LabScribe Data Acquisition Software Manual.

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Introduction

Welcome

Thank you for choosing *iWorx* LabScribe Data Recording and Analysis Software. Developed over a 5-year period, LabScribe software is the result of more than seventy man years of collective experience in data recording. We are confident that this software will make your data recording and analysis easier and welcome suggestions for improving our products. Please contact us with comments, concerns or suggestions at 800-234-1757 or via e-mail at: support@iworx.com.

How to Use This User's Guide

This User's Guide assumes you know how to operate your computer and are familiar with basic Windows terminology. The **Table of Contents** lists each chapter and its contents. You can use it or the index to locate pages on a particular subject. The **Appendix** provides some useful reference materials.

We have divided the subject matter into categories and explained each in detail, but if you'd rather cut to the chase, The **Quick Start** chapter should have you recording data in less than an hour.

System Requirements

LabScribe recording software requires a Pentium II-level computer running Windows 98, Windows ME, Windows 2000, or Windows XP with at least 128 megabytes of RAM and at least 50 megabytes of free space on your hard drive.

The preferred processor is a Pentium III or Pentium 4 with AGP graphics card, 256 megabytes of RAM running Windows 98/Me or Windows 2K/XP. The minimum recommended system configuration is a Pentium II, 300 megahertz computer. The faster the processor, the smoother the screen scrolling, however, all data is recorded regardless of the screen scrolling display.

Installation

From CD

LabScribe software is provided on a CDROM. If you don't have a CD drive, the software installer can be downloaded from our FTP area. Point your browser to http:/www.iworx.com., select Support from the directory, and sign up for the *iWorx* Users' Area. All installers are available at the Users' Area.

WARNING: Do not connect your *iWorx* hardware to the computer until **AFTER** the software installation is complete.

To install the software using the CDROM:

1 Insert the LabScribe installation CD.

2 A welcome screen will appear offering to install **Software**, **Hardware**, or **Manuals**.

3 Choose **Software**, then choose the Windows operating system currently in use (**XP, 98, 2000, ME**). At the prompt enter your name, the name of your company or institution, and software serial number (on the CD cover). Click **Next.** It is important to note that the software will not install without a proper serial number. Installation will now proceed. Follow the instructions presented by the **Install Wizard**. The **Install Wizard** will tell you when the installation is complete. The installer will restart your computer once the software installation is complete

4 After installing the LabScribe software, you can install lab manuals associated with various kits by clicking the **Manuals** button. You must install the LabScribe program before you can install the laboratory manuals

5 You can also install Adobe Acrobat Reader, which is required to view .pdf versions of the lab experiments.

6 Remove the installation CD from the drive, connect and turn on your iWorx Hardware.

Note: *When your hardware is connected for the first time, Windows will advise you "New Hardware found" and proceed to load the driver automatically. If for some reason Windows cannot locate the driver. Point the install wizard to the **iWorx/LabScribe/drivers folder** in the **Program Files folder**.*

From User's Area

To install using the downloaded installer from our FTP site:

1 Go the **Users' Area** on the iworx.com website. Select the proper installer for the Windows operating system on your computer. After downloading the LabScribe software installer, double click on the downloaded file. It is a self extracting archive, which will automatically launch the installer after it extracts. (Files are normally stored in the **Windows Temp Folder**). The installer will then open the **Install Wizard** and walk you through the installation.

2 Go to step 3 above.

Registration and Updates

Be sure to register on-line at our website at: http://www.iworx.com. Registering your software ensures that you are notified of updates, new releases, send the free upgrades you are entitled to for as long as you use the program. Software and .pdf manuals are available from the password protected area of our website. Passwords are available to registered users only by submitting an e-mail request.

Comments and Suggestions

iWorx/CB Sciences understands that user feedback is critical to the improvement of any software product. If you have ideas, suggestions or criticisms, please contact us at: support@iworx.com.

Technical Support

If you cannot find an answer in this User's Guide, please check the list of FAQ's (Frequently Asked Questions) on our website. If you still cannot find a solution to your problem, technical support is available to all registered users at no charge via e-mail, phone, fax or mail. When requesting technical support, please follow the steps listed below:

- Write down your question or problem and the actions you took that created the problem.
- Be prepared to duplicate the problem.
- Note any error messages.
- Note your computer model.
- Note your operating system version.
- Note the amount of RAM (Random Access Memory) in your computer.
- Note your LabScribe Software version number.

See the sample customer support form in the appendix of this manual.

Contacting *iWorx*/CB Sciences

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Web: http://www.iworx.com

For Technical Support

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Chapter 1: Quick Start

Start here if you are already familiar with data recording concepts. This chapter contains all you need to know to begin recording data quickly and easily.

Managing Signals

The management of recorded data is divided into three steps:

1 Recording data onto the computer,

2 Navigating the recorded data to find particular areas of interest, and

3 Outputting the data either in printed or analyzed form.

Recording Data

Recording data is the most basic of the three steps. It is also the only one that is time critical. That is, you must record data when it happens, whereas navigating, analyzing or printing data can occur anytime after the data has been recorded. The following section explains the basic concepts and controls required to record data using the LabScribe software.

Start Recording

The most basic control in the LabScribe software is the one that starts and stops the recording. This control is found in the upper right hand corner of the **Main** window. After ensuring that the source of your signal is properly connected to your data acquisition device, click the **Start** button to begin recording. While data is being recorded the **Start** button will change to a **Stop** button. Click **Stop** at any time to end data recording.

Displaying Data

The events you want to record using the LabScribe software may be very slow, like the discharge curve of a 9-Volt transistor battery, which can take hours; or very fast, like the QRS complex in a human electrocardiogram, which may take only a fraction of a second. LabScribe software allows you to record both slow and fast events, while displaying the recorded results in a format that is easily interpreted. To manage the temporal display of your data in the LabScribe software, a parameter called **screen time** is used.

1 **Screen time** is simply the amount of time represented by one full screen of data. When the program opens, the default screen time is set to 10 seconds. You can change the **screen time** by using the **Half** or **Double Display Time** controls in the toolbar (Figure 1-1 on page 4).

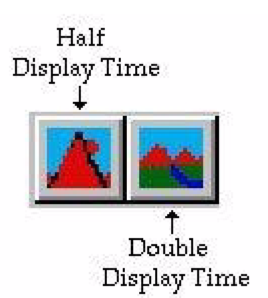


Figure 1-1: The Display Time icons on the LabScribe Main window toolbar.

• Clicking the **Half Display Time** button (big mountain) “halves” the screen time. So, a 10-second, full-screen display becomes a five-second, full-screen display, effectively doubling the display resolution.

• Clicking the **Double Display Time** button (little mountain) doubles the screen time. Therefore, a 10-second, full-screen display becomes a 20-second, full-screen display allowing twice as much data to be displayed on one screen.

2 To manage the vertical display on the data on the **y-axis** of the window, the LabScribe software uses an **AutoScale** feature. The **AutoScale** function examines the recorded data in the current screen and adjusts the display so that the data is centered along the y-axis, and the amplitude is adjusted to allow the best possible view of all of the data.The **AutoScale** button is located on the channel bar of each data channel.

• Clicking the **AutoScale** button resizes the data and centers it on the current screen. The **AutoScale** button can be used as frequently as needed.

• Clicking the **AutoScale** button, when large artifact spikes are present on the screen, will result in a smaller than optimal display of real data since the **AutoScale** function sets the highest and lowest data points close to the upper and lower limits of the screen.

3 The **value display** box also appears on the channel bar above the channel window. The amplitude value of the data at the position of the cursor or the value of the data point that is currently being recorded is displayed in the box, in the units you specified. If you are using **Dual Cursor Mode,** the difference between the amplitudes at **Cursor 1** and **Cursor 2** will be displayed.

4 To the right of the **value display** box, you will see a red triangle which is used to move the channel bar up and down, Moving the triangle changes the size of the channel window and the amount of space allocated to the adjacent channels.

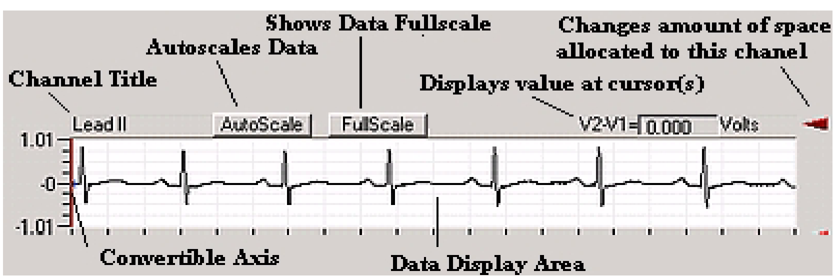


Figure 1-2: The common controls of each channel in the LabScribe Main window.

Controls

The main controls for the LabScribe program are located in the **Preferences** dialogue windows in the **Edit Menu**. Controls are also found on the **right-click** menu of each channel. The **Preferences** dialogue pages are used to control basic program parameters, such as the outputs, sample speed, and recording mode. The **right-click** menu is generally used to manipulate the raw data through online functions, such as transformations that convert the raw data to rates, integrals, derivatives, and more.

The Preferences Dialogue Pages

From the **Preferences** dialogue pages, parameters controlling the **Channels**, **Sampling**, **Stimulator(s)**, computed **Functions**, and **Output Sequences** can be set. For example, the number of channels to be displayed in the **Main** window and their titles, the sampling rate, and the display width of the screen can be set from this dialogue window. Many more parameters, some explained in other sections of this manual, can be set from the **Preferences** pages. These parameters can also be saved as a **settings file**, to be used again and again to perform the same experiment. The creation of groups of settings and the actual settings themselves is accomplished through the functions of the **Settings Menu**.

The Channel Right-Click Menu

From the channel **right-click menu**, some of the parameters also controlled in the **Preferences** dialogue pages, can be set. These include **Input Mode**, **Units**, **SetScale**, and **Title**.

More importantly, raw data can be transformed by computed functions and displayed as values which provide an easier interpretation of the data. For example, cyclic data, like that of an ECG, can be transformed by **Rate** function to a plot of the subject's heart rate (BPM). Some of the functions available include: **Frequency, Period, Integral, Derivative, Channel Math, Spirometry Volumes,** and **EEG Power Spectrum**. By default, the source of raw data for the transformation is set to the channel above the computed function channel; but, the channel that is the source of the raw data can be specified through the **Set Raw Ch** function on the **right-click menu**.

Some other functions, like software-based **Filters** and **Stimulator Displays**, are also controlled from the **right-click menu**.

Saving Data

Data recorded in a file can be saved, closed, and opened at a later time for analysis.

To save the recorded data in a file, select **Save As** in the **File** menu. Name the file in the **file name** box. Choose a destination on the computer in which to save the file (e.g. the *iWorx* or class folder). Click the **Save** button to save the file (as an ***.iwd** file).

Navigating Data

Once recorded, data is "navigated" or moved through in a few ways:

Analysis Window

An area of the data can be selected for viewing and measurement in the **Analysis** window.

1. Use the screen time controls (**Half** or **Double Display Time**) to provide a better view of recorded events. Click on the **Double Display Time** button (little mountain in toolbar, Figure 1-1 on page 4) until all of the data is visible in a single screen.
2. Use the **Dual Cursor** button (button with two vertical lines in Figure 1-1 on page 4) in the toolbar. Two cursor lines appear on the **Main** window. Use the cursors to bracket areas of interest within the visible data. The selected area can then be expanded to full screen in the **Analysis** window.

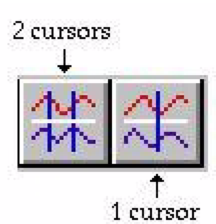


Figure 1-3: The Cursor icons on the LabScribe Main window toolbar.

3. Once the cursors are positioned, click the **Analysis** button in the toolbar. The area of data between the cursors will now be displayed full screen in the **Analysis** window. Other cursor uses are described in the **Display** section of this manual.

Marks

Marks can also be used to navigate data. A **Mark** is a text annotation made while recording or after recording, that is locked to the data at a certain point in time.

1. To mark the record while you are recording, use the keyboard to type a message on the **Marks** line. Pressing **Return** or **Enter** on the keyboard will enter the text mark on the recording at that time.

2 When reviewing data, you can move directly to a mark from anywhere in the data using the **Marks** window. To open the **Marks** window, click on the **Marks** button in the toolbar or select **Marks** from the **Window** menu of LabScribe. Select the mark of interest. Click the **GoTo** button to move directly to the area of data that contains the mark.

3 **Marks** can be entered after data recording is complete using the **Single Cursor** button (the button with a single vertical line in Figure 1-1 on page 4).

4 The text attached to a mark can be seen at the bottom of the screen, just above the timeline. Text marks can be dragged and dropped anywhere in the record. For example, a mark may denote that a drug was administered at a certain time. Using the mouse, you can click on the text associated with a mark and drag it to the channel to which it corresponds.

Scroll Bar

Lastly, data can be navigated by using the scroll bar at the bottom of the **Main** window. Click on the right scroll arrow to move to the data on the right side of the screen. Click on the left scroll arrow to move to data on the left side.

Getting Data Out

Printing Data

The most obvious method of exporting data is to print it. The **Print** command in the LabScribe software prints the window (**Main, Analysis, ScopeView, Journal**) in the foreground.

To print the **Main** window, use the **Display Time** controls to adjust the amount of data on the screen. Pull down the **File** menu and select **Print**. Choose from the following print ranges that are available:

- **All**: Prints the complete file.
- **Pages from___ to ___**: Prints only the pages in the range selected.
- **Selection**: Prints only data visible in the window.

Copying and Pasting Data

Data can be exported using the **Cut, Copy** and **Paste** commands located in the **Edit Menu** of the program.

The **Copy** command always looks at the window in the foreground. For instance, using the **Copy** command, while the **Main** window is in the foreground, copies the data in the **Main** window to the clipboard (as a picture). Adjusting the screen time affects what data will be included in the picture. Copying data is best done from the **Analysis** window; you have more control over which channels and time domain will be displayed and copied.

Exporting Data

Select areas of data in the file can be saved for export.

- Select the area of data to be saved and exported using the **Dual Cursor** mode in the **Main** window.
- Click the **Analysis** button in the toolbar to view the selected data in the **Analysis** window.
- Open the **File** menu and select **Export**. A dialog box appears and provides for the naming and format of the file to be exported from the **Analysis** window. Files to be exported can be saved pictures (**.bmp - bitmap** and **.png - portable network graphics** formats are currently supported), text file (**.txt - ASCII** or **.atf - Axon Text**), as a **MatLab** file (**.mat**), or a **DADiSP** file (**.dat**).
- Complete data files can be saved, from the **Main** window, as a **MatLab** file or **DADiSP** file.

Analysis

Apart from the cursor measurements available in the LabScribe **Main** window, analysis occurs in two places. Data manipulation, close examination, and a variety of calculations are handled in the **Analysis** window. and wave to wave transforms are called from each channel's **right-click** menu while viewing the **Main** window. For specific information on analyses that each of these categories can perform, refer to the chapter in this manual on **Analysis**. The basics are summarized in this chapter.

On a given selection of data displayed in the **Analysis** window, the program can calculate and report the selected parameters. These are displayed across the top of the window in the **Calculated Value Display** area. By selecting the **Send To Journal** items in the **Tools** menu (or **right-click menu**), these values for the selected parameters can be sent to a part of the LabScribe program called the **Journal**.

Journal

The **Journal** is an internal word processing application capable of accepting calculated numbers from the **Analysis**, **FFT**, or **XY** window as well as copied pictures from any window, In addition to values and pictures, text can be put into the **Journal** using the keyboard. This allows lab reports or explanatory documents to be composed without having to leave the LabScribe program. The **Journal** contents are saved to disk in the popular **.rtf** format, so that saved **Journal** documents can be imported and opened for editing or printing by any commercially available word processing program. To access the **Journal**, select the **Journal** item from the **Windows** menu of the LabScribe software or the **Journa**l icon on the LabScribe toolbar.

Calculations

In the **Analysis** window, data can be reduced using mathematical operators like **mean** or **maximum**. These operators generally take a selection of data, operate on it and produce a single number as a result.

A second and quite different type of analysis requires that an entire set of data be transformed, point for point, into a completely different, but related set of data. Transforming data into its first derivative is a good example of this type of analysis. LabScribe software includes several of these **Wave-to-Wave** transforms in the **right-click** menu of each channel.

The list of available functions is always expanding. LabScribe V1.8 includes: **Periodic** functions, **Integrals**, **Derivatives**, **Channel Math**, **Filters**, **Power**, **Spirometry**, **Cardiac**, and **EEG**. By default, calculated channels always use the channel immediately above them as the **raw data channel**. This works, if the channel above the calculated channel can be used as a source of the signal to be transformed. For example, if you select the **Rate** function (under **Periodic**) to be displayed on Channel 4 of a 214, the pulse transducer can be connected to Channel 3. But, transformed data can also be displayed on channels that do not have inputs (Channels 5, 6, 7, 8) or channels that are unused. Going to the **Set Raw Ch**annel item at the bottom of the channel **right-click** menu allows the source of the raw data to be selected from the channels listed in the submenu.

These calculations are also available in the **Function** list on the **Channels** window of the **Preferences** dialogue window. Functions typically used on signals recorded in a biology lab are listed. Functions can be changed, and these modifications can be saved in new **settings files** stored in the **Settings Groups**.

Chapter 2: Acquisition

The Basics:

Time, Temporal Resolution, Sample Speed, and Aliasing

Temporal resolution in digitally recorded data is determined by the sampling rate, also known as sampling speed. To select a suitable sampling rate, you will need some background on the theory and use of analog-to-digital converters (ADC).

The ADC in the *iWorx* computer interface takes simple voltage measurements at regular intervals. The voltage measurements (Y-axis values) and the times at which the voltages were recorded (X-axis values) are sent by the *iWorx* interface to the LabScribe software as a pair of (X,Y) coordinates. The LabScribe software displays these coordinates as data points by plotting them. The software then connects the data points with a line to create the smooth, graphical appearance of an analog chart recording; but, only the data points themselves are hard measurements. The lines that are drawn to connect the data points are “educated guesses” made by the software and may be misleading. For example, if the sampling speed being used is not fast enough for the data being recorded, the display will not accurately represent the real data. This misleading behavior of data acquisition software, can be avoided by using a sampling speed that is fast enough for the data being recorded.

When the sampling speed is set in the LabScribe software, the hardware is being told what the time interval between samples will be. For example, 100 samples per second equals one sample every 10 milliseconds. To avoid creating displays that may be misleading, a simple question about the sampling interval needs to be asked: Is there a chance that something important has occurred between the sample points?

If the answer is “yes,” then the sampling speed must be increased in order to see and record that event. In the example presented in Figure 2-1 on page 9, a sine wave with a frequency of 100Hz is sent to the ADC. In the screen on the left, the data points, recorded by an ADC set to the same sampling speed as the frequency of the sine wave, are marked.

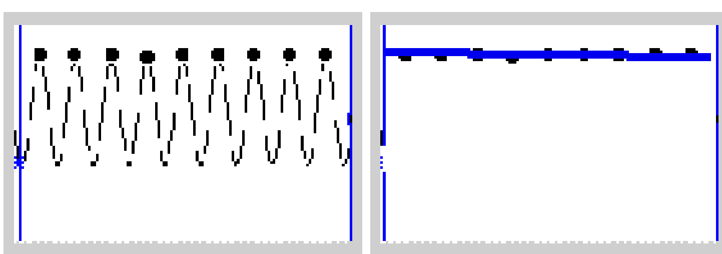


Figure 2-1: A 100Hz sine wave recorded at 100Hz. The samples coincide with the peaks of waves; so, the data points can be connected by a straight line.

Because the sine wave has the same frequency as the sampling rate, each recorded data point occurs at the same place in each cycle of the sine wave. In the screen on the right, a straight line is the result when the data points are connected by a line. The line is a false representation of the real data, which is a sine wave. To fix the problem and render a better picture of the data, a faster sampling rate is required. If the sampling rate is increased to 110 samples a second, the data points would be a millisecond closer to each other than at 100 samples a second, but a 100Hz sine wave would still have only one data point for each cycle. When the data points are connected by a line, a sine wave with a frequency of 0.1Hz is displayed on the screen. Again, the wave displayed on the screen is not a true representation of the real wave because the sampling speed is too slow.

So, how fast does the sampling speed need to be to record a reasonable representation of a real waveform? A general rule of thumb is to sample at a rate that is a minimum of five times faster than the fastest frequency of interest in the waveform.

To determine the optimal sampling frequency, find the shortest event in a sample recording. For example, the **R** wave has the shortest duration of any event in the ECG and should be used to determine the sampling speed needed to record a reasonable representation of the ECG. Next, find the rise time (in seconds) of the **R** wave. The rise time is the time it takes the wave of interest to go from its start to about 2/3 of full value, In the case of the **R** wave in an ECG, this value is about 20 milliseconds (0.020 seconds).

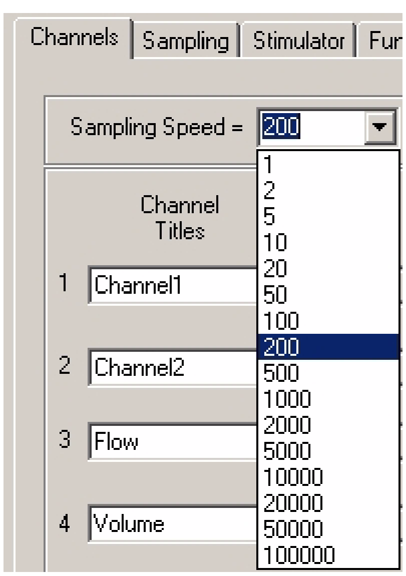
Substitute the value 0.02 for the rise time in the following equation to determine the bandwidth of the event (R wave):

$$0.159/\text{Rise Time} = \text{Bandwidth}$$

$$0.159/0.020 = 8$$

Finally, multiply the bandwidth by five to determine the minimum sampling frequency needed, which is 40Hz in this example. Higher sampling rates give better pictures, at the expense of making data files larger. Therefore, choosing a proper sampling speed must be a balance between the accurate portrayal of the data and the unwieldy size of the data file.

The default sampling speed set in the LabScribe software is 200 samples per second. This is adequate to execute most of the laboratory experiments presented in the laboratory manuals furnished with the *iWorx* teaching kits.



If sampling speeds are set manually, it is always best to start sampling the data at the fastest speed possible, then, slowly reduce the sampling rate to a speed where data initially begins to degrade. Finally, set the sampling speed just above the rate that initially cause degradation. See the examples of pulse waves sampled at different frequencies in the appendix.

Sampling rates are set from the **Sampling Speed** menu on the **Channels** page of the **Preferences** dialogue window. The **Preferences** dialogue window is called by selecting **Preferences** from the **Edit Menu**.

The speeds displayed in the **Sampling Speed** menu are rates per second per channel. This menu is dynamic, the maximum available sampling speed will adjust depending on how many channels are open.

Make sure the **Display Time**, as programmed on the **Channels** page of the **Preferences** dialogue window, is set to 10 sec before doing the following exercise.

Exercise

1. Plug the DIN connector on the cable of the pulse transducer (PT-104) furnished with your kit into Channel 3 on the *iWorx* interface. Wrap the plethysmograph firmly around the end of the subject's middle finger.

2 Open the **Channels** page in the **Preferences** dialogue window, and set the sampling speed to 1000 samples per second. Record 10 seconds of data.

3 Next, set the sampling speed to 500 samples/second and record an additional 10 seconds of data.

4 Repeat this procedure for sampling speeds of 200, 100, 50, 20 and 10 samples/second.

Using the **Dual Cursor** function, select a section of each recording block from the **Main** window. Display the section in the **Analysis** window. Closely examine the recorded data as displayed in the **Analysis** window. Notice that the signal becomes progressively more coarse as the sampling rates go down, until eventually the signal is unrecognizable.

Vertical Resolution

As stated earlier in this chapter, the ADC takes measurements at regular time intervals to produce data points with X,Y coordinates, and that the LabScribe software later plots and connects the data points with lines.

The temporal resolution of the incoming signal was the topic of the previous section of this chapter. In this section, the vertical, or voltage, or amplitude resolution of the signal will be discussed.

When making a measurement of length with a ruler, the accuracy of the measurement is determined by how many gradations are printed on the ruler. Clearly, a ruler with gradations every eighth of an inch is more precise than a ruler with only a gradation every inch. The more lines or gradations there are per unit of measure, the more accurate the ruler.

If the ADC is considered to be a ruler for voltage, then, its resolution (its number of gradations) is determined by a parameter called “bit depth.”

In an 8-bit word, or byte, there are 256 (2^8) different possibilities for the value of the byte. A 9-bit word has twice that many possibilities (512), a 10-bit word has four times as many (1024) and so on. The ADC used in the *iWorx* 104/204/114 is 12-bit, providing 4,096 different possibilities for measurement. Since the input range of the 12-bit (204/104/114) ADC is fixed at ±5V (a full scale difference of 10V), the minimum measurement that can be made with an *iWorx* 204/104/114 unit is 10V/4,096, which is about 2.4 milliVolts. On the other hand, the *iWorx* 214/118 uses a 16-bit ADC providing 65,536 different possibilities. Since the input range of the *iWorx* 214 unit is 10V which can be divided by 65,536, the minimum measurement that the *iWorx* 214 can make is 152µV. In the case of the *iWorx* 118, the minimum measurement is 304µV because the *iWorx* 118 has a input range of ±10V (a full scale difference of 20V) with 16-bit resolution.

It is important to realize that it is not possible to make a measurement with more precision than ±2.4mV with the *iWorx* 204/104/114 (or ±152µV with the *iWorx* 214 or ±304µV with the *iWorx* 118) unless the bit depth is increased or the input range is narrowed. Changing the bit depth requires a different ADC to be in place in the unit. However, the input range can be easily narrowed by applying the amplification (gain) to the signal before the signal is presented to the ADC. If a 1000X gain is applied to the incoming signal by an amplifier, the minimum resolution of the ADC improves to ±2.4µV for the *iWorx* 204/104/114, ±152nV for the *iWorx* 214, and ±304nV for the *iWorx* 118.

Signal Conditioning

Gain

As pointed out in the section on vertical resolution, there is a minimum voltage beneath which the ADC cannot read. This voltage is ±2.4mV for *iWorx* 204/104/114, ±152µV for the *iWorx* 214, and ±304µV for the *iWorx* 118. If the signal being measured is very small, additional gain can be applied to the signal before it is presented to the ADC.

For example, consider an ECG, whose total peak to peak amplitude is only 2 mV. The number of steps that can be resolved with an *iWorx* 204 is 2mV/4.8mV or a little more than 2 steps, which is not sensitive enough to see any meaningful changes. If an amplifier is placed between the signal and the analog to digital converter (ADC), the "raw" signal can be amplified by a selected **gain**. For example, if the gain is 100 times (X100), the 2mV ECG signal becomes a 200mV signal. Now, when the amplified signal is presented to the ADC, it is 100 times bigger. Since the minimum signal of ±2.4mV for the *iWorx* 204 remains the same and the recorded signal is 100 times bigger, the noise is now only 1/40th of the amplitude of the signal (4.8V peak to peak /200mV signal).

If the signal is amplified 100 times (X100) and recorded with an *iWorx* 214, the results would be better. The minimum signal now would represent only 1/658th of the total signal (304µV/200mV). From this comparison it can be seen that a 16-bit ADC is much more tolerant of small signals, making the gain required to view a small signal with a 16-bit unit less critical.

Adding gain to the recording system improves the signal to noise ratio of the measuring system, but, the cost is that the ADC cannot see any signal above the +5V or below the -5V input limits (+10V and -10V on the *iWorx* 118). In the case where X100 gain is applied to a 0.1V signal, the amplified signal becomes 10V. This is above the +5V input limit of the ADC, so the signal is **out of range**. In fact, the **effective** input range of *iWorx* ADC units is equal to ±5V/Gain (±10V/Gain for 118). So, if a gain of X10 is used on an amplifier, the effective input range of the ADC drops to ±0.5V (±5V range/X10 gain). Any input signal larger than 0.5 volts will be out of range. If a gain of X100 is applied to the input signal, the effective input range of the ADC is restricted to ±0.05V, and so on.

Bioamplifiers

The bioamplifier channels of the *iWorx* 214/204/114 units apply gain to the input signals coming through them, when different recording modes are selected. The following table shows the gains applied for the modes selected:

Table 2-1: Gains for Each Bioamplifier Mode or Filter Setting

Mode	204	114	214
ECG (0.3-150Hz)	x1000	x1000	x1000
EMG (3-10KHz)	x1000	x1000	x1000
EEG (0.3-35Hz)	x10000	x1000	x1000

On the *iWorx* 214/114, the gain and filter modes are selected from the **Mode** menu on the **Channels** page of the Preferences dialogue window in the **Edit Menu**, or the **Input Mode** function in the **right-click** menu of Channels 1 or 2. On the *iWorx* 204, the gain and filter modes are selected by pressing the red mode button on the front panel of the instrument.

DIN 8 Inputs

The DIN 8 inputs on *iWorx* analog to digital converters can apply up to X1000 gain. This is accomplished through the placement of a gain programming resistor within the DIN 8 connector of the transducer or cable that can be plugged into the DIN 8 inputs of the *iWorx* units. Gain programming resistors are ALREADY PRESENT IN ALL *IWORX* TRANSDUCERS. Gain programming resistors can be installed on NON- *IWORX* transducers by rewiring the connector. Consult the hardware section in the appendix of this manual for the pin configurations and diagrams of the DIN 8 connectors used with *iWorx* ADC's.

Offset

Offset is sometimes referred to as "positioning." Some recorders, amplifiers, and transducers have a knob that positions the baseline of the recording on the screen. Positioning control permits the centering of the signal which makes measurements more convenient, or the lowering of the baseline to accommodate the display of a signal that has more gain applied to it. The availability of the **AutoScale** feature in the LabScribe software reduces the need for a positioning knob. In fact, the very low noise of the *iWorx* 214/118 makes positioning controls unnecessary as signals are automatically centered and expanded to fill the recording screen when the **AutoScale** button is clicked.

Filters

Filters can be set to remove certain frequencies from signals. Hopefully, the frequency information removed when the filters are applied is noise and not part of the signal of interest. There are two basic types of electronic filters: **Low Pass** and **High Pass**. When used in combination with each other, these filters can create either **Band Pass** or **Band Reject** (**Notch**) filters.

By definition, **Low Pass** filters PASS only those frequencies beLOW the set frequency. For example: in an electrocardiogram, a large percentage of the ECG signal information is contained in frequencies below 40Hz. A significant noise source in such recordings is the 60Hz line voltage (110V AC power, or mains) used to power equipment and lights. A 50Hz **Low Pass** filter would allow all frequencies below 50Hz (including lots of ECG information) to pass to the recorder, but would exclude all frequencies above 50Hz, including the 60Hz noise from the mains. The end result of using the 50Hz Low Pass filters is the creation of a quieter, more readable ECG. In general, the application of a low pass filter "quiets" the baseline and improves the signal to noise ratio of the recording.

On the other hand, **High Pass** filters PASS frequencies HIGHer than the set frequency. These filters can remove low frequency interference, such as baseline drift or a standing offset voltage, so that the user sees a more stable baseline.

The simultaneous use of **High Pass** and **Low Pass** filters can create a **Band Pass** filter. Three different analog band pass filters are available for the bioamplifiers on the *iWorx* 214, 204 and 114. The **Band Pass** filters on the *iWorx* 114/214 are enabled automatically when they are selected from the **Mode** menu on the **Channels** page of the **Preferences** dialogue window, or from the **Input Mode** function on the **right-click** menu of Channels 1 or 2. The **Band Pass** filters on the *iWorx* 204 are enabled when the mode button on the front panel is pressed. These are 4th order active electronic filters with the following values:

Table 2-2: Band Pass Filter Frequencies

Band	Application	204	214	114
0.3-35 Hz	EEG/ECG	X	X	X
0.1-150 Hz	ECG	X	X	X
3Hz-10KHz	EMG	-	X	X
3Hz-2KHz	EMG	X	-	-

Another set of **High Pass**, **Low Pass** and **Band Pass** filters can also be applied to each channel from the **Filter** function located on the **right-click** menu of each channel. These filters are not "Hardware" filters; they are executed in software and work on all ADC units running LabScribe software. Unlike hardware filters, software filters can be applied AFTER the data is recorded. These filters also work in real time and can be applied to data as it is being recorded.

Averaging in LabScribe

In addition to filtering, the LabScribe software can apply another quieting technique to data recorded at speeds less than 200 samples per second. In the section of temporal resolution, it was demonstrated that fast events require fast sampling speeds. What happens if slow events are recorded at a fast sampling speeds? More information is collected than is needed to accurately display the signal. What should be done with the extra data? At sampling speeds of 100 samples/sec or less, the LabScribe program operates on the “extra data” using a technique similar to the oversampling employed by CD players to reduce noise. The amount of oversampling that occurs is determined by the sample speed that you set. The end result is that small signals recorded at slow speed will appear less noisy than small signals recorded at high speed.

Outboard Conditioning

The *iWorx* 114/214/204 contain amplifiers and filters which can be controlled by the LabScribe software.These amplifiers and filters should be adequate for most applications. In cases where additional or custom signal conditioning is required, outboard devices can be used to condition the signal before it is presented to the *iWorx* ADC. *iWorx* makes a full range of amplifiers for this purpose, but any amplifier with an analog output can be used. This allows other amplifiers, like those from Thornton or Grass, or special purpose devices, like those made by Warner Instruments, Axon instruments, or World Precision Instruments, to be used with *iWorx* ADC units. Outputs from these and other devices can be connected to the available BNC inputs on the front panel of *iWorx* ADC units. Outputs of external devices can also be connected to the DIN 8 inputs with an adapter cable available from *iWorx*.

The *iWorx* 118 contains no built in amplifiers. It depends completely on external devices for signal conditioning.

Chart Mode

Once the signal source is connected to the *iWorx* unit and the signal conditioners are configured, data recording can begin. The most basic controls required are the ones that turn the recording on and off. LabScribe has three ways to **Start** a recording and two ways to **Stop** it.

Starting

The dialog boxes (Figure 2-2 on page 14) show the options for starting the recording process for both groups of hardware.

Figure 2-2: The LabScribe Start dialogue boxes

User

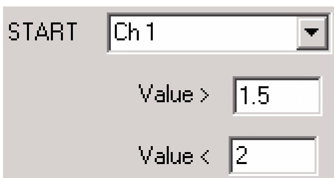
The easiest away to start the recording is for the **User** to manually press the **Start** button in the upper right hand corner of the LabScribe **Main** window. **User** is the default setting in Labscribe. Recording begins when the **User** presses the **Start** button. and will continue until one of the **Stop** conditions is met. **Pretriggering** is not possible in the **User** (manual) mode.

External Trigger

Sometimes, it is necessary to synchronize the beginning of the recording with the beginning of an external event. The LabScribe software can be configured to start recording when the *iWorx* hardware detects a voltage pulse (+3 to +5V amplitude) through the BNC connector of the **Trigger** input. Many devices have **Trigger** or **TTL** outputs that are capable of starting the LabScribe recording software; these devices include: stimulators, relays, pumps, valves and cameras.

Triggered from Channel:

For various reasons, data recording may not need to begin until the data itself reaches certain criteria. For example, it may be necessary to record an animal's body temperature, only if the base temperature exceeds 100°F. The LabScribe software could be programmed to begin recording when the data on the temperature channel exceeded 100°F. Thresholds above and below a certain data value can be set to start the recording.



Open the **Preferences** dialogue window from the **Edit Menu**. Click on the tab for the **Sampling** page. Pull down the **Start Mode** menu and select the **channel (Ch)** that contains the data to be used as a trigger. Set the values that the data must meet before recording is triggered. The diagram demonstrates that LabScribe is programmed to look for a trigger from the data on Channel 1 when the amplitude of the data is above 1.5V and below 2 V. **This feature is NOT available on iwx104/204/108 hardware.**

Pre triggering

When an **Ext**ernal **Trig**ger or a trigger from a data channel (**Ch**)is used, the data just before the trigger occurs may be important to record as well. For example, if the **R** wave is used to trigger the recording of an ECG, the **P** wave and other parts of the ECG that occur before the **R** wave can be recorded. The **PreTrigger** feature of the LabScribe software can be used to look back in time and display a small piece of data prior to the trigger. To enable pretriggering, check the box next to the label **PreTrigger** (in the **Start Mode** box on **Sampling** page of the **Preferences** dialogue window. Enter the amount of pretrigger time needed in the edit box to the right of the **Pretrigger** label.

Stopping

Once recording begins, the LabScribe programs offers two different ways to halt the recording: **User** or **Timed**.

User

User is the default **Stop** value for LabScribe and can be reset from the **Stop Mode** box on the **Sampling** page in the **Preferences** dialogue window. In **User** mode, the **Stop** button in the upper right hand corner of the LabScribe **Main** window will stop the recording when clicked. The **Start** button toggles to the **Stop** button, after the **Start** button is clicked to begin the recording. The **Stop** button remains visible until it is clicked.

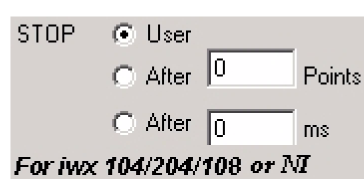


Figure 2-3: The LabScribe Stop dialogue boxes.

Timed

When **Timed** is selected as the stop mode, the LabScribe software will stop recording automatically after a predetermined time (in ms), which is entered into the edit box.

On an *iWorx* 104/204/108, the additional option of stopping after a set number of points is available.

Scope Mode

When to Use the Scope Mode

The first devices used to record data were electromechanical. These devices used a stylus or very fine pen that was moved by a sensitive motor. The frequency response of these machines was very low; the fastest events that they could record were on the order of tenths of a second. As science progressed, it became obvious that there were faster things in nature than pen recorders could visualize. The oscilloscope or "scope" is able to take a fast, brief snapshot of an event, but the continuous chart-like recording was sacrificed. An oscilloscope capturing a fast moving electrical signal, like an action potential, is analogous to high speed, stop motion photography capturing the movement of a hummingbird's wing.

To effectively use the **Scope** mode in the LabScribe program, the length of the snapshot (display time) and the sampling rate need to be set to accurately visualize the event. Events that are best captured using the **Scope** mode are brief and repetitive. Action potentials, and most neurophysiological signals, are good examples of signals that are best recorded in **Scope** mode.

In addition to being able to capture a very brief event in time, a proper trigger is needed to begin the recording of the event at the moment it takes place. Using the example of stop motion photography, if the high speed camera snapped the picture too soon or too late, the picture may not show the event that was trying to be captured. So, the acquisition of data at the right moment requires a proper trigger. In the **Scope** mode either of the previously discussed "non-manual" modes, **External Trigger** or **Trigger from Channel**, can be used to start the sweep.

Acquiring Data in the Scope Mode

Scope mode can be enabled from the **Sampling** page in the **Preferences** dialogue window, which is accessible under the **Edit Menu**. Data can be acquired on as many channels as are available in **Scope** mode. Data can be viewed in either **Chart** or **Scope** format with some limitations. Switching between formats can be accomplished by clicking on the **ScopeView** or **Main** window icons in the LabScribe toolbar. The limitations to viewing data in the **Scope** or **Chart** format are the following:

- If data is recorded in **Scope** mode, each sweep or record segment is treated as a block of data. When viewed in **Chart** mode, sweeps (or blocks) are laid end to end, in the order that they were acquired. Data can be scrolled, and any single block can be sent to the **Analysis** window.
- If data is recorded in **Chart** mode, the FIRST block or record segment will be taken as the sweep length (display time). Each block will appear as a sweep in the **ScopeView** window.

Set up the software

To program LabScribe to record in **Scope** mode, pull down the **Edit Menu** and select **Preferences**. Open the **Sampling** page of the **Preferences** dialogue window. Click on the **Scope** button. Next, set the **Start** mode that will begin the recording of the sweep. The triggers that are available are: **User**, for manual starting of the sweep that can be linked to the output of the ADC; **External Trigger**, for triggering by an external source; **Trigger by Channel**, for triggering by an input signal.

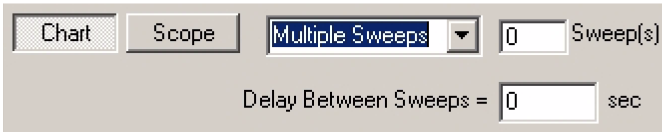


Figure 2-4: The Scope application setup controls

Next, the acquisition mode needs to be selected. This mode can be set to either **Repetitive** or **Multiple**, and is selected from the drop-down menu next to the **Scope** button on the **Sampling** page of the **Preferences** dialogue window.

Repetitive mode

When the **Start** button is clicked in **Repetitive** mode, each new sweep overwrites the previous sweep. Real oscilloscopes work in this way. When the **Stop** button is clicked, only the last trace is saved.

Multiple sweep mode

When the **Start** button is clicked in **Multiple Sweeps** mode, LabScribe will acquire and save a predetermined number of sweeps. The number of sweeps in a series can be typed in the **Sweep(s)** box on the **Sampling** page. The beginning of each recorded sweep is determined by the **Start mode** conditions. A **Delay Between Sweeps** can also be programmed in the **Multiple Sweep** mode. If zero is selected as the **Delay Between Sweeps**, the next sweep in the series is taken as soon as the software is ready, which is typically in 2 to 5 milliseconds.

Sweep Length

When operating in **Scope** mode, LabScribe takes “snapshots” of data. Each “snapshot” is called a sweep and has a pre-determined length. The sweep length (or **display time**) is set in the **Stop Mode** section of the **Sampling** page from the **Preference** dialogue window. By choosing **Timed** as the **Stop Mode**, the sweep length (in msec) can be entered into the edit box in that section of the page.

Sampling Rate

Determining the optimal sampling frequency in **Scope** mode is the same procedure as used for **Chart** mode. First, find the shortest event in the record. If the compound action potential is used as an example, the spike goes from baseline to about 80% of its full amplitude in about 0.35 ms. If you substitute.00035s for the rise time in the following equation:

$$0.159/\text{Rise Time} = \text{Bandwidth}$$

$$0.159/0.00035 = 454$$

If the bandwidth is multiplied by five, the minimum sampling frequency is 2270Hz. Doubling the sampling rate to 5kHz insures that the trace recorded is representative of the signal.

If the entire event of interest is only 0.1 sec long, a sweep at 5,000 samples per second occupies only 500 data points. Since the LabScribe program can accommodate up to 100,000 points per screen while recording, there is substantial room available for a wider display or a greater sampling rate.

Saving Your Data

Every Software manual has a section on the importance of backup and saving. LabScribe is no different. **SAVE YOUR DATA!**

Consider that the data acquisition process imposes new and different constraints on the task of saving data. A word processor or spreadsheet document can be saved anytime that the user thinks about it. The user simply stops writing and saves the document.

In a data recording application, data is constantly being added, sometimes at fantastic rates! (200,000 bytes/second at top speed) To save data, would require the recording to be stopped. In most recording applications, this is impractical.

When the recording is stopped LabScribe saves the current data to disk. This file can be seen in the LabScribe folder as **backup.iwd**. As the LabScribe program acquires data, it buffers the unsaved raw data to a file on the hard disk. This file can be seen in the LabScribe folder as **iwx_d_bin.buf**. In the event of an unexpected loss of power or computer crash, the data is preserved. When the LabScribe software is reopened after such an event, LabScribe will ask the user if they want to recover the data. If the answer is yes, the backup file is recovered and data is preserved. To view the recovered data file, use the **Open** command in the **File** menu to open the **backup.iwd** file. To permanently save the data, use the **Save As** function BEFORE RECORDING ANY NEW DATA. Recording new data will overwrite the **backup.iwd** file.

Chapter 3: Display

Introduction

From a functional standpoint, the LabScribe program is really two programs. It is primarily a **data acquisition application**, whose main task is to record analog experimental data as data points (with X and Y values) and store these data points on the computer. The second task of the LabScribe program is to **graphically display** the collected data in a way that is understandable to the user. Chapter 2 explains the various controls and options relative to the acquisition of data. This chapter will discuss considerations regarding the display of collected data on the various windows in the LabScribe user interface.

User Interface

The LabScribe user interface contains seven primary windows; **Main**, **Analysis**, **ScopeView**, **XY**, **FFT**, **Marks**, and **Journal**. There are also dialogue windows, accessible through the **Preferences** selection in the **Edit Menu**, which provide controls of the **Channels**, **Sampling**, **Stimulator**, computed **Functions**, **Output Sequences**, and **Advanced**. Most of the interface related features in LabScribe can be found in the **Main** window (Figure 3-1 on page 19). LabScribe can display up to sixteen channels in the **Main** window.

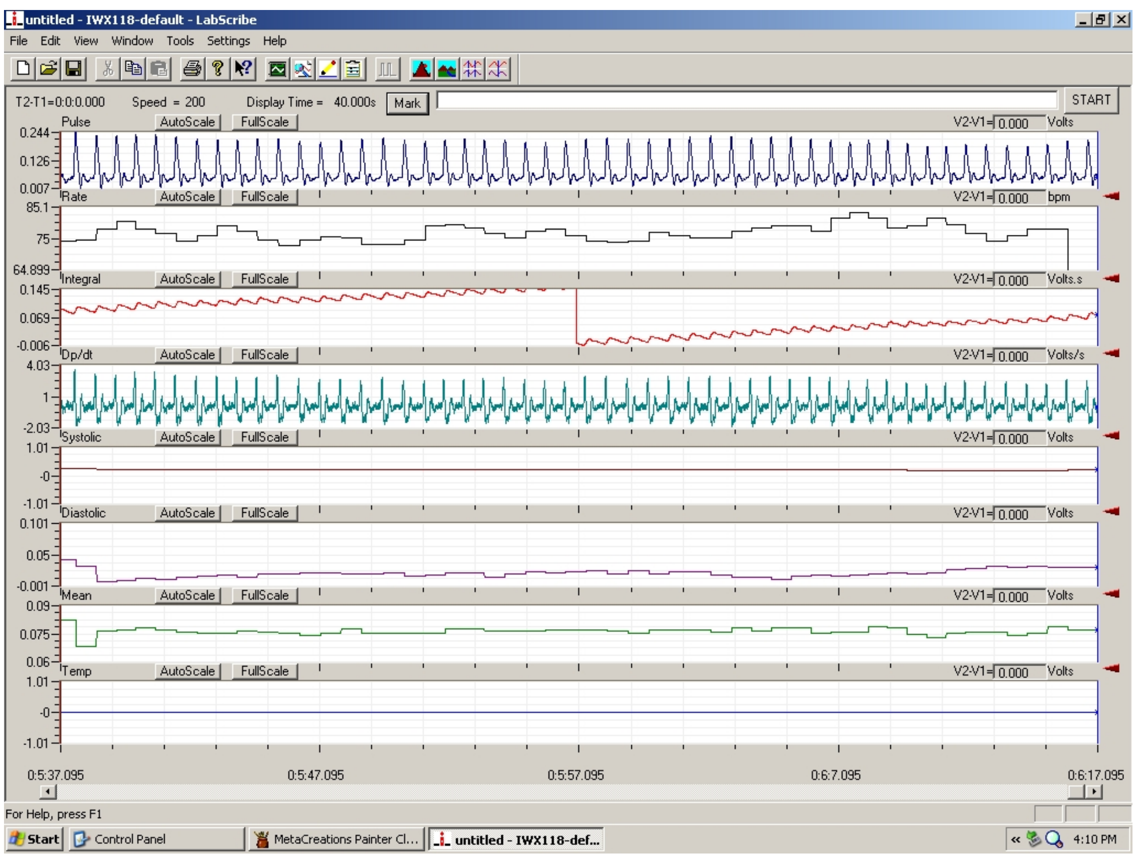


Figure 3-1: The LabScribe Main window.

Each channel has its own set of controls located in a **Channel Bar** immediately above each channel's data window (Figure 3-2 on page 20). Y-axis scaling is printed to the left of the data. The **Channel Bar** contains the **Channel Title**, buttons for Y-axis display control (**Autoscale**, **Zoom-In**, **Zoom-Out**, **FullScale**, and **Preferred Scale**) and a **Value Display** area. The **Value Display** box located to the extreme right on the channel bar will display different things depending on the state of the program. While recording, the **Value Display** box shows the value of the last data point collected. Off-line, in **Single Cursor** mode, the **Value Display** box displays the Y-axis value of the data point intersected by the cursor. In **Dual Cursor** mode, the **Value Display** box displays the difference between Y-axis values intersected by the 2 cursors.

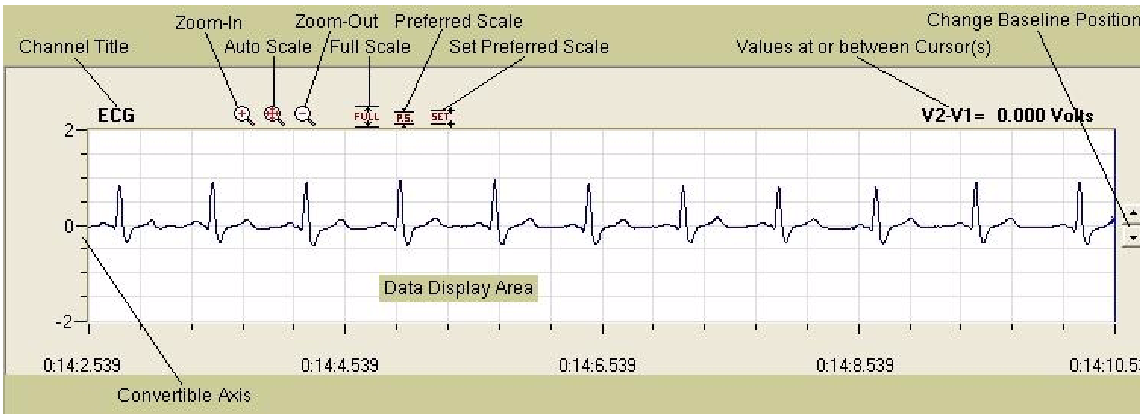


Figure 3-2: The common controls for channels displayed in the *<u>LabScribe</u>* *Main window.*

Cursors

If someone handed you a paint brush, gestured in a general direction, and said: "Paint that!"; you would probably want to clarify exactly what "that" was. In mathematical terms, the verb "paint" is the **function** and the object "that" is the **argument**. In mathematical operations, it is important to understand exactly the "that" you are operating on.

This is also true for LabScribe software. Many commands are included in the program that allow the user to zoom, measure, and calculate. In order for these commands to work, a mechanism is required for instructing the software about the area of data or specific data points to be addressed. LabScribe uses cursors to identify the data points. This explanation of cursors begins with basic modes of operation and applies them to problems in the windows where the cursors are used.

Cursor Modes

Cursors are vertical lines that pass through all channels. The LabScribe software has two cursors. Icons in the toolbar allow you to choose between using **Single Cursor** or **Dual Cursor** modes (Figure 3-3 on page 20). Cursors can also be "garaged," or placed all the way to the left hand side of the data so they measure or report nothing. Cursors in the LabScribe software are always in one of three modes — garaged, single, or dual.

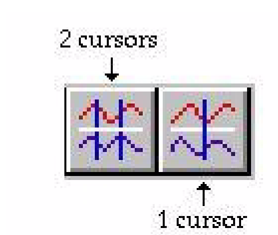


Figure 3-3: Cursor controls on the LabScribe Main window toolbar.

To access **Single Cursor** mode, press the **Single Cursor** icon (Figure 3-3 on page 20) in the toolbar. In this mode, the value of the data point on each channel, that is intersected by the cursor bar, is reported in the **Value Display** area on the right side of each channel bar. The time for the position of the cursor is reported in the **Clock Area** in the upper left hand corner of the **Main** window. **Single Cursor** mode is used to determine values and to place marks in the record after recording has stopped.

To access **Dual Cursor** mode, press the **Dual Cursor** icon (Figure 3-3 on page 20) in the toolbar. In this mode, the **Value Display** area reports the difference in value between **Cursor 1** and **Cursor 2**. In a similar way, the **Clock Area** reports the difference in time between the two cursors. When using **Dual Cursor** mode, the cursor farthest to the left is always **Cursor 1** and the other to the right is always **Cursor 2**. **Dual Cursor** mode is also used to define the right and left boundaries of a selection of data. This selected area can be used to define the contents of the **Analysis** window, or to determine what two values are used to accomplish the **Units Conversion** function.

Moving Cursors

Once cursors have been called, they may be moved by placing the mouse over the cursor bar, clicking, holding, and dragging them to the right or left. Cursors may also be moved using the arrow keys on the keyboard. In **Dual Cursor** mode, you can change the cursor that is moved by using the UP arrow. Pressing the RIGHT or LEFT arrow key on the keyboard, moves the cursor one data point. Holding the SHIFT key down while using the arrow key causes the cursor to move 5 data points at a time; and, holding the CONTROL key down while pressing a RIGHT or LEFT arrow moves the cursor forward 10 points at a time.

Behavior of Cursors

In **Single Cursor** mode, the value displayed represents the value identified on the channel by the one and only cursor. If the data is scrolled so that the cursor goes off screen, the cursor is automatically garaged, and the channel display area will display the value of the visible data point furthest to the right.

In **Dual Cursor** mode, **Cursor 1** is always the left hand cursor. If **Cursor 2** is moved to the left of **Cursor 1**, it becomes **Cursor 1**. Values reported in the **Value Display** area are always the difference between **Cursor 2** and **Cursor 1** (Cursor 2 minus Cursor 1). If the data is scrolled, so that one of the cursors is no longer on the screen, that cursor is automatically garaged and the display goes to **Single Cursor** mode.

Exercise

Load the datafile **Exercise1.iwd** in the Program Files->*iWorx*->LabScribe->tutorial files folder, by selecting the **Open** item in the **File Menu**. The data displayed on Channel 1 is a ±2V sine wave. Note that the **Value** in the **Value Display** area corresponds to the voltage of the last data point (farthest to the right) in the window.

- Select **Single Cursor** mode by pressing the **Single Cursor** icon in the toolbar (Figure 3-3 on page 20).
- Record the value that corresponds to the position of the cursor.
- Click, hold, and drag the cursor over the highest point in a given cycle of the data. Adjust the position of the cursor bar left or right by using the LEFT or RIGHT arrow keys on the keyboard. Adjust the position of the cursor bar so that the **Value** in the **Value Display** area reads +2V.
- Call the **Dual Cursor** mode by pressing the **Dual Cursor** icon in the toolbar (Figure 3-3 on page 20).
- Position **Cursor 1** so that it is over the maximum value in a given cycle, then position **Cursor 2** over the minimum value as shown (Figure 3-4 on page 22). The **Value** reported will be 4V.
- Now, drag **Cursor 2** to the minimum value before **Cursor 1**. When you release **Cursor 2**, it becomes **Cursor 1** and the new **Value** reported is -4V.

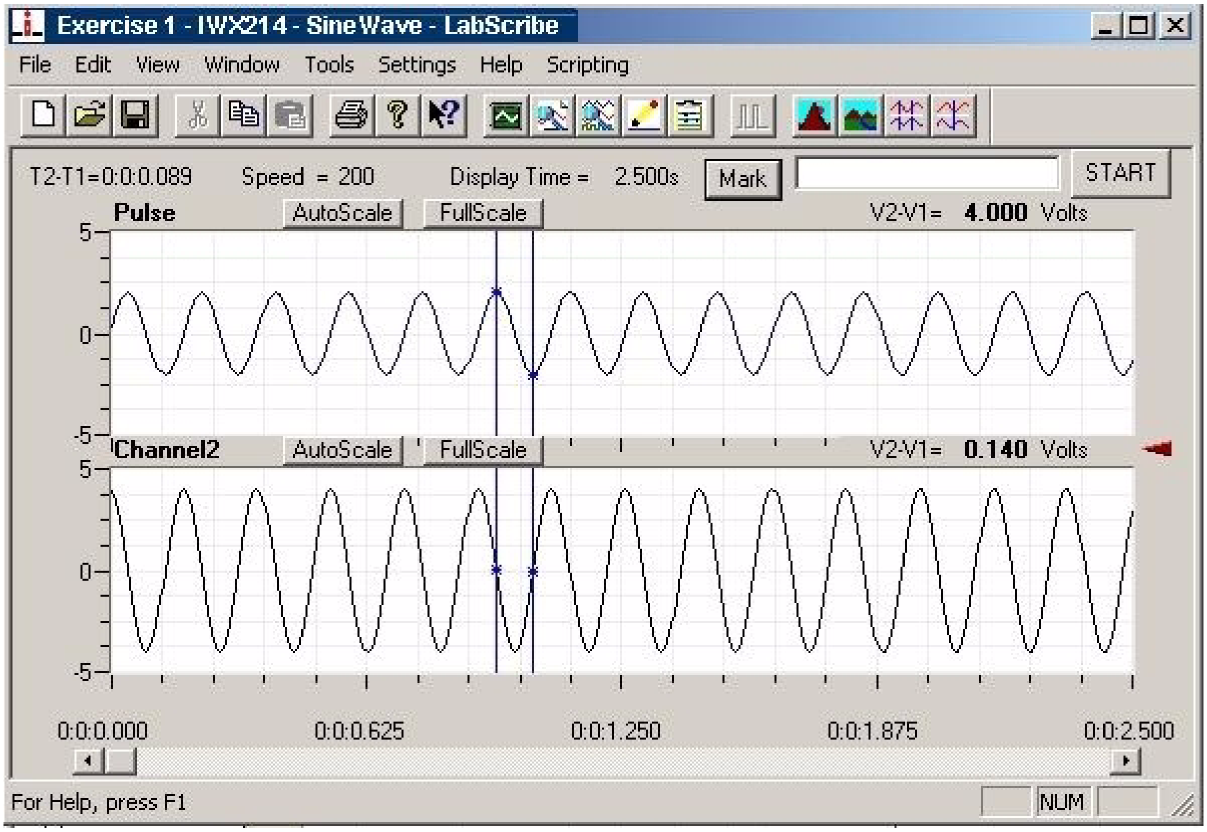


Figure 3-4: Cursors placed on LabScribe Main window to measure voltage difference, V2-V1.

Main Window Display Considerations

Recorded data has two important dimensions: Length and Height. The length is the **Time** axis and the height is the **Amplitude**. Each of these has its own set of controls

Managing Display Time

The events recorded using LabScribe software may occur over varying time frames. For example, recording the discharge curve of a 9-Volt transistor battery could take hours, while recording the QRS complex in a human electrocardiogram might take only a fraction of a second. LabScribe software allows the recording of both very slow and very fast events while displaying the recorded results in a format that is easily interpreted. To manage the time display in the LabScribe software, we use a parameter called **Display Time**. **Display Time** is the amount of time represented by one full screen of data. When the program opens, the default **Display Time** is set to 10 seconds. **Display Time** can be changed by using the display controls in the toolbar (Figure 3-5 on page 23), or by manually entering a **Display Time** in the place provided at the top of the **Channels** page of the **Preferences** dialogue window, which is launched by selecting the **Preferences** under the **Edit** menu.

Clicking the **Half Display Time** icon (big mountain) halves the screen time. If you clicked this icon once, a 10-second full-screen display would become a 5-second, full-screen display, This doubles the screen resolution, but cuts the amount of data seen on the screen in half. Clicking the **Double Display Time** icon (little mountain) doubles the screen time. In this case, a 10-second, full-screen display would become 20-seconds wide. This reduces the screen resolution by half, but doubles the amount of data that you see on the screen.

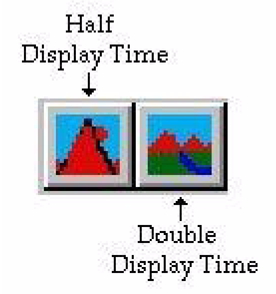


Figure 3-5: Display Time icons in LabScribe Main window toolbar.

Limits

Using the **Double Display Time** control compresses the data. The display time can be doubled as many times as requested until the limit of the maximum size of the data file or 1,000,000 data points. While recording, a maximum of 100,000 data points can be displayed in a single screen.

Using the **Half Display Time** tool expands the record as many times as requested. But, the Labscribe program will not display less than 10 data points on a screen of data.

Double-clicking the **Display Time** area at the top of the **Main** window resets the X-axis time display to the default value originally entered on the **Channels** page of the **Preferences** dialogue window.

Examples

Here are two examples demonstrating the use of the **Display Time** feature. In the first example (Figure 3-6 on page 23), a human electrocardiogram is recorded with a 160-second screen time. Notice that the record is compressed and it is impossible to resolve detail in individual events. By clicking **Half Display Time** five times, the screen time is reduced from 160 seconds to about five seconds, making individual events clearly visible.

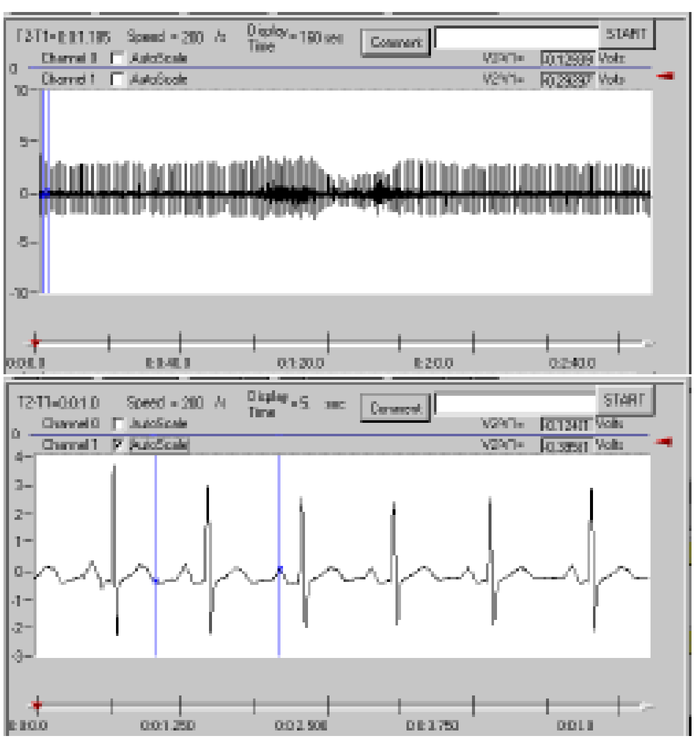


Figure 3-6: ECG viewed with a long screen time (top) and a short screen time (bottom).

In the second example (Figure 3-7 on page 24), a one hour battery discharge curve is shown in two views. The 2-second screen time shows almost a straight line, but clicking **Double Display Time** eight times reveals the entire curve. The **Display Time** parameter, with its two controls, effectively handles the time display.

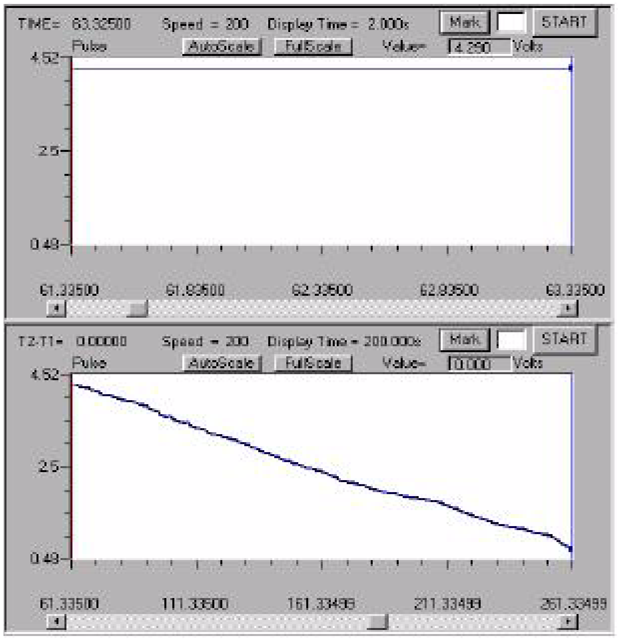


Figure 3-7: Voltage drop of 9-Volt transistor battery viewed with short (top) and long (bottom) screen times.

Managing Amplitude Display

The vertical display of your signal is managed in a number of ways. In each channel toolbar (Figure 3-8 on page 24), there are six icons. They represent: **Zoom-In** (x2), **AutoScale**, **Zoom-Out** (x2), **Full Scale**, **Preferred Scale**, and **Set Preferred Scale** features. In addition, on the right side of each channel display area is a scroll UP/DOWN control to offset the recorded wave up or down.

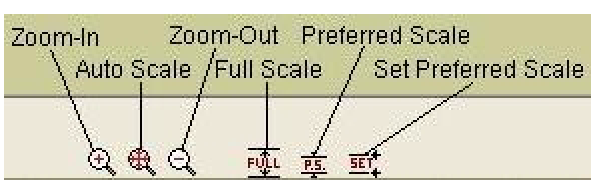


Figure 3-8: The channel toolbar in the LabScribe Main window.

AutoScale

AutoScale, as used in the LabScribe software, reviews the current screen of data on the channel of interest and locates the highest and lowest data points in that screen. It then adjusts the Y-scale range to include those points. To use **AutoScale**, click on the center button in the first group of three on the upper left side of each channel bar.

FullScale

Pressing the **FullScale** item adjusts the Y-scale to its maximum value of +/-5Volts (+/-10Volts on the 118).

Zoom-In/Out

From any view of data, pressing the **Zoom-In** button will double the displayed size of the trace. Pressing the **Zoom-Out** button will reduce the displayed size of the trace by a factor of 2.

Preferred Scale

For any data, there is a basic range within which the Y values of the signal will occur. For example, if measuring room temperature, the user might select a range of 50°F to 100°F because it is doubtful that the signal will move beyond these limits. If an event of interest occurs during the recording, the area of interest can be expanded using the **Zoom** or **AutoScale** tools. To return to the **Preferred Scale** set by the user, simply click the **P.S.** button in the channel toolbar.

Set Preferred Scale

To set the range of the **Preferred Scale**, click the **SET** icon in the channel toolbar and enter upper and lower limits of Y-scale in the **Set Scale** dialogue window that appears.

Scroll Up/Down

When the **Zoom** tools are used, the data may drift above or below the center of the display area, or even go out of the range of display. To adjust the position of the trace on a channel, click the **Up** or **Down arrow** buttons to the right of the channel's data display area.

Channel Handles

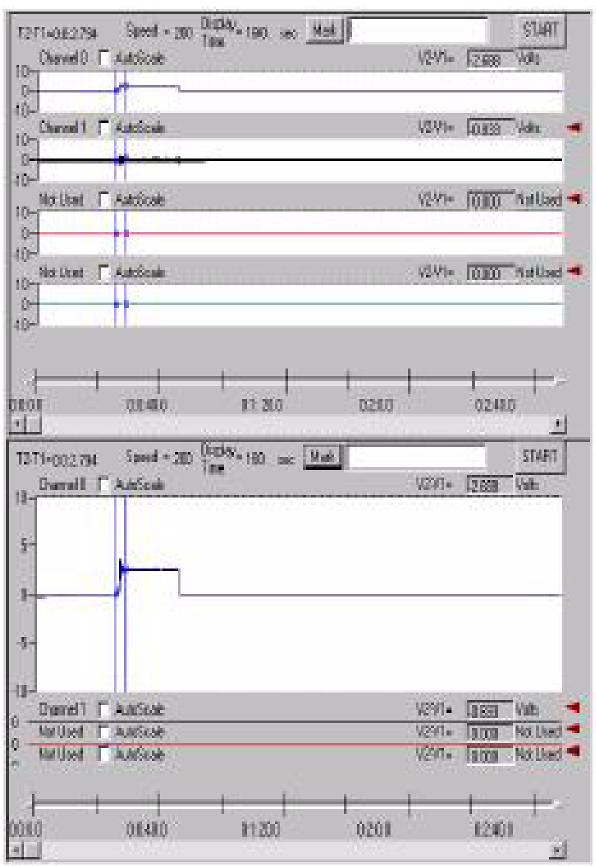


Figure 3-9: The height of the data displays for four channels in the Main window as set by the default setting (top), and after the handle for Channel 1 was slid down (bottom).

In addition to scaling the height of the signal to fit in a given channel area, the amount of display area allotted to each channel in the **Main** window can be controlled using the **channel handles**, the small red triangles to the right of each channel bar. To change the allocated space for a channel, click on the **channel handle** and drag it up or down (Figure 3-9 on page 25). Notice that when one channel bar is dragged into another, both move. This way all channels above and below a channel of interest can be minimized with just two mouse strokes.

Converting Units

When used with *iWorx* or *National Instruments* hardware, the LabScribe software functions as a calibrated voltmeter, which means the software will accurately display the exact voltage that the user presents to the analog-to-digital converter. The displayed (and default) units will always be **Volts**. While this is useful in many cases, it is not always the most appropriate unit.

If the LabScribe software is used to record the output of a transducer designed to measure a physical parameter, such as force or pressure, other units are more appropriate. In these cases, Volts can be changed into milligrams or grams. The LabScribe software can handle these conversions easily, provided that the function (or transducer) that relates voltage to real units is linear.

The first step in converting voltage input to real units is to record a portion of data at two known values. In the case of a force transducer, record output at two known forces such as zero and 100 grams. The recorded trace may look something like Figure 3-10 on page 26.

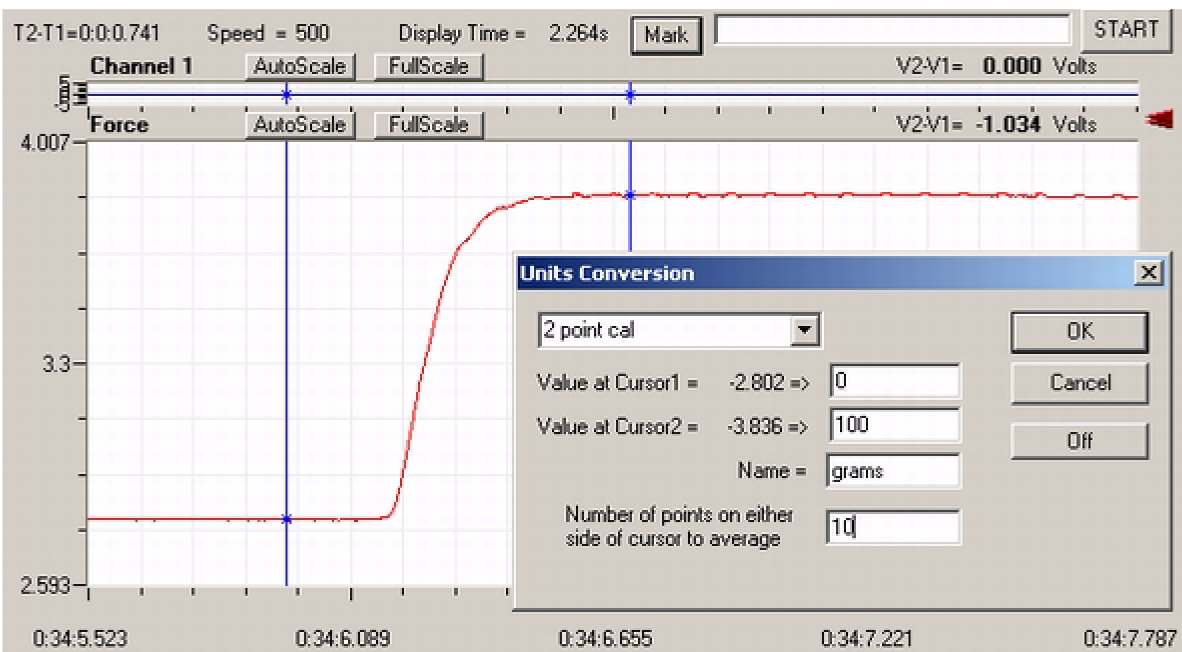


Figure 3-10: Data file of weights hung from a transducer and the units conversion dialogue window that sets volts to grams.

Once recording is complete, proceed to the **Dual Cursor** mode in the **Main** window. (See the Cursors section of this chapter.) The **Units Conversion** dialogue window cannot be entered without being in **Dual Cursor** mode. Position **Cursor 1** over one of the known values, and **Cursor 2** over the other known value.

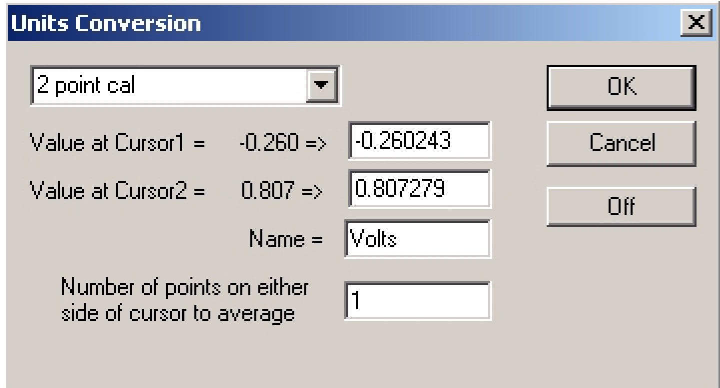


Figure 3-11: The Units Conversion dialogue window showing the 2-point calibration boxes.

Right-click the mouse anywhere on the channel to be converted to open the **right-click** menu. Select **Units** from the **right-click** menu and the **Units** dialogue window will appear. The typical conversion of the output of a tranducer is a **2 point cal**ibration, which is the default conversion method (Figure 3-11 on page 27). Below that menu is an area where the values for the positions of the cursors are listed. The values on the left are the voltage values at the positions of **Cursors 1** and **2**. Enter the corresponding values in real units into the two value boxes on the right. In the **Name** area, enter the name of the unit to be displayed on the Y-axis. If a unit name is not entered, Volts will be used as a default name.

If the data to be converted is noisy, the exact values at the cursors may introduce an error that can be large. By entering a non-zero number (**N**) in the **average** box at the bottom of the **Units Conversion** dialogue window, the Y-values for the **N** points on either side of the cursors will be averaged to yield a smoothed value with less error due to noise. Typical settings for the number of points used in the **average** value is 3 or 4 points for the 200 samples/sec setting.

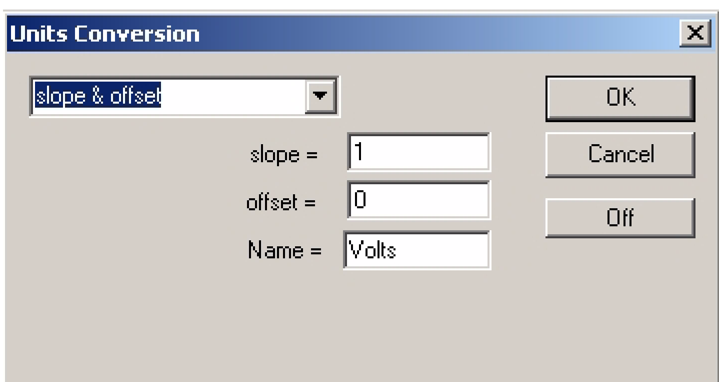


Figure 3-12: The Units Conversion dialogue window showing slope and offset boxes.

It is also possible to set the **slope** and **offset** directly, if those values are known (Figure 3-12 on page 27). For example, if a pressure transducer produces 5mV (0.005V) per mmHg, the slope would be 0.005 and the units would be mmHg. To use **slope** in a units conversion, the **slope** must be expressed as **Volts/unit**. Ideally, when a sensor puts out zero volts, the value of the converted units would also be zero. For many sensors this is true. However, there are many sensors that can have their offset changed by ambient conditions, such as changing barometric pressure. To correct for sensor offset, determine the value (in converted units) that LabScribe reports on the screen when the sensor should be reading zero. Enter this value in the offset area of the **Units Conversion** dialogue window.

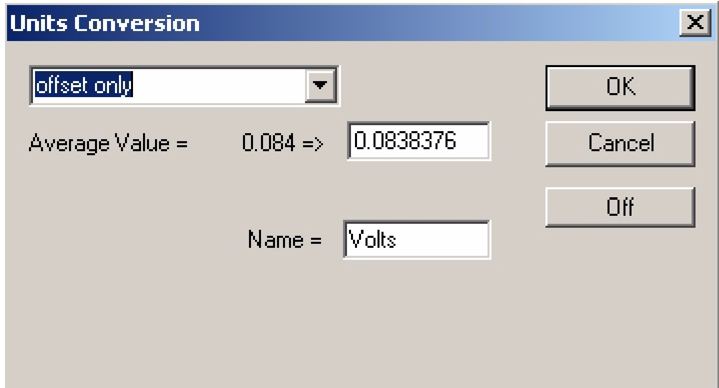


Figure 3-13: The Units Conversion dialogue window showing offset only boxes.

Sometimes, it is necessary to keep the units conversion relationship and change the offset, like turning the offset control on an amplifier. For example, if we want to set a particular region to zero, set the two cursors around the desired region of data. Select **Units** from the **right-click** menu. Choose **offset only** from the drop-down menu (Figure 3-13 on page 28). The average value between the two cursors can now be set to the required offset value (zero, in this example).

Units can also be set from the **Channels** page of the **Preferences** dialogue window. Each channel can be set with the conversion factors provided by the transducer manufacturer (see the section on **Preferences** in this manual).

All of the recorded data, acquired by the hardware as raw data, are displayed as voltages. From time-to-time, it may be desirable to turn off the **Units Conversion**, and simply view the raw data. To view raw data, open the **Units Conversion** dialogue window (Figure 3-11 on page 27). Notice that the program reports the current values in voltage at each cursor and the representative converted values. Selecting **Off** in this dialogue window returns the original display to **Volts** as the default unit.

Inverting the Trace

When recording physical parameters, such as temperature, pressure or force, it is best if the polarity of the data display matches the real-world behavior of the parameter. For example, if the observed temperature goes up, the trace on the computer screen should go up. Increasing pressure or force should also produce a positive or upward deflection of the trace.

Depending how sensors and amplifiers are wired, this may or may not be the case. In the event that the data display has the wrong sense or polarity, the trace can be inverted by selecting **Invert** from the **right-click** menu of any data channel. As with **Units Conversions**, the **Invert** function can be switched **Off** at any time.

Marks

The LabScribe software can record lots of data, but the data of interest must easily be located and retrieved to be useful. Also, information needs to be extracted from the data to make it useful. To locate specific sections of data and to differentiate parts of the record from one another, it is possible to put **Marks** on the data while LabScribe is recording. **Marks** are one of three navigation tools provided by the LabScribe software. In addition to being made on-line. **Marks** can be inserted and edited after the recording has stopped.

Making Marks On-Line

Marks (and their associated comments) can be placed on the recording without interrupting the flow of data to the computer.

As soon as the **Start** button is clicked and data recording begins, the LabScribe program sets an active text cursor on the **Mark** line, next to the **Mark** button on the **Main** window. On the **Mark** line, the user can type a comment describing an upcoming step in the experiment. The comment will be associated with the next mark that is placed on the recording.

The mark is placed on the recording when the **Enter** (or **Return**) key on the keyboard is pressed, or the **Mark** button on the **Main** window is clicked. The mark will be signified by a vertical line that is inserted on the data at the moment the **Enter** key is pressed or the **Mark** button is clicked. When recording is halted, the typed comment that was loaded on the Mark line prior to the event can be seen in the **Text Display** area at the bottom of the screen.

A mark is time-locked to the record at the moment the **Return** or **Enter** key is pressed. An unlimited number of marks can be attached to the record. The vertical line on the recording, that is associated with a mark, is provided as visual confirmation that the mark has been placed. While data is being recorded, only one mark can be seen on a given screen. Offline all the marks are visible.

Making Marks Off-Line

Marking events as they happen is a necessity for events that are time critical, like drug deliveries or experimental interventions. Information about the experiment that is important, but not time critical, can be marked on the recording after the recording is completed. An example of the type of comment to be added to the record would be a change in room temperature.

To add this information to the record after recording is completed, select the **Single Cursor** mode from the LabScribe toolbar. Position the single cursor bar on the record where the mark is to be positioned. Type the text (a maximum of 50 characters), associated with the new mark, on the **Mark** line in the **Main** window. Click the **Mark** button; and, the mark and its text comment are inserted at the position of the cursor.

Editing Marks

Marks already on the record can be changed by going to the **Marks** window, available from the **Window** menu or the LabScribe toolbar. The **Marks** window is a dialogue box containing a list of all marks in a record (Figure 3-14 on page 29).

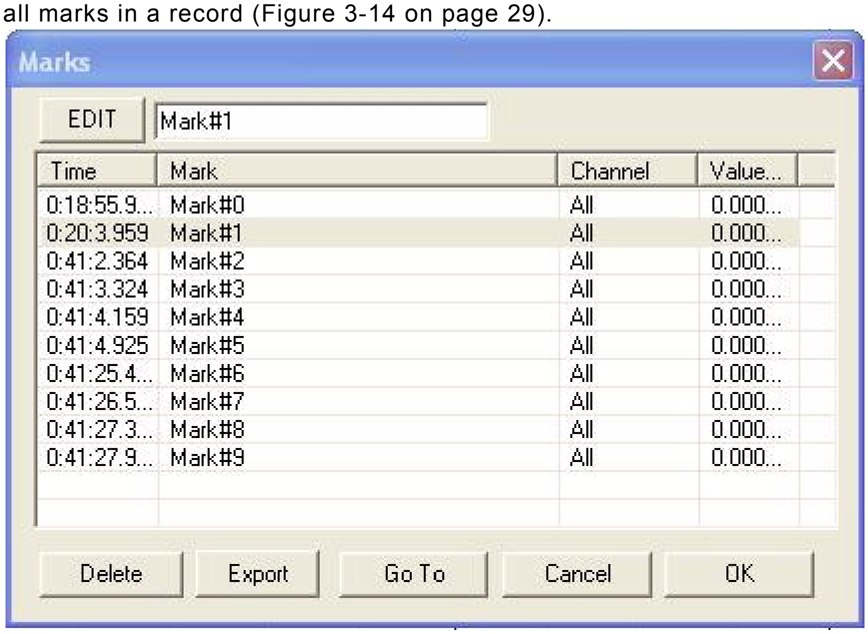


Figure 3-14: The LabScribe Marks window.

To edit a mark, highlight the mark, change the text of the comment associated with the mark in the **edit** box at the top of the window, and click the **Edit** button in the upper left hand corner of the window. Marks can also be edited or deleted by right-clicking on the comment in the **Text Display** area at the bottom of the **Main** window.

Navigating By Marks

Marks that are placed on the recording can serve as "sign posts", indicating where important sections of data are located. By highlighting a specific mark listed in the **Marks** window and clicking the **Go To** button, the LabScribe software will find the data point associated with that mark and display that section of data in the **Main** window. In this manner, the user can move between important areas of an experiment without hunting or scrolling for the areas of interest.

Positioning Mark Comments

On presentations or printed copies of the data record, it is useful to position the text of the comment associated with a mark directly over the data to which it applies. This is particularly useful if more than one channel of data was recorded, and the mark does not apply to all channels.

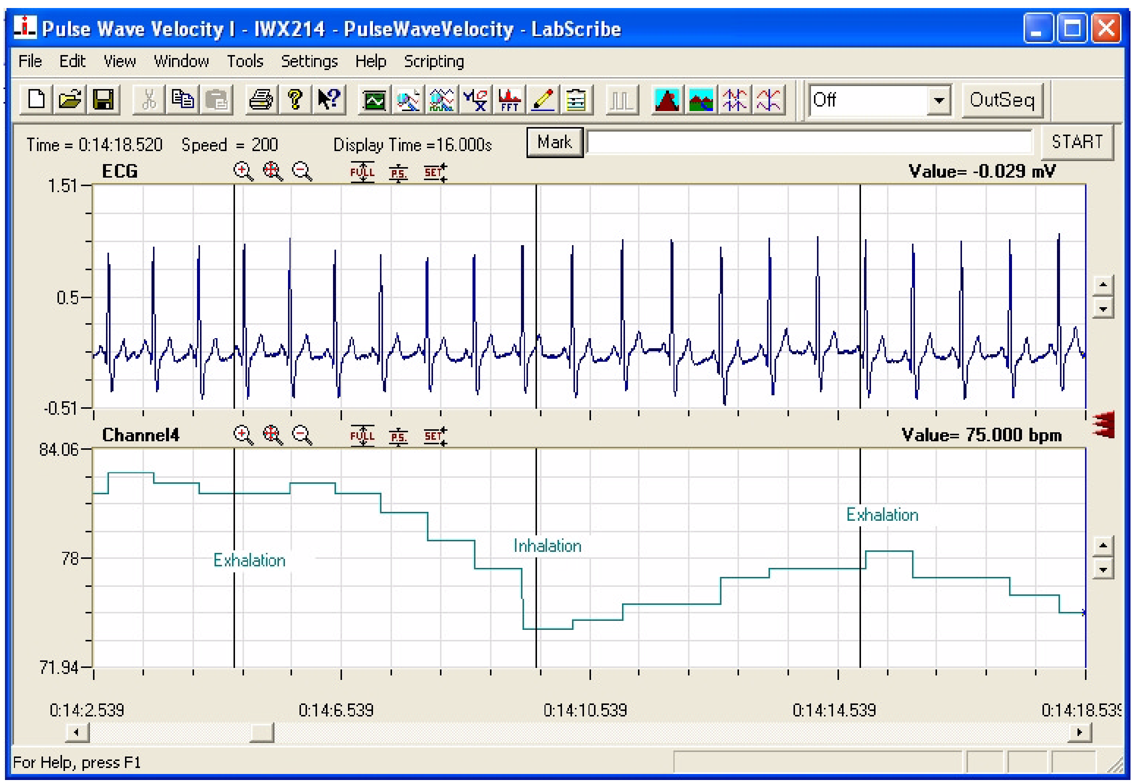


Figure 3-15: Comments moved on to the channel data display in the Main window.

When marks are created, the comments appear in the **Text Display** area at the bottom of the **Main** window above the **Time** axis. After recording has stopped, comments associated with marks can be dragged into the data area of the record. The text of these comments can be read and printed in any window in which the data appears (Figure 3-15 on page 30).

Sometimes, it is necessary to return the marks in a particular view to the **Text Display** area at the bottom of the **Main** window. To do this, select **Marks** from the **View** menu and **Reset Location** from the **Marks** submenu. This command returns only the mark comments on the data window of the current screen of data to the bottom of the **Main** window. All other marks will remain where they were originally positioned. The **Reset Marks** command is active only on the **Main** window.

Exercise

1. Click **Start** and record a few minutes of data.
2. As data is being recorded, type the word "Test 1" on the keyboard and strike the **Return** or **Enter** key on the keyboard.
3. Wait one minute, type "Test 2" and strike the **Return** or **Enter** key.
4. Click **Stop**. Scroll through the data using the scroll bar on the bottom of the **Main** window until you locate "Test 1" in the **Text Display** area.
5. Open the **Marks** window from the **Window** menu, or by clicking on the **Marks** icon in the LabScribe toolbar. Select the mark "Test 2" in the **Marks** window.
6. Click on **Go To** to close the **Marks** window. Notice that the record in the **Main** window has moved to the "Test 2" mark.
7. Using the mouse, click and hold on the comment "Test 2" at the bottom of the screen. Continue holding the mouse button down, and drag the mark comment to a new position on one of the available channels.
8. Release the mouse button and the mark is locked on the selected channel. Comments positioned in this way will remain where they are placed and will print exactly as you see them.
9. Try this exercise again with a mark created off-line. To create an off-line mark, open the **Single Cursor** mode by clicking the **Single Cursor** icon in the LabScribe toolbar. Position the cursor where the off-line mark is to be positioned. Type some text on the comment line at the top of the screen, and press the **Return** or **Enter** key. The mark appears at the cursor location and the comment appears at the bottom of the screen.

Sorting and Exporting marks

The **Marks** window displays the **Time** that a mark was made, the text comment attached to the **Mark**, the **Channel** on which the mark was made, and the **Value** of the amplitude at the mark. Marks can be sorted by **Time**, **Channel**, or the text comment of the **Mark** by clicking on the column titles. Click once to organize marks in ascending order, and a second time to change to descending order.

Using the standard Windows commands, SHIFT-CLICK and CONTROL-CLICK, specific marks can be highlighted. Once selected, use the **Export** button to send selected marks to a text file which can be opened in Excel or another spreadsheet program.

Voltmeter

Large digital readouts of the amplitudes recorded on each channel can be displayed on the left side of each channel in the **Main** window. Select the **Voltmeter** function from the **View** menu to display these readouts. The readouts are active while data is being recorded, can display the amplitude of the trace on each channel at the position of a **Single Cursor**, or can display the difference in amplitudes between the positions of **Dual Cursors** on each channel.

Views

LabScribe V1.8 can acquire data on up to eight channels on the *iWorx* 118 (four channels on the *iWorx* 104, 114, 204, or 214), but it can display data on up to sixteen channels. The extra channels can be used to display computed functions that are mathematically derived from the raw data. For example, the arterial pressure from eight different animals could be recorded on channels 1-8. Simultaneously, the **Rate** function could be used on Channels 9-16 to calculate the heart rate of each animal from its recorded blood pressure on Channels 1-8. As with any multi-channel display, the more channels that are displayed means there is less space that can be given to each channel. In the case of a 16-channel **Main** window display, it is hard to resolve detail in the trace of recorded data in each channel.

LabScribe solves this problem by allowing the user to create as many as eight different collections of channels that can be displayed on the screen at one time. Each collection of channels that is displayed is known as a **View**. Using the example from the previous paragraph, a **View** could be created that displayed the arterial pressure from Channel 1 and the calculated heart rate for the same animal displayed on Channel 9. The data from Channels 1 and 9 would appear in the first and second data display areas, respectively. The other fourteen raw data and computed heart rate channels would not be displayed. For the data recorded from another animal on Channel 2, another view with Channels 2 and 10 (its matching rate channel) can be created. Each **VIEW** can have up to eight channels

Using VIEWS

To use **Views**, select **Preferences** from the **Edit** menu to open the **Preference** dialogue window. Click on the **Advanced** tab to open that page. Select the number of different views that you want to create from the dialogue box at the top of the page. Enter a number equal to or less than 8.

For each view listed, check the boxes for each of the sixteen available channels to be displayed in that view. A check in a given box will include that channel in the view. Up to 8 channels may be selected. Channels will be displayed in numerical order starting with the lowest number. Each view can also be given a name. Click **OK** to exit the **Advanced** page.

Once created each view will be listed as a display option in the **View** menu. You can change views at any time by selecting its name from the **View** menu.

Display Considerations in Other Windows

Data is only recorded in the **Main** window. However, other windows can receive selected data from the **Main** window for closer examination or display in another format, like a XY plot or FFT. There are several viewing options available in these other windows that are not available in the **Main** window. The actual discussion of analytical functions found in these windows is deferred to the **Analysis** chapter, later in this manual.

The Analysis Window

Data can be imported into the **Analysis** window from the **Main** window using the **Dual Cursors**. The data to be transferred to the **Analysis** window is selected by placing the cursors on either side of the data of interest. Once the data is selected, it is transferred from the **Main** window to **Analysis** window when the **Analysis** icon is selected from the LabScribe toolbar or **Analysis** is selected from the **Window** menu. In the **Analysis** window, all channels are displayed and **AutoScale**d. A segment of data from an 8-channel record, with only Channels 1 and 3 displayed, is shown in Figure 3-16 on page 33.

Channels are selected for display by clicking on the **Channel Titles** in the **Display Channels** list on the left margin of the **Analysis** window. Multiple channels can be selected using the standard Windows SHIFT-CLICK and CONTROL-CLICK commands to add or remove channels.

The **default** view will show all selected channels in **Tiled** mode, one channel above the other in the display (top, Figure 3-16 on page 33). Checking the **Stacked** box (on the left margin of the **Analysis** window) will overlay the selected channels (bottom, Figure 3-16 on page 33).

Expanding or contracting the time displayed in the **Analysis** window can be controlled by two different methods. The **Display Time** buttons (**Half** or **Double Display Time**) at the top of the **Analysis** window can be used, as well as the **Zoom In** and **Zoom Out** functions in the **right-**

click menu of the window. To open this menu, **right-click** in the data display area of the **Analysis** window. These **Zoom** functions behave exactly like the **Display Time** functions in the LabScribe toolbar.

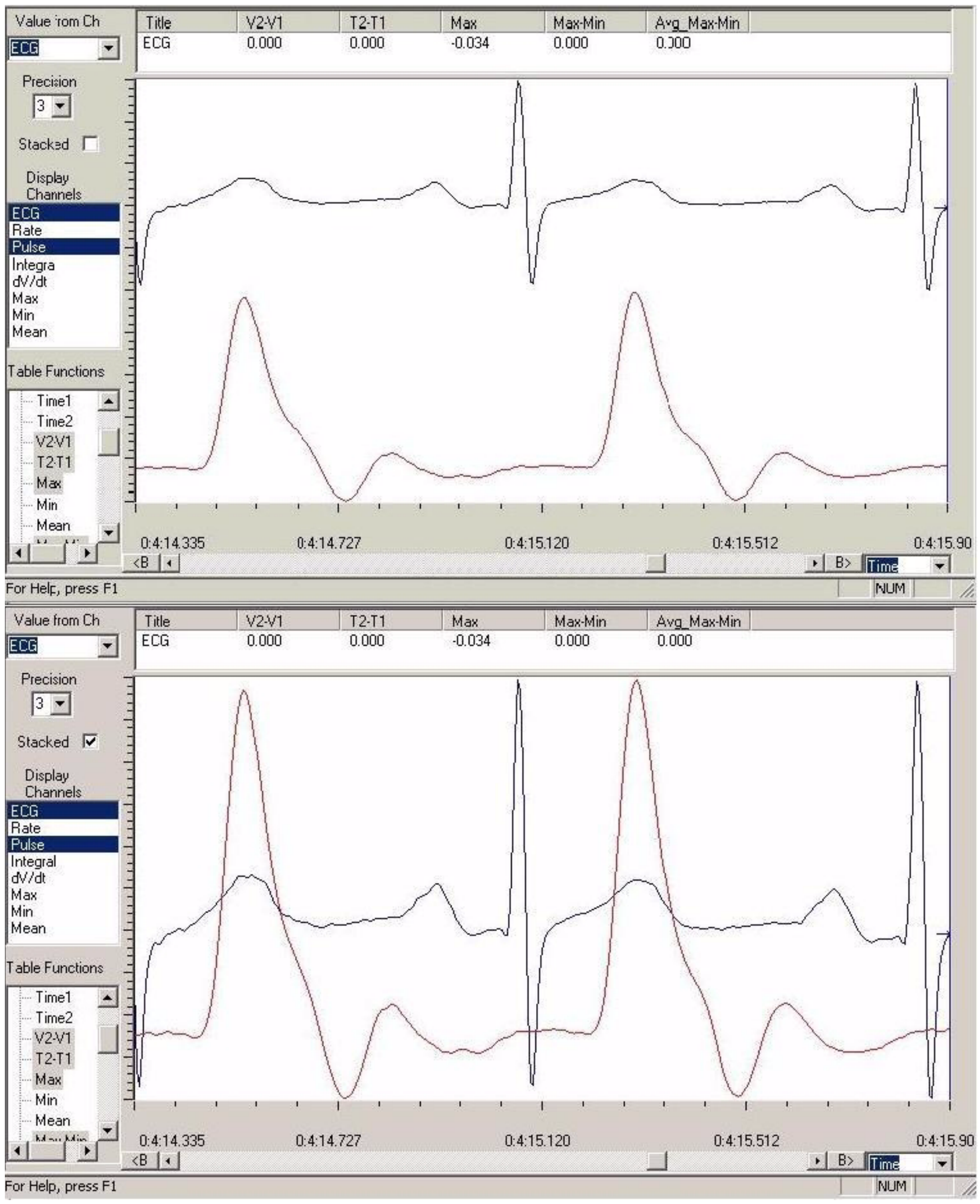


Figure 3-16: Two channels of data displayed in tiled mode (top) and in stacked mode (bottom) on the Analysis window.

As in the **Main** window, data can be scrolled using the bar at the bottom of the **Analysis** window. The user can also move forward and backward through the recording, a block of data at a time, by clicking on one of the **B** buttons at either end of the scroll bar in the **Analysis** window.

By default, the Analysis window displays **Channel Amplitude** data on the **Y-axis** and **Time** on the **X-axis**.

Data on any channel can be substituted for **Time** by selecting a **Channel Title** from the list box in the lower right-hand corner of the **Analysis** window (Figure 3-16 on page 33).

In this way, **XY** or **XYY** plots can be constructed. When the **Analysis** window is in **XY mode**, the functions or calculations available in the **Table Functions** list change to choices more appropriate for the **XY plot.** This is discussed in greater detail in the **Analysis** chapter.

The XY Window

Data can be imported into the **XY** window from the **Main** window using the **Dual Cursors**. The data to be transferred to the **XY** window is selected by placing the cursors on either side of the data of interest. Once the data is selected, it is transferred from the **Main** to **XY** window when the **XY** icon is selected from the LabScribe toolbar, or **XY View** is selected from the **Window** menu.

In the **XY** window, there are two **linear displays** (Y,T) and an **XY plot** (Y1,Y2). The linear displays are plots of the amplitudes (Y-values) as a function of time for the channels selected for the **XY plot**. The channels to be used in the **XY plot** are selected by highlighting the title of the channel from the drop-down list next to each linear display.

Expanding or contracting the time displayed in the **XY** window can be controlled by two different methods. The **Display Time** buttons (**Half** or **Double Display Time**) at the top of the **XY** window can be used, as well as the **Zoom In** and **Zoom Out** functions in **right-click** menu of the window. To open this menu, **right-click** in either of the **linear display** areas, or on the display area of the **XY plot**. As before, these **Zoom** functions behave just like the **Display Time** functions on the LabScribe toolbar.

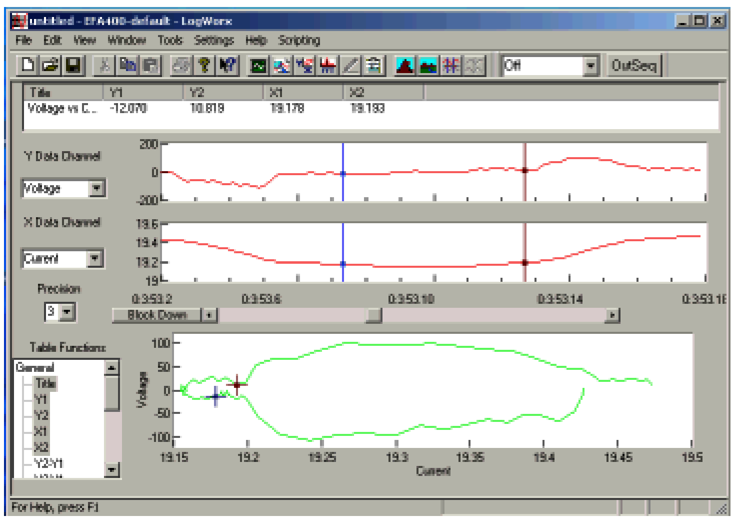


Figure 3-17: Two channels of data displayed in linear (top) and in XY plot (bottom) on the XY Window.

Data in the **XY** window can be scrolled using the bar underneath the **linear displays**. The user can also move forward and backward through the recording, a block of data at a time, by clicking on the **Block Down** and **Block Up** buttons on either end of the scroll bar in the **XY** window.

When the **XY** window is open, only the functions and calculations more appropriate for the **XY plot** are available in the **Table Functions** list. This is discussed in greater detail in the **Analysis** chapter.

The FFT Window

Data can be imported into the **FFT** window from the **Main** window using the **Dual Cursors**. The data to be transferred to the **FFT** window is selected by placing the cursors on either side of the data of interest. Once the data is selected, it is transferred from the **Main** to **FFT** window when the **FFT** icon is selected from the LabScribe toolbar, or **FFT (Spectrum)** is selected from the **Window** menu.

In the **FFT** window, there are a **linear display** (Y,T) and a **FFT plot**. The linear display is the plot of the amplitude (Y-values) as a function of time for the channel selected for the **FFT plot**. The channel to be used in the **FFT plot** is selected by highlighting the title of the channel from the drop-down list next to the linear display.

Expanding or contracting the time displayed in the **FFT** window can be controlled by two different methods. The **Display Time** buttons (**Half** or **Double Display Time**) at the top of the **FFT** window can be used, as well as the **Zoom In** and **Zoom Out** functions in **right-click** menu of the window. To open this menu, **right-click** in either of the **linear display** areas, or on the display area of the **FFT plot**. As before, these **Zoom** functions behave just like the **Display Time** functions on the LabScribe toolbar.

Data in the **FFT** window can be scrolled using the bar underneath the **linear display**. The user can also move forward and backward through the recording, a block of data at a time, by clicking on the **Block Down** and **Block Up** buttons on either end of the scroll bar in the **FFT** window.

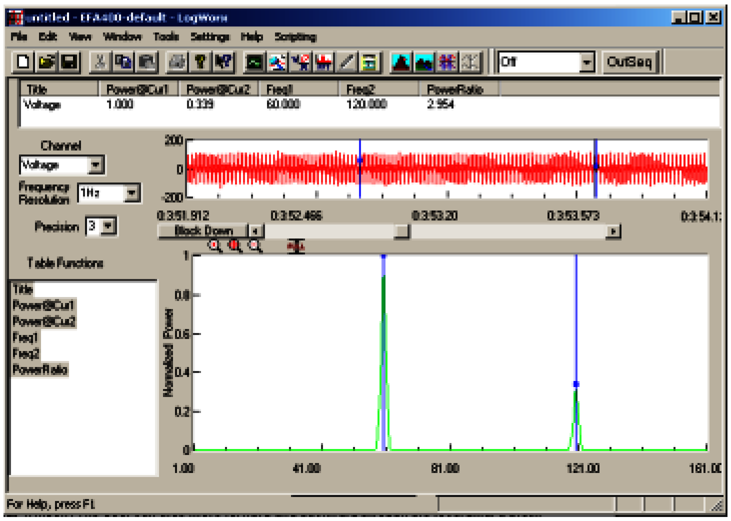


Figure 3-18: Two views of Data displayed in linear (top) and in FFT Mode (bottom) on the FFT Window.

When the **FFT** window is open, only the functions and calculations more appropriate for the **FFT plot** are available in the **Table Functions** list. This is discussed in greater detail in the **Analysis** chapter.

The Scope Window

As described in the **Acquisition** chapter, **Scope** mode is a different way of looking at the data being recorded. Normally, the events recorded in **Chart** mode are slow and continuous. The events recorded in **Scope** mode are fast and collected in a series of sweeps of limited duration. All of the sweeps in series are the same length.

Moving data from the **Main Chart** window to the **Analysis** window allows the data from the same time segment for each recorded channel to be overlaid. The **ScopeView** window is similar, but it allows different time segments of the same channel to be overlaid on the window.

In **ScopeView**, the **Channel** pop-down menu lists the channels that can be displayed in the **ScopeView** window. Selecting a channel will have its sweeps or blocks displayed in the **ScopeView** window. The **Display Sweeps** list box controls which sweeps for the selected channel are displayed. Multiple sweeps can be selected using the standard Windows SHIFT-CLICK and CONTROL-CLICK commands to add or remove sweeps.

Chapter 4: Controls

Menus

File

The LabScribe software supports all of the elements found in a standard **File** menu:

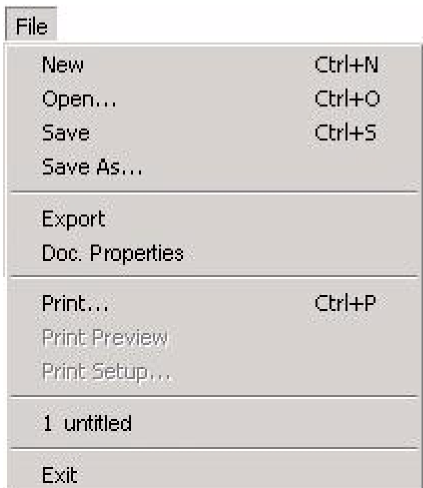
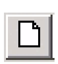
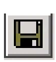


Figure 4-1: The LabScribe File menu.



New: Opens a new file. Only one acquisition window may be open at a time. This function is also available from the toolbar.

Open: Opens a previously recorded file, and is also available from the toolbar.



Save: Saves data to the file currently open, and is also available from the toolbar.

Save As: Saves data to a new file with a different name or format.

Export: Allows the user to export the data viewed as text, a picture, or in a variety of formats appropriate to external analysis programs.

Doc Properties: Shows sample speed, gain and other information concerning the data in the file

Print: Prints the window in the foreground, and is also available from the toolbar.

Print Preview: Previews the image to be printed.

Print Setup: Dialogue box for control of the printing characteristics.

Recent File: Displays the last four files opened by LabScribe.

Exit: Quits the program.

Edit

The LabScribe software supports elements found in a standard **Edit** menu:

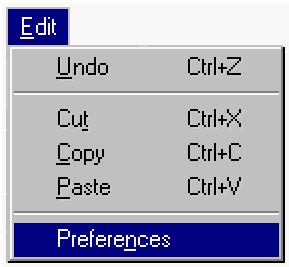


Figure 4-2: The LabScribe Edit menu.

Undo: Un-does the last command.

Cut: Inside the LabScribe program, **Cut** and **Paste** commands work only in the **Journal**. Also available from the toolbar.

Copy: Copies the window in the foreground to the clipboard for pasting. Also available from the toolbar.

Paste: Pastes the contents of the clipboard to the **Journal**. Also available from the toolbar.

Preferences: Calls a multi-page dialogue box that controls settings for **Channels**, **Sampling**, **Stimulator**, computed **Functions**, **Output Sequences**, and **Advanced** items.

View

The **View** menu supports display elements unique to the LabScribe software.

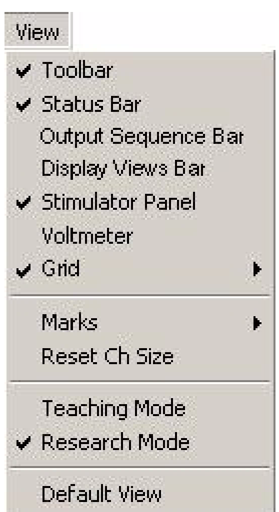


Figure 4-3: The LabScribe View menu.

Tool bar: Hides or displays the LabScribe toolbar.

Status bar: Hides or displays the Windows status bar.

Output Sequence Bar: Hides or displays the Output Sequence toolbar.

Display Views Bar: Shows the available channel views in a toolbar

Stimulator Panel: Hides or displays the Stimulator toolbar.

Voltmeter: Displays amplitude values in large type and in digital voltmeter fashion, to the left of each channel display window.

Grid: Displays a 20 x 8 grid on each channel.

Marks: Opens a submenu with controls for showing, hiding, or resetting marks.

Reset Channel **Size:** Returns all open channels to their default screen spacing.

Teaching Mode: limits the functions listed in the **right-click menu** and **Preferences** windows to those commonly used in teaching.

Research Mode: expands the functions listed in the **right-click menu** and permits use of the **Advanced** page in the **Preferences** dialogue window.

Views: Allows the user to select any of the views of the **Main** window created on the **Advanced** page of the **Preferences** dialogue window. See **Research Mode**.

Window

The **Window** menu allows the different windows used to display data to be selected.

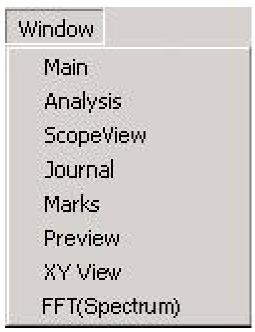
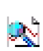
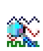


Figure 4-4: The LabScribe Window menu.

Main: Brings the **Main** window to the foreground. Also available from the LabScribe toolbar.



Analysis: Brings the **Analysis** window to the foreground. Also available from the LabScribe toolbar.



ScopeView: Brings the **ScopeView** window to the foreground. Also available from the LabScribe toolbar.

Journal: Brings the **Journal** to the foreground. Also available from the LabScribe toolbar.

Marks: Brings the **Marks** list to the foreground. Also available from the LabScribe toolbar.

Preview: Brings the **Preview** window to the foreground, where real time inputs into all open channels are displayed.

XY View: Brings the **XY View** window to the foreground. Also available from the LabScribe toolbar.

FFT (Spectrum): Brings the **FFT** window to the foreground. Also available from the LabScribe toolbar.

Tools

The **Tools** menu provides functions that can find and move specific data points to tables created in the **Journal**.

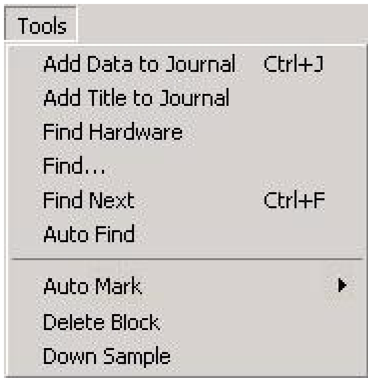


Figure 4-5: The LabScribe Tools menu.

Add Data to Journal: Sends the calculated values for the selected **Table Functions** from the **Analysis** or **ScopeView** windows to the **Journal**.

Add Titles to Journal: Sends the titles of the calculated values for the selected **Table Functions** from the **Analysis** or **ScopeView** windows to the **Journal**.

Find Hardware: Identifies and initializes the computer's connection to *iWorx* data acquisition device.

Find: Calls a dialogue box for programming the placement of cursors on data displayed in the **Analysis** or **ScopeView** windows.

Find Next: Finds the next data point in the file which meets the criteria set in the **Find** box.

Auto Find: Automatically finds each successive data point in the file that meets the criteria set in the **Find** dialogue box. Calculated values from the **Table Functions** selected in the **Analysis** window are automatically added to the **Journal** for each matching data point.

Auto Mark: Calls a list of functions that can automatically locate characteristic data points, like the LVEDP or QRS, in a data file displayed in the **Analysis** or **ScopeView** window.

Delete Block: Can be used in the **Analysis** window to delete the current block. **Warning: This cannot be undone!**

Down Sample: Used to downsample the data, This reduces the information in the file, and should be used with caution. **Warning: This cannot be undone!**

Settings

The **Settings** menu contains functions to load and edit files containing preset recording and analysis parameters. Selecting a file from the list programs LabScribe to record data in a specified manner.

Figure 4-6: The LabScribe Settings menu.

Load Group: Loads a group of existing setting files. Each file contains the recording and analysis parameters needed in LabScribe to record a specific experiment or type of data.

Edit Group: Allows the user to edit existing settings files in a group, remove them from a group, or to add new ones to a group.

Test 1, Test 2, Test 3: Examples of the names given to the experimental settings in a group.

Help

The **Help** menu provides links to information about the LabScribe software and hardware.

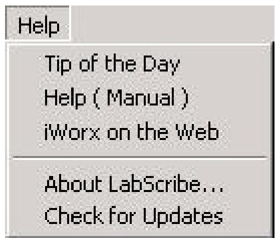


Figure 4-7: The LabScribe Help menu.

Tip of the Day: Selecting this function displays a important bit of information about LabScribe and *iWorx* units

Help (Manual): Sends user to the on-line version of the LabScribe software manual. Also available from the toolbar.

***iWorx* on the Web**: Takes the user to the *iWorx* home page.

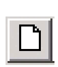
About LabScribe: Displays version and copyright information pertaining to the LabScribe program.

Check for Updates: Checks the LabScribe.com website for the latest version of software.

Toolbars

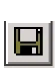
Main toolbar

Figure 4-8: The toolbar in the LabScribe Main window.



New: Opens a new file. Only one acquisition window may be open at a time.

Open: Opens a previously recorded file.



Save: Saves data to the file currently open.

Cut: Inside the LabScribe program, the **Cut** and **Paste** commands work only in the **Journal**.

Copy: Copies the window in the foreground to the clipboard for pasting.

Paste: Pastes the contents of the clipboard to the **Journal**.

Print: Prints the window in the foreground.

Help (Manual): Sends user to the on-line version of the LabScribe software manual.

Main: Brings the **Main** window to the foreground.

Analysis: Brings the **Analysis** window to the foreground.

ScopeView: Brings the **ScopeView** window to the foreground.

XY View: Brings the **XY View** window to the foreground.

FFT (Spectrum): Brings the **FFT** window to the foreground.

Marks: Brings the marks list to the foreground.

Journal: Brings the **Journal** to the foreground.

Stimulator Panel: Hides or displays the **Stimulator** toolbar.

Half Display Time; Reduces the time displayed on the screen by a factor of 1/2, each time the icon is clicked.

Double Display Time: Increases the time displayed on the screen by factor of 2, each time the icon is clicked.

2-Cursor Mode: Click icon to display two cursors on the data window. Time and voltage differences between the data points intersected by the cursors are measured.

1-Cursor Mode: Click icon to display one cursor on the data window. Absolute time and voltage from the beginning of the trace to the cursor are displayed.

Stimulator Toolbar

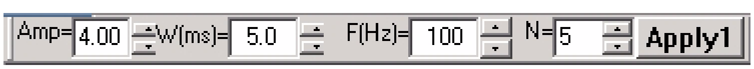


Figure 4-9: The Stimulator Control Panel on the LabScribe Main window.

Amp: Amplitude of the stimulus pulse in Volts.

W: Width of the pulse in milliseconds (ms).

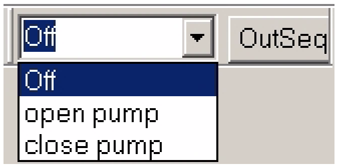
F: Frequency of stimulation in Hertz (Hz).

N: Number of pulses.

Apply: applies any changes to the stimulus protocol made through the **Stimulator Toolbar**. Clicking **Apply** while recording will send a stimulus pulse from the output.

- In the **Train** and **Step** modes, only the **Apply** button is enabled.
- In the **Constant** mode, the **Amp** and the **Apply** button are enabled.

Output Sequence Toolbar



The **Output Sequence Toolbar** is a drop-down list containing sequences of analog or digital outputs defined on the **Output Sequence** page of the **Preferences** dialogue window. Clicking the **OutSeq** button will fire the output sequence selected from the list. Selecting a new sequence in the drop-down list also automatically fires that sequence.

Dialogue Windows

Preferences for *iWorx* 104/204/108

There are five pages in the **Preferences** dialogue window for these *iWorx* units. *Preferences for the iWorx 114/214/118 are covered on page 46*.

Figure 4-10: The pages of the Preferences dialogue window for the iWorx 104/108/204.

Sampling Page

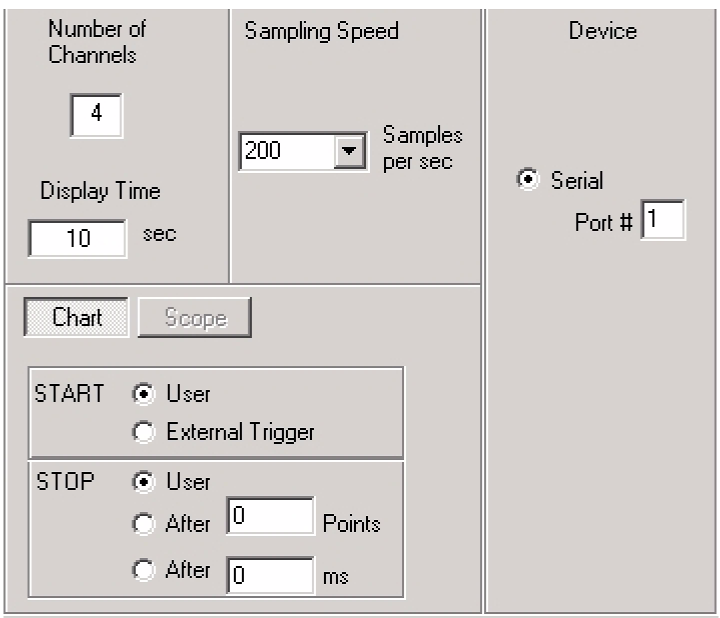


Figure 4-11: The Sampling page of the Preferences dialogue window for iWorx 104/108/204.

Sampling Speed: Sets the number of samples taken every second on each channel.

Display Time: Sets the time and the amount of data displayed on the screen

Num Channels: Sets the number of channels displayed.

Device: Selects the device from which data will be collected.

Start: Selects the **Start** mode. Refer to the section on **Triggering**

Stop: Selects the **Stop** mode. Refer to the section on **Triggering**.

Chart: Sets the acquisition mode to **Chart**.

Scope: Sets the acquisition mode to **Scope**.

Channel 1-8 Page

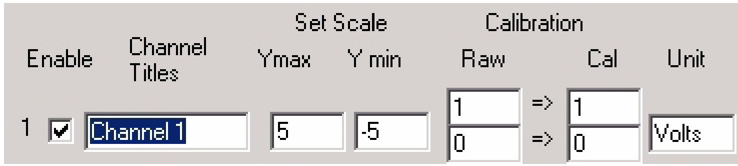


Figure 4-12: The Channels page of the Preferences dialogue window for iWorx 104/108/204.

Enable: Makes the channel available for recording.

Channel Title: Title or Label assigned to the channel

Set Scale: Sets the maximum and minimum Y-axis values.

Calibration: Used to convert 2 raw data values to 2 corresponding calculated values, using a linear scale. For more information refer to the **Units Conversion** section.

Units: Name of the units to which the raw data has been converted.

Stimulator Page

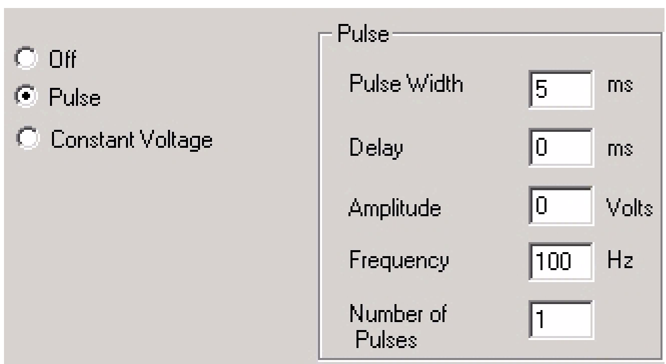


Figure 4-13: The Stimulator page of the Preferences dialogue window for iWorx 104/108/204.

Off: Turn the stimulator off.

Pulse: Enables **Pulse** mode.

Constant Voltage: Set Stimulator to put out a constant voltage.

Refer to the **Stimulator** section for more information on stimulator parameters.

Functions Page

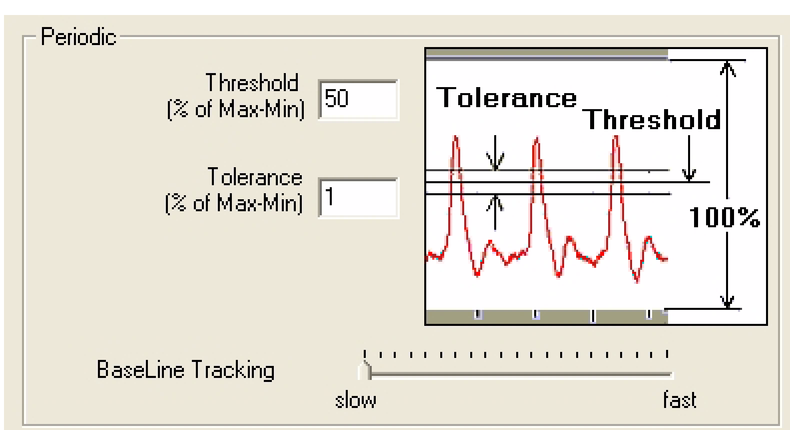


Figure 4-14: The Periodic section of the Preferences dialogue window for iWorx 104/108/204.

For on-line **Periodic** functions, like rate and frequency, there are **Threshold** and **Tolerance** levels that the raw data must meet or exceed for these functions to accurately determine the values of the computed parameters. **Threshold** and **Tolerance** levels can be adjusted on this page. Off-line, the parameter known as **Baseline Tracking** can be set to track the speed at which periodic changes in the baseline occur.

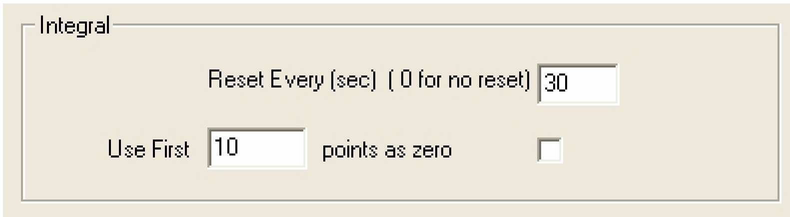


Figure 4-15: The Integral section of the Preferences dialogue window for iWorx 104/108/204.

For another set of computer functions, **Integrals**, the number of data points used to determine the baseline and the time interval at which the baseline is reset can be programmed.

Reset every (sec): Used to set the **Integral** reset time.

Use First "N" points as zero: Removes the effects of a DC baseline when calculating an Integral. This feature is useful in applications where the baseline is difficult to set to zero.

Network Page

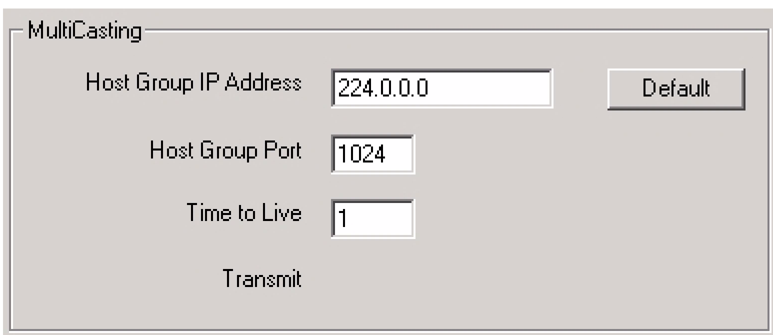


Figure 4-16: The Networks section of the Preferences dialogue window.

Multicasting: The Multicasting version of LabScribe transmits the acquired data over a peer to peer network.

Host Group IP address: Should be the same for the transmitting *IWorx* unit and the receiving *iWorx* unit(s).

Host Group Port: The port at which the Host transmits.

Time to Live: The number retransmission or "hops" of data packets allowed. Setting the number to 1 ensures that the multicasting data does not "leak" out of the LAN and cause network congestion.

Preferences for *iWorx* 114/214/118

There are six pages in the **Preferences** dialogue box. *Preferences for the iWorx 104/204/108 are covered on page 43*.

Figure 4-17: The pages of the Preferences dialogue window for iWorx 114/118/214.

Channels Page

The preferences that can be set for all channels include:

Sampling Speed: Sets the number of samples taken every second on each channel.

Display Time: Sets the time and the amount of data displayed on the screen

Num Channels: Sets the number of channels displayed on the **Main** window.

The preferences that can be set for each individual channel include:

Channel Title: Edits the title of each channel to better identify the parameter recorded.

Mode: Sets the record or the display mode of the channel. Channels 1 and 2 on the *iWorx* 214 (Channel 1 only on the 114) have record modes which allow either the bioamplifiers to be activated with a bandpass filter (0.03-150Hz, 0.3-35 Hz, or 3-10KHz) or the BNC input to be activated for recording signals from other devices with analog outputs.

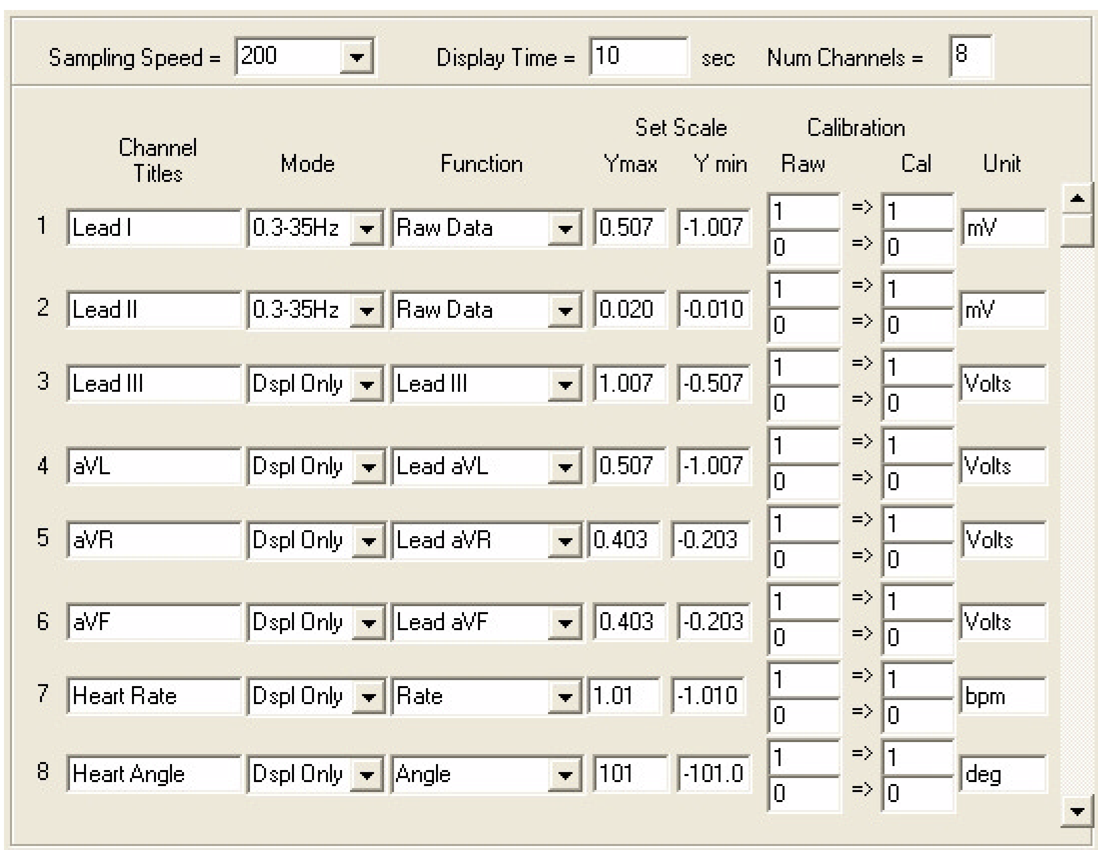


Figure 4-18: The Channels page of the Preferences dialogue window for iWorx 114/118/214.

Function: Selects either Raw Data or one of the many available calculated values to be displayed on the channel.

Set Scale: Sets the maximum and minimum Y-axis values.

Calibration: Used to convert 2 raw data values to 2 corresponding calculated values, using a linear scale. For more information refer to the **Units Conversion** section

Units: Name of the units to which the raw data has been converted.

Sampling Page

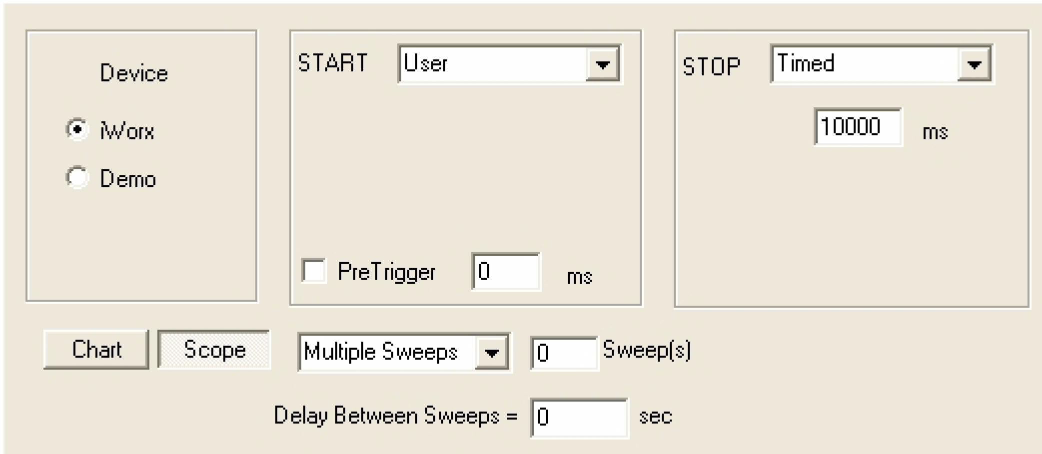


Figure 4-19: The Sampling page of the Preferences dialogue window for iWorx 114/118/214.

Device: Selects the device from which data will be collected.

Start: Selects the **Start** mode. Refer to the section on **Triggering**

Stop: Selects the **Stop** mode. Refer to the section on **Triggering**.

Chart: Sets the acquisition mode to **Chart**.

Scope: Sets the acquisition mode to **Scope**. For **Scope** mode, recordings can be made in **Repetitive** or **Multiple Sweep** mode, where the recording stops after "N" sweeps. The **Delay between Sweeps** can also be specified in case of **Multiple Sweep** mode.

Stimulator Page

Used to setup the **Stimulator(s)** on the *iWorx* 114/214/118. There are 5 modes: **Off**, **Pulses**, **Trains**, **Constant**, and **Step**. The available parameters in each of these modes can be preset and made part of a settings file.

Refer to the **Stimulator** section of the **Input/Output** chapter for information on the programming of the stimulator.

Functions Page

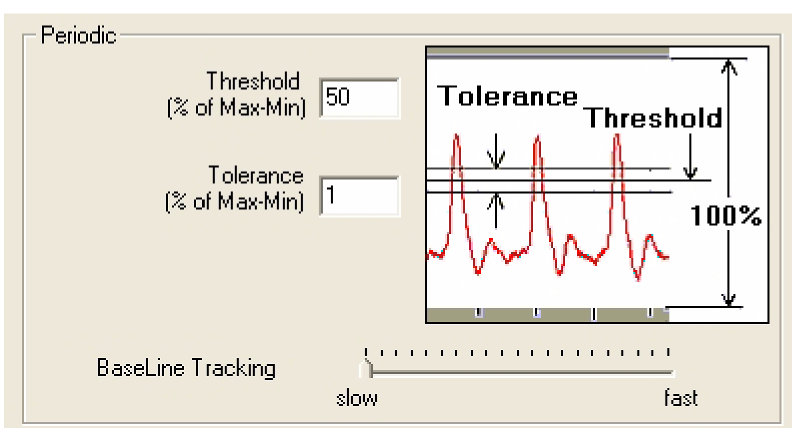


Figure 4-20: The Periodic section of the Preferences dialogue window for iWorx 114/118/214.

For on-line **Periodic** functions, like rate and frequency, there are **Threshold** and **Tolerance** levels that the raw data must meet or exceed for these functions to accurately determine the values of the computed parameters. **Threshold** and **Tolerance** levels can be adjusted on this page. Off-line, the parameter known as **Baseline Tracking** can be set to track the speed at which periodic changes in the baseline occur.

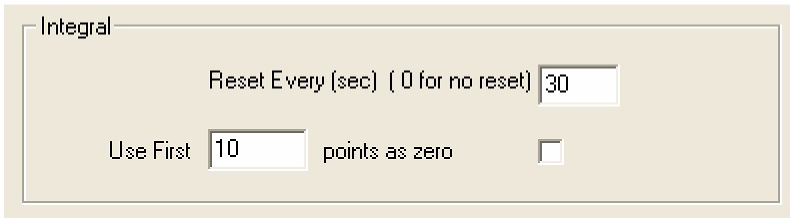


Figure 4-21: The Integral section of the Preferences dialogue window for iWorx 114/118/214.

For another set of computer functions, **Integrals**, the number of data points used to determine the baseline and the time interval at which the baseline is reset can be programmed.

Reset every (sec): Used to set the **Integral** reset time.

Use First "N" points as zero: Removes the effects of a DC baseline when calculating an Integral. This feature is useful in applications where the baseline is difficult to set to zero.

Output Sequences Page

Refer to the **Digital Inputs** and **Digital Outputs** sections of the Inputs/Outputs chapter for information on configuring this page.

Advanced Page

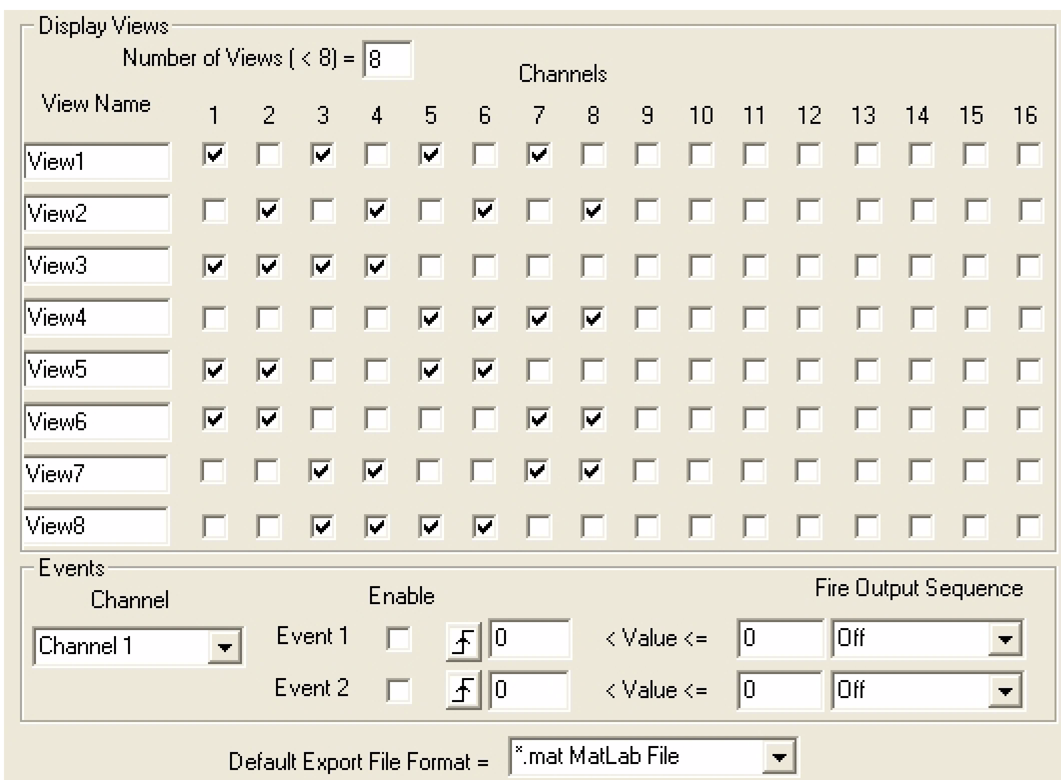


Figure 4-22: The Advanced page of the Preferences dialogue window for iWorx 114/118/214.

In the **Views** section of this page, different combinations of data channels can be programmed to be displayed when selected from the **View** menu on the **Main** window.

In the **Events** section of this page, an event occurring on a data channel can be programmed as the trigger for an **Output Sequence** when the amplitude of the event is between upper and lower limits.

The default format for exporting data files can also be selected on this page.

Chapter 5: Analysis

Overview

Today's analog to digital converters make acquiring data very easy. The challenge to all users is to extract meaning from the mountains of recorded data in order to generate conclusions, reports, and Nobel Prizes. This process is called analysis.

Built into the LabScribe data recording software is a powerful array of data analysis tools. The variety of tools available strike a balance between the straightforward, general operations that everyone uses and the vertical, complex routines that only YOU use. So, LabScribe is a powerful analytical tool that can go to work on data right away, or be customized to execute very specific, complex analysis routines.

Analysis in LabScribe is divided into five types or kinds. Each kind addresses specific analytical requirements. The following sections of this chapter explain how each type is used.

Analyses of the First Kind: Wave-to-Wave Transforms

Analytical functions of this kind take ALL of the data in a channel and apply a transform, which converts the entire waveform described by the data points into a completely new wave, that is displayed on a different channel. Examples of this kind of analysis would be the first derivative or the integral.

Currently there are 27 functions of the **First Kind**, or **Wave-to-Wave Transforms**, included in the LabScribe program. These functions can only be accomplished on the **Main** window. They are called from the **right-click** menu and can be used **on-line** or **off-line**. When used **on-line**, the functions can operate at the top acquisition rate of the program, 100,000 samples per second.

On the **right-click** menu, the transforms are organized into groups. The functions within a group have similar setup requirements and are usually located in a sub menu. While the list of available functions is always expanding, LabScribe V1.8 includes the following groups: **Periodic**, **Integral**, **Derivatives**, **Channel Math**, **Filter**, **Power**, **Spirometry**, **Cardiac**, **EEG**, and **Gain Telegraph**. Each group is discussed below.

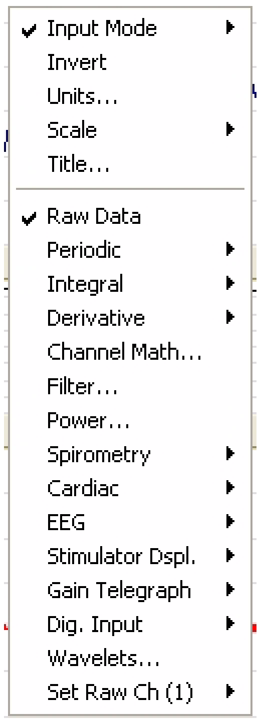
Before beginning to explain the various **First Kind** functions, it is appropriate to ask: "Where does the RAW DATA for a wave-to-wave analysis come from?" It is a question that is appropriate for all of the **First Kind** functions. By default, calculated channels (channels displaying wave-to-wave transforms) always use the channel immediately above them as the raw data channel. For example, if the **Rate** function is selected on Channel 2, the electrocardiogram equipment or pulse sensor should be connected to Channel 1. Likewise, by default, an integral set on Channel 4 expects the raw data input to come from Channel 3.

It is possible to select another channel, besides the one above the calculated channel, as the source of raw data. To select the raw data channel for a function, highlight the **Set Raw Ch**annel item at the bottom of the channel **right-click** menu. This opens a submenu. From the submenu, select the channel that is the source of raw data for the calculated function. For example, opening the **right-click** menu for Channel 2, and setting the **Set Raw Ch** to Channel 3, causes any calculated functions called on Channel 2 to look at Channel 3 (the channel below) for its source of raw data as opposed to the default (Channel 1, the channel above).

The settings for any of these wave-wave analysis functions are available on the **Functions** page of the **Preferences** dialogue window. These settings are factory set to include most biological signals; but, they may be modified for any signal type and stored in **Settings** files.

Setup Transform

Whether calculated functions are performed **on-line** (in real time) or **off-line** (after recording has stopped), their setup is the same. To set up a calculated (wave-to-wave transform) channel:



•Right- click in the display area of the channel being set as a calculated function. A menu of function choices appears

•Highlight and select one of the functions.

•By default the channel will look to the channel above for its raw data. If you require a different channel to supply the raw data, select it from the **Set Raw Channel** item at the bottom of the right-click menu.

•Click the **Start** button. Click **AutoScale** for the raw data channel; then, click **AutoScale** for the calculated channel.

The calculated function will then be displayed; no other setup is required. Specific setups for the different groups of functions are described below.

Figure 5-1: The Right-Click for a channel displayed on the LabScribe Main window.

Periodic

Periodic functions operate on cyclic data to produce a graphical representation of how the **Rate**, **Frequency**, **Period**, **Cycle Maximum**, **Cycle Minimum**, **Cycle Mean**, or **RMS** (Root Mean Square) vary with time. The program calculates these parameters with each cycle of the signal and displays the calculation on the screen.

Threshold

To make these types of calculations on each cycle, the software must have a way of defining a cycle of data. As data is collected on-line or processed off-line, the LabScribe program begins the calculation by using the **AutoScale** feature to determine the **Max** and **Min** values in a given screen of data. Then, the program uses a **Threshold** value to find points on the recording where the trace repeatedly crosses the threshold with a positive slope. The control for the **Threshold** level can be found on the **Functions** page of the **Preferences** dialogue window, in the **Periodic** section. The **Threshold** level is set at **X%** of maximum value in any given screen of data. By default, **X%** is set to **60%**, which is adequate for almost all biological signals. The **Threshold** percentage can be changed by entering a different number in its box. Finally, the program defines the time between the points, where the recording repeatedly crosses the threshold line with a positive slope, as a **Period** (Figure 5-2 on page 52).

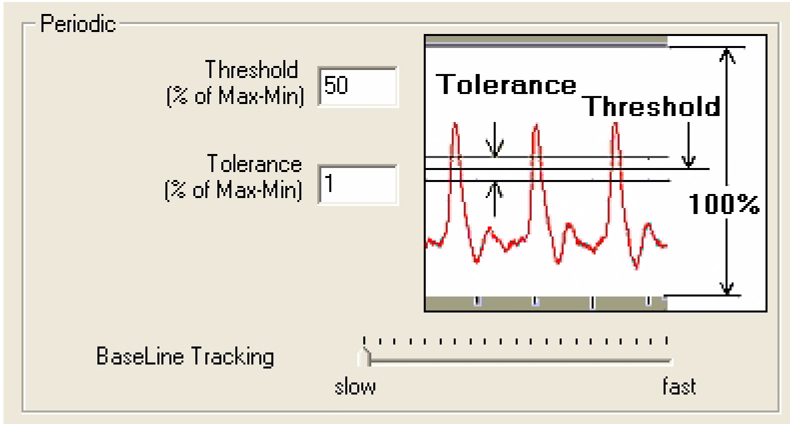


Figure 5-2: The Periodic section of the Preferences dialogue window.

Tolerance

A second **Periodic** control known as **Tolerance**, or hysteresis, is present on the **Functions** page of the **Preferences** dialogue window. **Tolerance** is used to reduce false triggering due to noise in the signal. By default the tolerance is set at 3%, if the threshold is set at 60% then the signal has to cross from below 58.5% (60 - 3/2) to above 61.5% (60 + 3/2) for a threshold crossing to be detected. The maximum value between two threshold crossings is taken to be the peak, and adjacent peaks are used to calculate the periodic functions.

Exercise

To see **Threshold** and **Tolerance** in use, record some pulse data using the **Tutorial** setting from one of the **Settings** groups. Apply the **Rate** function to the channel below the recording channel.

The **Rate** function must be able to ignore the second small wave associated with each larger pulse wave; otherwise, it will report a rate that is twice what it should be. Using the **Rate** function on an ECG would mean that **Threshold** and **Tolerance** should be set so that only one wave of the three separate and distinct waves per beat can be counted.

Baseline Tracking

The next challenge to programming a **Periodic** calculation is to exclude the baseline drift.

The most commonly observed signal in the **Periodic** category is blood pressure. Setting thresholds on this type of data is useful only if the diastolic value does not change dramatically over the course of the experiment. The program could be made to compensate for such changes by clicking the **AutoScale** button while recording. If the observer wants to look at the entire range of pressures while following rate, it is not convenient to use AutoScale repeatedly.

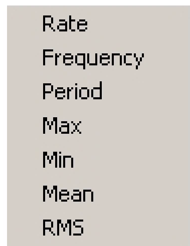
LabScribe handles drift on the baseline by using a **Baseline Tracking** function, which is also located in the **Periodic** section of the **Functions** page in the **Preferences** dialogue window.

Baseline Tracking applies a HIGH PASS filter, that has adjustable strength, to the data before LabScribe determines the **Rate** or any other **Periodic** function. HIGH PASS filters and AC COUPLING can constrain the signal around zero. In our example of measuring blood pressure, **Periodic** functions can be done without complications from changes in the diastolic value. Using **Baseline Tracking** while using **Rate** or any other **Periodic** function means that the data is faithfully followed, even through dramatic changes of the baseline.

Setup

If baseline shifts are causing a loss of a **Periodic** function online proceed to the **Functions** page in the **Preferences** dialogue window. To use **Baseline Tracking**, advance the **Baseline Tracking** slide bar about 10% from the left side. Return to the **Main** window and check the recording. If the **Periodic** function is still being dropped online, increase the amount of filtering by moving the **Baseline Tracking** slide bar another 10%.

Activating Periodic Transforms



All **Periodic** functions are selected in the same manner. To use any of these functions, **right-click** on the display area of the channel where the function is to be displayed. Select **Periodic** from the **right-click** menu and a submenu appears. Select one of the functions in the submenu. By default, raw data will be collected on the channel immediately above the calculated channel (Channel 1 for calculated Channel 2, Channel 3 for calculated Channel 4, etc.). Use the **Set Raw Ch**annel function at the bottom of the **right-click** menu for the calculated channel to select a different channel as the source of raw data. Click **Start** in the **Main** window to begin recording. **AutoScale** the raw data, then **AutoScale** the calculated channel. No other setup is required.

The functions in the **Periodic** submenu are:

Rate: The program takes the **period** in seconds and divides this value into 60. The result is a **rate**, which is expressed in beats per minute

Frequency: The program takes the **period** in seconds and divides this value into 1. The result is a **frequency**, which is expressed in Hz or cycles per second.

Period: The program takes the **Period** for each cycle.

Min: The program examines all of the points in the current period and finds the lowest value.

Max: The program examines all of the points in the current period and finds the highest value.

Mean: The program examines all of the points in the current period and finds the average of all values.

RMS: The program examines all of the points in the current period and finds the Root Mean Square value for all points

Integral

The integral is the area under the curve. The **Integral** function, as executed by the LabScribe software, calculates a continuous sum of all the data points on a given channel and plots the running total. Data points with values above zero make the **Integral** larger, those with values less than zero make the **Integral** smaller. To successfully complete the calculation of the **Integral**, the location of the zero-line and the portion of the data being examined need to be known.

Setting the baseline of the raw data channel to zero is the more important of the two requirements since this function defines the difference between positive and negative areas of the recording. If the baseline of the raw data record is in the positive range of amplitudes, then the **Integral** will have a positive slope, even though no signal is present. Conversely, if the baseline of the raw data is in the negative range, the **Integra**l will have a negative slope.

The portion of raw data to be integrated should be a manageable size. If too much raw data is integrated, navigating through the data and measuring changes in the **Integral** value is more difficult.

There are two parameters that can be set to control the **Integral** functions. These are found in the **Integra**l section on the **Functions** page of the **Preferences** dialogue window. All these parameters are involved in setting or maintaining the zero-line for the **Integra**l calculation.

Zero

As mentioned above, the **Integral** function adds the amplitudes of successive data points and plots the total. The problem is determining where the zero-line is located. LabScribe and most other data programs take the value zero volts as the zero-line. If real units, such as grams or mmHg are used, the LabScribe software will take the zero units value as zero.

LabScribe also has a **Use First "Number" points as zero** option. When the box next to this function is checked, the first **"Number"** of data points collected are averaged and used by the program as zero. This feature is particularly useful when trying to integrate signals that are difficult to zero manually.

An example of the application of this feature is illustrated in Figure 5-3 on page 54. The output of a respiratory flow sensor is the raw data displayed on the upper channel in each window; the lower channel in each window is the integral of the upper channel, or the volume flowing through the sensor.

In this example, the setting of zero is critical because any offset of the raw data from zero will be taken as a flow and, subsequently, be interpreted as a volume. Two examples of the respiratory integral are shown. In each case the flow sensor has a small, but stable offset. In the example on the left, the integral shows constant increase in volume, as the flow is constant. In the record on the right, where the **Use First "Number" points as zero** option is used, the initial flow is constant and is set to zero, so the initial volume is zero. When the flow increases to a level above the "effective" zero-line, the volume increases on the integral channel.

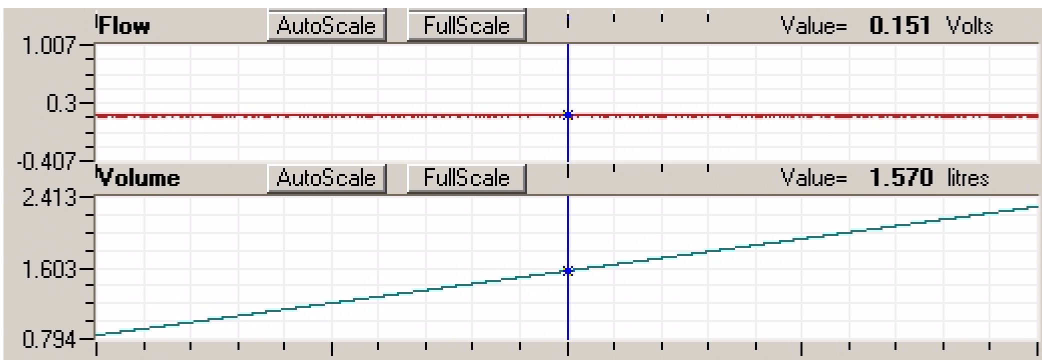


Figure 5-3: Integral without Zero.

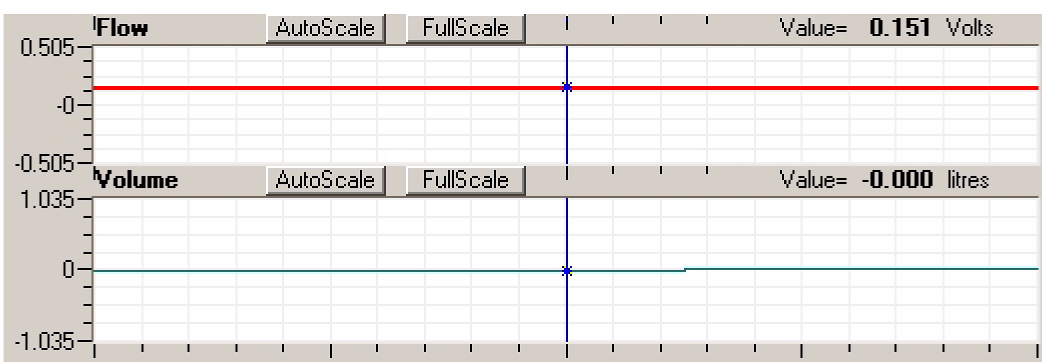


Figure 5-4: Integral with Zero

The **Reset** control in the **Integra**l area on the **Functions** page of the **Preferences** dialogue window determines when the **Integral** or running count will reset itself to zero. This option allows the **Integra**l to reset itself after a preset time. This is a useful option if the data being integrated contains artifacts that move the **Integral** artificially up or down. The **Reset** function keeps the **Integral** trace in the field of view. In the respiration example, if inhaled air is at 20^{o}C and exhaled air is closer to body temperature, then exhaled air has a larger volume. Since the subject exhales more than he or she inhales, the integral record with have a slow upward drift. Resetting the trace periodically will return it to zero.

Activating Integral Functions

Both **Integral** functions are selected in the same manner. To use either of these functions, **right-click** on the display area of the channel where the function is to be displayed. Select **Integral** from the **right-click** menu and a submenu appears. Select one of the functions in the submenu.

By default, raw data will be collected on the channel immediately above the calculated channel (Channel 1 for calculated Channel 2, Channel 3 for calculated Channel 4, etc.). Use the **Set Raw Ch**annel function at the bottom of the **right-click** menu for the calculated channel to select a different channel as the source of raw data.

Click **Start** in the **Main** window to begin recording. **AutoScale** the raw data, then **AutoScale** the calculated channel. No other setup is required.

The functions in the **Integral** submenu are**:**

Integral: As mentioned above, the integral function adds the value of successive data points and plots the total.

Abs.**Integral:** The **Abs**olute Value of the **Integral**, as the name implies, makes all values of the integral positive and plots the running total. The **Abs. Integral** is used for analysis of cyclic data such as unit action potentials or EMG data. The integral value is programmed to reset after each cycle.

Derivative

The **Derivative** function calculates the derivative at each point in the raw data, and then displays it on the calculated channel. On the channel where the **Derivative** is displayed, the units are changed to the units of the raw data channel/second. On a channel programmed to display the **Second Derivative**, the units are the units of the raw data channel/second/second.

Activating Derivative Function

To use either of the **Derivative** functions, **right-click** on the display area of the channel where the function is to be displayed. Select **Derivative** from the **right-click** menu and a submenu appears. Select one of the functions in the submenu. By default, raw data will be collected on the channel immediately above the calculated channel (Channel 1 for calculated Channel 2, Channel 3 for calculated Channel 4, etc.). Use the **Set Raw Ch**annel function at the bottom of the **right-click** menu for the calculated channel to select a different channel as the source of raw data.Click **Start** in the **Main** window to begin recording. **AutoScale** the raw data, then **AutoScale** the calculated channel. No other setup is required.

The functions in the **Derivative** submenu are**:**

First: Takes the first derivative at each data point in the raw data and plots it on the calculated channel

Second: Takes the second derivative at each data point in the raw data and plots it on the calculated channel

Channel Math

The **Channel Math** function applies a user-defined function to points from raw data channels and displays the output on a calculated channel. Each raw data channel can be a term in the user-defined expression.

For example, if the **Channel Math** function was selected on Channel 4. The following function could be programmed: Ch4 = Ch1/Ch2.

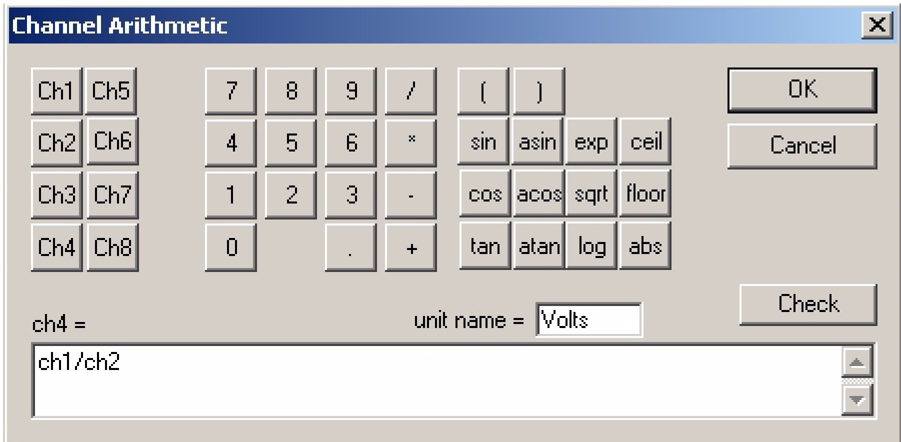


Figure 5-5: The Channel Math dialogue window from the channel right-click menu.

The result displayed on Channel 4 is every Channel 1 data point divided by the corresponding Channel 2 data point. A full range of **trig** and **log** functions, as well as the common mathematical operators, are available in the **Channel Arithmetic** dialogue window. The **unit name** for the calculated value can be specified in a box. There is also a **Check** Expression feature, which will check for errors like unclosed parentheses or division by zero. Since division by zero is a possible occurrence even in legitimate expressions, the program substitutes the last calculated value for the quotient, if division by zero is attempted.

Activating Channel Math

To use the **Channel Math** function, **right-click** on the display area of the channel where the function is to be displayed. Select **Channel Math** from the **right-click** menu and program the expression to be displayed on the selected channel. Set units if desired, and click OK.

Filter

Each channel has its own digital **Filter** that can be used on-line or off-line. When used on-line, the program applies an *8-pole Butterworth* filter, which reduces noise effectively on most smoothly varying signals. However, sharp voltage steps, like the ones used in a voltage clamp application, are not well tolerated by the on-line version of the digital filter. The solution for filtering sharp changes in voltage is to use a different type of filter off-line. When the **Stop** button is clicked, LabScribe recalculates the entire record as it applies a *201*st*order raised-cosine FIR* filter.

To use the **Filter** function, **right-click** on the display area of the channel where the signal to be filtered is displayed. If you intend to display the filtered data on the same channel as the raw data, go to the **Set Raw Ch**annel function at the bottom of the **right-click** menu, and set the channel to take the raw data from itself. Select **Filter** from the **right-click** menu. In the **Set Filter** window, drag the boundaries of the filter to create the desired filter. Click **OK**. No other setup is required.

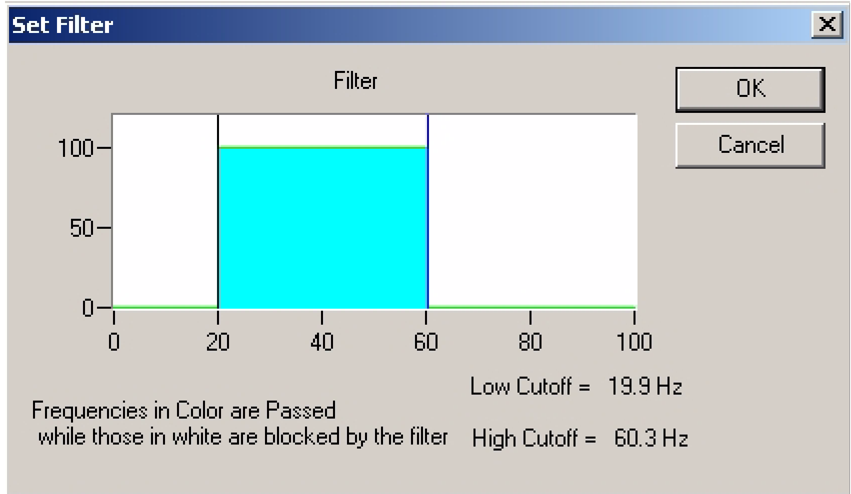


Figure 5-6: The digital (software) Filter dialogue window from the channel right-click menu.

The graphic interface in the **Set Filter** window is straight forward. The BLUE area corresponds to the frequencies that are passed, and the WHITE area corresponds to frequencies that are rejected. To remove high frequencies from the signal, click on the right boundary of the BLUE area and drag this boundary to the left. To remove low frequencies from the signal, click on the left boundary of the BLUE area and drag this boundary to the right. After clicking and dragging a boundary, it can be placed more accurately with the arrow keys on the keyboard. Boundaries can be placed in configurations that create High Pass, Low Pass, Band Pass (*Figure 5-6 on page 57*), or Notch filters.

Notice that the **Filter** is subject to the Nyquist limitation of frequency. The maximum frequency in the **Set Filter** window is exactly half of the sample frequency.

Power

The **Power** function performs a Fast Fourier Transform (FFT) on data in the selected channel and returns the average **Power** in the frequency band selected.

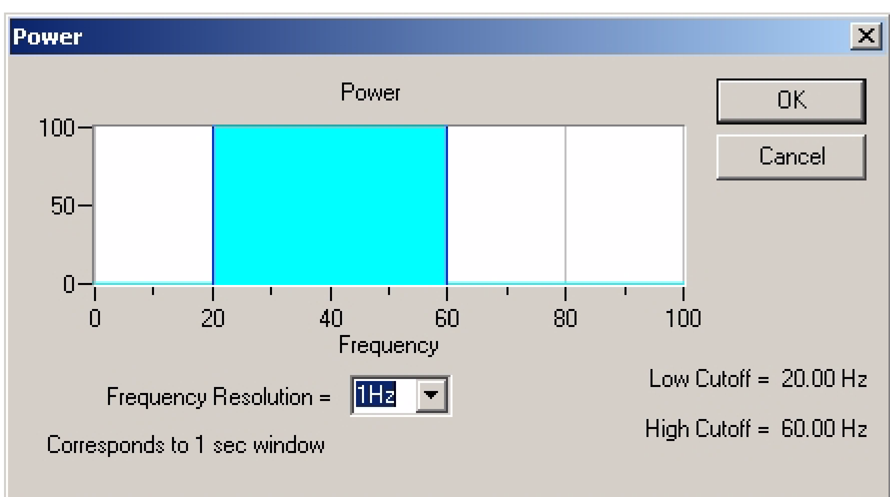


Figure 5-7: The Power dialogue window from the channel right-click menu.

In LabScribe V1.8, this function works only off-line. The graphic interface in the **Power** dialogue window is similar to the one in the **Set Filter** dialogue window. The band of frequencies selected from the Power dialogue window are not filtered, but they are subjected to a FFT whose output is known as a **Power number**. In addition to specifying the range of frequencies transformed, the frequency resolution can be selected. The higher the frequency resolution, the more data points required to compute the FFT. Therefore, at slow sampling rates, higher frequency resolutions may require the processing of more data points from longer recording periods

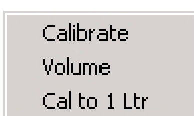
Spirometry

The **Spirometry** function is a specialized version of the integral function for use with the *iWorx* spirometer. This transducer, which measures respiratory volumes, is a sensitive air flow sensor. LabScribe integrates the flow values measured by the sensor and displays volume. The settings for this integration are specifically designed for volume calculations. By selecting the **Volume** function in the **Spirometry** sub-menu, a couple of required settings are installed by the program.

LabScribe will take the first 50 data points, average them together and use the result to set the zero-line of the **Volume** channel. This is necessary because the output of the air flow sensor is always offset; and any offset would cause the **Volume** channel to display a volume change, even though there was no air flowing through the sensor.

The **Volume** integral also resets every 30 seconds. During spirometry experiments, the volume trace drifts upward because the volume of exhaled air is larger than the volume of inhaled air. Cooler inhaled air at room temperature occupies less volume than warmer exhaled air. The **Volume** integral will drift up and out of view, as it reports correct values, unless a periodic reset is employed.

Activating Volume Function



To use the **Volume** function, **right-click** on the display area of the channel where the **Volume** is to be displayed. Select **Spirometry** from the **right-click** menu and a submenu appears. Select **Volume** in the submenu. By default, raw data will be collected on the channel immediately above the calculated channel (Channel 1 for calculated Channel 2, Channel 3 for calculated Channel 4, etc.). Use the **Set Raw Ch**annel function at the bottom of the **right-click** menu for the calculated channel to select a different channel as the source of raw data.

To accurately convert the flow data of the sensor to volumes (in liters), the calibration value for the air flow sensor must be entered into the program. The default calibration value used by the program is **0.150 Vs/liter**. The actual calibration value of the flow sensor being used is written on a label on the side of the flow sensor unit. To convert the flow data to volumes, open the **Spirometry** submenu and select **Calibrate**. The **Spirometry Calibration** dialogue window appears. Enter the calibration value printed on the side of the air flow sensor into the box on the calibration window. Enter the value exactly as it is written. Click **OK**.

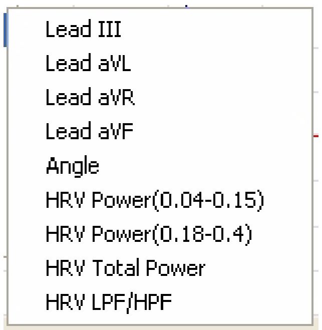
Click **Start** in the **Main** window to begin recording. **AutoScale** the raw data (Air Flow) channel, then **AutoScale** the **Volume** channel. No other setup is required.

Cardiac

The **Cardiac** functions are specifically used for the analysis of electrocardiograms (ECG). Four of the **Cardiac** functions calculate **Leads: III, aVL, aVF** and **aVR** from the recordings of **Lead I** on Channel 1 and **Lead II** on Channel 2. LabScribe can be programmed to do these calculations because all the points of view in a 6-lead ECG are in the same plane (frontal) of the body, and each lead can be considered as a vector. So, if any two of limb leads are recorded, the other four leads can be calculated from them.

The **Cardiac** submenu also includes four other functions. The **Cardiac Angle** function is available, which can calculate the vector of the cardiac depolarization that passes through the interventricular septum. Three **Power** functions, which are special cases of the general power function described earlier, are also available.These three power functions are useful for heart rate variability (**HRV**) analysis. **Low Frequency** (**LF**) **Power** (0.04-0.15 Hz), **High Frequency** (**HF**) **Power** ((0.18-0.4 Hz) and **Total Power** are each calculated from the transformation of a tachogram of an ECG on one of the raw data channels.

Activating Cardiac Functions



To use the **Cardiac** functions, **right-click** on the display area of the channel where the function is to be displayed. Select **Cardiac** from the **right-click** menu and a submenu appears. Select one of the functions in the submenu. To calculate **Leads III**, **aVL**, **aVF** or **aVR** automatically, **Leads I and II** must be recorded on Channels 1 and 2, respectively. **Angle** and the **HRV Power** functions are usually taken from the Lead II ECG channel since it is normally the one with largest QRS complexes. Use the **Set Raw Ch**annel function at the bottom of the **right-click** menu to select the raw data source for the calculated channel. Click **Start** in the **Main** window to begin recording. **AutoScale** the raw data, then **AutoScale** the calculated channel. No other setup is required.

EEG

The **EEG** function is another specialized case of the **Powe**r function. In this function, a preset frequency band is available for each component of the EEG: **Alpha**, **Beta**, **Theta**, and **Delta**. For each selected band, LabScribe calculates the average **Power** in the band and displays the value against time. These are beneficial functions to use when teaching students, because they can clearly see the effect that behavior has on components of the EEG.

Activating EEG Functions

To use the **EEG** functions, **right-click** on the display area of the channel where the function is to be displayed. Select **EEG** from the **right-click** menu and a submenu appears. Select one of the EEG frequency bands from the submenu. Use the **Set Raw Ch**annel function at the bottom of the **right-click** menu to select the raw data source for the calculated channel.

Click **Start** in the **Main** window to begin recording. **AutoScale** the raw data on the EEG channel, then **Autoscale** the calculated channel. No other set up is required.

Stimulator Display

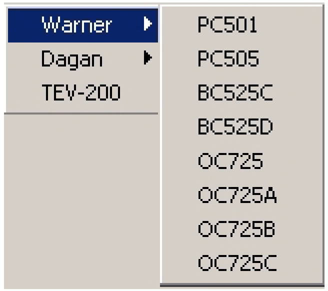
The **Stimulator Dspl** (Display) function is really a control that permits a representation of the stimulator output to be displayed on the data recording. This display control can be used on-line or off-line. Two output displays, **Out1** and **Out2,** are available. **Out1** functions on all *iWorx* hardware that have a stimulator. **Out2** functions only when used on the *iWorx* 118, which has two independent stimulator outputs.

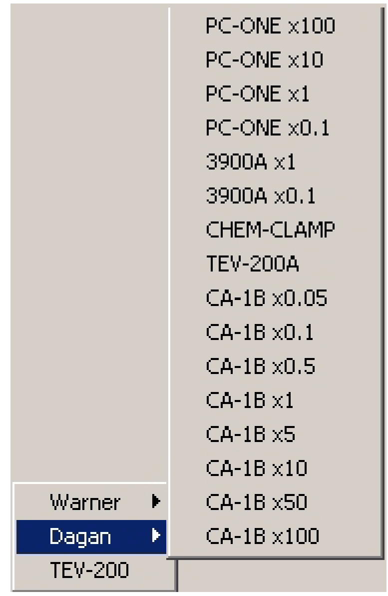
Because of the way the **Stimulator Dspl** control is programmed in LabScribe, the stimulus waveform can be shown on any one of the recording channels without losing the capability of that channel to record data. On a specific channel, the user can "toggle" between displays of the data and the stimulus records.

Activating Stimulator Display

To use the **Stimulator Dspl**, **right-click** on the display area of the channel where the stimulator output will be shown. Select **Stimulator Dspl** from the **right-click** menu, and a submenu appears. Select one of the **Out**puts from the submenu. Click **Start** in the **Main** window to begin recording. **AutoScale** the channels that need to be reset. To return the stimulator display channel to showing recorded data, select **Raw Data** in the **right-click** menu of that channel.

Gain Telegraph





The **Gain Telegraph** function is slightly different from the other functions in the **right-click** menu. Some amplifiers have an additional output that sends a calibration signal to the data recording unit. This calibration signal relays information about the gain settings of the external amplifier. This information permits the recording program to re-calibrate the amplifier output in the correct units regardless of the gain set on the amplifier. The list of amplifiers supported by this feature can be found in the **Gain Telegraph** submenu.

Using Gain Telegraph

Connect the analog output of the supported amplifier to any input channel. For this example, assume this is Channel 1. Next, connect the gain telegraph output of the amplifier to any input channel. For this example, assume this is Channel 2.

Open the **right-click** menu on the analog input channel (Ch 1), and select the supported amplifier from the **Gain Telegraph** submenu. Next, set **Raw Data Ch**annel on the analog input channel (Ch 1) to the channel (CH 2) receiving the gain telegraph output of the amplifier.

Wavelet

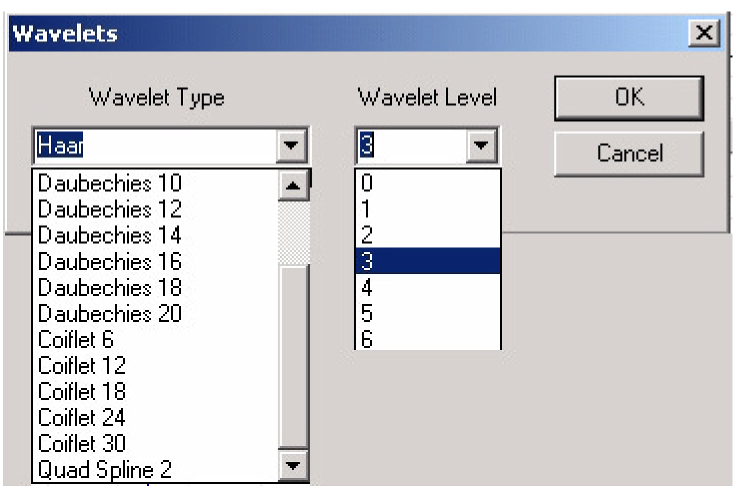


Figure 5-8: The Wavelet dialogue window in the channel right-click menu.

The **Wavelet** function performs a Wavelet Transform (DWT) on data in the selected channel and returns the DWT at the level selected. In LabScribe V1.8, this function works only off-line.

Analyses of the Second Kind: Digested Data

The functions in this kind of analysis take a group of data points, selected by the user, and "digests" them into a single value. These values can be saved to a **Journal** within LabScribe, or exported to other programs. This kind of analysis can proceed in the **Analysis** window or the **ScopeView** window. There are currently 31 functions available in the LabScribe program to do this kind of analysis. Some of the functions are: **Mean**, **Max**, or **Max-Min**.

While the use of “second kind” functions is the same in both windows, (Analysis and ScopeView) the set-up and layout is slightly different from window to window. Each window and the use of second kind functions are described below.

Analysis Window Setup

The **Analysis** window (see Figure 5-9 on page 62) is used to display and perform calculations on selected pieces of data captured from the **Main** window. The data used in the **Analysis** window is defined by placing the cursors on either side of the data while it is displayed in the **Main** window. The data is then captured by either clicking the **Analysis** icon on the LabScribe toolbar or selecting **Analysis** from the **Windows** menu. Data from all channels within the selected area is displayed in the **Analysis** window.

The channels containing the data of interest can be chosen for display by selecting their names from the **Display Channels** list on the left side of the **Analysis** window. Use the standard Windows commands, SHIFT-CLICK and CONTROL-CLICK, to select the channels. The selected channels are **autoscaled** and *tiled* in the data display area, one channel beneath the other. Clicking the **Stacked** radio box will overlay the selected channels in the **Analysis** window. Since **AutoScale** is always enabled in the **Analysis** window, the stacked channels will be **autoscaled** on the same Y-axis.

Many of the same tools in the **Main** window are also available in the **Analysis** window. These include: **Display Time** controls; **Marks**, which are the same as the ones positioned in the **Main** window; **Dual Cursor** mode (Single Cursor mode is unavailable); scroll bars to fine tune the area of data upon which the selected functions will operate; and **Block-Up** and **Block-Down** buttons on either end of the scroll bar that provide shortcuts for scrolling to the next or previous block.

Data in the **Analysis** window can be operated upon by the functions in the table on the left side on the **Analysis** window. Again, the **Dual Cursors** are positioned on the left and right edges of the data to be analyzed. LabScribe will immediately calculate and display the values for the selected parameters in the **Calculated Value Display** area at the top of the **Analysis** window. Calculations can be performed on only one channel at a time. So, the channel to be measured needs to be selected from the **Value from Ch**annel pop-down menu in the upper left corner of the **Analysis** window. The precision of the calculations performed is adjustable from the **Precision** pop down below the **Value from Ch**annel pop-down menu.

There are 31 analytical functions available in the **Table Functions** list in the lower left side of the **Analysis** window. The functions are described below. The values listed in the **Calculated Value Display** area can be sent to the **Journal** for formatting and inclusion in reports. To do this, **right-click** in the display area in the **Analysis** window, and select **Add Title** or **Add Data to Jrnl**. These commands are also accessible from the **Tools** menu.

The **Analysis** window can also be copied, printed, or exported to ASCII, .png, or .bmp format documents.

Figure 5-9: The LabScribe Analysis window.

Analysis Window Components

Display Channels List

The **Display Channels** list allows the user to pick which channels to display in the **Analysis** window. Clicking on a channel name selects the channel and deselects any other channel that was previously selected. Multiple channels can be selected using the standard Windows commands, SHIFT-CLICK and CONTROL-CLICK.

Table Functions List

The functions selected in the **Table Functions** list determine the calculations performed on the data points between the two cursors in the **Analysis** window. These analyses can be performed only on one channel at a time. The results of the selected calculations are displayed in the **Calculated Value Display** area at the top of the **Analysis** window.

Value from Channel List

The **Analysis** window can only operate on the data points from one channel at a time. Select the channel to be analyzed from the **Value from Ch**annel list in the upper left corner of the **Analysis** window.

Tiled or Stacked Display

By default, the channels selected for display are presented in **Tiled** mode. Each channel is displayed in its own area, as they are shown in the **Main** window. By clicking the **Stacked** box in the left margin of the **Analysis** window, selected waveforms can be overlaid on the same set of axes.

Right-Click Menu in the Analysis Window

Right-click in the display area of the **Analysis** window to bring up a menu like the one in Figure 5-10 on page 63. Selecting **Add Title to Journal** sends the names of the analyses (calculations) being performed (and displayed at the top of the **Analysis** window) to the **Journal**. Selecting **Add Data to Journal** sends the calculated values from these analyses to the **Journal**. The **right-click** menu also gives the user the option to **Zoom In** or **Zoom Out** to refine the selection. The **Zoom In** function will expand the area between the cursors to full screen. When the **Zoom Out** function is used, the original screen of the **Analysis** window is positioned in the middle of a 2X larger data set. So, for each click of the **Zoom Out** function, the time displayed on the window is two times longer.

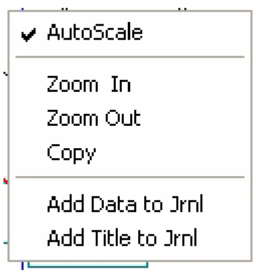


Figure 5-10: The Analysis window right-click menu.

The **Table Functions** are the same for the **Analysis** window and **ScopeView** windows and are described after the **ScopeView** setup.

ScopeView Window Setup

The **ScopeView** window (see Figure 5-11 on page 64) is used to display and perform calculations on **Sweeps** of data recorded on the **Main** window while it is configured in **Scope** mode. In the **ScopeView** window, DIFFERENT time segments (or sweeps) of data from the SAME channel are displayed. This differs from the **Analysis** window where the SAME time segment of data from ALL channels is displayed. For a discussion of sweeps and acquisition in the **Scope** mode, see the **Scope** section of *Chapter 3: Acquisition*.

To enter the **ScopeView** window, click the **ScopeView** icon on the LabScribe toolbar or select **ScopeView** from the **Window** menu. All sweeps from the selected channel are displayed in the **ScopeView** window. Sweeps of interest can be selected in the **Display Sweeps** list on the left side of the **ScopeView** window. Use the standard Windows commands, SHIFT-CLICK and CONTROL-CLICK. The selected sweeps are **autoscaled** and *tiled* in the data display area, one sweep beneath the other. Clicking the **Stacked** radio box will overlay the selected sweeps in the **ScopeView** window. Since **AutoScale** is always enabled in the **ScopeView** window, the stacked sweeps will be autoscaled on the same Y-axis. At the bottom of the **ScopeView** window, the average of all selected sweeps is displayed

Many of the same tools in the **Main** window are also available in the **ScopeView** window. These include: **Display Time** controls; **Marks**, which are the same as the ones positioned in the **Main** window; **Dual Cursor** mode (Single Cursor mode is unavailable); and scroll bars to fine tune the area of data upon which the selected functions will operate.

Data in the **ScopeView** window can be operated upon by the functions in the table on the left side of the **ScopeView** window. Again, the **Dual Cursors** are positioned on the left and right edges of the data to be analyzed. LabScribe will immediately calculate and display values for the selected parameters in the **Calculated Value Display** area at the top of the **ScopeView** window. Calculations can be performed on only one sweep at a time. So, the sweep to be measured needs to be selected from the **Value from...** pop-down menu in the upper left corner of the **ScopeView** window. The precision of the calculations performed is adjustable from the **Precision** pop down below the **Value from...** pop-down menu.

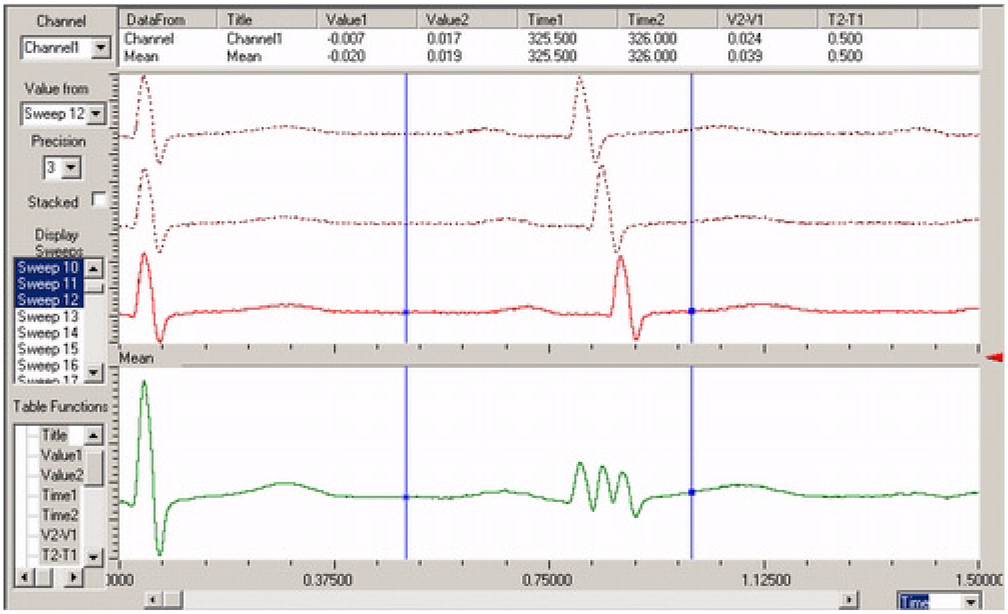


Figure 5-11: The LabScribe ScopeView window.

There are 31 analytical functions available in the **Table Functions** list in the lower left side of the **ScopeView** window. The functions are the same as the ones offered in the **Analysis** window. There are two rows of calculated values in the **Calculated Value Display** area. The first row contains the values from the selected sweep or block listed in the **Value from...** menu. The second row has the average of the calculated values from all the sweeps displayed in the **ScopeView** window. These values can be sent to the **Journal** for formatting and inclusion in reports by **right-clicking** in the display area in the **ScopeView** window and selecting **Add Title** or **Add Data to Jrnl**. These commands are also accessible from the **Tools** menu.

The **ScopeView** window can be copied, printed, or exported to ASCII, .png, or .bmp format documents.

ScopeView Window Components

Display Sweeps List

The **Display Sweeps** list allows the user to pick which Sweeps to display in the **ScopeView** window. Clicking on a sweep name selects the sweep and deselects any other sweeps that were previously selected. Multiple sweeps can be selected using the standard Windows commands, SHIFT-CLICK and CONTROL-CLICK.

Table Functions List

The functions selected in the **Table Functions** list determine the calculations performed on the data points between the two cursors in the **ScopeView** window. These analyses can be performed only on one sweep at a time. The results of the selected calculations are displayed in the **Calculated Value Display** area at the top of the **ScopeView** window.

Value from Sweep List

The **ScopeView** window can only operate on the data points from one channel at a time. Select the channel to be analyzed from the **Value from...** pop-down menu in the upper left corner of the **ScopeView** window.

Tiled or Stacked Display

By default, the sweeps selected for display are presented in **Tiled** mode. Each sweep is displayed in its own area. By clicking the **Stacked** box in the left margin of the **ScopeView** window, selected sweeps can be overlaid on the same set of axes.

Right-Click Menu in the ScopeView Window

Right-click in the display area of the **ScopeView** window to bring up a menu like the one in Figure 5-12 on page 65. Selecting **Add Title to Journal** sends the names of the analyses (calculations) being performed (and displayed at the top of the **ScopeView** window) to the **Journal**. Selecting **Add Data to Journal** sends the calculated values from these analyses to the **Journal**. The **right-click** menu also gives the user the option to **Zoom In** or **Zoom Out** to refine the selection. As before, cursors are used to determine the portions of the data to be zoomed to full screen. The **Zoom In** function will expand the area between the cursors to full screen. When the **Zoom Out** function is used, the original screen of the **ScopeView** window is positioned in the middle of a 3X larger data set. So, for each click of the **Zoom Out** function, the time displayed on the window is three times longer.

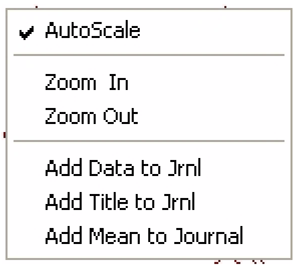


Figure 5-12: The ScopeView right-click menu.

Table Functions

These functions are available in both the **Analysis** and **ScopeView** windows.

V1, V2, T1, T2, V2-V1, T2-T1

This group of functions simply reports the values in time and voltage for the data points intersected by each of the two cursors in the **Analysis** or **ScopeView** window. The difference in time or the difference in voltage (or calibrated Y-value) can also be reported.

Max, Min, Mean, Max-Min

For this group of functions, all data points between the cursors are examined. The maximum, the minimum, or the mean value in the data set are reported. The difference between the maximum and minimum value can also be reported.

Area, Integral, and ABS_Integral

All the integral and area functions are calculated as integrals. The **Area** function uses the line between **V1** and **V2** as the zero baseline, and then calculates the integral. The **Area** function gives more control over which segments of a waveform are included in the integral.

For the **Integral** calculation, zero Volts (or zero calculated Y-value) is used as the zero reference for the integral. Values above zero add to the **Integral**, and values below the zero-line subtract from the **Integral**.

The **ABS_Integral** is very much like the **Integral**, except that the program takes the absolute value of the raw data before performing the integral operation.

dv1/dt, dv2/dt, max dv/dt, Min dv/dt, Avg dv/dt

The functions in this group report *first derivatives*. The **dv1/dt** and the **dv2/dt** are the derivatives at **V1** and **V2**, respectively. These points are the intercepts of **Cursors 1** and **2** with the data of the selected channel. **Max dv/dt** finds the largest dv/dt values for all of the data points between the two cursors. **Min dv/dt** looks for the smallest dv/dt values for all of the data points between the two cursors. The **Avg dv/dt** finds the slope of the line of best fit for all the data points between the cursors.

Avg Max, Avg Min, Avg Max-Min, Avg Mean, Avg Period, Avg Freq.

These functions determine the mean or average (**Avg**) value of parameters: **Maximum**, **Minimum**, **Mean**, **Max-Min**, **Period**, **Frequency** taken from periodic data displayed in the **Analysis** or **ScopeView** window. LabScribe uses **Threshold** set in the **Preferences** dialogue window for determining the cycles. When the cursors are placed around a section of cyclic data, the selected function calculates and displays the average of the designated parameter from the selected data. For example, if the cursors are placed around five successive ECG cycles, the **Avg_Max** function will calculate the average amplitude of the five R waves in the selected data, assuming the R waves are the largest amplitudes in the data file. The algorithms used in these functions are the same as the ones employed in the off-line functions.

Copy, Export, and Print Analysis and ScopeView Windows

To copy the view of data displayed in the **Analysis** or the **ScopeView** window, use the **Copy** command in the **Edit** menu. The image can be pasted into any program (including the **Journal**) that supports the clipboard.

To export the data viewed, use the **Export** command in the **File** menu. Select the format of the file from the list at the bottom of the **Export File** window.

To print the data viewed, use the **Print** command in the **File** menu. The print range, which is either the selection in the **Analysis** window or all the data, can be selected in the **Print** window.

Analyses of the Third Kind: Redisplayed Data

As covered in the display section of this manual, data is recorded only into the **Main** window. **Main** window displays are *linear* or *in series*, meaning that Y-value parameters are recorded with respect to time.

Data recorded in a linear manner can be redisplayed in a format that is different than the standard Y-T plot. Currently, LabScribe v1.8 supports **XY plots** and **FFT**. A host of measurements, like the ones available in the **Second Kind Analyses**, can be made from each type of redisplayed data window.

XY Plot

In an **XY plot**, the Y-values from one channel in the **Main** window are plotted against the Y-values from another **Main** window channel. The resulting **XY plot** is dramatically different from a linear plot of data against time.

XY View Window Components

Display Channels List

Located to the left of the linear display area, two drop-down menus allow the user to select which channel's Y-values will be chosen for the Y and X axes of the **XY plot**.

Table Functions List

The functions selected in the **Table Functions** list determine the calculations performed on the data points between the two cursors in the **XY plot** display. The results of the selected calculations are displayed in the **Calculated Value Display** area at the top of the **XY View** window.

Right-Click Menu in the XY Plot

Right-click in the display area of the **XY View** window to bring up a menu like the one in Figure 5-13 on page 67. Selecting **Add Title to Journal** sends the names of the analyses (calculations) being performed, and displayed at the top of the **XY View** window, to the **Journal**. Selecting **Add Data to Journal** sends the calculated values for the analyses to the **Journal**. The **right-click** menu also gives the user the option to **Zoom In** or **Zoom Out** to refine the selection of linear data only. The **Zoom In** function will expand the area between the cursors to full screen. When the **Zoom Out** function is used, the original screen of the **Analysis** window is positioned in the middle of a 2X larger data set. So, for each click of the **Zoom Out** function, the time displayed on the window is two times longer.

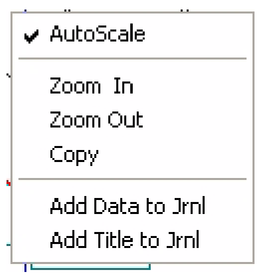


Figure 5-13: The XY View window right-click menu.

Table Functions

Title,Y1, Y2, X1, X2, Y2-Y1,X2-X1, Max_y, Min_Y, Mean_Y, Max_X, Min_X, Mean_X, Length

This group of functions simply reports the values in time and voltage for the data points intersected by each of the two cursors in the **XY View** window. As the cursors are moved in the linear data plots, data points in the **XY plot** are highlighted. The **Min**imum, **Max**imum, **Mean**, or **Difference** functions apply to data in the range of data. **Length** refers to the length of the line segment identified between the highlighted data points.

Slope, dY1/dx, dY2/dx, Max_dY/dx,Min_dY/dx, Mean_dY/dx, Max-Min

For this group of functions, all data points between the cursors are examined. The **Max**imum, the **Min**imum, or the **Mean** value of the slope in the data set are reported. The slope at each of the highlighted points in the **XY plot** is also reported.

Area_wrt_Ymin, Area_wrt_zero, Area_wrt_Y1, Loop_Open, Loop_closed

The **Area** functions are integrals which can use several points as the zero baseline. These functions have the abbreviation “**wrt**,” which means “with respect to”. So, the **Area_wrt_Ymin** function returns the area between the plotted curve and an imaginary horizontal line intersecting the minimum Y-value. Similarly, **Area_wrt_zero** uses a horizontal line at zero for the area calculation, and **Area_wrt_Y1** uses the value at the minimum Y as the reference line. Each of these areas returns a *partial* area of the plot. You may need to use several *areas* to capture the entire area of the plot.

The **Loop** functions assume that the **XY plot** is a loop, The area enclosed by the loop is returned by the **Loop_Closed** function. The **Loop_Open** function closes a nearly complete loop with a line. This function returns the area enclosed by the loop

Copy, Export, and Print XY View Window

To copy the view of the data displayed in the **XY View** window, use the **Copy** command in the **Edit** menu. The image can be pasted into any program (including the **Journal**) that supports the clipboard.

To export the data viewed, use the **Export** command in the **File** menu. Select the format of the file from the list at the bottom of the **Export File** window.

To print the data viewed, use the **Print** command in the **File** menu. The print range, which is either the selection in the **XY View** window or all the data, can be selected in the **Print** window

FFT

FFT is short for *Fast Fourier Transform*, a mathematical operation that displays recorded data as the relative amplitudes of the frequency components that make up the recorded signal. FFT plots have **Frequency** on the X-axis and the **Power** (amplitude) contained in each frequency on the Y-axis. FFT is used to determine the relative strengths of frequency components in a raw signal. For example, in the EEG studies, the *Alpha* band is frequently mentioned. *Alpha* waves are EEG signals with frequencies between 8 and 13 Hz. If a FFT is performed on an EEG recording that has a high number of *Alpha* waves, the FFT will show a spike or a higher amplitude (**Power**) at the frequencies in the *Alpha* band.

The LabScribe software can perform *Fast Fourier Transforms* on selected pieces of recorded data in the **FFT** window. Like other analysis windows (**Analysis**, **ScopeView**, **XY View**), the data used in the **FFT** is selected from the **Main** window by using cursors to *bracket* the data region of interest. Then, the **FFT** window is called either from the **Windows** menu or by clicking the **FFT** icon on the toolbar at the top of the **Main** window. The selected data is moved to the **Linear Display** area in the **FFT** window, where adjustments can be made which optimize the size of the **FFT plot**.

To insure problem-free operation of the **FFT function**, there are a couple of rules to keep in mind:

1. The mathematical underpinnings of digital sampling, which makes the LabScribe software work, begin with a criteria known as the Nyquist Sampling Theorem. Harry Nyquist showed that the SAMPLING RATE MUST BE AT LEAST TWICE THE HIGHEST FREQUENCY IN THE SAMPLE to reconstruct the original signal and capture its fundamental frequency.

The converse of this rule is that the FASTEST FREQUENCY THAT CAN BE RELIABLY RECORDED IS A HALF OF THE SAMPLING RATE. If a recording was made at 1000 samples per second, the maximum frequency that could be recorded reliably would be 500Hz. If a recording was made at 100 samples per second, the maximum frequency that could be recorded reliably would be 50Hz. When a FFT is performed on data recorded with LabScribe, the program sets the X-axis to a scale from 0Hz (DC) to a frequency that is a half of the sampling rate. A region of the scale can be expanded by using the cursors and the functions of the **right-click** menu, but frequencies greater than half the sampling rate cannot be viewed.

2. To make a FFT work, the transform must operate on a SPECIFIC NUMBER OF DATA POINTS. The number of data points used in the FFT is algorithm dependent. The LabScribe program indicates the location of the best selection of FFT data on the linear display section of the **FFT** window by using a gray line, in addition to the two cursors used to select the data used in the FFT. Move the cursor as close to the suggested point as possible. If it is not possible to make the selection reach to the suggested end point, LabScribe will fill in the remaining data points with zeros so the frequency content of the data that you DID select will not be affected.

As stated in the first rule that governs FFT functions, LabScribe sets the X-axis limits in the **FFT** window according to sample rate. Likewise, the number of data points used in the FFT calculation sets the resolution of the X-axis range. If more data points are used, the available **Frequency Resolution** will be greater. **Frequency Resolution** is set from the drop-down menu in the left hand margin of the **FFT** window. Resolution choices are limited to 100Hz, 10 Hz, 1 Hz and 0.1 Hz. If the FFT cannot be displayed with the required frequency resolution, more data points need to be used to make the calculation.

Moving and manipulating data in the FFT window

As with other analysis functions handled by the LabScribe program, it is necessary to select the data to be operated upon by the program. The **Display Time** controls are used to get the data of interest onto a single screen. Then, the data to be analyzed is selected by using the **Dual Cursors** to bracket the data as it is displayed in the **Main** window. Finally, the selected data is moved to the **FFT** window by clicking the **FFT** icon on the LabScribe toolbar or by selecting **FFT** from the **Windows** menu.

Once the primary data set is moved to the **FFT** window, the **Dual Cursors** on the linear graph of the raw data (above the actual FFT display area) can be used to fine-tune the data selection. Only the data between the cursors in the linear graph is actually used in the calculation. The data displayed on the linear graph and available for the transform can be changed using the **Display Time** icons on the **FFT** window or the scroll bar under the linear graph. **Right-click** on the line graph to open a menu with Zoom In and Zoom Out functions which can also be used to increase or decrease the amount of raw data that can be selected for the FFT. As mentioned, the LabScribe program suggests the end point for the data selection with a gray line. The second cursor used for data selection should be as close to the gray mark as possible.

The **FFT plot** of the selected data is displayed in the area below the linear graph of the raw data. The FFT display area has its own **right-click** menu with the **Zoom In** and **Zoom Out** functions and set of **Dual Cursors**. These features can be used to expand or contract the area of the FFT graph between the cursors. This set of **Dual Cursors** also reports the values for the selected **Table Functions** listed to the left side of the **FFT** window. The values and the titles, which are listed in the **Calculated Value Display** area at the top of the window, can be copied to the **Journal** by using the functions in the **right-click** menu for the FFT display area.

FFT Window Components

Display Channel List

Located to the left of the linear display area, this drop-down menu allows the user to select the channel to be used in the FFT plot.

Table Functions List

The calculations to be performed on the region of the FFT plot between the **Dual Cursors** are selected from the **Table Functions** list to the left of the **FFT** display area. The results of the selected calculations are displayed in the **Calculated Value Display** area at the top of the **FFT** window.

Right-Click Menu in the FFT Plot

Right-click in the **FFT** display area to bring up a menu like the one in Figure 5-14 on page 70. Selecting **Add Title to Journal** sends the names of the analyses (calculations) being performed, and displayed in the **Calculated Value Display** area at the top of the **FFT** window, to the **Journal**. Selecting **Add Data to Journal** sends the values for these calculations to the **Journal**.

This **right-click** menu also has **Zoom In** or **Zoom Out** functions which allow the user to refine display of the FFT plot. As explained in other analyses, the cursors in this plot can be used to determine the portions of the data to be expanded to full screen.

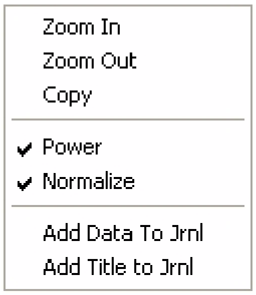


Figure 5-14: The FFT window right-click menu.

Table Functions

Title, Power@Cur1, Power@Cur2, Freq1, Freq2, Power Ratio

This group of functions simply reports the **Power** and **Frequency** values at **Cursor 1** and **Cursor 2** in the FFT plot. The **Power Ratio** returns a value equal to **Power@Cur1**/ **Power@Cur2**.

Copy, Export, and Print FFT Windows

Use the **Copy** command in the **Edit** menu to copy the view of data displayed in the **FFT** window. This image can be pasted into any program, (including the **Journal**) that supports the clipboard.

To export the data viewed, use the **Export** command in the **File** menu. Select the format of the exported file from the list at the bottom of the **Export File** window.

To print the data viewed, use the **Print** command in the **File** menu. The print range, which is either the selection in the **FFT** window or all the data, can be selected in the **Print** window

Analyses of the Fourth Kind: Detected Data Conditions

LabScribe software can be used to identify **Regions Of Interest** (**ROI**) in recorded data. The identified data points can be sent to either the **Journal** or the **Marks** window, where they can be used to either build a report or be exported. While identifying data does not constitute an analysis *per se*, the detection of specific data ALWAYS precedes analysis. For example, to measure changes in Left Ventricular End Diastolic Pressure (LVEDP) over time, the LVEDP points need to be located in the field of blood pressure data and the corresponding values need to be recorded. The statistical manipulation of the recorded LVEDP values is classified as analysis; but, the first critical step in the “analysis” was the extraction of the relevant data points or regions of interest from the complete data. The events (data points or regions of interest) that can be detected by the LabScribe program are classified into two categories: **General** and **Specific**.

General Events

General events can be located easily through the **Find** or the **Auto Find** dialogue windows.

Find Dialogue Window

The **Find** dialogue window is accessed by selecting **Find** from the **Tools** menu. The **Find** function is only available on the **Analysis** or the **ScopeView** window. Therefore, to manipulate data with this function, data must be captured from the **Main** window and placed in either of those two windows. Data points of interest can be identified using stock commands from the **Find** dialogue window. These commands can move cursors to: the **Prev**ious or **Next Max**imum; the **Prev**ious or **Next Min**imum; **Data Above** or **Below** a certain amplitude; data at a specific **Mark** with a particular STRING in a comment; data at an **Old** or **New Cursor** position; and more. The calculations to be performed on the selected data points, or on the data between the points, are chosen from the **Table Functions** list before the **Find** dialogue window is opened.

The first step in the **Find** function is the selection of the **Cursor 1 Position** from the box to the right of this label. The next step in the **Find** function is the selection of **Cursor 2 Position** from the box to the right of this label. Once the source of the data is selected and the **Find** routine is completed, it can be saved by clicking the **Save** button on the **Find** dialogue window. The named routine is saved in the **Auto Find** folder as an **.iwa** file. When the **Find** dialogue window is open, saved routines can be recalled by clicking on the **Load** button.

Find Example

As an example, the **Find** function could be used to determine the time (**T2-T1**) between two events. Occasionally, *R* waves in an ECG have significantly higher amplitudes than the other *R* waves in the same recording. The **Find** function could be used to measure the time between adjacent supranormal *R* waves. The process would include:

- Transferring the data of interest from the **Main** window to the **Analysis** window.
- Selecting the calculations (**V1**, **V2**, **V2-V1**, **T2-T1**) to be performed on the data from the **Table Functions** list.
- Placing one of the **Dual Cursors** on a supranormal *R* wave on the left side of the **Analysis** window.
- Pulling down the **Tools** menu and selecting the **Find** function.
- Programming the cursor positions. To find the next supranormal *R* wave in the data, the **Cursor 1 Position** is set equal to **Old Cursor 1** (which is already on a supranormal *R* wave). The **Cursor 2 Position** is set to **Data Above**, and the data channel is selected. The threshold amplitude, above which the **Find** function will stop, is entered into the box below the label, **Cursor 2 Position**. Then, the **Find** routine is saved.
- Clicking the **Find** button to place the cursors and to display the values for the selected **Table Functions** at the top of the **Analysis** window.
- Copying values and their headings to the **Journal** via the **Add Title to Jrnl** and **Add Data to Jrnl** functions in the **right-click** menu of the **Analysis** window.

Auto Find Dialogue Window

The **Auto Find** dialogue window (Figure 5-15 on page 72) is like the **Find** window. It is also accessible from the **Tools** menu, and works only from the **Analysis** or **ScopeView** window. However, the **Auto Find** function can be programmed to find multiple data points with the same parameters within a data selection. The values at those points can be used for **Second Kind Analyses**. Then, the results on these analyses can be written to the **Journal**, automatically.

The **Auto Find** function can find the same types of data points found with the **Find** function, like: **Next Max**imum, **Previous Min**imum, **Data Above** a given value, the next **Mark** containing a particular alpha-numeric STRING, and more. Like **Find** routines, **Auto Find** routines may be constructed from the various parameters available and saved in the **Auto Find** folder. For periodic functions, maximum values, and minimum values, LabScribe uses the threshold values set for **Periodic** data on the **Functions** page in the **Preferences** dialogue window for the **Main** window. Just like other measurements of periodic data, the data must be scaled properly, which can be accomplished in most cases by clicking the **AutoScale** button in the **Main** window.

Auto Find Example

As an example, the **Auto Find** routine can be used to place cursors on all the *R* waves in an ECG record and to measure the period (**T2-T1**) of each beat. The easiest way to begin the **Auto Find** routine is to manually place the cursors on the two successive *R* waves at the beginning of the record. When selecting the commands to use in this routine, the user should ask themselves: " Where are the next two data points that are needed for measuring the next period (**T2-T1**)?" The answer is that the first data point in the next period is the second *R* wave from the preceding period; and, the second R wave in the next period is the next maximum value or *R* wave in succession. Therefore, to make accurate measurements on the next period, the **Auto Find** window is programmed to set the **Cursor 1 Position** to be **Old Cursor 2,** and the **Cursor 2 Position** to be the **Next Max**.

After the number of repetitions specified or the specified end of the **Auto Find** routine is reached, the **Auto Find** routine can be saved by clicking **Save** on the dialogue window. The named **Auto Find** routines are saved as **.iwa** files, and they can be called by clicking on the **Load** button in the dialogue window.

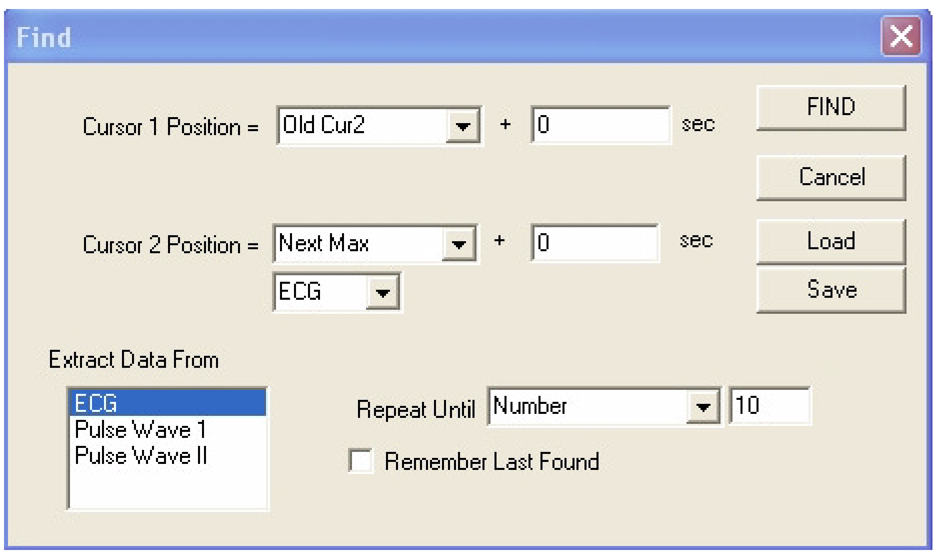


Figure 5-15: The Auto Find dialogue window.

Specific Events

The detection of **Specific** events within a recording requires the use of an algorithm to find the point or **region of interest** (**ROI**). The *LVEDP*, the *R* in an ECG, and the *P* wave in an ECG are good examples of **Specific** events. Detection of these data points requires a defined software routine that resides in the LabScribe program. The routines are accessible by selecting **Auto Mark** from the **Tools** menu and the name of the specific event from the **Auto Mark** pull-down menu. When the detection routine is run on the selected data, the software puts **Marks** on the data at the detected points. The automatic placement of **Marks** on the data accomplishes two things; first, it identifies the data points that need to be manipulated; second, it provides the user with visual cues to confirm that the software did the job of detecting the correct points. Based on the instructions given to LabScribe, the detected data can be exported as text or loaded into a script.

In LabScribe V1.8, there are **Auto Mark** functions available to detect: the **QRS** wave components of the ECG; the **LVEDP**; **Arterial Pressures**; **Maximal Response**; and **Peak Detection**.

For example, if the **Auto Mark** detector is used to locate the *R* waves in an ECG, the **QRS** function is selected from the **Auto Mark** submenu on the **Tools** menu. A window known as the **AutoMark QRS Dialog** appears on the screen. It contains a display of the data to be used with the marking routine. On this window, selections must be made for the **Data Channel** that is the source of the recording being marked, the **Maximum** Heart **Rate** (BPM) in the data of interest, and the **Start** and **Stop** points for marking the data of interest.

The **Start** and **Stop** points could be the beginning and the end of the data file (Doc.), respectively. They could also be any **Mark** on the data file. Since **Marks** can be placed on the data after the recording, it is possible to place and use **Marks** that are on the margins of the data of interest. To assist in *R* wave detection, a threshold level must be set on the data.

Finally, press **Preview** and close the **AutoMark QRS Dialog** window by clicking **OK**. Each *R* wave in the selected section of data will be marked with a **Text Mark**. These marks can be viewed and edited in the **Marks** window. The **Marks** window is organized so that the marks can be sorted by **Time** (ascending or descending), **Channel**, or by **Content** by clicking on the title of the column in the **Marks** table. Individual comments, or ranges of comments, may be selected or deselected using the SHIFT and CONTROL keys. Appropriate collections of selected comments can be exported or deleted.

Analysis of the Fifth Kind: Things Not Possible with 1st, 2nd, 3rd, or 4th Kind of Analyses

It is impossible to include all of the possible analyses and plotting capabilities required for biological research in a single program. We provide, what we believe to be, useful tools for completing the most common kinds of analyses. For circumstances where the built-in analysis tools fall short of the user's requirements, LabScribe has a **Script** function. A **script** is a program, written in any of the languages supported by LabScribe, that can perform a series of calculations on selected data. Once created, a script can be placed in the **Scripts** folder located in the LabScribe folder. The script will then appear as a menu item in the LabScribe **Scripting** menu. When selected, the **script** takes the selected range of recorded data, saves the data in a format compatible with the scripting language, loads the scripting program, and then executes the script on the saved data. The scripting programs supported by LabScribe are listed below. For example, we have created a **script** in Python, which operates on the *R-R* intervals of the ECG, which are detected by an **Auto Mark** function in the **Tools** menu. Then, the *R-R* script computes and displays a tachogram, plots Delta R-R histograms, and determines values for statistics, such as mean, mode, and standard deviation.

Writing Scripts

LabScribe has a special folder called **Scripts** located in the LabScribe folder. Any scripting files or executables placed in this folder will be included in the **Scripting** menu when LabScribe is launched.

Scripts can be run from the **Main**, **Analysis**, or **ScopeView** windows in the LabScribe program. Different data is presented to the script depending on which window is used to call the script.

The **Default Export File Format**, for exporting the data that the script will use, is set on the **Advanced** page of the **Preferences** dialogue window. The default file format is **.mat**, or the **Matlab File** format. For information about the MatLab and DADiSP file formats, refer to the **Export** section of this manual.

Scripts in the Main Window

When a script is run from the **Main** window, LabScribe saves the complete data file in the **Scripts** folder as either **input.mat** (Matlab) or **inputXX.dat** (DADiSP). In DADiSP, each block is numbered as it is saved XX, starting with 00. When LabScribe calls the script file, the Windows operating system opens the script file in the program associated with it. For example, a Python script should open in the Python program, and a MatLab script will open in the MatLab program and so on. Scripts should be set up to open and analyze data files with the names as described.

Scripts in the Analysis Window

When a script is run from the **Analysis** window, LabScribe saves the data in the **Analysis** window display in the **Scripts** folder as either **input.mat** (Matlab) or **input.dat** (DADiSP). When LabScribe calls the script file, the Windows operating system opens the script file in the program associated with it. For example, a Python script should open in the Python program, and a MatLab script will open in the MatLab program and so on. Scripts should be set up to open and analyze data files with the names as described.

Scripts in the ScopeView Window

When a **script** is run from the **ScopeView** window, LabScribe saves the data in the **ScopeView** window display in the **Scripts** folder as either **input.mat** (Matlab) or **input.dat** (DADiSP). When LabScribe calls the script file, the Windows operating system opens the script file in the program associated with it. For example, a Python script should open in the Python program, and a MatLab script will open in the MatLab program and so on. Scripts should be set up to open and analyze data files with the names as described.

Chapter 6: Input and Output

Stimulator

The **Stimulator** page in the **Preferences** dialogue box controls the Digital-to-Analog Converter or DAC of the *iWorx* hardware. It can be reached by selecting **Preferences** from the **Edit** menu. Four modes of output are available from this dialogue window: **Pulse**, **Trains**, **Constant** (voltage), and **Step**.

Trains and **Step** protocols are available only on the *iWorx* 114/214/118. The *iWorx* 118 has two DAC's, each can be controlled independently of the other.

The stimulator feature sends the DAC output to the outside world. Using controls described below, output protocols can be built from "square wave" components that are listed on the **Simulator** page of the **Preferences** dialogue window. The available output range of the stimulator is ±5V (±10V for *iWorx* 118).

Pulse Protocols

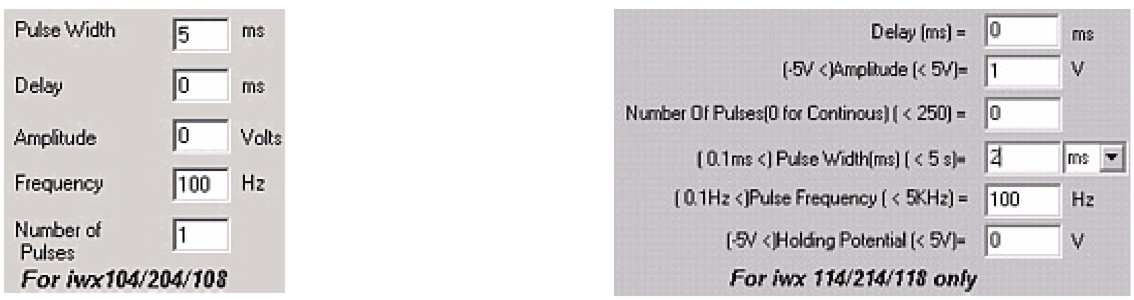


Figure 6-1: The parameter boxes on the Stimulator page of the Preferences dialogue window.

In order to understand how protocols are created, it is necessary to define the terms used on the **Stimulator** page of the **Preferences** dialogue window:

Delay: This is the time between the beginning of the recording, at the clicking of the **Start** button, and the first pulse. Delay is adjustable between 0 and 650ms (6500 ms for *iWorx* 118).

Amplitude: This is the height or voltage of the pulse or wave being generated. The amplitude programmed from the **Preferences** window will be the same for all pulses leaving the stimulus output unless the amplitude is changed manually from the **Preferences** window or the **Stimulator Control Panel**, or automatically from a programmed sequence (more later).

Number of Pulses: The total number of pulses that can be sent from the stimulator output after the **Start** button is clicked.

Pulse Width: The pulse is the basic unit of an output protocol and it has two basic dimensions, amplitude, as described above, and length. The length of the pulse is also called pulse width or pulse duration. The pulse duration is adjustable between 0.1ms and the period of the pulse (as programmed by the **Pulse Frequency**).

Pulse Frequency: This is the number of programmed pulses that are delivered in one second period of time. Pulse frequency is adjustable between 0.1Hz and 5000Hz. The maximum frequency that can be set is dependent on the pulse duration. In the case of the *iWorx* 104/204, the frequency is also dependent on the sampling rate. Remember that the period (P) is the inverse of the frequency (F), or P = 1/F.

Holding Potential: This is a voltage between + and -5V that can be programmed to shift the resting voltage of an excitable tissue (like a nerve). It is also known as a holding voltage because it can be used to hyperpolarize the membrane potential of an excitable tissue and prevent it from depolarizing or “firing”.

Building Output Protocols in Pulse Mode

To record stimulus pulses like the examples that follow, the stimulator output of an *iWorx* unit can be connected to one of its own BNC inputs. On the *iWorx* 104 and 118, this is easily accomplished by using a BNC-BNC cable. However, the stimulator outputs of the *iWorx* 114, 214, and 204 units are three color-coded banana jacks; so, a Double Banana-BNC adapter or cable is needed to connect two of the banana jacks to one of the BNC inputs. To record positive pulses, connect the adapter to the positive (red) and ground (green) banana jacks; to record negative pulses, connect the adapter to the negative (black) and ground (green) banana jacks. Double-Banana adapters have a flag or bump on one side that indicates that side should be attached to the ground jack.

Warning: Never connect both the positive (red) and the negative (black) banana outputs of a 114, 214, or 204 unit to its own inputs at the same time, as this causes a short circuit that could damage the amplifier. These red and black outputs can be connected to other devices (nerve chambers, stimulating electrodes, and more) at the same time, but not to its own inputs at the same time.

An Example of Continuous Pulses

1 To construct and record some examples of stimulus pulses, select **Preferences** from the **Edit** menu. On the **Channels** page of the **Preferences** dialogue window set a channel that has a BNC input to record at 10,000 samples/sec and display 0.5 second on the screen (Figure 6-2 on page 76).

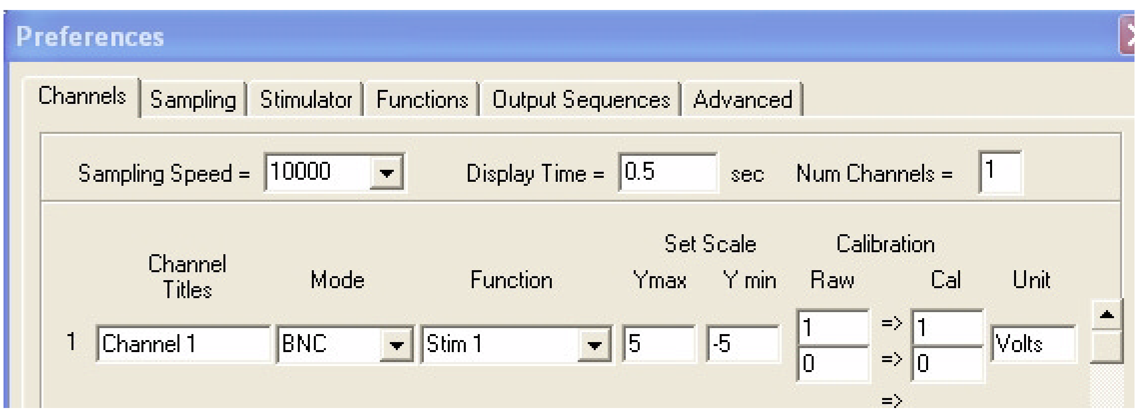


Figure 6-2: Channels page of the Preferences dialogue window set for the pulse mode example.

2 Go to the **Stimulator** page of the **Preferences** dialogue window; select **Pulses** from the box in the upper left corner of the page.

3 Enter the following values into the appropriate boxes on the **Stimulator** page:

Delay	100msec (an arbitrary value)
Amplitude	1V
Number of Pulses	0 (for continuous)
Pulse Width	5ms
Pulse Frequency	100 Hz

These settings will create a protocol that delivers continuous square waves with 1V amplitude and 100Hz frequency.

4 Press the **Start** button. The DAC will wait 100 milliseconds (the **Delay** value entered) and begin to deliver 5ms pulses at the rate of 100 pulses per second. Each pulse will be 1V high. These pulse parameters can be adjusted in any way with one exception: the pulse width cannot be longer than the inverse of the frequency (or the period). In this example, the 100Hz square wave delivers 100 events or pulses every second. Therefore, each single event or pulse must occur in 1/100th of a second, which is a 10ms period. In this example, the pulse width cannot be longer than the period of 10ms, or the pulse will overlap the next pulse. The percentage of the period occupied by the pulse width is known as the duty cycle and refers to the amount of time the output amplifiers are active.

An Example of a Burst of Pulses

Use the settings listed for the example of continuous pulses to produce a short burst of pulses, with one exception. Set the **Number of Pulses** to a number other than zero. If the number 10 is entered in this box, the output from the DAC would wait the 100 millisecond delay from the **Start** signal, deliver its 100Hz square wave of 5ms by 1V pulses as before, but stop when 10 pulses had been delivered. A graphical representation of the two examples above is pictured in Figure 6-3 on page 77.

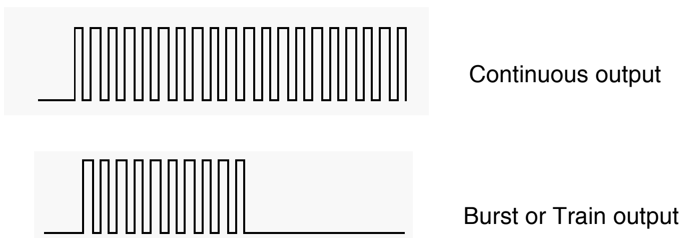


Figure 6-3: Continuous (top) and burst (bottom) of pulses that are the same amplitude, width, and frequency.

Train Protocol

The Train Protocol is Available Only on the *iWorx* 114/214/118.

A train of pulses is more properly called a burst of pulses. Trains contain a specified **Number of Pulses**; occur a specified number of times, **Number of Trains**; and, occur at regular intervals, **InterTrain Duration**. The train protocol is an extension of the pulse protocol and it is essential to be familiar with the pulse protocol to use the train protocol.

The terms used on the **Stimulator** page of the **Preferences** dialogue window for configuring trains of pulses, include:

Delay: This is the time between the beginning of the recording, at the clicking of the **Start** button, and the first pulse. Delay is adjustable between 0 and 1,000 seconds.

Amplitude: This is the height or voltage of the pulse or wave being generated. The amplitude programmed from the **Preference** window will be the same for all pulses leaving the stimulus output unless the amplitude is changed manually from the **Preference** window or the **Stimulator Control Panel**, or automatically from a programmed sequence (more later).

Number of Pulses: This is the number of pulses in one train.

Pulse Width: The pulse is the basic unit of an output protocol and it has two basic dimensions, amplitude, as described above, and length. The length of the pulse is also called pulse width or pulse duration. The pulse duration is adjustable between 0.1ms and the period of the pulse (as programmed by the **Pulse Frequency**).

Pulse Frequency: This is the number of programmed pulses that are delivered in one second period of time. Pulse frequency is adjustable between 0.1Hz and 5000Hz. The maximum frequency that can be set is dependent on the pulse duration. In the case of the *iWorx* 104/204, the frequency is also dependent on the sampling rate. Remember that the period (P) is the inverse of the frequency (F), or P = 1/F.

Number of Trains: Number of Trains

Inter Train Duration: The length of time between successive trains or bursts.

Holding Potential: This is a voltage between + and -5V that can be programmed to shift the resting voltage of an excitable tissue (like a nerve). It is also known as a holding voltage because it can be used to hyperpolarize the membrane potential of an excitable tissue and prevent it from depolarizing or “firing.”

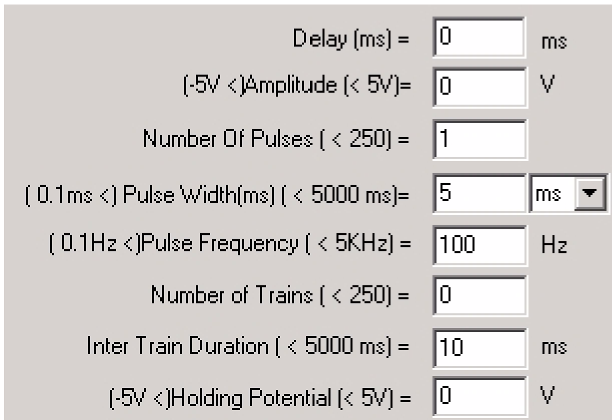


Figure 6-4: The parameter boxes on the Stimulator page of the iWorx 114, 214, or 118 set for Train mode.

Building Output Protocols in Train Mode

Connect the stimulus outputs to one of its own BNC inputs as described in the section of the chapter, **Building Output Protocols in Pulse Mode**.

Never connect both the positive (red) and the negative (black) banana outputs of a 114, 214, or 204 unit to its own inputs at the same time, as this causes a short circuit that could damage the amplifier. These red and black outputs can be connected to other devices (nerve chambers, stimulating electrodes, and more) at the same time, but not to its own inputs at the same time.

In many applications, more than one burst or train of pulses must be delivered. Before the parameters of the trains or bursts are specified, the dimensions of the pulses that will fill the bursts must be selected. After the pulse is designed, the frequency, duration, and number of trains can be programmed.

An Example of Pulse Trains

1. To construct and record an example of pulse trains, select **Preferences** from the **Edit** menu. On the **Channels** page of the **Preferences** dialogue window set a channel that has a BNC input to record at 10,000 samples/sec and display 0.5 second on the screen (Figure 6-2 on page 76).
2. Go to the **Stimulator** page of the **Preferences** dialogue window; select **Trains** from the box in the upper left corner of the page.
3. Enter the following values into the appropriate boxes on the **Stimulator** page:

Delay	100msec (an arbitrary value)
Amplitude	1V
Number of Pulses	10 (10 pulses at 100 Hz = 0.1 sec)
Pulse Width	5ms
Pulse Frequency	100 Hz
Number of Trains	25

Inter Train Duration 900ms

These settings will create a protocol that delivers: a train of pulses every second; 10 pulses in each train with a frequency of 100 Hz; and, all pulses with an amplitude of 1V and a width of 5msec. Since a train occurs every second and is 100msec long, the time between trains, the **Inter Train Duration,** needs to be 900msec.

4 Press the **Start** button. The **DAC** will wait 100 milliseconds (the delay value entered) and begin to deliver ten 5ms pulses in a tenth of second. Each pulse will be 1V high. After 900 milliseconds, a second burst of ten pulses with the same parameters will occur. These bursts will appear in this manner until a total of 25 bursts have occurred.

5 If you only wanted the train or burst to repeat four times, the number 4 should be entered in the **Number of Trains** box. The completed output protocol should look something like Figure 6-5 on page 79.

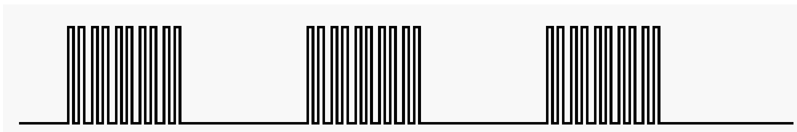


Figure 6-5: Burst of pulses separated by Inter Train Durations.

Constant Voltage Protocol

Selecting the **Constant** (voltage) option on the **Stimulator** page of the **Preferences** dialogue window disables the entry boxes for all stimulus parameters, except **Amplitude** and **Delay**. When the **Start** button is clicked, the voltage set on the **Stimulator** page is delivered to the low voltage output of the *iWorx* unit. The voltage output terminates when the **Stop** button is pressed.

Step Protocol

The Step Protocol is Available Only on the *iWorx* 114/214/118.

Step mode is used almost exclusively for voltage clamp protocols. In **Step** mode, the amplitude of stimulator output can be increased or decreased in a step-wise manner, and the user can specify the following parameters: **Delay**, **Start Amplitude**, **End Amplitude**, **Number of Steps**, **Step Width**, and **Inter Step Width**.

Building Output Protocols in Step Mode

The amplitude of each individual step in the protocol is determined by the LabScribe program with the **Start**ing and **End**ing **Amplitudes** and the **Number of Steps** entered on the **Stimulator** page. The equation used to do this calculation is:

$$\frac{(\textbf{Start Amplitude} - \textbf{End Amplitude})}{\textbf{Number of Steps}} = \text{Voltage Increment}$$

If the user knows the voltage increment needed at each step, the equation can be transposed to solve for the **Number of Steps** required in the protocol and this value can be entered on the **Stimulator** page:

$$\frac{(\textbf{Start Amplitude} - \textbf{End Amplitude})}{\text{Voltage Increment}} = \textbf{Number of Steps}.$$

Likewise, if the user knows the previous amplitude and the voltage increment, the succeeding amplitude can be calculated:

Previous Amplitude + Voltage Increment = Succeeding Amplitude

With the starting, ending, and incremental voltages set through preferences, the voltage will change in a step wise manner until the ending voltage is reached. The length of the protocol is determined by the **Step Width** and the time between steps, the **Inter Step Width**.

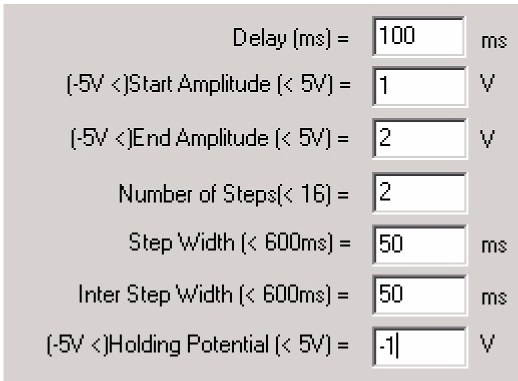


Figure 6-6: The parameter boxes on the Stimulator page of the iWorx 114, 214, or 118 set for Step mode.

An Example of Voltage Steps

1. To construct and record an example of pulses in step mode, select **Preferences** from the **Edit** menu. On the **Channels** page of the **Preferences** dialogue window set a channel that has a BNC input to record at 10,000 samples/sec and display 0.5 second on the screen (Figure 6-2 on page 76).
2. Go to the **Stimulator** page of the **Preferences** dialogue window; select **Step** from the box in the upper left corner of the page.
3. Enter the following values into the appropriate boxes on the **Stimulator** page:

Delay	0
Starting Amplitude	-1V
Ending Amplitude	+1V
Number of Steps	8
Step Width	100 ms
Inter Step Width	0
Holding Potential	0

4. These settings will create a wave form that starts at -1 Volt and climbs to +1Volt in eight steps, each step has a voltage increment of 0.25V and 100ms wide.
5. Press the **Start** button. The resulting wave would be similar to the step-wise elevation of output amplitude seen in Figure 6-7 on page 80.

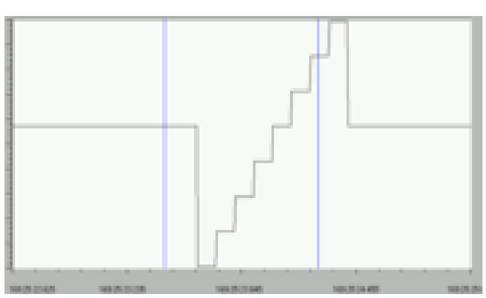


Figure 6-7: An example of a continuous step protocol.

6. To create a step protocol where the voltage returns to a baseline value between steps, alter the **Inter Step Width** to a number greater than zero. The resulting wave would be similar to

that seen in Figure 6-8 on page 81.

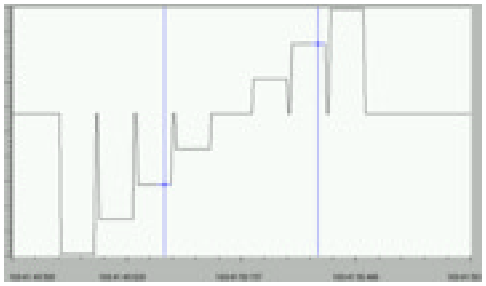


Figure 6-8: An example of a step protocol punctuated by returns to baseline between steps.

7 A **Constant** voltage protocol can be combined with the **Step** protocol to have the voltage return to a different baseline after the completion of the step sequence. For example, setting the **Holding Potential** in the sample step protocol to 500mV would cause the output amplitude of the stimulator to return to 500mV at the end of the step sequence. Subsequent firings of the protocol would begin from the new baseline of 500mV, drop to the **Start Amplitude** in the example (-1V), step to the **End Amplitude** (+1V), and then return to the **Holding Potential** of 500mV.

The Stimulator Panel

Selecting the **Stimulator Panel** item in the **View** menu (Figure 6-9 on page 81) will place a **Stimulator Control Panel** (Figure 6-10 on page 81) on the **Main** window, if the stimulator is programmed to be in **Pulse** and **Constant** modes.

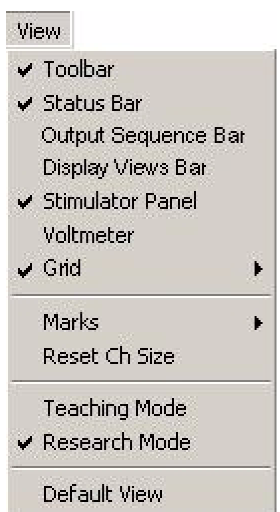


Figure 6-9: The View menu.

Changes to the pulse amplitude, width, frequency, and number of pulses can be made as recording is proceeding. To complete the changes, the **Apply** button must be clicked.

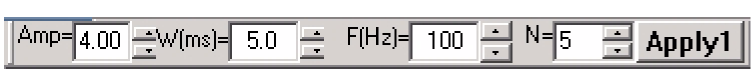


Figure 6-10: The Stimulator Control Panel.

Note: *The Stimulator preferences dialog will draw whatever protocol you specify. Be sure to examine the output representation carefully before closing the dialog to confirm that this is in fact the output that you want. If you request junk, the stimulator will deliver exactly what you ask.*

Stimulator Display

On *iWorx* 114/214/118, the stimulator output can be fed to a channel on the LabScribe recording window by the hardware. So, it is possible to view the stimulator output on any channel without using a cable to connect the output to an input.

Right click on the channel. Select **Stimulator Dspl**, and then **Out1** or **Out2**. **Out2** displays the second stimulator output (DAC2) and is available only on the *iWorx* 118.

Stimulus Protocols Built with the Sequence Builder

Experiments are often designed to record the response of a cell (or a tissue) to progressively larger or more frequent stimuli. In these cases, parameters of the stimulus are changed before each recording of the cell's response to the next stimulus. The **Output Sequence Builder**, a page in the **Preferences** dialogue window, can be used to automatically change parameters of the stimuli released from the **DAC**.

For example, excitable tissues like nerves and muscles are composed of multiple fibers, each with a different diameter, conduction velocity, and threshold. Fibers with higher thresholds require a larger stimuli to evoke their action potentials. Increasing the amplitude of the stimulus sent to the excitable tissue will cause more fibers in the tissue to fire. This is known as recruitment and is measured as an increase in the amplitude of the tissue's compound action potential.

In **Scope** mode, the **Output Sequence Builder** and other pages (**Channels**, **Sampling**, **Stimulator**) in the **Preferences** dialogue window can be used to record each response of the excitable tissue to a stimulus and automatically increase the amplitude of the stimulus between each trial.

Channels Page

To construct an example of an **Output Sequence** designed to control the DAC and to record in **Scope** mode, select **Preferences** from the **Edit** menu. On the **Channels** page of the **Preferences** dialogue window set:

Sampling Speed	20000
Display Time	0.030 sec
Number of Channels	1
Channel Title	Stimulus
Mode	BNC
Function	Stem 1

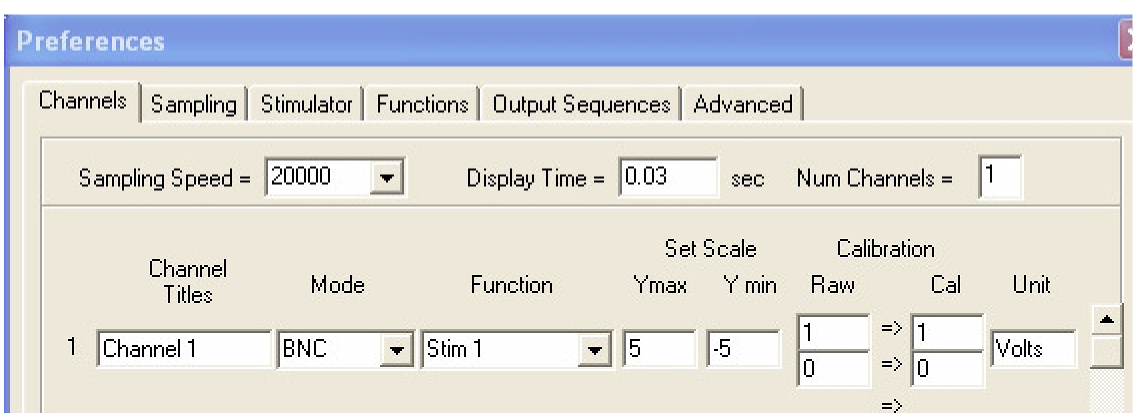


Figure 6-11: Channels page of the Preferences dialogue window set for testing an Output Sequence.

Sampling Page On the **Sampling** page, select **Scope** as the recording mode; change **Repetitive** to **Multiple Sweeps**; and set the number of **Sweeps** to 10.

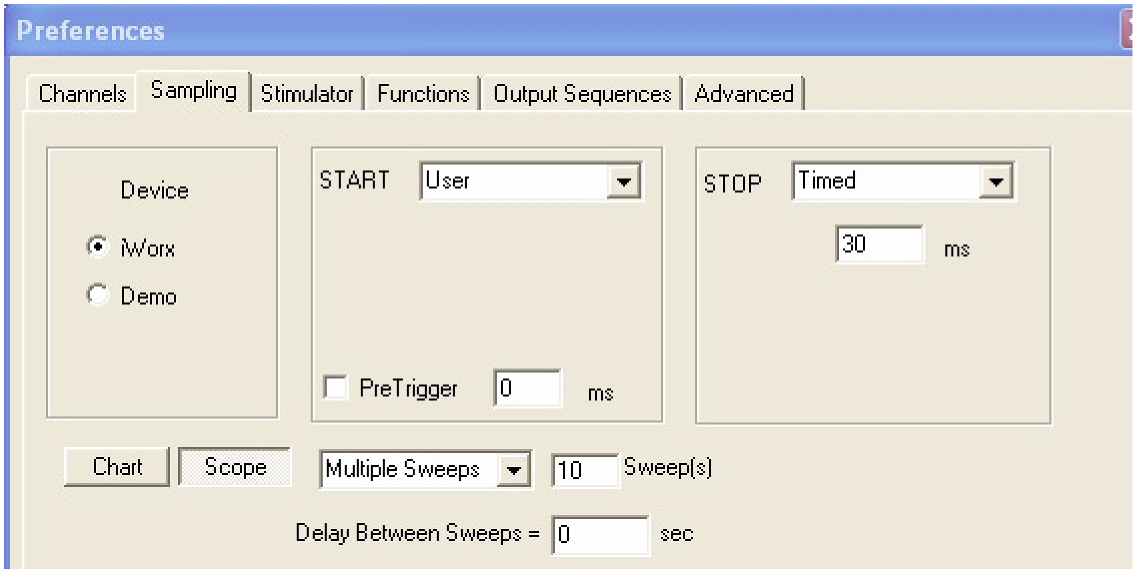


Figure 6-12: Sampling page of the Preferences dialogue window set for testing an Output Sequence.

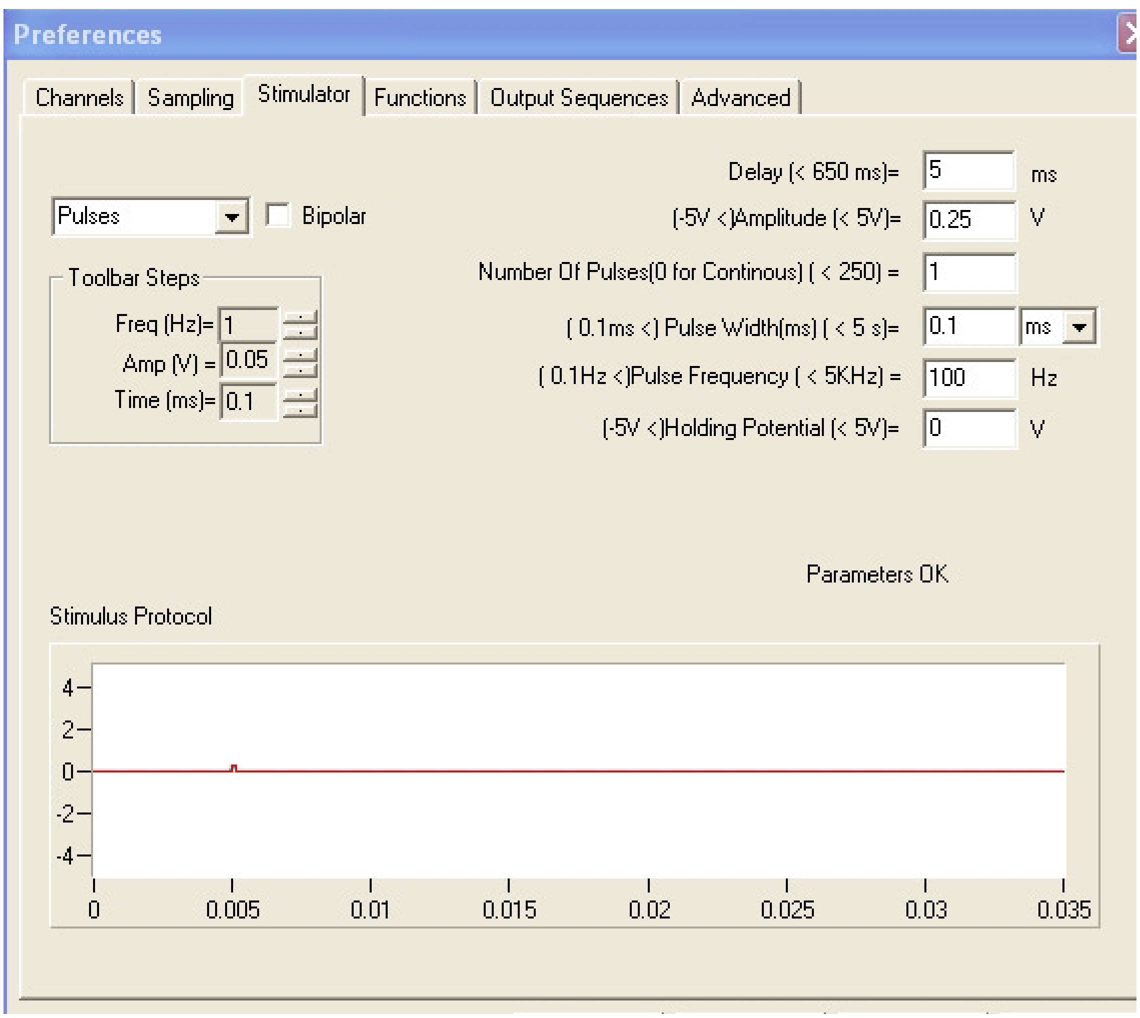


Figure 6-13: Stimulator page of the Preferences dialogue window set for testing an Output Sequence.

Stimulator Page

On the **Stimulator** page, select **Pulses** as the stimulating mode and set the parameters.

- Toolbar Steps

  Freq (Hz) = 1; **Amp (V)** = 0.05; **Time (ms)** = 0.1.

- Initial Parameters

Delay	5 ms
Amplitude	0.25 V
Number of Pulses	1
Pulse Width	0.1 ms
Pulse Frequency	100 Hz
Holding Voltage	0 V

Output Sequence Page

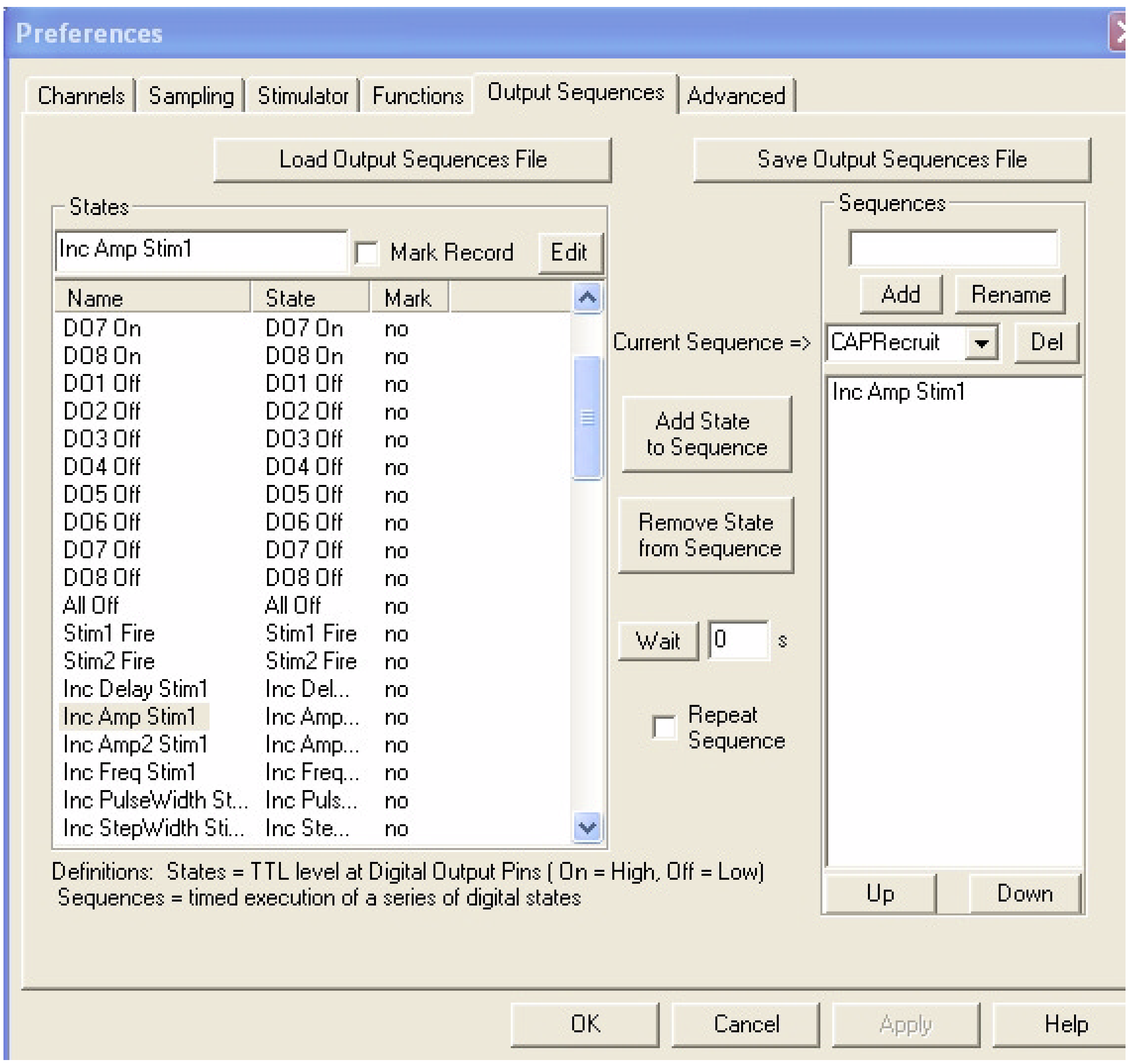


Figure 6-14: Output sequences page of the Preferences dialogue window.

1. On the **Output Sequences** page, add a test sequence to the list of current sequences. Type the name of the test sequence in the **edit** box above the **Add** and **Rename** buttons.
2. Select the name of the new test output sequence from the list next to the label, **Current Sequence**.

3 Select the state entitled **Inc Amp Stim 1** from the list of states on the left side of the page.

4 Click on the button **Add State to Sequence** to add the state to the test sequence.

5 Click **OK** at the bottom of the page.

6 Return to the **Main** window; select the test sequence from **OutSeq** list to the right of the LabScribe toolbar. Click the **OutSeq** button. The LabScribe program generates, displays, and records the ten progressively larger stimulus pulses on ten successive **Scope** sweeps.

7 Click on the **ScopeView** icon in the LabScribe toolbar to view the sweeps recorded for each stimulus amplitude.

Digital Outputs

The *iWorx* 118 has up to eight Digital Outputs in two banks. BNC's 5 -8 can be configured as **Digital Inputs** or as **Digital Outputs**. Each digital output can be controlled independently.

Digital states

For each digital output there are two states, **On** and **Off**. So for 8 digital outputs we have 16 states. A few more states are predefined in LabScribe such as

1)**All off:** turns all digital outputs off

2)**Stim1 Fire**: Fires stimulator 1 (DAC 1)

3)**Stim2 Fire**: Fires stimulator 2 (DAC 2)

Naming States

Each digital state can be named. To name a digital state, select the state. Type the new name of the state in the **edit** box under the label **States**. Put a check next to Mark Record if you want a mark to be placed on the record when the digital state is fired. Click **Edit** to save the changes to the state. For example, in the figure below, **DO2** on has been labelled as **Pump On** and set to place a mark in the record when it is fired.

Sequences

Digital states can be grouped together in **Sequences**. A **Sequence** allows timed execution of digital states.

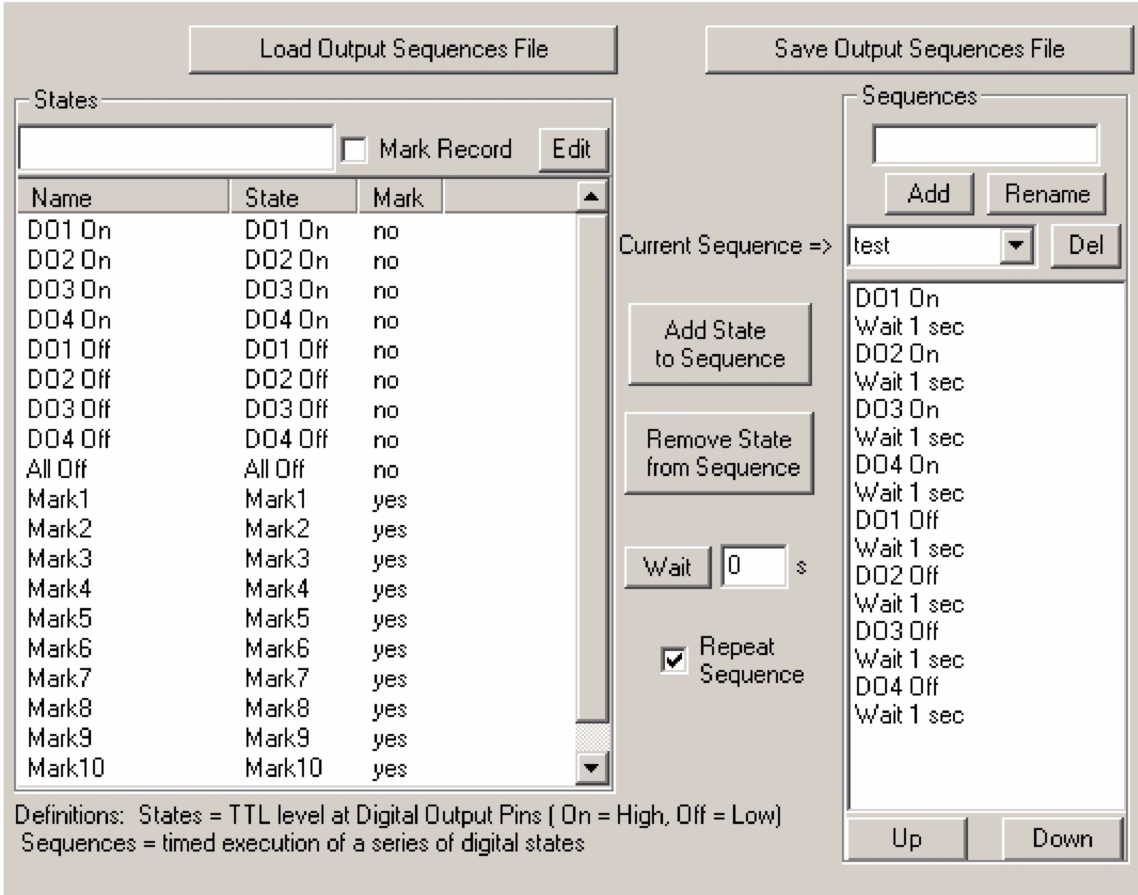
Creating Sequences

To create a **Sequence**, type the name of the sequence in the **edit** box under the label Sequences**,** and click **Add**.

Editing a Sequence

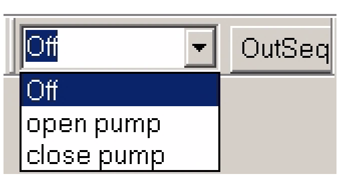
Select the sequence to be edited in the **Current Sequence** drop-down box. To add a digital state to the sequence, select the digital state from the list on the left side of the window, and click **Add State to Sequence.** To remove a state from the sequence, select the state in the sequence and click **Remove State from Sequence**. To have the *iWorx* device wait for a specified period of time between different digital states, type a time (in seconds) in the edit box next to the **Wait** button, and click **Wait** to insert the waiting period into the sequence**.**

The timing for the digital inputs is handled by the computer and since Windows is not a real-time operating system, there is an inherent lag in the processing of events. The digital output timing should be within 1 second. To set more than one state at the same time add all the states



you want to set simultaneously to the sequence before setting wait. The LabScribe program will "OR" all the states and execute them when it reaches the wait statement or the end of the sequence. To continuously repeat the sequence, select **repeat sequence** checkbox. The order of the states in the sequence can be changed by using the **up** and the **down** buttons.

Firing a Sequence

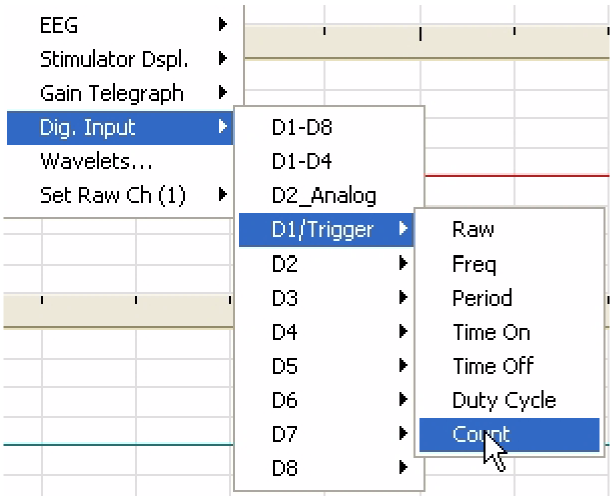


When digital sequences are created and the *iWorx* 118 hardware is connected with Labscribe. The Digital Output toolbar is enabled. You can turn off or on this toolbar using View->Digital Output Bar. The toolbar consists of a drop-down box, that lists all the digital output sequences that have been created in the preferences dialog box. While recording to fire a digital output sequence just select it from the drop-down list, or if the sequence was already selected click on the DOut button next to the torpedoing box.

Digital Inputs

The *iWorx* 118 has up to 8 Digital inputs in two banks. BNC's 5 -8 can be configured as digital inputs or as digital outputs. To enable digital inputs, select the **Enable Digital Inputs** checkbox in the **Digital I/O** page in **Preferences**.

Viewing Digital Inputs



Once enabled in the **Preferences** dialog box. digital inputs can be viewed on any channel either online or offline. To enable digital inputs on a channel, **right-click** on the channel and go to **Dig. Input.** Digital inputs can be viewed as one 8-bit word (D1-D8) or as a 4-bit word (D1-D4). **Digital Input 1** and **Digital Input 2** are special inputs. **Digital Input 1** also serves as an edge triggered input, which can detect pulses as small as 50ns. **Digital Input 2** also doubles as an 8-bit resolution, unipolar analog input. It allows the input of an analog signal with a range of 0 to +10 Volts, and resolves it to within approximately 40 mV. When selected, it acquires at the same speed as the other analog input channels. To view this 8-bit analog data select **D2_Analog**.

Each of the digital inputs can be viewed as a raw data (1-bit) or as a calculation performed on the data, such as:

Frequency: The frequency of digital events

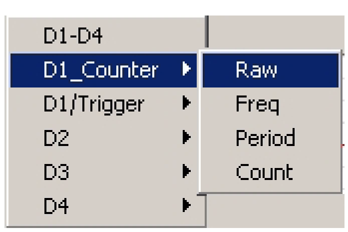
Period: The period of digital events

Time On: The time that the digital input was On, during a period.

Time Off: The time that the digital input was Off, during a period.

Duty Cycle or (Time On/Period) x 100: Gives the percentage of time that the digital input was **ON** during a period.

Count: Counts the number of digital events. When selected shows a dialog box that can be used to set the time after which the count should be reset. This is useful for counting the number of events over a time interval, like 10 seconds.



There is also a built-in 8-bit counter on **D1**. The counter counts the number of negative-going pulses between samples. This counter can be used to detect frequencies greater than the sampling speed.

Events

As LabScribe acquires data, it is aware of the value of each data point as it happens. It should then be possible to "train" the software to watch for values above or below a specified level and have LabScribe advise the user when such conditions are met. This feature in LabScribe is called an "EVENT." Events are set up in the events area at the bottom of the ADVANCED tab of the PREFERENCES menu. Each channel can have two such events specified.

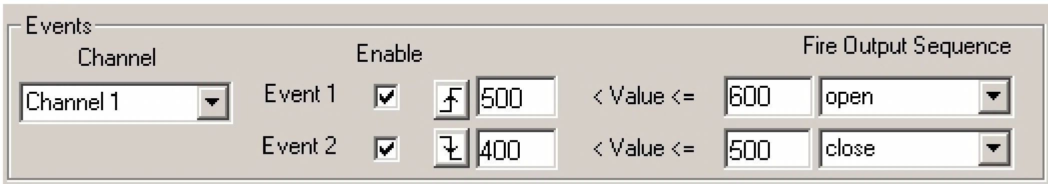


Figure 6-15: Controls for the Event programming on the iWorx 114/214/118

LabScribe advises the user that a data condition has been met by firing an output sequence.

A possible application might be as follows: Suppose we create two sequences in the sequences builder: a sequence that turns **I/O 1** ON, and another that turns **I/O 2** OFF. If we send the **I/O 1** output line to a valve at the bottom of a reaction chamber, we can open and close the valve and release pressure. If we also attach a pressure sensor to the chamber and run its conditioned output into channel 1 of the *iWorx* 118 data acquisition system, LabScribe can then follow the pressure in the reaction chamber. We can then create a pair events that will follow the pressure on Channel 1 and when the value goes from below 500mmHg to above 600 mmHg LabScribe will fire the first sequence that will open the valve and release the pressure. When the value on Channel 1 drops from above 500mmHg to below 400 mmHg, LabScribe will fire the second sequence and close the valve. When the value of pressure observed on Channel 1 goes above 500mmHg, **I/O 1** turns on and opens the valve releasing the pressure. When the pressure falls below 500 mmHg **I/O 1** turns off and the valve closes.

Chapter 7: Using Settings

The Settings Menu

LabScribe offers users a lot of choices for recording and displaying data. When certain choices are used repeatedly, a template, known as a **settings file**, can be created to reduce the time required to program the recording software and the A/D converter.

To understand how to use **settings files**, two terms need to be defined: **settings group** and **settings file**. A **settings group** is actually a simple text document that can contain up to 100 individual **settings files**. Each **settings file** is a collection of settings for performing an experiment and are programmed by users through the **Preferences** dialogue window from the **Edit** menu. The settings contained in a file include items like: the number and titles of channels in the LabScribe windows; the sampling speed; the units conversions; the stimulator settings.

In addition to the hardware and software provided in its teaching kits, *iWorx* provides laboratory manuals with a variety of experiments. To support the use of experiments in the manuals, *iWorx* has created a **settings group** for each laboratory manual. Each settings group contains a **settings file** for each experiment in the manual. Settings groups are loaded on the computer during the installation of the LabScribe recording software. Once a settings group is loaded, the settings files within the group can be called from a list on the **Settings** menu.

Calling A Settings File

*Figure 7-1: The **Settings** menu.*

Before a **settings file** can be selected and activated, the **settings group** that contains the file must be loaded. To do this, select **Load Group** from the **Settings** menu (Figure 7-1 on page 89).

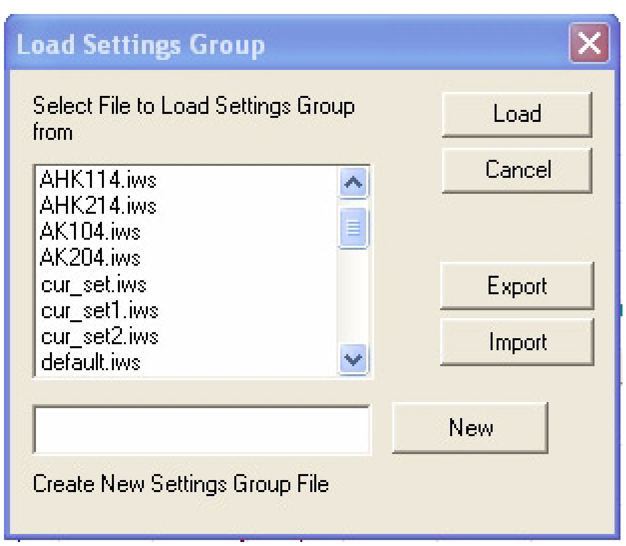
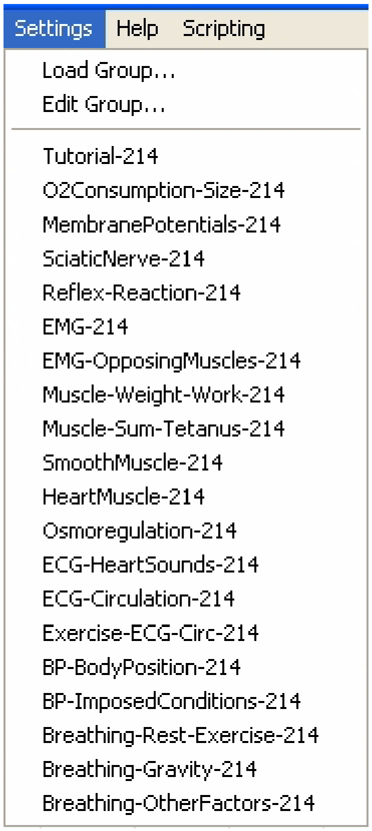


Figure 7-2: The Load Settings Group dialogue window.

The **Load Settings Group** dialogue window will appear (Figure 7-2 on page 89). All the **settings groups** that are available will appear in the list box on the left side of this settings group dialogue window. Highlight the settings group needed, and click the **Load** button to load the selected **settings group** and close the dialogue window.



Once a **settings group** is loaded, all of the **settings files** contained in the group appear by name in the lower bracket of the **Settings** menu (Figure 7-3 on page 90). To select a specific **settings file**, highlight the name of the file and click it. The settings associated with the selected file will load into the LabScribe program and set parameters for recording and displaying data.

For a settings group associated with an *iWorx* teaching kit, the names of the settings files on the list correspond to the names of the experiments in the lab manual.

If the *iWorx* laboratory manuals are installed from the installation CD as prescribed, each settings file in the settings group for a teaching kit is associated with a **helper file**, which is a .pdf copy of the laboratory exercise as it appears in the *iWorx* laboratory manual.

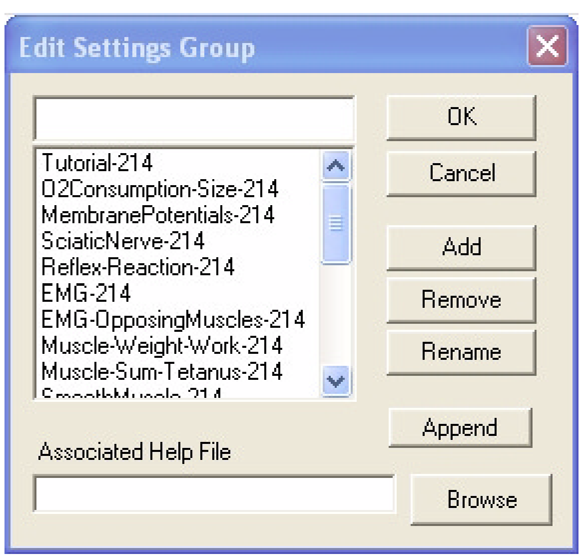
Users can design their own settings groups and files. They can also associate their own setting files with documentation (experimental procedures, protocols, instructions, lab exercises) of their own design.

Figure 7-3: The Settings menu with an expanded settings list.

Creating a New Settings Group

To create a new settings group. Choose the **Load Group** command from the **Settings** menu (Figure 7-1 on page 89), type an appropriate group name in the title box at the bottom of the **Load Settings Group** dialogue window (Figure 7-2 on page 89) and press the **New** button. The new settings group name will now appear in the list box on the left of the window.

Editing Settings Group



The **Settings Group** currently being used can be edited by selecting the **Edit Group** function from the **Settings Menu**.

Figure 7-4: The Edit Settings Group dialogue window.

Adding a New Settings to Group

Before adding a new individual **settings file** to a **settings group**, configure the LabScribe program to do the experiment you want to do. For example, go to the **Channels** page in the **Preferences** dialogue window and select the number of channels needed, their titles, and any on-line **Functions** that are needed to display or interpret the data. If these settings are going to become a **settings file** in an existing settings group, make sure that group is already loaded before proceeding. Next, select the **Edit Group** function in the **Settings** menu.

When the **Edit Settings Group** dialogue window appears, type the name of the new individual settings file in the blank area at the top of the dialogue window. Press the **Add** button. This new settings file is now part of the current group, and it will appear at the bottom of the list box (only after the **Add** button is pressed). Click **OK** to leave the **Edit Settings Group** window. This new settings file will be added to the settings list on the **Settings** menu when the **Edit Settings Group** dialogue window is closed.

Helper Files

Helper files are documents with experimental instructions, diagrams, and illustrations that can be linked to **settings files** and displayed on the computer screen when a settings file is selected. On the LabScribe installation CD, *iWorx*/CB Sciences provides a laboratory manual and a **settings group** for each of its kits. In the installation process, a .pdf copy of each individual lab experiment in a manual is linked to the corresponding settings file in the settings group for that manual. When the user selects a settings file to do a particular experiment, a .pdf copy of the linked helper file (the experimental write-up) opens in Acrobat Reader. The user now has a set of instructions, on the computer screen, to follow as they do the experiment.

Users can attach their own helper files to their own settings files. Although, *iWorx*/CB Sciences has chosen to attach .pdf documents to its setting files, any file (HTML, Word Perfect, MS Word, etc.) can be linked to a settings file.

To create a new settings file with an attached helper file, select the **Edit Group** function in the **Settings** menu. When the **Edit Settings Group** dialogue window appears, type the name of the new individual settings file in the blank area at the top of the dialogue window. Then, use the **Browse** button in the lower right corner of the **Edit Settings Group** window (Figure 7-4 on page 90) to locate the helper file on the computer being used. Once the helper file is found using the browser, select the file, and click the **Open** button on the browser window. The path to the helper file will appear in the **Associated Help File** box. Press the **Add** button. This new settings file is now part of the current group, and it will appear at the bottom of the list box (only after the **Add** button is pressed). Click **OK** to leave the **Edit Settings Group** window. This new settings file will be added to the settings list on the **Settings** menu when the **Edit Settings Group** dialogue window is closed. If the new settings file is selected from the list, its associated helper file will open automatically.

Deleting a Setting

To remove or rename a settings file, select **Edit Group** from the **Settings Menu**. In the list box on the **Edit Settings Group** window, highlight the file to be removed or renamed; its name will appear in the title field (the box above the list box). Click **Remove** to delete the selected settings file from the settings group. If the file is to be renamed, change the name in the title field, and click **Rename**. Click **OK** to close the **Edit Settings Group** dialogue window. The settings file, that was removed or renamed, no longer appears in the list under the **Settings Menu**.

Editing a Setting File

An individual settings file may be edited using either of two methods. If the settings file has an error or an omission, select the settings file from the list on the **Settings Menu**. Once the settings file is loaded and the computer screen has configured itself according to the commands from the settings file, go to the **Preferences** dialogue window under the **Edit Menu** on the LabScribe **Main** window. Make the needed changes to the settings file.

Then, select **Edit Group** from the **Settings Menu**. Once the **Edit Settings Group** dialogue window is open, highlight the name of the setting file that was edited, and click the **Remove** button. This is done because the old name of the settings file needs to be removed from the list box before the revised settings file can be renamed and saved. Type the new name of the revised settings file in the title box (above the list box). Click the **Add** button and the new name of the revised settings file will be added to the list box.

Renaming Settings

To rename a settings file, pull down the **Settings Menu** and select **Edit Group**. From the list box in the **Edit Settings Group** dialogue window, select the settings file to be renamed.Type the new name of the settings file in the title box (above the list box). Click **Rename**.

Appending a Settings to this Group

Settings files can be appended from one **Settings Group** to another. First, load the settings group that will receive the settings files from the other group. Do this by pulling down the **Settings Menu**, selecting **Load Group**, and selecting the settings group that will receive the transferred settings files.

Next, to find the settings group that will be donating settings to the first group, pull down the **Settings Menu** again, select **Edit Group**, and click the **Append** button in the **Edit Settings Group** window. An **Open** window appears; this window allows the user to browse the computer for the donor settings group. Select the donor group and click the **Open** button on this window. All the settings files from the donor group, and the links to the helper files associated with these setting files, are added to the list for the recipient group. Use the **Remove** and **Rename** buttons to alter the revised list of setting files in the recipient group.

Exporting and Importing Settings

A settings group with its associated helper files can be exported to a folder on the computer. or a folder containing a settings group from another computer can be imported.

Settings groups, on a computer where LabScribe is used, can be exported, transferred, and imported into LabScribe folder on another computer. To export a settings group, pull down the **Settings** menu and select **Load Group**. Highlight the name of settings group to be exported on the list in the **Load Settings Group** dialogue window. Click the **Export** button on this window.

A **Save As** window will open. The **Save As** window can be used to browse for a second settings group; or, it can be used to pick a destination folder for the settings group to be exported. Once the settings group to be exported is selected by highlighting its name and icon, its name will appear in the **File Name** box on the **Save As** window. The **Save As** window can now be used to create or to browse for a destination folder where the soon-to-be settings group can be stored. Select the folder that will receive this exported settings group, and click the **Save** button.

Copy the folder with the **exported settings group** to the other computer. This exported settings group can be imported as a whole into the LabScribe program on the recipient computer by using the **Import** function. To use the **Import** function, pull down the **Settings Menu** on the recipient computer, select **Load Group**, and click the **Import** button on the **Load Settings Group** window. An **Open** window appears and it can be use to browse the recipient computer for the imported settings group. Find and select the settings group to be imported, and click the **Open** button. The imported settings group will be added to the list of settings groups in the copy of LabScribe on the recipient computer. Individual settings files from the imported settings group can be added to another settings group on the recipient computer by using the **Append** function.

Chapter 8: Export

Printing

Once you have recorded and analyzed your data, you'll probably want to create a report or other presentation. This can be done in a variety of ways, the easiest of which is to simply print the recorded data. The LabScribe software uses a WYSIWYG (What You See Is What You Get) printing scheme. That is, the print command will print the forward window exactly as it appears. This is particularly important for the Journal and the Analysis window. These windows require that the correct segments of data be displayed exactly as you want to print them before they can be printed. Call up a print dialog that offers three print options:

1) Print all

2) Print a selected range of pages

3) Print just the current display.

It is also possible to change the print setup from the print dialogue.

It is important to note that the Main window prints the entire recorded file at the screen time selected. In other words, a 60 second data file would print in one page if the screen time were set to 60, two pages if screen time was 30 and so on.

Cutting, Copying and Pasting

LabScribe supports cutting and copying from all windows. Copying is done from any window using the **Copy** command in the Edit menu. Within the LabScribe program, pasting is supported only in the **Journal**. To paste into the **Journal**, first copy data from either the **Main** or **Analysis** windows. Open the **Journal** and go to the **Edit** menu. Select **Paste**. Journal images can be copied and pasted to other programs for editing.

Saving and Saving As

Once recorded, the LabScribe program can save data in its own binary format using the **Save** or **Save As** command found in the **File** menu. These commands work the same as they do in every other program written for Windows 95/98/Me/NT or XP. Selecting **Save As** will create a copy of the file on the disk with a new name. LabScribe saves three documents with each file saved:

1. The actual raw data, which is held in a file with the.iwd extension (*iWorx* Document).
2. The **Journal** file, which carries the same name as the data document, but uses the extension .rtf (Rich Text Format).
3. The settings documents with the extension .iws (*iWorx* Settings).

Journal

The **Journal** is actually very similar to WordPad. Files created and saved from the **Journal** go to the disk in .rtf format allowing them to be opened and edited in any program that supports that format. A formatted and edited .rtf file may then be printed in whatever program you are using to read it, including the LabScribe software.

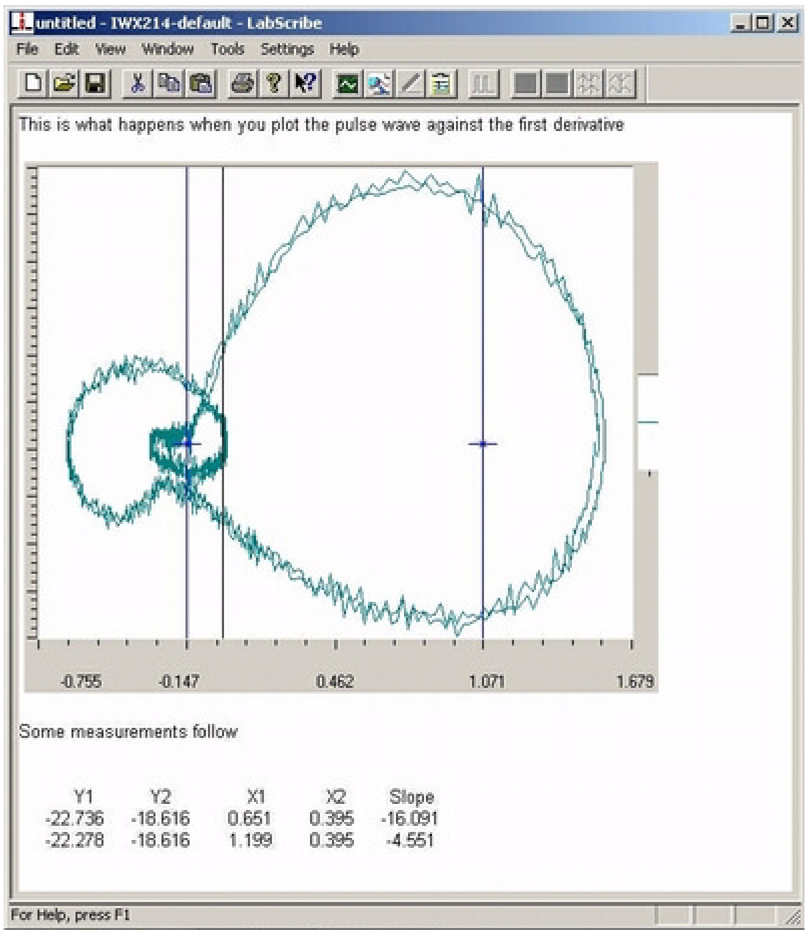


Figure 8-1: Text and image as displayed in the ***Journal*** *window.*

In addition to images, calculated values from the **Analysis** window or the **ScopeView** window can be moved to the **Journal** by calling the **Add Data to Journal** command in the **Tools** menu. Prior to moving calculated values, it is recommended that the title line from the **Analysis** window be moved by using the **Add Titles to Journal** command in the **Tools** menu. Titles and data are tab delimited so they can be easily formatted in any word processing program.

By moving pictures and calculated values to the **Journal** and adding typed comments from the keyboard, an entire lab report can be created without ever leaving the LabScribe program.

Exporting Data

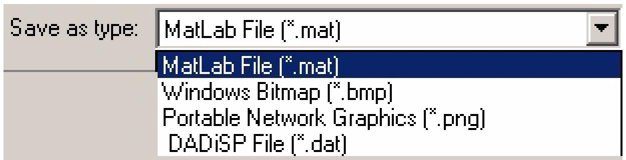
Data can be exported from LabScribe, either as numbers or as pictures, from the **Main** window, the **Analysis** window, or the **ScopeView** window. To export data, select **Export** from the **File** menu, and choose the file's format, location, and name in the dialogue window.

Exporting pictures

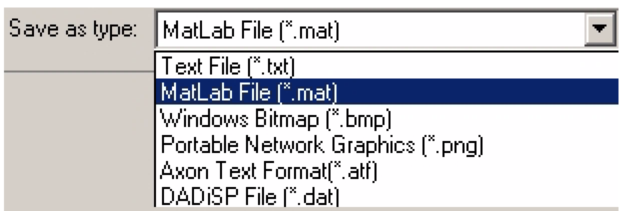
The current display can be exported as a picture in bitmap (.bmp) format or in a portable network graphics (.png) format. Png is a high resolution format for images.

Exporting numerical data

If data is exported from the **Main** window, the complete data file is exported, in either Matlab or DADiSP formats.



If data is exported from the **Analysis** or **ScopeView** windows, then only the data displayed in the window is exported.



Data from the **Analysis** or **ScopeView** windows can be saved in Text (.txt), Matlab (.mat), Axon Text Format (.atf), or DADiSP (.dat) format.