THE ART AND SCIENCE OF PCB DESIGN

lecture 02 - WHAT'S A PCB?

what are they and how do we build them?

@ MIT

BUT FIRST ANNOUNCEMENTS

- who are we and why you should listen to us
- registration is closed!
- we have a Course 2 number (2.S975 (U) and 2.S980 (G))
- VMs are still coming!
- track 2 proposals due tonight over email!

- *we'll be in 38-500 tomorrow!*

registration

- we can’t take any more people!
- four options to be registered under
  - 6.S092 - 6 units, undergrad
  - EC.S03 - 6 units, undergrad
  - 2.S975 - 3 units, undergrad
  - 2.S980 - 3 units, graduate

this is a *nightmare* to keep track of
there are two of us
make sure you’re registered for the thing you’d like to be!

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registration

- get academic credit by completing:
  - Track 1 - completing the labs, doing DRs, and soldering a lab kit
  - Track 2 - completing a proposal, doing DRs, and completing a writeup at the end
  - Track 3 - being exceedingly cool 😎

- at end of semester we will:
  - check our records, see if you're eligible for credit
  - if you are, we'll give you credit for whatever you're registered for
  - if not, we can't give you credit

feel free to register as a listener, but it doesn't really get you anything

fischer

fischermoseley.com/projects

- MIT ‘22 6-1/8 flex, MEng ‘23
- currently working with Joe Steinmeyer on curriculum dev stuff
- former EE lead for MIT FSAE
- TA’d 6.111/205 last semester

- worked on:
  - satellites (some stuff is in orbit!)
  - racecars / 100kW-scale power electronics
  - superconducting qubits
  - physical modeling (some stuff in PNAS)
  - robotics/dynamics/optimization/ML
  - digital systems
  - atomic clocks

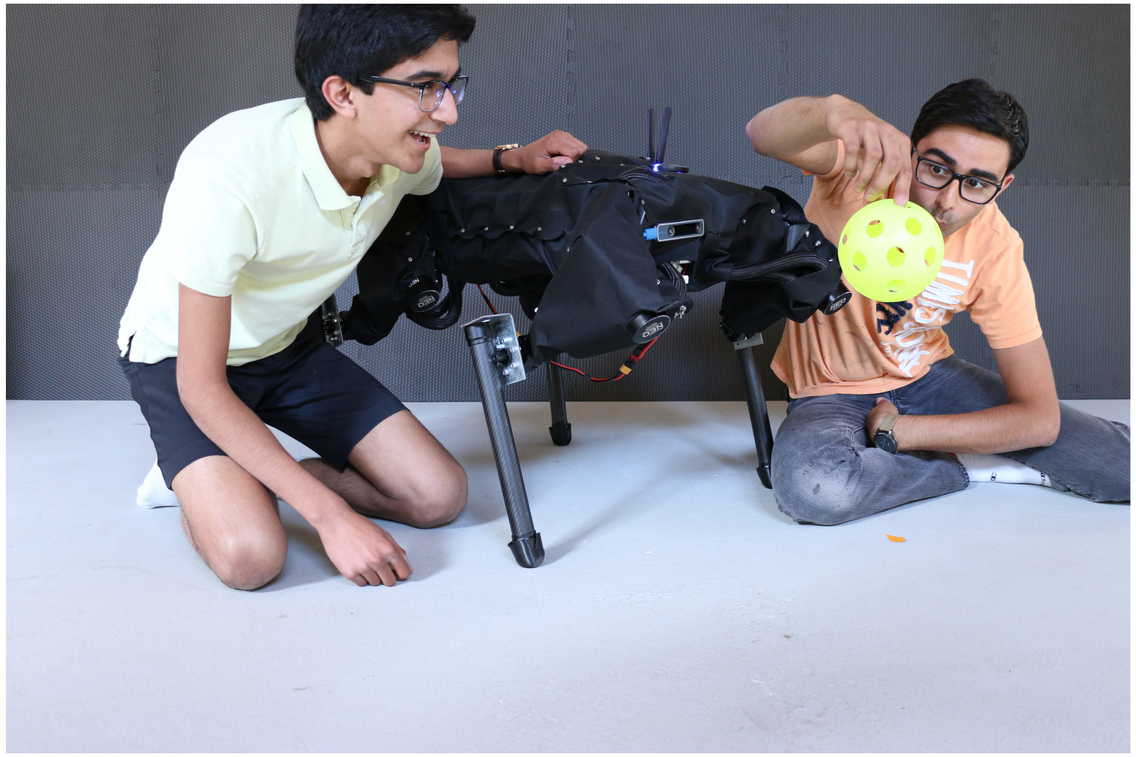

MCMXVI
MASSACHVSETTS INSTITVTE OF TECHNOLOGY

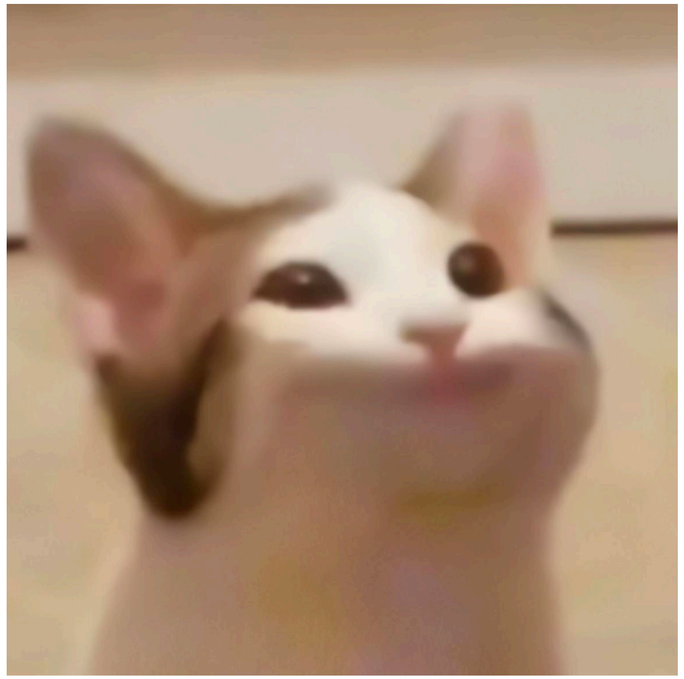
adi

adim.io

- MIT’ 22 (EE), SM/PhD (MechE)
- working with Professor Sangbae Kim
- MIT Solar Car (battery systems, machining), MIT D-Lab (engineering for the developing world)
- I do some film + photo :)

- worked/working on:
  - Mechanical/Electrical design of legged + dynamics Robots
  - Motor control, and testing
  - Hydrogen-powered motorcycle project
  - Small ambulances for rural Ghana
  - Solar-car battery + battery management systems
  - Walking robots for lunar exploration





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LAs

some genuinely incredible people

Will Vu

Winnie Szeto

Jesse George-Akpenyi

questions?

what is a PCB?

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- *Tell me that it's proud of me*
- *Go kart*
- *firespinning light*
- *Motor controller*
- *boba machine pcb pls*
- *Make my BB8 robot follow me (not sure if that’s something you can make a pcb do)*
- *An over-engineered black box with de-bounced front-end, a low-noise amplifier, an overpowered DSP, delicately containerized RF transmission and reception sections using the second-harmonics of oven-controlled crystal oscillators, carefully-tuned distributed-element filters, and double-balanced RF mixers - all used to transmit incredibly simple data using 256-QAM with CRCs and Huffman coding, all powered by a custom switched-mode power supply with active power-factor correction - all leading to a*

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what is a PCB?

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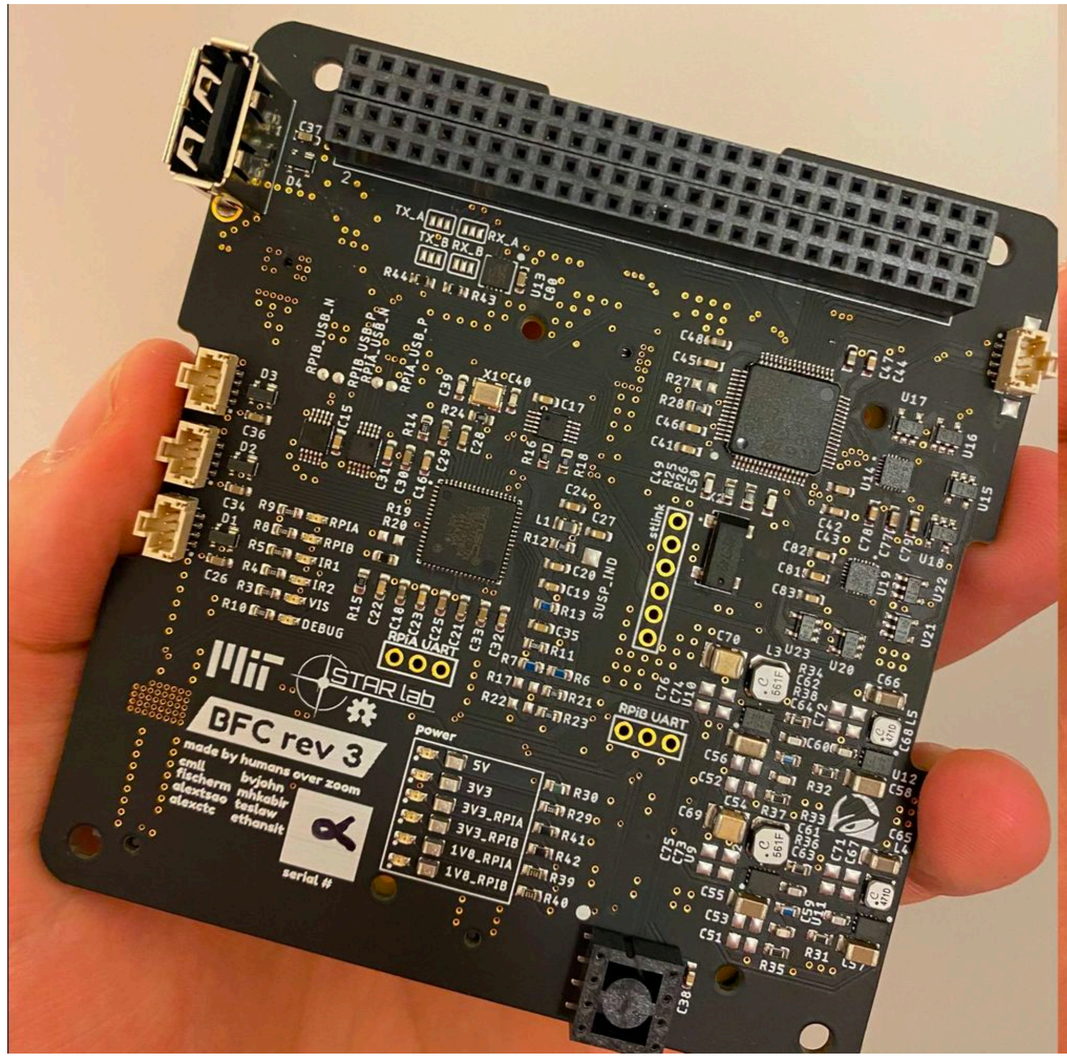

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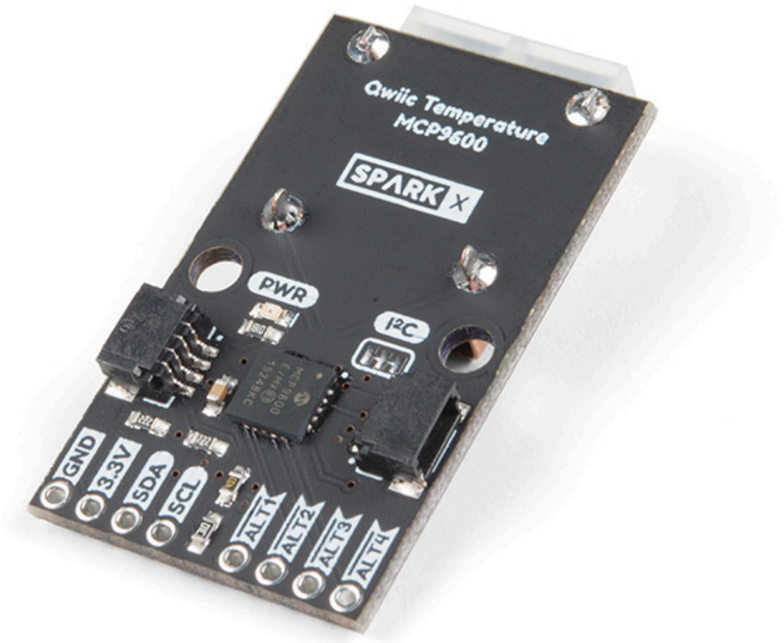
what is a PCB?


Qwiic Temperature
MCP9600
SPARKX
PWR
I²C
GND
3.3V
SDA
SCL
ALT1
ALT2
ALT3
ALT4

what is a PCB?

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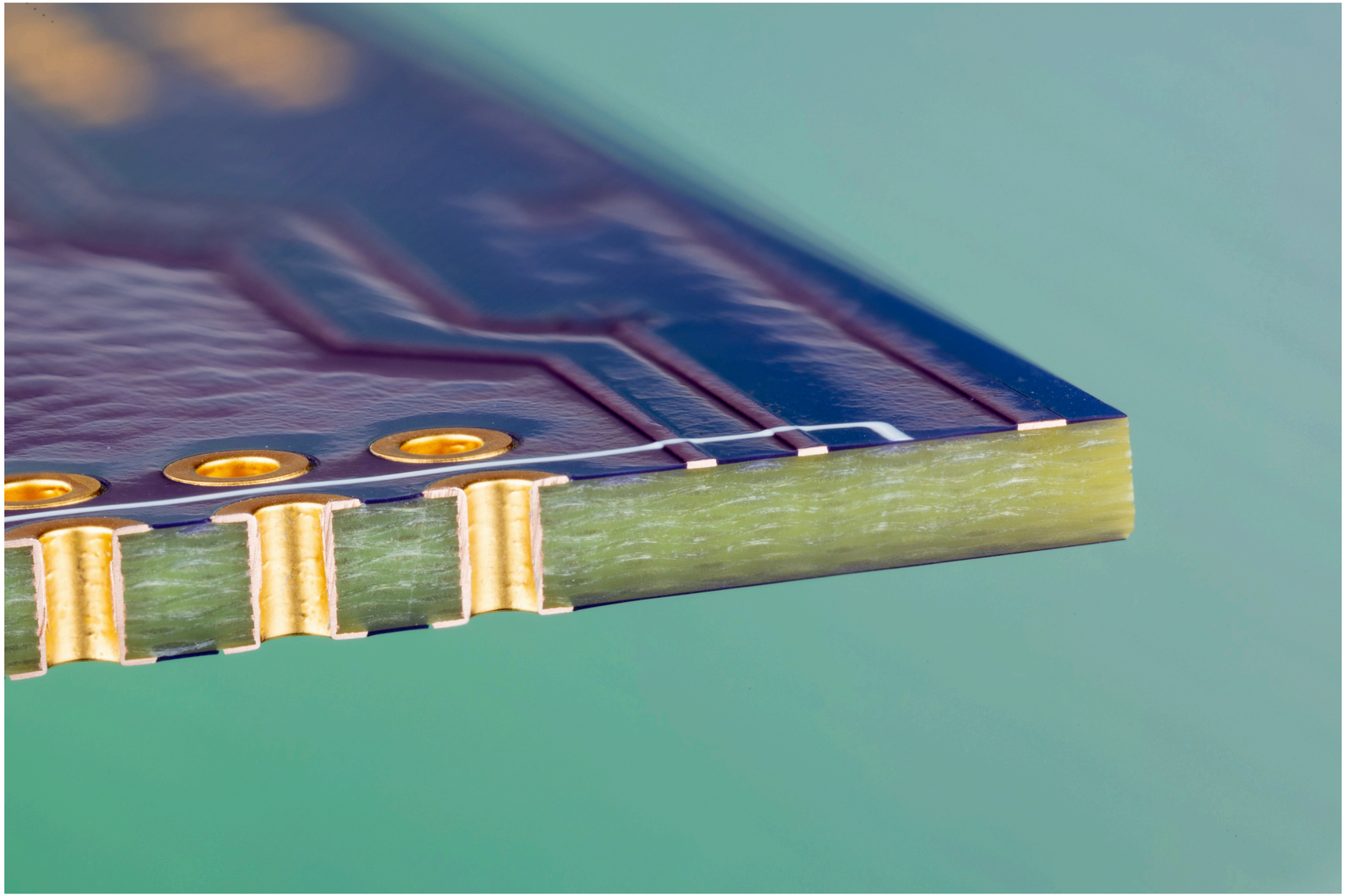

what is a PCB?

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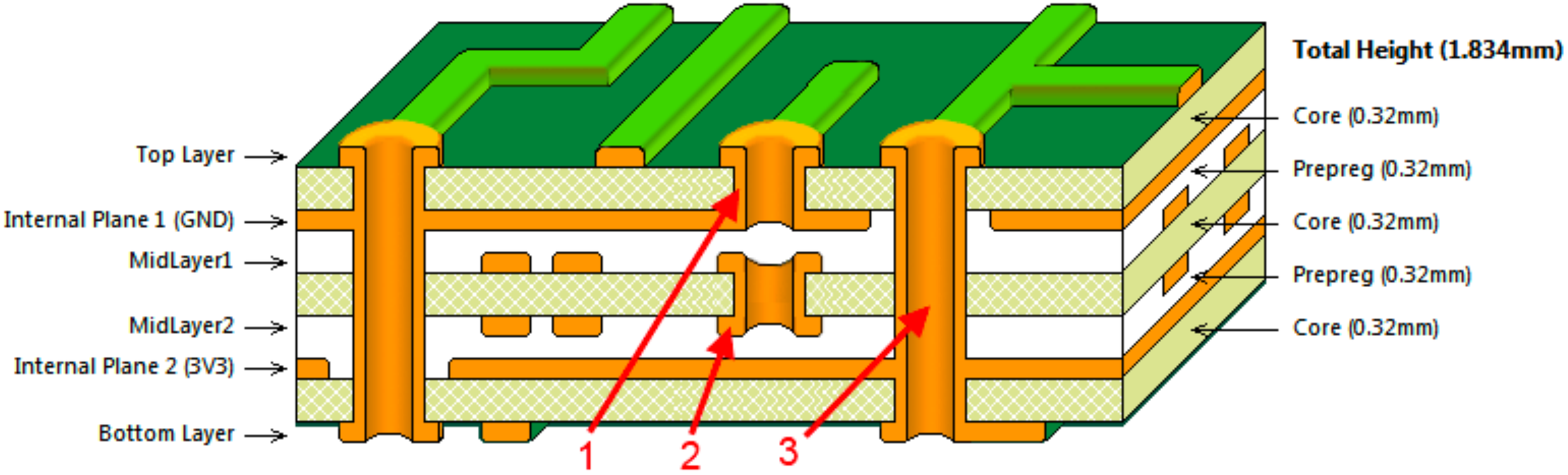
- ***Multi Layer PCBs***



what is a PCB?

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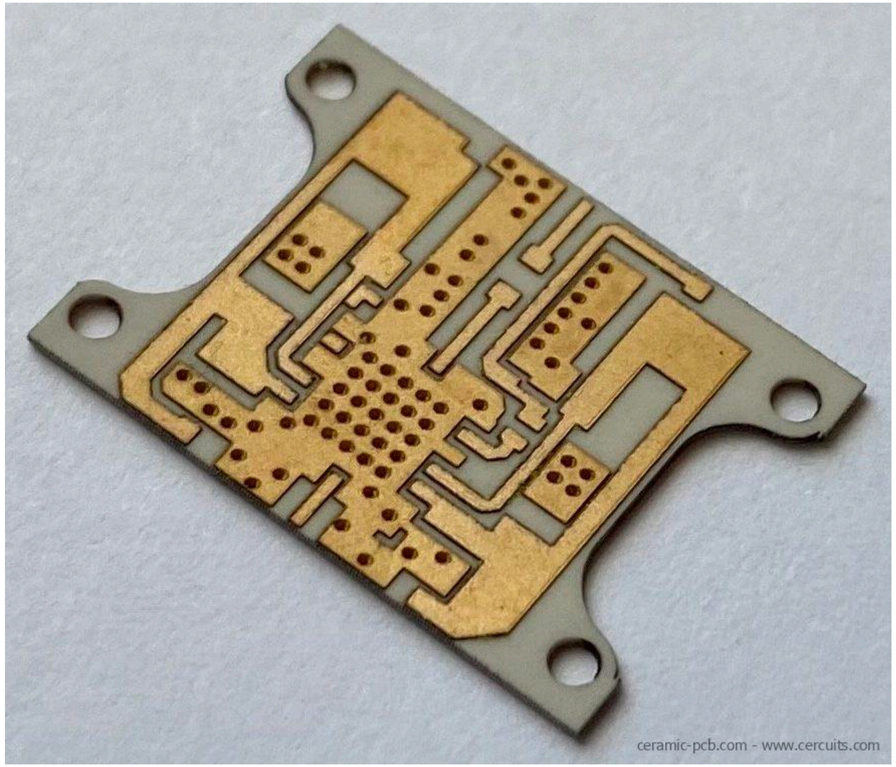
- *Multi Layer PCBs*
- *Aluminum/Ceramic PCBs*



what is a PCB?

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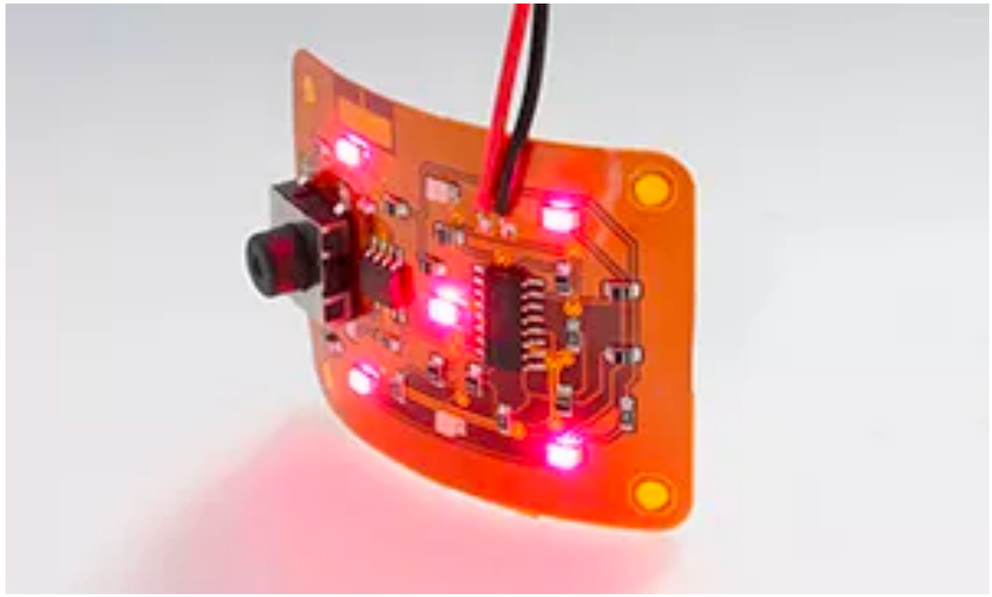
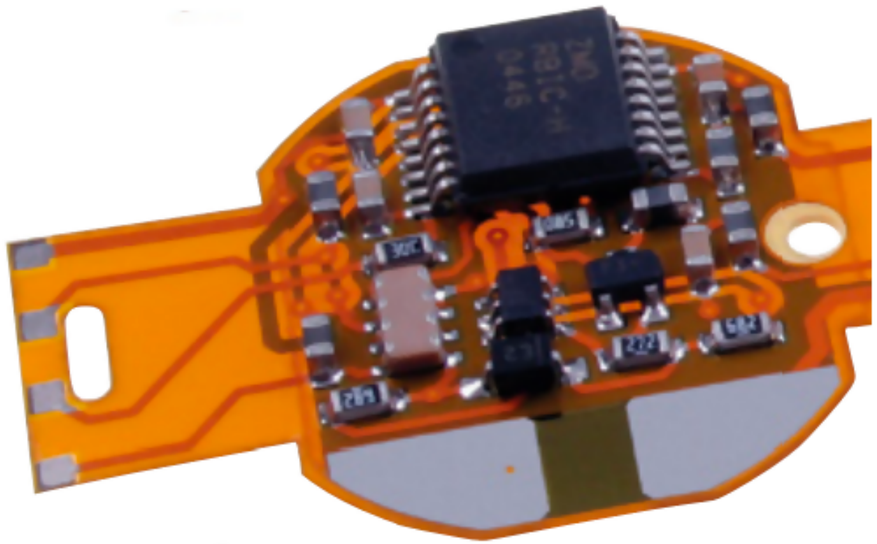
- *Multi Layer PCBs*
- *Aluminum/Ceramic PCBs*
- *Flex PCBs*

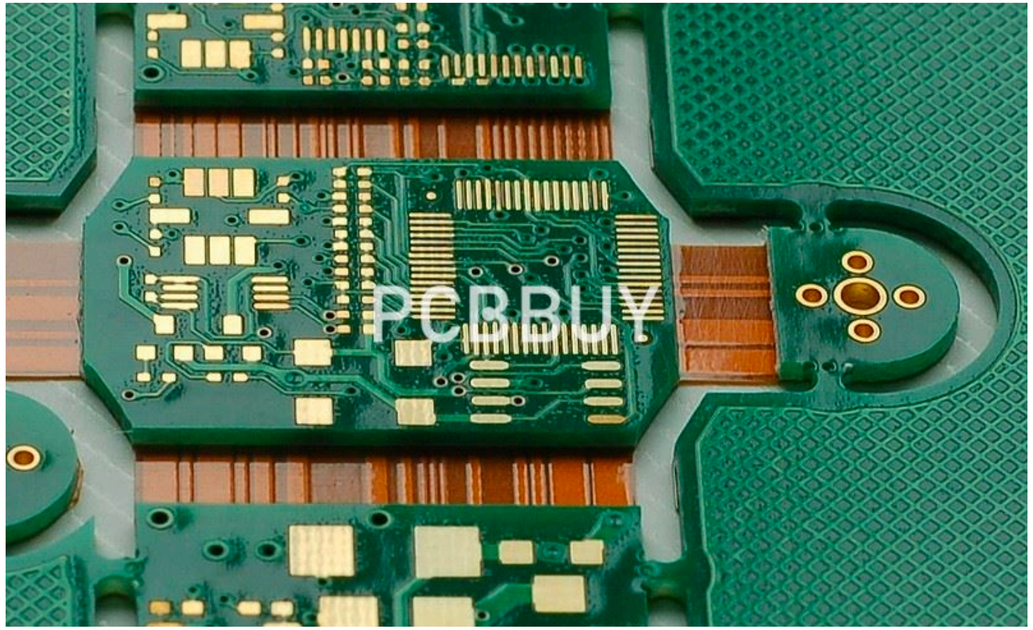


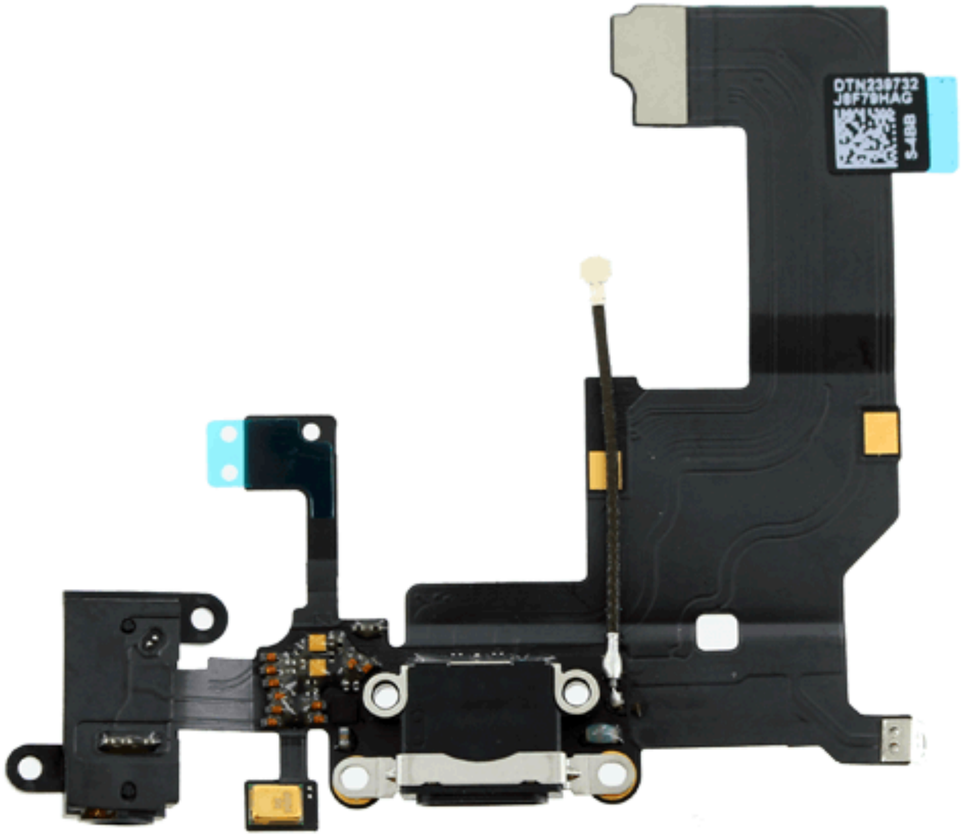


what is a PCB?

THE ART AND SCIENCE of PCB DESIGN

- *Multi Layer PCBs*
- *Aluminum/Ceramic PCBs*
- *Flex PCBs*
- *Rigid-Flex PCBs*





what is a PCB?

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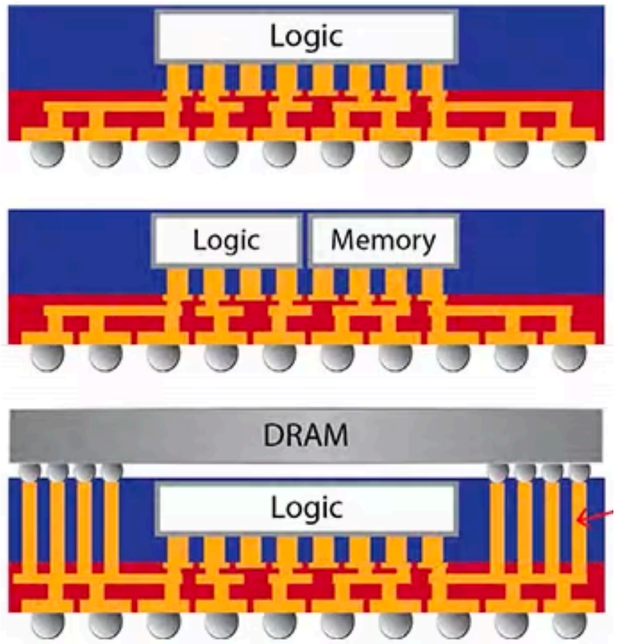
- *Multi Layer PCBs*
- *Aluminum/Ceramic PCBs*
- *Flex PCBs*
- *Rigid-Flex PCBs*
- *Other Wild Stuff (HDI, ELIC, FOWLP, SLP)*



what is a PCB?

THE ART AND SCIENCE OF PCB DESIGN

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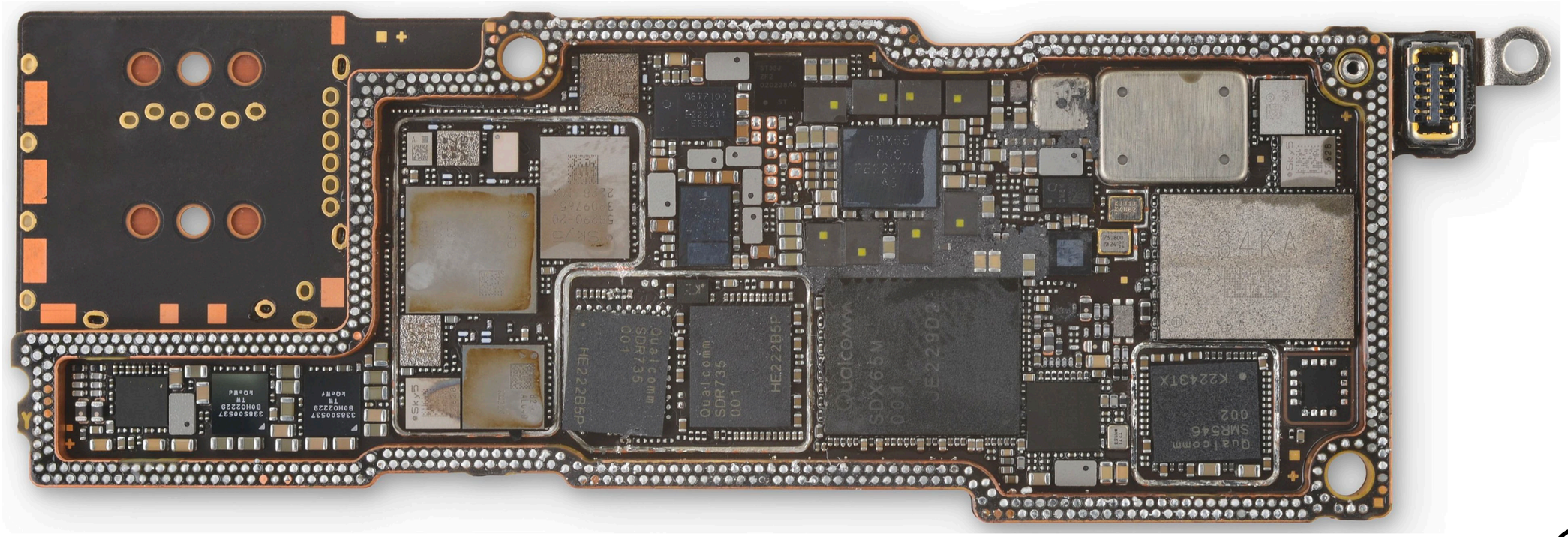
- *Other Wild Stuff (HDI, ELIC, FOWLP, SLP)*



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what goes on them?

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what goes on them?

- *resistors*
- *capacitors*
- *inductors*
- *transistors*
- *integrated circuits - chips*
- *connectors*

what goes on them?

THE ART AND SCIENCE of PCB DESIGN

- *resistors*
- *capacitors*
- *inductors*
- *transistors*
- *integrated circuits - chips*
- *connectors*

you'll see all of these in the bluetooth speaker design! (for track 1)

questions?

what else can you do with them?

what else can you do with them?

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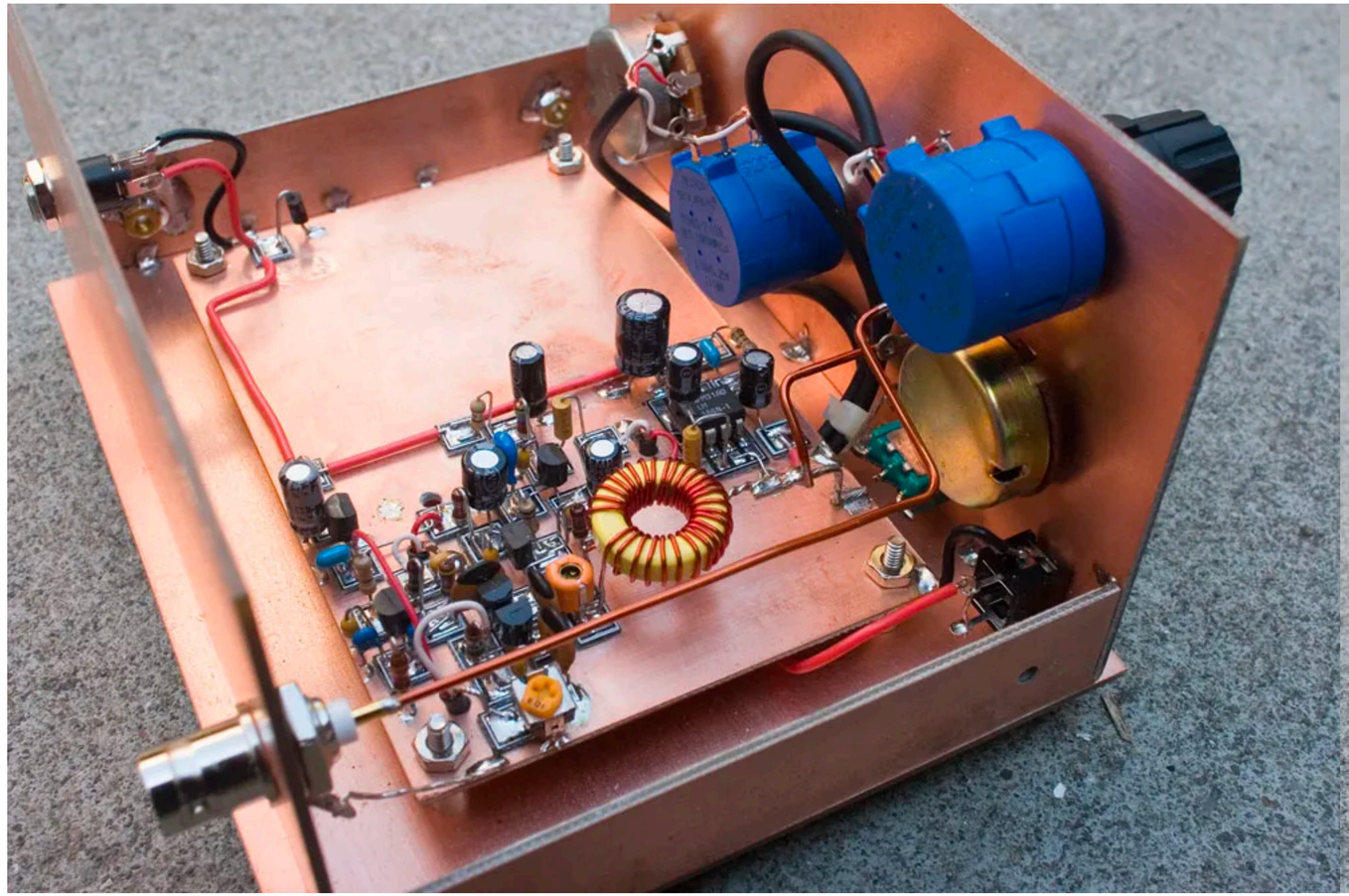
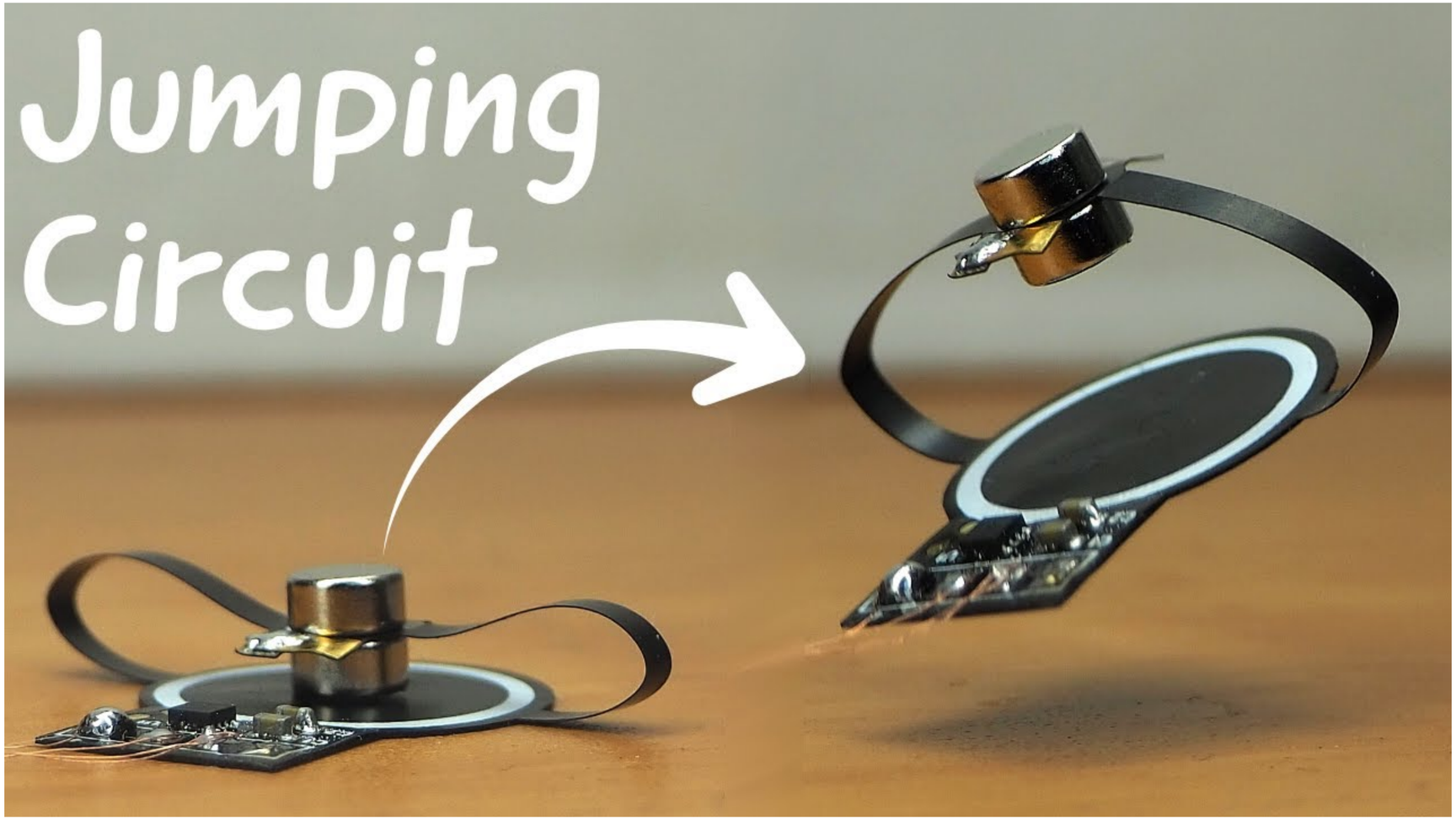


what else can you do with them?

what else can you do with them?



how do you make them?

how do you make them?

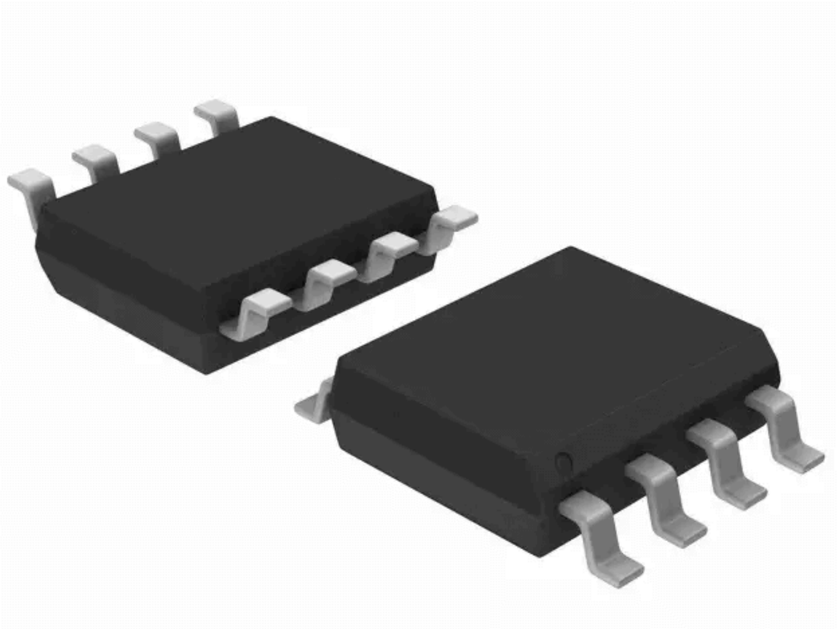
- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
- *assembly*
- *testing*

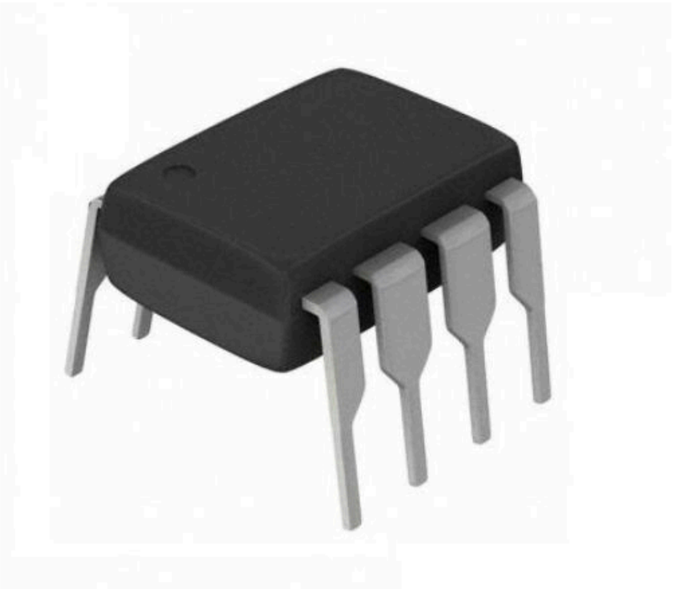
how do you make them?

- *circuit design*
  - *specs*

how do you make them?

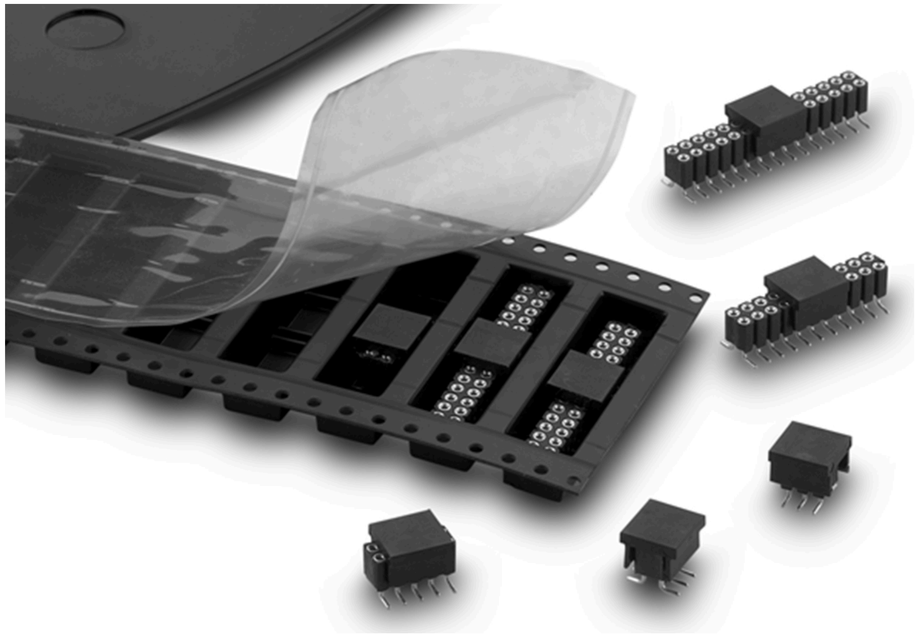
- *circuit design*
  - *specs*
  - *packaging (of the individual part)*

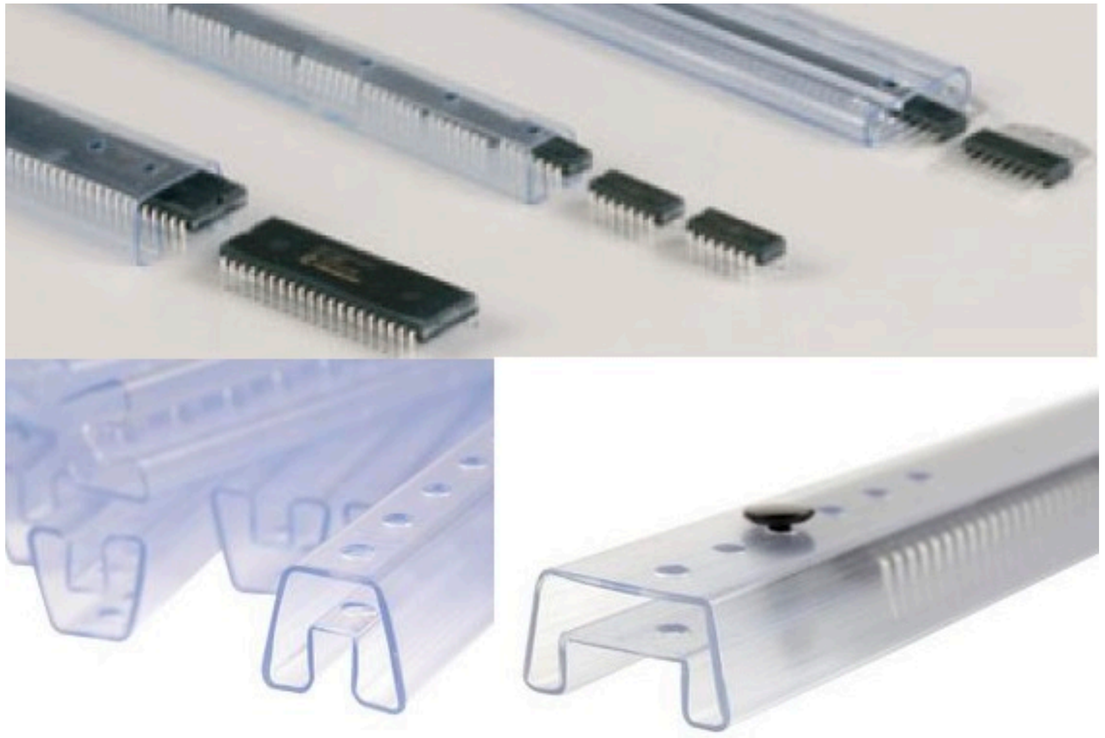




how do you make them?

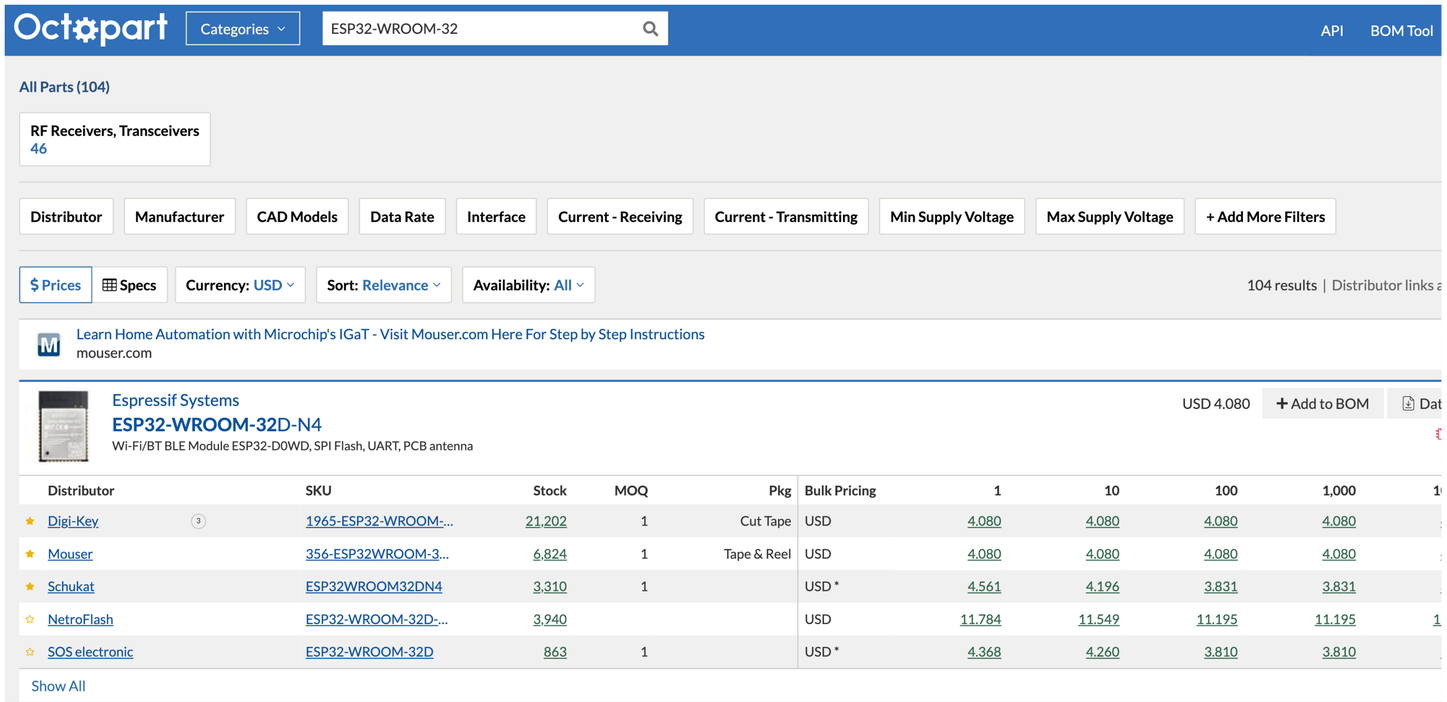
- *circuit design*
  - *specs*
  - *packaging (of the individual part)*
  - *packaging (of all the parts)*





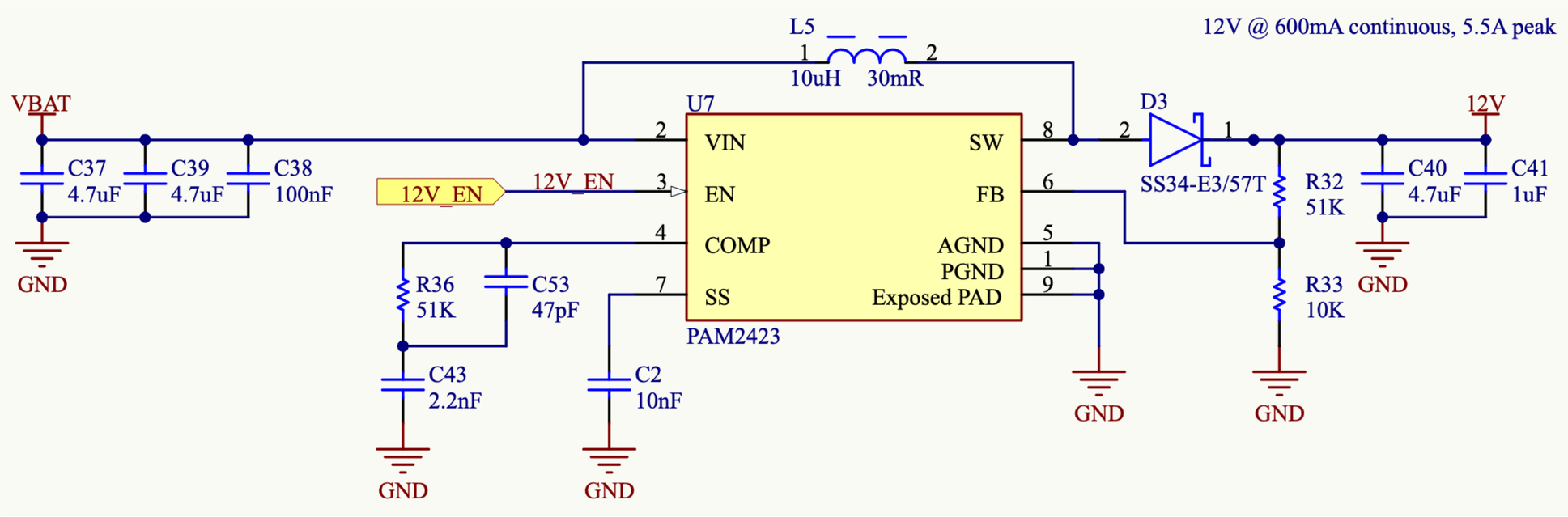
how do you make them?

- *circuit design*
  - *specs*
  - *packaging (of the individual part)*
  - *packaging (of all the parts)*
  - *pricing*
  - *availability*



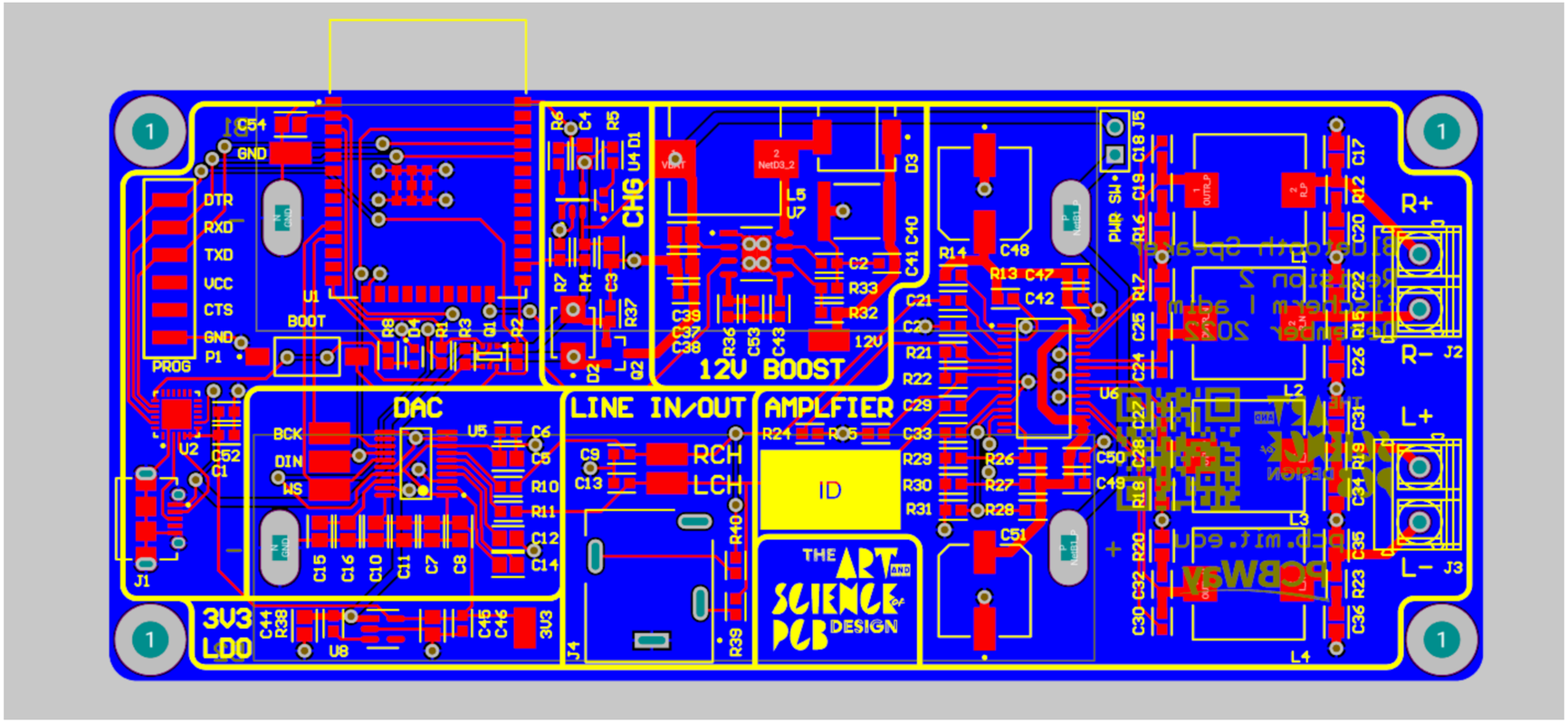
how do you make them?

- *circuit design*
- *schematic capture*



how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*



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how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
  - *component placement*
  - *routing*
  - *Design Rule Check (DRC)*
  - *gerber generation*

how do you make them?

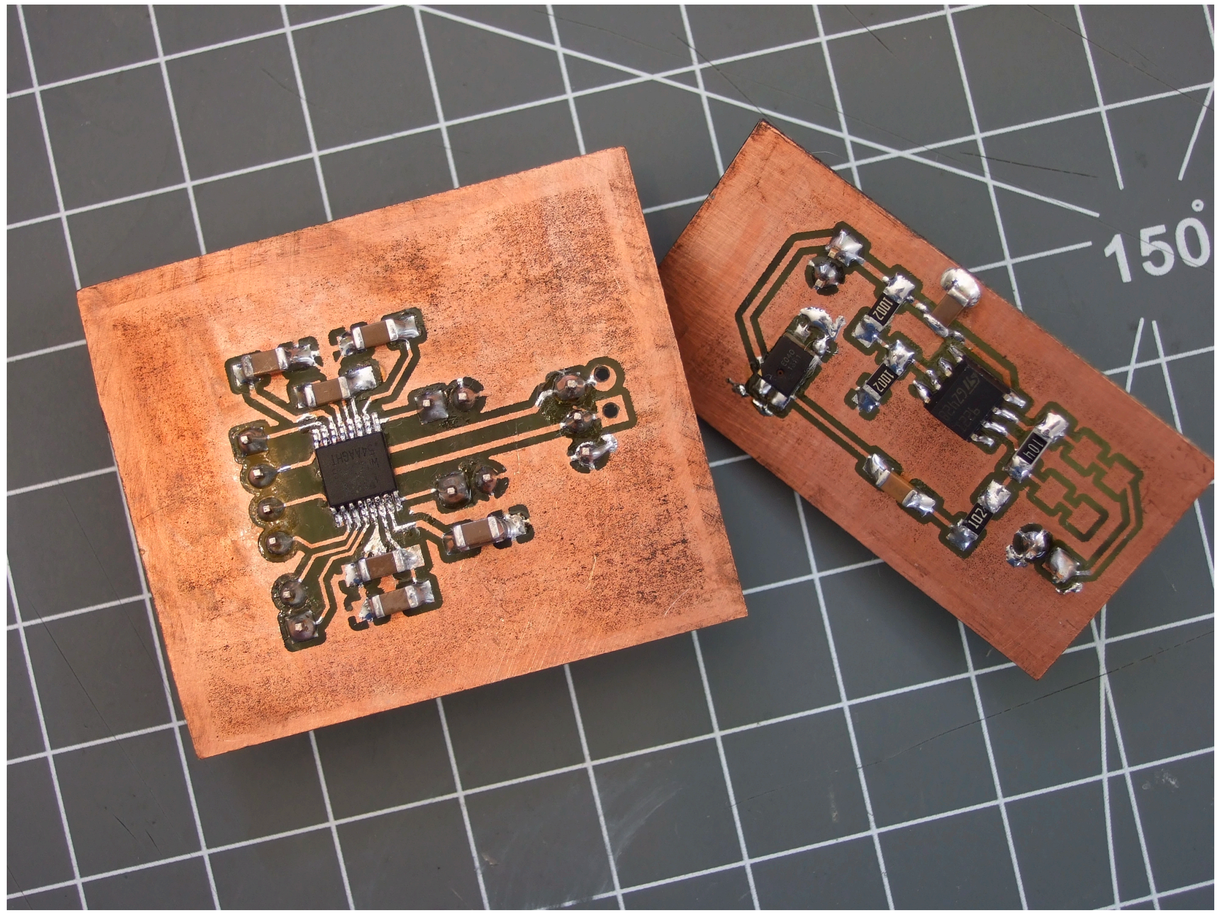
- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
  - *professional fab house*

how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
  - *professional fab house*
  - *pcb mill*

how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
  - *professional fab house*
  - *pcb mill*
  - *toner transfer*



how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
- *assembly*

how do you make them?

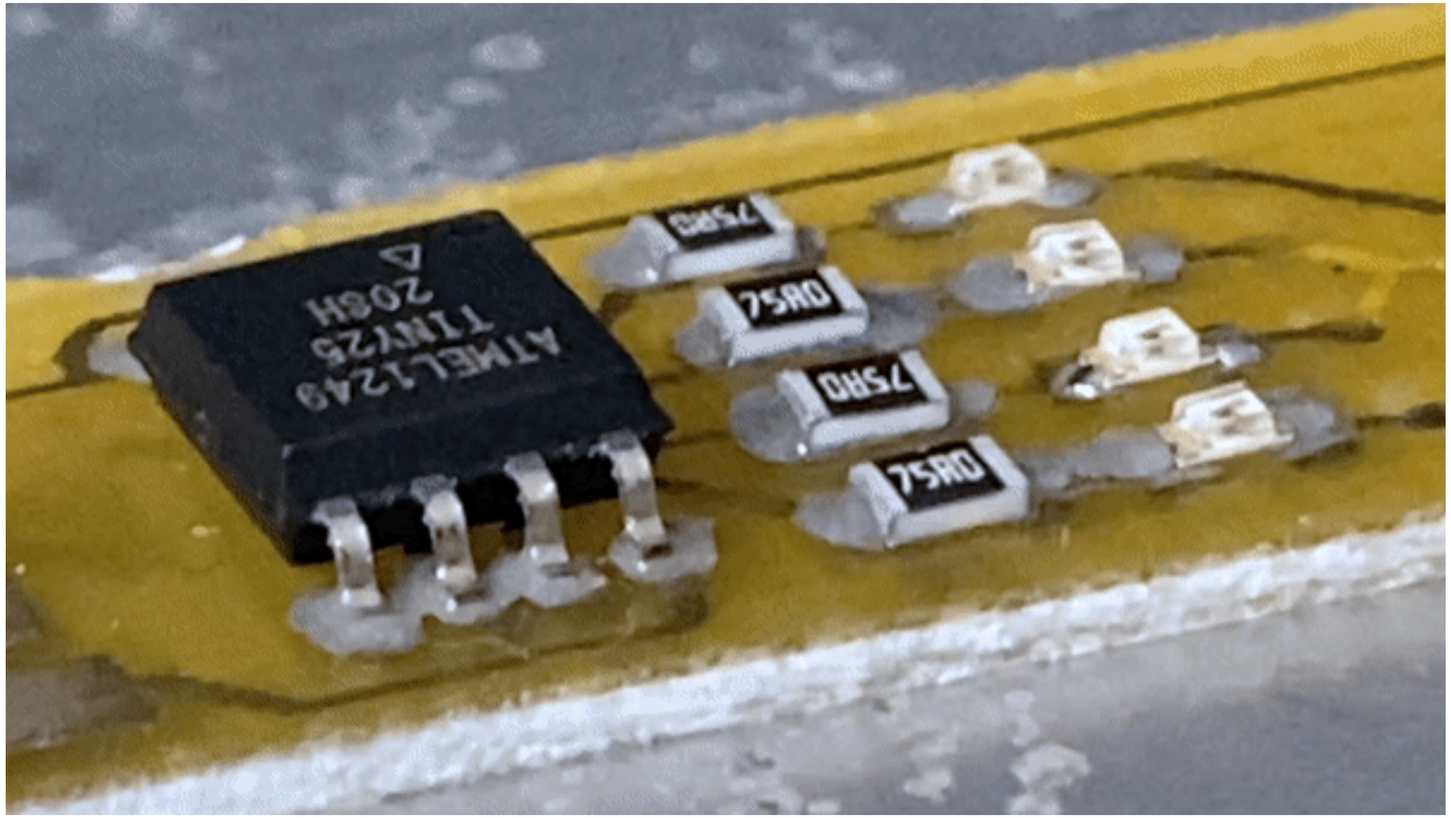
- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
- *assembly*
  - *applying solder paste*

how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
- *assembly*
  - *applying solder paste*
  - *placing parts*

how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
- *assembly*
  - *applying solder paste*
  - *placing parts*
  - *reflowing boards*



how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
- *assembly*
- *testing*

how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
- *assembly*
- *testing*
  - *doing it for a board you're making for the 1st time*

how do you make them?

- *circuit design*
- *schematic capture*
- *board layout*
- *fabrication*
- *assembly*
- *testing*
  - *doing it for a board you're making for the 1st time*
  - *doing it for a board you're making for the nth time*

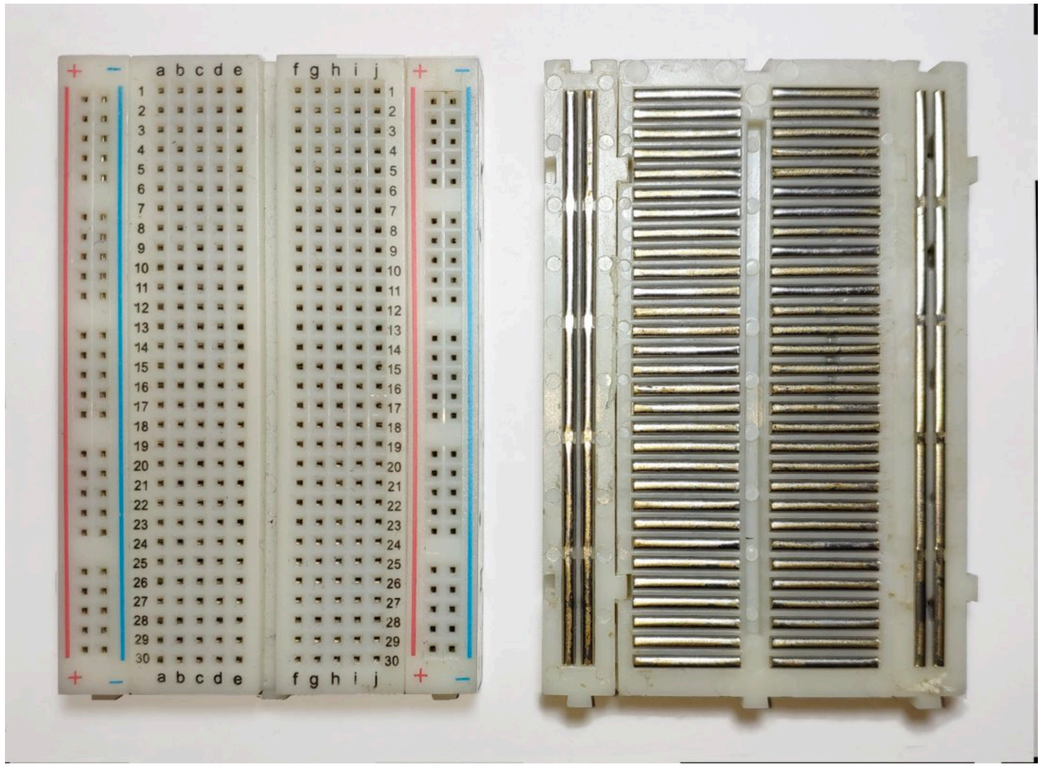
that’s it!
questions?

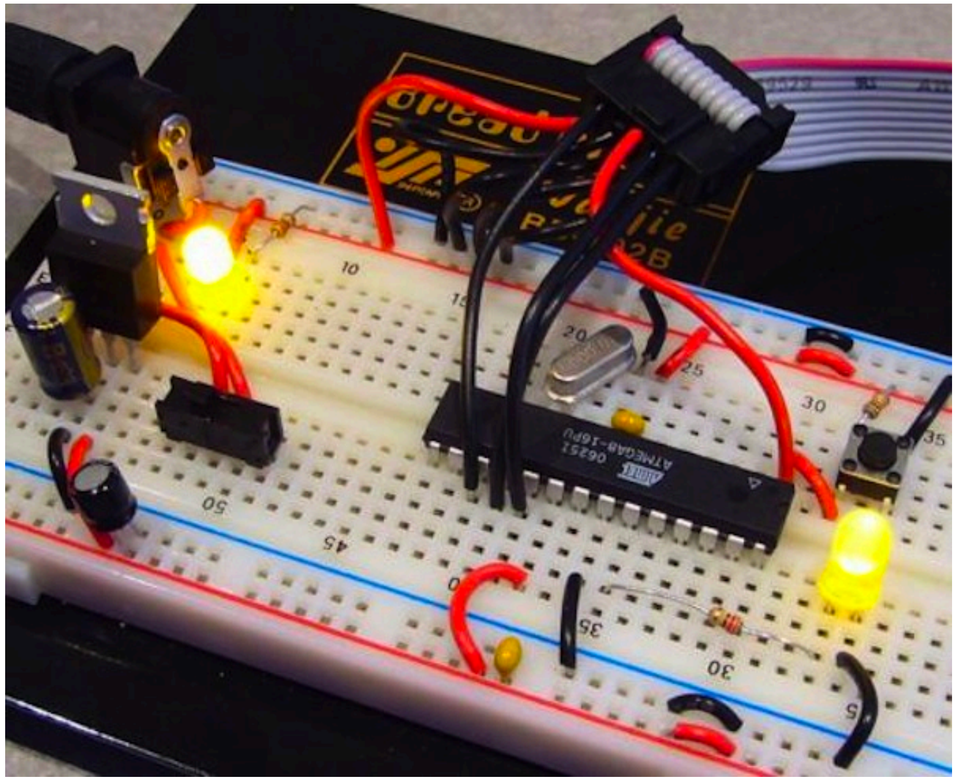
appendix: how else to connect things

- *solderless breadboards*
- *solderable breadboards*
- *perfboard*
- *point-to-point construction*
- *wire wrapping*
- *free-form assembly*
- *manhattan style*

how else to connect things?

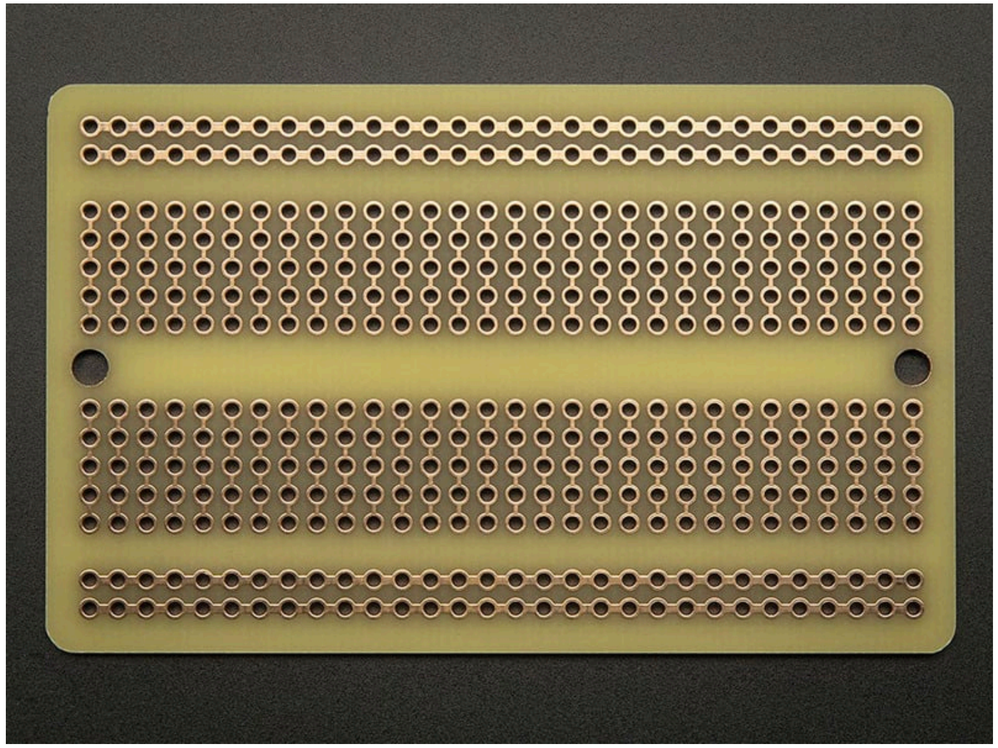
- *solderless breadboards*

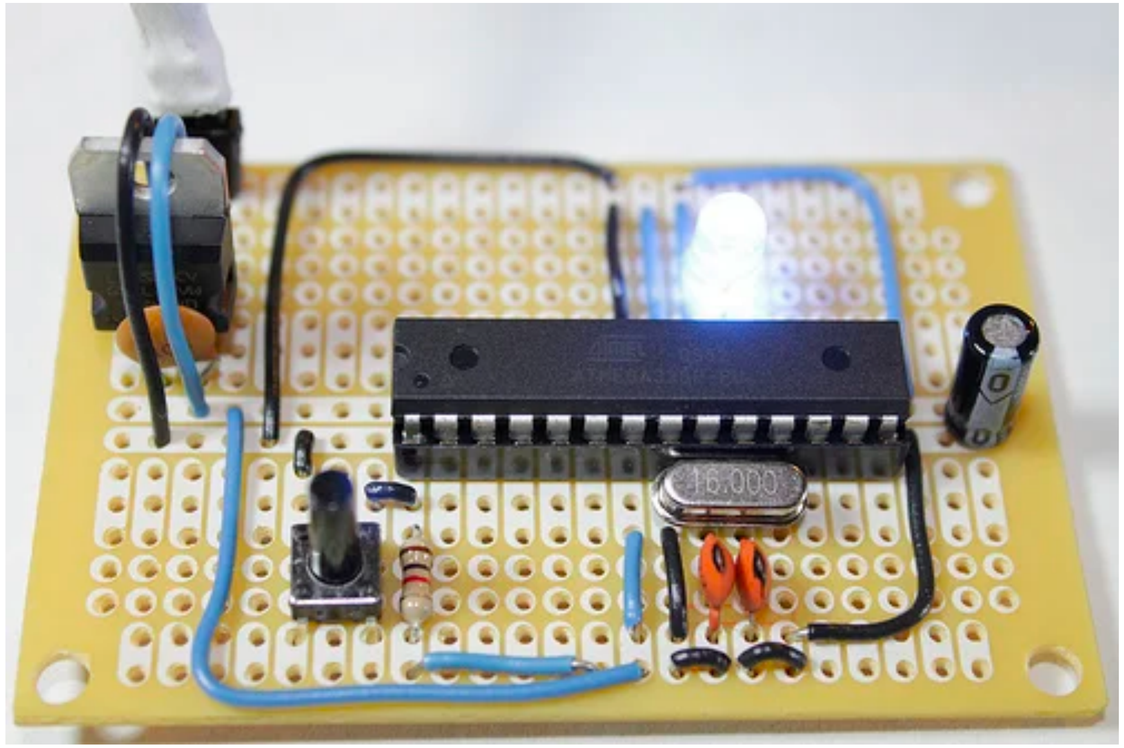




how else to connect things?

- *solderless breadboards*
- *solderable breadboards*





how else to connect things?

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how else to connect things?

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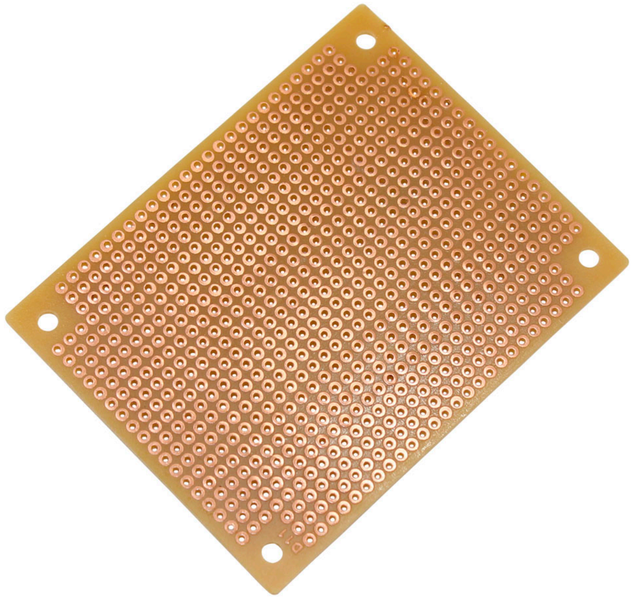

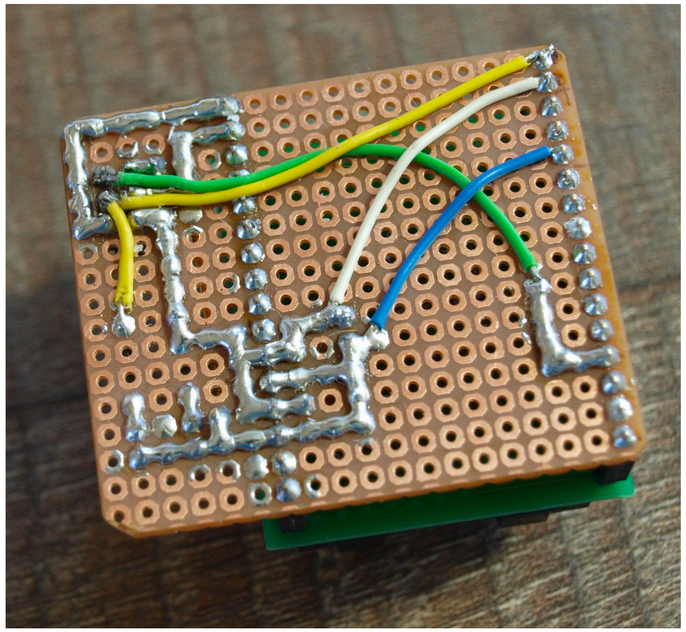

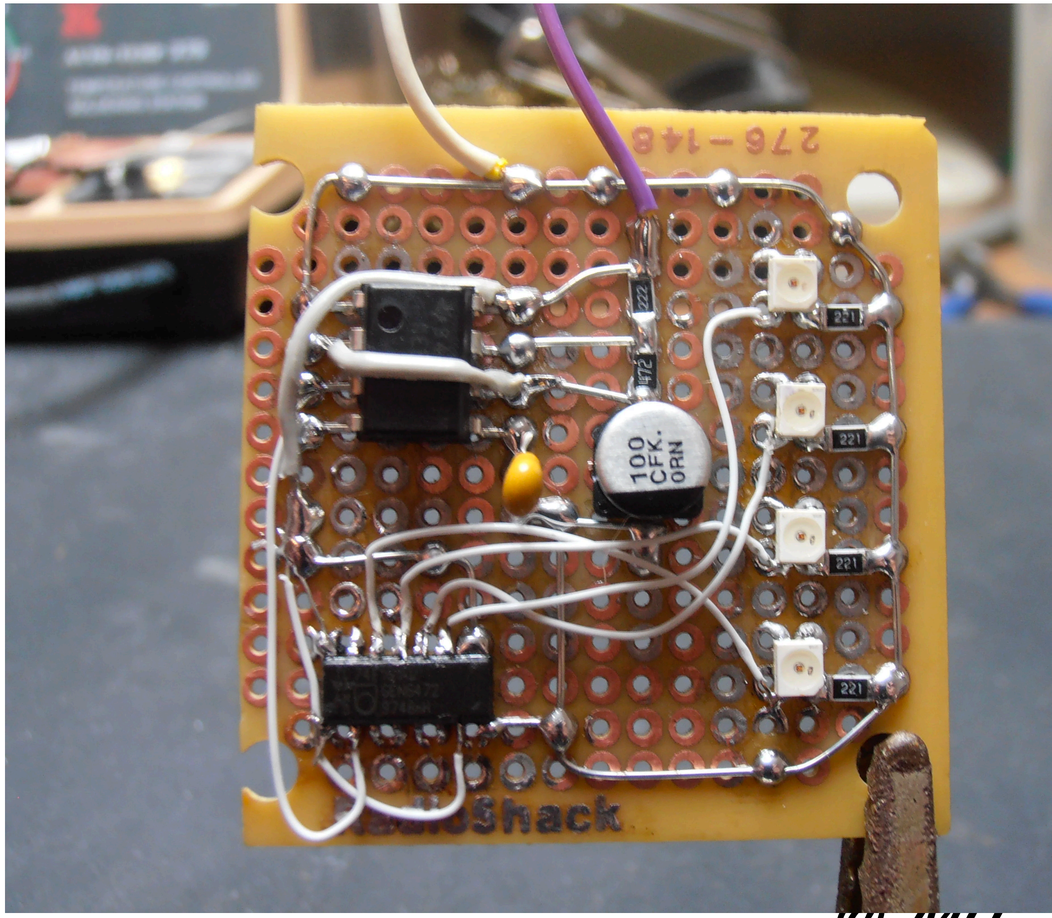

how else to connect things?

- *solderless breadboards*
- *solderable breadboards*
- *perfboard*
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how else to connect things?

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- *solderable breadboards*
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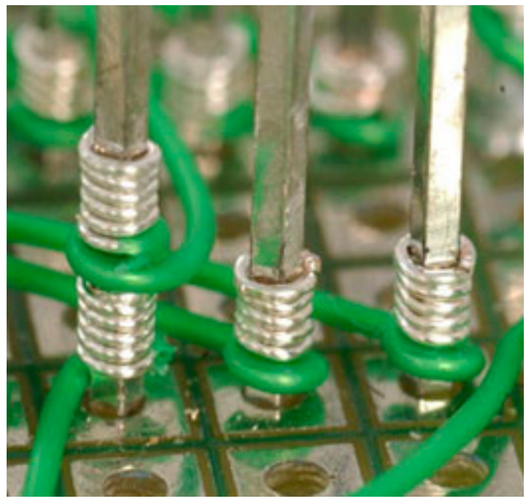
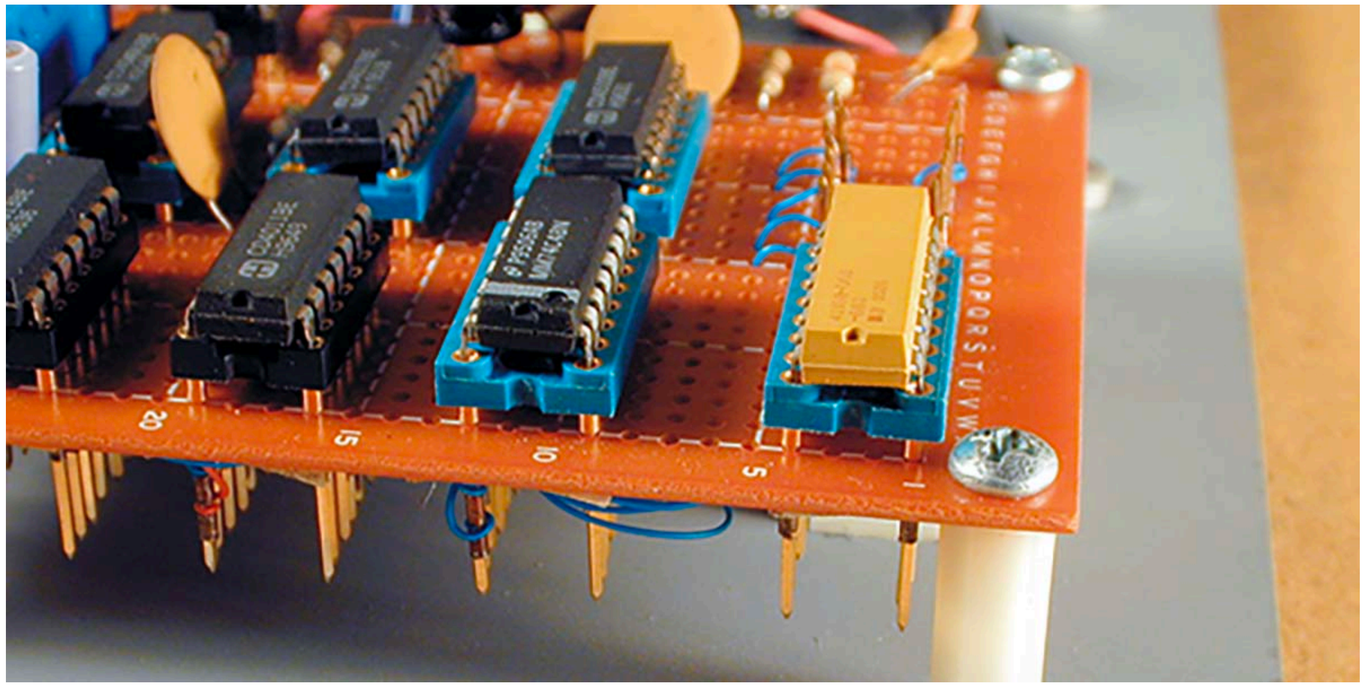
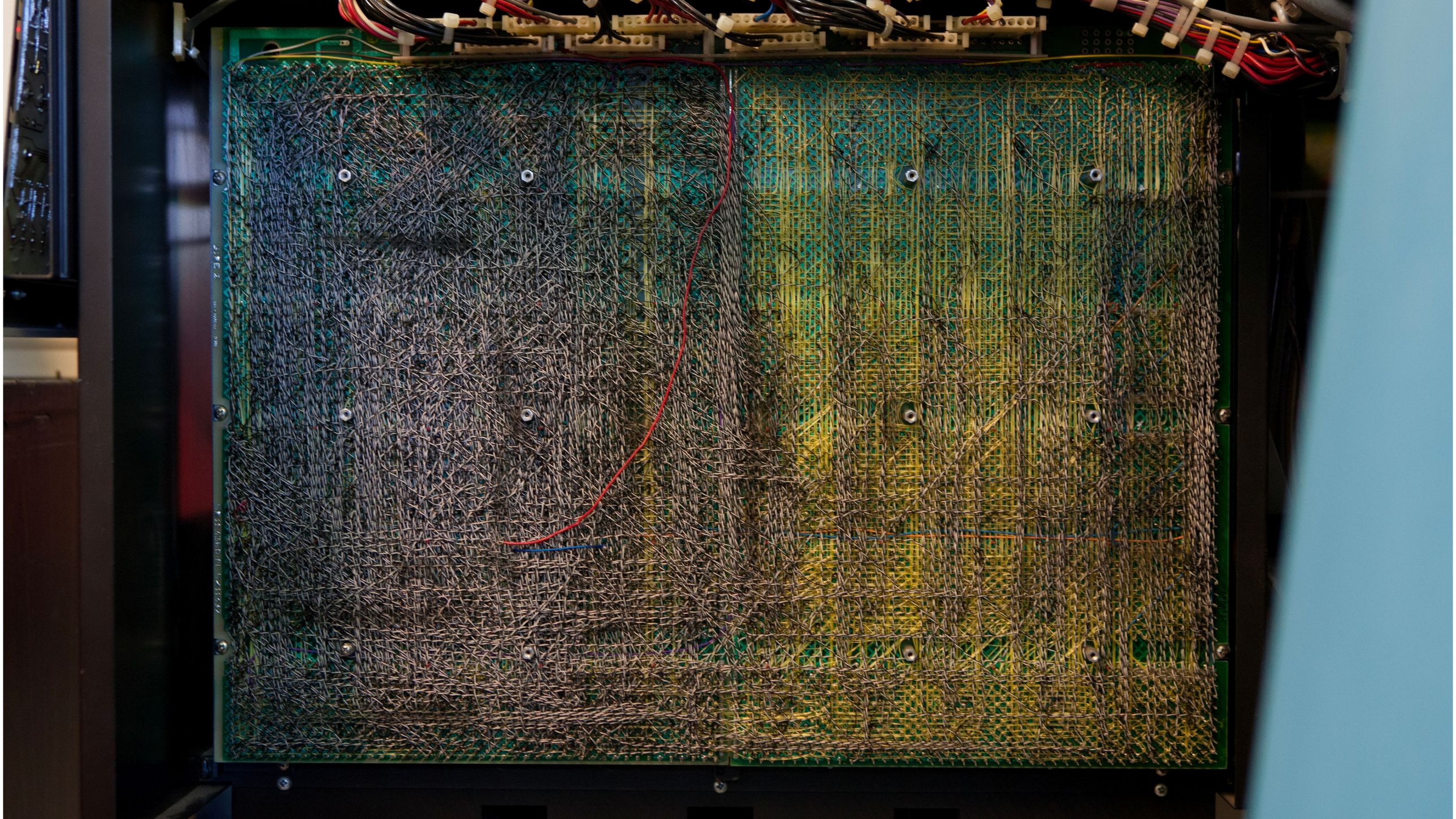
- *point-to-point construction*
- *wire wrapping*







how else to connect things?

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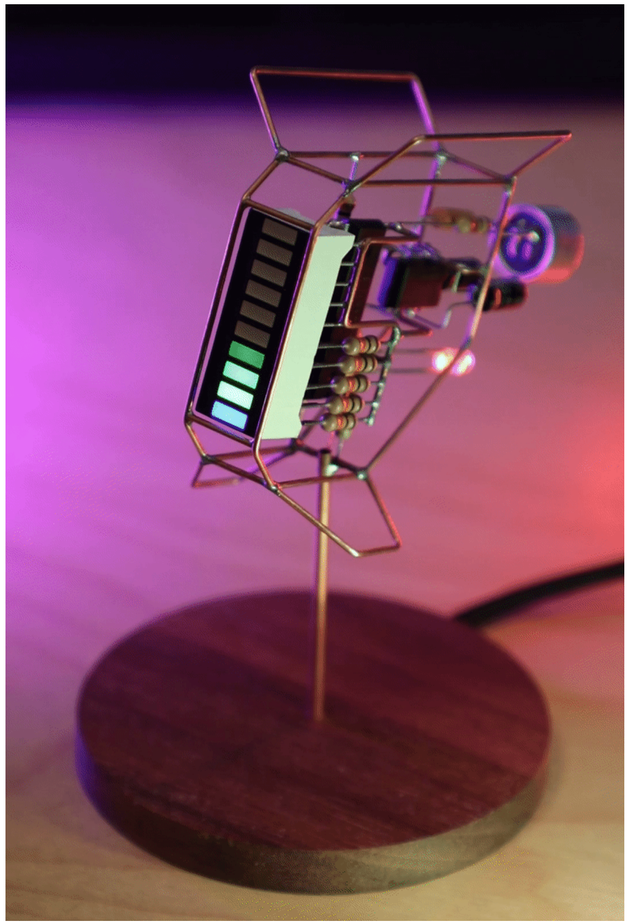

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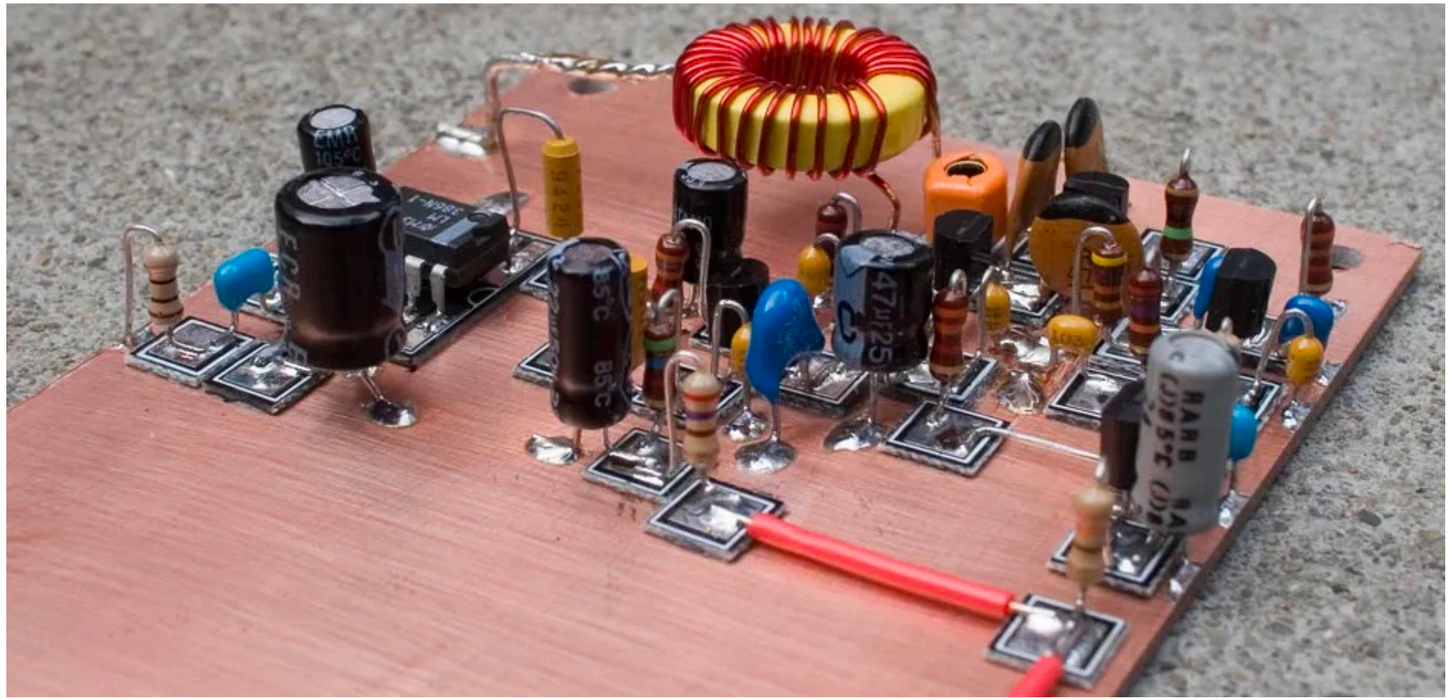

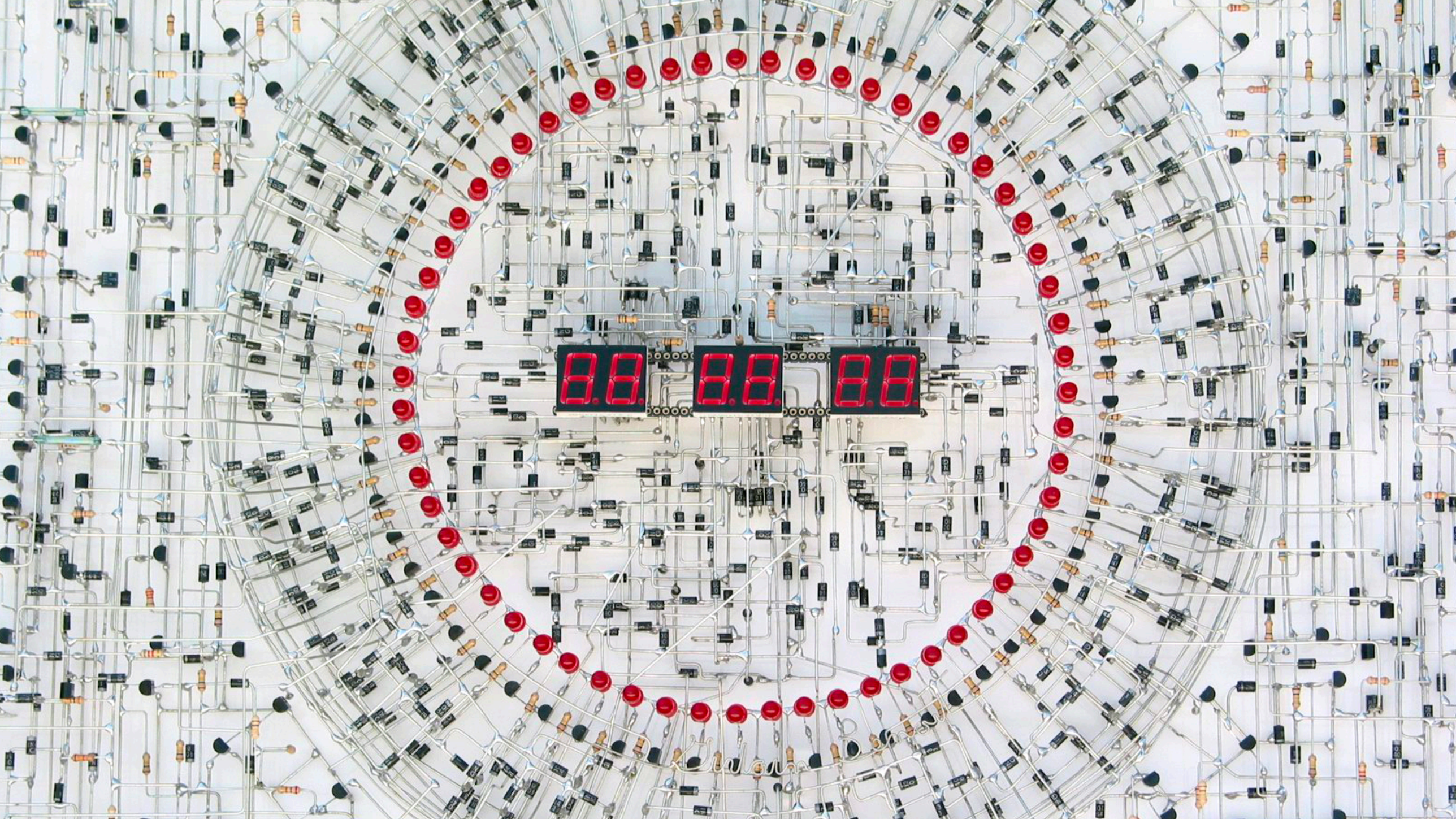

questions?

lecture feedback form is on piazza!