

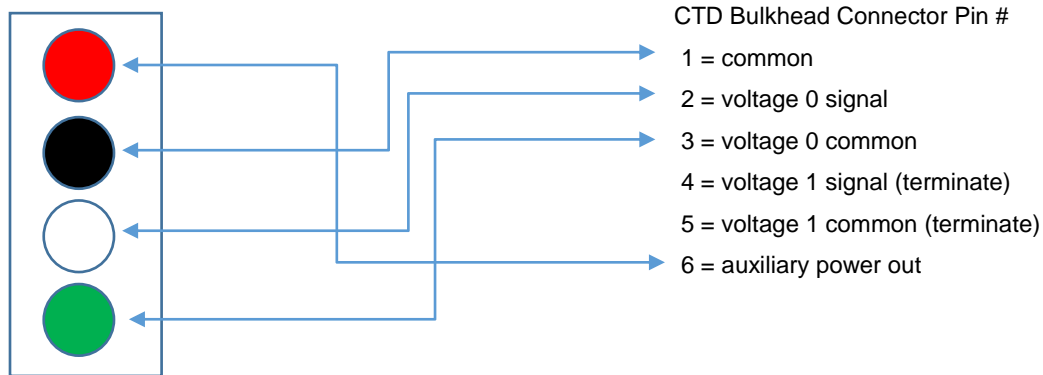
Sea-Bird Electronics CTDs are capable of accepting a 0-5 volt analog signal through an auxiliary port on the instrument enabling it to record data from a Turner Designs C-Sense pCO<sub>2</sub> sensor. Fundamental to this operation is the cable connecting the C-sense to the CTD. For clarity, the auxiliary port that will be used on the Sea-Bird CTD is a “differential input”.

## Cabling

Below is a diagram of the pin outs for the necessary cable.

C-sense Pigtail wire color	Function	CTD Connection
Red	Supply Voltage: 6-12 VDC	Auxiliary Power Out
Black	Supply Ground: 0 VDC	Common
White	Positive Signal to CTD: 0-5 VDC	Voltage 0 signal
Green	Negative Signal to CTD: 0 VDC	Voltage 0 common

C-Sense Pigtail



The connector that interfaces to the Sea-Bird bulkhead auxiliary differential input is an AG206-FS from Impulse. The other end of the cable, native to the C-sense, will have 4 pins plus an alignment pin. This connector is a MCIL-4-FS from Impulse. Be sure to terminate the unused wires for the voltage 1 signal and voltage 1 common as they will not be used.

## Configuration of CTD to Measure External Voltages

In addition to creating the proper cable, the CTD has to be configured to record the analog output of the C-Sense. This can be done with Sea-Bird's terminal software, SeaTerm. The example below is from the configuration of an SBE19. After connecting to the CTD with SeaTerm, execute the following commands, (CR) = carriage return.

```
S>DS(CR)
```

The response from the instrument will look something like the following.....

```
# SEACAT PROFILER V21321-3.1d SN 2848 03/12/14 13:18:41.698
# strain gauge pressure sensor: SN = 193017, range = 500 psia, tc = -105
# clk = 32768.305 iop = 177 vmain = 10.8 vlith = 4.8
# mode = MOORED
# sample interval = 60 seconds
# delay before measuring voltages = 4 seconds
# samples = 485 free = 114978 lwait = 0 msec
# SW1 = C8 battery cutoff = 7.3 volts
# number of voltages sampled = 0
# logdata = NO
```

Notice the “# number of voltages sampled = 0” message declaring that no external voltages will be sampled. Some Sea-Bird CTDs have multiple differential input ports. In this case, voltages 0 and 1 are associated with endcap connector Auxiliary Differential Input 0, 1, and voltages 2 and 3 are associated with endcap connector Auxiliary Differential Input 2, 3. If you have more than one Auxiliary Differential Input on your CTD, you will need to determine which bulkhead connector is available to you, and which voltages are associated with that connector.

Execute the following command to instruct the CTD to sample an external voltage.

```
SBE19 command: S>SV2 (CR)
```

Result: This command instructs the CTD to sample two external voltages, 0 and 1. With an SBE19, valid inputs are 0, 2, and 4. There is no way to tell the SBE19 to sample only one voltage.

Execute the following command to confirm the changes took effect.

```
S>DS(CR)
```

The response from the instrument will look something like the following.

```
# SEACAT PROFILER V21321-3.1d SN 2848 03/12/14 13:18:41.698
# strain gauge pressure sensor: SN = 193017, range = 500 psia, tc = -105
# clk = 32768.305 iop = 177 vmain = 10.8 vlith = 4.8
# mode = MOORED
# sample interval = 60 seconds
# delay before measuring voltages = 4 seconds
# samples = 485 free = 114978 lwait = 0 msec
# SW1 = C8 battery cutoff = 7.3 volts
# number of voltages sampled = 2
# logdata = NO
```

Notice that the “number of voltages sampled” now equals 2.

The example below is for the configuration of an SBE 19 Plus V2 CTD.

```
SBE19 plus V2 command: S>VOLT0=Y
```

Result: With the SBE19 plus V2, you can instruct the CTD to sample voltage 0 only. Check the status of the instrument with a “DS” command before and after execution to verify the changes took effect.

## Sea-Bird SBE Data Processing

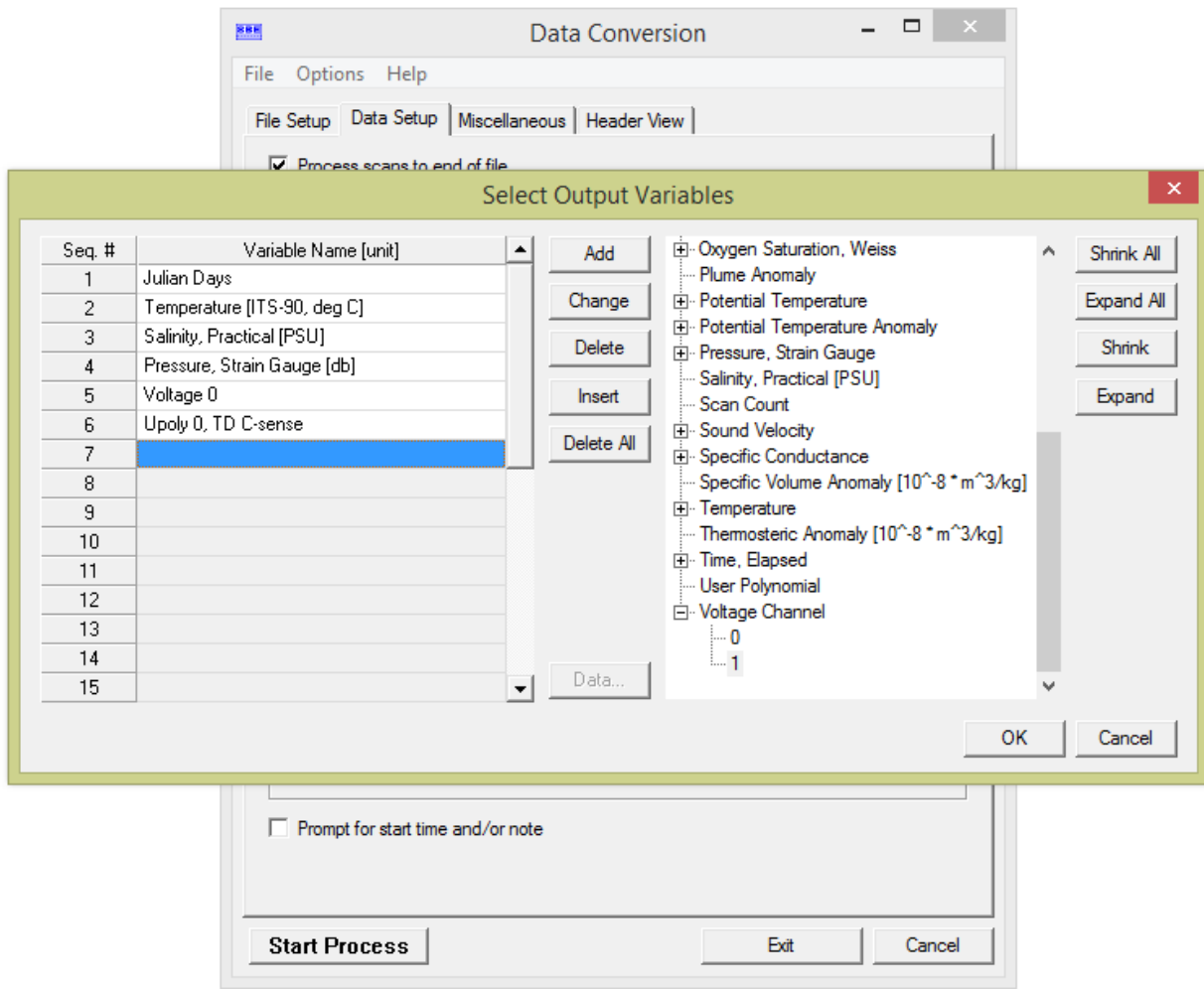
These steps are necessary ONLY if you need the raw voltages converted to ppm by Sea-Bird software. After enabling the CTD to measure external voltages, those voltages will be written to the \*.hex file and can be converted to engineering units of ppm with a simple  $y = mx + b$  calculation.

### 1) Modifying the \*.xmlcon file

- Open SBE Data Processing. Click on “Run” in the upper left corner and scroll down to the first entry in the list, “Data Conversion”. If this is the first time you have run SBEDataProcessing-Win32, the software will display a dialogue box alerting you to the creation of a default program setup file. Click on “OK”. The “Data Conversion” window will open with 3 tabs at the top, “File Setup”, “Data Setup”, “Miscellaneous”.
- Within the “File Setup” tab, under “Instrument configuration file”, click the “Select” button. A new window will open. Browse to the \*.xmlcon file that came with your Sea-Bird CTD (older versions of con files are simply \*.con instead of \*.xmlcon; consult Sea-Bird to get the latest \*.xmlcon file for your instrument). Highlight this file and then click “Open”. The \*.xmlcon filename you selected will appear in the text box.
- Click on the “Modify” button below the “Instrument configuration file” text box. A new window will open titled “Configuration for the SBE 19 Seacat CTD”.
- Click on the drop down menu next to “External voltage channels” and select “2”. This action will result in two entries being added to the “Channel” list at the bottom of the window, one entry will read “A/D voltage 0”, the other, “A/D voltage 1”. Under the “Sensor” column, these channel entries should be listed as “Free”, unless these channels were previously used for something else.
- Double click on the cell in the “Sensor” column associated with “A/D voltage 0”. A new window will open titled, “Select New Voltage Sensor”. Click on the last entry in the list, “User Polynomial”, then click “OK”. A new window will open titled, “User Polynomial”
- Enter the relevant information representing your C-sense into the text boxes, “Serial Number”, “Calibration Date” and “Sensor Name”. The remaining text boxes are for the calibration coefficients of the C-sense. These values can be read from the calibration sheet that shipped with your instrument. In the text box next to “A0”, enter the offset, and in the text box next to “A1”, enter the slope. Click on “OK” and the “User Polynomial” window will close. On the right side of the remaining window, click on the “Save As” button. Provide a filename representative of the configuration you created with the C-sense coefficients, then click “Save”. Click “Exit” to close the “Configuration for the SBE19 Seacat CTD” window.

2) Using your new \*.xmlcon file to convert data

- Within the “Data Conversion” window, under “Input configuration file”, click on the “Select” button to browse to the \*.xmlcon file you created in step 2.
- Click on the “Data Setup” tab. Select the options that are relevant to the data collected. Most often, you will want to process all scans so the “Process scans to end of file” checkbox should be checked, and the “Scans to skip over” text box should be filled with a 0. Select the “Output format”, either “ASCII” or “Binary”. Select if you want to process data from the upcast and the downcast from the “Convert data from” text box. Confirm the “Create file types” text box is completed with “Create converted data(.CNV) file only”
- Click on the “Select Output Variables” button. The “Select Output Variables” window will open.
- The “Seq. #” column on the left side of the “Select Output Variables” window is representative of which column number that variable will be in the data file. It is customary to have time as the first column so, on the right hand side of the window, grab the scroll bar and scroll down until you see, “Time, Elapsed”. Click on the plus sign next to “Time, Elapsed” and 4 choices will show. Click on “julian days” and it will be highlighted. Click on “Add” in the middle of the window, and “Julian Days” will show on the left side of the GUI next to “Seq. # 1”. Repeat this procedure for the variables of interest. This most often includes, temperature, salinity, and pressure. To write the voltage data from the C-sense to the data file, scroll all the way to the bottom and click the plus sign next to “Voltage Channel”. Numbers representing the aux voltages that were enabled during the pre-deployment configuration of the CTD will appear. In this case, you should see “0” and “1”. If you wired the C-sense to the CTD in the way that was described in the Cabling section, the signal from the C-sense is associated with voltage 0. Highlight “0”, then click “Add”, as you did with other variables. To have converted ppm from the C-sense written to the file, click on “User Polynomial”, then click “Add”. Figure X below shows the GUI with a typical variable list including raw voltages(Voltage 0) and converted ppm data(Upoly 0, TD C-sense) from a C-sense. When all variables of interest are represented, click on “OK”. The following figure shows the SBE Data Processing GUI with a typical set of variables selected for output to the converted \*.csv file, including a timestamp in Julian Days, temperature, salinity, and pressure from the CTD, raw voltage from the C-sense, as well as ppm from the C-sense, denoted by the “Upoly 0, TD C-sense” entry.



**Figure 1:** Screen shot of SBE Data Processing software configured to convert a \*.hex file containing voltages from a C-sense to a \*.csv file. "Voltage 0" is directed as output to the file, as well as converted ppm, represented by the "Upoly 0, TD C-sense" entry.

- Click on the "File Setup" tab.
- Under "Input directory", click on the "Select" button to browse to the \*.hex file you want converted. Under "Output directory" click on the "Select" button to browse to the directory where you want the converted file to land. The contents of the "Name append" text box will be added to the filename after conversion. For example, if you have a \*.hex filename of "station1data.hex" and you enter into the append text box, "\_converted", the resulting filename will be "station1data\_converted.csv". Click on "Start Process". The progress bar informs you of the status of the operation.