

The Tutorial ECG Lab and LabScribe Software

Exercise 1: Recording an ECG

1. Click on the Record button, located on the upper right side of the LabScribe Main window (Figure T-T-L1). The signal should begin scrolling across the screen.
2. Click on the AutoScale buttons at the upper margins of the ECG and Heart Rate channels. The ECG and heart rate recording should expand to fill the channel windows.

Note: If you are recording an ECG from yourself, click on the Record button and then move away from the computer, the monitor, the mouse, and the keyboard. Sit quietly while recording at least thirty seconds of data that are artifact-free. Click the AutoScale buttons after stopping the recording.



Figure T-T-L1: ECG and heart rate data in the LabScribe Main window.

Note: If the user clicks the Record button and there is no communication between the iWorx unit and computer, an error window will appear in the center of the Main window. Make sure the iWorx unit is turned on and connected to the USB port of the computer. Click OK and select the Find Hardware function from the LabScribe Tools menu.

3. Click Stop to halt recording; your record should look like the figure above.
4. Select Save As in the File menu, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder). Designate the file type as *.iwxdata. Click on the Save button to save the data file.

Exercise 2: Explore the LabScribe Main Window

Once you have recorded data, explore some of the functions of the LabScribe software that are available on the Main window by clicking on buttons, or pulling down menus and selecting functions. See what happens to the images on the recording channels as you change the Display Time, Zoom In or Out, or Invert the signal.

The configuration of the Main window used for this experiment was designed by manipulating some of the controls on the Main window and some of the controls on other windows, like the Preferences dialogue window available from the Edit menu. The configuration used for this experiment was saved as the settings file, Tutorial-Human-LS2, that you selected from the Settings menu and are using for this experiment.

Additional tools in the LabScribe software are covered in Exercises 3 through 6.

Channel Recording Area

Each channel has its own recording area ([Figure T-T-L2](#)) and its own controls and indicators:

- Channel Menu has controls for inverting and copying the graph, hiding and minimizing the channel, changing the title of the channel, converting units, and setting the scale of the Y-axis.
- Channel Title, which can be changed through the Channels Menu or the Preferences dialogue window.
- Channel Mode and Function identifies the input used and any computed function being performed on the input signal. A pull-down setup menu opens when this area is clicked.
- Zoom In button doubles the height of the signal displayed without altering the real amplitude of the signal. Zoom Out button halves the height of the signal displayed without altering the real amplitude of the signal.
- AutoScale button increases the height of the signal displayed to within 5% of the upper and the lower limits of the Y-axis.
- Add Function button opens a pull-down menu used to select a computed function to be performed on the channel. When the function is selected, the additional channel and any controls for programming the function open automatically.
- Values display lists the Y-value of a data point at the position of a single cursor, or the difference between the Y-values of the points identified by two cursors.
- Position the trace on a channel by placing the cursor on the recording area, holding down the mouse button, and sliding the trace up or down.
- Adjust the height of an individual channel by placing the cursor on the margin between that channel and the channel above or below it. When this control is active, the cursor turns into a

double-headed arrow. Hold down the mouse button and slide the margin up or down to change the height of the channel display.

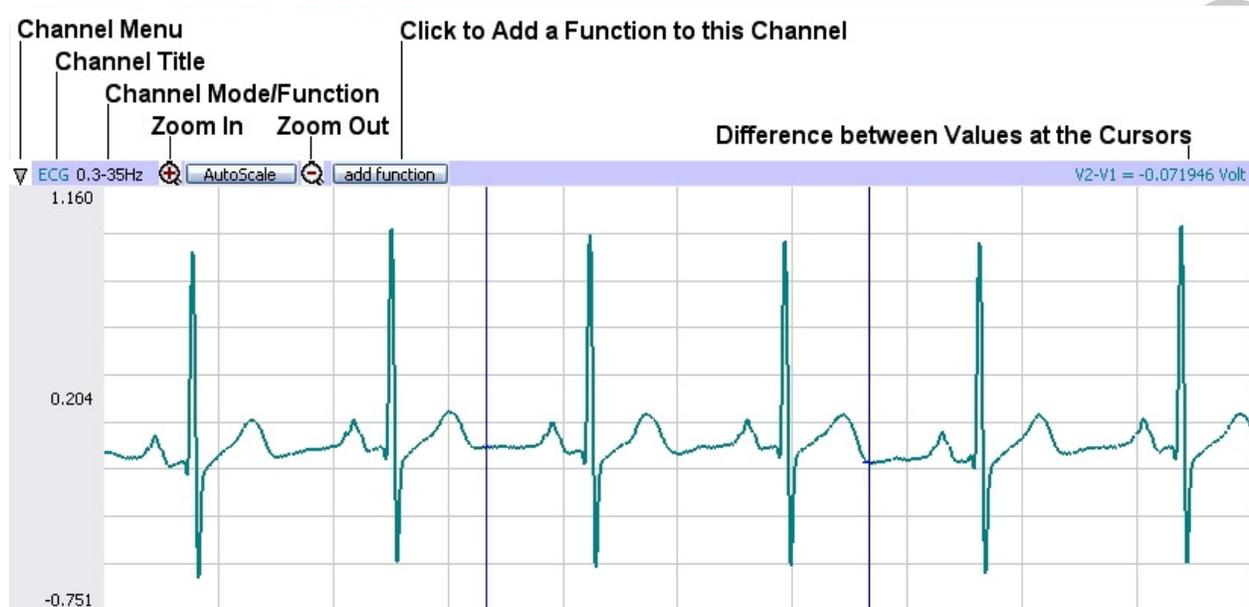


Figure T-T-L2: Control buttons and values for a typical LabScribe recording channel.

Time Displays and Mark Controls

Just above the uppermost channel in the LabScribe Main window are the displays for the time parameters of the recording and controls for marking the recording (Figure T-T- L3):

- Speed is the number of samples taken each second of the recording. Sampling rate is controlled from the Preferences dialogue window on the Edit menu.
- Display Time is the length of time of recorded data that is seen on the Main window. Display time is controlled from the Preferences dialogue window on the Edit menu or by the Display Time icons on the LabScribe toolbar.
- Mark button is clicked to place a mark at a point of interest on a live recording. Clicking the Enter key on the keyboard will also add marks to a live recording.
- Mark Menu is opened by clicking on the arrow to the right of the Mark button. This menu has controls for adding and deleting preset marks, and resetting the positions of marks. Mark Box is an area where comments associated with preset marks are composed. Preset marks can be added to a list by using the Add function in the Marks menu. To activate a preset mark for use, click on the arrow at the right side of the Mark Box and select the preset mark to be used.
- Time or T2-T1 displays the time of the recording at the position of a single cursor, or the difference in time between the positions of two cursors placed on the recording.

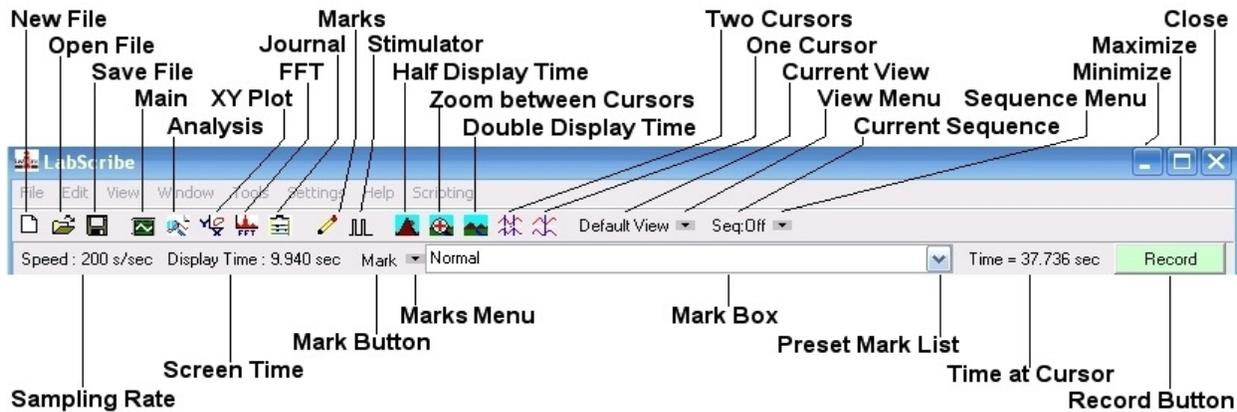


Figure T-T-L3: Menus, toolbars, displays and controls of the Main window.

Toolbars

Just above the Time Displays and Mark Controls are the toolbars for manipulating data files, LabScribe windows, time displays, cursors, screen views, and output sequences.

File Toolbar

- New File: Click on this icon to open a new data file using the current settings for the program.
- Open File: Click on this icon to open data files that were previously recorded and saved.
- Save File: Click on this icon to save the current data in a file.

LabScribe Toolbar

- Main Window: Click on this icon to return to the window where recorded data is first displayed and on-line computed functions can be performed.
- Analysis Window: Click on this icon to send the data between the left and right margins of the Main window to the Analysis window for additional measurements.
- XY Plot: Click on this icon to plot the amplitudes of two channels, like pressure and volume, against each other. This plots one channel to another, not a channel to time.
- FFT: Click on this icon to perform a Fast Fourier Transform on data for determining the power spectrum of the waveform.
- Journal: Click on this icon to open a notepad for recording critical data points, data windows, comments, and responses to questions for their eventual transfer to word processing, graphing, and other programs used for expressing experimental results.
- Marks Window: Click on this icon to open the list of marks created during the data recording. The comments associated with the marks can be edited.

- **Stimulator:** Click on this icon to open the Stimulator Control Panel under the toolbar. The type of stimulus and its parameters are selected from the control panel. The stimulator is only needed in experiments that require the generation of action potentials or muscle twitches.

Display Time Controls

- **Half Display Time:** Click on this icon to halve the length of the recording displayed on the screen. For example, if ten seconds of data is displayed on the screen, clicking this icon will display only five seconds.
- **Double Display Time:** Click on this icon to double the length of the recording displayed on the screen. For example, if ten seconds of data is displayed on the screen, clicking this icon will display twenty seconds.

Cursors

- **Two Cursors:** Click on this icon to place two cursors on the window. These cursors can be used for measuring the differences in time or amplitude for the positions of the two cursors.
- **One Cursor:** Click on this icon to place a cursor on the window. This cursor can be used for measuring the time and amplitude at the position of the cursor.

View Controls

- **Current View:** This box displays the name of the current combination of channels, or view, displayed on the window.
- **View Menu:** Displays the controls for creating, copying, naming, and editing views.

Sequence Controls

- **Current Sequence:** This box displays the name of the sequence of commands used to automate sampling and stimulation.
- **Sequence Menu:** Displays the controls for starting, stopping, editing, opening, and saving sequences of commands.

Exercise 3: Making Marks on a Recording

Large amounts of data can be recorded with LabScribe software. However, to be useful, the data that is interesting needs to be located and retrieved easily. Specific sections of data can be located or distinguished from sections by placing marks and comments at those locations in the data file. Marks, with or without text comments attached, can be placed on the data during or after the recording. The text comments associated with marks can also be composed and saved, before the recording begins, in the Preset Mark List.

Entering Marks While Recording

Practice adding marks with comments during a recording.

1. Make sure the electrodes and the lead wires are attached to the subject and the recording cable. Also, make sure the cable is attached to the recording unit in the correct manner and the LabScribe software is configured to record data.
2. Click Record. Adjust the height of the traces on the ECG and Heart Rate channels by using the AutoScale buttons.
3. During data recording, an active text cursor appears in the Mark Box ([Figure T-T-L3](#)). Type the subject's name in the Mark Box using the keyboard
4. Click on the Mark button on the Main window or press the Enter key on the keyboard to place the mark on the recording.
5. Use the same procedure to place additional marks and comments while continuing to record data.
6. Click on the Stop button to end the recording. Open the File menu and select Save.

Making and Entering Preset Marks

Marks can be composed and added to a list before data recording begins.

1. Before recording another block of data, move the screen cursor to the Mark Box and click the mouse button to make a text cursor appear in this box.
2. Write a comment in the Mark Box. Pull down the Mark menu and select Add to Mark Presets.
3. Pull down the Preset Mark List, that is to the right of the Mark Box, and confirm the presence of the preset mark you just created.
4. Click Record. Adjust the height of the traces on the ECG and Heart Rate channels by using the AutoScale buttons.
5. Pull down the Preset Mark List and select the preset mark you composed. The preset mark should appear in the Mark Box.
6. Click on the Mark button on the Main window or press the Enter key on the keyboard to place the preset mark on the recording.
7. Click on the Stop button to end the recording. Open the File menu and select Save.

Entering Marks on Recorded Data

Additional marks and comments can be added to a data file after the recording is completed.

1. Find a region of interesting data in your current data file.
2. Click on the One Cursor icon on the Main window toolbar.
3. Use the mouse to position the cursor on the data of interest.
4. Put a text cursor in the Mark Box and compose a comment.

5. Click on the Mark button on the Main window, or press the Enter key on the keyboard, to place the added mark on the recorded data.
6. Open the File menu and select Save.

Exercise 4: Analyzing Your Data in the Main Window

Time and amplitude measurements can easily be performed on the Main window using cursors. The values obtained can be saved in the Journal along with other notes pertinent to the experiment.

Navigating the Main Window

There are two ways to navigate through a data file in the Main window to reach regions of interest: scrolling or using marks.

Scrolling

1. Locate the scroll bar below the time marks on the lower margin of the Main window.
2. To move the recording to the left or the right in small increments, click on the arrows at the ends of the scroll bar.
3. To scroll slowly through the recording, click on and hold on the arrows at the either end of the scroll bar.
4. To scroll quickly through the recording, click on and hold on the slider as you move it to the left or the right.
5. If you click on the Half or Double Display Time icons on the toolbar, the width of the slider will change in proportion to the display time of the data file. When the display time on the screen is longer, the slider is longer.

Using Marks

1. Open the Marks window to see a list of the marks ([Figure T-T-L4](#)). The Marks window can be opened by clicking the Mark icon on the toolbar. The Marks window can also be opened by pulling down the View menu and selecting Marks from the list ([Figure T-T-L5](#)).
2. Click on the Number of the mark to select a mark.
3. Click on the GoTo Mark button. The Marks window will disappear and the region of the data file around the selected mark will be displayed on the Main window.



Figure T-T-L4: The Marks Window.

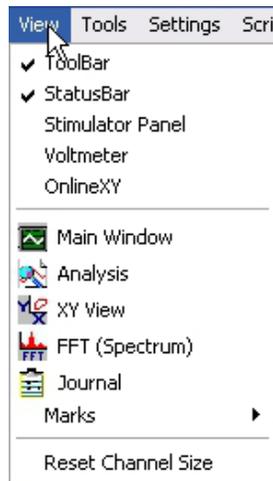


Figure T-T-L5: The View menu.

Making Measurements on the Main Window

Amplitudes, differences in amplitudes, times, and differences in times of waves displayed on the Main window can be taken using the cursors. The cursors are vertical blue lines that appear on each channel displayed in the Main window when either of the two Cursor icons in the toolbar are clicked.

Using two cursors:

1. Click on the Two Cursors icon in the toolbar to place two vertical blue bars on the Main window.
2. Click on and drag the cursors, to the left or to the right, to place them on the largest peaks of two adjacent ECG cycles on the ECG channel (Figure T-T-L6). The difference in time between the peaks is the value labeled T2-T1, which is displayed next to the Record button.

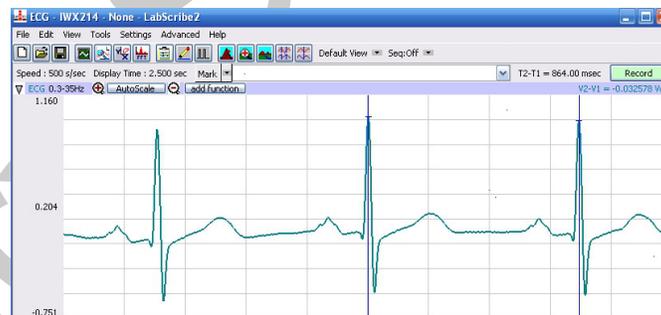


Figure T-T-L6: Two cursors used to measure the period (T2-T1) of an ECG cycle

3. Click on and drag one of the cursors to the baseline to the left of the largest peak. Place the other cursor on the largest peak to the right of the first cursor (Figure T-T-L7). This difference in the amplitudes at the cursors is the value labeled as V2-V1, which is displayed below the Record button.



Figure T-T-L7: Two cursors used to measure the amplitude (V2-V1) of the largest peak of the ECG.

Using a single cursor:

1. Click on the One Cursor icon in the toolbar to place a vertical blue line on the Main window ([Figure T-T-L8](#)).

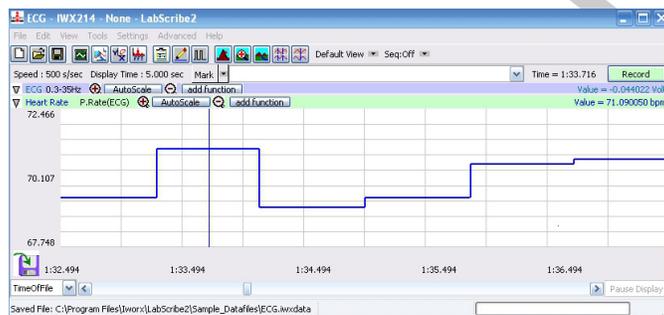


Figure T-T-L8: One cursor used to measure the heart rate of the subject from the data on the Heart Rate channel.

2. Click on and drag the cursor to a plateau on the Heart Rate channel. The time of the recording at this position is the value labeled Time, which is displayed next to the Record button. The Value for the amplitude at this position is the heart rate of the subject at that moment in time, which is displayed below the Record button.

The Journal

The Journal is a window that can be used as a notebook. Notes about the experiment and values from measurements on the Main window can be typed directly into the Journal. Also, recordings on the screen and data in tables can be copied and pasted into the Journal. From the Journal, the items present can be pasted into other programs, or printed directly.

1. Open the Journal by either clicking on the Journal icon on the toolbar or pulling down the View menu and selecting Journal.
2. Use the keyboard to type a note regarding this experiment or the values of the measurements taken with the cursors in the Journal.
3. Display ten seconds of ECG data on the Main window. Use the Display Time icons or the Display Time box on the Preferences dialogue window to set the Display Time.

4. Copy the data on the Main window to the clipboard file by selecting the Copy command in Edit menu.
5. Place a text cursor on the Journal window by clicking on the open area of the window. Use the Paste icon on the Journal toolbar, which is on the top margin of the Journal window, to paste a copy of the data from the Main window into the Journal.
6. Open the File menu and select Save.
7. Click on the Journal icon on the toolbar or pull down the View menu and select Journal to close the Journal.

Exercise 5: Analyzing Your Data in the Analysis Window

Additional analyses can be performed on data displayed in the Analysis window through a number of functions that include derivatives, integrals, and general parameters.

Selecting Data for the Analysis Window

The segment of the recording that is displayed on the Main window is the data that can be transferred easily to the Analysis window.

1. Locate a five-second section of the ECG recording with representative ECG waves. Use the Display Time icons or the Display Time box on the Preference window to adjust the Display Time of the Main window to 5 seconds.
2. Click on the Analysis window icon in the toolbar or select Analysis from the View menu to transfer the data displayed in the Main window to the Analysis window ([Figure T-T-L9](#)).



Figure T-T-L9: ECG, pulse and heart rate data in the Analysis window.

Navigating in the Analysis Window

Channels and data are displayed on the Analysis window as they are on the Main window. However, you will find that some displays, like Value or Time, will appear in tables above each channel. Also, some controls, like AutoScale, appear under functions on the Channel menu or in shortcuts like the menu that appears when the Y-axis is clicked.

- **Scrolling**
 - Use the slider and arrows on the scroll bar to move the recording to the left or the right.
- **Marks**
 - Use the Go To button on the Marks window to position the data around the selected mark in the center of the window.
- **Display Time**
 - Click on the Display Time icons to change the length of the recording shown in the window.
- **Channel Margins**
 - Click on and drag the margins between channels to increase or decrease the heights of channels.
- **Trace Position**
 - Click on and drag the trace to adjust its vertical position on a channel.
- **Channel Stacking**
 - Click on the Stack/Superimpose button ([Figure T-T-L10](#)) in the lower left corner on the Analysis window to superimpose the channels upon each other. Click on the Stack button, a second time, to restack the channels above and below each other.

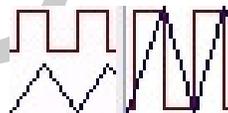


Figure T-T-L10: The Stack/Superimpose button toggles between two modes: stack seen on the left and superimpose seen on the right.

- **Channel Menu**
 - Pull down the Channel menu to copy, hide, delete the selected channel, and more. Other functions allow data to be copied from the Analysis window to the Journal in tabular format

Making Measurements on the Analysis Window

Measurements on data displayed in the Analysis window are performed using cursors and functions selected in the following manner:

1. Click on the add function button to open a menu of mathematical functions that can be performed on the data displayed in the Analysis window.
2. Open the submenus to familiarize yourself with the parameters available in each category:
 - General: provides amplitudes and times of the data at the positions of the cursors, differences in amplitudes and times between the data, the maximum and minimum values of the data between the cursors, and more.
 - Derivative: provides the slope of the data at the positions of the cursors, and the maximum, minimum, and mean slope of the data between the cursors.
 - Integral: provides the area or absolute area under the recording, or the integral or the absolute integral of the recording, between the cursors.

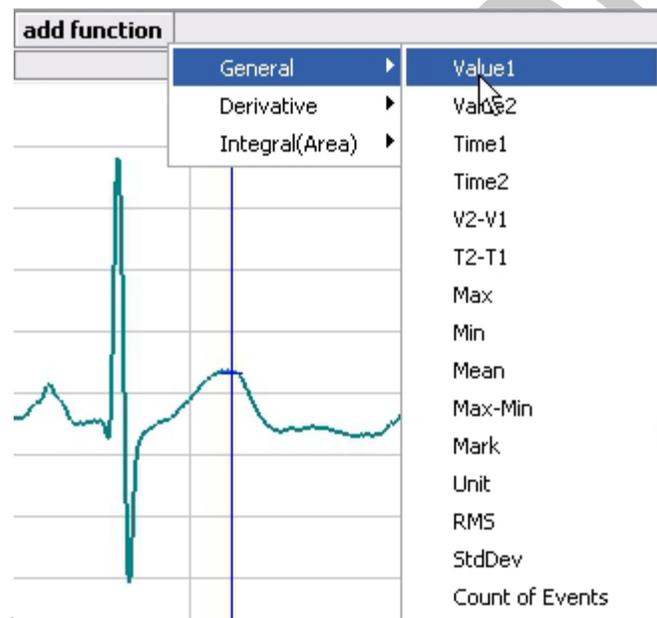


Figure T-T-L11: The Add Function menu in the Analysis window.

3. Open the General category and select Value1. Open the General category, three additional times, to select Value 2, V2-V1, and T2-T1. After each function is selected, the name of its parameter appears on the Function Table. The values of the each parameter on each channel appear on a table across the top of each channel.
4. Click on the Two Cursor icon on the toolbar. Place one cursor on the largest peak of an ECG cycle displayed on the ECG channel. Place the second cursor on the largest peak of the adjacent ECG cycle.
5. The values, in the table above the recording area of the ECG channel, are the amplitudes at the cursors (Values 1 and 2), the difference in the amplitudes at those cursors (V2-V1), and the time between the cursors (T2-T1).

6. The values, in the table above the recording area of the Heart Rate channel, are the heart rates at the cursors (Values 1 and 2), the difference in the heart rates at those cursors ($V2-V1$), and the time between the cursors ($T2-T1$).
7. Create a table of these parameters and their values in the Journal by transferring the titles and the values of the parameters with the following steps:
 - Go to the Channel menu of any channel and select Add Title to Journal to create a labeled header for the table;
 - Go to the Channel menu of any channel and select Add All Data to Journal to add data from all channels to the table, or;
 - Go to the Channel menu of a specific channel and select Add Ch. Data to Journal to add data from the selected channel to the table.

Exercise 6: Applying a Computed Function to Your Data

The data files generated or used in the previous exercises all displayed two channels of data, ECG and Heart Rate. The data recorded on the ECG channel is a recording of the subject's electrocardiogram. The trace displayed on the Heart Rate channel is derived from the data on the ECG channel. On the Heart Rate channel, a mathematical function is programmed to measure and convert the time between the largest peaks of the ECG cycles into the subject's heart rate and display the rate on the Main window as a histogram.

In this exercise, you will learn how to apply another computed function, the Period, to your ECG recording.

1. Display the ECG data recorded from your subject on the Main window.
2. Adjust the Display Time of the Main window to ten seconds by either using the Half or Double Display Time icons on the toolbar or entering the Display Time in the appropriate box on the Preferences dialogue window, which is available from the Edit menu.
3. To select the new computed function to be performed on the ECG data, click on the add function button on the ECG channel. The Computed Function menu will appear ([Figure T-T-L12](#)).
4. Use the screen cursor to highlight Periodic. Select Period from the list of available periodic functions. When the selection is made, an additional channel appears on the Main window behind the Periodic Setup window ([Figure T-T-L13](#)).
5. On the Periodic Setup window, select the parameters needed to perform the period function properly.
 - Select Use Percentage of Max and Min to place the critical threshold and tolerance values at a specific height of the largest peaks in the recording.
 - The threshold determines which peaks in the recording will be used in the calculation of the ECG period. The largest peak in each ECG cycle is the easiest peak to identify and use in calculating the period of each ECG cycle.
 - Select a threshold level that goes through the middle of the largest peaks and is above

the tops of the smaller peaks in the recording. The default value for the threshold is set to 60 by the settings file. This value is suitable for normal electrocardiograms.

- The threshold level can be changed by using the arrows to the right of the threshold value box, by typing the desired value into the box, or by dragging the blue threshold line on the graph up or down. When the threshold is set at the proper level, the time point at the top of the largest peak in each ECG cycle will be used to determine its period.
- The tolerance determines the range of values around the threshold that will be accepted as time points in the calculation of the periods of the ECG cycles.
- Select a tolerance level that will include the top of the largest peak in each ECG cycle. The default value of the tolerance is set to 3 by the settings file. This value is suitable for normal electrocardiograms if the top of the largest peak in each ECG cycle is within 3% of the threshold level. If the largest peak in an ECG cycle is below this range, increase the tolerance value or lower the threshold if possible.
- The tolerance level can be changed by using the arrows to the right of the tolerance value box, by typing the desired value into the box, or by dragging the blue tolerance line on the graph up or down.
- Click OK.

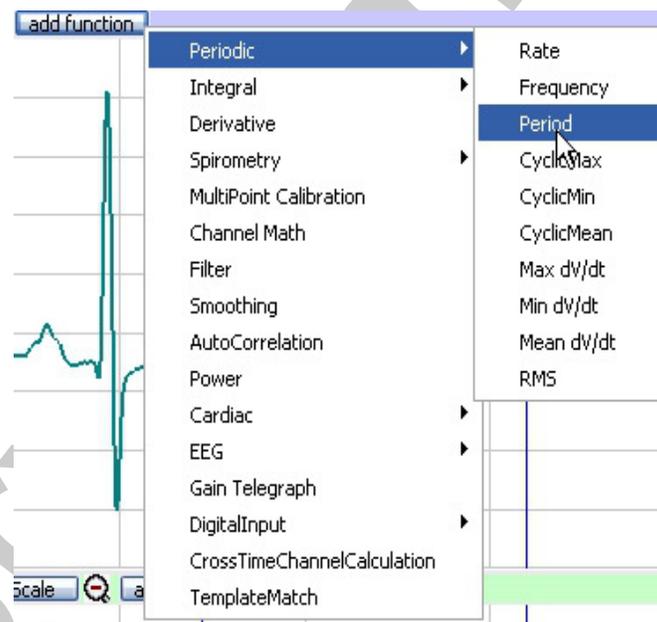


Figure T-T-L12: The Computed Function Menu.

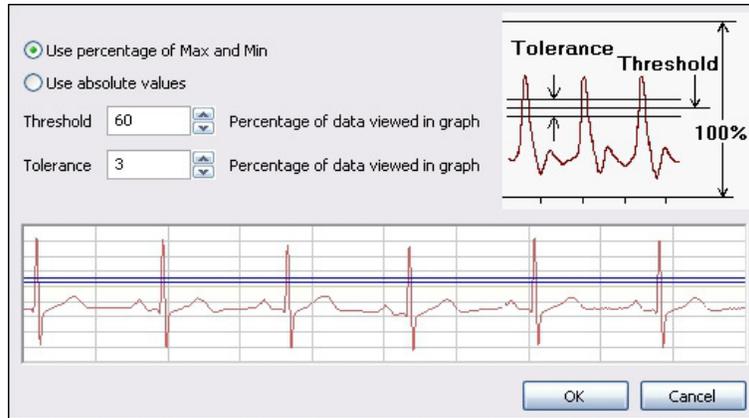


Figure T-T-L13: The Periodic Setup window.

6. Click on the AutoScale button on the new computed channel to magnify the trace on that channel (Figure T-T-L14).
7. Pull down the Channels menu on the new computed function channel and select Title. Change the name of channel to Period. Click OK.
8. Measure the periods of a couple of the ECG cycles on Period channel using the techniques learned in either Exercise 3 on the Main window or Exercise 4 on the Analysis window.



Figure T-T-L14: ECG (top), heart rate (middle), and period (bottom) displayed on the Main window.