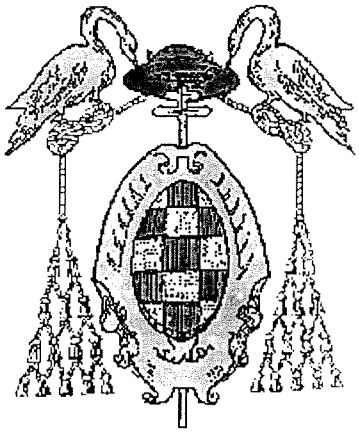
UNIVERSIDAD DE ALCALÁ
DEPARTAMENTO DE ELECTRÓNICA

Ingeniería en Electrónica



Laboratorio de Fundamentos de Bioingeniería

Práctica 1

Captación y registro de señales bioeléctricas.

1.- CAPTACIÓN Y REGISTRO DE SEÑALES BIOELÉCTRICAS.

1.1.- OBJETIVO.

Introducir al alumno en el registro de diferentes señales bioeléctricas utilizando el sistema MP100 de Biopac Systems y el programa "AcqKnowledge".

Para ello se dispone del manual del sistema MP100 y del "AcqKnowledge".

Tal y como se estudia en la asignatura de teoría, la actividad fisiológica de las células en las diferentes estructuras biológicas provoca potenciales bioelécticos tanto intracelulares como extracelulares. En esta práctica se estudiarán dos potenciales extracelulares principalmente, como son el ECG (electrocardiograma) y EOG (electrooculograma).

1.2.- ELECTROCARDIOGRAFÍA (ECG).

1.2.1.- Introducción.

La electrocardiografía convencional estudia el registro de la actividad eléctrica cardíaca. Esta actividad se registra en forma de una línea que presenta distintas inflexiones que se corresponden con el paso del estímulo eléctrico desde el lugar donde normalmente se origina, el nodo sinusal, hasta los ventrículos a través del sistema específico de conducción (SEC). Dicho sistema esta formado por el nodo sinusal, las vías preferenciales de conducción interauricular e internodal, el nodo auriculoventricular (AV), el haz de His, las dos ramas del haz de His y sus divisiones, con sus respectivas redes de Purkinje. Cuando el estímulo llega a la unión Purkinje-músculo, se produce el acoplamiento excitación -contracción.

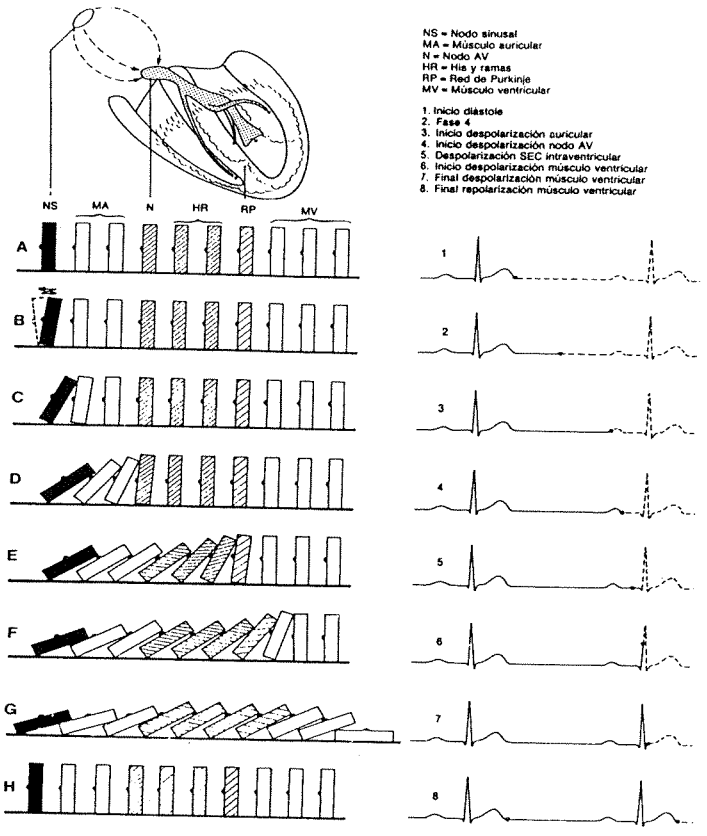


Figura 1 . Secuencia de activacion cardiaca.

1.2.2.- Nomenclatura de las ondas.

Cuando se registra un ECG, se inscribe una serie de ondas por cada ciclo cardíaco. Einthoven denominó a estas ondas P, Q, R, S y T, de acuerdo con su orden de inscripción, correspondiendo la onda P a la despolarización auricular, el complejo QRS a la despolarización ventricular y la onda T a la repolarización ventricular (fig.2). En ocasiones, a continuación de la onda T se graba una pequeña onda llamada U.

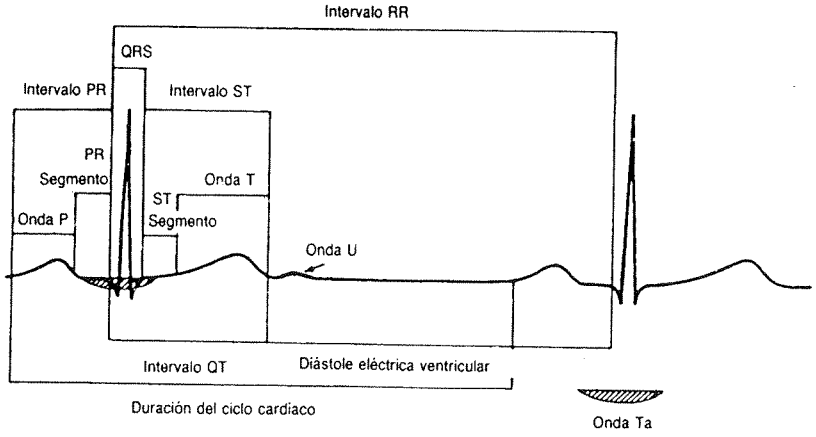


Figura 2. Relaciones temporales entre las diferentes ondas del ECG y nomenclatura de los diferentes intervalos y segmentos.

1.2.3.- Registro del E.C.G.

Utilizando el sistema MP100 se debe realizar un registro del ECG mediante una derivación bipolar según el triángulo de Einthoven que contenga varios ciclos cardiacos completos (5 o más).

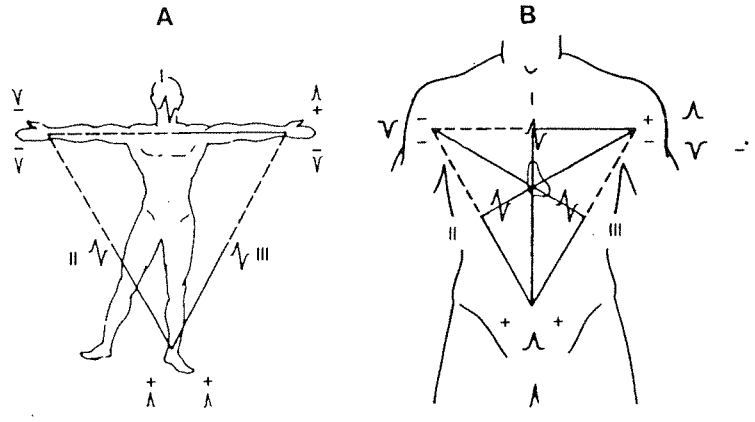


Figura 4. A. Triángulo de Einthoven. B. Su traslado al cuerpo humano.

1.2.4.- Rutina de interpretación.

Utilizando el programa "Acknowlegde" estudiense los siguientes parámetros:

-Ritmo y frecuencia cardíaca.
-Intervalo y segmento PR.
-Intervalo QT.
-Análisis de la onda P.
-Análisis del complejo QRS.
-Análisis del segmento ST y de la onda T.
-Análisis de la onda U.

1.3.- ELECTROOCULOGRAFÍA (EOG).

1.3.1.- Introducción.

El significado biológico del sistema motor ocular reside en una primera instancia, en la realización de movimientos oculares con el objetivo de dirigir la fóvea (zona de mayor agudeza visual de la retina) hacia aquellas zonas del campo visual que presentan mayor interes.

1.3.2.- El electrooculograma.

La electrooculografía (EOG) es el método basado en el registro de la diferencia de potencial existente entre la córnea y la retina. El potencial córneo-retinal está producido por las hiperpolarizaciones y despolarizaciones de las células de la retina que en conjunto generan un dipolo orientado en la dirección del eje del ojo, positivo en la zona corneal y negativo en la retina (figura 5). Las oscilaciones de la mirada en cualquier sentido producirán variaciones de la corriente de campo que se podrán detectar mediante un sistema de electrodos periorbiculares (figura 6).

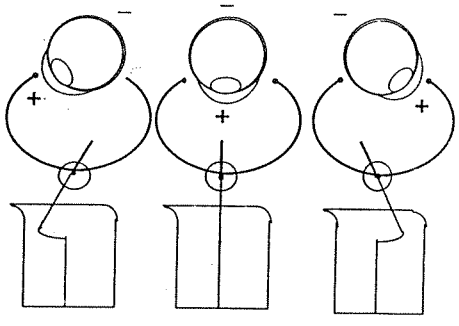


Figura 5.- Dipolo ocular

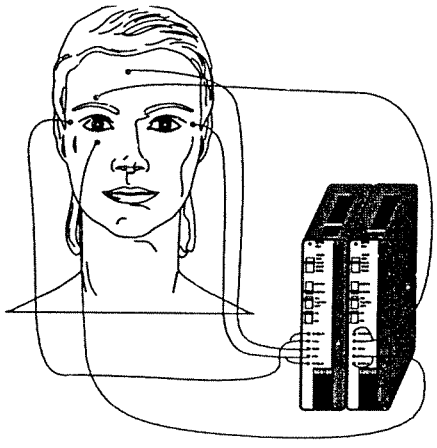
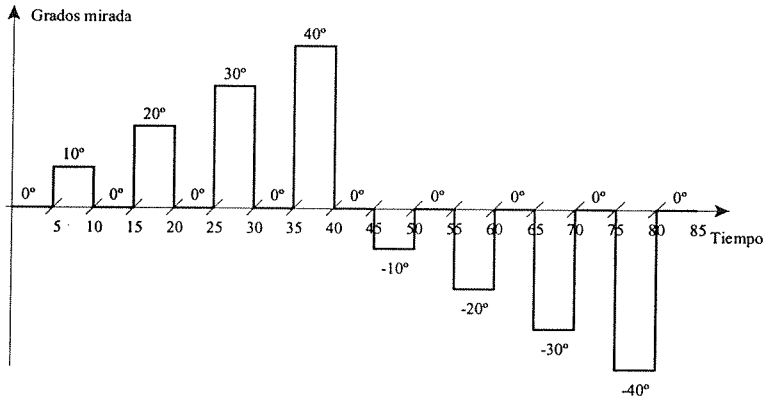
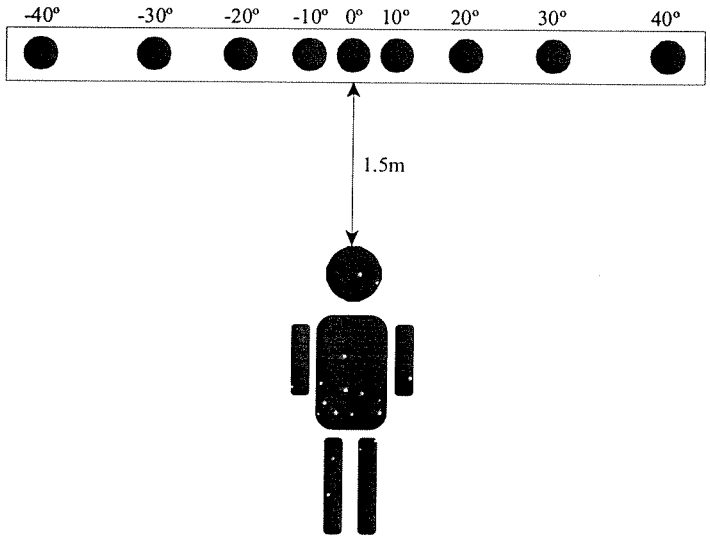


Figura 6.- Dibujo de la colocación de los electrodos y del registro del EOG.

1.3.3.- Registro de un E.O.G.

Utilizando el sistema MP100 obténgase el E.O.G para la siguiente distribución de la mirada:



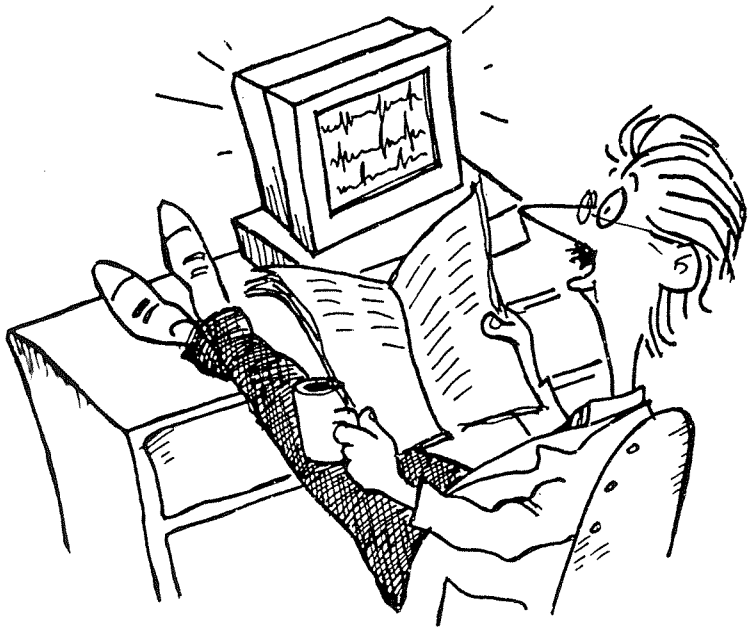


1.3.4.- Rutina de interpretación.

Utilizando el programa "Acknowledge" estudiense los siguientes parámetros:

- Tiempo de respuesta del ojo.
- Grado de linealidad de la respuesta del ojo y posible margen de linealidad.

Let the MP100WSW work for you!



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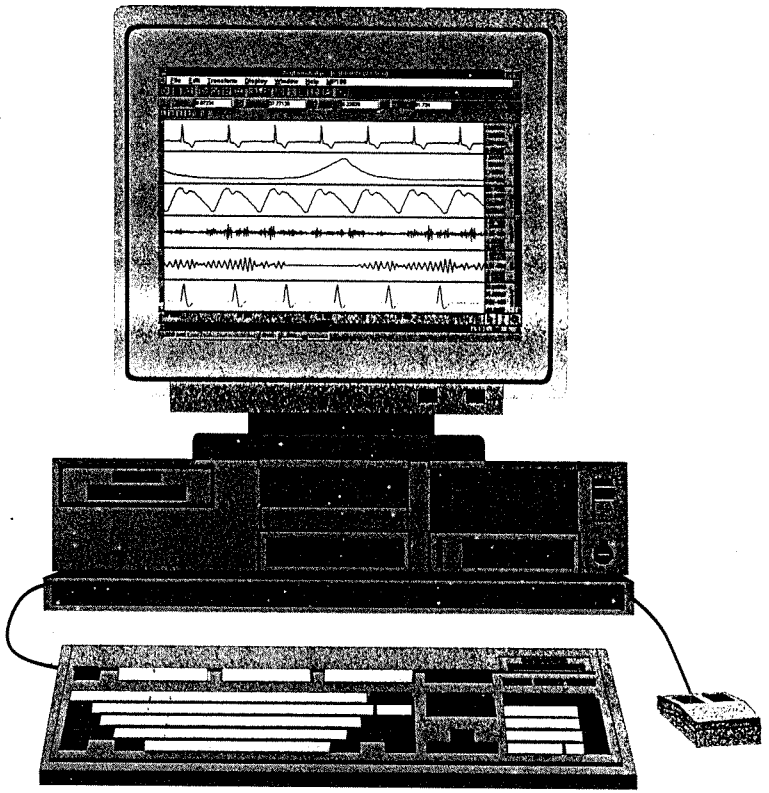
BIOPAC Systems

MP100WSW Demonstration
for Windows

Acq*Knowledge* 3

Turn your personal computer into a complete physiological workstation



and start doing twice the work in half the time!

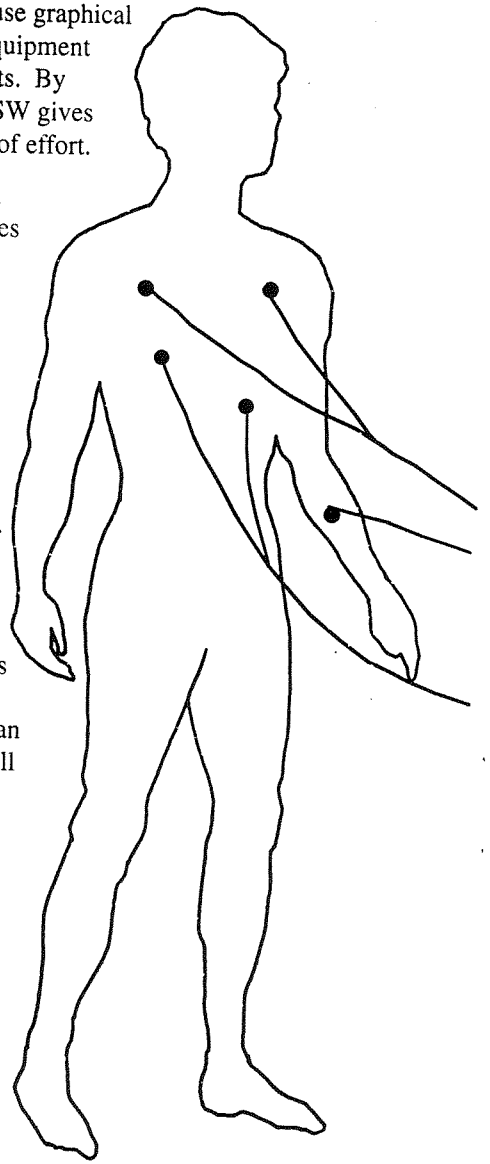
Basic Questions

What is the MP100WSW?

MP100WSW stands for MP100 Work Station for Windows. It is a complete and expandable data acquisition system which functions like an "on screen chart recorder," allowing you to record, view, save and print data. It includes all the necessary hardware and software required to turn any PC into a powerful data acquisition workstation specifically designed to work in life science applications.

Since the MP100 takes advantage of the capabilities of your PC, it is as powerful as larger and more expensive data acquisition systems, but has a familiar, easy-to-use graphical interface. The MP100WSW will reduce your equipment setup time and increase the quality of your results. By harnessing the power of your PC, the MP100WSW gives you publication quality results with a minimum of effort.

This guide and the accompanying demonstration disk are designed to highlight some of the features of the MP100WSW by working through some common applications and showing you some sample data files.



What do I need to run the demo?

The minimum requirement is a PC which runs Windows 3.1 or higher. A Macintosh version of the MP100WSW demo is also available, and can be obtained by contacting BIOPAC Systems, Inc.

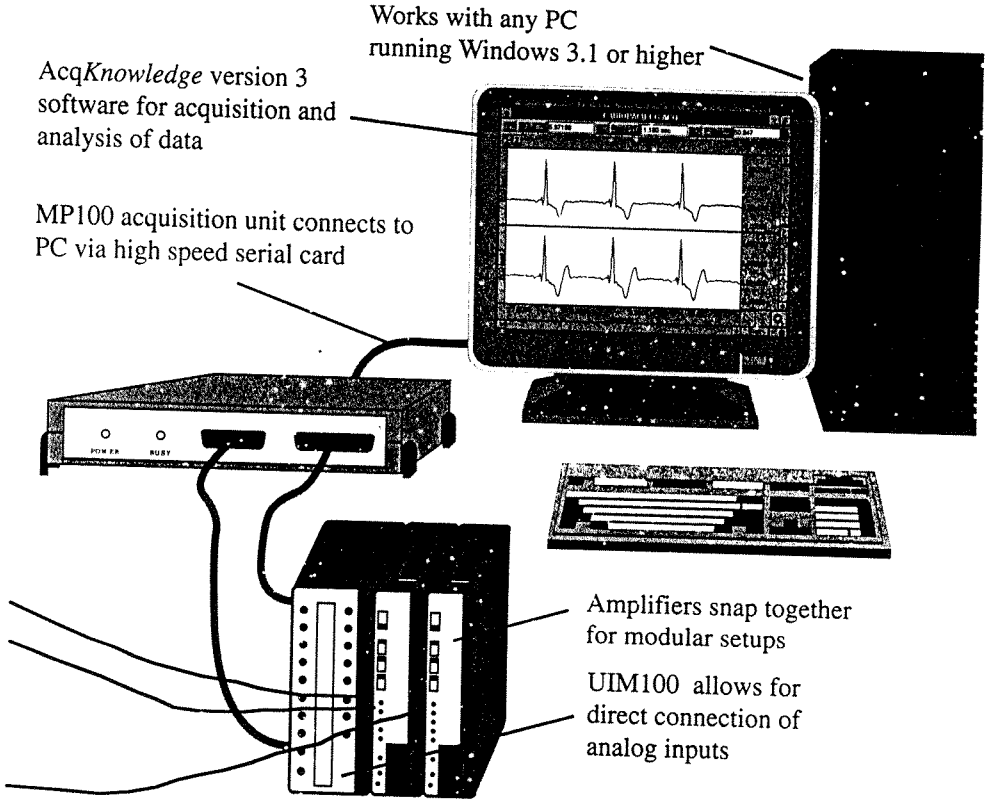
What will the demo disk show me?

The demo pretends the MP100 hardware is connected to your PC. When the "Start" button is pressed, data is plotted on screen exactly as if it were actually recording data off a subject. You can stop the recording at any time. You can then scroll through the data, examine specific sections, take readings, and perform analyses.

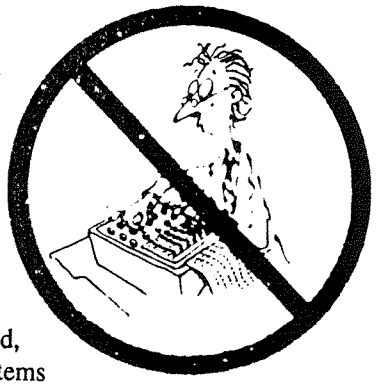
What can't I do in the demo?

First, you will only be able to open the sample files provided on the disk, or generated by this demo version. Second, you cannot save or print. These are the only limitations. All other features are exactly the same as in the actual program.

The basic components of the MP100WSW are shown below with the addition of two ECG100A amplifier modules. For this example, a two channel ECG recording is shown. Of course, this is only one possible configuration. In addition to ECG, Biopac Systems, Inc. manufactures amplifiers and signal conditioning modules designed to measure EMG, respiration, pulse, EEG, temperature, eye movement, skin conductance, and evoked potentials. We also have a general purpose amplifier that allows you to connect other devices, including bridge transducers like pressure, force and strain gauges.



All workstations include the MP100 acquisition unit, Acq*Knowledge* software, and a universal (non-amplified) module that allows you to connect existing equipment such as pre-amplified electrodes, transducers, and chart recorders. In addition, you can mix and match up to sixteen amplifiers designed to collect specific kinds of physiological signals (such as ECG, respiration, and EMG). As you can tell, these modules snap together, allowing you to create a customized data acquisition workstation. Since the data is stored on your PC and can easily be transformed, many of the time consuming setup tasks that other systems require are a thing of the past.



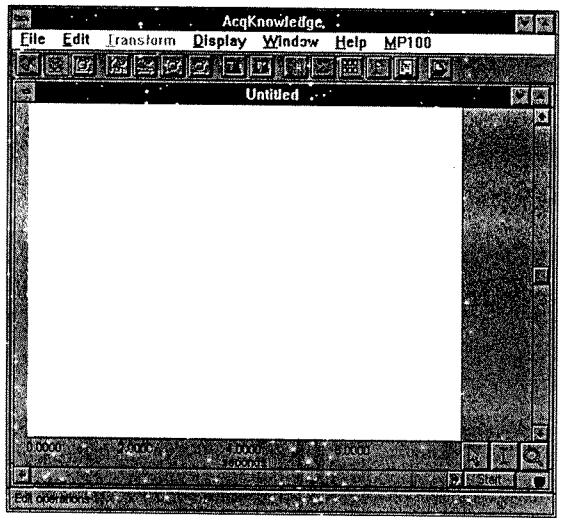
No calibration required!

The MP100WSW has several advantages over other recording systems. We have designed the MP100WSW to be as flexible as possible, giving you full control over how data is collected. You can perform mathematical transformations on data either while it is being acquired or after the fact. Our Acq*Knowledge* software allows you to perform a range of measurements, calculations, and transformations after the data has been collected....most can be performed with a click or two of the mouse button.
Since the MP100WSW is a PC-based system, data files can be copied, saved and backed-up like other PC files. You can also export data to other programs, either in numerical format for use with programs like Excel or SPSS, or save data in graphical format and place the images into programs like Word, Wordperfect, or PageMaker.
While data is being collected, the MP100WSW also allows you to....

- Easily change the number of channels (up to 16 analog and 16 digital) used for collection.
- Plot the waveforms to make full use of available screen space.
- Scroll back through the old data while the new data is being collected.
- View recorded values graphically and numerically.
- Perform, display and store on-line calculations during the recording.
- Have complete control over acquisition parameters such as sampling rate, length of recording, and when to begin a recording.
- Use the on-screen annotation and journal while recording data.
- Store the data directly to any disk or device. The amount of data you collect is limited only by the available disk space.

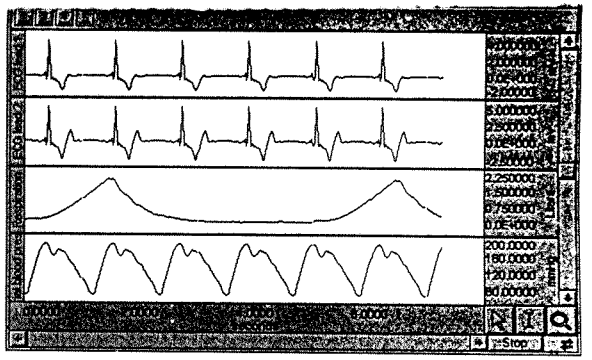
Let's begin...

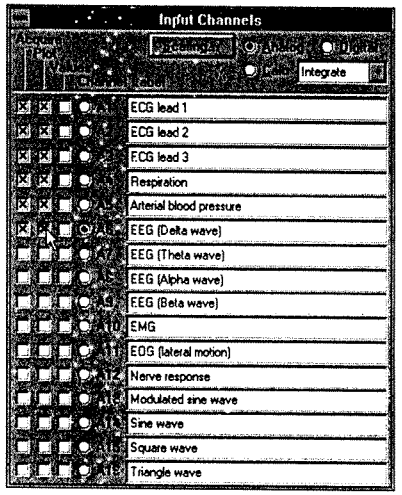
The MP100WSW has its own installation program that can be run from Windows. To install the demo on your hard drive, start Windows and insert the demo disk into the floppy disk drive (in this case the A: drive). Choose the Run command from the File menu in the Program Manager. Type "A:\SETUP" in the command line dialog box and click "OK." Follow the instructions in the dialog boxes until setup is complete.



By default, the setup program creates a MP100DEM directory and installs files to this directory. It will also create a program group called MP100WS Demo 3.0 and creates an icon for the application and the associated data files. Once you have installed the demo files, start the Application by double-clicking the Acq*Knowledge* icon. An untitled window will automatically be created.

screen and you will immediately see four channels of data scrolling across the main window. This is a simulated real time recording, and is what you would see during actual use of the MP100WSW. Data will be collected for 30 seconds, although you may stop it earlier by clicking on the "Stop" button.



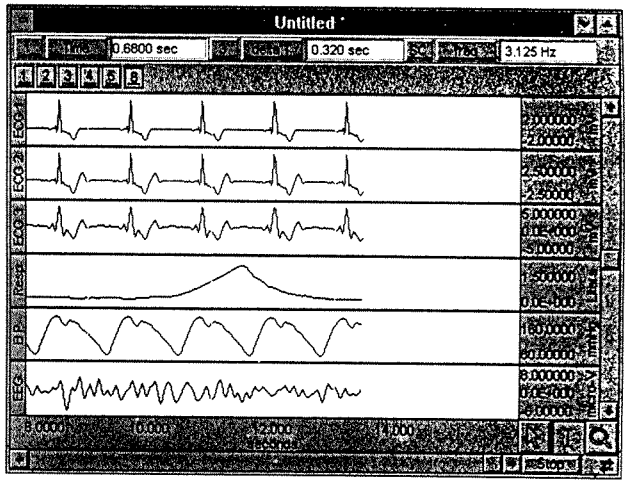


One advantage of the MP100WSW is its flexibility. Since the MP100WSW software uses the familiar point and click Windows interface, many of the operations that used to require mechanical adjustments are now just a mouse click away. Now you can change the amount and type of data you collect just by clicking the mouse in a dialog box.

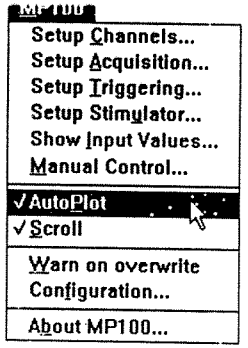
To see how easy this is, choose the "Setup Channels" item from the MP100 menu. You will see three columns of boxes next to rows of text boxes that describe different types of sample data. If you would like to collect and plot sample data for a given channel, check the boxes that correspond to the Acquire and Plot columns for that channel.

For instance, in the sample dialog box above, the Acquire and Plot boxes next to ECG lead 3 and EEG (channel 6) have been checked in addition to the channels that are normally checked at startup. This means that the next time the start button is pressed, data will be collected on these channels, and that the data will also be plotted on the screen as it is being acquired.

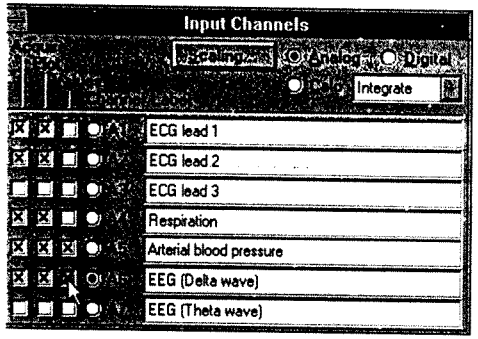
The graph to the right shows how the screen would appear if data were collected using the channel setup shown above.



of the window, the waveforms continuously scroll from right to left. For long recordings, it may be desirable to view the data collected earlier in the acquisition while new data is coming in. To demonstrate this, go up to the "MP100" menu and uncheck "Scroll" and "Autoplotting" (the checkmarks will disappear). Start the acquisition again. Now when the data plot reaches the right limit, the screen will not be rewritten. At this point you can use the horizontal scroll bar to look back through the data. Note that the scroll bar position indicator is changing while the data collection is taking place. This indicates that the record is getting longer as new data is being acquired.

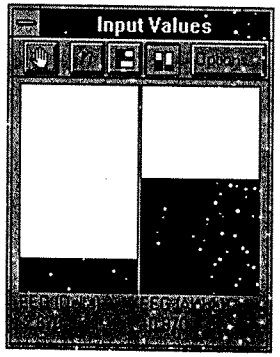


You can re-select "Autoplot" to again view the new data as it is acquired. During long recordings, you may wish to do other things with your PC such as word processing. By minimizing or resizing the window, the MP100WSW can be busily collecting data in the background while you're using another program. The MP100WSW software will never miss any data. You can even reposition the windows to watch the data coming in while you are typing away in your word processing program.

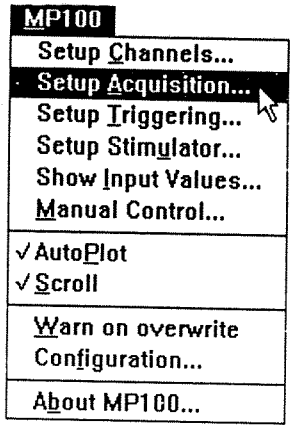


In addition to the ability to collect data in the background, the MP100WSW also gives you total control over the channel acquisition parameters. To illustrate this, choose "Setup Channels" from the "MP100" menu. To the left of each channel, the "Acquire" checkbox enables acquisition and the "Plot" checkbox enables plotting. If plotting is turned off, the data from that channel will be recorded, but not plotted on the screen.

After the data is recorded, you can turn the channel plotting on by holding down the Ctrl key and clicking in the channel boxes at the upper left of the graph window. The "Values" checkbox will cause the channel's current value to be numerically displayed in the "Input Values" window. The "Scaling..." button lets you convert incoming signals into other units (such as ft/lbs, millimeters, liters, etc.). This allows you to easily translate the voltage read by the MP100 into the units of the device being measured. The dot to the left of the channel number indicates which channel the scaling applies to.

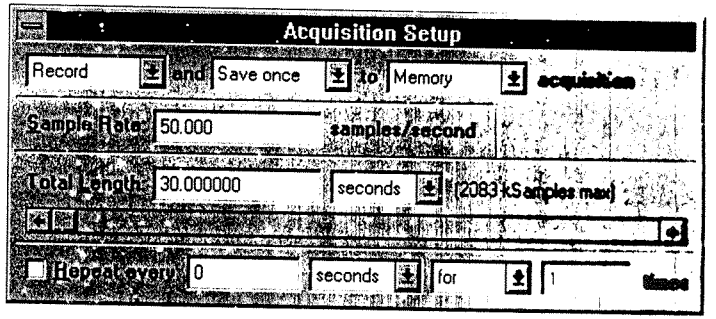


Choosing "Input values..." from the "MP100" menu displays a window showing the instantaneous input channel values in numerical and/or bar chart format. This is useful for displaying data as it is being acquired, and can be especially useful for biofeedback procedures. The size and precision of the values in the "Input values" window can be changed to suit your needs.



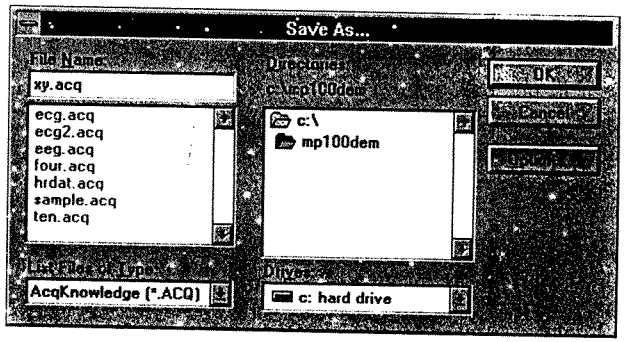
To further control the acquisition, select "Setup Acquisition" from the "MP100" menu. The "Acquisition mode" window will appear. This is where you can setup parameters controlling the data collection. There are several options here, but the basic ones are "Sample rate" and "Total Length". Sample rate is analogous to the mm/sec setting on a chart recorder. To change it simply type in the desired value in the "Sample rate" box. The amount of data recorded is set by either adjusting the "Total Length" scroll box or entering the length value directly. The units for the length can be set to samples, msec, seconds, minutes or hours by clicking on the popup menu to the right of the "Total Length" value. Beginning the acquisition again (clicking on the "Start" button) will cause these new settings to go into effect.

The storage device can be changed to store data to memory or disk. Any storage medium that you can copy a file to can be used (including removable hard disks and optical disks).



You can also setup more sophisticated acquisitions using signal averaging. For most applications, the MP100WSW is limited only by the computing environment (system speed, available memory and the like). Acq*Knowledge* will only let you enter valid parameters.

All acquisition parameters including window positions are saved along with the data when the "Save" command is chosen. This way you can open a data file and collect new data without having to reset any parameters. The "Save" dialog box is not available in the demo but is shown here for reference. Saving the data as an AcqKnowledge file (ACQ) saves data in a binary file format which uses minimal disk space. "TXT" is a standard ASCII format that can easily be read by other programs. Windows Metafiles (WMF) files can be read by most Windows-based drawing and word processing programs.



Easy Viewing

The MP100WSW software (Acq*Knowledge*) makes it easy to display and view your data. We have designed the software to provide an easy to use interface for working with data and displaying information. Acq*Knowledge* includes...

On-screen measurement tools that can be used to instantly find a host of measurements, including minima, maxima, intervals, BPM, and more.

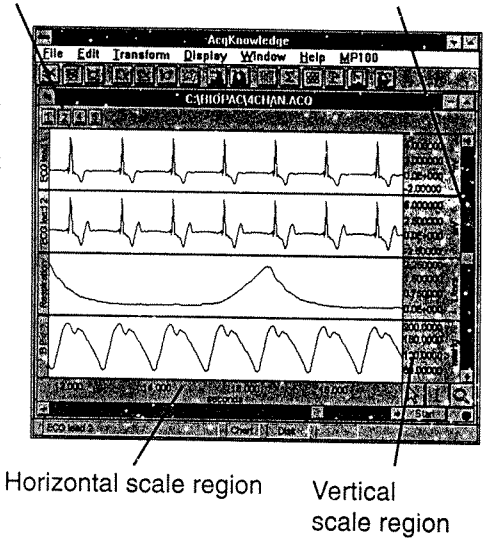
Functions which allow you to superimpose, tile, compress, expand, duplicate or remove waveforms.

Standard Windows editing features that allow you to cut, copy and paste data using familiar commands.

Built-in ability to view several files on the screen at the same time.

Printing utilities that allow you to produce high resolution plots.

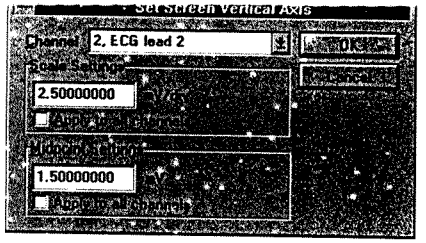
No more manual data extraction!

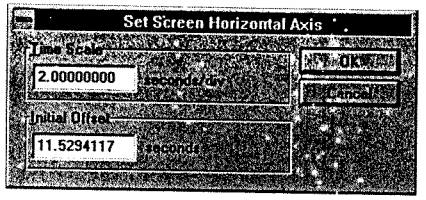


In the upper left portion of the acquisition window there is a row of small boxes which indicate the acquired channels. The box on the left corresponds to the waveform at the top of the screen. The box that appears depressed is the selected channel. Only one channel can be selected at a time. If a color monitor is used, each channel's waveform and indicator box will be the same color. Measurements can be taken from any channel, while transformations and editing operations apply to the selected channel or, in some cases, to multiple channels. To select a channel, click on either the waveform or its channel box using the arrow tool.

In the example above, channel 2 (ECG lead 2) was selected and its indicator box depressed. The "label" of the selected channel is displayed in the text box in the lower left hand corner of the screen. The vertical scroll bar adjusts the vertical offset of the selected channel. You may use it to slide the selected waveform's scale up or down. To adjust the vertical scale of the selected channel click the mouse on the vertical scale region. The vertical scale dialog box will appear.

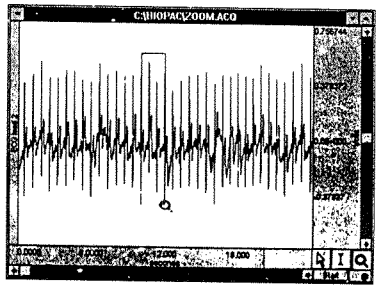
value and click on the "Ok button". The selected waveform's screen amplitude should now be twice as large as it was before. You have complete independent control over each channel. To display the optimal vertical scale for all channels choose "Autoscale waveforms" from the "Display" menu.

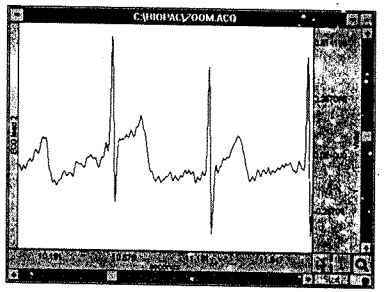




You may also compress or expand the displayed waveforms along the horizontal (time) axis. Simply click anywhere in the horizontal scale region. The horizontal scale box comes up allowing any entry you desire. After the "Ok" button is pressed, the screen will be redrawn with the new time scale setting.

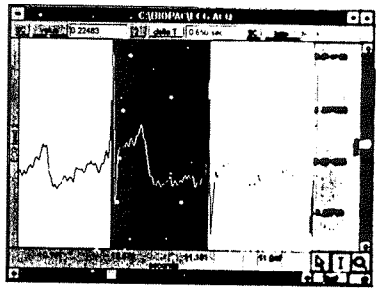
To enlarge a section of interest, click on the zoom tool in the lower right hand corner of the window. The zoom tool allows you to select an arbitrary section of data and "zoom in" to examine that area in more detail. To do this, press the mouse button and drag the mouse so it forms a box over the desired area. Now release the mouse button and you will instantly see the enlarged area (below). To zoom back select "Zoom previous" from the "Display" menu.





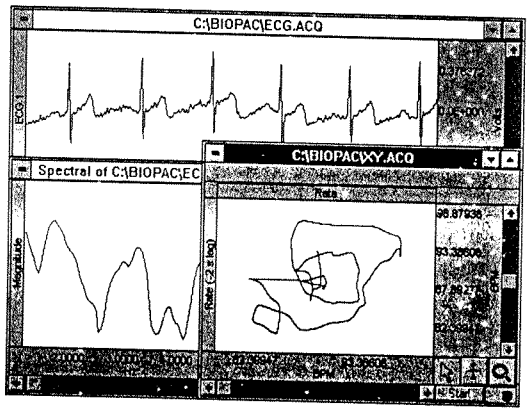
To temporarily hide a channel click on the channel's indicator box while holding down the CTRL key. A cross-hatched "grid" will be displayed over the box and the display will be redrawn without this channel. Repeating this operation will cause the waveform to reappear. To duplicate or remove a selected waveform choose "Duplicate" or "Remove waveform" from the "Edit" menu.

To take specific measurements click on the measurement tool in the lower right portion of the window. Select a section of the data by clicking and dragging the cursor across the waveforms as shown. In the example to the right, the interval between two peaks is selected. The two peaks occur 1.220 seconds apart, which results in a BPM of 49.18 as indicated in the second window.

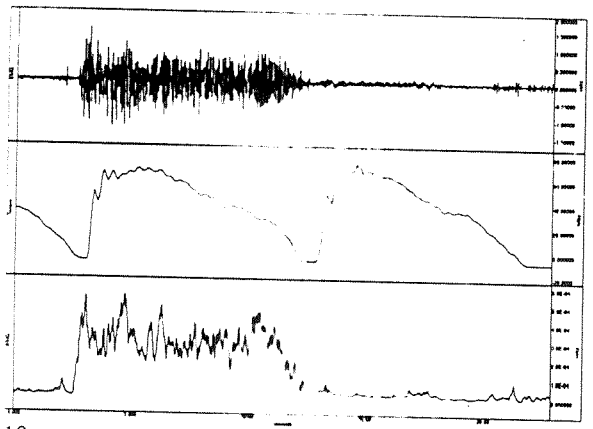


menus at the top of the window. You can increase the number of measurement windows shown by making the window wider. To change the measurement functions, simply click on the popup menu next to the measured value and select a different measurement. You can also change the channel each measurement is based on by choosing from the "SC" popup menu. By default, measurements are taken from the selected channel (as indicated by SC). The values will change while the measurement tool is being dragged over the waveform. You can easily measure absolute functions like value, time and sample number or use functions that operate over the highlighted area. These include min, max, mean, delta T and others.

The measurement tool is also used to edit waveforms. The highlighted area can be cleared, cut, copied or pasted. Data is edited from the selected waveform only. You can copy a section of one waveform and paste it in another by selecting the destination waveform before pasting it. You can also perform edits (such as pasting) between windows. To copy an entire waveform from one window to another you should use "Select All" from the "Edit" menu and then "Copy". Now switch to the other window and choose "Insert Waveform" from the "Edit" menu.



The Windows environment allows you to display several files on the screen at one time. Simply select "Open" from the "File" menu and make your selection. The windows can be moved and resized to ease in viewing. Clicking on the window brings it to the front. This is very useful for comparing files.



Although you cannot do it in the demo, in the actual program you can print out the waveforms as seen on the screen by selecting "Print" from the "File" menu. The Acq*Knowledge* software supports standard output devices (printers, plotters) and can produce high-resolution plots on virtually any printer. To the left is a sample printout.

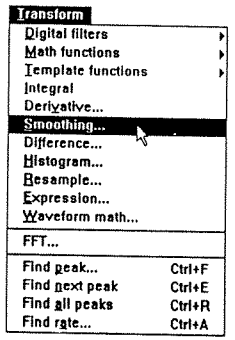
Powerful Analysis

One advantage of saving data on disk is that you can quickly and easily perform post-hoc analyses on your data. The MP100WSW is as powerful an analytical tool as it is flexible. In addition, the software is designed to provide you with immediate feedback from each operation. Using Acq*Knowledge*, you will be able to...

- Use digital filtering and smoothing.
- Find patterns within data sets.
- Automatically find peaks and calculate rate data.
- Perform mathematical and statistical operations.
- Log results and observations to a journal.

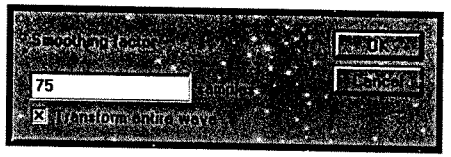
No need for manual data entry.

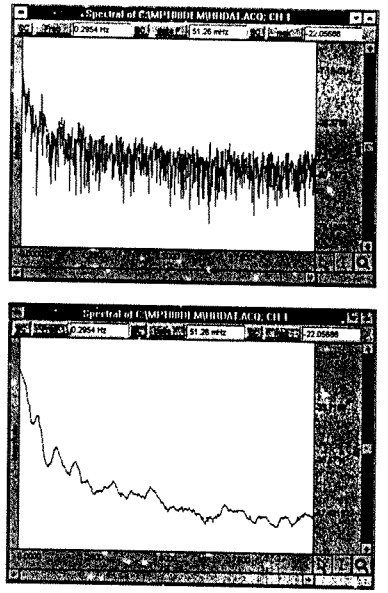
To give you an idea of how the MP100WSW provides immediate feedback, try the following transformation. Open the file HRDATA.ACQ. Choose FFT from the transform menu and click on the OK button (the defaults will work for now). The results will be plotted in a new window and should look like the window shown below.



Now select "Smoothing" from the "Transform" menu. The Smoothing transformation is a moving average over the specified number of samples.

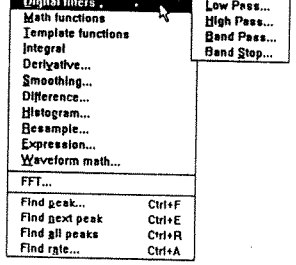
A dialog box will come up allowing a numeric entry. Type in 75 and click on the "Ok" button.

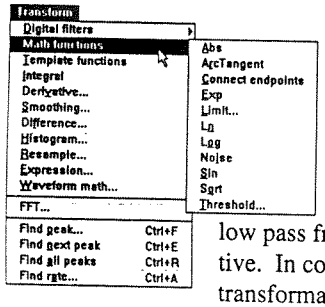




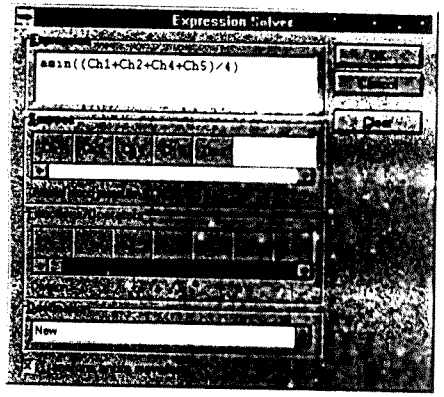
Whether you are performing complex analyses or simply editing, Acq*Knowledge* offers the same ease of use and familiar interface. In both examples above, Acq*Knowledge* modified the entire waveform, although you also have the option of highlighting a section of data and applying the operation to the selected area only. In either case the waveform is instantly operated on and the results are plotted on the screen. If you do not wish to alter the original data you can use the "Duplicate waveform" command in the "Edit" menu to make a copy of the waveform. The copy can then be altered instead.

which modify waveform data. The "Digital Filter" menu item has a sub-menu with four types of filter operations. For most datasets, the default filter parameters may be used and will produce relatively robust results. Several mathematical transformations are available under the "Math functions" sub-menu. Some transformations will produce a dialog with parameters which can be changed.



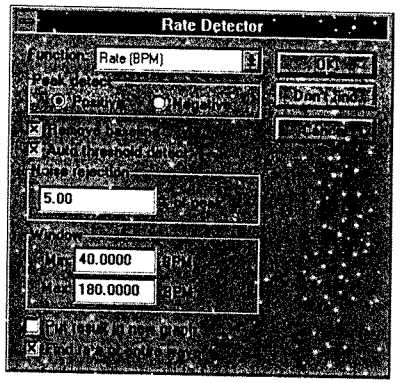


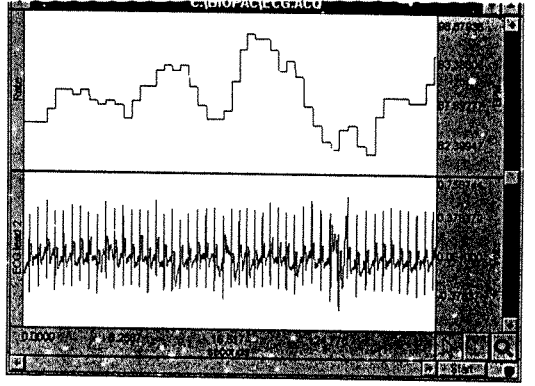
To examine the relationship between two different waveforms, the "Template functions" sub-menu provides a host of options. The "Integral" transformation results in a running total of all selected waveform values (using a trapezoidal rule integration). The "Derivative" transformation approximates an ideal differentiator. It allows you to specify a low pass frequency to filter the data prior to performing the derivative. In contrast to the derivative function, the "Difference" transformation is a running subtraction over the number of points specified.



The "Expression Solver" option lets you perform a range of mathematical operations, everything from addition and subtraction to arcsine and log transformations. Now you can perform complex operations in a single step. The example to the left computes the mean of channels 1, 2, 4 and 5, and then arcsine transforms the result and saves the output to a new channel. You can also save the output to a new channel, and you can transform sections of waveforms or entire waveforms.

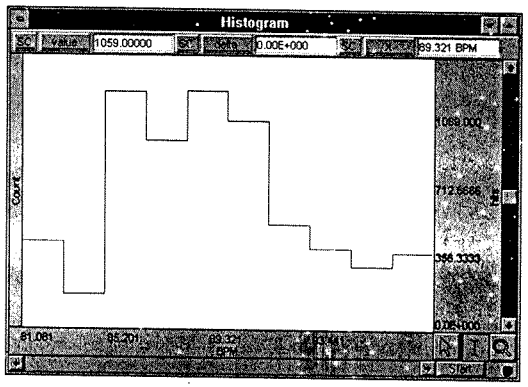
In addition to performing mathematical functions, the Acq*Knowledge* software can also search for peaks and calculate rate information (such as BPM). For example, suppose you want to calculate the rate for the entire ECG waveform once it has been collected. To do this, select "Find rate" from the "Transform" menu. The rate calculation dialog box will appear. As you can tell, there are a number of options here that allow you to customize the rate calculation. The rate calculation can operate as a simple threshold detector or can include more sophisticated parameters such as noise rejections and windowing. By default, Acq*Knowledge* will automatically calculate the threshold values and compute the rate for the entire waveform.





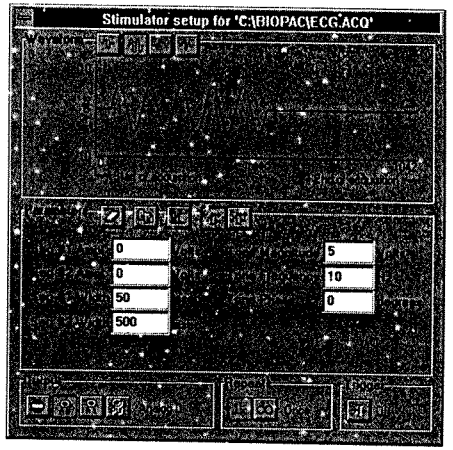
the right, the rate has been calculated and added to a new channel. This waveform can be operated on just as any other waveform, giving you the ability to transform data after it has been acquired.

One related type of transformation is the histogramming feature. This allows you to display data in summary format and examine the central tendency characteristics and variability within a waveform. To see how this feature works, choose Histogram from the Transform menu.



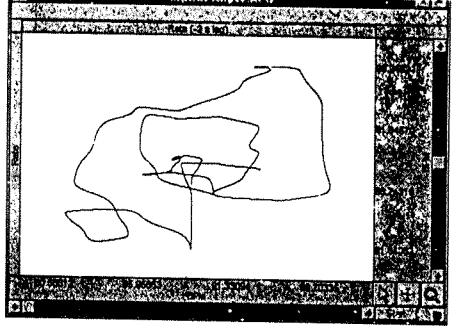
This dialog box prompts you to enter the number of "bins" to sort the values into, and the upper and lower bounds of the data to be sorted. For now, click Ok and use the default settings. The resulting waveform should look like the window to the left. As with almost every feature in Acq*Knowledge*, you can experiment with different settings to suit your needs.

Acq*Knowledge* also includes tools that allow you to work more efficiently. One such feature is the stimulator window, which is useful for creating stimulus signals and other types of output signals. The stimulator window allows you to choose from a number of "pre-shaped" waveforms, including pure tones, square waves and ramp waves. You can also use the arbitrary waveform option to output more complex waveforms.

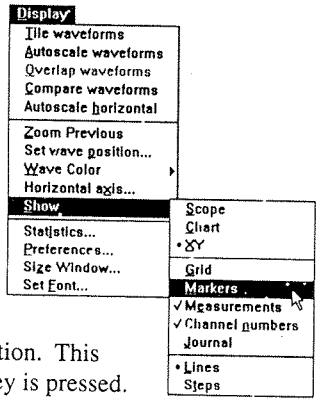


To see how this feature works, choose Setup Stimulator from the MP100 menu. Click on the 1x button in the Repeats section of the dialog box. This enables the output options and displays a square wave (which is the default). You can easily change the type of output waveform by clicking on the icons at the top of the dialog box. You can also alter the characteristics of the signal (duration, amplitude, and so forth) by typing in new values in the text boxes below the waveform.

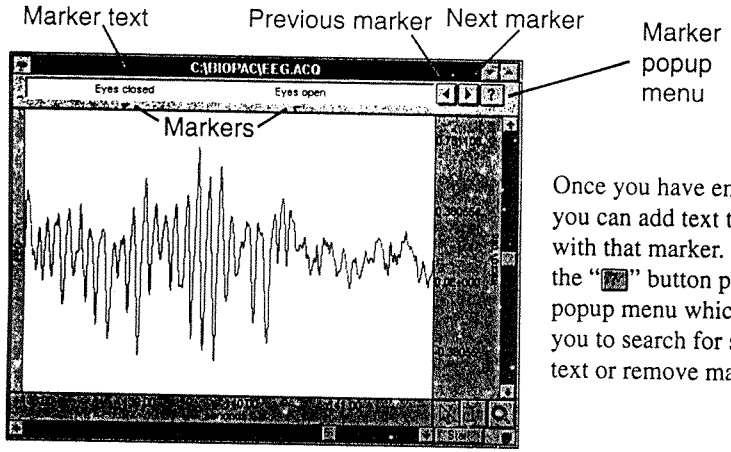
display options, including X-Y plotting. You can switch from one display mode to another using the toolbars in the upper left hand corner of the window. By clicking on these buttons, you can alternately have your PC display emulate a chart recorder, oscilloscope, or plot data from one channel against data from another channel. X-Y plots are useful for respiration studies, vectorcardiograms, and investigations into nonlinear dynamics (as shown to the right).



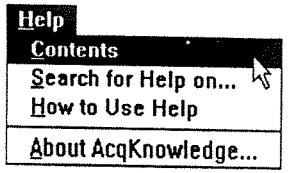
For some data acquisitions, you may need to record when an event (such as a manipulation) occurred. For this, we'll use the on-screen marker feature. With an open graph window choose "Show" and then "Markers" from the "Display" menu. This will cause the marker display to be shown near the top of the graph window.



Each marker is represented by a small downward pointing triangle and can be annotated with up to 80 characters of text. To add a new marker, position the cursor in the space between the bottom of the marker text and the top of the graph and click the mouse button. Another way to mark events is by pressing the "F 9" key during an acquisition. This causes a marker to be entered at exactly the time the F 9 key is pressed.



Once you have entered a marker you can add text to be associated with that marker. Clicking on the "▨" button produces a popup menu which will allow you to search for specific marker text or remove markers.



On-line help is always available from the help menu and contains a subset of the user manual as well as helpful hints and a useful table of scientific constants and conversions.

As you can see from this quick overview of the MP100WSW, it is a very powerful research tool. The analysis and editing software provides you with immediate feedback during analysis, reducing the amount of time needed to process data for reports.

Ordering Information for the MP100WSW for Windows™

The MP100WSW for Windows™ (P/N MP100WSW) consists of the following:

Software: Acq*Knowledge* version 3 acquisition and analysis software

Hardware: MP100 Acquisition Unit:
- Serial cable
- ISA100 high speed serial card
- MP100 power supply
- UIM100 (Universal interface module)
- UIM100 to MP100 cable set
- Complete set of documentation

For questions regarding the interface between your equipment or transducers and the MP100WSW, please give our Applications Department a call. We will be happy to discuss your specific requirements.

Ordering Address:

BIOPAC Systems, Inc.
275 South Orange Avenue
Santa Barbara, CA 93117, U.S.A.

Phone: (805) 967-6615
FAX: (805) 967-6043
BBS: (805) 967-9435