Lab 1: Intro to S1XT33N

EECS 16B Spring 2024

We'll start on Berkeley Time!

Slides: https://links.eecs16b.org/lab1-slides

TA & ASE Introductions

Administrativa

- Make sure you have created an instructional web account to log in to lab computers (Visit links.eecs16b.org/webacct to create your account)
- Ensure that your gradescope account email matches your official main Berkeley email (you may not receive lab grades otherwise)

Lab Overview and Goals

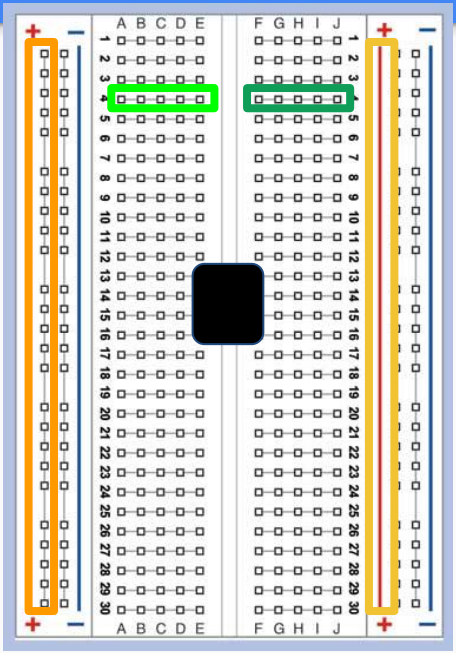
Lab Overview

- Lab equipment training
- Build inverting amplifier on your physical breadboard

Lab Goals

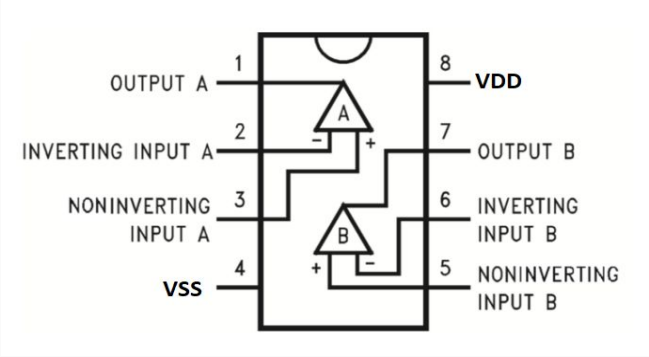
- Gain experience in debugging circuitry
- Practice breadboarding on a physical breadboard
- Learn how to use lab equipment!!!

Breadboarding 101



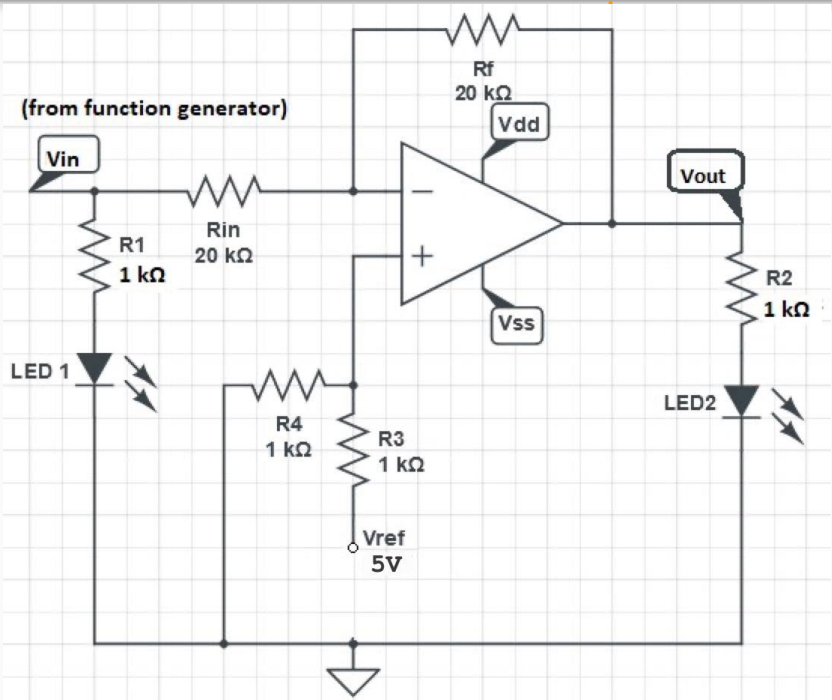
- Numbered rows are connected
  - Not connected over the notch!
- Rails connected vertically, but not to each other
  - The 2 red rails are NOT connected
- IC chips like op amps need to straddle the notch
  - Otherwise you'll short the pins together
- Rails are reserved for power traces.
  - + for DC voltage like 3.3V, - for gnd
- Color code wires for easier debugging
  - Red for power, black for gnd
- Keep things planar (flat)! Avoid excessively long wires

Lab Kit Op-Amps



- Match the notch with the diagram
- 2 op-amps on one chip
- Must straddle the notch!
- Op-amp must be powered to provide at output

Today's Circuit



- Inverting amplifier, but with an offset
- No current into inputs of op amp, so

$$i_{in} = (V_{in}-V^-)/R_{in} = (V^--V_{out})/R_f$$

- $V^- = V^+$, and solving for V_{out} we get:

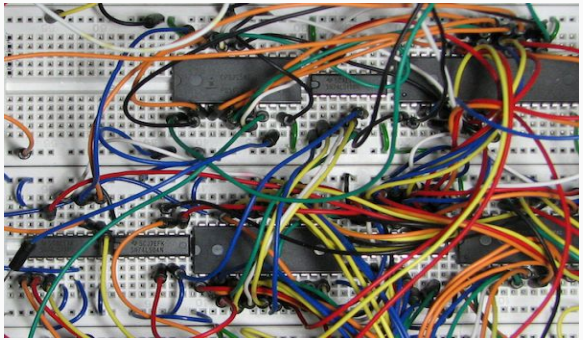
$$V_{out} = -(R_f/R_{in})V_{in} + (1+R_f/R_{in})V^+$$

- Plug in resistance values:

$$V_{out} = -V_{in} + 2(V_{ref}/2) = -V_{in} + 5V$$

Debugging 101

- Bugs happen (VERY often) - need skills to identify and fix them
  - Debugging circuits is like debugging a software program
  - Use tools like an oscilloscope to debug instead of a debugger
- Test often!
  - Take advantage of modularity and test individual parts of your circuit and test as you go
  - Make sure you see what you expect
- The oscilloscope is your friend.
  - Use it to gather clues as to what's going wrong
- Build cleanly - staff will not debug spaghetti
- Plan where components will go ahead of time
  - Tinkercad is a great tool to use for this



Common Bugs

- Grounds (breadboard ground, equipment grounds) need to all be connected/shorted
- LEDs have orientation
  - Anode (+): longer leg
  - Cathode (-): shorter leg
- Need to power op-amp with Vdd and Vss

Reminders

- Collaboration is extremely important. Collaborate not just with your lab partner, but with everyone around you.
- Don’t be afraid to ask questions if something doesn’t make sense! Submit to help queue as often as you like.
- We are here to support you.

Lab Checkoff

1. **Open the lab** (can use Datahub link or download ipynb files)
2. **Read** Lab 1 Note and 16B Debugging Guide in the ipynb
3. **Watch** Lab Equipment videos in the ipynb
4. **Build** a inverting amplifier with LEDs

Requirements for checkoff:

a) Show behavior of LEDs
b) Show input and output signals on oscilloscope
c) Have ALL Qs answered in ipynb and be prepared to answer checkoff Qs

Make sure you're marked as checked off before you leave!

Important Forms/Links

- Help request form: https://eecs16b.org/lab-help
- Checkoff request form: https://eecs16b.org/lab-checkoff
- Extension Requests: https://eecs16b.org/extensions
- Slides: https://links.eecs16b.org/lab1-slides

Equipment Training

You will watch videos for equipment training these during section, but please refer to these slides and the resources in the Jupyter notebook as a supplement to the demos.

Power Supply

- Use to generate DC voltages for our circuits.
- +6V, +25V, -25V channels
- Voltage limit: set to maximum output voltage needed
- Current limit: set to 100mA = 0.1A
- **For this lab: use +6V channel**
- *The video might have a brief moment where it shows the usage of the -25V channel or plugging into earth ground. Neither of those will be needed for lab this semester!*

Multimeter

- Use to measure voltage, current, resistance
- Continuity test: plays a sound if there is electrical connection
  - Can use to check if power and ground are shorted

Function Generator

- Use to generate waveforms (square wave, sinusoids, etc.)
- Use Black cable, NOT the Gray cable
- Channel Setup -> Output Load: Always use High Z
- Waveforms
  - Chose type: square wave, sine wave, etc.
- Parameters
  - Adjust frequency, period, amplitude, phase, offset, duty cycle, etc.
- For this lab: generate a sine wave

Oscilloscope

- Use to view waveforms (square wave, sinusoids, etc.)
- Use Gray cable, NOT the Black cable
- Probe test: Follow instructions in equipment guide to view square wave
- Use knobs to adjust horizontal, time division; vertical, voltage division; vertical shift
- Trigger
  - Use to view static signal
- Cursors/Meas
  - Use to take measurements
- For this lab: view sine wave at input and output of inverting amplifier