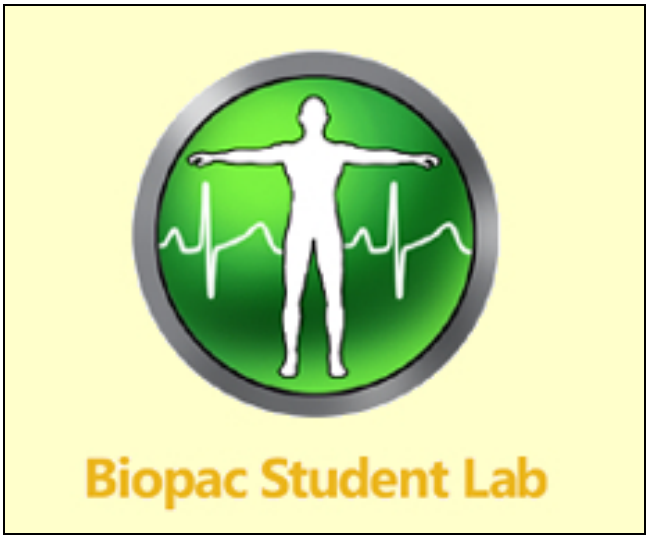
Biopac Student Lab 4.1

Windows® 10, 8, 7
Mac OS X 10.7-10.11, macOS Sierra

BSL *PRO* TUTORIAL



BIOPAC Systems, Inc.
42 Aero Camino, Goleta, CA 93117
(805) 685-0066, Fax (805) 685-0067

info@biopac.com
www.biopac.com

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Welcome to the Biopac Student Lab *PRO*!

To learn how the Biopac Student Lab *PRO* works, complete this interactive Tutorial and read the Overview Chapter of the BSL *PRO* Manual. For an in-depth discussion of BSL *PRO* features and how they can make your work easier, read further chapters of the BSL *PRO* Manual.

The BSL *PRO* Manual (PDF format) is under the Help menu of the BSL *PRO* application.

Note that it is not necessary to record data (nor be connected to the MP recording hardware) to conduct this tutorial.

The particulars of setup and recording are application specific and are discussed only generally in this Tutorial. For detailed instructions about setup and recording, consult the BSL *PRO* Manual and the BSL *PRO* Hardware Guide—and follow your particular lesson plans and application notes.

This tutorial demonstrates use of BSL *PRO* software using BIOPAC MP36 or MP35 data acquisition units. MP45 users may note different features when using the software —consult the BSL *PRO* Manual for more detailed information about using BSL *PRO* with all MP hardware. (MP30 hardware is not supported in BSL *PRO* 4.)

All life science applications for the BSL *PRO* system involve setting up the hardware for acquiring signals (such as electrodes, leads, and the BIOPAC MP data acquisition unit,) setting up BSL *PRO* software, acquiring data (recording) and analyzing the data.

This tutorial assumes BSL *PRO* is already installed to your hard drive. (If not, insert the CD and follow the prompts.)

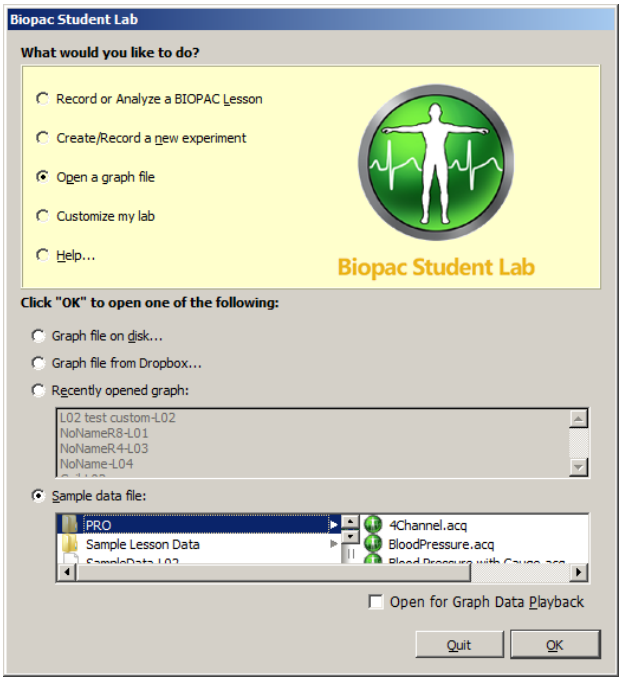
LAUNCH BSL *PRO*

1. Launch the BSL application using the Desktop shortcut, or click **Start > All Programs > Biopac Systems, Inc > Biopac BSL 4.1**.

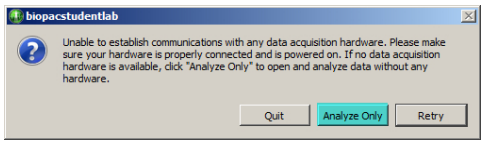
   In Mac OS X:

   - From Finder, choose **Go > Applications > Biopac Student Lab 4.1** and double-click the Biopac Student Lab application icon.
   - If **MP hardware** is not connected or is unavailable, see details at right.

2. In the Biopac Student Lab Startup Wizard, choose **"Open a graph file."**
3. Proceed to the next section "**Opening a Data File**."



If the BSL application is launched without an active **MP36/35/45** hardware connection, the communication dialogs shown below will be displayed. Simply click "**Cancel**" and "**Analyze Only**" to continue this tutorial without hardware. (Or, connect/power on the hardware and click "**Retry**.")



MP hardware communication is required for recording data, but is not necessary in order to conduct this tutorial. BSL sample and saved data files can be opened and analyzed on any computer that has BSL installed, even when MP hardware is unavailable.

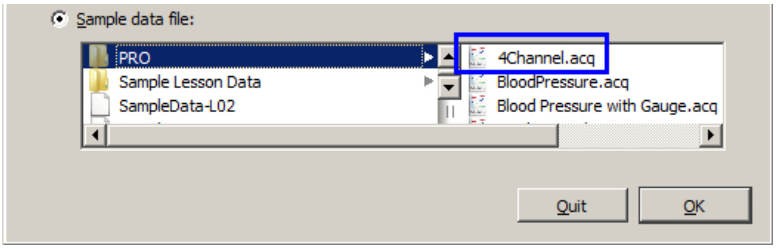
OPENING A DATA FILE

After selecting **"Open a graph file"**, choose **"Sample data file > PRO > 4Channel.acq"** and click OK.

OR

Sample Data files may also be browsed to in the BSL application window via File > Open.

From File > Open, choose **4Channel.acq** from the list of *PRO* sample data files.



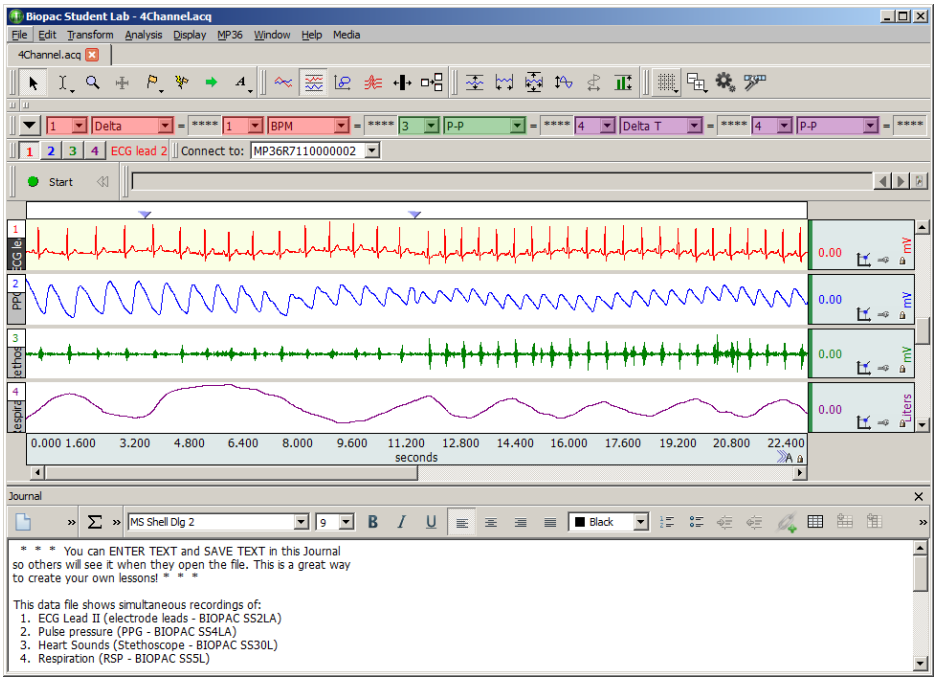
In the default Biopac Student Lab 4 installation, sample data files are located in the PRO folder:

Windows: <drive>:\Program Files (x86)\BIOPAC Systems, Inc\Biopac Student Lab 4.1\Sample Data\PRO

Mac: <drive>/Applications/Biopac Student Lab 4.1/Sample Data/PRO

The sample data file **4Channel.acq** is used in this tutorial. This data file shows simultaneous recordings of ECG Lead II, Pulse Pressure (PPG,) Heart Sounds (Stethoscope,) and Respiration. This setup provides quantitative data on how the cardiac and respiratory cycles change as metabolic demands on the body change. You may also review other sample files to familiarize yourself with BSL *PRO* applications and tools.

Observe the **BSL *PRO* display** and, if needed, adjust the window so your display resembles the figure at the right.



NOTE: To observe a simulation of how data is recorded in real time, open the 4Channel.acq file in **Playback** mode by checking the "**Open for Graph Data Playback**" option in the Startup window. Then click the "Replay" button in the upper left portion of the graph.

The **BSL *PRO* display** consists of a **graph window** and a **Journal**. Adjust the size of the Journal by dragging the bar that separates it from the graph window. You may resize the entire window to best fit your computer screen by dragging its corner (or elsewhere on its perimeter). Many of the toolbars and buttons can also be repositioned to suit personal preference.

SAVING A DATA FILE

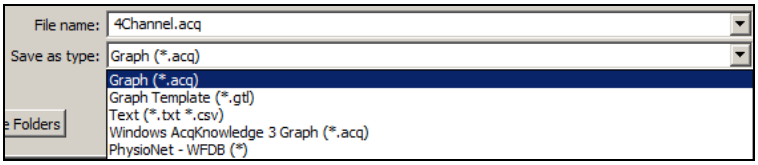
Save a copy of the sample file, if desired.

To save a copy, choose **File > Save As** and rename the file, i.e., "4Channel_Test.acq."

As you practice using BSL *PRO* tools and commands, you may substantially alter your sample file. If so, you may choose to close it without saving and then reopen a fresh working copy to continue the Tutorial.

You may want to practice on a copy of the **4Channel.acq** sample file. That way you can experiment with BSL *PRO* without worrying about any saved modifications to the sample file provided with the software installation.

By default, BSL *PRO* data files are saved in the BSL *PRO* format with the "**.acq**" filename extension. Saving a file in the BSL *PRO* format saves the graph data and the journal notes, the setup parameters (established under the MP menu,) and window positions. **Except in exceptional cases, you will save data files in the default *graph* (*.acq) or graph template (*.gtl) format.**



IMPORTANT! Saving as a Graph Template does not save any data—only the setup parameters.

Part 1: Acquisition Parameters

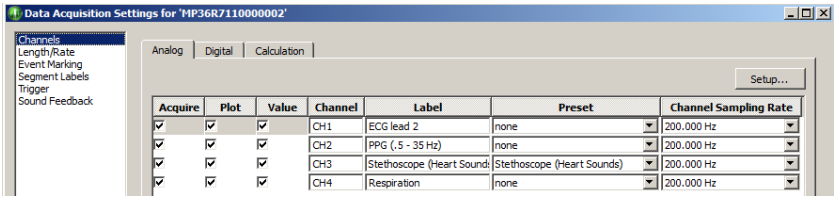
Each BSL *PRO* lesson—including experiments that you may design—will have unique procedures for attaching electrodes, transducers, and other signal monitoring equipment. Signal monitoring equipment is connected to the MP hardware, and the MP hardware in turn is connected to the computer. Follow the instructions for your particular experiment to set up the hardware.

Before recording, however, you must set data acquisition parameters in the BSL *PRO* software. (See "Set Up Acquisition" on page 10 and "Part 2: Recording" on page 11 for more details. Again, it is not necessary to record data in order to conduct this tutorial.)

SET UP CHANNELS

Choose the menu command **MP menu > Set Up Data Acquisition > Channels** to generate the **Input channels setup** dialog.

The **Input channels setup** dialog displays options for determining which channels receive data, what type of data the channels receive, and how data is displayed and interpreted onscreen.



Data Input Channels

Analog Input Channels

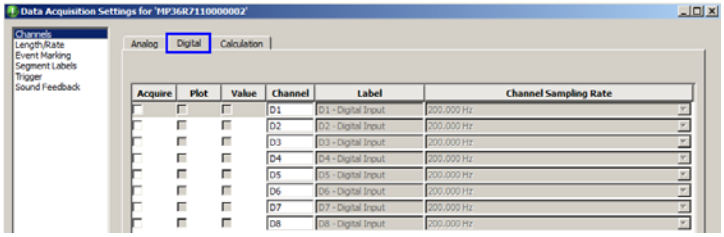
Digital Input Channels

Calculation Channels

Note the three kinds of **data input channels** and read about them at right.

Analog Input Channels (above) are the most common type of channel and are used to acquire any data with "continuous" values. Examples of this include nearly all physiological applications where input devices (transducers and electrodes) produce a continuous stream of varying data.

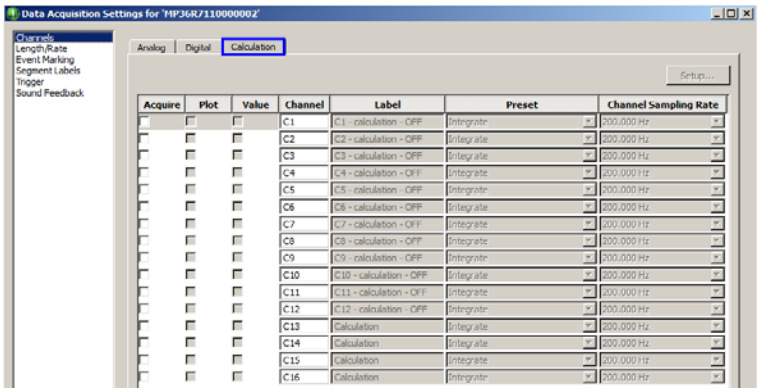
- BSL *PRO* records and displays up to four analog signals from devices connected to analog input ports on the front panel of the MP unit.



Digital Input Channels (above) in contrast to analog input channels, collect data from signal sources operating with only two values, such as on/off devices. Digital channels are used, for example, in studies of stimulus response patterns and reaction time to log signals from push-button switches, auditory/visual stimulus devices, and timing devices.

- BSL *PRO* records and displays up to eight digital signals from devices connected to the I/O port on the back of the MP unit.

- MP45 Users: The MP45 cannot record digital channels or use triggering, and some output control functions are disabled.

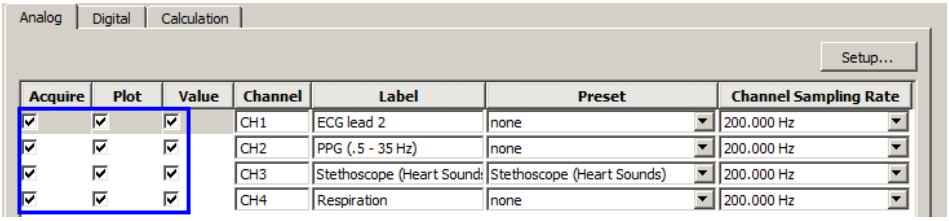


Calculation channels (above) transform data in some fashion and act on existing data from other channels. The original source data is not altered—it is mathematically transformed and stored in a modified form in the new calculation channel.

- For example, if you wanted to know the difference between CH1 and CH2 data for every point of data collection, you could set up a calculation channel to acquire the data from those two analog channels and plot a waveform of the difference.
- Up to 16 calculation channels are available. This allows for the performance of complex operations involving two or more calculation channels, such as filtering ECG data and then computing BPM.

Channel Setup Options

Note the three **checkbox settings** for each channel that determine whether a channel acquires data, whether the data is plotted as a waveform on the screen, and how the data values are displayed.



Acquire

Acquire records data into memory via the selected channel, but the data will not be displayed unless you also select “Plot”.

Plot

Plot displays the recorded data on screen so you can view the waveforms.

- In some cases you may not want to plot data on the screen. For example, you may want to acquire data on an input channel and run a calculation function before displaying it on screen. In that case, you would select “Acquire”, but not “Plot” for the Input Channel, and “Acquire” and “Plot” for the Calculation Channel.

Value

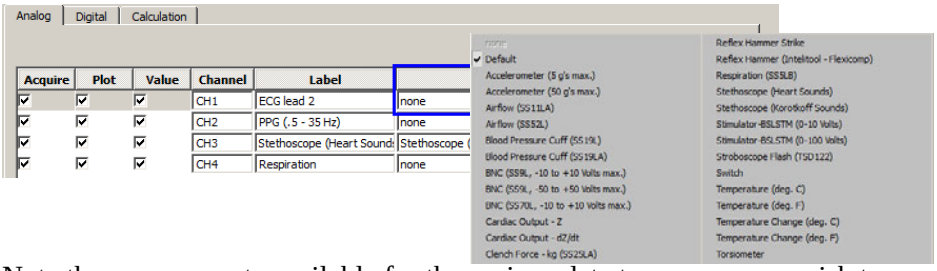
Value allows incoming data values to be displayed numerically and/or in “bar chart” format in a separate window during acquisition. Checking this option (under the MP menu) enables you to open a **Show Input Values** bar graph in which the values will be displayed.

- **Value** is useful for tracking slowly changing values such as heart rate, respiration rate, or the concentration of chemicals in a substance.

Channel Presets

Click the **Preset** icon (down arrow) to the right of any analog channel label to view a menu of parameter presets.

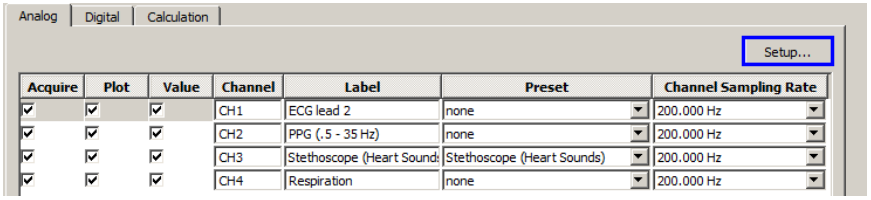
Press **ESC** (Escape key) to close the menu without selecting a new preset option.



Note the many presets available for the various data types you may wish to acquire.

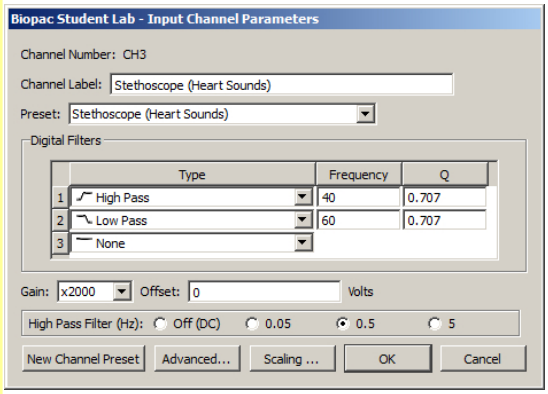
Setup

Setup... Click the **Setup** button for Analog Input Channel **CH3, Stethoscope (Heart Sounds).**



Clicking **Setup** generates the **Input Channel Parameters** dialog (below,) allowing access to all channel settings for gain, offset, filtering and other recording parameters.

View the **Input Channel Parameters** dialog for **CH3**.



Read about **Input Channel Parameters** at right.

The **Channel Preset** for **CH3** is "Stethoscope (Heart Sounds)." The **Channel Label** is the same as the preset name. (A channel's label is not always the same as the name of its preset parameters—you will often label a channel differently to better describe its data.)

Gain

Gain specifies the extent to which an incoming signal is amplified. Preset gain settings are educated guesses for the data type selected and should be used as initial starting values; you may need to adjust the gain depending on how the amplified signal appears once data is collected.

> Some types of signals (such as EEG) typically need greater amplification than other types of signals (such as ECG or EMG,) although ideal gain settings are best determined on a case-by-case basis.

To set the gain for a given channel, choose a value from the pull-down menu. Higher gain results in greater amplification. Setting the gain too high results in data that is "clipped." Setting the gain too small results in data that appears "flatlined." For the best resolution, establish gain such that the maximum peaks of the signal are close to the maximum range. Consult the BSL *PRO* Manual for a complete discussion of gain.

Offset

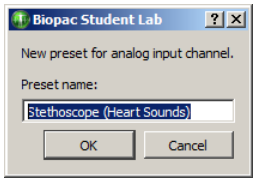
Offset enables you to correct the offset of an incoming analog signal by adding or subtracting a constant prior to amplification. The correction is generally zero, but may be set if a transducer or electrode has inherent offset, a condition especially true of signals collected in DC mode.

High Pass Filter

High Pass Filter is set for the type of signal to be recorded. For example, High Pass Filter (AC coupling) is generally used for biopotential signals such as ECG and EEG, while OFF (DC coupling) is best for transducer signals measuring absolute values such as force, pressure, and temperature. In AC-coupled mode, you may adjust the upper limit of the bandwidth of the signal being recorded by choosing one of three high pass (HP) filter options.

New Channel Preset

The **New Channel Preset** button brings up a dialog allowing custom channel presets to be configured and saved.



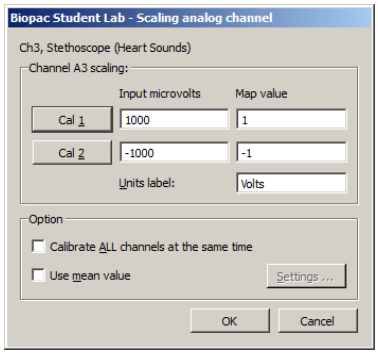
Advanced

Advanced options allow access to custom parameters such as minimum acquisition sample rate, transducer type, setting up advanced ranges/grids and calibration types. For more specifics on Advanced options, consult the BSL *PRO* Manual.

Scaling

Click the **Scaling** button to generate the **Scaling analog channel** dialog.

The **Scaling** button at the bottom of the Input Channel Parameters dialog generates the **Scaling analog channel** dialog, which allows conversion of incoming signals into other units (such as ft/lbs, millimeters, liters, etc.).



Note the scaling parameter options and see **scaling and calibration** details at right.

Scaling allows you to easily translate the voltage read by the MP hardware into the units being measured. Note that, for CH3, Stethoscope (Heart Sounds,) the Units label has been changed to “Volts.”

Calibration is performed *prior* to acquisition, never while recording.

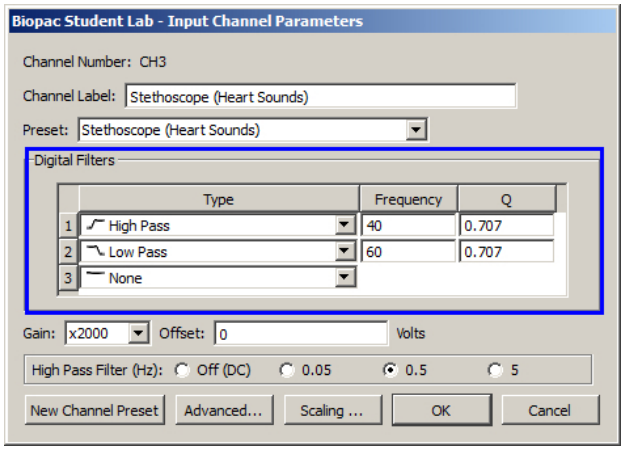
Input values (**Cal1** and **Cal2**) from a transducer may be calibrated to known low and high values (i.e., temperature). When an acquisition is performed, data samples from the selected channel are scaled accordingly and the vertical (amplitude) scale reflects the rescaled units.

Click **Cancel** to exit the dialog without changing scaling parameters and return to the **Input Channel Parameters** dialog.

Calibration is unique to each application and not demonstrated in this Tutorial. To calibrate, follow the guidelines of the specific lab lesson or application note. To read more about calibration, consult the BSL *PRO* Manual.

Digital Filtering

Note the **Digital Filters** options and see details at right.



The MP unit hardware-based **Digital Filters** are three cascading, second-order filters that can be set independently using the pull-down boxes. They are designed primarily for basic signal conditioning (e.g., removing 50/60 Hz noise,) rather than for filtering data to retain physiological signals of interest (such as retaining alpha activity from an EEG signal). Specify a **filter type** (low pass, high pass, band pass, or band stop,) **frequency,** and **Q setting**.

Saving Input Parameters

See details about **saving input parameters** at right.

Click **Cancel** to exit the dialog without changing parameters and return to the **Set up Channels** dialog.

Click **Cancel** to exit the dialog without changing parameters. Choosing **OK** sets the input channel parameters, including any changes you may have made.

When you save a data file, all acquisition parameters for every channel are saved along with the recording. This enables you to open a saved data file and collect new data without having to reset any parameters.

This feature also enables you to save parameters only—without data—in the Graph Template file format (.gtl).

A Graph Template does not retain recorded data, but retains all setup and acquisition parameters saved with the original file. When the graph template file is opened, all previous setups are ready for data recording. This is useful for creating your own lessons. Consult the BSL *PRO* Manual to learn more about Graph Template files.

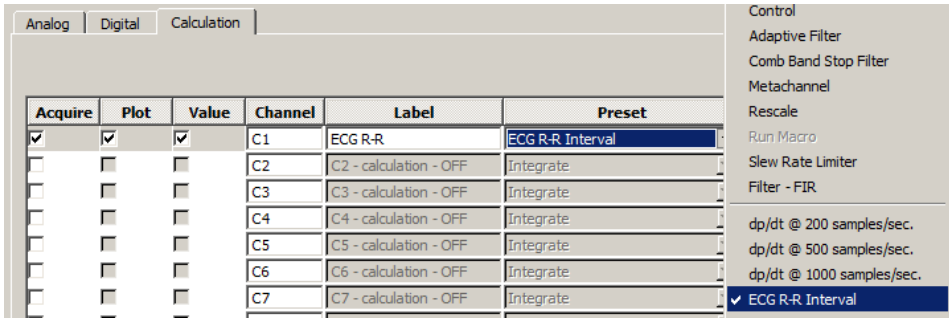
Digital Channel Parameters

Digital channels have only two fixed values; no parameter and scaling options are available. For more information, consult the BSL *PRO* Manual. (Digital channels are not supported in MP45 hardware.)

Calculation Channel Parameters

Calculation channels acquire data from analog input channels (or digital input channels, or other calculation channels) and perform the selected operation on that data. The original source data is not altered—it is mathematically transformed and stored in a modified form in the new calculation channel.

An important concept to understand is that calculation channels are not input channels, and must ultimately acquire data from an input channel that collects signals from an external source. When the source of a calculation channel is another calculation channel, that calculation channel in turn must acquire its data from an input channel (usually an analog input channel, though possibly a digital input channel).

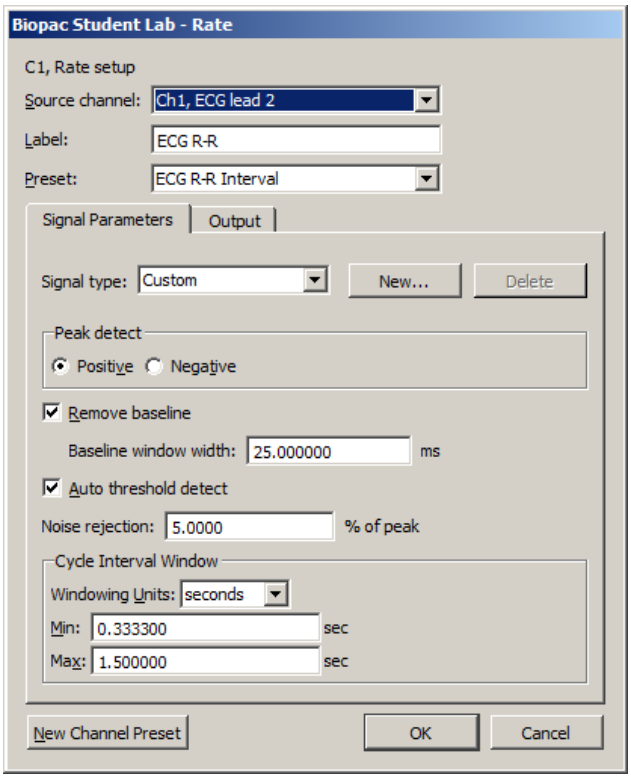


With the **Calculation Channel** tab active, open the **Presets dialog** (down arrow) for **Calculation Channel C1.**

Choose the preset option **ECG R-R Interval**.

For example, calculation channel C1 can be set up to compute the R-R Interval of the ECG data on analog input channel CH1.

To do this, click the **Preset** icon (down arrow) to the right of Calculation Channel C1 to generate a menu of calculation channel presets. Choose the preset option "**ECG R-R Interval.**"



Setup... Click the **Setup** button in the upper right corner of the **Calculation Channel** dialog to generate the **Rate** dialog.

Choose the **Signal Parameters** tab.

Note the **Signal Parameters** for the **ECG R-R Interval** calculation, and see details at right.

Click **Cancel** to exit the dialog without changing rate parameters and return to the **Set up Channels** dialog.

Note the **Rate Signal Parameters** dialog for the selected "**ECG R-R Interval**" preset. The **Source** data for the calculation is acquired from "CH1, ECG lead 2" and the **Function** (behind Output tab) is to compute the interval in seconds.

Were you to record with these rate parameters, **Analog Input Channel CH1** would acquire the ECG data from the subject, and **Calculation Channel C1** would in turn compute the R-R Interval of the data collected on CH1.

Uncheck the **Acquire**, **Plot** and **Value** boxes in the **Calculation Channel** tab.

Unchecking the "**Acquire**" option turns off the calculation channel. It will no longer acquire, plot, nor display data.

Click the **close button** to exit the **Input channels setup** dialog and return to the graph window.

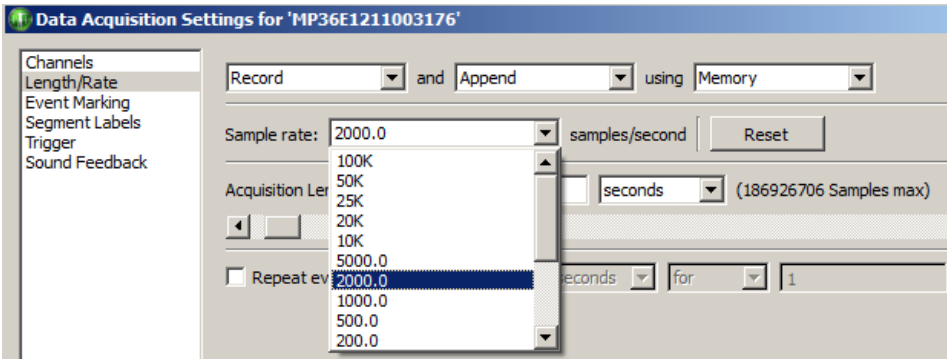
SET UP ACQUISITION

Choose the menu command **MP menu > Set Up Data Acquisition > Length/Rate**.

Note the acquisition parameter options of the **Set Up Acquisition** dialog and read about them at right.

Once the channels are set up, the next step is to set up the acquisition parameters. The **Length/Rate** dialog displays options for controlling how and where data will be stored, sample rate for data collection, and the duration of each acquisition.

Default acquisition parameters are to **Record and Append using Memory** at a sample rate of **2000 samples per second** for **1800 seconds** (30 minutes).



The three pull-down menus at the top of the **Acquisition setup** dialog allow control over the recording mode and where the acquisition data will be saved.

Data Storage Options

Default parameters are set to **Record and Append using Memory**, which tells BSL *PRO* to append acquisitions until the file is saved and to store the data in computer memory during the acquisition. Options can be set to save data once each segment is acquired, to "autosave," and to utilize the computer's hard drive for storage.

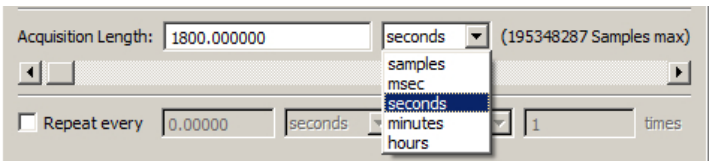
Sample Rate

Sample Rate determines how many samples per second the MP unit will acquire. Choose the desired value in the pull-down menu; you may need to scroll up to see higher values. The default sample rate is 2000 samples per second, but the best sample rate will vary depending upon the nature of the data being acquired.

Acquisition Length

Acquisition Length is set by using the scroll bar or entering the length directly into the value box. Units are selected in the pull-down menu to the right. The default setting is to acquire data for 1800 seconds (30 minutes,) but length of acquisition will vary depending upon the experimental design.

The MP unit will stop acquiring data when the specified length is reached. You may also stop acquisition at any time by clicking on the "**Stop**" button (enabled during recording,) by default in the upper left region of the graph window.



Repeat every

The **Repeat every** option allows you to acquire data from repeated trials using the same parameters for each trial.

Click the **close button** to exit the **Set Up Acquisition** dialog and return to the graph window.

Consult the BSL *PRO* manual for more information about acquisition parameters.

TRIGGERING, OUTPUT CONTROL, AND OTHER MP MENU OPTIONS

Click on the **MP menu** and view other available commands. Read about them at right.

Note the options on the MP menu and read about some of them below.

- MP45 Users: MP45 menu commands differ from those available for the MP36/35. Consult the BSL *PRO* Manual for more information.

Set up Triggering allows you to start an acquisition "on cue" from a trigger device connected to the MP unit. (Not supported in MP45 hardware.)

Access Triggering via **MP menu > Set Up Data Acquisition > Trigger**.

Show Input Values opens a window that displays input data in numerical format as it is being acquired. (This function is enabled only when the "Show Input Values" option for a channel is enabled in the Input channel parameters dialog.)

Output Control generates a submenu of Output Controls. The MP36/35 outputs signals via ports on its back panel. To output analog signals, use the "Analog Out" port; to output digital signals, use the "I/O" port.

- Available output controls for the MP36/35 are **CH to Output**, **Voltage**, **Digital Outputs**, **Pulses**, **Stimulator-BSLSTM**, **Pulse Sequence**, **Human Stimulator – STMHUM**, **Visual Stim Controllable LED – OUT4, Sound Sequence** and **Stimulator-SS58L**. Consult the BSL *PRO* Manual for more information. (**Pulse Sequence** is available only on MP36/MP35A hardware. **Voltage** is available in MP35 only.)

Part 2: Recording

See details about recording data at right.

If the MP unit is not connected, review recording details at right and proceed to the following section.

Once the input channels and acquisition parameters are set up, you are ready to record. To acquire data, the MP unit must be connected to your computer and powered on. (If the MP unit is not properly connected or not communicating with your computer, you will be unable to record data and an error prompt will appear.)

Recording a file is beyond the scope of this tutorial, other than to practice acquiring a few segments of "flatline" practice data.

- To acquire useful data, electrodes, transducers and other devices must be in place to collect signals from your subject. If no input devices (e.g. electrodes or transducers) are connected to the MP unit, but the MP unit is connected to the computer, the unit will acquire—and BSL *PRO* will display—a small, "flatline" value of random signal "noise" with a mean of about 0.0 Volts.

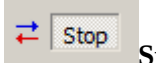
If the MP data acquisition unit is connected, practice recording a new data file.

- Choose **File > New** to open an "Untitled" graph window and practice recording.
- Use the **Start/Stop** button in the graph window to acquire multiple, short segments of "flatline" practice data.
- Use the **Rewind** button in the Toolbar to delete a data segment.
- Choose **File > Close** to close the practice graph without saving.

If the MP unit is connected, choose **File > New** to open an "Untitled" graph window and practice recording data. If no MP unit is connected, read about recording below and proceed to the following section of this tutorial.

Start acquisition by clicking the **Start button** in the upper left corner of the graph window, or by pressing "**Ctrl + Spacebar**." The circle next to the Start/Stop button, when green and solid, indicates that the MP hardware is communicating with the computer, ready to record.

Once an acquisition has started the Start/Stop button in the graph window changes to Stop. (The two opposing arrows to the left of the button indicate that data is being collected. The "Busy" status light on the front of the MP unit also indicates that data is being collected.)



Stop an acquisition at any time by clicking the **Stop button**, or by pressing "**Ctrl + Spacebar**." An acquisition automatically stops when it reaches the Acquisition Length parameter in the Set up Acquisition dialog.

In the default **Append** mode, BSL *PRO* can record multiple segments in a single file. Simply "Start" again to append another recording segment. An **append marker** indicates the beginning of each new recording segment.


The **Rewind** button to the right of the Start button deletes the last recorded segment.

Acquisition parameters cannot be changed while recording is in progress. If acquisition parameters are modified during a pause between recording segments, and then the recording is restarted, BSL will warn that previous data will be overwritten (unless the "Warn on Overwrite" option in the MP menu is disabled). Similarly, deleting a recorded segment with the **Rewind** command will generate a warning.

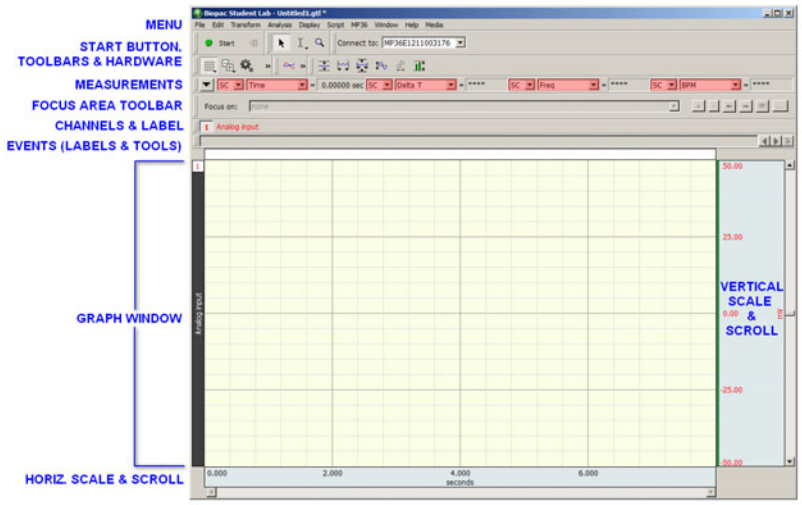
After recording multiple short segments, choose **File > Close** to close the practice data window without saving.

Recording is unique to each application. Follow the recording guidelines for your specific lab lesson, experiment, or application note. To read more about recording, consult the BSL *PRO* Manual.

Part 3: Display

Note the features of the **BSL *PRO* display** in the labeled figure at right.

The BSL *PRO* graph window is designed to provide you with a powerful yet easy-to-use interface for viewing and manipulating data.



CHANNELS

Selecting Channels

Note the four channels of data in the display of sample file **4Channel.acq**.

Click the **CH2 channel number box** (or its "PPG" label to the left of the waveform) to make it the active channel.

The **4Channel.acq** sample file contains four different types of data, each in its own channel with a border between each waveform display. To the left of each waveform is a channel label, with the channel number color-coded to help identify each waveform: ECG Lead 2, PPG (Pulse Pressure,) Stethoscope (Heart Sounds,) Respiration.

In the upper left of the graph window, a row of small, numbered boxes indicate the acquired channels. The color for each channel's waveform, label and corresponding indicator box and can be changed. The box on the left corresponds to the waveform at the top of the screen.

The box that appears highlighted is the **selected**, or "**active**," channel. The label of the active channel is displayed to the right of the channel number boxes and is highlighted in the graph window to the left of the waveforms.

To make a channel active, select its channel number box or its label with the arrow tool. Only one channel can be active at a time. In the example shown here, Channel 2 (PPG) is active.

Transformations and editing operations generally apply to the active channel, though in some cases, to multiple channels. Measurements can be taken from any channel, whether active or not.

Hiding channels

To focus on one channel, it is sometimes helpful to temporarily "hide" another. To **hide a channel**, click on that channel's number box while holding down the **Alt** key. The channel's number box is lined over and the display redrawn with the hidden channel's data not visible. Pressing **Alt** and clicking the channel's number box again causes the waveform to reappear.

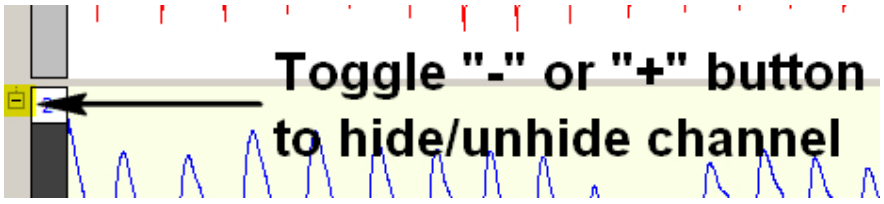
Hold down the **Alt** key and click on the **CH2 PPG** channel number box to hide the channel.

Hold down **Alt** and click again to unhide the channel.

Multiple channels can be hidden. Hiding an active channel makes the following visible channel become active. Note, though, that a hidden channel can be made active (even while hidden) by clicking its channel number box.

Collapsing Channels

In BSL versions 4.1.1 and higher, individual or multiple channels may be hidden from view or "collapsed" by simply clicking the "-" button appearing in the upper left region of each channel. (Click "+" to restore the channel.)



Collapsing a channel allocates more vertical space to remaining channels, enhancing the view of the visible data.

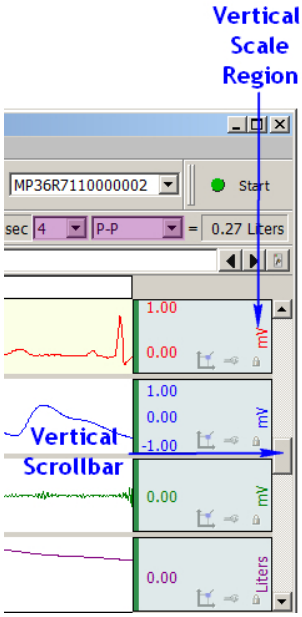
NOTE: In certain Windows operating systems, the "+" and "-" buttons may instead appear as triangular boxes.

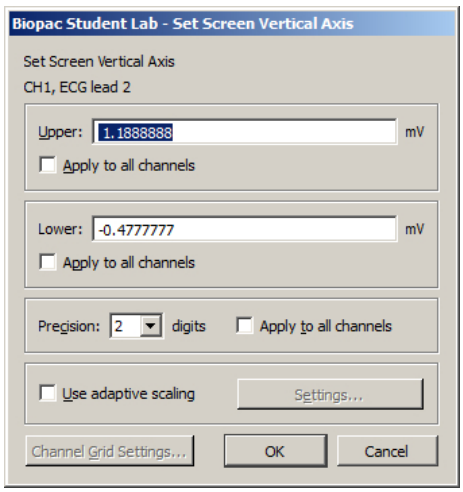
SCALE

Adjust Vertical Scale

Adjust the **Vertical Scale** of **CH1**.

- Click in the vertical scale region of the channel to generate the **Set Screen Vertical Axis** dialog.
- **Change the Upper and Lower** ranges to one-half the current values.
- Click **OK** to set the new scale and close the dialog.
- **Observe** the rescaled waveform in the graph window.





Repeat the previous step to adjust the vertical scale of **CH2**, **CH3**, and **CH4**.

The **vertical scale** at the right edge of the graph window displays the amplitude units and range for each channel.

You can independently adjust the vertical scale of each waveform. Click the mouse in the vertical scale region corresponding to that waveform's channel to generate a vertical scale dialog. Type in scale values that result in a scale range about half the current value and click **OK.** The waveform's screen amplitude should now be about twice as large as it was before.

Select each channel's waveform and use the **vertical scroll bar** to adjust the midpoint of each.

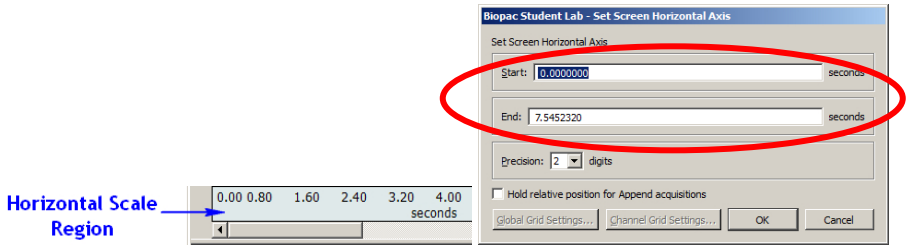
After changing the vertical scale, use the **vertical scroll bar** to adjust the midpoint of each channel. The scroll bar acts independently upon each channel; you must select the channel first.

Adjust Horizontal Scale

Adjust the **Horizontal (Time) Scale** of all waveforms.

- Click in the horizontal scale region to generate the **Set Screen Horizontal Axis** dialog.
- Change the **Start and End ranges** to one half the current values.
- Click **OK** to set the new scale and close the dialog.
- **Observe** the rescaled waveform in the graph window

The horizontal scale affects all channels.



The **horizontal scale** can be adjusted to any range to compress or expand the displayed waveforms along the horizontal (time) axis. **The horizontal scale affects all channels.**

Click the horizontal scale region to generate the horizontal scale dialog. Type in an upper range value that is about half the current value and click **OK**. The horizontal scale of all waveforms should now be about twice as large as it was before.

Use the **horizontal scroll bar** to scroll to the beginning and end of the recording.

Adjusting horizontal scale allows you to magnify the screen display to better examine a waveform, but note that the waveforms may no longer fit in the data window. The file, however, contains the complete record even if all data is not displayed on the screen.

To view the beginning of the recording (time zero,) scroll left with the **horizontal scroll bar**. To view the end, scroll right. The horizontal (time) scale along the bottom of the graph window denotes when the data was recorded relative to the beginning of the acquisition.

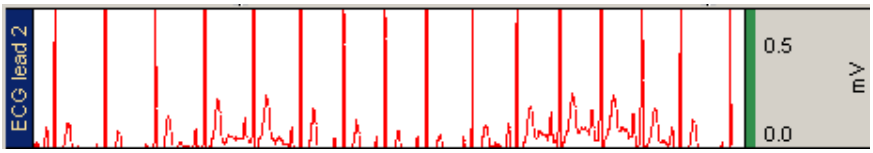
AUTOSCALE	**Autoscale commands** determine the optimal scale for waveforms and centers the display. Note: Once waveforms are optimally scaled, repeating an autoscale command has no apparent effect. As needed to practice autoscale commands, individually adjust the scale of each channel as you have done in prior steps and scroll midpoints away from center.

Autoscale Waveforms (Vertical)

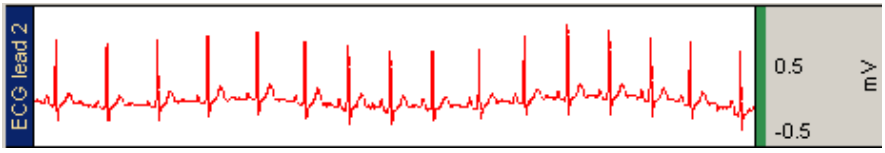
Select a channel.


Click the **Vertical Autoscale** icon in the Toolbar at the top of the graph window to optimize the vertical scale of the **selected** waveform.

Right-click in another channel to select it, and choose **Autoscale Single Waveform** from the pop-up menu to optimize the vertical scale of that **selected** waveform.



Note the graph display of the waveform before and after autoscaling.




To optimize the vertical scale of an individual channel, select the channel and click the **Vertical Autoscale** icon in the **Toolbar** at the top of the graph.

- Shortcut: right-click to select a waveform and choose **Autoscale Single Waveform** from the pop-up menu.

Choose **Display > Autoscale Waveforms** to optimize the vertical scale of **all** waveforms.

To optimize the vertical scale for all channels and center the waveforms vertically, choose the menu command **Display > Autoscale Waveforms**.

- Shortcut: right-click to select a waveform and choose **Autoscale Waveforms** from the pop-up menu.

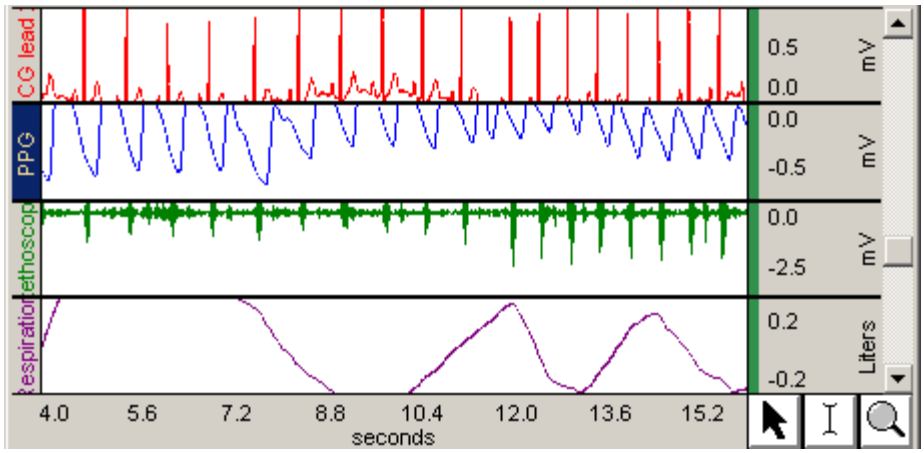
Autoscale Horizontal

Choose **Display > Autoscale Horizontal** to optimize the horizontal (time) scale of **all** waveforms.

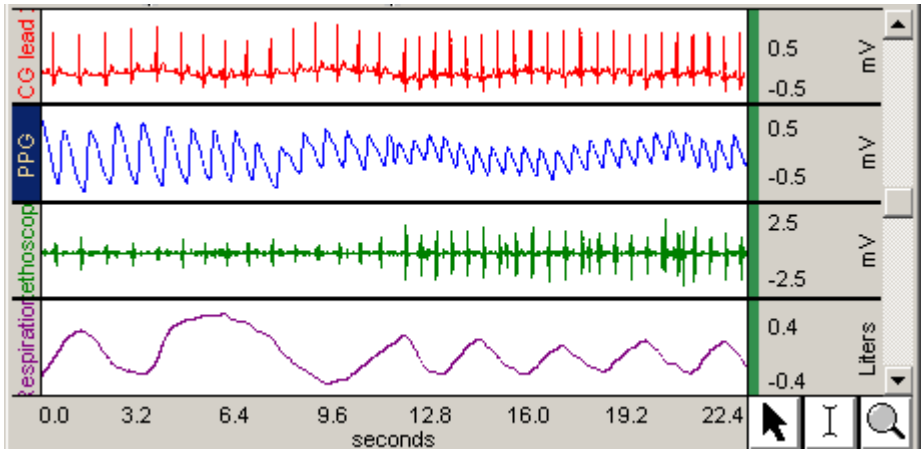
Choose **Display > Autoscale Waveforms** (Vertical) again.

Note that the entire recording is displayed.

Choosing *Autoscale Horizontal* and then *Autoscale Waveforms* from the *Display menu* is the standard way to quickly and easily display the entire recording.



Note the graph display of all waveforms before and after autoscaling. (Graph display after autoscaling is shown on next page.)



To optimize the horizontal scale for all waveforms and make all the data visible in the graph, choose the menu command **Display > Autoscale Horizontal**. This sets the horizontal (time) scale range to start at 0 (beginning of acquisition) and end at the end of the recording. The entire recording is displayed.

- Shortcut: click on the **Horizontal Autoscale** icon in the Toolbar at the top of the graph window.

GRIDS AND GRID OPTIONS

Toggle the **Grid** icon in the Toolbar to "show" grid lines.

Right-click in the waveform region and choose **Grid Options** from the pop-up menu to generate the Grid Options dialog.

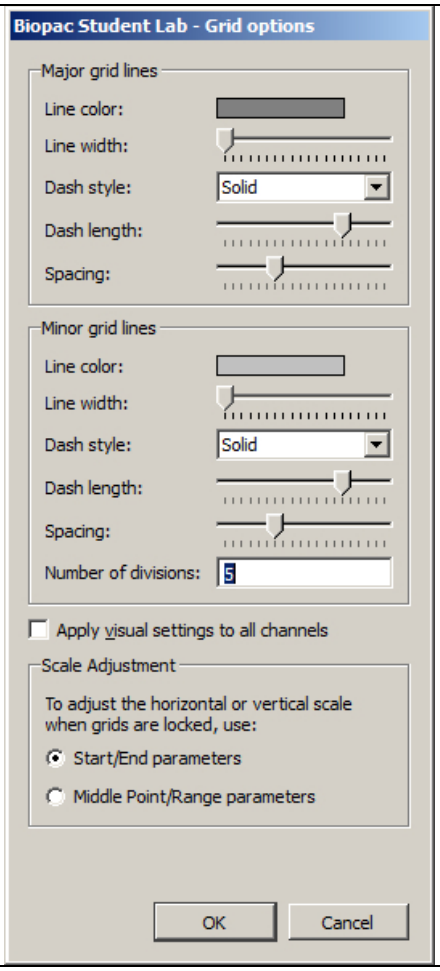
Note the available grid options.

Right-click in the waveform region to generate a pop-up menu, and deselect **Grid** to "hide" the grid lines.

The **Grids** icon on the Toolbar "shows" or "hides" grids. Alternately, choose the **Display > Show > Grid,** or right-click in the waveform region and select or deselect **Grid**.

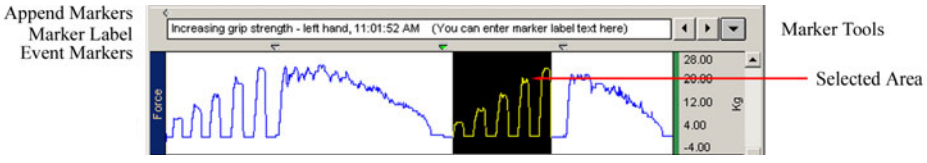
Display > Show > Grid Options generates the **Grid Options** dialog, with settings that control the display. Alternately, right-click in the waveform region and choose **Grid Options**.

Additional Grid adjustment options can be accessed by clicking the **Vertical Axis** area of any channel or the **Horizontal Time Axis** area at the bottom of the graph window. For full details about Grids, please see the BSL *PRO* Manual.



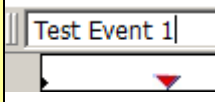
EVENTS AND MARKERS

See details about Append and Event markers at right.



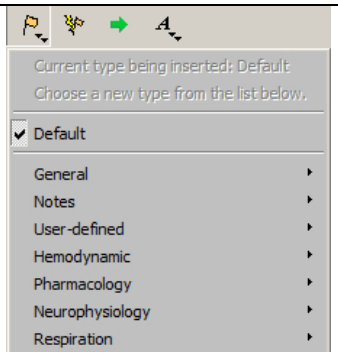
Event markers are used to identify important data points in a recording so they can be referenced later. For instance, you may want to note when an experimental condition began or when an external event occurred so you can examine any possible reaction. Event marker labels help reference these data locations.

The event marker that is active (selected) is colored red and its label displayed.

Append Markers **Event Markers** **Event Tools** **Event Summary Preferences**	**Append markers** are displayed in the event region below the event label box. They are automatically inserted by BSL *PRO* to mark the beginning of recording segments. To help identify separations between appended segments, a black vertical line appears in the graph directly below the append markers. **Event markers** are also displayed below the event label box. They are manually inserted during or after recording. To insert an event marker *during* recording, press the Esc key and enter a label in the marker label text box. This enters an event at exactly the time the key is pressed. To insert an event marker *after* recording, click the Event  icon on the toolbar, and then click in the event marker region above the data point to be marked. If desired, enter a label in the marker label text box. Click and hold the left mouse button down on the **Event** toolbar icon to open a menu of available event types, any of which can be selected for insertion into the event marker region.  **Event Tools** are located at the right of the event marker region. Use the tools to jump through the markers, or use the **Event Palette** to search for specific events, manage events, and to paste an event summary to the Journal. **Event Summary Preferences** are located in Display > Preferences > Event Summary Preferences. Use this feature to set options for grouping and sorting events.
	To show or hide the events or the event bar, choose the menu command **Display > Show > Events** or **Display > Show > Event Bar**. You may also use the handy  toolbar button to show/hide specific elements in the graph. *Note*: Not all sample files included with BSL *PRO* include append markers, but all files you create with the software will include automatic append markers at the beginning of each recorded segment. Consult the BSL 4 *PRO* Manual for more information about markers.
Add and **label** a new event marker in the event marker region.	To add a new **event marker**, activate the **Events** tool  , then click above the data point you wish to mark, in the space between the bottom of the marker label box and the top of the graph.  Enter a new marker's label by typing in its activated label text box. You may change an active marker's label by entering new text in its label box. (Clicking on an existing marker with the Arrow tool selects that marker and makes it active.)

 Use the **Event Tools** to move through the markers and **activate** the event marker that you added in the previous step.

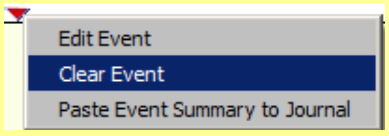
Use the **Event Tools right and left arrows** to move through the markers. Move to the marker you added in the previous step. When active (selected,) it will be colored red and its label displayed. 



The marker that you added is a red inverted triangle, as it is an event marker that you added to the recorded file. (The triangle is the default event marker type.) Holding down the left mouse button over the Events toolbar opens the Events menu, where many additional event types are available. For more details on specific event types, consult the BSL 4 *PRO* Manual.

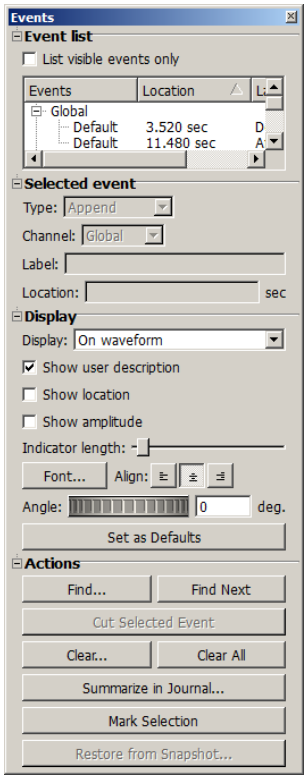
The "Zap" tool  is handy for removing events from the event marker region. After selecting the tool, the cursor will assume a "lightning bolt" shape (below) when positioned over the event region. Clicking on an unwanted event with this cursor will permanently remove the event from the graph. Note: The "Zap" tool does not work on Append markers inserted by the application during recording. (See next page for details on using "Clear Event" to remove Append markers.)

Right click any selected event and choose **Clear Event** to delete the marker activated in the previous step.

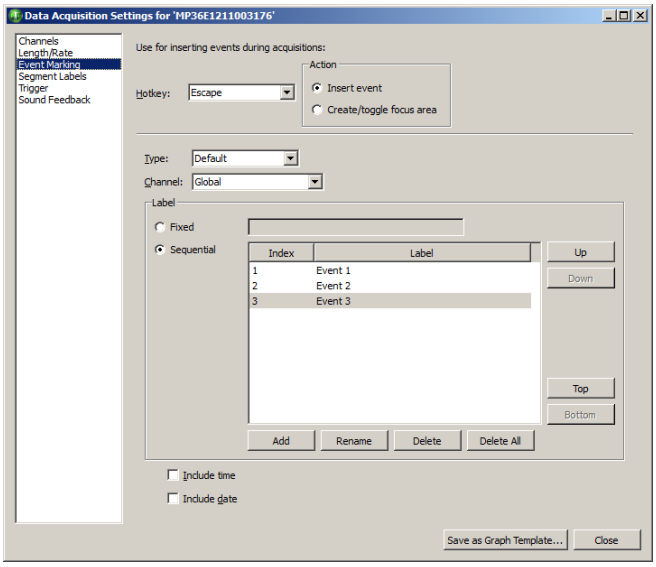


NOTE: Append event markers cannot be deleted.

The **Event Palette** button  generates specific controls for customizing event markers. See the BSL 4 *PRO* manual for more details on managing and controlling events using this powerful feature.



MP36 Click **MP menu** > **Set Up Data Acquisition** and choose **Event Marking** to generate the **Event Marking Setup** dialog.



Event Marking setup offers options for assigning function keystrokes used to insert particular event types, and/or pre-defined event labels. This allows you to **pre-establish custom labels** *before* recording that are entered when an event is inserted *during* recording. This is helpful for entering various event types with descriptive labels during recording at exactly the moment an event occurs, when you otherwise might not have time to label them.

Note the various features of the **Event Hotkey Setup**.

Event Marking Setup can be used for:

- Linking a particular event type to a function keystroke
- Determining whether an event is affiliated with a particular channel or applied globally.
- Creating **custom event labels**, either **fixed** or **sequential** that are inserted with the press of a function key while recording.
- Indexing and reordering the custom labels.
- Adding time and/or date stamps to the label.

SELECTION TOOLS

When working with data, you will use one of three selection tools: **Arrow**, **I-Beam**, and **Zoom**.

Selection Tool icons are located in the upper left corner of the display window. Click on an icon to activate the tool indicated for the editing or analysis function to be performed. Selection tools may also be activated by choosing the menu command **Display > Cursor Style**.

You will often use the Zoom tool and I-Beam tool to select a portion of a waveform to edit or analyze. Once you have selected (highlighted) an area, you can perform a variety of operations—such as editing, measuring, or transforming data.

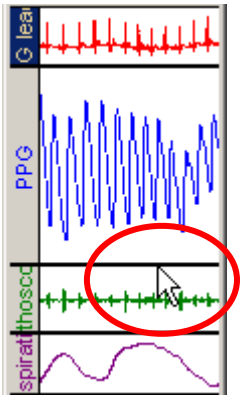
Arrow Tool

Select the **Arrow tool** in the lower right corner of the graph window.

The **Arrow tool** is a general-purpose cursor that is used to select a waveform or channel, scroll through data, adjust chart boundaries between waveforms, select options from pull-down menus, etc. All other cursors default to the arrow style when moved outside of the waveform region.

Use the Arrow tool to resize the chart boundaries between waveforms.

Choose **Display > Reset Chart Display** to return the display to equal sized waveform "tracks."



You may use the Arrow tool to adjust chart boundaries and better view a waveform's "track." Position the Arrow tool over a boundary line between waveforms. When the cursor changes style, drag to resize the track of that waveform. (The I-Beam tool similarly changes style and can be used to adjust chart boundaries.)

Choose **Display > Reset Chart Display** to evenly display the waveform "tracks" in the graph window.

I-Beam Tool

Select the **I-Beam tool** from the toolbar.

Click and drag the I-Beam tool across the waveforms to select an area of data.

Click the I-Beam tool in the waveforms—**without dragging**—to select a single data point.

The **I-Beam tool** is used to select an area of a waveform (or multiple waveforms) to be edited, measured, or transformed.

Clicking and dragging the I-Beam tool across waveforms selects and highlights an area of data. You can perform a variety of operations (editing, measuring, transforming, copying, pasting measurements to the Journal) on the selected data.

As you scroll though waveforms with the I-Beam tool and highlight areas of data to be measured, note that the values in the channel measurement boxes above the graph window adjust themselves continuously.

It is important to note, even without dragging, that the I-Beam tool always selects at least one sample point. If a single point is selected, the cursor will "blink." If multiple points are selected, the area will be highlighted.

Zoom Tool

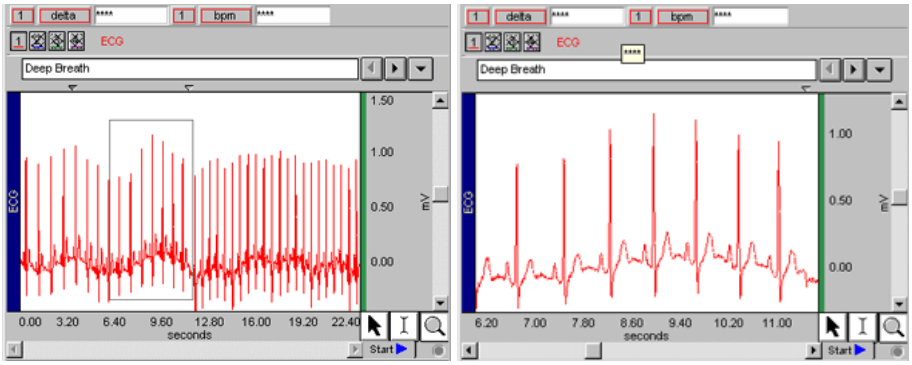
Select the **Zoom Tool** from the toolbar.

Click, drag, and release the Zoom tool in a waveform to select and magnify a section of data.

Zoom again.

Choose **Display > Zoom Back**, or press "**Ctrl –**" (Control + Minus keys,) to undo the previous Zoom command.

NOTE: For Mac OS, use the "**command**" key in place of the **"Ctrl"** key for all BSL keyboard shortcuts.



The **Zoom tool** magnifies a portion of any wave for examination.

Click on the waveform with the Zoom tool in the area you wish to examine, or hold the left mouse button and drag the Zoom tool so it forms a box over the desired area. Then release the mouse button to display the enlarged area.

The Zoom tool magnifies all waveforms. You may want to hide other channels to focus on the channel you wish to zoom in on.

You may "undo" previous zooms by choosing **Display > Zoom Back**, or by pressing "**Ctrl –**" (Control + Minus keys).

Choose **Display > Autoscale Horizontal** and **Display > Autoscale Waveforms** to center all waveforms and display the entire recording.

Choosing **Autoscale Horizontal** and then **Autoscale Waveforms** (Vertical) from the Display menu is the standard way to quickly and easily return to a display of the entire recording.

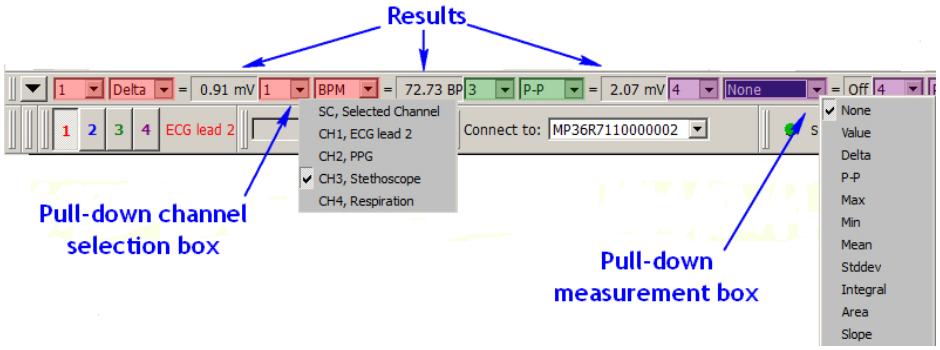
MEASUREMENTS

Over 30 measurement types are available in BSL *PRO* via the Measurements pull-down menu. Some measurements (such as Time or Value) look at only a single data point whereas other measurements (such as Mean and Delta T) examine a selected range of data."

Measurement features can be automated so that measurements are taken and pasted into the Journal file when a specific event occurs, or at pre-specified, user-defined time intervals.

Measurement Boxes

Read about **measurement boxes** at the right.



The **measurement region** is located near the top of the graph window. For each measurement, there are pull-down boxes that specify the channel to be measured and type of measurement, and a value box that displays the results.

To **specify the channel to be measured**, click on the channel selection box and choose from the pull-down menu. When the designation "**SC**" is chosen (default,) measurements are taken from the channel that is active, or "selected," in the graph window.

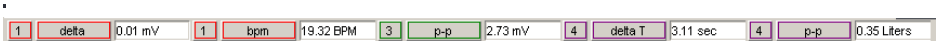
To **specify a measurement type**, click on the measurement box and choose from the pull-down menu.

Measurement results are displayed in the box to the right of the measurement type. Results reflect the waveform data selected in the graph window with the I-Beam tool.

Taking Measurements

Note the **measurement boxes** in the **4channel.acq** sample file.

As you drag the I-Beam tool across waveforms, note the change in values in the channel measurement boxes.



The sample file **4Channel.acq** displays five measurement boxes in the region below the Toolbar. The first is configured to measure **CH1 Delta**, the second to measure **CH1 BPM**, the third **CH3 P-P**, the fourth **CH4 Delta T**, and the fifth **CH4 P-P**.

- If all five measurement boxes are not displayed, drag the window wider.

The measurements adjust themselves continuously as you scroll through the waveforms with the **I-Beam** tool, reflecting the area of data highlighted in the graph window.

It is important to note that **the I-Beam always selects either a single point or an area spanning multiple sample points**. When a single point is selected, the cursor will "blink." When multiple points are selected, the area will be highlighted. If an area is defined and a single point measurement is selected, such as X-axis T (Time,) the measurement will reflect the last selected point.

Hide CH1 and CH2.

To hide channels, hold the **Alt** key and click the channel number boxes.

- Hiding a channel removes its waveform from the graph display.
- When an active channel is hidden, the subsequent visible channel becomes active.

In the following exercise we will observe the results in the three measurement boxes that are configured for **CH3 P-P, CH4 delta T**, and **CH4 P-P.** If all the measurement boxes are not displayed, drag the window wider.

Compare the **P-P** measurements for **CH3, Stethoscope** and **CH4, Respiration** during the "Deep Breathing" and "After Exercise" segments of the recording.

To practice taking measurements, select and compare approximately eight seconds of "Deep Breathing" data with eight seconds of "After Exercise" data.

- Using the **I-Beam** tool, select 8 seconds of data in the "Deep Breath" segment.

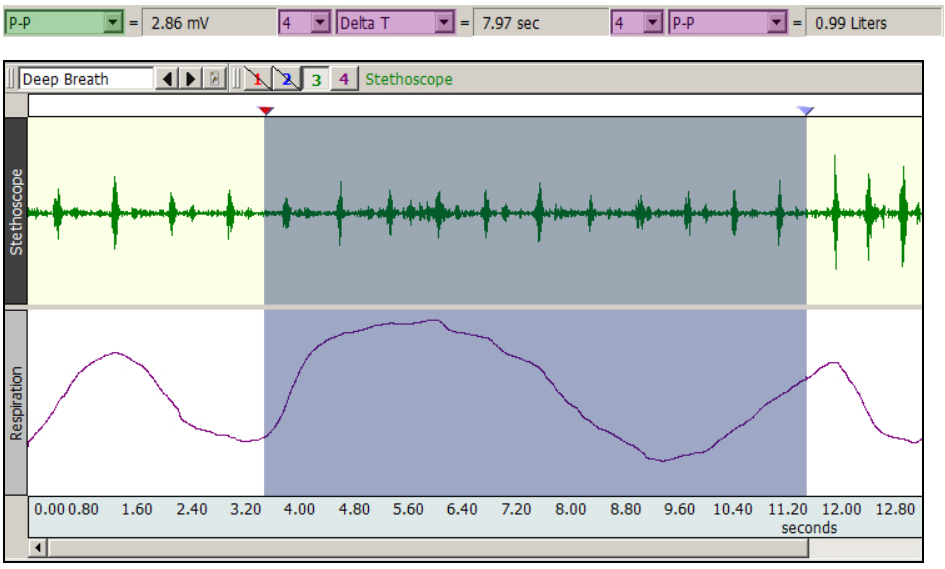
  Note the p-p measurement results in the measurement boxes for CH3 and CH4.

- Choose **Edit > Journal > Paste Measurement**.

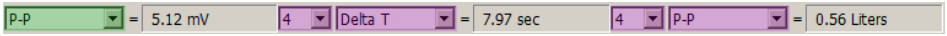
  Read the measurement results that have been pasted into the Journal.

- Select 8 seconds of data in the "After Exercise" segment.

  Note the p-p measurement results in the measurement boxes for CH3 and CH4.



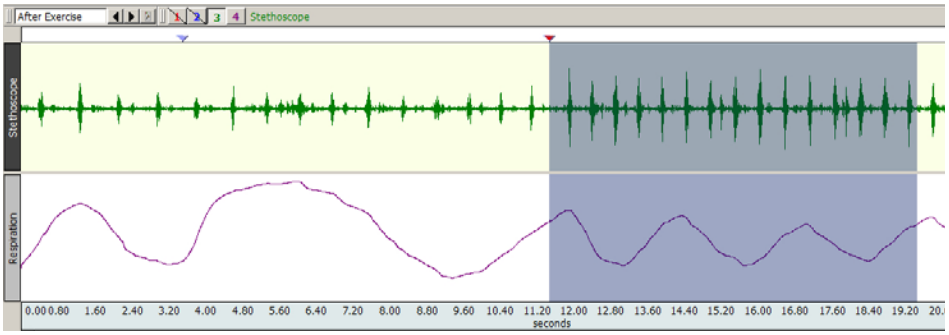
Labeled event markers identify the data segments for each condition. When selecting an area of each segment with the I-Beam tool, note the **CH4 Delta T** measurement to determine 8 seconds of data.



- Choose **Edit > Journal > Paste Measurement**.

  Read the measurement results that have been pasted into the Journal.

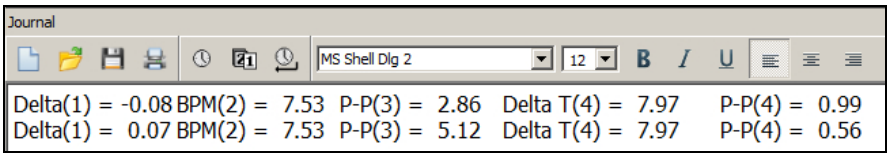
In the Analysis and Journal sections of this Tutorial, you will learn more about taking measurements and pasting measurement data to the Journal.



Compare the **P-P** measurement results for **CH3, Stethoscope (Heart Sounds)** and for **CH4, Respiration** under each condition.

The menu command **Edit > Journal > Paste Measurement** pastes each measurement to the Journal. Review the **Journal** entries shown below.

If the Journal is not displayed, go to **Display > Show** and check the Journal option.



Part 4: Analysis

ANALYSIS OVERVIEW

One advantage of saving data files to disk is that you can quickly and easily perform post-hoc analyses of your recorded data. BSL *PRO* software is a powerful and flexible analytical tool designed to provide you with immediate feedback from each operation. Using BSL *PRO*, you are able to...

- Use digital filtering and smoothing.
- Find patterns within data sets.
- Automatically find peaks and calculate rate data.
- Perform mathematical and statistical operations.
- Log results and observations to a journal.
- Mark events during acquisition or analysis.
- Transform data after it has been acquired.

To get an idea of how BSL *PRO* provides immediate feedback, run a **Find Peak** function on the **4Channel.acq** sample file.

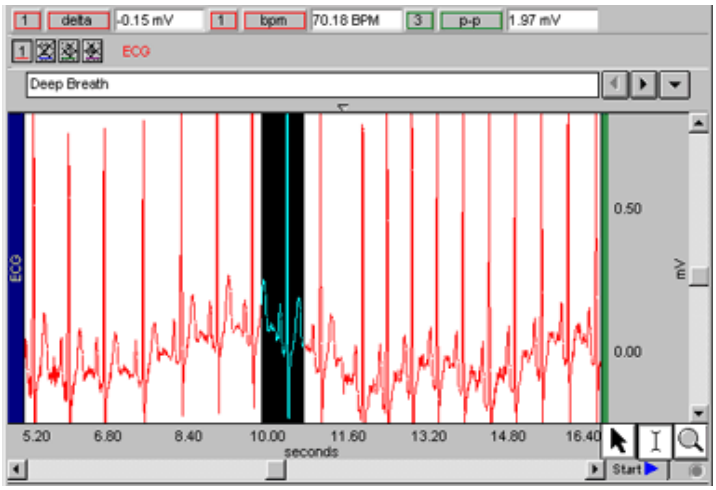
Adjust the display of the sample file **4Channel.acq** to view ten seconds of ECG data.

- **Select CH 1, ECG**.
- **Hide** other channels
- **Zoom** in on about ten seconds of data
- **Autoscale** the waveform as needed.

Select CH 1 and hide the other channels by pressing **Alt** and clicking the channel number boxes.

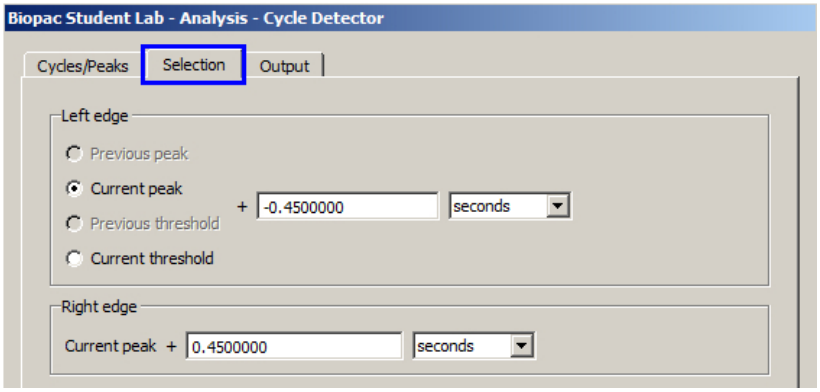
Use the **I-Beam** tool to select one ECG cycle, as shown in the screen shot at right.

Use the **Zoom** tool to examine a 10-second portion of the waveform. To center your display after zooming, use the **Autoscale Waveforms (Vertical)** command from the Toolbar or from the Display menu.



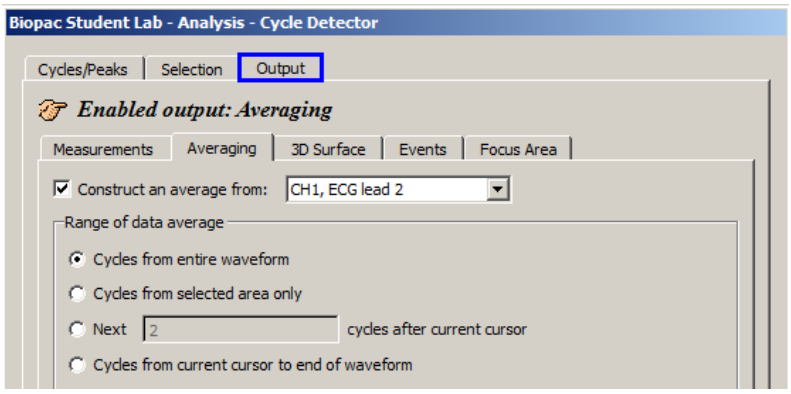
Choose **Analysis > Find Cycle** to generate the Find Cycle dialog.

Click the **Selection** tab and Set the first cursor to "**Current Peak + (-.45) sec**" and the second cursor to "**Peak + (+.45) sec**".

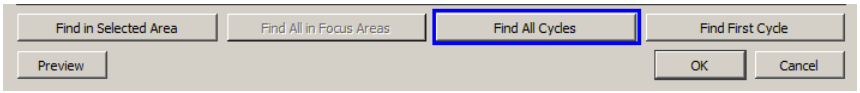


Note the settings in the **Find Cycle dialog**. BSL *PRO* automatically calculates a threshold level based upon a percentage of the peak in the selection of data that you highlighted.

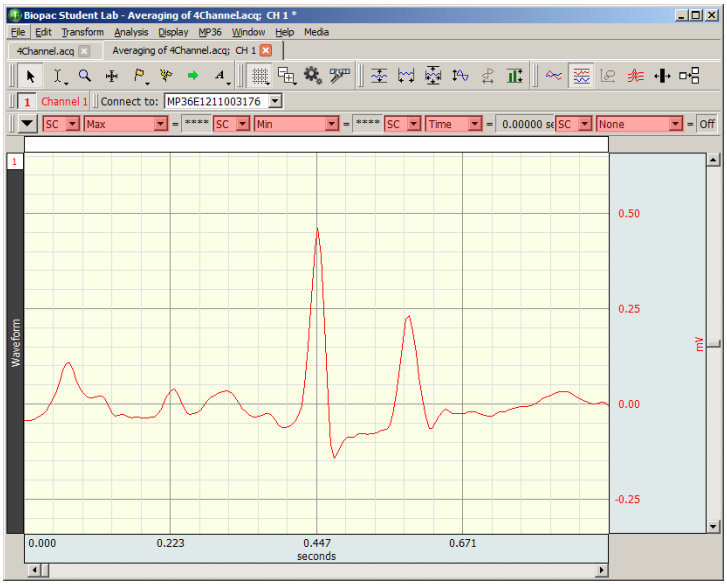
Click the **Output** tab and select "Averaging > Construct an average from" **CH1 ECG Lead II.**



Click the "**Find All Cycles"** button.



BSL PRO runs through the data and generates a new graph window showing the **average ECG** for the entire recording.



You may also average a selected portion of the recording. This feature is useful when comparing the ECG complex during different sections of an experiment.

Close the **Averaging** result graph without saving and return to the graph display window.

ANALYSIS > FIND RATE

In addition to performing mathematical functions, the BSL *PRO* software can search for peaks and calculate rate. The **Find Rate** function will calculate rate information for a variety of cyclical data, including BPM, Hz, peak max, peak min, P-P, area, and mean.

For example, suppose you want to **calculate BPM** for the entire ECG waveform once it has been collected.

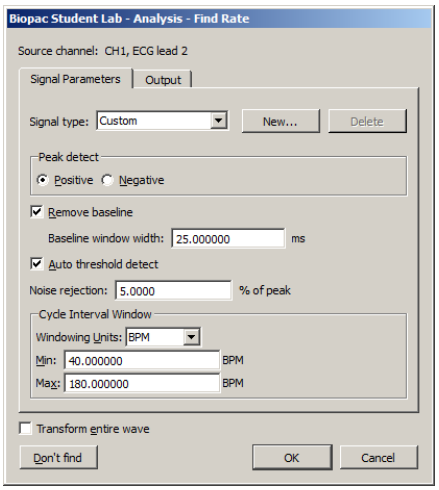
Select **CH 1, ECG**.

Choose **Analysis > Find Rate**.

Select the function **Rate (BPM)**.

Check to enable "**Transform entire wave**."

To do this, select CH 1 and choose the menu command **Analysis > Find Rate** to generate the **Find Rate** dialog. View the functions available both the Signal Parameters and the Output tabs.



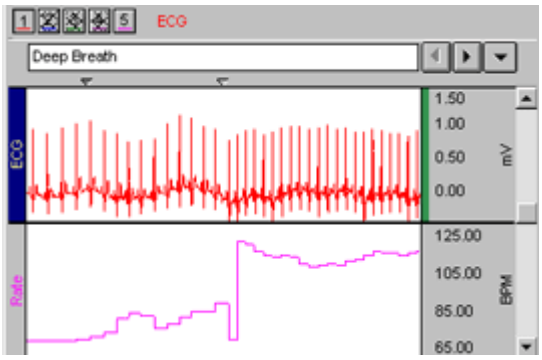
Note the other options allowing you to customize the Rate calculation. Find Rate can operate as a simple threshold detector or can include more sophisticated parameters such as noise rejection and windowing. Custom "Signal types" (or presets) can also be created and saved.

Click **OK.**

BSL PRO calculates the rate and displays its graph.

Note the new **CH 5 Rate** channel that has been added to the graph window.

BSL *PRO* calculates the threshold values and computes the rate for the entire waveform. The **rate is charted** and added to the current graph window. Options enable you to limit the transformation to a selected area, and to display the rate graph in a new window.



ANALYSIS > HISTOGRAM

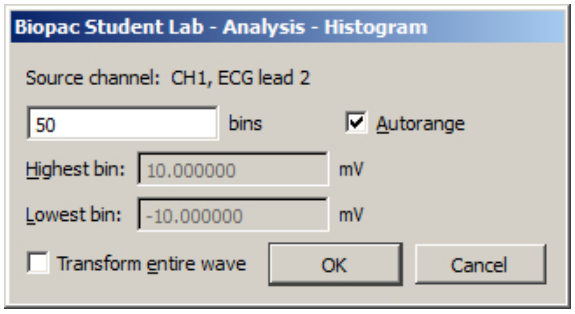
A related type of transformation is the **histogram**, which allows you to display data in summary format and examine the central tendency characteristics and variability within a waveform.

Select **CH 1, ECG**.

Choose **Analysis > Histogram**.

Set the bins value to "**50**."

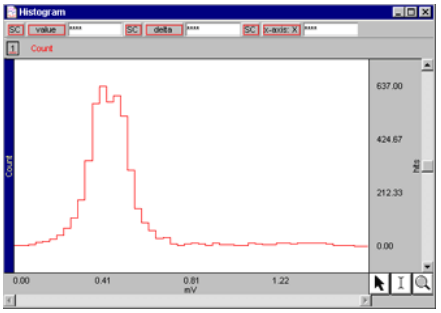
Choosing **Analysis > Histogram** generates the **Histogram Options** dialog. The dialog prompts you to enter the number of "bins" to sort the values into, and (if you do not accept the default "autorange") to enter the upper and lower bounds of the data to be sorted. Type "**50**" in the bins entry and click **OK**.



Click **OK**.

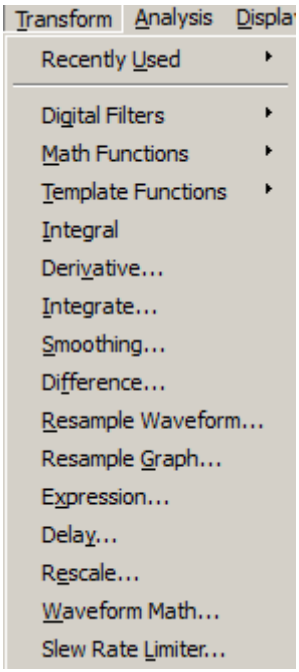
Close the **Histogram** graph window without saving.

The resulting waveform is generated in a new graph window and should resemble the **histogram plot** shown here.



THE TRANSFORM MENU

Scroll through the options under the **Transform** menu command and note the available functions.



The **Transform menu** contains a number of functions that modify waveform data.

The **Digital Filter** sub-menu has both FIR and IIR types of filter operations. For most datasets, the default filter parameters may be used and will produce relatively robust results.

The **Math Functions** sub-menu lists several available mathematical transformations. Some transformations produce a dialog with parameters that can be changed.

The **Template Functions** sub-menu provides a host of options to examine the relationship between two different waveforms.

The **Integral** transformation results in a running total of all selected waveform values (using trapezoidal rule integration).

The **Derivative** transformation approximates an ideal differentiator. It allows you to specify a low pass frequency to filter the data prior to performing the derivative. The **Difference** transformation is a running subtraction over the number of points specified.

The **Expression** option allows you perform a range of mathematical operations, from simple addition and subtraction to arcsine and log transformations. You can perform complex operations in a single step. For example, you can compute the mean of several channels, and then use the arcsine function to transform the result and save the output to a new channel. You can transform entire waveforms or sections of waveforms.

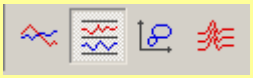
Remove a new channel selecting **CH 5** and choosing **Edit > Remove Waveform**.

To remove a channel from a file, select it and choose **Edit > Remove Waveform**. Take care to select the channel you wish to remove, as you may not undo this command.

Show all four channels of the **4channel.acq** graph.

Return to the **4Channel.acq** graph window. “Show” channels that are hidden by holding the **Alt** key and clicking the channel number boxes.

DISPLAY MODES



BSL *PRO* offers a number of display options, including **Scope**, **Chart**, **X/Y Plot**, and **Stacked Plot**. Chart is the default display mode.

You can switch from one display mode to another using the Toolbar icons in the upper left hand corner of the window. By clicking on these icons, you can alternately have your display emulate a chart recorder (Chart mode,) oscilloscope (Scope mode,) or plot data from one channel against data from another channel (X/Y Plot Mode).

Stacked Plot displays multiple time ranges on top of each other and is enabled for acquisitions set to Append (except when in X/Y mode). In this mode, all appended segments are stacked in the display, but only one segment “slice” is active (“selected”). To view an individual segment, click the Chart mode icon.

 Click on the **Scope** display mode icon.

The **Scope** display mode emulates an oscilloscope. All waveforms are in a single window with no borders between channels. Waveforms can overlap.

- Choose **Display > Tile Waveforms**
- Choose **Display > Overlap Waveforms**
- **Hide** CH 1 and CH 2.
- **Analyze** the **CH 3** and **CH 4** waveforms.

Display menu options determine the display of waveform data.

 Click on the **X/Y Plot** display mode icon.

- Set the **X-axis** to "Respiration."
- Set the **Y-axis** to "Stethoscope."

Analyze the relationship between **CH 3, Stethoscope (Heart Sounds)** and **CH 4, Respiration**. Note the differences between the "Deep Breath" and "After Exercise" data segments.

X/Y Plots are useful for respiration studies, vectorcardiograms, and investigations into non-linear dynamics.

In X/Y display mode, the **X-axis** and **Y-axis** labels correspond with the channels that are being plotted. To set the axes, click on the labels and choose the channel to plot from the pull-down menu.

In X/Y display mode, the **I-Beam** tool becomes a cross hair. When scrolled across the graph window, the X-axis and Y-axis values are displayed in the measurement region above the graph window.

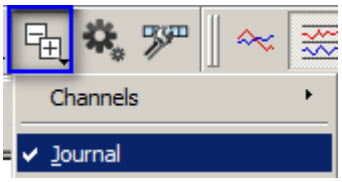
 Return to the **Chart** display mode, show all channels, and autoscale waveforms.

Click on the **Chart** display icon to return to Chart mode. Show any hidden channels by holding the **Alt** key and clicking the channel number boxes.

Choose **Autoscale Horizontal**, then **Autoscale Waveforms** to optimally scale and center all waveforms.

Part 5: Journal

 Toggle the Display shortcut on the Toolbar and select "Journal" to hide and show the Journal region of the display.



Adjust the size of the Journal region by dragging the boundary that separates the Journal from the graph window.

The **Journal** is a text editor built into the BSL software that allows you to record notes and data at the same time you are acquiring and analyzing data. Journal entries are saved with the BSL *PRO* data file. You can copy measurements and wave data (in numeric format) from the graph to the Journal, and export Journal data to other programs for further analysis.

If the Journal is not in view, choose the menu command **Display > Show** and select Journal.

You may adjust the size of the Journal display with the mouse by dragging the boundary bar that separates the Journal from the Graph window.

JOURNAL TEXT ENTRY

Place the cursor at the beginning of the Journal and type notes.

Type any notes you want directly in the Journal. Your keystrokes are entered where the cursor is placed. The Journal accepts standard keyboard text entries (except certain keystroke combinations reserved for BSL *PRO* functions.)

JOURNAL TIME AND DATE TOOLS

Time, Date, AutoTime

Time, **Date**, and **AutoTime** tools are in the top left corner of the Journal window. They record the time and/or date directly into the Journal.

- Time and date are entered according to your computer's system clock and calendar. If incorrect, check your system settings.

Enter a **time** stamp.

 Once the cursor is placed in the Journal, click the Time tool (clock icon.)

- Place the cursor at the end of existing journal entries.
-  Click the Time tool (clock icon) to enter a **time** stamp.
- Review the Journal.

Enter a **date** stamp.

- Place the cursor at the end of existing journal entries.
-  Click the Date tool (calendar icon) to enter a **date** stamp.
- Review the Journal.

Activate the **AutoTime** tool and enter time/date stamps.

-  Click the icon to **activate AutoTime**.
- Place the cursor where you want the time/date stamp to be inserted.
- Press the **Enter** key.
- Press the **Enter** key again.
- Review the Journal.
-  Click the icon again to **deactivate AutoTime**.

PASTE MEASUREMENTS TO THE JOURNAL

Set Measurement Preferences

Choose the menu command **Display > Preferences > Measurements** or click the Preferences toolbar shortcut and choose **Measurements**.

MAC: Biopac Student Lab > Preferences > Measurements

Review the options that determine how measurements and wave data are pasted into the **Journal**.

The current time is entered at the cursor point.

 Once the cursor is placed in the Journal, click the **Date** tool (calendar icon.) The current date is entered at the cursor point.

 Click the **AutoTime** tool (clock icon with arrow – upon activating, the icon will appear depressed). Then, place the cursor in the Journal and press the **Enter** (Return) key.

If the AutoTime tool is activated—and if the cursor is positioned in the Journal text region—the current time/date is inserted each time the **Enter** key is pressed.

- To reset the Enter key to its normal “Return” function in the text editor, toggle the AutoTime icon again.

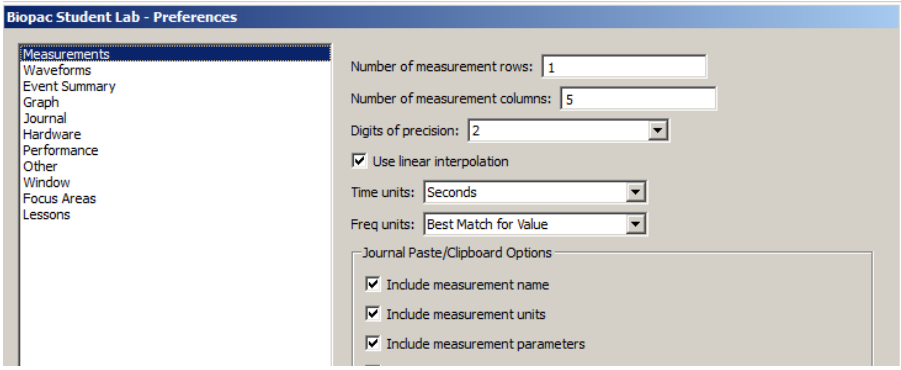
The AutoTime function records the time at the instant the **Enter** (Return) key is pressed. This is very useful for entering time stamps during recording while data is being collected.

Measurement Preferences options control how measurements and wave data are formatted, when pasted directly from the graph window to the Journal using the **Edit > Journal** submenu commands

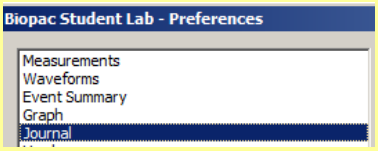
You can also set general text options for the Journal in Preferences. To set the text word wrap option, right-click anywhere in the journal text entry region.

Check:

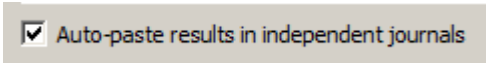
- Include measurement name
- Include measurement units
- Include measurement parameters



Choose the **Journal Preferences**.



For this tutorial, select the "Auto-paste results in independent journals" option under the Journal Preferences, so that data pasted into the Journal will be easily identifiable.



Set Measurements

Set a measurement box for **CH 1 BPM**.

- Choose **CH 1** as the selected channel.
- Choose "**BPM**" as the measurement.

From the pull-down menus in the measurement box, choose **CH 1** as the selected channel, and **BPM** as the measurement.

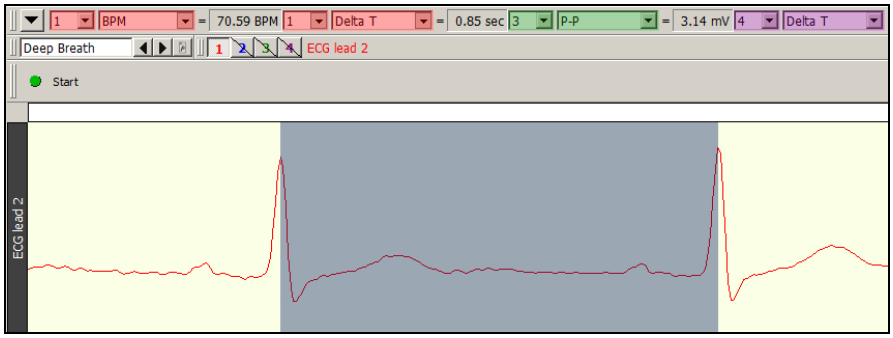
- TIP: If the channel you wish to measure is the active channel, you can set **SC** (selected channel) as the channel to be measured.

Set a second measurement box for **CH1 Delta T (Time)**.

- Choose **CH 1** as the selected channel.
- Choose "**Delta T**" as the measurement.

From the pull-down menus in another measurement box, choose **CH 1** as the selected channel, and **Delta T** (Time) as the measurement.

Use the **I-beam** tool to select an area of data from the **peak of one R-wave to the peak of the next R-wave**.



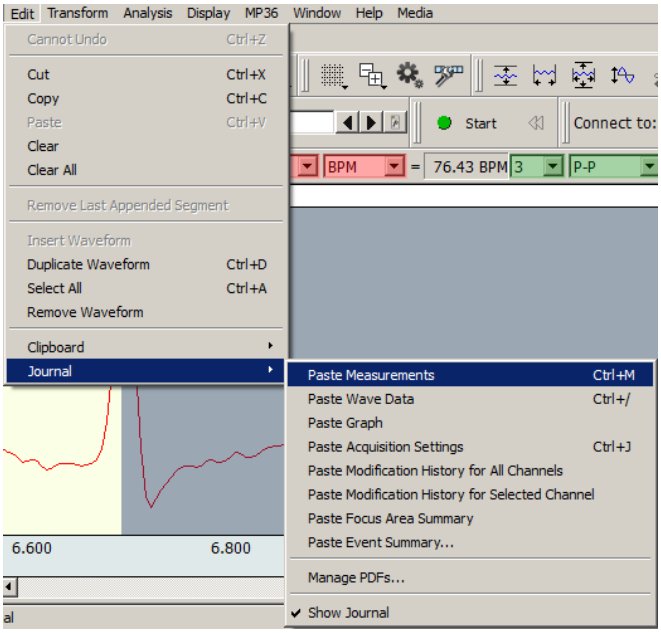
Zoom in on the **CH1 ECG** data. Identify and select a region from the peak of one R-wave to the peak of the next R-wave.

Paste Measurement Data

Click the cursor in the Journal where you want to paste the measurement.

Choose the menu command **Edit > Journal > Paste Measurements**.

Review the Journal entry.



When you use the **Paste Measurements** function, all measurements showing a value will be written to the Journal.

You may also paste measurements using the Σ button on the Journal toolbar.

If you do not want a particular measurement pasted to the Journal, go to the pull-down menu for that measurement and select the option “None.”

PASTE WAVE DATA TO THE JOURNAL

Use the **I-Beam** tool to select the portion of the waveform you are interested in.

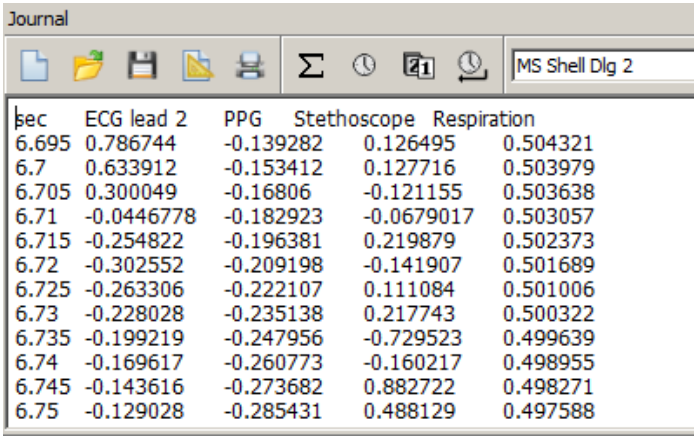
Click the cursor in the Journal where you want to paste the wave data and choose **Edit > Journal** > **Paste Wave Data**

Review the Journal entry.

The **Paste Wave Data function** writes to the Journal all the data points of the selected area in the graph window.

It is very easy to import a lot of data into the Journal using this command.

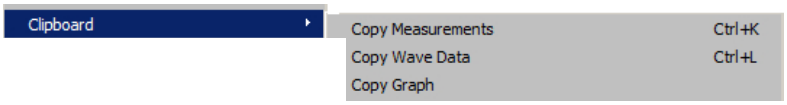
You are not pasting simply a measurement—you are pasting all the data points of the selected area of the waveform in all channels. If you select one second of a wave that was sampled at 1000 Hz, 1000 numbers will be pasted into the Journal. The values will be formatted in columns headed by the respective channel names.



sec	ECG lead 2	PPG	Stethoscope	Respiration
6.695	0.786744	-0.139282	0.126495	0.504321
6.7	0.633912	-0.153412	0.127716	0.503979
6.705	0.300049	-0.16806	-0.121155	0.503638
6.71	-0.0446778	-0.182923	-0.0679017	0.503057
6.715	-0.254822	-0.196381	0.219879	0.502373
6.72	-0.302552	-0.209198	-0.141907	0.501689
6.725	-0.263306	-0.222107	0.111084	0.501006
6.73	-0.228028	-0.235138	0.217743	0.500322
6.735	-0.199219	-0.247956	-0.729523	0.499639
6.74	-0.169617	-0.260773	-0.160217	0.498955
6.745	-0.143616	-0.273682	0.882722	0.498271
6.75	-0.129028	-0.285431	0.488129	0.497588

Journal data may be exported to file types *.odt” or *.xls for subsequent import into other programs such as spreadsheets.

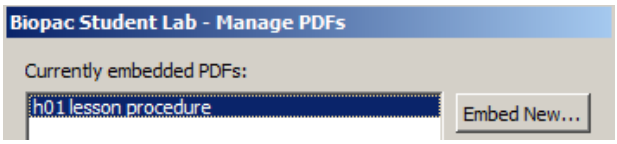
If you wish to copy graph window data not to the Journal, but directly into external programs, use the **Edit > Clipboard** submenu commands. Copy measurements, wave data, and graphs for pasting directly into word processors, spreadsheets, and graphic programs.



The Journal is saved with the data file. If the data file is closed and reopened, the Journal notes and window position will be as when the file was last saved.

EMBEDDING PDFS INTO THE JOURNAL

PDFs can be embedded into the Journal by choosing **Edit > Journal > Manage PDFs**. Simply click "Embed new" and navigate to the desired PDF file. The PDF will appear in the Journal under a separate tab. There is no limit to the amount of PDFs you can embed, and original Journal content is not affected. **Manage PDFs** is also accessible by right-clicking in the Journal window and selecting from the contextual menu.



JOURNAL TEXT TOOLS

Review and practice using the text tools for working with Journal notes.

Journal Text Tools are activated by icons in the **Journal Toolbar** at the top of the Journal and below the graph window.

New Journal


New Journal deletes all text currently in the Journal.

Load Text


Load Text enables the import of data from other files into the Journal. It generates a window to import files limited to files types *.txt and *.jcq.

Save Text


Save Text allows you to export Journal notes to separate file types *.txt or *.xls. This is useful for exporting data to other programs, such as spreadsheets, for further manipulation and analysis.

Page Setup


Page Setup modifies the page setup options to be used for printing Journal text (paper size, source, orientation and margins.)

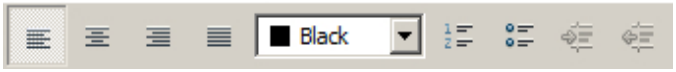
Print Journal


Print Journal displays advanced printer options and prints Journal content.

JOURNAL FORMATTING TOOLS

This section of the Journal toolbar sets the font size and style.

This section of the Journal toolbar sets text justification, color, numbering, bulleting, and indents.



The final section of Journal toolbar buttons allows for the creation and formatting of tables. (Create table, add row, add column, delete row, delete column, merge cells, and split cells.)

JOURNAL HYPERLINK TOOL

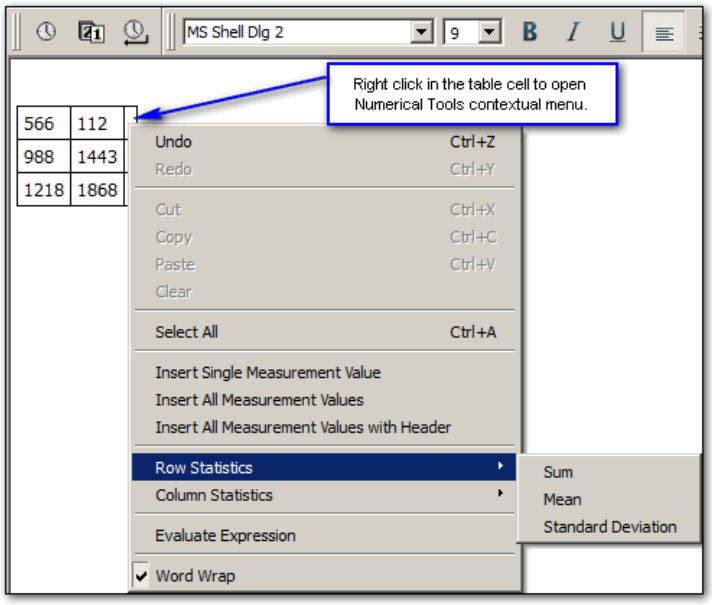
You may embed live web links in the Journal using the **Insert link**  toolbar button. This opens a dialog for entering the URL (web address,) along with a text field for assigning a title for the link. The new link will appear in the Journal where the cursor was previously placed.

JOURNAL NUMERICAL TABLE TOOLS

Numerical Tools operations permitted within a Journal table:

- Insert a single measurement value
- Insert all measurement values
- Insert all measurement values with header row
- Sum, Mean and Standard Deviation statistics for table rows and columns
- Expression evaluation

The **Numerical Table Tools** function allows easy insertion of measurements and numerical data into a Journal table, which can then be computed and evaluated via basic mathematical operations and expressions. This eliminates the need to export data to a spreadsheet application in order to validate statistics gathered during the course of an experiment.



Part 6: Printing Graphs

Read about the **Print** functions to the right.

The **File > Print** command will print what is displayed in the graph window. You control how data will be printed by controlling how the data is displayed on the screen.

For instance, if you've zoomed, changed scale, or hidden a channel, only the portion of data visible in the graph window will be printed. This can be useful if you want to print only a portion of the graph.

Adjust the graph window to show the portion of the graphs you wish to print.

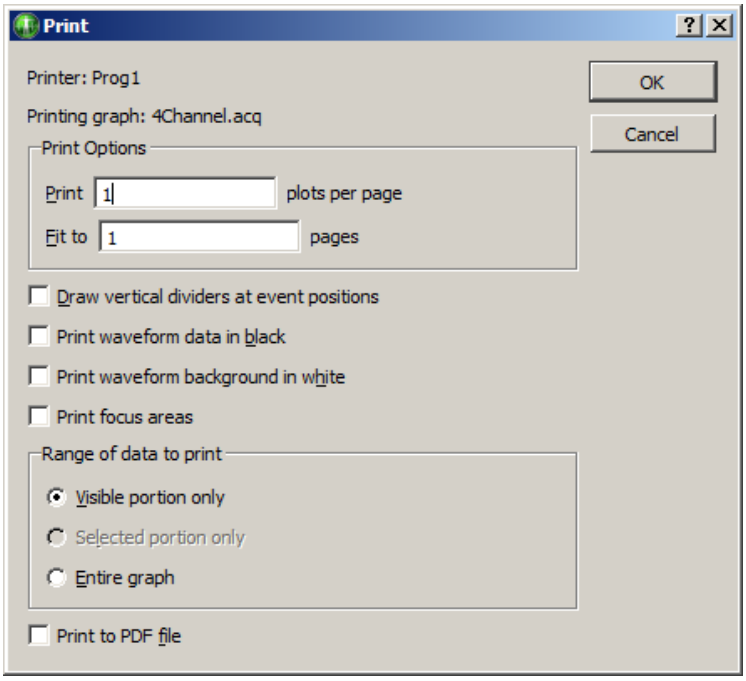
Show or hide the waveform channels you wish to print.

To print a portion of the data file, use the zoom tool, scale tools, and scroll bars to display the portion of the recording you wish to print. To print the complete data file, choose **Display > Autoscale Horizontal** and **Display > Autoscale Waveforms** to center waveforms and display the entire recording.

Choose **File > Print** and click the 'Print' button to generate the **Print Graph** dialog.

Choose **OK** to print the graph window.

Review the printed result.



Choosing **File > Print** generates a dialog with options that will depend on the printer (and operating system) you are using. Set print options as desired, and use the Print Setup command to set paper size, orientation, etc. Consult the BSL *PRO* Manual for more information about printing. Refer to the user manual for your computer and/or printer for details about your particular printer.

Close the **4channel.acq** sample data file.

This completes the BSL *PRO* 4.1 Tutorial. Following is a brief description of other sample files that you may wish to review.

Sample Data Files

To further familiarize yourself with features of BSL *PRO* and see how it can make your work easier, open and examine other data sample files included with the BSL *PRO* installation. Sample files include the following.

SAMPLE FILE NAME	DESCRIPTION OF DATA
4Channel.acq	Provides quantitative data on how the cardiac and respiratory cycles change as metabolic demands on the body change. *(Demonstrated in this Tutorial)*
BloodPressure.acq	Shows simultaneous recordings of Blood Pressure and Korotkoff Sounds.
Blood Pressure with Gauge.acq	Shows simultaneous recordings of Blood Pressure and Korotkoff Sounds with onscreen mm/Hg gauge display.
earthwormdata.acq	This data shows the nerve response from an isolated earthworm nerve. The nerve was placed on a Nerve Chamber and stimulated using the SS58L Low Voltage Stimulator. The display shows the raw response in Channel 1, the stimulus in Channel 2 and the filtered nerve response in Channel 40.
earthworm smooth muscle.acq	The first channel shows spontaneous contractions from isolated earthworm gut smooth muscle. The data was recorded using the SS12LA Force Transducer connected to the MP unit. The second channel shows the peak to peak response of each contraction.
EEG.acq	Shows how EEG activity changed when the Subject opened and closed her eyes (markers indicate change).
EMGwForce.acq	Shows simultaneous recordings of Clench Force and EMG, correlating motor unit recruitment to increased power of skeletal muscle contraction and measuring changes in EMG and Force when the muscles become fatigued.
FingerTwitch1.acq	Shows simultaneous recordings of Force, Displacement, and Stimulator output. The Stimulator pulse induced skeletal muscle twitch causing the Subject's finger to lift a small weight.
FingerTwitch2.acq	Channel 1 displays the force generated from the twitch of a finger after a stimulus was delivered to the forearm of a human subject. Channel 2 shows the stimulus. The event markers above the graph window mark the points in the recording when the stimulus frequency was increased.
NerveConduction.acq	Channel 1 displays the stimulus voltage and Channel 2 the motor (EMG) response of a muscle. The display is in the Overlap Segment mode, which is an easy way to view the EMG response to different levels of stimulus.
ValidateMeasurements.acq	Demonstrates multiple measurements on a selected area of data.

Sample Graph Templates

The following sample graph templates (*.gtl files) are also included. Graph templates contain no data, but are preset and ready to use for recording various experiments, after which they can be saved as *.acq files.

BPM Gauge.gtl	Heart Rate gauge window example. Displays ECG and Heart Rate (BPM) in the graph window and shows Heart Rate in a gauge window. It includes the range band option, shaded red, to indicate Maximum Heart Rate range. To change Gauge parameters, choose Preferences from right contextual menu when the mouse is over the gauge window.
Heart Template.gtl	Preset for ECG, Pulse and Heart Rate channels, with Input Values display.
Segment Timer Gauge.gtl	Segment Timer gauge example. Records and displays ECG in the graph window and a segment timer in the gauge window. The template is setup to record ECG Lead II on CH 1, however no connections are needed to verify the segment timer.
SS19L Gauge.gtl	Setting up Gauge view for working with Blood Pressure Cuff Transducer SS19L.
SS19LA Gauge.gtl	Setting up Gauge view for working with Blood Pressure Cuff Transducer SS19LA.

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If BIOPAC Systems, Inc. receives notice of such defects during the warranty period, BIOPAC Systems, Inc. will at its option, either repair or replace the hardware products that prove to be defective in materials or workmanship. This warranty applies only if your BIOPAC Systems, Inc. product fails to function properly under normal use and within the manufacturer's specifications. This warranty does not apply if, in the sole opinion of BIOPAC Systems, Inc., your BIOPAC Systems, Inc. product has been damaged by alteration, accident, abuse, misuse, neglect, improper packing, shipping, modification or servicing, by any party other than BIOPAC Systems, Inc. If a problem arises, please contact us for authorization before returning an item.

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