

Experiment BI-1: ECG Signal 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

C-DIN-BB: Din to Breadboard cable

C-BNC-BB: BNC to Breadboard cable

A-BREADBOARD: Breadboard.

Alcohol swabs

Disposable ECG electrodes

Start the Software

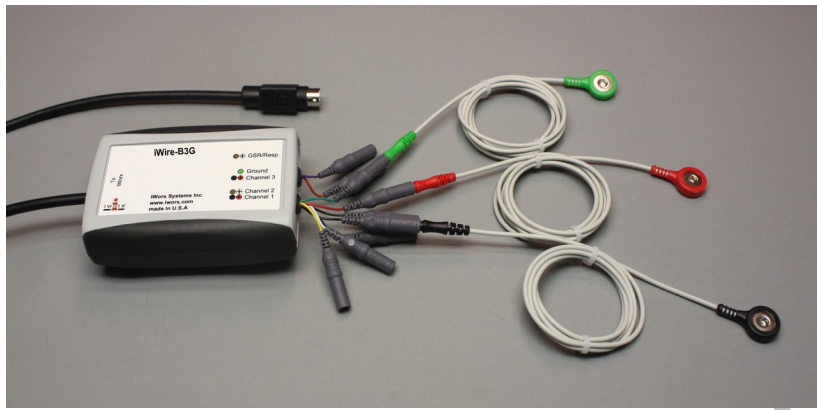
1. Click on LabScribe
2. Click Settings → BioInstrumentation → ECGFilter
3. Once the settings file has been loaded, click the **Experiment** button on the toolbar to open any of the following documents:
 1. Appendix
 2. Background
 3. Labs
 4. Setup (opens automatically)

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.

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

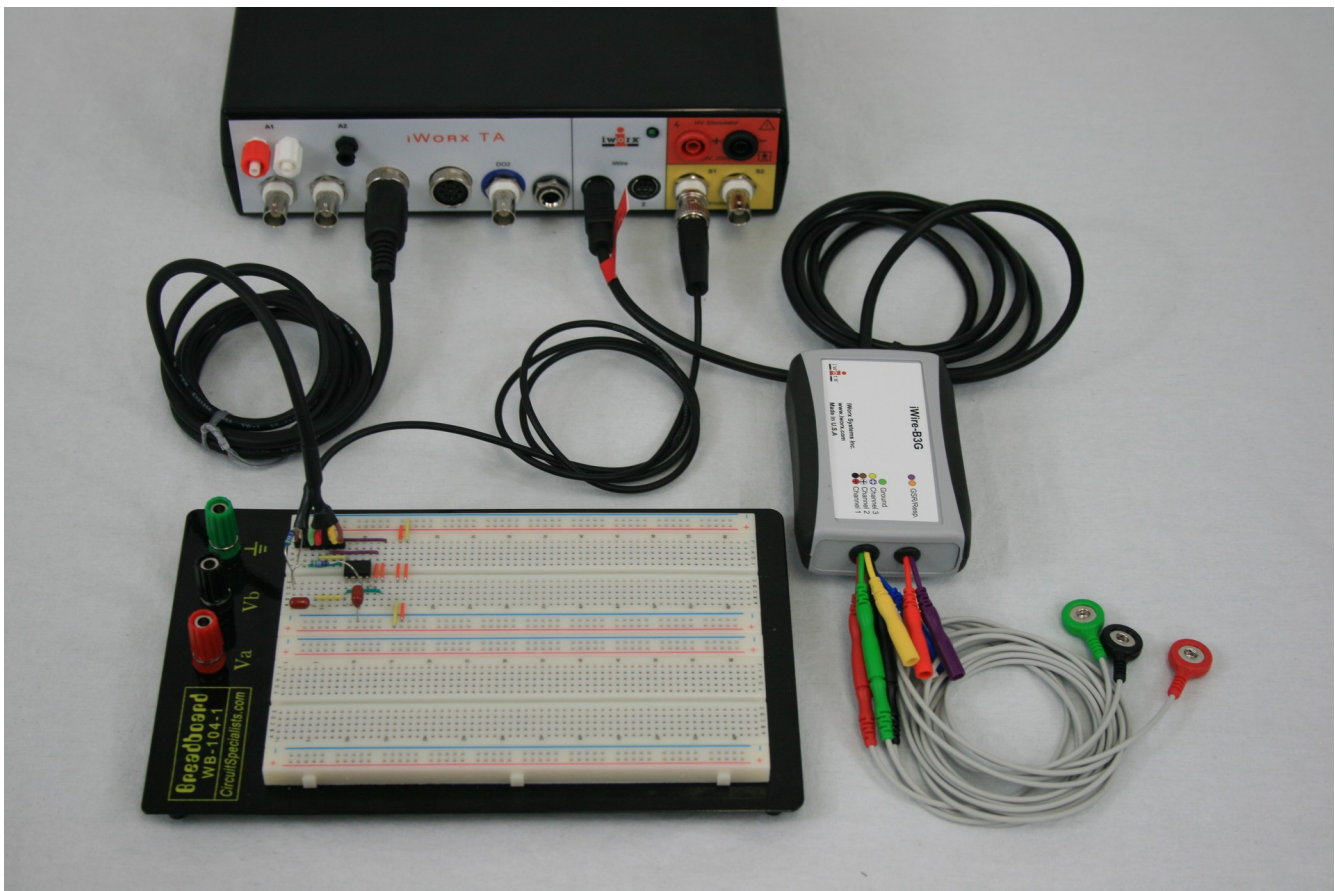
2. Insert the connectors on the red, black, and green electrode lead wires into the matching sockets on the ECG cable.
3. Instruct the subject to remove all jewelry from their wrists and ankles. Another option is to use the area just under each clavicle which will give a better recording.
4. Use an alcohol 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.

Breadboard Setup

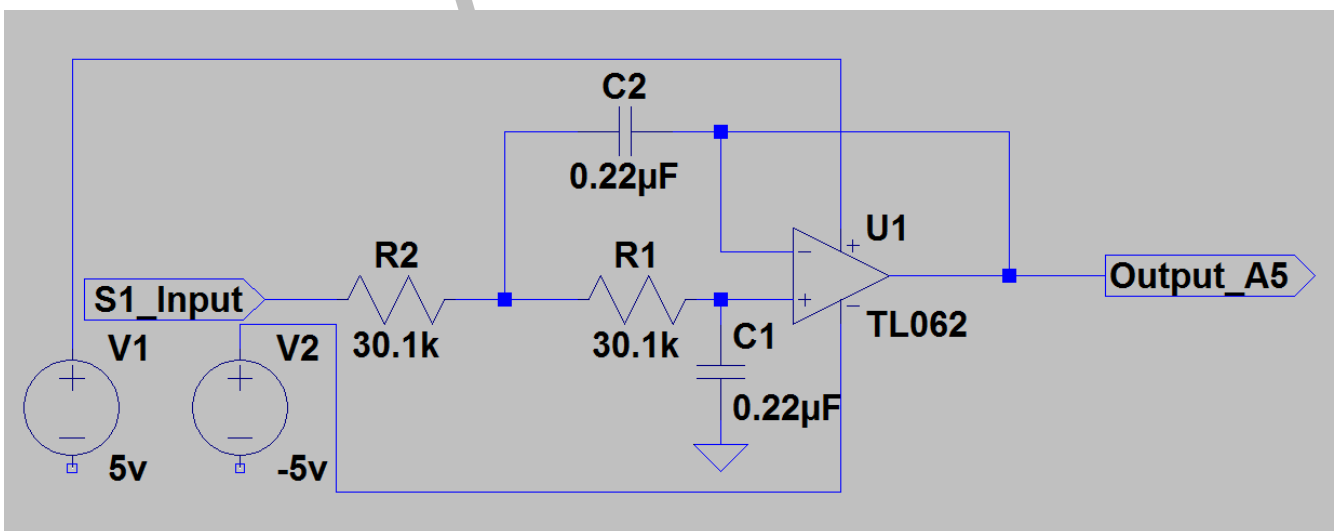
1. Insert the BNC connector on the end of the C-BNC-BB cable into the S1 stimulator port of the IX-TA-220
2. Connect the other end of the C-BNC-BB cable to the breadboard.
3. Insert the DIN8 connector of the C-DIN-BB cable into the A5 port of the IX-TA-220.
4. Connect the other end of the C-DIN-BB cable to the breadboard.



Design the Filter Circuit

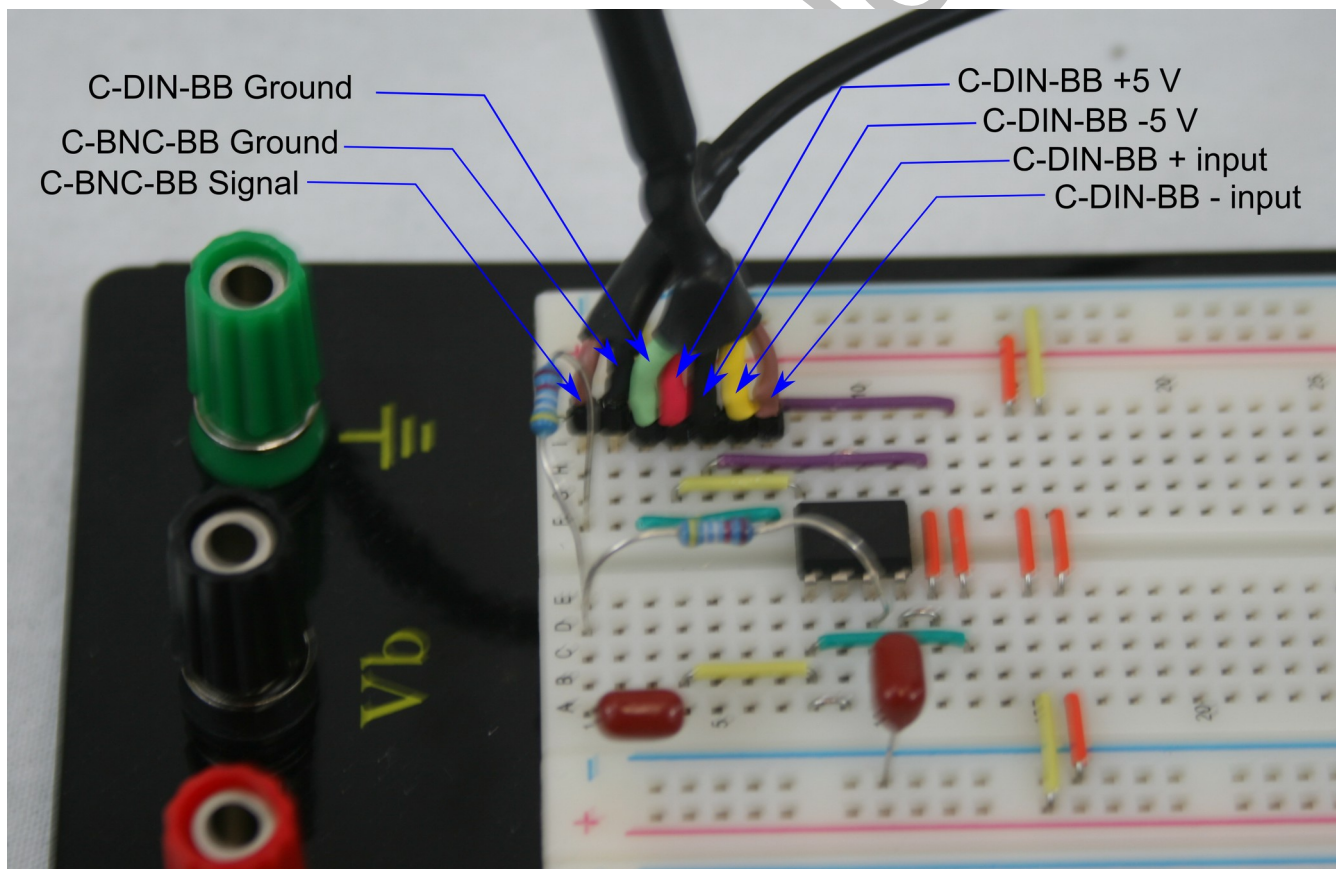
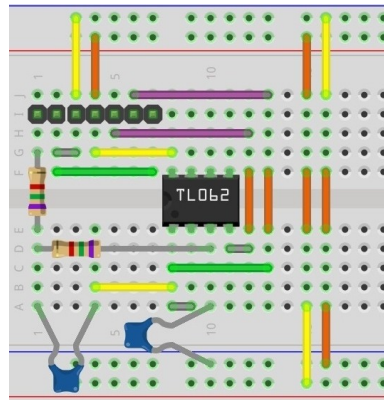
Here is an example of a filter circuit for a 2 pole low pass filter.

Circuit



The Filter is a Sallen Key 2-pole low pass filter. Its job is to remove 60Hz electrical noise picked up from fluorescent lights, computers and AC power lines.

It is implemented here on the breadboard.



Setting up LabScribe

The provided ECGFilter 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:
 - A5 (Filtered ECG): This is the output of the Filter
 - i1 2 (Raw ECG): This is the ECG measured by the iWire-B3G
 - S1 (Stimulator): This is what the Stimulator is outputting, which is same as the Raw ECG Channel. You do not have to enable this channel.

Preferences Dialog

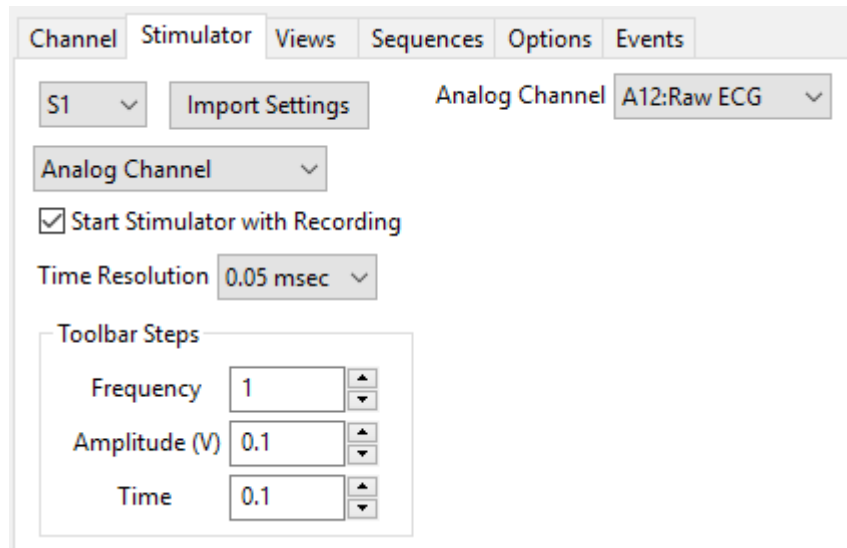
Channel | Stimulator | Views | Sequences | Options | Events

Acquisition Mode: Chart | Start: User | Stop: User | Speed: 1000 Samples/Sec | Display Time: 12.184000 sec

	Title	Mode/Function	Y Max	Y Min	Add Function	Units	Color
<input type="checkbox"/>	A1 Raw Ch 1	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	A2 Raw Ch 2	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	A3 Raw Ch 3	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	A4 Raw Ch 4	Off	5.000000	-5.000000	Add Function	Units	
<input checked="" type="checkbox"/>	A5 Filtered ECG	DIN8	0.334837	-0.202036	Add Function	Units	
<input type="checkbox"/>	A6 Raw Ch 6	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	DO2 DO2	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	A8 Raw Ch 8	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	EM1 EM1	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	EM2 EM2	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	i1 1 i1 1	Off	5844.3311	-1897.861	Add Function	Units	
<input checked="" type="checkbox"/>	i1 2 Raw ECG	DC-10kHz 50mV	-0.962093	-2.382150	Add Function	Units	
<input type="checkbox"/>	i1 3 i1 3	Off	1.944953	-1.486055	Add Function	Units	
<input type="checkbox"/>	i1 4 i1 4	Off	0.380391	-0.202361	Add Function	Units	
<input type="checkbox"/>	SpO2 SpO2	Off	5.000000	-5.000000	Add Function	Units	
<input type="checkbox"/>	HR HR	Off	5.000000	-5.000000	Add Function	Units	
<input checked="" type="checkbox"/>	S1 Stim 1	Record	0.628298	-0.461561	Add Function	Units	
<input type="checkbox"/>	S2 S2	Off	5.000000	-5.000000	Add Function	Units	

OK Cancel

- **Stimulator Tab**
 - Choose S1 stimulator
 - Set the mode to Analog Channel
 - Choose A12: Raw ECG as the analog channel to be send to the Stimulator output
 - Enable Start Stimulator with Recording.



Exercise 1: The ECG and LowPass filter

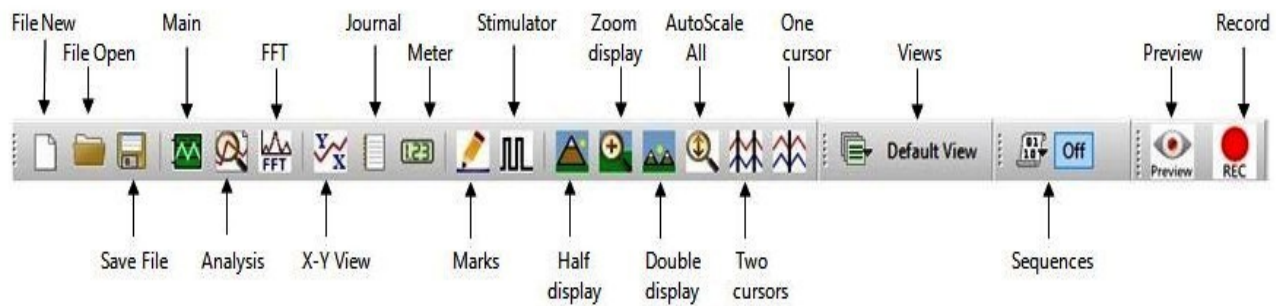
Aim: To record an ECG and low pass filter the signal to reduce 60 Hz noise.

Procedure

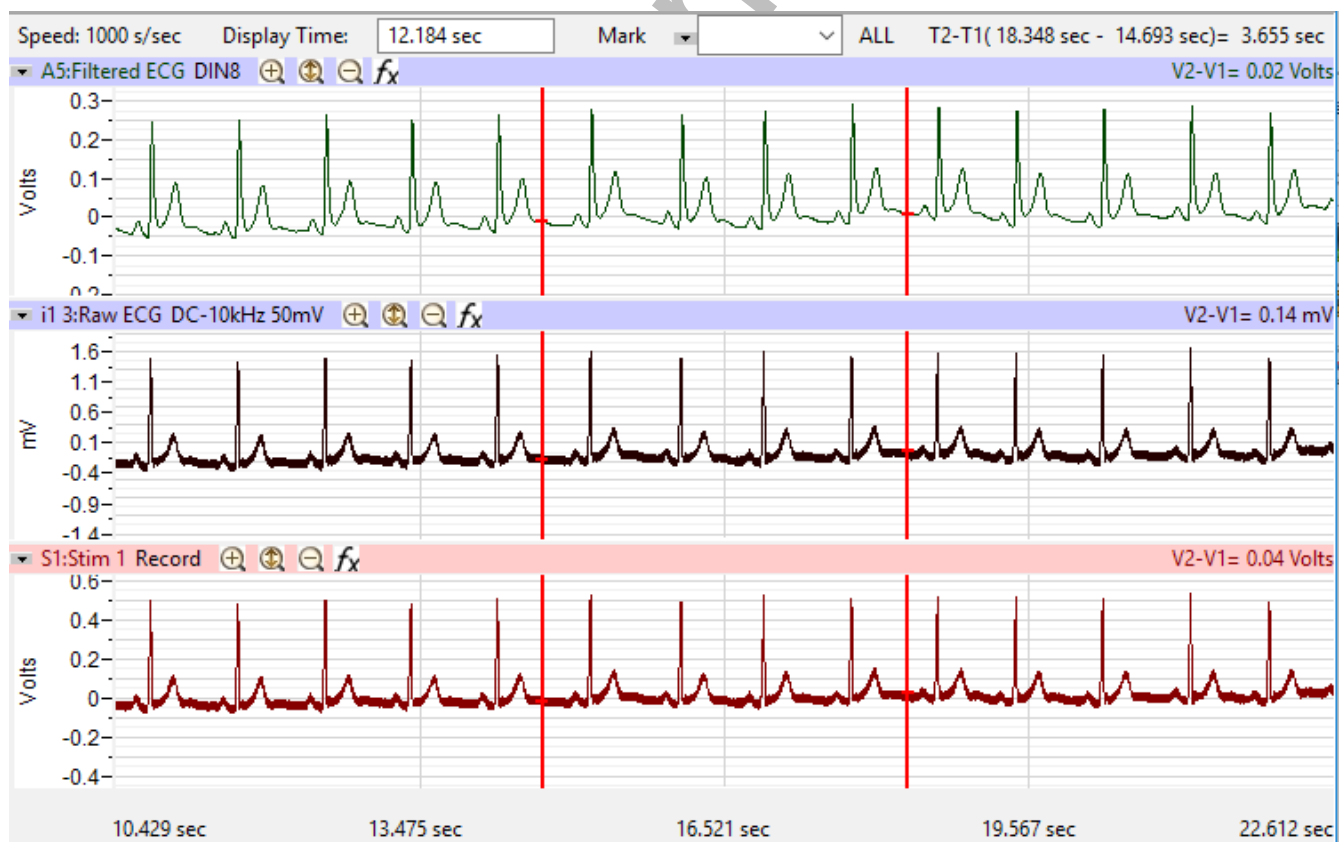
1. Click on the Record button, located on the upper right side of the LabScribe Main window. The signal should begin scrolling across the screen.

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.

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



3. Record for a minute or two.
4. 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.
5. The signals on A12 and S1 are the same, and have some 60Hz noise.
6. The Filtered Signal is recorded on Channel A5. The 60 Hz noise has been filtered out with the 2 pole low pass filter, as set according to the Setup PDF document.



Optional Exercises: The ECG and Signal Conditioning.

Extend the first exercise to test other signal conditioning that can be performed on the ECG signal.

For example:

- 1) What happens if you use a 4 pole filter instead of a 2 pole filter?
- 2) What happens if you use a different topology for the filter?
- 3) What happens if you use a high pass filter?
- 4) What happens if you use a band pass filter?
- 5) What filter cutoffs are best at reducing the noise but still maintain the signal?