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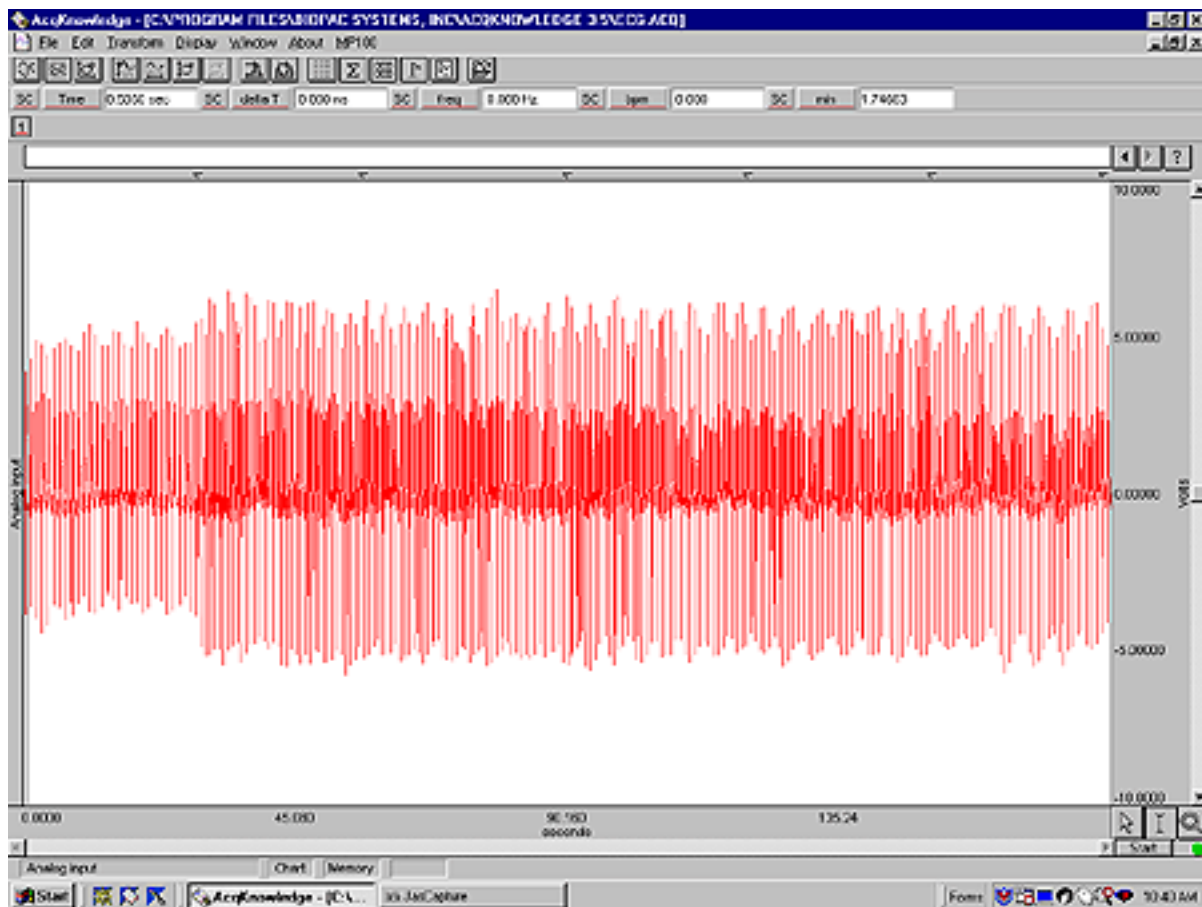
ECG Analysis using the Offline Averaging Mode

For years, cardiologists examined paper charts of ECG signals to create an averaged ECG complex. They took each individual cardiac cycle, measured each part of the complex with a ruler, wrote down each value, and calculated the means to derive an averaged ECG complex. As you can imagine (or have experienced), this task took a great deal of time and patience. When the need arose to analyze two or more different scenarios (e.g., baseline—response), the task had to be performed even more carefully, to accurately comparison of the ECG.

The AcqKnowledge software has a powerful averaging feature that automatically derives an averaged signal from a specific number of cycles (averaging is found in the Peak Detection menu). And, you can easily compare two, three, or more averaged ECG signals with just a few mouse clicks.

Getting Started

To begin, open your ECG data file.

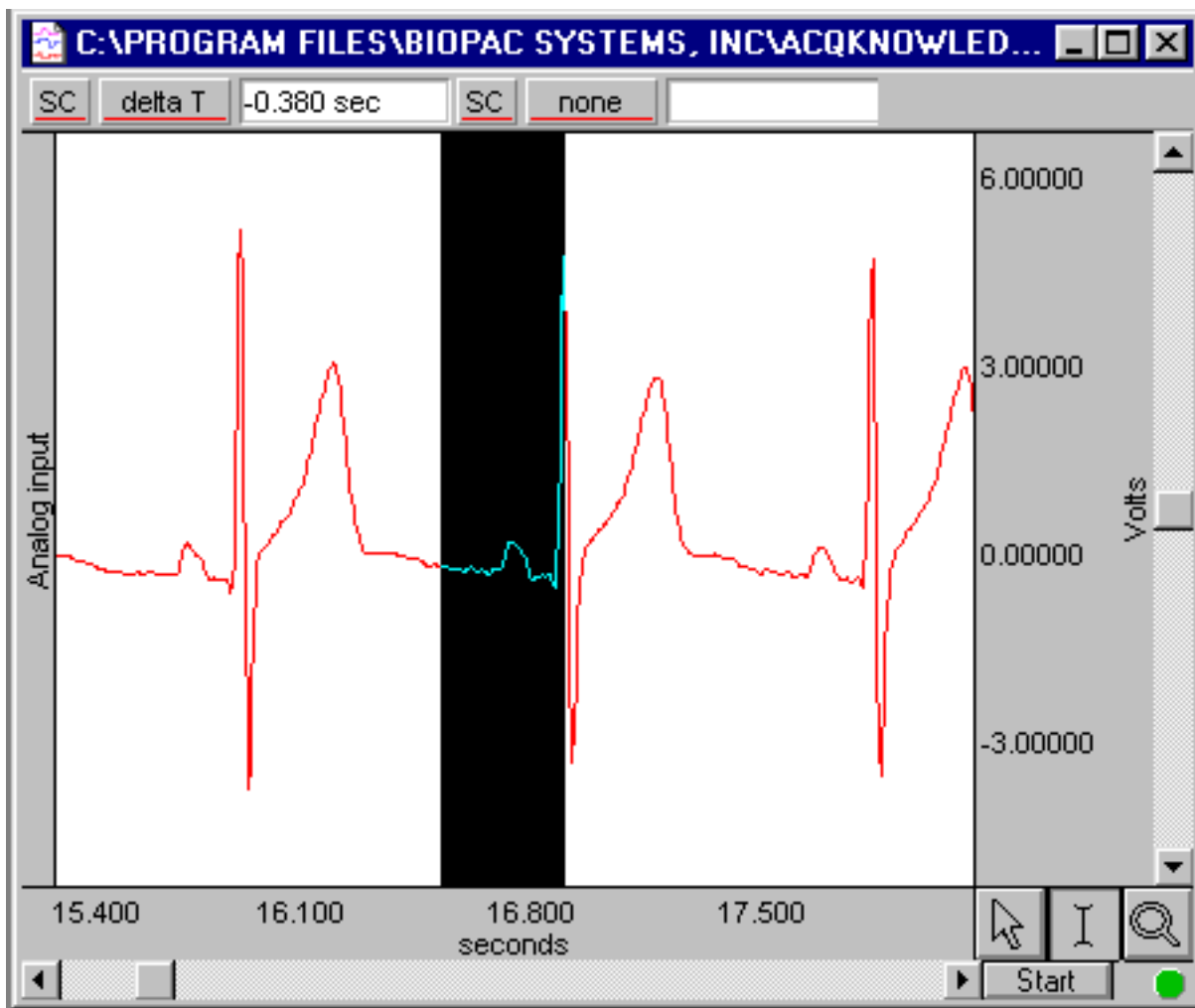


For our example, we acquired ECG from a subject at rest (baseline), immediately after vigorous exercise, and at 30-second increments during recovery.

Setup the Averaging Function

The first step in using the averaging function for ECG in AcqKnowledge is to determine the typical length of each ECG cycle. AcqKnowledge identifies the peak of each R wave as a reference point. Because of this fact, you need to set a window around the R wave, both backward to look at the P and Q waves, and forward to examine the S and T components.

Zoom into one representative ECG complex from your first sample. Set a measurement channel to SC (selected channel), and the measurement to delta T. With your cursor on the peak of the R wave, click and drag your cursor backward past the P wave, until you reach the midpoint of the P wave and previous T wave (see below). This time period represents the averaging period before the R wave.



Write down the delta T value (remember to note *negative* time). Then, click on the peak of the R wave, and drag the cursor past the T wave. Write down the delta T value (positive time). This time period represents the averaging period after the R wave.

Next, highlight the area that you are averaging and select the Transform Menu option. Under that menu you will then select Find Peak. (see box below)

Peak Detector

Find peak:

Positive peak Negative peak User defined interval

Threshold:

Level: Volts

Fixed Tracking

Start point:

Cursor Start time sec

Interval: sec

Min. interval: 0.00500000 sec

Set first cursor to:

+ sec

Set second cursor to:

+ sec

Paste measurements into journal

Off-line Averaging

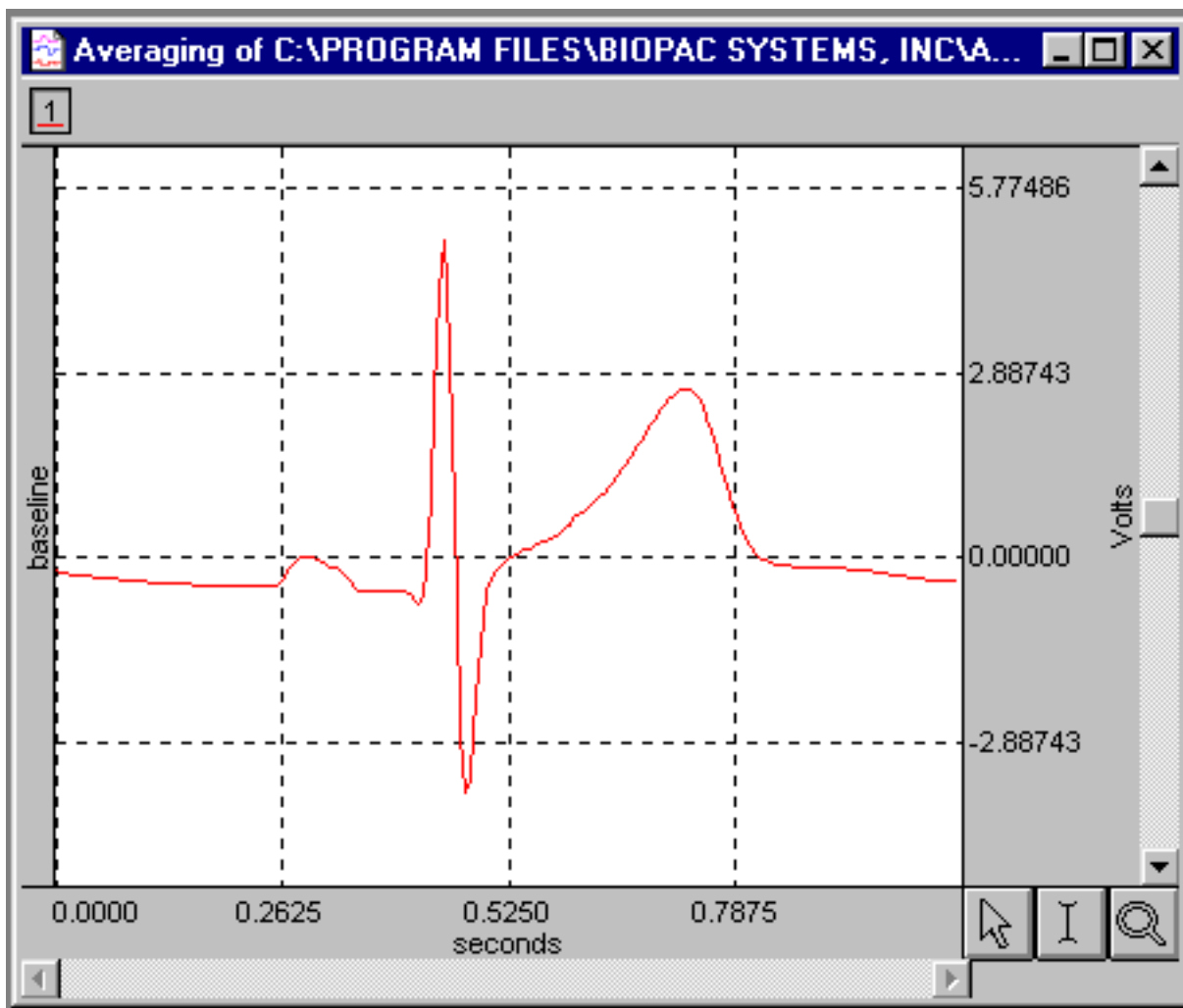
Check the Off-line Averaging box. You will then be given the option of entering your delta T measurements into the first and second cursor boxes. Enter the negative time value for the first cursor (time before R wave), and the positive value for the second cursor (time after R wave).

The value of the Threshold level in the Peak Detector box determines how the software will read each R wave. The value found in the Threshold box was determined by the selected area you chose. If you see 0 in this box, cancel and reselect the area you want to view.

Click on the Setup Averaging box and select the Averaging Range (entire waveform, selected area, etc.). Choose Selected Area, click OK, and then Ave Start.

Your Averaged ECG Signal

The system will now calculate the averaged ECG Complex. Your signal will look similar to this:



Comparing Multiple Waveforms

While this averaged ECG signal by itself gives you an excellent diagnostic tool, the ability to compare other scenarios will be an even more valuable tool. The following graph (next page) shows the averaged ECG complex for the baseline period, and also immediately after exercise plus one for each 30-sec interval during the recovery phase (total of six waveforms).

Each time you perform the analysis, the system will automatically create a new graph window. To view multiple analyses in one graph window, you must use the Select All function from the Edit menu and copy the averaged complex. From the Edit menu use the Insert Waveform function to insert each additional averaged ECG complex.

Once you have copied all your waveforms into one graph window, you can now label each channel individually. On your first averaged waveform, click on the Channel Label box (far left of the channel), and change the name of the channel. You may want to change the colors of the waveforms to provide more contrast in your final presentation.

Set All Channels to Same Scale

First, make sure all waveforms are visible. You also need to view each waveform using the same vertical scale. To do this, click on the Set Screen Vertical Axis box (right hand side of that channel), and click all three of the Apply to All Channels buttons. You should see something like this:

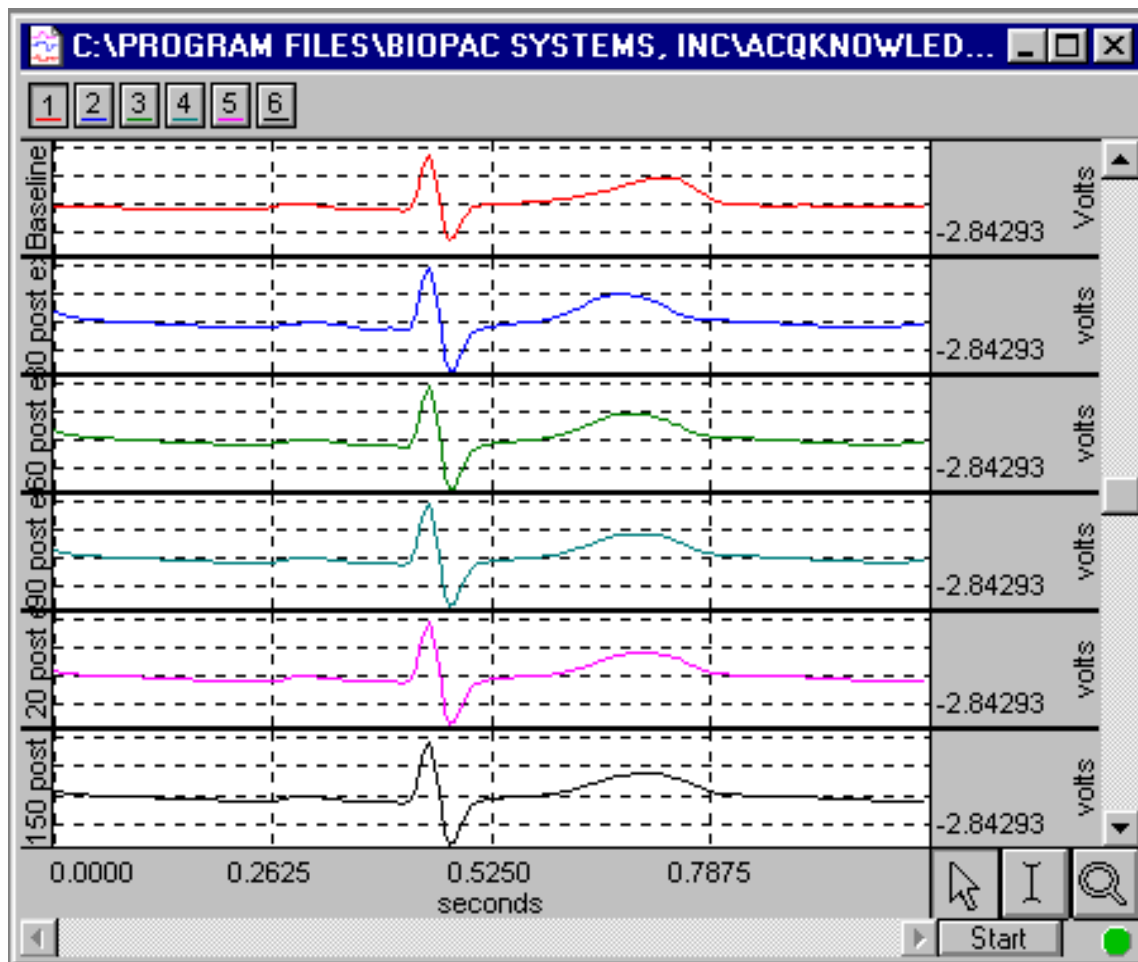
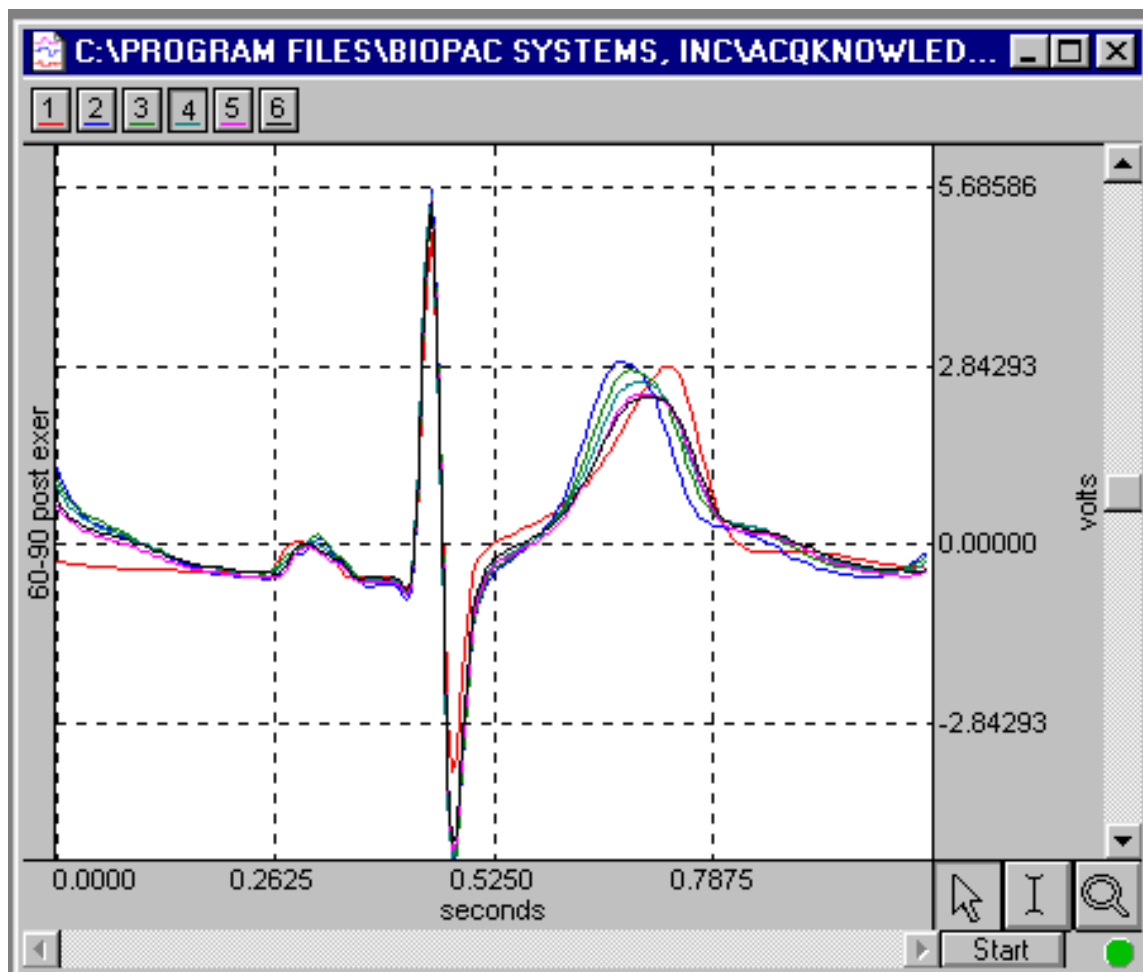


Chart Mode



Scope Mode

Once you have all the waveforms on a standardized scale, click on the Scope Mode button in the Tool Bar, and you'll see something like the display above.

If you don't see all the waveforms in the window, you may have two very similar waves which overlap one another, or you may not have used the "Apply to All Channels" command properly in the vertical scale box. [NOTE: you must use the "Apply to All Channels" command. If you don't, the channels you'll see using the Scope mode won't be uniform, and you won't get an accurate comparison.]

As you can see, the Chart mode allows you to see each individual averaged waveform, while the Scope mode gives you an overlapped comparison of each averaged ECG cycle.

This application note involves data averaging after the acquisition, or off-line averaging. Another method of averaging available on the MP100 system is on-line averaging. See Application Note AS105B for an on-line averaging example using Auditory Brainstem Response (ABR).

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