

Experiment BI-3: ECG Noise Identification and Conditioning

Equipment Required

PC or Mac Computer

IX-TA-220 data acquisition unit and power supply

USB cable

iWire-B3G ECG cable and electrode lead wires

Alcohol swabs

Disposable ECG electrodes

Note - Connect the iWire-B3G to the IXTA prior to turning it on.

ECG Cable Setup

1. Insert the connector on the end of the iWire-B3G ECG cable into the iWire 1 input on the front of the IXTA.
2. Insert the connectors on the red, black, and green electrode lead wires into the matching sockets on the ECG cable.
3. Instruct the subject to remove all jewelry from their wrists and ankles. Another option is to use the area just under each clavicle which will give a better recording.
4. Use an alcohol swab to clean and scrub a region with little or no hair, on the inside of the subject's right wrist/clavicle. Let the area dry.
5. Remove a disposable ECG electrode from its plastic shield, and apply the electrode to the scrubbed area on the wrist or under the clavicle.
6. Repeat Steps 5 and 6 for the inside of the left wrist/clavicle and the inside of the right ankle or lower right abdomen.
7. Snap the lead wires onto the electrodes, so that:
 - the red (+1) lead is attached to the left wrist or just under the left clavicle,
 - the black (-1) lead is connected to the right wrist or just under the right clavicle,
 - the green (C or ground) lead is connected to the right leg or on the abdomen.
8. 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.



Setting up LabScribe

The provided ECGNoise LabScribe setting file has been preset with the following settings. The instructions here are for your information and to help you modify other iWorx lab experiments to add the option for additional signal conditioning.

Open the Preferences dialog, by choosing Edit→Preferences from the Main Menu.

- **Channels Tab.**
 - Enable the Channels to be recorded and Label them. These channels will be used:
 - i1 2 (Raw ECG): This is the ECG measured by the iWire-B3G

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Exercise 1: The ECG and 60 Hz Noise

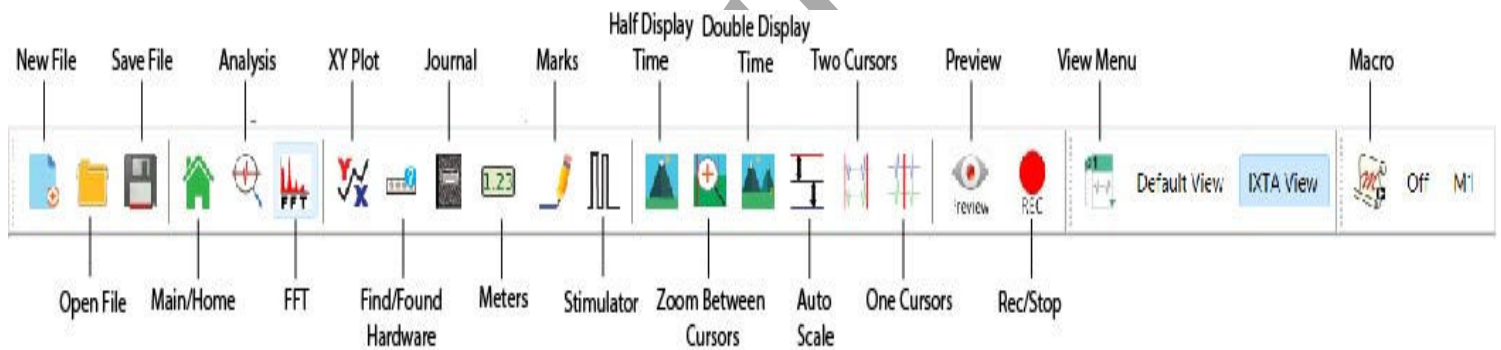
Aim: To record an ECG and identify the noise and use software filters.

Procedure

1. Introduce noise into the ECG signal, by spreading out the ECG leads. Keep the red and green cables (positive and ground) together. Separate the black cable (negative) from the red and green cables so environmental noise is picked up by the amplifier.
2. Click on the Record button, located on the upper right corner of the LabScribe Main window. 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.

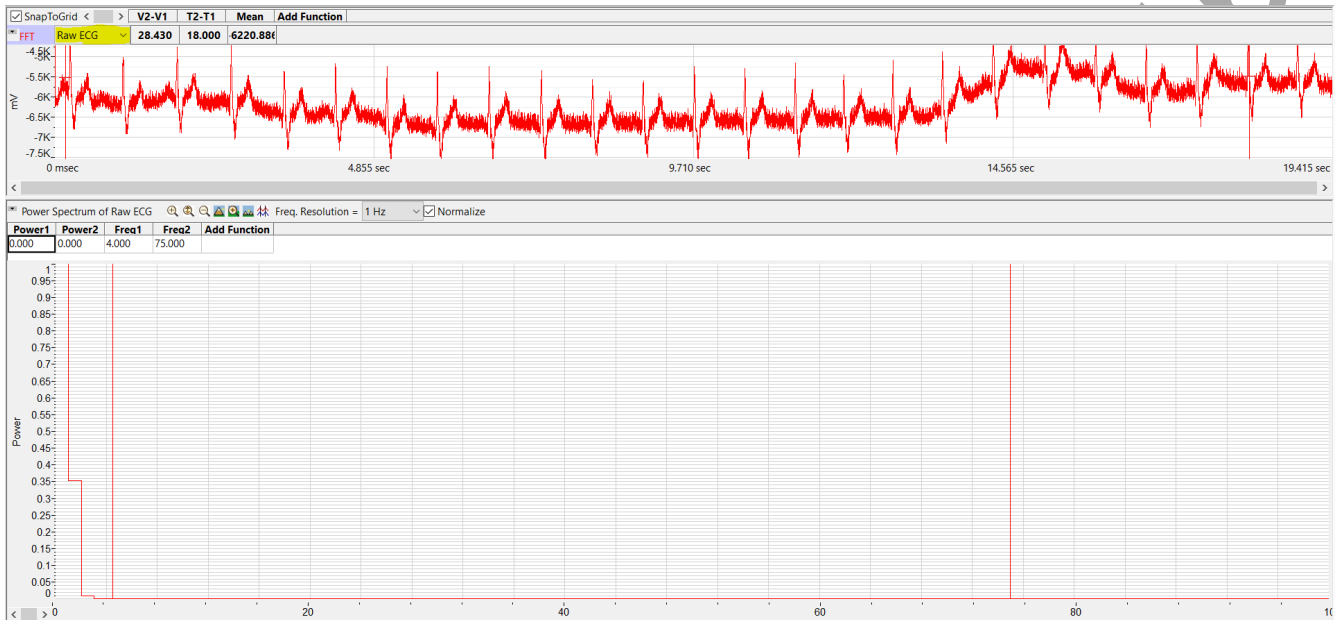
3. Click on the AutoScale All button on the LabScribe toolbar, to Autoscale all the channels.



4. Record for a minute or two.
5. Click Stop to halt the recording and click File → Save As to save your data file.
 - Channel A12: Raw ECG is the Raw ECG signal recorded by the iWire-B3G.
 - Channel S1: Stim 1 is the output of the Stimulator that is send to the breadboard
 - Channel A5: Filtered ECG is the Filtered output of the ECG signal, after signal conditioning on the Breadboard.
6. The signals on A12 and S1 are the same, and should be noisy.

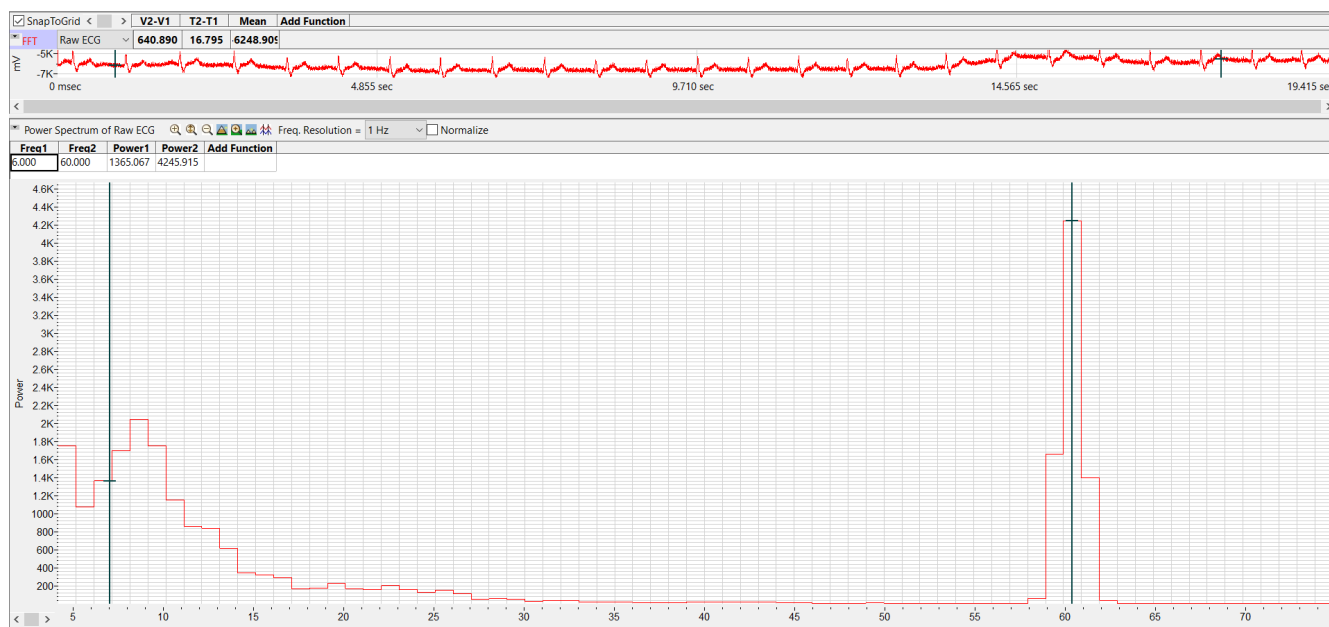
Identifying the frequency of the noise.

Click on the FFT icon  to switch to FFT window.



- Choose the Raw ECG channel (highlighted in the image above).
- Make sure you have enough data in the window, You may need to click on the double display time to increase the displayed data.
- Place the cursors in the Raw ECG channel to select the region to perform the FFT.
- Click the AutoScale All button above the FFT graph. You will then see the FFT of the selected signal in the bottom graph.
- The signal strength near DC is too high in this case to see the noise components.
- Place the Cursors in the FFT window around 4 Hz and around 75Hz, Then click on the Zoom Between Cursors icon above the FFT graph.
- The FFT graph will now show data between 4 Hz and 75 Hz.
- Click on the Autoscale All button for the FFT graph to autoscale the data.
- Place the second cursor on the peak, you will see that it is at 60Hz.

We have thus determined that the main source of our noise is at 60 Hz.



Software Filters for reducing the noise:

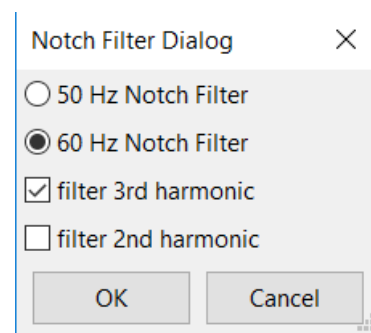
Option1: Notch Filter:

The notch filter can be used to remove 60Hz noise.

To create a channel with the notch filter.

- Click on the **fx** on the Raw ECG channel bar.
- Choose 60 Hz notch filter. You may select to filter out the harmonics as well.
- Click OK.

A notch filter channel is now created.

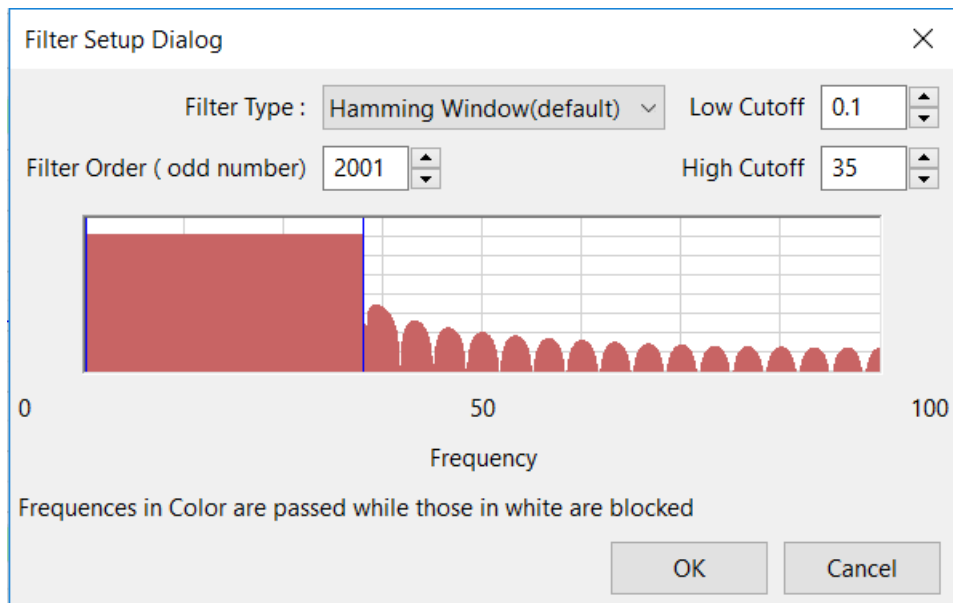


Option2: FIR Filter:

A FIR (finite impulse response) filter can be used to reduce the noise in the signal.

To create a channel with an FIR filter:

- Click on the Raw ECG channel bar.
- Set the Low and High cutoff. For human ECG, a low cutoff of 0.1Hz and a High Cutoff of 35Hz works well.
- Choose the filter type and the order of the filter.



Labscribe window with the 2 options is shown below.



Optional:

- Use the breadboard from the ECG filter lab to use a hardware filter.
- Change the sampling speed to see how the signal gets affected.
- Change the FIR filter, see how the various parameters affect the signal.