



BIOPAC Systems, Inc.

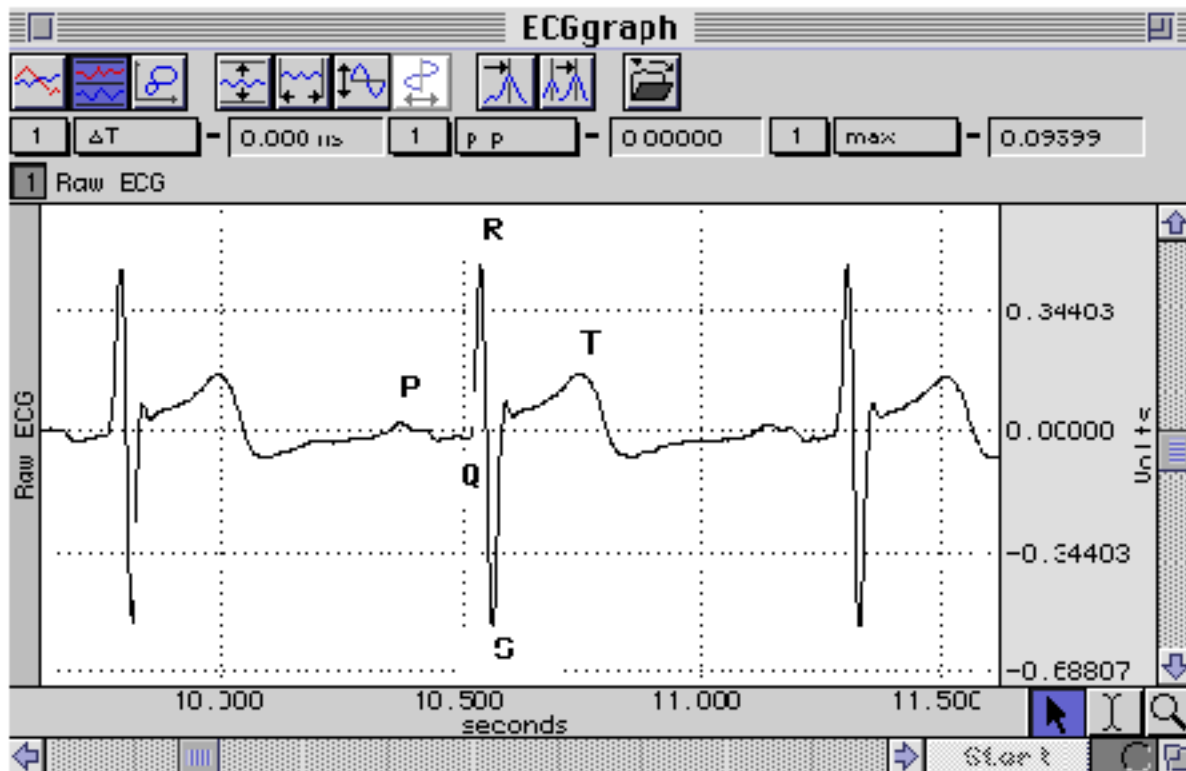
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#PS148 - Automated ECG Analysis

An electrocardiogram (ECG) is a graphical recording of the changes occurring in the electrical potentials between different sites on the skin as a result of cardiac activity. The electrical activity of the heart is a sequence of depolarizations and repolarizations. *Depolarization* occurs when the cardiac cells, which are electrically polarized, lose their internal negativity. The spread of depolarization travels from cell to cell, producing a wave of depolarization across the entire heart. This wave represents a flow of electricity that can be detected by electrodes placed on the surface of the body. Once depolarization is complete, the cardiac cells are restored to their resting potential, a process called *repolarization*.

This flow of energy takes on the form of the ECG wave, and is characterized by an initial P wave, followed by the QRS complex, and then the T wave. The P wave is associated with depolarization of the atria, the QRS complex is associated with depolarization of the ventricles, and the T wave with repolarization of the ventricles.

This application note was designed to assist with the advanced analysis of ECG data, specifically P, Q, R, S and T Wave analysis. This application note describes how to setup the Biopac Student Lab PRO software to find R time, R height, Rate, Inter-Beat Interval, S height, P height, Q height, T height and how to place your measurements into the journal.



Equipment

- BIOPAC Student Lab data acquisition system
- SS2L Electrode Lead Set
- EL503 electrodes (or equivalent)

Hardware Setup

- Setup Analog Channel 1 using the ECG signal Preset
- Plug the SS2L electrode set into CH1

ECG ANALYSIS

The timing windows used to detect the P, Q and T Wave Analysis section of this Application Note correspond to a standard ECG recording and they may have to be altered to suit your data. The time windows for peak identification (i.e. Set first cursor to X, Set second cursor to Y) will need to be preset and the values given in this paper will work for most P, Q, and T wave analysis. This option can be found under Transform in the Find Rate window and they can be altered to change the width of the highlighted peak areas.

If you want to cycle through each ECG complex semi-automatically, you can click on the peak to peak icon located at the top of the window, in order to get each measurement. This is a box with a picture of two peaks in it, located towards

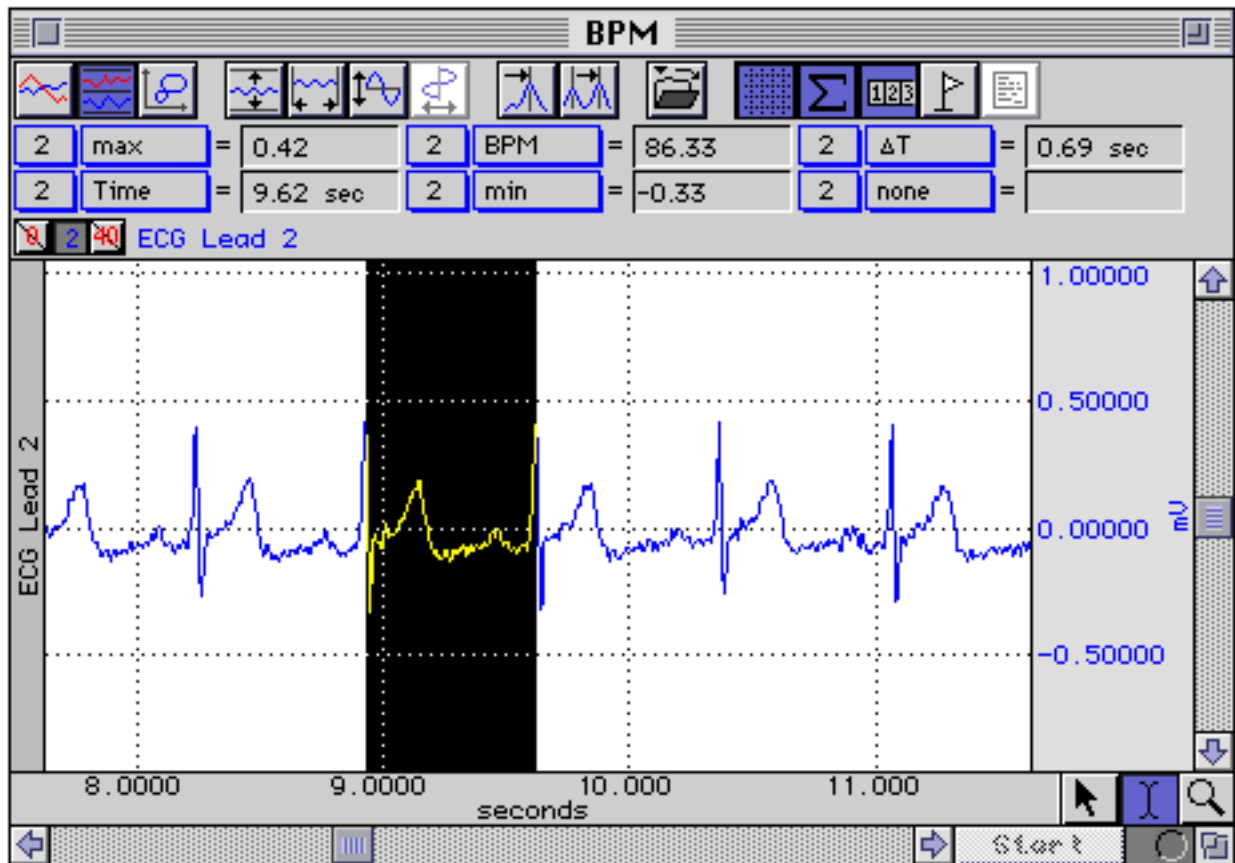
the top of the screen. By clicking on this you will advance the highlighted area to the next measurement.

JOURNAL

Before doing any of the following ECG analysis you may want to open a journal in order to automatically store your measurements. You can do this by opening a journal and clicking the Paste to journal option found under Transform in the Find peak window. This will automatically enter your measurements where they can be saved as a text file. Excel and other statistical graphing programs will allow you to open these files for further analysis (see App. Note AS or PS143, Importing Data Into Excel).

R WAVE ANALYSIS

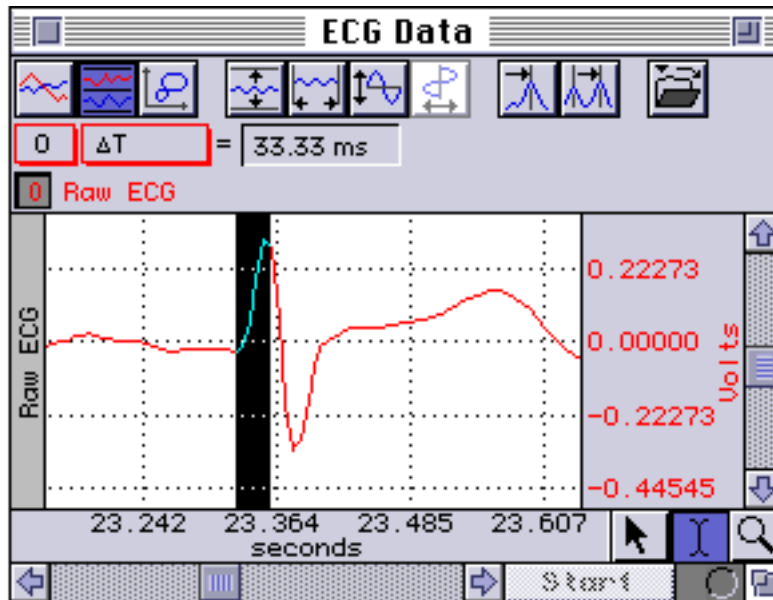
To find the R Time, R Height, Rate, Inter-Beat Interval, and S value you must select time, max, BPM, delta T (T) and min from the Measurement Windows, as shown on the next page. To find these measurements from the ECG data you must use the I beam tool to highlight an entire QRS complex and click on Find peak under the Transform menu. Select OK and this will find the first R Time, R Height, Rate, Inter-Beat Interval and S Height. To Find all peaks, go back to the Transform menu and select Find all peaks (with the PC version you must highlight all of the data first by clicking on Select All from the Edit menu). This procedure will initiate the complete ECG analysis.



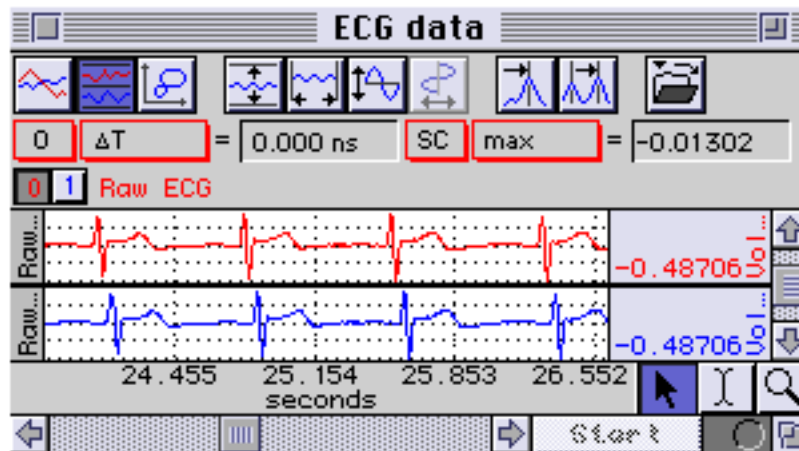
- Select time, max, BPM, delta T (T) and min from measurement windows
- Highlight the first QRS complex with the I beam tool
- Click on Find peak under the Transform menu, select OK
- Click on Find all peaks under the Transform menu, select OK

P and Q WAVE ANALYSIS

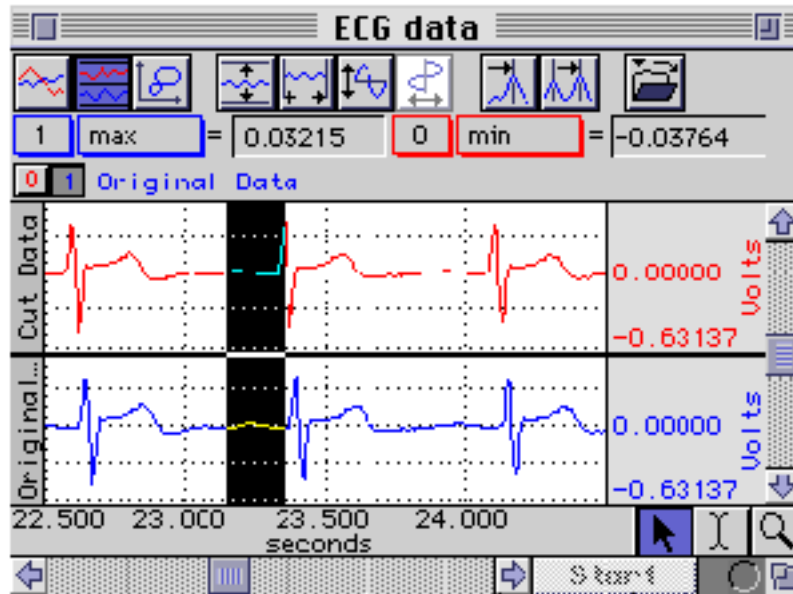
To measure P height and Q height of the ECG data you must duplicate the waveform by clicking on Edit and selecting Duplicate waveform. Then use the I beam tool to determine the amount of time between the Q and R waves. This is done by selecting delta T (T) in a Measurement Box and highlighting the area between the Q and R peaks with the I beam tool, as shown below.



Cut the same time period of data from the beginning of the duplicated waveform. This is done by highlighting a portion of the data at the beginning of the waves and selecting cut from the Edit menu. This offsets the two waves and allows you to measure the P and Q heights automatically, when using the Peak Detection function.



Next, set one measurement box to max and set the SC channel to the original data. This will give you the P height measurements. Set a second measurement box to min and set the SC channel to the cut data. This will give you the Q height measurements. Then, highlight the QRS of the cut data, with the I beam and select Find peak from the Transform menu. In this window you must Set first cursor to Peak. Then change the number directly to the right of Set first cursor to -0.2 sec, also make sure that Set second cursor to is 0 sec. This will position the highlighted area over the P wave on the original data and the Q wave of the cut data. You may also have to raise the Threshold in this window, in order to avoid measuring the T wave (see below). Select OK; this will find the P wave on the original data and it will find the Q wave on the cut data.



You may have to raise the Threshold in the Find peak window, because if the threshold is not higher than the T wave you will get R wave and T wave measurements. This can be avoided by selecting Find peak from the Transform menu and raising the Threshold so it will not detect the T wave.

- Duplicate the waveform by selecting Duplicate waveform from the Edit menu.
- Use the I beam tool to determine the amount of time between the Q and R.
- Cut this amount of time out of the duplicated wave by selecting Cut from the Edit menu.
- To get P Height, select max from the measurement box and set the SC channel to the original data.
- To get Q Height, select min from the measurement box and set the SC channel to the cut data.
- Highlight the first QRS of the cut data and click on Find peak from Transform.
- Set first cursor to peak, Set first cursor to -0.2 sec and Set second cursor to 0 sec, select OK.

T WAVE ANALYSIS

To find the T Waves of the ECG data, you must highlight a single QRS complex from the cut data, and click on Find peak from the Transform menu. Select Peak and Set first cursor to 0.05 sec, then Set second cursor to 0.5 sec. You must have one Measurement box set to max. Select OK and this will find the T Wave heights. Use the peak to peak icon to advance the highlighted area to the next measurement.

- Set one measurement box to max and SC channel to the cut data.
- Highlight the first QRS complex from the cut data and select Find peak from Transform.
- Select Peak and Set first cursor to 0.05 sec and Set second cursor to 0.5 sec, select OK.

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