Intro PCBs

Jonathan Bachrach

EECS UC Berkeley

September 8, 2016
Last Time

- Introduced Nucleo-L432KC
Going to talk about PCBs and Soldering
- schematic capture
- layout: place and route
Breadboards

- tedious to wire up things but
- easy to swap out components but
- other options are wire wrap etc
- wiring errors and fragile
What is PCB?

- stack of layers: substrate, copper, soldermask, silkscreen
- manufactured at factory
Substrate

- makes up bulk of board
- insulating layer
- typically made of FR-4 fiberglass laminate
- we use FR-1 as non toxic when milled
Copper Layer

- makes electrical connections
- typically thin layer of copper foil bonded on substrate
- etched to the designed pattern

Sean Klaiber
- Pad is copper shape to which component pins are soldered.
- Trace is copper wiring connecting pads.
- Copper pour also used to connect pads – copper filled area.
- Usually copper pour is used as a ground.
Solder Mask

- is a layer of material which solder does not adhere to
- usually applied to entire board except for pads
- prevents solder from flowing onto traces
- soldermask is typically green and gives board its color
- available in other colors

Sean Klaiber
Silkscreen

- is a layer of material for “artwork” such as text and drawings
- usually contains
  - component labels,
  - name of board, and
  - component outlines

Robotroom
Conformal Coating

- has extra protective layer to protect from elements
- usually silicone rubber, polyurethane, acrylic, or epoxy.
- inexpensive
- has copper on only one side
- limited wiring possible
- quality inversely proportional to number of jumper wires
Double Sided Board

- have copper on two sides: top and bottom
- vias or through holes are holes passing through one layer to the next
- often vias are plated so that they can connect copper between top and bottom layers
- extra internal copper layers
- usually have power and ground planes
- more expensive as add layers
Vias

- makes electrical connections
- typically thin layer of copper foil bonded on substrate
- called plated through hole or PTH
- etched to the designed pattern
Components

- through hole – older – wires into holes
- surface mount – newer – tabs to pads
Through Hole Components

- bigger
- mounted using wires and plated holes

by Cyp

by Christian Taube
- smaller
- mounted on one side
- tabs to pads

by Zephyris
Soldering Techniques

- soldering station with flux
- reflow – place surface mount components onto solder paste
- wave soldering – bath of solder
Reflow Soldering

- squeegee solder paste using solder mask
- dispense solder paste through syringe
- majority of components use imperial units for pin spacing
- standard is thousandth of an inch or “mil”
- use mm for mechanical and manufacturing type requirements like hole sizes and board dimensions
Design Rules

Minimum

- trace width
- trace spacing
- drill size
- annular ring diameter

Smart prototyping
keep trace sizes and spaces wider than minimum
width appropriate to current because copper has resistance
use ground plane
on four layer board use ground and power planes
Design Rule Checker – DRC

- check net connectivity
- check that board meets design rules
- CAD tools run this for you
- manufacturers usually run this before submitting jobs

Real time DRC in EasyEDA
- file format for PCB manufacturing data
- board design software should be able to export in this format
- one file per board layer
- each file with 2D vector image
- also need NC Drill file for holes (in excellon file format)
high volume
- silkscreen
- photoengraving

small volume
- photomask and etch
- laser resist ablation
- pcb milling

hobbyist
- laser-printed resist
- vinyl film and resist
Panelization

- multiple boards on single panel
- used to reduce manufacturing time and cost
- broken into separate boards called depaneling
- some manufacturers will score between panels

by Brian Benchoff
Advanced Circuits 4pcb.com: have special student offer $33 each

Seeed Studios in China: $9.90 + shipping for 10 copies of 5cm x 5cm board
History of PCBs

- Invented in 1903 by Albert Hanson
- Thomas Edison played with conductors on linen
- Etching process patented by Arthur Berry in 1913
- Paul Eisler invented modern PCB in 1936
limited conductivity

**Additive Manufacturing**

Voltera
Printed Electronics

- limited components
3D Printing Circuits – Voxel8
Logistics

- Find Partners
  - 2 for labs
  - up to 3 for projects

- Lab2 section
  - tomorrow 4-5p Jacobs 220
  - no section this Monday

- Lab2 gear
  - Borrow nucleos: buy later, bring more tomorrow
  - Need breadboards and wires + microUSB cable

- Sign up for Othermill training
  - three slots between now and next Thursday
  - Alternative slots: Fri 2-3:30p, Tue 5:30-7p, Wed 1-2:30p
Next Time

- Milling boards
- Assembly and soldering
- Learn Eagle: https://learn.sparkfun.com/tutorials/using-eagle-board-schematic
  and https://learn.sparkfun.com/tutorials/using-eagle-board-layout

- Printed Circuit Boards on Wikipedia: https://en.wikipedia.org/wiki/Printed_circuit_board


- EE4: Circuit Board Design by Ducky Lin for CalSol team