

Open Hardware: Breadboard to PCB

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Open Source Bridge 2014

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Overview

① Oven Controller Project

- Background
- Terminology

② Making Decisions

- Parts, Design Tool, Fab, Assembly

③ PCB Design

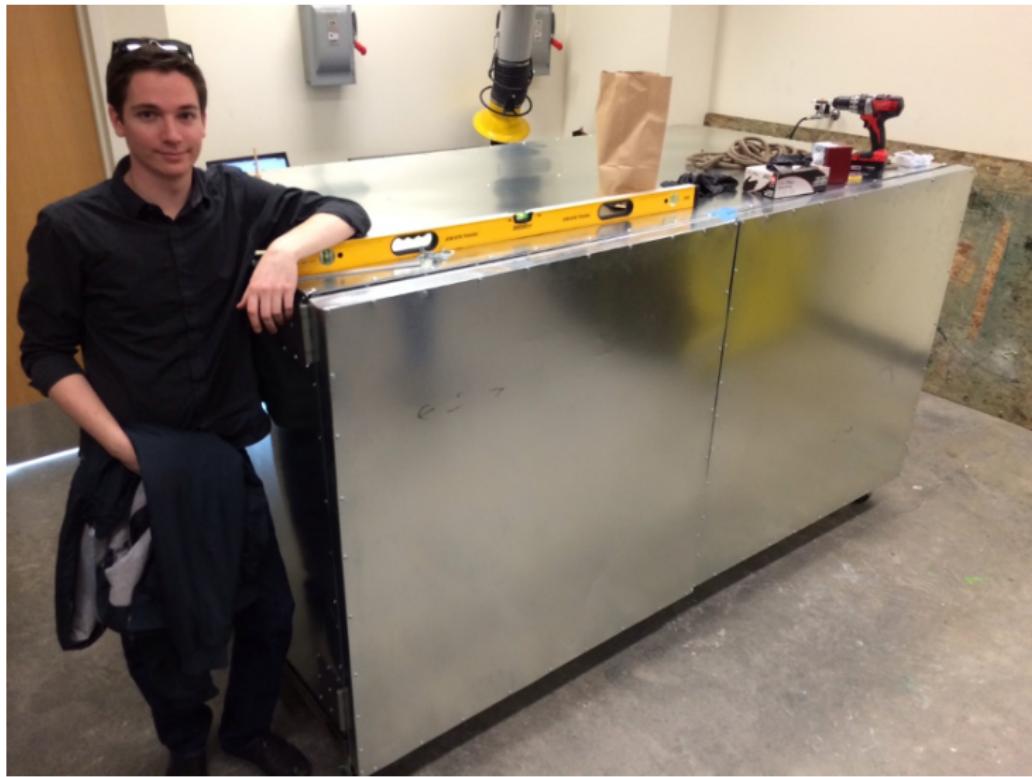
- Through-hole
- Surface-mount

④ Resources

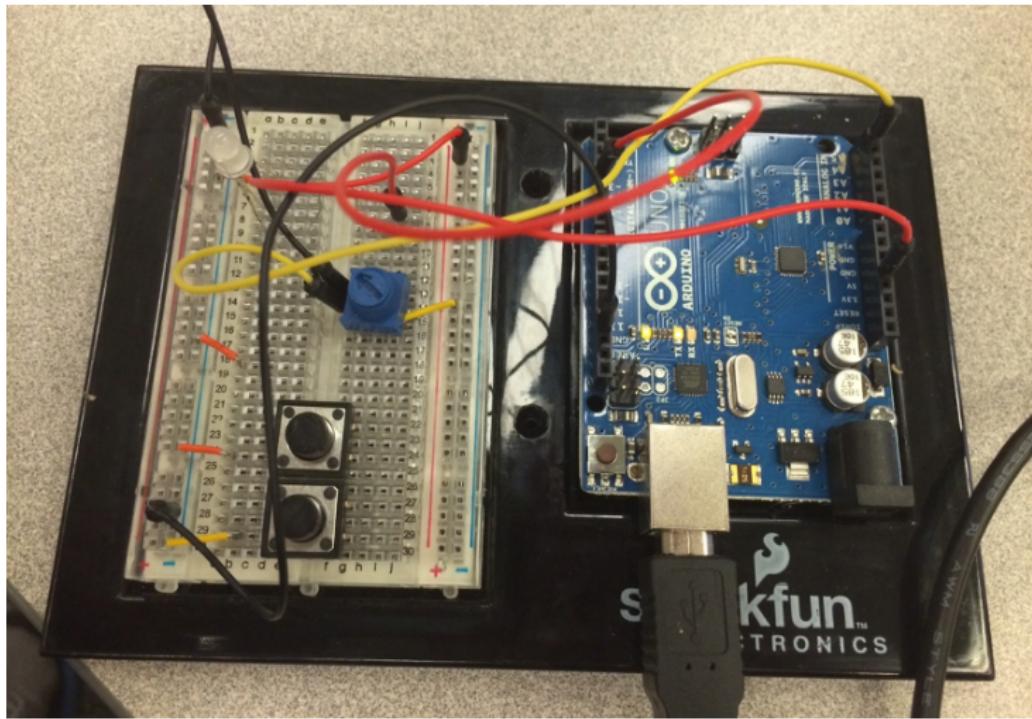
Portland State Aerospace Society



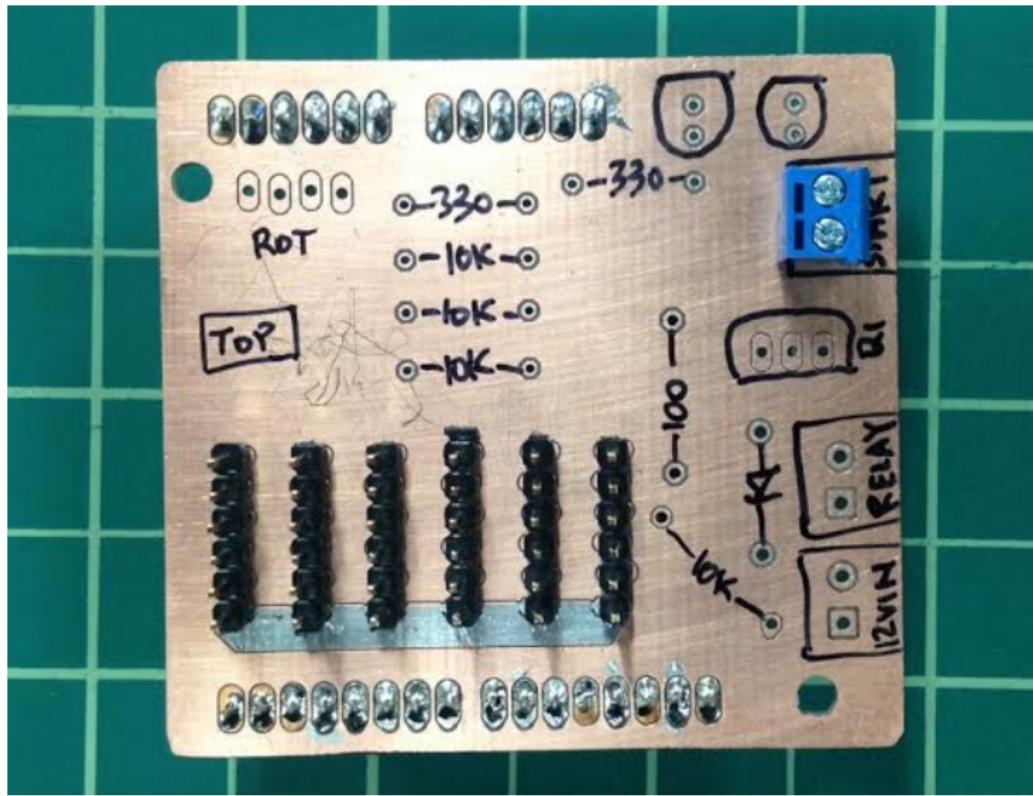
"We built you an oven!"



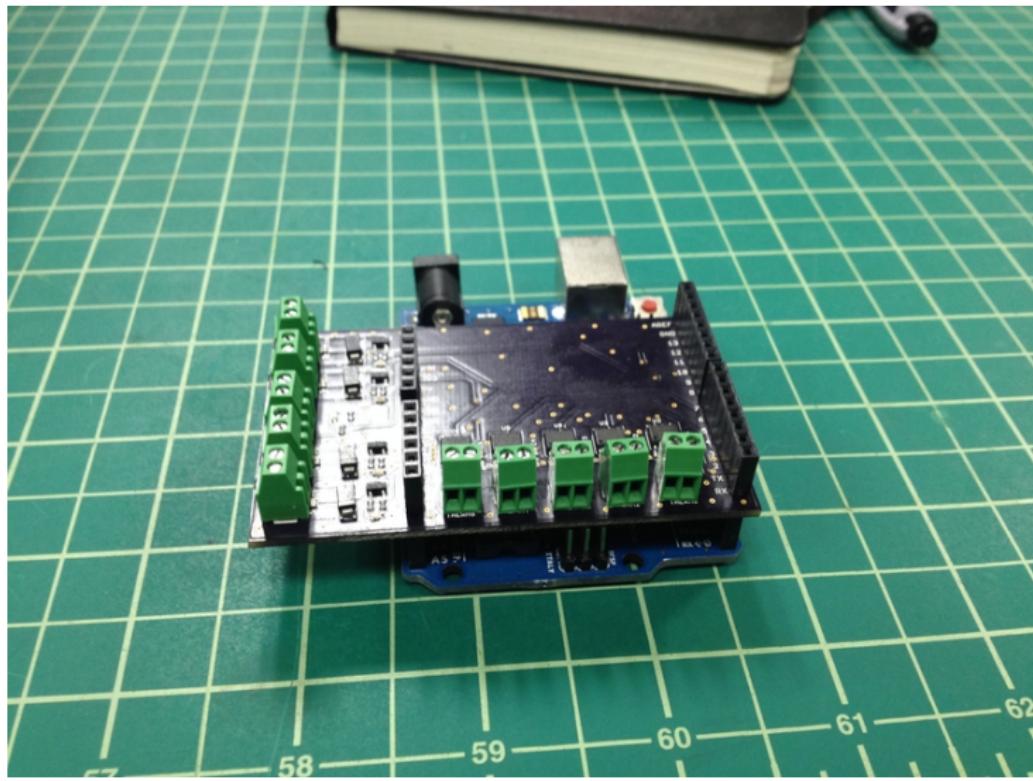
"... here are the electronics!"



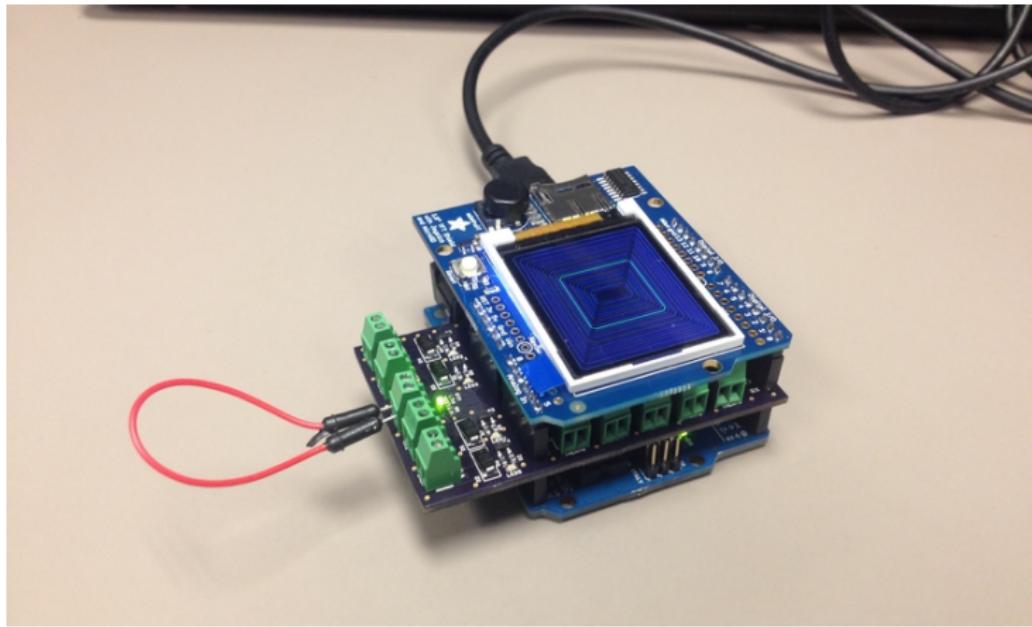
Through-hole Arduino Shield



Surface-mount Arduino Shield

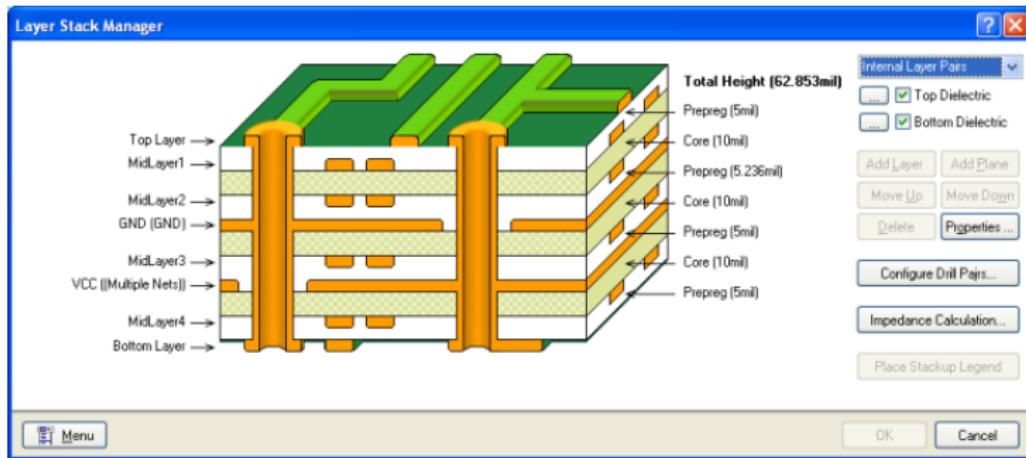


Finished product



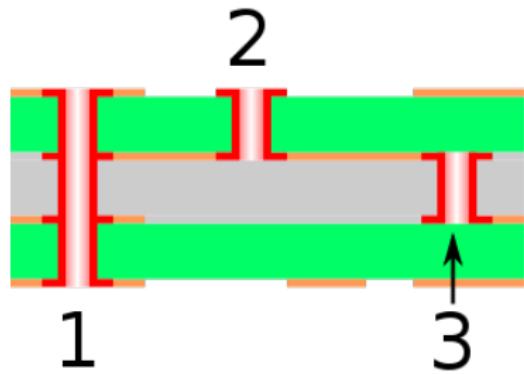
Terminology

Layer Stackup



Vias

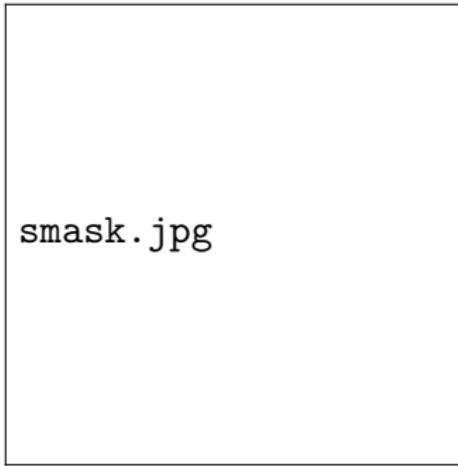
- ① Through-hole
- ② Blind
- ③ Buried



Soldermask



mask.jpg

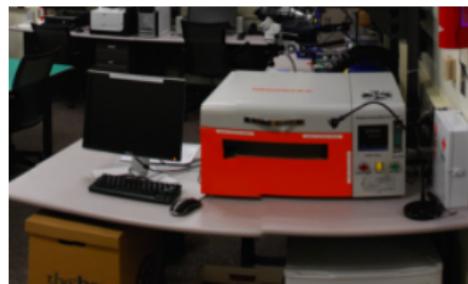


smask.jpg

Reflow

Reflow Profile

- ① Leaded
- ② Non-leaded



Let's make a printed circuit board.

Process

- ① Make decisions
- ② Choose parts
- ③ Draw schematic
- ④ Draw layout
- ⑤ Buy parts
- ⑥ Fab the board
- ⑦ Assemble the board
- ⑧ Test the board

Making Decisions

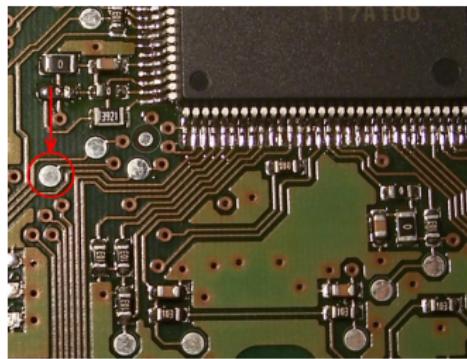
Making Decisions: Parts and Assembly

Through-hole



Solder by hand

Surface-mount

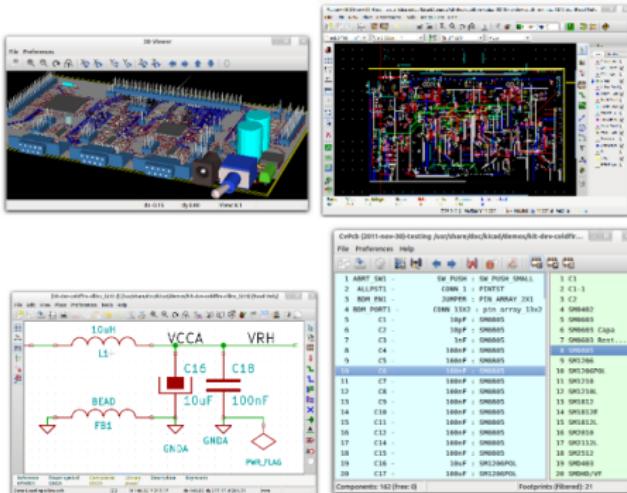


Stencil, Reflow

Making Decisions: Design Tool

- ① Altium
- ② DxDesigner/PADS
- ③ Eagle
- ④ gEDA
- ⑤ KiCad

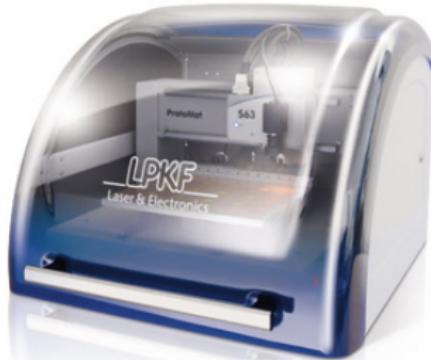
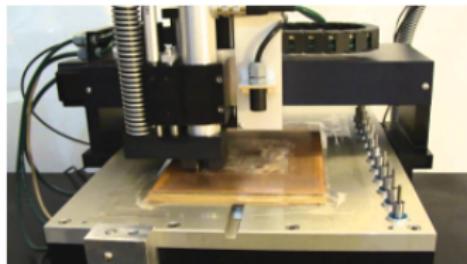
KiCad



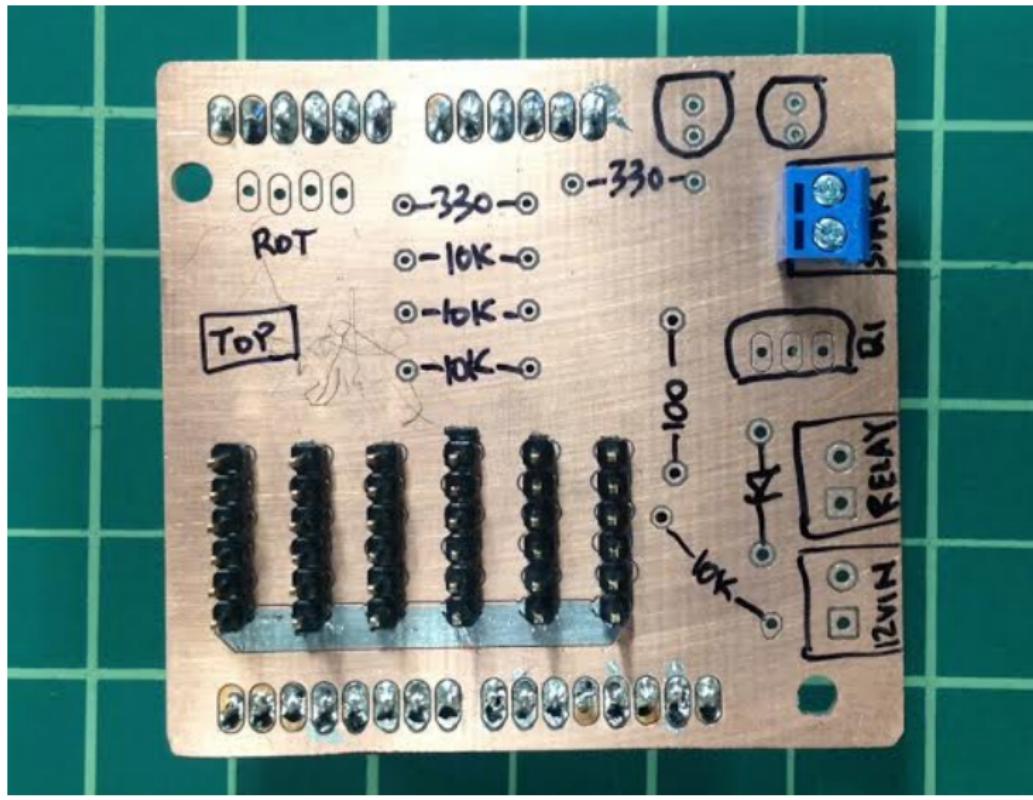
Making Decisions: Fab House



ADVANCED
CIRCUITS



Oven Board v1



v1 Decisions



Through-hole
Solder by hand



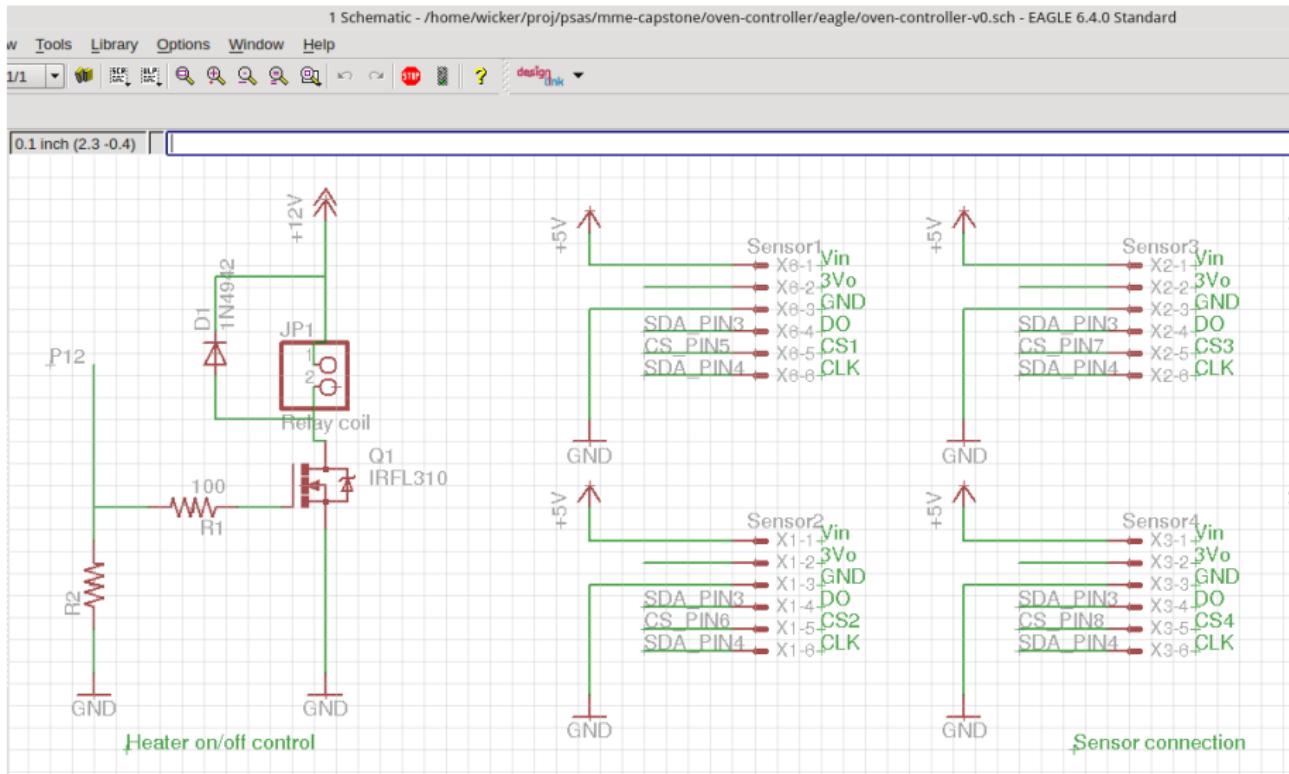
EAGLE®
www.cadsoft.de

● Eagle

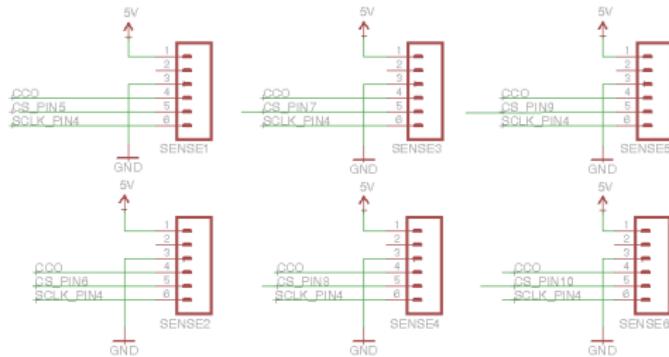
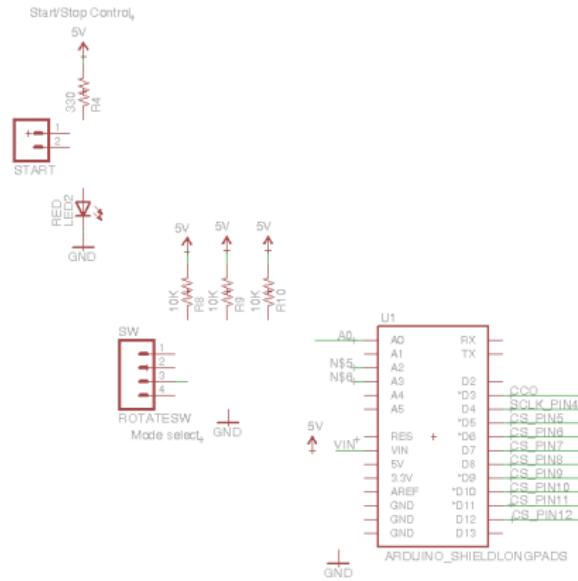


Grid

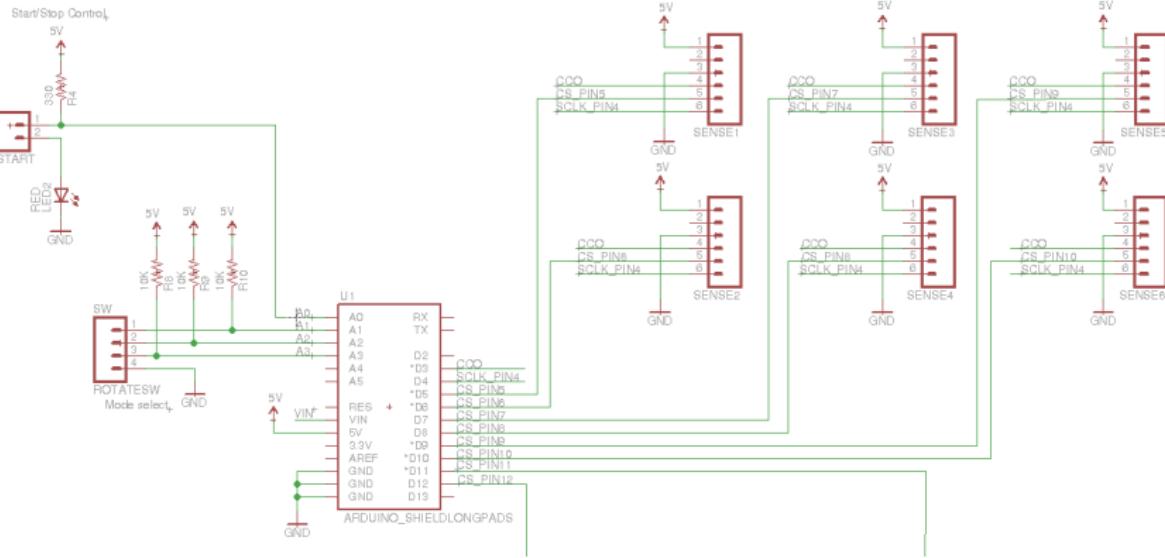
0.1" mils != mm



Place symbols with pins



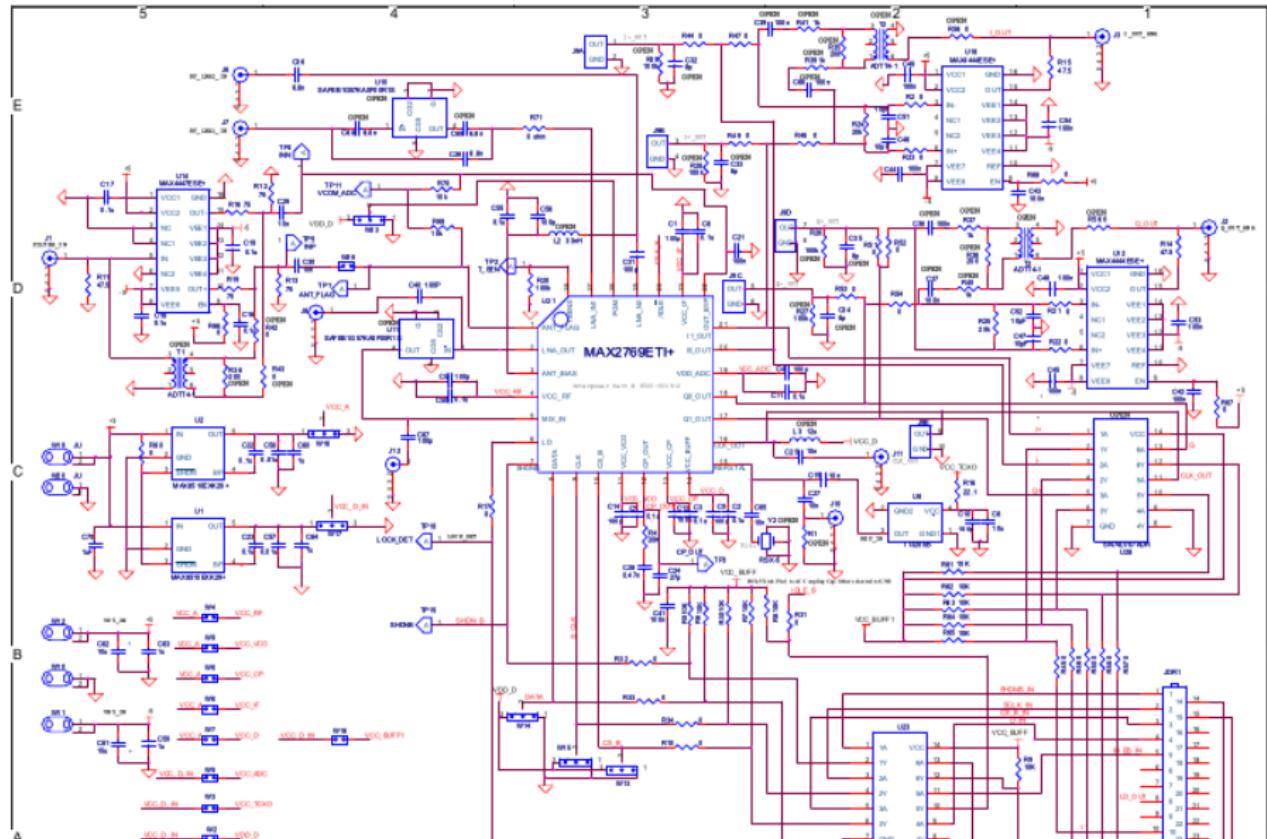
Show connections!



Things to think about

- ① Signal flow left to right
- ② Power and ground
- ③ Symbol layout doesn't have to look like the footprint
- ④ Net names for traceability
- ⑤ Boxes around sections to show options or functionality
- ⑥ Multiple pages for a complicated circuit
- ⑦ Text to give more information - are you the layout person?

Bad Example: MAX2769 Eval Board



Good Example: GPS RF Front-end Board

Okay, now what?

- ① Design Review
- ② Notebook

Land patterns and footprints

Sparkfun headers, trusting libraries

Placing components

Placing Iterating between component and schematic Symbol != footprint

Routing traces

- ① No 90 degrees
- ② trace width (impedance)
- ③ Henry Ott
- ④ Autorouter :(

Gerbers

Get the board back... now what?

- ① Inspect, test with a multimeter
- ② Solder in parts
- ③ Test with a multimeter
- ④ Power it up

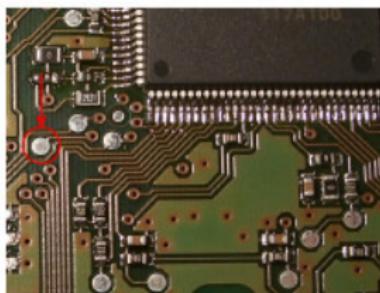


Oven Board v3



v3 Decisions

Surface-mount



Stencil, Reflow



EAGLE
www.cadsoft.de

Eagle



Lots of new parts

Symbols are OK but... datasheets!

Making order carts at Digikey, choosing parts, buying 100 at a time, standard RLC packages, temp coefficients (X7R), component boxes, ESD bags

Update the circuit

The footprint is a lie



Good Layout

Polygons of ground, staple vias to ground, ground and stapled vias around the edges of the board

Silkscreen

Three settings from Eagle. It's not just for assembly, it's also for debug, don't put reference designators under items. Try to align them with the axis.

Soldermask

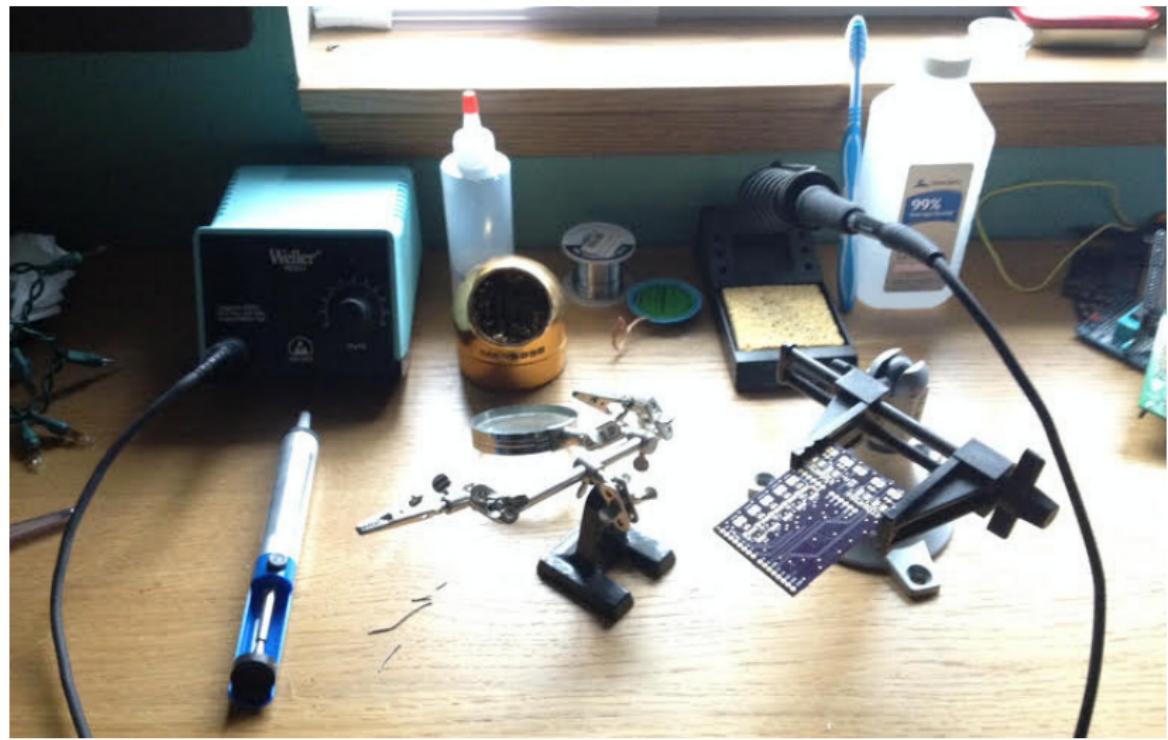
Order parts, then order the board.

Assembly

Surface mount first! Parchment paper stencils. Also Silhouette Portrait cutter. Place stencil on jig. Spread solder paste. Remove stencil. Place parts. Place in oven. Reflow. Test. Then solder the through-hole parts. Harder to remove.

Rework

Wick, flux, solder sucker, vacuum, hot air gun.



Test

And it works!

All the things

- ① Where are the open hardware meetups?
- ② IPC-610-A
- ③ J reflow standard
- ④ Henry Ott's Electromagnetic Compatibility Engineering

The End