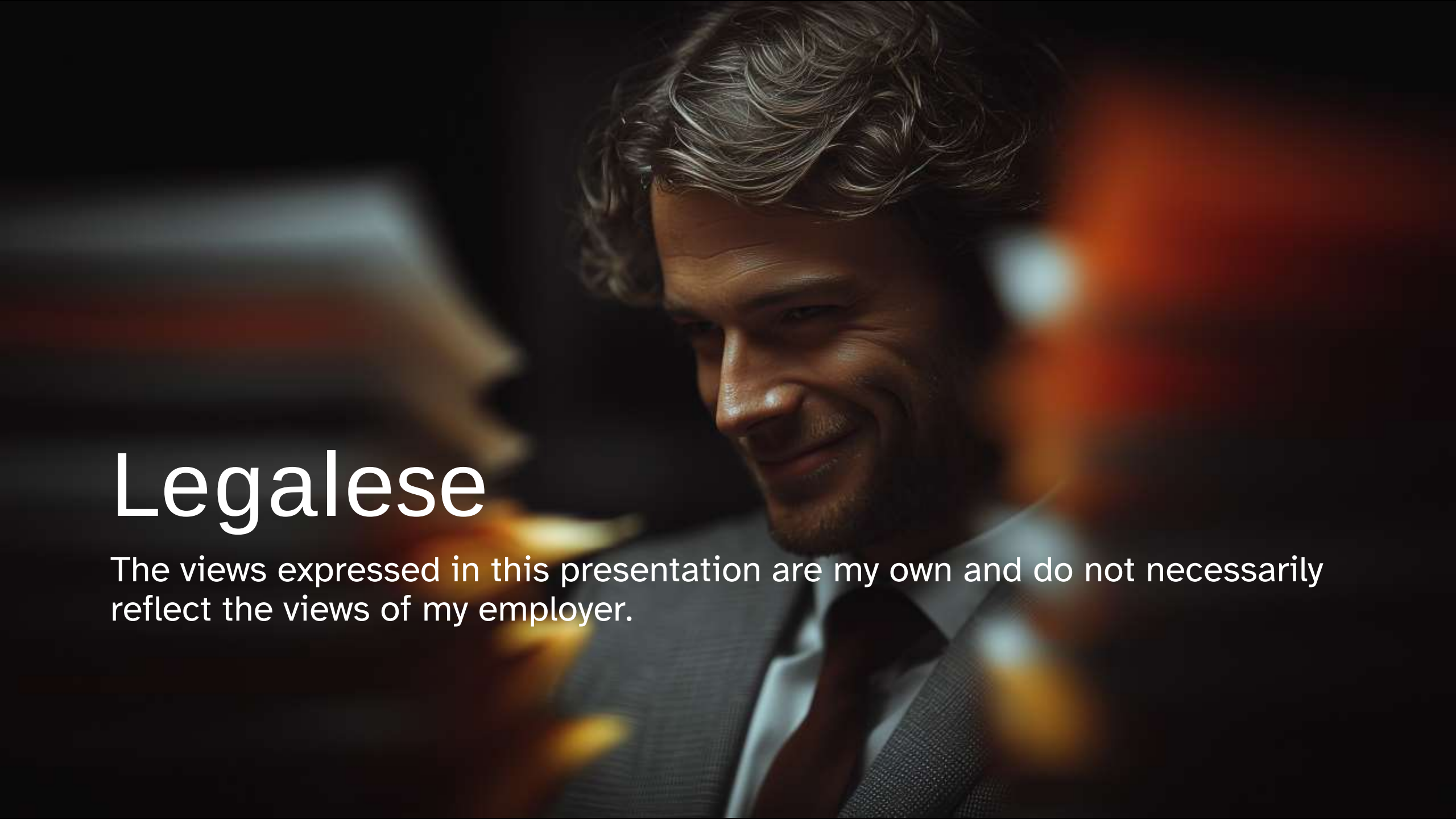

So you want to make a badge?
Badge Creation 101, from SAO to full #badgelife
Jeff “BigTaro” Geisperger
A little bit of self-doxx



Legalese

The views expressed in this presentation are my own and do not necessarily reflect the views of my employer.

First off... who is this guy anyway?

- Jeff, el-heffe, BigTaro, BT, that badge guy, ey YOU



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FD Party Badge

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Gunslinger-B-Gone & Sheriff SAO

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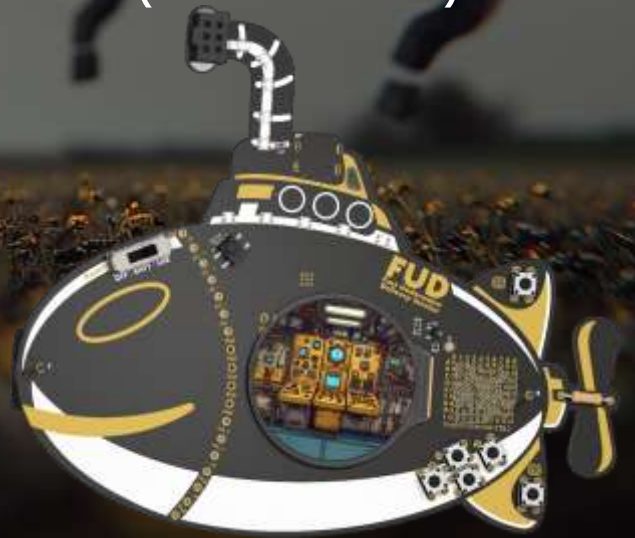
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FD Party Badge



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Submarine Badge

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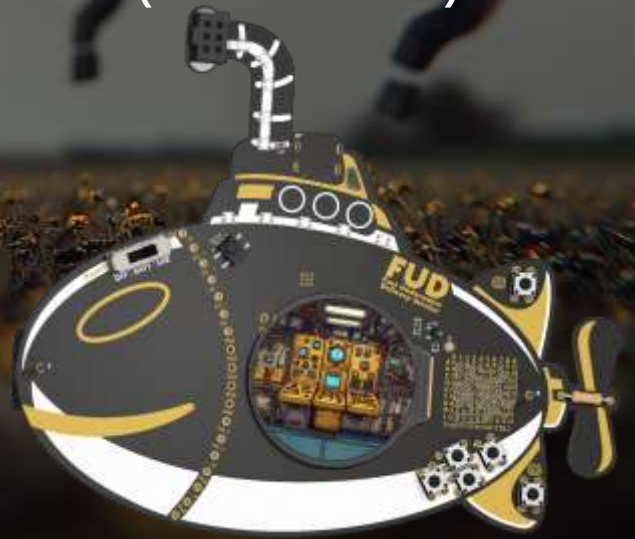
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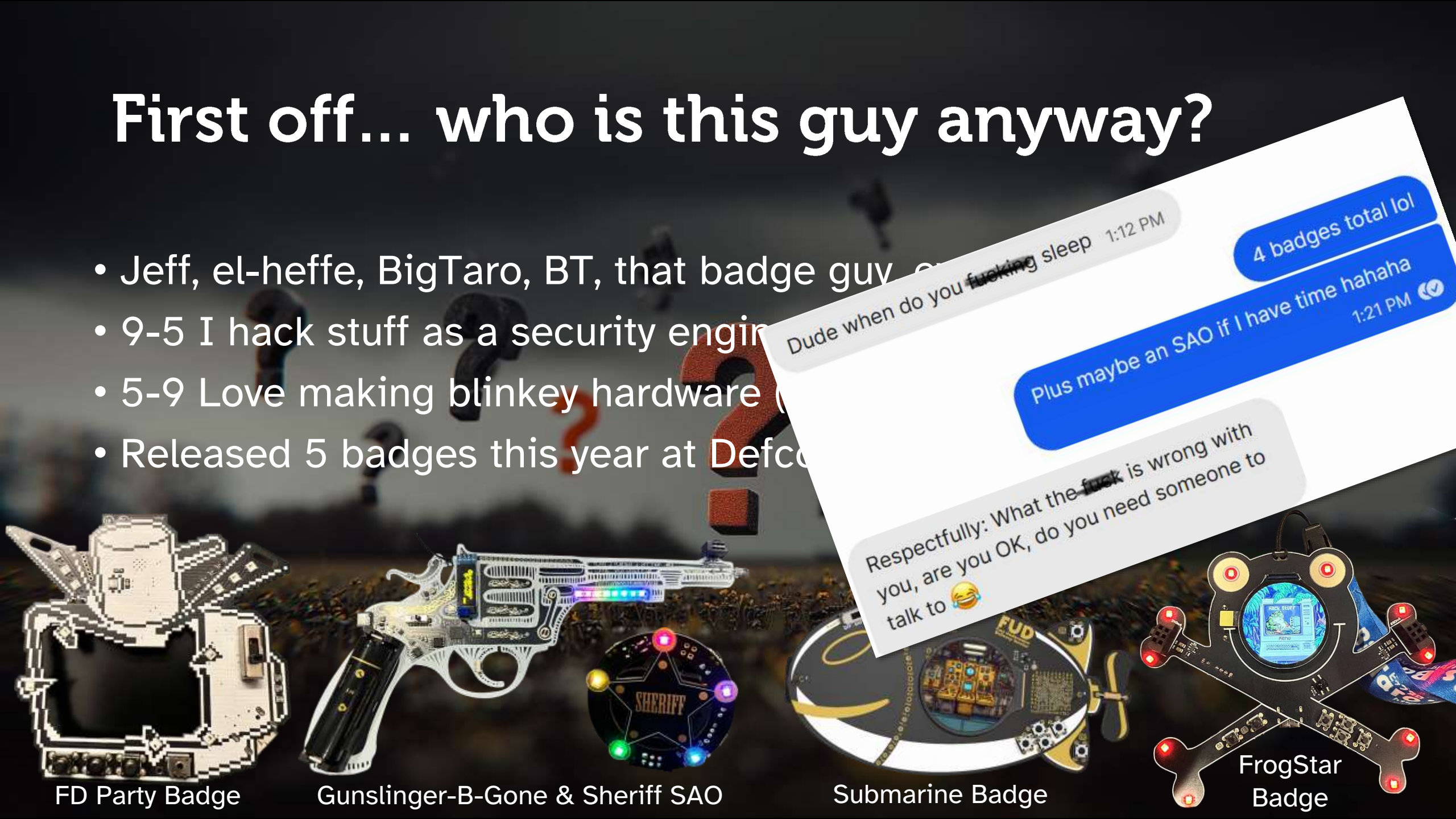
Submarine Badge



FrogStar Badge

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FD Party Badge

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DISCLAIMER



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This talk is: Build a badge from near-zero knowledge, get it working, have fun



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This talk is: Build a badge from near-zero knowledge, get it working, have fun

This talk isn’t: Making an incredibly optimized, power efficient, 1337 badge

Agenda



Agenda

- What is an SAO?



Agenda

- What is an SAO?
- Let’s make an SAO!



Agenda

- What is an SAO?
- Let’s make an SAO!
- Prototype a working badge



Agenda

- What is an SAO?
- Let’s make an SAO!
- Prototype a working badge
- Let’s turn it into a real badge



What is an SAO?



What is an SAO?

- WTF is an SAO anyway?

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What is an SAO?

- WTF is an SAO anyway?
- Shi**y/Simple Add-On
- Let’s you put a thing on a thing to get more bling
- Works independently or in tandem with another badge
- Can be as simple or complex as you want



Why start with an SAO?



Why start with an SAO?

- SAOs are a simple way to get into making hardware



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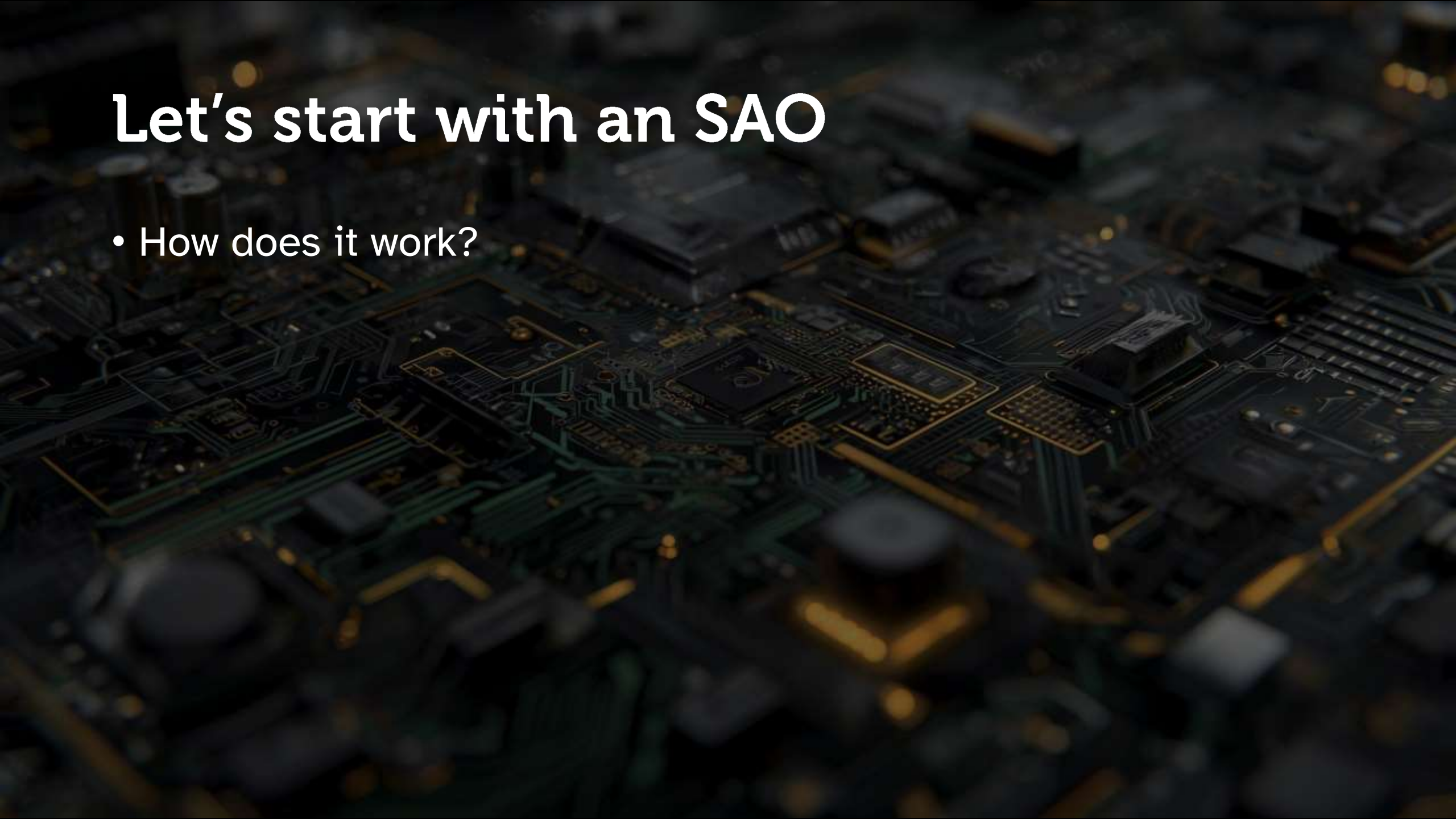
- SAOs are a simple way to get into making hardware
- Easy simple wins aka “Look Ma! I made a thing!”
- Do you enjoy the process?
- Won’t break the bank
  - 200 SAOs ~ $250 compared to thousands for badges

Let’s start with an SAO



Let’s start with an SAO

- How does it work?



Let's start with an SAO

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  - Current standard 1.69bis, lol



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Photo Credits: TwinkleTwinkie

Female: Example Female Connector: SFH11-PBPC-D03-ST-BK

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Female: Example Female Connector: SFH11-PBPC-D03-ST-BK

Male: Search AliExpress/Amazon for "Shrouded male 2.54mm pitch 2x3"

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- **tl;dr** 6 pin connector, only care about the left 2 pins (looking top down) for simple SAOs

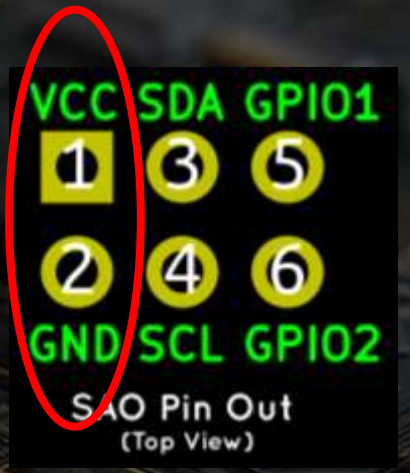






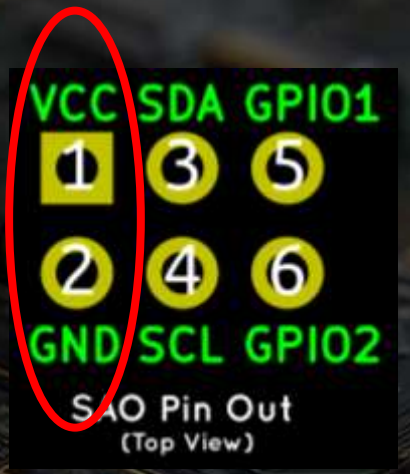
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  - The other 4 are for communicating with a host badge




Female Keyed SAO Connectors

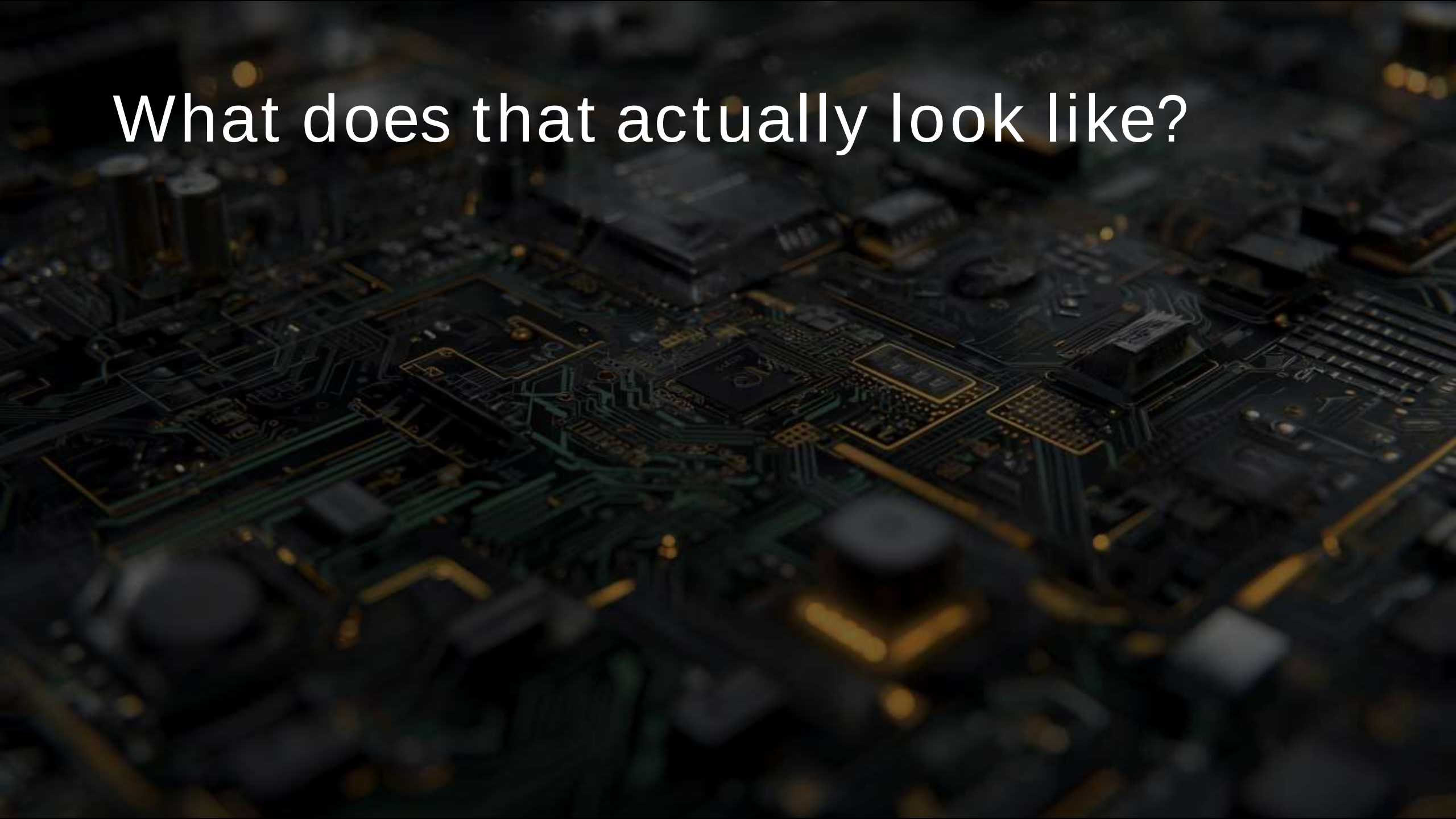

Male Shield/Box SAO Connectors

Photo Credits: TwinkleTwinkie

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What does that actually look like?

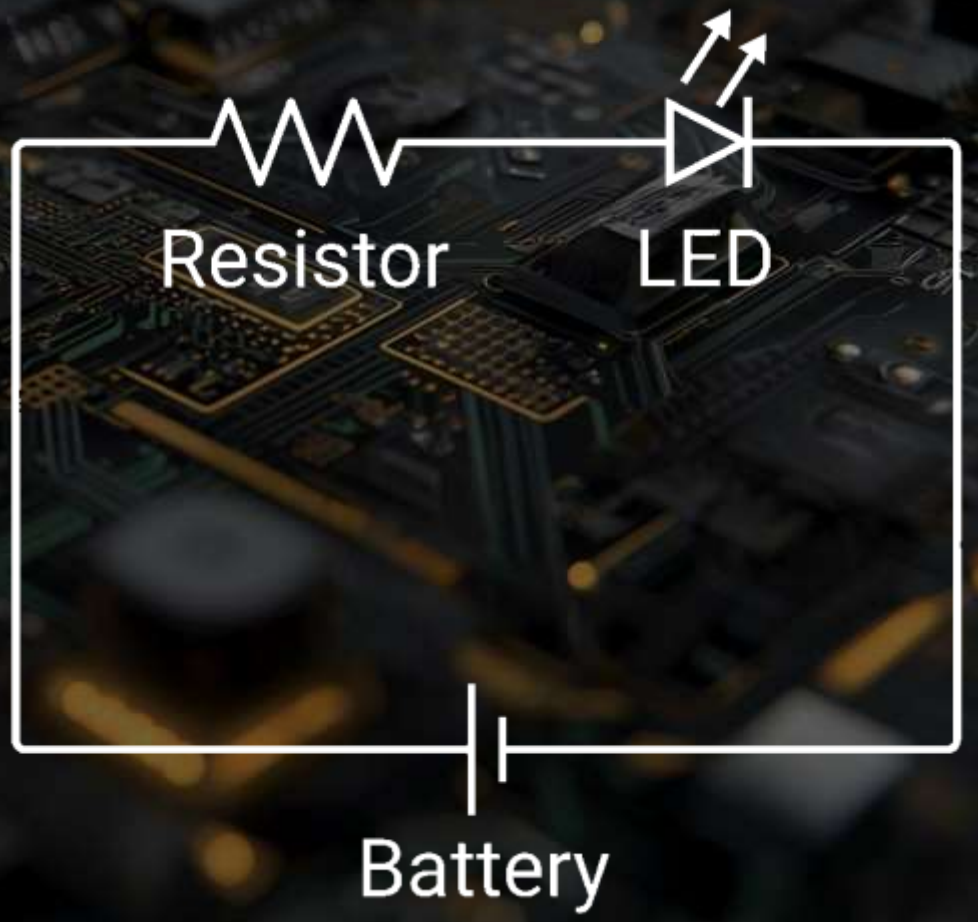


What does that actually look like?

- Let’s make one, with a single LED that’s always on

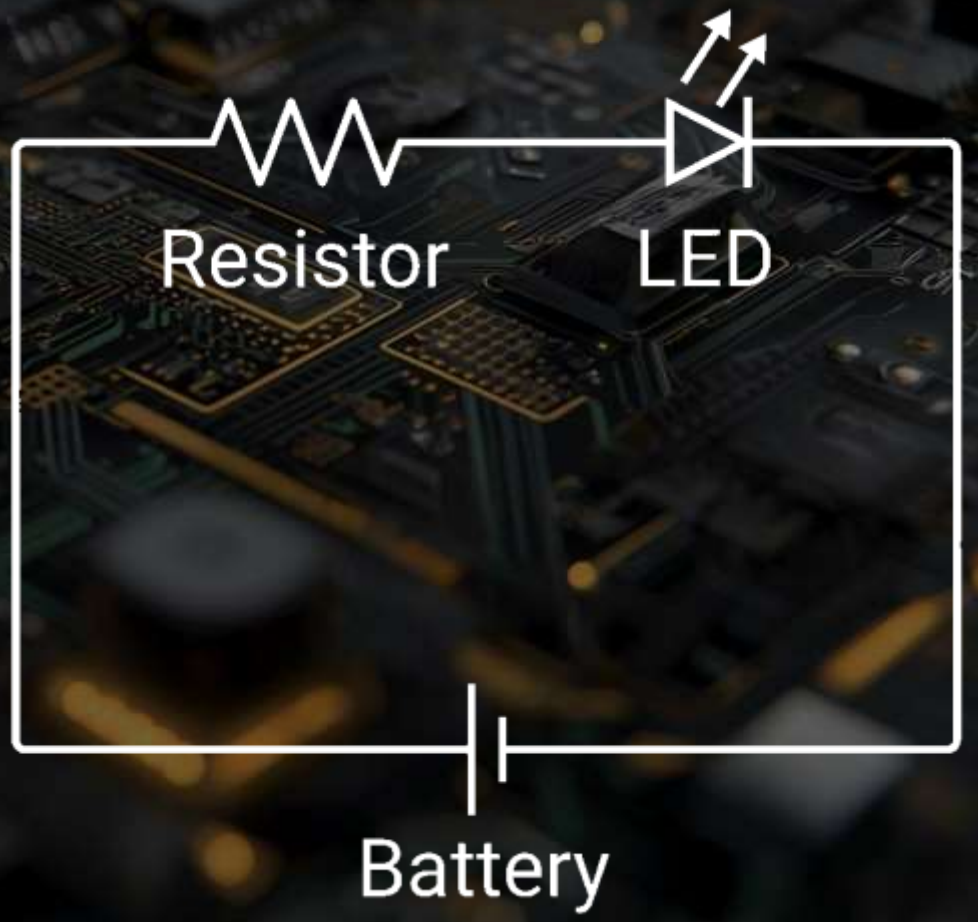
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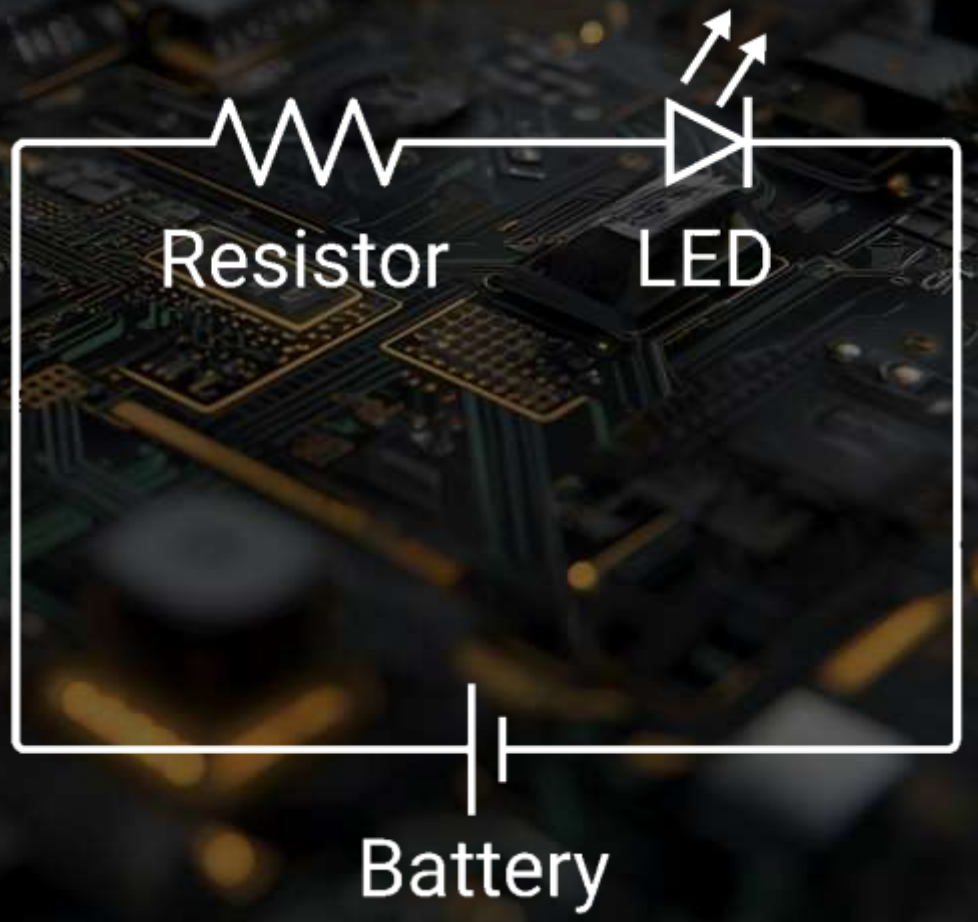
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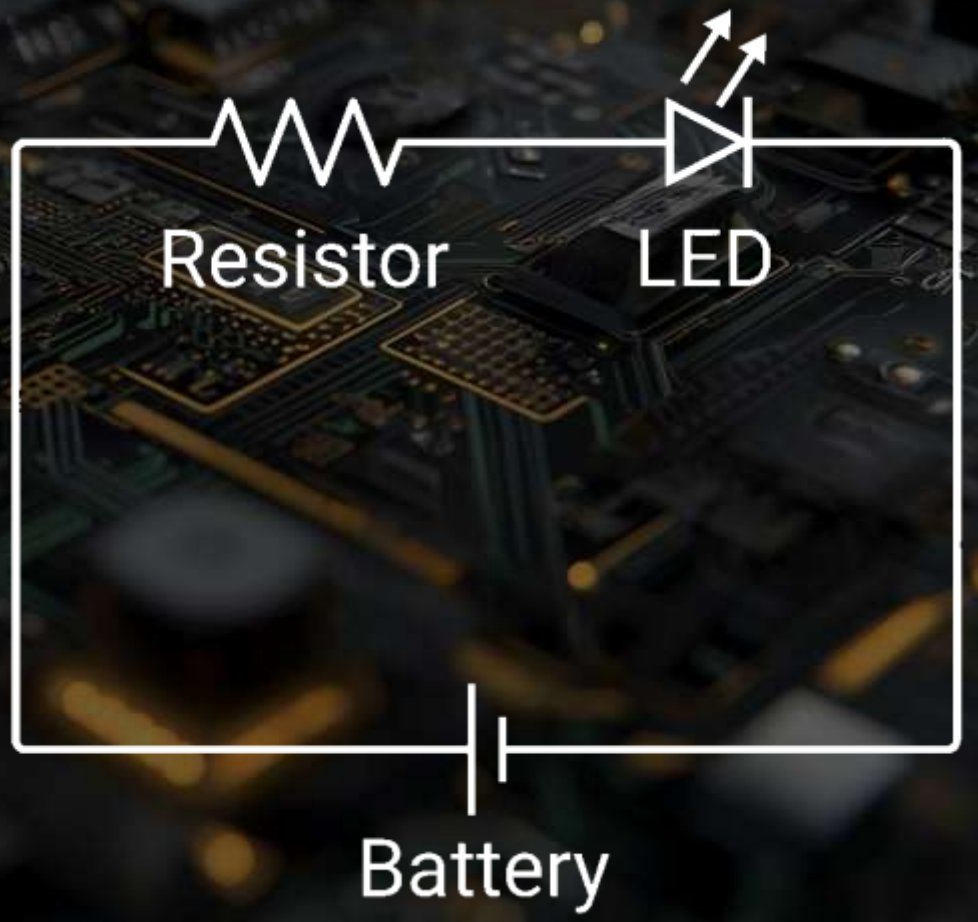
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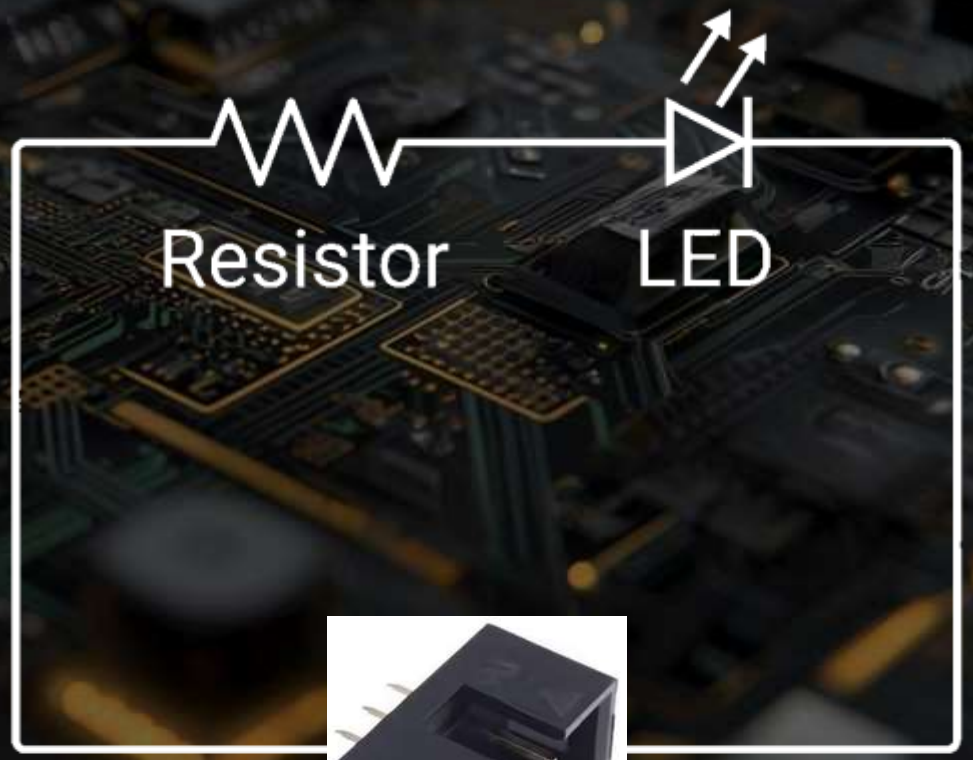
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  - Resistor
  - LED
  - Power Source
- SAO Connector is the power





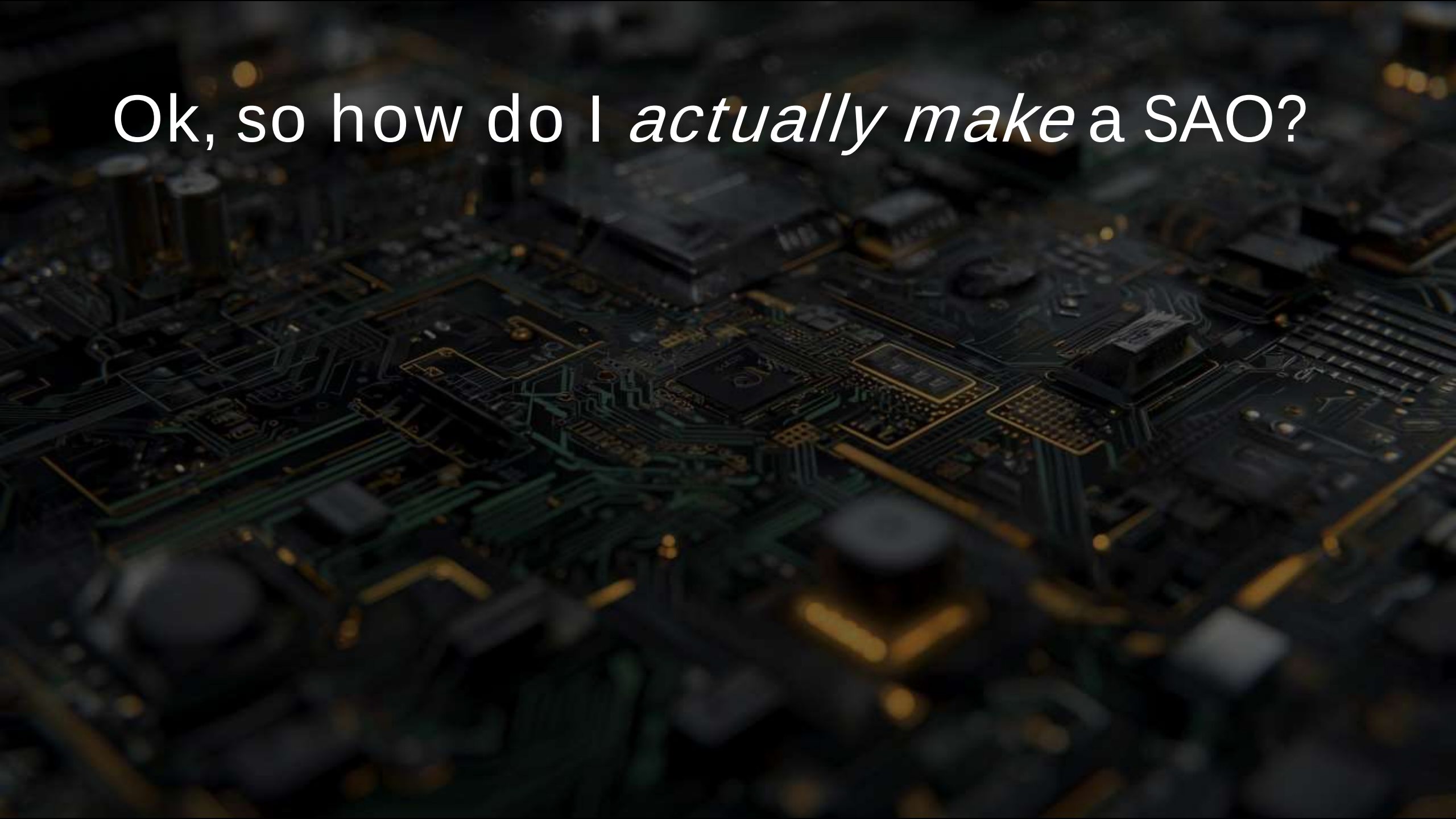
SAO Connector



Circuit done, what's next?

Let’s make the SAO a reality

Ok, so how do I *actually make* a SAO?



Ok, so how do I *actually make* a SAO?

- Start with an EDA
  - Electronic Design Automation
  - Go from circuit to circuit board

Ok, so how do I *actually make* a SAO?

- Start with an EDA
  - Electronic Design Automation
  - Go from circuit to circuit board
- What are some EDAs?
  - KiCad – Free, pretty decent
  - EasyEda – Free, less featured then KiCad, tightly intertwined to JLCPCB
  - AutoDesk Eagle - $$, monthly subscription, student version is free
  - Altium Designer – $$$$, but better for complex designs, more sophisticated modeling and auto-routing

Let's build an SAO in KiCad



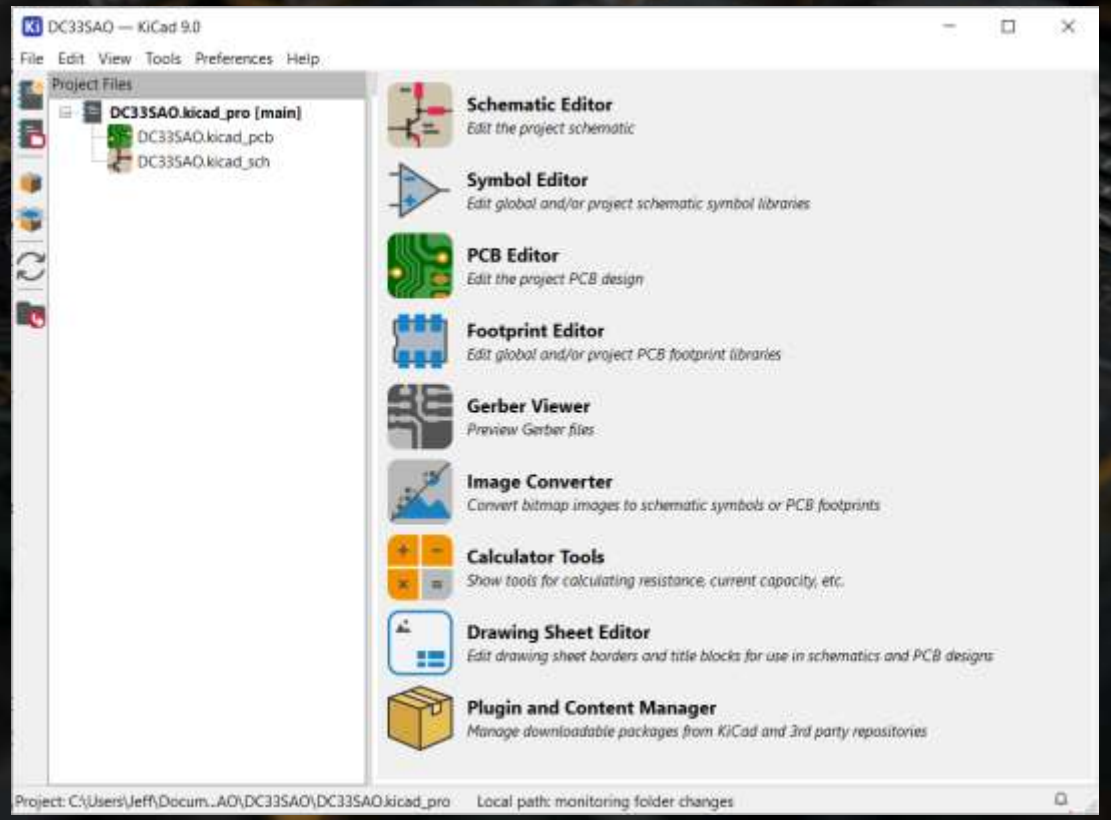
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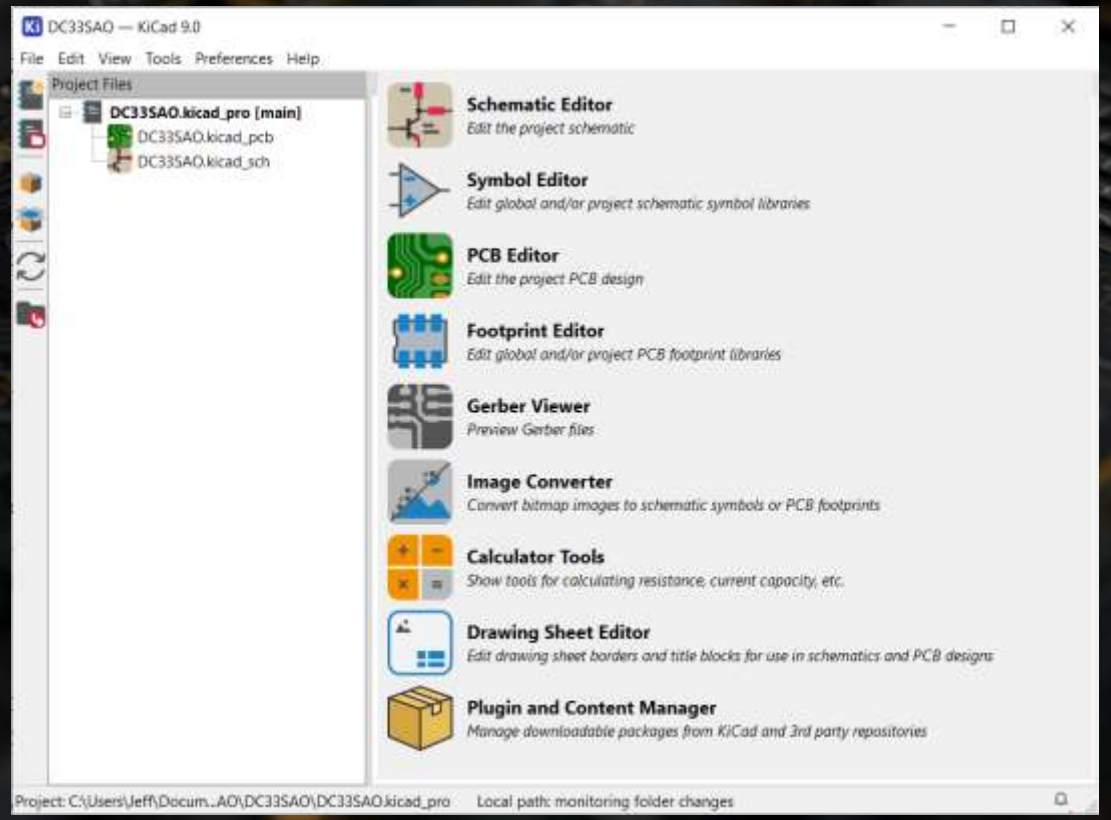
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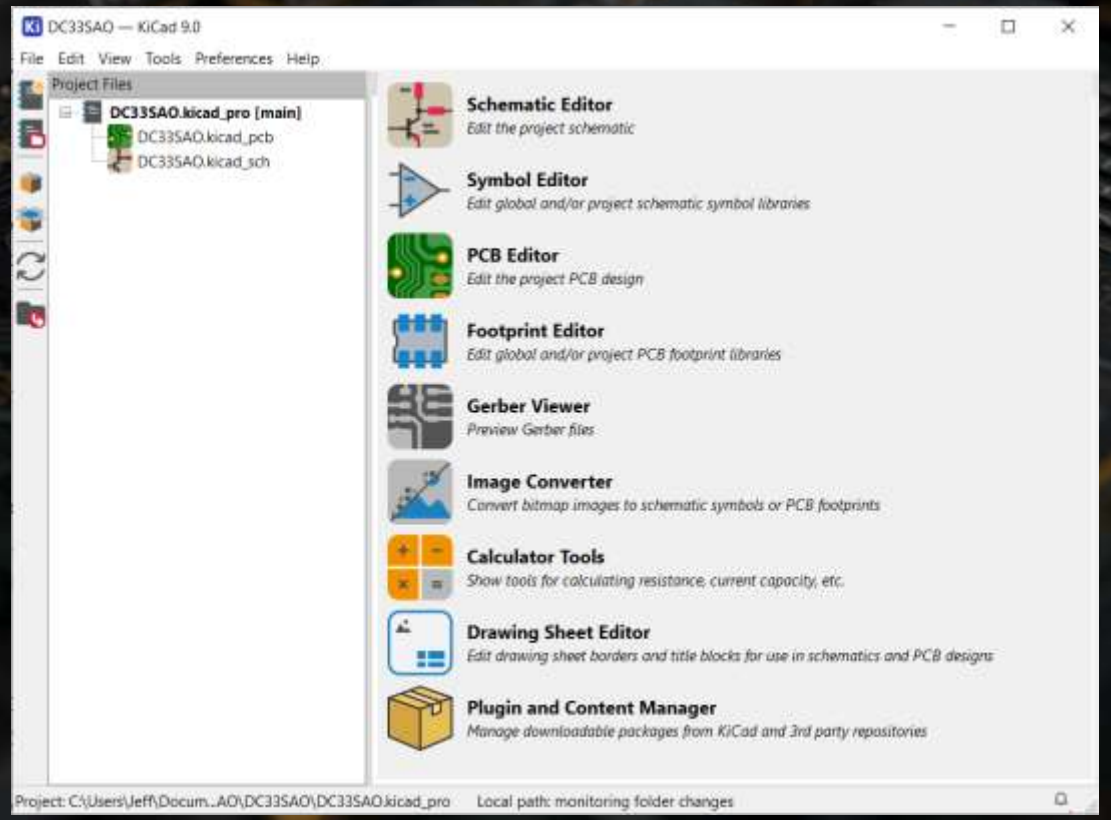
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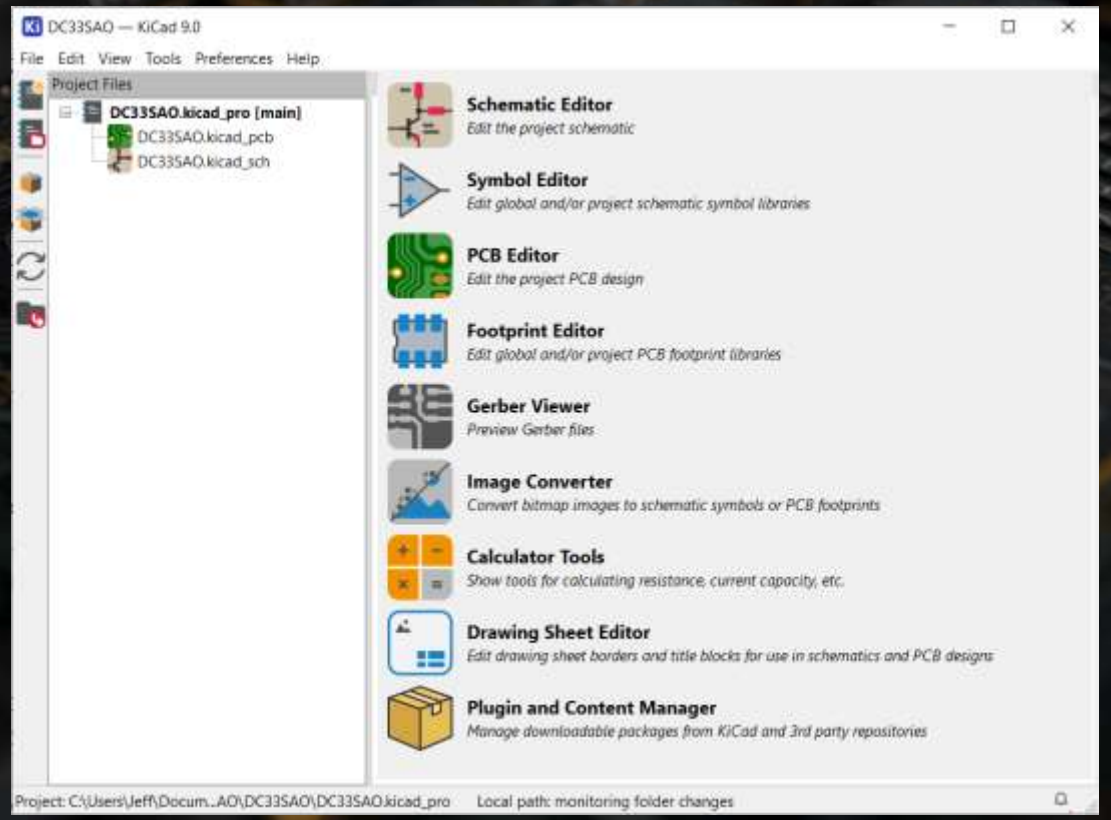
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  - Build your schematic
  - Asign footprints



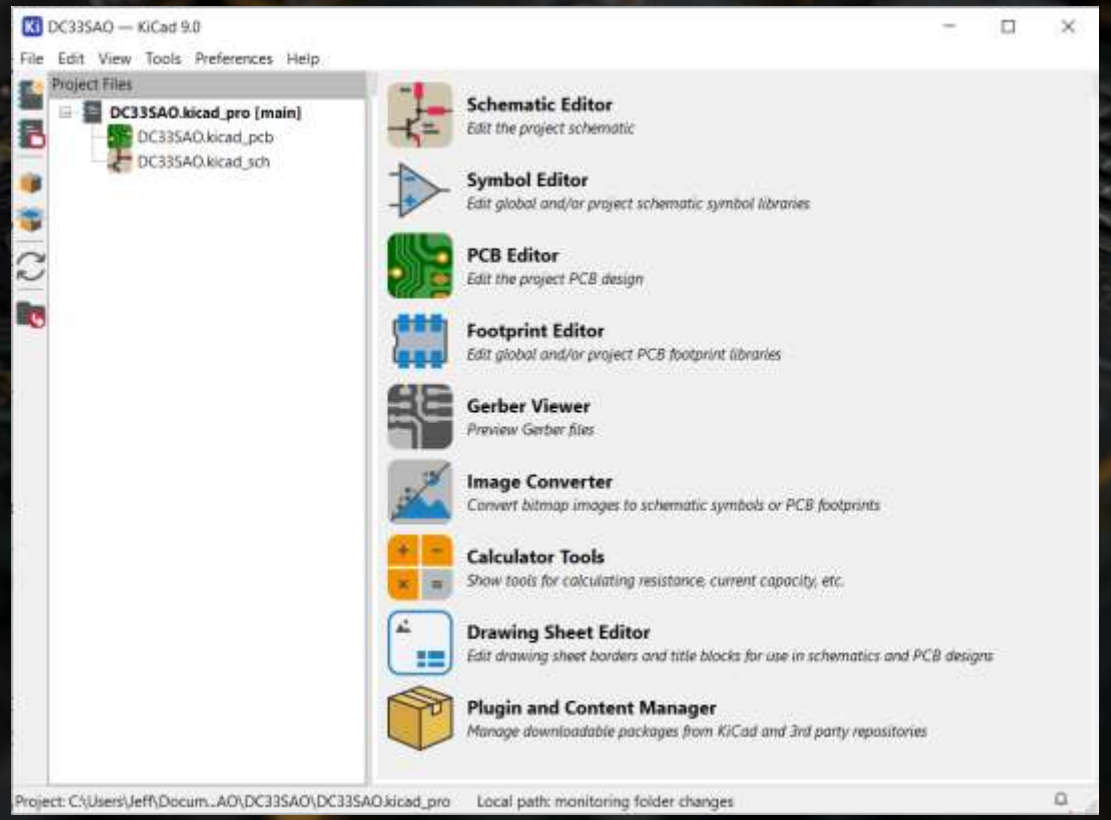
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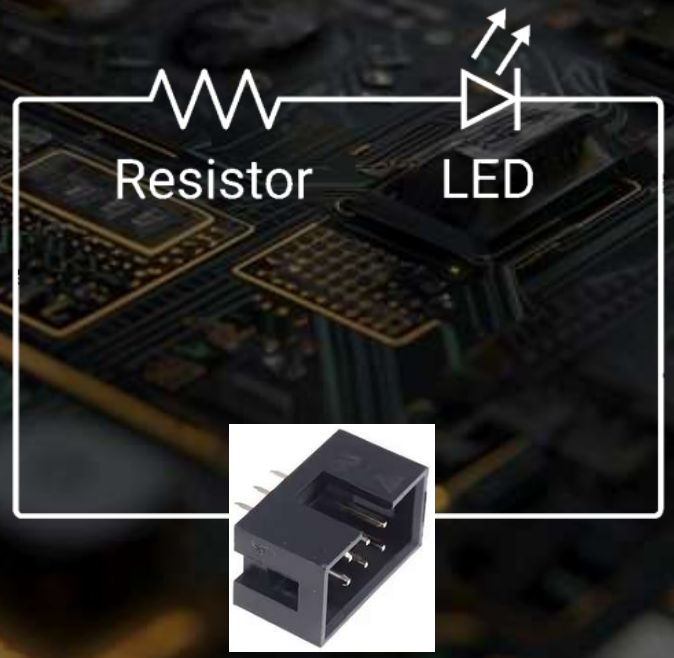


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  - Export to the factory!

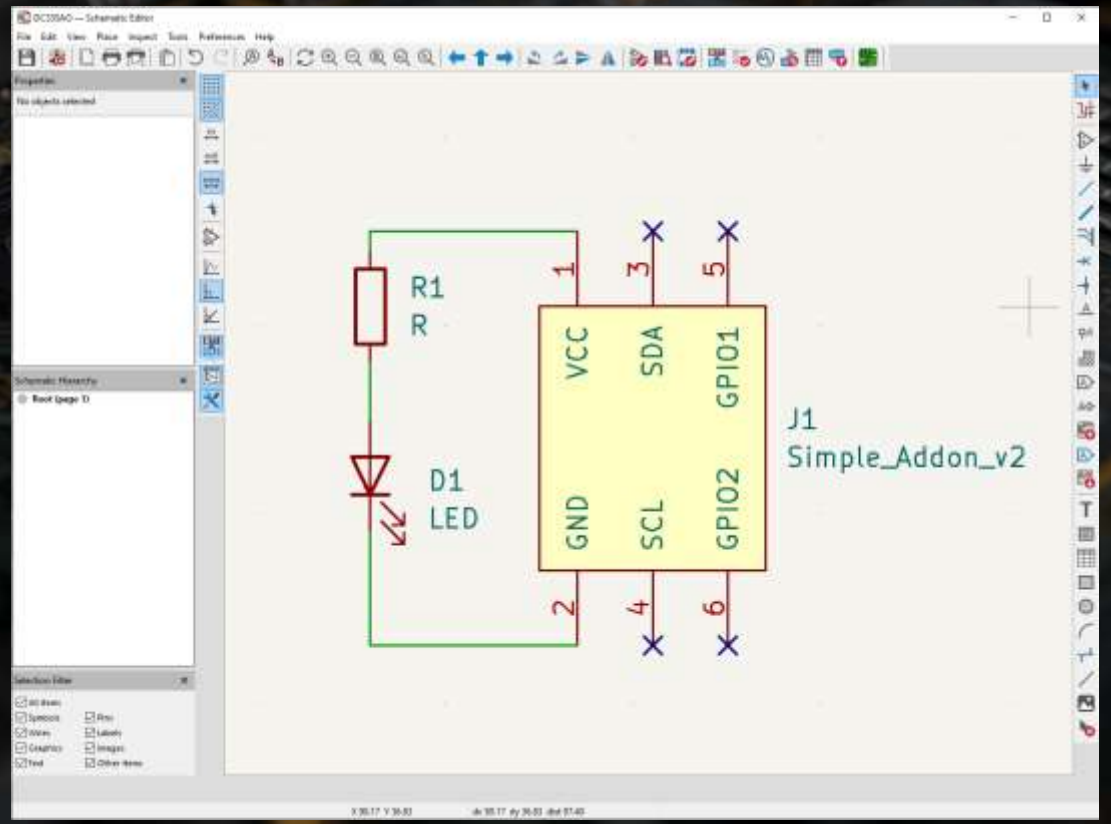


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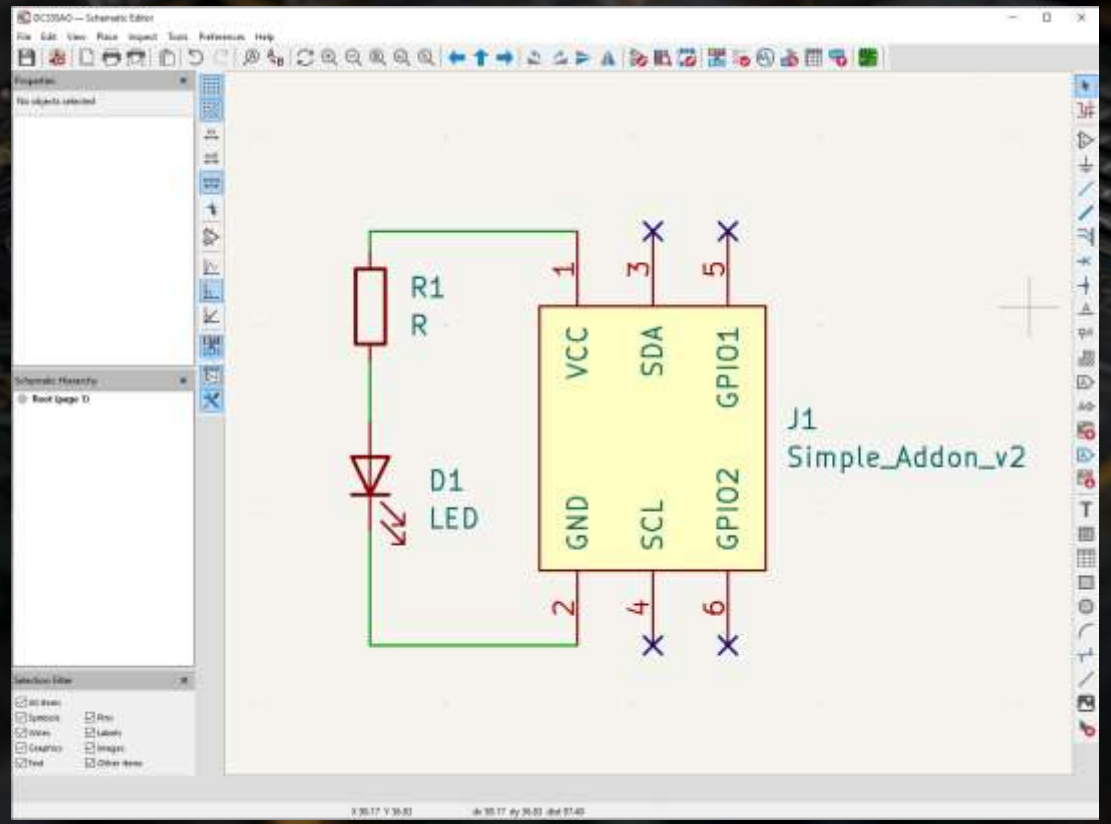
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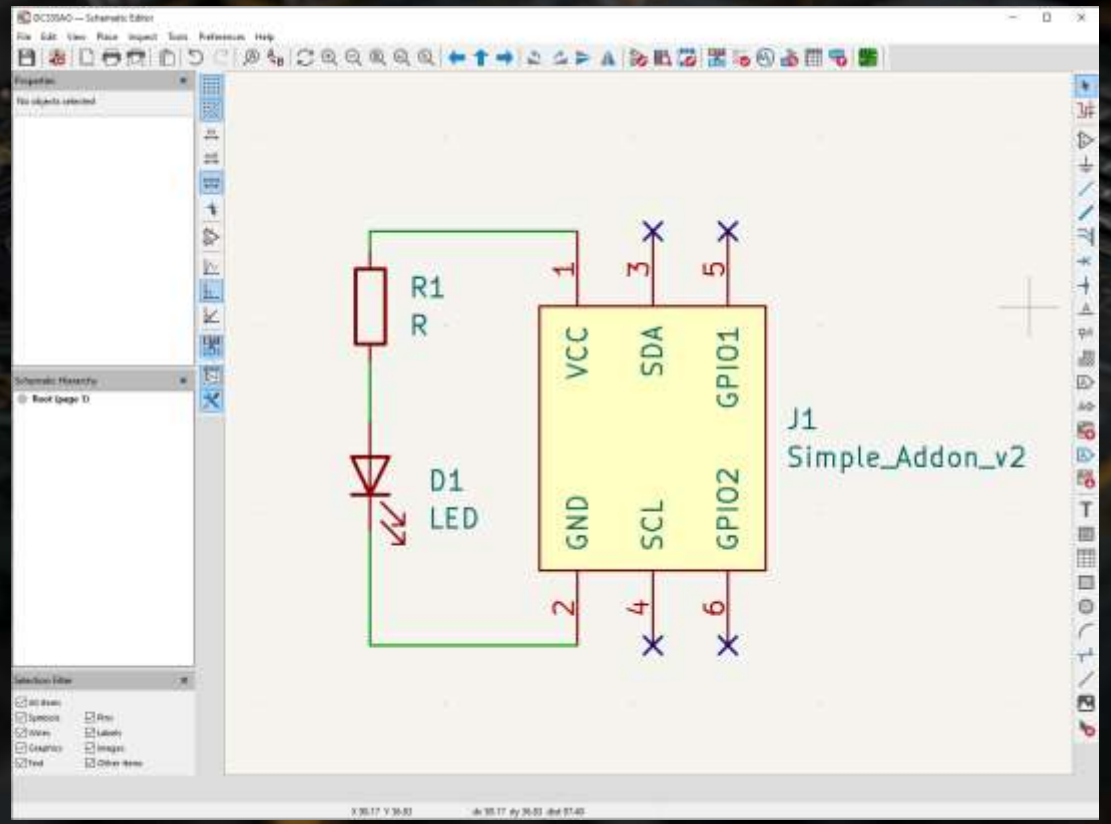
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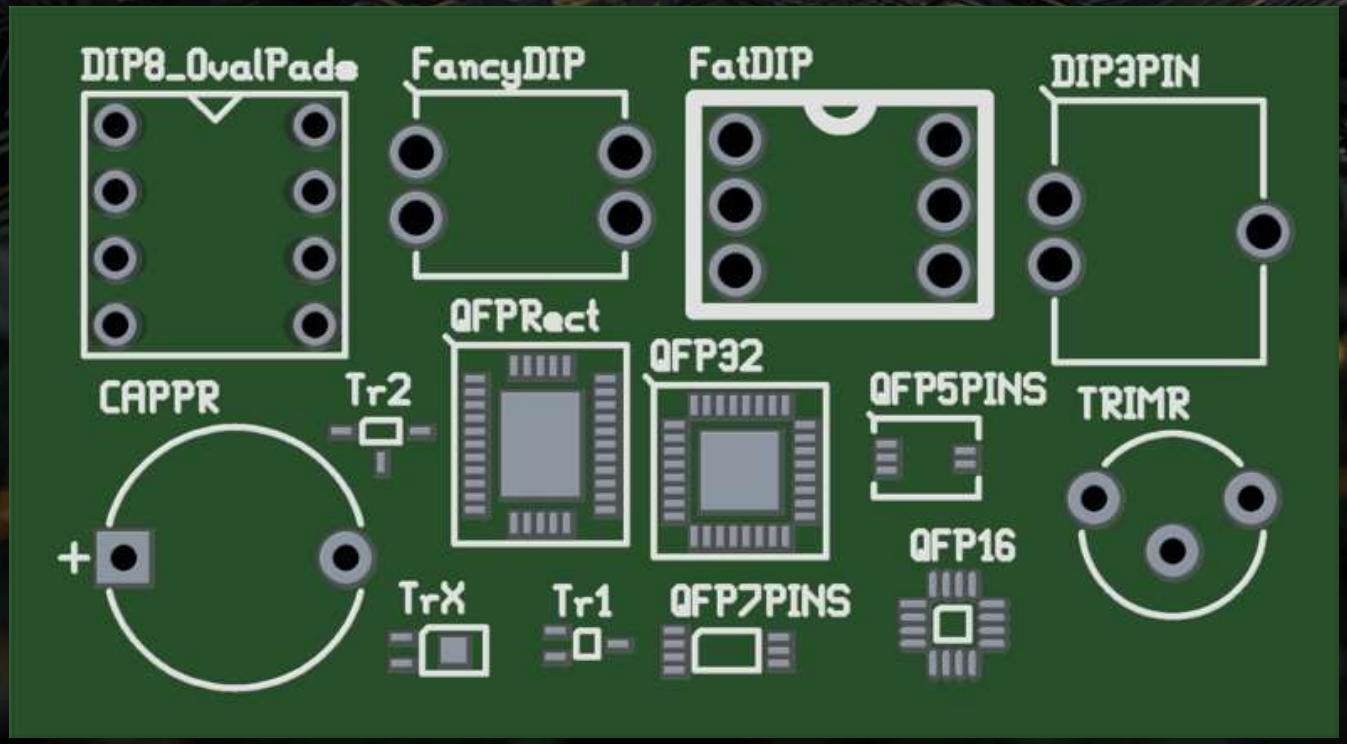
- Place the LED, resistor and SAO symbols
- Connect the wires
- Wait, where do I get an SAO symbol for KiCad?



https://hackaday.io/project/175182-simple-add-ons-sao

Now comes the tricky part, footprints!

- Footprints are the pads and through holes on a PCB that let the component electronically attach to it



But which footprint do I use?



Photo Credit: almois.ru

But which footprint do I use?

- Um, excuse me, I have standards



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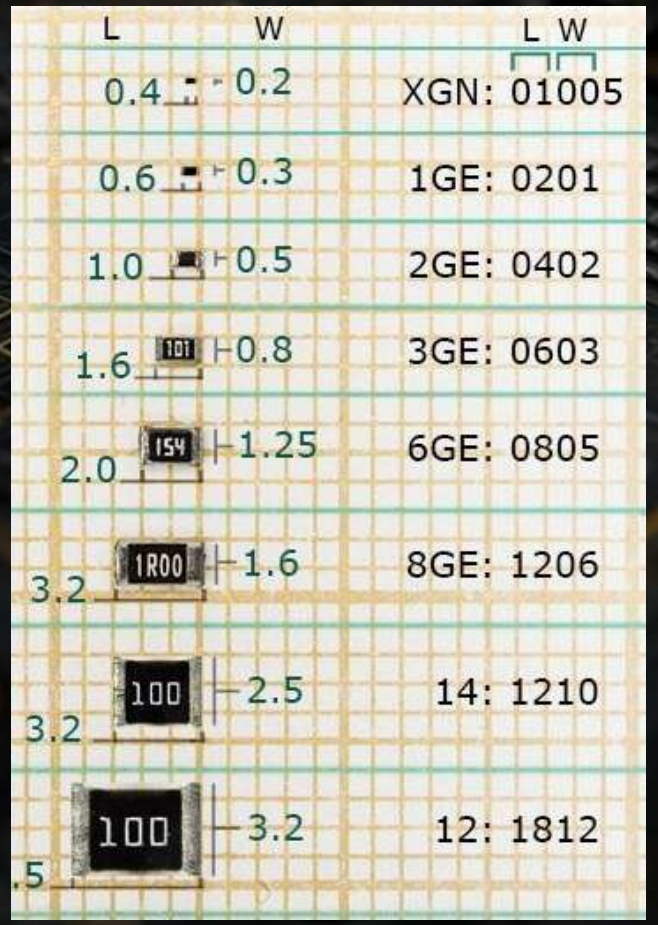


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- Design your layouts to be reworkable
  - Room for soldering iron/vacuum/etc...
  - Able to be reworked on a hotplate

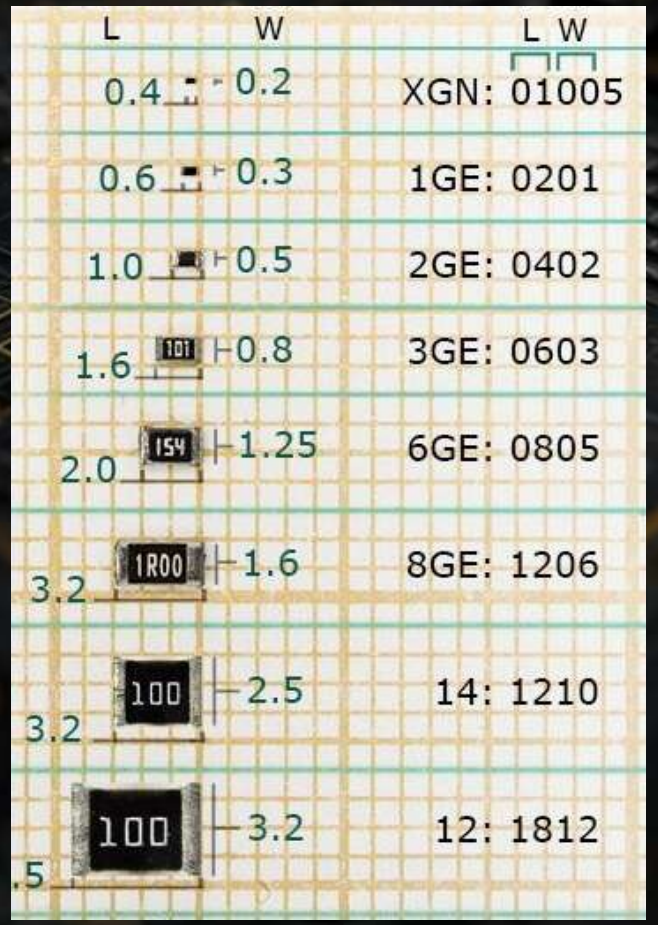


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- Make sure your parts are human solderable
  - 0603/1608 or bigger (if they fit)

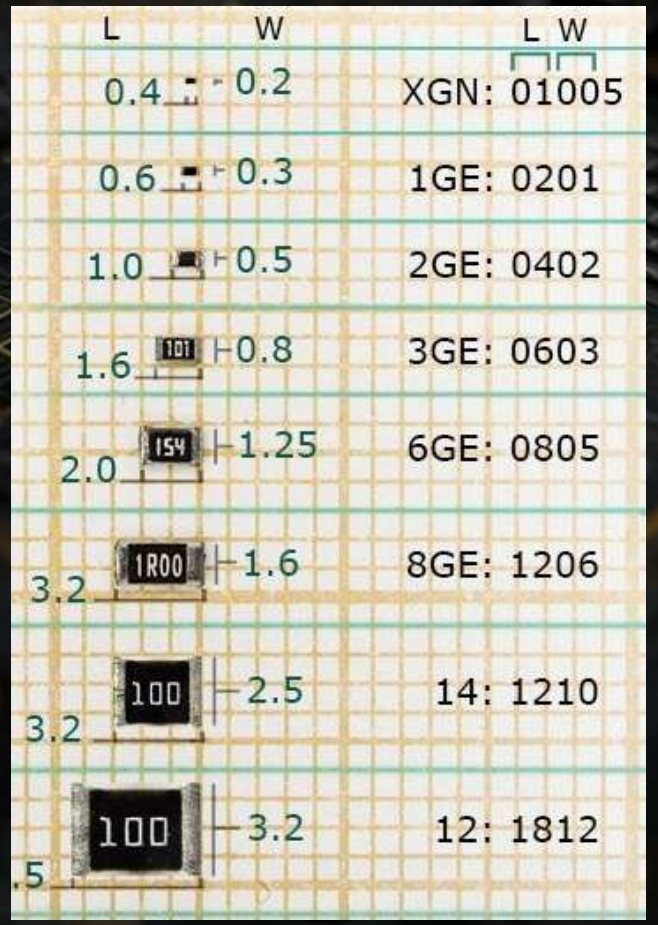


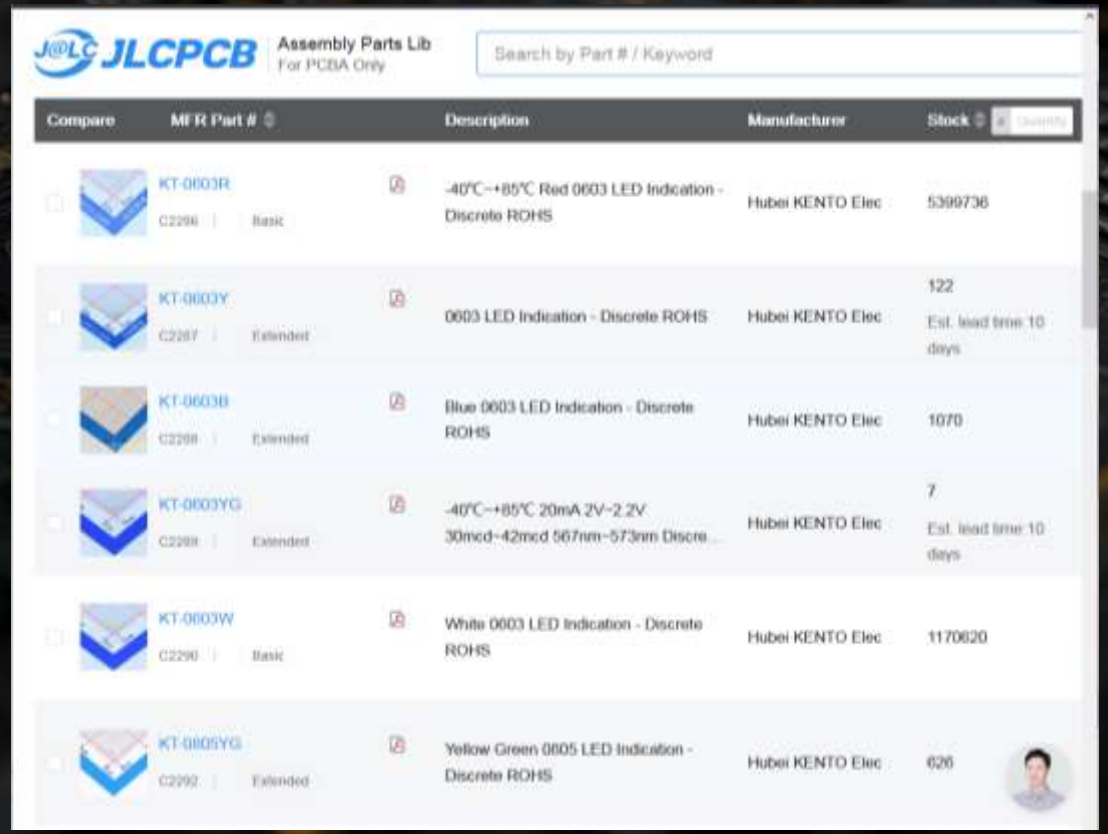
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Ok, we picked our size, are we good?



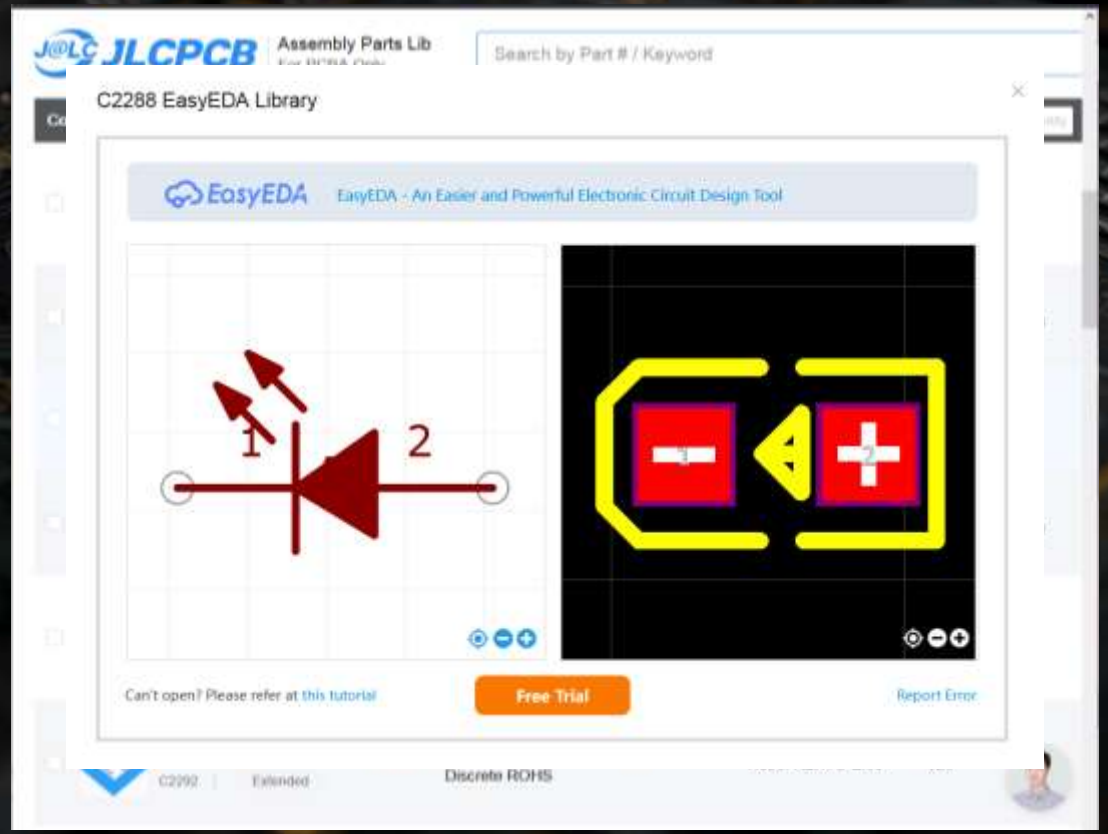
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- Check your suppliers for availability/footprints/etc...



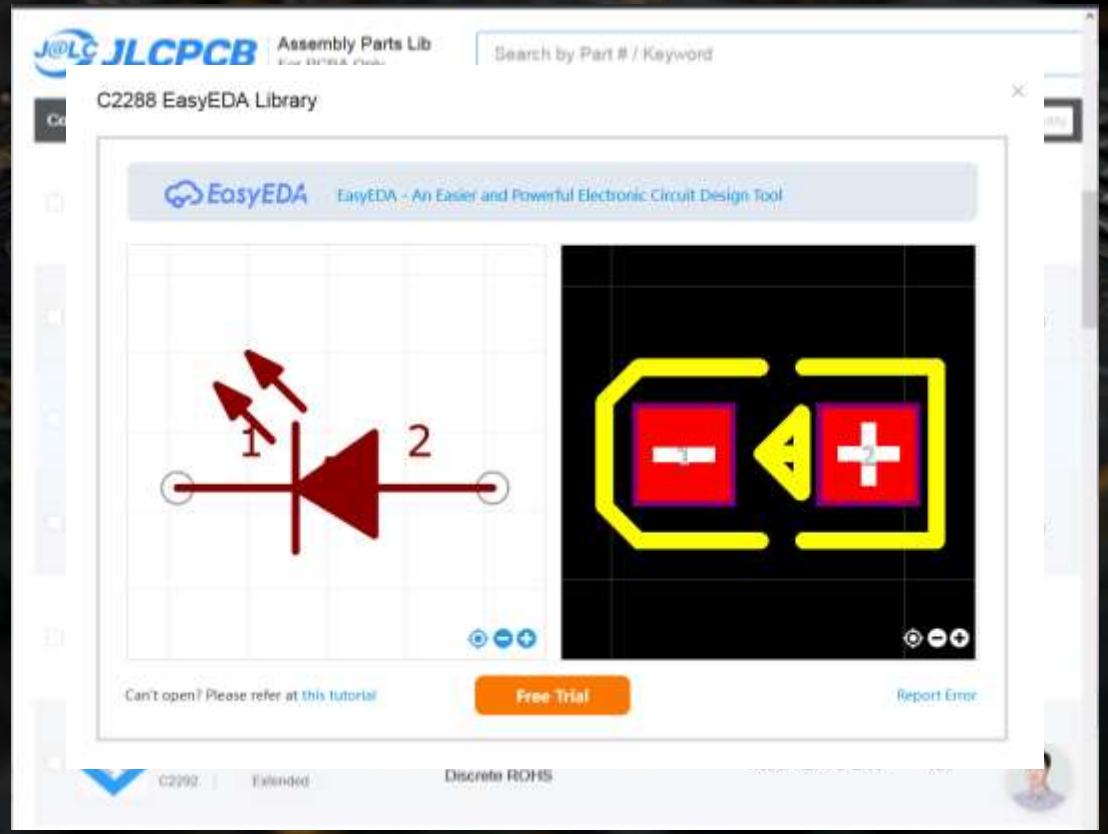
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- Some manufacturers like JLCPCB also provide footprints for their parts
  - WARNING: Not always great, but good enough



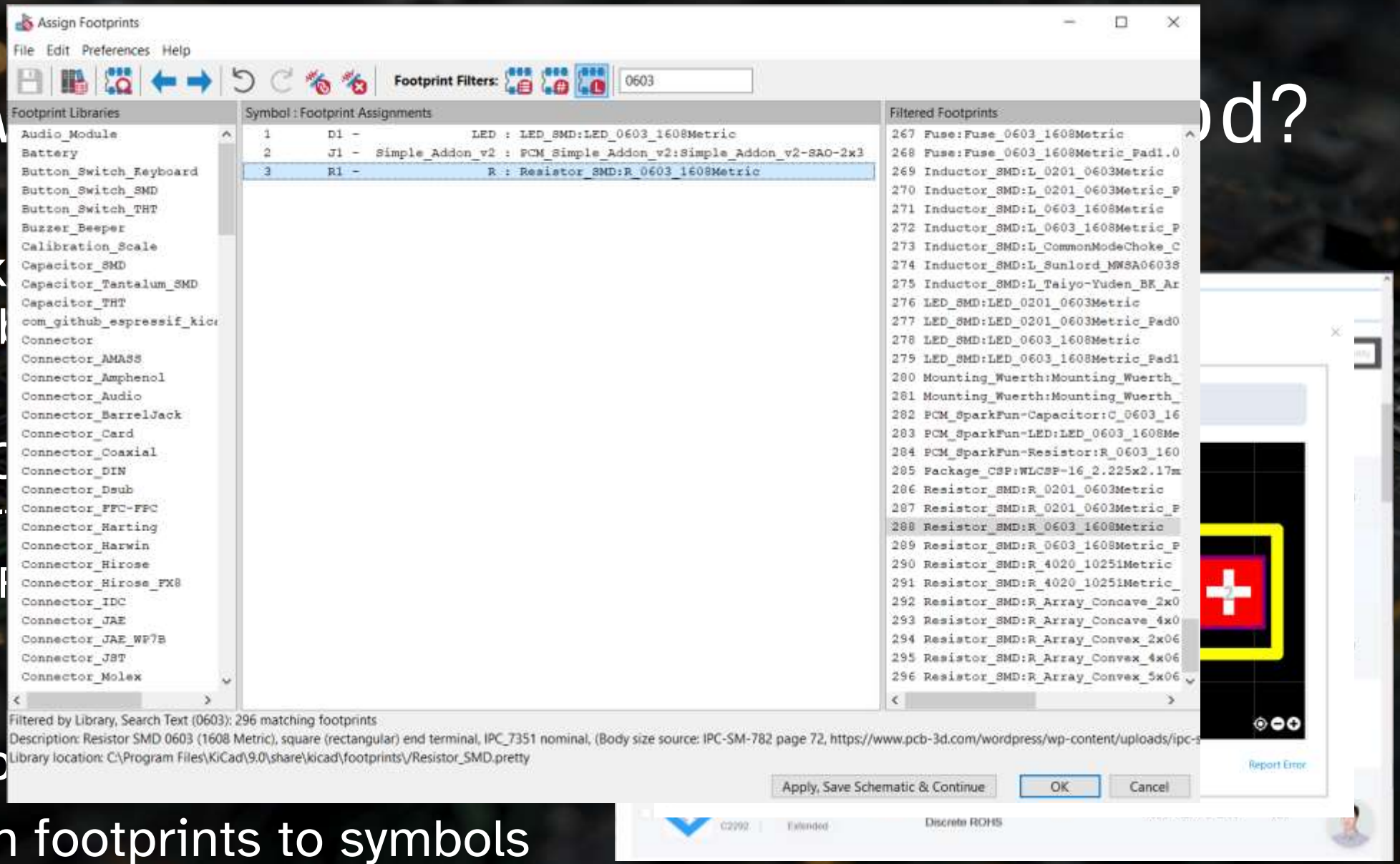
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  - WARNING: Not always great, but good enough
- Use a tool like easyeda2kicad to import footprints to KiCad

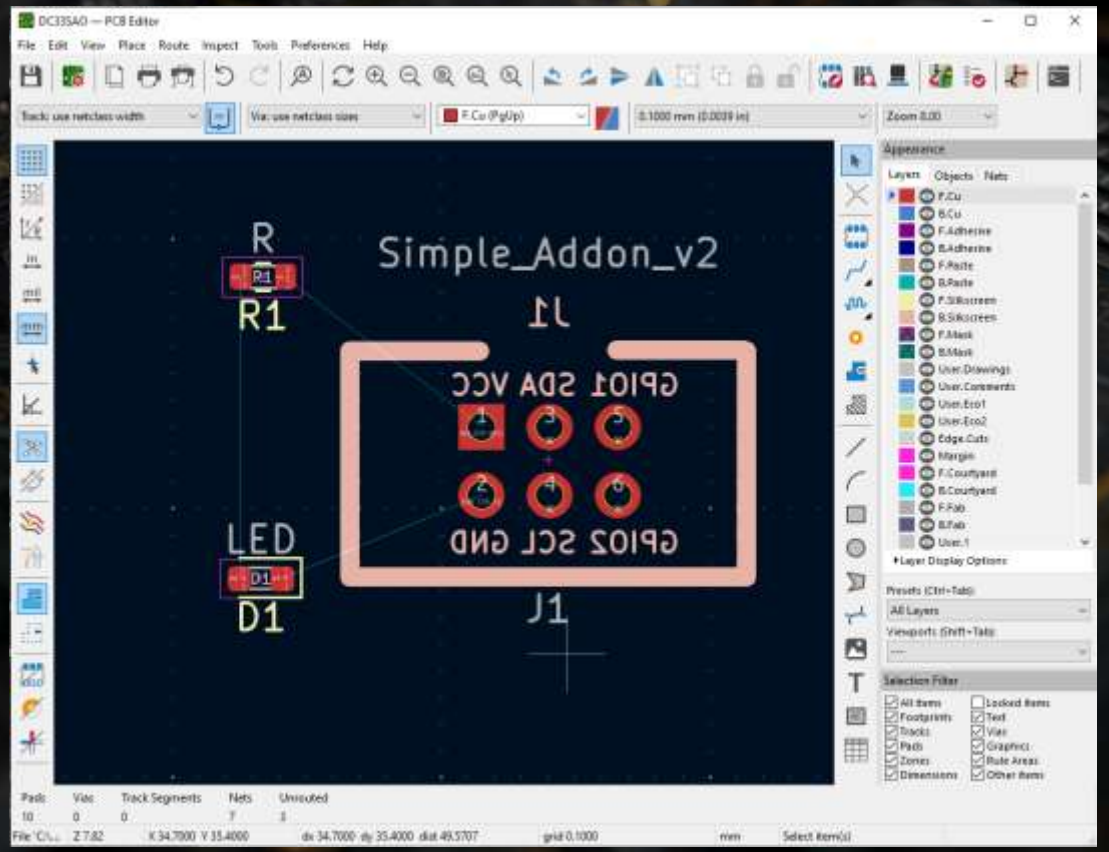


Ok, w…od?

- Check … availab…
- Some … JLCPC… footpr…
  - WAR… but …
- Use a … to imp…
- Assign footprints to symbols

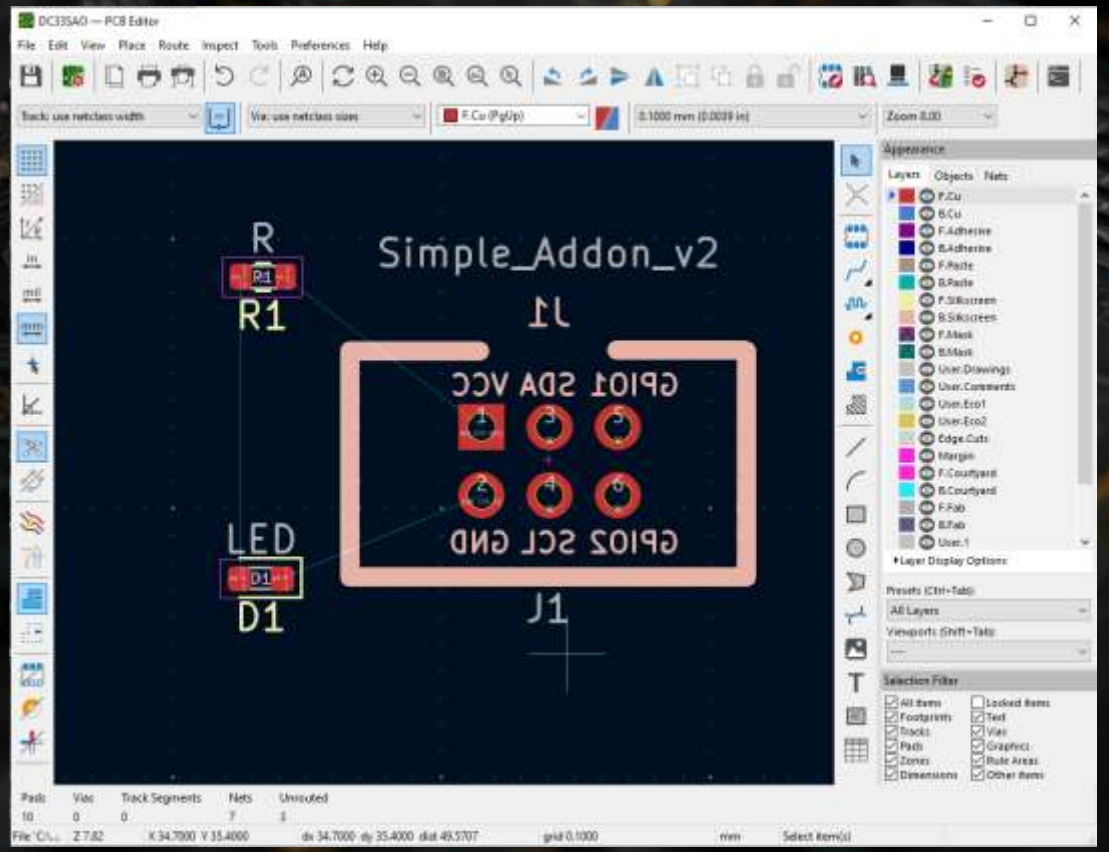


Next up the PCB Editor



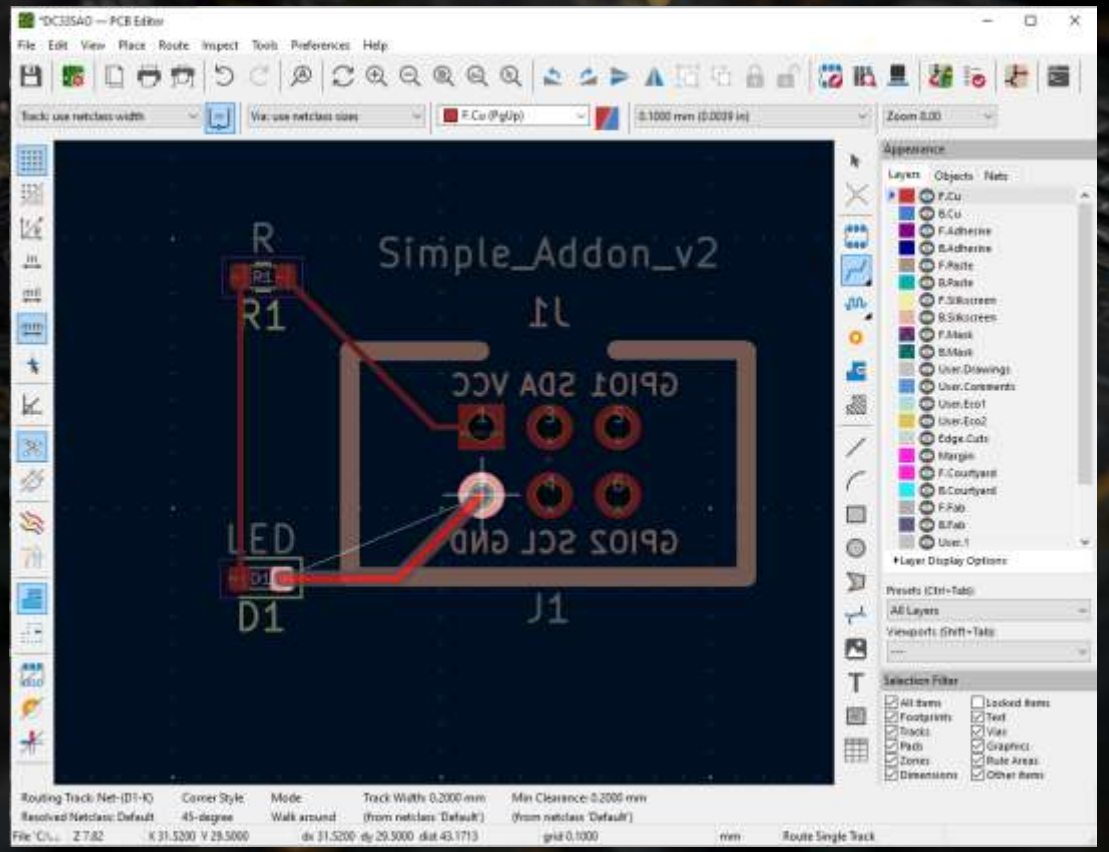
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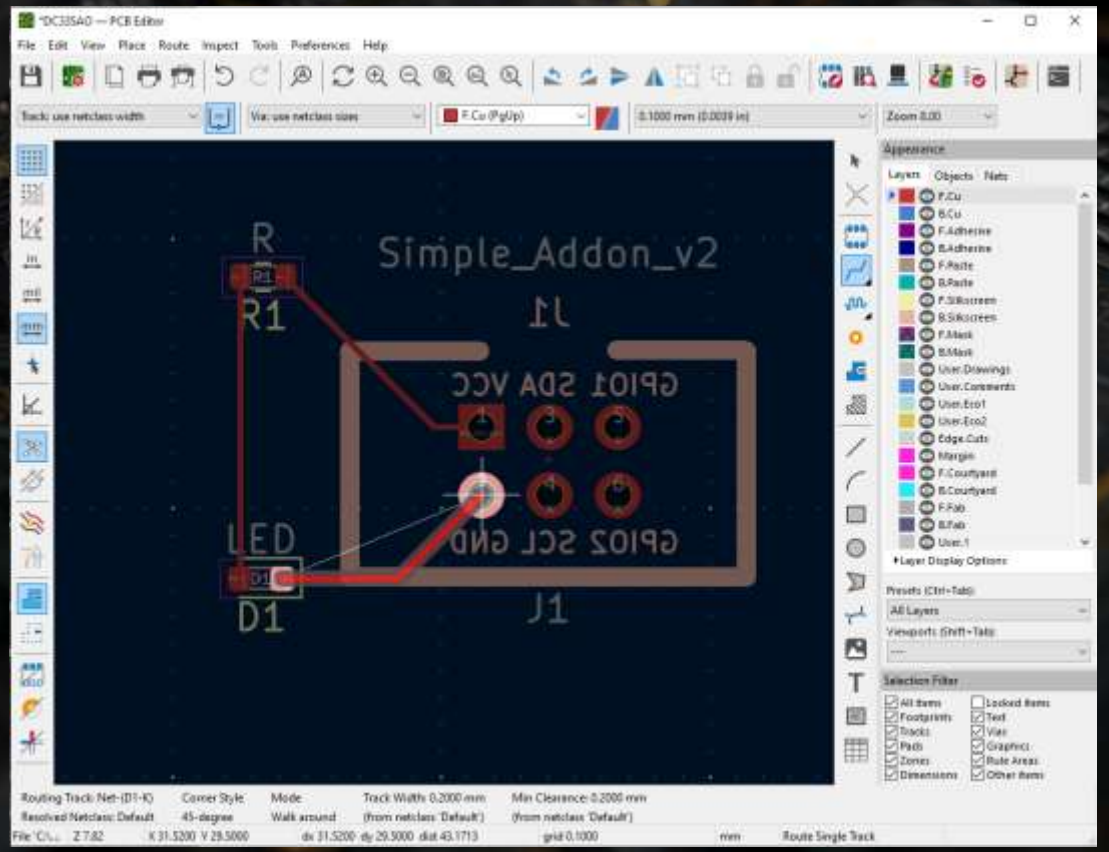
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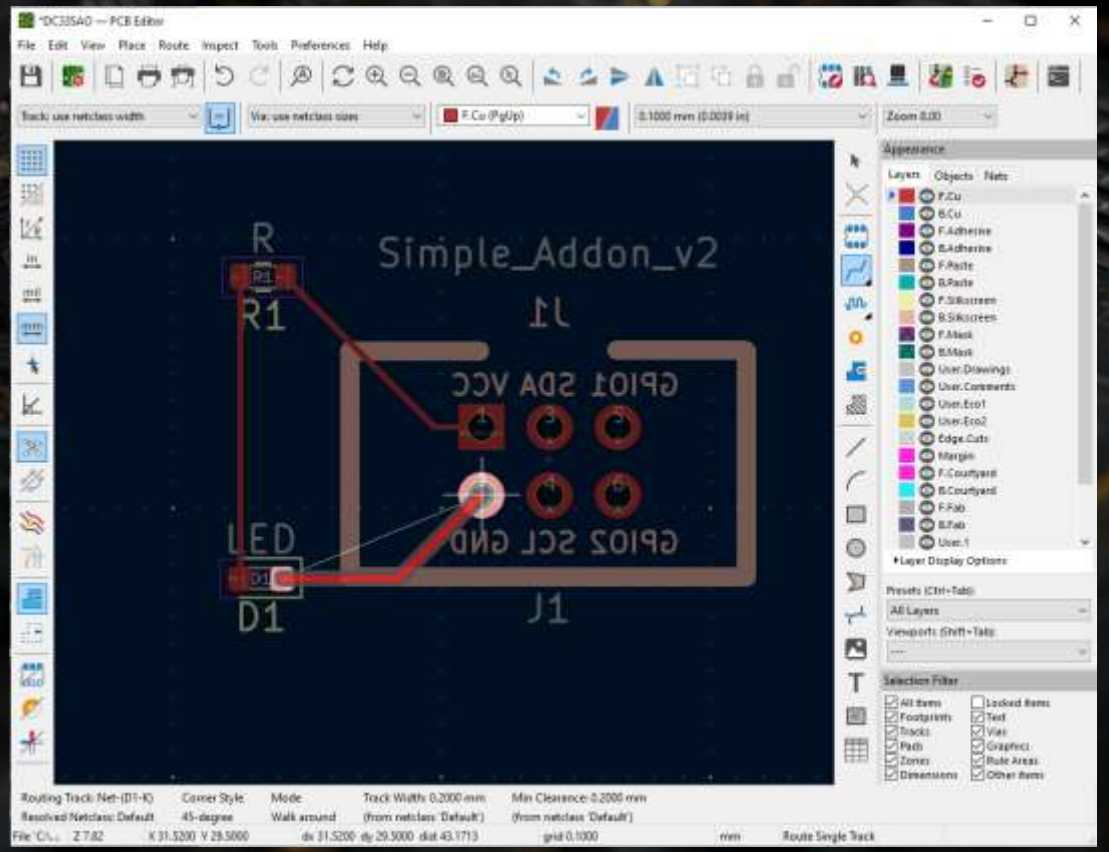
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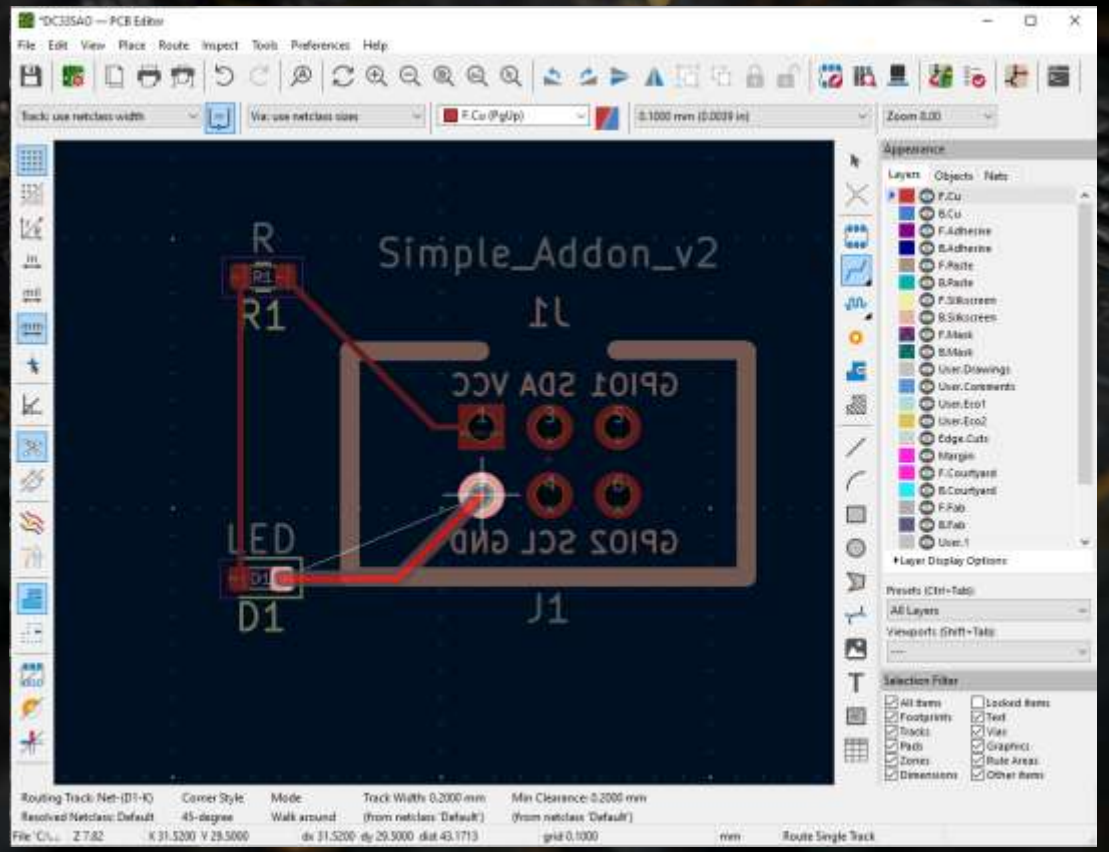
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- BUT WAIT?
- What about the art?!



The Art!

- Find/License/Create Art



Vector by Soco St

The Art!

- Find/License/Create Art
- SVG Format



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- 4ish Colors or less



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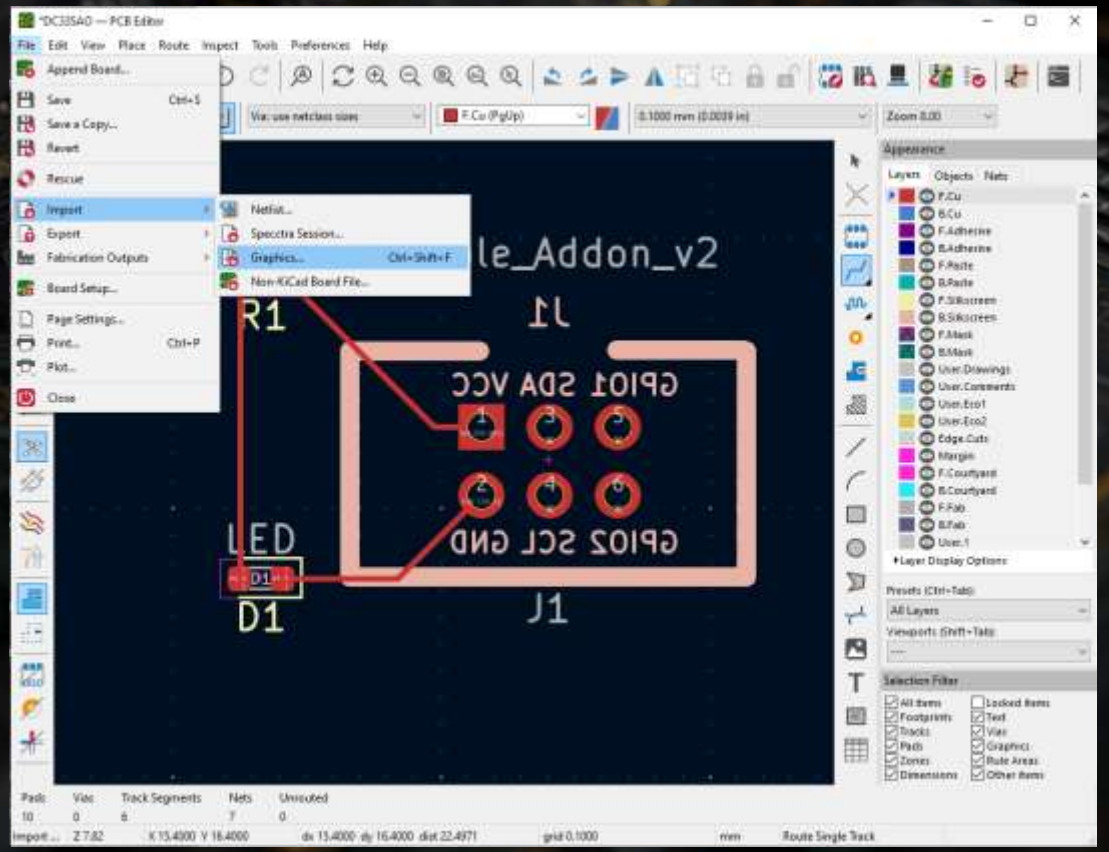
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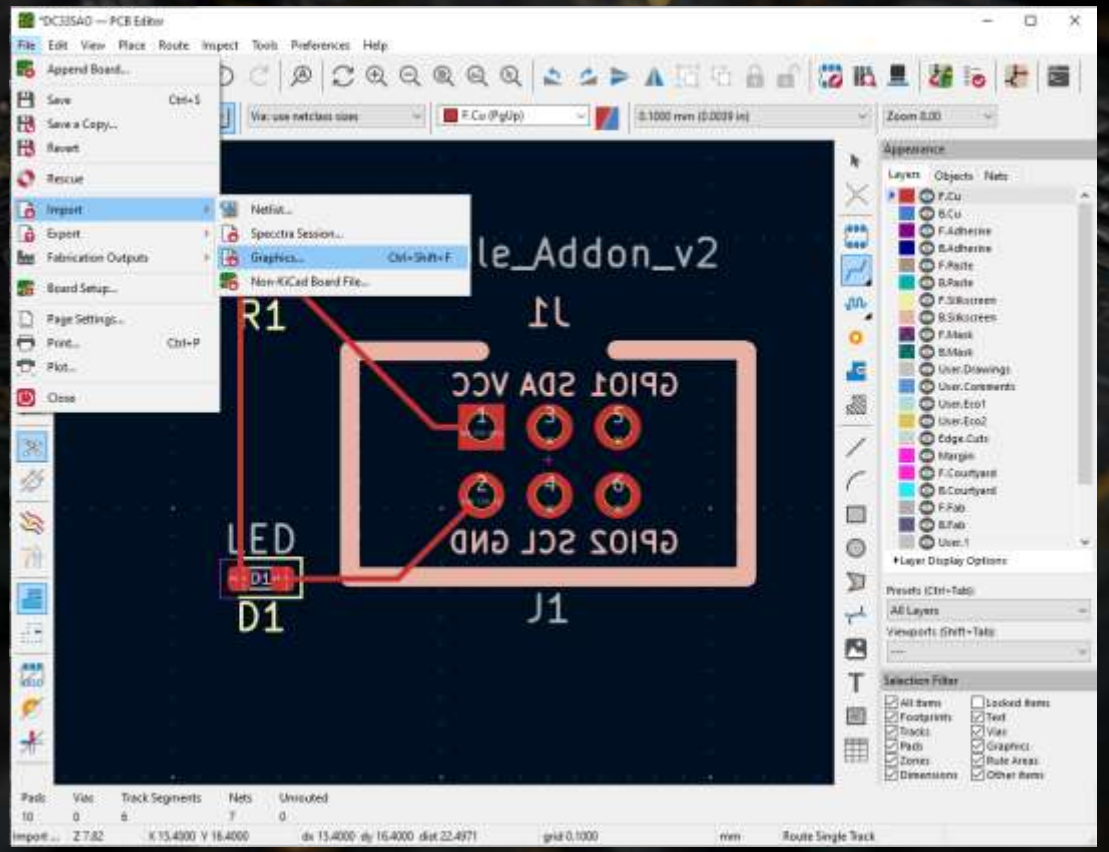
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Import the art into KiCad



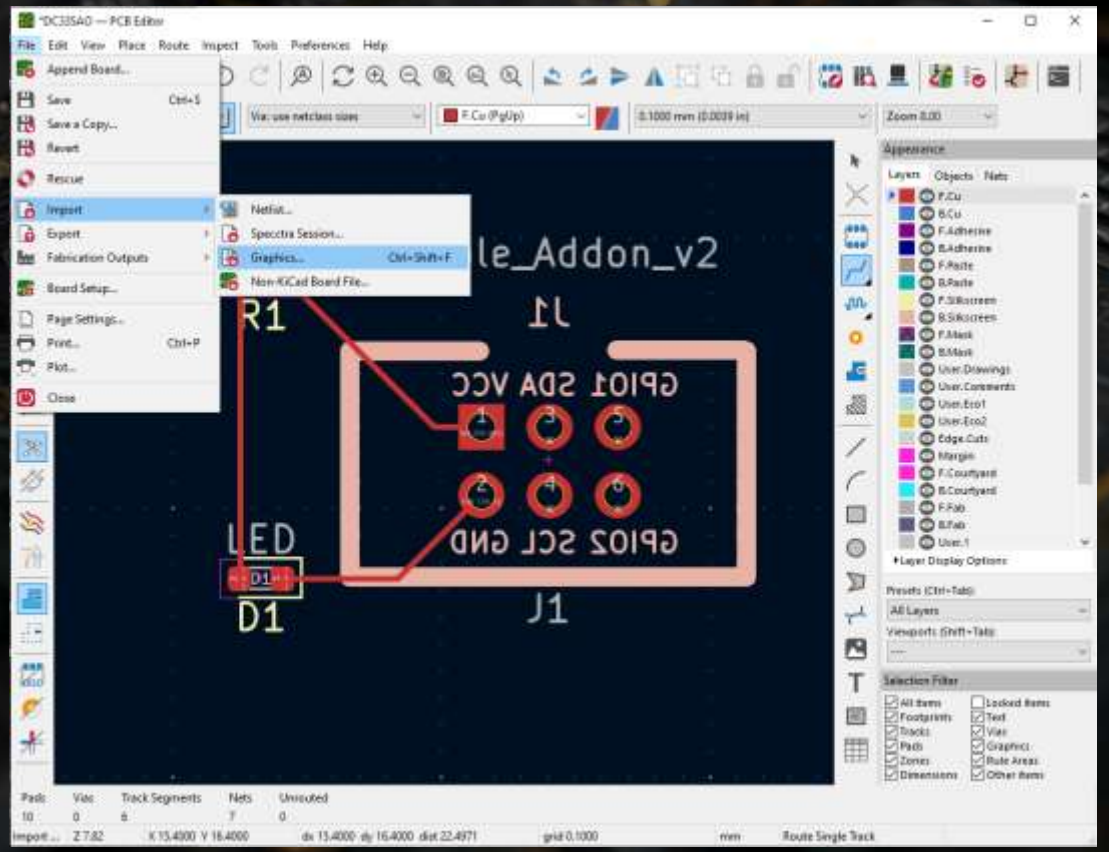
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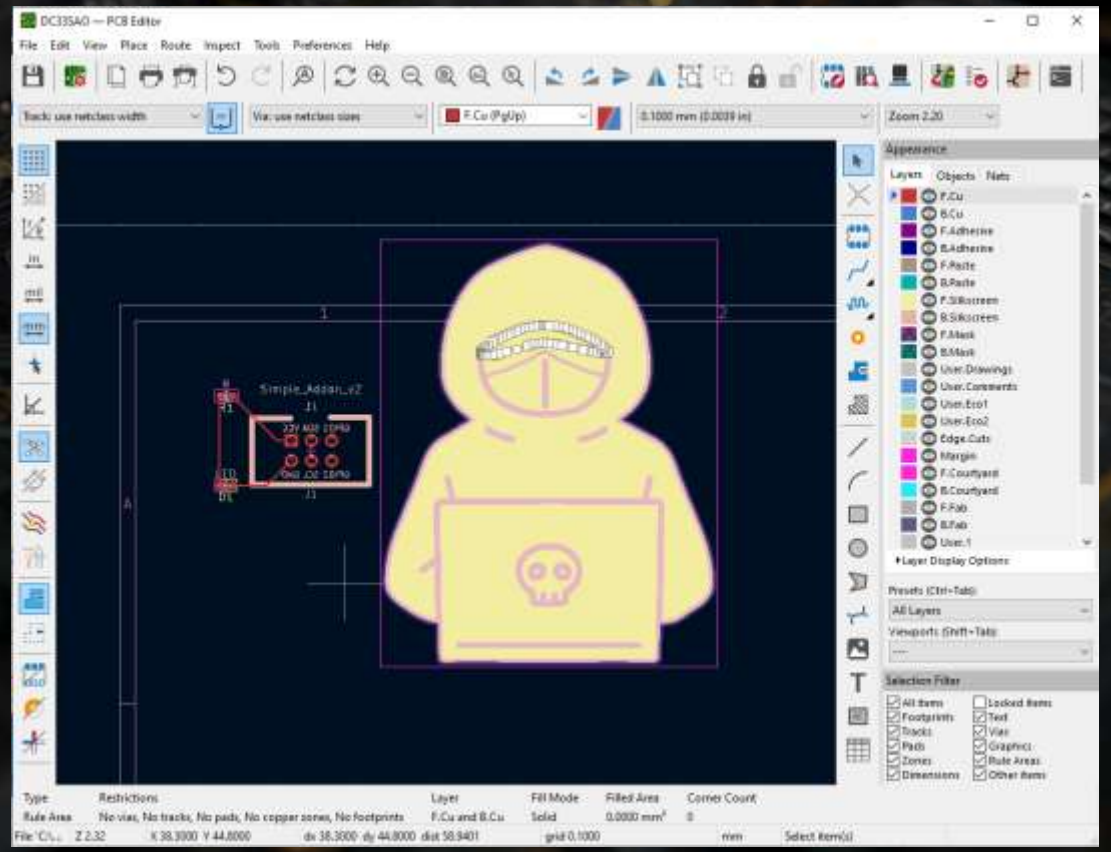
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- Import the SVG
- Break it apart to layers



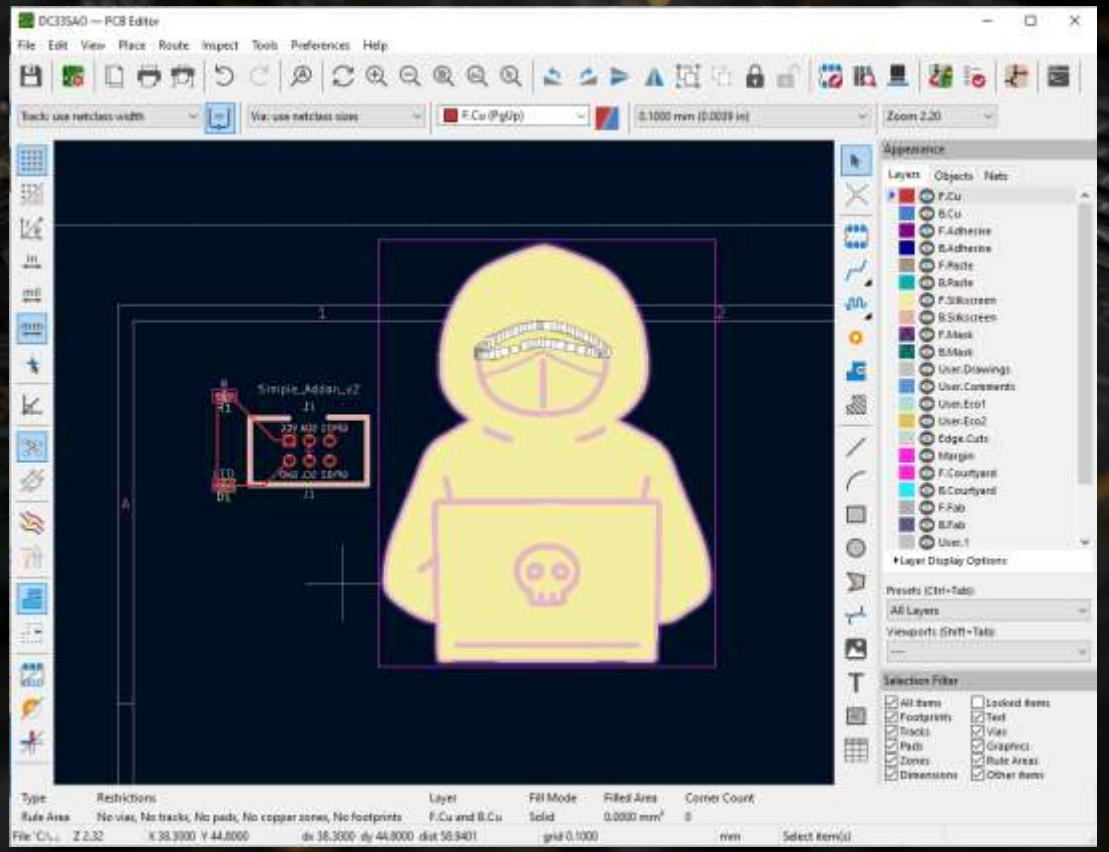
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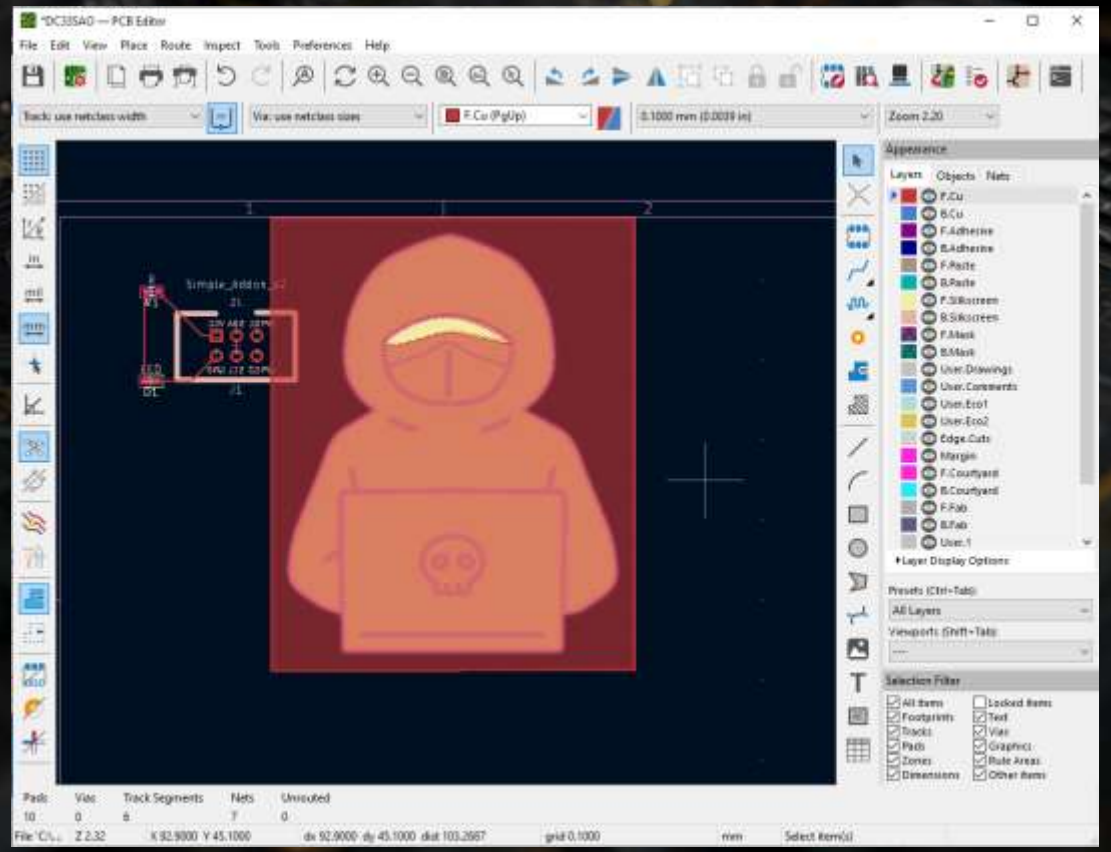
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- Transparent areas a rule area
  - Set to keep out zone fills



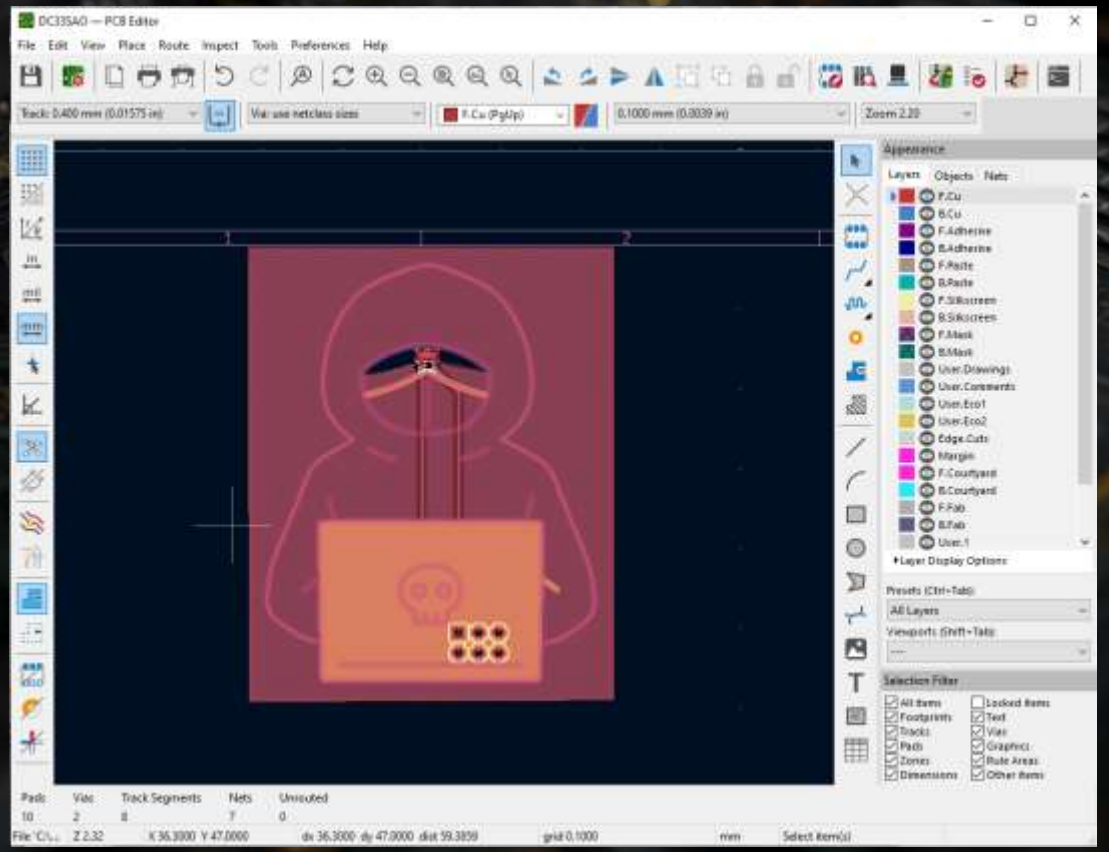
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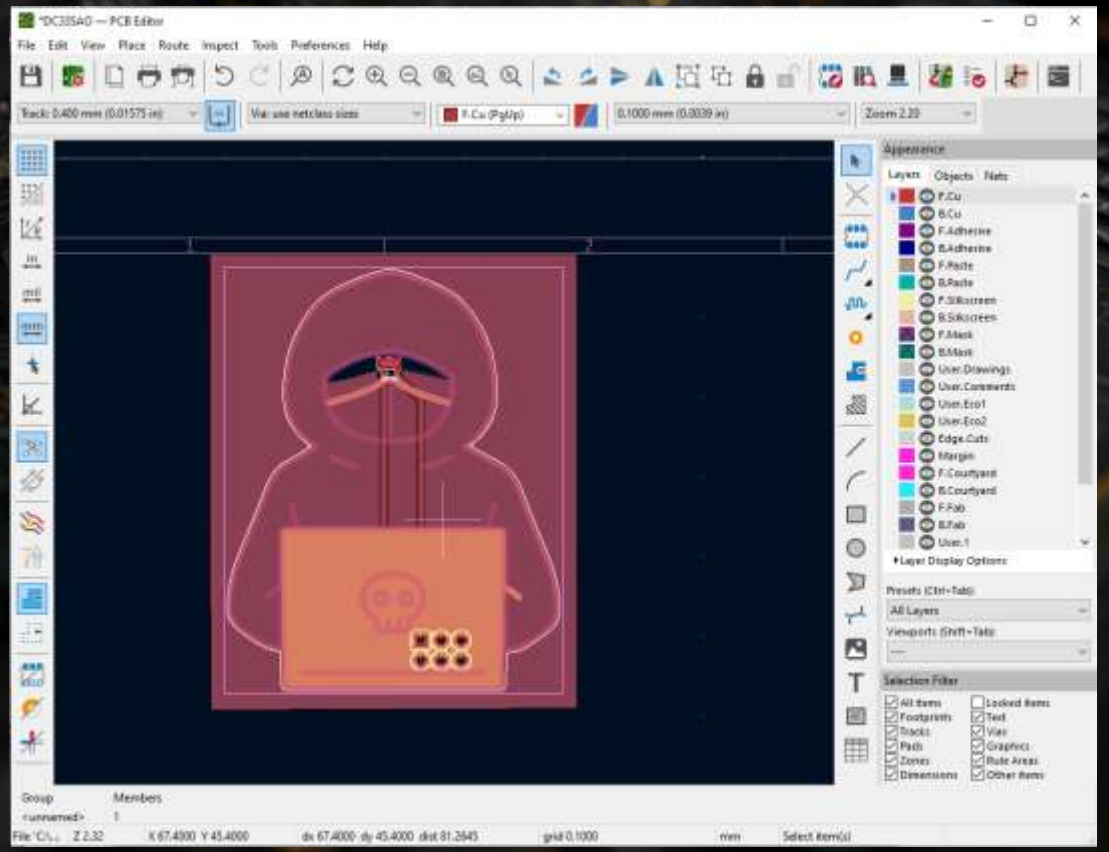


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- Move your parts onto the art in an *aesthetic* position

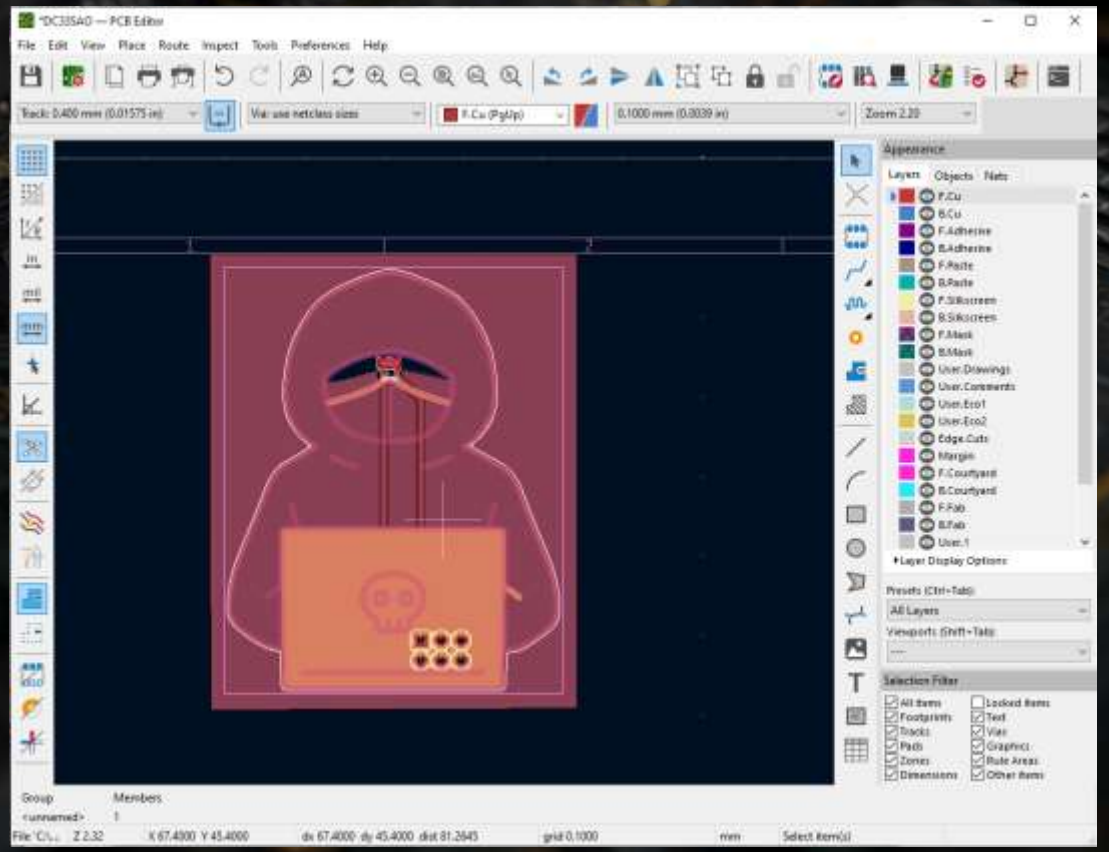


Outline Your Image



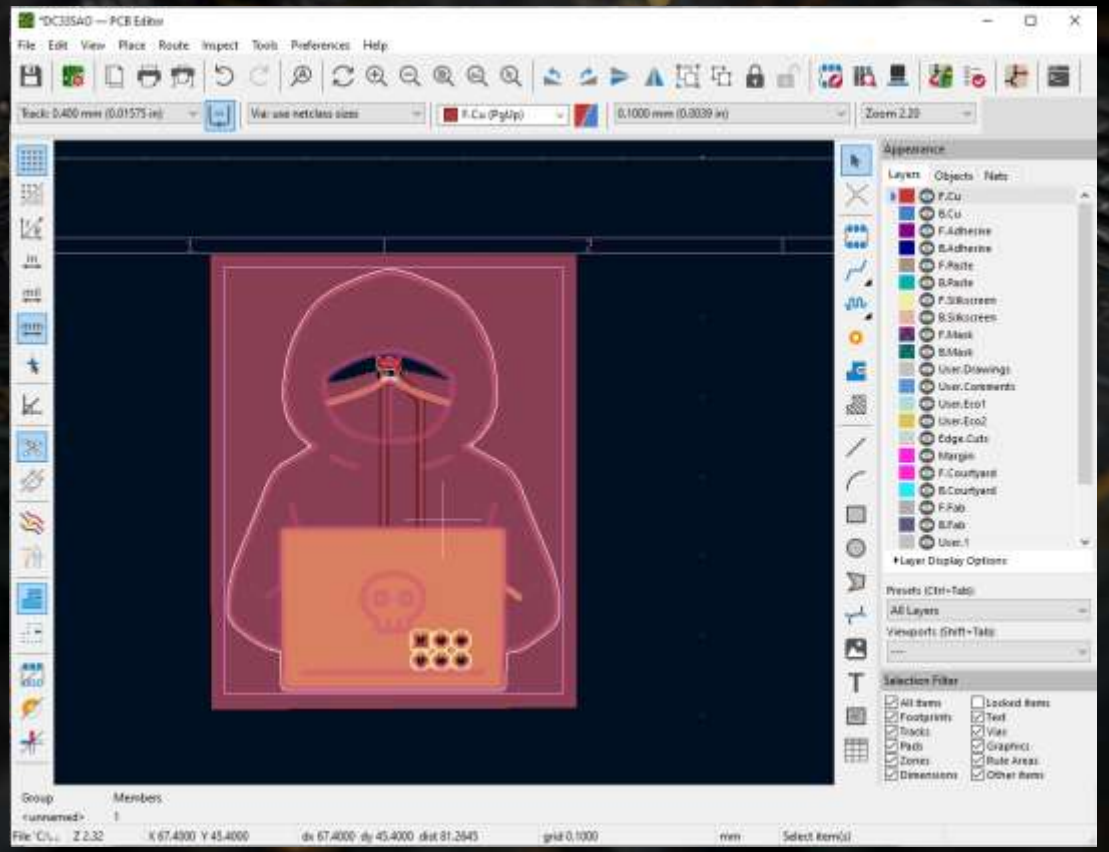
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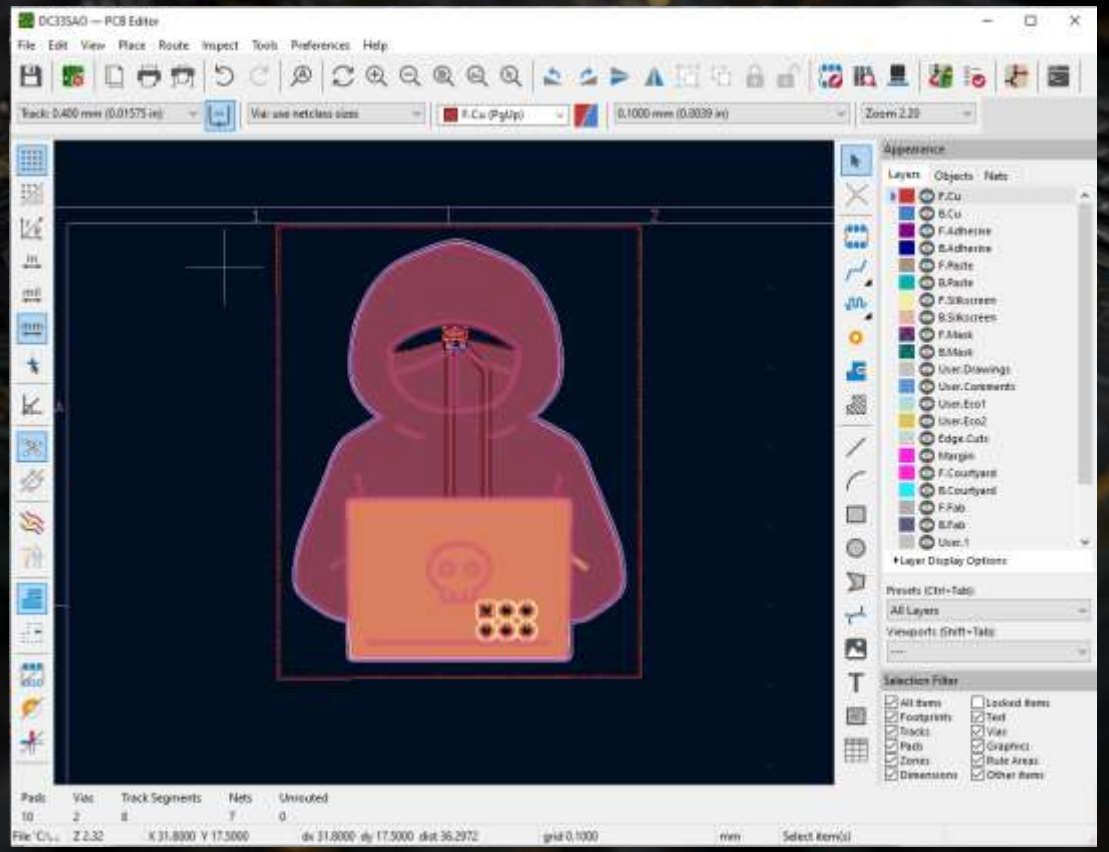
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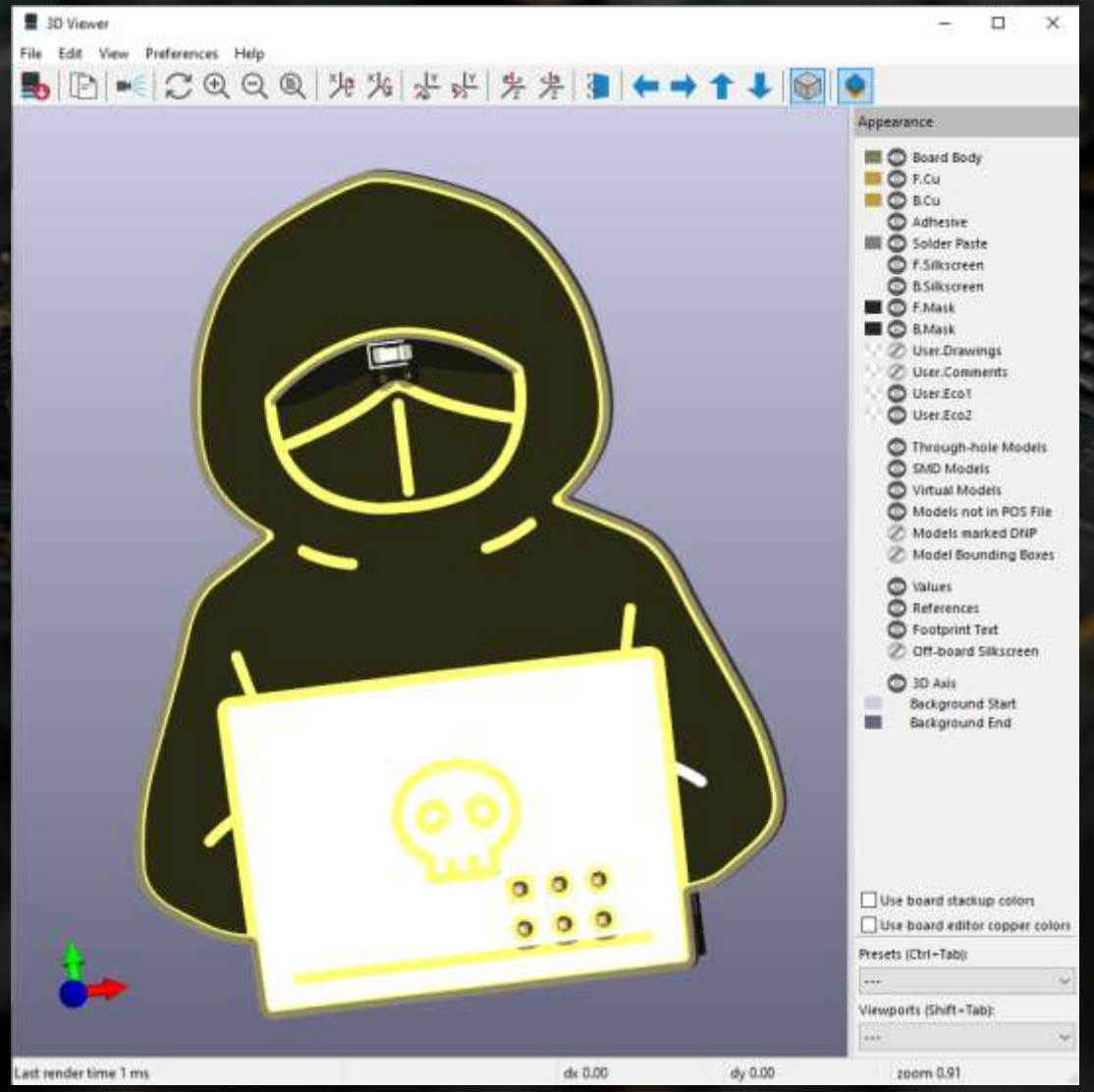
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- View your SAO in 3D!

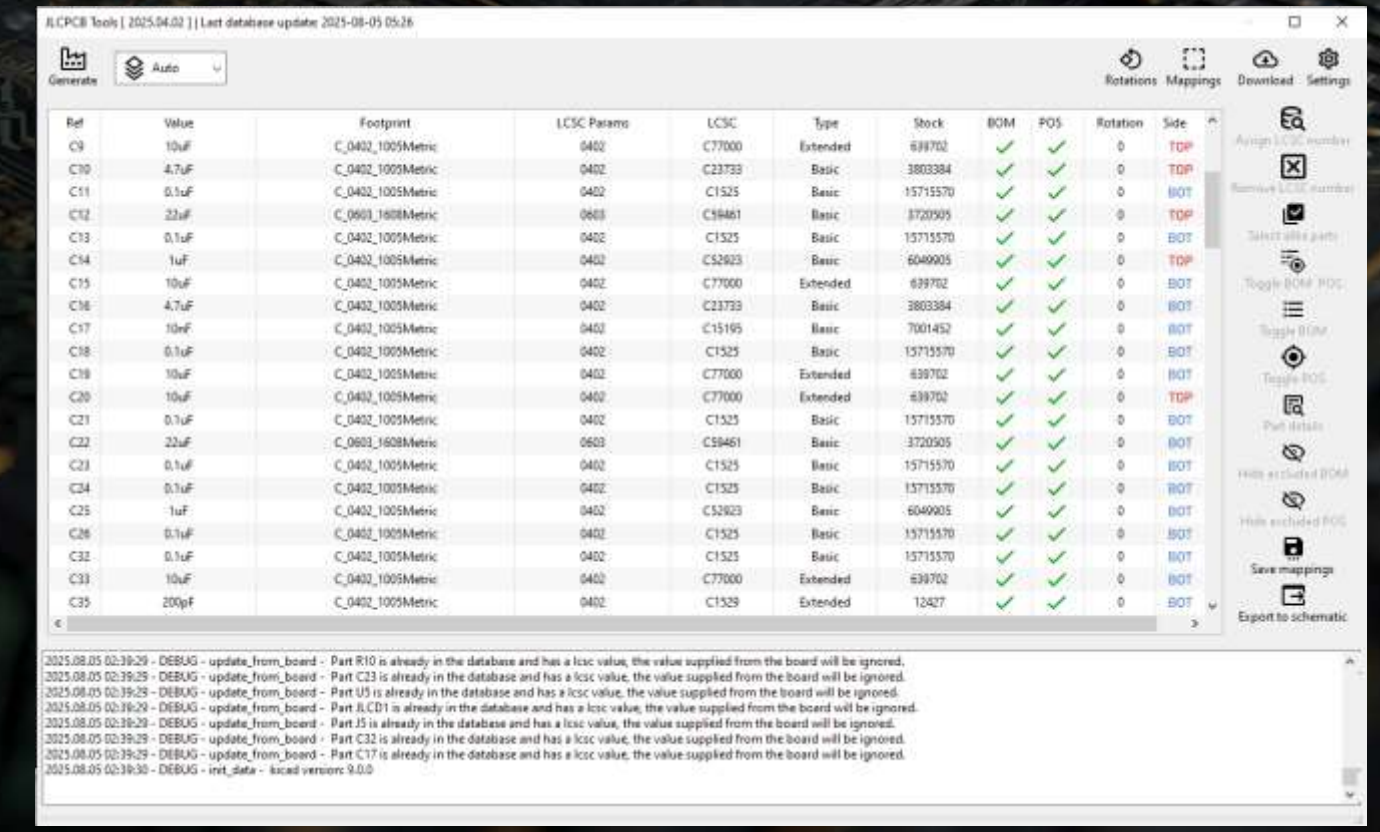


Export for Manufacturing



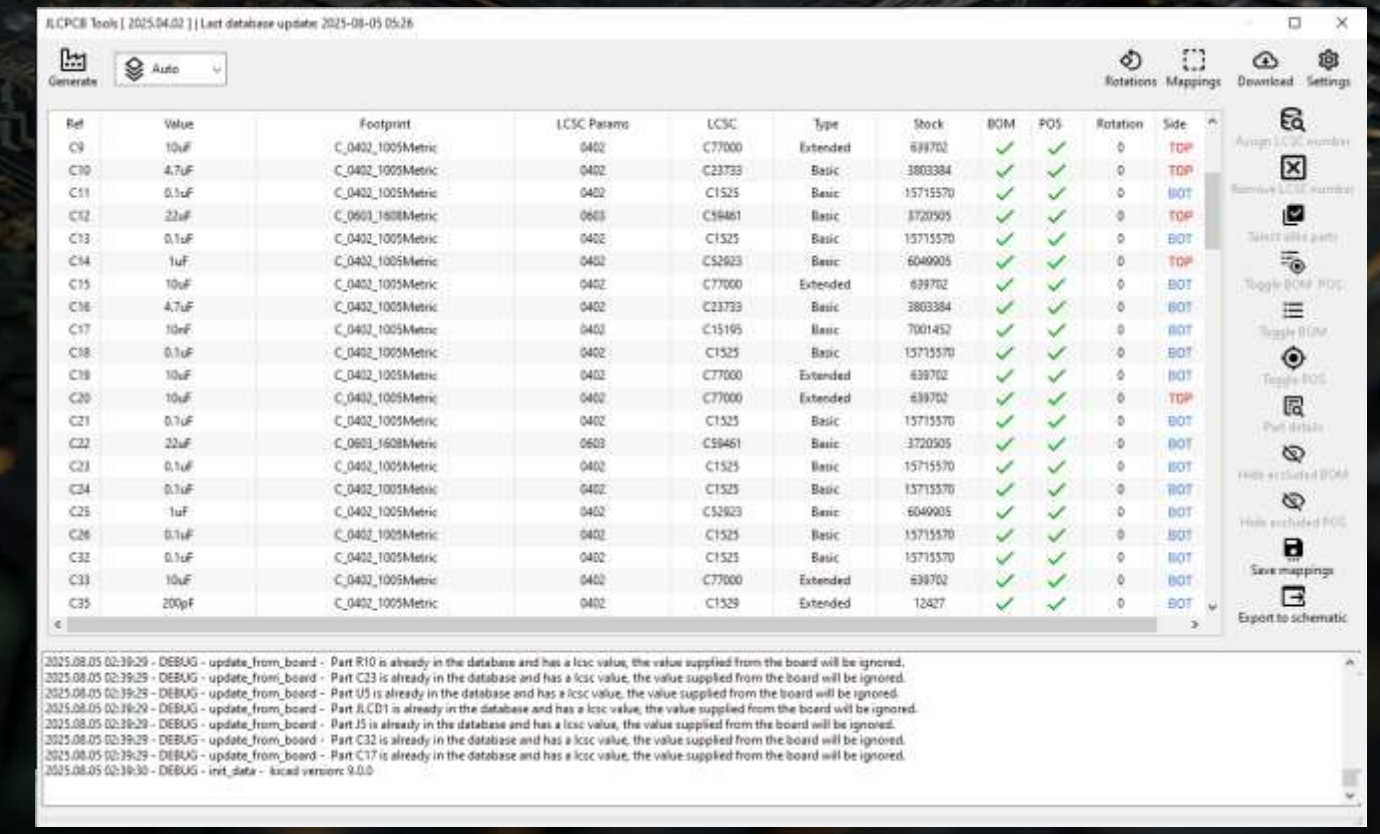
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- Use a plugin such as kicad-jlcpcb-tools
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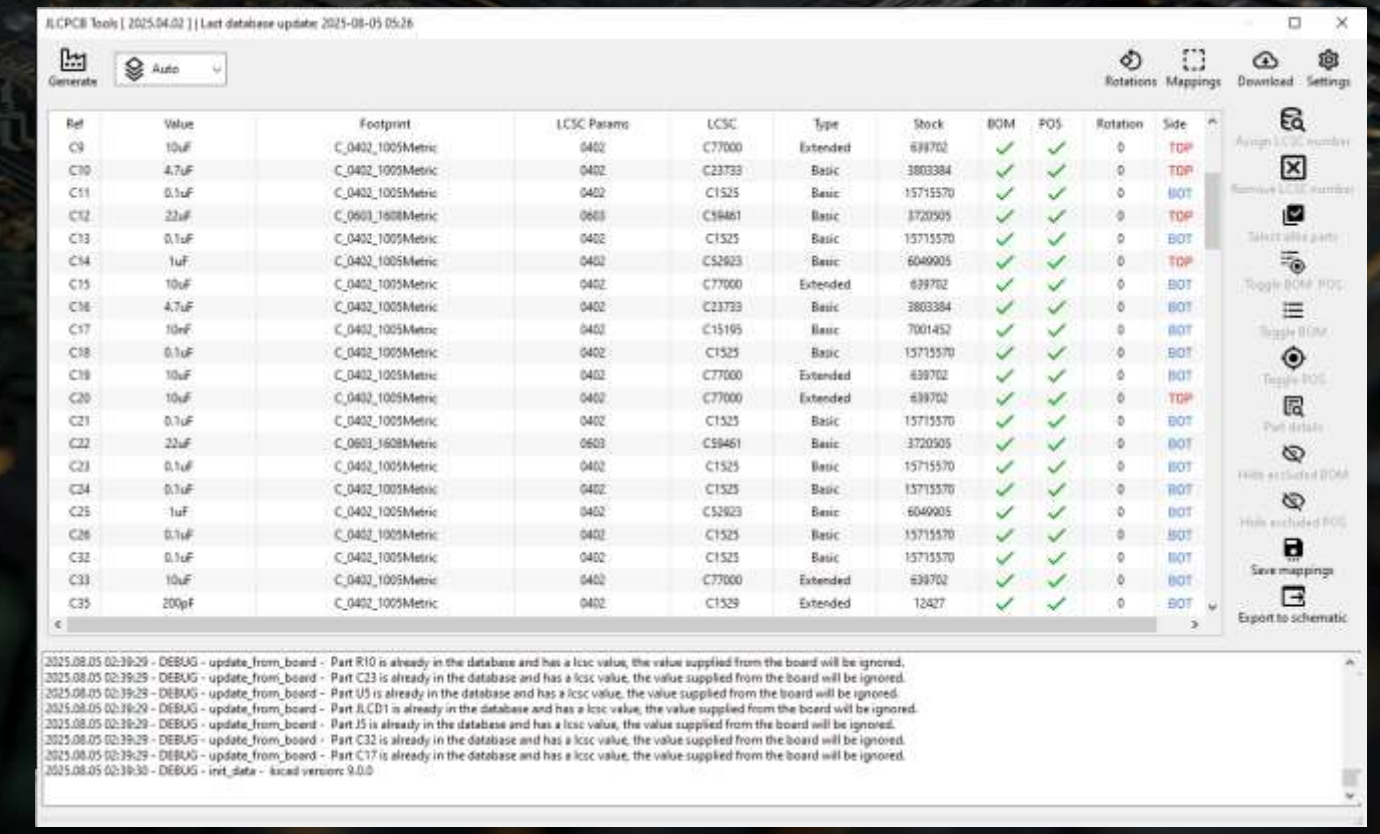
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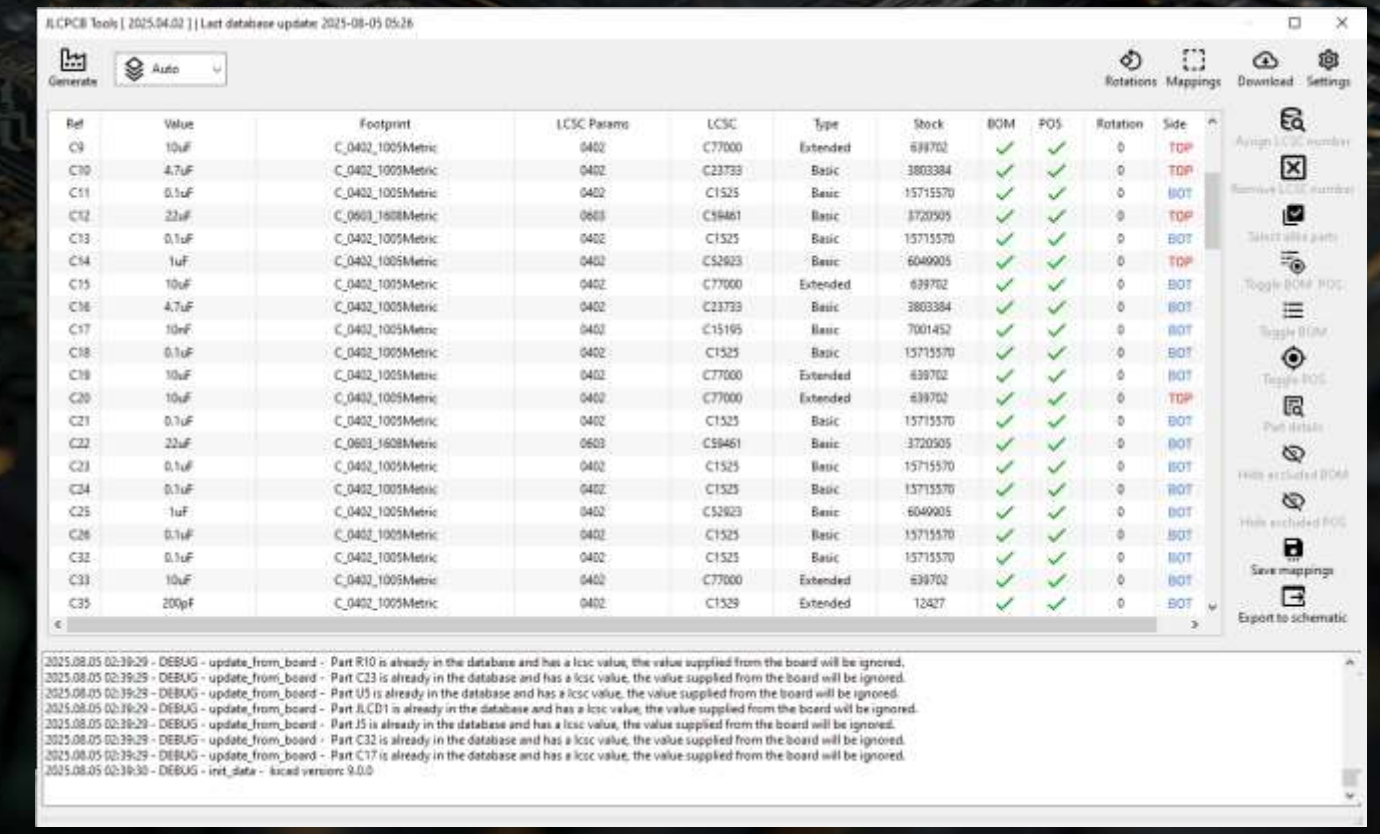
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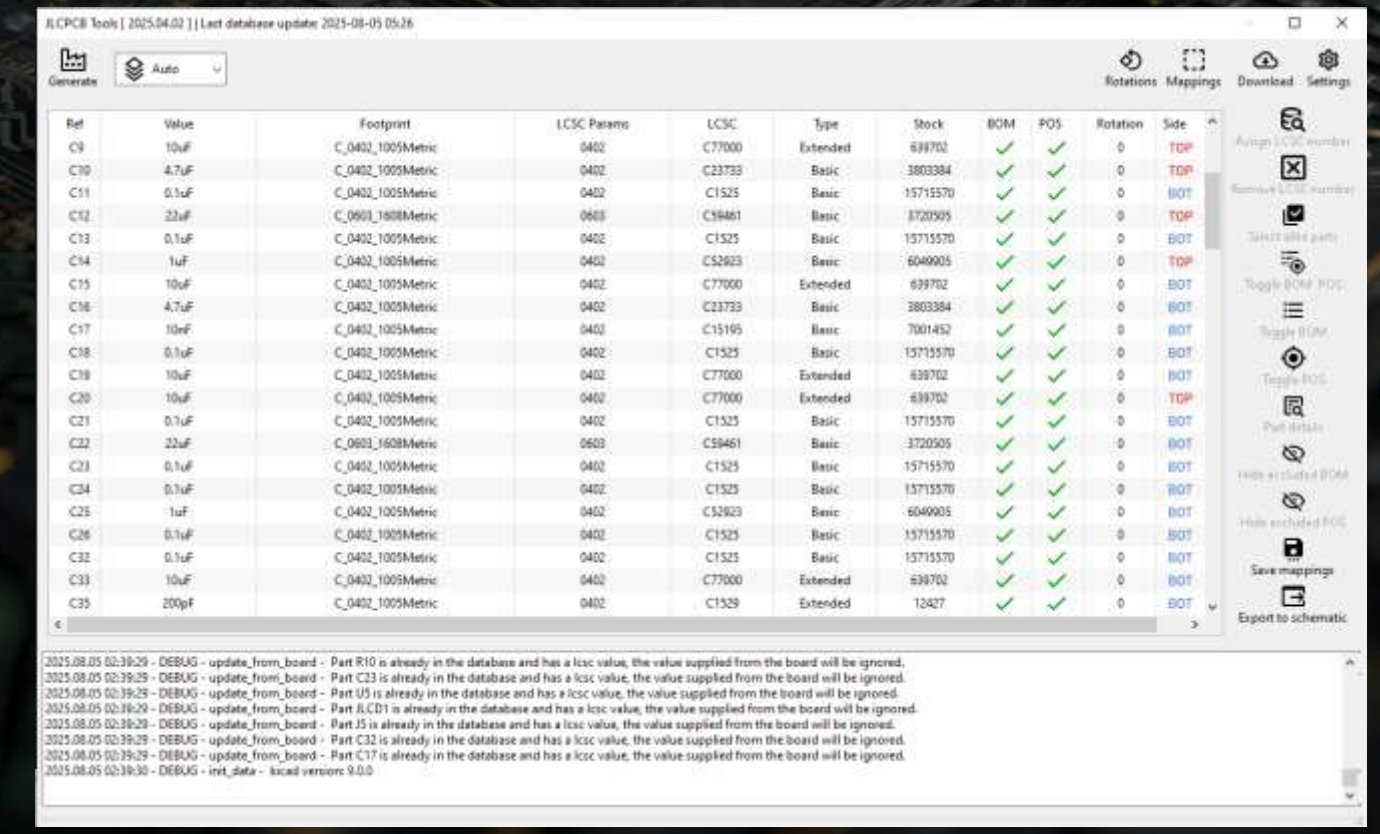
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- Voilà! #badgelife

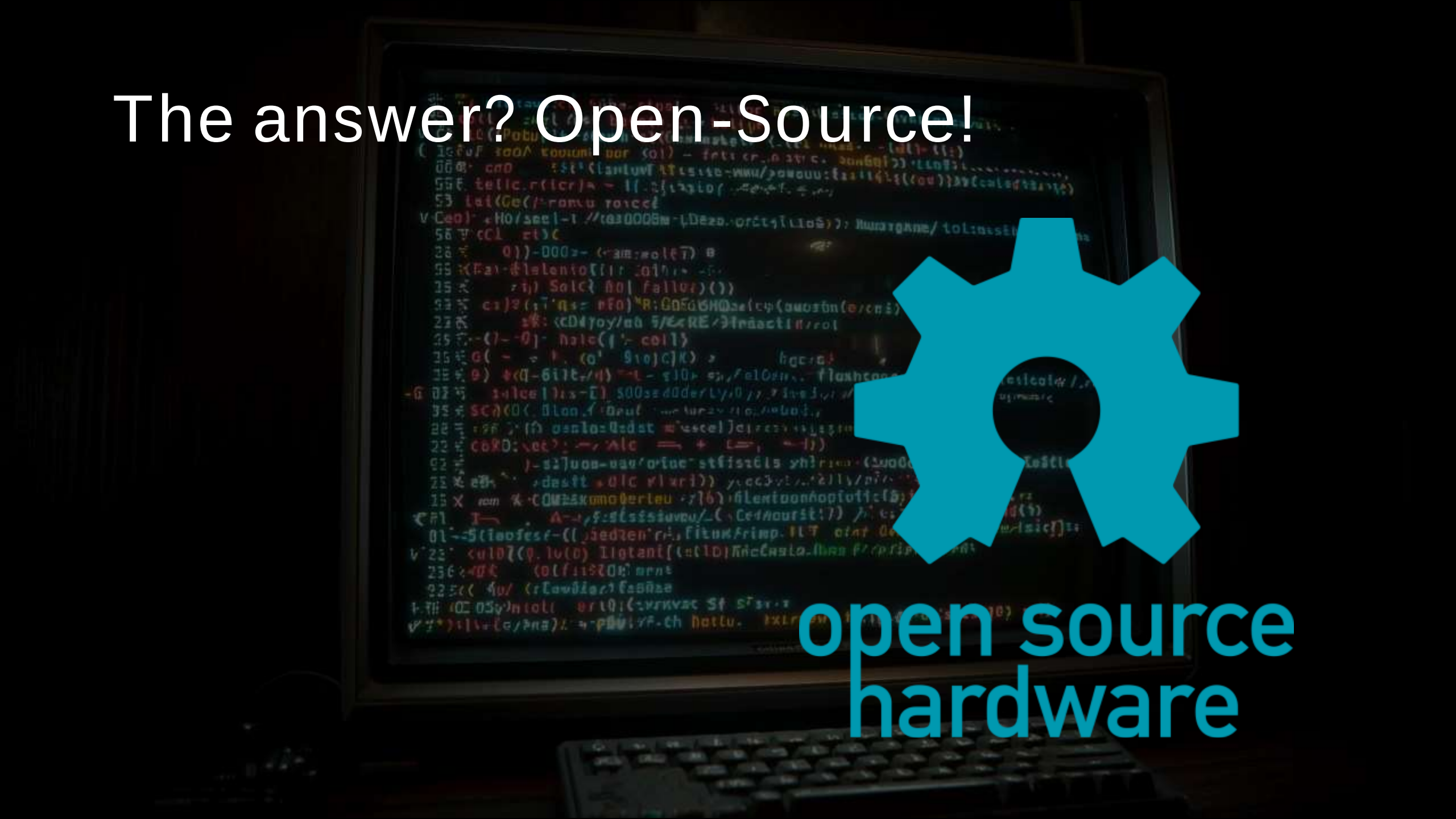




Draw The Rest of the Owl

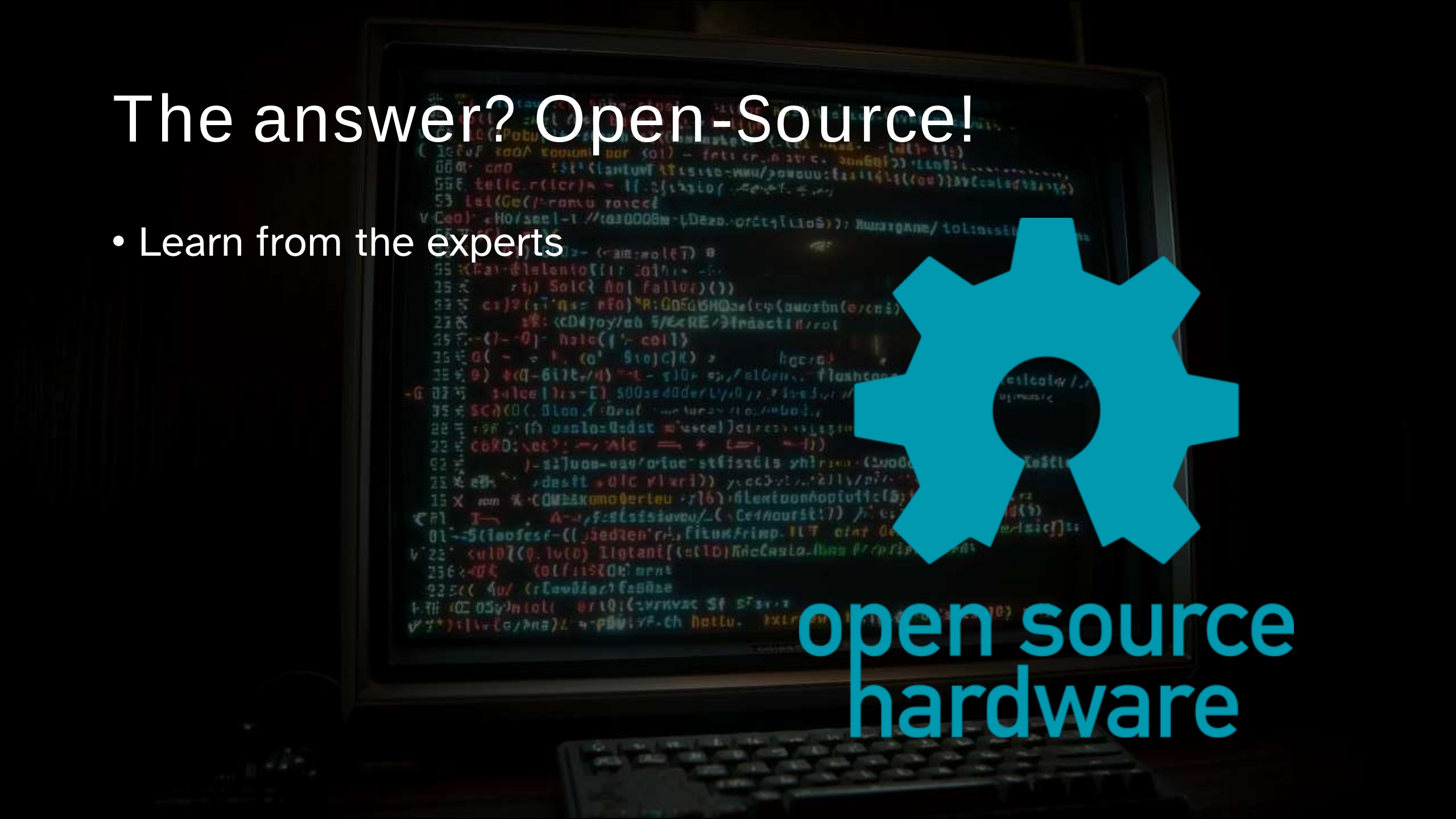
So how do we go from simple circuits to full #badgelife?

The answer? Open-Source!



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- Learn from the experts



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open source hardware

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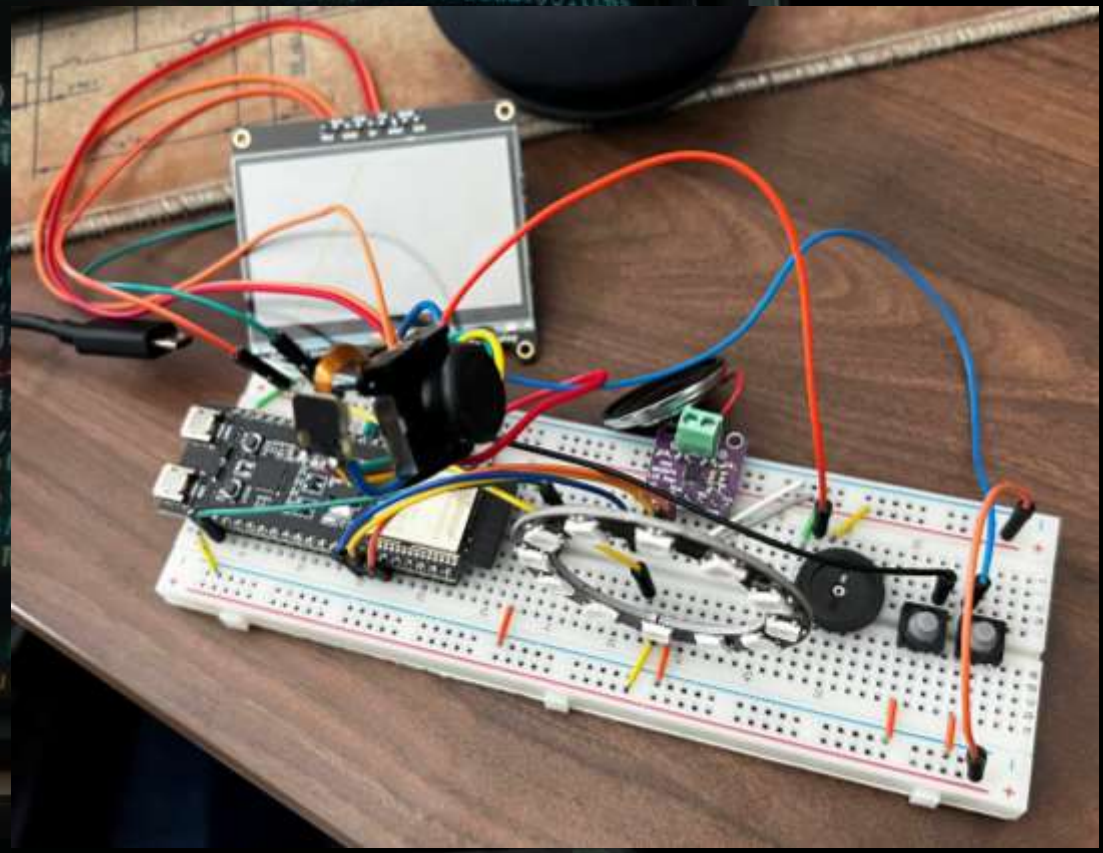
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- Please support them, buy their development boards not knockoff clones



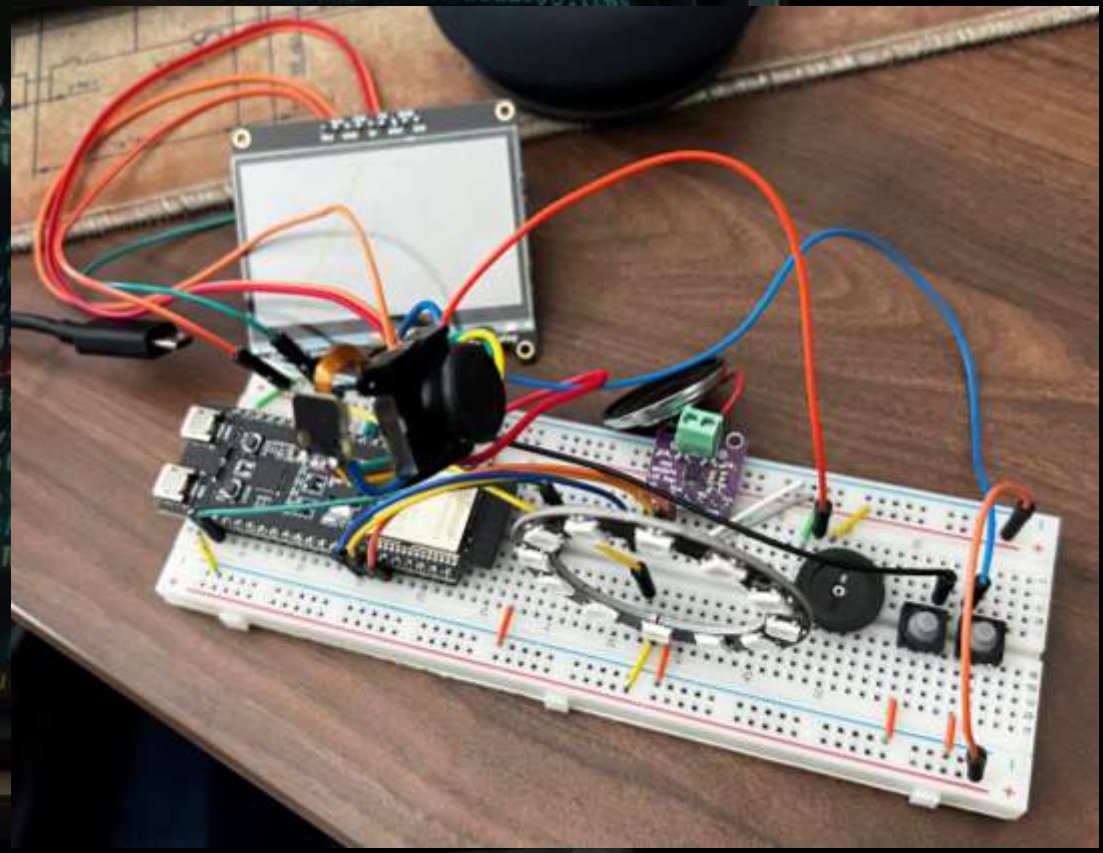
open source hardware

Prototype the circuit on a breadboard



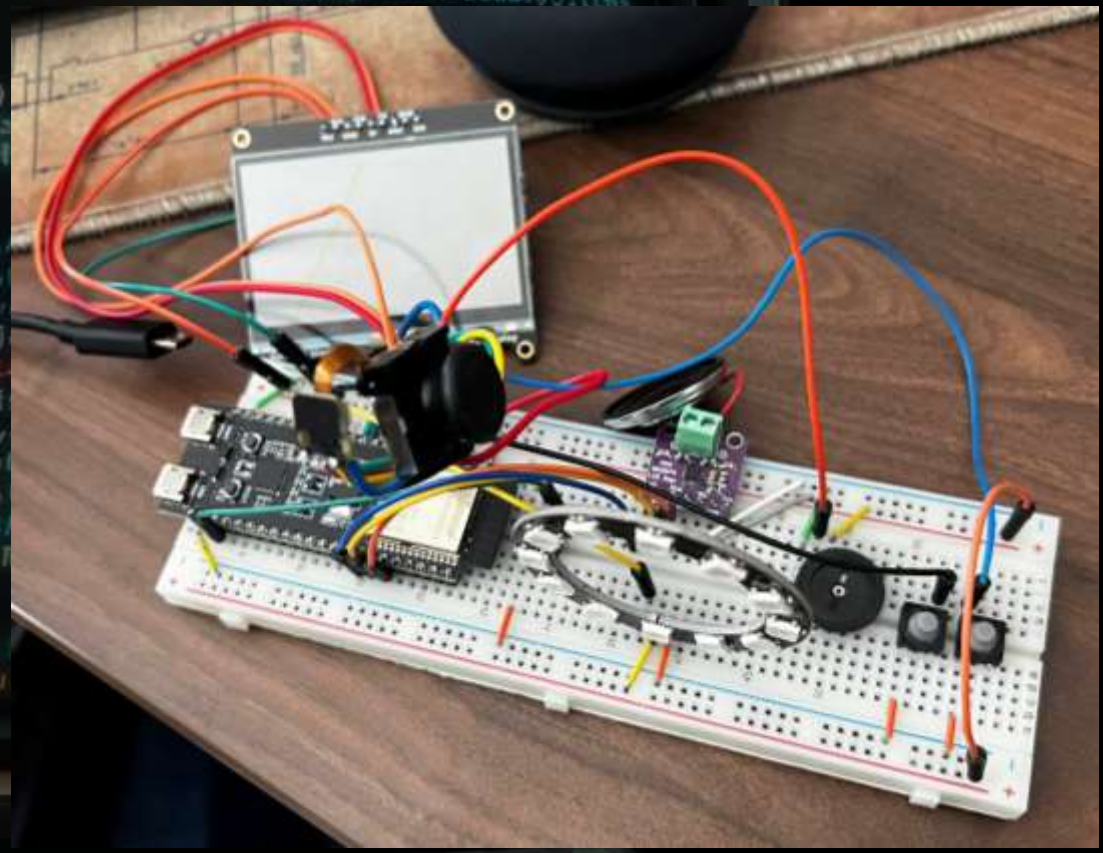
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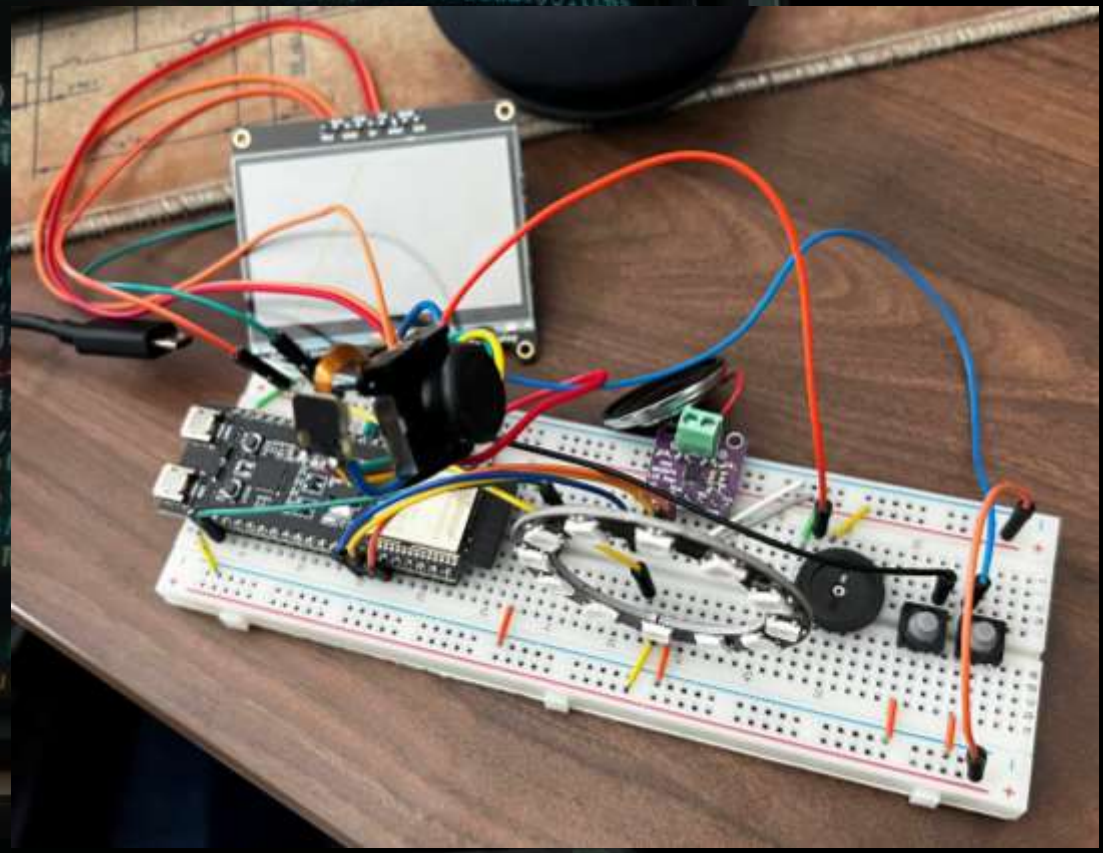
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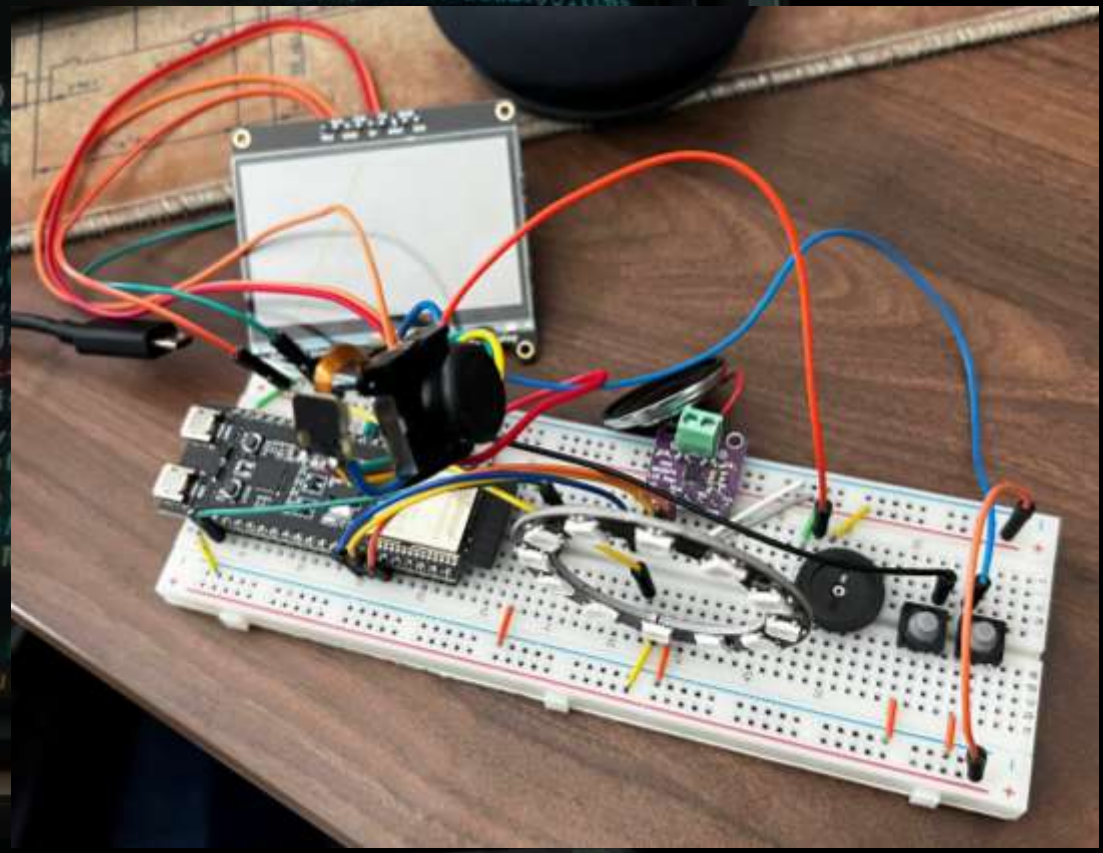
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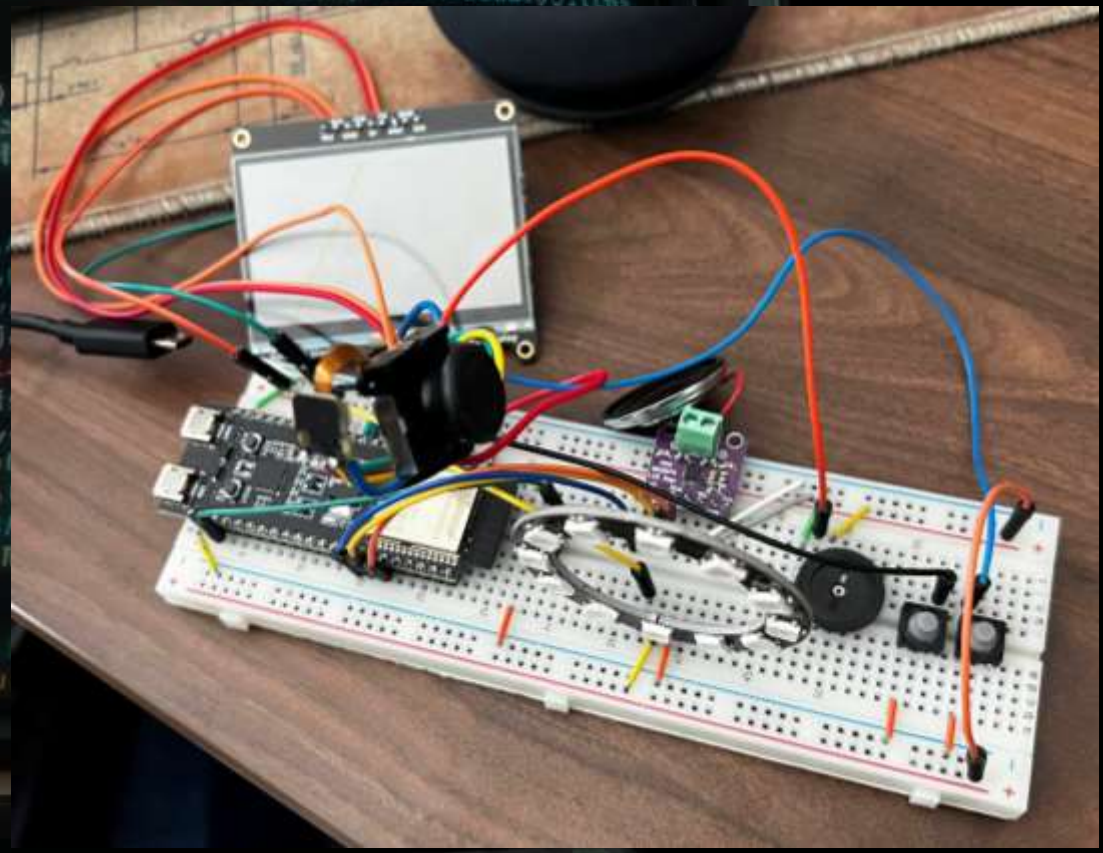
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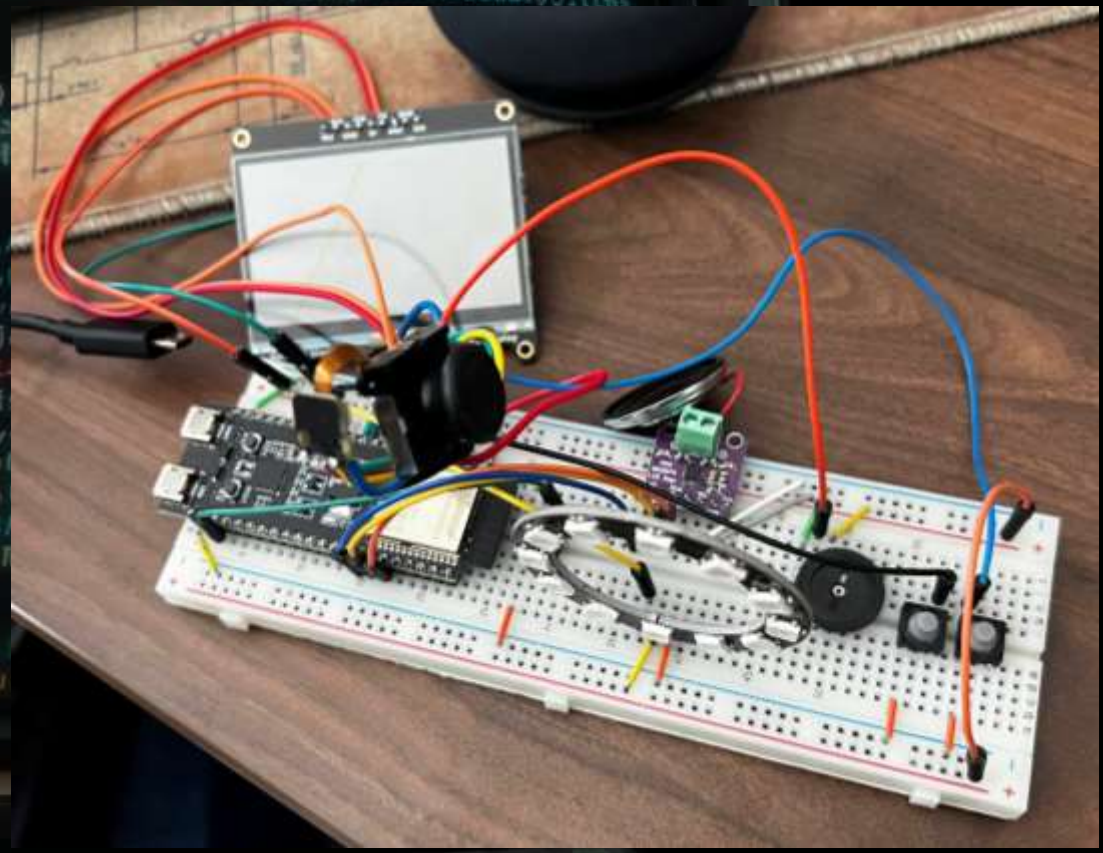
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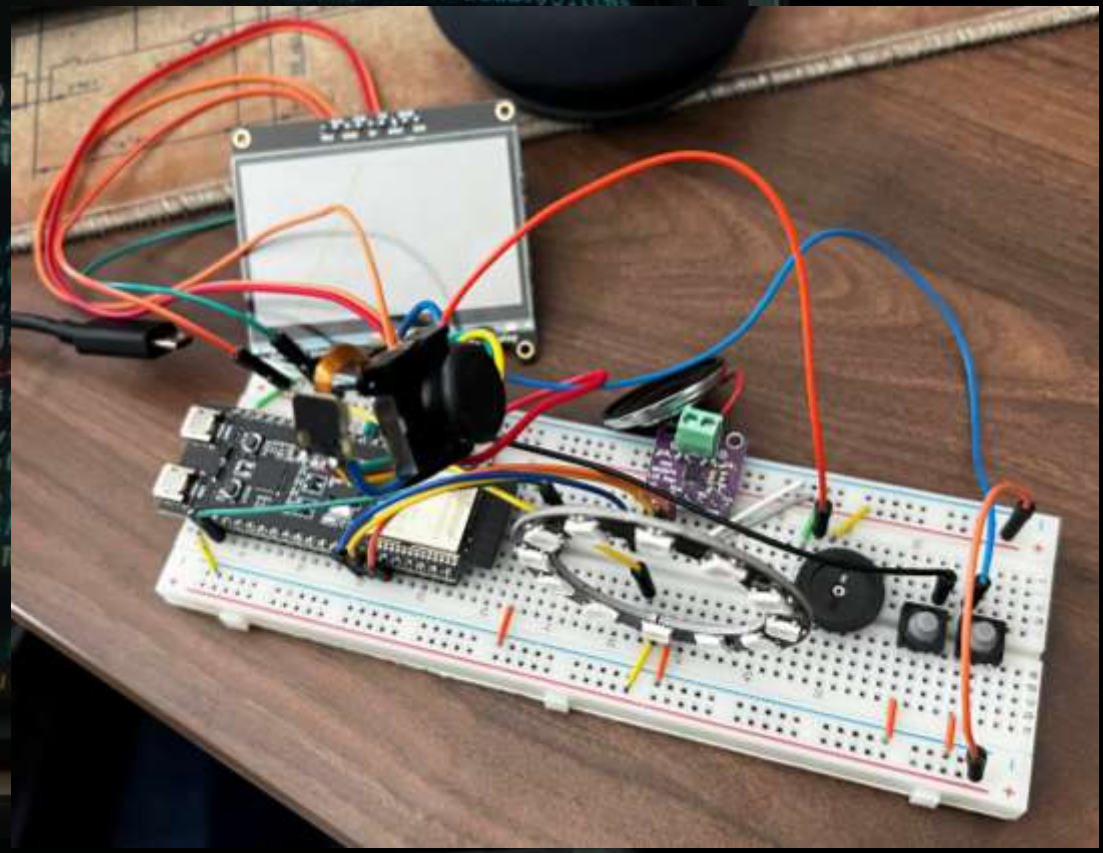
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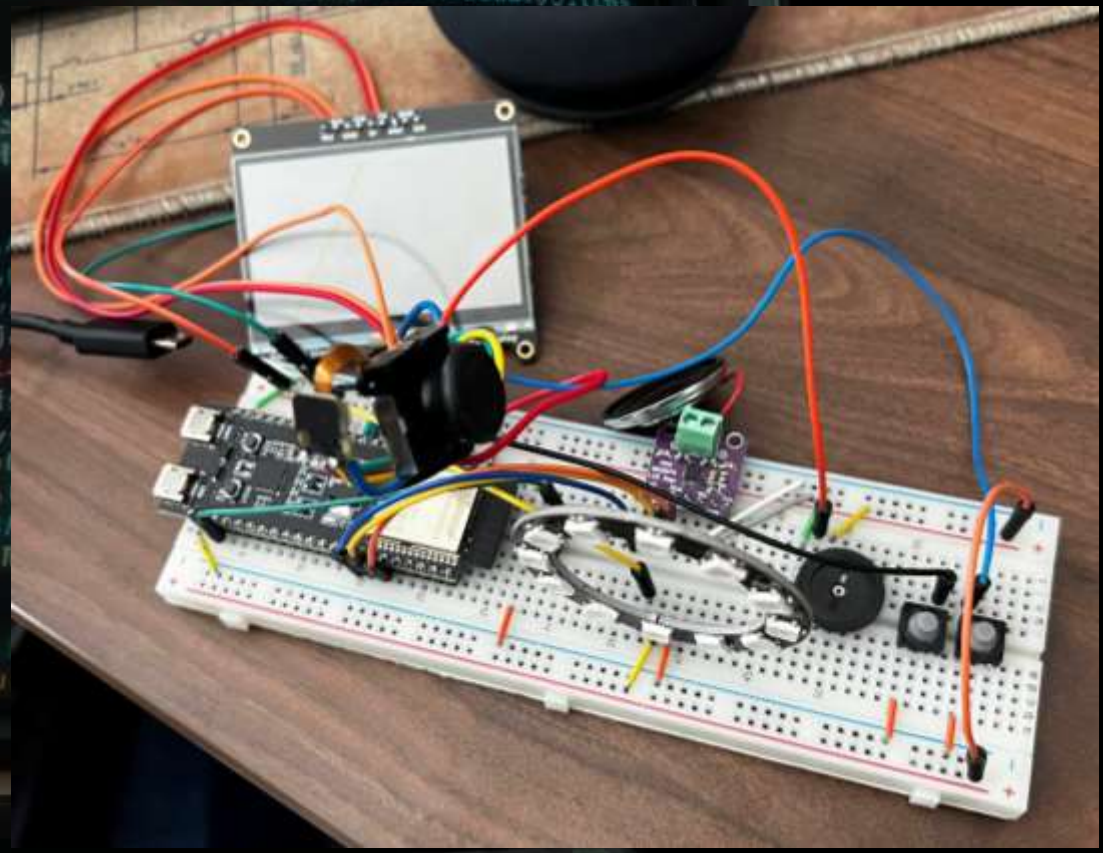
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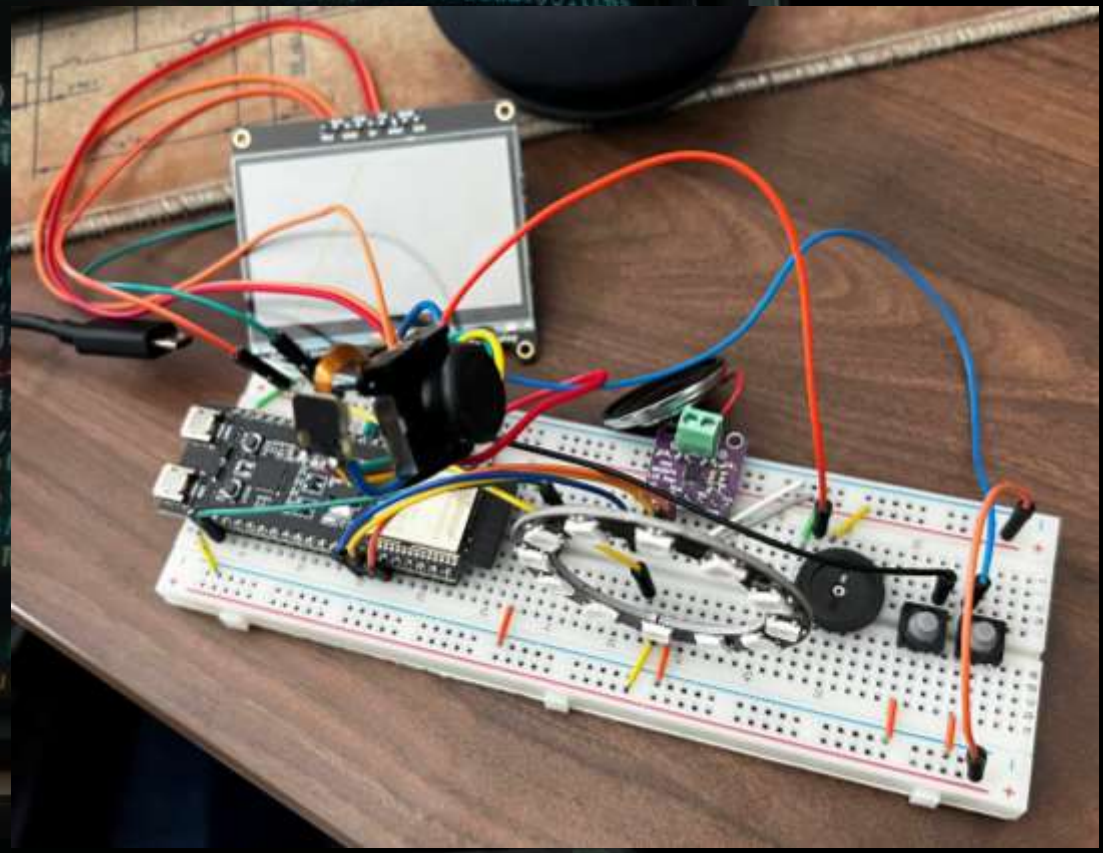
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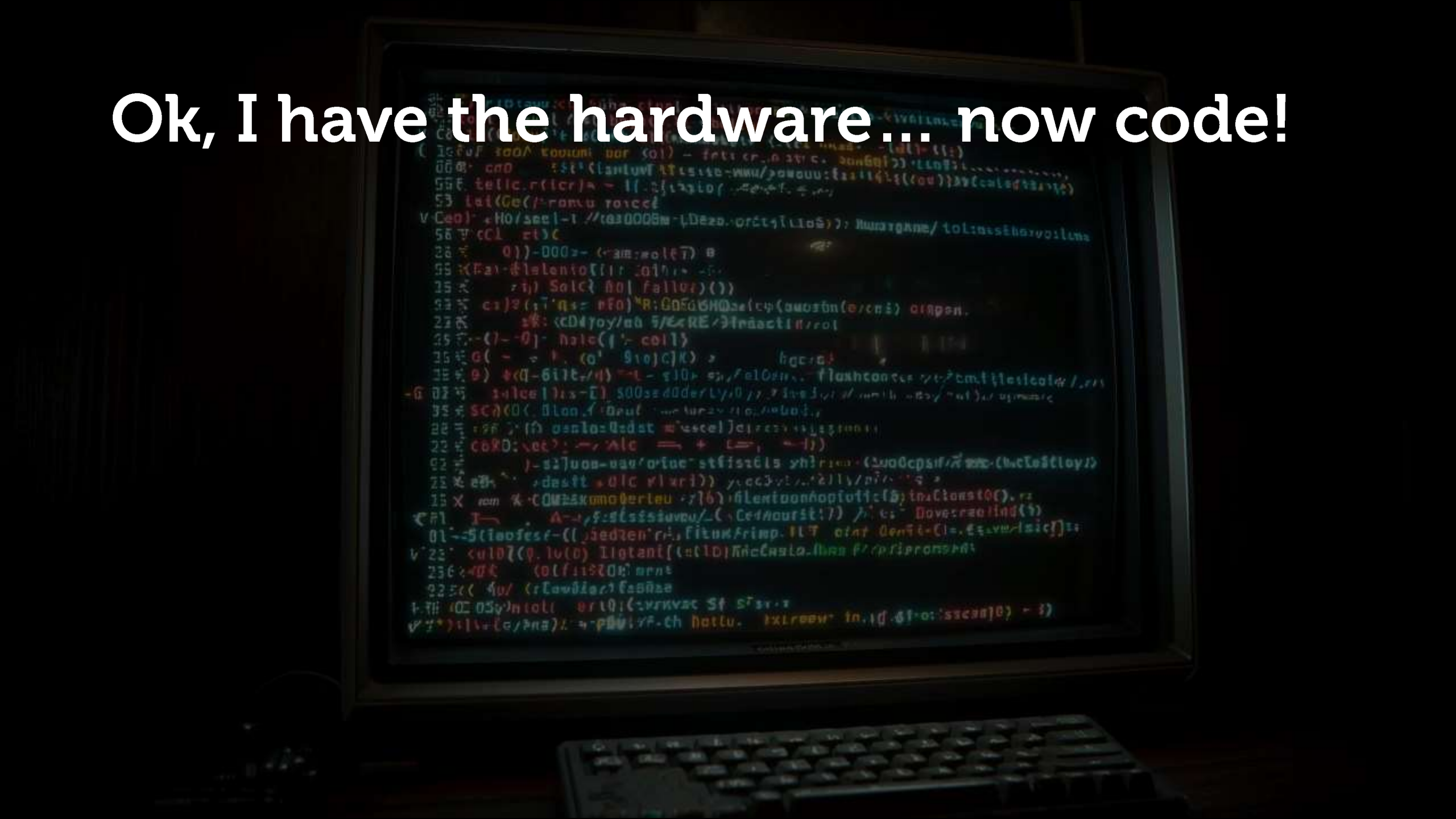


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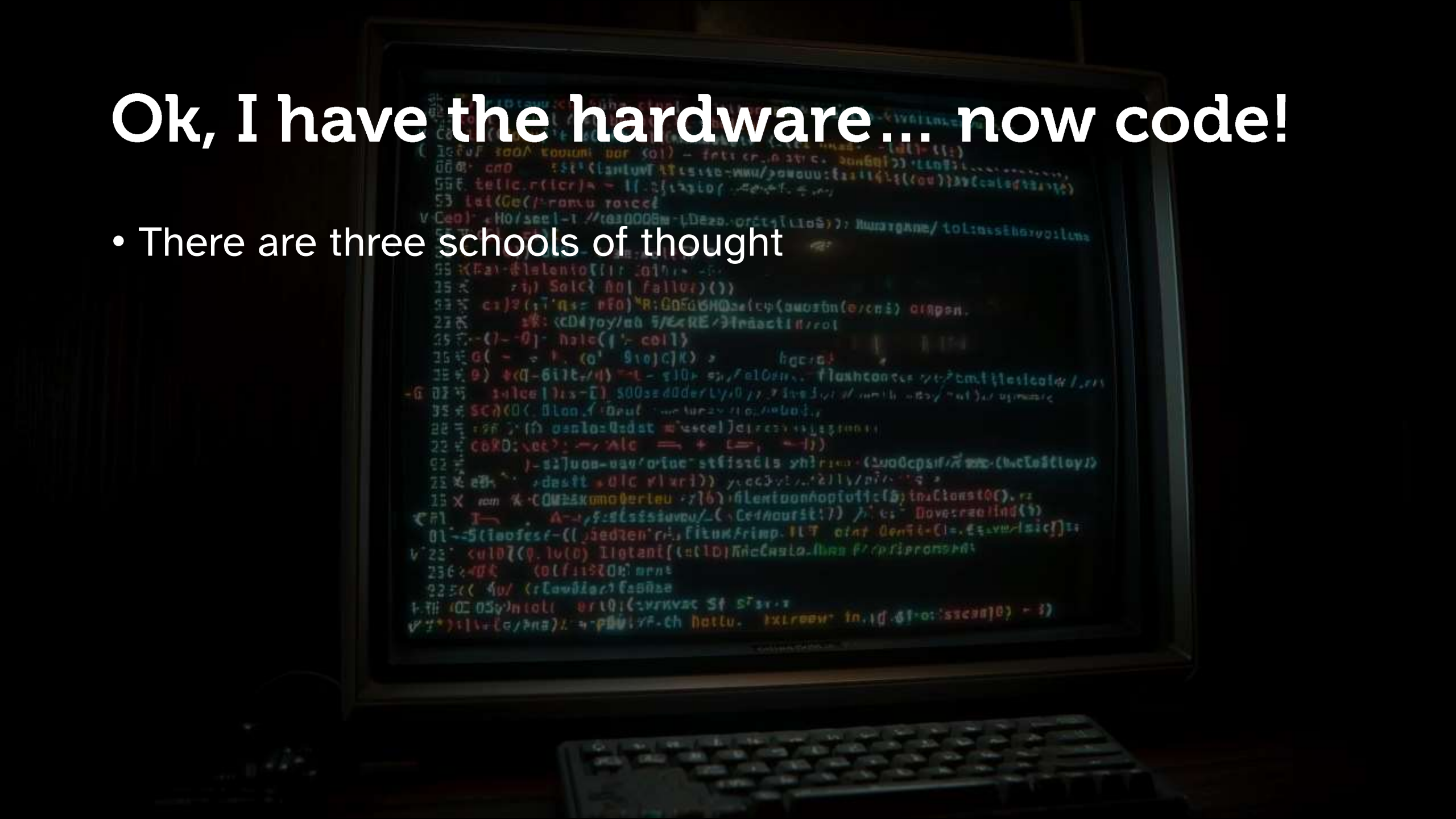


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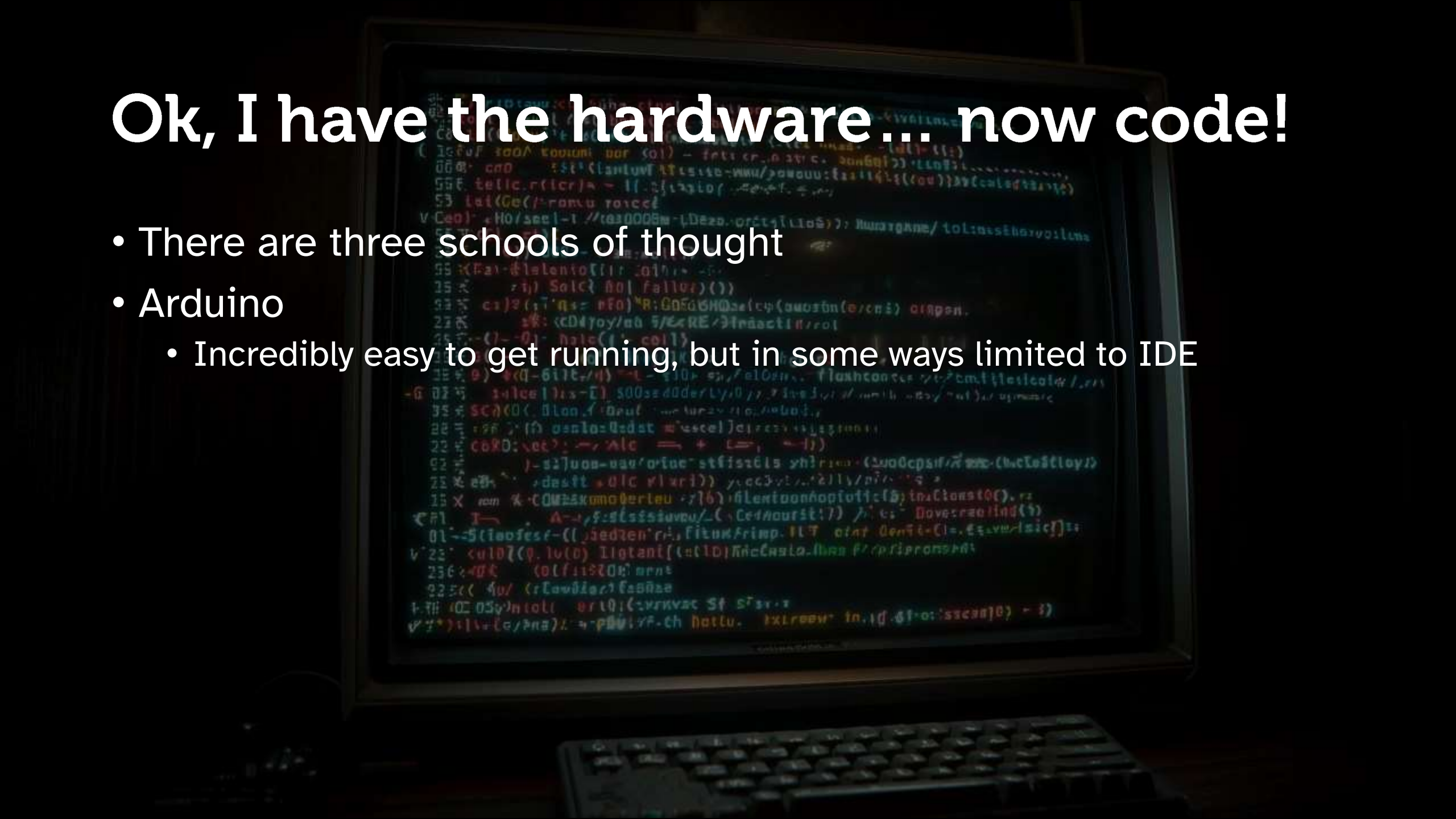
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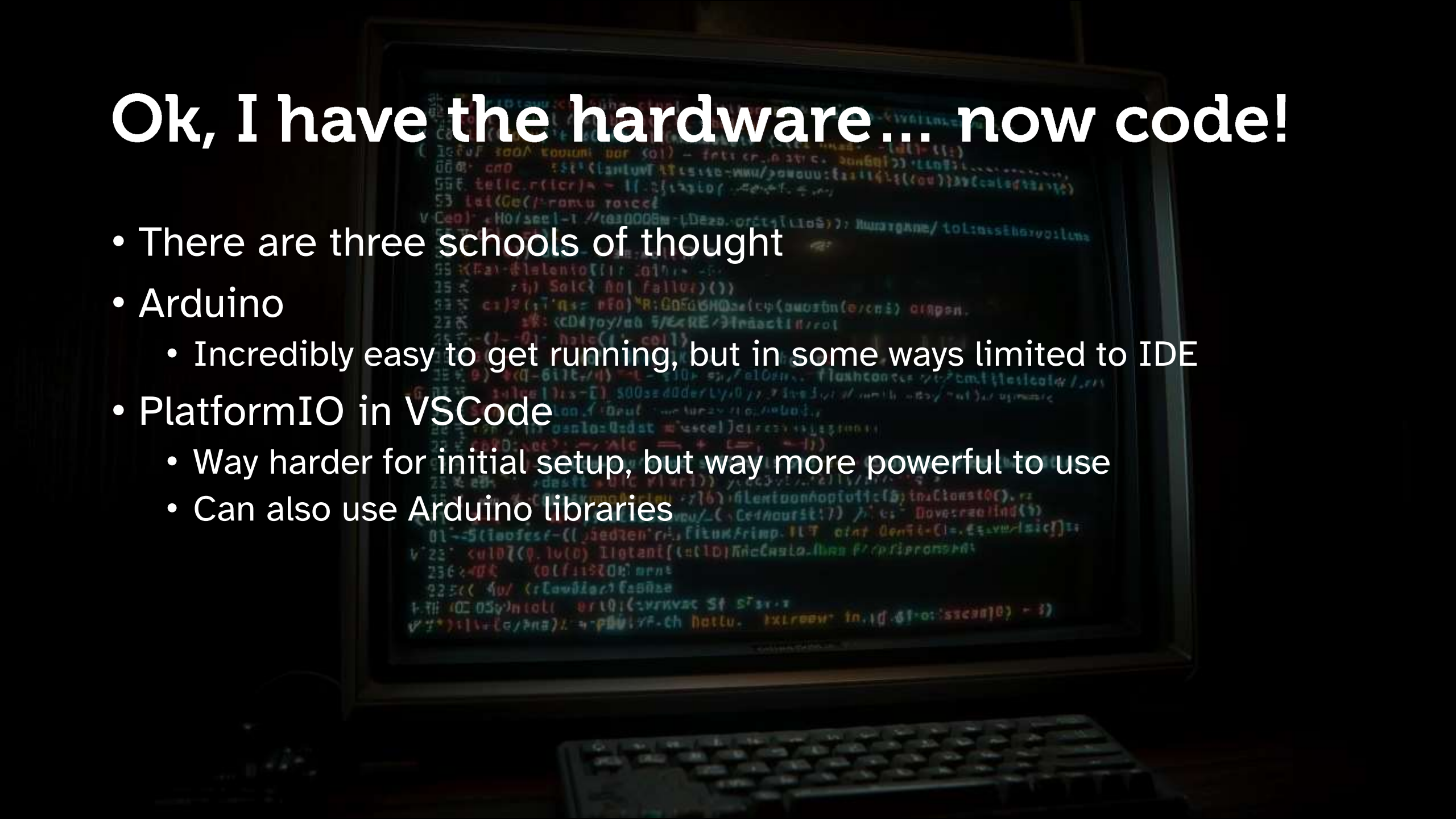
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- Arduino
  - Incredibly easy to get running, but in some ways limited to IDE



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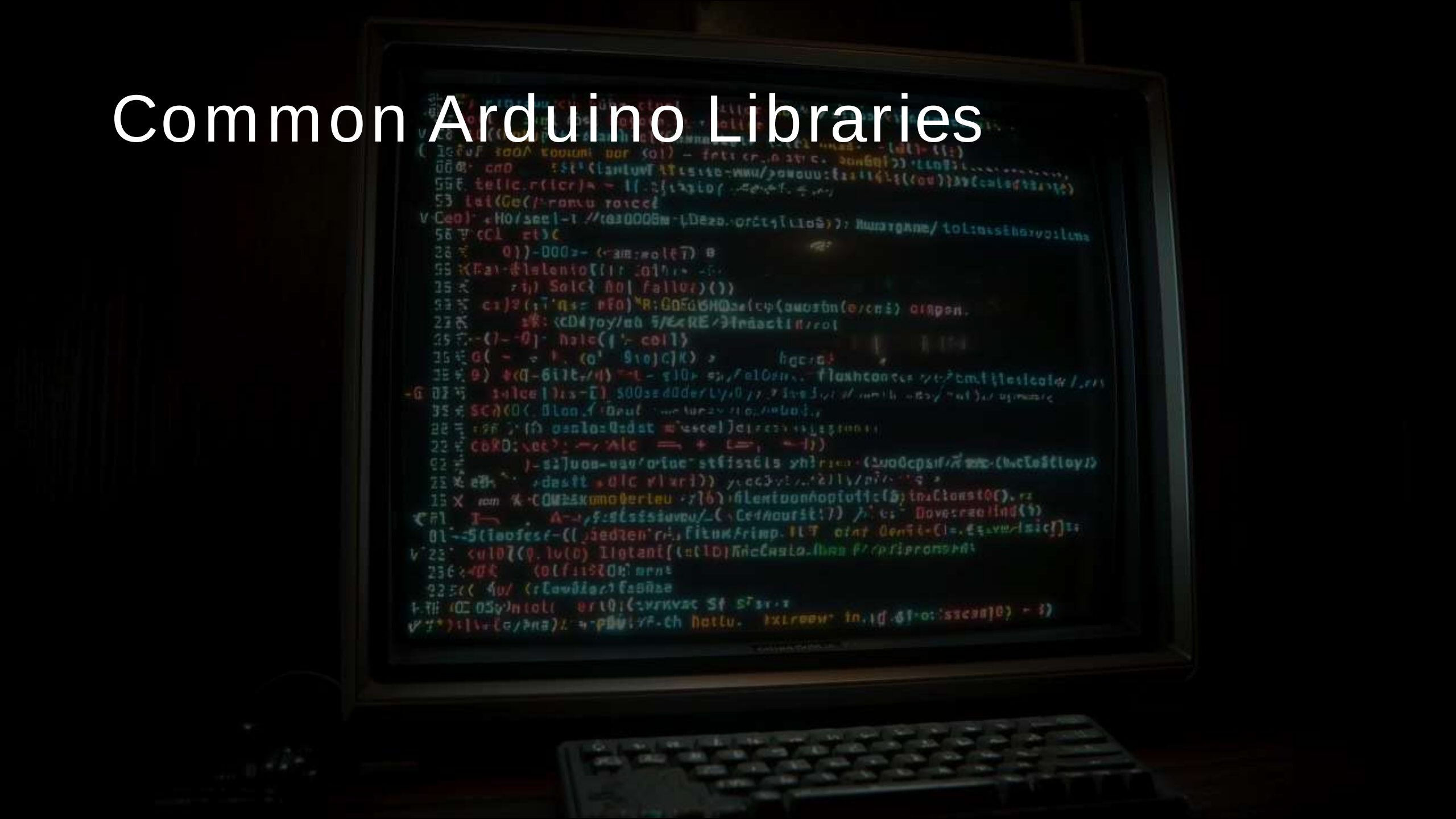
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  - Way harder for initial setup, but way more powerful to use
  - Can also use Arduino libraries



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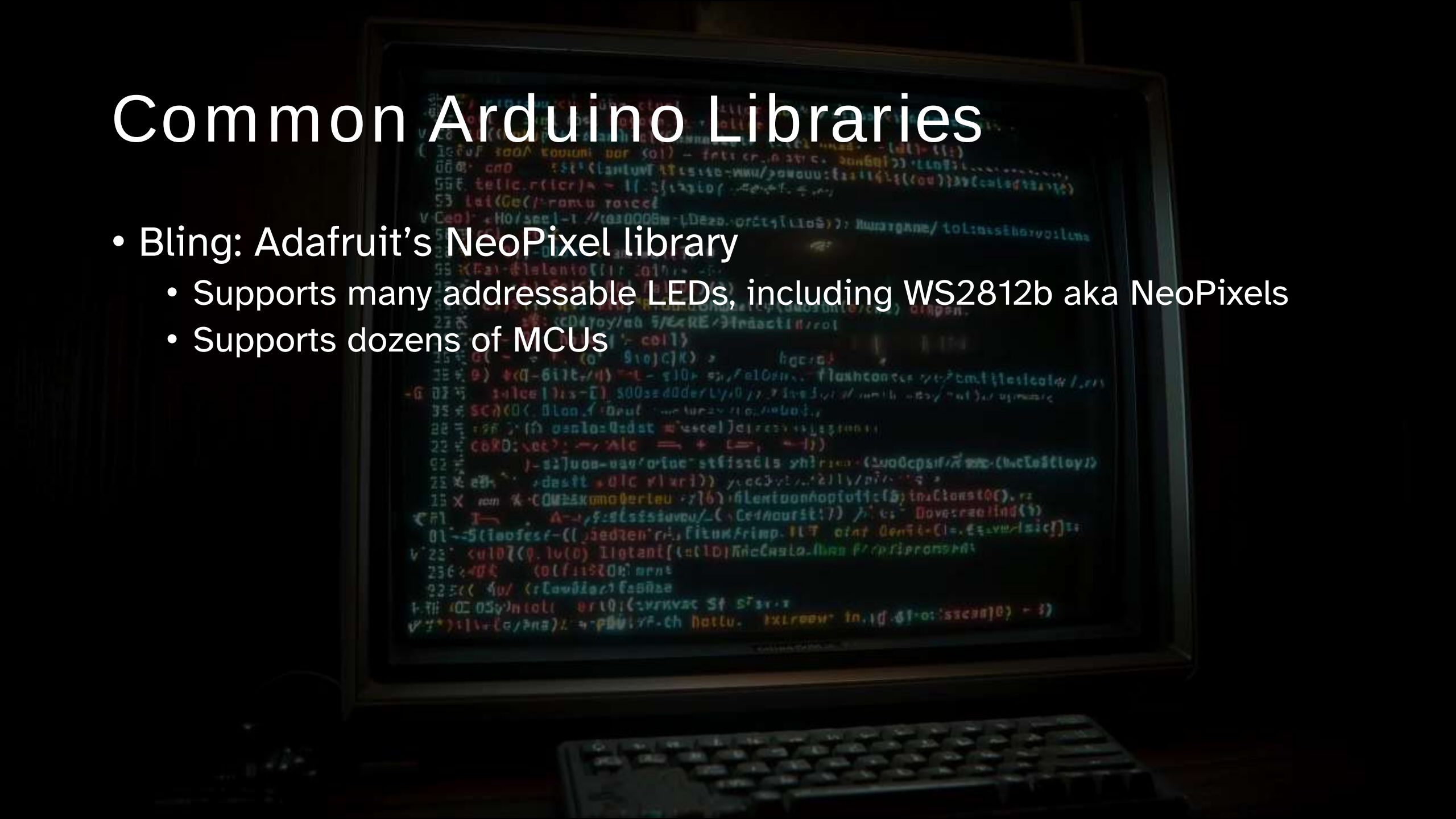
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  - Can also use Arduino libraries
- Compile your own
  - Use a manufacturer supplied toolchain for your MCU
  - Can use more esoteric chipsets, but may have to port everything

Common Arduino Libraries



Common Arduino Libraries

- Bling: Adafruit's NeoPixel library
  - Supports many addressable LEDs, including WS2812b aka NeoPixels
  - Supports dozens of MCUs



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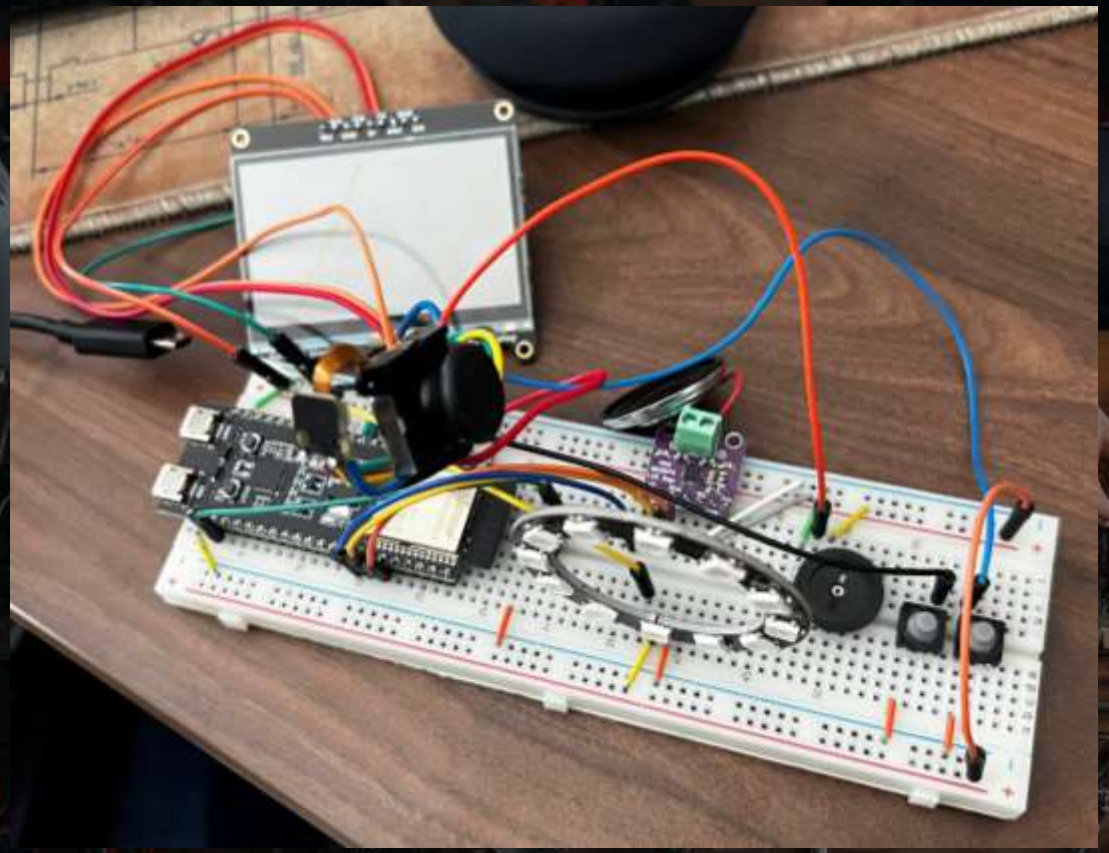
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  - Works with ESP32/RP2XXX DMA controllers for fast writes
- Input: ButtonFever, ezButton
  - Support interrupt handles or polling state
  - "Debounce" buttons to prevent duplicate input


Cool I have a working
Prototype, what next?

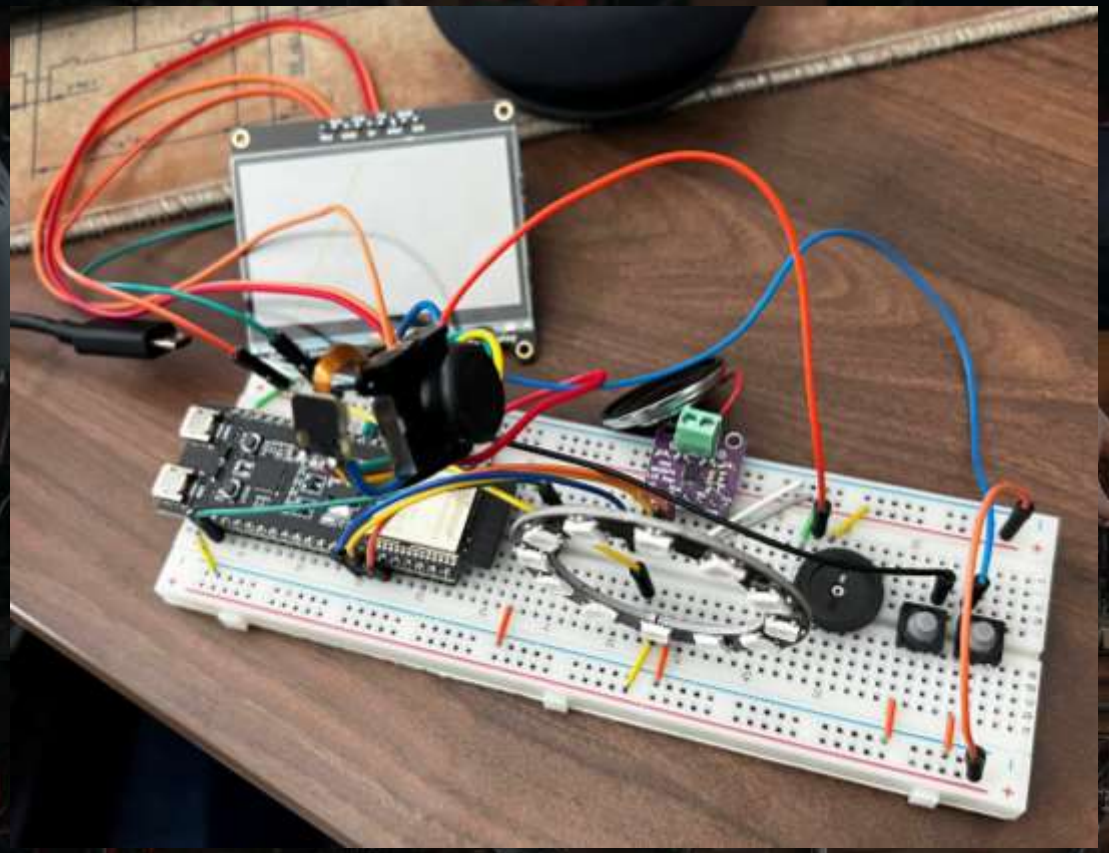
From Breadboard to KiCad Schematic

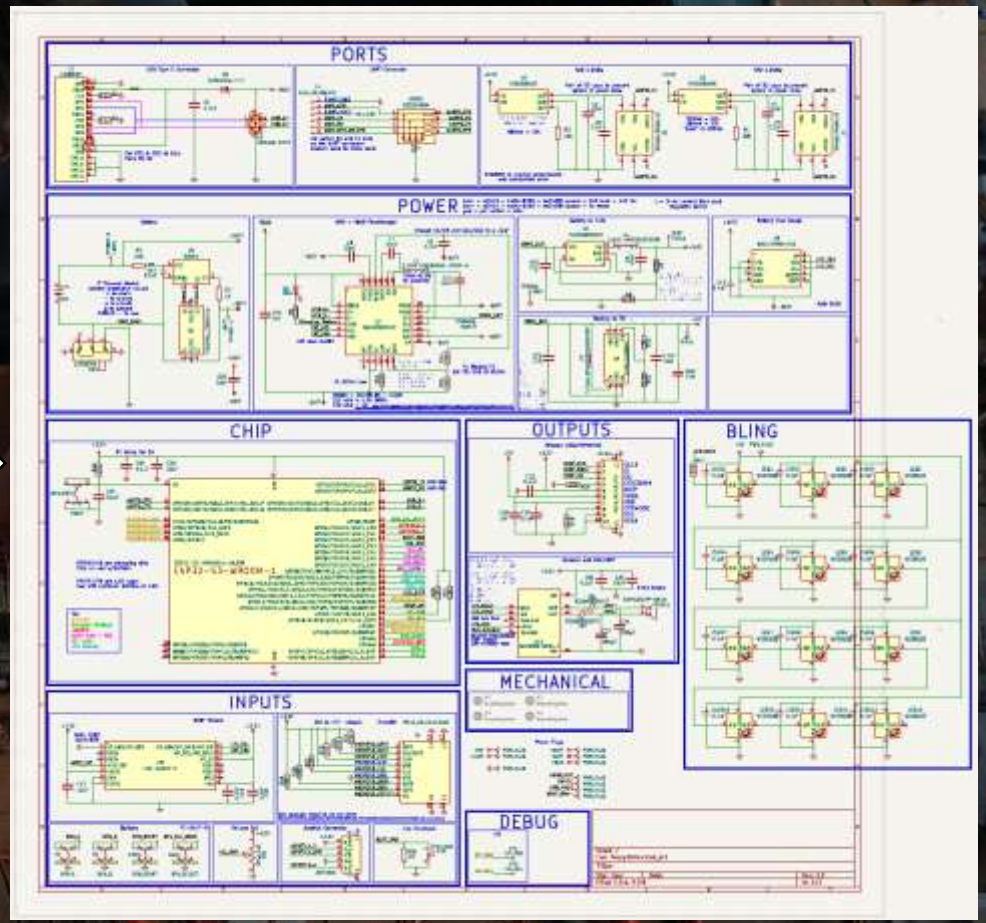
How do I go from this...



From Breadboard to KiCad Schematic

How do I go from this... to this!?



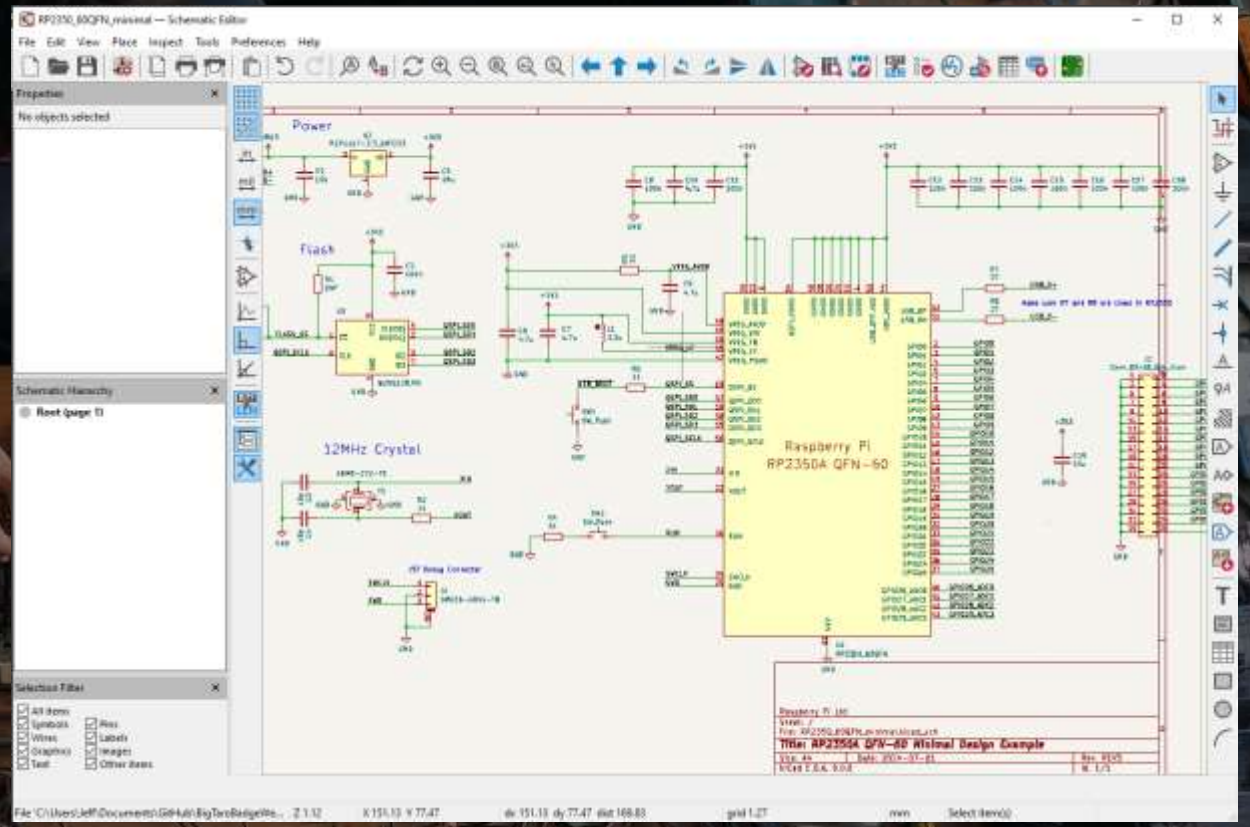


Start with the brains



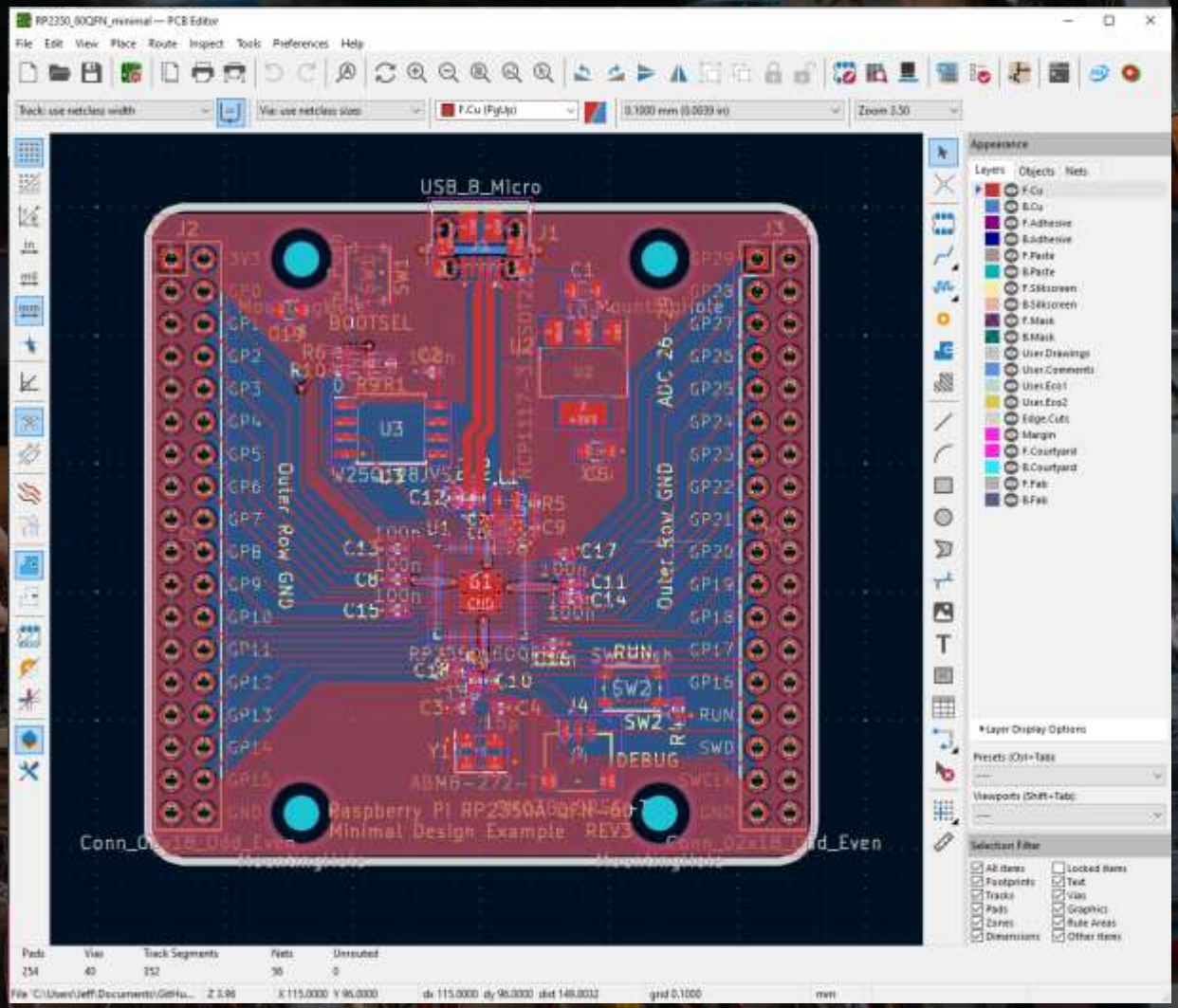
Start with the brains

- Raspberry Pi Foundation provides a working reference board for KiCad
  - https://datasheets.raspberrypi.com/rp2350/Minimal-KiCAD.zip



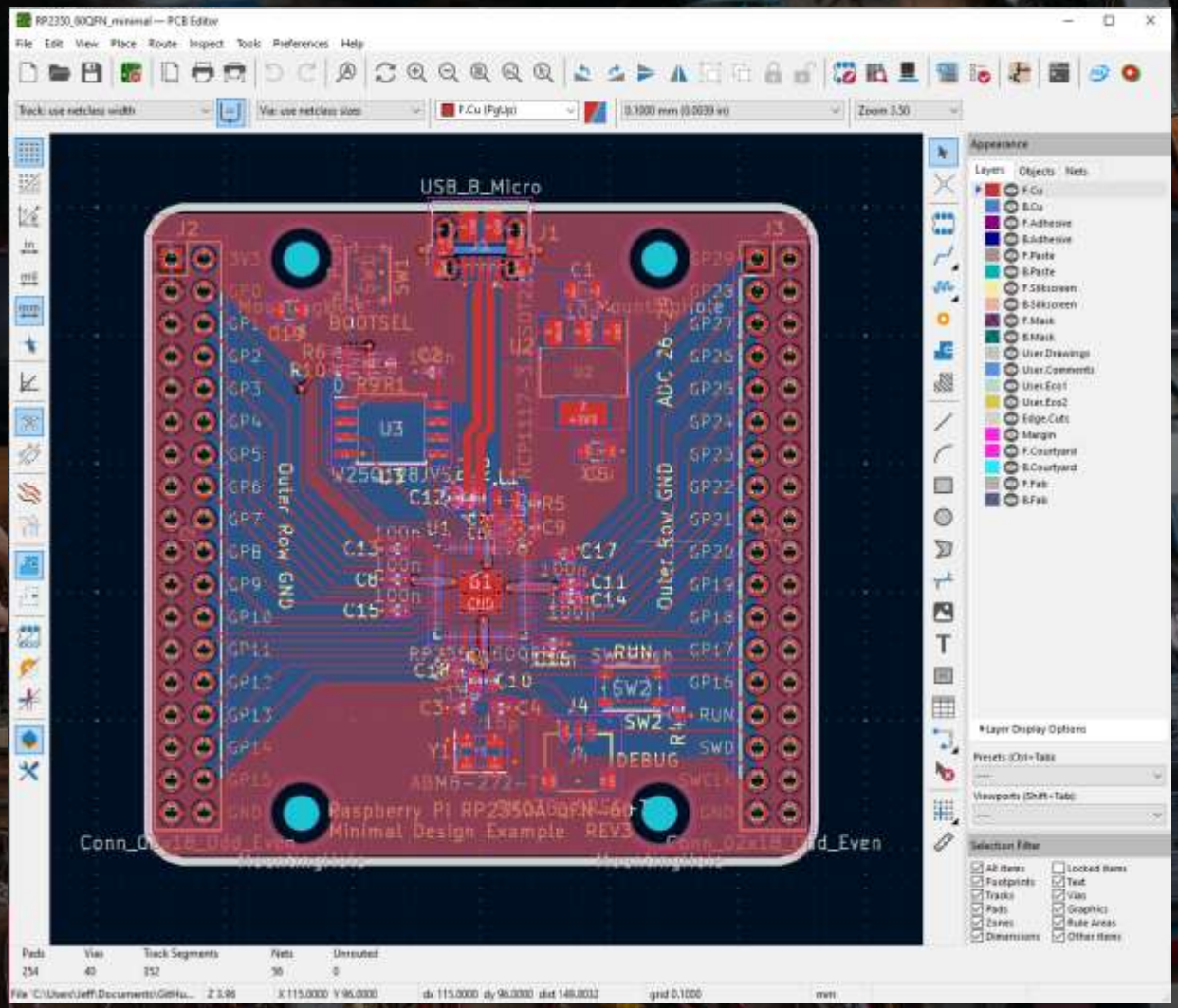
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Start with the brains

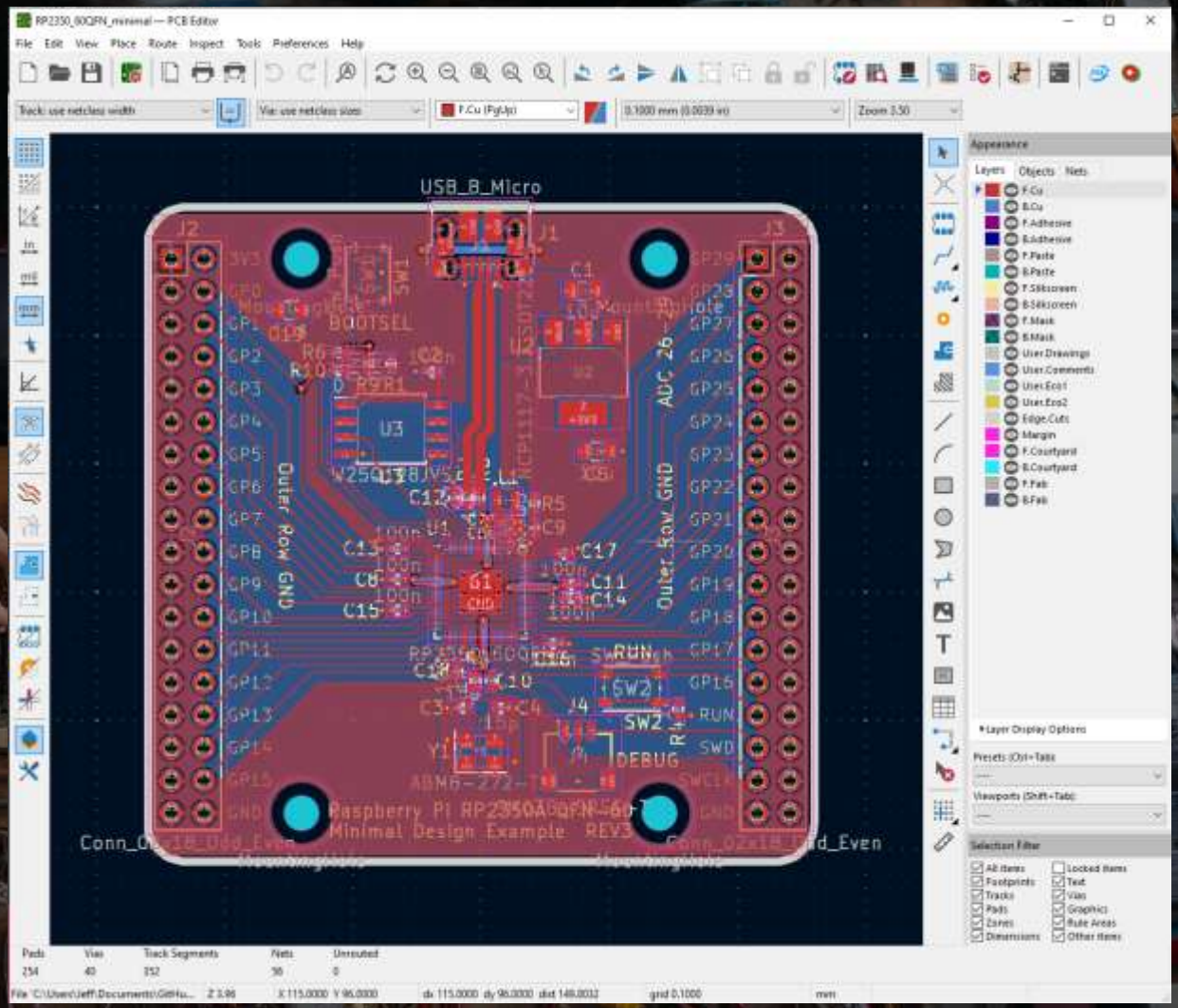
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- Has both schematic and layout
- Is it the best? Eh?



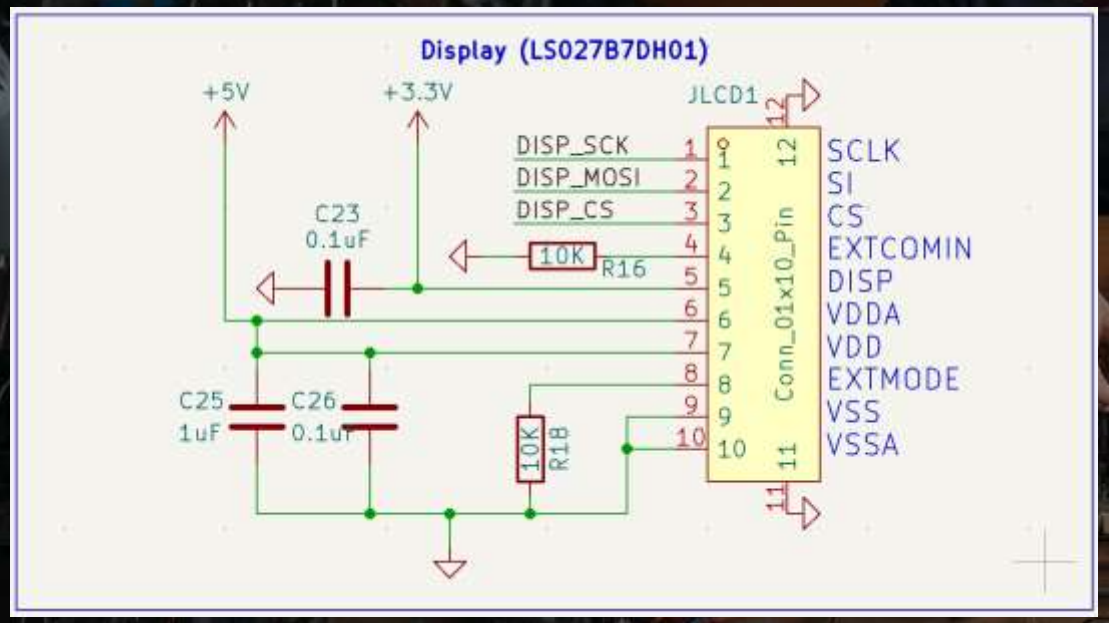
Start with the brains

- Raspberry Pi Foundation provides a working reference board for KiCad
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- Has both schematic and layout
- Is it the best? Eh?
- Does it work out the box? Hell ya

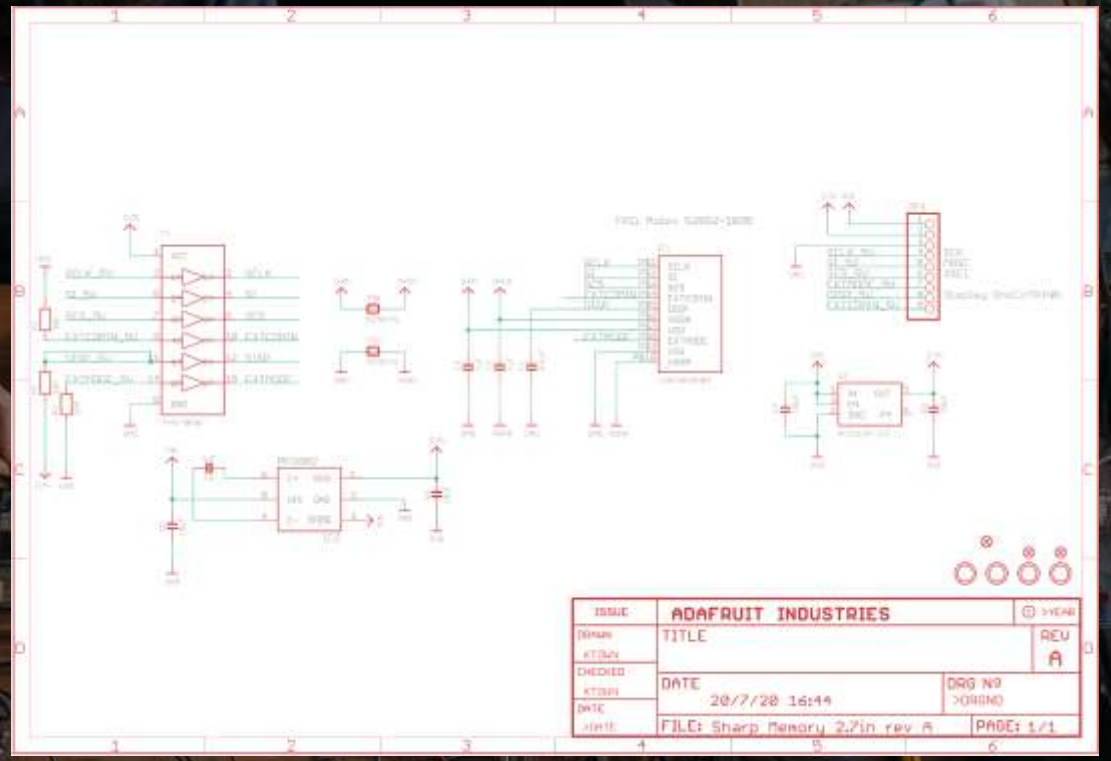




Next, hodge-podge your OSS in

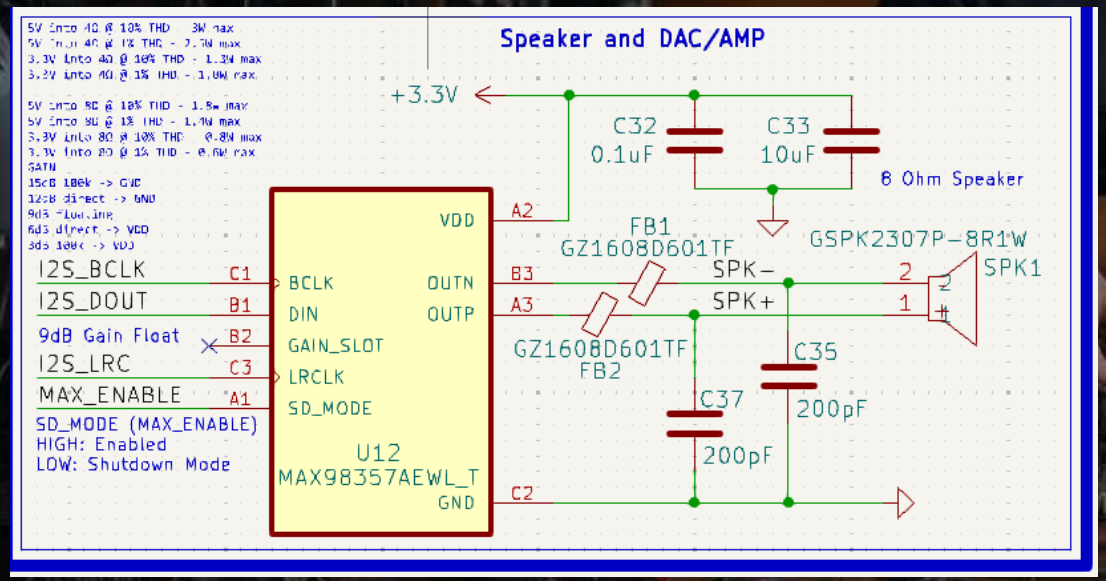


My schematic for the Sharp Memory LCD Display

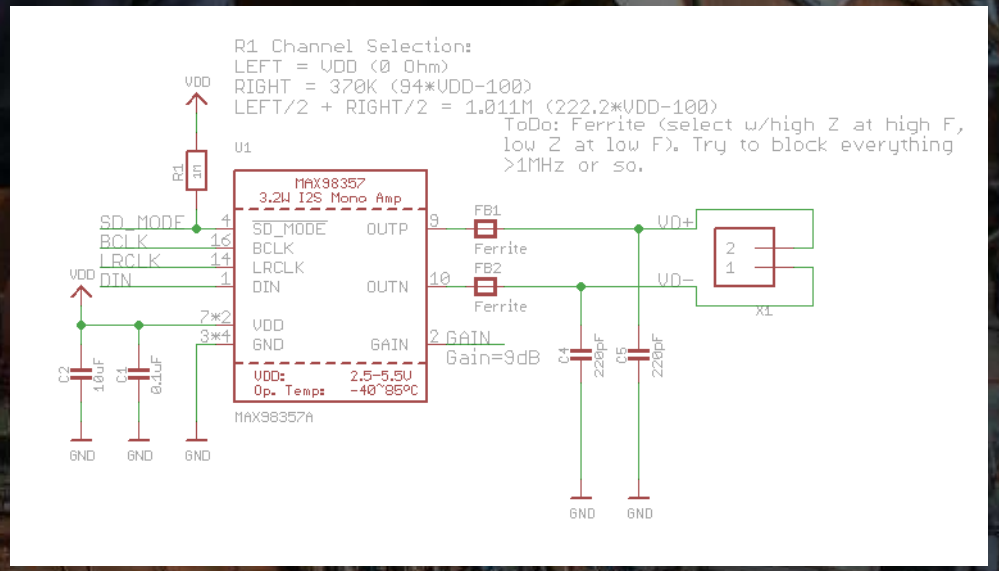


Adafruit's schematic for the same display's breakout

Example, the MAX98357 Amp

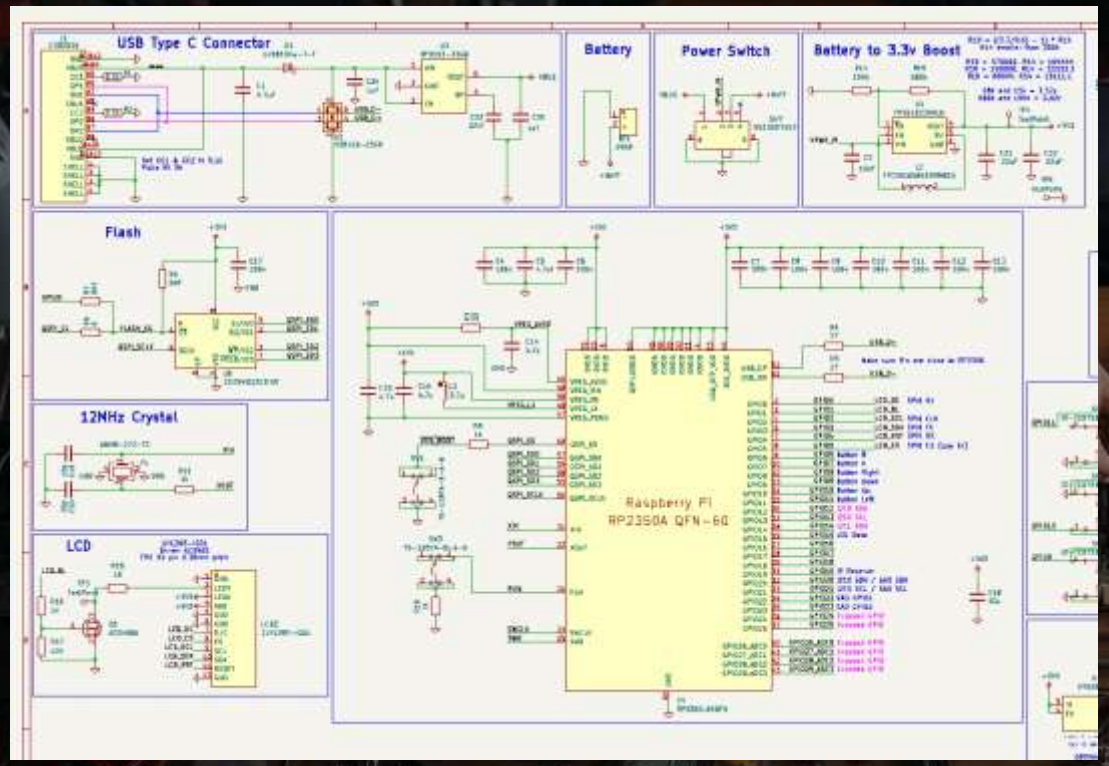


My Circuit for a badge last year

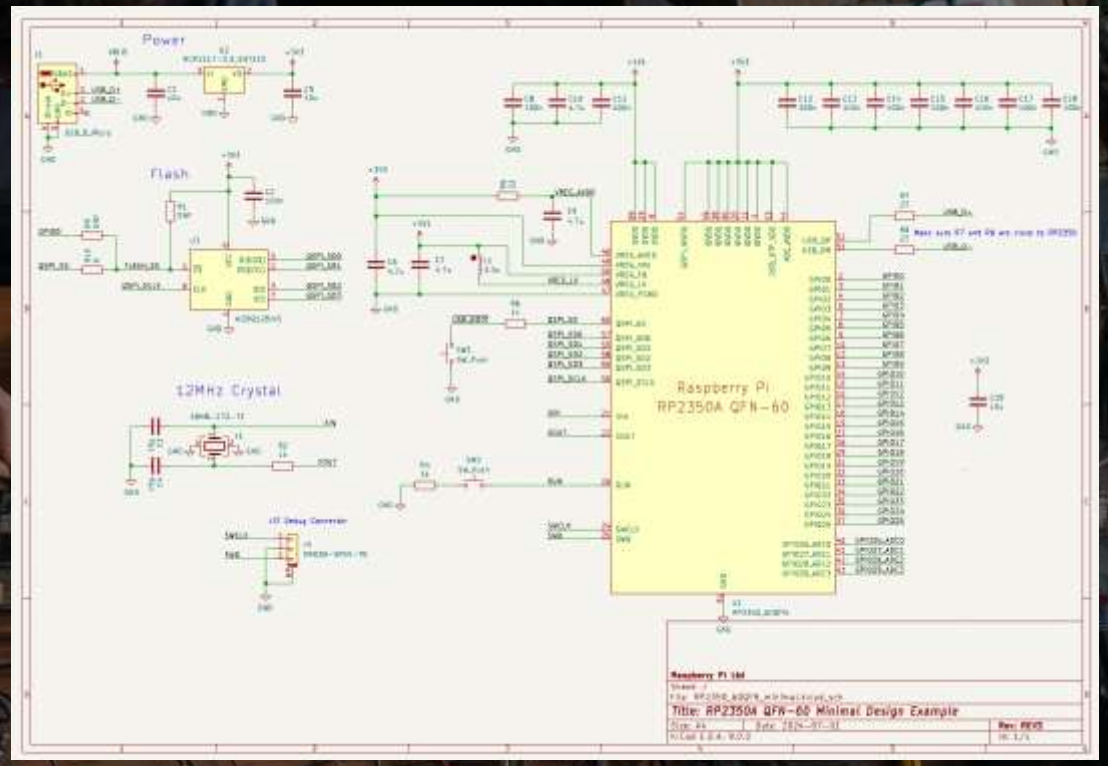


Adafruit's Circuit

Get a working badge!

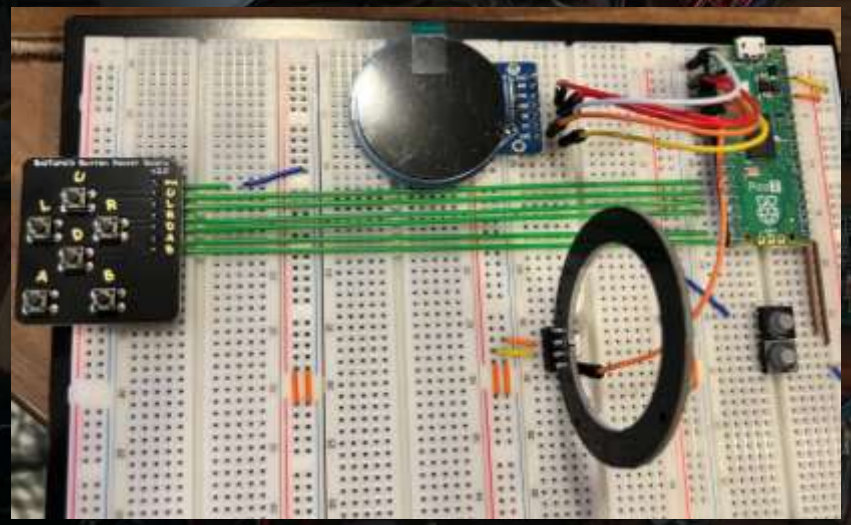


My schematic for the FrogStar badge (RP2350)



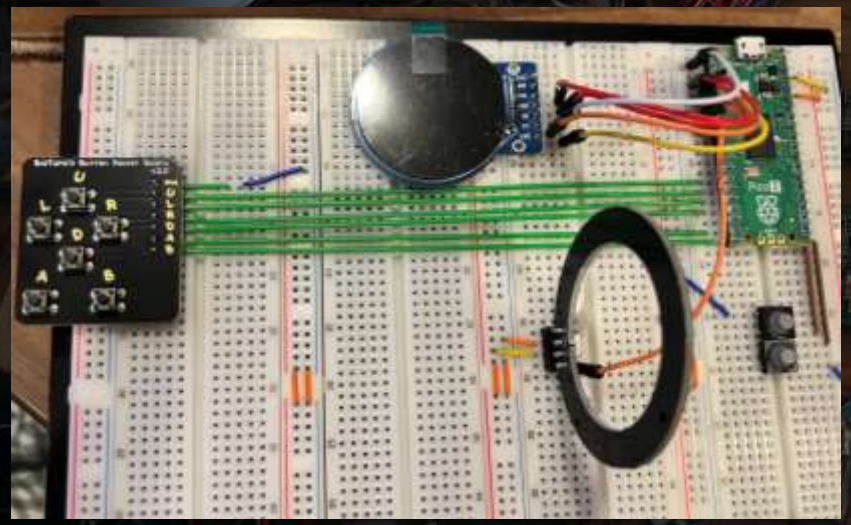
RP2350 official reference design

FrogStar's Progression

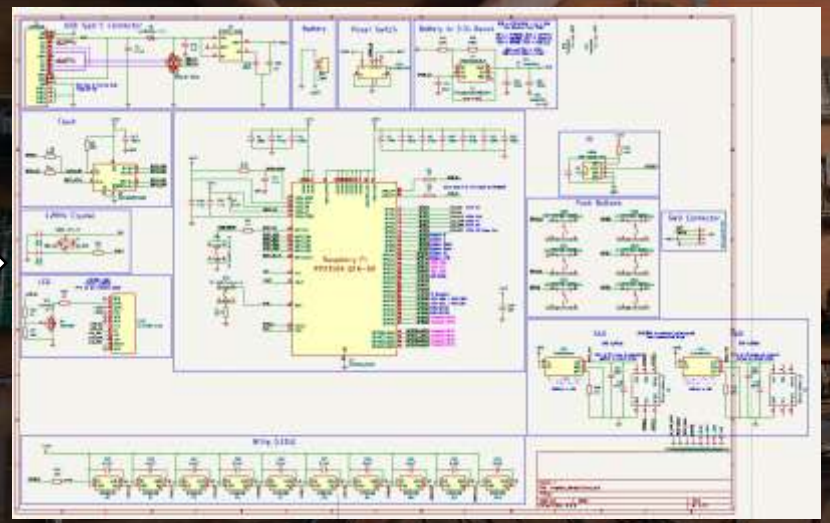


Breadboard with Pico2 (RP2350)

FrogStar's Progression

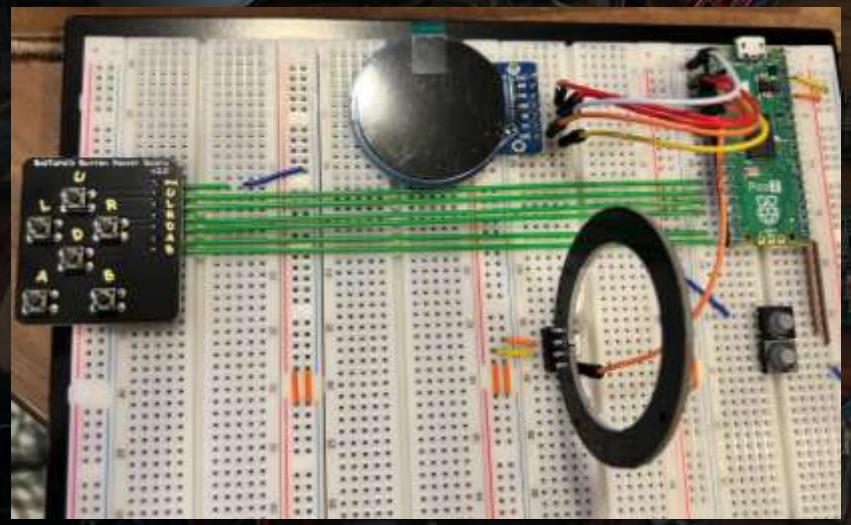


Breadboard with Pico2 (RP2350)

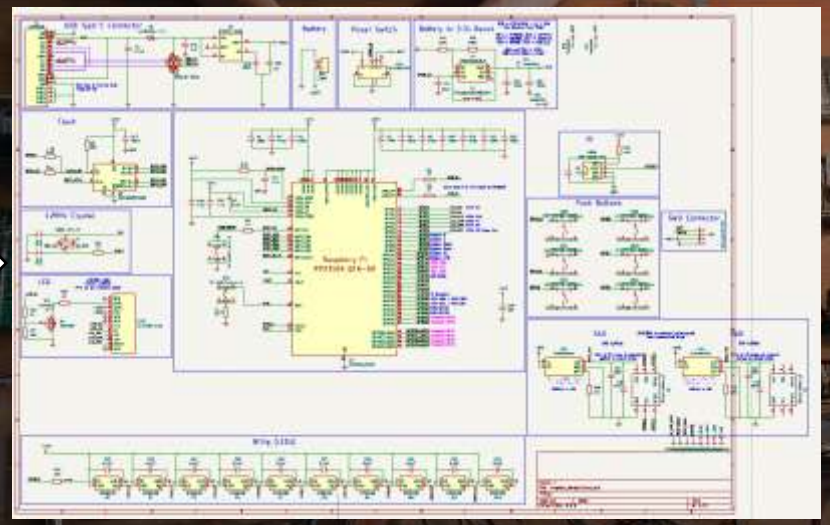


Schematic based on reference RP2350

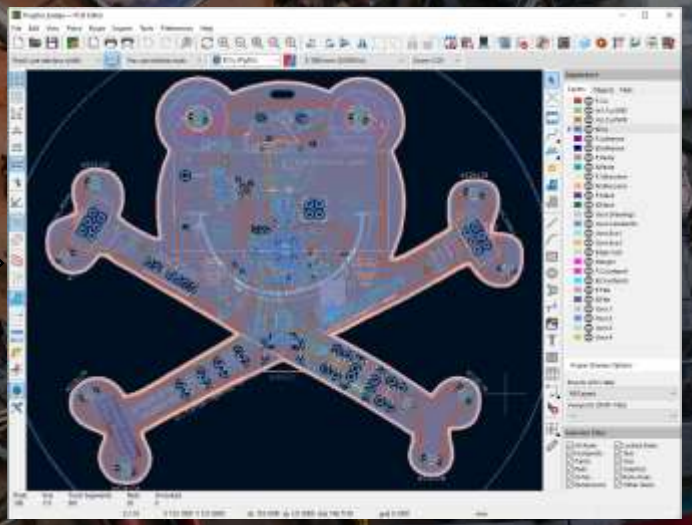
FrogStar's Progression



Breadboard with Pico2 (RP2350)



Schematic based on reference RP2350

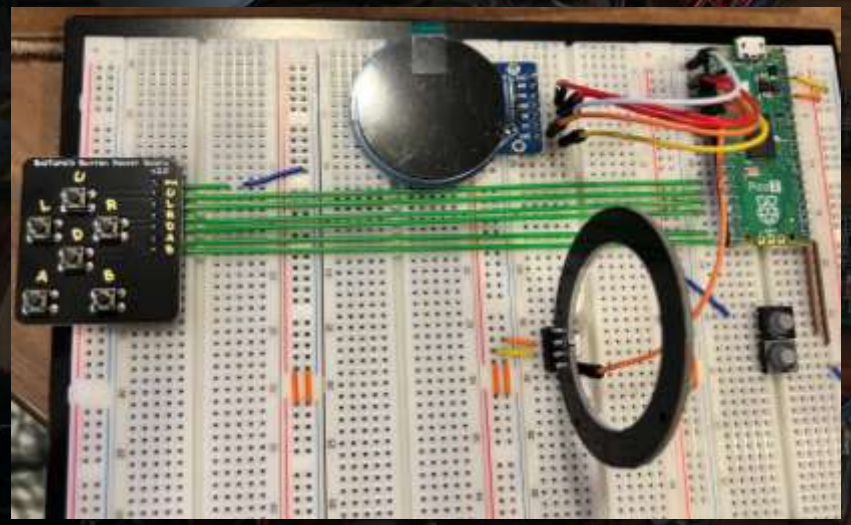


Layout the PCB

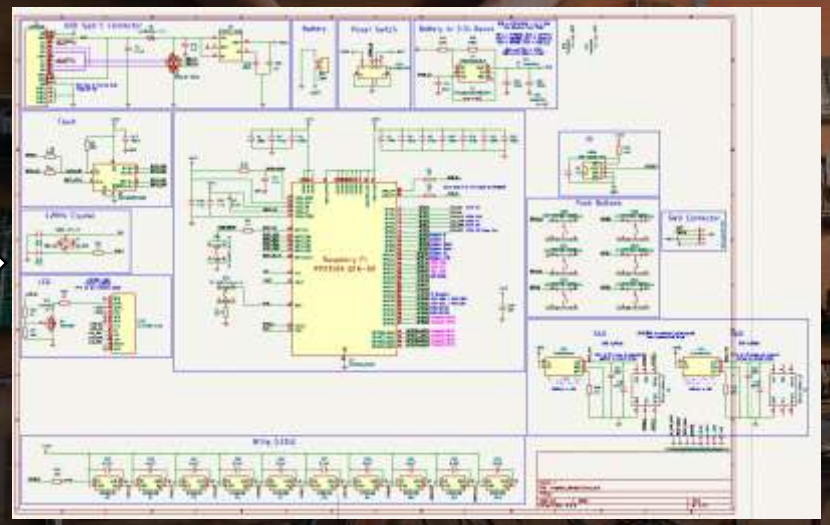
FrogStar's Progression



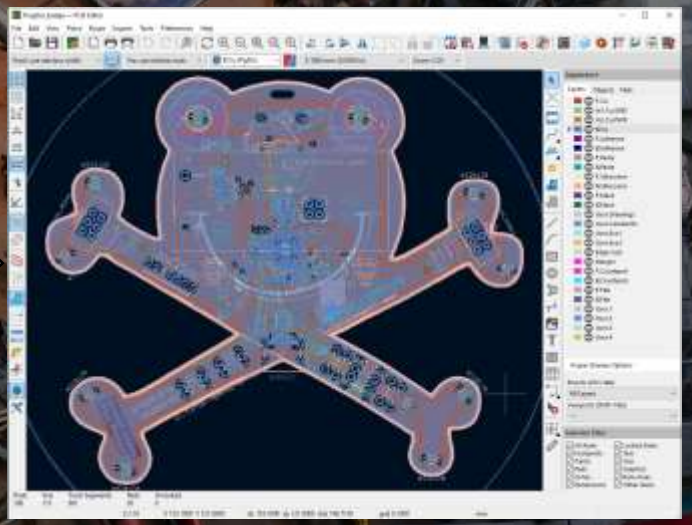
The Final Badge!



Breadboard with Pico2 (RP2350)



Schematic based on reference RP2350



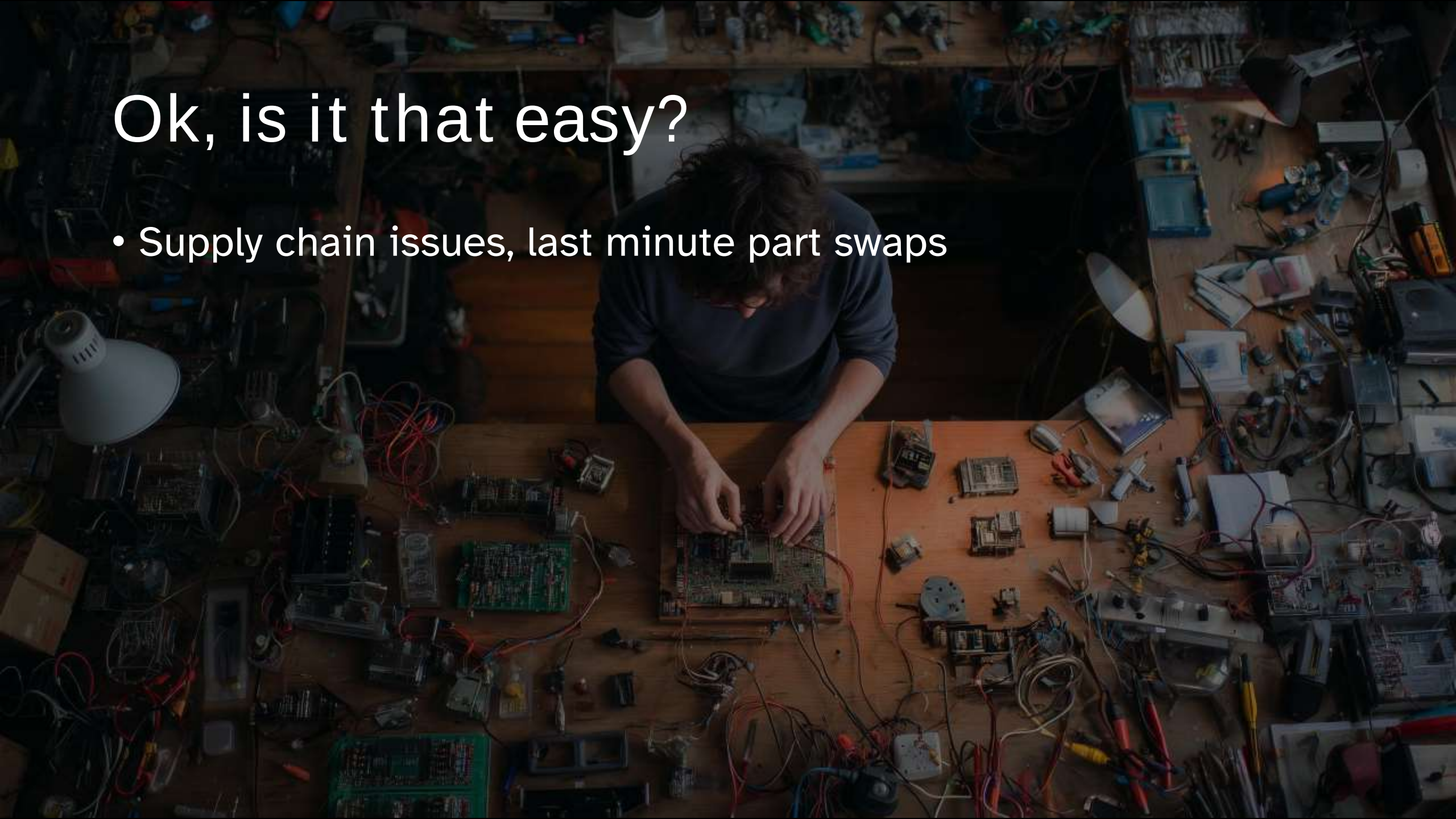
Layout the PCB

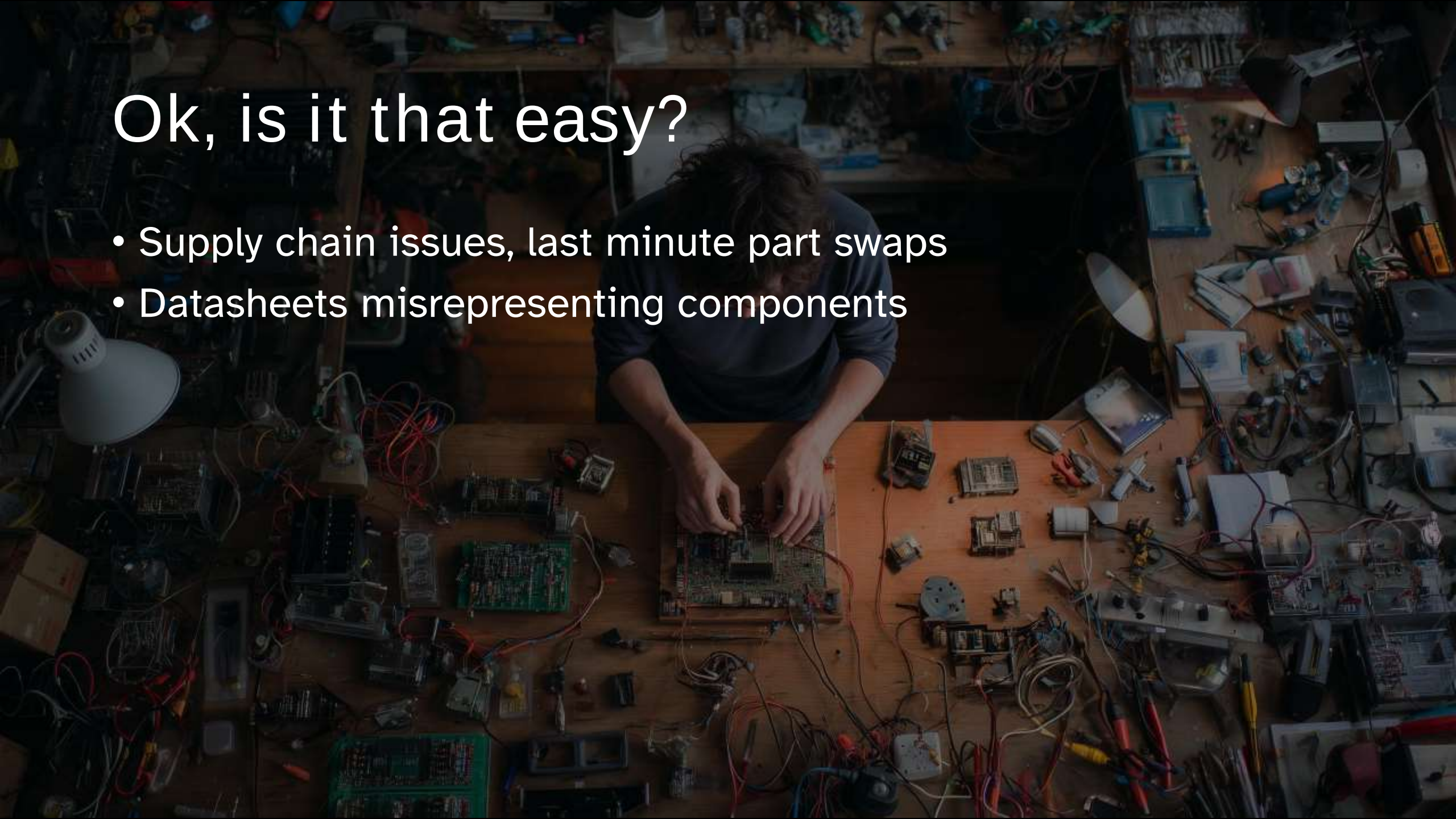
Ok, is it that easy?



Ok, is it that easy?

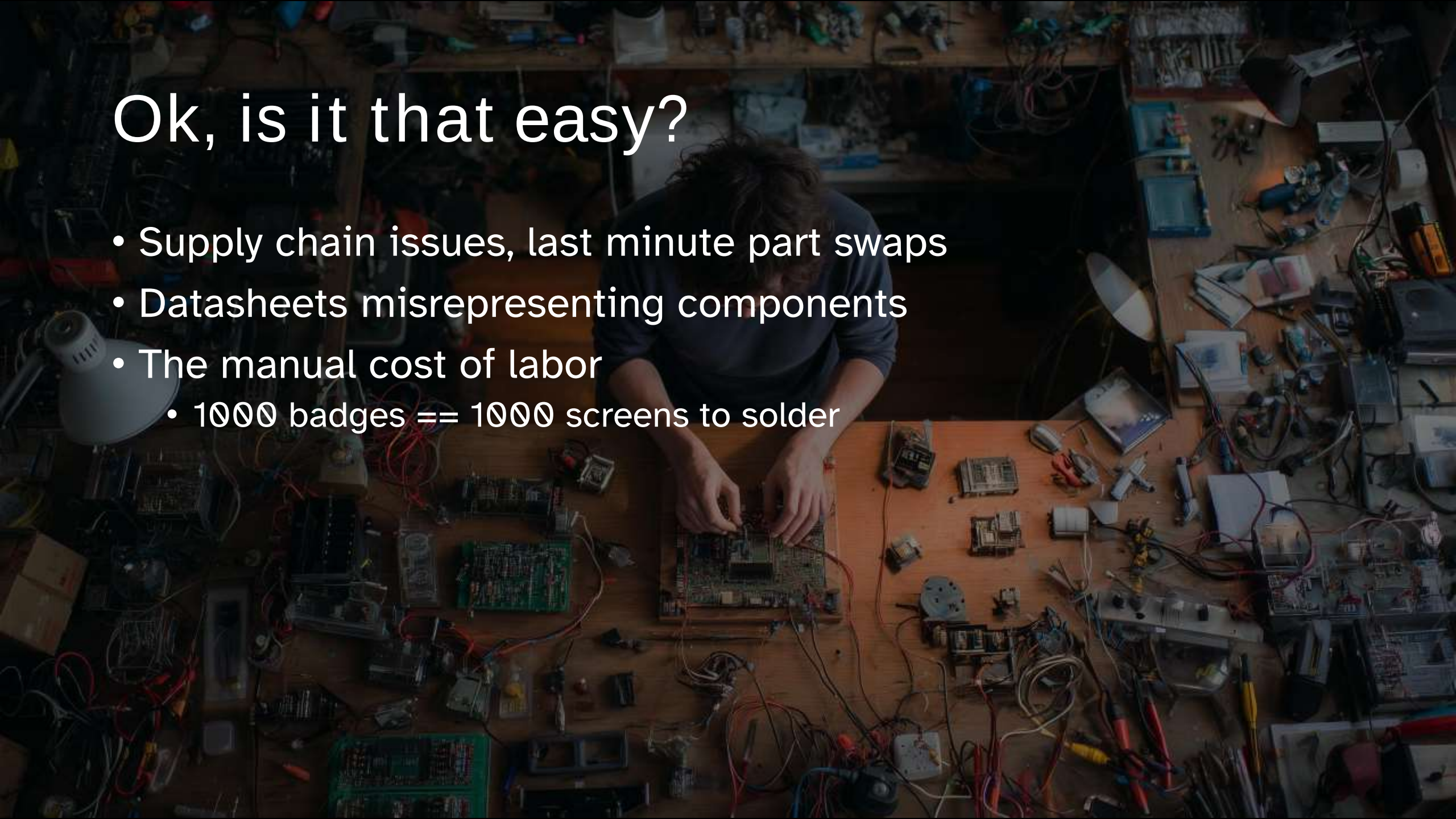
- Supply chain issues, last minute part swaps





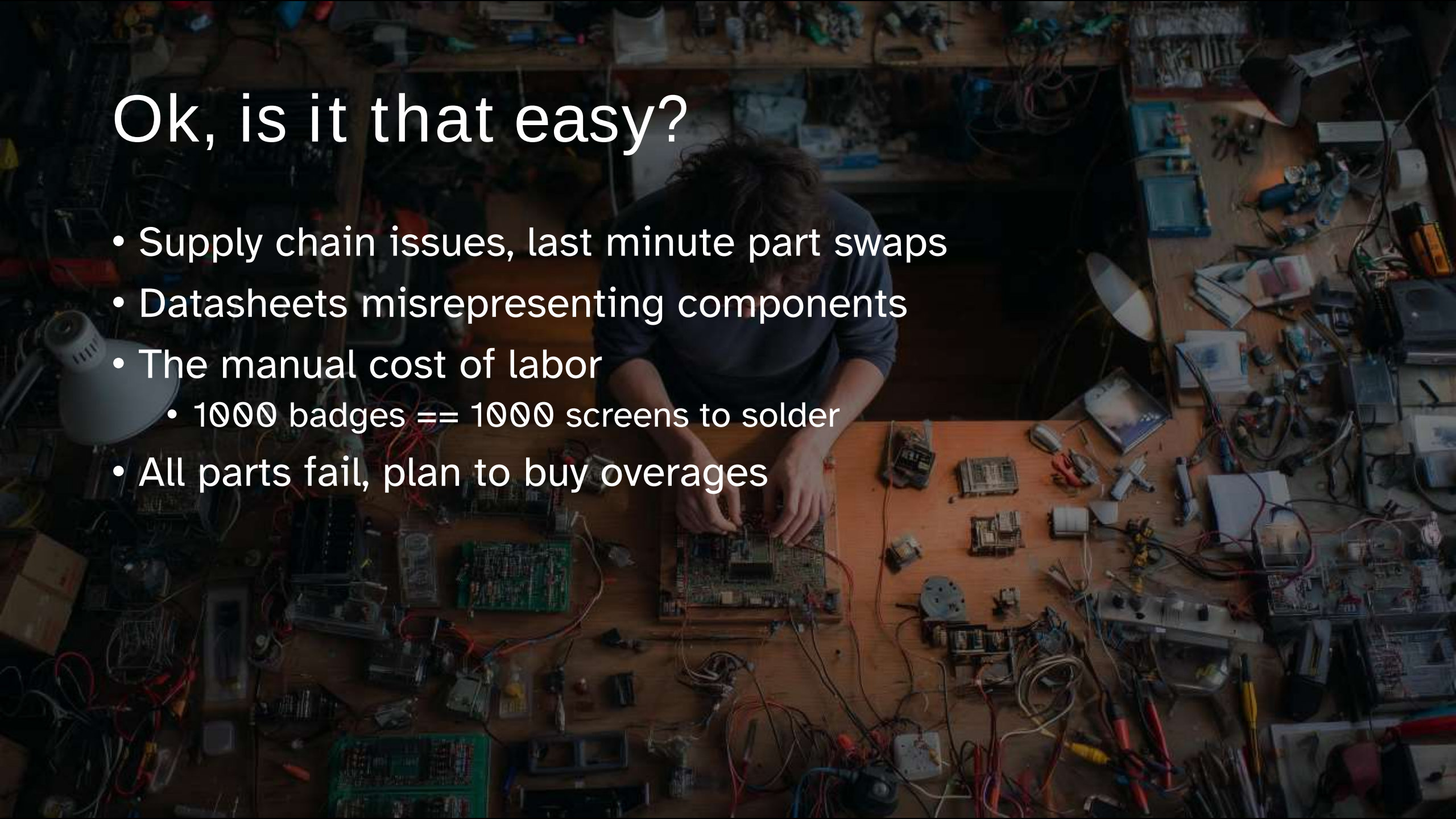
Ok, is it that easy?

- Supply chain issues, last minute part swaps
- Datasheets misrepresenting components



Ok, is it that easy?

- Supply chain issues, last minute part swaps
- Datasheets misrepresenting components
- The manual cost of labor
  - 1000 badges == 1000 screens to solder



Ok, is it that easy?

- Supply chain issues, last minute part swaps
- Datasheets misrepresenting components
- The manual cost of labor
  - 1000 badges == 1000 screens to solder
- All parts fail, plan to buy overages

Ok, I did all that… Did I do good?



Ok, I did all that… Did I do good?

- Is it fun?



Ok, I did all that… Did I do good?

- Is it fun?
- My personal requirements for a badge



Ok, I did all that… Did I do good?

- Is it fun?
- My personal requirements for a badge
  - Awesome bling and light patterns



Ok, I did all that… Did I do good?

- Is it fun?
- My personal requirements for a badge
  - Awesome bling and light patterns
  - CTF Challenges



Ok, I did all that… Did I do good?

- Is it fun?
- My personal requirements for a badge
  - Awesome bling and light patterns
  - CTF Challenges
  - Preventing e-waste



Ok, I did all that… Did I do good?

- Is it fun?
- My personal requirements for a badge
  - Awesome bling and light patterns
  - CTF Challenges
  - Preventing e-waste
    - Something fun and repeatable when done



Ok, I did all that… Did I do good?

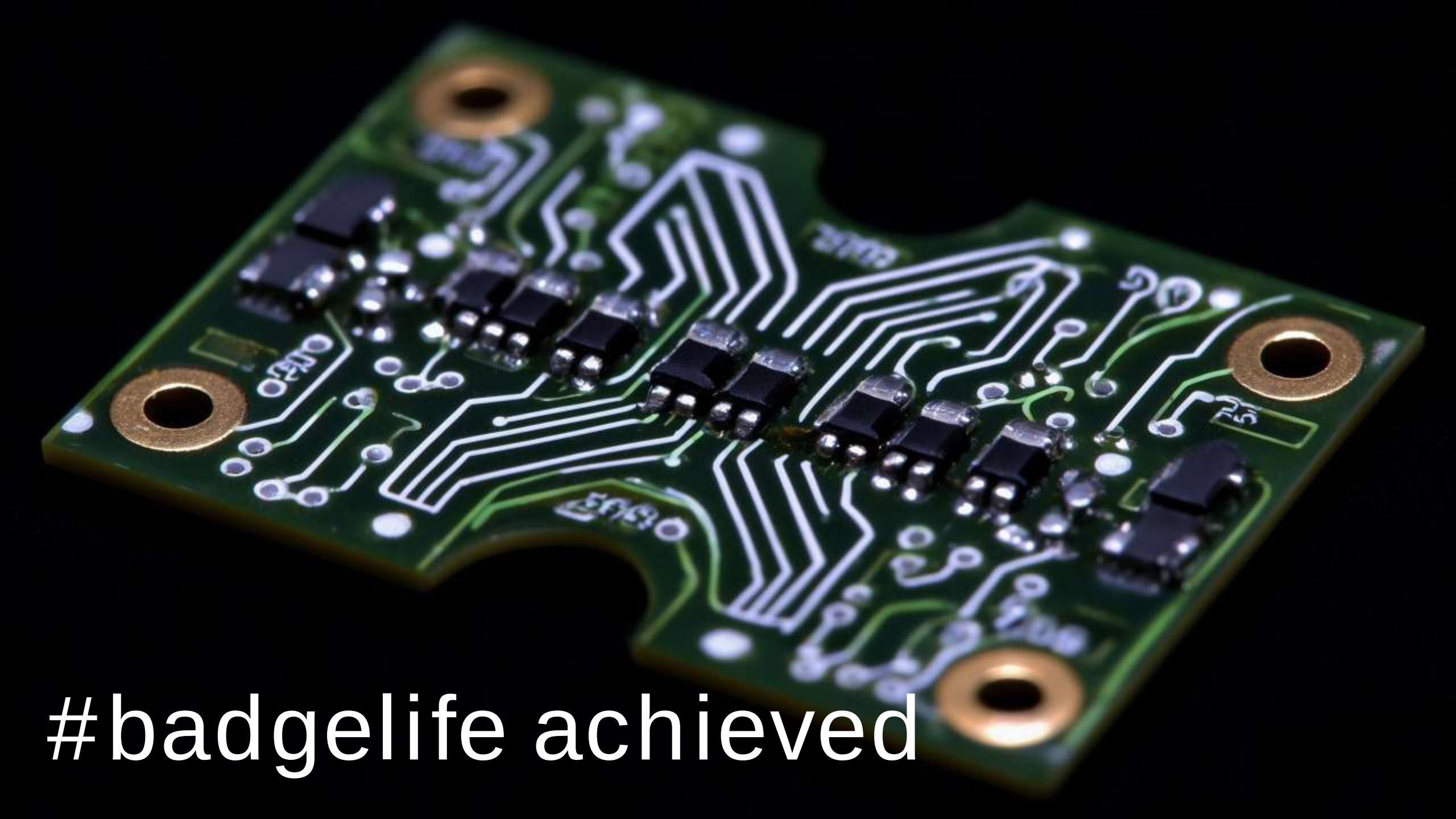
- Is it fun?
- My personal requirements for a badge
  - Awesome bling and light patterns
  - CTF Challenges
  - Preventing e-waste
    - Something fun and repeatable when done
    - Can it be a dev board?



Ok, I did all that… Did I do good?

- Is it fun?
- My personal requirements for a badge
  - Awesome bling and light patterns
  - CTF Challenges
  - Preventing e-waste
    - Something fun and repeatable when done
    - Can it be a dev board?
    - Does it do something besides blink?
      - e.g. Gunslinger is a TV-B-Gone
      - e.g. Frogstar has a Frogger Game
      - e.g. FightDystopa can detect *certain* BLE MACs




#badgelife achieved



Any Questions?

Signal: jeff.01

Bluesky: @bigtaro.bsky.social

Discord: bigtaro

See more of my work at https://bigtaro.net