Experiment HH-4: The Six-Lead Electrocardiogram

Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

iWire-B3G ECG cable and electrode lead wires

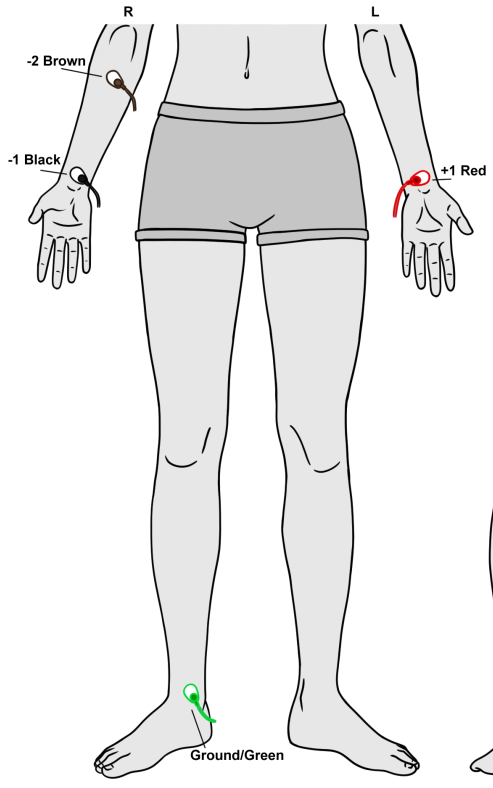
Disposable ECG electrodes

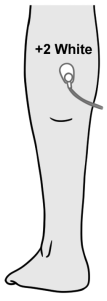
Note – You must connect the iWire-B3G to the IXTA prior to turning it on.

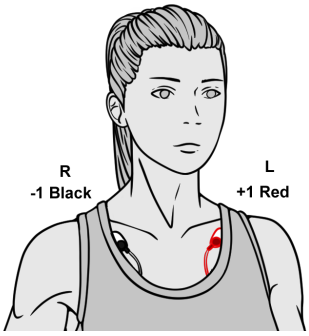
ECG Cable Setup

1. Locate the iWire-B3G ECG cable and electrode lead wires in the iWorx kit.
2. Insert the connector on the end of the iWire-B3G ECG cable into the iWire 1 input on the front of the IXTA.
3. Insert the black, red, green, brown and white connectors on the five color-coded electrode lead wires into the matching sockets on the ECG cable.
4. Instruct the subject to remove all jewelry from their neck, wrists and ankles.
5. Place the electrodes in the locations mentioned below.
6. Snap the lead wires onto the electrodes, so that:

- the red (+1) lead is attached to the left wrist or under the left clavicle,
- the black (-1) lead is connected to the right wrist or under the right clavicle,
- the green (ground) lead is connected to the right ankle.
- the white (+2) lead is attached to the left leg – mid calf,
- the brown (-2) lead is connected to the right forearm.







RECOMMENDED

Sample Lab

9. Instruct the subject to sit quietly with their hands in their lap. If the subject moves, the ECG trace will move off the top or bottom of the screen. If the subject moves any muscles in the arms or upper body, electromyograms (EMGs) from the muscles will appear on the ECG recording as noise.

Figure HH-4-S1: The iWire-B3G ECG cable connected to an IXTA.

iworx Sample

Experiment HH-4: The Six-Lead Electrocardiogram

Exercise 1: Six Lead ECG from Resting Subject

Aim: To record a Six Lead ECG from a resting subject and determine the QRS axis of the subject's heart.
Approximate Time: 15 minutes

Procedure

1. Click on the Record button.
2. Click on the AutoScale All button. Your recording should look like the figure below.
    - If the signal on the Lead I and the Lead II channels is upside down when compared to trace 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

Figure HH-4-L1: Six lead ECG generated by recording Leads I and II on Channels 1 and 2, respectively. The remaining limb leads are derived by computed functions.

Work Sample Lab

3. When you have a suitable trace, type **Resting ECG/Pulse** in the Mark box to the right of the Mark button. Click the mark button to attach the comment to the data. Record for at least 5 minutes.
4. Click Stop to halt recording.
5. Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

Data Analysis

1. Scroll through the recording and find a section of data with ten good ECG cycles in succession.
2. Use the Display Time icons to adjust the Display Time of the Main window to show the complete ECG cycles on the Main window.

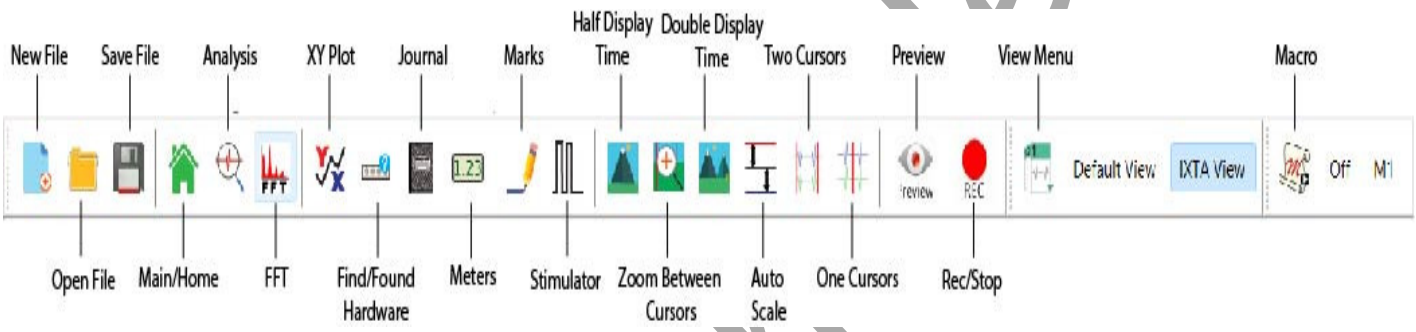


Figure HH-4-L2: The LabScribe toolbar.

3. Data can be collected from the Main window or the Analysis window. If you choose to use the Analysis window, click on the Analysis window icon in the toolbar.
4. The mathematical functions, V2-V1 and T2-T1 should appear on screen. Values for V2-V1 and T2-T1 on each channel are seen in the table across the top margin of each channel, or to the right of each graph.
5. Once the cursors are placed in the correct positions for determining the amplitudes of each wave in an ECG cycle, the values of the amplitudes 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.

IworX Sensing Lab

Figure HH-4-L3: Six lead ECG displayed on the Analysis window with cursors in position to measure the amplitude of the R wave.

6. Use the mouse to click on and drag the cursors to specific points on the ECG recording to measure the following (measure at least 5 ECG cycles):
    - The R-wave amplitude. To measure the R wave amplitude, place one cursor on the Q wave that precedes the R wave and the second cursor on the peak of the R wave. The value for V2-V1 on the ECG channel is this amplitude.
    - The P-wave amplitude. To measure the P wave amplitude, place one cursor on the baseline that precedes the P wave and the second cursor on the peak of the P wave. The value for V2-V1 on the ECG channel is this amplitude.
    - The T-wave amplitude. To measure the T wave amplitude, place one cursor on the baseline that precedes a P wave and the second cursor on the peak of the T wave that is in the same cycle as the P wave. The value for V2-V1 on the ECG channel is this amplitude.
8. Calculate the mean amplitudes of the P wave, the R wave, and the T wave for each ECG lead. Enter your results into the Journal and Table 1.

IWorx Sample

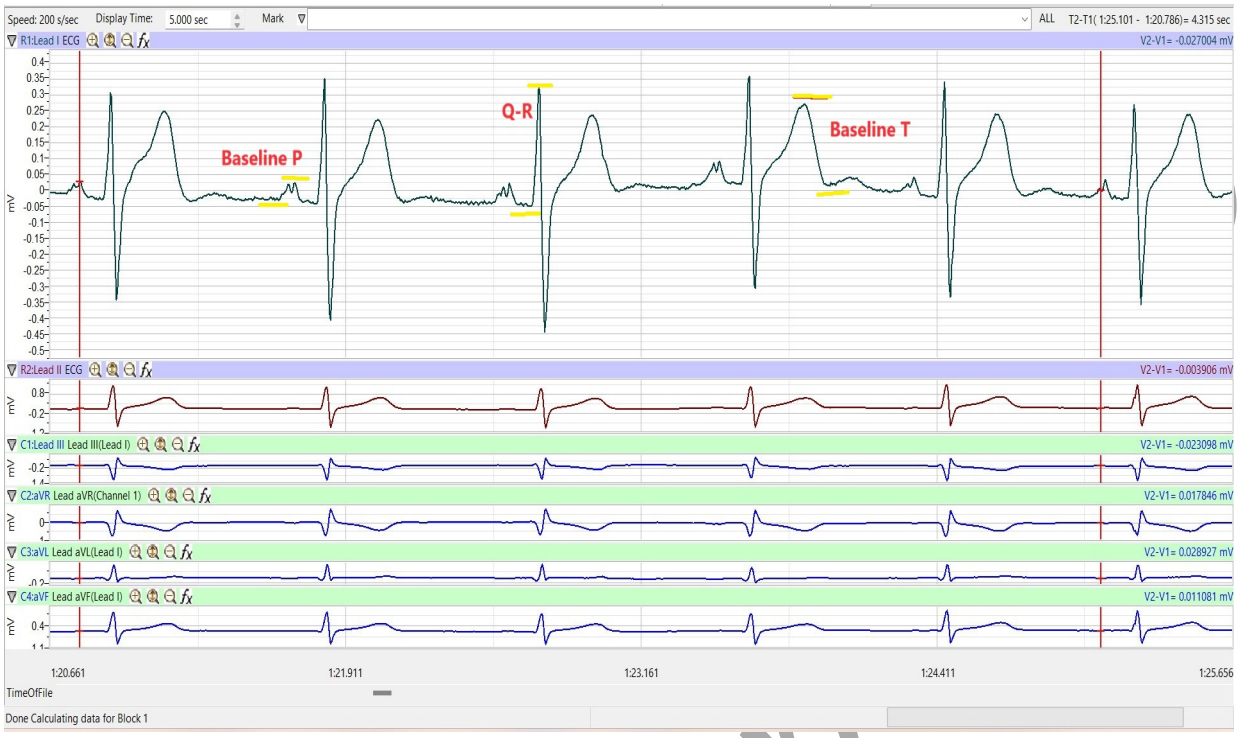


Figure HH-4-L4: ECG recording displayed in the Analysis window. Lines and labels were added to indicate the locations where cursors should be placed to measure the amplitudes of R (Q-R), P (Baseline-P), and T (Baseline-T) waves.

Table HH-4-L1: The Mean Amplitudes (in millivolts) for Each ECG Wave Recorded from Each Lead.

	Mean Amplitudes (mV)		
	P Wave	R Wave	T Wave
Lead I			
Lead II			
Lead III			
aVR			
aVL			
aVF			

Worx Samp

9. Determine the QRS axis of the subject:
    - Examine the ECG recordings from the six limb leads. Find the lead that creates an ECG where the magnitude of the R wave is equal to magnitude of the S wave, but the two waves go in opposite directions. This lead is known as the **isoelectric lead**. The isoelectric lead often has the smallest QRS.
    - Examine a diagram of Einthoven's Triangle in the Background section and the vector diagram below. Determine which two leads are close to being perpendicular to the isoelectric lead. The QRS axis of the heart is the perpendicular lead that best fits the direction of the other ECG leads.

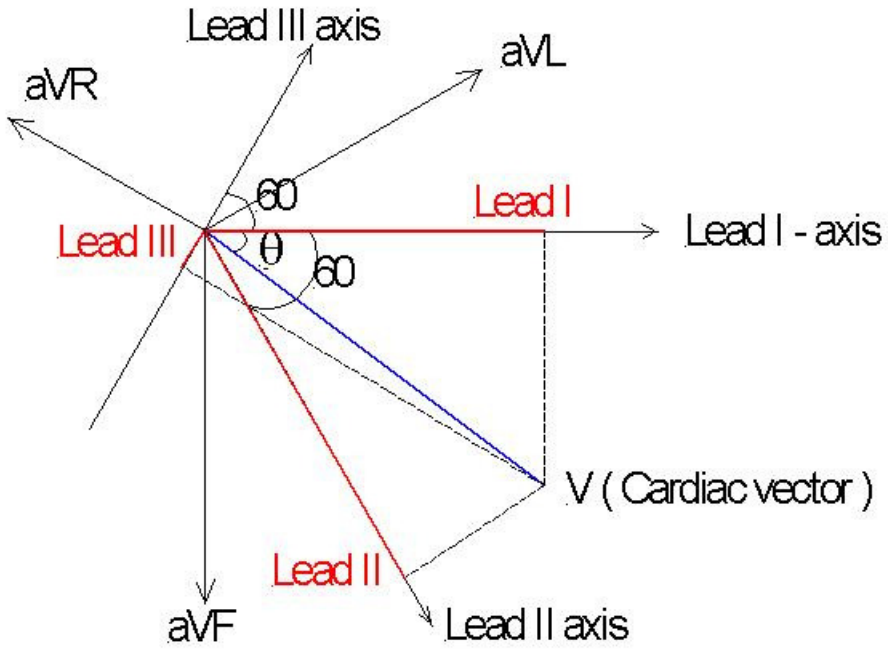


Figure HH-4-L5: Einthoven's Triangle showing vectors.

- If *none* of the leads are isoelectric, look for two of the leads that are close to being isoelectric. These two leads are always 30^{o} apart. Find the perpendiculars for each lead and choose an approximate QRS axis within the 30^{o} range. Occasionally each of the six coronal leads is small and/or isoelectric. The axis cannot be determined and is called indeterminate. This is a normal variant.

Iworx Sys Lab

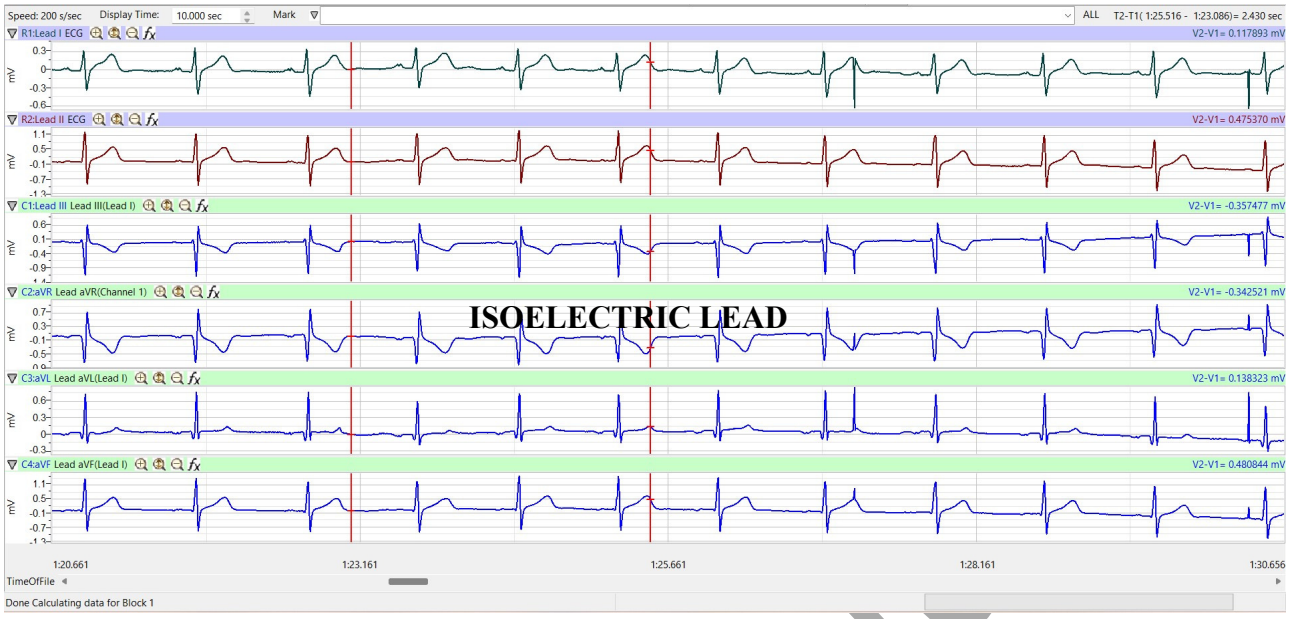


Figure HH-4-L5: ECG recording showing an isoelectric lead.

Questions

1. From which leads were upright R waves recorded? From which electrode (left arm, right arm, left leg, or right leg) and along which axis (-150, -30, 0, 60, 90, 120 degrees) were these leads "looking" at the depolarization of the ventricle? You may need to refer to the Background information to answer these questions.
2. From which leads were inverted R waves recorded? From which electrode (left arm, right arm, left leg, or right leg) and along which axis (-150, -30, 0, 60, 90, 120 degrees) were these leads looking at the depolarization of the ventricle?
3. Which lead is the isoelectric lead?
4. What is the QRS axis of the subject's heart? Is the QRS axis of your subject within the normal range of the QRS axis? Refer to your textbook to find the normal range.
5. Which ECG lead provided the largest R wave for the subject?
6. Which lead is closest to the QRS axis of the heart?

Exercise 2: Six Lead ECG from Other Subjects

Aim: Record or obtain Six Lead ECGs from other subjects and determine the QRS axes of their hearts.

Approximate Time: 15 minutes per subject

Procedure

Repeat Exercise 1 on another subject. Record a six lead ECG from as many subjects as possible.

Data Analysis

Use the same techniques used in Exercise 1 to analyze the data from other subjects.

IWorx Sample

Questions

1. Do the R waves from the same lead go in the same direction for all subjects? The P waves? The T waves?
2. What would cause an ECG wave from the same lead to go in the opposite directions in different subjects?
3. Do all subjects have the same QRS axis? What is the range of QRS axes from all the subjects in the class? Does the any subject have a QRS axis that is outside the normal range?
4. Does any subject have an inverted P or T wave on any lead when compared to the same lead from a normal ECG?

IworX Sample Lab