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Triton

Operation Manual

Firmware Version 1.0

WARRANTY, TERMS, AND CONDITIONS

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

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

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

In case the system needs to be shipped back to the factory, please contact SonTek/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 original shipping container using original packing material and all delivery cost to SonTek/YSI 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.

INTRODUCTION

This manual is organized into the following sections:

- **Section 1. Triton Components, Terminology, and Sampling** – Definition of terms used in this manual, plus a general description of Triton sampling.
- **Section 2. Getting Started** – Instructions for collecting data with the Triton in the most-common configurations.
- **Section 3. Direct-Command Interface** – Direct serial communication with the Triton using a terminal or terminal emulator.
- **Section 4. Compass/Tilt Sensor Operation**
- **Section 5. Triton Hardware** – Description of Triton electronics, cables, connectors, and instructions for accessing system components.
- **Section 6. Operational Considerations** – Concerns relating to power supply, instrument mounting, coordinate systems, maintenance, and troubleshooting.
- **Section 7. Autonomous Deployment** – Instructions for operating from battery power and using the internal recorder.
- **Section 8. Optional External Sensors** – Concerns relating to optional external sensors.
- **Section 9. Additional Support**
- **Appendix A. Triton Binary Data File Format**

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Section 1. Triton Components, Terminology, and Sampling

1-1. System Components

The Triton (Figure 1) uses a submersible housing for all system electronics (receiver, processor, recorder, compass/tilt sensor) and alkaline battery packs. The system can also operate on external power. The following terms are used regularly when referring to the Triton.

- **Probe** – The probe consists of one transmitter and three receivers (for 3D measurements). Probe components and functions are shown in Figure 2.
 - **Transmitter** – The central acoustic transmitter generates a short pulse of sound with the majority of energy concentrated in a narrow beam (6 mm in diameter).
 - **Receivers** – The acoustic receivers are mounted on arms from the central probe head. The receivers are sensitive to a narrow beam, and are focused on a common volume located a fixed distance from the probe head (nominally 10 cm).
 - **Sampling volume** – The sampling volume is the physical location where the Triton makes 3D velocity measurements. Details: *Triton Principles of Operation*.
- **Mounting stem** – The probe is mounted either on a rigid 15-cm metal stem or on a 0.7-m flexible cable (with a rigid stem at the probe end).
- **Receiver** – The receiver electronics amplify and filter signals to/from the probe.
- **Processor** – The Triton processor consists of two printed circuit boards that perform all Doppler velocity processing. The boards are mounted inside the submersible housing.

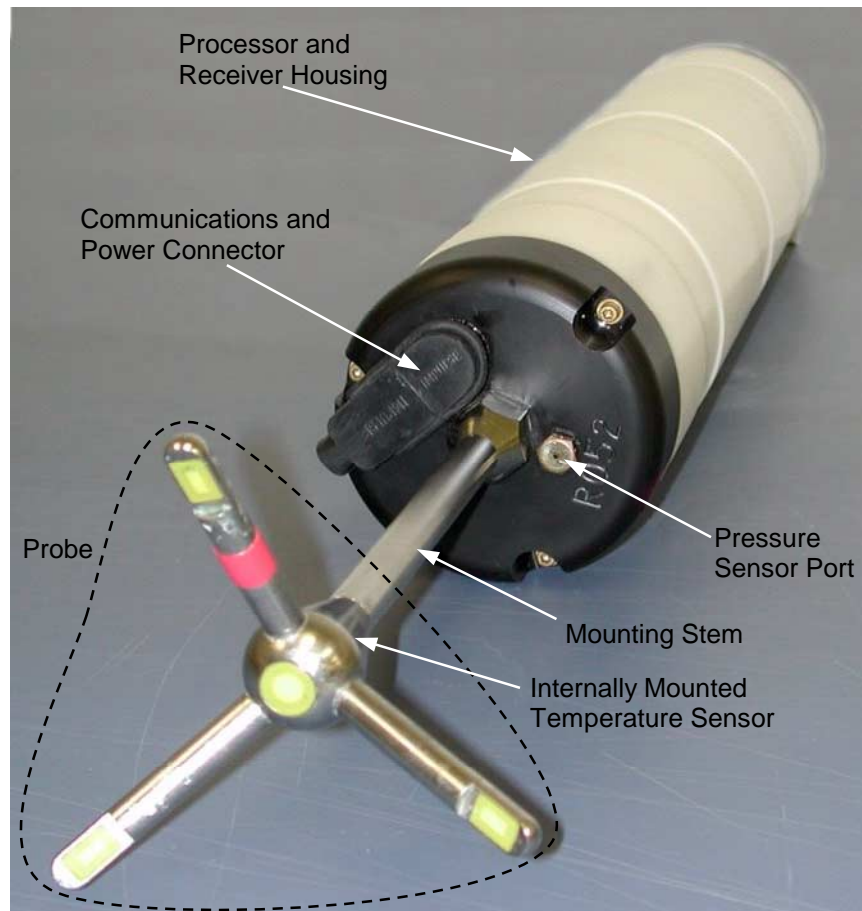


Figure 1 – Triton Underwater Configuration

- **Power and communication cable** – A single cable carries DC power and serial communication between the processor and the controlling computer/data logger. See §3-1 for the serial communication protocols used by the Triton.
- **Temperature sensor** – Data from the probe-mounted temperature sensor (§6-7) compensates for changes in sound speed, which is used to convert Doppler shift to water velocity. See *Triton Principles of Operation* for the effect of sound speed on velocity data.
- **Compass/tilt sensor** – This sensor measures magnetic heading and 2-axis tilt (maximum tilt $\pm 50^\circ$). It allows the Triton to report velocity measurements in Earth coordinates (East/North/Up or ENU). Details: Section 4.
- **Pressure sensor** – This sensor is mounted in the probe end of the processor housing. The sensor provides an integrated measure of deployment depth and pressure-series for wave height measurements integrated with Triton velocity data. Details: §6-8.
- **Battery power** – The Triton uses battery power for autonomous deployments or as a backup in case optional external power fails. Details: §6-1 for input power requirements; Section 7 for autonomous operation; §5-7 for battery access.

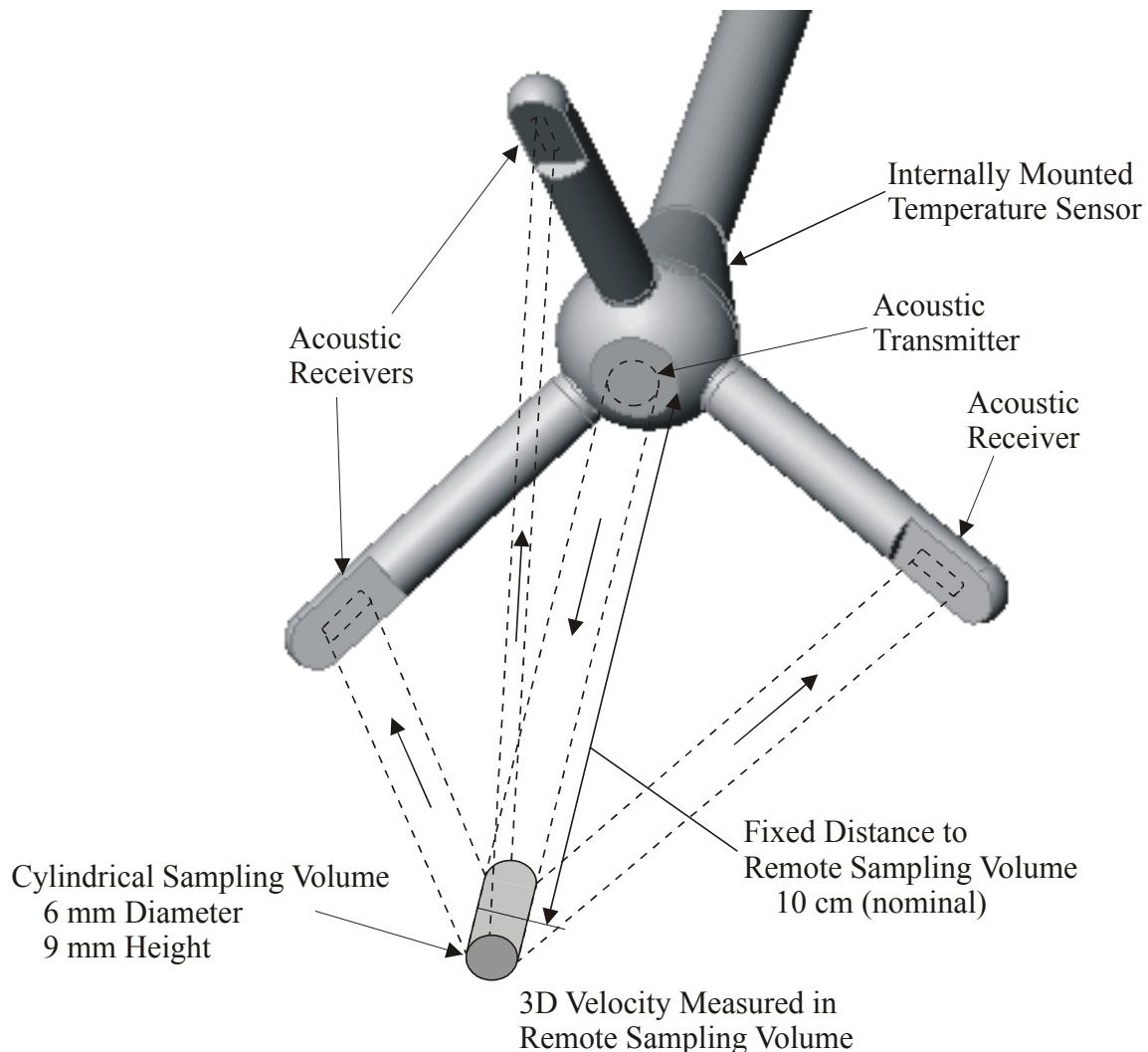


Figure 2 – Triton Probe and Sampling Volume

1-2. Definitions and Terminology

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

- **Direct-command interface** – Direct serial communication with the Triton to control system operation and retrieve data.
- **BREAK** – A serial communication signal that causes a hardware reset and returns the Triton to command mode. A **BREAK** consists of holding the transmit line high for at least 300 ms, and is a standard function in most terminal emulator programs.
- **Temperature** – Water temperature (in °C). A default value is entered by the user, and another value is measured using an internal temperature sensor. Temperature is used for sound speed calculations.
- **Salinity** – Water salinity (in ppt). A user-supplied value is used for sound speed calculations.
- **Sound speed** – Speed of sound in water (in m/s). This is used to convert the Doppler shift to velocity. Sound speed is calculated either from user-specified temperature and salinity, or from measured temperature and user-input salinity (§3-8). See the *Triton Principles of Operation* regarding the effect of sound speed on velocity data.

1-3. Sampling Strategies

There are several terms specific to Triton sampling strategies when collecting water-current data and when collecting wave/pressure data. This section discusses those two strategies.

1-3.1. Water-Current Sampling Strategies

The Triton supports three basic water-current sampling strategies (Figure 3).

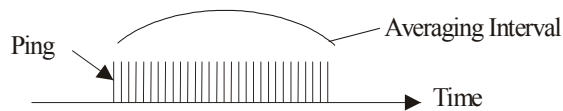
- **Continuous sampling** – This is used for real-time data collection or for autonomous deployments that do not have power or data limitations. The sample interval is the same as the averaging interval, and burst sampling is disabled. The system collects data at all times.
- **Reduced duty-cycle sampling** – This occurs when the sample interval is greater than the averaging interval. When not collecting data, the Triton enters a low-power state (<1 mW). The duty cycle is calculated as the ratio of the averaging interval to the sample interval. For example, an averaging interval of one minute with a sample interval of five minutes gives a 20% duty cycle and extends battery life by a factor of five.
- **Burst sampling** – This lets you to obtain information about short-term flow variation without requiring continuous operation. The Triton collects a number of samples in rapid succession, and then enters the sleep mode. The duty cycle is calculated as follows.

$$\text{Duty cycle} = (\text{Samples_per_burst} * \text{Averaging_interval}) / \text{Burst_interval}$$

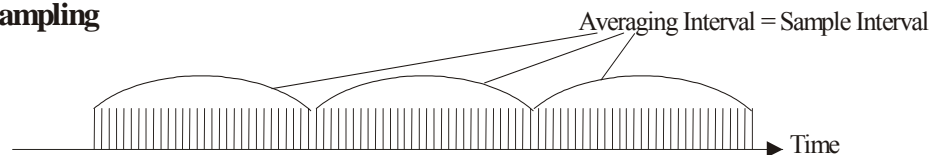
Terms associated with this sampling strategy include:

- **Ping** – A single estimate of the 3D water velocity.
- **Pinging rate** – The number of pings per second (Hz). The Triton pings at 10 Hz.
- **Sample** – A sample refers to the mean of a number of pings to produce an estimate of 3D water velocity. A sample includes velocity, standard deviation, signal strength, and sensor data (temperature, pressure, compass).

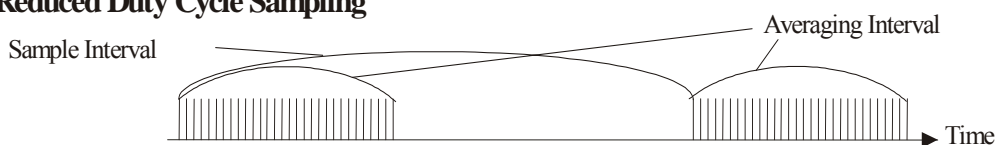
Triton Sample



Continuous Sampling



Reduced Duty Cycle Sampling



Burst Sampling

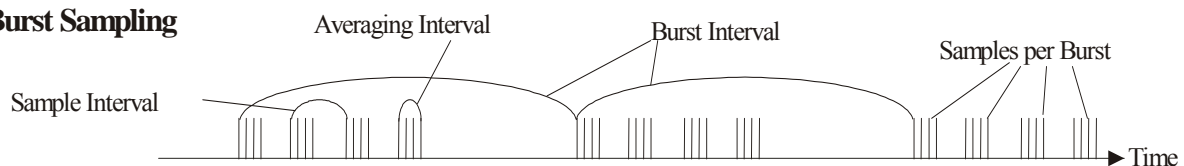


Figure 3 – Triton Water-Current Sampling Strategies

- **Averaging interval** – The period of time, in seconds, over which the Triton averages data before computing a sample.
- **Sample time** – The Triton records date and time from its internal clock with each sample. The recorded time represents the start of the averaging interval.
- **Sample interval** – The time between sequential samples, in seconds. This is defined as the time from the start of one sample to the start of the next sample, and must be greater than or equal to the averaging interval (or the averaging interval will take precedence).
- **Burst sampling** – Allows you to record a number of samples in rapid succession, and then place the Triton in a low-power state for an extended period. Burst sampling obtains information about both the short- and long-term variation of water velocity without the power and memory required for continuous sampling.
- **Burst interval** – The period of time, in seconds, between each sampling burst. This is measured from the start of one burst to the start of the next burst, and must be greater than the total time required for each burst.
- **Samples per burst** – The number of samples recorded during each burst.

1-3.2. Wave/Pressure Data Sampling Strategies

The Triton's wave data collection ability allows the system to collect wave height data, including the wave-frequency spectra. To facilitate wave measurements and reduce demands on power and storage capacity of the Triton, SonTek implemented the following scheme for pressure data collection to process wave times-series data for pressure (P) and horizontal (UV) velocities. When wave data collection is enabled, the Triton samples the pressure sensor at a specified rate for a specified duration and stores raw pressure data in the recorder. You can choose how often the pressure series needs to be collected: one pressure record every n^{th} profiles (Figure 4).

When recording of pressure time series is enabled, the Triton records the mean and the standard deviation of pressure over the averaging interval and stores them with the header information.

After downloading the data from the Triton to a PC, you can get a wave-frequency or directional spectrum, and/or extract the raw pressure time series, using the software provided as a part of the Triton system.

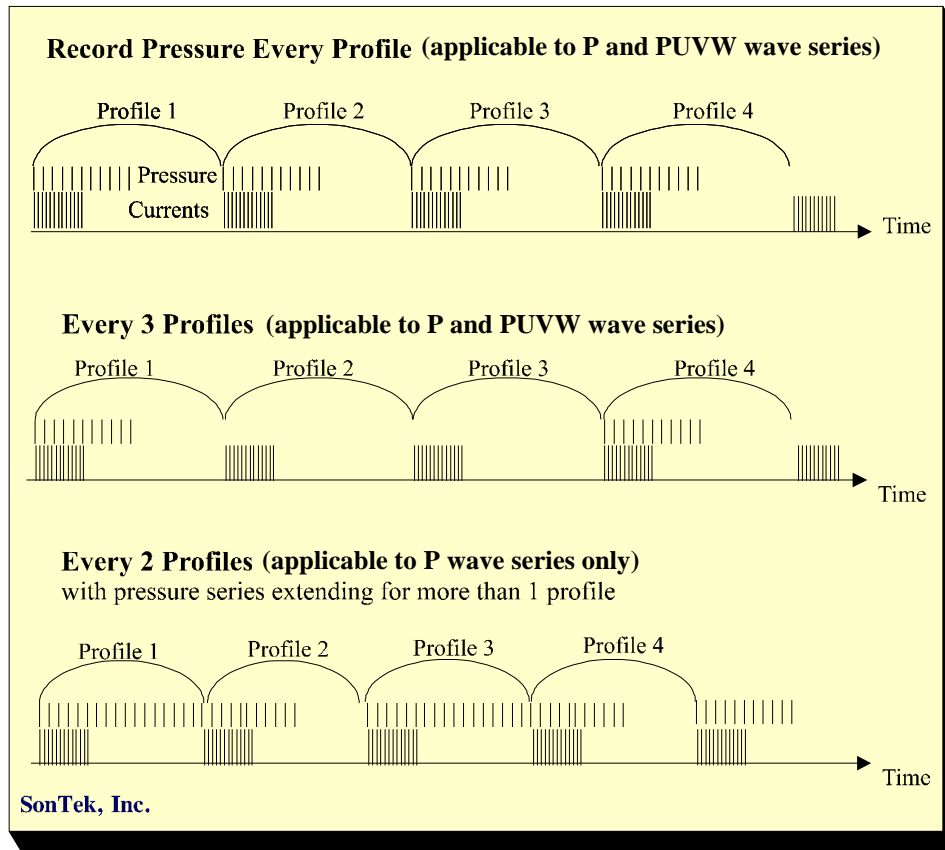


Figure 4 – Examples of different sampling strategies for recording pressure time series data using the Triton

Section 2. Getting Started

This section contains basic instructions for using the Triton in the most common configurations. These instructions are not intended to be comprehensive, but should be sufficient to learn about the instrument and start collecting data.

Initial testing is best done in a small tank of water where velocities can be introduced by stirring the water; a flume is a great option if available. Testing can also be done in air without any damage to the system, but no meaningful velocity data will be collected. If testing in water, be sure there is sufficient scattering material for good operation (§6-10).

2-1. Input Power and Battery Operation

The Triton can be run from three different types of power sources.

- SonTek-supplied DC power supply
- SonTek-supplied internal Triton batteries
- User-supplied external power (battery or other)

SonTek DC Power Supply

- All Triton systems include a DC power supply. Different power supplies are used depending on system requirements.
- Cables are configured to match the power supply included with the system.
- If the system includes internal batteries, the system is set up to use the external DC supply instead of the batteries when the DC supply is present.
- To use, simply connect the power/communications cable to the Triton, and then plug the power supply into an outlet.

SonTek Internal Batteries

- Battery capacity and expected battery life are described in §7-2.1.
- Battery packs for different system configurations are described in §5-7.
- Batteries for autonomous systems are always connected to the instrument. To use the system from battery power, just connect the power/communication cable and send a **BREAK** (within *SonTerm*) or run any of the Triton software programs.
- All systems include an external DC power supply. If this supply is connected, it will be used instead of the internal batteries. The DC supply is recommended for system testing to conserve battery power.

User-Supplied Power

- The Triton offers several different input power configurations for optimal performance in a variety of applications.
- See §6-1 for a description of input power requirements.
- See §5-5 for system wiring diagrams.

To Avoid Draining the Batteries When System is Not in Use

- Always power the system off before storing the system to prevent draining the batteries.
- All Triton configurations can be powered off by establishing direct communications using *SonTerm* and sending the command **PowerOFF** (§3-7).

2-2. System Diagnostics Using *ArgCheck*

ArgCheck lets you quickly verify all aspects of Triton operation. Learning to use this program, and using it on a regular basis, is the **best way to ensure consistently good data**. The instructions here are not intended to be comprehensive; see the *Triton Software Manual* for details.

1. Mount the probe in a tank of water such that a tank bottom or wall is 20 to 30 cm (8 to 12 in) from the tip of the probe.
2. Add a small amount of the provided seeding material to ensure sufficient scattering material (see *Triton Principles of Operation*).
3. Connect the Triton power and communication cable(s) from the instrument to COM1 of the controlling computer and to the external power supply included with the system.
4. Start *ViewTriton* using **Start | Programs | SonTek Software | ViewTriton**.
5. Click **ArgCheck** on the *ViewTriton* main menu.
6. The screen display will update every few seconds (watch the time icon in the corner). Look at the on-screen display to verify the following.
 - The water has sufficient scattering material.
 - All receivers see similar signal profiles – same height and location.
 - The boundary reflection is present; move the probe to see the boundary return move.
 - The electronic noise level is reasonable.
7. Click **Exit** to return to the *ViewTriton* main menu.

2-3. Real-Time Data Collection with SonTek Software

Detailed software descriptions are in the *Triton Software Manual*. Basic instructions are given here.

1. Mount the probe in a small tank of water.
2. Add a small amount of the provided seeding material to ensure sufficient scattering material (see *Triton Principles of Operation*).
3. Connect the Triton power and communication cable(s) from the instrument to COM1 of the controlling computer and to the external power supply included with the system.
4. Start *ViewTriton* using **Start | Programs | SonTek Software | ViewTriton**.
5. Click **Realtime** on the *ViewTriton* main menu.
6. Set an averaging interval of 10 seconds, specify a recording file name, and press **OK** to send the parameters to the system. See Section 3 and the *Triton Software Manual* for details about parameter settings.
7. Click on the green **Play** symbol (▶) to start data output and display.
8. Click on the red **Record** symbol (●) to start recording. Make note of the file name.
9. Allow the Triton to collect several minutes of data. Stir the tank as necessary to introduce a reasonable velocity signal.
10. Stop data collection by clicking on the black **Stop** symbol (■).
11. Exit the real-time data collection software and use the postprocessing software to look at the data collected (§2-4).

2-4. Viewing SonWave-Triton Data (PostProcessing)

ViewTriton includes a post-processing utility to display and analyze Triton data.

1. Start *ViewTriton* using **Start | Programs | SonTek Software | ViewTriton**.
2. Click **PostProcessing** on the *ViewTriton* main menu.
3. Use **File | Open** to select a data file to load.
4. Select a file recorded with the real-time software (or use the demonstration file included with the software) and click **OK** to load the data.
5. Click **OK** when the software shows a summary of the data file.
6. The software will now show a time-series plot of all velocity data in the file. Try using the following features. See the *Triton Software Manual* for more options.
 - Change the velocity scale by double-clicking on the vertical axis.
 - Change the time display by selecting **View | X-Axis Display as**.
 - Zoom in and out of portions of the data using the zoom in and out icons.
 - Experiment with other icons and menus to see the processing options.
7. Exit the postprocessing software by selecting **File | Exit**.

2-5. Real-Time Data Collection using Serial Output Data

The Triton is often integrated with a variety of data loggers using the direct-command interface and serial output data. For this type of application, it will be helpful to gain experience with the system using the direct-command interface. For a detailed description of all commands, see Section 3. For details on using the *SonTerm* terminal emulator, see the *Triton Software Manual*.

1. Connect the Triton power and communication cable(s) from the instrument to COM1 of the controlling computer and to the power supply included with the system.
2. Start *SonUtils* using **Start | Programs | SonTek Software | SonUtils**.
3. Click **SonTermW** on the *SonUtils* main menu.
4. The blue (top) portion of the screen shows output from the Triton; the white (bottom) portion shows commands sent by the user.
5. Capture all communication to a text file by selecting **File | Log File**.
6. Click the **BREAK** symbol (or press Alt+B) to bring the system into command mode (the Triton command prompt is ">").
7. Type **help** and press <Enter> at the command prompt to show menus of the available commands.
8. Use the four "Show" commands (**Show Conf**, **Show System**, **Show Setup**, **Show Deploy**) to display all Triton parameter settings.
9. Type **compass CONT** to display data from the internal compass/tilt sensor (if installed). Rotate and tilt the Triton to verify compass operation (§4-1). Press any key to stop data output.
10. Type **sensor CONT** to display data from the temperature, pressure, and battery voltage sensors (§3-11 and §6-8). Press any key to stop data output.
11. Type **dir** and press <Enter> to view the contents of the internal recorder.
12. Select reasonable operating parameters for trial data collection. A sample set of commands is below; see Section 3 for details.

```
VelRange 5 <CR>
AvgInterval 10 <CR>
SampleInterval 10 >CR>
DataFormat LONG <CR>
OutFormat ASCII <CR>
```

13. Begin data collection with the **start** command.
14. Allow the Triton to output a number of samples, and then exit *SonTermW* (**File | Exit**). Now review the output data in the log file specified in Step 5. See §3-16.2 for output data format.

2-6. Autonomous Deployment

Autonomous deployments (i.e., stand-alone) use the internal recorder for data storage and typically operate on battery power. Section 7 has detailed instructions for autonomous deployments. This section provides a brief overview of the steps used to collect a sample deployment from external power. It assumes you already have a basic familiarity with the direct-command interface.

1. Connect the Triton communication cable from the instrument to COM1 of the controlling computer.
2. Connect the Triton to the battery supply to be used during deployment.
3. Start *SonUtils* using **Start | Programs | SonTek Software | SonUtils**.
4. Click **SonTermW** on the *SonUtils* main menu.
5. Capture all communication to a text file by selecting **File | Log File**.
6. Click the **BREAK** symbol (or press Alt+B) to bring the system into command mode.
7. Select reasonable operating parameters for trial data collection. A sample set of commands is below; see Section 3 for details.

```
VelRange 5 <CR>
AvgInterval 10 <CR>
SampleInterval 10 >CR>
BurstMode NO <CR>
DataFormat LONG <CR>
OutFormat ASCII <CR>
Deployment TEST <CR>
```

8. Begin data collection using the **Deploy** command (this ensures that data is written to the internal recorder).
9. Allow the Triton to collect several minutes of data.
10. Click the **BREAK** symbol (or press Alt+B) to bring the system into command mode.
11. Type **dir** and press <Enter> to view the contents of the internal recorder. You should see a file named **TEST001**.
12. Exit *SonTermW* (**File | Exit**).
13. From the *SonUtils* main menu, click **SonRecW**.
14. Click **Connect** to establish communication with the Triton and list the contents of the recorder.
15. Select the file to be retrieved, and then click **Download** to transfer the data to the computer hard disk.
16. Exit *SonRecW* (**File | Exit**).
17. Look at the data recorded on the recorder using the postprocessing software in *ViewTriton* as described in §2-4.

Section 3. Direct-Command Interface

Before starting data collection, you must set several operational parameters. You can do this using the direct-command interface or the Triton software. This section describes the direct-command interface using a terminal emulator (such as *SonTerm*).

- Section 3-1 describes communication protocols and settings.
- Section 3-2 provides an overview of the operational modes of the Triton.
- Section 3-3 gives an important notice about cycling the Triton power source.
- Section 3-4 presents the syntax rules for the direct-command interface.
- Section 3-5 gives a summary of all available commands.
- Sections 3-6 through 3-15 describe each command in detail.
- Section 3-16 describes the data output format.

3-1. Serial Communication Protocols and Settings

The Triton can communicate using either of the following two serial communication protocols (see §6-6 for details). The protocol is set at the factory based on user requirements. Both of these protocols can use the direct command interface described here in Section 3.

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

3-2. Modes of Operation

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

- Command mode
- Data acquisition mode
- Deployment mode
- Sleep mode

3-2.1. Command Mode

- The Triton can send and receive commands related to all aspects of instrument operation.
- You can enter the command mode from any other mode by sending a **BREAK** (§3-4).
- You can enter the command mode from the data acquisition mode using the run-time command “+++”.
- You can put the Triton 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 sample mode from the command mode, use the command **Sample**.
- To enter the sleep mode from the command mode, use the command **PowerOff**.
- If the Triton is left idle in the command mode for more than five minutes, it will enter the sleep mode to conserve power.

3-2.2. Data Acquisition Mode

- Data acquisition mode is used for real-time data collection, typically connected to an external power supply and computer or data logger.
- Data acquisition mode is entered from command mode with the command **start**. After the command, the Triton takes a few seconds to initialize and then begins data collection.
- In data acquisition mode, the Triton ignores the deployment parameters **StartDate**, **StartTime**, and all burst-sampling parameters.
- If the internal recorder has been enabled (**Recorder ON**), data are output both over the serial port and to the internal recorder.
- If the recorder has been disabled (**Recorder OFF**), data are sent only to the serial port.
- You can exit the data acquisition mode and return to the command mode by sending a **BREAK** (§3-4) or by using the run-time command “+++”.
- While in data acquisition mode, the Triton can enter a low-power state between samples. This state is similar to, although not the same as, the sleep mode. The Triton will enter the low-power state if the system command **AutoSleep** is set to **ON** (the default setting). See §3-7 regarding the **AutoSleep** command and §3-14 regarding the effects of the power saving state on the run-time commands.

3-2.3. Deployment Mode

- Deployment mode is used for autonomous data collection (internal recording, typically with battery power).
- Deployment mode is entered from command mode using the command **Deploy**.
- In deployment mode, the instrument starts data collection at the date and time specified by **StartDate** and **StartTime**. If the current date and time are after the specified start date and time, the system begins data collection immediately.
- In deployment mode, data are always stored to the internal recorder regardless of the **Recorder ON/OFF** parameter.
- In deployment mode, the Triton will always enter the low-power state between samples regardless of the **AutoSleep** parameter (**AutoSleep** is forced **ON**).
- You can exit the deployment mode and enter the command mode by sending a **BREAK**.

3-2.4. Sleep Mode

- Sleep mode is used to conserve power when the Triton is not in use. In the sleep mode, the Triton consumes less than 1 mW of power.
- The sleep mode is entered from the command mode using the command **PowerOff**.
- You can exit the sleep mode and enter command mode by sending a **BREAK** or by sending the command “+++” (§3-14).
- When in sleep mode, the Triton will not respond to any other external commands. The exception is if system power is switched off and on (§3-3).
- If the Triton is left idle in command mode for more than five minutes, it will enter the sleep mode to conserve power.

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

- Always power the system off before storing the system to prevent draining the batteries.
- The splash-proof configuration can be powered off using the switch on the front panel.
- All Triton configurations can be powered off by establishing direct communications using *SonTerm* and sending the command **PowerOff** (§3-7).

3-3. Special Notice when Changing Power Sources

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

- If previously in command or sleep mode, the system will enter command mode.
- If previously in data acquisition mode, the system will immediately start real-time data collection.
- If previously in deployment mode, the system will start 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 sample mode, the system will again enter sample mode and wait for a command to begin a new sample.

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

- Always power the system off before storing the system to prevent draining the batteries.
- All Triton configurations can be powered off by establishing direct communications using *SonTerm* and sending the command **PowerOff** (§3-7).

IMPORTANT:

- When some computers and data loggers are turned on or off, they send a signal out the serial port that can be interpreted by the Triton as a **BREAK** (§3-4).
- If the Triton is connected to the serial port, this can interrupt data collection or bring the Triton out of sleep mode and cause the loss of data or the draining of the batteries.
- Always disconnect the Triton from the computer or data logger **before** turning the computer on or off.

3-4. Command Syntax

Definition of **BREAK**:

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

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

1. The Triton can be brought into the command mode from any other mode by sending a **BREAK**.
2. All commands consist of a single keyword that may be followed by one or more ASCII parameters.
3. The commands and parameters are not case sensitive.
4. When the Triton has completed a command and is ready to accept another command, it will send the prompt character ">".
5. Parameters may be numeric (either integer or floating point), alphanumeric, or a combination (e.g., a date or time string).
6. Commands must be terminated by a carriage return – <CR>.
7. The Triton echoes every character as it is received (except for run-time commands received during data collection – see §3-14).
8. After receiving the <CR> that signals the end of the command string, the Triton echoes with an additional line feed character – <LF>.
9. If the Triton recognizes a command as valid it will transmit: <LF>OK<CR><LF>.
10. If a command is not recognized, the parameters are out of range, or if the command cannot be executed in the present state, the Triton returns an error message followed by <CR><LF>.

IMPORTANT:

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

3-5. Direct-Command Summary

The tables below summarize all direct commands that can be used with the Triton, including any abbreviations (i.e., short versions of the same command). These commands are categorized and explained in different sections and tables based on their function.

- Help commands (§3-6)
- System commands (§3-7)
- Setup commands (§3-8)
- Deployment commands (§3-9)
- Recorder commands (§3-10)
- Sensor commands (§3-11)
- Compass commands (§3-12)
- Show commands (§3-13)
- Run-time commands (§3-14)
- Wave data commands (§3-15)
- CTD commands (§8-1)

The following abbreviations are used for input parameters to the Triton.

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

Help Commands (Section 3-6)

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

System Commands (Section 3-7)

Command	Short	Function	Parameters
Start	(none)	Starts real-time data collection (enter data acquisition mode)	
Deploy	(none)	Starts autonomous deployment (enter deployment mode)	
SaveSetup	(none)	Save current parameters to EEPROM	
Defaults	DEF	Sets all parameters to factory defaults	
Ver	(none)	Shows CPU firmware version	
DSPVer	(none)	Shows DSP firmware version	
BoardRev	(none)	Shows electronics board revision number	
SerNum	(none)	Shows Triton serial number	
Date <date>	(none)	Shows / sets system clock date	yy/mm/dd
Time <time>	(none)	Shows / sets system clock time	hh:mm:ss
PowerOff	(none)	Puts Triton in sleep mode	
AutoSleep <mode>	AS	If ON, Triton enters reduced power state between samples	ON or OFF
OutMode <mode>	OM	Selects data output mode	AUTO or POLLED
OutFormat <format>	OF	Specifies output data format	ASCII, BINARY, SEABIRD, METRIC, or ENGLISH
Recorder <status>	(none)	Turns internal recording on or off	ON or OFF
RecMode <mode>	(none)	Sets recording mode	NORMAL

Setup Commands (Section 3-8)

Command	Short	Function	Parameters
Temp <temperature>	(none)	Set default temperature (°C)	d.d
Sal <salinity>	(none)	Set default salinity (ppt.)	d.d
AvgInterval <seconds>	AI	Set averaging interval (sec)	d
SampleInterval <seconds>	SI	Set time between samples (sec)	d
VelRange <range>	VR	Sets velocity range (index value)	d [0 to 5]
CoordSystem <system>	CY	Set coordinate system for velocities	BEAM, XYZ or ENU
TempMode <mode>	TM	Set temperature used for sound speed calculations	USER or MEASURED
DataFormat <format>	DF	Set output and stored data format	LONG or SHORT

Deployment Commands (Section 3-9)

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

Recorder Commands (Section 3-10)

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

Sensor Commands (Section 3-11)

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

Compass Commands (Section 3-12)

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

Show Commands (Section 3-13)

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 Wave	s wave	Display wave sampling parameters
Show Other	s other	Display miscellaneous Triton parameters

Run-Time Commands (Section 3-14)

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

*These commands available only in data acquisition mode.

Wave Data Commands (Section 3-15)

Command	Shortcut	Function
RecordWSeries	RWS	Enables wave data collection and specifies how often pressure time series data is collected
WSeriesRate	WSR	Sampling rate for wave (P or PUVW) time series collection; Hz
WSeriesLength	WSL	Number of samples (128-4096) in wave series (P or PUVW). Note: Wave series length in seconds equals WSL/WSR.
WSeriesType	WST	Selects the wave series type: P_SERIES or PUV_SERIES
OutWseriesMode	OWM	Wseries acquisition mode; AUTO or POLL

CTD Commands (Section 8-1)

Command	Shortcut	Function
CTD	(none)	Display most recent CTD reading
CTD CONT	(none)	Display continuous CTD readings
CTD Talk	(none)	Direct serial communication with CTD

3-6. Help Commands

The Triton direct-command interface contains several on-line help commands. These are designed such that, by starting with “Help”, you are led through a series of menus that show all Triton commands. The following help commands display all commands you would normally use for any aspect of Triton operation. Entering any of these commands at the direct-command prompt will display the appropriate help menus.

- **Help** – Lists all available help menus
- **Help System** – General system commands (§3-7)
- **Help Setup** – Real-time data collection commands (§3-8)
- **Help Deploy** – Autonomous deployment commands (§3-9)
- **Help Recorder** – Data recorder commands (§3-10)
- **Help Sensor** – Peripheral sensor commands (§3-11)
- **Help Compass** – Compass/tilt sensor commands (§3-12)
- **Help Show** – Commands to display system configuration (§3-13)
- **Help Wave** – Wave data commands (§3-15)

3-7. System Commands

System commands relate to general operation of the Triton.

- 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

- This command starts real-time data collection, putting the Triton into data acquisition mode (§3-2.2).
- The system first saves all recently entered commands (i.e., does a **saveSetup**).
- Data collection begins immediately (**startDate** and **startTime** are ignored).
- Burst sampling cannot be used (burst sampling parameters are ignored).
- The system enters a low-power state between samples if **AutoSleep** is **ON**.
- Run-time commands can only be used when **AutoSleep** is **OFF**.
- Data will be stored to the recorder if enabled (**Recorder ON**).

Deploy

- This command starts autonomous data collection, putting the Triton into deployment mode (§3-2.3).
- The system first saves all recently entered commands (i.e., does a **saveSetup**).
- Data collection begins when the Triton clock reaches the specified **startDate** and **startTime**. If the current date and time is after the specified start date and time, data collection begins immediately.
- Triton data are stored to the recorder regardless of the **Recorder** setting.
- The system enters a low-power state between samples (**AutoSleep** is forced **ON**).
- Note: Do not confuse the **Deploy** and **Deployment** commands (§3-9).

saveSetup

- This saves all current parameter settings to internal memory (EEPROM).
- This must be done before the system is shut down (or before a **BREAK** is sent) or any recently entered commands will be lost.
- This is performed automatically as part of the **start**, **Deploy**, and **sample** commands.

Defaults or DEF

- This sets all parameters (except baud rate) to the factory default values. The baud rate remains at the currently active value. To change the baud rate, see §5-4.
- See the individual command descriptions for default values.

Ver

- This outputs the version number of the CPU firmware.

DSPVer

- This outputs the version number of the DSP firmware.

BoardRev

- This outputs the revision number of the Triton processing electronics boards.

SerNum

- This command returns the instrument serial number from memory (should match the serial number on the Triton probe).

Date [yy/mm/dd]

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

Time [hh:mm:ss]

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

PowerOff

- This puts the Triton into sleep mode (§3-2.4).
- We recommend placing the Triton in sleep mode whenever it is not in use.
- The Triton will enter sleep mode if left idle in command mode for more than five minutes.

AutoSleep or AS [ON|OFF]

- Default parameter: **ON**
- Without parameter: returns its current setting.
- This setting determines whether the Triton enters a reduced power state during data collection.
- When **ON**, the Triton will enter the reduced power state between samples. Power consumption is less than 1 mW in the reduced power state.
- When **OFF**, the Triton electronics remain active even when not collecting data.
- Must be **OFF** to use the Run-Time commands (§3-14).
- In deployment mode, **AutoSleep** is forced **ON**.

OutMode or OM [AUTO|POLLED]

- Default parameter: **AUTO**
- Without parameter: returns its current setting.
- This setting determines whether data are sent over the serial port after the completion of a sample (**AUTO**), or only sent when a specific run-time command is received (**POLLED**).
- The run-time command “o” (Output) causes the output of the last sample from the buffer to be sent (§3-14).

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

- Default parameter: **ASCII**
- Without parameter: returns its current setting.
- This setting determines the format of the data output through the serial port. Section 3-15 has a description of the output data formats (**BINARY**, **ASCII**, **SEABIRD**, **METRIC**, **ENGLISH**).
- Data stored on the internal recorder are always stored in binary format.

Recorder [**ON**|**OFF**]

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

RecMode [**NORMAL**|**BUFFER**]

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

3-8. Setup Commands

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

- Temperature
- Salinity
- Averaging interval
- Sample interval
- Velocity Range
- Coordinate system
- Data format

Note that the timing commands `AvgInterval` and `sampleInterval` are also listed under deployment commands (§3-9).

Each command is shown with its full name, short name (if one exists), optional parameters (in brackets), parameter range (if appropriate), and appropriate 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 (-5.0°C to 60.0°C), the user-specified temperature is set to this value.
- This temperature value is used to calculate sound speed if `TempMode` is set to `USER`.
- See the *Triton Principles of Operation* regarding the effect of sound speed on velocity data.

Sal [d.d]

- Default parameter: 34.5 (ppt)
- Parameter range: 0.0 to 60.0 (ppt)
- Without parameter: returns its current setting.
- When used with a valid input parameter (0 ppt to 60 ppt), the salinity is set to this value.
- This salinity value is used to calculate sound speed.
- See the *Triton Principles of Operation* regarding the effect of sound speed on velocity data.

AvgInterval or **AI** [d]

- Default parameter: 120 (s)
- Parameter range: 1 to 3600 (s; maximum is equivalent to 60 minutes)
- Without parameter: returns its current setting.
- When used with a valid integer parameter, the averaging interval is set to this value (in seconds).
- The minimum effective averaging interval is 3 s. Settings less than 3 s, unless using the real-time software, give data output at 3-s intervals. Settings above 3 s give data output at the specified time (or at the `sampleInterval`, if higher).

SampleInterval or SI [d]

- Default parameter: 1200 (s; 20 minutes)
- Parameter range: 1 to 43200 (s; maximum is equivalent to 12 hours)
- Without parameter: returns its current setting.
- When used with a valid integer parameter, the sample interval is set to this value (in seconds).
- Sample interval is the time between the start of successive samples (§1-3).
- If **AvgInterval** > **SampleInterval**, then **AvgInterval** will take precedence.

VelRange or VR [d]

- Default parameter: 5 (Automatic velocity range; see table below)
- Parameter range: 0 to 5 (see table below for velocity range value)
- Without parameter: returns its current setting.
- When used with an integer parameter from 0 to 5, the velocity range is set to this value. The table below shows the maximum velocity range corresponding to each setting.
- Except for severely power-limited applications, we recommend using the automatic velocity range (index value 5).
- If the velocity range is set too low, data may become corrupted and unrecoverable.
- See the *Triton Principles of Operation* for more information about velocity range settings.

VR Index	10-MHz Triton Velocity Range
0	±3 cm/s
1	±15 cm/s
2	±50 cm/s
3	±200 cm/s
4	±600 cm/s
5	Automatic (0 to 600 cm/s)

CoordSystem or CY [BEAM|XYZ|ENU]

- Default parameter: XYZ
- Without parameter: returns its current setting.
- When used with an appropriate parameter, it sets the coordinate system to this value.
- **BEAM** causes velocity data to be stored and output as along-beam velocities.
- **XYZ** causes velocity data to be recorded and output in the Cartesian coordinate system relative to the Triton.
- **ENU** causes the Triton to use the compass/tilt sensor (if installed) data to transfer velocity data in Earth (East-North-Up) coordinates.
- See §6-4 for coordinate system details.

TempMode or TM [USER|MEASURED]

- Default parameter: **MEASURED**
- Without parameter: returns its current setting.
- When used with an appropriate parameter, it sets the temperature mode to this value.
- This determines whether the user-input temperature (**USER**), or the value from the temperature sensor (**MEASURED**), is used for sound speed calculations.
- The temperature sensor is specified as accurate to $\pm 0.1^{\circ}\text{C}$. We recommend using **MEASURED** unless there is reason to suspect the temperature sensor has been damaged.
- See the *Triton Principles of Operation* regarding the effect of sound speed on velocity data.

DataFormat or DF [LONG|SHORT]

- Default parameter: **LONG**
- Without parameter: returns its current setting.
- When used with an appropriate parameter, it sets the data format to this value.
- This determines the format of data output over the serial port and to the internal recorder. **LONG** format includes all available diagnostic data and requires 36-76 bytes of data storage per sample (binary format). **SHORT** includes only minimal diagnostic data and requires 20-60 bytes of storage per sample (binary format). **SHORT** is intended only for autonomous deployments with large data storage requirements.
- See §3-15 and §7-2 regarding the calculation of data storage requirements.

3-9. Deployment Commands

Deployment commands affect the parameters used for autonomous deployments.

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

Note that two of the timing commands (averaging interval and sample interval) are also listed under Setup Commands (§3-8).

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

Deployment [name]

- Default parameter: **DEF**
- Without parameter: returns its current setting.
- When used with an ASCII string of no more than five characters (letters or digits), the deployment name is set to this value.
- This determines the file name under which data are stored to the internal recorder.
- All data from a single **Deploy** or **Start** command are stored in one file.
- The file name on the recorder is the deployment name with a 3-digit number indicating the sequence of files under this name. For example, if the deployment name is **LAKE**, the data from the first **Deploy** or **Start** command will be stored in a file named **LAKE001**. If data collection is stopped and re-started without changing the deployment name, the numbers will increment; e.g. **LAKE002**, **LAKE003**, etc.
- Note: Do not confuse the **Deployment** and **Deploy** commands (§3-7).

Comments

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

StartDate or SD [yy/mm/dd]

- Default parameter: **1995/01/01** (January 1, 1995)
- Without parameter: returns the deployment start date.
- When used with a date in the correct format (see **Date** command, §3-7), the starting date for data collection is set. This date is used only in deployment mode (i.e., **Deploy** command).
- If the start date/time are before the current date/time, data collection begins immediately.

StartTime or ST [hh:mm:ss]

- Default parameter: **00:00:00**
- Without parameter: returns the deployment start time.
- When used with a time in the correct format (see **Time** command, §3-7), the start time of data collection is set. This time is used only in the deployment mode (i.e., **Deploy**).
- If the start date/time are before the current date/time, data collection begins immediately.

AvgInterval *OR* **AI** [**d**]

- See description under Setup Commands (§3-8).

SampleInterval *OR* **SI** [**d**]

- See description under Setup Commands (§3-8).

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

- Default parameter: **NO**
- Without parameter: returns its current setting.
- Burst sampling can only be used in deployment mode (data collection started with the **Deploy** command). In data collection mode (using the **start** command), this parameter is ignored. See §1-3 for a description of burst sampling.
- **NO** disables burst sampling; **YES** enables burst sampling.

BurstInterval *OR* **BI** [**d**]

- Default parameter: **1200** (s; 20 minutes)
- Parameter range: **1** to **43200** (s; maximum is equivalent to 12 hours)
- Without parameter: returns its current setting.
- When used with a valid integer parameter, the burst interval is set to this value (in seconds). See §1-3 for a description of burst sampling.
- This command is ignored unless **BurstMode** is set to **YES**, and data collection is started with the **Deploy** command.

SamplesPerBurst *OR* **SB** [**d**]

- Default parameter: **1**
- Parameter range: **1** to **1000**
- Without parameter: returns its current setting.
- When used with a valid integer parameter, the number of samples per burst is set. See §1-3 for a description of burst sampling.
- This command is ignored unless **BurstMode** is set to **YES**, and data collection is started with the **Deploy** command.

3-10. Recorder Commands

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

- Listing files
- Checking recorder capacity
- Extracting data

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

Dir *or* **LD**

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

Format

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

RecStatus

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

Recorder [ON|OFF]

- See description under System Commands (§3-7).

RecMode [NORMAL|BUFFER]

- See description under System Commands (§3-7).

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

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

CD (*for Current Deployment*)

- Returns which recorder deployment file is now open.

RC (*for Retrieve Configuration*)

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

RSA [**N**] (*for Retrieve Sample in ASCII*)

- Retrieves **N** samples from the current file in ASCII format.
- If **N** is not specified, one sample is retrieved.
- The first sample retrieved will be the one given by the file marker; after executing this command, the file marker is moved to the next sample after those retrieved.
- See §3-15 for a description of the output data format.

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

- Retrieves **N** samples from the current file in binary format.
- If **N** is not specified, one sample is retrieved.
- The first sample retrieved will be the one given by the file marker; after executing this command, the file marker is moved to the next sample after those retrieved.
- See §3-15 for a description of the output data format.

FS (*for First Sample*)

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

LS (*for Last Sample*)

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

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

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

CS (*for Current Samples*)

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

NS (*for Number of Samples*)

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

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

Example 1: Retrieve configuration data from deployment LAKE001.TRI

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

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

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

3-11. Sensor Commands

In normal Triton operation, all commands to the sensors are handled automatically, and no direct commands need to be sent. These commands are provided for diagnostic purposes only. See §6-7 and §6-8 for information about the temperature and pressure sensors.

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

Sensor [CONT]

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

PressOffset

- Display the pressure sensor offset value. See §6-8 for details on pressure sensor calibration.

PressScale

- Display the pressure sensor calibration 1st order coefficient. See §6-8 for details on pressure sensor calibration.

PressScale_2

- Display the pressure sensor calibration 2nd order coefficient value. See §6-8 for details on pressure sensor calibration.

3-12. 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 Triton operations. For a detailed description of the optional compass/tilt sensor, see Section 4.

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

Compass [CONT]

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

Compass CAL

- Perform a compass/tilt sensor calibration.
- This is done to account for ambient magnetic fields that will affect compass heading (typically caused by ferrous metals) and should be performed before any deployment.
- The Triton 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 §4-4 for more information about compass calibration and for details on interpreting the calibration score.

3-13. Show Commands

There are several “show” commands to display current Triton parameter settings. Samples of these commands and their outputs are shown below.

Show Conf

- Displays the Triton hardware configuration (§5-1 describes individual settings). Example:

```
>show conf
HARDWARE CONFIGURATION PARAMETERS
-----
System Type ----- TRI
Sensor serial # ----- R050
Sensor frequency - (kHz) ----- 10000
Number of beams ----- 3
Beam Geometry ----- 3_BEAMS
Slant angle - (deg) ----- 15.0
Orientation ----- UP
Compass installed ----- YES
Recorder installed ----- YES
Temperature sensor ----- YES
Pressure sensor ----- YES
Ctd sensor ----- NO
PressOffset - (dbar) ----- -0.419400
PressScale -- (dbar/count) ----- 0.000379
PressScale_2 - (pdbar/count^2) - -23
Waves Option ----- YES
```

Show System

- Displays the current system parameters. Example:

```
>show system
CURRENT SYSTEM PARAMETERS
-----
CPU Ver --- TRI 1.0
DSP Ver --- DSP 1.0
BoardRev -- REV C
Date ----- 2001/07/02
Time ----- 11:43:49
AutoSleep - YES
OutMode --- AUTO
OutFormat - ASCII
Recorder -- ON
RecMode --- NORMAL
```

Show Setup

- Displays the current data collection setup parameters. Example:

```
>show setup
CURRENT SETUP PARAMETERS
-----
Temp ----- 22.20 deg C
Sal ----- 0.00 ppt
TempMode ----- USER
Sound Speed ---- 1488.2 m/s
AvgInterval ---- 10 s
SampleInterval - 300 s
CoordSystem ---- XYZ
VelRange ----- +/-3 cm/s
DataFormat ---- LONG
```

Show Deploy

- Displays the current deployment parameters. Example:

```
>show deploy
CURRENT DEPLOYMENT PARAMETERS
-----
Deployment ----- BOUND
StartDate ----- 2000/10/01
StartTime ----- 09:49:51
AvgInterval ----- 10 s
SampleInterval -- 10 s
BurstMode ----- DISABLED
BurstInterval --- 1200 s
SamplesPerBurst - 1
Comments:
Triton Testing
SonTek/YSI - We know how fast the water moves.
Do you?
```

Show Wave

- Displays the current wave sampling parameters. Example:

```
>show wave
WAVE SAMPLING PARAMETERS
-----
WaveSeriesType ----- PUV_SERIES
RecordWseries ----- every 1 profiles
WseriesRate ----- (Hz) ----- 2
WseriesLength --- (points) -- 512
WseriesDuration - (s) ----- 256
WaveFreqSpectra ----- NO
WaterDepth -----(m) ----- 0.00
OutWseriesMode ----- AUTO
MinCorrLevel -----(%) ----- 10
```

Show Other

- Displays miscellaneous parameters associated with the Triton system. Example:

```
>show other
MISCELLANEOUS PARAMETERS
-----
Coh. Pulse Lag ----- 0.00 m
Transformation Matrix:   2.658   -1.316   -1.340
                        -0.012   2.332   -2.320
                        0.344   0.344   0.344
```

3-14. Run-Time Commands

Run-time commands are used during data collection and have been added to simplify integration of the Triton with a variety of data-logging systems.

- **AutoSleep** (§3-7) is normally disabled (**OFF**) to ensure that the Triton will immediately respond to run-time commands.
- If **AutoSleep** is **ON** (to reduce power consumption), or if the system is in deployment mode (which forces **AutoSleep ON**), you will need to send several characters before entering any run-time command to ensure the system is awake (see below).
- Run-time commands are commonly used while using the **POLLED** output mode (see **outMode** in §3-7). This causes the system to only output a data sample upon request, and not to output data automatically at the end of a sample.

Run-time commands are typically used as follows.

- If **AutoSleep** is **OFF**, run-time commands can be sent at any time.
- If **AutoSleep** is **ON**, the Triton must be alerted by sending a few carriage returns (<CR>; ASCII character code 13) before sending the run-time command.
 - It may be necessary to send more than one <CR> because during some phases of its operation, the Triton serial port is unable to recognize the arrival of a single character.
 - When the Triton recognizes the <CR>, it will respond with a \$ prompt to indicate that for the next 10 seconds it will accept run-time commands.
 - Any <CR> that arrives after the Triton has output the \$ sign is ignored (although it does reset the 10-second countdown).
 - If no additional characters are received within 10 seconds, the Triton will resume regular operation, and the sequence will have to be repeated in order to wake the system up.
 - After the Triton is awake and it outputs the \$ sign, you can use any of the single character run-time commands to communicate with the system.
- If the Triton is in the middle of an averaging interval, it continues pinging. As long as no **BREAK** or "+++" sequence are sent, the system continues working as usual.

The run-time commands described below can be used without causing any delay or interruption of data collection. Triton 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); allow for up to a 1-second delay after sending one of these commands.

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

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

o (*output last sample*)

- Sending o (letter “oh”; not zero) tells the Triton to output the last data sample collected.
- The last sample is stored internally and is updated at the end of each averaging interval.
- At the end of each averaging interval, the Triton places the sample in an output buffer in the format specified by the **outFormat** command (**BINARY**, **ASCII**, **SEABIRD**, **METRIC**, **ENGLISH**; see §3-15).
- If the **outMode** (output mode) command is set to **AUTO**, the Triton immediately transmits the buffer contents through the serial port. If **outMode** is set to **POLLED**, the Triton 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 will be 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 Triton uses only a few milliseconds of processing time to re-transmit the entire data buffer.

T (*output date/time*)

- Sending the character “T” during data collection causes the Triton to output the current date and time from the Triton clock.
- The clock is read immediately before the date/time data are output, which can be up to one second after the **T** command is sent.
- The date/time output will be in **ASCII** or **BINARY** format depending on the current setting of the **OutFormat** parameter. If **OutFormat** is set to **ASCII**, **SEABIRD**, **METRIC**, or **ENGLISH**, time is output in **ASCII** format.
- In ASCII format, the following line will be sent.

```
yyyy/mm/dd hh:mm:ss.hh <CR><LF>
```
- In **BINARY** format, the following nine bytes will be sent.

Run Time Command “T” Binary Output Record

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

c+ and **c-** (*clock adjust*)

- The **c** command is used to adjust the Triton clock.
- **c+** advances the clock one second.
- **c-** sets the clock back one second.
- After a successful completion of this command, the Triton will output the acknowledgment: **OK** <CR><LF>.

A (*averaging interval time left*)

- Sending the character “A” during data collection causes the Triton to output the time left in the current averaging interval (in seconds).
- The remaining time is output in either **ASCII** or **BINARY** format depending on the setting of the **OutFormat** parameter. If **OutFormat** is set to **ASCII**, **SEABIRD**, **METRIC**, or **ENGLISH**, the time remaining is output in **ASCII** format.
- In **ASCII** format, the following line will be sent, where *<TimeLeft>* is an integer value without leading spaces.

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

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

Run-Time Command “A” Binary Output Record

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

3-15. Wave Data Commands

The commands described in this section control wave and pressure time series data collection for the Triton.

RecordWSeries *or* **RWS** [**d**]

- Default parameter: 0 (do not collect pressure data)
- Parameter range: 0, or 1 to 255 profiles
- Without parameter: returns its current setting.
- When used with a valid parameter, controls the collection/recording of the pressure series data. The pressure data will be collected every **d** profiles. Note that the time between successive pressure records will be **d** × **ProfilingInterval** (seconds).
- If set to 0, no wave data is collected.

WSeriesRate *or* **WSR** [**d**]

- Default parameter: 1 Hz
- Parameter range: 1, 2, or 4 Hz (Note: If **VR=5**, **WSR** can be 1 or 2; if **VR=0** through 4, **WSR** can be 1, 2, or 4.)
- Without parameter: returns its current setting.
- When used with a valid parameter, specifies the sampling rate for the wave (P or PUVW) time series collection.

WSeriesLength *or* **WSL** [**d**]

- Default parameter: 1024 samples
- Parameter range: 128 to 4096 samples
- Without parameter: returns its current setting.
- When used with a valid parameter, sets the length of the wave time series (in samples). The length of the wave series in seconds equals **WSL/WSR**.
- The extraction software included with the Triton system uses 128-second data segments. As such, we recommend that **WSL** be a multiple of that number. For more accurate wave parameter estimation, we also recommend a minimum wave series length of 1024 seconds; however, you may choose to use a smaller value if desired.

WSeriesType *or* **WST** [**P_SERIES|PUV_SERIES**]

- Default parameter: **PUV_SERIES**
- Without parameter: returns its current setting.
- When used with a valid parameter, sets the wave series type.
 - **P_SERIES** – Tells system to collect pressure series data only (2 bytes/sample).
 - **PUV_SERIES** – Tells the system to collect pressure, U, V, and W data (6 bytes/sample).

OutWseriesMode *or* **OWM** [**AUTO|POLL**]

- Default parameter: **AUTO**
- Without parameter: returns its current setting.
- This 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 (**POLL**).
- The run-time command “o” (Output; not a zero) causes the output of the last sample from the buffer to be sent (§3-14).

3-16. Output Data Format

- The Triton can output data over the serial port in a variety of formats depending on the setting of the **OutFormat** command (§3-7).
 - Binary – Used for the most efficient data transmission and storage.
 - ASCII – Standard tab-delimited ASCII format with all variables output as integers (no decimal points in data).
 - SeaBird – Specialized format for integrating with SeaBird inductive modem.
 - Metric – Tab-delimited ASCII format with all variables in metric units.
 - English – Tab-delimited ASCII format with all variables in English units.
- The setting of **OutFormat** affects only data sent to the serial port.
- Data written to the internal recorder are always stored in binary format.
- ASCII and binary formats are used for data sent to the serial port during data collection and for data retrieved using the recorder commands.
- SeaBird, Metric, and English formats are used only for data output over the serial port during data collection.

3-16.1. Binary Data

Triton binary sample data uses the same format for several different methods of access.

- Output over the serial port during data collection
- Using the run-time command “o” (§3-14)
- Using the recorder command **RSB** (§3-10)
- Each Triton sample will consist of several different data records, depending on the setting of the data format parameter (**LONG** or **SHORT** – see §3-8) and whether any external sensors are installed. The data records will be in the following order.

Triton Sample	(22 or 38 bytes)
CTD Sample if present	(16 bytes)
Checksum sample	(1 byte)

The record size can vary from 23 to 69 bytes, depending on system configuration.

See Appendix A for precise definitions of the binary structures used, and for an explanation of how the checksum is calculated.

3-16.2. ASCII Data

ASCII data is output in a tab-delimited format with one line of data for each sample.

- The same format is used whether output is generated during data collection, using the run-time command “o” (§3-14), or with the recorder command **rsa** (§3-10).
- The output is one line per sample, tab-delimited such that it gives a tabular format easily loaded by data processing software (each column of data represents a variable).
- The exact format of the output depends on the setting of the data format parameter (**LONG** or **SHORT**) and whether optional sensors are installed (CTD).

Triton **LONG** Sample Format – ASCII

Column	Contents	Units
1	Year Sample time at start of averaging interval	
2	Month	
3	Day	
4	Hour	
5	Minute	
6	Second	
7	Velocity 1 (Beam 1 / X / East)	0.1 cm/s
8	Velocity 2 (Beam 2 / Y / North)	0.1 cm/s
9	Velocity 3 (Beam 3 / Z / Up)	0.1 cm/s
10	Standard error 1 (Beam 1 / X / East)	0.1 cm/s
11	Standard error 2 (Beam 2 / Y / North)	0.1 cm/s
12	Standard error 3 (Beam 3 / Z / Up)	0.1 cm/s
13	Signal strength (Beam 1)	counts
14	Signal strength (Beam 2)	counts
15	Signal strength (Beam 3)	counts
16	Percent good pings	%
17	Heading	0.1 degrees
18	Pitch	0.1 degrees
19	Roll	0.1 degrees
20	Standard deviation heading	0.1 degrees
21	Standard deviation pitch	0.1 degrees
22	Standard deviation roll	0.1 degrees
23	Mean temperature	0.01 °C
24	Mean pressure	counts
25	Standard deviation of pressure	counts
26	Input power level	0.2 volts
27	Reserved for future use (set to 0)	
28	Range to boundary from probe tip (if detected)	0.1 cm
29-40	Wave Spectra data – see §3-16.6	
41-44	CTD data if installed – see §3-16.7	

Triton **SHORT** Sample Format – ASCII

For the **SHORT** data format, several values are combined to reduce the total amount of data.

- Reported signal strength is the mean of all beams (3 for 3D probes, 2 for 2D probes).
- Reported standard error is defined based on the coordinate system.

$$\text{Beam coordinates} \quad \sigma V = \sqrt{(\sigma V1^2 + \sigma V2^2 + \sigma V3^2)}$$

$$\text{XYZ coordinates} \quad \sigma V = \sqrt{(\sigma Vx^2 + \sigma Vy^2)}$$

$$\text{ENU coordinates} \quad \sigma V = \sqrt{(\sigma VE^2 + \sigma VN^2)}$$

Column	Contents	Units
1	Year Sample time at start of averaging interval	
2	Month	
3	Day	
4	Hour	
5	Minute	
6	Second	
7	Velocity 1 (Beam 1 / X / East)	0.1 cm/s
8	Velocity 2 (Beam 2 / Y / North)	0.1 cm/s
9	Velocity 3 (Beam 3 / Z / Up)	0.1 cm/s
10	Standard error (see above)	0.1 cm/s
11	Signal strength (see above)	Counts
12	Mean temperature	0.01 °C
13	Mean pressure	Counts
14	Input power level	0.2 volts
15-26	Wave Spectra data – see §3-16.6	
27-30	CTD data if installed – see §3-16.7	

3-16.3. SEABIRD Data

The SeaBird format is a specialized data format used when integrating the Triton with the Sea-Bird inductive modem.

- The output is one line per sample, tab-delimited such that it gives a tabular format easily loaded by data processing software (each column of data represents a variable).
- The same output format is used regardless of the setting of the **DataFormat** parameter. The **DataFormat** setting affects only data stored to the internal recorder.
- The system outputs the ASCII character “#” followed by a 1-second delay before the output of each sample.

For the SeaBird output format, several values are combined to reduce the total amount of data.

- Reported signal strength is the mean of all beams (3 for 3D probes, 2 for 2D probes).
- Reported standard error is defined based on the coordinate system.

$$\text{Beam coordinates} \quad \sigma V = \sqrt{(\sigma V_1^2 + \sigma V_2^2 + \sigma V_3^2)}$$

$$\text{XYZ coordinates} \quad \sigma V = \sqrt{(\sigma V_x^2 + \sigma V_y^2)}$$

$$\text{ENU coordinates} \quad \sigma V = \sqrt{(\sigma V_E^2 + \sigma V_N^2)}$$

Column	Contents	Units
1	Serial number	
2	Year Sample time at start of averaging interval	
3	Month	
4	Day	
5	Hour	
6	Minute	
7	Second	
8	Velocity 1 (Beam 1 / X / East)	0.1 cm/s
9	Velocity 2 (Beam 2 / Y / North)	0.1 cm/s
10	Velocity 3 (Beam 3 / Z / Up)	0.1 cm/s
11	Standard error (see above)	0.1 cm/s
12	Signal strength (see above)	Counts
13	Heading	0.1°
14	Pitch	0.1°
15	Roll	0.1°
16	Status (internal use)	

3-16.4. METRIC Data

Metric format is a special ASCII text output in a tab-delimited format with one line of data for each sample, with all data in metric units.

- The same format is used whether output is generated during data collection or using the run-time command “o” (§3-14).
- The output is one line per sample, and is tab-delimited such that sequential samples give a tabular format easily loaded by data processing software.
- The exact format of the output depends on the setting of the **DataFormat** parameter (**LONG** or **SHORT**) and whether optional sensors are installed (CTD).

Triton LONG Sample Format – Metric

Column	Contents	Units
1	Year Sample time at start of averaging interval	
2	Month	
3	Day	
4	Hour	
5	Minute	
6	Second	
7	Velocity 1 (Beam 1 / X / East)	cm/s
8	Velocity 2 (Beam 2 / Y / North)	cm/s
9	Velocity 3 (Beam 3 / Z / Up)	cm/s
10	Standard error 1 (Beam 1 / X / East)	cm/s
11	Standard error 2 (Beam 2 / Y / North)	cm/s
12	Standard error 3 (Beam 3 / Z / Up)	cm/s
13	Signal strength (Beam 1)	counts
14	Signal strength (Beam 2)	counts
15	Signal strength (Beam 3)	counts
16	Percent good pings	%
17	Heading	°
18	Pitch	°
19	Roll	°
20	Standard deviation heading	°
21	Standard deviation pitch	°
22	Standard deviation roll	°
23	Mean temperature	°C
24	Mean pressure	dBar
25	Standard deviation of pressure	dBar
26	Input power level	volts
27	Reserved for future use	
28	Range to boundary from probe tip (if detected)	m
29-40	Wave Spectra data – see §3-16.6	
41-44	CTD data if installed – see §3-16.7	

Triton **SHORT** Sample Format – Metric

For the **SHORT** data format, several values are combined to reduce the total amount of data.

- Reported signal strength is the mean of all beams (3 for 3D probes, 2 for 2D probes).
- Reported standard error is defined based on the coordinate system.

$$\text{Beam coordinates} \quad \sigma V = \sqrt{(\sigma V1^2 + \sigma V2^2 + \sigma V3^2)}$$

$$\text{XYZ coordinates} \quad \sigma V = \sqrt{(\sigma Vx^2 + \sigma Vy^2)}$$

$$\text{ENU coordinates} \quad \sigma V = \sqrt{(\sigma VE^2 + \sigma VN^2)}$$

Column	Contents	Units
1	Year Sample time at start of averaging interval	
2	Month	
3	Day	
4	Hour	
5	Minute	
6	Second	
7	Velocity 1 (Beam 1 / X / East)	cm/s
8	Velocity 2 (Beam 2 / Y / North)	cm/s
9	Velocity 3 (Beam 3 / Z / Up)	cm/s
10	Standard error (see above)	cm/s
11	Signal strength (see above)	counts
12	Mean temperature	°C
13	Mean pressure	counts
14	Input power level	volts
15-18	CTD data if installed – see §3-16.7	

3-16.5. ENGLISH Data

English format is a special ASCII text output in a tab-delimited format with one line of data for each sample, with all data in English units.

- The same format is used whether output is generated during data collection or using the run-time command “o” (§3-14).
- The output is one line per sample, and is tab-delimited such that sequential samples give a tabular format easily loaded by data processing software.
- The exact format of the output depends on the setting of the **DataFormat** parameter (**LONG** or **SHORT**) and whether optional sensors are installed (CTD).

Triton LONG Sample Format – English

Column	Contents	Units
1	Year Sample time at start of averaging interval	
2	Month	
3	Day	
4	Hour	
5	Minute	
6	Second	
7	Velocity 1 (Beam 1 / X / East)	ft/s
8	Velocity 2 (Beam 2 / Y / North)	ft/s
9	Velocity 3 (Beam 3 / Z / Up)	ft/s
10	Standard error 1 (Beam 1 / X / East)	ft/s
11	Standard error 2 (Beam 2 / Y / North)	ft/s
12	Standard error 3 (Beam 3 / Z / Up)	ft/s
13	Signal strength (Beam 1)	counts
14	Signal strength (Beam 2)	counts
15	Signal strength (Beam 3)	counts
16	Percent good pings	%
17	Heading	°
18	Pitch	°
19	Roll	°
20	Standard deviation heading	°
21	Standard deviation pitch	°
22	Standard deviation roll	°
23	Mean temperature	°F
24	Mean pressure	psi
25	Standard deviation of pressure	psi
26	Input power level	volts
27	Reserved for future use	
28	Range to boundary from probe tip (if detected)	ft
29-32	CTD data if installed – see §3-16.7	

Triton **SHORT** Sample Format – English

For the **SHORT** data format, several values are combined to reduce the total amount of data.

- Reported signal strength is the mean of all beams (3 for 3D probes, 2 for 2D probes).
- Reported standard error is defined based on the coordinate system.

$$\text{Beam coordinates} \quad \sigma V = \sqrt{(\sigma V1^2 + \sigma V2^2 + \sigma V3^2)}$$

$$\text{XYZ coordinates} \quad \sigma V = \sqrt{(\sigma Vx^2 + \sigma Vy^2)}$$

$$\text{ENU coordinates} \quad \sigma V = \sqrt{(\sigma VE^2 + \sigma VN^2)}$$

Column	Contents	Units
1	Year Sample time at start of averaging interval	
2	Month	
3	Day	
4	Hour	
5	Minute	
6	Second	
7	Velocity 1 (Beam 1 / X / East)	ft/s
8	Velocity 2 (Beam 2 / Y / North)	ft/s
9	Velocity 3 (Beam 3 / Z / Up)	ft/s
10	Standard error (see above)	ft/s
11	Signal strength (see above)	counts
12	Mean temperature	°F
13	Mean pressure	counts
14	Input power level	volts
15-26	Wave Spectra data – see §3-16.6	
27-30	CTD data if installed – see §3-16.7	

3-16.6. Wave Spectra Data

This section describes the format of the Triton ASCII wave data coming over a serial port when either acquiring data in real-time using a terminal emulator or reading the data from the recorder using recorder commands. This description is complimentary to formats presented in the other portions of §3-16. The wave data comes immediately after the corresponding profile data.

```
Wave header  32  DEFAULT      C23          1 1997 10 15 10 49 0 1 6 1 1 150
Pressure series 2000    2000    2000    2000    2000    2000
```

The header format is as follows:

```
Data Type (internal)
Number of bytes (internal)
System serial number (c23)
ProfileNumber
6 values for profile time (year, month, day, hour, minute, second)
SensorType: 0-Strain gage, 1-Paros, 2-Druck
WseriesRate in Hz (1, 2, or 4)
WseriesLength in samples (128-4096)
Wave Spectra Recorded (0-No, 1-yes)
Water Depth (cm)
10 wave spectral amplitude bands (cm)
Wave significant height Hmo (cm) and peak period (s)
```

A wave Header is followed by a pressure time series (P_SERIES) consisting of WSeriesLength 3-byte unsigned integers. Each integer will contain:

- For Strain-gauge, raw A/D converter counts
- For Serial Paros, pressure in 0.001 dbars
- For Druck, frequency in 0.001 Hz

If **wseriesType (wst)** is set to **PUV_SERIES**, the above-mentioned P_SERIES data is followed by U, V, and W data consisting of WSeriesLength 2-byte unsigned integers that contain:

- U data in mm/s
- V data in mm/s
- W data in mm/s

3-16.7. CTD Data Format

This section describes the format of CTD data.

The CTD sensor data (if present) are given on the same line immediately following the sample data. A sample output is below (showing only the CTD data, not the rest of the sample).

```
87514 468151 0 351354
```

The data format is as follows:

- CTD temperature (units 0.0001 °C)
- CTD conductivity (units of 0.00001 Siemens per meter)
- CTD pressure (units of 0.001 decibar). Note: the CTD may not include a pressure sensor.
- CTD salinity (units of 0.0001 ppt)

Section 4. Compass/Tilt Sensor Operation

The Triton (underwater and autonomous configurations only) can be equipped with a compass and 2-axis tilt sensor.

- This sensor provides heading, pitch, and roll data.
- The sensor used is the Precision Navigation TCM2.
- Compass data is used to translate velocity from the instrument XYZ coordinate system to an Earth coordinate system (East-North-Up or ENU).
- For more information about the ENU coordinate system, see §4-3.
- See §4-1 for details about testing basic compass operation.

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

- The compass must be correctly installed for the orientation of the Triton (up- or down-looking)
- The system remains within the $\pm 50^\circ$ limit of the tilt sensor.
- See §4-2 for details about compass installation.

The compass includes a built-in calibration feature to account for the effects of ambient magnetic fields (i.e., nearby ferrous metals).

- We recommend performing a compass calibration before each deployment.
- When properly calibrated, the compass provides heading accurate to $\pm 2.0^\circ$, and pitch and roll accurate to $\pm 1.0^\circ$ up to 50° .
- See §4-4 for details about compass calibration.

Because the compass communicates with the Triton system through an RS-232 interface, it is possible for the user to communicate directly with the compass.

- All communication with the compass is done automatically by the Triton.
- Direct communication with the compass should not normally be necessary.
- Section 4-5 explains how to communicate directly with the compass/tilt sensor.

4-1. Testing Compass Operation

This section describes a simple procedure to verify compass operation using a continuous display of heading, pitch, and roll. The display can be obtained using the direct-command interface or the compass calibration software.

- Start the display of compass data.
- If using the direct-command interface, the command **Compass CONT** gives a continuous output of heading, pitch, and roll (§3-12).
- The compass calibration software (see the *Triton Software Manual*) provides a graphical display of compass data.
- Point the Triton X-axis (§6-4.2) towards each compass direction (North, South, East, and West).
- Compare the compass output with the expected reading. Remember that the Triton reports heading relative to magnetic north.
- Test the pitch and roll sensors by tilting the Triton about the X-axis (roll) and Y-axis (pitch) respectively.
- Compare the output measurements with estimated tilt angles.

The compass must be oriented up (which means the Triton will be oriented down if the compass is installed for down-looking operation), and the orientation setting must match the compass installation. See §4-2 for details about compass installation and orientation.

- This test should be conducted in an area predominantly free of magnetic material (i.e., ferrous metals).
- 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.
- This is not intended as a precise test, but a means to evaluate basic performance.
- For best results, we recommend performing a compass calibration before every deployment (§4-4).

4-2. Compass Installation

The Triton is configured at the factory for up, down, or side-looking operation based on user requirements. You can determine the compass orientation by using the `show Conf` command from the direct-command interface (§3-13 and §5-1).

- Down-looking: probe and mounting stem are **below** the Triton processor housing.
- Up-looking: probe and mounting stem are **above** the Triton processor housing.
- side-looking: the positive Z-axis is defined along the axis of the acoustic transmitter from the sampling volume towards the sensor. The positive X-axis is defined vertically down along the axis of the mounting stem or cable (from the conditioning module towards the sensor). The positive Y-axis is defined to give a right-hand coordinate system.
- **Precise compass alignment is performed at the factory; compass installation should not be modified by the user.**
- **Contact SonTek if you need to switch between up/down/side-looking operation.**

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

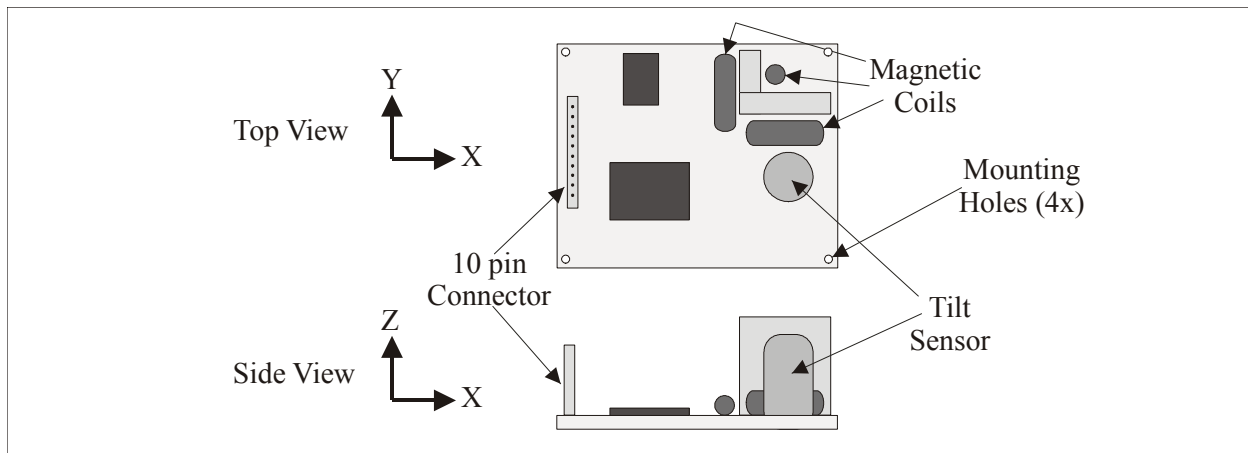


Figure 5 – Compass/Tilt Sensor and XYZ Coordinate System

Figure 5 shows the compass/tilt sensor and its XYZ coordinate system.

- The compass must be operated with the component side facing upwards (within the $\pm 50^\circ$ tilt limit); operation in any other orientation will result in invalid compass data and corrupted velocity data using the ENU coordinate system.
- The compass X-axis is aligned with the probe X-axis at the factory using a combination of hardware and software settings.
- Heading is defined based on the probe X-axis. That is, when heading reads 0° , the X-axis is pointing north.
- Pitch is defined as a rotation about the Y-axis.
- Roll is defined as a rotation about the probe X-axis.

Figure 6 shows the installation of the Triton compass/tilt sensor for down-looking and up-looking operation. The system is drawn with the probe looking down. Figure 7 shows the compass/tilt sensor mounted for side-looking operation.

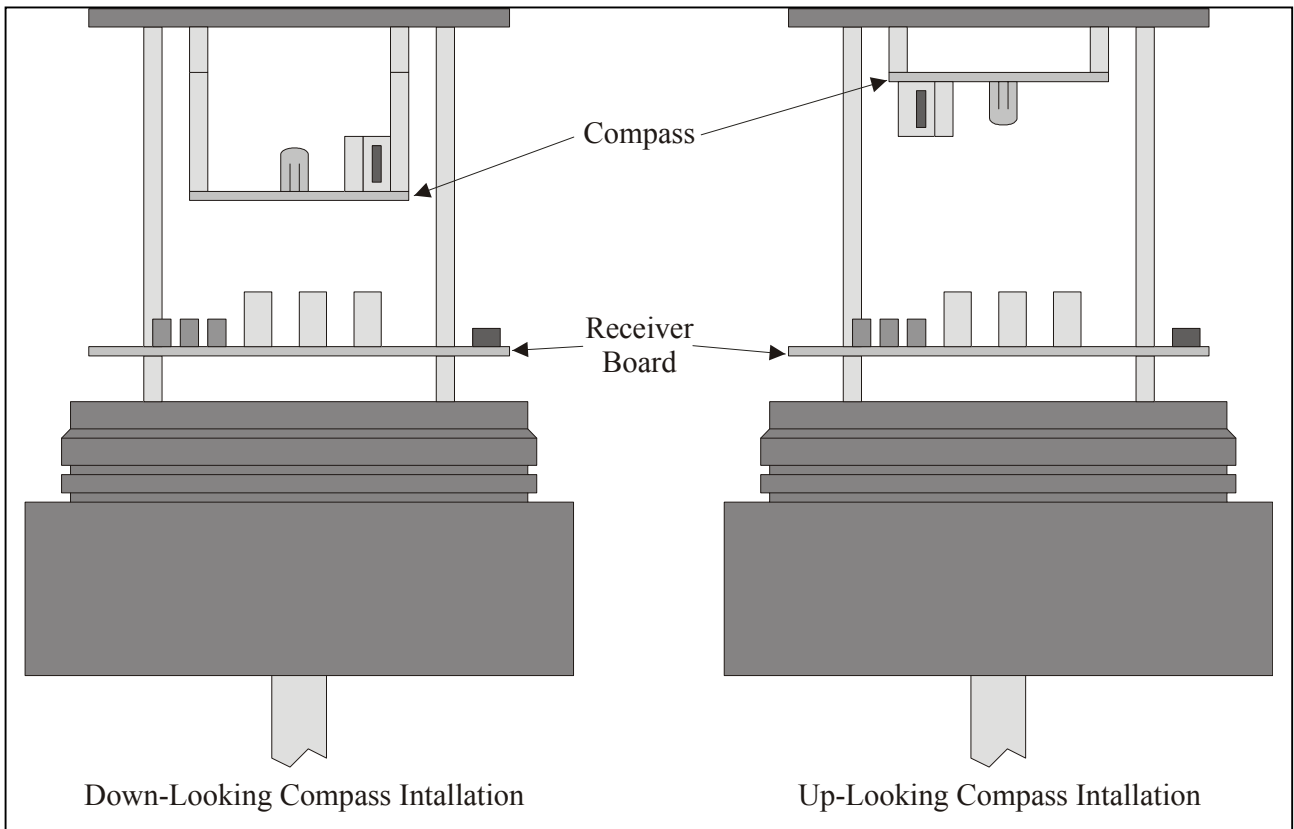


Figure 6 – Compass Installation for Up and Down-Looking Operation

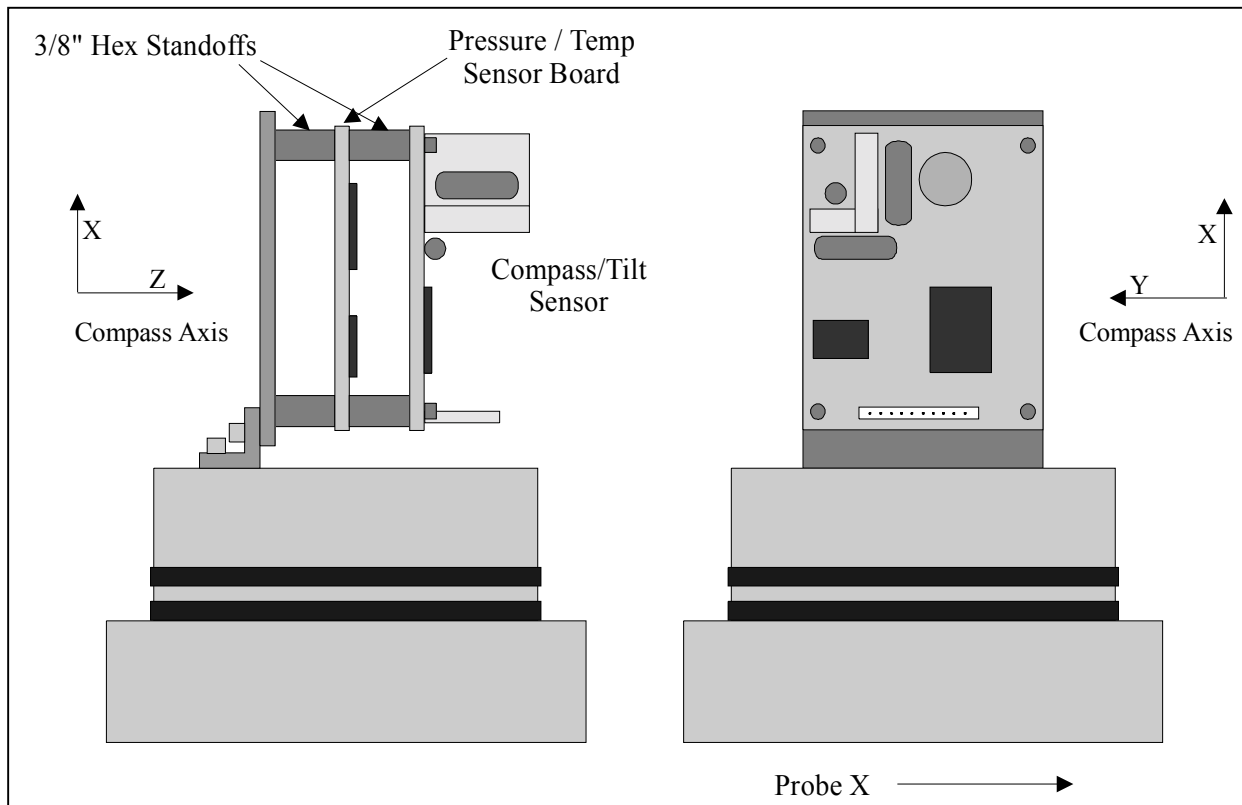


Figure 7 – Compass Installation for Side-Looking Operation

4-3. The ENU Coordinate System

The primary advantage of using the compass is the ability to report velocity data in Earth coordinates – independent of the orientation of the Triton.

- When using the Earth (ENU or East/North/Up) coordinate system, velocity is reported in Earth coordinates regardless of the physical orientation of the Triton.
- A Triton mounted with an unknown orientation will provide velocity data consistent with the direction and speed of the water current itself.
- Proper compass operation requires correct installation as described in §4-2, and operation within the $\pm 50^\circ$ tilt limitation.

The translation of velocity data to Earth coordinates is enabled or disabled through commands to the Triton and is transparent to the user.

- Selection of the coordinate system is done using the `CoordSystem` command (§3-8) or by a menu item in the data acquisition software (see *Triton Software Manual*).
- When the compass is installed, heading, pitch, and roll data are stored with each sample if the `DataFormat` parameter is set to `LONG` (§3-8).
- Compass data are not stored using the `SHORT` data format (§3-8).

The Triton performs vector-averaging using compass data during each sample.

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

4-4. Compass Calibration

The compass can be calibrated to compensate for ambient magnetic fields, which may cause errors in heading measurements.

- Magnetic distortion is most-commonly caused by ferrous metals.
- If the Triton is mounted on or near anything that contains magnetic material or that generates a magnetic field, the compass should be calibrated before starting data collection.
- The compass should be calibrated when moved to a different environment or mounting apparatus.
- We recommend calibrating the compass before each deployment.

There are two methods for compass calibration. The first is to use the compass calibration software described in the *Triton Software Manual*. Alternatively, you can use the compass commands from the direct-command interface, as described here. The two methods achieve identical results.

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

H9V9M5 . 3 :

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

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

4-5. Communicating with the Compass

All compass communication is handled automatically by the Triton. Under normal circumstances, you should not need to communicate directly with the compass. However, should communication be necessary, you can “talk” to the compass through the Triton.

- Establish communication with the Triton.
- Send the following command to establish a direct link with the compass.

```
echo 1
```

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

```
$C143.2P3.4R5.4T24.5*3f
```

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

Section 5. Triton Hardware

5-1. Hardware Configuration Settings

Hardware configuration settings can be displayed using the `show conf` command from the direct command interface (§3-13). A sample output is given below.

```
>show conf
HARDWARE CONFIGURATION PARAMETERS
-----
System Type ----- TRI
Sensor serial # ----- R050
Sensor frequency - (kHz) ----- 10000
Number of beams ----- 3
Beam Geometry ----- 3_BEAMS
Slant angle - (deg) ----- 15.0
Orientation ----- UP
Compass installed ----- YES
Recorder installed ----- YES
Temperature sensor ----- YES
Pressure sensor ----- YES
Ctd sensor ----- NO
PressOffset - (dbar) ----- -0.419400
PressScale -- (dbar/count) ---- 0.000379
PressScale_2 - (pdbar/count^2) - -23
Waves Option ----- YES
```

- Serial number: Stamped on the probe end cap.
- Frequency: Lists the acoustic frequency of the Triton.
- Number of beams / Beam geometry / Slant angle: The Triton use 2 or 3 beams for 2D or 3D probes. The nominal beam angle is 15°. See the *Triton Principles of Operation* for details on the beam geometry used.
- Orientation: Measurement orientation of the system for up-looking or down-looking operation. This setting matches the compass installation (§4-2). Also, note that the orientation will affect the definition of the XYZ coordinate system (§6-4).
- Compass / Recorder / Temperature / Pressure / CTD: These specify which sensors have been installed. All systems include the recorder and temperature sensor.
- PressOffset/PressScale/PressScale_2: Pressure sensor calibration parameters (§3-11, §6-8).

5-2. Internal Electronics and Wiring Overview

This section provides information about the internal layout of the Triton. For more information, see the following sections.

- Section 4-2 – Compass installation
- Section 5-3 – Triton processor
- Section 5-6 – Accessing electronics

5-2.1. Underwater / Autonomous Triton Configurations

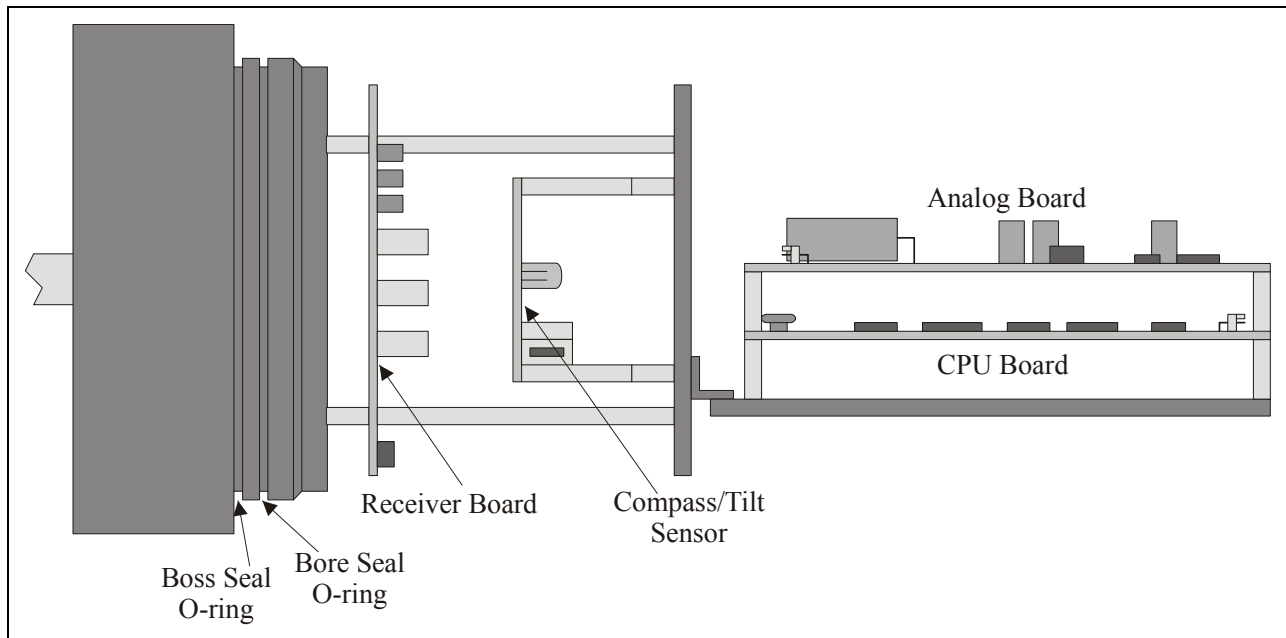


Figure 8 – Internal Electronics (Underwater and Autonomous Configurations)

Figure 8 shows the internal layout of the Triton for the underwater and autonomous configurations. The system is shown with the mounting stem and probe to the left, and the optional compass/tilt sensor installed for down-looking operation (§4-2).

- Dual o-ring seals are mounted on the inside of the end cap. When opening the system, take care to avoid damage to o-rings and surfaces. Clean and inspect o-rings and surfaces before closing the system.
- The receiver board is mounted on three 3/8" standoffs mounted directly to the end cap. The transducers are permanently wired to the receiver board.
- An internal mounting frame for the compass/tilt sensor and Triton processor is mounted on three 2½" standoffs attached to the receiver board.
- The compass/tilt sensor is mounted above the receiver board (§4-2).
- The processor (analog and CPU boards) is mounted on two sets of four ½" standoffs. The analog board is on top of the CPU board. The two boards connect via an edge connector at the right end (as shown in Figure 8). See §5-3 for a description of the processor.

The cables used to connect the different portions of the Triton are described below. For details about the location of each connector on the Triton processor, see §5-3.

- A 16-pin ribbon cable connects the receiver board to the analog board. The cable uses the same connectors at each end with pin-to-pin wiring, so it can be installed in either direction. The keyed connectors can be installed in only one direction.
- The compass/tilt sensor interface cable goes from a 10-pin red connector on the compass to a keyed, 5-pin, red connector on the CPU board (labeled *Compass*).
- A 2-wire cable from the temperature sensor connects to a keyed, 2-pin, red connector on the analog board (labeled *Temperature*).

- A 5-wire cable from the pressure sensor (if installed) connects to a keyed, 5-pin, red connector on the analog board (labeled *Pressure*).
- The DC power supply is connected to a keyed, 3-pin, red connector on the analog board. DC power (whether from a battery pack or an external supply) is wired to this connector (Figure 9). See §6-1 for input power specifications.
- RS232 or RS422 serial communication is wired from the underwater connector on the end cap to a keyed, 5-pin, red connector on the CPU board (labeled *User*).
- A red 3-pin connector on the CPU board is used for the RS232 interface to the optional integrated CTD sensor.

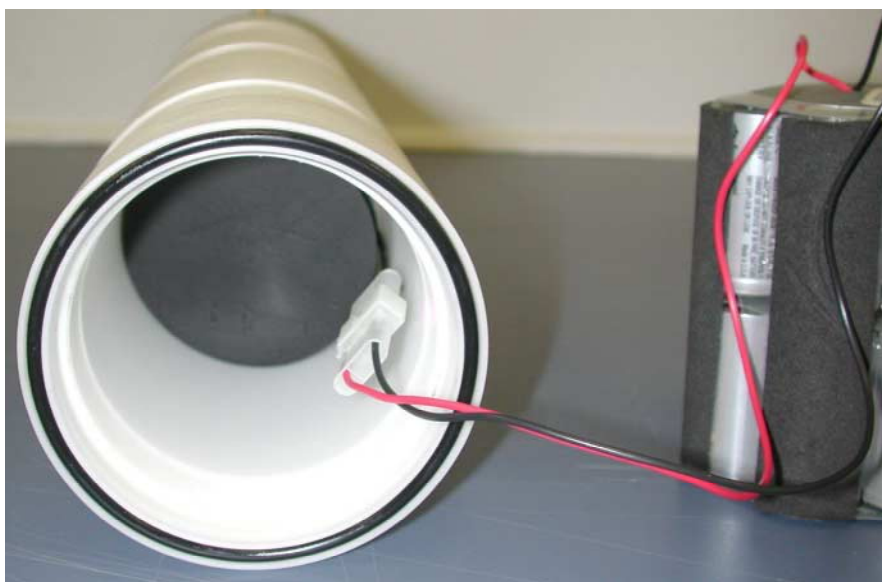


Figure 9 – Triton Battery Connection

5-3. Triton Processor

The Triton processor consists of two printed circuit boards called the analog and CPU boards. Mounting of the Triton processor is described in §5-2.

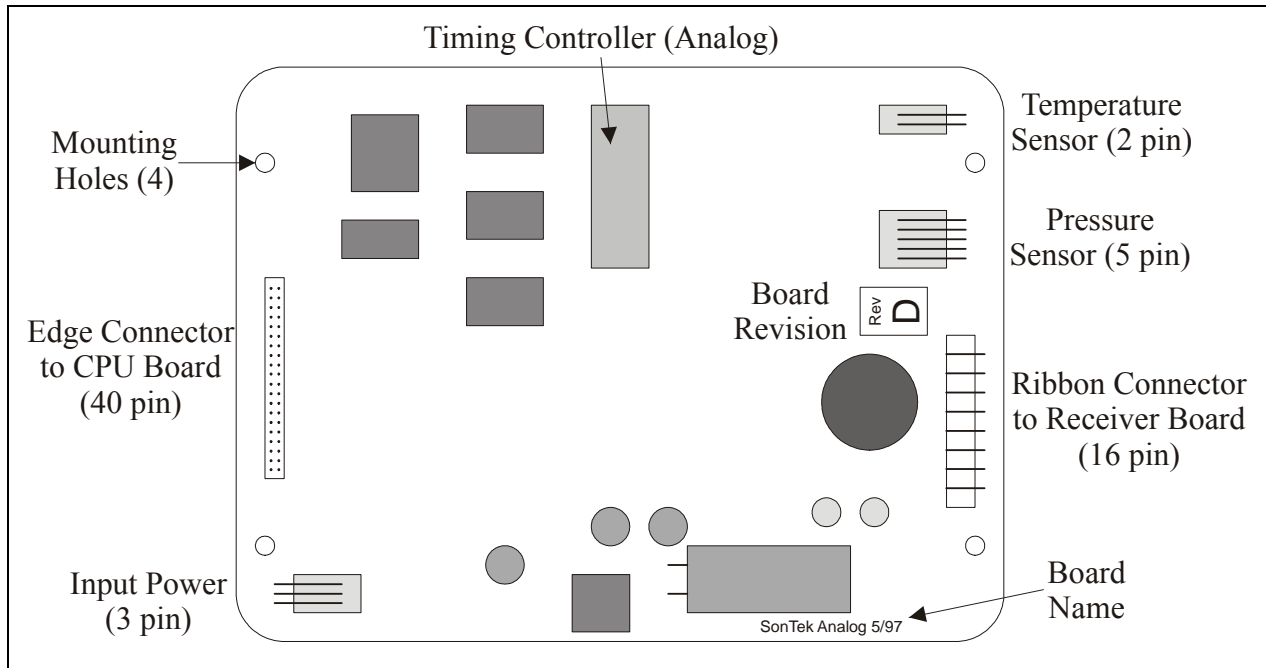


Figure 10 – Triton Processor Analog Board

Figure 10 shows the layout of the analog board.

- A keyed, 3-pin, red connector (labeled Power) is connected to the input power wiring. See §6-1 for input power specifications.
- A 40-pin edge connector mates below to the CPU board.
- A keyed, 2-pin, red connector (labeled Temperature) connects to the temperature sensor in the probe.
- A keyed, 5-pin, red connector (labeled Pressure) connects to the pressure sensor (if installed) in the end cap.
- A keyed, 16-pin connector (not labeled) connects to a ribbon cable to the receiver board.
- A programmable logic chip (called the analog timing controller) on the top center of the board is used to control the timing of the Triton transmit/receive circuitry. The chip is mounted in a socket to simplify installation. Upgrades for the analog timing controller may be periodically available; see §5-6.2 for installation instructions.
- The board includes four holes for mounting, which match the mounting holes in the CPU board and are used with a set of #4-40 screws and standoffs.
- The board revision is printed on the middle right portion of the board. The board name is shown in the bottom right corner.

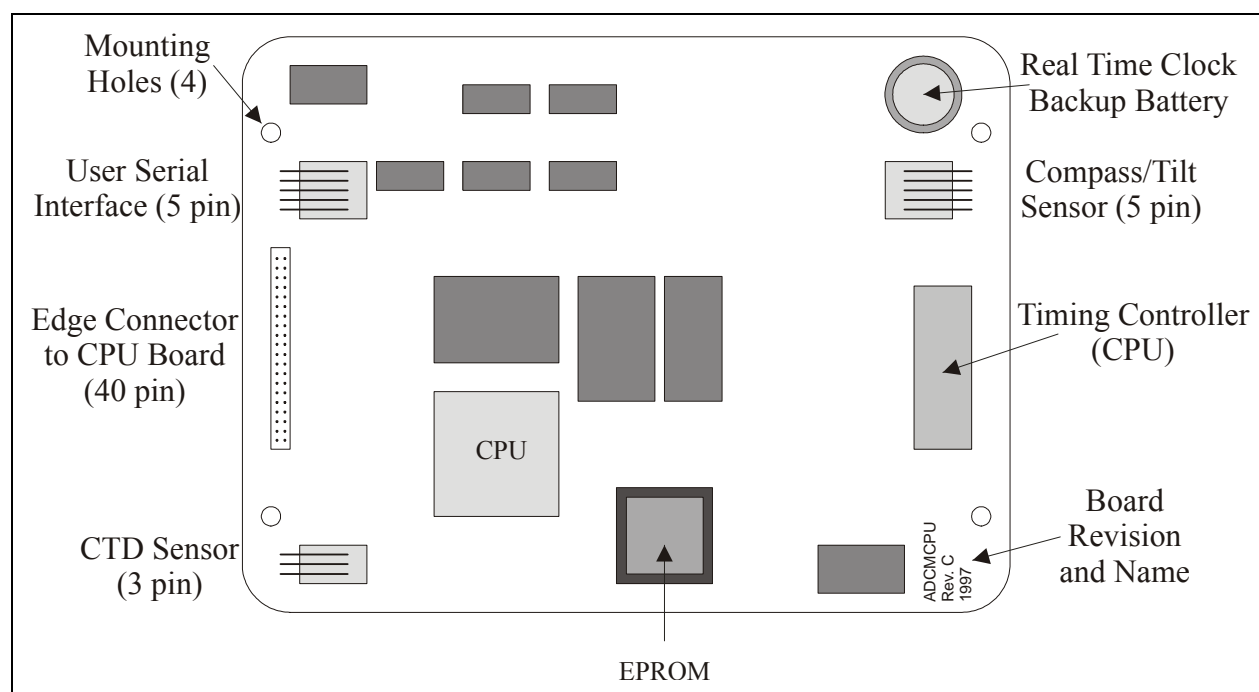


Figure 11 – Triton Processor CPU Board

Figure 11 shows the layout of the CPU board.

- A 5-pin, red connector (labeled User) connects to the Triton underwater connector for the external serial communication interface (RS232 / RS422).
- A 5-pin connector (labeled Compass) provides the power and RS232 interface to the internal compass/tilt sensor (if installed).
- A 40-pin edge connector mates above to the analog board.
- A 3-pin, red connector (labeled CTD) connects the RS232 interface to the optional integrated CTD sensor.
- The backup battery is installed in the upper right hand corner of the board. This is used to supply the real-time clock when main power is not available. See §6-2 for details.
- The EPROM containing the software to control Triton operation is installed in a socket in the bottom center of the board. Upgrades for the Triton CPU EPROM may be periodically available. See §5-6.2 for details.
- The system CPU, the main computational power of the Triton, is mounted in the bottom center of the board, just above and to the left of the CPU EPROM.
- A programmable logic chip (called the CPU timing controller) on the top center of the board is used to control the timing of all Triton operations. The chip is mounted in a socket to simplify installation. Upgrades for the CPU timing controller may be periodically available. See §5-6.2 for installation instructions.
- The board name and revision are printed in the bottom-right corner.

5-4. Communication Baud Rate Setting

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

UserDefaultBaudRate Set [baud rate]

- Default parameter: **9600**
- Parameter range: **1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200**
- Without parameter: returns its current setting.
- If given with a valid parameter in the form shown above, sets the baud rate to this value.
- If the command is recognized as valid, the system will transmit an “OK <CR><LF>” followed by the command prompt “>” at the old baud rate setting. All further communication is done using the new baud rate. The setting is used until a new value is set.
- Note that the command **Defaults** (§3-7) does not reset the communication baud rate.

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

5-5. Cables and Connectors

5-5.1. Underwater / Autonomous Triton Configurations

The Underwater and Autonomous Triton systems use the same cables and connectors for external power and communication.

- The 6-pin, underwater-mateable connector is manufactured by Impulse Enterprises.
- The bulkhead connector (on the instrument housing) part number is BH-6-FS.
- The cable connector part number is IL-6-MP.
- The address for Impulse Enterprises is:

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

The following table describes the Triton power and communication cable wiring for use with both RS232 and RS422. Data transfer is listed relative to the Triton: **Data Out** or **Tx** refers to data sent by the Triton; **Data In** or **Rx** refers to commands received by the Triton.

Pin	Wire color	RS232	RS422
1	White	External power (6-12 VDC; §6-1)	External power (6-12 VDC; §6-1)
2	Black	Data out	Tx+
3	Red	Data in	Tx-
4	Black	Not used	Rx+
5	Green	Not used	Rx-
6	Black	Ground	Ground

RS232

- When using RS232 serial communication, the user end of the power and communication cable is terminated with a DB9 female connector for serial communication and a coaxial power plug for external DC input power.
- The center pin of the coaxial power connector serves as positive (+); the outer shield is negative (-). Different types of coaxial connectors are used depending on the system type.
- The DB9 female connector is wired to be compatible with standard PC serial communication ports as shown in the following table.

RS232 Serial Communication DB9 Female Connector Wiring

Pin #	Signal	Pin #	Signal	Pin #	Signal
1	Not used	4	Not used	7	Not used
2	Data Out (to Pin 2 of IL-8-MP)	5	Ground (to Pin 8 or IL-8-MP)	8	Not used
3	Data In (to Pin 3 of IL-8-MP)	6	Not used	9	Not used

RS422

- When using RS422 serial communication, the power and communication cable is terminated with a coaxial power plug and a DB25 connector wired for RS422.
- The center pin of the coaxial power connector serves as positive (+); the outer shield is negative (-). Different types of coaxial connectors are used depending on the system type.
- For systems with no batteries or alkaline batteries, power from the coaxial connector is wired to Pin 1 (external power) and can accept 8 to 30 VDC. The power supply included with the system (matching this coaxial plug) supplies 24 VDC.
- For systems with rechargeable batteries, power from the coaxial connector is wired to Pin 5 (external battery). This should only be used with the battery charger / power supply included with the system.
- RS422 systems include a RS232/RS422 converter and a DB25/DB9 converter.
- The end of this chain is a DB9 connector wired for RS232 as shown in the preceding table. This allows the cable to be connected to a PC's serial communication port.

5-6. Accessing Electronics

This section contains basic instructions for opening the Triton electronics housings. However, the Triton should not need to be opened on a regular basis. The most common reason for opening the Triton is to replace the battery pack (§5-7).

5-6.1. Underwater / Autonomous Triton Configuration

To gain access to the underwater or autonomous Triton, use the following steps.

1. Perform all maintenance in a static-free environment.
2. See §5-2.1 for a description of the internal layout of the Triton. See §5-3 for a description of the Triton processor.
3. To remove the “blind” end cap (i.e., no connector/plug), first insert the two pins (provided in the tool kit) into the pinholes in the end cap. Using a metal bar or wrench between the two pins (Figure 12), turn the end cap counter-clockwise to remove it.
4. Carefully slide out the battery pack and disconnect the pack from the instrument (Figure 13).
5. While open, protect all o-rings and o-ring surfaces from damage.

When installing the end cap with electronics, use the following steps.

1. Clean and inspect all o-rings and o-ring surfaces for damage; replace o-rings if necessary.
2. Re-connect the internal wiring harness to the battery pack (if removed).
3. If possible, purge the underwater housing with a dry, inert gas (nitrogen, argon).
4. Slide the battery pack back into the housing, taking care to avoid catching wires or damaging o-rings or o-ring surfaces.
5. Secure the end cap to the underwater housing.



Figure 12 – Triton End Cap Removal

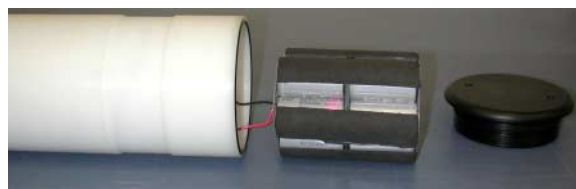


Figure 13 – Triton Battery Pack Removal

5-6.2. Replacing the CPU EPROM and Other Programmable Chips

The Triton processor includes three programmable chips: the CPU EPROM, the analog timing controller, and the CPU timing controller.

- See §5-3 for the location and a description of the function of each of these chips.
- Upgrades (most commonly the CPU EPROM) may be periodically available from SonTek.
- Basic installation instructions are given below.
- See §5-2 and §5-3 for a description of the internal mounting, wiring, and Triton processor.

Downloadable CPU firmware

- Systems produced after September, 2000 will have downloadable firmware.
- Firmware upgrades can be performed by simply connecting the system to a computer and running the appropriate software, without physically installing a new chip.
- For downloadable firmware upgrades, all needed software and instructions will be provided with the upgrade.

Accessing the processor

- Perform all maintenance in a static-free environment.
- Access the system electronics using the instructions in §5-6.1.
- Make note of the orientation of the processor boards before removing it.
- Remove all connectors from the analog board.
- Remove the four #4-40 screws that hold the analog board to the CPU board.
- Lift the analog board straight up to disconnect the edge connector going to the CPU board. Take care not to bend or damage any pins on the connector.
- Remove all connectors from the CPU board.
- Remove the four hex standoffs that hold the CPU board to the mounting hardware.

Replacing the CPU EPROM

- A special chip removal tool (called a PLCC extractor) will simplify the removal of the old chip. With this tool, the two ends are placed on two corners of the socket; compressing the tool lifts the EPROM from the socket.
- Alternatively, a very small flat blade screwdriver can be used to remove the old chip. Insert the screwdriver in the slots in each corner and slowly work the chip up (alternating from opposite corners) until it comes free of the socket.
- When installing the new chip, align the rounded corner of the chip with the similar corner of the socket.
- Lay the chip on the socket and align each pin with the corresponding groove.
- Firmly press the chip into the socket until it is securely set.
- Keep the old EPROM in a static-safe bag until you have verified system operation (after verifying operation it can be discarded).

Replacing the analog / CPU timing controller

- Chips for the analog and CPU timing controller use the same package, but are not interchangeable.
- Be certain that you install the correct chip in the correct socket when replacing these controllers, or the system will not operate.
- Either timing controller chip can be removed using a small flat blade screwdriver.
- Carefully pry each edge of the chip up until you can lift the chip by hand.
- When installing the new chip, align the semicircle on the chip with the semicircle shown on the socket and circuit board.
- Take care not to bend or damage any pins when installing the chip.
- Seat the chip securely by hand.
- Keep the old chip in a static-safe bag until you have verified system operation (after verifying operation the chip can be discarded).

Assembling the processor

- Install the CPU board on the internal hardware and secure with the four hex standoffs. Make sure to install the board with the same alignment used before removing the boards.
- Connect all appropriate internal wiring to the CPU board. See §5-3 for details on internal connectors.
- Install the analog board on top of the CPU board. Carefully align all pins on the edge connector, seat the connector securely, and secure the analog board with four #4-40 screws.
- Connect all appropriate internal wiring to the analog board. See §5-3 for details on internal connectors.
- Close the system following instructions in §5-6.1.

Verifying system operation after a change

- Following any EPROM or timing controller change, you should immediately verify basic system operation.
- After closing the system, connect the power and communication cable, and then apply power to the system.
- Test the operation of the transducers in water using the system diagnostic software (ArgCheck or ArgADVck – see the *Triton Software Manual*).
- Run the real-time data collection software as described in the *Triton Software Manual*. Set the instrument for a short averaging time (10 seconds) and begin data collection. Place the probe in a small tank of water with some seeding material, and move the probe to verify the basic collection of velocity data.
- Verify temperature and (optional) pressure sensor operation by checking data output (either with the real-time software or through a terminal emulator using the **sensor CONT** command).
- Verify (optional) compass/tilt sensor operation using the compass calibration software or through a terminal emulator using the **Compass CONT** command.
- If all functions are normal, you can safely discard the old chips.

5-7. Battery Packs

5-7.1. Autonomous Configuration – Alkaline Batteries

The internal alkaline battery pack is built from 14 C-size alkaline batteries, wired for a nominal capacity of 17.5 Ah at 10.5 V.

- The battery pack is installed in a separate compartment within the housing.
- Battery packs are not rechargeable and should be properly disposed of when drained.
- See §7-2.1 for details on calculating battery life.
- See §5-6.1 for details on battery removal/replacement procedures.

To Avoid Draining of Batteries When System is Not in Use

- Always power the system off before storing the system to prevent draining the batteries.
- All Triton configurations can be powered off by establishing direct communications using *SonTerm* and sending the command **PowerOFF** (§3-7).

Section 6. Operational Considerations

6-1. Input Power Supply

6-1.1. Input Power – Autonomous Configuration (Alkaline Batteries)

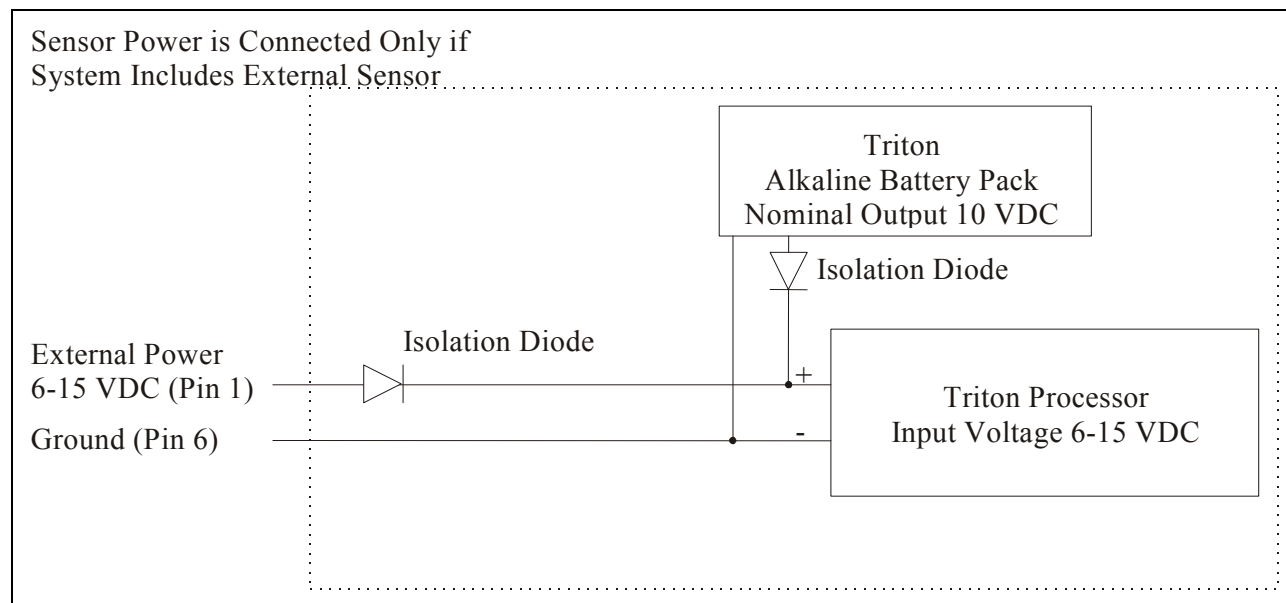


Figure 14 – Input Power Wiring for Autonomous Configuration (Alkaline Batteries)

The Triton processor operates on 6 to 15 VDC input power.

- If the input voltage is less than 6 VDC, the Triton will not operate reliably.
- An input voltage greater than 15 VDC will permanently damage the electronics.
- The measured input voltage can be accessed from the direct-command interface (§3-11) and the stored data (§3-15 and the *Triton Software Manual*).

When running from internal battery power:

- Battery power is wired directly to the Triton processor.
- Bypassing the voltage regulator provides the lowest possible power consumption.
- Do not replace the batteries with a configuration that supplies more than 15 VDC.
- Keep track of battery capacity to prevent the loss of data.
- The Triton internal recorder uses a solid state EEPROM that is not affected by power loss.

- When running from external power (through Pin 1 of the bulkhead connector):
- External battery power is wired directly to the Triton processor.
- Bypassing the voltage regulator provides the lowest possible power consumption.
- **Do not supply more than 15 VDC** – this will seriously damage the Triton.
- The internal alkaline batteries are isolated from external power using a diode.
- The Triton internal recorder uses a solid state EEPROM that is not affected by power loss.

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

- Always power the system off before storing the system to prevent draining the batteries.
- The Triton is powered off by establishing direct communications using *SonTerm* and sending the command **PowerOff** (§3-7).

See the following sections for more information.

- Section 5-5 – Input wiring diagrams
- Section 7-2.1 – Power consumption and battery life

6-2. Real-time Clock Backup Battery

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

- The battery is installed on the CPU processor board (§5-3).
- The battery can be expected to last for many years with no maintenance.
- If the backup battery dies, the system clock will reset when main power is disconnected.
- Contact SonTek before attempting to replace the battery.

6-3. Mounting and Installation

The Triton can be mounted in several ways depending on the application. These range from temporary mounts for short-term data collection projects (a few minutes to a few hours), to permanent installations for long-term monitoring stations. For all installations, there are a few common points to keep in mind.

- Clamp the Triton securely (§6-3.1).
- Avoid having excess magnetic material near the instrument (§6-3.2).
- Avoid flow interference that may be caused by the mounting frame (§6-3.3).
- Align the probe perpendicular to the expected flow direction to avoid possible self-generated flow interference (§6-3.3).

6-3.1. Secure Mounting

The Triton is normally supported by circular clamps at two locations along the probe housing. Housing diameter varies with system configuration.

- Underwater / Autonomous configuration: clamp diameter is 9.9 cm (3.90 in) to fit in the recessed grooves for a secure installation
- Splash-Proof configuration (for probe mounting): clamp diameter is 5.1 cm (2.0 in)



Figure 15 – Optional Triton Mounting Clamps

The mounting clamps shown in Figure 15 (for the underwater / autonomous configuration) are available from SonTek.

6-3.2. Magnetic Material

The Triton uses an optional magnetic compass/tilt sensor to report velocity data in Earth coordinates.

- Ferrous metal in the mounting structure near the instrument can affect the accuracy of compass measurements and hence the accuracy of velocity data.
- All mounting fixtures should be designed using non-ferrous metals or plastics.
- Other ferrous metals near the instrument (less than 1-m away) should be minimized.

A compass calibration should be performed before any deployment to account for any ambient magnetic fields. If possible, the calibration should be performed with the Triton mounted exactly as it will be for deployment. See §4-4 for details on compass calibration.

6-3.3. Flow Interference

The Triton measures velocity in a small sampling volume (0.25 cm^3 ; 0.015 in^3) located 10 cm (4 in) from the tip of the probe (see the *Triton Principles of Operation* for details). The placement of the sampling volume relative to other structures in the water must be considered so that the Triton measures velocity free from flow interference.

Structures

- The Triton probe should be installed well clear of any underwater structures, particularly those upstream.
- Consider the size and location of nearby structures, and the probable magnitude and direction of flow, when choosing an installation site.

Probe orientation relative to flow

- The Triton should be oriented so that the axis of the transmit transducer is roughly perpendicular to the expected direction of flow (Figure 16).
- For 3D down-looking probes, this is usually a simple matter since the probe is most commonly looking vertically, down into a region of horizontal flow.
- For side-looking probes (2D and 2D/3D), the probe should be oriented looking across the expected direction of flow (so the X-axis aligns with the expected flow).
- Side-looking probes have been tested and show negligible flow interference with the X-axis as much as 40 to 50° away from the direction of flow.
- If a side-looking probe is oriented directly up or down-stream, the probe will almost certainly see flow interference in the sampling volume.

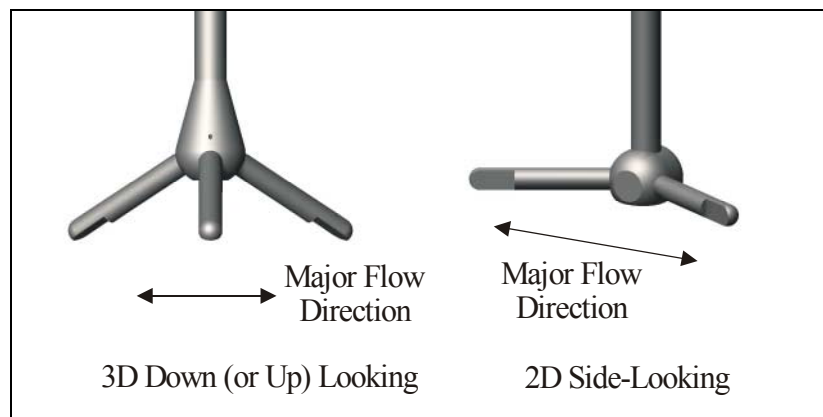


Figure 16 – Preferred Flow Direction to Avoid Flow Interference

6-4. Velocity Data Coordinate System

The Triton supports three coordinate systems for velocity data:

- ENU (East-North-Up, or Earth coordinates)
- XYZ
- Beam

The coordinate system setting is determined in the setup menu of the real-time software (see the *Triton Software Manual*) or using the `CoordSystem` command from the direct-command interface (§3-8).

6-4.1. ENU (East-North-Up) coordinate system

The primary advantage of using the internal compass/tilt sensor is the ability to report velocity data in ENU (East/North/Up or Earth) coordinates – independent of the orientation of the Triton.

- When using the ENU coordinate system, velocity is reported in Earth coordinates regardless of the physical orientation of the Triton.
- A Triton mounted in an unknown orientation will provide velocity data consistent with the direction and speed of the water current itself.
- Proper compass operation requires correct installation as described in §4-2, and operation within the $\pm 50^\circ$ tilt limitation.

The translation of velocity data to ENU coordinates is enabled or disabled through commands to the Triton and is transparent to the user.

- Selection of the Earth coordinate system is done using the `CoordSystem ENU` command (§3-8) or by a menu item in the data acquisition software (see the *Triton Software Manual*).
- When the compass is installed, heading, pitch, and roll data are stored with each sample if the `DataFormat` is set to `LONG` (§3-8).
- Compass data are not stored using the `SHORT` data format (§3-8).

The Triton performs vector averaging using compass data during each sample.

- Triton velocity data in each sample are averaged using continually updated compass data.
- If the Triton changes orientation during a sample, velocity data will be averaged in Earth coordinates and will not be contaminated by instrument motion.
- Using any other coordinate system for the Triton (beam or XYZ) eliminates this Earth coordinate system vector averaging and can contaminate data if the instrument moves during the course of an averaging interval.

6-4.2. XYZ coordinate system

Using the XYZ coordinate system, velocity measurements are stored using a right-handed Cartesian coordinate system relative to the Triton probe.

- The coordinate system is different depending on whether the system orientation is up or down-looking.
- The coordinate system change is necessary to be able to use compass data to rotate XYZ velocity data to the ENU coordinate system.

The Triton is configured at the factory for up, down, or side-looking operation.

- Down-looking operation is defined as the probe and mounting stem being **below** the Triton processor housing.
- Up-looking operation is defined as the probe and mounting stem being **above** the Triton processor housing.
- Side-looking operation is only available when using the cable probe.

It is important to understand that up or down-looking orientation from a Triton system level (as described above) is separate from probe construction (which is either down or side looking). For example, a 3D down-looking **probe** can be used with the **system** oriented either up or down-looking.

6-4.3. BEAM coordinate system

The BEAM coordinate system is provided for diagnostic and very specialized purposes only, and is not commonly used.

- Each velocity component is reported as the bistatic velocity for a particular receiver (see the *Triton Principles of Operation*).
- Positive velocities are away from the probe; negative velocities are towards the probe.
- Receiver #1 is marked with a red band on the receiver arm. The receivers are numbered clockwise from #1 when looking down the stem towards the probe.

6-5. Wave/Pressure Data Collection

When wave data collection is enabled, the Triton will collect raw pressure series spectral data at a specified interval. This has the following consequences:

Data storage

Recording pressure time-series data requires additional memory. As such, the maximum number of profiles that can be stored by the Triton's recorder is reduced. To calculate recorder capacity when collecting wave/pressure data, see §7-2.2.

Power consumption

With **RecordWSeries** disabled, the Triton consumes power only during the averaging interval (power consumption during sleep is negligible – 1 mW). When **RecordWSeries** is enabled, the Triton typically consumes the same amount of power during an averaging interval as when this feature is disabled. However, if the pressure series extends beyond the averaging interval the Triton will consume approximately 1 W, instead of 1 mW. This must be taken into account when calculating power requirements for a deployment.

Profiling interval

The duration of the pressure time series T_p must be at least 15 s less than the time between successive time series PRI. Also, the time between successive pressure records must differ by at least 15 s from the duration of the profiling interval. Example: if PRI=300 s, RWS=1 (record pressure every profile), the maximum duration of the wave series WSL must be less than 285 s. If PRI=300 and RWS=2 (record pressure every other profile), then $315 < WSL < 585$ or $WSL < 285$.

6-6. Serial Communication Protocol

The Triton supports the following serial communication protocols. The default protocol configuration is RS232. This is the protocol used by the standard serial ports on PC-compatible computers.

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

The default communication settings for all both protocols are:

- 9600 baud (§5-4 explains how to change baud rate settings)
- 8 data bits (fixed)
- No parity (fixed)
- 2 stop bits (fixed)

Note that switching from RS232 to RS422 changes the electrical interface only and has no effect on the command interface of the Triton. RS232-to-RS422 converters are available commercially and allow a Triton using RS422 communication to be connected to the RS232 serial port of a PC-compatible computer. One supplier for of RS232-to-RS422 converters is shown below.

B&B Electronics	Phone: (815) 433-5100	Part numbers:
707 Payton Rd	Fax: (815) 433-5109	Converter – 422COR
Ottawa, IL 61350	Internet: www.bb-elec.com	Power Supply – 422PS

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

6-7. Temperature Sensor

To measure temperature, the Triton uses a thermistor mounted on the inside of the probe head.

- The coupling of the thermistor to the metal probe head gives good response to changes in temperature and ensures the temperature data accurately reflect the water temperature at the area in which velocity measurements are being made.
- The temperature sensor has a specified accuracy of $\pm 0.1^{\circ}\text{C}$.
- Temperature data are sampled once per second during the averaging interval, and the mean value is recorded with each sample.

The Triton firmware includes two parameters to calibrate the internal temperature sensor.

- **TempOffset** and **TempScale** allow a linear calibration to be applied to temperature data.
- For the specified accuracy of the sensor ($\pm 0.1^{\circ}\text{C}$) no calibration is required; these parameters are set to 0.0 and 1.0 respectively.

The temperature calibration parameters are used as shown below.

$$\text{True_T} = \text{TempOffset} + \text{TempScale} * \text{Measured_T}$$

where

- True_T = True temperature ($^{\circ}\text{C}$) output and stored by the Triton
- TempOffset = Temperature offset value ($^{\circ}\text{C}$); default is 0.0
- TempScale = Temperature scale value (no units); default is 1.0
- Measured_T = Uncorrected temperature value from thermistor

Temperature offset and temperature scale are not normally used, and are not displayed by the software or discussed in Section 3. To access their values from the direct-command interface, use the commands **TempOffset** and **TempScale** respectively. To set these values based on a user-calibration of the temperature sensor, use the following commands, where X.X and Y.Y are the desired calibration coefficients.

```
TempOffset set X.X
TempScale set Y.Y
```

6-8. Pressure Sensor

If the Triton includes the optional pressure sensor, the sensor is mounted in a recessed hole on the end cap as shown in Figure 1 (at the beginning of this manual).

- The sensor is protected by a retaining plug that screws into the end cap.
- If you suspect problems, please contact SonTek before trying to access the sensor.

Two types of pressure sensors are available.

- A strain gage pressure sensor is available in full-scale ranges from 10 to 60 meters, and provides an accuracy of 0.1% of the range. The strain gage sensor outputs data as an analog voltage.
- Strain gage sensor data are sampled by the Triton 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 (in memory).
- The constants are stored in each data file and can be accessed from the Triton direct-command interface.
- Pressure in counts is converted to decibar using the following formula.

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

dBar	= measured pressure (decibar)
PressOffset	= offset calibration constant (decibar)
PressScale	= 1 st order calibration constant (decibar/count)
PressScale_2	= 2nd order calibration constant (decibar /count ²)
Counts	= measured pressure (counts)

When using the SonTek data conversion software to access Triton data files, the conversion from counts to decibars is done automatically.

If accessing the binary data files directly, you will need to convert the pressure counts to physical units (decibars). The pressure calibration constants (PressOffset, PressScale, and PressScale_2) can be accessed three ways.

- Through the direct-command interface (§3-11)
- From the data conversion software *.CTL file (see the *Triton Software Manual*)
- 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 A for details on the binary data format.

6-7.1. Modifying Pressure Offset Value for Atmospheric Pressure Variations

The pressure sensors used by the Triton are not vented to the atmosphere.

- The pressure data will change with variations in atmospheric pressure.
- Large atmospheric variations can cause pressure variations as large as 0.1 to 0.2 decibars. This is equivalent to 10 to 20 cm (4 to 8 in) of water level.
- If an external measure of barometric pressure is available, this can be used to correct pressure data in postprocessing.

The factory calibration is set to give a pressure of zero at atmospheric pressure at the time / place of calibration. When deploying the instrument, it may be desired to reset the pressure offset to give zero pressure at the time / place of deployment. This can be done using the following steps.

- Establish direct communication with the Triton using *SonTerm*.
- Send a **BREAK** to establish communication.
- Send **show Conf**, and take note of the **PressOffset** value. As an example, let us assume that value is 0.5400 decibars.
- Send **sensor CONT**. This will start a continuous output of temperature, pressure, and battery voltage data. After 5 to 10 samples, press any key to stop output. Take note of the typical pressure value. For this example, let us assume it is -0.230.
- Calculate the new pressure offset to set the pressure value in air to zero.

$$\begin{aligned} \text{New_PressOffset} &= \text{Old_PressOffset} - \text{Pressure_Value} \\ (\text{i.e. } \text{New_PressOffset} &= 0.5400 - (-0.230) = 0.7700) \end{aligned}$$

- Set the new value by entering **PressOffset set 0.7700** (for this example).
- Send **show Conf** to verify the **PressOffset** value.
- Send **sensor Cont** to verify that the pressure data is close to zero (should be less than 0.05). Press any key to stop the output of sensor data.

6-8. Routine Maintenance

Under normal conditions, the Triton requires little maintenance for years of reliable performance. Normal wear does not change instrument performance, and the Triton never requires recalibration for velocity data (unless the probe is physically damaged). This section discusses suggested routine maintenance procedures.

6-8.1. Regular Diagnostic Procedures – ArgCheck

The Triton software includes a diagnostic program called *ArgCheck*. Use and interpretation of the program is described in the *Triton Software Manual*.

We recommend running this program on a regular basis, at the very least before every deployment. The program can verify all aspects of Triton operation.

6-8.2. Cleaning the Transducers

Biological growth on the transducers does not affect velocity measurements, but can decrease acoustic signal strength and potentially increase noise in velocity data when operating in clear water.

- Periodic cleaning of the Triton transducers may be needed to maintain optimal performance in areas of high biological activity.
- Triton transducers are encapsulated in an epoxy that is impervious to damage from barnacles or other types of growth.
- To remove growth, simply clean with a stiff brush. The transducer epoxy is very durable and cannot be easily damaged except by direct impact.
- We recommend coating the transducers with anti-fouling paint for deployments in regions of high biological activity (§6-9).

6-8.3. Cable Maintenance

The underwater cables used with the Triton 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, so reasonable precautions should be taken.
- Inspect all Triton cables and connectors for damage on a regular basis; replace if necessary.
- In areas where cables may be subject to physical damage, additional protection can be added to the cable. One common method is to split a garden hose and wrap it around the cable.

6-8.4. O-rings

All Triton housings use a dual (redundant) o-ring seal.

- All SonTek o-ring seals are designed for full-ocean depth pressures, even if the housings and transducers have lower pressure ratings.
- The o-rings will provide faultless performance as long as care is taken whenever the system is opened.
- Whenever the housing is opened, clean and inspect all o-rings and o-ring surfaces; replace o-rings when necessary. Even small cuts or small bits of debris can create a leakage path.
- While the system is open, protect o-ring surfaces from scratches or other damage.
- Spare o-rings are included in the Triton tool kit.
- Contact SonTek if additional o-rings are needed.

6-8.5. Condensation in Triton Housings

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

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

6-9. Protection from Biological Fouling

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

- Biological growth causes a loss in signal strength, but does not affect velocity measurements.
- Both the Triton transducers and the underwater housings can be coated with commercial anti-fouling paints to prevent biological growth.
- Thick layers of anti-fouling paint on the transducers will decrease acoustic signal strength and could potentially introduce seeding requirements (§6-10).
- For most applications, the loss of signal strength caused by anti-fouling paint does not have a significant effect on instrument performance.

Within the United States, we recommend using an anti-fouling paint called Interlux Tri-Lux II. This paint contains a biocide, a copper derivative, which allows its use on all metals; see contact information for the manufacturer below.

Courtaulds Coatings	Phone: (908) 686-1300
2270 Morris Avenue	Fax: (908) 686-8545
Union, NJ 07083 USA	Internet: www.yachtpaint.com

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 parts, any type of anti-fouling paint can be used.

- When painting metal parts, a suitable conversion layer must be applied to the metal for adhesion and to isolate the metal from the anti-fouling paint.
- We suggest Interlux 360 Underwater Metal Primer (same manufacturer as above).
- The primer should be applied to all exposed metal surfaces **except** sacrificial zinc anodes.
- Apply the anti-fouling paint to all surfaces of the instrument that require protection **except** sacrificial zinc anodes.
- If anti-fouling protection is desired for some portion of the cable, the paint can be applied directly to the polyurethane jacket without primer.

Follow the instructions on the paint container with the following exceptions.

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

6-10. Seeding

If Triton velocity data appears "noisy", the most common cause is a lack of scattering material in the water.

- See the *Triton Principles of Operation* for details about how/why the Triton uses scattering material for velocity measurements.
- A lack of scattering material can increase the instrument-generated noise in velocity data. If insufficient scattering material is present, the Triton will not be able to accurately make velocity measurements.
- In most laboratory applications, and almost all field applications, there is sufficient scattering material naturally present for Triton operation.
- Large laboratory basins often have insufficient natural scattering material.
- The diagnostic software *ArgCheck* is used to evaluate the operational environment (see the *Triton Software Manual*).
- A lack of scattering material can be remedied by adding seeding.

An ideal seeding material should have the following qualities.

- Neutrally buoyant (to remain in suspension for a long period of time)
- Mean particle diameter of 10-20 μm (for peak sensitivity of the acoustic signal)
- Inexpensive, readily available, with no adverse effects on the operating environment

The best seeding material we have located (from an acoustics point of view) are hollow glass spheres with a mean diameter of approximately 10 μm and a mean density close to that of water.

- A small bottle of this material (mixed with water) is included with the Triton.
- A small amount of this material is sufficient for testing in small tanks.
- Larger quantities can be purchased from the manufacturer at the address below.

Potters Industries	Phone: (610) 651-4700
Valley Forge, PA USA	Internet: www.pottersbeads.com
Part name: Potters Sphericel	

For most applications, a more practical seeding material is lime or pulverized limestone (the chalk commonly used on athletic fields).

- Large bags are inexpensive and readily available from most hardware stores.
- While not perfect, the acoustic performance is sufficient for most applications.
- A variety of distribution arrangements can be used to seed even very large tanks.
- A minor note of caution: repeated addition will gradually increase the pH in a tank (in addition to creating a layer of lime/limestone on the bottom of the tank).

6-11. Troubleshooting

This section provides suggestions for diagnosing problems with the Triton. If you have trouble finding the source of a problem, please contact SonTek.

6-11.1. *Velocity Data Appears Noisy or Unreasonable*

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

- Lack of scattering material in the water is the most common problem (particularly in large laboratory tanks). See §6-10 and the *Triton Principles of Operation* for seeding requirements.
- Run *ArgCheck* as described in the *Triton Software Manual*. This will address all aspects of Triton operation, especially signal strength (scattering/seeding issues) and probe operation.
- Verify the velocity range setting is appropriate for the operating environment (see *Triton Principles of Operation*).
- Verify the probe is not fouled with debris.
- Verify the Triton mounting is stable and that instrument motion is not causing noise in the velocity data.
- Look at the compass/tilt sensor data (if installed). Look for large tilt values that may indicate the Triton is not near vertical (or is even upside down). Look at how compass/tilt data changes with time to see if the deployment package is moving.
- Consider any possible influences of the deployment environment, particularly flow interference from nearby underwater structures (§6-3.3).
- Consider the orientation of the probe with respect to the flow direction to be sure the probe is not causing flow interference in the sampling volume (§6-3.3).

6-11.2. Cannot Communicate with the Triton

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

- Verify all cables to the Triton are securely connected.
- Verify the power supply is providing 6 to 15 VDC to the processor (or 6 to 30 VDC through the external supply, see §6-1). When power is first connected, the Triton should wake up and enter the mode last used (i.e., command, data acquisition, or deployment mode – see §3-2). Measure the input current when power is applied to see if the system is drawing any power. Try using an alternative power source if possible.
- Verify the computer serial port is functioning correctly. Try using a different computer.
- Verify the baud rate, serial port, and other communication parameters match Triton settings (§3-1 and the *Triton Software Manual*).
- If the Triton software is unable to establish communications, try direct communications using a terminal emulator (*SonTerm*). When power is applied, see if the Triton will respond to a **BREAK**.

6-11.3. Compass/Tilt Sensor

If you suspect a problem with the Triton compass/tilt sensor, try the following.

- Follow the procedure outlined in §4-1 for a basic compass function test.
- If you see problems with heading, perform a compass calibration and retest compass function. A bad compass calibration can cause a major distortion to the heading data.
- Be sure the Triton is oriented properly based on compass installation (up or down-looking – see §4-2).

6-11.4. Cannot Retrieve Data from Internal Recorder

The following items are common causes of communication errors when retrieving data from the internal recorder (using the *SonRec* software).

- The data-extraction baud rate is too high for reliable operation (by default it runs at 115200). The maximum baud rate is a function of the length and quality of cables, the computer, and the operating environment (external noise). Run *SonRec* using a lower extraction rate (see the *Triton Software Manual*).
- Some computers have poor quality serial ports and are unable to retrieve large amounts of data at high baud rates. Try using another computer or lower extraction baud rate.
- If you are still unable to retrieve data from the internal recorder using *SonRec*, establish direct communications with the Triton, and use the recorder commands to access data files directly (§3-10). Check that the file size and number of samples is reasonable. Download a portion of the data manually to verify that all data are present.

6-11.5. Missing data from autonomous deployment

The Triton internal recorder was designed for extremely high reliability; recorder failures are very rare.

- The only data losses that have occurred are because of problems with the Triton power supply.
- If you have a deployment that appears to be missing data, look at the battery voltage recorded with each sample. Check that these values are reasonable based on the type of power supply used and the length of the deployment.
- If you cannot determine what happened, please contact SonTek.

Section 7. Autonomous Deployment

Autonomous deployments are applications where the Triton is operating from battery power (either internal or external) and storing data on the internal recorder.

7-1. Selecting Operating Parameters

The choice of Triton operating parameters depends upon the nature of the deployment and the goal of the study. Guidelines for the most important parameters are given below.

7-1.1. System parameters

See §3-7 for details about these parameters.

Parameter	Comments
Date	Set the system clock before deployment.
Time	Set the system clock before deployment.
AutoSleep	This should be set ON for autonomous deployments. The Deploy command automatically causes the system to enter a low-power state between samples regardless of the setting of this parameter (it forces AutoSleep ON).
OutMode	This is not typically important for autonomous deployments, since it affects only data output over the serial port and not data stored on the internal recorder. If storing data with an external data logger, set the parameter (AUTO/POLLED) as required by the data logger.
OutFormat	This is not typically important for autonomous deployments, since it affects only data output over the serial port and not data stored to the internal recorder. If storing data with an external data logger, set the parameter (ASCII / BINARY / SEABIRD / METRIC / ENGLISH) as required by the data logger.
Recorder	This should be set ON for autonomous deployments. The Deploy command automatically stores data to the internal recorder regardless of the setting of this parameter (it forces the recorder ON).
RecMode	This is not currently enabled and should be set to NORMAL .

7-1.2. Setup and Deployment Parameters

See §1-3, §3-8, §3-9, and §3-15 for details about these parameters.

Parameter	Comments
Temp	The default temperature setting should not matter, since most deployments will use TempMode MEASURED .
Sal	The default salinity should be as accurate as possible. As long as salinity is accurate to ~2 ppt, sound speed variations will have no significant effect on the accuracy of velocity data.
TempMode	This should be MEASURED for all but specialized applications (data from the temperature sensor are used for sound speed calculations).
CoordSystem	If the system includes a compass/tilt sensor, this is normally set to ENU . It is set to XYZ for systems without the compass/tilt sensor.
VelRange	This is normally set to AUTO to give the best performance over the widest velocity range. The pre-set velocity ranges are used only for power-limited applications (§7-2). If using pre-set velocity ranges, choose the lowest range setting that you are confident the velocities will not exceed (see the <i>Triton Principles of Operation</i>).
DataFormat	This is set to LONG to store all diagnostic data except for memory-limited applications. See §7-2 to calculate data storage requirements. When possible, we recommend using the LONG format to have the greatest flexibility in data analysis.
StartDate / StartTime	These parameters determine the precise start date/time of the first sample. They are used to synchronize the data set with other sensors or to synchronize the time-series on a regular interval (e.g., on the hour).
AvgInterval	This varies with the interests of the deployment. It is typically based on real variations in water velocity: what averaging time is needed for a good mean value of the currents. The exception is for fast sampling for short deployments or in conjunction with burst sampling.
SampleInterval	This varies with the desired time resolution of currents and power / memory requirements.
BurstMode	Burst sampling is not commonly used, but does allow monitoring of both short and long-term variations in the currents (§1-3).
BurstInterval	When using burst sampling, this is set based on the desired time resolution of currents and power/memory requirements.
SamplesPerBurst	When using burst sampling, this is set based on the desired time resolution of currents and power/memory requirements.
RecordWSeries	Controls the collection/recording of the pressure series data.
WSeriesRate	Specifies the sampling rate for the wave time series collection.
WSeriesLength	Sets the length of the wave time series in samples.
WSeriesType	Sets the wave series type to either P or PUVW.
OutWSeriesMode	Determines when data are sent over the serial port – automatically or when polled.
RecordFreqSpectra	Only available when WSeriesType is set to P_SERIES .
Water Depth	

7-2. Battery Life and Data Storage Requirements

7-2.1. Battery Life

Power Consumption

- With the **AUTO** velocity range, the Triton consumes 0.48 W.
- Using a pre-set velocity range, the Triton consumes 0.22 W.
- The **AUTO** velocity range is recommended for the best performance except for severely power-limited applications (see the *Triton Principles of Operation*).
- Power consumption for the optional CTD must be accounted for (if installed). It is estimated by the equation below. For example, using an **AvgInterval** of 60 seconds, the CTD power will be 0.08 W (giving total power consumption of 0.58 W using the **AUTO** velocity range).

$$\text{CTD_Power (Watts)} = 5 / \text{AvgInterval (seconds)}$$

- The total power consumption is the sum of the Triton power consumption with any optional sensors (CTD).
- **IMPORTANT:** These power consumption values assume power is fed through the direct battery power connection to the Triton processor rather than through the secondary voltage regulator or the DC-to-DC converter (for systems with rechargeable batteries - see input power specifications in §6-1). Using the secondary voltage regulator or DC-to-DC converter increases power consumption by a factor of two during data collection, and during sleep mode (from <1 mW to 0.5 W).

Battery Pack Capacity

- SonTek recommends using 80% of the nominal battery capacity to allow for temperature variations (nominal capacities are at 20°C) and a reasonable safety margin.
- The Triton Autonomous alkaline battery pack outputs 10.5 V with a nominal capacity of 17.5 Ah. Using 80% of nominal capacity gives 147 Wh of energy.
- User-supplied batteries and power systems will have widely varying capacities, which must be calculated on a case-by-case basis.

Duty Cycle

- Duty cycle is the percentage of time the Triton is actively collecting data.
- When not collecting data, the Triton enters a low-power state (< 1 mW). Note power consumption in the low-power state is negligible only if using the direct battery power connection (see input power specifications, §6-1).
- When not using burst sampling, duty cycle is calculated as:
(AvgInterval / SampleInterval)
- When using burst sampling, duty cycle is calculated as:
((AvgInterval * SamplesPerBurst) / BurstInterval)
- Battery life scales directly with duty cycle. For example, a duty cycle of 0.2 (20%) increases battery life by a factor of five.
- See §1-3 for a description of sampling strategies and duty cycle calculation.

Battery Life Calculation

Battery life is calculated as:

$$\text{Battery_life} = \text{Battery_capacity} / \text{Power_consumption} / \text{Duty_cycle}$$

Example: An Autonomous Triton with alkaline battery pack (no CTD) will be deployed using the **AUTO** velocity range, **AvgInterval** 120 seconds, **SampleInterval** 600 seconds, no burst sampling.

- Battery capacity is ≈ 147 Wh, power consumption is ≈ 0.5 W (≈ 0.48 W using the **AUTO** velocity range setting), which gives power for ≈ 294 hours (≈ 12 days) of continuous operation.
- Duty cycle is $(120 / 600) = 0.2$. Total battery life is therefore $(12 / 0.2) = 60$ days.

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

- Always power the system off before storing the system to prevent draining the batteries.
- The Triton splash-proof configuration can be powered off using the switch on the front panel.
- All Triton configurations can be powered off by establishing direct communications using *SonTerm* and sending the command **PowerOFF** (§3-7).

7-2.2. Data Storage Requirements

Data File Size

- The Triton stores 418 bytes of header information for each file.
- Each velocity sample uses 39 bytes (**DataFormat LONG**) or 23 bytes (**DataFormat SHORT**). When possible, we recommend using the **LONG** data format.
- Recording **P_SERIES** data adds 2 bytes per sample; recording **PUV_SERIES** data adds 6 bytes per sample.
- The integrated CTD adds 16 bytes per sample.
- All samples from an individual deployment are stored in a single file.
- Total File Size = 418 + (Bytes_Per_Sample * Number_of_Samples)

Recorder Capacity

- The standard Triton recorder has a 4-MB capacity.
- The standard (4-MB) Triton recorder is divided into 64 blocks of 64 KB. Only one data file can be written in one block (although one data file can occupy multiple blocks). The recorder can hold a maximum of 64 data files. If you record several small data files (less than 64 KB per file), the recorder will reach maximum capacity before 4 MB of velocity data have been stored.
- Be sure to format the recorder to erase all files before any deployment.

Calculating Recorder Life

- Example: A Triton with the standard 4-MB recorder is set up as follows: no CTD, record **LONG** data format samples, **AvgInterval**=120 s, **SampleInterval**=1800 s, no burst sampling, record **PUV_SERIES** data (6 bytes per sample), **RWS**=4 (wave series every two samples), **WSR**=1, **WSL**=1024.
- The data has 39 bytes per sample plus the additional wave data (6 bytes x 1024; one every 4 samples).
- This yields 3150 bytes per hour, allowing the recorder to last 55 days.

Calculating Recorder Capacity When Collecting Wave/Pressure Data

This section describes how to calculate the Triton recorder capacity when collecting wave/pressure data.

When **RecordWSeries** is enabled,

the **P_SERIES** wave type adds $\text{PressureHeaderSize} + \text{WSL} * 3$ bytes to each N^{th} profile; and

the **PUV_SERIES** wave type adds $\text{PressureHeaderSize} + \text{WSL} * 9$ bytes to each N^{th} profile.

Therefore, the profile size needs to be adjusted accordingly.

When a CTD is installed, 16 extra bytes are added to each profile.

The equation for computing the data storage requirements needs to be modified as follows:

$$\begin{aligned} \text{PROFILE_SIZE} &= 82 + (\text{N_BEAMS} * \text{N_CELLS} * 4) + \\ &\quad 16 \text{ (if CTD data is present)} \\ \\ \text{WAVESERIES_SIZE} &= 82 + (3 * \text{WSL}) \text{ (when WST is P_SERIES)} \\ \text{WAVESERIES_SIZE} &= 82 + (9 * \text{WSL}) \text{ (when WST is PUV_SERIES)} \end{aligned}$$

Where WSL is Wave Series Length (in samples).

The total file size then the profile size multiplied by the number of profiles plus the file header (416 bytes) plus the pressure series length multiplied by the relative fraction of pressure records expressed as the ratio of the total number of profiles / RecordWseries parameter.

$$\text{FILE_SIZE} = 416 + (\text{N_PROFILES} * \text{PROFILE SIZE}) + \frac{\text{NPROFILES}}{\text{RWS}} * \text{WAVESERIES_SIZE} \text{ (if RWS >0)}$$

Where RWS is Record Wave Series parameter, determining how often the wave time series are recorded.

7-3. Starting an Autonomous Deployment

Autonomous deployments can be started two ways.

- From the direct-command interface using a terminal or terminal emulator (e.g., *SonTerm*)
- Using the Windows-based *ViewTriton* deployment software (see the *Triton Software Manual*)

This section describes starting an autonomous deployment using the direct-command interface. See Section 3 for details about the direct-command interface. The steps below include redundant checks to verify all aspects of Triton operation.

1. Run the diagnostic software *ArgCheck* to verify all aspects of system operation. See the *Triton Software Manual* for detailed instructions on using and interpreting the software.
2. Perform the deployment procedure with the Triton operating from the batteries that will be used for deployment. Do not disconnect power after initiating the deployment.
3. Perform a compass calibration if the compass/tilt sensor is installed (§4-4). This should be done with the system mounted in the deployment frame with batteries and other instrumentation installed.
4. Record all communication with the Triton for future reference. This can be done using the log file option in *SonTerm* (see the *Triton Software Manual*).
5. **BREAK** – To wake the system up and establish communication.
6. **show Conf** – Check parameters.
7. **show system** – Check parameters (§7-1.1). Modify parameters as needed.
8. **show setup** – Check parameters (§7-1.2). Modify parameters as needed.
9. **show Deploy** – Check parameters (§7-1.2). Modify parameters as needed.
10. **save setup** – To save parameters (redundant – done by **Deploy** command).
11. **Compass CONT** – To check compass operation (if installed). Rotate and tilt the Triton to verify compass data (§4-1). Press any key to stop output.
12. **dir** – Check for files on the internal recorder. Make sure there is sufficient space for this deployment. **Format** to erase the recorder if necessary.
13. **show** – Verify parameters with all four “Show” commands one last time.
14. **Deploy** – To initiate the deployment.
15. Watch for any error messages. If practical, leave the computer connected to the Triton until the first sample has been output.
16. Disconnect the cable from the computer before turning the computer off. Some computers will send the equivalent of a **BREAK** over the serial port when turned off, which can interrupt the deployment and cause the loss of data.
17. Disconnect the communication cable, install the dummy plug, and deploy the Triton.

7-4. Wave Frequency Spectra Calculations

The wave-frequency spectra are estimated using standard methods appropriate to simple linear theory. It includes: segmentation of the data into 256-sample segments with at least 128-samples 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.

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/SONWAVEPRO 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:

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

For a complete description of directional wave computations, refer to the SonWavePro Application Note (SonWavePro.pdf) included in the *ViewTritonPro* software directory.

Section 8. Optional External Sensors

The Triton can include several externally mounted, integrated sensors.

- The sensors are connected to the Triton using special interface cables.
- The most commonly integrated sensor is the SeaBird MicroCat CTD.
- A range of other sensors (OBS, transmissometer, conductivity, etc.) can be integrated using analog output voltages. Depending on the type of sensor, it may receive input power from the Triton, or it may use a separate power supply.

For details on available sensors and configurations, contact SonTek.

8-1. SeaBird MicroCat CTD

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

8-1.1. CTD Splitter Cable

Systems with the optional integrated CTD include a special splitter cable to connect the CTD to the Triton.

- The splitter cable connects to the Triton, the CTD, and the standard power and communication cable.
- The splitter cable routes power and communication between the CTD and Triton.
- The Triton includes additional internal wiring and software modifications to integrate the CTD.

8-1.2. CTD Data Storage / Output

CTD data is stored with each Triton sample.

- CTD data is stored and output with the full resolution provided by the CTD sensor.
- See §3-15 for details about CTD output data format.

8-1.3. Timing of CTD Data

The CTD is sampled once during each Triton sample at the beginning of the averaging interval.

- The CTD sample is taken 5 seconds after the start of the Triton averaging interval.
- The time reported by the Triton reflects the start of the averaging interval.
- An averaging interval of at least 10 seconds is required for the integrated CTD.
- The CTD system is put in a low-power sleep mode to conserve power except during the time required to take a sample.

8-1.4. CTD Commands

In normal operation, all commands to the optional external CTD 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 Triton operation.

H CTD

- Displays help on external CTD sensor commands.

CTD

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

CTD CONT

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

CTD Talk

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

8-1.5. When Not Using the Optional CTD

Systems with the integrated CTD may occasionally need to be used without the CTD. This section explains how to “uninstall” and “install” the CTD for these occasions.

To Uninstall the CTD

- Establish direct communication with the Triton using a terminal emulator (*SonTerm*).
- **BREAK** to wake-up the system.
- **Show Conf** to check hardware parameters. Verify **CTDInstalled** is set to **YES**.
- **CTDInstalled set NO** to uninstall the CTD.
- **SaveSetup** to save the parameter setting.
- **Show Conf** to check system parameters. Verify **CTDInstalled** is set to **NO**.
- The system can now be used without the CTD. Use the standard Triton cable without the special CTD splitter cable.

To Install the CTD

- Establish direct communication with the Triton using a terminal emulator (*SonTerm*).
- **BREAK** to wake-up the system.
- **Show Conf** to check hardware parameters. Verify **CTDInstalled** is set to **NO**.
- **CTDInstalled set YES** to install the CTD.
- **SaveSetup** to save the parameter setting.
- **Show Conf** to check hardware parameters. Verify **CTDInstalled** is set to **YES**.
- The system can now be used with the CTD. Use the special CTD splitter cable.

8-2. External Analog Sensors

Not yet available. Contact SonTek.

Section 9. Additional Support

Any additional questions can be directed to SonTek/YSI by phone, FAX, or email. Regular 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
World Wide Web	http://www.sontek.com

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

Appendix A. Triton Binary Data File Format

The file format described in this appendix is valid for Triton CPU firmware versions 1.0 and later. For information about changes in the Triton data file format from previous firmware versions, contact SonTek.

A-1. Overview

The structure of a Triton binary data file with N samples is shown below. The size of each sample is a function of the setting of the data format parameter (**LONG** or **SHORT**) and what external sensors are installed (§7-2.2).

```
File Header 418 bytes
Sample 1 (23 - 69) bytes
Sample 2 (23 - 69) bytes
...
Sample N (23 - 69) bytes
```

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

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

Each of the structures mentioned above are described in detail (using their C language definitions) in the remainder of this appendix.

A-2. File Header Structures

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

Triton Date and Time Structure (8 bytes)

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

Triton Sensor Configuration Structure (96 bytes)

```
typedef struct {
    char    ConfigType;           /* Type      0x40      */
    char    ConfigVer;           /* Version   0x02      */
    int     Nbytes;               /* Bytes in configuration */
    DateTimeType ConfigTime;      /* Date created or last modified */
    unsigned char SoftwareVerNum; /* Ver number of ADCM firmware */
    unsigned char DspSoftwareVerNum; /* Ver number of DSP firmware */
    char    BoardRev;            /* Electronics board revision */
    char    SerialNumber[10];     /* Sensor serial number */
    char    AdcmType;             /* Low Nibble: 0-3MHz 1-1.5MHz */
                                        /* High Nibble: 0-MD 1-XR 2-SL */
    char    Nbeams;               /* 2, 3, or 4 */
    char    BeamGeometry;         /* 0- 2 Beams; 1- 3 Beams */
                                        /* 2- 4 Beams, 1 Vertical */
                                        /* 3- 4 Beams, Janus */
    int     SlantAngle;           /* in 0.1 deg */
}
```

```

char    SensorOrientation;    /* 0-down; 1-up; 2-side    */
char    CompassInstalled;    /* 0-No; 1-Yes            */
char    RecorderInstalled;   /* 0-No; 1-Yes            */
char    TempInstalled;       /* 0-No; 1-Yes            */
char    PressInstalled;      /* 0-No; 1-Yes            */
char    CtdInstalled;        /* 0-No; 1-Yes            */
int     XformMat[16];        /* From Beam to XYZ veloc. */
int     CompassOffset;       /* Degress to East of North */
long    PressScale;          /* Nanobar per count      */
long    PressOffset;         /* Microbar                */
char    PowerSaveMode;       /* if 1 system off after 5 min
                             /*     idle in command mode */

long    SeabirdOutputDelay;  /* 0-no 1-yes              */
unsigned char SpareA;        /* Old UserBaudRate      (New 6.1) */
int     PressScale_2;        /* pico dbar per count^2  */
unsigned char SpareB;        /* Old CpuAddress        (New 6.1) */
int     PingDelay;           /* set to all 0s          */
unsigned char YsiInstalled;  /* 0-No; N-Bytes to collect */
char    ExtPressInstalled;   /* 0-None; 1-Paros; 2-Druck
                             /*     ParosFreq          */

unsigned char RecorderSize;  /* in Mbytes (default is 2 Mb) */
char    Spare2[4];           /* set to all 0s          */
} AdcmSensorConfigType;

```

Triton Operation Configuration Structure (64 bytes)

```

typedef struct {
char    ConfigType;          /* Type      0x41          */
char    ConfigVer;           /* Version   0x03          */
int     Nbytes;              /* Bytes in configuration */
DateTimeType ConfigTime;    /* Date created or last modified */
int     NpingsPerBeam;      /* Consecutive pings for each beam */
int     SampInterval;       /* Samp Interval in 16/Ft units */
int     Lag;                 /* Samp spacing for AutoCorrelation */
int     PulseLength;        /* In cm (along profiling axis ) */
int     RecLength;          /* In cm Receiver recovery delay */
int     MinBlankLength;     /* In cm Blank to first bin */
int     OperatingRange;     /* Max range in m          */
int     PingDelay;          /* In m Delay befor next ping */
int     AutoFilter;         /* 0-fixed filter; 1-auto filter */
int     FilterA[2];         /* Fixed filter coefficients */
int     FilterB[2];         /* Fixed filter coefficients */
char    ModemMode;          /* Modem Mode              */
int     TempOffset;         /* in 0.01 deg C          */
int     TempScale;          /* in 0.0001 TrueT/MeasuredT */
unsigned char NominalNoise[MAX_BEAMS];
unsigned char VelRangeInd;   /* Velocity range for Triton
                             /* 0=3cm/s 1=10cm/s 2=30 cm/s
                             /* 3=100cm/s 4=300cm/s 5=Auto range */

char    FastMode;           /* 0 - NO, 1-YES          */
char    SampleRecordMode;   /* 0- no 1- yes           */
char    UseCompassFlux;     /* 0- no 1-yes            */
unsigned char CorrMagScale; /* default is 20          */
char    Spare[12];          /* Set to all 0s          */
char    DebugOn;           /* Set to all 0s          */
} AdcmOperConfigType;

```

Triton User Setup Parameters Structure (258 bytes)

```

typedef struct {
unsigned char ConfigType;    /* Type      0x42          */
unsigned char ConfigVer;     /* Version   0x02          */
unsigned int  Nbytes;        /* Bytes in configuration */

```

```

DateTimeType  ConfigTime;          /* Date created or last modified */
int           Temp;              /* 0.1 deg C                      */
int           Sal;              /* 0.1 ppt                        */
int           Cw;              /* 0.1 m/s                        */
char          TempMode;         /* 0- User value  1- Measured     */
long          AvgInterval;      /* in s                           */
long          SampleInterval;   /* in s                           */
unsigned int  PingInterval;     /* in 0.1 s                       */
unsigned int  BurstMode;        /* 0-Disabled; 1-enabled         */
long          BurstInterval;    /* in s                           */
unsigned int  SamplesPerBurst;  /*                               */
char          CoordSystem;      /* 0-Beam;      1-XYZ; 2-ENU      */
char          OutMode;          /* 0-Auto;      1-Polled          */
char          OutFormat;        /* 0-Binary;    1-Ascii          */
              /* 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 Jan 1, 1980 */
char          CommentLine1[60];
char          CommentLine2[60];
char          CommentLine3[60];
char          AutoSleep;
int           CohLag;           /* in cm, vert. from instrument  */
              /* if > 0 Arg will operate in    */
              /* coherent mode                */
char          DataFormat;       /* 0-long 1-short                */
unsigned char RecordPseries;    /* Pressure Time series recording */
              /* 0 - No time series recorded   */
              /* N - Record series every Nsamples */
char          PseriesParam;     /* Pressure Time series recording */
              /* Bit                            */
              /* 0      Compute/record spectra  */
              /*      0-NO 1-YES              */
              /* 1      Unused                  */
              /* 2-3    Sampling rate          */
              /*      00 - 1 Hz                */
              /*      01 - 2 Hz                */
              /*      10 - 4 Hz                */
              /* 4-5    Pseries Type          */
              /*      00 - P_series           */
              /*      01 - PUV_Series       */
              /*      10 -                   */
unsigned int  PseriesLength;     /* Number of points in Pseries   */
              /* Max is 4096                   */
char          OutPseriesMode;    /* 0 - AUTO 1 - POLLED          */
              /* 0-no spectra NOT computed    */
              /* 1-yes P_spectra computed     */
int           WaterDepth;       /* in cm for spectra calculations */
              /* if 0 or negative, it gives    */
              /* height of Argonaut above bottom */
char          MinCorrLevel;
char          spare[6];
} AdcmUserSetupType;

```

A-3. Data Sample Structures

Each Triton sample will consist of several different data records, depending on the setting of the data format parameter (**LONG** or **SHORT** – see §3-8) and whether any external sensors are installed. The data records will be in the following order

```
Triton Sample           (22 or 38 bytes)
CTD Sample if present  (16 bytes)
Checksum                (1 byte)
```

There are two different Triton data sample structures, depending on the setting of the data format parameter.

Triton LONG Sample Structure (38 bytes)

```
typedef struct {
    unsigned char   SyncChar;           /* 1 Fixed 0xB1          */
    unsigned char   Nbytes;             /* 1 Including ChkSum    */
    unsigned long   Time;               /* 4 time as seconds since 00:00:00 Jan 1,1980 */
    int             Vel[MAX_BEAMS];     /* 6 Vel in mm/s        */
    unsigned char   VelStd[MAX_BEAMS]; /* 3 Vel in mm/s        */
    unsigned char   Amp[MAX_BEAMS];    /* 3 Amplitude in counts */
    unsigned char   PercentGood;       /* 1 Percent good pings */
    unsigned int    Heading;           /* 2 Heading in .1 deg  */
    char            Pitch;             /* 1 Pitch in .4 deg    */
    char            Roll;              /* 1 Roll in .4 deg     */
    int             Temp;              /* 2 in .01 deg C       */
    unsigned long   Pres;              /* 4 in A/D Converter counts */
    unsigned int    SigmaPres;         /* 2 in A/D Converter counts */
    unsigned char   Vbatt;             /* 1 Battery voltage    */
    unsigned int    BoundaryRange;     /* 2 in 0.1 cm units    */
    unsigned char   StdHeading;        /* 1 Std. Dev. in .1 deg */
    unsigned char   StdPitch;          /* 1 Std. Dev. in .1 deg */
    unsigned char   StdRoll;           /* 1 Std. Dev. in .1 deg */
    unsigned char   ExtraByte;         /* 1 For future use     */
    /* 38 bytes          */
} TritonLongSampleType;
```

Triton SHORT Sample Structure (22 bytes)

```
typedef struct {
    unsigned char   SyncChar;           /* 1 Fixed 0xB1          */
    unsigned char   Nbytes;             /* 1 Including ChkSum    */
    unsigned long   Time;               /* 4 time as seconds since 00:00:00 Jan 1,1980 */
    int             Vel[3];             /* 6 Vel in mm/s        */
    unsigned char   MeanVelStd;        /* 1 Vel in mm/s        */
    unsigned char   MeanAmp;           /* 1 Amplitude in counts */
    int             Temp;              /* 2 in .01 deg C       */
    unsigned long   Pres;              /* 4 in A/D Converter counts */
    unsigned char   Vbatt;             /* 1 Battery voltage    */
    unsigned char   ExtraByte;         /* 1 For future use     */
    /* 22 bytes          */
} TritonShortSampleType;
```

Wave Series Data Structure

```

P_series      unsigned short int P[WASEVSERIESLENGTH]

PUV_series   unsigned short int P[WASEVSERIESLENGTH] /* pressure      */
              short int U[WASEVSERIESLENGTH]        /* X/E component */
              short int V[WASEVSERIESLENGTH]        /* Y/N component */

```

CTD Data Structure

```

typedef struct {          /* # bytes*/
    long      Temp;      /* 4 in 0.0001 deg C      */
    long      Cond;      /* 4 in 0.00001 mho       */
    long      Press;     /* 4 in 0.001 dbar        */
    long      Sal;       /* 4 in 0.0001 ppt        */
} CtdType;              /* ---- */
/* 16 bytes total */

```

A-4. Checksum Calculation

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

```
Checksum = ComputeChecksum( buffer, Sample_Length - 1 );
```

In this statement, *buffer* is a pointer to the memory location where the sample begins (i.e., the name of the character array where the sample was placed). *ComputeChecksum* adds the first *Sample_Length - 1* bytes starting at location *buffer*, and 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.

```

#define CHECK_SUM_OFFSET 0xA5
unsigned char ComputeChecksum( unsigned char *buf, int n )
{
    int i;
    unsigned char ChkSum = CHECK_SUM_OFFSET;
    for(i=0;i<n;i++) ChkSum += buf[i];
    return(ChkSum);
}

```

A-5. Examples of Binary Output Records

Data Format	CTD	Bytes Per Sample
Long	No	39
Short	No	23
Long	Yes	55
Short	Yes	39
Long	No	55-69
Short	No	39-53

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