

# Experiment CP-1: The Electrocardiogram (ECG) and the Pulse

## Exercise 1: The ECG and the Pulse in a Resting Subject

Aim: To measure and correlate the ECG and the pulse in a resting individual.

### Procedure

1. Click on the Record button, located on the upper right side of the LabScribe Main window ([Figure CP-1-L1](#)). The signal should begin scrolling across the screen.

*Note: If the user clicks the Record button and there is no communication between the iWorx unit and computer, an error window will appear in the center of the Main window. Make sure the iWorx unit is turned on and connected to the USB port of the computer. Click OK and select the Find Hardware function from the LabScribe Tools menu.*

2. Click on the AutoScale button at the upper margin of the ECG, Pulse, and Pulse Integral channels. Your recording should look like [Figure CP-1-L1](#).
  - If the signal on either the ECG or the Pulse channel is upside down when compared to trace in [Figure CP-1-L1](#), click on the downward arrow to the left of the channel title and select the Invert function. The trace should now look similar to the one in the figure
  - If a larger ECG signal is required, the electrodes should be moved from the wrists to the skin immediately below each clavicle.
  - If the pulse signal is small or noisy, adjust the tension on the strap holding the pulse plethysmograph to the finger.
3. When you have a suitable trace, type <Subject's Name> Resting ECG/Pulse in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to attach the comment to the data. Record for a minute or two.
4. Click Stop to halt recording. Your data may look like [Figure CP-1-L1](#).



Figure CP-1-L1: ECG, pulse, and pulse integral displayed on the Main window. The arrow is placed above a dichrotic notch.

5. Select Save As in the File menu, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder). Designate the file type as \*.iwxdata. Click on the Save button to save the data file.

### Data Analysis

1. Scroll through the recording and find a section of data with five or six exemplary ECG/pulse cycles in succession.
2. Use the Display Time icons to adjust the Display Time of the Main window to show at least four complete ECG/Pulse cycles on the Main window. Four adjacent ECG/Pulse cycles can also be selected by:
  - Placing the cursors on either side of a group of four complete ECG/Pulse cycles.
  - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment with the four selected ECG/Pulse cycles to the width of the Main window.
3. Click on the Analysis window icon in the toolbar ([Figure CP-1-L2](#)) or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window ([Figure CP-1-L3](#)).

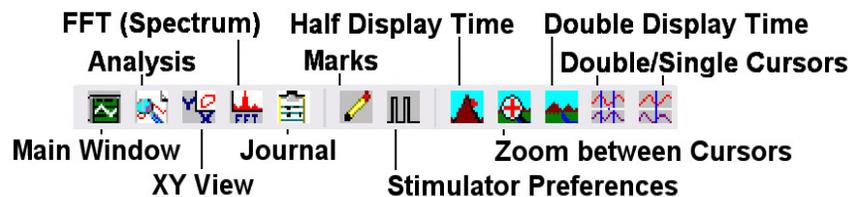


Figure CP-1-L2: The LabScribe toolbar.

4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The names of the mathematical functions used in the analysis, V2-V1 and T2-T1, appear in this table. The values for V2-V1 and T2-T1 from each channel are seen in the table across the top margin of each channel. In this exercise will only need to record the values for T2-T1.
5. Once the cursors are placed in the correct positions for determining the time intervals on each ECG/Pulse cycle, the values of the time intervals can be recorded in the on-line notebook of LabScribe by typing their names and values directly into the Journal, or on a separate data table.
6. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal. To use these functions:
  - Place the cursors at the locations used to measure the amplitudes and period of the ECG/Pulse cycle.
  - Transfer the names of the mathematical functions used to determine the amplitudes and time interval to the Journal using the Add Title to Journal function in the ECG Channel pull-down menu.

- Transfer the values for the amplitudes and beat period to the Journal using the Add Ch. Data to Journal function in the ECG Channel pull-down menu.

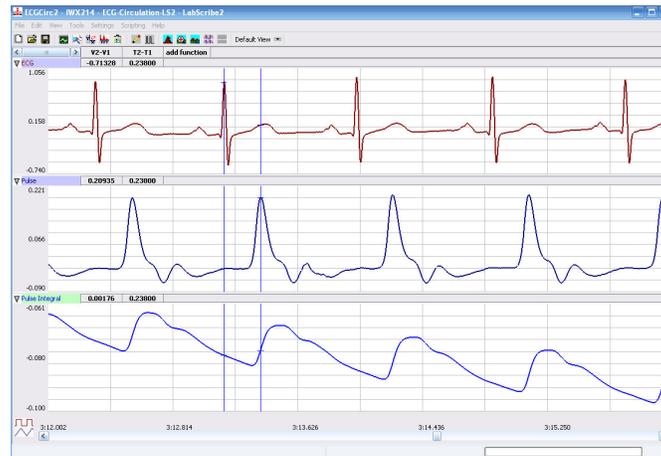


Figure CP-1-L3: ECG, pulse and pulse integral displayed on the Analysis window with cursors in place to measure the R-Pulse interval with the T2-T1 function.

7. Use the mouse to click on and drag the cursors to specific points on the ECG/Pulse recording to measure the following:
  - The beat period, which is the time interval between two adjacent R waves (Figure CP-1-L3). To measure the beat period, place one cursor on the peak of a R wave and the second cursor on the peak of the adjacent R wave. The value for T2-T1 on the ECG channel is the beat period. Measure the beat period for two additional pairs of R waves.
  - The R-Pulse interval, which is the time interval between the peak of the R wave and the peak of the pulse wave that follows the R wave (Figure CP-1-L3). To measure this interval, place one cursor on the peak of a R wave and the second cursor on the peak of the pulse wave to its right. The value for T2-T1 on any channel is this interval. Measure this interval for two additional ECG/Pulse cycles.
8. Calculate the following values and record your results into the Journal or on a separate data table:
  - The average beat period, in seconds/beat.
  - The heart rate, which is expressed in beats per minute and calculated from the average beat period by using the following equation:
    - Heart Rate (beats/minute) = 60 seconds/minute/# seconds/beat
  - The average R-Pulse interval.

## ***Questions***

1. What electrical and mechanical events take place during the R wave?
2. What events take place in the cardiovascular system during the R and pulse waves?
3. The signal recorded on the Pulse channel is rate of change of the blood pressure entering the subject's finger tip. When this signal is integrated, the waveform displayed on Pulse Integral channel is similar to an arterial pressure curve. Is there a short plateau or dip during each cycle displayed on the Pulse Integral channel? This plateau or dip is called the dichrotic notch. If you optimized the tension on the plethysmograph strap to record a large, clean pulse wave from your subject, you should see a dichrotic notch on the Pulse Integral channel.
4. What event recorded on the ECG channel corresponds to the dichrotic notch? What causes a dichrotic notch?

## **Exercise 2: The ECG and the Pulse in Other Subjects**

Aim: To measure and correlate the ECG and the pulse in other subjects.

### ***Procedure***

Repeat Exercise 1 on other subjects.

### ***Data Analysis***

Analyze the data for each subject using the same techniques used in Exercise 1.

## ***Questions***

1. Is the time interval between the R wave and the peak of the pulse wave the same for each subject? Does this time interval differ with heart rate?
2. Do you see any differences in the size or shape of dichrotic notches from different subjects? Remember: the tension on the plethysmograph strap affects the shape of the pulse recording.
3. Is the time interval between the peak of the pulse wave and the bottom of the dichrotic notch the same for each subject?
4. What factors would affect the shape or position of the dichrotic notch?

## **Exercise 3: The Effect of Cold on the Pulse**

Aim: To measure the effects of cold on the pulse and heart rate.

### ***Procedure***

1. Attach the plethysmograph to the middle finger of the subject's left hand. Instruct the subject to sit quietly with their hands in their lap.
2. Click on the Record button. The signal should begin scrolling across the screen.
3. Click on the AutoScale button at the upper margin of the ECG, Pulse, and Pulse Integral

channels. Your recording should look like [Figure CP-1-L3](#). Use the same techniques used in Exercise 1 to display the signals properly.

4. When you have a suitable trace, type <Subject's Name> RoomTempECG/Pulse in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to attach the comment to the data. Record for a minute or two.
5. Type Cold ECG/Pulse in the Mark box to the right of the Mark button. Place a bag containing a mixture of ice and cold water on the subject's left forearm. At the same time, press the Enter key on the keyboard to attach the comment to the data. Record for two minutes while the cold pack is on the subject's forearm.
6. Type Remove in the Mark box. Simultaneously remove the ice bag and press the Enter key on the keyboard.
7. Record for an additional two minutes; then, click Stop to halt recording.
8. Select Save in the File menu on the LabScribe window.

### **Data Analysis**

1. Scroll through the recording and find a section of data with four or five exemplary ECG/Pulse cycles, in succession, that were recorded at room temperature.
2. Use the Display Time icons, or the cursors and the Zoom between Cursors button, to adjust the Display Time of the Main window to show at least four complete ECG/Pulse cycles on the Main window.
3. Click on the Analysis window icon in the toolbar ([Figure CP-1-L2](#)) to transfer the data displayed in the Main window to the Analysis window ([Figure CP-1-L4](#)).
4. Look at the Function Table in the Analysis window and make sure the mathematical functions used in the analysis, V2-V1 and T2-T1, appear.
5. Once the cursors are placed in the correct positions for determining the amplitude and time intervals, transfer the names and values of the parameters measured in the Analysis window to the Journal using one of the two techniques described in Exercises 1, or transfer the values to a separate data table.
6. Use the mouse to click on and drag the cursors to specific points on the ECG/Pulse recording to measure the following:
  - The pulse wave amplitude. To measure the pulse wave amplitude, place one cursor on the baseline that precedes the pulse wave and the second cursor on the peak of the pulse wave. The value for V2-V1 on the Pulse channel is this amplitude. Determine the pulse amplitude for three pulse waves.
  - The beat period. Measure the time between two adjacent R waves using the same technique employed in Exercises 1 and 2. Determine the beat period for three ECG/Pulse cycles.
  - The R-Pulse interval. Measure the time between the peak of the R wave and the peak of the pulse wave using the same technique employed in Exercises 1 and 2. Determine this interval for three ECG/Pulse cycles.

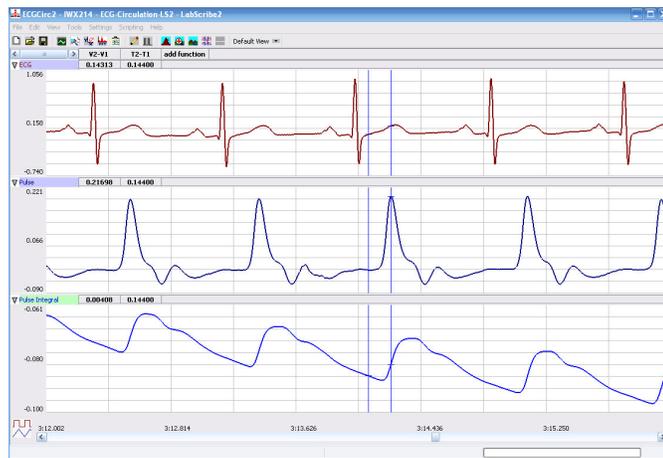


Figure CP-1-L4: ECG, pulse and pulse integral displayed on the Analysis window with cursors in place to measure the pulse amplitude with V2-V1 function.

7. Repeat Steps 5 and 6 for the data at 1 and 2 minutes into the cooling period, and at 1 and 2 minutes into the rewarming period
8. Calculate the following values and type your results into the Journal or on a separate data table:
  - The average pulse wave amplitude while the forearm was at room temperature, cooled for 1 and 2 minutes, or rewarmed for 1 and 2 minutes.
  - The heart rate while the forearm was at room temperature, cooled for 1 and 2 minutes, or rewarmed for 1 and 2 minutes.
  - The average R-Pulse interval while the forearm was at room temperature, cooled for 1 and 2 minutes, or rewarmed for 1 and 2 minutes.

### Questions

1. What effect does cooling have on the amplitude of the pulse wave?
2. Does cooling of the forearm affect the heart rate, or the time interval between the R wave and the peak of the pulse wave?
3. Through what mechanism does cooling affect the peripheral circulation?
4. What other factors may affect peripheral circulation?

### Exercise 4: The Effect of Heat on the Pulse

Aim: To measure the effects of heat on the pulse and heart rate.

#### Procedure

1. Move the plethysmograph to the middle finger of the subject's right hand.
2. Follow the directions used in Exercise 3 to do an experiment on the right forearm of the subject with a bag of warm water. Mark the recording to indicate when the bag of warm water was

applied and removed from the forearm.

### *Questions*

1. What effect does warming have on the amplitude of the pulse wave?
2. Does warming of the forearm affect the heart rate, or the time interval between the R wave and the peak of the pulse wave?
3. Through what mechanism does warming affect the peripheral circulation?