

Debugging Analog Circuitry

- Common issues
- Sanity checks
- Unit testing
- System testing

Crazy Wires!

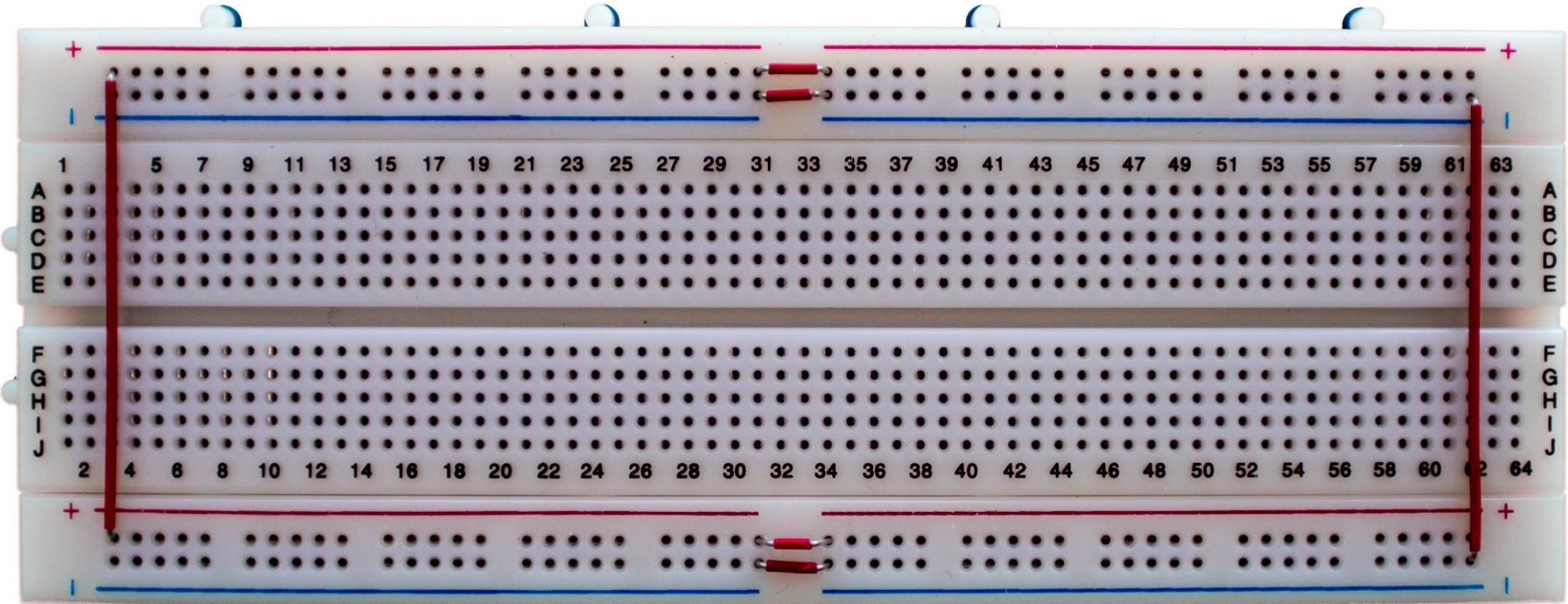
- Red/Black: VCC/GND
- Purple/Grey: Battery/return
- Other colors are signal wires
(decide on a color scheme!)
- Shorten wires
- Twist out/return wires
- Plugs are removable, but soldered joints are smaller.
- Use soft over rigid wires

How to solder wires like a Pro!

ECI

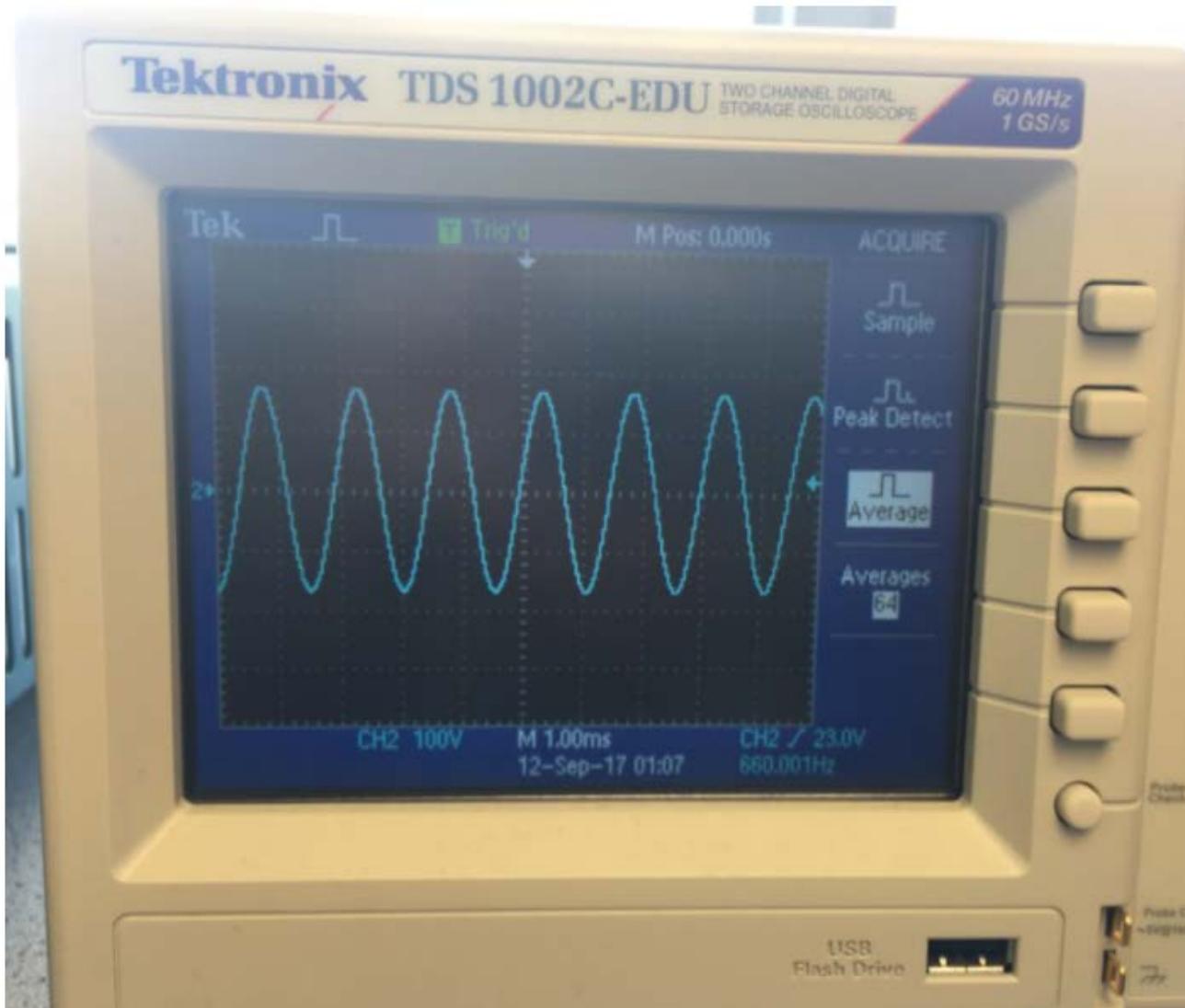


Common Reference



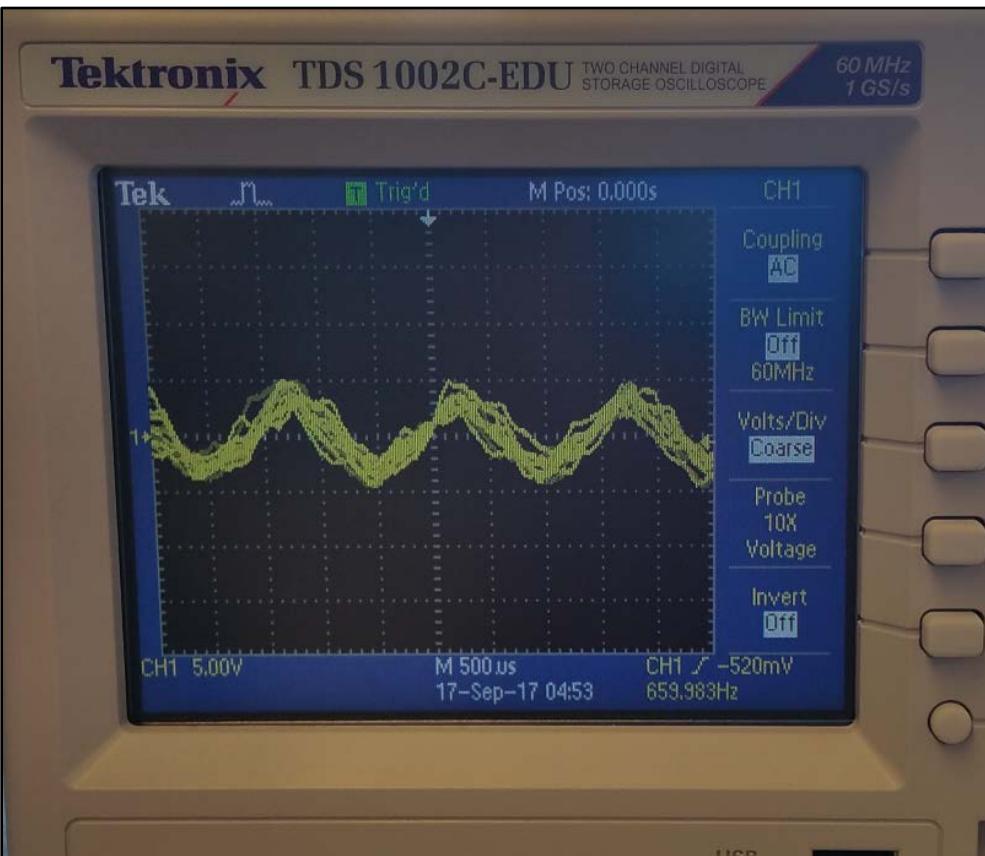
Microphone - Sanity Check

- Play 660Hz tone to a speaker, what do I expect the signal to look like?



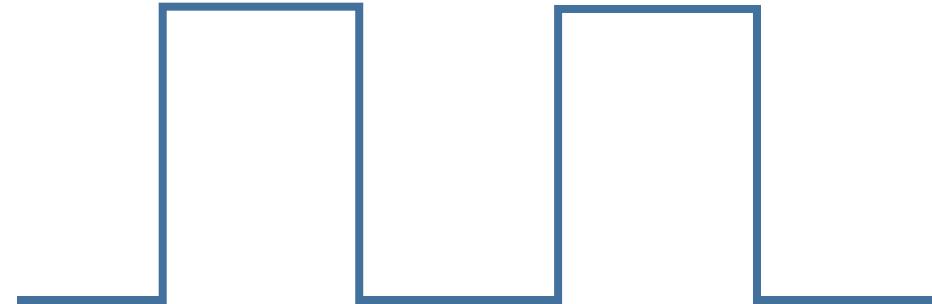
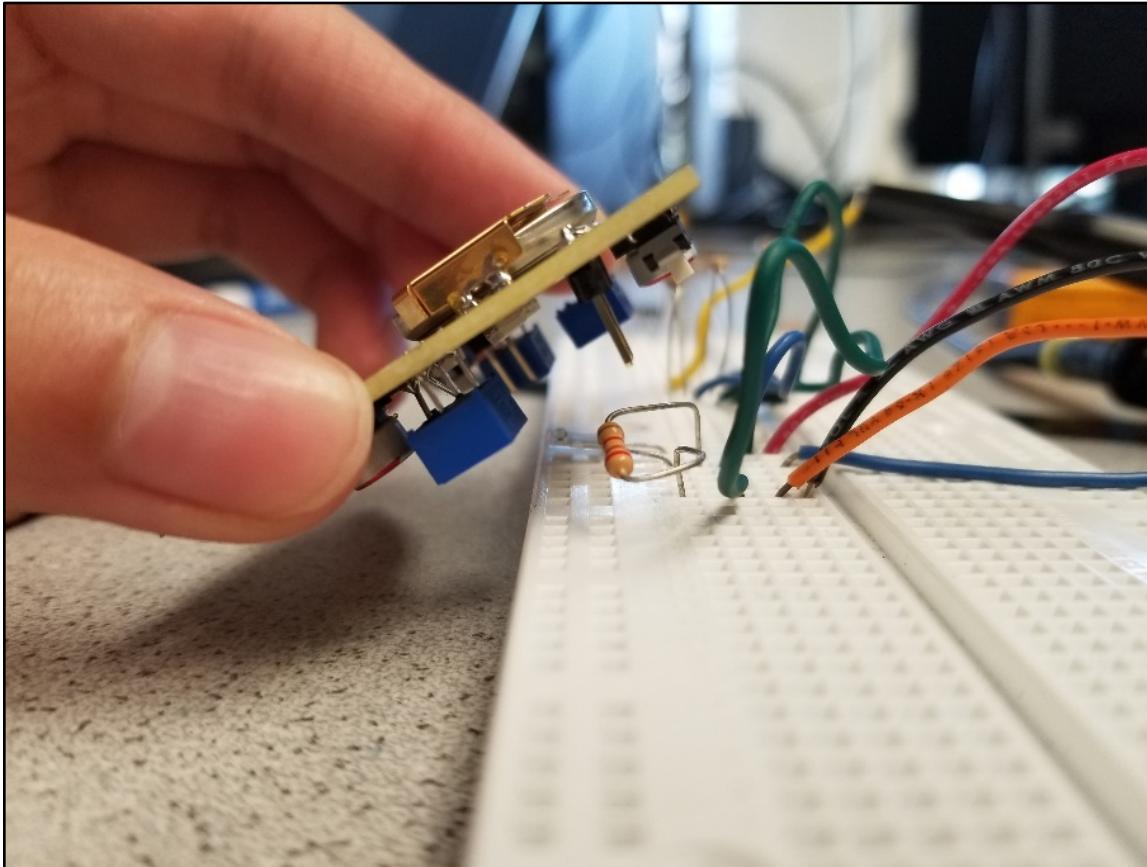
Microphone - Sanity Check

- Play 660Hz tone to a speaker, what do I expect the signal to look like?



Treasure - Sanity Check

- Emit a treasure signal - what do I expect my sensor output to look like?



Treasure – Sanity Check

- What if the output looks like a saw tooth wave?

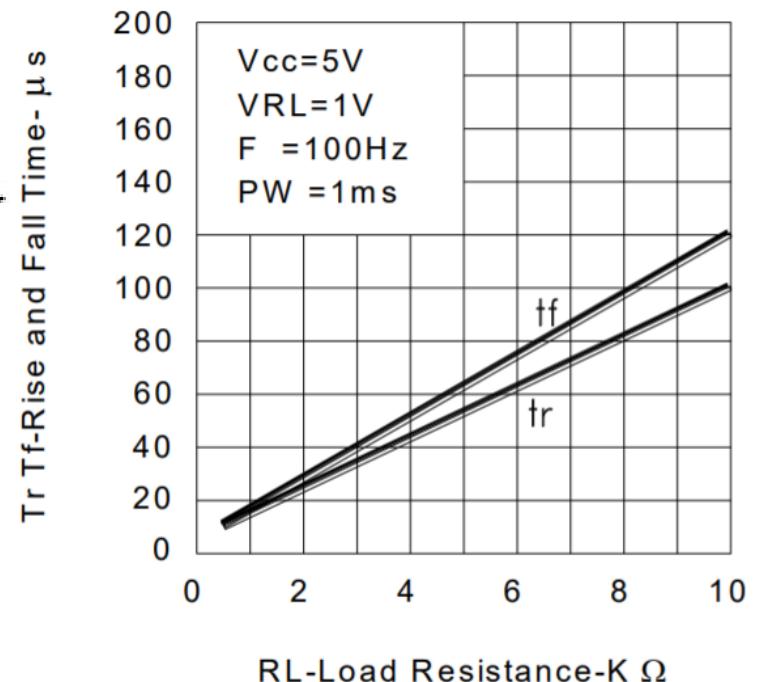
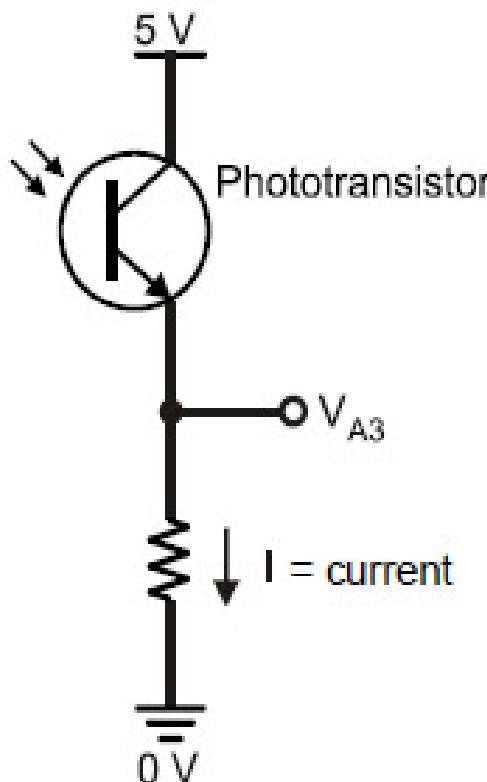
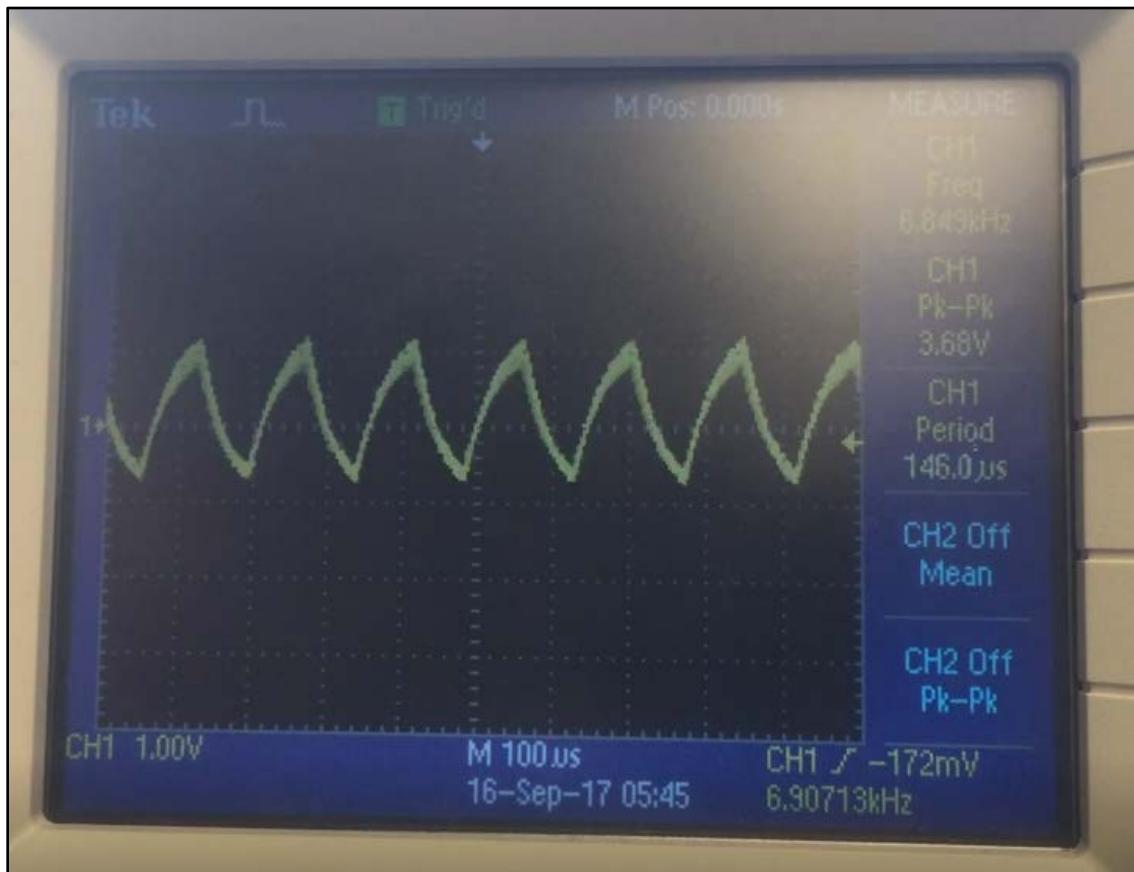
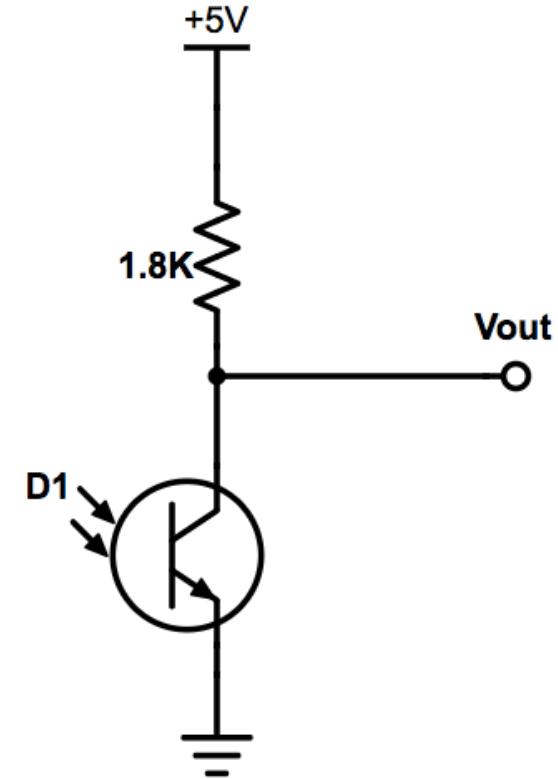
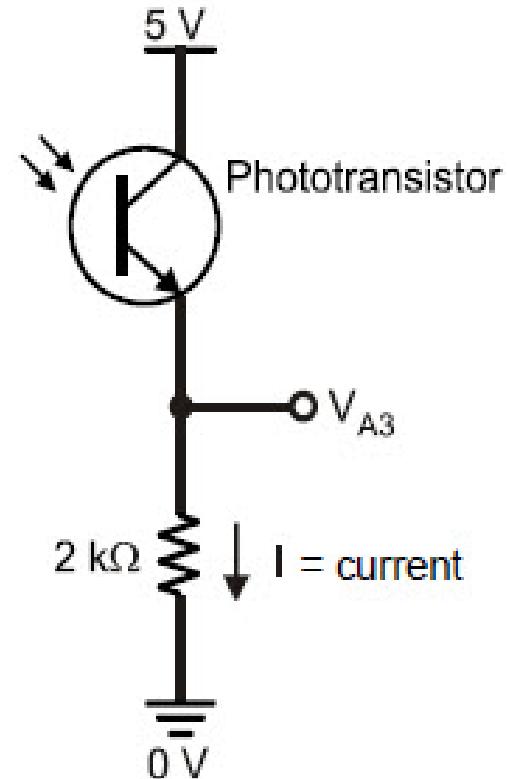
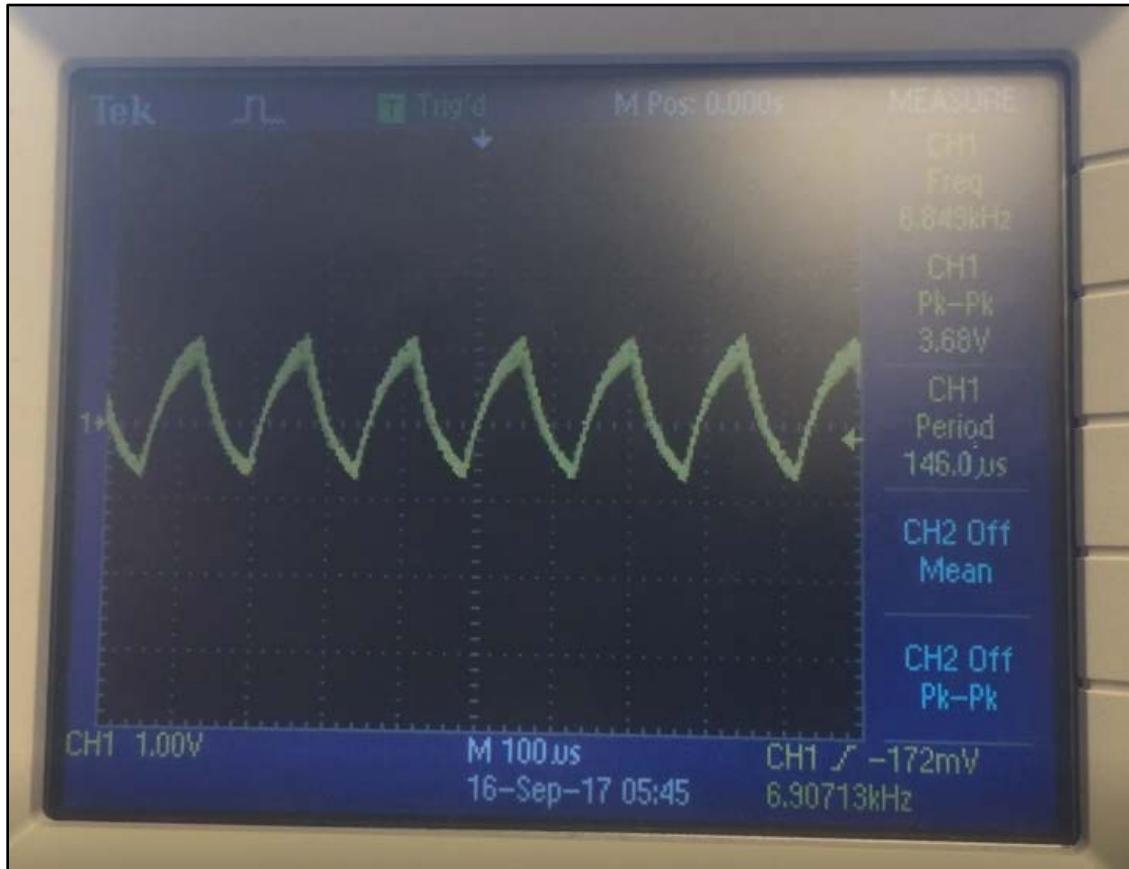


FIG.3 RISE AND FALL TIME VS LOAD RESISTANCE

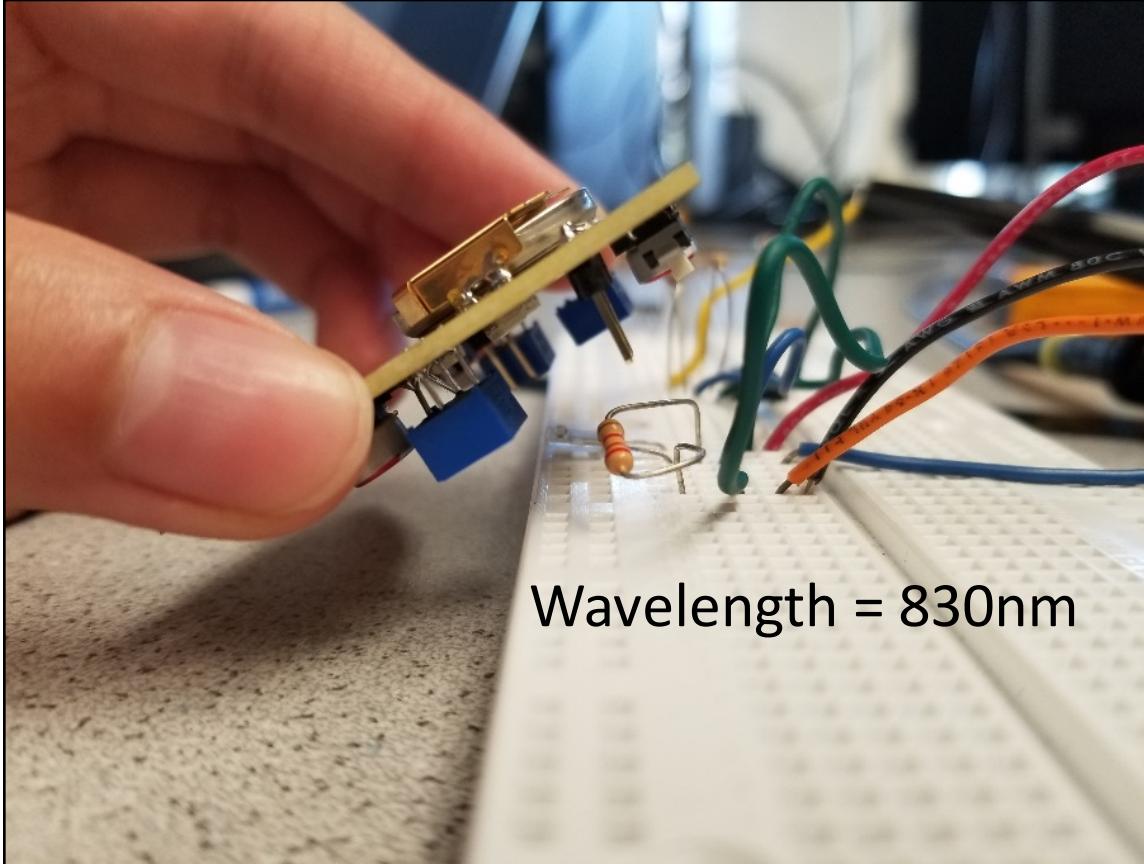
Treasure - Sanity Check

- What if the output looks like a saw tooth wave?



Treasure - Sanity Check

- What if it is damped?



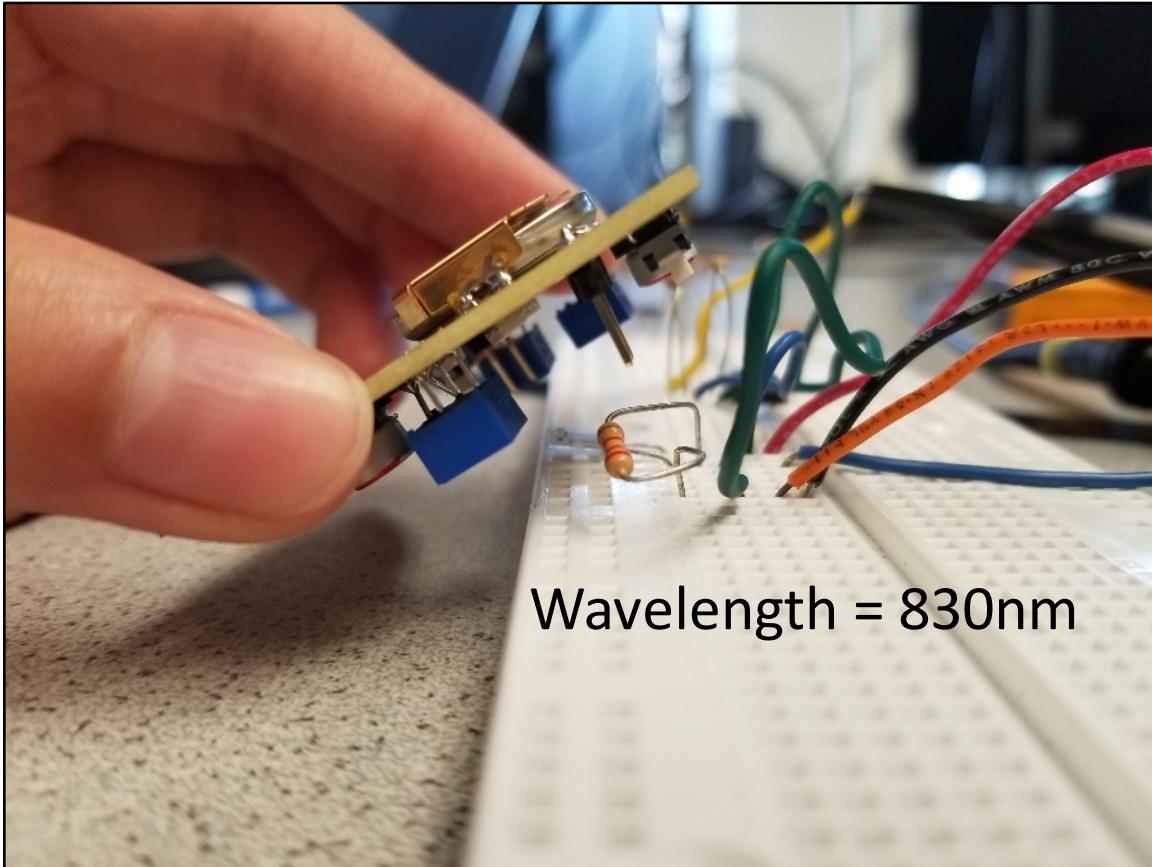
Wavelength = 830nm



Wavelength = 830nm

Treasure - Sanity Check

- Know Thy Sensor!



Wavelength = 830nm

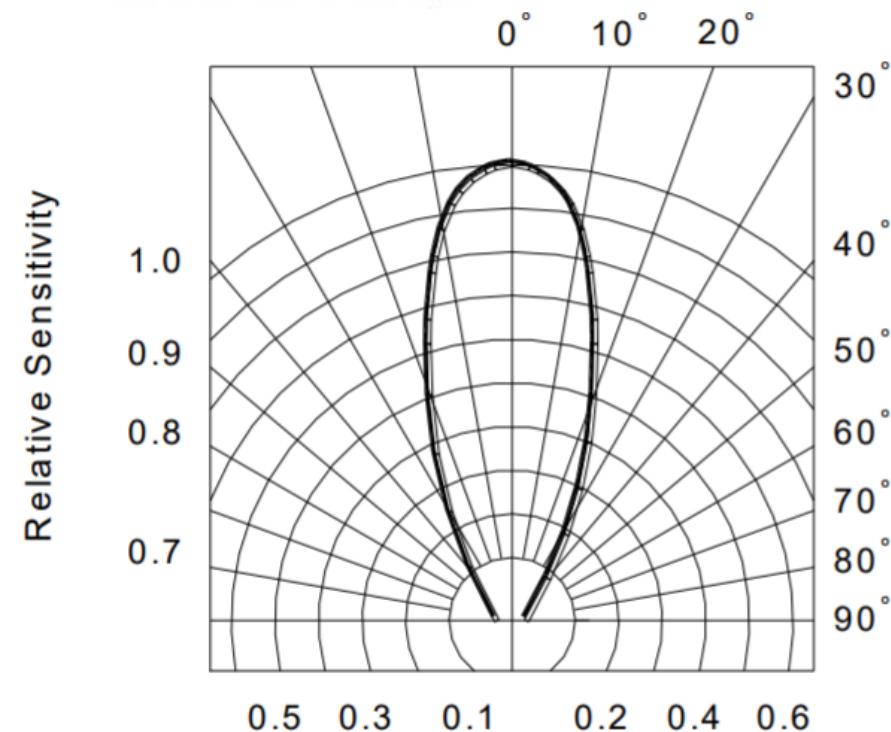
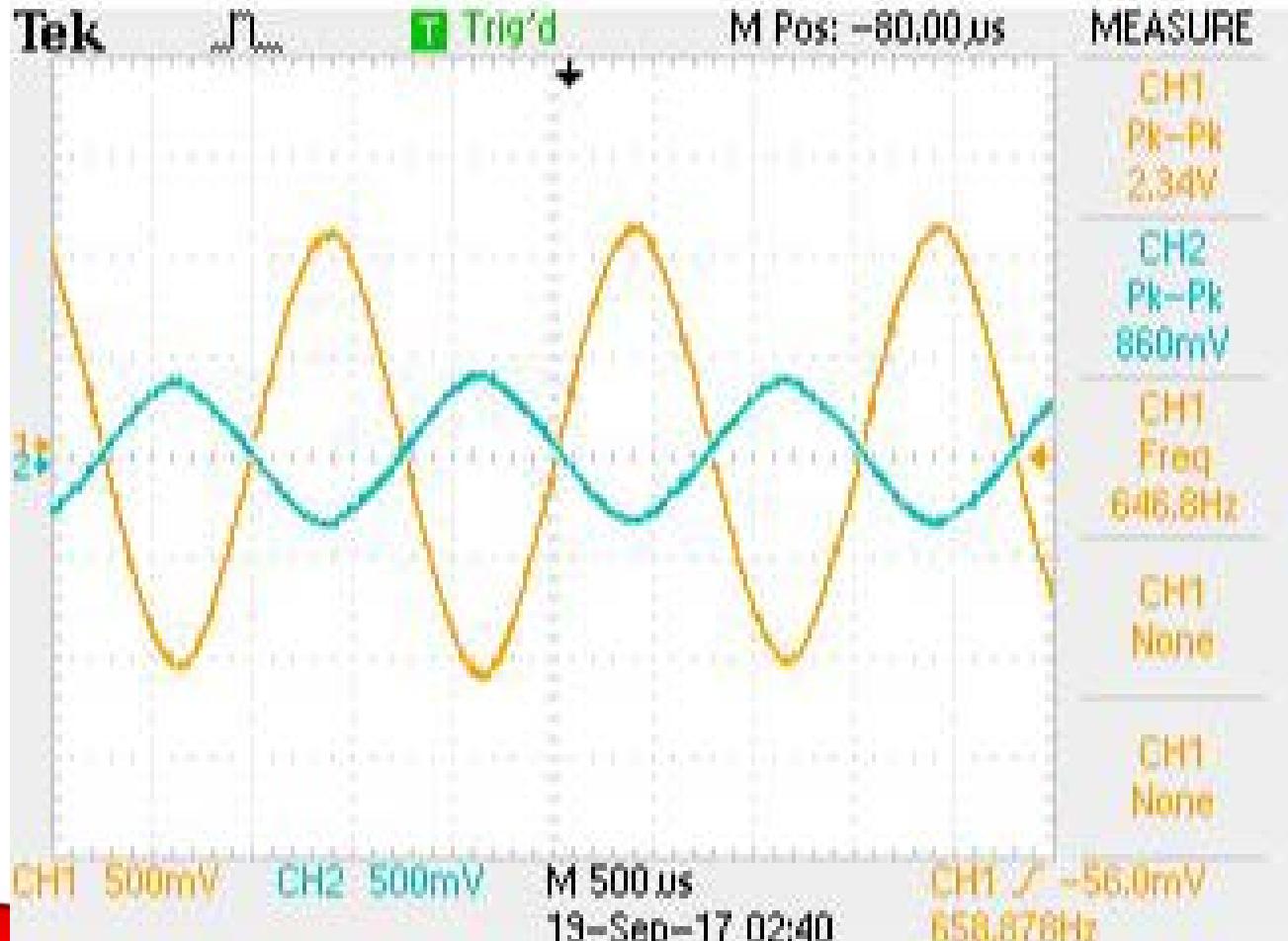
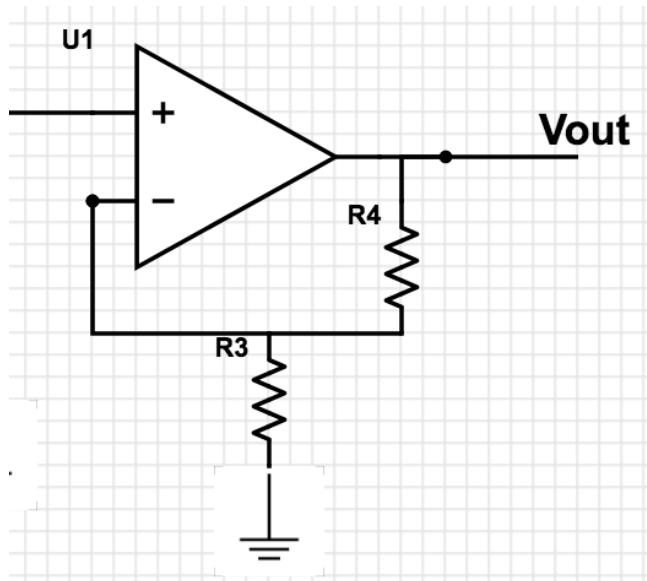


FIG. 5 SENSITIVITY DIAGRAM

Amplifiers - Sanity Check

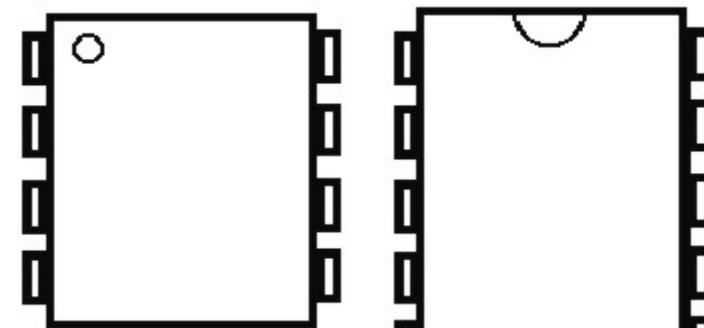
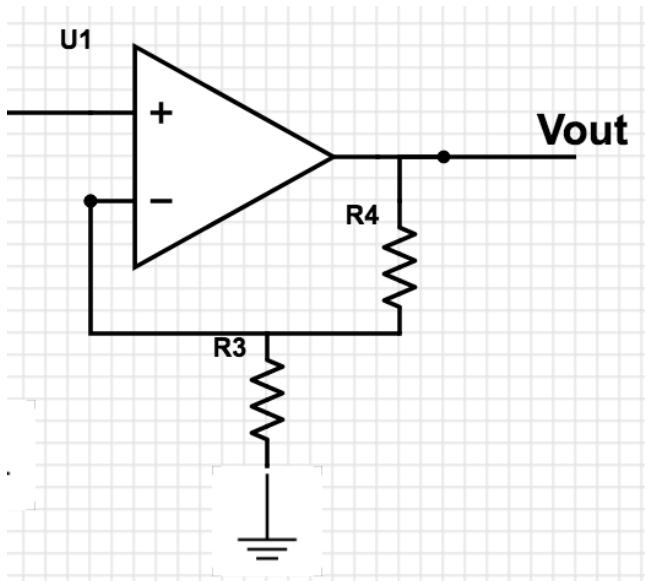
- What does a sine wave look like after an amplifier?
 - A bigger sine wave!



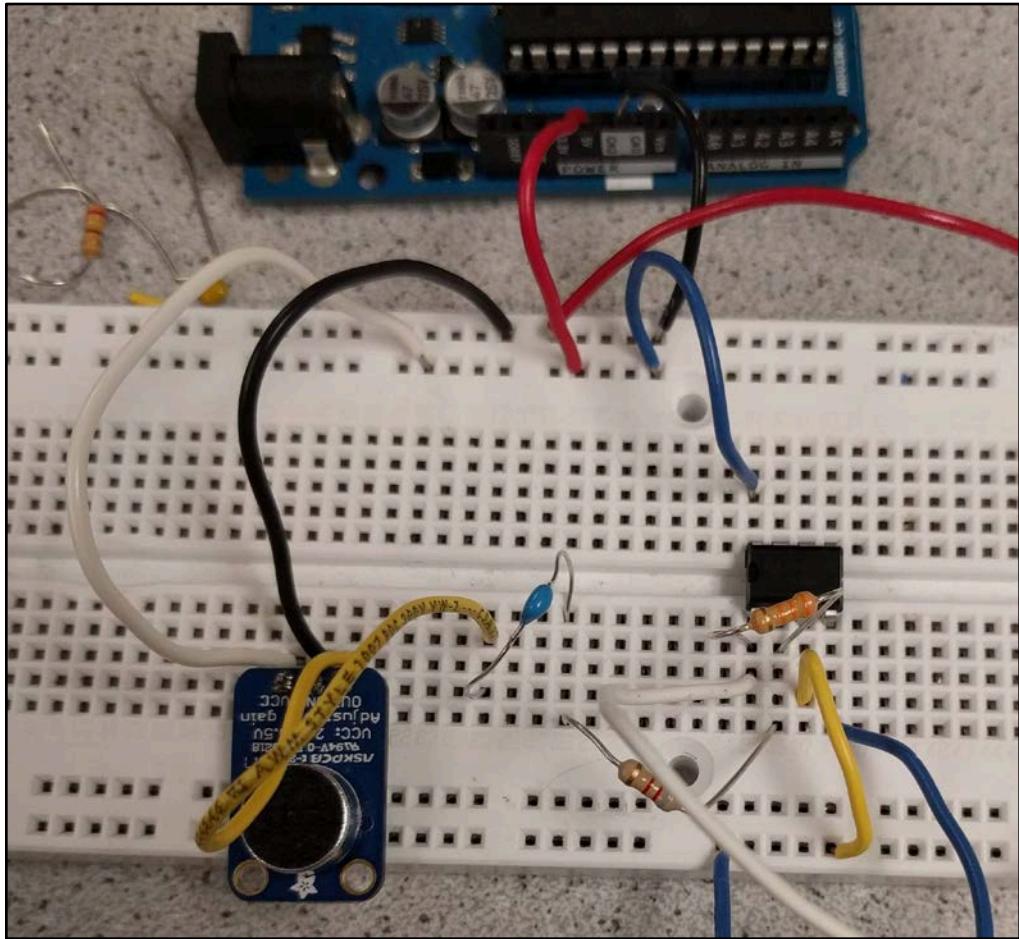
Amplifiers - Sanity Check

- What if there is no output?

- Is it powered / hooked up right?
- Is it saturated?
 - Check the DC value of your input signal
 - Recalculate the amplification
 - Check if the scope is set to AC

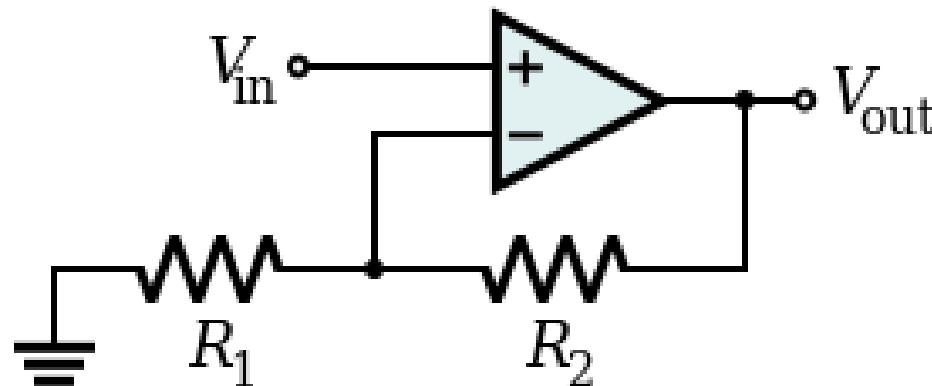


Case Study

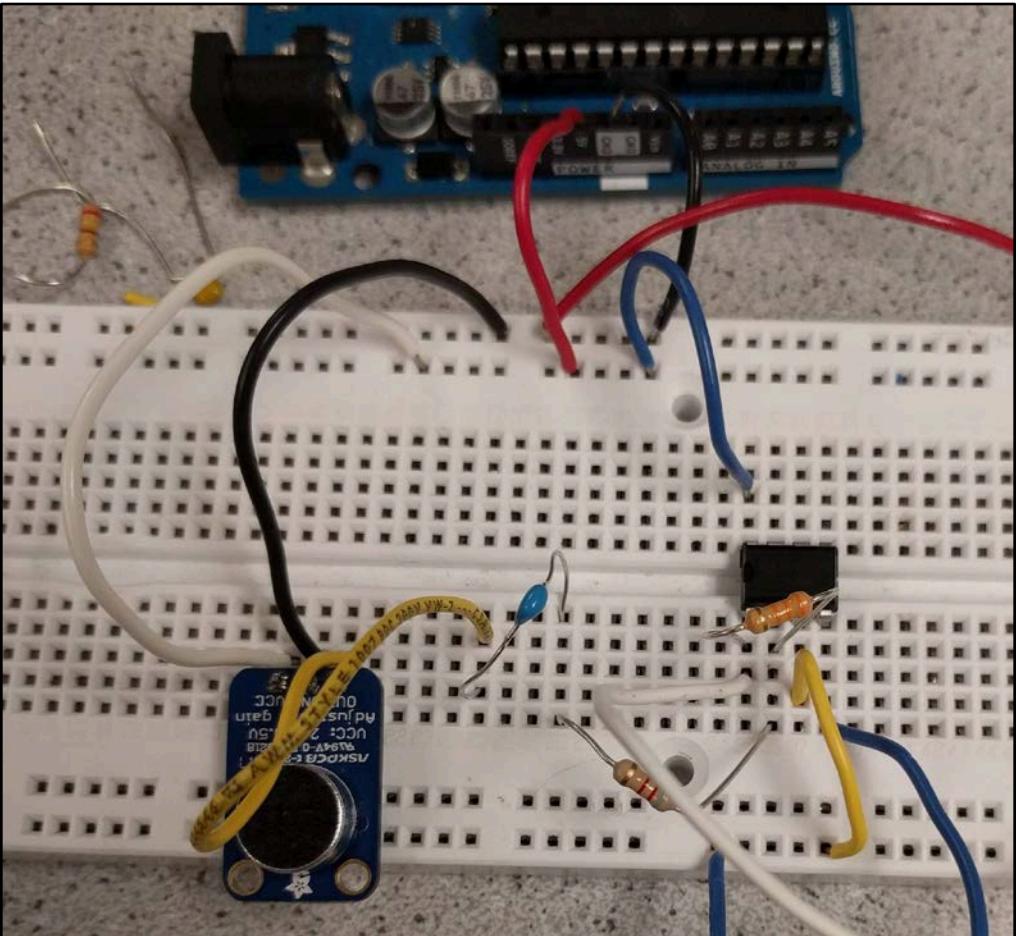


No output from the amplifier!

- At first, we were using smaller resistors, $300\ \Omega$ and $100\ \Omega$.
- Can you choose values that are too big?
 - Input bias current
 - Input offset current



Case Study

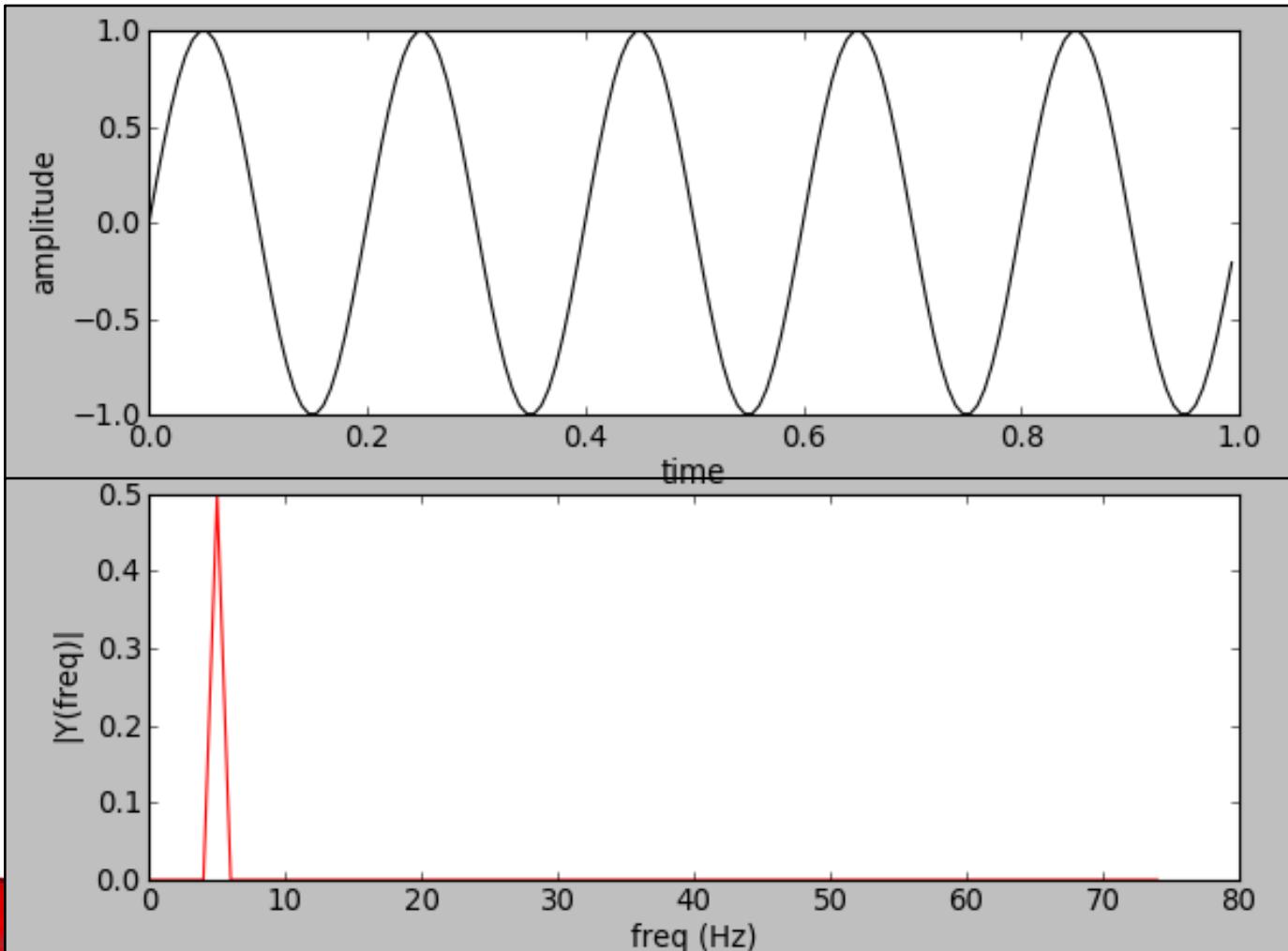


No output from the amplifier!

- At first, we were using smaller resistors, $300\ \Omega$ and $100\ \Omega$.
- Changing to larger resistors such as $3\ k\Omega$ and $1\ k\Omega$ gave us a cleaner signal, but still no gain.
- In fact, even with the resistors in the correct orientation, we sometimes got fractional gain.
- We also tried to feed V+ of our op-amp with a smaller voltage, such as 2.5 V , but this did not help with our signal.
- We also tried putting a low pass filter at the input, but this did not help with our signal either.

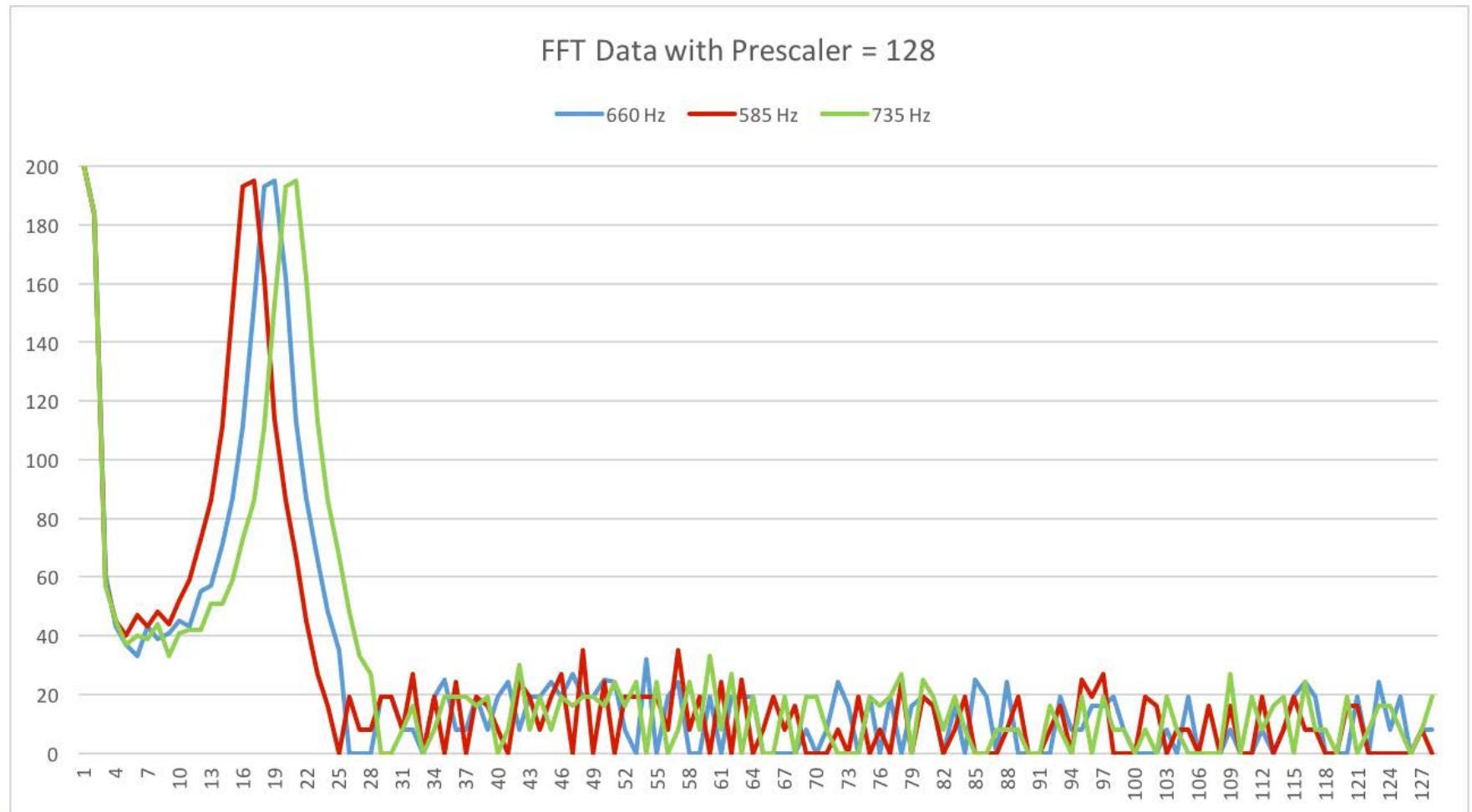
FFT - Sanity Check

- What does a sine wave look like in an FFT?



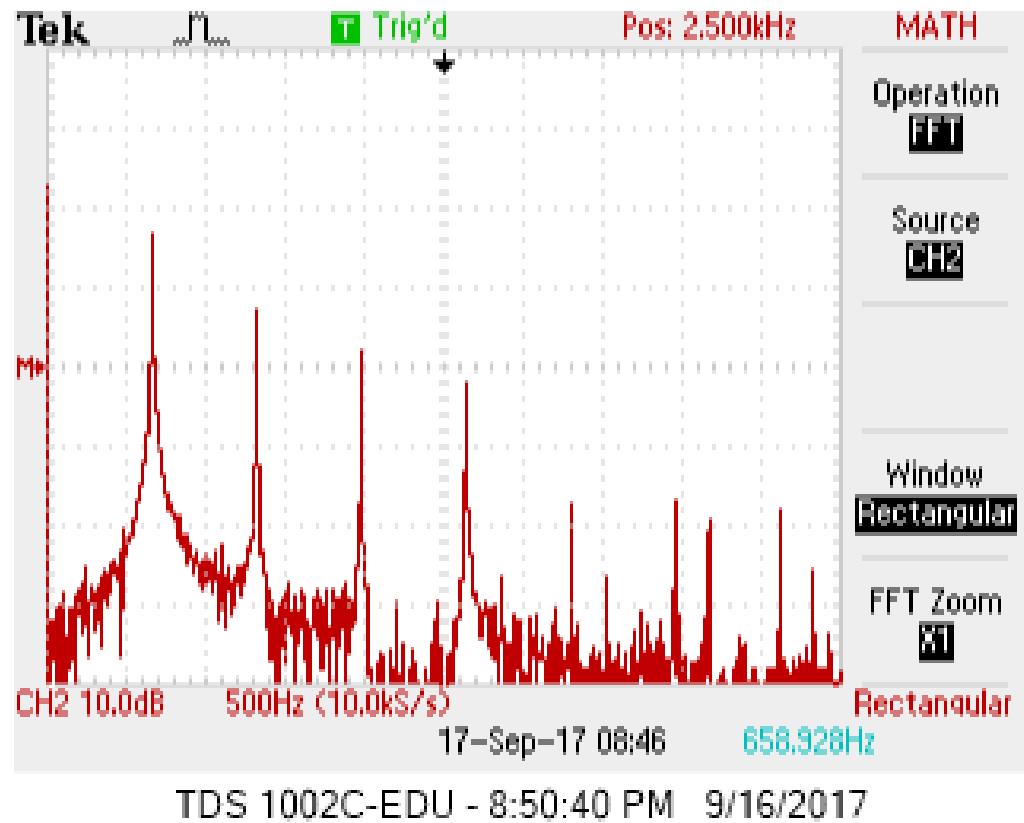
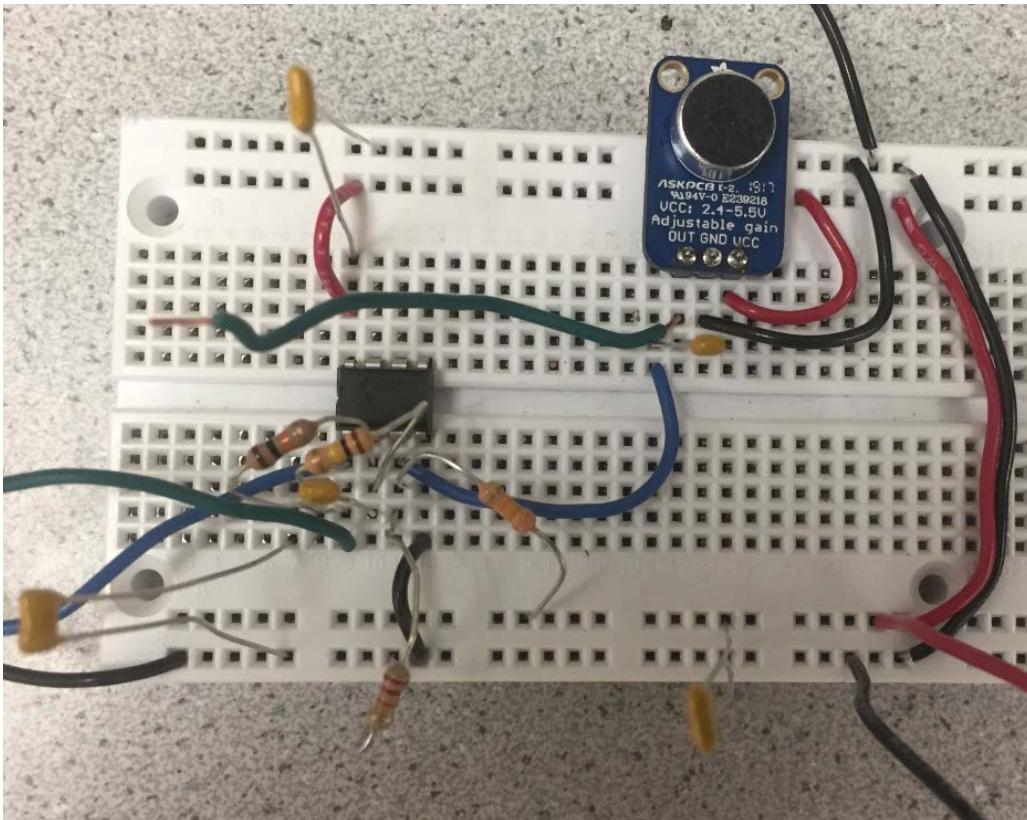
FFT - Sanity Check

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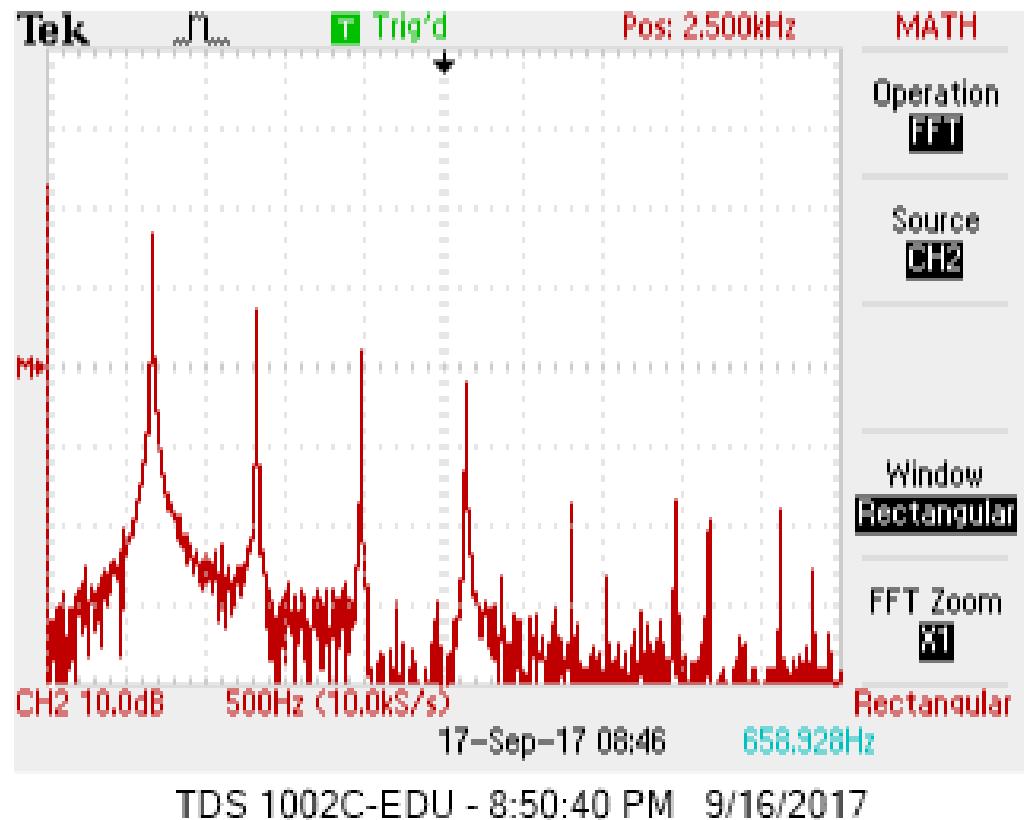
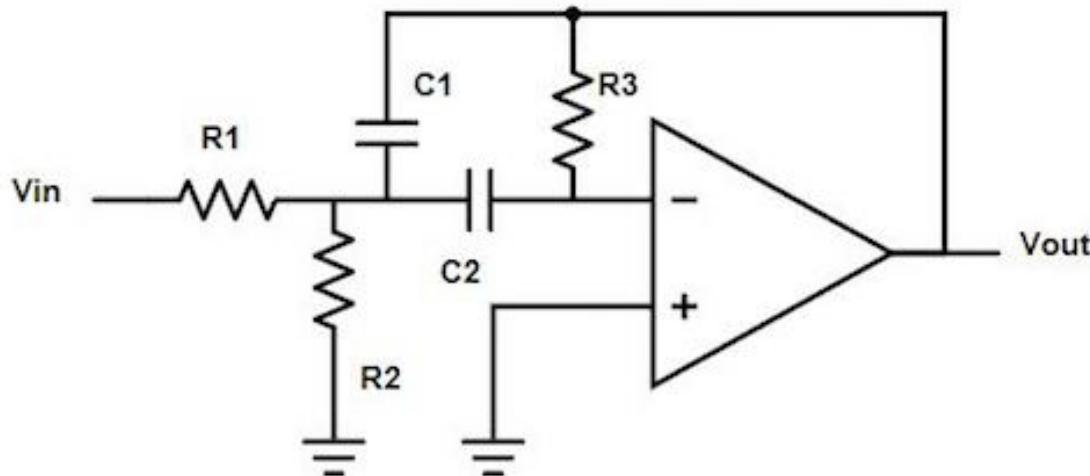
FFT - Sanity Check

- What does a sine wave look like in an FFT?



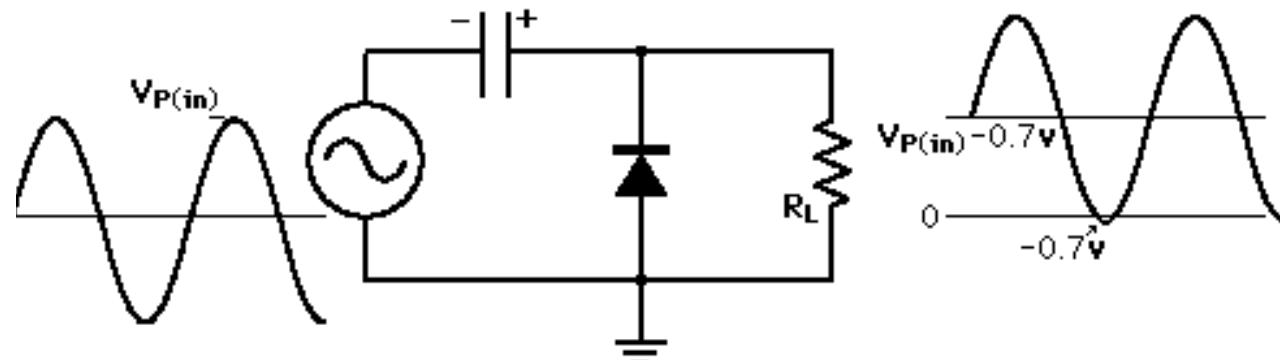
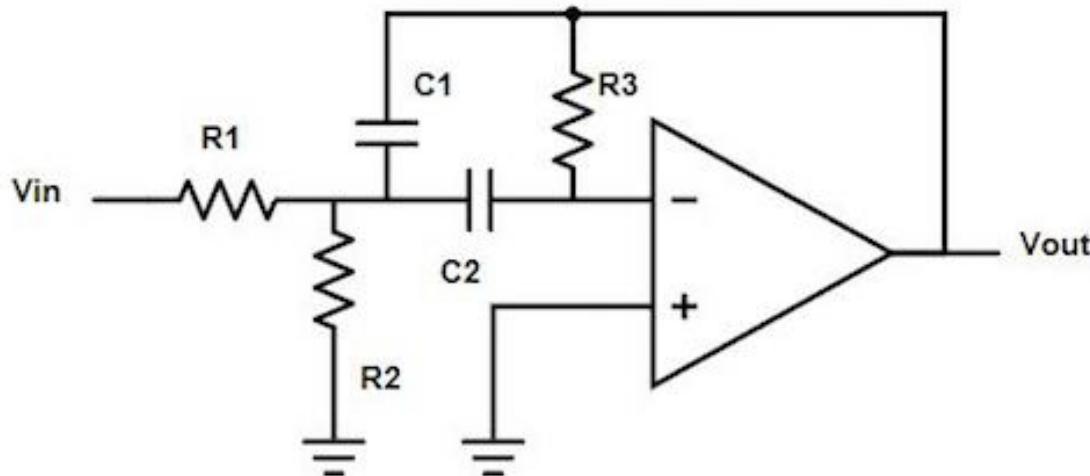
FFT - Sanity Check

- What does a sine wave look like in an FFT?
 - Stuff grabbed off the internet, probably expects a negative rail



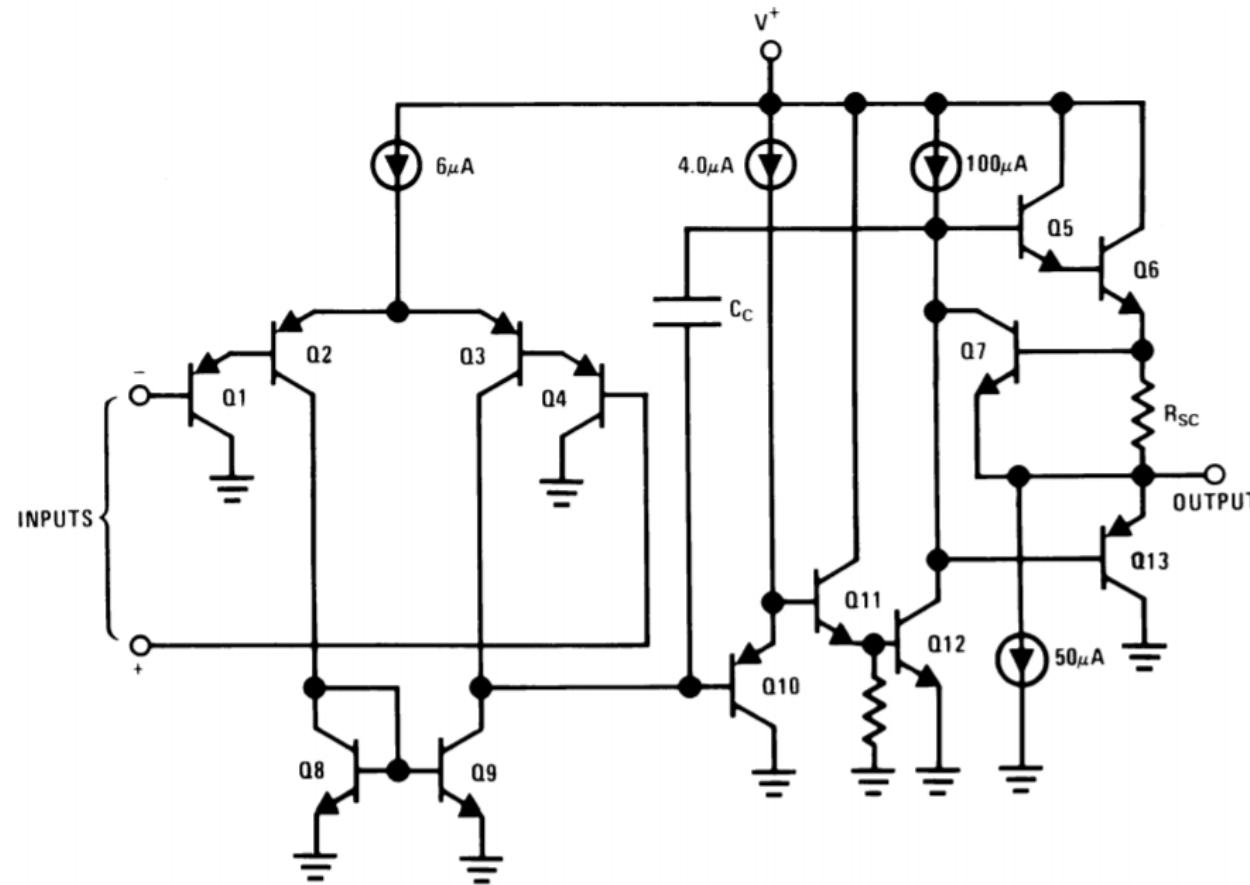
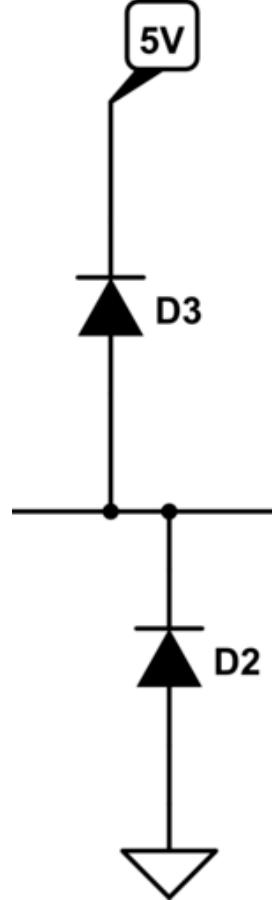
FFT - Sanity Check

- What can I do if I really want to use *this* filter?
 - Make a negative supply and use an op-amp that can handle that!
 - Bias your signal around 2.5V and send in 2.5V on the reference



Supply Rail

- What happens when you send in voltage outside of the supply rail?
 - Best case: it survives, or completely fails
 - Worst case: it sort-a keeps working!



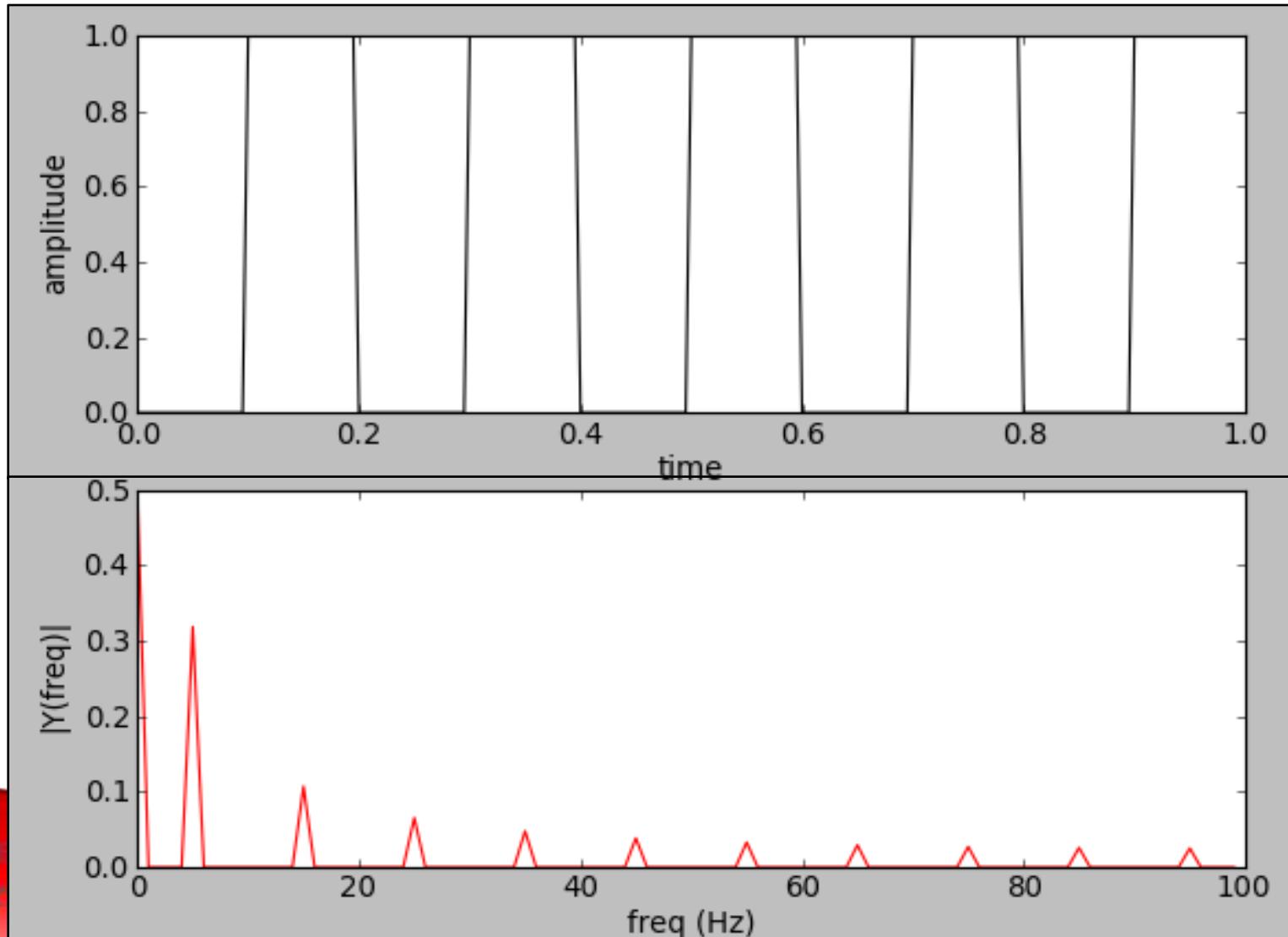
*MAX: GND-0.3V

Figure 16. Schematic Diagram

NEVER GO BEYOND THE SUPPLY RAIL!

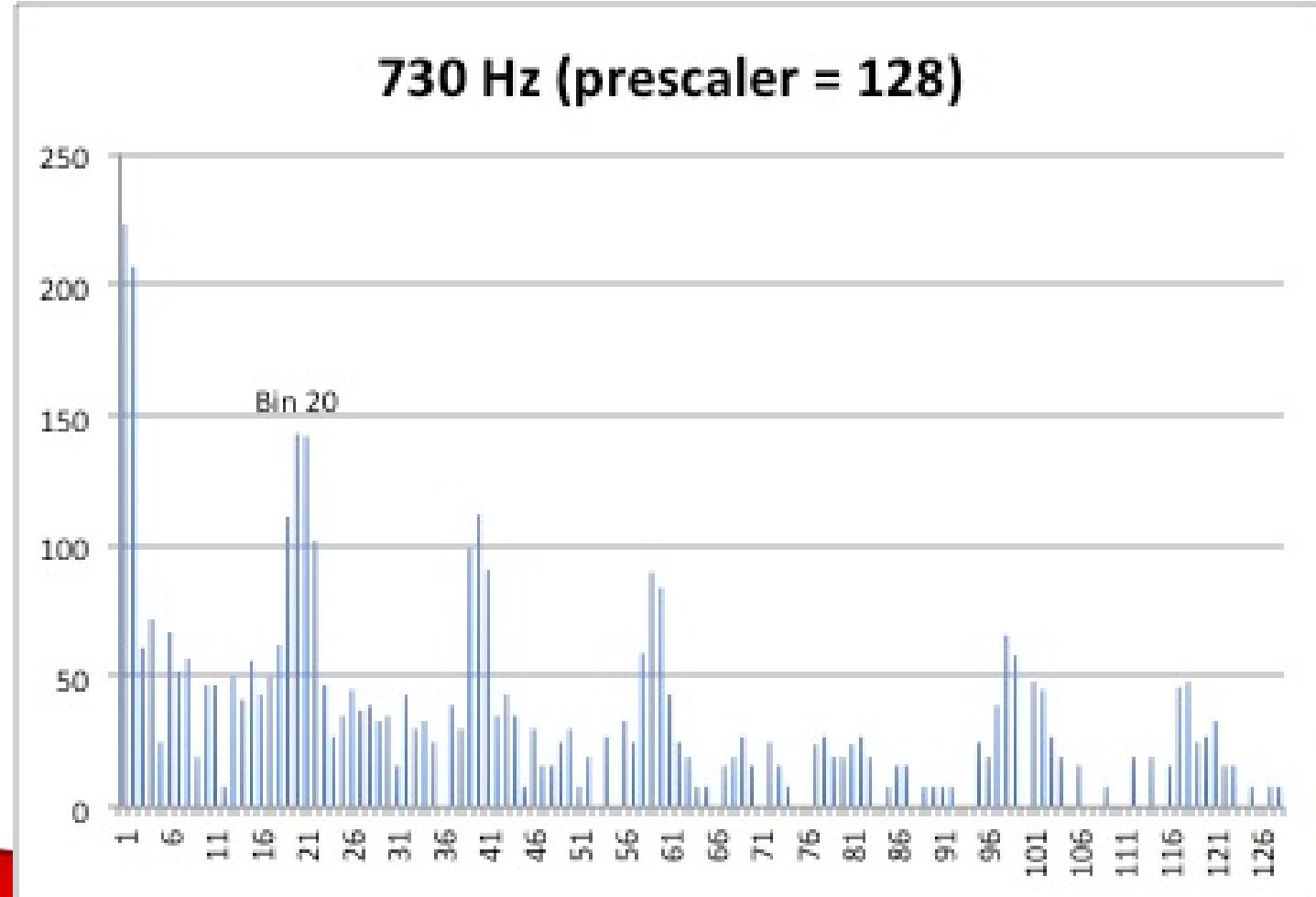
FFT - Sanity Check

- What does a square wave look like in an FFT?



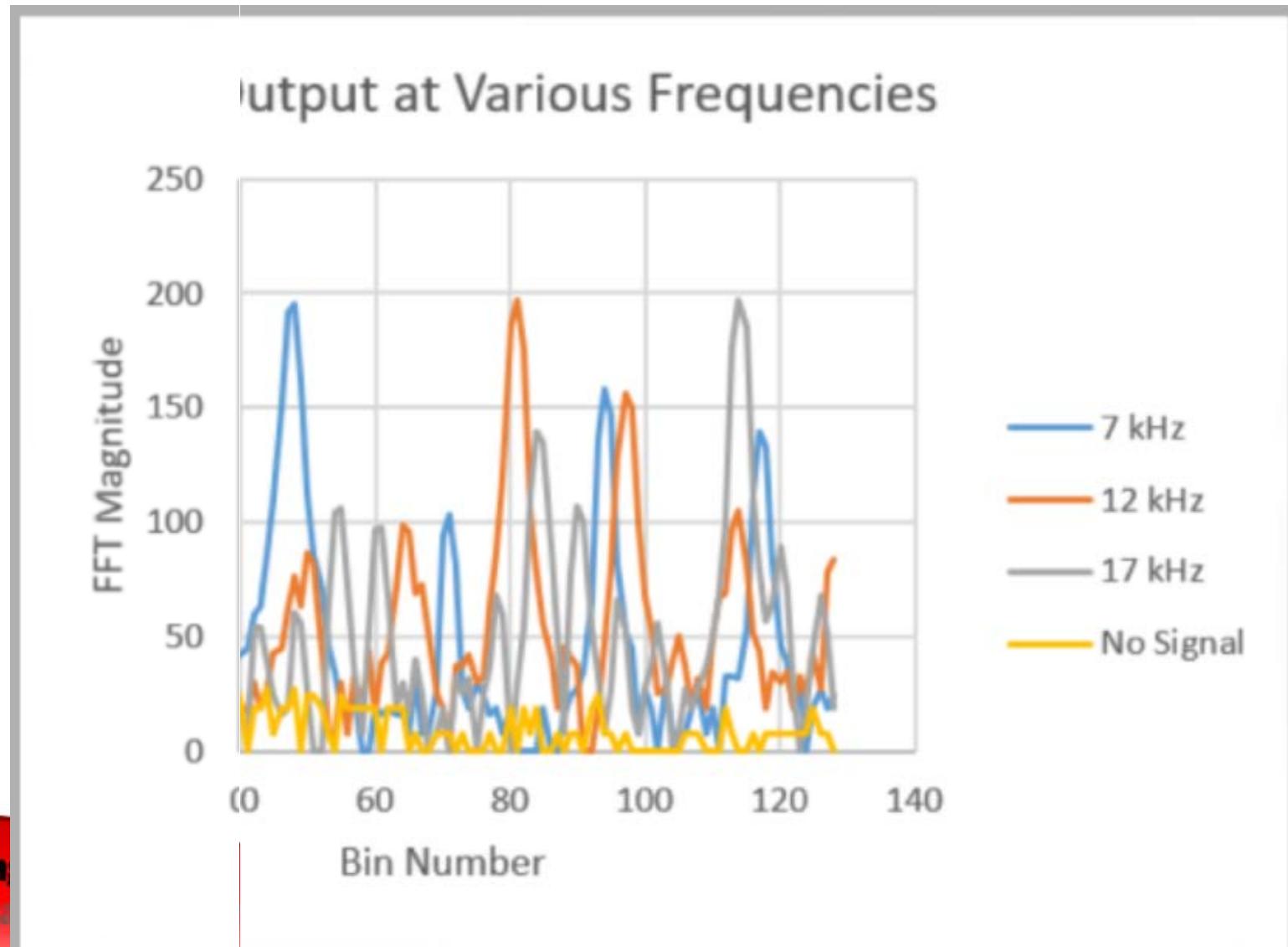
FFT - Sanity Check

- What does a square wave look like in an FFT?



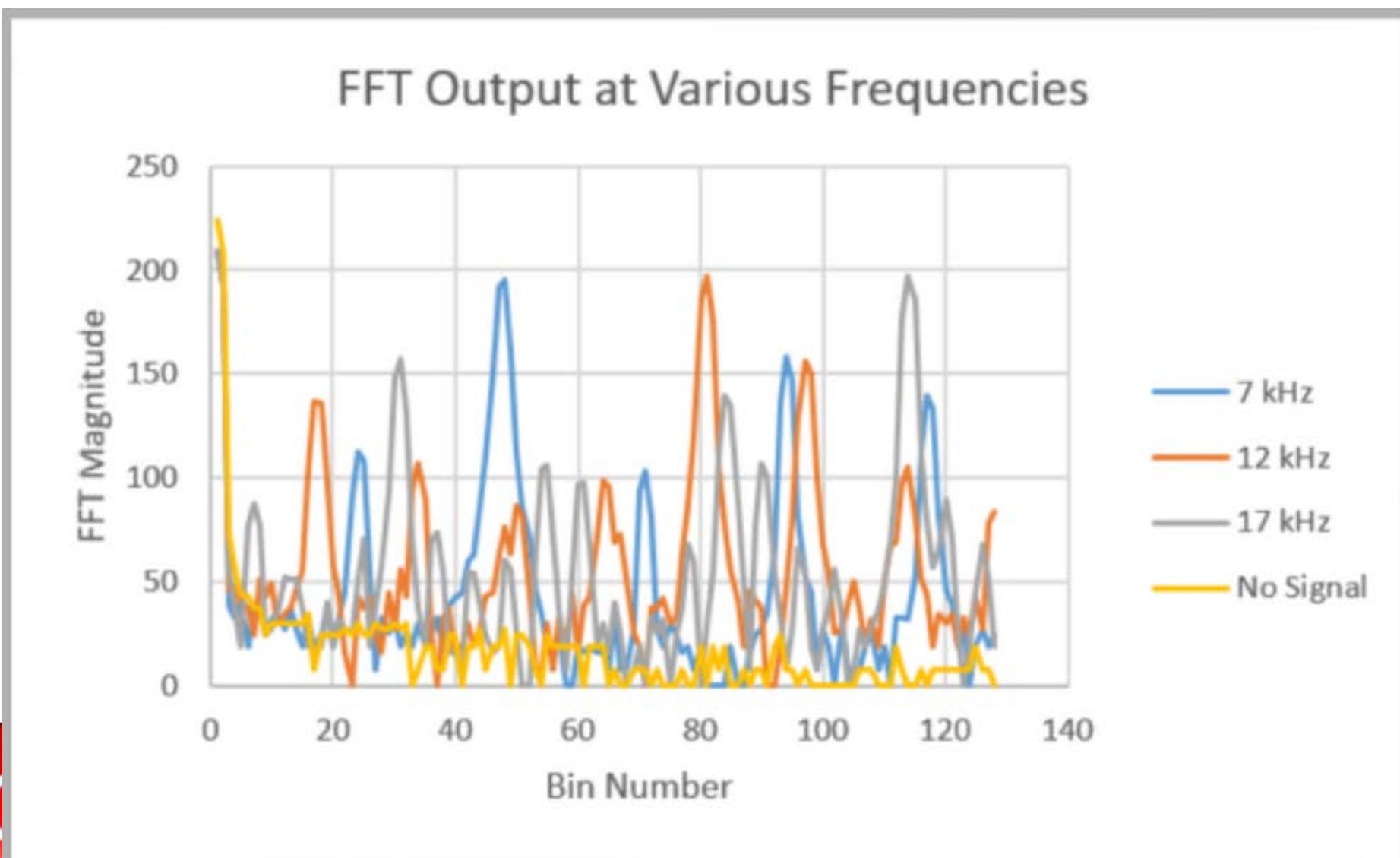
FFT - Sanity Check

- What does a square wave look like in an FFT?



FFT - Sanity Check

- What does a square wave look like in an FFT? • WHY??



Conclusion

- Perform sanity checks!
- If things aren't working, reach out before the deadline!

Go Build Robots!

