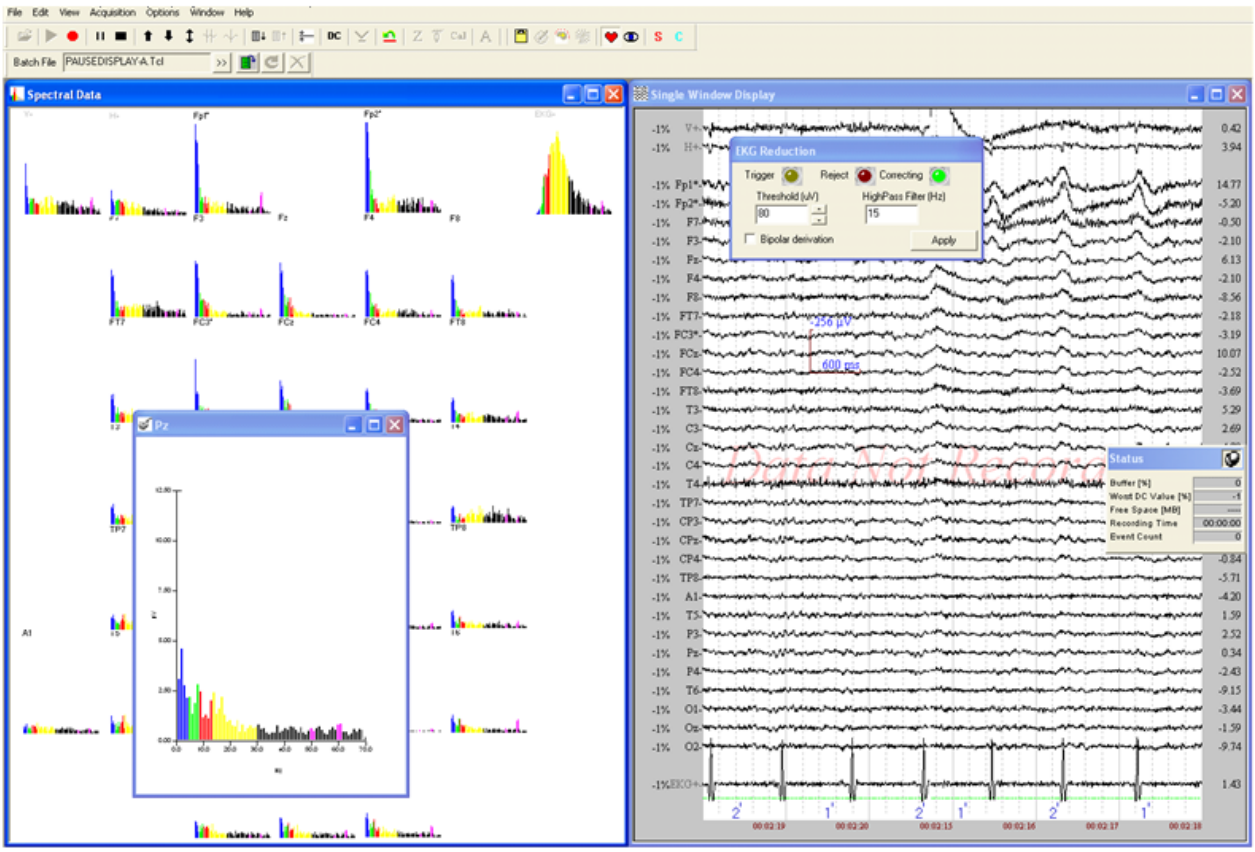
Acquire 4.5



Online Acquisition of
Neurophysiological Data

COMPUMEDICS
NeuroScan

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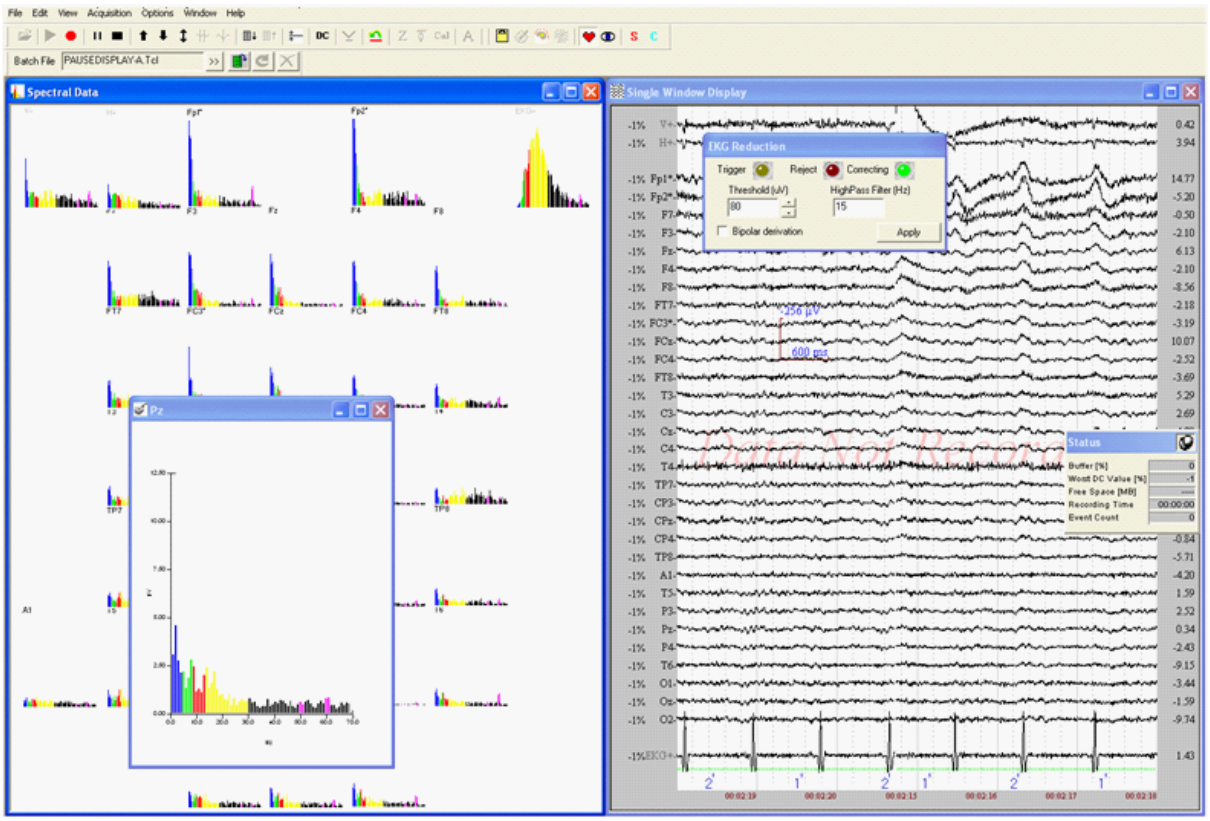
1 Acquire

ACQUIRE 4.5

Online Acquisition of Neurophysiological Data



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1.1 Contact Information

For Technical Support...

If you have any questions or problems, please contact Technical Support through any of the following routes.

If you live outside the USA or Canada, and purchased your system through one of our international distributors, please contact the **distributor** first, especially if your system is under warranty.

In all other cases, please use **techsup@neuroscan.com**, or see the other Support options on our web site (*http://www.neuroscan.com*).

Or, if you live in the USA or Canada, please call **1-877-717-3975**. International callers should use **1-704-749-3200**.

For Sales related questions, please contact your local distributor, or contact us at **sales@neuroscan.com**.

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1.2 The ACQUIRE Module

Welcome to the Compumedics/Neuroscan ACQUIRE program - a flexible, high speed tool for reliable electrophysiological data acquisition with multiple online signal processing features. The ACQUIRE Module records *averaged*, *epoched*, and *continuous* EEG data from 256+ channels with the ESI system and up to 70 channels with the SCAN 4.5 system. Data are acquired either from your *SynAmps*, *SynAmps*^{2}, *SynAmps RT*, *NuAmps*, or *SynAmps Wireless* amplifiers. Discrete epochs are *windowed around trigger events*, with pre-trigger intervals supported. Trigger events can be generated *externally,* such as from STIM or other stimulus presentation system, and accepted by ACQUIRE. ACQUIRE can save online *average* files, *single-sweep* and *continuous* EEG files that can be subsequently processed off-line using the EDIT module. ACQUIRE has several ***online*** analysis and display features, including:

- frequency analyses;
- linear derivation calculations;
- digital bandpass filtering;
- topographic EEG potential mapping;
- stimulus and response sorting, with variable length windowing;
- audio monitoring of one or more recorded channels;
- online dipole source computation (using the SOURCE V2 program);
- online artifact reduction;
- online PCA/ICA.

ACQUIRE records and displays continuous EEG data along with a stream of stimulus and response event markers. This continuous recording can then be broken down into discrete epochs with user selected pre- and post-stimulus intervals. The general steps to collect data with ACQUIRE are: 1. create or select a setup file to configure the system; 2. enter subject information; and 3. acquire (and save) the data.

It is assumed that you have a fundamental acquaintance with the operation of the Windows XP operating system. The operations of the mouse, path designation, characteristics of windows, and use of tool and status bars will not be detailed here (please refer to your Windows documentation for further information).

Directions in this manual are given with the assumption that you are using a mouse to make desired choices. It is also possible to make many of the selections via the keyboard. Many of the key words on the menu screens will have one letter underlined. Selections may be made by pressing those letters on the keyboard in conjunction with the Alt key (hold down the Alt key, and simultaneously press the key of the underlined letter). Where

options on the drop-down menu lists have a letter underlined, typically you need only to press the letter on the keyboard. Other keyboard shortcuts that use the *Ctrl + key* (e.g., *Ctrl P*) are shown on the pull-down menus.

If you have not already installed the SCAN 4.5 software, please refer to the Installation and Orientation manual (Overview...) for directions. It is ***essential*** that the software be installed within Windows using the installation CD provided from Compumedics/Neuroscan (copying the software from another computer will not work).

The Scan 4.5 software is a Hot Fix version of the 4.3.1 version. It will be installed in the Scan 4.5 folder, replacing the existing files.

If you have not worked through the *SCAN Tutorials*, you are encouraged to do so. The Tutorials will help familiarize you with much of the functioning of ACQUIRE (and EDIT).

Hyperlinks

You will occasionally see text written with a bold, colored font, as in **Contact Information** 2. These are hyperlinks. Click the text to go directly to the indicated section.

1.2.1 Starting Acquire

For SynAmps users: always make sure the SynAmp(s) is turned ON and that SN1 (and SN2, SN3, etc.) appears BEFORE you boot your PC.

Installing the Amplifiers in the SW

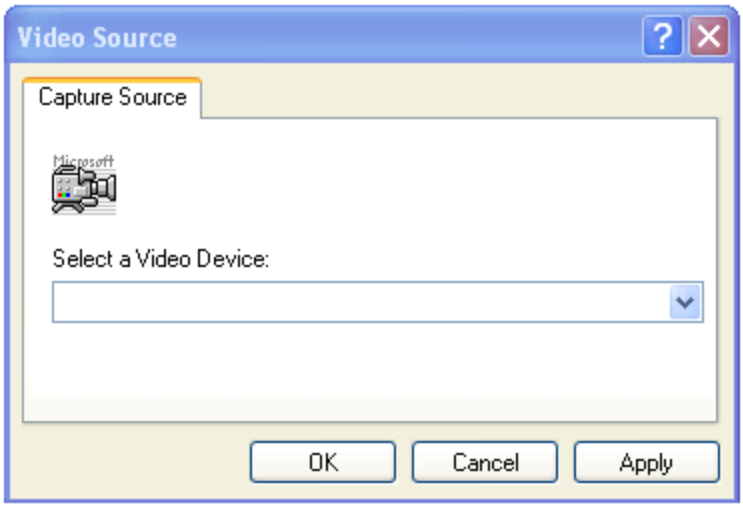
If you have not already *installed* your amplifiers when you installed the SCAN 4.5 software, you should do so at this point (you only need to do it once). Run the Amplifier Install program (**Start** → **All Programs** → **Scan 4.5**), and the "Select an amplifier" display will appear.

Highlight the amplifiers you are using and click **OK**. The Amp Simulator can be used in place of any amplifiers, and it provides a way to simulate acquisition for testing,

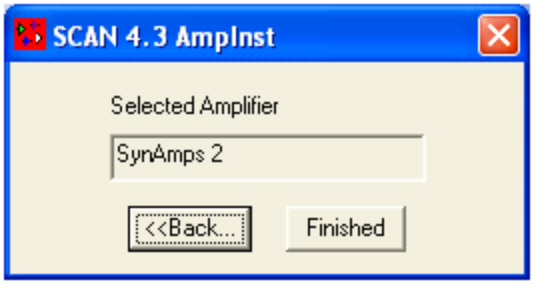
demonstration, or diagnostic purposes.

Video Camera is used if you want to superimpose a 2D map of the EEG data on the view from the camera. It does not record synchronized video along with the EEG.

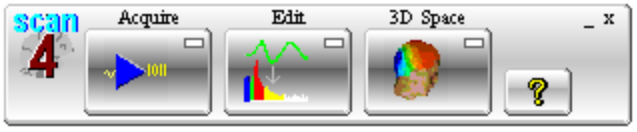
If you enabled the **Video Camera** option, the first time you run ACQUIRE or EDIT you will see the Video Source display. Select the Video Device from the pull-down list, and click **Apply** and **OK**, or just click **OK**.



After selecting the amplifiers and video option, you will then see a display confirming your selection. If you made a mistake, click **Back** to return to the previous screen; otherwise click **Finished**. Your amplifiers are then installed.



To start ACQUIRE, you should first double-click the SCAN 4.5 icon  , and the Program Launcher will appear.

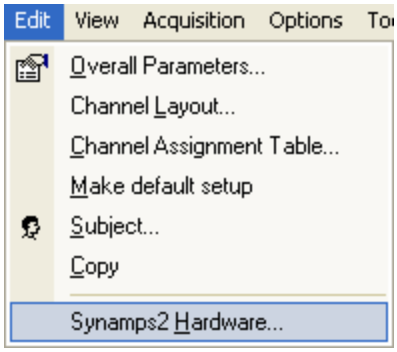


Start ACQUIRE by clicking the ACQUIRE icon  from the Program Launcher.

The small green rectangle in the upper right corner of the Acquire icon  lets you know that a version of ACQUIRE is already open. Should the ACQUIRE program close due to some illegal operation, and you still see the rectangle on the icon, it is necessary to close and reopen the Program Launcher before reopening ACQUIRE.

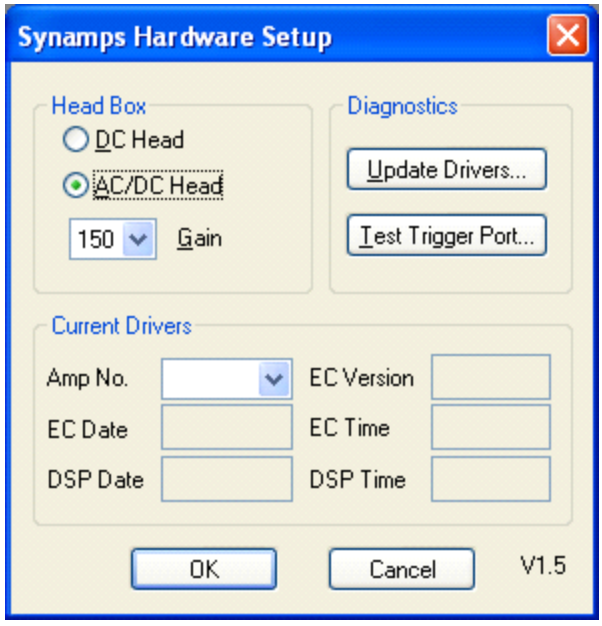
Amplifier Settings in the SW

To complete the installation, you will need to enter settings specific for your amplifiers. After starting ACQUIRE, click **Edit**. At the bottom of the menu you should see the option specific for your amplifiers. If you see the **Amplifier Simulator** line at the bottom, that means that your amplifiers are not installed, and you should rerun the *ampinstall* program (close ACQUIRE first).



SynAmps

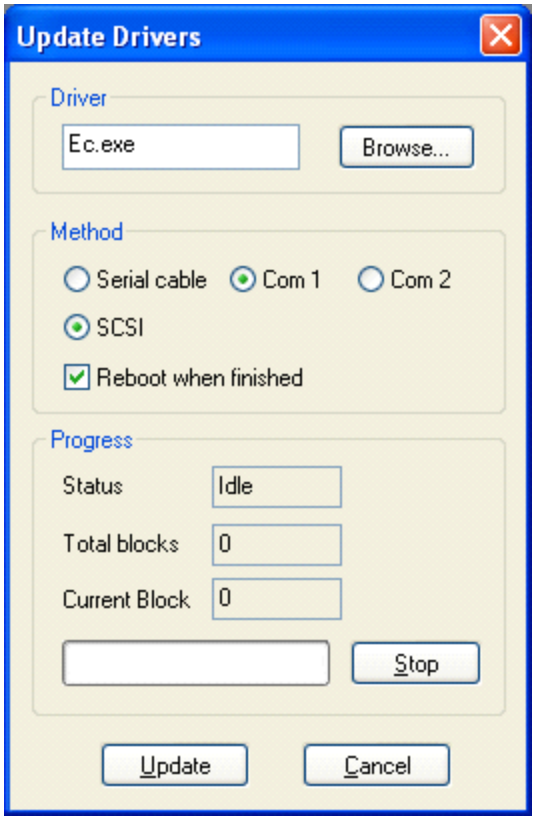
If you have a *SynAmps* system, for example, select the **SynAmps Hardware** option, and a dialog box will appear. Indicate the appropriate settings for your system. The other Compumedics/Neuroscan amplifiers will have their own hardware screens. These are described below and in their respective manuals. (With your amplifiers connected, you should see version, date and time information in the fields).



AC/DC. Indicate whether the *SynAmps* headbox(es) is **DC** only, or **AC/DC** (newer systems are **AC/DC**).

Headbox Gain. Select either **30** or **150**x headbox **Gain** (newer systems have 150x Gain, unless special ordered for 30x).

Current Drivers. The **Current Drivers** fields show the *EC.exe* file version, date and time, and the *DSPSYNAM.exe* date and time for the *SynAmps* indicated in the **Amp No.** field. Click on the down arrow beside this field to see additional *SynAmps*. If these fields are empty, then there is a communication problem with the *SynAmps(s)*. Generally, you should install the latest versions of EC and DSPSYNAM. The current version of EC is 1.4 - this is the version you should be using with SCAN 4.5. The latest versions may be downloaded from our web site (www.neuroscan.com), or obtained from Technical Support (*techsup@neuroscan.com*). The new files should be placed in a known directory, such as the ...*Scan4.5**SynAmps* directory. Then click on the **Update Drivers** button in the **Diagnostics** section, and the Update Drivers window will appear.



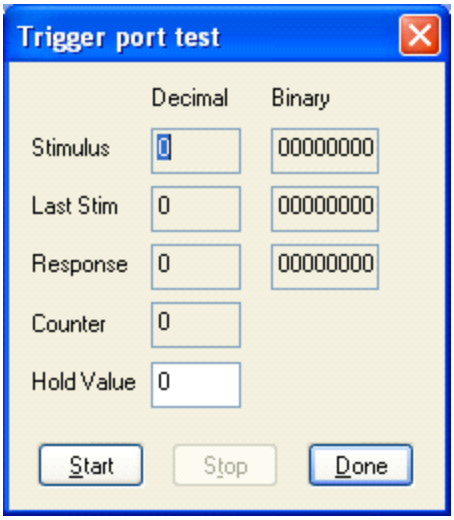
Click on the **Browse** button, and find and select the *Ec.exe* program. The preferred method of transmission is over the SCSI cable. Click SCSI, and "check" the **Reboot when finished** box (if you are updating more than one file or more than one *SynAmps*, check this option when you perform the final update). Then click **Update**, and watch the progress of the transmission. Repeat the same process for the *Dspsynam* file. Repeat the process for additional *SynAmps*. As of approximately February, 2001, new SynAmps no longer have the serial cable download capability - you must use the SCSI method. See the SynAmps manual for download directions using the serial cable.

Note
Do NOT interrupt the downloading process or else the programs may become corrupted, rendering the SynAmps unbootable. It is recommended that you disable your Screen Saver and any other Power Management options that are enabled in Windows.

If there is a problem with transmission over the SCSI cable, turn the PC and *SynAmps* off, then attach the serial cable supplied with the *SynAmps* (newer *SynAmps* do not have the serial connection), and reboot (*SynAmps* first). Then on the **Update Drivers** screen, select the Serial cable, and select either Com 1 or Com 2 (depending on where you have the serial cable). Then try the update procedure again.

If this fails also, contact Compumedics/Neuroscan technical support.

In the **Diagnostics** section, there is another option called **Test Trigger Port**. Clicking it displays the Trigger port test window. This is useful for testing the triggers coming from Stim^2 or other stimulus presentation system.



In Stim^2, go to **Options** → **Program Settings**. At the bottom of the display is the Trigger Test button. Clicking the button will send a byte code of 255 to SCAN. You should see all stimulus binary 8 fields flash to 1 when you click the button. You will likely need to increase the **Pulse Width** duration Pulse Width (ms): 250 (on the Programs Settings display) to see the 0's change to 1's. You should also see the **Last Stim** field display 255. Alternatively, you can run any Stim^2 program that sends triggers, and see the fields change with each trigger.

For a more complete description of the diagnostic use of the **Test Trigger Port**, please see Appendix B at the end of the Overview (Installation and Orientation) manual. If you are having difficulties registering triggers in ACQUIRE, that Appendix is a trigger troubleshooting guide.

SynAmps^2

Each *SynAmps*^{2} amplifier/headbox contains 64 monopolar EEG channels, 4 bipolar channels, and 2 high level input channels. Please refer to the *SynAmps*^{2} user guide for a complete description of the features specific to *SynAmps*^{2}. The majority of the software interface for *SynAmps*^{2} is the same as described in this manual.

NuAmps

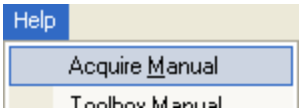
Each *NuAmps* amplifier/headbox provides inputs for up to 40 monopolar channels. All channels are always recorded as true monopolar channels, with the ground as the negative input. The reference you select is computed at a later stage. Please refer to the *NuAmps* user guide for a complete description of the features specific to *NuAmps*. The majority of the software interface for *NuAmps* is the same as described in this manual.

SynAmps Wireless

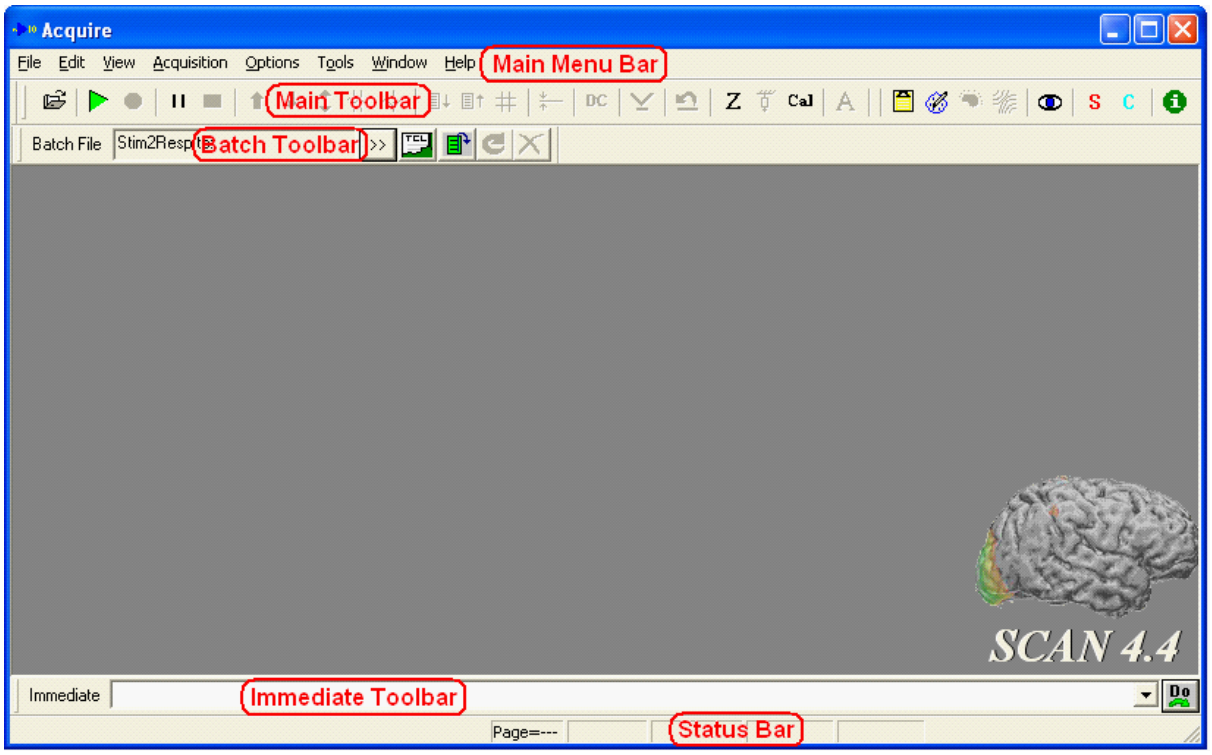
Each *SynAmps Wireless* recording unit provides inputs for up to 32 referential channels. Please refer to the *SynAmps Wireless* user guide for a complete description of the features specific to *SynAmps Wireless*. The majority of the software interface for *SynAmps Wireless* is the same as described in this manual.

1.2.2 Introduction to ACQUIRE

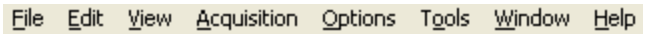
This manual details the operations found in ACQUIRE. For the most part, the features are organized in a left-to-right and top-to-bottom fashion. That is, explanations begin with the Main Menu bar options on the left, and proceed across the menu bar (**File**, **Edit**, **View**...). The features under each are explained from the top one to the bottom one. Toolbar options are next, followed by the Display Tabs, and any remaining options. Please use the Table of Contents to find the desired sections. Note that this manual also exists in PDF format (in the PDF folder under Scan4.5). This help file may be accessed from within ACQUIRE, by going to **Help** → **Acquire Manual**.



The main display in ACQUIRE is seen. If you do not see the Toolbars shown below, go to **View** → **Toolbars**, and enable/disable the toolbars, as desired. If you are not using batch files online, it is a good idea to remove the toolbars, thereby giving you a larger display area.



Main Menu Bar. These options access much of the functionality of the ACQUIRE program, and are described in more detail below. Click one to see additional options.



Main Toolbar. Many of the specific operations in ACQUIRE can be accessed by clicking a Toolbar icon. These are described in detail below.

Batch Toolbar. This is used if you are automating acquisition using Batch files. Please see the Tcl Batch Manual for details.

Data Display. Data being acquired are displayed in this area.

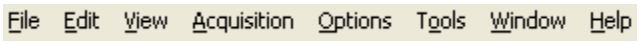
Immediate Toolbar. This line is used to execute single batch commands. Please see the Tcl Batch Manual for details.

Status Bar. These fields display time and voltage information, display page numbers, and the currently used workspace and setup files.

All of the functionality in ACQUIRE is described in more detail below.

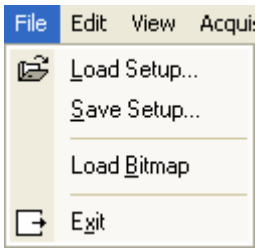
2 Main Menu Bar

The Main Menu bar of ACQUIRE at the top of the screen shows the menu options. Below is a description of each menu option.



2.1 File

The File option in the Main Menu is used for retrieving and saving Setup files. The functions for each of the **File** menu options are listed below:



Note
In this as well as other pull-down menus, the corresponding Toolbar icons are shown adjacent to the menu items, wherever applicable.

Load Setup. This option is used to retrieve existing Setup files. Clicking it, or clicking the icon from the Toolbar , displays the Select Setup File display. Go to the folder where your setup file is saved, double-click on it, or select it and click Open.

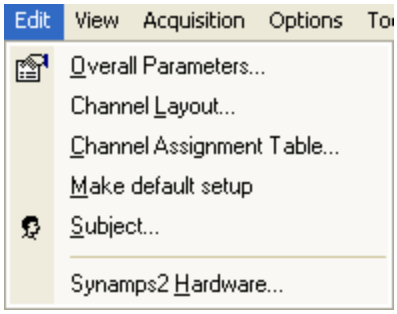
Save Setup. This option opens a standard Save As display, in which you can enter a file name for your setup file to be saved, and designate the folder in which you want it to be stored. Click Save to save the setup file.

Load Bitmap. Click this option to retrieve one of the bitmap (*.bmp) snapshot files that you have saved (this requires the use of the video camera; see the **Video** 94 section below).

Exit. Exits ACQUIRE.

2.2 Edit

The *Edit* menu options are used to create or modify files that will configure some of the ACQUIRE program parameters.



Creating (or retrieving) a setup file is typically the first operation performed in ACQUIRE. The acquisition parameters that you select - number of channels, digitization rate, pre- and post-trigger intervals, online features, etc. - are entered in the **Overall Parameters** sections. The options under EDIT are also saved in the setup files, and have to do with the layout of the Multiple Window Display, the channel order in Single Window Displays, how the channels are assigned to the amplifiers, what Subject information you wish to save, and so forth.

One or more Setup files that you create will ordinarily exist on your disk, and selecting the desired one will avoid having to re-enter the parameters each time start ACQUIRE.

2.2.1 Overall Parameters

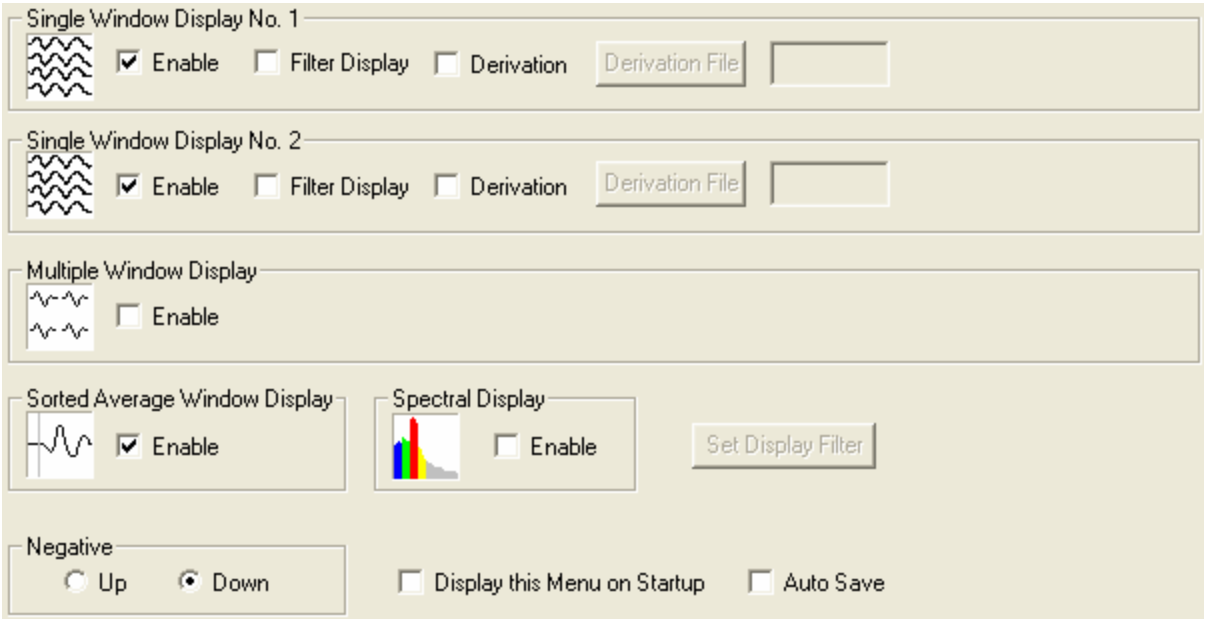
The Overall Parameters access the configuration options in ACQUIRE. There are two methods for changing acquisition values, depending on the type of the variable. Some variables, known as *toggles*, describe different states of the system. These variables have a limited number of states, such as "Enable" and "Disable". To change the state of these variables place the pointer on the variable and press the left mouse button, or click on the down arrow to see a pull-down menu. Look through the available options and select the desired state. The other type of variable is a *continuous* variable. To change these variables, click the pointer on the variable field, and type the desired value from the keyboard.

The configuration options are accessed by clicking on one of the tabs:

If you have a MagLink RT license, you will see additional tabs. These are described in the MagLink RT manual.

2.2.1.1 Startup

The Startup options are displayed below.



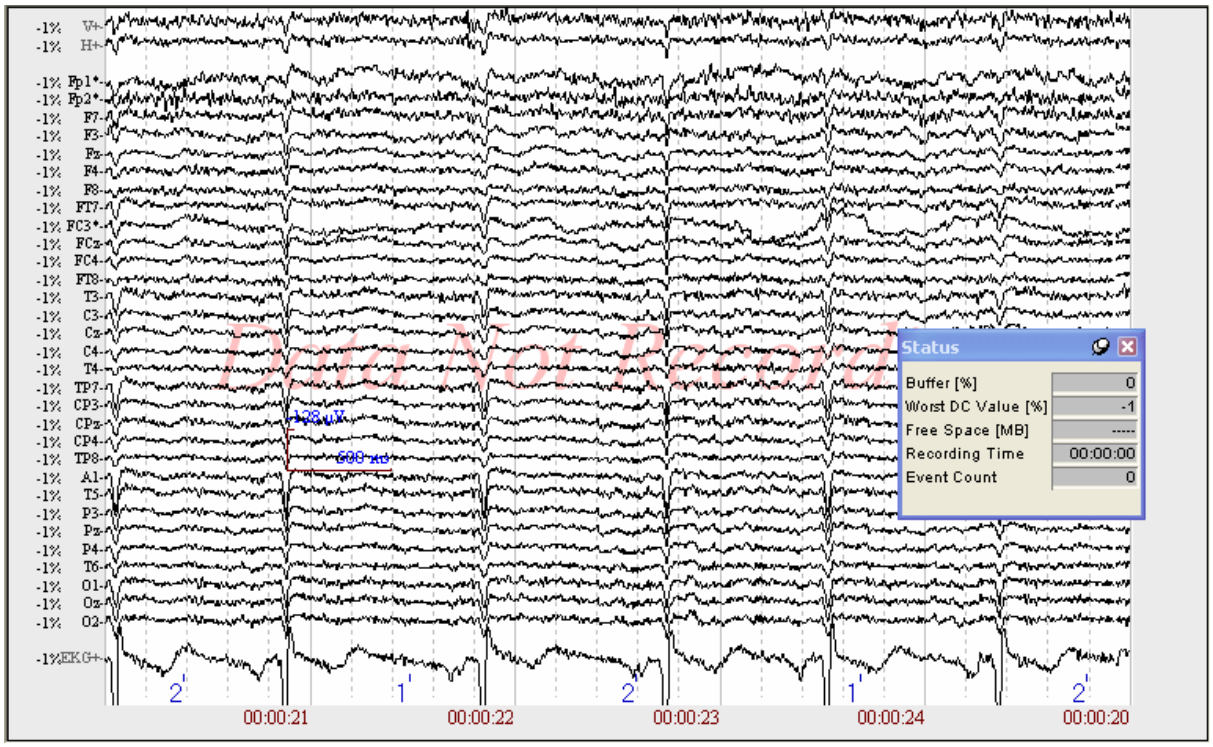
Single Window Display #1. The Single Window Display contains all of the EEG channels in a single display, as with Continuous data files. If you enable **SWD #1**, the data will be displayed in a single window during acquisition.

If you want to filter the **SWD #1** data, enable the Filter Display option, described below. Doing so will activate the Set Display Filter button (described below).

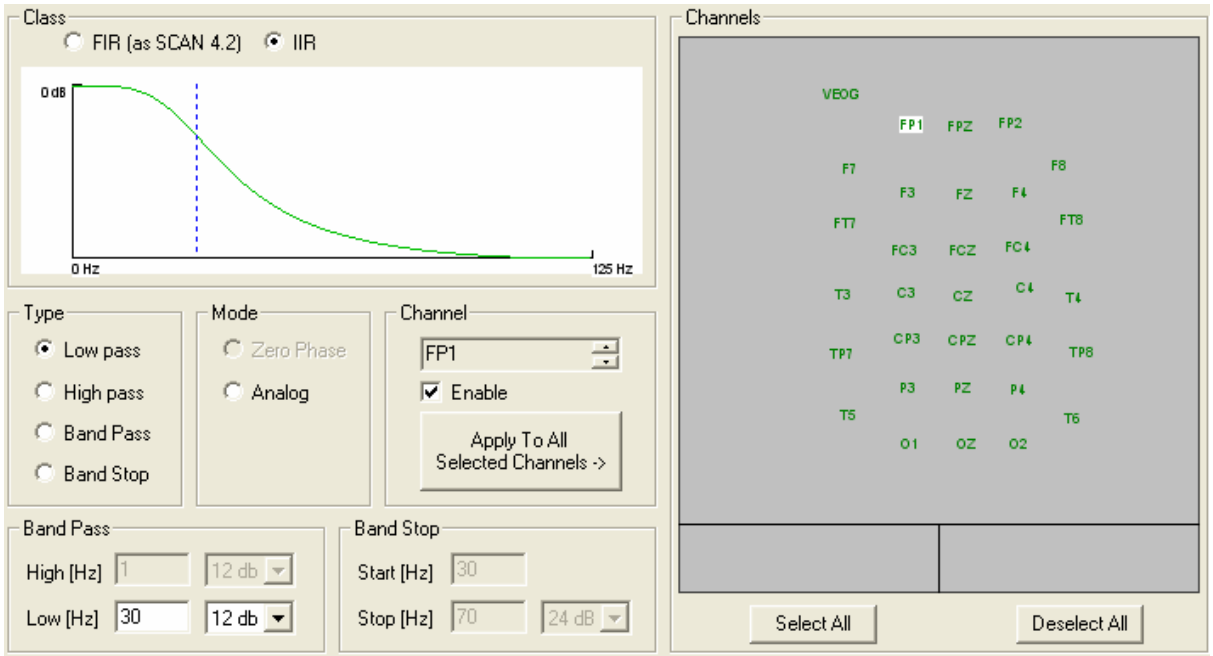
If you want to apply a Linear Derivation file to the SWD #1 display during acquisition, enable the Derivation option. Doing so activates the Derivation File button. Click it to select the .ldr file that you want to apply (see the **Derivation** section below).

Single Window Display #2. Enabling **SWD #2** allows you to display a second Single Window Display during acquisition. This is convenient in instances where you wish to see the raw data as well as the data following application of a Filter, Derivation file, or online correction. The options will be grayed out unless you have enabled the SWD #1; you cannot use SWD #2 by itself. The options for SWD #2 are the same as for SWD #1.

If you were to click the green Start Data Display arrow, you would see a scrolling paper-like EEG display of the ongoing signals. The channels are displayed in a vertical fashion; additional channels, or subsets of channels, may be displayed on user-created display pages. The bolder vertical lines in the display delineate seconds; the dashed vertical lines appear every 200ms (these may be turned on or off in the Single Window Options under the *Options* selection on the Main Menu bar, discussed below). The numbers appearing at the bottom of the display during acquisition indicate the stimulus and response type codes from STIM (or other similar system). The Single Window Display may be sized, relocated, and closed in the same manner as other displays in Windows.



Filter Display. In the Single Window Display fields are the Filter Display options. When you enable one of these, the Set Display Filter button will become active. Click it and the Filter window will be displayed, allowing you to select various online filtering parameters.



The Filter window is divided into 7 main sections: Class, Type, Mode, Channel,

Band Pass, Band Stop, and the Channels display. The graphic display at the top of the window shows the results of the settings you enter.

Class. There are two classes of filters: Finite Impulse Response (**FIR**) and Infinite Impulse Response (**IIR**). SCAN 4.2 and earlier versions used FIR; IIR is being introduced with version SCAN 4.3. FIR (Analog) is a non-recursive filter in which only previous and current input values are included in the calculation of the new output values from the filter. FIR is therefore fundamentally phase blind to output since it does not consider the previous output in the generation of the next output. The nature of the FIR (Analog) filter permits a linear, predictable phase *error* that does not occur with FIR (Zero Phase). FIR (Zero Phase) does not introduce phase errors.

IIR is a recursive filter (in essence, a filter that runs backward), which keeps track not only of previous and current input values, but also the previously calculated output values. It is therefore slightly less prone to phase mismatches than FIR (Analog).

Care

Be careful when using the IIR filter with slopes steeper than 12dB, especially with faster sampling rates. For example, the filter may become unstable with a 20kHz AD file, when using a 24dB slope and a high pass up to 1.3Hz.

Type. You may select one of the following options:

Low pass filtering only (passes frequencies below the inputted setting, attenuates faster frequencies). Clicking this option activates the Low (Hz) field in the Band Pass section below.

High pass filtering only (passes frequencies above the inputted setting, or attenuates slower frequencies). Clicking this option activates the High (Hz) field in the Band Pass section below.

Band Pass filtering passes frequencies within the Low and High pass settings (and attenuates frequencies outside of this range). Clicking this option activates the High (Hz) and Low (Hz) fields in the Band Pass section below.

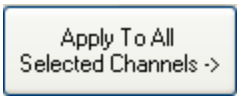
Band Stop filtering passes frequencies outside the Low and High pass settings (and attenuates frequencies within this range). Clicking this option activates the Start (Hz) and Stop (Hz) fields in the Band Stop section below.

Mode. In online acquisition there is no Zero Phase option, for either FIR or IIR. (Zero Phase shift filtering is possible offline with FIR). You may select whether or not to *Rectify* the waveforms prior to filtering (FIR only). This option is implemented primarily for EMG recordings, and is useful for identifying the onset of an EMG burst.

Channel. Notice that in this display, as opposed to the other similarly appearing displays (*Amplifiers* and *Channel Attributes*), there is an Enable button. Individual channels may be selected for filtering, although the steps are

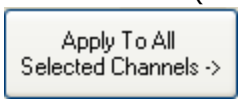
slightly different than selecting channels in the other screens. The basic steps are to 1) select the channels to be modified, 2) enter the desired settings, and 3) apply the settings to the selected channels. The order matters in this instance.

For example, retrieve the *Quik-Cap32.ast* file, and go to the Filter display. All channels are set for Low Pass filtering at 30Hz (12dB/oct.). All of the channels are selected by default (green). Let's say we want to change the filtering on the VEOGL and HEOG channels, AND, remove any filtering from the rest of the channels. First, disable the 

field (so the check mark is not there). Then click the 

button. This disables any preset filtering for all of the channels. Next, 

of the channels (so they are red), and then double click the VEOGL and HEOG channels (to select only them). Then, enable the 

button. Select the Band Pass and enter a High Pass cutoff of 3Hz and a Low Pass cutoff of 20Hz (with a 24dB rolloff from the pull-down menus). Then click the 

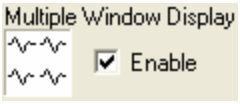
button. This will apply the new settings to the artifact channels only. To verify the filter settings for a given channel, click the left mouse button once on the channel. The current filtering parameters for that channel will be displayed in the Type, Mode, etc. fields. *Note: if you want to select several channels in a group, you can drag a rectangle around the ones you wish to select (or deselect).*

Band Pass. Part or all of this region will be active depending on which Type of filtering you selected above. When active, enter the desired High or Low pass filter setting in the window(s), and use the pull-down arrow to access several different roll-off settings (in dB per octave). The higher the dB/octave selection, the steeper the filter roll-off. Note the changes on the top diagram as you select different dB levels. The High and Low pass values you entered will be represented by vertical lines in the diagram (to see the changes, click, for example, to the High pass field and then back to the Band Pass field).

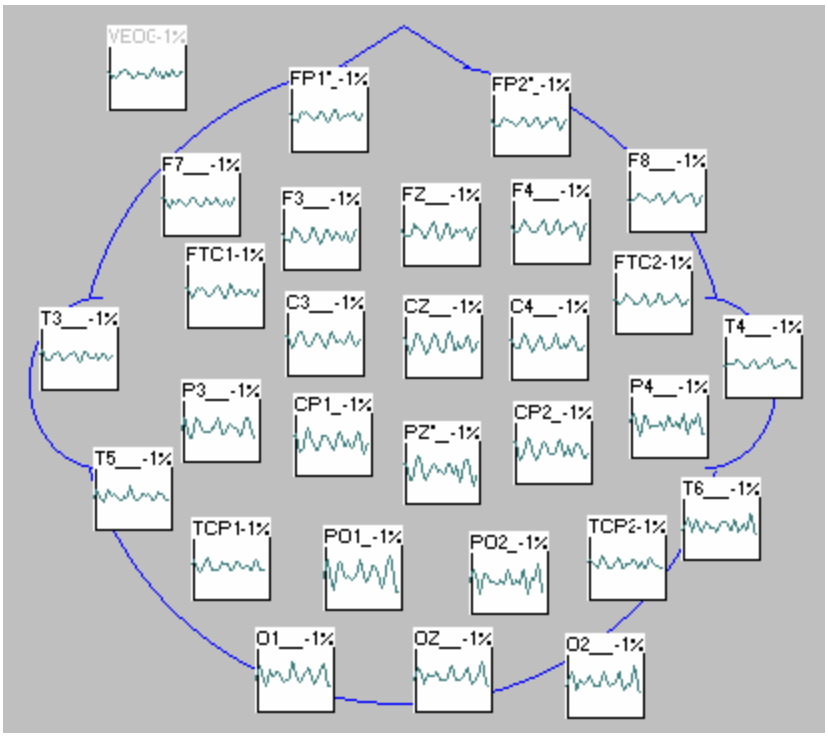
Band Stop. This region will be active if you selected the Band Stop type of filtering above. Enter or select the desired options as described in the Band Pass section above. *Note: Band Stop filtering is basically the opposite of Band Pass filtering. Band Pass filtering affects frequencies primarily outside the designated range, and Band Stop affects frequencies primarily within the designated range.*

Click OK when you are ready to continue. The incoming *display* waveforms will be filtered accordingly. This option has no effect on the data that are saved - only the filter parameters you set via the **Amplifier Settings** options will affect the data that are saved. The option allows you to observe incoming data that have, for example, attenuated slow wave artifacts or attenuated EMG. You might, for example, have the Single Window Display No.1 show the essentially raw incoming data, and have the Single Window Display No.2 show the filtered data.

Derivation. Linear derivation transforms allow you to create new channels as arbitrary linear combinations of existing channels. For example, you might create a linear derivation file that recomputes the incoming unipolar montage as a bipolar montage, and display this with one of the Single Window Displays. If you enable the **Derivation** option, you should then click the Derivation File button. This will access an Open File utility, through which you may select a Linear Derivation file (*.ldr* extension) that you created either in the Montage Editor or with your text editor (please see the EDIT module for a more complete description of linear derivation files, as well as Appendix B at the end of the EDIT manual). You may have up to two *.ldr* files at a time (one per Single Window Display). *Note: the additional Display Pages you may have created will not be available if you apply an LDR file.*



Multiple Window Display. If you enable the Multiple Window Display, ongoing activity is displayed in individual windows, in discrete epochs. Epoched and Averaged data are always displayed in a Multiple Window Display. The windows are labeled according to the information entered in the **Channel Assignment Table**.

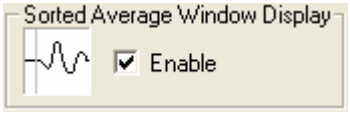


By clicking on any channel you may zoom-in and monitor a channel with a larger sized window. Note that when you position the mouse in one of the electrode fields, you will see the corresponding electrode label, ms, and μV values on the **Status Bar** at the bottom of the screen.

Note

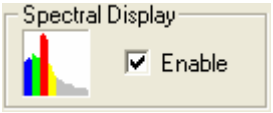
You may rearrange the positions and resize the boxes in the Channel Layout section under Edit on the Main Menu bar. Changes saved in that section will be invoked during acquisition.

Others. These are additional parameters included in the Startup options.

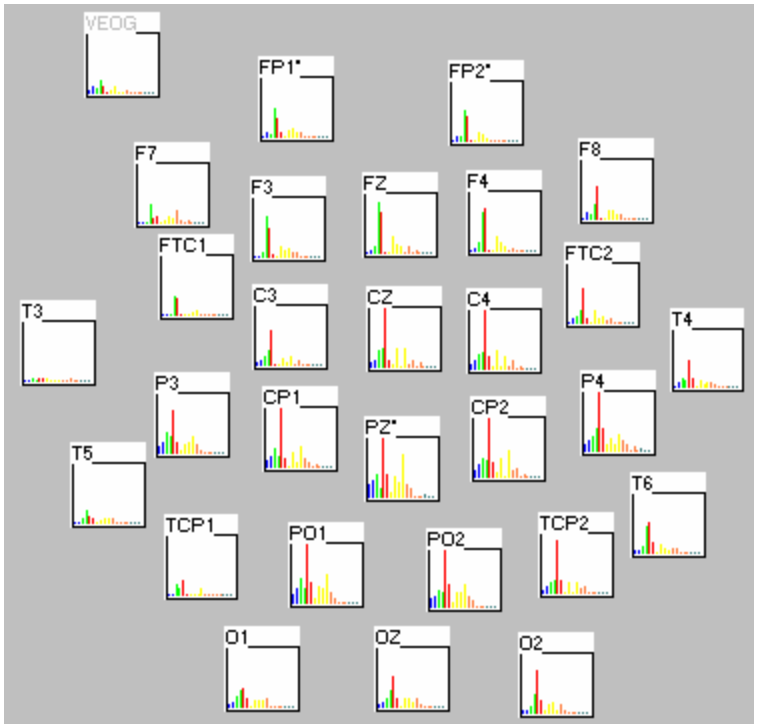


Sorted Average Window Display. Enabling this option is required for online sorting (refer to the online **Sorting** 45 description below). When enabled, you will see the "sorted" average accumulating in its own labeled window. *Note: waveforms in this window will not appear until the first trigger is received.* At that point, you may zoom in and monitor a channel with a larger sized window. Note that when you position the mouse in one of the electrode fields, you will see the corresponding electrode label, ms, and μV values on the **Status Bar** at the bottom of the screen.

Spectral Display. The online Spectral Display option is used in tandem with either the Multiple or Sorted Average display.



It displays the results of an online FFT using settings you entered in the **Frequency** 43 section (please refer to that section for a complete description).

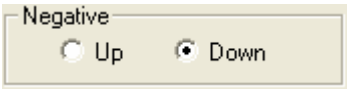


As with the Multiple Windows Display, you may zoom in and monitor a channel with a larger sized window. Note that when you position the mouse in one of the electrode fields, you will see the corresponding electrode label, frequency (Hz) and μV values on the **Status Bar** at the bottom of the screen. The display may be set for **Histogram**, as shown above, or with line drawings.

Set Display Filter. You must have selected the 

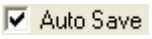
for either or both Single Window Displays for this button to be active. Clicking it displays the Filter parameters described above.

Negative. The Negative fields allow you to reverse the polarity on the display. If you want the negative part of the y-axis to go up from zero, select **Up**. If you want it to go down, select **Down**.



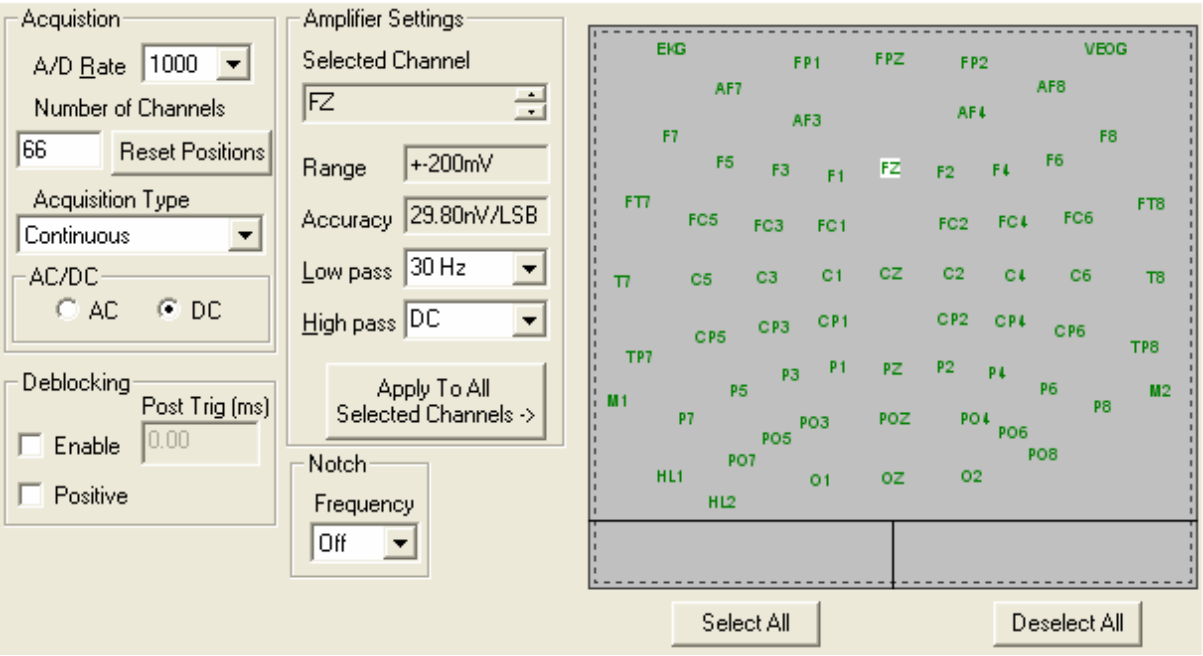
Display this Menu on Startup. When enabled, you will see the Startup page when you begin acquisition (convenience option).

Auto Save. The Auto Save field will automatically open a Save File Utility at the beginning of acquisition (saving the step of clicking the Save File button).



2.2.1.2 Amplifiers

The amplifiers section allows you to enter the A/D rate, number of channels, Acquisition type, AC/DC mode, and gain and filter settings. The display is divided into 2 major regions: Acquisition and Amplifier Settings. The parameters that you see will vary somewhat depending upon the amplifiers you have - *SynAmps*, *SynAmps*^{2}, *SynAmps Wireless*, or *NuAmps* (*SynAmps*^{2} were installed in the figure below). The differences among amplifiers are summarized in **Appendix A** 124.



Acquisition. The basic parameters for acquisition are entered in these fields.

A/D Rate. The digitization rate determines how often data are sampled by the analog-to-digital converters. For *SynAmps* systems, you may select from preset options ranging from 100 to 100000. Click on the desired value and this number will appear in the A/D field. *SynAmps*^{2} have a maximum AD rate of 20000, and the maximum AD rate for *NuAmps* is 1000Hz. *SynAmps Wireless* has AD Rates of 256, 512, and 1024Hz.

The rate will determine the duration of the sample according to the following ratio:

Total Duration (secs) = # of points / Digitization rate

For example, if the number of points is 500, and the digitization rate is 500 times per second or 500Hz, then the duration of the sample epoch will be 1000ms, or 1 second.

There is an interdependence among the following parameters: number of points per sweep (described below), digitization rate, pre-trigger interval (X minimum; described below), and post-trigger interval (X maximum; described below). If you change any one of these parameters, another parameter will automatically be changed along with it in order to maintain a consistent relationship among all four, as follows:

- If you change the number of points per sweep, a new sample interval will be created by increasing/ decreasing the poststimulus interval (X maximum).
- If you change the pre-trigger interval (X minimum), then a new number of points will be computed.

- If you change the post-trigger interval (X maximum), then a new number of points will be computed.

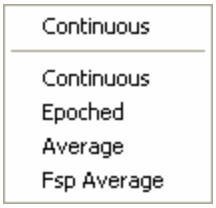
Note
The interval between sampled points is the reciprocal of the digitization rate.

Number of Channels. Enter the number of EEG channels that you will be recording.

Reset Positions

Reset Positions. This button is used to restore the electrode display positions to their default settings. The default positions are a matrix of the display windows, where the electrode channels are place in numerical order on the basis of how they appear in the **Channel Assignment** table. The Reset Position button is also used, when necessary, where you increase the number of channels beyond banks of 32. For example, if you begin with a 32 channel setup file, then add another *SynAmps* to get 64 channels (and make the change in the Number of Channels field), you may need to click the Reset button in order to see the additional 32 channels.

Acquisition Type. Select the type of file that you wish to record: Continuous, Epoched, Average or Fsp Average (described below). *SynAmps Wireless* has the Continuous type only.



Continuous. In continuous mode the data are displayed in a scrolling EEG, paper-like format in the *Single Window Display* (described above). In this display, relative amplitude is on the vertical axis, and time is on the horizontal axis. Data already on the screen are removed from the display as new data are recorded and displayed in their place. Files created with the continuous mode will have a *.cnt* extension. Information related to the duration of a recording, the number of minutes of EEG for which there is hard disk space, and stimulus and response event markers are all displayed on the continuous screen. Data can be replayed offline with the EDIT module.

Creating EEG epochs from continuous data files
Continuous data files created in ACQUIRE can be transformed into epoched data files offline with the EDIT program. EDIT uses event markers placed in continuous data files to locate event-locked epochs of data. A continuous file can be transformed into an epoched file by two different means. You can create an epoched file directly from the continuous file, or you can create an event file first and then create an epoched EEG file. An event file is an ASCII file containing a byte offset (from the beginning of the file) for each event in the continuous file that can be edited manually with a text

editor. For more details on epoching data files, see the EDIT manual.

Special configuration concerns for continuous acquisition.
Data throughput. Continuous direct to disk recording is a difficult task for any computer to perform. Fast digitization rates, large numbers of channels employed in the continuous mode, multiple screens, and multiple online calculations are more likely to exceed the ability of your machine. As a consequence, errors may occur if you are running close to the limit of your machine. Furthermore, with the rapid evolution of installed hardware, there is no way for us to anticipate what these limits may be. Our philosophy has been to avoid setting the limits on acquisition and to allow the user to push the system to its limit.

The best way to determine how fast your system can go is to run a number of test recordings if you are interested in high acquisition rates. The primary indicator that the capabilities of the system are being exceeded is the percentage of buffer space being used. Incoming data in the ACQUIRE module are stored in a double buffer. This means that while one buffer is being filled with data, another buffer is being written to disk. If you see that the Buffer value (seen in the Status box during acquisition) begins to climb, this is an indication that you are running out of buffer memory, and that the computer cannot store the data fast enough to disk. It is normal for this value to increase temporarily when the disk is accessed. However, if this value starts to increment consistently, it is likely that you have exceeded the speed of your computer. In that case you should either slow down the acquisition rate, and/or decrease the number of online functions.

Increasing your throughput. There are a number of ways to increase the speed of continuous acquisition. Listed below are some potential solutions:

1. Defragment your disk. How fast the system can write data to disk is a primary limitation of continuous data acquisition. One factor that influences disk speed is how often it has to move the disk head(s) to a different location on the disk. The disk can write data much faster if there is a large block of contiguous space available. With continuous usage of your disk the large unused blocks become fragmented into smaller and smaller portions scattered throughout the disk, and the real speed of the drive is significantly slowed. The solution to this problem is to defragment the disk regularly with a utility designed for this purpose.

2. Display fewer windows - ACQUIRE gives you the potential to display the data in multiple windows and with multiple analysis features during acquisition; however, limitations imposed by your computer's abilities may not permit all of them at the same time.

3. Obtain faster hardware - Finally, you can, of course, obtain faster hardware. High rates can be achieved with systems that have been optimized for continuous data acquisition. You can also obtain a faster display card. There are a number of inexpensive display cards that have been optimized for graphics interfaces that can significantly increase waveform display. Or, you can get a faster disk. The disk drive is often the major bottleneck to continuous acquisition.

Epoched. In the Epoched mode, single-sweep epochs of sample waveforms are stored to disk (see *Multiple Window Display* above) with an *.eeg* extension. The system checks to make sure there is enough space on the disk for the requested number of sweeps before acquisition begins. Sweeps are initiated whenever a TTL pulse is received from the amplifiers.

During acquisition the Status box will display the current total number of sweeps. This number will increment as events are received. The Status box will display the trigger 'type' value of the last sweep. The type value is the number read from the trigger port. For example, if the current hold value is zero and a value of 1 is received at the parallel port, then a value of 1 will be displayed as the current type value. Displayed also will be the number of accepted and rejected sweeps.

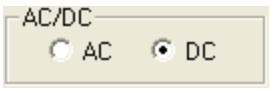
Acquisition will terminate when the total number of requested sweeps has been stored to disk (or sooner by user interrupt). To pause the acquisition display in order to examine the waveforms or for other reasons, click on the *Pause/Review* button  on the Toolbar (clicking on the *Record*  icon will suspend acquisition). Click the icon again to resume storage to the same data file. You can restart acquisition, with all of the current settings, by clicking on the *Restart* button  on the Toolbar.

Average. The Average Acquisition Type is used to obtain simple online averages; files are stored with an *.avg* extension.

Sweeps are initiated in the same manner as with epoch recording, and the number of accepted, rejected, and individual sweep types is similarly displayed. The average is displayed as it accumulates in its own Multiple Window Display. Acquisition will terminate when the total number of requested sweeps has been averaged, or by user interrupt. Prior to acquisition a Save File utility will allow you to enter a file name and any path preferences. During acquisition, you will see a Status box that will show the percentage of buffer space being used, the free space available on your hard drive, recording time, the event count, the number of accepted and rejected sweeps, the trigger type code of the last sweep, and the percent complete. Percent Complete is based on the number of Sweeps you selected in the General section on the Epochs screen under Overall Parameters.

F_{sp} Average. The F_{sp} mode (F statistic at a single point) can be used to make a statistical inference as to the presence/absence of an evoked potential embedded within background noise. Its primary use has traditionally been with brain stem Eps, but may have validity for other EP components. It is described in more detail below.

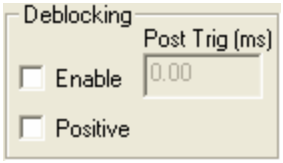
AC/DC (*SynAmps* and *SynAmps*^{2} only). Indicate whether you intend to record in AC or DC mode.



Note
When you record in AC mode, the AC coupled filters are added as a secondary step. The DC filtering still occurs, and the issues that affect DC recordings are still present when you record in AC mode. For example, you can still saturate the channels in AC mode. It will appear, however, as a flattening out of the signal, rather than a drifting of the signal out of range.

DC Correction / DC Level (*SynAmps* and *NuAmps* only). If a DC Correction is enabled, enter in the DC Level field the percentage of offset value beyond which an automatic correction will occur (e.g., if you enter 60%, automatic correction will occur when the DC offset exceeds this value).

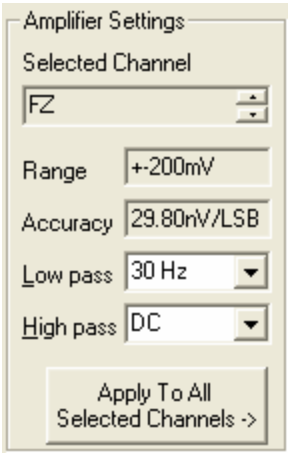
Deblocking (*SynAmps*^{2} only). The **Deblocking** feature should be enabled to reduce stimulus artifact, such as, SEP stimulation artifact. You must be in **DC Mode** to use Deblocking. Deblocking essentially suspends acquisition for a [typically brief] span of time. For example, deblocking can be used to suspend acquisition during the few ms's in which an SEP stimulus artifact is present. Set the deblock time in the **Post Trig (ms)** field.



Deblocking is controlled by a TTL signal sent from the peripheral device to the System Unit using the Deblocking Interface cable P/N 00081300 (included with the System Unit package). This cable connects to the Inter-System Unit connector on the back of the System Unit. The duration of the TTL pulse should be no longer than the duration of the artifact (data are lost during the span in which deblocking is employed). The Deblocking pulse must return to the original response bit resting state (typically 5V) between pulses. In other words, the default condition uses negative logic, and deblocking will occur when the TTL pulse goes to 0V. If you enable the **Positive** option, the system will use positive logic. That is, the resting state is 0, and deblocking will occur when the TTL pulse goes to 5V.

Beginning with SCAN V4.3.2, there is a Deblocking transform in EDIT, as well.

Amplifier Settings. These fields allow you to set the Gain (*SynAmps* only) and Filter settings for the individual amplifier channels. The basic operation consists of entering the new values, selecting the channels that you wish to modify, and then applying the modifications. In practice, you may find it easier to select the channels, then enter the new settings and apply them. Either method will work.



Selected Channel. This displays the currently selected channel, the one that is highlighted in the channel display below._

Gain. The gain factor affects all channels. *SynAmps* users may toggle from among settings specifically calculated for their systems. *NuAmps* have a single fixed Gain of 19. *SynAmps*^{2} have a fixed Gain (DC Mode = 10x; AC Mode = 2010x). *SynAmps Wireless* have user selected Gains from 6 to 6000Hz. You may program channels to have different gains - such as an artifact channel with a lower gain than the EEG channels (*SynAmps* only). In this case, it is recommended that you determine the overall Gain by using the majority Gain of the EEG channels. The Calibration procedure (see Calibration section below, *SynAmps* only) will adjust a local scaling factor for each individual channel, so you need not be overly concerned with the degree of precision of the overall scale factor. Generally, lower gain settings are used with particularly high amplitude channels, such as EMG from active muscle groups; higher gains may be selected when looking at very low amplitude signals, such as ABRs.

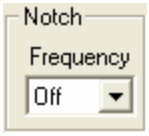
Range and Accuracy information corresponding to the selected gain settings are displayed in the adjacent fields to the right. The Range values indicate the upper and lower voltage limits for each channel - if the incoming voltage exceeds these limits, the channel will saturate. Accuracy refers to the precision of voltage measurement along the y-axis. The value displayed indicates the resolution ability (in μV). If the accuracy is, for example, .087μV, then the voltage resolution will be in .087μV steps. This is similar to the dwell time on the x-axis, or, in other words, the *time* difference between adjacent data points. Accuracy is the least measurable *voltage* difference between points. (Sixteen bits are available to "describe" voltage, that is, 2 to the 16th power minus 1 discrete voltage values are possible per data point. The resolution is thus interactive with the gain. The greater the gain, the smaller the voltage step per bit, and the greater the resolution).

Low pass. Selections of low pass filter settings are presented in a pull-down window. Click on the desired setting (for example, a setting of 100Hz attenuates frequencies faster than 100Hz and passes frequencies lower than 100Hz). Additional, offline filtering options are available in the EDIT module.

High Pass. Selections of high pass filter settings are presented in a pulldown window. Click on the desired setting (for example, a setting of 1Hz attenuates

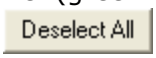
frequencies slower than 1Hz and passes frequencies faster than 1Hz). Additional, offline filtering options are available in the EDIT module.

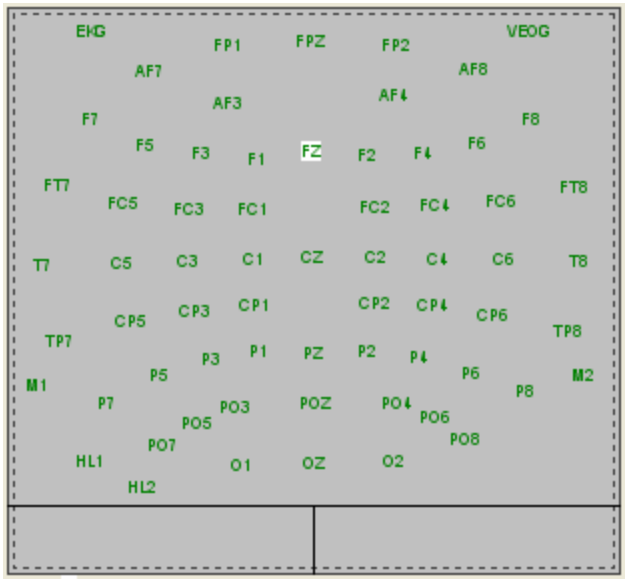
Notch Frequency. The Notch Frequency field allows you to apply a 50Hz or 60Hz notch filter during acquisition. In general, it is better not to use the notch filter if you can avoid it (since it will filter genuine EEG/EMG data in the same frequency range).



32-Bit Acquisition (*NuAmps* only). The  option lets you acquire data in either 32-bit or the original 16-bit modes. If you are recording DC, you must use 32-bit acquisition because of the wider dynamic range it allows, and to record the slowest frequency activity accurately. In general, 32-bit acquisition is preferred in all cases. The one consideration is that it will essentially double the file size as compared to the 16-bit mode.

Channel Display. The channel display part of the dialog is used to select the channels that you wish to modify. The electrode labels and their positions on the screen are all user determined. The **Channel Assignment** list, described below, is perhaps the easiest place to enter the electrode labels, although these can be modified in other places. The positions of the electrode displays are created in the **Channel Layout** feature, described below. If you are using one of the preset setup files, the labels and positions have already been set using the Channel Assignment and Channel Layout features. Many people prefer to make their own setup files, using their own labels, and display positions.

Channels can be selected, or deselected, by double clicking the mouse on a channel (green is selected and red is deselected), or you can use the  and  buttons to affect all channels.



A single selected channel will show a white background behind the electrode label FZ, and the label will be displayed in the **Selected Channel** field. Click the mouse button once on an electrode label to select it; double-click to change its state (selected or deselected). Drag a box around a group of channels to select or deselect the group, if desired.

When you have selected the channels that you wish to modify, enter the desired Gain, Low Pass and High Pass filter settings in the Amplifier Settings fields. Then click the **Apply to Selected Channels** button to apply the changes.

You may verify the changes you have made by clicking an electrode label once and looking at the values in the **Amplifier Settings** display.

2.2.1.3 High Level Inputs (SynAmps2 and SynAmps RT only)

Psychophysiological signals arising from peripheral devices, such as GSR, EKG, respiration amplifiers, etc., should only be connected through the High Level Inputs (HLIs) on the bottom edge of the *SynAmps²* and *SynAmps RT* (14 pin Redel connector). The HLIs are isolated from the patient connections. The HLI ground is connected to the System Unit ground (computer ground).

There are several places in the ACQUIRE program that are relevant for configuring the HLIs. These include the **Amplifiers (SN2)** options, the **High Level Inputs** options, the **Channel Assignment Table**, and **Channel Layout**. We will use an example to describe the various settings shortly. Briefly, the various dialog screens are used as follows:

Amplifiers (SN2). Select the number of channels, including the HLIs; set Filtering for HLIs (if any)
High Level Inputs. Main screen for configuring the HLIs

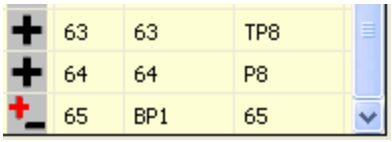
Channel Assignment Table. Used to select the HLI channels
Channel Layout. Used to size and position the HLI displays

Example. Let's say you are using the supplied 64 channel setup file (in the *SynAmps2* folder) for *SynAmps²*, and you want to add a HLI channel to record pupil diameter. The analog voltage output of the pupillometer ranges from 0 to 5V, where 0V = 0mm, and 5V = 15mm.

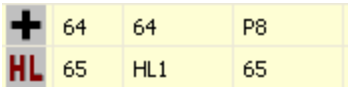
1. Retrieve the setup file.

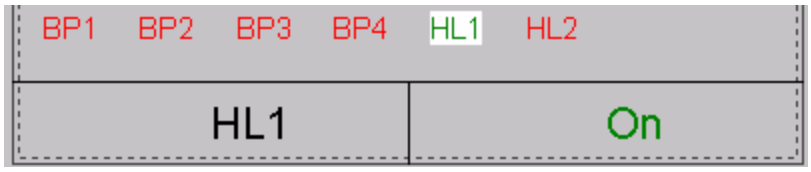
2. Go to the **Amplifiers (SN2)** options. In the Number of Channels field, enter 65 in place of 64, and click OK.

3. Go to **Edit** → **Channel Assignment Table**, and scroll to the bottom of the list. In this case, the 65th channel was assumed to be a bipolar channel - that is the next unassigned channel in the display.

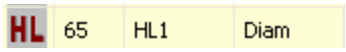


4. Click the  area to highlight the entire line, and then double-click HL1 on the Physical Channels display (or click once and then click the Add button). You will see the HLI symbol  appear for channel 65, and the HL1 channel will be "On".

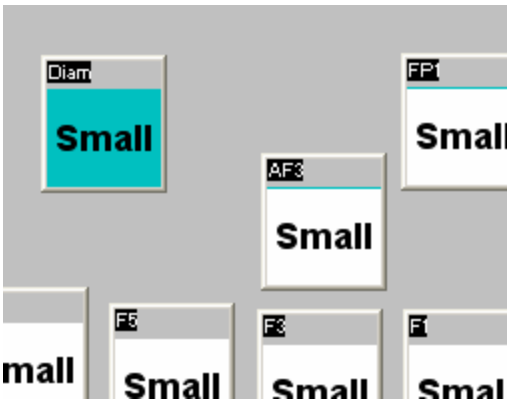




5. Double-click the "65" in the channel Label column, and enter a new label, such as "Diam". Then click OK to leave the **Channel Assignment Table**.



6. Click **Edit** → **Channel Layout**. Scroll down to the bottom of the electrode list and highlight the "Diam" electrode you created. You will then see its electrode circled in the "radar" display. Drag it to a new location.



7. Click OK to return to the **Channel Layout** screen. You will see the new electrode display for the HLI channel (Diam). Size and position it as desired. (*Note: you may set the display Scalar here, if needed, or in Step 9 below*). Then click OK to exit the **Channel Layout**.

If you do not see the new channel in the **Channel Layout**, it may be positioned off-screen. Click the Adjust Positions button, and use the **Spacing** arrows to reduce the display to the point that you see the new channel. Then reposition and resize the new channel, and lastly use the **Spacing** arrows again to restore the display.

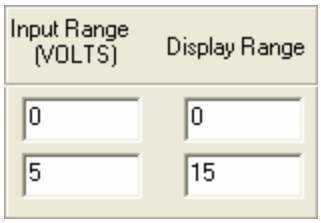
8. Return to the **Amplifiers (SN2)** screen, and you will see the new HLI channel in the channel display. If you want to apply a filter to the HLI channel, select the channel and set the filter as desired. In most cases you will *NOT* want to filter the HLI. Apply a filter only if you are sure you need to do so.

9. Next, go to **Edit** → **Overall Parameters** → **High Level Inputs**. For this example, we will assume you have a single amplifier; if you have more than one, the process is the same - just select the amplifier containing the HLI that you are configuring.

High Level Inputs
Channel. Select the HLI **Channel** to be configured. In this case there is only the single channel. If you have multiple amplifiers chained together, you will see HLIs for all of the amplifiers (HL1, HL2, HL3, HL4, etc.).

Label. Label is the electrode label that you entered in Step 5. The Default label is the one you entered at that point. You can change it by entering a new Label. This will override any previous label you entered.

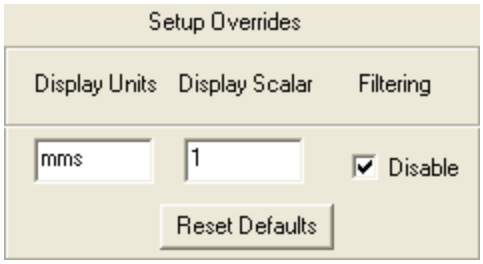
Scaling
Input Range. The Input and Display Range fields are used to configure the SCAN software to interpret the voltages from the external devices in a meaningful way. The Input Range is the voltage range that will be input into the amplifiers. Valid voltages are between +/- 5V.



Display Range. The Display Range is the range of values that will be displayed on the screen in ACQUIRE.

To continue the example, we said that the analog voltage output of the pupillometer ranges from 0 to 5V, where 0V = 0mm, and 5V = 15mm. Enter the values as shown in the Scaling section.

Setup Overrides
Display Units. You can set the Units displayed on the Y-axis as needed to make them meaningful for the HLI data. The Default units are the autoscaled nV, μV, mV, etc. To change it, enter whatever units are meaningful in the field (for example, enter "mm", or "psi").



Note
The labels should not contain any spaces, and there is a 10 character maximum. "mms" was entered for this example.

Display Scalar. The Display Scalar is the same at the Scalar seen in the **Channel Layout** dialog screen (Step 7). These settings allow you to alter the display scaling factor specifically for the HLI channel(s), thus increasing or decreasing their amplitudes in relation to changes in the other EEG channels. The scalar multiplies the global scale factor. For example, if the global scale factor is 2 (the number displayed on the Status Bar and affected by the Up and Down arrows on the Toolbar), and the scalar value is 2, then the display will be multiplied by a factor of 4. The scalar setting affects the screen display only, and has no effect on the stored data. The Default value is the value displayed on the **Channel Layout** display; a Custom value you enter for the Display Scalar will override the value set on the **Channel Layout** display.

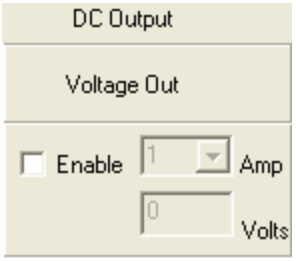
Filtering. The default state is disabled, since in most cases you do not want to filter the HLIs. If you enable the Filtering option, then whatever filtering you assign to the HLI channels under Amplifiers (Step 8) will be applied to the HLIs. Be careful doing this, since in most cases you do not want to filter the analog voltage output from the peripheral device. If you select the default Disable option, this will override any filter settings that

were made on the Amplifiers page, and no Filtering will be applied. Leave it disabled for this example.

Reset Defaults. Click the 

button to return the fields to the default settings (mV, a Scalar of 1, and Disabled Filtering).

DC Output
Some transducers require a DC voltage in order to operate. The *SynAmps²* is capable of producing a differential output. That is, it has a positive, negative and ground output. The voltage on the output is always symmetrical about the ground (e.g., -5 and +5V, -1 and +1V, but not -1 and +5V). Enable the field and enter the **Volts** you want to use. There is one independent voltage source per amplifier/ headbox (see the pinout information in the *SynAmps*^{2} manual). If you have multiple amplifiers linked together, the **Amp** field lets you select which amplifier is being addressed. The DC output begins at the start of acquisition, and ends when acquisition is terminated. The maximum voltage is 9V. If you need a DC voltage, please consult your device specifications.

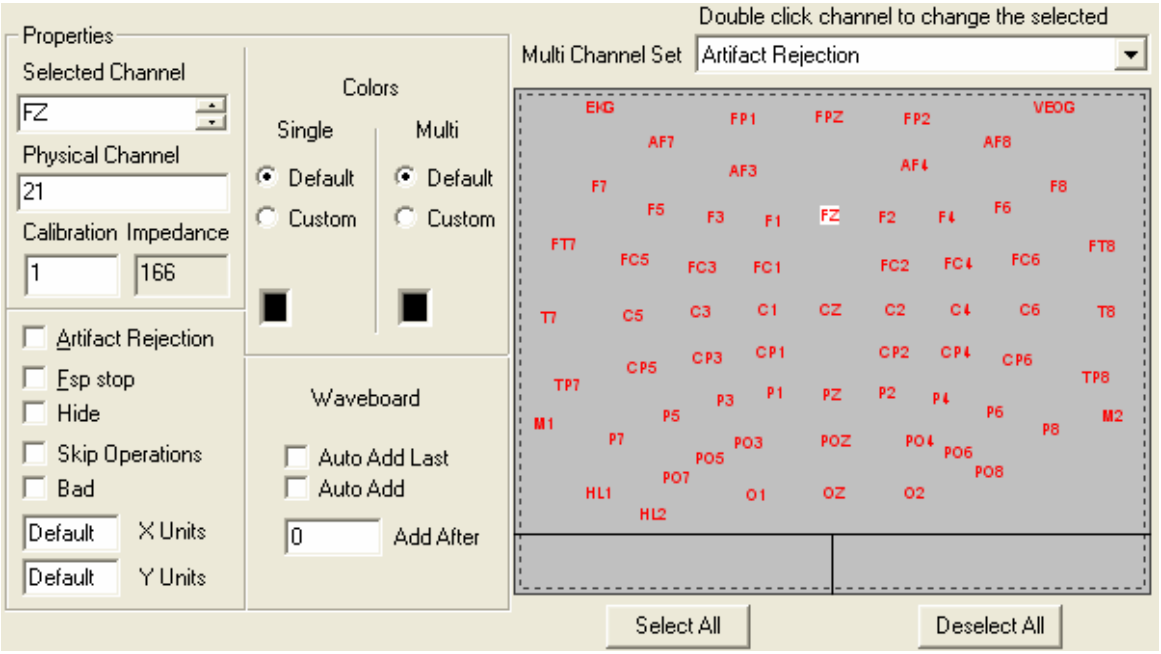


In our example, there is no DC output voltage. Leave it Disabled.

10. The HLI is now completely configured, and you should save the setup file with the HLI configuration. Click **File** → **Save Setup** to save the setup file.

2.2.1.4 Channel Attributes

The Channel Attributes display is used to set a variety of parameters for individual or all channels. The channels display part of the screen is used to select or deselect the electrode channels that you want to modify, and the other fields are used to select the attributes that are to be applied to the selected channels.



Selecting Channels. Channels may be selected by clicking the electrode label once (in the channel display) to select the individual channel. The background area behind it will turn white, and the electrode will appear in the Selected Channel field. You can change the "selected" or "deselected" status of an individual channel by double-clicking the electrode label. This is useful when you want to select multiple electrodes for the same modification. When selected, the electrode label will be green; when deselected, the label will be red. Use the Select All button to select all the channels, and the Deselect All button to deselect all channels. Double clicking an electrode label also applies to that channel the modification that is displayed in the **Multi Channel Set** field. The operations may be understood more easily with a couple of examples.

Selecting a single channel for a particular attribute. Click the pull down arrow for the **Multi Channel Set** field to see the list of attributes that may be assigned. Select the desired attribute (e.g., **Bad**). Unless previously modified, all channels will be deselected (red). Double-click a channel to select it and assign the attribute (the corresponding field will be enabled, such as ☑ Bad).

Selecting multiple channels for a particular attribute. Select the **Multi Channel Set** attribute to be applied (such as, **Auto Add to Waveboard**). Then click the Select All button. The attribute will be enabled (☑ Auto Add). Double click any electrode labels to deselect them, if you do not want the attribute applied to those channels.

Properties. The Properties area displays many of the attributes that may be modified for each channel.

Selected Channel. As described above, the Selected Channel field will reflect the channel that has been selected in the channel display. The up and down

arrow buttons can also be used to select a channel. An individual channel is "selected" when it appears in the Selected Channel window. You can also **Rename** the electrode label by overtyping the electrode label in the Selected Channel. Then click inside the montage display area (not on a label) to see the change.

Physical Channel. The Physical Channel field displays the number of the actual amplifier channel that is carrying the signal that is displayed in the Selected Channel field.

Calibration. The Calibration field displays the Selected Channel's calibration value. The default calibration value for all channels is 1. After you perform a Calibration (*SynAmps* only), and save the calibration values with the setup file, these values will be seen in the Calibration field.

Impedance. The Impedance field shows the values that were observed when you exited the Impedance routine. These values will be stored along with the data file, and may be reviewed, channel by channel, in EDIT.

Artifact Rejection. Enabling the Artifact Rejection field allows you to designate one or more channels that will be scanned for artifact in the automatic artifact rejection of sweeps. Typically, electrodes that monitor eye movement as well as those that pick up other sources of artifact are selected with this option. When viewed in acquisition or in offline editing, the Artifact Rejection channel labels will contain an asterisk (*) after the label.

Fsp Stop. You may designate which channel(s) you wish to have monitored for termination criteria during the F_{sp} Averaging process. If you selected **All** for the **Termination Method** in the **F_{sp} Average** display (under **Overall Parameters**), then you need not specify the channels again here. If you selected **Select** in that section, then you will need to select the channels individually.

Hide. This option allows you to Hide electrodes on the screen display. Select the channels to be hidden as described above. The data for hidden channels will be recorded even though the waveforms do not appear.

Skip Operations. This option allows you to set certain electrodes to be skipped, or ignored, in data analysis. For example, a setup file could include channels that are used to initiate sweeps or monitor artifact. Skip channels, in contrast to Bad channels, are generally known in advance, and are designated in the setup file prior to acquisition. These channels would not normally be included in other stages of processing, such as for autoscaling and in common average re-referencing, and may be *skipped* using this feature. Select the channels to be Skipped, as described above. When viewed in acquisition or in offline editing, the Skipped channel labels will be in black type, regardless of the color you had selected for **Text** (under **Options**).

Bad. This option allows you to select electrodes to be excluded from certain statistical operations, such as averaging, variance computation, mapping, or artifact removal. Select the Bad channels, as described above. Bad channels, in contrast to Skip channels, are encountered during acquisition, resulting from bad electrodes or abnormally high artifact. When viewed in acquisition or in

offline editing, the Bad channel labels will be in red type, regardless of the color you had selected for **Text** (under **Options**).

Note
As a general rule, Bad and Skipped channels will not be included in operations that involve the combination of multiple channels. These include, for example, Autoscaling, Spatial SVD, Common Average Reference and Global Field Power, Mapping, Ocular Artifact Reduction, etc., and the channels marked as Bad or Skip will be excluded from these operations. On the other hand, channel-by-channel operations (such as filtering) are performed on Bad and Skipped channels, as well. That is, if the operation performed on the Bad channel does not affect the same operation performed on other channels (i.e., the Bad is independent from the other channels), then the operation will ignore the Bad or Skip settings.

X Units. This option allows you to enter a label for values along the x-axis. You may set the label independently for each channel - the channel that is displayed in the Selected Channel field is the one that you are setting. The *Default* label is "ms". If you change this, and wish to return to the default label later, select Default.

Y Units. This option allows you to enter a label for values along the y-axis. You may set the label independently for each channel - the channel that is displayed in the Selected Channel field is the one that you are setting. The *Default* label is "μV". If you change this, and wish to return to the default label later, you must enter the word "Default" (with a capital D).

Colors. The Colors fields allow you to set the waveform colors independently for each channel. Further, you can set the new colors to appear only in a Single Window Display or only in a Multiple Window Display (or both). The Default setting is the color you specified using **Options** → **Single Window Settings** → **Waveform color** or **Options** → **> Multiple Window Settings** → **General** → **Waveform**. Click the Single or Multi Color Code field to access the standard Colors palette, and select a color for the specified channels. Select the channels to be modified in the same way as described above.

Waveboard. Waveforms from the online average files can be sent automatically to the Waveboard.

Auto Add Last. When enabled, this option will automatically send the final waveforms from the AVG file to the Waveboard.

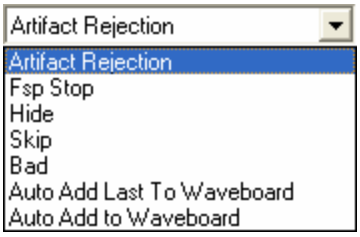
Auto Add. The Auto Add and Add After options are linked. When enabled, the Auto Add option will automatically send waveforms from the building AVG file to the Waveboard, after every X number of sweeps. Enter the desired number of sweeps in the Add After field.

For example, if you have selected the Auto Add option, and have entered 10 in the Auto Add After field, the average of the first 10 sweeps will be sent to the Waveboard automatically. Then the average of the next 10 will be sent, and so forth. If you also enabled the Auto Add Last option, the final averaged waveforms will be sent automatically to the Waveboard. If your total number of

sweeps is a multiple of the number in the Add After field, then the last two waveforms sent to the Waveboard should be identical. *Note: If, for example, you are sending the average of every five sweeps to the Waveboard, and there are 40 sweeps, you will only see 7 waveforms on the Waveboard. You will need 41 sweeps to have the last subaverage sent.*

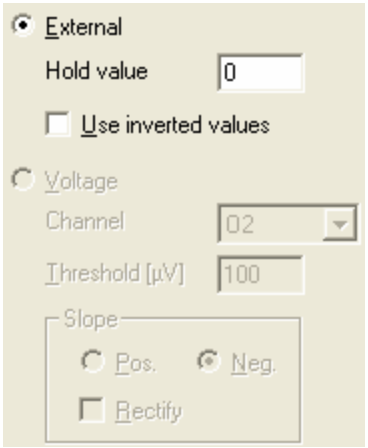
Add After. Refer to the Auto Add description above for the use of this option.

Multi Channel Set. The Multi Channel Set options are used to select the attribute of function that you want to apply to the selected channels. If you want to assign certain channels as Artifact Rejection channels, for example, select Artifact Rejection from the pull-down list. Double-click on the desired channels in the montage display, so they appear in green. Use the Select All and Deselect All buttons as needed to facilitate channel selection. The settings will become permanent when you resave the setup file.



2.2.1.5 Triggers

The Triggers fields determine how sweeps are to be initiated during acquisition.



External Settings. With External Triggering (all acquisition systems), sweeps are initiated by an external device, such as STIM. Click on the radio field to select External triggering (if needed).

Hold Value. The Hold (bit pattern) value determines what value of the signal at the trigger port will initiate a sweep; a value other than the hold value will trigger acquisition. If a sweep is initiated by the number 255 (bits 0-7 all high), for example, the number 255 will appear in the Last Type field of the Status box. Hold values are applicable to External (8-line parallel port) triggering, as

with the STIM system. The threshold for triggering will typically be zero if you are triggering from the STIM audio interface port. Trigger types may range between 1 and 255.

Different machines and setups may require different values in the threshold field. If you specify what you believe to be the correct hold value for your machine, but the program seems to be acquiring sweeps of data spontaneously, there is an easy way to find the correct hold value. Notice the number that is displayed in the **Last Type** field of the Online average box in ACQUIRE. This number corresponds to the bit pattern that is being read from the trigger port. The value that is displayed here while a sweep is spontaneously initiated is the hold value.

Use Inverted Values. With current STIM and STIM^2 systems, there should be no need to invert the triggers (leave disabled). When enabled, this field sets ACQUIRE to read the inverted TTL values. For example, a "1" will appear as "255" if Use Inverted Values is enabled. With older STIM systems, or with some other stimulation systems, you may need to invert the triggers. As a general rule, if you are not seeing any triggers in ACQUIRE, try turning the Use Inverted Values field On (or Off). Also, see the **Test Trigger Port** option as a tool for diagnosing triggering problems.

Voltage selection field. This field will allow triggers to be registered, and sweeps to be initiated on the basis of a user-selected voltage on a selected channel. Whether the option is available or not depends on which acquisition you have, and which acquisition mode you are using. For example, voltage triggering is not supported at all with *NuAmps*. It is available for *SynAmps* and *SynAmps*^{2}, as long as you are in **Epoched** acquisition mode.

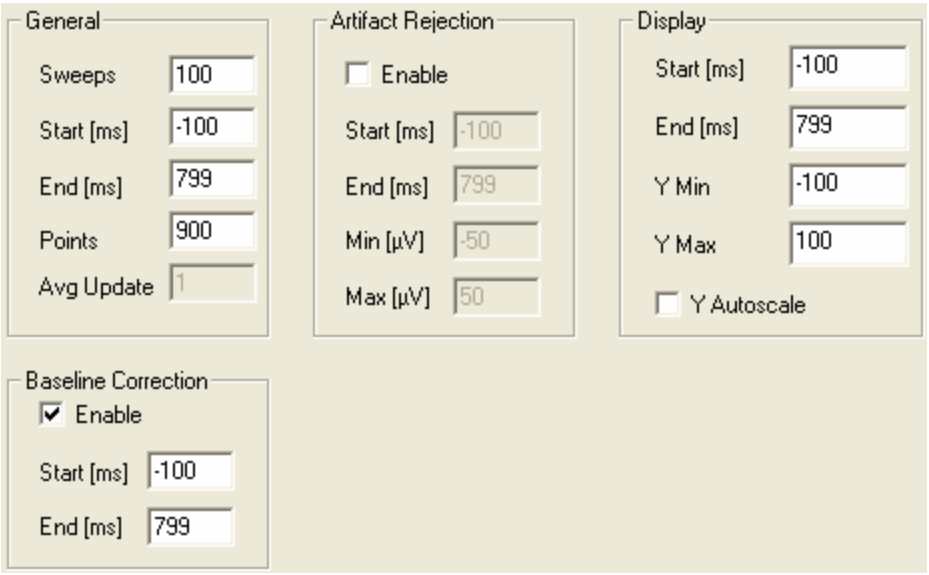
Channel. Select the channel that will carry the voltage trigger signal. This could be a regular channel, such as the VEOG channel, where you want trigger to occur on the basis of blinks, or, perhaps more commonly, a dedicated voltage channel where you record voltage changes from a peripheral device.

Threshold. Enter the threshold value in microvolts.

Slope/Rectify. Indicate whether the voltage trigger will be in the positive or negative direction. You can also **Rectify** the channel, which will cause all of the voltages to have the same valence.

2.2.1.6 Epochs

The features in these fields allow you to specify parameters of the recording epoch.

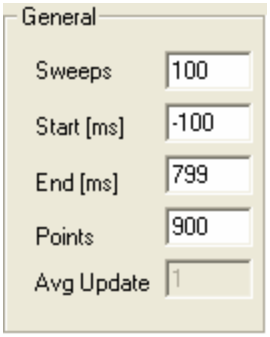


Note

There has been one notable change in SCAN 4.2, which is to make the data point count more accurate. For example, in prior versions, if you had an AD rate of 1000, and epoch spans from -100 to 900ms, the program would show that you have 1000 data points (one per ms). In reality there are 1001 data points, when you include the starting point, the ending point, and the zero point. In 4.2 and all subsequent versions, all points are counted. In the 4.2 Epoching transform, for example, let's say you have an AD rate of 250, and you wish to create epochs from 0 to 1000ms. You will find that there are now 251 points, rather than 250 points in the prior versions. If you wish to create epochs with a "power of 2" number of points, you should go by the points field (512), not the Start/Stop times.

Does this mean you cannot combine your old data files with new ones? No. Your old data files will be read in the new way. For example, retrieve the vep.avg file in an prior version of EDIT, and it will show an epoch span from -50 to 500ms. Retrieve the same file in 4.2, and it will show -50 to 499ms. The last point is dropped automatically (there is no latency shift). When you retrieve your prior setup files in ACQUIRE 4.2, the epoch settings will be automatically adjusted to insure that old and new files will be compatible. The only way to encounter problems is if you, for example, create a new setup file where you specify -50 to 500ms, and try to compare those files with older ones. The new ones will have one additional data point, so the files cannot be compared. Should that happen, the Cut Epoch transform can be used to remove the additional point from the end of the file.

General. These parameters control the number of sweeps to be acquired, the starting and ending time points of the recording epoch, the number of points per epoch, and the average update setting.



Sweeps. Clicking this field allows you to input the number of sweeps you wish to acquire. If you anticipate acquiring an undetermined or large number of sweeps, then put a value that you will likely not exceed in this field. Data will be saved to the disk on a sweep-by-sweep basis until the sweep number is reached, or until you terminate acquisition by pressing the **Stop** button. *This parameter has no effect for continuous recordings.* If you are saving single-sweeps, and you have specified more sweeps than the current disk has space for, you will receive a warning that you will run out of space.

Start [ms]. Clicking this field allows you to specify the beginning of the recording epoch (in milliseconds) with respect to the trigger. This value must be a negative number or zero. For example, if you want to begin the recording epoch 100ms prior to the stimulus, enter minus 100 (-100).

End [ms]. Clicking this field allows you to specify the end of the recording epoch (in milliseconds), that is, the end of the sampling epoch with respect to the trigger. For example, if a 1000ms post-trigger interval is desired, set the end value to 1000. All sample intervals must include time zero within the interval. It is not possible to construct an interval in which the Start time is greater than zero, or the End time is less than zero.

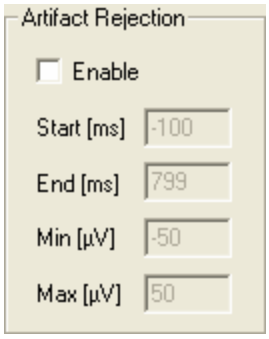
Note
For continuous recordings, the Start and End values have no direct effect on the initial recording. It is convenient, however, to set these values to an interval that will most likely be used when constructing offline epochs and averages with the EDIT module.

Points. The number of points is the number of time samples at each channel. For example, with an A/D Rate of 500Hz, a Start time of -100ms and an End time of 1000ms, there would be 551 points per channel (including the point at 0ms). The maximum number of points possible (the maximum epoch span) depends on your computer's memory.

Avg Update. The number entered in this field specifies how often the online average file is updated. If, example, you wish to have the accumulating average waveform recomputed after every 5 sweeps, enter 5 in this field. This field is only accessible when you have selected Average for the **Acquisition Type** in the **Amplifiers** section.

Artifact Rejection. These parameters control the automatic rejection of sweeps during acquisition that contain voltages in excess of criteria that you set. The

Start and End points specify where in the epoch a scan for artifact will begin. If a value exceeds the Minimum or Maximum in the interval on a selected channel, the sweep is rejected. Otherwise, it is accepted.



Enable. Enable the option if you desire artifact rejection.

Start [ms]. The Start point sets the position within the sampling period (in milliseconds), with respect to the trigger event, at which the search for artifact will begin.

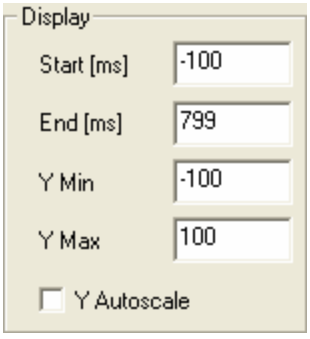
End [ms]. The End point sets the position within the sampling period (in milliseconds), with respect to the trigger event, at which the search for artifact will terminate.

Min [µV]. The Minimum value is the low cutoff value for artifact rejection. Values lower than the artifact Minimum will result in rejection of the sweep.

Max [µV]. The Maximum value is the high cutoff value for artifact rejection. Values higher than the artifact Maximum will result in rejection of the sweep.

Note
Be sure to enable at least one of the channels for artifact rejection. All Artifact Rejection channels will be monitored for artifacts.

Display. These fields allow you to set the millisecond and microvolt limits for the display waveforms.



Start [ms]. The X Start point sets the beginning time point of the display.

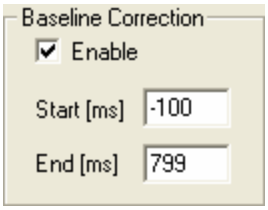
End [ms]. The X End point sets the ending time point of the display.

Y Min. The Y Min point sets the lower voltage limit for the display.

Y Max. The Y Max point sets the upper voltage limit for the display.

Y Autoscale. When enabled, the y-axis will be scaled automatically. The automatic scaling is symmetric, that is, the upper and lower limits will be the same value (absolute value), and are determined on the basis of the largest (absolute) value detected in the sweep.

Baseline Correction. Baseline correction is performed by estimating an averaged value (DC offset) for part or all of the sample epoch. The average value is subtracted from each point in the sampling epoch for each electrode. The portion of the epoch to be used in estimating the DC offset is specified in the **Start** and **Stop** fields.



Enable. The Enable option is used to turn on/off the baseline correction option while making an online average. This toggle has no effect on the single sweep EEG file, nor does it affect offline baseline correction in the EDIT module.

Start [ms]. The Start point sets the beginning of the interval in which the mean DC offset is estimated.

End [ms]. The End point sets the end of the interval in which the mean DC offset is estimated.

Here are a couple of examples that illustrate the use of baseline correction:

Correcting the baseline using the entire interval. Suppose you are recording spontaneous EEG with a sample period of 2.56 seconds or 2560ms. To compute a baseline adjustment correction factor for the entire sample epoch, enter 0 for the start point and 2560 for the end point. These values will result in the entire sample epoch centered on the baseline, with a mean of zero.

Correcting the baseline using the prestimulus interval. Suppose you are recording an evoked potential with a pre-stimulus sample period of 200ms and a poststimulus period of 800ms. To compute a baseline adjustment based on the pre-stimulus period, enter -200 (200ms prior to stimulus onset) for the start point and 0 (0ms prior to stimulus onset) for the end point. These values will result in an averaged evoked potential that is baseline corrected in the pre-stimulus sampling period.

Note
The baseline correction affects the display only - it is not saved with the data

file. It is applied before online artifact rejection. If you perform artifact rejection again offline, you should apply the baseline correction first.

2.2.1.7 Fsp Average

The F_{sp} mode provides an implementation of the single-point F statistic estimate of signal quality developed by Elberling and Don, 1984, 1987. The single-point F statistic (F_{sp}) is a ratio of waveform magnitude measured against an averaged background noise. Signal strength is determined over a fixed interval in which the signal is likely to occur. Background noise is estimated by measuring variability at a single point located anywhere within the response interval. This ratio follows an F-distribution with a given number of degrees of freedom (Elberling and Don, 1984). The F statistic can then be used to make a statistical inference as to the presence/ absence of an evoked response embedded within background noise. The criteria and decision rules required to make this 'quality' decision have been developed so far for the auditory brainstem response (ABR) only (Elberling and Don, 1987). However, this method can be applied to other types of signals as long as the appropriate degrees of freedom have been determined and validation of the statistical independence of the single point have been met. When this mode is selected, a block-by-block estimate of the F_{sp} is displayed in a window adjacent to each averaged waveform.

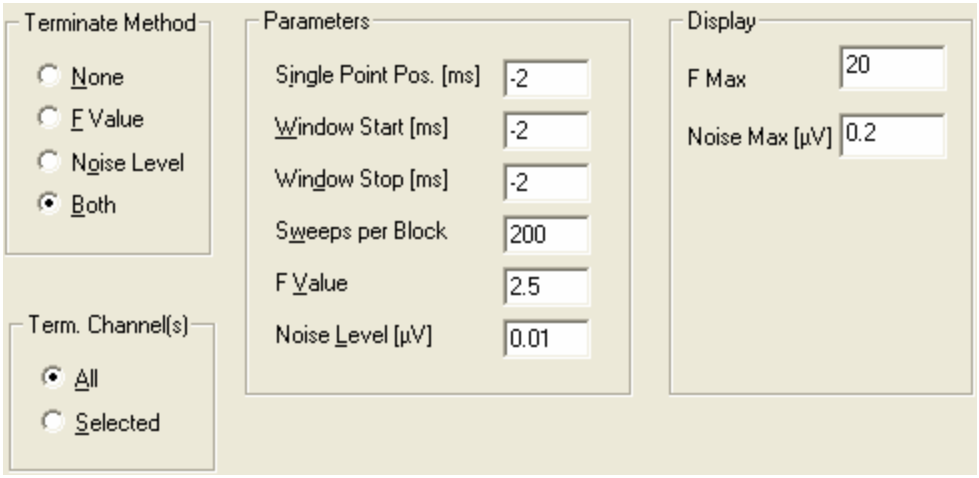
Averaging in this mode is performed in a 'blocked' format. In the blocked format two ongoing averages are maintained by the system: the within block average and the between block average. The within block average reflects the current ongoing activity as it is accumulating. The between block average is the grand average of all the Bayesian weighted within block averages. For the ABR waveform, 200 or more sweeps are typically averaged together to construct a within block average. The F_{sp} statistic and background noise are estimated for each block and displayed at the completion of a within block average. The current within block average is then weighted by a Bayesian function of the background noise and added to the between block grand average. The Bayesian function is the reciprocal of the background noise for the current block divided by the sum of the reciprocal noise for all blocks. This has the effect of minimizing the contribution of noisy blocks to the grand average (Elberling and Wahlgreen, 1985). Click on the tab portion of the display. A dialogue box will appear that allows you to set the parameters relevant to the F_{sp} average mode.

Elberling, C. and Don, M. 1984. Quality estimation of averaged auditory brainstem responses. *Scand Audiol*, **13**, 187.

Elberling, C. and Wahlgreen, O. Estimation of auditory brainstem response, ABR, by means of Bayesian inference. *Scand Audiol*, **14**, 89.

Elberling, C. and Don, M. 1987. Detection functions for the human auditory brainstem response. *Scand Audiol*, **16**, 89-92.

The Fsp screen will only be accessible when you select F_{sp} Average under Acquisition Type in the *Amplifiers* section (not available for *SynAmps Wireless*).



Listed below is an explanation of each of these parameters.

Terminate Method. Select one of the options below if you want to employ an F_{sp} termination method.

None. Data collection will continue until the specified number of sweeps has been collected.

F-value. It is possible to terminate data acquisition when the current F_{sp} value equals or exceeds a specified F value. The F value field sets the terminate criteria. A typical value for this field for the ABR is 3.1. The F criterion will terminate acquisition when the terminate method is set to **F Value** or **Both** on the designated channels.

Noise level. Data acquisition can also be terminated if the background noise is lower than a specified value. The noise value field sets the terminate criteria. A typical value for this field is 0.02µV. The noise criterion will terminate acquisition when the terminate method is set to **Noise Level** or **Both** on the designated channels.

Both. Acquisition will be terminated if either the F_{sp} or noise criteria are met.

Terminate Channel(s). The terminate channels fields allow you to specify which channels will be monitored for termination criteria:

All. Acquisition will terminate if any channel in the current montage reaches a criterion.

Selected. Acquisition will terminate on user selected channels. Channels are selected in the **Channel Attributes** section described above, or the **Individual Channel Settings** described below.

Parameters. The Parameters section lets you specify the following settings used in the Fsp analyses.

Single Point Positive [ms]. The point position value determines the location (in milliseconds) within the sample interval (Start to End ms) of the single-point

estimate of the background noise. Under normal circumstances, this value would be placed within the bounds of the window start and stop point (see below).

Window Start [ms]. The Window Start point determines the starting location (in milliseconds) of the response window. For the ABR a value of 2ms is typical.

Window Stop [ms]. The Window Stop point determines the ending location (in milliseconds) of the response window. For the ABR a value of 10ms is typical.

Sweeps per Block. The Sweeps per Block value determines the number of sweeps that is collected for the ongoing within-block average. For the ABR a value of 250 sweeps is typical.

FValue. Input the desired FValue that, when reached, will terminate acquisition. A typical value for the ABR is 3.1.

Noise Level [μV]. Input the desired noise level that, when reached, will terminate acquisition. A typical value for the ABR is 0.03μV.

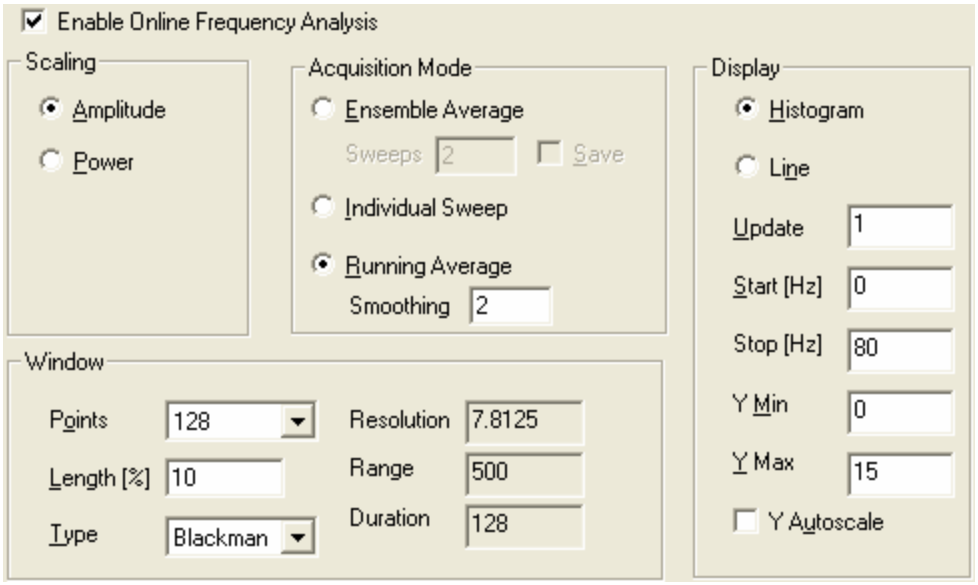
Display. These fields are used to set the scaling range in the F_{sp} data display. This information is saved as part of the *.avg* file.

FMax. The FMax sets the upper limit of the range on the F value display. A typical value is 20, although you may go lower for a more sensitive display.

Noise Max (μV). The Noise Max sets the upper limit of the Noise Level display. A typical value is 0.3μV.

2.2.1.8 Frequency

This option accesses the parameters for Online Frequency Analysis. The online frequency analyses will always be linked to the raw incoming data. You cannot, for example, do an online FFT of data undergoing online filtering.



Enable Online Analysis. Enable the option to activate the lower fields. You can use Online Frequency Analysis with any Acquisition Type.

Scaling. Scaling lets you select which of 2 options you would like for computation of the EEG power spectrum: **Amplitude** and **Power**. The amplitude option takes the square root of the power spectrum to express the units in microvolts. The power option computes a standard power spectrum with values expressed in microvolts squared.

Window*.* Windowing is employed to control spectral leakage.

Points. Points in the FFT must be a factor of two. Click in the field and select a number from the list. Note that the number of points you select is directly related to the frequency **Resolution**. The greater the number of points, the more precise the resolution.

Length (%) refers to the extent of the windowing taper. A typical value is 10%, specifying that the extent of the windowing occurs at the upper and lower 10% of the sweep **Duration**.

Type. Click in the Type field, and select the type of windowing you wish. Current options are Blackman, Cosine, Hamming, Hanning, Parzen, and Welch.

Resolution/Range/Duration. These are informational values. **Resolution** is the width of each frequency bin. The **Range** indicates the frequency range that is calculated and available for display, and is dependent on the number of points and digitization rate. **Duration** is equal to the number of points divided by the digitization rate (as described previously), and is the duration of the sweep used for the online FFT.

Acquisition Mode*.* The acquisition mode lets you determine how you want the FFT to be computed.

Acquisition Mode. There are three acquisition modes. Click in the field to toggle through the options.

Individual Sweep. If you select the Individual Sweep option, the FFT is calculated for every sweep. The remaining parameters are grayed out in Individual Sweep mode.

Ensemble Average. If you select Ensemble Average, the FFT is calculated across a series of sweeps. An ensemble spectral average is created using a series of processing steps. First, time domain EEG epochs are windowed and converted into the frequency domain using an FFT algorithm. Second, power spectral estimates are computed from the real and imaginary results of the FFT. Third, the power spectral estimates are averaged together. Ensemble averaging of spectra generally will improve the accuracy of the estimates of the EEG frequency assuming that the EEG spectrum is relatively stable and not in flux, as in the case of changes in wakefulness. For example, if the power spectrum is computed on a single sweep, the variability of the estimate will be equal to the estimate itself. Variability decreases proportionally to the number of sweeps in the average. The more

sweeps, the better the estimate of spectral composition. If your EEG is relatively stable over a series of discrete epochs, a valid method to estimate EEG frequency content is to average in the frequency domain. When you click Ensemble Average, note that 1) the **Sweeps** field becomes active, and 2) you will have the option to **Save Sweeps** as an AVG file. Enter the number of sweeps to be used in the ensemble average in the **Sweep** field, and enable or disable the **Save Sweeps** field, as desired.

Running Average. The Running Average mode allows you to perform an online smoothing operation with the FFT and online maps. ACQUIRE waits until the specified number of Spectra have been collected (the number in the **Smoothing** field), then it will sum the sweeps, and then average them. When a new sample (sweep) comes in, it replaces the oldest sample and then reaverages. It is essentially a running circular buffer or a moving spectral average. The Running Average is applied to online FFT spectra and maps. The Running Average affects the display only, and has no effect on the saved data.

Display. The display option area allows you to specify various parameters of the online EEG spectrum display.

Display Mode. The FFT display can be in a histogram (**Histogram**), or in linear form (**Line**).

Update. If you are using **Individual Sweeps** or **Running Average** mode (described below), enter the number of sweeps to be included in the Update field. During acquisition, the FFT display will be updated after the number of sweeps you enter.

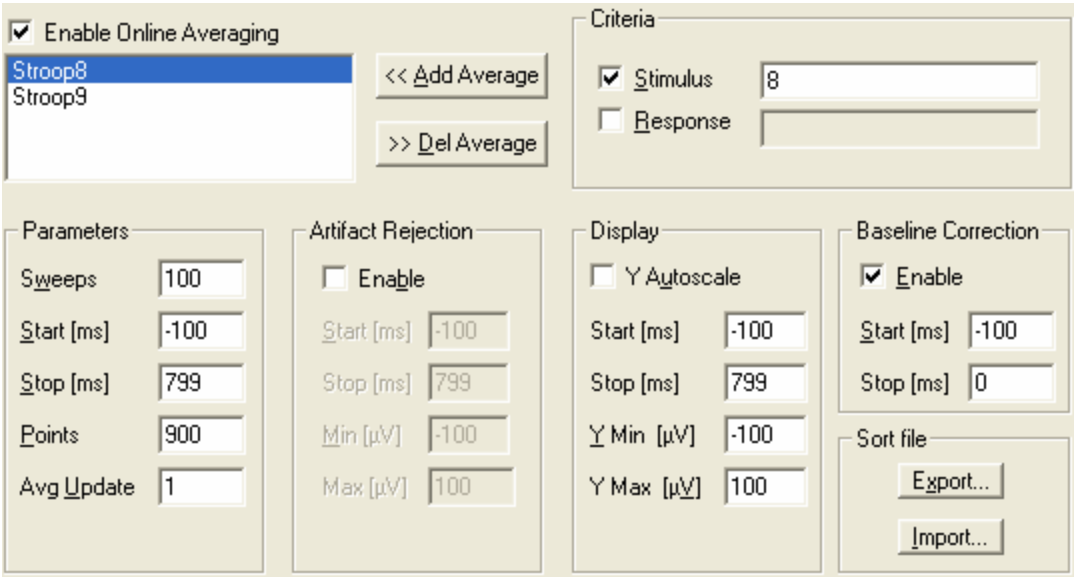
Start Hz / Stop Hz. Specify the frequency range that you would like to have displayed from the minimum (Start) to the maximum (Stop). The Stop value cannot exceed the **Range** value in the Window field above.

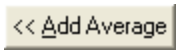
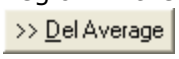
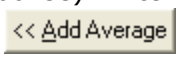
Y Min / Y Max. Select the y-axis range of values using the Y Min and Y Max fields.

Y Autoscale. When enabled, the program will perform automatic scaling along the y-axis, in which the Y Max value will be adjusted according to the maximum value present in each sweep.

2.2.1.9 Sorting

The sorting option allows you to perform Online Averaging (click Enable box to activate the page). You may create up to 10 different averages, in which you may sort by types of stimuli and of responses.



You must first specify the average files that will be created. Click  , and a Windows Save File utility will appear. Enter a file name - the *.avg* extension will be added automatically. You will see the file names being added to the region in the display. If you wish to remove a file name, highlight it and click the  button. You will likely have more than one sorted file. To set up multiple files, set all the criteria that you wish for the first file, including the *criteria* that you will be using for the sort (stimulus, response). Enter the type codes (explained below) for the first sorted file. Then click the  button to create the next file, and enter all of the information for it. Repeat this for each sorted file you wish to create. Click on the individual average files to review the settings for each file. Notice that in this process you can, for example, have two averages that are exactly the same except that one could have the Artifact Rejection option enabled, and the other average could include all sweeps. You can in this way see the effects of the various parameter settings on the same data file.

Stimulus Criteria. Enable this field if you will be sorting on the basis of stimulus type codes. The **Stimulus** field will become active. Enter the type code(s) of the stimuli.

You may sort on the basis of the Stimulus type codes. In a typical auditory P300 paradigm, let's say the FREQ tones all had type codes of 100, and the RARE tones had type codes of 200. One sorted average would be for the FREQ stimuli, coded as 100 in the Stimulus field, and the other sorted average would be for the RARE stimuli, coded as 200 in the Stimulus field. The convention for criteria fields is as follows. For non-sequential numbers, place a comma between the numbers, such as 1,5,9. For sequential numbers, place a hyphen between the first and last number in the range, such as 10-15. These may be combined in one line: 1,3,5-10,12-15,18,20. The averages will be based on these codes.

Response Criteria. Enable this field if you will be sorting on the basis of response type codes. The **Response** field will become active. Enter the type code(s) of the responses.

You may sort on the subject's responses using the Response codes sent by the STIM response pad, or other device for sending a compatible response type code. For example, if you want to compare responses with the first response pad button to responses with the second response pad button, create 2 sorted average files - one having a 1 in the Response field, and the other having a 2 in the Response field. You may specify stimuli using the conventions described in the Stimulus section above. (Response types from the STIM pad are 1, 2, 4, and 8).

Note

The Mouse and Response Pad responses from Stim^2 (software only version) are interpreted as stimulus responses (blue) in ACQUIRE. The Response option will not recognize these responses. However, the Stimulus option will, assuming the response type codes do not overlap with the stimulus type codes (e.g., it will not differentiate a stimulus type code of 1 from a response type code of 1).

Parameters, Artifact Rejection, Display and Baseline Correction These areas are the same as in the **Epochs** 36 section. The settings will affect the online averages only.

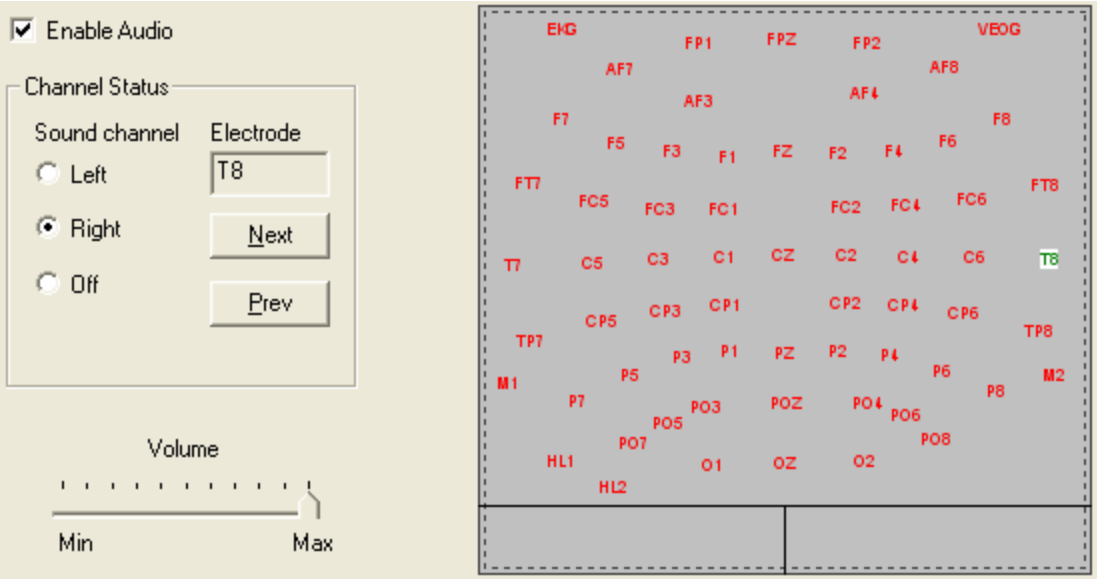
Sort file. The sorting parameters may be saved as a separate file that can be imported in other setup files.

Import Sort File. Sorting parameters can be saved to .srt files. You can therefore select different .srt files without recreating the setup file, or you may have different setup files that use the same .srt file. Use the Import Sort File field to retrieve an exiting .srt file.

Export Sort File. Once the sorting parameters are set, you can save them to a .srt file (.srt extension).

2.2.1.10 Audio

It is possible to use the audio portion of Windows to enhance data acquisition. For example, if you are acquiring EMG signals, you can hear the EMG amplitude through your PC's audio system. (*Hint: to do this most effectively, use the online filtering feature to reduce all activity other than the EMG potentials*). To use this feature, you must have DirectX installed (supplied with the SCAN 4.5 CD), and a sound board in your PC.



Select whether the sounds are to be played on the left, right or neither speaker *for each EEG channel to be monitored*. You may select a single channel for audio presentation by clicking on *Next* or *Previous*. until you see the desired channel in the Electrode window, then select either the *Left* or *Right* speaker. Alternatively, you may select the channel, or combination of channels, from the montage display. Double-click on the label to change the state of the desired channel(s). If desired, you may drag a rectangle around a group of electrodes. Use the sliding Volume control to set the volume level.

The default state is for all channels to be *Off*. When you click a channel *On* (double click on the channel), the default speaker is the *Right* one. As you step through the recording channels you can select which combinations you want for the *Left*, *Right* or neither (*Off*) speakers.

2.2.1.11 Mapping

The Mapping display sets the parameters for online mapping of EEG or EP data. You may use *.map* files that were supplied with SCAN, or created with MAPGEN. Online mapping of EEG data is linked with the online **Spectral Display**, and uses the same update settings. You may show up to 5 maps at a time. The following parameters are set for each map (and will vary with the A/D rate and Points):

Label. Enter a label for the map you have enabled, or use the default ones.

Minimum. For Minimum, enter the lower scale value for the display, or use the default settings (for frequency domain mapping this would typically be 0).

Maximum. For Maximum, enter the higher scale value for the display, or use the default settings (for typical EP recordings, the Minimum and Maximum might be -15 and 15, respectively).

Domain. This field allows you to select between Time and Frequency domain mapping (time domain is used with EP recordings, where you are analyzing voltage changes across the epoch; frequency domain is used primarily with EEG recordings, where you are analyzing voltages at various frequencies). Time domain is used with Average and Fsp Average acquisition modes only, or when using a Sorted average. See also the *Stop* section just below.

Start. The Start and Stop fields allow you to specify the frequency limits for Frequency domain recordings, or you can use the default settings. Enter the starting frequency point (Hz). If you enter an integer, the program will automatically enter the value corresponding to the nearest actual data point. With time domain mapping, the Start value should always be set to zero.

Stop. Enter the stop frequency point (Hz). The actual values of the Start and Stop frequencies will depend on the digitization rate and number of points. If you enter a Stop value of 8.0, for example, the calculations will use the nearest actual frequency bin boundary.

With Time domain mapping, the value that is entered into the Stop field is an integer, such as 1, 2, etc. This number designates how frequently the maps will be displayed. For example, entering a "1" will result in a new map being constructed and displayed at every data point; entering a "2" will result in maps at every other data point.

LDR Filename. You may display online maps for combinations of channels you create with linear derivation files. On the **Startup** page, you may designate up to two *.ldr* files (one for each Single Window Display). Click on the **LDR Filename** field, and an Open File utility will appear allowing you to select an LDR file that you have created.

Map Filename. You can display the maps using any of the orientations you have created in Mapgen. Click on the **Map Filename** field, and an Open File utility will appear, allowing you to select a map file (*.map* extension). If you are mapping *.ldr* data, remember to create a *.map* file that corresponds to the number of channels and new labels in the derived file. *Note: as of the time of this writing, it is essential that there be exact agreement between the labels in the .*map *file and in the ACQUIRE setup file. This means the case must agree (Cz will not work with CZ), and be sure there are no spurious spaces or other characters.*

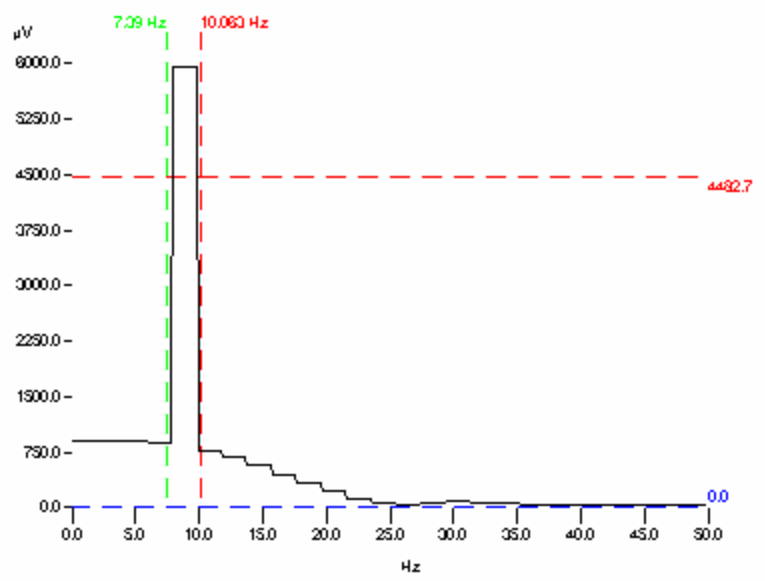
Data Source. You may link the map to any of several files, including the RAW data, as well as the sorted averages. You must use Time domain in order to select one of the Sorted average files for the source. Click on the down arrow to see what data files are available for mapping. You need to be in **Average** acquisition

mode, or have sorted averages listed and enabled in the **Sorting** section, prior to entering the settings in the **Mapping** section.

Video. Enable the video and select the map you want to use with the overlay in the video display. To use this option you must have installed a video camera on your PC. The complete video functioning is described below in the Toolbar icon section under the **Video** 94 related icons  .

When you are using the online mapping feature, you will see that as soon as you click a scaling arrow, highlight a display, etc., the Active Map display will appear. This will have buttons available for each map that you have selected for display (Delta, Theta, etc.). (You must have at least two online maps for the Active Map display to appear).

To understand the function of the Active Map buttons, you should first enlarge one of the channels in the Spectral Data display to full size. You will see in addition to the power spectrum display two vertical dashed lines and two horizontal dashed lines.

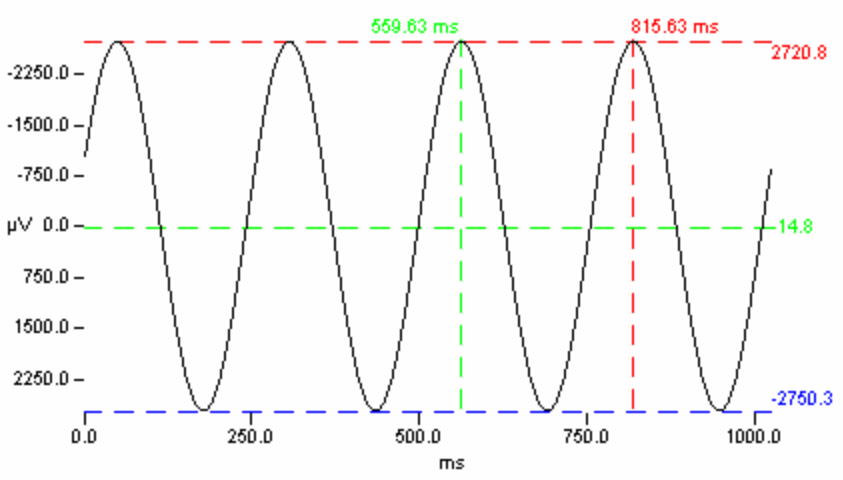


You can move the lines by grabbing them with the left mouse button, and dragging them to a new position. If you position the mouse between the two vertical lines, and above the upper horizontal line, you may drag both vertical lines at the same time, thereby preserving the frequency interval between them. With a power spectrum display, the lower horizontal line must remain at zero.

The two vertical lines define the frequency band width that will be mapped. These settings override the ones you made in the **Mapping** section described above. By clicking one of the active buttons on the Active Map display, you can direct the frequency band defined by the two vertical lines to the map display of you choice. For example, if you set the vertical lines as shown above, and click the Alpha button on the Active Map display, the Alpha map will display that frequency range. The frequencies shown below the map will change accordingly, and "(Alpha)" will appear to the side of the Spectral Data title, letting you know which map has the "focus" for the selected frequency range.

By moving the horizontal line up and down (grab and drag with the left mouse button), you can vary the scale on the map the has the "focus" for the new frequency range.

Time domain file mapping. If you selected **Average** under **Data Source** in the **Mapping** section, the map will be linked to the average data file (a time domain file). You should be saving the data to see this function. The operation is basically the same as for Frequency domain mapping. The difference is that you will be mapping the average of the data points within the window you set. An enlarged display of one of the channels in the online average might appear similar to the following.

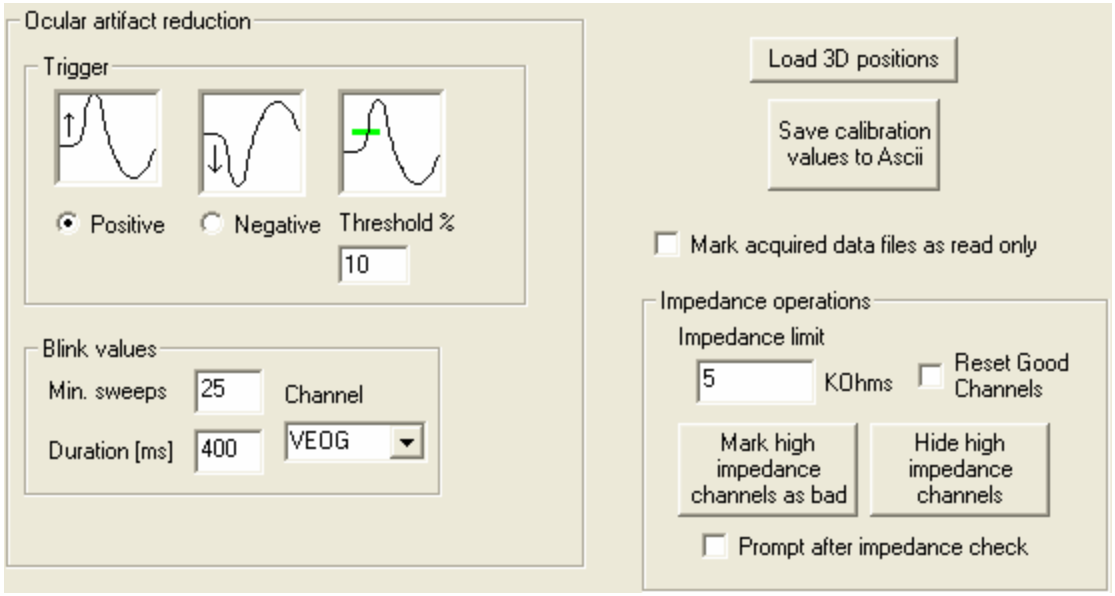


In this example we used a signal generator to send a sine wave to all channels. The map will display the average of the points within the span of the vertical lines. As above, you can direct the new mapping parameters to any of the online maps by clicking one of the buttons on the Active Map display.

The horizontal lines are used to set the scaling values for the map. Set the red and blue lines to the upper and lower limits of the scale, and the green line will be positioned automatically at the midpoint between them. In the above example, the map was all white (zero voltages), as the positive and negative values averaged each other to zero.

2.2.1.12 Miscellaneous

Several additional options are accessed from the Miscellaneous section.



Ocular artifact reduction. These fields allow you to enter the ocular artifact reduction parameters that will be used when you apply the transform in EDIT; they have no effect online during acquisition. The parameters you set in an ACQUIRE setup file will be saved with data files, and will be present in EDIT (so you will not have to enter them in EDIT). See the Ocular Artifact Reduction description in the EDIT manual for more complete details about the parameters.

Trigger. Select **Positive** if you will be using values greater than the Threshold. Select **Negative** if you will be using values less than the Threshold.

Threshold. Enter the Threshold percentage you will be using.

Blink Min Sweeps. Enter the minimum number of sweeps that must be detected.

Blink Duration (ms). Enter the Duration of the averaged blink artifact.

Blink Channel. Select the artifact channel from the list.

Load 3D positions. The 

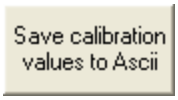
button displays the standard Open File utility for selecting a 3DD file from 3DSpaceDx that contains the digitized electrode

and PAN positions. The 3DD file must agree with the electrode labels in the ACQUIRE setup file (typically, the ACQUIRE setup file will be used in 3DSpaceDx when the electrodes are digitized).

 **Care**

Be careful using this option! The 3DD file that you load should be from the same subject whose EEG you are recording. If you save the setup file, the 3DD file will become part of the setup file in ACQUIRE. The position data will therefore be included with ANY subject's recordings obtained with the setup file, which will of course result in incorrect position data for those subjects. The option is intended for occasions where you are recording several EEG files from the SAME subject, having a single 3DD file. It is also possible to load the 3DD position data in EDIT, as well as in SOURCE and CURRY, if you are unsure whether you want to add the file in ACQUIRE.

Save calibration values to ASCII. Use this button to save the Calibration values to an ASCII text file (used with *SynAmps*). Clicking the button opens the standard Save As utility window. Use it to select a path and to enter a file name (DAT extension added automatically). The calibration values will be stored in this file (and may be reviewed with a text editor).



Mark Read Only. When enabled, this option will automatically mark the acquired data files as "Read Only" files, thus preventing any unintentional modifications in EDIT. To unmark the data files, locate the file using the Windows Explorer. *Right click* on it and go to Properties. Deselect *Read Only* in the *Attributes* section.

Impedance Operations. These options have to do with Impedance operations.

Impedance Limit. The Impedance Limit is associated with the **Mark Bad** and **Hide Channels** options. When the obtained impedance for a channel exceeds the Impedance Limit, the channel will be marked as Bad or will be Hidden, depending upon which option was enabled. You may select either option, but not both.

Reset Good Channels. The Reset Good Channels option, when enabled, is used to reset any previous Bad or Hide channels to normal channels (when impedances are subsequently retested).

Mark Bad and **Hide Channels**. These options are used to automatically set channels as either "Bad" or "Hide" channels when the impedance level exceeds the threshold value you enter in the Impedance limit field. This is particularly useful in 128 or 256 channel recordings where it is not unusual to have a few channels with high impedances. The buttons 

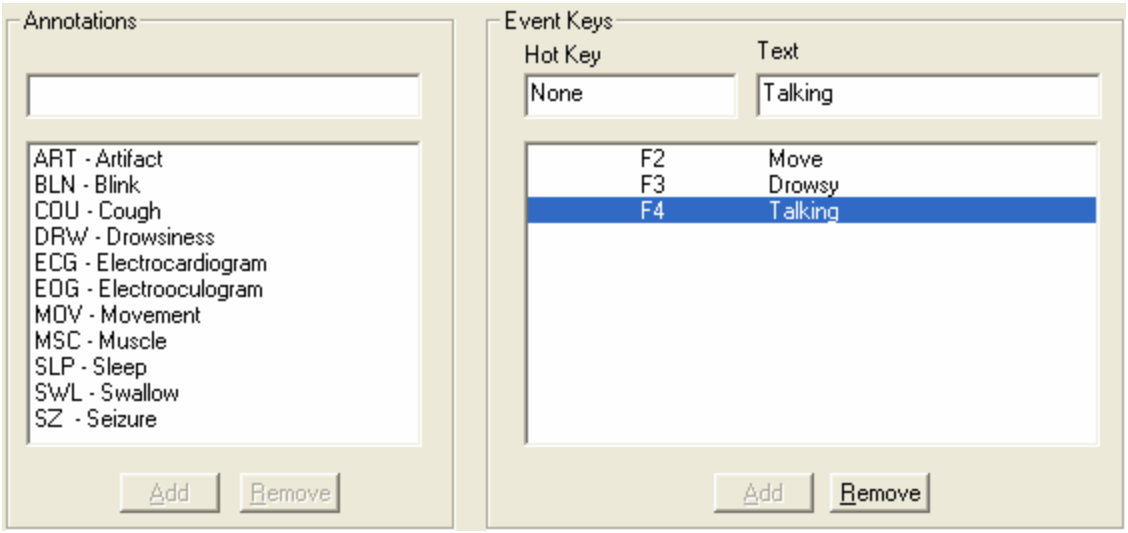
and 

, when clicked, will set the high impedance channels as Bad channels, which will exclude them from many of the offline analyses in EDIT, OR as Hide channels, which will hide those channels from the display (the data are still recorded).

Prompt after Check. This option, when enabled, will prompt you to use the other options after performing an impedance check.

2.2.1.13 Events

These fields allow you to enter various comments into continuous files during acquisition. These comments may be viewed when you replay the data file in EDIT.



There are two ways you can insert comments in the continuous file - Annotations and Event Keys.

Annotations. Enter a text string in the Annotations field and click the Add button. When you click the Annotation icon A from the Toolbar, you can select the line that you wish to add. If you want to remove a line from the Annotations list, highlight it and click Remove.

You can insert text "on the fly" during acquisition by clicking the Annotation icon A and then entering any text you wish. The comment will appear at the point where you clicked the icon (you must be saving the data for the Annotation icon to be active).

Event Keys. The Function keys from F2 through F11 have been set with the comments seen in the Events window. These can be changed, or used as they are. During acquisition, just press the function key for the comment to be inserted. To change one of these default comments, highlight the key you want to change, then click the Remove button. Place the cursor in the Hot Key field, and press the Function key. Then enter whatever comment you wish in the Text field, and press Add. To add new keys, place the cursor in the Hot Key field, and press the key. Enter the text comments and click Add - you will get an error message if the key is already being used for another purpose.

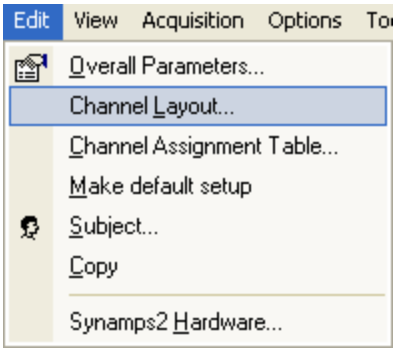
2.2.1.14 Blink Reduction

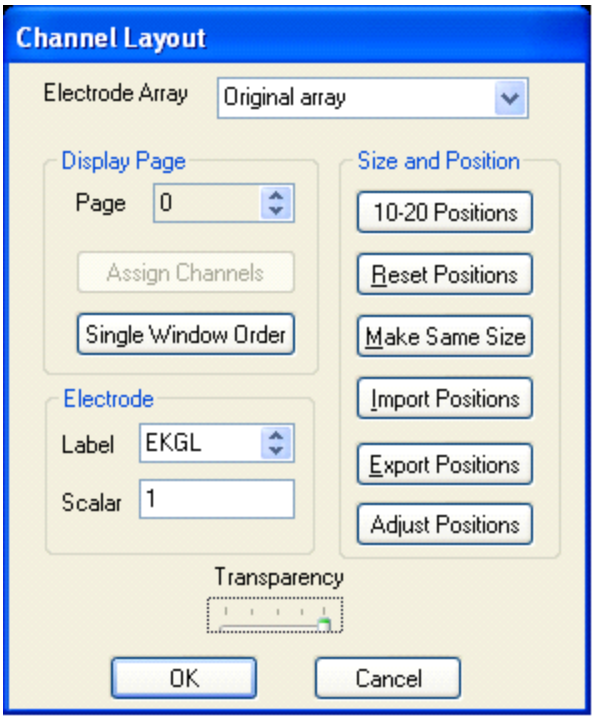
The Blink Reduction computation is similar to the offline Ocular Artifact Reduction transform. One difference is that online Blink Reduction uses a rolling average of N sweeps, where N is the number entered for Averages. Based on those sweeps, an internal LDR file is computed and applied to all channels except the trigger channel (the coefficient is 1.0 for the trigger channel, therefore the corrected channel would be a flat line), and any Skipped channels. Linear transmission coefficients are computed, and there is a point-by-point proportional subtraction, based on the averaged artifact in the trigger channel. Note: the data are buffered in the correction process, so you may notice a slight delay (about 40ms). The online transform functions basically the same way that the offline Ocular Artifact Reduction transform works (see that section in the EDIT manual for more details). Unlike the offline Ocular Artifact Reduction transform, the online Blink Reduction routine lets you reject sweeps using Artifact Rejection criteria.

The Blink Reduction transform is part of the Toolbox add-in software, and requires a Toolbox license (your dongle must be programmed for the Toolbox to access the option). Contact sales@neuroscan.com or techsup@neuroscan.com if you want to purchase the Toolbox. The operation of the Blink reduction transform (online and offline) is described in the Toolbox manual.

2.2.2 Channel Layout

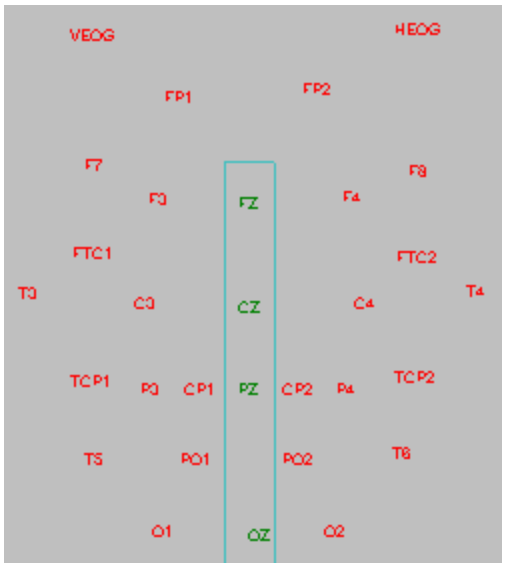
Selecting this option brings up the Channel Layout dialog screen, as well as the individual electrode displays. If you retrieved an existing setup file, such as *Quik-Cap32.ast*, the displays will appear in a layout that approximates the cap electrode placements. If you created the setup file using the **Make Default Setup** option, the displays will appear in a matrix form. The following features are seen in the Channel Layout display.





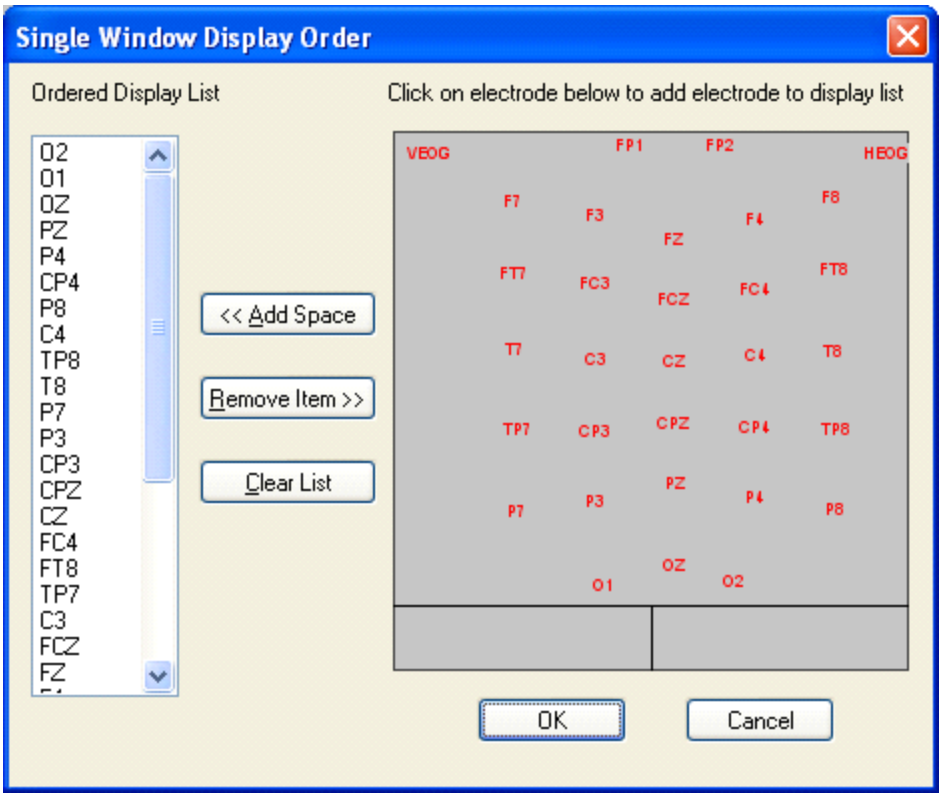
Electrode Array. This feature allows you to select the Original array, or up to 3 arrays created with *.ldr* files, assuming these have already been selected on the **Startup** section under **Overall Parameters**. By highlighting an *.ldr* array from the pull-down list, you may alter the size and positions its electrode channel windows.

Display Page. The Display Page feature allows you to assign electrode channels to additional screen display pages. To do this, click the up arrow button at the end of the **Page** field. The field will display a 1 and the Assign Channels button will become active. The screen behind the *Channel Layout* screen will be empty. Click the **Assign Channels** button, and see the Channels in Page 1 display. Double click on the individual electrode labels (so they turn green), to add them to the first additional display page, and/or use the Select All and Deselect All buttons. You can also drag a rectangle around a group of channels to select the group.



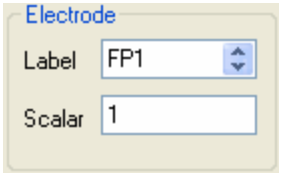
Click OK when you are through, and you will see the selected electrode displays. Size and position them as desired. Through this process you can assign electrodes to any display page you wish. You may assign the same channel to more than one display page (for example, you might want the artifact channel to appear on each display page). Use the down arrow button to get back to the original display page. Click OK when you are through, and be sure to resave your setup file if you wish to retain the changes you have made. *Note: if you have applied an LDR file to the online display, the additional display pages will be disabled.*

Single Window Order. This option allows you to reorder the sequence of channels on the CNT file display. (The same feature may be selected from the *Channel Order* option that appears when you click the *right mouse* button on a CNT file). Clicking it displays the following screen.



The current order of channels is in the left side column. To remove a channel from the list, just highlight it and click the Remove Item >> button. *Note: this removes the channel from the list, not from the display. There will always be the same number of channels displayed; this option will only alter the order.* To reorder the display completely, click the Clear List button. Then click the channel labels in the montage display in the order that you want them to appear. As you rebuild the list, you might want to separate the channels with spaces. Click the << Add Space to leave a space between the channels as you select them. If you omit some channels, they will be added at the bottom of the Single Window Display. Click OK when you are through to see the new ordering. To save the CNT file with the new order, click Save As under File. You will then have the option of either overwriting the existing file, or creating a new one.

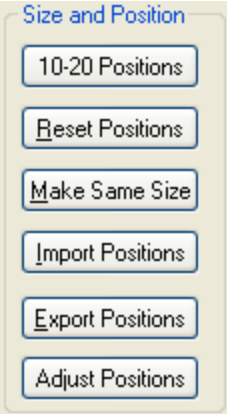
Electrode. Notice first in the background screen, with all of the labeled electrode boxes, that you can *select* one by clicking on the darker bar at the top of the box (turns box a highlighted color). The label in the **Label** field will show the highlighted electrode.



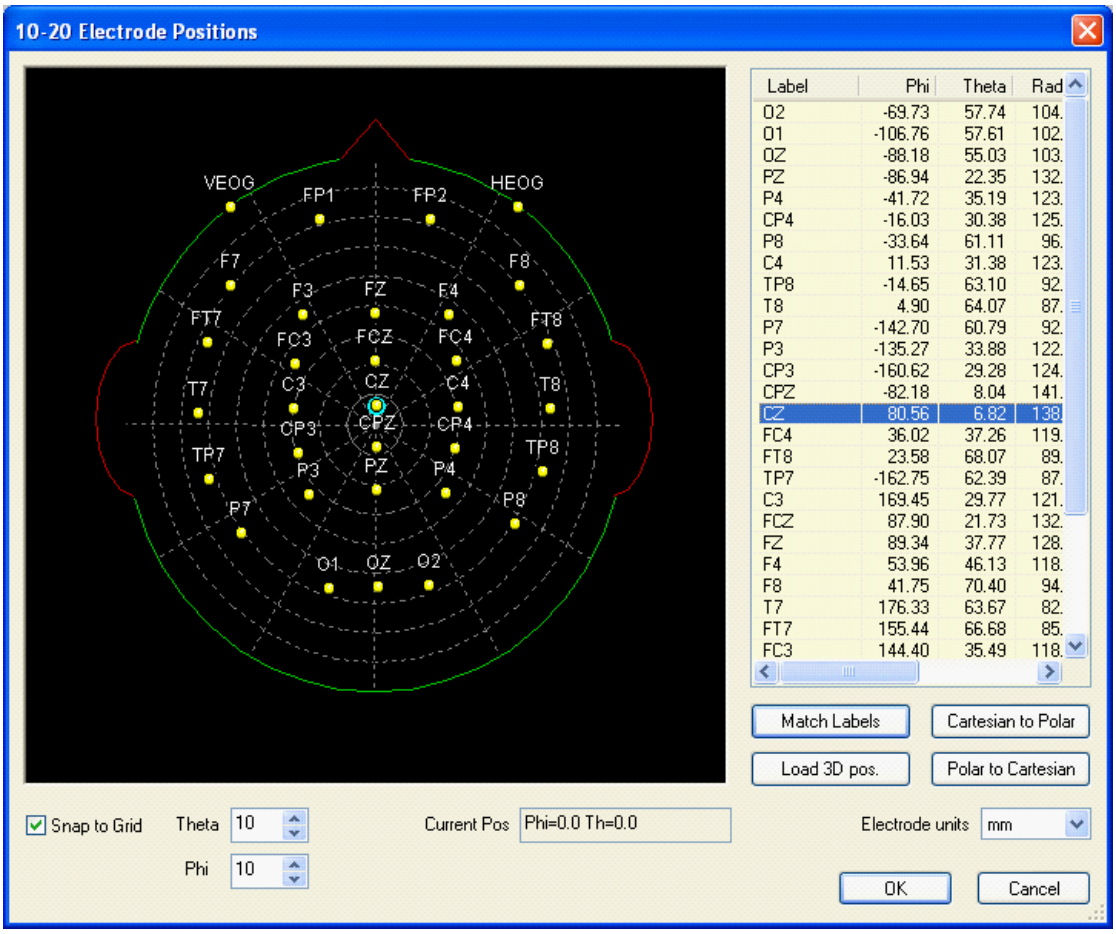
You can Rename the electrode by overtyping the label. You can select an

electrode display either by clicking on the display itself (on the label bar at the top of the display), or by using the up and down arrow buttons at the end of the label field. The **Scalar** feature allows you to alter the display scaling factor for individual channels - the channel that is displayed in the Label field is the one that you are setting. For example, you might want the display scale for the VEOG channel to be different from the other EEG channels. In that instance, set the VEOG scalar to 0.5, while leaving the other channels with a scalar of 1. The scalar multiplies the global scale factor you have set during acquisition. For example, if the global scale factor is 2 (the number displayed on the **Status Bar** and affected by the **Up** and **Down** arrows on the Toolbar), and the scalar value is 2, then the display will be multiplied by a factor of 4. The scalar setting affects the screen display only, and has no effect on the stored data.

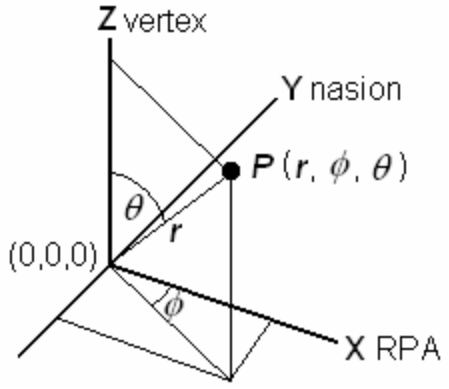
Size and Position. The Size and Position buttons are used to position the electrodes displays automatically, resize the displays, and import/export electrode position files.



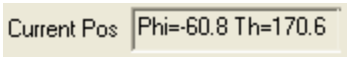
10-20 Positions. This button is used to position the electrode displays automatically according to the 10-20 system, or from electrode position information contained in the 3DD file created in 3DSpaceDx when the electrode positions were digitized.



Two electrode positioning systems are supported: Cartesian and Polar. The Cartesian positioning system is the X,Y, and Z coordinate system, where the x-axis runs from the left ear (negative) to the right ear (positive), the y-axis runs from the nasion (positive) through the inion (negative), and the z-axis runs from the vertex (positive) though the intersection of the x- and y-axes, to points below (negative). The 0,0,0 point is the intersection of all three axes, in the center of the head.



The Spherical Polar Coordinate system uses Phi, Theta and Radius values to express the 3D location of the electrodes. The Phi and Theta values can be

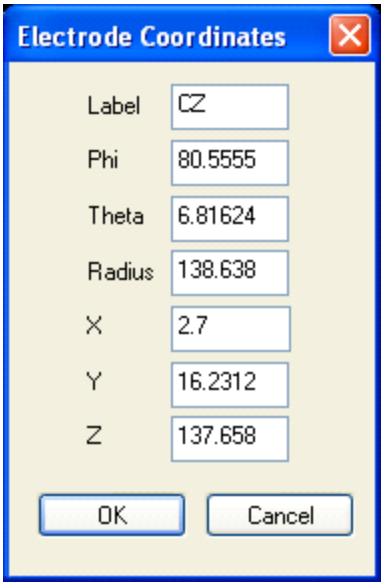
read in the lower part of the display 

. Theta and Phi are angles, expressed in degrees. **Theta** is the number of degrees away from the Z axis (in any direction). **Phi** is the number of degrees away from the X axis, where positive degrees are in the counterclockwise direction, and negative degrees are in the clockwise direction. **Radius** is a fixed value for each electrode, derived from group averaged MRI data (unless you load the 3DD file for the subject). The two angles and the distance are used to describe any point in three dimensions.

The same electrode position can therefore be expressed in X, Y, and Z coordinates or in Phi, Theta and Radius values. All six values for a given electrode are shown in the table on the right side of the display.

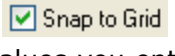
Label	Phi	Theta	Radius	X	Y	Z
FZ	89.34	37.77	128.13	0.90	78.48	101.27
CZ	0.00	1.11	138.92	-0.00	16.00	138.00
PZ	-86.94	22.35	132.91	2.70	-50.47	122.93

Double-click on one of the electrodes to see the Electrode Coordinates display.

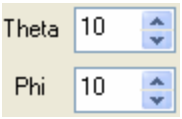


From this screen you may edit the electrode label, and modify the Polar and Cartesian coordinates manually, if desired. Click OK to apply the changes. (If you change the Polar coordinates, click the 

button to modify the Cartesian coordinates automatically, and vice versa).

Electrodes can be repositioned manually on the display. You can place them at any point, or you can have them "snap" to defined positions. The latter option is enabled with the 

field. You can control the sensitivity of the "snapping" by the values you enter in the Theta and Phi fields.



Valid entries for these fields are from .01 to 10 degrees. When theta is set to 10, for example, the moving electrode will snap from one position to the next in discrete 10 degree steps. Similarly, when phi is set for 10, the moving electrode will snap from one position to the next in discrete 10 degree steps. If the "Snap to grid" field is not checked, you can place the electrode at any position.

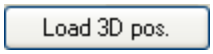
The 

field allows you to change the unit of measurement to mm's, cm's, m's, or inches.

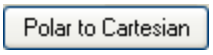
The remaining options on the display are as follows.

The 

button is used to position the electrodes according to the 10-20 placement system. This assumes you are using conventional electrode labels. The program recognizes the labels and positions the electrodes accordingly. This feature is particularly useful when you are creating setup files from scratch (such as, after clicking Make Default Setup), or in any circumstance in which the electrode positions are not there (such as when you import data files with no position information). The new positions will be transferred to the Channel Layout display when you click OK.

The 

button allows you to retrieve and apply position information obtained from a 3DD file created in 3DSpaceDx. This will allow you to reposition the electrodes in cases where the labels are not from, or extend beyond (as with 128 or 256 channel data files), the 10-20 system labels. The electrodes will be positioned according to their locations when they were digitized. Retrieve the 3DD file and click OK to transfer the position information.

Lastly, when you manually reposition an electrode, you may see the Polar coordinates change, but not the Cartesian coordinates. Click the 

button to compute the Cartesian coordinates automatically. The 

button will do the converse.

Reset Positions / Make Same Size. When one of the electrode channel boxes is highlighted, you may increase its size by clicking on the display area. It will change from SMALL to LARGE (or vice versa). The Small size is the size that the display will have by default. The Large size, is the size it will be, during acquisition or review, when you click inside the display once to enlarge it to the intermediary size (double click it to go to full size). Or, you can click and drag a corner of an electrode display to a new size of your choice. If you want

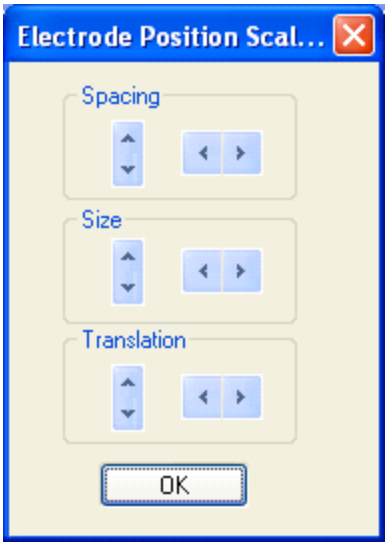
all of the boxes to be the size of the one you have just set, click *Make Same Size* and all boxes will be set to the size of the one that is highlighted. You may also reposition the displays by dragging them from the top label bar on each display. Clicking on the *Reset Positions* button to return the boxes to their original orientation and size. *Note: if you selected more than 32 channels under* Amplifiers *above, and yet only the first 32 are displayed, click Reset Positions to see all the channels*. The positions you set will be reflected in the Multiple Windows Displays during acquisition. You can, for example, position the boxes to approximate the 10-20 system, as shown below.

When you have successfully concluded the individual channel assignments, click on OK to enable the changes. Remember to SAVE the Setup file if you plan to use these settings repeatedly. Click on CANCEL to exit the individual setting options without making any changes to existing settings. *Note: You must click OK to save the position information before you click the Make Same Size button again. Otherwise, the new position information will be lost when you click Make Same Size, and the electrode displays will return to their original positions.*

Import and Export Positions. Note that there are two buttons used for importing and exporting electrode position information. This is the size and position information of the electrode displays for the Multiple Window Display. You can export the information from one data file, and then import it with a different (but matching in terms of number of channels and channel labels) data file.

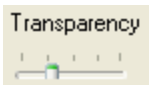
For example, if you have one complete setup file with the sizes and positions the way you want them, and second setup file with sizes and positions you don't like, you can apply the information from the first one to the second one. Retrieve the first setup file, and click the Export Positions button. Enter a file name and path (the .asc extension will be added automatically). Then exit the display, retrieve the second setup file, and return to the Channel Layout display. Click the Import Positions button, and retrieve the ASCII file that was created above. This will apply the size and position information from the first setup file to the second one.

Adjust Positions. The Adjust Positions option is used to reposition or resize the electrode displays automatically. Clicking the button displays the following screen.



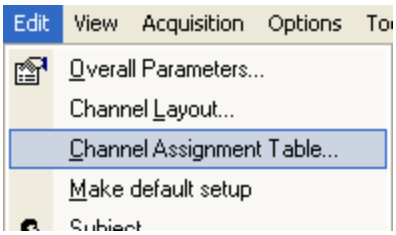
The three groups of adjustments are for Spacing, Size, and Translation. **Spacing** expands or compresses the grouping of the displays either vertically  , or horizontally  . Similarly, the **Size** buttons increase or decrease the size of the electrode displays either vertically or horizontally. The **Translation** buttons will shift the entire grouping of the displays vertically or horizontally.

Transparency. The Transparency setting allows you to see through the Channel Layout dialog screen. This is especially helpful when you have a large number of electrodes that may be hidden beneath the dialog. When you move the mouse over the Channel Layout screen, it will become opaque; move it off the screen and it will become transparent to the degree you set with the sliding bar.

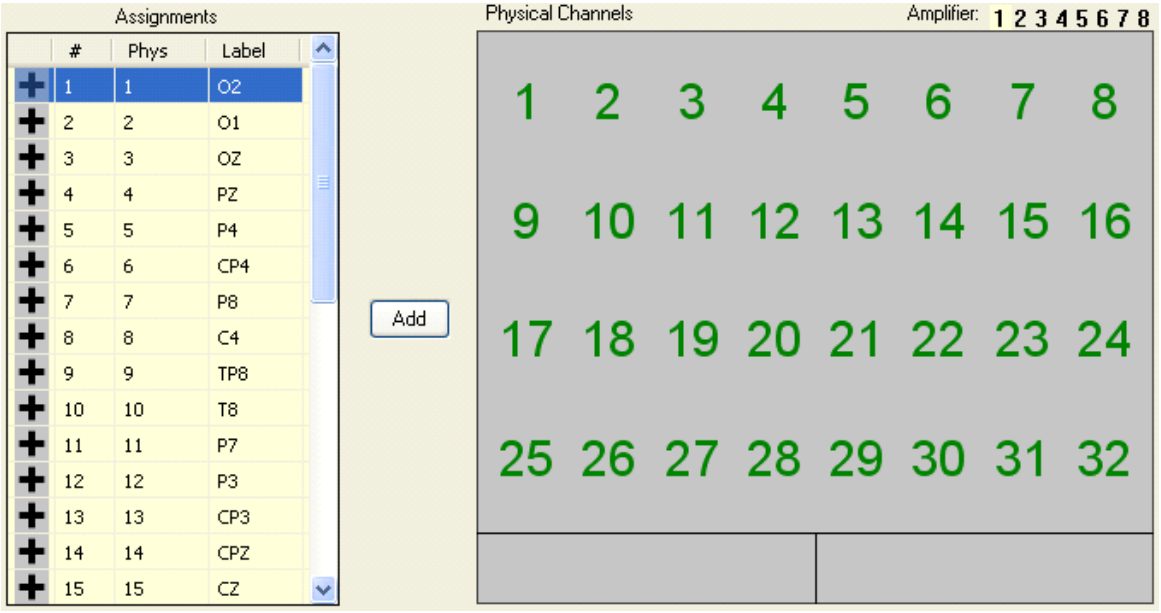


2.2.3 Channel Assignment Table

The Channel Assignment Table displays the Channel Assignment screen, consisting of the first bank of physical channels and their corresponding labels.



SCAN can be configured to operate with from 1 to 70 channels, and ESI can be configured from 1 to 256 channels (with *SynAmps*), in groups of 32 channels. Channels for the other amplifiers will be displayed similarly. Additional channel assignment screens will be accessible if more than 32 channels are selected in the **Amplifiers** section (under **Overall Parameters**), **Number of Channels** field. Electrode labels may be substituted for the default numbers by clicking on the label fields and inputting the desired electrode label from the keyboard. Electrode channel assignment can be remapped with *SynAmps* and *SynAmps*^{2} systems.



Channels are assigned to the lowest numbered inputs and are given the lowest channel assignments (one-to-one mapping). On *SynAmps* and *SynAmps*^{2} based systems, channels can be reassigned within a bank of 32 or 70 channels, respectively. For example, if you are recording 10 channels with a *SynAmps* - the first 8 physical channels and the 29th and 30th physical channels, enter 10 for the number of channels under Amplifiers, and relabel the Physical Channels 9 and 10, as 29 and 30, respectively. It is easiest if you make changes from the top and work your way down. You can do this by highlighting the line you want to change (

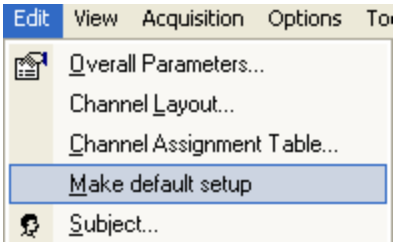
), and then double-clicking the 29 in the Physical

Channels display. This will change the Phys channel to 29. You can also click the 29 once, and click the Add button. Or, you can click the Phys. field of the channel for channel 9, enter 29, and then click the Label field to enter a new label. Note that whenever you change a physical channel to a new channel that is the number of an existing channel, the number of the existing channel will be replaced with the number of the new channel. That is, if you reassign channel 3 to 9, then channel 9 will become channel 3, thus the recommendation to start at the top and work down the channel assignment list. Click the Reset button to return the list to its original state. The procedure for *SynAmps*^{2}, *NuAmps*, and *SynAmps Wireless* is basically the same.

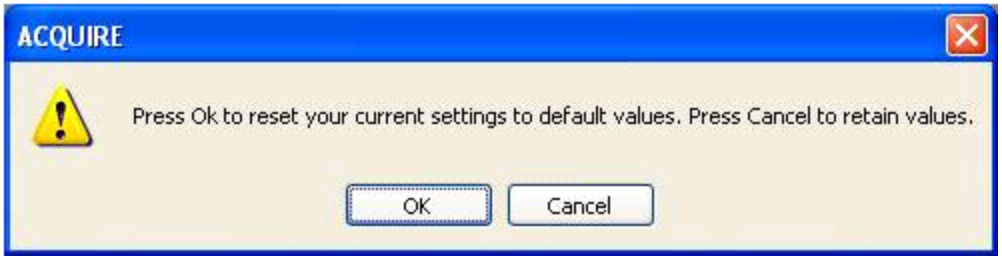
Click OK to apply any changes you have made, or Cancel to leave the screen without applying any changes. Remember to SAVE the setup file for future applications (use **Save Setup...** under **File**).

2.2.4 Make default setup

The **Make default setup** option replaces the settings in the current Setup file with those in the supplied default file.

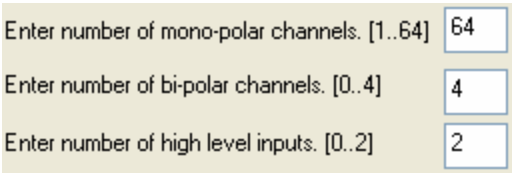


Click on the **Make default setup** line under **Edit** on the Main Menu bar, and you will get a warning saying that you are about to replace the current settings with the default ones.



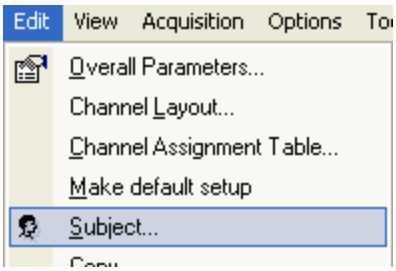
Click *OK* if you wish to proceed and *Cancel* to exit without making any changes. The option is useful if, for example, you have several errors in a setup file you are creating, and wish to recreate it from scratch. If you are trying to modify an existing setup file, and encounter difficulties making it function properly, try recreating the new setup file after selecting Make default setup.

If you have *SynAmps*^{2}, you will be asked to Enter number of amplifiers. [1..8] 1, and then you can select the number of monopolar, bipolar, and HLI channels you want to have.

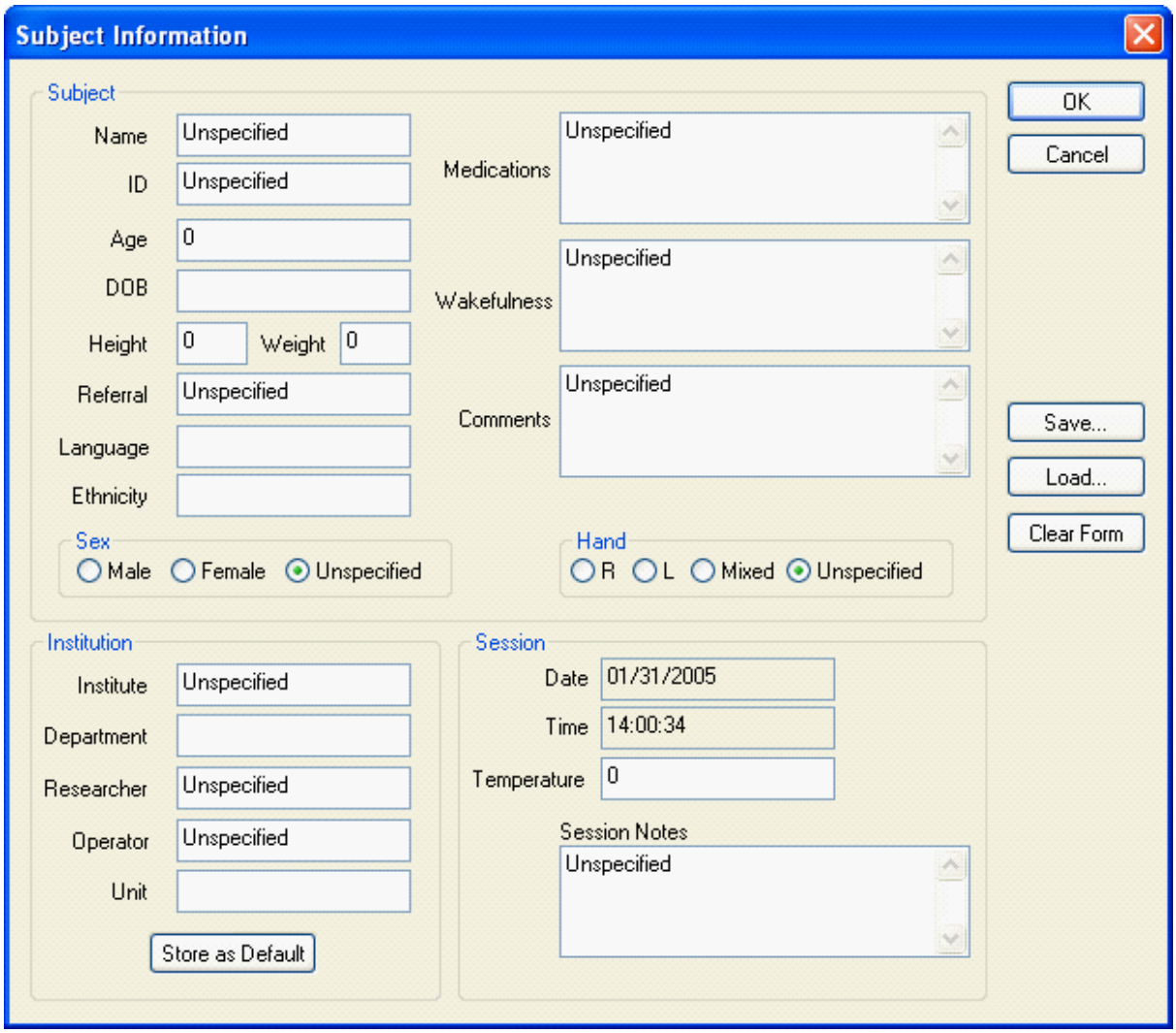


2.2.5 Subject

Clicking on **Subject** displays the Subject Information screen.



The top part of the screen displays Subject related fields in which you may enter the Name, ID number, and so forth. The text fields at the right allow you to enter free-flowing text to describe Medications, levels of Wakefulness, and other Comments. Sex and Handedness buttons are in the middle of the screen. At the bottom there are fields for Institution information and Session information. The Date and time fields are added automatically.

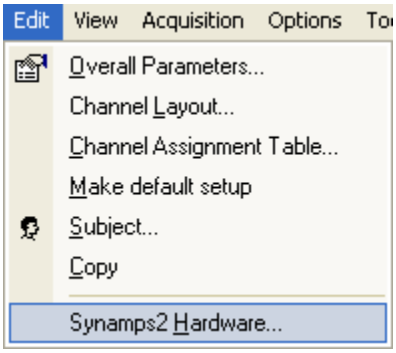


At the bottom left there is a Store as Default button that may be useful, for example, if you are obtaining multiple recordings over time from the same subject, or if there are many fields that contain the same information for all subjects.

When you have entered the information, click on the Save... button on the right, and a Windows Save File utility will appear. Give the file a name, and the *.sub* extension will be added automatically. The information that you save will be included in the header file, and will be accessible from the EDIT module. To recall a saved *.sub* file, click on the Load... button. An Open File utility will appear, allowing you to select the desired file. To cancel the information in the fields and prepare for new information to be entered, click on the Clear Form button. When you are finished, click **OK** to continue. Click **Cancel** to exit the dialog box.

2.2.6 SynAmps, SynAmps2, NuAmps, or SynAmps Wireless Hardware

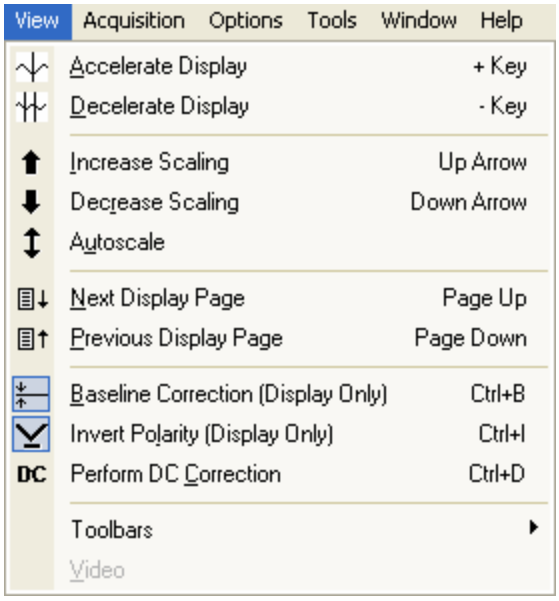
Depending upon which amplifiers you have installed, you will see a corresponding option in the **Edit** menu screen. If none of these options appear, and instead you see the Amplifier Simulator line, then you need to run the AMPINSTALL program.



If the appropriate option is present, click on it to enter, review, or edit the settings. See the **Amplifier Settings in the SW** 4 section above for details.

2.3 View

Display options during acquisition are controlled by commands listed in the menu under **View**, or, more easily, from the Toolbar located just beneath the Main Menu bar. The Toolbar is enabled by clicking **View** → **Toolbars** → **Main Toolbars**. The commands may be accessed with the mouse during acquisition. The following is a description of the actions of each command.



Accelerate Display (*single window display only*). The Accelerate Display option will increase the speed of the display (fewer number of seconds will be displayed on the screen). Pressing the button on the Toolbar will have the same effect.

Decelerate Display (*single window display only)*. The Decelerate Display option will slow down the screen (increased number of seconds displayed on the screen). This function may also be accessed from the Toolbar . You should see a decrease in spacings between the second indicators as you decrease the speed. See also the "Set seconds per page" option described under Accelerate Display.

Increase Scaling (*Single and Multiple Window and Frequency displays*). The Increase Scaling option will increase the scale of the amplitude in the selected screen display. The gain of the screen will increase by a power of 2 each time you press this key. This feature may be selected directly from the Toolbar . If you are displaying both the Single and Multiple Window Displays, you can select either screen by clicking the mouse on the gray horizontal bar at the top of the display. The scaling options will be applied to the active display. The screen amplitude affects only the display, not the data stored to disk.

Decrease Scaling (*Single and Multiple Window and Frequency displays*). The Decrease Scaling option will decrease the scale of the amplitude in the selected screen display. This feature may be selected directly from the Toolbar .

Autoscale (*Single and Multiple Window and Frequency displays*). The Autoscale function automatically sets the amplitude scaling to the largest and smallest voltages detected from any channel. This is the same as the button on the Toolbar.

Next Display Page. This option allows you to step through electrode display pages that are created in the **Channel Layout** section. Selecting this option, or the corresponding icon on the Toolbar , will cycle forward through the pages you have created.

Previous Display Page. Select this option, or the corresponding icon on the Toolbar , to cycle backward through display page. The Next and Previous Display Page options will be grayed out if you have not created additional display pages.

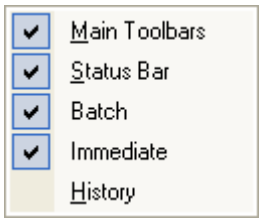
Baseline Correction (Display Only). The Baseline Correction option is used to center the baseline of waveforms graphically with their associated labels located on the left-hand side of the screen. This operation is performed each time the waveforms begin drawing from the left-hand side of the screen and has no effect on the actual data. The Baseline Correction option will toggle on and off each time you select the field, or select the corresponding icon from the Toolbar . Baseline Correction is particularly useful with DC recordings, in which the DC values will cause a large offset of the starting screen location.

Invert Polarity (Display only). The Invert option will invert the polarity of the signals in the display. This option is most easily accessed from the corresponding icon on the Toolbar . (The default setting is negative voltage up).

Perform DC Correction (*SynAmps* only). Performs single DC correction with each use to remove DC components (will center signals at the baseline). DC corrections can be performed manually by clicking the Toolbar icon DC, or automatically when you Enable the "DC Correction" option (see **AC/DC** 19 section below). When a DC correction occurs, you will see a DC' event marker at the bottom of the Single Window display (along with the stimulus and response events). The DC corrections will be stored in

the data file, and are treated as events in the file.

Toolbars. This option lets you enable/disable the display of the Main Toolbars, Batch controls, and Status Bar.

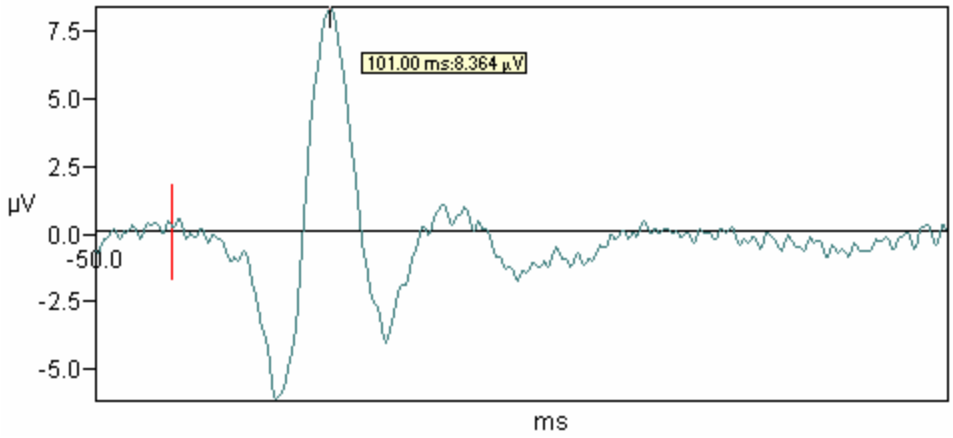


Main Toolbars. This is the row of icons at the top of the display, beneath the Main Menu bar. See the **Main Toolbars** 94 section below for details.

Status Bar. Enabling the option displays the Status Bar at the bottom of the screen. The Status Bar contains several informational fields. Brief explanations of the Toolbar options may be seen in the Status Bar by moving the mouse over the fields on the Toolbar (e.g., Auto Scale Display). To the right you will see additional fields. These will become active when you position the mouse on one of the electrode fields in the Multiple Window display or Averaged display. With the Single Window Display, the channel nearest the position of the mouse indicator will be shown. The Status Bar fields will then show the Display Page number, the Scaling factor (if any), the Electrode label, the time in ms, and the microvolt voltage corresponding to the mouse position.

If the Spectral Data option has been selected in the Start Acquisition dialog box, and the mouse is positioned in one of these electrode fields, you will see the corresponding Frequency (Hz) and µV values in the Status Bar displays.

With time domain Multiple Window Displays, you can see the time and voltage for each data point by positioning the mouse at the desired point. A Tooltip display will show the values.

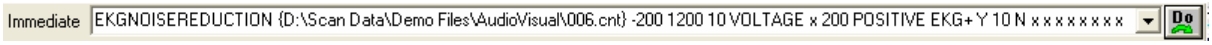


With CNT files, you may read the time point from the Status Bar field, and the

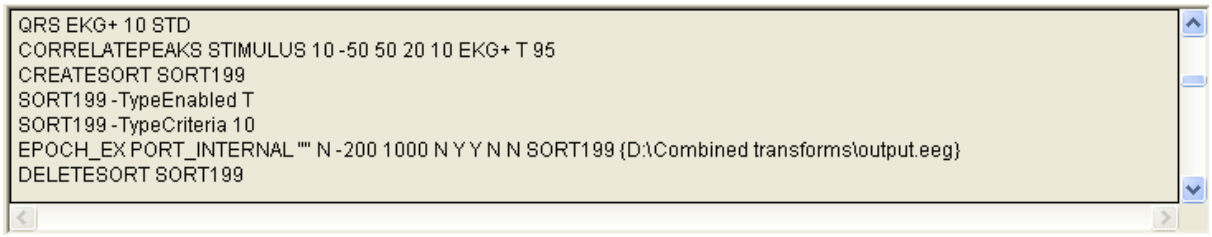
voltage for each channel and data point in the column on the right.

Batch. This displays the Batch toolbar, used to retrieve, create, edit, and execute batch files (refer to the Tcl Batch Manual for details).

Immediate. This displays the Immediate toolbar, which is used to execute a single batch command. The 10 most recent transforms are saved (click the pull-down arrow to access them). Click the Do button to execute the command (refer to the Tcl Batch Manual for details).



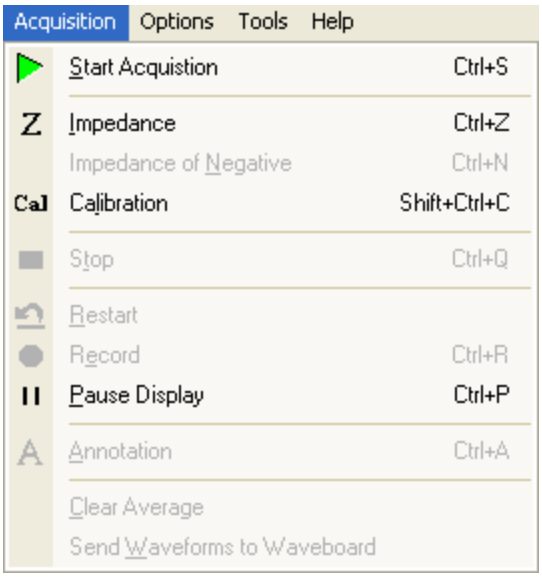
History. The History field saves a list off most operations that are performed (primarily used in EDIT for saving a history of the transforms that have been used). It is helpful for keeping a record of operations performed and for creating batch files that use the same series of operations (refer to the Tcl Batch Manual for more details).



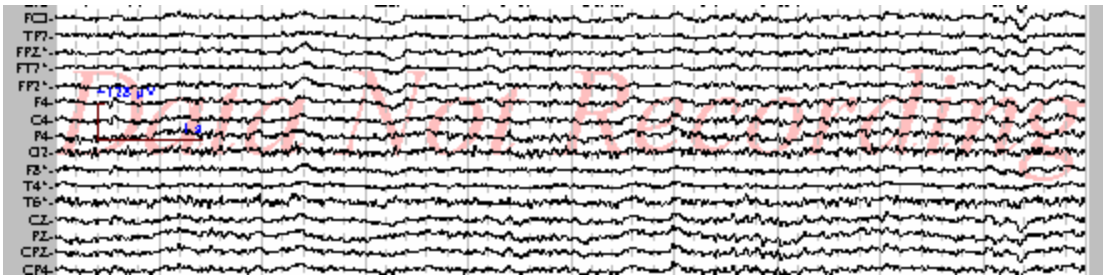
Video. This option will be active if you have a video camera installed. You will also see additional video control icons on the Toolbar. Details are found in the **Video** 94 section.

2.4 Acquisition

Clicking on Acquisition on the Main Menu bar activates a pull-down menu containing a variety of options. Different ones will be available depending upon where you are in the acquisition process. Most of them may be accessed more easily from the Toolbar icons, or from *right mouse* button menus.

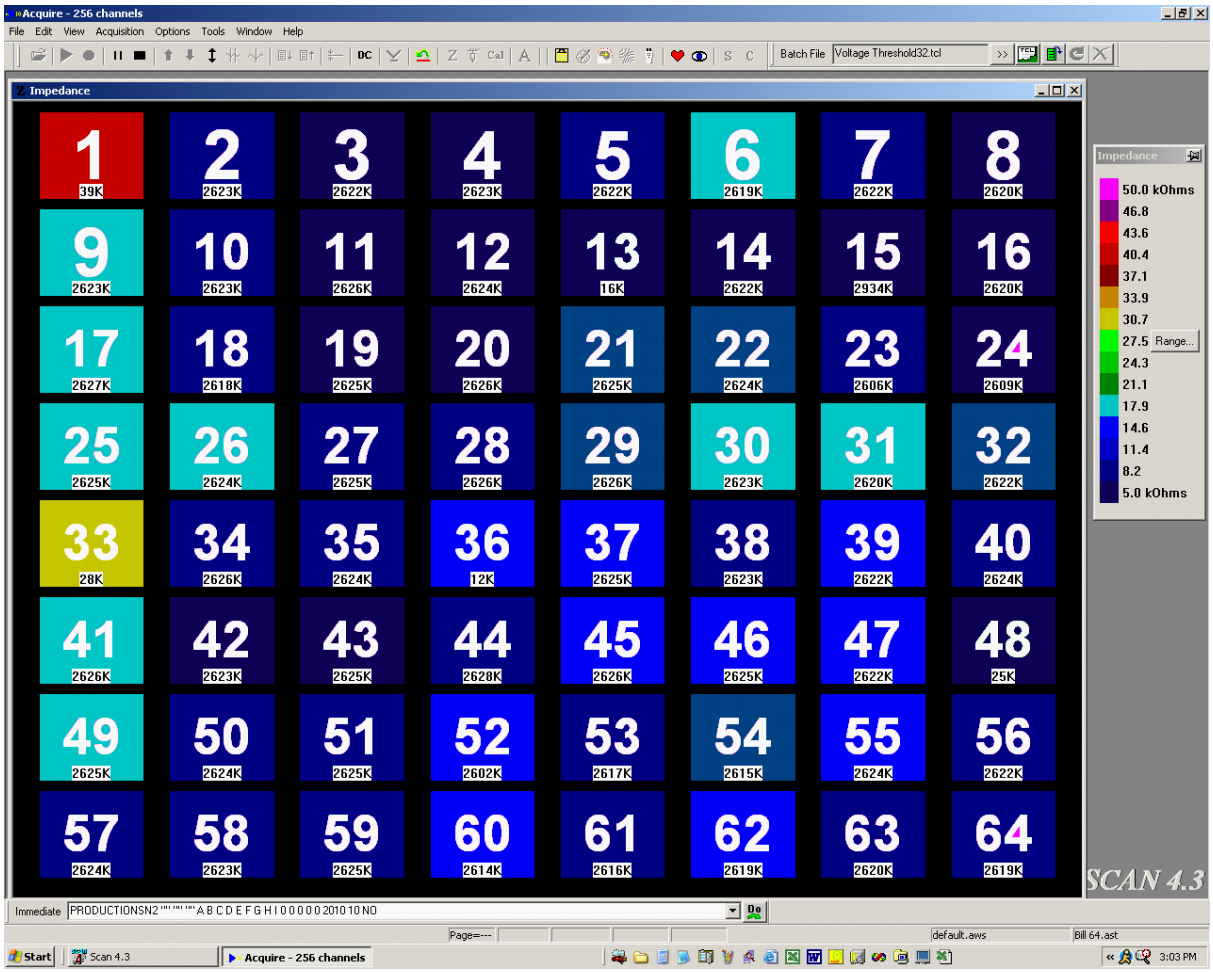


Start Acquisition. When you click on Start Acquisition (or click the green arrow on the left end of the Toolbar), you will see the acquisition Display window(s). When the acquisition display appears, you will see a message saying:



This is just a reminder; it will disappear when you begin data storage.

Impedance. Electrode impedance may be measured via the Impedance command under the Acquisition menu as the electrodes are applied, or between recordings to verify acceptable resistance levels. Clicking on this option, or going directly from the Toolbar icon Z, displays the Impedance screen, which consists of numbered or labeled color boxes corresponding to each channel.



Also displayed is a color scale calibrated in kOhms. Note that the range of the scale may be varied by clicking on Range and entering the Threshold and Maximum kOhm values. Typically the impedance screen is displayed throughout the electrode application, initially with a wide range on the color scale (e.g., Maximum value of 50kOhms). As the impedances drop down, you might wish to use a more sensitive scale (e.g., 0 to 10kOhms) to verify that all impedances are uniformly low (e.g., at or below 5kOhms). Setting the Minimum value to 5kOhms will result in the appearance of a black square when the impedance drops below 5kOhms. You might wish to check the impedances periodically between acquisitions to verify that the resistances are still low and comparable across channels.

You also have the option to mark as Bad or Hide any channels where the impedance exceeds a threshold you set. Go to the **Miscellaneous** display (under **Overall Parameters**) to see these Impedance selections.

Impedance operations. These options will automatically set channels as either "Bad" or "Hide" channels when the impedance level exceeds the threshold value you enter in the Impedance limit field. This is particularly useful in 128 or 256 channel recordings where it is not unusual to have a few channels with high impedances. The Mark high impedance channels as bad and Hide high impedance channels buttons, when clicked, will set

the high impedance channels as Bad channels, which will exclude them from many of the offline analyses in EDIT, OR as Hide channels, which will hide those channels from the display (the data are still recorded in either case). You may select either option, but not both. The Prompt after impedance check option, when enabled, will prompt you to use the options.

The impedance values that are present when you close the impedance routine are saved with the data file. To see these values (or to print them out after saving them to a text file), *right click* between electrode displays in EDIT, and select the View Impedance Values option.

When you exit the impedance routine, you will be asked if you want to save the values to a log file. The log file is a text file that contains an accumulating list of impedance tests, with the date, time, subject name, ID number, and amplifier serial number (*SynAmps Wireless*). By default, that file is called *impedances.log*. If you have not performed an impedance test, all values will be 0's. If you do an impedance test prior to a peek recording (*SynAmps Wireless*), the most recent impedance values will be saved with the data file and to the log file.

If you perform an impedance check and save the EEG, then switch setup files without performing a new impedance test, the impedances saved with the new data file will be 0's. If you change setup files and want valid impedances, it is necessary to perform a new impedance check prior to recording with the new setup file.

You can change the path and name for the .log file if you wish. Run **regedit** from the **Start** → **Run** line, and go to *HKEY_LOCAL_MACHINE\Software\Neuroscan\Acquire\Setup*. If the ImpedanceLogFile line is there, then the indicated path will be used to store the log file. Modify the path using **New** → **String Value**.

If that entry is not there, the log file will be stored in the *HKEY_LOCAL_MACHINE\Software\Neuroscan\Acquire\State* folder, using the DataDirectory REG_SZ entry. The default path will vary depending on whether you have XP or Vista. The default path for XP is *C:\Documents and Settings\All Users\Application Data\Neuroscan\Scan4.5*. If you have Vista, the default path will be *C:\ProgramData\Neuroscan\Scan4.5*.

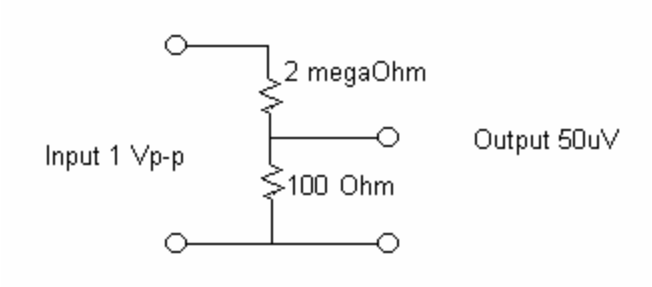
When you enter Acquire again, the new path and file name will be used. You can clear the contents of the .log file simply by opening it, deleting the contents, and resaving it.

Impedance of Negative Electrodes (*SynAmps* and *SynAmps*^{2}). With bipolar recordings there are positive and negative electrodes (depending on how they are inserted in the headbox). The default measurement is for the positive electrode (which is the active electrode for unipolar recordings). Use this option to measure the impedance of the negative electrodes during Impedance testing. The feature is more easily accessed from the Toolbar icon .

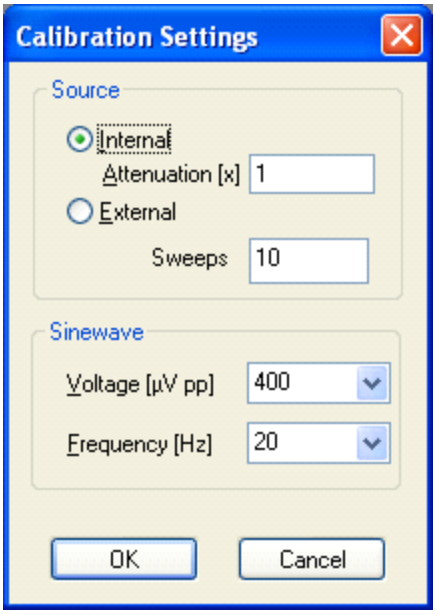
Calibration (SynAmps only). The calibration feature of ACQUIRE can be used to

accomplish two things: (1) Scale potential values to microvolt units; and (2) Make software adjustments across channels to compensate for small differences in amplifier gains. The Calibration option is selected from the Acquisition drop-down menu, or from the Cal icon on the Toolbar.

Calibration signals may be generated *internally*, or through the use of *external* signals. For external calibration signals it is assumed that you are able to generate a calibration pulse or continuous signal with a known peak-to-peak or baseline-to-peak value in the microvolt range. Unless you have a special calibration signal device (perhaps built into your amplifiers), you will usually create the calibration signal by first generating the waveform in the range of volts, and then attenuating the signal to the microvolt range. For example, you may generate a 1.0V pulse analog signal, then use a 20,000:1 attenuator to reduce the 1.0V signal to 50μV. Alternatively, you might use a function generator in combination with an oscilloscope to generate and measure a continuous signal (e.g., a 10Hz sine wave) prior to attenuation. Ordinarily, all channels should receive a copy of the same calibration signal so that they are consistently calibrated and "in balance".



Internal Calibration *(SynAmps)*. Click *Internal*, and enter the desired Voltage and frequency values (e.g., 400μV and 20Hz). Leave the *Attenuation* value at 1. Please refer to the *SynAmps* user manuals for more information on the use of the calibration option.



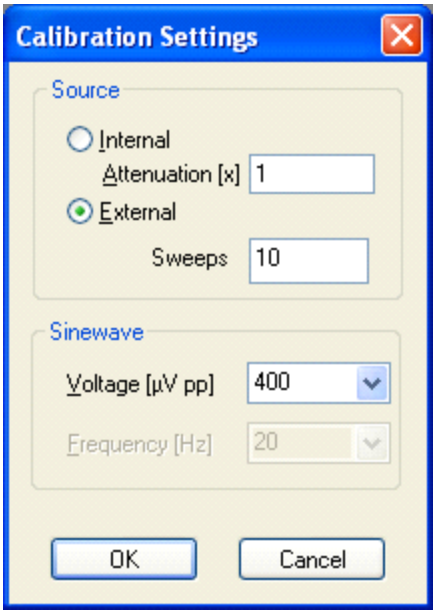
Important note: *internal calibration with a SynAmps is performed with a Gain of*

500. If you are using much higher gains during acquisition and wish to verify that the calibration results are correct, use *external* calibration with a known signal. Or, calibrate as usual then record a known voltage signal where your *Gain* is the *same as what you use during acquisition*. Then measure the peak-to-peak voltage of the recorded signal in EDIT to verify that the amplitude is correct.

After you have entered the values, click OK and the calibration process will begin (described below).

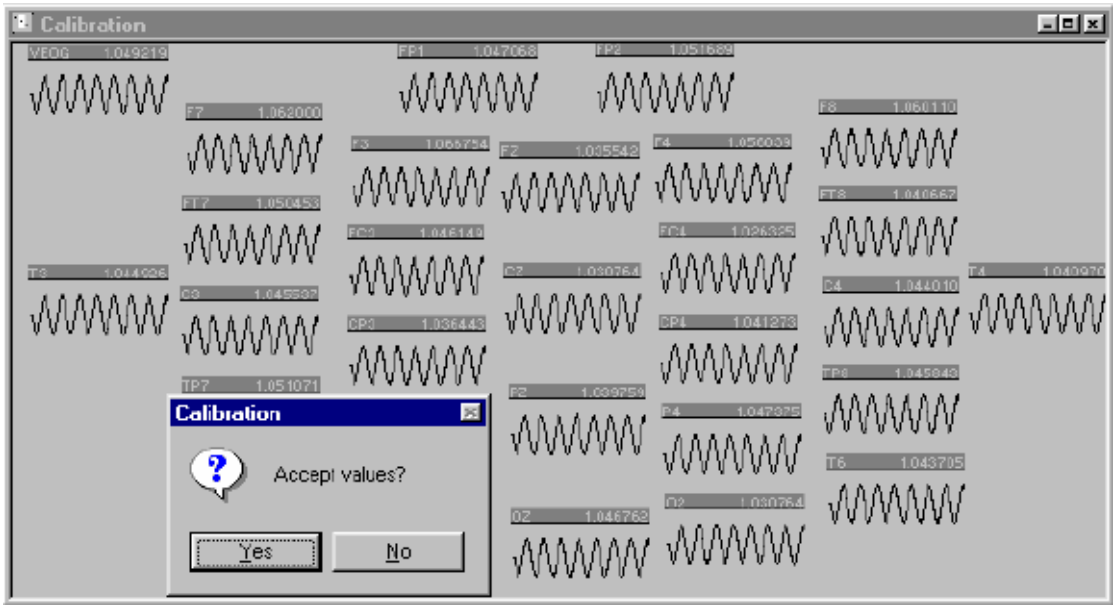
External Calibration *(SynAmps)*. For an external calibration source, you will be using a calibration signal that is independent from the *SynAmps*. Typically, this is a signal from a signal generator. If you are using a signal generator, it should be capable of producing a biologically appropriate voltage, such as 50μV. This can be accomplished with an attenuator that you supply, as described above.

Click on the Calibration option under the Acquisition menu, and then click on the *External* button in the Calibration Settings menu. Enter the desired number of sweeps. Enter the peak-to-peak voltage (in μV) of the sine wave signal you are using (for example, 50μV). The *Attenuation* value should be set to 1 if you are not using an attenuator. If you are, enter that value in the *Attenuator* field, and the unattenuated value for the Sinewave *Voltage*.



Note that you can enter the exact voltage going into the headbox, with an *Attenuator* value of 1, and the result will be the same. The *frequency* of the signal is determined by the external generator, and is not entered in ACQUIRE. Again, it is assumed that the amplifier output to SCAN is approximately 1V for each channel (-.8 to 1.2V).

After setting the values on the calibration screen, click OK. This screen will be replaced with a Multiple Display Window, with displays corresponding to the electrode channels. You will see sequential sweeps of the sine wave. After 10 sweeps you will see a screen like the one shown.



You will be asked whether or not to accept the calibration values. The values referred to are the numbers in the upper right hand corner of each channel display box. When calibrated properly, these numbers should all closely approximate 1.0, plus/minus approximately 0.05.

Beware of calibration values that equal 1.000 at all channels. This is an indication that the *Gain* setting in ACQUIRE does not match the actual amplifier gain. Watch also for clipped or partially out of range sine wave signals seen during the calibration process - the amplifier output is too great. The sine waves should appear as in the figure above.

The calibration values are simply multipliers used to correct any minor deviations among channels. The signals received from the amplifier are multiplied by the calibration values to obtain the "true" values used throughout SCAN.

The calibration values are stored as part of the setup file. If you acquire data using more than one setup file, you will need to *complete the calibration process for each one*. If you make any changes to the gain or filter settings on your amplifiers, you should recalibrate the setup files. You should periodically rerun the calibration process for all setup files to verify that the amplifiers are stable and functioning properly. How often should you calibrate? There is no absolute answer to this question. Solid state amplifiers should not vary significantly over periods of months, or longer. However, the calibration procedure provides a quick test of the system to make sure all amplifiers are functioning properly. A quick daily check is not necessarily too often, if your particular method is not overly involved, and it is a nice reassurance to include in a publication. Monthly checks could result in significant data loss if a channel malfunctions shortly after it is checked. There is no harm in calibrating frequently; there is risk in calibrating too infrequently. The calibration values become part of the header of acquired data files, and may be reviewed and edited in EDIT.

If all of the calibration values are consistently too high or too low, and you are certain that your calibration settings are accurate, then you may need to adjust

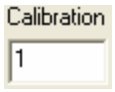
the *Gain* setting (in the AD card Setup screen), as described above. If one or several values are too high or too low, this is an indication of amplifier or other hardware malfunction.

As a final test of the calibration procedure, record a sine wave signal of known voltage. Then go into Edit and measure the peak-to-peak amplitude to verify it is the same as the original signal. It is not necessary to do this after you make the initial verification that the calibration procedure is yielding accurate values.

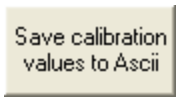
Calibration (NuAmps systems). *NuAmps* are factory calibrated, and require no further calibration. Additionally, no filter circuitry is built in on the pure DC amplifiers, and *NuAmps* use very high-precision preamplifiers with moderate gain coefficient (19). Such design eliminates the potential possibility to have serious inter-channel differences in gain. Variation among amplifiers is typically well less than 1%.

Calibration (SynAmps^2 systems). The *SynAmps*^{2} and *SynAmps RT* amplifiers are factory calibrated, and require no further calibration.

Calibration (SynAmps Wireless). Similarly, the *Synamps Wireless* amplifiers are factory calibrated, and require no further calibration.



Saving/Viewing the Calibration Values (*SynAmps*). As mentioned above, the calibration values are saved with the data files. You can also save them separately in a text file. To view the cal values that are saved with the data file, go to the **Channel Attributes** display (under **Overall Parameters**). The calibration value for each selected channel is shown in the Calibration field.



To save the calibration values to a text file (*SynAmps*), click the **Save calibration values to Ascii** button in the **Miscellaneous** section (under **Overall Parameters**). A Save As utility window will appear in which you may specify the path and enter a file name (.dat extension added automatically). View the file using a text editor (such as Notepad, Wordpad, etc.). The calibration values can also be saved offline in EDIT.

Stop. Clicking on the Stop 

line, or the  icon on the Toolbar, terminates storage of information, and closes the Single and Multiple Window Displays.

Restart. Clicking this line 

allows you to restart data acquisition. For example, if you have begun recording data, and an interruption occurs, you can restart acquisition with this option. You will be prompted to reenter the file names of files to be saved. This feature may be accessed directly from the Toolbar icon  .

Record. This option serves the same function as the Record icon  from the

Toolbar. Please refer to that section for more details.

Pause Display. This option serves the same function as the Pause icon from the Toolbar. Please refer to that section for more details.

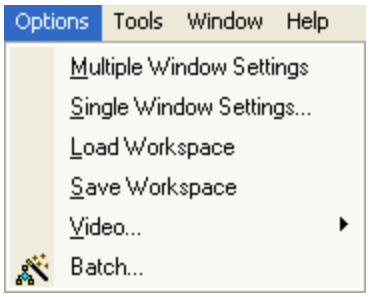
Annotation. Clicking on this option allows you to add text remarks at any point in the continuous recording. For example, if you wish to make a note about extraneous lab noise at a certain point in the recording, click immediately on the annotation line or, preferably, the Type annotation button on the Toolbar. A window will appear in which you may type whatever note you wish. When you replay the continuous data file (in EDIT), you will see the comment at the time point at which you initially clicked the annotation button. This option will become active during data storage only. (See also the **Events** 54 options, described above).

Clear Average. The Clear Average option will clear the accumulated sweeps in an online average file. It may also be accessed by clicking the *right mouse* button between electrode displays in a Multiple Windows display for online averages.

Send Waveforms to Waveboard
This option will send waveforms to the Waveboard. It is also accessed by clicking the *right mouse* button between electrode displays in a Multiple Display Window for an online average. It is not necessary to start the Waveboard first - it will be opened automatically. Please see the Waveboard Appendix at the end of the EDIT manual for a complete description of its operations.

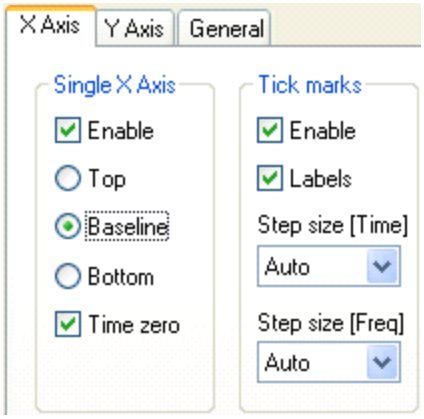
2.5 Options

The Options fields allow you to set a variety of personal preferences used in the display windows, such as, colors, axis labels, etc. You may also save and later recall size and position information for the data windows you open. All of the settings are saved in "Workspace" files.



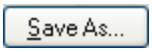
Multiple Window Settings. Clicking on the **Multiple Windows Settings** option displays a dialog box containing 3 option tabs: the **X-Axis**, the **Y-Axis**, and **General**.

X-Axis. The X-Axis page is divided into **Single X-Axis** and **Tick marks** sections.



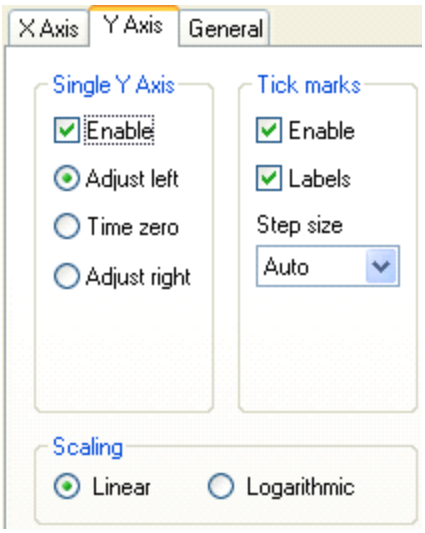
Single X-Axis. Click on the *Enable* field (check mark will appear) to display the x-axis in the multiple window displays for averaged or epoched files. Next, select whether you would like the axis to appear at the *top*, the *baseline*, or *bottom* of the waveform display. Click on the *Time Zero* box to have a vertical line drawn at time zero.

Tick marks. Click on the *Enable* field if you would like tick marks displayed on the x-axis. Click on the *Label* button if you would like labels to appear under the tick marks. Under the *Step size* options (Time and Freq) you may select the interval between successive tick marks. The Time domain steps are in ms, and the Frequency domain steps are in Hz. Click on the pull-down arrow indicator and highlight/click the desired option (range is from 0.1ms to 100 seconds under the Time field and .5Hz to 10kHz under the Freq field; or, select *Auto* to let the program place the marks automatically).

When you are satisfied with the settings, click on the 

button to add the information to the workspace file, then click on **OK** to continue. Click on **Cancel** to leave the page without applying any of the selections.

Y-Axis. The Y-Axis page is divided into 3 regions: **Single Y-Axis**, **Tick mark**s, and **Scaling**.

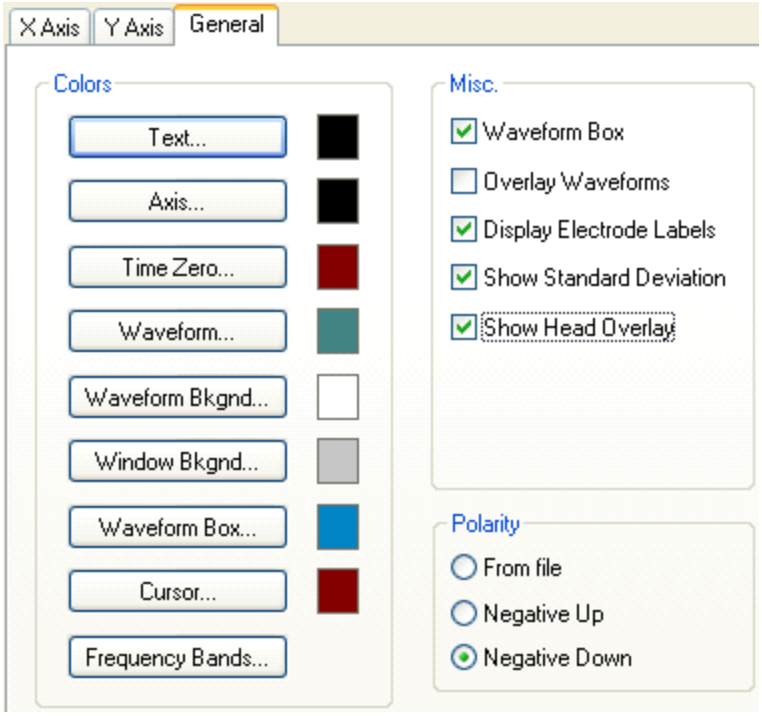


Single Y-Axis. lick on the *Enable* field (check mark will appear) to display the y-axis in the multiple windows displays. Next, select whether you would like the axis to appear at the left end of the x-axis (click *adjust left*), the right end of the x-axis (click *adjust right*), or intersecting with the zero point on the x-axis (click *Time zero*).

Tick marks. Click on the *Enable* field if you would like tick marks displayed on the y-axis. Click on the *Label* button if you would like the labels to appear aside the scale. Under the *Step size* option you may select the interval between successive tick marks. Click on the pull-down arrow indicator and highlight/click the desired option (range is from 0.01μV to 100mV; or, select *Auto* to let the program place the marks automatically).

Scaling. Select whether you would like the scaling to be *linear* or using a *logarithmic* scale.

When you are satisfied with the settings, click on the Save As... button to add the information to the workspace file, then click on **OK** to continue. Click on **Cancel** to leave the page without invoking any of the selections.

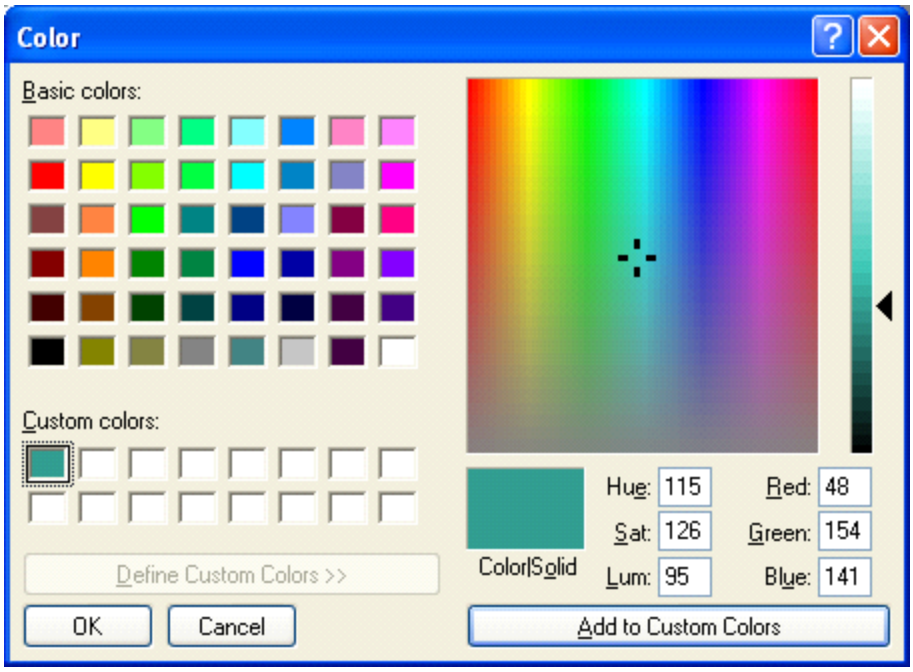


General. The General page is divided into **Colors**, **Misc.**, and **Polarity** options.

Colors. Under the Colors section you may specify the color for various display features, including Text, Axes, Time Zero, Waveform, Frequency Bands, Waveform Background, Waveform Box, Cursor, and Window Back-ground. Selecting any of these *except* the Frequency Bands option, will display the basic color palette consisting of 48 options. Click on the desired color, then click **OK** to invoke the color.

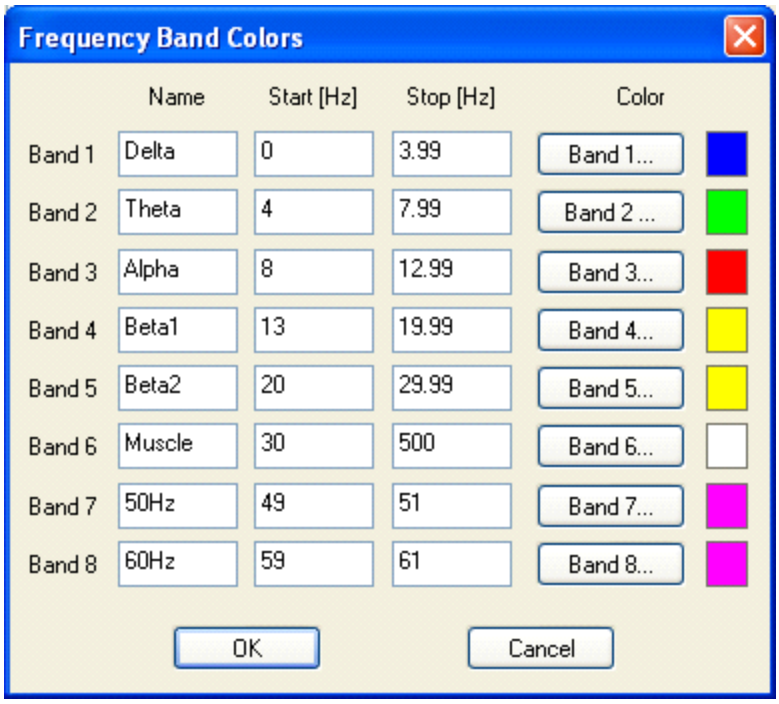
Note
The Text color will determine the color of the electrode labels. When selecting the Text color, bear in mind that Bad channel labels will always appear in red, and Skipped channel labels will always appear in black, regardless of the color you select for the Text.

If you would like to create your own custom color, click on the **Define Custom Colors>>** bar. An extension to the color palette will appear. In the large color screen, catch the reticule with the mouse, move it around the spectrum, and see the corresponding color in the Color/Solid box below. Notice also the intensity bar on the far right. Catch the triangular indicator with the mouse, and slide it up and down to vary the intensity of the color in the Color/Solid box. When you have decided on a color, click on the **Add to Custom Colors** bar, and the color will be repeated in one of the Custom boxes on the original Color screen. Create as



many customized colors as you wish. Notice that each of the display features options will bring up the color palette with the custom colors you have created. To select one of the custom colors, click on the box, then click **OK** *to* invoke the color for the display feature you had selected.

The Frequency Bands option is the only exception to the other *Colors* options. Clicking on this option displays the Frequency Band Colors window. With this feature you may 1) label up to eight EEG frequency bands, 2) define the start and stop frequency limits for up to eight EEG frequency bands, and 3) select a color for each frequency band. Note that these settings apply only to the Online Frequency Analysis you selected in the **Frequency** section (under **Overall Parameters**).

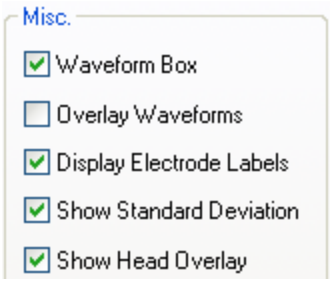


The default frequency band names are Delta, Theta, Alpha, Beta1, Beta2, Muscle, 50Hz and 60Hz; however, you may rename these as you desire.

You may also redefine the frequency limits of each band. Keep in mind that the actual frequency resolution will be determined by the *Points* value you selected in the **Frequency** section (under **Overall Parameters**), and the AD rate. For example, 256 points, with a sampling rate of 1000Hz, gives a frequency resolution of approximately 3.9Hz. Therefore, while you might define, for example, Alpha as 8.0 to 12.99Hz, the actual Start and Stop values may be closer to 7.8Hz and 11.7Hz. With 1024 points, the actual Start and Stop points are approximately 7.84 and 12.74, respectively. The program will round the Start and Stop points you enter, but realize that these are not the exact values that are calculated. Notice also that you may have overlapping frequency bands. For example, the 60Hz band is completely encompassed by the EMG band.

Lastly, you may define the colors for each band by clicking on the corresponding button in the *Color* column. The color palette will appear, as described above. Select the desired color and click **OK** to continue.

Misc. In the miscellaneous field you may select additional display options.



Waveform box. This field toggles the Waveform Box on and off. This is the line box that surrounds the electrode display. The color is controlled by the Waveform Box color button.

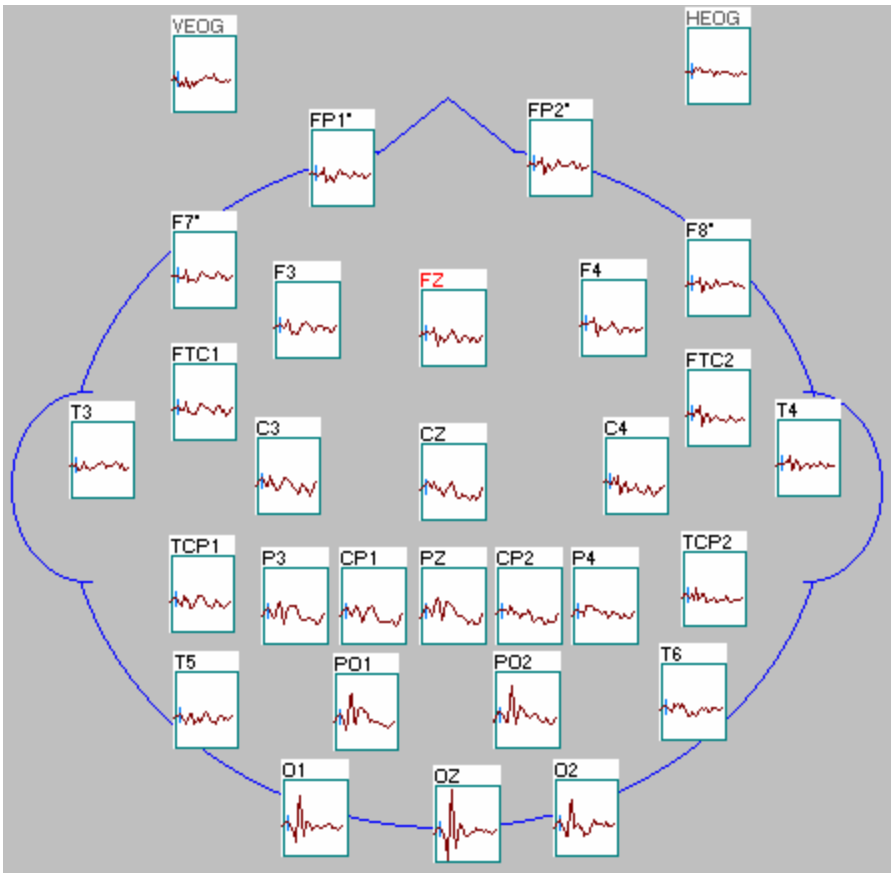
Overlay Waveforms. The Overlay Waveforms option applies to epoched files. Enable it, and as you step through the EEG file, you will see successive sweeps overlain on the previous sweeps.

Display Electrode Labels. This option will toggle the display of the electrode labels (in the upper left hand corner of the displays).

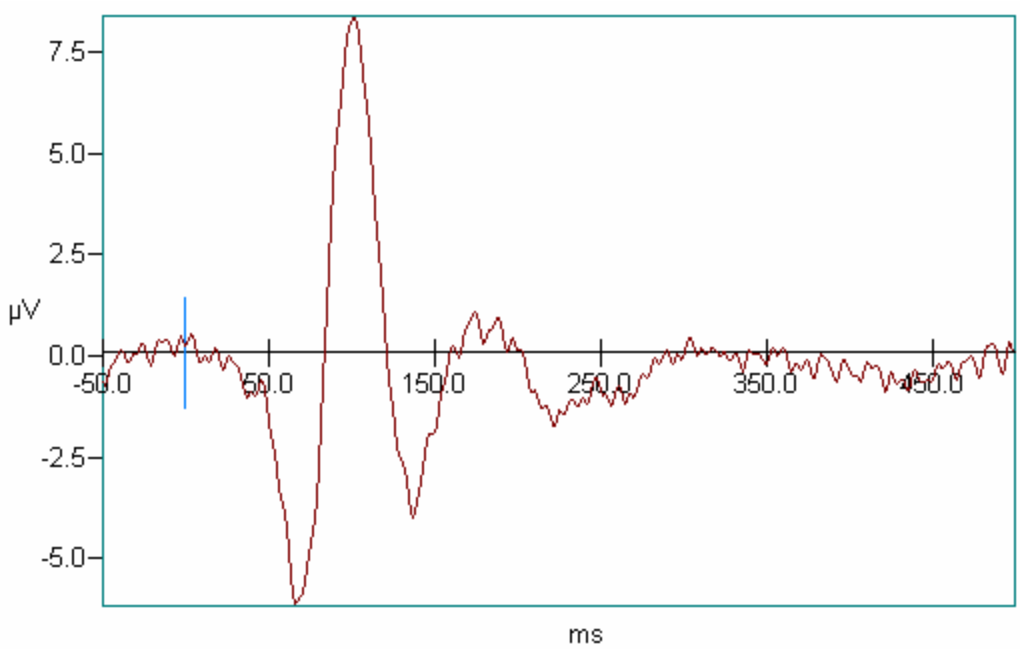
Show Standard Deviation. This field toggles the display of the Standard Deviation for averaged data files, assuming the sweeps or files must have been averaged with the Compute Standard Deviation option enabled. When averaging single sweeps, that option is found on the Averaging transform display, in the Options section. When group averaging AVG files, the Compute Standard Deviation option is found on the Group Averaging Properties display.

Show Head Overlay. When enabled, this option will display the head overlay.
Polarity. These fields allow you to set the polarity when the file is retrieved. You can set it for **From File** to use whatever polarity setting is saved with the data file. Or, you can select **Negative Up** or **Negative Down** to override the data file and always present the polarity the way you want.

Illustrations of Display Parameters The following figures are presented to simplify the parts of the display that may be controlled independently using the settings described above. Shown is a Multiple Window Display. The gray area between the electrode displays is set by the **Window Background** color control. The white area within the displays is controlled by the **Waveform Background** control. The black electrode label color is set by the **Text** control. The gray color for the VEOG and HEOG channels indicates that these are **Skipped** channels. The red color for the FZ label indicates that this was set as a **Bad** channel. Labels that have an asterisk have been designated as **Artifact Rejection** channels. The dark green box around each electrode display is the **Waveform Box**; it is toggled on or off by the Waveform Box field. The color of the waveforms themselves is set by the **Waveform** control. The blue head shape is the **Head Overlay**. Zooming in on a channel gives the following display.



The positions of the x and y axes are controlled by the **Single X Axis** and **Single Y Axis** buttons (such as, the Top, Baseline, and Bottom options for the X axis). In the above example, the X-axis is set for **Baseline**, and the Y-axis is set for **Adjust Left**. The **Tick Marks** controls toggle the tick marks on and off, toggle the tick mark labels on and off, and set the interval between the tick marks. The vertical blue line on the x-axis around 0μVs is the **Time Zero** mark (it may be toggled on or off, and the color may be selected). This is seen on all of the channels on the Multiple Window Display (not just when you zoom into one of them).

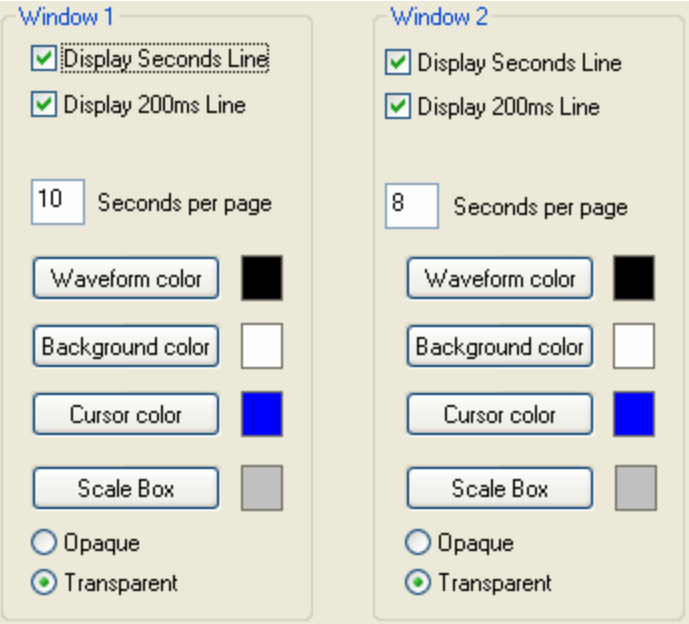


Note

For printing purposes you may want to have all white backgrounds.

When you are satisfied with the settings, click on the *Save As*... button to add the information to the workspace file, or to create a new workspace file (you may want to have more than one workspace file depending on the operations you routinely perform; the *.aws* extension is added automatically). Click on *OK* to continue, or click on *Cancel* to leave the page without applying any of the selections.

Single Window Settings... The Single Window Options dialog box allows you to set parameters for the Single Window Displays. These include whether or not you wish to show the *Seconds Lines* and the *200ms Lines* in the display. You may also select the number of seconds per page to be displayed (this may be changed during replay with the accelerate and decelerate icons).



You may also select the color for the Waveforms, Background, Cursor (text in the scale tool), and Scale Box (background for the scale tool). Clicking on any of these buttons will access the Color field used before (see the description under General under the Multiple Windows Settings for details). You also have the option to make the background of the Scale Tool transparent or opaque. The Scale Box color will have no effect if the background is Transparent. If you have two CNT files open, you may enter independent settings for it. Click Save As... to store the setting you have entered in the AWS (workspace) file, then click **OK** to continue.

The "Window 2" fields are used in ACQUIRE when you are displaying two single windows (the second one is grayed out in EDIT).

Load Workspace. The options that you have selected above are stored in a workspace file (*.aws* extension). The workspace file also stores the sizes and positions of the various windows that you have opened. You may save and recall different "workspaces". Use the Load Workspace option to retrieve a workspace file that you have previously created. Selecting the option will display the standard Open File utility from which you may select a workspace file. EDIT will retain the most recent workspace file, and apply it the next time you run the program. The workspace file that is being used is displayed on the right side of the Status Bar (if your screen resolution is too low, you may not see this).

Save Workspace. The Save Workspace option is used to save the Options you have selected above, as well as the sizes and positions of the data display screens you have opened. You may wish to have several different workspace files, depending on the operations you are performing. When you have the settings and displays in a way that you would like to retain, click Save Workspace. Use the standard Save As utility to enter a file name and path (the *.aws* extension is added automatically). We recommend you make a backup copy of your workspace files in case they should become corrupted.

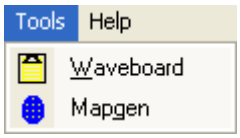
Video. The Video option is used to setup up parameters for the video camera, and for

taking snapshot pictures. These options are more easily accessed from the icons on the Toolbar  , or from the *right mouse* button options found by clicking in the video display screen. These are all described below in the **Main Toolbar** 94 section.

Batch.... This option accesses the Autorun feature used with BATCH files. Please refer to the Tcl Batch Commands manual for operational details.

2.6 Tools

These options are used to access other programs within SCAN. Clicking it displays the list below.

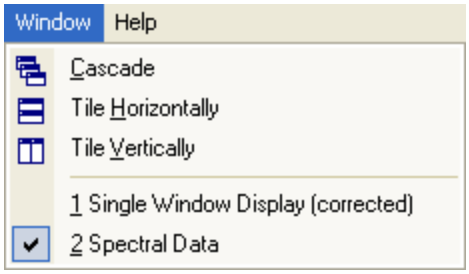


Waveboard. The Waveboard is a separate program that is used to display and measure waveform. It can be used with ACQUIRE and EDIT, and may be opened with the Toolbar icon indicated. In ACQUIRE, for example, you can send waveforms to the Waveboard as an online average is being created. See the Waveboard appendix at the end of the EDIT manual for complete details.

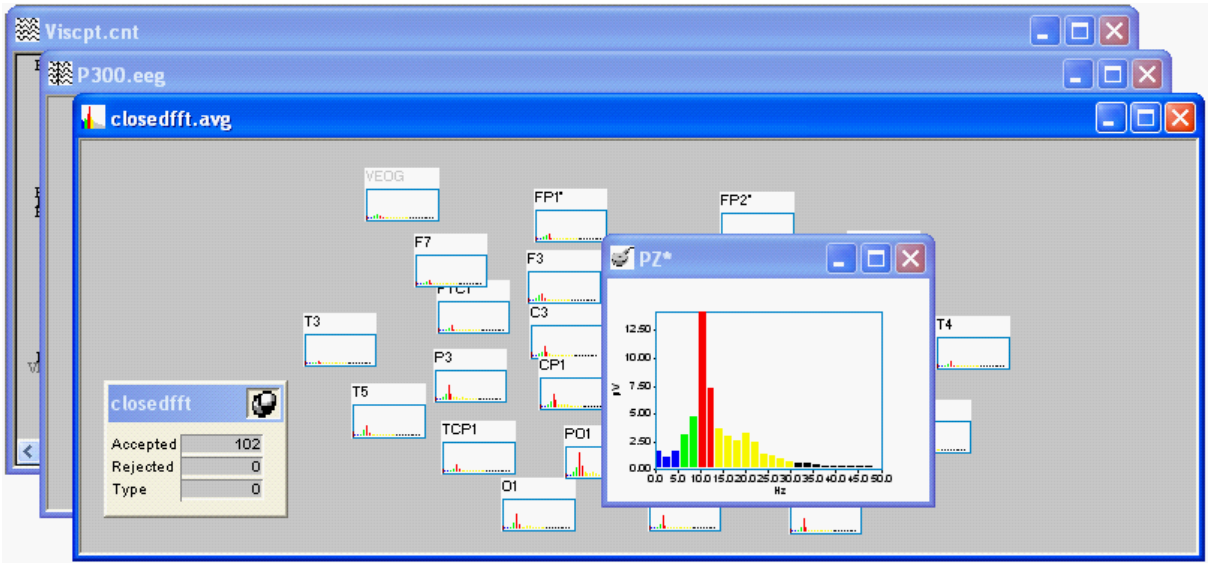
Mapgen. MapGen is a program used to create or modify 2D map files. It may also be opened from the Toolbar, using the indicated icon. See the MapGen appendix at the end of the EDIT manual for complete details.

2.7 Window

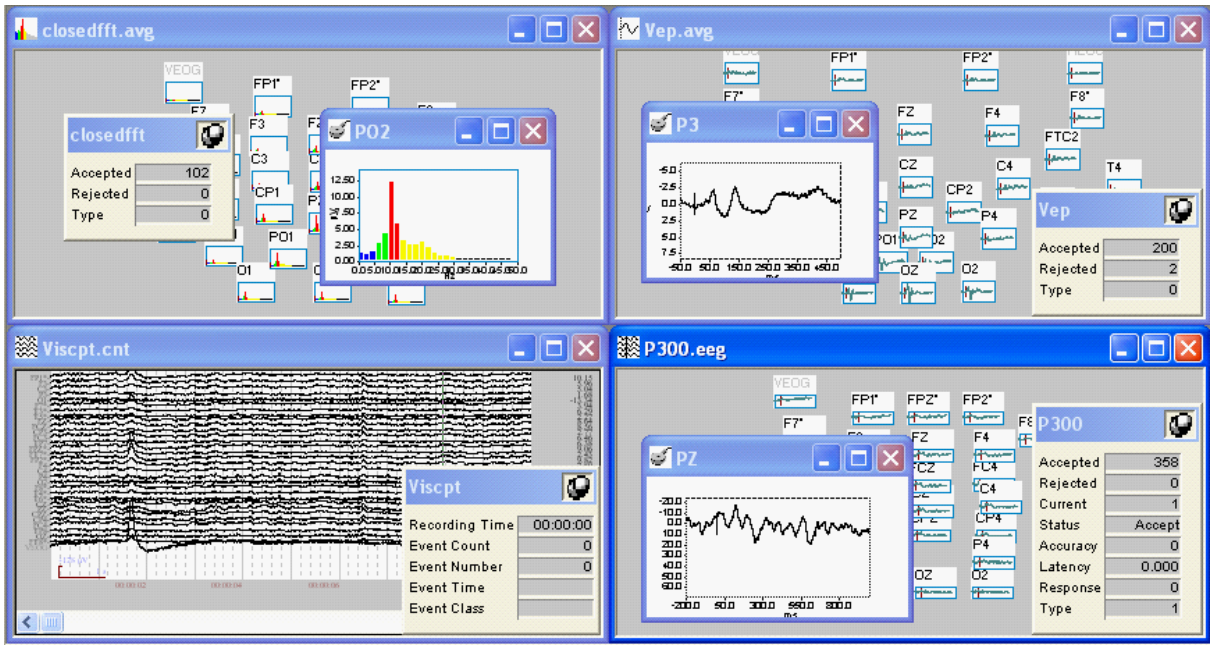
These options function as with most Windows programs, and serve to organize the presentation of multiple windows on the screen.



Cascade. Selecting Cascade aligns the windows in a stack of overlying "cards", with the edges exposed to allow access for highlighting, as shown below.



Tile Horizontally. Tile horizontally will automatically arrange windows in a horizontal manner, stretching from one side of the screen to the other, top to bottom. With multiple windows (e.g., more than 3), however, the Tile Horizontal, or Tile Vertical option will arrange the window displays in a well-organized fashion, as shown below:

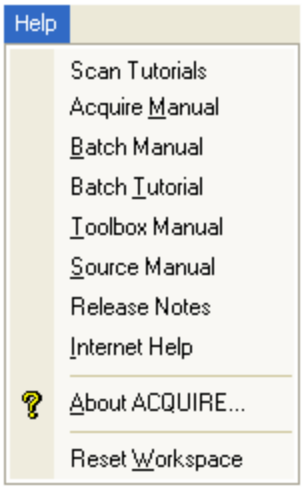


Tile Vertically. Tile Vertically will automatically arrange windows in a vertical manner, stretching from the top of the screen to the bottom, side by side. With multiple windows, however, the Tile Vertically, or Tile Horizontally option will arrange the window displays in a well-organized fashion, as shown above.

List of Open Files. You will also see a list of files that are currently open. You can direct the "focus" to a file by selecting it from the list.

2.8 Help

The Help option accesses the following:



Scan Tutorials. This manual contains several tutorials to introduce you to acquisition and analysis using SCAN.

ACQUIRE Manual. This selection will give you immediate access to this manual in PDF format.

BATCH Manual. This selection will give you immediate access to the Tcl Batch Commands manual in PDF format.

Batch Tutorial. This option access the Tcl Batch Tutorial manual, which provides an introduction to Batch commands.

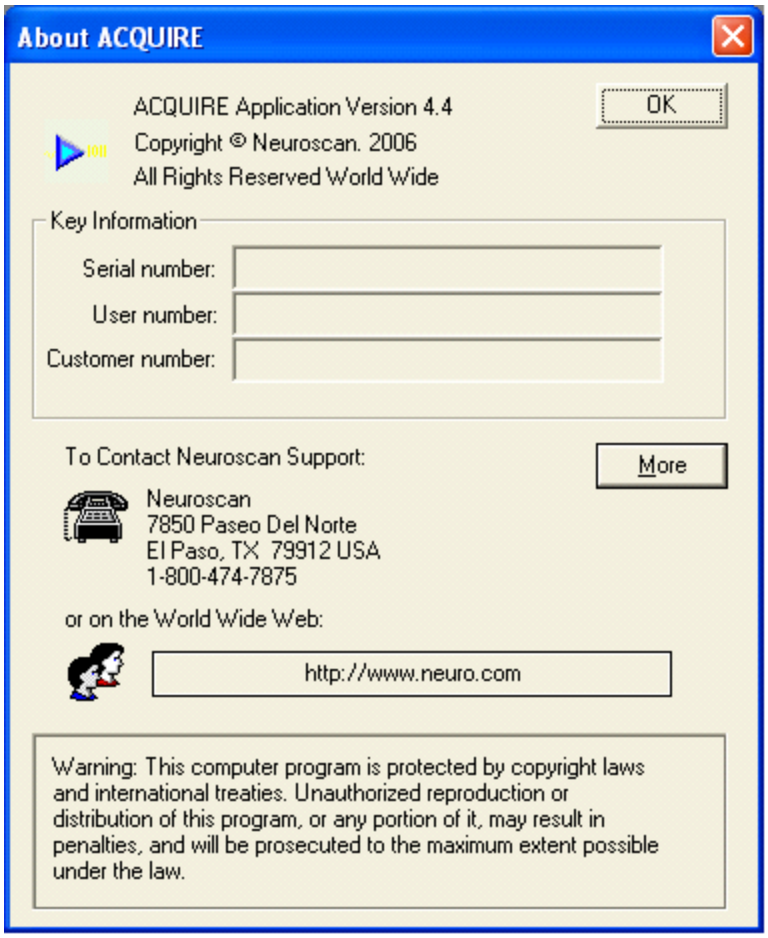
Toolbox Manual. This selection accesses the Toolbox manual, containing details for Blink Reduction, PCA/ICA, and other options.

SOURCE Manual. This selection will give you immediate access to the SOURCE V2 manual in PDF format (assuming you have a SOURCE V2 license).

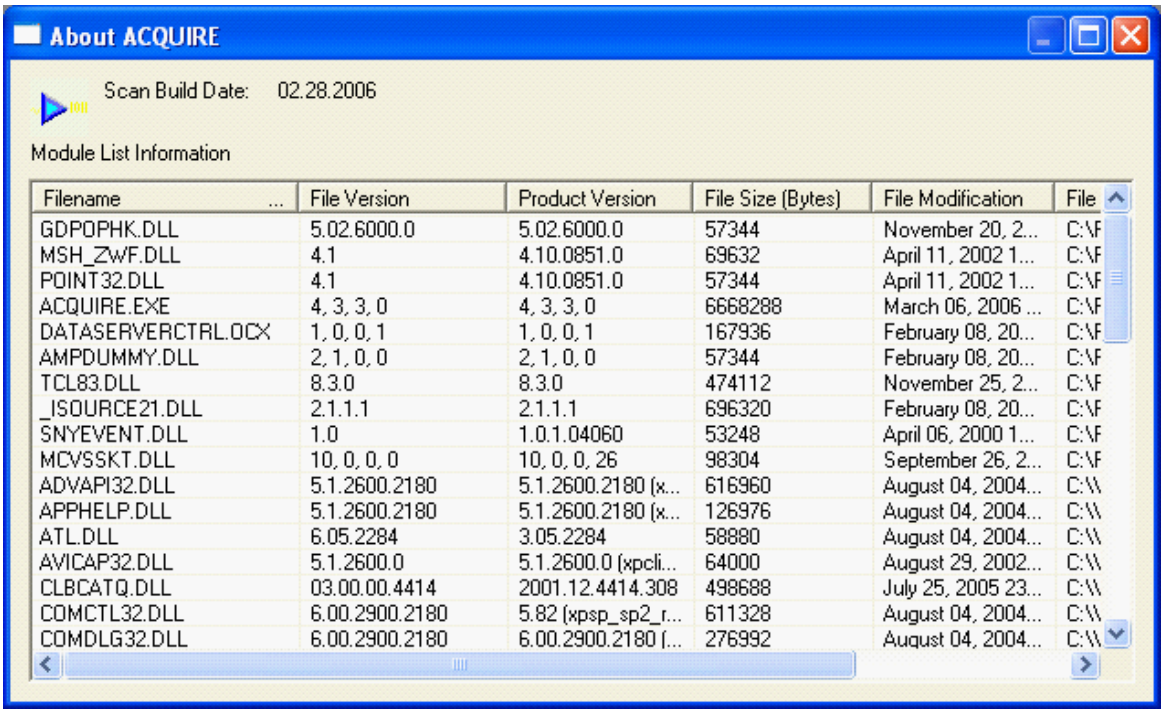
Release Notes. This accesses the most recent Release Notes.

Internet Help. This section will connect to our web site (www.neuroscan.com). From there you may go to the Technical Notes or other sections for additional information or files to download.

About ACQUIRE. Selecting this will option will show you the current version of ACQUIRE that you have installed and the serial number of your software lock, as well as your User and Customer numbers. These are used to activate capabilities of your software lock and to track the lock.



You may be directed by Technical Support to click the More button. This displays the programs that are currently being used in your version of SCAN.



Filename	File Version	Product Version	File Size (Bytes)	File Modification	File
GDPOPHK.DLL	5.02.6000.0	5.02.6000.0	57344	November 20, 2...	C:\F
MSH_ZWF.DLL	4.1	4.10.0851.0	69632	April 11, 2002 1...	C:\F
POINT32.DLL	4.1	4.10.0851.0	57344	April 11, 2002 1...	C:\F
ACQUIRE.EXE	4, 3, 3, 0	4, 3, 3, 0	6668288	March 06, 2006 ...	C:\F
DATASERVERCTRL.OCX	1, 0, 0, 1	1, 0, 0, 1	167936	February 08, 20...	C:\F
AMPDUMMY.DLL	2, 1, 0, 0	2, 1, 0, 0	57344	February 08, 20...	C:\F
TCL83.DLL	8.3.0	8.3.0	474112	November 25, 2...	C:\F
_ISOURCE21.DLL	2.1.1.1	2.1.1.1	696320	February 08, 20...	C:\F
SNYEVENT.DLL	1.0	1.0.1.04060	53248	April 06, 2000 1...	C:\F
MCVSSKT.DLL	10, 0, 0, 0	10, 0, 0, 26	98304	September 26, 2...	C:\F
ADVAPI32.DLL	5.1.2600.2180	5.1.2600.2180 (x...	616960	August 04, 2004...	C:\\
APPHELP.DLL	5.1.2600.2180	5.1.2600.2180 (x...	126976	August 04, 2004...	C:\\
ATL.DLL	6.05.2284	3.05.2284	58880	August 04, 2004...	C:\\
AVICAP32.DLL	5.1.2600.0	5.1.2600.0 (xpcli...	64000	August 29, 2002...	C:\\
CLBCATQ.DLL	03.00.00.4414	2001.12.4414.308	498688	July 25, 2005 23...	C:\\
COMCTL32.DLL	6.00.2900.2180	5.82 (xpsp_sp2_r...	611328	August 04, 2004...	C:\\
COMDLG32.DLL	6.00.2900.2180	6.00.2900.2180 (...	276992	August 04, 2004...	C:\\

Reset Workspace. In previous versions of SCAN 4.0 we encountered occasional situations where the workspace file would become corrupted. This resulted in a variety of unusual operational difficulties. The problems were resolved by deleting the workspace file (.aws extension). In SCAN 4.2 and subsequent versions, we have made it easier to do the same thing. Selecting the **Reset Workspace** option will delete the workspace file being used, and restore the original *default.aws* file. You should make a backup copy of your workspace files to avoid having to recreate them if you have to use Reset Workspace.

3 Main Toolbars

The Main Toolbars are located near the top of the screen. This is a very handy feature since it allows rapid selection of options available during acquisition. If you do not see the Main Toolbar, go to **View** → **Toolbars** → **Main Toolbars** and enable the option.

The options are highlighted when they are accessible. This depends upon where you are in the Acquisition process. You may not see all of the icons displayed above; some are only seen if you have the appropriate hardware and software licenses, and the Video option selected.

3.1 Toolbar Icons

Select Setup File  . Clicking this option opens a standard Open File utility for selecting setup files.

Recording Controls  . These four buttons function similarly to those on a tape recorder. The green arrow indicator  will *start* the acquisition in a monitor mode (not saving the data). The red button is the *Record* button  . Clicking it opens a Windows Save File utility for allowing you to enter a file name and designate the directory in which you want the data to be stored. Data storage will begin after you click the Save button on the Save As... display. If, during a recording, you click the *Record* button a second time, data storage will be *suspended* - clicking it again will continue the save to the same file (with the exception of *SynAmps Wireless*, when writing to its Flash drive). The button with the two vertical lines is the *Pause* button  . If you click this during acquisition, the *display* will be paused, and data collection will continue. The purpose is to allow you to examine a feature of interest without disrupting the data storage. This is opposed to the *Stop* icon, the black rectangle  , which will close the current data file.

You will get a warning message during storage when you get to the last 10MB of space on the hard drive. Storage will cease when you reached the last 5MB of free space.

> *Use of Peripheral Devices for Data Storage* - We recommend that you do *NOT* acquire data directly to a peripheral storage device. Communication with these devices tends to be relatively slow, and you will likely encounter data overflows or lost data. Copy files to the peripheral storage devices offline. With SCAN 4.2 on, the offline analysis software (EDIT) can read data files directly from write once, read-only CDs.

Increase scale factor  . *(Single, Multiple and Frequency displays)* Increases amplitude of the signals in the display only. If you have multiple display windows open, only the one that is highlighted will be affected. The gain of the screen will increase by a power of 2 each time you press this key. If you are displaying both the Single and Multiple Window Displays, you can select either screen by clicking the mouse on the gray horizontal bar at the top of the display. The scaling options will be applied to the active display. The screen amplitude affects only the display, not the data stored to disk.

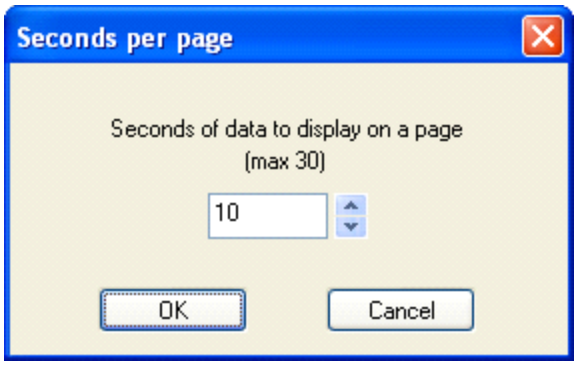
Decrease scale factor  . *(Single, Multiple and Frequency displays)* Decreases amplitude of the signals in the display only. If you have multiple display windows open, only the one that is highlighted will be affected.

Auto Scale  . (*Multiple Window Display*) Automatically sets the amplitude scaling to the largest and smallest voltages detected from any channel.

Decelerate  . *(Single Display only)* Slows the speed of the signal display. If you have multiple display windows open, only the one that is highlighted will be affected.

Accelerate . *(Single Display only)* Increases the speed of the signal display. If you have multiple display windows open, only the one that is highlighted will be affected. Screen acceleration will not affect how fast data are digitized or written to disk. However, we do not recommend running the display at high speeds during data recording. If you are displaying both the *single* and the *multiple window displays*, note that the *single window display* must be selected for the accelerate (and decelerate) option to apply.

With continuous files, you can also click the *right mouse* button inside the display, and select the Set seconds per page option. From that screen, you can enter the number of seconds displayed.



A note about display speed. Depending on the speed and type (unaccelerated) of your graphics display card, more or less time may be required to display waveforms on the screen. Too fast of a display may place a burden on the computer to keep up with the specified digitization rate. This will be reflected in the buffer overflow line in the **Status Box**. If the percent of Buffer space being used rises in a monotonic fashion, this is an indication that you are exceeding the limitations of your computer. You should either decrease the rate of acquisition, decrease the number of online features, or obtain a faster graphics card or computer.

Next display page . Displays next page of selected electrodes *(will not be highlighted unless additional pages exist)*. Display pages are created in the **Channel Layout** section. If you have multiple display windows open, only the one that is highlighted will be affected.

Previous display page . Shows previous page of selected electrodes *(will not be highlighted unless additional pages exist)*. If you have multiple display windows open, only the one that is highlighted will be affected.

Grid display . (*Multiple Window display*) Selecting this option will rearrange the channel windows into a grid display. Deselect the option to return to the original display.

Baseline correction . *(Single and Multiple display)* The Baseline correction option is used to center the baseline of waveforms graphically with their associated labels located on the left-hand side of the screen. This operation is performed each time the

waveforms begin drawing from the left-hand side of the screen and has no effect on the actual data. The Baseline correction option will toggle on and off each time you click the icon. Baseline correction is particularly useful with DC recordings, in which the DC values will cause a large offset of the starting screen location. If you have multiple display windows open, only the one that is highlighted will be affected.

DC Correction DC. *(SynAmps only)* Performs single DC correction with each use to remove DC components (will center signals at the baseline). DC corrections can be performed manually by clicking the Toolbar icon, or automatically when you Enable the "DC Correction" option (see **AC/DC** section). When a DC correction occurs, you will see a DC' event marker at the bottom of the Single Window display (along with the stimulus and response events). The DC corrections will be stored in the data file, and are treated as events in the file.

> *Considerations about DC corrections*. When a DC correction occurs, it creates a discontinuity in the data immediately surrounding the correction. For that reason, the Epoch File transform, in EDIT, will not create an epoch if the epoch contains a DC correction. The DC correction events are considered permanent for the same reason. Therefore, you should use DC corrections only sparingly. If you have frequent DC corrections, you may wind up with a data file that cannot be epoched. If there are frequent, automatic DC corrections, or, if you find that you have to apply frequent, manual DC corrections, those are indications of an acquisition problem with one or more channels. There could be high impedance, a bad electrode lead or wire, a DC battery potential problem, or other cap/cable problems. You should resolve these problems before acquiring the data.

Invert polarity  . *(Single and Multiple display)* Negative voltage upward instead of down. If you have multiple display windows open, only the one that is highlighted will be affected.

Restart acquisition  . Clicking this button allows you to restart data acquisition. For example, if you have begun recording data, and an interruption occurs, you can restart acquisition with this option. You will be prompted to reenter the file names of files to be saved.

Start/Stop Impedance Z. This is a Toolbar shortcut for going directly to the Impedance testing routine, described in more detail below.

Impedance of negative electrodes  (*SynAmps*). With bipolar recordings there are positive and negative electrodes (depending on how they are inserted in the headbox). The default measurement is for the positive electrode (which is the active electrode for unipolar recordings). Use this button to measure the impedance of the negative electrodes during Impedance testing.

Calibration Cal (*SynAmps*). This icon accesses the Calibration function. Please see the **Calibration** 72 section above for more details.

Type annotation A. This feature allows you to add text remarks in the continuous recording to designate any significant events. Clicking on the button will display a window in which you may insert comments (see also the **Events** 54 section under

Overall Parameters). The comments will be seen when you replay the data file in EDIT, at the point at which you initially clicked the Type annotation button. You must be saving the data for this option to be active.

Video capabilities in ACQUIRE  . If you have a PC camera installed on your computer, you may use it in ACQUIRE to map your online data (2D maps) on to the picture from the camera. One common example is the case where you have an electrode grid lying on the surface of the brain, and you want to map the EEG/EP activity to the grid while recording the data. This would allow you to visualize, for example, the spread of epileptic activity.

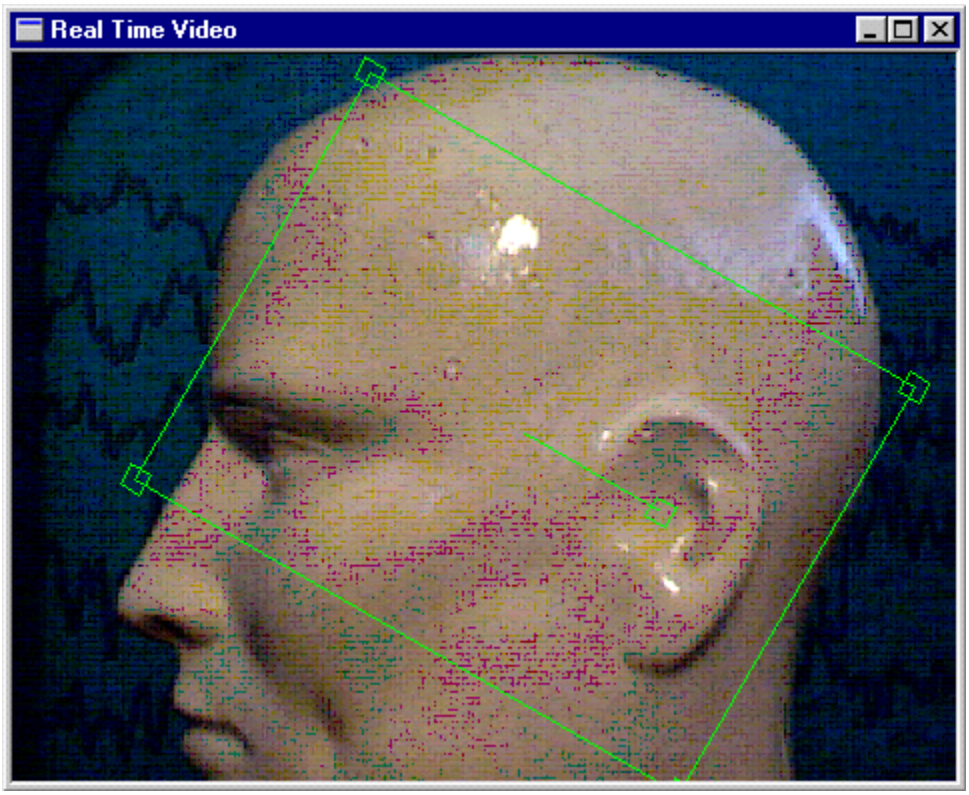
You must select the Video Camera option when you run the Amplifier Install program. Close ACQUIRE and EDIT and then go to **Start** → **All Programs** → **Scan4.5** and run  Amplifier Install . Make sure your amplifiers are selected, then select **Video Camera** if you want to map the EEG data onto a picture from the camera. Then click **OK** and **Finished** on the next dialog. Start ACQUIRE as usual.

Video Camera

If you have selected Video Camera in the Amplifier Install program, you will see several icons grouped together on the Toolbar  . (Make sure the camera is working before you try to use it in ACQUIRE). If you do not have a camera, there are still ways you can superimpose 2D maps on existing BMP images. See the section entitled "**Right mouse options with online mapping** 110" below.

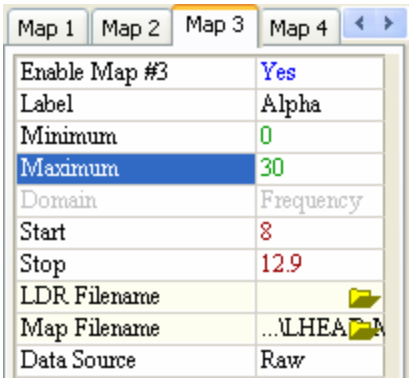
View Video  . If the camera has not been started in ACQUIRE, only the first of the 5 icons will be functioning. Click it to enable the camera display. The remaining icons will then become active.

The demonstration below will simply map EEG results to a "dummy" head. This is to illustrate how the process works. The display will appear with a green box (yours may be a color other than green).



Overlay. The box is the overlay, and it is used to superimpose a map display on top of the image that you are seeing through the camera. It can be resized by grabbing one of the small boxes at a corner and dragging the box to a new size. The box can be rotated by grabbing the box coming from the line in the middle of the overlay, and dragging it to a new orientation. The entire box may be moved by clicking inside the box and dragging it to a new location.

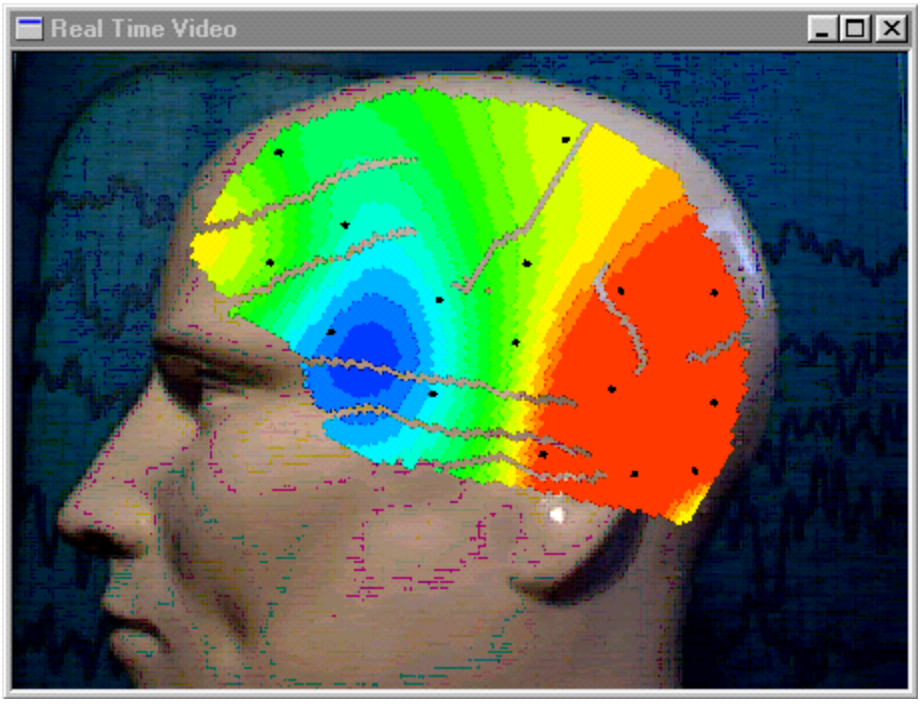
Next, we need to set the **Mapping** parameters to map the desired activity using the appropriate map file.



In this example, we are mapping alpha activity using the supplied *Lhead.map* file. The *.map file that you use must match the labels used in the setup file.

Now start acquisition (in this case we used Continuous mode and a Single Window display), and you will see the map displayed in its usual window, as well as the same map superimposed on the camera display. You will likely need to position and size the map so it lies meaningfully on the camera display. You may also need to scale the map display.

As the EEG scrolls, you will see the map change on the camera display. With that as a basic demonstration of the capabilities, we will now look at the remaining options. Many of these are accessed using the Toolbar icons, while others use options on the *right mouse* accessed menu list, or options listed under **Options** on the Main Menu bar.



Snapshot with overlay . Clicking this button takes a snapshot of the camera view and saves it with the overlay image. The figure above is a snapshot with the

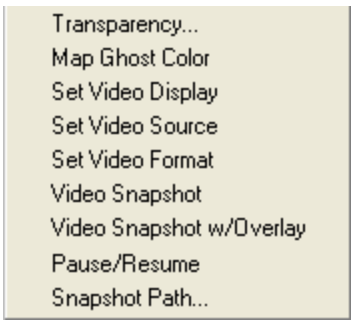
overlay. The snapshot is saved as a bitmap (*.bmp) file. The folder and file name are set using the **Snapshot Path** option, described below.

Snapshot  . Clicking this button takes a snapshot (bitmap) of the camera image without the overlay.

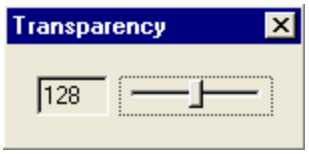
Load Snapshot  . Use this option to retrieve a bitmap snapshot file that has been saved. (See the **Snapshot Path** option below for determining the folder and file name). The Pause / Resume Video button will be "pressed" (paused) when a file is retrieved.

Pause / Resume Video  . Use the icon to Pause the video display, and then resume it.

***Right mouse* button options within the video display**. Other features related to video are accessed by clicking the *right mouse* button within the video display.



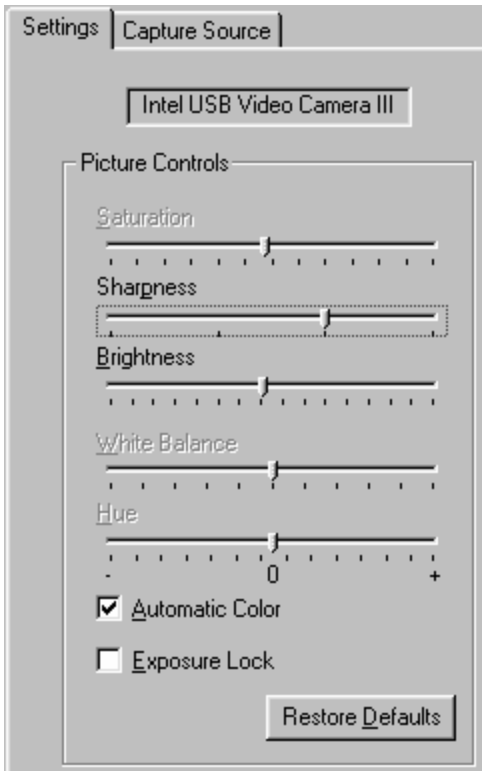
Transparency.... This option determines the degree of transparency of the overlay. Click it to see the following display.



Slide the bar for more or less transparency. The higher the number, the more transparent the overlay image will be.

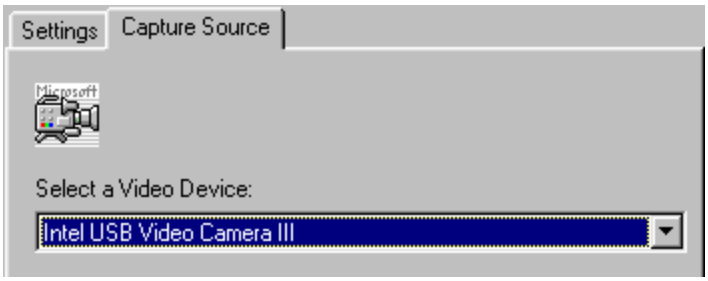
Map Ghost Color. This option is used to change the color of the overlay box in the video display. Clicking it will display the standard Color display. Select a desired color or create you own custom color.

Set Video Display. The graphic interfaces that you see here depend on which capture system you are using, and its own drivers. These are independent of the SCAN software. Please refer to your capture system documentation for this information.

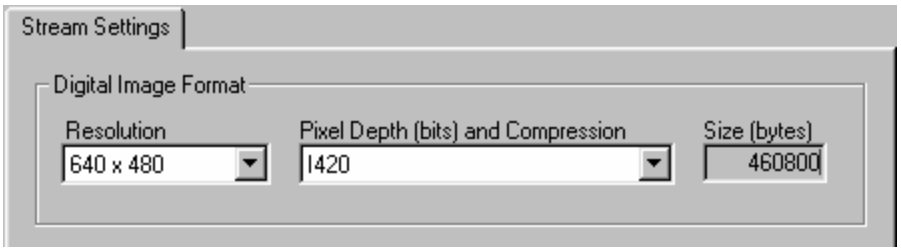


Set Video Source. Use this option to make changes to the video camera configuration. With the camera display on, adjust the controls to the desired settings. You will see the effect on the display. (Turn Automatic Color off to access the grayed out parameters). Click the Restore Defaults button to return to the original default settings.

Click the Capture Source tab if you have more than one video device, and you want to switch from one to the other.



Set Video Format. This option is used to set the video stream settings. Click it to see the following display.

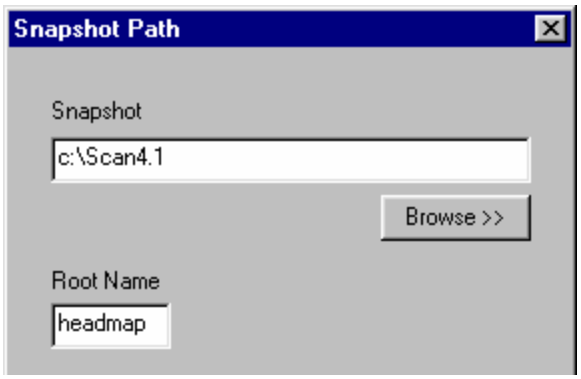


Change the resolution and Pixel Depth as desired (changes to the file size will be displayed).

Video Snapshot and **Video Snapshot with Overlay**. These options provide the same snapshot-taking functions as the icons described above. (Bitmap files are created with and without the overlay).

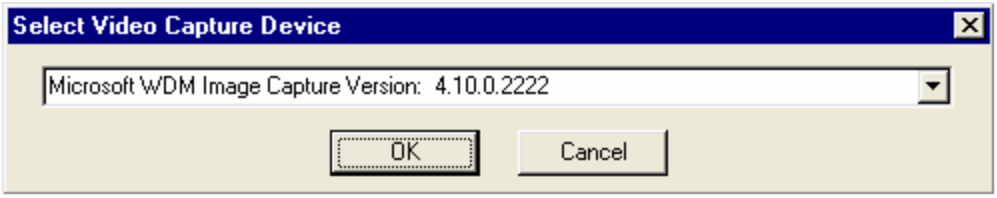
Pause / Resume. This is the same as the Pause / Resume icon described above (pauses and resumes video).

Snapshot Path. Use the Snapshot Path option to set the folder in which you want the bitmaps to be placed. Use the Browse button to select a different folder, if desired. The Root Name is the first part of the file name that will be used. In the example below, "headmap" was used as the root. Successive snapshots will be automatically labeled as headmap1.bmp, headmap2.bmp, headmap3.bmp, etc.



The one remaining option related to video not found on the Toolbar or on the *right mouse* button options is found under **Options** → **Video** → **Select Capture Device**.

Select Capture Device. If you have more than one Capture Device, this option is used to select the one to be used.



Click the pull-down arrow to see and select the desired device.

Launch Waveboard  . Clicking on this button launches the Waveboard. The Waveboard is useful for measuring amplitudes and latencies at specified points on the waveforms. Waveforms are selected and sent to the Waveboard, where the measurements are made. The complete operation of the Waveboard is described in the Waveboard Appendix at the end of the EDIT manual.

Launch Montage Editor  . This icon may be used to launch the Montage Editor. The Montage Editor may be used to create or modify a montage or linear derivation file without leaving ACQUIRE. Refer to the Montage Editor Appendix at the end of the EDIT manual for complete details.

SOURCE Reconstruction  . This button starts the SOURCE V2 program, assuming your dongle has been programmed for SOURCE. SOURCE uses several source localization models to compute single or multiple dipole sources. It can be used online in ACQUIRE or offline in EDIT. Please refer to the SOURCE manual for operating instructions.

PCA\ICA  . This icon accesses the PCA\ICA (Principle and Independent Component Analyses) program (a Toolbox license is required to access the program). It can be used online in ACQUIRE or offline in EDIT. Please refer to the Toolbox manual for operational details.

Blink reduction  . This icon is used to initiate the Blink Reduction routine (a Toolbox license is required to access the program). For details, please refer to the Toolbox Manual.

Client/Server Operation 

. Beginning with SCAN 4.3, the Network version of ACQUIRE is set up from within the ACQUIRE program itself (rather from the Program Launcher in older versions). The network version of ACQUIRE allows you to monitor/control acquisition from a remote computer. One computer is configured as the Server to send data over a network to a remote Client computer. The Client can control acquisition just as though it was attached to an amplifier. *Each connected PC MUST have its own SCAN 4.5 license (Full license or Acquisition only), with the software installed.*

Introduction

"Client/Server operations" is an industry term which refers to data exchange through a network. Many approaches can be used for such exchange. SCAN 4.5 uses TCP to transfer information between two systems using a Local Area Network (LAN). Each system can act as server or as a client. SCAN 4.5 supports only one client per server. That means if one client is already connected to a server, other clients cannot receive data from that station.

Some terms

TCP is the abbreviation for Transmission Control Protocol. **LAN** stands for Local Area Network. The SCAN system that sends EEG data is referred further as a **server**. The SCAN system which receives data is referred as a **client**. The **IP address** is a machine name, such as "ftp.microsoft.com", or a dotted number, such as "128.56.22.8".

The following types of information are sent between systems:

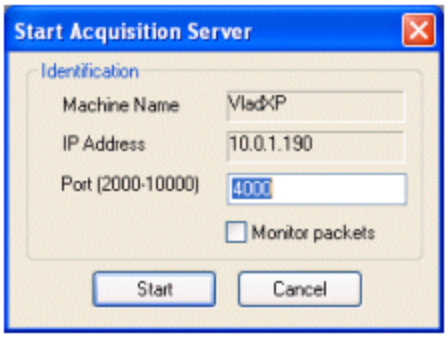
1. Commands (or control codes);
2. Files (e.g., AST setup files);
3. Data (e.g., EEG and events code stream, EDF header).

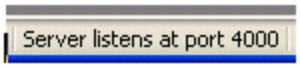
Commands are used to synchronize operations between the two systems. For example, starting acquisition or impedance measurement on the server will send a corresponding command to the client, and the client will show the same displays. Both server and client can send commands to each other.
AST files are sent automatically from server to client to make sure that client will expect the same number of channels, with same channel names as the server that is acquiring. The stream of data is sent by the server as soon as acquisition or impedance measurement starts.
All types of information are transmitted as packets structured according to format described in the "Packet structures" section below. You can use that information to write to the client side. Clients written on C and Java can run on Windows or Unix-based systems.

Starting ACQUIRE as a Server

Start ACQUIRE on the server computer. The main program window will open. The two rightmost icons 

on the main Toolbar are related to client/server operations. Press the S(erver) button to activate the following dialog:

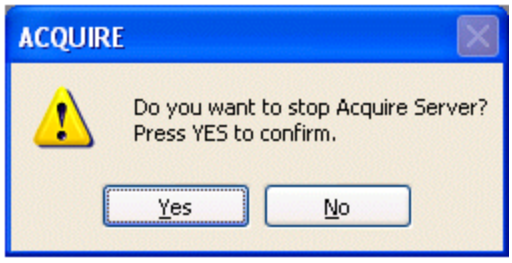


It identifies the computer by Machine Name and IP address. In that dialog you can specify the TCP number for the port that will be used to exchange information. You can use the default value 4000, or set any address in the range 2000-10000. Just make sure that both sides (server and client) are using the same port number. The last setting – "Monitor packets" - will allow you to see some statistics while the EEG data are streaming. Press the "Start" button to start the server. The Status bar will show: 

.

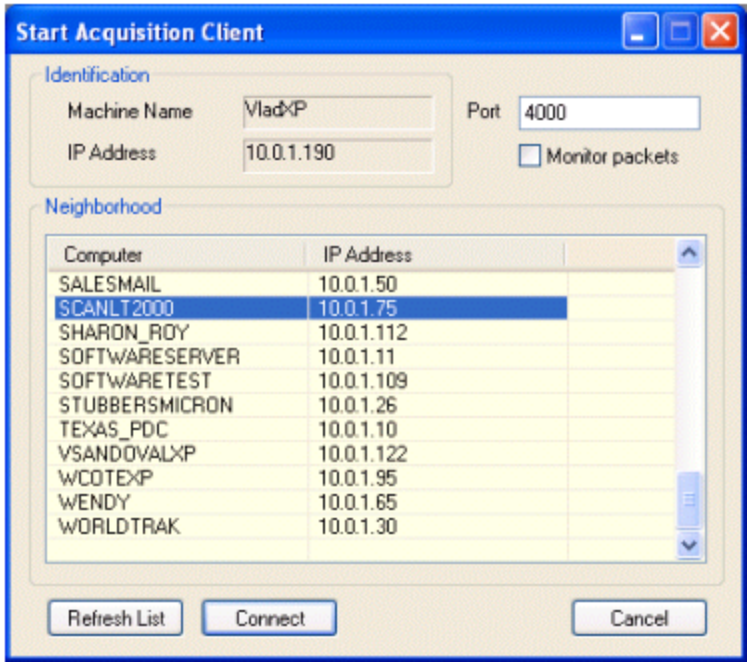
Any time you want to stop running the server, press the S(erver) button again, which will bring the dialog: Press Yes button to confirm. The status bar will show 

.



Starting ACQUIRE as a Client

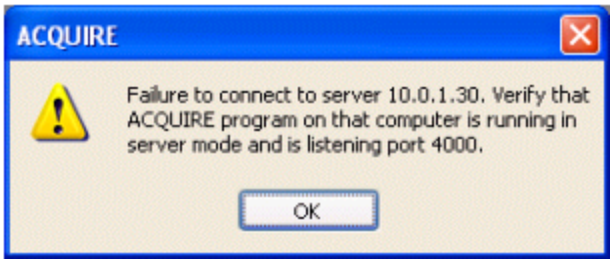
Now start ACQUIRE on the client computer. Press the C(lient) button to activate the following dialog:



Along with identification information, port number and the "Monitor packet" check box, the dialog shows you the network neighborhood as a list of computer names and corresponding IP addresses. If you were connected to a server previously, then the same computer will be selected from the list. Select the computer you want to connect to, and press the Connect button.

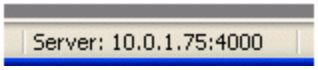
Important notes:

1. Looking in the network for other computers may take some time (several seconds), and that may delay the appearance of the "Start Acquisition Client" dialog on your screen.
2. Before the client can connect to another computer, you need to start the Server there first. If server is not started, then the client will fail to connect, and you will see a warning, such as:



3. If a system enters in client mode, then usage of the local amplifier will be disabled. That means, if you press the button, the program will not acquire data from the local amplifier, but will wait for the data stream from the server.
4. You can connect to the server even after it starts acquisition.
5. If the server stops or exits, then the client status bar will show "Server was stopped".

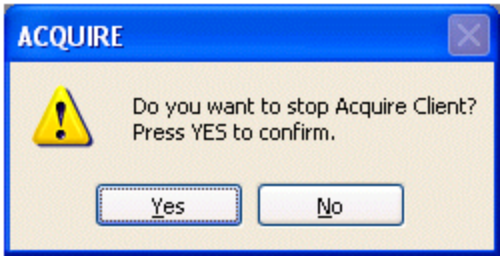
If you connected successfully, then the status bar reads as:



.

The IP address of the server and port number used are identified. The server toolbar also updates and shows the IP address of the connected client.

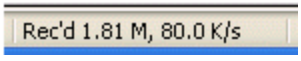
Any time you want to disconnect the client from the server, press the C(lient) button again, and a warning will appear. Press Yes to confirm.
If you exit the program on either side, the transmission will be stopped automatically. Therefore, there is no need to stop the server or the client explicitly, if you do not plan to switch the servers or clients during the same working session.



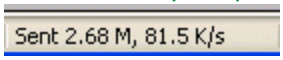
Sending data from server to client

This is the easiest part of SCAN 4.5 client/server operation. On the server side, execute the steps you normally do to acquire an EEG/EP recording: select a setup file, modify it as needed, and then start acquisition (or impedance measurement). Immediately, the same registration will appear on the client computer screen. You can initiate data storage from either system. If you switch to impedance measurement on the server computer, the client will switch to the impedance screen as well.

If you enabled "Monitor packets", then the status bar will show simple statistics on data transfer. For example, the client program may show something like:



.

This message is interpreted as "So far received 1.81 megabytes of data, current speed of transmission is 80.0 kilobytes per second". The status bar on the server system may look like: 

.

That is interpreted as "So far sent 2.68 M, current transmission speed is 81.5 K per second". This status message is updated every second. If the network is shared by many PCs on your LAN, the current speed can slightly fluctuate over time.

This monitoring tool can be used to evaluate the maximum sampling rate for acquisition on this client/server configuration. The current speed of transmission should be close to the EEG data stream output (per second), which is equal to:

(EEG number of channels + 1 event channel)*(Sampling rate)*(2 bytes),

where "2 bytes" means 16-bit data are sent.

For example, if you are recording 40 EEG channels at 1000Hz sampling rate, then you have the following EEG data stream output:

(40+1)*1000*2=82000 bytes=80.07 K/second

This value is close to speeds shown above for the client and server computers. If the transmission speed starts to decline from the expected EEG data stream output, this indicates that your network cannot accommodate the acquisition speed. The client will draw EEG in a step-wise manner as well, which is an indication that there are problems with the network bandwidth.

Should that happen, you may decrease (or even shut down) all other network traffic by switching off other workstations in your LAN. Or, you can build a separate dedicated LAN to connect directly the ACQUIRE server and client. The last method guaranties the highest throughput; in that case the maximum acquisition rate closely depends on the type of LAN connection you use. For example, a 10Base-T connection provides the transfer speed as 10 Mbps. That means that for a 40 channel recording you can reach an acquisition rate close to:

15000Hz = (10*1024*1024/(8*(40+1)*2))

Packet structures and command set

Who should read this section? This section is intended for users who want to write their own client program to pull data online from the ACQUIRE server during acquisition. The ACQUIRE program uses stream sockets (neither datagram nor raw sockets) to guarantee data delivery in the proper order. Refer to Windows Socket Specification or books on TCP for more information on this socket type and socket programming.

Packet structure. All information sent between the client and server is organized as packets. Each packet consists of a 12-byte header and an optional body. The header structure is the following:

```
typedef struct {
        char            m_chId[4];    // ID string, no trailing '\0'
        WORD  m_wCode;                // Code
        WORD  m_wRequest;             // Request
        DWORD           m_dwSize;     // Body size (in bytes)
} PacketHeader;
```

If **body size** field is 0, then no body is sent. Otherwise, the receiving socket should read the specified number of bytes and process them according to meaning of the header's **ID** string, **Code** and **Request** fields.

Byte ordering. Different machine architectures store data using different byte orders. For example, Intel-based machines store data in the reverse order of Macintosh (Motorola) machines. Intel's byte order, called "little-Endian," is also the reverse of the network standard "big-Endian" order. The following table explains these terms:

Byte ordering	Meaning
Big-Endian	The most significant byte is on the left end of a word.
Little-Endian	The most significant byte is on the right end of a word.

ACQUIRE always sends the packet header translated to "big-Endian" (network) notation. But the content of the data and file packets (as proprietary information) is always sent in native Intel "little-Endian" format. This means that ACQUIRE performs the following operations on packet's header:

```
void PacketHeader::Convert(BOOL bSending)
{
   if (bSending) {
    // Convert from host byte order to network byte order
    // (Little-Endian to Big-Endian) while sending
    m_wCode      = htons (m_wCode);
    m_wRequest   = htons (m_wRequest);
    m_dwSize     = htonl (m_dwSize);
   } else {
    // Convert from network byte order to host byte order
    // (Big-Endian to Little-Endian) while receiving
    m_wCode      = ntohs (m_wCode);
    m_wRequest   = ntohs (m_wRequest);
    m_dwSize     = ntohl (m_dwSize);
   }
}
```

Command set. The Header **ID string** consists of 4 upper case letters, without the trailing '\0'. It can be one of the following:

```
"CTRL"      - control code
"FILE"      - file packet
"DATA"      - data packet
```

This ID specifies what kind of information is sent in other fields and in the optional

body. The following table summarizes the possible combinations:

Packet ID string	Code		Request		Body size
	Value	Meaning	Value	Description	
"CTRL"	1	General Control Code	1	Request for Version	0
			2	Closing Up Connection	0
	2	Server Control Code	1	Start Acquisition	0
			2	Stop Acquisition	0
			3	Start Impedance	0
			4	Change Setup	0
			5	DC Correction	0
	3	Client Control Code	1	Request for EDF Header	0
			2	Request for AST Setup File	0
			3	Request to Start Sending Data	0
			4	Request to Stop Sending Data	0
"FILE"	1	Setup file	1	Neuroscan AST Format	≠ 0
"DATA"	1	Information	1	Version Information	≠ 0
			2	Standard EDF Header	≠ 0
	2	EEG data	1	Neuroscan 16-bit Raw Data	≠ 0
			2	Neuroscan 32-bit Raw Data	≠ 0

The Server computer sends general and server control codes, file and data packets. The Client side should send only general and client control codes, and be able to process (or simply drop) incoming file and data packets.

Important note. As ACQUIRE uses some other codes and requests internally, avoid the usage of numbers not presented in the table.

Program examples

Standard client operations. Normally, the client program first connects to the ACQUIRE server; second, it requests for configuration information and processes it; third, it asks for EEG data and then receives them for further processing/ display/storage; and, finally, it disconnects from the ACQUIRE server. The following are basic client actions:

1. Connect to ACQUIRE server through TCP socket.
2. Send "Request for EDF Header".
3. Read "DATA" packet with EDF Header and process it to extract electrode information.
4. Send "Request to Start Sending Data".
5. Read incoming "DATA" packets with 16/32-bit EEG data with further processing, displaying and storage.
6. Send "Request to Stop Sending Data".
7. Send "Closing Up Connection".
8. Disconnect from ACQUIRE server by closing up the client TCP socket.

"Minimum" client operations. The basic sequence can be reduced. If you manually set the number of channels on the client side, then you may skip steps 2 and 3. Exiting the client program will also close all sockets, so you may also trim

out steps 6-8. Finally, the minimum sequence of operations is:

1. Connect to ACQUIRE server through TCP socket.
2. Send "Request to Start Sending Data".
3. Read incoming "DATA" packets with 16/32 EEG data, process and display them.
4. Exit from client program (to automatically disconnect from ACQUIRE server).

Example "Reader" program and source code Included with the 4.5 installation is a sample "reader" program that can be used to display the data on a second computer (without the need for a second SCAN license). To run the program, go to the ...*Scan4.5* folder and run the NetReader.exe program. You can run the program on the same computer where you have SCAN, if you wish. Follow the directions on the displayed screen. You should see the EEG signals on the "reader" at the same time as you see them in ACQUIRE. Event information will also be displayed. The source code for the program in found in the *\Scan4.5\NetAcquire* folder.

Display Status Window . From time to time you may "lose" the Status boxes seen in the data displays. Should this happen, click the button to restore them.

4 Saving and Acquisition

When you have finished entering the settings, you will probably want to save the setup file you have created. Go to **File** → **Save Setup**, and enter the file name (or overwrite an existing setup file). *We strongly recommend that you not overwrite the setup files that came with the system. Start with one of them, modify it as desired, and then save it with a different name*.

Click the green Start Data Display arrow to begin data acquisition. The enabled display window(s) will appear, and you will see the incoming signals. When you start the STIM2 system (or other stimulus presentation system with acceptable trigger codes), you will see the stimulus and response type codes appear on the Single Window Display(s).

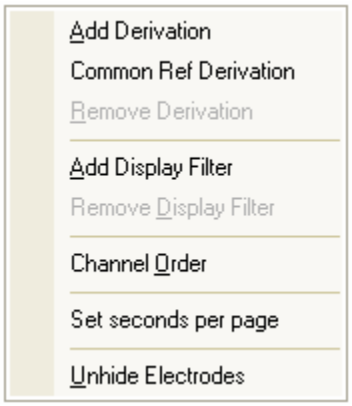
The recording control buttons are on the Toolbar . Click on the *Record* icon (the red dot) on the Toolbar to enter any file names and path designations. Clicking on Save in the utilities window will exit the window and data storage will begin. To stop data acquisition, click on the *Stop* button (black rectangle) on the Toolbar, or the Stop option under Acquisition on the Main Menu bar. The button with the two vertical lines is to Pause the display. (See also the Toolbar section 94 above for additional information).

4.1 Right Mouse Context Menus

Throughout SCAN you will find that many additional options are accessed by *right clicking* on different parts of the display. Different menus appear for different file types (CNT, EEG and AVG), as well as clicking between or within windows in the Multiple Window Display.

***Right mouse* options in the Single Window Display**. You may apply linear

derivation files, different filtering characteristics, and reorder the channels in the Single Window display "on the fly" by clicking the *right mouse* within the display. You will see the following list of options.

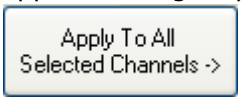


Add Derivation. Add Derivation allows you to apply an LDR transform to the CNT file during acquisition. This is the same option that may be set up in advance on the **Startup** screen under **Overall Parameters** (see the **Derivation** section above). The applied LDR is for display purposes only. *Note: if you apply an LDR file, the additional display page function will be disabled.*

Common Ref Derivation. Selecting this option will compute and display the data with a common average reference.

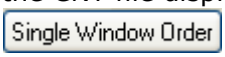
Remove Derivation. Click this option to remove the applied LDR transform.

Add Display Filter. Clicking this option displays the Filter screen (see the **Filter** 12 section above), and performs the same function as the Filter option on the **Startup** display under **Overall Parameters** (except that it may be applied during acquisition). Enter the settings as desired, click the

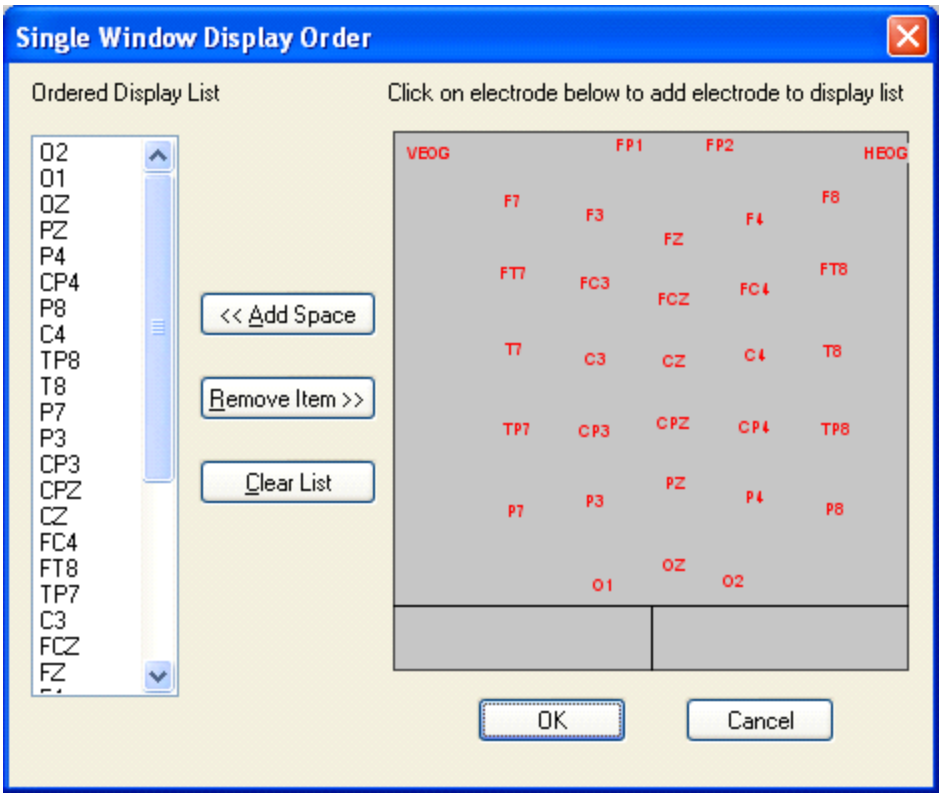


button, and click OK to apply the filter to the displayed CNT file. The filter will affect the display only.
Remove Display Filter. Clicking this option removes the effects of the Add Display Filter option.

Channel Order. This option allows you to reorder the sequence of channels on the CNT file display. (The same option may be selected from the



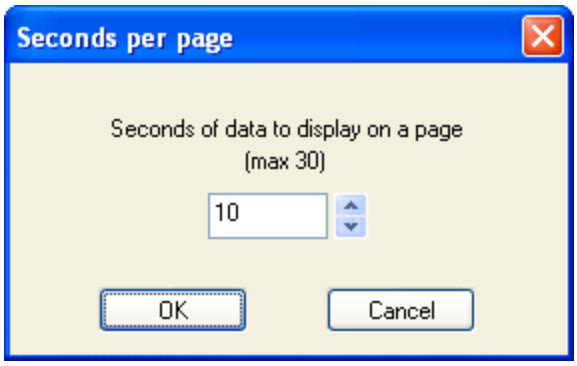
button on the **Channel Layout** display). Clicking it displays the following screen.



The current order of channels is in the left side column. To remove a channel from the list, just highlight it and click the Remove Item >> button. *Note: this removes the channel from the list, not from the display. There will always be the same number of channels displayed; this option will only alter the order.*

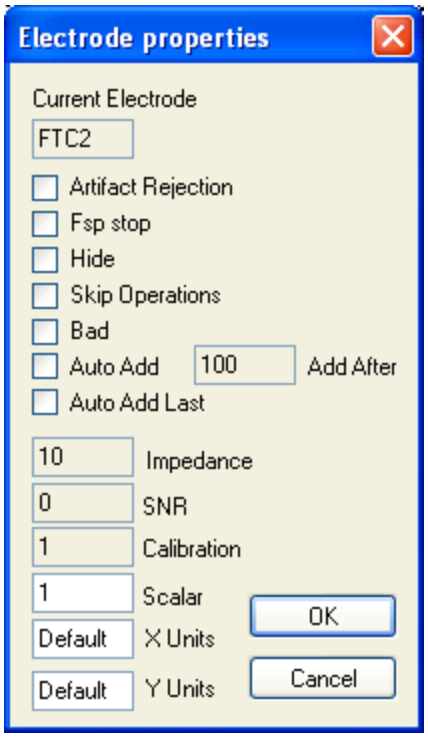
To reorder the display completely, click the Clear List button. Then click the channel labels in the montage display in the order that you want them to appear. As you rebuild the list, you might want to separate the channels with spaces. Click the << Add Space to leave a space between the channels as you select them. If you omit some channels, they will be added at the bottom of the Single Window Display. Click OK when you are through to see the new ordering.

Set seconds per page. This option is used as an alternative to the Accelerate and Decelerate icons on the Toolbar. Clicking it displays the "Seconds per page" screen.

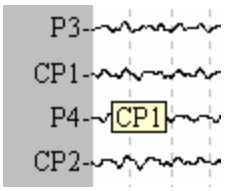


Unhide Electrodes. Clicking this option will "unhide" all electrodes that have been marked with the "Hide" option.

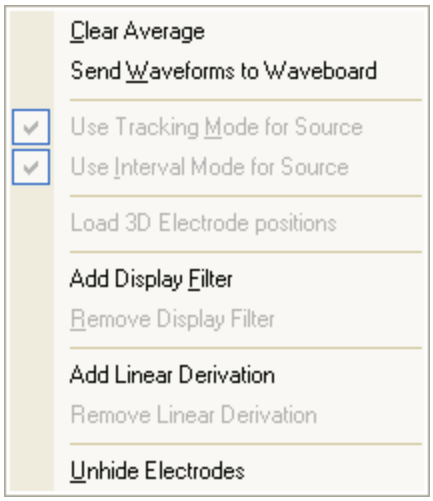
***Right mouse* options by clicking on the Electrode Labels**. In a Single Window Display, click on an electrode label from the list on the left to see the Electrode Properties display. From this screen you may designate a channel "on the fly" as an Artifact Rejection, Bad, Skip and so forth channel. These are the same options that you see in the **Channel Attributes** section (under **Overall Parameters**).



If you move the mouse over the electrode labels, you will see a Tooltip showing the electrode label. This is particularly useful when many channels are being displayed, and the labels may be too small to read otherwise.



***Right Mouse* options with Multiple Window Displays**. The *right mouse* button provides access to several additional options that are useful with the Multiple Window Displays (with online AVG files). Position the mouse cursor **between** electrode display windows, and click the *right mouse* button. The following list of options will appear (not all options appear with frequency domain files).



Clear Average. In any of the online average displays it is possible to clear the average by clicking the *right mouse* button *inside* the Average Window, but *outside* the electrode channel displays. Click the Clear Average option to clear the online average.

Send Waveforms to Waveboard. When you select this option, the waveforms in the online average file will be sent to the Waveboard. It is not necessary to open the Waveboard first - it will open automatically.

Use Tracking Mode for Source/Use Interval Mode for Source. These options are used with the SOURCE program (refer to the SOURCE manual for details).

Load 3D Electrode positions. Use this option to merge the .3DD file from 3DSpaceDx to the data file being acquired (requires a Polhemus digitizer to measure the xyz coordinates for the electrodes and functional landmarks). You can also merge the .3DD file offline in EDIT, or within the SOURCE program.

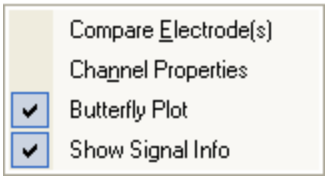
Add/Remove Display Filter. These are the same options described above for continuous data files in which a display filter can be applied to the Multiple Window Display.

Add/Remove Linear Derivation. These are the same options described

above for continuous data files in which a linear derivation file can be applied to the Multiple Windows Display. The difference is that you must have the same number of input and output channels in the LDR file. The use with Multiple Windows Displays is primarily for weighting, as with Spatial Filter generated LDR files.

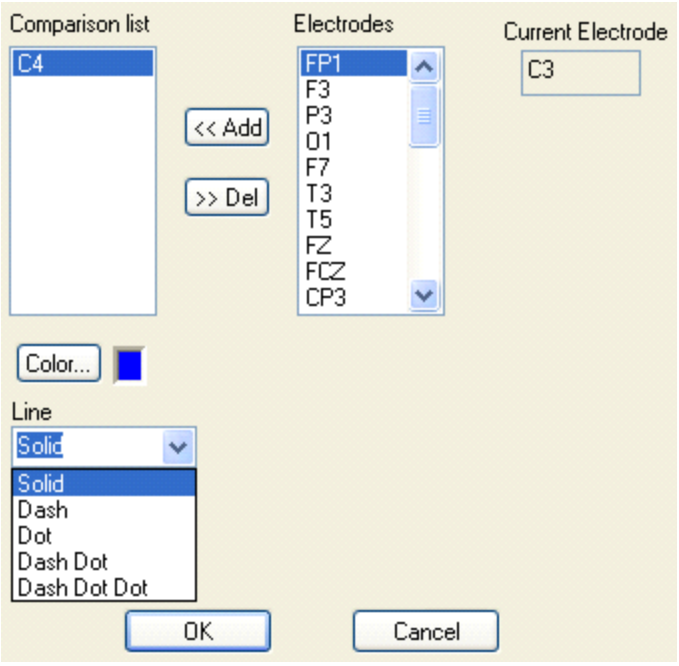
Unhide Electrodes. This option toggles the display of the channels designated as Hide channels.

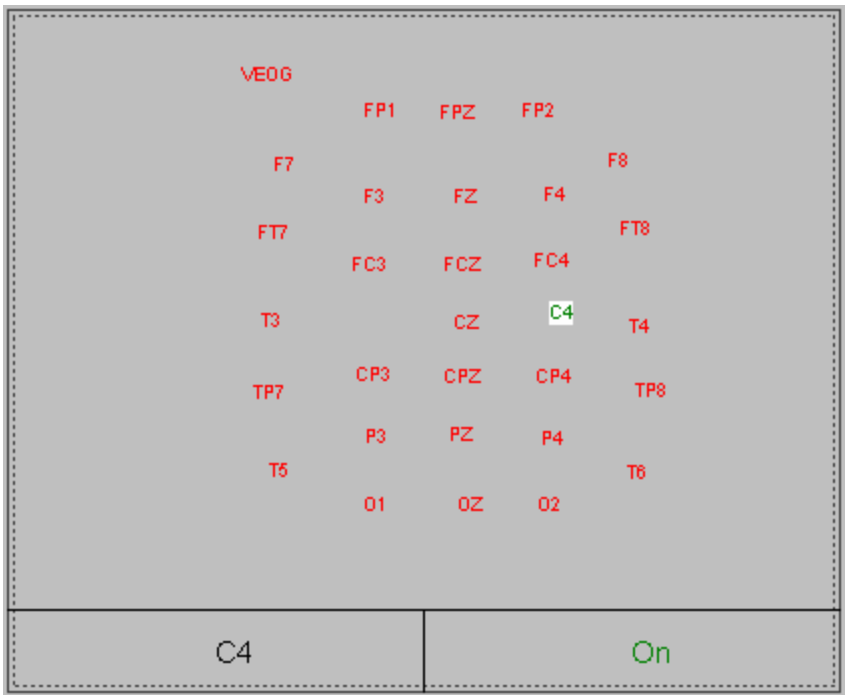
***Right mouse* options inside an electrode display**. If you position the mouse inside an electrode display, and click the *right mouse* button, you will see the following options.



Compare Electrode(s). This feature allows you to select electrodes to superimpose on the original electrode display. In the *Electrodes* column, highlight an electrode of interest, and click the 

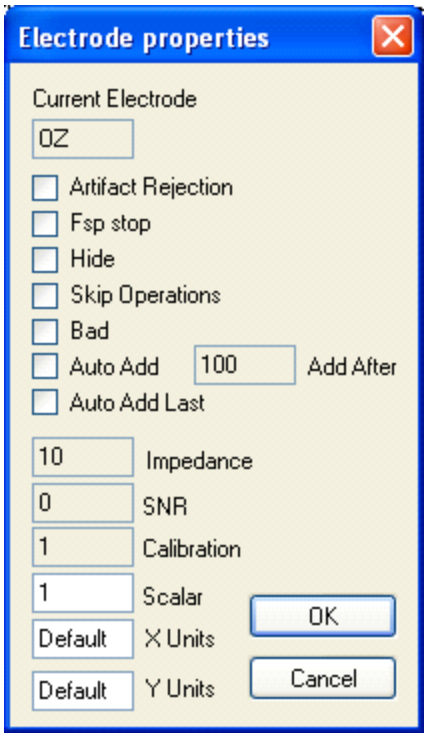
button. The electrode will move to the *Comparison List* column. Alternatively, you can just click on the desired electrode(s) on the right side montage display.



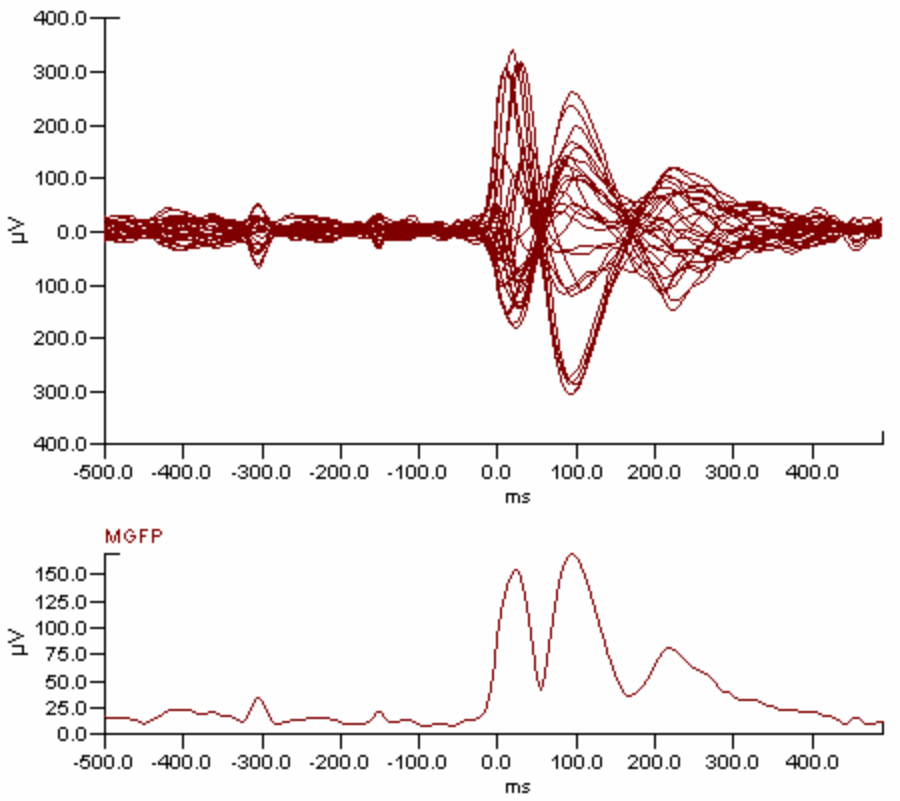


You also have the option to change the color or line style of any electrode in the list by clicking on the Color... button, or by selecting one of the line style options from the Line pull-down menu. Added electrodes can be deleted by highlighting the electrode and then clicking on the >> Del button. The *Current Electrode* field indicates the display you originally chose with the *right mouse* button. The super-imposed channels will appear in that display. To disable the Compare option, delete all electrodes from the Comparison List.

Channel Properties. Clicking this option displays the Electrode Properties display, where you may designate a channel "on the fly" as an Artifact Rejection, Bad, Skip, and so forth channel. These are the same options that you see in the **Channel Attributes** section (under **Overall Parameters**).

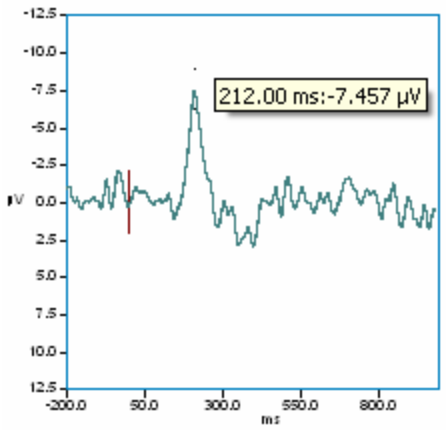


Butterfly Plot. Selecting this option will superimpose all channels together, plus calculate the Mean Global Field Power for the displayed epoch. The data will be redisplayed as shown below.

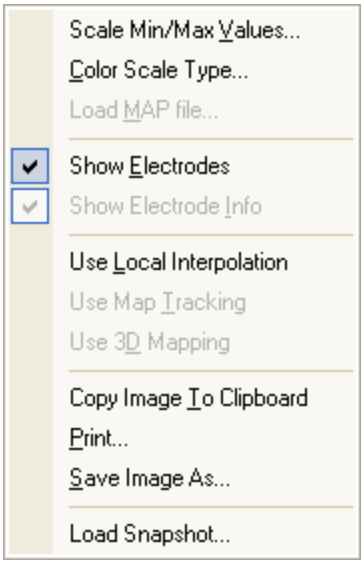


Deselect the option (or just close the window) to return to the original display.

Show Signal Info. This option enables the Tooltip that is seen as you move the mouse over a waveform.

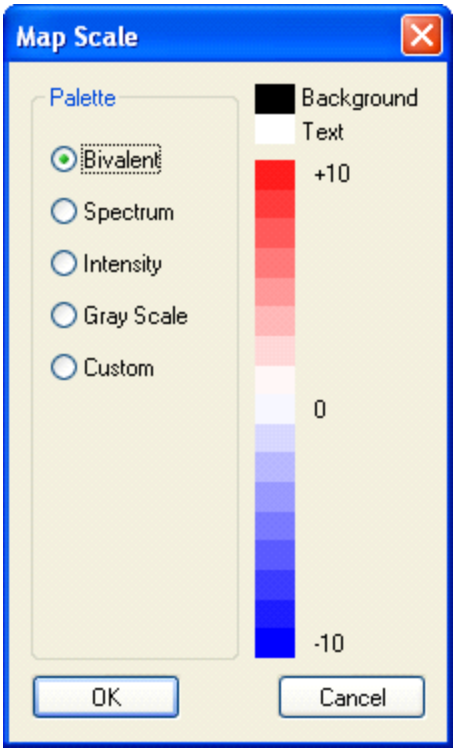


***Right mouse* options with online mapping**. If you click the *right mouse* button on an online map, you will see the displayed list of options. These perform the same operations as described in EDIT for offline mapping.



Scale Min/Max Values... Selecting this option displays the Map Scales screen, from which you may modify the Y Min and Y Max display scale values (µ Vs), and the X Min and X Max frequency interval (Hz).

Color Scale Type... Selecting this option displays the Level Control Options screen. The options displayed on the screen allow you to select from several color schemes to use for the maps. These are described completely in the EDIT manual, and fairly self-evident. Select an option, and click OK to see the new color schemes. With the Custom option, you have the opportunity to select any colors you wish, for the scale as well as for the Background and Text.



Load Map File. This option allows you to change *.map files without having to go back to the Mapping screen. Selecting it will display an Open File utility from which you may select a different .map file. Again, the .map files that you use

must agree in terms of the electrode labels with those in the setup file (under Channel Assignments). There may be fewer channels in the .map file than in the setup file, but not more. The .map files are created in MapGen.

Show Electrodes. This option will toggle on and off the "dots" that represent the electrode positions, as placed on the map template when it was created in MapGen.

Show Electrode Information. When enabled, you will see the voltage current values at each electrode site when you position the mouse over the electrode.

Use Local Interpolation. The default interpolation method is the Global Method, which uses all sites in the interpolation. The Local Method typically uses the 4 nearest electrodes for interpolation. The former produces a smoother map, but may take slightly longer to compute. Computational details may be found in the EDIT manual.

Use Map Tracking. This option is used offline in EDIT only.

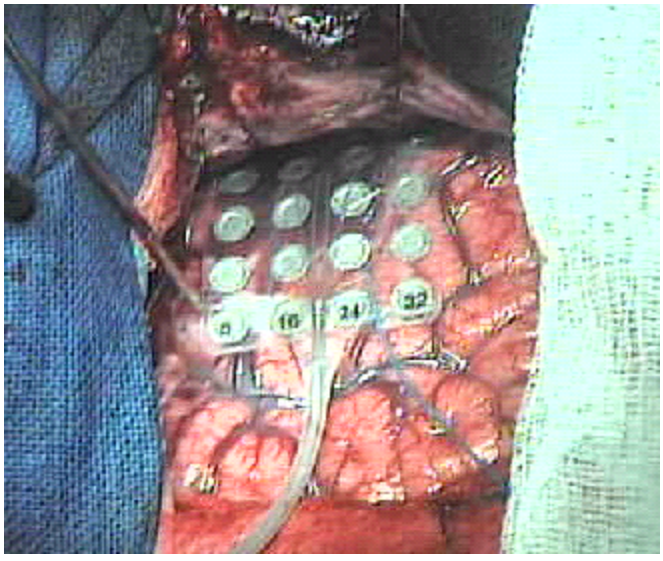
Use 3D Mapping. This option is used offline in EDIT only.

Copy Image To Clipboard. This option copies the map display to the Windows Clipboard, where it may then be pasted into other Windows applications.

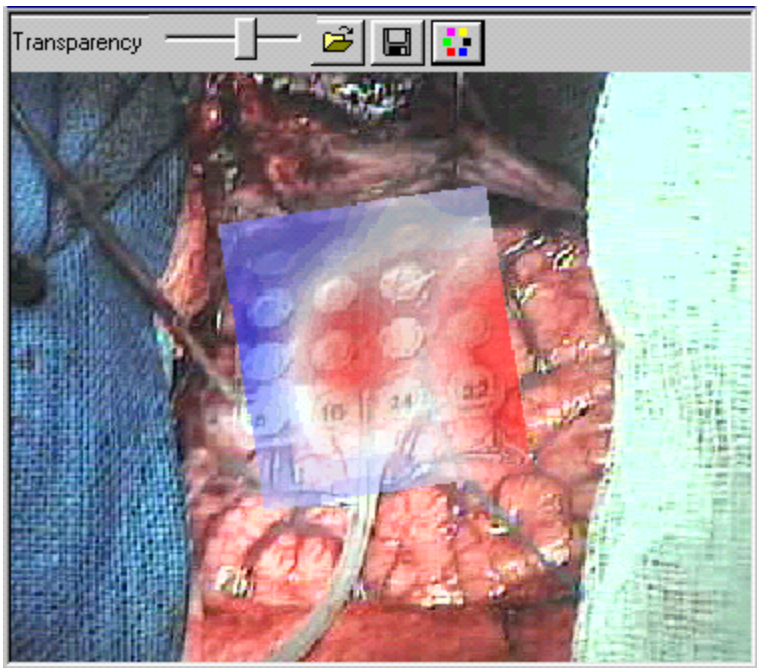
Print. This option opens the standard Print dialog screen.

Save Image As. Use this option to save the image as a Windows metafile (.wmf), it may then be inserted into other Windows applications. You have more editing options with a metafile than you do with regular .jpg or .bmp files.

Load Snapshot. This option allows you to load a BMP file and then superimpose a 2D map on top of the BMP image. One application would be to superimpose EP data recorded from a cortical grid on a BMP picture of the grid in place.

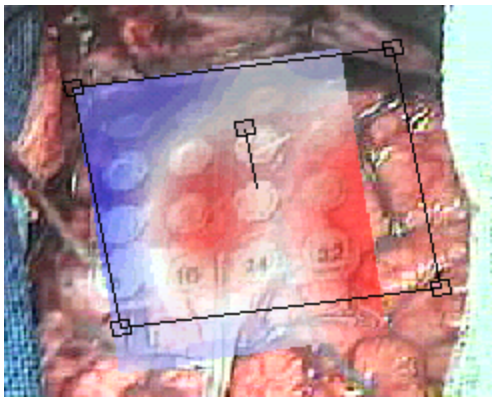


A 2D map can be positioned directly over the grid to show the potential distribution.



To generate a display such as the one above, you will need first to create a 2D map in the desired shape. Please refer to the MapGen manual for complete directions. Basically, you need to create a small shape in blue (about the size of a quarter), import it in MapGen, and then place the electrodes on it. The output is a *map file that can be selected from within ACQUIRE.

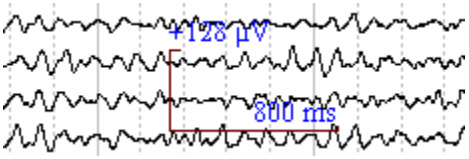
Set up the 2D map display as usual, *right click* on the map display, and select the Load Snapshot option to load a BMP file. You will see the map superimposed on the BMP, with a control box. Use the control box corners as you would any other window to resize and reposition the 2D map. Grab/drag the center box to rotate the image. Use the Toolbar icons to make the map display more or less transparent, to load a different file, to save the image as a BMP file, and to change the Color of the control box lines.

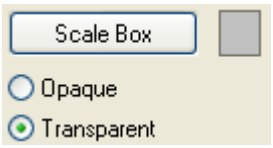


Left click inside the map part to display the control lines; click outside the map display to hide the control lines.

4.2 Scale Tool

On the scrolling Single Window display, you will see a Scale Tool. You can change the color of it, and make it opaque, if desired. Close the Single Window display, and go to **Options** → **Single Window Settings**. The Scale Tools options are at the lower part of the display.

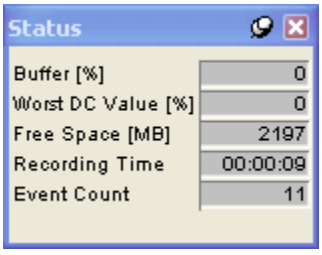




When you use the up and down arrows from the Toolbar to scale the waveforms, the scale tool will be adjusted accordingly.

4.3 Status Boxes

A Status box will be seen in the data windows during acquisition. The fields in the Status Boxes vary depending on the file type (CNT, EEG or AVG). From time to time you may "lose" the Status boxes seen in the data displays. Should this happen, click the button on the Toolbar to restore them.



Buffer [%]. This value shows what percentage of the buffer space is being filled during acquisition. If this number remains consistently high, it may be an indication that you are close to or exceeding the limits of your machine (see #1 under **Special configuration concerns for continuous acquisition** 19 above).

Sticky pins. The Status boxes have a "Sticky Pin" in the upper right hand corner. They are convenient devices to make the Status boxes stick with the data files where they belong, or elsewhere.

Worst DC Value [%]. This shows the greatest percentage of amplifier saturation.
Free space [MB]. This value provides an ongoing indication of how much free space remains on your hard disk drive (or other drive designated for storage). It is activated when you start storing the data.

Recording Time. While saving the data, the Recording Time indicates how long the saving process has been in progress. The clock does not stop when acquisition is paused. It is activated when you start storing the data.

Event Count. This field displays the accumulated count of events in the file (such as, the number of triggers and responses sent from STIM). It is activated when you start storing the data.

5 Appendix A: Differences in ACQUIRE Among Amplifiers

There are a few differences in ACQUIRE depending upon which amplifiers you have installed - *SynAmps*, *SynAmps*^{2}, *SynAmps RT*, *SynAmps Wireless,* or *NuAmps*. Additional information regarding each feature may be found above, or in the amplifiers manuals.

A/D Rate

The A/D Rate is found in the Amplifiers section, in the Acquisition section. *SynAmps*^{2} and *SynAmps RT* have a maximum A/D Rate of 20000Hz (regardless of the number of channels). *SynAmps* have a maximum A/D Rate of 20000Hz when using more than 8 channels, 50000Hz when using the 8 designated channels, and 100000Hz when using the 4 high speed bipolar channels. *NuAmps* have a maximum A/R Rate of 1000Hz. *SynAmps Wireless* have AD Rates of 256, 512, and 1024.

Number of Channels (per Amplifier)

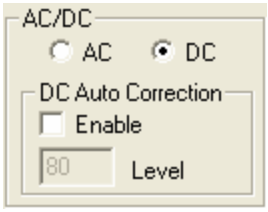
The Number of Channels field is found in the Amplifiers section, under Overall Parameters. For a single *SynAmps*^{2} or *SynAmps RT*, the maximum number of channels is 70 (64 mono, 4 bipolar, and 2 HLI). A single *SynAmps* has a maximum number of 32 channels (28 mono and 4 bipolar). *NuAmps* have a maximum of 40 channels (mono). *SynAmps Wireless* has a maximum of 32 channels.

Acquisition Mode

SynAmps Wireless amplifiers are used in Continuous mode only. The other amplifiers can use any acquisition mode.

AC/DC

The AC/DC option is found in the Amplifiers section, under Overall Parameters. With *SynAmps*, *SynAmps*^{2} and *SynAmps RT* you can record in either AC or DC modes. *NuAmps* have DC mode only. *SynAmps Wireless* are AC only.



DC Correction and DC Level

The DC Correction and DC Level options are found in the Amplifiers section, in the Acquisition section. The options are available for *SynAmps* and *NuAmps* only.

Deblocking

The Deblocking option is found in the Amplifiers section, in the Acquisition section. The option is available for *SynAmps*^{2} and *SynAmps RT* only.

Gain

The Gain 

setting is found in the Amplifiers section, in the Amplifier Settings section. The Gain field is displayed for *SynAmps* and *NuAmps* only. *SynAmps* have a programmable Gain, from 150 to 12500. *NuAmps* have a fixed gain of 19. *SynAmps*^{2} and *SynAmps RT* also have a fixed Gain: 10 in DC Mode and 2010 in AC Mode. *SynAmps Wireless* amplifiers have a fixed Gain of 1500.

Individual Channel Assignment (Gain and Filter)

With *SynAmps*, you can assign different Gain and Filter parameters to selected channels. With *SynAmps*^{2} and *SynAmps RT*, you can assign different Filter parameters to selected channels (the Gain is fixed). With *NuAmps*, the Gain and Filter parameters are the same across all channels (no individual channel programming). *SynAmps Wireless* has assignable Filtering across channels.

32 Bit Acquisition

The 32 Bit Acquisition setting is found in the Amplifiers section, in the Amplifier Settings section. The option is relevant for *NuAmps* only. The 

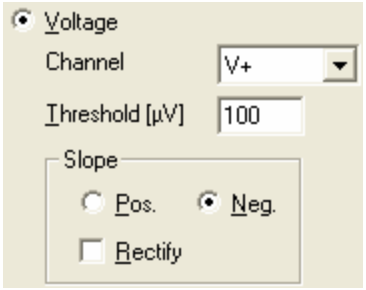
option lets you acquire data in either 32-bit or the original 16-bit modes. If you are recording in DC, you must use 32-bit acquisition because of the wider dynamic range it allows, and to record the slowest frequency activity accurately. In general, 32-bit acquisition is preferred in all cases. The one consideration is that it will essentially double the file size as compared to the 16-bit mode.

High Level Inputs

The High Level Inputs screen is seen with *SynAmps*^{2} and *SynAmps RT* only. It is used to configure ACQUIRE to receive signals from sources other than the amplifiers.

Voltage Triggering

The Voltage settings options are found in the Triggers section under Overall Parameters. Voltage triggering is an option with *SynAmps, SynAmps*^{2} and *SynAmps RT* only. You must be in Epoched acquisition mode for the fields to be active. Voltage Triggering is not an option with *SynAmps Wireless*.



Perform DC Correction

DC Corrections during acquisition are made when you click the DC button on the Toolbar (or by clicking **View** → **Perform DC Correction**). The option is used with *SynAmps* only.

Calibration

Calibration is initiated by clicking the Cal button on the Toolbar (or from **Acquisition** → **Calibration**). Calibration is possible with *SynAmps* only. *SynAmps*^{2}, *SynAmps RT, NuAmps*, and *SynAmps Wireless* are factory calibrated, and no local adjustments are needed.