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

\[ i_{in} = \frac{(V_{in} - V^-)}{R_{in}} = \frac{(V^+ - V_{out})}{R_f} \]

● \( V^- = V^+ \), and solving for \( V_{out} \) we get:

\[ V_{out} = -\left(\frac{R_f}{R_{in}}\right)V_{in} + \left(1 + \frac{R_f}{R_{in}}\right)V^+ \]

● Plug in resistance values:

\[ V_{out} = -V_{in} + 2\left(\frac{V_{ref}}{2}\right) = -V_{in} + 5V \]
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](https://eecs16b.org/lab-help)
- Checkoff request form: [https://eecs16b.org/lab-checkoff](https://eecs16b.org/lab-checkoff)
- Extension Requests: [https://eecs16b.org/extensions](https://eecs16b.org/extensions)
- Slides: [https://links.eecs16b.org/lab1-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