

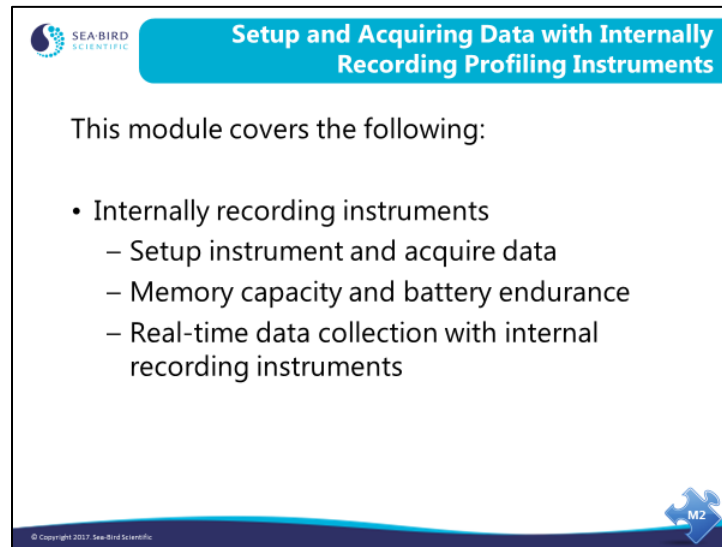


Setup and Acquiring Data with Internally
Recording Profiling Instruments

Sea-Bird Scientific University Module 2



Overview



SEA-BIRD SCIENTIFIC

Setup and Acquiring Data with Internally Recording Profiling Instruments

This module covers the following:

- Internally recording instruments
 - Setup instrument and acquire data
 - Memory capacity and battery endurance
 - Real-time data collection with internal recording instruments


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M2

We are going to discuss SeatermV2, the user interface or terminal program for internally recording instruments that can output data in XML (instruments developed and/or redesigned since 2006). By the end of this module you should be able to:

- Use SeatermV2 to prepare an internally recording instrument for deployment.
- Use SeatermV2 to transfer data stored in an internally recording instrument to your computer.


Sea-Bird Software for Recording and Processing Data



Sea-Bird software for recording and processing data

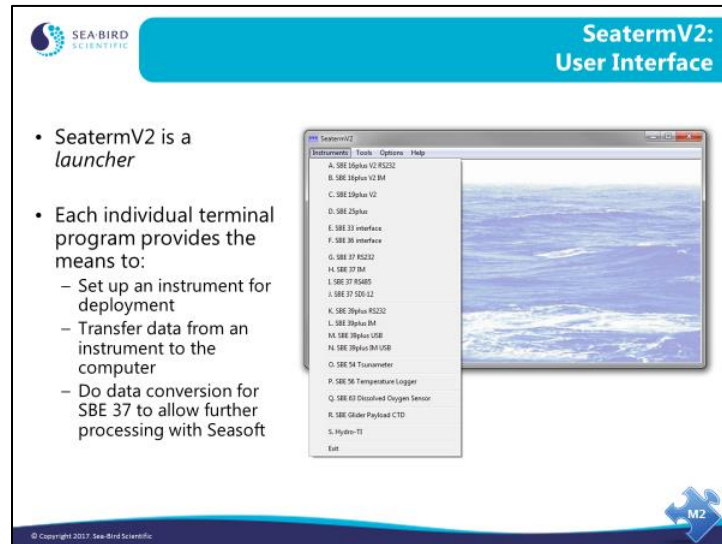
- **SeatermV2** - user interface for internally recording instruments that can output data in XML
- **Seaterm** - user interface for older instruments
- **Seasave V7** - software for real-time data collection
 - Most instruments that can report real-time use Seasave V7
- **SBE Data Processing** – software for post-processing data

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There are four software programs that Sea-Bird has developed for interfacing with instruments and processing data. In this module, we will be using Seaterm V2 and Seaterm to communicate and download data from internally recording instruments.

SeatermV2: User Interface for Internally Recording Instruments



- SeatermV2 is a *launcher*
- Each individual terminal program provides the means to:
 - Set up an instrument for deployment
 - Transfer data from an instrument to the computer
 - Do data conversion for SBE 37 to allow further processing with Seasoft

SeatermV2 is a terminal program *launcher* for use with instruments developed or redesigned in 2006 and later. The common feature of this generation of instruments is the ability to output data in XML. SeatermV2 launches one of the following terminal programs, depending on the communication protocol required:

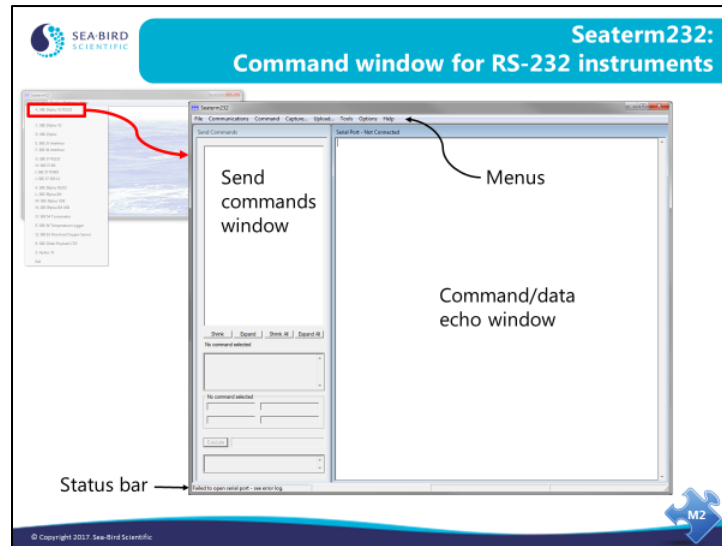
- Seaterm**232** – for communication via RS-**232** (standard serial communications)
- Seaterm**IM** – for communication via **I**nductive **M**odem telemetry (proprietary protocol that Sea-Bird developed for use in moorings; it supports instruments deployed in parallel, with each instrument assigned a unique address)
- Seaterm**485** – for communication via RS-**485** (4-wire serial communications, which allows instruments to be placed in parallel on the communications cable and each instrument to be addressed uniquely)
- Seaterm**USB** – for communication via **USB**

Currently, SeatermV2 supports the following instruments:

- SBE 16*plus* V2, 16*plus*-IM V2, 19*plus* V2 (all firmware version 2.0 and greater)
- SBE 25*plus*
- SBE 37-IM, IMP, SM, SMP, SI, SIP (all firmware version 3.0 and greater)
- SBE 37 IMP-IDO, SMP-IDO, SIP-IDO, IMP-ODO, SMP-ODO, SIP-ODO
- SBE 39*plus*
- SBE 54
- SBE 56
- SBE 63
- Glider Payload CTD

Note: SeatermV2 can also launch Seaterm (older terminal program) if you select the SBE 33 or 36 Deck Unit, providing easy access to Seaterm to set up a deck unit used with an SBE 19*plus* V2 or 25*plus*.

Seaterm232: Interface for RS-232 Instruments

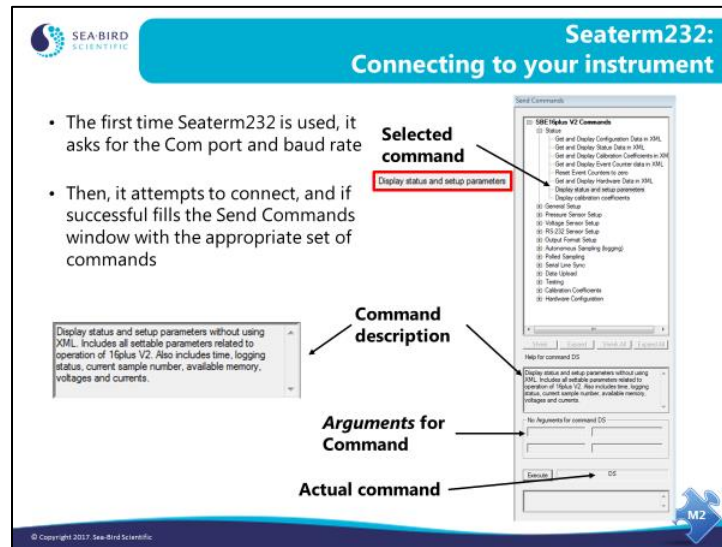


Seaterm232 opens if you select *SBE 19plus V2* in SeatermV2's Instruments menu. Seaterm232 is compatible with instruments with an RS-232 interface: *16plus V2*, *19plus V2*, *25plus*, *37(-SM, SMP, SMP-IDO, SMP-ODO, SI, SIP, SIP-IDO, SIP-ODO)*, *54*, *63*, and *Glider Payload CTD*. Seaterm485 and SeatermIM have similar menus and functions.

Looking at Seaterm232:

- Menus – For tasks and frequently executed instrument commands.
- Send Commands window – Contains commands applicable to your instrument. The list appears after you connect to the instrument.
- Command/Data Echo window – Commands and instruments responses are echoed here. Title bar of this window shows the current Com port and baud rate.
- Status bar (at bottom) - Shows if Seaterm232 is connected, disconnected, capturing communications to a file, or uploading data from the instrument memory.

Seaterm232 (continued)



Seaterm232 attempts to automatically connect to the instrument through the user-selected Com port and baud rate. If not initially successful, it cycles through all other supported baud rates. When it succeeds, it queries the instrument with a **GetHD** (Get Hardware Data) command, to determine the instrument type and firmware version. XML command files, with each file containing a list of commands for each firmware version of a specific instrument, are installed automatically when you install SeatermV2, and are located in the same directory as SeatermV2. Seaterm232 fills the *Send Commands* window with the appropriate set of commands for the instrument, from the XML command file. Below is a summary of the function of each of the menus:

File: Manually loads an XML command file if it does not load automatically (these files should be installed automatically when you install SeatermV2, and are located in the same directory).

Communications: Configures communications (baud rate and serial port); connects to the instrument; and disconnects from the instrument (releases the serial port so you can run another program, such as Seasave, without exiting Seaterm232).

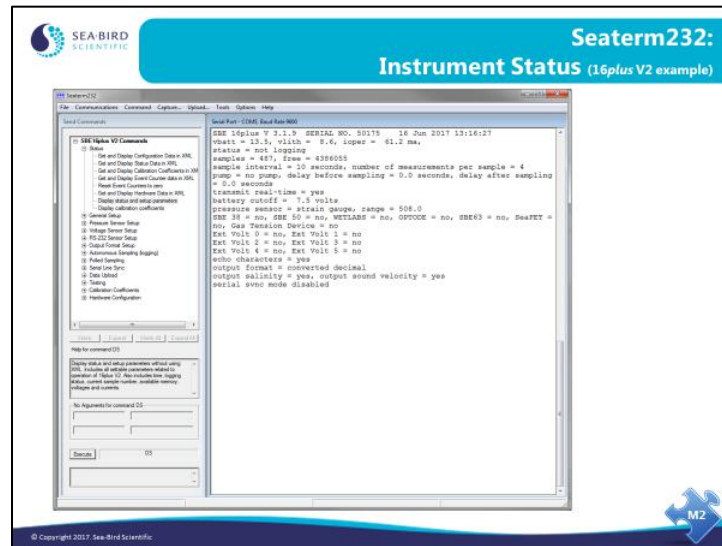
Command: Interrupts and stops instrument response to a command; sends a stop command to stop logging; sets date and time based on user-supplied software running on your computer; and sends a 5-second break (useful for instruments sampling in Serial Line Sync mode).

Capture: Causes Seaterm232 to write everything received from the instrument to a file (useful for some real-time operations and for diagnostics).

Upload: Starts the protocol for transferring data from the instrument's memory to your computer.

Tools: Starts a protocol for saving diagnostic information to a file that you can e-mail to Sea-Bird; converts data from an SBE 37 (so it can be processed with SBE Data Processing); and sends an XML script to the instrument (allowing automation of programming a number of instruments with the same setup).


Seaterm232 (continued)



The instrument status report contains much valuable information:

- Instrument type, firmware revision, serial number, and date and time.
- Main battery voltage and back-up battery voltage. Operating current, pump current, and current to external voltage sensors provide an indication of the battery lifetime you can expect, as well as the health of the instrument in general.
- The status entry indicates whether the instrument is logging data or not.
- The number of scans to average sets the sample rate.
- Memory: scans collected, number of scans that can fit in the remaining memory, and the number of casts collected.
- The 19plus V2 can operate in profiling or moored mode. In profiling mode it is powered continuously, while in moored mode it powers down between samples. The 19plus V2 waits until the conductivity sensor's frequency rises, indicating that there is water in the cell, to turn on the pump. The threshold for the pump turn-on is the *minimum conductivity frequency* (see next page for more information). In addition, there is a time delay from when that frequency is reached to the pump turn-on, to allow air to leave the plumbing.
- If the 19plus V2 is set to autorun=yes, it starts logging automatically when external power is applied. If the 19plus V2 is set to ignore its magnetic switch, it can only be made to collect data via commands sent by a terminal program.
- Battery type can be Alkaline, NiMH, or Ni-Cad. Battery type influences the cutoff voltage, which is the power level that causes the instrument to shut itself off because it does not have sufficient power to sample.
- Pressure sensor type and range are entered at the factory.
- Which auxiliary sensor channels are enabled and logged with the CTD data.
- Whether to show entered commands on screen as you type.
- Output data format.

Calculating Memory Capacity (*continued*)



Memory Capacity in Time for Internal Recorders

- Sample rates:
 - SBE 19 = 2 scans / second or less
 - SBE 19*plus* and 19*plus* V2 = 4 scans / second or less
 - SBE 25 = 8 scans / second or less
 - SBE 25*plus* = 16 scans / second

$$\text{Memory Endurance In Seconds} = \frac{\text{Memory Capacity In Scans}}{\text{Sample Rate}}$$

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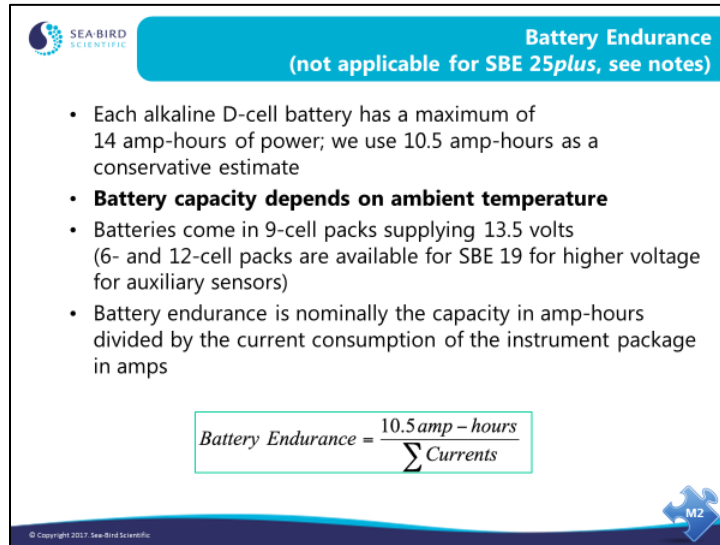
M2

Memory endurance in time is the ratio of memory capacity in scans divided by the instrument sample rate.

- The SBE 19 sample rate can vary from 2 samples per second to 4 minutes between samples.
- The SBE 19*plus* and 19*plus* V2 sample rate is 4 Hz (4 samples per second); however, you can average between 1 and 32767 samples, for a range of 0.25 seconds to 2.3 hours between samples stored in memory.
- The SBE 25 samples at 8 Hz and can average between 1 and 8 scans, for a range of 0.125 seconds to 1 second between samples stored in memory.
- The SBE 25*plus* samples at 16 Hz, for 0.0625 seconds between samples stored in memory.

Full memory? All of these CTDs continue to take measurements, but they **will not record the new data or overwrite the data that is already in memory**. If you are transmitting real-time data, they will transmit the data.

Calculating Battery Endurance



Battery Endurance
(not applicable for SBE 25*plus*, see notes)

- Each alkaline D-cell battery has a maximum of 14 amp-hours of power; we use 10.5 amp-hours as a conservative estimate
- **Battery capacity depends on ambient temperature**
- Batteries come in 9-cell packs supplying 13.5 volts (6- and 12-cell packs are available for SBE 19 for higher voltage for auxiliary sensors)
- Battery endurance is nominally the capacity in amp-hours divided by the current consumption of the instrument package in amps

$$\text{Battery Endurance} = \frac{10.5 \text{ amp-hours}}{\sum \text{Currents}}$$


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Battery endurance is difficult to estimate, because a battery's life depends on the ambient temperature. Moreover, batteries tend to lose their capacity as they age. The information on this slide is a good rule of thumb for alkaline batteries. However, for critical work, consider that batteries are cheap, so you might as well start with a new set.

Note for SBE 25*plus*:

The SBE 25*plus* has a 12-cell battery pack with a nominal capacity of 18.6 Amp-hours; Sea-Bird recommends using a conservative value of 14 Amp-hours.


Calculating Battery Endurance (*continued*)




Battery Endurance Examples

- SBE 19*plus* V2
 - 0.070 amps for the SBE 19*plus* V2
 - 0.100 amps for the SBE 5M pump
 - Maximum sampling time
 $\approx 10.5 / (0.070 + 0.100) \approx 61$ hours

- SBE 25 (with SBE 43 Dissolved Oxygen Sensor)
 - 0.19 amps for the SBE 25
 - 0.15 amps for the SBE 5T pump
 - 0.006 amps for the SBE 43
 - Maximum sampling time
 $\approx 10.5 / (0.19 + 0.15 + 0.006) \approx 30$ hours





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Where do you find the information on current draws? See the specifications in the CTD manual for the CTD and pump; see Sea-Bird brochures / specification sheets for any auxiliary sensors (such as the SBE 43, etc.). For any *third party* sensors (such as a WET Labs fluorometer, Teledyne Benthos altimeter, etc.), see the brochure / specification sheet provided by the manufacturer. **You must include all of the current draws for all of the sensors being powered by the CTD.**


Activity: Setup SBE 19plus V2 and Collect Some Data

1. Click Start / Programs / Sea-Bird / SeatermV2 (not Seaterm!).
2. In SeatermV2: select *SBE 19plus V2* in Instruments menu. Seaterm232 appears.
3. In Seaterm232 (if this is the first time you using the software): Verify COM port matches computer connection and baud=9600, and click *OK*.
 - Seaterm232 should automatically connect and fill the Send Commands window.
4. Type in the commands below (upper or lower case, it does not matter) or send commands using the Send Commands window. **The 19plus V2 prompts you to enter some commands twice.**

<i>Send Commands</i> CATEGORY	COMMAND	DESCRIPTION
General Setup	OutputExecutedTag=y or OutputExecutedTag=1	Enable output of executing and executed tags, making it easier to use the Send Commands window to transmit commands.
	BatteryType=alkaline	Alkaline batteries in housing.
	InitLogging	Reset memory, so data recording starts at beginning of memory.
Pressure & Voltage Setup	Volt0=N or Volt0=0	No auxiliary sensor 0 installed. Note: We disabled all other auxiliary sensors for you for this activity.
Output Format Setup	OutputFormat=2	Transmit raw data as decimal numbers; needed for next step.
Polled Sampling	TS	Request 1 scan of data. Conductivity frequency (Hz) is second number in output; this is the zero (dry cell) frequency. Use this frequency below when setting pump start frequency.
Profiling Mode Setup	MP	Set to profiling mode.
	NAvg=1	Set number of scans to average to 1, to record and transmit at 4 Hz.
	IgnoreSwitch=N or IgnoreSwitch=0	Enable magnetic switch to start and stop logging.
	MinCondFreq=CCCC	Set pump start frequency to: [zero conductivity frequency (from TS) + 500] (i.e., add 500 to zero conductivity frequency, and use that number in place of CCCC)
	PumpDelay=60	Set pump start delay to allow time for air to leave the plumbing.
Output Format Setup	OutputFormat=0	Transmit raw data as hexadecimal numbers; needed for Seasave (later!).
Status	DS	Verify setup.

5. Move the magnetic switch to ON.
6. When you get bored, move the magnetic switch to OFF.

Activity (*continued*)




Activity (*continued*)

When done with the setup, the status (DS) response should look like this (items not shown in bold may vary):

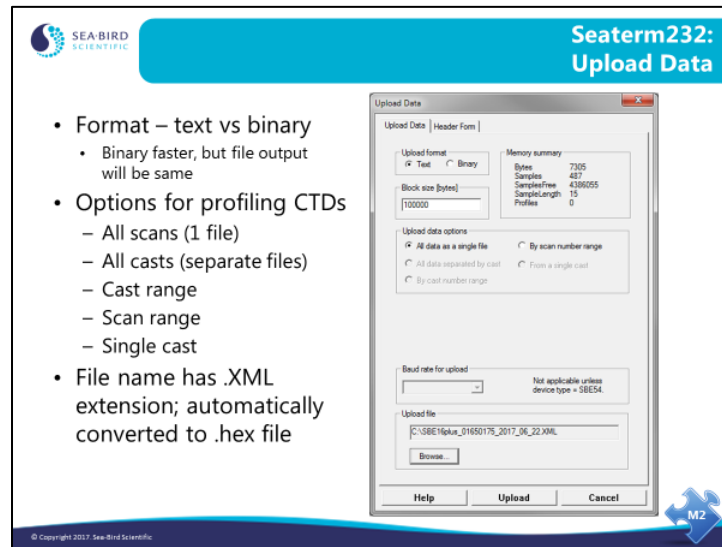
SeacatPlus V 2.5 SERIAL NO. 4000 24 Jan 2011 14:02:13
vbatt = 10.1, vllth = 8.9, ioper = 61.9 ma, lpump = 20.8 ma, lext01 = 76.2 ma,
status = not logging
number of scans to average = 1
samples = 0, free = 5981649, casts = 0
mode = profile, minimum cond freq = 3500 *, pump delay = 40 sec
autorun = no, ignore magnetic switch = no
battery type = alkaline, battery cutoff = 7.5 volts
pressure sensor = strain gauge, range = 1000.0
SBE 38 = no, WETLABS = no, OPTODE = no, SBE63 = no, Gas Tension Device = no
Ext Volt 0 = no, Ext Volt 1 = no
Ext Volt 2 = no, Ext Volt 3 = no
Ext Volt 4 = no, Ext Volt5 = no
echo characters = yes
output format = raw HEX

Minimum conductivity frequency varies from instrument to instrument; should equal the zero conductivity frequency + 500 for standard seawater applications



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Transferring Stored Data



- Format – text vs binary
 - Binary faster, but file output will be same
- Options for profiling CTDs
 - All scans (1 file)
 - All casts (separate files)
 - Cast range
 - Scan range
 - Single cast
- File name has .XML extension; automatically converted to .hex file

When you click the Upload menu in Seaterm232, you start a process that produces an upload file that is compatible with our data processing software (SBE Data Processing).

Upload Format: Seaterm232 can upload in text or binary. Binary is approximately twice as fast; the resulting output file is the same, regardless of which upload method you use.

Upload Data Options: Data from an internally recording profiling instrument can be transferred to your computer in one of the following ways:

- **All scans:** All scans in instrument are uploaded into 1 file.
- **All casts:** All casts stored in instrument are uploaded; each cast is in a separate file identified by a 3-digit cast number appended to uploaded file name. If user header information is to be added, Seaterm232 prompts for it before uploading each cast.
- **By cast range:** Enter range. If user header information is to be added, Seaterm232 prompts for it before uploading each cast.
- **By scan range:** Enter range. Useful when data is not arranged in casts or only part of a cast is desired.
- **Single cast:** Enter cast number.


Upload file: After Seaterm232 completes the upload to the .XML file, it automatically converts to a .hex file, which is compatible with Seasave and SBE Data Processing.

(XML is a *language* that is both human- and computer-readable. Software can recognize data fields more easily in XML. For example, the 19plus V2 **GetCD** status command outputs '<PumpDelay>40</PumpDelay>' to define the pump delay; there is an opening and closing tag, so there is no ambiguity on the value, and the line location in the response does not affect data readability. In contrast, the **DS** command outputs 'pump delay = 40 sec' on a line with other information; if Sea-Bird changes the location of that line within the response, any software *reading* the response would have to be updated to find the new location.)

Note on Calibration Coefficients: The .XML file and .hex file contain raw data – frequencies and voltages from the sensors. Calibration coefficients are applied in post-processing, using the instrument configuration (.xmlcon or .con) file, to convert the output to engineering units (°C, S/m, etc.). The 19plus V2 can also output real-

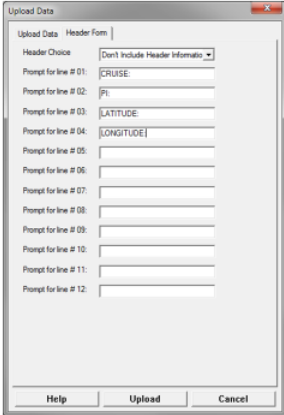
time data in engineering units, using the calibration coefficients programmed into the instrument; these do not affect the raw data that is uploaded from memory.


Transferring Stored Data (*continued*)



**Seaterm232:
Header Information**

- User defined form
- Prompt for header info
 - A form with user-entered prompts (shown in dialog box) is presented during upload of each data file
- Include default header
 - Places the same user-entered header (shown in dialog box) in all data files
- Don't include header
 - No user header is inserted in data files





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Now we are looking at the Header Form tab from the dialog box shown in the previous slide. User headers may be placed in uploaded data files, to provide more details about the conditions of the cast.

- If *Prompt for Header Information* is selected, the prompts are used to guide the user's file entries as each cast is uploaded.
- If *Include default header* is selected, these are the only entries that will be added to each file's header; the default entries should reflect more complete information.

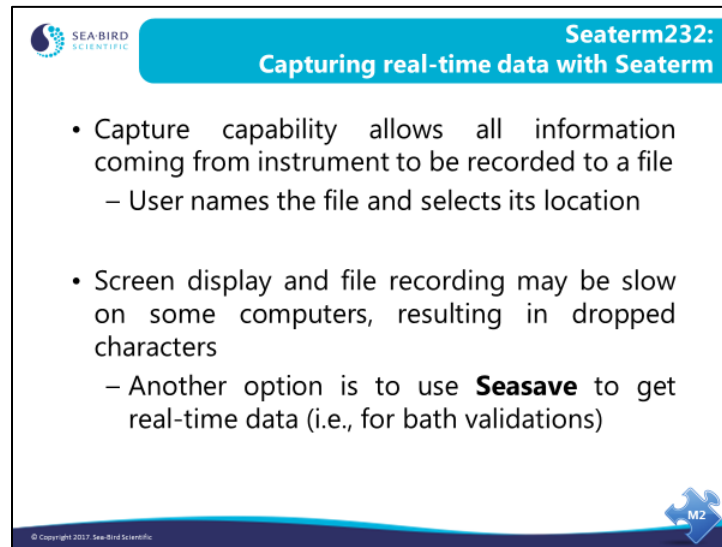
Activity: Transfer Data from CTD to Computer

1. Turn off the magnetic switch if you have not already done so. **You must stop logging data before you upload data.**
2. Click Start / Programs / Sea-Bird / Seaterm**V2** (not Seaterm!).
3. In SeatermV2: select *SBE 19plus V2* in Instruments menu. Seaterm232 appears.
4. In Seaterm232, click Upload menu.
 - A. In Save As dialog box: save the data in your C:\Data folder with name *intrec* (i.e., C:\Data\intrec.xml), and click *Save*.
 - B. In Upload Data dialog box: select *All data as a single file*, make other selections as desired, and click *Upload*.
5. Look in C:\Data. You should see 2 files: intrec.xml and intrec.hex. Seaterm232 automatically converted the uploaded data in intrec.xml into a .hex file, which is compatible with Seasave and SBE Data Processing.

Note:

- Seaterm232 provides a default file name in the Save As dialog box, which includes the instrument type, instrument serial number, year, month, and day. In this activity, we are not using the default file name, but in a real deployment you may find it useful.

Capturing Real-Time ASCII Data




The slide features the SEA-BIRD SCIENTIFIC logo in the top left corner. The title 'Seaterm232: Capturing real-time data with Seaterm' is displayed in a blue header bar. The main content consists of two bullet points with sub-points. In the bottom right corner, there is a blue puzzle piece icon labeled 'M2'. At the bottom left, a small copyright notice reads '© Copyright 2017 Sea-Bird Scientific'.

- Capture capability allows all information coming from instrument to be recorded to a file
 - User names the file and selects its location
- Screen display and file recording may be slow on some computers, resulting in dropped characters
 - Another option is to use **Seasave** to get real-time data (i.e., for bath validations)

The capture capability allows Seaterm232 to place all characters received into a file. This is useful for testing instruments, performing diagnostics, or in some cases recording real-time data. Note that there is no testing of data integrity and the act of displaying the characters on the screen while they are being written to a file may cause some characters to be lost.


Using Internally Recording Instruments for Real-Time Applications



Real-Time Data With Internally Recording Instruments


- SBE 19, *19plus*, *19plus V2*, 25, or *25plus* may be used for real-time data; casts are recorded in instrument memory as well as on a computer by Seasave
- One method is to connect CTD directly to computer
 - For 1600 m sea cables and low baud rates (600 baud)
 - SBE 19 requires optional optical isolation for communication lines
- Another method is to deploy CTD with:
 - SBE 33 Deck Unit and SBE 32 Carousel Water Sampler, or
 - SBE 33 Deck Unit and SBE 55 ECO Water Sampler, or
 - SBE 36 Deck Unit and PDIM
 - For 10,000 m sea cables

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SBE 19s may be outfitted with high power cable drivers and optical isolation for transmitting real-time data. The SBE *19plus*, *19plus V2*, 25, and *25plus* come standard with this equipment. With the addition of a Deck Unit and associated underwater equipment listed above, the data telemetry is the same as discussed for the SBE *911plus*.


Using Internally Recording Instruments for Real-Time Applications (*continued*)



Real-Time Data With Internally Recording Instruments


- SBE 19, 19*plus*, 19*plus* V2, 25, or 25*plus* may be used for real-time data; casts are recorded in instrument memory as well as on a computer by Seasave
- One method is to connect CTD directly to computer
 - For 1600 m sea cables and low baud rates (600 baud)
 - SBE 19 requires optional optical isolation for communication lines
- Another method is to deploy CTD with:
 - SBE 33 Deck Unit and SBE 32 Carousel Water Sampler, or
 - SBE 33 Deck Unit and SBE 55 ECO Water Sampler, or
 - SBE 36 Deck Unit and PDIM
 - For 10,000 m sea cables

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Unlike the SBE 19 and 25, the SBE 19*plus*, 19*plus* V2, and 25*plus* **do not** have to be asleep when you move the magnetic switch to the On position.


Using Internally Recording Instruments for Real-Time Applications (*continued*)



Real-Time Data For Internal Recording With Water Sampling

- Water sampling requires SBE 33 Carousel Deck Unit and interface option in SBE 32 Carousel Water Sampler
 - Interface option in SBE 32 provides power at underwater package and telemetry similar to *9plus*
 - Allows data transmission over 10 km sea cables
- Or, use SBE 33 Carousel Deck Unit with standard SBE 55 ECO Water Sampler; same capabilities as SBE 33 / SBE 32 system described above

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The SBE 19, *19plus*, *19plus V2*, *25*, and *25plus* can be equipped with water sampling equipment. The SBE 33 Carousel Deck Unit and SBE 32 Carousel (or SBE 55 ECO) provides power and telemetry for the CTD very similar to the *11plus* / *9plus* setup. In addition to water sampling, this equipment allows data telemetry over 10 km of sea cable and supplies more than enough power for the CTD and auxiliary sensors.

