Laser Optical Plankton Counter

SOFTWARE OPERATION MANUAL

Brooke Ocean Technology Ltd

50 Thornhill Drive, Unit 11
Dartmouth, Nova Scotia
Canada B3B 1S1

Phone: (902) 468-2928
Fax: (902) 468-1388
E-mail: sales@brooke-ocean.com
www.brooke-ocean.com

The Laser Optical Plankton Counter was developed by Dr. Alex Herman of the Department of Fisheries and Oceans, Ocean Sciences Division, Bedford Institute of Oceanography

Fisheries and Oceans Canada | Pêches et Océans Canada

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1 LOPC SOFTWARE OVERVIEW

The LOPC graphical user interface (GUI) serves four main roles:

1. **Instrument Control**
   The user interface provides the user with a simple interface to control the instrument (LOPC) without knowledge of the underlying instrument or control commands.
2. **Data Acquisition**
   The LOPC software acquires data from the instrument via a serial port and parses the data using a framed, binary byte-stuffing protocol.
3. **Real-time Data Processing and Display**
   Data collected by the software is processed in real-time and graphically displayed for easy interpretation by the user.
4. **Data Playback**
   Raw data files can be replayed for post-cruise observation and analysis purposes.

2 INSTALLATION

2.1 System Requirements for LOPC Data Acquisition Computer

Minimum system requirements:

- PC with a Pentium IV (1 GHz or greater) processor (non-Celeron)
- Microsoft Windows 2000, Service Pack 2 or later
- 256 MB of RAM
- Super VGA Monitor: 1024 x 768 resolution or higher, minimum 16 bit color (65535 colors)
- CD-ROM drive
- 2 GB free hard-disk space (mostly for data collection and storage)
- MS Windows compatible mouse
- Two (2) available serial ports

Recommended system requirements:

- 40GB (or greater) hard-disk
  Long periods of profiling can yield data sets in the order of 100's of MB and even GB's
- CD-R or CD-RW drive
  Data backup
- 3D graphics card with 32MB (or greater) on-board RAM
  Increases computer processing efficiency and graphical "smoothness"

2.2 Software Installation

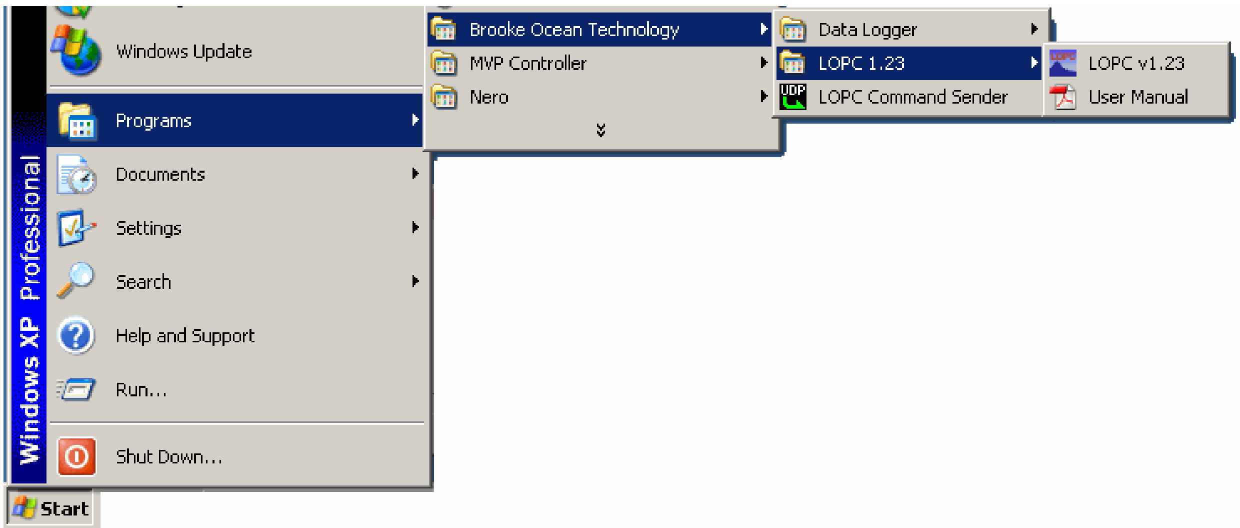
Proper installation of the LOPC software is crucial for correct operation. During installation, the setup program registers components with the operating system and stores various registry keys that the software requires for proper operation.

Installation of the interface software is a three-step process:

Step 1
Insert the LOPC Installation CD and run the **'LOPCvXXX-Install.EXE'** file found on the CD by double clicking on the file.

Step 2
Follow the instructions given by the installation program.

Step 3
Run the software by clicking Start > Programs > Brooke Ocean Technology > LOPC > LOPC



3 DESCRIPTION

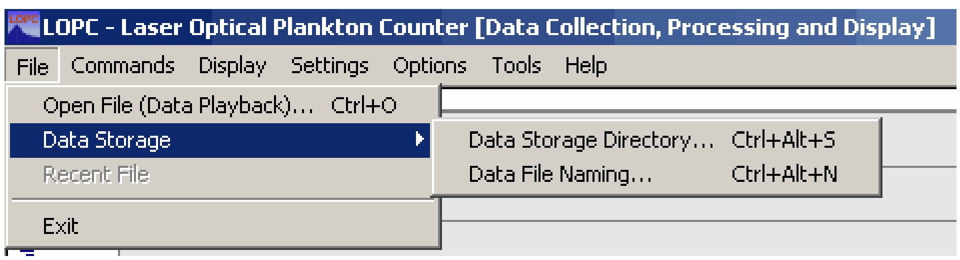
3.1 Main Menu

The main menu provides access to all user configurable options and the various data display features.

NOTE: Menu options that load dialog (popup) windows for further configuration are indicated by the … following the menu option. Also, a menu option followed by ▶ indicates a sub-menu to follow for this selection (see Data Storage menu option in section 3.1.1).

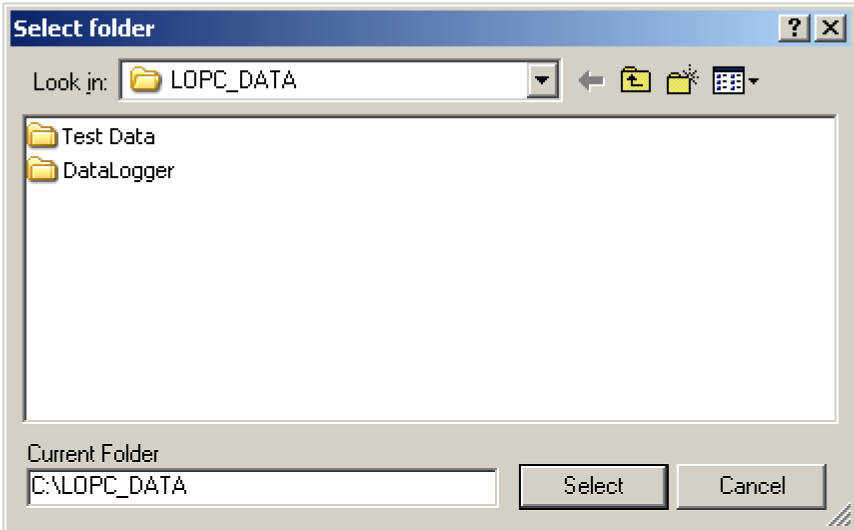
3.1.1 File

The File menu provides data file operations.

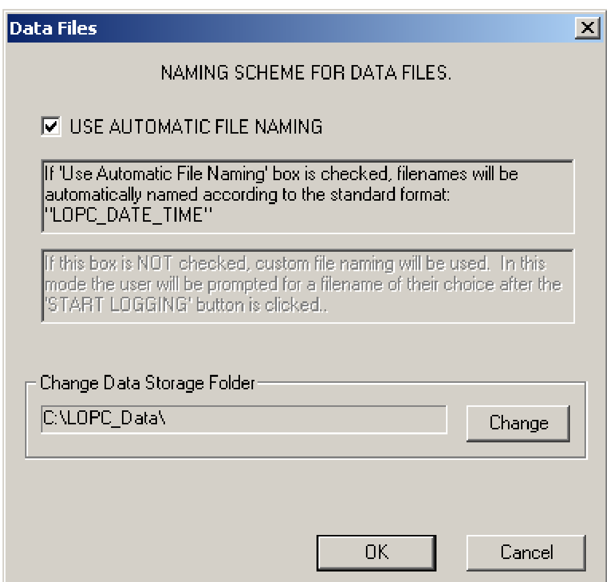


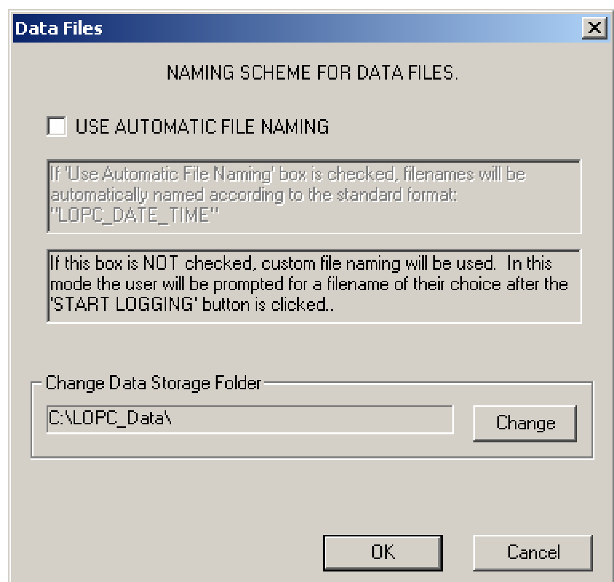
Open File (Data Playback)…
This function allows playback of a previously acquired raw data file. The interface behaves as if real-time data acquisition were in progress with the exception of controlling playback speed. This feature will be discussed in detail in section 7.

Data Storage > Data Storage Directory
Sets the directory/folder where the data files will be stored during data acquisition. The default value of **'C:\'** is configured during installation. To change this, open the **'Data Storage Directory'** dialog window; navigate through the directory structure to find the desired directory (or create a new folder/directory). When the desired folder is found or created, double click it and then click the **'Select'** button to save the selection. Ensure that the correct folder path appears in the **'Current Folder'** window before clicking Select; otherwise, an incorrect folder will be selected.



Data Storage > Data File Naming
A dialog is loaded to configure data file naming properties.





The default naming scheme for LOPC data files is "LOPC_yyyy-mm-dd_hhmmss.bin" - 'year-month-day_HourMinuteSecond' that data collection started for these files [*Data files and their format will be discussed in section 6*]. To enable this naming format, place a checkmark in the **'USE AUTOMATIC FILE NAMING'** checkbox. To use a custom-naming format, uncheck this box and the user will be prompted for a filename when logging is initiated. **DO NOT** add file extensions to the filename (such as .dat or .bin), these will be added automatically during file creation. The data storage directory can also be changed from this dialog by clicking the **'Change'** button and selecting a new data path as previously discussed. The process followed in using custom file naming is discussed in section 5.4.

3.1.2 Commands

The command menu provides a list of commands that may be used to access the instrument directly for control or configuration purposes.

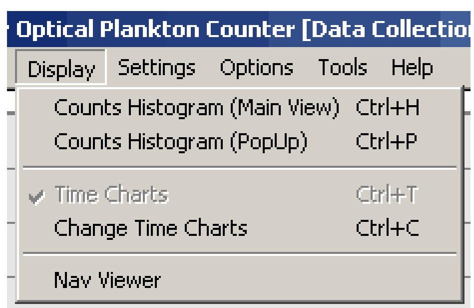
Snapshot > Take Snapshot
Command the instrument to begin taking a snapshot. [*For a description and discussion of snapshots, see section 5.6*] This function is enabled only after scanning has started (i.e., the software has started acquiring data after it informs the instrument to begin scanning); initiated by clicking the **'Start'** button.

Snapshot > Store Snapshot
Command the instrument to store a previously taken snapshot. This function is enabled only after scanning has been stopped.

NOTE: The 'Snapshot' command is a diagnostic tool that provides a troubleshooter with a sample of raw engineering data. This feature in only used when a malfunction is suspected and should only be used at the manufacturers request.

3.1.3 Display

The display menu provides a list of views available within the application. Active views will appear disabled (grayed) in the menu.



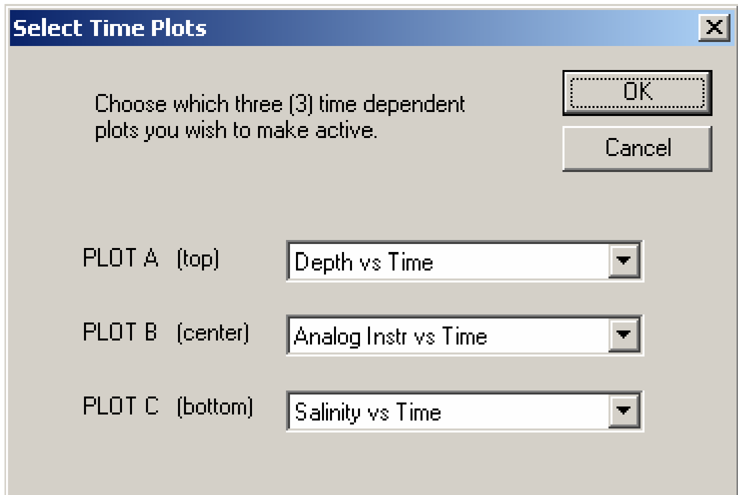
Counts Histogram (Main View)
Load and display the Binned Data view in the main window. [*For a description and discussion of the Binned Data view, see section 3.3*]

Counts Histogram (Popup)
Load and display the Binned Data view in a separate popup window. [*For a description and discussion of the Binned Data popup view, see section 3.6*]

Time Charts
Load and display the Time Charts view in the main window. [*For a description and discussion of the Time Plots view, see section 3.5*]

Change Time Plots

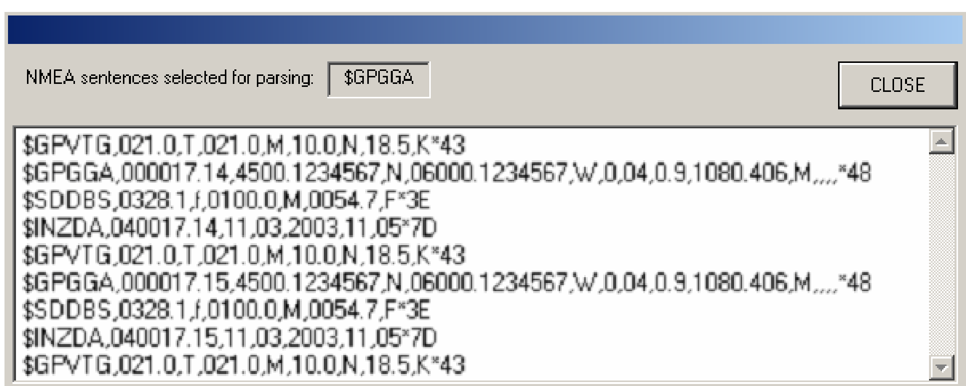
This function loads a dialog box that enables the user to select a desired set of time plots to display. Plots A, B and C are linked to the plots appearing at the top, center, and bottom respectively.



To change one (or all) of the plots displayed, select the new plot from the dropdown list in the desired position. This option is only available when the Time Plots view is active.

Nav Viewer

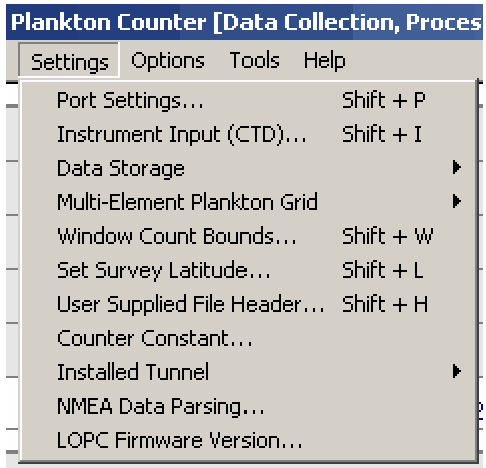
This loads a window that displays a scrolling view of the navigational data (GPS/NMEA) being received. This function will only work when data is being acquired by clicking the ‘Start Acquisition’ or the ‘Start Logging’ buttons.



The “NMEA sentence selected for parsing:“ indicates which NMEA sentence is being used to extract the lat, long and time.

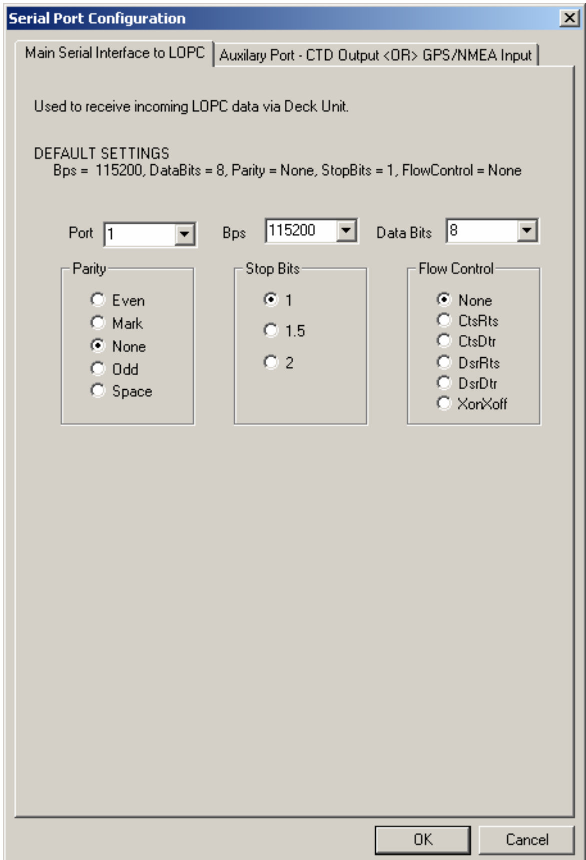
3.1.4 Settings

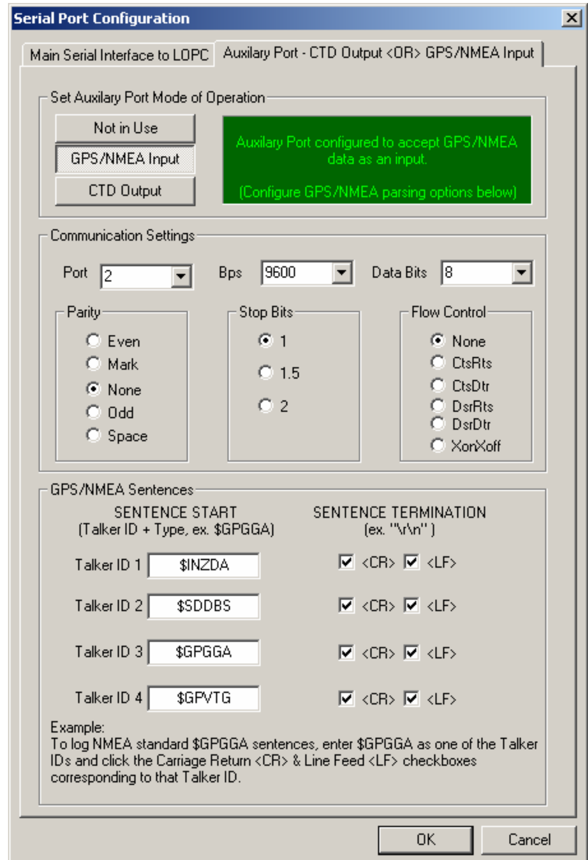
The Settings menu provides access to various program options that may be customized for a particular situation and user preference.



Port Settings…
Configure the serial port communication parameters.

The first time this dialog window is opened, it will contain pre-loaded default values for all parameters. Any changes made will be stored and re-loaded on following runs. The **'Main Serial Interface to LOPC'** port is to be configured to communicate with the Deck Unit interface box which links the LOPC data acquisition computer to the instrument. The **'Auxiliary Port – CTD Output <OR> GPS/NMEA Input'** can be configured as an auxiliary port that can be used to output data to a secondary logging PC (for example, outputting CTD data to a tow body such as a Moving Vessel Profiler – MVP). *Enabled by clicking the* **'CTD Output'** *button*. The Auxiliary Port can also be configured as a **GPS/NMEA** input. Enable by clicking the **'GPS/NMEA Input'** button. If neither option is desired, click the **'Not in Use'** button to disable them.

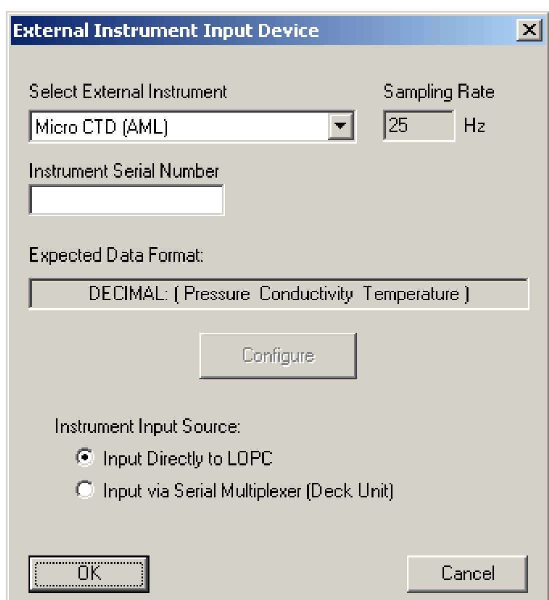




Instrument Input

Select an input instrument, such as a CTD, that is connected to the LOPC (if applicable).

When the model is selected, the sampling frequency of the device is displayed for verification purposes.



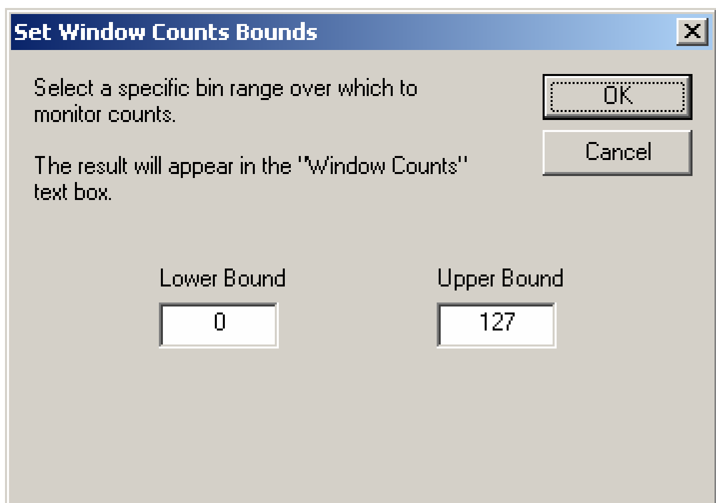
Data Storage > Data Storage Directory
Same as **'Data Storage Directory'** option found under the File menu in section 3.1.1.

Data Storage > Data File Naming
Same as **'Data File Naming'** option found under the File menu in section 3.1.1.

Multi-Element Plankton (MEP) Grid
This sub-menu provides options for controlling the Multi-Element Plankton Grid view [*discussed in section 3.4*].

> Max MEP Length - set the maximum display length of a MEP element
> Grid Scaling Factor - set the scaling factor of the MEP grid
> Disable MEP Grid - disable/enable the MEP Grid. Disabled when checked

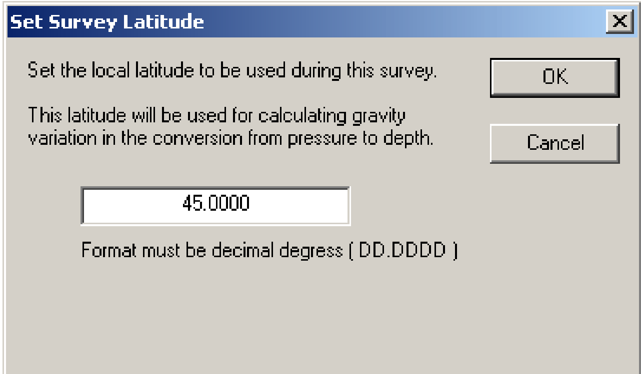
Window Count Bounds
Set the upper and lower bounds on a sub-sample of bins to which the Window Counts textbox on the Control Bar will be attached [*see section 3.2.3*].



Setting a lower and upper bound here allows specification of a sub-sample or range over which to keep a running total of counts detected. The bounds can be set from 0 – 127 (which would give the full range) with each number representing 15 microns. For example, setting the lower bound to 10 and the upper bound to 30 would result in a running total of counts being tracked and displayed in the 'Window Counts' textbox for all counts detected in the 150 – 450 micron range.

Set Survey Latitude

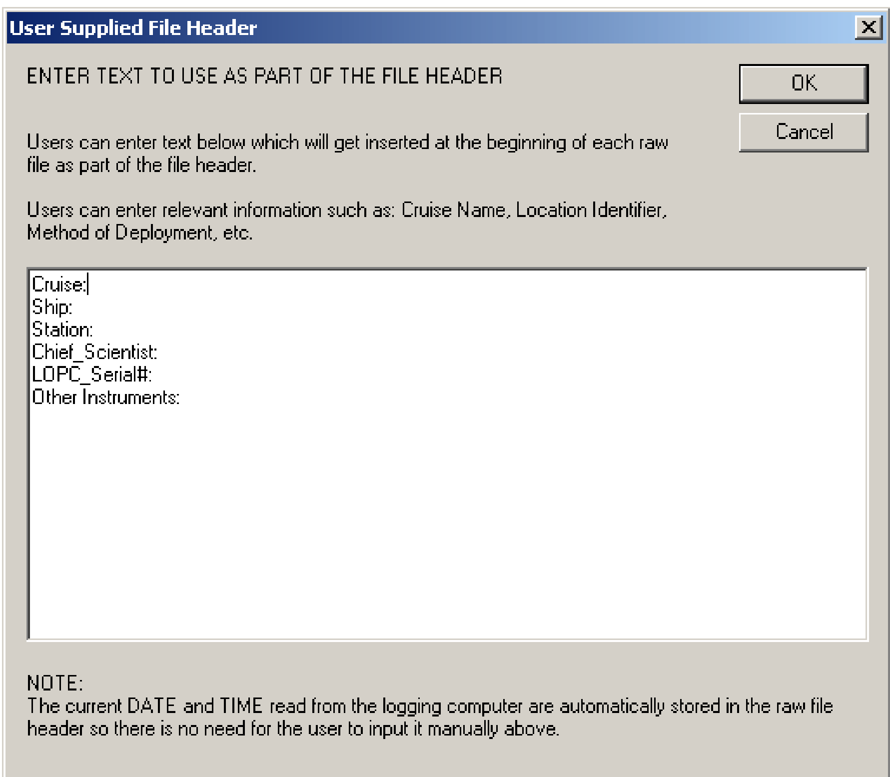
Set the local latitude relevant to the current survey location.



This latitude value is used in calculating the gravity variation applied in the conversion from pressure to depth. This conversion is not applied in the data that is logged, so an incorrect value here will only affect the values displayed on the screen to the user. The actually data stored in the log files is the raw pressure data directly from the CTD.

User Supplied File Header

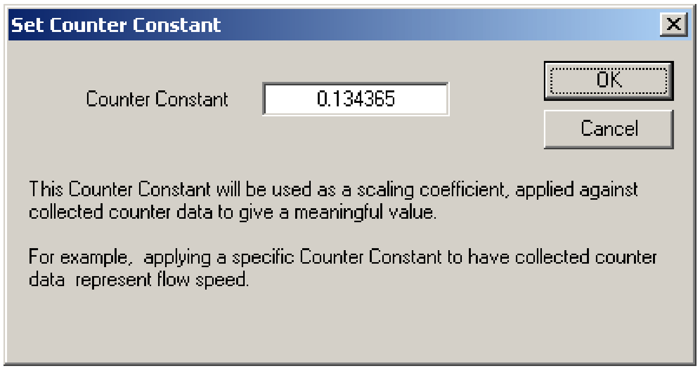
Users can save any text here that they wish to be inserted at the beginning of a raw data file as part of the file header.



The text entered and stored here will appear at the beginning of each raw data file. The date and time of each file creation is automatically entered in the file header and does not need to be entered by the user.

Counter Constant

This option allows configuration of a device-specified counter constant for interpretation of counter data received from an external electronic counter instrument.



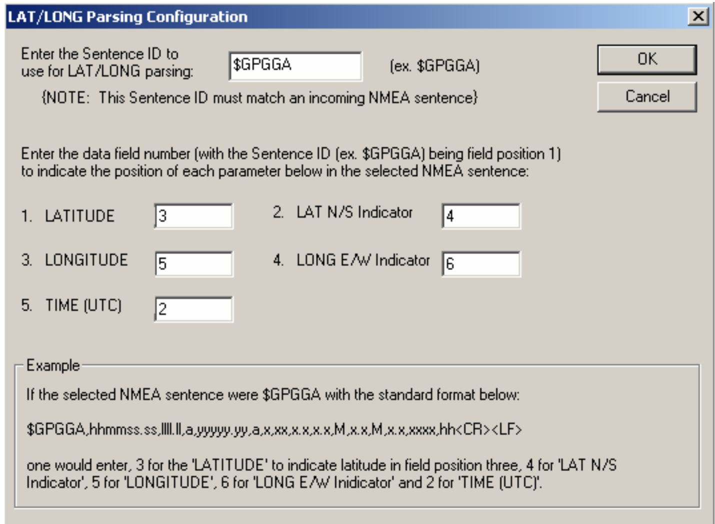
This Counter Constant is used as a scaling coefficient that is applied to collected counter data to give the user a more intuitive value for data display. For example, the Counter Constant shown above is used to convert electronic counter data received from a General Oceanics Flowmeter into a real-time flow speed measurement. For a discussion on calculating the Counter Constant shown above, see Software Appendix II.

Installed Tunnel

This option allows the user to select the appropriate tunnel size for their configuration. The tunnel size parameters will affect certain algorithms such as calculated Flow Rate.

NMEA Data Parsing…

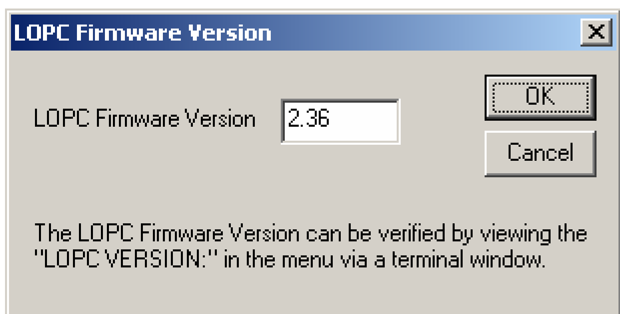
If a NMEA data source is available and is being logged by the LOPC software, this option should be configured to allow extraction and parsing of the Latitude, Longitude, and Time.



Configuration of this option will instruct the software how to extract the lat, long and time for display on the NMEA Data section of the control bar (section 3.2.6).

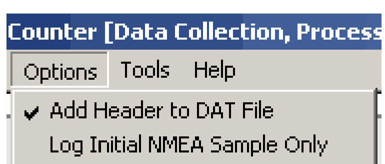
LOPC Firmware Version…

This option should be kept up to date and ensure that it matches the firmware version of your LOPC. The software uses the firmware version to determine the proper data format to expect from this model of LOPC.



3.1.5 Options

The Options menu provides the ability to enable or disable several basic program settings.



Add Header to DAT File

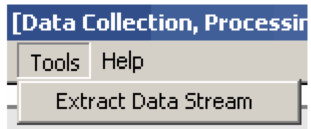
This option (enabled when checked) will instruct the software to write the file header to the parsed ASCII file (*.DAT) as well as the raw binary file (*.BIN). If this option is not checked, the header will be written to the raw binary file only.

Log Initial NMEA Sample Only

With this option checked, only the initial NMEA/GPS sample received is written to file. With this option unchecked, all incoming NMEA/GPS data is logged to file as it is received.

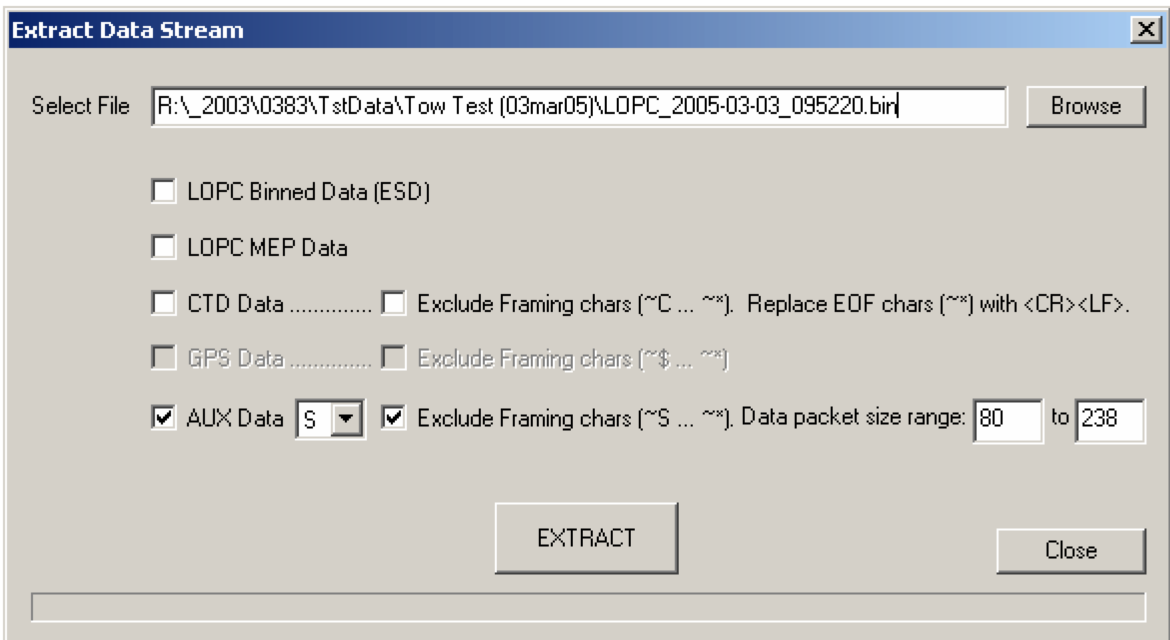
3.1.6 Tools

The Tools menu provides access to supporting LOPC functions. These functions may assist data processing, but are not required for normal system use.



Extract Data Stream

The Extract Data Stream function allows the user to copy a single data stream from a raw binary file to another location. This option is useful in cases where the data collected from a sensor must be processed by a program supplied by the manufacturer.



An example of the Extract Data Stream dialog is shown above. When a binary file is selected, the file is scanned and only those check boxes associated with frames found in the file will be activated. The AUX Data selection contains a drop-down list with all frame types not included in the first four checkboxes.

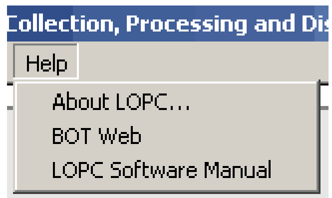
For all frame types other than LOPC SEP and MEP data, the option is available to strip all framing characters inserted by the LOPC. This allows the raw sensor data to be extracted as if it were collected directly from the sensor.

AUX Data extraction allows specification of a size range allowed for the data frames.

- Frames larger than the maximum or smaller than the minimum will be discarded and later reported as dropped.
- Frames smaller than the maximum, but larger than the minimum will be reported as corrupt. The last ‘minimum’ characters will be extracted to the output file.
- If the minimum size is specified as zero, then valid data frames may be any size up to the specified maximum. Larger frames will be dropped.

3.1.7 Help

The Help menu provides access to program details, BOT information, and an online copy of this manual.

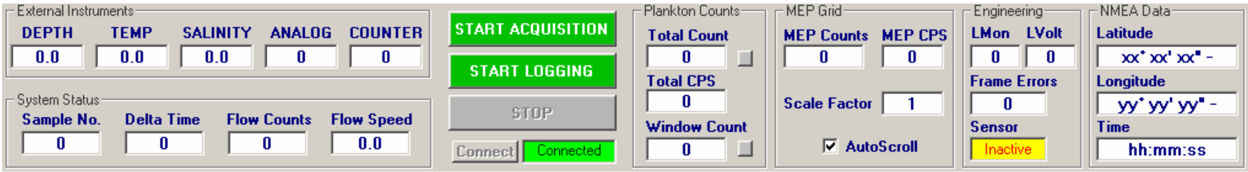


About LOPC
Displays an 'About Box' providing information about the software such as version numbers, contact information, etc.

BOT Web
Loads your default Internet browser and connects to the Brooke Ocean Technology website (if an Internet connection is available).

LOPC Software Manual
Loads a PDF copy of this manual in Adobe Acrobat (if available).

3.2 Control Bar



The Control Bar (found at the bottom of the main window) displays various data streams in real-time, and provides controls for starting and stopping the logging process.

3.2.1 External Instruments

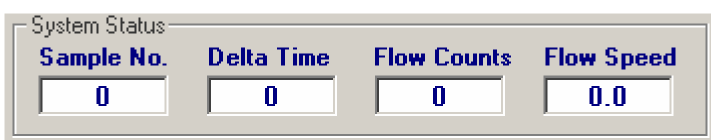
This subsection displays real-time environmental data collected from external instrument inputs, such as a serial CTD, an analog input such as a fluorometer, and an electronic counter input such as a flow meter.

NOTE: The "ANALOG" textbox shown here is reserved for displaying data from the LOPCs own analog channel accessed via the "AUX1" bulkhead connector. Any analog devices connected to external instruments will have their analog data logged, but will not be displayed here.

3.2.2 System Status

This subsection displays engineering data received from the LOPC in half-second intervals.

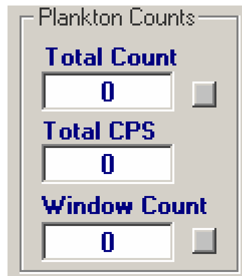
1. **Sample No** – the current sample number received from LOPC.
2. **Delta Time** – the accumulated time-in-beam or the scan time for the Flow Counts below.
3. **Flow Counts** – the total number of plankton detected in a sample that fall within the pre-set size range.
4. **Flow Speed** – this represents an estimation of flow speed of water through the sampling tunnel. This flow speed estimation is calculated using an algorithm that uses the Delta Time and Flow Counts above. By having the number of counts detected in a specified size range (Flow Counts) associated with a 'time of passage' for those detected counts (Delta Time), an estimation of Flow Speed can be determined by applying that ratio to a predefined equation.



3.2.3 Plankton Counts

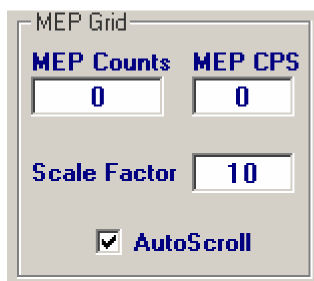
This subsection displays cumulative count data.

1. **Total Count** – the total number of single element plankton detected since starting. The value displayed here may be reset to zero at any time by clicking the button at the right side of the value.
2. **Total CPS** – bug 'Counts per Second'.
3. **Window Count** – the total number of single element bugs detected within the user selected 'Window Count Bounds'. The value displayed here may be reset to zero at any time by clicking the button at the right side of the value.



3.2.4 MEP Grid

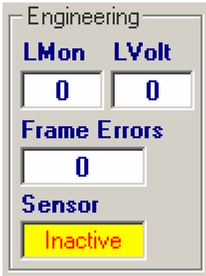
1. **MEP Counts** – the total number of MEP detected since starting
2. **MEP CPS** – the number of MEP counts per second
3. **Scaling Factor** – the MEP Grid Scaling factor
4. **AutoScroll** – enable/disable auto-scrolling for the MEP Grid



3.2.5 Engineering

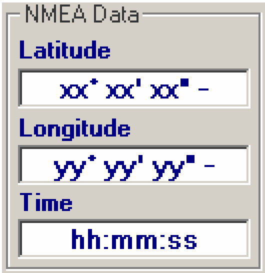
1. **LMon** – LMon (Laser Monitor) is the average laser level (intensity) across all elements.
2. **LVolt** – LVolt is the Laser Voltage required to maintain the preset Laser Monitor value.
3. **Frame Errors** – indicates the number of frame errors detected (if any). Frame errors indicate communication reliability problems. If frame errors are detected, the system should be checked for faulty cables, configuration, or other problems that could be causing the errors.

4. **Sensor** – indicates whether or not the LOPC is active and ready for logging.



3.2.6 NMEA Data

This subsection displays the Latitude, Longitude, and Time from an incoming NMEA sentence that is configured for parsing. See section 4.1.2 for NMEA sentence logging and parsing configuration.

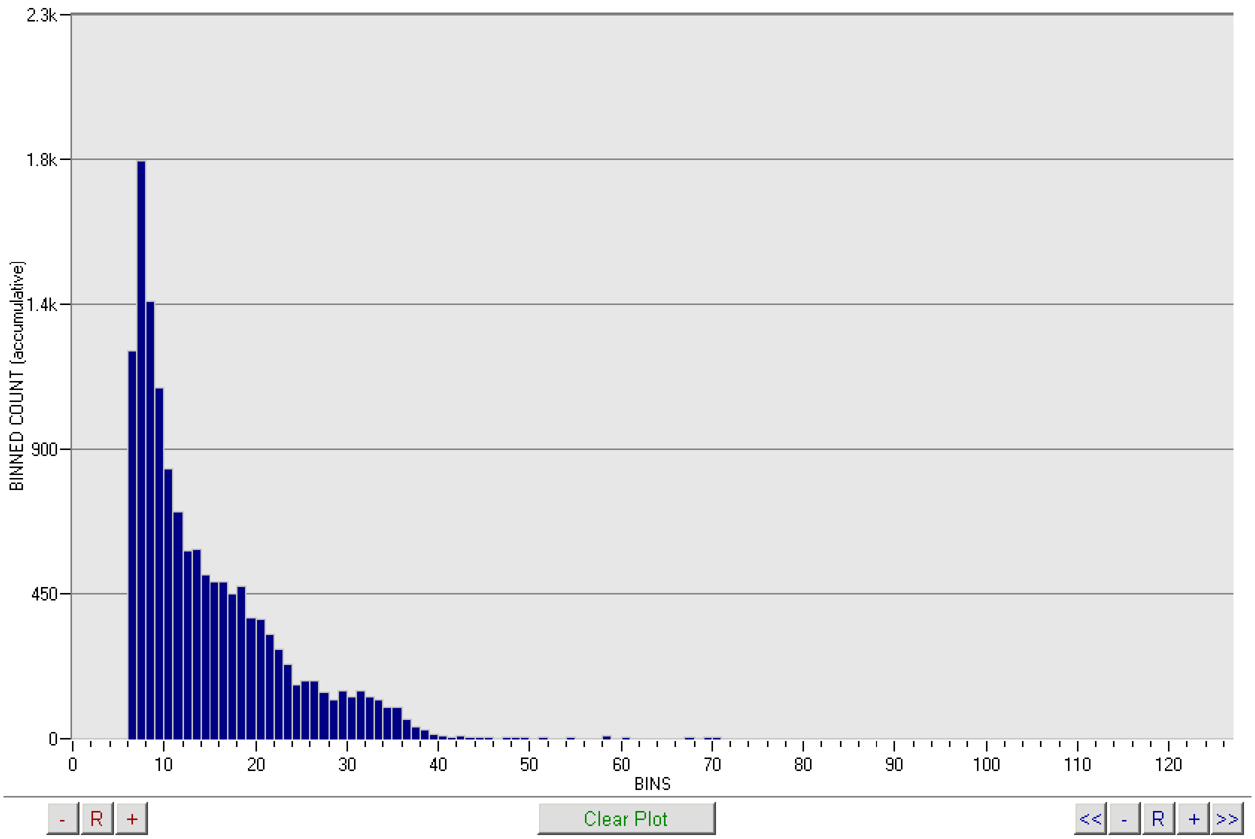


3.2.7 Control Buttons

These Start and Stop buttons are used to start and stop the data collection and logging process. As well as starting and stopping the acquisition software, these buttons control the LOPC data collection by sending the appropriate start or stop command to the instrument. A status window indicates whether a successful serial port connection was established or not. If not, the Connect button is enabled to try again. These will be discussed in detail in the Operation section [*section 5*].

3.3 Binned Data View

The binned data view is the default view when the application starts. An example of this view while the LOPC is operating is shown below.



3.3.1 Plot Histogram

This plot displays a histogram illustrating the cumulative plankton counts over the 128 bins (0 - 127). The plankton counts are summed within individual bins each time new sample data is received.

If the user wishes to concentrate on a specific section of bins (i.e. specific particle sizes), you can do so by zooming in on a section of the plot. To do this, click and hold the left mouse button on the lower bound of the bin range you wish to zoom in on. While holding the left mouse button down, drag the mouse to the right and release the button when the desired upper bound is reached.

3.3.2 Plot Scaling Buttons

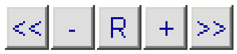
There are several control buttons found along the bottom of the plot that are used to manipulate the plot display.

Y-Axis Scaling 

The **'– '** button decreases the y-axis range (zoom in); the **'+'** button increases the y-axis range (zoom out); and the **'R'** button resets the y-axis to the default.

The **'Clear Plot'** button 

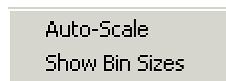
in the center sets all 128 bins to zero. The bins begin accumulating again after the button is clicked. Resetting the plot only applies to the display; the collected data is not affected.

X-Axis Scaling 

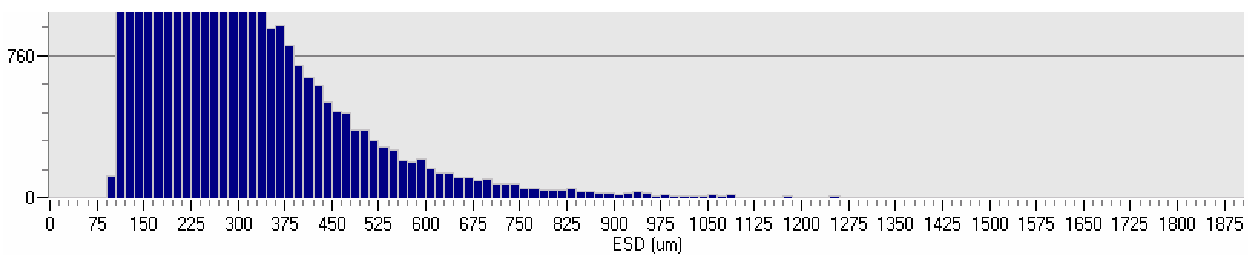
The **'<<'** and **'>>'** buttons pan left and right respectively. Panning only works if the plot is zoomed in on a specific range on bins. The **'-'** and **'+'** buttons decrease the bin range (zoom in) and increase the bin range (zoom out) as with the y-axis buttons above. The **'R'** button resets the x-axis to display all 128 bins.

3.3.3 Context Menu

Right clicking the mouse on the plot window will reveal the context menu for the Binned Data View.



This menu allows the user to toggle the Auto-Scale and Show Bin Sizes or Show Bins features. Auto-Scale enables the plot to automatically scale the y-axis depending on the current plot values. Show Bin Sizes displays the bin sizes (in μm) corresponding with the bin numbers. [Each bin represents 15 microns. For instance, bin 10 would hold all counts detected in the 150 – 175 micron range]

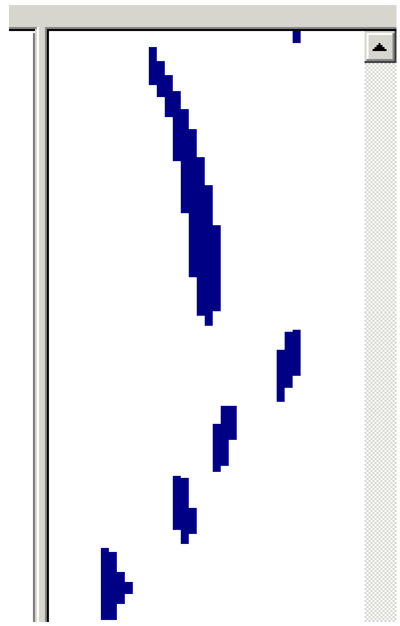


3.4 Multi-Element Plankton Grid View

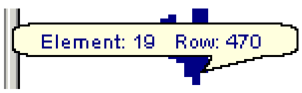
This view displays a graphical interpretation of data collected for Multi-Element Plankton.

3.4.1 MEP Grid

The software accepts raw MEP data received from the LOPC and displays a representation of the data in a grid. This grid is 35 elements wide, representing the 35-element resolution of the LOPC. As new data is received, it is appended to the bottom of the grid. If **AutoScroll** is checked, the grid will automatically scroll up when new data is appended, thus always displaying the most recent data and mimicking the flow of the plankton through the tunnel of the LOPC.



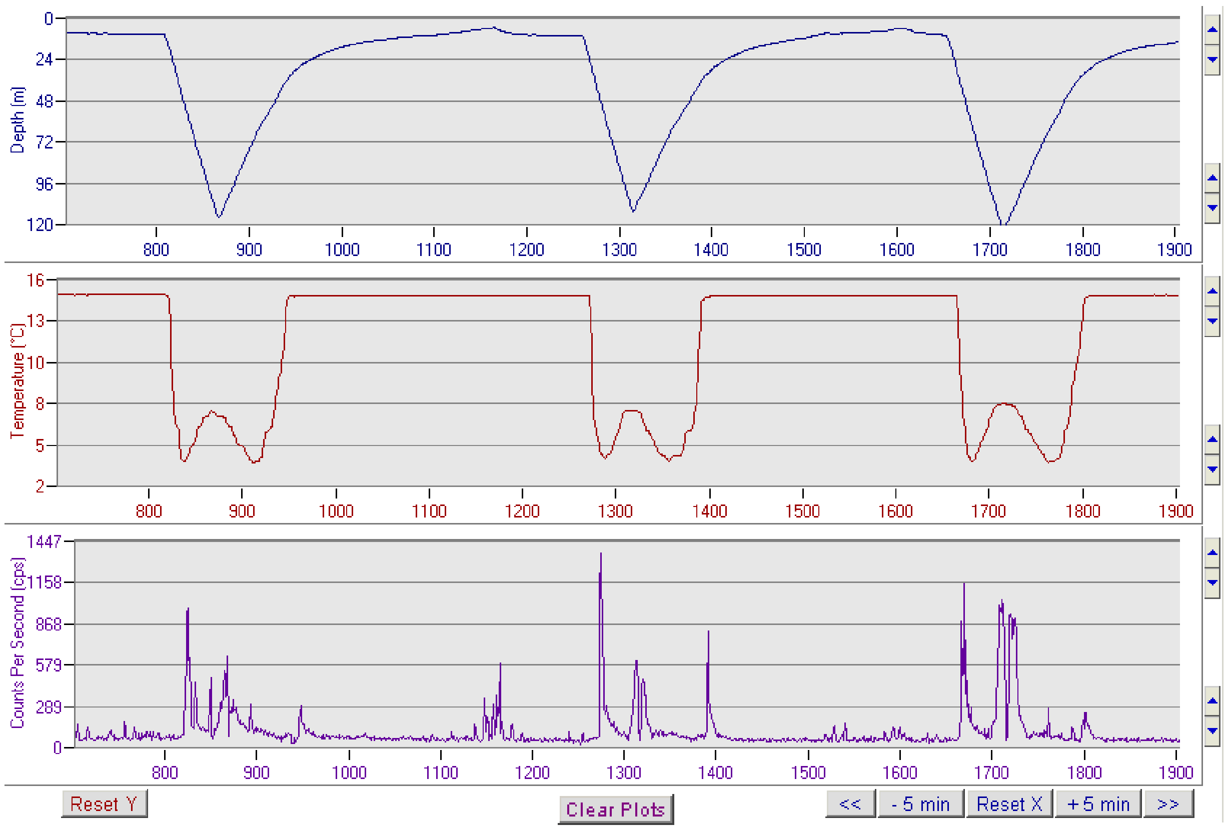
By left clicking the mouse on a section of the grid, a popup window will appear indicating the element number and row of the position clicked.



The shape profiles or outlines shown in the MEP grid represent raw data only, no data processing or interpretation is performed.

3.5 Time Charts View

An example of the time charts view is shown below with Depth vs. Time, Temperature vs. Time, and Counts per Second vs. Time plots displayed.



3.5.1 Charts Description

This view displays a set of three time-based strip charts. The set of charts to be displayed can be changed as per section 3.1.3.

These charts display time on the x-axis (in seconds). The y-axis contains the time/sample-dependent values associated with the respective chart type. The user can zoom in on a y-axis range by clicking and dragging the mouse over the desired sub-section.

The various chart types are:

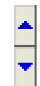
1. Depth vs. Time - extracted from CTD data.
2. Temperature vs. Time - extracted from CTD data.
3. Counts per Second vs. Time - calculated from Binned Data.
4. Salinity vs. Time - calculated from CTD data.
5. Counts per Second vs. Time (window) - calculated from Binned Data window.
6. Counts per Volume vs. Time - calculated from Binned Data.
7. Flow Speed vs. Time - calculated from engineering data.

8. Analog Instrument vs. Time - data from analog device (if connected)
9. Counter Input vs. Time - data from electronic counter device (if connected)

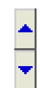
3.5.2 Scaling Buttons

The Reset Y button is used to reset the y-axis. The y-axis will be set to the maximum-minimum values contained within each data set. This button is used to reset a plot's y-axis if it has been previously zoomed in.

The << | - 5 min | Reset X | + 5 min | >> buttons control the X-axis or time scale. The **'<< '** and **'>>'** buttons pan the plots left and right respectively. The **'- 5 min'** and **'+ 5 min'** buttons decrease and increase the X-axis range respectively. The 5-minute increase or decrease will be translated to the plot in an increase or decrease of the X-axis range by 600 samples (2 samples/second * 60 seconds/minute * 5 minutes = 600 samples). The **'Reset X'** button will reset the X-axis range to the default number of samples.



The Y-axis scaling buttons (on the right) provide complete control of the lower and upper bounds of the Y-axis. Each plot (A, B, and C) has individual Y-axis scaling controls. The upper set of buttons control increasing and decreasing of the upper bound of the Y-axis.

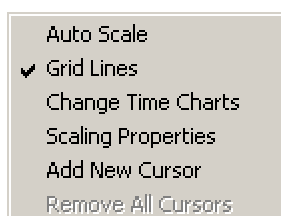


The lower set of buttons control increasing and decreasing of the lower bound of the Y-axis.

The Clear Plots button will clear all recorded data from each chart. The data being logged in unaffected, only the displayed chart data is reset.

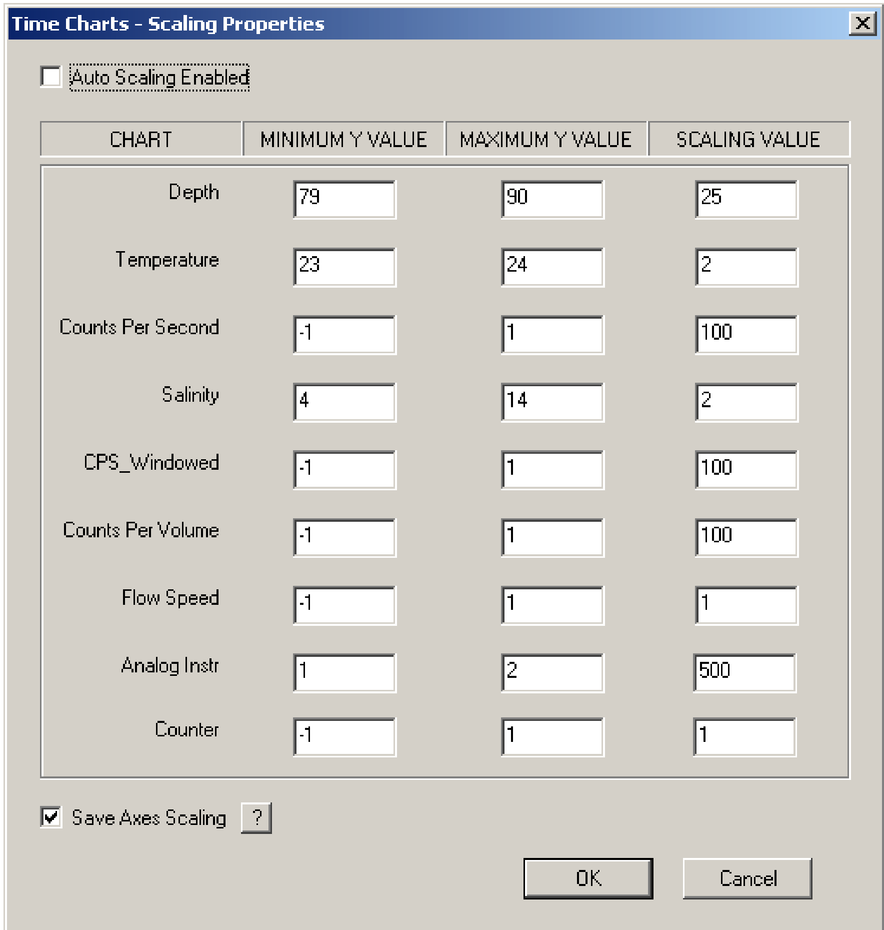
3.5.3 Context Menu

Right clicking the mouse on the plot window will reveal the context menu for the Time Plots View.



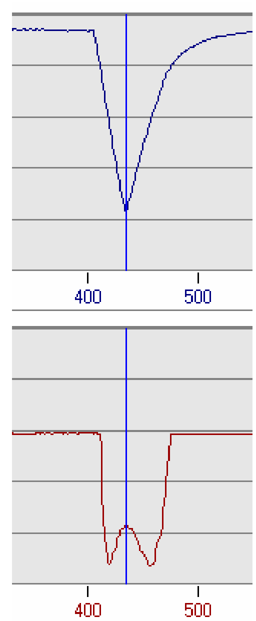
1. **Auto-Scale** - toggle automatic Y-axis scaling.
2. **Grid Lines** - toggle displaying of horizontal grid lines.
3. **Change Time Plots** - displays a dialog window for editing the set of time plots to be displayed. [*See section 3.1.3*]
4. **Scaling Properties** - allows the user to control the Y-axis of all time charts by entering the minimum and maximum Y-axis values for each chart. In this dialog, a user can also control the scaling value for each chart. The scaling value determines the amount of Y-axis increase or decrease is applied each time one of the Y-axis scaling buttons are clicked (see section 3.5.2). From this dialog, users can also enable/disable 'AutoScaling' and

enable/disable 'Save Axes Scaling'. When 'Save Axes Scaling' is enabled, the last available settings for the time charts are stored and persist from session to session.



5. **Add New Cursor** – allows a user to insert a cursor at a specified position for cross referencing interesting data points across different charts.

Selecting this option will load an input window where you can enter the sample number where you want the cursor to appear.

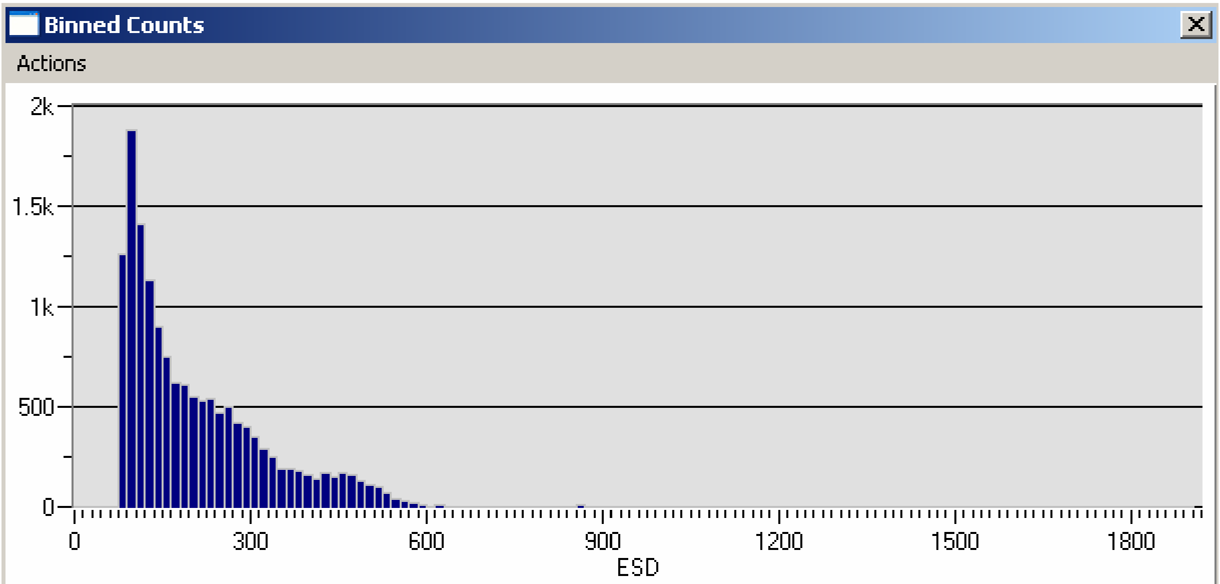


Added cursors are input across all charts at the position entered as in the graphic to the right.

6. **Remove Cursors** – clicking this option will remove all cursors from all charts. A popup window will load requesting that the user confirm their choice before the action is executed.

3.6 Binned Data Popup

This popup window displays a view of the binned data histogram similar to the Binned Data View of the main window.



This feature allows simultaneous observation of both the Time Plots and Binned Data views. The Actions menu present in the popup window provides the option to clear the chart. Invoking this command clears only the display; it does not change any of the logged data.

3.7 Status Bar

The status bar, located at the bottom of the main window, displays the current state of the software as well as various data collection parameters.

The sections of the status bar are described below starting from left to right.

3.7.1 State

This section of the status bar displays the current state of the LOPC software.

States are:

1. **IDLE** - the software is sitting in an idle state, neither collecting nor logging data.
2. **Scanning** - No Logging - this state indicates that the software is collecting, processing, and displaying data but it is NOT being logged to file.
3. **Scanning & Logging** - the software is collecting, processing, and displaying data. The data is being logged to file.

3.7.2 Start Time

Indicates time at which data collection was started.

3.7.3 Elapsed Time

The length of time since data collection started.

3.7.4 Data Source

The source of the data being processed and displayed.

Sources are:

1. **LOPC** - the data is being collected from the LOPC via the serial port in real-time.
2. **Filename (ex. LOPC_date-time.bin)** - the software is in playback mode (see section 7), thus the data source is a previously acquired raw data file.

3.7.5 Data Destination

This displays the destination (path and filename) of the file to which data is being logged.

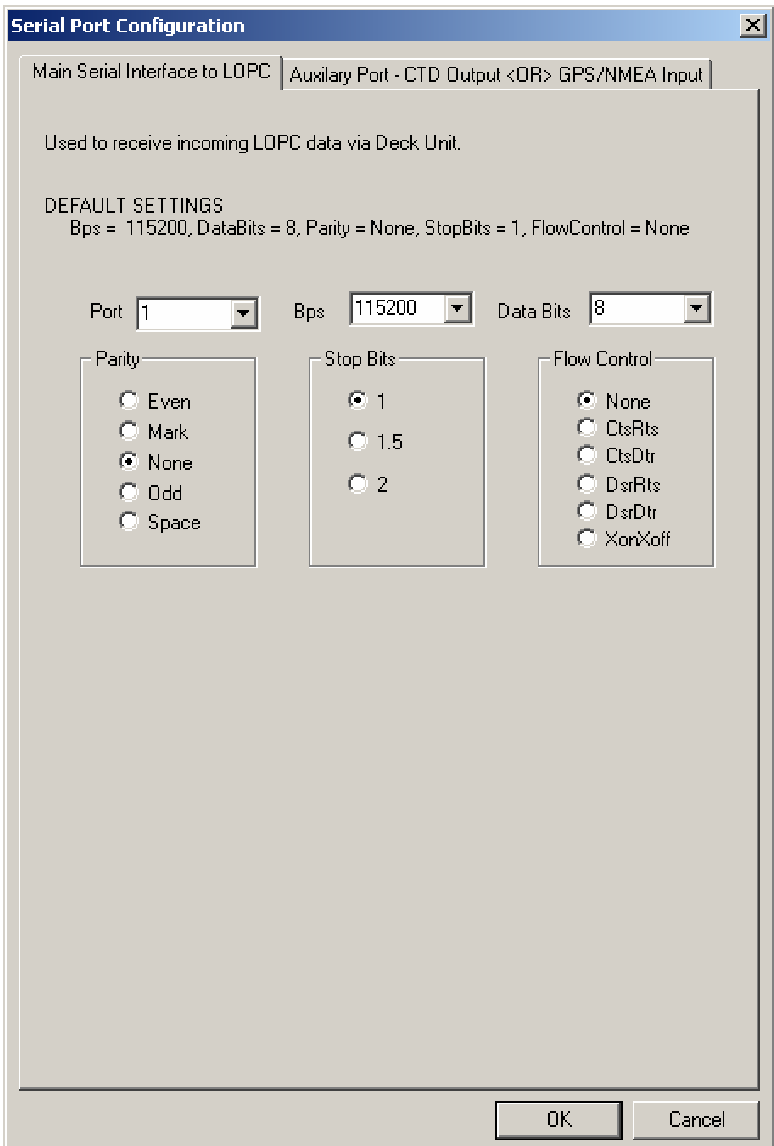
4 CONFIGURATION

Ensure that all options under the Settings menu are checked and configured properly before deploying the LOPC and starting data acquisition.

4.1 Port Settings

4.1.1 Main Serial Interface to LOPC

This port is configured to communicate with the LOPC Deck Unit, which acts as the communications mediator between the interface software and the underwater instrument. Proper communication parameters are shown below.



4.1.2 Auxiliary Port – CTD Output <OR> GPS/NMEA Input

The auxiliary communications port can be configured for CTD data output (if applicable), or a GPS input (if applicable).

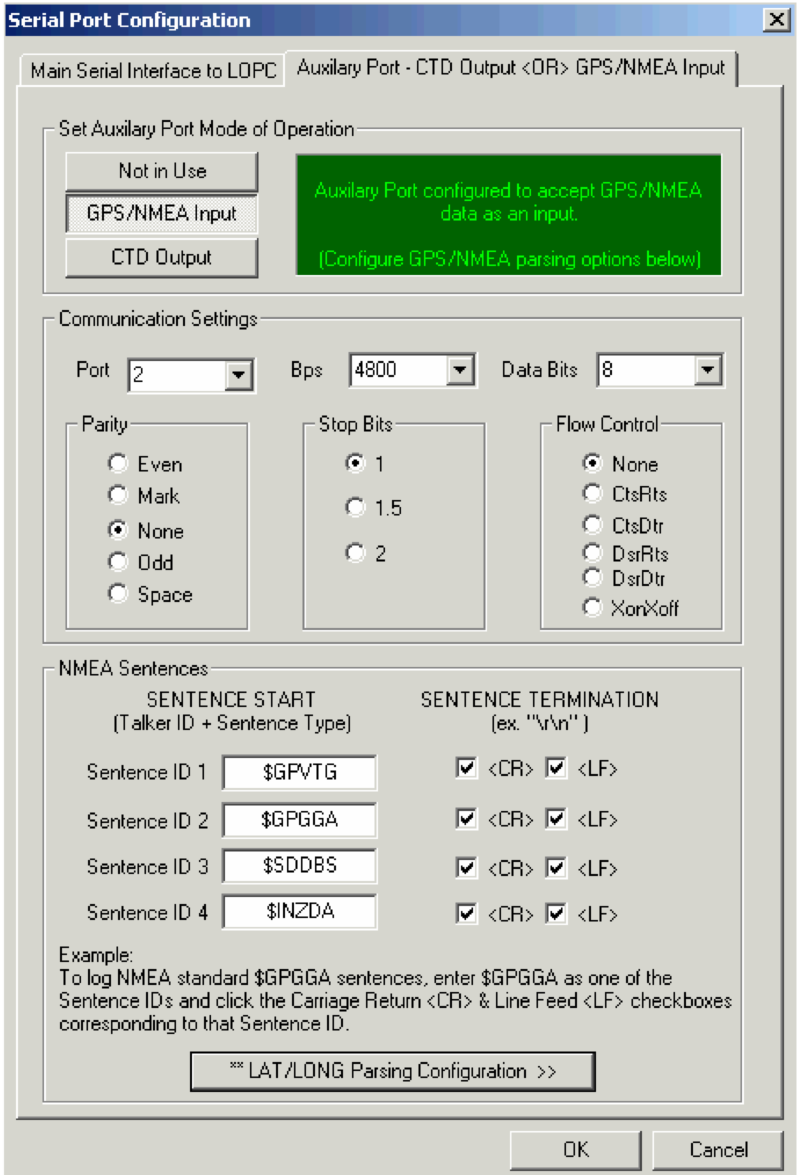
GPS/NMEA Input

If a GPS source is available, it can be multiplexed into the LOPC data stream by connecting it to the AUX Port of the LOPC data acquisition computer (usually serial port 2).

To enable this option, follow these steps:

Step 1:

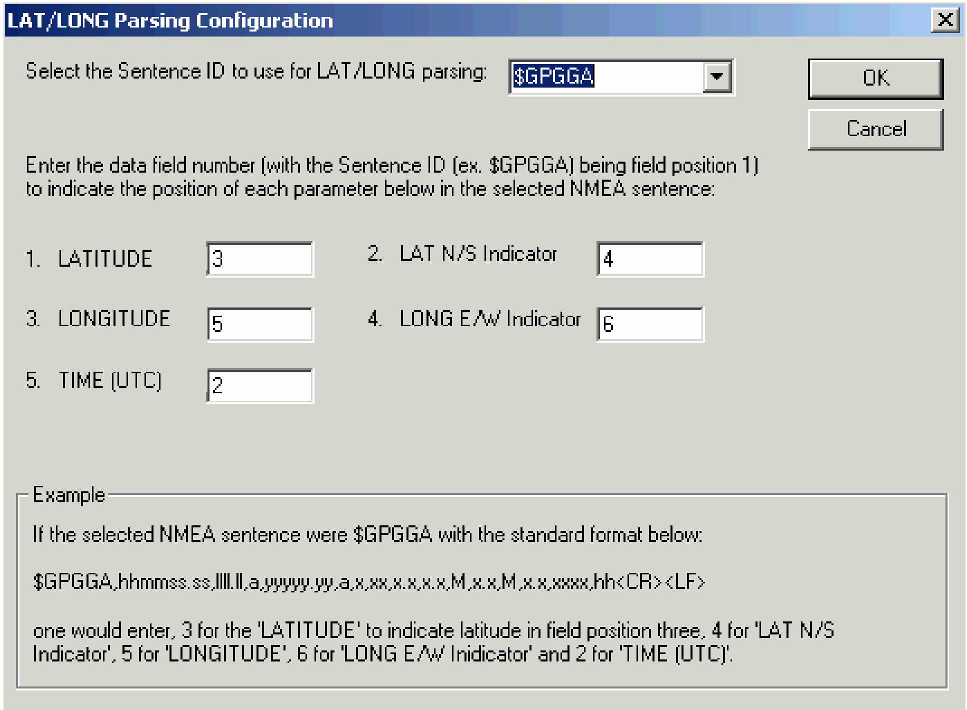
This option is enabled by clicking the **'GPS/NMEA Input'** button; which will in turn activate the remaining controls in the dialog that require proper configuration for this option to function correctly.



Step 2:
Configure the communication settings.

Step 3:
Configure the GPS/NMEA Sentence identifiers. Each NMEA string that the user wishes to log has to have a properly configured **'SENTENCE START'** and a **'SENTENCE TERMINATION'** defined. Note that all standard NMEA Sentence ID's have a $ followed by 5 characters and end with a carriage return <**CR**> and a line feed <**LF**>. A maximum of four (4) NMEA string types can be logged simultaneously.

> *Step 3.1 (optional):*
> The user can configure the LOPC software to parse the Latitude, Longitude, and Time from one of the selected NMEA strings. This option is configured by clicking the **"** LAT/LONG Parsing Configuration >>**" button that will load the configuration window below:



Step 3.2:
To configure the Lat/Long extraction and parsing, select he appropriate NMEA sentence from the dropdown list at the top (NOTE: only NMEA strings that have been configured for logging will be available here).

Step 3.3:
Using the format of the selected NMEA sentence, enter the field positions of the Lat, Long, Time parameters in textboxes 1 – 5. There is an example at the bottom of this dialog for reference. These field positions are used to extract the Latitude, Longitude, and Time from the selected NMEA sentence and display the formatted parameters in the "NMEA Data" section of the main Control Bar (see Section 3.2.6). Click '**OK**' to activate configuration.

Step 4:
Click **'OK'** to save and apply Port Settings.

CTD Output
The LOPC has a CTD data source connected to it, this CTD data can be re-routed to another device via the AUX port. This may be useful for devices that require this CTD data such the depth data required for MVP operation (or any other tow body).

To enable this option, follow these steps:

Step 1:
Enable this option by clicking the **'CTD Output'** button.

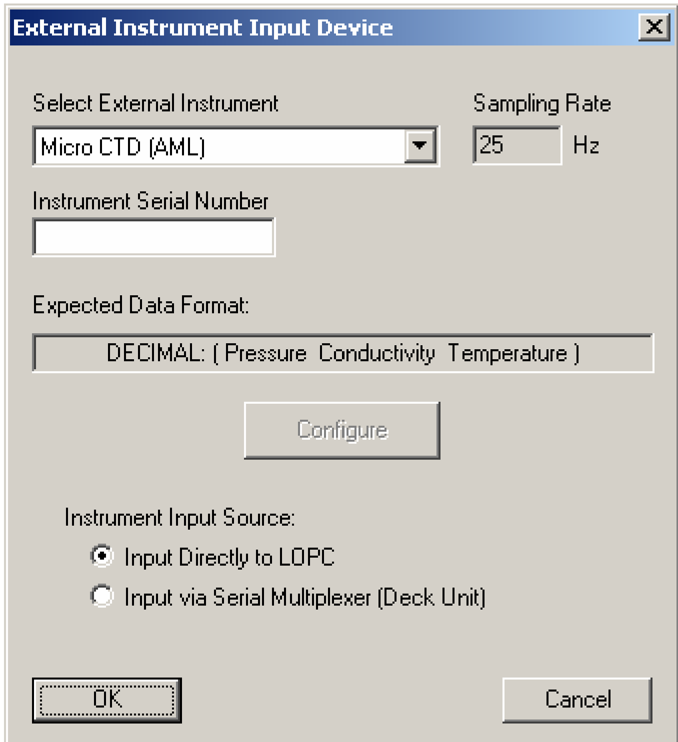
Step 2:
Configure the proper communication settings.

Step 3:
Click **'OK'** to save and apply configuration.

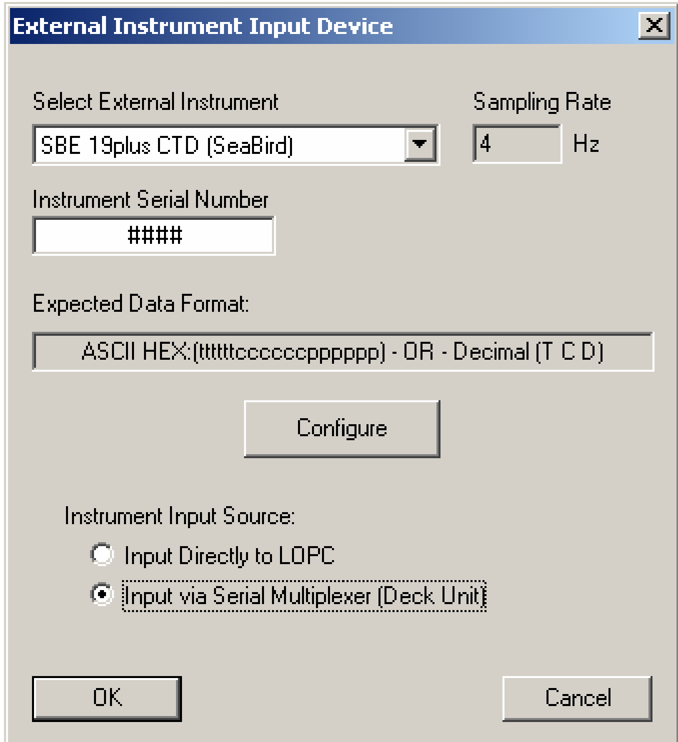
Not in Use
This button disables both of the above options and should be clicked if neither of these options is desired.

4.2 Instrument Input (i.e. CTD input)

If the user wishes to integrate an external serial instrument, such as a CTD, the proper device should be selected from the dropdown box before data acquisition begins so that the data will be parsed correctly.



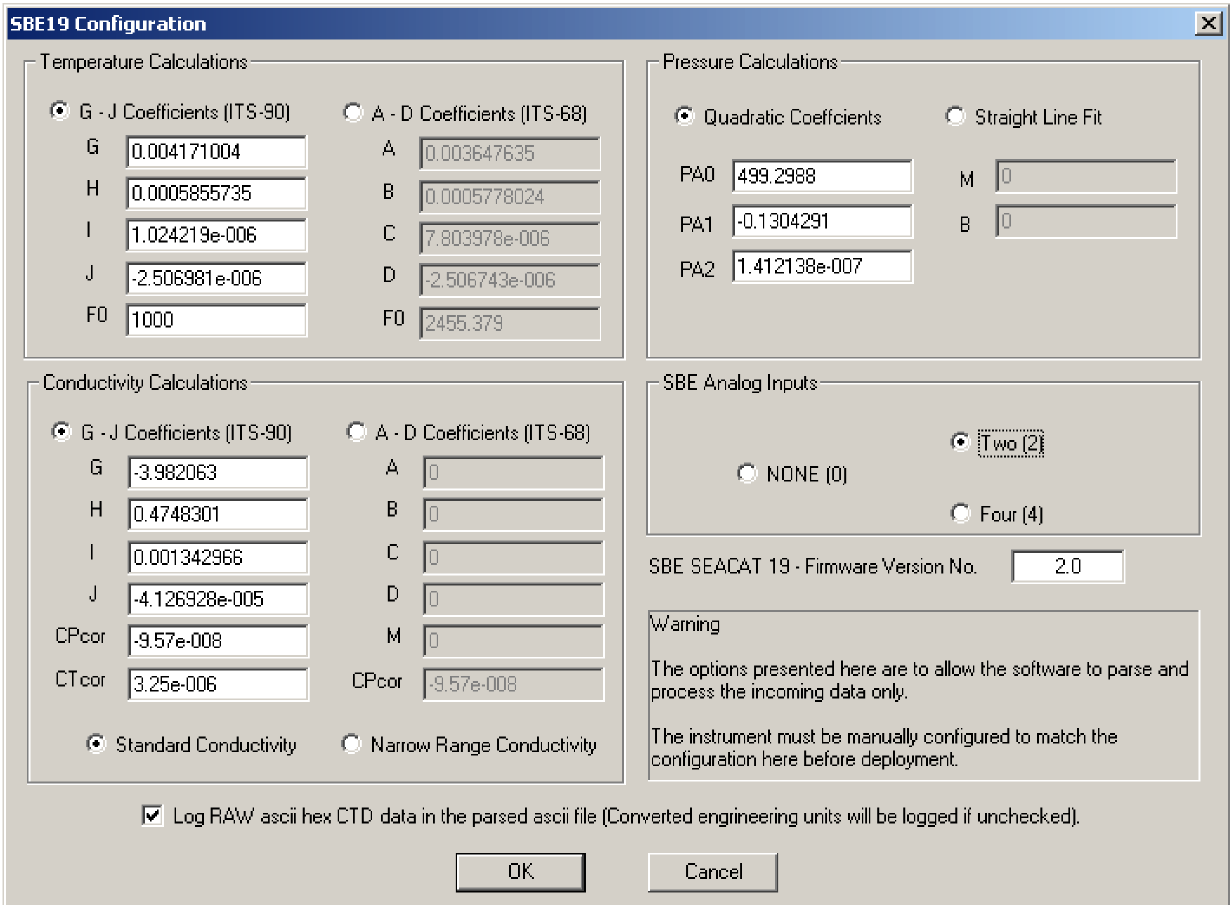
When an instrument is selected as the desired input, the Sampling Rate and the Expected Data Format will be updated to match the selection. The Instrument Serial Number can be updated as well. This serial number will be added to the file header and serves as an important record of the instrument used to collect the data. If the selected instrument requires further configuration, the "Configure" button will be enabled and the user should click this button to verify/update any additional configuration options. This is illustrated below with the selection of a Sea-Bird SBE 19plus CTD:



It is important to select the "Input via Serial Multiplexer (Deck Unit)" option if the CTD input is via the Deck Unit Multiplexer and not connected directly to the LOPC. This affects data parsing and formatting. Please refer to the **Deck Unit Multiplexer – User's Manual** for more information.

4.2.1 Sea-Bird SBE 19 CTD Configuration

If a Sea-Bird SBE 19 CTD is selected as the serial instrument input to the LOPC, further configuration is required. By clicking the “Configure” button, the following dialog window will load which allows the user to select the desired options and input/update the calibration coefficients for the CTD.



In this dialog window, the user should select the desired equations to be used in converting the raw frequencies to engineering units for temperature, conductivity, and pressure. The set of coefficients and equations to use for each data set is selected by clicking on the appropriate radio button at the top of each section.

When a radio button is selected the appropriate set of textboxes are enabled to allow the user to input/update the correct coefficients to be used with these equations. These coefficients are obtained from the calibration sheets provided by Sea-Bird. The coefficients are saved by the software and only need to be input by the user the first time they use the instrument and must be updated only when the coefficients change due to recalibration of the CTD.

The user should choose whether they have their CTD configured for Standard or Narrow Range conductivity, as well as, selecting the correct number of analog inputs that their CTD is configured to sample.

WARNING: The values entered in this screen are only used for data processing and display. The CTD is not configured or controlled by the LOPC. CTD configuration must be performed before it is connected to the LOPC for data input. Please refer to the CTD user manual to determine values that will result in proper data processing.

The last option available to the user is whether they wish to have the SBE19 CTD data logged to the processed ASCII file (see section 6) as converted engineering units (converted by the LOPC software) or have the data logged as the raw frequencies in ASCII hex (no processing).

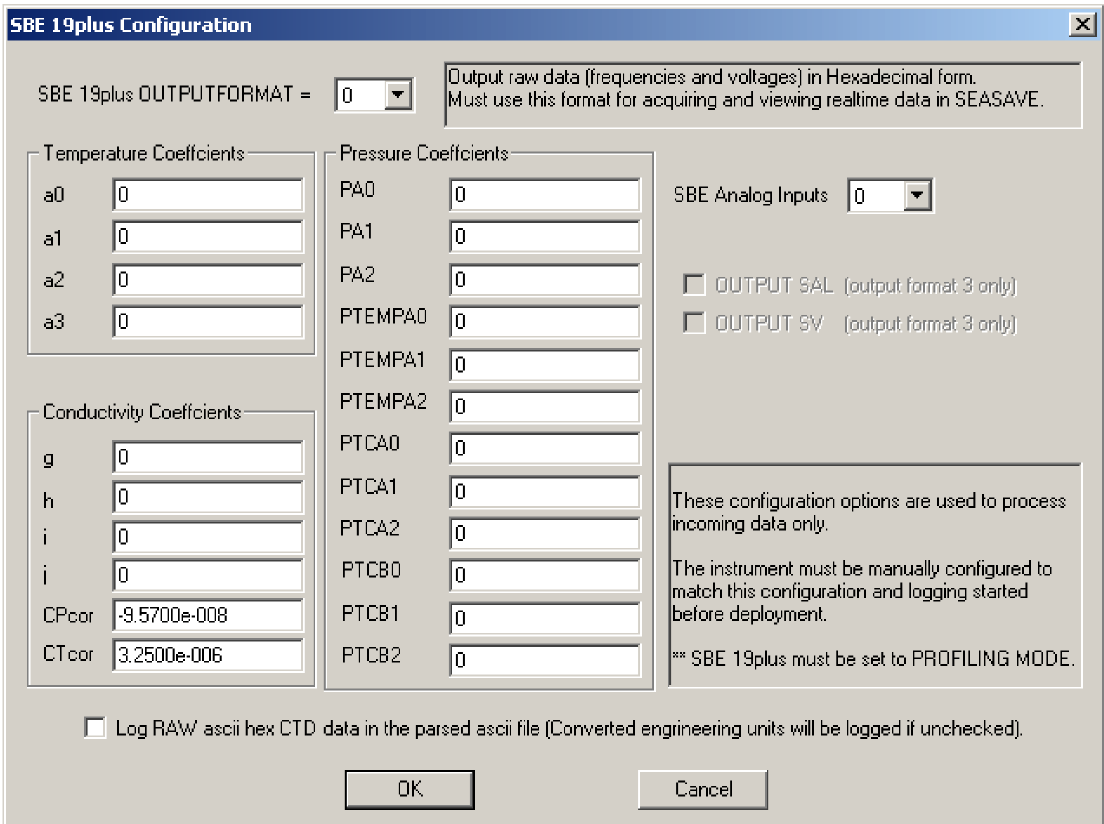
NOTE: The raw ASCII hex data from the SBE19 will always be logged as raw data along with the raw LOPC data in the *.bin files no matter which option the user chooses. The choice above affects what will appear in the processed ASCII file only, the raw ASCII hex data (which will be a duplicate of what is stored in the BIN file) or the converted engineering units.

After the desired options are selected and the proper coefficients input, the user should click **'OK'** to store the configuration for use – clicking **'Cancel'** will dump any changes made and revert to the last saved configuration or the installation defaults. When the **'OK'** button is clicked, the user will have to confirm the changes by clicking "YES" before the changes are saved and implemented. Then click "OK" on the Instrument Input dialog window to confirm selection of the SBE19 - configuration is now complete.

NOTE: The "ANALOG" display box located on the "External Instruments" section of the main control bar (see section 3.2.1) is reserved for display of the analog data collected by the main analog channel on the LOPCs AUX1 input connector. Any analog devices connected to an external instrument such as a SBE19 CTD, will be processed and logged in the data files, but will not appear in the "ANALOG" textbox on the main window.

4.2.2 Sea-Bird SBE 19plus CTD Configuration

If a Sea-Bird SBE 19plus CTD is selected as the serial instrument input to the LOPC, further configuration is required. By clicking the **'Configure'** button, the following dialog window will load which allows the user to select the desired options and input/update the calibration coefficients for the CTD.



The user should first configure the OUTPUTFORMAT that the CTD will be using. The options are '0', for the raw hex data output and '3' for the converted decimal output. If the converted decimal output (3) is selected, the user can also enable/disable the OUTPUT SAL and OUTPUT SV options. These options cannot be used with OUTPUTFORMAT 0. The number of analog inputs (select '0' for none) into the SBE 19plus should also be configured here.

WARNING: The values entered in this screen are only used for data processing and display. The CTD is not configured or controlled by the LOPC. CTD configuration must be performed before it is connected to the LOPC for data input. Please refer to the CTD user manual to determine values that will result in proper data processing.

The last option available to the user is whether they wish to have the SBE19plus CTD data logged to the processed ASCII file (see section 6) as converted engineering units (converted by the LOPC software) or have the data logged as the raw frequencies in ASCII hex (no processing).

NOTE: The raw ASCII hex data from the SBE19plus will always be logged as raw data along with the raw LOPC data in the *.bin files no matter which option the user chooses. The choice above affects what will appear in the processed ASCII file only, the raw ASCII hex data (which will be a duplicate of what is stored in the BIN file) or the converted engineering units.

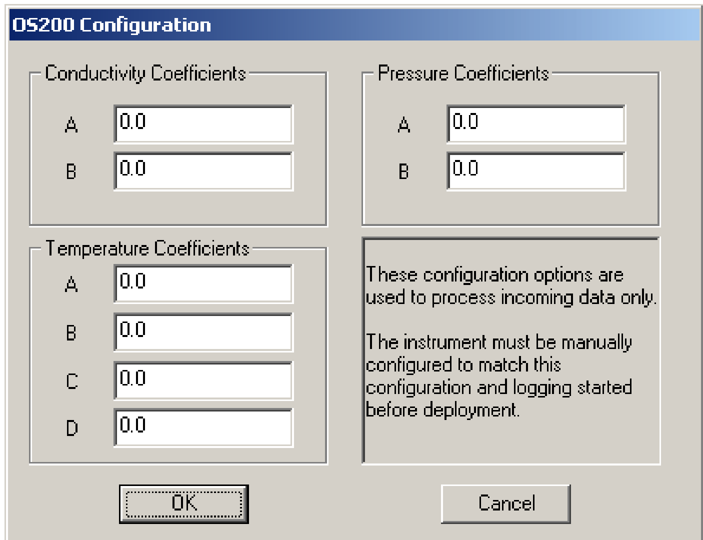
After the desired options are selected and the proper coefficients input, the user should click **'OK'** to store the configuration for use – clicking **'Cancel'** will dump any changes made and revert to the last saved configuration or the installation defaults. When the **'OK'** button is clicked, the user will have to confirm the changes by clicking "YES" before the changes are saved and implemented. Then click "OK" on the Instrument Input dialog window to confirm selection of the SBE19plus - configuration is now complete.

NOTE: The "ANALOG" display box located on the "External Instruments" section of the main control bar (see section 3.2.1) is reserved for display of the analog data collected by the main analog channel on the LOPCs AUX1 input connector. Any analog devices connected to an external instrument such as a SBE19plus CTD, will be processed and logged in the data files, but will not appear in the "ANALOG" textbox on the main window.

4.2.3 Ocean Sensors OS200

The OS200 CTD from Ocean Sensors provides a great degree of flexibility by allowing the output format to be customized to any application. The LOPC Data Acquisition software requires the first four numbers in each CTD line to be "AS0 AS1 AS3 AS6". Please refer to the OS200 documentation for instructions on how to program the sensor to output this format.

Select **'Configure'** to view the OS 200 configuration screen.



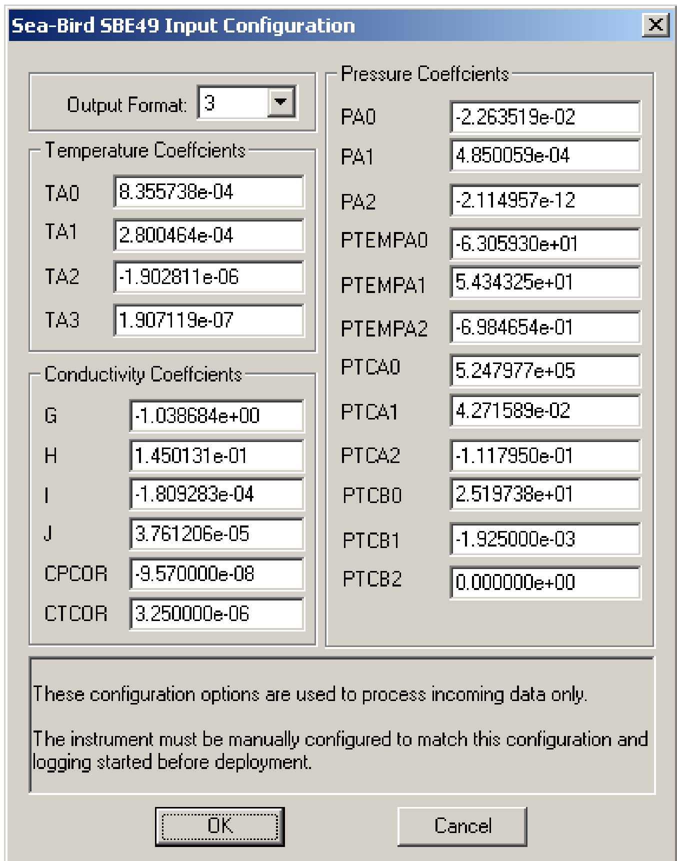
WARNING: The values entered in the configuration screen are only used for data processing and display. The CTD is not configured or controlled by the LOPC. CTD configuration must be performed before it is connected to the LOPC for data input. Please refer to the CTD user manual to determine values that will result in proper data processing.

The eight coefficients must be obtained from the calibration sheet provided by Ocean Sensors for the specific OS200 CTD that is connected to the LOPC. Enter the calibration coefficients in the proper fields and click **'OK'** to close the dialog.

4.2.4 Sea-Bird SBE49 FastCAT

The LOPC Data Acquisition software supports data collection from the Sea-Bird SBE49 FastCAT using any of the four output formats supported by the sensor. The configuration screen provides a method of specifying the calibration coefficients for the sensor. These coefficients are required for output format zero or two.

Select **'Configure'** to view the SBE49 configuration screen.



The calibration coefficients for the SBE49 are unique to each sensor and are found on the calibration sheets provided by Sea-Bird. If output format one or three is used, these coefficients do not need to be entered.

WARNING: The values entered in the configuration screen are only used for data processing and display. The CTD is not configured or controlled by the LOPC. CTD configuration must be performed before it is connected to the LOPC for data input. Please refer to the CTD user manual to determine values that will result in proper data processing.

4.3 Data Storage

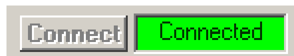
[*See section 3.1.1*]

5 OPERATION

Before operating the LOPC software, be sure to check all software parameters are properly configured.

5.1 Status Indicators

When the software is loaded, an attempt is made to establish a serial connection with the main serial port using the port settings stored from the last run. If the connection is established successfully, the connection status indicator will appear as below.



If the serial port connection failed, the user will be notified with an error message and the status indicator will appear as below.

The **'Connect'** button will also be enabled to allow the user to reattempt the connection.

Another status indicator is the LOPC Sensor, which is part of the 'Engineering' data set. After a serial port connection is established, but before data acquisition or logging has started, the software will constantly poll the LOPC to maintain a check on its activity. If the software deems that the LOPC Sensor is active and ready to start profiling, the status indicator will appear as below.

If the LOPC is not powered, not responding, or the software identifies that the LOPC is not ready to start logging the status indicator will appear as below.

5.2 Start Acquisition

By clicking the **'Start Acquisition'** button, the software is put into a state whereby data is collected, processed, and displayed.

Data is being logged, but to a temporary file ONLY! This temporary file is overwritten each time **'Start Acquisition'** is clicked. To log data in proper data files, use the **'Start Logging'** button (next section).

5.3 Start Logging

Starting in this mode performs similar startup actions as clicking **'Start Acquisition'** button [*section 5.2*], except data is logged to a proper data file from the start.

Therefore, clicking this button is a one-step process that commands the LOPC to begin scanning, begins data collection, processing, display, and logging to file with a single mouse click. Whereas, the **'Start Acquisition'** button requires a two-step process if it is clicked first. The initial clicking of the **'Start Acquisition'** button initiates scanning and data collection, but logging to a proper data file will not start until the **'Start Logging'** button is clicked.

The reason for having a two-step process available is to provide the user manual control over when logging to file begins. This logging delay is often necessary when the LOPC is being deployed. As the LOPC enters the water, the top layers along the surface often contain large amounts of bubbles and debris as a result of the ship's wake. These can be detected by the LOPC and cause large amounts of 'inaccurate' data when the LOPC is being deployed and recovered. With the Start Acquisition/Start Logging system, the user can monitor the data being collected (Start Acquisition) and manually start logging (Start Logging) when they feel it has cleared the 'contaminated' surface of the water.

5.4 Data Logging and File Handling Protocols

The LOPC software follows a data file naming and file handling protocol that is meant to give the user flexibility while at the same time provide some means of safety and allow recovery from minor data logging mishaps.

Start Mode 1

If a user initiates data acquisition (but not logging) by clicking the **'Start Acquisition'** button, log files are created called **'LOPC_PRELOGGING_DATADUMP'** (a *.bin file for raw binary data and a *.dat file for parsed ASCII data, see Section 6). These temporary files will store any data collected as a fail-safe in case the situation arises where a user neglects to start logging (by clicking the 'Start Logging' button). These temporary files provide the user with a safeguard so that if they do neglect to click the '**Start Logging**' button and decide that the data may be useful, the data can be salvaged from the temporary files. However, this is a one-time safeguard only; the next time the **'Start Acquisition'** button is clicked, these temporary files are overwritten with new data.

Start Mode 2

If a user sets the software in data acquisition mode (by clicking the **'Start Acquisition'** button only) initially, and following that clicks the **'Start Logging'** button to set the software into full data logging mode, data logging will end with the temporary files and logging will be transferred to the proper data logging files. All data collected from that point forward is stored in data files that are properly named according to the options selected by the user. File naming procedures will be discussed in the next section.

Start Mode 3

User can also initiate data collection and logging by clicking the **'Start Logging'** button only. This will set the software into full data logging mode and bypass the acquisition only mode. In this startup mode, there is no data logging to temporary files; data is immediately logged to the properly named data files in the format selected by the user.

5.5 Log File Naming

As previously mentioned, in ‘Start Acquisition’ mode, data is logged to temporary files that are overwritten the next time **‘Start Acquisition’** is clicked. These temporary files always use the same filename (**‘LOPC_PRELOGGING_DATADUMP’**), thus there is only one chance to recover data that you wish to save but did not log to a permanent data file.

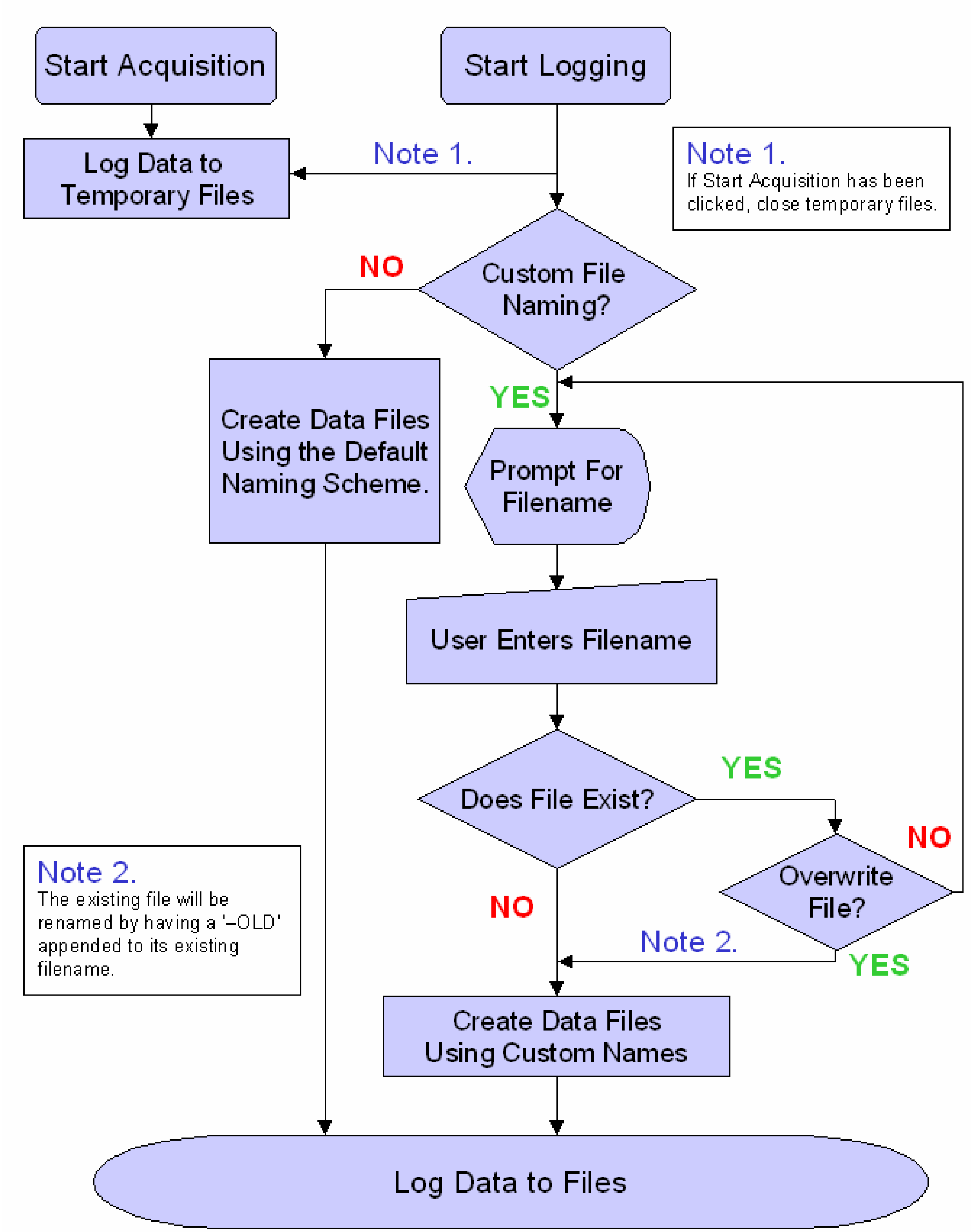
In ‘Start Logging’ mode, a check is performed whether or not the user has selected to use custom file naming or default file naming (software chooses filename). In default file naming mode, log files are created using the current date and time in the following filename format: LOPC_yyyy-mm-dd-hhmmss.*.

If a user chooses to use custom file naming (*see section 3.1.1*), when the **‘Start Logging’** button is clicked they will be prompted to enter a filename. The last filename used is presented to allow the user to modify this filename for the new data files. The filename is verified by checking existing files, if a filename entered is matches as an existing file, (for example if you neglect to update the filename from that presented in the filename prompt) the user will be asked if they wish to overwrite the exiting file with the new file. By answering no at this prompt, the user will be prompted again for a different filename. If the user selects yes to overwrite the existing file, the new file will take the place of the existing file.

There is an extra failsafe added that allows a user to recover from a file overwriting error. If a user chooses to overwrite an existing file, it will not be erased immediately. The new file will take the current filename (the one entered by the user) and the existing file will be renamed to ‘filename-OLD’. This prevents the user from overwriting a file inadvertently.

NOTE: This is a ONE-CHANCE safe guard only! If the user were to again start a profile and enter the same name a third time, the most recent file would claim the filename, the second file would be renamed to the ‘filename-OLD’ file and the original file would be LOST!

The flowchart shown in the following figure provides a graphical illustration of the file naming process.


Start Acquisition
Start Logging
Log Data to Temporary Files
Note 1.
Note 1.
If Start Acquisition has been clicked, close temporary files.
NO
Custom File Naming?
YES
Create Data Files Using the Default Naming Scheme.
Prompt For Filename
User Enters Filename
Does File Exist?
YES
NO
Overwrite File?
NO
Note 2.
YES
Note 2.
The existing file will be renamed by having a '–OLD' appended to its existing filename.
Create Data Files Using Custom Names
Log Data to Files

5.6 Snapshot – Raw Data Dump

A snapshot is an engineering tool for detecting or diagnosing potential problems with the LOPC. Normal operation does not require this feature to be used. However, if a problem is suspected, snapshot data can be useful in determining if there is a problem and help in determining what the issue may be. Taking and storing snapshots are described in [*Section 3.1.2*].

When the command is issued to take a snapshot, the interface software informs the LOPC to carry out the command. The user can monitor the success of a snapshot by monitoring the LED next to the Snapshot caption in the System Status area of the control bar. During a snapshot, the LED will turn green and '1' will appear in the Snapshot text box. While the snapshot is in progress (8 seconds) raw digital data is collected that is completely unprocessed and stored in memory. This process is completed underway, while acquiring and logging data and without interruption.

However, to retrieve the snapshot data, it must be stored on an internal Compact Flashcard and downloaded after the LOPC is recovered. To perform this action, data acquisition and logging must be stopped. The command to store the snapshot is found in [*Section 3.1.2*]. Issuing this command will prompt a popup dialog window.

The user must enter a file number and then click **'Store'**. The text window will update the user as to the progress of the data storage. The LOPC is shipped with a 64-MB internal Compact Flash Card. This means that the LOPC can store up to seven (7) snapshots before the pressure case is opened and the snapshot data retrieved. To store multiple snapshots, just enter a different file number when prompted to store the snapshot as in the above dialog window.

WARNING: Failure to change/increment the snapshot number will overwrite a previous snapshot data file if one exists on the Flash Card with the same file number.

WARNING: When a snapshot is taken, it is stored in volatile memory (RAM) until the user stores the snapshot data to the Flash Card (via the 'Store Snapshot' command). If the LOPC is powered off before it is stored, the snapshot data will be lost. Also, only one snapshot can be stored in memory at a time. If a second snapshot has been taken before the first was stored to the Flash Card it will be replaced but the data from the second snapshot and the first snapshot data will be lost!

6 DATA ACQUISITION AND LOGGING

This section discusses the data files that store the data acquired from the LOPC and processed by the interface software. The data files are described in reverse order to which they are written since it provides an easier means of describing the raw data format.

6.1 Processed Data Files

Processed data files (*.dat) are ASCII text files containing data received from the LOPC after it has been extracted from its raw binary, byte-stuffed format.

```
L1 0 0 0 0 0 0 5 9 8 8 1 3 0 2 4 4 3 5 10 5 7 3 1 4 1 0 3 4 4 0 2 2
L2 0 2 0 0 0 0 1 2 1 1 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0
L3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L5 0 100 30 4 43 0 2549 0 0 2248
C +20.6601 2.35578 -0.056 0.2567 3.8045
M 34 19068 12 32942
M 33 19065 15 174
M 32 19070 3 107
M 31 19048 23 265
M 30 19056 9 131
M 34 19506 14 32966
M 33 19506 14 195
M 32 19512 5 124
M 34 19935 9 32948
M 33 19933 13 178
M 32 19939 1 103
C +20.6602 2.35579 -0.056 0.2600 3.8046
M 26 20845 1 32869
M 25 20826 30 291
M 24 20831 21 186
M 4 23768 7 33251
M 3 23760 23 1403
M 2 23761 22 1092
M 8 24538 11 33091
M 7 24534 19 719
M 6 24535 16 469
M 19 31613 3 32881
M 18 31611 8 141
M 17 31605 20 281
M 16 31609 11 171
M 24 32464 6 33017
M 23 32456 23 1409
M 22 32458 20 1232
L1 0 0 0 0 0 0 6 8 8 7 4 2 3 2 2 7 3 5 4 6 5 3 1 2 3 7 2 3 0 4 2 0
L2 3 2 0 3 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
L3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L5 0 100 31 7 116 0 2550 0 0 2247
```

File format description:

L1 - L4 these four lines contain the 128 bins (32 bins per line) of single element plankton counted during this half-second sample. The 128 bins are split over 4 lines of 32 each to make the data files more readable by a user.

```
L1 0 0 0 0 0 0 6 8 8 7 4 2 3 2 2 7 3 5 4 6 5 3 1 2 3 7 2 3 0 4 2 0
L2 3 2 0 3 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
L3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L5 0 100 31 7 116 0 2550 0 0 2247
```

For example, in the sample above, there are 6 counts in Bin-28 (the first bin = Bin-0), 10 counts in Bin-29, 12 counts in Bin-30, 8 counts in Bin-31, 2 counts in Bin-32, etc. Each bin count value will be appended to the stored bin counts found on the bin plot.

L5 system status/engineering data.

Description of the L5 line from the sample above (from left to right):

0	= Snapshot Indicator
100	= Threshold
31	= Sample Number
7	= Flow Counts
116	= Delta Time
0	= Buffer Overrun
2550	= Laser Monitor (LMon in A/D counts)
0	= Electronic Counts *
0	= Count Period *
2247	= Laser Voltage (LVolt in A/D counts) **

The binned data (L1-L5 lines) is transmitted by the LOPC every half-second (2 Hz).

*** As of LOPC firmware version 2.25 and later, line L5 contains two (2) extra data fields that are appended to the end of the line. These data fields are used for an external electronic counter input that may not be available on all units. These fields are:**

Electronic Counts (0-256) – electronic pulse counts received from a connected counter device. (8th field on line L5)

Count Period (0-65535) – the accompanying period that the electronic counts represent. (9th field on line L5)

These fields combined are used to calculate values that can represent data such as flow speed.

**** This final field (LVolt) is found in LOPC firmware version 2.36 and greater. This field represents the output voltage to the laser to allow it to maintain a preset laser intensity that is observed in the LMon (Laser Monitor) field.**

C indicates a line of **'Instrument'** data from any attached serial instruments. The rate at which this is transmitted by the LOPC, and the data it contains, depends on the instrument model in use (ex. Micro CTD (AML) has a sample rate of 25Hz, whereas a SBE 19plus has a sampling rate of 4Hz). This data string format is determined by the instrument in use.

Instrument connected via Deck Unit Mux:
If the instrument (CTD) is connected via the Deck unit multiplexer, no extra data fields are append to the sample. The data that is logged in the 'C' line will be exactly as output from the instrument. Such as the sample of SBE 19plus data below (a SBE 19plus CTD sample with two SBE 0-5v inputs at the end):

```
C +20.6602 2.35579 -0.056 0.2600 3.8046
```

Instrument connected directly to LOPC (via INSTR bulkhead):
The 'C' line will contain the instrument data, however, it will also have an additional field attached to the end which is the analog sample (in A/D counts) from the LOPC's AUX1 bulkhead. The LOPC's analog interface in sampled each time a new Instrument data sample is received, so the analog sampling rate is determined by the attached serial instrument. From the SBE 19plus sample above, if the CTD was attached directly to the LOPC, it would have an additional analog voltage sample (3209) from the LOPC appended to the end as shown below:

C +20.6602 2.35579 -0.056 0.2600 3.8046 **3209**

With LOPC firmware version 2.25 and greater, a second data field is appended to the instrument data (in addition to the analog data). This field is the Counts per Second (CPS) detected by the LOPC. This field is presented here so it can be output to other devices, tow bodies, AUV's, etc. so that the information can be used/integrated into another data set. This would further add to the CTD sample as shown below (CPS = 122):

C +20.6602 2.35579 -0.056 0.2600 3.8046 3209 **122**

M indicates a portion of Multi-Element Plankton (MEP) data, where the form is 'M Element-Number Scan-Number Scan-Length Peak- Laser Monitor'. The MEP data is sent whenever the opportunity is available. Both the binned data (**L1-L5** lines) and the Instrument data (**C** lines) take precedence over MEP data.

```
M 26 20845 1 32869
M 25 20826 30 291
M 24 20831 21 186
M 4 23768 7 33251
M 3 23760 23 1403
M 2 23761 22 1092
```

In the sample MEP data above, it can be observed that some of the Peak-Laser fields (last field on each line) appear much larger than the others (i.e. the 1st and 4th lines).

This field is an overloaded 16-bit number with the most significant bit set to indicate that this line of data is the start of the new MEP. When the data is parse by the surface software (or post-processing software) this is removed from the data by masking the 16th bit or just subtracting 32768 from the field value. The max value for this field is only 14 bits so there is no risk of missing the start of an MEP or falsely creating a new one.

```
M 21 21190 32 33184
M 20 21210 47 635
M 19 21222 32 479
M 18 24474 8 32916
M 17 24469 47 787
M 16 24471 43 588
```

This is required for situations as in the sample above. It may appear without the overloaded bit method that the data above represents a single MEP (since the elements numbers are in order) when in fact it is not. It is actually two MEP's, each with 3 elements. The overloaded bit field is also required for framing. The MEP data stream can be interrupted by ‘C’ lines or ‘L’ lines because they take priority. Therefore, if we have MEP data, followed by CTD data and then more MEP; the only way to know for sure if this is the same MEP or not is by the 'overloaded bit method'.

The example below represents ONE MEP:

```
M 21 21190 32 33184
M 20 21210 47 635
M 19 21222 32 479
C 0110.3 37.255 09.773 0 0
M 18 24469 47 787
M 17 24471 43 588
```

However, in this very similar example, there are two separate MEP's:

```
M 21 21190 32 33184
M 20 21210 47 635
M 19 21222 32 479
C 0110.3 37.255 09.773 0 0
M 18 24474 8 32916
M 17 24469 47 787
M 16 24471 43 588
```

6.1.1 Description of Log File Fields

Snapshot Indicator
This value indicates whether a snapshot is in progress. A **'1'** indicates a snapshot is in progress, **'0'** indicates no snapshot is in progress. [*Found on **L5** lines – position 1*]

Threshold
The threshold is used to set a lower limit on signal level detection, which ensures that the LOPC is operating above the "noise level" of internal active components. This improves the accuracy and reliability of detection data. [*Found on **L5** lines – position 2*]

Sample Number
A counter indicating number of samples taken by the LOPC at 2Hz. [*Found on **L5** lines – position 3*]

Flow Counts
The Flow Counts indicate the number of counts within a pre-determined size range within the current 0.5-second sample (can be used in combination with Delta Time for flow calculations). [*Found on **L5** lines – position 4*]

Delta Time
Delta Time is the accumulated time for all counts detected in the Flow Counts window to pass through the beam (can be used in combination with Flow Counts for flow calculations). [*Found on **L5** lines – position 5*]

Buffer Overrun
Used to indicate an internal buffer overrun. "1" if a buffer overrun occurs, "0" otherwise. [*Found on **L5** lines – position 6*]

Laser Monitor (LMon)
Laser Monitor is the mean laser intensity detected by all 35 elements of the photo-diode array during this 0.5-second sample. [*Found on **L5** lines – position 7*]

Laser Voltage (LVolt)
Laser Voltage is the input voltage to the laser. This value is a monitor of a laser control circuit that will increase or decrease the laser input voltage as required to maintain a preset level (LMon). [*Found on **L5** lines – position 10*]

Element-Number
Indicates the element within the 35-element photo-diode array to which this line of MEP data pertains. [*Found on **M** Lines – position 1*]

Scan-Number
The Scan-Number is read from a 16-bit internal counter (0 – 65535) that is incremented every 35μs to provide a measure of time. The Scan-Number indicates the "time" at which the MEP entered the beam for this element. [*Found on **M** Lines – position 2*]

Scan-Length
Scan-Length indicates the number of scans, or the "length of time", a portion of a MEP was detected on the element in question. [*Found on **M** Lines – position 3*]

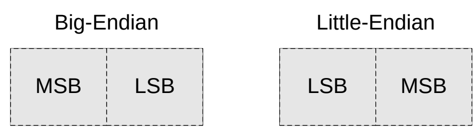
Peak- LaserLevel
The maximum level of laser light detected on this element during passage of a MEP. [*Found on **M** Lines – position 4*]

6.2 Binary Data Stream

The Laser Optical Plankton Counter (LOPC) data stream is saved to binary files by either the Windows interface software, or the optional Data Logger unit. Depending upon the system configuration, the stream may contain data from the LOPC and other sensors. This document will describe the format of the resulting binary files.

6.2.1 Multi-byte Values

All multi-byte values, 16-bit unsigned integers for example, appear in the binary data file in big-endian format, where the bytes are ordered from most significant to least significant. This is an issue for Intel-based PCs which store values in little-endian format.



As an example, take the following bytes, which represent a value of 3718 stored by the LOPC:

0E 86

Arranging the MSB and LSB as shown above, we get the values shown below.

Format	MSB	LSB	Decimal Value
Big-Endian	0E	86	3,718
Little-Endian	86	0E	34,318

The difference in decimal values makes it clear that care must be taken when reading the binary values to ensure that the data is interpreted properly.

6.2.2 File Header

The binary files produced by the LOPC system contain an ASCII header followed by the binary LOPC data. Processing/parsing software should ignore all data until a valid frame (as described later) is found. The header contains system configuration information that is not described in this document.

6.2.3 LOPC Binary Data Format

The LOPC binary data stream contains three sources of data, Binned Count Data, Multi-Element Plankton data and CTD (or other serial input) data. These data streams are framed by the LOPC prior to transmission. The LOPC uses a delimiter (DLE) character followed by a control character to define the start and end of a frame. The tilde (~) character is used for DLE.

The end of a frame control character (ETX) is an asterisk (*). The start of a frame (FRAME ID) may be specified by L, M, C, or $.

The basic layout of a data frame is as follows:

<DLE><FRAME ID>`<BINARY DATA PACKET>`**<DLE><ETX>**

Binned Count Data:

~L`<binary data packet>`**~***

Multi-Element Plankton data:

~M`<binary data packet>`**~***

CTD (serial) data:

~C`<instrument data, usually ASCII>`**~***

Note:

The CTD (serial) data packet is usually not a binary format. The data is inserted into each CTD frame exactly as collected from the sensor. The LOPC then appends two values in ASCII format.

- A numeric representation of the analog input (0-4095)
- The total number of single-element plankton that have been counted since the last CTD frame appeared in the LOPC data stream.

An example of a CTD frame including the two supplemental values is shown below. The first three values are CTD data, followed by an analog count of zero, and seven single-element plankton have been counted since the last CTD frame.

~C*-0000.1 00.001 21.266 0 7***~***

A fourth possible frame type may appear in an LOPC binary data file:

GPS data:

~$`<ASCII GPS data>`**~***

This data stream cannot be output from the LOPC directly, however, if the user is making use of a GPS attached to a Deck Unit MUX, the GPS data will be integrated into the LOPC data stream as shown above.

6.2.4 Double DLE's

Since the data being transmitted is binary, there is a high probability that from time to time a DLE (~) will appear in the data stream as part of the data packet which is not part of the framing characters. This can cause problems for the receiving/parsing software since when it reads a DLE, it will expect that the next character is a frame ID or ETX character.

When the LOPC is framing a data packet for transmission, it checks each byte to be sent. If it detects that there is a DLE to be transmitted as part of the data packet (not part of the framing characters), it will insert a second DLE immediately after the data DLE detected. What this does is it provides the LOPC software with a conclusive indicator that this DLE is part of the data and not a framing character.

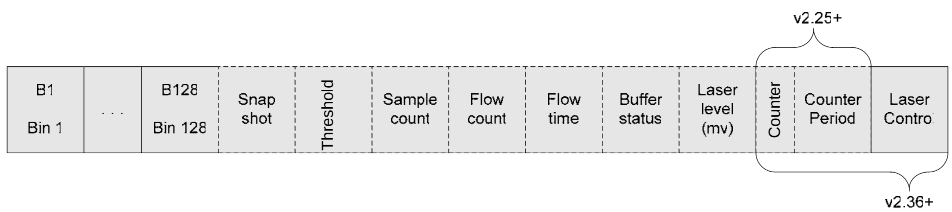
During the data parsing process, this second DLE must be removed so that the data packet is returned to its original form.

6.2.5 Single-Element Plankton Counts

Single-element plankton (SEP) counts appear once every half second in the output data stream.

~L*data_block***~***

The data block may contain 270, 273, or 275 bytes of data depending upon the firmware version of the LOPC. The firmware version may be viewed by watching the LOPC output during power-up. The data block format is shown in the following figure.



The count data is arranged in 128 bins with each bin containing the number of counts for that size range (starting from 100µm and incrementing 15µm for each increasing bin). The number of counts for each bin is represented by the decimal equivalent of the two bytes assigned to that particular bin.

For example, if we have a Binned-Counts data packet that starts out with the following bytes:

~ DLE	L	00 MSB	2D LSB	00 MSB	33 LSB	00 MSB	3A LSB	08 MSB	02 LSB	. . .

The resulting bin counts would be as follows.

Bin #	Size Range	Binary Data		Counts (decimal)
		MSB	LSB	
Bin 1	100-115µm	00	2D	45
Bin 2	116-130µm	00	33	51
Bin 3	131-145µm	00	3A	58
Bin 4	146-160µm	08	02	2050
…	…	…		…
Bin 128	…	…		…

NOTE: The maximum number of counts possible is 65535 counts per bin - a limit that should not be reached in practical usage.

The remaining bytes of the data packet contain engineering data describing various operational parameters.

Field	Bytes	Description
Snapshot	2	0: Normal operation 1: A snapshot is in progress
Threshold	2	The configured lower detection limit in microns.
Sample Count	2	Current sample number
Flow Count	2	Number of counts detected in the bin range used for Flow Speed calculations
Flow Time	2	Transit time for all Flow Counts above. Also used in calculation of Flow Speed.
Buffer Status	2	0: Buffer Ok 1: Buffer overrun
Laser Level	2	Current average laser level across all photo-diode elements.
Counter	1	Number of pulses detected on the counter input
Counter Period	2	Period of the pulses detected on the counter input
Laser Control	2	Configured Set value for the Laser Control Algorithm

The ASCII output from the LOPC processing software contains five lines for each SEP packet. An example is shown below.

```
L1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L5 0 100 1 0 0 0 2211 0 0 2101
```

Lines L1 to L4 each contain 32 bin counts. Line L5 contains the engineering data described in the above table. Note that in the example, all bins have zero counts.

6.2.6 Multi-Element Plankton Frame Format

A Multi-Element plankton (MEP) frame contains four bytes of framing data and a variable length data packet. However, the data packet must be a multiple of six since each group of six bytes have a relationship that is required for interpretation.

The data is parsed by group (6-byte chunks), therefore, only one group of bytes is required for explanation purposes – the rest of the data set is parsed by repeating the process for each of the remaining six-byte groups.

For illustration purposes, the following sample MEP frame will be used to assist with the explanation:

7E DLE	4D	96 MSB A	21 LSB A	30 MSB B	0A LSB B	79 MSB C	E7 LSB C	7E DLE	2A ETX

The 7E4D at the beginning and the 7E2A at the end are the framing characters ~M and ~* respectively. This leaves us with 96 21 30 0A 79 E7 as the actual data packet. For simplicity, this example contains only one 6-byte group. Normally, a MEP frame contains several (sometimes hundreds) of these 6-byte groups of data.

The 6-byte data group is subdivided into three 16-bit blocks (we will label them A, B and C) with each pair of bytes representing the high-byte + low-byte of each 16-bit number successively.

Using our sample data:

Value	Bytes		Decimal Value
	MSB	LSB	
A	96	21	38,433
B	30	0A	12,298
C	79	E7	31,207

A, B and C as a whole, contain the values for four MEP parameters.

Element # (the actual photo-diode element blocked by the MEP),
Possible value: 0 – 34

Scan Counter (a 16-bit timer which is the “time-of-travel” reference),
Possible value: 1 - 65535

Length (transit time through beam, or number of Scan Counter ticks)
Possible value: 1 – 2047

Peak Intensity (a measure of the amount of laser light blocked by the particle).
Possible value: 1 - 4095

The following figure illustrates the format and bit positions for blocks A, B, and C and the four MEP parameters that they contain.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
A	N1	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1	P0	E5	E4	E3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
B	X	X	E2	E1	E0	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	L0

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
C	S15	S14	S13	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	S0

Where:

P11 – P0	12-bit peak intensity value
E5 – E0	6-bit element number
L10 – L0	11-bit length value
S15 – S0	16-bit scan count
N1	A special bit used to indicate that this is the beginning of a new MEP. When set, the current 6-byte group and all following groups with the bit clear belong to the same MEP.
X	Unused bits

Using the table above, our sample data would yield the following results:

Element # = 14
Scan Counter = 31207
Length = 10
Peak = 33476

In the ASCII (*.DAT) file generated by the LOPC software, this data would translate to the following line of data:

```
M 14 31207 10 33476
```

(the leading M is just used in the ASCII data to indicate a line of MEP data)

Note that the Peak value is 33476, yet the max peak value is 4095. This is because N1 in A was set to indicate that this was the beginning of a new MEP. This indicator bit is carried over into the ASCII file so that it is obvious to the user which lines of MEP data belong to which MEP; since an individual MEP requires several lines of MEP ASCII data to represent it.

For example, below is the full data representation for the MEP sample being used in the explanations (note that the last line indicates the beginning of another MEP and does not belong to this individual MEP):

```
M 14 31207 10 33476
M 13 31208 12 1514
M 12 31212 51 3302
M 11 31221 54 2612
M 22 13005 19 33485
…
```

This overloaded Peak value can also be used by any post-processing software to easily identify and separate individual MEPs.

To extract the actual Peak Intensity value for this line, just subtract 32768 (which clears N1). For example, 33476 – 32768 = 708, which is the actual Peak Intensity for this line of MEP data.

6.2.7 File Header

Each raw data file that is created (the *.bin files) will have a file header inserted at the beginning before any data is logged to the file. A sample of the header is below:

```
# ___  PC DATE-TIME  ___
# Date: Monday, August 09, 2004
# Time: 14:55:28

# ___  USER SUPPLIED HEADER  ___
# Cruise:
# Ship:
# Station:
# Chief_Scientist:
# LOPC_Serial#:
# Other Instruments:

# ___  LOPC SOFTWARE CONFIG  ___
# External_Instrument:        SBE 19plus CTD (SeaBird)
# Ext_Instr_Serial#:          None
# Ext_Instr_Link:             Deck Unit Mux
# Survey_Lat:                 45.0000
# Tunnel_Type:                Standard
# Counter_Constant:           0.134365
# Aux_Port_Mode:              Not In Use
# Data_Directory:             C:\LOPC_DATA\
# File_Naming:                Custom Naming
# NAV Configuration:
#   Sentence_To_Parse:        $GPGGA
#   LatPos: 3, NS: 4, LongPos: 5, LongEWPos: 6, TimePos: 2.

# -- SBE 19plus CTD (SeaBird) --
# OUTPUTFORMAT:                        0
# SBE_ANALOGS:                         2
# Log_Raw_Data_To_Ascii_File:          NO
# A0: 1.26704100e-003, A1: 2.64920000e-004, A2: -8.16872500e-007, A3: 1.79550800e-007
# G: -1.05527900e+000, H: 1.51578300e-001, I: -3.89692500e-004, J: 5.02756100e-005, CPcor: -
9.5700e-008, CTcor: 3.2500e-006
# PA0: -9.65709000e-001, PA1: 1.54452700e-003, PA2: 6.45445200e-012, PTCA0: 5.11069900e+005,
PTCA1: -2.51470600e+001, PTCA2: -2.57308400e-001, PTCB0: 2.40587500e+001, PTCB1: -8.50000000e-
004, PTCB2: 0.00000000e+000, PTEMPA0: -6.48460600e+001, PTEMPA1: 5.12614500e+001, PTEMPA2: -
2.27064700e-001
**********
# CFXVER=2.36
# DSPVER=2.32
# DIRECT_RS-232_MODE=0
# SERIAL_INPUT=RS-232,9600,8-N-1
# THRESHOLD=100
# CALIBRATION_COEFF=1.000
# MIN_BACKGROUND=512
# MINUS_THRESHOLD=-100
# MINUS_TIMEOUT=995
# FLOW_WINDOW=10-20
# SCAN_TIMEOUTS=3-1000
# SCAN_ELEMENTS=0-34
# BKGRND_COEFF_AB=0.005/0.995
# SIGNAL_COEFF_AB=0.600/0.400
# CF1_SN=51314
# BIOS=2.27
# PicoDOS=2.27
# LASER_SET_RANGE=1650-2500
# LASER_CTRL_INC=1
# LASER_INIT=2100
# LASER_CTRL_INTERVAL=50
# BKGRND_CTRL=2550
# CTRL_MODE=1
# COMBINED_ELMENTS=2
**********
```

 # ___ PC DATE-TIME ___

This section contains the current date and time when this file was created as read from the logging computer.

 # ___ USER SUPPLIED HEADER ___

Custom header information as input by the user (see “Settings” section).

 # ___ LOPC SOFTWARE CONFIG ___

This section list a series of parameters that are configured in the LOPC software.

Following the “LOPC SOFTWARE CONFIG” section, there may be a section illustrating a CTD configuration. This may or may not exist depending on whether or not the CTD actually requires any configuration. For instance, if the LOPC software is configured to operate with a SBE 19 or SBE 19plus, this section would exist. However, if the CTD being used were an AML Micro CTD, this section would not exist since the AML CTD has no configuration parameters.

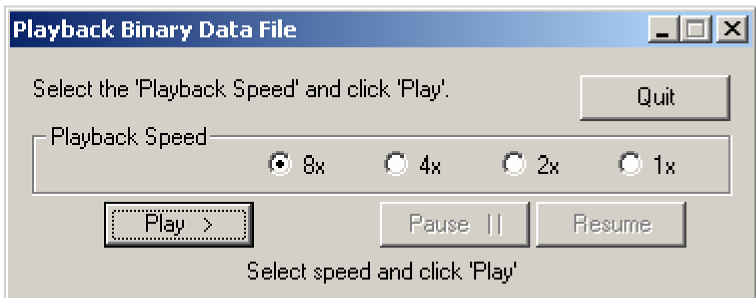
If this section is present, it will contain CTD configuration details as well as the calibration coefficients for this instrument.

The final section (contained between the “**********” lines) lists operational and configuration parameters from the LOPC’s memory. This block is read from the LOPC and provides a record of the LOPC configuration under which this data file was collected.

7 DATA PLAYBACK

Raw data files (*.bin) may be replayed at any time for visual interpretation and analysis of the data, or just to reproduce an ASCII text file (*.dat) of the data for manual inspection or post-processing.

The playback dialog window is displayed by clicking the **'Open File (Data Playback)'** option from the **'File'** menu. This command prompts the user to select a file for playback [**ONLY RAW BINARY FILES (*.bin) CAN BE USED FOR PLAYBACK**]. After selecting a file and clicking open, the playback dialog is loaded.



The user can select the desired playback speed and then click **'Play'** to begin playback of the data. The playback speed can be changed while the playback is in progress if the user wishes to increase or decrease the playback speed. The playback can be paused at any time by clicking the **'Pause'** button and then resumed by clicking the **'Resume'** button. The progress of the playback is indicated at the bottom of the dialog window by showing the user the current section of data being processed in relation to the total data to be processed. The process is stopped at any point during playback or after the end of the data file is reached by clicking the **'Quit'** button.

NOTE: The header that will appear in the resulting DAT file will contain the playback date and time followed by the header information from the source BIN file.

WARNING: To avoid data file corruption, file playback should always be stopped using the 'Quit' button in the playback window. DO NOT stop playback using the 'STOP' button in the main window or by closing the program.

Software Appendix I

Application Shortcut Keys

Application Shortcut Keys

Below is a list of shortcut keys to perform the indicated operations and functions:

Operation	Shortcut Keys
Open File for Playback	Ctrl + O
Switch to Binned Data View	Ctrl + B
Switch to Time Plots View	Ctrl + T
Binned Data Popup Window	Ctrl + P *
Change Port Settings	Shift + P **
Change Input Instrument	Shift + I **
Change Data Storage Directory	Ctrl + Alt + S **
Change Data File Naming	Ctrl + Alt + N **
Change Counter Constant	Shift + C *
Change Window Count Bounds	Shift + W **
Set Survey Latitude	Shift + L **
Change Time Charts	Ctrl + C *
Modify User Supplied Header	Shift + H **

* Only available when Time Charts View is active.

** Not available after scanning/data acquisition has begun.

Software Appendix II

Sample Derivation of a Counter Constant

Sample Derivation of a Counter Constant

The following sample Counter Constant derivation applies to a General Oceanics Flowmeter (2031H) with Standard Speed Rotor.

Standard Speed Rotor Constant	= 26783
This relates to ONE (1) mechanical rotor count	= 0.026873 meters
Since mechanical counter produces 10 counts per revolution, ONE (1) complete rotor revolution (0.026873*10)	= 0.26873 meters
The electronic sensors produce 2 pulses per revolution only, therefore, the electronic rotor constant (0.26873/2)	= 0.134365 meters/pulse

COUNTER CONSTANT = 0.134356 meters

If the user were using this device, this number should be entered and stored in the Counter Constant dialog which can be found under the 'Settings' menu..

Software Appendix III

Software Change Log

Software Change Log

Version 1.23

- Sea-Bird SBE25 CTD support added

Version 1.22

- Sea-Bird SBE49 CTD support added
- Ocean Sensors OS200 CTD support added
- Automatic precision update added to time plots
- Original BIN file headers are retained during file playback
- Corrected a minor display issue with Windows XP.

Version 1.21

- Added the Extract Stream Data tool.
- Software version included in the output file headers.

Software Appendix IV

Manual Updates