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Argonaut-SL System Manual Firmware Version 12.0

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RECORD OF CHANGES

Effective	Description
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Declaration of Conformity

Manufacturer's Name: SonTek/YSI Inc
Manufacturer's Address: 9940 Summers Ridge Road
San Diego, CA 92121-3091 U.S.A.

SonTek/YSI declares that the product(s):

Equipment Type: Water Velocity Measurement Device

Model: Argonaut Series

Product Name: Argonaut XR 3.0 MHz, 1.5 MHz, 750 kHz, and 500 kHz;
Argonaut SL 3 MHz, 1.5 MHz, and 500 kHz;
Argonaut SW 3 MHz;
Argonaut DVL 3 MHz, 1.5 MHz, and 500 kHz;
Argonaut MD 3 MHz and 1.5 MHz.

Conforms to the following European Union Council Directives and Standards as of 5/21/04:

EMC DIRECTIVE 89/336/EEC: -EN 61326 (1997), A1 (1998), A2 (2001), Class "A"
-EN 61000-3-2 (2000)
-EN 61000-3-3 (1995)
-IEC 61000-4-2 (1995), A1 (1998), A2 (2000)
-IEC 61000-4-3 (2002), A1 (2002)
-IEC 61000-4-4 (1995), A1 (2000), A2 (2001)
-IEC 61000-4-5 (1995), A1 (2001)
-IEC 61000-4-6 (1996), A1 (2000)
-IEC 61000-4-11 (2001)

Director of Sales and Marketing,

Chris Ward

Release Notice

This is the April 1, 2009 release of the *Argonaut-SL System Manual*. During the creation of this manual, the following were the latest available versions of firmware/software. As such, if you are using different firmware/software versions, not all aspects of this manual may apply.

- Argonaut firmware version 12.0
- *ViewArgonaut* software version 3.70

Trademarks

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Warranty, Terms, and Conditions

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 as a result of errors in the measurements.

If your system is not functioning properly, first try to identify the source of the problem. If additional support is required, we encourage you to contact us immediately, and we will work to resolve the problem as quickly as possible.

If the system needs to be returned to the factory, please contact SonTek/YSI 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 the original shipping container using the original packing material with all delivery costs 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 a new packaging crate and material.

About This Manual

Thank you for your interest in using a SonTek Argonaut Side-Looking (SL) system. This *Argonaut-SL System Manual* describes how to install and configure the Argonaut-SL system and its associated software. It includes instructions and guidelines for the most common applications for which this system is used.

Scope and Audience

Even if you have used other SonTek acoustic Doppler products, we recommend that you spend some time reading this manual to learn about the special features of this system.

This manual is more “application-oriented” in that it tries to explain how to use the Argonaut-SL system for specific, real-world applications. If you intend to use the instrument for other applications (e.g., in lab experiments, etc.), or if you need detailed information about the instrument itself, please [contact us](#).

How to Use This Manual

This manual was especially designed for on-line viewing through a computer. Even though you may now be reading a paper copy of this manual, an “electronic” copy of this manual was provided to you on the distribution disk (*Argonaut-SL.pdf*).

The use of this “PDF” file requires you to have the **Adobe® Acrobat Reader®** software installed on your computer. This software is freely available from Adobe at <http://www.adobe.com>.

This *Argonaut-SL.pdf* file is also used as a Help file within the *ViewArgonaut* software program. If you install *ViewArgonaut* on your computer using the default installation instructions (§1.3), the *Argonaut-SL.pdf* file will be in the folder C:\Program Files\SonTek\Manuals and a shortcut to the manual will be created (Start|Programs|SonTek Software|Argonaut-SL Manual).

The PDF version of this manual makes it easy for you to navigate within the document. Several hyperlinks (in blue) let you quickly go to referenced sections, figures, tables, and [glossary](#) definitions. Additionally, you can use the built-in search features of Acrobat to find specific words and phrases. With the PDF copy, you can also print out high-quality copies of the manual to paper (for your organization’s personal use only and not for resale or redistribution).

You do not need to read this manual in sequential order. We do suggest you read [Section 1 \(Getting Started / Read Me First!\)](#) if you are a new user or if you have just received a new system. Glance through the [Table of Contents](#) and pick out those topics that interest you.

Reader Feedback

Your feedback about the Argonaut-SL system and this manual will help us to improve our products. Please let us know what improvements we can make by contacting us via telephone, fax, or e-mail (see next page for [Contact Information](#)).

Contact Information

Any questions, concerns, or suggestions can be directed to SonTek by telephone, fax, or email. Business hours are 8:00 a.m. to 5:00 p.m., Pacific Standard Time, Monday through Friday.

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

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Section 1. Getting Started / Read Me First!

1.1. Start Here!

Thank you for your interest in the SonTek Argonaut Side-Looking (SL) system ([Figure 1-1](#) or [Figure 1-2](#)). Although we would like you to read and familiarize yourself with the entire manual before making a measurement, we realize many people just want to play with their new system when they first receive it. As such, we're going to let you play with the system right now!

- This section assumes that you are a new user, or that you have just received a new Argonaut-SL system.
- In either case, all we are going to do here is explain how to interconnect and test your Argonaut-SL system to give you confidence that the system is functioning properly.
- Afterwards, other sections of the *Argonaut-SL System Manual* will provide the details you need to know regarding system applications, features, operation, and maintenance.

Note: The *Argonaut-SL System Manual* was designed for on-line viewing using a computer. A PDF copy of the manual is provided as an integral part of the *ViewArgonaut* program. For details, read [About This Manual](#) at the front of the *Argonaut-SL System Manual*.



Figure 1-1. Low-Profile Systems: SL500 (left); SL1500 (center); SL3000 (right)

1.2. Unpack the System

As obvious as this may sound, you will need to unpack your system after you receive it. During the unpacking process, you should:

- Check the shipping container and its contents for obvious damage.
- Verify you have received all expected items. This can be done using the *Packing List* that accompanied the shipping container. However, interpreting the *Packing List* is not always obvious (e.g., some listed items like the recorder are *inside* the sealed housing). It may be simpler for you to compare your original *Quotation* or *Sales Order* with the items you received. Standard Argonaut-SL equipment items are shown in [Figure 1-3](#), [Figure 1-4](#), [Figure 1-5](#), or [Figure 1-6](#) depending on model type.
- Contact SonTek regarding damaged or missing items.
- We strongly recommend you keep the shipping container and all its packing material in a safe place. If you need to return your system to the factory, the original shipping container and packing material will help ensure its safe return.



Figure 1-2. Original Canister-Style SL

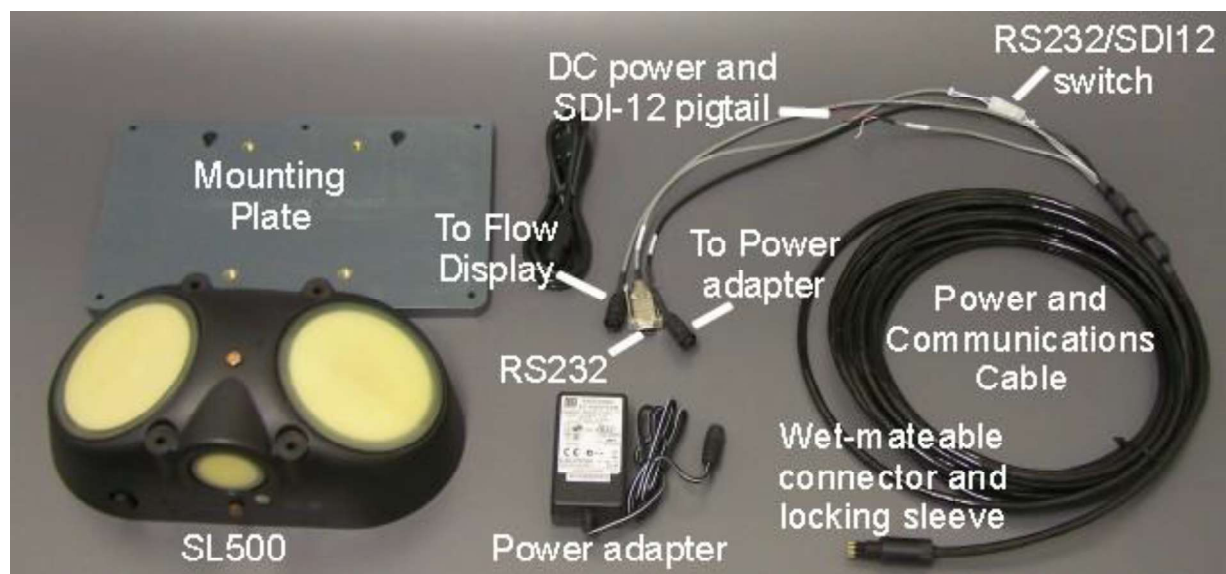


Figure 1-3. SL500 with Standard Equipment



Figure 1-4. SL1500 with Standard Equipment



Figure 1-5. SL3000 with Standard Equipment



Figure 1-6. Original Canister Style 1500 or 3000-kHz Argonaut-SL with Standard Equipment

1.3. Install the Software

Argonaut-SL systems typically ship with one CD-ROM disk that contains the applicable software programs and documents. Although we may not use all the programs during this Getting Started session, we will install all the primary software programs and documentation at this time.

To install the standard Argonaut-SL programs and manual (*SonUtils*, *ViewArgonaut*, *Argonaut-SL.pdf*):

- _ Insert the Argonaut distribution CD into your computer's CD-ROM drive.
- _ An installation menu should automatically appear after the CD has been inserted.
 - If the installation menu does not appear in a few seconds, click **Start | Run** and type **d:\install.exe** where **d:** is the letter of your CD-ROM drive.
- _ Click the installation button for the *SonUtils* program, and then follow the on-screen installation instructions.
- _ Repeat the process of clicking the installation button for the remaining programs on the CD (e.g., *ViewArgonaut*).
- _ Note: To view the PDF version of the *Argonaut-SL System Manual*, which is included during *ViewArgonaut* installation, you will need to have a copy of **Adobe® Acrobat Reader®** installed on your computer. If necessary, you can download a free copy of this reader from <http://www.adobe.com>.
- _ The PDF version of the manual makes it easy for you use the hypertext links and search features contained within the document to find topics of interest.

1.4. Interconnect the System

All we are going to do here is interconnect the system enough to test the Argonaut-SL itself. We will do this “right out of the box” so you can quickly gain some experience in how to set up and use the SL. Later, you can refer to the *Argonaut-SL System Manual* for detailed information on how to interconnect other peripherals that may comprise your system. Refer to **Figure 1-3** through **Figure 1-6** (depending on model type) for assistance in identifying system components.

- _ Locate the Power/Serial Communications Cable and connect the cable's keyed, 8-pin, wet-mateable connector to the SL.
 - Caution:** When mating the connector to the SL, push the connector with enough force to overcome the resistance of the wet-mateable pins. Push the connector until its face is flush with the female bulkhead connector. Do not simply tighten the locking sleeve during the mating process; just tightening the sleeve will not ensure proper pin alignment nor will it supply the required force to ensure a waterproof seal.
- _ Connect the cable's RS-232 connector to an appropriate COM port on your computer (usually COM1).
- _ Connect the cable's power input connector(s) to your power supply. For our testing purposes, try to use the Power Adapter supplied with the system.
 - Caution:** If you will be applying power to the SL using a different external power source (e.g., automobile battery, variable power supply, etc), be aware that the SL requires a 7 to 15 VDC power supply to operate. Do not exceed the 15 VDC maximum or damage to the electronics will occur. Use “clean” power (e.g., filtered, no spikes).
- _ Run some simple tests; see §1.5.

1.5. Run Some Simple Tests

We now want to run just a few simple tests to give us some confidence that the system is functioning “right out of the box.”

- _ If you have not already done so, install at least the *SonUtils* program (§1.3).
- _ Interconnect the system as described in the previous section (§1.4).
- _ Apply power to the SL system.
- _ Start the *SonUtils* program (**Start|Programs|SonTek Software|SonUtils***). *Note: The *SonUtils* program shortcut may contain a release number; for example, **SonUtils4**.
- _ If necessary, set up the **Communications** parameters within *SonUtils* – typically **COM1**, **Baud Rate 9600** mode (**Figure 1-7**). If you need more information about setting the communications parameters, use **Help|SonUtils Help** and refer to the section on **Communications**.
- _ If necessary, set the **Input Type** to **Command** mode. Note: At this point, we only want to test the SL, so we will not test any other communication mode (e.g., **SDI-12**). For details on SDI-12 communications, see §5.8.3 and **Appendix E** of the *Argonaut-SL System Manual*.
- _ Click **Break** (or press **Alt+B**) to send the initialization (i.e., wake-up) command to the SL. You should see a copyright/initialization message similar to the one shown in **Figure 1-7**.

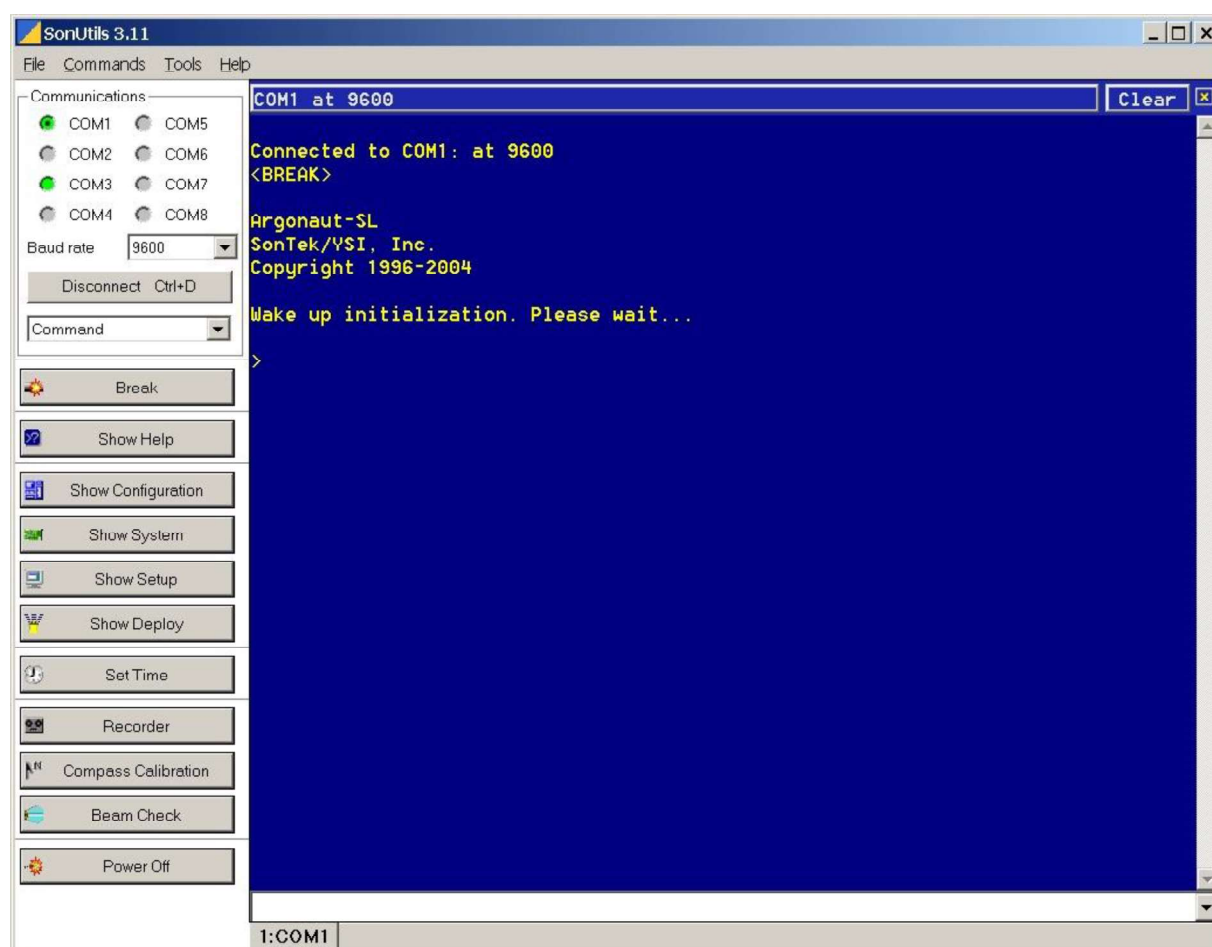


Figure 1-7. Establishing Communications using SonUtils

- **Note:** While we are using *SonUtils*, if no valid entry is sent to the system for five minutes, the SL may power itself down to conserve energy. If this happens, just send another **Break** to the SL to wake it up again. Whether your SL goes to sleep after five minutes depends on the system configuration. Typically, an SL will go to sleep after five minutes.
- Let's record all our commands and the results to a log file in case we need to review any settings or problems. Click **File|Open Log File** (or press **Ctrl+L**). Enter a file name and location when prompted.
- Click each of the following four controls to get various listings that show how your system is configured.
 - **Show Conf** – Lists the SL hardware configuration. Example:

```
>show conf
HARDWARE CONFIGURATION PARAMETERS
-----
System Type ----- SL
Sensor serial # ----- E1000
Sensor frequency - (kHz) ----- 1500
Number of beams ----- 2
Beam Geometry ----- 2_BEAMS
Vertical Beam ----- YES
Slant angle - (deg) ----- 25.0
Orientation ----- SIDE
Compass installed ----- NO
Recorder installed ----- YES
Temperature sensor ----- YES
Pressure sensor ----- YES
PressOffset - (dbar) ----- -1.450000
PressScale -- (dbar/count) ---- 0.000167
PressScale_2 - (pdbar/count^2) - 23
Ctd sensor ----- NO
Ext. Press. sensor ----- NONE
YSI sensor ----- NO
Waves Option ----- NO
Internal SDI-12 Option ----- YES
Internal Flow Computations ----- YES
Analog Output Option ----- NO
Multi-cell Profiling Option ---- YES
Housing Type ----- LOWPROFILE
```

- **Show System** – Lists current system parameters. Example:

```
>show system
System Parameters
-----
CPU Ver ----- ARG 11.0
BoardRev ----- REV G
Date ----- 2004/12/23
Time ----- 08:50:23
AutoSleep ----- YES
VoltageProtection- YES
OutMode ----- AUTO
OutFormat ----- ENGLISH
Recorder ----- ON
RecMode ----- NORMAL
```


- **Show Setup** – Lists current SL setup parameters. Example:

```
>show setup
Setup Parameters
-----
Temp ----- 20.00 deg C
Sal ----- 0.00 ppt
TempMode ----- MEASURED
Sound Speed ---- 1481.6 m/s
AvgInterval ---- 120 s
SampleInterval - 900 s
CellBegin ----- 2.00 m
CellEnd ----- 10.00 m
CoordSystem ---- XYZ
RevXVelocity --- NO
PowerPing ----- YES
ProfilingMode -- YES
Ncells ----- 10
CellSize ----- 1.00
BlankDistance -- 1.00
```

- **Show Deploy** – For systems with internal records, lists current deployment parameters. Example:

```
>show deploy
CURRENT DEPLOYMENT PARAMETERS
-----
Deployment ----- TEST
StartDate ----- 2005/03/01
StartTime ----- 12:00:00
AvgInterval ---- 120 s
SampleInterval -- 900 s
BurstMode ----- DISABLED
BurstInterval --- 1200 s
SamplesPerBurst - 1
Comments:
This is a test file.
```

- Now we will run a short deployment to ensure the transmit and receive circuitry is functioning. First, we need to enter some parameters to tell the SL how long to *ping* (i.e., how long to collect and display data). Note that the parameters we are about to enter are not typical parameters; we are only using them to quickly test the system. Enter the following four parameters (press **<Enter>** after each entry; upper, lower, or mixed case letters can be used).

```
>AvgInterval 60      (or you can use the shortcut of "ai 60")
OK                  (SL's acceptance response)
>SampleInterval 60   (or "si 60")
OK
>OutFormat English   (or "of english"; ensures output is not in binary)
OK
```

- Type in **START** and press **<Enter>**. The system will begin to collect and display data every ten seconds. You should see a display similar to the following. At this point, the values displayed are meaningless, especially if your SL is pinging “in air” rather than in water. Note: To learn which data are displayed in each column, refer to **Appendix D** of the *Argonaut-SL System Manual*.

```
>start
Checking Setup Parameters...
4194304 free bytes left in recorder.
Free space is sufficient for 2.82 days of operation.
```

```

Data will be recorded to file TEST001.
OK
2005 04 05 03 55 11      0      0      -1 255 255  0  0  0  0  0
0  0  0  0  0  0  1818      16      0  71  20  20  34  29
30      0      -1      0      13  0
 1  -146      51 191  88  36  32
 2   179     -117 249 116  35  29
 3   -95      -13 204  94  35  29
 4   146     -65 235 108  34  29
 5   -80     -34 183  84  34  29
 6  -236      54 162  74  34  29
 7  -147      49 178  82  34  29
 8  -111      32 255 121  34  29
 9   -56     -94 161  74  34  29
10    85    -122 255 125  34  29

```

- To stop the SL data collection process, click **Break** (or press **Alt+B**) to send the initialization (i.e., wake-up) command to the SL. You should see a copyright/initialization message similar to the one shown in [Figure 1-7](#). Now press **<Enter>**.

Note: The reason we pressed **<Enter>** is to prevent the SL from resuming the data collection process. This is because, depending on how your system is configured, if you do not send another command to the SL within three minutes of sending the **Break**, the system will once again start collecting data. This is a safety precaution that helps to resume a deployment in case extraneous signals received by the SL are incorrectly interpreted as a **Break** (e.g., when a communication cable is being connected/disconnected, or power to the system is lost temporarily).

- There are several “internal” sensors that we can check — Temperature, Pressure, and Battery Voltage. Type in **SENSOR CONT** (for “sensor continuous” test) and press **<Enter>**. The *SonUtils* screen will begin to show Temperature (in °C), Pressure (in dBar), and Battery Voltage (in VDC).

```

>sensor cont
Temp = 17.22    Pressure = 0.05    Battery = 14.3
Temp = 17.24    Pressure = 0.05    Battery = 14.3
Temp = 17.24    Pressure = 0.05    Battery = 14.3

```

- When you are ready to stop the sensor check, press **<Enter>**.
- To check the internal recorder, type in **DIR** and press **<Enter>**. The *SonUtils* screen will display a listing of any files that are currently stored on the recorder (if any), the number of recorder bytes used, and the number of recorder bytes free.
- That’s it! We’ve finished running these simple tests as a quick way to familiarize you with the system and to ensure the system is functioning. If you are an experienced user, you can begin the process of setting up for a “real” application (see [§1.6](#) for suggestions).
- When you have finished your testing, you can now power down and disconnect the SL. To power down the SL, enter the **PowerOff** command or remove power from the system.
- If you need more information about how to set up and use the system, the next section ([§1.6](#)) gives you some suggestions on what you can do next.

1.6. Learn the Details

So now what? Well, that really depends on your experience level or on what you would like to do. Most sections of the *Argonaut-SL System Manual* can be read independently. That is, you do not have to read them in sequential order. Here are a few suggestions:

New Users

- [Appendix B – Argonaut-SL Principles of Operation](#)
- [Section 2 – An Introduction to the Argonaut-SL System](#)
- [Section 3 – Argonaut-SL System, Features, and Considerations](#)
- [Section 4 – Argonaut-SL Applications](#)
- [Section 5 – Preparing the Argonaut-SL for Deployment](#)
- [Section 6 – Retrieving and Analyzing Argonaut-SL Data](#)

Experienced Users / Software Users / Deployment Information

- [Section 5 – Preparing the Argonaut-SL for Deployment](#)
- [Section 6 – Retrieving and Analyzing Argonaut-SL Data](#)

Theory and Details

- [Appendix B – Argonaut-SL Principles of Operation](#)
- [Appendix G – Internal Flow Calculations](#)

Section 2. An Introduction to the Argonaut-SL System

The following topics are covered in Section 2:

- [What is an Argonaut-SL?](#)
- [Where can an Argonaut-SL be used?](#)
- [Why use an Argonaut-SL?](#)

2.1. What is an Argonaut-SL?

The Argonaut-SL is an acoustic Doppler current meter that looks horizontally across a body of water (e.g., river, channel, harbor) and measures water velocity, stage, and total water flow. The SL is easily installed on a riverbank, bridge abutment, or other vertical structure ([Figure 2-1](#)).

- The SL measures velocity in a user-programmable cell extending up to 120 m horizontally from the instrument (maximum measurement range varies with frequency). Flow disturbances caused by the mounting structure can be avoided by positioning the measurement cell beyond the area affected by the structure.
- Newer SLs include a vertical acoustic beam for stage measurements (some older SLs did not include a vertical beam). Stage can be combined with velocity and user-supplied channel geometry to compute total flow.
- The SL never requires calibration — velocity accuracy is not affected by biological growth.
- Options for velocity profiling, telemetry, and water quality sensors extend the capability of the SL to a wide variety of applications.

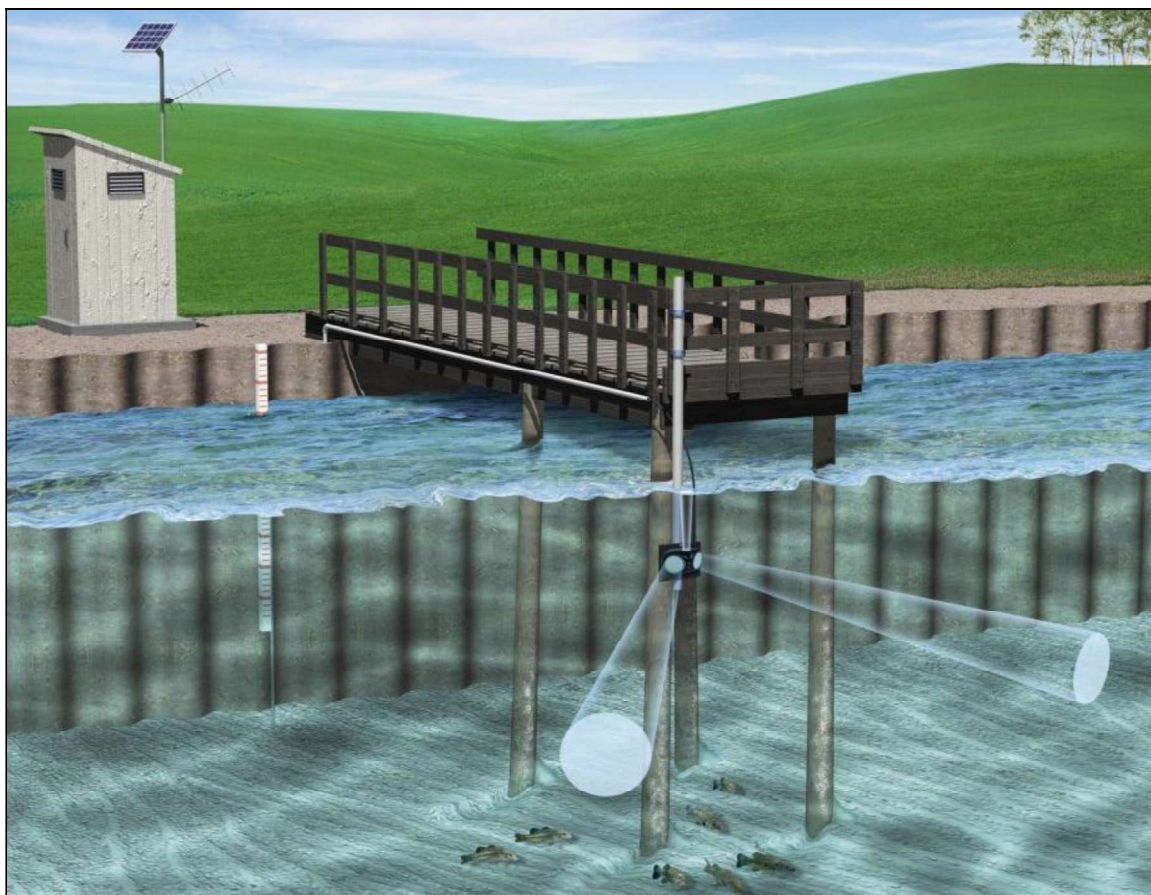


Figure 2-1. Typical Argonaut-SL Installation

The Argonaut-SL system combines proven state-of-the-art acoustic Doppler instrumentation with a Windows-based (98/2000/NT/XP) software package. The high degree of accuracy and ease of use that the system provides allows you to confidently measure water current velocities and flow using a single mode of operation.

2.2. Where can an Argonaut-SL be used?

The Argonaut-SL system has been designed to work in a wide variety of water resource applications and locations, including:

- River discharge monitoring
- Velocity indexing
- Irrigation channels
- Water supply
- Flood alert systems
- Pollution monitoring (with optional YSI sonde)
- Vessel traffic / ship berthing
- Offshore platforms

2.3. Why use an Argonaut-SL?

The Argonaut-SL system and its software package were designed and tested by hydrologists for hydrologists. The system itself provides unparalleled ease of use and accuracy with the sophistication needed to handle some of the most complicated environmental conditions that can be encountered in the field.

New users will find data collection and analysis a simple task, while advanced users will benefit from the flexible processing and analytical tools that are provided. One of the major benefits of the SL is that long and complicated training courses are not required before you can start collecting meaningful data.

Now for a little bit of history about why the water resources community needed an instrument such as the SL.

Acoustic Doppler current meters, and in particular Doppler current profilers, have been established for many years as one of the best ways to measure water velocity. Advantages of Doppler current meters such as the Argonaut-SL include:

- Measurements are made in a remote sampling volume free from flow distortion.
- Velocity data are free from drift; the SL never requires calibration.
- Doppler technology has no inherent minimum detectable velocity, giving excellent performance at low flows.
- The SL has no moving parts, is immune to biofouling contamination, and can have user-applied anti-fouling paint to prevent growth.
- The same robust computational algorithms are used for velocities from 1 cm/s to 6 m/s.

For many years, most Doppler current meters were 3D systems designed to profile looking either up or down. However, to install a system permanently on the bottom of a river, channel, or harbor is very expensive, and system inspection and maintenance is very difficult. The SL provides the same performance and advantages of the 3D Doppler meters, but allows the system to be installed from a vertical structure within the water column. This is commonly a bridge pier, the vertical side of a channel, or some other structure in the water.

Mounting the SL from an existing structure allows for easy installation, easy instrument access for inspection and maintenance, and keeps the instrument safe from potential damage by vessel traffic. The remote sampling volume and programmable measurement location of the SL means that the velocity data can be collected some distance away from the instrument, free of any flow interference or effects from structures in the water. Thus, the SL provides high quality, accurate, and robust velocity data from a simple mounting structure.

Many river gauging sites that previously used travel time current meters have been replaced with the SL. While the travel time systems provided good performance, they required costly installation and maintenance procedures including detailed installation surveys and cross-channel cables. The SL provides all the advantages of a travel time system, with the many added benefits of a Doppler system, and a much simpler and less expensive installation procedure.

The SL is also popular as part of a vessel traffic system in harbors and shipping channels. The remote measurement can provide accurate, real-time current data from the shipping channel while the instrument is safely and easily installed on a pier, piling, or channel marker.

Section 3. Argonaut-SL System, Features, and Considerations

The following topics are covered in Section 3:

- [Argonaut-SL System](#)
- [Argonaut-SL Frequently Asked Questions](#)

3.1. Argonaut-SL System

All new Argonaut-SL systems come with the following standard features.

- Two-beam transducer design for measuring 2D water velocity
- Stage measurement (using a vertical acoustic beam)
- User-programmable sampling volume size (see [Table 3-1](#))
- Multi-cell current profiling (i.e., 10 individual “sections” in addition to the standard integrated velocity cell). See [§4.2](#) and [§B-6.4](#).
- Integrated pressure sensor (SL500 and SL1500 only)
- Internal compass/2-axis tilt sensor (SL500 and SL1500 only)
- Real-time flow calculations based on user-supplied channel geometry
- RS-232 and SDI-12 communication protocols
- 4-MB internal recorder capacity (over 50,000 samples)
- Temperature sensor on exposed titanium pin for fast response
- Polycarbonate mounting plate (SL500 and SL3000; SL1500 has integrated mounting plate)
- *ViewArgonaut* software program (Windows 98/NT/2000/XP/Vista) for instrument setup, data collection, and post-processing
- *SonUtils* software program (Windows 2000/XP/Vista) for direct communication and system diagnostics
- PDA software (*SonUtils* and deployment modules)

Optional features can include the following.

- 4-20 mA and 0-5 VDC analog output modules – available variables include X velocity, Y velocity, velocity magnitude, temperature, mean signal strength, stage, flow, and total volume (Note: only one output variable per output module). See [§4.3](#) and [Appendix F](#).
- External battery pack for autonomous operation
- RS-422 serial communication for long cable installations – up to 1500 m (5000 ft)
- Integrated SeaBird CTD

[Table 3-1](#) lists a summary of Argonaut-SL specifications.

Table 3-1. Summary of Argonaut-SL Specifications

Specification	Details			
Water velocity	Range: ±6 m/s (19.5 ft/s) Resolution: 0.1 cm/s (0.003 ft/s) Accuracy: ±1% of measured velocity, ±0.5 cm/s (0.015 ft/s)			
Sampling volume size (user programmable)	<u>Low-Profile Housing</u> SL500: 1.5 to 120 m (5 to 390 ft) SL1500: 0.2 to 20 m (0.7 to 65 ft) SL3000: 0.1 to 5 m (0.3 to 16 ft)		<u>Original Canister Housing</u> 1500-kHz: 0.5 to 20 m (1.6 to 65 ft) 3000-kHz: 0.2 to 5 m (0.7 to 16 ft)	
Stage measurement (vertical beam)		<u>500 kHz</u>	<u>1500 kHz</u>	<u>3000 kHz</u>
	Min. depth	0.2 m (0.7 ft)	0.15 m (0.5 ft) ¹ 0.4 m (1.3 ft) ²	0.10 m (0.3 ft) ¹ 0.25 m (0.8 ft) ²
	Max. depth	18 m (59 ft)	10 m (33 ft)	5 m (16 ft)
	Accuracy	±0.1%, ±0.6 cm	±0.1%, ±0.3 cm	±0.1%, ±0.3 cm
Physical parameters	<u>Low Profile Housing (SL500, SL1500, SL3000)</u> Dimensions: SL500: 33.2 cm (13.1 in) x 17.8 cm (7.0 in) x 12.4 cm (4.9 in) SL1500: 25.4 cm (10.0 in) x 17.0 cm (6.7 in) x 7.95 cm (3.13 in) SL3000: 16.0 cm (6.30 in) x 11.2 cm (4.40 in) x 6.2 cm (2.43 in) Weight: <u>SL500</u> <u>SL1500</u> <u>SL3000</u> In air: 6.0 kg (13.2 lb) 2.4 kg (5.3 lb) 1.2 kg (2.6 lb) In water: 1.1 kg (2.5 lb) 0.2 kg (0.5 lb) 0.3 kg (0.7 lb) Pressure rating: 30 m (100 ft) 30 m (100 ft) 30 m (100 ft) Operating temperature: -5°C to 60°C (23°F to 140°F) Storage temperature: -10°C to 70°C (14°F to 158°F) <u>Original Canister Housing (1500-kHz, 3000-kHz)</u> Dimensions: 1500 & 3000 kHz: 15.2 cm (6 in) diameter x 18.0 cm (7.1 in) length Weight: <u>1500 & 3000 kHz</u> In air: 2.5 kg (5.5 lb) In water: -0.3 kg (-0.7 lb) Pressure rating: 200 m (650 ft) Operating temperature: -5°C to 40°C (23°F to 104°F) Storage temperature: -10°C to 50°C (14°F to 122°F)			
Power requirements	Input power: 7-15 VDC Power consumption: ■ 500 kHz: 1.0-1.3 W ■ 1500 kHz: 0.7-1.3 W ■ 3000 kHz: 0.7-1.3 W			
Temperature sensor	Resolution: ±0.01°C Accuracy: ±0.5°C			
Recorder size	4 MB (over 50,000 samples)			
Pressure sensor (option)	Strain gauge: 0.25% accuracy			
Communication protocols	RS-232 and SDI-12 standard; RS-422 optional			
Multi-cell profiling	10 cells (in addition to the single, horizontally-integrated cell)			
Analog outputs (option)	Available output types (only 1 type can be used per deployment, but 2 modules can be used per system): ■ 4-20 mA ■ 0-5 VDC Available output parameters (1 module per parameter; maximum of 2 modules per system): ■ X velocity ■ Average SNR (signal-to-noise ratio) ■ Y velocity ■ Stage ■ Velocity magnitude ■ Flow ■ Temperature ■ Volume ■ Pressure ■ Cell end location			

Notes: ¹ = Low-profile housing ² = Original canister housing

3.2. Argonaut-SL Frequently Asked Questions

The following topics are covered in this section.

- What does the “SL” mean?
- What is the SL's intended application?
- How does the SL compare with other SonTek Argonaut products?
- What is the SL actually measuring?
- Where in the channel is the SL measuring the water velocity?
- Can the SL profile the currents?
- Can the SL measure reversing flow?
- How does water clarity relate to SL water velocity measurements?
- Should I use an Argonaut-SL or an Argonaut-SW for my application?
- Can the SL record data internally?
- Does the SL have an internal battery?
- Can I run the SL using a topside battery and solar panel?
- What communication protocols are supported?
- Can I output analog data such as a 4-20 mA current loop?
- How long can the power/communications cable be?
- How do I mount the SL?

3.2.1. What does the “SL” mean?

“SL” is our acronym for “Side-Looking”. This is because the beams of an SL ([Figure 3-1](#)) are projected across a channel in a horizontal plane ([Figure 3-2](#)). Most of our other acoustic Doppler instruments are designed for use as an upward or downward looking instrument. That is, the acoustic beams in our other systems are projected vertically through the water column.

3.2.2. What is the SL's intended application?

The SL is intended to be side-mounted, looking horizontally into a layer of water ([Figure 3-2](#)). This could be in a natural stream/river, canal, or port/harbor. An important consideration in the design of the SL is that it would be a device capable of calculating discharge values (flow rates). That is, in addition to measuring water velocity and stage (with the vertical acoustic beam), it can also calculate and report channel flow. This can be done in several ways – by entering the cross-sectional area into the SL, by using theoretical equations for flow calculations, or by entering an empirically derived *index-velocity* relation (see [Appendix G](#) – Internal Flow Calculations).



Figure 3-1. Low-Profile Systems: SL500 (left); SL1500 (center); SL3000 (right)

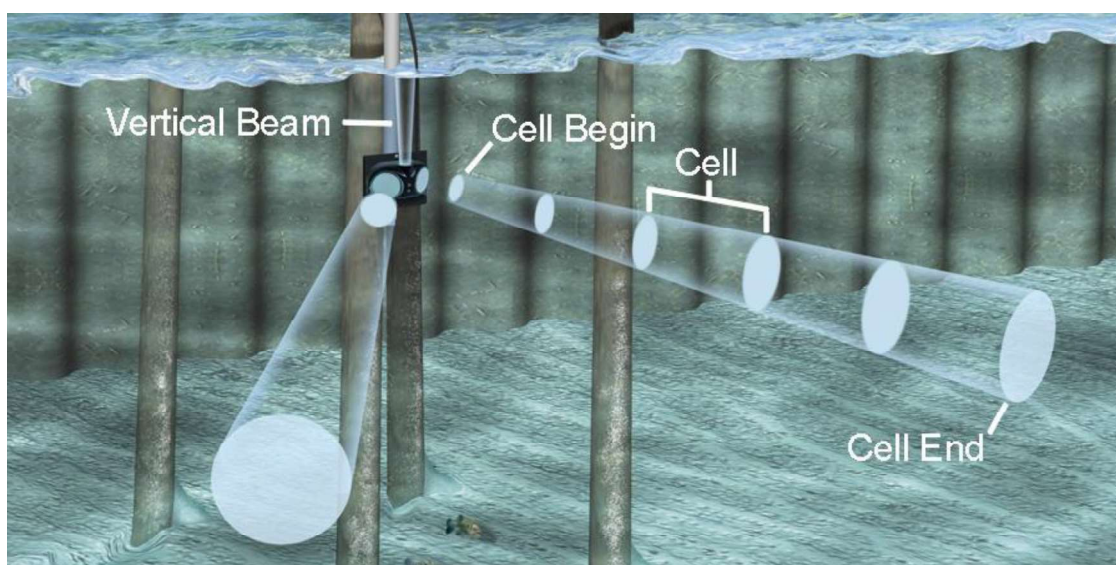


Figure 3-2. Argonaut-SL Beam Pattern

3.2.3. How does the SL compare with other SonTek Argonaut products?

The Argonaut-SL (Figure 3-1) electronics architecture is very similar to our other Argonaut products. The output data uses the same format as our Argonaut-SW (Shallow Water; Figure 3-3a) and Argonaut-XR (Extended Range; Figure 3-3b). As such, many of the basic commands and settings are the same, and the SL is fully supported by the *ViewArgonaut* program (examples in §5.7). The SL is designed for side-looking operation (Figure 3-2). The SW is designed for small channels and rivers. The XR is designed for larger rivers, lakes, and coastal applications.

3.2.4. What is the SL actually measuring?

The SL has three acoustic beams (Figure 3-2). When mounted properly on the side of a channel, one beam points straight up (the vertical beam), and the other two point up/down stream at a 25° angle. The upward-looking beam measures the stage, while the two slanted beams measure the water velocity via the Doppler method in two dimensions. The stage and velocity information are used to compute the flow, mean-velocity, and channel area (see Appendix B – Argonaut-SL Principles of Operation for details). The SL is also equipped with an internal sensor that measures water temperature, which is used to compute automatically the speed of sound in the water.



Figure 3-3. Argonaut-SW Shallow Water (a) and Argonaut-XR Extended Range (b) Systems

3.2.5. Where in the channel is the SL measuring the water velocity?

When mounted properly along the axis of the channel ([Figure 3-2](#)) — with one beam pointed upstream and one downstream — the SL will measure the average velocity from an imaginary horizontal layer over a user-specified range (see [Appendix B – SL Principles of Operation](#)).

3.2.6. Can the SL profile the currents?

Yes. When the profiling mode feature is enabled, the SL reports up to ten additional water velocity cells. The number, size, and position of these cells (five of which are depicted in [Figure 3-2](#)) are user-selectable. These ten profiling cells are in addition to the single dynamic cell mentioned above. For an example data file showing the multi-cell velocity profile, see [§6.5.1](#).

3.2.7. Can the SL measure reversing flow?

Yes. When mounted properly with one beam pointing upstream and the other beam pointed downstream ([Figure 3-2](#)), the SL is able to detect when the flow changes directions.

3.2.8. How does water clarity relate to SL water velocity measurements?

Doppler velocity sensors, such as the SL, actually measure the movement of particles in the water, as opposed to measuring the water movement itself. This carries the assumption that the movement of the particles in the water is representative of the movement of the water itself. This actually turns out to be a very safe assumption (on which we have built our business). So if you have a body of water where no particles are present, the physics are such that Doppler current meters will not work. Thankfully, most natural environments usually have something suspended other than just water molecules (even if it is just tiny air bubbles).

What makes the SonTek Doppler system different from most other manufacturers is the sensitivity level. SonTek's technology is excellent at deciphering reflected acoustic energy from the background noise. As such, even a small amount of particles in the water is usually good enough for most measurements. Keep in mind that SonTek instruments evolved from high-end laboratory and oceanographic instrumentation, so we are quite experienced in these environments.

Often times the reflective “scatterers” are either microscopic or even transparent organisms. As such, the visual clarity of the water (either observed or measured optically) typically has no bearing on how well a Doppler will work. Low scattering conditions, when present, will typically reduce the maximum range of the system, but will not cause it to cease operation. If you have any questions about whether the SL will work in your environment, [contact SonTek](#).

3.2.9. Should I use an Argonaut-SL or an Argonaut-SW for my application?

The Argonaut-SL ([Figure 3-1](#)) has become increasingly popular in recent years because it is so easy to install and maintain. Shorter cable runs, lower risk of loss/burial, and lower installation costs are some of the reasons SLs are preferred. In general, because they are fix-mounted on the side of a channel, a side-looking device should be installed such that its location is consistently at 30-70% of the maximum stage for optimal flow performance. Here are some instances when our [SW](#) system ([Figure 3-3a](#)) should be considered in place of an SL.

- **Large variations in water level** – If the water level falls near or below the level at which the SL is installed, the SL cannot measure properly. As such, while the SL may work fine in small channels, even down to 0.3 m (1 ft) or so, the SL is better suited for sites that do not typically show large variations in water level. With the bottom-mounted [SW](#), you can generally collect data down to 0.3 m (1 ft), which may be critical in small channels.

- **Stratified flow** – The SL measures in a sampling volume that spans through a horizontal layer. For calculating flow, it is assumed that the water velocity in this layer is representative of the channel velocity. This works exceptionally well for sites where an index-velocity will be performed, and the SL can even detect reversing flow. However, since it measures in only one location along the vertical cross-section, theoretical flow calculations may not hold up if the flow is highly stratified. Within the SW, you can use the multi-cell feature to collect incremental velocity data for up to ten additional cells.
- **Complex velocity profile** – In certain complex flow regimes, the vertically integrated velocity measurement of the SW provides more information about the velocity distribution within the channel and can therefore produce a more robust theoretical flow estimate. The SW also works equally well at sites where an index-velocity calibration will be performed. The downside of bottom-mounting is that it can involve a more complex installation, longer cables, and the risk of the unit being covered by debris or buried by silt.

In many cases, both the SW and SL are perfectly viable solutions for the same measurement location. Your decision should then be based on the ease of installation, ongoing maintenance, flow stratification, and how variable the water level is. If you have questions regarding the best instrument to use for your application, [contact SonTek](#).

3.2.10. Can the SL record data internally?

The SL has a 4-MB internal recorder that can typically store more than 50,000 data samples.

3.2.11. Does the SL have an internal battery?

There is no internal battery in the SL; an optional external battery pack is available. The SL requires a 7-15 VDC power supply for operation; it is commonly run from a 12 VDC battery connected to a solar panel. For details about power requirements, see §7.2.

3.2.12. Can I run the SL using a topside battery and solar panel?

Yes. The power consumption of the SL is about 0.7-1.5 watt. It can easily run from such a setup.

3.2.13. What communication protocols are supported?

The standard SL supports RS-232 or SDI-12 data output protocols. SL systems can also be set at the factory to use the RS-422 or RS-485 protocols, but not in conjunction with SDI-12.

3.2.14. Can the SL be used with the Modbus data collection network?

Yes, the SL can be used with the external Modbus Interface Module (MIM) for easy integration with existing Modbus data collection networks. See [Appendix I](#) for details.

3.2.15. Can I output analog data such as a 4-20 mA current loop?

Yes, the SL can provide analog outputs using either a 4-20 mA current loop or a 0-5 VDC voltage loop. To do this, you need to order the appropriate output module(s) from SonTek that enable analog outputs. The limitation is that for every parameter you want to output, an additional module is required. As such, we highly recommend the use of either the RS-232 or SDI-12 outputs if possible. [Table 3-1](#) lists the available analog output parameters. See §4.3 and [Appendix F](#) for more information about analog output operations.

3.2.16. How long can the power/communications cable be?

The rule of thumb normally applied is up to 100 m (300 ft) for standard RS-232 or SDI-12 when using the SonTek-supplied cable. For greater lengths, an SL with RS-422 protocol can be used.

3.2.17. How do I mount the SL?

The SL includes a mounting plate that either attaches to the system or is integral to the system (SL1500) for easy bolting to a variety of structures. See §5.2 for installation information.

Section 4. Argonaut-SL Applications

This section describes some common applications where Argonaut-SL systems are used. Overall, the topics in Section 4 are written as a brief summary for new users of this technology. In many cases, each section listed below could easily be expanded more thoroughly. If you are interested in more extensive explanations, we would suggest that you attend one of our training sessions (held throughout the year). The U.S. Geological Survey also conducts similar training courses specific to their applications. If you are interested in attending a training session, please [contact us](#). The following topics are covered in Section 4.

- Section 4.1 – [Real-Time Flow Monitoring and Sample Installations](#)
- Section 4.2 – [Multi-cell Velocity Profile and Flow Modeling](#)
- Section 4.3 – [Analog Outputs – Integration with Data Acquisition and Control Systems](#)
- Section 4.4 – [Modbus Interface Module: Modbus Data Acquisition Networks](#)

4.1. Real-Time Flow Monitoring and Sample Installations

The SL is intended to be side-mounted, looking horizontally into a layer of water. This could be in a natural stream/river, canal, port/harbor, or on an offshore platform. An important consideration in the design of the SL was that it would be a device capable of calculating discharge values (flow rates). That is, in addition to measuring water velocity and stage (with the vertical beam), it can also calculate and report the channel flow. This is done by entering the cross-sectional area into the SL, and using either theoretical equations for flow calculations or entering an empirically derived “index-velocity” relation (see [Appendix G](#) – Internal Flow Calculations).

- The SL is typically mounted to the side of a channel, on a bridge abutment, or on a piling in the water ([Figure 4-1](#)). General guidelines for system installation are given in [§5.1](#).
 - Note that the beams in this figure do not extend all the way across the channel.
 - While it is generally a good idea to obtain a relatively large sampling volume, it is not necessary (or even beneficial) to measure the full river width.
 - Often a smaller section, chosen based on the flow distribution within the river, can be the best means to provide accurate discharge monitoring.
- Stage is measured using the vertical acoustic beam. Water velocity is measured in an integrated cell using two slanted acoustic beams (see [Appendix B](#) – Principles of Operation).
- Stage and velocity are combined with user-supplied information about channel geometry to determine total flow in the channel. For details about the calculation of total flow, see [§B-5](#) and [Appendix G](#).
- While the SL can operate in depths as little as 0.3 m (1 ft), we do not recommend using the SL at sites that show large variations in water level.



Figure 4-1. Typical Argonaut-SL Installation

- The challenge with sites that show large variations in water level is that the SL must be installed low enough to operate properly at the lowest common water level. This location may then not provide a good velocity sample at higher water levels.
- At sites with large variations in water level, you may want to consider other options for flow monitoring such as the Argonaut-SW or Argonaut-XR. To learn more about other SonTek flow monitoring sensors, please [contact us](#).

When monitoring within ports and harbors or from offshore platforms, often the velocity is of primary interest (rather than discharge calculations).

- In these situations, it may be important that the SL report velocity in Earth (East-North-Up) coordinates rather than Cartesian (XYZ) coordinates relative to the system orientation.
- For these applications, the SL can include an internal compass and tilt sensor.
- When mounting a system that will be using the internal compass and tilt sensor, it is important to avoid large metal structures that may affect the ambient magnetic field and bias the data from the internal compass.

4.2. Multi-cell Velocity Profile and Flow Modeling

The Argonaut-SL is equipped with a feature that allows the system to record a multiple-cell velocity profile. Refer to [Figure 4-2](#).

- With the multi-cell feature, the system can record up to ten additional velocity cells.
- The profile is calculated in addition to, and independently from, the single velocity cell.
- When the multi-cell profile is enabled, the SL will report up to eleven velocity values — one for the standard integrated cell and up to ten cells from the velocity profile.

In the example shown in [Figure 4-2](#), the integrated velocity cell spans most of the center of the channel, while the multi-cell velocity profile has been set up to divide the full channel into ten velocity cells.

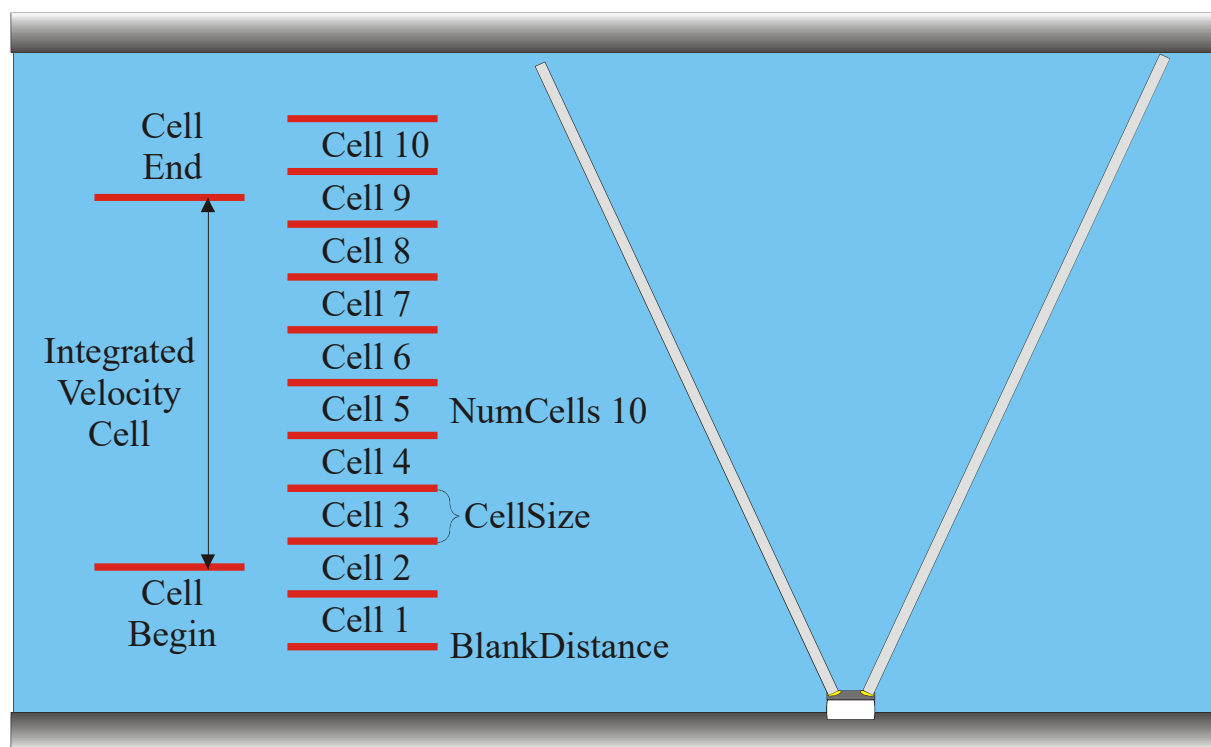


Figure 4-2. Multi-cell Velocity Profile and Single Integrated Velocity Cell (top view, looking down on SL)

- Typically, the single integrated cell will be located to provide the best index velocity measurement for discharge calculations.
- The data from the multi-cell velocity profile provides information on the structure of velocity across the channel.
 - Multi-cell data includes velocity/speed, direction, signal strength, and standard error information.
 - These data are commonly used in applications where flow reversals and other unique flow characteristics are expected. One common location is a tidally influenced river.
 - The velocity profile data allows for a level of analysis and interpretation beyond what can be achieved using the single integrated velocity cell.
 - For most applications, where flow calculations are the primary goal, the single integrated cell provides sufficient data. That is, flow calculations never use any of the data reported by the multi-cell feature. The multi-cell profile is offered for users interested in more in-depth analysis of the flow conditions.
- The example shown here is only one way to use the multi-cell profile. The profile can be set up with a wide variety of parameters depending on the interests of the user.
- For more details about the multi-cell velocity profile, see the following sections.
 - [§B-7.2 – Standard Error of Velocity Data](#)
 - [§5.4.2 – Multi-cell Profiling Parameters](#)
 - [§5.7.8 – Multi-cell Profiling Parameters \(ViewArgonaut\)](#)

4.3. Analog Outputs – Integration with Data Acquisition and Control Systems

The Argonaut-SL offers an optional feature to generate analog output signals proportional to measured parameters.

- Two types of analog output signals are available — 4-20 mA current loop and 0-5 VDC voltage output.
- The SL can use only one output type at any given time, but up to two output modules can be connected at one time (allowing you to monitor up to two different variables).
- Each analog signal is proportional to the value of one variable measured by the SL. These variables can include flow, total volume, stage, X-velocity, Y-velocity, velocity magnitude, average SNR, pressure, temperature, and cell end location.
- For details about how the analog output modules work, see §5.4.5 and [Appendix F](#). For details about how to deploy a system using the analog outputs, see §5.8.10.

The primary purpose of using the analog output signals is to allow easy integration of the SL into existing data acquisition and control systems.

- Many such systems have existing inputs for analog signals, and this allows the SL to be used in conjunction with these systems.
- Using the analog outputs is, in many ways, a “dumbing-down” of the output of the SL since we are converting high-precision digital values to analog signals (any digital-to-analog-to-digital conversion will cause some loss in accuracy and precision). Additionally, it is not possible to provide analog output signals for all diagnostic data available from the SL.
 - When possible, we encourage you to use one of the digital data collection methods supported by the SL. This includes SDI-12 data collection ([Appendix E](#)) and Modbus data collection ([Appendix I](#)).
- When using an SL in an analog output application, we strongly recommend that you enable internal recording of data.
 - Recorded data files should be downloaded, reviewed, and archived on a regular basis.
 - The internal data provides full access to all diagnostic data and is essential when reviewing system performance.

4.4. Modbus Interface Module: Modbus Data Acquisition Networks

Modbus is a data collection protocol that allows for the integration of digital data from a variety of instruments. This technique provides reliable, high quality digital data using an accepted data collection protocol standard. Using the Modbus Interface Module, the SL can be easily connected to a Modbus network to allow full access to all SL data parameters. For more details, see [Appendix I](#).

Section 5. Preparing the Argonaut-SL for Deployment

The following topics are covered in Section 5:

- [Selecting an Installation Site](#)
- [System Installation](#)
- [System Interconnection](#)
- [Selecting Operating Parameters](#)
- [Autonomous Deployment Considerations](#)
- [Site Survey and Diagnostic Procedures](#)
- [Deployment Examples using ViewArgonaut Software](#)
- [Deployment Examples using a Direct Command Interface \(SonUtils\)](#)

5.1. Selecting an Installation Site

The most important factor in the accuracy of Argonaut-SL measurements, particularly in relation to flow calculations, is the choice of the measurement site. When installing the SL, it is important to consider the location and orientation of all three acoustic beams, the depth at which the sensor is installed, the flow conditions in the water, and the integrity of the power and communication cable.

- [Beam Considerations](#)
- [Installation Location and Water Depth](#)
- [Flow Considerations](#)
- [Cable Protection](#)

5.1.1. Beam Considerations

The orientation of the Argonaut-SL at the deployment site will have an impact on system performance ([Figure 5-1](#)). Three aspects of system orientation are important — beam obstructions, direction of flow, system alignment.

- The SL has three acoustic beams.
 - The two velocity beams are positioned to look horizontally across the channel. The beams are slanted 25° off the axis of the instrument; one beam should face the upstream flow, while the other should face downstream. See §[B-3.1](#) for a precise description of beam locations.
 - The vertical beam points straight up towards the surface. This beam is used to collect stage data for use in computing flow/stage. See §[B-4](#) and §[B-5](#) for more information.
 - It is essential that no physical obstructions be near or in the path of any beam.

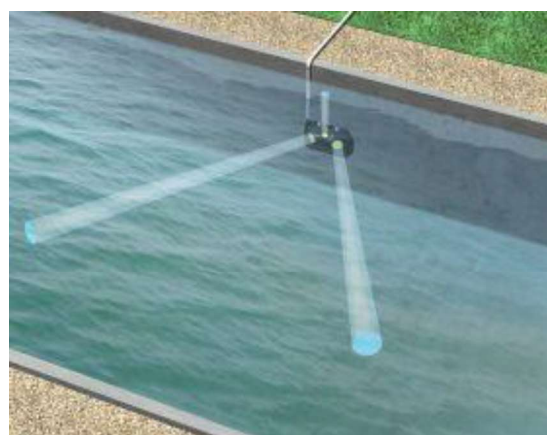


Figure 5-1. Argonaut-SL Beams



Figure 5-2. Argonaut-SL alignment with respect to flow direction

- The SL is normally aligned to look directly across the river, with the primary direction of flow parallel to the front of the system (Figure 5-2). Thus the X-axis of the SL will be parallel to the primary flow direction (§B-9.2).
 - This alignment can generally be done “by eye”, as small errors will have negligible impact on system performance.
 - When using the SL as an index velocity device, the index velocity calibration will account for the orientation of the system relative to the flow direction.
 - If using the SL for theoretical flow calculations, it will be more important to align the X-axis with the axis of the channel for accurate flow calculations.
 - For information about index and theoretical flow calculations, see §G-2.
 - In all cases, it is critical that the mounting orientation be repeatable.
 - The mounting structure should be constructed so that the SL is returned to the exact position when the sensor is removed for maintenance or inspection.
 - See §5.2.6 for example mounting structures.
- The system should be installed as level as possible.
 - When practical it is a good idea to use a small bubble level when installing the system.
 - If the system includes a compass/tilt sensor, you can look at data from this sensor to check if the system is level.
 - Large tilt angles ($>3-5^\circ$) can affect both velocity and stage measurements.
 - When tilted, the velocity beams may hit the surface or bottom, which will potentially interfere with velocity measurements.
 - The reliability of the vertical beam stage measurement decreases at larger tilt angles.

5.1.2. Installation Location and Water Depth

The SL is usually installed in the middle of the water column, allowing it to achieve the maximum possible measurement range without interference from the surface or bottom (§B-9.1). However, the choice of installation depth can be more difficult for sites with large variation in water depth. Some guidelines follow.

- For installation depth, consider the lowest water level that is commonly seen at the site.
- For sites with significant changes in water level, the SL is normally installed somewhat above mid-water depth at the lowest water level.
 - This provides good performance at low water levels, while also keeping the system high enough to get reasonable data at higher water levels.
 - Example: If water level varies from 3 to 5 meters, the SL might be installed 2 m above the bottom. This places it 1 m below the surface at low water (still allowing a good measurement range) and 3 m below the surface at higher water (high enough in the water column to get velocity data away from bottom effects).
- When selecting an installation depth, consider the bottom depth across the entire channel. Check for the presence of sand bars or other irregularities in the bottom profile to avoid possible interference with the beams.
- If you have questions about the best location to install a system, please [contact us](#).

5.1.3. Flow Considerations

Carefully consider the flow environment at the Argonaut-SL installation site. The site should be chosen to provide uniform flow conditions to improve measurement accuracy.

- Keep in mind that site selection is normally the most important factor for the overall accuracy of a flow monitoring station.
- The installation site should be selected so that flow conditions are reasonably constant over the physical area occupied by the beams.
- The SL should be as far as possible from any intake or outlet structures. Additionally, the SL should not be placed close to the beginning or end of a culvert or pipe.
- The SL should be located in a straight section of channel, away from curves that can cause variations in the flow distribution.
- The SL should be located away from any underwater structures or vegetation that can cause turbulence or changes in the flow distribution.

In some cases, it will not be practical to avoid all these considerations when selecting a site. As such, it will be more important to review carefully all SL data when analyzing performance.

5.1.4. Cable Protection

Consider how the environment might affect the SL's power and communications cable.

- The cable jacket is made of polyurethane and provides good resistance to abrasion and mechanical damage. However, in many environments cable damage from abrasion, floating debris, or vandalism is a likely source of system problems. In these cases, additional precautions should be taken to prevent damage to the cable. This can include burying the cable and/or enclosing the cable within a mechanical conduit.
- Because of the high-quality underwater connector used, damage to the cable will not result in flooding of the system.
- The individual conductors are twisted and shielded to provide reduce electrical noise in long cable runs. This provides reliable serial communications in a wide variety of environments.

5.2. System Installation

This section provides guidelines for installing the SL system. Your application may differ from the examples presented here. There are many effective ways to install the SL, depending on the environment and available materials. If you have installation questions, please [contact SonTek](#).

5.2.1. Argonaut-SL Mounting: SL500 Low-Profile Housing

- The SL is normally mounted to an underwater structure with its transducer head perpendicular to the flow of water ([Figure 5-2](#)).
- The mounting should keep the instrument stable; it should not shift or move with time.
- The SL should be mounted as level as possible. That is, the measurement plane formed by the two angled acoustic beams should be parallel to the water surface, ideally within 1-2 degrees (as verified with a bubble level). This will prevent the horizontal beams from hitting the surface or bottom and causing interference with velocity data. It is also important for the reliability of the vertical beam data.
- The SL includes a strain gauge pressure sensor. You should zero the pressure sensor offset at installation so it takes into account the difference in atmospheric pressure between the factory setting and the local deployment site. Refer to ¶7.5.1 for instructions.
- A mounting plate is included with the SL to simplify installation.
 - [Figure 5-3](#) shows a drawing of the mounting plate and SL500. This drawing includes all mounting holes and dimensions. All dimensions in this drawing are in inches.
 - The mounting plate has four holes drilled to match the bolt pattern in the SL's housing.
 - The bolts used to attach the SL to the mounting plate are included in the tool kit.
 - The mounting plate also has six holes drilled in a rectangular pattern for easy installation to a user-supplied fixture. Hole diameters are 0.71 cm (0.28 in) for use with 1/4-inch bolts.
- If preferred, you can also mount the SL without the mounting plate using the SL's four through-holes ([Figure 5-3](#)) and the mounting bolts supplied with the system.

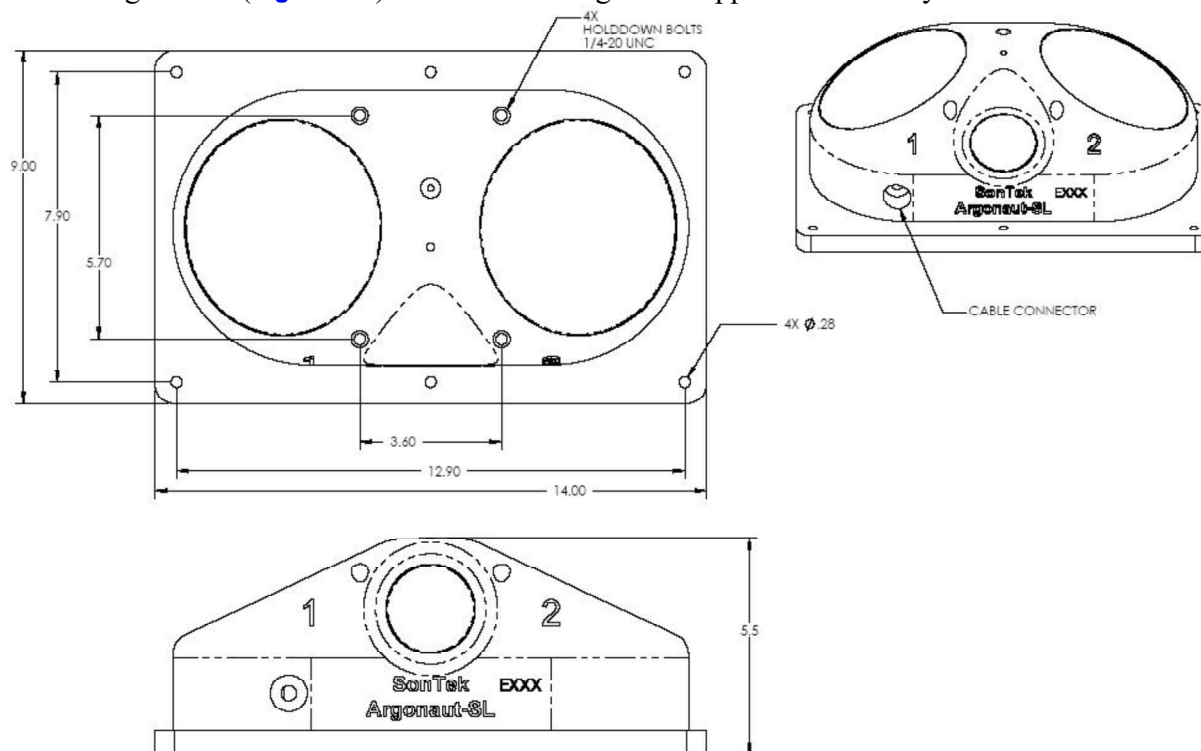


Figure 5-3. Low-Profile SL500 dimensions (in inches)

5.2.2. Argonaut-SL Mounting: SL1500 Low-Profile Housing

- The SL is normally mounted to an underwater structure with its transducer head perpendicular to the flow of water ([Figure 5-2](#)).
- The mounting should keep the instrument stable; it should not shift or move with time.
- The SL should be mounted as level as possible. That is, the measurement plane formed by the two angled acoustic beams should be parallel to the water surface, ideally within 1-2 degrees (as verified with a bubble level). This will prevent the horizontal beams from hitting the surface or bottom and causing interference with velocity data. It is also important for the reliability of the vertical beam data.
- The SL includes a strain gauge pressure sensor. You should zero the pressure sensor offset at installation so it takes into account the difference in atmospheric pressure between the factory setting and the local deployment site. Refer to ¶7.5.1 for instructions.
- The SL1500 housing includes integral flanges and mounting holes. [Figure 5-4](#) shows the SL1500 mounting holes and dimensions. All dimensions are in inches.
 - Holes are provided to support a variety of mounting arrangements.
 - The mounting plate has four holes drilled in a rectangular pattern for easy installation to a user-supplied fixture. Hole diameters are 0.71 cm (0.27 in) for use with ¼-inch bolts.
- The housing has several machined slots designed for use with U-bolts for easy mounting to a pipe. The slots accommodate U-bolts for pipes an outer diameter of 2.5-7.6 cm (1-3 in).
 - **Important:** Always use a U-bolt with a support bracket (right) to prevent straining or bending of the SL housing.

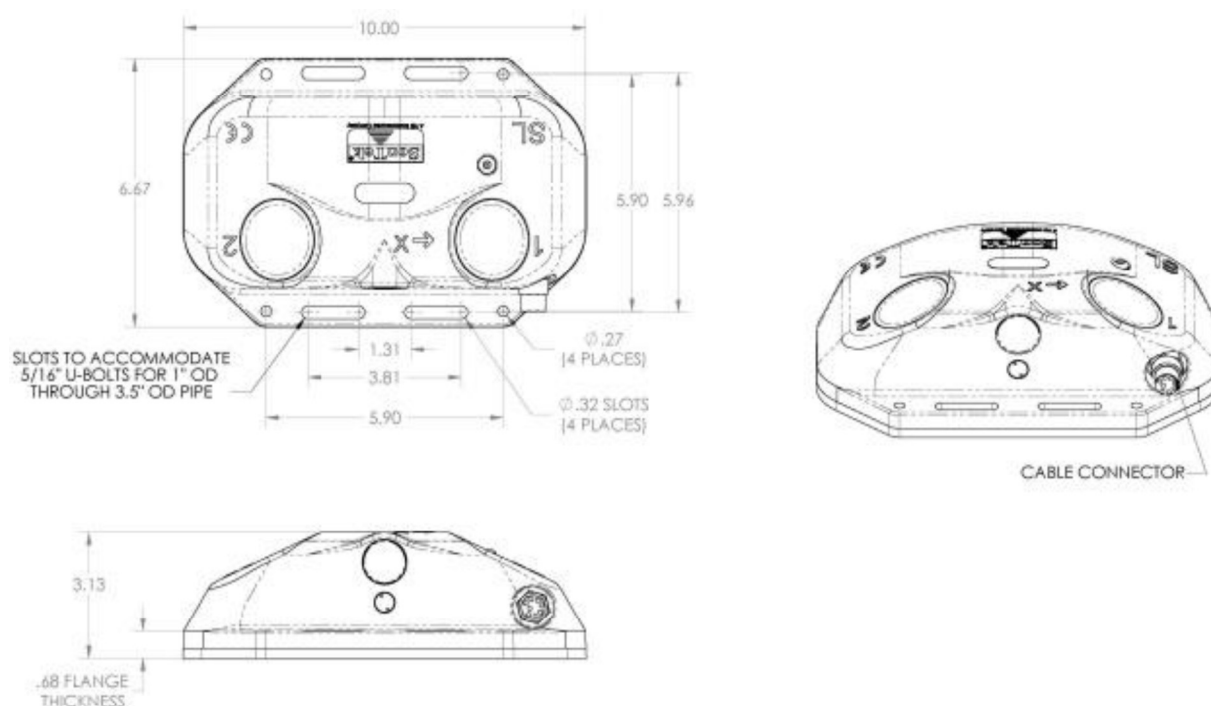


Figure 5-4. Low-Profile SL1500 dimensions (in inches)

5.2.3. Argonaut-SL Mounting: SL3000 Low-Profile Housing

- The SL is normally mounted to an underwater structure with its transducer head perpendicular to the flow of water ([Figure 5-2](#)).
- The mounting should keep the instrument stable; it should not shift or move with time.
- The SL should be mounted as level as possible. That is, the measurement plane formed by the two angled acoustic beams should be parallel to the water surface, ideally within 1-2 degrees (as verified with a bubble level). This will prevent the horizontal beams from hitting the surface or bottom and causing interference with velocity data. It is also important for the reliability of the vertical beam data.
- The SL includes a strain gauge pressure sensor. You should zero the pressure sensor offset at installation so it takes into account the difference in atmospheric pressure between the factory setting and the local deployment site. Refer to ¶7.5.1 for instructions.
- A mounting plate is included with the SL to simplify installation.
 - [Figure 5-3](#) shows a drawing of the mounting plate and SL500. This drawing includes all mounting holes and dimensions. All dimensions in this drawing are in inches.
 - The mounting plate has four holes drilled to match the bolt pattern in the SL's housing.
 - The bolts used to attach the SL to the mounting plate are included in the tool kit.
 - The mounting plate also has six holes drilled in a rectangular pattern for easy installation to a user-supplied fixture. Hole diameters are 0.71 cm (0.28 in) for use with 1/4-inch bolts.
- If preferred, you can also mount the SL without the mounting plate using the SL's four through-holes ([Figure 5-3](#)) and the mounting bolts supplied with the system.

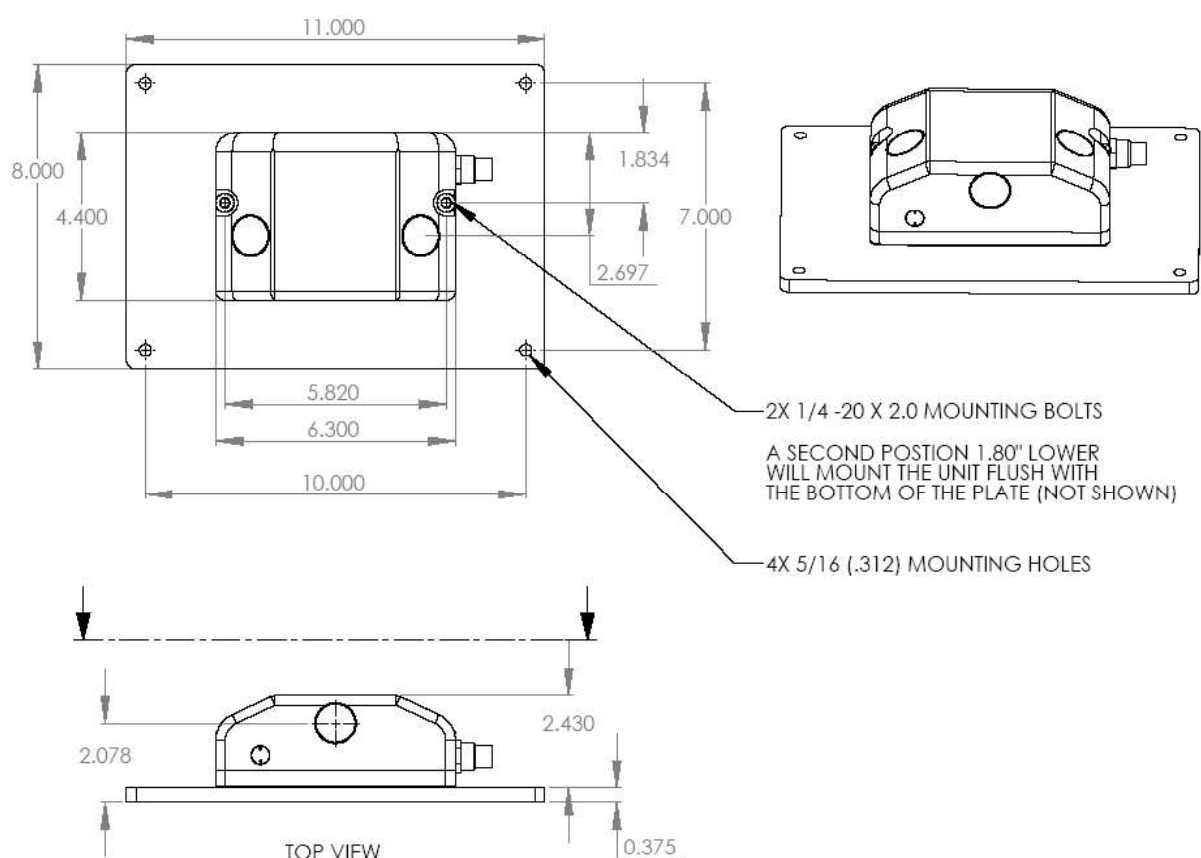


Figure 5-5. Low-Profile SL3000 dimensions (in inches)

-
- Technical drawing of a rectangular plate with 8 holes. The top view shows a square layout with dimensions 7.8 x 7.8. The holes are arranged in a 2x4 grid. The top view includes dimensions: 7.8, 6.85, 5.827, 1.973, .95, 0, .95, .827, .685, 7.8. The side view shows a thickness of .63. The drawing includes a detail of a hole with dimensions 4X Ø.28 THRU and Ø.75 Ψ.40.

Figure 5-6. 1500 and 3000-kHz Argonaut-SL (original canister models) mounting plate dimensions (in inches)

- The bottom of the SL canister housing has four mounting holes ([Figure 5-7](#)). The holes have threaded inserts for ¼"-20 bolts.

CAUTION

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

- [Figure 5-7](#) also shows the location of the acoustic beams and the SL's X-axis relative to the mounting bolt pattern. The underwater connector enters the housing at the bottom of the figure, with the vertical beam looking up.

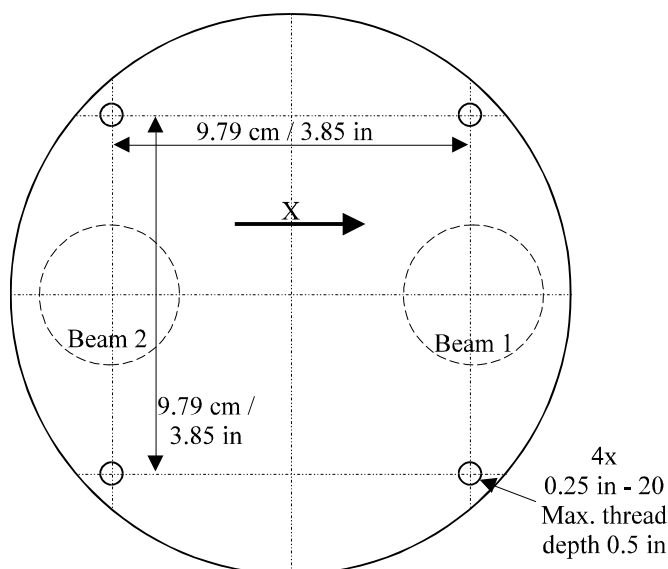


Figure 5-7. Argonaut-SL Mounting (original canister models)

5.2.5. 1500 and 3000-kHz External Battery Housing Mounting Information

- For autonomous operation, the 1500 and 3000-kHz Argonaut-SL can be equipped with an external battery housing. The housing is connected to the SL via a splitter cable (§7.1.3).
- The battery housing holds one battery pack consisting of 24 D-cell alkaline batteries. See §5.5.2 for details on estimating battery life.
- **Figure 5-8** shows a typical installation of an SL with an external battery housing. The battery housing connector is recessed in the end cap and is accessed from the side. SL systems with the external battery housing include the housing, one alkaline battery pack, the splitter cable, a dummy plug, and a mounting plate to hold the SL and battery housing (this is normally attached to a user-supplied deployment frame).

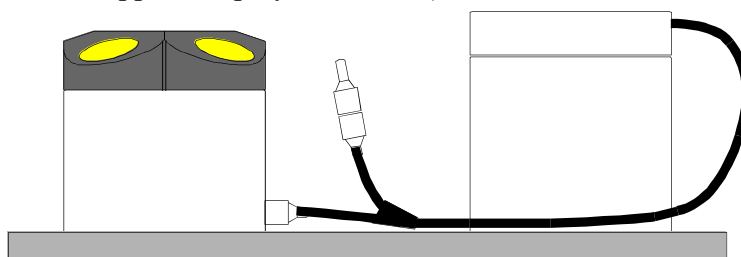


Figure 5-8. Argonaut-SL with External Battery Housing

- A mounting plate is included that will secure both the SL and the battery pack.
 - A drawing of the mounting plate is shown in **Figure 5-9**.
 - All dimensions in this drawing are given in inches.
 - This plate is designed for use with several different system types, and as such has holes for different mounting arrangements.

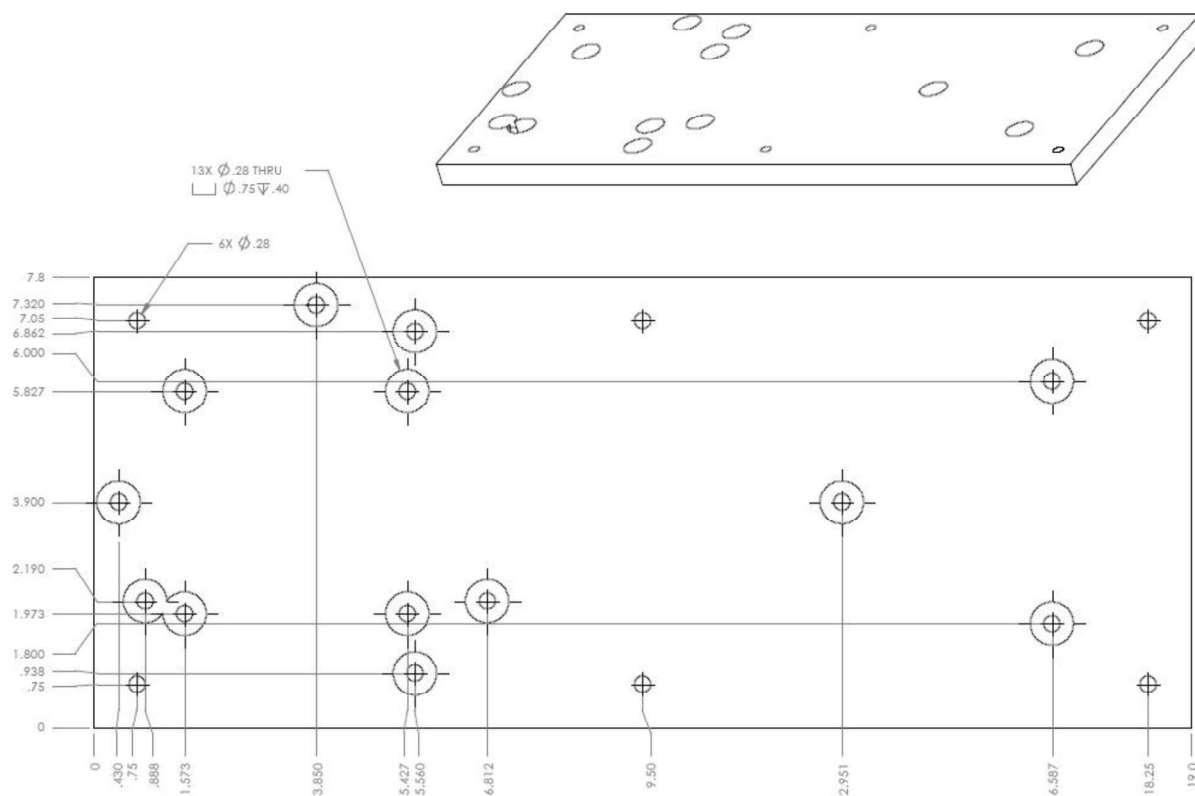


Figure 5-9. Mounting plate dimensions for external battery housing and 1500 or 3000-kHz Argonaut-SL

- The battery housing has three threaded inserts on the bottom of the housing for easy installation. **Figure 5-10** shows the bolt pattern on the bottom of the battery housing.
 - The threaded inserts use $\frac{1}{4}$ "-20 bolts; no more than $\frac{1}{2}$ " of thread should be engaged to avoid damage to the housing.
 - The system includes bolts that are the correct length for use with the SL battery housing mounting plate.
- To reduce magnetic interference from the batteries in systems that have a compass/tilt sensor installed, the battery housing should be no closer than 12 cm (5 in) from the SL. The mounting plate included with the SL places the housing at this distance. When using batteries near the SL, you should perform a compass calibration before each deployment; the calibration should be done each time the battery pack is changed. See §7.6.3 for details on compass calibration.

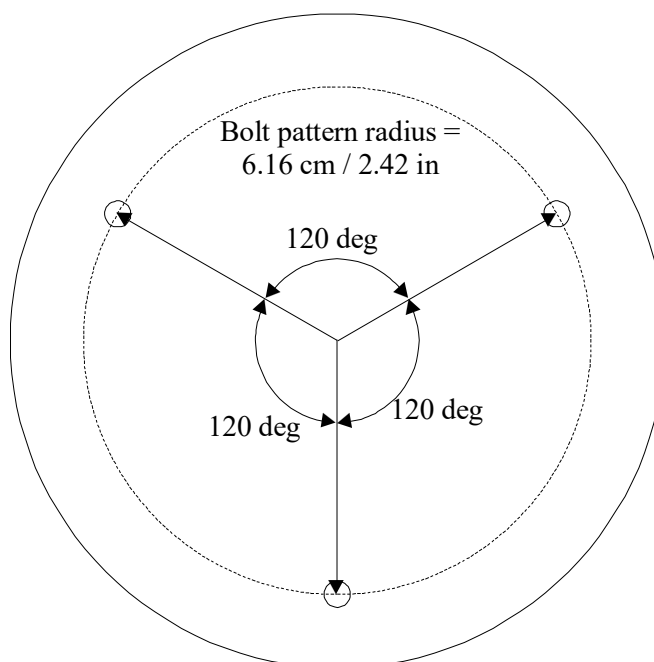


Figure 5-10. Argonaut-SL Battery Housing Bolt Pattern

5.2.6. Sample SL Installations

This section includes pictures and general descriptions of several SL installations. The examples shown here show both the original canister design (for our 1500 and 3000-kHz SL systems) and for our newer low-profile housings (SL500, SL1500, SL3000). These examples apply equally well to either design.

As described in §5.1, some of the critical elements of any SL are as follows.

- The SL should be rigidly mounted and should not move while collecting data.
- The SL should be mounted level, with the velocity beams parallel to the water surface and the vertical beam perpendicular to the water surface.
- The SL mounting depth should be carefully chosen based on the variation in water depth that is expected at the site (§5.1.2).
- Ideally, the SL installation will allow easy retrieval of the sensor for inspection and maintenance, and will ensure that the sensor is returned to the exact position and orientation.
- The SL mounting should take into consideration the location of each acoustic beam with respect to the surface, bottom, and any obstacles in the water (§5.1.1).

SL Mounting Example #1

- This 1500-kHz SL ([Figure 5-11](#)) is installed in large, unlined irrigation channel.
- The mount uses a modular mounting system that is available from SonTek.
 - The mounting frame comes in modular 1.2-m (4-ft) sections that can be connected together for use in any size channel.
 - The mounting angle can be adjusted to level the system for a wide range of bank slopes.
 - The SL slides on the mounting frame, allowing easy recovery of the system for inspection, and then easy return to the same mounting location and orientation.
- For more information about this mounting system, please contact SonTek/YSI.



Figure 5-11. Argonaut-SL Mounting Example #1

SL Mounting Example #2

- This 1500-kHz SL (**Figure 5-12**) is installed in a rectangular, concrete line irrigation channel.
- It is mounted to a simple metal frame.
 - The frame is hinged at the upper end.
 - Though it cannot be seen in the photo, the frame is also bolted to the wall a short distance below the top to keep the mounting secure.
- The lower mounting bolts can be easily removed and the system raised out of the water for inspection and maintenance.
- The cable is enclosed in a conduit for protection.

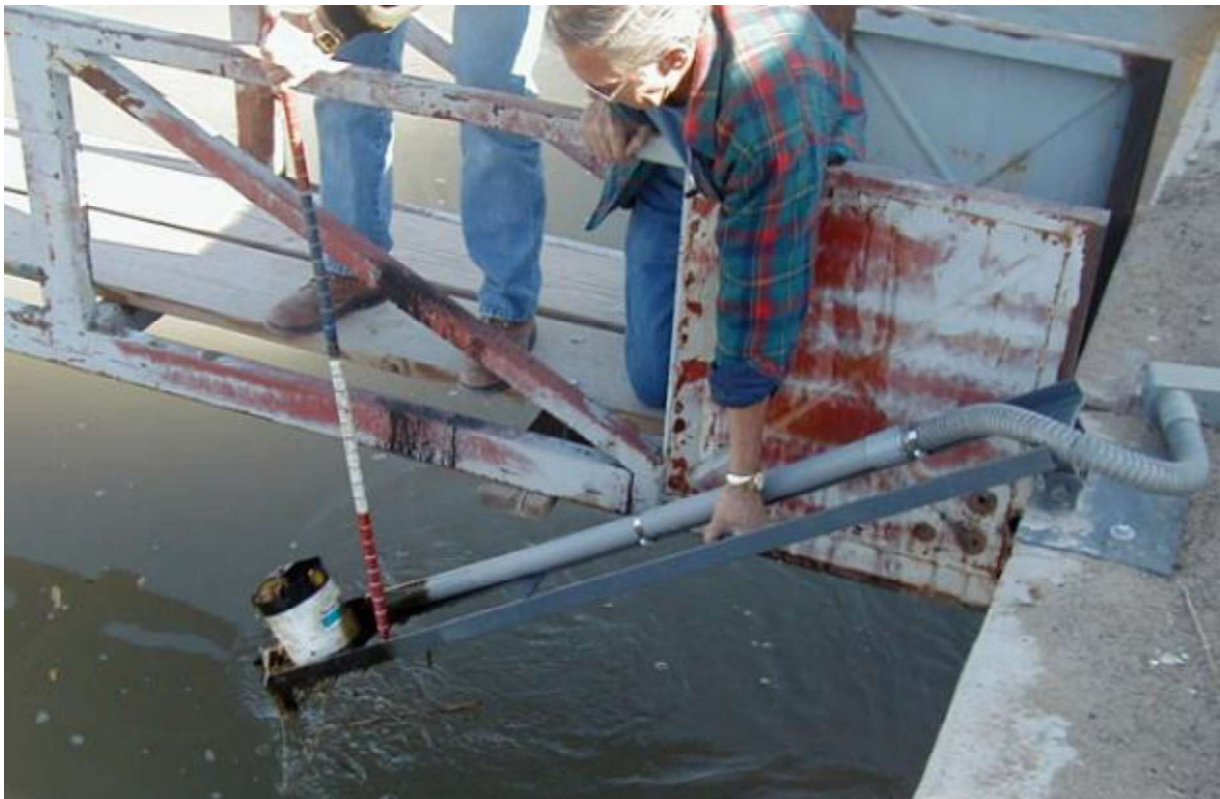


Figure 5-12. Argonaut-SL Mounting Example #2

SL Mounting Example #3

- This SL500 ([Figure 5-13](#)) is mounted from a bridge piling in a large shipping channel.
- The SL is secured to a round pipe that passes through several sleeves secured to the piling.
- By first loosening the bolts on the sleeves, the SL can easily be raised for inspection and maintenance.
- Marks on the mounting pipe allow the SL to be returned to the same depth and orientation after inspection.



Figure 5-13. Argonaut-SL Mounting Example #3

SL Mounting Example #4

- This SL500 ([Figure 5-14](#)) is mounted to the side of a large river, where the edge is a near-vertical wall at a location where the river flows through a city.
- The mounting frame is built from a commercially available, modular construction material.
- The mounting platform is built to allow the SL to be installed level, even if the main mounting frame (going into the water) is installed with some amount of tilt.
- For inspection and maintenance, the mounting frame can be raised and lowered by sliding it along the vertical mounting frame.
- The exact mounting depth is precisely marked to ensure the SL is set at the same depth each time.



Figure 5-14. Argonaut-SL Mounting Example #4

SL Mounting Example #5

- This 1500-kHz SL (**Figure 5-15**) is installed from the side of a small, natural stream.
- The mounting board is hinged at one end (not shown in the picture), allowing the entire frame to be lifted out of the water for inspection and maintenance.



Figure 5-15. Argonaut-SL Mounting Example #5

5.3. System Interconnection

Figure 5-16 shows the 500-kHz Argonaut-SL with all standard equipment, and **Figure 5-19** shows the 1500/3000-kHz Argonaut-SL with all standard equipment.

- The SL housing itself contains all system electronics, including the internal recorder.
- A polycarbonate mounting plate is included, along with screws to secure the SL to the mounting plate. The mounting plate has four holes for 6-mm (0.25”) bolts to mount the system as needed (§5.2).
- The SL power and serial communication cable (standard length 10 m) mates to the system using an 8-pin, wet-mateable, underwater connector.
 - This connector can be mated wet.
 - If necessary, the connector can be mated underwater, but we do not generally recommend doing this.
 - Both connectors must be clean of dirt and debris before mating.
 - Connect the underwater connector to the system before applying power.
 - Secure the locking sleeve to prevent accidental disconnecting of the system.

Caution: When mating the connector to the SL, push the connector with enough force to overcome the resistance of the wet-mateable pins. Push the connector until its face is flush with the female bulkhead connector. Do not simply tighten the locking sleeve during the mating process; just tightening the sleeve will not ensure proper pin alignment nor will it supply the required force to ensure a waterproof seal.

- The “dry” end of the power and serial communications cable has connectors for both serial communications (§5.3.1 and §5.3.1) and DC power input (§5.3.3).
- The system includes a power adapter. The SL can use this adapter when external AC power is available. If AC power is not available, you can connect a user-supplied DC power source to the bare wires (sometimes referred to as *flying leads* or *pigtails*) on the power and serial communications cable (see §5.3.3 for connection details).



Figure 5-16. 500-kHz Argonaut-SL with Standard Equipment



Figure 5-17. SL1500 with Standard Equipment



Figure 5-18. SL3000 with Standard Equipment



Figure 5-19. 1500 or 3000-kHz Argonaut-SL with Standard Equipment

5.3.1. RS-232 / RS-422 Serial Communications

The standard Argonaut-SL supports RS-232 and SDI-12 communication protocols.

- RS-232 is the primary means of communicating with the system. It is used to program all system operating parameters and to download data from the internal recorder.
- RS-232 can also be used for real-time data collection in a variety of output formats for data loggers and data collection platforms that support RS-232 serial input.
- SDI-12 is provided as a means to interface to standard data loggers. The SL is compatible with SDI-12 protocol versions 1.0, 1.1, 1.2, and 1.3.
- When interfacing the system with an SDI-12 data logger, the SL must first be programmed using RS-232, and then switched into SDI-12 operating mode (see sample SDI-12 deployments in §5.7.12, §5.8.3, and Appendix E).

The standard SL power and serial communications cable (Figure 5-16 through Figure 5-19) has connectors for both RS-232 and SDI-12 (Figure 5-20).

- A DB-9 female connector carries RS-232 serial communication. The wiring matches the standard serial port wiring on most computers.
- The cable has three bare wires (Figure 5-16 through Figure 5-19). The white wire is for SDI-12 serial communications and can be directly connected to most data loggers. The red and black wires are for DC input power. **Caution:** Power on these leads must not exceed 16 VDC!
- The power and serial communications cable uses a white, “jumper switch” connector (Figure 5-20) to switch between the RS-232 and SDI-12 serial communications modes. When connected, the SL uses the RS-232 serial bus. When open, the SL uses the SDI-12 serial bus.

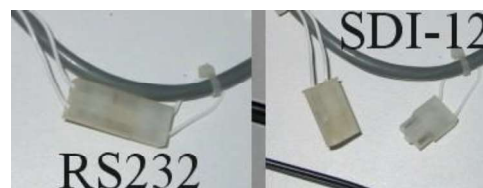


Figure 5-20. RS-232 / SDI-12 jumper switch

- Refer to §5.7.12, §5.8.3, and Appendix E for details on how to set up an SDI-12 deployment.

5.3.2. RS-422 Serial Communication

The Argonaut-SL can optionally be equipped to use RS-422 communication protocol.

- RS-422 allows the use of longer cables – up to 1500 m (5000 ft).
- When using RS-422, the SL uses the same command interface as with RS-232, and is fully compatible with all software used with RS-232.
- An SL that is configured for RS-422 cannot use the SDI-12 communication protocol and cannot be interfaced to an SDI-12 data logger.
- When set up for RS-422, an RS-422 to RS-232 converter is typically required to connect the SL to your computer. This converter is usually included with the SL. The converter matches the SL cable on one side (DB25) and should include a connector (DB9) to match your computer on the other side.
- The RS-422 to RS-232 converter requires a separate power supply, which is usually included with the system.
 - The converter and power supply must be connected between your computer and the SL before you will be able to establish communications.

- Take special care when connecting the power supply to the RS-422 to RS-232 converter; these converters are easily damaged by voltage spikes.
- You should connect the power plug to the RS-422 to RS-232 converter before connecting the power supply to the AC outlet.
- After the RS-422 to RS-232 converter is correctly installed, you can follow all standard deployment procedures for an RS-232 deployment.

5.3.3. Power Supply

The SL typically operates from an external DC voltage (7-15 VDC). This can be either from the AC-to-DC converter included with the system or from a user-supplied source. For autonomous deployments, the SL can use power from an external DC source (e.g., battery pack, solar panel).

- When AC power is available at the installation site, you should use the included AC-to-DC power supply with the system. A connector for the Power Adapter is installed on the power and serial communications cable ([Figure 5-16](#) through [Figure 5-19](#)).
- When using the external battery housing (§5.2.5), use the splitter cable (§7.1.3) to connect the battery housing to the SL. This cable has three connectors. The first (8-pin male) connects to the SL. The second (2-pin male) connects to the battery housing and supplies power to the SL. The third (8-pin female) connects to the power/communications cable to configure the system and to download data. During the actual deployment, you must terminate this 8-pin female with a “dummy plug”, which prevents water from entering the connector.
- When necessary, other user-supplied DC power sources can be used (e.g., car battery, variable DC power supply). To connect to another DC power source, use the red and black power supply wires on the SL power/communications cable ([Figure 5-16](#) - [Figure 5-19](#)).
 - Black is ground – The SL uses a common ground for both power and communications.
 - Red is positive and should be 7-15 VDC. **Caution:** Do not exceed the 16 VDC maximum or damage to the electronics will occur. Use “clean” power (e.g., filtered, no spikes).
 - For details on other power supply requirements, see §7.2.
- During normal operation, the SL consumes 0.7 to 1.5 W, depending on system frequency and configuration. For details on power consumption, see §5.5.2.
- Reduced duty-cycle operation (e.g., collecting data for 5 of every 15 minutes) can reduce total power consumption. However, unless power requirements are a significant limitation, we recommend running the system continuously to get the best possible data quality.
 - Reduced duty-cycle deployments will not significantly reduce power requirements when the SL is connected to an SDI-12 data logger. This is because the SL is required to be continuously awake to respond to incoming commands from the data logger.
 - To calculate power requirements and battery life, see §5.5.2.

5.4. Selecting Operating Parameters

The following sections provide guidelines for setting the most important operating parameters of the Argonaut-SL. The sections are divided as follows.

- Primary operating parameters: §5.4.1
- Multi-cell profiling parameters: §5.4.2
- Internal flow parameters: §5.4.3
- Wave spectra parameters: §5.4.4
- Analog output parameters: §5.4.5

5.4.1. Primary Operating Parameters

This section contains guidelines for setting the main operating parameters of the SL. For detailed instructions to begin a deployment, see either §5.7 (using *ViewArgonaut*) or 5.8 (using *SonUtils*). Note: The *ViewArgonaut* descriptor is listed first, and the corresponding direct command from [Appendix C](#) is shown in brackets; e.g., [Command].

- Internal Clock [Date/Time] – Be certain to check/set the SL internal clock before any deployment to ensure accurate time is used. All data collected with the SL is marked with time from the internal clock.
- Unit System [OutFormat] – The unit system determines the scaling units used for real-time data output and for entering channel dimensions for flow data. Standard settings are English (feet, ft/s) and Metric (meters, cm/s).
- Enable Recorder [Recorder] – This setting (ON/OFF) determines if data are stored to the internal recorder. Even when recording data to an external data logger, we recommend the ON setting as the internally recorded data provides additional diagnostic data. If the recorder becomes full during a deployment, the SL will continue to output data in real-time but will no longer store data to the internal recorder. We encourage you to monitor recorder status and periodically download data to ensure full access to all diagnostic data.
- File Name [Deployment] – This setting determines the file name under which data are stored to the internal recorder. You can select up to five letters or numbers. The system automatically adds three digits, starting with 001 and incrementing for each file thereafter. For example, if the file name is set to TEST, the first data file started would be recorded as TEST001, the next would be TEST002, and so on.
- Starting Date and Time [StartDate/StartTime] – The combination of starting date and time is used to begin a deployment at some future time. If these values are set to some future date/time, and data collection is initiated with the Deploy command, the first sample begins at the date/time specified. If set to a date/time that has already passed, or if data collection is initiated with the Start command, data collection begins immediately.
- User Comments [Comments] – You can enter up to three comment lines, each with a maximum of 60 characters. The comments will be stored in the data file.
- Averaging Interval [AvgInterval] – The averaging interval determines the period of time (in seconds) that the SL averages data for each sample. Settings as short as 10 seconds are allowed; however, we do not recommend settings less than 60 seconds. We recommend using the largest value based on the required data output rate. Settings of 300 to 900 seconds (5 to 15 minutes) are typical. Longer averaging times will reduce the amount of noise in velocity and flow data.
- Sampling Interval [SampleInterval] – The sampling interval sets the period (in seconds) from the start of one sample to the start of the next. It must be greater than or equal to AvgInterval. Setting this value greater than AvgInterval can reduce power consumption, as the system normally enters a low power state between samples. For example, using AvgInterval 300 and SampleInterval 900 gives a 1/3-duty cycle and reduces total power requirements by a factor of 3. Unless the application has significant power limitations, we recommend setting SampleInterval equal to AvgInterval for the best quality data.
 - **Important:** When interfacing with an external data logger using SDI-12, the data logger will control the interval between samples. The value of SampleInterval will be ignored.

- Power Ping [[PowerPing](#)] – Using **PowerPing** will decrease the variance (noise) in velocity measurements. To see the exact effect of decreased variance on your measurement accuracy, see the Principles of Operation (§[B-7.2](#)). Decreased variance means a shorter averaging time can be used to reach a desired instrument uncertainty (noise) level. For example:
 - For the SL, the typical decrease in variance with **PowerPing** is a factor of 4.
 - If variance decreases 4x, averaging time for a given uncertainty decreases 4x.
 - That is, an averaging time of 1 minute using **PowerPing** would be equivalent to using an averaging time of 4 minutes during normal operation.
 - The exact effect on instrument uncertainty varies; see §[B-7.2](#).
 - **IMPORTANT:** The improved performance of **PowerPing** applies only to instrument generated uncertainty.
 - It is essential to consider real variations in water velocity and select an averaging time sufficient to remove those variations.
 - When operating in an environment with large natural variations in flow (e.g., wave influenced environments or rivers with large natural fluctuations), you should choose an averaging time long enough to remove those natural variations.
 - In many conditions, natural variations will be more important than instrument uncertainty when selecting the averaging time.
 - When should you use **PowerPing**?
 - If there are no input power limitations, we recommend always using **PowerPing** to provide optimal system performance.
 - If you have limited battery power:
 - ♦ We generally recommend using **PowerPing** with the longest possible averaging time based on available power and desired sampling scheme.
 - ♦ With **PowerPing YES**, we recommend a minimum averaging time of 1 minute. An important exception to this is a deployment environment where a long averaging time is required because of natural variations in the flow (e.g., operating in a wave environment). In this case, select the averaging time needed to remove the natural variations. In a wave environment, this might be 5 minutes or longer.
 - ♦ If the power budget allows you to use **PowerPing** with the longer averaging time, we recommend using it. If the power budget does not allow the use of **PowerPing**, the normal operating mode will still provide excellent data quality.
 - ♦ For the exact effect of **PowerPing** on power consumption, see §[5.5.2](#).
- Cell Begin [[CellBegin](#)] – This determines the distance (from the transducer head) where the SL begins its integrated velocity measurement. The value of Cell Begin should be determined as part of a site survey as described in §[5.6.1](#).
 - Cell Begin might need to be set to a larger value than expected if something in the water is causing a flow disturbance (e.g., submerged pile). A physical structure upstream of the SL, though not in the path of the beams, could cause flow that is not representative of the portion to be measured. In this case, Cell Begin should be set beyond the disturbed flow so data are not biased by non-uniform flow.
- Cell End [[CellEnd](#)] – This determines the distance (from the transducer head) where the SL ends its integrated velocity measurement. The value of Cell End should be determined as part of a site survey as described in §[5.6.1](#).

- Coordinate System [[CoordSystem](#)] – This setting determines the coordinate system used for velocity data.
 - For the SL, this is normally set to **xyz** to report velocity relative to system orientation.
 - For systems that include an internal compass and tilt sensor, you may set this value to **ENU** for some special applications.
 - For more information about the coordinate system, see §[B-9.2](#).
- Reverse X Velocity [[ReverseXVelocity](#)] – The Argonaut-SL water velocity measurements are normally reported using a Cartesian (**xyz**) coordinate system relative to the sensor. The [ReverseXVelocity](#) parameter determines the orientation of the positive X velocity with respect to the system.
 - This parameter allows the instrument to be installed on either side of a river, and still be programmed to report a positive X velocity.
 - This parameter only affects data when the coordinate system setting is **xyz**.
 - For more information about the coordinate system, see §[B-9.2](#).
 - When [ReverseXVelocity](#) is set to **NO**:
 - The +X velocity is the direction marked with an arrow on the front of the SL housing (this is in the direction of beam 1).
 - The –X velocity is opposite of the arrow marked on the front of the SL housing
 - The +Y velocity is horizontally away from the SL.
 - The –Y velocity is horizontally toward the SL.
 - When [ReverseXVelocity](#) is set to **YES**:
 - The +X velocity is opposite of the arrow marked on the front of the SL housing.
 - The +X velocity is in the direction marked with an arrow on the front of the SL housing (this is in the direction of beam 1).
 - The +Y velocity is horizontally away from the SL.
 - The –Y velocity is horizontally toward the SL.
- Temperature Mode [[TempMode](#)] – This setting determines the source of temperature data for sound speed compensation — measured or user. Except in very unusual applications, this is set to **MEASURED** for real-time temperature compensation using the SL’s temperature sensor.
- Default Water Temperature [[Temp](#)] – This temperature value is used to calculate sound speed if the Temperature Mode [[TempMode](#)] is set to **USER**. When [TempMode](#) is set to **MEASURED** (the default), the [Temp](#) value is not used. Normally, a user input for temperature is only required for system testing and specialized applications.
- Default Water Salinity [[Sal](#)] – Salinity (in ppt) is used for sound speed compensation. Salinity should be entered accurately (ideally within 1 ppt) to ensure accurate sound speed data.
- Start Deployment [[Start](#)] – This command is used to begin data collection immediately; the settings of [StartDate](#) and [StartTime](#) are ignored. The system checks operating parameters and recording space, and then begins collecting the first sample. This is the typical action when Enable Recorder is **OFF**.
- Start Deployment [[Deploy](#)] – This command is used to begin data collection at the time specified by [StartDate](#) and [StartTime](#); if this date/time has already passed, data collected begins immediately. This is the typical action when Enable Recorder is **ON** or when SDI-12 mode is being used.

5.4.2. Multi-cell Profiling Parameters

The Argonaut-SL has a feature that allows the system to record a multiple cell velocity profile. See §B-6.4 for more information about this feature. See §6.5.1 for an example multi-cell velocity profile data file.

- When the multi-cell profile is enabled, the instrument will report up to eleven velocity values — one for the standard integrated cell and up to ten cells from the velocity profile.
- Additional parameters are required to define the velocity profile; these are described below.
- The profile is calculated in addition to, and independently from, the single integrated velocity cell.

Figure 5-21 displays a typical setup with multi-cell velocity profiling. In this example, the velocity profile has been set up to span horizontally the entire channel's width. The example shown here is only one way to use the multi-cell profile. The profile can be set up with a wide variety of parameters depending on your interests.

The following parameters are required to define the multi-cell velocity profile. Note: The corresponding direct command from Appendix C is shown in brackets; e.g., [Command].

- Profiling Mode [ProfilingMode] – When enabled, the profiling mode (often referred to as multi-cell profiling) 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. When Profiling Mode is set to **YES**, you must enter values for blanking distance [BlankDistance], cell size [CellSize], and number of cells [NumCells]. When Profiling Mode is **NO**, these values are ignored. Data for each cell is collected and output in the format described in Appendix D.
- Blanking Distance [BlankDistance] – This refers to the region in front of the transducers where no measurements can be made. It is measured as the distance from the instrument's

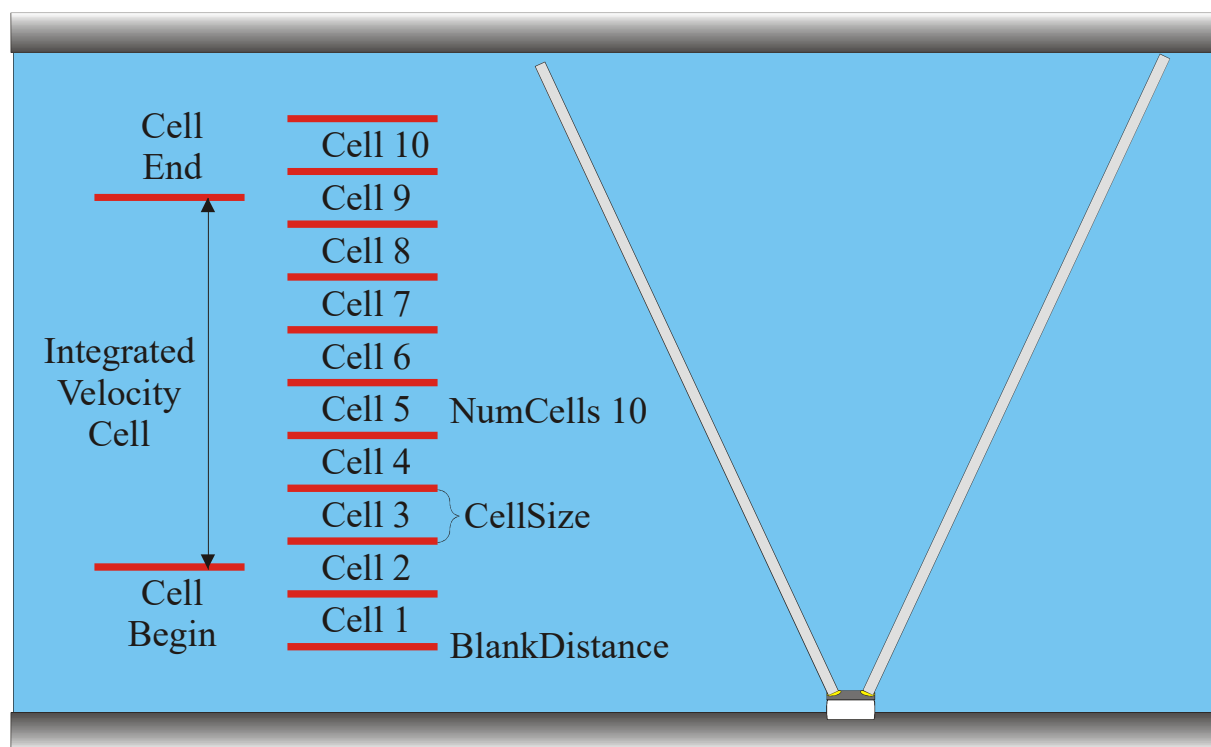


Figure 5-21. Multi-cell Velocity Profile and Single Integrated Velocity Cell

transducers to the start of the first cell in the velocity profile. The blanking region is needed to give time for the transducers and electronics to recover from the transmit pulse. The setting of this parameter is determined by the desired location of the multi-cell velocity profile.

- Cell Size [**CellSize**] – This determines the horizontal distance from the start of one cell to the start of the next cell. For details about the exact spatial extent of the velocity cell, see [Appendix B](#) (Principles of Operation). [Table C-2](#) lists the minimum value for each SL model.
- Number of Cells [**NCells**] – This determines the number of cells to record in the multi-cell profile. The minimum value is 1; the maximum value is 10.

5.4.3. Internal Flow Parameters

The Argonaut-SL calculates the total flow in the channel as follows.

- The vertical acoustic beam measures stage.
- With user-supplied channel geometry, the SL calculates the total area in the cross-section based on stage.
- The SL measures a horizontally integrated velocity over some portion of the water layer.
- The SL relates measured velocity to mean velocity in the channel using either a theoretical estimate or a user-supplied index calibration.
- Area is multiplied by mean channel velocity to give flow.
- Total volume is the cumulative sum of flow rate multiplied by elapsed time.

You must provide certain data to the SL for flow calculations. An overview of this data is given below. Detailed examples for each channel type are given in §5.7.10 and §5.8. Note: The corresponding direct command from [Appendix C](#) is shown in brackets; e.g., [**Command**].

- Select Geometry [**ChannelType**] – The SL supports four channel types — **Irregular** open channel, **Trapezoid** open channel, trapezoidal closed **Culvert**, and stage/area **Equation**.
 - **Irregular** ([Figure 5-38](#), [Figure C-3](#); §5.7.10-*ViewArgonaut*, §5.8.2-*SonUtils*) – This is usually a natural streambed whose shape is defined by up to 20 survey points (X, Y) over the cross-section of the stream. The survey points must follow a few rules:
 - The elevation of the first point (Y₁, [Figure C-1](#)) must be greater than any other point.
 - Survey points must be entered in order of increasing width (X, [Figure C-3](#)).
 - **Trapezoid** ([Figure 5-39](#), [Figure C-3](#); §5.7.10-*ViewArgonaut*, §5.8.1-*SonUtils*) – Typically, a concrete-lined channel whose shape is defined by three parameters – **Bottom Width**, **Top Width**, and **Channel Depth**.
 - **Culvert** ([Figure 5-40](#); §5.7.10-*ViewArgonaut*, §5.8.3-*SonUtils*) – Typically, a concrete-lined channel with a closed top whose shape is defined by three parameters – **Bottom Width**, **Top Width**, and **Channel Depth**.
 - **Equation** ([Figure 5-41](#), [Figure 5-42](#); §5.7.10-*ViewArgonaut*, §5.8.4-*SonUtils*) – One or more equations that establish a relationship between measured stage and cross sectional area in the channel.
- Input Dimensions [**SetGeometry**] – Dimension requirements are based on the channel type entry (above). The dimensions can be entered in either metric (meters) or English (feet) units based on the Units System [**OutFormat**] setting.

- System Elevation [[SetArgElevation](#)] – The elevation of the SL within the channel is needed to determine the relationship between measured stage, total channel depth, and channel area.
 - For **Irregular** channels ([Figure 5-38](#), [Figure C-](#)) or a stage/area **Equation**, SL elevation is given as the height of the vertical beam transducer face relative to the same local datum used for channel survey points.
 - For **Trapezoid** ([Figure 5-39](#), [Figure C-3](#)) or **Culvert** ([Figure 5-40](#)) channels, SL elevation is given as the height of the vertical beam transducer face relative to the bottom of the channel.
- Mean-Velocity Calculation Method [[VelEquation](#)] – The relationship between velocities measured by the SL and mean velocity in the channel can be determined two ways.
 - **Disabled** – This setting disables internal flow calculations. Flow and area data are not calculated, are not output in real time, and not stored in the internal file.
 - **Theory** – A 1/6-power law relationship (using the location of the SL velocity cell relative to the channel geometry) is used to convert measured velocity to mean channel velocity.
 - **Index** – A user-supplied index relationship can be used to relate SL velocity to mean velocity in the channel. This requires three index coefficients (*Vintercept*, *Vslope*, and *Stage Coefficient*; [[SetIndexCoef](#)]) to define the relationship between measured and mean velocity.

$$V_{\text{mean}} = V_{\text{intercept}} + V_{\text{meas}} * (V_{\text{slope}} + (\text{StageCoef} * \text{Stage}))$$

where

V_{mean}	= mean velocity in the channel
$V_{\text{intercept}}$	= user-supplied velocity offset (cm/s or ft/s)
V_{meas}	= SL measured velocity
V_{slope}	= user-supplied velocity scale factor (no units)
<i>StageCoef</i>	= user-supplied water depth coefficient (1/s)
<i>Stage</i>	= measured stage (total water depth in m or ft)

Note that, in general:

1. The **Index** method provides for a better data set than the **Theory** method. However, you must provide information that may be difficult to obtain. Developing an index relationship involves several independent flow measurements and detailed data analysis to develop the coefficients of the index equation.
 2. In natural streams (**Irregular** channel type), the preferred method is **Index**. This is because unusual channel geometry can cause large flow variations across the width of the channel, and an accurate theoretical flow calculation can be very difficult to determine.
 3. In **Trapezoid** or **Culvert** installations, flow data obtained from the **Theory** methods can provide excellent results.
- Total Volume Calculation [[TotalVolume](#)] – If enabled, allows the SL to calculate total volume, which is the cumulative sum of flow rate multiplied by elapsed time. Flow and total volume data can be output in a variety of units depending on the **TotalVolume** setting (below). This parameter also affects real-time data output for RS-232, SDI-12, and analog output data.
 - 0: Disabled. Flow rate is output in cfs or m³/s based on the settings of [OutFormat](#).
 - 1: Flow rate in cfs, total volume in acre-ft.

- 2: Flow rate in gpm (U.S. gallons per minute), total volume in gallons.
- 3: Flow rate in mgd (10^6 U.S. gallons per day), total volume in gallons.
- 4: Flow rate in m^3/s , total volume in m^3 .
- 5: Flow rate in l/s (liters per second), total volume in liters.
- 6: Flow rate in mld (10^6 liters per day), total volume in m^3 .
- Remember Total Volume [[RememberTotalVolume](#)] – This parameter determines how the Argonaut performs total volume calculations when data collection is interrupted and restarted. It is available only if firmware version 12.0 and higher; prior to this firmware version, total volume was reset to zero any time that data collection was stopped and started. There are three options available. When establishing a new site, or starting a new season at an existing site, the most common setting is **INITIALIZE** with an initial volume value of zero. For ongoing operations at a given site, the most common setting is **CONTINUOUS**.
 - **CONTINUOUS**: The Argonaut continuously accumulates volume, even when data collection is temporarily interrupted. To do this, it stores the last good measurement, including the date/time of the measurement, flow rate, and total volume. If data collection is stopped and restarted, the Argonaut accumulates volume from the last good measurement and estimates the volume accumulation for the period between the two files.
 - **INITIALIZE**: The Argonaut starts data collection at a user specified volume value (commonly zero when installing the instrument at a new site) and continuously accumulates volume from that point. The starting value for total volume in that file is specified using the **InitialVolumeValue** command. If data collection is stopped and restarted, the Argonaut automatically switches over to **CONTINUOUS** total volume calculations.
 - **RESET**: The Argonaut starts volume for each file at zero (0). If data collection is stopped and restarted, the Argonaut starts the volume accumulation once again at zero.
- Allow Total Volume Reset [[AllowVolumeReset](#)] – This parameter sets whether the **Reset Flow Total** button on the Argonaut Flow Display (§H-2) is active. When set to **YES**, the Reset Total Volume key can be used at any time during data collection to reset the total volume calculation to zero. When set to **NO**, the Reset Total Volume key will not do anything (this is to prevent unauthorized field personnel from resetting the total volume calculation).
- Total Volume Criteria [[TotalVolumeFlowCriteria](#); [TotalVolumeVelocityCriteria](#)] – This determines which samples are added to the total volume calculations made by the SL. This affects all total volume data recorded and output by the system. This feature removes the effects of small, residual velocities that may be present in stagnant water on the total volume calculation.
 - Disabled: The default setting; all samples are added to the total volume calculations.
 - Flow: Samples are only added to the total volume if the calculated flow rate for that sample meets one of the following criteria.
 - Greater than or equal to ($\geq$) a user-specified threshold.
 - Less than or equal to ($\leq$) a user-specified threshold.
 - Absolute value of flow is greater than or equal to (magnitude $\geq$) specified threshold.
 - Velocity: Samples are added to total volume only if measured velocity (V_x) for that sample meets one of the following criteria.
 - Greater than or equal to ($\geq$) a user-specified threshold.
 - Less than or equal to ($\leq$) a user-specified threshold.
 - Absolute value of V_x is greater than or equal to (magnitude $\geq$) specified threshold.

5.4.4. Wave Spectra Parameters

The following parameters are required only when using the optional wave spectra measurement feature. This feature uses a time-series of data from the pressure sensor to estimate the wave spectra at the installation site. Details about wave spectra measurements can be found in §J-1.

- Wave Spectra Calculations [[WaveSpectra](#)] – This enables or disables wave spectra calculations based on a setting of **YES** or **NO**.
 - A minimum value of Averaging Interval [[AvgInterval](#)] must be set for wave spectra calculations, as described in §J-1.
 - PowerPing [[PowerPing](#)] cannot be used when wave spectra calculations or pressure series recording are enabled.
- Water Depth [[WaterDepth](#)] – This sets the water depth used for wave spectra calculations.
 - Water depth is necessary for choosing the appropriate dispersion relation in wave spectra computations.
 - If not entered (i.e., 0), the Argonaut's depth (calculated from mean pressure) is used.
 - A water depth 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.
 - A positive value is interpreted as the fixed depth value at the deployment site.
- Record Pressure Series [[RecordPSeries](#)] – This enables or disables recording of the raw pressure time-series data used for wave spectra calculations.
 - When set to **YES**, the Argonaut stores 1024 samples of raw pressure (collected at 1 Hz) with each sample.
 - Recording of the raw pressure data allows for additional analysis of wave spectra in post processing.
 - Be aware that enabling this parameter greatly increases the file size, and decreases the maximum recording time, available on the internal recorder.
 - In general, we recommend setting this value to **NO** for most applications.
 - PowerPing cannot be used when wave spectra calculations or pressure series recording are enabled.

5.4.5. Analog Output Parameters

The following parameters are required only when using the optional analog output module(s). These modules generate an analog signal, either a 4-20 mA current loop or a 0-5 VDC voltage, proportional to one or more parameters measured by the Argonaut-SL. Details about the analog output modules can be found in [Appendix F](#).

See [§5.7.14](#) and [§5.8.10](#) for examples of a deployment using analog outputs.

- Analog Output type [[AnalogOutputType](#)] – This determines the type of analog output modules to be used. Two types are available — **Current** (4-20 mA current loop) or **Voltage** (0-5 VDC). Up to two output modules can be used with two different parameters at one time, but all modules used must be of the same [AnalogOutputType](#).
- Set Up Analog Outputs [[SetupAnalogOutput](#)] – The following settings are required to configure each analog output module.
 - **Channel** – Each analog output module is assigned an address from 1 to 2. The modules are configured at SonTek and labeled with the programmed address. When using multiple modules from a single system, each module must have a different address.
 - **Parameters** – [Table C-3](#) lists all parameters that are available as analog outputs. Also shown are the units used (either English or metric) to specify the upper and lower limits of the analog output.
 - **MinVal/MaxVal** – These user-specified values determine how the analog signal is generated. They are provided to narrow the range of values represented by the analog output signal based on the operating environment, thereby improving the resolution provided by the analog data. **MinVal** and **MaxVal** are defined in the units system specified by the [Out-Format](#) setting (**Metric** or **English**). [Table C-3](#) shows the absolute upper and lower limits for these values for each variable.

5.5. Autonomous Deployment Considerations

An autonomous deployment is one in which the Argonaut-SL records data internally and operates from an independent power supply. The following sections describe how to calculate data storage capacity of the internal recorder ([§5.5.1](#)) and expected battery life ([§5.5.2](#)). Note that the *ViewArgonaut* Deployment software also provides automatic calculations of recorder and battery life ([§5.7.15](#)).

If you are collecting data in real-time, we encourage you also to record data internally as a back-up and to ensure full access to all diagnostic data. If the recorder fills during a deployment, the Argonaut will continue outputting data in real-time (RS-232, SDI-12, or analog output), but will no longer store data to the internal recorder.

5.5.1. Data Storage

The Argonaut-SL includes an internal 4 MB (4,194,304 bytes) recorder. To calculate the total number of days of recorder capacity requires the following information.

- The number of bytes to be recorded with each SL sample.
- The number of samples recorded per day.

In addition to the basic sample structure, which is always recorded and requires 67 bytes, there are several different types of data that may be recorded with each Argonaut sample. [Table 5-1](#) shows the number of bytes for each type of data.

- Internal flow data are stored whenever internal flow calculations are enabled and require 8 bytes. To disable internal flow calculations, set [VelEquation](#) to **Disabled**.
- Total volume data are stored whenever total volume calculations are enabled and require 25 bytes. To disable internal flow calculations, set [TotalVolume](#) to **Disabled (0)**.
- If the multi-cell velocity-profiling feature is enabled, this adds [**8*NCells**] to each sample, where [NCells](#) is the number of velocity cells being recorded.
- Wave spectra data are stored whenever wave spectra calculations are enabled and require 24 bytes. To disable wave spectra calculations, set [WaveSpectra](#) to **NO**.
- Pressure series data are recorded if enabled and requires 3072 bytes. We do not recommend recording this data except in special circumstances. To disable recording of pressure time series set [RecordPSeries](#) to **NO**.
- YSI data is recorded if the optional external YSI sensor is installed; this requires 100 bytes.
- CTD data is recorded if the optional external CTD sensor is installed; this requires 16 bytes.

The total number of bytes per sample is the sum of all the enabled data types shown in [Table 5-1](#).

During normal sampling (when [BurstMode](#) is set to **NO**), the number of samples recorded per day can be calculated based on the user-specified sampling interval (§[5.4.1](#)).

$$\text{SamplesPerDay} = 86400 / \text{SampleInterval}(\text{seconds})$$

When using burst sampling ([BurstMode](#) **YES**), the number of samples recorded per day can be calculated based on the user-specified burst interval and samples per burst (§[C-9](#)).

$$\text{SamplesPerDay} = \text{SamplesPerBurst} * 86400 / \text{BurstInterval}(\text{seconds})$$

Recorder capacity, in number of days of operation, can be calculated as:

$$\text{DaysCapacity} = \text{TotalSpace} / (\text{TotalBytesPerSample} * \text{SamplesPerDay})$$

[TotalSpace](#) is the remaining space in the recorder at the start of data collection; when empty, the recorder has a 4-MB capacity (4,194,304 bytes). [Table 5-2](#) shows a few examples of recorder capacity based on starting data collection with an empty recorder.

Table 5-1. Number of Recorded Data Bytes

Data Type	Number of Bytes	Parameter Setting to Enable Recording	Parameter Setting to Disable Recording
Main Sample	67	Always recorded	Always recorded
Flow	8	VelEquation THEORY VelEquation INDEX	VelEquation DISABLED
Volume	25	TotalVolume > 0	TotalVolume 0
Multi-cell	8*Ncells	ProfilingMode YES	ProfilingMode NO
Wave Spectra	24	WaveSpectra YES	WaveSpectra NO
Record Pressure Series	3072	RecordPSeries YES	RecordPSeries NO
YSI	100	Always recorded if installed	Always recorded if installed
CTD	116	Always recorded if installed	Always recorded if installed

Table 5-2. Argonaut-SL Recorder Capacity Examples

Deployment Setup	Bytes Per Sample	Samples Per Day	Days Capacity
Internal Flow: YES Total Volume: NO Multi-cell profile: NO WaveSpectra: NO RecordPSeries: NO CTD: NO YSI: NO Averaging Interval: 300 s (5 min) Sample Interval: 900 s (15 min)	75	96	582
Internal Flow: YES Total Volume: YES Multi-cell profile: YES (10 cells) WaveSpectra: NO RecordPSeries: NO CTD: NO YSI: NO Averaging Interval: 300 s (5 min) Sample Interval: 900 s (15 min)	180	96	242
Internal Flow: NO Total Volume: NO Multi-cell profile: YES (10 cells) WaveSpectra: YES RecordPSeries: NO CTD: YES YSI: NO Averaging Interval: 1024 s (17 min) Sample Interval: 1800 s (300 min)	187	48	467
Internal Flow: NO Total Volume: NO Multi-cell profile: YES (10 cells) WaveSpectra: YES RecordPSeries: YES CTD: YES YSI: NO Averaging Interval: 1024 s (17 min) Sample Interval: 1800 s (300 min)	3259	48	26
Internal Flow: YES Total Volume: YES Multi-cell profile: YES (10 cells) WaveSpectra: NO RecordPSeries: NO CTD: NO YSI: YES Averaging Interval: 300 s (5 min) Sample Interval: 300 s (5 min)	280	288	52

5.5.2. Power Requirements

Power requirements for the Argonaut-SL can be calculated as follows.

- The SL uses 0.7-1.5 W during continuous operation, depending on system frequency and operating parameters. [Table 5-3](#) shows typical power consumption values.

Table 5-3. Argonaut-SL Typical Power Consumption Values

Frequency	Power Ping Enabled	Flow Display Installed	Power Consumption
500 kHz	NO	NO	1.0 W
500 kHz	NO	YES	1.3 W
1500 or 3000 kHz	NO	NO	0.7 W
1500 or 3000 kHz	NO	YES	1.0 W
1500 or 3000 kHz	YES	NO	1.2 W
1500 or 3000 kHz	YES	YES	1.5 W

- During an autonomous deployment, when the sampling interval is greater than the averaging interval (§5.4.1), the SL will enter a low-power sleep mode between samples to conserve power. Power consumption is negligible during the sleep mode, allowing the total deployment length to be extended by an amount determined by the duty cycle.
 - For normal sampling (BurstMode is NO), duty cycle can be calculated as follows.

$$\text{DutyCycle} = \text{AvgInterval} / \text{SampleInterval}$$
 - For burst sampling (BurstMode is YES), duty cycle is calculated as follows.

$$\text{DutyCycle} = \text{SamplesPerBurst} * \text{AvgInterval} / \text{BurstInterval}$$
 - If the SL is connected to a real-time SDI-12 data logger, the SL will not enter sleep mode between samples. In this case, assume a 100% duty cycle for battery calculations.
 - If the SL has a Flow Display installed, the SL will not enter sleep mode between samples. In this case, you should assume a 100% duty cycle for battery calculations.
- Battery capacity will depend on the type of battery being used.
 - The standard SL battery pack is wired to output 12.0 V with a nominal capacity of 40.0 A-h. This gives a nominal battery capacity of $(12.0 * 40.0) = 504 \text{ Wh}$.
 - For a user-supplied battery, calculate the nominal battery capacity as rated voltage multiplied by capacity in A-h.
 - For battery life calculations, we recommend 80% of the nominal capacity to account for voltage decay, temperature effects, and a reasonable safety margin. For the standard SL battery pack, this gives a working battery capacity of $(0.8 * 504) = 400 \text{ Wh}$.
- Battery life can be calculated as follows.

$$\text{BatteryLife (hrs)} = \text{BatteryCapacity (W-h)} / (\text{PowerConsumption (W)} * \text{DutyCycle})$$

[Table 5-4](#) show few example deployments with expected battery life. Note that for most deployments, we advise using a conservative estimate of total battery life (we typically use a value of 80% of the rated capacity of the battery). This allows for a margin of error to account for temperature effects and other factors that can reduce total battery capacity.

Table 5-4. Argonaut-SL Battery Life Capacity Examples

Deployment Setup	Battery Capacity	Maximum Battery Life (100%)	Conservative Battery Life (80%)
500-kHz SL Autonomous Deployment Flow Display Installed 1.0 W Power Consumption Averaging Interval 300 s (5 min) Sample Interval 300 s (5 min) Duty Cycle 100%	Standard SL battery 504 W-h nominal 400 W-h conservative	21 days	16 days
1500-kHz SL Autonomous Deployment PowerPing Off Flow Display Not Installed 0.7 W Power Consumption Averaging Interval 300 s (5 min) Sample Interval 900 s (15 min) Duty Cycle 33%	Standard SL battery 504 W-h nominal 400 W-h conservative	90 days	72 days
1500-kHz SL SDI-12 Deployment PowerPing On Flow Display Not Installed 1.2 W Power Consumption Averaging Interval 120 s (2 min) Sample Interval 900 s (15 min) Duty Cycle 100% (SDI-12)	Standard SL battery 504 W-h nominal 400 W-h conservative	17 days	14 days

5.6. Site Survey and Diagnostic Procedures

We recommend you do the basic diagnostic procedures described here before all deployments.

- This procedure uses our Windows-based utility program, *SonUtils*. For details about this program, see the *SonUtils* manual (part of its Help menu).
- The reference data provided by following this procedure can be useful in recognizing potential problems before a deployment, and for analyzing unusual results after recovering data from the instrument.
- This procedure assumes the system has been installed at the deployment site. However, many of the diagnostics can also be performed “in the office” before installing the system.
 - These diagnostics can either be done in air or with the SL in a container filled with at least 60 cm (2 ft) of water.
 - We recommend performing this diagnostic procedure both in the office before departing for the field, and at the field site before collecting actual deployment data.
 - Becoming familiar with the diagnostic procedure before going into the field can be very useful for a smooth, easy deployment.

When installing an SL at a new site, you should perform a site survey to determine the correct system settings.

- For the site survey, you should measure or estimate the cross section at the installation site. Some questions that should be answered:
 - What is the lowest water level likely to be seen at this site?
 - What is the water depth in the region the SL will be measuring?
 - Are there any variations in water depth with range from the transducers?
 - Are there any sand bars or other bottom features that may potentially interfere with the SL beams? Is there a potential for these to form in the future?
 - Be sure to look at the river both upstream and downstream of the system to consider the path of all acoustic beams (§B-3.1).
- Some general advice for setting Cell Begin and Cell End:
 - It is more important to pick a representative portion of the flow than to measure the maximum portion of the river.
 - Select Cell Begin and Cell End so that the measurement volume is placed in the main channel away from any potential sources of flow interference.
- When selecting a value for Cell Begin, consider the following:
 - What type of flow interference is generated by structures near the SL?
 - How far away from the SL does the flow interference extend?
 - Cell Begin should be selected to be past any likely flow interference.
- When selecting a value for Cell End, consider the following:
 - Are there any underwater obstacles the system is likely to hit? These obstacles may be identified by running BeamCheck or Diagnostics (§5.6.1).
 - Are there upstream structures that would generate flow interference? Cell End should be selected so the measurement volume is free of the effect of these structures.
 - At what range is the opposite bank or wall likely to be seen? Cell End should be set some distance (at least 10% of the range) before these items.

- What is the aspect ratio for the proposed value of Cell End (§B-9.1)?
 - Be sure to calculate the aspect ratio for the lowest water level likely to be seen at this site, and keep this within reasonable limits.
 - When carefully mounted, the SL can provide reliable measurements to an aspect ratio of 15-20 (§B-9.1). In some situations, measurements to a larger aspect ratio can be made, but considerable care should be taken.
- Can the measurement be made without surface or bottom interference, or do we need to set a shorter value for Cell End?

Perform the following steps to run the diagnostic procedure:

1. Preliminary:
 - a. Install *SonUtils* on your computer (§1.3).
 - b. Install the system as it will be for the actual deployment (unless you are conducting this procedure “in the office”). See §5.1 – **Selecting an Installation Site** and §5.2 – **System Installation** for details.
 - c. Connect the SL’s power and communications cable (§5.3–**System Interconnection**).
 - d. Connect the system to the power source that will be used during the deployment.
 - e. Connect the RS-232 cable to an available COM port on your computer.
2. Start the *SonUtils* program (**Start|Programs|SonTek Software|SonUtils***). *Note: The *SonUtils* program shortcut may contain a release number; for example, **SonUtils3**.
 - *SonUtils* provides direct communications with the SL using a text command interface.
 - In the example below, user-entered commands are shown in **Bold**, instrument responses are shown in a *fixed* font, and comments are shown in *italics* (comments do not appear in an actual *SonUtils* session window).
 - Commands are not case sensitive (i.e., you can use upper and/or lower case letters).
 - It is good practice to capture all communications to a log file for future reference. In *SonUtils*, click **File|Open Log File**, and then specify a folder and file name for the log. *SonUtils* will now record all communications in a plain-text file.
3. Establish communications by sending a **Break** to the instrument.

<BREAK> *Click BREAK icon to awaken system.*

```
Argonaut-SL
SonTek/YSI, Inc.
Copyright 1996-2005
Wake up initialization. Please wait...
>
```

4. Check sensor data and power supply. Make sure that temperature sensor and pressure sensor (if installed) data are reasonable for the environment, and that battery voltage data matches the expected output of your supply. To stop the continuous display of data, press <Enter>.

```
>Sensor CONT Start output of sensor data.
Temp = 19.53   Pressure = 0.03   Battery = 12.1
Temp = 19.49   Pressure = 0.06   Battery = 12.1
Temp = 19.47   Pressure = 0.03   Battery = 12.1
Temp = 19.49   Pressure = 0.03   Battery = 12.1
Temp = 19.49   Pressure = 0.06   Battery = 12.1
↓           ↓           ↓           ↓           ↓
Press <ENTER> to stop data output.
```

- Temperature is output in °C; battery voltage is output in V.
 - Pressure is output in dBar. 1 dBar equals 1 meter (3.3 ft) of water depth.
 - Ideally, with the system in air, pressure should read less than 0.1 dBar. When mounted in water, the pressure should be within 0.1 dBar of the depth (in meters). That is, if the system is mounted at a depth of 2.0 m, the pressure should read 1.9-2.1 dBar.
 - If the pressure sensor shows a significant offset, you will need to reset the pressure offset. To do this, use the command **ResetPressOffset** as shown below.
 - ♦ Type **ResetPressOffset**.
 - ♦ If the system is in air, enter 0 when prompted.
 - ♦ If the system is in water, measure the distance from the water surface to the top of the vertical beam and enter this value when prompted (the SL will prompt you to use either feet or meters depending on the setting of the **OutFormat** parameter).
- ```
>ResetPressOffset
Input distance (m) from the top of the system
to the water surface. Enter 0 in air, -1 to abort.
0
New PressOffset set.
OK
>
```
- Repeat the **Sensor CONT** command and verify the new pressure offset setting by comparing the output pressure to the deployment depth.
  - For more information about setting the pressure offset, see §7.5.1.
5. Check water level data (if the SL has a vertical beam). Make sure that measured water level matches the environment. Note that a value of -1 will be output if the system is in air or the water surface is not detected. It is common to see a few -1 readings even though the system is within range of the surface; this is because we are looking at raw, unaveraged data. To stop the continuous display of data, press <Enter>.
- ```
>Level CONT           Start output of water level data.
2182                  Water level is output as mm above the top of the SL.
2180                  This sample data was taken in 2.1 m (6.9 ft) of water.
2183
2185
2186
↓ ↓
Press <ENTER> to stop data output.
>
```
6. Run either Beam Check (within *SonUtils*) or the Diagnostics software (within *ViewArgonaut*) and record at least 20 pings. These two pieces of software serve the same function. Interpretation of data from these two programs is described in §5.6.1.

5.6.1. Beam Check / Diagnostics Data

To help determine the operating parameters of the SL, data output from the *Beam Check* module (within *SonUtils*) or *Diagnostics* module (within *ViewArgonaut*) is crucial. These programs provide an acoustic survey of the local site's conditions and should be used to specify the values of **Cell Begin** and **Cell End**.

Beam Check and *Diagnostics* both provide access to the same data in similar formats; either one can be used to evaluate a deployment site. However, *Beam Check* provides several additional features that are very valuable when analyzing data: display of Cell Begin and Cell End locations, and a theoretical decay curve. We encourage you to use *Beam Check* whenever possible. All sample data output in this section was generated through *Beam Check*.

To run Beam Check from within *SonUtils*

1. Click the **Beam Check** button within *SonUtils* to launch the *Beam Check* module. (For details about *Beam Check*, refer to *SonUtils* Help).
2. In *Beam Check*, click the **Play** button to start data collection.
3. Click the **Record** button to store data to a file.
4. Click the **Averaging** button. This will display *Beam Check* data as a running average of pings. This helps to remove the noise inherent in the acoustic reflections, and makes the mean signal profile easier to interpret.
5. Allow the SL to collect at least 20 pings of data. [Figure 5-22](#) shows a sample output with the SL deployed looking across a natural river with the opposite bank starting about 50 m away. See [Sample Output Description #1](#) on page 63.

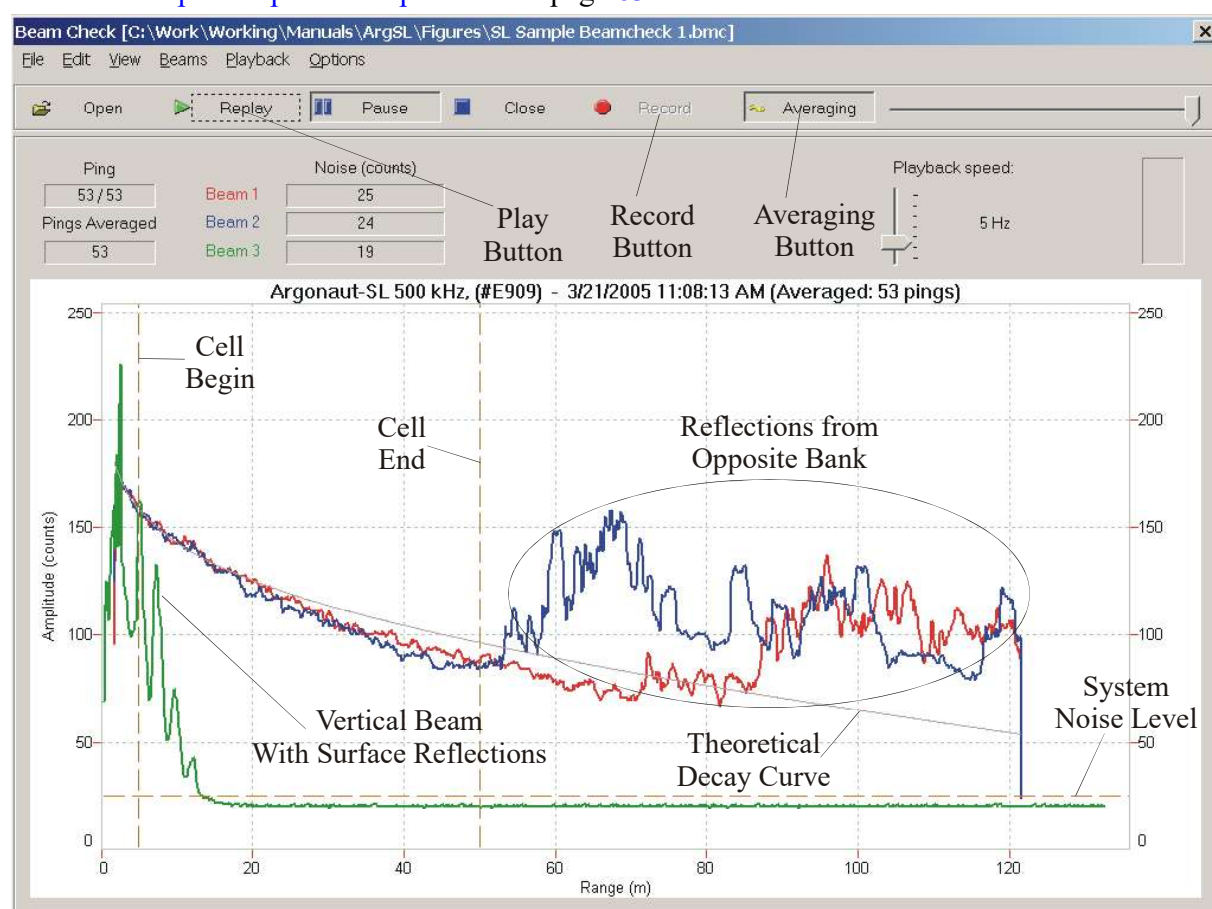


Figure 5-22. Beam Check Sample Output #1

To run Diagnostics from within *ViewArgonaut*

1. Run *ViewArgonaut* to launch the main menu.
2. Click the **Diagnostics** button to launch the *Diagnostics* module within *ViewArgonaut*.
3. In **Diagnostics**, click the **Connect** button. Specify the correct serial (COM) port and baud rate, and click **OK** to start data collection.
4. Click the **Record** button to store data to a file.
5. Click the **Averaging** button. This will display *Diagnostics* data as a running average of pings. This helps to remove the noise inherent in the acoustic reflections, and makes the mean signal profile easier to interpret.
6. Allow the SL to collect about 20 pings of data. [Figure 5-23](#) shows a sample output with an SL deployed about 2.1 m from the opposite bank.
7. For detailed analysis of the data, see [Sample Output Description #1](#) on page 63.

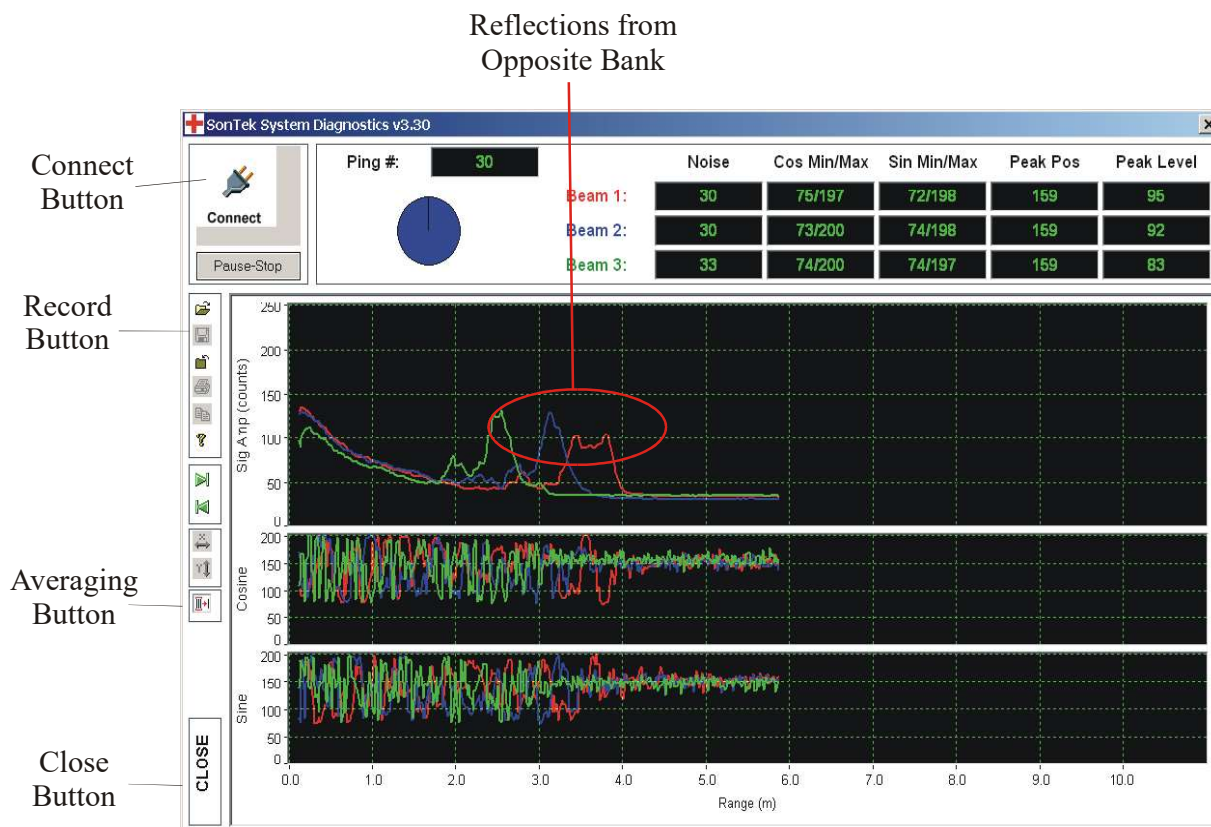


Figure 5-23. Diagnostics Sample Data

Sample Output Description #1

Figure 5-22 (*Beam Check* in *SonUtils*) shows a sample output from an SL installation. Detailed analysis of this example is given here. For other examples, see [Sample Output Description #2](#) (page 64) and [Sample Output Description #3](#) (page 66).

- This sample data was collected in a large natural river using a 500-kHz SL. The SL is mounted from a piling at a site on the river about 3 m below the surface.
- Beam 3 (green), the vertical beam, is looking towards the surface and shows multiple reflections from the surface. In general, we are only verifying that the vertical beam sees the surface at a reasonable location. The analysis of *Beam Check* data focuses on Beams 1 and 2.
- The reflections of Beam 1 (red) and Beam 2 (blue) from the opposite bank can be seen to start at about 50 m.
- You can see the programmed values of Cell Begin (5 m) and Cell End (50 m), respectively.
 - These lines represent the currently programmed values in the SL. They are not recommend values, but are just plotted to help you visualize the current system settings.
 - In this example, the plotted locations of Cell Begin and Cell End have already been set to good values for this location.
- When looking at data from Beams 1 and 2, we note the following.
 - Both beams show nearly identical behavior out to a range of about 50 m, when they begin to see the opposite bank. The two beams diverge when they see the bank; this is common since they are seeing the bank at different locations (one upstream, one downstream).
 - Both beams follow the theoretical decay curve closely out to a range of about 50 m. This is a good indication that neither beam is seeing interference from underwater obstacles.
 - Both beams have signal strength well above the system noise level at the programmed value of cell end.
- When selecting values of Cell Begin and Cell End, we have considered the following.
 - Cell Begin is set to 5 m, placing the start of the cell away from the flow interference generated by the piling to which the SL is mounted. There are no other structures or pilings in the water near the system.
 - Cell End is set to 50 m, ending before we start to see reflections from the opposite bank.
 - The SL was about 3 m below the surface when this data was recorded, which is at a relatively low water level. At this site, the SL is closer to the surface than to the bottom (which is at least 5 m below the SL). For a Cell End of 50 m, this gives an aspect ratio of 17 (50/3), which is a reasonable value for the operation of the SL (§B-9.1).
- In general when looking at data from Beams 1 and 2, the following features should be noted.
 - What type of signal strength am I seeing? Are the two beams showing the same level?
 - At what range does the acoustic return flatten out to the noise level?
 - Acoustic signal strength is an indicator of the maximum measurement range of the system. In this example ([Figure 5-22](#)), the signal strength is well above the noise floor for the entire measurement range.
 - Am I seeing any large reflections from any underwater obstacles? Are these obstacles where I expect them to be based on my knowledge of the deployment site? Have I set my operating parameters to avoid interference from these obstacles?
 - When looking at data from the opposite bank of the channel, be sure to consider the topography of the installation site. Changes in the width of the stream (either upstream or downstream of the installation site) can affect the location of reflections.

Sample Output Description #2

Figure 5-24 (Beam Check in *SonUtils*) shows a sample output from an SL installation. Detailed analysis of this example is given here. For other examples, see [Sample Output Description #1](#) (page 63) and [Sample Output Description #3](#) (page 66).

- This sample data was collected in a small irrigation canal using a 1500-kHz SL. The SL is mounted on a wall of the canal about 1 m below the surface.
- Beam 3 (green), the vertical beam, is looking towards the surface and shows multiple reflections from the surface. In general, we are only verifying that the vertical beam sees the surface at a reasonable location. The analysis of Beam Check data focuses on Beams 1 and 2.
- The reflections of Beam 1 (red) and Beam 2 (blue) from the opposite bank can be seen to start at about 8 m.
- You can see the programmed values of Cell Begin (2 m) and Cell End (5.5 m), respectively.
 - These lines represent the currently programmed values in the SL. They are not recommend values, but are just plotted to help you visualize the current system settings.
 - In this example, the plotted locations of Cell Begin and Cell End have already been set to good values for this location.
- When looking at data from Beams 1 and 2, we note the following.
 - Both beams show nearly identical behavior out to a range of about 8 m, when they begin to see the opposite bank. The two beams diverge when they see the bank; this is common since they are seeing the bank at different locations (one upstream, one downstream).

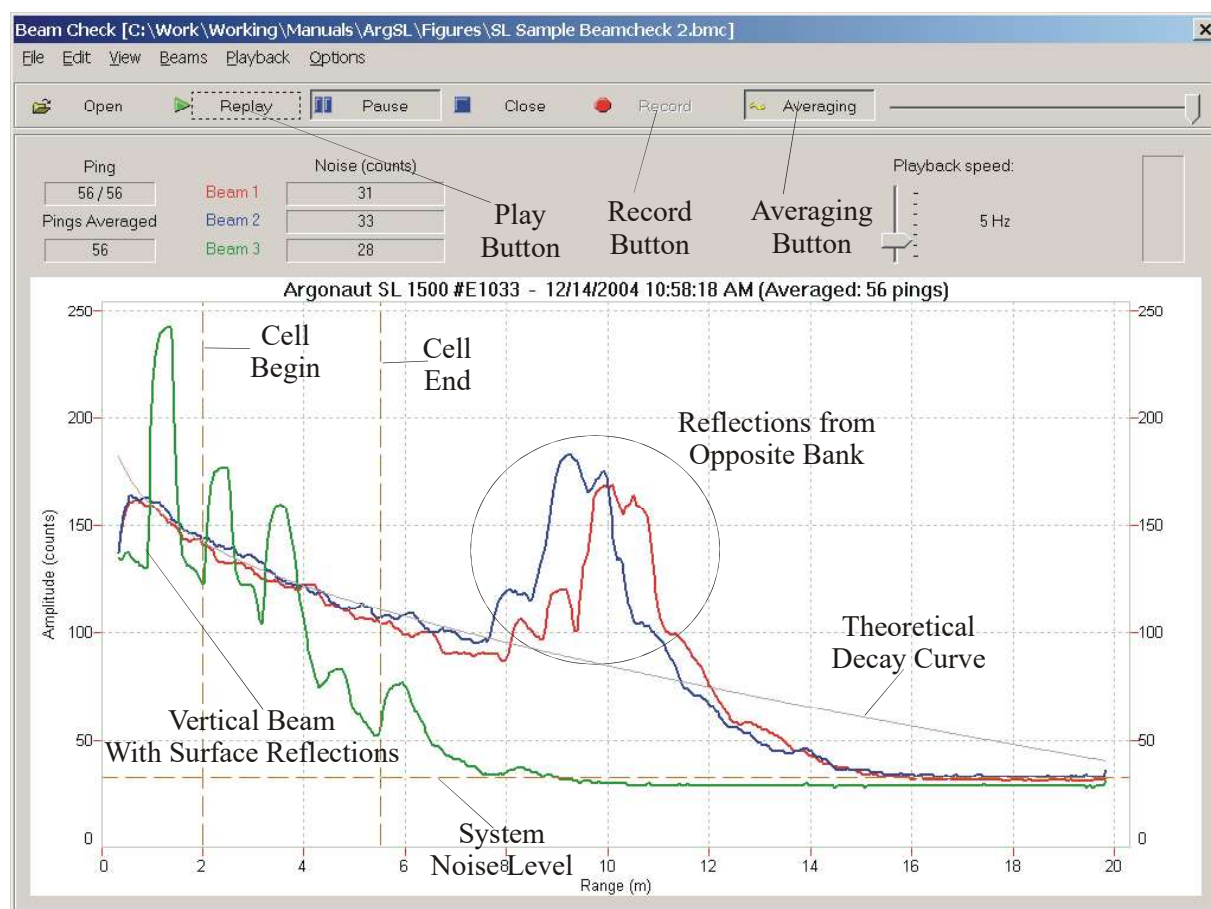


Figure 5-24. Beam Check Sample Output #2

-
- Both beams follow the theoretical decay curve closely out to a range of about 8 m. This is a good indication that neither beam is seeing interference from any underwater obstacles.
 - Both beams have signal strength well above the system noise level at the programmed value of cell end.
 - When selecting values of Cell Begin and Cell End, we have considered the following.
 - Cell Begin is set to 2 m, placing the start of the cell away from any flow interference associated with the bank.
 - Cell End is set to 5.5 m, ending before we start to see reflections from the opposite bank.
 - The values of Cell Begin and Cell End were chosen to give a measurement volume located in the center portion of the canal, a good representative sample of the overall flow.
 - The SL was about 1 m below the surface when this data was recorded, which is at a relatively low water level. The SL is roughly in the middle of the water column (1 m below the surface, 1 m above the bottom). For a Cell End of 5.5 m, this gives an aspect ratio of 5.5 (5.5/1) — a very safe value for the operation of the SL (§B-9.1).
 - In general when looking at data from Beams 1 and 2, the following features should be noted.
 - What type of signal strength am I seeing? Are the two beams showing the same level?
 - At what range does the acoustic return flatten out to the noise level?
 - Acoustic signal strength is an indicator of the maximum measurement range of the system. In this example (Figure 5-24), the signal strength is well above the noise floor for the entire measurement range.
 - Am I seeing any large reflections from any underwater obstacles? Are these obstacles where I expect them to be based on my knowledge of the deployment site? Have I set my operating parameters to avoid interference from these obstacles?
 - When looking at data from the opposite bank of the channel, be sure to consider the topography of the installation site. Changes in the width of the stream (either upstream or downstream of the installation site) can affect the location of reflections.

Sample Output Description #3

Figure 5-25 (*Beam Check* in *SonUtils*) shows a sample output from an SL installation. Detailed analysis of this example is given here. For other examples, see [Sample Output Description #1](#) (page 63) and [Sample Output Description #2](#) (page 64).

- This sample data was collected in a large natural river with a 500-kHz SL. The SL is mounted on a piling near one bank of the river about 5 m below the surface.
- Beam 3 (green), the vertical beam, is looking towards the surface and shows multiple reflections from the surface. In general, we are only verifying that the vertical beam sees the surface at a reasonable location. The analysis of Beam Check data focuses on Beams 1 and 2.
- Both Beam 1 (red) and Beam 2 (blue) show a smooth, steady decay in signal strength with range. No significant reflections are seen out to the maximum range (120 m) of the system.
- You can see the programmed values of Cell Begin (5 m) and Cell End (120 m), respectively.
 - These lines represent the currently programmed values in the SL. They are not recommend values, but are just plotted to help you visualize the current system settings.
 - In this example, the plotted locations of Cell Begin and Cell End have already been set to good values for this location.
- When looking at data from beams 1 and 2, we note the following.
 - Both beams show nearly identical behavior over the full range of the system.
 - Both beams follow the theoretical decay curve reasonably well to the maximum range of 120 m. This is a good indication that neither beam is seeing interference from any un-

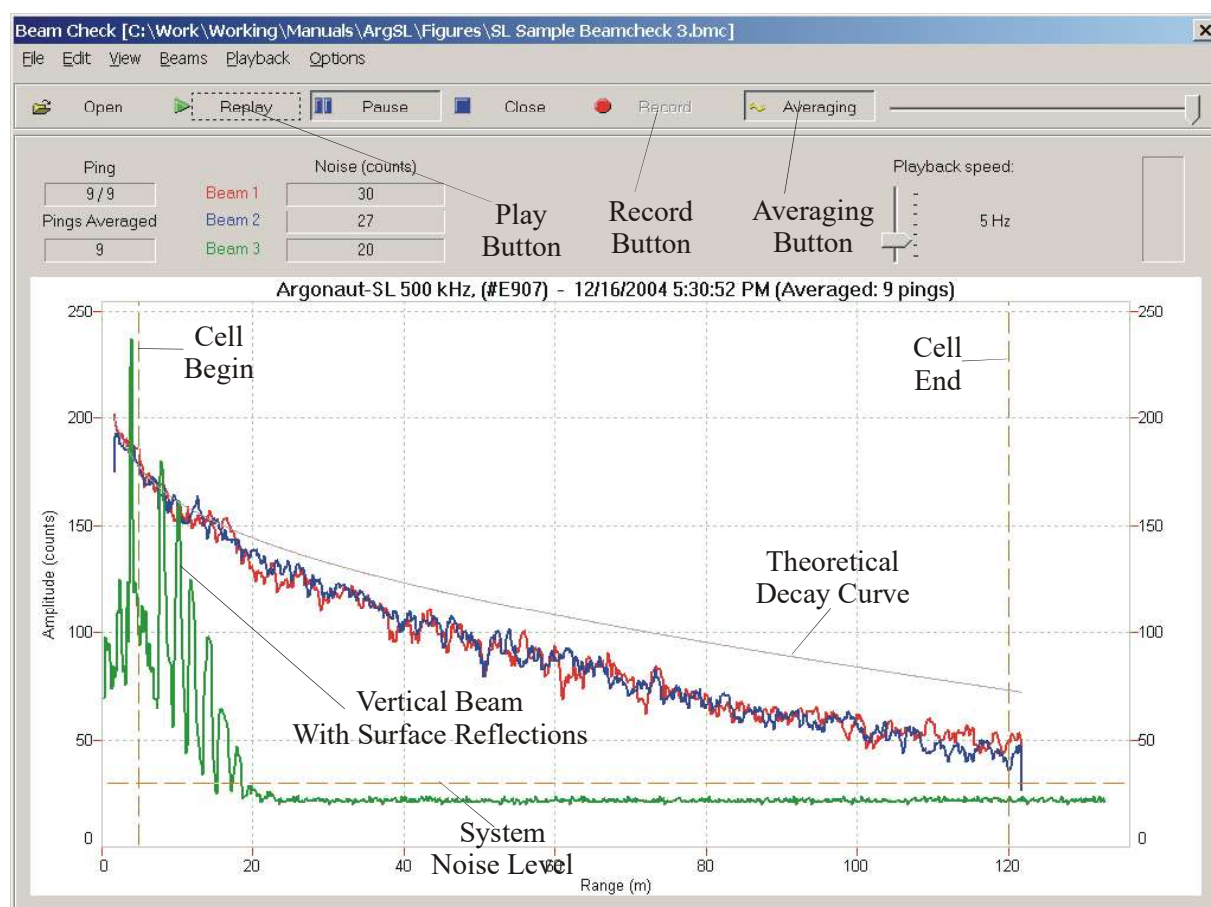


Figure 5-25. Beam Check Sample Output #3

derwater obstacles. They do show some deviation from the predicted decay, though this is not unusual as the decay prediction is only approximate.

- Both beams have signal strength well above the system noise level all the way to the maximum range of 120 m.
- When selecting values of Cell Begin and Cell End, we have considered the following.
 - Cell Begin is set to 5 m, placing the start of the cell away from any flow interference associated with the bank.
 - Cell End is set at a value of 120 m, using the maximum range of the system.
 - The values of Cell Begin and Cell End were chosen to give a measurement volume covering as much of the river as possible. This is a large, deep, natural river; it was felt that the SL could safely operate over this distance without any surface or bottom interference.
 - The SL was about 5 m below the surface when this data was recorded, which is at a relatively low water level. The SL is closer to the surface than the bottom, which is about 7 m below the SL at the mounting piling (and is deeper in the center of the channel). For a Cell End value of 120 m, this gives an aspect ratio of 24 (120/5). This is a somewhat aggressive value for the aspect ratio, but it was considered reasonable given the knowledge of the river (§B-9.1).
- In general when looking at data from Beams 1 and 2, the following features should be noted.
 - What type of signal strength am I seeing? Are the two beams showing the same level?
 - At what range does the acoustic return flatten out to the noise level?
 - Acoustic signal strength is an indicator of the maximum measurement range of the system. In this example (Figure 5-25), the signal strength is well above the noise floor for the entire measurement range.
 - Am I seeing any large reflections from any underwater obstacles? Are these obstacles where I expect them to be based on my knowledge of the deployment site? Have I set my operating parameters to avoid interference from these obstacles?
 - When looking at data from the opposite bank of the channel, be sure to consider the topography of the installation site. Changes in the width of the stream (either upstream or downstream of the installation site) can affect the location of reflections.

5.7. Deployment Examples using ViewArgonaut Software

There are two main ways to deploy the Argonaut-SL:

- *ViewArgonaut* Deployment module (described in this section), using one of these methods:
 - Standard deployment (e.g., via RS-232); §5.7.1
 - SDI-12 deployment (less common); §5.7.2
 - Modbus deployment (using Modbus Interface Module); §5.7.3
- Direct Command Interface using *SonUtils* (§5.8).

Both methods provide access to all the same commands and features within the SL; most users will probably use the *ViewArgonaut* Deployment software.

5.7.1. General ViewArgonaut Deployment Procedure: Standard

A standard deployment is one in which the Argonaut-SL is operating independently, and is not under the control of an external data logger. The SL operating parameters and the system's internal clock determine the relative timing of the velocity samples. Deployments controlled by external data loggers are covered in §5.7.2.

The basic steps for initiating a standard deployment are as follows.

- Install the SL in the channel following guidelines in §5.1.
- Connect the power/communications cable from the SL to the power supply that will be used during deployment.
- Connect the power/communications cable from the SL to an available serial (COM) port on your computer.
- Select RS-232 mode by “mating” the white plastic jumper-switch connector (Figure 5-20). For a standard deployment, this connector should always be mated.
- Perform a site survey using either Beam Check (*SonUtils*) or Diagnostics (*ViewArgonaut*) to select operating parameters and confirm the SL is operating properly (§5.6).
- Run the *ViewArgonaut* Deployment software to program all settings for your application as described in §5.7.4 through §5.7.16.
- If this is an autonomous deployment (i.e., battery powered), then after starting the deployment, disconnect the power and communications cable from your computer. Secure the connector and protect it from weather and moisture.
- The system is now deployed. When you are ready to retrieve/analyze data, see Section 6.

5.7.2. General ViewArgonaut Deployment Procedure: SDI-12

The Argonaut-SL is an SDI-12 compliant sensor. The SL can be used with any external data recorder/logger that has an SDI-12 interface.

When interfacing the SL with an SDI-12 data logger, the SL must first be programmed using RS-232 communications, and then switched into SDI-12 mode. The SL communications cable has a jumper-switch connector (Figure 5-20) that is used to choose between the RS-232 and SDI-12 communication protocols. For detailed information about the SDI-12 protocol and connection requirements, see Appendix E.

- The white plastic jumper-switch connector is used to choose between the RS-232 and SDI-12 communication protocols.
- When the connector is “mated”, the system is in RS-232 mode.
- When the connector is “open”, the system is in SDI-12 mode.

To interface the SL with an external SDI-12 data logger, use the following guidelines.

- Connect the “wet” end of the power/communications cable to the SL (§5.3).
- Connect the power supply to the SL cable (use the power supply that will be used during the deployment).
- Select RS-232 mode by “mating” the white plastic jumper-switch connector (Figure 5-20).
- Connect the RS-232 cable to an available COM port on your computer.
- Perform a site survey using either Beam Check (*SonUtils*) or Diagnostics (*ViewArgonaut*) to select operating parameters and confirm the SL is operating properly (§5.6).
- Run the *ViewArgonaut* Deployment software to program all settings for your application as described in §5.7.4 through §5.7.16.
- Disconnect the RS-232 connector from your computer.
- Select SDI-12 mode by “opening” the white jumper-switch connector (Figure 5-20).
- Connect the SDI-12 data cable to your data logger (§E-5).
- The system will now communicate with the data logger based on the setup of the SL and the data logger. A general summary of the SDI-12 command interface is given below.

When you are ready to exit SDI-12 mode and return the Argonaut-SL to RS-232 mode:

- “Mate” the RS-232/SDI-12 jumper switch (Figure 5-20) to enable the RS-232 serial bus.
- Connect the DB9 connector on the SL power/communications cable to an available serial port on your computer.
- Run *SonUtils*.
- Send the following command to the system.


```
?EXIT!           (You must press <Enter> after typing this command.)
Switching to RS-232 Mode
>
```
- The system is now in RS-232 command mode using the RS-232 serial bus, and is now ready to receive commands.

General Summary of SDI-12 Command and Response Interface

A general summary of the command interface and data output format is given below. See [Appendix E](#) for a detailed description of the SDI-12 command interface and data format.

- Samples can be initiated using either the **m** or **c** command (this depends on the capabilities of the data logger). Sample command sequences and SL responses are shown below. Note there are several ways to access SL data depending on which version of the SDI-12 interface is being used.
- The SL only supports the **SonTek** SDI-12 format (**Sidekick** format was discontinued after firmware version 8.9).
- The following SDI-12 interface method uses the **m** command (in this example, the SL is using SDI-12 address **a**)

```
am!           Data logger requests measurement.
a3159          SL will have nine parameters ready in 315 seconds
               (300 s for averaging interval; 15 s for overhead).
a              SL has completed the measurement.
aD0!         Data logger requests first data set.
a+62.26+0.00+2.654+2.6 SL returns first four parameters:
                  - Temperature (°C or °F).
                  - Pressure (dBar or psi)
```

- Stage (meters or feet); a -1 is reported if the water surface was not detected.
- Cell end (meters or feet). See Note 1 below.

aD1! Data logger requests second data set.

a+1.435-0.055+1.436+30.1+15.377

SL returns next five parameters:

- Vx velocity (cm/s or ft/s).
- Vy velocity (cm/s or ft/s).
- Vmag velocity magnitude (cm/s or ft/s).
- Mean Signal-to-Noise ratio (dB).
- Total flow (m³/s or ft³/s). Note that the flow value will only be present when flow calculations are enabled. Also, the number of decimal places will change depending on the magnitude of the flow (to stay within the output limits required with SDI-12).

Some of the following commands would apply only if multi-cell profiling is used. See Note 2 below.

aM1! Data logger requests Cell 1 measurement.

a0004 SL will have four parameters ready immediately.

aD0! Data logger request Cell 1 data.

a+1.033-0.088+1.037+38.7 SL returns cell 1 data:

- Vx velocity (cm/s or ft/s).
- Vy velocity (cm/s or ft/s).
- Vmag velocity magnitude (cm/s or ft/s).
- Mean Signal-to-Noise ratio (dB).

aM2! Data logger requests Cell 2 measurements.

aD0! SL response format is the same for all cells.

aM3! Data logger requests Cell 3 measurements.

aD0! SL response format is the same for all cells.

aM4! Data logger requests Cell 4 measurements.

aD0! SL response format is the same for all cells.

aM5! Data logger requests Cell 5 measurements.

aD0! SL response format is the same for all cells.

aM6! Data logger requests additional data parameters.

aD0! SL supplies additional data parameters (number of parameters depend on enabled options).

a+12.1+3805.2+10.234+9.456

- Battery voltage (V).
- Remaining recorder space (Kbytes).
- Flow rate (variable units).
- Total volume (variable units).

- The following SDI-12 interface method uses the **c** command (in this example, the SL is using SDI-12 address **a**). Note: **c** command only supported in SDI-12 v1.2 and later.

aC! Data logger requests measurement.

a31234 SL will have 34 parameters ready in 312 seconds (number of parameters returned will depend on enabled features, including multi-cell). Data logger waits until the measurement is completed.

aD0! Data logger requests first data set.

a+62.26+0.00+2.654+2.6 SL returns first four parameters:

- Temperature (°C or °F).
- Pressure (dBar or psi).
- Stage (meters or feet); a -1 is reported if the water surface was not detected.
- Cell end (meters or feet). See Note 1 below.

aD1! Data logger requests second data set.

a+1.435-0.055+1.436+30.1+15.377

SL returns next five parameters:

- Vx velocity (cm/s or ft/s).
- Vy velocity (cm/s or ft/s).
- Vmag velocity magnitude (cm/s or ft/s).
- Mean Signal-to-Noise ratio (dB).
- Total flow (m³/s or ft³/s). Note that the flow value will only be present when flow calculations are enabled. Also, the number of decimal places will change depending on the magnitude of the flow (to stay within the output limits required with SDI-12).

The following commands would apply only if multi-cell profiling is used. See Note 2 below.

aD2! *Data logger requests Cell 1 data.*

a+1.033-0.088+1.037+38.7

SL returns Cell 1 data:

- Vx velocity (cm/s or ft/s).
- Vy velocity (cm/s or ft/s).
- Vmag velocity magnitude (cm/s or ft/s).
- Mean Signal-to-Noise ratio (dB).

aD3! *Data logger requests Cell 2 data.*

SL response format is the same for all cells.

aD4! *Data logger requests Cell 3 data.*

SL response format is the same for all cells.

aD5! *Data logger requests Cell 4 data.*

SL response format is the same for all cells.

aD6! *Data logger requests Cell 5 data.*

SL response format is the same for all cells.

aD7! *SL supplies additional data parameters (number of parameters depend on enabled options).*

a+12.1+3805.2+10.234+9.456

- Battery voltage (V).
- Remaining recorder space (Kbytes).
- Flow rate (variable units).
- Total volume (variable units).

Notes:

1. When outputting real-time data, if the **ReverseXVelocity** command is enabled, the SL will change the sign of the **CellEnd** output parameter.
2. Another method exists for using doing multi-cell data in SDI-12 mode for SDI-12 version 1.0 only. This is called the SDI-12 multi-address method. For details, see §E-6.3.

5.7.3. General ViewArgonaut Deployment Procedure: Modbus

- Follow the standard deployment procedure described in (§5.7.1).
- Connect power to the MIM.
 - The Argonaut operates from 7-16 VDC power. Power consumption varies with instrument configuration (see §5.5.2).
 - The MIM operates from 9-16 VDC power, and consumes less than 0.5 W of power.
 - The Argonaut and MIM can often be run from the same power supply. Be sure the power supply used to operate these devices is sufficient for your required deployment length.
- If necessary, change the Modbus address, baud rate, and parity settings of the MIM (§I-5).

- Connect the DB9 connector from the Argonaut power and communication cable to the **Argonaut** port on the MIM.
- The MIM will establish communications with the Argonaut and start data collection.
 - You should see the **Argonaut Communication** LED light up when communication is established. This may take 1-2 minutes.
- Connect a cable from the **Modbus Communication** port on the MIM to your Modbus data acquisition system.
 - Data on the MIM will be available when the Argonaut completes the first sample.
 - Access data on the MIM as you would any other Modbus RTU slave device.
 - See §I-7 for a description of where different data values can be found.

5.7.4. ViewArgonaut Deployment Software Overview

The *ViewArgonaut* Deployment software follows the popular “wizard” style interface, using a sequential series of screens to configure all required parameters. One such screen, with additional annotations, is shown in [Figure 5-26](#). A few of the features of the Deployment software are listed below.

- The software can be used three different ways:
 - To plan a deployment without actually being connected to an Argonaut system.
 - To load desired parameter settings to an Argonaut system without starting a deployment.
 - To load settings and start a deployment.
- An index of all steps in the deployment process is shown on the left side of each screen.
- You can move between steps using the **Back** and **Next** buttons.
 - You can also move between steps by clicking on the desired step within the index.
 - **IMPORTANT:** Be aware that many of the steps in the index consist of more than one screen. Using the index to move between steps could potentially cause you to miss one or more screens with important system parameters.
- Each screen displays parameters related to a specific aspect of data collection.
- The software automatically creates a log file each time you connect with the Argonaut system. This provides a record of commands sent to the system and instrument responses for the entire deployment procedure. Log files are stored within a “Log Files” subdirectory of the *ViewArgonaut* program folder (normally C:\Program Files\SonTek\ViewArgonaut\Log Files). The log files use a naming format giving the date they were created and a sequential number so that no log files are overwritten.
- The typical deployment procedure is to move through each screen in sequential order, setting and verifying all commands.
- The final steps of the deployment software (§5.7.16) allows you to:
 - Save all settings to a template file (on your computer) for future use.
 - Upload settings to the instrument and save them to internal (non-volatile) memory.
 - Start data collection.

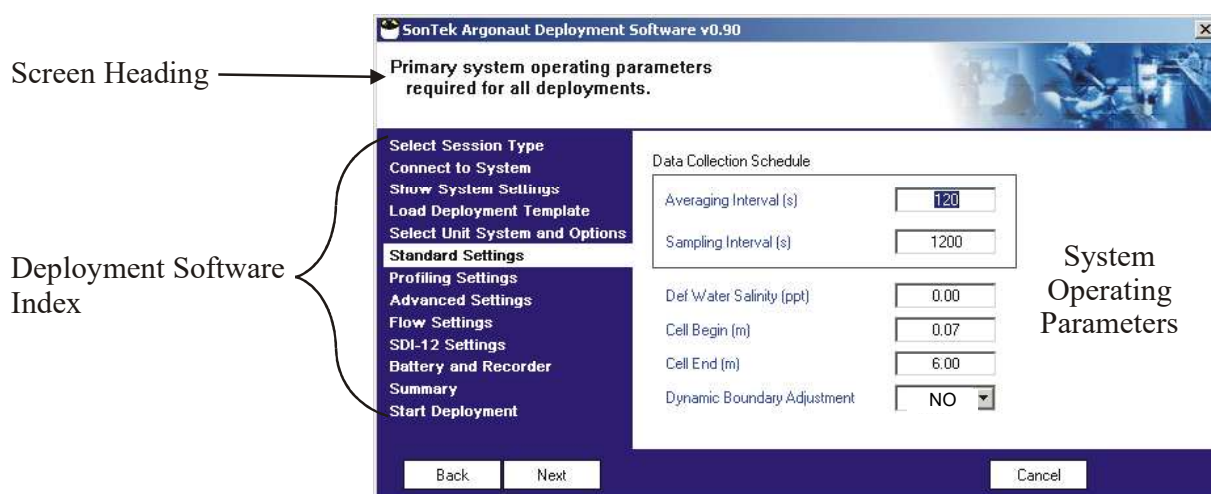


Figure 5-26. Typical Deployment Software Screen

5.7.5. Creating Template Files (*ViewArgonaut*)

The Deployment software uses template files to store all instrument hardware and operating parameter settings.

- Template files are specific for a given instrument type, frequency, and configuration.
- You can create multiple template files for a given instrument.
- You can use a template file for multiple instruments of the same type and hardware configuration. This can be useful when applying the same operating parameters to different instruments in different locations.

No sample template files are included with the Argonaut software, but they can be easily created for your instrument using the following steps.

- Connect the system to an available serial (COM) port on your computer.
- Connect the system power supply.
- Run *ViewArgonaut* and click **Deployment** on the main menu.
- Follow the procedure outlined in §5.7.6 for connecting to the system.
- Set the operating parameters for your application as outlined in §5.7.7 – §5.7.15.
- At the **Deployment Summary** screen (§5.7.16), click **Save Configuration to File**.
- The software will prompt you for a file name and location in which to save the template file.
 - The default template folder (when using the standard *ViewArgonaut* installation procedure) is C:\Program Files\SonTek\ViewArgonaut\Templates.
 - The Deployment software will automatically list files stored in this folder during the **Load Deployment Template** step (§5.7.6).
 - Template files can also be stored in another folder if desired.

5.7.6. Starting the Deployment Process (*ViewArgonaut*)

With the exception of the first few screens, the deployment process is very similar whether you are connecting directly to an instrument or planning a deployment using a template file. To start the deployment process:

- If you will be connecting directly to a system:
 - Connect the system to an available serial (COM) port on your computer.
 - Connect the system power supply.
- Run *ViewArgonaut* and click on the **Deployment** button from the main menu.
- The first Deployment screen is shown in Figure 5-27.
 - If you are connecting directly to a system, select **Direct system setup**. The next screen is shown in Figure 5-28. To establish communications with the system:
 - Select the correct serial (COM) port and baud rate for your system.
 - Click **Connect to System**.
 - Progress is displayed as communications are established and settings are downloaded.
 - After communications are established, click **Next** to view the hardware configuration settings (Figure 5-30).
 - If you are planning a deployment from a template file, select **Plan a deployment**. The next screen is shown in Figure 5-29, where you will be prompted to select a template file.
 - The main window will list the files in the default template folder (C:\Program Files\SonTek\ViewArgonaut\Templates).

- To load a file from another location, select **Load from file** and click **Open File** to browse for your desired template file.
- When you have selected the desired template file, click **Next** to view all the major hardware configuration settings for this system (**Figure 5-30**).

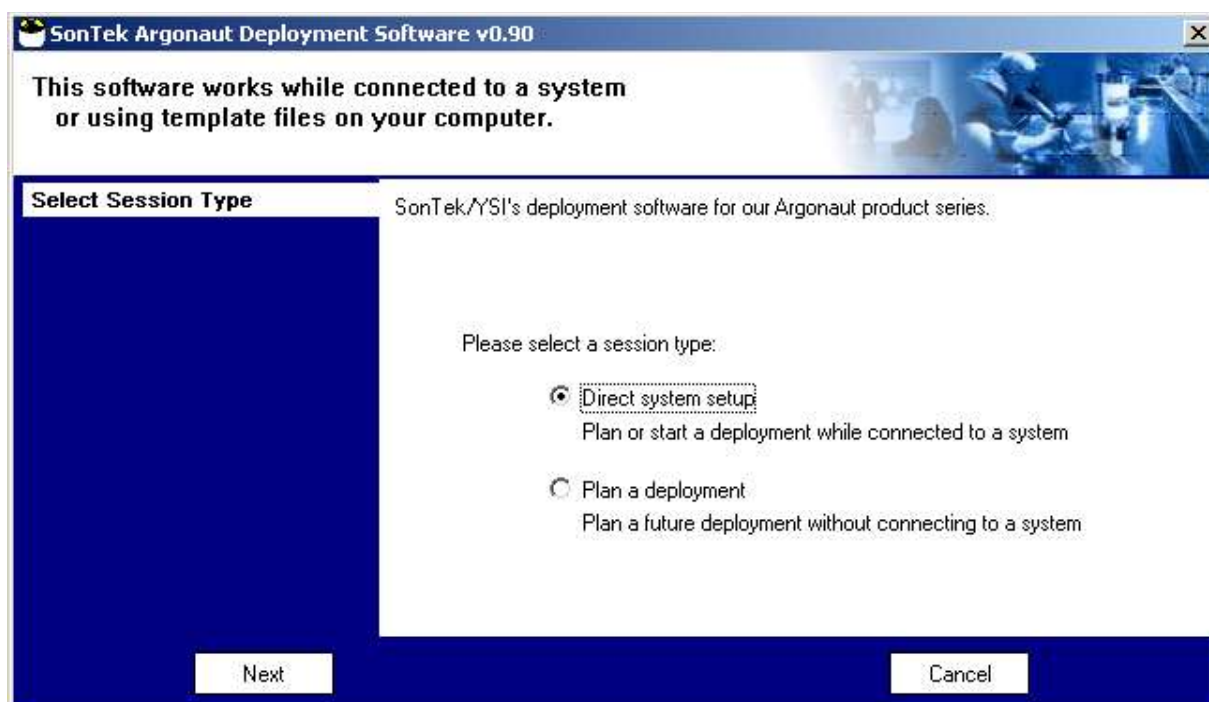


Figure 5-27. Deployment Software: Select Session Type

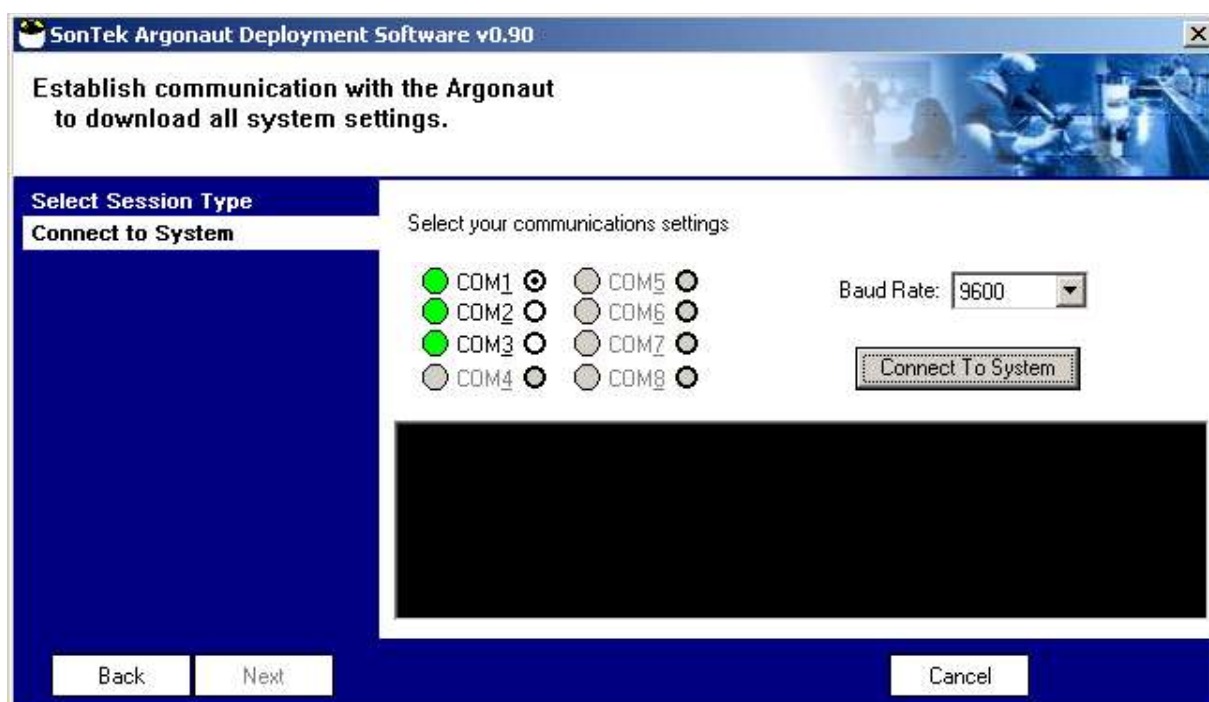


Figure 5-28. Deployment Software: Connect to System

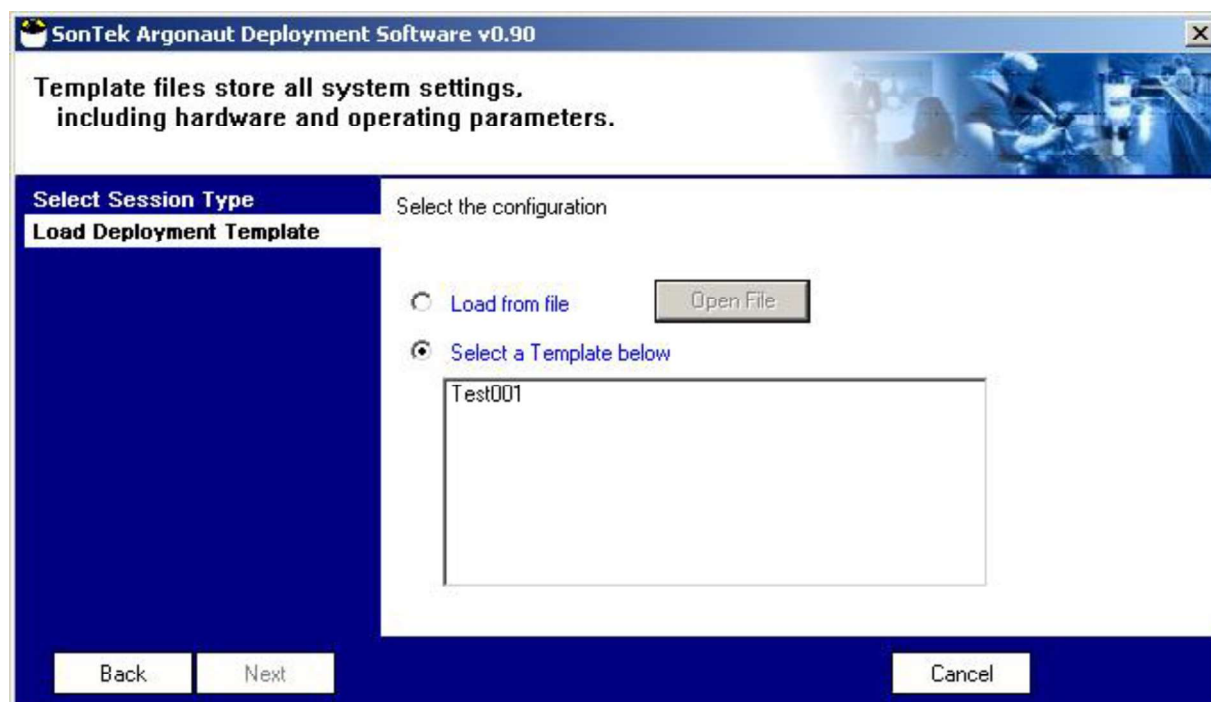


Figure 5-29. Deployment Software: Load Template File

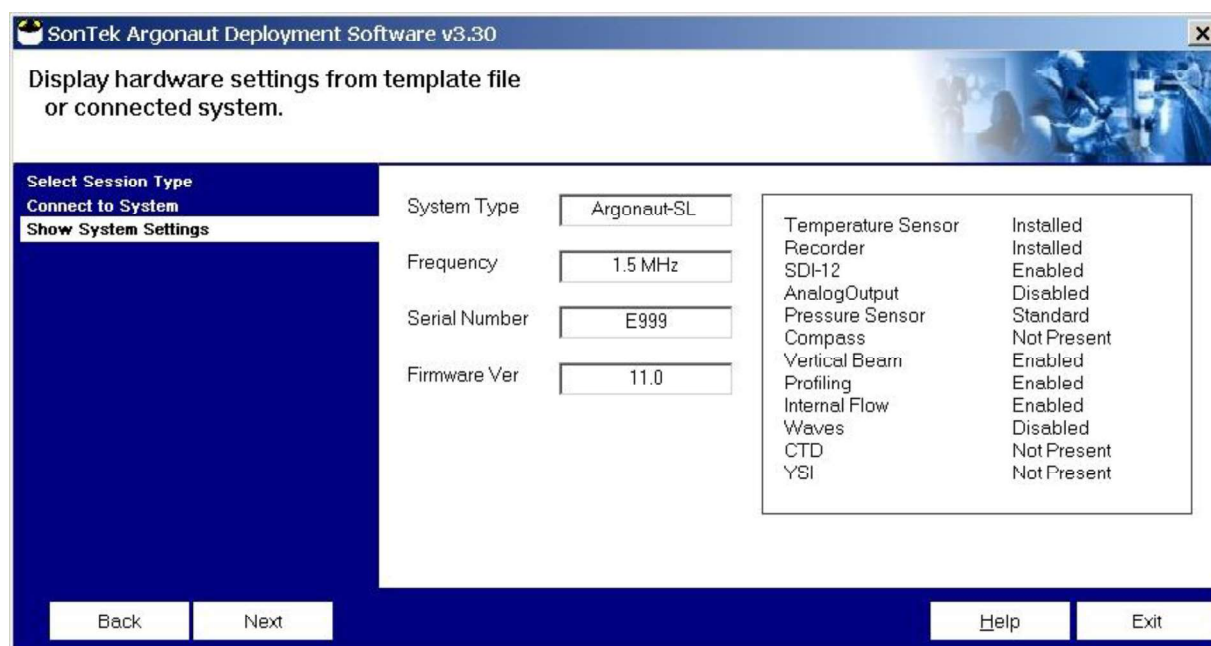


Figure 5-30. Deployment Software: Hardware Settings

- When connected directly to a system, you can proceed in two ways on the **Load Deployment Template** screen (**Figure 5-31**):
 - Select **Use existing system settings** to work with settings downloaded from the system.
 - Select **Load from file** or **Select a template below** to work with settings from an existing template file and apply those settings to the current system.
 - The main window will list the files in the default template folder (C:\Program Files\SonTek\ViewArgonaut\Templates).
 - To load a file from another location, select **Load from file** and click **Open File** to browse for your desired template file.
 - When loading a template, the hardware settings in that template must match the hardware settings of the current system, or the template file will not be loaded.
- When ready, click **Next**.
- All system parameters can be input in either **English Units** or **Metric Units**, as chosen in the **Select Unit System and Options** screen (**Figure 5-32**). This setting also affects the output units used for any real-time output data (RS-232, SDI-12, or analog output).
- Check boxes on right side of the screen let you display or hide various parameter settings.
 - We recommend reviewing all installed parameter settings before each deployment.
 - Show Profiling Settings (§5.7.8)
 - Show Wave Settings (§5.7.11)
 - Show Advanced Settings (§5.7.9)
 - Show SDI-12 Settings (§5.7.12)
 - Show Flow Settings (§5.7.10)
 - Show Analog Settings (§5.7.14)
 - Note that SDI-12 and Analog Output cannot be used at the same time, so the *Deployment* software will not allow you to select both options.
 - Any parameter settings that are not reviewed by the software will not be changed from their current settings.
- When ready, click **Next** to start setting all necessary parameters.

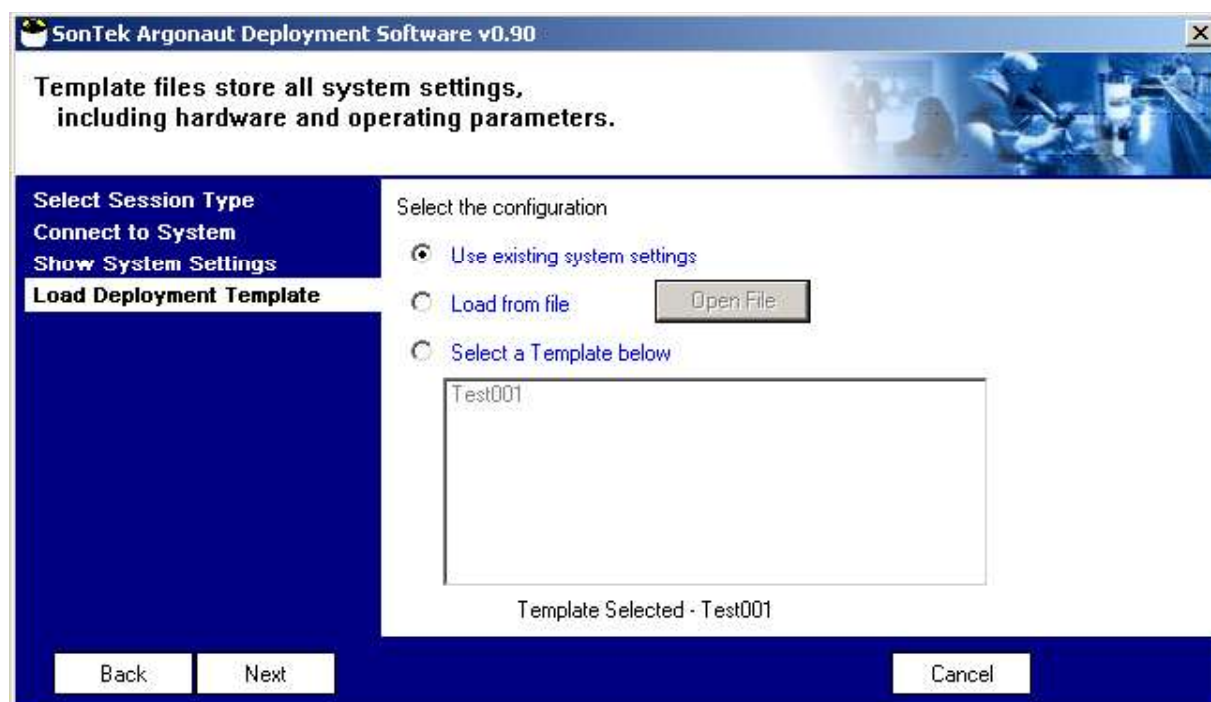


Figure 5-31. Deployment Software: Load Template File or Use Existing Settings

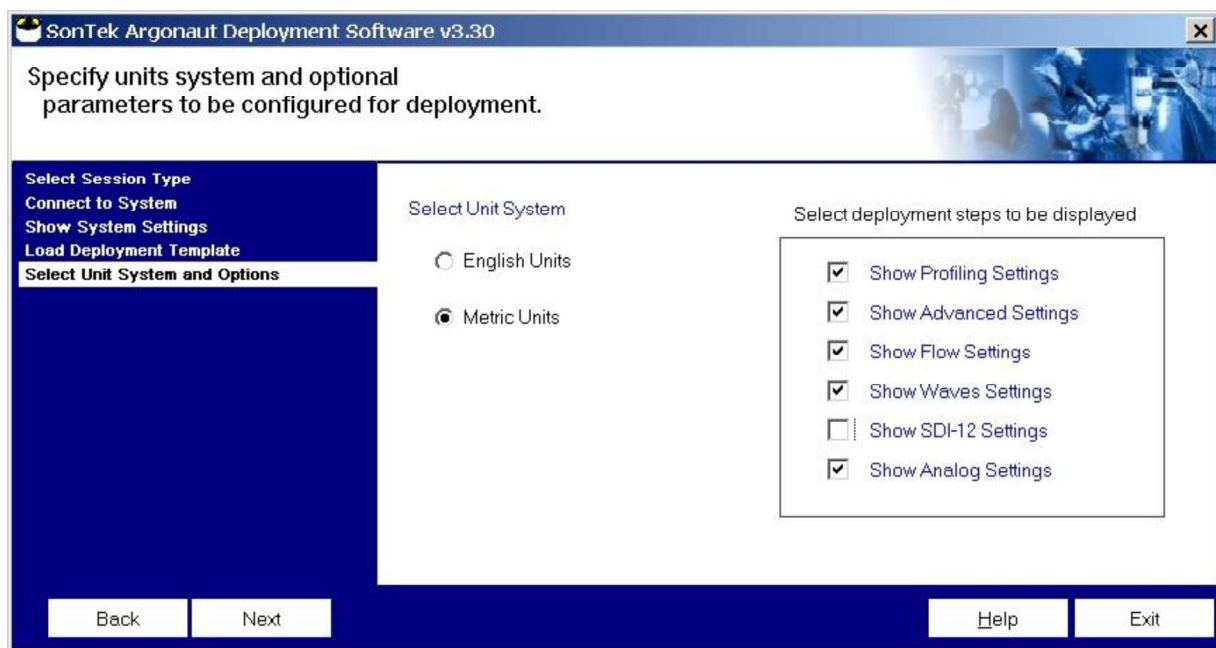


Figure 5-32. Deployment Software: Parameter Overview

5.7.7. Standard Operating Parameters (ViewArgonaut)

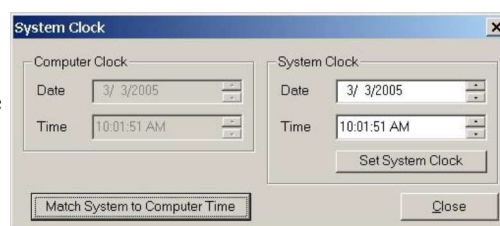
Standard operating parameters are settings required for any Argonaut-SL system and any deployment type. These parameters are divided between two screens ([Figure 5-33](#) and [Figure 5-34](#)).

The first screen ([Figure 5-33](#)) presents the following parameters. Refer to §5.4.1 or [Appendix C](#) for details about setting each parameter. After all parameters are properly set, click **Next**.

- **File Name** (same as [Deployment](#) command)
- **Start Date** (same as [StartDate](#) command)
- **Start Time** (same as [StartTime](#) command)
- **Comments** (same as [Comments](#) command)

The **Set System Date/Time** button on the first screen ([Figure 5-33](#)) opens a dialog box (right) that lets you synchronize the Argonaut clock to your computer's time or to any desired date and time.

- Click **Match System to Computer Time** to synchronize the Argonaut clock to your computer clock.
- Alternatively, enter the desired date and time and click **Set SystemClock** to set the clock to whatever time reference is being used.



The second screen ([Figure 5-34](#)) presents the following parameters. Refer to §5.4.1 or [Appendix C](#) for details about setting each parameter. After all parameters are properly set, click **Next**.

- **Averaging Interval** (same as [AvgInterval](#) command)
- **Sampling Interval** (same as [SampleInterval](#) command)
- **Def Water Salinity** (same as [Sal](#) command)
- **Cell Begin** (same as [CellBegin](#) command)
- **Cell End** (same as [CellEnd](#) command)

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Specify data file name, start date and time, and comments to be included in the file.

Select Session Type
Connect to System
Show System Settings
Load Deployment Template
Select Unit System and Options
Standard Settings
Profiling Settings
Advanced Settings
Flow Settings
Waves Settings
Analog Output Settings
Battery and Recorder
Summary
Start Deployment

File Name: RIVER
Start Date: 1/ 1/1995
Start Time: 12:00:00 AM
Set System Date/Time

Comments:
The Argonaut-SL is a fine instrument
Sure to make any child happy under the Christmas tree
Order yours in fashion colors today!

Back Next Help Exit

Figure 5-33. Deployment Software: Standard Operating Parameters #1

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Primary system operating parameters required for all deployments.

Select Session Type
Connect to System
Show System Settings
Load Deployment Template
Select Unit System and Options
Standard Settings
Profiling Settings
Advanced Settings
Flow Settings
Waves Settings
Analog Output Settings
Battery and Recorder
Summary
Start Deployment

Data Collection Schedule

Averaging Interval (s): 120
Sampling Interval (s): 900
Def Water Salinity (ppt): 0.00
Cell Begin (m): 2.0
Cell End (m): 10.0

Back Next Help Exit

Figure 5-34. Deployment Software: Standard Operating Parameters #2

5.7.9. Advanced Operating Parameters (ViewArgonaut)

Advanced operating parameters are present on all Argonaut-SLs, but are not commonly used. These parameters are most commonly set to their default values except for specialized applications. These parameters are divided between two screens ([Figure 5-36](#) and [Figure 5-37](#)).

The first screen ([Figure 5-36](#)) presents the following parameters. Refer to §5.4.1 or [Appendix C](#) for details about setting each parameter. After all parameters are properly set, click **Next**.

- **Temperature Mode** (same as [TempMode](#) command)
- **Default Water Temperature** (same as [Temp](#) command)
- **Coordinate System** (same as [CoordSystem](#) command)
- **Reverse X Velocity** (same as [ReverseXVelocity](#) command)
- **Enable Flow Display** (determines setting of [AutoSleep](#) command; see §H-2)
- **Power Ping** (same as [PowerPing](#) command))

The second screen ([Figure 5-37](#)) presents the following parameters. These parameters are all related to burst sampling, which is described in §B-9.5. Refer to §5.4.1 or [Appendix C](#) for details about setting each parameter. After all parameters are properly set, click **Next**.

- **Burst Mode** (same as [BurstMode](#) command)
- **Burst Interval** (same as [BurstInterval](#) command)
- **Samples Per Burst** (same as [SamplesPerBurst](#) command)
- **Averaging Interval** (this parameter is also shown in standard operating parameters; §5.7.7).
- **Sampling Interval** (this parameter is also shown in standard operating parameters; §5.7.7).

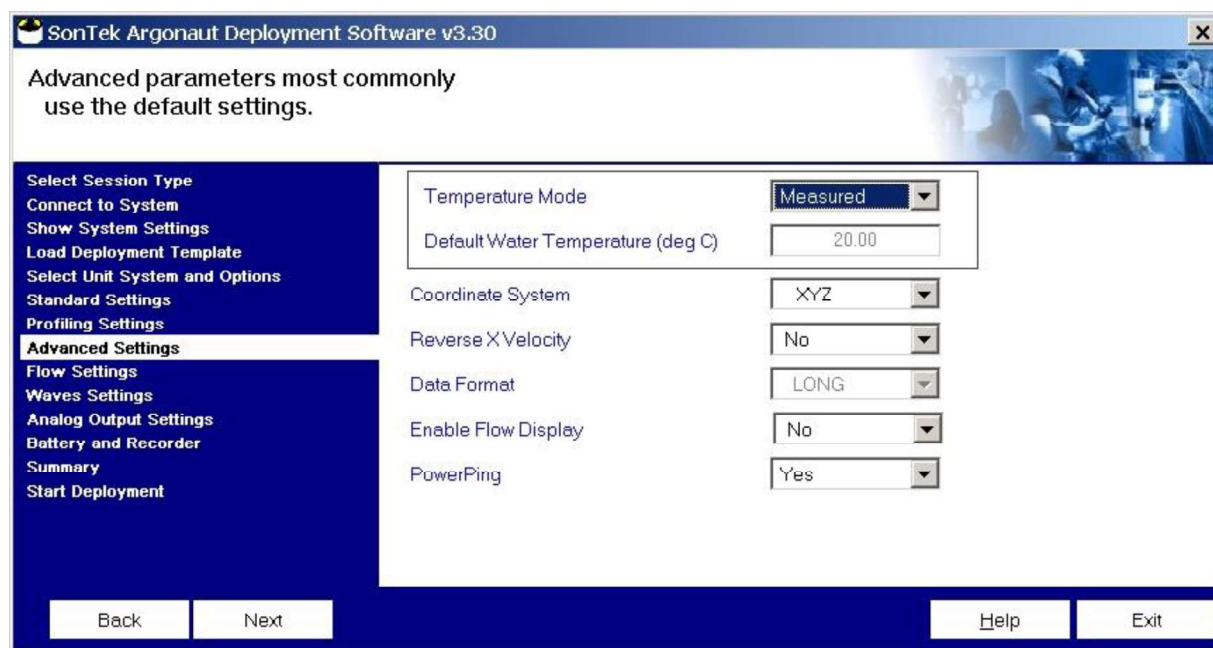


Figure 5-36. Deployment Software: Advanced Operating Parameters #1

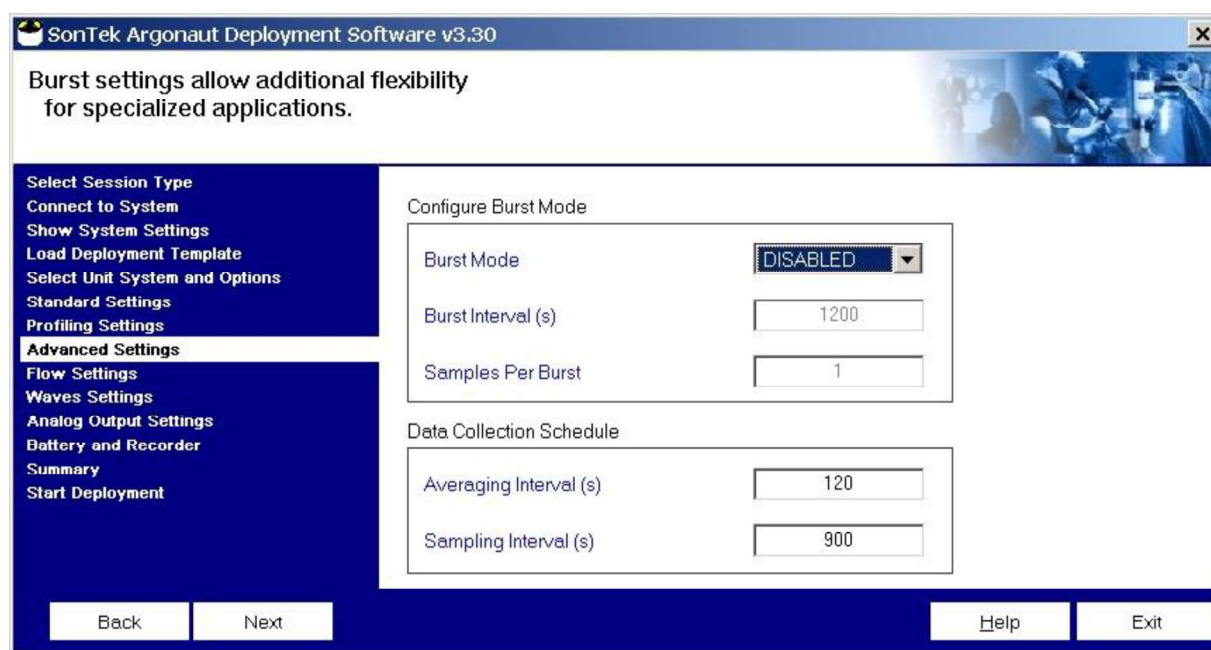


Figure 5-37. Deployment Software: Advanced Operating Parameters #2

5.7.10. Internal Flow Parameters (ViewArgonaut)

The Argonaut-SL is capable of making real-time flow calculations. To do this, additional parameters are required (see §5.4.3). Flow calculation parameters include:

- Parameters to define channel geometry. In the channel geometry screen, the channel type selection changes the layout of the screen to show the required parameters. Choices include:
 - Irregular Channel Type (Figure 5-38)
 - Trapezoid Channel Type (Figure 5-39)
 - Culvert Channel Type (Figure 5-40)
 - Equation Channel Type (Figure 5-41)

Note: You may see references to Round Channel Type and Ellipse Channel Type. These channel types are not available for use with the Argonaut-SL.

- Parameters to determine the [Mean-Velocity Calculation Method](#) (Figure 5-43).
- A parameter to enable and select units for [Total Volume Calculations](#) (Figure 5-44)

Irregular Channel Type

Figure 5-38 shows the screen for an irregular channel type (usually a natural stream). The following parameters are specified on this screen. Enter the parameters, and then click **Next** to continue.

- Select Geometry:** When set to **Irregular**, this parameter will change the layout of the screen to display the appropriate channel geometry parameters for an irregular channel type.
- Input Dimensions:** These are the dimensions for an irregular channel. Enter a minimum of 3 and a maximum of 20 survey points to define the shape of the channel cross-section.
 - X values (**Width**) must be entered in increasing order.
 - First Y value (**Elev**) must be greater than all other Y values.
 - Use the cursor keys or mouse to move through the survey point input boxes.
 - To insert a new point (i.e., a new “row”) between existing points, use the **Insert** key.
 - To delete an existing point (i.e., remove a “row”), use the **Delete** key.
- System Elevation:** This is measured at the top of the system and is referenced to the local datum. See Figure C-2.
- The **Open Flow File** button can be used to load a pre-defined channel geometry file.
- Later, you can save channel geometry information to a file for future use using the **Save Flow File** shown in Figure 5-43.
- Use the **Show Geometry** checkbox to show/hide the graphic display of channel geometry.

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Channel geometry is required for real-time flow calculations.

Select Session Type
Connect to System
Show System Settings
Load Deployment Template
Select Unit System and Options
Standard Settings
Profiling Settings
Advanced Settings
Flow Settings
Waves Settings
Analog Output Settings
Battery and Recorder
Summary
Start Deployment

Select Geometry

Irregular

Input Dimensions

P...	Width	Elev
1	0.000	5.000
2	1.000	5.000
3	2.000	3.000
4	3.000	1.000
5	5.000	0.500
6	7.000	0.300
7	9.000	0.200
8	11.000	0.400
9	12.000	1.000
10	13.000	3.000
11	14.000	5.000
12	15.000	5.000
13		

System Elevation

2.000 (m)

System Elevation is measured at the top of the system and is referenced to the local datum.

Open Flow File

Show Geometry

Back Next Help Exit

Figure 5-38. Deployment Software: Irregular Channel Geometry

Trapezoid Channel Type

Figure 5-39 shows the screen for a trapezoid channel type (normally a concrete-lined channel). The following parameters are specified in this screen. When all parameters are correctly specified, click **Next** to continue.

- **Select Geometry:** When set to **Trapezoid**, this parameter will change the layout of the screen to display the appropriate channel geometry parameters for a trapezoidal channel type.
- **Input Dimensions:** These are the dimensions for a trapezoidal channel.
 - **Channel Depth** (see graphic for interpretation)
 - **Bottom Width** (see graphic for interpretation)
 - **Top Width** (see graphic for interpretation)
- **System Elevation:** This is the vertical distance from the bottom of the channel to the top of the system. See **Figure C-3**.
- The **Open Flow File** button can be used to load a pre-defined channel geometry file.
- Later, you can save channel geometry information to a file for future use using the **Save Flow File** shown in (**Figure 5-43**).
- Use the **Show Geometry** checkbox to show/hide the graphic display of channel geometry.

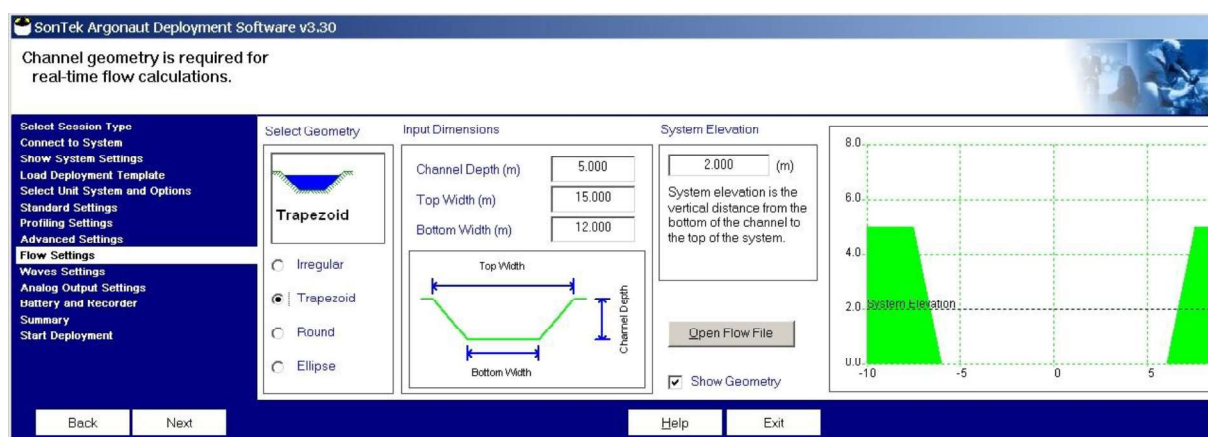


Figure 5-39. Deployment Software: Trapezoid Channel Geometry

Culvert Channel Type

Figure 5-40 shows the screen for Culvert channel type (normally a concrete-lined channel with a closed top). The following parameters are specified in this screen. When all parameters are correctly specified, click **Next** to continue.

- **Select Geometry:** When set to **Culvert**, this parameter will change the layout of the screen to display the appropriate channel geometry parameters for a culvert channel type.
- **Input Dimensions:** These are the dimensions for a culvert channel.
 - **Channel Depth** (see graphic for interpretation)
 - **Bottom Width** (see graphic for interpretation)
 - **Top Width** (see graphic for interpretation)
- **System Elevation:** This is the vertical distance from the bottom of the channel to the top of the system. See **Figure 5-40**.
- The **Open Flow File** button can be used to load a pre-defined channel geometry file.
- Later, you can save channel geometry information to a file for future use using the **Save Flow File** shown in (**Figure 5-43**).
- Use the **Show Geometry** checkbox to show/hide the graphic display of channel geometry.

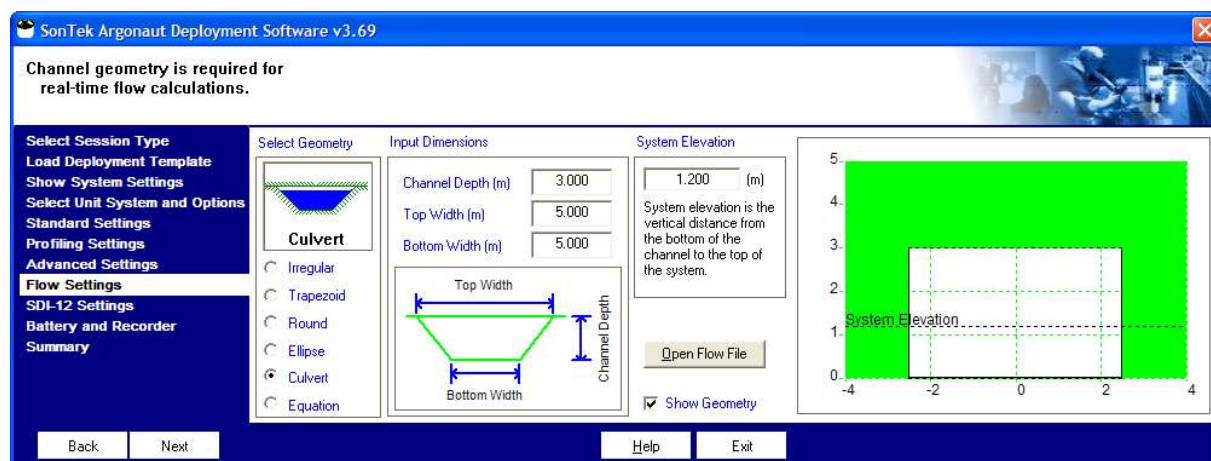


Figure 5-40. Deployment Software: Culvert Geometry

Equation Channel Type

Figure 5-41 shows the screen for Equation channel type; this can represent a variety of locations where a stage/area equation has been found to be the best option. The following parameters are specified in this screen. When all parameters are correctly specified, click **Next** to continue.

- **Select Geometry:** When set to **Equation**, this parameter will change the layout of the screen to display the appropriate parameters for a stage area equation.
- **Input Dimensions:** These are the details of a stage area equation.
 - **Equation Summary Table** (shows all stage/area equations that have been input)
 - **Add Equation** (click this button to add another stage/area equation using the dialog shown in **Figure 5-42**)
 - **Remove Equation** (click this button to remove the last stage/area equation)
 - Stage area equations must be entered in order of increasing stage, and the stage ranges for equations must be continuous. The plot at the right of the dialog shows the stage/area relationship. You must independently verify the validity of any stage/area equation used.
- **System Elevation:** This is the vertical location of the top of the system relative to the local datum.
- The **Open Flow File** button can be used to load a pre-defined channel geometry file.
- Later, you can save channel geometry information to a file for future use using the **Save Flow File** shown in (**Figure 5-43**).
- Use the **Show Geometry** checkbox to show/hide the graphic display of channel geometry.

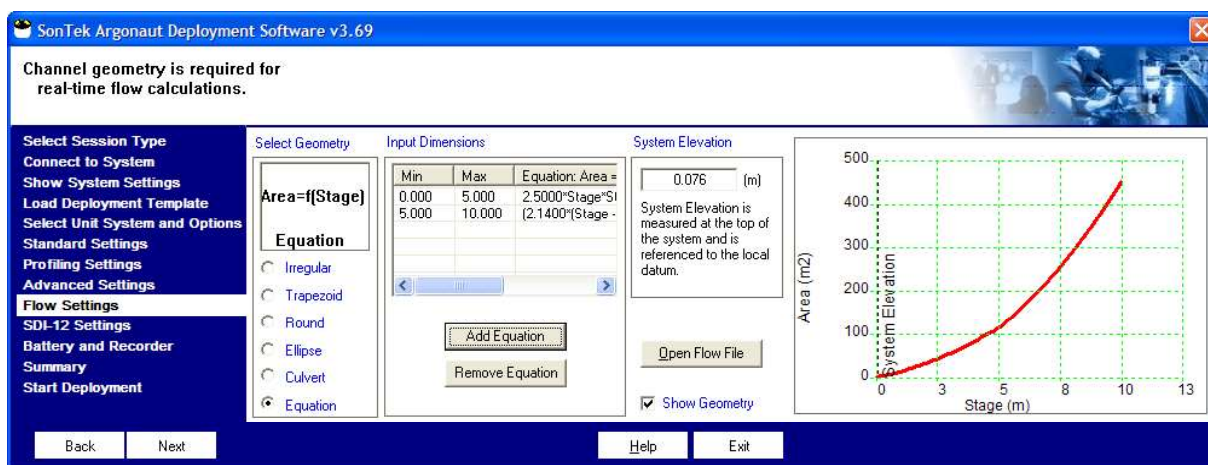


Figure 5-41. Deployment Software: System Elevation

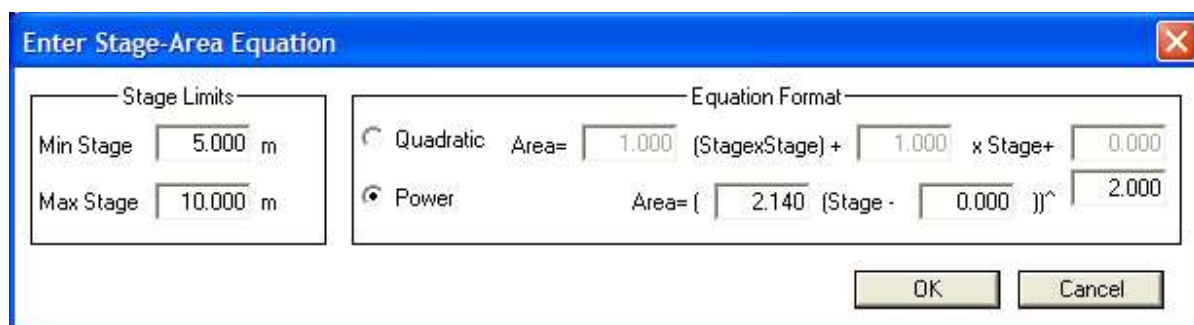


Figure 5-42. Deployment Software: Stage-Area Equation

Mean-Velocity Calculation Method

Figure 5-43 shows the screen for determining how to convert measured velocity to mean channel velocity. The following parameters are specified in this screen. When all parameters are correctly specified, click **Next** to continue.

- **Select Mean-Velocity Calculation Method:** Set the velocity equation type.
 - **Disabled:** Flow calculations will not be made.
 - **Index Calibration:** Three parameters are required to relate measured velocity to mean velocity. For information about these parameters, see §5.4.3 and §G-2.2.
 - Vintercept
 - VSlope
 - Stage Coeff
 - **Theoretical Flow Calculation:** Using the location of the SL's velocity cell relative to the channel geometry, a 1/6-power law relationship is used to convert measured velocity to mean channel velocity. For more information about this calculation, see §G-2.1.
- The **Save Flow File** button can be used to save the current channel geometry file for future use. You will be prompted for a file and path name.
- Channel geometry can be loaded from an existing file using The **Open Flow File** button on the channel geometry screens (Figure 5-38 and Figure 5-39).

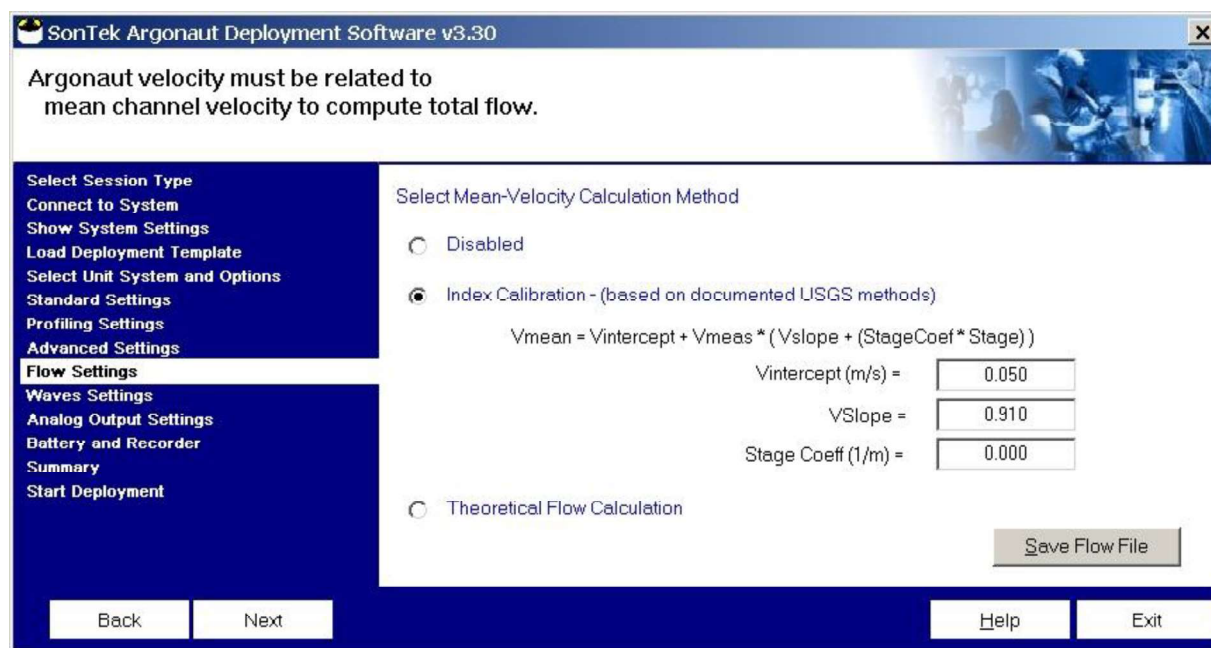


Figure 5-43. Deployment Software: Mean Velocity Equation

Total Volume Calculations

Figure 5-44 shows the screen for enabling and configuring total volume calculations and for selecting the output units to be used. The following parameters are specified in this screen. When all parameters are correctly specified, click **Next** to continue.

- **Select Output Units:** Set the output units to be used for flow and total volume.
 - **No total volume output:** Volume calculations will not be made. Flow rate in cfs or m³/s based on the Units selection.
 - **cfs & acre-ft:** Flow rate in cfs, total volume in acre-ft.
 - **gpm & gallons:** Flow rate in gpm (U.S. gallons per minute), total volume in gallons.
 - **mgd & gallons:** Flow rate in mgd (10⁶ U.S. gallons per day), total volume in gallons.
 - **m³/s & m³:** Flow rate in m³/s, total volume in m³.
 - **l/s & liters:** Flow rate in l/s (liters per second), total volume in liters.
 - **mld & m³:** Flow rate in mld (10⁶ liters per day), total volume in m³.
- **Allow Total Volume Reset:** Set whether or not the **Reset Flow Total** button on the Argonaut Flow Display ([Appendix H](#)) is active. When set to **YES**, the button on the Argonaut Flow Display allows you to reset the volume calculation to zero. When set to **NO**, the button on the Argonaut Flow Display is disabled.
- **Remember Total Volume:** Set how the Argonaut accumulates total volume when data collection is interrupted and restarted.
 - **Continuous:** When data collection is interrupted and restarted, the Argonaut uses data from the last flow and volume measurement made by the system. Volume data in the new file starts from this last good value, and includes an estimate of the flow during the time between files.

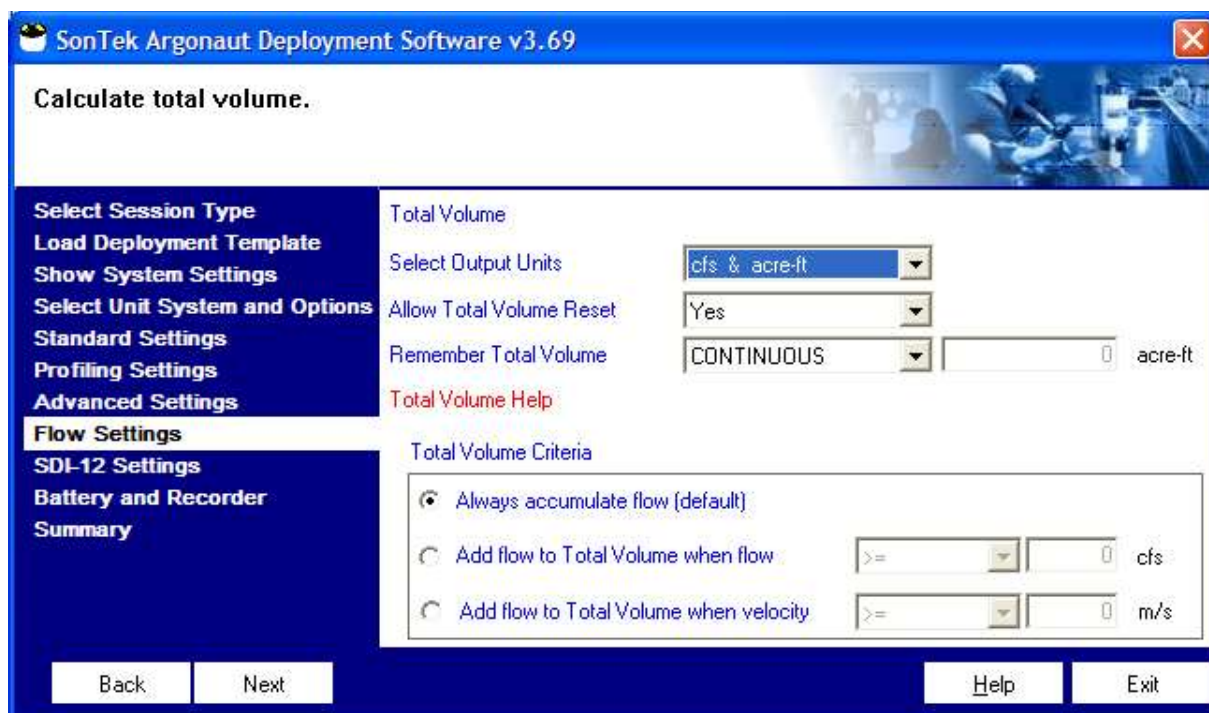


Figure 5-44. Deployment Software: Total Volume

- **Initialize:** Volume data in this file starts at the volume value specified in the box to the right. The units for the starting volume value are specified by the setting of Total Volume Units. If data collection is later interrupted and restarted, the Argonaut switches to Continuous operation mode and accumulates volume from that point. This setting is commonly used when establishing a new site, or beginning a new period of operation for a site (such as a new irrigation season). In this case, an initial volume value of 0 is specified to start the volume calculations at zero and accumulate continuously from that point forward.
- **Reset:** Volume data in this file starts from a value of zero. If data collection is interrupted and restarted, volume data for each new file also start from a value of zero.
- **Total Volume Criteria:** Determine which samples are used for total volume calculations.
 - **Always accumulate flow (default):** Every sample is used for total volume calculations.
 - **Add flow to Total Volume when flow:** use samples when flow rate:
 - **>=** a user-specified flow rate.
 - **<=** a user-specified flow rate.
 - **magnitude >=** a user-specified flow rate.
 - **Add flow to Total Volume when velocity:** use samples when velocity (V_x):
 - **>=** a user-specified flow rate.
 - **<=** a user-specified flow rate.
 - **magnitude >=** a user-specified flow rate.

5.7.11. Wave Spectra Parameters (ViewArgonaut)

Wave profiling parameters are only required if the optional wave spectra measurement feature is installed and will be used. The parameters are displayed on one screen, shown in [Figure 5-45](#).

The screen presents the following parameters. Refer to §5.4.4 or J-1 for details about setting each parameter. After all parameters are properly set, click **Next**.

- **Wave Spectra** (same as [WaveSpectra](#) command)
- **Water Depth** (same as [WaterDepth](#) command)
- **Record Pressure Series** (same as [RecordPSeries](#) command)

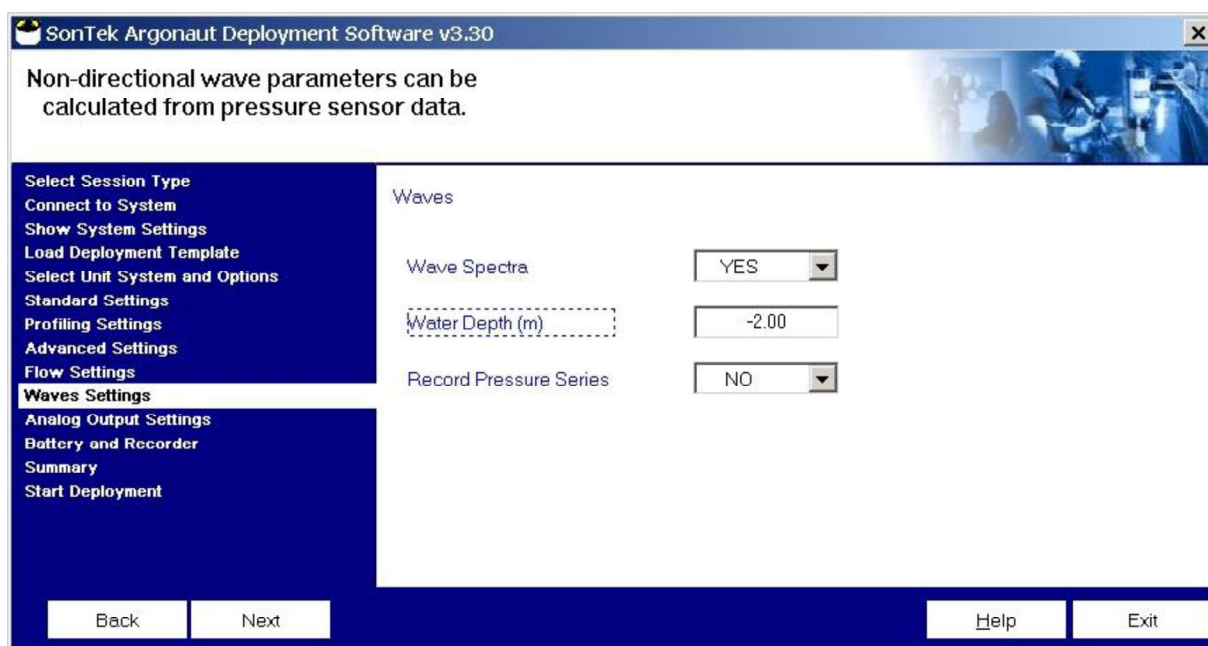


Figure 5-45. Deployment Software: Waves Settings

5.7.12. SDI-12 Interface Parameters (ViewArgonaut)

SDI-12 interface parameters are only required for deployments in which the Argonaut-SL will be controlled by an external SDI-12 data logger.

- SDI-12 operation fundamentally changes the nature of data collection by the SL.
- During an SDI-12 deployment, the external data logger controls the timing of each velocity sample.
 - The system waits for a command from the data logger before making a measurement.
 - Without a signal from the data logger, the system may never record velocity data.
 - The only exception to this is if **SDI-12 Auto Sampling** is set to **YES** (see below). In this case, if an extended period of time passes with no commands from the data logger, the system will start autonomous operation until a data logger command is received.
- In a standard (non-SDI-12) deployment, the system will not recognize any incoming commands from an SDI-12 data logger.
- The choice of deployment type (standard or SDI-12) is crucial, as an error in this selection can easily result in the loss of all data.
- The external analog output converters (§5.7.14 and Appendix F) cannot be used during an SDI-12 deployment.

Figure 5-46 shows the SDI-12 interface parameter screen. The following parameters are specified in this screen. Refer to Appendix E for details about SDI-12 operating parameters. When all parameters are correctly specified, click **Next** to continue.

- **SDI-12 Mode:** Chooses whether this will be an SDI-12 deployment.
 - **Turn SDI-12 OFF:** Used for a standard deployment.
 - **Turn SDI-12 ON:** Used for an SDI-12 deployment.
- **Address:** Used to select the communication address between the SL and the data logger.

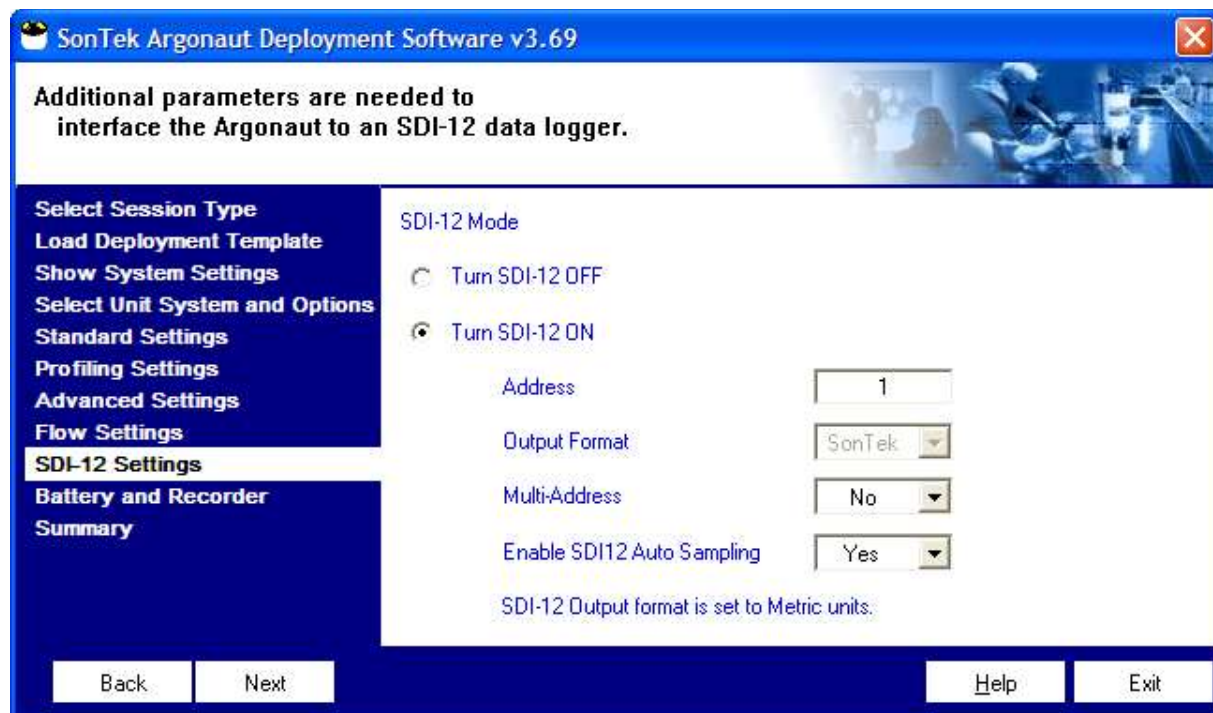


Figure 5-46. Deployment Software: SDI-12 Interface Parameters

- **Output Format:** Always set to **SonTek**.
- **Multi-Address:** Determines if multiple addresses will be used to handle data collected during multi-cell profiling. See §E-6.3 for more details.
- **Enable SDI12 Auto Sampling:** Determines if the system will start autonomous operation if an extended period passes without a command from the data logger. For standard deployments where data is collected at regular intervals, this will normally be set to **YES** and the setting of **Sampling Interval** should be set to match the sample interval from the data logger. If using irregular or event driven sampling, this value will normally be set to **NO**. See §E-2 for more details.
- **SDI-12 Output format is set to...:** Shows whether the output data format is set for English or Metric units.

5.7.13. External Sensor (YSI or CTD) Parameters (ViewArgonaut)

If the SL includes the optional YSI or CTD sensor, no additional parameter settings are required.

- Data from the sensor will be automatically sampled with each SL sample.
- When deploying the system, verify that the appropriate setting (YSI or CTD) is marked as Installed on the hardware parameter screen ([Figure 5-30](#)).
- Follow the recommended deployment procedures for the YSI (§J-2) or CTD (§J-3) sensor as appropriate.

5.7.14. Analog Output Parameters (ViewArgonaut)

The Argonaut-SL can be equipped with optional analog output modules to generate analog signals proportional to one or more variables measured by the system. Analog output parameters are only needed for deployments in which the SL is connected to external analog output converters.

- Analog output modules are available in two varieties — ones that generate a 4-20 mA current loop and ones that generate a 0-5 VDC output voltage.
- Up to two output modules can be used with a system at the same time (one per output variable). However, both modules must be the same type, either 4-20 mA or 0-5 VDC.
- When using the analog output modules, no other form of real-time data output is available (i.e., neither RS-232 nor SDI-12 real-time data output can be used).
- When using an analog output module, we strongly recommend storing data to the internal recorder. This ensures access to all diagnostic data when reviewing data in post-processing (the analog output signals greatly reduce the amount of available data).
- The external analog output converters cannot be using during an SDI-12 deployment.

Figure 5-47 shows the analog output parameter screen. The following parameters are specified in this screen. Refer to **Appendix F** for details about analog output. When all parameters are correctly specified, click **Next** to continue.

- **Output Type:** Chooses whether this will be an analog output deployment.
 - **Disabled:** No analog output converters will be used.
 - **Current (4-20 mA):** The analog converters will generate a 4-20 mA current loop.
 - **Voltage (0-5 VDC):** The analog converters will generate a 0-5 VDC output voltage.
- **Output Parameters:** Specify parameters for all converters that will be used.
 - **Parameter:** Select the SL parameter that the analog signal will be proportional to.
 - **Min Value:** Select the minimum value to scale the output of the analog output signal.
 - **Max Value:** Select the maximum value to scale the output of the analog output signal.
 - **Units:** These are shown only for information here, and are determined by the choice of Units system (§5.7.6) and the Total Volume output (§5.7.10).

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Additional parameters are needed to interface the Argonaut to the external analog output modules.

Select Session Type
Connect to System
Show System Settings
Load Deployment Template
Select Unit System and Options
Standard Settings
Profiling Settings
Advanced Settings
Flow Settings
Analog Output Settings
Battery and Recorder
Summary
Start Deployment

Analog Output

Output Type: Current (4-20mA)

Output Parameters

Channel	Parameter	Min Value	Max Value	Units
1	Flow	0.00	100.00	cfs
2	Disabled	0.00	0.00	-

Back Next Help Exit

Figure 5-47. Deployment Software: Analog Output Parameters

The following overview explains how to deploy a system using one or more analog output modules. For detailed information about how to use the analog output modules, see [Appendix F](#).

- Connect the “wet” end of the power/communications cable to the SL (§5.3).
- Connect the power supply to the SL cable (use the power supply that will be used during the deployment).
- Select RS-232 mode by “mating” the white plastic jumper-switch connector ([Figure 5-20](#)).
- Connect the RS-232 cable to an available COM port on your computer.
- Set and review all SL operating parameters using the *ViewArgonaut Deployment* software. Start data collection as you would for a standard deployment.
- When the analog output option is enabled, the values output by the SL are written to control the analog output modules. A sample output, when two analog output modules are connected, is shown here.

```
$1AO+00016.96  
$2AO+00012.02
```

- One output string is written for each analog output module to be controlled.
 - The string starts with the module address.
 - It is followed by the analog value (mA or VDC) to be output from the module.
 - These values are calculated based on the relationship between the measured parameter value and the **MinVal** and **MaxVal** limits set by the user as described in §C-17 and [Appendix F](#).
- After starting data collection, each analog output module must be connected to the RS-232 output of the Argonaut. A special cable, with one connector for each output module to be used, is supplied with the system. See [Appendix F](#) for details about this cable.

5.7.15. Battery Life and Recorder Capacity (ViewArgonaut)

The **Battery and Recorder** menu (Figure 5-48) provides estimates of battery life and recorder capacity during autonomous deployments. The following parameters are shown on the screen.

- **Battery Type:** Two battery types are supported.
 - **Argonaut-SL Battery Pack** – Standard Argonaut packs are commonly used with the SL, so entries for **Battery Voltage** and **Battery Capacity** are set to their standard values.
 - **User Supplied Battery** – For a user-supplied battery, you must enter the **Battery Voltage** and **Battery Capacity** before the software can compute an estimate of battery life.
- **Battery Voltage:** This is the nominal operating voltage of the battery, which can be expected to change during the course of the battery's life.
 - The Argonaut can operate on an input voltage of 7-15 VDC. Exceeding 16 VDC will cause severe damage to the electronics.
- **Battery Capacity:** This is the nominal rating of the battery, in amp hours (A-h).
 - An entry in this field is needed to calculate the expected battery life.
 - Keep in mind that the capacity of many rechargeable batteries can vary depending on the age of the battery and its charge/discharge history.
- **Battery Capacity Multiplier:** This is a safety factor used for battery life calculations.
 - We recommend using a value of 80%. This allows a safety factor to account for cold weather (which can significantly reduce battery capacity) and for changes in battery voltage with time.
 - For deployments in very cold environments, a lower value may be needed.
- **Power Consumption:** This value is determined by the software based on system type, hardware configuration, and operating parameters. It is an approximate value that can vary slightly from system to system.

Figure 5-48. Deployment Software: Battery Life and Recorder Capacity

- **Duty Cycle:** This is the percentage of time the system is actively collecting data, based on sampling parameters (Averaging Interval, Sample Interval, and Burst parameter if enabled).
 - The system will normally enter a low power state between samples to conserve power and extend battery life.
 - Note that the duty cycle is always 100% for an SDI-12 deployment. This is because the data logger, not the SL, controls the timing of velocity samples. As such, the SL does not enter into a low power state between samples so that it can respond to commands from the data logger.
 - Duty cycle is always 100% if the Flow Display is enabled. This is because the Argonaut does not enter a low power state between samples when using the Flow Display so it can respond to commands from the Flow Display keypad.
 - More information on duty cycle can be found in §B-9.5.
- **Battery Life:** This value is estimated (in days) based on all provided parameters. The basic equation is:

$$\text{Battery life (hours)} = (V * Ah * BCM) / (PC * DC)$$
 where
 - V = Battery voltage
 - Ah = Battery capacity
 - BCM = Battery capacity multiplier
 - PC = Power consumption
 - DC = Duty cycle
- **Enable Recorder:** This is used to turn on or off the internal recorder.
 - We strongly recommend always recording internal data even when interfacing with an external data logger, as it provides a backup of all data and additional diagnostic data.
 - If the recorder is full, you will not be allowed to start a new deployment with internal recording enabled. You will need to download the existing data and format the recorder (see below), or disable internal recording.
 - If the recorder becomes full during a deployment, the Argonaut will continue to output real time data (RS-232, SDI-12 or analog output), but will no longer record data to the internal recorder. We encourage you to monitor recorder status and periodically download data to ensure full access to all diagnostic data for post-processing.
- **Recorder capacity (Free space is sufficient for...):** This is estimated based on the current amount of free space on the recorder and the system operating parameters.
 - Recorder capacity calculations are based on currently specified operating parameters.
 - This value may not be accurate for SDI-12 deployments as the external data logger controls the timing of velocity samples.
- The **Show Recorder Details** button can be used to view the current contents of the internal recorder, to download data from the recorder, and to format the recorder. An example of the **Recorder** dialog box is shown in Figure 5-49.

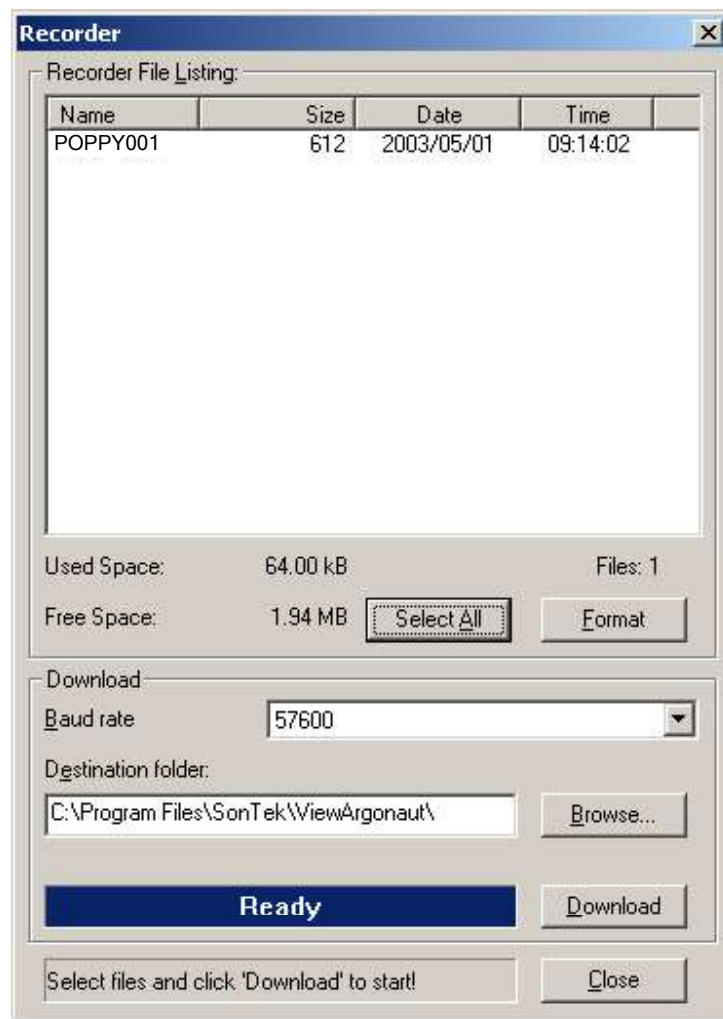


Figure 5-49. Deployment Software: Show Recorder Details

- Features of the **Recorder** dialog box (Figure 5-49):
 - A directory of files on the recorder is shown in the main part of the screen.
 - Click on a file to select that file.
 - Hold down the **CTRL** or **SHIFT** key while clicking on files to select multiple files.
 - Use the **Browse** button to select the destination directory for downloaded files.
 - Click **Download** to transfer all specified files.
 - Click **Format** to erase the recorder.
 - You will be prompted to confirm your decision. Remember, no data can be recovered after the recorder has been formatted.
 - You cannot delete individual files; the entire recorder must be erased at one time.
 - When done, click **Close** to return to the Deployment software.

5.7.16. Updating Parameters and Starting a Deployment (ViewArgonaut)

The final step in deploying the Argonaut-SL is to transfer all system settings to the instrument and, if desired, start the deployment.

Figure 5-50 shows an example **Deployment Summary** screen.

- This screen shows an overview of the deployment configuration parameters specified in earlier screens.
- The **Save Configuration to File** button can be used to create a new template file.
 - Clicking this button will prompt you to enter a name and path for the template file.
 - Template files can be used to ensure the same settings are used each time an SL is deployed.
 - Template files can also be used to apply identical settings to systems of the same type that are being deployed in different locations.
- After reviewing the summary, click **Next** to continue.

Figure 5-51 shows the final screen in the deployment software. This screen is used to transfer all specified settings to the instrument, and to start the deployment.

- The **Update System** button is used to transfer all settings to the instrument.
 - All settings are saved to non-volatile memory in the instrument and will not be lost if system power is removed.
 - Settings can be transferred without starting a deployment if desired.
 - An updated display will be shown on the screen while settings are transferred.
- The **Start Deployment** button is used to begin the deployment.
 - This button will first transfer all settings to the instrument if it has not already been done using the **Update System** button.
 - An updated display is shown on the screen as settings are transferred.

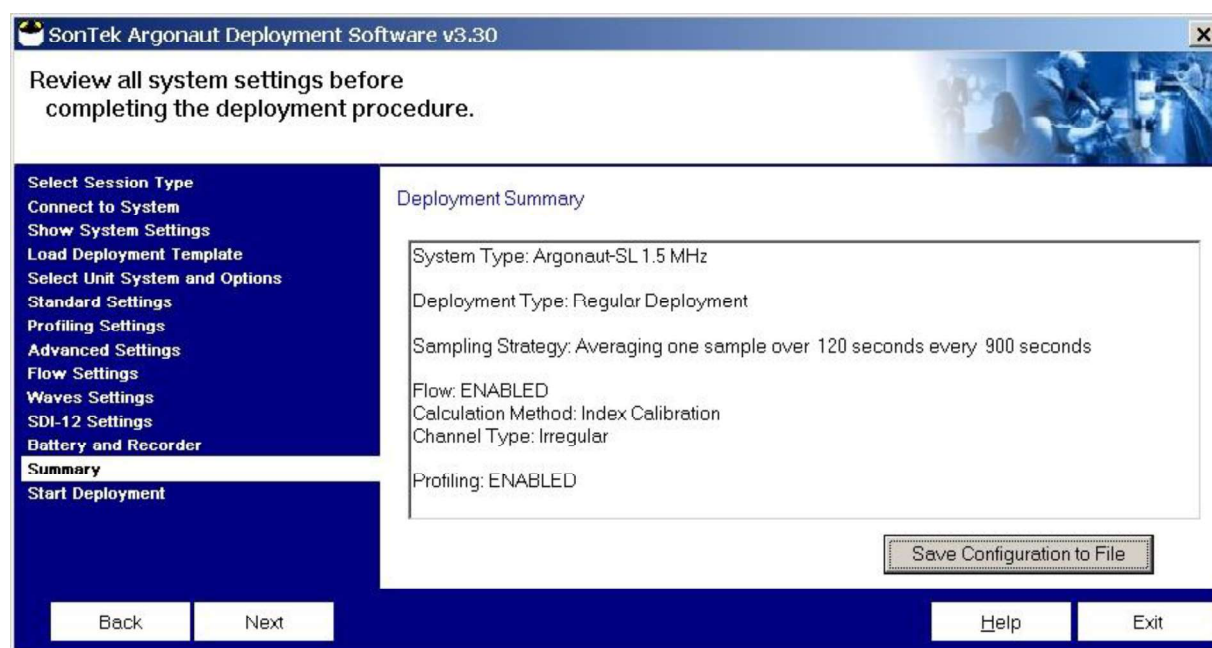


Figure 5-50. Deployment Software: Deployment Summary

- All communications with the instrument are captured to a log file for future reference. The button **View Log File** can be used to view the log file created with this session.
 - The software automatically creates a log file each time you connect with the instrument. This provides a record of commands sent to, and responses from, the instrument for the entire deployment procedure. Log files are stored within a “Log Files” subdirectory of the *ViewArgonaut* program folder (normally C:\Program Files\SonTek\ViewArgonaut\Log Files). They use a naming format giving the date they were created and a sequential number so that no log files are overwritten.
- For standard deployments (SDI-12 mode is NO), you can watch the first few samples generated by the system being output to the screen if desired.
- After starting the deployment, disconnect the power and communications cable from your computer. Secure the connector and protect it from weather and moisture.
- The system is now deployed. When you are ready to retrieve/analyze data, see [Section 6](#).

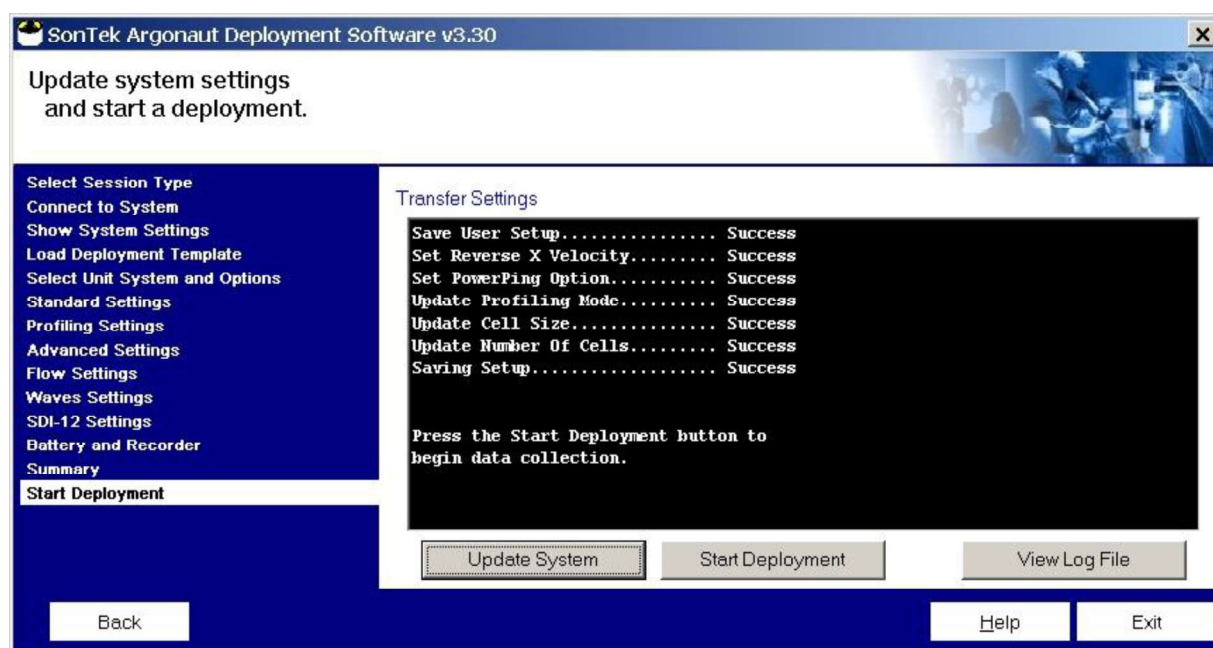


Figure 5-51. Deployment Software: Transfer Settings

5.8. Deployment Examples using a Direct Command Interface (SonUtils)

Another way to deploy the Argonaut-SL is through direct serial communications using *SonUtils*.

- Both this method and the Deployment software (§5.7) offer access to all parameters.
- Using direct commands via *SonUtils* removes the graphical interface provided by the *View-Argonaut* Deployment software, and lets you communicate directly with the instrument.
- The instructions shown here can also be used to deploy the system using a PDA via the *SonUtils* PDA software.

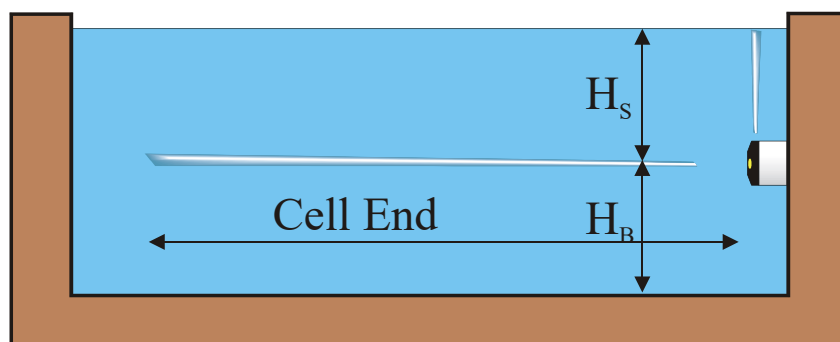
This section provides detailed deployment instructions for the following applications.

- [SonUtils Autonomous Deployment – Trapezoid Channel](#)
- [SonUtils Autonomous Deployment – Natural \(Irregular\) Channel](#)
- [SonUtils Autonomous Deployment – Trapezoidal Closed Culvert](#)
- [SonUtils Autonomous Deployment – Stage/Area Equation](#)
- [SonUtils Real-Time Interface Using RS-232](#)
- [SonUtils Modbus Interface Module Deployment](#)
- [SonUtils Wave Spectra Deployment](#)
- [SonUtils External Sensor \(YSI or CTD\) Deployment](#)
- [SonUtils Analog Output Deployment](#)

Common Preliminary Steps

The following common steps apply to the sample deployments presented in this section.

- Start the *SonUtils* program (**Start|Programs|SonTek Software|SonUtils***). *Note: The program shortcut may contain a release number; for example, **SonUtils3**.
 - *SonUtils* provides direct communications with the instrument using text commands.
 - In the examples below, user-entered commands are shown in **Bold**, instrument responses are shown in a *fixed* font, and comments are shown in *italics* (comments do not appear in an actual *SonUtils* session window).
 - Commands are not case sensitive (i.e., you can use upper and/or lower case letters).
 - It is good practice to capture all communications to a log file for future reference. In *SonUtils*, click **File|Open Log File**, and then specify a folder and file name for the log. *SonUtils* will now record all communications in a plain-text file.
- Before conducting any deployment, perform the site survey and Diagnostic Procedures described in (§5.6).
- Before deploying the SL, you must perform a site survey to determine the correct settings for **CellBegin** and **CellEnd**.
 - You must know the channel geometry at the location where the SL will be installed.
 - **CellBegin** and **CellEnd** should be set to avoid the flow interference generated by the walls of the channel and any underwater structures.
 - You should confirm your settings by using the Beam Check module within *SonUtils* (or **ViewArgonaut|Diagnostics**) to verify the acoustic beams have a clear path and that the channel boundaries match the expected values. Refer to §5.6.
 - To avoid having the acoustic beams “hit” the surface or bottom, you must consider the aspect ratio (**Figure 5-52**).



If $H_S < H_B$, Aspect Ratio = Cell End / H_S

If $H_B < H_S$, Aspect Ratio = Cell End / H_B

Figure 5-52. Argonaut-SL side-looking installation

- A conservative upper limit for the aspect ratio of the SL is 20.
- The maximum **CellEnd** value should be set considering the effective aspect ratio based on an expected range of water depths. For example, suppose channel width is 40 feet, and the SL is 1 foot below the surface. An aspect ratio of 20 would say that the maximum **CellEnd** value should be 20 feet, not the full channel width of 40 feet.

How to Automate a Deployment using a Command File

You can automate any deployment by creating a command file.

- A command file is a plain text file created with any ASCII editor (e.g., *Notepad* or **Tools|Edit Command File** within *SonUtils*).
- Each line in the text file is a single command (or an extension of a command).
- Rather than manually typing your entries into the command file, it is sometimes easier to open a log file (**File|Open Log File**) to record a deployment session. You can then edit the saved log file to remove or modify commands.
- To run a command file from within *SonUtils*, click **Tools|Run Command File**, and then select the previously created command file that you wish to execute.
- After running a command file, but before executing the **Start** or **Deploy** commands, you can review your settings by using the applicable **Show** commands (**Show Conf**, **Show System**, **Show Setup**, **Show Deploy**, **Show FDatum**). Note: Depending on your application, you can also include the **Start**, **Deploy**, and **Show** commands as part of the command file.
- A sample command file is shown after each of the example deployments in this section.

5.8.1. SonUtils Autonomous Deployment – Trapezoid Channel

This example shows the Argonaut-SL command sequence and instrument responses used to set up the SL for a deployment in a *trapezoidal open channel* (see **Figure C-3**) using a direct command interface (e.g., *SonUtils*).

- Review the *Common Preliminary Steps* (§5.8), including the opening of a log file.
- Enter the following commands in sequence, substituting the appropriate measurement parameters for your particular application.

<BREAK>

Click BREAK icon to awaken system.

```

Argonaut-SL
SonTek/YSI, Inc.
Copyright 1996-2005
Wake up initialization. Please wait...
>Recorder ON           Set internal recording on.
OK
>OutFormat English     Use English units for output/flow data.
OK
>Deployment Canal       Name the data file "Canal" (5 characters maximum).
OK
>TempMode Measured     Use internal temperature sensor.
OK
>Sal 0                 Set salinity to 0.0 ppt.
OK
>CellBegin 2.0         Based on site survey (always in meters).
OK
>CellEnd 10.0          Based on site survey (always in meters).
OK
>CoordSystem XYZ       Set XYZ velocity coordinates.
OK
>ReverseXVelocity NO   Standard velocity coordinate system (§5.4.1).
OK
>AvgInterval 300       300 seconds = 5 minutes
OK
>SampleInterval 900    900 seconds = 15 minutes
OK
>PowerPing YES         Turn PowerPing On
OK

The following 3 commands would apply only if multi-cell profiling is used.
>BlankDistance 1.0     Distance to start of first cell (always in meters).
OK
>CellSize 1.0          Size of each cell (always in meters).
OK
>NCells 10             Number of cells to collect.
OK
End of multi-cell profiling commands.

>Date                  Check and/or set internal clock.
2002/11/20
>Time
16:55:37
>ChannelType Trapezoid Regular (normally concrete) channel.
OK
>SetGeometry           As an example, see Figure C-3.
Enter trapezoid channel parameters as prompted.
Enter -1 to abort command.

Enter width at bottom (ft): 40.0 Enter dimensions as prompted.
Enter width at top (ft): 50.0 Since OutFormat=English, this is in
Enter channel depth (ft): 10.0 feet; if Metric, it would be meters.
To display geometry use Show Geo.

>SetArgElevation 5.0   Relative to bottom of channel. Since OutFormat=
OK                      English, this is in feet; Metric would be meters.
>VelEquation Theory    Theoretical velocity relation.
OK
>TotalVolume 1         Enable total volume calculation in cfs and acre-ft.
OK
>RememberTotalVolume Initialize
                        Establishing new site, start total volume at 0.

```

```
OK
>InitialVolumeValue 0.0
OK
>AllowVolumeReset YES   Enable Reset button on Argonaut Flow Display.
OK

The following 2 commands would only apply if data collection were to begin
at some future time rather than immediately. That is, if data collection
is to begin immediately, do not enter StartDate and StartTime.
>StartDate 2005/12/31   The date collection is to begin as yyyy/mm/dd.
OK
>StartTime 13:00:00     The time collection is to begin as hh/mm/ss.
OK
End of future start date/time entries.

>SaveSetup              Save all parameter settings to non-volatile memory.
OK
```

- Review all your settings to make sure they are appropriate/correct. The commands to do this are shown below. Command responses are self-explanatory and are not shown here.

```
>Show Conf
...Hardware configuration data displayed in tabular format.
OK
>Show System
...System parameters displayed in tabular format.
OK
>Show Setup
...Setup parameters displayed in tabular format.
OK
>Show Deploy
...Deployment parameters displayed in tabular format.
OK
>Show FDatum
...Flow settings displayed in tabular format.
OK
```

- After all parameter settings are valid, you can either use the **Start** or **Deploy** command to begin data collection. **Start** begins data collection immediately; **Deploy** begins data collection at the specified **StartDate** and **StartTime**.

```
>Start
Checking Setup Parameters...

4194304 free bytes left in recorder.
Free space is sufficient for 408.32 days of operation.
Recorder mode is NORMAL.

Data will be recorded to file CANAL001.
OK
```

- You can automate the above deployment entries by creating a command file; see [How to Automate a Deployment using a Command File](#) (§5.8). The sample command file shown below sets the same operating parameters as described earlier in this section.

```
Recorder ON
OutFormat English
Deployment Canal
TempMode Measured
Sal 0
CellBegin 2.0
CellEnd 10.0
```



```

CoordSystem XYZ
ReverseXVelocity NO
AvgInterval 300
SampleInterval 900
PowerPing YES
BlankDistance 1.0      (multi-cell profiling only)
CellSize 1.0           (multi-cell profiling only)
NCells 10              (multi-cell profiling only)
Date                   (shows current time from SL clock)
Time                   (shows current time from SL clock)
ChannelType Trapezoid
SetGeometry            (the following 3 lines are SetGeometry parameters)
40.0                   (width at channel bottom)
50.0                   (width at channel top)
10.0                   (channel depth)
SetArgElevation 5.0
VelEquation Theory
TotalVolume 1
RememberTotalVolume Initialize
InitialVolumeValue 0.0
AllowVolumeReset YES
StartDate 2005/12/31   (for future rather than immediate data collection)
StartTime 13:00:00     (for future rather than immediate data collection)
SaveSetup

```

5.8.2. SonUtils Autonomous Deployment – Natural (Irregular) Channel

This example shows the Argonaut-SL command sequence and instrument responses used to set up the SL for a deployment in an *irregular open channel* (see [Figure C-](#)) using a direct command interface (e.g., *SonUtils*).

- Review the *Common Preliminary Steps* (§5.8), including the opening of a log file.
- Enter the following commands in sequence, substituting the appropriate measurement parameters for your particular application.

```

<BREAK>                Click BREAK icon to awaken system.
Argonaut-SL
SonTek/YSI, Inc.
Copyright 1996-2005
Wake up initialization. Please wait...
>Recorder ON           Set internal recording on.
OK
>OutFormat English    Use English units for output/flow data.
OK
>Deployment River      Name the data file "River" (5 characters maximum).
OK
>TempMode Measured    Use internal temperature sensor.
OK
>Sal 0                Set salinity to 0.0 ppt.
OK
>CellBegin 2.0        Based on site survey (always in meters).
OK
>CellEnd 10.0         Based on site survey (always in meters).
OK
>CoordSystem XYZ      Set XYZ velocity coordinates.
OK
>ReverseXVelocity NO  Standard velocity coordinate system (§5.4.1).
OK

```

```
>AvgInterval 300      300 seconds = 5 minutes
OK
>SampleInterval 900   900 seconds = 15 minutes
OK
>PowerPing YES       Turn PowerPing on.
OK

The following 3 commands would apply only if multi-cell profiling is used.
>BlankDistance 1.0    Distance to start of first cell (always in meters).
OK
>CellSize 1.0         Size of each cell (always in meters).
OK
>NCells 10            Number of cells to collect.
OK
End of multi-cell profiling commands.

>Date                 Check and/or set internal clock.
2002/11/20
>Time
16:55:37
>ChannelType Irregular Natural channel.
OK
>SetGeometry          As an example, see Figure C-.
Enter Channel Geometry points in the following format:
Horiz distance dd.d (ft) Elevation (re Datum) dd.dd (ft).
Example 5.5 4.25
Press ENTER after each entry; To exit enter -1
Point 1:  1.0 10.0      X,Y survey points are used to define the shape of
Point 2:  9.0 5.0       the channel. Since OutFormat=English, these values
Point 3: 15.0 1.0       are in feet; if Metric, values would be in meters.
Point 4: 21.0 0.5
Point 5: 30.0 0.5
Point 6: 35.0 1.0
Point 7: 40.0 5.0
Point 8: 45.0 10.0
Point 9: -1            Enter -1 to finish.
To display geometry use Show Geo.

>SetArgElevation 4.0   Relative to same origin as channel elevation data.
OK                     Since OutFormat=English, this is in feet;
                       if Metric, it would be meters.
>VelEquation Index     Index velocity relation.
OK
>SetIndexCoef 0.05 0.95 0.00 Set three index coefficients.
OK                      $V_{mean} = 0.05 + V_{meas} * (0.95 + (0.00 * Stage))$ 
>TotalVolume 0         Disable total volume calculations.
OK

The following 2 commands would only apply if data collection were to begin
at some future time rather than immediately. That is, if data collection
is to begin immediately, do not enter StartDate and StartTime.
>StartDate 2005/12/31  The date collection is to begin as yyyy/mm/dd.
OK
>StartTime 13:00:00    The time collection is to begin as hh/mm/ss.
OK
End of future start date/time entries.

>SaveSetup            Save all parameter settings to non-volatile memory.
OK
```

- Review all your settings to make sure they are appropriate/correct. The commands to do this are shown below. Command responses are self-explanatory and are not shown here.

```
>Show Conf
...Hardware configuration data displayed in tabular format.
OK
>Show System
...System parameters displayed in tabular format.
OK
>Show Setup
...Setup parameters displayed in tabular format.
OK
>Show Deploy
...Deployment parameters displayed in tabular format.
OK
>Show FDatum
...Flow settings displayed in tabular format.
OK
```

- After all parameter settings are valid, you can either use the **Start** or **Deploy** command to begin data collection. **Start** begins data collection immediately; **Deploy** begins data collection at the specified **StartDate** and **StartTime**.

```
>Start
Checking Setup Parameters...
4194304 free bytes left in recorder.
Free space is sufficient for 408.32 days of operation.
Recorder mode is NORMAL.
Data will be recorded to file RIVER001.
OK
```

- You can automate the above deployment entries by creating a command file; see [How to Automate a Deployment using a Command File](#) (§5.8). The sample command file shown below sets the same operating parameters as described earlier in this section.

```
Recorder ON
OutFormat English
Deployment River
TempMode Measured
Sal 0
CellBegin 2.0
CellEnd 10.0
CoordSystem XYZ
ReverseXVelocity NO
AvgInterval 300
SampleInterval 900
PowerPing YES
BlankDistance 1.0      (multi-cell profiling only)
CellSize 1.0           (multi-cell profiling only)
NCells 10              (multi-cell profiling only)
Date                  (shows current date from SL clock)
Time                  (shows current time from SL clock)
ChannelType Irregular
SetGeometry           (the following 9 lines are SetGeometry parameters)
1.0 10.0              (X,Y geometry point 1)
9.0 5.0               (X,Y geometry point 2)
15.0 1.0              (X,Y geometry point 3)
21.0 0.5              (X,Y geometry point 4)
30.0 0.5              (X,Y geometry point 5)
```

```
35.0 1.0          (X,Y geometry point 6)
40.0 5.0          (X,Y geometry point 7)
45.0 10.0         (X,Y geometry point 8)
-1               (stops geometry point entries)
SetArgElevation 4.0
VelEquation Index
SetIndexCoef 0.05 0.95 0.00
TotalVolume 0
StartDate 2005/12/31 (for future rather than immediate data collection)
StartTime 13:00:00   (for future rather than immediate data collection)
SaveSetup
```

5.8.3. SonUtils Autonomous Deployment – Trapezoidal Closed Culvert

This example shows the Argonaut-SL command sequence and instrument responses used to set up the SL for a deployment in a *trapezoidal closed culvert* ([Figure 5-40](#)) using a direct command interface (e.g., *SonUtils*).

- Review the *Common Preliminary Steps* (§5.8), including the opening of a log file.
- Enter the following commands in sequence, substituting the appropriate measurement parameters for your particular application.

```
<BREAK>          Click BREAK icon to awaken system.
Argonaut-SL
SonTek/YSI, Inc.
Copyright 1996-2005
Wake up initialization. Please wait...
>Recorder ON      Set internal recording on.
OK
>OutFormat English Use English units for output/flow data.
OK
>Deployment Canal Name the data file "Canal" (5 characters maximum).
OK
>TempMode Measured Use internal temperature sensor.
OK
>Sal 0            Set salinity to 0.0 ppt.
OK
>CellBegin 2.0    Based on site survey (always in meters).
OK
>CellEnd 10.0     Based on site survey (always in meters).
OK
>CoordSystem XYZ  Set XYZ velocity coordinates.
OK
>ReverseXVelocity NO Standard velocity coordinate system (§5.4.1).
OK
>AvgInterval 300  300 seconds = 5 minutes
OK
>SampleInterval 900 900 seconds = 15 minutes
OK
>PowerPing YES    Turn PowerPing On
OK

The following 3 commands would apply only if multi-cell profiling is used.
>BlankDistance 1.0 Distance to start of first cell (always in meters).
OK
>CellSize 1.0     Size of each cell (always in meters).
OK
>NCells 10        Number of cells to collect.
```

```

OK
End of multi-cell profiling commands.

>Date                Check and/or set internal clock.
2002/11/20
>Time
16:55:37
>ChannelType Culvert  Regular (normally concrete) closed channel
OK
>SetGeometry          As an example, see Figure C-3.
Enter trapezoid channel parameters as prompted.
Enter -1 to abort command.

Enter width at bottom (ft): 50.0  Enter dimensions as prompted.
Enter width at top (ft):    50.0  Since OutFormat=English, this is in
Enter channel depth (ft):  10.0  feet; if Metric, it would be meters.
To display geometry use Show Geo.

>SetArgElevation 5.0  Relative to bottom of channel. Since OutFormat=
OK                    English, this is in feet; if Metric, then meters.
>VelEquation Theory  Theoretical velocity relation.
OK

>TotalVolume 1        Enable total volume calculation in cfs and acre-ft.
OK
>RememberTotalVolume Initialize
                        Establishing new site, start total volume at 0.
OK
>InitialVolumeValue 0.0
OK
>AllowVolumeReset YES Enable Reset button on Argonaut Flow Display.
OK

The following 2 commands would only apply if data collection were to begin
at some future time rather than immediately. That is, if data collection
is to begin immediately, do not enter StartDate and StartTime.
>StartDate 2005/12/31  The date collection is to begin as yyyy/mm/dd.
OK
>StartTime 13:00:00    The time collection is to begin as hh/mm/ss.
OK
End of future start date/time entries.

>SaveSetup            Save all parameter settings to non-volatile memory.
OK

```

- Review all your settings to make sure they are appropriate/correct. The commands to do this are shown below. Command responses are self-explanatory and are not shown here.

```

>Show Conf
...Hardware configuration data displayed in tabular format.
OK
>Show System
...System parameters displayed in tabular format.
OK
>Show Setup
...Setup parameters displayed in tabular format.
OK
>Show Deploy
...Deployment parameters displayed in tabular format.
OK
>Show FDatum
...Flow settings displayed in tabular format.
OK

```

- After all parameter settings are valid, you can either use the **Start** or **Deploy** command to begin data collection. **Start** begins data collection immediately; **Deploy** begins data collection at the specified **StartDate** and **StartTime**.

```
>Start
```

```
Checking Setup Parameters...
```

```
4194304 free bytes left in recorder.
```

```
Free space is sufficient for 408.32 days of operation.
```

```
Recorder mode is NORMAL.
```

```
Data will be recorded to file CANAL001.
```

```
OK
```

- You can automate the above deployment entries by creating a command file; see [How to Automate a Deployment using a Command File](#) (§5.8). The sample command file shown below sets the same operating parameters as described earlier in this section.

```
Recorder ON
OutFormat English
Deployment Canal
TempMode Measured
Sal 0
CellBegin 2.0
CellEnd 10.0
CoordSystem XYZ
ReverseXVelocity NO
AvgInterval 300
SampleInterval 900
PowerPing YES
BlankDistance 1.0      (multi-cell profiling only)
CellSize 1.0          (multi-cell profiling only)
NCells 10              (multi-cell profiling only)
Date                  (shows current time from SL clock)
Time                  (shows current time from SL clock)
ChannelType Culvert
SetGeometry           (the following 3 lines are SetGeometry parameters)
50.0                    (width at channel bottom)
50.0                    (width at channel top)
10.0                    (channel depth)
SetArgElevation 5.0
VelEquation Theory
TotalVolume 1
RememberTotalVolume Initialize
InitialVolumeValue 0.0
AllowVolumeReset YES
StartDate 2005/12/31   (for future rather than immediate data collection)
StartTime 13:00:00    (for future rather than immediate data collection)
SaveSetup
```


5.8.4. SonUtils Autonomous Deployment – Stage/Area Equation

This example shows the command sequence and instrument responses used to set up the SL for deployment when using a *stage/area equation* using a direct command interface (e.g., *SonUtils*).

- Review the *Common Preliminary Steps* (§5.8), including the opening of a log file.
- Enter the following commands in sequence, substituting the appropriate measurement parameters for your particular application.

```
<BREAK>                               Click BREAK icon to awaken system.
Argonaut-SL
SonTek/YSI, Inc.
Copyright 1996-2008
Wake up initialization. Please wait...
>Recorder ON                           Set internal recording on.
OK
>OutFormat English                     Use English units for output/flow data
OK
>Deployment River                       Name the data file "River" (5 characters maximum).
OK
>AutoSleep YES                         Flow Display not in use (§H-2).
OK
>TempMode Measured                     Use internal temperature sensor.
OK
>Sal 0                                 Set salinity to 0.0 ppt.
OK
>CellBegin 2.0                         Based on site survey (always in meters).
OK
>CellEnd 10.0                          Based on site survey (always in meters).
OK
>CoordSystem XYZ                       Set XYZ velocity coordinates.
OK
>ReverseXVelocity NO                   Standard velocity coordinate system (§5.4.1).
OK
>AvgInterval 300                       300 seconds = 5 minutes
OK
>SampleInterval 900                   900 seconds = 15 minutes
OK
>PowerPing YES                         Enable PowerPing.
OK

The following 3 commands would apply only if multi-cell profiling is used.
>BlankDistance 1.0                     Distance to start of first cell (always in meters).
OK
>CellSize 1.0                          Size of each cell (always in meters).
OK
>NCells 10                             Number of cells to collect.
OK
End of multi-cell profiling commands.

>Date                                 Check and/or set internal clock.
2002/11/20
>Time
16:55:37
>ChannelType Equation                 Stage/area equation to calculate area.
OK
>SetGeometry
Enter equations in order of increasing stage.
Equation #1
```

```
Equation Type (1=Quadratic, 2=Power, -1=DONE): 1
Area = A*Stage*Stage + B*Stage + C
Min Stage (m): 0
Max Stage (m): 5
Constant A: 2.5
Constant B: 10.3
Constant C: 0.95
Equation #2
Equation Type (1=Quadratic, 2=Power, -1=DONE): 2
Area = (A*(Stage - B))^C
Min Stage (m): 5
Max Stage (m): 10
Constant A: 2.14
Constant B: 0
Constant C: 2
Equation #3
Equation Type (1=Quadratic, 2=Power, -1=DONE): -1
Area Equations
# Min (m)    Max (m)
1  0.000     5.000    Area = 2.5000*Stage*Stage + 10.3000*Stage + 0.9500
2  5.000    10.000    Area = (2.1400*(Stage - 0.0000))^2.0000
OK
>SetArgElevation 2.50  Relative to same origin as channel elevation data.
OK                      Since OutFormat=English, this is in feet;
                        if Metric, it would be meters.
>VelEquation Index    Index velocity relation.
OK
>SetIndexCoef 0.05 0.95 0.00 Set three index coefficients.
OK                      Vmean = 0.05 + Vmeas * (0.95 + (0.00*Stage))
>TotalVolume 0        Disable total volume calculations.
OK
The following 2 commands would only apply if data collection were to begin
at some future time rather than immediately. That is, if data collection
is to begin immediately, do not enter StartDate and StartTime.
>StartDate 2005/12/31 The date collection is to begin as yyyy/mm/dd.
OK
>StartTime 13:00:00   The time collection is to begin as hh/mm/ss.
OK
End of future start date/time entries.
>SaveSetup            Save all parameter settings to non-volatile memory.
OK
```

- Review all your settings to make sure they are appropriate/correct. The commands to do this are shown below. Command responses are self-explanatory and are not shown here.

```
>Show Conf
...Hardware configuration data displayed in tabular format.
OK
>Show System
...System parameters displayed in tabular format.
OK
>Show Setup
...Setup parameters displayed in tabular format.
OK
>Show Deploy
...Deployment parameters displayed in tabular format.
OK
>Show FDatum
...Flow settings displayed in tabular format.
OK
```

- After all parameter settings are valid, you can either use the **Start** or **Deploy** command to begin data collection. **Start** begins data collection immediately; **Deploy** begins data collection at the specified **StartDate** and **StartTime**.

```
>Start
Checking Setup Parameters...
4194304 free bytes left in recorder.
Free space is sufficient for 297.22 days of operation.
Recorder mode is NORMAL.
Data will be recorded to file RIVER001.
OK
```

- You can automate the above deployment entries by creating a command file; see [How to Automate a Deployment using a Command File](#) (§5.8). The sample command file shown below sets the same operating parameters as described earlier in this section.

```
Recorder ON
OutFormat English
Deployment River
AutoSleep YES
TempMode Measured
Sal 0
CellBegin 2.00
CellEnd 10.00
CoordSystem XYZ
ReverseXVelocity NO
AvgInterval 300
SampleInterval 900
PowerPing YES
BlankDistance 1.00      (multi-cell profiling only)
CellSize 1.00          (multi-cell profiling only)
NCells 10              (multi-cell profiling only)
Date                   (shows current date from SW clock)
Time                   (shows current time from SW clock)
ChannelType Equation
SetGeometry            (the following 13 lines are SetGeometry parameters)
1
0
5
2.5
10.3
0.95
2
5
10
2.14
0
2
-1                        (stops equation entry point entries)
SetArgElevation 0.71
VelEquation Index
SetIndexCoef 0.05 0.95 0.00
TotalVolume 0
StartDate 2005/12/31    (for future rather than immediate data collection)
StartTime 13:00:00     (for future rather than immediate data collection)
SaveSetup
```

5.8.5. SonUtils SDI-12 Deployment

The Argonaut-SL is an SDI-12 compliant sensor. The SL can be used with any external data recorder/logger that has an SDI-12 interface.

When interfacing an Argonaut-SL with an SDI-12 data logger, the SL must first be programmed using RS-232 communications, and then switched into SDI-12 mode. The SL communications cable has a jumper-switch connector ([Figure 5-20](#)) that is used to choose between the RS-232 and SDI-12 communication protocols. For detailed information about the SDI-12 protocol and connection requirements, see [Appendix E](#).

- The white plastic jumper-switch connector is used to choose between the RS-232 and SDI-12 communication protocols.
- When the connector is “mated”, the system is in RS-232 mode.
- When the connector is “open”, the system is in SDI-12 mode.

To interface the SL with an external SDI-12 data logger, use the following procedure.

- Connect the “wet” end of the power/communications cable to the SL (§5.3).
- Connect the power supply to the SL cable (use the power supply that will be used during the deployment).
- Select RS-232 mode by “mating” the white plastic jumper-switch connector ([Figure 5-20](#)).
- Connect the RS-232 cable to an available COM port on your computer.
- Start the *SonUtils* software program.
- Set and review SL operating parameters for your particular application as described in Sections 5.8.1 through 5.8.9. Follow the appropriate procedure up to the point where the **Start** (or **Deploy**) command is issued; that is, do not send either of these commands at this time.
- Select the desired address for SDI-12 communication while in RS-232 mode. A sample command sequence is:

```
>SDI12Address a          Select address a.
OK
>SDI12MultiAddress NO    Disable multi-address mode.
OK
>SDI12AutoSampling YES   Enable SDI-12 Auto Sampling.
OK
>SaveSetup               Save settings to memory.
OK
>SDI12Address            Verify address setting.
Current Sdi12 Address:  a
```

- Review all your settings to make sure they are appropriate/correct. The commands to do this are shown below. Command responses are self-explanatory and are not shown here.

```
>Show Conf
...Hardware configuration data displayed in tabular format.
>Show System
...System parameters displayed in tabular format.
>Show Setup
...Setup parameters displayed in tabular format.
>Show Deploy
...Deployment parameters displayed in tabular format.
>Show FDatum
...Flow settings displayed in tabular format.
>Show SDI12
...Parameters for SDI-12 interface.
OK
```

- Tell the system to switch to the SDI-12 communication protocol.

```
>Sdi12 ON           Place the system in SDI-12 mode.
OK
Checking Setup Parameters...
4194304 free bytes left in recorder.
Free space is sufficient for 408.32 days of operation.
Recorder mode is NORMAL.
Switching to SDI-12 mode
SDI-12 address is: 0
```

Note: The data storage estimate shown in the above example is only accurate in SDI-12 mode if the SL's SampleInterval parameter matches the data logger's sampling interval. In SDI-12, the SL has no knowledge of its expected sampling scheme. As such, the SL cannot accurately estimate the data storage information.

- Disconnect the RS-232 connector from your computer.
- Select SDI-12 mode by “opening” the white jumper switch connector ([Figure 5-20](#)).
- Connect the SDI-12 data cable to your data logger.
- The system will now communicate with the data logger based on the setup of the SL and the data logger. A general summary of the SDI-12 command interface is given below.

When you are ready to exit SDI-12 mode and return the Argonaut-SL to RS-232 mode:

- Connect the RS-232/SDI-12 jumper switch ([Figure 5-20](#)) to enable the RS-232 serial bus.
- Connect the DB9 connector on the SL power/communications cable to an available serial port on your computer.
- Run *SonUtils*.
- Send the following command to the system; you must press <Enter> after the command.

```
?EXIT!
Switching to RS-232 Mode
>
```

- The system is now in RS-232 command mode using the RS-232 serial bus, and is now ready to receive commands.

General Summary of SDI-12 Command and Response Interface

A general summary of the command interface and data output format is given below. See [Appendix E](#) for a detailed description of the SDI-12 command interface and data format.

- Samples can be initiated using either the **m** or **c** command, depending on the capabilities of the data logger. Sample command sequences and Argonaut-SL responses are shown below. Note that there are several different ways to access SL data depending on which version of the SDI-12 interface is being used.
- The SL only supports the **SonTek** SDI-12 format (**Sidekick** format was discontinued after firmware version 8.9).
- The following SDI-12 interface method uses the **m** command (in this example, the SL is using SDI-12 address **a**)

```
aM!           Data logger requests measurement.
a3159         SL will have 9 parameters ready in 315 seconds
              (300 s for averaging interval, 15 s overhead).
a             SL has completed the measurement.
aD0!        Data logger requests first data set.
```

a+62.26+0.00+2.654+2.6 SL returns first four parameters:

- Temperature (°C or °F).
- Pressure (dBar or psi)
- Stage (meters or feet); a -1 is reported if the water surface was not detected.
- Cell end (meters or feet). See Note 1 below.

aD1! Data logger requests second data set.

a+1.435-0.055+1.436+30.1+15.377

SL returns next five parameters:

- Vx velocity (cm/s or ft/s).
- Vy velocity (cm/s or ft/s).
- Vmag velocity magnitude (cm/s or ft/s).
- Mean Signal-to-Noise ratio (dB).
- Total flow (m³/s or ft³/s). Note that the flow value will only be present when flow calculations are enabled. Also, the number of decimal places will change depending on the magnitude of the flow (to stay within the output limits required with SDI-12).

Some of the following commands would apply only if multi-cell profiling is used. See Note 2 below.

aM1! Data logger requests Cell 1 measurements.

a0004 SL will have four parameters ready immediately.

aD0! Data logger request Cell 1 data.

a+1.033-0.088+1.037+38.7 SL returns cell 1 data:

- Vx velocity (cm/s or ft/s).
- Vy velocity (cm/s or ft/s).
- Vmag velocity magnitude (cm/s or ft/s).
- Mean Signal-to-Noise ratio (dB).

aM2! Data logger requests Cell 2 measurements.

aD0! SL response format is the same for all cells.

aM3! Data logger requests Cell 3 measurements.

aD0! SL response format is the same for all cells.

aM4! Data logger requests Cell 4 measurements.

aD0! SL response format is the same for all cells.

aM5! Data logger requests Cell 5 measurements.

aD0! SL response format is the same for all cells.

aM6! Data logger requests additional data parameters.

aD0! SL supplies additional data parameters (number of parameters depend on enabled options).

a+12.1+3805.2+10.234+9.456

- Battery voltage (V).
- Remaining recorder space (Kbytes).
- Flow rate (variable units).
- Total volume (variable units).

- The following SDI-12 interface method uses the **c** command (in this example, the SL is using SDI-12 address **a**). Note: **c** command only supported in SDI-12 v1.2 and later.

aC! Data logger requests measurement.

a31234 SL will have 34 parameters ready in 312 seconds (number of parameters returned will depend on enabled features, including multi-cell). Data logger waits until the measurement is completed.

aD0! Data logger requests first data set.

a+62.26+0.00+2.654+2.6 SL returns first four parameters:

- Temperature (°C or °F).
- Pressure (dBar or psi).
- Stage (meters or feet); a -1 is reported if the water surface was not detected.
- Cell end (meters or feet). See Note 1 below.

aD1! *Data logger requests second data set.*
a+1.435-0.055+1.436+30.1+15.377
SL returns next five parameters:

- Vx velocity (cm/s or ft/s).
- Vy velocity (cm/s or ft/s).
- Vmag velocity magnitude (cm/s or ft/s).
- Mean Signal-to-Noise ratio (dB).
- Total flow (m³/s or ft³/s). Note that the flow value will only be present when flow calculations are enabled. Also, the number of decimal places will change depending on the magnitude of the flow (to stay within the output limits required with SDI-12).

The following commands would apply only if multi-cell profiling is used. See Note 2 below.

aD2! *Data logger request Cell 1 data.*
a+1.033-0.088+1.037+38.7
SL returns cell 1 data:

- Vx velocity (cm/s or ft/s).
- Vy velocity (cm/s or ft/s).
- Vmag velocity magnitude (cm/s or ft/s).
- Mean Signal-to-Noise ratio (dB).

aD3! *Data logger requests Cell 2 data.*
SL response format is the same for all cells.

aD4! *Data logger requests Cell 3 data.*
SL response format is the same for all cells.

aD5! *Data logger requests Cell 4 data.*
SL response format is the same for all cells.

aD6! *Data logger requests Cell 5 data.*
SL response format is the same for all cells.

aD7! *SL supplies additional data parameters (number of parameters depend on enabled options).*
a+12.1+3805.2+10.234+9.456

- Battery voltage (V).
- Remaining recorder space (Kbytes).
- Flow rate (variable units).
- Total volume (variable units).

Notes:

1. When outputting real-time data, if the **ReverseXVelocity** command is enabled, the SL will change the sign of the **CellEnd** output parameter.
2. Another method exists for using doing multi-cell data in SDI-12 mode for SDI-12 version 1.0 only. This is called the SDI-12 multi-address method. For details, see §E-6.3.

5.8.6. SonUtils Real-Time Interface Using RS-232

For some applications, real-time data acquisition systems can use the direct RS-232 serial output of the SL. This section describes concerns for interfacing the SL for real-time serial interface.

To interface the SL with an external RS-232 data acquisition system, use the following procedure. For more details about the SL output data format, see §D-2.

- Connect the “wet” end of the power/communications cable to the SL (§5.3).
- Connect the power supply to the SL cable (use the power supply that will be used during the deployment).
- Select RS-232 mode by “mating” the white plastic jumper-switch connector (Figure 5-20).
- Connect the RS-232 cable to an available COM port on your computer.
- Start the *SonUtils* software program.
- Set and review SL operating parameters for your particular application as described in Sections 5.8.1 through 5.8.3. You may need to change the setting of the **OutFormat** command depending on your data output requirements. You have three choices for this command; all formats present the same data values in the same order:
 - **ASCII** – Outputs data using the metric units matching the internal resolution of the SL. These are generally uncommon units, but the output has the advantage of not having any decimal places.
 - **Metric** – Outputs data using a common metric units convention.
 - **English** – Outputs data using a common English units convention.
- As appropriate, begin data collection using either the **Start** or **Deploy** command. Sample output strings for each format are shown below.
- A detailed description of the output format and sample output strings for each format is shown in §D-2.

5.8.7. SonUtils Modbus Interface Module Deployment

- Follow the standard SonUtils deployment procedure as described in §5.8.1 through §5.8.9. Follow the procedure up to the point where the **Start** (or **Deploy**) command is issued; but do not send either command. The last command that you send should be **SaveSetup**.
- Connect power to the MIM.
 - The Argonaut operates from 7-16 VDC power. Power consumption varies with instrument configuration (see §5.5.2).
 - The MIM operates from 9-16 VDC power, and consumes less than 0.5 W of power.
 - The Argonaut and MIM can often be run from the same power supply. Be sure the power supply used to operate these devices is sufficient for your required deployment length.
- If necessary, change the Modbus address, baud rate, and parity settings of the MIM (§I-5).
- Connect the DB9 connector from the Argonaut power and communication cable to the **Argonaut** port on the MIM.
 - The MIM will establish communications with the Argonaut and start data collection.
 - You should see the **Argonaut Communication** LED light up when communication is established. This may take 1-2 minutes.
- Connect a cable from the **Modbus Communication** port on the MIM to your Modbus data acquisition system.
 - Data on the MIM will be available when the Argonaut completes the first sample.
 - Access data on the MIM as you would any other Modbus RTU slave device.
 - See §I-7 for a description of where different data values can be found.

5.8.8. SonUtils Wave Spectra Deployment

When deploying a system that includes the optional wave spectra measurement capability, several additional parameters must be set. Following is an overview of the wave spectra parameters. For detailed information about how to use the wave spectra measurement capability, see §J-1.

- Set and review SL operating parameters for your particular application as described in Sections 5.8.1 through 5.8.10. Follow the appropriate procedure up to the point where the **Start** (or **Deploy**) command is issued; that is, do not send either of these commands at this time.
- For a complete description of wave parameters, see §5.4.4 and § C-16.
- Be sure to verify the following parameters are appropriately set for wave data collection as described in §J-1.
 - **AvgInterval** A longer value (typically at least 1024 seconds) is required.
 - **PowerPing** This must be disabled for wave data collection.
- Set the necessary wave spectra parameters.

```
>WaveSpectra ON           Enable wave spectra calculations.
OK
>WaterDepth -0.5          Set total water depth at site.
OK
>RecordPSeries NO         Select Recording of Pressure time series.
OK
>SaveSetup                Save settings to memory.
```

- After entering valid parameters, you can use either the **Start** or **Deploy** command to begin data collection. **Start** begins data collection immediately; **Deploy** begins data collection at the specified **StartDate** and **StartTime**.

5.8.9. SonUtils External Sensor (YSI or CTD) Deployment

If the SL includes an optional YSI or CTD sensor, no additional parameter settings are required.

- Data from the sensor will be automatically sampled with each SL sample.
- When deploying the system, verify that the appropriate setting (**YSI** or **CTD**) is marked as **Installed** on the hardware parameter settings in response to the **Show CONF** command.
- Follow the recommended deployment procedures for the YSI (§J-2) or CTD (§J-3) sensors as appropriate.

5.8.10. SonUtils Analog Output Deployment

The Argonaut-SL can be equipped with optional analog output modules to generate analog output signals proportional to one or more variables measured by the system.

- Analog output modules are available in two varieties — ones that generate a 4-20 mA current loop and ones that generate a 0-5 VDC output voltage.
- Up to two output modules can be used with a system at the same time (one module per analog output). However, both modules must be of the same type, either 4-20 mA or 0-5 VDC.
- When using the analog output modules, no other form of real-time data output is available (i.e., neither RS-232 nor SDI-12 real-time data outputs can be used).
- When using an analog output module, we strongly recommend storing data to the internal recorder. This ensures access to all diagnostic data when reviewing data in post-processing (the analog output signals greatly reduce the amount of available data).

Following is an overview of how to deploy a system using one or more analog output modules. For detailed information about how to use the analog output modules, see [Appendix F](#).

- Connect the “wet” end of the power/communications cable to the SL (§5.3).
- Connect the power supply (that will be used during the deployment) to the SL cable.
- Select RS-232 mode by “mating” the white plastic jumper-switch connector ([Figure 5-20](#)).
- Connect the RS-232 cable to an available COM port on your computer.
- Start the *SonUtils* software program.
- Set and review SL operating parameters for your particular application as described in Sections 5.8.1 through 5.8.9. Follow the appropriate procedure up to the point where the **Start** (or **Deploy**) command is issued; that is, do not send either of these commands at this time.
- Set the necessary analog output parameters. This example assumes you are using two analog output modules that generate a 4-20 mA current loop.

```
>OutFormat English           Use English units for output/flow data
OK
>TotalVolume 1              Use acre-ft for total volume data.
OK
>AnalogOutputType Current   Modules are 4-20 mA current loop.
OK
>SetupAnalogOutput 1 Flow 0.0 10.0 Channel 1, Flow rate,
OK                             range 0.0 to 10.0 cfs.
>SetupAnalogOutput 2 Volume 0 100.0 Channel 2, Total volume,
OK                             range 0 to 100.0 acre-ft.
>Show AO                    Display analog output settings.
AO SETTINGS
-----
Chan Parameter   MinVal   MaxVal
1      FLOW      0.00    10.00   cfs
2      VOLUME    0.00   100.00   acre-ft
>SaveSetup         Save setting to memory.
```

- After all parameter settings are valid, you can either use the **Start** or **Deploy** command to begin data collection. **Start** begins data collection immediately; **Deploy** begins data collection at the specified **StartDate** and **StartTime**.

```
>Start
Checking Setup Parameters...
```

```
4194304 free bytes left in recorder.  
Free space is sufficient for 408.32 days of operation.  
Recorder mode is NORMAL.  
Data will be recorded to file ANLOG001.  
OK
```

- When the analog output option is enabled, the values output by the SL are written to control the analog output modules. A sample output, when two analog output modules are connected, is shown here.

```
$1AO+00016.96  
$2AO+00012.02
```

- One output string is written for each analog output module to be controlled.
 - The string starts with the module address.
 - It is followed with the analog value (mA or VDC) to be output by the module.
 - These values are calculated based on the relationship between the measured parameter value and the **MinVal** and **MaxVal** limits set by the user as described in §C-17 and [Appendix F](#).
- After starting data collection, each analog output module must be connected to the RS-232 output of the Argonaut-SL. A special cable, with one connector for each output module to be used, is supplied with the system. See [Appendix F](#) for details about this cable.

Section 6. Retrieving and Analyzing Argonaut-SL Data

The data analysis suggestions and examples in this section refer to the binary data files recorded on the Argonaut's internal recorder. Data analysis is typically done using the *ViewArgonaut* program. Many of the data analysis tips provided here can be used for data collected by other methods (e.g., through an SDI-12 data logger), but using the internally recorded files provides access to the full range of diagnostic data.

6.1. How to Download Data

There are three ways, all very similar, in which you can download data from the Argonaut-SL.

- The Recorder module within *ViewArgonaut Deployment* (§6.1.1).
- The Recorder module within *SonUtils* (§6.1.2).
- The Recorder module within *ViewArgonaut* (§6.1.3).

6.1.1. Download Data Using ViewArgonaut Deployment

This section explains how to download data files using the *ViewArgonaut Deployment* module.

- Connect the power and communications cable to the system and to an available serial port of your computer. See §1.4 for details.
- Make sure the RS-232/SDI-12 jumper switch is mated (selecting RS-232 serial communication). Note: Chances are you only need to verify this connector ([Figure E-1](#)) if the SL was connected to an SDI-12 data logger. For details about SDI-12 operation, see [Appendix E](#).
- Apply system power.
- Run *ViewArgonaut*. Click the **Deployment** button from the main menu to open the Deployment module.
- Follow the standard Deployment module procedure (for direct connection to the system) as described in §5.7.
- From the **Battery and Recorder** screen ([Figure 5-48](#)), click the **Show Recorder Details** button.
 - This opens the recorder dialog to download any files on the recorder.
 - You can also reformat the recorder if necessary. Remaining recorder space is displayed on the **Battery and Recorder** screen.
 - The operation of this dialog is described in detail in §5.7.15.
- After downloading files (and formatting the recorder if necessary), re-deploy the system from the Deployment module following the instructions in §5.7.

6.1.2. Download Data Using SonUtils

This section explains how to download data files using the *SonUtils* program.

- Connect the power and communications cable to the system and to an available serial port of your computer. See §1.4 for details.
- Make sure the RS-232/SDI-12 jumper switch is mated (selecting RS-232 serial communication). Note: Chances are you only need to verify this connector ([Figure E-1](#)) if the SL was connected to an SDI-12 data logger. For details about SDI-12 operation, see [Appendix E](#).
- Apply system power.
- Run *SonUtils*.

- Click **Break** (or press **Alt+B**) to send the initialization (i.e., wake-up) command to the SL. You should see a copyright/initialization message similar to the one shown in [Figure 1-7](#).
- Click the **Recorder** button on the left side of the *SonUtils* screen. This opens the recorder interface that displays the contents of the internal recorder. An example is shown in [Figure 6-1](#).
- Click the **Browse** button (lower right part of **Recorder** dialog box) to specify the destination folder to which files will be downloaded.
- Select individual files by clicking on the file name in the directory listing.
- Holding down the **Ctrl** or **Shift** keys and clicking on multiple files allows you to download multiple data files at a same time.
- When ready, click the **Download** button. A display will show progress as individual files are downloaded.
- For detailed information about the Recorder module, see the *SonUtils User Guide* (PDF file).

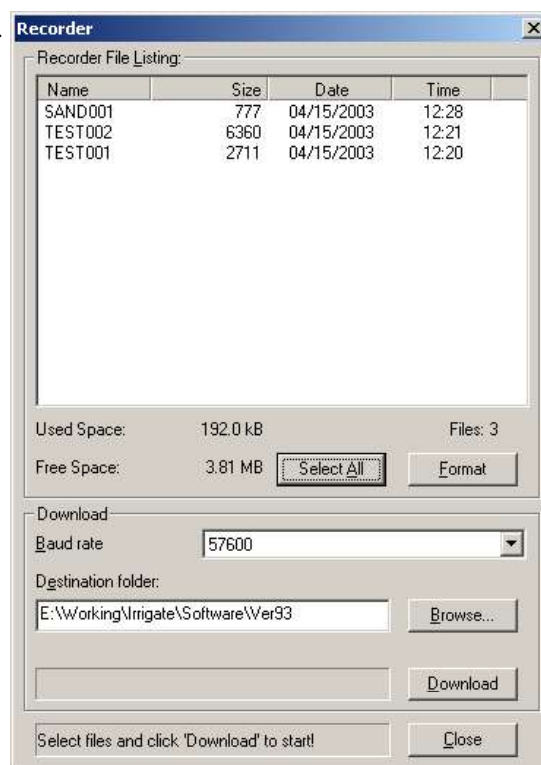


Figure 6-1. SonUtils Recorder module

6.1.3. Download Data Using ViewArgonaut

This section explains how to download data files using the *ViewArgonaut* program.

- Connect the power and communications cable to the system and to an available serial port of your computer. See [§1.4](#) for details.
- Make sure the RS-232/SDI-12 jumper switch is mated (selecting RS-232 serial communication). Note: Chances are you only need to verify this connector ([Figure E-1](#)) if the SL was connected to an SDI-12 data logger. For details about SDI-12 operation, see [Appendix E](#).
- Apply system power.
- Run *ViewArgonaut*, and then click the **Recorder** button from the main menu. This will open the *ViewArgonaut* Recorder module ([Figure 6-2](#)).
- Select the correct COM port and baud rate (always 9600 baud) in the **Settings** box.
- Click the **Connect** icon. The software will wake up the system and download the recorder's directory. This process may take a few minutes. The directory will be similar to the one shown in [Figure 6-2](#).
- Click **Browse**, and then specify the destination folder to which files will be downloaded.
- Select individual files by clicking on the file name in the directory listing. Hold down the **Ctrl** or **Shift** keys while clicking to select multiple files for downloading at the same time.
- When ready, click **Download**. A display will show progress as individual files are downloaded. For Recorder module details, see the *ViewArgonaut User Guide* (PDF file).

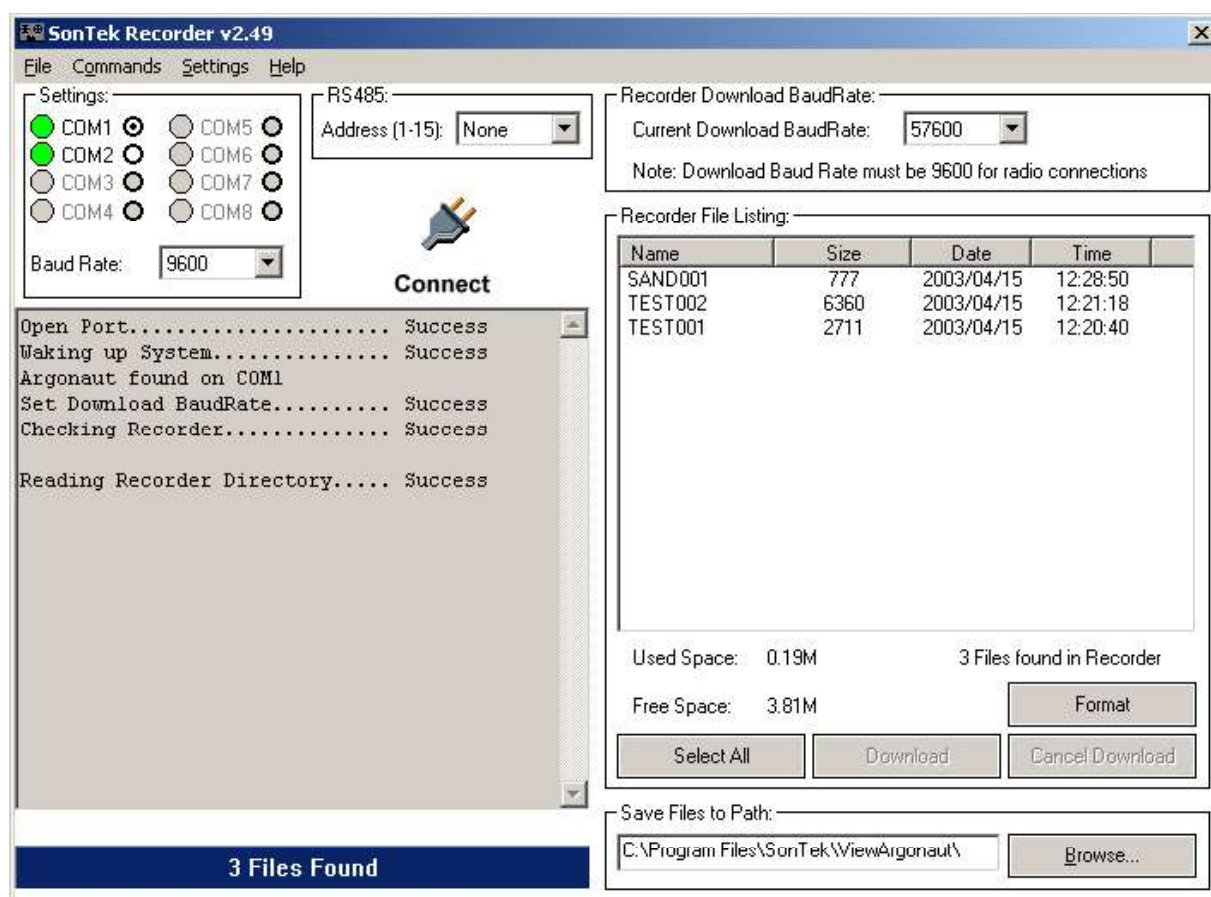


Figure 6-2. ViewArgonaut Recorder module

6.2. Recorded Data

With each sample, the Argonaut-SL records the following data.

- Velocity (V_x , V_y)
- Stage (on systems with vertical beam)
- Flow (if internal flow calculations are enabled)
- Cross-sectional area (if internal flow calculations are enabled)
- Volume (if both internal flow and volume calculations are enabled)
- Standard error of velocity (V_x , V_y)
- Measured signal strength (Beam 1, 2)
- Measured noise level (Beam 1, 2)
- Signal-to-noise ratio (Beam 1, 2) – calculated from signal strength and noise level
- Temperature
- Pressure (for systems equipped with a pressure sensor)
- Battery voltage
- Cell begin (starting location of single integrated velocity cell)
- Cell end (ending location of single integrated velocity cell)

Most commonly, velocity, stage, and flow are of primary interest. However, the other data does provide quite a bit of additional information. At the very least, this data should be reviewed to ensure the system is operating properly.

6.3. Quality Control Data

Some of the primary quality control parameters are described in the following sections.

- Signal-to-noise ratio (SNR) – §6.3.1
- Signal strength and noise level – §6.3.2
- Standard error of velocity – §6.3.3
- Stage – §6.3.4
- Temperature, pressure and battery voltage – §6.3.5
- Cell begin and cell end – §6.3.6
- Internal diagnostic data – §6.3.7

6.3.1. Signal-to-Noise Ratio (SNR)

The Argonaut-SL measures velocity by looking at the reflections of an acoustic pulse from particles in the water.

- The magnitude of the reflection is called signal strength, which varies with the amount and type of suspended material (called scatterers) and the distance from the transducers.
- Signal strength decreases with distance from the transducer due to geometric spreading and sound absorption.
- The maximum measurement range of the SL is determined by the distance at which signal strength approaches the electronics noise level.
- Signal strength is commonly used as signal-to-noise ratio (SNR), which compares the magnitude of the received signal to the ambient electronics noise level. SNR is reported in a logarithmic scale (dB).

The first step when looking at data from an Argonaut-SL is to review the SNR data.

- If SNR is too low, the SL cannot accurately measure water velocity.
- The minimum acceptable SNR value is 3 dB.
- Low SNR values can be caused by various factors.
 - Clear water may not have enough scatterers to generate a strong acoustic return.
 - If one or more transducers are blocked (e.g., vegetation, piling), this can reduce SNR and significantly affect system operation (see sample data set in §6.5.2).
 - If something causes the system noise level to change, this can affect SNR even if scattering conditions in the water are not changed (see §6.3.2 and sample data set in §6.5.1).
- When SNR values are low (even if still above 3 dB), the system may need to reduce its maximum measurement range to avoid regions of low SNR. When this occurs, the recorded value of Cell End will show the changes in the sampling volume definition (see §6.3.6).
- SNR can vary significantly with time due to changing conditions in the water.
- Variations of 10-20 dB over time are common.
- SNR variations can occur on short and long time scales, and can be difficult to predict even when detailed information about the deployment conditions is available.
- Look for large changes in SNR, or situations where the SNR for the two beams are behaving differently. This can be a sign of something interfering with a beam (see sample data in §6.5.2 and §6.5.3).

- Look for large “step” changes, where SNR either increases or decreases significantly (>10 dB) and stays at or near the new higher or lower level. These changes can be valid (caused by changes in the environment), but may also be caused by changes in the noise level or by vegetation or other obstructions near a transducer beam.

In general, if SNR data are reasonably high (above 10 dB) and stays at a reasonably consistent level over time, this indicates good quality data and there is no need for concern. However, if SNR is low or shows large fluctuations with time, we recommend reviewing the following data.

- Signal strength and noise level – §6.3.2
- Cell end – §6.3.6

6.3.2. Signal Strength and Noise Level

Signal strength and noise level are the two raw variables used to calculate SNR.

- As described in §6.3.1, signal strength is the magnitude of the reflection of an acoustic pulse from suspended material in the water.
- Noise level is the measured acoustic return when no acoustic pulse has been transmitted. This represents the ambient electronics noise level.
- Both signal strength and noise level are measured and recorded with each sample in internal units called *counts*. One *count* equals 0.43 dB.
- SNR is calculated from signal strength and noise level using the following formula.

$$\text{SNR} = 0.43 * (\text{SignalStrength} - \text{NoiseLevel})$$

Acoustic return data are normally assessed as SNR, but might need to be assessed in its raw format for a few reasons.

- If there is unusual behavior in the SNR data, looking at raw signal strength and noise level may help isolate the problem.
- If you are trying to relate the acoustic return to the amount of suspended sediment in the water, this data should be assessed as signal strength and not as SNR.

If SNR data are low or are showing unusual behavior, you should look at both signal strength and noise level data.

- Signal strength should show essentially the same fluctuations as SNR. If SNR is showing large fluctuations while signal strength remains nearly constant, this indicates a problem with a changing noise level.
- Noise level for the Argonaut-SL is typically 30-35 counts. Noise level should not fluctuate more than 2-3 counts over time.
- If noise level changes, or is significantly higher than 35 counts, this indicates a problem with the system, a noisy power supply, or a noisy environment.
- While problems with noise level are unusual, they can have a major effect on SL operation.
- If you detect a problem with system noise level, please [contact SonTek/YSI](#), and we will help you isolate the cause.
- See a sample data set with changes in noise level in §6.5.1.

Signal strength is primarily a function of the amount and type of particulate matter in the water.

- While signal strength cannot be immediately converted to sediment concentration, it provides an excellent qualitative picture of sediment fluctuations and, with proper calibration, can be used to estimate sediment concentration.
- When relating the acoustic return strength to suspended sediment concentration, this should be done using signal strength data rather than SNR data. This is because SNR can be affected by changes in noise level, while signal strength should only be affected by changes in the environmental conditions in the water.
- Signal strength, SNR, and noise level can all be accessed from *ViewArgonaut*. This allows you to select the type of acoustic return data most appropriate to your needs.
- For more information about using acoustic signal strength to monitor changes in suspended sediment concentration, please [contact SonTek/YSI](#).

6.3.3. Standard Error of Velocity

Each velocity sample recorded by the Argonaut-SL is the average of a number of pings.

- The SL pings once per second over the period specified by the [averaging interval](#).
- The system records the standard error of velocity based on data from individual pings.
- Standard error is the standard deviation of the velocity measurement from each ping, divided by the square root of the number of pings.
- Standard error is a direct, statistical measure of the accuracy of the mean velocity data.
- Measured standard error includes instrument-generated noise and real variations in velocity.
- Instrument-generated velocity noise can be estimated based on operating parameters (averaging time and sampling volume, or cell size). This is useful in planning deployments, particularly for determining the operating parameters required for a desired accuracy. For details on estimating standard error based on operating parameters, see [Appendix B](#).
- Typically, measured standard error agrees with predicted values to within about 20%.

Some important details about how standard error is recorded are listed here.

- Standard error is recorded with 0.1 cm/s resolution for each velocity component in the coordinate system specified for data collection. For the SL, this is usually XYZ (§[B-9.2](#)).
- To minimize data storage requirements, the SL uses a single byte to record standard error. This means the maximum value of standard error is 25.5 cm/s (0.84 ft/s).
- If measured standard error exceeds this value, the value of 25.5 cm/s (0.84 ft/s) is recorded.

When looking at standard error as a quality control parameter, the following should be noted.

- The measured standard error will typically match predicted values to within 20%.
- When the SL is out of water, it reports the maximum standard error of 25.5 cm/s (0.84 ft/s).
- Fluctuations in standard error are often caused by valid variations in the water velocity.
- If you observe large changes in the water velocity, carefully consider the measurement environment. For example, are there valid variations in water velocity, such as the presence of waves that could account for these changes?
- Standard error is a function of measurement volume size and the number of samples.
- If measured standard error agrees reasonably well with predicted values over time, standard error can be used as a direct measure of the accuracy of velocity data.

6.3.4. Stage Data

Stage from the vertical beam can be an excellent indicator of system performance.

- Your knowledge of flow conditions and channel geometry can usually provide a good estimate of what are reasonable stage values.
- If the SL cannot detect the surface with the vertical beam, it will not report stage data. This is more common in very shallow (<0.5 m; 1.5 ft) or deep (>3 m; 10 ft) water.
- If the system is tilted on installation, this can make vertical beam data unreliable.
- If the vertical beam is blocked (e.g., vegetation), data may be unreliable.
- Large flow obstructions immediately upstream can create irregular surface conditions that may reduce the reliability of vertical beam data.
- In shallow water (<0.5 m; 1.5 ft), the vertical beam can mistake a multiple reflection as the surface signal. This can cause the system to overestimate depth (typically by a factor of 2), or can cause measured stage to vary drastically from one sample to another. These situations are uncommon, but can occur in certain environments.
- If measured stage data appears reasonable and consistent for the environment, this indicates that both stage and velocity data are likely to be reliable.
- You can compare stage to pressure (see §6.3.5) to verify vertical beam operation.
 - Pressure is also affected by changes in atmospheric pressure, so the changes in stage will not exactly match the changes in pressure.
 - Pressure and stage should follow the same general pattern, and a major deviation from this can indicate a problem either with the pressure sensor or with the vertical beam.
 - See §6.5.2 for a sample data set comparing pressure and vertical beam data.

6.3.5. Temperature, Pressure, and Battery Voltage

Temperature, pressure, and battery voltage are three additional values recorded with each sample that can provide useful information about a deployment.

- Temperature data should be reasonable given the environment.
- Often you will see patterns that reflect the environmental conditions. These can include daily temperature cycles, and temperature cycles related to changes in the flow conditions (e.g., the water may be warmer when flow speeds are lower as it has a greater amount of time to be warmed by the air).
- If temperature data shows a constant value at unrealistically high or low values (typically 60°C; 140°F), this indicates a problem with the temperature sensor.
- Temperature data are used to compute sound speed for Doppler velocity calculations. Problems with the temperature sensor will affect velocity data reported by the system.
- Pressure data (if present) should indicate a reasonable water depth given the deployment environment.
 - Pressure in metric units is given in dBar; 1 dBar is equal to 1 m depth.
 - Pressure in English units is given in psi; 1 psi is equal to 2.2 ft depth.
- Pressure data are affected both by changes in water level and by changes in atmospheric (barometric) pressure.
 - Changes in atmospheric pressure can cause pressure changes equivalent to a depth change of up to 0.3 m (1.0 ft).
 - Thus, pressure by itself is not an accurate indicator of water depth.

- You can compare pressure data to stage data (§6.3.4) to verify vertical beam operation.
 - Pressure and stage should follow the same general pattern; major deviations from this pattern can indicate a problem with either the pressure sensor or the vertical beam.
 - See §6.5.2 for a sample data set comparing pressure and vertical beam data.
- You should monitor battery voltage to ensure a sufficient supply of power to the system.
- Decay of battery voltage should match expectations based on battery capacity and deployment length (see §5.3.3).
- If the battery is connected to a solar panel, the battery voltage may show a daily cycle that corresponds to the battery being recharged during the day.
- When battery voltage approaches the minimum operation value, the Argonaut will automatically shut down to avoid damage to the electronics (see §7.2).

6.3.6. Cell Begin and Cell End

The Argonaut-SL records the starting and ending locations of the single integrated velocity cell (Cell Begin and Cell End) with each sample.

- Cell Begin and Cell End parameters are specified during setup. These parameters give the location of the sampling volume used by the system.
- Cell Begin is fixed and will not be adjusted with time.
- Cell End may be “pulled back” (i.e., shortened) for low signal strength (if the SNR at the end of the sampling volume is too low, the SL will automatically reduce the value of Cell End to avoid contaminating velocity data).
- Plot Cell End over the course of the deployment. Look to see if it provides a consistent value, or if it is being pulled back periodically because of low SNR values.
- These parameters are recorded with 0.1-m (0.3-ft) resolution for 1500 and 3000-kHz systems, and 0.5-m (1.5-ft) resolution for 500-kHz systems to minimize data storage.
- When looking at changes in Cell Begin and Cell End, the recorded changes (i.e., with changing water depth) will occur in large steps.
- These large jumps in Cell End are an artifact of how the data are recorded. The actual values used for data collection are adjusted with much higher precision. Only the recorded values use the coarser resolution.

With each sample, the Argonaut-SL monitors the SNR profile within the sampling volume.

- If at any point the signal strength is too low for reliable velocity measurements, the Argonaut will end the sampling volume at that range.
- Under most conditions, the SL is able to measure out to the specified maximum range.
- In some environments, the return signal strength from the water will be too low, and the system will have a reduced measurement range. In this situation, the system will automatically cut off the sampling volume at the maximum effective range. The exact limits of the sampling volume are recorded with each sample as Cell Begin and Cell End.
- Low signal strength may be caused by clear water, but can also be caused by the transducers being blocked with debris.

6.3.7. Internal Diagnostic Data

Internal diagnostic data was added to the Argonaut with firmware version 9.3. This data can be extremely valuable when troubleshooting data files.

- Internal diagnostic data is equivalent to having a *Beam Check* or *Diagnostics* data file (§5.6.1) recorded periodically throughout the deployment.
- The default is to record internal diagnostic data every 100 samples. For a 15-minute averaging interval, this corresponds to roughly once per day.
- The main part of the internal diagnostic data is a profile of signal strength for all velocity beams versus range from the system.
 - Note: Internal diagnostic data does not include data from the vertical beam.
- This profile of signal strength is displayed as raw signal strength (in counts) or as SNR.
- Both signal strength plots include a theoretical decay curve for comparison of the signal strength profile.
 - This can be used to emphasize variations in the profile that may be caused by underwater obstacles, or by variations in the scattering strength.
- The signal strength profile can be interpreted as described for *Beam Check* or *Diagnostics* data in sections §5.6.1.
- Within the *ViewArgonaut* Processing module, the internal diagnostic data can be viewed by clicking **Diag** on the toolbar, by using the **View | Diagnostic Data** pull down menu, or by pressing **Ctrl+D**.
- Sample plots of internal diagnostic data are shown in §6.5.2 and §6.5.3.

6.4. General Guidelines for Data Analysis

The following outline suggests steps to follow when looking at Argonaut-SL data. All plots mentioned here can be created using the *ViewArgonaut* Processing module (see *ViewArgonaut User Guide* for details). Be aware, most data-related problems cause changes in data that are readily apparent. If all data from the SL appears to provide reasonable values, you can have considerable confidence in the accuracy of the measurements.

- Run *ViewArgonaut* and start the **Processing** module. Open the data file and load all samples.
- The initial plot will normally display velocity (top graph) and SNR (bottom graph).
- Look at the SNR data.
 - What are typical SNR values? Are they high enough for reliable data? (§6.3.1)
 - How much variation is seen in SNR values? Does the variation appear reasonable for real-world variations in water conditions? (§6.3.1)
 - Was the system out of the water at any time during the deployment?
 - Is there any suggestion that the system or a beam may be blocked (e.g., vegetation)?
- Look at velocity data.
 - Are velocity values realistic based on the deployment environment?
 - Is velocity data consistent with time?
- Create a plot of stage data. See §6.3.4.
 - Does stage appear reasonable for the deployment environment?
 - Are there periods when stage is not reported? Do these match periods when the SL was out of the water, or when something else interfered with stage measurements?
- Check the Flow Datum loaded into the SL to ensure accurate channel geometry was entered.
- Create plots of the stage and the cross-sectional area.
 - Is the calculated cross-sectional area reasonable based on changes in stage?
- Create plots of velocity, stage, and flow.
 - Are calculated flow values reasonable based on changes in stage and flow velocity?
 - Are flow values reasonable based on the deployment environment?
- Create plots of signal strength and noise level.
 - Do changes in signal strength match changes in SNR? (§6.3.2)
 - Is noise level constant to within 2-3 counts?
- Create plots of velocity and standard error of velocity.
 - Do standard error of velocity values match predicted values? (§6.3.3)
 - Do standard error of velocity values seem to match the sample-to-sample variation seen in the velocity data?
- Create plots of temperature, pressure, and battery voltage. See §6.3.5.
 - Is temperature data reasonable for the deployment environment?
 - Is pressure data reasonable for the deployment environment? Does pressure data show the same general variations as stage data?
 - Is battery voltage consistent with the power supply?
 - Does the system have sufficient power for reliable operation?
- View the internal diagnostic data (see §6.3.7 and §5.6.1).
 - Is the signal strength profile reasonable for the environment?
 - Do both beams show similar signal strength profiles?
 - Are reflections from the opposite bank or underwater obstacles where you expect them?
 - How does the signal strength profile compare to the theoretical decay curve?
 - How does the signal strength profile change with time within the data file?

6.5. Sample Data Files

This section describes basic analysis of a few Argonaut-SL sample data files.

- These files were chosen to illustrate features and anomalies encountered in SL data.
- We have not used “perfect” data to give you an idea of what real-world data may look like.
- Despite the examples shown here, in many cases SL files will not display any of these “interesting” features and can be used with minimal analysis and post-processing.

In each of the following sections, we provide basic information about the data file and show a few data plots generated by the *ViewArgonaut* Processing module. This section does not provide detailed instructions for using *ViewArgonaut*; for details on using this software, refer to the *ViewArgonaut User Guide* (the PDF help file included with the software). Each of these sample data files is included with the *ViewArgonaut* software installation.

6.5.1. Sample Data File 1 (SLDemo1.arg) – Tidally Influenced River

The `SLDemo1.arg` data file represents three days of data collected with a 500-kHz SL in a large, tidally influenced river. The data set has slightly more than five tidal cycles. **Figure 6-3** shows plots of velocity (top graph) and SNR (bottom graph) over the 3-day deployment.

- The velocity shows a very typical tidal signature, where the magnitude of the flow varies between successive tidal cycles.

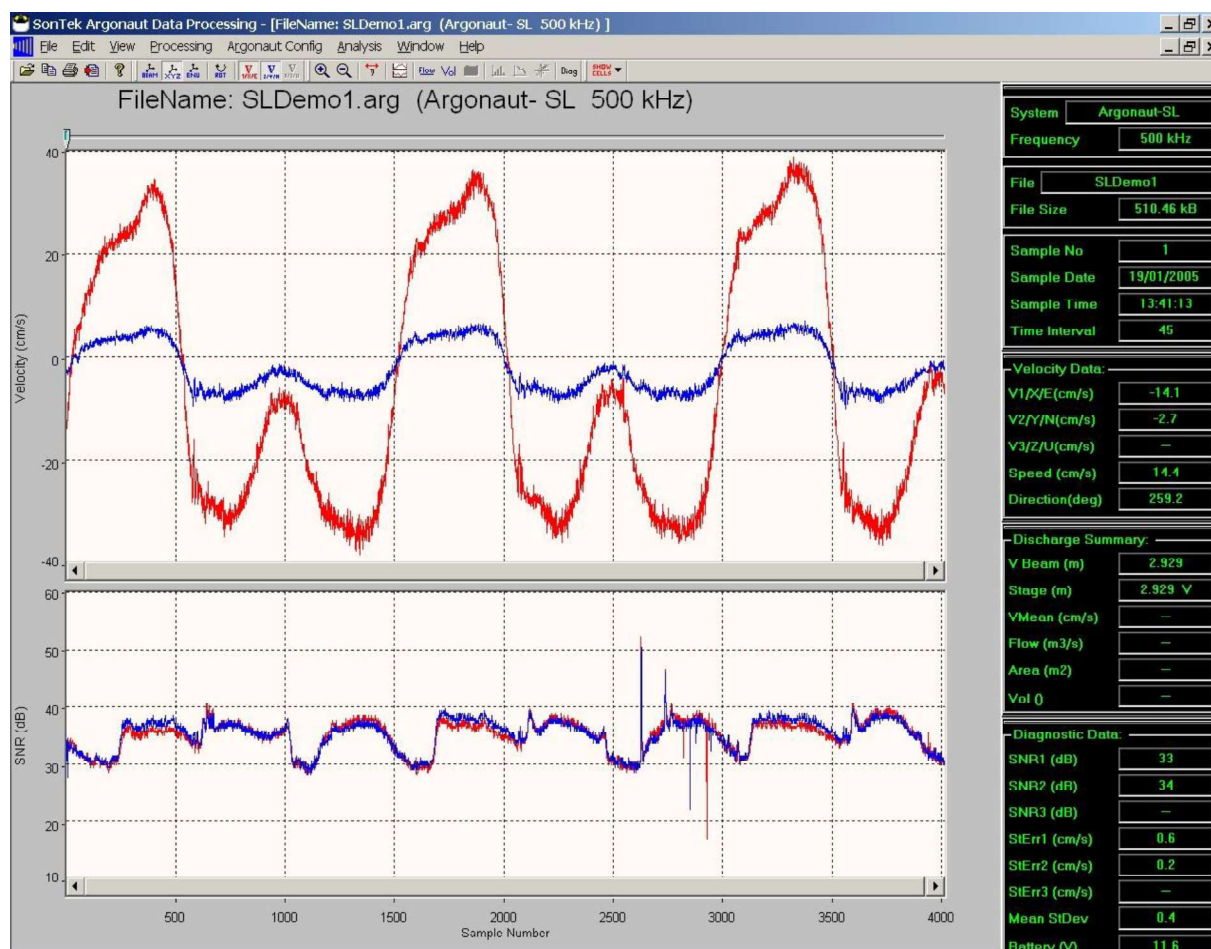


Figure 6-3. Sample Data File 1 (SLDemo1.arg) – Velocity and SNR

- The SL was not oriented exactly perpendicular to the flow. As such, the top graph shows a small Y-velocity (blue line) in addition to the predominate X-velocity signal (red line).
 - While worth noting, this is not a cause for concern. What is important is that the SL mounting is stable and repeatable, so that system orientation does not change if the SL is periodically retrieved for inspection or cleaning.
- The SNR data for Beams 1 and 2 (Figure 6-3, red and blue lines, bottom graph) are typically very close together, and show reasonable (5-10 dB) fluctuations over the course of the file.
 - There are several spikes in the SNR data between samples 2500 and 3000 that we will evaluate later.
- At first glance, data quality appears excellent and there are no immediate areas of concern.

Figure 6-4 shows plots of stage, pressure data, and velocity for this file.

- Stage is plotted on the top graph, left axis using a green line.
- Pressure data is plotted on the top graph, right axis using a dashed black line.
- Velocity (Vx in red, Vy in blue) is plotted on the bottom graph.
- Stage shows a very typical tidal response, correlating with the tidal fluctuations seen in velocity.
- Stage and pressure show essentially identical variations over the course of the file.
 - The offset between stage and pressure data is not unusual and typically indicates some change in atmospheric pressure since the pressure sensor offset was last changed.

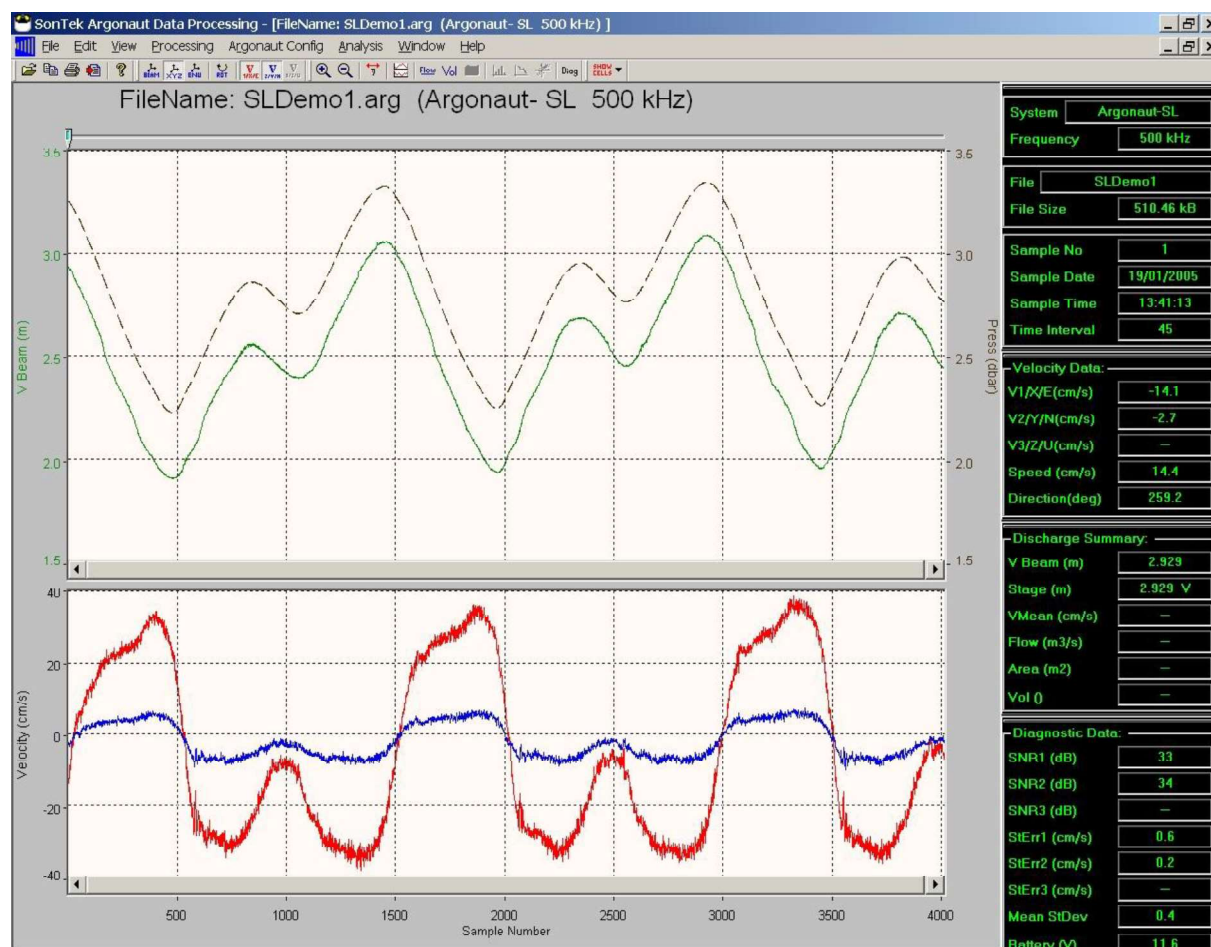


Figure 6-4. Sample Data File 1(SLDemo1.arg) – Stage, Pressure, and Velocity

Figure 6-5 shows plots of signal strength (top graph) and noise level (bottom graph) for a subset of the total data file (samples 2500 to 3000).

- Signal strength for both beams shows notable spikes near sample numbers 2625 and 2740.
 - The spikes correspond to upward spikes seen in the SNR data (**Figure 6-3**).
 - These may be caused by debris floating down the river through the acoustic beams.
 - No anomalies or unusual behavior in velocity is seen at these samples in **Figure 6-3**, indicating that whatever caused the change in signal strength did not significantly affect the velocity measurement.
 - Large spikes of this nature are not unusual, as many rivers can carry significant amounts of debris. As long as debris is not blocking a beam, and there is no effect on the velocity data, these spikes in signal strength are not a concern.
- There are several spikes in noise level (some in Beam 1, some in Beam 2) between samples 2700 and 2950 in **Figure 6-5**.
 - These upward spikes in noise level correspond to downward spikes in SNR (**Figure 6-3**) seen at the same samples. Recall that SNR is calculated as signal strength minus noise level; as such, an increase in noise level causes a decrease in SNR.
 - Even with the increased spikes in noise level, SNR values at these samples remain very strong (always greater than 15 dB).
 - No changes or anomalies in velocity data are seen at these samples.
 - While noise changes like this are somewhat unusual, in this case they have no significant effect on system operation and are no cause for concern.

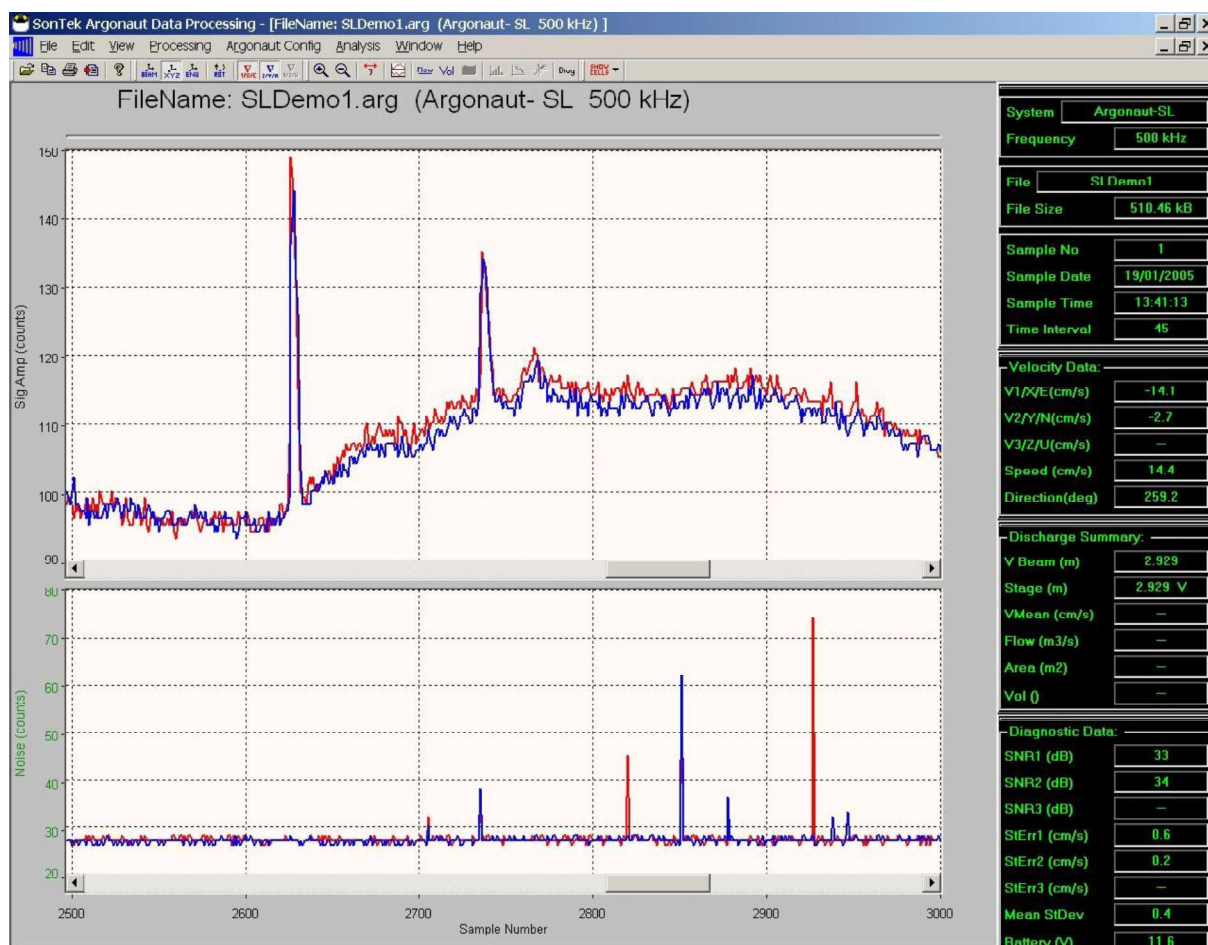


Figure 6-5. Sample Data File 1 (SLDemo1.arg) – Signal Strength and Noise

Figure 6-6 shows the plot of multi-cell X-velocity (top graph) and SNR (bottom graph).

- The system was set for a total measurement range (Cell Begin to Cell End) of 5 to 50 m. This range was divided into 5-m cells for the multi-cell velocity profile.
- The X-velocity from Cell 1 (red line), Cell 3 (dark blue), Cell 5 (light blue), and Cell 9 (gold) are plotted on the top graph.
 - Increasing cell numbers indicate further distances from the system (Cell 1 covers from 5-10 m; Cell 3 from 15-20 m; Cell 5 from 25-30 m, and Cell 9 from 45-50 m).
- A positive V_x indicates flow downstream (ebb tide plus the natural river flow), while a negative V_x indicates flow upstream (flood tide).
 - During ebb tide (+ V_x), there is little variation in flow between different cells, indicating a uniform velocity distribution across the channel width.
 - During flood tide (- V_x), we see significant variation in velocity between cells. Cells nearest to the SL are moving slower, while those further away are moving faster.
- At this site, there is a bend in the river just downstream of the system.
 - During ebb tide (+ V_x), water is coming from upstream through a long straight section and is uniformly distributed across the channel.
 - During flood tide (- V_x), water is coming from downstream through the river bend. The river bend has the effect of forcing a greater portion of the flow to one side of the river.
- This is a good example of the type of data that can be obtained with the multi-cell velocity-profiling feature, providing flow structure details that could not otherwise be known.

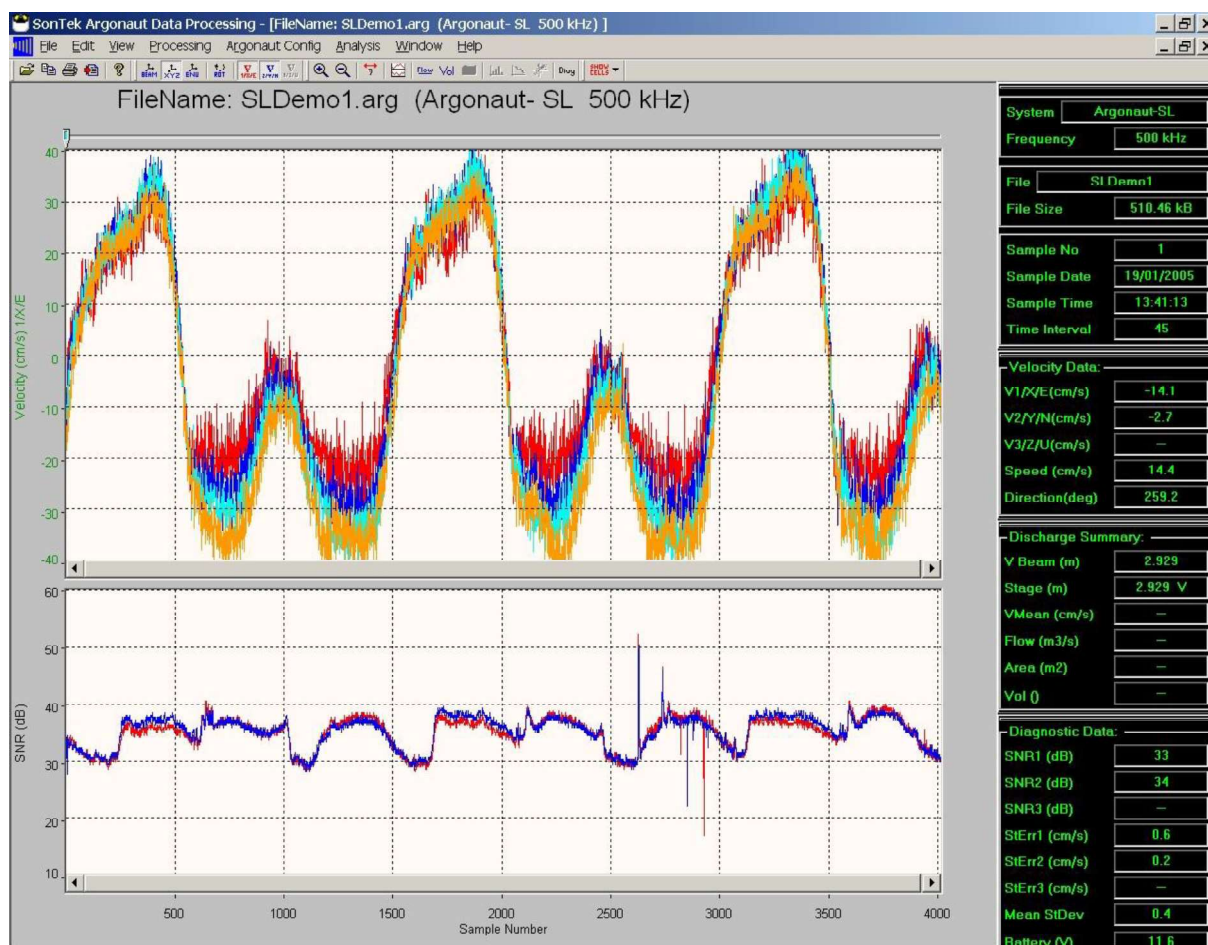


Figure 6-6. Sample Data File 1 (SLDemo1.arg) – Multi-cell X-velocity and SNR

6.5.2. Sample Data File 2 (SLDemo2.arg) – Large Changes in Stage Data

The SLDemo2.arg data file represents five days of data collected with a 1500-kHz SL with a measurement range of about 5 m in a small river. Flow in this river is fairly low except during rain events. Figure 6-7 shows graphs of velocity (top) and SNR (bottom) over the 5-day period.

- Velocity shows several small increases to around 20 cm/s, and one large event starting at about Sample 400. During this event, velocity peaks at over 60 cm/s.
- The SL is not mounted exactly perpendicular to the flow. As such, the SL sees a small Y velocity (blue line, top graph) in addition to the predominately X velocity (red line, top graph).
 - While worth noting, this is not a cause for concern. What is important is that the SL mounting is stable and repeatable, so that system orientation does not change if the SL is periodically retrieved for inspection or cleaning.
- SNR values for Beams 1 and 2 are very consistent up through about sample 450, but start to show significant variations between beams after this point.
 - During the remainder of the file, the SNR for each beam varies considerably.
 - At times, the difference in SNR between beams is more than 15 dB, far more than would normally be expected.
 - Although not shown here, signal strength shows the same variations as SNR (there is no change in noise level). This confirms that water conditions cause variations in SNR.
 - Variations of this magnitude between beams are a concern and are discussed later.

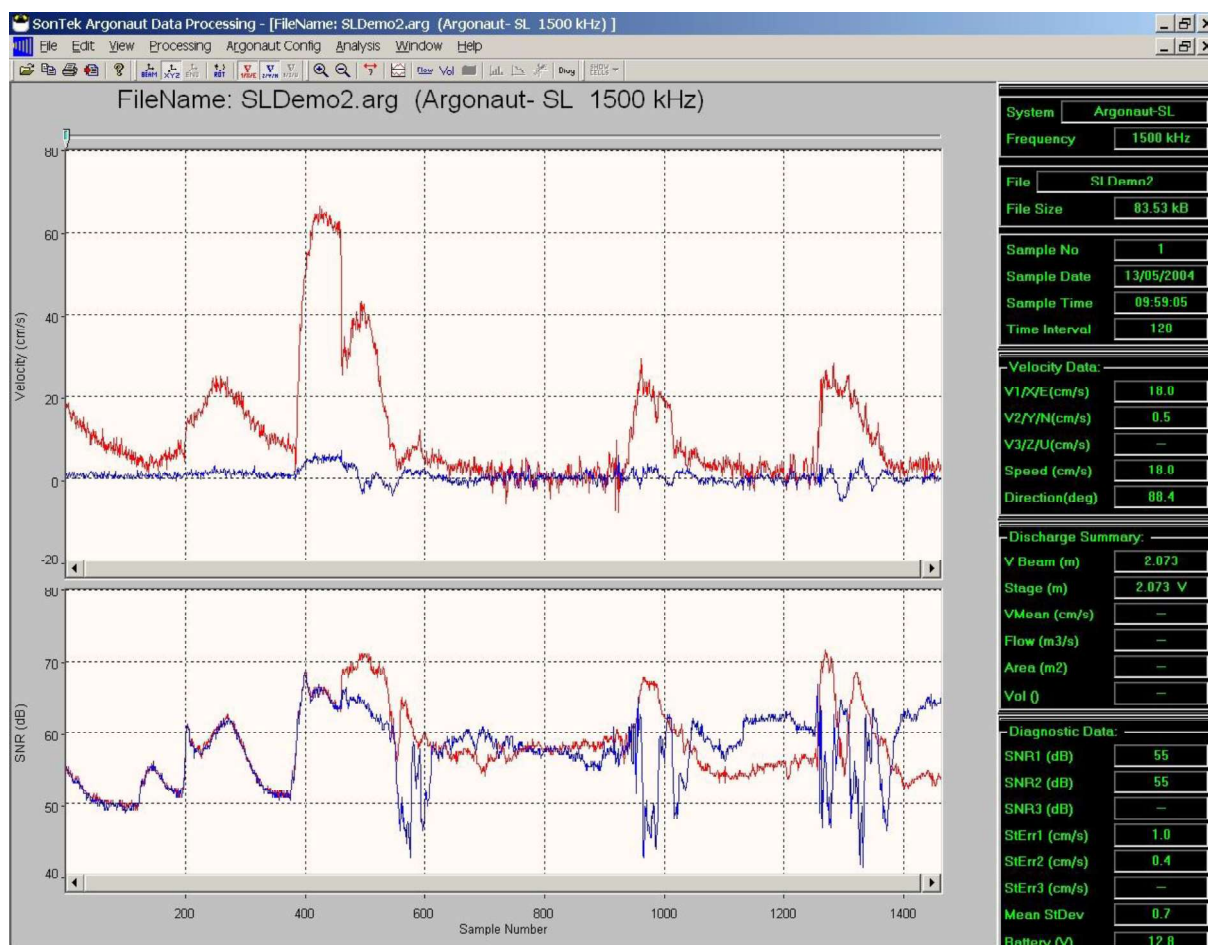


Figure 6-7. Sample Data File 2(SLDemo2.arg) – Velocity and SNR

Figure 6-8 shows plots of stage, pressure, and velocity.

- Stage is plotted on the top graph, left axis using a green line.
- Pressure data is plotted on the top graph, right axis using a dashed black line.
- Velocity (V_x in red, V_y in blue) is plotted on the bottom graph.
- Increases in stage correspond to increased velocity during rain events.
- Stage data shows large step changes around sample numbers 100-200 and 500-550.
 - These changes seem too large and rapid to reflect valid changes in the stage.
- Pressure data shows the same general pattern as stage data.
 - The large step changes in stage data are not seen in pressure data.
 - The difference between stage and pressure data changes during each rain event. This is likely caused by a significant change in atmospheric pressure associated with the rainstorm.
- As with the changes in SNR seen earlier in **Figure 6-7**, the jumps in stage are a cause for concern. This will be addressed next.

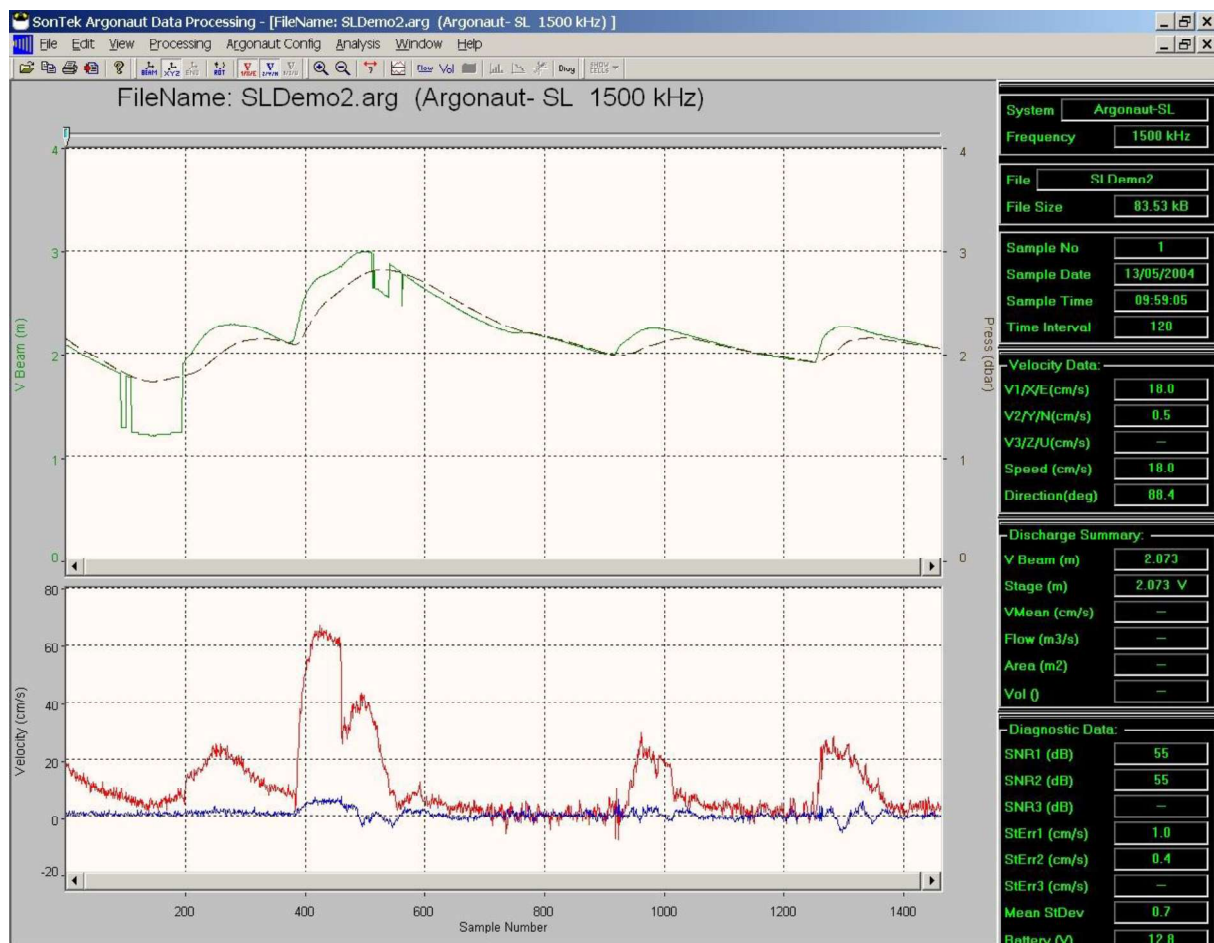


Figure 6-8. Sample Data File 2(SLDemo2.arg) – Stage, Pressure, and Velocity

To gain insight into the variations in SNR and jumps in stage, we look at the internal diagnostic data from this file. **Figure 6-9** plots the diagnostic data from one sample (501).

- The SL in this data file uses a total range of 5 meters; as such, we are only interested in the signal strength profile in the first 5 meters.
 - The light blue, dashed vertical lines in **Figure 6-9** show Cell Begin and Cell End.
 - **Figure 6-9** has been zoomed-in to show a range of 0 to 6 meters.
- The first few diagnostic profiles (up through Sample 500, not shown here) show normal signal strength profiles.
- Starting with Sample 501, the signal strength profiles show significant anomalies.
 - The bumps in the signal profile between 2 and 4 meters are far outside the expected signal strength profile (the gray line is the theoretical decay curve).
 - Looking at diagnostic data from the remaining samples in this file, we see large variations in the signal strength profile in all samples after 501.
 - These large variations indicate that both beams are seeing debris.
- Though the velocity data from these periods still appears reasonable, given the large variations in the signal strength profile, it is likely that this interference will have had some impact on measured velocity.
 - Velocity data will likely still provide a reasonable representation of the true conditions, but will not meet the SL's most stringent velocity specification.
 - There is no realistic way to estimate the effect of this debris on velocity data.
- Given the amount of debris in the velocity beams, some debris could be accumulating above the system and affecting the vertical beam measurements as seen earlier in **Figure 6-8**.
 - A site inspection was able to confirm that branches were periodically getting attached to the instrument platform and remaining directly above the system.
 - These branches caused the large step changes seen earlier in stage data (**Figure 6-8**).

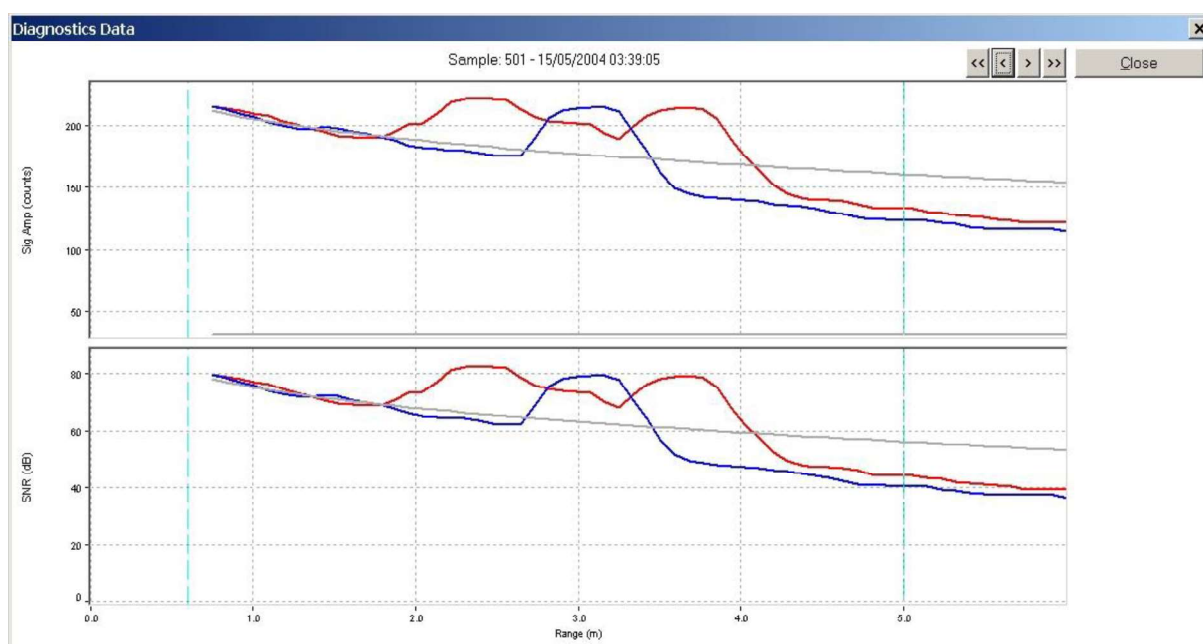


Figure 6-9. Sample Data File 2(SLDemo2.arg) – Signal Amplitude and SNR Diagnostic Data

6.5.3. Sample Data File 3 (SLDemo3.arg) – Velocity Values Reading Low

The SLDemo3.arg data file represents 22 days of data collected with a 1500-kHz SL with a measurement range of about 4 meters in a small, rectangular, concrete lined canal. Flow in this canal is driven by pumping from a nearby water treatment plant, and follows a daily cycle. The user was concerned, as measured velocity and flow values were lower than expected. **Figure 6-10** shows plots of velocity (top graph) and SNR (bottom graph) over the 22-day deployment.

- Velocity shows daily fluctuations driven by the water treatment plant.
- Typical velocity values are less than 20 cm/s, except for a few short periods of higher flow.
- There is a notable Y-velocity (top graph, blue line) considering the relatively low magnitude of the X-velocity (top graph, red line).
 - The SL is installed on the side of a concrete channel, looking directly across the channel. The Y-velocity indicates a notable cross-channel flow.
 - The SL is slightly downstream from a river bend, which causes this cross channel flow.
 - While not an ideal installation site, the cross-channel flow in this case is not a major problem but is something to be aware of.
- As for SNR (bottom graph), Beam 1 (red) shows fairly consistent values with a large change near Sample 1100. Beam 2 (blue) fluctuates somewhat (up to 5 dB) relative to Beam 1.
 - Normally, we expect the two beams to show consistent behavior.
 - While the 5 dB fluctuations between beams is not a huge variation, it is enough to warrant some concern. This is discussed next.

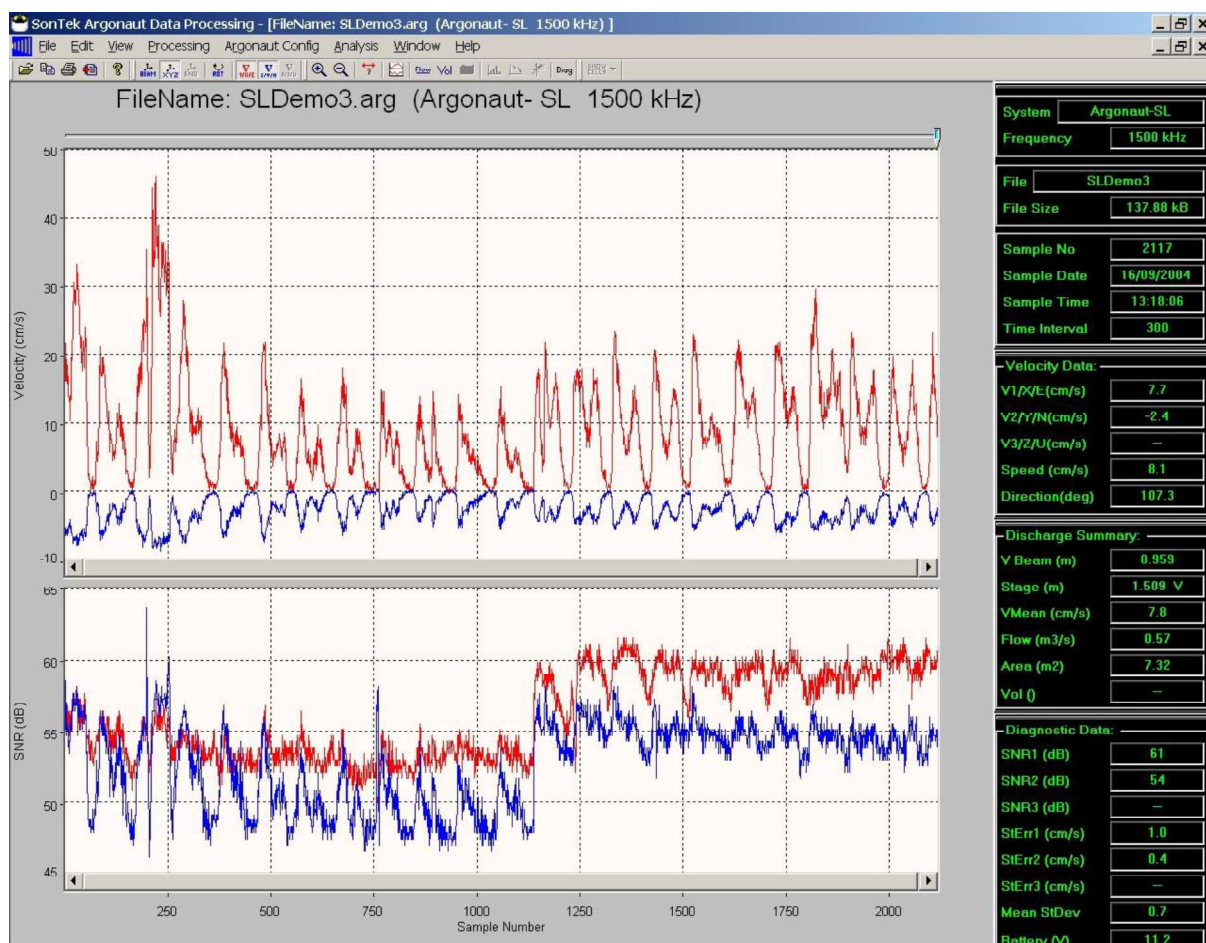


Figure 6-10. Sample Data File 3(SLDemo3.arg) – Velocity and SNR

Figure 6-11 shows plots of stage, pressure, and velocity.

- Stage is plotted on the top graph, left axis using a green line.
- Pressure data is plotted on the top graph, right axis using a dashed black line.
- Velocity (Vx in red, Vy in blue) is plotted on the bottom graph.
- Stage data shows daily fluctuations that correspond to variations in pumping from the nearby water treatment facility.
 - Pressure data shows the same fluctuations as velocity, with small variations driven by changes in atmospheric pressure.
 - There is one large downward decrease in stage near Sample 750. This is seen both in stage and pressure data, indicating that this is a valid change in the stage.

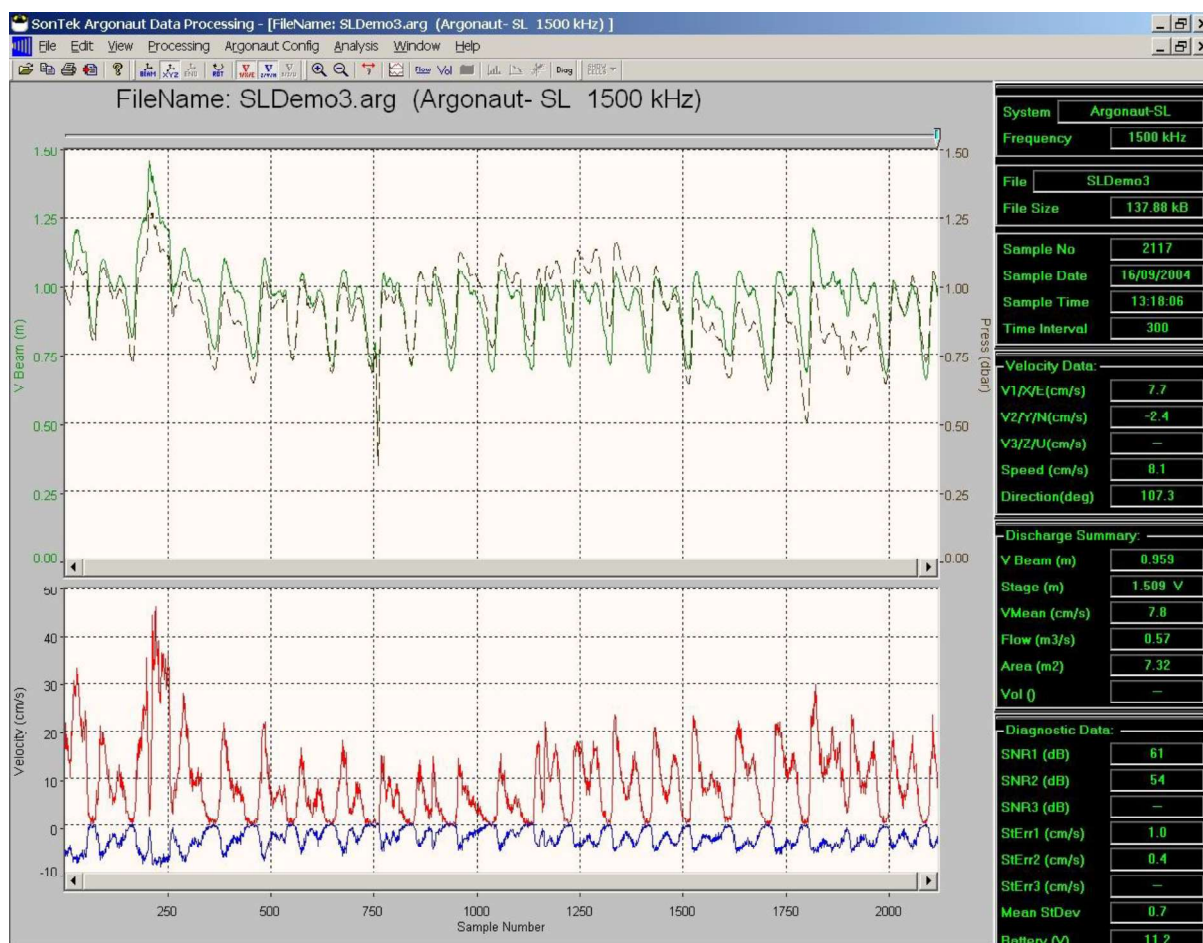


Figure 6-11. Sample Data File 3(SLDemo3.arg) – Stage, Pressure, and Velocity

Figure 6-12 shows the internal diagnostic data for one sample (1201).

- The SL data from this file has a total range of 4 meters; as such, we are only interested in the signal strength profile in the first 4 meters.
 - The light blue, dashed vertical lines in **Figure 6-12** show Cell Begin and Cell End.
 - **Figure 6-12** has been zoomed in to show a range of 0 to 6 meters.
- Most diagnostic profiles show normal signal strength profiles, with some minor variation from the standard decay curve.
 - **Figure 6-12** shows an example of this variation. In particular, notice the small bumps (or waves) in signal strength over the range of 1 to 3 meters.
 - The fluctuations in signal strength for Beams 1 and 2 indicate these beams are seeing something within the water column.
- Investigation of this site shows that during the summer (when this file was collected), the site experiences significant weed growth.
 - The weed growth is sufficient that some weeds are influencing the beams.
 - This explains the changes in SNR shown earlier in **Figure 6-10**, and the fluctuations in the signal strength profile seen in **Figure 6-12**.
- The weed growth could very easily affect measured velocity data, and would most likely cause the velocity data to read too low (as observed by the user).
- At this site, the solution was to increase site maintenance (weed removal) during the summer to prevent this interference.

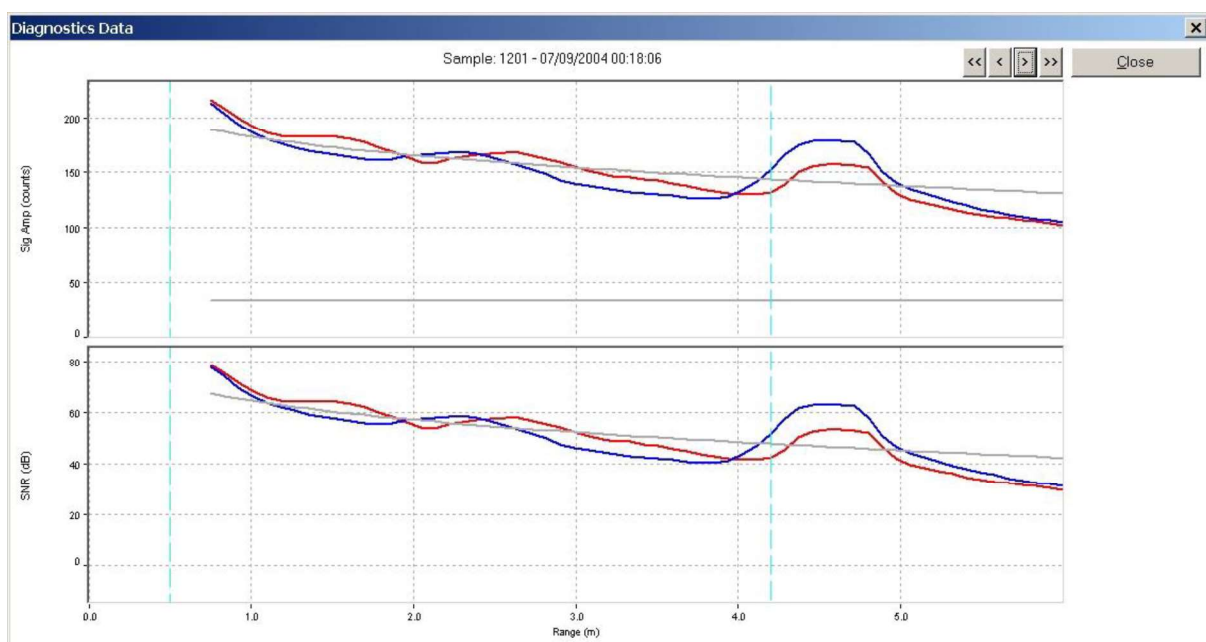


Figure 6-12. Sample Data File 3(SLDemo3.arg) – Signal Amplitude and SNR Diagnostic Data

Section 7. Argonaut-SL Hardware

The following Argonaut-SL hardware-related items are described in this section:

- Cables and Connectors
 - Power/Communications Cable
 - Serial Communication Protocol
 - Splitter Cable and Dummy Plug (for Argonaut-SL with Batteries)
 - Communication Baud Rate Setting
- Power Supply
- Internal Electronics and Wiring Overview
 - Analog Board
 - CPU Board
 - Receiver Board
- Temperature Sensor
- Pressure Sensor
- Compass/Tilt Sensor
 - Testing Compass Operation
 - Compass Configuration
 - Compass Calibration
 - Communicating with the Compass
- Real-time Clock Backup Battery
- Accessing Electronics
- Upgrading the CPU EPROM
- Battery Pack Replacement

7.1. Cables and Connectors

7.1.1. *Power/Communications Cable*

There are several different versions of the power and communication cable for the Argonaut-SL, depending on the system configuration. In all cases, the cable mates with the instrument using a wet-mateable underwater connector. These connectors provide reliable operation in the most challenging environments.

- These connectors are designed to be able to be safely mated when wet.
- Both connectors (bulkhead and cable) should be free of dirt and debris before mating.
- It is possible to mate these connectors underwater, though we do not recommend except when absolutely necessary.
- These connectors are manufactured by Impulse Enterprises:

Impulse Enterprises, 8254 Ronson Rd, San Diego, CA 92111

Phone: +1-800-565-7050 Fax: +1-858-565-1649 Internet: www.impulse-ent.com

Each SL cable configuration is described in detail in the remaining portion of this section. Note that there may be slight differences between the newer low-profile housings (SL500, SL1500, SL3000) and the original canister housings (1500 and 3000-kHz systems).

SL500 / SL1500 / SL3000 Cable Configuration

For SL500/1500/3000 underwater connectors:

- The bulkhead connector (on the SL housing) is part number MCBH-8-FS.
- The cable connector part number is MCIL-8-MP (with locking sleeve).

The dry end of the power/communications cable can terminate in 3 ways: RS232/SDI-12 (**Figure 7-1**), RS232/SDI-12/Flow Display, and RS422.

For cables that support RS232 and SDI-12:

- A DB9 connector for RS-232 serial communication. This connector is configured to match the standard serial ports on a PC. **Figure 7-2** shows the wiring of this connector.
- A power plug for external DC input power. This plug matches the AC-to-DC converter (15 VDC) included with the system.
 - Pin 1 (marked with a dot) is positive (7-16 VDC).
 - Pin 2 (unmarked) is ground.
- A 3-conductor connector is used to switch between RS-232 and SDI-12 communications.
 - Closed = RS-232
 - Open = SDI-12 (see **Appendix E**)
- Three bare wires that connect to external power and/or an SDI-12 communication device.
 - Black = Common ground (for both input power and communications)
 - Red = Positive input power (7-15 VDC). Do not exceed 16 VDC! (see §7.2)
 - White = SDI-12 serial communications



Figure 7-1. Argonaut-SL Power/Communication Cable

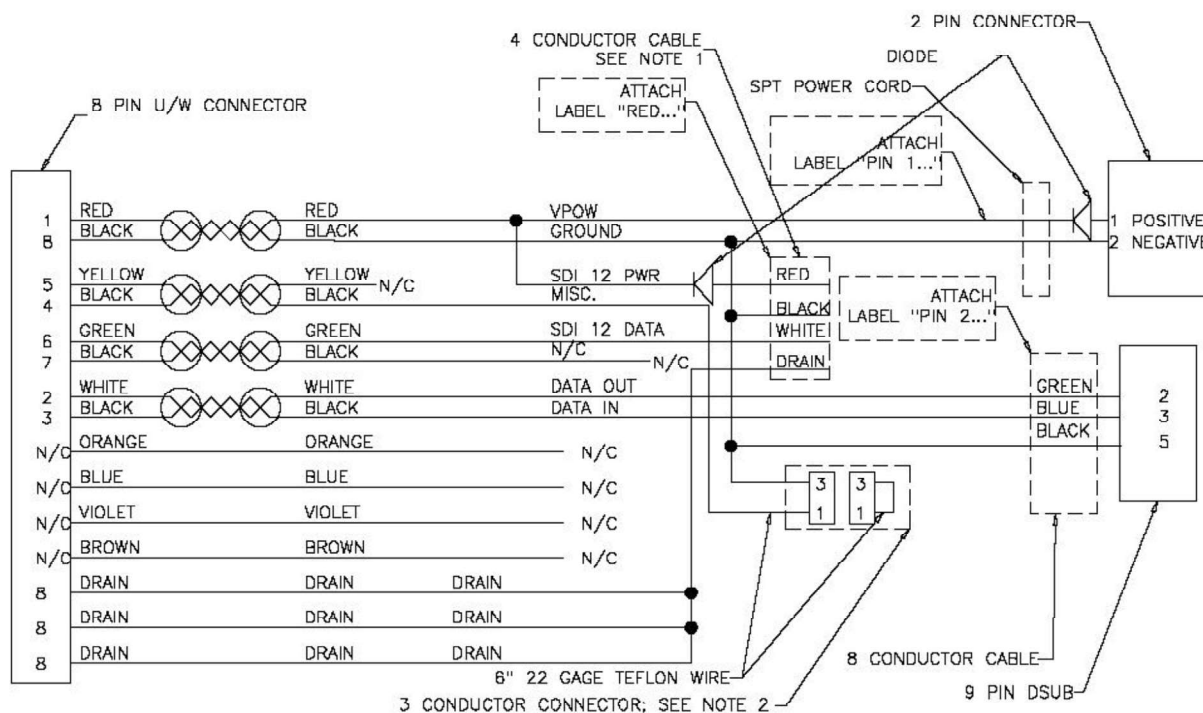


Figure 7-2. SL500 / SL1500 / SL3000 Power and Communications Cable wiring diagram (RS-232 / SDI-12)

Figure 7-2 shows the wiring of the SL500 / SL1500 / SL3000 (low-profile systems) power and communication cable for RS232 and SDI-12 (wire colors are for a standard SonTek cable). Data transfer is listed relative to the SL: **DATA OUT** for data being sent by the SL; **DATA IN** for commands being received by the SL.

The power and communication cable may also support the Argonaut Flow Display (**Appendix H**) in addition to RS232 and SDI-12 communication. This cable is the same as the standard RS232 and SDI-12 connector with the addition of a 5-pin connector on the dry end of the cable. This connector is used for the Flow Display; wiring for this cable is shown in **Figure 7-3**.

The third power and communication cable option for the 500-kHz SL supports RS422 serial communication. This cable cannot support SDI-12 communication or the use of the Flow Display. The dry end of this cable has the following two connectors.

- A DB25 connector for RS-422 serial communication. **Figure 7-4** shows the wiring of this connector.
- A power plug for external DC input power. This plug matches the AC-to-DC converter (15 VDC) included with the system.
 - Pin 1 (marked with a dot) is positive (7-16 VDC).
 - Pin 2 (unmarked) is ground.

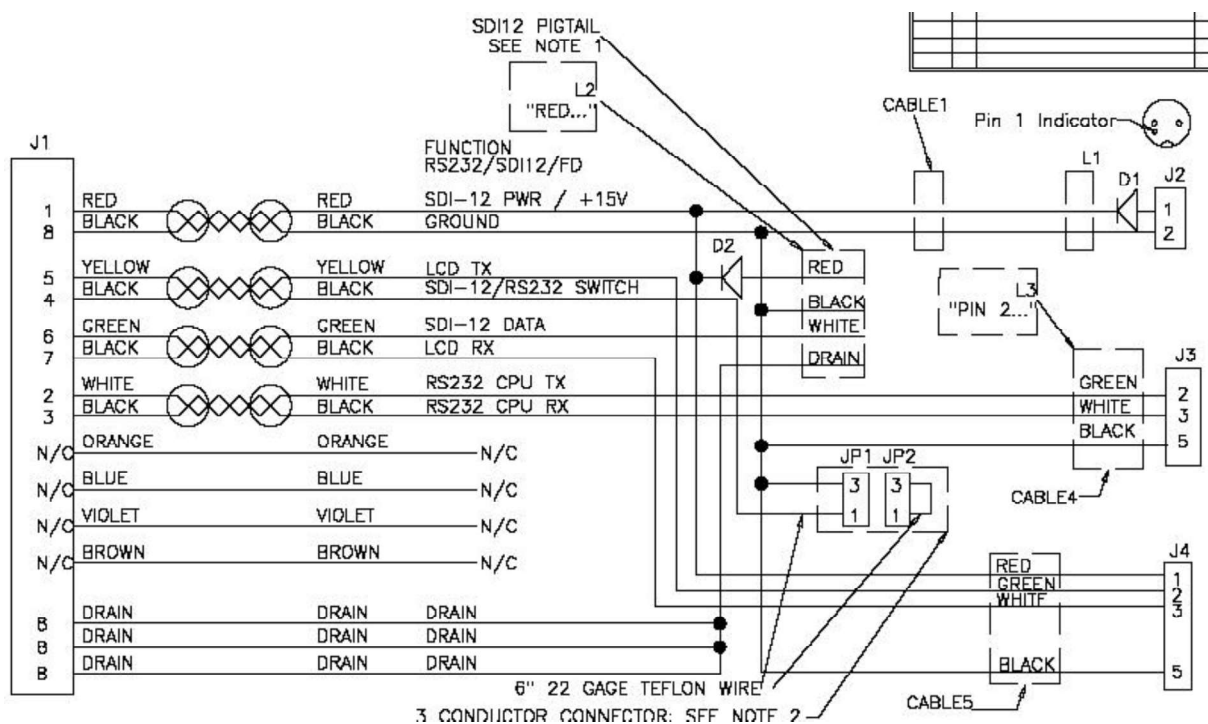


Figure 7-3. SL500/SL1500/SL3000 Power/Communications Cable wiring diagram (RS-232/SDI-12/Flow Display)

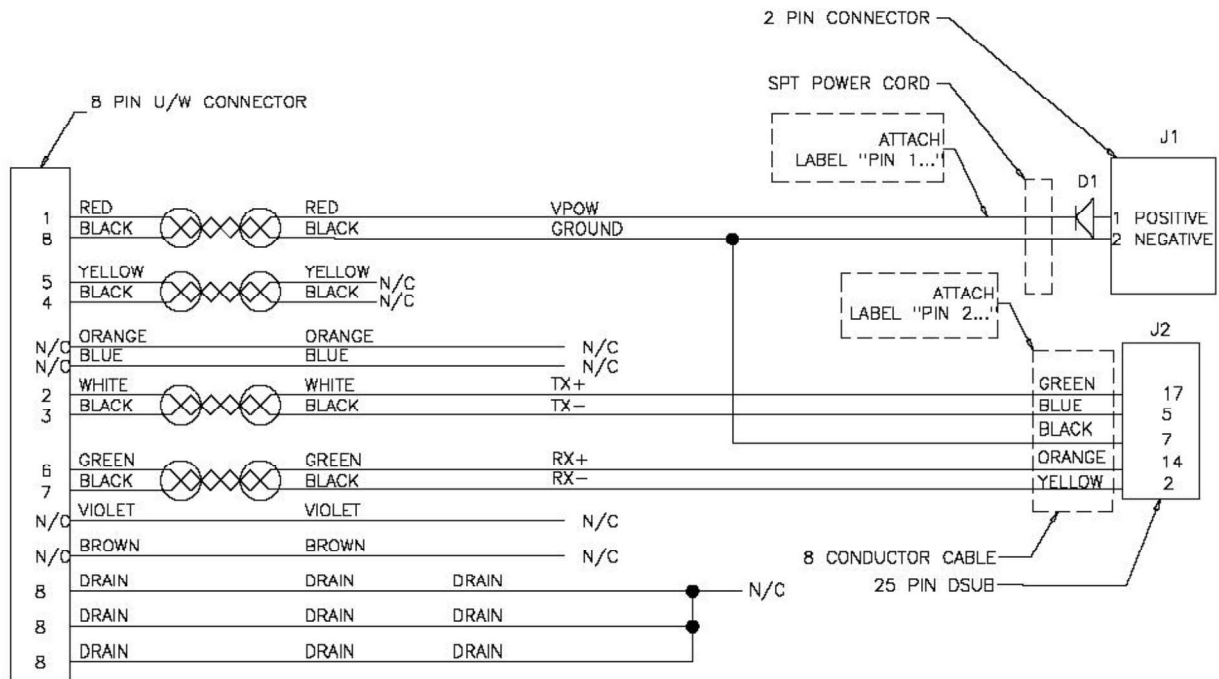


Figure 7-4. SL500 / SL1500 / SL3000 Power and Communications Cable wiring diagram (RS-422)

1500 and 3000-kHz Original Canister Housing Argonaut-SL Cable Configurations

The 1500 and 3000-kHz original canister housing SLs use the following underwater connector.

- The bulkhead connector (on the SL housing) part number is BH-8-FS
- The cable connector part number is IL-8-MP (with locking sleeve).

The dry end of the power/communications cable can terminate in three ways: RS232/SDI-12 for systems that do not support the Flow Display ([Figure 7-1](#)), RS232/SDI-12 for systems that support the Flow Display, and RS422.

- [Figure 7-5](#) shows the wiring of the 1500 and 3000-kHz SL power and communications cable for RS232 and SDI-12 systems that do not support the Flow Display (wire colors are for a standard SonTek cable). These systems were built before April 2005.
- [Figure 7-6](#) shows the wiring of the 1500 and 3000-kHz SL power and communications cable for systems that support the Argonaut Flow Display ([Appendix H](#)) in addition to RS232 and SDI-12. These systems were built after April 2005.
- [Figure 7-7](#) shows the wiring of the 1500 and 3000-kHz SL power and communication cables for systems using the RS-422 communications protocol.

Data transfer is listed relative to the SL: **DATA OUT** for data being sent by the SL; **DATA IN** for commands being received by the SL.

Notice 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. Pin 1 can accept input voltages from 12-24 VDC; the additional internal regulator supplies no more than 12 VDC to the Argonaut processor. System power consumption using the external power pin is notably higher than when using the battery power pin (Pin 5).

The second input power pin (Pin 5) is for battery power input. The voltage from Pin 5 goes directly to the Argonaut processor and must be in the range of 7-15 VDC. Higher voltage will damage Argonaut electronics. Pin 5 is used for autonomous deployments from battery power. This method reduces power consumption because the voltage regulator is bypassed. See [§7.2](#) for details about input power options and power consumption.

Descriptions for each of the cable/connector types follow.

Cable/connector description for 1500 and 3000-kHz original canister housing Argonaut-SL systems using RS232/SDI-12 (without Flow Display). Refer to [Figure 7-5](#).

- A DB9 connector is used for RS-232 serial communication. This connector is configured to match the standard serial ports on a PC.
- A coaxial power plug is used for external DC input power. This plug matches the AC-to-DC converter (24 VDC) included with the system.
 - The center conductor is positive (24 VDC).
 - The outer shield is ground.
 - Note that this power supply goes through an additional linear voltage regulator before reaching the Argonaut electronics, allowing the use of the higher 24 V supply.
 - Because of the additional regulator, powering the Argonaut through this connector is less efficient and should only be done using the supplied AC-to-DC converter when AC power is available.
 - When powering the Argonaut from a battery supply, use the bare wire power connectors mentioned below.
- A 3-conductor connector is used to switch between RS-232 and SDI-12 communications.
 - Closed = RS-232
 - Open = SDI-12 (see [Appendix E](#))
- Three bare wires connect to external power and/or an SDI-12 communication device.
 - Black = Common ground (for both input power and communications)
 - Red = Positive input power (7-15 VDC). Do not exceed 16 VDC! (see [§7.2](#))
 - White = SDI-12 serial communications

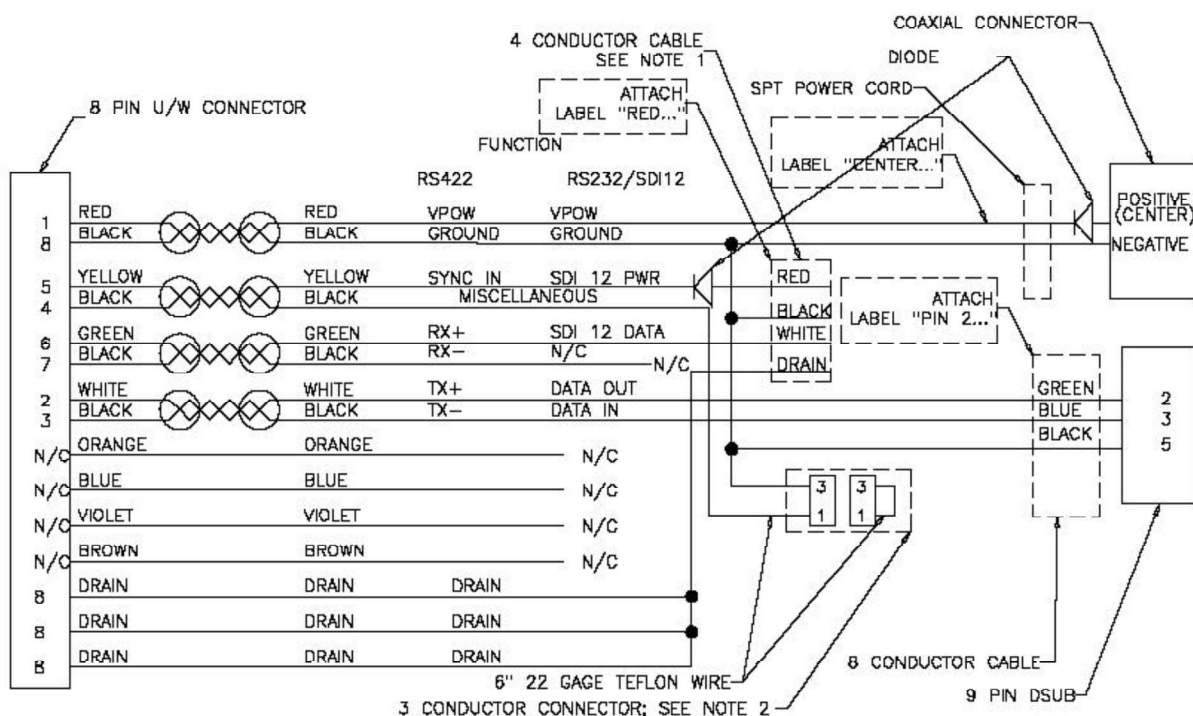


Figure 7-5. 1500 & 3000-kHz Original Canister Housing Power/Comms Cable wiring diagram (RS-232/SDI-12)

Cable/connector description for 1500 and 3000-kHz original canister housing SL systems using RS232 / SDI-12 / Flow Display. Refer to [Figure 7-6](#).

- A DB9 connector for RS-232 serial communication. This connector is configured to match the standard serial ports on a PC.
- A power plug for external DC input power. This plug matches the AC-to-DC converter included with the system (which provides 15 VDC).
 - Pin 1 (marked with a dot) is positive (7-16 VDC).
 - Pin 2 (unmarked) is ground.
- A 3-conductor connector is used to switch between RS-232 and SDI-12 communications.
 - Closed = RS-232
 - Open = SDI-12 (see [Appendix E](#))
- A 5-conductor connector matches the connector on the Flow Display.
- Three bare wires that connect to external power and/or an SDI-12 communication device.
 - Black = Common ground (for both input power and communications)
 - Red = Positive input power (7-15 VDC). Do not exceed 16 VDC! (see [§7.2](#))
 - White = SDI-12 serial communications

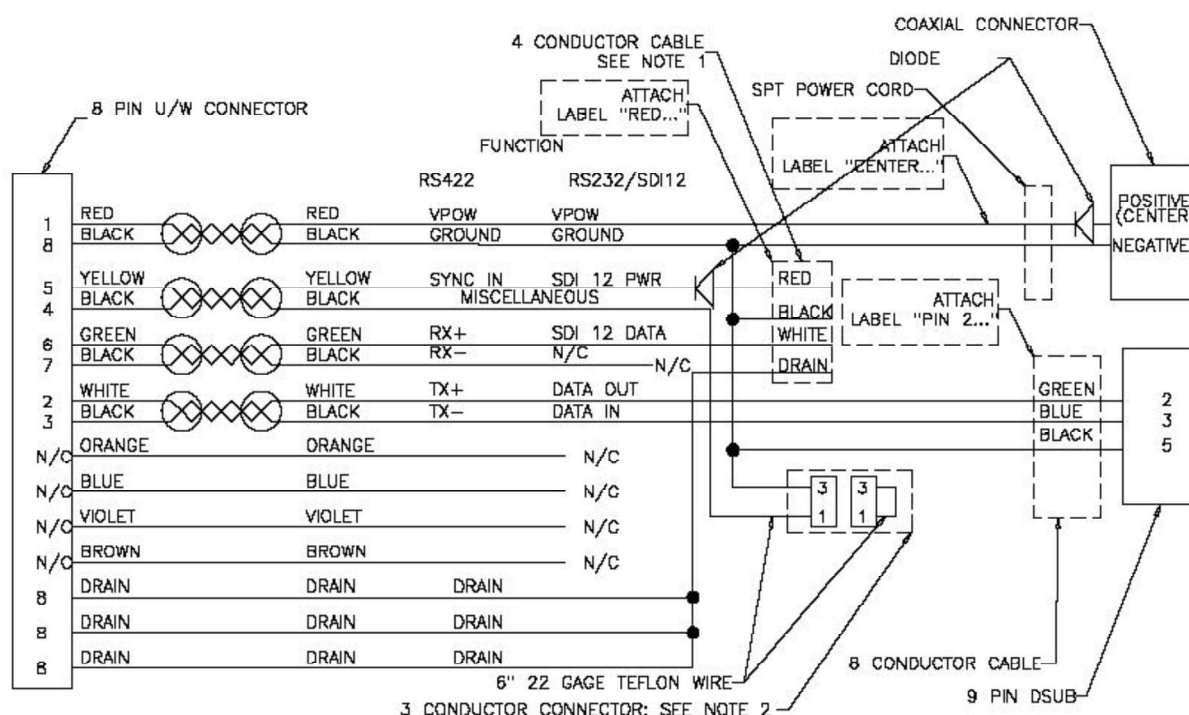


Figure 7-6. 1500 & 3000-kHz Original Canister Housing SL Power and Communications Cable wiring diagram (RS-232/SDI-12/Flow Display)

Cable/connector description for 1500 and 3000-kHz original canister housing SL systems that support RS-422 communications cannot support SDI-12 or Flow Display. The dry end of this cable has two connectors. Refer to [Figure 7-7](#).

- A DB25 connector for RS-422 serial communication. [Figure 7-4](#) shows the wiring of this connector.
- A power plug for external DC input power. This plug matches the AC-to-DC converter included with the system (which provides 15 VDC).
 - Pin 1 (marked with a dot) is positive (7-16 VDC).
 - Pin 2 (unmarked) is ground.

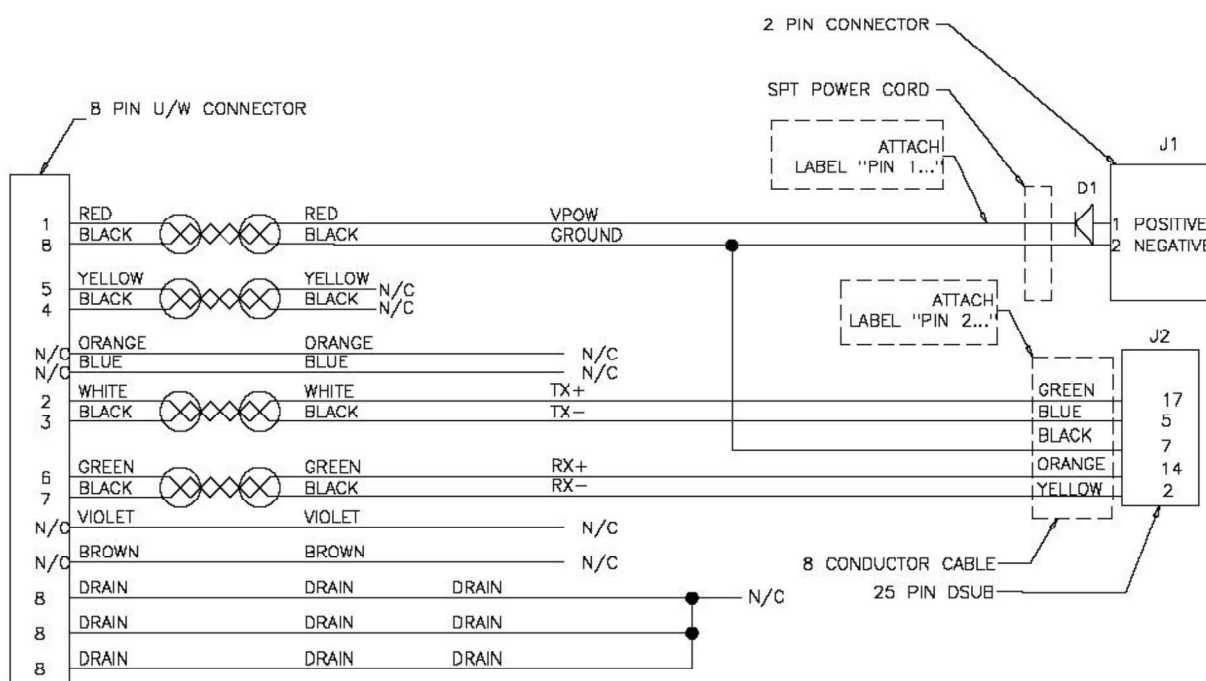


Figure 7-7. 1500 & 3000-kHz Original Canister Housing SL Power/Comms Cable wiring diagram (RS-422)

7.1.2. Serial Communication Protocol

The Argonaut-SL can communicate using the following communication protocols.

- RS-232 – Single system operation with cable lengths to 100 meters (300 feet)
- SDI-12 – Single system operation with cable lengths to 100 meters (300 feet)
- RS-422 – Single system operation with cable lengths to 1500 meters (5000 feet).

The standard SL configuration supports both RS-232 and SDI-12 protocols. You can switch between the two protocols as described in [Appendix E](#). The SL uses a different command interface depending on which communication type is used.

- RS-232 – Direct-command interface ([Appendix C](#)). RS-232 is always used to program the operating parameters of the SW.
- SDI-12 – Uses a reduced direct-command interface, which is typically used in conjunction with RS-232 for complete programming capabilities. See [Appendix E](#) for details.

To support RS-422, the SL must be specially configured at the factory. When using RS-422, the SL uses the same direct-command interface used with RS-232. When configured for RS-422, the SL cannot support SDI-12 communication.

The default communication settings for RS-232 and RS-422 are as follows.

- 9600 baud (§[7.1.4](#) explains how to change baud rate settings)
- 8 data bits (fixed)
- No parity (fixed)
- 1 stop bit (fixed)

7.1.3. Splitter Cable and Dummy Plug (for Argonaut-SL with Batteries)

1500 and 3000-kHz Argonaut-SL (original canister housing) systems with external batteries use a special splitter cable to connect the battery housing to the Argonaut. This cable has three connectors ([Figure 7-8](#)). 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 communications cable to configure the system and download data; it is terminated with a dummy plug during deployment.

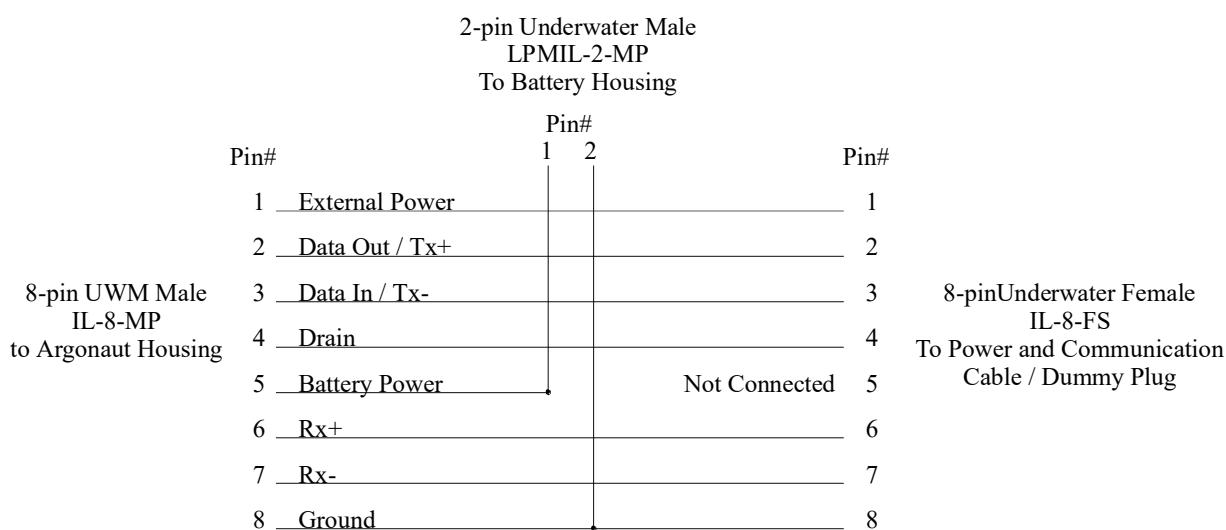


Figure 7-8. Argonaut-SL Splitter Cable for Battery Pack

Figure 7-8 shows the wiring of the splitter cable. The connector part numbers shown are for Impulse underwater connectors (see §7.1.1 for contact information). The part number for the 2-pin bulkhead connector on the battery housing is Impulse LPMBH-2-FS.

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

7.1.4. Communication Baud Rate Setting

The Argonaut communication baud rate, normally 9600 baud, is set at the factory and does not usually need to be changed. However, for some specialized applications, you may wish to set a different baud rate. This is done through special command using the direct command interface ([Appendix C](#)). The command format is shown below.

`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 valid, the system transmits “OK <CR><LF>” followed by the command prompt “>” at the old baud rate setting. All further communications are done using the new baud rate. The setting is used until a new value is set.
- Note that the command [Defaults](#) (§C-7) does not reset the communication baud rate.

All 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.

7.2. Power Supply

The Argonaut-SL electronics operate on 7-15 VDC input power.

- If the input voltage is less than 7 V, the Argonaut will not operate reliably.
- A supply voltage greater than 16 V will seriously damage the Argonaut electronics!
- Power consumption during data collection varies with system configuration and operating parameters (see §5.5.2 for details).
- The SL measures and stores the input voltage value. This information can be accessed via using the [Sensor](#) command (§C-12), or through the output data (§6.3.5 or [Appendix D](#)).
- When running the SL from batteries, keep track of battery capacity to prevent the loss of data caused by insufficient power. The data recorder uses an EEPROM that retains data if the batteries are drained. See §5.5.2 for details about estimating power consumption and battery life.

The Argonaut firmware includes detailed routines to monitor the input voltage level.

- The monitoring routines are enabled or disabled using the [VoltageProtection](#) command (§C-7). SonTek strongly recommends leaving this option enabled (the default setting).
- If the voltage level is below 8.0 V, the Argonaut will output a warning message when data collection is started, but will allow data collection to continue.
- If the voltage level is below 7.5 V, the Argonaut issues a warning message upon receiving the **Start**, **Deploy**, or **SDI12 ON** command, and will not allow data collection to continue.
- If the voltage level falls below 7.0 V during data collection, the Argonaut shuts down automatically to avoid potential harm to the system electronics due to the low power supply.
 - When the system shuts down for low voltage, the Argonaut will then check the battery voltage levels every two hours.

- If battery voltage has shown a significant recovery, with levels greater than 10.0 V, the system will restart data collection.
- This allows the system to resume operation when solar panels have been able to recharge the batteries enough to allow reliable operation.
- When the voltage level is below 7.0 V, the Argonaut will not read or write any data to the EEPROM to avoid potentially corrupting system memory.

1500 and 3000-kHz Argonaut-SL systems (original canister housing) that were built before April 2005 also have a second power input option that can operate from a 12-24 VDC input power.

- Systems that support this additional power input pin use a coaxial power connector (§7.1.1).
- This power supply pin passes through an additional linear voltage regulator before supplying the Argonaut electronics.
 - This pin can accept input voltages from 12-24 VDC.
 - The internal regulator supplies no more than 12 VDC to the Argonaut processor.
 - System power consumption using this pin is notably higher during data collection and in sleep mode than it is when using the direct supply pin.
 - This pin should only be used with the AC-to-DC converter supplied with the system when AC power is available.
 - When deploying the system from battery power, use the direct power supply pin (7-15 VDC) for the most efficient operation.

7.3. Internal Electronics and Wiring Overview

This section provides information about the internal layout of the Argonaut-SL. This is provided for reference only; there should be no need for the SL to be opened by the user unless with specific instructions from SonTek/YSI. The SL's internal electronics, with all major parts labeled, are shown in [Figure 7-9](#), [Figure 7-10](#), and [Figure 7-11](#). See [§7.8](#) for details about opening the SL.

The cables used to connect the different portions of the Argonaut electronics are described below. For details about the location of each connector, refer to [§7.3.1](#) (Analog) and [§7.3.2](#) (CPU).

- 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 (Pin 5) is wired directly to the Analog board.
 - Power from the **External supply** pin (Pin 1) is wired through a voltage regulator (installed in the Argonaut housing) before reaching the connector on the Analog board.
 - See [§7.1](#) for details about wiring of the underwater connector; see [§7.2](#) for details on the Argonaut input power specifications.
- RS-232/RS-422/SDI-12 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 RS-232 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 for the RS-232 interface to the optional CTD.

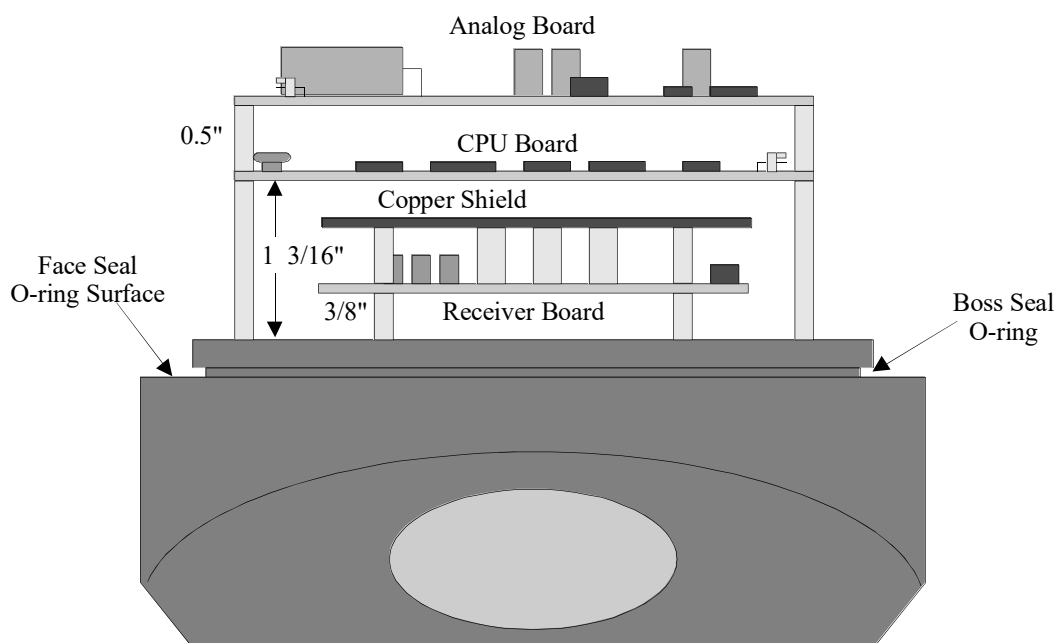


Figure 7-9. Inside the 1500/3000-kHz Argonaut-SL (Drawing)



Figure 7-10. Inside the 500-kHz Argonaut-SL (Photo)

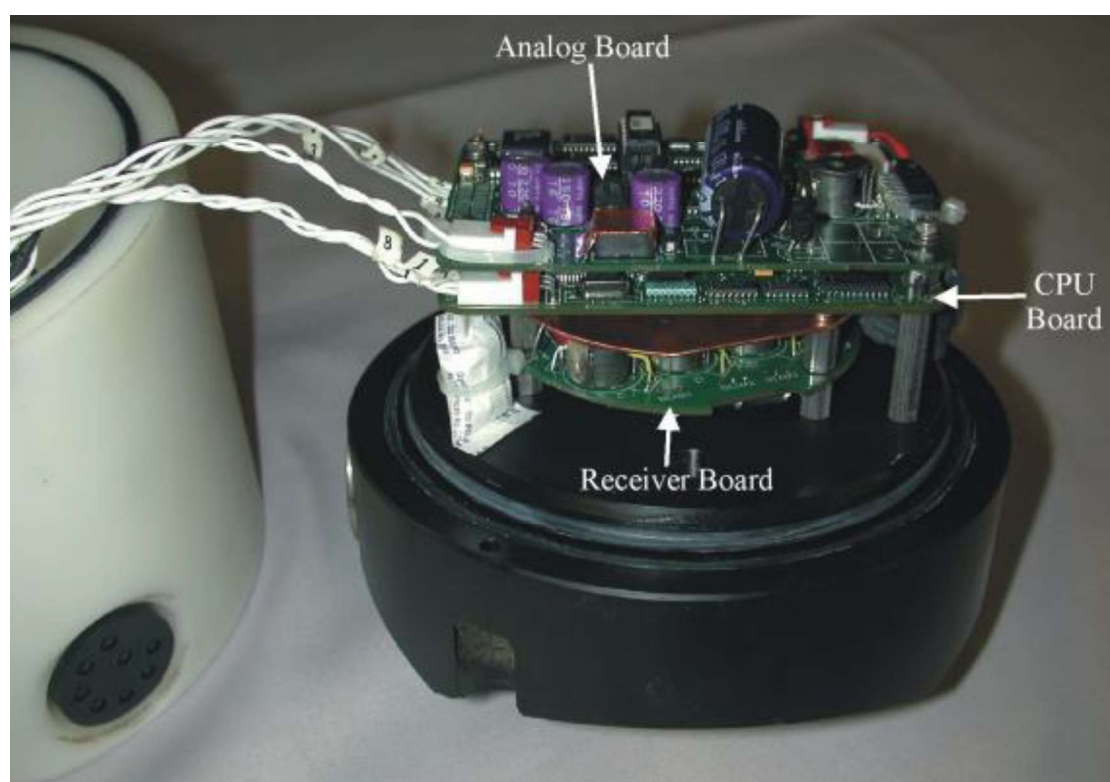


Figure 7-11. Inside the 1500/3000-kHz Argonaut-SL (Photo)

7.3.1. Analog Board

Figure 7-12 shows the layout of the Analog board.

- A 16-pin, keyed connector (left side) connects to a ribbon cable that goes to the Receiver board (Figure 7-14).
- The board name and revision are printed next to the pressure sensor connector.
- The red, 5-pin connector (labeled **Pressure**) connects to the pressure sensor.
- A red, 2-pin, keyed connector (labeled **Temp**) connects to the temperature sensor.
- A red, 3-pin, keyed connector (labeled **Power**) is connected to the input power wiring. See §7.2 for input power specifications.
- A 40-pin edge connector mates the Analog board to the CPU board (Figure 7-13).
- The Analog board includes four (4) holes for mounting, which match the mounting holes on the CPU board and are used with a set of #4-40 screws and standoffs.

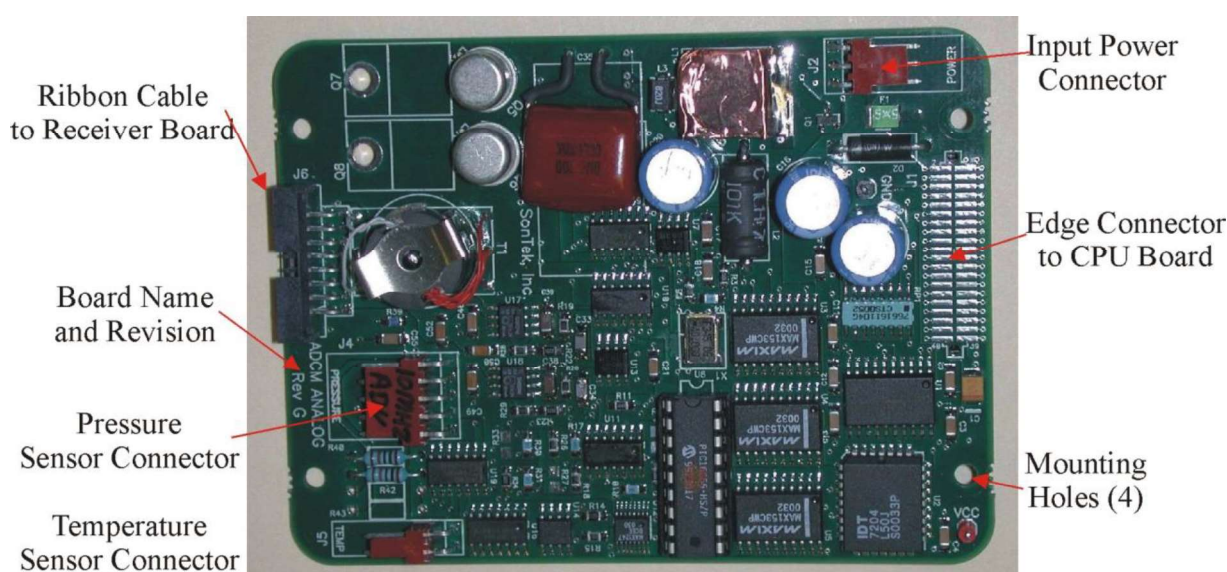


Figure 7-12. Argonaut-SL Analog Board

7.3.2. CPU Board

Figure 7-13 shows the layout of the CPU board.

- The board name and revision are printed in the upper left corner.
- The EPROM containing the firmware to control SL operation is installed in a socket at the center of the board. Downloadable updates may be available periodically (see §7.9).
- The internal clock's backup battery is installed in the lower left corner of the board. This battery is used to supply the real-time clock when main power is not available (§7.5).
- A 40-pin edge connector mates to the Analog board (Figure 7-12).
- A red, 5-pin connector (labeled **User**) connects to the external power/communication connector for external serial communications (RS-232, SDI-12, or RS-422).
- The CPU board includes four (4) holes for mounting, which match the mounting holes on the Analog board and are used with a set of #4-40 screws and standoffs.

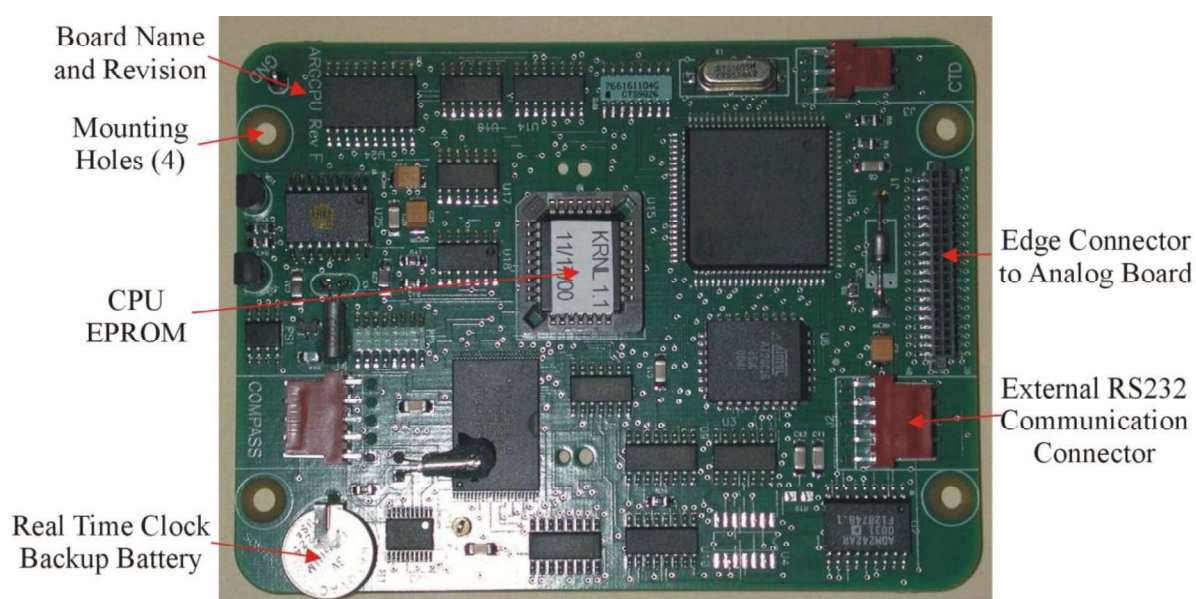


Figure 7-13. Argonaut-SL CPU Board

7.3.3. Receiver Board

Figure 7-14 shows the layout of the Receiver board.

- The board revision is printed near the center of the board.
- A 16-pin, keyed connector (left side) connects to a ribbon cable to the Analog board.
- The Receiver board includes three (3) holes for mounting, which are used with a set of #4-40 screws and standoffs.

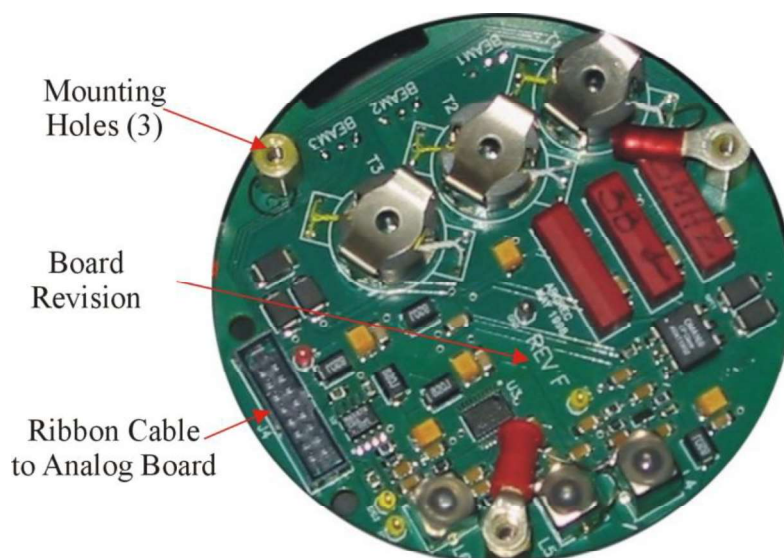


Figure 7-14. Argonaut-SL Receiver Board

7.4. Temperature Sensor

- To measure temperature, the SL uses a thermistor mounted on the inside of the transducer head. The thermistor is coupled to a titanium pin exposed to the water. This minimizes the insulating effects of the plastic housing.
- The temperature sensor has a specified accuracy of $\pm 0.5^{\circ}\text{C}$.
- Temperature data are sampled once per second during the averaging interval, and the mean value is recorded with each sample. Temperature is stored with a resolution of 0.01°C .

7.5. Pressure Sensor

The Argonaut-SL includes a strain gage pressure sensor mounted in a recessed hole on the transducer head. The sensor ([Figure 7-15](#)) is recessed and protected from physical damage using a vented bronze screw with multiple holes to allow pressure equalization. If you suspect problems, [contact SonTek](#) before trying to access the sensor.

In areas with high concentrations of suspended sediment, it is possible for the venting holes in the bronze screw to become blocked.

- If this occurs, the sensor may stop responding to changes in water level or show a dampened response.
- To clear the problem, carefully remove the bronze screw from the SL transducer head.
- Use a paper clip or other small device to clear any blockage in the venting holes. Do NOT place any sharp objects into the pressure sensor cavity or use any mechanical device to clear the pressure sensor cavity.
- Rinse the pressure sensor cavity with fresh water.
- After cleaning, replace the bronze screw and tighten snugly, but do not over-tighten as this can damage the threads on the SL transducer head.

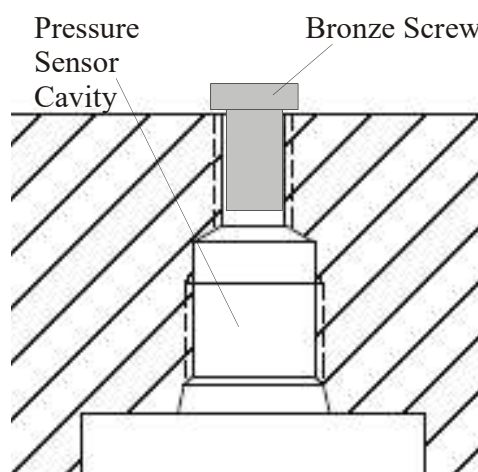


Figure 7-15. Argonaut-SL Pressure Sensor

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 decibars 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 (1st order) calibration constant set a factory (decibar/count)

PressScale_2 = quadratic (2nd order) calibration constant set a factory (decibar /count²)

Counts = measured pressure (counts)

The values for [PressOffset](#), [PressScale](#), and [PressScale_2](#) can be accessed three ways: through the direct command interface (§[C-12](#)), from the data conversion software *.ctl file, 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/count² 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/count²) and must be multiplied by 10^{-12} . See [Appendix D](#) for details on the binary data format.

When using *ViewArgonaut*'s data conversion software to extract Argonaut binary data files into ASCII format, the software does the conversion from counts to decibars automatically.

7.5.1. Changing the Pressure Sensor Offset

The SL pressure sensor measures the combination of the water pressure and atmospheric (barometric) pressure. Because of this, the pressure sensor reading may change due to changes in atmospheric pressure. To minimize the effects of this, you should zero the pressure sensor offset when installing the system at a deployment site. An easy way to zero the pressure sensor offset is using the direct command interface from SonUtils ([ResetPressOffset](#)). Instructions to do this are in §[5.6](#) as part of the diagnostic procedures to be done before each system deployment.

7.6. Compass/Tilt Sensor

Some Argonaut-SL systems may include an internal compass and tilt sensor.

- When installed, the compass and 2-axis tilt sensor provides heading, pitch, and roll data.
- The sensor used is a high performance compass designed and built by SonTek/YSI.
- Compass data is used to monitor system orientation (particularly pitch and roll), and in some applications to translate velocity from the instrument XYZ coordinate system to an Earth coordinate system (East-North-Up or ENU; see §[B-9.2](#)).

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

- 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. See §[7.6.3](#) for compass calibration details.
- Because the compass communicates with the Argonaut through an RS-232 interface, it is possible for you to communicate directly with the compass. The Argonaut handles all communication with the compass automatically, and direct communication with the compass should not normally be necessary. See §[7.6.4](#) for compass communication details.

7.6.1. 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 every deployment (§[7.6.3](#)).

- The SL must be oriented as it will be during deployment, with the vertical beam looking up and the velocity beams looking horizontally.
- This test should be conducted in an area predominantly free of magnetic material.
- Start the display of compass data:
 - Using the direct-command interface within SonUtils, the command **Compass CONT** (§C-13) gives a continuous output of heading, pitch, and roll.
- Heading, pitch, and roll data is defined as follows.
 - Heading data indicates the orientation of the SL's X-axis.
 - Heading of 0° indicates the X-axis points north.
 - Heading of 90° indicates the X-axis points east.
 - Heading of 180° indicates the X-axis points south.
 - Heading of 270° indicates the X-axis points west.
 - Pitch is defined as rotation about the Y-axis.
 - Roll is defined as rotation about the X-axis.
- Point the SL's X-axis (marked on the transducer head) towards each compass direction — North, South, East, West. Compare the compass output with the expected reading.
- Test the pitch and roll sensors by tilting the SL 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 ($\pm 10^\circ$ heading, $\pm 5^\circ$ tilt). Large errors or a lack of response indicates a problem with the compass.

7.6.2. Compass Configuration

The Argonaut compass is configured at the factory; no user modifications are required. 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 7-16 and **Figure 7-17** show the installation of the compass in the 500-kHz and 1500/3000-kHz systems, respectively. This installation orientation is fixed at the factory and should not be changed by the user.

7.6.3. Compass Calibration

The compass must 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 ma-



Figure 7-16. 500-kHz Argonaut-SL Compass Board

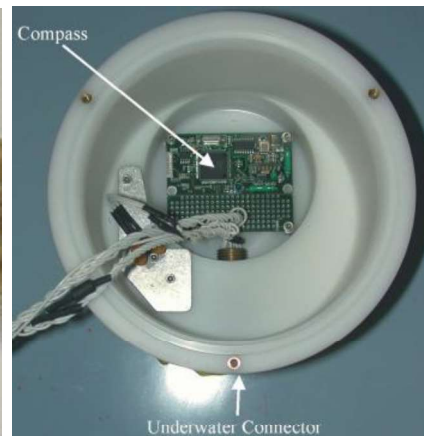


Figure 7-17. 1500/3000 SL Compass

terial or generates a magnetic field, the compass should be calibrated before starting data collection. Additionally, the compass must be recalibrated when moved to a different environment or mounting apparatus.

There are two methods for compass calibration. The first is to use the compass calibration feature within *SonUtils*. Alternatively, you can use the compass commands from the direct command interface (§C-13).

To perform a compass calibration using *SonUtils*:

- Run *SonUtils* and establish communication with the SL by clicking **BREAK**.
- Click the **Compass Calibration** button in *SonUtils*.
- Click the **Start** button on the compass calibration dialog.
- The compass is now in multiple-point calibration mode and is collecting sample points.
- Rotate the compass slowly through 360° 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 varying pitch and roll, you must tilt the system by more than 45°.
- When this has been done, click the **Stop** button to end the calibration.
- The Argonaut will respond with a calibration score, as described below.

To begin a compass calibration using the compass direct commands (§C-13):

- Run *SonUtils* and establish communication with the SL by clicking **BREAK**.
- 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° 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 varying pitch and roll, you must tilt the system by more than 45°.
- When this has been done, press any key to end the calibration.
- The Argonaut will respond with a calibration score similar to the following.

```
H9V9M5.3:
```

This is an indication of the quality of the calibration. The numbers after the **H** and the **V** should be high (0-9 scale), and the number after the **M** should be low (0-100 scale). The **H** value reflects the horizontal calibration quality; **V** reflects the vertical calibration quality; **M** reflects 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, repeat the calibration. If the results do not improve, consider changing the Argonaut's location or modifying the mounting structure.

7.6.4. Communicating with the Compass

The Argonaut does all compass communications automatically; under normal circumstances, you should not need to communicate directly with the compass. However, should the need arise, you can communicate through the Argonaut by establishing communication and bypassing the SL's 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 compass
```

If the compass is operating properly, it should be continuously sending data to the Argonaut, which will be redirected to the screen. The data will be similar to the following:

```
%3BB7E94E03B616FD3B15F74E9FA809733F4B*79
%3C04EA1703A516343B5FF736FFA009813F49*7E
%3C03EA13039B16363B5EF731FFAC09833F49*05
%3C01EA0C039B163C3B5DF73CFFA909783F4A*76
```

The compass will now accept direct commands. Direct communication with the compass should only be done under instruction from SonTek/YSI; required compass commands will be provided. When communication with the compass is no longer desired, typing three plus signs or three equals signs in succession (“+++” or “===”) or sending a **BREAK** will return the Argonaut to command mode.

7.7. Real-time Clock Backup Battery

The Argonaut has a backup battery to power the system clock when main power is unavailable.

- The battery is installed on the processor CPU board (see §7.3.2).
- The battery can be expected to last for many years with no maintenance.
- If the backup battery dies, the system clock will reset when power is disconnected.
- [Contact SonTek](#) before attempting to replace the battery.

7.8. Accessing Electronics

CAUTION: There is rarely a need for users to access the inside of the Argonaut-SL. There are no user serviceable parts, and none of the internal components requires periodic maintenance. The information in this section is provided as reference material only. We strongly discourage opening the SL unless instructed to do so by a SonTek engineer or technician.

This section contains basic instructions for opening the SL (only if necessary). Please [contact SonTek](#) before opening the SL.

To open the 500-kHz Argonaut-SL

1. Perform all work in a static safe environment.
2. See §7.3 for a description of the internal layout of the SL, electronics, and connections.
3. Disconnect the power and communications cable from the system.
4. Remove the six screws that hold the plate to the back of the pressure housing.
5. Carefully lift the plate from the housing.
6. While the system is open, protect all o-rings and o-ring surfaces from damage.

To close the 500-kHz Argonaut-SL

1. Clean and inspect the o-rings and o-ring surfaces for damage; replace o-rings if necessary.
2. Check all internal wiring to ensure it is installed correctly and securely (§7.3).
3. Carefully place the backing plate onto the pressure housing.
4. Secure the plate to the housing using the six screws; tighten snugly, but do not over tighten as this can damage the housing.

To open the 1500 or 3000-kHz Argonaut-SL

1. Perform all work in a static safe environment.
2. See §7.3 for a description of the internal layout of the SL, electronics, and connections.
3. Disconnect the power and communications cable from the system.
4. Remove the three bolts that hold the transducer head to the pressure housing.

5. Carefully lift the head from the housing. The connecting wires should be long enough to allow the head to be placed next to the housing.
6. Disconnect the input power to the Argonaut processor at the red, 3-pin connector to the Analog board (labeled **Power**; [Figure 7-12](#)).
7. Disconnect the 5-pin, red serial communication connector from the internal wiring to the CPU board (labeled **User**; [Figure 7-13](#)).
8. If installed, disconnect the 5-pin, red compass/tilt sensor connector from the CPU board (labeled **Compass**; [Figure 7-13](#)).
9. While the system is open, protect all o-rings and o-ring surfaces from damage.

To close the 1500 and 3000-kHz Argonaut-SL

1. Clean and inspect the o-rings and o-ring surfaces for damage; replace o-rings if necessary.
5. Connect the input power to the Argonaut processor at the red, 3-pin, keyed connector on the Analog board (labeled **Power**; [Figure 7-12](#)).
6. Connect the red, 5-pin, keyed serial communication connector for the internal wiring to the CPU board (labeled **User**; [Figure 7-13](#)).
7. If installed, connect the red, 5-pin, keyed compass/tilt sensor connector from the CPU board (labeled **Compass**; [Figure 7-13](#)).
8. Check all other internal wiring to ensure it is installed correctly and securely (§7.3).
9. 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.
10. 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.

7.9. Upgrading the CPU EPROM

Downloadable CPU firmware

- All Argonaut-SL systems have downloadable firmware. That is, firmware can be updated through software, without the need to replace the firmware's microchip.
- Firmware upgrades may be periodically available; check the SonTek web site for details.
- For firmware upgrades, all software and instructions will be provided with the upgrade. [Contact SonTek](#) for details.

Verifying system operation after a change

- Following any EPROM change, you should verify basic system operation.
- Turn the system off and on.
- Perform system diagnostics as described in §5.6.1.

7.10. Battery Pack Replacement

For autonomous deployments, batteries for the Argonaut-SL are contained in a separate underwater housing. The underwater housing is connected to the SL using a special splitter cable (§7.1.3). The SL battery housing contains one battery pack consisting of 24 D-cell batteries.

To remove the battery pack

1. Perform all work in a static safe environment.
2. Disconnect the splitter cable (§7.1.3) 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 when accessing the housing to protect the o-rings and o-ring surfaces from damage.
5. Disconnect the wires 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

1. Inspect the o-rings and surfaces on the end cap and housing; replace o-rings if necessary.
2. Place the new battery pack into the housing with the wires at the top.
3. Feed the battery wires through the hole on the internal retaining plate.
4. Place the internal retaining plate on top of the battery pack, and secure it with the screws.
5. Connect the keyed battery pack cable to the end cap.
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 tighten as this can damage the threaded inserts in the housing.

Section 8. System Maintenance

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

- [Regular Diagnostic Procedures](#)
- [Cleaning the Transducers](#)
- [Cable Maintenance](#)
- [O-rings](#)
- [Condensation in Argonaut Housing](#)
- [Corrosion Protection for Metal Parts](#)
- [Protection from Biological Fouling](#)
- [Protection in High-Temperature Environments](#)

8.1. Regular Diagnostic Procedures

At the beginning of each deployment, follow the diagnostic procedures described in §5.6.1.

- Capture all system responses to a log file within *SonUtils*; this provides an excellent record of system performance.
- Record at least 20 pings using the **Beam Check** module within *SonUtils*, or the **Diagnostics** module within *ViewArgonaut* as described in §5.6.1.
 - These two pieces of software serve the same function. They provide valuable information about both the operation of the SL and the conditions at the deployment site.
- Capture a log file during the actual deployment of the system.
 - This is done automatically when using the **Deployment** module within *ViewArgonaut*.
 - If you are using *SonUtils* and the direct command interface ([Appendix C](#)), you will need to open a log file manually within *SonUtils*.
- Collect and archive all log files and diagnostic files from each deployment. These files provide valuable information when evaluating data.

8.2. Cleaning the Transducers

Biological growth on the transducers does not affect velocity measurements, but it can decrease acoustic signal strength and reduce the effective measurement range of the Argonaut-SL.

- Periodic cleaning of the SL transducers may be needed to maintain optimal performance in areas of high biological activity.
 - 500-kHz SL transducers are encapsulated in urethane, which can potentially be damaged by shelled organisms such as barnacles. The transducers are still very durable, and cannot be easily damaged except by direct impact. However, in areas of high biological activity regular cleaning is important.
 - 1500 and 3000-kHz SL transducers are encapsulated in an epoxy that is impervious to damage from barnacles or other types of growth. The transducer epoxy is very durable and cannot be easily damaged except by direct impact.
- To remove growth, carefully clean with a non-metallic brush.
- We recommend coating the transducers with anti-fouling paint for deployments in regions of high biological activity (§8.7).

8.3. Cable Maintenance

The underwater cables used with the SL 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.
- Any underwater cable is susceptible to damage and reasonable precautions should be taken.
- Regularly inspect all SL cables and connectors for damage, and replace if necessary.
- The cable can also be routed through protective conduit to provide further protection from damage or vandalism.

8.4. O-rings

The Argonaut-SL housing uses an o-ring seal (see [Figure 7-9](#) and [Figure 7-10](#)).

- 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 reliable performance as long as care is taken whenever the system is opened. While the system is open, protect o-ring surfaces from scratches or other damage.
- There should be no regular need to open the SL housing; it should only be opened on instructions from SonTek support personnel.
- Whenever the housing is opened, clean and inspect all o-rings and o-ring mating surfaces; replace o-rings if necessary.
- Spare o-rings are included in the Argonaut tool kit.

8.5. Condensation in Argonaut Housing

Moisture in the air can damage Argonaut electronics if allowed to condense inside the housing.

- All underwater housings include desiccant to absorb moisture.
- Whenever opening the housing, minimize exposure of the desiccant to humid air.
- If you suspect the desiccant has been saturated, replace 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.

8.6. Corrosion Protection for Metal Parts

The Argonaut-SL has only a few exposed metal parts, and these parts are designed to be immune to corrosion concerns in fresh or salt water.

- The transducer cups are made of titanium.
- The exposed thermistor pin is made of titanium.
- The screws and threaded inserts that hold the back plate to the housing are made of brass.
- No regular maintenance or precautions are required to avoid corrosion.

8.7. Protection from Biological Fouling

The Argonaut-SL has excellent resistance to biological fouling and can operate reliably even with biological growth on the transducers.

- Biological growth may cause a loss in signal strength, but it does not affect the water velocity measurements.

- Both the transducers and the underwater housing can be coated with anti-fouling paints to prevent biological growth.
 - Anti-fouling paint is typically only required in warm, coastal environments where barnacles and similar biological growth is common.
 - **IMPORTANT:** For 500-kHz transducers, use only an anti-fouling paint approved for urethane transducers. This special type of paint is available from most marine supply stores. One suitable paint is MDR Anti-Fouling Transducer Paint (www.mdramazon.com).
- 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 SL.
- 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. This paint contains a biocide (a copper derivative) that allows its use on all metals. For information on Interlux paints, see: www.yachtpaint.com/usa/.

Normal anti-fouling paints, which use cuprous 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.
- Our experience with the above paint (Interlux Tri-Lux) on SonTek systems causes us to recommend its use for all systems.

When applying the anti-fouling paint:

- Follow the instructions provided with the paint on all areas except the transducers.
- When painting the transducers, apply only one coat. Make the paint as smooth and uniform as possible, and avoid trapping any air bubbles on the transducer face.
- If anti-fouling protection is desired for some portion of the cable, the paint can be applied directly to the polyurethane jacket

8.8. Protection in High-Temperature Environments

The Argonaut-SL is designed to operate in temperatures up to 40°C (104°F).

- Normal operation in water will rarely approach the SL's maximum temperature limitation.
- However, in some environments, the SL may be out of the water (while still operating) for extended periods. One common example would be an irrigation channel that only has water flowing a portion of the time.
- Sitting in the sun on a warm day, the Argonaut-SL may approach or even exceed its maximum temperature limitation.
- One way to reduce the effects of the sun is to mount the SL in a shaded location.

Section 9. System Troubleshooting

This section provides basic assistance in determining and resolving problems with the Argonaut-SL system. If you need further assistance, please [contact our Support department](#).

- [Cannot Establish Communications with the Argonaut-SL](#)
- [Cannot Retrieve Data from the Internal Recorder](#)
- [Missing Data from an Autonomous Deployment](#)
- [Cannot Communicate with an SDI-12 Data Logger](#)
- [Velocity Data Appears Noisy or Unreasonable](#)
- [Vertical Beam is Unable to Detect Water Level](#)
- [Compass/Tilt Sensor Data Unreasonable](#)

9.1. Cannot Establish Communications with the Argonaut-SL

If you cannot establish communications with the Argonaut-SL, review the following items.

- Power source:
 - Be sure the power supply is providing from 7 to 15 VDC to the system.
 - Note that some SL systems will accept 12-24 VDC through the external supply regulator, while others operate solely from the 7-15 VDC supply. See §7.2 for details.
 - When power is first connected to the SL, it should wake up and enter the last mode it was in (command mode, data acquisition mode, or deployment mode; see §C-3).
 - Measure the input current when power is applied to see if the SL is drawing any power.
 - If possible, try using an alternative power source.
- Computer:
 - Be certain that the computer serial port is functioning correctly; ports on laptop computers can periodically fail.
 - If possible, try using another computer or another serial port.
 - If using a USB-to-serial cable, try another one or a different brand (www.usbgear.com).
 - If using a PDA, you may need to use a null modem.
- Communication parameters:
 - Be certain the baud rate, communication serial port, and other parameters being used in the software match the Argonaut-SL settings (see §C-1).
- Cable connections:
 - Cables and connectors are the most common failure point in field equipment.
 - Verify all system cables are securely connected. Underwater connectors should be fully mated (faces flush) before tightening the locking sleeve. Do not use the locking sleeve to force the faces flush.
 - Verify any user-supplied cables and connectors are properly wired.
 - Check that all cables are intact and no cuts or physical damage are visible.
 - If using a USB-to-serial cable, try another one or a different brand (www.usbgear.com).
- Direct communication:
 - If the *ViewArgonaut* program modules (Deployment, Real-time, Recorder) are unable to establish communications, try direct communications using *SonUtils*.
 - When power is applied, see if the SL will respond to a **BREAK** (**Alt+B** in *SonUtils*).
 - Refer to [Appendix C](#) for details about the direct command interface.

9.2. Cannot Retrieve Data from the Internal Recorder

If you have trouble retrieving data from the internal recorder, review the following items.

- Be aware that problems with the actual recorder memory card are very rare.
- The data-extraction baud rate may be set too high for reliable operation.
 - SonTek recorder software retrieves data from the internal recorder using a higher baud rate to speed up the download process.
 - The default download baud rate is 57600. For most situations, this provides fast and reliable data retrieval.
 - The maximum reliable baud rate is a function of cable quality/length, the computer, and the environment (external noise sources). If necessary, you may need a lower baud rate.
 - All recorder download utilities (the Recorder modules within *SonUtils* and *ViewArgonaut*) provide the ability to change the download baud rate.
 - If data retrieval fails at the default baud rate, try setting a lower download baud rate. See the *SonUtils* and *ViewArgonaut* manuals for details.
- 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.
 - If problem persists, try using another computer.

If you are still unable to retrieve data from the internal recorder, [contact our Support department before](#) formatting the recorder, as other data retrieval methods may be available.

9.3. Missing Data from an Autonomous Deployment

The SL's recorder was designed for high reliability; recorder failures are extremely uncommon.

- Missing data is most commonly traced to problems with the power supply. If power is toggled on/off while the system is in deployment mode, a new data file is created and its file name is incremented by "1".
- When analyzing recorded data, look at the measured battery voltage (§6.3.5) as this provides information on the condition of the power supply.
- Check that sufficient recorder space remained for data collection.
- If any real-time data logging is available (typically SDI-12 or via the analog output modules), compare data from these systems for that period.
- If the SL was interfaced to an SDI-12 data logger, the data logger must initiate each velocity sample. Check data logger operation/cables to ensure collection commands reached the SL.
- View the log files collected at the start of deployment (§5.5 and §8.1). Look specifically at measured battery voltage, recorder space, and estimate recorder life.

9.4. Cannot Communicate with an SDI-12 Data Logger

If you cannot establish communications between the Argonaut-SL and an SDI-12 data logger, review the following items. In all cases, you should review [Appendix E](#).

- Have you completed all steps required to place the SL in SDI-12 mode?
 - The SL must first be programmed using the RS-232 serial interface.
 - The SL is put into SDI-12 operating mode using the command `sd12 ON`.
 - The SL must then be switched to use the SDI-12 serial bus by opening the RS-232/SDI-12 jumper switch on the power communication cable ([Figure E-1](#)).
 - See detailed deployment instructions in §5.7.12 and §5.8.3.

- Do you have the correct SDI-12 address specified?
- Try simulating SDI-12 command operation using *SonUtils*. See §E-4 for details.
 - This allows you to send SDI-12 commands to the SL over the RS-232 serial bus.
 - This verifies that the SL has been placed in SDI-12 operating mode and is prepared to respond to SDI-12 commands.

9.5. Velocity Data Appears Noisy or Unreasonable

If the velocity data from the Argonaut-SL do not appear reasonable, review the following list.

- Evaluate the deployment site (see §5.1).
 - Is it in an area with stable flow conditions?
 - Is the SL oriented correctly with respect to the direction of flow?
 - Is the SL mount level?
 - Are there any underwater objects that could cause interference?
 - Do all beams have a clear, unobstructed path?
 - Is there any debris caught on the system that could be influencing data collection?
- Consider the SL operating parameters.
 - Are the settings for **CellBegin** and **CellEnd** reasonable for the operating environment?
 - Is the value of the averaging interval long enough to eliminate instrument noise and real variations in flow? We do not recommend using **AvgInterval** settings less than 60 seconds; settings from 120 to 900 seconds are more common.
 - Re-evaluate the other deployment parameters to see if these might have had some unforeseen effect on performance.
- Look at signal-to-noise ratio data (SNR).
 - SNR should be greater than 3 dB.
 - SNR from the two velocity beams should be essentially the same.
 - Evaluate signal strength and noise data for potential problems.
 - Refer to §6.3.1 and §6.3.2 for more information.
- Check signal strength data using the Beam Check module of *SonUtils*, or the Diagnostics module of *ViewArgonaut*. See §5.6.1.
 - Be sure all beams have sufficient signal strength for reliable operation.
 - Verify no large objects (structures, lines, fish, etc.) obstruct the acoustic beam paths.
- Check the standard error of velocity data.
 - See **Appendix B** (Principles of Operation) for a description of the expected behavior of these data.
 - Verify the standard error values are reasonable based on the values for averaging interval and cell begin / cell end. See §6.3.3.
 - Large standard error values can be caused by motion of the SL mounting – be sure the mounting is stable.
 - Large standard error values can also be caused by turbulence in the water; evaluate the deployment site to variable flows.
- Check stage data. See §6.3.4.
 - Was the system able to measure stage accurately?
 - Was water depth sufficient for reliable operation?
 - What was the aspect ratio (ratio between water depth and measurement range)? Is this a reasonable value (see **Appendix B**)?

- Check the values of cell begin and cell end in the output data.
 - Do they match the input settings? See §6.3.6.
 - If cell begin or cell end are being adjusted, why?
 - Low signal strength?
 - See [Appendix B](#) (Principles of Operation).
- Check temperature, pressure, and battery voltage data.
 - Is temperature data reasonable given the deployment environment?
 - Is pressure data reasonable given the deployment environment?
 - How does pressure data compare to stage data?
 - Is the power supply sufficient and reliable?
 - All the above can be indicators of other problems that affect velocity data (see §6.3.5).
- If the system is equipped with a compass/tilt sensor, review the data from this sensor. In particular, look for tilt values that may indicate the deployment package is not level. Also, look at how these values change with time to see if the deployment package is moving.

9.6. Vertical Beam is Unable to Detect Water Level

If the Argonaut-SL is equipped with the vertical beam, and it is unable to measure the water level properly, the following list may be helpful in establishing the source of the problem.

- Is the vertical beam blocked by debris or sediment?
- Is the system installation level?
 - Large tilt angles can prevent the vertical beam from operating reliably.
 - If the system has a compass/tilt sensor, look at tilt data to verify the installation is level.
- What is the approximate water depth?
 - The minimum and maximum water depths depend on the system frequency.
 - 500 kHz: 0.4 to 18.0 m (1.3 to 59 ft)
 - 1500 kHz: 0.25 to 10.0 m (0.8 to 33 ft)
 - 3000 kHz: 0.1 to 5.0 m (0.3 to 16 ft)
 - Was the water depth within the operating range of the system?
 - Is the pressure sensor offset correct? See ¶7.5.1 for details.
- What are the surface conditions above the instrument?
 - Large turbulence or waves above the SL can affect the reliability of level measurements.
 - Debris above the instrument can also affect operation of the vertical beam (see sample data in §6.5.2).
 - An ideal measurement site should have smooth and even surface conditions.

9.7. Compass/Tilt Sensor Data Unreasonable

If the Argonaut-SL is equipped with the compass/tilt sensor, and you suspect that its data are unreasonable, the following items may be helpful in establishing the source of the problem.

- Follow the procedure outlined in §7.6.1 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 SL is oriented properly based on compass installation (i.e., side-looking – see §7.6.3).

Appendix A. Glossary

This appendix provides a description of the major terms and abbreviations used in discussing the Argonaut current meters and current profiling in general.

Term	Description
analog outputs	The Argonaut is capable of providing up to two analog output signals to external devices. Two types of analog outputs are available — <i>current</i> (4-20 mA current loop) or <i>voltage</i> (0-5 VDC). An Argonaut can use up to two output modules with two different parameters at one time, but all modules must be of the same type. For analog output commands, see §C-17. For details about using analog outputs, see Appendix F .
area	Cross-sectional area is used for Argonaut flow calculations. Area is calculated using the measured <i>water level</i> (from the SL vertical beam), user-supplied <i>channel geometry</i> , and the SL <i>elevation</i> within the channel. For more information on cross-sectional area, see Appendix G (Internal Flow Calculations).
aspect ratio	Aspect ratio is the ratio of the horizontal measurement range to the vertical distance to the nearest boundary, surface, or bottom. Aspect ratio is important when setting the operating parameters of the SL. For more information about aspect ratio when selecting operating parameters, see §B-9.1.
averaging interval or AI	This determines the period of time (in seconds) that the Argonaut averages data for each sample. Settings as short as 10 seconds are allowed; however, we do not recommend settings less than 60 seconds. We recommend using the largest value based on the required data output rate. Settings of 120 to 900 seconds (2 to 15 minutes) are typical. Longer averaging times will reduce the amount of noise in velocity and flow data. For command details, see AvgInterval (§C-8).
blanking distance or BD	The blanking distance parameter applies only to Argonauts that have the multi-cell velocity profiling feature enabled. Blanking distance is the region in front of the transducers where no measurements can be made. This parameter is measured as the distance (in meters) from the instrument to the start of the first range cell. The blanking region is required to give time for the transducers and electronics to recover from the transmit pulse. That is to say, the transducers/electronics need time to switch from the transmit mode to the receive mode. For details, see BlankDistance (§C-8).
cell	The area of water in which data is averaged and collected; also referred to as depth cells or range cells. The size of these data collection points is determined by a user-selected <i>cell size</i> .
cell begin	This determines the distance where the Argonaut begins its integrated velocity measurement, and is selected based upon the operating environment as part of the site survey (cross reference to section describing site survey procedure). For details, see CellBegin (§C-8).

Term	Description
cell end	This determines the distance where the Argonaut ends its integrated velocity measurement, and is selected based upon the operating environment as part of the site survey (cross reference to section describing site survey procedure). See CellEnd (§C-8) for details.
cell size or CS	This parameter is used only with the multi-cell velocity profiling feature. This determines the distance from the start of one cell to the start of the next cell. Cell size defines the resolution of the velocity profile (in meters). Keep in mind there are advantages and disadvantages to selecting small or large cell sizes: • Small cells allow you to get higher-resolution profile data, especially in shallow water. However, more small cells are needed to profile to a specific range, which means that individually analyzing small-cell data can be a time consuming process. • Large cells make data analysis of individual cells easier. However, the resolution of the profile will be lower, which could make it more difficult to analyze shallow water data. For command details, see CellSize (§C-8). For detailed information about multi-cell velocity profiling, see §B-6.4.
channel type	This parameter defines the type of channel in which the Argonaut is installed; the parameter is required for internal flow calculations. The Argonaut-SL supports four channel types: Irregular open channel, Trapezoid open channel, trapezoidal closed Culvert , or any channel that can be represented with a stage/area Equation . See §C-15 for details.
cross-sectional area	See area .
depth cell	See cell .
flow	This is the total flow (or discharge) as calculated by the Argonaut. Flow is calculated as follows (see §B-5 for details). • Measured stage is combined with user supplied channel geometry to calculate cross sectional area. • Velocity measured by the Argonaut is related to mean channel velocity by either a theoretical flow model or Index velocity equation. • Mean channel velocity is multiplied by cross sectional area to give flow.
modbus interface module (MIM)	An external device used to integrate the Argonaut with a Modbus digital data collection network. See Appendix I .
noise level	This refers to the ambient signal level as measured when there is no acoustic return from the water. It is measured and recorded with each Argonaut sample, primarily to allow calculation of the signal-to-noise ratio (SNR). Noise level is measured and recorded in internal units called counts; one count equals 0.43 dB.
number of cells	This parameter is used only with the multi-cell velocity profiling feature. This determines the number of cells to record in the multi-cell profile. The minimum value is 1; the maximum value is 10.
ping	A single estimate of the 2D water velocity profile.
ping rate	The rate at which water velocity is sampled. The Argonaut samples (pings) once per second.

Term	Description
profile	In addition to its more general use, profile refers to the collection of a number of pings to produce a mean estimate of the water velocity at each range cell. A single “profile” includes velocity, standard error, and return signal strength data. The Argonaut can only profile data if the multi-cell velocity-profiling feature is enabled.
profiling range	The range to which a system can profile is determined by user-selected values for <i>blanking distance</i> , <i>cell size</i> , and <i>number of cells</i> . The maximum profiling range of a system is determined primarily by the system’s frequency (Table 3-1), but can be restricted by the amount of scatterers in the water or by interference from physical boundaries (surface, bottom, objects in beam path).
range cell	See <i>cell</i> .
salinity	A value that indicates a user-entered determination of the amount of salinity, in parts per thousand (ppt), in the water. This value is used in sound speed calculations.
sample	A sample refers to the mean data values recorded for each AvgInterval . Sample data includes mean velocity, stage, flow, signal strength, SNR, temperature, and a variety of other parameters
sample interval	Sample interval is the time between the start of successive samples.
sample time	The Argonaut records data and time from its internal clock with each profile. The recorded time represents the start of the averaging interval.
sampling volume	The sampling volume is the physical location of the water velocity measurement. See Appendix B – Argonaut-SL Principles of Operation .
scatterers	This term refers to suspended material in the water that will reflect an acoustic signal. Scatterers can be suspended sediment, biological material, or air bubbles. The instrument measures velocity by looking at the reflected sound from the acoustic scatterers in the water, so it is important to consider the nature of the scatterers when looking at the system’s velocity data.
signal strength	This refers to the strength of the reflected acoustic signal. It is a function of the acoustic conditions of the water — primarily the amount and type of suspended material (scatterers) present. Signal strength is measured and recorded in internal units called counts; one count equals 0.43 dB. It is most commonly converted to SNR before being used as a quality control parameter. Signal strength can also be used as an indicator of suspended sediment levels; for more information on this application, see the Appendix B – Argonaut-SL Principles of Operation
SNR (signal-to-noise ratio)	SNR is the ratio of the received acoustic signal strength to the ambient noise level. It is expressed in logarithmic units (dB), and is perhaps the most important quality control data for the Argonaut. For details about using SNR as a data quality parameter, see §6.3.1. SNR is calculated using the formula: $SNR = 0.43 * (SignalStrength - NoiseLevel)$.

Term	Description
sound speed	The speed of sound, in meters per second or feet per second, at the transducer face. Sound speed is used to convert the Doppler shift to water velocity. Sound speed is calculated either from a user-specified temperature and salinity, or from an automatically measured temperature and a user-entered salinity.
stage	Stage is defined as the measured water depth referenced to the local datum. The water level is referenced to the top of the Argonaut. Stage is calculated as Water Level plus the Argonaut's elevation.
temperature	A value that indicates the temperature of the water, in °C or °F, at the transducer head. This value is used in sound speed calculations. Temperature can be measured automatically from a sensor, or entered manually by the user. The mean and standard deviation of measured temperature are recorded with each profile.
time	See sample time .
transducers	The Argonauts typically have two or three acoustic electro-mechanical ceramic devices (i.e., transducers) that are used to transmit and receive acoustic signals (see Figure 5-1).
water level	If the Argonaut is equipped with a vertical beam, it is used to measure the level of water above the top of the instrument. Stage is calculated as Water Level plus the Argonaut's elevation.

Appendix B. Argonaut-SL Principles of Operation

This *Argonaut-SL System Manual* appendix introduces the operating principles of the SonTek/YSI Argonaut Side-Looking (SL) acoustic Doppler current meter ([Figure B-1](#)). It does not attempt to provide a detailed discussion of all technical issues, nor does it provide a detailed description of SL operation. To learn more about specific SL applications, please refer to other sections within the *Argonaut-SL System Manual* or [contact SonTek/YSI](#).

- [B-1 – Overview](#)
- [B-2 – The Doppler Shift and Monostatic Current Meters](#)
- [B-3 – Beam Geometry and 2D Velocity Measurements](#)
- [B-4 – Stage Measurement \(Vertical Acoustic Beam\)](#)
- [B-5 – Flow Calculations](#)
- [B-6 – Argonaut-SL Data](#)
- [B-7 – Quality Control Data](#)
- [B-8 – Flow Data](#)
- [B-9 – Special Considerations](#)
- [B-10 – Contact Information](#)



Figure B-1. 1500 or 3000 kHz Argonaut-SL (top);
500 kHz Argonaut-SL (bottom)

B-1. Overview

The Argonaut-SL (commonly referred to as the “SL”) is a Doppler current meter designed to measure precise water velocities in a horizontal layer ([Figure B-2](#)). In addition to velocity measurements, the SL provides stage and flow measurements in the field. The SL (like the rest of SonTek’s Argonaut current meter product line) provides the technological advantages of complex/expensive current profilers in a simple, inexpensive, and easy to use package. SL attributes include:

- Horizontally integrated velocity measurement
- Invariant factory calibration — no periodic recalibration required
- Vertical acoustic beam for stage measurement
- Simple operation (very few user entries needed)
- Excellent performance for low and high flows
- Accuracy — 1% of measured velocity
- Built-in temperature sensor

Typical applications for which the SL is used include:

- River discharge monitoring
- Velocity indexing
- Irrigation
- Flood alert systems
- Water supply
- Environmental monitoring
- Vessel traffic
- Offshore platforms
- Ship berthing

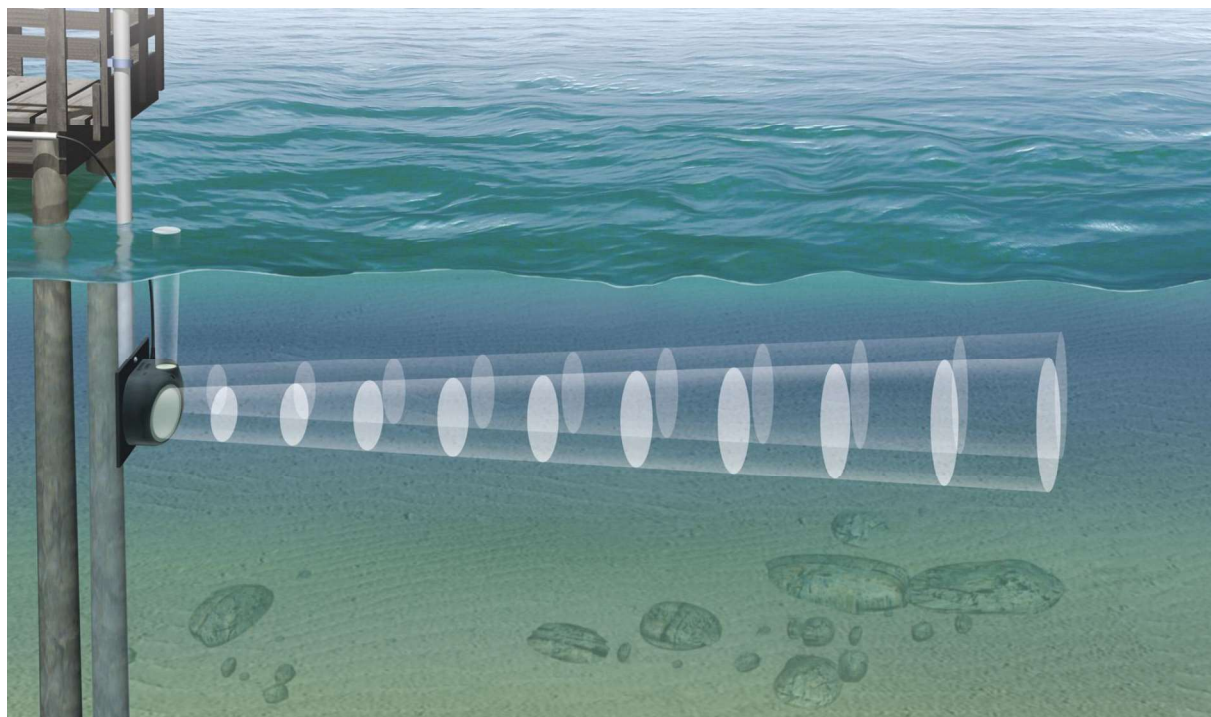


Figure B-2. Typical Argonaut-SL Application

B-2. The Doppler Shift and Monostatic Current Meters

The SL measures water velocity using a physical principle called the Doppler shift. This principle 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. For a Doppler current meter, this can be expressed as:

$$F_d = -2F_0 \frac{V}{C}$$

where

F_d = Change in received frequency (Doppler shift)

F_0 = Frequency of transmitted sound

V = Represents relative velocity between source and receiver (i.e., motion that changes the distance between the two); +V means the distance from source to receiver is increasing.

C = Speed of sound

The SL is a *monostatic* Doppler current meter. [Figure B-3](#) depicts the operation of a monostatic Doppler current meter.

- Monostatic means the same transducer is used as both transmitter and receiver.
- The transducer generates a short pulse of sound at a known frequency (F_0), which then 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 (e.g., sediment, biological matter, bubbles).
- Some reflected energy travels back along the transducer axis, where the transducer receives it.
- The SL electronics measure the change in frequency of the received signal.
- The Doppler shift measured by a single transducer relates to the water velocity along the axis of the acoustic beam of that transducer.
- If the distance between the transducer and the target is decreasing, frequency (F_D) increases; if the distance is increasing, frequency (F_D) decreases. 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 (T_P), the Argonaut measures the water velocity at different distances from the transducer.

It is important to note that the SL measures the velocities of particles in the water, and not the water velocity itself.

- The velocity of particles in the water is assumed to match the velocity of the water. This assumption has been tested extensively and found to be very reliable.
- If there is no particulate matter in the water, the system cannot measure velocity. In general, the practical limitation of clear water is not whether the system can make velocity measurements, but what is the maximum range (distance from the system) at which the system can measure velocity. In clear water, the maximum measurement range may be reduced. Note: *Clear water* is a relative term; visual inspection is not a good way to determine particle concentration. Use the *SonUtils* Beam Check module to make this determination.

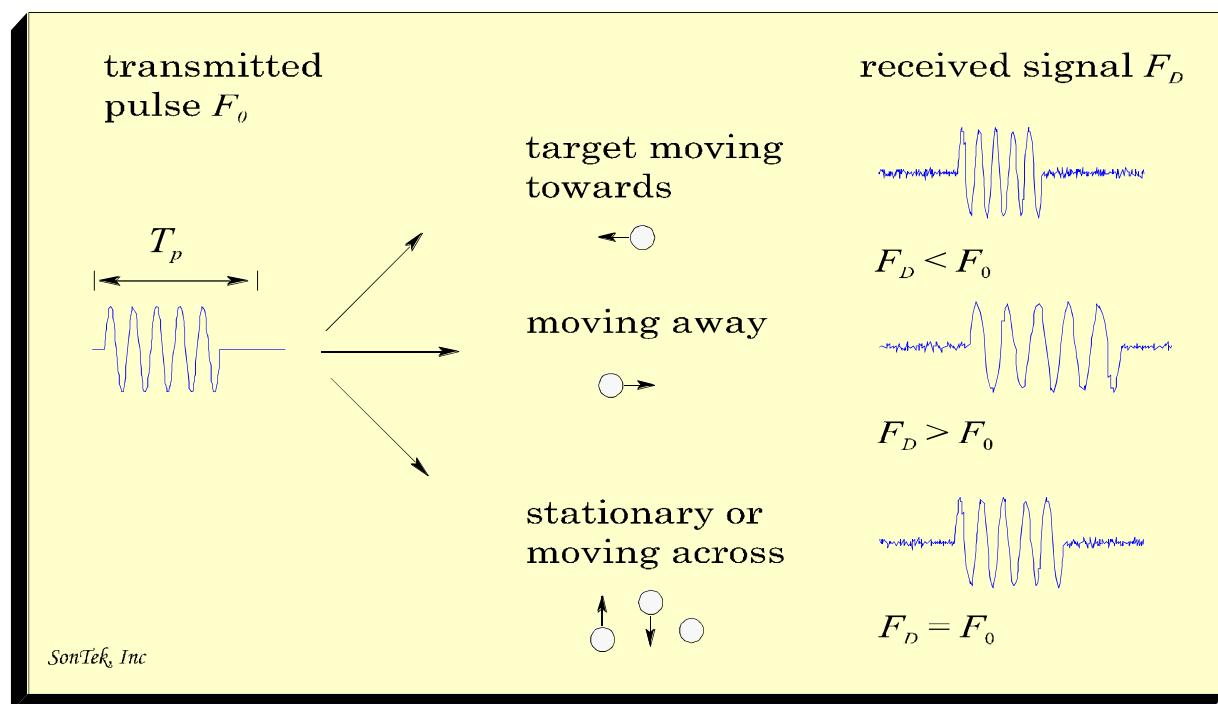


Figure B-3. Measuring target velocity with a monostatic Doppler system

B-3. Beam Geometry and 2D Velocity Measurements

The SL is designed for horizontal operation from underwater structures such as bridge pilings and channel walls.

- The system measures 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 ([Figure B-4](#)).
- The velocity measured by each beam is referred to as the *along-beam velocity*.
- Beam velocities are converted to XY (Cartesian) velocities using the beam geometry.
- In most applications, the orientation of the SL is known and XY velocities are used directly.
 - XY velocities are reported relative to the orientation of the SL; if the SL is looking across a stream, X is parallel to the direction of flow and Y is across the stream (§[B-9.2](#)).
 - Some SL systems include an internal compass/tilt sensor. This allows the SL to report velocities in Earth (East-North-Up or ENU) coordinates, independent of system orientation.
- All new SL systems include a vertical beam to measure the distance from the system's transducer head to the water surface; some older SLs do not include the vertical beam.

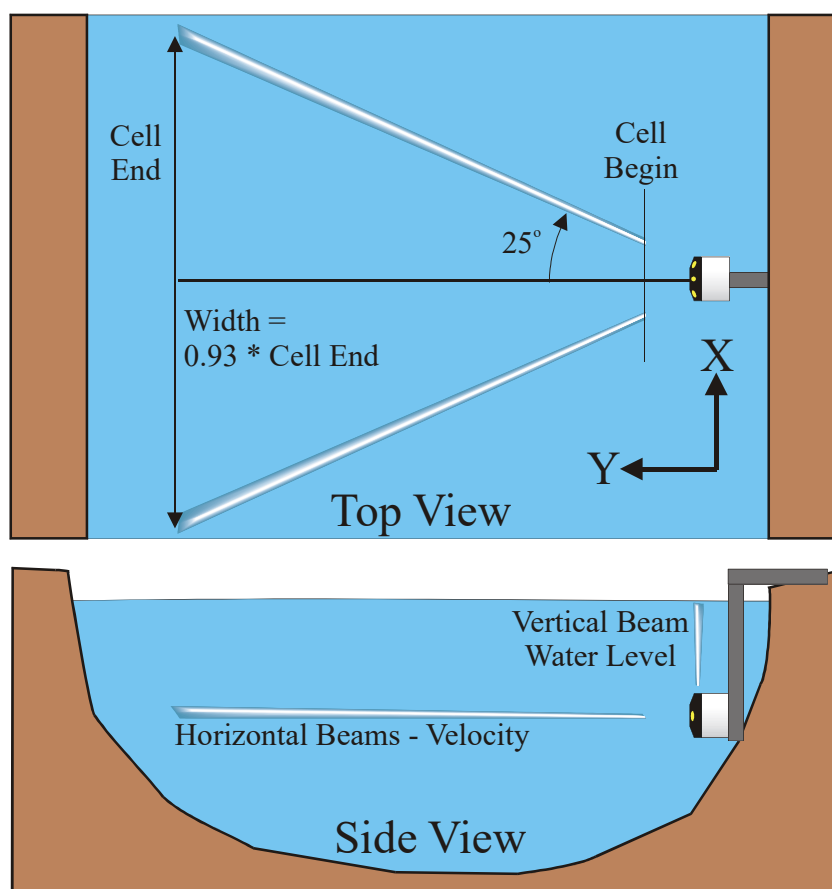


Figure B-4. Argonaut-SL Beam Geometry

B-3.1 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.

- 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. Example: At 4 m, the width is 3.7 m.
- The limits of the measurement volume are determined by user-selected parameters (see §B-9.1 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 central axis of the instrument.
- 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. The pulse length is a function of system frequency, as defined in Table B-1. The receive window is based on the settings of CB and CE. The measurement volume weighting function of the SL is shown in Figure B-5.

Table B-1. Argonaut-SL Pulse Length

Frequency	Pulse Length
500 kHz	2.0 m
1500 kHz	0.5 m
3000 kHz	0.25 m

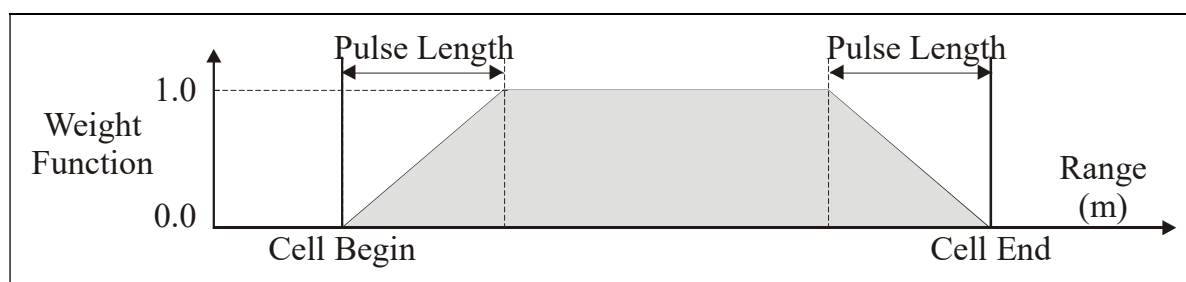


Figure B-5. Argonaut-SL Measurement Volume Weighting Function

B-4. Stage Measurement (Vertical Acoustic Beam)

All new SL systems have a vertical acoustic beam to measure stage ([Figure B-2](#)).

- The vertical beam sends a short pulse of sound and listens for the reflection from the surface.
- The surface reflection is strong and clearly defined, allowing the SL to precisely measure the time at which the return reflection is received.
- To convert the reflection time to surface range, the SL needs to know the speed of sound in water at the survey site, which is primarily a function of temperature and salinity.
 - The SL's internal temperature sensor automatically compensates for changing conditions by continually updating the sound speed used for surface range calculations.
 - Salinity is user defined (i.e., the SL does not automatically adjust for salinity variations).
- The vertical beam also works under ice, measuring the range to the bottom of the ice. This determines the water depth beneath the ice as needed for discharge monitoring.
- The vertical beam's operating range varies with acoustic frequency as shown in [Table B-2](#).

Table B-2. Vertical Beam Operating Range

Frequency	Minimum Depth	Maximum Depth
500 kHz	0.40 m	18 m
1500 kHz	0.25 m	10 m
3000 kHz	0.10 m	5 m

B-5. Flow Calculations

One of the primary functions of an SL with a vertical beam is to provide real-time flow data. The SL combines water velocity data (from the slanted beams) and stage data (from the vertical beam) with user-supplied channel geometry information about the installation site. The SL supports flow calculations for a variety of environments.

- Natural streams (defined by a series of survey points)
- Regular (trapezoidal) channels (typically concrete lined)
- Regular (trapezoidal) culverts with a closed top (typically concrete lined)
- Any channel that can be represented with a stage/area equation

The SL combines channel geometry with stage to calculate the cross-sectional area. The area is then multiplied by the mean channel velocity to determine flow. The relationship between the velocity measured by the SL and the mean channel velocity can be determined two ways.

- Theoretical flow calculations (§[B-5.1](#))
- Index velocity calibration (§[B-5.2](#))

The SL can use the measured flow rate to compute the total volume of water that has passed the system. Total volume is the cumulative sum of flow rate multiplied by time. This could be used to determine the amount of water delivered through an irrigation channel over a given time span. Total volume is available both in real-time display and output, as well as in the recorded data.

B-5.1 Theoretical Flow Calculations

Theoretical flow calculations are used when no reference flow data are available; that is, only channel geometry and data measured directly by the SL are available. For theoretical flow calculations, the SL makes use of the following information.

- The largest variations of velocity occur with changing depth within the channel.
- Based on the supplied channel geometry, the SL can determine the vertical location of the velocity measurement within the water column. The system assumes the river follows a power-law velocity profile model with a 1/6 power-law coefficient.

- Using this model, combined with the location of the SL velocity measurement, the SL estimates a relationship between the measured velocity and the mean channel velocity.
- The relationship between measured and mean channel velocity will change as water depth changes, since the location of the SL measurements within the water column is also changing.
- The theoretical velocity calculation of the SL should provide good results for regular, concrete lined channels, or culverts (typically rectangular or trapezoidal in shape) where the SL is installed near the midpoint of the water depth.
- For natural streams or sites with large variations in water depth, SonTek recommends developing an index velocity calibration (§B-5.2) to provide accurate flow data specific to that site.

B-5.2 Index Velocity Calibration

An index velocity calibration is a popular technique for monitoring discharge when reference discharge measurements are available.

- Discharge measurements are made at a variety of water levels and flow conditions.
- SL water velocity data and stage data are collected at the same time as reference discharge measurements.
- The data are analyzed to determine empirically a relationship between the SL measured velocity and the mean channel velocity.
- This relationship is then input into the SL, which outputs calibrated flow data in real time.
- The empirical index relationship uses the following form:

$$V_{\text{mean}} = V_{\text{intercept}} + V_{\text{meas}} * (V_{\text{slope}} + (\text{StageCoef} * \text{Stage}))$$

where

V_{mean}	= mean velocity in the channel
$V_{\text{intercept}}$	= user-supplied* velocity offset (cm/s or ft/s)
V_{meas}	= SL measured velocity
V_{slope}	= user-supplied* velocity scale factor (no units)
StageCoef	= user-supplied* water depth coefficient (1/s)
Stage	= measured stage (total water depth) (m or ft)

*Note: These constants are empirically derived coefficients based on a number of user-made, independent discharge measurements. These coefficients relate SL measured velocity to mean channel velocity as determined by the independent measurements. The details of how these constants are derived are beyond the scope of this appendix. For information, [contact SonTek](#).

An index velocity calibration will usually supply more accurate flow data than a theoretical flow calculation. However, an index calibration requires extensive reference data and data analysis expertise to construct — for some applications, this is not practical. In these situations, the theoretical flow calculations can provide good quality flow data.

B-6. Argonaut-SL Data

B-6.1 Sampling Strategy

The SL averages data for a fixed interval for each reported water velocity sample.

- The SL samples velocity (i.e., *pings*) each second. The type of velocity ping depends on whether [PowerPing](#) is enabled. Using [PowerPing](#) provides improved performance, but increases power consumption. Refer to the *Argonaut-SL System Manual* for [PowerPing](#) details.
- The SL pings the vertical beam once per second to measure stage data.
- Pings are accumulated over a user-specified averaging interval (typically 1 to 15 minutes), and average values for velocity, stage, and a variety of diagnostic data are reported.

- The sampled data are normally recorded to the SL internal recorder, and can also be reported to an external data logger (§B-9.3).
- The SL can operate continuously (i.e., start the next sample immediately after completing a sample), or it can enter a low-power (i.e., “sleep”) state between samples to conserve power.
- See (§B-9.5) for sampling strategy considerations.

B-6.2 Velocity Data

In general, SL velocity data are used directly without any post-processing.

- The SL can measure water velocities from less than 0.01 m/s to 6.0 m/s.
- The velocity response will not change or drift with time; the SL never requires recalibration.
- The SL measures flow direction and will accurately report reversing flow.
- 2D velocity data are normally output in Cartesian coordinates (XY) relative to SL orientation.
 - See (§B-9.2) for more information about the SL’s coordinate system.
 - Some systems may include an internal compass, allowing velocity data to be output in Earth (ENU or East-North-Up) coordinates (§B-9.2).
- Velocity data are accurate to 1% of the measured velocity (after accounting for random noise; see §B-7.2).
- The SL provides diagnostic parameters with each sample to verify the quality and accuracy of the data (§B-7).

B-6.3 Accuracy of Velocity Data

When discussing the accuracy of the SL water velocity data, we are referring to the presence of any bias in mean velocity measurements. Velocity data may have random short-term variations (noise) that do not reflect a bias to velocity data (§B-7.2). Two factors influence accuracy of SL velocity data — sound speed and beam geometry.

- The effect of sound speed is described in §B-9.4. With properly specified salinity data, sound speed errors are negligible (less than 0.25%).
- Beam geometry is fixed during system construction, and will not change with time (unless there is catastrophic physical damage to the system).
- The SL calibration is specified to $\pm 1.0\%$ of the measured velocity.
- There is no potential for zero offset or drift in velocity measurements. There is no inherent minimum measurable velocity.

B-6.4 Multi-cell Velocity Profiling Data

This SL feature can record the measured velocity profile using more than one cell (Figure B-6).

- The profile can include up to ten (10) independent velocity cells.
- The user specifies the following three parameters.
 - Blanking distance: distance (m) to the start of the first cell
 - Cell size: length (m) of each cell
 - Number of cells

The multi-cell water velocity data are calculated separately from the standard, single cell (i.e., Integrated Velocity Cell in Figure B-6) reported by the system. There does not need to be any specific relationship between the multi-cell parameters and the parameters for the fixed velocity cell (CellBegin and CellEnd).

- The location of multi-cell velocity data is fixed based on the user-specified operating parameters — blanking distance, cell size, and number of cells.

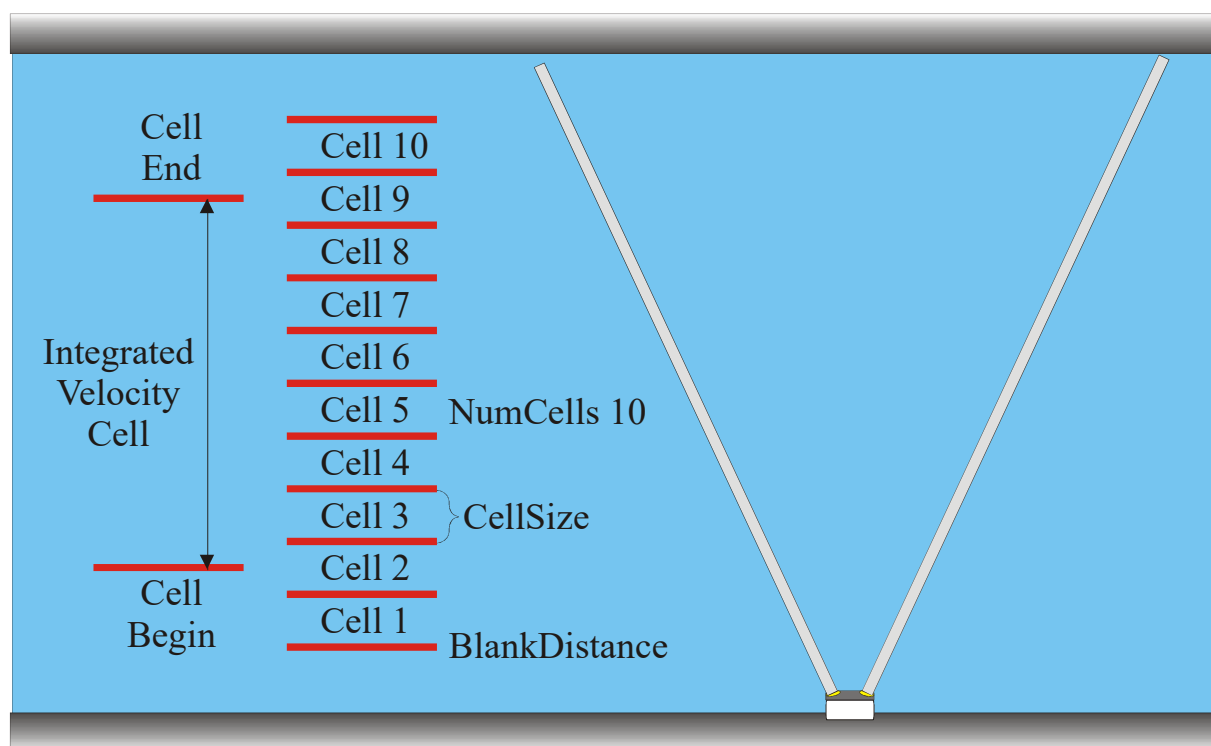


Figure B-6. Multi-cell velocity profiling

- Unlike the single integrated velocity cell, multi-cell velocity data are not automatically screened for low signal-to-noise ratio (SNR) values (§B-7.1).
- SNR values are recorded with each velocity cell.
- The user needs to monitor SNR data and consider the location of each velocity cell before using the multi-cell velocity data.

B-7. Quality Control Data

The SL records quality control data with each sample to evaluate the quality of velocity data.

- Signal-to-noise ratio (SNR) – §B-7.1
- Standard error of velocity – §B-7.2

B-7.1 Signal-to-Noise Ratio (SNR)

The Argonaut-SL measures velocity by looking at the reflections of an acoustic pulse from particles in the water.

- The magnitude of the reflection is called signal strength. It varies with the amount and type of suspended material, and with the distance from the transducers.
- Signal strength decreases with distance from the transducer due to geometric spreading and sound absorption.
- The distance at which signal strength approaches the electronics noise level determines the maximum measurement range of the SL.
- Signal strength is commonly used as the signal-to-noise ratio (SNR), which compares the magnitude of the received signal to the ambient electronics noise level. SNR is reported in a logarithmic scale.
- Signal strength data are measured and recorded in internal logarithmic units called counts.

- Signal strength and noise level are recorded in counts; one count equals 0.43 dB.
- Signal strength is converted to SNR by subtracting the noise level and converting to dB.
- The SL requires a minimum SNR (≈ 3 dB) to make accurate velocity measurements.

For the SL, the location and size of the measurement volume is variable depending on system frequency and operating parameters.

- Signal strength and SNR reported are the mean value over the measurement volume.
- Signal strength decreases with range from the transducers and will vary with conditions in the water. For good operating conditions, SNR should be greater than 3 dB.

In some cases, the SL may adjust the size of the measurement volume based on SNR.

- With each sample, the SL monitors the SNR profile within the measurement volume.
 - In most conditions, the SL is able to measure to its specified maximum range ([Table B-3](#)).
 - If at any point the signal strength is too low for reliable velocity measurements, the SL will end the measurement volume at that 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.

Table B-3. Typical Maximum SL Measurement Range

Frequency	Maximum Range
500 kHz	120 m
1500 kHz	20 m
3000 kHz	5 m

Signal strength is primarily a function of the amount and type of particulate matter in the water.

- While signal strength cannot be immediately converted to sediment concentration, it provides an excellent qualitative picture of sediment fluctuations and, with proper calibration, can be used to estimate sediment concentration.
- For more information about this application, please [contact SonTek](#).

B-7.2 Standard Error of Velocity Data

Each velocity sample recorded by the Argonaut-SL is the average of a number of pings.

- The SL records the standard error of velocity based on data from all pings.
- The type of ping depends on whether [PowerPing](#) is enabled. PowerPing can reduce the uncertainty of velocity measurement, but may increase power consumption.
- Standard error is the standard deviation of velocity divided by the square root of the number of pings. It is a direct, statistical measure of the accuracy of the mean velocity data.
- Measured standard error includes instrument generated noise and real variations in velocity.
- Instrument-generated velocity noise can be estimated based on operating parameters. This is useful in planning deployments, particularly for determining the operating parameters required for a desired accuracy.
- Typically, measured standard error agrees with predicted values to within about 20%.

Standard error is a function of the size of the measurement volume, the averaging interval, and the effect of [PowerPing](#). The formulas in [Table B-4](#) are used to predict the standard error of SL velocity data based on these parameters. The formula can also be used to predict the standard error of multi-cell velocity data. Note: Formulas are based on the acoustic frequency of the system.

Table B-4. Argonaut-SL Standard Error Prediction Formula

Frequency	Standard Error Prediction Formula
500 kHz	$\sigma V = \frac{29}{\sqrt{AI} \sqrt{CS}}$
1500 kHz	$\sigma V = \frac{19}{PP \sqrt{AI} \sqrt{CS}}$
3000 kHz	$\sigma V = \frac{14}{PP \sqrt{AI} \sqrt{CS}}$

where

σV = Predicted standard error of Velocity (cm/s)

PP = PowerPing factor (see below)

AI = Averaging interval (seconds)

CS = Cell size (m)

The effect of **PowerPing** depends on the maximum range of the system – the value of CellEnd. Refer to the *Argonaut-SL System Manual* for a complete description of how to use PowerPing to improve system performance. **Table B-5** shows the effect of PowerPing for various settings.

Table B-5. Effect of PowerPing Settings

Frequency	PowerPing Setting	CellEnd	PowerPing Factor (PP)
1500 kHz	OFF	Any value	1.0
1500 kHz	ON	≤ 10.0 m	2.4
1500 kHz	ON	20.0 m	2.0
3000 kHz	OFF	Any value	1.0
3000 kHz	ON	≤ 4.0 m	2.4
3000 kHz	ON	8.0 m	2.1

For the integrated velocity cell, cell size is calculated as follows (refer back to **Table B-1** for the SL's pulse length).

$$CS = \text{CellEnd} - \text{CellBegin} - \text{PulseLength}$$

For multi-cell velocity profile data, cell size is simply the user-specified value. **Table B-6** lists predicted standard error values for various combinations of frequency, cell size, and averaging interval.

Table B-6. Argonaut-SL Typical Predicted Velocity Precision (Standard Error)

500-kHz Argonaut-SL				
Averaging Interval	PowerPing	10-m Cell	30-m Cell	100-m Cell
1 minute	NO	1.2 cm/s	0.7 cm/s	0.4 cm/s
5 minutes	NO	0.5 cm/s	0.3 cm/s	0.2 cm/s
1500-kHz Argonaut-SL				
Averaging Interval	PowerPing	2-m Cell	5-m Cell	15-m Cell
1 minute	NO	1.7 cm/s	1.1 cm/s	0.6 cm/s
5 minutes	NO	0.8 cm/s	0.5 cm/s	0.25 cm/s
1 minute	YES	0.7 cm/s	0.5 cm/s	0.3 cm/s
5 minutes	YES	0.3 cm/s	0.2 cm/s	0.15 cm/s
3000-kHz Argonaut-SL				
Averaging Interval	PowerPing	0.5-m Cell	2-m Cell	5-m Cell
1 minute	NO	2.5 cm/s	1.3 cm/s	0.8 cm/s
5 minutes	NO	1.1 cm/s	0.6 cm/s	0.4 cm/s
1 minute	YES	1.1 cm/s	0.5 cm/s	0.3 cm/s
5 minutes	YES	0.5 cm/s	0.2 cm/s	0.15 cm/s

B-8. Flow Data

With each sample, SLs that have a vertical beam can record cross-sectional area and flow.

- Cross-sectional area depends on the user-supplied channel geometry and stage.
- Typically, the accuracy of area data is most strongly influenced by the accuracy of channel geometry, rather than uncertainty in stage data.

The Argonaut-SW can also be programmed to calculate total volume in addition for flow rate.

- Total volume is the cumulative sum of flow rate multiplied by elapsed time, and represents the total volume of water that has passed the SW.
- Total volume can be accumulated continuously between files (when data collection is interrupted and restarted) or reset with each data file. Several methods are also provided to reset total volume (restart the accumulation at zero) within a data file, if required.
- Total volume can be output in a variety of different units as required by the user.

The accuracy of flow data depends on a few factors.

- Accuracy of cross-sectional area
- Accuracy of velocity data (§B-7.1)
- Method used to relate measured velocity to mean channel velocity (§B-5)

In general, the primary factor in determining the accuracy of flow data is the method used to relate measured velocity to mean velocity. Some guidelines:

- A well-established index calibration can give real-time flow accuracy of about 2-3% of the measured flow.
- Theoretical flow calculations in a regular channel (i.e., trapezoidal, concrete lined) may give accuracy of about 3-5%. This can be strongly affected by nearby intake or outlet structures, or by nearby changes in channel geometry (including bends in the channel).
- Theoretical flow calculations in natural streams are difficult. They can provide reasonable results in streams with a simple, uniform cross section, but are notably limited in wide, shallow streams where velocity can vary dramatically across the width of the stream.

The SL can also be programmed to calculate total volume in addition for flow rate.

- Total volume is the cumulative sum of flow rate multiplied by elapsed time, and represents the total volume of water that has passed the SL.
- Total volume is normally accumulated over the full span of each data file. Methods are provided to reset total volume (restart the accumulation at zero) within a data file, if required.
- Total volume can be output in a variety of measurement units as required by the user.

B-9. Special Considerations

This section lists some considerations you should be aware of when using an SL.

B-9.1 2D Horizontal Current Measurement

The SL measures the 2D water velocity in the plane formed by its two acoustic beams, parallel to the water surface (Figure B-2). The SL is typically installed near mid-water depth and can measure over a range up to 120 m (depends on system frequency). This allows the SL to be installed on an underwater structure, but still measure the water velocity away from any flow interference generated by the structure.

The definition of the SL measurement volume was given in §B-3.1. It is critical that no underwater obstacles are within the measurement volume as they may seriously affect velocity data accu-

racy. Before a deployment, you should perform a site survey (including data collection with the *SonUtils* BeamCheck utility) to check for beam obstructions, and to verify operating parameters.

Although SL transducers concentrate most of their 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 (e.g., the opposite bank) 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.

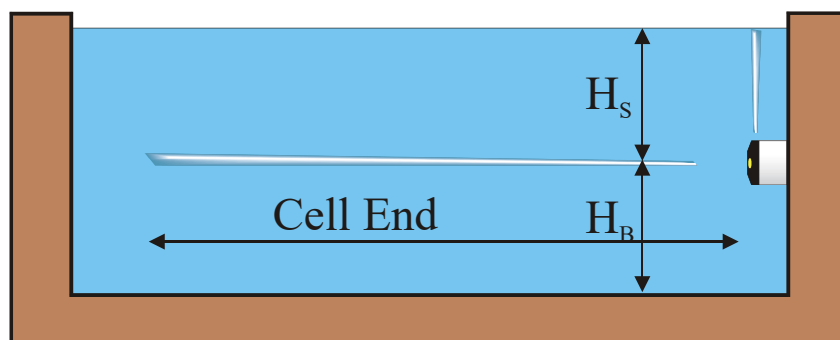
Although side lobe energy levels are very small, reflections from the opposite boundary may be much stronger than the return signal from the water, potentially affecting velocity measurements. The potential for side lobe interference exists in the last 10% of the measurement range. To avoid interference, the end of the measurement volume should be placed no closer than 10% of the total distance to the boundary (e.g., if opposite boundary is at 10 m, the end of the volume should be at 9 m). The SL includes software (BeamCheck module in *SonUtils*) to perform a site survey that helps you determine the maximum effective range for a particular installation.

When determining the maximum measurement range of the SL, you must also consider the aspect ratio, which relates measurement range to depth.

- Aspect ratio ([Figure B-7](#)) is the ratio of the horizontal measurement range (typically the Cell End parameter) to the vertical distance to the nearest boundary, either the surface or bottom.
- If operating in a river with variable depths, you should consider the aspect ratio at the shallowest parts of the stream, and not just the aspect ratio at the end of the measurement volume.
- In general, the SL will provide highly reliable data for aspect ratios up to 15-20. In some cases, it can provide reliable data at aspect ratios up to 40, but significant caution should be taken in these situations to verify the SL is not seeing any interference from the boundary.
- It is critical, especially with larger aspect ratios, to ensure the SL is installed level. If the SL beams are tilted up or down, this could cause the beams to hit the surface/bottom and may affect velocity data even at ranges where the aspect ratio is not particularly high.
- A careful site survey is critical to the proper setting of SL operating parameters.

B-9.2 Coordinate System

The SL supports three coordinate systems for velocity data — ENU (East-North-Up), XYZ, and Beam. The coordinate system setting is determined through a software setting in either the *ViewArgonaut* program or the [CoordSystem](#) direct command (§[C-8](#)) via *SonUtils*.



If $H_S < H_B$, Aspect Ratio = Cell End / H_S

If $H_B < H_S$, Aspect Ratio = Cell End / H_B

Figure B-7. Argonaut-SL Aspect Ratio

Here is a brief description of the coordinate systems used by SonTek.

- **ENU** – Requires an internal compass/tilt sensor. Allows velocity data to be recorded in ENU (East-North-Up) coordinates. Using the ENU coordinate system allows the SL to report velocity data independent of instrument orientation.
- **XYZ** – When using the XYZ coordinate system, velocity measurements are stored using a right-handed Cartesian coordinate system relative to the SL.
- **BEAM** – This coordinate system reports the along-beam velocity. Positive velocity is away from the SL; negative velocity is towards the SL.

ENU (East-North-Up) Coordinate System

For systems with a compass/tilt sensor, velocity can be recorded in Earth or ENU (East-North-Up) coordinates. Using the ENU coordinate system allows the SL to report velocity data independent of instrument orientation.

Most SL systems do include a compass/tilt sensor, and velocity data are normally recorded in the XYZ coordinate system (see below). Even when the SL does include a compass/tilt sensor, velocity data is often recorded in XYZ coordinates as the X-axis is commonly aligned with the primary flow direction of the river.

The translation of velocity data from XYZ to Earth (ENU) coordinates is enabled or disabled through commands to the SL and is transparent to the user. Selection of the coordinate system is through the **CoordSystem** command (§C-8) or through the *ViewArgonaut* program. When the compass is installed, heading, pitch, and roll data are stored with each sample.

When using ENU, velocity is reported in Earth coordinates regardless of the physical orientation of the SL. An SL mounted with an unknown orientation will provide velocity data consistent with the direction and speed of the water current itself. Since the SL is a 2D velocity sensor, the rotation to ENU velocity coordinates is only accurate if the SL is installed reasonably close to level (with the beams looking horizontal). If the SL is installed looking vertically up or down (such as in a narrow channel), the ENU velocity rotation will not be accurate.

The 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. As such, the SL should not be installed on a buoy or other object that will move during the course of an averaging interval.

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.
- The positive Y-axis lies along the axis of the sensor housing away from the transducer head.
- The orientation of the positive X-axis can be changed using the **ReverseXVelocity** command (§C-8). The use of this command allows the SL to report positive X-velocity for downstream flow regardless of which side of the river the SL is installed.

Beam Coordinate System

When using the BEAM coordinate system, the SL reports along-beam velocity — positive velocity is away from the SL; negative is towards the SL. The X-axis stamped on the transducer head always points to beam number 1. Beam velocities are normally used only for system testing at the factory, and are rarely used for field installations.

B-9.3 Real-Time Data Output

The SL offers several options for real-time data output.

- Only one output type (RS232, RS422, SDI-12, Modbus, analog outputs) can be used at a time.
- Both RS232 and RS422 can output the complete velocity and diagnostic data set (§B-6).
- The SDI-12 serial bus can output a portion of the SL sample data, including velocity and limited diagnostic data. Multi-cell velocity data (§B-7.2) can also be output in real-time.
 - For SDI-12 operation, the SL is programmed using the RS-232 serial bus, and then switched into SDI-12 mode.
 - The SL's SDI-12 interface is compatible with SDI-12 revisions 1.0, 1.1, 1.2, and 1.3. Options are provided to allow integration with a variety of data logger types.
 - When using SDI-12, the external data logger controls the timing of SL data collection.
- Using the Modbus Interface Module (Appendix I) to access data on a Modbus data collection network allows full access to all velocity and diagnostic data.
 - The Modbus protocol provides a standardized means to acquire reliable digital data from a variety of sensors.
 - Using the MIM allows the SL to be integrated with a Modbus data collection network.
- The SL can optionally be set up to generate analog output signals (Appendix F).
 - The SL can generate up to two analog output signals at the same time.
 - Analog outputs can be either 4-20 mA or 0-5 VDC (only one analog output type can be used on a single system at any given time).
 - An external analog converter is required to generate the analog output signals. One converter is required for each analog output signal.
 - Each analog output signal can represent one variable. The following variables are available: flow, total volume, stage, X-velocity, Y-velocity, velocity magnitude, SNR, temperature, and cell end location.
 - The user specifies the range of values represented by the analog output signal, customizing the output range to the particular environment.

The SL can record data to the internal recorder at the same time as any of the above real-time data outputs are being used. SonTek encourages users to record, regularly download, and archive data from the internal recorder to ensure full access to diagnostic data.

B-9.4 Sound Speed Considerations

The SL uses sound speed to convert the Doppler shift to water velocity. This section describes how to correct SL velocity data for errors in the sound speed used for data collection.

- The SL uses an internal temperature sensor for automatic sound speed compensation; user corrections are rarely needed.
- Sound speed corrections are normally required only if salinity has been incorrectly specified.

Speed of sound is a function of temperature and salinity. Generally, a temperature change of 5°C or a salinity change of 12 parts per thousand (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 0-60 ppt) gives a sound speed range of 1375-1600 m/s (total change of 14%).

SL velocities scale directly with sound speed; that is, a 1% error in sound speed results in a 1% error in velocity measurements. The following formula is used for post-processing corrections and can be directly applied to the output velocity data of the SL.

$$V_{\text{true}} = V_{\text{orig}} (C_{\text{true}} / C_{\text{orig}})$$

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 SL's measurement volume, although these errors are generally very small. To calculate the correct location of the SL's measurement volume, use the following formula.

$$Z_{\text{true}} = Z_{\text{orig}} (C_{\text{true}} / C_{\text{orig}})$$

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

B-9.5 Argonaut-SL Sampling Strategy Considerations

This section describes the sampling strategies supported by the SL ([Figure B-8](#)) — continuous sampling, reduced duty cycle sampling, and burst sampling. The terms used here are defined in [Appendix A](#) (Glossary) and [Appendix C](#) (Direct Commands) of the *Argonaut-SL System Manual*.

Continuous Sampling – Continuous sampling is used for real-time data collection when there are no power supply or data limitations. For continuous operation, **SampleInterval** is set to the same value as **AvgInterval**, burst sampling is disabled (**BurstMode NO**), and the SL continually collects data. The duty cycle for continuous operation is 100%.

Reduced Duty Cycle Sampling – For many autonomous deployments, the SL uses a reduced duty cycle where **SampleInterval** is greater than **AvgInterval**, and burst sampling is disabled (**BurstMode NO**). When the SL is not collecting data, it enters a low power state where power

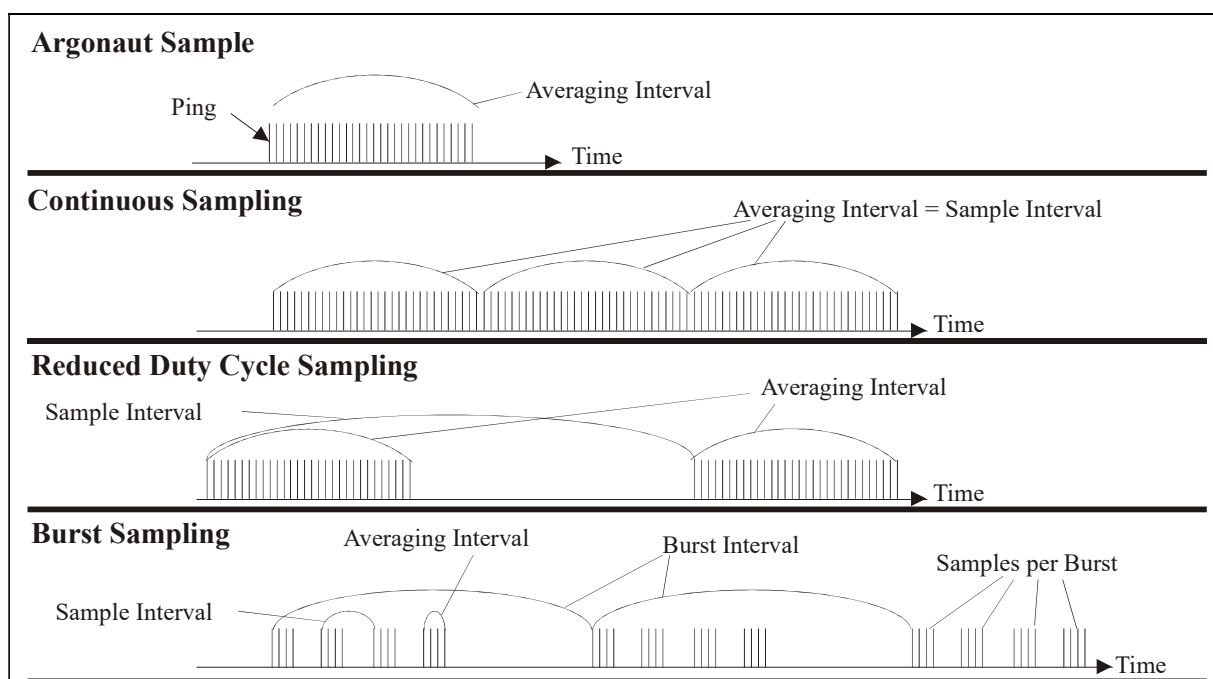


Figure B-8. Argonaut-SL Sampling Strategies

consumption is less than 1 mW. Duty cycle is calculated as the ratio of **AvgInterval** to **SampleInterval**. Battery life is extended by the inverse of the duty cycle. Example: an **AvgInterval** of 300 s (5 minutes) and a **SampleInterval** of 900 s (15 minutes) yields a 33% duty cycle and extends battery life by a factor of three.

$$\text{Duty cycle} = \text{AvgInterval} / \text{SampleInterval}$$

Burst Sampling – Burst sampling lets you obtain information about short-term flow variation without requiring continuous operation. In this mode, the SL 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.

$$\text{Duty cycle} = (\text{SamplesPerBurst} * \text{AvgInterval}) / \text{BurstInterval}$$

An example of burst sampling: set **AvgInterval** to 60 seconds, **SampleInterval** to 60 seconds, **BurstMode** to **YES**, **BurstInterval** to 900 seconds, and **SamplesPerBurst** to 5. With these settings, the SL will collect five one-minute samples in a row, and then enter a low power state for ten minutes. This gives a duty cycle of 33%, extending battery life by a factor of three. Burst sampling is used when there are no significant data storage limitations, but there are power limitations (so continuous sampling is not practical), and the user is interested in the short-term variation of velocity data.

B-10. Contact Information

Any questions, concerns, or suggestions can be directed to SonTek by telephone, fax, or email. Business hours are 8:00 a.m. to 5:00 p.m., Pacific Standard Time, Monday through Friday.

Phone : (858) 546-8327
Fax : (858) 546-8150
Email : inquiry@sontek.com (General information)
 sales@sontek.com (Sales information)
 support@sontek.com (Support information)
Web : <http://www.sontek.com>

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

Appendix C. Argonaut Direct Command Interface

This appendix describes the direct command interface. These commands are used to program and control Argonaut operation. This appendix covers the following system types:

- Argonaut-MD (Mooring Deployment)
- Argonaut-SL (Side Looking)
- Argonaut-SW (Shallow Water)
- Argonaut-XR (Extended Range)

Some commands are not available for all system types, and some commands are used in slightly different ways for different system types. When appropriate, these differences are described in detail with each command.

The direct command interface is used only when communicating with the Argonaut on the RS-232 or RS-422 serial bus. The SDI-12 interface uses a different, more limited, set of commands that are consistent with the SDI-12 protocol specifications (see [Appendix E](#)). You can enter the commands shown in this appendix using the terminal emulator functions of our *SonUtils* software program.

This appendix has the following sections.

- Section [C-1](#) describes communication protocols and settings.
- Section [C-2](#) provides an overview of the operational modes of the Argonaut.
- Section [C-3](#) gives an important notice about cycling the Argonaut power source.
- Section [C-4](#) presents the syntax rules for the direct-command interface.
- Section [C-5](#) gives a summary of all available commands.
- Sections [C-6](#) through [C-17](#) describe each command in detail.

C-1. Serial Communication Protocols and Settings

The Argonaut can communicate using several serial communication protocols (for additional information, see [Section 7](#) – Hardware).

- RS-232 – Full system control with cable lengths to 100 meters (300 feet)
- RS-422 – Full system control with cable lengths to 1500 meters (4900 feet)
- SDI-12 – Limited data logger interface with cable lengths to 100 meters (300 feet)

Some additional information about serial communication protocol:

- The official specification on maximum cable length for RS-232 and SDI-12 is 60 m (200 ft). However, using SonTek’s high quality shielded communication cable, we have found reliable communications with cable lengths to 100 m (300 ft).
- SDI-12 serial communication is standard with the Argonaut-SL, Argonaut-SW, and Argonaut-XR. It is not available with the Argonaut-MD.
- SDI-12 serial communication is available only in combination with RS-232; it cannot be used in combination with RS-422.
- The Argonaut is set at the factory to use either RS-232 or RS-422 serial communication protocol as specified by the customer. This setting is fixed and cannot be changed by the user.
- If the Argonaut supports SDI-12 serial communication, the user can switch between RS-232 and SDI-12. When SDI-12 is used, the Argonaut is first programmed using RS-232, and then switched to SDI-12 to interface with an external data logger. For details, see [Appendix E](#) (SDI-12 Interface).

The default communication settings for RS-232 and RS-422 protocols are as follows.

- 9600 baud – [Section 7](#) (Hardware) explains how to change baud rate setting
- 8 data bits (fixed)
- No parity (fixed)
- 1 stop bit (fixed)

C-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 Mode](#)

C-2.1 Command Mode

- Command mode is only available when using RS-232 or RS-422 serial communications.
- The Argonaut can send and receive commands related to all aspects of instrument operation.
- You can enter the command mode from any other mode except SDI-12 mode by sending a [BREAK](#) (§C-4).
- For details about how to enter command mode from SDI-12 mode, see [Appendix E](#).
- You can enter the command mode from the data acquisition or deployment mode using the run-time commands “[+++](#)” or “[===](#)” (§C-14).

- 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 ON**.
- 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.
 - Exception: When the Argonaut receives a **BREAK** (§C-4) to interrupt data collection, it enters command mode. If no valid command is received within five minutes, data collection restarts. This feature helps prevent loss of data in case an unintentional **BREAK** is received (e.g., a cable is cut or disconnected; user accidentally sends only a **BREAK** signal).

C-2.2 Data Acquisition Mode

- Data acquisition mode is used for real-time data collection during which you are typically connected to an external power supply and computer or RS-232/RS-422 data logger.
- Data acquisition mode is entered from command mode with the command **Start**. After the **Start** command, the Argonaut will first initialize and then begin data collection.
- In this mode, the Argonaut ignores the deployment parameters **StartDate** and **StartTime**.
- If the internal recorder is enabled (**Recorder ON**), data are output to both the serial port and recorder. If the recorder is disabled (**Recorder OFF**), data are sent only to the serial port.
- You can exit data acquisition mode and return to command mode by sending a **BREAK** (§C-4) or by using the run-time commands “+++” or “===” (§C-14).
- 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 enters the low-power state if **AutoSleep** is **ON** (the default setting). See §C-7 regarding **AutoSleep** and §C-14 regarding the effects of the power saving state on run-time commands.

C-2.3 Deployment Mode

- Deployment mode is used for autonomous data collection (i.e., internal recording, typically with battery power). Review **Section 5** for operational considerations for your system.
- 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.
- Data are also output in real-time to the serial port in deployment mode.
- While in deployment 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 enters the low-power state if **AutoSleep** is **ON** (the default setting). See §C-7 regarding **AutoSleep** and §C-14 regarding the effects of the power saving state on run-time commands.
- You can exit the deployment mode and enter the command mode by sending a **BREAK**.

C-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** (§C-4) or by sending the commands “+++” or “==” (§C-14).
- 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 (§C-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.
 - Exception: When the Argonaut receives a **BREAK** to interrupt data collection, it enters command mode. If no valid command is received within five minutes, data collection restarts. This feature helps prevent loss of data in case an unintentional **BREAK** is received (e.g., a cable is cut or disconnected; user accidentally sends only a **BREAK** signal).

C-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 E](#).
- 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 waits for 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. The data logger determines the start time of each sample.

C-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 will enter the mode it was last 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.
- In any data collection mode (data acquisition, deployment, or SDI-12), the Argonaut will open a new deployment on the internal recorder when power has been cycled.
 - If the recorder is full when this occurs, the Argonaut will continue data collection without recording, so that real-time data is still available.

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

- Always put the system in sleep mode before storing it to prevent draining the batteries.
- All Argonaut configurations can be put in sleep mode by establishing direct communications using *SonUtils*, and then sending the command **PowerOff** (§C-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** (§C-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 **before** turning the computer on or off.

C-4. Command Syntax

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

- The **BREAK** is an RS-232 or RS-422 serial communication signal that causes a hardware reset and places the instrument in command mode (§C-2.1). 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**; *SonUtils* (supplied with the system) uses **Alt+B** (a **BREAK** icon is also shown on the *SonUtils* screen).
- Note that the definition of a **BREAK** is different for SDI-12 communication protocol. See [Appendix E](#) for details.

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

- The Argonaut can be brought into the command mode (§C-2.1) from any other mode except SDI-12 mode (§C-2.5) by sending a **BREAK**. Note: For details about how to enter command mode from SDI-12 mode, see [Appendix E](#).
- All commands consist of a single keyword that may be followed by one or more ASCII parameters. The commands and parameters are not case sensitive (i.e., upper and/or lower case letters can be used).
- When the Argonaut has completed a command and is ready to accept another command, it will send the prompt character “>”.
- Parameters may be numeric (either integer or floating point), alphanumeric, or a combination (e.g., a date or time string).
- Commands must be terminated by a carriage return — <CR> (i.e., the **Enter** key).
- The Argonaut echoes every character as it is received (except for run-time commands received during data collection; §C-14).
- After receiving the <CR> that signals the end of the command string, the Argonaut echoes with an additional line feed character — <LF>.
- If the Argonaut recognizes a command as valid, it will transmit: <LF>**OK**<CR><LF>.
- 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 to 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 **before** turning the computer on or off.

C-5. Direct Command Summary

The tables below summarize the direct commands that can be used with the Argonaut, including any command abbreviations. These commands are grouped 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)
- s Text string (e.g., FLOW, CURRENT)
- 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)

Show Commands (§C-6)

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
Show Sdi12	S Sdi12	Display SDI-12 communication settings
Show AO	S AO	Display analog output parameters
Show FDatum	S FDatum	Display internal flow parameters
Show Geo	S Geo	Display channel geometry parameters (internal flow)
Show Druck	S Druck	Show Druck pressure sensor parameters
Show ParosFreq	S ParosFreq	Show Paros frequency pressure sensor parameters

System Commands (§C-7)

Command	Short	Function	Parameters
Start		Starts real-time data collection (enters data acquisition mode)	
Deploy		Starts autonomous deployment (deployment mode)	
SaveSetup	SSU	Save current parameters to EEPROM	
Defaults	DEF	Sets all parameters to factory defaults	
Ver		Shows CPU firmware version	
BoardRev		Shows electronics board revision number	
SerNum		Shows Argonaut serial number	
Date <date>		Shows / sets system clock date	yy/mm/dd
Time <time>		Shows / sets system clock time	hh:mm:ss
PowerOff	OFF	Puts Argonaut in sleep mode	
AutoSleep <mode>	AS	If ON, Argonaut enters reduced power state during gaps in data collection	On / Off
VoltageProtection <status>	VP	If ON, Argonaut monitors supply voltage for safety.	On / Off
OutMode <mode>	OM	Selects data output mode	Auto / Polled
OutFormat <format>	OF	Specifies output data format	Ascii, Binary, or SeaBird
Recorder <status>		Turns internal recording on or off	On / Off

Setup Commands (§C-8)

Command	Short	Function	Parameters
Temp <temperature>		Set default temperature (°C)	d.d
Sal <ppt>		Set default salinity (ppt)	d.d
TempMode <mode>	TM	Set temperature used for sound speed calculations	USER or MEASURED
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, SL and SW only)	d.d
CellEnd	CE	Set end location of measurement volume (Argonaut XR, SL and SW only)	d.d
DynBoundAdj <mode>	DBA	Set dynamic boundary adjustment mode (XR and SW only)	YES or NO
CoordSystem <system>	CY	Set coordinate system for velocities (ENU not available in SL and SW)	BEAM, XYZ or ENU
ReverseXVelocity <mode>	RXV	Change definition of +X velocity relative to sensor (SL and SW only)	YES or NO
AllowOneBeam <mode>	AOB	If yes, system switches to 1-beam solution if one transducer is blocked [SW only].	YES or NO
PowerPing <mode>		If yes, enables PowerPing for improved velocity performance.	YES or NO
IceDetection <mode>	ICE	If yes, system will attempt to detect ice on surface of open channel [SW only].	YES or NO
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

Deployment Commands (§C-9)

Command	Short	Function	Parameters
Deployment <name>		Set deployment name (5 characters max.)	ASCII text
Comments		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 <#>	SB	Set number of samples per burst	d

SDI-12 Interface Commands (§C-10)

Command	Short	Function	Parameters
Sdi12		Places the system in the SDI-12 mode	ON
Sdi12Address		Sets the SDI-12 interface address	d
Sdi12MultiAddress	SDIMA	Sets multi-address mode, used to collect multi-cell data with SDI-12 version 1.0	YES or NO

Recorder Commands (§C-11)

Command	Short	Function	Parameters
Dir or LD		List deployments currently on recorder	
Format		Erase all data from recorder	
RecStatus		Show recorder size and free space left	
Recorder <status>		Turns internal recording on or off	ON or OFF
CheckRecorderSpace		Returns recorder space in days of operation based on current parameter settings.	

Sensor Commands (§C-12)

Command	Short	Function	Parameters
Sensor		Display most recent temperature, pressure, and battery voltage data	CONT
PressOffset		Display pressure sensor calibration offset	
PressScale		Display pressure sensor calibration 1 st order coefficient	
PressScale_2		Display pressure sensor calibration 2 nd order coefficient	
ResetPressOffset	RPO	Prompts user to enter depth to change pressure offset to calibrate sensor.	
Level		Display range to surface using vertical beam (output in mm) (SW and SL with vertical beam only)	CONT
Druck		Display pressure and temperature data from optional Druck (RPT) sensor.	CONT
ParosFreq		Display pressure and temperature data from optional Paros frequency sensor.	CONT
CTD		Display conductivity, temperature, salinity, and pressure data from the optional CTD sensor.	CONT or TALK
YSI		Establish direct communications with optional YSI multi-parameter sensor.	TALK

Compass Commands (§C-13)

Command	Short	Function	Parameters
Compass		Display most recent heading, pitch, and roll data	CONT
Compass CAL		Perform a compass calibration	
Compass TYPE		Report compass type and firmware version	

Run-Time Commands (§C-14)

Command*	Short	Function
+++ or ===		Return to command mode (stop data collection)
O		Transmit last sample
T		Transmit Argonaut date and time
C+		Adjust real-time clock +1 second
C-		Adjust real-time clock -1 second
A		Transmit time left in current averaging interval (seconds)
V		Reset total volume calculation to 0.

*These commands available only in data acquisition mode and when **AutoSleep** is **OFF**.

Internal Flow Commands (§C-15)

Command	Short	Function	Parameters
ChannelType	CHT	Set/show channel type	Irregular, Trapezoid, Round, Ellipse, Culvert, Equation
SetGeometry	SCG	Set channel geometry	(interactive)
EditGeometry	ECG	Edit irregular channel geometry	d d.d d.d
SetArgElevation	SELEV	Set/show Argonaut elevation	d.d
VelEquation	VEQ	Set/show velocity equation type	Disabled, Theory, or Index
SetIndexCoef	SCF	Set index velocity equation coefficients	d.d d.d d.d
SaveFlowDatum		Save flow settings to non-volatile memory	
TotalVolume	TV	Select output units for total volume data.	d (value from 0 to 6)
RememberTotalVolume	RTV	Select method for accumulating total volume when data collection is interrupted and restarted	Continuous, Initialize or Reset
InitialVolumeValue	IVV	Set starting total volume value when in RememberTotalVolume mode Initialize	d.d
AllowVolumeReset	AVR	Enable/disable use of Reset Total Volume key on the Argonaut Flow Display	YES or NO
OutputVolumeRecord	(none)	Output last good flow and volume	
EraseVolumeBuffer	(none)	Erase record of previous total volume and flow measurements used for RememberTotalVolume mode Continuous	
TotalVolumeFlowCriteria	TVFC	Set flow criteria for accumulating total volume.	Disabled, or <criteria> d.d
TotalVolumeVelocityCriteria	TVVC	Set velocity criteria for accumulating total volume.	Disabled, or <criteria> d.d

Waves Commands (§C-16)

Command	Short	Function	Parameters
WaveSpectra	WS	Enables/disables recording of wave height spectra parameters with each sample	YES or NO
WaterDepth	WD	Sets deployment water depth for calculation of wave height spectra	d.d
RecordPSeries	RPS	Enables/disables recording of raw pressure time series used for wave spectra calculation	YES or NO

Analog Output Commands (§C-17)

Command	Short	Function	Parameters
AnalogOutputType	AOT	Select type of analog output signal used: Current (4-20 mA loop) or Voltage (0-5 VDC). Available only on systems with analog output option.	Disabled, Current, or Voltage
SetupAnalogOutput	SAO	Setup analog output specifications: channel number, output variable, and min/max limits. Only on systems with analog output option.	d s d.d d.d or d RESET

C-6. Show Commands

The “show” commands display current Argonaut parameter settings. Samples of these commands and their outputs are shown below. Note that the exact output format of each command will vary depending on the system type and the optional parameters that are installed.

Show Conf

- Displays the Argonaut hardware configuration.
- Example:

```
>Show Conf

Hardware Configuration
-----
System Type ----- SW
Sensor serial # ----- T18
Sensor frequency - (kHz) ----- 3000
Number of beams ----- 2
Beam Geometry ----- 2_BEAMS
Vertical Beam ----- YES
Slant angle - (deg) ----- 45.0
System Orientation ----- UP
Recorder installed ----- YES
Temperature sensor ----- YES
Internal SDI-12 Option ----- YES
Internal Flow Computations ----- YES
Analog Output Option ----- YES
Multi-cell Profiling Option ---- YES
```

Show System

- Displays the current system parameters.
- Example (click parameter for description or see §C-7):

```
>Show System
System Parameters
-----
CPU Ver ----- ARG 11.0
BoardRev ----- REV G
Date ----- 2003/04/23
Time ----- 08:50:23
AutoSleep ----- YES
VoltageProtection - YES
OutMode ----- AUTO
OutFormat ----- ENGLISH
Recorder ----- ON
```

Show Setup

- Displays the current data collection setup parameters.
- Example (click parameter for description or see §C-8):

```
>Show Setup
Setup Parameters
-----
Temp ----- 20.00 deg C
Sal ----- 0.00 ppt
TempMode ----- MEASURED
Sound Speed ---- 1481.6 m/s
AvgInterval ---- 120 s
SampleInterval - 900 s
CellBegin ----- 0.07 m
CellEnd ----- 6.00 m
DynBoundAdj ---- YES
```

```
CoordSystem ---- XYZ
RevXVelocity --- NO
AllowOneBeam --- YES
PowerPing ----- YES
IceDetection --- NO
ProfilingMode -- YES
Ncells ----- 5
CellSize ----- 0.30
BlankDistance -- 0.30
```

Show Deploy

- Displays the current deployment parameters.
- Example (click parameter for description or see §C-9):

```
>Show Deploy
DEPLOYMENT PARAMETERS
-----
Deployment ----- SAND
StartDate ----- 2003/04/21
StartTime ----- 18:15:59
AvgInterval ----- 120 s
SampleInterval -- 900 s
BurstMode ----- DISABLED
BurstInterval --- 1200 s
SamplesPerBurst - 1
Comments:
This is Comment Line 1 and I can be 60 characters in length.
This is Comment Line 2 and I can be 60 characters in length.
This is Comment Line 3 and I can be 60 characters in length.
```

Show SDI12

- Displays the current SDI-12 operating parameters. For SDI-12 details, see [Appendix E](#).
- Example (click parameter for description or see §C-10):

```
>Show Sdi12

SDI-12 Parameters
-----
Sdi12Address ----- D
Sdi12 Multi-Address - NO
```

Show AO

- Displays the current analog output parameters. See [Appendix F](#) for analog output details.
- Example (see §C-17):

```
>Show AO

AO SETTINGS
-----
Chan Parameter MinVal MaxVal
1          SNR      0     60 dB
2          LEVEL    0      5 ft
3          VELX     -3      3 ft/s
4          FLOW    -100    100 cfs
```

Show FDatum

- Displays the current internal flow datum parameters.
- Example (see §C-15):

```
>Show FDatum
Flow equation type is: INDEX
Q      = Vmean x Area
Vmean = Vintercept + Vmeas x (Vslope + (StageCoef x Stage))
```

```

Index coefficients:
  Vintercept:    0.049 (ft/s)
  Vslope:       0.950
  StageCoef:    0.000 (1/s)
Arg Elevation is: 0.00 (ft).
Flow channel type: TRAPEZOID
Width at bottom: 0.300 ft
Width at top:    1.000 ft
Vertical depth:  1.000 ft
TotalVolume output: 0 (DISABLED)
TotalVolume settings:
  0 (DISABLED)
  1 (CFS+ACRE-FT)
  2 (GPM+GAL)
  3 (MGD+GAL)
  4 (M3/S+M3)
  5 (L/S+L)
  6 (MLD+M3)
TotalVolume flow criteria: DISABLED
TotalVolume velocity criteria: DISABLED

```

Show Geo

- Displays the current channel geometry parameters (for internal flow calculations).
- Example (see §C-15):

```

>Show Geo

Flow channel type: TRAPEZOID
Width at bottom:   0.300 ft
Width at top:      1.000 ft
Vertical depth:    1.000 ft

```

Show Druck

- Displays the optional Druck pressure sensor calibration parameters.
- Example:

```

>Show Druck

Druck pressure sensor calibration data
-----
SN:
F0:      0.000e+00
X: 0.0000000e+00
Y: 0.0000000e+00
T0: 0.0000000e+00
D0: 0.0000000e+00
DT: 0.0000000e+00

K00: 0.0000000e+00  K01: 0.0000000e+00
K10: 0.0000000e+00  K11: 0.0000000e+00
K20: 0.0000000e+00  K21: 0.0000000e+00
K30: 0.0000000e+00  K31: 0.0000000e+00
K40: 0.0000000e+00  K41: 0.0000000e+00
K50: 0.0000000e+00  K51: 0.0000000e+00

K02: 0.0000000e+00  K03: 0.0000000e+00
K12: 0.0000000e+00  K13: 0.0000000e+00
K22: 0.0000000e+00  K23: 0.0000000e+00
K32: 0.0000000e+00  K33: 0.0000000e+00
K42: 0.0000000e+00  K43: 0.0000000e+00
K52: 0.0000000e+00  K53: 0.0000000e+00

```


Show ParosFreq

- Displays the optional Paros frequency pressure sensor calibration parameters.
- Example:

```
>Show ParosFreq
```

```
ParosFreq pressure sensor calibration data
```

```
-----
```

```
SN:
```

```
F0: 0.0000000e+00
```

```
U0: 0.0000000e+00
```

```
Y1: 0.0000000e+00
```

```
Y2: 0.0000000e+00
```

```
C1: 0.0000000e+00
```

```
C2: 0.0000000e+00
```

```
C3: 0.0000000e+00
```

```
D1: 0.0000000e+00
```

```
D2: 0.0000000e+00
```

```
T1: 0.0000000e+00
```

```
T2: 0.0000000e+00
```

```
T3: 0.0000000e+00
```

```
T4: 0.0000000e+00
```

```
T5: 0.0000000e+00
```

C-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 (§C-2.2).
- The system first saves all recently entered commands (i.e., does a **SaveSetup**).
- Data collection begins immediately (**StartDate** and **StartTime** are ignored).
- The system enters a low-power state between samples if **AutoSleep** is **ON**.
- Allows run-time commands (§C-14) to be used (only when **AutoSleep** is **OFF**).
- Argonaut data will be stored to the recorder if enabled (**Recorder ON**).

Deploy *(do not confuse with **Deployment** command, §C-9)*

- Starts autonomous data collection, putting the Argonaut into deployment mode (§C-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.
- The system enters a low-power state between samples if **AutoSleep** is **ON**.
- Prevents run-time commands (§C-14) from being used.
- Argonaut data are stored to the recorder regardless of the **Recorder** setting.

SaveSetup or SSU

- 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 ON** 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 **Section 7** (Hardware).
- See the individual command descriptions for default values.

Ver

- Outputs the version number of the CPU firmware.

BoardRev

- Outputs the revision number of the Argonaut CPU board.

SerNum

- Returns the instrument serial number from memory (should match the serial number stamped 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 2001/09/11** or **Date 01/09/11** are equivalent commands setting the date to September 11, 2001.
- Always check/set the internal clock before any deployment to ensure accurate time is used.

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.).
- Always check/set the internal clock before any deployment to ensure accurate time is used.

PowerOff or OFF

- Places the Argonaut into sleep mode (§C-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 (§C-14).
- Must be **OFF** to support the Flow Display (§Appendix H).

VoltageProtection or VP [ON|OFF]

- Default parameter: **ON**
- Without parameter: returns its current setting.
- When **ON**, Argonaut monitors battery voltage and will not allow a deployment to start below a certain voltage, and will shut down operation when battery drops below a critical level.
- When **OFF**, the Argonaut does not monitor input voltage level except for critical functions.
- For details about critical voltage levels, see §7.2.

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 Last Sample) causes the output of the last sample from the buffer to be sent (§C-14).

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

- Default parameter: **ASCII**
- Without parameter: returns its current setting.
- With parameter: Sets the units format of the real-time data output through the serial port.
 - For Argonaut-SL and Argonaut-SW systems: Also sets the units format for entering channel dimensions for flow data (§C-15).
 - For systems using Analog Outputs: Also affects the units used when entering analog output scaling parameters ([Appendix F](#)).
- Standard settings are **ENGLISH** (feet, ft/s, °F) and **METRIC** (meters, cm/s, °C).
- [Appendix D](#) describes the output data formats (**BINARY**, **ASCII**, **SEABIRD**, **METRIC**, **ENGLISH**).
- **SEABIRD** format is used only with the Argonaut-MD and the optional inductive modem.
- Data stored on the internal recorder are always stored in binary format ([Appendix D](#)).

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. Even when recording data to an external data logger we recommend setting this value to **ON**, as the internally recorded data provides additional diagnostic information.
- 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.
- If the recorder becomes full during a deployment, the Argonaut will continue to output data in real time (RS-232, SDI-12, or analog output) but will no longer record data to the internal recorder. We encourage you to monitor recorder space and to download data regularly to ensure full access to all Argonaut diagnostic data.

C-8. Setup Commands

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

• Temperature	• Reverse X Velocity
• Salinity	• Allow one beam solutions
• Temperature mode	• Power ping
• Averaging interval*	• Ice detection
• Sample interval*	• Profiling mode
• Cell begin	• Number of cells
• Cell end	• Cell size
• Dynamic boundary adjustment	• Blanking distance
• Coordinate system	

*Note: The timing commands **AvgInterval** and **SampleInterval** are also deployment commands (§C-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**.
- When **TempMode** is set to **MEASURED** (the default), the **Temp** value is not used. User input temperature is only required for factory system testing and specialized applications.
- See [Appendix B](#) (Principles of Operation) for the effect of sound speed on velocity data.

Sal [d.d]

- Default parameter: 34.5 (ppt) for the MD; 0.0 (ppt) for the SL, SW, and XR.
- Parameter range: 0.0 to 300.0 (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. Salinity should be entered with the best possible accuracy (ideally within 1 ppt) to ensure accurate sound speed data.
- See [Appendix B](#) (Principles of Operation) for the effect of sound speed on velocity data.

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**) entered via the **Temp** command, or the real-time value from the temperature sensor (**MEASURED**), is used for sound speed calculations. We recommend using **MEASURED** for the vast majority of Argonaut applications, unless there is reason to suspect the temperature sensor has been damaged.
- A setting of **USER** is only required for factory system testing and specialized applications.
- See [Appendix B](#) (Principles of Operation) for the effect of sound speed on velocity data.

AvgInterval or AI [d]

- Default parameter: 120 (seconds; 2 minutes)
- Parameter range: 10 to 3600 (seconds; maximum is equivalent to 60 minutes)
- Without parameter: returns its current setting (in seconds).
- When used with a valid parameter, sets the averaging interval, which is the period of time over which the instrument averages data to compute a mean water velocity profile.
- Settings as short as 10 s are allowed; however, we do not recommend settings less than 60 s. We recommend using the largest value based on the required data output rate. Settings of 120 s to 900 s (2 to 15 minutes) are typical — note that the longer the averaging interval, the lower the standard error of the velocity and flow data.
- See [Appendix B](#) (Principles) for the effect of **AvgInterval** on sampling strategies.
- This command can also be used as a deployment command (§C-9).

SampleInterval or SI [d]

- Default parameter: 1200 (seconds; 20 minutes)
- Parameter range: 10 to 43200 (seconds; maximum is equivalent to 12 hours)
- Without parameter: returns its current setting (in seconds).
- When used with a valid integer parameter, sets the sample interval (in seconds). Sample interval is the time between the start of successive samples.
- This determines the period from the start of one sample to the start of the next; it must be greater than or equal to **AvgInterval**. Setting this value greater than **AvgInterval** can reduce power consumption, as the system normally enters a low power state between samples. Example: using **AvgInterval** 300 and **SampleInterval** 900 gives a 1/3-duty cycle and reduces total power requirements by a factor of 3. Unless the application has significant power limitations, we recommend setting this value to be the same as **AvgInterval** to provide the best quality data. See §B-9.5.
- If **AvgInterval** > **SampleInterval**, then **AvgInterval** takes precedence. See [Appendix B](#) (Principles of Operation) for the effect **SampleInterval** has on sampling strategies.
- Note that when the Argonaut is interfaced with an external data logger using SDI-12, the data logger will control the interval between samples, and **SampleInterval** will be ignored.
- This command can also be used as a deployment command (§C-9).

CellBegin or CB [d.d] (SL, SW, and XR systems only)

- For parameter range, see [Table C-1](#).
- 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 (SW and XR systems) or horizontal (SL systems) distance from the transducer head.
 - For the Argonaut-SW: This determines the vertical distance (from the top of the system) where the SW begins its integrated velocity measurement. It is normally set to the minimum value (0.07 m) to allow the SW to measure the maximum portion of the water column. This might be set to a larger value if a physical structure on the bottom could cause flow interference in the bottom portion of the water column. It can also be set to a larger value when the SW is used as a side-mounted velocity sensor.

- The measurement volume size (the difference between **CellBegin** and **CellEnd**) must be at least some minimum size based on system type and frequency; see [Table C-1](#).
- See [Appendix B](#) (Principles of Operation) for definition of Argonaut measurement volume.

CellEnd or **CE** [**d.d**] (*SL, SW, and XR systems only*)

- For parameter range, see [Table C-1](#).
- 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 (SW and XR systems) or horizontal (SL systems) distance from the transducer head.
 - For the Argonaut-SW: This determines the vertical distance (from the top of the system) where the SW ends its integrated velocity measurement. It is normally set to the maximum value (6.00 m) to allow the SW to measure the maximum possible portion of the water column. This would normally only be set to another value when the system is used as a side-mounted velocity sensor. When **DynBoundAdj** is set to **YES**, the system will automatically adjust the cell end value based on the current water level.
- The measurement volume size (the difference between **CellBegin** and **CellEnd**) must be at least some minimum size based on system type and frequency; see [Table C-1](#).
- When **ReverseXVelocity** is set to **YES**, the system makes a change to real-time output data to indicate this difference. The reported **CellEnd** value is given as a negative number.
- See [Appendix B](#) (Principles of Operation) for definition of Argonaut measurement volume.

Table C-1. Minimum/Maximum Cell Begin, Cell End, and Measurement Volume Size

System Type	System Frequency	Cell Begin		Cell End		Minimum CE-CB
		Min Value	Max Value	Min Value	Max Value	
SL ¹	500 kHz	1.50 m	118.5 m	5.50 m	120 m	4.00 m
SL ¹	1500 kHz	0.20 m	19.5 m	1.20 m	20 m	1.00 m
SL ¹	3000 kHz	0.10 m	9.8 m	0.60 m	10 m	0.50 m
SL ²	1500 kHz	0.50 m	19.5 m	1.50 m	20 m	1.00 m
SL ²	3000 kHz	0.20 m	9.8 m	0.70 m	10 m	0.50 m
SW	3000 kHz	0.07 m	5.0 m	0.32 m	6 m	0.25 m
XR	750 kHz	0.8 m	46.5 m	4.30 m	50 m	3.50 m
XR	1500 kHz	0.50 m	19.5 m	1.50 m	20 m	1.00 m
XR	3000 kHz	0.20 m	9.8 m	0.70 m	10 m	0.50 m

Note: ¹ = Low-Profile Housing; ² = Original Canister Housing

DynBoundAdj or **DBA** [**YES|NO**] (*SW and XR systems only*)

- This command is available only in SW and XR systems.
- Default parameter: **YES**
- Without parameter: returns its current setting.
- When set to **YES**, the SW and XR systems dynamically adjust the values of **CellBegin** and **CellEnd** to reflect the changes in water level.
- The SW and XR systems behave differently in terms of how **DynBoundAdj** works:
 - For the Argonaut-SW:
 - The SW measures water level using its vertical acoustic beam.
 - It is not normally used in wave environments, so no wave height estimate is done.

- For open channel measurements (with a free water surface), the highest point for velocity measurements is immediately below the mean water level.
- For measurements in a full pipe, the highest point for velocity measurements is 0.8 times the range to the opposite wall of the pipe. This is done to avoid potential side-lobe contamination because the solid pipe boundary has different acoustic characteristics than a free water surface (see [Appendix B](#) – Principles of Operation for details).
- For the Argonaut-XR:
 - The XR measures mean water level elevation using pressure sensor data.
 - The XR estimates wave height as two times the standard deviation of pressure data.
 - The lowest water level is the mean water level minus the estimated wave height. This should represent the water level in the trough of the wave.
 - The highest point for velocity measurements is set to 0.9 times the lowest water level as estimated above.
- **DynBoundAdj** can be used in three different ways.
 1. To measure currents throughout the entire water column, set **CellBegin** to its minimum value, set **CellEnd** to its maximum value, and set **DynBoundAdj** to **YES**. For minimum and maximum values of **CellBegin** and **CellEnd**, see [Table C-1](#). Example: A 3000-kHz Argonaut-SW would use the following settings.


```
CellBegin 0.07
CellEnd 6.00
DynBoundAdj YES
```
 2. To monitor the currents in a fixed-thickness layer as close to the water surface as possible, set **CellEnd** to its maximum value, set **CellBegin** equal to **CellEnd** minus the desired layer thickness, and set **DynBoundAdj** to **YES**. For minimum and maximum values of **CellBegin** and **CellEnd**, see [Table C-1](#). Example: To set a 1500-kHz Argonaut-XR to measure a 3-m thick layer as close to the surface as possible, the settings would be:


```
CellBegin 17.00
CellEnd 20.00
DynBoundAdj YES
```
 3. To monitor currents in a fixed-thickness layer at some location in the water column, but to pull that layer back if the water level drops too low, set **CellBegin** to the desired starting location of the layer, set **CellEnd** to the desired ending location of that layer, and set **DynBoundAdj** to **YES**. Example: To set a 1500-kHz Argonaut-XR to measure a layer from 5 m to 12 m above the system, but to pull back this layer if the water level drops too low, the settings would be as follows. In this example, if water level was to drop to 10.5 m, the XR would measure a layer from 2.45 m to 9.45 m assuming no waves are present (this 7-m layer ends at $[0.9 \times 10.5 \text{ m}]$).


```
CellBegin 5.00
CellEnd 12.00
DynBoundAdj YES
```
- If **DynBoundAdj** is **NO**, the Argonaut uses the fixed location parameters (**CellBegin** and **CellEnd**). Example: When monitoring currents in a fixed layer (1 to 3 m above the system), use the following commands. These settings will not be adjusted with changing water level.


```
CellBegin 1.00
CellEnd 3.00
DynBoundAdj NO
```

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

- Default parameter: **ENU** (for MD and XR); **XYZ** (for SL and SW)
- 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. This is used only for factory system testing and specialized applications.
- **XYZ** causes velocity data to be recorded and output in the Cartesian (XYZ) coordinate system relative to the Argonaut. Recommended for SL and SW systems.
- **ENU** causes the Argonaut to use the compass/tilt sensor (if installed) data to transfer velocity data in Earth (East-North-Up) coordinates. Recommended for MD and XR systems; not available for SL and SW systems.
- See §B-9.2 for coordinate system details.

ReverseXVelocity or **RXV** [**YES**|**NO**] (*SL and SW systems only*)

- This parameter is available only in Argonaut-SL and Argonaut-SW systems, and is active only when **CoordSystem** is set to **XYZ**.
- Default parameter: **NO**
- Without parameter: returns its current setting.
- When used with a valid parameter, modifies the sign of the X-coordinate velocity.
 - **NO** causes XYZ velocity data to be reported in the standard coordinate system.
 - **YES** changes the XYZ coordinate system, reversing only the X-axis.
- This parameter is provided for applications where, because of how the system is installed, downstream flow gives a negative X-velocity. Setting **ReverseXVelocity** to **YES** will change the sign of the X-velocity, which can simplify data analysis.
- It is crucial to be aware of the setting of this parameter, particularly in an environment with reversing flows, as it has a major impact on reported velocity data.
- When **ReverseXVelocity** is set to **YES**, the system makes a change to real-time output data to indicate this difference.
 - The reported **CellEnd** value is given as a negative number.
 - Since **CellEnd** will, by its nature, always be positive, this change is an indicator in real-time data that **ReverseXVelocity** has been set to **YES**.
- See §B-9.2 for coordinate system details.

AllowOneBeam or **AOB** [**YES**|**NO**] (*SW systems only*)

- This parameter is available only in Argonaut-SW systems, and is active only when **CoordSystem** is set to **XYZ**.
- Default parameter: **YES**
- Without parameter: returns its current setting.
- When **YES**, the SW will monitor the signal strength from the two slanted (velocity) beams.
 - A significant difference in signal strength indicates that one beam is blocked, typically by sediment or debris.
 - When this occurs, the SW switches to a 1-beam velocity solution. The 1-beam solution assumes no vertical velocity (Y-velocity is 0). This is generally a reasonable assumption for the SW (i.e., that the velocity is purely in the horizontal or X direction).

- The Y-velocity is flagged as a bad value.
- The SW automatically returns to a 2-beam solution when both transducers are operating properly.
- When **no**, the SW will always use a 2-beam solution.
- When both beams are operational, a 2-beam solution always provides more robust and accurate velocity data. However, a 1-beam solution can still provide reliable results when one of the transducers has been blocked.
- When looking at recorded or output data, the following will be true if the SW has switched to a 1-beam solution.
 - The X-velocity will be calculated using only the non-buried transducer.
 - This affects both the single integrated velocity cell and multi-cell velocity data.
 - The Y-velocity will be reported as a bad value flag.
 - The recorded value will be 32767 (maximum integer value).
 - The real-time output value will be 32.767 m/s, or the equivalent value depending on the output format and output units selected.
 - This value is output in RS232, SDI-12, and Analog Output formats for the Y-velocity.
 - 1-beam solutions affect both the single integrated velocity cell and multi-cell velocity data.
 - *ViewArgonaut Processing* automatically recognizes the bad value flag, and does not plot the Y-velocity for those samples using a 1-beam solution.
 - Both signal strength (counts) and SNR (dB) are reported as zero for the blocked beam.
 - Signal strength and SNR are reported accurately for the remaining good velocity beam.

PowerPing [**YES**|**NO**] (*system frequencies above 500 kHz only*)

- This parameter is available only in systems with a frequency above 500 kHz.
- **PowerPing** cannot be used in combination with Wave Spectra measurements.
- Default parameter: **no**
- Without parameter: returns its current setting.
- When **no**, the system will use its normal operating mode.
- When **yes**, velocity measurement performance is improved.
- **PowerPing** changes how the Argonaut samples velocity.
 - This can significantly reduce the instrument uncertainty (noise) in velocity data for a given set of operating parameters.
 - Although power consumption increases, **PowerPing** may allow the Argonaut to use a shorter averaging time resulting in a net decrease in power needs.
- Using **PowerPing** will decrease the variance in velocity measurements.
 - To see the exact effect of decreased variance on your measurement accuracy, see the Principles of Operation (§B-7.2).
 - Decreased variance means a shorter averaging time can be used to reach a desired instrument uncertainty (noise) level. For example:
 - Depending on the system type and configuration, **PowerPing** will typically decrease variance by a factor of 3 to 6.

- If variance decreases by a factor of 4, averaging time needed for a given uncertainty will decrease by a factor of 4.
- In this case, an averaging time of 1 minute using **PowerPing** would be equivalent to an averaging time of 4 minutes using normal operation.
- The decrease in variance will depend on the measurement range of the system.
 - Using the maximum range of the system (i.e., 20 m for a 1500-kHz Argonaut-SL) gives a smaller decrease in variance.
 - Using half or less of the maximum range (i.e., 10 m for a 1500-kHz Argonaut-SL) gives the largest decrease in variance.
- **IMPORTANT:** The improved performance of **PowerPing** applies only to instrument generated uncertainty.
 - It is essential to consider real variations in water velocity and select an averaging time sufficient to remove those variations.
 - When operating in an environment with large natural variations in flow (e.g., wave influenced environments or rivers with large natural fluctuations), you should choose an averaging time long enough to remove those natural variations.
 - In many conditions, natural variations will be more important than instrument uncertainty when selecting the averaging time.
- When should you use **PowerPing**?
 - If there are no input power limitations, we recommend using **PowerPing** to provide optimal system performance.
 - If you have limited battery power:
 - We generally recommend using **PowerPing** with the longest possible averaging time based on available power and desired sampling scheme.
 - ♦ With **PowerPing YES**, we recommend a minimum averaging time of one minute.
 - An important exception to the above is a deployment environment in which a long averaging time is needed because of natural variations in the flow (e.g., operating in a wave environment).
 - ♦ In this case, select the averaging time based on the minimum time needed to remove natural variations. In a wave environment, this may be 5 minutes or longer.
 - ♦ If the power budget allows you to use **PowerPing** with the longer averaging time, we recommend using **PowerPing**. If the power budget does not allow the use of **PowerPing**, normal operating mode will still provide excellent data quality.
 - For the exact effect of **PowerPing** on power consumption, see §5.5.2.
- **Example #1:** 3000-kHz Argonaut-SW in a small natural stream
 - An SW is to be installed in a natural stream. It is to be run from a 12V battery with nominal capacity of 50 amp-hours. Data should be recorded every 15 minutes. The site will be serviced, with a new battery installed, every 90 days.
 - We recommend using a conservative value of 80% of nominal battery capacity.
 - Battery Power = Voltage (V) x Capacity (amp-hour) x 0.8 (for 80%)
 - For this example, this gives $(12.0 * 50.0 * 0.8) = 480 \text{ Wh}$.
 - For a 90-day battery life, the effective power consumption should be:
 - Effective Power = Battery Power (Wh) / Deployment length (hours)
 - For this example, this gives $(480 \text{ Wh} / (90 \text{ days} * 24 \text{ hours})) = 0.22 \text{ W}$.

-
- SW power consumption with **PowerPing** enabled is 1.2 W.
 - Duty cycle is averaging interval divided by sample interval.
 - Effective Power = Duty Cycle * System Power
 - For this example, we need a duty cycle of $(0.22 \text{ W} / 1.2 \text{ W}) = 0.18$ or less to achieve effective power of 0.22 W.
 - Using a 2-minute averaging interval and a 15-minute sampling interval (duty cycle = $2/15 = 0.13$), with **PowerPing** enabled, 480 Wh should power the SW for a period of $(480 \text{ Wh} / (1.2 \text{ W} * (0.13 \text{ duty cycle})) = 3000 \text{ hours} = 125 \text{ days}$. This leaves a comfortable safety margin on battery life for the 90-day service interval.
 - **Example #2:** 1500-kHz Argonaut-SL with vertical beam on ocean pier
 - An SL is to be installed on an ocean pier in a wave-influenced environment. Based on typical wave period, a minimum averaging time of 5 minutes is needed to remove wave influence. Data is to be recorded every 15 minutes.
 - With **PowerPing** enabled, SL power is 1.2 W. An averaging interval of 5 minutes and a sample interval of 15 minutes give a duty cycle of $(5/15 = 0.33)$. This yields an effective power consumption of $(1.2 * 0.33) = 0.40 \text{ W}$.
 - With **PowerPing** disabled, SL power is 0.7 W. An averaging interval of 5 minutes and a sample interval of 15 minutes give a duty cycle of $(5/15 = 0.33)$. This yields an effective power consumption of $(0.7 * 0.33) = 0.23 \text{ W}$.
 - The above power consumption values should be used in conjunction with the expected battery capacity and the expected service interval. If the power consumption is sufficient to use **PowerPing**, it should be enabled. If power limitations do not allow the use of **PowerPing**, the Argonaut will still provide excellent data quality.

IceDetection or **ICE** [**YES**|**NO**] (*SW systems only*)

- This parameter is available only in Argonaut-SW systems.
- Default parameter: **NO**
- Without parameter: returns its current setting.
- When **NO**, the SW does not look for evidence of ice coverage.
- When **YES**, the SW will look for evidence of ice coverage on the surface of an open channel.
- **IceDetection** uses data from the temperature sensor.
 - If temperature is less than 5° C, the SW will look for evidence of ice coverage.
 - If temperature is greater than 5° C, the SW assumes no ice coverage is present and returns a score of 0.
- The SW uses the acoustic profile of signal strength and velocity to determine the presence of ice coverage.
 - This is a proprietary algorithm developed by SonTek/YSI.
 - An **IceDetection** score less than 50 indicates no significant ice is present.
 - An **IceDetection** score greater than 150 indicates complete ice coverage.
 - An **IceDetection** score between 50 and 150 can indicate partial ice coverage, floating ice, or variable ice conditions.
 - If the **IceDetection** score is greater than 50, the SW will pull the end of the sampling volume back from the bottom of the ice.
 - Because of the nature of the ice bottom, the SW will see side lobe interference from the bottom of the ice. When ice coverage is present, the SW is not able to measure all the way to the surface (unlike with a free water surface where we can measure velocity all the way to the surface).
 - When the **IceDetection** score is greater than 50, the SW ends the sampling volume at a range of 0.8 times the distance to the bottom of the ice.
 - This change in the sampling volume size can be seen in the CellEnd data recorded by the system.
 - Because the SW makes use of the acoustic signal strength and velocity profile, the system requires a minimum depth to make the **IceDetection** measurements.
 - The SW requires a minimum of 0.30 m (1 ft) of water from the top of the system to the bottom of the ice (or to the water surface) to attempt **IceDetection** measurements. If the depth is less than this requirement, the **IceDetection** score will be reported as 0.
 - In depths between 0.30 m (1 ft) and 0.70 m (2.5 ft), the **IceDetection** score will have a slightly different response. In general, in these depths the **IceDetection** score will be lower than for similar ice conditions in deeper water.
 - In depths greater than 0.70 m (2.5 ft), **IceDetection** algorithms function optimally.
- See *Argonaut-SW System Manual* for sample ice detection data.

Profiling Mode Commands

The following four commands (**ProfilingMode**, **NCells**, **CellSize**, and **BlankDistance**) are available on systems with the multi-cell velocity profile feature enabled. This feature is available only on Argonaut-SL, Argonaut-SW, and Argonaut-XR systems. Profiling Mode 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. See §B-7.2 for Profiling Mode information.

ProfilingMode or **PM** [**YES|NO**] (*SL, SW, and XR systems only*)

- This command enables or disables the multi-cell profiling mode of operation.
- 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 **ProfilingMode** to **YES** requires you to enter values for number of cells (**NCells**), cell size (**CellSize**), and blanking distance (**BlankDistance**). Data for each cell is collected and output in the format described in **Appendix D**.

NCells or **NC** [**d**] (*SL, SW, and XR systems only*)

- This command sets the number of cells in which to collect profile data.
- Default parameter: **1**
- Parameter range: **1** to **10**
- 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**] (*SL, SW, and XR systems only*)

- This command sets the size of the range cell to be used in the profiling mode.
- Default parameter: Default is for profiling mode disabled (**ProfilingMode NO**).
- Parameter range: See **Table C-2**.
- 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.
- **CellSize** determines the distance (vertical distance for SWs and XRs; horizontal distance for SLs) from the start of one cell to the start of the next cell. This defines the resolution of the velocity profile (in meters). Keep in mind there are advantages and disadvantages to selecting small or large cell sizes:
 - Small cells allow you to get higher-resolution profile data, especially in shallow water. However, more small cells are needed to profile to a specific range, which means that individually analyzing small-cell data can be a time consuming process.
 - Large cells make data analysis of individual cells easier. However, the resolution of the profile will be lower, which could make it more difficult to analyze shallow water data.

BlankDistance or **BD** [**d.d**] (*SL, SW, and XR systems only*)

- This command sets the blanking distance to be used in the profiling mode.
- Default parameter: Default is for profiling mode disabled (**ProfilingMode NO**).
- Parameter range: See **Table C-2**. Note: Most applications will use the minimum blanking distance; a higher value is only needed for special applications.
- Without parameter: returns its current setting in meters.

- When used with a valid parameter, sets the blanking distance to this value. Note: This parameter is always in meters regardless of the **OutFormat** setting.
- Blanking distance refers to the region in front of the transducers where no measurements can be made. This parameter is measured as the distance (in meters) from the instrument's transducers to the start of the first range cell (also referred to as depth cell). The blanking region is required to give time for the transducers and electronics to recover from the transmit pulse. That is to say, the transducers/electronics need time to switch from the transmit mode to the receive mode.

Table C-2. Minimum/Maximum Cell Size and Blanking Distance Settings

System Type	System Frequency	Cell Size		Blanking Distance	
		Min Value	Max Value	Min Value	Max Value
SL ¹	500 kHz	1.5 m	30 m	1.50 m	118.5 m
SL ¹	1500 kHz	0.4 m	8 m	0.20 m	19.5 m
SL ¹	3000 kHz	0.2 m	4 m	0.10 m	9.8 m
SL ²	1500 kHz	0.4 m	8 m	0.50 m	19.5 m
SL ²	3000 kHz	0.2 m	4 m	0.20 m	9.8 m
SW	3000 kHz	0.2 m	4 m	0.07 m	5.0 m
XR	750 kHz	0.8 m	15 m	0.8 m	48.8 m
XR	1500 kHz	0.4 m	8 m	0.50 m	19.5 m
XR	3000 kHz	0.2 m	4 m	0.20 m	9.8 m

Note: ¹ = Low-Profile Housing; ² = Original Canister Housings

C-9. Deployment Commands

Deployment commands affect parameters used for autonomous deployments. See [Section 5](#) and [Appendix B](#) for operational considerations for autonomous deployments.

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

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. Note that two of the timing commands ([AvgInterval](#) and [SampleInterval](#)) are also Setup Commands (§C-8).

Deployment [**name**] *(do not confuse with [Deploy](#) command, §C-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 command determines the file name under which data are stored to the internal recorder. You can select up to five letters and/or numbers. The file name on the recorder is the user-entered deployment name with a 3-digit number indicating the sequence of files under this name. The system automatically adds the three digits, starting with 001 and incrementing for each file thereafter. For example, if you use **Deployment TEST**, the first data file started by the first [Deploy](#) or [Start](#) command would be recorded as **TEST001**. If data collection is stopped and re-started without changing the deployment name, the numbers will increment; e.g., **TEST002**, **TEST003**, etc.
- All data from a single [Deploy](#) or [Start](#) command are stored in one file.

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](#) (§C-7) in the correct format, sets the starting date for data collection. This date is used only in deployment mode (using the [Deploy](#) command, §C-7).
- If the start date/time is 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](#) (§C-7) in the correct format, sets the starting time for data collection. This time is used only in the deployment mode (using the [Deploy](#) command, §C-7).
- If the start date/time is before the current date/time, data collection begins immediately.

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

- See the description for [AvgInterval](#) under Setup Commands (§C-8).

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

- See the description for [SampleInterval](#) under Setup Commands (§C-8).

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

- Default parameter: **NO**
- Without parameter: returns its current setting.
- **NO** disables burst sampling; **YES** enables burst sampling.
- When using burst sampling (**BurstMode YES**), two additional parameters ([BurstInterval](#) and [SamplesPerBurst](#)) are used to determine the relative timing of Argonaut samples. See [Appendix B](#) (Principles of Operation) for a description of the burst sampling strategy.

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

- Default parameter: **1200** (seconds; maximum is equivalent to 20 minutes)
- Parameter range: **1** to **43200** (seconds; 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). **BurstInterval** is the time between the start of successive bursts. See [Appendix B](#) (Principles of Operation) for a description of the burst sampling strategy.
- 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. **SamplesPerBurst** is the number of velocity samples collected in each sampling interval with each burst. **SamplesPerBurst** multiplied by [SampleInterval](#) must be less than or equal to [BurstInterval](#). **SamplesPerBurst** is only used when burst sampling is enabled (**BurstMode YES**). See [Appendix B](#) (Principles of Operation) for a description of the burst sampling strategy.
- This command is ignored unless [BurstMode](#) is set to **YES**, and data collection is started with the [Deploy](#) command.

C-10. SDI-12 Interface Commands

Starting with firmware version 7.5, the Argonaut-SL, SW, and XR systems offer internal SDI-12 capabilities that require no external devices or converters. The Argonaut-to-SDI-12 interface commands are described in this section. [Appendix E](#) describes the internal SDI-12 interface and command structure in detail.

SDI12 ON

- Places an Argonaut-SL, SW, or XR system in the SDI-12 interface mode.
- To exit the SDI-12 interface mode, you would use the SDI-12 command of ?EXIT!. See [Appendix E](#) for details.

SDI12Address [d]

- Default parameter: 1
- Parameter range: 0 through 9, a through z, A through Z
- 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.

SDI12MultiAddress or SDIMA [NO|YES]

- Default parameter: NO
- Without parameter: returns either the current SDI-12 multi-address setting (if the SDI-12 interface option is installed), or an error message (if the SDI-12 option is not installed).
- NO disables multi-address operation; YES enables multi-address operation.
- Multi-address operation is used to collect the multi-cell velocity profile data from a data logger that is running SDI-12 protocol version 1.0. For a description of how to use multi-address operation, see [Appendix E](#).

SDI12AutoSampling or SDIAS [NO|YES]

- Default parameter: YES
- Without parameter: returns either the current SDI-12 auto sampling setting (if the SDI-12 interface option is installed), or an error message (if the SDI-12 option is not installed).
- NO disables SDI-12 auto sampling; YES enables SDI-12 auto sampling.
- Auto sampling is used to allow the Argonaut to collect data if an extended period of time passes without receiving a command from the data logger; this is to prevent the unnecessary loss of data in the event of a problem with the data logger or cable (§E-2).

C-11. Recorder Commands

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

- Listing files
- Checking recorder capacity

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. Erased data can NOT be recovered.
- 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 typically takes 30-60 seconds).

RecStatus

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

Recorder [ON|OFF]

- See [Recorder](#) description under System Commands (§C-7).

CheckRecorderSpace *or* **CRS**

- Returns both the number of free bytes currently available on the recorder, and the recorder capacity (in days) based on current operating parameters.

C-12. Sensor Commands

In normal Argonaut operation, commands to the sensors are handled automatically, and no direct commands need to be sent. These commands are for diagnostics only. See [Section 7](#) (Hardware) for information about the temperature and pressure sensors. Note: Some sensors are not available as options for all systems (e.g., pressure sensors are not available with Argonaut-SW systems).

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 (VDC) data.
- With parameter: Display continuously the temperature (°C), pressure (decibar), and battery voltage (VDC) data.
- Press <Enter> to stop the continuous output of data.

PressOffset

- Display the pressure sensor offset value.

PressScale

- Display the pressure sensor calibration 1st order coefficient.

PressScale_2

- Display the pressure sensor calibration 2nd order coefficient value.

ResetPressOffset or RPO *(only in systems with pressure sensor)*

- Prompts user to enter the current depth of the Argonaut (distance from the water surface to the top of the system).
 - If **OutFormat** setting is **English**, this value should be entered in feet.
 - For any other **OutFormat** setting, this value should be entered in meters.
 - If the system is in air, enter a value of 0.
- The system uses this value to calibrate the pressure-offset value (**PressOffset**) for changes in barometric pressure. System pressure readings will now reflect true water depth.

Level [CONT] *(SL and SW systems only)*

- This command is available only on SL and SW systems that have the vertical beam.
- Without parameter: Display once the currently measured range to the water surface (mm).
- With parameter: Display continuously the currently measured range to water surface (mm).
- The level data returned by this command are raw, unaveraged data. The Argonaut uses an intelligent averaging algorithm with vertical beam data so that if occasional samples return incorrect readings, the final average value during data collection is not affected.
- Press <Enter> to stop the continuous output of data.

Druck [CONT]

- Available only in systems that include the optional Druck RPT (Resonant Pressure Transducer) pressure sensor.
- Without parameter: Display once the current pressure (decibar), temperature (°C), and frequency (Hz) output of the Druck sensor.
- With parameter: Display continuously the current pressure (decibar), temperature (°C), and frequency (Hz) output of the Druck sensor.
- Press <Enter> to stop the continuous output of data.

ParosFreq [CONT]

- Available only in systems that include the optional Paros frequency pressure sensor.
- Without parameter: Display once the current pressure (decibar), temperature (°C), pressure frequency (Hz), and temperature frequency (Hz) output of the Paros sensor.
- With parameter: Display continuously the current pressure (decibar), temperature (°C), pressure frequency (Hz), and temperature frequency (Hz) output of the Paros sensor.
- Press <Enter> to stop the continuous output of data.

CTD [CONT | TALK]

- This command is available only in systems that include the optional CTD sensor.
- Without parameter: Display once the current temperature (°C), conductivity (Siemens per meter), pressure (decibar), and salinity (ppt) output of the CTD sensor.
- With parameter **CONT**: Display continuously the current temperature (°C), conductivity (Siemens per meter), pressure (decibar), and salinity (ppt) output of the CTD sensor.
- Press <Enter> to stop the continuous output of data.
- With parameter **TALK**: Establishes direct serial communication with the external CTD. See the CTD sensor manual for details on sending commands to the CTD. To return to the command mode, type “+++” or send a **BREAK** to the Argonaut.

YSI [TALK]

- This command is available only in systems that include the optional YSI multi-parameter sensor.
- Without parameter: returns error message.
- With parameter **TALK**: Establishes direct serial communication with the external YSI. See the YSI sensor manual for details on sending commands to the YSI. To return to the command mode, type “+++” or send a **BREAK** to the Argonaut.

C-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 7](#) (Hardware). Note: Not all systems are equipped with a compass/tilt sensor; at present, only MD, SL, and XR systems can be equipped with a compass.

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 7](#) (Hardware) for more information about compass calibration and for details on interpreting the calibration score.

Compass TYPE

- Report compass type and compass firmware version. The Argonaut uses two different compass types (TCM2 and SonTek) depending on system type and production date. This command reports the currently installed compass version.
- Sample command outputs for each compass type are shown below.

```
>Compass TYPE
Compass Type...TCM2
Version.....2.820
Compass is NOT matrix capable.
OK
```

```
>Compass TYPE
Compass Type...SonTek/YSI
Version.....1.000
Compass is matrix capable.
OK
```

- See [Section 7](#) (Hardware) for more information about the different compass types.

C-14. Run-Time Commands

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

- Run-time commands are commonly used (but not required) while using the **POLLED** output mode (see **OutMode** in §C-7). This causes the system to output a data sample only on request, and not to output data automatically at the end of a sample.
- Run-time commands should normally be used with **AutoSleep** set to **NO** (§C-7). This ensures the system will always respond to characters received through the serial port.
- You can also use run-time commands when **AutoSleep** is **YES**. To do this, first re-establish communications with the system. Do this by sending a few carriage returns (<CR>; ASCII character code 13) over the communications cable using a terminal emulator such as our *SonUtils* program. 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.
- Note that at some periods of data collection, it may take up to two seconds for the Argonaut to respond to a run-time command.

+++ or === (*alternative BREAK command*)

- Sending three + characters, three = characters, or any combination of three + or = characters (i.e. +=+), in succession causes the Argonaut to terminate data collection and return to the command mode (§C-2.1).
- The characters must arrive within a time span of three 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 (§C-2.4). 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 without the quotes) tells the Argonaut to output the last data sample collected. Note: This command is not 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 **OutFormat** (**BINARY**, **ASCII**, **METRIC**, **ENGLISH**; see [Appendix D](#)).
- 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 **OutFormat** setting.
 - 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>
 - If **OutFormat** is set to **BINARY**, 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 (<i>e.g.</i> , 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 D 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 **OutFormat**.
 - 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>

- If **OutFormat** is set to **BINARY**, 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 D explains checksum calculation.)

V (*reset total volume*)

- The **v** command is used to reset the total volume calculation.
- When this command is received, the total volume is reset to 0, and then begins again to accumulate total volume data.
- The time and type of reset (based on a run-time command) are also recorded in the data file.

C-15. Internal Flow Commands

The following commands set parameters related to internal flow calculations. Internal flow commands are only available on Argonaut-SL and Argonaut-SW systems that use a vertical beam for water level measurement. For details on internal flow calculation features, see [Appendix G](#).

VelEquation or **VEQ** [**DISABLED** | **THEORY** | **INDEX**]

- Without parameter: displays the currently selected velocity equation type.
- With parameter: sets the type of equation used for the mean-velocity calculation method, which is used to relate the water velocity measured by the Argonaut to the mean water velocity in the channel (used for flow calculations).
 - **DISABLED** – Flow computations are not performed, output, or recorded.
 - **THEORY** – This selects a theoretical relationship for computing flow. A 1/6-power law relationship, using the location of the velocity cell relative to the channel geometry, is used to convert measured velocity to mean channel velocity. The theoretical relation takes into account the location of the Argonaut water velocity measurement relative to the overall vertical velocity profile. This relation can provide good results in regularly shaped channels, but is limited in natural streams where an **INDEX** relation is normally needed.
 - **INDEX** – A user-supplied index relationship can be used to relate velocity to mean velocity in the channel. This requires three index coefficients (*Vintercept*, *Vslope*, and Stage Coefficient) to define the relationship between measured and mean velocity. These index coefficients are derived through regression analysis. The *VIntercept*, *VSlope*, and *StageCoef* index coefficients are entered using the [SetIndexCoef](#) command.

$$V_{\text{mean}} = V_{\text{intercept}} + V_{\text{meas}} * (V_{\text{slope}} + (\text{StageCoef} * \text{Stage}))$$

where

V_{mean}	= mean velocity in the channel
$V_{\text{intercept}}$	= user-supplied velocity offset (cm/s or ft/s)
V_{meas}	= measured velocity
V_{slope}	= user-supplied velocity scale factor (no units)
StageCoef	= user-supplied water depth coefficient (1/s)
Stage	= measured stage (total water depth in m or ft)

After V_{mean} is calculated, Flow can then be computed as:

$$\text{Flow} = \text{Area} \times V_{\text{mean}}$$

Note that, in general:

1. The **Index** method provides for a better data set than the **Theory** method. However, the user must provide information that may be difficult to obtain. Developing an index relationship involves numerous independent flow measurements and detailed data analysis to develop the coefficients of the index equation.
2. In natural streams (**Irregular** channel type), the preferred method is **Index**. This is because unusual channel geometry can cause large flow variations across the width of the channel, and an accurate theoretical flow calculation can be very difficult to determine.
3. In **Trapezoid**, **Round pipe**, or **Ellipse** pipe installations, flow data obtained from the **Theory** methods can provide excellent results.

ChannelType or **CHT** [**IRREGULAR** | **TRAPEZOID** | **ROUND** | **ELLIPSE** | **CULVERT** | **EQUATION**]

- Default parameter: **IRREGULAR**
- Without parameter: returns the current **ChannelType** setting.
- With parameter: sets the current **ChannelType** setting to that value.
- Each channel type requires a different set of parameters to define precisely the channel geometry. These parameters are set using the **SetGeometry** command.
 - **IRREGULAR** (SL: [Figure C-](#); SW: [Figure C-2](#)) – This is usually a natural streambed whose shape is defined by up to 20 survey points (X, Y) over the cross-section of the stream. The survey points must follow a few rules:
 - The elevation of the first point (Y₁) must be greater than any other point.
 - Survey points must be entered in order of increasing width (X).
 - **TRAPEZOID** (SL: [Figure C-3](#); SW: [Figure C-4](#)) – Typically, a concrete-lined channel whose shape is defined by three parameters – **Bottom Width**, **Top Width**, and **Channel Depth**.
 - **ROUND** ([Figure C-5](#)) – A round pipe of a given **Diameter**. Note that only the SW is intended for installation in pipes; the SL is not designed for pipe installation.
 - **ELLIPSE** ([Figure C-6](#)) – An elliptical pipe of a given **width** and **Height**. Note that only the SW is intended for installation in pipes; the SL is not suitable for pipe installation.
 - **CULVERT** (SL: [Figure C-7](#); SW: [Figure C-8](#)) – Typically, a concrete-lined channel whose shape is defined by three parameters – **Bottom Width**, **Top Width**, **Channel Depth**. The channel is closed on top – commonly seen where a canal or stream passes under a road.
 - **EQUATION** – In some situations, the most effective method of calculating channel area is to use an empirically developed equation between stage and area. The Argonaut supports two equation types (quadratic and power), and up to five separate equations can be defined for different stage ranges. When using a stage/area **EQUATION**, you should always develop an index velocity relation, as no information is available for a meaningful theoretical flow calculation. You are responsible for verifying the accuracy and validity of the stage/area relationship.

SetGeometry or **SCG**

- This is an interactive command whose function depends on the **ChannelType** setting. The system will prompt you to enter all needed channel geometry parameters.
- These parameters must be entered in either metric (meters) or English (feet) units based on the setting of **OutFormat**.
- See the following examples and [Section 5](#) for information on how to use this command.
 - **Irregular**: Requires entries for up to 20 survey points to define the geometry of the channel. The elevation of the first point (Y₁) must be greater than any other point. Survey points must be entered in order of increasing width (X).
 - Example:


```
>ChannelType Irregular    Refer to Figure C- (SL) or Figure C-2 (SW).
>SetGeometry
Enter Channel Geometry points in the following format:
Horiz distance dd.d (ft) Elevation (re Datum) dd.dd (ft).
Example 5.5 4.25
Press ENTER after each entry; To exit enter -1
Point 1:  1.0 10.0  X,Y survey points are used to define the shape of
Point 2:  3.0 5.0   the channel. OutFormat determines entry units.
Point 3:  5.0 1.0
```

↓ ↓ ↓ ↓ ↓
 Point 13: **-1** *Enter -1 to finish.*
 To display geometry use Show Geo.

- **Trapezoid:** Requires entries for bottom width, top width, and channel depth.

- **Example:**

```
>ChannelType Trapezoid                      See Figure C-3 (SL) or Figure C-4 (SW).
OK
>SetGeometry
Enter trapezoid channel parameters as prompted.
Enter -1 to abort command.

Enter width at bottom (ft): 5.0      Enter dimensions as prompted.
Enter width at top (ft):      15.0      OutFormat determines entry units.
Enter channel depth (ft):      10.0
To display geometry use Show Geo.
```

- **Round:** Requires entry for pipe diameter.

- **Example:**

```
>ChannelType Round                          See Figure C-5.
OK
>SetGeometry
Enter round pipe diameter as prompted.
Enter -1 to abort command.

Enter pipe diameter (ft): 4.0      Enter diameter as prompted. If
To display geometry use Show Geo. OutFormat determines entry units.
```

- **Ellipse:** Requires entries for pipe width and pipe height.

- **Example:**

```
>ChannelType Trapezoid                      See Figure C-6.
OK
>SetGeometry
Enter elliptical pipe dimensions as prompted.
Enter -1 to abort command.

Enter pipe width (ft):      6.0      Enter pipe width as prompted.
Enter pipe height (ft):      4.0      Enter pipe height as prompted.
To display geometry use Show Geo. OutFormat determines entry units.
```

- **Culvert:** Requires entries for bottom/top width and channel depth.

- **Example:**

```
>ChannelType Culvert                        See Figure C-7 (SL) or Figure C-8 (SW).
OK
>SetGeometry
Enter dimensions.
Enter -1 to abort command.

Enter width at bottom (ft): 15.0      Enter dimensions as prompted.
Enter width at top (ft):      15.0      OutFormat determines entry units.
Enter channel depth (ft):      5.0
To display geometry use Show Geo.
```

- **Equation:** Requires various parameter entries.

- **Example:**

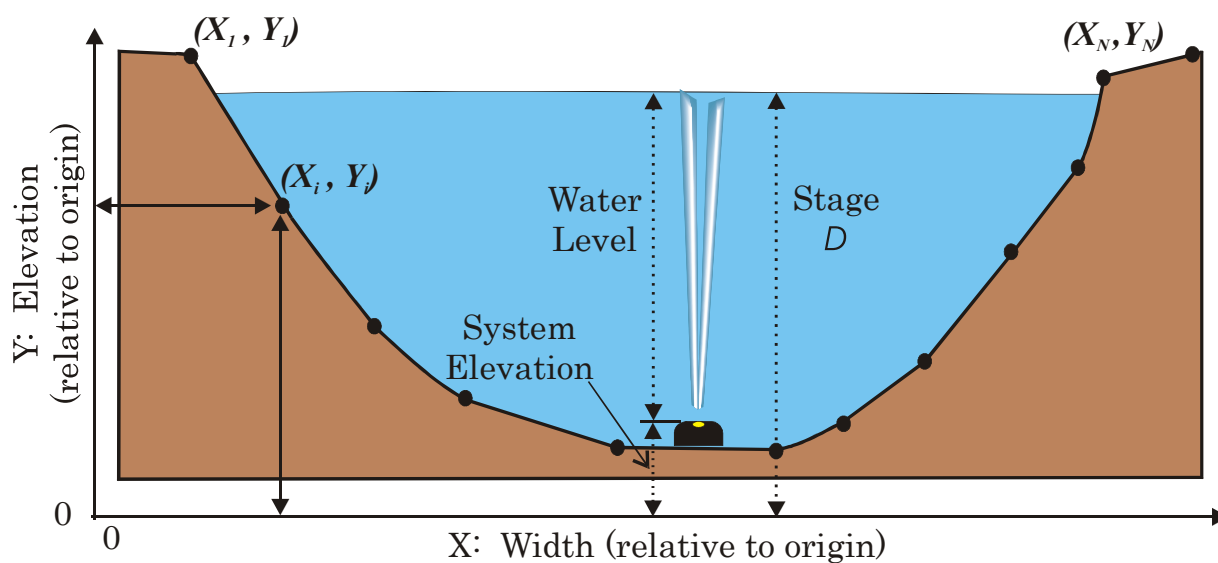
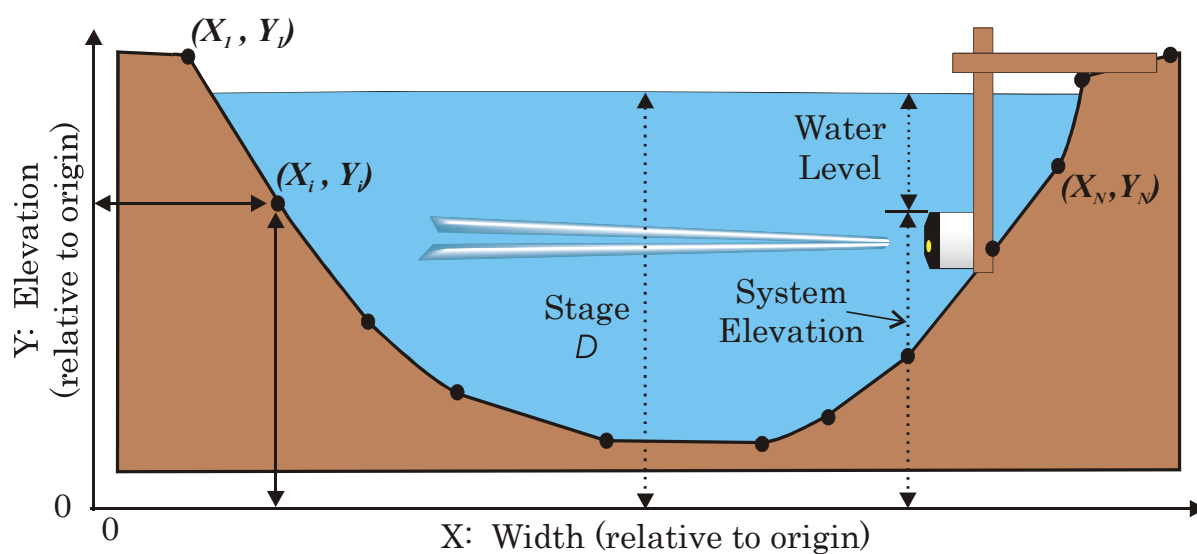
```
>ChannelType Equation
OK
> SetGeometry
Enter equations in order of increasing stage.
```

*Enter equations as prompted.
Number and type of equations will vary.
OutFormat determines entry units.*

```
Equation #1
  Equation Type (1=Quadratic, 2=Power, -1=DONE): 1
  Area = A*Stage*Stage + B*Stage + C
  Min Stage (m): 0
  Max Stage (m): 5
  Constant A: 2.5
  Constant B: 10.3
  Constant C: 0.95
Equation #2
  Equation Type (1=Quadratic, 2=Power, -1=DONE): 2
  Area = (A*(Stage - B))^C
  Min Stage (m): 5
  Max Stage (m): 10
  Constant A: 2.14
  Constant B: 0
  Constant C: 2
Equation #3
  Equation Type (1=Quadratic, 2=Power, -1=DONE): -1
Area Equations
# Min (m) Max (m)
1 0.000 5.000 Area = 2.5000*Stage*Stage + 10.3000*Stage + 0.9500
2 5.000 10.000 Area = (2.1400*(Stage - 0.0000))^2.0000
```

EditGeometry or ECG [DataPoint X_Distance Y_Elevation]

- This command is available only if **ChannelType** is set to **Irregular**; if this command is used with any other **ChannelType** setting, an error message will be returned.
- Without parameter: it displays the current **Irregular** channel geometry survey points.
- With parameters: allows you to edit a previously defined channel geometry survey point.
- The sequential number of the data point is entered as the first parameter, followed by the horizontal (x) distance of the data point, followed by the vertical elevation (y) of the data point.
 - Example: **ECG 3 2.4 3.15** would mean that the third data point is being changed to a horizontal distance of 2.4 (m or ft) and a vertical elevation of 3.15 (m or ft).
- These parameters must be entered in either metric (meters) or English (feet) units based on the setting of **OutFormat**.



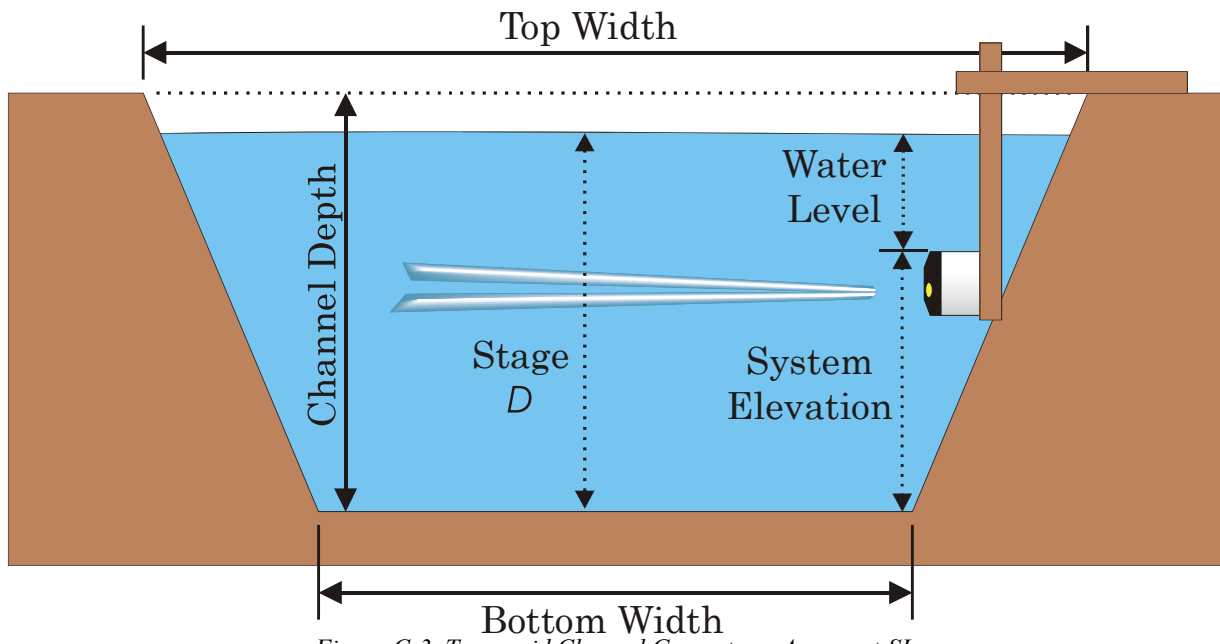


Figure C-3. Trapezoid Channel Geometry – Argonaut-SL

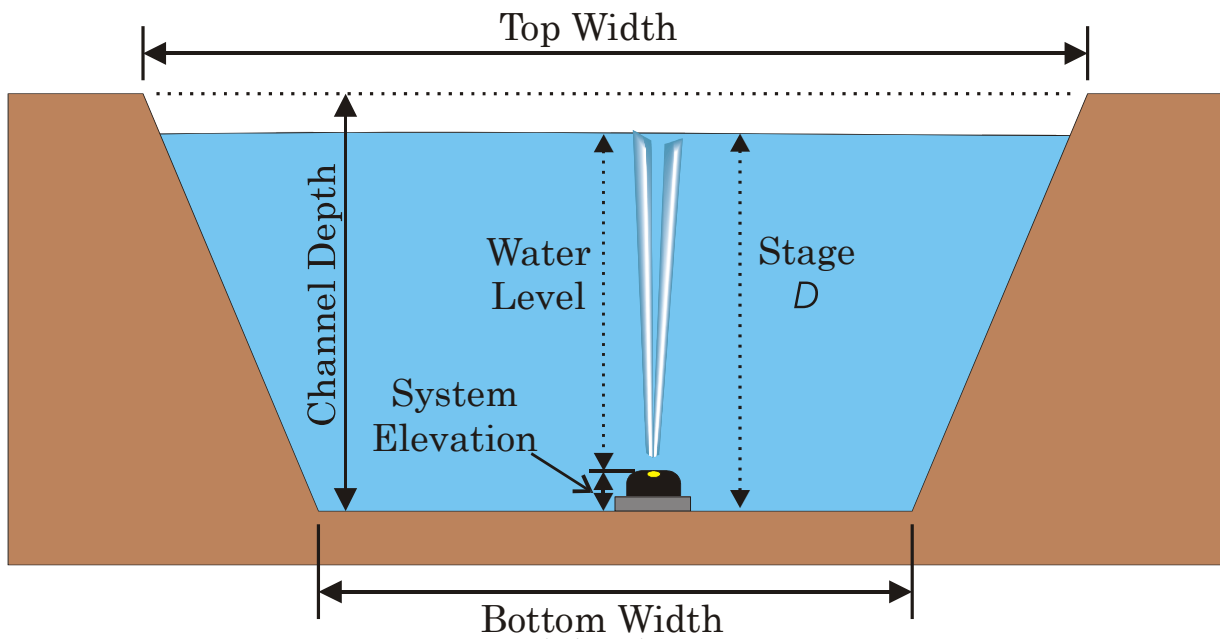


Figure C-4. Trapezoid Channel Geometry – Argonaut-SW

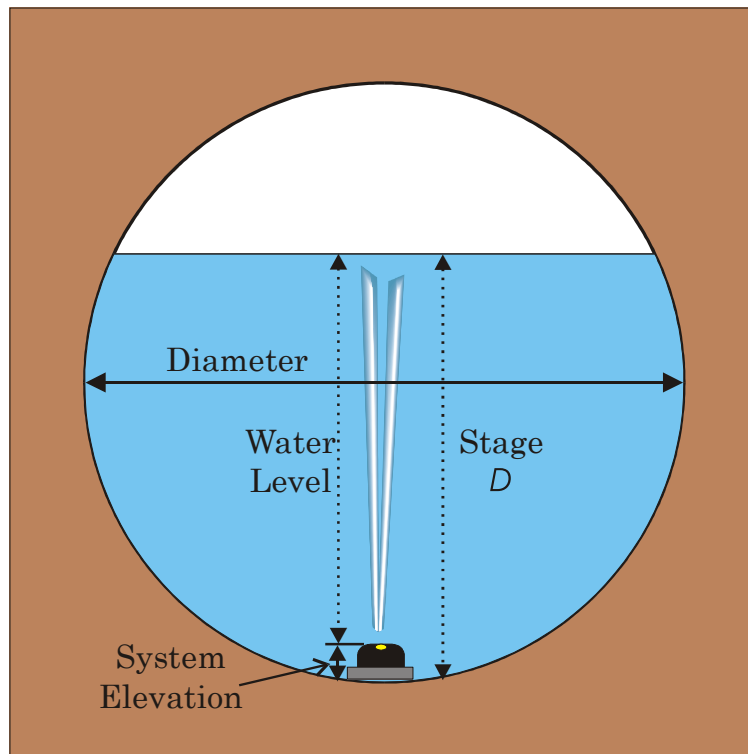


Figure C-5. Round-Pipe Geometry – Argonaut-SW

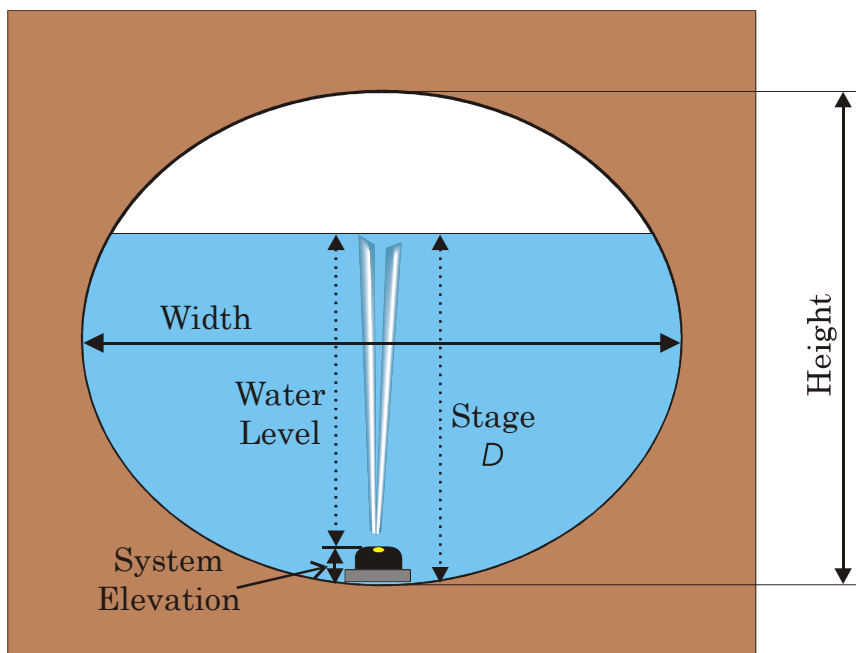


Figure C-6. Ellipse Pipe Geometry – Argonaut-SW

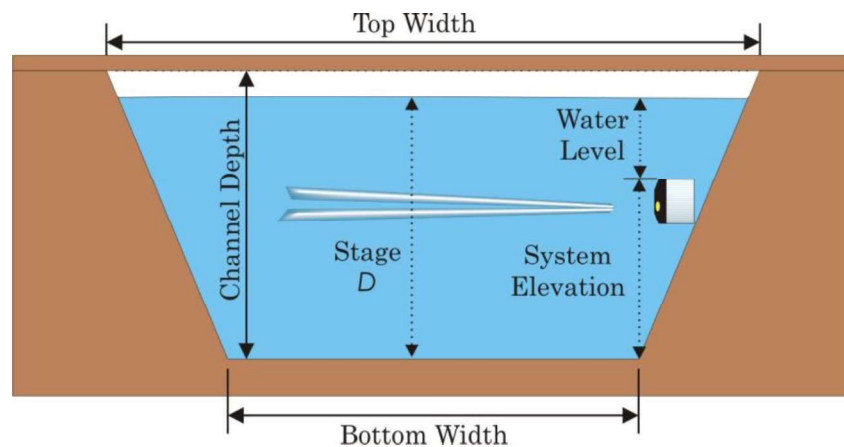


Figure C-7. Culvert Channel Geometry – Argonaut-SL

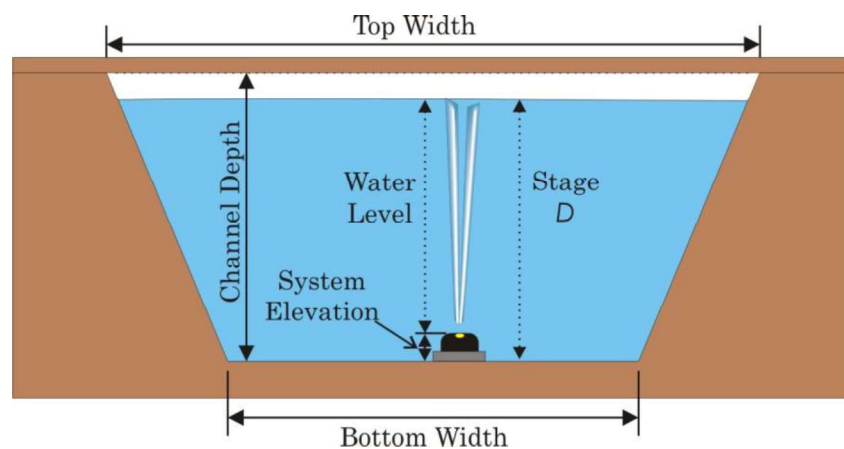


Figure C-8. Culvert Channel Geometry – Argonaut-SW

SetArgElevation or **SELEV** [d.d]

- Without parameter: displays the current Argonaut elevation setting.
- With parameter: sets the elevation of the Argonaut within the channel.
- Parameter entered in either metric (m) or English (feet) units based on **OutFormat** setting.
- Argonaut elevation within the channel determines the relationship between measured stage, total channel depth, and channel area. Elevation differs for each **ChannelType** setting.
 - **Irregular**: The height of the top of the system (vertical beam transducer face) relative to the same datum as other channel survey points (i.e., the local datum). Available for SL (**Figure C-**) and SW (**Figure C-2**) systems.
 - **Trapezoid**: The height of the top of the system (vertical beam transducer face) relative to the bottom of the channel. Available for SL (**Figure C-3**) and SW (**Figure C-4**) systems.
 - **Round**: The height of the top of the system (vertical beam transducer face) relative to the bottom of the pipe. Available for SW (**Figure C-5**) systems only.
 - **Ellipse**: The height of the top of the system (vertical beam transducer face) relative to the bottom of the pipe. Available for SW (**Figure C-6**) systems only.
 - **Culvert**: The height of the top of the system (vertical beam transducer face) relative to the bottom of the channel. Available for SL (**Figure C-7**) and SW (**Figure C-8**) systems.
 - **Equation**: The height of the top of the system (vertical beam transducer face) relative to the same datum used to develop the stage/area equation (i.e., the local datum). Available for SL (**Figure C-7**) and SW (**Figure C-8**) systems.

SetIndexCoef or SCF [VIntercept VSlope StageCoef]

- Sets the three index coefficients for **VelEquation INDEX**.
- Without parameter: returns the current index coefficient settings.
- With parameters: set the index velocity equation coefficients.
- These parameters must be entered in either metric (meters) or English (feet) units based on the setting of **OutFormat**. The units of measurement for these coefficients are:
 - *VIntercept* – Either m/s or ft/s (depends on **OutFormat** setting)
 - *VSlope* – No units
 - *StageCoef* – Either 1/m or 1/ft (depends on **OutFormat** setting)
- Example: **SetIndexCoef 0.34 0.88 0.22**

SaveFlowDatum or SaveFD

- Stores flow datum settings in nonvolatile system memory after this command is entered.

ResetFlowDatum

- Clears all flow datum settings made during this session. To make changes permanent, use the **SaveFlowDatum** command.

TotalVolume or TV [d]

- Selects output units for flow rate and total volume output. These output units are used for RS232, SDI-12, analog output, and Flow Display data.
- The parameter *d* is a value from 0 to 6 selected from the following unit combinations.
 - 0: Total volume is disabled. Flow rate in cfs or m³/s based on **OutFormat** setting.
 - 1: Flow rate in cfs, total volume in acre-ft.
 - 2: Flow rate in gpm (U.S. gallons per minute), total volume in gallons.
 - 3: Flow rate in mgd (10⁶ U.S. gallons per day), total volume in gallons.
 - 4: Flow rate in m³/s, total volume in m³.
 - 5: Flow rate in l/s (liters per second), total volume in liters.
 - 6: Flow rate in mld (10⁶ liters per day), total volume in m³.

RememberTotalVolume or RTV [CONTINUOUS | INITIALIZE | RESET]

- Default parameter: **CONTINUOUS**
- Without parameter: returns the current **RememberTotalVolume** setting.
- With parameter: sets the current **ChannelType** setting to that value.
- Determines how the Argonaut performs total volume calculations when data collection is interrupted and restarted. Available in firmware versions 12.0 and later; prior to this version, total volume was reset to zero any time data collection was stopped and started.
- Three options are available for **RememberTotalVolume**.
 - **CONTINUOUS**: The Argonaut continuously accumulates volume, even when data collection is interrupted temporarily. To do this, the Argonaut stores the last good measurement (including the date/time of the measurement), flow rate, and total volume. If data collection is stopped and restarted, the Argonaut accumulates volume from the last good measurement and estimates the volume accumulation for the period between the two files.
 - **INITIALIZE**: The Argonaut starts data collection at a user specified volume value (commonly zero when installing the instrument at a new site) and continuously accumulates volume from that point. The starting value for total volume in that file is specified using the **InitialVolumeValue** command. If data collection is stopped and restarted, the Argonaut automatically switches over to **CONTINUOUS** total volume calculations.

- **RESET**: The Argonaut starts volume for each file at zero (0). If data collection is stopped and restarted, the Argonaut starts the volume accumulation once again at zero (0).

InitialVolumeValue *or* **IVV** [d.d]

- Default setting: 0.0
- Without parameter: displays the current Argonaut initial volume value setting.
- With parameter: sets the starting total volume value for this data file. This starting value is only used if **RememberTotalVolume** is set to **INITIALIZE**; for any other **RememberTotalVolume** setting, this value is ignored.
- Volume value should be entered in units based on the current **TotalVolume** units setting.

AllowVolumeReset *or* **AVR** [YES|NO]

- Default setting: YES
- Without parameter: displays the current Argonaut allow volume reset setting.
- With parameter: sets whether the **Reset Flow Total** button on the Argonaut Flow Display (§H-2) is active. When **YES**, the **Reset Total Volume** key can be used during data collection to reset the total volume calculation to zero. When **NO**, the **Reset Total Volume** key does nothing (this prevents unauthorized personnel from resetting the total volume calculation).

OutputVolumeRecord

- This command outputs the last good flow and volume measurement made by the Argonaut. The units used for this will match the setting of the **TotalVolume** parameter.
- This flow and volume data is used by the Argonaut in **RememberTotalVolume** mode **CONTINUOUS** to allow the instrument to make continuous volume measurements even when data collected is interrupted temporarily and restarted.
- Sample output:
 >OutputVolumeRecord
 Time 2009/03/10 19:44:44
 Volume 20622.137 m3
 Flow 1.814 m3/s

EraseVolumeBuffer

- This command erases the total volume buffer used by the Argonaut to track the last valid volume and flow measurement. This data is required by the Argonaut for **CONTINUOUS** calculation of total volume when data collection is interrupted.
- The command should only be sent if you are certain that you do not wish to accumulate from the last total volume measurement.
- After sending this command, data collection started in **RememberTotalVolume** mode **CONTINUOUS** will have a starting volume value of 0.0.

TotalVolumeFlowCriteria *or* **TVFC** [Disabled|*criteria* d.d]

- Select flow criteria for accumulating total volume calculation.
 - **TVFC Disabled**: all samples added to total volume (no flow criteria used)
- Three different criteria are available.
 - **>=**: Flow rate must be greater than or equal to user-specified value. The example below would only accumulate total volume if flow rate is greater than or equal to 1.00 (in whatever flow rate units are selected).
 - **TVFC >= 1.00**

- **<=**: Flow rate must be less than or equal to user-specified value. The example below would only accumulate total volume if flow rate is less than or equal to -1.00 (in whatever flow rate units are selected).

- **TVFC <= -1.00**

- **abs>=**: Absolute value of flow rate must be greater than or equal to user-specified value. The example below would only accumulate total volume if the absolute value of the flow rate is greater than or equal to 1.00 (in whatever flow rate units are selected).

- **TVFC abs>= 1.00**

- Only one of **TotalVolumeFlowCriteria** and **TotalVolumeVelocityCriteria** can be enabled at a given time; enabling one value will automatically disable the other.

TotalVolumeVelocityCriteria *or* **TVVC** [**Disabled**|*criteria d.d*]

- Select velocity criteria for accumulating total volume calculation.
 - **TVVC Disabled**: all samples added to total volume (no velocity criteria used)
- Three different criteria are available.
 - **>=**: Velocity (Vx) must be greater than or equal to user specified value. The example below would only accumulate total volume if Vx is greater than or equal to 1.00 (in whatever velocity units are selected).
 - **TVVC >= 1.00**
 - **<=**: Velocity (Vx) must be less than or equal to user specified value. The example below would only accumulate total volume if Vx is less than or equal to -1.00 (in whatever velocity units are selected).
 - **TVVC <= -1.00**
 - **abs>=**: Absolute value of velocity (Vx) must be greater than or equal to user specified value. The example below would only accumulate total volume if the absolute value of Vx is greater than or equal to 1.00 (in whatever velocity units are selected).
 - **TVVC abs>= 1.00**
- Only one of **TotalVolumeFlowCriteria** and **TotalVolumeVelocityCriteria** can be enabled at a given time; enabling one value will automatically disable the other.

C-16. Waves Commands

The following commands are available only in Argonaut-SL and XR systems that have the optional wave height spectra installed.

WaveSpectra [YES|NO]

- Without parameter: returns the current **WaveSpectra** setting.
- With parameter: enables or disables **WaveSpectra** calculations.
- **NO** disables **WaveSpectra** calculations; **YES** enables **WaveSpectra** calculations.
- **WaveSpectra** cannot be used when **PowerPing** is enabled (§C-8).

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

- Without parameter: returns the current **WaterDepth** setting.
- With parameter: sets the **WaterDepth** parameter (in meters).
- Specifies the water depth at the deployment site (in meters). **WaterDepth** 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 **WaterDepth** 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.

RecordPSeries or **RPS** [YES|NO]

- Without parameter: returns the current **RecordPSeries** setting.
- With parameter: enables or disables **RecordPSeries**.
- 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*.
- Note that a setting of **YES** will have a major impact on the total recorder capacity. This setting will add 3072 bytes to each sample vs. a typical usage of 60 bytes. As such, this will reduce total recorder capacity by a factor of about 50.
- **RecordPSeries** cannot be used when **PowerPing** is enabled (§C-8).

C-17. Analog Output Commands

The following commands are used to set up and control the optional analog output modules. For details about the analog output modules, see [Appendix F](#).

AnalogOutputType *or* **AOT** [**DISABLED**|**CURRENT**|**VOLTAGE**]

- Without parameter: returns the current **AnalogOutputType** setting.
- With parameter: sets the **AnalogOutputType** to the specified value. The setting determines the type of analog output module to be used.
 - A setting of **CURRENT** indicates that all analog output modules connected to the system generate a 4-20 mA current loop.
 - A setting of **VOLTAGE** indicates that all analog output modules connected to the system generate a 0-5 VDC output voltage.
 - When set to **DISABLED**, the analog output modules are not used. Analog output must be **DISABLED** if other types of real-time output data are to be used (i.e., RS-232 or SDI-12).
- Only one type of analog module can be used from a single system at any given time, but up to two modules of the selected type can be used simultaneously.

SetupAnalogOutput *or* **SAO** [**Chan** **OutParam** **MinVal** **MaxVal**] | [**Chan** **RESET**]

- Without parameter: displays the settings of all analog output channels (see example below).
- Sets or displays the AO processing parameters.
- **Chan** is the channel number (1 or 2) of the analog output module.
- **OutParam** is the desired analog variable you wish to output. The acceptable parameters are:
 - **VELX**: X-velocity component (for **CoordSystem XYZ**) or East velocity component (for **CoordSystem ENU**).
 - **VELY**: Y-velocity component (for **CoordSystem XYZ**) or North velocity component (for **CoordSystem ENU**).
 - **VELMAG**: velocity magnitude, calculated as follows based on coordinate system:
 - **VELMAG** = $\sqrt{V_x^2 + V_y^2}$ for **CoordSystem XYZ**
 - **VELMAG** = $\sqrt{V_{east}^2 + V_{north}^2}$ for **CoordSystem ENU**
 - **VELMAG** is signed based on the value of V_x (**XYZ**) or V_{east} (**ENU**). For example, in **XYZ** coordinates, if $V_x > 0$, **VELMAG** will be positive. If $V_x < 0$, **VELMAG** will be negative.
 - **SNR**: Average signal-to-noise ratio for all beams (*excluding vertical beam, if present*)
 - **TEMP**: Water temperature
 - **PRESS**: Pressure (*only SL and XR systems with a pressure sensor*)
 - **LEVEL**: Water level relative to the top of the Argonaut system (vertical beam transducer face), as measured by the vertical acoustic beam (*not available in XR systems*).
 - **FLOW**: Discharge as calculated with internal flow parameters (*not available in XRs*).
 - **VOLUME**: Total volume as calculated with internal flow parameters.
 - **CELLEND**: End location of cell.
- **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 analog output 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.

- **Table C-3** shows the ranges of **MinVal** and **MaxVal** for each of the parameters. For a given parameter value, the analog output is determined by the following formula.

$$AO_{Value} = AO_{Min} + (CurrentValue - MinVal) * (AO_{Max} - AO_{Min}) / (MaxVal - MinVal)$$

where

AO_{Value}: analog output value (either mA or VDC).

AO_{Min}: is 4.0 mA for 4-20 mA current loop, or 0.0 VDC for 0-5 VDC voltage output

AO_{Max}: is 20.0 mA for 4-20 mA current loop, or 5.0 VDC for 0-5 VDC voltage output

CurrentValue: parameter value in units shown in table above.

MinVal: user specified minimum analog output range (units shown in **Table C-3**)

MaxVal: user specified maximum analog output range (units shown in **Table C-3**)

If the parameter value exceeds **MinVal** or **MaxVal**, the analog output signal retains its minimum or maximum allowed value, respectively.

- Sending **SAO Chan RESET** (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.
- Examples of command syntax:

>SAO

AO SETTINGS

Chan	Parameter	MinVal	MaxVal	
1	VELX	-3.0	3.0	ft/s
2	FLOW	-100.0	100.0	cfs

>SAO 2 VelY -400 400

Configures the selected channel (2) of the Argonaut to send the Y-velocity component (**VelY**) to the Converter's address (2) and to limit the scaling range to ± 400 cm/s (or ft/s).

>SAO 2 RESET

Clear all entries made for channel 2 of the Argonaut.

Table C-3. Maximum Range for MinVal and MaxVal Analog Output Parameters

Parameter	Metric Units	Absolute MinVal / MaxVal Limits	English Units	Absolute MinVal / MaxVal Limits
VelX (X velocity)	cm/s	-1000 to 1000 cm/s	ft/s	-20 to 20 ft/s
VelY (Y velocity)	cm/s	-1000 to 1000 cm/s	ft/s	-20 to 20 ft/s
VelMag (velocity magnitude)	cm/s	-1000 to 1000 cm/s	ft/s	-20 to 20 ft/s
SNR (signal-to-noise ratio)	dB	0 to 100 dB	dB	0 to 100 dB
Temp (temperature)	°C	-5 to 60 °C	°F	20 to 140 °F
Press (pressure)	dbar	0 to 100 dbar	psi	0 to 150 psi
Level (water level)	m	0 to 50 m	ft	0 to 150 ft
Flow	*	-1x10 ¹⁰ to 1x10 ¹⁰	*	-1x10 ¹⁰ to 1x10 ¹⁰
Volume	*	-1x10 ¹⁰ to 1x10 ¹⁰	*	-1x10 ¹⁰ to 1x10 ¹⁰
CellEnd	M	0 to 150 m	ft	0 to 500 ft

* - Units for flow and volume are variable based on setting of **TotalVolume** parameter (§C-15).

Appendix D. Argonaut Data Outputs

The output data and binary file formats described in this appendix are valid for Argonaut CPU firmware version 12.0 for the Argonaut-MD, SL, SW, and XR systems. This appendix describes:

- [Argonaut Binary Data File Format](#) (§D-1)
- [Argonaut Real-Time RS-232 Serial Data Output](#) (§D-2)

D-1. Argonaut Binary Data File Format

Argonaut binary data files are either generated using the real-time data collection software, or are files stored and retrieved from the Argonaut internal recorder. Each of these methods uses the same binary file format. The following binary data structures are described in this section.

- [Basic Structure of Argonaut Binary Data Files](#) (§D-1.1)
- [Binary File Header Structures](#) (§D-1.2)
- [Binary Data Sample Structures](#) (§D-1.3)
- [Internal Flow Structures](#) (§D-1.4)
- [Diagnostic Data Structures](#) (§D-1.5)
- [Binary Checksum Calculation](#) (§D-1.6)

D-1.1 Basic Structure of Argonaut Binary Data Files

The basic structure of the Argonaut binary data file is described in this section.

- The format and size of the file will change depending on the system type (e.g., Argonaut-MD, SL, SW, XR, etc.) and what optional features (e.g., pressure sensor, etc.) are installed.
- Included in the descriptions below are variable values (stored with each file) to determine what data are contained within the file.
- The binary files include embedded checksum values to verify file integrity. Calculation of checksum values is described in (§D-1.6).
- The transmission order of the binary data is as follows:

```

File Header (418 bytes)
Flow Datum (194 bytes if present)
Diagnostic Data (165 bytes if present)
Total Volume Record (40 bytes if present)
Vertical Beam Configuration (24 bytes if present)
Sample 1 (variable number of bytes depending on installed options)
Sample 2
    ↓    ↓
Sample N

```

Where:

- **File Header** has three structures that are always present:
 - Hardware configuration (AdcmConf, 96 bytes; §D-1.2)
 - Operation parameters (AdcmOper, 64 bytes; §D-1.2)
 - User setup parameter (UserSetup, 258 bytes; §D-1.2)
- **Flow Datum** has one structure that may be present:
 - Present if $(\text{AdcmOper.AnalogOutput} / 16) = 0$
 - Flow datum structure (FlowDatum, 194 bytes; §D-1.4)
- **Diagnostic Data** has one structure that may be present:
 - Present if $(\text{AdcmOper.StoreDiagnosticData} > 0)$
 - Diagnostic header structure (DiagnosticHeader, 165 bytes; §D-1.5)

- **Total Volume Record** has one structure that may be present:
 - Stores last valid Argonaut flow and volume measurement prior to start of this data file.
 - Present if $((\text{AdcmOper.AnalogOutput}/16)=0)$ and $(\text{AdcmConf.SoftwareVerNum}>120)$
 - Total Volume Record structure (TotalVolumeRecord, 40 bytes; §D-1.4)
- **Vertical Beam Configuration** has one structure that may be present:
 - Present if $(\text{AdcmConf.VerticalBeam} == 1)$
 - Vertical beam configuration structure (VbConf, 30 bytes; §D-1.2)
- **Sample 1 through Sample N** has a variable set of structures depending on what options are installed and enabled in the system. The structure of the binary sample data has some or all of the following items:
 - Argonaut sample – one structure is always present
 - Argonaut long sample (LongSample, 37 bytes; §D-1.3)
 - Noise data – one structure is always present
 - Noise sample (Noise, 3 bytes; §D-1.3)
 - CTD data – one structure may be present
 - Present if $(\text{AdcmConf.CtdInstalled} = 1)$
 - CTD data (CTD, 16 bytes; §D-1.3)
 - Wave spectra data – one structure may be present
 - Present if $((\text{UserSetup.WaveSpectra}\&1) = 1)$
 - Wave spectra data (Aband, 24 bytes; §D-1.3)
 - YSI data – one structure may be present
 - Present if $(\text{AdcmConf.YsiInstalled} > 0)$
 - YSI data (YSI, number of bytes equals value of $\text{AdcmConf.YsiInstalled}$; §D-1.3)
 - Flow data – one structure may be present
 - Present if $((\text{AdcmOper.AnalogOutput}/16)=1)$ and $(\text{FlowDatum.FlowEquationType}>0)$
 - Flow data (Flow, 8 bytes; §D-1.4)
 - Total Volume data – one structure may be present
 - Present if $((\text{Flow data is present}) \text{ and } (\text{FlowDatum.TotalVolume} > 0))$
 - Total volume data (TotalVolume, 25 bytes; §D-1.4)
 - Profile data – one structure may be present
 - Present if $(\text{AdcmOper.ProfilingMode} = 1)$
 - Nbeams = AdcmConf.Nbeams
 - Ncells = AdcmOper.Ncells
 - Profile data (Profile, $4*\text{Nbeams}*\text{Ncells}$ bytes; §D-1.3)
 - Checksum – always present (See §D-1.6 for checksum calculations.)
 - 1-byte checksum of all data in sample up to this point.
 - Pressure time-series data – one structure may be present
 - Present if $((\text{UserSetup.WaveSpectra}\&2) = 1)$
 - Pressure series data (Pseries, 3072 bytes; §D-1.3)
 - Diagnostic data – one structure may be present
 - Present if $(\text{AdcmOper.StoreDiagnosticData} > 0)$ and $((\text{SampleNumber} \% \text{AdcmOper.StoreDiagnosticData}) = 1)$
 - Nbeams = AdcmConf.Nbeams
 - Diagnostic data (DiagnosticData, $131 + (768*\text{Nbeams})$ bytes; §D-1.5)
 - Vertical Beam Diagnostic data – one structure may be present
 - Present if $(\text{AdcmConf.VerticalBeam} == 1)$ and $(\text{AdcmOper.StoreDiagnosticData} > 0)$ and $((\text{SampleNumber} \% \text{AdcmOper.StoreDiagnosticData}) = 1)$
 - Vertical Beam Diagnostic data (VBDiagnosticData, 776 bytes; §D-1.5)

D-1.2 Binary File Header Structures

Each Argonaut file header structure is described below using the C language definition. The first structure, *DateTimeType*, is referenced by other structures.

Date and time structure (8 bytes)

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

Hardware Configuration (AdcmConf) (96 bytes)

```
typedef struct {
    char          ConfigType;          /* Type          0x40          */
    char          ConfigVer;           /* Version       0x02          */
    short 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          AdcmType;            /* Low Nibble: 0-3MHz 1-1.5MHz */
                                      /* High Nibble: 0 - MD          */
                                      /* 1 - XR                      */
                                      /* 2 - SL                      */
                                      /* 6 - SW                      */
    char          Nbeams;              /* 2, 3, or 4                  */
    char          BeamGeometry;        /* 0- 2 Beams; 1- 3 Beams      */
                                      /* 2- 4 Beams, 1 Vertical      */
                                      /* 3- 4 Beams, Janus          */
    short 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                 */
    short int     XformMat[16];         /* From Beam to XYZ veloc      */
    short int     CompassOffset;        /* Degress to East of North    */
    long int      PressScale;           /* Nanobar per count           */
    long int      PressOffset;          /* Microbar                    */
    char          PowerSaveMode;        /* if 1 system off after 5 min */
                                      /* idle in command mode        */
    long int      SeabirdOutputDelay;   /* 0-no 1-yes                  */
    unsigned char EnableWaves;         /* V 8.4 WaveOption            */
    short int     PressScale_2;         /* pico dbar per count^2       */
    unsigned char StoreRawVelocity;    /* 0 = disable, any other value */
    short int     PingDelay;           /* set to all 0s               */
    unsigned char YsiInstalled;        /* 0-No; N-Bytes to collect     */
    char          ExtPressInstalled;    /* 0-None; 1-Paros; 2-Druck     */
    unsigned char RecorderSize;        /* in Mbytes (default is 2 Mb)  */
    char          VerticalBeam;        /* 0-no 1-yes                   */
    char          Sdi12Installed;       /* bit 1 SDI12 no/yes           */
    char          ProfilingInstalled;   /* bit 1 profiling mode no/yes  */
    char          HousingType;         /* 0: Old, cylindrical can      */
                                      /* 1: New, low profile housing  */
} AdcmConf;
```

Operation parameters (AdcmOper) (64 bytes)

```

typedef struct {
    char        ConfigType;          /* Type          0x41          */
    char        ConfigVer;           /* Version       0x02          */
    short int    Nbytes;              /* Bytes in configuration      */
    DateTimeType ConfigTime;         /* Date created or last modified */
    short int    NpingsPerBeam;       /* Consecutive pings for each beam*/
    short int    SampInterval;        /* Samp Interval in 16/Ft units */
    short int    Lag;                 /* Samp spacing for AutoCorrelation*/
    short int    PulseLength;         /* In cm (along profiling axis ) */
    short int    RecLength;           /* In cm Receiver recovery delay */
    short int    MinBlankLength;      /* In cm Blank to first bin      */
    short int    OperatingRange;      /* Max range in m                */
    short int    PingDelay;           /* In m Delay before next ping   */
    short int    AutoFilter;          /* 0-fixed filter; 1-auto filter */
    char        SaveDisableLevelAdj; /* Save-able DisableLevelAdj    */
    char        SDI12AutoSampling;   /* 0-no      1-yes               */
    char        Spare[6];             /* Set to 0                      */
    char        ModemMode;
    short int    TempOffset;          /* in 0.01 deg C                */
    short int    TempScale;           /* in 0.0001 TrueT/MeasuredT    */
    unsigned char NominalNoise[3];
    unsigned char VelRangeInd;        /* Velocity range for Arg-ADV     */
    /* 0- 3cm/s 1- 10cm/s 2-30 cm/s */
    /* 3- 100 cm/s 4-300 cm/s      */
    char        PlcBinary;            /* 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              */
    short int    CellSize;             /* in cm                        */
    char        SdiFormat;            /* No longer used as of ver 9.0 */
    char        AnalogOutput;         /* Low nibble                   */
    /* 0 - disabled 1 - enabled    */
    /* 2 - current 2 - voltage      */
    /* Hi nibble EnableFlow        */
    /* 0 - disabled 1 - enabled    */
    unsigned char StoreNoiseData;     /* 0 - No, 1 - Yes              */
    unsigned char StoreDiagnosticData; /* 0 - Do not store             */
    /* 1-255: store every N samples */
    unsigned char ReverseXVelocity;   /* For SW and SW only           */
    /* 0 - use standard +X velocity */
    /* 1 - reverse +X velocity      */
    char        StoreVBTimeSeries;    /* 0 - No, 1 - Yes              */
    unsigned char PICVersion;         /* Analog board PIC version     */
    char        DebugOn;              /* Set to all 0s                */
} AdcmOper;

```

User setup parameters (UserSetup) (258 bytes)

```

typedef struct {
    unsigned char ConfigType;          /* Type          0x42          */
    unsigned char ConfigVer;           /* Version       0x02          */
    unsigned short int Nbytes;          /* Bytes in configuration      */
    DateTimeType ConfigTime;         /* Date created or last modified */
    short int    Temp;                 /* 0.1 deg C                  */
    short int    Sal;                  /* 0.1 ppt                    */
    short int    Cw;                   /* 0.1 m/s                    */
    unsigned short int BlankDistance; /* in cm                      */
    unsigned short int PulseLength;   /* in cm                      */
    unsigned short int CellSize;       /* in cm                      */

```

```

char      TempMode;           /* 0- User value  1- Measured */
long int   AvgInterval;       /* in s */
long int   SampleInterval;    /* in s */
unsigned short int PingInterval; /* in 0.1 s */
unsigned short int BurstMode;  /* 0-Disabled; 1-enabled */
long int   BurstInterval;     /* in s */
unsigned short int SamplesPerBurst;
char      CoordSystem;        /* 0-Beam;      1-XYZ; 2-ENU */
char      OutMode;            /* 0-Auto;      1-Polled */
char      OutFormat;          /* 0-Binary;    1-Ascii */
/* 2-Metric;    3-English */
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 01/01/1980 */
char      CommentLine1[60];
char      CommentLine2[60];
char      CommentLine3[60];
char      AutoSleep;
char      DynBoundAdj;        /* 0- No      1- Yes (for XR only) */
short int CellBegin;          /* in cm, vert. from instrument */
short int CellEnd;            /* in cm, vert. from instrument */
short int CohLag;             /* in cm, vert. from instrument */
char      DataFormat;         /* 0-long      1-short */
char      WaveSpectra;        /* 0-no        1- yes */
short int WaterDepth;         /* in cm for spectra calculations */
/* if 0 or negative, it gives */
/* height of Argonaut above bottom */

} UserSetup;

```

Vertical beam configuration (VbConf) (30 bytes)

```

typedef struct {
    unsigned char  SyncChar1;    /* 0xBB */
    unsigned char  SyncChar2;    /* 0xE4 */
    unsigned char  Data[28];
} VbConf;

```

D-1.3 Binary Data Sample Structures

There are several Argonaut data sample structures, depending on what options are installed and enabled in the system

Argonaut data sample structure (LongSample; 37 bytes)

This structure is always present.

```

typedef struct {
    unsigned char  SyncChar;      /* Fixed 0xB0 */
    unsigned char  Nbytes;        /* Including ChkSum */
    unsigned long  Time;          /* Seconds since Jan 1, 1980 at 0 */
    int            Vel[3];        /* Vel in mm/s */
    unsigned char  VelStd[3];     /* Vel in mm/s */
    unsigned char  Amp[3];        /* Amplitude in counts */
    unsigned char  IceDetection;  /* Ice Detection Score */
    unsigned int   Heading;       /* Heading in .1 deg */
    char           Pitch;         /* Pitch in .4 deg */
    char           Roll;          /* Roll in .4 deg */
    int            Temp;          /* in .01 deg C */
    long           Pres;          /* in counts (Strain Gauge) */
    /* in 0.0001 dbars (Druck) */
    unsigned int   SigmaPres;     /* in A/D Converter counts */
    unsigned char  Vbatt;         /* Battery voltage */
}

```

```
    unsigned char    CellBegin;           /* in .1 m units      */
    unsigned char    CellEnd;             /* in .1 m units      */
    unsigned char    StdHeading;          /* Std. dev. in .1 deg */
    unsigned char    StdPitch;            /* Std. dev. in .1 deg */
    unsigned char    StdRoll;             /* Std. dev. in .1 deg */
} LongSample;
```

Noise data structure (Noise; 3 bytes)

This structure is always present.

```
typedef struct {
    unsigned char    Noise[3];           /* Noise in counts     */
} Noise;
```

Argonaut CTD data structure (CTD; 16 bytes)

This structure is present if (AdcmConf.CtdInstalled = 1).

```
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        */
} CTD;
```

Argonaut wave spectra data structure (Aband; 24 bytes)

This structure is present if ((UserSetup.WaveSpectra&1) = 1).

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

YSI data structure (YSI; variable number of bytes)

This structure is present if (AdcmConf.YsiInstalled > 0).

```
Nbytes = AdcmConf.YsiInstalled
typedef struct {
    unsigned char    Data[Nbytes];
} YSI;
```

Profiling data structure (Profile; 4*Ncells*Nbeams bytes)

This structure is present if (AdcmOper.ProfilingMode = 1).

```
Nbeams - AdcmConf.Nbeams
Ncells - AdcmOper.Ncells
typedef struct {
    int            VelAvg[Nbeams][Ncells]; /* in mm/s */
    unsigned char    VelStdAvg[Nbeams][Ncells]; /* in mm/s */
    unsigned char    AmpAvg[Nbeams][Ncells]; /* in counts */
} ProfileType;
```

Pressure time series structure (Pseries; 3072 bytes)

This structure is present if ((UserSetup.WaveSpectra&2) = 1).

```
typedef struct {
    unsigned char    Data[3072];
} Pseries;
```

D-1.4 Internal Flow Structures

Each Argonaut data structure is described below using the C language definition.

Flow datum structure (FlowDatum) (194 bytes)

This structure is present if $(\text{AdcmOper.AnalogOutput} / 16) = 0$.

```
typedef struct {
    unsigned char SyncChar;          /* Fixed 0xB5 */
    unsigned char Nbytes;            /* Including ChkSum */
    long int      ArgElevation;       /* Argonaut elevation (0.1 mm) */
    short int     FlowOffset;         /* have to be divided by 1000 */
    short int     FlowVelScale;       /* have to be divided by 1000 */
    short int     FlowLevelScale;     /* have to be divided by 1000 */
    /* Above are 3 terms of the index */
    /* flow equation */
    char          FlowEquationType;   /* 0 - flow calc. disabled */
    /* 1 - Theoretical */
    /* 2 - Index equation */
    char          ChangeFlowSign;     /* change Flow sign */
    long int      X[MAX_DATUM_SIZE];  /* X coord (0.1 mm) */
    long int      Y[MAX_DATUM_SIZE];  /* Y coord (0.1 mm) */
    char          ChannelType;        /* 0 - Irregular channel */
    /* 1 - Trapezoid channel */
    /* 2 - Round pipe */
    /* 3 - Ellipse pipe */
    char          TotalVolume;        /* 0 - No total volume output */
    /* 1 - cfs & acre-ft */
    /* 2 - gpm & gallons */
    /* 3 - mgd & gallons */
    /* 4 - m3/s & m3 */
    /* 5 - l/s & liters */
    /* 6 - mld & m3 */
    char          Spare[18];          /* spare (set to 0) */
} FlowDatum;
```

Flow data structure (Flow) (8 bytes)

This structure is present if $((\text{AdcmOper.AnalogOutput} / 16) = 1)$ and $(\text{FlowDatum.FlowEquationType} > 0)$.

```
typedef struct {
    long int Flow;          /* in 0.001 m^3/s */
    long int Area;          /* in 0.01 m^3 */
} Flow;
```

Total volume data structure (TotalVolume) (25 bytes)

This structure is present if $((\text{Flow data is present}) \text{ and } (\text{FlowDatum.TotalVolume} > 0))$.

```
typedef struct {
    double Volume;          /* in m^3/s */
    long int SampleTime;     /* end time of sample */
    long int ResetTime;      /* time of last volume reset */
    char     LastResetType;  /* 0 - start of data file */
    /* 1 - RS232 hot command reset */
    /* 2 - SDI12 command reset */
    /* 3 - Flow Display reset */
    char     Spare[8];       /* Set to 0 */
} TotalVolumeSampleType;
```


Total volume record structure (TotalVolumeRecord) (40 bytes)

This structure is present if ((AdcmOper.AnalogOutput/16)=0) and (AdcmConf.SoftwareVerNum>120). It stores the last good flow and total volume measurement made by the Argonaut prior to this data file, and is used to provide continuous total volume measurements between files.

```
typedef struct {
    unsigned char  SyncChar;          /* BUFFER_SYNC_CHAR  0xB6          */
    unsigned char  Nbytes;            /* Total structure size            */
    double         Volume;            /* in m^3                        */
    long int       SampleTime;        /* end time of sample              */
    long int       ResetTime;        /* time of last volume reset       */
    char          LastResetType;      /* 0 - start of data file          */
                                          /* 1 - RS232 hot command reset     */
                                          /* 2 - SDI12 command reset        */
                                          /* 3 - Flow Display reset         */
    long int       LastFlowRate;      /* in 0.0001 m3/s                 */
    char          Spare[17];          /* Set to all 0s                  */
} TotalVolumeRecordType;
```

D-1.5 Diagnostic Data Structures

Each Argonaut data structure is described below using the C language definition. These structures are present if (AdcmOper.StoreDiagnosticData > 0) and ((SampleNumber % AdcmOper.StoreDiagnosticData) = 1).

Diagnostic header structure (DiagnosticHeader) (165 bytes)

```
typedef struct {
    unsigned char  Data[165];
} DiagnosticHeader;
```

Diagnostic data structure (DiagnosticData) (131 + Nbeams*768 bytes)

```
typedef struct {
    unsigned char  Data[131 + Nbeams*768];
} DiagnosticData;
```

Vertical Beam Diagnostic data structure (VBDiagnosticData) (776 bytes)

```
typedef struct {
    unsigned char  SyncChar1;        /* 0xBB          */
    unsigned char  SyncChar2;        /* 0xE5          */
    unsigned char  Data[774];
} VBDiagnosticData;
```

D-1.6 Binary 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 *ComputeChecksumByte* 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 following C program statement computes the checksum.

```
Checksum = ComputeChecksumByte(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). *ComputeChecksumByte* adds the first *Sample_Length - 1* bytes starting at location *buffer*, then adds the value 0xA5. The result of this summation is truncated to one (unsigned) byte and returned. The addition of the value 0xA5 is done so that an all-zeros sample does not produce a valid checksum.

```
unsigned char ComputeChecksumByte(unsigned char* buf, int nBytes)
{ unsigned char ChkSum = 0xA5;
  for(int i = 0; i < nBytes; i++)
    ChkSum += buf[i];
  return ChkSum; }
```

D-2. Argonaut Real-Time RS-232 Serial Data Output

The Argonaut can send output data over the serial port in a variety of formats depending on the setting of the **OutFormat** command (§C-7).

- **BINARY** – Used for the most efficient data transmission storage (§D-2.1).
- **ASCII** – Standard tab-delimited ASCII format with all variables output as integers (§D-2.2).
- **METRIC** – Tab-delimited ASCII format with all variables in metric units (§D-2.2).
- **ENGLISH** – Tab-delimited ASCII format with all variables in English units (§D-2.2).
- **SEABIRD** – Special format for integrating SeaBird inductive modem (not described here).

The setting of **OutFormat** affects only data sent to the serial port. Data written to the internal recorder are always stored in binary format. Data can be output over the serial port in two ways:

- Automatically, as each sample is completed during data collection (if **OutMode AUTO**; §C-7).
- Manually, using the run-time command “o” (§C-14).

D-2.1 Binary Data Output

When outputting data in binary format, the binary structure transmitted by the system matches the binary sample record stored in the Argonaut with one exception — no diagnostic data is sent to the serial port. The binary record transmitted with each sample is described below. See §D-1.3 through §D-1.6 for detailed descriptions of each structure and the checksum calculation.

- Argonaut sample – one structure is always present.
 - Argonaut long sample (LongSample, 37 bytes; §D-1.3)
- Noise data – one structure is always present.
 - Noise sample (Noise, 3 bytes; §D-1.3)
- CTD data – one structure may be present.
 - Present if (AdcmConf.CtdInstalled = 1).
 - CTD data (CTD, 16 bytes; §D-1.3)
- Wave spectra data – one structure may be present.
 - Present if ((UserSetup.WaveSpectra&1) = 1).
 - Wave spectra data (Aband, 24 bytes; §D-1.3)
- YSI data – one structure may be present.
 - Present if (AdcmConf.YsiInstalled > 0).
 - YSI data (YSI, number of bytes equals value of AdcmConf.YsiInstalled; §D-1.3)
- Flow data – one structure may be present.
 - Present if ((AdcmOper.AnalogOutput / 16) = 1) and (FlowDatum.FlowEquationType>0)
 - Flow data (Flow, 8 bytes; §D-1.4)
- Total volume data – one structure may be present.
 - Present if ((Flow data is present) and (FlowDatum.TotalVolume > 0))
 - Total volume data (TotalVolume, 25 bytes; §D-1.4)
- Profile data – one structure may be present.
 - Present if (AdcmOper.ProfilingMode = 1).
 - Nbeams = AdcmConf.Nbeams
 - Ncells = AdcmOper.Ncells
 - Profile data (Profile, 4*Nbeams*Ncells bytes; §D-1.3).
- Checksum – always present (See §D-1.6 for checksum calculations.).
 - 1-byte checksum of all data in sample up to this point.
- Pressure time-series data – one structure may be present.
 - Present if ((UserSetup.WaveSpectra&2) = 1).
 - Pressure series data (Pseries, 3072 bytes; §D-1.3).

D-2.2 ASCII / Metric / English Data Output

For **OutFormat** settings of **ASCII/METRIC/ENGLISH**, the serial output uses the same basic format, and differs only in the units system and precision used. For each of these **OutFormat** settings, data are output as a long string of ASCII numbers separated by spaces. Each output value reflects one variable. The exact number and order of values output would vary depending on what optional features are installed and enabled. Data are output in the following order.

- Argonaut sample including noise data (§D-2.3)
- CTD data if present (§D-2.4)
- Wave spectra data if present (§D-2.5)
- YSI data if present (§D-2.6)
- Flow and total volume data if present (§D-2.7)
- Profile data if present (§D-2.8)
- Pressure time series data if present (§D-2.9)

There is one exception to the output formats described here. If the Argonaut is being used (or has been used in the past) with the Modbus Interface Module ([Appendix I](#)), a special output format may be enabled. This special Modbus format is not documented here. To check if this format is enabled, use the direct command interface ([Appendix C](#)) from *SonUtils* to send the command **ModbusOutput**. A returned value of **YES** indicates that the special Modbus format has been enabled; **NO** indicates the standard output described here. To disable the special Modbus output format, send the command **ModbusOutput NO**.

A sample output string, using an **OutFormat** setting of **METRIC**, is shown below. In this example (for a 2-beam, Argonaut-SW), the system includes Flow and Profile data. Note that the first line of output data is quite long, and wraps as three lines of text in the sample output shown here.

```
2003 05 20 08 23 50      -7.4      0.5    1.002    4.1    4.1    0.0 138 136    0 100
0.0    0.0    0.0    0.0    0.0    0.0 17.19      0.000    0.000 11.4    0.1    1.0
31  29    0      -0.0981      1.4056
1    -4.6      -4.4    8.2    8.2 174 157
2    -9.6      -9.3    8.2    8.2 125 136
3   -18.8     18.9    8.2    8.2 115 116
4     8.6      0.9    8.2    8.2 112  94
5     6.2      8.7    8.2    8.2  99 110
```

D-2.3 Argonaut Sample Data

- The sample output includes 31 columns of data. See [Table D-1](#) for details.
- All Argonauts sample temperature and pressure (if sensor is installed) once per second. The mean value of temperature, and the 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 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 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 XR and SL, the system is assumed stationary during the course of each averaging period. Compass data are sampled once at the beginning of each averaging period.
 - Systems without a compass will report zero values for compass/tilt sensor data.

Table D-1. Argonaut ASCII/Metric/English Data Output 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 or SW systems with vertical beam)	0.1 cm/s mm	cm/s m	ft/s ft
10	Standard error of velocity 1 (Beam 1/X/East)	0.1 cm/s	cm/s	ft/s
11	Standard error of velocity 2 (Beam 2/Y/North)	0.1 cm/s	cm/s	ft/s
12	Standard error of velocity 3 (Beam 3/Z/Up) [0 for SWs]	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) [0 for SWs]	counts	counts	counts
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 [0 for SWs]	counts	dBar	PSI
25	Standard deviation of pressure [0 for SWs]	counts	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	Noise level (Beam 1)	counts	counts	counts
30	Noise level (Beam 2)	counts	counts	counts
31	Noise level (Beam 3)	counts	counts	counts

*ENU velocity components require the system to have a compass installed.

D-2.4 CTD Data

- The CTD data output includes four columns of data. See [Table D-2](#) for details.
- CTD data are included on the same line as the primary sample data.
- CTD data are sampled once at the beginning of each averaging period.

Table D-2. CTD Data Output Format

Col	Contents	ASCII	Metric	English
1	CTD temperature	0.0001 °C	°C	°F
2	CTD conductivity	0.00001 Siemens / meter	Siemens / meter	Siemens / meter
3	CTD pressure	0.001 dBar	dBar	psi
4	CTD salinity	0.0001 ppt	ppt	ppt

D-2.5 Wave Spectra Data

- The wave spectra output includes 12 columns of data. See [Table D-3](#) for details.
- Wave spectra data are included on the same line as the primary sample data.
- Wave spectra calculations are based on the time-series of pressure sensor data. Pressure sensor data are sampled once per second over the course of the averaging period.

Table D-3. Wave Spectra Data Output Format

Col	Contents	ASCII	Metric	English
1	Wave height for period band from 2 to 4 seconds	mm	cm	ft
2	Wave height for period band from 4 to 6 seconds	mm	cm	ft
3	Wave height for period band from 6 to 8 seconds	mm	cm	ft
4	Wave height for period band from 8 to 10 seconds	mm	cm	ft
5	Wave height for period band from 10 to 12 seconds	mm	cm	ft
6	Wave height for period band from 12 to 14 seconds	mm	cm	ft
7	Wave height for period band from 14 to 16 seconds	mm	cm	ft
8	Wave height for period band from 16 to 18 seconds	mm	cm	ft
9	Wave height for period band from 18 to 20 seconds	mm	cm	ft
10	Wave height for period band greater than 20 seconds	mm	cm	ft
11	Significant wave height	mm	cm	ft
12	Typical wave period	s	s	s

D-2.6 YSI Data

- YSI data output will vary depending on the exact multi-parameter probe configuration.
- YSI data are included on the same line as the primary sample data.
- [Contact SonTek](#) for the output format for your particular system.

D-2.7 Flow and Total Volume Data

- Flow and total volume data are included on the same line as the primary sample data.
- Flow and total volume calculations are based on measured stage data from the SL or SW vertical beam, measured velocity data, and user-supplied channel information. For details, see [§C-15](#).
- If total volume calculations are not enabled, Flow Data output includes two columns of data. See [Table D-4](#) for details.

Table D-4. Flow Data Output Format

Col	Contents	ASCII	Metric	English
1	Flow	0.0001 m ³ /s	m ³ /s	ft ³ /s
2	Area	0.0001 m ²	m ²	ft ²

- If total volume calculations are enabled, then Flow and total volume data output includes five columns of data. The units used for output depend both on the setting of the [OutFormat](#) parameter and on the selection of [TotalVolume](#) units. See [Table D-5](#) for details.

Table D-5. Flow and Total Volume Data Output Format

Col	Contents	OutFormat ASCII	OutFormat Metric or English					
			TV = 1	TV = 2	TV = 3	TV = 4	TV = 5	TV = 6
1	Flow	0.0001 m ³ /s	ft ³ /s	gpm ⁽¹⁾	mgd ⁽²⁾	m ³ /s	liter/s	mld ⁽³⁾
2	Area	0.0001 m ²	ft ²	ft ²	ft ²	m ²	m ²	m ²
3	Volume	liters	acre-ft	gallons	gallons	m ³	liters	m ³
4	Reset time ⁽⁴⁾	seconds	days	days	days	days	days	days
5	Reset type ⁽⁵⁾	⁽⁵⁾	⁽⁵⁾	⁽⁵⁾	⁽⁵⁾	⁽⁵⁾	⁽⁵⁾	⁽⁵⁾

Notes:

1. gpm is U.S. gallons per minute.
2. mgd is 106 U.S. gallons per day
3. mld is 106 liters per day
4. Reset time is the elapsed time since the total volume value was reset to zero (which is done at the start of the file, and can also be done during a data collection).
5. Reset type is the last method used to reset total volume to zero. A value of 0 indicates the start of the data file; a value of 1 indicates it was reset using the RS232 run-time V-command; a value of 2 indicates it was reset using the SDI-12 command "aR!" or "aR0!"; and a value of 3 indicates it was reset using the keypad on the Argonaut Flow Display.

D-2.8 Profile Data

- Profile data are shown on separate lines from the primary sample data.
- Profile data include a variable number of values depending on the number of acoustic beams the system uses for velocity (two for SL or SW, three for XR), and the number of cells specified by the user (maximum of ten).
 - Profile data include one line for each cell.
 - Each line includes either seven values (for 2-beam systems; [Table D-6](#)) or ten values (for 3-beam systems; [Table D-7](#)).

Table D-6. Profile Data Output Format for a 2-Beam System (Argonaut-SL and SW)

Col	Contents	ASCII	Metric	English
1	Cell number			
2	Velocity 1/X	mm/s	cm/s	ft/s
3	Velocity 2/Y	mm/s	cm/s	ft/s
4	Standard error of velocity 1/X	mm/s	cm/s	ft/s
5	Standard error of velocity 2/Y	mm/s	cm/s	ft/s
6	Signal strength (Beam 1)	counts	counts	counts
7	Signal strength (Beam 2)	counts	counts	counts

Table D-7. Profile Data Output Format for a 3-Beam System (Argonaut-XR)

Col	Contents	ASCII	Metric	English
1	Cell number			
2	Velocity 1 / X / East	mm/s	cm/s	ft/s
3	Velocity 2 / Y / North	mm/s	cm/s	ft/s
4	Velocity 3 / Z / Up	mm/s	cm/s	ft/s
5	Standard error of velocity 1 / X / East	mm/s	cm/s	ft/s
6	Standard error of velocity 2 / Y / North	mm/s	cm/s	ft/s
7	Standard error of velocity 3 / Z / Up	mm/s	cm/s	ft/s
8	Signal strength (Beam 1)	counts	counts	counts
9	Signal strength (Beam 2)	counts	counts	counts
10	Signal strength (Beam 3)	counts	counts	counts

D-2.9 Pressure Time-Series Data

- Pressure time-series data are output as a series of samples on a number of separate lines from all other sample data.
- 1024 sample points are output regardless of the length of the time-series collected. The actual time-series length will match the specified averaging period (one pressure sample is collected per second).
- Pressure samples are output using units of mm for **OutFormat** settings of **ASCII/METRIC/ENGLISH**.

Appendix E. Argonaut-SL/XR Internal SDI-12 Interface

E-1. Introduction

Argonaut-SL, SW, and XR systems (hereafter “Argonaut”) have the capability to interface with external data loggers using the Serial Digital Interface (SDI-12) communications protocol. This appendix describes internal SDI-12 features, wiring, commands, operation, and SDI-12 protocol. The Argonaut can be interfaced with any data logger supporting SDI-12 version 1.0, 1.1, 1.2, or later. SDI-12 is ideal for data logging applications that have the following requirements.

- For low cost system integration
- For additional data recorder/transmitter requirements
- For battery powered operation with minimal current drain
- For cable lengths up to 100 m (300 ft) between the Argonaut and the data recorder. The official specification on maximum cable length for RS-232 and SDI-12 is 60 m (200 ft). However, using SonTek’s high quality shielded communication cable, we have found reliable communications with cable lengths to 100 m (300 ft).

Note: The SDI-12 mode is not supported in Argonauts with either the *Wave Spectra* option or the *YSI Multiprobe* integrated sensor.

E-2. Instrument Control and SDI-12 Auto Sampling

In an SDI-12 deployment, the Argonaut acts as a slave — the SDI-12 data logger controls the timing of all data collection. This allows the data logger to control the sampling of several independent instruments to assure the desired timing and comparison of data. However, if the Argonaut never receives data logger commands, it will never collect any data. If there is a problem with the data logger or a cable, this can result in the complete loss of data from a deployment.

To help prevent the loss of data when possible, starting with firmware version 12.0 the Argonaut supports the **SDI-12 Auto Sampling** function. This function works as follows.

- The Argonaut monitors the time between commands received from the data logger.
- If an extended period has elapsed with no data logger the commands, the Argonaut starts auto sampling (without input from the data logger).
- The length of time without a data logger command required before **SDI-12 Auto Sampling** is started is the longest of the following.
 - A minimum time of 2 hours.
 - Four times the programmed value of **Sampling Interval**.
 - Four times the interval between the last two SDI-12 commands from the data logger.
- Once **SDI-12 Auto Sampling** has started, samples are taken at the interval determined by the programmed settings of **Averaging Interval** and **Sampling Interval**.
- If the data logger recovers and sends a command to the Argonaut, the system will stop auto sampling and will revert to data logger control.

Below are some guidelines when setting **SDI-12 Auto Sampling**.

- If the data logger is programmed to collect samples at a regular interval:
 - It is generally recommended that **SDI-12 Auto Sampling** be set to **YES**.
 - The programmed value of **Sampling Interval** should match the interval at which the data logger is programmed to collect data.
 - The data logger will normally control the timing of all data samples.
 - If an extended period passes with no commands from the data logger, the Argonaut will begin auto sampling.

- If the data logger is programmed to collect samples at an irregular interval, or if the data logger is using event-driven sampling (such as sampling only during storm events):
 - It is generally recommended that **SDI-12 Auto Sampling** be set to **NO**.
 - The data logger will always control the timing of Argonaut samples, and auto sampling will never be turned on.

E-3. Switching Between RS-232 and SDI-12 Operating Modes

Two distinct changes need to take place when switching the Argonaut between the RS-232 operating mode and the SDI-12 operating mode.

- A hardware change is required to select which serial bus, RS-232 or SDI-12, is being used. Only one serial bus can be used at any given time.
 - The hardware change is made using the RS-232/SDI-12 jumper switch on the power and communications cable ([Figure E-1](#)).
 - When the switch is closed (connector is mated), the system uses the RS-232 serial bus.
 - When the switch is open (connector is not mated), the system uses the SDI-12 serial bus.
- A software change is made to select the command protocol used. The system can respond either to RS-232 commands or to SDI-12 commands, but it cannot respond to both command types at the same time.
 - RS-232 commands are described in [Appendix C](#).
 - SDI-12 commands are described in this appendix.

The following steps are used to switch from RS-232 command mode to SDI-12 command mode.

- Hardware preparation:
 - Connect the 8-pin underwater connector to the system (see [§1.4](#) and [Figure 1-3](#)).
 - Connect the DB9 connector to an available serial port on your computer.
 - Make sure the RS-232/SDI-12 jumper switch on the power/communications cable is closed (mated), enabling the RS-232 serial bus.
 - Apply system power.
- Connect the SDI-12 pigtail portion of the power/communications cable to your data logger. One portion of the cable has three bare wires ([Figure E-1](#)). Two of the wires are for DC input power (red is power, black is common ground). The third wire (white) is for SDI-12 communications and can be directly connected to most data loggers. See [§E-5](#) for details about the SDI-12 cable connections.
- Because the system is now in RS-232 mode, you can send all the commands needed to configure the system for your application. Detailed instructions in how to prepare the system for deployment are given in [§5.7](#) and [§5.8](#).
- The final command to place the system in SDI-12 software mode is shown below. This command can be sent from *SonUtils*, or will be sent automatically by *ViewArgonaut Deployment* software when an SDI-12 deployment has been selected.

```
>SDI12 ON                               Switch to SDI-12 software operating mode.
OK
```

- Disconnect the RS-232/SDI-12 jumper on the power/communications cable ([Figure E-1](#)).
- The system is now in SDI-12 mode using the SDI-12 serial bus.
- The Argonaut will now receive SDI-12 commands from the data logger.

The following steps are used to exit SDI-12 mode and return the Argonaut to RS-232 mode.

- Connect the RS-232/SDI-12 switch ([Figure E-1](#)) to enable the RS-232 serial bus.
- Connect the DB9 connector on the Argonaut power/communications cable to an available serial port on your computer.
- Run the *ViewArgonaut Deployment* software and connect to the Argonaut. If the Argonaut is in SDI-12 mode, the software will detect this and automatically switch to RS-232 mode.
- Alternatively, you can manually switch to RS232 mode using *SonUtils*. Send the following command to the system; you must press **<Enter>** after the command.

?EXIT!

Switching to RS-232 Mode

>

- The system is now in RS-232 command mode using the RS-232 serial bus, and is now ready to receive commands.

E-4. Simulating SDI-12 Commands Using SonUtils

The *SonUtils* software has a feature that can be used to simulate SDI-12 operation and test system response to SDI-12 commands.

- This involves placing the system in SDI-12 software mode, but continuing to use the RS-232 serial bus to send and receive commands.
- This can be useful when testing the interface between the system and the SDI-12 data logger.

The following steps describe how to use *SonUtils* to test SDI-12 operation.

- Hardware preparation:
 - Connect the 8-pin underwater connector to the system (see §1.4 and [Figure 1-3](#)).
 - Connect the DB9 connector to an available serial port on your computer.
 - Make sure the RS-232/SDI-12 switch on the power/communications cable is closed (mated), enabling the RS-232 serial bus.
 - Apply system power.
 - Run *SonUtils*.

- Establish communications by sending a **BREAK**.

<BREAK>

Click BREAK icon to awaken system.

Argonaut-SW

SonTek/YSI, Inc.

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Wake up initialization. Please wait...

- Because the system is now in RS-232 mode, you can send all the commands needed to configure the system for your application (§5.8).
- In the upper left portion of the *SonUtils* screen (just below the **Communications** parameters), there is a pull-down menu that shows the input type. This is normally set to **Command**.
- Use the pull-down menu to select **SDI-12** mode. This will automatically send the following command to the system.

>**SDI12 ON**

OK

Checking Setup Parameters...

Switching to SDI-12 mode

SDI-12 address is: a

- The system is now in SDI-12 software operating mode, but is using the RS-232 serial bus. We can now send standard SDI-12 commands via the RS-232 serial bus using *SonUtils*.
- In **SDI-12** mode, *SonUtils* will automatically append **!** to the end of each command (when the **<Enter>** key is pressed) as required by SDI-12 protocol. This simplifies the typing needed to enter SDI-12 commands.
- You can now type any SDI-12 command and see the instrument response. For example, if you type “**aI**” (without the quotes, without the trailing **!**, and where **a** is the system’s SDI-12 address), and then press **<Enter>**, *SonUtils* will send the following command string, and you should see a response similar to the one shown here.

aI!

A12 SonTek SW 93 T18

- This mode can be used to test the response of the system to any SDI-12 command.
- To exit SDI-12 mode and return to RS-232 command mode, use the pull-down menu to select **Command**. This will automatically send the following command to the system, and will return it to RS-232 command mode.

?EXIT!

Switching to RS-232 Mode

>

E-5. Connecting the Argonaut to a Data-Logger

To make it easier for an Argonaut with external SDI-12 to work with external data storing systems, the power and communications cable ([Figure E-1](#)) includes separate termination wires to be used with SDI-12 capable data-loggers.

The cable has an underwater connector on one end ([Figure 1-3](#)). The termination of the other end of the cable will vary depending on system type, but will always include the following items.

- SDI-12 pigtail (these are three bare wires):
 - Red ----- Power to Argonaut (+7 to +15 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.
- RS-232 connector (DB9), wired to match a standard PC serial port.
- A 3-conductor connector that is used to switch between RS-232 and SDI-12 communications. This is called the RS-232/SDI-12 jumper switch.
 - Closed (mated) = RS-232
 - Open (not mated) = SDI-12

The same communications cable is used for both SDI-12 and RS-232 operations. The jumper switch is used to change the hardware between the two modes ([Figure E-1](#)); a software command is also needed (see §E-3). When the jumper switch is mated, RS-232 mode is enabled. When the jumper switch is not mated, SDI-12 mode is enabled. The suggested connection sequence is:

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

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

E-5.1 Input Power

The Argonaut requires 7-15 VDC input power (12 VDC recommended). Normally, the Argonaut is a low power device; however, when it transmits acoustic pulses, it requires up to 400 mA for short bursts. Make sure your wiring and battery are capable of supplying sufficient current.

Words of caution:

- Make sure your wiring and battery are 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 sure the connections are reliable.
- Use shielded cables in noisy environments.
- **Warning:** The power line does not have over-voltage protection. Voltages above +16V on the pigtail will damage Argonaut electronics.



Figure E-1. Argonaut-SW Power/Communications Cable

E-5.2 SDI-12 Power and Communications Cable Wiring

The exact configuration of this cable varies depending on the Argonaut system type and configuration. For detailed wiring information, see §7.1.

E-6. Collecting Data Using SDI-12

This section describes the SDI-12 command sequences used to interface to the Argonaut. For detailed instructions on how to configure the Argonaut for an SDI-12 deployment, see §5.7.12 (*ViewArgonaut*) or §5.8.3 (*SonUtils*). The basic SDI-12 data collection sequence is as follows.

- The example commands below use SDI-12 Address **a**.
- The SDI-12 data logger initiates a new sample in the Argonaut by sending one of the following three commands.

<u>Data Collection Command</u>	<u>Argonaut Response</u>	<u>Description</u>
aM!	a1329<cr><lf>	§E-8.1
aM0!	a1329<cr><lf>	§E-8.1
aC!	a13211<cr><lf>	§E-8.2

- The Argonaut requires a 15-second overhead time to complete all calculations. As such, the sample will be ready after a period no more than 15 seconds longer than the specified averaging interval.
 - **IMPORTANT:** Be sure the data logger allows sufficient time between samples for both the averaging interval and overhead time.
- If the concurrent measurement command (**aC!**) is used, all parameters can be retrieved using the **aDn!** commands (§E-6.1).
- If one of the measure commands (**aM!** or **aM0!**) is used:
 - The primary Argonaut data parameters can be retrieved using the **aD0!** and **aD1!** commands.
 - The Argonaut generates more data than many SDI-12 sensors, so retrieving all this data requires some additional SDI-12 commands.
 - For SDI-12 version 1.1 and later, you can retrieve additional parameters using the multiple measurement commands described in §E-6.2.
 - For SDI-12 version 1.0, you can retrieve additional parameters using the multi-address mode described in §E-6.3.
- After the sample is complete, the Argonaut waits in a reduced power state until the SDI-12 data logger initiates another sample.

E-6.1 SDI-12 Version 1.2: Concurrent Measurement

Version 1.2 of the SDI-12 communication protocol supports the Concurrent Measurement command (“**C**”; §E-8.2). This command is well suited to the relatively large amount of data generated by the Argonaut since it allows a larger number of parameters to be returned. A typical command sequence for the Argonaut is shown below.

- The example below uses SDI-12 Address **a**.
- In the example, the Argonaut is using an averaging interval of 120 seconds; as such, the data sample will be ready in, at most, 132 seconds (**a13238**).

- The number of data values reported with a concurrent measurement command will vary depending on system type and configuration (§E-8.2).
- In this example, all possible data values are available; as such, the system will return 38 values (**a13238**).

<u>Data Collection Command</u>	<u>Response</u>	<u>Description</u>
aC!	a13238<cr><lf>	See §E-8.2
<u>Data Retrieval Command</u>	<u>Response</u>	<u>Description</u>
aD0!	a±T.TT±P.PPP±L.LLL±CC.C<cr><lf>	[Main line 1]
aD1!	a±X.XX±Y.YY±Z.ZZZ±S.S±F.FFF<cr><lf>	[Main line 2]
aD2!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 1]
aD3!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 2]
aD4!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 3]
aD5!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 4]
aD6!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 5]
aD7!	a±c.ccccc±t.ttttt±p.ppp±s.ssss<cr><lf>	[CTD]
aD8!	a±B.B±R.R±F.FFF±V.VVV±I<cr><lf>	[Misc]

- For a complete description of all output parameters, see §E-8.3.
- Some output data lines are only reported if certain features are installed and enabled.
 - Multi-cell data are only reported if **ProfilingMode** has been enabled
 - Only the first five cells of a multi-cell profile are reported (even if more than five cells are recorded).
 - If less than five cells are being collected, only those cells are reported.
 - CTD data are only reported if the optional external CTD is installed.
 - If one or more data line is not present, all subsequent lines will be moved up to respond to an earlier **aDn!** command. For example:
 - If multi-cell is turned off, and CTD is not installed, the Misc line will be returned in response to the **aD2!** command.
 - If multi-cell is turned on with three cells, and the CTD is not installed, the Misc line will be returned in response to the **aD5!** command.
- Some values on individual lines are only present if that measurement has been enabled. For complete details on the content of each line, see §E-8.3.

E-6.2 SDI-12 Version 1.1: Multiple Measurement

Version 1.1 of the SDI-12 communication protocol supports multiple measurement commands for each instrument. For the Argonaut, we use the multiple measurement commands to access different lines of data from the instrument.

- The example below uses SDI-12 Address **a**.
- In the example, the Argonaut is using an averaging interval of 120 seconds; as such, the data sample will be ready in, at most, 132 seconds (**a1329**).
- Only the first measurement command (**aM!** or **aM0!**) actually starts a new sample.
 - Data retrieval commands issued following this command (**aD0!** and **aD1!**) retrieve the main data from the single integrated velocity cell.
 - The system will return eight values for the single integrated velocity cell, plus a ninth value if internal flow calculations are enabled.

- Subsequent measurement commands (**aMn!**) retrieve additional lines of data available from the same measurement.
 - Data from this measurement command are available immediately (**a0004**).
 - The number of parameters returned with each line depends on the specific line of data and instrument configuration (§E-8.1).
 - These commands do not actually start a new measurement, but just report data from the most-recent primary measurement command (**aM!** or **aM0!**).
- In this example, we are collecting all possible data values from the instrument.

<u>Data Collection Command</u>	<u>Response</u>	<u>Description</u>
aM! or aM0!	a1329<cr><lf>	See §E-8.1
<u>Data Retrieval Command</u>	<u>Response</u>	<u>Description</u>
aD0!	a±T.TT±P.PPP±L.LLL±CC.C<cr><lf>	[Main line 1]
aD1!	a±X.XX±Y.YY±Z.ZZZ±S.S±F.FFF<cr><lf>	[Main line 2]
aM1!	a0004<cr><lf>	
aD0!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 1]
aM2!	a0004<cr><lf>	
aD0!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 2]
aM3!	a0004<cr><lf>	
aD0!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 3]
aM4!	a0004<cr><lf>	
aD0!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 4]
aM5!	a0004<cr><lf>	
aD0!	a±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 5]
aM6!	a0004<cr><lf>	
aD0!	a±c.cccc±t.ttttt±p.ppp±s.ssss<cr><lf>	[CTD]
aM7!	a0005<cr><lf>	
aD0!	a±B.B±R.R±F.FFF±V.VVV±I<cr><lf>	[Misc]

- For a complete description of all output parameters, see §E-8.3.
- Some output data lines are only reported if certain features are installed and enabled.
 - Multi-cell data are only reported if **ProfilingMode** has been enabled
 - Only the first five cells of a multi-cell profile are reported (even if more than five cells are recorded).
 - If less than five cells are being collected, only those cells are reported.
 - CTD data are only reported if the optional external CTD is installed.
 - If one or more data line is not present, all subsequent lines will be moved up to respond to an earlier **aMn!** + **aD0!** command. For example:
 - If multi-cell is turned off, and CTD is not installed, the Misc line will be returned in response to the **aM1!** + **aD0!** command.
 - If multi-cell is turned on with three cells, and the CTD is not installed, the Misc line will be returned in response to the **aM4!** + **aD0!** command.
- Some values on individual lines are only present if that measurement has been enabled. For complete details on the content of each line, see §E-8.3.

E-6.3 SDI-12 Version 1.0: Multi-Address

Version 1.0 of the SDI-12 communication protocol does not provide a simple method to retrieve the number of values reported by the Argonaut. To accommodate additional data when using version 1.0, a special multiple address mode was developed.

- The user specifies the base address of the Argonaut using the **SDI12Address** command.
- The user enables multiple addresses by sending the command **SDI12MultiAddress YES**.
- The Argonaut will use the user-specified base address and up to seven sequential addresses. Each of the next seven addresses is used for one additional line of data.
- Because the Argonaut will be using up to eight sequential addresses (one for the main data, and up to seven additional lines of data), the selected address must allow eight sequential addresses. As such, only the following sets of base address settings are allowed.
 - 0 through 2
 - a through s
 - A through S

Following is an example of the use of the multi-address mode to retrieve data. The system is connected and programmed using RS-232 data collection as described in §5.8.3. The final commands issued to the Argonaut using *SonUtils* are:

```
>SDI12Address a      Select address a.
OK
>SDI12MultiAddress YES Enable multi-address mode.
OK
>SaveSetup          Save setting to memory.
OK
>SDI12 ON           Change to SDI-12 mode.
OK
```

After sending the **SDI12 ON** command, the RS-232/SDI-12 switch is opened to enable the SDI-12 bus. The system can then be connected to the data logger. The series of commands sent by the data logger should be similar to the following.

- In this example, the Argonaut is using the base SDI12 Address **a**, and is using multi-address values of **b** through **h**.
- In the example, the Argonaut is using an averaging interval of 120 seconds; as such, the data sample will be ready in, at most, 132 seconds (**a1329**).
- Only the measurement command to the base address (**am!** or **am0!**) actually starts a new sample.
 - Data retrieval commands issued following this command (**ad0!** and **ad1!**) retrieve the main data from the single integrated velocity cell.
 - The system will return eight values for the single integrated velocity cell, plus a ninth value if internal flow calculations are enabled.
- Subsequent measurement commands to additional addresses (**bm!** through **hm!**) prepare the system to retrieve additional lines of data.
 - Data from these measurement commands are available immediately (**b0004**).
 - The number of parameters returned with each line depends on the specific line of data and instrument configuration (§E-8.1).
 - These commands do not actually start a new measurement, but just report data from the most-recent base address measurement command (**am!**).

- In this example, we are collecting all possible data from an Argonaut.

<u>Data Collection Command</u>	<u>Response</u>	<u>Description</u>
aM!	a1329<cr><lf>	See §E-8.1
<u>Data Retrieval Command</u>	<u>Response</u>	<u>Description</u>
aD0!	a±T.TT±P.PPP±L.LLL±CC.C<cr><lf>	[Main line 1]
aD1!	a±X.XX±Y.YY±Z.ZZZ±S.S±F.FFF<cr><lf>	[Main line 2]
bM!	b0004<cr><lf>	
bD0!	b±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 1]
cM!	c0004<cr><lf>	
cD0!	c±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 2]
dM!	d0004<cr><lf>	
dD0!	d±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 3]
eM!	e0004<cr><lf>	
eD0!	e±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 4]
fM!	f0004<cr><lf>	
fD0!	f±x.xx±y.yy±z.zz±s.s<cr><lf>	[Cell 5]
gM!	g0004<cr><lf>	
aD0!	g±c.cccc±t.ttttt±p.ppp±s.ssss<cr><lf>	[CTD]
hM!	h0005<cr><lf>	
aD0!	h±B.B±R.R±F.FFF±V.VVV±I<cr><lf>	[Misc]

- For a complete description of all output parameters, see §E-8.3.
- Some output data lines are only reported if certain features are installed and enabled.
 - Multi-cell data are only reported if **ProfilingMode** has been enabled
 - Only the first five cells of the multi-cell profile are reported (even if more than five cells are recorded).
 - If less than five cells are being collected, only those cells are reported.
 - CTD data are only reported if the optional external CTD is installed.
 - If one or more data line is not present, all subsequent lines will be moved up to respond to an earlier address. For example:
 - If multi-cell is turned off, and CTD is not installed, the Misc line will be returned in response address **b** (**bM!** + **bD0!**) – one address past the base address.
 - If multi-cell is turned on with 3 cells, and the CTD is not installed, the Misc line will be returned in response address **d** (**dM!** + **dD0!**) – three addresses past the base address.
- Some values on individual lines are only present if that measurement has been enabled. For complete details on the content of each line, see §E-8.3.

E-7. Summary of Argonaut SDI-12 Commands

Show SDI12	Lists current SDI-12 settings.
Sdi12 ON	Puts the system in SDI12 mode.
Sdi12Address a	Sets the SDI-12 address of the system (“a” in this example).
Sdi12MultiAddress YES/NO	Enables multi-address mode. Note: This mode is only used when using multi-cell data from a data logger that supports only SDI-12 protocol v1.0. If the data logger supports SDI-12 v1.1 or higher, this parameter should be set to NO as there are simpler methods for extracting multi-cell velocity data.
Sdi12AutoSampling YES/NO	Enables or disabled SDI-12 auto sampling (§E-2). When enabled, the Argonaut will begin autonomously collecting data if an extended period passes with no command from the data logger. If disabled, the Argonaut will collect data only when it receives a command from the data logger.
?EXIT!	Exits SDI-12 mode and enters RS-232 mode.

E-8. SDI-12 Command and Response Protocol

This is a brief description of the SDI-12 “command and response” protocol used by the Argonaut. For detailed information about the SDI-12 protocol itself, refer to the most recent version of *A Serial Digital Interface Standard for Hydrologic and Environmental Sensors*, coordinated by the SDI-12 Support Group, 135 East Center, Logan, Utah (<http://www.sdi-12.org/>).

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 in **bold**. 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.

E-8.1 Measure Command “M”

The Measure command (**M**) 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.

<u>Command</u>	<u>Response</u>	<u>Description</u>
aMc!	atttn<cr><lf> a<cr><lf>	Initiate measurement Sent when measurement complete and data is available.

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 data line to be retrieved. Depending on system configuration, **c** can be a value from 0 through 7, where a value of 1-7 represents an additional data line to be retrieved, and a value of 0 (or null) represents the main data lines from the single integrated velocity cell. See §E-6.2 for an exact description of the data returned for each value of **c**. Note that only the last **aM!** or **aM0!** command actually initiates a measurement; the other commands simply report the specified data from the most recent measurement.
- 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. When making a new measurement, this value is equal to the [Averaging Interval \(AI\)](#) + 15 seconds. This provides extra time for system overhead in taking a velocity sample. When reporting additional data lines from a previous measurement (using a **c** value from 1-7), this value will be 000.
- 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:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
aM!	a1329<cr><lf>	132 s	9	Start new measurement for single integrated velocity cell.
aM3!	a0004<cr><lf>	0 s	4	Report data from Cell 3 (if ProfilingMode YES). Note: Reported data was taken at the time of last aM! command for Cell 3 as defined by the multi-cell profile parameters.

The number of parameters reported in response to an **aMc!** command depends on the data line requested and the system configuration.

- For details on which data line is reported with a particular **aMc!** command, see §E-6.2
- The primary measurement command (**aM!** or **aM0!**) reports eight values if internal flow calculations are not enabled, and nine values if internal flow calculations are enabled.
- Multi-cell data lines always report four values.
- The CTD data line always reports four values.
- The Misc data line reports 2 to 5 values.
 - If total volume calculations are disabled, and ice detection (Argonaut-SW only) is disabled, the Misc data line reports 2 values.
 - If total volume calculations are enabled, and ice detection (Argonaut-SW only) is disabled, the Misc data line reports four values.
 - If total volume calculations are disabled, and ice detection (Argonaut-SW only) is enabled, the Misc data line reports 3 values.
 - If total volume calculations are enabled, and ice detection (Argonaut-SW only) is enabled, the Misc data line reports two values.

E-8.2 Concurrent Measurement Command

The Concurrent Measurement command (c) was added to 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 **am!** command; however, the **nn** field has an extra digit (allowing additional output parameters), 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 ([AvgInterval](#)+12), 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 "nn" 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.

The number of data values reported with a concurrent measurement command will depend on the instrument type and configuration.

- A minimum of 10 values and a maximum of 38 are available with each measurement.
- A main set of 10 values is available with any Argonaut SDI-12 measurement.
- If internal flow calculations are enabled, one additional value is returned.
- If total volume calculations are enabled, two additional values are returned.
- If ice detection is enabled (Argonaut-SW only), one additional value is returned.
- If the multi-cell velocity profile is enabled, four values are returned per cell for up to the first five cells, giving a maximum of 20 data values for multi-cell.
- If the external CTD sensor is installed, four additional parameters are returned.

E-8.3 Send Data Command "D"

The Send Data Command (**D**) 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**, **c**, or **v** command must be sent.

The exact response to a **d** command depends on the type of SDI-12 data collection being used. For a detailed description of different data collection modes, and which data line will be output for a given **d** command, see §E-6.

All possible responses to the **d** command are shown below.

<u>Data line</u>	<u>Output</u>
Main line 1	a±T.TT±P.PPP±L.LLL±CC.C<cr><lf>
Main line 2	a±X.XX±Y.YY±Z.ZZ±S.S±F.FFF<cr><lf>
Cell 1	a±x.xx±y.yy±z.zz±s.s<cr><lf>
Cell 2	a±x.xx±y.yy±z.zz±s.s<cr><lf>
Cell 3	a±x.xx±y.yy±z.zz±s.s<cr><lf>
Cell 4	a±x.xx±y.yy±z.zz±s.s<cr><lf>
Cell 5	a±x.xx±y.yy±z.zz±s.s<cr><lf>
CTD	a±c.cccc±t.tttt±p.ppp±s.ssss<cr><lf>
Misc	a±b.b±r.r±f.f±v.v±i.i<cr><lf>

Where:

<u>Data Format</u>	<u>Metric</u>	<u>English</u>
T.TT = Mean Temperature	°C	°F
P.PPP = Mean Pressure	decibar	psi
L.LLL = Level	m	ft
CC.C = Cell End	m	ft
X.XX = Velocity component 1 ⁽¹⁾ (beam 1/X/East)	cm/s	ft/s
Y.YY = Velocity component 2 ⁽¹⁾ (beam 2/Y/North)	cm/s	ft/s
Z.ZZ = Velocity component 3 ^(1,2) (beam 3/Z/Up)	cm/s	ft/s
S.S = Mean Signal-to-Noise Ratio ⁽¹⁾	dB	dB
F.FFF = Flow ³	m ³ /s	ft ³ /s
x.xx = Velocity component 1 ⁽⁴⁾ (beam 1/X/East)	cm/s	ft/s
y.yy = Velocity component 2 ⁽⁴⁾ (beam 2/Y/North)	cm/s	ft/s
z.zz = Velocity component 3 ^(2,4) (beam 3/Z/Up)	cm/s	ft/s
s.s = Mean Signal-to-Noise Ratio ⁽⁴⁾	dB	dB
c.cccc = Conductivity from CTD sensor	S / m	S / m
t.tttt = Temperature from CTD sensor	°C	°F
p.ppp = Pressure from CTD sensor	decibar	psi
s.ssss = Salinity from CTD sensor	ppt	ppt
b.b = Battery voltage	V	V
r.r = Remaining recorder space (-1 is recorder is off)	Kbytes	Kbytes
f.fff = Flow ⁽⁵⁾	(5)	(5)
v.vvv = Total volume ⁽⁵⁾	(5)	(5)
i = Ice detection score ⁽⁶⁾		

Notes:

- (1) These reported values are the single integrated velocity cell.
- (2) For 2D sensors (SL, SW), velocity component 3 is the magnitude calculated from components 1 and 2.
- (3) Flow value is reported only if internal flow is enabled; if disabled, Main Line 2 reports only 4 values.
- (4) These values are from the multi-cell velocity profile. Cell parameters are defined by profiling parameters [CellSize](#), [BlankDistance](#), [Ncells](#), and the cell number represented by that particular data line.
- (5) Flow and total volume are only reported on the Misc line if total volume calculations are enabled; units are determined by the [TotalVolume](#) setting (§C-15). If total volume calculations are disabled, the ice detection score (if enabled) will be the third parameter on the Misc data line.
- (6) Ice detection score is only reported if ice detection has been enabled (Argonaut-SW only) (§C-8).

E-8.4 Continuous Measurements “R”

The Continuous Measurement command (**R**) was added to the Version 1.2 SDI-12 Specification. Sensors that are able to monitor continuously 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.

While the original definition of the **R** commands does not apply to the Argonaut, we have adapted one of the **R** commands to a special function not available with other SDI-12 commands.

Command	Response
aR! or aR0!	a+0<cr><lf> or a+1<cr><lf>

Where:

- a** is the sensor address (“0-9”, “A-Z”, “a-z”, “*”, “?”).
- R** or **R0** are the upper case ASCII characters representing the Continuous Measurements command.
- ±** is a polarity sign (+ or -).

The function of this command is to reset the total volume calculations to zero. When this command is received, and if total volume calculations are enabled, the Argonaut will reset the computed total volume to zero and respond with **a+1**. If total volume calculations are not enabled, the Argonaut will respond with **a+0**. When total volume is reset, this affects both real-time output data and values recorded in the data file (§□-).

E-8.5 Initiate Verify Command “V”

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 are 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.

<u>Subsequent Command</u>	<u>Response</u>													
aD0	a+123.456+78.9+y<cr><lf>													
	<table><tr><th><u>Key</u></th><th><u>Description</u></th><th><u>Value</u></th></tr><tr><td>+123.456</td><td>Fixed test data</td><td></td></tr><tr><td>+78.9</td><td>Fixed test data</td><td></td></tr><tr><td>y</td><td>ROM checksum test</td><td>0=Failed, 1 = Passed</td></tr></table>	<u>Key</u>	<u>Description</u>	<u>Value</u>	+123.456	Fixed test data		+78.9	Fixed test data		y	ROM checksum test	0=Failed, 1 = Passed	
<u>Key</u>	<u>Description</u>	<u>Value</u>												
+123.456	Fixed test data													
+78.9	Fixed test data													
y	ROM checksum test	0=Failed, 1 = Passed												

E-8.6 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.

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

E-8.7 Send Identification Command "I"

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

<u>Command</u>	<u>Response</u>
aI!	allccccccmmmmmmvvvx...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").
ccccccc	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 **aI!** command:

a12 SonTek SW 93 T18<cr><lf>

E-8.8 Change Sensor Address

The Change Sensor Address Command (**A**) 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 is invalid, the address is out of range, or the EEPROM programming operation fails.

<u>Command</u>	<u>Response</u>	<u>Description</u>
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:

<u>Command</u>	<u>Response</u>	<u>Description</u>
aA2!	2<cr><lf>	Change sensor address from " a " to " 2 ".

Appendix F. Argonaut Analog Output Option

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

F-1. Overview of the Argonaut Analog Output Option

The Argonaut AO option works as follows.

- One external AO converter is required for each AO channel. Two types of AO converters are available:
 - Current: 4-20 mA current loop output (DGH part number D3261)
 - Voltage: 0-5 VDC voltage output (DGH part number D3171)
- A firmware feature in the Argonaut generates a modified RS-232 serial output to control the AO converter. The AO converter accepts the RS-232 serial output from the Argonaut and generates the desired analog signal.
 - This firmware feature must be enabled at the factory for the AO option to function.
- Only one type of AO converter can be used on a single Argonaut at any given time.
- Up to two AO converters of the same type can be used with the same system at one time. Each AO converter is individually configured as a different AO channel (1 or 2).
- The AO signal generated by each converter is proportional to the value of one Argonaut variable.
- Ten AO output variables are available — flow, volume, stage, X-velocity, Y-velocity, velocity magnitude, average SNR, pressure, temperature, and cell end location.
- When using more than one AO converter, each converter must be configured for a unique address (1 or 2).
- When using the AO option, no other real-time data output (i.e. RS-232, SDI-12, Modbus) is available.

F-2. Analog Output Wiring

Along with the AO converter, SonTek supplies an adapter cable. This cable has two functions:

- It connects the AO converter to the Argonaut during data collection.
- It can connect the AO converter directly to your computer to verify converter operation and, if necessary, configure the converter. AO converters are configured at SonTek and should not need to be re-programmed by the user.

Figure F-1 shows a schematic drawing of the AO converter and AO adapter cable; **Figure F-2** is a picture of the cable. Both these figures represent the use of only one AO converter.

When using more than one AO converter from a single system, the converters must be wired in series. This is shown in **Figure F-3**.

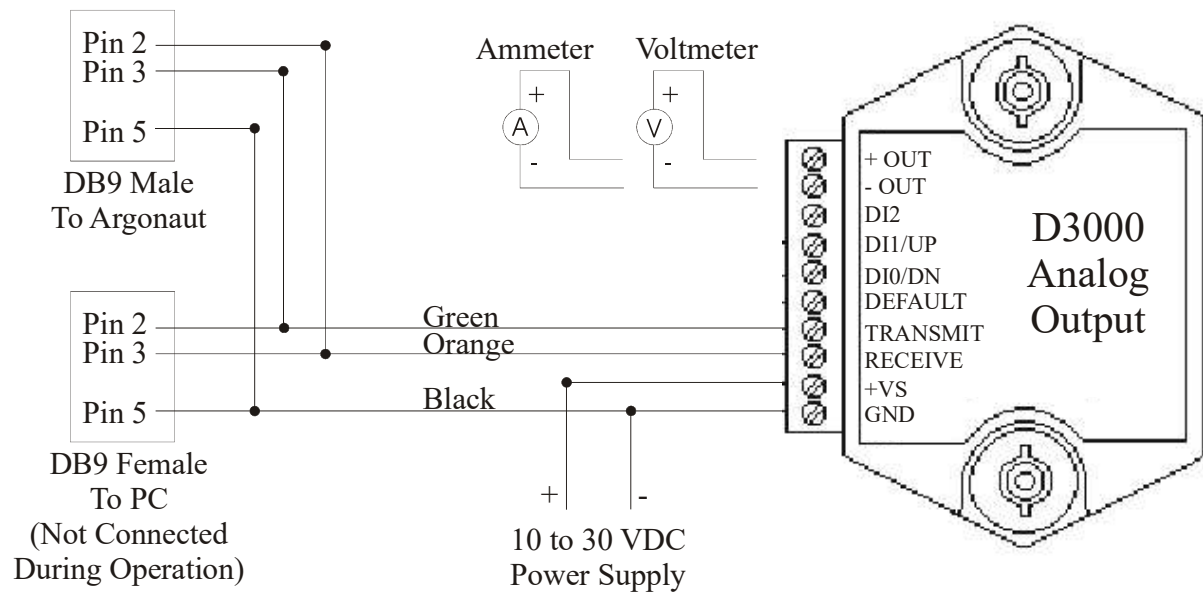


Figure F-1. AO Converter and Wiring: Schematic Drawing

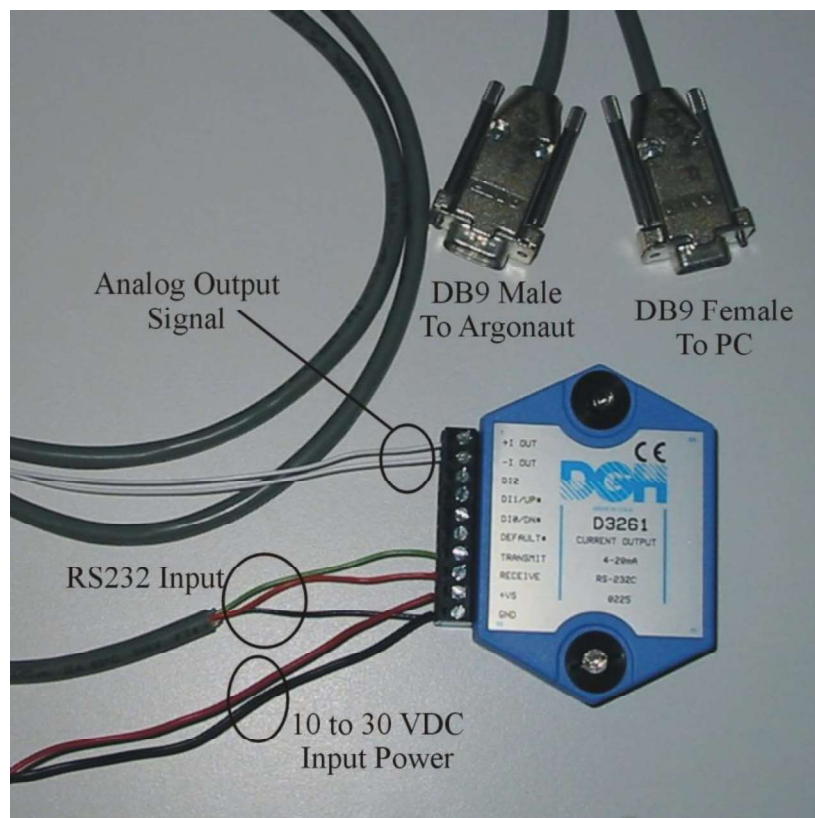


Figure F-2. AO Converter and Wiring: Sample Photograph

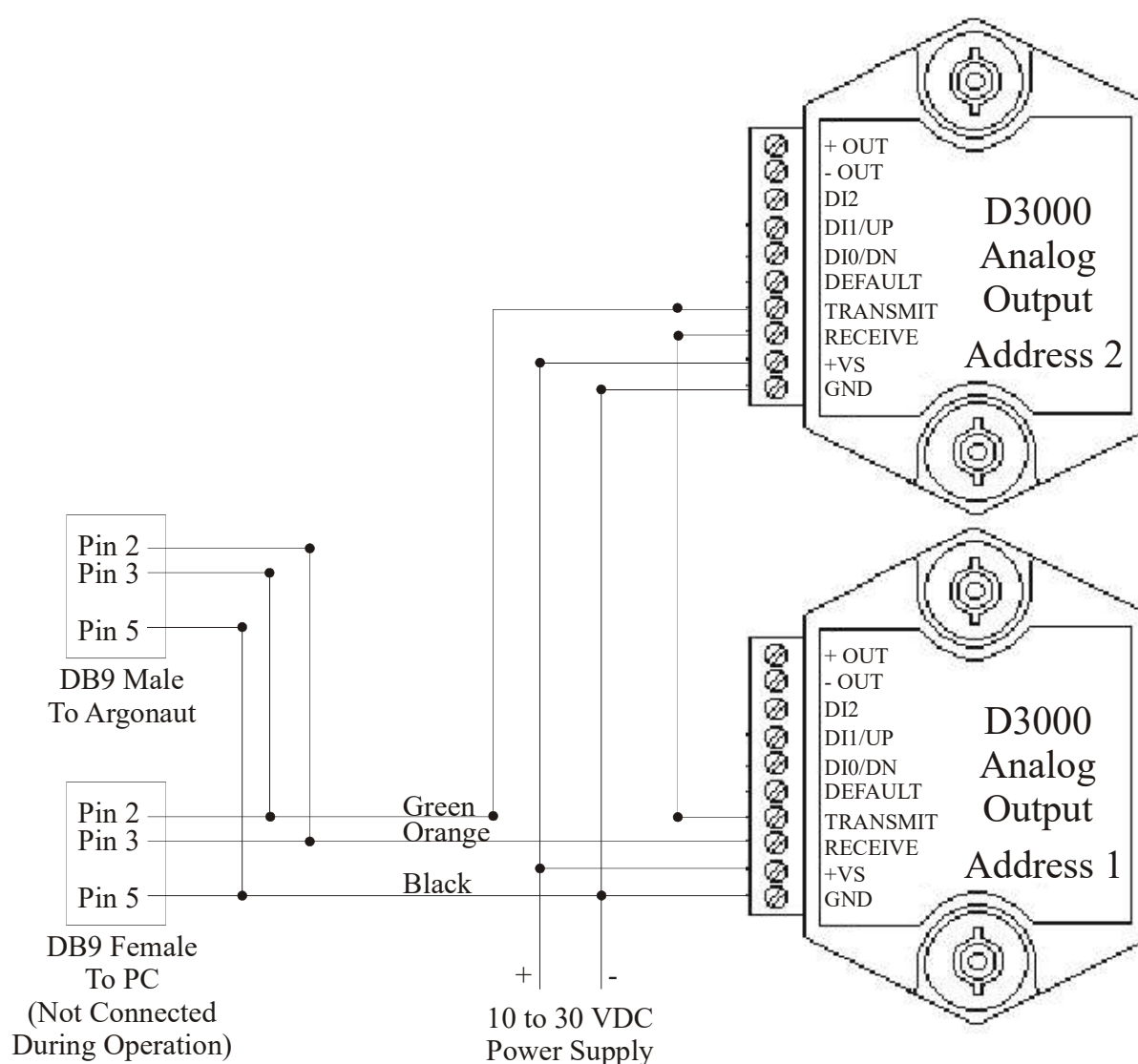


Figure F-3. AO Converter and Wiring: Multiple Converter Operation

The AO adapter cable has the following connections.

- DB9 Male
 - Mates to the DB9 female connector on the Argonaut power and communications cable.
 - After the Argonaut has been configured and data collection started, the power and communications cable is connected here.
- DB9 Female
 - This connector will match the standard serial (COM) port connection on a PC.
 - This connector is provided to verify converter operation and, if needed, to manually program the AO converter.
 - The AO converter is pre-programmed with all needed parameters at SonTek before shipping. Under normal circumstances, you should not need to modify these settings.
 - For information on how to program the AO converter and verify operation, see §F-4.
 - During normal data collection, this connector must be left unconnected and should be protected from weather and moisture.

- A pigtail with three bare wires (orange, green, and black)
 - When using one AO converter, the converter is connected to the AO adapter cable as shown in [Figure F-1](#).
 - When using two AO converters from a single system, the converters are connected in series as shown in [Figure F-3](#).
- AO converter power supply
 - Each AO converter requires a power supply of 10-30 VDC.
 - The maximum AO converter power consumption is about 1 W.
 - The power supply is connected to the AO converter as shown in [Figure F-](#) (single converter) and [Figure F-3](#) (multiple converters).

F-3. Analog Output Deployment Procedure

This section describes the basic procedure for deploying a system using the AO option.

1. Before going to the deployment site, verify the basic operation of each converter to be used following the procedure in [§F-4](#).
2. Install the Argonaut, connect the instrument power supply, and connect the power and communications cable to your computer.
3. Connect each AO converter to the adapter cable and power supply as shown in [Figure F-](#) (single converter) or [Figure F-3](#) (multiple converters).
4. Follow the procedure for programming the Argonaut for AO operation as described in Section 5 of the appropriate System Manual.
5. After starting data collection from *SonUtils*, disconnect the communications cable (DB9 female) from your computer and re-connect it to the DB9 male connector on the AO adapter cable. Wait as the first few samples are output by the Argonaut; monitor the analog output signal as sampled by your data acquisition system to verify system operation.

Note: We strongly recommend enabling internal data recording in addition to the analog output signal to allow access to full diagnostic data. If recording is enabled, data will be stored on the internal recorder in addition to being sent to the COM port as an analog output.

F-4. Configuring the AO Converter

Each AO converter purchased from SonTek is configured at the factory. The information in this section is provided for verification of AO converter operation. Information about configuring the AO converter is provided for reference only; for additional details, see the D3000/4000 AO Converter manual.

To verify that the AO converter is functioning properly, use the following steps.

1. Connect the AO converter to a serial port on your computer using the female, 9-pin, serial connector on the AO adapter cable provided by SonTek ([Figure F-](#)).
 - If you are using multiple AO converters, verify the operation of each converter separately following the wiring diagram in [Figure F-](#). Each converter must have a unique address (1 or 2).

2. Connect the pigtail (exposed wires) on the cable to the converter as follows ([Figure F-](#)):
 - Black wire to **GND** (ground)
 - Orange wire to **RECEIVE**
 - Green wire to **TRANSMIT**
3. Connect a power source (10 to 30 VDC) to the AO converter as follows ([Figure F-](#)):
 - Negative wire to **GND** (ground)
 - Positive wire to **+VS**
4. Connect terminals of the analog sensing/control unit to **+OUT** and **-OUT** ([Figure F-](#)).
5. After connecting the serial cable, power source, and pigtail, apply power to the system.
6. On your computer, run *SonUtils*. In *SonUtils*, select the appropriate COM port and set the baud rate to 9600.
7. In *SonUtils*, type the command **\$1RD** and press <Enter>. In this example, this converter is using address 1; if the converter is using a different address, replace 1 with the correct address (valid addresses are 1 or 2).
8. If the converter is properly configured, you receive the following response. This response is for the *current* type of converter; the *voltage* converter response will differ slightly.


```
*+00004.00.
```
9. If no response is received, try an alternate baud rate or address (see Step 7 above). Note: All commands to the AO converter must begin with a dollar sign (\$); all responses from the Converter will begin with an asterisk (*).

If the AO converter is not already set up to communicate with the Argonaut, you will need to configure it. To configure the converter, use the following steps. A partial description of the converter's setup word is shown in [Table F-1](#). Note: The following steps assume the converter is in the condition as received from the manufacturer (operating at 300 baud).

1. Connect the converter to a serial port on your computer using the male, 9-pin, serial connector (DB9-M) on the AO adapter cable provided by SonTek ([Figure F-](#)).
 - If using multiple AO converters, verify the operation of each converter separately using [Figure F-](#). Note: Each converter must have a unique address (1 or 2).
2. Connect the pigtail (exposed wires) on the cable to the converter as follows ([Figure F-](#)):
 - Black wire to **GND** (ground)
 - Orange wire to **RECEIVE**
 - Green wire to **TRANSMIT**
3. Connect a power source (10 to 30 VDC) to the AO converter as follows ([Figure F-](#)):
 - Negative wire to **GND** (ground)
 - Positive wire to **+VS**
4. After connecting the serial cable, power source, and pigtail, apply power to the system.
5. On your computer, run *SonUtils*. In *SonUtils*, select the appropriate COM port and set the baud rate to 300.
6. First, verify you can communicate with the converter. In *SonUtils*, type the command **\$1RD** and press <Enter>. In this example, this converter is using address 1; if the converter is using a different address, replace 1 with that value (valid addresses are 1 or 2).

7. If the converter is properly configured, you receive the following response. This response is for the *current* type of converter; the *voltage* converter response differs slightly. If no response is received, try an alternate baud rate or address (see Step 6).

*+00004.00.

8. Read the existing setup word by typing **\$1RS** <Enter>. The typical response is:

```
*318501C0      Meaning:  31:  Address 1
                        85:  300 Baud, no parity, with linefeed
                        01:  2-byte time delay, echo off
                        C0:  7-digit display
```

9. Write-enable the converter EEPROM: **\$1WE** <Enter>.

10. Send a new setup word. The following setup word assumes an address of 1. To set a different address, replace the 31 with the appropriate value from [Table F-1](#).

```
$1SU310205C0   Meaning:  31:  Address 1
                        02:  9600 Baud, no parity, no linefeed
                        05:  2-byte time delay, echo on
                        C0:  7-digit display
```

11. Read the new setup word to confirm it is correct: **\$1RS** <Enter>. The typical response is:

*310501C0

12. Write-enable the Converter EEPROM: **\$1WE** <Enter>.

13. Store the changes: **\$1RR** <Enter>.

14. The change in baud rate will not occur until after the last command has been sent. At this point, change the baud rate in *SonUtils* to 9600. Now send the command **\$1RD** to verify communication with the converter is now at 9600 baud. The converter response should be:

*+00004.00.

Table F-1. Converter's Setup Word Description

Byte	Purpose	Setting	Description
1	Address	31	Address 1
		32	Address 2
		33	Address 3
		34	Address 4
2	COM Setting	82	9600 baud, no parity, with linefeed (default)
		85	300 baud, no parity, with linefeed
		02	9600 baud, no parity, no linefeed (optional)
		05	300 baud, no parity, no linefeed (optional)
3	Advanced COM Setting	01	2-byte time delay, no echo
		05	2-byte time delay, echo on
4	Display Settings/Mode Select	80	6-digit display, manual mode disabled,
		C0	7-digit display, manual mode disabled

F-5. Analog Output Commands

The commands used to setup and control the optional analog output modules are described in detail in [§C-17](#). For example deployment procedures, see [§5.7.14](#) and [§5.8.10](#).

Appendix G. Internal Flow Calculations

Beginning with Argonaut firmware version 8.3 (November 2001), the ability to perform internal flow computations became available for Argonaut-SL and SW systems. Internal flow capabilities were greatly expanded in firmware version 9.3 (May 2003), and the ability to calculate total water volume was added in firmware version 10.7 (December 2004).

G-1. Overview of Argonaut Internal Flow Computations

The SL and SW systems compute flow (discharge) as the product of *Mean Velocity* (computed from an index or theoretical relation between mean-velocity to the velocity measured by the Argonaut) and *Cross-Sectional Area* (computed from a relationship between measured water level and cross-sectional area). Computing flow using the Argonaut requires you to input specific velocity and channel geometry parameters. Total volume is computed as the cumulative sum of flow multiplied by elapsed time, and represents the amount of water that has passed the system during a given span of time. The remaining sections in this appendix describe the settings and equations used to program the Argonaut to compute flow.

G-2. Velocity Equations

The Argonaut measures water velocity integrated over some portion of the stream cross-section.

- The location and orientation of the measurement volume depends on system type, installation location, and channel geometry.
- For flow calculations, the Argonaut needs to know the mean water velocity over the entire cross-section.
- Typically, the velocity measured by the Argonaut will not be exactly equal to the mean velocity; a relationship between measured and mean velocity must be established.
- Two relationships (velocity equations) are supported — *theory* and *index*.
 - Internal flow settings select the appropriate velocity equation (**VelEquation THEORY** or **VelEquation INDEX**) to compute mean channel velocity, and to enter the channel geometry parameters to compute the cross-sectional area.
 - These settings can either be entered from the *ViewArgonaut* program (§5.7) or the direct command interface (§5.8 and §C-15).

G-2.1 Theoretical Velocity Equation

The theoretical velocity equation (**VelEquation THEORY**) relates measured and mean velocity based on the channel geometry, measurement location, and theoretical flow equations.

- The Argonaut flow theory is based on a 1/6-power law velocity profile. Separate flow models predict the velocity distribution for open channel and pipe flow.
- The flow model accounts for channel geometry, water depth, installation location, and measurement volume location. Each of these is continuously updated based on data measured by the Argonaut.
- The theoretical flow model provides good results for regular channel geometries:
 - Concrete lined open channels
 - Concrete lined rectangular or trapezoidal culverts
 - Natural lined open channels with near-trapezoidal shape
 - Round and elliptical pipes

- The theoretical flow model has significant limitations in natural streams with complicated cross-sectional geometry and complicated flow structures. For these installation sites, an index calibration is recommended.
- A technical note with a more detailed description of the theoretical flow calculation is available from SonTek on request.
- The theoretical velocity equation can be set either using the graphical flow interface provided in *ViewArgonaut* (§5.7), or using the direct command interface (§5.8 and §C-15).

G-2.2 Index Velocity Equation

The index velocity equation (**VelEquation INDEX**) is an empirically derived relationship between measured velocity and mean velocity.

- The index relationship is derived by making several independent discharge measurements in a variety of flow and stage conditions, while measuring water velocity with the Argonaut.
- Data are processed using regression analysis to determine the coefficients of the index equation, which define the relationship between measured velocity and mean channel velocity. For details on these calculations, see the references provided in §G-6.
- The Argonaut supports index velocity equations in the following form.

$$V_{\text{mean}} = V_{\text{intercept}} + V_{\text{meas}} * (V_{\text{slope}} + (StageCoef * Stage))$$

- The user supplies the index velocity coefficients *Vintercept*, *Vslope*, and *StageCoef*.
- The Argonaut provides the measured velocity (*Vmeas*) and *Stage*. *Stage* is defined as the water level relative to the local datum (see §G-3).
- Index velocity coefficients can be set either using the graphical flow interface provided in *ViewArgonaut* (§5.7), or using the direct command interface (§5.8 and §C-15).
- The following is an example of setting the index velocity relation using direct commands.

```
>VelEquation INDEX
OK
>OutFormat English
OK
>SetIndexCoef 0.100 0.780 0.073
```

The command sequence shown above sets the following values for the index coefficients.

- *Vintercept*: 0.100 ft/s
- *Vslope*: 0.780
- *StageCoef*: 0.073 1/ft

Note: The index coefficients can be entered in English or Metric units based on the setting of the **OutFormat** parameter. Be sure this parameter is properly set to match the derived values of the index coefficients.

G-3. Channel Geometry

To compute cross-sectional area, the Argonaut needs to know the shape of the channel and where within the channel the system is installed. This allows the Argonaut to relate water level (measured relative to the system) to the portion of the channel that is full, and as such, to the cross-sectional area. The following items are needed to determine this relationship.

- Channel type and detailed channel dimensions
- Argonaut elevation within the channel

An overview of channel geometry input requirements is given below. Detailed examples for each channel type are given in §5.7, §5.8, and C-15.

- **ChannelType**: The Argonaut-SL supports four channel types (**IRREGULAR** open channel, **TRAPEZOID** open channel, closed trapezoidal **CULVERT**, and stage/area **EQUATION**); the Argonaut-SW supports six channel types (**IRREGULAR** open channel, **TRAPEZOID** open channel, **ROUND** pipe, **ELLIPSE** pipe, closed trapezoidal **CULVERT**, and stage/area **EQUATION**).
 - **IRREGULAR** (SL: [Figure C-1](#); SW: [Figure C-2](#)) – This is usually a natural streambed whose shape is defined by up to 20 survey points (X, Y) over the cross-section of the stream. The survey points must follow a few rules:
 - The elevation of the first point (Y₁) must be greater than any other point.
 - Survey points must be entered in order of increasing width (X).
 - **TRAPEZOID** (SL: [Figure C-3](#); SW: [Figure C-4](#)): Typically, a concrete-lined channel whose shape is defined by three parameters – **Bottom Width**, **Top Width**, and **Channel Depth**.
 - **ROUND** ([Figure C-5](#)): A round pipe of a given **Diameter**. Note: Only the SW is intended for installation in pipes; the SL is not suitable for pipe installation.
 - **ELLIPSE** ([Figure C-6](#)): An elliptical pipe of a given **Width** and **Height**. Note: Only the SW is intended for installation in pipes; the SL is not suitable for pipe installation.
 - **CULVERT** (SL: [Figure C-7](#); SW: [Figure C-8](#)): Typically, a concrete-lined channel with a closed top whose shape is defined by three parameters – **Bottom Width**, **Top Width**, and **Channel Depth**. One common example is where a stream or canal passes under a road.
 - **EQUATION**: Allows you to supply a mathematical equation that defines the relationship between measured stage and the cross sectional area of the channel. Two equation types are supported: quadratic and power. Up to five different equations, each valid for a specific range of stage, can be used to define the stage/area relationship for a given site.
- **SetArgElevation**: The elevation of the Argonaut within the channel is needed to determine the relationship between measured water level, total channel depth, and channel area.
 - For **Irregular** channels (SL: [Figure C-1](#); SW: [Figure C-2](#)), Argonaut elevation is given as the height of the vertical beam transducer face relative to the same datum as other channel survey points.
 - For **Trapezoid** (SL: [Figure C-3](#); SW: [Figure C-4](#)), **Round** (SW only: [Figure C-5](#)), **Ellipse** (SW only: [Figure C-6](#)), or **Culvert** (SL: [Figure C-7](#); SW: [Figure C-8](#)) channels, Argonaut elevation is given as the height of the vertical beam transducer face relative to the bottom of the channel or pipe.
 - When using a stage/area **Equation**, Argonaut elevation is given as the height of the vertical beam transducer face relative to the local datum used when developing the stage/area relationship.

G-4. Total Volume Calculations

The Argonaut can also be programmed to calculate total volume, the cumulative sum of flow multiplied by elapsed time. This represents the amount of water that has passed the Argonaut over the elapsed measurement time.

- **TotalVolume**: When total volume calculations have been enabled, flow and volume data can be output in a variety of units, as described in §C-15.

- **Remember Total Volume:** This determines how the Argonaut accumulates total volume when data collection is stopped and started (i.e. to download a data file from the instrument). There are three possible settings, as described in §C-15.
 - **Continuous:** The Argonaut continuously accumulates volume, even when data collection is interrupted temporarily. If data collection is stopped and restarted, the Argonaut accumulates volume from the last good measurement and accounts for the period between the two files.
 - **Initialize:** The Argonaut starts data collection at a user specified volume value (commonly zero (0) when installing the instrument at a new site) and continuously accumulates volume from that point. If data collection is stopped and restarted, the Argonaut automatically switches over to **Continuous** operation.
 - **Reset:** The Argonaut starts volume for each file at zero (0). If data collection is stopped and restarted, the Argonaut starts the volume accumulation once again at zero.
- **Reset Total Volume:** The total volume calculation is set to 0 at the beginning of data collection. It can also be reset to 0 at any point within the data file using three methods.
 - The run-time command “v” (§C-14)
 - The SDI-12 command aR! or aR0! (§E-8.4)
 - Using the **Reset Flow Total** button on the Argonaut Flow Display (§H-2)
- **Allow Volume Reset:** This enables/disables the use of the **Reset Flow Total** button on the Argonaut Flow Display (§H-2). When enabled, the **Reset Flow Total** can be used to reset the total volume calculation to zero (0). When disabled, the **Reset Flow Total** does not have any effect on volume calculations. This is provided for users who do not want field personnel to have the ability to reset the total volume calculation (§C-15).
- **Total Volume Criteria:** The total volume calculation can use flow or velocity criteria to determine which samples are used in the total volume criteria. By default, data from all samples are used for volume calculations. However, samples can be compared using various criteria on either flow rate or velocity and only accumulated if they meet these criteria.
 - See **TotalVolumeFlowCriteria** and **TotalVolumeVelocityCriteria** (§C-15)

G-5. Additional Considerations when Using Internal Flow Computations

This section describes additional considerations when using internal flow computations.

G-5.1 Real-Time Serial Output

During real-time data collection, two fields (Flow, Area) are added to the serial output data stream if only flow calculations are enabled. Five fields (Flow, Area, Volume, Reset Time, Reset Type) are added if both flow and total volume calculations are enabled. For details on the output format, see [Appendix D](#).

G-5.2 Internal Recording

When collecting data, if **VelEquation** is not **DISABLED**, the Argonaut adds two variables (consuming 8 bytes) to each sample for recording: Flow ($0.0001 \text{ m}^3/\text{s}$) and Area (cm^2). If total volume calculations are enabled (**TotalVolume** > 0), the Argonaut adds an additional 25 bytes to each sample for data recording. For details on calculating data storage requirements, see §5.5.1.

G-5.3 SDI-12 Output

When using SDI-12 data collection with internal flow calculations, flow is output as one of the real-time parameters. This means nine parameters are sent with each velocity sample (versus

eight parameters if internal flow is disabled). If total volume calculations are enabled, volume data can also be accessed using an additional SDI-12 data output line (see [Appendix E](#)).

G-5.4 Analog Output

Internal flow and volume data are two of the parameters that can be output with the optional analog output modules, generating either a 4-20 mA current loop or 0-5 VDC voltage proportional to the measured flow. The internal flow and volume parameters must first be configured as described in this appendix. For details about setting up the analog output modules, see [Appendix F](#).

G-6. References

The references that follow address the mathematical process of developing an index calibration rating. Note that this process has evolved with time, and there have been several important revisions to the basic procedure. Only more recent papers, using methods that are generally considered more reliable, are shown here.

- Morlock, Scott E., Nguyen, Hieu T., and Ross, Jerry H., “Feasibility of Acoustic Doppler Velocity Meters for the Production of Discharge Records from U.S. Geological Survey Streamflow-Gauging Stations”, U.S.G.S., Water-Resources Investigations Report 01-4157.
- <http://hydroacoustics.usgs.gov/reports/advm.pdf>
- Sloat, J.V., and Gain, W.S. (1995), “Application of acoustic velocity meters for gauging discharge of three low-velocity tidal streams in the St. Johns River Basin, Northeast Florida”, U.S. Geological Survey Water-Resources Investigation Report 95-4230, 26 p.
- http://fl.water.usgs.gov/PDF_files/wri95_4230_sloat.pdf
- Patino, E., and Ockerman, D. (1997). Computation of Mean Velocity in Open Channels Using Acoustic Velocity Meters. Open File Report 97-220, U.S. Geological Survey.
- <http://pubs.er.usgs.gov/usgspubs/ofr/ofr97220>
- Simpson, M.R., and Bland, R. (2002). Methods for Accurate Estimation of Net Discharge in a Tidal Channel, to be published in J. Oceanic Engrg. IEEE.
- http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=19377&arnumber=895351&count=19&index=3
- Rantz, S.E. and others, “Measurement and Computation of Streamflow Volume 2. Computation of Discharge.” U.S. Geological Survey, Water Supply Paper 2175.
- http://pubs.usgs.gov/wsp/wsp2175/html/wsp2175_vol2_pdf.html

Appendix H. Argonaut Flow Display

The Argonaut Flow Display ([Figure H-1](#)) is an LCD display that can be attached to an Argonaut SL, SW, or XR. The display provides real-time viewing of essentially all parameters measured by the Argonaut. The Flow Display is directly controlled by the Argonaut and is operated from the same power supply as the Argonaut.

H-1. Hardware, Wiring, and Firmware Changes

The Flow Display was released in January 2005. For an Argonaut SL, SW, or XR to support the Flow Display, the following must be true.

- The Argonaut must be running firmware version 10.7 or later.
- The internal wiring of the Argonaut must support control of the Flow Display.
 - Argonaut-SWs shipped after December 2004 have the required internal wiring.
 - Argonaut-SLs or XRs shipped after April 2005 have the required internal wiring.
 - Older Argonaut systems must be returned to the factory for internal wiring modifications.
- The power/communications cable must be modified to support the Flow Display and include a connector to the Flow Display.
 - The 5-pin, Switchcraft connector includes a weatherproof seal for outdoor operation.
 - This connector is on the end of the power and communication cable.
 - Wiring diagrams for the modified power and communication cables are shown in [§7.1](#).

H-2. Flow Display Operation

To enable Flow Display operations:

- Connect the Argonaut cable and power supply for deployment as you normally would.
- Connect the Flow Display to the connector on the power/communications cable.
- Deploy the Argonaut using standard procedures ([§5.7](#) and [§5.8](#)) with the following additions that allow the Argonaut to respond to inputs from the Flow Display keypad.
 - If using *ViewArgonaut Deployment* software, set **EnableFlowDisplay** to **Yes**.
 - If using direct commands (*SonUtils*), send **AutoSleep NO** as part of the procedure.
- The Argonaut can now control the Flow Display automatically.

Regarding Flow Display use:

- Data screens are only available when the Argonaut is actively collecting data.
- The display provides several screens, each displaying various parameters measured by the Argonaut. The data presented on the screens depends on system type and configuration.
- To scroll through screens, press **Next Screen**.



Figure H-1. Argonaut Flow Display

- You can change the units used by the Flow Display.
 - Press **Change Units** to scroll through the different units options ([Table H-1](#)).
 - This action has no effect on Argonaut data collection, or on the output units used for RS232, SDI-12, or Analog Output. It affects only the display.

Table H-1. Flow Display Units Options

	English 1	English 2	English 3	Metric 1	Metric 2	Metric 3
Flow rate	ft ³ /s	gpm ⁽¹⁾	mgd ⁽²⁾	m ³ /s	liters/s	mld ⁽³⁾
Total volume	acre-ft	gallons	gallons	m ³	liters	m ³
Velocity	ft/s	ft/s	ft/s	m/s	m/s	m/s
Depth ⁽⁴⁾	ft	ft	ft	m	m	m
Temperature	°F	°F	°F	°C	°C	°C
Pressure	psi	psi	psi	dBar	dBar	dBar
SNR	dB	dB	dB	dB	dB	dB
Battery	V	V	V	V	V	V
Compass (heading, pitch, roll)	°	°	°	°	°	°

(1) gpm is U.S. gallons per minute. (2) mgd is 10⁶ U.S. gallons per day. (3) mld is 10⁶ liters per day.

(4) Depth (from the vertical beam) is reported as stage and includes instrument elevation (from the flow datum) if this value has been defined.

- The LCD display includes a backlight for easier viewing.
 - Press **Back Light** to turn the backlight on or off.
 - The backlight automatically turns off after one minute.
- You can reset the total volume calculation to zero using the Flow Display.
 - To do this, press **Reset Flow Total**.
 - You will be prompted to press **Reset Flow Total** three times to confirm your decision.
 - If you press any other key during this process, or if you wait more than 10 seconds between key presses, reset is aborted (i.e., total volume calculation will not be changed).
 - Resetting the total volume here does affect the total volume data stored on the Argonaut's internal recorder, and the data output using RS232, SDI-12, or Analog Output devices.
 - The **Reset Flow Total** key is only active if the Argonaut has been programmed with the setting **Allow Volume Reset** as **YES**. If you do not want field personnel to be able to reset the volume calculation to zero, set **Allow Volume Reset** to **NO** (§C-15).

H-3. Power Consumption

Using the Flow Display will increase the total power consumption of the Argonaut. This should be taken into account for battery-operated systems.

- Flow Display power is drawn from the same power supply as the Argonaut.
- The Flow Display itself consumes approximately 0.3 W of power.
- To support the Flow Display, the Argonaut must have the **AutoSleep** parameter set to **NO**.
 - In *ViewArgonaut Deployment* software, setting **EnableFlowDisplay** to **YES** does this.
 - In *SonUtils*, sending **AutoSleep NO** does this.
 - With AutoSleep set to No, the Argonaut will not enter a low power state between samples. This will have a significant impact on overall power consumption.

- When using the Flow Display, you should plan that the combined use of the Argonaut and the Flow Display will consume between 1.0 and 1.5 W of power continuously (even when the Argonaut is not collecting data).
 - The exact power consumption depends on system type and configuration.
 - For more details, see §5.5.2.

H-4. Flow Display Limitations

The Flow Display does have some limitations to its operation.

- It can only be used when the Argonaut and power/communications cable have been modified to support the Flow Display.
 - Older systems (§H-1) need to be returned to the factory for Flow Display modifications.
- It can only be used with the Argonaut SL, SW, and XR firmware version 10.7 or later.
- It cannot be used with any Argonaut that has an external CTD or YSI sensor.
- It cannot be used with any Argonaut that uses RS-422 serial communication.
- Argonaut-SL and XR systems that support the Flow Display will no longer have the 24 V input power connector.
 - These systems used to have two input power connectors: the main battery supply (7 to 15 VDC) and the coaxial power connector (12 to 24 VDC).
 - When modified to support the Flow Display, these systems have only the main battery supply (7 to 15 VDC). This supply does NOT have over-voltage protection; input voltage greater than 16 VDC will severely damage the Argonaut electronics.
- Total system power consumption will increase as described in §H-3 and §5.5.2.

Appendix I. Modbus Interface Module (MIM)

The SonTek/YSI Modbus Interface Module (MIM) is a device that allows an Argonaut-SL, SW, or XR (running firmware version 11.3 or later) to be connected to a Modbus data acquisition network. This provides a simple and powerful method for accessing all major parameters measured by the Argonaut on an established data collection and control network. This document describes the operation of the Argonaut with the MIM in the following sections.

- [How the MIM Works](#)
- [Argonaut System Requirements](#)
- [Programming the Argonaut for Data Collection](#)
- [Accessing Argonaut Data on the Modbus Network](#)
- [Changing Modbus Address and Communication Settings](#)
- [Starting Modbus Data Collection](#)
- [Primary Argonaut Parameters: Modbus Register Locations](#)
- [Additional Argonaut Parameters: Modbus Register Locations](#)
- [MIM Floating Point Number Format](#)

I-1. How the MIM Works

This section describes how the MIM ([Figure I-1](#)) works.

- The MIM operates on 9-16 VDC power; commonly from the same Argonaut power supply.
- The MIM has two RS232 serial ports.
 - The **Argonaut** port communicates with the Argonaut and retrieves data from the system.
 - The **Modbus** port connects to the Modbus network.
- The Argonaut is programmed directly from a PC before being connected to the MIM. After the Argonaut is configured and all settings saved, the Argonaut RS232 cable is connected to the **Argonaut** port on the MIM.
- When power is applied, the MIM looks for an instrument on the **Argonaut** port. If it finds an instrument, it does the following:
 - Reads a few basic parameter settings.
 - Enables a special Modbus output format.
 - Starts data collection.
 - With each sample, the MIM reads the Argonaut output; measured parameters are placed in Modbus registers. Only parameters from the main sample are stored in the registers. This includes velocity, stage, flow, CTD, and wave spectra data.
 - Data from the multi-cell velocity profile, integrated YSI sensor, and pressure time series for wave measurements are not available in the MIM.
- Using the **Modbus** port, the MIM is accessed in the same manner as any other Modbus slave device. The user programs the Modbus network to select the desired parameters from the appropriate registers ([§I-7](#)).



Figure I-1. Modbus Interface Module (MIM)

- The MIM has four status LEDs.
 - **Power** (green) – ON whenever the MIM has sufficient input power.
 - **Argonaut Communications** (green) – ON whenever the MIM has established communications with an Argonaut and the Argonaut is actively collecting data.
 - **Modbus Communications** (yellow) – ON for 1 second each time a communication packet is received (whether successful or not) over the **Modbus** port.
 - **Modbus Error** (red) – ON whenever an unsuccessful communication packet is received on the **Modbus** port — most common cause: incorrect Modbus communication parameters (§1-4 and §1-5). The LED remains lit until a successful packet is received.
- The **Reset** switch is used to return all Modbus communication parameters (§1-4) to their default states (Modbus address 1, baud rate 19200, Even parity). To use this switch:
 - Press the switch for at least 5 seconds.
 - After 5 seconds, the **Argonaut Communication**, **Modbus Communication**, and **Modbus Error** LEDs will start flashing. This indicates the default parameters have been set.
 - Release the switch to begin using the system with the default communication parameters.

I-2. Argonaut System Requirements

- The MIM is compatible with Argonaut-SL, SW, and XR systems.
- The Argonaut must be running firmware version 11.3 (or later).
- The Argonaut must be running exclusively from the RS232 interface. That is, the MIM cannot be used in conjunction with SDI-12 data collection ([Appendix E](#)) or the analog output modules ([Appendix F](#)).

I-3. Programming the Argonaut for Data Collection

The Argonaut is programmed from the RS232 interface just as you would for a standard deployment; all special settings are handled automatically by the MIM. See §5.7 and §5.8 for details about programming the Argonaut.

When selecting operating parameters, take notice of the following parameters, as they will affect the data seen on the Modbus network.

- The MIM is not compatible with SDI-12 or analog output data collection. Both of these options must be disabled for the MIM to operate.
- **Units** selection during the deployment procedure determines the output units seen on the Modbus network.
 - For *ViewArgonaut* deployments, this is set on the **Parameter Overview** page ([Figure 5-32](#)).
 - For *SonUtils* deployments, use the **OutFormat** [**English** or **Metric**] command.
 - A detailed description of the units used for all parameters is given in §1-7.
- If you are interested in flow rate from the Argonaut-SL or SW, you must program and enable flow calculations within the instrument ([Appendix G](#)). This includes the following:
 - Specify the dimensions of the channel (channel geometry).
 - Specify the installation location (elevation) of the Argonaut in the channel.
 - Specify a method for mean velocity calculation: theoretical or index calibration.
- If you are interested in total volume calculations (the cumulative volume that passes by the Argonaut with time), you must enable this data output.
 - This is done from the **Total Volume** page within the **Deployment** software ([Figure 5-44](#)).
 - A variety of output units is available. The units specified affect both flow rate and volume and will override the **Units** setting of the instrument for flow parameters.

- Be certain that timing parameters (**AvgInterval** and **SampleInterval**) are compatible with the update rate expected on the Modbus network. Data seen on the MIM is updated each time the Argonaut completes a sample.
 - We recommend an averaging interval of at least 60 seconds to remove turbulent variations in the canal. When possible, use a longer averaging time (5 minutes is common).
- We strongly encourage you to enable the internal recording of data in the Argonaut.
 - Internally recorded data files contain a variety of diagnostic data that is not available in the real-time data output to the MIM.
 - For detailed analysis of Argonaut data, the internally recorded files are essential.
 - The internal recorder has a 4 MB capacity. Depending on system configuration and operating parameters, this is sufficient for 4-12 months of operation (see §5.5.1).
 - Internally recorded files should be downloaded and archived regularly. These will prove extremely valuable if any future data analysis is required.
 - One parameter on the MIM is the remaining recorder space (in days). This can be used to monitor recorder status and determine when instrument service (to download and archive data) is needed.

I-4. Accessing Argonaut Data on the Modbus Network

The MIM complies with the *MODBUS Over Serial Line* specification for an RTU slave unit. The default communication settings (per the Modbus specification) are listed below. See §I-5 for details on how to change the Modbus address and communication parameters.

- MIM device address 1
- Baud rate 19200
- Parity Even
- 8 data bits, least significant bit sent first
- 1 start bit
- 1 stop bit

The Argonaut data parameters most likely to be accessed are stored in a sequential series of input registers, as described in §I-7.

In addition to the data values shown in input registers, the MIM uses a number of holding registers as described in table I-1 below. The user may want to access these registers to monitor data collection status and MIM configuration.

Table I-1. Holding Register Values

Register	Value type	Description
40201	Unsigned integer	Sampling state: • A 1 means the MIM has established communications with the Argonaut, and it is actively collecting data. • A 0 means data collection is not active; the MIM is trying to establish communications.
40202	Unsigned integer	The number of times data collection has been started since the MIM was powered on.
40301	Unsigned integer	Modbus address; this should be a value from 1 to 247. • Writing a new value to this register can be used to change Modbus address. To put new setting in effect, you must then write a 1 to register 40304.
40302	Unsigned integer	Modbus baud rate: • 1 = 300 baud • 2 = 600 baud • 3 = 1200 baud • 4 = 2400 baud • 5 = 4800 baud • 6 = 9600 baud • 7 = 14400 baud • 8 = 19200 baud • 9 = 38400 baud • 10 = 57600 baud • 11 = 115200 baud • Writing a new value to this register can be used to change the Modbus baud rate. To put new setting in effect, you must then write a 1 to register 40304.
40303	Unsigned integer	Modbus parity setting: • 1 = NONE • 2 = EVEN • 3 = ODD • Writing a new value to this register can be used to change Modbus parity. To put new setting in effect, you must then write a 1 to register 40304.
40304	Unsigned integer	Enable register for Modbus communication settings. • Writing a 1 to this register will save and put into effect any changes to the values in registers 40301, 40302, and 40303. • The value read from this register will always be 0.
49001	Unsigned integer	MIM firmware version number. • This value, divided by 100, is the firmware version number. For example, a value of 123 would indicate firmware version 1.23.
49002	Unsigned integer	MIM firmware build number. Serves as an additional version reference with the firmware version number.

I-5. Changing Modbus Address and Communication Settings

There are three ways to change the Modbus address and communication settings.

- Using the *MIM Setup* software (see below)
- Using the Modbus network directly to write to a specific set of holding registers (see below)
- Using the **Reset** switch to return to default parameter settings (§I-1)

I-5.1 Using MIM Setup Software to Change Communication Settings

The *MIM Setup* program is normally used to change the Modbus communication parameters.

- *MIM Setup* is installed automatically as a part of *SonUtils* (version 4.00 and later).
 - If you do not have *SonUtils* on your computer, you can download from www.sontek.com.
 - Although it is automatically installed with *SonUtils*, *MIM Setup* is a separate program.
- To use this program:
 - Connect the MIM **Modbus** port to a serial port on your PC. No other Modbus devices should be connected to your PC.
 - Apply power to the MIM.
 - Run *MIM Setup* – click **Start | Programs | SonTek Software | MIM Setup**. You will see the window shown in [Figure I-2](#).
 - Click **Connect**. *MIM Setup* searches all serial ports for the MIM. When found, the program displays the current address, baud rate, and parity settings.
 - Enter the desired address, baud rate, and parity.
 - Click the **Submit** button; the MIM will begin using the new parameters.
 - Exit the software and connect the MIM to your Modbus master device.

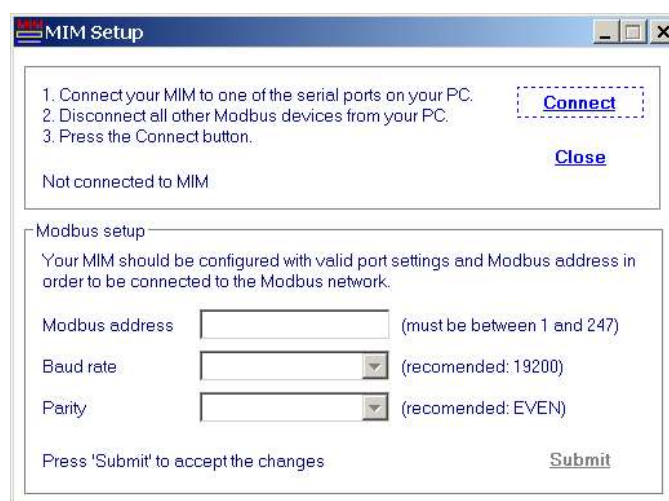


Figure I-2. MIM Setup Program

I-5.2 Using Modbus Network to Change Communication Settings

A less common method for changing Modbus communication parameters is to write to a specific set of Modbus holding registers. The settings for Modbus communication parameters are stored in a series of Modbus registers as described in [Table I-1](#). To change the communication settings:

- Write the desired value(s) to the register(s) shown in [Table I-1](#).
 - Communication parameters are stored in registers 40301, 40302, and 40303.
 - New settings do not take effect immediately.

- Write a value of 1 to register 40304.
 - As soon as this is done, the MIM will save and use the new settings.
 - If power is lost before writing to register 40304, the MIM will operate using the previous parameters; any changes will be lost.

Example – To change the settings to Modbus address 10, baud rate 9600, and no parity:

- Write the value 10 to register 40301 (address).
- Write the value 6 to register 40302 (baud rate).
- Write the value 1 to register 40303 (parity).
- Write the value 1 to register 40304 to put changes into effect.

You can do the four steps above using a single multiple-register write sequence. However, be sure the last register specified is 40304 (so all other settings are done before new settings are put into effect).

I-6. Starting Modbus Data Collection

- Install the Argonaut and perform a site survey to determine proper operating parameters for the instrument (§5.1 through §5.6).
- Connect power to the Argonaut and MIM.
 - The Argonaut operates from 7-16 VDC power. Power consumption varies with instrument configuration (see §5.5.2).
 - The MIM operates from 9-16 VDC power, and consumes less than 0.5 W of power.
 - The Argonaut and MIM can often be run from the same power supply. Be sure the power supply used to operate these devices is sufficient for your required deployment length.
- If necessary, change the Modbus address, baud rate, and parity settings of the MIM (§I-5).
- Deploy the Argonaut following the standard procedure (§5.7 and §5.8).
 - For *ViewArgonaut* deployments, the final step is to click the **Update System** button to save all parameters (Transfer Settings page, Figure 5-51)
 - For *SonUtils* deployments, the final step is to send the **SaveSetup** command.
 - It is not necessary to start data collection, as the MIM will do this automatically. However, the system will still operate reliably even if data collection was previously started (though this may result in an additional file on the internal recorder).
- Connect the DB9 connector from the Argonaut power/communication cable to the **Argonaut** port on the MIM.
- The MIM will establish communications with the Argonaut and start data collection.
 - You should see the **Argonaut Communication** LED light up when communication is established. This may take 1-2 minutes.
- Connect a cable from the **Modbus Communication** port on the MIM to your Modbus data acquisition system.
 - Data on the MIM will be available when the Argonaut completes the first sample.
 - Access data on the MIM as you would any other Modbus RTU slave device.
 - See §I-7 for a description of where different data values can be found.

I-7. Primary Argonaut Parameters: Modbus Register Locations

Each parameter measured or calculated by the Argonaut is stored in a separate MIM register.

- Values are stored as 4-byte floating-point numbers (see §I-9) in two Modbus registers.
- Primary Argonaut parameters (velocity, stage, flow rate, etc.) are always found in the same register locations.
 - Primary parameters are described in [Table I-2](#), including parameter output units.
 - Additional parameters are available for special applications. For details on the locations of these additional parameters, see §I-8.
- The Argonaut outputs several parameters. As such, it may not be practical to retrieve and store all Argonaut parameters on the Modbus network.
 - [Table I-2](#) lists the parameters we consider most important for monitoring data quality.
 - We strongly encourage you to monitor and record these parameters to provide a detailed record for detailed quality control analysis.
 - In [Table I-2](#), we provide basic guidelines for using each parameter. For additional information about interpreting data quality parameters, see §6.3.
- We also encourage you to enable the internal recording of data in the Argonaut.
 - Internally recorded data files contain a variety of diagnostic data that is not available in the real-time data output to the MIM.
 - For detailed analysis of Argonaut data, the internally recorded files are essential.
 - The internal recorder has a 4 MB capacity. Depending on system configuration and operating parameters, this is sufficient for 4-12 months of operation (see §5.5.1).
 - Internally recorded files should be downloaded and archived regularly. These will prove extremely valuable if any future data analysis is required.
 - One parameter on the MIM is the remaining recorder space (in days). This can be used to monitor recorder status and determine when instrument service (to download and archive data) is needed.

Table I-2. Primary Argonaut Parameters (fixed Modbus register location)

Parameter	Register	Units	Notes
Sample number	30001 & 30002	n/a	Number of good samples received since the MIM was last turned on.
Sample time	30003 & 30004	Decimal day	Sample time (start of the averaging interval) from the Argonaut internal clock; units are decimal days since the start of the year (e.g., 06:00 a.m. on January 5 is shown as 4.250).
X velocity	30005 & 30006	Metric: m/s English: ft/s	The measured X-velocity from the Argonaut.
Stage	30007 & 30008	Metric: m English: ft	Total water depth in the channel. This is the water level measured by the Argonaut vertical beam (depth above the vertical beam) plus the Argonaut elevation in the channel programmed by the user for flow calculations. A value of -1.0 indicates the water surface was not detected.
Flow rate	30009 & 30010	See Note 1	Flow rate calculated by the Argonaut.
Total volume	30011 & 30012	See Note 1	Total water volume calculated by the Argonaut. This is the cumulative sum of flow rate multiplied by elapsed time.
Flow area	30013 & 30014	See Note 1	Cross-sectional area of the water at the measurement site; calculated based on channel geometry and stage. A value of -1.0 indicates no stage data was available (water surface not detected by the vertical beam).
Mean velocity	30015 & 30016	Metric: m/s English: ft/s	Mean channel velocity used for flow calculations. This is calculated from the X-velocity measured by the Argonaut and the mean velocity calculation method (theory or index) selected by the user for flow calculations.
Y velocity	30017 & 30018	Metric: m/s English: ft/s	The measured Y-velocity from the Argonaut. For most applications, this will be close to 0. It may deviate from 0 in very shallow water (for the SW), or if an SL is installed in an unusual situation (strong cross flow, near a channel bend, or in an area with accelerating flow). In many situations, a large Y-velocity may indicate a problem with instrument operation.
Temperature	30019 & 30020	Metric: °C English: °F	Water temperature measured by the Argonaut (§6.3.5).
Pressure	30021 & 30022	Metric: dBar English: psi	Water pressure measured by the Argonaut (for systems that include a pressure sensor). This value is not adjusted for the Argonaut installation depth (it represents only water pressure above the sensor).
Argonaut battery voltage	30023 & 30024	volts	Battery voltage as measured by the Argonaut. For most 12 VDC power supply systems, this should be > 11.0 V. The Argonaut can operate on 7-16 VDC (§6.3.5).
Remaining recorder space	30025 & 30026	days	Remaining space on the Argonaut internal recorder; expressed as days of operation. A value of -1 means the internal recorder is not turned on. A value of 0.0 means the recorder is full. We strongly recommend regularly downloading and archiving internally recorded data for future data analysis.
Cell end	30027 & 30028	Metric: m English: ft	The location of the end of the measurement volume (§6.3.6). For: •SWs: This should be roughly equal to the water depth above the system. Some difference between water level and cell end will be seen due to the resolution used to store cell end. •SLs: This should match the programmed Cell End value. In some conditions, cell end may be automatically reduced due to low signal levels.
SNR beam 1	30029 & 30030	dB	SNR values should always be above 3.0 dB, and will typically be 20-50 dB (§6.3.1).
SNR beam 2	30031 & 30032	dB	SNR values should always be above 3.0 dB, and will typically be 20-50 dB (§6.3.1).
SNR beam 3	30033 & 30034	dB	SNR values should always be above 3.0 dB, and will typically be 20-50 dB (§6.3.1). •SNR data for beam 3 will only be present with the Argonaut-XR. For the Argonaut-SL and SW, this value will always be 0.0

Note 1: The output units used for flow rate, total volume, and flow area depend on two settings: **Units** selected for data output and **Total Volume** setting. **Units** are either **Metric** or **English**. **Total Volume** is either disabled (no volume calculations are output) or one of six settings. The output units used for each setting are shown in [Table I-3](#).

Table I-3. Flow Rate and Volume Output Units

Units	Total Volume Setting	Flow rate units*	Volume units	Area units
Metric	0: Disabled	m ³ /s	Not output	m ²
	1: cfs and acre-ft	ft ³ /s	acre-ft	ft ²
	2: gpm and gallons	U.S. gallons / minute	U.S. gallons	ft ²
	3: mgd and gallons	10 ⁶ U.S. gallons / day	U.S. gallons	ft ²
	4: m ³ /s and m ³	m ³ /s	m ³	m ²
	5: liters/s and liters	Liters/s	liters	m ²
	6: mld and m ³	10 ⁶ liters / day	m ³	m ²
English	0: Disabled	ft ³ /s	Not output	ft ²
	1: cfs and acre-ft	ft ³ /s	acre-ft	ft ²
	2: gpm and gallons	U.S. gallons / minute	U.S. gallons	ft ²
	3: mgd and gallons	10 ⁶ U.S. gallons / day	U.S. gallons	ft ²
	4: m ³ /s and m ³	m ³ /s	m ³	m ²
	5: liters/s and liters	Liters/s	liters	m ²
	6: mld and m ³	10 ⁶ liters / day	m ³	m ²

* The flow rate unit of m³ is typically defined as being equal to 1000 liters.

I-8. Additional Argonaut Parameters: Modbus Register Locations

In addition to the primary Argonaut parameters (§I-7), all parameters measured by the Argonaut can be accessed on the MIM (with the exception of multi-cell velocity data).

- These additional parameters repeat many of the primary Argonaut parameters.
- Many parameters will have the same location for all system configurations; see [Table I-4](#).
- The location of some parameters will vary with system configuration.
 - In particular, the presence of the optional integrated CTD or wave spectra measurements will change the location of some parameters.
 - [Table I-5](#) describes these parameters for different system configurations.
- Values are stored as 4-byte floating-point numbers (see §I-9) in two Modbus registers.

Table I-4. Main Parameters (fixed Modbus register location)

Parameter	Register	Units	Notes
Year	30035 & 30036		Sample time (start of averaging interval)
Month	30037 & 30038		Sample time (start of averaging interval)
Day	30039 & 30040		Sample time (start of averaging interval)
Hour	30041 & 30042		Sample time (start of averaging interval)
Minute	30043 & 30044		Sample time (start of averaging interval)
Second	30045 & 30046		Sample time (start of averaging interval)
Velocity (V1/Vx/V _{east})	30047 & 30048	Metric: cm/s English: ft/s	Measured velocity; depends on coordinate system setting
Velocity (V2/Vy/V _{north})	30049 & 30050	Metric: cm/s English: ft/s	Measured velocity; depends on coordinate system setting
Velocity (V3/Vz/V _{up})	30051 & 30052	Metric: cm/s English: ft/s	Argonaut-XR only: Measured velocity; depends on coordinate system setting
Water level (from vertical beam)	30051 & 30052	Metric: m English: ft	Only if vertical beam is installed (SL or SW). This is water level above the vertical beam and does not include system elevation used for flow calculations. A value of -1 indicates water level not detected.
Standard Error of Velocity (V1/Vx/V _{east})	30053 & 30054	Metric: cm/s English: ft/s	Depends on coordinate system setting
Standard Error of Velocity (V2/Vy/V _{north})	30055 & 30056	Metric: cm/s English: ft/s	Depends on coordinate system setting
Standard Error of Velocity (V3/Vz/V _{up})	30057 & 30058	Metric: cm/s English: ft/s	Depends on coordinate system setting
Signal amplitude (beam 1)	30059 & 30060	counts	See Note 1 to calculate SNR.
Signal amplitude (beam 2)	30061 & 30062	counts	See Note 1 to calculate SNR.
Signal amplitude (beam 3)	30063 & 30064	counts	See Note 1 to calculate SNR.
Ice detection	30065 & 30066	See §C-8	Argonaut-SW only, and only if ice detection enabled
Heading	30067 & 30068	degrees	Only if compass/tilt sensor installed.
Pitch	30069 & 30070	degrees	Only if compass/tilt sensor installed.
Roll	30071 & 30072	degrees	Only if compass/tilt sensor installed.
Standard deviation of heading	30073 & 30074	degrees	Only if compass/tilt sensor installed.
Standard deviation of pitch	30075 & 30076	degrees	Only if compass/tilt sensor installed.
Standard deviation of roll	30077 & 30078	degrees	Only if compass/tilt sensor installed.
Temperature	30079 & 30080	Metric: °C English: °F	From Argonaut temperature sensor.
Pressure	30081 & 30082	Metric: dBar English: psi	Only if pressure sensor installed.
Standard deviation of pressure	30083 & 30084	Metric: dBar English: psi	Only if pressure sensor installed.
Battery voltage	30085 & 30086	volts	Argonaut supply voltage
Cell begin	30087 & 30088	Metric: m English: ft	Location of beginning of measurement volume
Cell end	30089 & 30090	Metric: m English: ft	Location of end of measurement volume
Noise (beam 1)	30091 & 30092	counts	See Note 1 to calculate SNR.
Noise (beam 2)	30093 & 30094	counts	See Note 1 to calculate SNR.
Noise (beam 3)	30095 & 30096	counts	See Note 1 to calculate SNR.

Note 1: To calculate SNR for each beam, $SNR = 0.43 * (\text{Signal amplitude} - \text{Noise})$

Table I-5. Additional Parameters
(not always present; Modbus register location varies with system configuration)

Parameter	Units	To enable parameter output	System configuration	Modbus register
Flow rate	See Note 1.	Enable flow calculations	CTD No, Waves No	30097 & 30098
			CTD Yes, Waves No	30105 & 30106
			CTD No, Waves Yes	30121 & 30122
			CTD Yes, Waves Yes	30129 & 30130
Area (cross section)	See Note 1.	Enable flow calculations	CTD No, Waves No	30099 & 30100
			CTD Yes, Waves No	30107 & 30108
			CTD No, Waves Yes	30123 & 30124
			CTD Yes, Waves Yes	30131 & 30132
Volume	See Note 1.	Enable flow calculations and total volume output	CTD No, Waves No	30101 & 30102
			CTD Yes, Waves No	30109 & 30110
			CTD No, Waves Yes	30125 & 30126
			CTD Yes, Waves Yes	30133 & 30134
Time since last volume reset	Metric: days English: days	Enable flow calculations and total volume output	CTD No, Waves No	30103 & 30104
			CTD Yes, Waves No	30111 & 30112
			CTD No, Waves Yes	30127 & 30128
			CTD Yes, Waves Yes	30135 & 30136
Last volume reset type	See Argonaut manual.	Enable flow calculations and total volume output	CTD No, Waves No	30105 & 30106
			CTD Yes, Waves No	30113 & 30114
			CTD No, Waves Yes	30129 & 30130
			CTD Yes, Waves Yes	30137 & 30138
Temperature (CTD)	Metric: °C English: °F	Integrated CTD must be installed and enabled	Any configuration.	30097 & 30098
Conductivity (CTD)	Metric: mS English: mS	Integrated CTD must be installed and enabled	Any configuration.	30099 & 30100
Pressure (CTD)	Metric: dBar English: psi	Integrated CTD must be installed and enabled	Any configuration.	30101 & 30102
Salinity (CTD)	Metric: ppt English: ppt	Integrated CTD must be installed and enabled	Any configuration.	30103 & 30104
Wave height, band 1 (2-4 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30097 & 30098
			CTD Yes	30105 & 30106
Wave height, band 2 (4-6 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30099 & 30100
			CTD Yes	30107 & 30108
Wave height, band 3 (6-8 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30101 & 30102
			CTD Yes	30109 & 30110
Wave height, band 4 (8-10 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30103 & 30104
			CTD Yes	30111 & 30112
Wave height, band 5 (10-12 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30105 & 30106
			CTD Yes	30113 & 30114
Wave height, band 6 (12-14 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30107 & 30108
			CTD Yes	30115 & 30116
Wave height, band 7 (14-16 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30109 & 30110
			CTD Yes	30117 & 30118
Wave height, band 8 (16-18 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30111 & 30112
			CTD Yes	30119 & 30120
Wave height, band 9 (18-20 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30113 & 30114
			CTD Yes	30121 & 30122
Wave height, band 10 (>20 s)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30115 & 30116
			CTD Yes	30123 & 30124
Wave height (significant)	Metric: cm English: ft	Wave spectra must be installed and enabled	CTD No	30117 & 30118
			CTD Yes	30125 & 30126
Wave period	Metric: seconds English: seconds	Wave spectra must be installed and enabled	CTD No	30119 & 30120
			CTD Yes	30127 & 30128

Note 1: The output units used for flow rate, total volume, and flow area depend on two settings: **Units** selected for data output and **Total Volume** setting. **Units** are either **Metric** or **English**. **Total Volume** is either disabled (no volume calculations are output) or one of six settings. The output units used for each setting are shown in [Table I-3](#).

I-9. MIM Floating Point Number Format

The MIM stores all Argonaut data values as floating point numbers. This section explains how this is done.

- Floating-point numbers require four bytes of storage.
- A Modbus register contains two bytes of data, so it takes two Modbus registers to store one floating-point number.
- Since a floating-point number occupies two Modbus registers, there are a few ways a floating-point number can be arranged.
 - There are two likely combinations of how the bytes of a floating-point number could be arranged in the two Modbus registers.
 - The Modbus specification does not explicitly state the correct arrangement for a floating-point number, although a preferred method is suggested ([Table I-6](#)).
 - The Modbus preferred solution for storage of a floating point is, essentially, the opposite of the IEEE standard ([Table I-7](#)).
- Most Modbus devices use the Modbus preferred method for storing floating-point numbers.
- Most Modbus master devices (to which the MIM will be connected) will support either floating-point storage format.
 - The Modbus preferred method is generally called *Floating Point*, while the other (IEEE) method is called *Inverse Floating Point* or *Reverse Floating Point* or *Floating Point Swapped*.
 - The terminology may vary depending on the Modbus device used.
- This should not affect most users. However, some users will need to switch how their Modbus master device recognizes the floating-point number in order to read the MIM (Argonaut) data correctly.

The MIM uses the Modbus preferred method for storing a floating-point number. [Table I-6](#) details the Modbus preferred method (used by the MIM). [Table I-7](#) details the “inverse” method (IEEE).

Table I-6. Modbus Preferred Floating Point Number Storage (used by MIM)

Bit Values	Register N		Register N+1	
	Byte 0	Byte 1	Byte 0	Byte 1
	FFFFFFFF	FFFFFFFF	SEEEEEEE	EEEEFFFF

F – Fractional part of floating point number
 S – Sign of floating point number
 E – Exponent of floating point number

Table I-7. IEEE Floating Point Number Storage

Bit Values	Register N		Register N+1	
	Byte 0	Byte 1	Byte 0	Byte 1
	SEEEEEEE	EEEEFFFF	FFFFFFF	FFFFFFF

F – Fractional part of floating point number
 S – Sign of floating point number
 E – Exponent of floating point number

Appendix J. Optional Features and External Sensors

The Argonaut can include several optional features, each described in this appendix.

- [SonWave Wave Spectra Collection](#)
- [YSI Multi-Parameter Probe](#)
- [SeaBird MicroCat CTD](#)

J-1. SonWave Wave Spectra Collection

The XR/SL models of the Argonaut equipped with a pressure sensor and the SonTek *SonWave* wave spectra collection package can 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.

J-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:

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

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:

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

J-1.2 Setup for Collecting Wave Frequency Spectra

Only Argonaut SL and XR systems with a pressure sensor and the optional SonWave data collection firmware can be set up to collect wave spectra. Wave setup commands that affect wave data collection of the Argonaut are described in §C-16.

The following parameters must be specially set for wave spectra data collection.

- **AvgInterval**
 - An averaging interval of at least 300 seconds must be used to collect wave spectra (this provides a long enough time series for accurate wave spectra estimation).
 - The typical averaging interval for wave spectra is around 1000 seconds, providing a long time series for accurate spectra estimation.
- **PowerPing**
 - **PowerPing** must be disabled when wave spectra calculations are to be made.
 - This is generally not a concern, since wave spectra calculations already require a long averaging interval and the improved performance of **PowerPing** is not required.
- **WaveSpectra**
 - Wave spectra calculations must be enabled by setting **WaveSpectra** to **YES**.
- **WaterDepth**
 - To calculate the correct dispersion relation, the Argonaut must know the water depth at the site. This is done using the **WaterDepth** parameter.
 - A **WaterDepth** 0 setting indicates the mean pressure sensor data will be used for water depth.
 - A **WaterDepth** setting less than 0 indicates the height of the Argonaut above the bottom.
 - This is then added to the mean pressure data to give the total depth at the site.
 - As such, a **WaterDepth** setting of -0.5 m would indicate the Argonaut is installed 0.5 m above the bottom of the site.
 - A **WaterDepth** setting greater than 0 is taken to indicate a constant depth at the site.
- **RecordPSeries**
 - This parameter is set to enable or disable recording of the raw pressure time series.
 - A parameter setting of **YES** provides for additional data analysis in post processing.
 - However, enabling recording of the pressure series will greatly increase data storage requirements, and thus decrease total recorder life (see §5.5.1). We generally recommend setting this parameter to **NO** except for special circumstances.

J-1.3 Wave Data Format

If **WaveSpectra** is enabled, the Argonaut will output 12 additional values with each sample. The first 10 fields correspond to the mean wave amplitudes for each of the period bands 1 through 10. Field 11 is the significant wave height computed as described in §J-1.1. Field 12 is the peak wave period. The exact output format for real-time data is described in §D-2.5.

J-2. YSI Multi-Parameter Probe

The YSI probe series is 6820. Detailed information was not available when this manual was published. Contact SonTek for specifics.

J-3. SeaBird MicroCat CTD

The SeaBird MicroCat CTD with RS-232 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. The CTD model most commonly integrated with the Argonaut system is the SeaBird MicroCat SBE37-SI.

J-3.1 CTD Connection

The CTD can be connected to the Argonaut through several different SonTek-supplied splitter cable configurations depending on the Argonaut's configuration. In all cases, however, the CTD itself will be connected to a 4-pin XSG-type connector. [Figure J-1](#) shows the wiring of the end cap connector on the CTD housing when looking at the connector.

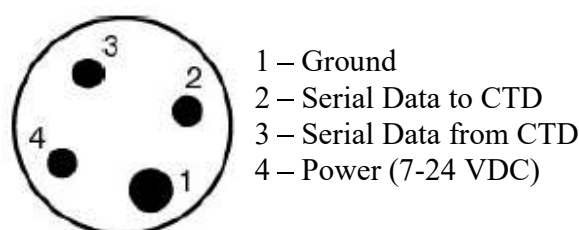


Figure J-1. XSG-4-BCL-HP-SS Connector

J-3.2 CTD Power and Memory Requirements

The Argonaut supplies power (12-15 VDC) to the CTD. As such, when deployed with a CTD, the Argonaut's power consumption will increase by about 0.5 W. This additional power consumption must be taken into consideration when calculating battery life ([§5.5.2](#)).

With a CTD installed, the Argonaut will record an additional 16 bytes to store the CTD's parameters. This memory requirement must be taken into consideration when calculating memory requirements ([§5.5.1](#)).

J-3.3 CTD Commands

Described below are commands that set up the Argonaut to acquire CTD data. In normal operation, all commands to the CTD sensor are sent automatically and no direct commands need to be sent. The commands are provided here only to assist in diagnosing problems and to give greater flexibility in Argonaut operations.

H CTD

- Displays help on external CTD sensor commands.

CTD [CONT]

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

CTD Talk

- Establishes direct serial communication with the external CTD.
- See the CTD sensor manual for details on sending direct commands to the CTD.
- To return to command mode, type “+++” or send a **BREAK** to the Argonaut.

J-3.4 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 (e.g., *SonUtils*) 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. Note: In this example, the first three lines are actually one long line that has “wrapped” because of its length. The bolded, underlined data depicts where the CTD data would appear. See §D-2 for details.

```

2005 05 26 16 00 36      0      0      -1 255 255  0  0  0  0  0
3055 -69 42  0  0  0  0  2360      46  5 71 20 20 41 40
40      244267      39      0      120

1      888      1751 255 228 43 40
2      1421      1570 255 255 42 40
3      549      1899 211 255 42 40

```

The data format is as follows:

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

J-3.5 CTD Binary Data Format

The SeaBird format is a specialized data format used when integrating the Argonaut 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 D](#).

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