

AI documentation: Week 4, electronics design

Martín Chujfi · MAS.863 How To Make (Almost) Anything, Fall 2026 · Conversation with Claude (Anthropic), Oct 12–14, 2026

This is a record of how I used Claude, an AI assistant, for the Week 4 assignment: from sharing the assignment through designing the board in KiCad, understanding the circuit, and preparing my documentation. Claude's internal reasoning and raw tool output are omitted; actions Claude took on my files are shown as grey lines.

Part 1 · Oct 12–13: from the assignment to a finished board (summary)

The first part of this conversation (from the assignment screenshot on Oct 12 to early Oct 13) is no longer available word for word: the conversation got long and Claude's working memory of it was condensed into a summary. This section is that summary, rewritten as a description, followed by every screenshot Martín shared during it. Everything from Part 2 onward is the verbatim conversation.

What Martín asked

- To digest the Week 4 (electronics design) assignment from the HTMAA class page, and how to launch KiCad.
- Whether a pulse controller for a benchtop Earth's-field NMR experiment (his possible final project) would work as the board, using parts from the class inventory. He sent screenshots of the inventory's MOSFETs, Schottky diodes and headers, and noted the board should be single-sided.
- Step-by-step questions while drawing the schematic: which parts to place, setting up the fab library and fixing footprints that weren't found (the library nickname had to be `PCM_fab`), the LED, the connectors J1 and J3, how to wire everything, which way the diode bar points, the difference between R5 and D2, the switch direction, a `PWR_GND` vs `GND` mix-up, and swapping symbols.
- A review of the schematic and footprints, then the PCB layout: what a net class is, Xiao orientation, placing D2 and Q1, keeping the USB end at the board edge, routing traces (including J1's pads 1 and 3), display modes, adding a filled ground zone, and fixing design-rule-check errors and warnings with keepout areas.
- Explanations of the physics and the circuit for his write-up: Earth's-field NMR, what the FID would look like, dephasing and T_2^* , why the polarizing coil must be perpendicular to Earth's field (and faces east-west), why an RF pulse isn't used at

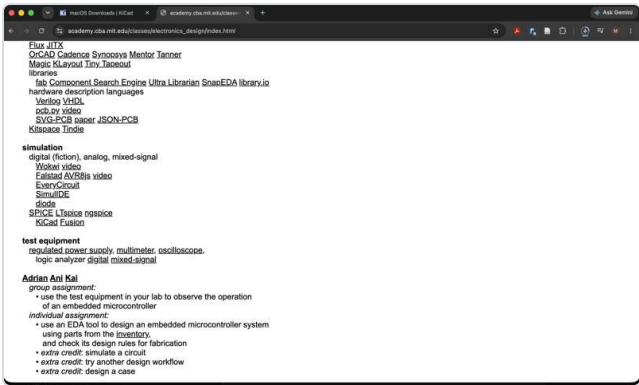
Earth's field, the tiny thermal magnetization, how MOSFETs Q1 and Q2 work, a formatted parts table, and how to write math and symbols in HTML.

What Claude did

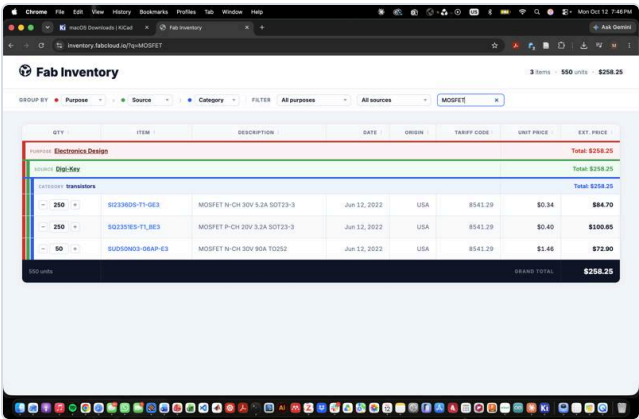
- Explained the assignment and proposed the NMR prepolarization pulse controller: an Xiao RP2040 switching a 12 V polarizing coil through a logic-level MOSFET (SI2336DS), with a flyback Schottky diode (CDBM1100), gate resistors and pull-downs, a trigger output, an LED, a button and a spare second channel (AUX).
- Guided each KiCad step and reviewed Martín's screenshots, pointing out wiring and footprint problems for him to fix. Martín drew the schematic and routed the board himself.
- Explained the NMR physics and circuit behavior so Martín could write his own documentation.
- Created a Week 4 page template (week4.html) with section headings and placeholder comments, and added Week 4 to the home and weekly lists. Martín wrote the text.

The design finished with 0 DRC errors (3 exclusions for pads intentionally left unconnected).

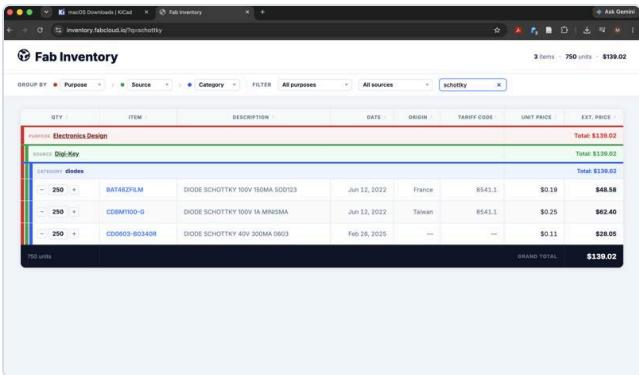
Screenshots shared during Part 1



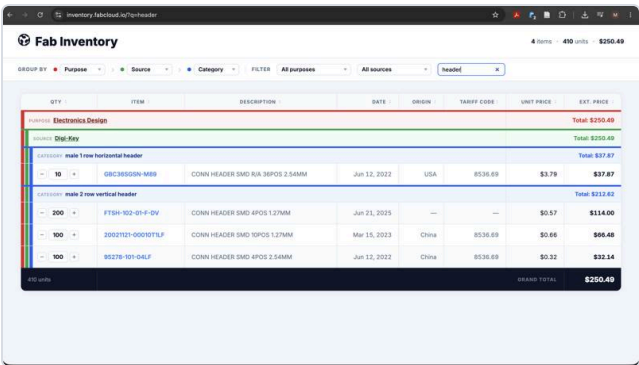
1. 3018×1794, shared Oct 12, 19:03



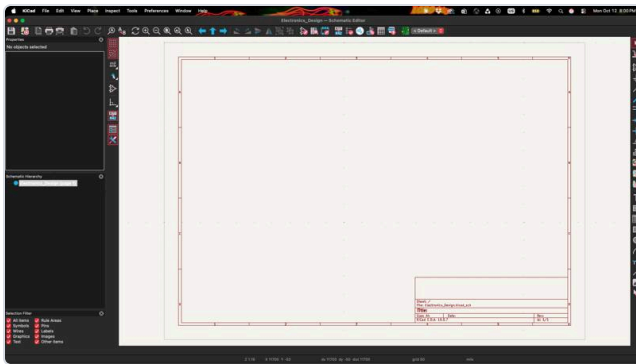
2. 3024×1964, shared Oct 12, 19:47



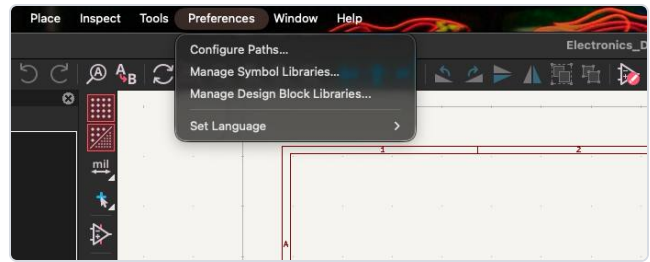
3. 3000×1752, shared Oct 12, 19:49



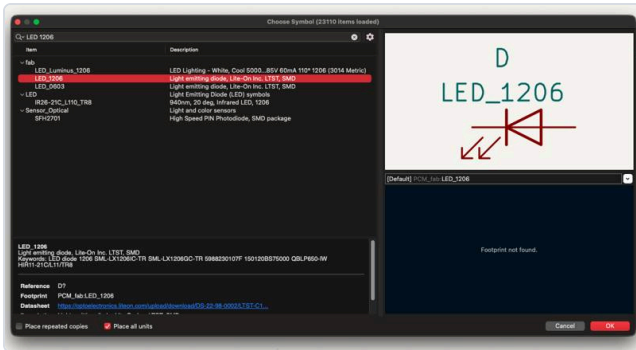
4. 3012×1708, shared Oct 12, 19:50



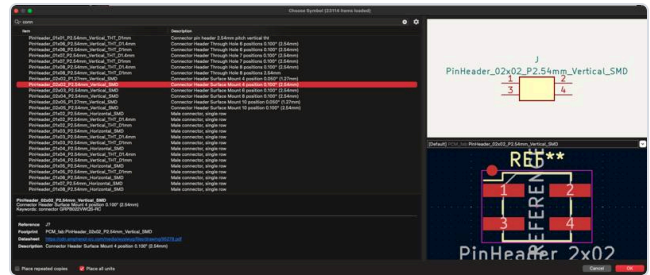
5. 1916×1080, shared Oct 12, 20:00



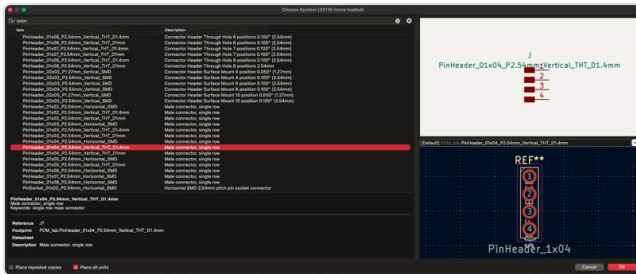
6. 693×277, shared Oct 12, 20:06



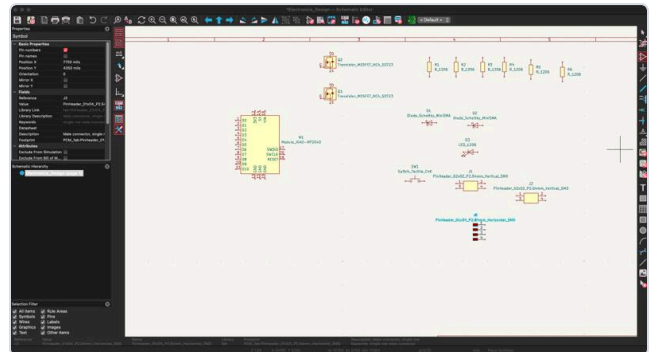
7. 1359×737, shared Oct 12, 20:24



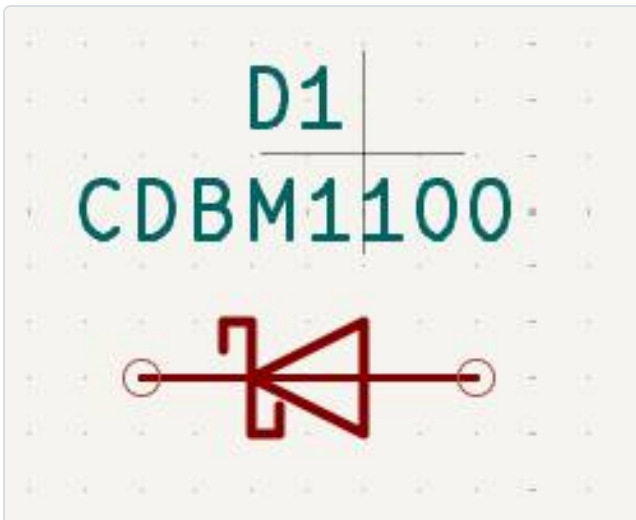
8. 1857×789, shared Oct 12, 20:30



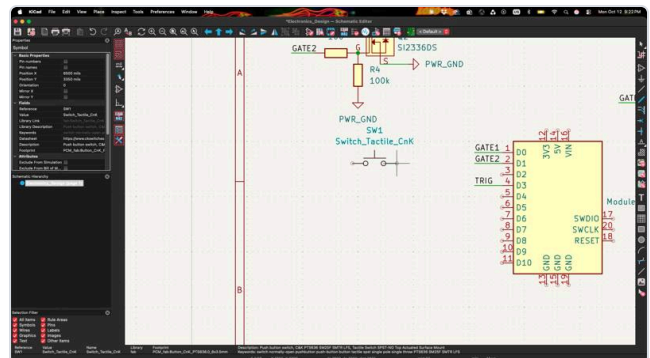
9. 1862×790, shared Oct 12, 20:31



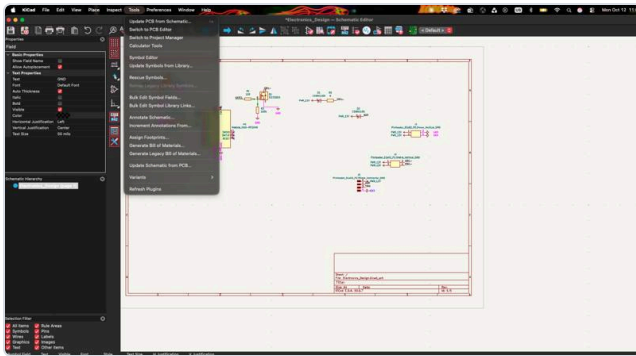
10. 1914×1050, shared Oct 12, 20:32



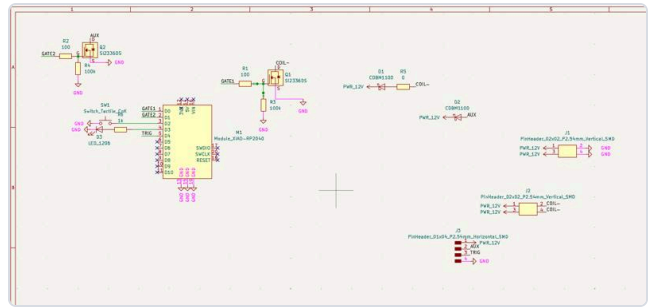
11. 249×204, shared Oct 12, 21:00



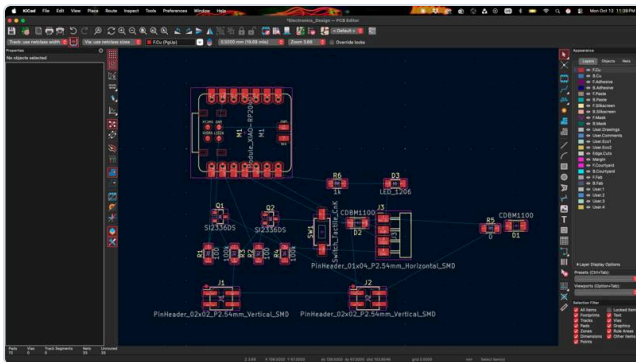
12. 1920×1080, shared Oct 12, 21:23



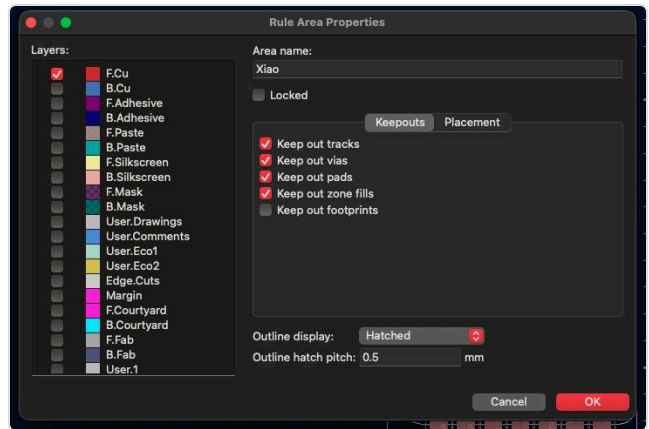
13. 1877×1035, shared Oct 12, 23:01



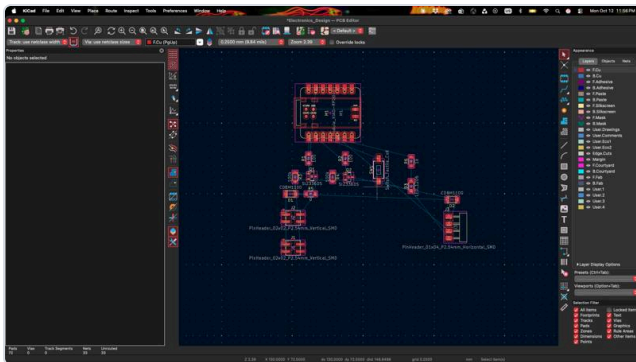
14. 1470×692, shared Oct 12, 23:02



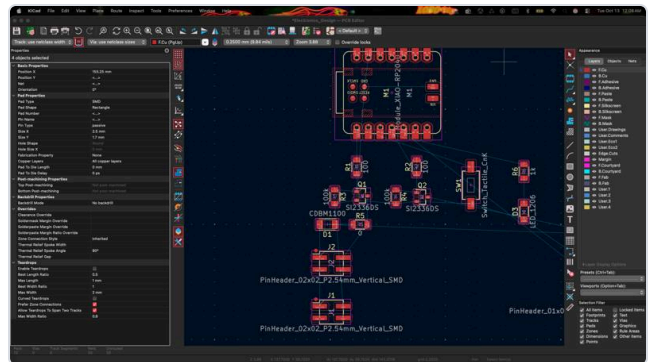
15. 1919×1080, shared Oct 12, 23:39



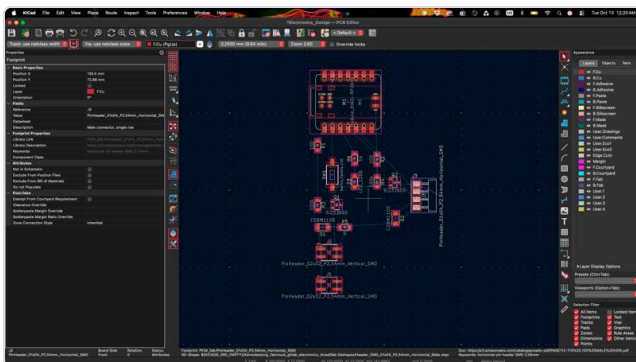
16. 729×487, shared Oct 12, 23:47



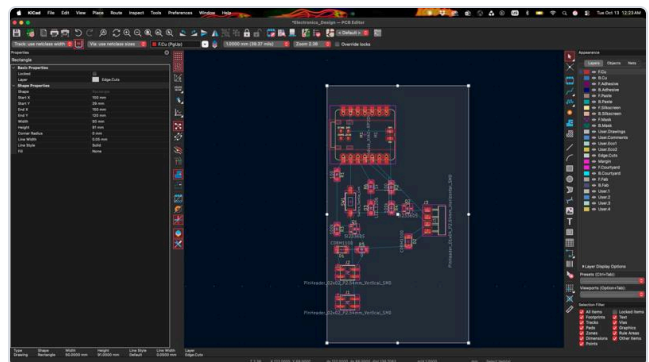
17. 1919×1080, shared Oct 12, 23:57



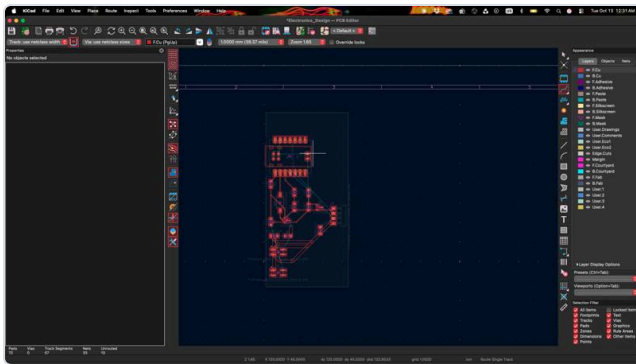
18. 1916×1080, shared Oct 13, 00:08



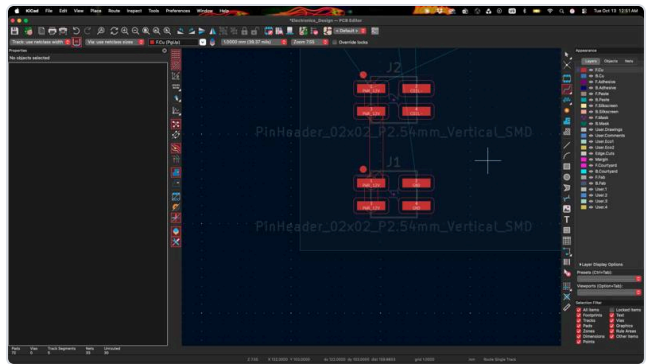
19. 1918×1080, shared Oct 13, 00:20



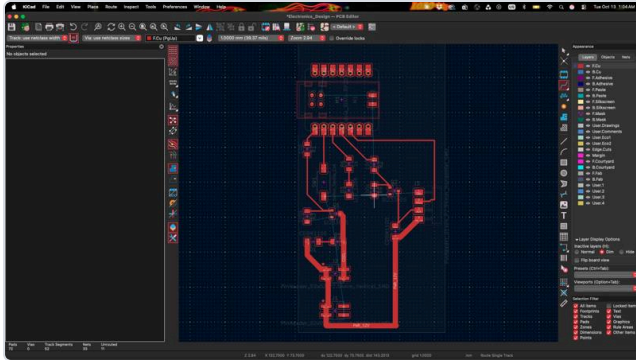
20. 1917×1080, shared Oct 13, 00:24



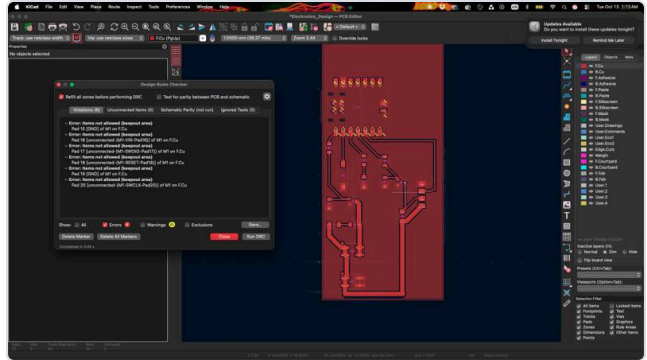
21. 1920×1080, shared Oct 13, 00:31



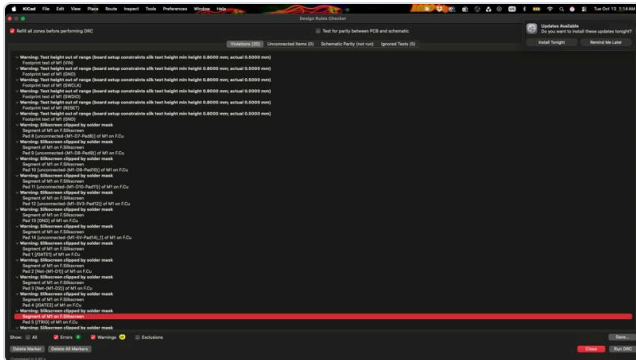
22. 1920×1080, shared Oct 13, 00:52



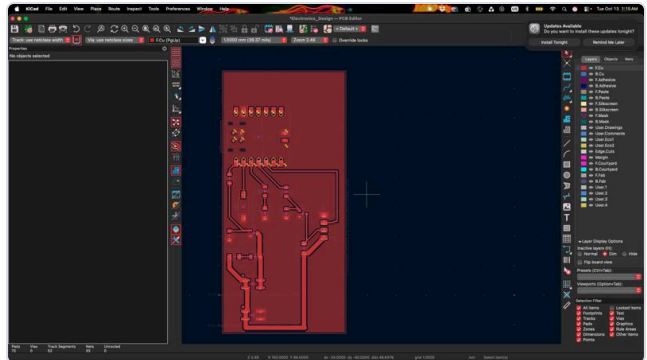
23. 1920×1080, shared Oct 13, 01:04



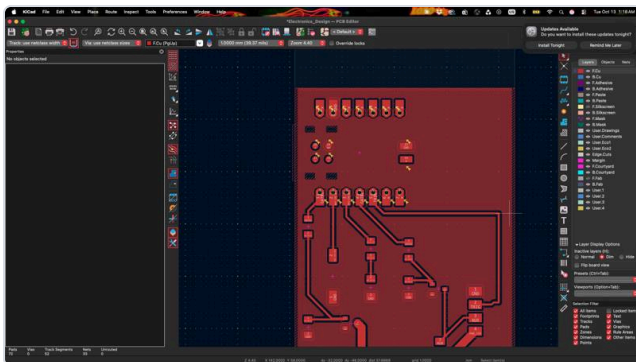
24. 1920×1080, shared Oct 13, 01:12



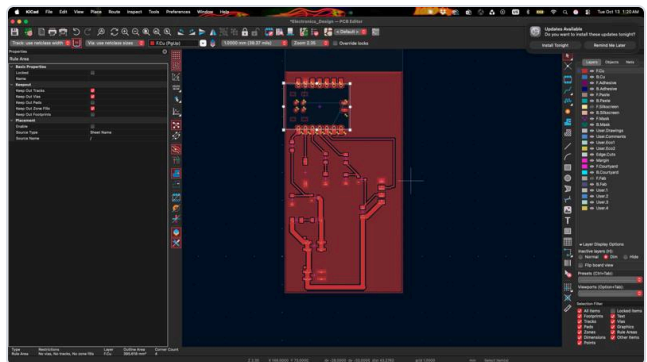
25. 1919×1080, shared Oct 13, 01:14



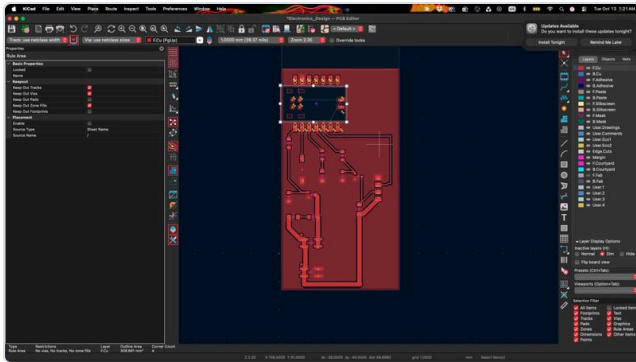
26. 1920×1080, shared Oct 13, 01:16



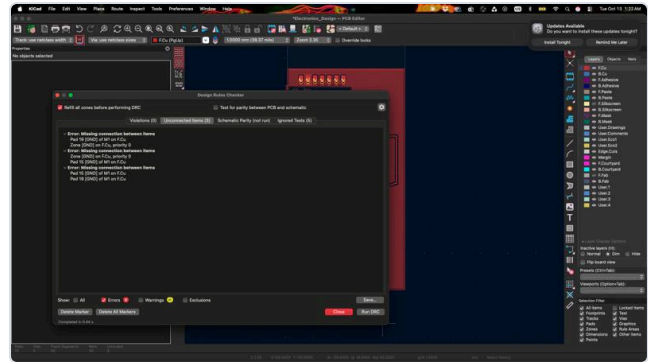
27. 1920×1080, shared Oct 13, 01:18



28. 1917×1080, shared Oct 13, 01:20



29. 1919×1080, shared Oct 13, 01:21



30. 1920×1080, shared Oct 13, 01:22

Passages of Claude's replies that Martín quoted back with questions

Add a new entry with name FAB and path ~/kicad/libraries/fab (or wherever you put it).

LED (1206)

ext to Q1, label GATE1 → R1 → Q1 G

anode → AUX.

assign the nets PWR_12V, COIL- and GND to it.

J1 left pads (1 & 3) straight up to J2 left pads (1 & 3), then up to D1's cathode.

From J1's bottom-left pad, run a trace down and along the bottom edge to the right, then up to D2's cathode and J3's 12V pin (the bottom one).

J1 left pads (1 & 3) straight up to J2 left pads (1 & 3)

If you'd rather see solid traces, look under Appearance → Layer Display Options (or the View menu) for the track display mode, and switch from outline to filled. It's purely visual.

Part 2 · Oct 13–14: understanding the circuit and documenting it (verbatim)

MARTÍN · TUE 2026-10-13 ~22:30

how are we generating 12V if the Xiao only puts up 3.3V?

CLAUDE

The Xiao doesn't make the 12 V, and neither does anything else on your board. The 12 V comes from an external supply, like a bench power supply or a 12 V wall adapter, plugged into J1. On J1, pins 1 and 3 are PWR_12V and pins 2 and 4 are GND. They're doubled up so the header can carry the coil current.

There are two separate power paths on the board, and they share only ground:

1. **Logic power:** USB powers the Xiao, and the Xiao runs on 3.3 V. All it does is put 3.3 V or 0 V on Q1's gate (and Q2's, if you use it). Almost no current flows into a MOSFET gate. It only needs to charge a tiny capacitance, so 3.3 V is plenty to switch it.
2. **Coil power:** current comes from the external +12 V on J1, goes through the coil on J2, then through Q1, and back to ground. When the gate is low, Q1 is off and no current flows. When it's high, Q1 is on and current flows through the coil.

So the Xiao never supplies or touches the 12 V. It just controls the switch that lets the 12 V supply drive the coil. It's like a light switch: your finger doesn't power the bulb, it just opens and closes the path. That's also why the Xiao's 5V/VIN pin is left unconnected. You don't want 12 V anywhere near it.

The **shared ground** matters. Q1's gate voltage is measured relative to its source, which sits on ground. If the Xiao's ground and the 12 V supply's ground weren't tied together, the "3.3 V" from the Xiao wouldn't mean anything to Q1.

Choosing a supply: the coil current isn't set by the board. It's set by the coil's resistance, $I = V / R_{\text{coil}}$. For example, a 5 Ω coil at 12 V draws about 2.4 A. Your supply has to deliver that much current, and you can turn the voltage down to lower the current and the field. If you use a bench supply with a current limit, set the limit a bit above the expected coil current, so a wiring mistake won't cook anything.

A good sentence for your write-up: *"The Xiao only provides the 3.3 V logic signal that switches the MOSFET; the coil is powered by an external 12 V supply through J1, and the two circuits share a common ground."*

MARTÍN · TUE 2026-10-13 22:43

explain J1 and J2 to me in a similar fashion, I really liked this explanation

CLAUDE

J1 and J2 are both just **connectors**. They're where things that aren't on the board plug in. Nothing is generated or processed in them. They're the doors that let current in and out.

J1 is the power input. The external 12 V supply plugs in here.

- Pins 1 and 3 go to **PWR_12V**, the "+" wire from the supply.
- Pins 2 and 4 go to **GND**, the "-" wire from the supply.

From J1, the +12 V runs over to the coil connector. The ground runs to Q1's source and joins the same ground the Xiao uses. J1 is the only place energy enters the coil circuit.

J2 is the coil output. The two leads of your prepolarization coil plug in here.

- One side of J2 connects to **+12 V**, coming straight from J1.
- The other side connects to **Q1's drain**, not to ground.

That second point is the key. The coil isn't wired across the supply directly. Its bottom end only reaches ground *through* Q1. Following the current around the loop:

+12 V (J1) → J2 → coil → J2 → Q1 → GND → back to the supply (J1)

When Q1 is off, that loop is broken, so the coil sits at 12 V on both ends and no current flows. When Q1 is on, the loop closes and current flows, building up the polarizing field. J2 is simply where the coil joins that loop. This arrangement is called a **low-side switch**, because the switch sits between the load and ground rather than between the supply and the load.

Why each connector has doubled pins: a single header pin is only rated for a couple of amps. Your coil may draw 2–3 A, and all of it passes through both J1 and J2. With two pins in parallel, each carries about half, which keeps the pins cooler and lowers the voltage you lose across the connector. This is also why the traces between J1, J2 and Q1 are wider than the signal traces from the Xiao. They carry the big current, while the gate trace carries almost nothing.

How the flyback diode (D2) fits in: D2, with R5 in series, sits right across J2, in parallel with the coil. A coil resists any sudden change in its current. When Q1 switches off, the current can't just stop, so it would push the drain voltage up until something breaks. D2 gives it a path that circles back through the coil, and R5 lets it die out quickly but safely. That fast switch-off is what kicks off your NMR signal.

A good sentence for your write-up: *"J1 brings in the external 12 V supply, and J2 connects the polarizing coil between +12 V and the MOSFET's drain, so the coil only conducts when the Xiao turns Q1 on. Both connectors use doubled pins to share the coil current."*

MARTÍN · TUE 2026-10-13 22:57

What is AUX supposed to be for?

⚙ Search earlier conversation for AUX net

⚙ Look for Q2, J3 and AUX in transcripts

CLAUDE

I lost the exact schematic details when our earlier conversation got long. So this is from the design intent, and you can check it against your KiCad file.

AUX is a second, spare switched output. It's Q2's channel, an exact copy of the coil circuit:

- the Xiao drives Q2's gate through its own resistor, with a pull-down;
- Q2's drain is the **AUX** net, which goes out to a connector;

- whatever you plug in there connects between +12 V and AUX. It switches on when the Xiao turns Q2 on, just like the coil does with Q1.

It isn't needed for the basic experiment. Polarize, switch off and record the FID uses only Q1. AUX is there so the same board can grow into the next steps without a redesign. The likely uses:

1. **A B₁ pulse coil (the most likely one).** To do spin echoes, you need short pulses at the Larmor frequency, about 2 kHz, from a second coil. The Xiao can toggle Q2 at that rate to drive it. That's the "optional 2 kHz B₁ pulses" idea.
2. **A protection relay for the receive coil.** During polarization, you may want to disconnect or short the pickup coil and amplifier so the big switching transient doesn't saturate them. AUX could drive a small 12 V relay that does that, timed by the Xiao.
3. **Anything else that needs 12 V switched on cue,** like an indicator, a fan, or a second polarizing coil.

The same rules apply as for the coil channel. The load goes between +12 V and AUX, never between AUX and ground. Anything inductive, like a coil or relay, needs a flyback diode across it. And the Xiao never sees the 12 V.

A good sentence for your write-up: *"A second MOSFET channel (Q2, AUX) is included as a spare 12 V switched output, so the board can later drive a B₁ excitation coil or a relay that protects the receiver during polarization."*

If you send me a screenshot of the AUX part of your schematic, I can confirm which connector it goes to and whether it needs its own flyback diode.

MARTÍN · TUE 2026-10-13 23:19

I need a bird's eye view of how the circuit works. how does the experiment go, and how is it mediated by the components?

CLAUDE

Here's the whole thing as one story. In short: the board is a **timed 12 V switch for the polarizing coil**, and the Xiao is the clock that decides when it's on and off. The sample does the physics, and a separate receiver picks up the signal.

The cast

Part	Role in the experiment
External 12 V supply → J1	Provides the energy for the polarizing field
Polarizing coil → J2	Turns current into the field B _p , about 10-20 mT, pointing east-west
Xiao RP2040	The conductor: runs the timing sequence from code

Part	Role in the experiment
Q1 + gate resistor + pull-down	The switch that lets the Xiao turn the coil current on and off
D2 + R5	Safely and quickly gets rid of the coil's current at switch-off
TRIG (on J3)	Tells your recorder "the signal starts now"
LED	Shows the coil is energized
Q2 / AUX	Spare channel for later (B ₁ pulses or a receiver-protection relay)

One scan, step by step

0. Idle. The pull-down holds Q1's gate at 0 V, even while the Xiao is booting. So Q1 is off and no current flows. The water's protons sit in Earth's field ($\sim 50 \mu\text{T}$) with a tiny net magnetization, too small to measure.

1. Polarize (a few seconds). The Xiao sets Q1's gate high. Q1 turns on and closes the loop: $12 \text{ V} \rightarrow \text{coil} \rightarrow \text{Q1} \rightarrow \text{ground}$. A couple of amps flow, and the coil makes B_p, a few hundred times stronger than Earth's field and perpendicular to it. The protons' magnetization grows along B_p with time constant T₁. For water that's $\sim 2\text{--}3 \text{ s}$, so you hold it for about $3\text{--}5 \times T_1$. The LED is on.

2. Switch off (well under a millisecond). The Xiao sets the gate low and Q1 turns off. The coil current can't stop instantly, so it loops around through D2 and R5 and dies out in a short time ($\tau = L / R$). That needs to be much faster than one Larmor period ($\sim 0.5 \text{ ms}$ at 2 kHz). The spins can't follow the field as it disappears, so the magnetization is left pointing east-west, **perpendicular to Earth's field**. That's the same result as a 90° pulse. R5 sets that speed, and it's what keeps the voltage spike on Q1 ($12 \text{ V} + I \cdot R_5$) below its 30 V limit.

3. Trigger. At the same moment, the Xiao pulses TRIG on J3. Your scope or ADC starts recording, so every scan begins at exactly the same point in time.

4. Free precession (a fraction of a second). With B_p gone, the magnetization precesses around Earth's field at $\sim 2.2 \text{ kHz}$. The rotating magnetization induces a tiny voltage in a pickup coil. That's the FID, decaying with T₂. *This board doesn't pick up or amplify that signal.** A separate preamplifier, filter and ADC do. That's the next piece of the project.

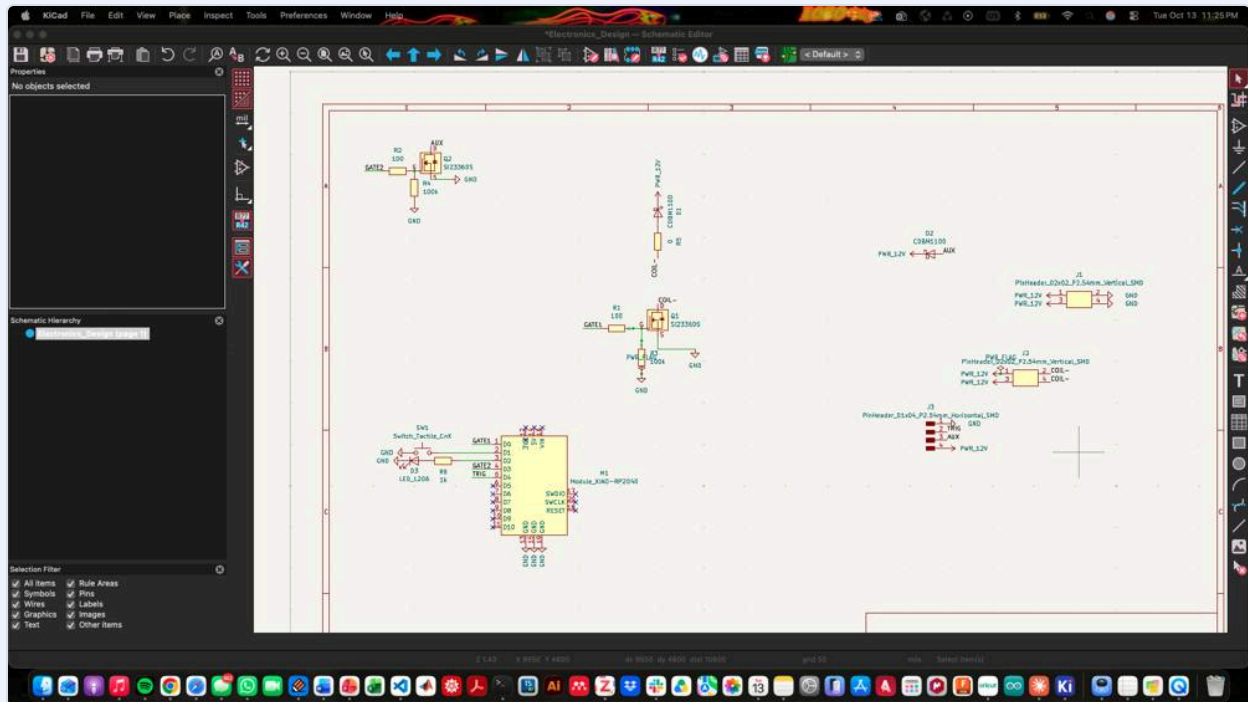
5. Repeat and average. The Xiao waits, then starts over. Adding many scans averages down the noise, because the FID adds up coherently and the noise doesn't.

The handoff, in one line

Code (Xiao) $\rightarrow$ gate voltage $\rightarrow$ Q1 switch $\rightarrow$ coil current $\rightarrow$ polarizing field $\rightarrow$ magnetization $\rightarrow$ fast switch-off (D2/R5) $\rightarrow$ precession $\rightarrow$ FID in the pickup coil.

A good paragraph for your write-up: "The board controls the prepolarization step of an Earth's-field NMR experiment. The Xiao turns on a MOSFET that drives a 12 V coil for a few seconds, building up the sample's magnetization perpendicular to Earth's field. It then switches the coil off abruptly, with a flyback diode and resistor dissipating the coil's energy quickly and safely. The magnetization then precesses at the Larmor frequency, about 2 kHz, producing the signal. A trigger output synchronizes the recording, and a second MOSFET channel is reserved for future excitation pulses."

MARTÍN · TUE 2026-10-13 23:26



here, where you refer to d2, do you mean d1?

CLAUDE

Yes, I meant D1. Thanks for catching it. On your schematic:

- **D1 (with R5 in series)** sits between PWR_12V and **COIL-**, so it's the coil's flyback diode. Everywhere I wrote "D2 + R5" in the last two explanations (the J2 section and the bird's-eye table), read **D1 + R5**.
- **D2** sits between PWR_12V and **AUX**, so it's the flyback diode for the AUX channel. That also answers my earlier question: AUX does have its own diode.

Your screenshot clears up a few other things too:

- **The AUX load plugs into J3.** J3 is GND, TRIG, AUX and PWR_12V on pins 1 to 4. Whatever you drive with AUX goes between pins 4 (+12 V) and 3 (AUX). Q2 is the switch, with R2 as its gate resistor and R4 as its pull-down, and D2 catches its spike. It's the same pattern as the coil channel, which uses Q1, R1, R3 and D1.

- **TRIG goes out on J3 pin 2**, with ground right next to it on pin 1, so a single scope or ADC cable picks up both.
- **SW1 and D3 complete the sequence.** SW1 is a button you can use to start a scan. D3, the LED with R6 (1k), is the "coil on" indicator.
- **R5 is currently 0 Ω .** For now, the coil current just circulates through D1 and dies out with $\tau = L / R_{\text{coil}}$. That's safe, but it's the slowest switch-off. If you later need a faster, more non-adiabatic switch-off, you swap R5 for a real resistor, keeping 12 V + I·R5 under Q1's 30 V limit.

MARTÍN · WED 2026-10-14 07:45

The cast	
Part	Role in the experiment
External 12 V supply → J1	Provides the energy for the polarizing field
Polarizing coil → J2	Turns current into the field B _p , about 10–20 mT, pointing east-west
Xiao RP2040	The conductor: runs the timing sequence from code
Q1 + gate resistor + pull-down	The switch that lets the Xiao turn the coil current on and off
D2 + R5	Safely and quickly gets rid of the coil’s current at switch-off
TRIG (on J3)	Tells your recorder “the signal starts now”
LED	Shows the coil is energized
Q2 / AUX	Spare channel for later (B ₁ pulses or a receiver-protection relay)

4. Why each part

could you combine these two tables? I.e, have a column for why and one for role in the experiment

⚙ Find the earlier "Why each part" table

CLAUDE

Only the heading of the "Why each part" table came through, not its rows. So I rebuilt that column from your schematic, with the corrected labels (D1 for the coil, D2 for AUX):

Part	Role in the experiment	Why this part
J1 (2×2 header)	Brings in the external 12 V supply that powers the coil	Pins are doubled (1/3 = +12 V, 2/4 = GND) so the coil current is shared across two pins
J2 (2×2 header)	Connects the polarizing coil between +12 V and COIL–	Doubled pins for the same reason as J1: the full coil current passes through it
Xiao RP2040 (M1)	Runs the timing sequence from code: polarize, switch off, trigger, repeat	Programmable, accurate timing, powered by USB, and its 3.3 V logic is enough to switch the MOSFETs
Q1 (SI2336DS)	Turns the coil current on and off	Fully on at a 3.3 V gate voltage (logic-level), very low on-resistance (~46 m Ω), rated 30 V / 4.3 A, which covers a 12 V, few-amp coil

Part	Role in the experiment	Why this part
R1 (100 Ω)	Sits between the Xiao pin and Q1's gate	Limits the current spike into the gate when it switches and damps ringing
R3 (100 k Ω)	Holds Q1's gate at 0 V when the Xiao isn't driving it	Keeps the coil off during boot or reset, so it never switches on by accident
D1 (CDBM1100)	Gives the coil current a path when Q1 turns off	Schottky: fast, with a low forward drop. Its 100 V / 1 A rating covers the brief turn-off pulse
R5 (0 Ω for now)	In series with D1; sets how fast the coil current dies out	A 0 Ω placeholder: replace it with a real resistor for a faster switch-off, keeping $12\text{ V} + I \cdot R5$ below 30 V
J3 (1 $\times$ 4 header)	Carries GND, TRIG, AUX and +12 V out to other equipment	Puts the trigger and the spare channel on one connector
TRIG (J3 pin 2)	Tells the scope or ADC "the signal starts now"	Every scan starts recording at the same moment, so scans can be averaged
Q2 + R2 + R4	Spare switched 12 V channel (AUX)	Same parts as the coil channel, for later B ₁ pulses or a relay that protects the receiver
D2 (CDBM1100)	Flyback diode for whatever is on AUX	Any coil or relay on AUX produces the same turn-off spike
SW1	Button to start a scan	Lets you trigger an experiment by hand without a computer command
D3 + R6 (LED, 1 k Ω)	Shows the coil is on	A visual check that the coil is energized; R6 limits the LED current

MARTÍN · WED 2026-10-14 07:56

Gives the coil current a path when Q1 turns off

is this due to Lenz's law or Faraday's law? be concise

CLAUDE

It's both, working together:

- **Faraday's law** says a changing current in the coil induces a voltage: $V = -L \cdot dI/dt$. If Q1 cut the current off almost instantly, dI/dt would be huge, and so would the voltage.
- **Lenz's law** gives that voltage its direction. It opposes the change, so the coil pushes to keep the current flowing the same way. That drives COIL— well above 12 V.

D1 gives that current somewhere to go. It circulates through D1 and R5 and dies out gradually, so the voltage spike stays near $12\text{ V} + I \cdot R5$ instead of destroying Q1.

For your write-up: *"By Faraday's and Lenz's laws, the coil resists the sudden drop in current; D1 lets that current circulate and decay safely."*

MARTÍN · WED 2026-10-14 08:39

Protect / switch to receive D3 → Q2 (AUX) drives a relay or switch, so the sensitive preamp is disconnected during polarization and the switch-off spike, and connected only once it's quiet

can you explain what the purpose of AUX is. I still don't get it.

CLAUDE

Here's AUX in terms of the one problem it solves.

The problem: one experiment, two wildly different signal sizes

- The **polarizing coil** runs on 12 V and a couple of amps, and at switch-off it kicks out a spike of tens of volts.
- The **FID** you want to record is **microvolts**, picked up by a pickup coil sitting right next to (or inside) the polarizing coil. Often it's the very same coil.

Your receiver (preamp + ADC) has to be extremely sensitive to see microvolts. If it's connected while the polarizing coil is on, or during the switch-off spike, it gets hit with volts. Best case, it saturates and takes a long time to recover, so you miss the start of the FID, which is the strongest part. Worst case, it gets damaged.

The fix: disconnect the receiver until it's quiet

You put a **relay** (an electrically controlled switch) between the pickup coil and the preamp, and time it:

1. **Polarizing:** the relay is open. The preamp is disconnected and protected.
2. **Switch-off:** still open. The spike and ringing happen while the preamp can't see them.
3. **A few ms later, once it's quiet:** the relay closes. The preamp is connected and records the FID.
4. **Done:** the relay opens again, ready for the next scan.

It's like plugging your ears during the bang, then listening for the echo.

Where AUX comes in

The Xiao has to time that relay, because only it knows when the switch-off happened. But a relay's coil typically needs 12 V and tens of milliamps, more than a 3.3 V Xiao pin can supply. So the Xiao drives **Q2**, and Q2 switches the relay coil from the 12 V supply, exactly the way Q1 switches the polarizing coil. The relay coil plugs into J3 between +12 V (pin 4) and AUX (pin 3), and D2 absorbs the relay coil's own turn-off spike.

So: **Q1 runs the polarizing coil, and Q2 (AUX) runs the receiver's protection switch.** Both are timed by the same Xiao code.

Do you need it right now? No. For a first test, you can ignore AUX completely. It's there so that when you build the receiver, you can add protection or switching without redesigning the board. (Later it could also drive B₁ pulses for spin echoes, but receiver protection is its most likely use.)

For your write-up: *"A second MOSFET channel (AUX) drives a relay that keeps the sensitive receiver disconnected during polarization and the switch-off transient, and connects it only once it's quiet, so it can record the microvolt-level FID."*

MARTÍN · WED 2026-10-14 08:41

```
<!-- How the circuit works: Q1 switches the polarizing coil, Q2 the aux output, flyback diodes,
|| R5 for tuning the switch-off speed, and the Xiao pin map:
|| D0 = coil MOSFET, D1 = button, D2 = LED, D3 = aux MOSFET, D4 = trigger. -->

<p>The schematic is given above. What this circuit is essentially doing is the following:</p>
<p>(1) You press the switch/button hooked up to D1 and the Xiao starts a measurement. (2) Later, with programming, the Xiao sets D0 to high, turning on Q1 (the MOSFET).
12 V drive current through the coil (J2) for a programmed time. (3) After this time, D0 is set to low, turning off Q1, and the current decays through D1 and R5. (4) When
the pulse is switched off, D4 pulses on J3 to tell a data recorder (more on that in coming weeks) to start capturing the FID.

</p>
<!--
```

how do i explain aux in this workflow

CLAUDE

I'd add AUX as a final step, and mark it as something the board is ready for rather than something it does yet:

(5) Optionally, D3 can switch on Q2, which powers whatever is connected to the AUX output on J3. In the future, this will drive a relay that keeps the sensitive receiver disconnected during the polarizing pulse and the switch-off spike, and connects it only once things are quiet, so it can record the microvolt-level FID.

If you'd rather keep it shorter:

(5) A second MOSFET (Q2), switched by D3, provides a spare 12 V output (AUX on J3). I plan to use it to protect the receiver: a relay will keep it disconnected until the switch-off spike has passed.

Two small things in your current text:

- **"D1" means two things here:** the Xiao pin D1 (the button) in step 1, and the diode D1 in step 3. Readers will trip on that, so write "pin D1" and "diode D1", or "the flyback diode (D1)".
- In step 2, "12 V drive current" should be "12 V drives current".

MARTÍN · WED 2026-10-14 09:00

How did I change the thickness of the lines in the PCB design to make the 12V lines

fatter

CLAUDE

You did it with a **net class**, a named group of nets that share the same routing rules. The steps were roughly:

1. **Created a power net class.** In the PCB editor, **File → Board Setup → Design Rules → Net Classes**. Next to Default, you added a new class (e.g. "Power") with a wider **Track Width** than Default.
2. **Assigned the high-current nets to it.** In the bottom half of that same page (**Netclass assignments**), you added patterns that put **PWR_12V**, **COIL-** and **GND** (and AUX) into the Power class.
3. **Routed with net class widths.** In the track-width dropdown on the top toolbar, **"Use netclass widths"** was selected. So any track you started on a PWR_12V or COIL- pad came out fat automatically, and the Xiao signal traces (GATE1, TRIG...) stayed thin under Default.

To see your exact numbers for the write-up, open **File → Board Setup → Net Classes** again. The Track Width column shows both classes side by side.

For your page: *"I created a separate net class for the 12 V, coil and ground nets with wider traces, since they carry the coil's few amps of current, while the logic signals from the Xiao use the default narrow traces."*

MARTÍN · WED 2026-10-14 09:04

what were the design rules I gave this thing?

- ⚙ Checked which folders on Martín's computer are connected
- ⚙ Listed a folder on Martín's computer
- ⚙ Asked for access to the MAS.863 folder (to find the KiCad project); access granted
- ⚙ Searched for the KiCad project file
- ⚙ Read the design rules and net classes from the KiCad project file
- ⚙ Read the routed track widths and copper zones from the KiCad board file

CLAUDE

I read these straight from your KiCad project. All values are in mm.

Board-wide minimums (Board Setup → Design Rules → Constraints)

Rule	Value
Minimum track width	0.4
Copper-to-board-edge clearance	0.5
Hole clearance / hole-to-hole	0.25

Rule	Value
Minimum via diameter / through-hole	0.5 / 0.3

Net classes (Board Setup → Net Classes)

Class	Track width	Clearance	Nets
Default	0.4	0.4	Everything else: GATE1/2, TRIG, AUX, LED, button
Power	1.5	0.4	PWR_12V and COIL– (assigned by the patterns <code>*PWR_12V*</code> and <code>*COIL-*</code>)

Your routed tracks match this: all PWR_12V and COIL– segments are 1.5 mm, and every signal trace is 0.4 mm.

Ground pour: GND isn't in the Power class. It's a filled copper zone on F.Cu with 0.4 clearance, 0.4 minimum thickness, and 0.5 mm thermal-relief gaps and spokes. That's better than a fat trace, since the whole pour carries the return current. I said GND was in the Power class in my last message. That was wrong; it's the pour.

Keepouts: two rule areas under the Xiao keep copper out of where its pads and USB end sit.

The 0.4 mm track and clearance match the 1/64" end mill used for milling, and 1.5 mm traces comfortably carry the coil's few amps.

MARTÍN · WED 2026-10-14 09:12

Can you give me those two tables in HTML so I can add them to my documentation

⚙️ Checked the table styles in `style.css` and `week4.html`

CLAUDE

Here they are, using the `.table-wrap` style you already added to `style.css`:

```
<div class="table-wrap">
  <table>
    <caption>Board-wide design rules (Board Setup → Design Rules → Constraints). All
    values in mm.</caption>
    <thead>
      <tr><th>Rule</th><th>Value</th></tr>
    </thead>
    <tbody>
      <tr><td>Minimum track width</td><td class="num">0.4</td></tr>
      <tr><td>Copper-to-board-edge clearance</td><td class="num">0.5</td></tr>
      <tr><td>Hole clearance / hole-to-hole</td><td class="num">0.25</td></tr>
      <tr><td>Minimum via diameter / through-hole</td><td class="num">0.5 / 0.3</td></tr>
    </tbody>
  </table>
</div>
```

```

<div class="table-wrap">
  <table>
    <caption>Net classes (Board Setup → Net Classes). All values in mm.</caption>
    <thead>
      <tr><th>Class</th><th>Track width</th><th>Clearance</th><th>Nets</th></tr>
    </thead>
    <tbody>
      <tr>
        <td>Default</td><td class="num">0.4</td><td class="num">0.4</td>
        <td>Everything else: GATE1/2, TRIG, AUX, LED, button</td>
      </tr>
      <tr>
        <td>Power</td><td class="num">1.5</td><td class="num">0.4</td>
        <td>PWR_12V and COIL- (assigned by the patterns <code>*PWR_12V*</code> and
        <code>*COIL-*</code>)</td>
      </tr>
    </tbody>
  </table>
</div>

```

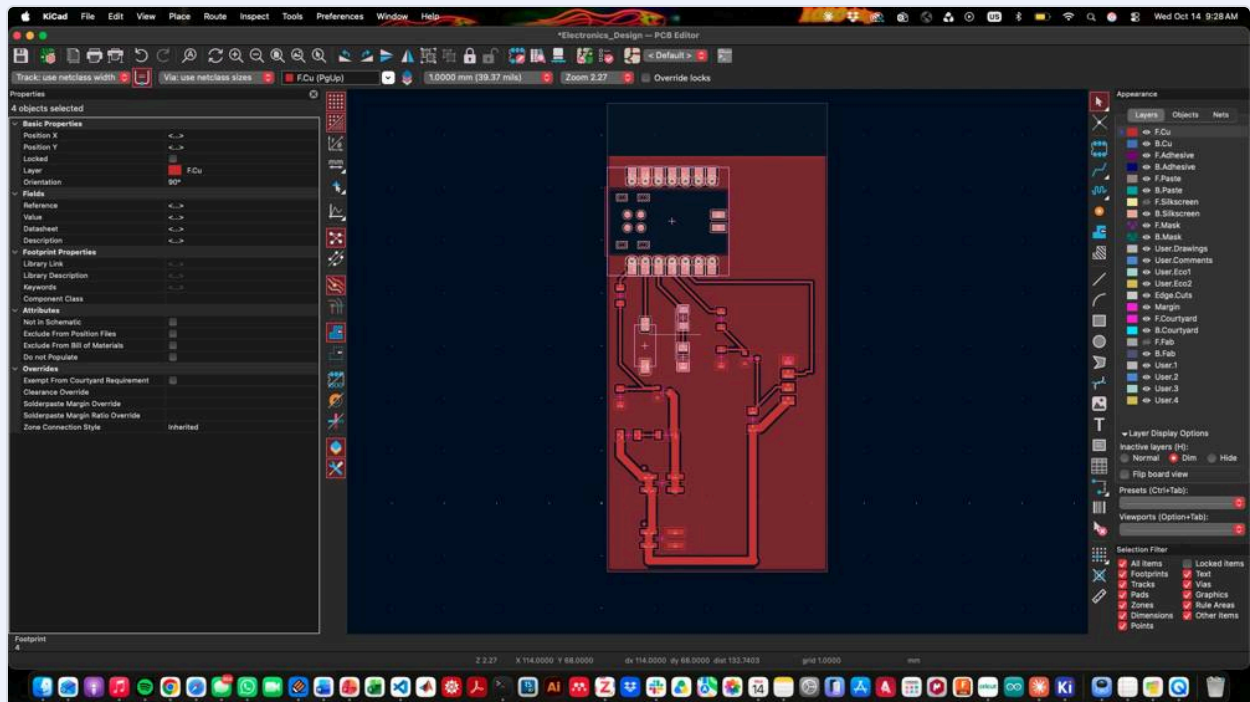
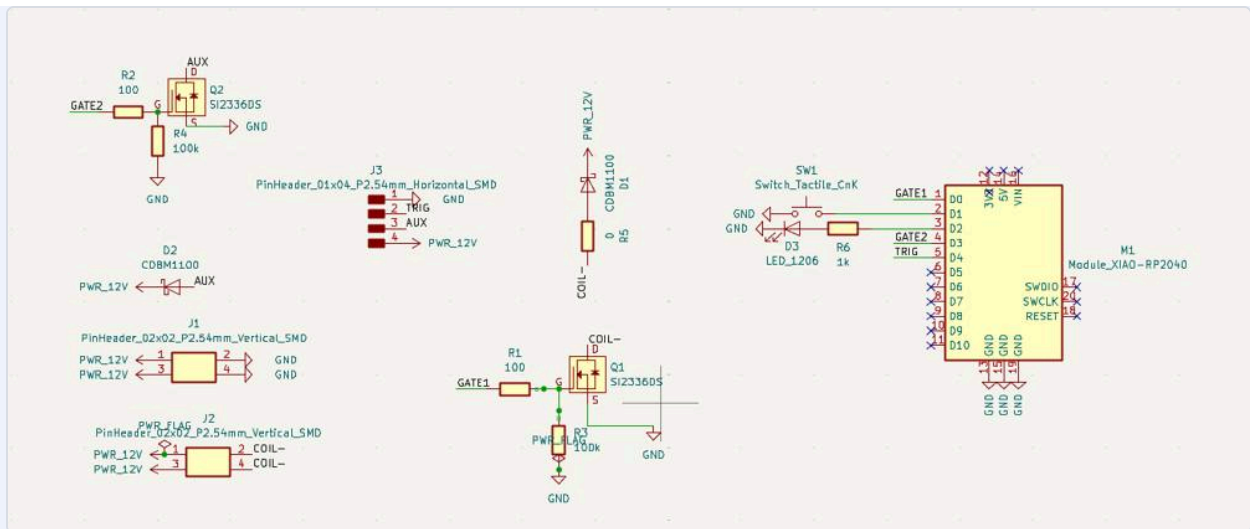
Your existing table in `week4.html` (line 110) won't get this styling yet. The line reads `<div class="table-wrap"></div>`, so the div closes before the table starts. Delete that `</div>` and put a `</div>` after the `</table>` on line 177, so the table sits inside the wrapper like the ones above.

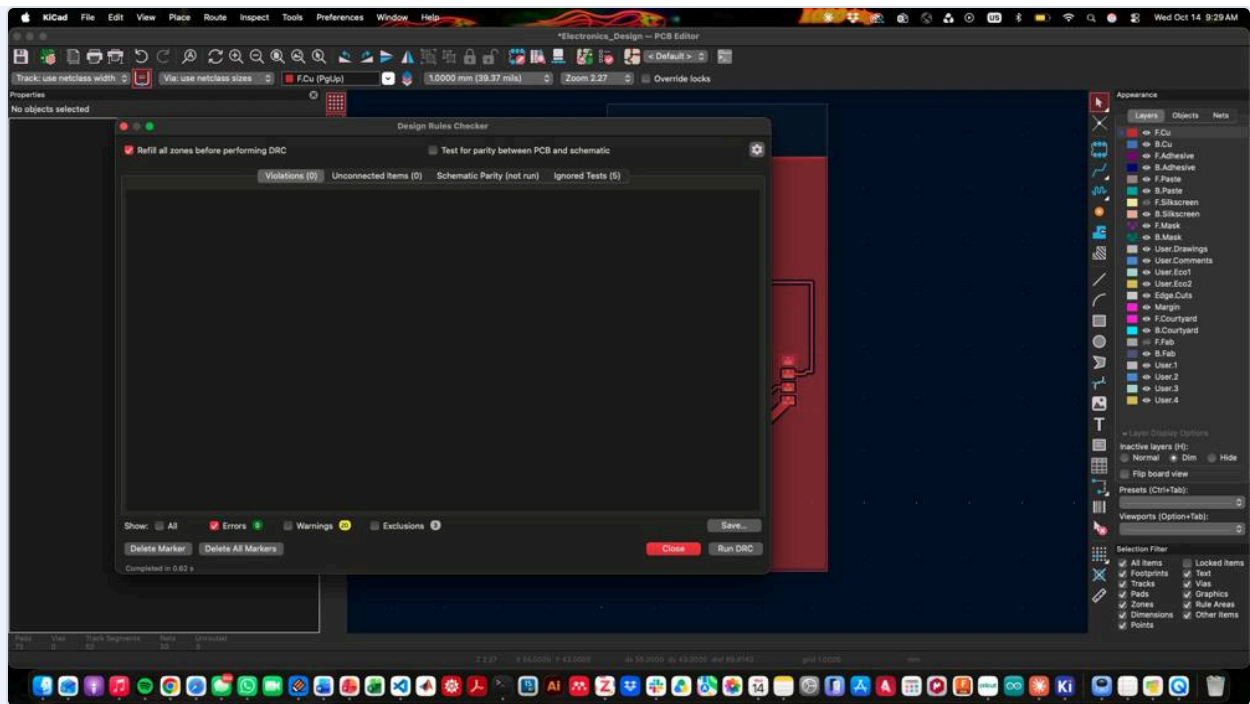
MARTÍN · WED 2026-10-14 09:30

Okay, this is this week's assignment. I understand the assignment as "use kicad to design a circuit." I don't really know how to start or what to do. could you digest this for me?

Setting up a KiCad project for a Fab Academy assignment.

This week is **electronics design**. You draw a small circuit board in software and get it ready to be manufactured, but you don't make it yet. Making it is usually next week's "electronics production". Here's the assignment piece by piece.





I will be adding these pictures to my website, so I need you to turn them into JPGs, compress them, and save them in my repo in a new folder called `w4_images`. Please tell me what you call each picture so I can reference them properly

- ⚙️ Convert screenshots to compressed JPGs
- ⚙️ Saved the compressed images into the `w4_images` folder of the website repo

CLAUDE

I saved the four screenshots as compressed JPGs in a new `w4_images` folder in your repo. In the order you sent them:

Picture	File name	Size
Assignment page + my explanation	<code>w4_images/assignment.jpg</code>	127 KB
Schematic	<code>w4_images/schematic.jpg</code>	55 KB
PCB layout	<code>w4_images/pcb_layout.jpg</code>	161 KB
DRC results	<code>w4_images/drc.jpg</code>	133 KB

The two big screenshots were reduced to 1600 px wide. The schematic JPG came out a little larger than its PNG, because JPG doesn't compress flat-color line drawings well. It's still small.

To use them on your page:

```
<div class="figure">
  
```

```
<figcaption>Schematic</figcaption>
</div>
```

Two things to update in files that already point at the old `images/week4/` folder:

- **The commented-out figure blocks in `week4.html`** (schematic, layout, drc) use `images/week4/...png`. Change them to `w4_images/...jpg` when you uncomment them.
- **The Week 4 row on the home and weekly pages** uses `images/week4/3d.png` as its thumbnail, and that file doesn't exist. Change it to `w4_images/pcb_layout.jpg`, or to a 3D view if you add one, before you push. Otherwise the thumbnail will show up broken.

MARTÍN · WED 2026-10-14 09:36

okay, how do I do the 3d view of my board? is that worth including?

CLAUDE

Yes, it's worth including. It's the one picture that shows what the finished board will physically look like, and it'll make a good thumbnail for your Week 4 row on the home page. It takes about two minutes.

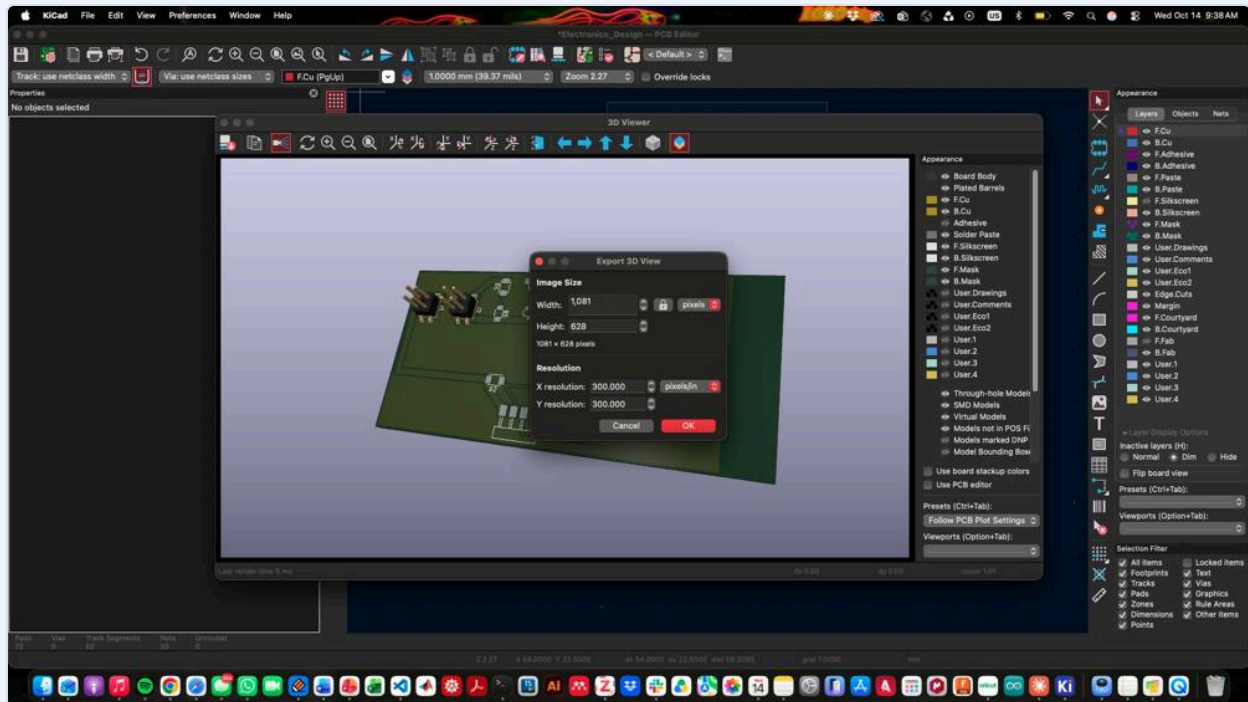
How to do it in KiCad:

1. **Open the 3D viewer.** In the PCB Editor, choose **View → 3D Viewer** (or press **Option+3**).
2. **Pick an angle.** Drag to rotate, scroll to zoom. A slightly tilted view from above usually looks best. The toolbar also has preset views (top, front, and so on).
3. **Optional: a nicer render.** Turn on raytracing for realistic lighting and copper: the **Raytracing** toggle in the 3D viewer's toolbar, or in its **Preferences** menu. It takes a few seconds to render.
4. **Export it.** Choose **File → Export Current View as PNG** (or JPEG) and save it anywhere.

One thing to expect: some fab library footprints don't come with 3D models. Those parts will show up as bare copper pads rather than little components. That's normal, and you can mention it in your write-up. The board outline, traces and ground pour will all show.

Send me the exported image, or save it to the `w4_images` folder. I'll compress it to `w4_images/3d.jpg`, and you can use it both in the 3D View section of `week4.html` and as the Week 4 thumbnail on the home and weekly pages.

MARTÍN · WED 2026-10-14 09:39



this is what's available for save

CLAUDE

That dialog is fine. Just a few settings:

- **Width:** change 1,081 to about **1600**. The lock keeps the height in proportion, and it'll look sharper on wide screens.
- **Resolution (300 pixels/in):** leave it. It only matters for printing; web pages ignore it.
- Click **OK** and save it into your `w4_images` folder, e.g. as `3d.png`. I'll convert and compress it from there.

Before you export, it's worth adjusting the view:

- **Zoom in** so the board fills more of the frame. Right now it takes up about half the image, with a lot of empty background.
- **The Xiao doesn't appear.** That's because its footprint has no 3D model, so you just see its pads. That's fine; mention it in a caption, e.g. "*3D view of the board (the Xiao RP2040 module has no 3D model, so only its pads are shown).*"
- For a more realistic look, turn on **raytracing**, using the rightmost highlighted button in the 3D viewer's toolbar, before exporting.

Once it's saved, tell me and I'll make `w4_images/3d.jpg` out of it.

MARTÍN · WED 2026-10-14 09:47

okay, I pushed everything to my website and it looks about good. For the AI documentation, would you be able to generate a pdf starting from when I initially sent you the screenshot of the assignment from my HTMAA page up to now?

Claude then generated this PDF from the conversation.