems only)*

- This command is only available in XR and SL systems that have the optional Profiling Mode feature installed (see above).
- Default parameter: **`1`**
- Parameter range: **`1`** to **`5`**
- Without parameter: returns its current setting.
- When used with a valid parameter, sets the number of cells in each profile.

`CellSize` *or* **`CS [d.d]`** *(used in* **`XR`** *and* **`SL`** *systems only)*

- This command is only available in XR and SL systems that have the optional Profiling Mode feature installed (see above).
- Default parameter: **`0.5`** meter (for 1.5-MHz XR and SL systems)
- Parameter range: **`0.25`** to **`10`** meters
- Without parameter: returns its current setting in meters.
- When used with a valid parameter, sets the range cell size in each profile to this value.

`BlankDistance` *or* **`BD [d.d]`** *(used in* **`XR`** *and* **`SL`** *systems only)*

- This command is only available in XR and SL systems that have the optional Profiling Mode feature installed (see above).
- Default parameter: **`0.5`** meter (for 1.5-MHz XR and SL systems)

- Parameter range: **`0.4`** to **`10`** meters
- Without parameter: returns its current setting in meters.
- When used with a valid parameter, sets the blanking distance to this value.

`DynBoundaryAdj` *`or`* **`DBA [YES|NO]`** *(used in **`XR`** systems only)*

- This command is only available in XR systems.
- Default parameter: **`NO`**
- Without parameter: returns its current setting.
- When set to **`YES`**, the XR dynamically adjusts the values of **`CellBegin`** and **`CellEnd`** to reflect the changes in a changing water level. Examples: (1) To monitor the currents in the upper 2 m of water below the surface, set **`CB`** to **`13`**, **`CE`** to **`15`**, and **`DBA`** to **`YES`**; (2) To measure currents throughout the entire water column, set **`CB`** to **`0.4`**, **`CE`** to **`15`**, and **`DBA`** to **`YES`**.
- When set to **`NO`**, the XR uses the fixed cell location parameters (**`CellBegin`** and **`CellEnd`**) entered above. Example: When monitoring currents in a fixed layer (1 m above the bottom) set **`CB`** to **`1`**, **`CE`** to **`2`**, and **`DBA`** to **`NO`**.

3.9. Deployment Commands

Deployment commands affect the parameters used for autonomous deployments.

- Deployment name
- Averaging interval
- Sample interval
- Start date and time
- Burst sampling parameters.

Note that two of the timing commands (averaging interval and sample interval) are also listed under Setup Commands (§3.8).

Each command is shown with its full name, short name (if one exists), optional parameters (in brackets), parameter range (if applicable), and appropriate detailed information.

`Deployment [name]` *(do not confuse with* **`Deploy`** *command, §3.7)*

- Default parameter: **`DEF`**
- Without parameter: returns its current setting.
- When used with an ASCII string of no more than five characters (letters or digits), the deployment name is set to this value. This determines the file name under which data are stored to the internal recorder.
- All data from a single **`Deploy`** or **`Start`** command are stored in one file.
- The file name on the recorder is the deployment name with a 3-digit number indicating the sequence of files under this name. For example, if the deployment name is **`LAKE`**, the data from the first **`Deploy`** or **`Start`** command will be stored in a file named **`LAKE001`**. If data collection is stopped and re-started without changing the deployment name, the numbers will increment; e.g. **`LAKE002`**, **`LAKE003`**, etc.

`Comments`

- This command lets you enter comments that will be stored in the data file.
- There are three comment lines, each with a maximum of 60 characters.

`StartDate` *or* **`SD [yy/mm/dd]`**

- Default parameter: **`1995/01/01`** `(January 1, 1995)`
- Without parameter: returns the deployment start date.
- When used with a date in the correct format (see **`Date`** command, §3.7), sets the starting date for data collection. This date is used only in deployment mode (using the **`Deploy`** command, §3.7).
- If the start date/time are before the current date/time, data collection begins immediately.

`StartTime` *or* **`ST [hh:mm:ss]`**

- Default parameter: **`00:00:00`**
- Without parameter: returns the deployment start time.
- When used with a time in the correct format (see **`Time`** command, §3.7), sets the starting time for data collection. This time is used only in the deployment mode (using the **`Deploy`** command, §3.7).
- If the start date/time are before the current date/time, data collection begins immediately.

AvgInterval *or* **AI [d]**

- See description under Setup Commands (§3.8).

SampleInterval *or* **SI [d]**

- See description under Setup Commands (§3.8).

BurstMode *or* **BM [NO|YES]**

- Default parameter: **NO**
- Without parameter: returns its current setting.
- Burst sampling can only be used in deployment mode (data collection started with the **Deploy** command). In data collection mode (using the **Start** command), this parameter is ignored. See §1.2 and §1.3 for a description of burst sampling.
- **NO** disables burst sampling; **YES** enables burst sampling.

BurstInterval *or* **BI [d]**

- Default parameter: **1200** (s; maximum is equivalent to 20 minutes)
- Parameter range: **1** to **43200** (s; maximum is equivalent to 12 hours)
- Without parameter: returns its current setting.
- When used with a valid integer parameter, the burst interval is set to this value (in seconds). See §1.2 and §1.3 for a description of burst sampling.
- This command is ignored unless **BurstMode** is set to **YES**, and data collection is started with the **Deploy** command.

SamplesPerBurst *or* **SB [d]**

- Default parameter: **1**
- Parameter range: **1** to **1000**
- Without parameter: returns its current setting.
- When used with a valid integer parameter, the number of samples per burst is set. See §1.2 and §1.3 for a description of burst sampling.
- This command is ignored unless **BurstMode** is set to **YES**, and data collection is started with the **Deploy** command.

3.10. SDI-12 Interface Commands

Starting with firmware version 7.5, the Argonaut-XR and SL offers internal SDI-12 (Serial-Digital Interface) capabilities that require no external devices or converters. Appendix 2 describes the internal SDI-12 interface support in detail. The Argonaut commands are described in this section, and the format of the SDI-12 commands is described in Appendix 2.

`sdi12 ON`

- Places an Argonaut-XR or SL system in the SDI-12 interface mode.
- To exit the SDI-12 interface mode, you must use the ?EXIT! command described below.

`sdi12address [d]`

- Default parameter: **`1`**
- Parameter range: **`0`** through **`9`**
- Without parameter: returns either the current SDI-12 interface address (if the SDI-12 interface option is installed), or an error message (if the SDI-12 option is not installed).
- When used with a valid integer parameter, sets the Argonaut's SDI-12 interface address.
- If more than one sensor is to be connected to the SDI-12 bus, make certain each sensor has a unique address.

`sdi12format [SIDEKICK|SONTEK]`

- When given without parameter, returns the current data output format being used.
- When given with a valid parameter, sets the data output format. Appendix 2 describes these two formats in detail.

`?EXIT!`

- Executing this command causes the Argonaut to exit the SDI-12 interface mode and return to the standard Argonaut operating mode.

3.11. Recorder Commands

Recorder commands allow direct access to data stored in the Argonaut internal recorder.

- Listing files
- Checking recorder capacity
- Extracting data

Each command is shown with its full name, short name (if one exists), optional parameters (in brackets), and appropriate detailed information. The end of this section gives examples of how recorder commands can be used to access data on the internal recorder.

`Dir` *or* **`LD`**

- Lists a directory of the deployments currently stored on the recorder.

`Format`

- Erases all data from the recorder.
- Naturally, you should take some care before executing this command.
- Upon execution, you are asked to confirm the erasure of all data. The Argonaut will give an updated display showing its progress in re-formatting the memory card (the process will take a few seconds).

`RecStatus`

- Shows the installed recorder size and the amount of free space remaining.

`Recorder [ON|OFF]`

- See description under System Commands (§3.7).

`RecMode [NORMAL|BUFFER]`

- See description under System Commands (§3.7).

`OD [name]` *(for Open Deployment)*

- When the open deployment command is given an existing file name as its parameter, it allows access to data within that file.
- Upon opening a file, a marker is placed on the first sample in the file. The file marker specifies the next sample to retrieve and is used by other recorder commands.

`CD` *(for Current Deployment)*

- Returns which recorder deployment file is now open.

`RC` *(for Retrieve Configuration)*

- Retrieves configuration information from the currently open file.
- This includes all information in the file header that is stored only once per data file.
- This information is retrieved in a self-explanatory ASCII text format.

RSA [N] (for Retrieve Sample in ASCII)

- Retrieves **N** samples from the current file in ASCII format.
- If **N** is not specified, one sample is retrieved.
- The first sample retrieved will be the one given by the file marker; after executing this command, the file marker is moved to the next sample after those retrieved.
- See Section 3.16 for a description of the output data format.

RSB [N] *(for Retrieve Sample in Binary)*

- Retrieves **N** samples from the current file in binary format.
- If **N** is not specified, one sample is retrieved.
- The first sample retrieved will be the one given by the file marker; after executing this command, the file marker is moved to the next sample after those retrieved.
- See Section 3.16 for a description of the output data format.

FS *(for First Sample)*

- Moves the file marker to the first sample in the file.

LS *(for Last Sample)*

- Moves the file marker to the last sample in the file.

GS [sample number] *(for Go to Sample)*

- Moves the file marker to the sample number specified.
- This sample will be the next retrieved with the **RSA** or **RSB** commands.

CS *(for Current Samples)*

- Returns the number of current samples shown by the file marker.

NS *(for Number of Samples)*

- Returns the number of samples in the currently open file.

The following are examples of how to access recorder data from the direct-command interface. The Argonaut software includes a program to download data files (see the *Argonaut Software Manual*) and the direct access commands here are not needed for most applications.

Example 1: Retrieve configuration data from deployment LAKE001.ARG

- **LD** to list deployments
- **OD LAKE001** to open the deployment
- **RC** to retrieve configuration

Example 2: Retrieve the last 5 samples in ASCII format from deployment LAKE001.ARG

- **LD** to list deployments
- **OD LAKE001** to open the deployment
- **NS** to retrieve the number of samples in the file (assume 1355 for this example)
- **GS 1351** to go to sample number 1351 in the file (fifth from the last sample)
- **RSA 5** to retrieve the last five samples in ASCII format

3.12. Sensor Commands

In normal Argonaut operation, all commands to the sensors are handled automatically, and no direct commands need to be sent. These commands are provided for diagnostic purposes only. See Section 6.6 for information about the temperature and pressure sensors.

Each command is shown with its full name, short name (if one exists), optional parameters (in brackets), and appropriate detailed information.

`Sensor [CONT]`

- Without parameter: Display once the current temperature (°C), pressure (decibar), and battery voltage (V DC) data.
- With parameter: Display continuously the temperature (°C), pressure (decibar), and battery voltage (V DC) data. Press any key to stop the output of sensor data.

`PressOffset`

- Display the pressure sensor offset value. See Section 6.6 for details on pressure sensor calibration.

`PressScale`

- Display the pressure sensor calibration 1st order coefficient. See Section 6.6 for details on pressure sensor calibration.

`PressScale_2`

- Display the pressure sensor calibration 2nd order coefficient value. See Section 6.6 for details on pressure sensor calibration.

3.13. Compass Commands

In normal operation, all commands to the compass are sent automatically and no direct commands need to be sent. The commands in this section are provided to assist in diagnosing problems and to give greater flexibility in Argonaut operations. For a detailed description of the optional compass/tilt sensor, see Section 4.

Each command is shown with its full name, short name (if one exists), optional parameters (in brackets), and appropriate detailed information.

`Compass [CONT]`

- Without parameter: Display once the most recent heading, pitch, and roll data from the compass/tilt sensor.
- With parameter: Display continuously the heading, pitch, and roll data from compass/tilt sensor (updated twice per second). Press any key to stop data output and return to command mode.
- Data are output in a self-explanatory, ASCII text format.

`Compass CAL`

- Perform a compass/tilt sensor calibration.
- This is done to account for ambient magnetic fields that will affect compass heading (typically caused by ferrous metals) and should be performed before any deployment.
- The Argonaut will output instructions for performing the calibration and provide a continuous display of heading, pitch, and roll.
- Press any key to terminate the calibration, view the calibration score, and return to command mode.
- See Section 4.4 for more information about compass calibration and for details on interpreting the calibration score.

3.14. Show Commands

There are four “show” commands to display current Argonaut-ADV parameter settings. Samples of these commands and their outputs are shown below.

`Show Conf`

- Displays the Argonaut hardware configuration. See Section 5.1 for information about individual settings.
- Example:

```
>show conf

HARDWARE CONFIGURATION PARAMETERS
---------------------------------
System Type -------------------- SL
Sensor serial # ---------------- E15
Sensor frequency - (kHz) ------- 1500
Number of beams ---------------- 2
Beam Geometry ------------------ 2_BEAMS
Vertical Beam ------------------ NO
Slant angle - (deg) ------------ 25.0
Orientation -------------------- SIDE
Compass installed  ------------- NO
Recorder installed ------------- YES
Temperature sensor ------------- YES
Pressure    sensor ------------- NO
PressOffset  - (dbar) ---------- 0.000000
PressScale  -- (dbar/count) ---- 0.000000
PressScale_2 - (pdbar/count^2) - 0
Ctd         sensor ------------- NO
Ext. Press. sensor ------------- NONE
YSI         sensor ------------- NO
Waves Option ------------------- NO
```

`Show System`

- Displays the current system parameters.
- Example:

```
>show system

CURRENT SYSTEM PARAMETERS
-------------------------
CPU Ver --- ARG 3.0
DSP Ver --- DSP 1.0
BoardRev -- REV E
Date ------ 2001/01/21
Time ------ 09:26:35
AutoSleep - YES
OutMode --- AUTO
OutFormat - ASCII
Recorder -- ON
RecMode --- NORMAL
ModemMode - NO
```

`Show Setup`

- Displays the current data collection setup parameters.
- Example:

```
>show setup

CURRENT SETUP PARAMETERS
------------------------
Temp ----------- 20.00 deg C
Sal ------------ 34.50 ppt
TempMode ------- MEASURED
Sound Speed ---- 1520.9 m/s
AvgInterval ---- 120 s
SampleInterval - 1200 s
CoordSystem ---- XYZ
DataFormat ----- LONG
CellBegin ------ 1.00 m
CellEnd -------- 5.00 m
ProfilingMode –- YES
Ncells --------- 5
CellSize ------- 4.00
BlankDistance -- 0.50
```

`Show Deploy`

- Displays the current deployment parameters.
- Example:

```
>show deploy

CURRENT DEPLOYMENT PARAMETERS
-----------------------------
Deployment ------ DEF
StartDate ------- 1995/01/01
StartTime ------- 00:00:00
AvgInterval ----- 120 s
SampleInterval -- 1200 s
BurstMode ------- DISABLED
BurstInterval --- 1200 s
SamplesPerBurst - 1
Comments:
Get your Argonaut today
Fun for the whole family
Now with profiling mode option
```

3.15. Run-Time Commands

This section describes how to communicate with the Argonaut while the system is in data acquisition mode.

- Run-time commands are commonly used while using the **`POLLED`** output mode (see **`OutMode`** in §3.7). This causes the system only to output a data sample on request, and not to output data automatically at the end of a sample.
- To "talk" to an Argonaut during a deployment (*i.e.*, when it is in the data acquisition mode), you must first re-establish communications with the system. This is done by sending a few carriage returns (<CR>; ASCII character code 13) over the communications cable using a terminal emulator such as SonTek's *SonTerm* or *SonTermW*. Note: You may have to send more than one <CR> because during some phases of its operation, the Argonaut does not recognize the arrival of just one character.
- After the Argonaut recognizes the <CR>, it responds with a **`$`** prompt. This indicates that for the next 10 seconds run-time commands will be accepted. If no additional characters are received within 10 seconds, the Argonaut automatically resumes its regular power management mode of operation. If this occurs, the sequence will have to be repeated to talk to the system. Note: When several carriage returns are sent and recognized, the Argonaut ignores them and just resets the 10-s countdown. In addition, if the Argonaut is in the middle of an averaging interval, it continues transmitting (pinging) at the nominal 1-Hz rate whether the system has been awakened or not. As long as you do not send a **`BREAK`** or the "**`+++`**" sequence, the system continues collecting data as usual.
- After the Argonaut responds with the **`$`** prompt, you can use any of the commands described below to communicate with the system. The commands can be used without causing any delay or interruption of data collection (except for a few milliseconds that the system spends in executing the command). Argonaut responses to any of these commands may be delayed up to one second (this is the frequency at which the incoming command buffer is checked), so allow up to a 1-s delay after sending a command.

`+++` *`(alternative`* ***`BREAK`*** *`command)`*

- Sending three + characters in succession causes the Argonaut to terminate data collection and return to the command mode.
- The characters must arrive within a time span of 3 seconds.
- This command is provided as an alternative to sending a **`BREAK`** when relaying data over a modem (where sending a **`BREAK`** command may not be possible).
- This command can also be used to wake the Argonaut from sleep mode. Note that the system may not recognize the first + character. You may need to send more than three + characters in succession to wake the system.

`O` *`(output last sample)`*

- Sending an "**`O`**" (letter O) tells the Argonaut to output the last data sample collected. Note: This command is <u>not</u> available if **`OutFormat`** = **`SEABIRD`**.
- The last sample is stored internally and is updated at the end of each averaging interval.
- At the end of each averaging interval, the Argonaut places the sample in an output buffer in the format specified by the **`OutFormat`** command (**`BINARY`**, **`ASCII`**, **`METRIC`**, **`ENGLISH`**; see §3.16).

- If **`OutMode`** (output mode) = **`AUTO`**, the Argonaut immediately transmits the buffer contents through the serial port. If **`OutMode`** = **`POLLED`**, the Argonaut continues data collection without transmitting the buffer contents.
- In either output mode (**`AUTO`** or **`POLLED`**), the last sample remains in the output buffer until the next sample is completed. At this time, the contents of the buffer are replaced with the new sample.
- When using the **`POLLED`** output mode, it is your responsibility to request transmission of the buffer after each sample is collected and before the averaging interval for the next sample is completed.
- The data sample upload can be done as many times as desired without significantly affecting data collection, since the Argonaut uses only a few milliseconds of processing time to retransmit the entire data buffer.

`T` *`(output date/time)`*

- Sending a "**`T`**" during data collection tells the Argonaut to output the current date and time from its internal clock. Note: This command is not available if **`OutFormat`** = **`SEABIRD`**.
- The clock is read immediately before the date/time data are output, which can be up to one second after the **`T`** command is sent.
- The date/time output will be in **`ASCII`** or **`BINARY`** format depending on the current setting of the **`OutFormat`** parameter. If **`OutFormat`** is set to **`ASCII`**, **`METRIC`**, or **`ENGLISH`**, time is output in **`ASCII`** format.
- In ASCII format, the following line will be sent.

```
yyyy/mm/dd hh:mm:ss.hh  <CR><LF>
```

- In **`BINARY`** format, the following nine bytes will be sent.

Run Time Command "T" Binary Output Record

Field	Offset	Length	Description
Year	0	2	Integer four digit calendar year (*e.g.*, 1995)
Month	2	1	Unsigned character
Day	3	1	Unsigned character
Hour	4	1	Unsigned character
Minute	5	1	Unsigned character
Sec100	7	1	Unsigned character - hundredths of a second
Second	6	1	Unsigned character
CheckSum	8	1	1-byte checksum of preceding eight bytes (Appendix 1 explains checksum calculation.)

`C+` *`and`* ***`C-`*** *`(clock adjust)`*

- The **`C`** command is used to adjust the Argonaut's internal clock.
- **`C+`** advances the clock one second.
- **`C-`** sets the clock back one second.
- The Argonaut acknowledges successful completion of this command with: **`OK`** <CR><LF>.

`A` *`(averaging interval time left)`*

- Sending an "**`A`**" during data collection tells the Argonaut to output the time remaining in the current averaging interval (in seconds). Note: This command is not available if **`OutFormat`** = **`SEABIRD`**.
- The remaining time is output in either **`ASCII`** or **`BINARY`** format depending on the setting of the **`OutFormat`** parameter. If **`OutFormat`** is set to **`ASCII`**, **`METRIC`**, or **`ENGLISH`**, the time remaining is output in **`ASCII`** format.
- In **`ASCII`** format, the following line will be sent, where <*TimeLeft*> is an integer value without leading spaces.

```
<TimeLeft><CR><LF>
```

- In **`BINARY`** format, the following five bytes will be sent:

Run Time Command "A" Binary Output Record

Field	Offset	Length	Description
Time left	0	4	Time left in seconds as a 4-byte integer
CheckSum	4	1	2-byte checksum of preceding 4 bytes (Appendix 1 explains checksum calculation.)

3.16. Output Data Format (Sample Data)

- The Argonaut can output data over the serial port in a variety of formats depending on the setting of the **`OutFormat`** command (§3.7).
  - **`BINARY`** – Used for the most efficient data transmission and storage.
  - **`ASCII`** – Standard tab-delimited ASCII format with all variables output as integers (no decimal points in data).
  - **`SEABIRD`** – Specialized format for integrating with SeaBird inductive modem.
  - **`METRIC`** – Tab-delimited ASCII format with all variables in metric units.
  - **`ENGLISH`** – Tab-delimited ASCII format with all variables in English units.
- The setting of **`OutFormat`** affects only data sent to the serial port.
- Data written to the internal recorder are always stored in binary format.
- **`ASCII`** and **`BINARY`** formats are used for data sent to the serial port during data collection and for data retrieved using the recorder commands.
- **`SEABIRD`**, **`METRIC`**, and **`ENGLISH`** formats are used only for data output over the serial port during data collection.

3.16.1. Binary Data

Binary data files generated by the Argonaut, using either the real-time data collection software or the internal recorder, use the same format. Appendix 1 has a detailed description of the Argonaut binary file format. Argonaut binary sample data uses the same format for several different methods of access.

- Output over the serial port during data collection
- Using the run-time command "**`O`**" (§3.15)
- Using the recorder command **`RSB`** (§3.11)
- Each Argonaut sample will consist of several different data records, depending on the setting of the **`DataFormat`** parameter (**`LONG`** or **`SHORT`** – see §3.8).
- For most applications, the **`LONG`** record is used to enable access to all available diagnostic data. The **`LONG`** data format uses a 38-byte record for each sample. The last byte of this record is a checksum of the preceding 37 bytes. See Appendix 1 for details.
- For autonomous deployments with data storage limitations, and for some other specialized applications, the **`SHORT`** record may be used to reduce the amount of data per sample (at the cost of eliminating some of the diagnostic data). The **`SHORT`** data format uses a 22-byte record for each sample. The last byte of this record is a checksum of the preceding 21 bytes. See Appendix 1 for details.
- See *Argonaut Principles of Operation* for information about interpreting the data types.

3.16.2. ASCII / METRIC / ENGLISH Sample Data

When outputting Argonaut data over the serial port in ASCII/METRIC/ENGLISH format, there are two basic data output types.

- First are the hardware configuration and user-setup parameters.
  - These are output using the **RC** recorder command.
  - This output contains all parameters relating to the hardware configuration of the Argonaut (serial number, frequency, number of beams, etc.) and all user-setup parameters (averaging interval, sample interval, temperature, and salinity, etc.).
  - This output is presented in a self-explanatory text format.
- The second ASCII data output type contains data from one Argonaut sample.
  - This is output over the serial port during data collection using the “**O**” run-time command (§3.15) and the **RSA** recorder command (§3.11).
  - The output is one line per sample in a tabular format that can be easily loaded by data processing software.
  - The exact format of the output sample depends on the setting of the data format parameter (**LONG** or **SHORT**).
  - See *Argonaut Principles of Operation* for information about interpreting data types.

Argonaut LONG Sample Format

- When **LONG** data format is specified, the data output consists of 28 columns. The following table shows the contents and units used with each column.
- All Argonauts sample temperature and pressure once per second. The mean value of temperature and mean and standard deviation of pressure are reported.
- The nature of the data from the compass/tilt sensor (heading, pitch, and roll) depends on the system configuration.
  - For the Argonaut MD, the reported values represent the mean over the averaging period (as the system may move during the course of an averaging period). Compass and tilt sensor data are sampled with each ping (once per second).
  - For the Argonaut XR (and SL with compass/tilt sensor), compass and tilt sensor data are sampled once at the beginning of the averaging period. This value is used to rotate velocity data from the instrument’s XYZ coordinates to ENU coordinates and is reported with the data.
  - For the Argonaut XR and SL, the system is assumed stationary during the course of each averaging period.

Argonaut ASCII/METRIC/ENGLISH Data Output - LONG Data Format

Col	Contents	ASCII	Metric	English
1	Sample time (start of averaging interval) - Year			
2	Sample time (start of averaging interval) - Month			
3	Sample time (start of averaging interval) - Day			
4	Sample time (start of averaging interval) - Hour			
5	Sample time (start of averaging interval) - Minute			
6	Sample time (start of averaging interval) - Second			
7	Velocity component 1 (Beam 1/X/East)	0.1 cm/s	cm/s	ft/s
8	Velocity component 2 (Beam 2/Y/North)	0.1 cm/s	cm/s	ft/s
9	Velocity component 3 (Beam 3/Z/Up) **– OR –** Water level (SL systems with vertical beam; Appendix 2)	0.1 cm/s mm	cm/s cm	ft/s ft
10	Standard deviation component 1 (Beam 1/X/East)	0.1 cm/s	cm/s	ft/s
11	Standard deviation component 2 (Beam 2/Y/North)	0.1 cm/s	cm/s	ft/s
12	Standard deviation component 3 (Beam 3/Z/Up)	0.1 cm/s	cm/s	ft/s
13	Signal strength (Beam 1)	counts	counts	counts
14	Signal strength (Beam 2)	counts	counts	counts
15	Signal strength (Beam 3)	count	count	count
16	Percent good pings	%	%	%
17	Heading	0.1°	°	°
18	Pitch (rotation about the Y-axis)	0.1°	°	°
19	Roll (rotation about the X-axis)	0.1°	°	°
20	Standard deviation heading	0.4°	°	°
21	Standard deviation pitch	0.4°	°	°
22	Standard deviation roll	0.4°	°	°
23	Mean temperature	0.01°C	°C	°F
24	Mean pressure	count	dBar	PSI
25	Standard deviation of pressure	count	dBar	PSI
26	Input power level	0.2 V	V	V
27	Starting location of sampling volume (vertical distance)	0.1 m	m	ft
28	Ending location of sampling volume (vertical distance)	0.1 m	m	ft
29+	Note: Additional fields may appear depending on installed options. See Section 8 for the data format of wave spectra, CTD, and other optional sensors.			

Argonaut SHORT Sample Format

- When **`SHORT`** data format is used, the data output contains 14 columns. The following table shows the contents and units used with each column.
- For the **`SHORT`** data format, reported signal strength is the mean of all working beams (three beams for Argonaut XR and MD; two beams for Argonaut SL).
- Reported standard deviation is the defined based on the coordinate system:

Beam Coordinates	$\sigma V = \sqrt{(\sigma V1^2 + \sigma V2^2 + \sigma V3^2)}$
XYZ Coordinates	$\sigma V = \sqrt{(\sigma Vx^2 + \sigma Vy^2)}$
ENU Coordinate	$\sigma V = \sqrt{(\sigma VE^2 + \sigma VN^2)}$

Argonaut ASCII/METRIC/ENGLISH Data Output - SHORT Data Format

Col	Contents	ASCII	Metric	English
1	Sample time (start of averaging interval) - Year			
2	Sample time (start of averaging interval) - Month			
3	Sample time (start of averaging interval) - Day			
4	Sample time (start of averaging interval) - Hour			
5	Sample time (start of averaging interval) - Minute			
6	Sample time (start of averaging interval) - Second			
7	Velocity component 1 (Beam 1/X/East)	0.1 cm/s	cm/s	ft/s
8	Velocity component 2 (Beam 2/Y/North)	0.1 cm/s	cm/s	ft/s
9	Velocity component 3 (Beam 3/Z/Up)	0.1 cm/s	cm/s	ft/s
10	Mean standard deviation (see above)	0.1 cm/s	cm/s	ft/s
11	Mean signal strength (see above)	count	count	count
12	Mean temperature	0.01°C	°C	°F
13	Mean pressure **– OR –** Water level (SL systems with vertical beam; Appendix 2)	count mm	dbar cm	PSI ft
14	Input power level	0.2 V	V	V
15+	Note: Additional fields may appear depending on installed options. See Section 8 for the data format of wave spectra, CTD, and other optional sensors.			

3.17. Output Data Format (Profile Data)

Systems manufactured with the optional Profiling Mode feature will output profile data for each cell. The format of the data is shown in this section. Before profile data can be displayed, you must set the **`ProfilingMode`** (**`PM`**) command to **`YES`**. You must also make entries for number of cells (**`NC`**), cell size (**`CS`**), and blanking distance (**`BD`**). See §3.8 for command descriptions.

The following example and table show the format of Argonaut profile data.

```
 1   -251    -39    23   0   0   0  31  59  72
 2    129    155   -20   0   0   0  31  59  71
 3      0   2186    56   0   0   0   0   0   0
 4   -267     88   134   0   0   0  31  59  72
```

Argonaut Profile Data Format

Column	Contents
1	Cell number
2	Velocity data (V1 or Vx or Veast) in cm/s
3	Velocity data (V2 or Vy or Vnorth) in cm/s
4	Velocity data (V3 or Vz or Vup) in cm/s [3-beam systems only]
5	Standard deviation data (SD1 or SDx or SDeast in cm/s
6	Standard deviation data (SD2 or SDy or SDnorth in cm/s
7	Standard deviation data (SD3 or SDz or SDup in cm/s [3-beam systems only]
8	Amplitude (signal strength), Beam 1 in counts (1 count = 0.43 dB)
9	Amplitude (signal strength), Beam 2 in counts
10	Amplitude (signal strength), Beam 3 in counts [3-beam systems only]

Section 4. Compass/Tilt Sensor Operation

- The Argonaut MD and XR are equipped with a compass and 2-axis tilt sensor, which provides heading, pitch, and roll data. The Argonaut SL is not normally equipped with the compass/tilt sensor, but can be for specialized applications.
- The sensor used is the Precision Navigation TCM2.
- Compass data is used to translate velocity from the instrument XYZ coordinate system to an Earth coordinate system (East-North-Up or ENU; see §4.3).

While the compass provides excellent quality data, there are some limitations to keep in mind.

- Ensure the compass is correctly mounted for the orientation of the Argonaut (up- or down-looking), and that the installation matches the system orientation setting. See §4.2 for details about compass installation and orientation setting.
- The compass includes a built-in calibration feature to account for the effects of ambient magnetic fields (*e.g.*, nearby ferrous metals). We recommend performing a compass calibration before each deployment. When properly calibrated, the compass provides heading accurate to ±2.0° and pitch and roll accurate to ±1.0° up to 50°. See §4.4 for details about compass calibration.
- Because the compass communicates with the Argonaut through an RS-232 interface, it is possible for you to communicate directly with the compass. All communication with the compass is handled automatically by the Argonaut, and direct communication with the compass should not normally be necessary. For a discussion of how to communicate directly with the compass/tilt sensor, see §4.5.

4.1. Testing Compass Operation

A simple procedure exists to verify compass operation using a continuous display of heading, pitch, and roll. This is not intended as a precise test of compass accuracy, but a means to evaluate basic performance. For best results, we recommend performing a compass calibration before any deployment (§4.4).

- The compass must be physically oriented up (which means the Argonaut will be oriented down if the compass is installed for down-looking operation) and the orientation setting must match the compass installation. See §4.2 for compass installation/orientation details.
- This test should be conducted in an area predominantly free of magnetic material.
- Start the display of compass data:
    - If using the direct-command interface, the command **`Compass CONT`** gives a continuous output of heading, pitch, and roll (§3.13).
    - Or, use SonTek's compass calibration software, *CompCal* or *CompCalW* (see *Argonaut Software Manual*) to view a graphical display of compass data.
- Point the Argonaut X-axis (marked on the transducer head) towards each compass direction (North, South, East, and West) and compare the compass output with the expected reading.
- Test the pitch and roll sensors by tilting the Argonaut about the X-axis (roll) and Y-axis (pitch) respectively, and compare the output measurements with estimated tilt angles.
- The data should appear reasonable within the accuracy of this type of experiment (±10° heading, ±5° tilt). Large errors or a lack of response indicates a problem with the compass.

4.2. Compass Installation

The Argonaut is configured at the factory for up or down-looking operation. You can determine the configuration by using the `Show Conf` command from the direct command interface (§3.14 and §5.1). Both the installation of the compass and the orientation setting must be modified if the Argonaut is switched between up and down-looking operation.

The critical part of compass installation is to maintain a known orientation relative to the acoustic transducers. This allows the Argonaut to use the compass data to translate velocity data from the XYZ coordinate system (relative to the Argonaut) to the ENU coordinate system.

Figure 2 shows the compass/tilt sensor layout and its XYZ coordinate system. The compass must be operated with the component side facing upwards (within the ±50° tilt limit); operation in any other orientation will result in invalid compass data and corrupted velocity data when using the ENU coordinate system (non-recoverable data loss).

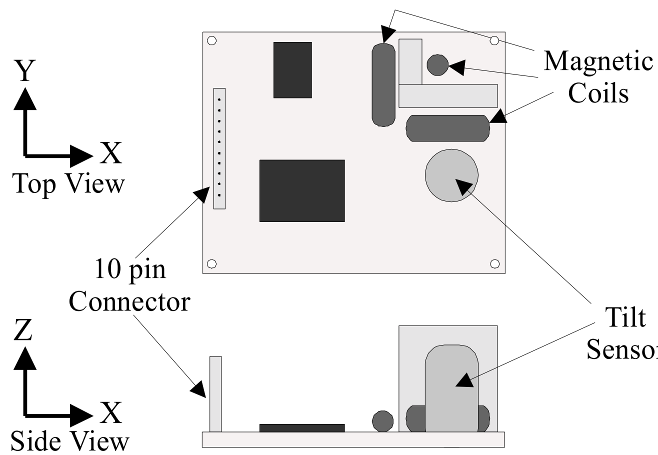


Figure 2 – Compass/Tilt Coordinate System

The compass has a 10-pin connector at one end for communication with the Argonaut. The positive X-axis is defined along the long axis of the compass board from the connector towards the magnetic coils. The positive Z-axis is defined perpendicular to the compass board, upwards from the side with the connector, coils, and tilt sensor. The positive Y-axis is defined for a right hand coordinate system.

Pitch is defined as a rotation about the Y-axis; positive pitch raises the magnetic coils above the connector. Roll is defined as a rotation about the X-axis; positive roll raises the magnetic coils above the tilt sensor.

4.2.1. Argonaut MD

The standard Argonaut MD system includes a compass/tilt sensor; it is installed at the factory to meet the orientation requirements of the user. If changing between up and down-looking operation, you must modify the compass installation and change the orientation setting as described below. See §5.6.1 for instructions on accessing the Argonaut MD electronics.

<u>Up-looking compass installation</u>

Figure 3 shows the installation of the Argonaut MD compass/tilt sensor for up-looking operation. The system is drawn with the transducer head looking down (as if placed on a table), but the compass is installed for up looking operation. Both the compass X-axis and the Argonaut X-axis are coming out of the page (the transducer shown is Beam 1). The compass is installed so that the component side will be facing up when the Argonaut transducers are up-looking.

For up-looking operation, the compass is mounted directly to a set of four 3/8” standoffs on the internal mounting plate (these standoffs are secured with lock-tite and cannot be easily removed).

The positive X-axis of the compass is aligned with the positive X-axis of the Argonaut (the compass coordinate system exactly matches the Argonaut up-looking XYZ coordinate system). See §6.4 for the definition of the Argonaut XYZ coordinate system; note that this coordinate system will change depending on whether the orientation setting is for up or down-looking operation.

When installing the compass, the board is secured using short #4-40 screws (spares are included in the Argonaut tool kit). Install fiber washers on both sides of the compass board for protection. It may be helpful to stick the washers to the compass board with a small amount of silicon grease before installing the compass (the o-ring grease in the Argonaut tool kit works well). The compass mounting screws should be tightened securely, but not over-tightened.

After installing the compass, you need to specify the system orientation so that the Argonaut will correctly interpret the compass data. To specify the orientation for up-looking operation, establish direct communication with the Argonaut and send the following command.

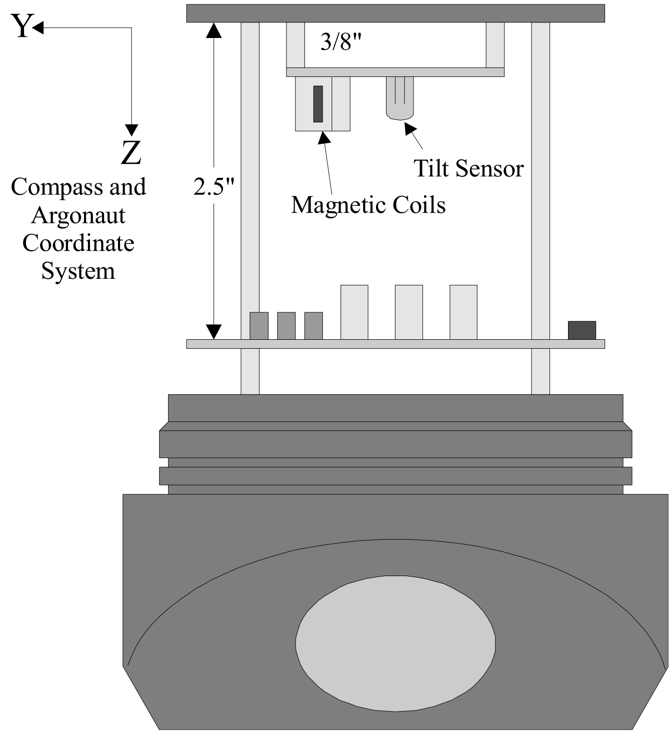


Figure 3 – Argonaut MD Up-Looking Compass Installation

```
ORIENTATION SET UP
```

After sending the command, send a **BREAK** to the system. List the hardware configuration parameters by sending a **Show Conf** command and verify that orientation is correctly set. The system is now ready for operation.

Down-looking compass installation

Figure 4 shows the installation of the Argonaut MD compass/tilt sensor for down-looking operation. The system is drawn with the transducer head looking down as if placed on a table. Both the compass X-axis and the Argonaut X-axis are coming out of the page (the transducer shown is beam 1). The compass is installed so that the component side will be facing up when the Argonaut transducers are down-looking.

For down-looking operation, four 1” standoffs are attached to the four 3/8” standoffs installed on the internal mounting plate (the 3/8” standoffs are secured with lock-tite and cannot be easily removed). The positive X-axis of the compass is aligned with the positive X-axis of the Argonaut (the compass coordinate system exactly matches the Argonaut down-looking XYZ coordinate system). See §6.4 for the definition of the

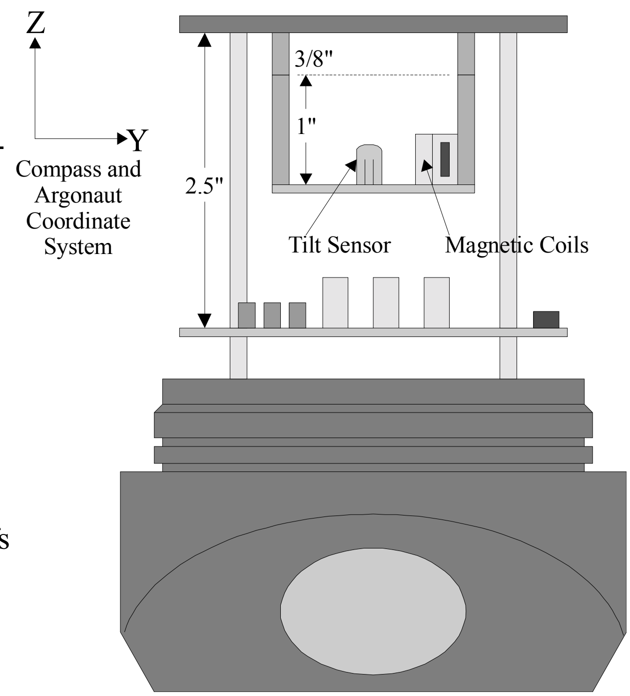


Figure 4 – Argonaut MD Down-Looking Compass Installation

Argonaut XYZ coordinate system; note that this coordinate system will change depending on whether the orientation setting is for up or down-looking operation.

When installing the compass, the board is secured using short #4-40 screws (spares are included in the Argonaut tool kit). Install fiber washers on both sides of the compass board for protection. It may be helpful to stick the washers to the compass board with a small amount of silicon grease before installing the compass (the o-ring grease in the Argonaut tool kit works well). The compass mounting screws should be tightened securely, but not over-tightened.

After installing the compass, you need to specify the system orientation so the Argonaut will correctly interpret the compass data. To specify the orientation for down-looking operation, establish direct communication with the Argonaut and send the following command.

```
ORIENTATION SET DOWN
```

After sending the command, send a **`BREAK`** to the system. List the hardware configuration parameters by sending a **`Show Conf`** command and verify that orientation is correctly set. The system is now ready for operation.

4.2.2. Argonaut XR and SL

The standard Argonaut XR system includes a compass/tilt sensor; unless otherwise specified, the compass is installed for up-looking operation. For most applications of the Argonaut SL, a compass/tilt sensor is not needed. If one is added, the compass installation and orientation settings are identical to the XR. See §5.6.2 for instructions on accessing XR and SL electronics.

Up-looking compass installation

Figure 5 shows the installation of the compass/tilt sensor in the Argonaut XR/SL housing for up-looking operation. The component side of the compass board is mounted away from the bottom of the housing. This ensures the compass faces up when the Argonaut is deployed looking up.

For up-looking operation, the compass is mounted on the bottom of the Argonaut housing using 3/8" standoffs. The positive Y-axis of the compass aligns with the positive X-axis of the Argonaut. The positive X-axis of the compass is aligned 90° clockwise of the positive X-axis of the Argonaut.

When installing the compass, the board is secured with short #4-40 screws (spares are included in the Argonaut tool kit). Install fiber washers on both sides of the compass board for protection. It may be helpful to stick the washers to the compass board with a small amount of silicon grease before putting the compass into the housing (the o-ring grease in the Argonaut tool kit works well). The same grease can be used to stick the #4-40 screws to the wrench when reaching into the canister. The compass mounting screws should be tightened securely, but not over-tightened.

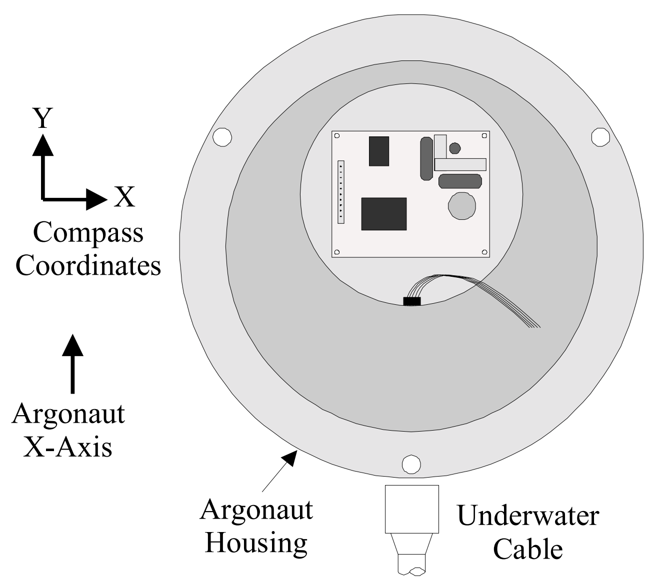


Figure 5 – Argonaut XR Up-Looking Compass Installation

After installing the compass, you need to specify the system orientation so the Argonaut will correctly interpret compass data. To specify the orientation for up-looking operation, establish direct communication with the Argonaut and send the following command.

```
ORIENTATION SET UP
```

After sending the command, send a **`BREAK`** to the system. List the hardware configuration parameters by sending a **`Show Conf`** command, and verify that orientation is correctly set. The system is now ready for operation.

<u>Down-looking compass installation</u>

Figure 6 shows the installation of the compass/tilt sensor in the Argonaut XR/SL housing for down-looking operation. The component side of the compass board is mounted towards the bottom of the housing. This ensures the compass faces up when the Argonaut is deployed looking down. Note that compass components that are below the board (*i.e.*, not directly visible when the compass is installed) are drawn with dashed lines in Figure 6.

For down-looking operation, a set of 3/4" hex standoffs (included in the Argonaut tool kit) must be installed onto the existing standoffs. This provides the necessary clearance to install the compass with the components facing down. These standoffs should be snugly screwed into the 3/8" standoffs, but take care not to over-torque as this may strip the threads.

For down-looking operation, the positive Y-axis of the compass should match the negative X-axis of the Argonaut. The positive X-axis of the compass is aligned 90° clockwise of the Argonaut X-axis.

When installing the compass, the board is secured with short #4-40 screws (spares are included in the Argonaut tool kit). Install fiber washers on both sides of the compass board for protection. It may be helpful to stick the washers to the compass board with a small amount of silicon grease before putting the compass into the housing (the o-ring grease in the Argonaut tool kit works well). The same grease can be used to stick the #4-40 screws to the wrench when reaching into the canister. The compass mounting screws should be tightened securely, but not over-tightened.

After installing the compass, you need to specify the system orientation so that the Argonaut will correctly interpret the compass data. To specify the orientation for down-looking operation, establish direct communication with the Argonaut and send the following command.

```
ORIENTATION SET DOWN
```

After sending the command, send a **`BREAK`** to the system. List the hardware configuration parameters by sending a **`Show Conf`** command, and verify that orientation is correctly set. The system is now ready for operation.

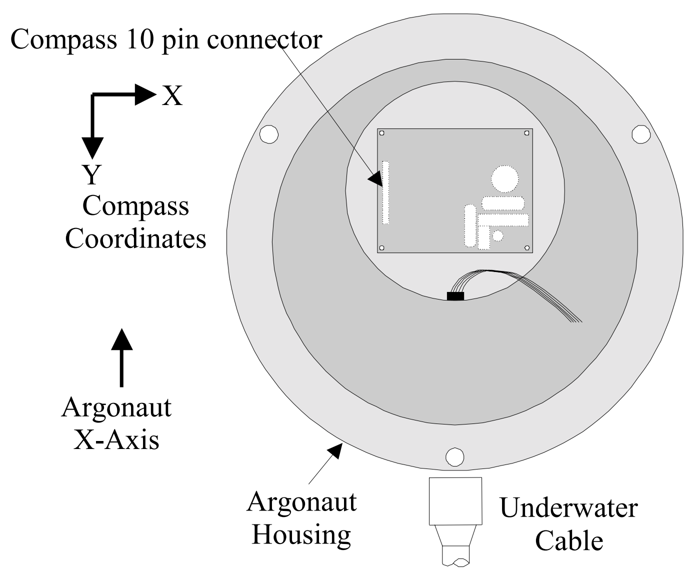


Figure 6 – Argonaut XR Down-Looking Compass Installation

4.3. The ENU Coordinate System

The translation of velocity data from XYZ to Earth (ENU) coordinates is enabled or disabled through commands to the Argonaut and is transparent to the user. Selection of the coordinate system is done using the **`CoordSystem`** command (§3.8) or by a menu item in the data acquisition software (see *Argonaut Software Manual*). When the compass is installed, heading, pitch, and roll data are stored with each sample if the **`DataFormat`** parameter is set to **`LONG`**; compass data are not stored using the **`SHORT`** data format (§3.8).

When using the ENU coordinate system, velocity is reported in Earth coordinates regardless of the physical orientation of the Argonaut (within the operational limits of the compass – specifically the ±50° tilt limitation). An Argonaut mounted with an unknown orientation will provide velocity data consistent with the direction and speed of the water current itself.

Argonaut MD velocity data in each sample are averaged using continually updated compass data. If the Argonaut MD changes orientation during a sample, velocity data will be averaged in Earth coordinates and will not be contaminated by instrument motion. Using any other coordinate system for the Argonaut MD (BEAM or XYZ) eliminates this Earth coordinate system vector averaging and can contaminate data if the instrument moves during the course of an averaging interval. For the Argonaut MD, we recommend using the ENU coordinate system except for specialized applications.

The Argonaut XR (and SL with optional compass) does not perform vector averaging of data during each sample. Compass/tilt sensor data are sampled once at the beginning of each averaging period. These instruments assume a stable orientation for the duration of the sample and apply the rotation from XYZ to ENU coordinates only once.

4.4. Compass Calibration

The compass can be calibrated to compensate for ambient magnetic fields, which may cause errors in heading measurements. Magnetic distortion is most commonly caused by ferrous metal near the Argonaut. If the Argonaut is mounted on or near anything that contains magnetic material or generates a magnetic field, the compass should be calibrated before starting data collection. Additionally, the compass should be calibrated when moved to a different environment or mounting apparatus.

There are two methods for compass calibration. The first is to use the compass calibration software, described in the *Argonaut Software Manual*. Alternatively, the operator can use the compass commands from the direct command interface.

To begin a compass calibration using the compass commands, establish communication with the Argonaut. Type the command **`Compass CAL`** and press ENTER. The system will output basic instructions for the calibration and give a continually updated output of heading, pitch, and roll. The compass is now in multiple-point calibration mode and is collecting sample points. Rotate the compass slowly through 360 degrees at least twice, varying the pitch and roll as much as possible, so that a complete rotation takes at least one minute to complete. When this has been completed, press any key to terminate the calibration. The Argonaut will respond with a calibration score, which will look like the following.

```
H9V9M5.3:
```

This is an indication of the quality of the calibration. The number following the **`H`** and **`V`** should be high (scale of 0 to 9) and the number following the **`M`** should be low (on a scale of 0 to 100). The number following the **`H`** reflects the quality of the horizontal calibration, the number following the **`V`** reflects the quality of the vertical calibration, and the number following the **`M`** reflect the amount of magnetic distortion present. While scores will vary, if either **`H`** or **`V`** is below 6, or if **`M`** is greater than 30.0, you should repeat the calibration. If the results do not improve, consider changing the location or modifying the mounting structure.

The compass calibration software follows an essentially identical procedure, and reports the same calibration score (see *Argonaut Software Manual* for details.)

4.5. Communicating with the Compass

All communication for system operation is done automatically by the Argonaut; under normal circumstances, you should not need to communicate directly with the compass. Should the need arise, you can communicate through the Argonaut by establishing communication and bypassing the Argonaut processor for a direct link to the compass.

To communicate with the compass, place the Argonaut in command mode. Send the following command to establish a direct link with the compass.

```
> echo 1
```

If the compass is operating properly, it should be continuously sending data to the Argonaut, which will be redirected to the user. The data will look something like:

```
$C143.2P3.4R5.4T24.8*3f
```

The compass will now accept direct commands. For details on communicating with the compass, or for a copy of the compass manual, contact SonTek. When communication with the compass is no longer desired, typing three plus signs in succession (“**`+++`**”) or sending a **`BREAK`** will return the Argonaut to command mode.

Section 5. Argonaut Hardware

5.1. Argonaut Hardware Configuration Settings

The hardware configuration of the different Argonaut systems depends on the requirements of the application. Argonaut hardware configuration settings can be displayed using the **`Show Conf`** command from the direct command interface (§3.14). A sample output of this command for an Argonaut SL is given below.

```
>show conf

HARDWARE CONFIGURATION PARAMETERS
---------------------------------
System Type -------------------- SL
Sensor serial # ---------------- E15
Sensor frequency - (kHz) ------- 1500
Number of beams ---------------- 2
Beam Geometry ------------------ 2_BEAMS
Slant angle - (deg) ------------ 25.0
Orientation -------------------- SIDE
Compass installed  ------------- NO
Recorder installed ------------- YES
Temperature sensor ------------- YES
Pressure    sensor ------------- NO
Ctd         sensor ------------- NO
PressOffset  - (dbar) ---------- 0.000000
PressScale  -- (dbar/count) ---- 0.000000
PressScale_2 - (pdbar/count^2) - 0
```

A brief description of each parameter is given below.

- System type: Set at the factory for MD, XR, or SL.
- Sensor serial number: The Argonaut serial number is stamped on the transducer head.
- Sensor frequency: Specifies the acoustic frequency of the Argonaut in kHz (3000 or 1500).
- Number of beams / Beam geometry / Slant angle: The Argonaut MD and XR use three beams for vertical operation. The Argonaut SL uses two beams for horizontal current measurements. The mounting angle of the Argonaut transducers is 25° for the Argonaut XR and SL, 45° for the Argonaut MD. See *Argonaut Principles of Operation* for details on the exact beam geometry and mounting angle used by each system.
- Orientation: Measurement orientation of the system for up-looking, down-looking, or side-looking operation. Note that this setting must match the compass installation for correct operation (§4.2). Also, note that the orientation will affect the definition of the XYZ coordinate system (§6.4).
- Compass / Recorder / Temperature / Pressure sensor: These settings specify which optional sensors have been installed. All systems include the recorder and temperature standard. The Argonaut MD and XR include a compass standard. The Argonaut XR includes a pressure sensor standard.
- PressOffset / PressScale / PressScale_2: Factory calibration parameters for the pressure sensor (§6.6).

5.2. Argonaut Internal Electronics and Wiring Overview

This section provides information about the basic internal layout of the Argonaut. For more information, refer to the following sections.

- Section 4.2 – Compass installation
- Section 5.3 – Argonaut processor and functional/connector descriptions
- Section 5.6 – Accessing electronics

5.2.1. Argonaut MD

Figure 7 shows the internal layout of an Argonaut MD. The system is shown with the transducers pointing down (as if resting on a table), although the compass is shown installed for upward looking operation. The system can be operated either looking up or down; it will be configured at the factory based on user specifications. You must modify the compass installation and system orientation setting if switching between up and down-looking operation; see §4.2.1 for details.

Starting at the transducer head and moving up, the following important items are seen.

- The dual o-ring seals are exposed on the top of the transducer head. Whenever opening the system, take care to avoid damage to all o-rings and o-ring surfaces. Clean and inspect o-rings surfaces before closing the system; replace o-rings when necessary.
- The receiver board is mounted on three 3/8" standoffs directly from the transducer head. The transducers are wired directly to the receiver board.
- An internal mounting frame for the compass/ tilt sensor and Argonaut processor is mounted on three 2.5" standoffs on the receiver board.
- The compass/tilt sensor is mounted from an internal mounting plate above the receiver board. The installation of the compass must match the system orientation setting for proper operation (§4.2.1).
- The Argonaut processor (consisting of the analog and CPU electronics boards) is mounted on two sets of four ½" standoffs from the internal mounting hardware. The analog board is on top (to the left in Figure 7) of the CPU board. The two boards are connected using an edge connector at one end of the board (the top end as shown in Figure 7). See §5.3 for a detailed description of the Argonaut processor.

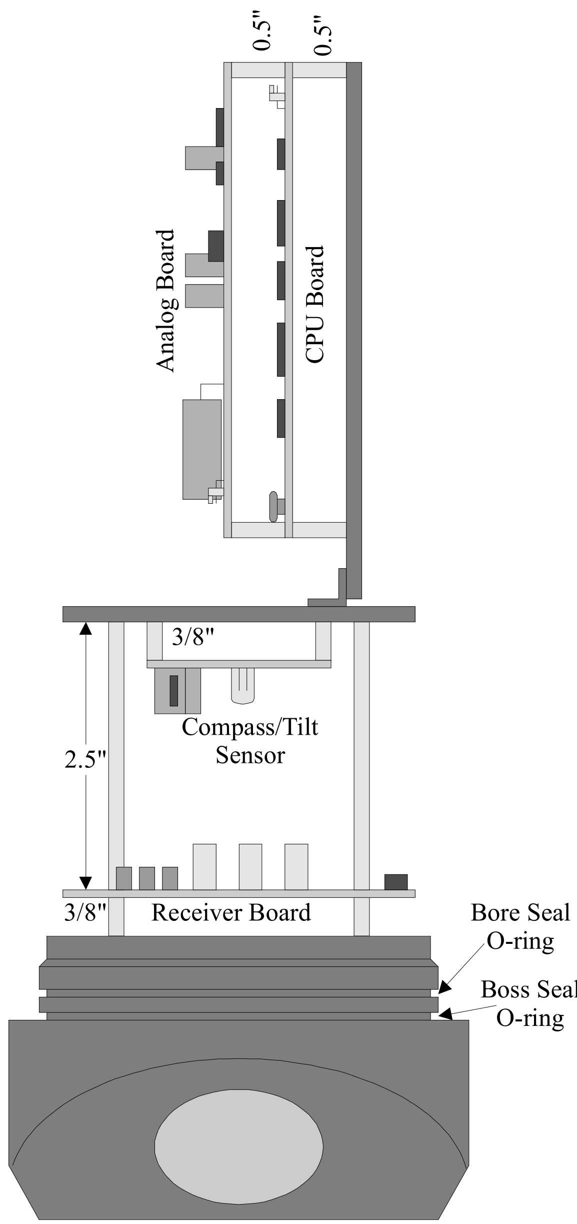


Figure 7 – Argonaut MD Internal System Layout

The cables used to connect the different portions of the Argonaut are described below. For details about the location of each connector on the Argonaut processor, see §5.3.

- A 16-pin ribbon cable connects the receiver board to the analog board. The cable uses the same connectors at each end with pin-to-pin wiring, so it can be installed in either direction. The keyed connectors can be installed in only one direction.
- The power and RS232 interface cable for the compass/tilt sensor goes from a keyed, 10-pin, red connector on the compass to a keyed, 5-pin, red connector on the CPU board (labeled **Compass**).
- A 2-wire cable from the temperature sensor connects to a keyed, 2-pin, red connector on the analog board (labeled **Temperature**).
- A 5-wire cable directly from the pressure sensor (if installed) connects to a keyed, 5-pin, red connector on the analog board (labeled **Pressure**).
- The external supply power is connected to a keyed, 3-pin, red connector on the analog board. Power from the Argonaut MD batteries is wired directly to the analog board. External power is wired through an additional voltage regulator (installed on the internal mounting hardware) before reaching the connector on the analog board. See §6.1 for details on the Argonaut input power specifications.
- RS232 or RS422 serial communication is wired from the underwater connector on the Argonaut MD end cap to a keyed, 5-pin, red connector on the CPU board (labeled **User**).
- A red, 3-pin connector on the CPU board is used for the RS232 interface to the optional integrated CTD.

5.2.2. Argonaut XR and SL

Figure 8 shows the internal layout of the Argonaut XR and SL. The system is shown with the transducers pointing down as if resting on a table. Starting at the transducer head and moving up, the following important items are seen.

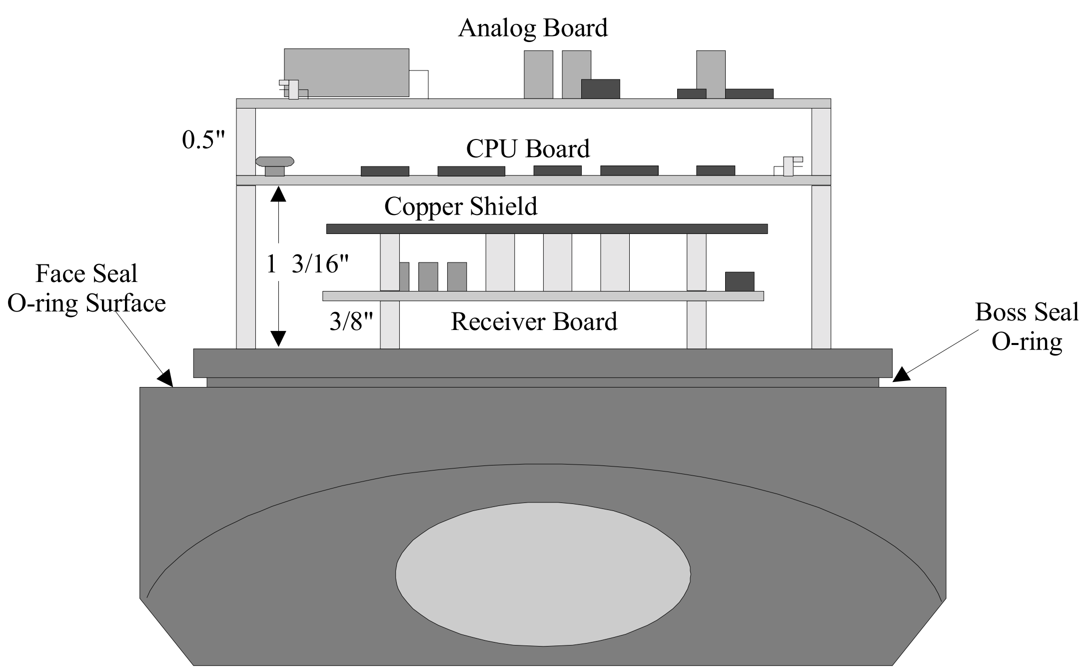


Figure 8 – Argonaut XR and SL Internal System Layout

- The dual o-ring seals are exposed on the top of the transducer head. Whenever opening the system, take care to avoid damage to all o-rings and o-ring surfaces. Clean and inspect o-rings surfaces before closing the system; replace o-rings when necessary.
- The receiver board is mounted on three 3/8" standoffs directly from the transducer head. The transducers are wired directly to the receiver board.
- The receiver board is electrically shielded from the other electronics using a copper plate mounted on three ½" standoffs above the receiver board.
- The Argonaut processor (consisting of the analog and CPU electronics boards) is mounted on four 1-3/16" standoffs directly from the transducer head. The two boards are separated using four ½" standoffs, and are connected using an edge connector at one end of the board. See §5.3 for a detailed description of the Argonaut processor.

The cables used to connect the different portions of the Argonaut are described below. For details about the location of each connector on the Argonaut processor, see §5.3.

- A 16-pin ribbon cable connects the receiver board to the analog board. The cable uses the same connectors at each end with pin-to-pin wiring, so it can be installed in either direction. The keyed connectors can be installed in only one direction.
- A 2-wire cable from the temperature sensor connects to a keyed, 2-pin, red connector on the analog board (labeled **Temperature**).
- A 5-wire cable directly from the pressure sensor (if installed) connects to a keyed, 5-pin, red connector on the analog board (labeled **Pressure**).
- Power from the underwater connector on the Argonaut housing is connected to a keyed, 3-pin, red connector on the analog board. Power from the **Battery supply** pin is wired directly to the analog board. Power from the **External supply** pin power is wired through an additional voltage regulator (installed in the Argonaut housing) before reaching the connector on the analog board. See §6.1 for details on the Argonaut input power specifications, and see §5.5.1 for details about wiring of the underwater connector.
- RS232 or RS422 serial communication is wired from the underwater connector on the Argonaut housing to a keyed, 5-pin, red connector on the CPU board (labeled **User**).
- The power and RS232 interface cable for the compass/tilt sensor (if installed) is wired from a keyed, 10-pin, red connector on the compass (mounted in the Argonaut housing) to a keyed, 5-pin, red connector on the CPU board (labeled **Compass**).
- A red, 3-pin connector on the CPU board is used for the RS232 interface to the optional integrated CTD.

5.3. Argonaut Processor

The Argonaut processor consists of two printed circuit (PC) boards called the analog and CPU boards. The boards are installed in the Argonaut separated by four, ½" standoffs, with the analog board on top; they are connected using a 40-pin edge connector at one end of the board. Figure 9 shows the basic layout of the analog board. Important features on the board are listed below.

- A keyed, 3-pin, red connector (labeled **Power**) is connected to the input power wiring. The Argonaut processor can accept an input supply from 6-15 V; higher voltages will result in serious damage to the electronics. See §6.1 for details on the Argonaut input power specifications.
- A 40-pin edge connector mates below to the CPU board. The connector is designed so the boards can be connected with either board on top. Except for specialized applications, the analog board is installed on top.
- A keyed, 2-pin, red connector (labeled **Temperature**) connects to the temperature sensor in the transducer head.
- A keyed, 5-pin, red connector (labeled **Pressure**) connects to the pressure sensor (if installed) in the transducer head.
- A keyed, 16-pin connector (not labeled on the board) connects to a ribbon cable that leads to the Argonaut receiver board.
- A programmable logic chip (called the analog timing controller) on the top center of the board is used to the control the timing of Argonaut transmit/receive circuitry. The chip is mounted in a socket to simplify installation. Upgrades for the analog timing controller may be periodically available; see §5.6.3 for installation instructions.
- The board includes four holes for mounting, which match the mounting holes in the CPU board and are used with a set of #4-40 screws and standoffs.
- The board revision is printed on the middle right portion of the board. The board name is shown in the bottom right corner.

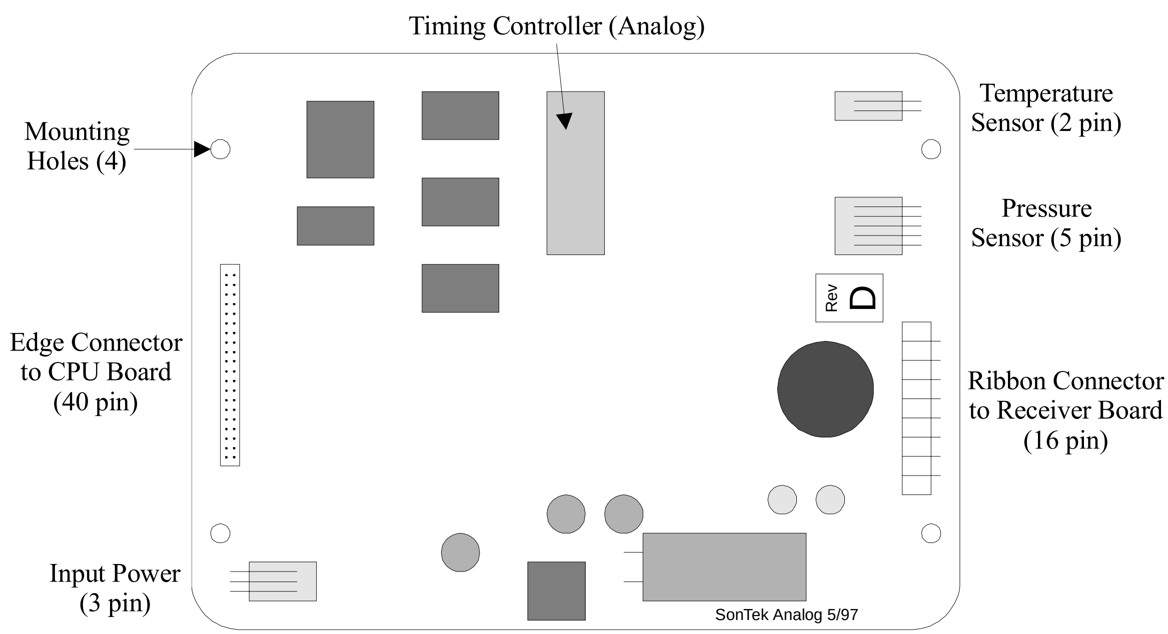


Figure 9 – Argonaut Processor Analog Board

Figure 10 shows the basic layout of the CPU board. Important features on the board are listed below.

- A 5-pin, red connector (labeled **User**) connects to the Argonaut underwater connector for the external serial communication interface (RS232/RS422).
- A 5-pin connector (labeled **Compass**) provides the power and RS232 interface to the internal compass/tilt sensor (if installed).
- A 40-pin edge connector mates above to the analog board. The connector is designed so that the boards can be connected with either board on top. Except for specialized applications, the CPU board is installed on bottom.
- A 3-pin, red connector (labeled **CTD**) connects to the RS232 interface to the optional integrated CTD sensor.
- The backup battery is installed in the upper right hand corner of the board; this is used to supply the real-time clock when main power is not available. See §6.1 for details.
- The EPROM containing the software to control velocity calculations, system operation, and user interface is installed in a socket in the bottom center of the board. Upgrades for the Argonaut CPU EPROM may be periodically available; see §5.6.3 for installation instructions.
- The system CPU, the main computational power of the Argonaut, is mounted in the bottom center of the board, just above and to the left of the CPU EPROM.
- A programmable logic chip (called the CPU timing controller) on the top center of the board is used to the control the timing of all Argonaut operations. The chip is mounted in a socket to simplify installation. Upgrades for the CPU timing controller may be periodically available; see §5.6.3 for installation instructions.
- The board name and revision is printed in the bottom right corner.

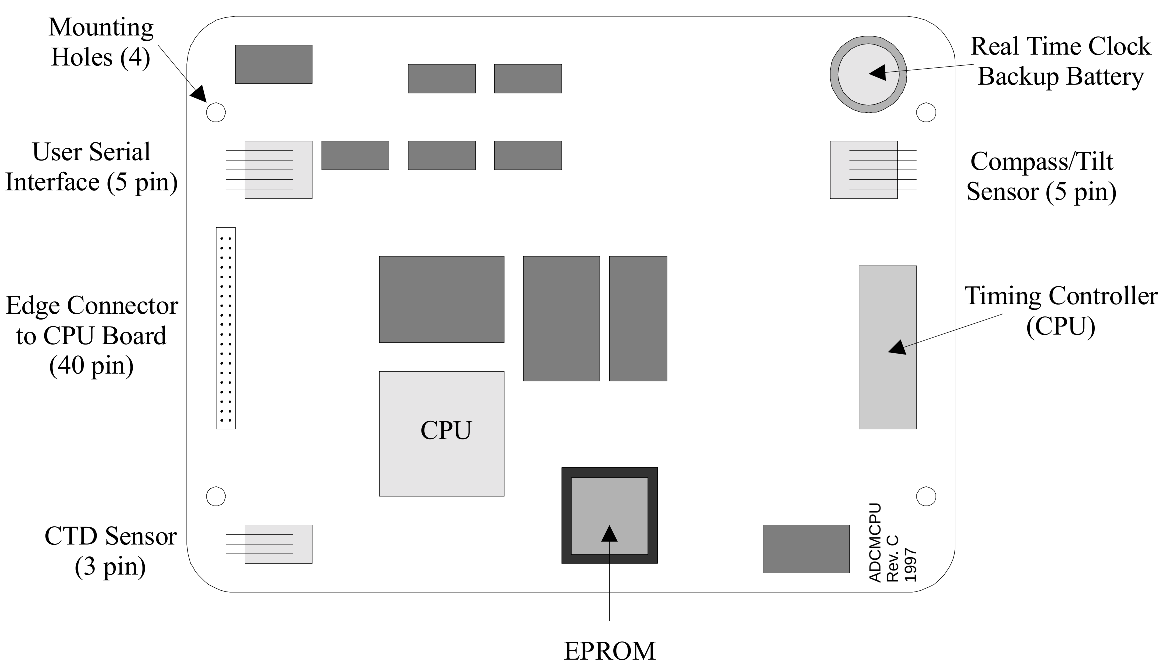


Figure 10 – Argonaut Processor CPU Board

5.4. Communication Baud Rate Setting

The Argonaut communication baud rate, normally 9600 baud, is set at the factory and should not normally need to be changed. However, for some specialized applications, you may wish to set a different baud rate. This is done by a special command from the direct-command interface. The command format is shown below. See Section 3 for details about the direct-command interface.

`UserDefaultBaudRate Set [baud rate]`

- Default parameter: **`9600`**
- Parameter range: **`1200`**, **`2400`**, **`4800`**, **`9600`**, **`19200`**, **`38400`**, **`57600`**, and **`115200`**
- Without parameter: returns its current setting.
- If given with a valid parameter in the form shown above, sets the baud rate to this value.
- If the command is recognized as valid, the system will transmit an "**`OK`** <CR><LF>" followed by the command prompt "**`>`**" at the old baud rate setting. All further communication is done using the new baud rate. The setting is used until a new value is set.
- Note that the command **`Defaults`** (§3.7) does <u>not</u> reset the communication baud rate.

SonTek software operates assuming a baud rate setting of 9600. If another baud rate setting is used, you will need to specify this in the software program. See the *Argonaut Software Manual* for details on specifying the communication baud rate.

5.5. Cables and Connectors

5.5.1. Power/Communication Cable and Bulkhead Connector

All Argonaut systems use the same bulkhead connector for external power and communication. This is an 8-pin underwater mateable connector manufactured by Impulse Enterprises. The bulkhead connector part number (for information only) is BH-8-FS; the cable connector part number is IL-8-MP (with locking sleeve). The address for Impulse Enterprises is:

Impulse Enterprises	Phone: (619) 565-7050
8254 Ronson Road	Fax: (619) 565-1649
San Diego, CA 92111 USA	

The following table shows the pin out for the Argonaut bulkhead connector. The wire colors shown are for the standard SonTek power and communication cable. Data transfer is listed relative to the Argonaut: Data Out / Tx refers to data being sent by the Argonaut; Data In / Rx refers to commands being received by the Argonaut. Wiring for both RS232 and RS422 serial communication is shown. See §6.5 for information about serial communication protocol.

Note that there are two different input power pins. Pin 1 is the external power input. The voltage from this pin passes through an additional voltage regulator inside the Argonaut. This pin can accept input voltages from 12-24 V DC; the additional internal regulator supplies no more than 12 V DC to the Argonaut processor. System power consumption using the external power pin is notably higher than when using the battery power pin.

The second input power pin (pin 5) is called the battery power input. The voltage from this pin goes directly to the Argonaut processor and must be in the range 7-15 VDC. Higher voltage will damage the Argonaut electronics. This pin is used for autonomous deployments from battery power because of the reduced power consumption when bypassing the additional voltage regulator. See §6.1 and §7.2 for details about input power options and power consumption.

Argonaut Bulkhead Connector Wiring

Pin number	Wire color	Function (RS232)	Function (RS422)
1	Red	External power (12-24 V DC)	External power (12-24 V DC)
2	White	Data Out	Tx+
3	Violet	Data In	Tx-
4	Drain	Drain	Drain
5	Yellow	Battery power (7-15 V DC)	Battery power (7-15 V DC)
6	Green	Not used	Rx+
7	Blue	Not used	Rx-
8	Black	Ground	Ground

When using RS232 serial communication, the user end of the power and communication cable is terminated with a DB9 connector for serial communication and a coaxial power plug for external DC input power. The DB9 connector is wired to be compatible with standard PC serial communication ports as shown in the table below. The coaxial power connector has the internal pin as positive and the outer shield as negative. Power from this plug is wired to pin 1, the external power supply pin, and can accept 12-24 V DC.

RS232 Serial Communication DB9 Connector Wiring

Pin #	Signal	Pin #	Signal	Pin #	Signal
1	Not used	4	Not used	7	Not used
2	Data Out	5	Ground	8	Not used
3	Data In	6	Not used	9	Not used

When using RS422 serial communication, the power and communication cable is terminated with the same coaxial power plug and a DB25 connector wired for RS422. Systems configured for RS422 also include a RS232/RS422 converter and a DB25/DB9 converter; the end of this chain is a DB9 connector wired for RS232 as shown in the table above. This allows the cable to be plugged directly into a PC serial communication port.

5.5.2. Splitter Cable and Dummy Plug – Argonaut XR and SL with Batteries

Argonaut XR and SL systems with the external batteries use a special splitter cable to connect the battery housing to the Argonaut. This cable has three connectors. The first (8-pin male) connects to the Argonaut. The second (2-pin male) connects to the battery housing and supplies power to the Argonaut. The third (8-pin female) connects to the power and communication cable to configure the system and download data; it is terminated with a dummy plug during deployment.

Figure 11 shows the wiring of the splitter cable. The connector part numbers shown are for Impulse underwater connectors; see §5.5.1 for contact information. The part number for the 2-pin bulkhead connector on the battery housing is Impulse LPMBH-2-FS (for information only).

The dummy plug used with the splitter cable is manufactured by Impulse Enterprises, Inc.; the part number is DC-8-MP (with locking sleeve).

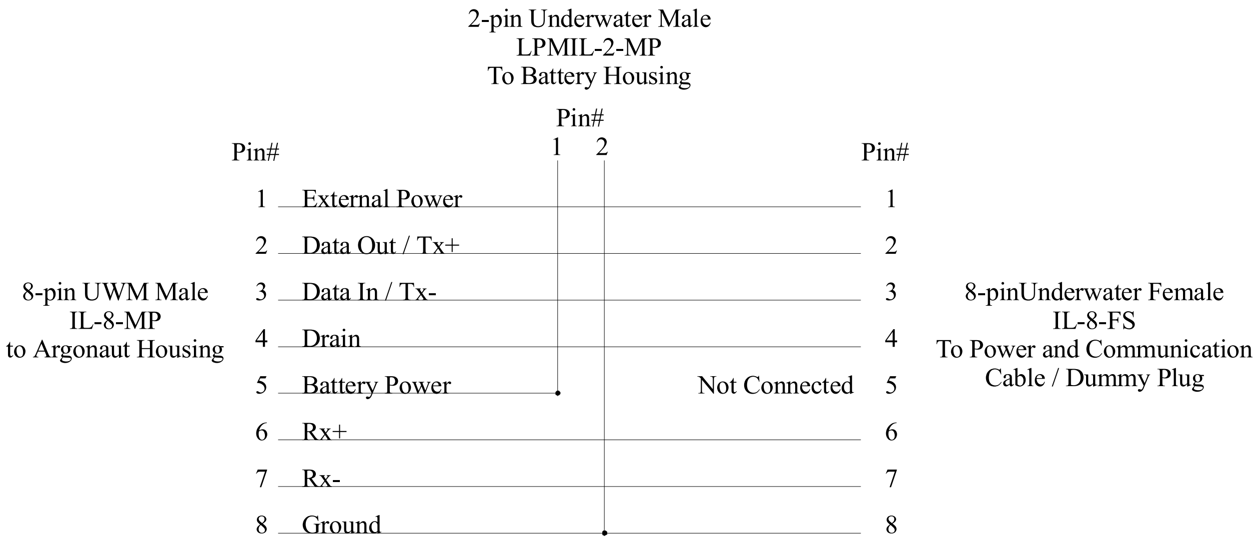


Figure 11 – Argonaut XR/SL Splitter Cable Wiring

5.6. Accessing Electronics

The Argonaut electronics should not need to be accessed on a regular basis. This section contains basic instructions for opening the Argonaut electronics housings. The most common reasons for opening any of the Argonaut underwater housings are to replace the battery pack (§5.7) or to modify the compass installation (§4.2). Additionally, there may be periodic upgrades to the Argonaut CPU EPROM and other programmable chips; see §5.6.3 for installation instructions.

5.6.1. Argonaut MD

To access the Argonaut MD processing electronics and internal compass, use the following steps.

1. Perform all maintenance in a static safe environment.
2. See §5.2.1 for a general description of the internal layout of the Argonaut MD. See §5.3 for a detailed description of the Argonaut processor and internal connectors.
3. Remove the bottom end cap and batteries following the instructions in §5.7.1.
4. Remove the three screws holding the sensor head to the pressure housing.
5. Carefully lift the head from the housing. Because of the bore seal o-ring, the transducer head may be difficult to remove. If necessary, have one person hold the housing while another person twists the transducer head back and forth.
6. Lift the head, electronics, and internal wiring out of the housing.
7. The input power wiring from the battery pack / end cap is connected to a wiring harness attached to the internal mounting hardware (where the additional voltage regulator is installed) and the Argonaut analog board. Disconnect the internal wiring from the harness at the 3-pin white plastic connector. See §6.1 regarding Argonaut input power.
8. Disconnect the 5-pin red serial communication connector from the internal wiring to the CPU board (marked **User** on the analog board).
9. While open, protect all o-rings and o-ring surfaces from damage.

When installing the head with electronics, use the following steps.

1. Clean and inspect all o-rings and o-ring surfaces for damage; replace o-rings if necessary.
2. Connect the 3-pin white plastic connector from the internal wiring to the wiring harness that connects to the internal mounting hardware and the analog board. The keyed connector can only be installed in one direction.
3. Connect the 5-pin red serial communication connector from the internal wiring to the CPU board (marked **User** on the analog board). The keyed connector can only be installed in one direction.
4. Check all other internal wiring (§5.2.1 and §5.3). Insert the wiring through the pressure housing (to where the internal battery pack is installed) such that it can be easily accessed from the other side.
5. Carefully insert the head into the pressure housing, aligning the holes on the head with the holes in the housing. The exact orientation of the head is not important.
6. Secure the head to the housing using the three screws (each with plastic isolator and washer); tighten snugly, but do not over tighten as this can damage the housing.
7. Gently pull the internal wiring from the bottom end of the housing to allow sufficient slack to install the battery pack.
8. Install the battery pack and close the bottom end cap as described in §5.7.1.

5.6.2. Argonaut XR and SL

The internal electronics and wiring of the Argonaut XR and SL are essentially identical with the exception of the compass/tilt sensor (standard on the Argonaut XR, not typically installed on the Argonaut SL). To access the Argonaut XR and SL processing electronics and internal compass, use the following steps.

1. Perform all maintenance in a static safe environment.
2. See §5.2.2 for a general description of the internal layout of the Argonaut XR and SL. See §5.3 for a detailed description of the Argonaut processor and internal connectors.
3. Remove the three screws holding the sensor head to the pressure housing.
4. Carefully lift the head from the housing. The internal wiring should be long enough to allow the transducer head to be set on a static-safe table next to the housing.
5. Disconnect the input power to the Argonaut processor at the red 3-pin connector to the analog board (labeled **Power** on the analog board).
6. Disconnect the 5-pin red serial communication connector from the internal wiring to the CPU board (labeled **User** on the CPU board).
7. Disconnect the 5-pin red compass/tilt sensor connector from the CPU board (labeled **Compass** on the CPU board).
8. While open, protect all o-rings and o-ring surfaces from damage.

When installing the head with electronics, use the following steps.

1. Clean and inspect all o-rings and o-ring surfaces for damage; replace o-rings if necessary.
2. Connect the input power to the Argonaut processor at the red 3-pin connector to the analog board (labeled **Power** on the analog board). The connector is keyed and can only be installed in one direction.
3. Connect the 5-pin red serial communication connector for the internal wiring to the CPU board (marked **User** on the analog board). The connector is keyed and can only be installed in one direction.

4. Connect the 5-pin red compass/tilt sensor connector from the CPU board (labeled **Compass** on the CPU board). The connector is keyed and can only be installed in one direction.
5. Check all other internal wiring (§5.2.2 and §5.3) to be sure it is installed correctly and securely.
6. Carefully insert the head into the pressure housing, aligning the holes on the head with the holes in the housing. The asymmetric bolt pattern allows only one orientation.
7. Secure the head to the housing using the three screws (each with plastic isolator and washer); tighten snugly, but do not over tighten as this can damage the housing.

5.6.3. Replacing the CPU EPROM and Other Programmable Chips

The Argonaut processor includes three programmable chips: the CPU EPROM, the analog timing controller, and the CPU timing controller. See §5.3 for the location and description of the function of these chips. Upgrades for these chips (most commonly the CPU EPROM) may be periodically available from SonTek. Basic installation instructions are given below. See §5.2 and §5.3 for descriptions of the internal mounting, wiring, and Argonaut processor.

<u>Accessing the processor</u>

1. Perform all maintenance in a static safe environment.
2. Access the system electronics following the instructions in §5.6.1 and §5.6.2.
3. Make note of the orientation of the processor boards before removing.
4. Remove all connectors from the analog board.
5. Remove the four #4-40 screws holding the analog board to the CPU board.
6. Lift the analog board straight up to disconnect the edge connector to the CPU board. Take care not to bend or damage any pins on the connector.
7. Remove all connectors from the CPU board.
8. Remove the four hex standoffs holding the CPU board to the mounting hardware.

<u>Replacing the chips</u>

The exact procedure depends on which chip(s) are to be replaced. Please note that the chips used for the analog and CPU timing controller use the same package, but they are **not** interchangeable. Be certain that you install the correct chip in the correct socket when replacing these controllers, or the system will not operate.

Either timing controller chip can be removed using a small flat blade screwdriver. Carefully pry each edge of the chip up until you can lift the chip up by hand. When installing the new chip, align the semi-circle on the chip with the semi-circle shown on the socket and circuit board. Take care not to bend or damage any pins when installing the chip. Seat the chip securely by hand. Keep the old chip in a static safe bag until you have verified system operation (after verifying operation it can be discarded).

When replacing the CPU EPROM, a special chip removal tool (called a PLCC extractor) is required to remove the old chip. With this tool, the two ends are placed on two corners of the chip socket; compressing the tool will lift the EPROM from the socket. When installing the new chip, align the rounded corner of the chip with the similar corner of the socket. Lay the chip on the socket and align each pin with the corresponding groove. Firmly press the chip into the socket until it is securely set. Keep the old EPROM in a static safe bag until you have verified system operation (after verifying operation it can be discarded).

Assembling the processor

1. Install the CPU board on the internal hardware and secure with the four hex standoffs. Make sure to install the board with the same alignment used before removing the boards.
2. Connect all appropriate internal wiring to the CPU board. See §5.3 for details on internal connectors.
3. Install the analog board on top of the CPU board. Carefully align all pins on the edge connector, seat the connector securely, and secure the analog board with four #4-40 screws.
4. Connect all appropriate internal wiring to the analog board. See §5.3 for details on internal connectors.
5. Close the system following instructions in §5.6.1 and §5.6.2.

Verifying system operation after a change

Following any EPROM or timing controller change, you should immediately verify basic system operation before discarding the old chips. After closing the system, connect the power and communication cable and apply power to the system. Establish direct communication through a terminal emulator by sending a **`BREAK`**. Set the instrument for a short averaging time (averaging and sample internal to 15 seconds), set the output format to ASCII, and begin data collection with the **`Start`** command. If data collection proceeds normally for a few samples, you can safely discard the old chips.

Note that it is possible to incorrectly connect (or not connect) cables within the housing, and this can potentially affect system operation. As soon as possible following any upgrade, perform a basic test of all system components. This includes the temperature and pressure sensors (use the **`Sensor CONT`** command; §3.12) and the compass/tilt sensor (§4.1). Most importantly, test operation of the transducers in water using the system diagnostic software (*ArgCheck* – see *Argonaut Software Manual*).

5.7. Replacing Battery Packs

5.7.1. Argonaut MD

The Argonaut MD pressure housing is divided in the middle; the processing electronics are mounted to the transducer head and are contained within the upper half of the instrument. A single battery pack consisting of 35 C-cell batteries is mounted in the lower half. The battery portion is larger than the electronics area. A dividing wall, with a central hole to allow the cables to pass, separates the two halves.

To access the battery pack, use the following steps.

1. Perform all maintenance in a static safe environment.
2. Remove the three screws holding the bottom end cap to the pressure housing.
3. Remove the bottom end cap. Because of the bore seal o-ring, the end cap may be difficult to lift off the pressure housing. If necessary, have one person hold the housing while another rocks the end cap back and forth.
4. The batteries are secured within the housing using several foam pads. After removing the end cap, remove the first pad from the housing.
5. There are two connectors from the end cap to the internal wiring - one for external power and one for serial communication. Each uses a unique, keyed connector that can only be connected one way. The connectors should be below the first pad; disconnect these.

6. Remove the second pad from above the battery pack and hold the housing at an angle to slide out the battery pack (watch for cables and connectors).
7. Remove the third mounting pad from between the batteries and the dividing wall.

To install batteries, use the following steps.

1. Inspect the o-rings and surfaces on both the end cap and housing; replace the o-rings if necessary.
2. Install the first foam pad next to the dividing wall to protect the internal wiring.
3. Slide the battery pack in, running the wiring along the side of the housing to allow access to all connectors after installing the battery pack.
4. Insert the second foam pad on top of the battery pack.
5. Connect the battery pack wiring to one of the two power connectors on the internal wiring. Connect the power and communication connectors from the internal wiring to the end cap.
6. Place all connectors on the pad above the battery pack.
7. Place the third pad on top of the connectors so all connectors are protected by the two pads.
8. Install the end cap, taking care to avoid trapping any wires between the housing and end cap. Align the end cap such that the holes match the housing; no specific alignment is required. You will need to apply some pressure to compress the pads when installing the end cap.
9. Secure with the three screws (use each screw with plastic isolator sleeve and washer) and tighten snugly; do not over tighten as this can damage the threads in the pressure housing.
10. Connect the external cable to the Argonaut and establish communications to verify instrument operation. If storing the instrument, place it in sleep mode using the **`PowerOff`** command.

5.7.2. Argonaut XR and SL

Batteries for the Argonaut XR and SL are contained in a separate underwater housing. The underwater housing is connected to the Argonaut using a special splitter cable (§5.5.2). The Argonaut XR/SL battery housing contains one battery pack consisting of 24 D-cell batteries.

To remove the battery pack, use the following steps.

1. Perform all maintenance in a static safe environment.
2. Disconnect the splitter cable from the battery pack.
3. Remove the screws holding the end cap to the battery housing. Lift the end cap off the housing. Because of the bore seal o-ring, it may be difficult to break the seal and remove the end cap. If necessary, have one person hold the housing while another gently rocks the end cap back and forth.
4. The battery housing is sealed using a dual o-ring seal (bore seal and boss seal); take care whenever accessing the housing to protect the o-rings and o-ring surfaces from damage.
5. Disconnect the wire from the battery pack to the end cap.
6. Remove the screws holding the internal retaining plate to the top of the battery pack. Remove the retaining plate from the battery pack.
7. Lift the battery pack from the housing.

To install a new battery pack, use the following steps.

1. Inspect the o-rings and surfaces on both the end cap and housing; replace the o-rings if necessary.
2. Place the new battery pack into the housing with the cables coming from the top.
3. Feed the battery cable through a hole in the internal retaining plate.
4. Place the internal retaining plate on top of the battery pack, and secure with the screws.
5. Connect the battery pack cable to the end cap. The connector is keyed and can only be aligned in one direction.
6. Install the end cap onto the battery housing; the alignment of the end cap relative to the housing is not important. Tighten the screws sufficiently to place the end cap flush against the housing; do not over-torque as this can damage the threaded inserts in the housing.

Section 6. Operational Considerations

6.1. Input Power Supply

The Argonaut processor operates on 7-15 VDC input power. Power consumption during data collection varies with configuration and operating parameters (see §7.2 for details). If the input voltage is less than 7 V, the Argonaut will not operate reliably. A supply voltage greater than 15 V to the processor will seriously damage the Argonaut electronics. The Argonaut measures and stores the input voltage; this can be accessed from the direct command interface (§3.12) and the output data samples (§3.16, Appendix 1, and the *Argonaut Software Manual*).

When running from externally supplied power, the input voltage is passed through an additional voltage regulator before going to the Argonaut processor. This regulator has a maximum voltage output of 12 VDC for input voltages to 24 VDC.

The additional regulator allows the use of an external power supply from 12 to 24 V. It also increases system power consumption during data collection and in sleep mode. For real-time data collection from an external supply, the difference in power consumption is typically not significant. For autonomous operation from battery power, the increase in power consumption caused by the additional regulator is typically high enough to affect deployment planning.

Battery power is normally wired directly to the Argonaut processor for autonomous deployments. For the Argonaut MD, with the batteries mounted in the same housing as the processor, the internal wiring is constructed for this arrangement at the factory. Battery power is always routed directly to the processor with no loss of efficiency.

For the Argonaut XR and SL, the underwater connector on the processor housing is wired with a separate input pin for battery power. This pin is wired directly to the Argonaut processor, bypassing the additional voltage regulator. The Argonaut XR and SL, with the SonTek supplied external battery pack and splitter cable, make use of the flexible input power wiring (§5.5.2). The power from the batteries is wired directly to the processor while the external supply (through the power and communication cable) is wired through the additional regulator.

IMPORTANT: If providing power directly to the Argonaut through the separate battery power pin, do not to exceed the 15 V maximum input voltage. Placing a higher voltage through this pin will seriously damage the Argonaut processor. If using a supply voltage greater than 15 V, route the power through the external supply pin. See §5.5.1 for connector wiring.

When running the Argonaut from batteries, keep track of battery capacity to prevent the loss of data because of insufficient power. The internal recorder uses a solid state EEPROM for data storage that is not affected if the batteries are drained. See §7.2 for details about estimating power consumption and battery life.

6.2. Real-Time Clock Backup Battery

The Argonaut also includes a backup battery (mounted on the processor – see §5.3) to power the system clock when main power is unavailable. This battery can be expected to last for many years. If the backup battery dies, the system clock will reset when main power is disconnected. Contact SonTek directly before attempting to replace the battery.

Note that when the Argonaut power supply is cycled (turned off and on), it will enter whatever mode it was previously in (command, data acquisition, deployment). See §3.3 for details.

6.3. Argonaut Mounting and Installation

6.3.1. Argonaut MD

There are three common ways to mount the SonTek Argonaut MD: clamped to the side of a mooring line, clamped to the side of a load bar, or mounted in an in-line load cage. The following considerations should help ensure a successful deployment.

- Clamp the Argonaut securely; avoid pieces that may vibrate loose.
- Avoid flow interference due to beam alignment.
- Avoid excess magnetic material near the instrument; perform a compass calibration before each deployment.

Secure mounting

The Argonaut MD can be supported either by circular clamps at two or more locations along the pressure housing, or by a combination of one or more circular clamps and a supporting plate below the lower end cap. The use of a supporting plate has the advantage of added security in the event a circular clamp becomes loose. (Note: Any supporting plate must have a hole in the center for the dummy plug from the power and communication connector.)

For deep-water deployments, be aware that the Argonaut MD pressure case may contract under pressure. This can cause circular clamps that are secure at the surface to become loose. Be certain to account for this in planning deep-water deployments.

When using in-line mooring frames, be certain that no portion of the frame is located directly in the path of the acoustic transducers. The Argonaut MD transducers are designed to produce very narrow beams (half power beam width is less than 2°). If all portions of the frame are at least 10° outside the beam center, there is no potential for interference.

Magnetic material

The Argonaut MD uses a magnetic compass to report velocity data in Earth coordinates. Ferrous metal in the mounting bracket or the mooring line near the instrument can affect the accuracy of compass measurements and hence the accuracy of velocity data. All mounting fixtures should be designed from non-ferrous metals, and other ferrous metals near the acoustic sensor head (less than 1 m away) should be minimized.

A compass calibration should be performed before any deployment to account for any ambient magnetic fields. If the Argonaut MD is installed on a mooring line made of ferrous metals, the calibration can be performed using a short section (2 m long) of the mooring line mounted in the same location as during deployment. This will simulate the effect of the mooring cable on compass operation. When possible, perform the calibration away from large structures containing ferrous materials (*e.g.*, ships, buildings, areas with reinforced concrete). See §4.4 and the *Argonaut Software Manual* for details on compass calibration.

Flow interference

Each Argonaut MD beam is slanted 45° off the axis of the pressure housing. The standard Argonaut MD measures velocity in a cell ranging from 0.5 m to 2.0 m vertically from the sensor. Since the beams are mounted at 45°, the cell starts with a radius of 0.5 m and has a maximum radius of 2 m. The deep water Argonaut MD measures velocity in a cell ranging from 0.5 to 3.5 m vertically from the sensor (horizontal extent starts with a radius of 0.5 m, ends with a radius of 3.5 m). While this provides a remote measurement free from flow interference in most situations, there is some potential for measurement interference in certain mounting arrangements. This can be avoided by following some basic precautions in instrument mounting.

Flow interference occurs when one acoustic beam is oriented directly downstream of the mooring line. If a small cable is used for the mooring line, it will have little effect on the flow pattern and should not influence Argonaut measurements. However, if a chain or other large line is used, it can create significant flow distortion that can potentially affect velocity measurements. To avoid this, we recommend mounting the Argonaut such that no beam tends to align downstream. This is shown for a simple mounting arrangement in Figure 12.

In a case where the Argonaut MD is mounted off the center of the mooring line, the instrument will tend to act as a fin and align downstream of the line. If the mooring line has been placed directly between two acoustic beams, as in Case 1 above, one beam will tend to be located directly downstream of the mooring line and may see flow interference.

No beam should be pointed directly at the mooring line, which can cause interference with the acoustic signals. If the mooring line is between two beams, as in Case 2 above, no beams are oriented towards the mooring line and no beams tend to align downstream, which greatly reduces the potential for flow interference. We advise keeping all acoustic beams oriented at least 30° away from the mooring line. An arrangement such as Case 2 (where the closest beam is 40° from the mooring) works well to avoid measurement interference in all beams.

6.3.2. Argonaut XR

The Argonaut XR is normally mounted on the bottom looking up. The mounting should keep the instrument securely fixed and not shift with time. The instrument should be as level as is practical (ideally within 10°). The internal tilt sensor allows the Argonaut XR to adapt its operation for non-level installations, but large tilt angles can have an adverse effect on near boundary performance. Installation tilt angles greater than 25° will have a serious impact on instrument performance.

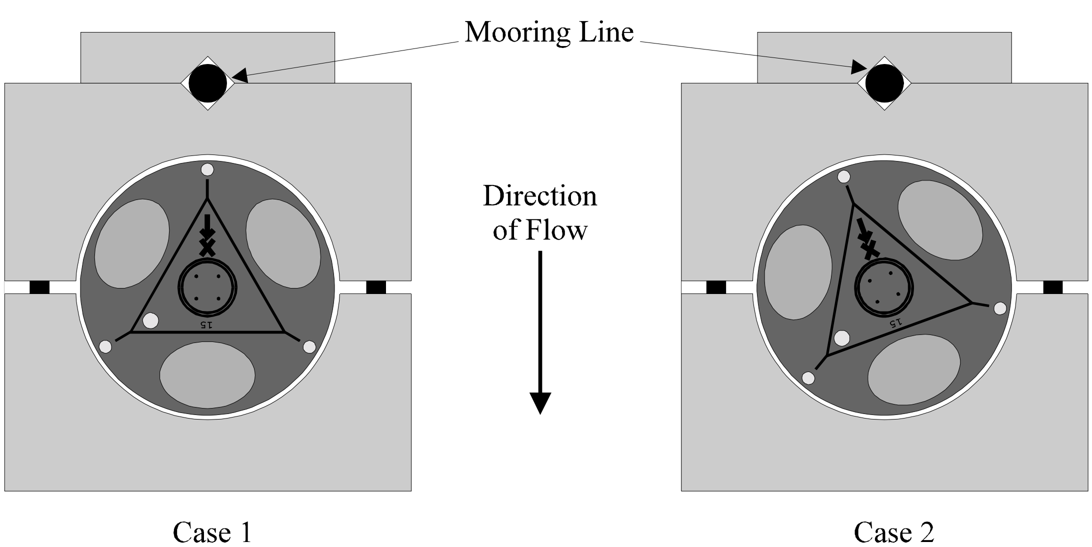


Figure 12 – Argonaut MD Mounting for "Fin" Effect

The XR housing has four mounting holes on the bottom for easy installation. The location of these holes is shown in Figure 13. The holes are set in a square pattern with each side of the square 9.79 cm (3.85 in) in length. The pattern can also be described as a diameter of 13.85 cm (5.45 in) with each hole at a 90° relative azimuth angle. The holes have stainless steel threaded inserts for ¼”-20 bolts.

Also shown in Figure 13 is the location of the acoustic beams and the XR’s X-axis relative to the mounting bolt pattern. In this figure, the underwater connector enters the housing at the top of the picture.

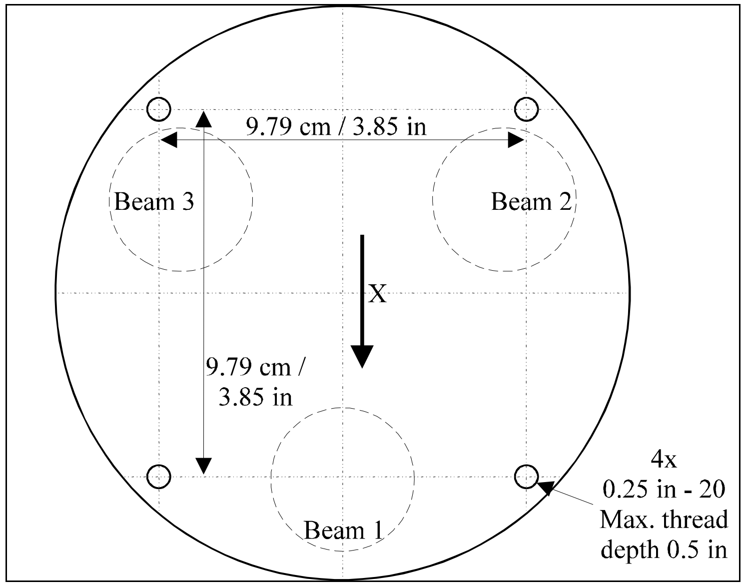


Figure 13 – Argonaut XR Mounting

IMPORTANT: The mounting holes have a limited thread engagement; no more than 0.5 inch should be engaged. Engaging too much thread can damage the inserts.

A mounting plate is included with the Argonaut XR to simplify installation. The square plate is 19.8 cm (7.8 in) on each side. It has four holes drilled to match the bolt pattern in the Argonaut housing. These holes are counter-bored on one side of the plate such that the mounting bolts will not protrude when the Argonaut XR is attached to the plate. The bolts used to attach the Argonaut to the mounting plate are included in the tool kit.

The mounting plate has four holes drilled in a square pattern for easy installation with the user-supplied mounting fixture. The holes are separated by 15.0 cm (5.9 in) center to center on each side. The holes are drilled 0.71 cm (0.28 in), and are typically used with ¼” mounting bolts.

The Argonaut XR uses a magnetic compass to report velocity data in Earth coordinates. Ferrous metal in the mounting or near the instrument can affect the accuracy of compass measurements and hence the accuracy of velocity data. All fixtures should be designed from non-ferrous metals, and other ferrous metals near the acoustic sensor head (less than 1 m away) should be minimized.

A compass calibration should be performed before any deployment to account for any ambient magnetic fields. See §4.4 and the *Argonaut Software Manual* for details on compass calibration.

6.3.3. Argonaut SL

The Argonaut SL is normally mounted looking to the side from an underwater structure. The mounting should keep the instrument securely fixed and not shift with time. Most importantly, the measurement plane formed by the two acoustic beams should be oriented parallel to the surface of the water with the greatest precision possible (ideally within 1-2 degrees). This will prevent the beams from hitting the surface or bottom and causing interference with velocity data.

The bottom of the SL housing has four mounting holes for easy installation (Figure 14). The holes are set in a square pattern with each side of the square 9.79 cm (3.85 in) in length. Alternatively, the pattern is described as a diameter of 13.85 cm (5.45 in) with each hole at a 90° relative azimuth angle. The holes have stainless steel threaded inserts for ¼”-20 bolts.

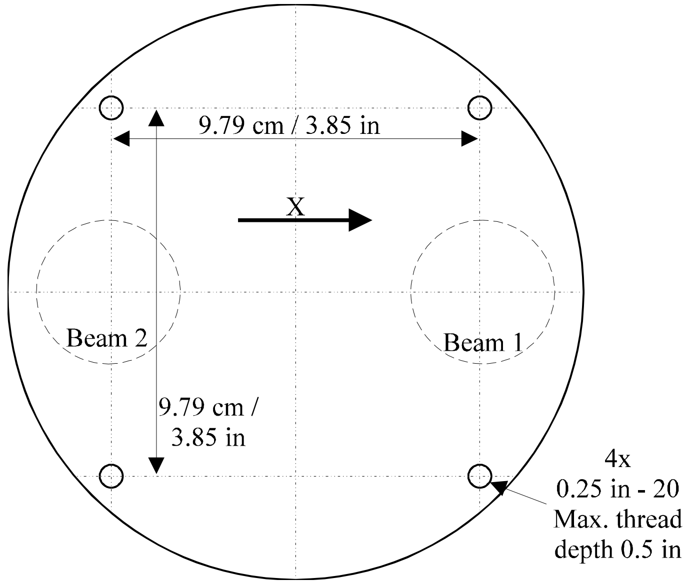


Figure 14 – Argonaut SL Mounting

Figure 14 also shows the location of the acoustic beams and the SL's X-axis relative to the mounting bolt pattern. In this figure, the underwater connector enters the housing at the top of the picture.

CAUTION: The mounting holes have a limited thread engagement; no more than ½" should be engaged. Exceeding this limit can damage the inserts.

A mounting plate is included with the SL to simplify installation. The square plate is 19.8 cm (7.8 in) on each side. It has four holes drilled to match the bolt pattern in the Argonaut housing. These holes are counter-bored on one side of the plate such that the mounting bolts will not protrude when the SL is attached to the plate. The bolts used to attach the SL to the mounting plate are included in the tool kit.

The mounting plate has four holes drilled in a square pattern for easy installation with the user-supplied mounting fixture. The holes are separated by 15.0 cm (5.9 in) center to center on each side. The holes are drilled 0.71 cm (0.28 in), and are typically used with ¼" inch mounting bolts.

6.3.4. External Battery Housing – Argonaut XR and SL

For autonomous operation, the Argonaut XR and SL can be equipped with an external battery housing. The housing is connected to the Argonaut through a special splitter cable (§5.5.2). The battery housing holds one battery pack consisting of 24 D-cell batteries, either alkaline or lithium. See Section 7 for details on autonomous deployment and procedures for estimating battery life.

Figure 15 shows the typical installation of an Argonaut XR or SL with the external battery pack. The battery housing connector is recessed in the end cap and is accessed from the side. Argonauts with the external battery housing include the housing, one alkaline battery pack, the splitter cable, dummy plug, and a mounting plate to hold the Argonaut and battery housing (this is normally attached to a user-supplied deployment frame).

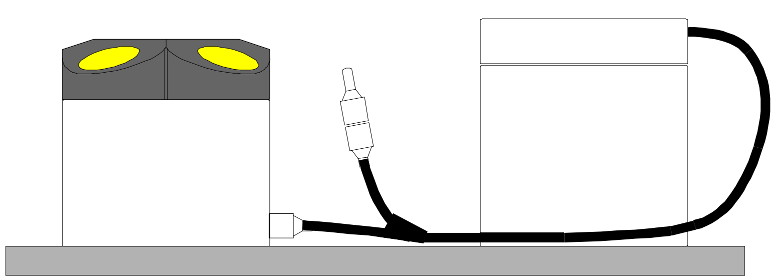


Figure 15 – Argonaut XR and SL Mounting with External Battery Housing

The battery housing has three threaded inserts on the bottom of the housing for easy installation. The bolt pattern on the bottom of the battery housing is shown in Figure 16. The threaded inserts use ¼”-20 bolts; no more than ½” of thread should be engaged to avoid damage to the housing. The system includes bolts that are the correct length for use with the mounting plate included with the system.

To reduce magnetic interference of the batteries with the compass/tilt sensor, the battery housing should be no closer than 12 cm (5 in) from the Argonaut. The mounting plate included with the system places the housing at this distance. Whenever using batteries near the Argonaut, you should perform a compass calibration before each deployment; the calibration should be performed each time the battery pack is changed. See §4.4 for details on compass calibration.

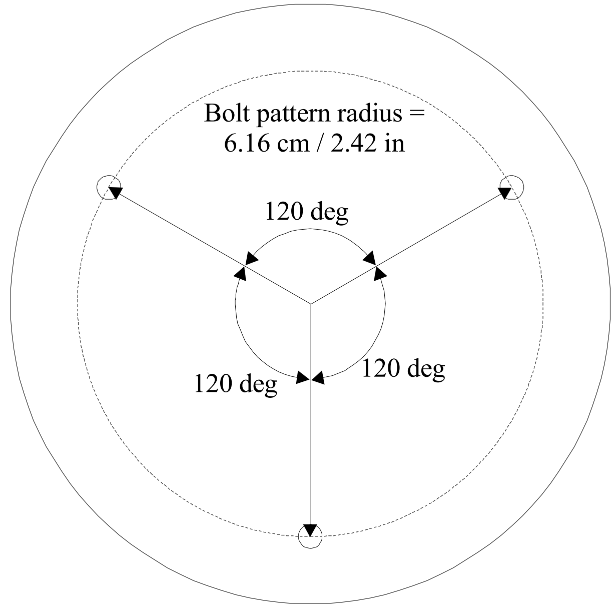


Figure 16 – Argonaut XR/SL Battery Housing Mounting Bolt Pattern

6.4. Argonaut Coordinate System

The Argonaut supports three coordinate systems for velocity data: ENU (East-North-Up), XYZ, and BEAM. The coordinate system setting is determined in the setup menu of the real time software (see the *Argonaut Software Manual*) or using the “CoordSystem” command from the direct command interface (§3.8).

<u>ENU (East-North-Up) coordinate system</u>

For systems with the optional compass/tilt sensor, velocity can be recorded in ENU (East-North-Up) coordinates. Using the ENU coordinate system allows the Argonaut to report velocity data independent of instrument orientation (within limitations – see §4.3).

Using the ENU coordinate system also allows the Argonaut MD to vector average pings within each sample (using updated compass/tilt information). If the Argonaut MD orientation changes during the averaging interval, velocity data will still reflect the true water velocity. When using the XYZ or BEAM coordinate system, velocity data can be corrupted if the Argonaut MD orientation changes during the averaging interval. For the Argonaut MD, SonTek recommends using the ENU coordinate system except for specialized applications by experienced users.

For the Argonaut XR, we assume that the installation is stationary and does not perform a vector average of velocity data on a ping-by-ping basis. Data from the compass/tilt sensor are sampled once at the beginning of the averaging period. The Argonaut XR is typically mounted on the bottom, and the orientation changes only minimally during a deployment. We recommend using the ENU coordinate system for most applications with the Argonaut XR.

The Argonaut SL does not normally include a compass/tilt sensor, and velocity data are normally recorded in the XYZ coordinate system (see below). When using the ENU coordinate system, be sure that the compass installation matches the hardware orientation setting. See §4.2 and §5.1 for details.

XYZ coordinate system

When using the XYZ coordinate system, velocity measurements are stored using a right-handed Cartesian coordinate system relative to the Argonaut. The positive X-axis is stamped into the transducer head for easy reference.

For the Argonaut MD and XR, the definition of the XYZ coordinate system depends on the hardware orientation setting (§5.1). For up-looking operation, the positive Z-axis is defined as upwards along the axis of the sensor housing away from the transducer head. For down-looking operation, the positive Z-axis is defined along the axis of the sensor housing from the top of the transducer head into the housing. In both cases, the positive Z-axis is vertically up based on the orientation of the system. The Y-axis is always defined from the X- and Z-axes to give a right-hand coordinate system.

Note that the alignment of the Y- and Z-axes with respect to the Argonaut housing changes depending on the Argonaut orientation.

For the Argonaut SL, the positive Y-axis is defined along the axis of the sensor housing away from the transducer head. For a typical deployment installation (with the cable from the sensor housing going vertically up), this results in the standard configuration of the positive Z-axis as vertically up (although the Argonaut SL measures velocity only in the XY plane).

BEAM coordinate system

When using the BEAM coordinate system, the Argonaut reports along beam velocity; positive velocity is away from the Argonaut, negative is towards the Argonaut. The X-axis stamped on the transducer head always points to beam number 1. If the Argonaut is placed on the floor with the transducers looking up (with the user looking down at the system) the transducers are numbered clockwise from #1.

6.5. Serial Communication Protocol

The Argonaut supports RS232 and RS422 serial communication protocols. Switching between RS232 and RS422 changes the electrical interface and has no effect on the command interface of the Argonaut. The default configuration is for RS232; this is the protocol used by the standard serial ports on PC-compatible computers and is considered reliable for cable lengths to about 100 m.

RS422 communication uses differential voltage signals to increase immunity to external noise. This allows operation over longer cables; RS422 is considered reliable for cable lengths to 1500 m. RS232 to RS422 converters are available commercially and allow an Argonaut using RS422 communication to be connected to the RS232 serial port of a PC-compatible computer. One supplier for this type of converter is shown below.

B&B Electronics	Phone (815) 434-0846	Converter Part # 422COR
707 Payton Rd	Fax (815) 434-7094	Power Supply Part # 422PS2
Ottawa, IL 61350 USA		

The choice of communication protocol is set at the factory and cannot be changed by the user. Contact SonTek directly if you have questions about the required serial communication protocol.

6.6. Temperature and Pressure Sensors

Temperature sensor

To measure temperature, the Argonaut uses a thermistor mounted on the inside of the transducer head. The thermistor is coupled to a titanium pin exposed to the water to minimize the insulating effects of the plastic housing. The temperature sensor has a specified accuracy of ±0.1°C. Temperature data are sampled once per second during the averaging interval and the mean value is recorded with each sample.

Pressure sensor

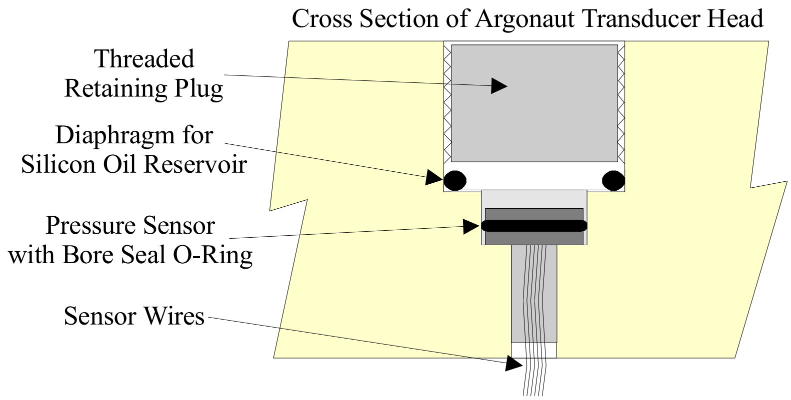


Figure 17 – Argonaut Pressure Sensor Mounting

If the Argonaut includes a strain gage pressure sensor, it is mounted in a recessed hole on the top transducer head as shown in Figure 17. The sensor is recessed and isolated from the water (for corrosion protection) by a diaphragm and silicon oil reservoir. The diaphragm is held in place by a plastic retaining plug that screws into the end cap. The pressure sensor forms a water tight seal using a bore seal o-ring. For added leak protection, the path into the Argonaut housing is filled with epoxy. Under normal conditions, you should not need to access the sensor directly. If you suspect problems, please contact SonTek before trying to access the sensor.

Data from the pressure sensor are sampled by the Argonaut electronics using a 12-bit A/D converter. Data are converted to a 2-byte integer scaling the A/D counts by 16 (giving a total count range of 0-65520, with a step size of 16 counts). Mean and standard deviation of pressure are recorded with each sample. Pressure data are stored in counts that must be converted to physical units (decibar) using three calibration constants.

The pressure calibration constants are measured at the factory and included with each system. The constants are stored in each data file and can be accessed from the Argonaut direct command interface. Pressure in counts is converted to decibar using the following formula.

$$\text{dbar} = \text{PressOffset} + (\text{PressScale} \times \text{Counts}) + (\text{PressScale\_2} \times (\text{Counts}^2))$$

where

dbar = measured pressure (decibar)
PressOffset = offset calibration constant set at factory (decibar)
PressScale = linear (1^{st} order) calibration constant set a factory (decibar/count)
PressScale_2 = quadratic (2nd order) calibration constant set a factory (decibar /count^2)
Counts = measured pressure (counts)

The values for PressOffset, PressScale, and PressScale_2 can be accessed three ways: through the direct command interface (§3.12), from the data conversion software *.CTL file (see the *Argonaut Software Manual*), or directly from the binary data file. In the first two methods, PressOffset and PressScale are output with the units shown above and can be used directly in the formula above. PressScale_2 is output with units of 10^{-12} decibar/count^2 and must be multiplied by (10^{-12}) before using in the above formula.

When using the binary data directly, each constant is stored as a long integer and must be converted to the appropriate units before using. PressOffset is stored in units of microbar and must be multiplied by 10^{-5}. PressScale is stored with units of (nanoBar / count) and must be multiplied by 10^{-8}. PressScale_2 is output with units of (pico-decibar/count^2) and must be multiplied by 10^{-12}. See Appendix 1 for details on the binary data format.

When using the data conversion software to extract Argonaut binary data files into ASCII format, the conversion from counts to decibars is done automatically by the software.

6.7. Routine Maintenance

Under normal conditions, the Argonaut requires little maintenance for years of reliable performance. Normal wear does not change instrument performance and the Argonaut never requires re-calibration for velocity data. This section describes suggested routine maintenance procedures.

Cleaning the transducers

Biological growth on the transducers does not affect velocity measurements, but can decrease acoustic signal strength and reduce the effective measurement range of the Argonaut. Periodic cleaning of the Argonaut transducers may be needed to maintain optimal performance in areas of high biological activity.

Except for deep-water (titanium) systems, Argonaut transducers are encapsulated in an epoxy that is impervious to damage from barnacles or other types of growth. To remove growth, simply clean with a stiff brush. The transducer epoxy is very durable and cannot be easily damaged except by direct impact.

Deep-water (titanium) Argonaut MD systems, made from titanium, use urethane for the transducers instead of epoxy. These transducers are not as resistant to damage as the epoxy transducers, and long-term barnacle growth can potentially damage the transducers. Fortunately, deep-water applications typically have little biological growth. These transducers can also be cleaned with a stiff brush, taking additional care not to scar the urethane during cleaning.

We recommend coating the transducers with anti-fouling paint for deployments in regions of high biological activity (§6.9).

Cable Maintenance

The underwater cables used with the Argonaut are often the most vulnerable part of the system. All standard SonTek cables use a durable polyurethane jacket that provides excellent long-term wear and abrasion resistance. However, any underwater cable is susceptible to damage and reasonable precautions should be taken. Inspect all Argonaut cables and connectors for damage on a regular basis, and replace if necessary.

O-rings

All Argonaut housings use a dual (redundant) o-ring seal. All SonTek o-ring seals are designed for full-ocean depth pressures, even if the housings and transducers have lower pressure ratings. The o-rings will provide faultless performance as long as care is taken whenever the system is opened. Whenever the housing is opened, clean and inspect all o-rings and o-ring surfaces; replace o-rings when necessary. While the system is open, protect o-ring surfaces from scratches or other damage. Spare o-rings are included in the Argonaut tool kit.

Condensation in Argonaut Housings

Moisture in the air can potentially damage Argonaut electronics if allowed to condense inside the housing. All underwater housings include desiccant to absorb moisture. Whenever opening the Argonaut housing, take care to minimize the exposure of the desiccant to humid air. If you suspect the desiccant has been saturated, replace the packet before closing the housing (spare desiccant is included in the Argonaut tool kit). When possible, purge the housing with a dry, inert gas (Nitrogen, Argon) before closing.

6.8. Troubleshooting

This section provides suggestions for diagnosing problems with the Argonaut. It should be useful in establishing the cause of most typical problems. If you have trouble finding the source of a problem, please contact SonTek directly.

<u>Cannot communicate with the Argonaut</u>

If you are unable to establish communications with the Argonaut, the following list may be helpful in identifying the problem.

- Power source: be sure that the power supply is providing between 7-15 VDC to the processor (or 12-24 VDC through the external supply regulator – see §6.1). When power is first connected to the Argonaut, it should wake up and enter the last mode it was in (command mode, data acquisition mode, or deployment mode – see §3.3). Measure the input current when power is applied to see if the system is drawing any power. Try using an alternative power source if possible.
- Computer: be certain that the computer serial port is functioning correctly; ports on some laptop computers have been known to have problems. Try using another computer if possible.
- Communication parameters: be certain that the baud rate, communication serial port, and other parameters being used match Argonaut settings (see Section 3).
- Cable connections: check that all wiring to the Argonaut is securely connected and that each connector is properly wired.
- Direct communication: if the Argonaut software programs are unable to establish communications (*Argonaut*, *CompCal*, *SonRec*), try direct communications using a terminal emulator (*SonTerm*). When power is applied, see if the Argonaut will respond to a **BREAK** (Alt+B in *SonTerm*).

<u>Compass/tilt sensor</u>

If you suspect a problem with the Argonaut compass/tilt sensor, follow the procedure outlined in §4.1 for a basic function test. Perform the test using both the output from the direct command interface and the compass calibration software. If you see problems with heading, perform a compass calibration and re-test compass function. A bad compass calibration can cause a major distortion to the heading data. Whenever testing compass operation, be sure the Argonaut is oriented properly based on compass installation (up or down-looking – see §4.2).

<u>Unreasonable velocity data</u>

If the velocity data from the Argonaut do not appear reasonable, the following list may be helpful in establishing the source of the problem.

- Check the signal amplitude data. See *Argonaut Principles of Operation* for a description of the expected behavior of these data. Be sure that the data have sufficient signal strength for reliable operation. Check that no large objects (structures, lines, fish, etc.) are interfering with the Argonaut acoustic beams. Run the Argonaut diagnostic software (*ArgCheck*) to attempt to identify the source of the problem.
- Check the output values of cell begin and cell end in the data (Argonaut XR and SL only). Check that these values match the input settings.

- Check the standard deviation data. See *Argonaut Principles of Operation* for a description of the expected behavior of these data. Check that the standard deviation values are reasonable based on the values of averaging interval and measurement volume size. Large standard deviation values may be caused by motion of the deployment package. Look at the compass/tilt sensor data to see if the system orientation shows large changes.
- Look at the compass/tilt sensor data. In particular, look for large tilt values that may indicate the deployment package is not lying flat (or is even upside down). Also, look at how these values change with time to see if the deployment package is moving.
- Consider any possible influences of the deployment environment. Common problems include underwater structures, boundary interference, deployment lines and cables, and schools of fish attracted by underwater moorings. Also, consider possible nearby sources of flow interference (bridges, piers, etc.) that might change the expected velocity signal. Areas of highly turbulent flow and large amounts of submerged bubbles can also affect velocity data.
- Look at the data from the temperature and pressure sensors to see if these are reporting reasonable values.
- Re-evaluate the deployment parameters used (particularly measurement volume location and timing parameters) to see if these might have had some unforeseen effect on performance.

<u>Cannot retrieve data from internal recorder</u>

Below are common causes of communication errors when retrieving data from the Argonaut internal recorder.

- The software is being run from a DOS prompt within Windows rather that a dedicated DOS environment. Memory resident features of Windows interfere with serial port operation. All Argonaut software should be run from a dedicated DOS environment.
- The data-extraction baud rate is too high for reliable operation. This can be a function of the length and quality of cables, the computer, and the operating environment (for external sources of noise). Run *SonRec* using a lower extraction rate (see *Argonaut Software Manual*).
- Some computers have poor quality serial ports and are unable to retrieve large amounts of data at high baud rates. Run the data retrieval software using a lower extraction rate (see *Argonaut Software Manual*). If problem persists, use another computer if possible.

If you are still unable to retrieve data from the internal recorder using *SonRec*, establish direct communications with the Argonaut and use the recorder commands to access data files directly (§3.11). Check that the file size and number of samples recorded is reasonable based on the deployment length and user-setup parameters. Download the configuration and some portion of the data manually to verify that all data are present.

<u>Missing data from autonomous deployment</u>

The Argonaut internal recorder was designed for extremely high reliability, and we have not had a single recorder failure. The only data losses that have occurred are because of problems with the Argonaut power supply. If you have a deployment that appears to be missing data, look at the battery voltage recorded with each sample. Check that these values are reasonable based on the type of power supply used and the length of the deployment. If you cannot determine exactly what has occurred, place the data file on our FTP site and contact SonTek directly (Section 8).

6.9. Protection from Biological Fouling

The Argonaut has excellent resistance to biological fouling and can operate reliably even with biological growth on the transducers. Biological growth causes a loss in signal strength, but does not affect velocity measurements.

Both the transducers and the underwater housings can be coated with commercial anti-fouling paints to prevent biological growth. Thick layers of anti-fouling paint on the transducers will cause a decrease in acoustic signal strength and will reduce the effective measurement range of the Argonaut. However, for most applications the loss of signal strength caused by anti-fouling paint does not have a significant effect on instrument performance.

Within the United States, we recommend using an anti-fouling paint called Interlux Tri-Lux II on all areas except for the transducer of deep-water titanium Argonaut MD systems. This paint contains a biocide, a copper derivative, which allows its use on all metals. For information on Interlux paints, contact:

Courtaulds Coatings	Phone (908) 686-1300
2270 Morris Avenue	Fax (908) 686-8545
Union, NJ 07083 USA	

Normal anti-fouling paints, which use coprous oxide based biocides, cannot be used on some metals as they cause galvanic corrosion. Outside the United States, anti-fouling paints containing TBT can be used on metal systems with a suitable primer. On plastic systems, any type of anti-fouling paint can be used.

IMPORTANT: For deep-water Argonaut MD transducers (encapsulated in urethane instead of epoxy) use only an anti-fouling paint approved for urethane transducers. These special types of paints are available from marine supply stores. One suitable paint is MDR Transducer Anti-Fouling Paint available from West Marine (contact information is below).

West Marine	Phone (800) 538-0775 / (408) 728-4430
P.O. Box 50050	Fax (408) 728-4360
Watsonville, CA 95077 USA	

When painting metal housings, a suitable conversion layer must be applied to the metal for adhesion and to isolate the metal from the anti-fouling paint. We suggest Interlux 360 Underwater Metal Primer. The primer should be applied to all exposed metal surfaces **except** sacrificial zinc anodes. Apply the anti-fouling paint to all surfaces of the instrument that require protection. Follow the instructions on the paint container with the following exceptions.

- Apply only one coat of anti-fouling paint to the transducers. Each layer of paint will cause some loss in signal strength and multiple layers can potentially affect system performance. Ensure that the paint has a smooth, even surface with no air bubbles.
- CAUTION: Do not paint the sacrificial zinc anode. Doing so will remove all corrosion protection.

If anti-fouling protection is desired for some portion of the cable, the paint can be applied directly to the polyurethane jacket without primer.

Section 7. Autonomous Deployment

7.1. Selecting Argonaut Operating Parameters

The choice of Argonaut operating parameters depends on the nature of the deployment and the goal of the study. Some guidelines for selecting the most important parameters are given below. For more information about each parameter, see Section 3.

System parameters: output mode, output format, recorder, recorder mode
The settings of **`OutMode`** (**`Auto`**/**`Polled`**) and **`OutFormat`** (**`ASCII`**/**`Binary`**) are typically not important for autonomous deployment, as they affect only the data output over the serial port and not data stored to the internal recorder. The **`Recorder`** setting (**`ON`**/**`OFF`**) only affects data collection initiated with the **`Start`** command; all autonomous deployments should be initiated with the **`Deploy`** command, which will force the recorder **`ON`**. The **`RecMode`** setting (**`Normal`**/**`Buffer`**) is typically **`Normal`** for autonomous deployments; the system stops recording data when the recorder is full.

Buffer mode, where the oldest data are overwritten when the recorder is full, is typically used when the recorder is acting as a data backup for real-time data installations.
Note – buffer mode is not currently implemented in the Argonaut

Sound speed: temperature, salinity, and temperature mode
For most Argonaut deployments, temperature mode is set to **`Measured`** and the user-specified temperature has no effect on instrument operation. Salinity should be as accurate as is practical; in regions with large variations, a mean value should be used. A salinity error of 12 ppt results in a velocity error of 1%, so salinity variations typically have a minimal effect. If precise temperature and salinity records are available, Argonaut velocity data can be easily corrected for sound speed changes in post-processing (see *Argonaut Principles of Operation*).

Coordinate system
For most Argonaut MD and XR deployments, the ENU (East-North-Up) coordinate system should be used. This allows the instrument to report velocity data in Earth coordinates regardless of instrument orientation. For the Argonaut SL, the XYZ coordinate system is normally used since instrument orientation is fixed based on the installation. BEAM coordinates are intended for experienced users in specialized applications.

Measurement volume: cell begin and cell end
For the Argonaut MD, the measurement volume size and location is constant. For the Argonaut XR and SL, the location of the measurement volume is set based on the environment and the goals of the study. Normally, cell begin is set as close to the Argonaut as possible while still avoiding flow interference from the mounting structure. Cell end is typically set at the maximum range of the environment (*e.g.*, if limited by surface, bottom, or underwater structures).

Timing parameters: averaging interval, sample interval, and burst sampling
As mentioned above, the choice of averaging interval is set based on the desired accuracy. However, in many environments the required averaging time is not determined by the Argonaut, but by real variations in the flow. Both of these factors should be taken into consideration when determining the averaging interval for a given deployment. See *Argonaut Principles of Operation* for calculating the expected accuracy based on the measurement volume and averaging interval.

For most autonomous deployments, the combination of averaging interval and sample interval determines the instrument duty cycle and thus the total battery life. Burst sampling (collecting a number of samples in rapid succession followed by a sleep period) lets you monitor both the short-term and long-term variations in flow, while maintaining a low, overall duty cycle. Burst sampling increases the amount of data recorded and may encounter limitations on storage space. The increased data storage requirements for burst sampling may have a significant impact on field operations. For details on storage requirements, see §7.2.

7.2. Calculating Battery Life and Data Storage Requirements

During continuous data collection (pinging once per second), the Argonaut MD has a mean power consumption of about 0.10 W. The Argonaut XR and SL have a mean power consumption of 0.2-0.3 W depending on the measurement volume size (larger measurement volumes use more power). These values assume that battery power is fed through the direct battery power connection to the Argonaut processor rather than through the external voltage regulator (§6.1). Power consumption through the voltage regulator is typically 0.3-0.4 W for the Argonaut MD and 0.6-0.7 W for the Argonaut XR and SL.

The Argonaut MD alkaline battery pack outputs 10.5 V with a nominal capacity of 35 Ah, and the lithium pack outputs 10.8 V with a nominal capacity of 52 Ah. When calculating battery life, SonTek recommends using 80% of the nominal capacity; this allows for temperature variations (nominal capacities are for 20°C) and a reasonable safety margin. Thus, alkaline and lithium packs have working capacities for the Argonaut MD of 295 Wh (0.8 * 10.5 * 35) and 450 Wh (0.8 * 10.8 V * 52 Ah), respectively. This is sufficient for about 120 and 190 days of continuous operation (using 0.1 W power consumption).

The Argonaut XR alkaline battery packs output 12 V with a nominal capacity of 42 AH; lithium packs output 10.8 V with a nominal capacity of 112 Ah. These packs have working capacities of 400 Wh and 960 Wh respectively. This is sufficient for 55-83 and 130-200 days of continuous operation (using 0.2-0.3 W power consumption).

In many situations, the Argonaut can use a reduced duty cycle to conserve battery power and extend deployment length. For example, the Argonaut can collect one 5-min average sample every fifteen minutes for an effective duty cycle of 33%. When not actively collecting data, the Argonaut consumes less than 1 mW of power; a 33% duty cycle increases the maximum deployment length by a factor of three (alkaline batteries are sufficient for one year). See §1.3 for a detailed description of sampling strategies and duty cycle calculation.

The Argonaut stores 418 bytes of header information per file and either 33 or 20 bytes for each velocity sample (based on the setting of the data format parameter). All samples from an individual deployment are stored in a single file. The Argonaut internal recorder has a 2-MB capacity and can store up to 62,000 or 100,000 samples. Except where required by data storage limitations, we suggest using the LONG data format setting (33 bytes per sample).

The Argonaut recorder is divided into 32 blocks of 64 KB each; only one data file can be written in one block, although one data file can occupy multiple blocks. Thus, the recorder can hold a maximum of 32 data files. If you record a large number of small data files (less than 64 KB per file), the recorder will reach maximum capacity before 2 MB of velocity data have been stored. Be sure to format the recorder to erase all files before any deployment.

7.3. Starting an Autonomous Deployment

Autonomous deployments are started from the Argonaut direct command interface using a terminal or terminal emulator. The Argonaut software includes a DOS based terminal emulator called *SonTerm* (see *Argonaut Software Manual*). See Section 3 for details about the direct command interface.

To start an autonomous deployment, establish direct communication with the Argonaut. There are four **`Show`** commands that display all operating parameters.

- **`Show Conf`** - hardware configuration parameters
- **`Show System`** - system operating parameters
- **`Show Setup`** - data collection parameters
- **`Show Deploy`** - autonomous deployment parameters

If you verify the settings of the parameters shown by the four commands above, you can be confident of a successful deployment. See §3.14 for sample outputs of the **`Show`** commands. Below is a list of recommended steps when starting an autonomous deployment. These include redundant checks to verify all aspects of Argonaut operation.

1. IMPORTANT: Always perform the deployment procedure with the Argonaut connected to and operating from the power supply that will be used for deployment. Do not disconnect power after initiating the deployment (§3.3).
2. Before deployment, perform a compass calibration if the system includes a compass/tilt sensor (§4.4). If practical, this should be done with the system mounted in the deployment frame with batteries and other instrumentation installed.
3. Record all communication with the Argonaut for future reference. This can be done using the **`Alt+F`** option in *SonTerm* (see *Argonaut Software Manual*).
4. Send a **`BREAK`** to wake the system up and establish communication.
5. Send **`Show Conf`**; check parameters to see they match desired/expected settings.
6. Send **`Show System`**; check parameters to see that they match desired settings. Of particular importance are the Argonaut date/time. Modify parameters as needed.
7. Send **`Show Setup`**; check parameters to see that they match desired settings. Of particular importance are cell begin and end (XR and SL only), dynamic boundary adjustment (XR only), averaging interval, and sample interval. Modify parameters as needed.
8. Send **`Show Deploy`**; check parameters to see that they match desired settings. Of particular importance are deployment name, start date and time, and the timing parameters (averaging interval, sample interval, and burst sampling parameters). Modify parameters as needed.
9. Send **`Save Setup`** to save all parameters (also done automatically by **`Deploy`** command).
10. Check compass operation (if installed) by sending **`Compass CONT`**. Rotate and tilt the Argonaut to verify performance (§4.1). Press any key to stop output.
11. Check recorder status using the **`Dir`** command. Make sure there is sufficient space for the data from this deployment. Format the recorder if necessary.
12. Verify settings in all four **`Show`** commands one final time.
13. Send the **`Deploy`** command to initiate the deployment. Watch for any error messages or for any unexpected response. If practical, leave the computer connected to the Argonaut until the first sample has been output.

14. IMPORTANT: Disconnect the cable from the computer before turning the computer off. Some computers will send the equivalent of a **BREAK** over the serial port when turned off, which can interrupt the deployment and cause the loss of data.
15. Disconnect the communication cable, install the dummy plug, and deploy the Argonaut.

Section 8. Argonaut Optional Features

8.1. Wave Spectra Collection Package: SONWAVE

The XR/SL models of the Argonaut equipped with a pressure sensor and the SonTek *SonWave* wave spectra collection package can now collect wave frequency spectra data. The spectra are estimated from the 1-Hz pressure time series collected over an averaging interval. The spectra are computed using standard methods appropriate to simple linear theory. They include: segmentation of the data into 256-point segments with at least 128-point overlap between consecutive segments; application of Hanning window to each segment with constant energy correction; and correction for sensor/water depth using a generalized first order dispersion relationship for surface waves.

8.1.1. Wave Frequency Spectra Calculations

The wave spectral estimates are presented as an array of coefficients, each giving the mean wave amplitude (proportional to square root of the energy) within a period band. Ten bands are used, which correspond to wave periods in the range:

Band #	Period range [s]
1	2 - 4
2	4 - 6
3	6 - 8
4	8 - 10
5	10 - 12
6	12 - 14
7	14 - 16
8	16 - 18
9	18 - 20
10	20 or longer

For each band, the software computes the mean wave amplitude, *A*, which is an integral of wave contributions within the period range in the band. If A_i is the amplitude for band *i*, the total wave energy is simply given by:

$$Total\ \ Energy\ (\sigma_A^2) = 0.5 \sum_{i=1}^{10} A_i^2$$

The *SonWave* outputs the band amplitudes in cm for consistency with velocity data, which are reported in cm/s.

A generally accepted estimate of the significant wave height can be easily obtained from the amplitudes using:

$$H_{mo} = 4\sqrt{Total\ \ energy}$$

8.1.2. Setup for Collecting Wave Frequency Spectra

Only an Argonaut XR/SL with pressure sensor and CPU firmware version 3.6 or later can be setup to collect wave spectra. Wave setup commands that affect wave data collection of the Argonaut are described below.

`WaveSpectra [YES|NO]`

- Enables or disables the collection of wave spectra.

`WaterDepth` *or* **`WD [d.d]`**

- Specifies the water depth at the deployment site, in meters. **`WD`** is necessary for choosing the appropriate dispersion relation in wave spectra computations.
- If not given, the Argonaut's depth (calculated from mean pressure) is used.
- A **`WD`** setting less than zero is interpreted as the height of the Argonaut above the bottom (*e.g.*, height of the Argonaut within the mooring structure), and the value is used together with the mean pressure to determine the true water depth. This is most commonly done when the exact depth of the site is unknown.

`RecordPressureSeries` *or* **`RPS [YES|NO]`**

- Enables or disables the recording of the raw pressure series data.
- When set to **`YES`**, the Argonaut stores 1024 samples of raw pressure (collected at 1 Hz) at the end of the sampling interval, *regardless of the sampling interval length*.

8.1.3. Wave Data Format

If **`WaveSpectra`** is enabled, the Argonaut will output 12 integer values at the end of each sample (after CTD data, if present). The first 10 fields correspond to the mean wave amplitudes (in mm) for each of the period bands 1 through 10. The 11th field is the significant wave height (in mm) computed as described in §8.1.1. The 12th field is the peak period (in units of 0.1 s).

Argonaut ASCII Data Output - Wave Sample Data (No CTD)

Format/Fields	Description	Unit
Long – 29-38 Short – 15-24	Wave amplitude for 10 period bands	mm
Long – 39 Short – 25	Significant wave height	mm
Long – 40 Short – 26	Wave peak period	0.1 s

In **`ASCII`** mode these values are output spaced by six digits. In **`Binary`** mode, each is output as a 2-byte unsigned integer. More detail on the binary data output is available in Appendix 1.

The output of the data extraction program GARGSAMP (or EARGSAMP) is similar to the Argonaut ASCII output. The only difference is that the wave amplitudes are reported in cm (or inches) for consistency with other data types. The peak period is converted to seconds.

8.2. Pressure Series Data Conversion: GARGPRES

This program extracts pressure series data recorded with each Argonaut sample. For each sample, information includes the sample number and 1024 raw pressure values (in counts). The command format is as follows.

```
GARGPRES [Argonaut file]
GARGPRES [Argonaut file] [output file]
GARGPRES [Argonaut file] [output file] [first sample] [last sample]
```

File names must be given without extension. GARGPRES generates an ASCII output file with the extension **`.PTS`**. The program assumes that the Argonaut data file has the extension **`.ARG`**. If no [output file] is specified, the program uses the same name as the binary data file. The [first sample] and [last sample] let you extract a subset of the data. If they are not specified the program extracts all samples in the file.

8.2.1. Considerations when collecting wave frequency spectra

If **`WaveSpectra`** is enabled, the Argonaut will collect spectral data for each averaging interval. This has the following consequences:

a. Recorder capacity – Since the spectral data adds 24 bytes to each sample, the result is a reduction in the maximum number of samples that can be stored in the Argonaut's 2-MB memory. For example, an Argonaut using the **`LONG`** data format without CTD data needs 33 bytes per sample. This allows for a maximum of 63,000 samples to be stored. When the spectral data are added, the size of each sample is increased to 57, and the maximum number of samples that can be stored is 36,473. This, however, should not be a concern in most sensible configurations. For example, if using a 20-minute sampling interval, a capacity of 36,473 samples is sufficient for 506 days of operation (1.4 years).

b. Power consumption – When WaveSpectra is enabled, the Argonaut will typically consume 25% more power than it would if this feature is disabled. Typical power consumption in an Argonaut XR/SL is approximately 200 milliwatts in continuous operation. Enabling WaveSpectra will increase this to about 250 milliwatts.

c. Averaging interval – When using the WaveSpectra feature the averaging interval must be set to at least 300 seconds. This is the minimum sample length required by the fast Fourier algorithms used in the spectral estimation (actually the FFT minimum is 256 s but 10-20 more seconds are needed for overhead).

Typically, wave spectra estimation is done with time-series about 1000 seconds long. To do this, the Argonaut averaging interval just needs to be set to the desired length.

Such "wave" time-series are usually collected at intervals of about 4-6 hours. However, since the Argonaut collects current data and wave data at the same time (they cannot be separated), normally it will be setup with the much shorter sampling intervals that are required for currents (1 hour or less). As a result, if both long averaging intervals for waves and short sampling intervals for currents are used, the Argonaut will generate vast amounts of wave data that are probably redundant (if the traditional 4-6 hour interval standard was correct).

Given the way in which frequency spectra are estimated (using 256-point segmentation), it seems reasonable to assume that using shorter time series (shorter averaging periods of say 5-6 minutes) more often (short sampling intervals of say 20-30 minutes), we can get spectral estimates at least as good as with the traditional wave sampling schemes. All that is needed is to average spectral estimates from consecutive samples down to the 4-6 hour traditional interval. This process is almost equivalent to segmentation except for the lack of overlapping between sampling intervals, and the fact that the spectra is "averaged" over the 4-6 hour period instead of spot sampled for only 20 minutes.

8.3. Argonaut External Sensors

The Argonaut can include several externally mounted, integrated sensors (the sensors connect to the Argonaut using special interface cables). The most commonly integrated sensor is the SeaBird MicroCat CTD. A range of other sensors (OBS, transmissometer, conductivity, etc.) can be integrated using analog output voltages. Depending on the type of sensor, it may receive input power from the Argonaut or it may use a separate power supply. For details on available sensors and configurations, contact SonTek.

8.3.1. SeaBird MicroCat CTD

The SeaBird MicroCat CTD with RS232 serial interface provides high quality conductivity, temperature, salinity, and pressure (optional) data. When integrated with the Argonaut, the MicroCat is sampled at the beginning of each averaging interval. Data are integrated in a CTD data structure within each Argonaut profile.

CTD Commands
Described below are commands necessary to setup the Argonaut for acquiring the CTD data. In normal operation, all commands to the optional external CTD sensor are sent automatically and no direct commands need to be sent. The commands in this section are provided to assist in diagnosing problems and to give greater flexibility in Argonaut operations.

`H CTD`
- Displays help on external CTD sensor commands.

`CTD`
- Displays most recent temperature (°C), conductivity (Siemens per meter), pressure (decibar), and salinity (ppt) data from the external CTD sensor
- Data are output in a self-explanatory, ASCII-text format.

`CTD CONT`
- Continually displays temperature (°C), conductivity (Siemens per meter), pressure (decibar), and salinity (ppt) data from the external CTD sensor
- Data are output in a self-explanatory, ASCII-text format.
- Press any key to stop data output and return to command mode.

`CTD Talk`
- Establishes direct serial communication with the external CTD.
- A manual for the CTD sensor is included; see this manual for details on direct commands to the CTD.
- To return to command mode, type “+++” or send a **`BREAK`** to the Argonaut.

8.3.2. CTD ASCII Data Format

This section describes the format of the Argonaut ASCII CTD data coming over a serial port when either acquiring data in real-time using a terminal emulator or reading the data stored in the recorder using recorder commands. The CTD sensor data (if present) are given in a single line immediately following the sample data.

```
            87514   468151        0   351354
```

The data format is as follows:

- CTD Temperature (units 0.0001 °C)
- CTD Conductivity (units of 0.00001 Siemens per meter)
- CTD Pressure (units of 0.001 decibar) (note the CTD may not include a pressure sensor)
- CTD Salinity (units of 0.0001 ppt)

8.3.3. CTD Binary Data Format

The SeaBird format is a specialized data format used when integrating the Argonaut MD with the SeaBird inductive modem. It consists of a single, 24-byte, binary record that is output with the completion of each sample. If the output format is set to **`SeaBird`**, the run-time commands are disabled. The last byte of the SeaBird record is a checksum of the preceding 23 bytes. Note that the setting of the output format does not affect data recorded to the internal recorder; the binary data format is always used. More detail on the binary data output is available in Appendix 1.

Section 9. Additional Support

Any additional questions can be directed to SonTek by phone, FAX, or email. Regular business hours are 8:00 am to 5:00 p.m., Pacific Standard Time, Monday through Friday.

Phone	(619) 546-8327
FAX	(619) 546-8150
Email	inquiry@sontek.com
World Wide Web	http://www.sontek.com

See our web page for information concerning new products and software / firmware upgrades.

Appendix 1. Argonaut Binary Data File Format

The file format described in this appendix is valid for Argonaut CPU firmware versions 3.0 and higher. For information about changes in the Argonaut data file format from previous firmware versions, contact SonTek.

A1.1. Overview

The basic structure of an Argonaut binary file with N samples is shown below. The size of each sample is a function of the setting of the **DataFormat** parameter (**LONG** or **SHORT**, see §3.8).

```
File Header 418 bytes
Sample 1 (22 or 38) bytes

Sample 2 (22 or 38) bytes
...
Sample N (22 or 38) bytes
```

The Argonaut file header consists of three binary structures in the following order.

```
Argonaut Sensor Configuration 96 bytes
Argonaut Operation Configuration 64 bytes
Argonaut User Setup Parameters 258 bytes
```

Each of the structures mentioned above are described in detail (using their C language definitions) in the remainder of this appendix. Source code is provided in **ARGDATA.H**, which is included on the software distribution disk.

A1.2. File Header Structures

Each Argonaut file header structure is described below using the C language definition. The first structure, "Argonaut Date and Time Structure", is referenced by other structures.

Argonaut date and time structure (8 bytes)

```
typedef struct {
   int  year;
   char day,
        month,
        minute,
        hour,
        sec100,
        second;
} DateTimeType;
```

Argonaut sensor configuration structure (96 bytes)

```
typedef struct {
  char     ConfigType;                /* Type      0x40               */
  char     ConfigVer;                 /* Version   0x02               */
  int      Nbytes;                    /* Bytes in configuration       */
  DateTimeType    ConfigTime;         /* Date created or last modified */
  unsigned char   SoftwareVerNum;     /* Ver number of ADCM firmware   */
  unsigned char   DspSoftwareVerNum;  /* Ver number of DSP firmware    */
  char            BoardRev;           /* Electronics board revision    */
  char     SerialNumber[10];          /* Sensor serial number          */
  char     SystemType;                /* Low Nibble:  0-3MHz  1-1.5MHz */
                                      /* High Nibble:                  */
                                      /*     0 - MD                    */
                                      /*     1 - XR                    */
                                      /*     2 - SL                    */
```

```
    char     Nbeams;                   /* 2, 3, or 4                     */
    char     BeamGeometry;             /* 0- 2 Beams; 1- 3 Beams         */
                                       /* 2- 4 Beams, 1 Vertical         */
                                       /* 3- 4 Beams, Janus              */
    int      SlantAngle;               /* in 0.1 deg                     */
    char     SensorOrientation;        /* 0-down; 1-up; 2-side           */
    char     CompassInstalled;         /* 0-No;   1-Yes                  */
    char     RecorderInstalled;        /* 0-No;   1-Yes                  */
    char     TempInstalled;            /* 0-No;   1-Yes                  */
    char     PressInstalled;           /* 0-No;   1-Yes                  */
    char     CtdInstalled;             /* 0-No;   1-Yes                  */
    int      XformMat[16];             /* From Beam to XYZ veloc.        */
    int      CompassOffset;            /* Degress to East of North       */
    long     PressScale;               /* Nanobar per count              */
    long     PressOffset;              /* Microbar                       */
    char     PowerSaveMode;            /* if 1 system off after 5 min    */
                                       /*     idle in command mode       */
    long     SeabirdOutputDelay;       /* For Seabird Inductive modem    */
    unsigned char UserBaudRate;        /* Default serial baudrate        */
    int      PressScale_2;             /* pico dbar per count^2          */
    unsigned char CpuAddress;          /* Address for 485 mode           */
    int      PingDelay;                /* set to all 0s                  */
    char     YsiInstalled;             /* 0-No;   1-Yes                  */
    char     ExtPressInstalled;        /* 0-None; 1-Paros; 2-Druck       */
                                       /*    ParosFreq                   */
    unsigned char RecorderSize;        /* in Mbytes    (default is 2 Mb)*/
    char     VerticalBeam;             /* 0 - no  1 -yes                 */
    char     Spare2[3];                /* set to all 0s                  */
  } ArgSensorConfigType;
```

<u>Argonaut operation configuration structure (64 bytes)</u>

```
  typedef struct {
    char     ConfigType;               /* Type      0x41                  */
    char     ConfigVer;                /* Version   0x02                  */
    int      Nbytes;                   /* Bytes in configuration          */
    DateTimeType    ConfigTime;        /* Date created or last modified  */
    int      NpingsPerBeam;            /* Consecutive pings for each beam*/
    int      SampInterval;             /* Samp Interval in 16/Ft units   */
    int      Lag;                      /* Samp spacing for AutoCorrel.   */
    int      PulseLength;              /* In cm (along profiling axis )  */
    int      RecLength;                /* In cm Receiver recovery delay  */
    int      MinBlankLength;           /* In cm Blank to first bin       */
    int      OperatingRange;           /* Max range in m                 */
    int      PingDelay;                /* In m  Delay befor next ping    */
    int      AutoFilter;               /* 0-fixed filter; 1-auto filter  */
    int      FilterA[2];               /* Fixed filter coefficients      */
    int      FilterB[2];
    char     ModemMode;
    int      TempOffset;               /* in 0.01 deg C                  */
    int      TempScale;                /* in 0.0001  TrueT/MeasuredT     */
    unsigned char NominalNoise[MAX_BEAMS];
    unsigned char VelRangeInd;         /* Velocity range for Arg-ADV     */
                                       /* 0- 3cm/s  1- 10cm/s  2-30 cm/s */
    char     FastMode;                 /* 0 - NO,  1-YES                 */
    char     SampleRecordMode;         /* 0- no   1- yes                 */
    char     UseCompassFlux;           /* 0- no   1-yes                  */
    unsigned char MaxLevelPressDiff;   /* in 10 cm (0 to 25.5 m)         */
    char     LevelOffset;              /* in mm (-128 to +127 mm)        */
    char     ProfilingMode;            /* 0 - no, 1- yes                 */
    char     Ncells;                   /* number of cells                */
    int      CellSize;                 /* in cm                          */
```

```
    char     SdiFormat;                  /* 0 - SonTek, 1- Sidekick       */
    char     Spare[6];                   /* Set to all 0s                 */
    char     DebugOn;                    /* Set to all 0s
  */} ArgOperConfigType;
```

<u>User setup parameters structure (258 bytes)</u>

```
  typedef struct {
    unsigned   char      ConfigType;   /* Type      0x42                  */
    unsigned   char      ConfigVer;    /* Version   0x02                  */
    unsigned   int       Nbytes;       /* Bytes in configuration          */
    DateTimeType         ConfigTime;   /* Date created or last modified   */
    int           Temp;                /* 0.1 deg C                       */
    int           Sal;                 /* 0.1 ppt                         */
    int           Cw;                  /* 0.1 m/s                         */
    unsigned int BlankDistance;        /* in cm                           */
    unsigned int PulseLength;          /* in cm                           */
    unsigned int CellSize;             /* in cm                           */
    char          TempMode;            /* 0- User value  1- Measured      */
    long          AvgInterval;                  /* in s                   */
    long          SampleInterval;               /* in s                   */
    unsigned int PingInterval;                  /* in 0.1 s               */
    unsigned int BurstMode;                     /* 0-Disabled; 1-enabled  */
    long          BurstInterval;                /* in s                   */
    unsigned int SamplesPerBurst;
    char          CoordSystem;         /* 0-Beam;     1-XYZ; 2-ENU        */
    char          OutMode;             /* 0-Auto;     1-Polled            */
    char          OutFormat;           /* 0-Binary;   1-Ascii             */
    char          RecorderEnabled;     /* 0-DISABLED; 1-ENABLED           */
    char          RecorderMode;        /* 0-NORMAL MODE; 1-BUFFER MODE    */
    char          DeploymentMode;           /* 0-Disabled; 1-enabled    */
    char          DeploymentName[9];        /* Dir name in recorder     */
    DateTimeType BeginDeploymentDateTime;   /* in s since Jan 1, 1980   */
    char          CommentLine1[60];
    char          CommentLine2[60];
    char          CommentLine3[60];
    char          AutoSleep;
    char          DynBoundAdj;         /* 0- No   1- Yes (for XR only)    */
    int           CellBegin;           /* in cm, vert. from instrument    */
    int           CellEnd;             /* in cm, vert. from instrument    */
    int           CohLag;              /* in cm, vert. from instrument    */
                                       /*   if > 0 Arg will operate in    */
                                       /*   coherent mode                 */
    char          DataFormat;          /* 0- LONG; 1- SHORT               */
    char          WaveSpectra;         /* 0-no    1- yes                  */
    int           WaterDepth;          /* in cm for spectra calculations  */
                                       /* if 0 or negative, it gives      */
                                       /* height of Argonaut above bottom */
  } ArgUserSetupType;
```

A1.3. Data Sample Structures

There are two different Argonaut data sample structures, depending on the setting of the data format parameter (**LONG** or **SHORT** – see §3.8).

Argonaut LONG sample structure (38 bytes)

```
  typedef struct {
    unsigned char   SyncChar;          /*  1  Fixed 0xB0          */
    unsigned char   Nbytes;            /*  1  Including ChkSum    */
    unsigned long   Time;              /*  4  Seconds since Jan 1,1980 at 0*/
             int    Vel[MAX_BEAMS];    /*  6  Vel in mm/s         */
    unsigned char   VelStd[MAX_BEAMS]; /*  3  Vel in mm/s         */
```

```
    unsigned char   Amp[MAX_BEAMS];     /*  3  Amplitude in counts */
    unsigned char   PercentGood;        /*  1  Percent good pings  */
    unsigned int    Heading;            /*  2  Heading in .1 deg   */
             char   Pitch;              /*  1  Pitch in .4 deg     */
             char   Roll;               /*  1  Roll in .4 deg      */
    int             Temp;               /*  2  in .01 deg C        */
    long            Pres;               /*  4  in counts (Strain Gauge)  */
                                        /*     in 0.0001 dbars (Druck)   */
    unsigned int    SigmaPres;          /*  2  in A/D Converter counts   */
    unsigned char   Vbatt;              /*  1  Battery voltage      */
    unsigned char   CellBegin;          /*  1  in .1 m units        */
    unsigned char   CellEnd;            /*  1  in .1 m units        */
    unsigned char   StdHeading;         /*  1  Std. dev. in .1 deg */
    unsigned char   StdPitch;           /*  1  Std. dev. in .1 deg */
    unsigned char   StdRoll;            /*  1  Std. dev. in .1 deg */
    unsigned char   ChkSum;             /*  1  CheckSum of preceding bytes */
  } ArgLongSampleType;                  /* ---- */
                                        /* 38  bytes total */
```

Argonaut SHORT sample structure (22 bytes)

```
  typedef struct {
    unsigned char   SyncChar;           /*  1  Fixed 0xB1          */
    unsigned char   Nbytes;             /*  1  Including ChkSum    */
    unsigned long   Time;               /*  4  Seconds since Jan 1,1980 at 0*/
             int    Vel[MAX_BEAMS];     /*  6  Vel in mm/s         */
    unsigned char   MeanVelStd;         /*  1  Vel in mm/s         */
    unsigned char   MeanAmp;            /*  1  Amplitude in counts */
    int             Temp;               /*  2  in .01 deg C        */
    long            Pres;               /*  4  in counts (Strain Gauge)  */
                                        /*     in 0.0001 dbars (Druck)   */
    unsigned char   Vbatt;              /*  1  Battery voltage      */
    unsigned char   ChkSum;             /*  1  CheckSum of preceding bytes */
  } ArgShortSampleType;                 /* ---- */
                                        /* 22  bytes total */
```

Argonaut CTD Data Structure

```
  typedef struct {
    long  Temp;           /* in 0.0001  deg C                              */
    long  Cond;           /* in 0.00001 Siemens per meter                  */
    long  Press;          /* in 0.001   Decibars                           */
    long  Sal;            /* in 0.0001  ppt                                */
  } CtdType;
```

Argonaut Wave Data Structure

```
  unsigned int Aband[10]; /* 20  Wave amplitude 2-4, 4-6,..20-more s in mm */
  unsigned int Hmo;       /*  2  Significant wave height in mm             */
  unsigned int Tp;        /*  2  Mean period in 0.1 s                      */
                          /* 16  bytes total */
```

Profiling Mode Data Structure

```
  extern int             VelAvg[MAX_BEAMS][MAX_CELLS];
  extern unsigned char   VelStdAvg[MAX_BEAMS][MAX_CELLS];
  extern unsigned char   AmpAvg[MAX_BEAMS][MAX_CELLS];
```

A1.4. Checksum Calculation

The Argonaut uses a checksum with each sample and whenever transmitting binary data over a serial port. The checksum is computed with the C function "ComputeCheckSum" included below. To understand how the checksum is computed, assume that a sample has been placed in a segment of memory (*i.e.*, a character array). The checksum value is stored as the last byte in this array. The checksum is computed by the following C program statement.

```
CheckSum = ComputeCheckSum( buffer, Sample_Length - 1 );
```

In this statement, "buffer" is a pointer to the memory location where the sample begins (*i.e.*, the name of the character array where the sample was placed). "ComputeCheckSum" adds the first "Sample_Length - 1" bytes starting at location buffer, then adds the value 0xA596. The result of this summation is truncated to one (unsigned) byte and returned. The addition of the value 0xA596 is done so that an all-zeros sample does not produce a valid checksum.

```
#define CHECK_SUM_OFFSET   0xA596
unsigned int ComputeCheckSum( unsigned char *buf, int n )
{
  int i;
  unsigned int ChkSum = CHECK_SUM_OFFSET;
  for(i=0;i<n;i++) ChkSum += buf[i];
  return(ChkSum);
}
```

A1.5. Examples of binary output records:

Long format, no CTD, no waves

```
Long Sample    37
Checksum        1
            ------
               38 bytes
```

Short format, no CTD, no waves

```
Short Sample   21
Checksum        1
            ------
               22 bytes
```

Long format, CTD, no waves

```
Long Sample    37
CTD data       16
Checksum        1
            ------
               54 bytes
```

Short format, no CTD, waves

```
Short Sample   21
Waves data     24
Checksum        1
            ------
               46 bytes
```

Long format, CTD, waves

```
Short Sample   37
CTD   data     16
Waves data     24
Checksum        1
            ------
               78 bytes
```

Appendix 2. Internal SDI-12 Support for Argonaut SL/XR

A2.1. Introduction

Starting with firmware version 7.5, the Argonaut-SL/XR offers internal SDI-12 (Serial-Digital Interface) capabilities that require no external devices or converters. This appendix describes internal SDI-12 features, wiring, new commands, operation, and SDI-12 protocol.

The SonTek Argonaut Acoustic Doppler Current Meter is fully compliant with version 1.2 of the SDI-12 protocol. It is easy to use and works with any data recorder/logger with an SDI-12 interface. SDI-12 is ideal for data logging applications with the following requirements.

- Where an additional data recorder/transmitter is required
- Battery powered operation with minimal current drain
- Low system cost
- Up to 200 feet of cable between the Argonaut and the data recorder

Note: The SDI-12 mode only works with standard Argonauts. Argonauts with *Wave Spectra*, *MicroCat CT*, *YSI Multiprobe*, or other integrated external sensors are not supported.

A2.2. Connecting the Argonaut to a Data-Logger

To facilitate operation of an Argonaut with external SDI-12 data storing systems, the Argonaut power/communication cable has been modified to include a separate termination to be used with SDI-12 capable data-loggers (Figure A2.1).

The cable has an 8-pin underwater connector on one end and three separate cable terminations on the other end. The description of these termination cables follows.

Note: Although the cable below represents the most common assembly, the cable for your system may vary. See §A2.2.3 and Figures A2.4 through A2.7 for information on the most common cable assemblies.

- SDI-12 pigtail:
  Red ---------------------- Power to Argonaut (+6 to +16 VDC)
  White ---------------------- Data (SDI-12)
  Black ---------------------- Ground
  WARNING: The power line does **not** have over-voltage protection. Voltages above +16V on the pigtail will damage Argonaut electronics.

- Coaxial power cable (for an optional AC/DC adaptor or external power above 16 VDC):
  Center pin ----------------- Power to Argonaut (+10 to +26 VDC)
  Jacket ----------------- Ground
  WARNING: The power line does **not** have over-voltage protection. Voltages above +26V on the coaxial power cable will damage Argonaut electronics.

- RS-232 cable (DB9):
  Pin 2 ------------------------ Data out
  Pin 3 ------------------------ Data in
  Pin 5 ------------------------ Ground
  Note: The remaining pins are not connected.

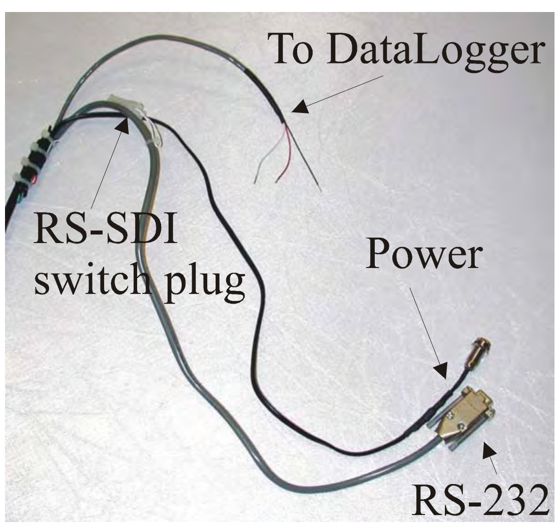


Figure A2.1. Argonaut power/communications cable modified for internal SDI-12 operation.

The same communications cable is used for both SDI-12 and RS-232 operations. A white, 2-pin switch plug is used to change the hardware between the two modes (Figure A2.1); a software command also needs to be sent (see §A2.3). When both ends of the plug are connected (the plug is shorted), RS-232 communication is enabled. When both ends of the plug are separated (the plug is open), SDI-12 communication mode is enabled (Figure A2.2). Suggested connection sequence is as follows (Figure A2.3):

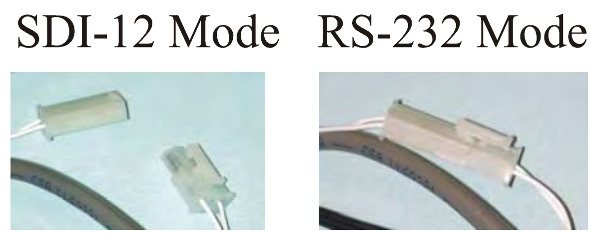


Figure A2.2. Switching hardware between SDI-12 and RS-232 modes.

- Attach 8-pin underwater connector on the communications cable to the Argonaut.
- Connect serial DB-9 connector to a serial port on your computer.
- Connect SDI-12 pigtail to the data-logger.

Most data-loggers have +12V power output that can be used to power the Argonaut through the SDI-12 cable (red lead) directly.

When using the supplied AC-to-DC power supply, or when operating the Argonaut with a power source that exceeds 16 VDC, or when operating a data logger that does not provide power to external sensors, the Argonaut can be powered using the coaxial power connector (up to 26 VDC).

A2.2.1. DC Power

The Argonaut requires 6-16 VDC input power (12.0 VDC recommended). Normally the Argonaut is a low power device, however, when it transmits acoustic pulses it requires up to 200 mA for short bursts. Make sure your wiring and battery are capable of supplying sufficient current.

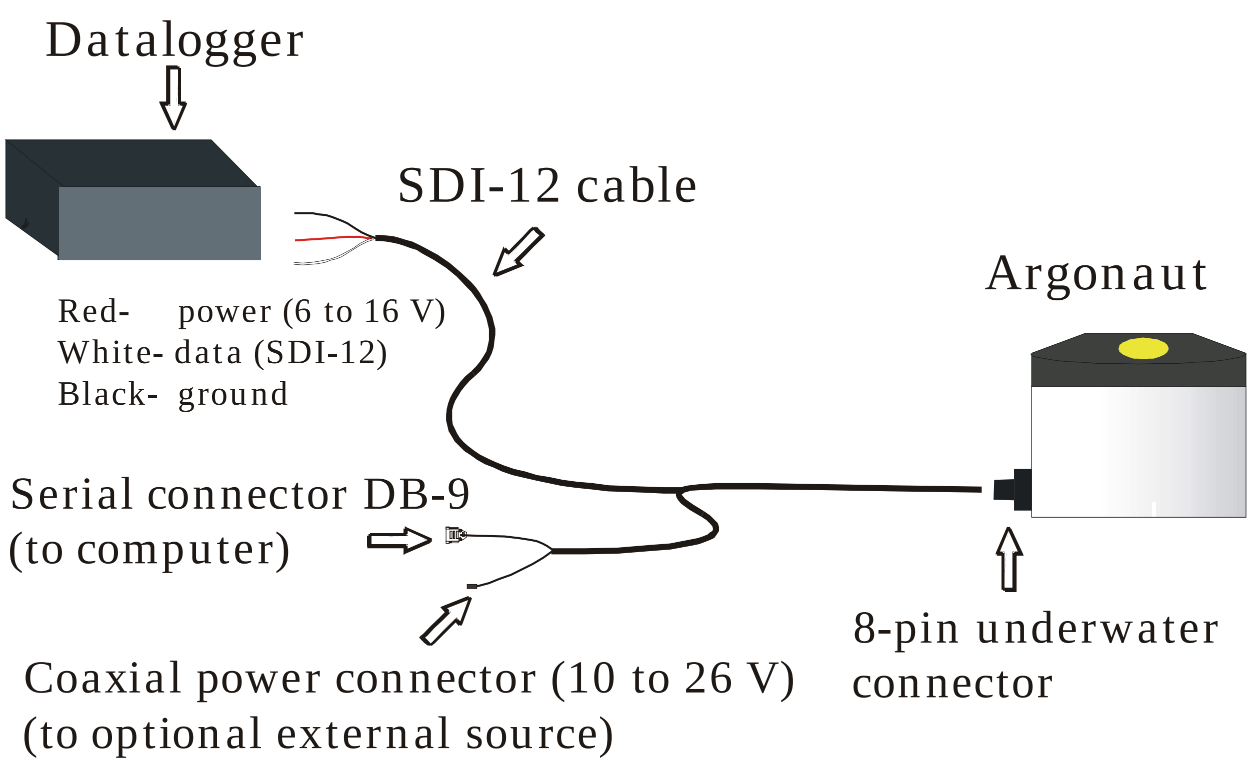


Figure A2.3. Connecting an Argonaut-SL to a data-logger.

A2.2.2. Words of Caution

- Make certain your wiring and battery is capable of supplying sufficient intermittent current for the Argonaut transmitter.
- Keep the lead wires as short as possible.
- Use large gauge wiring for long runs.
- Make certain the connections are reliable.
- Use shielded cables in noisy environments.

WARNING: The power line on the SDI-12 pigtail does not have over-voltage protection. Supplying voltage in excess of +16V will permanently damage Argonaut electronics.

A2.2.3. Variations of Argonaut to SDI-12 Power and Communications Cables

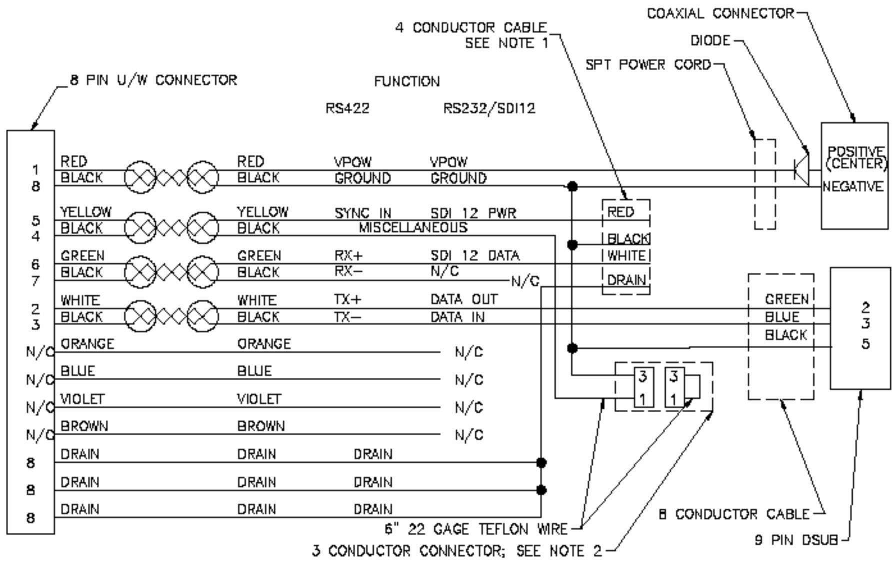
There are a few variations of the Argonaut-to-SDI-12 power and communications interface cable. In most cases, when an Argonaut is purchased new with the SDI-12 interface, you will receive the standard 10-m cable (Figure A2.4). However, there are a few cases where a new Argonaut system is being used as a replacement to an existing installation. As a result, this section will provide you with the information needed to modify older style cables that were not wired at the factory for SDI-12 use.

Figure A2.4 shows the version of cable that is shipped with new systems for cable lengths up to and including 10 m. For cables exceeding 10 m, refer to Figure A2.5.

The first task is to determine the revision and type of cable that is to be modified. Using Figures A2.4 through A2.7, determine the cable that needs to be modified.

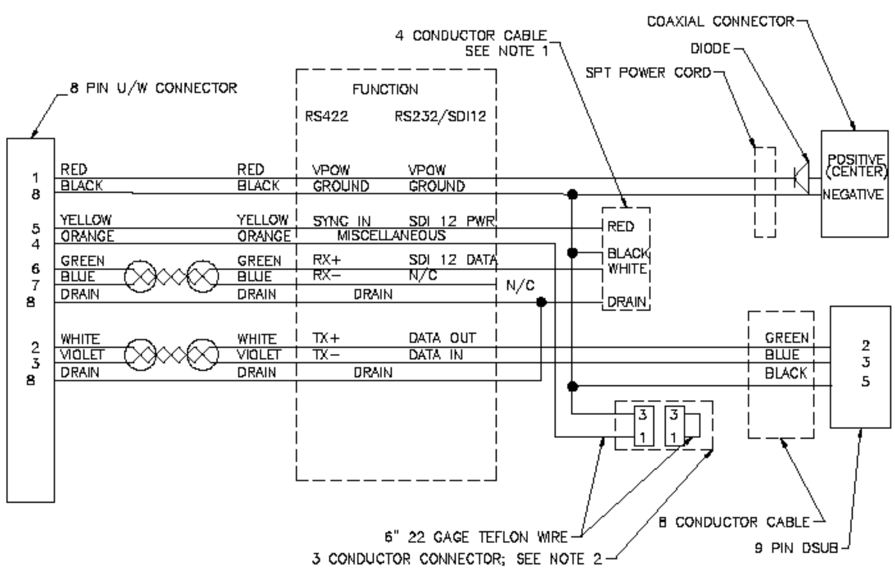
Each of the cables shown here shares a similar hookup, the main difference being in the number of conductors available. In each of the drawings, the left side represents the 8-pin wet-pluggable connector. The center section of the drawing represents the cable and a breakdown of the conductors and their functionality. The right side of the drawing represents each of the dry-side connectors.

If you have any questions regarding these cables, please contact SonTek.



1: MAKE CABLE A 1 FOOT PIGTAIL
OUTER INSULATION STRIPPED APPROX 3" FROM END
AND ENDS TINNED APPROX 1/4" (SEE SAMPLE)
2. WIRE PER SAMPLE
3. 3/4" HEAT SHRINK OVER ENTIRE SPLICE
4. APPLY WIRE TIES PER SAMPLE

Figure A2.4. Argonaut to SDI-12 interface cable (dwg 8004-10000). Standard 10-m (and shorter): 12 conductors and a drain.



1: MAKE CABLE A 1 FOOT PIGTAIL
OUTER INSULATION STRIPPED APPROX 3" FROM END
AND ENDS TINNED APPROX 1/4" (SEE SAMPLE)
2. WIRE PER SAMPLE
3. 3/4" HEAT SHRINK OVER ENTIRE SPLICE
4. APPLY WIRE TIES PER SAMPLE

Figure A2.5. Argonaut to SDI-12 interface cable (dwg 8004-20000). Standard wiring for cables exceeding 10 m: 8 conductors and a drain.

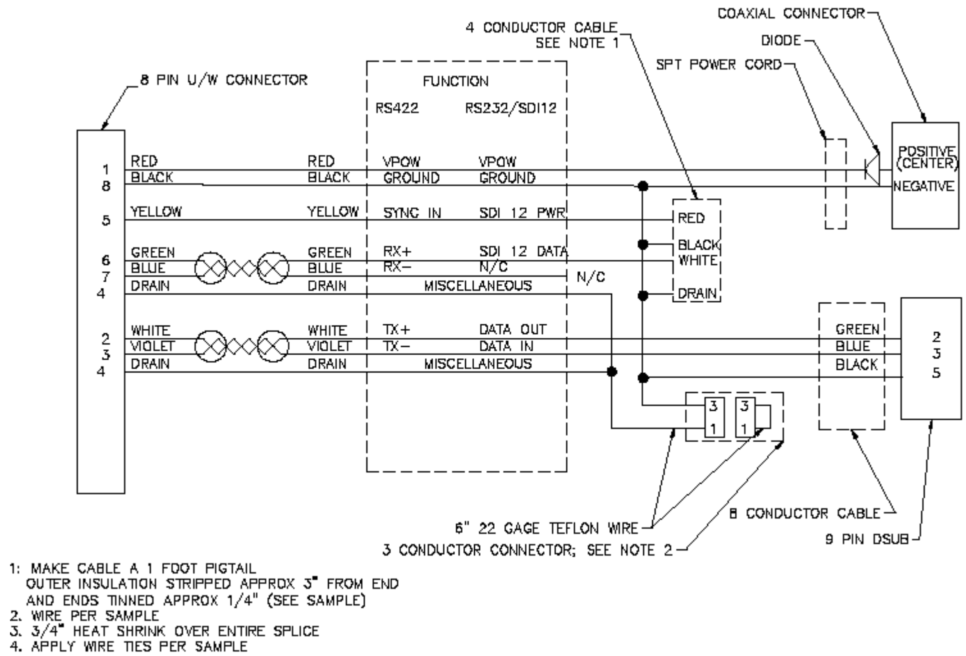


Figure A2.6. Argonaut to SDI-12 interface cable (dwg 8004-30000). Older cable: Drains as SDI-12 control line; 7 conductors & a drain.

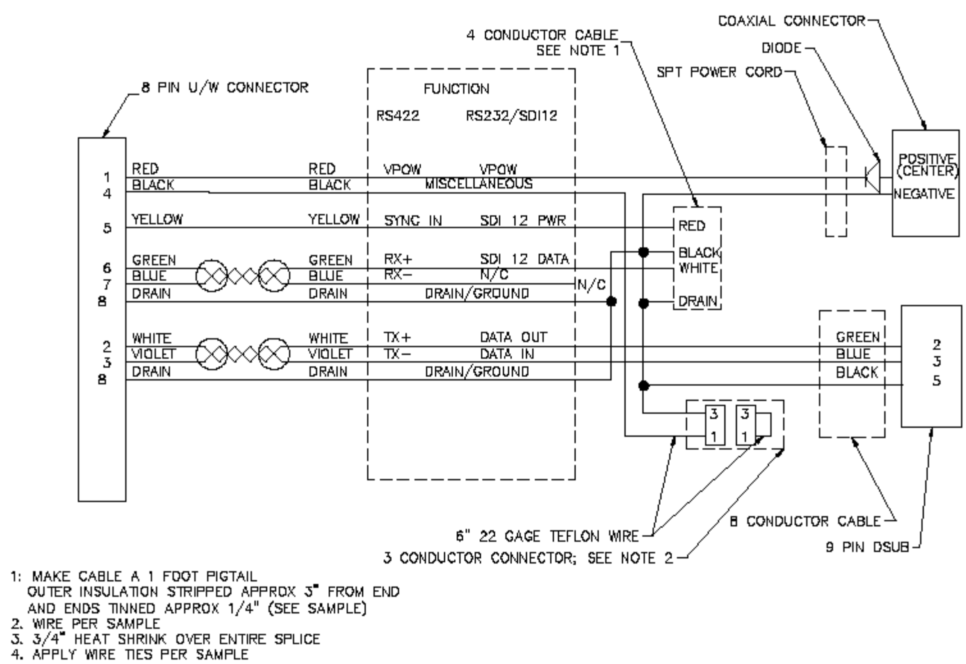


Figure A2.7. Argonaut to SDI-12 interface cable (dwg 8004-40000). Older cable: Drain as ground, black as SDI-12 control; 7 conductors and a drain.

A2.3. Setting Up the Argonaut for Data Collection

Connect the Argonaut to a computer and power as described above. The commands to set up the Argonaut operation parameters are only accessible when the system is in the RS-232 mode. To put the Argonaut into RS-232 mode, connect the RS-SDI switching plug (Figure A2.2).

On your PC, run either SonTerm or SonTermW. Within SonTerm, send an Argonaut **BREAK** (by entering **Alt+B** or **+++**) to wake-up the Argonaut. Note: If you receive a response after the **BREAK** similar to "The system is in SDI-12 mode…", you must type **?EXIT!** to return to RS-232 mode.

After communication has been established, verify that the Argonaut has the SDI-12 option installed and view its system address by entering the following command (<CR> = Enter key).

```
>sdi12address <CR>
```

If the SDI-12 option is enabled, the Argonaut will return the address being used:

```
Current Sdi12 address: 1.
```

If the SDI12 option is not enabled, the following error message is returned:

```
ERROR: System does not have SDI-12 Interface installed.
       SDI-12 commands are disabled
```

To change the Argonaut SDI-12 address, send the following command

```
>sdi12address 2 <CR>
```

where "2" is the desired SDI-12 address (acceptable addresses: "0-9", "A-Z", or "a-z"). If more than one sensor is to be connected to the SDI-12 bus, make certain each sensor has a unique sensor address.

The Averaging Interval (AI) is the period, in seconds, over which the Argonaut averages the data before computing mean velocity. This value also determines how long the SDI-12 measurement will take to complete. The Sampling Interval (SI) is irrelevant with the use of the Single-Sample mode to initiate a measurement. However, for command consistency you should set SI to a value equal to or greater than AI. When using an Argonaut as an SDI-12 sensor, do not set AI to more than 992 seconds (16.6 minutes). This limitation is necessary because the SDI-12 protocol only supports measurement intervals up to 999 seconds. The values shown in the following example will cause the Argonaut to measure and average flow data for a period of 60 seconds.

Configure the regular operating parameters of the Argonaut for your application using the direct command interface described in Section 3 of this manual. As an example:

To set Cell Begin (CB) to 0.5 m and Cell End (CE) to 15.0 m use the following. Note: To determine actual CB and CE values, use *ArgCheck* (see *Argonaut Software Manual*).

```
>CB 0.5 <CR>
>CE 15.0<CR>
```

To set averaging and sampling intervals to 30 s use:

```
>AI 30 <CR>
>SI 30 <CR>
```

To set output mode to AUTO use:

```
>OM AUTO<CR>
```

To set output format to ENGLISH use:

```
>OF ENGLISH<CR>
```

To set SDI-12 SIDEKICK format use (you may also use `SONTEK` in firmware v7.9 or later):

```
>sdi12format SIDEKICK <CR>
```

If you need the data to be stored on the Argonaut's internal recorder (in addition to being logged onto an SDI-12 data-logger), turn the recorder ON using:

```
>recorder on <CR>
```

After setup is complete, save your settings using:

```
>savesetup <CR>
```

To put the Argonaut into SDI-12 data collection mode use:

```
>SDI12 ON <CR>
```

The Argonaut sends this reply to indicate it is now in SDI-12 mode (see Important Notes #1):

```
OK
Checking Setup Parameters...
917504 free bytes left in recorder.
Free space is sufficient for 2.31 days of operation.
Recorder mode is NORMAL.
Switching to SDI-12 mode
SDI-12 address is: 1
```

You should verify that the Argonaut can now accept SDI-12 commands by sending the following SDI-12 "Send Identification" command and receiving the appropriate response (§A2.5.7).

`?I!` (*You may be required to enter a <CR> also; see Important Notes #2 first.*)
`112 SonTek  SL  79  E272`

You can now enter additional SDI-12 commands. When done, make sure you disconnect the RS-SDI switching plug (Figure A2.6) to complete the process of placing Argonaut in SDI-12 mode.

Important Notes:

1. If the recorder is enabled and already full, the Argonaut responds with an error message and will not enter SDI-12 mode. To proceed, the recorder has to be either disabled or formatted.
2. Depending on the terminal emulator you are using (*SonTerm* [for DOS] or *SonTermW* [for Windows]), you may be required to enter a `<CR>` to complete the command string.
   - *SonTerm* (for DOS) – Do **not** enter the terminating `<CR>`. The system recognizes the "`!`" character as the command terminator. If you inadvertently send a `<CR>`, you can return the system to a known state by sending a **BREAK**, or any other valid SDI-12 command not followed by a `<CR>`.
   - *SonTermW* (for Windows) – You **do** enter the terminating `<CR>`, assuming you have set the **File|Communications Mode** to **SDI-12**. If this item is set to **RS232/422/485**, the system will act the same as *SonTerm* for DOS (as described above).
3. If a **BREAK** is issued to an Argonaut that is in SDI-12 mode, the system will not stop its operation and will send the following message.

   ```
   112 SonTek  SL  79  E272
   System is in SDI-12 mode. To switch to RS232 type ?EXIT!
   ```

4. While in SDI-12 mode, the serial communications do not support full duplex. Therefore, the characters you enter are not echoed back to the screen.

A2.4. Summary of Argonaut SDI-12 Commands

A2.4.1. General Commands

help sdi12	Lists available SDI-12 commands.

A2.4.2. SDI-12 Commands

sdi12	`ON`	Puts the system in SDI12 mode.
sdi12address	a	Sets the SDI-12 address of the system.
sdi12format	`SIDEKICK|SONTEK`	Selects the data format for SDI-12.
?EXIT!		Exits SDI-12 mode and enters RS-232 mode.

A2.4.3. SDI-12 Data Formats

When operating in SDI-12 mode, the Argonaut supports two data output formats: SIDEKICK (in firmware v7.5 and later) and SONTEK (in firmware v7.9 and later).

SIDEKICK Output Data Format

To request and retrieve a data sample in SDI-12 SIDEKICK mode, issue these commands:

Command	Response	Description
"aM!" or "aM0!"		Initiate measurement request
"aD0!"	a±X.XX±Y.YY±Z.ZZ±V.VV±D.DD<cr><lf>	Retrieve first buffer of sample data
"aD1!"	a±S.±T.TT±P.PPP±B.B<cr><lf>	Retrieve second buffer of sample data

Where:

Data Format			Metric	English
X.XX	=	Velocity component 1 (beam 1/X/East)	cm/s	ft/s
Y.YY	=	Velocity component 2 (beam 2/Y/North)	cm/s	ft/s
Z.ZZ	=	Velocity component 3 (beam 3/Z/Up) **[XR only]**	cm/s	ft/s
		or Cell End **[SL only]**	m	ft
V.VV	=	Velocity Vector	cm/s	ft/s
D.DD	=	Mean Standard deviation	cm/s	ft/s
S.	=	Mean Signal Strength	counts	counts
T.TT	=	Mean Temperature	°C	°F
P.PPP	=	Mean Pressure	decibar	psi
B.B	=	Battery Voltage	volts	volts

SONTEK Output Data Format

Standard (Single Averaged-Cell) Data: To request and retrieve a standard (i.e., single averaged-cell) sample in SDI-12 SONTEK mode, issue these commands:

Command	Response	Description
"aM!" or "aM0!"		Initiate measurement request
"aD0!"	a±T.TT±P.PPP±L.LLL±CC.C<cr><lf>	Retrieve 1st and 2nd buffers of standard (single
"aD1!"	a±X.XX±Y.YY±Z.ZZ±S.<cr><lf>	averaged-cell) data

Where: (See below for data format description legend.)

Profiling Cell Data: To request and retrieve profiling cell sample data in SDI-12 SONTEK mode, issue the following commands. Profiling cell data are only available in systems that have the optional Profiling Mode feature installed.

Command	Response	Description
"aM!" or "aM0!"		Initiate measurement request
"aD0!"	a±T.TT±P.PPP±L.LLL±CC.C<cr><lf>	Retrieve 1st and 2nd buffers of standard (single
"aD1!"	a±X.XX±Y.YY±Z.ZZ±S.<cr><lf>	averaged-cell) data
"aM***n***!"		Request profiling cell (***n*** = cell number 1-5)††
"aD0!"	a±x.xx±y.yy±z.zz±s.<cr><lf>	Retrieve data for profiling cell ***n***

††Note: When issuing the "aM***n***!" command, the data that is sent will be the data that was stored in the buffer when the "aM!" command was issued. That is, subsequently issuing the same "aM***n***!" command will **not** display new data unless another "aM!" command is issued before issuing the "aM***n***!" command.

Where:

Data Format			Metric	English
Standard (Single-Averaged) Cell:				
T.TT	=	Mean Temperature	°C	°F
P.PPP	=	Mean Pressure	decibar	psi
L.LLL	=	Level	cm	ft
CC.C	=	Cell End	m	ft
X.XX	=	Velocity component 1* (beam 1/X/East)	cm/s	ft/s
Y.YY	=	Velocity component 2* (beam 2/Y/North)	cm/s	ft/s
Z.ZZ	=	Velocity component 3* (beam 3/Z/Up) **[XR only]**	cm/s	ft/s
		or Velocity Magnitude **[SL only]**	cm/s	ft/s
S.	=	Mean Signal Strength	counts	counts
Individual Profiling Cell (must have Profiling Mode option installed):				
x.xx	=	Velocity component 1† (beam 1/X/East)	cm/s	ft/s
y.yy	=	Velocity component 2† (beam 2/Y/North)	cm/s	ft/s
z.zz	=	Velocity component 3† (beam 3/Z/Up) **[XR only]**	cm/s	ft/s
		or Velocity Magnitude† **[SL only]**	cm/s	ft/s
s.	=	Mean Signal Strength†	counts	counts

Notes: * Cell parameters determined by CellBegin (CB) and CellEnd (CE).

† Cell parameters determined by CellSize (CS), BlankDistance (BD), and the cell number (1 through 5) selected in the "aM***n***!" command.

A2.5. SDI-12 Command and Response Protocol

This is a brief description of the Serial Digital Interface (SDI-12) Command and Response protocol used by the Argonaut to SDI-12 interface. Refer to the document "A Serial Digital Interface Standard for Hydrologic and Environmental Sensors". Version 1.2 April 12, 1996 Coordinated by the SDI-12 Support Group, 135 East Center, Logan, Utah.

During normal communication, the data recorder sends an address together with a command to the Argonaut. The Argonaut replies with a "response". In the following descriptions, SDI-12 commands and responses are enclosed in quotes. The SDI-12 address and the command/response terminators are defined as follows:

"a" is the sensor address. The following ASCII Characters are valid addresses: "0-9", "A-Z", "a-z", "*", "?". Sensors will be initially programmed at the factory with the address of "1" for use in single sensor systems. Addresses "0", "2-9", "A-Z", and "a-z" can be used for additional sensors connected to the same SDI-12 bus. Addresses "*" and "?" are wild card addresses that select any sensor, regardless of its actual address.

"!" is the last character of a command block.

"<cr><lf>" are carriage return (0D) hex and line feed (0A) hex characters. They are the last two characters of a response block.

Notes:

- All commands/responses are upper case, printable ASCII characters.
- Commands to the SDI-12 device (i.e., Argonaut) must be terminated with a "!" character.
- Responses from the SDI-12 device are terminated with <cr><lf> characters.
- The command string must be transmitted in a contiguous block with no gaps of more than 1.66 milliseconds between characters.

A2.5.1. Measure Command

The Measure command initiates a measurement sequence. Data values generated in response to this command are stored in the sensor's buffer for subsequent retrieval using "D" commands. The data will be retained in the sensor until another "M", "C", or "V" command is executed.

Command	Response	Description
"aMc!"	"atttn<cr><lf>"	Initiate measurement

Where:

a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").

M is the upper case ASCII character representing the Measure command.

c is the cell to be measured. If the Argonaut's ProfilingMode (PM) command is set to NO, the "c" argument can be omitted. If PM=YES, and Number of Cells (NC) has been set appropriately, then "c" can be a value from 0 through 5, where a value of 1 through 5 represents the cell to be measured, and a value of 0 (or null) represents a single cell with a range of CellBegin (CB) through CellEnd (CE). Report data taken at the time of the last "aM!" command (see Note[††] on page 102 regarding "aMn!").

ttt is a 3-digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have measurement data available in its buffer. This value is equal to the Averaging Interval (AI) + 5 seconds. This provides extra time to wake the handshake between the data-logger and the Argonaut.

n is a single-digit integer (0-9) specifying the number of values that will be placed in the data buffer. If "n" is zero (0), no data will be available using subsequent "D" commands.

Upon completion of the measurement, a service request “a<cr><lf>” is sent to the data recorder indicating the sensor data is ready. The recorder may wake the sensor with an SDI-12 BREAK (continuous spacing by the data recorder on the data line for at least 12 ms) and collect the data anytime after the service request is received, or when the specified processing time has elapsed.

Examples of “aMc!” commands:

Command	Response	Time	Values	Description
“aM!”	“a0609<cr><lf>”	60 s	9	Make one measurement from CB through CE.
“aM3!”	“a0004<cr><lf>”	0 s	4	Make a measurement of Cell 3 (if ProfilingMode=Yes). Note: Report data taken at the time of the last “aM!” command over the range set by the BC, CS, and NC commands (see Note†† on page 102 regarding “aMn!”).

A2.5.2. Concurrent Measurement Command

This is a new command for the Version 1.2 SDI-12 Specification. A concurrent measurement is one that occurs while other SDI-12 sensors on the bus are also taking measurements. This command is similar to the “aMc!” command; however, the nn field has an extra digit, and the sensor does not issue a service request when it has completed the measurement. Communicating with other sensors will NOT abort a concurrent measurement. Data values generated in response to this command are stored in the sensor’s buffer for subsequent collection using “D” commands. The data will be retained in the sensor until another “M”, “C”, or “V” command is executed.

Command	Response	Description
“aC!”	“atttnn<cr><lf”	Initiate measurement

Where:

a	is the sensor address (“0-9”, “A-Z”, “a-z”, “*”, “?”).
C	is the upper case ASCII character representing the Concurrent Measurement command.
ttt	is a 3-digit integer (000-999) specifying the maximum time (AI+5), in seconds, the sensor will take to complete the command and have measurement data available in its buffer.
nn	is a 2-digit integer (00-99) specifying the number of values that will be placed in the data buffer. If “n” is zero (0), no data will be available using subsequent “D” commands.

The data recorder may wake the sensor with an SDI-12 BREAK and collect the data anytime after the specified processing time has elapsed.

A2.5.3. Send Data Command

The Send Data Command returns sensor data generated as the result of previous “aMc!”, “aC!”, or “aV!” commands. Values returned will contain 33 characters or less. The sensor’s data buffer will not be altered by this command.

Command	Response
“aD0!” through “aD9!”	“a±d.d . . . ±d.d<cr><lf>”

Where:

a	is the sensor address (“0-9”, “A-Z”, “a-z”, “*”, “?”).
D0..D9	are the upper case ASCII characters representing the Send Data command.
±	is a polarity sign (+ or -).
d.d	represents numeric digits before and/or after the decimal. A decimal may be used in any position in the value after the polarity sign. If a decimal is not used, it will be assumed to be after the last digit.

Example: 1 +3.29 +23.5 -25.45 +300

If one or more values were specified and an “aD0!” returns no data (“a<cr><lf>” only), it means that the measurement was aborted and a new “M”, or “C”, or “V” command must be sent.

Example of “aD0!” and “aD1!” commands following an “aM!” or “aC!” command, where sdi12format=SIDEKICK:

Previous Command	Response	Description
“aM!” or “aC!”	“a0609<cr><lf>” or “a06009<cr><lf>”	See §A2.5.1 and §A2.5.2

Subsequent Command	Response	Description
“aD0!”	a±X.XX±Y.YY±Z.ZZ±V.VV±D.DD<cr><lf>	See §A2.5.3
“aD1!”	a±S.±T.TT±P.PPP±B.B<cr><lf>	

Where:

Data Format			Metric	English
X.XX	=	Velocity component 1 (beam 1/X/East)	cm/s	ft/s
Y.YY	=	Velocity component 2 (beam 2/Y/North)	cm/s	ft/s
Z.ZZ	=	Velocity component 3 (beam 3/Z/Up) **[XR only]**	cm/s	ft/s
		or Cell End **[SL only]**	m	ft
V.VV	=	Velocity Vector	cm/s	ft/s
D.DD	=	Mean Standard deviation	cm/s	ft/s
S.	=	Mean Signal Strength	counts	counts
T.TT	=	Mean Temperature	°C	°F
P.PPP	=	Mean Pressure	decibar	psi
B.B	=	Battery Voltage	volts	volts

Example of “aD0!” and “aD1!” commands following “aM!” command, where sdi12format=SONTEK:

Previous Command	Response	Description
“aM!” or “aM0!”	“a0608<cr><lf>”	See §A2.5.1

Subsequent Command	Response	Description
“aD0!”	a±T.TT±P.PPP±L.LLL±CC.C<cr><lf>	See §A2.5.3
“aD1!”	a±X.XX±Y.YY±Z.ZZZ±S.<cr><lf>	

Where:

Data Format			Metric	English
T.TT	=	Mean Temperature	°C	°F
P.PPP	=	Mean Pressure	decibar	psi
L.LLL	=	Level	cm	ft
CC.C	=	Cell End	m	ft
X.XX	=	Velocity component 1* (beam 1/X/East)	cm/s	ft/s
Y.YY	=	Velocity component 2* (beam 2/Y/North)	cm/s	ft/s
Z.ZZ	=	Velocity component 3* (beam 3/Z/Up) **[XR only]**	cm/s	ft/s
		or Velocity Magnitude **[SL only]**	cm/s	ft/s
S.	=	Mean Signal Strength*	counts	counts

*Note: Cell parameters determined by CellBegin (CB) and CellEnd (CE).

Example of “aD0!” command following “aM4!” command, where sdi12format=SONTEK and PM=YES:

Previous Command	Response	Description
“aM4!”	“a0004<cr><lf>”	See §A2.5.1

Subsequent Command	Response	Description
“aD0!”	a±x.xx±y.yy±z.zz±s.<cr><lf>	See §A2.5.3

Where:

Data Format			Metric	English
x.xx	=	Velocity component 1† (beam 1/X/East)	cm/s	ft/s
y.yy	=	Velocity component 2† (beam 2/Y/North)	cm/s	ft/s
z.zz	=	Velocity component 3† (beam 3/Z/Up) **[XR only]**	cm/s	ft/s
		or Velocity Magnitude† **[SL only]**	cm/s	ft/s
s.	=	Mean Signal Strength†	counts	counts

†Note: Cell parameters determined by CellSize (CS), BlankDistance (BD), Ncells (NC), and the cell number selected in the "aMc!" command (cell number 4 in this example).

Example of "aD0!" through "aDx!" commands following "aC!" command, where sdi12format=SONTEK, PM=YES, and NC=3:

Previous Command	Response	Description
"aC!"	"a06020<cr><lf>"	See §A2.5.2

Subsequent Command	Response		Description
"aD0!"	a±T.TT±P.PPP±L.LLL±CC.C<cr><lf>		See §A2.5.3
"aD1!"	a±X.XX±Y.YY±Z.ZZZ±S.<cr><lf>		
"aD2!"	a±x.xx±y.yy±z.zz±s.<cr><lf>	[for Cell 1]	
"aD3!"	a±x.xx±y.yy±z.zz±s.<cr><lf>	[for Cell 2]	
"aD4!"	a±x.xx±y.yy±z.zz±s.<cr><lf>	[for Cell 3]	

Where:

Data Format			Metric	English
T.TT	=	Mean Temperature	°C	°F
P.PPP	=	Mean Pressure	decibar	psi
L.LLL	=	Level	cm	ft
CC.C	=	Cell End	m	ft
X.XX	=	Velocity component 1* (beam 1/X/East)	cm/s	ft/s
Y.YY	=	Velocity component 2* (beam 2/Y/North)	cm/s	ft/s
Z.ZZ	=	Velocity component 3* (beam 3/Z/Up) **[XR only]**	cm/s	ft/s
		or Velocity Magnitude **[SL only]**	cm/s	ft/s
S.	=	Mean Signal Strength	counts	counts
x.xx	=	Velocity component 1† (beam 1/X/East)	cm/s	ft/s
y.yy	=	Velocity component 2† (beam 2/Y/North)	cm/s	ft/s
z.zz	=	Velocity component 3† (beam 3/Z/Up) **[XR only]**	cm/s	ft/s
		or Velocity Magnitude **[SL only]**	cm/s	ft/s
s.	=	Mean Signal Strength†	counts	counts

Notes: *Cell parameters determined by CellBegin (CB) and CellEnd (CE).
†Cell parameters determined by CellSize (CS), BlankDistance (BD), Ncells (NC), and the appropriate cell number (cells 1 through 3 in this example).

A2.5.4. Continuous Measurements

This is a new command for the Version 1.2 SDI-12 Specification. Sensors that are able to continuously monitor the phenomena to be measured, such as a shaft encoder, do not require a start measurement command. They can be read directly with the R commands (R0!….R9!). The R commands work exactly like the D (D0!….D9!) commands. The only difference is that the R commands do not need to be preceded with an M command. At this time, the operational characteristics of the Argonaut do not allow it to support the R commands.

A2.5.5. Initiate Verify Command

The Verify Command (V!) causes a verify sequence to be performed. The result of this command is similar to the “aM!” command except that the values generated are fixed test data and the results of diagnostic checksum tests. The data generated in response to this command is placed in the sensor’s buffer for subsequent collection using “D” commands. The data will be retained in the sensor until another “M”, “C”, or “V” command is executed.

Command	Response	Description
“aV!”	“atttn<cr><lf>”	Initiate verify sequence

Where:

a	is the sensor address (“0-9”, “A-Z”, “a-z”, “*”, “?”).
V	is the upper case ASCII character representing the Verify command.
ttt	is a 3-digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have data available in its buffer.
n	is a single-digit integer (0-9) specifying the number of values that will be placed in the data buffer. If “n” is zero (0), no data will be available using subsequent “D” commands.

Example of an Argonaut “aV!” command:

Command	Response	Time	Values	Description
“aV!”	“a0013<cr><lf>”	1 s	3	Return fixed data and diagnostic data for testing purposes.

Subsequent Command	Response
“aDO”	a+123.456+78.9+y<cr><lf>

Key	Description	Value
+123.456	Fixed test data	
+78.9	Fixed test data	
y	ROM checksum test	0=Failed, 1 = Passed

A2.5.6. Send Acknowledge Command

The Send Acknowledge Command returns a simple status response that includes the address of the sensor. Any measurement data in the sensor’s buffer is not disturbed.

Command	Response		
“a!”	“a<cr><lf>”	Where: a	is the sensor address (“0-9”, “A-Z”, “a-z”, “*”, “?”).

A2.5.7. Send Identification Command

The Send Identification Command responds with sensor vendor, model, and version data. Any measurement data in the sensor's buffer is not disturbed.

Command	Response
"aI!"	"allccccccccmmmmmmvvvxx. . .xx<cr><lf>"

Where:

a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
ll	is the SDI-12 version compatibility level (*e.g.*, version 1.2 is represented as "12").
cccccccc	is an 8-character vendor identification to be specified by the vendor and usually in the form of a company name or its abbreviation.
mmmmmm	is a 6-character field specifying the sensor model number.
vvv	is a 3-character field specifying the sensor version number.
xx…xx	is an optional field of up to a maximum of 13 characters to be used for serial number or other specific sensor information not relevant to operation of the data recorder.

Example of an Argonaut "1I!" command:

"112 SonTek SL 79 E272<cr><lf>"

A2.5.8. Change Sensor Address

The Change Sensor Address Command allows the sensor address to be changed. The address is stored in non-volatile EEPROM within the sensor. The Argonaut will not respond if the command was invalid, the address was out of range, or the EEPROM programming operation failed.

Command	Response	Description
"aAn!"	"n<cr><lf>"	Change sensor address

Where:

a	is the current (old) sensor address ("0-9", "A-Z", "a-z", "*", "?"). An ASCII "*" may be used as a "wild card" address if the current address is unknown and only one sensor is connected to the bus.
A	is an upper case ASCII character.
n	is the new sensor address to be programmed ("0-9", "A-Z", "a-z", "*", "?"). NOTE: To verify the new address, use the "Identify Command".

Example of a "Change Sensor Address" command:

Command	Response	Description
"1A2!"	"2<cr><lf>"	Change sensor address from "1" to "2"

Appendix 3. Vertical Beam Support for Argonaut SL Systems

A3.1. Introduction

Beginning with Argonaut firmware version 5.7 (April, 2000), support was added for Argonaut SL systems that have the optional vertical beam installed. Differences between standard Argonaut commands and data outputs are described in this appendix.

A3.2. Additional Commands for Vertical Beam Argonaut SL Systems

The following commands have been added to support vertical beam operation in the SL.

`VerticalBeam Set [YES|NO]`

- Enables or disables the use of the vertical beam.
- When set to **`YES`**, processing of vertical beam data requires additional CPU resources. As such, the minimum value for the averaging interval is 10 seconds.

`Level [CONT]`

- This command outputs the current water level value in mm.
- When used with the **`CONT`** parameter, the water level value is continually output until the spacebar is pressed.

A3.3. Real-Time Data Format for Vertical Beam Argonaut SL Systems

The following changes apply to the output data stream for vertical beam systems. See §3.16 for a full description of the Argonaut's output data format.

- When **`DataFormat`** = **`LONG`**, water level is reported instead of the third velocity component (V3/Vz/Vup).
- When **`DataFormat`** = **`SHORT`**, water level is reported instead of the pressure field. Note: If you need to report pressure data, either disable the vertical beam (**`VerticalBeam Set NO`**) or use **`DataFormat LONG`**.
- The water level measurement unit depends on the setting of **`OutFormat`**: **`ASCII`** = mm, **`Metric`** = cm, **`English`** = ft, **`Binary`** = mm.
- When no water level is detected, a value of –1 is reported.

A3.4. Software Changes for Vertical Beam Argonaut SL Systems

The following changes apply to the software programs when using a vertical beam system (see *Argonaut Software Manual*).

- Real-Time Data Acquisition (*ARGONAUT.EXE*) – Water level is reported in meters.
- Data Extraction (*GARGSAMP* / *EARGSAMP*):
  - When **`DataFormat`** = **`LONG`**, water level is reported instead of the third velocity component (V3/Vz/Vup).
  - When **`DataFormat`** = **`SHORT`**, water level is reported instead of the pressure field.
  - The water level measurement unit depends on the setting of **`OutFormat`**: **`Metric`** = m, **`English`** = ft.
  - When no water level is detected, a value of –1 is reported.

Appendix 4. Analog Output Option for Argonaut SL/XR Systems

A4.1. Introduction

Beginning with Argonaut firmware version 7.9 (April, 2001), the ability to output data in an analog format was added to Argonaut SL and XR systems. This appendix describes the Analog Output (AO) option and operational considerations.

A4.2. Overview of the Argonaut SL/XR Analog Output Option

The AO implementation in the Argonaut can store and output up to eight different AO channels, each configured individually. You can select a different output variable for each channel. Nine output variables are available – flow, velocity magnitude, level, X-velocity, Y-velocity, average amplitude, pressure, temperature, and cell end location. When you are using more than one serial-to-AO converter (described in §0 and hereafter referred to as Converter), each Converter must be configured for a unique address (1 through 8).

The following commands have been added to support the AO option.

`AnalogOutputType` *or* **`AOT [DISABLED|CURRENT|VOLTAGE]`**
- Sets the type of output to either **`CURRENT`** (4-20 mA) or **`VOLTAGE`**.
- When set to **`DISABLED`**, the analog output is not performed.

`SetupAnalogOutput` *or* **`SAO [Chan OutParam MinVal MaxVal] | [Chan RESET]`**
- Sets or displays the AO processing parameters.
- **`Chan`** is the channel number (1 through 8) of the Argonaut.
- **`OutParam`** is the desired analog variable you wish to output. The acceptable parameters are **`VELX`** (current velocity of the X component), **`VELY`** (current velocity of the Y component), **`VELMAG`** (velocity magnitude), **`AVGAMP`** (average signal amplitude), **`TEMP`** (water temperature), **`PRESS`** (pressure), **`LEVEL`** (of water above Argonaut; only available with vertical-beam systems), **`FLOW`** (not yet implemented), and **`CELLEND`** (end location of cell; only available in systems with a pressure sensor).
- **`MinVal`** and **`MaxVal`** are the minimum and maximum parameter limits. The reason for specifying the limit values is to allow you to obtain more accurate readings for your particular environmental conditions. For example, the velocity magnitude range for the Argonaut current meter is from 0 to 1000 cm/s. These values correspond to the Converter's limits of 4 and 20 mA, respectively. However, if the expected velocity magnitude is >125 and <250 cm/s, the corresponding AO values would vary between 6 and 8 mA, which only represents a fraction of the Converter's full range. Changing the minimum and maximum limit values to 125 and 250 cm/s will ensure that the scaling range expands to between 4 and 20 mA.
- The following table shows the ranges of **`MinVal`** and **`MaxVal`** for each of the parameters.
- Sending the **`SAO Chan RESET`** command (where **`Chan`** is the appropriate channel number) will clear the selected channel. This is useful if a mistake is made on one channel during data entry.

Maximum Range for `MinVal` and `MaxVal` Parameters

OutParam	MinVal	MaxVal	Units*
VELX	-1000 -20	1000 20	cm/s ft/s
VELY	-1000 -20	1000 20	cm/s ft/s
VELMAG	-1000 -20	1000 20	cm/s ft/s
AVGAMP	0	255	counts
TEMP	-5 20	45 113	°C °F
PRESS	0 0	50 150	dbar psi
LEVEL	0 0	50 150	m ft
FLOW	Not implemented	Not implemented	N/A
CELLEND	1 1	22 72	m ft

*Caution: Unit value depends on the Output Format (OF command) in effect when the AO was configured. If OF is changed after the AO setup, all channels are reset and must be re-entered. Ensure you set OF before setting up the AO channels.

- Examples of command syntax:

`SAO`
Returns AO settings for all Argonaut channels (1 through 8) in a column format. Example:

Chan	Parameter	MinVal	MaxVal	Unit(*see above Caution)
1	VelMag	0	20	ft/s
2	VelX	-4	4	ft/s
3	VelY	-4	4	ft/s
4	Level	0	10	ft
5	AvgAmp	0	128	counts
6	Press	0	5	psi
7	Temp	20	40	°F
8	CellEnd	2	10	ft

`SAO Chan OutParam MinVal MaxVal`
Configures the selected channel (**`Chan`**) of the Argonaut to send **`OutParam`** to the Converter's address (**`Chan`**) with the specified minimum and maximum values. The following example tells Argonaut channel 3 to send the Y-velocity component to the Converter whose address is 3 and to limit the scaling range to ±400 cm/s (or ft/s).

```
SAO 3 VelY –400 400
```

`SAO Chan RESET`
Clears the selected channel. The following example would clear all entries made for channel 3 of the Argonaut.

```
SAO 3 RESET
```

A4.3. Configuring the Serial-to-AO Converter

To output data in an analog-current format, the Argonaut-SL/XR uses an RS232 to 4-20 mA converter (mfg P/N D3261). To output data in an analog-voltage format, the Argonaut-SL/XR uses an RS232-to-Voltage converter (mfg P/N D3262). Both these converters are manufactured by DGH. For details about these converters, see the *DGH D3000/D4000 Series Users Manual*.

Before use, the Converter must be configured to communicate with the Argonaut. The following steps present the basic procedure.

1. Connect the Converter to a serial port on your computer using the male, 9-pin, serial connector (DB9-M) on the analog output cable provided by SonTek (Figure A4.1).
2. Connect the pigtail (exposed wires) on the other end of the cable to the Converter (example shown in Figure A4.2) as follows:
   - Black wire to **`GND`** (ground)
   - Orange wire to **`RECEIVE`**
   - Green wire to **`TRANSMIT`**
3. Connect a power source (10 to 30 VDC) to the Converter as follows (Figure A4.1):
   - Negative wire to **`GND`** (ground)
   - Positive wire to **`+VS`**
4. Connect terminals of the analog sensing/control unit to **`+OUT`** and **`–OUT`** (Figure A4.1).

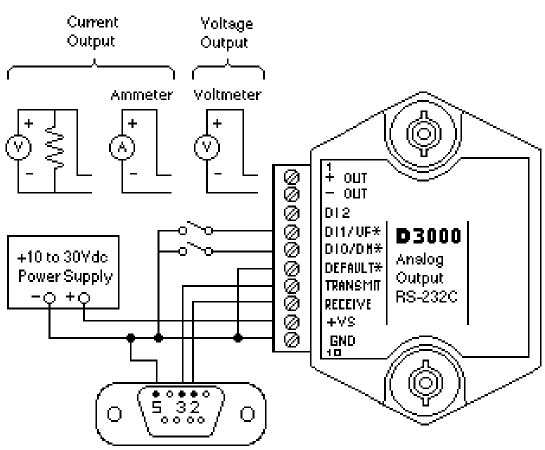


Figure A4.1. Connections to Converter

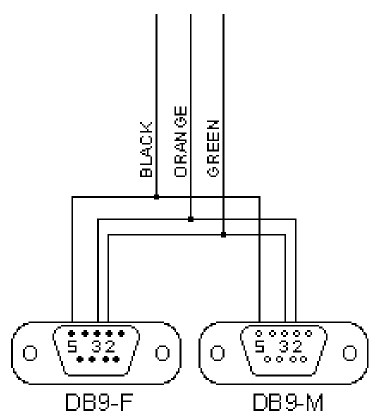


Figure A4.2. Pigtail Wiring Diagram

5. Connect a power source (10 to 30 VDC) to the Converter as follows (Figure A4.1):
6. After connecting the serial cable, power source, and pigtail, apply power to the system. On your PC, run a terminal emulator program such as SonTek's *SonTerm*.
7. In *SonTerm*, select the appropriate COM port and set the baud rate to 9600 (if the Converter was previously configured by SonTek or the user) or 300 (if the Converter is a new unit purchased directly from the manufacturer, DGH).
8. In *SonTerm*, enter the command **`$1RD`**. If the Converter is properly configured, you will receive a response of **`*+00004.00`**. If no response is received, try an alternative baud rate or address (see Step 7). Note: All commands to the Converter must begin with a dollar sign (**`$`**); all responses from the Converter will begin with an asterisk (**`*`**).

To configure the Converter for operation with the Argonaut, use the following command sequence. A description of the Converter's setup word is shown in the table below.

1. Read the existing setup word.

```
$1RS
*31070180
```

2. Write-enable the Converter EEPROM.

```
$1WE
*
```

3. Send a new setup word.

```
$1SU31820180
*
```

4. Read the new setup word to confirm it is correct.

```
$1RS
*31820180
```

5. Write-enable the Converter EEPROM, and then store the changes.

```
$1WE
*
$1RR
*
```

Converter's Setup Word Description

Byte	Purpose	Setting	Description
1	Address	31	Address 1
		32	Address 2
		33	Address 3
		34	Address 4
		35	Address 5
		36	Address 6
		37	Address 7
		38	Address 8
2	COM Setting	82	9600 baud, no parity, with linefeed (default)
		02	9600 baud, no parity, no linefeed (optional)
3	Advanced COM Setting	01	2-byte time delay, continuous disabled, limits disabled, no echo (default)
4	Display Settings/Mode Select	80	6-digit display, manual mode disabled, up/down mode (default)

A4.4. Configuring the Argonaut-SL/XR for use with the AO Converter

To configure the Argonaut SL or XR for operation with the AO Converter, use the following command sequence. We assume you are using SonTerm to “talk” to the Converter.

1. Choose the AO type (`DISABLED`, `CURRENT`, or `VOLTAGE`).

   `AOT CURRENT` (sets AO to use current-scaling)

2. Set desired data output format. Note that this entry will clear all AO channels. Do NOT change this value after you have set the AO channels; otherwise, you will have to re-enter all channel settings using the **`SAO`** command.

   `OF ENGLISH` (tells Argonaut to use English measuring units)

3. Configure all the AO settings for your application.

   `SAO 1 VELMAG –3 3`
   (sets Argonaut’s AO channel 1 to send velocity magnitude to address 1 of the Converter using minimum and maximum values of 3 ft/s)

4. Configure the Argonaut’s regular settings such as CB, CE, AI, SI, etc. (see the *Argonaut Operation Manual*).

5. Save your settings.

   `SaveSetup`

6. Start data collection.

   `Start`

7. Verify that the Argonaut outputs the AO data string, where 2.83 is the current value in mA. This value will vary depending on the flow conditions.

   `$1AO+00002.83`

8. Connect the male, DB-9 RS232 connector on the AO splitter cable (Figure A4.2) to the female, DB-9 RS232 connector on the Argonaut power and communications cable.

9. The Argonaut-AO system is now ready for data collection.

Notes:

a. If recording is enabled, the analog data will be stored on the recorder in addition to being sent to the COM port as an analog output.
b. If **`AOT`** is set to **`DISABLED`**, the data will be sent to the serial port according to the OutFormat setting.
c. If the **`OF`** command is sent to change the output format (English, Metric) after entering the AO commands, this will reset all AO settings. You will then have to re-enter all AO settings using the **`SAO`** command.

Index

SonTek/YSI
6837 Nancy Ridge Drive, Suite A, San Diego, CA 92121 USA
Telephone (858) 546-8327 • Fax (858) 546-8150
E-mail: inquiry@sontek.com • Internet: http://www.sontek.com

A YSI Environmental Company

SonTek/YSI Argonaut Software Manual

ViewArgonaut (Windows) Version 1.41
SonUtils (Windows) Version 1.81
DOS Version 5.90

TABLE OF CONTENTS

Section 1. Software Summary

Argonaut software includes Windows and DOS-based programs for real-time data collection, deployment site evaluation, system diagnostics, binary data conversion, compass calibration, recorder data extraction, and direct communication with the Argonaut.

- The Windows and DOS versions of the software perform the same functions with only minor differences in the user interface.
- The two versions of the software are provided to meet a variety of user applications. Note: Neither version supports systems with the Profiling Mode option.

All software is written for operation on PC-compatible computers.

- Windows software (*ViewArgonaut* and *SonUtils*) is Windows 95/98/2000/NT compatible.
- DOS software is written for DOS version 6.0 and higher.
- DOS software is best run from a dedicated DOS computer (or a Windows computer restarted in DOS mode). While the DOS-based programs may work from a DOS prompt within Windows, be aware that the background processes in Windows may interfere with program operation.

1.1. Windows-based Software

The Windows software consists of two programs, each performing several common Argonaut functions. Note: Many of the Windows and DOS-based programs use similar names; to differentiate, we have added a *W* to the end of the Windows-based programs that have a name similar to the DOS-based program.

- *ViewArgonaut* – see Section 3
  - Real-time data collection
  - Autonomous deployment planning
  - Diagnostic software (*ArgCheckW*)
  - Recorder data extraction (*SonRecW*)
  - Postprocessing and binary data conversion

- *SonUtils* – see Section 4
  - Terminal emulator (*SonTermW*)
  - Compass calibration (*CompCalW*)
  - Recorder data extraction (*SonRecW*)

1.2. DOS-based Software

The DOS software consists of several separate programs, each performing one common Argonaut function.

- *ArgCheck.exe* – diagnostic software
- *Argonaut.exe* – real-time data collection
- *CompCal.exe* – compass calibration
- *SonRec.exe* – recorder data extraction
- *SonTerm.exe* – terminal emulator
- *GARG*.exe* – a suite of programs for binary data conversion (Metric units)
- *EARG*.exe* – a suite of programs for binary data conversion (English units)
- Source – a subdirectory with source code (in C) for binary data conversion software; allows experienced users to easily write their own software to access binary data files

Section 2. Software Installation

All Argonaut software comes on a single CD-ROM disk that contains both Windows and DOS-based software. To install the software on your PC-compatible computer, use the following steps:

1. Insert the Argonaut software CD into your computer's CD-ROM drive.
2. Wait a moment for the SonTek Argonaut Software menu to appear (Figure 1). If the menu does not appear, use either *Windows Explorer* or **Start | Run** to locate and run *Install.exe* from the CD.
3. Use the **Read Me** option to learn more about the programs on the CD, and to review any last-minute information that may not be contained in the printed documentation.
4. <u>Windows-based Software</u>: Use the program setup options (*i.e.*, **ViewArgonaut Setup**, **SonUtils Setup**) to install the individual Windows-based Argonaut programs. Follow the on-screen instructions. Note that you will be asked to enter *Name*, *Company*, and *Serial* information. For the *Serial* field, use the serial number of your instrument.
5. <u>DOS-based Software</u>: Create a directory on your hard disk in which to store the Argonaut's DOS-based software (suggested directory name: **`ArgDOS`**). Use the **Argonaut DOS Programs** option (<u>not</u> Arg-ADV) to manually copy the entire contents of this CD folder into the directory you created on your hard disk. Note that the subdirectory named **`SRC`** can also be copied to your computer. It contains source code for some of the DOS programs in case you wish to create your own data extraction and analysis programs.

Figure 1 – Argonaut Software Setup Menu

6. The software installation is now complete. There is no need to restart the computer.
7. If desired, you can create shortcut icons for any or all of the software on the Windows desktop.

Section 3. ViewArgonaut Windows Software

3.1. Overview

The *ViewArgonaut* program (Figure 2) lets you:

- Run diagnostics – *ArgCheck* (§3.2).
- Retrieve data from the internal recorder – *SonRec* (§3.3).
- Prepare the instrument for an autonomous deployment – *Deployment* (§3.4).
- Prepare the instrument to collect data in real-time – *Realtime* (§3.5).
- Review/replay/manipulate data that was collected previously – *PostProcessing* (§3.6).

To begin using *ViewArgonaut*:

- Connect the Argonaut to the PC and apply system power (not needed for *PostProcessing*).
- Start *ViewArgonaut* (**Start|Programs|SonTek Software|ViewArgonaut**).
- Verify communication parameters at the bottom of the *ViewArgonaut* window (Figure 2).
  - **Connection Type: Cable-Direct** (computer to Argonaut) or **Radio-Indirect** (radio modem to Argonaut)
  - **Port:** The computer COM port used
  - **Baud Rate:** The communication baud rate; the default setting is **9600**
  - **Unit System: Metric** or **English** as the default unit system for display
- Select the module you wish to run (**ArgCheck**, **SonRec**, **Deployment**, **Realtime**, etc).

Figure 2 – ViewArgonaut Main Menu

3.2. ArgCheck System Diagnostics

ArgCheck is a diagnostic program used to verify Argonaut performance and to identify most problems. This Windows-based version performs the same basic functions and purpose as the DOS-based version that is described in Section 7.

- *ArgCheck* is the same diagnostic program used by SonTek technicians. It provides you with a powerful tool for understanding and verifying system performance.
- The output of *ArgCheck* is a plot of signal strength versus range from the instrument. This is used to determine the effective measurement range of the Argonaut and to look for interference from boundaries and underwater structures. As such, you can use *ArgCheck* to survey a deployment site.
- We recommend that you become familiar with *ArgCheck* and use it on a regular basis during data collection. Using *ArgCheck* to test the Argonaut before every experiment can identify problems that might otherwise be undetected, thereby reducing the potential for lost or corrupted data.

To run *ArgCheck*:

- For ideal testing conditions, mount the Argonaut in the location you are planning to conduct your experiment. Alternatively, mount the system in any open body of water for general diagnostics.
- Connect the Argonaut to the PC and apply power to the system.
- Start *ViewArgonaut* (**Start|Programs|SonTek Software|ViewArgonaut**).
- Verify the communication parameters at the bottom of the *ViewArgonaut* menu.
- Click the **ArgCheck** button on the *ViewArgonaut* menu.

Upon execution, the software will do the following.

- Establish communication with the Argonaut and download system operation parameters.
- Start the special *ArgCheck* operating mode.
- Initialize a continually updating display of signal strength versus range from the transducers. The display is updated about once every five seconds.
- See either Section 7 or the *Argonaut Principles of Operation* for information about the signal strength profiles displayed by *ArgCheck*.

ArgCheck includes the ability to record the displayed data to a file.

- Recording data provides a record of system performance.
- SonTek customer support may request a recorded *ArgCheck* file. *ArgCheck* data is a very effective way to evaluate system performance.
- To record data to an ASCII file:
  - Click **File|Export Data**.
  - Select a directory and specify a file name for the data. The software automatically adds the extension **`.chk`** to the file.
  - Click **OK** to start recording. All profiles are written to the file until you stop *ArgCheck*.
- When sending data to SonTek for analysis, record at least 5 to 10 profiles for reference.

See Section 7 for a listing of the tabular output format, for a sample of program output, for information about surveying a deployment site, and for information on system diagnostics.

3.3. SonRec Recorder Data Extraction

SonRec is used to download binary data files from the internal recorder. It works as follows.

- It establishes communication with the Argonaut at the standard communication rate (default 9600).
- It downloads a directory of files on the internal recorder.
- The user specifies which files to download.
- *SonRec* enters a special download mode at a higher baud rate (usually 115200), and downloads the specified files at this rate to a user-specified directory.

To run *SonRec*:

- Connect the Argonaut to the PC and apply system power.
- Start *ViewArgonaut* (**Start|Programs|SonTek Software|ViewArgonaut**).
- Verify the communication parameters at the bottom of the *ViewArgonaut* window (§3.1).
- Click the **SonRec** button.
- Upon execution, *SonRec* will establish communication with the Argonaut and download the recorder's directory (Figure 3).

The *SonRec* window (Figure 3) shows the following.

- A directory of files on the internal recorder
- Buttons to access the main program functions and to specify the download baud rate

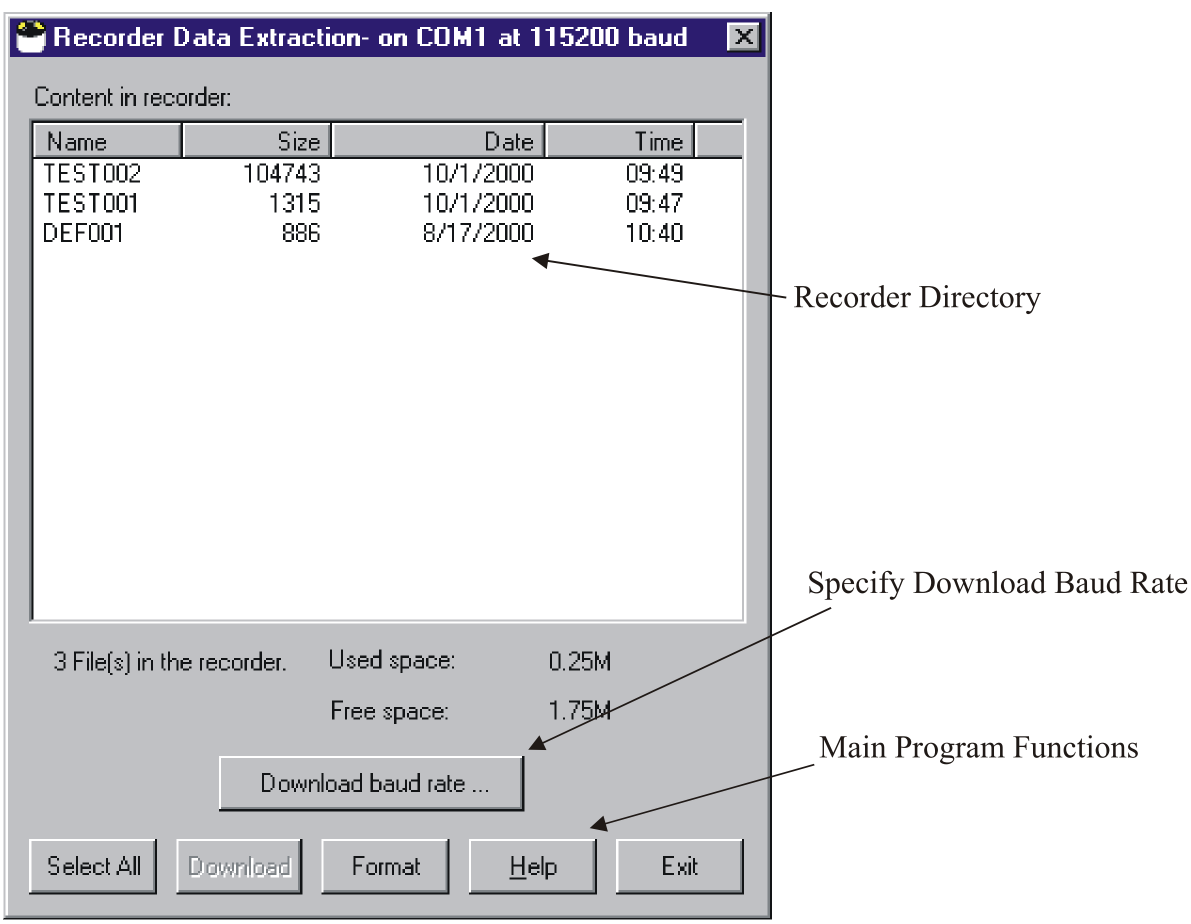


Figure 3 – *SonRec (ViewArgonaut)* Recorder Download Window

Basic Downloading Instructions

- Select one or more files from the display list. Files can be selected several ways.
  - Click a file to select a single file.
  - Hold the Control or Shift key, and click a series of files to select more than one file.
  - Click **Select All** to select all files on the recorder.
- Click **Download**.
- When prompted, select a destination directory for the extracted files. All selected files will be downloaded to this directory.
- Watch the program status as files are downloaded.

Formatting the Internal Recorder

- The **Format** button near the bottom of the window erases the internal recorder.
- Be certain that all files have been downloaded and backed up before erasing the recorder.
- Files cannot be recovered after the recorder has been erased.
- To erase the recorder, click **Format**, and then **OK** to confirm your decision when the warning window appears.

Download Baud Rate

- *SonRec* uses a higher baud rate to download data files (compared to the one used for standard system communication). The default download baud rate is 115200.
- High baud rates can only be used with high-quality, relatively short cables (such as the cables normally supplied with the Argonaut).
- If you have trouble downloading data, try using a slower download baud rate.

Communication parameters

- COM port and baud rate settings are modified in the main *ViewArgonaut* window. Be certain the correct settings are specified before starting *SonRec* (§3.1).

3.4. *Deployment*

Upon execution, the *ViewArgonaut* Deployment software does the following.

- Establishes communication with the Argonaut
- Prompts you to select a deployment type of autonomous or SDI-12
- Downloads the system configuration parameters and opens a window to select parameters

To deploy the Argonaut:

- Before every deployment, run *ArgCheck* as described in §3.2.
- Connect the Argonaut to the PC.
- Connect the Argonaut to the power source that will be used for deployment.
- Start *ViewArgonaut* (**Start|Programs|SonTek Software|ViewArgonaut**).
- Verify the communication parameters at the bottom of the *ViewArgonaut* window (§3.1).
- Click the **Deployment** button.
- When prompted, select **Autonomous Deployment** or **SDI-12 Deployment**.
- Specify necessary operating parameters in the setup windows (§3.4.1 and §3.4.2).
- For autonomous deployments, verify the Argonaut internal clock setting. Reset the clock if necessary.
- Click **Deploy** to send parameters to the system and start data collection.
- Disconnect the communication cable from the PC <u>before</u> turning the computer off.
- Install dummy plugs and other cables as needed. Deploy the system.

3.4.1. Autonomous Deployment

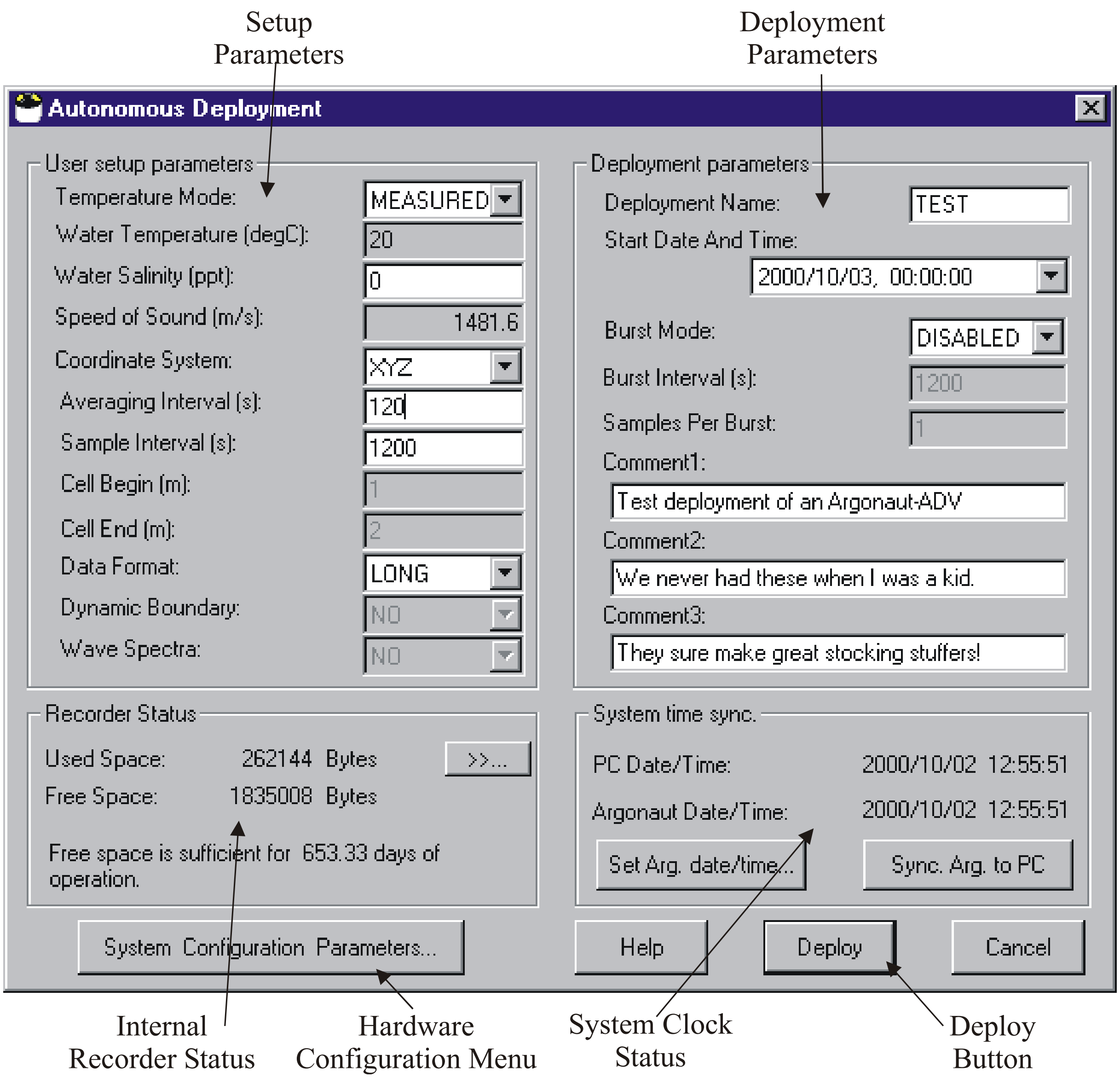


Figure 4 – *ViewArgonaut* Autonomous Deployment Setup Window

Figure 4 shows the autonomous deployment setup window.

- The top-left area lists setup parameters.
- The top-right area shows deployment parameters.
- The bottom-left area shows internal recorder status.
- The bottom-right area shows system and PC clock status.

The basic procedure for an autonomous deployment is below.

- Connect the Argonaut to the PC and the power supply to be used for deployment.
- Start *ViewArgonaut/Deployment* and select **Autonomous Deployment**.
- Verify hardware configuration parameters using **System Configuration Parameters**.
- Specify all setup and deployment parameters for your application.
- Check internal recorder status to ensure sufficient recording space. Download any existing files and format (erase) the recorder if necessary.
- Check system clock; reset if necessary.
- Click **Deploy** to start data collection.
- Disconnect the communication cable from the PC <u>before</u> turning the computer off.
- Install dummy plugs and other cables as needed. Deploy the system.

<u>Hardware Configuration Parameters</u>

- The **System Configuration Parameters** button at the bottom of the window opens a display window showing hardware parameters.
- Click **Close** to exit the configuration window.

<u>Internal Recorder Status</u>

- The bottom left of the screen shows the used and free space on the internal recorder.
- It also displays the total recording time based on the setup and deployment parameters.
- Pressing **>>...** opens a *SonRec* recorder extraction program that can be used to download data files and format (erase) the recorder (§3.3).

<u>System Clock Status</u>

- The bottom right of the window shows the current time from the PC clock and the Argonaut internal clock.
- Two buttons are provided to set the Argonaut clock either to match the PC clock, or to a user-supplied date and time.
- The Argonaut clock should be checked, and reset if necessary, before every autonomous deployment.

Setup and Deployment Parameters

Temperature Mode:

- **Temperature Mode** determines the source of temperature data used for sound speed calculations. Sound speed is used for Doppler velocity calculations (see *Argonaut Principles of Operation*).
- The default setting of **MEASURED** uses the Argonaut temperature sensor, and is recommended for most applications.
- The **USER** setting uses the user-supplied value shown in the menu.

Water Temperature

- This sets the user-supplied default temperature value used for sound speed calculations.
- This value is used, and can be changed, only if **Temperature Mode** is set to **USER**.
- This value is ignored during operation if **Temperature Mode** is set to **MEASURED**.

Water Salinity

- This sets the salinity value used for sound speed calculations, and should be specified as accurately as possible (ideally, to ±1 ppt or better).
- Sound speed is used for Doppler velocity calculations; see the *Argonaut Principles of Operation* for details.

Speed of Sound

- Sound speed is used for Doppler velocity calculations (see *Argonaut Principles of Operation*).
- The displayed sound speed is calculated based on the user-supplied temperature and salinity values shown in the setup window.
- Sound speed used by the Argonaut is calculated based on user-input salinity and data from the Argonaut temperature sensor (if **Temperature Mode** is **MEASURED**) or the user-input temperature (if **Temperature Mode** is **USER**).

Coordinate System

- This specifies the coordinate system used for velocity data: **BEAM**, **XYZ**, and **ENU**.
- **ENU** is normally recommended for systems with the internal compass/tilt sensor.
- **XYZ** is recommended for systems without the internal compass/tilt sensor.
- **BEAM** is for specialized applications only and is not commonly used.
- See the *Argonaut Operations Manual* for a description of velocity data coordinate systems.

Averaging Interval

- This specifies the averaging time for Argonaut data.
- The acceptable range of values is from 1 to 3600 seconds.
- The minimum effective averaging interval is 3 seconds. Settings less than 3 seconds, unless using the real-time software, give data output at 3-second intervals. Settings above 3 seconds give data output at the specified time (or at the sample interval, if higher).
- Systems with external sensors (CTD, YSI) have a minimum averaging interval of 10 seconds.
- See the *Argonaut Operations Manual* for a description Argonaut sampling.

Sample Interval

- This specifies the time from the start of one sample to the start of the next sample.
- The acceptable range of values is from 1 to 43200 seconds.
- If the **Sample Interval** < **Averaging Interval**, then **Averaging Interval** takes precedence.
- See the *Argonaut Operations Manual* for a description Argonaut sampling.

Cell Begin / Cell End

- Specify the location of the start and end of the measurement volume. The standard deviation (accuracy) of the velocity data is inversely proportional to the square root of the measurement volume size (cell end minus cell begin); larger measurement volume size gives lower standard deviation. See the *Argonaut Principles of Operation* for more details. The acceptable range is from 0.5 to 14.8 m.

Data Format

- This is the data format written to the internal recorder and output over the serial port.
- **LONG** includes complete system diagnostic data and is recommended for all applications that do not have data storage limitations.
- **SHORT** uses an abbreviated data format with minimal diagnostic data, and is intended for applications with data storage limitations.
- See the *Argonaut Operation Manual* for information about data storage format.

Dynamic Boundary

- This variable allows the Argonaut XR to automatically adjust the upper end of the measurement volume based upon data from the pressure sensor. A setting of **DISABLE** turns off the dynamic boundary adjustment and uses the fixed cell location parameters entered above. A setting of **INTEGRATED** will use the fixed value of cell begin and will adjust the end of the cell to be as close as possible to the surface. A setting of **LAYERED** will measure a layer whose thickness is defined by (Cell End – Cell Begin), with the upper edge of the layer as close to the surface as possible.

Wave Spectra

- See Section 8 in the *Argonaut Operation Manual*.

Deployment Name

- This specifies a root file name for data files recorded on the internal recorder.
- Up to five letters and/or numbers can be specified.

- A 3-digit termination is added to the specified file name, starting with 001 and incrementing (002, 003, …) each time data collection is stopped and started.
- The file names use the extension **.ARG**. For example, if the file name is **TEST**, the first file will be **TEST001.ARG**, followed by **TEST002,ARG**, etc.

Start Date and Time

- This specifies the starting date and time for the first sample in the deployment.
- If the current date and time is after the specified start date and time, the deployment will start immediately.
- All dates and times are based on the internal Argonaut clock.

Burst Mode

- This enables or disables burst sampling mode.
- Burst sampling is not commonly used; this parameter is typically **DISABLED**.
- See the *Argonaut Operation Manual* for a description of burst sampling.

Burst Interval

- When burst-sampling mode is enabled, this sets the time from the start of one burst to the start of the next burst.
- This parameter can only be modified when burst sampling is enabled.
- See the *Argonaut Operation Manual* for a description of burst sampling.

Samples Per Burst

- When burst-sampling mode is enabled, this sets the number of samples per burst.
- This parameter can only be modified when burst sampling is enabled.
- See the *Argonaut Operation Manual* for a description of burst sampling.

Comment 1/2/3

- Up to three comment lines are provided for you to document the data set.

3.4.2. SDI-12 Deployment

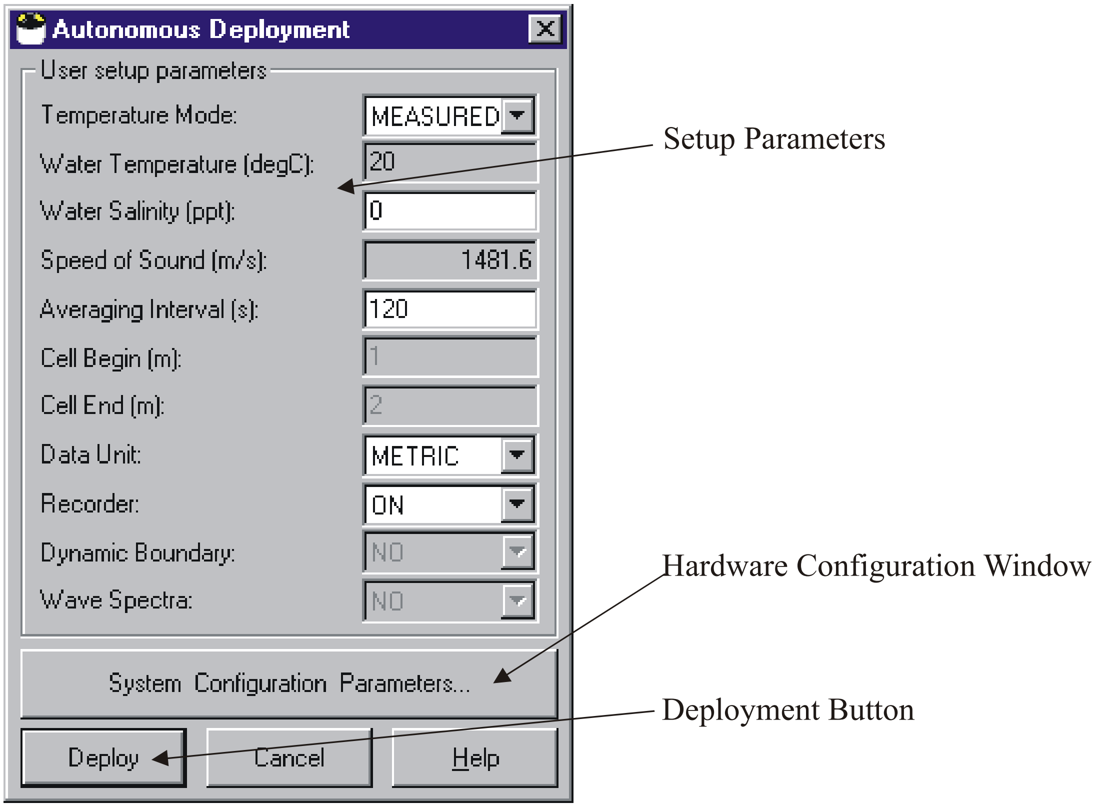


Figure 5 – *ViewArgonaut* SDI-12 Deployment Setup Window

Figure 5 shows the SDI-12 deployment setup window.

- The main area lists setup parameters.
- The bottom has the control buttons.

The basic procedure for an SDI-12 deployment is below.

- Connect the Argonaut to the PC and the power supply to be used for deployment.
- Start *ViewArgonaut/Deployment* and select **SDI-12 Deployment**.
- Verify hardware configuration parameters using **System Configuration Parameters**.
- Specify all setup parameters for your application. Note that the data format parameter is automatically set to **SHORT**.
- Click **Deploy** to start data collection.
- Disconnect the communication cable from the PC before turning the computer off.
- Connect the SDI-12 cable to the data logger.
- Install dummy plugs and other cables as needed. Deploy the system.

Hardware Configuration Parameters

- The **System Configuration Parameters** button at the bottom of the window opens a display window showing hardware parameters.
- Click **Close** to exit the configuration window.

Setup Parameters

Temperature Mode:

- **Temperature Mode** determines the source of temperature data used for sound speed calculations. Sound speed is used for Doppler velocity calculations (see *Argonaut Principles of Operation*).
- The default setting of **MEASURED** uses the Argonaut temperature sensor, and is recommended for most applications.
- The **USER** setting uses the user-supplied value shown in the menu.

Water Temperature

- This sets the user-supplied default temperature value used for sound speed calculations.
- This value is used, and can be changed, only if **Temperature Mode** is set to **USER**.
- This value is ignored during operation if **Temperature Mode** is set to **MEASURED**.

Water Salinity

- This sets the salinity value used for sound speed calculations, and should be specified as accurately as possible (ideally, to ±1 ppt or better).
- Sound speed is used for Doppler velocity calculations; see the *Argonaut Principles of Operation* for details.

Speed of Sound

- Sound speed is used for Doppler velocity calculations (see *Argonaut Principles of Operation*).
- The displayed sound speed is calculated based on the user-supplied temperature and salinity values shown in the setup window.
- Sound speed used by the Argonaut is calculated based on user-input salinity and data from the Argonaut temperature sensor (if **Temperature Mode** is **MEASURED**) or the user-input temperature (if **Temperature Mode** is **USER**).

Coordinate System

- This specifies the coordinate system used for velocity data: **BEAM**, **XYZ**, and **ENU**.
- **ENU** is normally recommended for systems with the internal compass/tilt sensor.
- **XYZ** is recommended for systems without the internal compass/tilt sensor.
- **BEAM** is for specialized applications only and is not commonly used.
- See the *Argonaut Operations Manual* for a description of velocity data coordinate systems.

Averaging Interval

- This specifies the averaging time for Argonaut data.
- The acceptable range of values is from 1 to 3600 seconds.
- The minimum effective averaging interval is 3 seconds. Settings less than 3 seconds, unless using the real-time software, give data output at 3-second intervals. Settings above 3 seconds give data output at the specified time (or at the sample interval, if higher).
- Systems with external sensors (CTD, YSI) have a minimum averaging interval of 10 seconds.
- See the *Argonaut Operations Manual* for a description Argonaut sampling.

Cell Begin / Cell End

- Specify the location of the start and end of the measurement volume. The standard deviation (accuracy) of the velocity data is inversely proportional to the square root of the measurement volume size (cell end minus cell begin); larger measurement volume size gives lower standard deviation. See the *Argonaut Principles of Operation* for more details. The acceptable range is from 0.5 to 14.8 m.

Data Unit

- This specifies if output data will be in Metric or English units.
- See the *Argonaut Operation Manual* for information about output data format.

Recorder

- This specifies if data will also be stored to the internal recorder.
- A setting of **ON** records data to the internal recorder; **OFF** disables internal recording.

Dynamic Boundary

- This variable allows the Argonaut XR to automatically adjust the upper end of the measurement volume based upon data from the pressure sensor. A setting of **DISABLE** turns off the dynamic boundary adjustment and uses the fixed cell location parameters entered above. A setting of **INTEGRATED** will use the fixed value of cell begin and will adjust the end of the cell to be as close as possible to the surface. A setting of **LAYERED** will measure a layer whose thickness is defined by (Cell End – Cell Begin), with the upper edge of the layer as close to the surface as possible.

Wave Spectra

- See Section 8 in the *Argonaut Operation Manual*.

3.5. Realtime

The Argonaut real-time software is used for data collection connected to a PC, and for playback of Argonaut data files. Basic operating instructions for the real-time software are below; additional details are provided in the remainder of this section.

To use the real-time software:

- Before every deployment, run *ArgCheck* as described in §3.2.
- Install the Argonaut as desired for your application.
- Connect the Argonaut to the PC and apply system power.
- Start *ViewArgonaut* (**Start|Programs|SonTek Software|ViewArgonaut**).
- Verify the communication parameters at the bottom of the *ViewArgonaut* window (§3.1).
- Click the **Realtime** button.
- Click the **Arg** icon in the upper-left corner of the screen to establish communication with the system and download operating parameters.
- Select the desired operating parameters and recording file name in the setup window.
- Click **OK** to accept parameters and send them to the system.
- Click the green play button (►) to start the output and display of data; this does <u>not</u> start data recording.
- Click the red record button (●) to start recording data to a file.
- Modify/adjust the data display as desired.

3.5.1. Real-time User Setup Window

After starting, the real-time software shows a blank data collection screen (Figure 7).

- Establish communication with the system by clicking the **Arg** icon in the upper-left corner of the screen or use the **System Communication** menu.
- The software will establish communication (using the communication parameters shown on the *ViewArgonaut* main menu, §3.1) and download the system configuration.
- The software displays the real-time setup window and lets you modify operating parameters as needed.

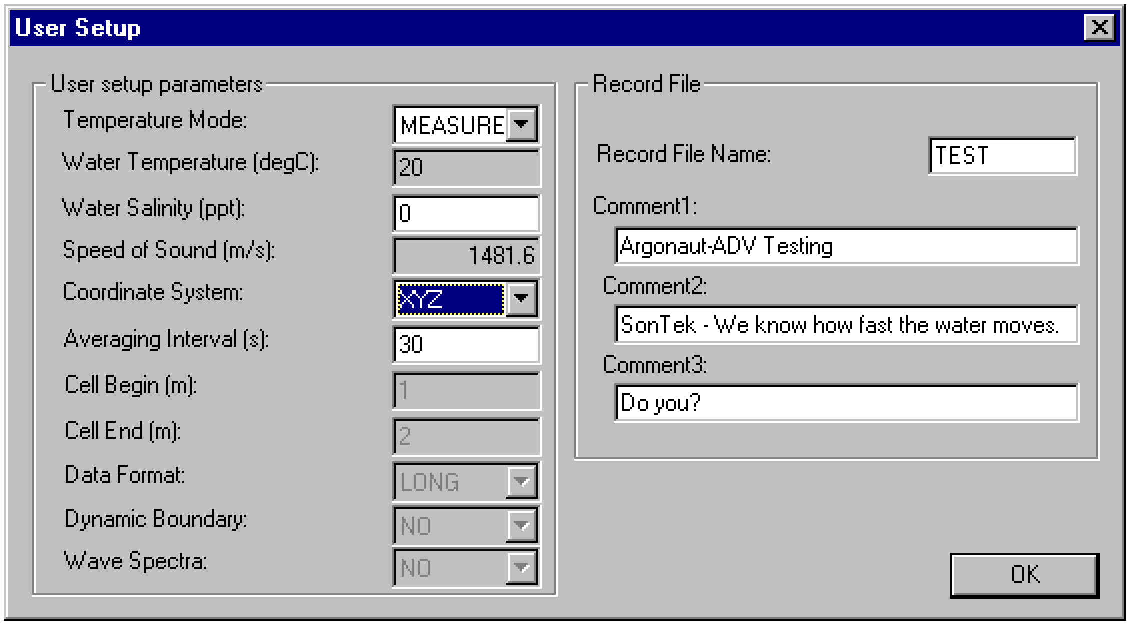


Figure 6 – *ViewArgonaut* Real-Time Data Collection Setup Window

Figure 6 shows the real-time setup window. Each parameter is discussed in detail below.

Temperature Mode:

- **Temperature Mode** determines the source of temperature data used for sound speed calculations. Sound speed is used for Doppler velocity calculations (see *Argonaut Principles of Operation*).
- The default setting of **MEASURED** uses the Argonaut temperature sensor, and is recommended for most applications.
- The **USER** setting uses the user-supplied value shown in the menu.

Water Temperature

- This sets the user-supplied default temperature value used for sound speed calculations.
- This value is used, and can be changed, only if **Temperature Mode** is set to **USER**.
- This value is ignored during operation if **Temperature Mode** is set to **MEASURED**.

Water Salinity

- This sets the salinity value used for sound speed calculations, and should be specified as accurately as possible (ideally, to ±1 ppt or better).
- Sound speed is used for Doppler velocity calculations; see the *Argonaut Principles of Operation* for details.

Speed of Sound

- Sound speed is used for Doppler velocity calculations (see *Argonaut Principles of Operation*).
- The displayed sound speed is calculated based on the user-supplied temperature and salinity values shown in the setup window.
- Sound speed used by the Argonaut is calculated based on user-input salinity and data from the Argonaut temperature sensor (if **Temperature Mode** is **MEASURED**) or the user-input temperature (if **Temperature Mode** is **USER**).

Coordinate System

- This specifies the coordinate system used for velocity data: **BEAM**, **XYZ**, and **ENU**.
- **ENU** is normally recommended for systems with the internal compass/tilt sensor.
- **XYZ** is recommended for systems without the internal compass/tilt sensor.
- **BEAM** is for specialized applications only and is not commonly used.
- See the *Argonaut Operations Manual* for a description of velocity data coordinate systems.

Averaging Interval

- This specifies the averaging time for Argonaut data.
- Parameter range: 1 to 3600 seconds
- Values less than 5 seconds will result in data output at 1-second intervals. It is not possible to output data at intervals greater than 1 second but less than 5 seconds.
- For values less than 5 seconds, the Argonaut does <u>not</u> measure and record range to the boundary with each sample.
- For values greater than 5 seconds, the Argonaut <u>does</u> measure and record boundary range with each sample.
- Systems with external sensors (CTD, YSI) have a minimum averaging interval of 10 seconds.
- See the *Argonaut Operations Manual* for a description Argonaut sampling.

Cell Begin / Cell End

- Specify the location of the start and end of the measurement volume. The standard deviation (accuracy) of the velocity data is inversely proportional to the square root of the measurement volume size (cell end minus cell begin); larger measurement volume size gives lower standard deviation. See the *Argonaut Principles of Operation* for more details. The acceptable range is from 0.5 to 14.8 m.

Data Format

- This parameter is not used with the real-time software.

Dynamic Boundary

- This variable allows the Argonaut XR to automatically adjust the upper end of the measurement volume based upon data from the pressure sensor. A setting of **DISABLE** turns off the dynamic boundary adjustment and uses the fixed cell location parameters entered above. A setting of **INTEGRATED** will use the fixed value of cell begin and will adjust the end of the cell to be as close as possible to the surface. A setting of **LAYERED** will measure a layer whose thickness is defined by (Cell End – Cell Begin), with the upper edge of the layer as close to the surface as possible.

Wave Spectra

- See Section 8 in the *Argonaut Operation Manual*.

Record File Name

- This specifies a root file name for data files recorded by the real-time software.
- Up to five letters and/or numbers can be specified.
- A 3-digit termination is added to the specified file name, starting with 001 and incrementing (002, 003, …) each time recording is stopped and started.
- The file names use the extension **.ARG**. For example, if the file name is **TEST**, the first file will be **TEST001.ARG**, followed by **TEST002,ARG**, etc.
- Files are stored in the directory shown under the **File|Open** option.

Comment 1/2/3

- Up to three comment lines are provided for you to document the data set.

3.5.2. Real-time Display

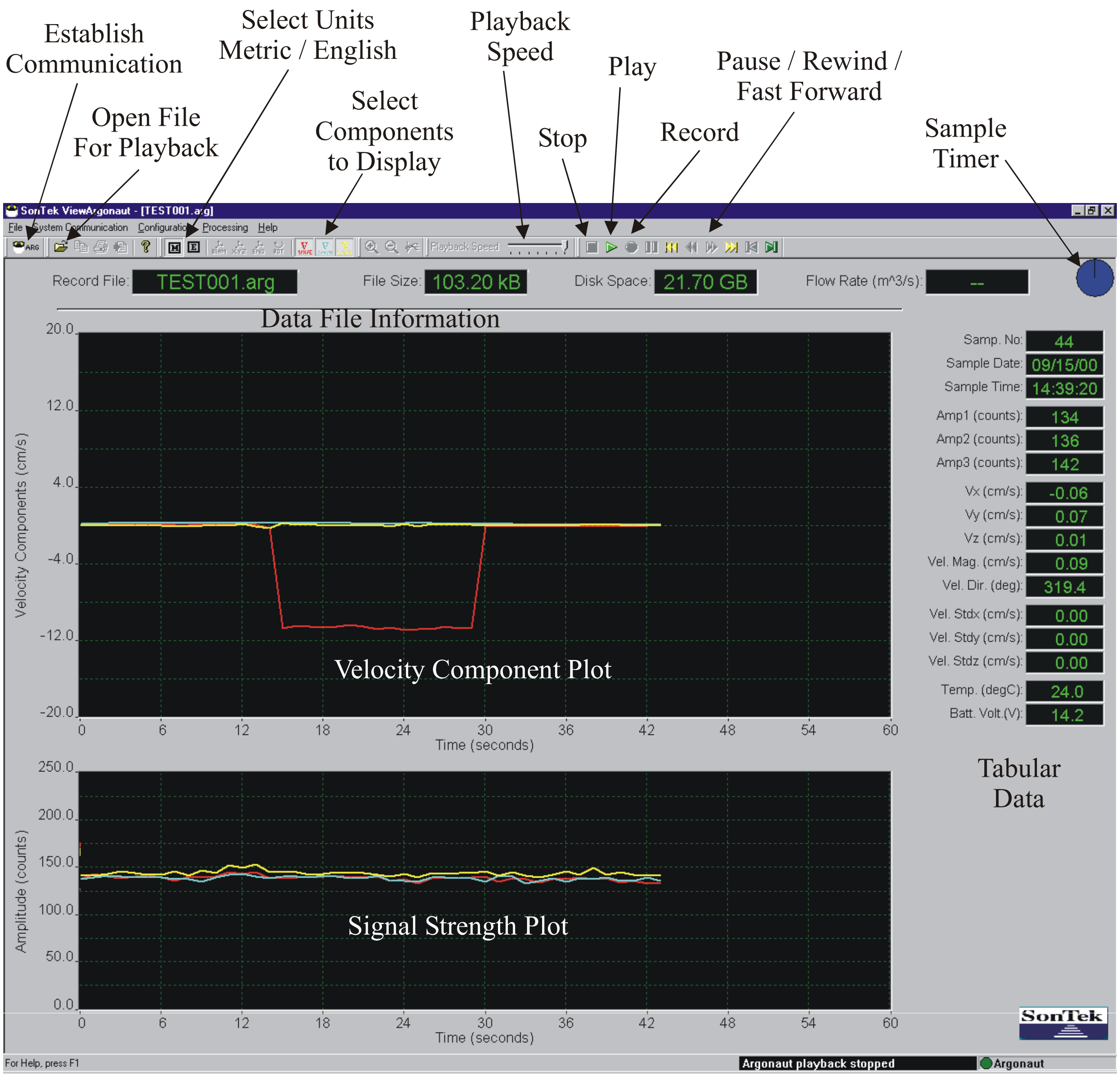


Figure 7 – *ViewArgonaut* Real-Time Data Collection Window

Figure 7 shows the Argonaut real-time data collection window.

- The top plots shows the three components of velocity versus time.
- The bottom plot shows signal strength for the three receivers versus time.
- The right side shows a tabular display of the most recent Argonaut sample.
- The top menu bar has several active buttons that are described below.
- Information pertaining to data recording is shown above the velocity plot.

Active Menu Buttons

The tool bar at the top of the screen is used to modify data collection and/or display. Each active button is labeled in Figure 7, and described from left to right below.

- **Establish Communication** – The **Arg** icon establishes communication with the Argonaut, downloads system parameters, and opens the User Setup window (§3.5.1).
- **Open File** – The folder icon is used to open an existing file for playback (§3.5.4).
- **Select Units** – The **M** and **E** buttons are used to select the units system, Metric or English, used for display and in the setup menu. This setting does not affect how data are collected or recorded (data are always recorded in Metric units).
- **Select Components** – The three **V** buttons are used to turn on/off the display of velocity components on the velocity plot. There is one button for each component, based on the user-specified coordinate system (**BEAM**, **XYZ** or **ENU**). You can display from 0 to 3 velocity components. This does not affect data collection or recording.
- **Playback Speed** – This option is used with the playback of existing data files (§3.5.4).
- **Stop** – The black stop button (■) is used to stop data collection or playback.
- **Play** – The green play button (►) is used to start data output and display (or playback), but does not start data recording.
- **Record** – The red record button (●) is used to start data recording, and must be pressed after the green play button (►). The fields above the velocity plot show if data recording is enabled, and details about the data file, if enabled.
- **Play Options** – The remaining play options (fast forward, rewind, etc) are not used for real-time data collection, but rather only for the playback of existing data files (§3.5.4).
- **Sample Timer** – The blue timer in the right corner is a visual display of the remaining time for the completion of each Argonaut sample.

Velocity Plot

- The velocity plot shows the three components of velocity in the user-specified coordinate system (**BEAM**, **XYZ** or **ENU**) versus time.
- You can turn on/off the plotting of individual velocity components using any of the three **Select Components** buttons on the tool bar.
- To change the velocity plot axis (vertical), double-click on the axis. A small window will appear that allows you to change the vertical plot scale.
- To change the time plot axis (horizontal), double-click on the axis. A small window will appear that allows you to change the horizontal plot scale.
- Changing plot axis does not affect data collection or recording.

Signal Strength Plot

- The signal strength plot shows the three components of signal strength (one for each receiver) versus time.
- The signal strength vertical-axis is fixed.
- The signal strength time-axis (horizontal) is set to match the velocity plot axis.
- Signal strength data is the best source of diagnostic data for system operation and should be monitored closely.
- See the *Argonaut Principles of Operation* for details about using and interpreting signal strength data.

Tabular Display

- The far right portion of the screen shows a tabular display of the most recent Argonaut sample.
- Displayed data includes velocity, signal strength, standard error, temperature, and battery voltage.
- See the *Argonaut Principles of Operation* for details about different types of data.

3.5.3. Data Recording

The real-time software records Argonaut data in a standard binary file format.

- The same format is used whether data are recorded using the real-time data collection software or the internal recorder.
- Within the standard data file format, there are two options for the format of individual samples: **LONG** or **SHORT**. The **SHORT** format is for autonomous deployments to reduce storage requirements for long deployments. Real-time data collection always uses the **LONG** data format.
- When data collection is started, the hardware configuration and user operating parameters are stored in a file header structure.
- With each sample (using the **LONG** format), the system stores a record containing time, velocity, signal strength, standard deviation, heading, pitch, roll, temperature, pressure, and several other parameters.
- All the data contained in these files can be accessed by the data conversion programs discussed in Section Section 6.
- The binary file format is described in detail in the *Argonaut Operation Manual*.

When using the real-time software to collect data, you also have the option of storing data internally on the Argonaut recorder.

- The real-time software does not affect settings that relate to the internal recorder; these are left as they were when the software was started.
- The most common reason to use the internal recorder while collecting real-time data is for a backup in case of computer malfunction or power loss.
- To use the internal recorder as a backup, do the following.
    - Run our *SonTerm* terminal emulator program (see §4.2-Windows; Section 9-DOS).
    - Send a **`BREAK`** to establish communication.
    - Erase the internal recorder if necessary using the **`Format`** command. Be sure to first retrieve and back up any files currently stored on the recorder.
    - Send the command **`Recorder ON`**.
    - Set a deployment name using the **`Deployment <name>`** command.
    - Send the command **`SaveSetup`**.
    - You can now run the real-time software, and the Argonaut will also record data on the internal recorder.

3.5.4. Playback of Recorded Data Files

The *ViewArgonaut* real-time software can also be used to play back existing data files. The screen looks the same as for real-time data collection (Figure 7). Use the following steps to play back a data file. Note: The *PostProcessing* (§3.6) module of *ViewArgonaut* is normally used to play back previously collected data.

- Start *ViewArgonaut* (**Start|Programs|SonTek Software|ViewArgonaut**).
- Click the **Realtime** button.
- Click the **Folder** icon in the upper left corner of the screen (or use **File|Open**). Select the directory and data file to open.
- The software will display a summary of the data file to load. Click **OK** to load the entire file, or specify a range of samples to load and then click **OK**.
- Click the green play button (▶) to start playback.
- Use the other music-style playback buttons as desired below.
- Modify/adjust the data display as desired.

The tool bar at the top of the screen is used for data playback. Each active button is labeled in Figure 7, and described from left to right below.

- **Establish Communication** – This button is not used for playback.
- **Open File** – The folder icon is used to open an existing file for playback (§3.5.4).
- **Select Units** – The **M** and **E** buttons are used to select the units system, Metric or English, used for display.
- **Select Components** – The three **V** buttons are used to turn on/off the display of velocity components on the velocity plot. There is one button for each component, based on the user-specified coordinate system (**BEAM**, **XYZ** or **ENU**). You can display from 0 to 3 velocity components.
- **Playback Speed** – Use this slide bar to adjust playback speed.
- **Stop** – The black stop button (■ or F5) is used to stop playback.
- **Play** – The green play button (▶ or F6) is used to start playback.
- **Pause** – This option (⏸ or F8) pauses the playback of data.
- **Full Rewind** – This option (⏮ or F9) returns to the beginning of the file (removes all data from the display).
- **Rewind** – This option (⏪ or F10) is not currently enabled.
- **Fast Forward** – This option (⏩ or F11) is not currently enabled.
- **Forward to End** – This option (⏭ or F12) loads and displays the entire file.
- **Step Forward** – This option (▶| or Spacebar) steps forward one sample at a time.
- **Sample Timer** – This is not used for playback.

Velocity Plot

- The velocity plot shows the three components of velocity in the user-specified coordinate system (**BEAM**, **XYZ** or **ENU**) versus time.
- You can turn on/off the plotting of individual velocity components using any of the three **Select Components** buttons on the tool bar.
- To change the velocity plot axis (vertical), double-click on the axis. A small window will appear that allows you to change the vertical plot scale.
- To change the time plot axis (horizontal), double-click on the axis. A small window will appear that allows you to change the horizontal plot scale.

Signal Strength Plot

- The signal strength plot shows the three components of signal strength (one for each receiver) versus time.
- The signal strength vertical-axis is fixed.
- The signal strength time-axis (horizontal) is set to match the velocity plot axis.
- Signal strength data is the best source of diagnostic data for system operation and should be monitored closely.
- See the *Argonaut Principles of Operation* for details about using and interpreting signal strength data.

Tabular Display

- The far right portion of the screen shows a tabular display of the current Argonaut sample.
- Displayed data includes velocity, signal strength, standard error, temperature, and battery voltage.
- See the *Argonaut Principles of Operation* for details about different types of data.

3.6. PostProcessing

ViewArgonaut postprocessing is used to display Argonaut data and to export data in ASCII format. To load a file, use the following steps. Note: The *Realtime* (§3.5.4) module of *View-Argonaut* can also be used to play back previously collected data, but the *PostProcessing* module is the preferred method.

- Start *ViewArgonaut* (**Start|Programs|SonTek Software|ViewArgonaut**).
- Click the **PostProcessing** button.
- Click the **File** icon in the upper left corner of the screen (or use **File|Open** or Ctrl+O). Select the directory and Argonaut data file to open.
- The software will show a summary of the specified data file. Click **OK** to load the entire file, or specify a range of samples to load and then click **OK**.
- The software will then plot the data as shown in Figure 8.

Figure 8 shows the Argonaut postprocessing screen with key features labeled.

- The top tool bar contains buttons for major postprocessing functions.
- The top plot shows the velocity data versus time.
- The bottom plot shows signal strength data versus time.
- The data file name is shown at the bottom of the screen.
- The right side of the screen shows a tabular display of one sample of data. The sample number is selected by a marker on the screen.

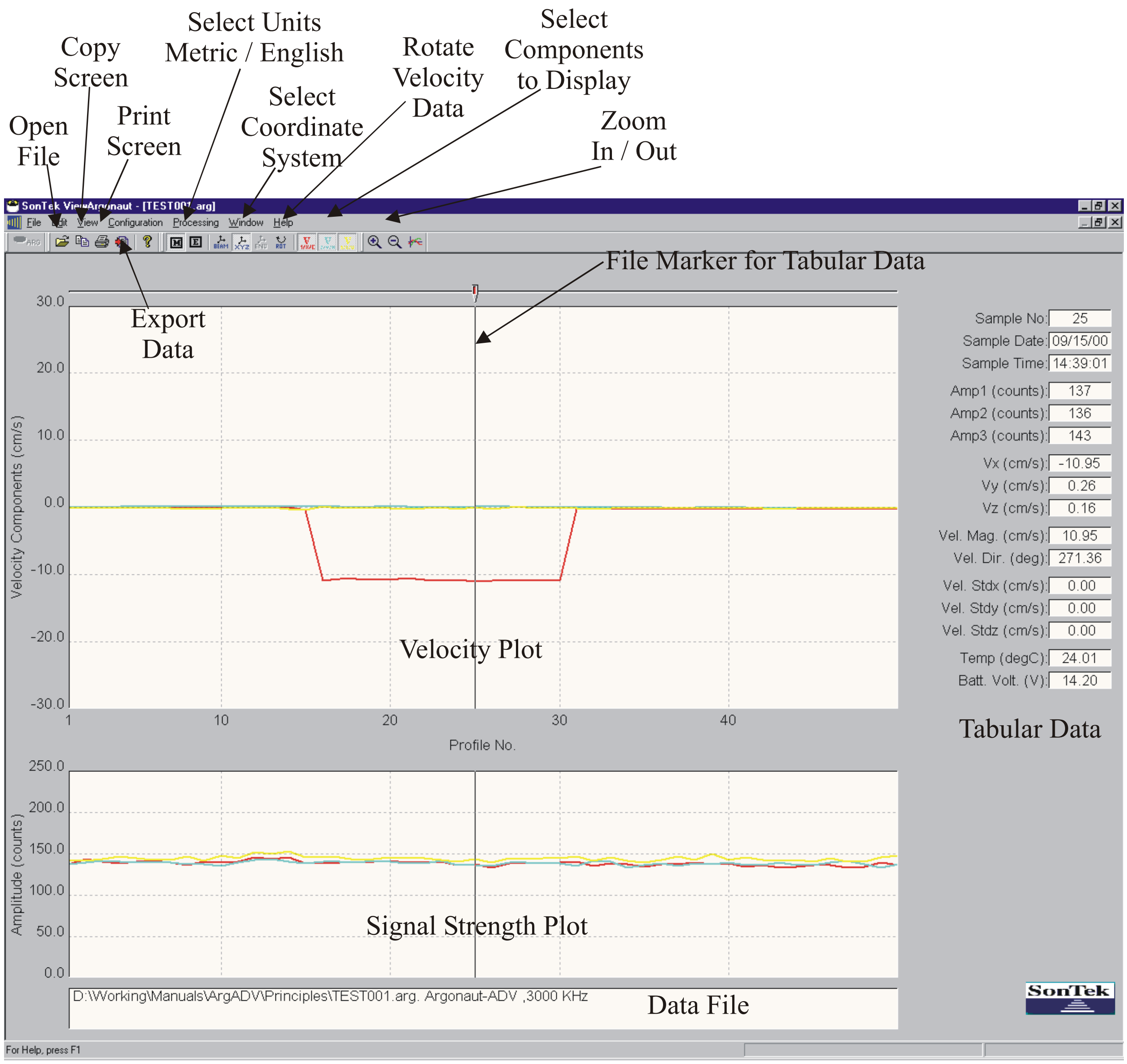


Figure 8 – *ViewArgonaut* PostProcessing Window

Velocity Plot

- The velocity plot shows the three components of velocity in the user-specified coordinate system (**BEAM**, **XYZ** or **ENU**) versus time.
- To change the displayed and exported coordinate system, click the desired coordinate system button on the tool bar.
- You can turn on/off the plotting of individual velocity components using any of the three **Select Components** buttons on the tool bar.
- To change the velocity plot axis (vertical), double-click on the axis. A small window will appear that allows you to change the vertical plot scale.
- To change the horizontal plot axis scale, use the zoom icons on the tool bar.
- To change the horizontal plot units between sample numbers and date/time, use **View|X Display As**.

Signal Strength Plot

- The signal strength plot shows the three components of signal strength (one for each receiver) versus time.
- The signal strength vertical-axis is fixed.
- The signal strength horizontal axis is set to match the velocity plot axis.
- Signal strength data is the best source of diagnostic data for system operation and should be monitored closely.
- See the *Argonaut Principles of Operation* for details about using and interpreting signal strength data.

Tabular Data

- The far right portion of the screen shows a tabular display of the selected sample.
- The sample to display is specified by a file marker shown as a vertical line on the velocity plot. Click and drag this line to change the displayed sample.
- Displayed data includes velocity, signal strength, standard error, temperature, and battery voltage.
- See the *Argonaut Principles of Operation* for details about different types of data.

PostProcessing Functions

The following buttons are shown on the tool bar, from left to right, to access postprocessing functions. Functions can also be also be accessed through the menus at the top of the screen.

- **Open File** – The folder icon is used to open a new file for postprocessing.
- **Copy Screen** – The copy icon copies the current postprocessing window to the clipboard for pasting into other programs.
- **Print Screen** – The print icon prints the current postprocessing window (a print dialog box will open to verify printer settings).
- **Export Data** – The export data function opens a dialog box to export data to an ASCII file (§3.6.2).
- **Select Units** – The **M** and **E** buttons select the display's unit system, Metric or English.
- **Select Coordinate System** – The three coordinate system icons (**BEAM**, **XYZ**, **ENU**) select the velocity data coordinate system displayed and exported. **ENU** can only be selected if the system has an internal compass/tilt sensor and the **LONG** data format was enabled. See the *Argonaut Operation Manual* for information about coordinate system settings.
- **Rotate Velocity Data** – The rotate icon (**ROT**) is used to rotate the velocity data relative to the vertical axis (**Z** for **XYZ** data, **U** for **ENU** data). **BEAM** velocity data cannot be rotated. A dialog box prompts you for the rotation angle and to activate the rotation. The rotation affects both displayed and exported data.
- **Select Components** – The three **V** buttons turn on/off the display of velocity components on the velocity plot. There is one button for each component, based on the user-specified coordinate system (**BEAM**, **XYZ**, **ENU**). You can display from 0 to 3 velocity components.
- **Zoom In**/**Out** – The zoom icons specify what portion of the data set is displayed.

Additional Menu Functions

- To change the horizontal plot axis unit between sample numbers and date/time, use **View|X Display As**.
- To view the hardware configuration parameters for this file, use **Configuration|Hardware**.
- To view the user setup parameters for this file, use **Configuration|User Setup**.

3.6.2. Exporting Data

The export data function in *ViewArgonaut-PostProcessing* is used to convert Argonaut data from the binary format (used by the real-time software and the internal recorder) to an easily accessible ASCII format. The following steps show how to export data.

- Load the desired file into the postprocessing software (§3.6).
- Select the desired coordinate system and perform any desired rotation of velocity data.
- Click **Export Data**.
- In the dialog box, specify the units system and the range of samples to export.
- Click **Export Selected Variable** to export the data specified in the dialog box, or click **Export All Variables** to export all data types.

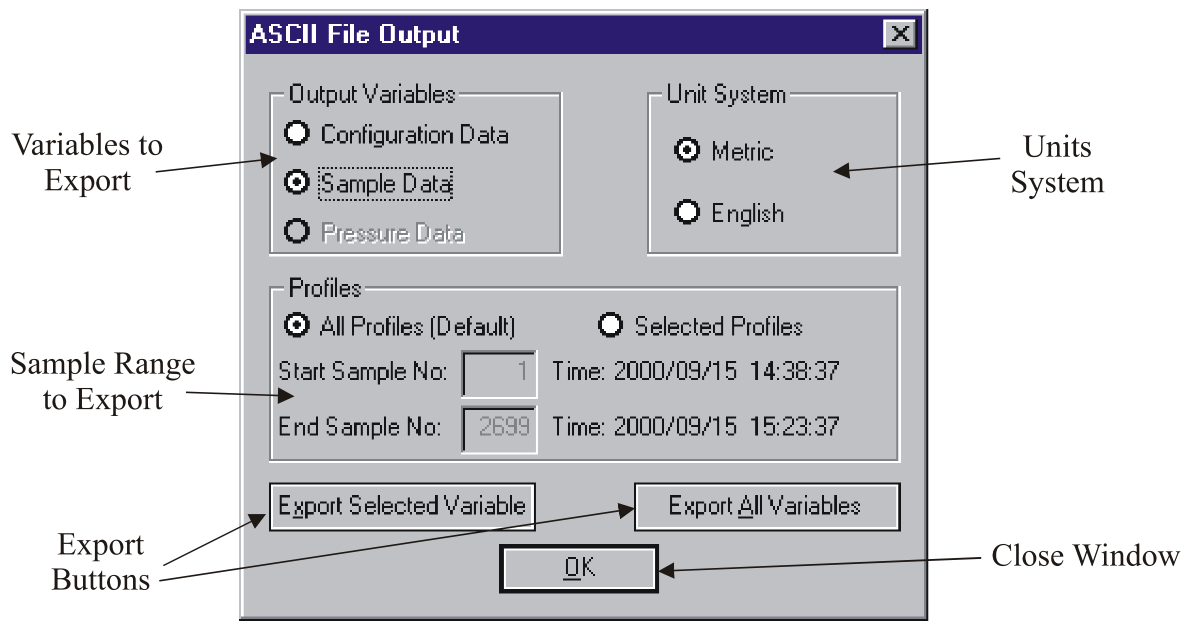


Figure 9 – *ViewArgonaut* Export Data Dialog Box

Figure 9 shows the export data dialog box.

- The type of data to export is specified at the top left.
- Units system is specified at the top right.
- The range of samples to export is specified in the center.
- The export buttons, for one or all types of data, are at the bottom.

Two types of data files can be exported.

- System configuration data (.ctl)
- Sample data (.dat)

System Configuration Data

- System configuration data contains all hardware and user configuration data required to define system-operating parameters.
- Configuration information is stored in a file using the same name as the data file but with a **.CTL** extension.
- Configuration information is presented in a self-explanatory, ASCII-text format using the units system specified in the export data dialog box.

Sample Data

- Sample data represents all data stored with each sample.
- Sample data are stored in a file using the same name as the data file but with a **.DAT** extension.
- Sample data is extracted using the units system specified in the export data dialog box.
- The output ASCII file stores one line for each sample in the file. The file is in ASCII-text format with tab-delimited columns. This format can be easily loaded by most analysis programs (spreadsheets, MatLab, etc.).
- The number and contents of the columns in the output file depends on the setting of the **Data Format** parameter (**LONG** or **SHORT**) during data collection. See Section 3.4 and the *Argonaut Operation Manual* for more details about data format parameters.
- The real-time software always uses the **LONG** data format.
- The contents and units of each column of the **.DAT** file for both formats (**LONG** or **SHORT**) are shown in the table below.
- See the *Argonaut Principles of Operation* for a description of different data types.

Section 4. *SonUtils* Windows Software

4.1. Overview

Figure 10 – *SonUtils* Main Menu

Upon startup, *SonUtils* displays the opening menu shown in Figure 10. From this menu, you can start the following programs.

- *SonTermW* – Terminal emulator (§4.2)
- *CompCalW* – Compass calibration (§4.3)
- *SonRecW* – Recorder data extraction (§4.4)

4.2. *SonTermW* Terminal Emulator

SonTermW is a terminal emulator used for direct communication with the Argonaut.

- All major Argonaut functions can be accessed from a terminal or terminal emulator.
- The Argonaut uses a simple, text-driven command interface described in detail in the *Argonaut Operation Manual*.

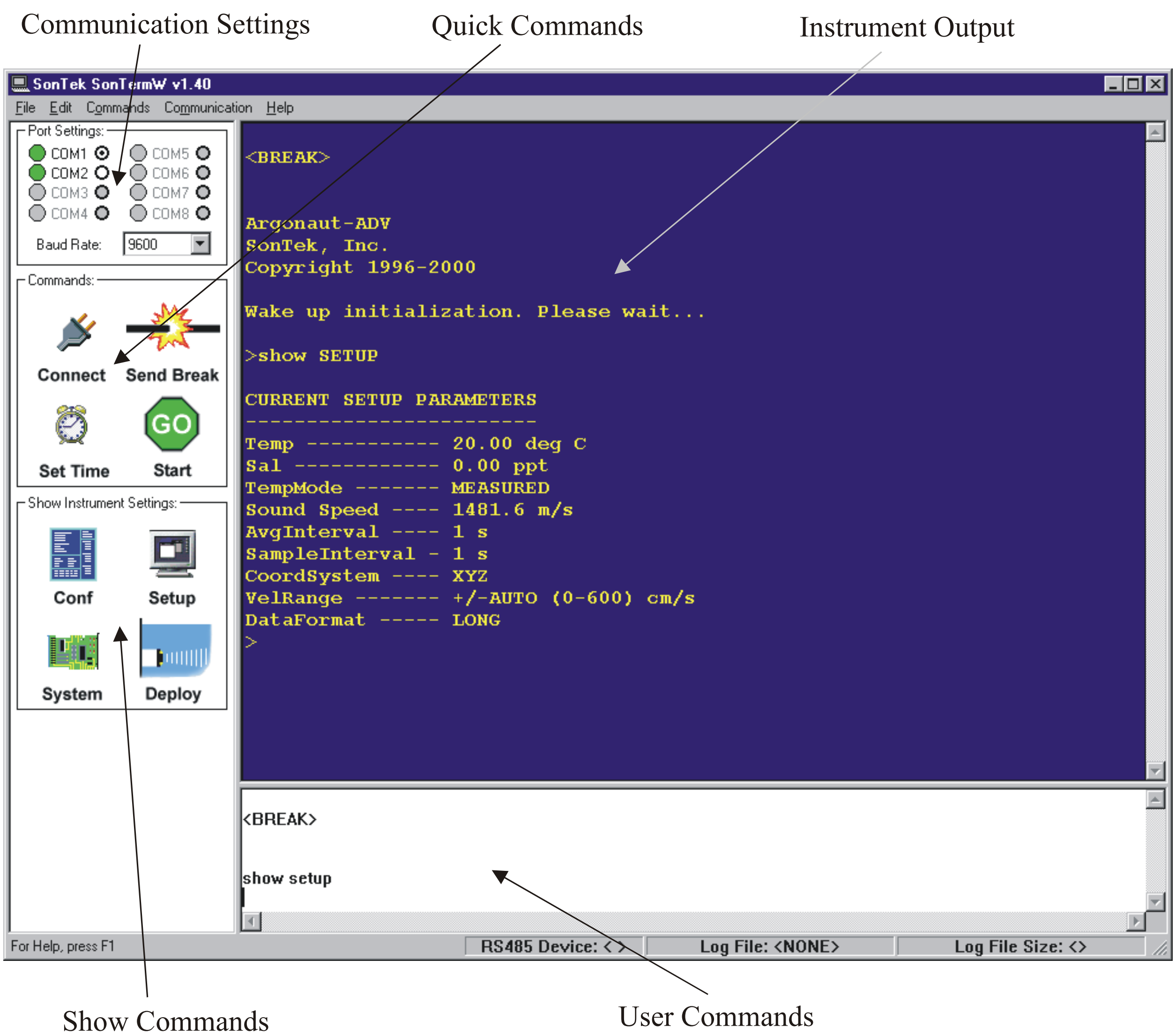


Figure 11 – *SonTermW* (Terminal Emulator) Main Window

The *SonTermW* window is divided into several sections (Figure 11).

- The top-left area is used to set basic communication parameters.
- The middle-left area contains a few of the most used commands that can quickly be sent to the instrument with a click of the button.
- The large blue area at the upper right shows instrument output. The Argonaut echoes all commands as they are received.
- The white area at the lower right is used for manually entering commands.

Communication parameters

- COM port and baud rate settings can be modified in the upper left area of the screen.
- Access to all communication settings (data bits, stop bits, etc.) can be set using **Communication|Settings** (Alt+S).

Quick Command Icons

- **Connect** establishes software control of the PC serial port.
- **BREAK** sends a break (transmit line held high for >300 ms) to wake the system up and place it in command mode.
- **Set Time** opens a window with the PC date and time displayed. The user can press **OK** to set the Argonaut clock to this time, or modify the displayed time and press **OK** to set the Argonaut clock to the desired time.
- **Start** sends the command to begin real-time data collection and place the system in data acquisition mode.
- **Conf** sends the command to show hardware configuration parameters.
- **System** sends the command to show system parameter settings.
- **Setup** sends the command to show setup parameter settings.
- **Deploy** sends the command to shows deployment parameter settings.

Log Files and Command Files

- Use **File|Log File** (Alt+L) to specify a log file in which to record all instrument output. All information shown on the blue screen is written to an ASCII text file.
- Use **File|Command File** (Alt+C) to specify a command file to send to the instrument. The file should be an ASCII text file with one command per line. This option lets you automate system configuration and deployment.

RS485 Multiple System Operation

- Use **File|Select RS485 Device** to specify the RS485 address used for multi-system operation.
- An address setting of 0 indicates RS485 is not being used. An address setting of from 1 through 15 prefaces all commands with that system address.
- See the *Argonaut Operation Manual* for details on RS485 multi-system operation.

4.3. *CompCalW* Compass Calibration

CompCalW is used to calibrate the internal compass/tilt sensor for the effects of ambient magnetic fields.

- *CompCalW* establishes communication and starts a display of compass data.
- *CompCalW* gives calibration instructions and displays compass data.
- At the end of calibration, *CompCalW* reports a calibration score. See the *Argonaut Operation Manual* for information about compass operation and calibration.
- *CompCalW* records all compass calibration data and results to a log file.

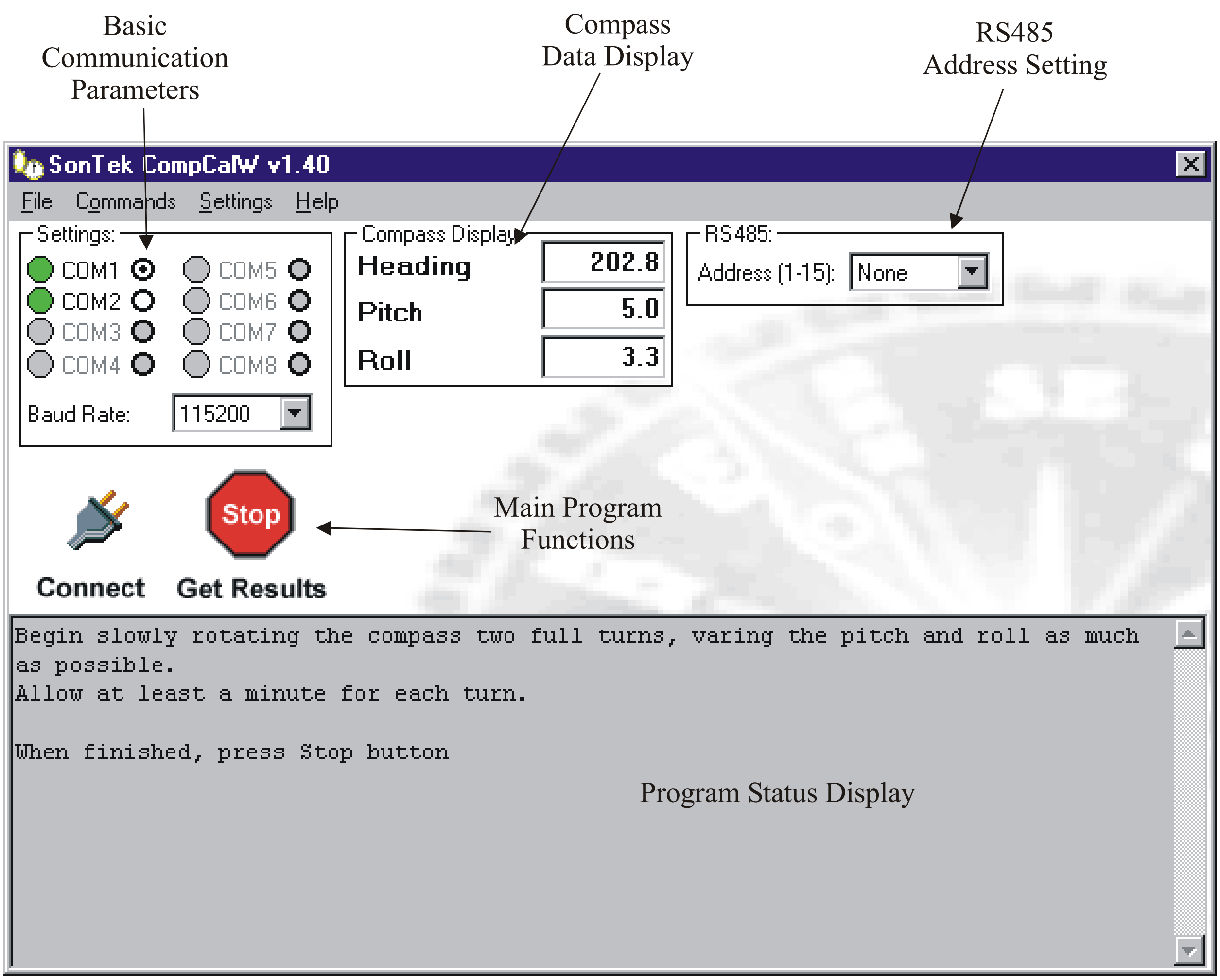


Figure 12 – *CompCalW* (Compass Calibration) Main Window

The *CompCalW* window is divided into several areas (Figure 12).

- The top area contains communication controls and parameters. This area also displays compass and tilt sensor data.
- The gray area at the bottom displays calibration instructions and program status.
- The **Connect** icon establishes communication with the Argonaut and starts the display of compass data.
- The **Go** icon starts the compass calibration procedure; **Stop** ends calibration.

Communication Parameters

- COM port and baud rate settings can be modified in the upper left portion of the screen.
- Access to all communication settings (data bits, stop bits, etc.) can be set using the **Settings|Port Settings** menu.

RS485 Multiple System Operation

- The top right of the screen specifies the RS485 system communication address.
- An address setting of 0 indicates RS485 is not being used. An address setting of from 1 through 15 prefaces all commands with that system address.
- See the *Argonaut Operation Manual* for details on RS485 multi-system operation.

Basic Calibration Instructions

- Start *CompCalW*.
- Click **Connect** to establish communication.
- Click **Go** to start the compass calibration and the display of compass data.
- Follow the instructions for calibration.
  - The Argonaut should be rotated through at least two complete rotations, varying pitch and roll as much as is practical (within the ±50° sensor limit).
  - If possible, calibration should be performed with the Argonaut installed in the mounting frame that will be used during deployment.
- At the end of calibration, press **Stop**. *CompCalW* reports a calibration score. See the *Argonaut Operation Manual* for information about the calibration score.
- *CompCalW* records all compass calibration data and results to a log file. These log files are generally used for quality assurance purposes, but are not essential to program operation (i.e., you can delete them). The log file name is in the format of year/month/day/hour/minute.cmp. For example, 0011061311.cmp stores data that was collected on November 6, 2000 at 13:11 (1:11 pm). The file can be viewed with any ASCII text editor.

4.4. *SonRecW* Recorder Data Extraction

SonRecW is used to download binary data files from the internal recorder.

- *SonRecW* establishes communication and displays a directory of the files currently stored on the Argonaut's internal recorder.
- You select the files you wish to download and where to place them.
- *SonRecW* enters a special download mode at a higher baud rate (usually 115200) and downloads the specified files.

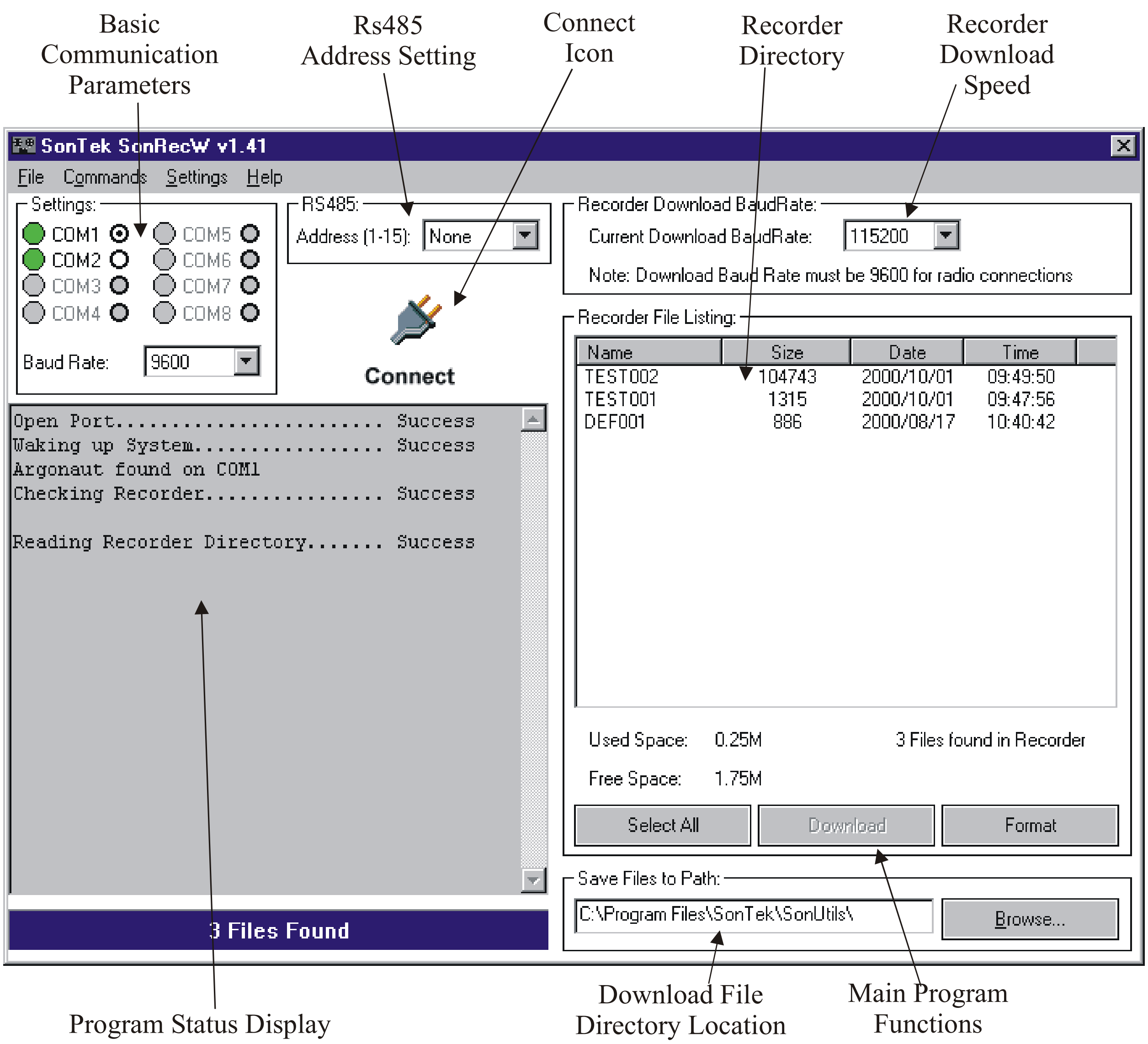


Figure 13 – *SonRecW* (Recorder Data Extraction) Main Window

The *SonRecW* window is divided into several areas (Figure 13).

- The top area shows communication parameters.
- The gray area on the left displays program status.
- The white area on the right displays a directory of the files on the internal recorder.
- The area on the lower right contains control buttons and shows the destination path.

Basic Downloading Instructions

- Click **Connect** to establish communication and display the recorder's directory.
- Specify a destination directory on the bottom right (or use the **Browse** button).
- Select one or more files from the display list. Files can be selected several ways.
    - Click a file to select a single file.
    - Hold the Control or Shift key and click a series of files to select more than one file.
    - Click **Select All** to select all files on the recorder.
- Click **Download** to copy all selected files to the specified directory.
- Watch the program status area on the left as files are downloaded.

Formatting the Internal Recorder

- The **Format** button on the bottom right erases the internal recorder.
- Be certain that all files have been downloaded and backed up before erasing the recorder.
- Files cannot be recovered after the recorder has been erased.
- To erase the recorder, click **Format**, and then **OK** to confirm your decision when the warning window appears.

Download Baud Rate

- *SonRecW* uses a higher baud rate to download data files (compared to the one used for standard system communication). The default download baud rate is 115200.
- High baud rates can only be used with high-quality, relatively short cables (such as the cables normally supplied with the Argonaut).
- If you have trouble downloading data, try using a slower download baud rate.

Communication parameters

- COM port and baud rate settings can be modified in the upper left area of the screen.
- Access to all communication settings (data bits, stop bits, etc.) can be set using the **Settings|Port Settings** menu.

RS485 Multiple System Operation

- The top center area of the screen specifies the RS485 system communication address.
- An address setting of 0 indicates RS485 is not being used. An address setting of from 1 through 15 prefaces all commands with that system address.
- See the *Argonaut Operation Manual* for details on RS485 multi-system operation.

Section 5. Real-Time Data Collection with ARGONAUT (DOS) Program

The DOS-based **ARGONAUT** program is used to collect data from an Argonaut in real time, while the system is connected to a PC-compatible computer. **ARGONAUT** must be run from DOS with a minimum 33-MHz 386 processor, 640-KB RAM, VGA graphics, and a hard disk. The program provides a menu driven format to select Argonaut data collection parameters, a real-time display of the velocity data, and writes the Argonaut data to binary files on the computer hard disk.

The **ARGONAUT** program has two display screens: setup and data acquisition. The setup screen is used to select Argonaut operating parameters. The data acquisition screen provides a graphical display of Argonaut data, as well as tabular information relating to data collection and recording. The following paragraphs provide an overview of program operation, show command line options that can be used to modify program operation, describe the setup and data acquisition screens, discuss the contents of Argonaut binary data files, and provide information on the configuration and log files used in conjunction with **ARGONAUT**.

5.1. Program Overview

When run with no command line options, **ARGONAUT** first tries to communicate with the Argonaut on COM1 at 9600 baud. If communication is established, it downloads the current hardware and user parameters and enters the setup screen.

If communication cannot be established, **ARGONAUT** loads the hardware configuration information specified in the file **ARGCONF.SEN**. This hardware configuration file is provided with the software for each system and should be located in the same directory from which the software is run. The hardware configuration file lets you enter the setup screen without being connected to the Argonaut (but does not allow data collection to be started).

In the setup screen, you can modify operating parameters, view hardware configuration and performance estimates, specify a recording file name, and start data collection. When data collection is started, the program sends all user settings to the Argonaut, enters the data acquisition screen, and begins collecting data. Within the data acquisition screen, you can modify the graphical display without affecting data collection or recording.

IMPORTANT: At the start of data collection, the Argonaut internal clock is set to match the computer clock. This time reference is used for all recorded data.

5.2. Command Line Options

Several command line options can be used to alter the operation of **ARGONAUT** . Options designated by a single letter (c, f, g, w) change the operation of the data acquisition program; several multiple character options change the serial communication parameters used to talk to the Argonaut.

The table below gives the single character command line options used to modify the operation of **ARGONAUT** .

ARGONAUT Command Line Options

Command	Function
ARGONAUT –c	Command file. This causes the program to send all commands in the user-generated ASCII text file **USERCONF.CMD** to the Argonaut before entering the setup screen. Thus, the parameters shown in the setup menu will reflect the settings given by commands in **USERCONF.CMD**.
ARGONAUT –f	Automatic file recording. This option causes the program to automatically select a file name for recording to the computer hard disk. See below for details on the file naming convention.
ARGONAUT –g	Automatically start data collection. This causes the program to skip the setup screen and immediately begin data collection. The Argonaut will use the same data collection parameters previously used (stored in internal memory in the Argonaut). This option includes automatic file recording. This command can be put at the end of the **AUTOEXEC.BAT** file and collection will resume after a power failure.
ARGONAUT –w	Black and white display. This option is useful on portable computers being used outdoors.

<u>Automatic file recording</u>

When using the automatic file-recording feature (**-f** or **-g**), you must edit or create the file **ARGFILE.DEF** to specify details relating to data file recording. This is a one-line ASCII text file, an example of which is shown below.

```
C:\ARGONAUT\AA  HOURLY
```

The first word specifies the path (**C:\ARGONAUT**) for the data file and the first two characters (**AA**) in the file name. The remainder of the file name is generated using the date and time from the computer clock (see Appendix 1). The second word on this line specifies the interval at which new data files are created. This is either done at the start of each hour (**HOURLY**) or when the file reaches a particular size (**SIZE** <Kbytes>). For example, **C:\ARGONAUT\AA SIZE 140** will create a new file each time the data file reaches 140 KB.

<u>Combinations of command line options</u>

Many of the command line options shown above can be used in combination to increase the flexibility of the data collection software. For example, the command "**ARGONAUT –cg**" combines the command file and auto start options. When this command is used, the program will send the commands specified in the ASCII file **USERCONF.CMD** to the Argonaut. It will then immediately begin data collection with a recording file named based upon date and time. Placing one of these commands at the end of the **AUTOEXEC.BAT** file can automatically re-start data collection in the event of a power failure.

When combining multiple command line options, all single character options should be listed following the same hyphen; the order in which options are listed does not matter.

<u>Communication settings</u>

Using the default settings, **ARGONAUT** will communicate with the Argonaut on COM1 at 9600 baud. The following options can be used to modify the communication port settings.

```
COM1, COM2
BR1200, BR2400, BR4800, BR9600, BR19200, BR38400, BR57600, BR115200
```

For example, the following command will run **ARGONAUT** with automatic file recording using serial port COM2 at 4800 baud.

```
ARGONAUT -f -COM2 -BR4800
```

The communication settings can be used individually or in combination with any of the other command line options. Each communication option should be listed separately on the command line as shown above; the order in which command line options appear does not matter.

5.3. Setup Mode

Unless run with the **-g** command line option (automatic start), **ARGONAUT** enters the setup screen after loading hardware and user configuration parameters. Figure 14 shows the setup screen (this example is using an Argonaut SL).

The setup screen is divided into three areas. The top right corner shows the computer date and time. The center right portion of the screen presents Argonaut hardware configuration information and a performance estimate based upon the current operating parameters. The left side of the screen has a number of active windows where you can select operating parameters for the Argonaut.

Computer date/time

The computer date and time are shown in the upper right hand corner of the screen. It is important to note that this is the date and time used for data collection by **ARGONAUT**. The Argonaut internal clock is set to match the computer clock.

Hardware configuration and performance estimate

Hardware configuration parameters are normally downloaded from the Argonaut. If the program is unable to establish communication with the Argonaut, it will load the hardware configuration specified by the file **ARGCONF.SEN** (§5.1). System type, serial number, and system frequency are values that are factory set for each Argonaut. Sensor orientation (for up/down/side looking operation) is set at the factory but may be changed by the user for certain applications (see the *Argonaut Operation Manual*).

Also on the right side of the screen is an estimate of the precision of velocity data based on the currently entered operating parameters. This value can be used as a predictor of the accuracy of velocity data collected using the specified parameters.

User setup parameters

The left portion of the setup screen displays a number of parameters that can be set for each deployment. To change these parameters, move through the items using the up/down arrow keys (or page up/page down). Information about the highlighted parameter is displayed at the bottom of the screen. The current item (highlighted) is changed or executed by pressing the **Enter** key. After pressing **Enter** on a highlighted item, you are prompted to enter a new value for the parameter, or to choose from a set of acceptable values. If a parameter is accidentally selected, you may recover by pressing the **Esc** key, leaving the parameter unchanged. A description of each item in the user setup menu is given below.

Water temperature (°C): (Enter value)
Temperature is required for calculating the speed of sound, which is used to convert Doppler shift to water velocity. The entered temperature may or may not be used for sound speed calculations depending upon the temperature mode setting (see below). The acceptable range of values if from -5 to 50°C.

Water salinity (ppt): (Enter value)
Salinity is required for calculating the speed of sound, which is used to convert Doppler shift to water velocity. The acceptable range of values if from 0 to 60 parts per thousand (ppt).

Speed of sound (m/s): (Derived value)
The speed of sound in water is given in the menu for information purposes only, and cannot be directly changed by the user. The displayed value is computed from the user-supplied values of temperature and salinity. If temperature mode is set to **MEASURED**, the sound speed used during data collection will be based upon the value from the Argonaut temperature sensor. See the *Argonaut Principles of Operation* for information on the effect of sound speed on Argonaut velocity data.

Temperature mode: (Multiple-choice)
Temperature mode refers to the source of temperature data used for sound speed calculations. **USER** indicates that the value input in the setup menu should be used; **MEASURED** indicates that the value from the Argonaut temperature sensor should be used. The temperature sensor used by the Argonaut is considered sufficiently reliable and accurate (± 0.1°C) for sound speed calculations, thus **MEASURED** is the common choice. The **USER** setting is occasionally used to

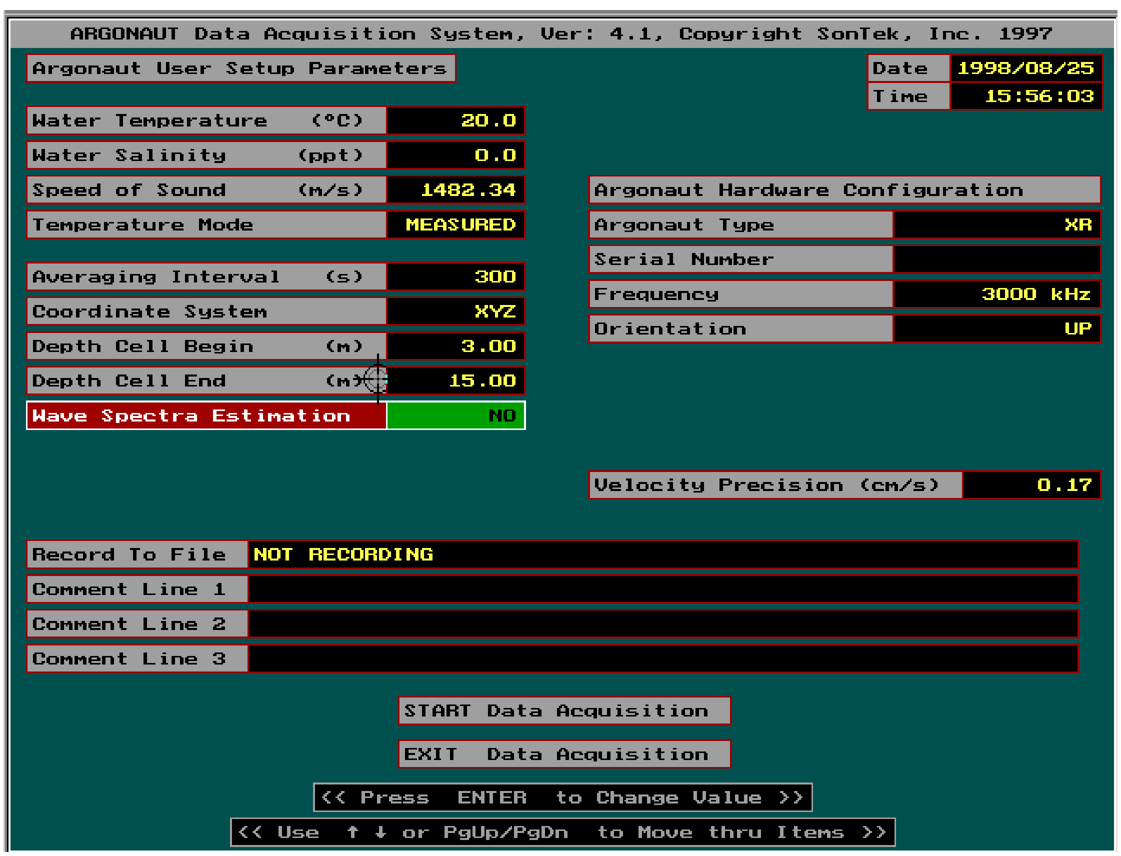


Figure 14 – ARGONAUT Setup Screen

simplify post-processing corrections using data from an external temperature / salinity sensor. Temperature is recorded with each sample, so post-processing corrections can be made using data from either temperature mode. Post-processing corrections for sound speed errors are rarely required; see the *Argonaut Principles of Operation* for details.

Averaging interval (s): (Enter value)
The Argonaut will accumulate samples internally for this period of time and then display and store the mean sample. The standard deviation (accuracy) of the velocity data is inversely proportional to the square root of the averaging interval (longer averaging times give lower standard deviations). See the *Argonaut Principles of Operation* for more details. The acceptable range of input values if from 10 to 3600 seconds.

The following two variables are present for the Argonaut SL and XR only, and are not available with the Argonaut MD.

Cell begin (m): (Enter value)
Specify the location of the start of the measurement volume. The standard deviation (accuracy) of the velocity data is inversely proportional to the square root of the measurement volume size (cell end minus cell begin); larger measurement volume size gives lower standard deviation. See the *Argonaut Principles of Operation* for more details. The acceptable range is from 0.5 to 14.8 m.

Cell end (m): (Enter value)
Specify the location of the end of the measurement volume. The standard deviation (accuracy) of the velocity data is inversely proportional to the square root of the measurement volume size (cell end minus cell begin); larger measurement volume size gives lower standard deviation. See the *Argonaut Principles of Operation* for more details. The acceptable range is from 1.0 to 15.0 m.

The following variable is present for the Argonaut XR only, and is not available with the Argonaut MD or SL (the menu item is not shown in Figure 14).

Dynamic boundary adjustment: (Multiple-choice)
This variable allows the Argonaut XR to automatically adjust the upper end of the measurement volume based upon data from the pressure sensor. A setting of **DISABLE** turns off the dynamic boundary adjustment and uses the fixed cell location parameters entered above. A setting of **INTEGRATED** will use the fixed value of cell begin and will adjust the end of the cell to be as close as possible to the surface. A setting of **LAYERED** will measure a layer whose thickness is defined by (Cell End – Cell Begin), with the upper edge of the layer as close to the surface as possible.

Coordinate system: (Multiple-choice)
This determines the coordinate system in which velocity data are displayed and stored. **BEAM** gives velocity data as along-beam velocities (not commonly used). **XYZ** gives velocity data in a Cartesian coordinate system relative to Argonaut orientation. **ENU** (for East-North-Up) reports data in an instrument-independent Earth coordinate system; this requires that the Argonaut have the optional compass/tilt sensor installed. The Argonaut MD and XR will typically use the ENU coordinate system; the Argonaut SL will typically use the XYZ coordinate system. Refer to the *Argonaut Operation Manual* for more details on coordinate systems.

Record to file: (Enter filename)
This item is used to assign a file for recording Argonaut data. Several checks have been incorporated to insure that a valid filename is given, the file can be created, and that an existing file is not accidentally overwritten. Data should only be written to the hard disk, not a floppy disk drive, as the slow access time and limited storage of a floppy disk can cause programs.

File comment 1/2/3: (Enter text)
These items let you enter up to three 60-character lines of text for documenting the data set.

START data acquisition: (Enter)
Once you are satisfied with the setup, data acquisition can be started by pressing **Enter** on this item. The program will initialize the Argonaut and enter the data acquisition mode.

EXIT data acquisition: (Enter)
Pressing **Enter** causes the program to terminate and return to DOS.

5.4. Data Acquisition Mode

After selecting **Start Data Acquisition** in the setup screen, the program displays the command sequence used to initialize the Argonaut, switches to the real-time display, and tells the Argonaut to begin collecting data. Figure 15 shows the real-time display screen.

The top of the screen displays information on the status of data acquisition. The center and upper right portion of the screen shows a tabular display of data from the last sample. The main portion of the screen provides a graphical time series of velocity data. The bottom shows which keys are active during data acquisition and the function of each.

Status information

The status portion of the screen is updated with each sample; each block is described below.

Recording to file
This displays the path and name of the Argonaut data file. If recording is disabled, the words **NOT RECORDING** are displayed.

File size (kb) / Disk space (kb) / Recording time left (h)
These fields will display information only if recording is enabled. **File Size** gives the current size of the data file in Kbytes. **Disk Space** gives the amount of space left on the disk on which the data file resides (also in Kbytes). **Recording Time Left** tells you how many hours of data can be collected at the present rate before the disk becomes full.

Start time
This time is obtained from the computer clock (note that the Argonaut clock is set to match the PC clock at the start of data collection) and represents the start of the first averaging interval.

Sample time
This represents the time of the sample currently displayed on the screen (start of the averaging interval).

Sample number
This is the number of the last velocity sample collected and currently displayed.

Tabular Data

The tabular data display is updated after every sample, and shows velocity and diagnostic data from the last Argonaut sample.

V1 / V2 / V3 or *Vx / Vy / Vz* or *VEast / VNorth / VUp*

These are the last values of the three velocity components in cm/s using the coordinate system specified in the setup mode (**BEAM**, **XYZ**, or **ENU**).

Sigma V1 / V2 / V3 or *Sigma Vx / Vy / Vz* or *Sigma VE / VN / VU*

These are the last values of standard deviations of the three velocity components in cm/s using the coordinate system specified in the setup mode (**BEAM**, **XYZ**, or **ENU**).

AMP1 / AMP2 / AMP3

These are the last values of signal amplitude measured at each of the three transducers, in counts. Counts are an internal logarithmic unit; one count equals 0.43 dB.

Heading / pitch / roll

These fields present data from the optional compass/tilt sensor (all fields will be blank if the compass/tilt sensor is not installed).

Temperature (°C)

This field displays the most recent data from the Argonaut temperature sensor.

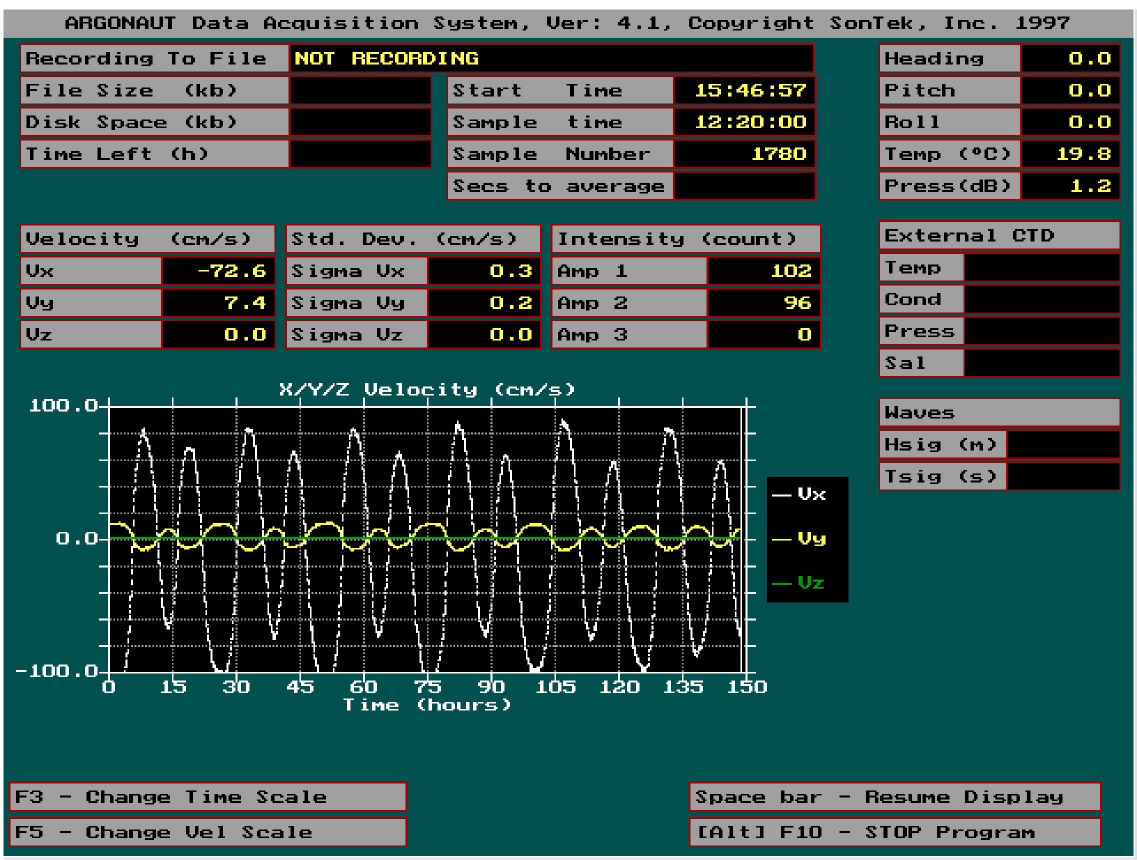


Figure 15 – ARGONAUT Real Time Display

Pressure (decibar)
This field displays the most recent data from the optional Argonaut pressure sensor, in decibars (will be blank if the pressure sensor is not installed).

External CTD: Temp, Cond, Press, Sal
These fields display the most recent data from the optional integrated CTD sensor. Temperature is displayed in °C, conductivity is displayed in Siemens per meter, pressure is displayed in decibars, and salinity is displayed in ppt. All fields are blank if the sensor is not installed.

Waves: Hsig, Tsig
These fields display the most recent significant wave height (Hsig in cm) and wave peak period (Tsig in s). All fields are blank if the sensor is not installed.

Graphical display

The graphical display shows a time series plot of the three velocity components. Components are plotted in white (V1 / Vx / Veast), yellow (V2, Vy, Vnorth), and green (V3, Vz, Vup). The horizontal and vertical scales of the plot can be changed using the active keys described below.

Active keys

Three active keys may be used during data collection. The first two keys (**F3** and **F5**) affect only the graphical display and do not alter or interrupt data collection. The third key (**Alt+F10**) stops data collection. Pressing the **Esc** key removes the pop up window if any key is pressed unintentionally.

F3 - Change time scale: (Multiple-choice)
Pressing the F3 key lets you select the time scale of the velocity sample plot. Time scale options are: 10, 30, 100, 300, 1000, 3000, and 10000 seconds.

F5 - Change Vel Scale: (Multiple-choice)
Pressing the F5 key lets you select the full scale of the time series plot. Velocity scale options are: ±10 cm/s, ±20 cm/s, ±50 cm/s, ±100 cm/s, ±200 cm/s, ±300 cm/s, and ±500 cm/s. Note that this setting does not affect recorded data.

[ALT] F10 - Stop Program: (Yes/No)
To stop data acquisition, you must press the **Alt** and **F10** keys simultaneously. After this is done, you are presented with a prompt (a Yes/No multiple-choice window) to confirm the intention to stop the program. Data collection/recording proceeds normally until the confirmation is given. Upon selecting **Yes**, the program returns to the setup screen. If the program was run with the automatic start option (**ARGONAUT -g**), confirmation after **Alt+F10** returns to the DOS prompt.

5.5. Data Recording

Argonaut data are recorded in a standard binary file format; the same format is used whether data are recorded using the real-time data collection software or on the internal recorder. Within the standard data file format, there are two options for the format of individual samples: **LONG** or **SHORT** data format. The choice of data format is set using the **DataFormat** command from the direct command interface (see the *Argonaut Operation Manual*). The **SHORT** format is provided for autonomous deployments to conserve internal data storage for long deployments. The real-time data collection always uses the **LONG** data format.

When data collection is started, the hardware configuration and user operating parameters are stored in a file header structure. With each sample (using the **LONG** format), the system stores a record containing time, velocity, signal strength, standard deviation, heading, pitch, roll, temperature, pressure, and several other parameters. All of the data contained in these files can be accessed by the data conversion programs discussed in Section 6. The binary file format is described in detail in the *Argonaut Operation Manual*.

When using **ARGONAUT** to collect data, you have the option to also store data internally on the Argonaut recorder. **ARGONAUT** does not affect any Argonaut settings that relate to the internal recorder; these are left in the same state during data collection, as they were when **ARGONAUT** was started. The most common reason to use the internal recorder while collecting data with **ARGONAUT** is for a backup in case of computer malfunction or power loss. To do this, you should use a terminal emulator (e.g., **SONTERM.EXE**) to set the Argonaut recorder to **ON**.

5.6. Associated Configuration and Log Files

There are several configuration and log files associated with the operation of **ARGONAUT**.

ARGONAUT Associated Configuration and Log Files

File Name	Function
ARG.LOG	Records all communication between computer and Argonaut in an ASCII text file; this file is overwritten each time **ARGONAUT** is run. Information recorded here can be useful when looking for errors in data collection.
ARGUSER.SET	Records settings for all user parameters; overwritten each time **ARGONAUT** is exited. This file is only used if the computer is unable to communicate with the Argonaut upon start up.
DISPLAY.SET	This binary file records the most recent graphical display settings from data acquisition mode.
ARGCONF.SEN	This file specifies the Argonaut hardware configuration parameters, and is included with the system software (§5.1).
USERCONF.CMD	This ASCII text file is used with the **-c** command line option (§5.2).
ARGFILE.DEF	This ASCII text file is used for automatic file recording with the **-f** or **-g** command line options (§5.2).

Section 6. GARG*/EARG* Data Extraction Programs (DOS)

All binary data files generated by the Argonaut, whether collected using the real-time data collection software **ARGONAUT** or recorded internally in Argonaut memory, use the same format. The precise format of the binary data files is given in the *Argonaut Operation Manual*. Several DOS-based programs are provided to extract different portions of the Argonaut binary data and convert the data to an ASCII text format.

Note: Two versions exist for most of the data extraction programs – **GARG*.EXE** and **EARG*.EXE**. The only difference between the two versions is the measurement unit. Programs beginning with a "G" extract the data in metric units; those beginning with "E" extract the data in English units. For simplicity in examples, only the "G" programs will be illustrated.

- **GARGCTL** / **EARGCTL** – Extracts the file configuration and setup information (recorded once for each data file).
- **GARGSAMP** / **EARGSAMP** – Extracts <u>all</u> data recorded with each Argonaut sample.
- **GARGAMP** / **EARGAMP** – Extracts raw signal strength data.
- **GARGVEL** / **EARGVEL** – Extracts velocity data as individual components (Beam, XYZ, ENU).
- **GARGSTD** / **EARGSTD** – Extracts velocity standard deviation data.
- **GARGPRES** – Extracts pressure time-series data (if collected by optional sensor).

Entering the name of any program from a DOS prompt without any parameters causes the program to display its command syntax.

6.1. Control File Extraction: GARGCTL / EARGCTL

GARGCTL (or **EARGCTL**) extracts the hardware configuration and user setup information from a binary data file. It is used by entering either of the commands below.

```
GARGCTL <Argonaut file>
GARGCTL <Argonaut file> <output file>
```

File names must be given without extension. The program assumes that the Argonaut data file has extension **.ARG** and assigns the output data file the extension **.CTL**. For example,

```
GARGCTL TEST HEADER
```

extracts the configuration information from Argonaut binary data file **TEST.ARG** and places it into an ASCII file named **HEADER.CTL**. If <output file> is not specified, the program will create an output file with the same name as the Argonaut data file (i.e., **TEST.CTL**). The information in the **.CTL** file is in a self-explanatory ASCII text format.

6.2. Sample Data Extraction: GARGSAMP / EARGSAMP

GARGSAMP (or **EARGSAMP**) extracts all data recorded with each Argonaut sample. This information includes time, velocity, standard deviation, signal amplitude, compass data, temperature, pressure, and diagnostic data. The file will show 0 for any data where the sensor is not installed (i.e. compass/tilt or pressure sensor). The command format is as follows.

```
GARGSAMP <Argonaut file>
GARGSAMP <Argonaut file> <output file>
GARGSAMP <Argonaut file> <output file> <first sample> <last sample>
```

File names must be given without extension. **GARGSAMP** generates an ASCII output file with the extension **.DAT**. The program assumes that the Argonaut data file has the extension **.ARG**. If no <output file> is specified, the program uses the same name as the binary data file. First sample and last sample let you extract a subset of the data. If they are not specified, the program extracts all samples in the file.

The ASCII tabular output file has one line per sample. There are no headers so commercial programs (Lotus, MatLab, etc.) can easily access the data. The tabular output file has several columns of data as shown in the following table with their unit of measurement.

GARGSAMP / EARGSAMP Tabular Output Data Format

Col	Contents	Metric	English
1	Sample time (start of averaging interval) – Year		
2	Sample time (start of averaging interval) – Month		
3	Sample time (start of averaging interval) – Day		
4	Sample time (start of averaging interval) – Hour		
5	Sample time (start of averaging interval) – Minute		
6	Sample time (start of averaging interval) – Second		
7	Velocity component 1 (Beam 1 / X / East)	cm/s	ft/s
8	Velocity component 2 (Beam 2 / Y / North)	cm/s	ft/s
9	Velocity component 3 (Beam 3 / Z / Up)	cm/s	ft/s
10	Standard deviation component 1 (Beam 1 / X / East)	cm/s	ft/s
11	Standard deviation component 2 (Beam 2 / Y / North)	cm/s	cm/s
12	Standard deviation component 3 (Beam 3 / Z / Up) **– OR –** Water level (SL systems with vertical beam; see *Operation Manual*)	cm/s cm	cm/s ft
13	Signal strength (Beam 1)	count	count
14	Signal strength (Beam 2)	count	count
15	Signal strength (Beam 3)	count	count
16	Percent good pings	%	%
17	Heading	°	°
18	Pitch (rotation about the Y-axis)	°	°
19	Roll (rotation about the X-axis)	°	°
20	Standard deviation of heading	°	°
21	Standard deviation of the pitch (rotation about the Y-axis)	°	°
22	Standard deviation of the roll (rotation about the X-axis)	°	°
23	Mean temperature	°C	°F
24	Mean pressure	dbar	PSI
25	Standard deviation of pressure	dbar	PSI
26	Input power level	V	V
27	Starting location of sampling volume (cell begin)	m	ft
28	Ending location of sampling volume (cell end)	m	ft
29-38	Wave amplitude for 10 period bands (if present)	cm	ft
39	Significant wave height (if present)	cm	ft
40	Wave peak period (if present)	s	s

Signal strength data is reported in internal logarithmic units called counts; one count equals 0.43 dB. See the *Argonaut Principles of Operation* for details on using the signal strength data.

Temperature and pressure data are sampled once per second. The mean value of temperature is reported; mean and standard deviation of pressure are reported.

The nature of the data from the compass/tilt sensor (heading, pitch and roll) depends upon the system configuration. For the Argonaut MD, the reported values represent the mean over the averaging period; compass/tilt sensor data are sampled with each ping (once per second). The Argonaut MD assumes that the system may move during the course of the averaging interval, and performs a ping-by-ping vector average of velocity data in Earth coordinates when using the ENU coordinate system.

For the Argonaut XR (and the Argonaut SL with compass/tilt sensor), compass/tilt data are sampled once at the beginning of the averaging period. This value is used the mean velocity from XYZ to ENU coordinates, and is reported with the data. For the Argonaut XR and SL, the system is assumed stationary during the course of each averaging period. See the *Argonaut Operation Manual* for more information about coordinate systems.

6.3. Amplitude Data Extraction: GARGAMP / EARGAMP

`GARGAMP` (or **`EARGAMP`**) extracts signal strength (amplitude) data from an Argonaut data file and writes the results of the conversion to an ASCII file in tabular format. The command format is as follows. Note: This software is only for systems that have the Profiling Mode option.

```
GARGAMP <Argonaut file>
GARGAMP <Argonaut file> <output file>
GARGAMP <Argonaut file> <output file> <first sample> <last sample>
```

File names must be given without extension. The program assumes that the Argonaut data file has the extension **`.ARG`**. If no <output file> is specified, the program uses the same name as the binary data file. The <first sample> and <last sample> parameters let you extract a subset of the sample data. If they are not specified the program extracts all samples in the file. The program creates ASCII output files with the extensions **`.A1`**, **`.A2`**, and **`.A3`**, which correspond to signal amplitudes for beams 1, 2, and 3.

The program generates tabular data files with one line per sample. The first value in each line is the sample number. This is followed by the measurement at each cell in the profile, starting with cell 1 (closest to the transducer). The range from the instrument to the center of each cell is given in the ASCII file generated by **`GARGCTL`**. This range can also be calculated by the formula: Range = Blanking Distance + (Cell Number * Cell Size). Note: If the Profiling Mode option is not installed on your system, or if ProfilingMode=NO, only one cell is available.

The measurement unit for signal strength data is an internal Argonaut unit called a count. One count equals 0.43 dB.

6.4. Velocity Data Extraction: GARGVEL / EARGVEL

`GARGVEL` (or **`EARGVEL`**) extracts velocity data from an Argonaut data file and writes the data to an ASCII file in tabular format. The command syntax is as follows. Note: This software is only for systems that have the Profiling Mode option.

```
GARGVEL <Argonaut file> [options]
```

where:

- <Argonaut file> is the name of an Argonaut binary data file (no extension).
- [options] includes one or more of the following optional parameters:
  - <-Oname> Name of output file (no extension). Defaults to input file name.
  - <-Nj:k> Extracts samples numbered *j* through *k*. Default is all samples.
  - <-Mddd.d> Magnetic declination. Default is MagDecl stored with data. Note: only the real-time program allows the inclusion of magnetic declination).
  - <-Ccoordsys> Change output coordinates to XYZ (**`-CXYZ`**) or ENU (**`-CENU`**). Default is to output data in whatever coordinates they were collected.
  - <-AAbsVel> Convert to absolute velocities relative to GPS (**`-AGPS`**) or to bottom (**`-ABOT`**). Default is to output velocities relative to the Argonaut. Note: Absolute velocities relative to GPS can only be used in the ENU system.
  - <-SPDR> Output velocities as magnitude and direction.

File names must be given without extension. The program assumes that the Argonaut data file has extension **`.ARG`**. If no output file name is specified, the program uses the same name as the Argonaut data file. Specifying the first and last sample <-Nj:k> lets you extract a subset of the data. If they are not specified, the program extracts all samples in the file. The program creates an ASCII output file with the extensions **`.V1`**, **`.V2`**, and **`.V3`**, which correspond to the standard deviation of velocity components based on the coordinate system selected (Beams 1/2/3, Vx/Vy/Vz, or Veast/Vnorth/Vup).

The measurement unit for velocity is cm/s (or ft/s).

Example:

```
GARGVEL  test1  -O\data\test1 -M11.3 -N1:200 -CENU –AGPS
```

will extract velocity profiles 1 to 200, from file **`test1`** and output velocity relative to GPS into file **`\data\test1`** using a magnetic variation of 11.3° in ENU coordinates.

6.5. Standard Deviation Data Extraction: GARGSTD / EARGSTD

`GARGSTD` (or **`EARGSTD`**) extracts standard deviation of velocity data from an Argonaut data file and writes the results of the conversion to an ASCII file in tabular format. The command format is as follows. Note: This software is only for systems that have the Profiling Mode option.

```
GARGSTD <Argonaut file>
GARGSTD <Argonaut file> <output file>
GARGSTD <Argonaut file> <output file> <first sample> <last sample>
```

File names must be given without extension. The program assumes that the Argonaut data file has the extension **`.ARG`**. If no <output file> is specified, the program uses the same name as the binary data file. The <first sample> and <last sample> parameters let you extract a subset of the sample data. If they are not specified the program extracts all samples in the file. The program creates an ASCII output file with the extensions **`.SD1`**, **`.SD2`**, and **`.SD3`**, which correspond to the standard deviation of velocity components based on the coordinate system selected (Beams 1/2/3, Vx/Vy/Vz, or Veast/Vnorth/Vup).

The program generates tabular data files with one line per sample. The first value in each line is the sample number. This is followed by the measurement at each cell in the sample, starting with cell 1 (closest to the transducer). The range from the instrument to the center of each cell is given in the ASCII file generated by **GARGCTL**. This range can also be calculated by the formula: Range = Blanking Distance + (Cell Number * Cell Size). Note: If the Profiling Mode option is not installed on your system, or if ProfilingMode=NO, only one cell is available.

The measurement unit for standard deviation of velocity is cm/s (or ft/s).

6.6. Pressure Series Data Extraction: GARGPRES

GARGPRES extracts pressure series data recorded with each Argonaut sample. For each sample, information includes the sample number and 1024 raw pressure values (in counts). The command format is as follows.

```
GARGPRES <Argonaut file>
GARGPRES <Argonaut file> <output file>
GARGPRES <Argonaut file> <output file> <first sample> <last sample>
```

File names must be given without extension. **GARGPRES** generates an ASCII output file with the extension **.PTS**. The program assumes that the Argonaut data file has the extension **.ARG**. If no <output file> is specified, the program uses the same name as the binary data file. First sample and last sample let you extract a subset of the data. If they are not specified the program extracts all samples in the file.

Section 7. Deployment Survey & Diagnostics with ARGCHECK (DOS)

This program is most commonly used to survey deployment sites for the Argonaut XR and SL, but is also a useful diagnostic tool for all Argonaut models. We encourage users to become familiar with the operation of this program; it is a valuable tool for understanding how the Argonaut works.

The output of **`ARGCHECK`** is a plot of signal strength versus range from the instrument. This is used to determine the effective measurement range of the Argonaut and to look for interference from boundaries and underwater structures. This section describes program output, describes how to use **`ARGCHECK`** to survey a deployment site, and describes how to use the program as a diagnostic tool.

When running **`ARGHECK`**, mount the Argonaut in the location you are planning to deploy the system. Alternatively, mount the system in any open body of water for general diagnostics. The program is run using one of the following commands.

```
ARGCHECK <COM port>
ARGCHECK <COM port> <output file>
```

<com port> is the communication port to which the instrument is connected (1 for COM1, 2 for COM2).

<output file> gives a file name to which data will be written; if no output file is specified, the program will not record the data. The output file uses a tabular ASCII format with 10 columns; the value in each column is shown in the table below.

ARGCHECK Tabular Output Data Format

Column	Contents	Units
1	Range sample number (within the profile)	
2	Distance from transducer	meters
3	Signal strength (beam 1)	counts
4	Signal strength (beam 2)	counts
5	Signal strength (beam 3)	counts
6	Sine velocity channel (beam 1)	vel-counts
7	Sine velocity channel (beam 2)	vel-counts
8	Sine velocity channel (beam 3)	vel-counts
9	Cosine velocity channel (beam 1)	vel-counts
10	Cosine velocity channel (beam 2)	vel-counts
11	Cosine velocity channel (beam 3)	vel-counts

`ARGCHECK` samples the return signal at a number of points within the total measurement range. This range is 15 m for systems operating at 1500 kHz (Argonaut XR, Argonaut SL, and deep-water titanium Argonaut MD) and 8 m for all systems operating at 3000 kHz (standard Argonaut MD). These samples provide a profile of signal strength (from each beam) with distance from the instrument. Resolution within the profile is approximately 4.8 cm for systems operating at 1500 kHz, and 2.2 cm for systems operating at 3000 kHz. The first column of the output data above is the sample number within the profile, while the second column is the range of that sample from the system.

Signal strength data are given in internal units called counts; one count equal 0.43 dB. Sine and cosine velocity data are given in internal units called "vel-counts"; these have no direct interpretation and are provided as a qualitative diagnostic tool (§7.3). The output file will have a series of profiles recorded in succession; successive profiles are distinguished using data from the first two output columns.

During operation, you can pause the display by pressing the **Spacebar** key; to resume the display update, press **Enter**. To exit the program, press **Esc**.

7.1. Sample Program Output

Figure 16 shows the **ARGCHECK** output from an Argonaut SL (note only two functional beams) deployed in a large body of water with no boundaries or underwater structures nearby.

The first plot is of primary interest to the user. This gives signal strength for each beam versus range from the system in meters. Signal strength is given in internal logarithmic units of counts where one count equals 0.43 dB. The profile of signal strength will typically start at a value from 130-180 counts, and will decay with range from the system.

Depending upon the environment, the signal strength profile may or may not reach the system noise level within the displayed range (15 m for the Argonaut XR, SL, and deep-water titanium Argonaut MD; 5 m for the standard Argonaut MD). In Figure 16, the signal strength profile does not reach the noise floor within the displayed measurement range. If the signal strength flattens out at the end of the range, this indicates that signal strength has reached the noise floor.

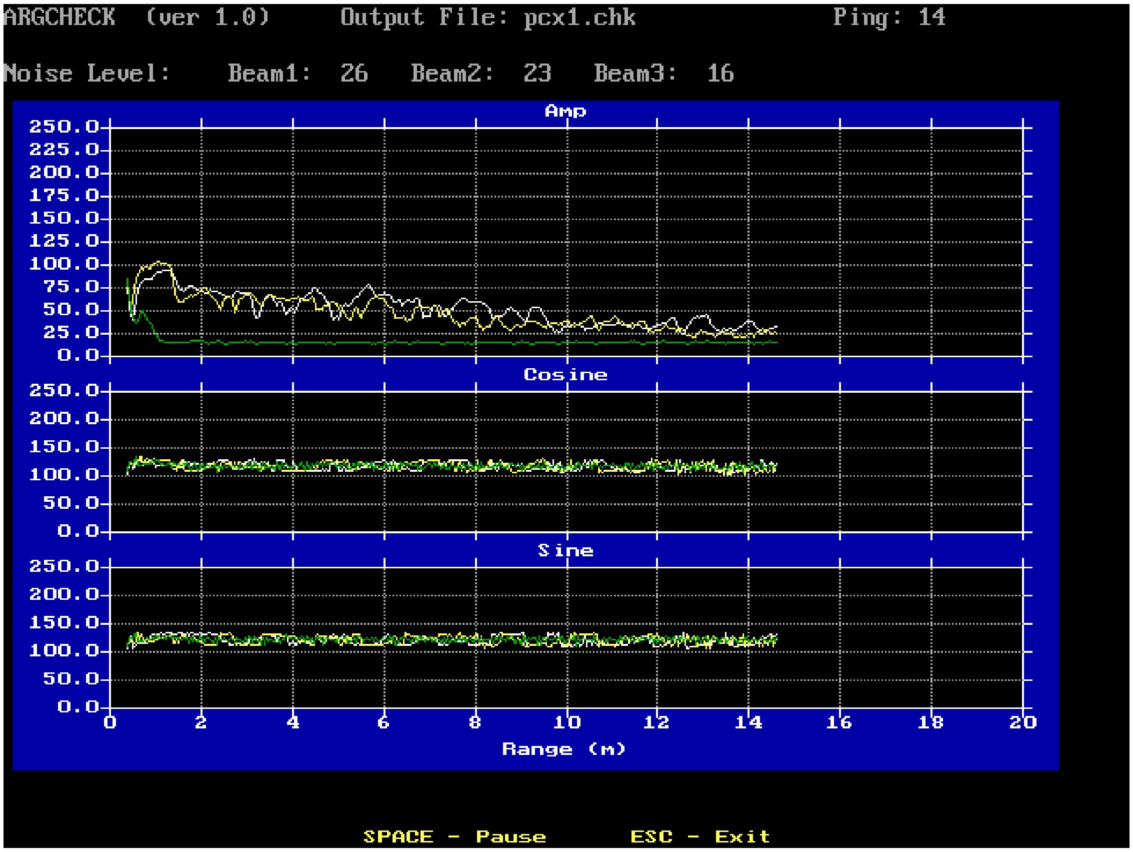


Figure 16 – ARGCHECK Output From Open Water

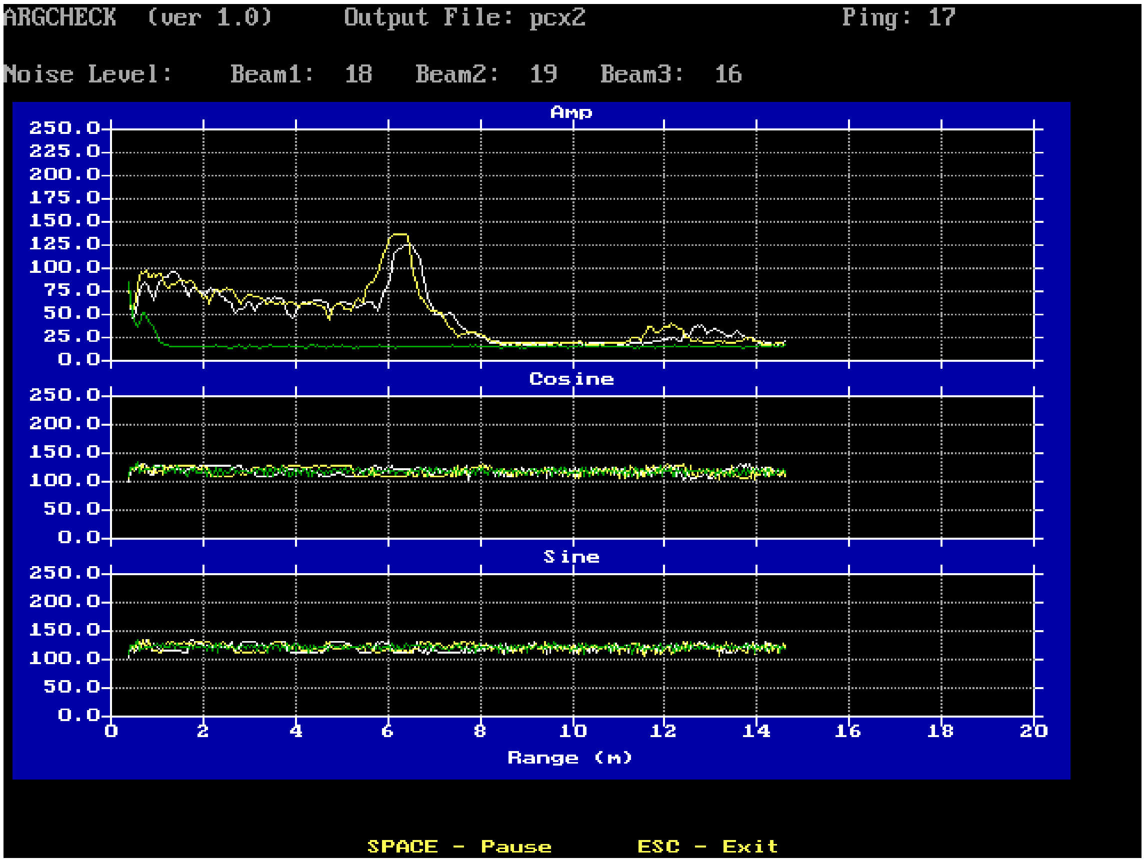


Figure 17 – ARGCHECK Output – Near Boundary Operation

The top of the screen shows the minimum signal strength value observed for each beam. To measure the noise level in each beam, run the system with the transducers in the air and look at the minimum signal strength levels shown at the top of the screen.

Figure 17 shows the output of **ARGCHECK** from an Argonaut SL deployed looking down with the transducers about six meters from the bottom.

In Figure 17 the bottom reflection can be clearly seen at a range of about 6 m. Following the bottom reflection, the signal strength rapidly drops down to the system noise level. It remains at this level for most of the rest of the profile. The small variations at a range of 12-14 m are caused by multiple bottom reflections.

7.2. Deployment Site Survey

Surveying the deployment site is typically only done for the Argonaut XR and SL, and is not required for the Argonaut MD. There are two main goals of a deployment site survey. First is to verify that the system is not seeing interference underwater structures, deployment lines, or boundaries. Second is to set the limits of the measurement volume based upon the environment.

<u>Acoustic interference</u>

It is important that the Argonaut does not see any interference from underwater objects whose reflections may contaminate the acoustic return signal (and hence affect velocity data). These objects may be underwater structures, boundaries (surface or bottom), or smaller items such as deployment lines and cables.

Any large objects within the measurement field will show up as spikes in the return signal; these spikes may be present in one or more beams. If any spikes are present in some portion of the measurement volume, velocity data will be contaminated to some degree. The acoustic return signal for each sample is highly variable; it is useful to store a number of pings to an output file and look at the mean profile to look for any consistent source of interference.

When working near underwater structures or deployment lines, interference can come from direct reflections and from flow distortion caused by the object. To the greatest extent possible, place the Argonaut measurement volume in an open water area free from sources of acoustic or flow interference.

Measurement volume limits

In open water, the maximum effective range for the Argonaut XR and SL is determined by the distance at which the signal strength approaches the noise level. For most environments, the signal strength will be above the noise level out to the maximum allowed range of 15 m. In clear water, signal strength may approach the noise level before reaching 15 m. This can be seen clearly from the output of **ARGCHECK**. Capturing a number of pings using the output file option, and plotting the mean signal strength versus range lets you directly measure the maximum range.

During operation, the Argonaut XR and SL will automatically end the measurement volume if the signal level is less than six counts higher than the noise level. This is to prevent contamination if signal strength levels are not sufficient. For example, if the end of the measurement volume is set to 15 m, but signal strength is only sufficient to a range of 13 m, the system will automatically end the measurement volume at 13 m. The precise start and end of the measurement volume is reported with each sample.

When working near boundaries or underwater structures, the limits of the measurement volume are set by the range at which the system sees the reflection from the boundary. This is illustrated in Figure 17. You must set the measurement volume limits to avoid any contamination from the boundary reflection. The only exception to this is when using the Argonaut XR up-looking with dynamic boundary adjustment – see the *Argonaut Operation Manual* for details.

The end of the measurement volume should be placed no closer than the greater of 0.25 m and 10% of the total range to the boundary. For the example in Figure 17, the boundary is at a range of 6 m; the end of the measurement volume should be at least 0.6 m (10% of 6 m) from the boundary. Thus, the end of the cell should be placed at 5.4 m or less. If there is any variation in boundary range or instrument mounting, the end of the measurement volume should be placed to avoid interference at all times.

7.3. System Diagnostics

When looking at the output data, there are four basic features to verify system operation: signal strength profile, noise level, boundary reflections, and sine/cosine data.

Signal strength profile

When looking at the signal strength profile, data from all active beams should be similar in magnitude and shape. Note that the Argonaut SL has only two beams; the third beam is still plotted but will show a constant signal strength at the noise level. Each beam should see initial signal strength of roughly the same magnitude and should decay at the same rate. Check that all beams have an unobstructed view and are not showing spikes from objects in their path.

When looking at the **ARGCHECK** output, keep in mind that individual samples will vary significantly from ping to ping. Look for features that are consistent over a number of pings. It is often helpful to record a number of pings and plot the mean profile to look for consistent features in the data.

Noise level

The system noise level for each beam can be directly measured by running **ARGCHECK** with the transducers out of the water. The output will show a spike close to the transducers, which should immediately decay to a constant noise level throughout the remainder of the profile. You can read the system noise level from the data at the top of the screen.

For the Argonaut XR and SL, the noise level is typically 35-55 counts. For the standard Argonaut MD (3000 kHz), the noise level is typically 50-70 counts. For the deep-water titanium Argonaut MD (1500 kHz), the noise level is typically 35-55 counts. The noise will vary slightly among different beams. If the noise level of any on beam is outside this range, this can be an indicator of a noisy environment or of problems with the system. Try moving the system away from any motors or electronics to see if the noise level changes. If problems persist, contact SonTek.

Boundary reflection

If the Argonaut has some type of boundary within the measurement range (surface, bottom or underwater structure), this boundary should be seen as a strong spike in the return signal profile. One example is illustrated in Figure 17. In most cases, all beams will see a reflection of approximately the same magnitude at the same range. In certain locations, the magnitude and location of the boundary reflection will vary between beams due to the different beam mounting angles and the nature of the boundary reflection. If the system is tested in very shallow water, it may show multiple boundary reflections with increasing range.

Sine/cosine data

The lower two plots in **ARGCHECK** show the sine and cosine velocity channels using internal units called vel-counts. These data have no direct interpretation and are provided for basic diagnostic purposes only. They will typically show a mean level through the profile of about 125 counts, with a small amount of variation around that level. The amount and nature of the variations depends upon the environment.

The only reason to be concerned is if they show a flat line with no variations. This indicates that something in the electronics is not functioning properly; contact SonTek if you see this when running **ARGCHECK** (with the transducer either in or out of the water).

Section 8. Compass Calibration with COMPCAL (DOS)

This program is provided with the Argonaut software to allow you to calibrate the internal compass/tilt sensor. Calibration is used to minimize the effects of ambient magnetic fields on compass data. We recommend that a compass calibration be performed before each deployment.

This program gives a graphical display of instrument orientation that can be used to insure that the compass/tilt sensor is functioning correctly. The program is intended to be self-explanatory; simply type **`COMPCAL`** at the DOS prompt for operating instructions. To run the calibration program, make sure that the instrument is powered up and connected to a computer serial port, and type one of the following commands:

```
COMPCAL <COM port>
COMPCAL <COM port> <baud rate>
```

where

<com port> is the serial port number to which the Argonaut is connected (1 for COM1 or 2 for COM2).

<baud rate> is the communication baud rate setting of the Argonaut; if no value is given, the program assumes the default setting of 9600 baud. Acceptable baud rate values are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.

Once started, the program shows a graphical display of compass orientation. At this point, the compass is not in calibration mode; it is in a monitoring mode where orientation data are output in real time. The graphical display provides three perspectives. To the right is a compass that indicates the direction the X-axis is pointing. To the left are tabular and graphical displays of pitch and roll. In the center is a 3D box with an X on the side corresponding to north. When this side is facing into the screen, the instrument X-axis is facing north.

To begin the calibration, press the **`F1`** key. The program will pause to put the compass in calibration mode; following this, the display will resume and the program provides instructions for instrument rotation at the bottom of the screen. Rotate the instrument slowly through two complete circles, while varying the pitch and roll as much as possible. Each turn should take about one minute; the exact starting and ending orientations are not important.

To end the calibration, either press the **`F1`** key again (to remain in the graphical display) or press the **`Esc`** key to exit with the calibration results. Pressing **`Esc`** at any time during this program will exit the program and display the results of the most recent calibration. Refer to the *Argonaut Operation Manual* for more information about compass calibration and for information on how to interpret the calibration score.

Section 9. Terminal Emulation with SONTERM (DOS)

This program is used for direct communication with the Argonaut over a computer serial port. To run the program type **`SONTERM`** at the DOS prompt. Direct communication with the Argonaut is used for a variety of functions including data collection, autonomous deployment, manual internal recorder data retrieval, system diagnostics, and placing the system in sleep mode. Refer to the *Argonaut Operation Manual* for more details about the direct command interface.

To establish direct communication with the Argonaut, connect the cable from the instrument to COM1 of your computer, supply power to the Argonaut, and run **`SONTERM`**. Press **Alt+B** to send a **`BREAK`** and establish communication. The Argonaut will respond with a message similar to "**`SonTek Argonaut, Copyright 2001, …`**" and will then return a command prompt ("**>**").

`SONTERM` displays user commands in yellow type and instrument output in blue type. There are several active keys for special functions within **`SONTERM`**, as shown in the first table below. One function, **Alt+S**, lets you change communications settings; details of this are shown in the second table. The default settings match the default communication parameters of the Argonaut.

SONTERM Function Keys

Key	Function
Alt+B	Sends a **`BREAK`** over the serial port. This involves holding the computer transmit data line high for a period of 500 milliseconds. The **`BREAK`** causes the Argonaut to terminate any operations (or exit the sleep mode) and enter the command mode.
Alt+F	Open or close a log file. If no log file is currently open, the program prompts you to enter a file name; everything that appears on the screen will be written to this file. If a log file is currently open, this function closes the file. When **`SONTERM`** is first started, no log file is used. Confirmation is required before the program will overwrite an existing log file.
Alt+C	Loads commands from an ASCII file. You are prompted to enter the file name. The file specified should be an ASCII text file with each line containing one command for the Argonaut. The program reads the commands from the specified file and sends them in order to the Argonaut. This is useful to ensure that a precise series of commands are sent to the Argonaut.
Alt+S	Set communication parameters, such as serial port number and baud rate. Refer to the table below for details.
Alt+X	Exit the program.

To change communication parameters within **`SONTERM`**, press **Alt+S**. This gives a menu with a number of active keys to set the communication port, baud rate, parity, number of data bits, and number of stop bits. The default baud rate is 9600 baud; see the *Argonaut Operation Manual* for details on changing the default baud rate. The fixed communication parameters are no parity, 8 data bits, and 2 stop bits; these are the default settings in **`SONTERM`**. The table below shows the active keys to set all available values for these parameters. When the desired parameters have been set, press **Esc** to return to normal **`SONTERM`** operation. The most recent parameter settings are saved to the computer hard disk and used when running **`SONTERM`**.

Changing Communication Parameters (Alt+S)

Parameter	**Keystroke and Function**		
Communication port	F1 - COM1	F2 - COM2	
Baud rate	1 - 300 2 - 1200 3 - 2400	4 – 4800 5 - 9600 6 – 19200	7 - 38400 8 - 57600 9 -115200
Parity	N - none E - even	O – odd H - high	L - low
Data bits	Alt+F7 - 7	Alt+F8 - 8	
Stop bits	Alt+F1 - 1	Alt+F2 - 2	
Defaults	D - Return all settings to default values (COM1, 9600 baud, no parity, 8 data bits, 2 stop bits)		

Section 10. Recorder Data Extraction with SONREC (DOS)

This program is used to extract data from the Argonaut internal recorder. To learn about its operation, type **`SONREC`** at the DOS prompt.

IMPORTANT: This program should be run from a dedicated DOS environment, not from a DOS prompt within Windows. Memory resident features of Windows interfere with serial port operation. Running this program from within Windows will, at the very least, slow down data retrieval, and can potentially cause the retrieval to fail.

To run from the DOS prompt, use one of the following commands.

```
SONREC <COM port>
SONREC <COM port> <baud rate>
SONREC <COM port> <baud rate> <extraction rate>
```

where

<com port> is the serial port number to which the Argonaut is connected (1 for COM1 or 2 for COM2).

<baud rate> is the communication baud rate setting of the Argonaut; if no value is given, the program assumes the default setting of 9600 baud. Acceptable baud rate values are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.

<extraction rate> is the baud rate at which data files will be retrieved from the recorder; if no value is given, it uses the default setting of 115200 baud. Acceptable extraction rate values are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.

For example, the command "**`SONREC 1 9600 38400`**" will establish communication with the Argonaut on COM1 at 9600 baud and download data files using 38400 baud.

For short cables (less than 30 m), the default extraction rate of 115200 baud provides the fastest downloading time. For longer cables, a slower baud rate may be needed to ensure reliable communication. If **`SONREC`** encounters a large number of communication errors while retrieving data, it will terminate the retrieval. Note that some computers (particularly older laptop computers) do not operate reliably at high baud rates and may not be able to work using the default setting of 115200. If you encounter problems with **`SONREC`**, run the program using a lower extraction rate.

The table below shows the typical download rates achieved with different baud rate settings. Extraction rates slower than 9600 baud are rarely needed and are not shown here. Actual retrieval rates may vary depending upon the environment and the type of computer used.

SONREC Data Retrieval Rates

Extraction rate	Effective retrieval rate	Download time for 1 MB
115200	4800 bytes per second	3.6 minutes
57600	3400 bytes per second	5.1 minutes
38400	2600 bytes per second	6.7 minutes
19200	1500 bytes per second	11.5 minutes
9600	850 bytes per second	20.5 minutes

Upon execution, **SONREC** wakes the Argonaut and establishes a direct link to the recorder at the specified extraction rate. The program then downloads the directory of files stored on the recorder and displays this information on the screen. The directory screen shows the following information.

- Number of files on recorder
- List of files including name, size, and date/time of creation.
- Recorder size (bytes)
- Recorder free space (bytes)
- Extraction baud rate
- Active keys and their function, as listed below
  - **Esc** - exit program
  - **Spacebar** - mark and unmark files for extraction
  - **F3** - retrieve all marked files
  - **Del** - format the recorder and erase all data

Within **SONREC**, move between files in the directory using the up/down arrow and page up/down keys. The **Spacebar** will mark and unmark one or more files for retrieval. Pressing **F3** retrieves all currently marked files. The program prompts you to input a destination path for the files; if no path is given, the current directory is used. While retrieving data files, the program provides ongoing information about progress with each file.

SONREC transmits data from the recorder in blocks, each of which includes a checksum for reliable data transmission. If the checksum fails, the program will attempt to transmit the same block again. If the program encounters a large number of errors during retrieval, it will abort the process. If this occurs, try running the program again at a lower data extraction rate.

Pressing the **Del** key will format the recorder and delete all data files. Before the files are deleted, you are prompted to enter the complete word “**Yes**” for confirmation. Be certain that all data are backed up before erasing the recorder. Data cannot be recovered after formatting the recorder. Pressing **Esc** will exit the program.

Data files extracted from the Argonaut recorder are assigned the extension **.ARG**.

Section 11. Additional Support

Any additional questions can be directed to SonTek by phone, FAX, or e-mail. Regular business hours are 8:00 am to 5:00 p.m., Pacific Standard Time, Monday through Friday.

Phone	(858) 546-8327
Fax	(858) 546-8150
Email	inquiry@sontek.com
World Wide Web	http://www.sontek.com

See our web page for information concerning new products and software / firmware upgrades.

Appendix 1. Automatic File Naming Convention

When automatically generating data file names in the real-time data collection software (running **ARGONAUT** with the **-f** or **–g** command line options), the software uses a file naming convention based upon the date and time at which the file was created (from the computer clock). Unless the clock has been reset such that two files are started within the same minute, the file name cannot be repeated. An example of this convention is shown below.

AA7ADM23.ARG

where

AA = starting two characters as specified in the file **ARGFILE.DEF** (§5.2).
7 = last digit of year (199**7**)
A = month (i.e. A = 10 = October)
D = day (i.e. D = 13)
M = hour (i.e. M = 22)
23 = minute
.ARG = all Argonaut data files use the same extension

The above file name is for a file started at 22:23 on October 13, 1997. Several tables showing the abbreviation for month, day, and hour are shown below.

Month

1 = January	4 = April	7 = July	A = October
2 = February	5 = May	8 = August	B = November
3 = March	6 = June	9 = September	C = December

Day

1 = 1	5 = 5	9 = 9	D = 13	H = 17	L = 21	P = 25	T = 29
2 = 2	6 = 6	A = 10	E = 14	I = 18	M = 22	Q = 26	U = 30
3 = 3	7 = 7	B = 11	F = 15	J = 19	N = 23	R = 27	V = 31
4 = 4	8 = 8	C = 12	G = 16	K = 20	O = 24	S = 28	

Hour

0 = 0	3 = 3	6 = 6	9 = 9	C = 12	F = 15	I = 18	L = 21
1 = 1	4 = 4	7 = 7	A = 10	D = 13	G = 16	J = 19	M = 22
2 = 2	5 = 5	8 = 8	B = 11	E = 14	H = 17	K = 20	N = 23

Index

6837 Nancy Ridge Dr., Suite A • San Diego, CA 92121 • Telephone (858) 546-8327 • Fax (858) 546-8150 • Internet: inquiry@sontek.com

Argonaut Principles of Operation

Table of Contents

1. Introduction

The SonTek/YSI Argonaut provides the remote velocity sampling and integrated flow measurements previously available only from complicated, high-priced current profilers at the price and ease of use of a single-point current meter. From shallow water to full ocean depth, the Argonaut provides the most reliable and accurate current measurements available at any price.

This document introduces the operating principles of the SonTek Argonaut. It does not attempt to provide a detailed discussion of all technical issues, nor does it provide a detailed description of Argonaut operation. To learn more about specific Argonaut applications, please contact SonTek.

2. The Doppler Shift and Monostatic Current Meters

The Argonaut measures the velocity of water using a physical principle called the Doppler shift. This states that if a source of sound is moving relative to the receiver, the frequency of the sound at the receiver is shifted from the transmit frequency.

$$F_d = -2F_s \frac{V}{C}$$

where

F_d -change in received frequency (Doppler shift)
F_s - frequency of transmitted sound
V - velocity of source relative to receiver (positive V indicates that the distance from source to receiver is increasing)
C - speed of sound

V represents the relative velocity between source and receiver (i.e., motion that changes the distance between the two).

Figure 1 shows the operation of a *monostatic* Doppler current meter, such as the Argonaut. The term monostatic refers to the fact that the same transducer is used as transmitter and receiver. The transducer generates a short pulse of sound at a known frequency, which propagates through the water. The transducer is constructed to generate a narrow beam of sound where the majority of energy is concentrated in a cone a few degrees wide. As the sound travels through the water, it is reflected in all directions by particulate matter (sediment, biological matter, bubbles, etc.). Some portion of the reflected energy travels back along the transducer axis, where it is received by the transducer and the Argonaut measures the change in frequency of the received signal. The Doppler shift measured by a single transducer reflects the velocity of the water along the axis of the acoustic beam of that trancducer.

If the distance between the trancducer and the target is decreasing, frequency increases; if the distance is increasing, frequency decreases (Figure 1). Motion perpendicular to the line connecting source and receiver has no effect on the frequency of received sound.

The location of measurements made by a monostatic Doppler current meter is a function of the time at which the return signal is sampled. The time since the pulse was transmitted determines how far the pulse has propagated, and thus specifies the location of the particles that are the source of the reflected signal. By measuring the return signal at different times following the transmit pulse, the Argonaut measures the water velocity at different distances from the transducer.

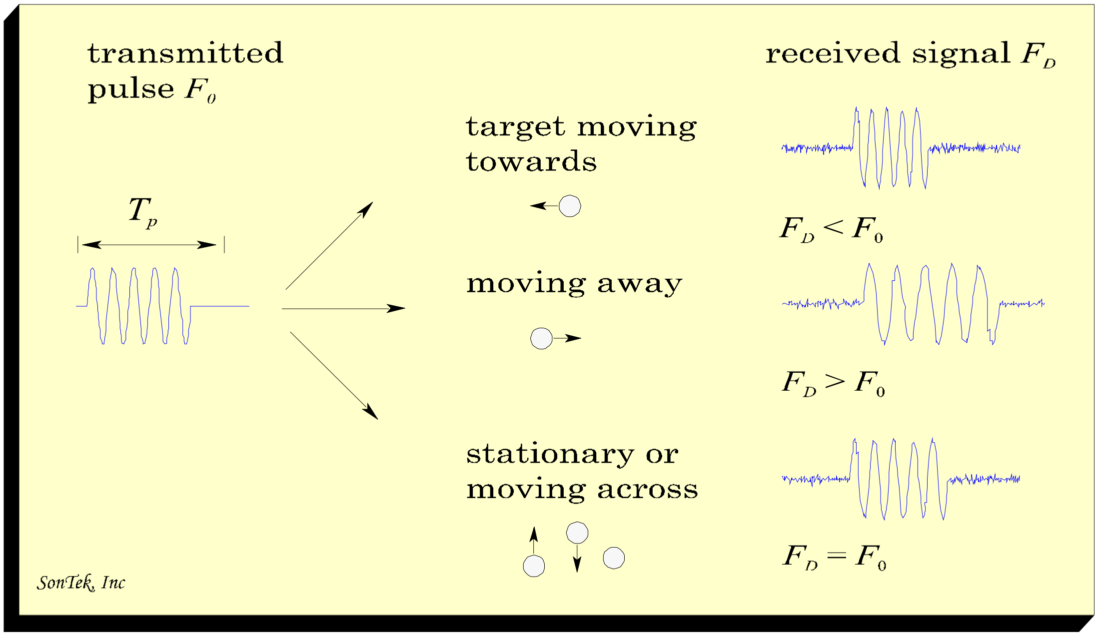


Figure 1 – Measuring target velocity with a monostatic Doppler system

3. Beam Geometry and 2D/3D Velocity Measurements

The Argonaut operates using two or three transducers that generate beams with different orientations relative to the flow of water. The velocity measured by one transducer is the projection of the 3D water velocity onto the axis of the acoustic beam. The system uses the relative orientation of the transducers to calculate the 2D or 3D water velocity from the along-beam velocity data. Each type of Argonaut uses different beam geometry optimized for its particular application.

The *Argonaut-MD* (Mooring Deployment) is designed for open water current monitoring and is typically installed as part of an instrument mooring. The MD uses three acoustic beams, each slanted 45° off the vertical axis of the instrument and equally spaced at 120° relative azimuth angles. This beam geometry provides the optimal 3D velocity response when operating in open water away from potential boundary interference.

The *Argonaut-XR* (Extended Range) is designed for bottom-mounted installations in shallow water. The XR uses three acoustic beams, each slanted 25° off the vertical axis of the instrument and equally spaced at 120° relative azimuth angles. This beam geometry provides the optimal balance between 3D velocity response, total measurement range, and near-boundary operation. The XR includes a pressure sensor to automatically adjust the measurement volume with changing water level; see §6.1 for details.

The *Argonaut-SL* (Side-Looking) is designed for horizontal operation from underwater structures such as bridge pilings and channel walls. The SL measures the 2D velocity in a horizontal layer (parallel to the water surface) away from the flow interference generated by the structure. The system uses two acoustic beams in a single plane, each slanted 25° off the instrument axis. This beam geometry is designed for side-looking applications, giving the optimal balance between 2D velocity response and total measurement range.

The velocity measured by each beam is referred to as the *along-beam velocity*. Beam velocities are converted to XYZ (Cartesian) velocities using the beam geometry. XYZ velocities are used in situations where the orientation of the Argonaut is known, most commonly for the SL. The MD and XR include an internal compass/tilt sensor to measure instrument orientation. This enables the MD and XR to report 3D velocity data in Earth (East-North-Up or ENU) coordinates.

4. Measurement Volume Definition and Location

The size and location of the Argonaut measurement volume is a function of the system configuration and user operating parameters. In all cases, the basic shape of the measurement volume is determined by beam geometry.

4.1. Argonaut MD

The MD is designed for up or down-looking deployment on open-water moorings. The measurement volume is a cone with sides sloped 45° off the vertical axis of the instrument. The location of the measurement volume is fixed: it starts 0.5 m away from and extends 2.0 m vertically from the instrument. The diameter of the measurement volume cone is equal to twice the distance from the transducer head; the cone has a diameter of 1.0 m at the base and 4.0 m at the top.

The precise vertical weighting within the measurement volume is determined by the convolution of the acoustic pulse with the receive window during which the return signal is sampled. For the standard MD, the acoustic pulse is 0.5-m long. During the receive window, the acoustic pulse travels 1 m. This weighting function is shown in Figure 2.

For the deep-water MD, the acoustic pulse is 1.0-m long. During the receive window, the acoustic pulse travels 2.0 m. This weighting function is shown in Figure 3.

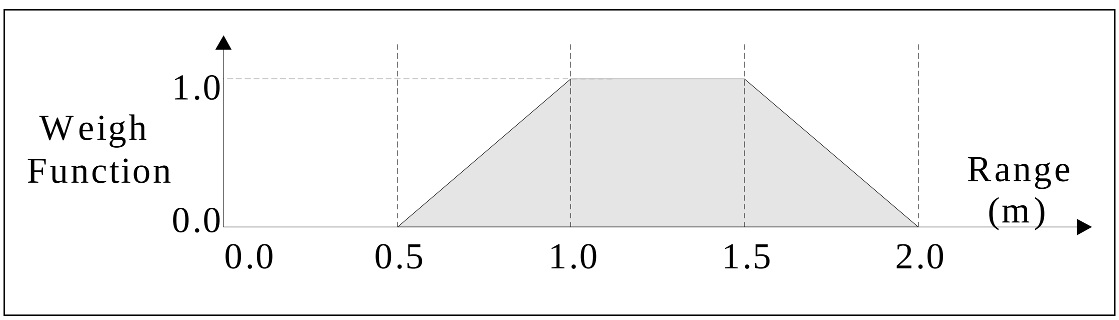


Figure 2 – Standard Argonaut MD Measurement Volume Weighting Function

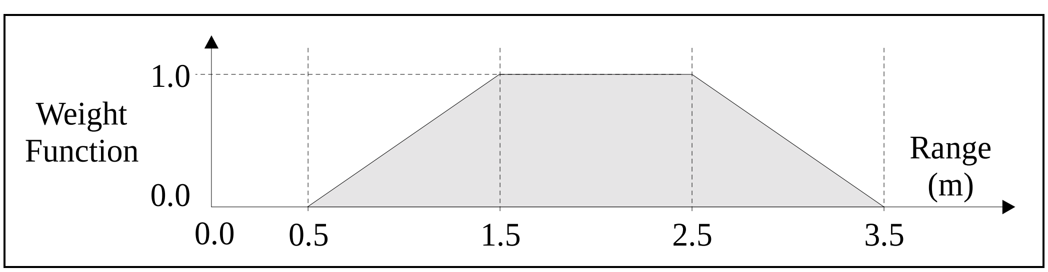


Figure 3 – Deep-Water Argonaut MD Measurement Volume Weighting Function

4.2. Argonaut XR

The XR is most commonly mounted on the bottom looking up, but can also be installed from a surface buoy or other structure looking down. The measurement volume is a cone with sides sloped 25° off the vertical axis of the instrument. The diameter of the measurement volume cone is 0.93 times the range from the transducer head (e.g., at 4 m, the cone has a diameter of 3.7 m).

The vertical extent of the measurement volume for the XR is set by the user and may be modified by the instrument using *dynamic boundary adjustment* (see §6.1). The vertical range of the measurement volume is defined by two parameters – *Cell Begin* and *Cell End*. Both are given in vertical distances from the transducers up to a maximum range of 15 m. The minimum difference between the two, and hence the minimum height of the measurement volume, is 0.5 m.

The precise vertical weighting within the measurement volume is determined by the convolution of the acoustic pulse with the receive window during which the return signal is sampled. For the XR, the acoustic pulse is 0.5-m long. The receive window is based on the settings of Cell Begin (CB) and Cell End (CE). The length of the receive window is equal to the measurement volume height (the difference between CB and CE). Figure 4 shows the weighting function and location of the XR measurement volume relative to the user-specified values of CB and CE.

Some portion of the measurement volume extends beyond the limits set by CB and CE. For typical operating parameters, more than 95% of the weighting function is contained within the specified cell limits. The area outside the specified cell limit has minimal affect, and is not normally considered part of the measurement volume.

4.3. Argonaut SL

The SL is designed for horizontal side-looking operation from underwater structures, but can also be used for vertical up or down-looking installations in narrow channels. The measurement volume is a V-shaped wedge in the plane defined by the two acoustic beams. The sides of the V are sloped 25° off the horizontal axis of the instrument. The width of the V is equal to 0.93 times the range from the transducer head (e.g., at 4 m, the width is 3.7 m).

The limits of the measurement volume are determined by user-selected parameters (see §6.2 for guidelines). This range is defined by two parameters – *Cell Begin* (CB) and *Cell End* (CE). Both are given in distance from the transducers along the axis of the instrument. The minimum difference between the two, and hence the minimum length of the measurement volume, is 0.5 m.

The precise weighting within the measurement volume is determined by the convolution of the acoustic pulse with the receive window during which the return signal is sampled. For the SL, the

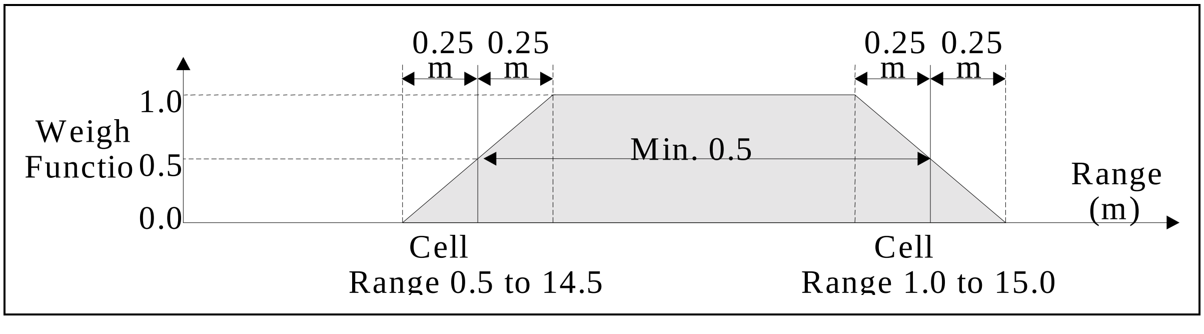


Figure 4 – Argonaut XR and SL Measurement Volume Weighting Function

acoustic pulse is 0.5-m long. The receive window is based up the settings of CB and CE. The length of the receive window is equal to the measurement volume length (the difference between CB and CE). The measurement volume weighting function of the SL is the same as for the XR (shown in Figure 4).

5. Argonaut Data

5.1. Velocity

In general, Argonaut velocity data is used directly as output from the system without any postprocessing. The Argonaut velocity response will not change or drift with time, and the system never requires recalibration. The Argonaut provides several diagnostic parameters with each sample to verify the quality and accuracy of the data. The remaining parts of this section describe the diagnostic data and give some general guidelines for its use.

5.2. Signal Strength

Signal strength is a measure of the strength of the acoustic return signal from the water; it decreases with distance from the transducer due to geometric spreading and sound absorption. The maximum measurement range of the Argonaut is determined by the distance at which signal strength approaches the electronics noise level. The noise level can be directly measured using the system diagnostic software (**ARGCHECK**) with the transducers in the air (i.e., out of the water).

Signal strength data is reported in internal logarithmic units called counts (1 count = 0.43 dB). In addition to its diagnostic use, signal strength provides an excellent qualitative measure of suspended sediment concentration. For more information about using signal strength data to monitor suspended sediment, contact SonTek.

For the MD, the location of the measurement volume is fixed and is well within the maximum measurement range of the system. The signal strength reported with each sample reflects the mean value over the measurement volume and will vary depending on water conditions. For good operating conditions, the signal strength should be at least 10 counts above the noise level.

For the XR and SL, the location and size of the measurement volume is programmable over a range up to 15.0 m from the system. The signal strength returned by the system is the mean signal strength over the specified measurement volume. Signal strength decreases with range from the transducers and will vary with conditions in the water. For good operating conditions, the mean signal strength reported with each sample should be at least five counts above the noise level.

The vertical extent of the measurement volume may be adjusted by the Argonaut in two cases. The XR may adjust the measurement volume based up pressure sensor data using *dynamic boundary adjustment* (see §6.1 for details). Additionally, both the XR and SL may adjust the measurement volume limits based up signal strength data as described below.

With each sample, the XR and SL monitor the signal strength profile within the specified measurement volume. If at any point the signal strength is too low for reliable velocity measurements, the Argonaut will end the measurement volume at that range.

In most conditions, the Argonaut is able to measure out to the specified maximum range of 15 m. In some environments, the return signal strength from the water will be too low and the Argonaut will have a reduced measurement range. In this situation, the system will automatically cut off the measurement volume at the maximum effective range. The exact limits of the measurement volume are recorded with each sample.

5.3. Standard Deviation

Each velocity sample recorded by the Argonaut is the average of a number of pings. In addition to mean velocity, the Argonaut records the standard deviation of these samples as a direct measure of the accuracy of the velocity data. The measured standard deviation includes instrument-generated noise and real variations of the water velocity.

Instrument-generated noise in velocity data can be estimated for a given set of operating parameters. This is useful in planning deployments, particularly for determining the operating parameters required for a desired accuracy. It can also be useful to compare the measured standard deviation to predicted values when analyzing data. Under normal operating conditions, these values will agree to within about 20%.

The MD pings once per second; standard deviation decreases with the square root of the number of samples averaged. Increased averaging times are used to improve the precision of velocity measurements. Table 1 shows predicted standard deviation for the MD. The predicted standard deviation for other averaging times can be calculated by scaling with the square root of the number of samples.

Table 1. Argonaut-MD Predicted Velocity Precision (Standard Deviation)

Single Ping	30 second average	120 second average
7.7 cm/s	1.4 cm/s	0.7 cm/s

The standard XR and SL operate at an acoustic frequency of 1500 kHz. The expected standard deviation for each system is a function of the size of the measurement volume and the number of samples averaged. Like the MD, the XR and SL ping once per second and the number of samples averaged is equal to the averaging time in seconds.

The formula below can be used to predict the standard deviation of XR and SL velocity data (in cm/s) based on cell size (CS, in meters) and the number of samples averaged (N). Cell size is the extent of the measurement volume and is equal to the difference between cell begin and cell end.

$$\sigma = \frac{20}{\sqrt{N}\sqrt{CS}}$$

Table 2 shows standard deviation values for the Argonaut XR and SL at different cell sizes and averaging times.

Table 2. Argonaut-XR/SL Predicted Velocity Precision (Standard Deviation)

	1 m Cell Size	3 m Cell Size	10 m Cell Size
Single ping	20 cm/s	11.5 cm/s	6.3 cm/s
30-s avg.	3.7 cm/s	2.1 cm/s	1.2 cm/s
120-s avg.	1.8 cm/s	1.1 cm/s	0.6 cm/s

For the MD, velocity performance is identical between horizontal (XY) and vertical (Z) data. For the XR, the values shown in Table 2 reflect the performance of horizontal (XY) velocity data; vertical (Z) velocity data will have lower noise levels by about a factor of two. For the SL, the values reflect standard deviation in the cross-range direction (X) direction; along-range (Y) data will have lower noise levels by about a factor of two.

5.4. Percent Good

The MD records one additional quality parameter with each sample – *percent good*. Percent good is based on a statistical analysis of signal strength data from each beam. The MD looks for large variations in the signal strength from each beam, and throws out points that fall outside a pre-determined threshold. This helps prevent data contamination from fish that may occasionally cross the acoustic beam, particularly on moorings that may attract schools of fish.

For the MD, percent good is the ratio of samples used for velocity calculations to the total number of samples taken. Percent good is not used by the XR or SL.

6. Special Considerations

6.1. Dynamic Boundary Adjustment – Argonaut XR

One of the most powerful capabilities of the XR is its ability to automatically adapt to changing conditions using a technique called *dynamic boundary adjustment*. When mounted on the bottom, the XR can adjust the limits of the measurement volume based up the water level reported by an internal pressure sensor. Thus, with changing tide or river stage, the XR will adapt its operation to match the environmental conditions.

There are two forms of dynamic boundary adjustment. When measuring vertically-integrated flow, the start of the measurement volume is typically as close to the XR as possible. The end is set as close to the water surface as possible. Velocity data from the XR represents an integration over the entire water column and can easily be used for total flow calculations.

The second form of dynamic boundary adjustment is called *layered flow*. The user specifies a layer of water (relative to the surface) that is of interest; typically, the XR will measure velocity in the top N meters of the water column. The XR will adjust the location of the measurement volume relative to itself, maintaining the desired layer at a constant range from the water surface.

When using dynamic boundary adjustment, the XR takes into account both the mean surface elevation and changes in the surface level during the averaging period. Thus, if the XR is operating in a wave environment, the top end of the measurement volume will be placed below the level where velocity data could be contaminated during the trough of a wave. To aid analysis, each sample includes the mean and standard deviation of pressure as well as the limits of the measurement volume.

6.2. 2D Horizontal Current Measurements – Argonaut SL

The SL is normally mounted from an underwater structure looking to the side. The SL measures the 2D water velocity in the plane formed by its two acoustic beams, parallel to the water surface. The SL is typically installed at mid-water depth and can measure over a range of up to 15 m. This allows the SL to be safely and easily installed on an underwater structure, but still measure the water velocity away from any flow interference generated by the structure.

The primary limitation for SL operation is the maximum measurement range relative to the total water depth. This is expressed as the aspect ratio between the horizontal distance from the SL (Range) and the vertical distance to the surface or bottom (Height). Aspect ratio is defined as Range/Height.

While Argonaut transducers generate very narrow beams, these beams will spread after some distance and may see interference from the surface or bottom. The SL can operate without interference to an aspect ratio of 4-5 in most conditions, and in some situations (with smooth boundaries and high scattering levels) to an aspect ratio of 8-10. For example, if installed at mid-water depth in 3 m of water, the SL can accurately measure over a range of at least 6 m and perhaps as much as 15 m. The SL includes diagnostic software (**ARGCHECK**) that helps you determine the maximum effective range for a particular installation.

6.3. Near-Boundary Data Collection – Argonaut XR and SL

The XR and SL are designed for shallow-water operation and provide excellent performance near boundaries (surface, bottom, or underwater structures). Argonaut performance near boundaries is limited by three factors – direct reflection from the boundary, side lobe interference, and variations in the boundary range.

The definition of the XR and SL measurement volume is discussed in Section 4. The true end of the measurement volume extends 0.25 m beyond the specified limit. This area is not normally considered part of the measurement volume since its relative weighting is quite small. However, if the boundary falls into this region, it can have a significant impact on velocity data. The user-specified end of the measurement volume must be placed a minimum of 0.25 m from any boundary to avoid interference from this portion of the measurement volume.

Although Argonaut transducers concentrate most of the acoustic energy in a narrow beam, some energy is transmitted in all directions. A portion of this energy will take a direct path to the boundary and the reflection will return while the main beam is still some distance from the boundary. This is known as side lobe energy and the reflections are called side lobe interference.

Although side lobe energy levels are very small, the reflection from the boundary is much stronger than the return from the water and can potentially affect velocity measurements. The potential for side lobe interference exists in the last 10% of the measurement range. To avoid potential interference, the end of the measurement volume should be placed no closer than 10% of the total distance to the boundary (e.g., the end of the volume should be at 9 m if the boundary is at 10 m). The distance from the cell end to the boundary should be the greater of the potential side lobe interference (10% of range) and the 0.25 m mentioned above.

One final consideration for near-boundary measurements is allowance for any possible variations in boundary range (typically variations in water level). These variations can be long-term (tide or river stage) or short-term (waves). When using the XR with dynamic boundary adjustment, these variations and any potential boundary interference are accounted for automatically (see §6.1). If the measurement volume limits are controlled by the user, they should be set to avoid boundary interference at all times during a deployment.

6.4. Non-Directional Wave Parameters - Argonaut XR and SL

Argonaut XR and SL systems that have a pressure sensor can be configured to collect and record estimates of wave frequency spectra. The spectra are estimated from the 1-Hz pressure time series collected over the averaging interval. The estimation is done using standard methods appropriate to simple linear theory including: segmentation of the data in 256-point segments with at least 128-point overlap between consecutive segments; application of Hanning window to each segment with constant energy correction; and correction for sensor/water depth using general first order dispersion relationship for surface waves.

The wave spectral estimates are presented as an array of coefficients, each giving the mean wave amplitude (square root of the energy) within a period band. Ten bands are used, which correspond to two-second periods ranging over 2-20+ seconds.

For each band, the Argonaut computes and reports the mean wave amplitude (A) for waves within the period range in the band. If A_i is the amplitude for band, i, the total wave energy is given by:

Total energy (σ_A^2) = $\Sigma(A_i^2)$ for i=1 to 10

A generally accepted estimate of the significant wave height can be easily obtained from the amplitudes using:

H_{mo}=4 * √(Total energy)

6.5. Sound Speed

The Argonaut uses sound speed to convert the Doppler shift to water velocity. This section discusses how to correct Argonaut velocity data for errors in the sound speed used for data collection. Since the Argonaut uses an internal temperature sensor for automatic sound speed compensation, user corrections are rarely needed.

In shallow water, the speed of sound in water is a function of temperature and salinity. Generally, a temperature change of 5°C or a salinity change of 12 ppt results in a change in sound speed of one percent. The full range of typical temperature and salinity levels, from -5 to 50°C and 0 to 60 ppt, gives a sound speed range of 1375 to 1600 m/s (total change of 14%). SonTek can provide an algorithm for sound speed calculations upon request.

Argonaut velocities scale directly with sound speed: a 1% error in sound speed results in a 1% error in velocity measurements. The following formula is used for postprocessing corrections and can be directly applied to the output velocity data of the Argonaut.

$V_{true} = V_{orig} (C_{true} / C_{orig})$

Where

V_{true} = Corrected velocity measurements
V_{orig} = Uncorrected (original) velocity measurements
C_{true} = True speed of sound
C_{orig} = Speed of sound used in original calculations

Errors in sound speed also affect the physical location of the Argonaut measurement volume, although these errors are generally very small. To calculate the correct location of the Argonaut measurement volume, use the formula:

$Z_{true} = Z_{orig} (C_{true} / C_{orig})$

Where

Z_{true} = Corrected measurement volume location
Z_{orig} = Uncorrected (original) measurement volume location
C_{true} = True speed of sound
C_{orig} = Speed of sound used in original calculations

Index

Using Frequency Pressure Sensors with SonTek/YSI ADPs, Hydras, and Argonauts

This document describes the use of *frequency pressure sensors* with SonTek acoustic Doppler current meters. SonTek supports two types of frequency pressure sensors: (1) the Druck RPT, a silicon resonant transducer (referred to as DRUCK) manufactured by Druck, Inc. and (2) the Paroscientific digiquartz transducer (referred to as PAROSFREQ) manufactured by Paroscientific, Inc.

1. Overview

Typically, SonTek instruments include *analog pressure sensors* (e.g., strain gage) that provide sufficient accuracy and stability (0.1 to 0.25 %) at a moderate cost. These sensors are usually installed within the system head (Figure 1). They are internal to the system and are usually referred to as PRESSURE or PRESSURE SENSOR within our documents and system command interface.

Some applications, however, require better long-term stability (e.g., tide studies, wave interaction with topography, long-term water-level monitoring, etc.). To accommodate these needs, SonTek has integrated *frequency pressure sensors*, which offer an order of magnitude better accuracy and stability (0.01%). The first supported sensor was the Paroscientific digiquartz with a serial interface (PAROS). These sensors, because of their size did not fit inside our systems and were mounted externally (Figure 1). The next supported sensor, the Druck RPT, did fit inside an ADP or ADVOcean head. However, for historical purposes, all *non-strain gage sensors* are usually referred to as EXTERNAL PRESSURE SENSOR within our documents and system command interface.

2. Serial External Pressure Sensors (PAROS)

As mentioned, the first external pressure sensor supported by SonTek was the Paroscientific digiquartz with serial interface (PAROS). The PAROS is connected to a system by a 1 to 2-m cable. The PAROS is available for ADP, PC-ADP, and Hydra systems. The differences, when compared with a strain-gage sensor, are as follows:

- The PAROS is an absolute sensor. It reads 1 dbar in air; a strain gage reports 0 dbars in air.
- Sampling rate is limited to 4 Hz (ADVs and Hydras) due to serial interface limitations.

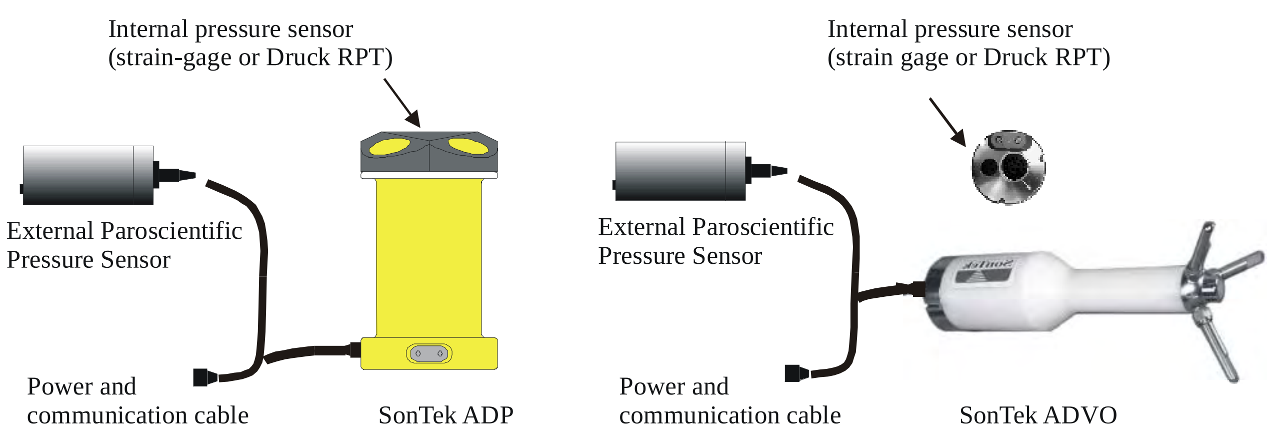


Figure 1: ADP and ADVOcean with external pressure sensors.

3. Frequency External Pressure Sensors

3.1. The Druck RPT (DRUCK)

Although the PAROS provides the required accuracy, its size and external location cause additional complications when mounting and deploying a system. SonTek, in collaboration with Druck, Inc., now offers the Druck RPT (resonant pressure transducer) sensor. This sensor is very compact and fits inside the same mounting socket as the regular strain gage (Figure 1). The DRUCK sensors are available for ADP, PC-ADP, Argonaut SL/XR, and Hydra systems. The differences, when compared with a strain-gage sensor, are as follows:

- The DRUCK is an absolute sensor. It reads 1 dbar in air; a strain gage reports 0 dbars in air.
- Requires a special interface to sample the frequency signal.
- Sampling rate is limited to 10 Hz (ADVs and Hydras) because of the time required to sample the frequency signal with sufficient precision.
- Requires calibration matrix (specific to each sensor) to be loaded into the processor (system CPU or a user PC) to obtain valid pressure readings.
- Available in 50-psia pressure rating only (equivalent to ≈22 dbar strain gage).

3.1.1. Sensor Calibration Template

Each current meter purchased from SonTek that has the DRUCK sensor installed already has the appropriate calibration coefficients loaded into the processor. If this information is lost, you can use the calibration sheet provided by the pressure sensor vendor to construct your own calibration file. The structure of the DRUCK calibration file, required by SonTek systems, is as follows.

- Pressure Sensor Serial Number
- Oscillator Frequency (in Hz)
- X
- Y
- Low end of temperature range
- Corresponding voltage of the diode
- Diode sensitivity
- K00 K01 K02 K03
- K10 K11 K12 K13
- K20 K21 K22 K23
- K30 K31 K32 K33
- K40 K41 K42 K43
- K50 K51 K52 K53

Note: The X, Y, and K coefficients can be found on the Druck calibration sheet.

Example – Druck calibration file **`1145118.drk`**:

```
1145118
12.0000000E+06
+8.8880000E+03
+5.5200000E+02
-10
622
-2.21
+1.6214761E+03  -2.0699499E-02  +5.5220000E-05  -5.6160001E-08
+1.8251241E+00  -5.8612000E-06  +3.6197001E-08  -3.8715001E-10
+3.8615943E-04  -1.5274000E-09  -4.7059999E-12  -1.3233001E-13
+7.0553313E-08  -1.9064000E-12  -4.0058001E-14  +9.0119996E-16
+1.7913088E-11  -1.3525000E-15  +1.7647000E-17  +3.8552999E-19
+3.7756621E-15  +1.9573000E-19  +3.6951001E-20  -3.3300999E-22
```

3.2. The Paroscientific Digiquartz (PAROSFREQ)

User requirements for deeper ratings (compared to DRUCK) and faster response (compared to PAROS) convinced SonTek to offer the Paroscientific digiquartz sensor with frequency output (PAROSFREQ). Functionally, the interface for the PAROSFREQ is identical to the interface for the DRUCK, as both are frequency-based sensors. The PAROSFREQ sensors are available for ADP, PC-ADP, and Hydra systems. The differences, when compared with a strain-gage sensor, are as follows:

- The PAROSFREQ is an absolute sensor. It reads 1 dbar in air; a strain gage reports 0 dbars.
- Requires a special interface to sample the frequency signal.
- Requires a special frequency splitter cable.
- Sampling rate is limited to 10 Hz (ADVs and Hydras) because of the time required to sample the frequency signal with sufficient precision.
- Requires a calibration (specific to each sensor) to be loaded into the processor (system CPU or a user PC) to obtain valid pressure readings.
- Available in 50-psia (≈22 dbar strain gage) and 100-psia (≈60-m strain gage) pressure ratings.

The structure of the calibration file corresponding to the PAROSFREQ sensor is similar to the DRUCK. For historic reasons, PAROSFREQ calibration file uses the .drk extension.

- Pressure Sensor Serial Number
- Oscillator Frequency (in Hz)
- U0
- N/A
- N/A
- N/A
- N/A
- Y1 Y2 Y3 N/A
- C1 C2 C3 N/A
- D1 D2 N/A N/A
- T1 T2 T3 T4
- N/A N/A N/A N/A
- N/A N/A N/A N/A

> Note: The U, Y, C, D, and T coefficients can be found on the Paroscientific calibration sheet.

Example – Paroscientific calibration file **`p68888.drk`**:

```
P68888
12.0000000E+06
5.880670
0.0
0.0
0.0
0.0
-3898.415      -10940.31         0.0          0.0
  224.5927          6.013600   -245.2861      0.0
    0.041219        0.0           0.0          0.0
   27.94067         0.859765     20.65914     26.99304
    0.0             0.0           0.0          0.0
    0.0             0.0           0.0          0.0
```

4. Additional System Commands

This section describes the system commands used for external pressure sensor operation.

4.1. ADPs and Hydras

The following commands apply to ADP and Hydra (ADVOcean) systems that have an external pressure sensor installed.

`ExtPressureSensorInstalled Set [NONE|PAROS|DRUCK|PAROSFREQ]`

- Selects or disables the external pressure sensor type.
- Set at the factory. Does not need to be changed except in some special cases.
- The external pressure sensor option limits the maximum sampling rate of an ADV to 4 Hz for the PAROS and to 10 Hz for a DRUCK or PAROSFREQ. To collect data at faster rates, you must disable the external pressure sensor option.

`PressFreqOffset Set [d]`

- Default parameters (in kHz): **`0`** (for DRUCK); **`21`** (for PAROSFREQ)
- Sets/displays frequency offset (in kHz).
- This parameter is set at the factory and should not be changed by the user.

`PAROS CONT` *or* **`DRUCK CONT`** *or* **`PAROSFREQ CONT`**

- This command provides a useful tool to verify and troubleshoot the frequency sensor.
- For PAROS sensors:
  - This command continually outputs pressure reading in dbar.
  - If the pressure reading is zero, the connection between the sensor and the processing electronics may be damaged (or open).
- For DRUCK and PAROSFREQ sensors:
  - This command outputs a sample consisting of converted pressure (dbar), temperature (°C), and raw frequency counts (Hz) in the following format:

    ```
    Druck Press =     10.03192    Temp = 22.11    Freq =   8055.674
    ```

  - The DRUCK frequency range (in air) is 7 to 10 kHz; the PAROSFREQ is 35 to 38 kHz.
  - If the frequency reading is zero, or is outside the range, the connection between the sensor and processing electronics may be damaged (or open).
  - If the frequency reading is reasonable, but the corresponding pressure is not, this indicates that the appropriate calibration is not loaded into the processor. Section 5 describes how to load the DRUCK calibration.

`Show DRUCK` *or* **`Show PAROSFREQ`**

- Displays DRUCK/PAROSFREQ calibration data in the following format:

```
Druck pressure sensor calibration data
--------------------------------------
SN:     1276950
F0:       1.200e+07
X:   8.4410000e+03
Y:   5.6000000e+02
T0: -1.0000000e+01
D0:  6.2900000e+02
DT: -2.2100000e+00

K00:  1.5962190e+03   K01: -2.6693000e-02
K10:  1.6820332e+00   K11: -1.0395800e-05
K20:  3.9933779e-04   K21: -4.9470601e-09
K30:  8.0327140e-08   K31: -1.4093000e-12
K40:  1.7388157e-11   K41:  2.2691999e-16
K50:  2.5953699e-15   K51:  1.3877999e-19

K02:  3.1005999e-05   K03:  2.6474001e-07
K12:  1.8332999e-08   K13:  8.2459997e-11
K22:  1.6572001e-11   K23: -1.7079999e-14
K32: -7.7020003e-15   K33: -9.9870002e-17
K42: -4.0642002e-18   K43: -1.0678000e-19
K52:  5.3660002e-21   K53: -2.8249999e-23
```

4.2. Argonaut SL/XR

The following command applies to Argonaut SL and XR systems that have an external pressure sensor installed.

`ExtPressInstalled [NONE|PAROS|DRUCK]`

- Selects or disables the frequency pressure sensor type.
- Set at the factory. Does not need to be changed.

5. Additional Software

This section describes additional software required to use external frequency pressure sensors (DRUCK/PAROSFREQ) with SonTek instruments.

5.1. Downloading and Extracting Druck Calibration: LDDRUCK/GTDRUCK

The **`LDDRUCK.EXE`** program *loads* the DRUCK/PAROSFREQ calibration file into the instrument's processor. The command syntax is:

```
LDDRUCK [DruckCalFile] [-COM port] [-Baud Rate] [-Address]
```

where

- `DruckCalFile` is the name of the calibration file (no extension).
- `-COM port` is the serial port to which the system is connected (1=COM1; 2= COM2).
- `-Baud Rate` is the communication baud rate setting of the system. If no value is given, the program assumes the default setting of 9600 baud. Acceptable baud rate settings are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.
- `-Address` is the address for a RS-485 system.

Example: **`LDDRUCK P84567 –p1 –b19200 –a2`** will download the file **`P84567.DRK`** onto the system at address **`2`** connected to COM port **`1`** at **`19200`** baud.

The **`GTDRUCK.EXE`** program *gets* (downloads) the DRUCK/PAROSFREQ calibration file from the instrument's processor to the user's PC. The command syntax is:

```
GTDRUCK [MyCalFile] [-COM port] [-Baud Rate] [-Address]
```

where

- `MyCalFile` is the name of the calibration file (no extension).
- `-COM port` is the serial port to which the system is connected (1=COM1; 2= COM2).
- `-Baud Rate` is the communication baud rate setting of the system. If no value is given, the program assumes the default setting of 9600 baud. Acceptable baud rate settings are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.
- `-Address` is the address for a RS-485 system.

Example: **`GTDRUCK B199 –p2 –b19200`** will retrieve the calibration data from the system connected to COM port **`2`** at **`19200`** baud and store the data into file **`B199.DRK`**.

5.2. PC-ADP Header Extraction: GADPHDR

During data collection, standard ADPs store mean pressure data (converted into dbars) in the header. PC-ADPs, however, usually profile at much faster rates. As such, the pressure data from the DRUCK or PAROSFREQ sensor is stored in raw frequency counts as a way to increase system performance. The extraction program **`GADPHDR.EXE`** lets you specify the DRUCK/PAROSFREQ calibration file so the pressure data can be converted into dbars during the data extraction process. The command syntax is:

```
GADPHDR [DataFile] [-P]
```

where

- `DataFile` is the name of the PC-ADP data file being extracted (.adp extension implied).
- `-P` is the name of the pressure sensor calibration file (.drk extension implied).

Example: **`GADPHDR MYDATA –Pp87654`** will extract header data from the **`MYDATA.ADP`** data file using DRUCK/PAROSFREQ calibration data from the **`p87654.DRK`** file. Note: If incorrect calibration data is used, the pressure data will not be correct.

5.3. ADP Wave Data Extraction: GADPWAVE/GADPPRES

To increase system performance when collecting wave or pressure series data, the ADP stores wave and pressure series data in raw frequency counts (DRUCK/PAROSFREQ sensors only). To extract the data, use the **`–P`** command line option to specify the DRUCK/PAROSFREQ calibration file so the data can be converted to dbars during the data extraction process. Examples:

```
GADPWAVE ADPWAVE –Pp87654
```

will extract wave data from the **`ADPWAVE.ADP`** using DRUCK/PAROSFREQ calibration from the **`p87654.DRK`** file.

```
GADPPRES ADPWAVE –Pp87654
```

will extract pressure series data from the **`ADPWAVE.ADP`** using DRUCK/PAROSFREQ calibration from the **`p87654.DRK`** file.

Note that in both cases that if incorrect calibration data is used, the output data will be invalid.

5.4. Hydra Data Extraction: GADVTS/GADVHDR

To increase system performance, the Hydra stores pressure series data in raw frequency counts (DRUCK/PAROSFREQ sensors only). To extract pressure series data, use the **`–D`** command line option to specify the DRUCK/PAROSFREQ calibration file so the data can be converted to dbars during the data extraction process. Examples:

```
GADVTS HYDRAFILE –Dp87654
```

will extract time-series data from the **`HYDRAFILE.ADR`** using DRUCK/PAROSFREQ calibration from the **`p87654.DRK`** file.

```
GADVHDR HYDRAFILE –Dp87654
```

will extract header data from the **`HYDRAFILE.ADR`** using DRUCK/PAROSFREQ calibration from the **`p87654.DRK`** file.

Note that in both cases that if incorrect calibration data is used, the output data will be invalid.

5.5. Windows Software Support

SonTek Windows-based software offers an alternative to the DOS extraction programs for handling the external pressure sensor calibration data.

5.5.1. Downloading Calibration File Using SonTermW

Starting with v2.0, SonTerm for Windows (*SonTermW*) provides an easy way to load the frequency pressure sensor calibration file into the system processor. Simply establish communication with the system in *SonTermW*, click the **Load Druck Calibration** icon, choose the appropriate file, and the load process will be performed.

5.5.2. Specifying Calibration File When Using ViewHydra

When opening a data file (.adr) with *ViewHydra*, you must supply a sensor calibration file (.drk) to convert pressure data to dbars. If no pressure calibration is provided, all pressure data will be displayed in raw frequency counts. *ViewHydra* lets you save the calibration data in an associated data file workspace, so the calibration data is loaded automatically the next time the data file is opened.

After the data file is loaded, you can select the sensor offset from the processing menu to convert the absolute pressure reading.

1. Run DRUCK/PAROSFREQ in *SonTermW* and make note of the pressure reading with the system in the air (say 10.025 dbar for this example).
2. In the **Processing|Sensor Calibration Settings…** menu, set **Sensor Type** to **Ext Pressure**, and then enter a value of **–10.025** (for this example) in the **Offset** field to convert pressure data into strain gage data (relative to the atmosphere).
3. Now use the **Processing|Recompute Burst Statistics File…** option to propagate the changes into the burst-averaged data.
4. When exiting the program, use the **Save (Overwrite) Workspace** option to store the calibration and offset data. The program will now remember this information for this data set.

5.5.3. Using ViewADP with PCADP Data and Waves

Data collected by a standard ADP stores mean pressure data in dbars; no additional conversion is needed. However, PC-ADP data and ADP wave series data (P-SERIES & PUV-Series) require pressure calibration.

When opening a data file with *ViewADP*, click the **Load ExtPres CalFile** button to specify the calibration file.

Notes:

1. If pressure calibration is not loaded, all pressure data will be displayed as raw frequencies.
2. If pressure calibration data is not loaded, wave data processing is disabled.
3. ViewADP will save the calibration data in the associated data file’s workspace. This allows the calibration data to load automatically the next time the data file is opened.