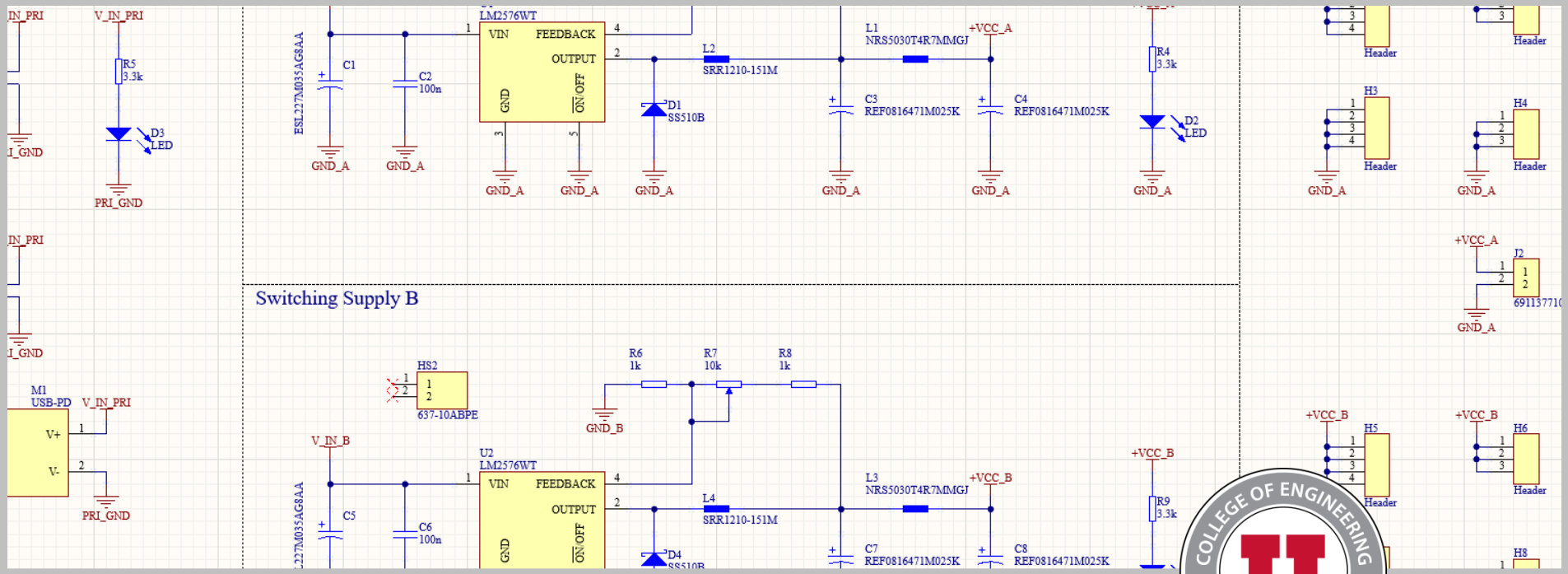
IEEE PCB Design Workshop: (Week 01)

Introduction to Schematics



Hosted By: Adrian Sucahyo and IEEE at the University of Utah

Adapted From: IEEE x FSAE Workshop SP25 with Nick Howard and Adrian Sucahyo

Workshop Outline

Tentatively scheduled for ~9 weeks

- Sept. 3 – Introduction to Schematics
- Sept. 10 – Schematics Continued
- Sept. 17 – Introduction to PCB Layout
- Sept. 24 – Layout Continued
- Oct. 1 – Open Work Session
- ** FALL BREAK **
- Oct. 22 – Soldering Week 1
- Oct. 29 – Soldering Week 2
- Nov. 5 – Soldering Week 3
- Nov. 12 – Final Notes and Next Steps

Workshop Logistics

- We **highly** recommend attending all workshop sessions
  - Each session is designed to build off previously discussed materials

- By the end of the workshop, you will be able to:
  - Build an adjustable USB-C Breadboard Power Supply
  - Understand the basics of schematic layout, PCB layout, and board manufacturing
  - Gain experience with through-hole and surface mount PCB assembly
  - Have a basic understanding of manufacturing techniques and equipment used in the industry

Workshop Logistics

- We hope to not charge a fee for this workshop and supporting materials
  - Tentative on ASUU funding for the Fall Semester
  - Will know by October if fees will be necessary

- Want to pursue a different project? Chat or Email Us!
  - We may be able to support individual projects get board manufactured

Want more experience?

- Consider joining the FSAE tractive team!
  - The Tractive Team is currently looking for students to assist with designing and assembling the electrical system for an electric formula-style race car!
  - No experience required!

U of U FSAE Discord Link

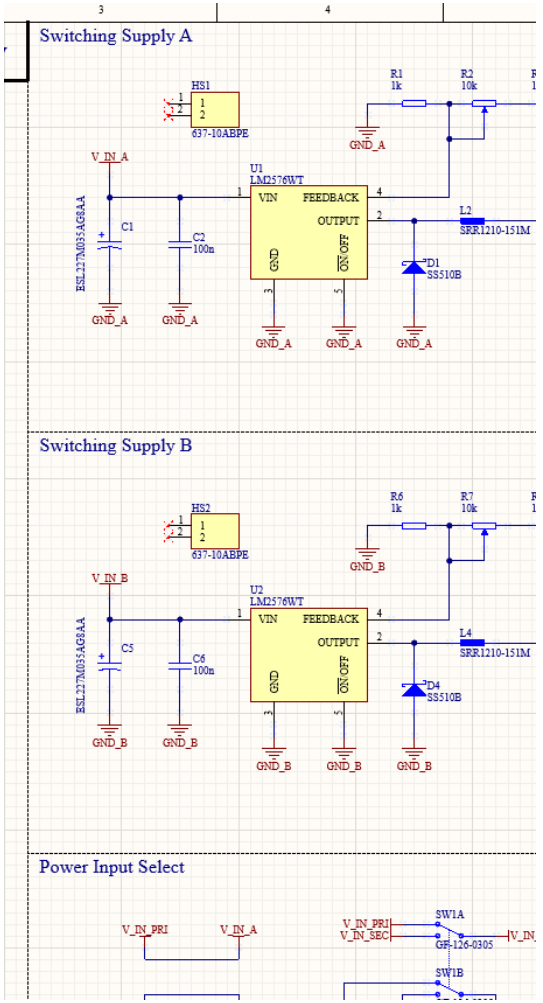
Join the IEEE Discord

- If you haven't already, please join the IEEE Discord server for additional information and updates regarding this workshop

U of U IEEE Discord Link

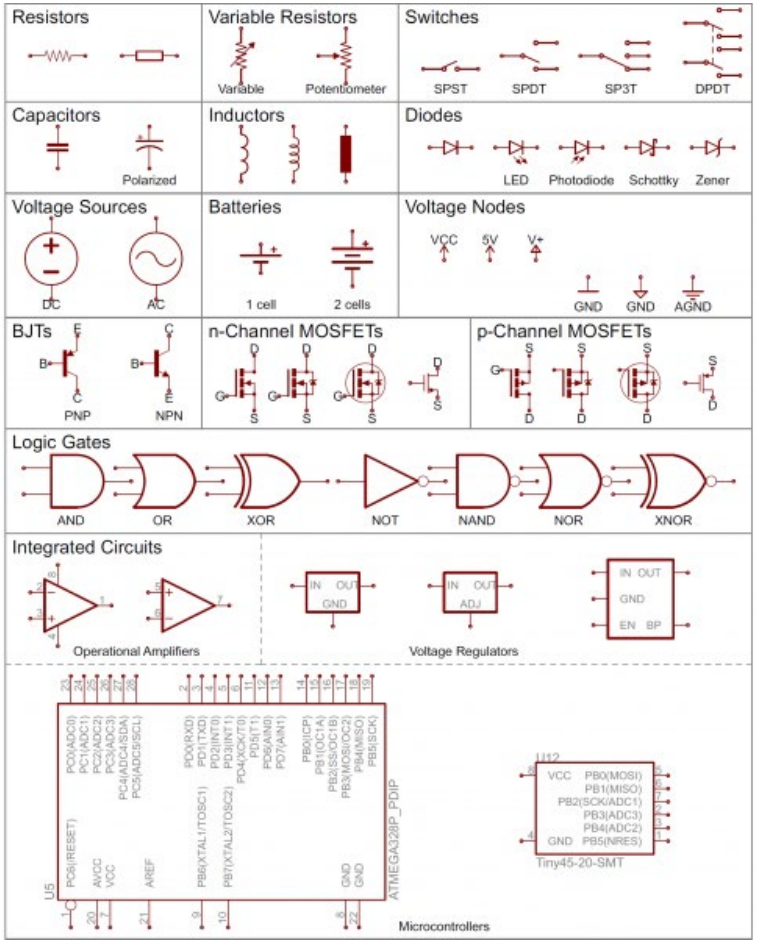
What is a schematic?

- Schematics are a graphical representation of an electrical circuit or system
  - A step up from a block diagram
  - Shows all parts and electrical connections in a circuit
  - Used to route PCB traces during layout
- Schematics are NOT a physical representation of component positions on the PCB



Components in a Schematic

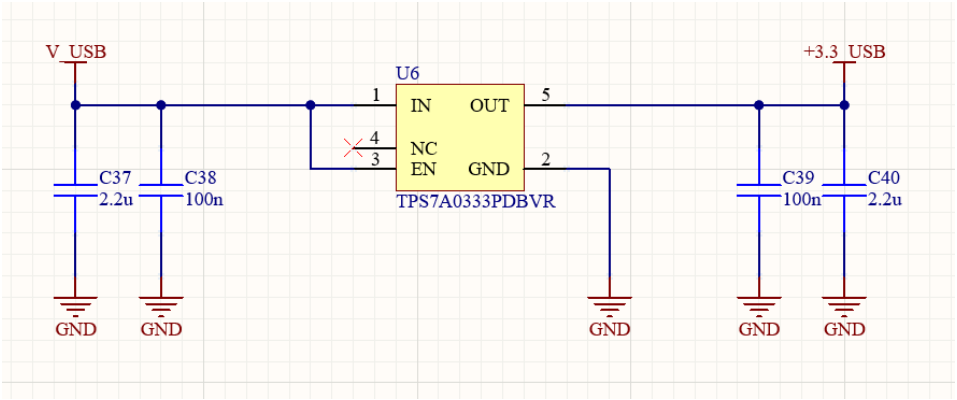
- Every electrical component will have its own symbol within the schematic
  - Contains all pins connected to the component
  - May contain additional information such as signal type
  - Relatively consistent across platforms

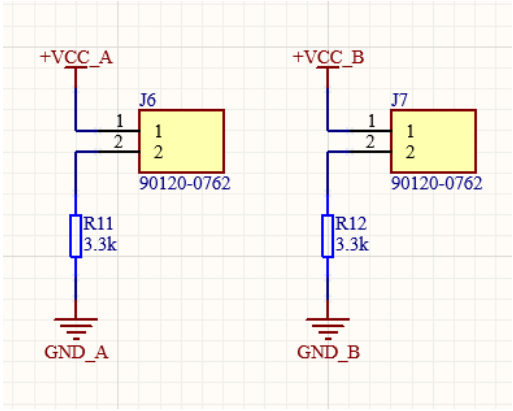


https://learn.sparkfun.com/tutorials/how-to-read-a-schematic/all

Symbol Attributes

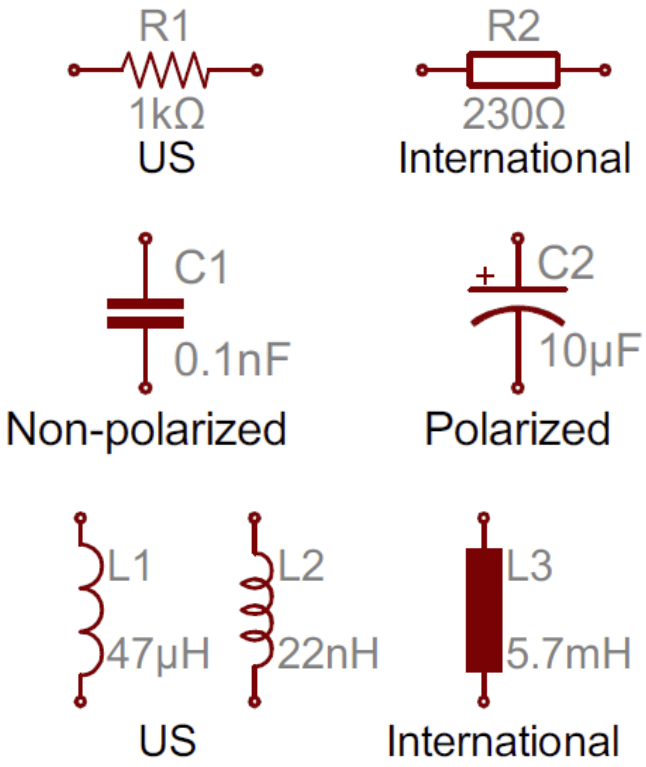
- Symbols may have additional information regarding the component they represent
  - Designators
  - Values
  - Part Numbers
  - Pin Name
  - Pin Number





US vs International Symbols

- You may see variations on certain components between US and International Schematics
  - Resistors, Capacitors, Inductors and more may have slightly different schematic symbols



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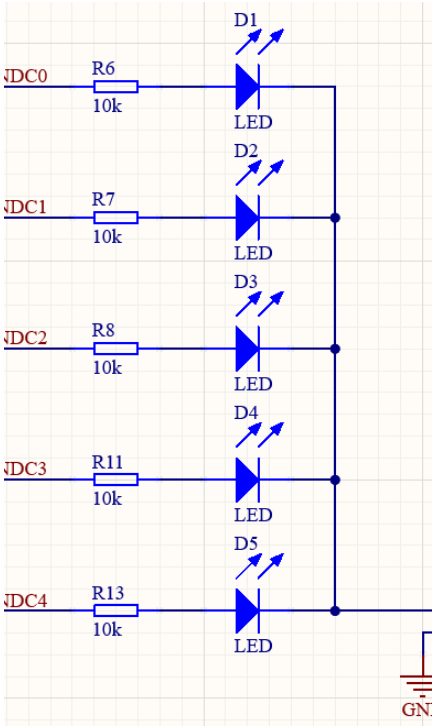
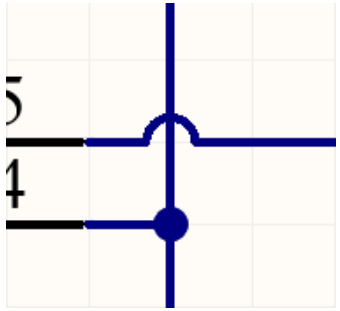
Nets and Nodes

- Schematic Nets are how components are electrically connected in a circuit
  - Represented with lines between components
- Nodes/Junctions are locations where wires split in two (or more)
  - A connection on a node is denoted by a dot

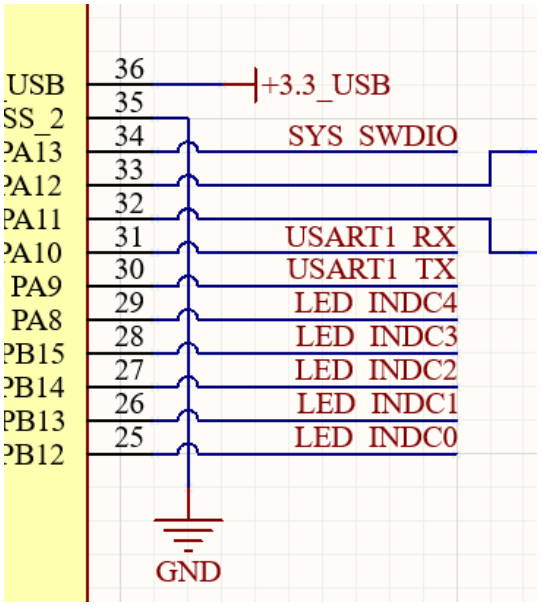


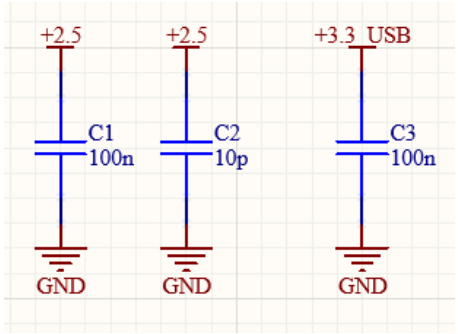


Net Labels

- Net Labels allow electrical connections to be made without having to draw a line between components
  - Net Labels tend to be local to the current schematic sheet
  - Power Labels tend to be global to the full design

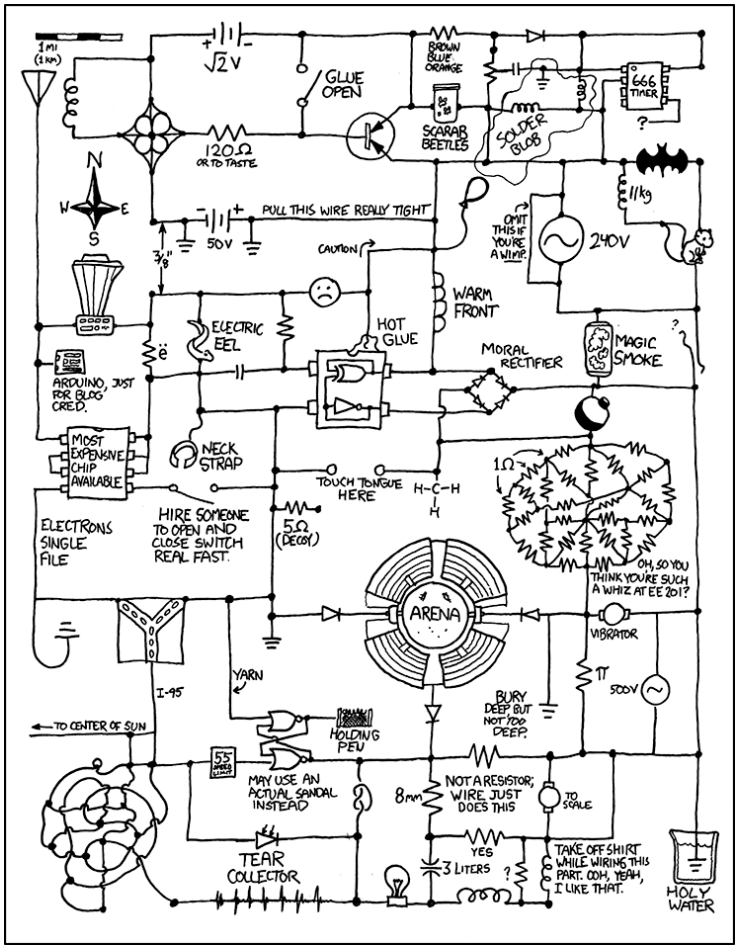
- Note: Ports are similar but have a different purpose
  - Useful for hierarchal / multi-sheet design





Good Schematic Practice

- Readability is KEY!
  - The schematic needs to be read by other engineers to assist with layout and debugging
  - Readable schematics make it easier to find electrical errors which would be translated into the physical layout

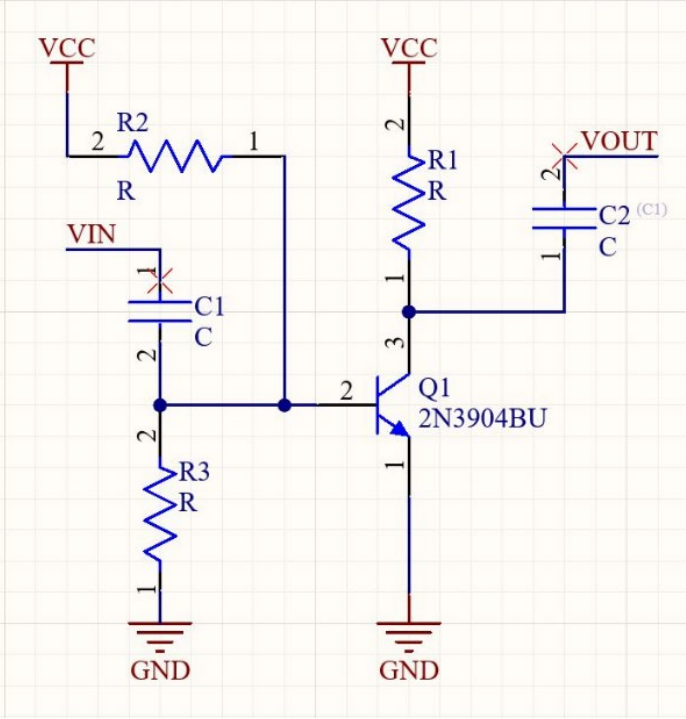


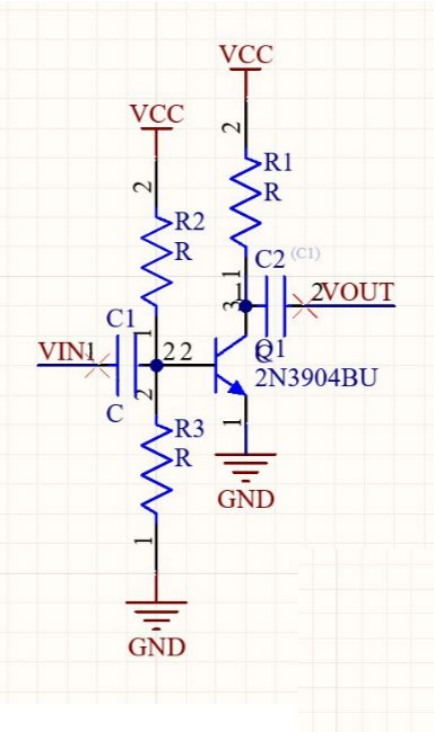
https://xkcd.com/730/

Tips:

- Read Left to Right
- Don’t Overcrowd
  - Use a larger sheet or use multi-sheet drawings
- Use Logical Blocks to Divide Circuit Elements
- Reference Manufacturer Datasheets
  - Follow established layouts
- Label Signals
  - Especially those which are not immediately obvious
- Keep Power Sources at the top and GND at the Bottom

Examples:


VCC
R2
R
VIN
C1
C
R3
R
GND
Q1
2N3904BU
VCC
R1
R
VOUT
C2
C
GND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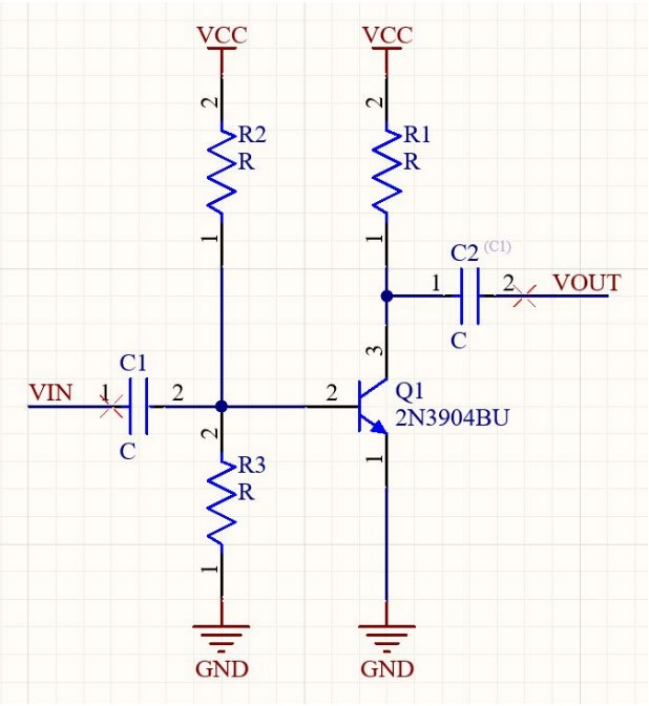
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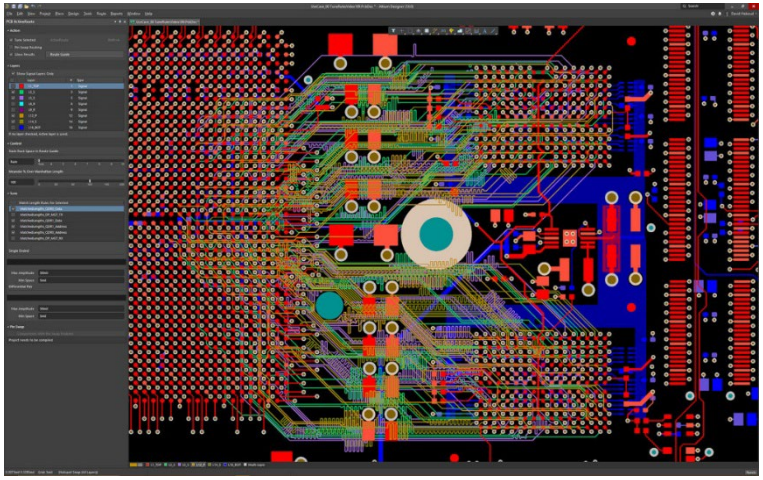
Q1
2N3904BU
GND

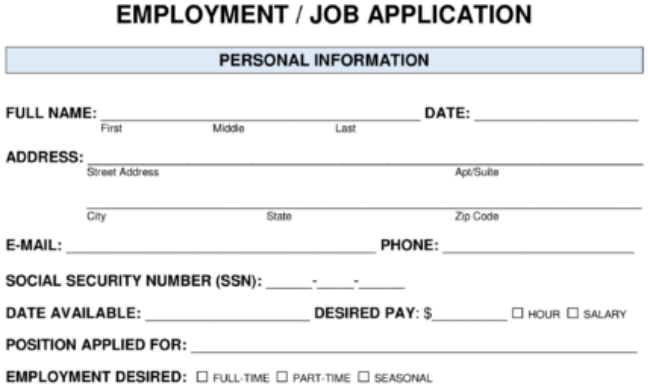
ECAD Software

- ECAD (Electronic Computer-Aided Design) are software used to design and create diagrams and layouts for PCBs
- There are many different vendors for ECAD software:
  - Altium
  - KiCAD
  - Eagle
  - OrCAD
  - EasyEDA

Why Altium?

- Altium is very commonly used in the industry for PCB and circuit assembly
- Not many opportunities to get access to the software outside of university
  - Please get your student license ASAP if you haven't already
- Great addition to your resume!





EMPLOYMENT / JOB APPLICATION

PERSONAL INFORMATION

FULL NAME: _____ DATE: _____
First Middle Last

ADDRESS: _____
Street Address Apt/Suite

_____
City State Zip Code

E-MAIL: _____ PHONE: _____

SOCIAL SECURITY NUMBER (SSN): ___-___-____

DATE AVAILABLE: _____ DESIRED PAY: $_____ ☐ HOUR ☐ SALARY

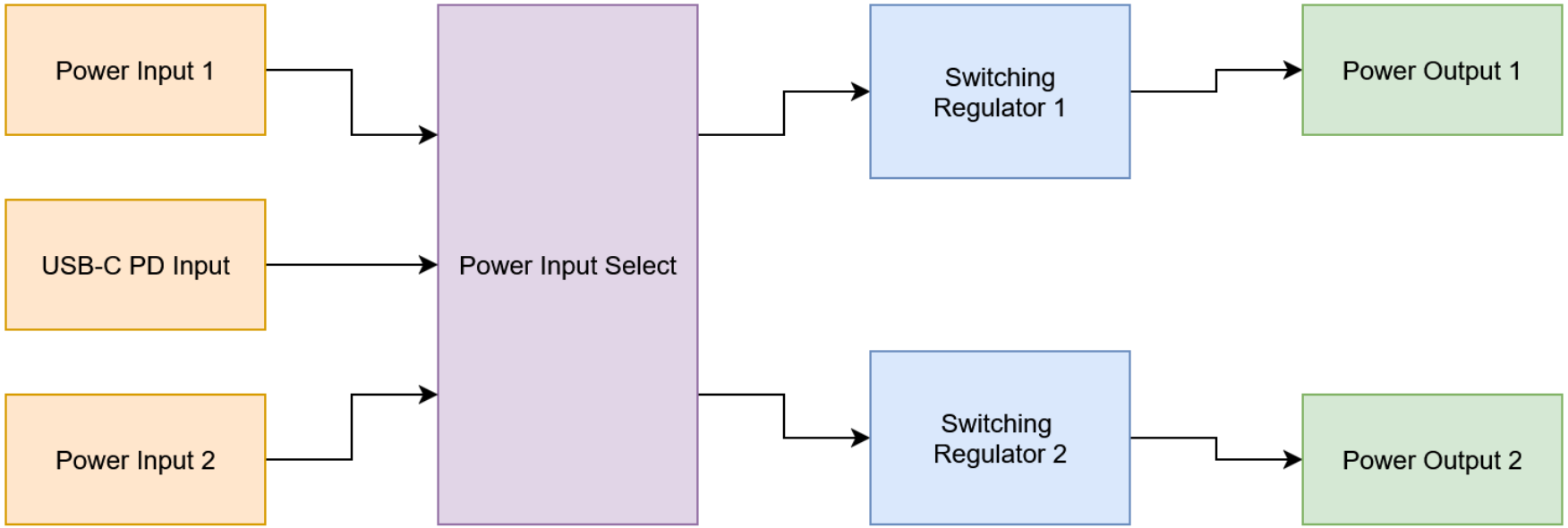
POSITION APPLIED FOR: _____

EMPLOYMENT DESIRED: ☐ FULL-TIME ☐ PART-TIME ☐ SEASONAL

Project Introduction

- **USB-C Breadboard Power Supply**
  - Dual Switching Supplies
    - Independent Voltage Outputs
    - Switch between isolated / tandem supplies
  - Dual Input Supplies
    - Primary and Secondary Supplies
    - Terminal Block Input
  - USB-C PD trigger on Primary Supply
    - Additional Barrel Jack DC input
  - Configurable output bleeder resistors

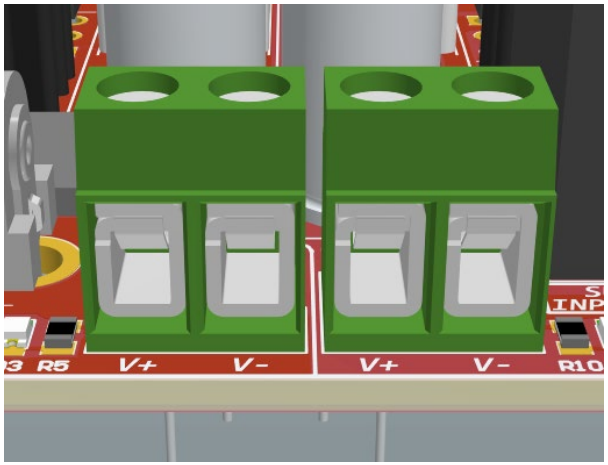
Block Diagram



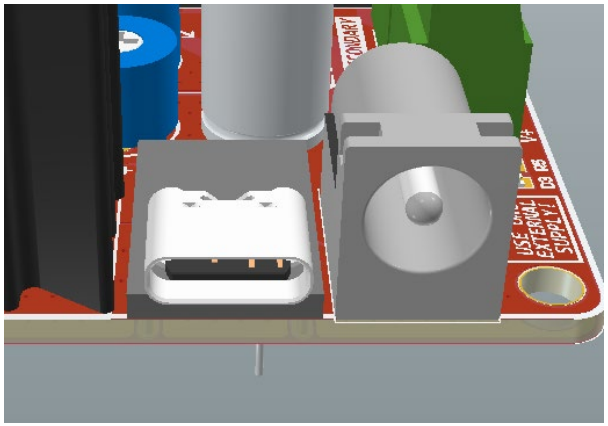
Block diagram drawn using draw.io

Power Inputs and Input Selection

- **Power Inputs**
  - Terminal Block Input
  - Barrel Jack Input
  - USB-C PD Breakout
  - 20 VDC Max

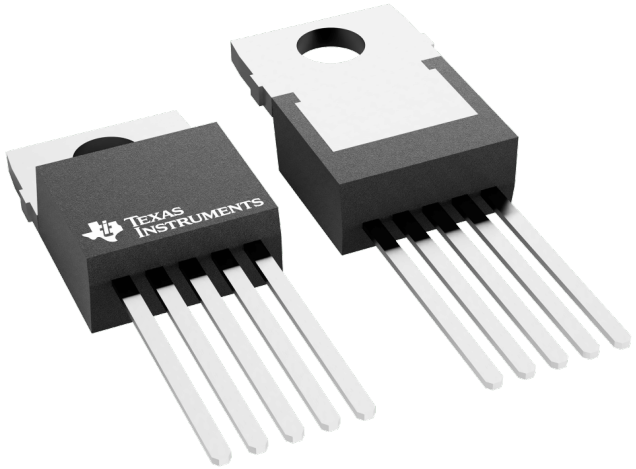


- **Input Selection**
  - Select between a primary and secondary supply
  - Isolate supply A and B for independent operation

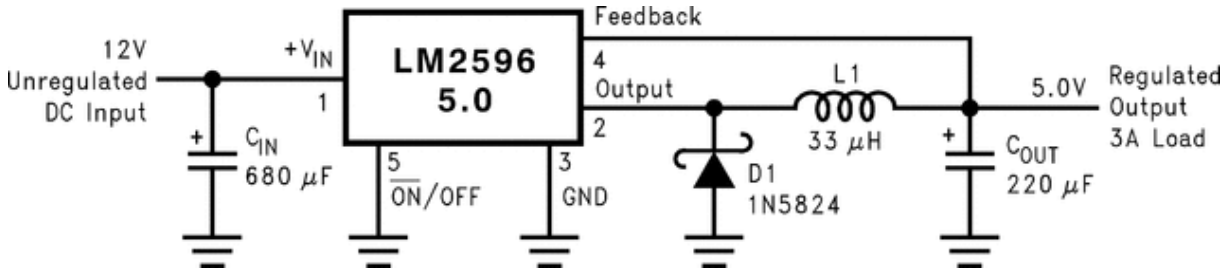


Switching Supplies

- **Texas Instruments Simple Switchers – LM2596**
  - Buck Converter
  - Adjustable Output
  - 3 Amp Output Load Capacity



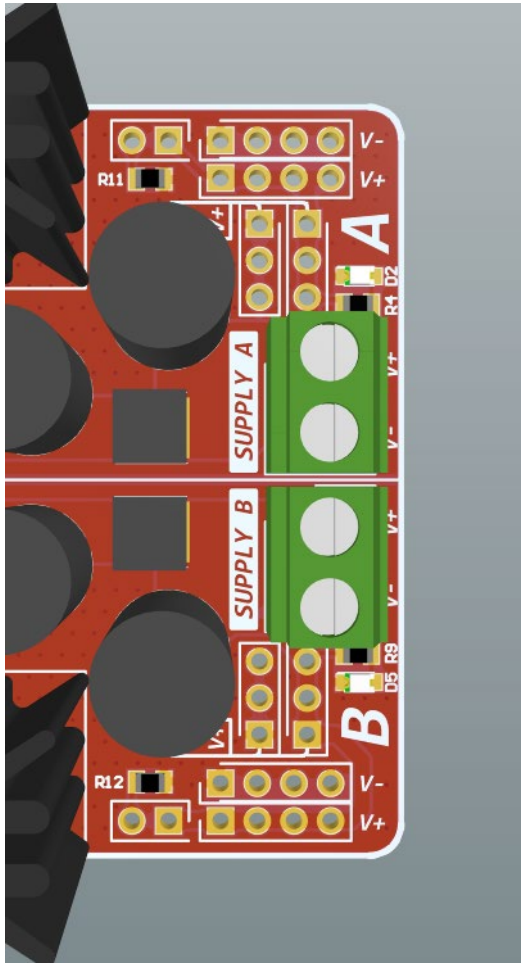
- Reference Datasheet for more information and reference circuit



https://www.ti.com/product/LM2596

Power Outputs

- **Power Outputs**
  - Terminal Block Input
  - Pin Headers
  - Breadboard width for easy utilization
- Output Bleeder Resistors



Questions?

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Download Today's Project Files

Navigate to the workshop GitHub and download today's files

https://github.com/IEEE-U-of-U/IEEE-PCB-Workshop-Fall-2025