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BSL *PRO* 3.7

BSL *PRO* TUTORIAL

PC/Windows® 98SE, Me, 2000 Pro, XP
Mac OS X 10.3-10.4

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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.

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 the use of BSL *PRO* 3.7 software with the BIOPAC MP35 data acquisition unit. MP30 users may note different features when using the software with the MP30 unit. Consult the BSL *PRO* Manual for information about using BSL *PRO* 3.7 with the MP30.

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. The purpose of this Tutorial is to familiarize you with the BSL *PRO* software tools that assist in acquiring and analyzing your data.

LAUNCH BSL *PRO*

1. Click the program icon on the desktop or in the Programs (Win)/Applications (Mac) folder.
   - From the Windows Start menu, choose **Start > Programs > Biopac Student Lab > BSL 3.7 > BSL PRO 3.7**.

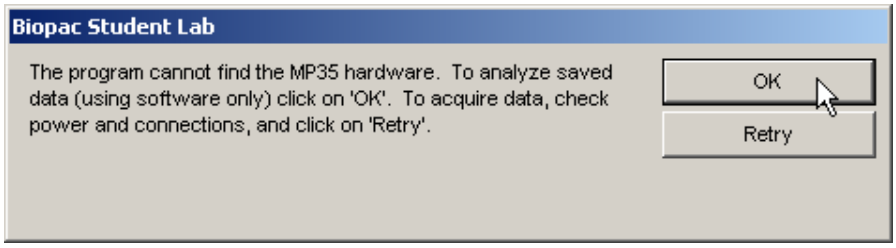
     If not connected to an MP data acquisition unit, click **OK** at the prompt to analyze saved sample data using software only.

2. BSL *PRO* will open an untitled graph window. Choose the menu command **File>Close** and proceed to the next step to open the sample data file used in this tutorial.

This tutorial illustrates some of the basic features of the Biopac Student Lab *PRO* software, and assumes you have already installed BSL *PRO* to your hard drive. (If not, insert the CD and follow the Install Wizard).

When you launch the program on your computer, BSL *PRO* checks to see if you have the BIOPAC MP data acquisition hardware connected. If the software can communicate with the recording hardware, BSL *PRO* generates an "Untitled" graph window, ready to record. For this tutorial, choose the menu command **File>Close** to close the untitled window, and proceed to the next step to open the sample file used in this tutorial.

If the BSL *PRO* software cannot communicate with the MP data acquisition hardware, you are prompted to "Retry" or to click "OK" to continue and analyze a saved data file using software only.

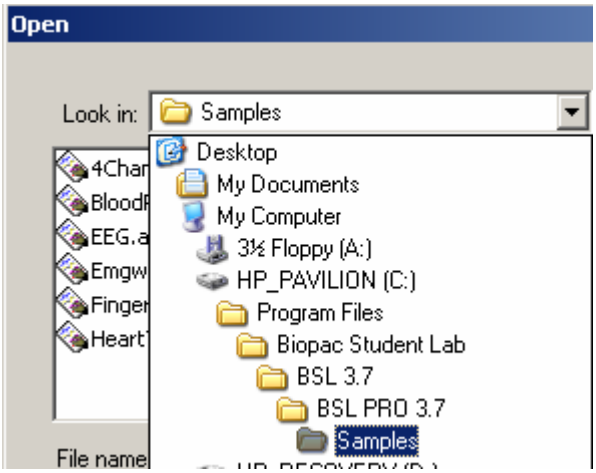


You do not need to record data, nor be connected to the MP recording hardware, to conduct this tutorial. Click **OK**.

Similarly, you do not need to be connected to MP recording hardware to analyze any data that you yourself may record and save to disk. This allows you review a previously saved file and analyze it with the powerful BSL *PRO* software on any computer, at home or in the lab, even when that computer is not connected to the MP data acquisition unit.

OPENING A DATA FILE

3. Choose **File>Open**.
4. Navigate to the BSL *PRO* 3.7 samples folder.

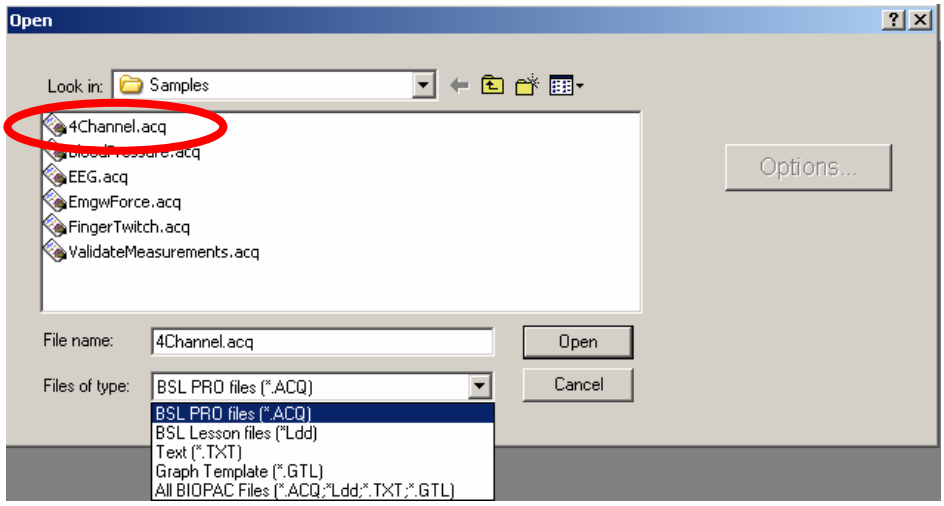


With the default Biopac Student Lab installation, sample data files are located in the BSL folder:

Win: C\Program Files\Biopac Student Lab\BSL 3.7\BSL PRO 3.7\Samples\

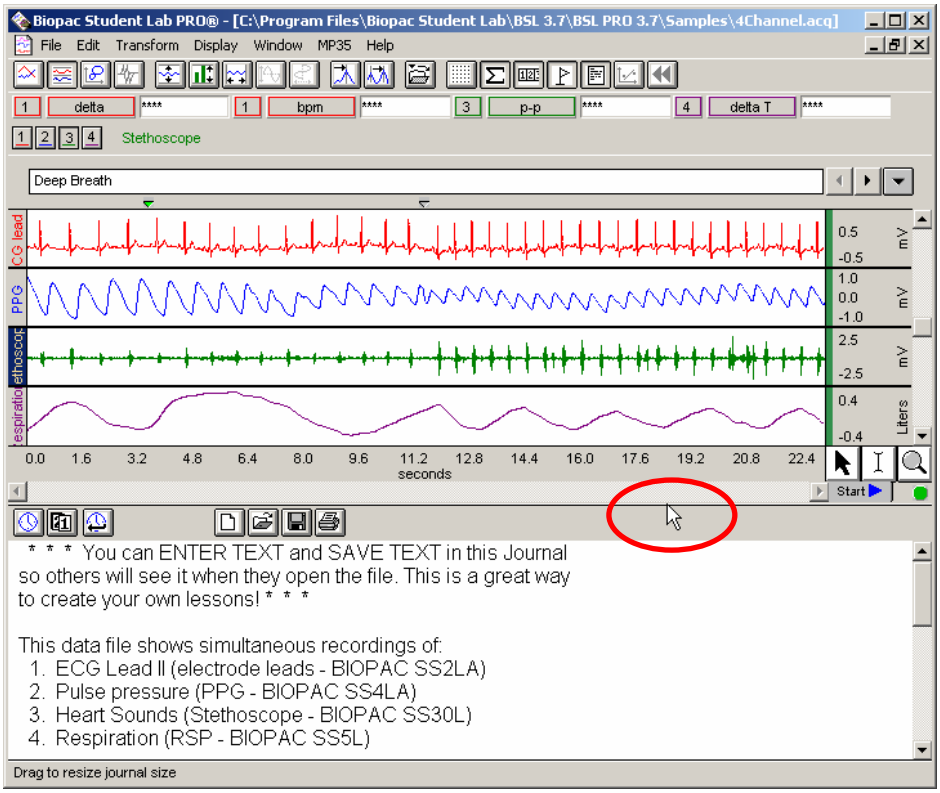
Mac: Drive\Applications\Biopac Student Lab\BSL 3.7\BSL PRO 3.7\Samples\

5. Open the sample file **4Channel.acq**.



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.

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



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 BSL *PRO* window to best fit your computer screen by dragging its corner (or elsewhere on its perimeter).

SAVING A DATA FILE

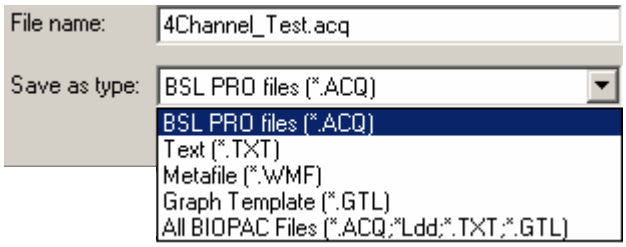
7. Save a copy of the sample file, if desired.

   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 changes you may make and save 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 MP35 menu), and window positions. **Except in exceptional cases, you will save data files in the default BSL *PRO* format (*.ACQ).**



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

Part 1: Acquisition Parameters

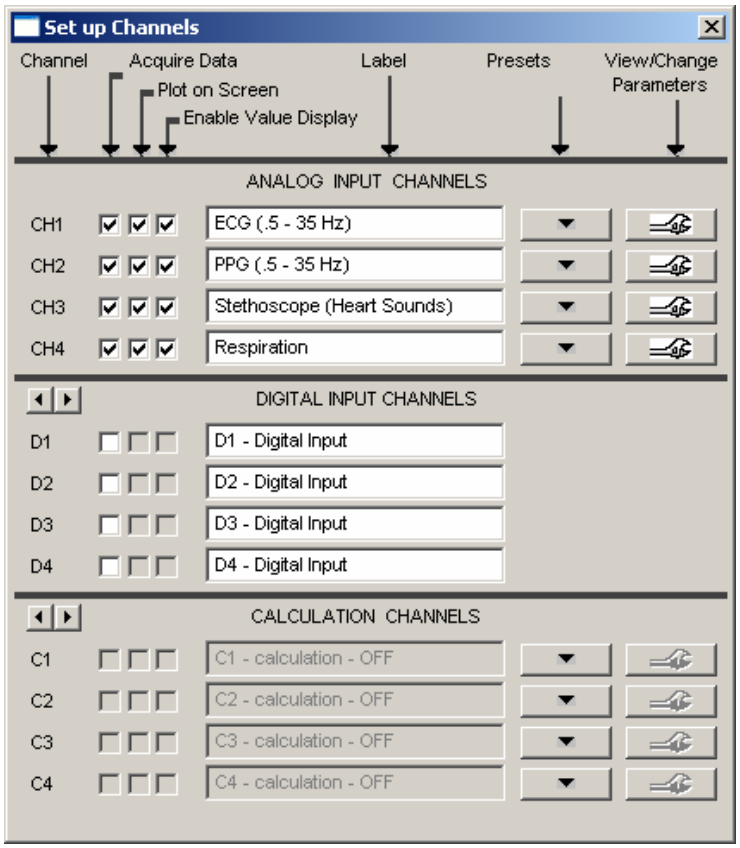
Each BSL *PRO* lesson—including experiments that you may design—will have unique procedures for attaching electrodes, transducers, and other signal monitoring equipment. Signal monitoring equipment is connected to the MP data acquisition unit, and the MP unit in turn is connected to your computer. Follow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

SET UP CHANNELS

8. Choose the menu command **MP35>Set up Channels** to generate the **Set up Channels** dialog.

The **Set up Channels** dialog displays options that determine which channels receive data, what type of data the channels receive, and how data is displayed and interpreted on your computer.



Data Input Channels

Analog Input Channels

Digital Input Channels

Calculation Channels

Analog Input Channels 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 of the MP35 acquisition unit.

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

Digital Input Channels, in contrast to analog input channels, collect data from signal sources 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.

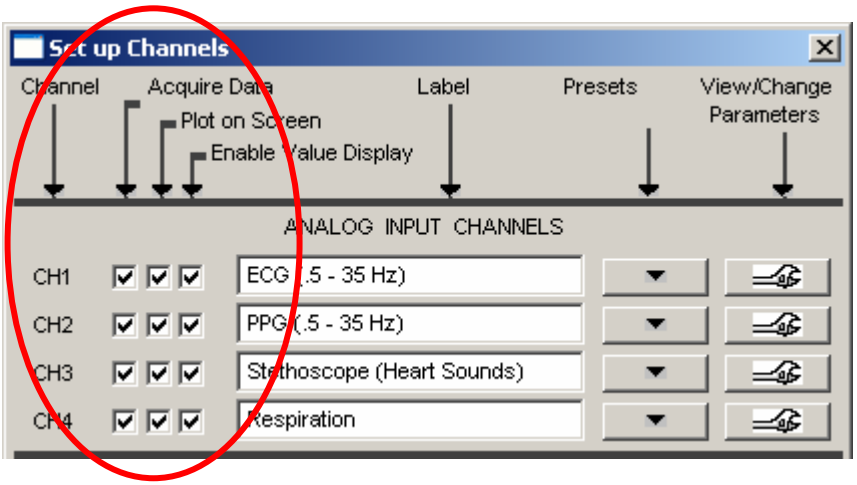
- BSL *PRO* records and displays up to eight digital signals from devices connected the I/O port on the back of the MP35 acquisition unit.
- MP30 Users: The MP30 cannot record digital channels. Consult the BSL *PRO* manual for information about setting up trigger and control devices.

Calculation channels transform data in some way (rather than collect external data as input channels do). Calculation channels acquire 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 12 calculation channels can be configured. This allows for complex calculations to be performed that involve two or more calculation channels, such as filtering ECG data and then computing BPM.

Channel Specification Options

10. 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 themselves may be optionally displayed.



Acquire Data

Acquire Data records data into memory via the selected channel, but the data will not be displayed unless you also select "Plot on Screen."

Plot on Screen

Plot on Screen 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 Data," but not "Plot on Screen" for the Input Channel, and "Acquire Data" and "Plot on Screen" for the Calculation Channel.

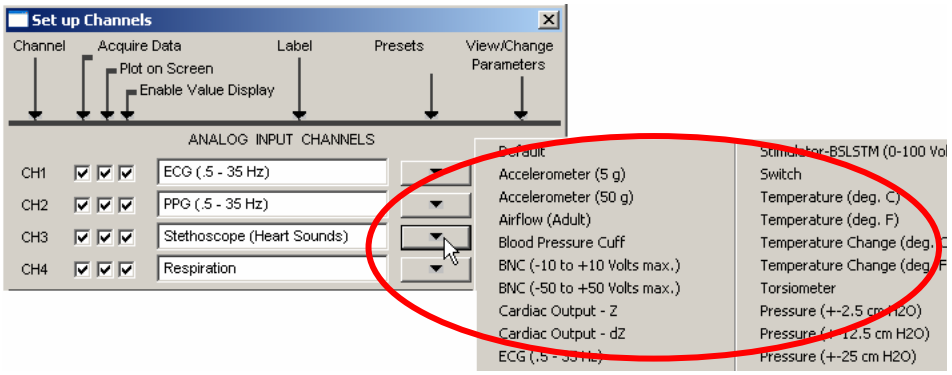
Enable Value Display

Enable Value Display allows incoming data values to be displayed numerically and/or in "bar chart" format in a separate window during acquisition. Checking this option enables you to open (under the MP35 menu) a **Show Input Values** window in which the values are displayed.

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

Channel Presets

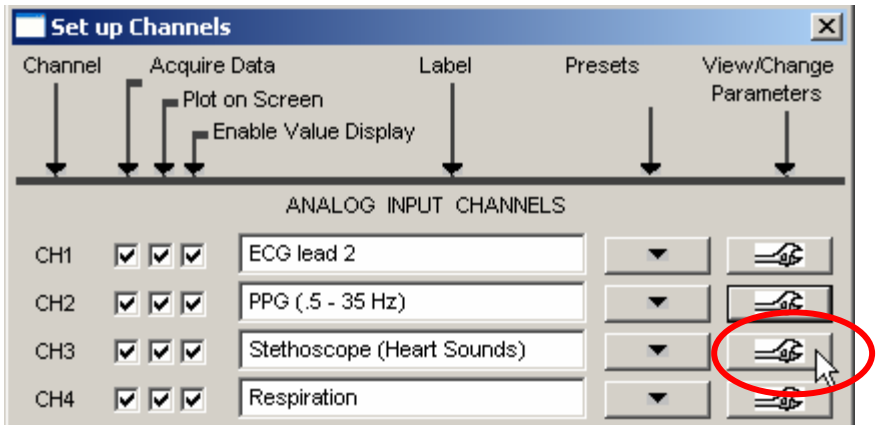
11.  Click the **Presets** icon (down arrow) to the right of any analog channel label to view a menu of parameter presets.
12. Press **ESC** (Escape key) to close the menu without selecting a new preset option.



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

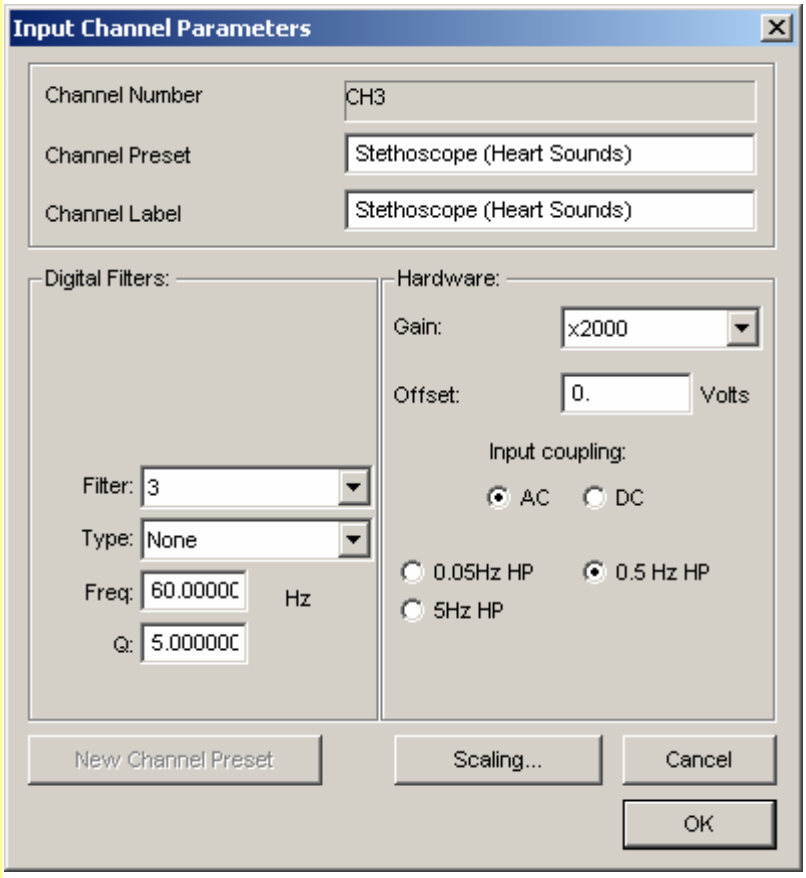
View/Change Parameters

13.  Click the **View/Change Parameters** icon (wrench) for Analog Input Channel **CH3, Stethoscope (Heart Sounds).**



Clicking **View/Change Parameters**  generates the **Input Channel Parameters** dialog for each channel, which allows specification of settings for gain, offset, and other recording parameters.

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



15. 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.

Input Coupling

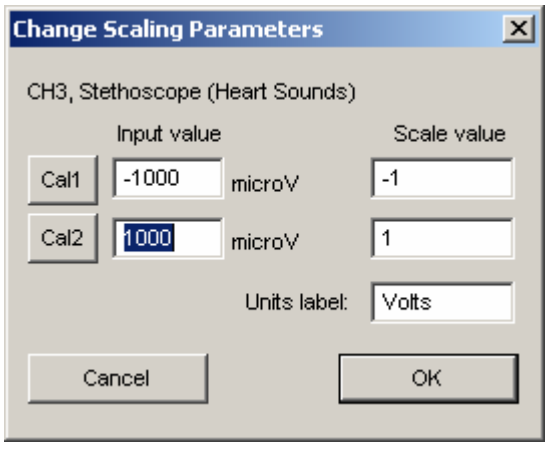
Input coupling is set for the type of signal you are recording. For example, AC coupling is generally used for biopotential signals such as ECG and EEG, while DC coupling is best for transducer signals measuring absolute values such as force, pressure, and temperature. In AC-coupled mode, you may adjust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

> MP30 Users: In AC mode, there are two high pass and two low pass filter options to choose from; in DC mode, there are two high pass options.

Scaling

16. Click the **Scaling** button to generate the **Change Scaling Parameters** dialog.

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



17. Note the scaling parameter options and read about **scaling and calibration** at right.

Scaling allows you to easily translate the voltage read by the MP35 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.

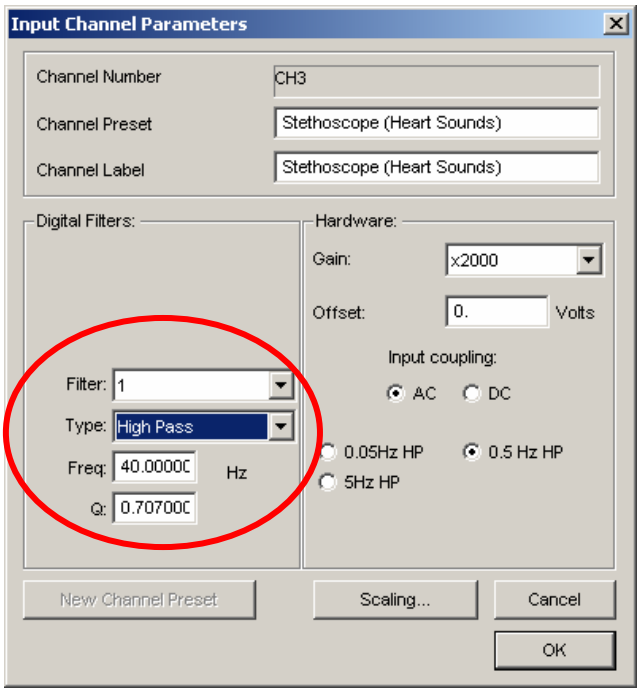
Input values (**Cal1** and **Cal2**) from a transducer may be calibrated to known low and high values (i.e., temperature). When an acquisition is performed, data samples from the selected channel are scaled accordingly and the vertical (amplitude) scale reflects the rescaled units.

18. 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

19. Note the **Digital Filters** options of the **Input Channel Parameters** dialog and read about them at right.



The MP35 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 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**.

- MP30 users: Digital filters are disabled during High Speed acquisition.

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

Saving Input Parameters

20. Read about **saving input parameters** at right.
21. Click **Cancel** to exit the dialog without changing parameters and return to the **Set up Channels** dialog.

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 contains no recording data, but contains the parameters that you have set up and saved with the file. When you open the template file, it is ready to record. This is useful for creating your own lessons. Consult the BSL *PRO* Manual to learn more about Graph Template files.

Digital Channel Parameters

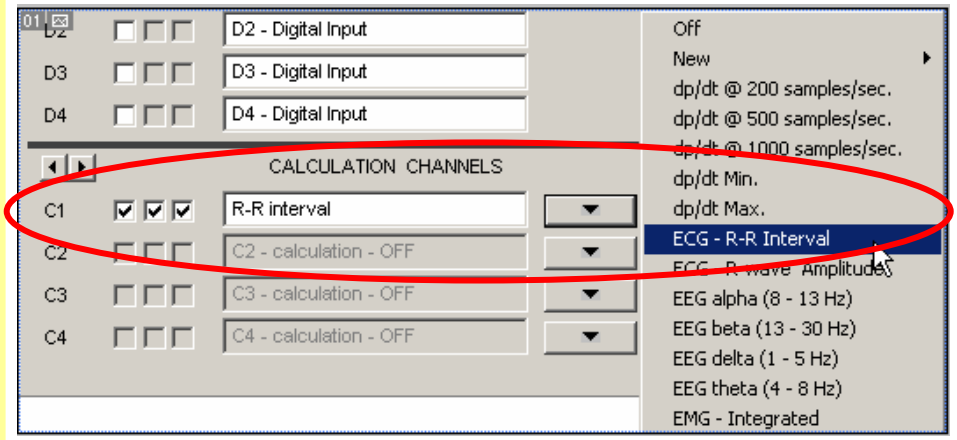
Digital channels have only two, fixed values; no parameter and scaling options are available. For more information, consult the BSL *PRO* Manual.

Calculation Channel Parameters

Calculation channels acquire data from analog input channels (or digital input channels, or other calculation channels) and perform a calculation 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. They must ultimately acquire their 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).

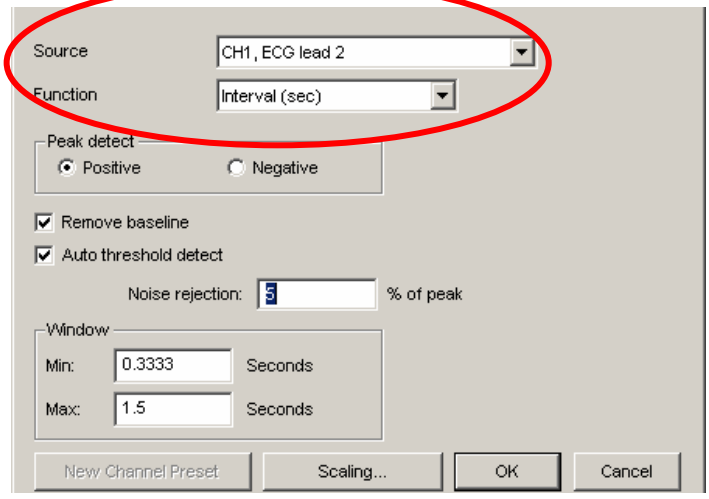
22.  Click the **Presets** icon (down arrow) for **Calculation Channel C1** and choose the preset option **ECG R-R Interval**.



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

To do this, click the **Presets** 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.**"

23.  Click the **View/Change Parameters** icon (wrench) to the right of **Calculation Channel C1** to generate the **Rate Parameters** dialog.
24. Note the **Rate Parameters** for the **ECG R-R Interval** calculation, and read about them at right.
25. Click **Cancel** to exit the dialog without changing rate parameters and return to the **Set up Channels** dialog.



Note the **Rate Parameters** dialog for the "**ECG R-R Interval**" preset you have chosen. The **Source** data for the calculation is acquired from "CH1, ECG lead 2" and the **Function** 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.

26.  Click the **Presets** icon of Calculation Channel C1 and choose **Off.**

27. Click the **close box** to exit the **Set up Channels** dialog and return to the graph window.

Choosing the "**Off**" preset option turns off the calculation channel. It will no longer acquire, plot, nor display data.

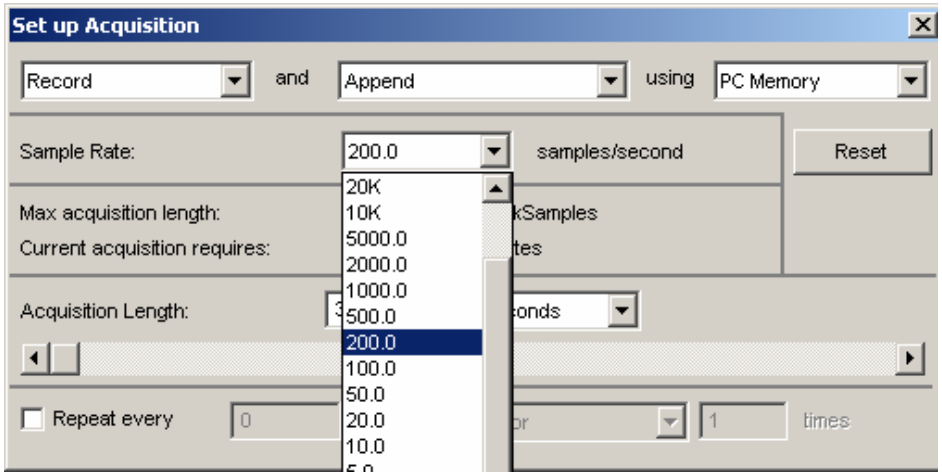
SET UP ACQUISITION

28. Choose the menu command **MP35>Set up Acquisition**.

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

Once you have set up the channels to be acquired, the next step is to set up the acquisition parameters. The **Set up Acquisition** dialog displays options that control, among other things, how and where data will be stored, the sample rate for data collection, and the duration (length) of each acquisition.

Default acquisition parameters are to **Record and Append using PC Memory** at a sample rate of **200 samples per second** for **30 seconds**.



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

Data Storage Options

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

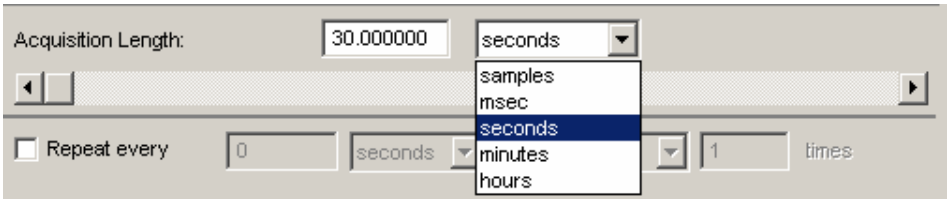
Sample Rate

Sample Rate determines how many samples the MP35 will acquire per second, and is analogous to the mm/sec setting on a chart recorder. Choose the desired value in the pull-down menu; you may need to scroll up to see higher values. The default sample rate is 200 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 using the scroll bar or entering the length directly into the value box. Units are set in the pull-down menu to the right. The default setting is to acquire data for 30 seconds, but length of acquisition will vary depending upon the experimental design.

The MP35 will stop acquiring data when the specified length is reached. You may also stop acquisition at any time by clicking on the "Stop" button that is enabled during recording in the lower right corner of the graph window.



Repeat

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

30. Click the **close box** 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 MP35 MENU OPTIONS

31. Click on the **MP35 menu** and view other available commands. Read about them at right.

Note the options on the MP35 menu and read about some of them below.

- MP30 Users: MP30 menu commands differ from those available for the MP35. 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 MP35 unit.

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 Set up Channels dialog).

Output Control generates a submenu of Output Controls. The MP35 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 MP35 are **CH3 to Output**, **Digital Outputs**, **Pulses**, **Voltage**, **Stimulator-BSLSTM**, and **Stimulator-SS58L**. Consult the BSL *PRO* Manual for more information.

Part 2: Recording

32. Read about recording a data file at right.

If the MP35 unit is not connected, read about recording at right and proceed to the following section.

Once you have set up the input channels and set up the acquisition parameters, you are ready to record. To acquire data, the MP unit must be connected to your computer and powered on. (If the MP35 is not properly connected and communicating with your computer, you will be unable to record and receive an error prompt.)

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 MP35 acquisition unit, but the MP35 is connected to the computer, the unit will collect—and BSL *PRO* will display—a small, "flatline" value of random signal "noise" with a mean of about 0.0 Volts.

33. If the MP35 data acquisition unit is connected, practice recording a new data file.
    - Choose **File>New** to open an "Untitled" graph window and practice recording.

If the MP35 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 lower right corner of the graph window, or by pressing "**Alt + Spacebar**." The circle next to the Start/Stop button, when green and solid, indicates that the MP35 hardware is communicating with the computer, ready to record.

- 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.

Once an acquisition has started, the Start/Stop button in the graph window changes to Stop. The two opposing arrows to the right of the button indicate that data is being collected. The "Busy" status light on the front of the MP35 also indicates that data is being collected.

Stop an acquisition at any time by clicking the **Stop button**, or by pressing "**Alt + 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 on the Toolbar deletes the last recorded segment.

You cannot change acquisition parameters while recording. If you change acquisition parameters during a pause between recording segments, when you attempt to start recording again, BSL will warn that your previous data will be overwritten (unless the "Warn on Overwrite" option in the MP35 menu is disabled). Similarly, deleting a recorded segment with the **Rewind** command will generate a warning.

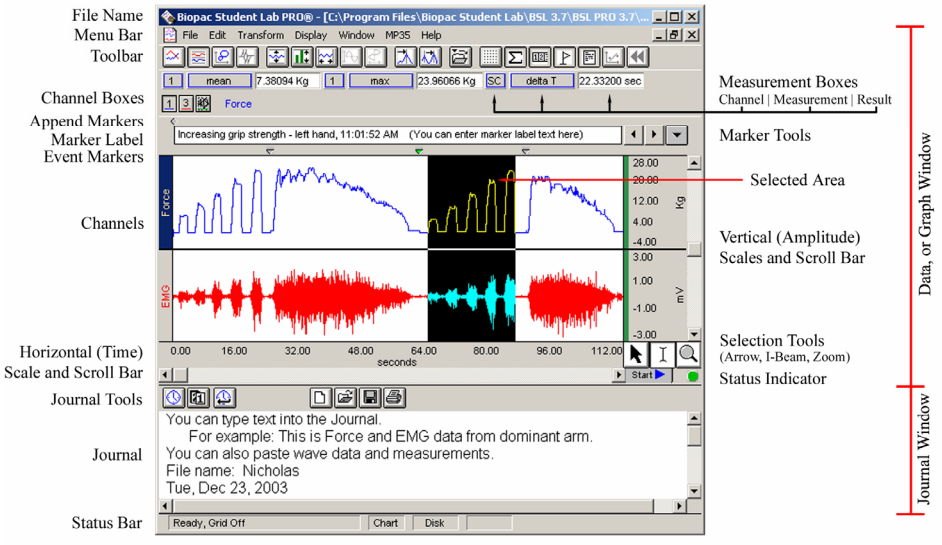
After recording multiple short segments, choose **File>Close** to close the practice data window without saving.

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

34. 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.



The Biopac Student Lab PRO Display

CHANNELS

Selecting Channels

35. Note the four channels of data in the display of sample file **4Channel.acq**.
36. Click the **CH2 channel number box** (or its "PPG" label to the left of the waveform) to make it active.

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, 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 indicator box correspond and can be changed. The box on the left corresponds to the waveform at the top of the screen.

The box that appears depressed 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

37. Hold down the **Ctrl** key and click on the **CH2 PPG** channel number box to hide the channel.
38. Hold down **Ctrl** and click again to make it reappear.

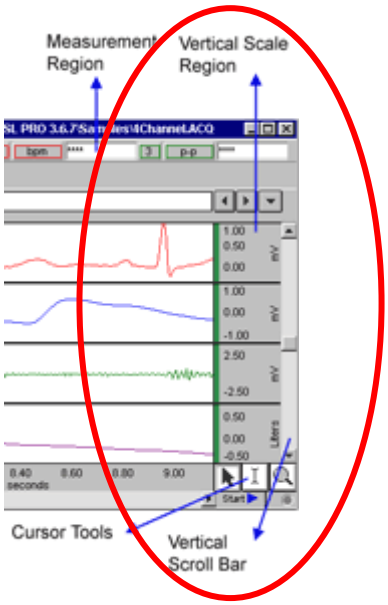
To focus on one channel, it is sometimes helpful to temporarily "hide" another. To **hide a channel**, click on that channel's number box while holding down the **Ctrl** (Control) key. The channel's number box is crossed-over and the display redrawn without this channel. Pressing **Ctrl** and clicking the channel's number box again causes the waveform to reappear.

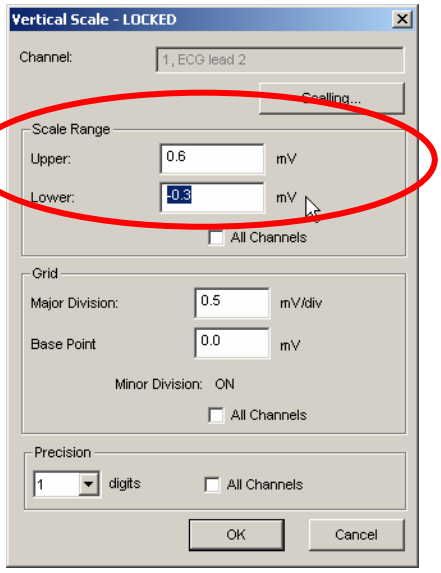
You can hide multiple channels. Hiding an active channel makes the following visible channel become active. Note, though, that a hidden channel can be made active (even while hidden) by clicking its channel number box.

SCALE

Adjust Vertical Scale

39. Adjust the **Vertical Scale** of **CH1**.
    - Click in the vertical scale region of the channel to generate the **Vertical Scale** dialog.
    - **Change the scale** range to one-half of its current value.
    - Click **OK** to set the new scale and close the dialog.
    - **Observe** the rescaled waveform in the graph window.





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

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

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.

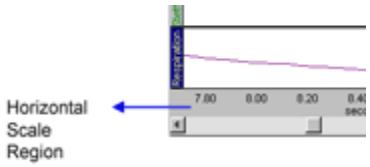
- Note: When grids are locked, the scale dialog includes grid settings. When grids are not locked, the dialog includes scale settings only. Refer to the discussion of **Grid Options** later in this tutorial.

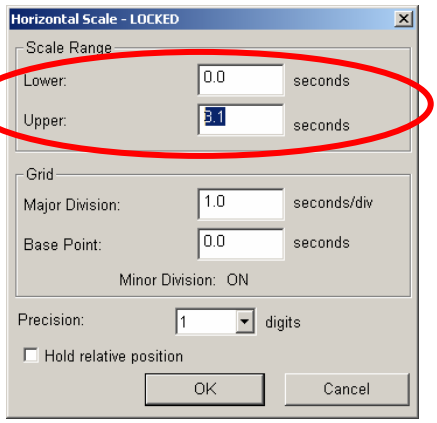
41. Select each channel's waveform and use the **vertical scroll bar** to adjust the midpoint of each.

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

42. Adjust the **Horizontal (Time) Scale** of all waveforms.
    - Click in the horizontal scale region to generate the **Horizontal Scale dialog**.
    - Change the scale range to one half of its current value.





- 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.

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

Click in 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.

- Note: When grids are locked, the scale dialog includes grid settings. When grids are not locked, the dialog includes scale setting only. Refer to the discussion of **Grid Options** later in this tutorial.

43. 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.

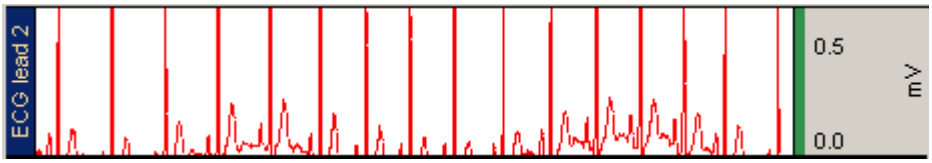
AUTOSCALE

Autoscale commands determine the optimal scale for waveforms and center their display.

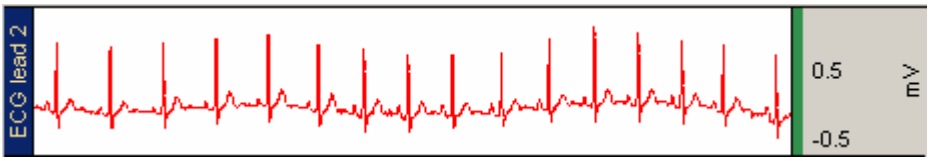
Note: Once waveforms are optimally scaled, repeating an autoscale command has no apparent effect. As needed to practice autoscale commands, individually adjust the scale of each channel as you have done in prior steps and scroll midpoints away from center.

Autoscale Waveforms (Vertical)

44. Select a channel.
45.  Click the **Vertical Autoscale** icon in the Toolbar at the top of the graph window to optimize the vertical scale of the **selected** waveform.
46. Right-click in another channel to select it, and choose **Autoscale** 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** from the pop-up menu.

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

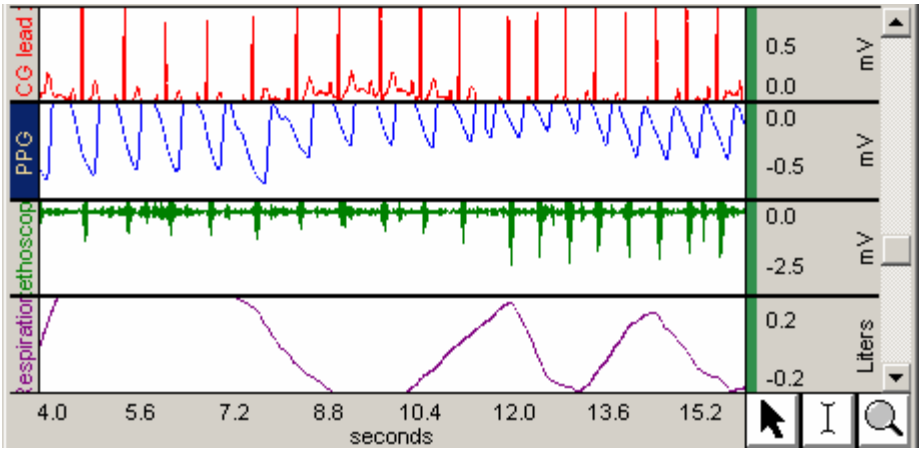
47. Choose **Display>Autoscale Waveforms** to optimize the vertical scale of **all** waveforms.

Autoscale Horizontal

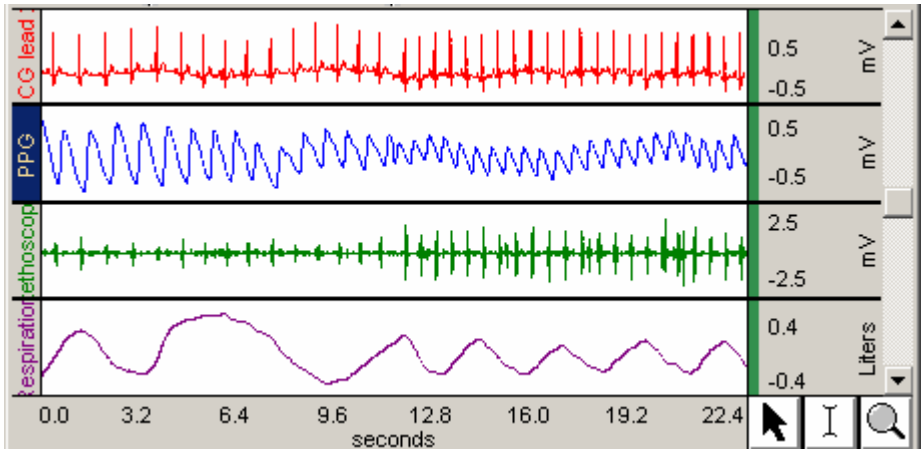
48. Choose **Display>Autoscale Horizontal** to optimize the horizontal (time) scale of **all** waveforms.
49. Choose **Display>Autoscale Waveforms** (Vertical) again.

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.



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.

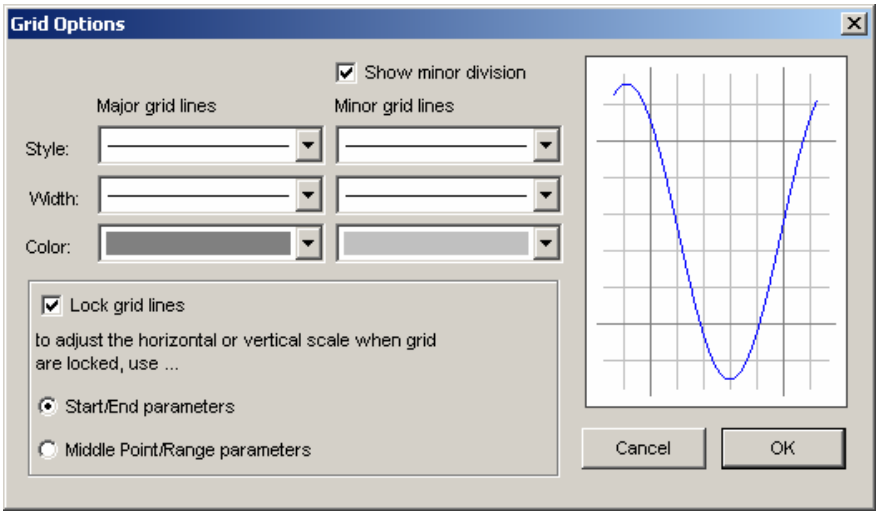
- Shortcut: click on the **Horizontal Autoscale** icon in the Toolbar at the top of the graph window.

GRIDS AND GRID OPTIONS

50. Toggle the **Grid** icon in the Toolbar to "show" grid lines.
51. Right-click in the waveform region and choose **Grid Options** from the pop-up menu to generate the Grid Options dialog.
52. Note the available grid options. Toggle the option **Show minor division** and click **OK** to view changes in the display.

Note that the option to "Lock grid lines" affects grid display.

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

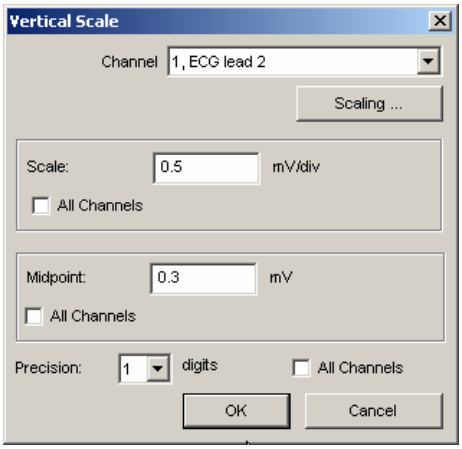


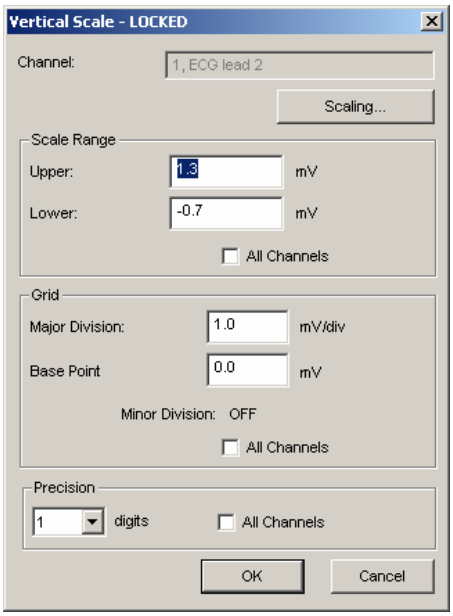
The **Grids** icon on the Toolbar "shows" or "hides" grids. Alternately, choose the **Display>Show>Grid,** or right-click in the waveform region and select or deselect **Grid**.

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

Note that the "Lock grid lines" option can affect the grid display. In general, "Unlocked" grids can help you view the data display on the monitor, while "Locked" grids can help with printing. See the BSL *PRO* Manual for more information about grids and grid options.

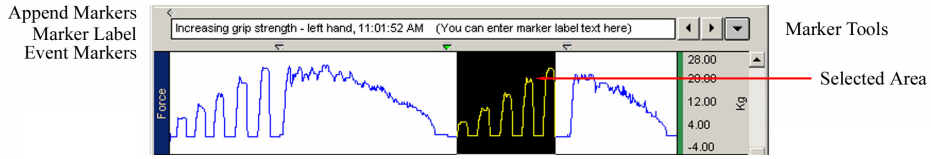
When grids are "locked," the scale dialog options include grid settings. When grids are "unlocked," scale dialogs include scale options only, as shown in these two screen shots of the vertical scale dialog. Refer to the discussion of **Scale** earlier in this Tutorial.





MARKERS

54. Read about markers at right.



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. Marker labels help reference these data locations.

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

Append Markers

Append markers are displayed in the marker region above the marker label box. They are automatically inserted by BSL *PRO* 3.7 to mark the beginning of recording segments.

Event Markers

Event markers are displayed below the marker label box. They are manually inserted during or after recording.

To insert an event marker *during* recording, press the **F9** (Win) or Esc (Mac) key and enter a label in the marker label text box. This enters a marker at exactly the time the key is pressed.

To insert an event marker *after* recording, click with the Arrow tool in the event marker region above the data point to be marked and enter a label in the marker label text box.

Marker Tools

Marker Preferences

Marker Tools are located at the right of the marker region. Use the tools to jump through the markers or generate a menu that allows you to search for specific markers, to manage markers, to paste a summary of markers to the Journal, and to generate a dialog to set **Marker Preferences**.

55.  Toggle the **Markers** icon on the Toolbar to hide and show the marker region of the graph window.

 The **Markers** icon on the Toolbar activates the marker display region near the top of the graph window. Alternately, you may choose the menu command **Display>Show>Markers**.

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 *PRO* Manual for more information about markers.

56. **Add** and **label** a new event marker in the event marker region.

To add a new **event marker**, click with the Arrow tool 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.)

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

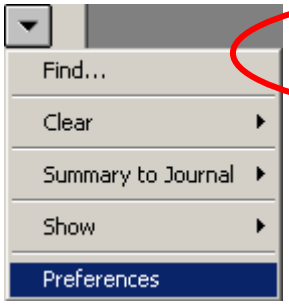
Use the **Marker Tools right and left arrows** to move through the markers. Move to the marker you added in the previous step. When active (selected), it will be colored and its label displayed.

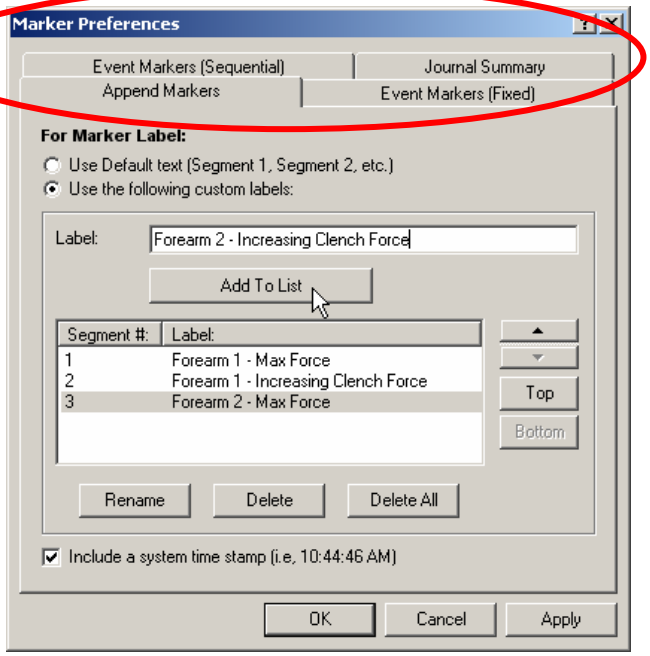
The marker that you added is a yellow-colored inverted triangle, as it is an event marker that you added to the recorded file.

58.  Click the **Marker Tools down arrow** to generate a pull-down menu. Choose **Clear>Active Event Marker** to delete the marker that you activated in the previous step.

The **Marker Tools down arrow** generates a menu and submenus of marker commands. Use the **Clear>Active Event Marker** command to clear the event marker that you added and activated in previous steps. Take care that you have activated the marker you wish to clear, as you may not undo this command.

59.  Click the **Marker Tools down arrow** and choose **Preferences** to generate the **Marker Preferences** dialog.





Click the Marker Tools down arrow and choose Preferences to generate a **Marker Preferences** dialog. Alternately, choose **File> Preferences>Markers**.

Marker Preferences has three tabs of options to auto-label markers, and one to format marker data summarized to the Journal.

60. Click through the tabs of the **Marker Preferences** dialog to note the options available for configuring **custom marker labels,** and for pasting a marker summary to the Journal.

Marker Preferences has tabs that allow you to **pre-establish custom labels** *before* recording that are entered when a marker is inserted *during* recording.

Custom labels (rather than the default labels "Segment 1," "Segment 2," etc.) can be pre-established for the **append markers** that are automatically inserted at the beginning of each new recording segment.

Custom labels, either **fixed** or **sequential**, can be pre-established for **event markers** that are inserted with the press of a function key while recording. This can help you enter markers with descriptive labels during recording at exactly the moment an event occurs, when you otherwise might not have time to label your markers.

Note also the Preferences tab that sets format and sort options for marker summaries that you may paste to the Journal.

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 lower right 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**.

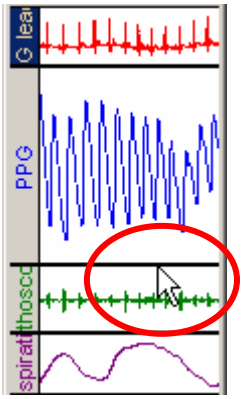
You will often use the Zoom tool and I-Beam tool to select a portion of a waveform to edit or analyze. Once you have selected (highlighted) an area, you can perform a variety of operations—such as editing, measuring, or transforming data.

Arrow Tool

61. 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.

62. Use the Arrow tool to resize the chart boundaries between waveforms.
63. 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

64. Select the **I-Beam tool** in the lower right corner of the graph window.
65. **Click and drag** the I-Beam tool across the waveforms to select an area of data.
66. **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.

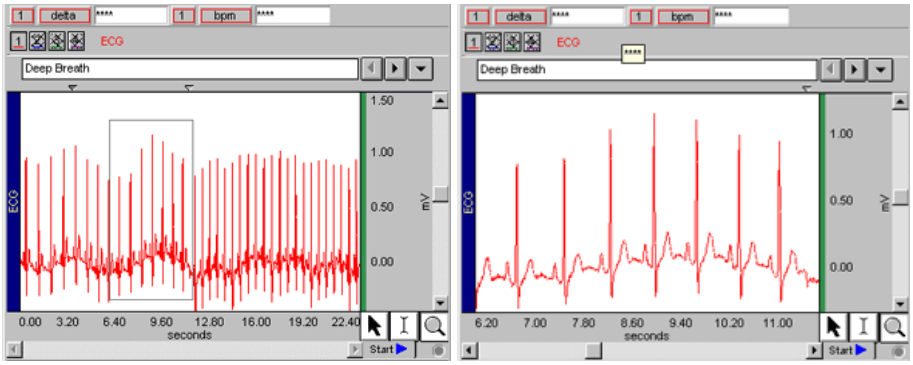
Clicking and dragging the I-Beam tool across waveforms selects and highlights an area of data. You can perform a variety of operations—editing, measuring, transforming, copying, pasting measurements to the Journal—on the selected data.

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

67. Select the **Zoom Tool** in the lower right corner of the graph window.
68. **Click, drag, and release** the Zoom tool in a waveform to select and magnify a section of data.
69. **Zoom** again.
70. Choose **Display>Zoom Back**, or press "**Ctrl –**" (Control + Minus keys), to undo the previous Zoom command.



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 hide other channels to focus on the channel you wish to zoom in on.

You may "undo" previous zooms (up to 5) by choosing **Display>Zoom Back**, or by pressing "**Ctrl –**" (Control + Minus keys).

71. 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.

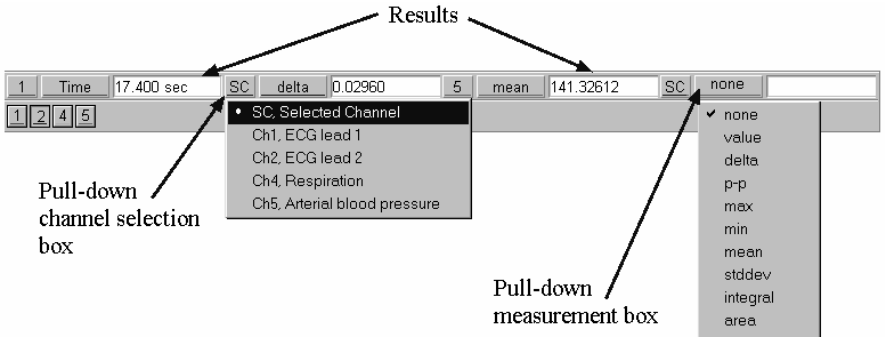
MEASUREMENTS

Using the **BSL *PRO* measurement tools**, you can easily use absolute functions—such as value, X-axis (time) and samples—that measure a single point, and use functions—such as min, max, mean, and Δ Time—that operate over a selected, highlighted area 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. Functions under the Transform menu (such as Find Peak) identify specific events based on a variety of threshold and window discriminators.

Measurement Boxes

72. 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

73. 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 Peak-to-Peak**, the fourth **CH4 Δ Time**, the fifth **CH4 Peak-to-Peak**.

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.

74. **Hide** CH1 and CH2.

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

- Hiding a channel removes its waveform from the graph display.
- A hidden channel can remain the active channel.

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.

75. 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 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**.

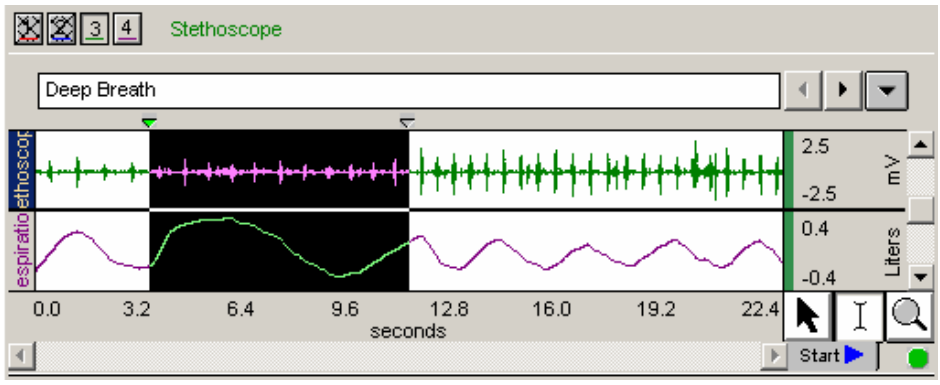
  Read the measurement results that have been pasted into the Journal.

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

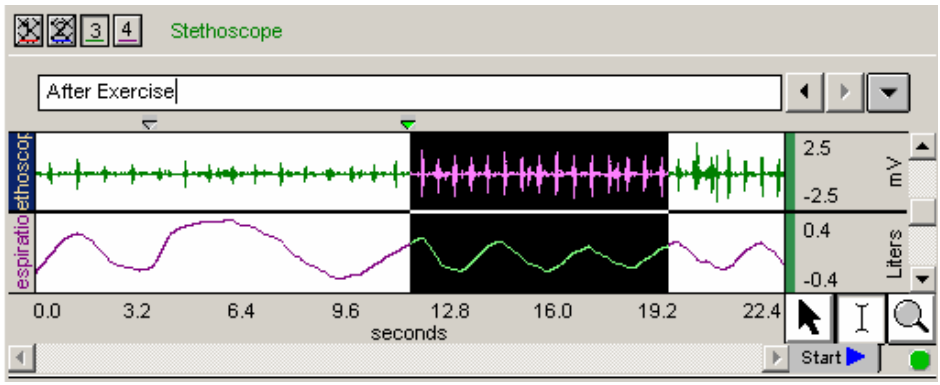
  Note the p-p measurement results in the measurement boxes for CH3 and CH4.

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

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



Labeled 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.

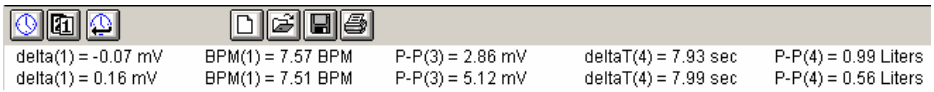


In the Analysis and Journal sections of this Tutorial, you will learn more about taking measurements and pasting measurement data to the Journal.

Compare the **Peak-to-Peak** 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, toggle the Journal icon in the Toolbar.



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.

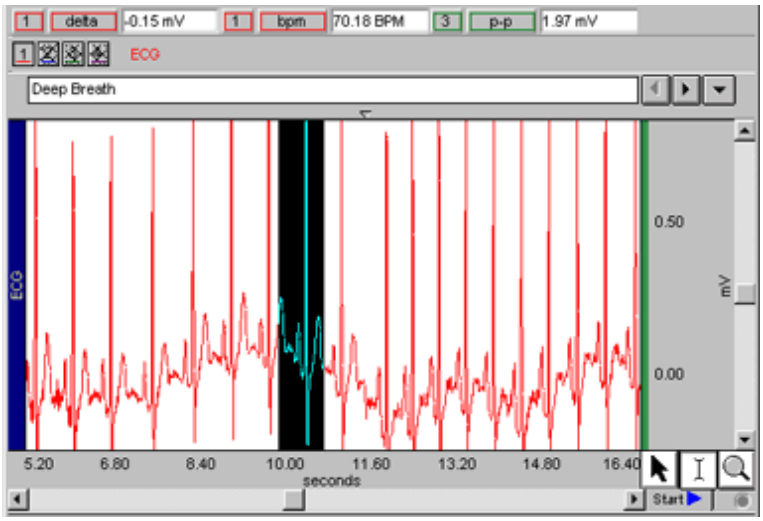
To get an idea of how BSL *PRO* provides immediate feedback, run a **Find Peak** function on the **4Channel.acq** sample file.

76. Adjust the display of the sample file **4Channel.acq** to view ten seconds of ECG data.
    - **Select CH1, ECG**.
    - **Hide** other channels
    - **Zoom** in on about ten seconds of data
    - **Autoscale** the waveform as needed.

Select CH1 and hide the other channels by pressing **Ctrl** and clicking their channel number boxes.

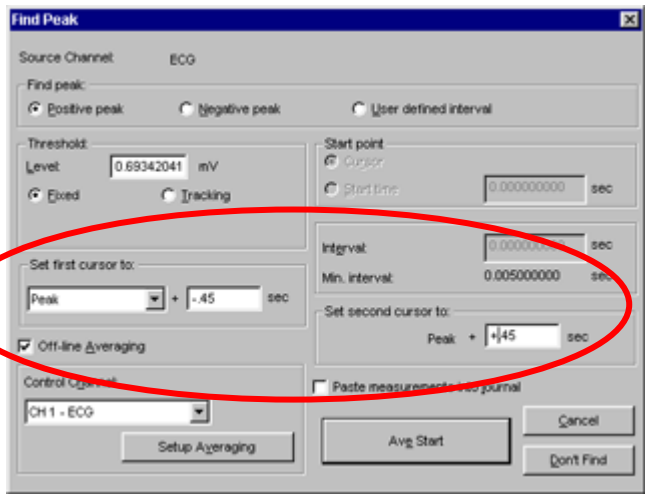
Use the **Zoom** tool to examine a 10-second portion of the waveform. To center your display after zooming, use the **Autoscale Waveforms (Vertical)** command from the Toolbar or from the Display menu.

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



78. Choose **Transform>Find Peak** to generate the Find Peak dialog.
79. Choose the **Off-line Averaging** option (in the bottom third of dialog).
80. Set the first cursor to "**Peak + (-.45) sec**" and the second cursor to "**Peak + (+.45) sec**."

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

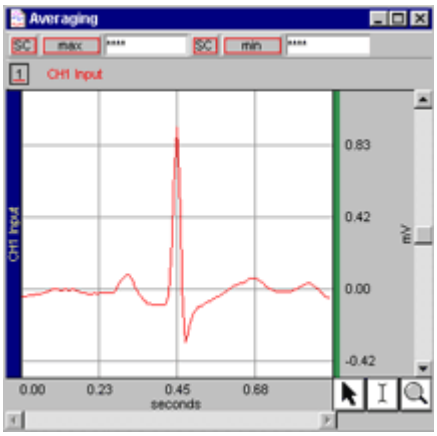


Choose **Off-line Averaging**, and set the first and second cursors relative to the peak.

81. Click the "**Ave Start"** button.

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

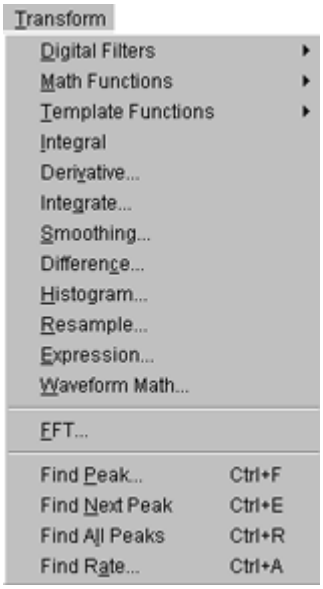
You may also set Find Peak to average a selected portion of the recording. This feature is useful when comparing the ECG complex during different sections of an experiment.



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

THE TRANSFORM MENU

83. 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 a 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 has an "Equation Generator" that lets you perform a range of mathematical operations, from 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.

TRANSFORM>FIND RATE

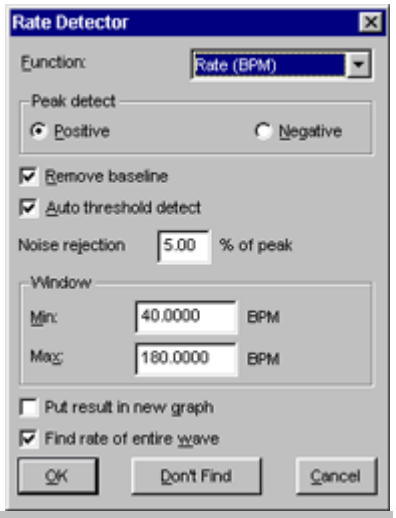
In addition to performing mathematical functions, the BSL *PRO* software can search for peaks and calculate rate. The **Find Rate** function will calculate rate information for a variety of cyclical data, including BPM, Hz, peak max, peak min, P-P, area, and mean.

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

84. Select **CH1, ECG**.
85. Choose **Transform>Find Rate**.
86. Select the function **Rate (BPM)**.
87. Check to enable "**Find rate of entire wave**."

To do this, select CH1 and choose the menu command **Transform>Find Rate** to generate the **Rate Detector** dialog. View the functions available on the pull-down menu and choose **Rate (BPM).**

Note the other options allowing you to customize the Rate calculation. The Rate Detector can operate as a simple threshold detector or can include more sophisticated parameters such as noise rejection and windowing.

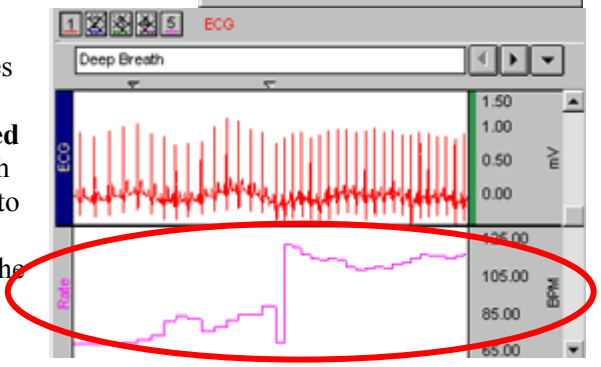


88. Click **OK.**

BSL PRO calculates the rate and displays its graph.

89. Note the new **CH5 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.



90. Remove the new channel selecting **CH5** and choosing **Edit>Remove Waveform**.

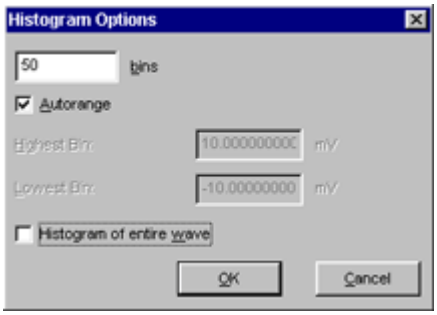
To remove a channel from a file, select it and choose **Edit>Remove Waveform**. Take care to select the channel you wish to remove, as you may not undo this command.

Transform>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.

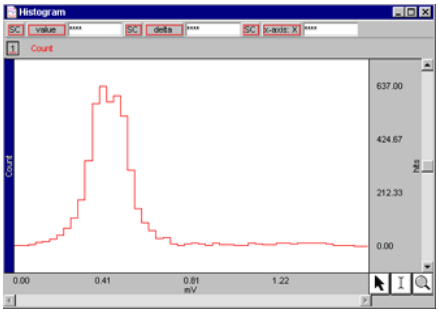
91. Select **CH1, ECG**.
92. Choose **Transform>Histogram**.
93. Set the bins value to "**50**."

Choosing **Transform>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**.



94. Click **OK**.
95. 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.



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

Return to the **4Channel.acq** graph window. "Show" channels that are hidden by holding the **Ctrl** key and clicking their channel number boxes.

DISPLAY MODES

BSL *PRO* offers a number of display options, including **Scope**, **Chart**, **X/Y Plot**, and **Overlap Segments**. 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).

Overlap Segments display is useful for comparing the waveforms of appended segments. The icon for this mode is enabled only in data files with multiple, appended recording segments. (Overlap Segments mode is not enabled in the sample files included with BSL 3.7.) Consult the BSL *PRO* manual for more information about display modes.

97.  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**
- Choose **Display> Autoscale Waveforms**
- **Hide** CH1 and CH2.
- **Analyze** the **CH3** and **CH4** waveforms.

Display menu options determine the display of waveform data.

Analyze the relationship between **CH3, Stethoscope (Heart Sounds)** and **CH4, Respiration**. Note the differences between the "Deep Breath" and "After Exercise" data segments.

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

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

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

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.

In X/Y display mode, the icon for the **Plot Standard Curve**  function is enabled in the Toolbar; it generates a dialog that enables you to enter values for colorimetric studies.

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

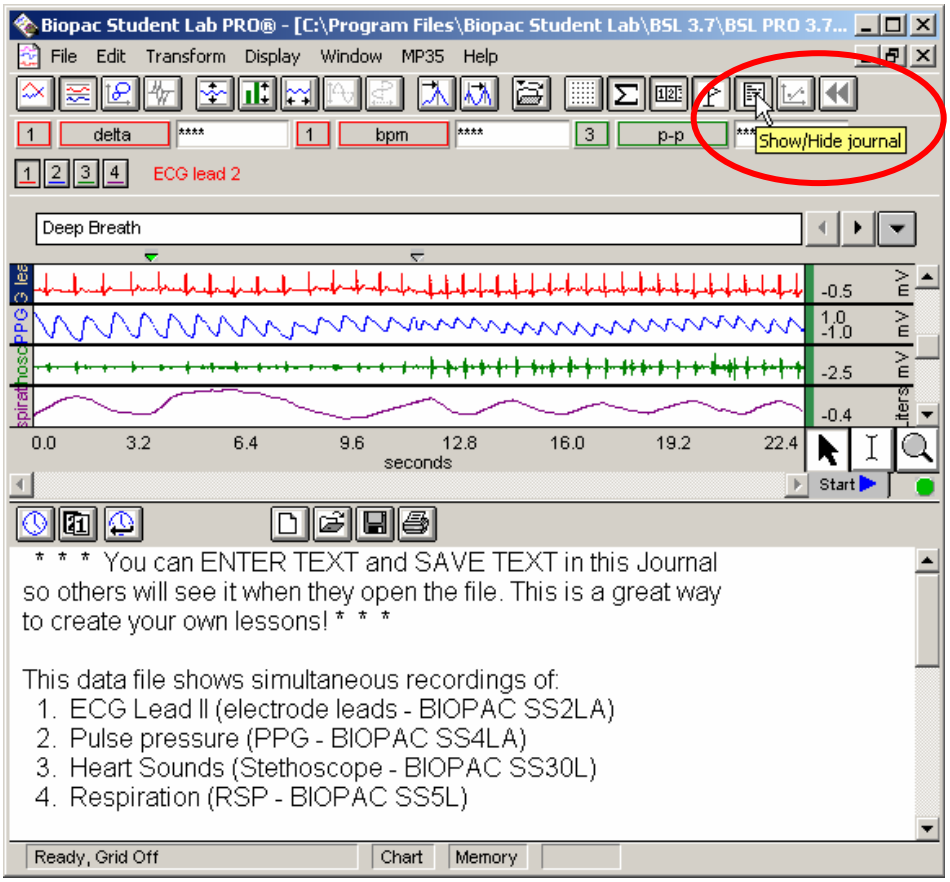
Click on the **Chart** display icon to return to Chart mode. Show any hidden channels by holding the **Ctrl** key and pressing their channel number boxes.

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

Part 5: Journal

100. Toggle the **Journal** icon on the Toolbar to hide and show the Journal region of the display.

101. 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.

Toggle the **Journal** icon on the Toolbar to display the Journal region. Alternately, choose the menu command **Display>Show>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.

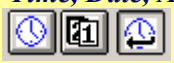
JOURNAL TEXT ENTRY

102. Place the cursor at the beginning of the Journal and type your 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



103. Enter a **time** stamp.
    - Place the cursor at the end of existing journal entries.
    -  Click the Time tool (clock icon) to enter a **time** stamp.
    - Review the Journal.
104. 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.
105. Activate the **AutoTime** tool and enter time stamps.
    -  Click the icon to **activate AutoTime**.
    - Place the cursor where you want the time 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 Journal Preferences

106. Choose the menu command **File>Preferences>Journal** to generate the **Journal Preferences dialog**.
107. Review the options that determine how measurements and wave data are pasted into the **Journal**.

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.

 Once the cursor is placed in the Journal, click the Time tool (clock icon.) 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 is entered each time you press the **Enter** key.

- 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.

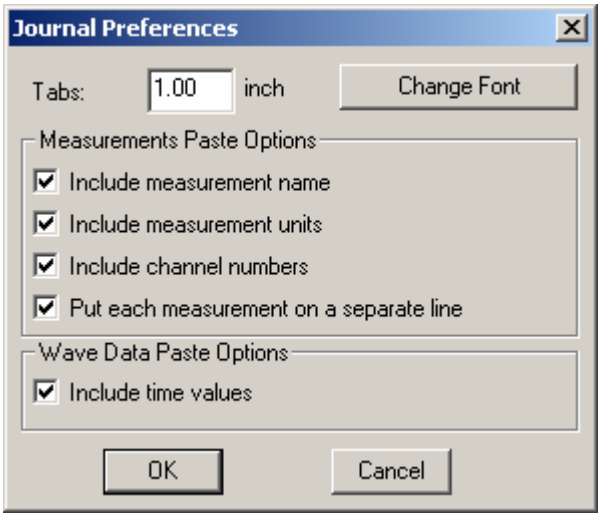
Journal Preferences options control how measurements and wave data are formatted, when pasted directly from the graph window to the Journal using the **Edit>Journal** submenu commands

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.

108. Check that all **Measurement Paste Options** are selected, as well as the "Include time values" option of the **Wave Data Paste Options**.
109. Click **OK** to accept any preference option changes.

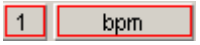
For this tutorial, select all of the measurement and wave data paste options so when you paste data to the Journal you can easily identify them.

When you plan to export measurements and data to other programs (such as an external spreadsheet program), it is sometimes best not to select all of the options, as some may affect formatting.



Set Measurements

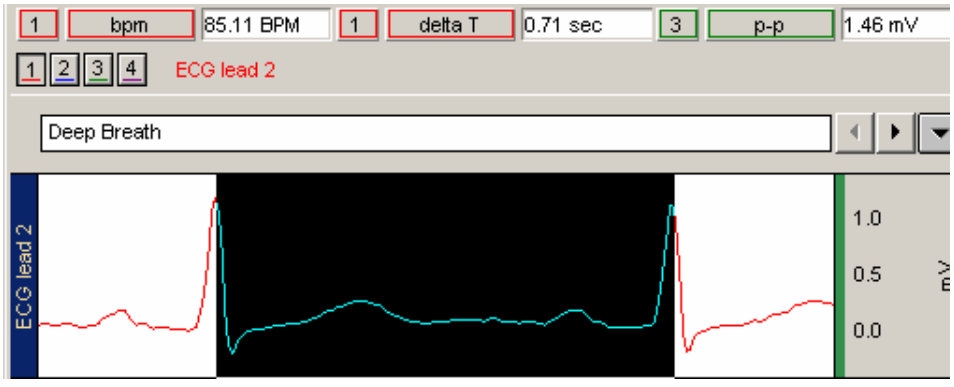
110. Set a measurement box for **CH1 BPM**.
    - Choose **CH1** as the selected channel.
    - Choose "**bpm**" as the measurement.
111. Set a second measurement box for **CH1 delta T (Time)**.
    - Choose **CH1** as the selected channel.
    - Choose "**delta T**" as the measurement.
112. Use the **I-beam** tool to select an area of data from the **peak of one R-wave to the peak of the next R-wave**.



From the pull-down menus in the measurement box, choose **CH1** 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.

From the pull-down menus in another measurement box, choose **CH1** as the selected channel, and **delta T** (Time) as the measurement.



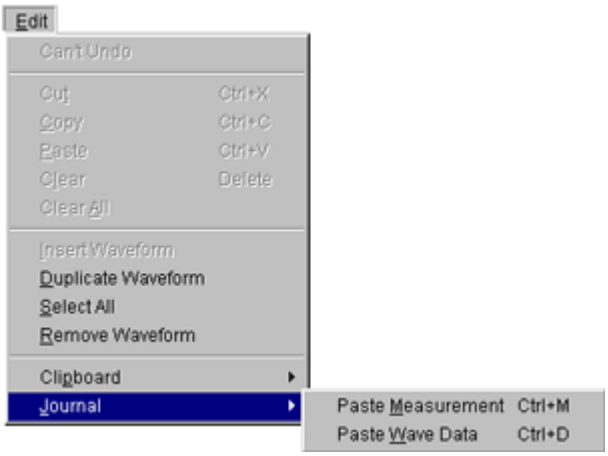
Zoom in on the **CH1 ECG** data. Identify and select a region from the peak of one R-wave to the peak of the next R-wave.

Paste Measurement Data

113. Click the cursor in the Journal where you want to paste the measurement.
114. Choose the menu command **Edit>Journal>Paste Measurement**.
115. Review the Journal entry.

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

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

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

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 put 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 200 Hz, 200 numbers will be pasted into the Journal. The values will be formatted in columns headed by the respective channel names.

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

sec	ECG lead 2	PPG	Stethoscope	Respiration
2	-0.0869751	-0.277161	-0.119781	0.115596
2.005	-0.0894775	-0.286896	-0.0761414	0.112861
2.01	-0.0946045	-0.296295	0.103607	0.110127
2.015	-0.0912476	-0.30481	0.0300598	0.107393
2.02	-0.0870361	-0.313049	-0.0326538	0.104863
2.025	-0.0863647	-0.321472	-0.0390625	0.102539
2.03	-0.0862427	-0.331207	0.0346375	0.100762
2.035	-0.0823975	-0.341309	0.0306702	0.0990527
2.04	-0.0697632	-0.351013	-0.0642395	0.0973438
2.045	-0.0325317	-0.360382	-0.0698853	0.0956348
2.05	0.0616455	-0.368073	0.0648499	0.0936865
2.055	0.25415	-0.374481	0.0737	0.0910205

Journal data may be exported to a file of type ".txt" 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.

JOURNAL TEXT TOOLS

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

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.

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

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, which are limited to files of type ".txt."

Save Text

Save Text allows you to export your Journal notes to a separate file of type ".txt." This is useful for exporting data to other programs, such as spreadsheets, for further manipulation and analysis.

Print Journal

Print Journal prints the contents of your Journal.

Part 6: Printing Graphs

120. 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 displayed in the graph window will be printed. This can be useful if want to print only a portion of the graph.

121. 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.

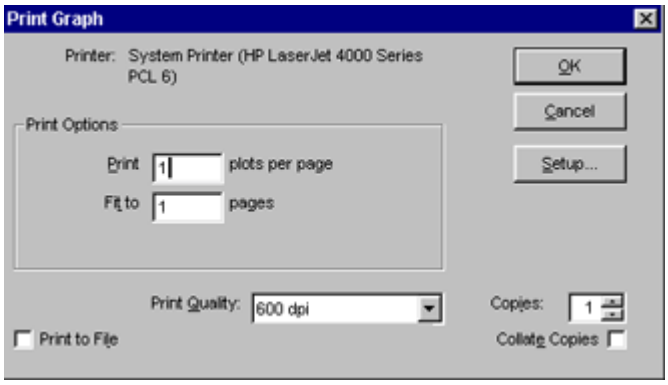
To print a portion of the data file, use the zoom tool, scale tools, and scroll bars to display the portion of the recording you wish to print.

To print the complete data file, choose **Display>Autoscale Horizontal** and **Display>Autoscale Waveforms** to center waveforms and display the entire recording.

122. Choose **File>Print** to generate the **Print Graph** dialog.

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

124. Review the printed result.



Choosing **File>Print Graph** 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.

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

This completes the BSL *PRO* 3.7 Tutorial. Following is a brief description of other sample files that you may wish to review.

Sample Data Files

To further your 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
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
StandardCurveData.acq	Shows a typical Standard Curve, used in colorimetric studies to find the concentrations of unknown solutions.
ValidateMeasurements.acq	Demonstrates multiple measurements on a selected area of data.

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