APPENDIX A

The Neuroscan

WAVEBOARD

Doc. number2205, Revision C

Contents

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Waveboard

The Waveboard is a handy utility program that may be used to display, annotate, and measure data from individual channels. It may be used as a stand-alone program, or it may be called from the ACQUIRE or EDIT programs. Its main features include:

- The display of Multiple Window data from channels selected from the same or different data files.
- Time and frequency domain files can be displayed on the Waveboard.
- The ability to mark time points for each channel (latency and amplitude).
- The ability to place one or two cursors to show latency and amplitude measurements and differences between them.
- Movable and adjustable X and Y measurement scales.
- Style and color modifications for each channel.

Waveboard Tutorial

Step 1 - Starting the Waveboard. The waveboard.exe program may be run as a stand-alone program by double-clicking on Waveboard.exe in the Scan4.3 folder. More commonly, you may launch the program by clicking the Waveboard icon from the Toolbar in ACQUIRE or EDIT. The Waveboard is used with the Multiple Window Displays (when collecting or retrieving single sweep data or on-line averages), and not with the Single Window Display (the continuously scrolling EEG).

For this demonstration we will use the Vep.avg demonstration file that is in your ScanData\Demo Files\Veps folder. Launch the EDIT program from the Program Launcher, and click File\ Open data files, or click the Open File icon . Set the Files of type pull-down menu to AVG files, then go to the ScanData\Demo Files\Veps folder and double-click on the Vep.avg file. The data file will appear similar to the following.

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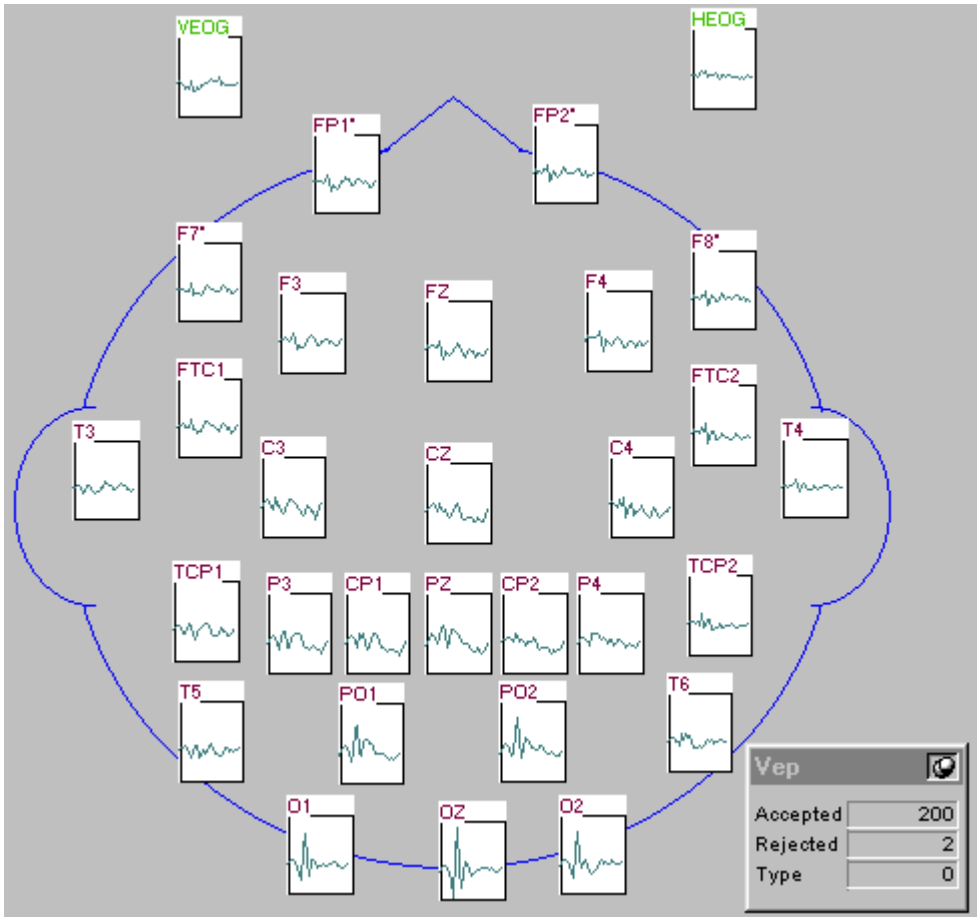

Now click the Waveboard icon from the Toolbar. Minimize the Waveboard display.

Step 2 - Copying data to the Waveboard. Let's copy O1, OZ and O2 to the Waveboard. Position the mouse cursor on the O1 display, enlarge it to mid- or full-size, and click the right mouse button. Select the Send Data to Waveboard option.

Repeat the same steps for the OZ and O2 electrodes. Now Maximize the Waveboard display by clicking on its icon Waveboard - ... from the Windows Toolbar. Maximize the waveform display inside the Waveboard display, if desired. The result will look similar to the following (your background and waveform colors will likely appear different, depending on the settings you selected in the Multiple Window Settings, under Options). Use the Up and Down arrows to scale the data on the display, as desired, and invert the polarity, if desired.

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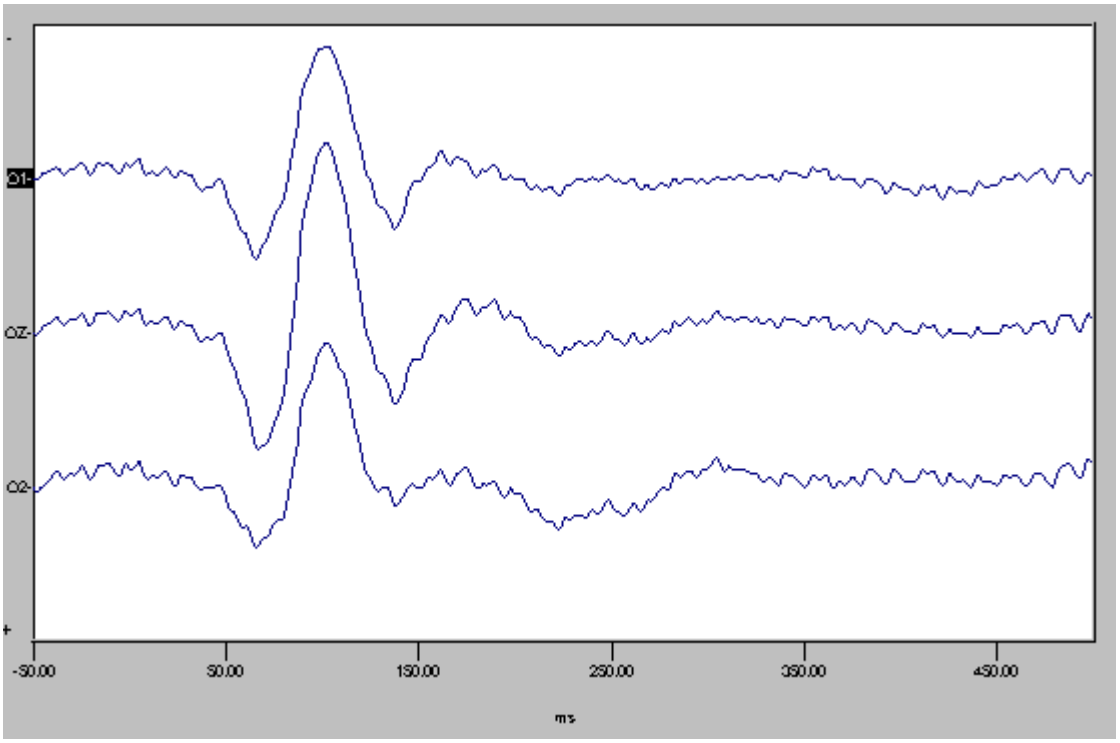
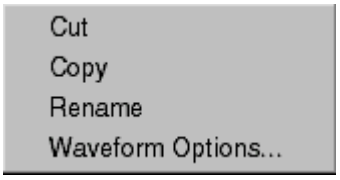
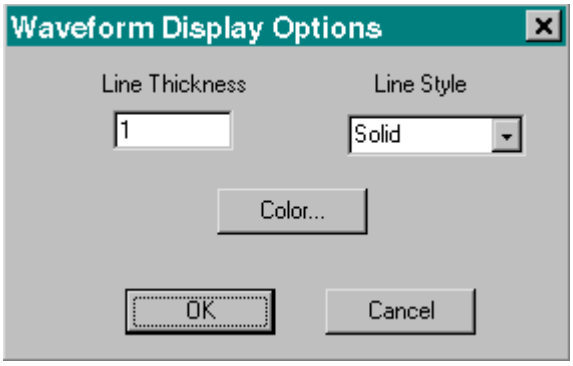


Step 3 - Changing colors. Let's change the colors to make it easier to tell the waveforms apart. Position the mouse over the O1 waveform label, and click the right mouse button. You will see the following list of options.



Select Waveform Options..., and see the following display.



As the display suggests, you can change the thickness of the waveform lines, or you can change the style of the line from solid to dots, dashes, etc. For now, just click the Color... button, and you will see the standard Windows Color Palette display.

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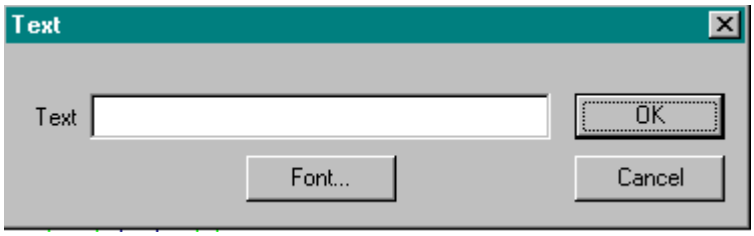
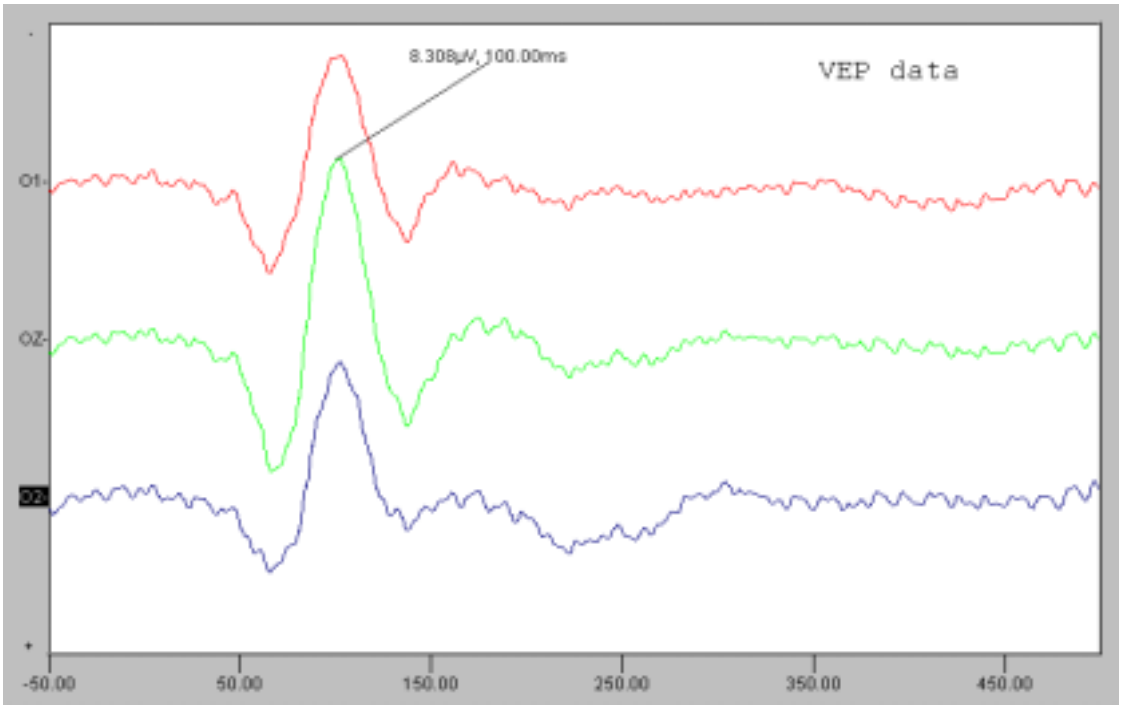
Select a color for the O1 waveform (red). If you don't like any of the displayed color options, click the Define Custom Colors>> bar, and select a customized color. Then click OK, and OK again. You should then see the new color for O1. Repeat the sequence to change OZ to a different color (green).

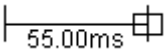
Step 4 - Adding Text. Now, let's add some text. Click the Add Text icon  , and click the left mouse button in the approximate area where you want to add the text. The Text display will appear.



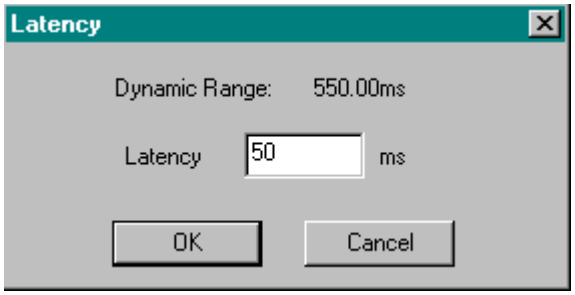
Click the mouse in the text field, and enter something like "VEP data". You can change the font style, size, and other characteristics by clicking the Font... button. Then click OK. The text will appear. You may reposition it by clicking and holding the left mouse button over the text to "grab" it, and drag the text to a desired location. Release the mouse to place it there. You can also click the right mouse button over the text. You will see a small option list which you can use to Delete the text or Edit the text. If you select Edit Text, you will get the same Text window as shown above.

Step 5 - Measuring Points. Now let's measure amplitude and latency of the peak of the P100 component at OZ. Click the Add Marker icon  , and then position the cross-hair at the P100 peak at OZ. Hold the left mouse button down, and drag the amplitude and latency values to a clear place on the display, then release the left mouse button to place it there. If you wish to change the placement, position the mouse over the measurements, and click and hold the left mouse button. You can then grab and drag the measurement information to a desired location. The indicator line will stay attached. Your display should now appear similar to the following.

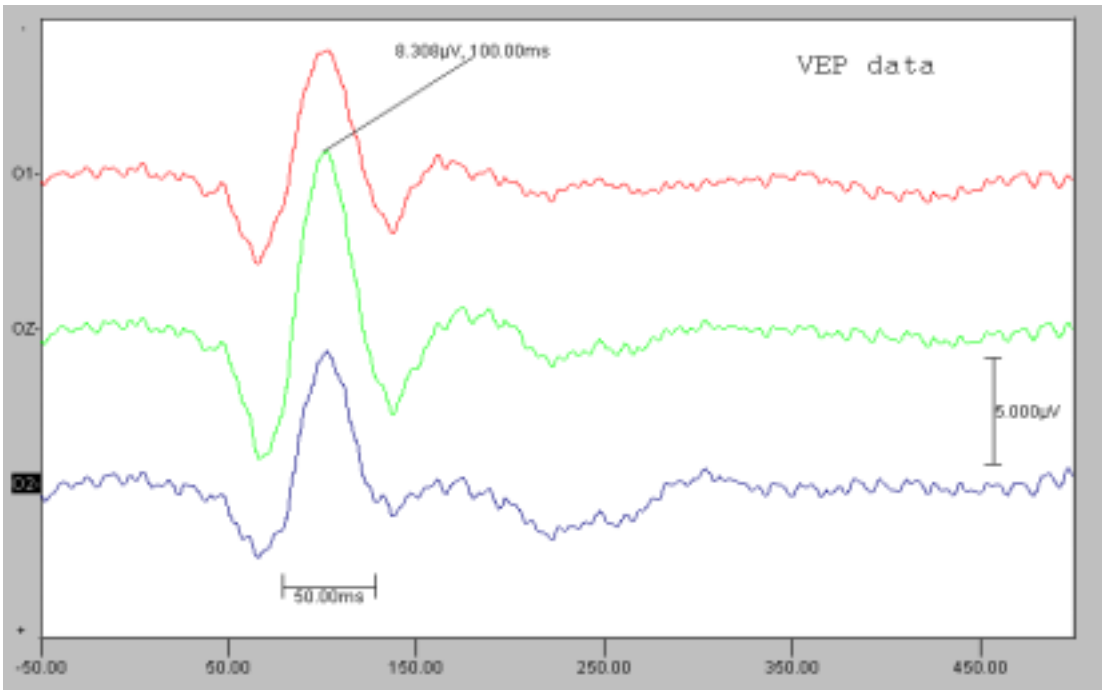


Step 6 - Adding Scale Tools. Now, let's add the Latency and Amplitude Scale Tools for precise measurement of latency and amplitude. Click the Latency Bar icon from the Waveboard Toolbar. You will see the x-axis scale tool. Click on it one time with the left mouse button, and a rectangle will appear on one end 

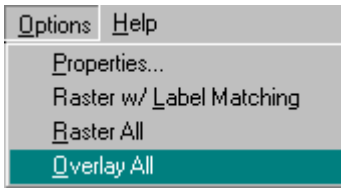
. By grabbing the rectangle with the left mouse button, you can extend or reduce the length of the scale tool. Alternatively, click on the scale tool with the right mouse button, and you will see a small option list. Selecting Delete will delete the scale tool. Selecting Set Latency will display the Latency window, through which you may select the length (in ms) of the tool. The Dynamic Range is the length of the entire epoch, and is the maximum range allowed for the scale tool.



Add the Amplitude Scale Tool (or y-axis tool) by clicking on its icon . The options for it are directly analogous to the Latency scale. You can reposition the scale tools by grabbing them with the left mouse button and dragging them to a desired location. Your display will now appear similar to the following.



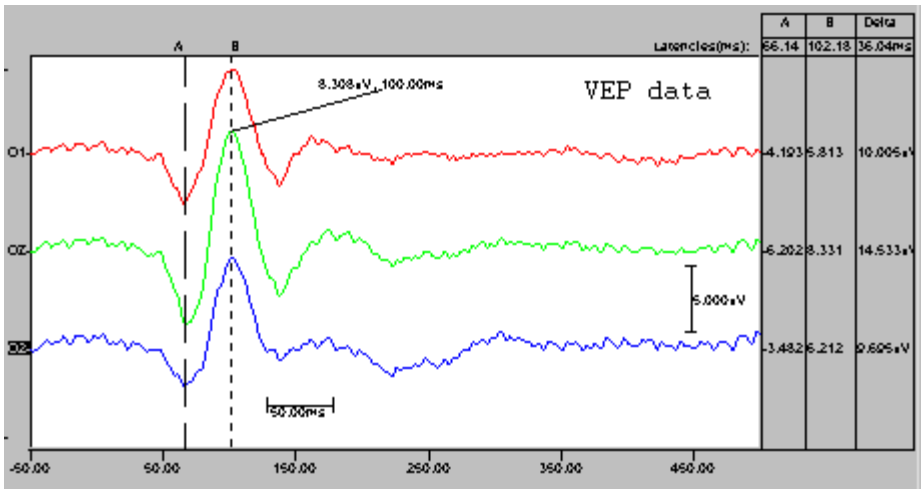
Step 7 - Moving the Waveforms. Note that it is possible to move each waveform up and down on the screen. Grab a channel label (O2) with the left mouse button, and drag it upward. If you want to overlay the waveforms on top of each other (so they have the same position for zero Volts on the screen, you can click and drag them into position, or do it more simply by selecting the Options \ Overlay All feature from the main menu bar.



To restore the channels to their original positions, select Options \ Raster All. If you were displaying channels from different data files that had the same labels (such as, OZ from two or more data files), you can select the Raster w/ Label Matching option. This will overlay waveforms that have the same labels (see step 10 below).

Step 8 - Using the Cursors. Next, let's do some relative latency difference measurements and some peak-to-trough measurements. Click the Enable Cursor 1 icon  from the Toolbar. You will see a vertical dashed line (Cursor 1) appear with the letter A at the top of it. You will also see several columns appear on the right side of the screen. Grab the cursor line with the left mouse button, and drag it back and forth. You will see the latency (in ms) of its current position displayed at the top of the first column, and the corresponding amplitude values (in uVs) for each of the waveform points. Position the cursor at the peak of the N70 component measured from OZ (about 66.3 ms).

Now enable the second cursor by clicking its icon  from the Toolbar. It will have the letter "B" at the top of it. Position it so that it is at the peak of the P100 component.



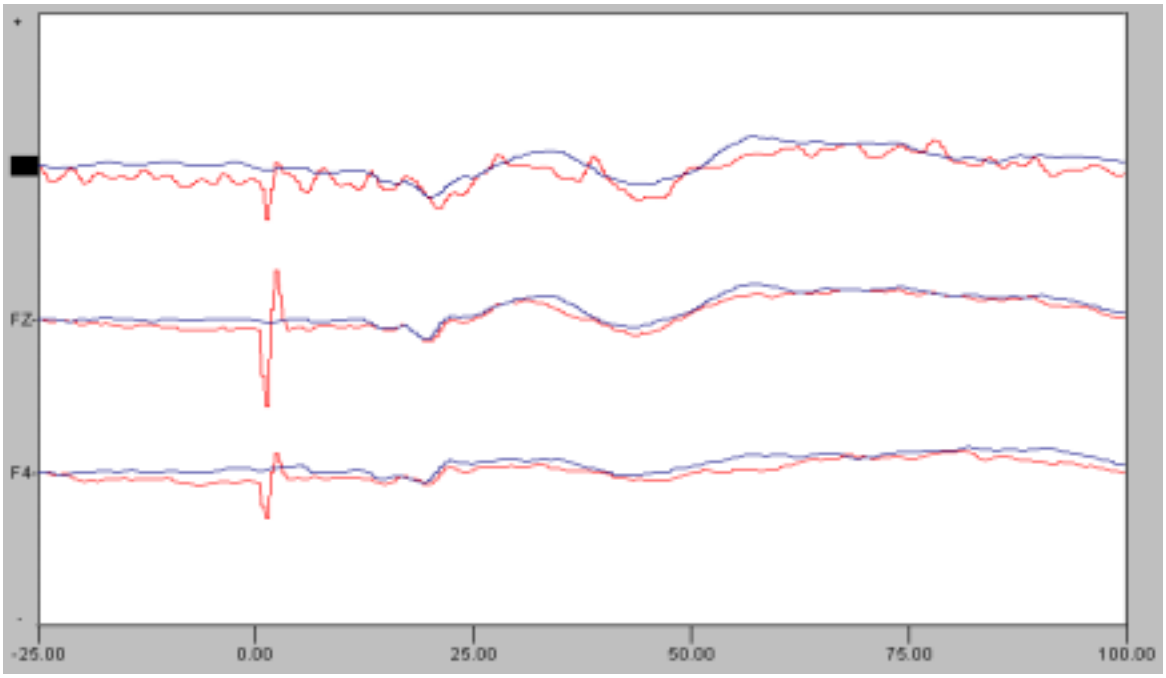
You will see two more columns of numbers on the right side of the display. In Column B, there is the latency of the second cursor as well as the amplitudes for that time point for each of the waveforms. The third column - Delta - displays the change in latency at the top, and the change in amplitude below for each channel, in relation to the position of the first cursor. This is a quick way to measure latency differences between two points, and the peak-to-trough amplitude differences.

Step 9 - Saving, Printing, etc. You can save the file by clicking File \ Save As..., or by clicking the Save icon from the Toolbar. Designate a path and file name, then click OK (the .wvb extension will be added automatically). You may then retrieve the file at a later time. You may also Print the file directly using the standard Windows printing conventions, or you may Copy the display to the Windows Clipboard.

Step 10 - Combining channels from different files. Lastly, one of the more useful aspects of the Waveboard is its capability for combining waveforms from different data files. *Note: The files must have the same epoch durations and number of points to combine them on the same Waveboard display.* In the Scan4.3\Demo\Seps directory there are two files called sepblk.avg and sepnoblk.avg. These are somatosensory EP recordings obtained during right median nerve stimulation. The sepnoblk.avg file did not use the Deblocking feature of the SynAmps, and the sepblk.avg file was acquired with deblocking. Deblocking blocks acquisition for brief spans of time, and can be used to eliminate SEP stimulus artifact. With the Waveboard, it is very easy to show the effects of deblocking between the two recordings.

Retrieve the sepnoblk.avg file in EDIT. The stimulus artifact is very apparent in electrodes F3, FZ and F4. Copy these to the Waveboard, as described above. It is a good idea at this point to change the color of these channels so it will be easy to tell them apart from the sepblk.avg data channels. Change the colors as described above.

Now retrieve the sepblk.avg data file (it is not necessary to close the first file). Send the same three channels to the Waveboard. Maximize the Waveboard display, and you will see the data from all 6 channels. Scale the display, as desired. Click Options \ Raster w/ Label Matching. This will overlay the channels with the same channel labels, and provides a convenient way to display data from two (or more) conditions on the same graph. (It is also a nice demonstration of the Deblocking feature of the SynAmps).



This concludes the Waveboard tutorial. The remainder of the manual describes all of the features of the Waveboard.

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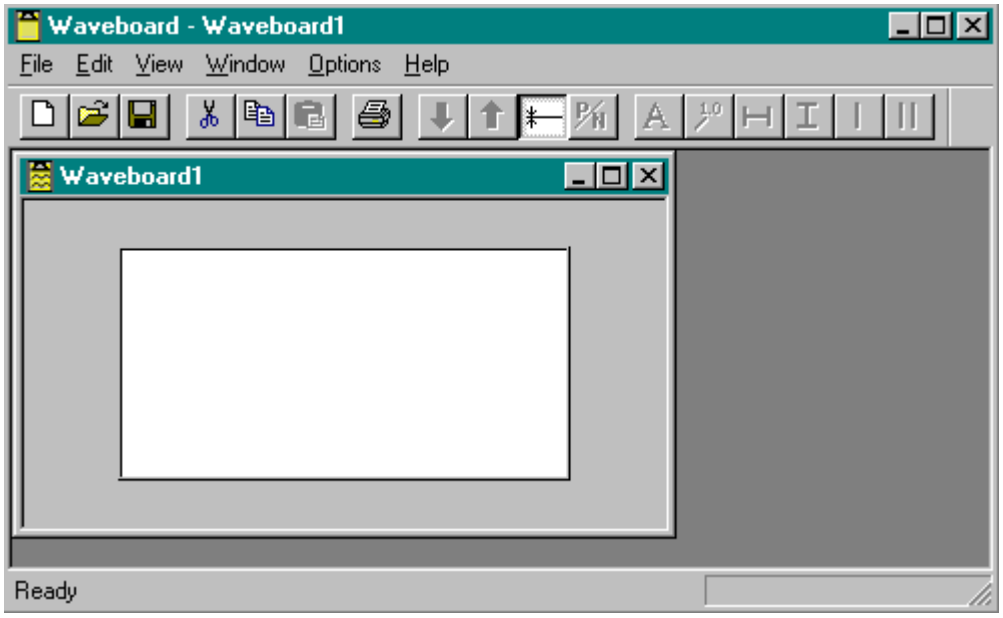
Operating the Waveboard

The waveboard.exe program may be run as a stand-alone program by double-clicking on Waveboard.exe in the Scan4.3 folder. More commonly, you may launch the program by clicking the Waveboard icon from the Toolbar in ACQUIRE or EDIT. The Waveboard is used with the Multiple Window Displays (when collecting or retrieving single sweep data or on-line averages), and not with the Single Window Display (the continuously scrolling EEG). In ACQUIRE, you can send waveforms to the Waveboard during acquisition, or you can Pause the recording and send the waveforms. You may send time domain or frequency domain data files to the Waveboard.

Starting the Waveboard and Sending Waveforms to it. The basic steps in operation are to start EDIT (or ACQUIRE) first, then click the Waveboard icon. The main Waveboard screen will appear.



There will be an empty Waveboard1 display, which can be enlarged to full size, if desired.

You may send individually selected channels to the Waveboard, or you may send all of them at one time. Click the right mouse button anywhere that is NOT in an electrode display window, and you will see the following list of options. Select the Send Waveforms to Waveboard option to send all the waveforms to the Waveboard. If you position the mouse within a single, enlarged electrode display and click the right mouse button, you will see the following display. Select the Send Data to Waveboard, and only the single waveform will be sent. Repeat the process for each waveform you wish to send. An example of the Waveboard display might look like the following.

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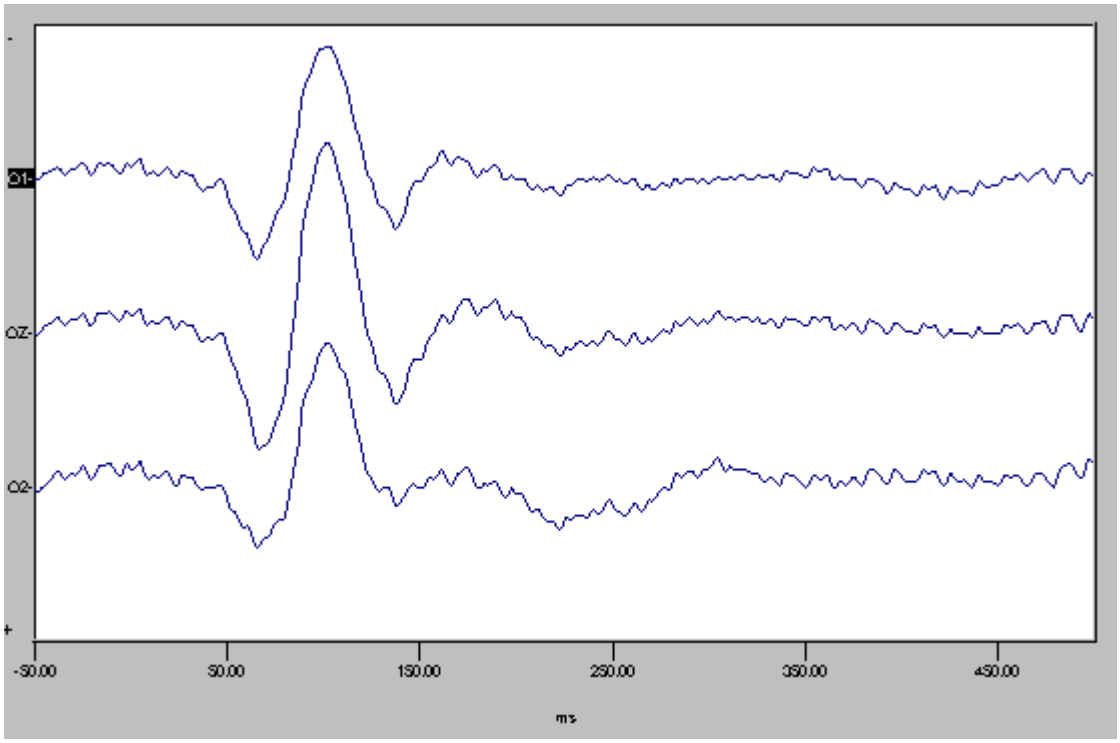
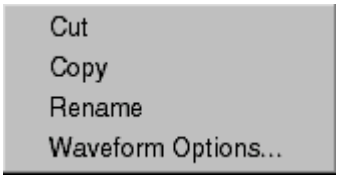


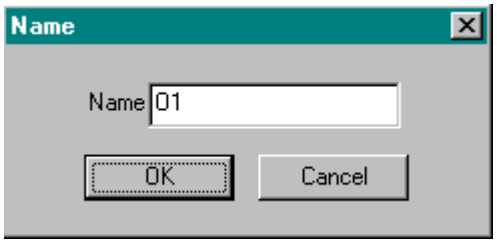
Positioning the waveforms on the display. The waveforms may be dragged up or down to new locations by grabbing the label with the left mouse button (the background of the label will change colors). It is also possible to reposition the waveforms automatically using the Raster and Overlay options described below under Options.

Some right mouse button options. There are some options that are accessible only with the right mouse button. Click on a waveform LABEL using the right mouse button. The following menu will appear.



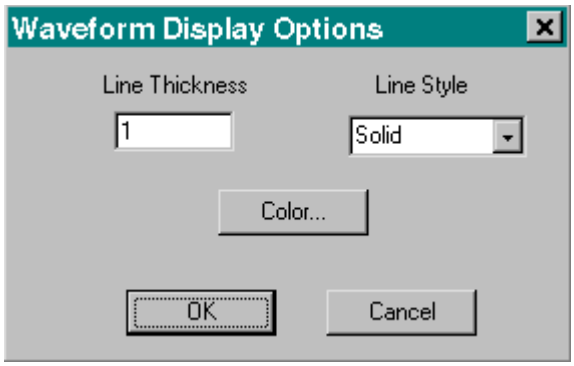
The Cut and Copy options are fairly standard and self-explanatory, and are described below.

Rename. You may rename the channel easily by selecting the rename option. The

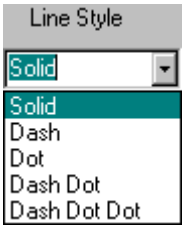


Name window will appear with the current electrode label. Type in a new label, and click OK.

Waveforms Options.... Selecting the Waveform Options line displays the following screen.



The default line thickness is 1, but you can increase the thickness up to a value of 10. The pull-down menu under Line Styles shows the different styles that may be selected for the waveforms.



Note: When changing the Line Styles, the Line Thickness should be set to 1.

You may change the color of the individual waveforms by clicking the Color... button. The standard Windows Color palette will appear.

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Select a color for the selected waveform, and click OK. If you don't like any of the displayed color options, click the Define Custom Colors>> bar, and select a customized color. Then click OK, and OK again. Repeat the process to select a new color for each channel, as desired.

Click the right mouse button anywhere else, and you will see the following list of options.

Paste. The Paste option will be active if you have previously Cut a waveform from the Waveboard (same function as Edit \ Paste from the Main menu bar). In combination, the Cut and Paste options may be used to take a waveform from one Waveboard display, and Paste it into another.

Clear All. Selecting this option will permanently delete all Waveboard contents (same function as Edit \ Clear All from the Main menu bar). You will see a warning asking for verification before the contents are deleted.

Save Display Image... This option opens a standard Save As... utility screen through which you may enter a file name, designate a path, and save the image as a Windows metafile (the .wmf extension is added automatically). This is the same function as File \ Save Display Image....

The majority of the remaining options are accessed from visible options within the Waveboard display. At the top of the main screen, the Main Menu list contains the following options: File, Edit, View, Window, Options and Help. Following the normal convention, you may either

make your selection with the left mouse button, or, where you see one letter underlined, you may use Alt + letter (Alt f) to access the drop-down menu lists. The Alt key is typically not needed when making a keyboard selection on the drop down menus. Shortcut information is provided on the drop-down menus. For example, to call the Print window, you can press Ctrl + P (Ctrl p) to go directly to the Print screen and bypass the File \ Print step. For the remainder of the manual it is assumed that you have a basic understanding of the standard Windows operations.

File

The options under File are standard Windows features, and will be described only briefly. They include New, Open, Close, Save, Save As, Print, Print Preview, Save Display Image..., Recent File, and Exit. Fewer options will be displayed if there is no Waveboard file open.

New. New opens a new Waveboard display to which data can be copied. You can access this option more easily from the Toolbar icon . Note that waveforms sent from EDIT or ACQUIRE will always be sent to Waveboard1. The waveforms may then be copied to a New Waveboard display that you open.

Open. The Open command displays a standard Open File utility. In the Files of type pull-down menu you can select preexisting Waveboard Files (*.wvb), or display all the files in the folder. Only *.wvb files may be opened. This option can be accessed directly from the Toolbar icon .

Close. The Close command will close whichever Waveboard file has the focus.

Save. The Save command saves the current Waveboard to its existing folder using its same name. If you try to Save a new file, one that has not been saved before, you will get the Save As... utility display.

Save As... The Save As... command opens a standard Save File utility which may be used to enter a file name and designate a destination folder. The .wvb extension is added automatically when Waveboard files are saved. Save As... can be accessed more easily from the Toolbar icon

Print... The Print... command displays a standard Print window which you can use to select the printer. The Print window can also be accessed from the Toolbar icon . Note that the screen image may not match exactly the image that is actually printed. Use the Print Preview option to view the printed output.

Print Preview. The Print Preview command will allow you to preview the information that you wish to print.

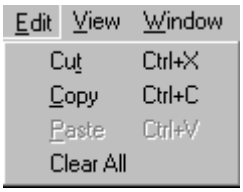
Save Display Image... This option opens a standard Save As utility for saving the display in a Windows metafile format. Enter a file name, designate the path, and click the Save button to save the file (the .wmf extension will be added automatically).

Recent File. The Recent File area shows a list of recently retrieved *.wvb files. If you wish to recall one of these, you can click the mouse directly on the file (instead of going through the extra steps using the File \ Open file process).

Exit. Exits the Waveboard.

Edit

The Edit option opens a menu list of standard Windows options for Cutting, Copying, Pasting and Clearing files.

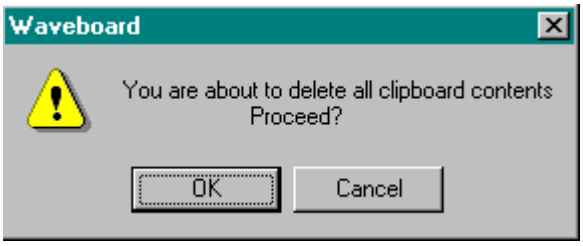


Cut. The Cut command can be used to remove individual waveforms from the Waveboard. Highlight the electrode Label (the background behind it will change colors), then select Cut, and that waveform will be removed (to the Windows Clipboard). Cut may be accessed more easily from its Toolbar icon . You can also click the right mouse button on the electrode label to access the Cut option.

Copy. The Copy command will copy a highlighted waveform (label) to the Windows Clipboard. It can be accessed more easily from the Toolbar , and also by clicking the right mouse button on the electrode label.

Paste. The Paste command will paste a waveform from the Windows Clipboard to the Waveboard display. It can be accessed more easily from the Toolbar , or by positioning the mouse where you want the waveform to be pasted and then clicking the right mouse button.

Clear All. The Clear All command will permanently delete all Waveboard contents. You will be asked for verification before the contents are deleted.



You can access the Clear All command more easily by clicking the right mouse button in any free space in the Waveboard display screen.

View

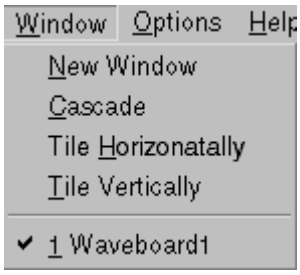
View is used to enable or disable the display of the Toolbar and Status Bar.

Toolbar. The Toolbar contains the icon shortcuts near the top of the main screen. These are described in more detail below.

Status Bar. The Status bar at the bottom of the main screen is used for displaying brief information about icon functions (position the mouse over the icon and read the status bar description). The Status Bar will also display the latency of the mouse position whenever the mouse cursor is positioned within the waveform display.

Window

The Window options include New Window, Cascade, Tile Horizontally, Tile Vertically, and a list of open windows.



New Window. The New Window option creates a new window that has the same contents as a previously opened Waveboard window. It can be used to make modifications to the Waveform display while retaining an original version of the display.

Cascade. Cascade is a standard Windows option that arranges open windows in an overlapping, stacked arrangement.

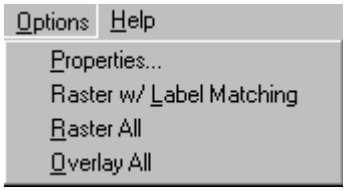
Tile Horizontally. The Tile Horizontally option will arrange the open windows automatically so that the windows span the width of the larger Waveboard window, one above, but not overlapping, another.

Tile Vertically. The Tile Vertically option will arrange the open windows automatically so that the windows span the height of the larger Waveboard window, side by side, but not overlapping, one another.

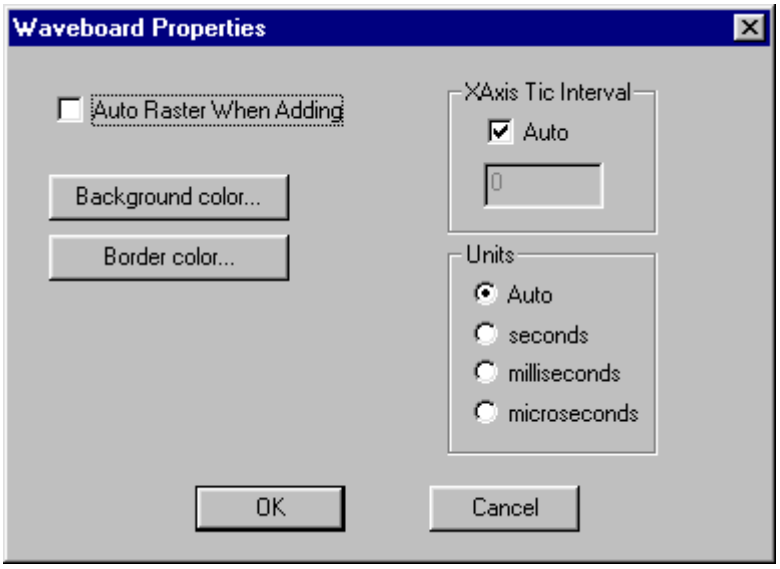
Open Windows List. Lastly you will see a list of the currently opened display windows. You can change the focus to any window by clicking on it from the list (so that the check mark is beside the window). In some instances, where a desired window is hidden completely behind another, this is an easier way to change the focus to the desired window.

Options

Options contains the following choices: Properties..., Raster w/ Label Matching, Raster All, Overlay All. Please refer also to the tutorial above for more information and examples.



Properties... Clicking the Properties option displays the following window.



Auto Raster When Adding. It allows you to enable or disable the Auto Raster option when you are adding files to the Waveboard. When enabled (check mark appears), the channels that are added to the Waveboard will be added above or below existing channels (not overlain). When disabled, new channels will be overlain on previously added channels.

Background Color. This option lets you select a color for the background behind the waveforms. Clicking the button shows the standard Color selection display. Select a color and click OK, and the background color will change.

Border Color. This option lets you select a color for the border area around the waveform display. Clicking the button shows the standard Color selection display. Select a color and click OK, and the border color will change.

XAxis Tic Interval. This allows you to set the tic marks along the x-axis of the waveform display. If you select Auto, the tic marks will be placed with an automatically selected interval. Deselect Auto and enter in an interval value (such as 100), and the tic marks will appear every 100ms.

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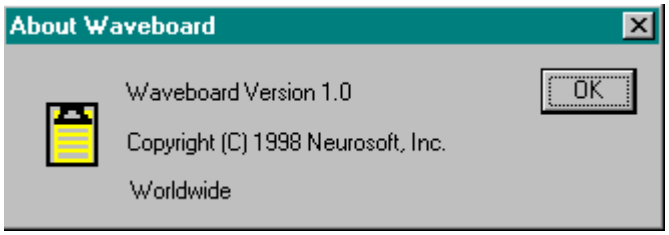
Units. The Units options let you select what units are used for values on the x-axis. "Auto" will autodetect the best scaling to use, but you may override it by selecting seconds, milliseconds, or microseconds.

Raster w/ Label Matching. When enabled, this option will take all channels having the same label and overlay them. For example, let's say you send O1, OZ and O2 to the Waveboard, from three different data files. If you select the Raster with Label Matching option, you will see the three O1 channels overlain on top of each other, the three OZ channels on top of each other, and the three O2 channels on top of each other.

Raster All. The Raster All option will display all channels that are on the Waveboard in non-overlapping space (none of the channels overlay any other channels).

Overlay All. The Overlay All option will overlay all the channels on the Waveboard. Whatever Baseline Correction computation you made in EDIT will be transferred automatically to the Waveboard.

Help - At the current time the Help option accesses only the About Waveboard display (contains version information).



Toolbar Icons

The icons on the Toolbar provide quick shortcuts to many of the common operations with the Waveboard, and, in some instances, provide the only means of access to some options.

The first seven icons - New file, Open File, Save As..., Cut, Copy, Paste, and Print are standard Windows icons and are described above. The remaining icons are specific to the Waveboard, and are described below.

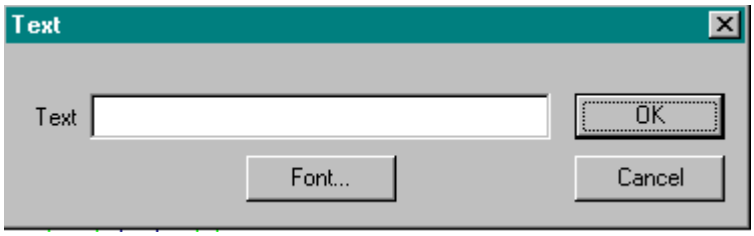
 *Up/Down Display Scale Arrows*. The Up and Down arrows are used to vary the display scale of the data displayed in the Waveboard. These alter the display scaling only, and have no effect on the original data file.

Baseline On/Off. Clicking this option centers the waveforms in their allocated regions on the display. It has no effect on the actual data measurements. If you have overlain the waveforms, enabling this option will cause the superimposed waveforms to line up according to the initial data point (which you may not want to do). Generally, you would not use this option with overlain waveforms.

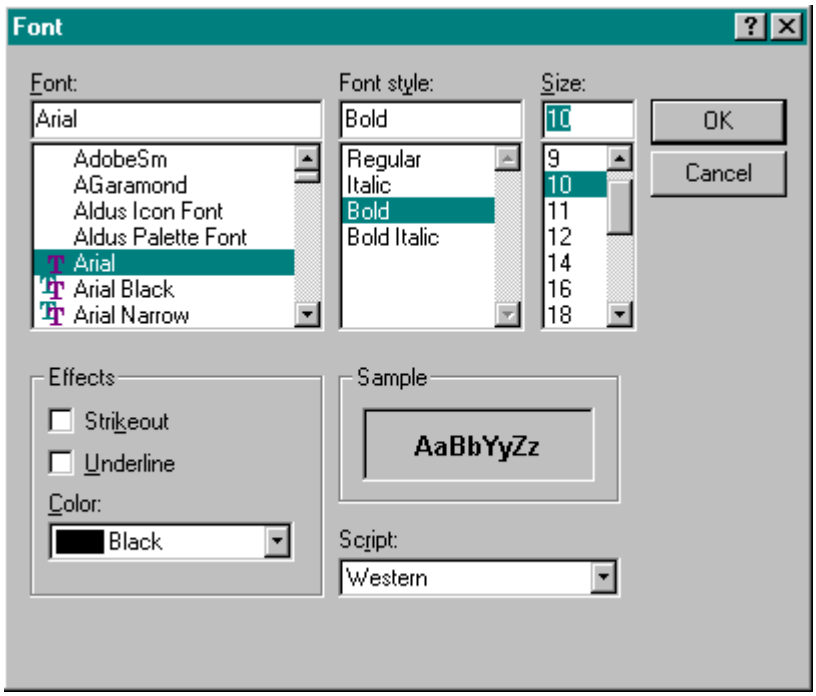
Polarity Reversal. The polarity icon inverts the display polarity (positive up to negative up). This affects the displayed data only, and has no effect on the original data file.

Enable/Disable Zero Indicator. Enabling the option will display a dashed line showing the zero-voltage baseline, as calculated in EDIT.

Add Text. This option allows you to add text to the Waveboard display. After clicking the icon, the Text window will appear. Click the left mouse button in the approximate area on the Waveboard



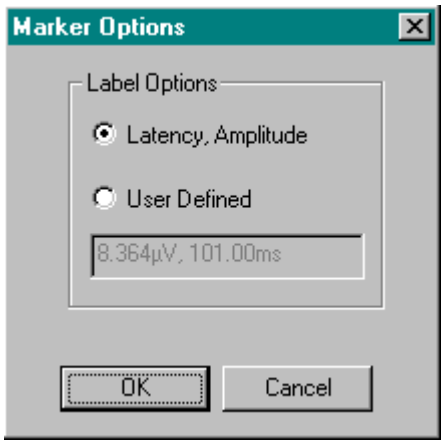
display where you want the text to appear, click the left mouse button again in the text field, and then enter the text you want to display. If you want to vary the font, style, size, etc., click first on the Font... button. A standard Font display screen will appear.



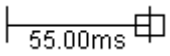
After you have entered your settings, click OK.

After you have placed the text on the screen, you may reposition it by grabbing it with the left mouse button, and dragging it to a new location. Click on the text with the right mouse button, and you have the option to Delete it, or to Edit it. If you wish to edit it, click the Edit Text option, and the same Text window shown above will appear.

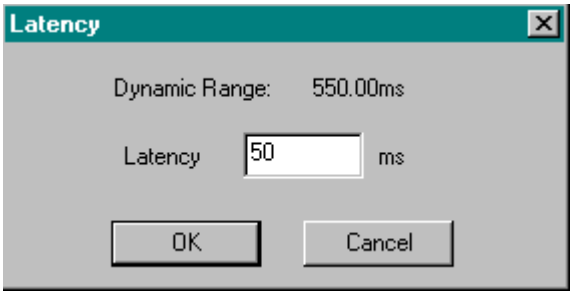
Add Marker. The Add Marker option allows you to add a marker that displays the millisecond and microvolt values for any point on a waveform. Click the icon, then position the cursor on the point of interest. Then click and hold the left button down, and drag the marker to a clear space and release the button. You can change the position by grabbing the marker with the left mouse button and dragging it to a new location. Click on the marker with the right mouse button, and you will see an option list consisting of Delete, which will delete the marker, and Options.... Clicking the Options line displays the Marker Options screen.



The default position uses the Latency and Amplitude values for the marks. You can modify that by selecting the User Defined option. This allows you to enter any text you wish (see Final Output Image below for example).

Scale tools. Next on the Toolbar are the two scale tools. The first displays a scale tool for the x-axis, or latency scale. The second displays a scale tool for the y-axis, or amplitude scale. Click the Latency Bar icon and the latency scale tool will appear. Click on the scale tool one time with the left mouse button, and a rectangle will appear on one end 

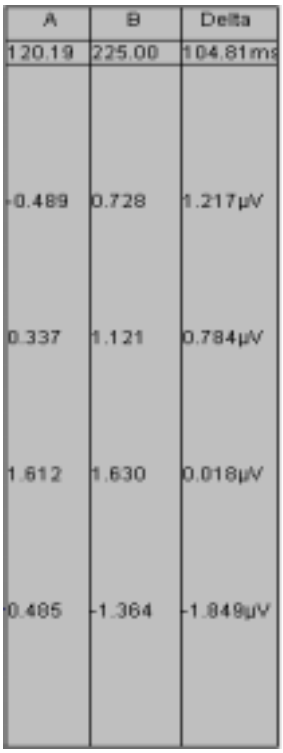
. By grabbing the rectangle with the left mouse button, you can extend or reduce the length of the scale tool. Alternatively, click on the scale tool with the right mouse button, and you will see a small option list. Selecting Delete will delete the scale tool. Selecting Set Latency will display the Latency window, through which you may select the length (in ms) of the tool. The Dynamic Range is the length of the entire epoch, and is the maximum range allowed for the scale tool.



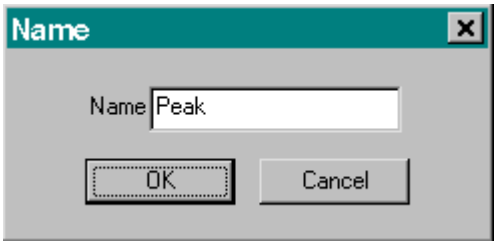
Operation of the Amplitude Scale Tool is directly analogous to the Latency scale. You can reposition the scale tools by grabbing them with the left mouse button and dragging them to a desired location. (See the tutorial above for graphic display).

Cursor 1 and Cursor 2. These buttons allow you to move one or two cursors on the Waveboard display to measure latencies, amplitudes, and differences between the cursors on all waveforms. (The second cursor is not active until you place the first one). Click the Enable Cursor 1 icon from the Toolbar. You will see a vertical dashed line (Cursor 1) appear with the letter A at the top of it. You will also see several columns appear on the right side of the screen. Grab the cursor line with the left mouse button, and drag it back and forth. You will see the latency (in ms) of its current position displayed at the top of the first column, and the corresponding amplitude values (in uVs) for each of the waveform points. Position the vertical dashed line at any point on the screen.

Now enable the second cursor by clicking its icon from the Toolbar. It will have the letter "B" at the top of it. Position it at a different point. You will see two more columns of numbers on the right side of the display. In Column B, there is the latency of the second cursor as well as the amplitude(s) for that time point for each waveform(s). The third column - Delta - displays the change in latency at the top, and the change in amplitude below for each channel, in relation to the position of the first cursor. This is a quick way to measure latency differences between two points, and the peak-to-trough amplitude differences. Below is a sample of the columns of measurements.

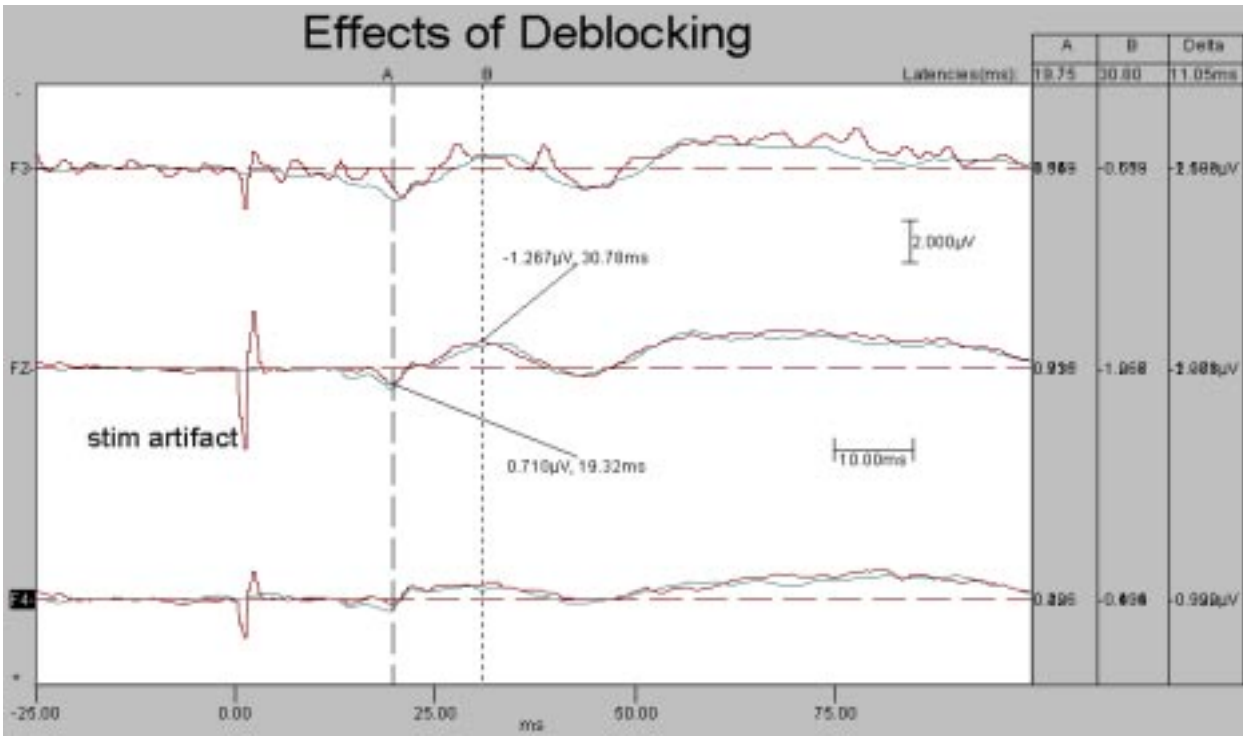


You can change the labels from "A" and "B" by clicking the right mouse button on the vertical cursor



line. You will see the Name display appear. Click the left mouse button on the text line, and enter the new cursor label. You can rename both cursors.

The Final Waveboard Image. The following display shows an example of the primary features of the Waveboard in a single image.



The numbers in the columns on the right side appear blurred because they are superimposed. (Move the waveforms to separate the numbers).