Notes on Lab 4: Differential Amplifiers Experimental Procedures

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Fall 2014

About the Experiments

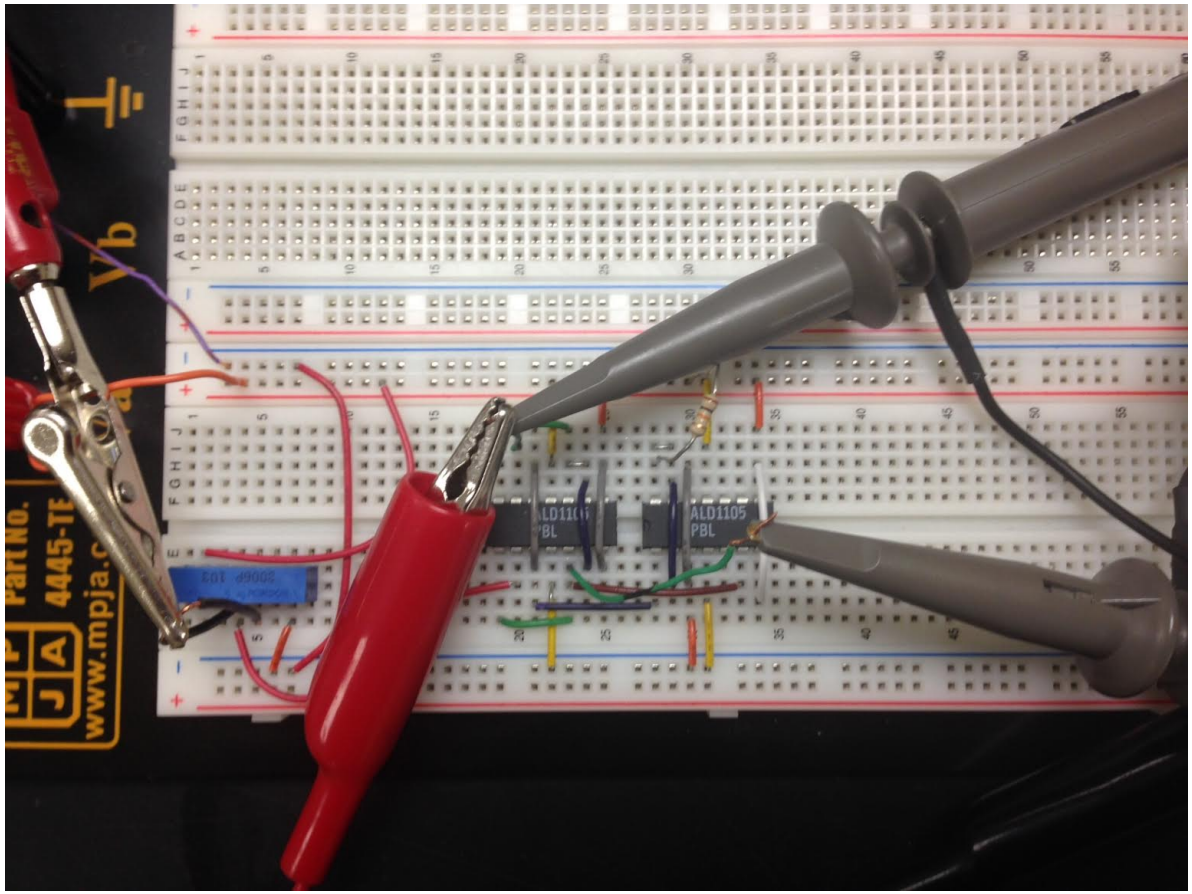
You are asked to construct the OTA circuit and measure its characteristics.

You will measure the following characteristics:

- Open-circuit gain.
- 3 dB bandwidth.
- Distortion (SFDR).

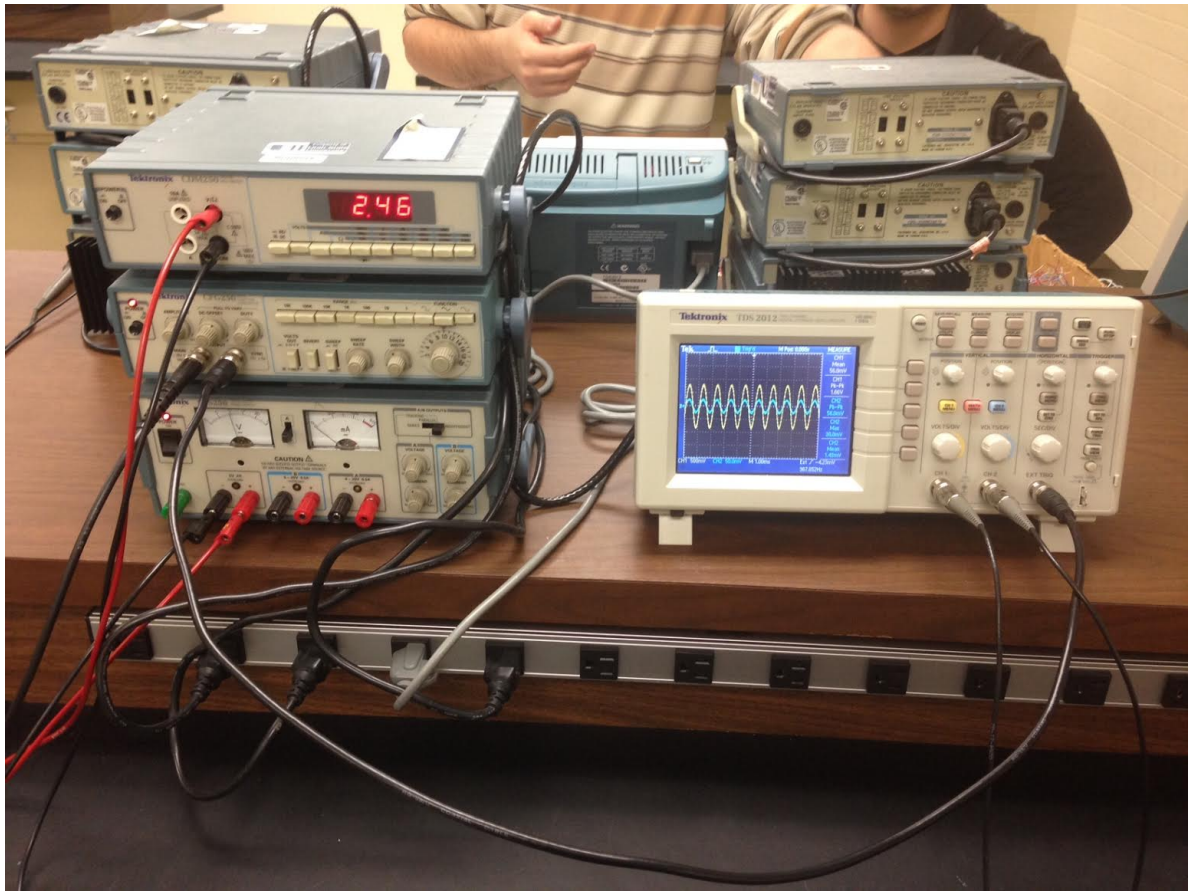
Constructing the Circuit

Keep wires as short as possible to minimize noise and parasitics. Use flat interconnections with right-angle bends that are easy to trace.



Connecting the Test Equipment

Connect the function generator's `SYNC` output to the scope's `EXT TRIG` input, and select the trigger source as "external". Set the scope probes to 1X. Use the fixed 5V output from the power supply.



Function Generator Output Limits

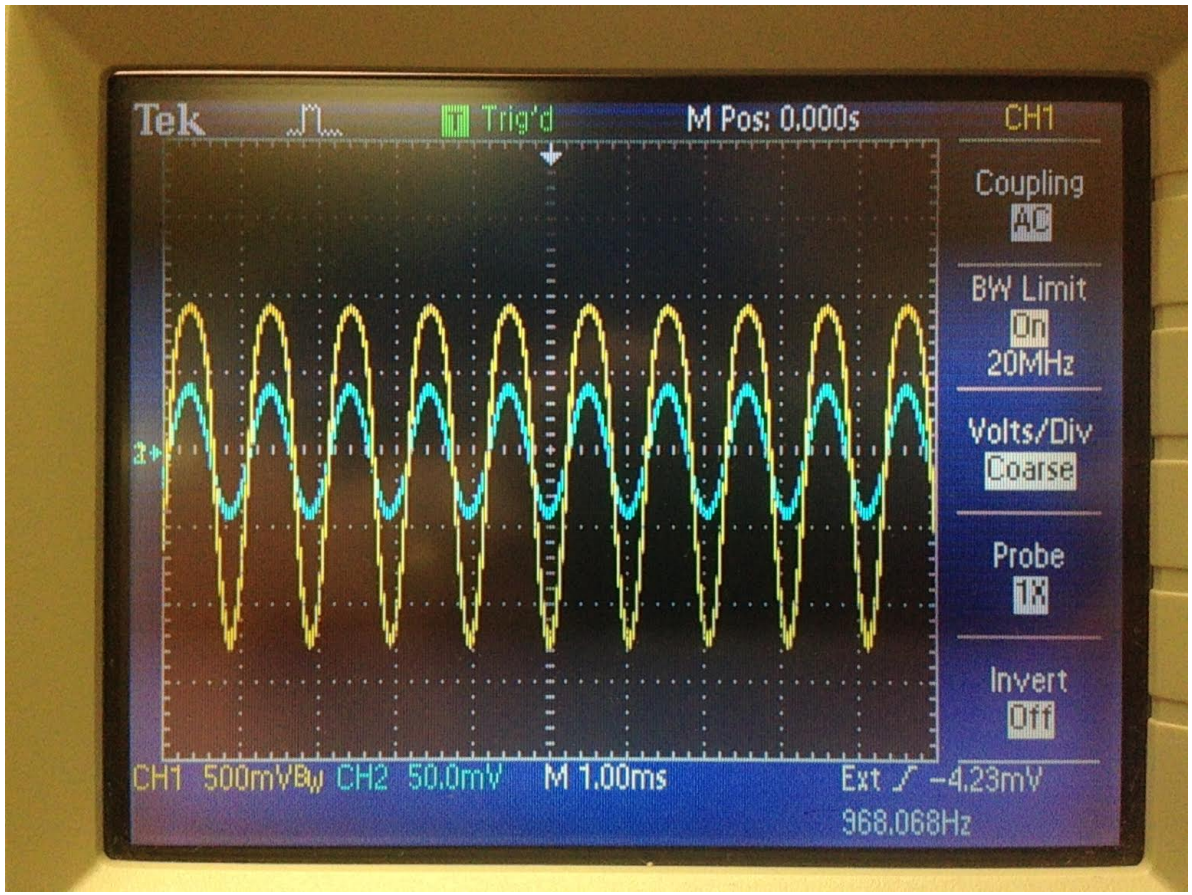
Make sure the function generator's range is set to 0–20 V.

Function Generator Offset Adjust

Pull out the function generator's offset adjust knob, and leave it pulled out for this lab.

Scope Channel Settings

On the oscilloscope channel menus, turn on BW Limiting and set the probe type to 1X.



Setup the Input Signal

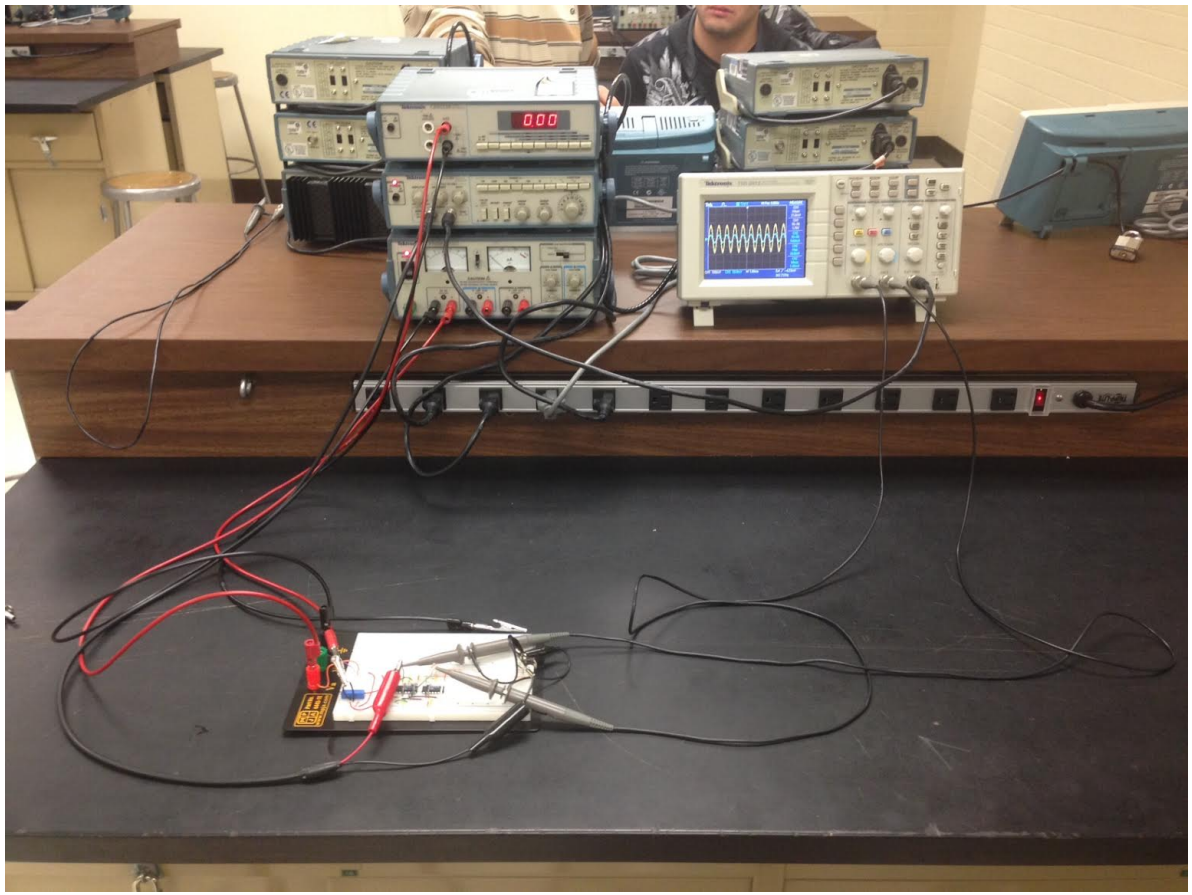
Connect the function generator to a scope channel on DC Coupling. On the scope, press the Measure button and make sure the channel's mean value is displayed.

Adjust the function generator offset until the mean value is close to 2.5 V.

Set the signal amplitude to the lowest measurable value (usually around 50 mV).

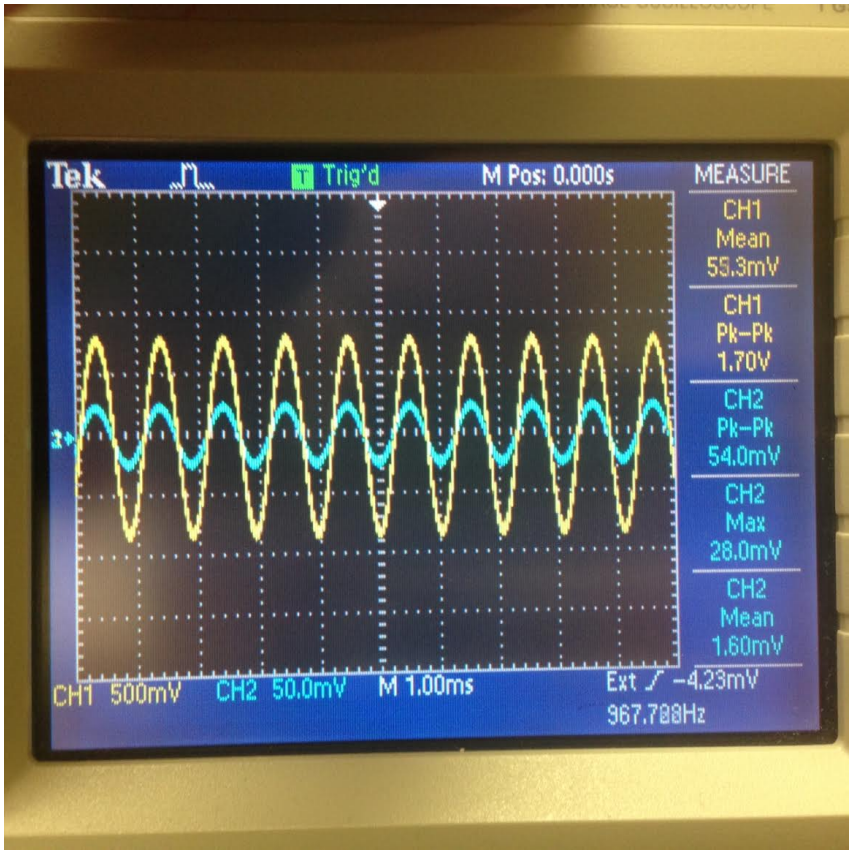
Interfacing with the Circuit

Connect one scope probe to the v_{sig} node, and the other probe to v_{out}. Connect the multimeter to the v_{ICM} node on the potentiometer.



Gain Measurement

Connect the scope probes to your circuit and set the channels to AC coupling. Adjust the potentiometer until the output amplitude is maximized. The multimeter should read close to 2.5 V. Using the scope's `Measure` button, measure the peak-to-peak amplitudes at the circuit's input and output, and record the gain (it should be around 30 V/V).



Bandwidth Measurement

After you achieve proper operation and measure the gain, you may measure the bandwidth by increasing the frequency until the gain decreases by 30%.

This measurement will show the biggest error compared to your pre-lab simulations. This is likely due to parasitic impedances in the breadboard connections, and possibly due to the scope's input impedance.

You can test the influence of the scope's input impedance by changing the probe type to 10X (you also need to change the scope's channel setting to 10X), which will increase the probe's resistance (and hence reduce any loading effect on the circuit's output node).

Setting up the FFT display

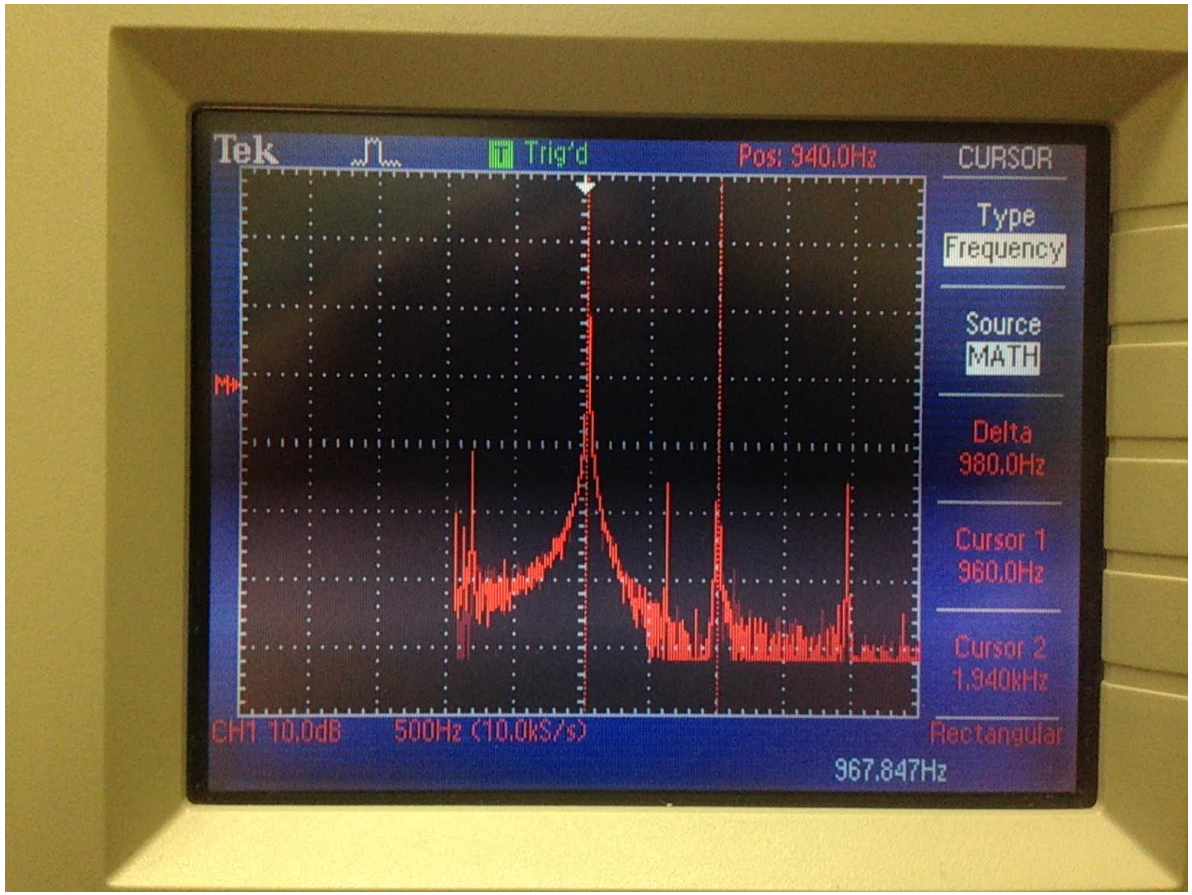
Return the function generator to a 1 kHz frequency, and select the scope's `MATH` function.

Set the function to texttttFFT with a `Rectangular Window`.

You may need to adjust the `Sec/Div` knob to obtain a sufficient window, and you will need to increase the `XZoom` setting and find 1 kHz using the horizontal positioning knob.

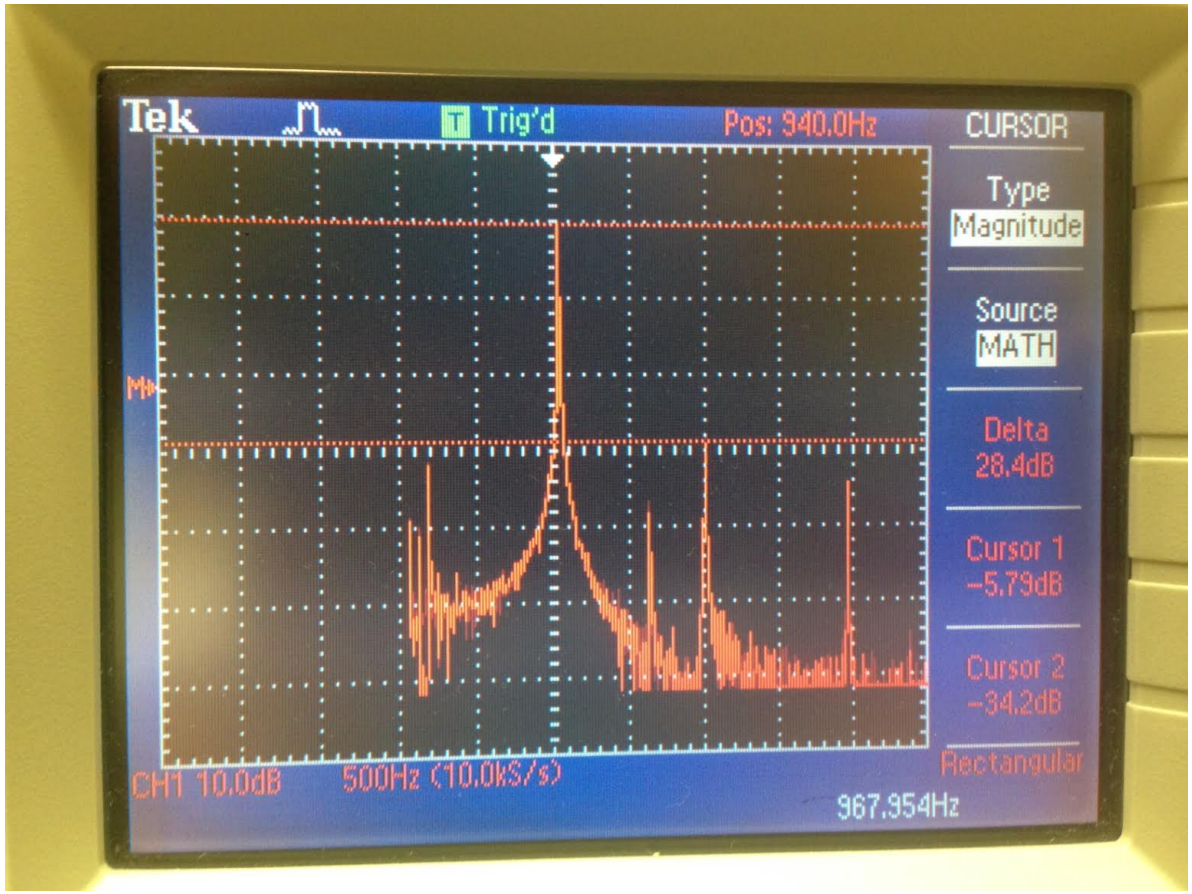
Verifying the FFT Setup

When the FFT display is setup properly, you should see something like this. You should see a prominent spike close to 1 kHz and a harmonic spike close to 2 kHz. Verify this using the `CURSOR` button in `Frequency` mode:



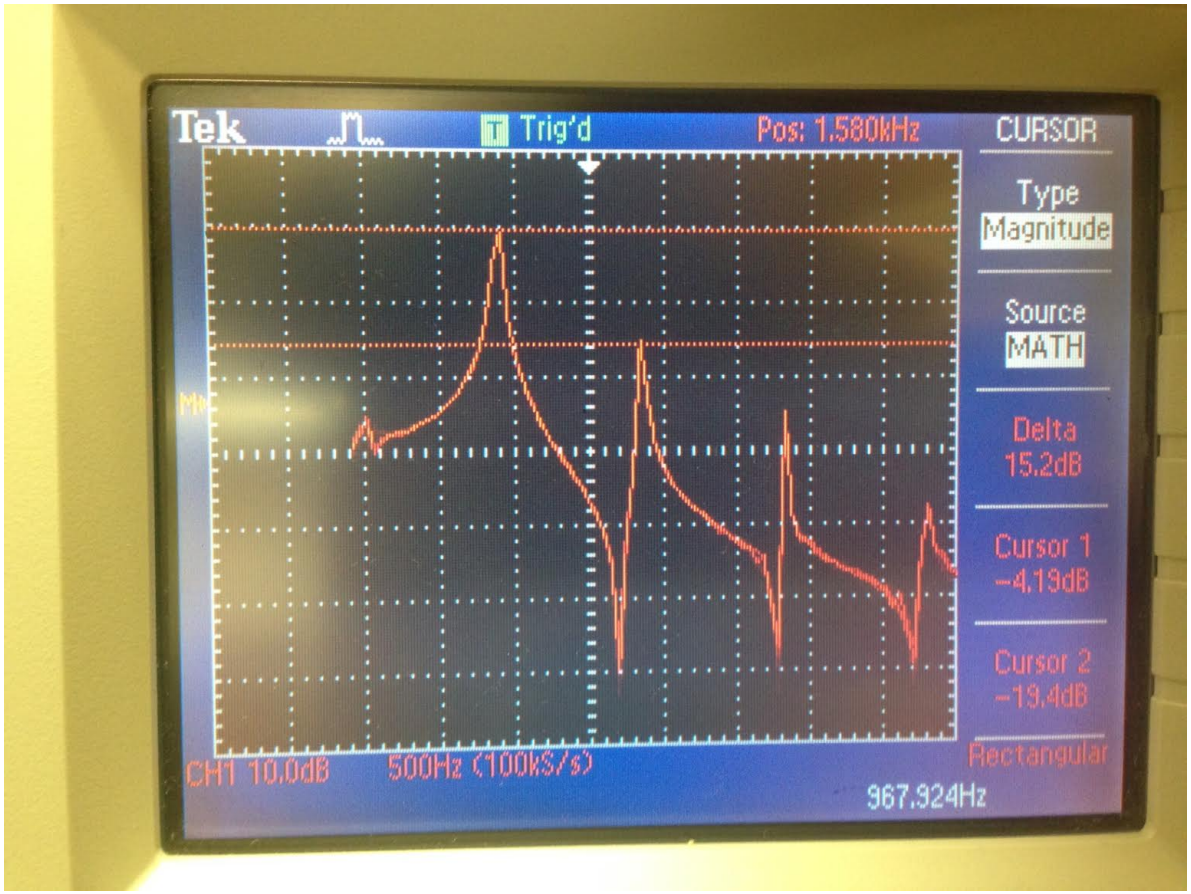
SFDR Measurement

When the FFT display is setup properly, you can measure the SFDR using the `Magnitude` cursors:



Second SFDR Measurement

Now slightly increase the function generator amplitude. You should find that the SFDR gets smaller (i.e. the distortion gets worse):



Visual Distortion

If you return the oscilloscope to the time display, you should be able to visually percive the distortion in the higher-amplitude case: