Notes on Lab 2

Chris Winstead

Utah State University

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About this Lab

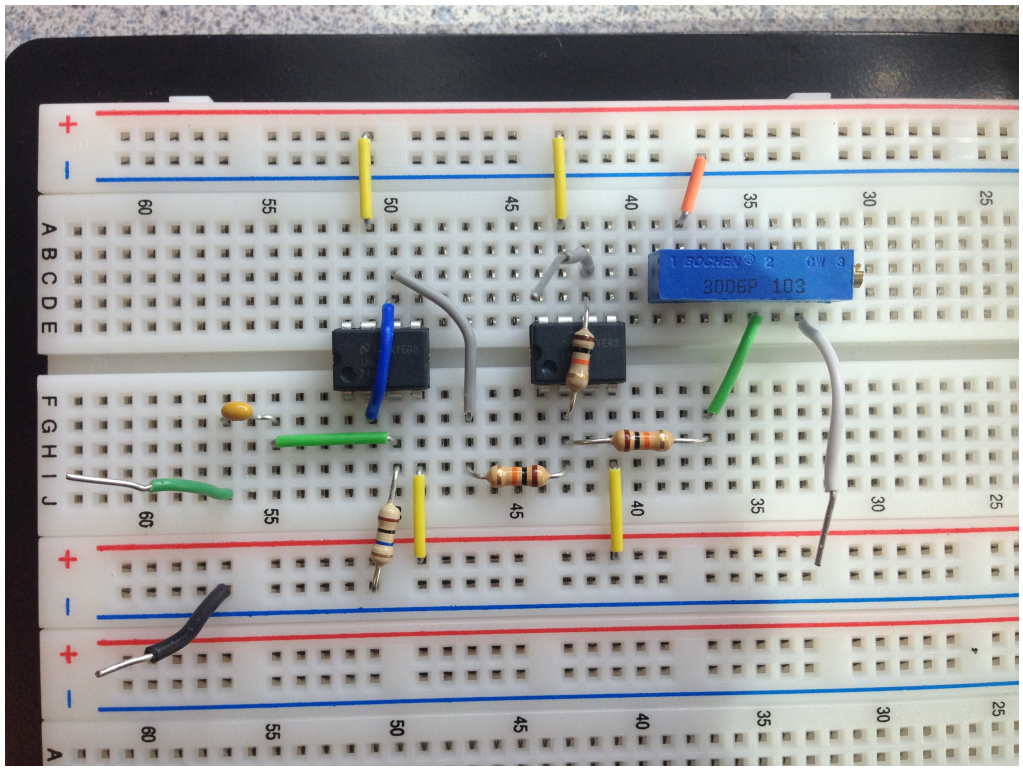
This lab explores superposition in inverting op amp configurations, and demonstrates the separation of AC and DC signals.

You will explore the following topics:

- A weighted summer comprised of two superimposed inverting configurations.
- Capacitive coupling for replacing a signal's DC component.
- Side-effects due to input resistance of amplifier configurations.
- Synchronizing the oscilloscope with the function generator.
- Voltage-follower and multi-stage configurations.

Preparing Your Circuits

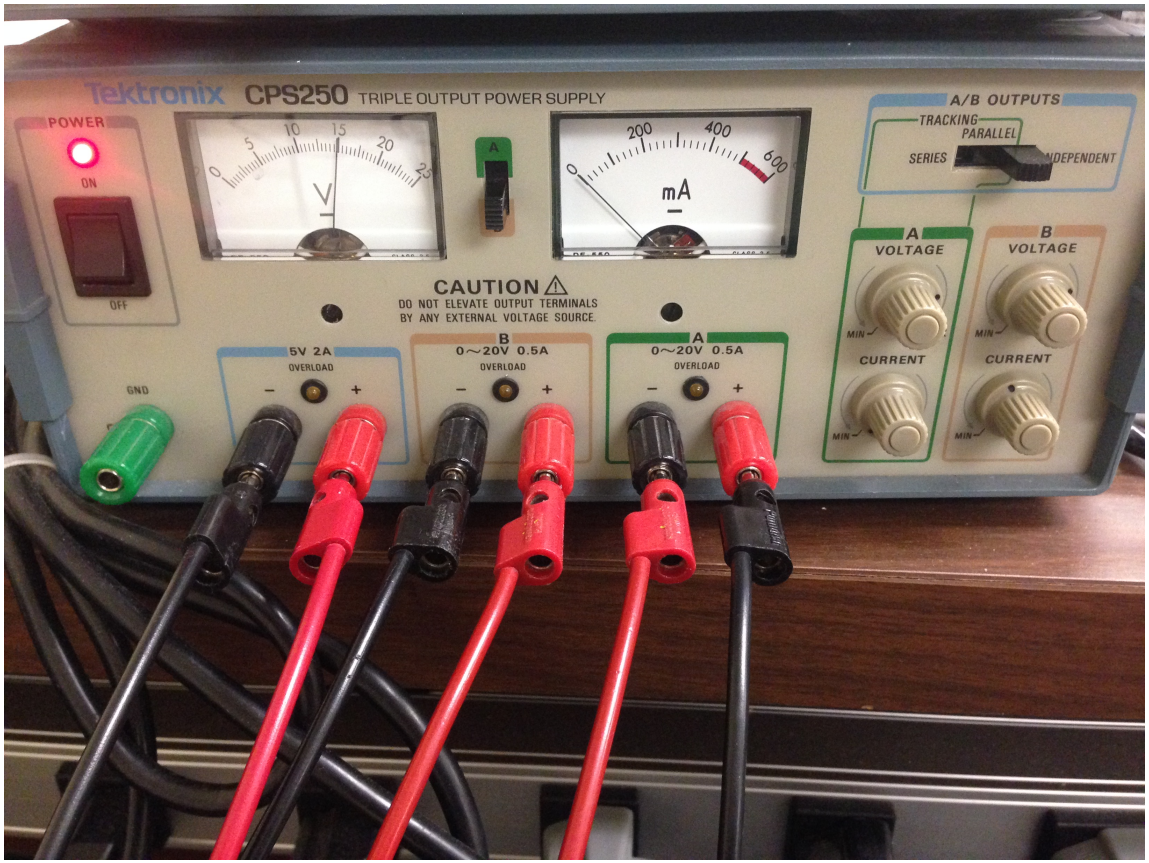
When constructing your circuit, use an organized breadboard layout. Avoid using long wires. This will improve the circuit's quality and make it easier to troubleshoot. You may find the best experience if you construct your circuits before coming to the lab. Here I've pre-assembled connections for all of the planned experiments:



Note: The resistor connections in this circuit are not necessarily the ones you will use in your lab. Follow your prelab results.

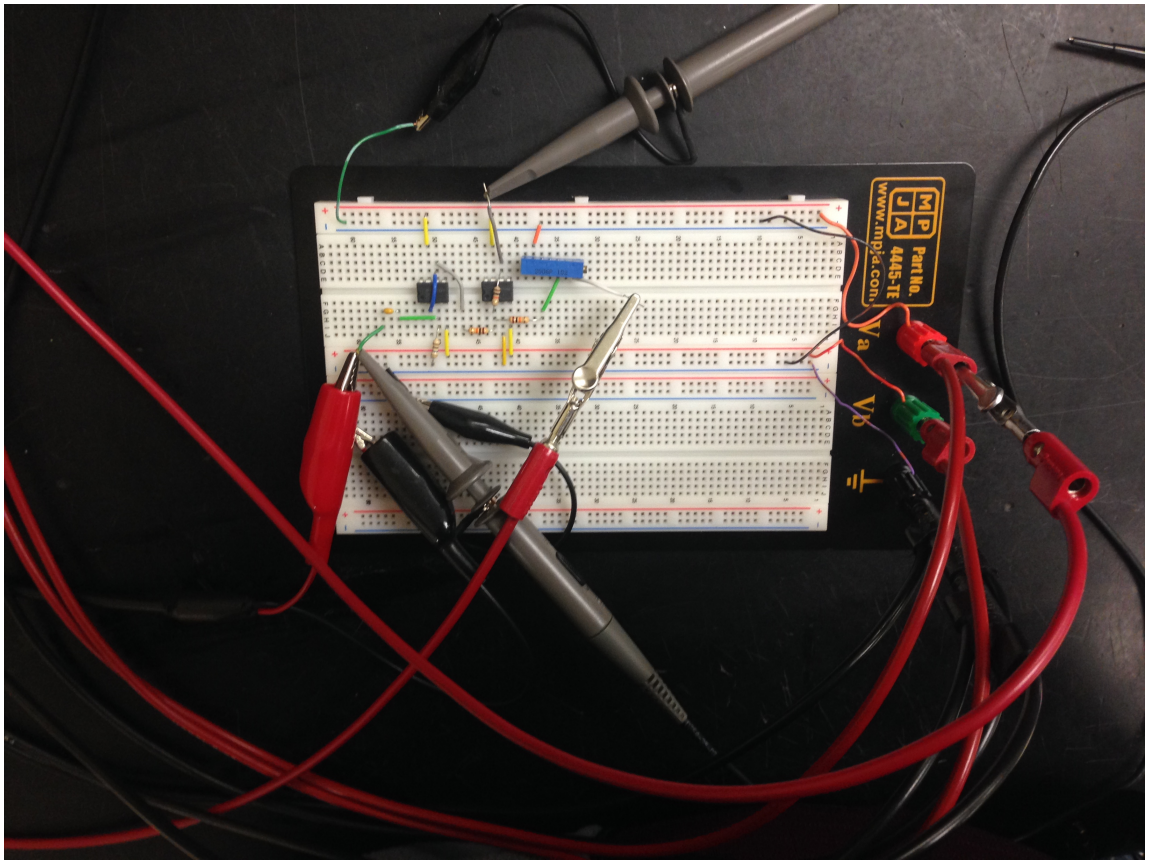
Connecting the Power Supply

In this circuit you will use all three outputs from the power supply. Use the A and B outputs for the op amp's power supplies. Connect them with opposite polarity as shown below. The remaining output is used to provide a fixed 5V reference.



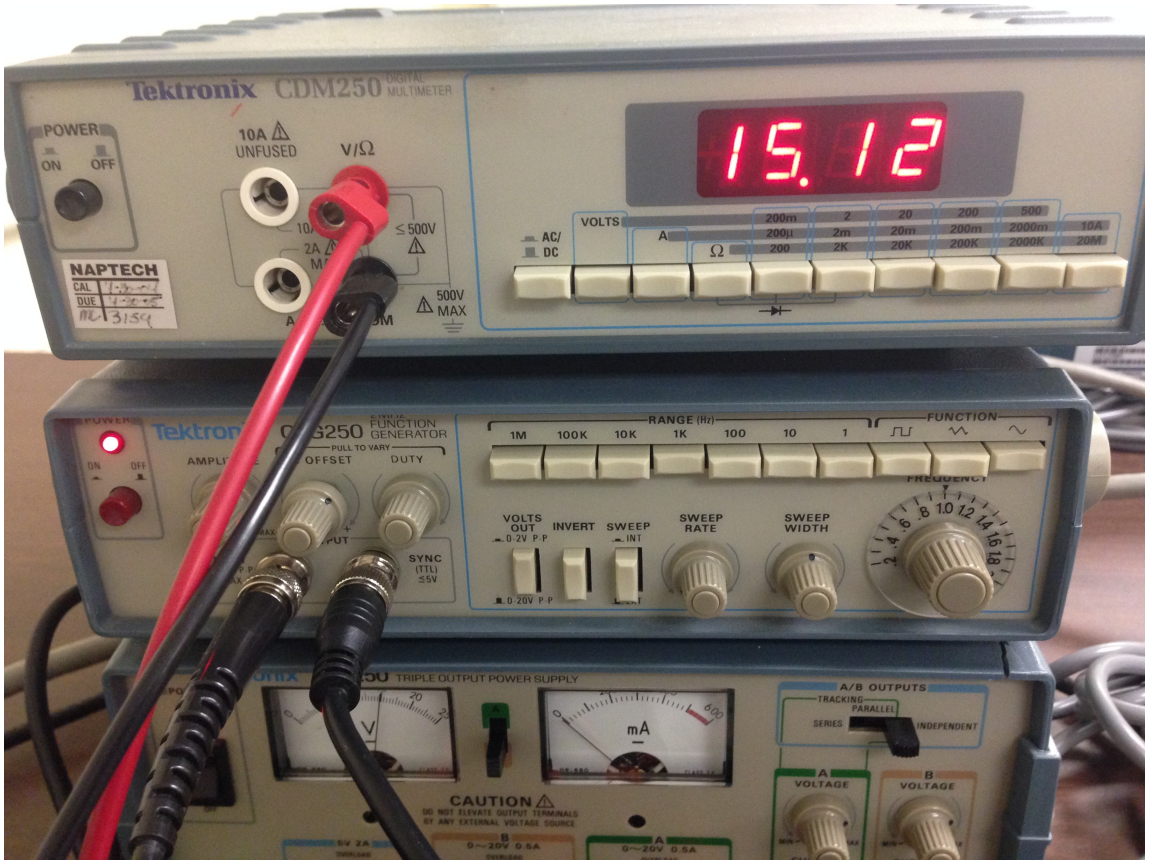
Connecting your Circuit

Be careful to use the correct polarity in your circuit connections. Try not to jumble your connections together. You want a clear view of all connections (and you don't want any of the connectors touching, which could create short circuits):



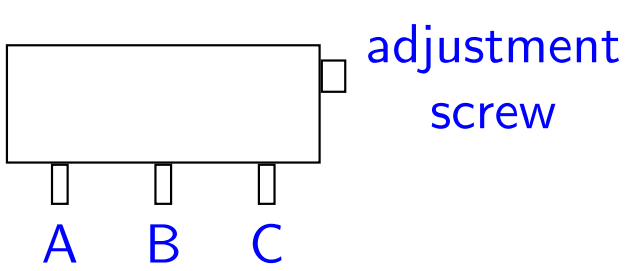
Verify the Power Rails

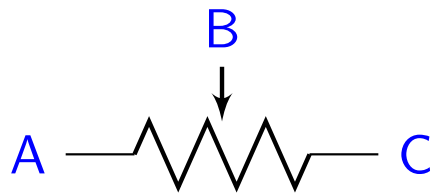
It is a good idea to measure your power signals to confirm that you have the intended voltage at each of your circuit's power nodes.



Adjusting the Potentiometer

In your circuits, one of the voltage inputs is supplied by a potentiometer, which allows you to adjust the DC offset appearing on the output signal. They come in a variety packages, but the one shown below is typical.

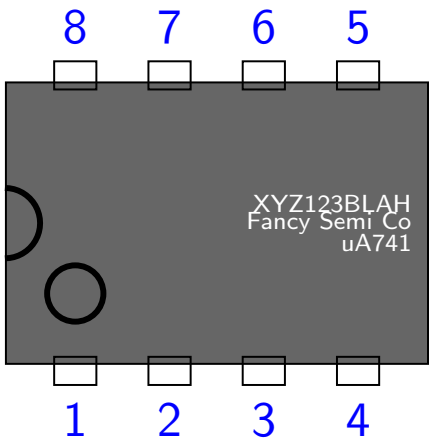




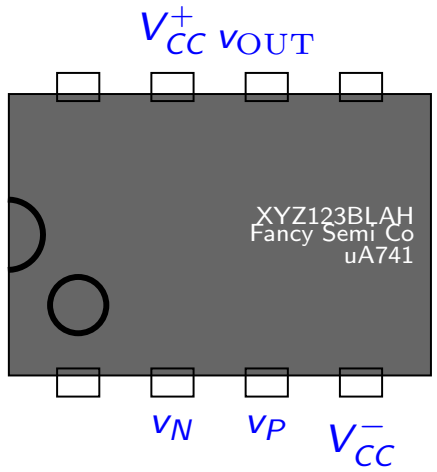
It will be best to keep the potentiometer output connected to the DMM so that you can monitor its value while making adjustments.

The 741 Op Amp

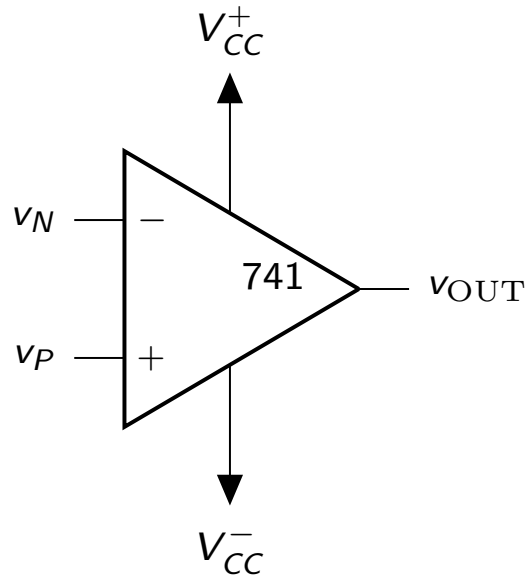
The 741 chip and its connections are shown below. We are not using some of the pins; leave them disconnected (refer to the product datasheet for more information about those pins). In our circuit, the positive rail is $V_{CC}^{+} = 15\,\text{V}$ and the negative rail is $V_{CC}^{-} = -15\,\text{V}$.



Pin Numbers



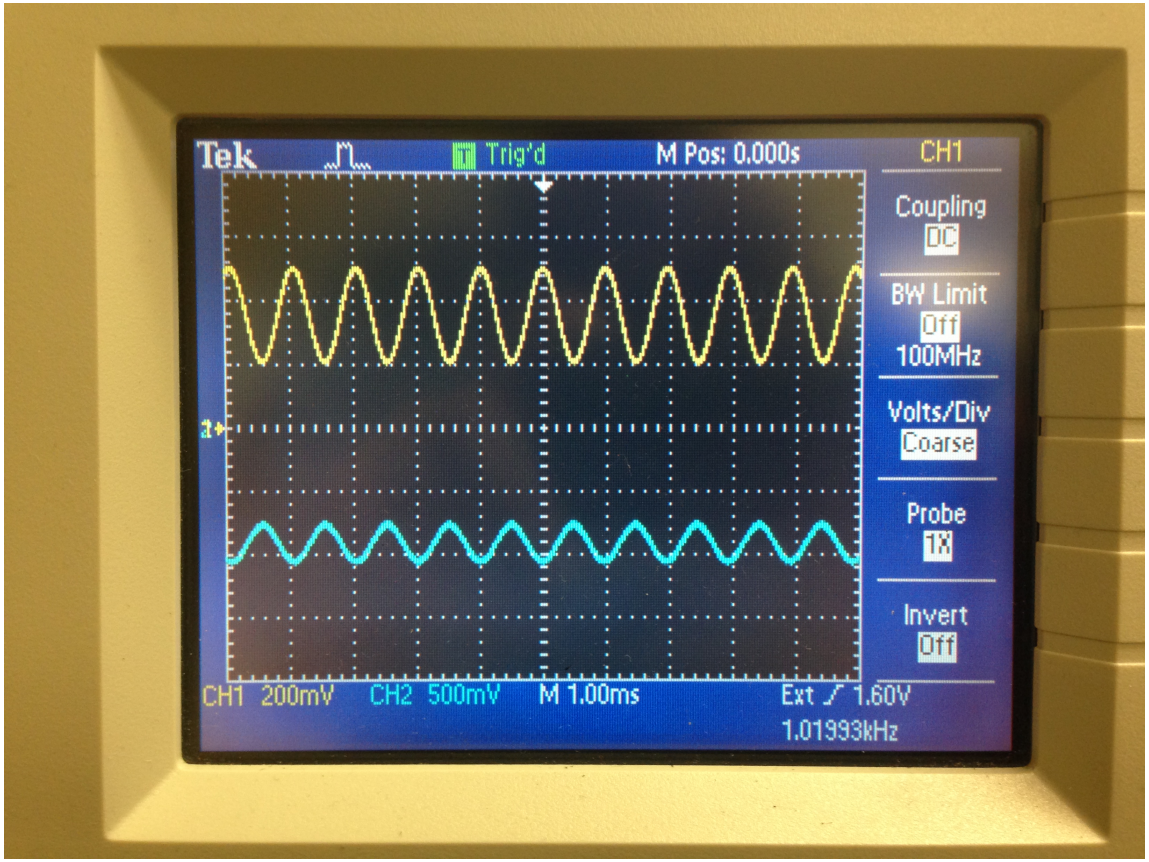
Electrical Connections



Schematic

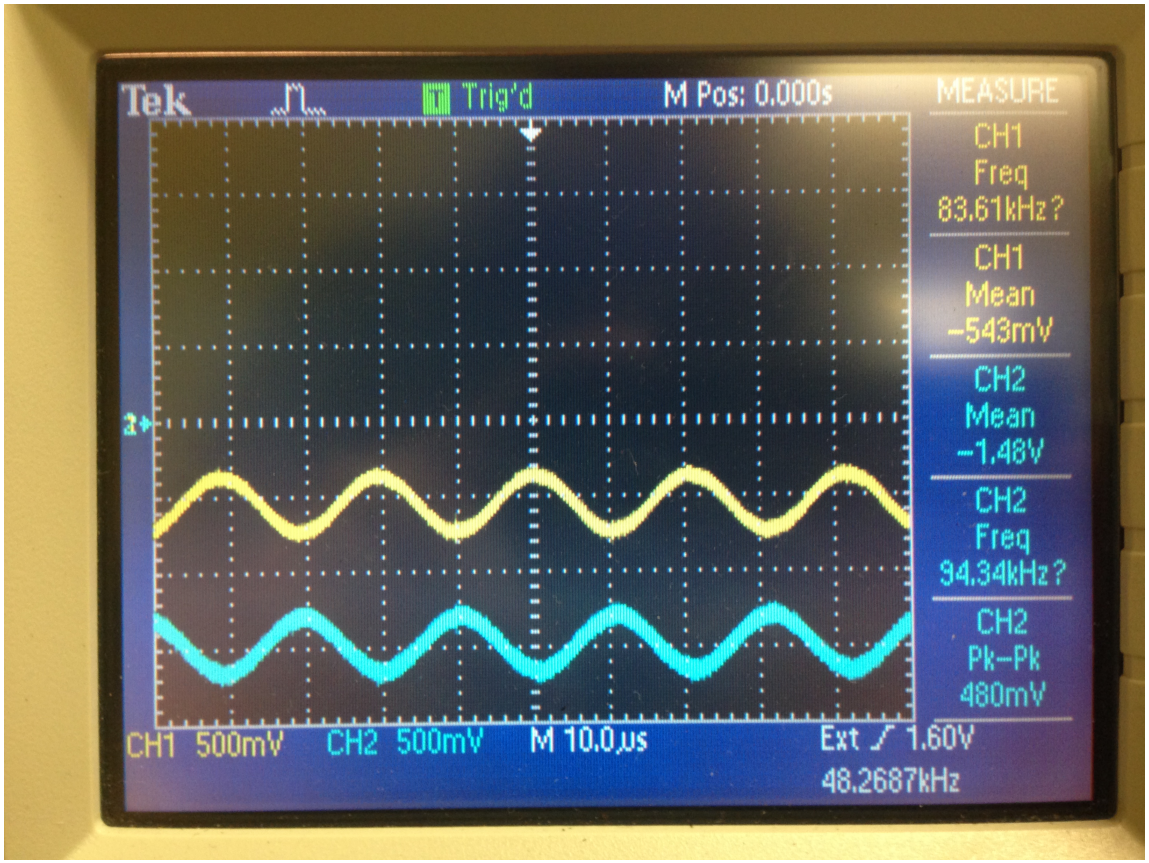
Observing DC Offsets

You will perform several experiments to observe and modify the DC offsets of your input and output signals. Make sure the oscilloscope channels are configured for DC coupling, and use the Measure menu to precisely measure the offsets.



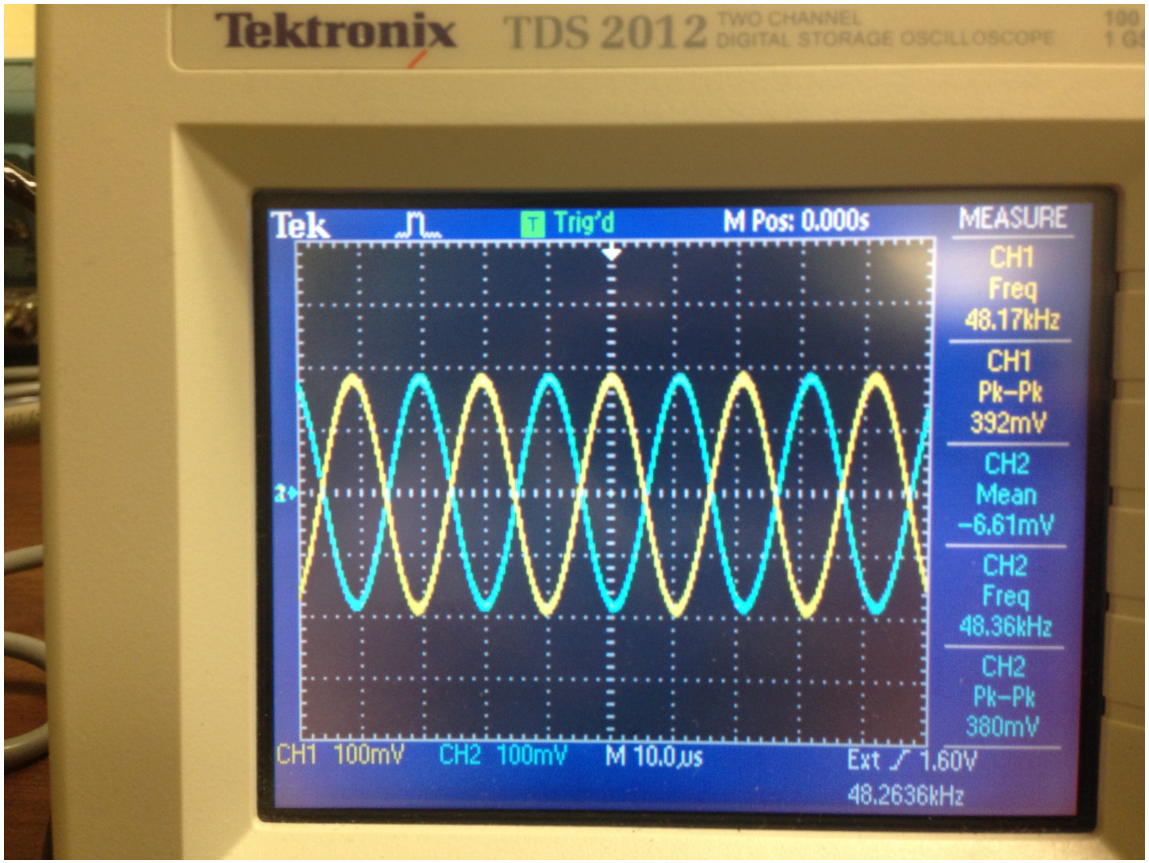
Measuring DC Offsets

You should use the `Mean` measurement for each channel in the `Measure` menu. For a sinusoid, the mean is equal to the DC offset.



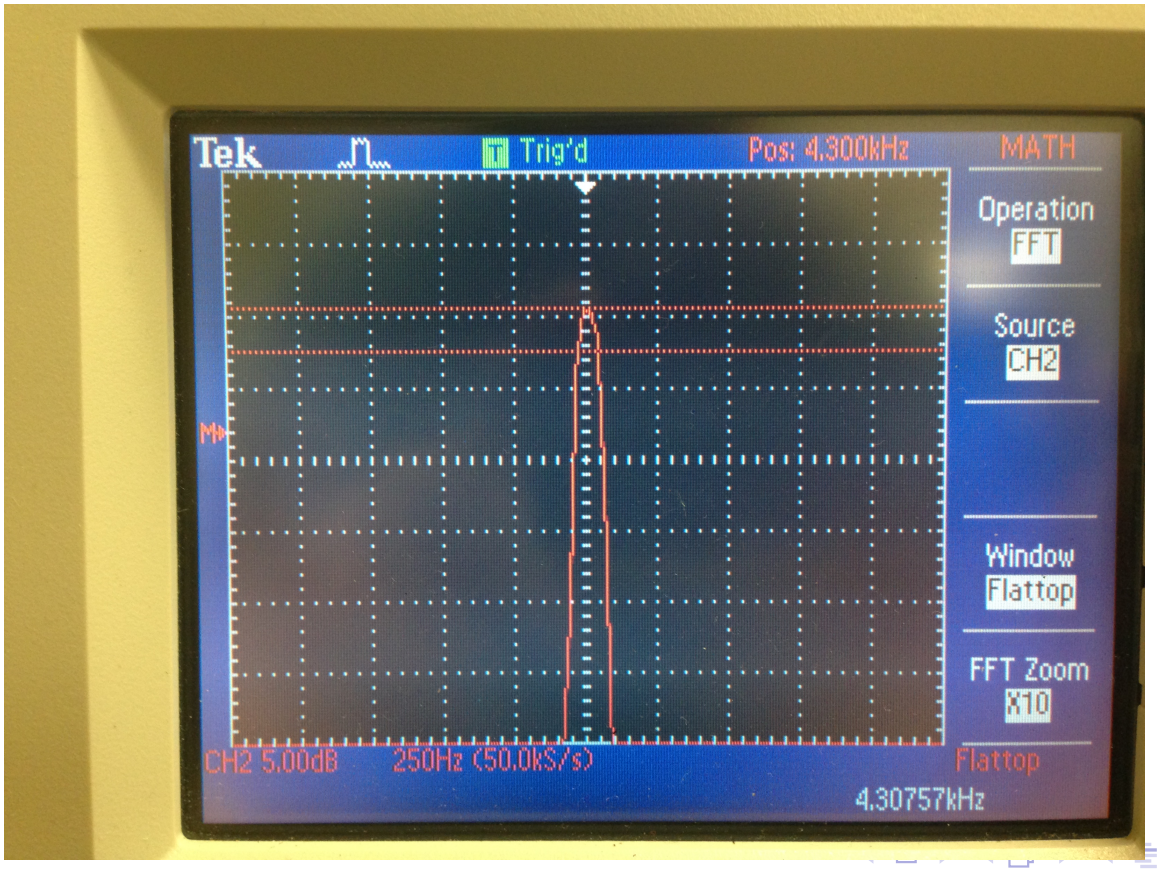
Measuring Amplitudes

To precisely measure the signals' amplitudes, you might find it helpful to switch the channel settings to AC coupling, then use the `Pk-Pk` setting for each channel in the `Measure` menu.



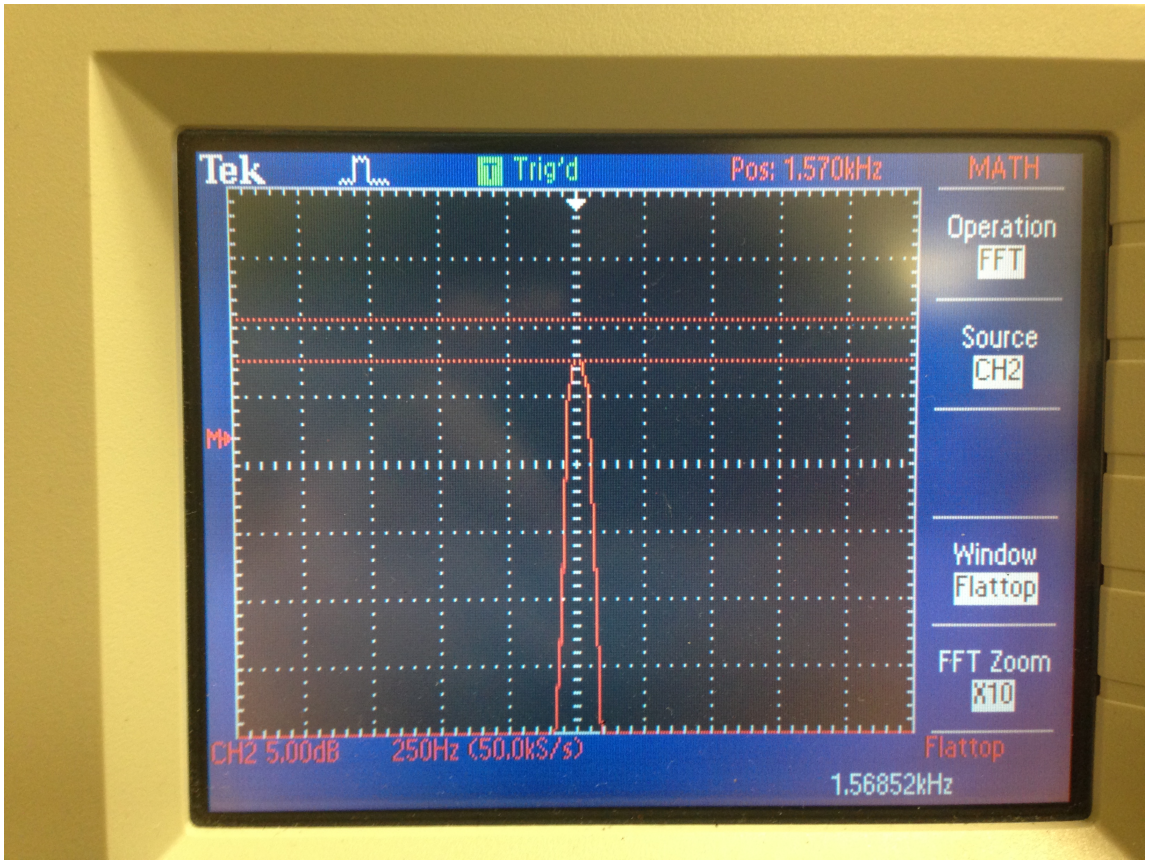
Frequency Measurements: Mid-Band

Two of your circuits will have both low-pass and high-pass characteristics. The mid-band is the range of frequencies for which the transfer function has maximum magnitude. When measuring cutoff frequencies, you should first locate the mid-band magnitude on the FFT display. Use the CURSOR to precisely measure the magnitude, and make sure you record the observed magnitude in your lab book.



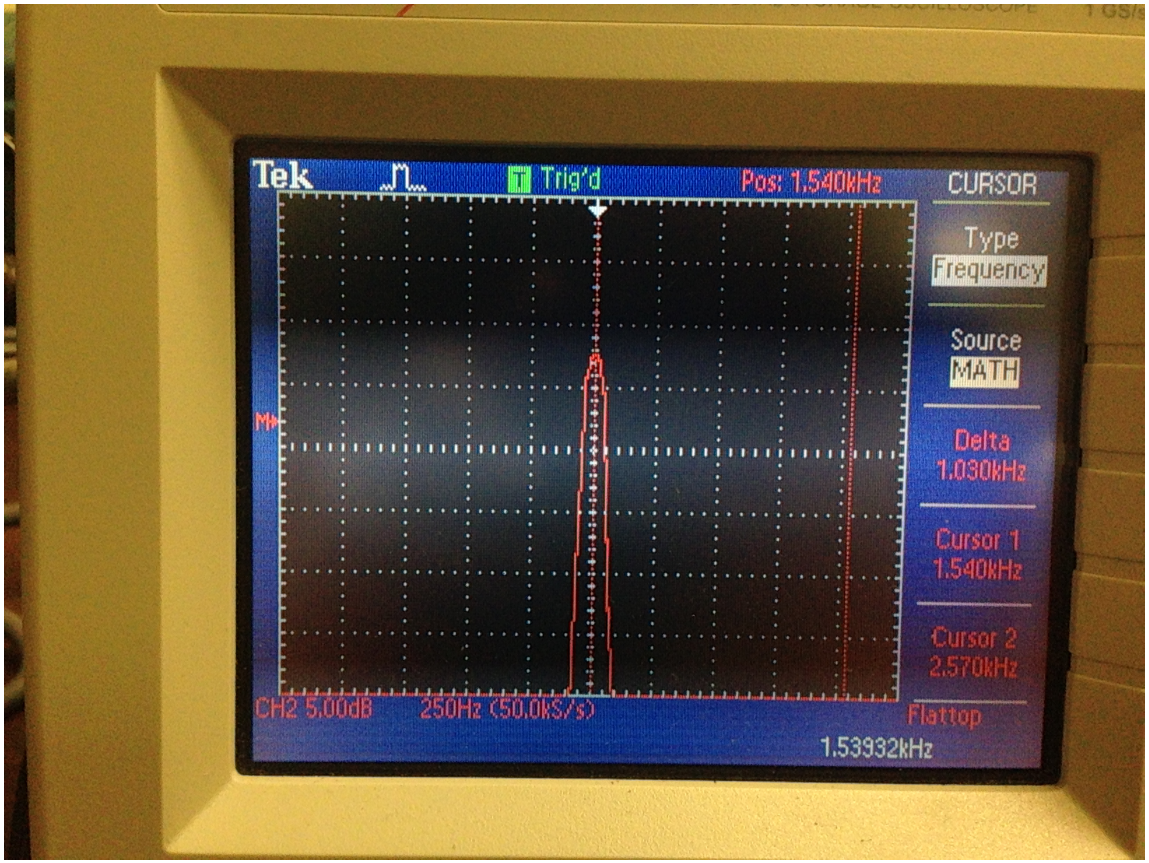
Frequency Measurements: -3dB

As in Lab 1, you will adjust the frequency on the function generator to locate the -3dB frequencies. To do this, position the second cursor 3dB below the mid-band magnitude. In this lab, you will find both low and high cutoff frequencies. I recommend using the FFT Zoom feature to precisely locate the -3dB point.



Precise Frequency Measurements

Once you have found the 3dB point, switch the cursor type to frequency in order to obtain a precise measurement.



Comparing Experiment and Simulation

In your SPICE simulations, you evaluated several specific cases. In your measurements, try and match those cases so you can make direct comparisons. If possible, plot your measured data together with the simulation results. These comparisons would be good to include in your report.

That's All

Repeat the procedures described in this lab to complete the assignment. When you are finished, ask the TA to sign off your work and record your score.