Intro PCBs

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EECS UC Berkeley

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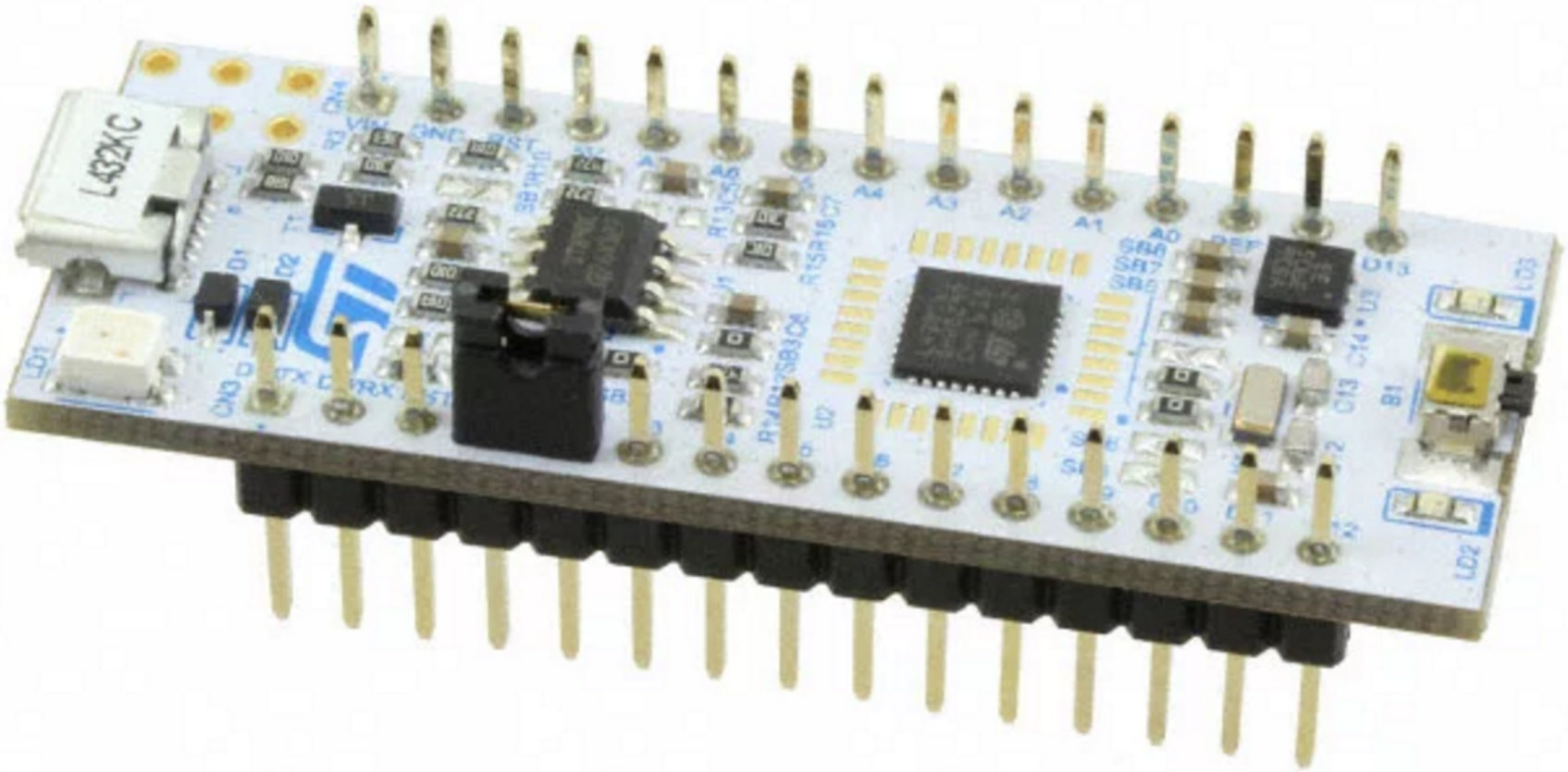
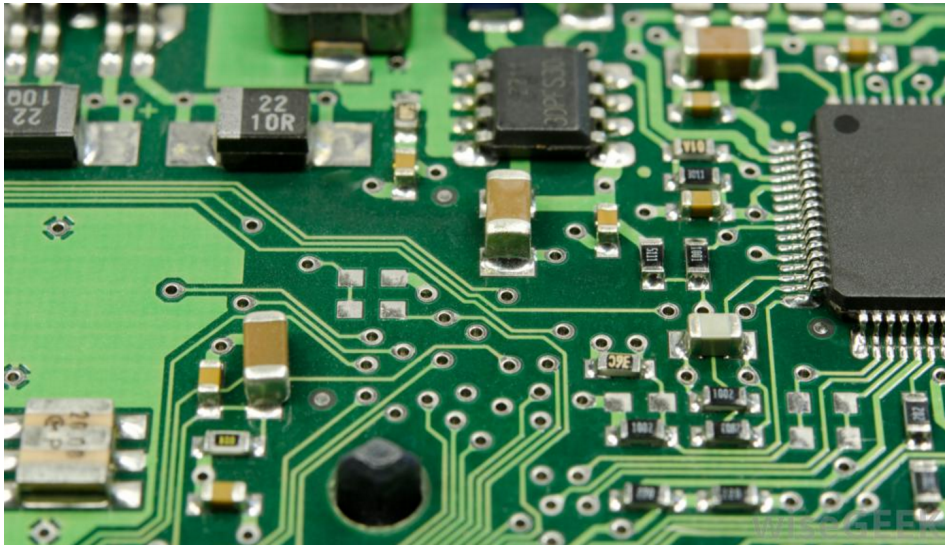
Last Time

- Introduced Nucleo-L432KC



Today

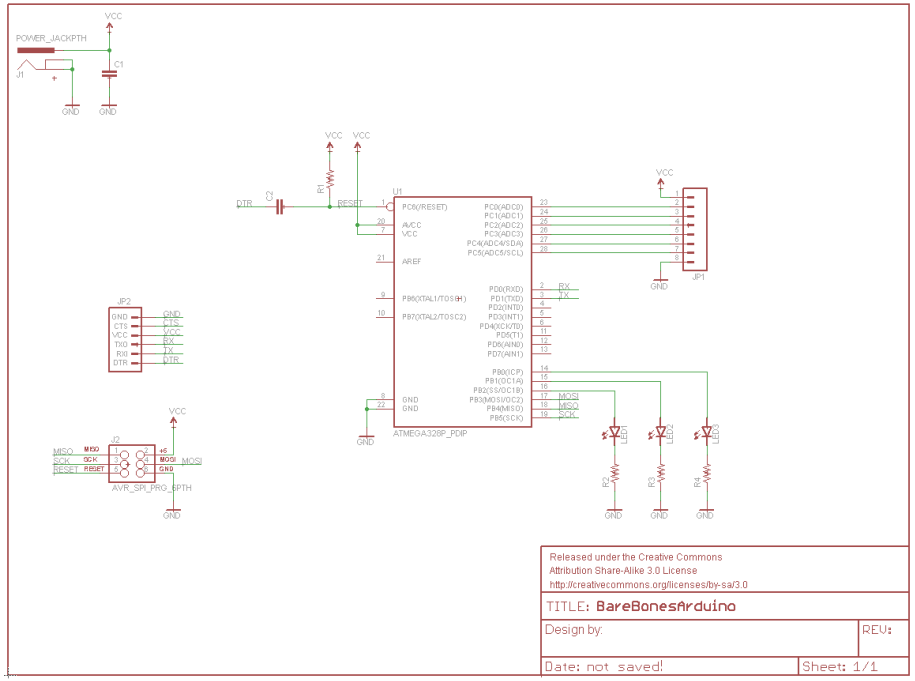
- Going to talk about PCBs and Soldering



wisegeek

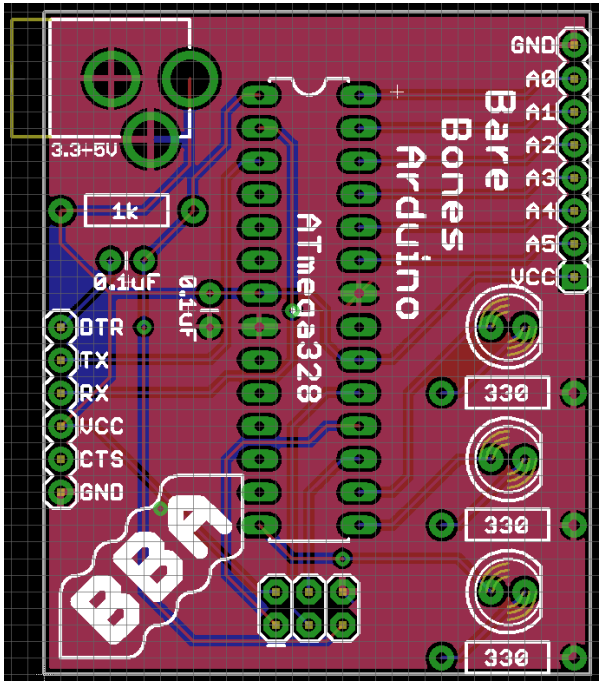
Traditional PCB CAD Design

- schematic capture
- layout: place and route



schematic

sparkfun

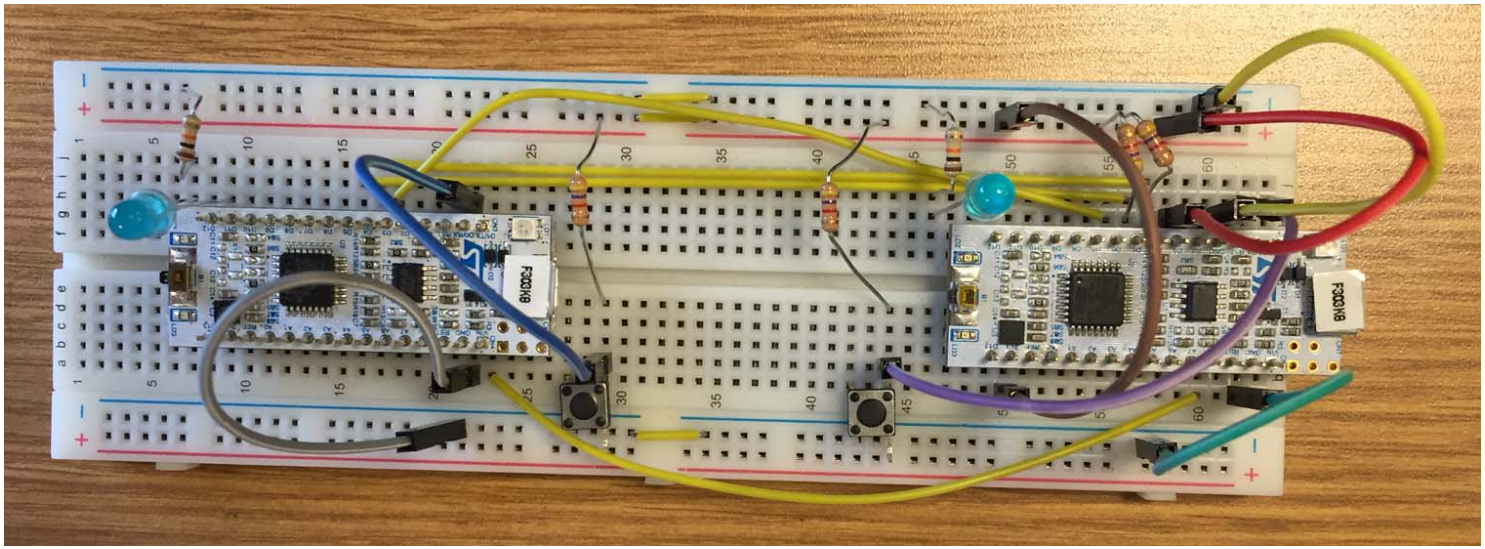


layout

eagle

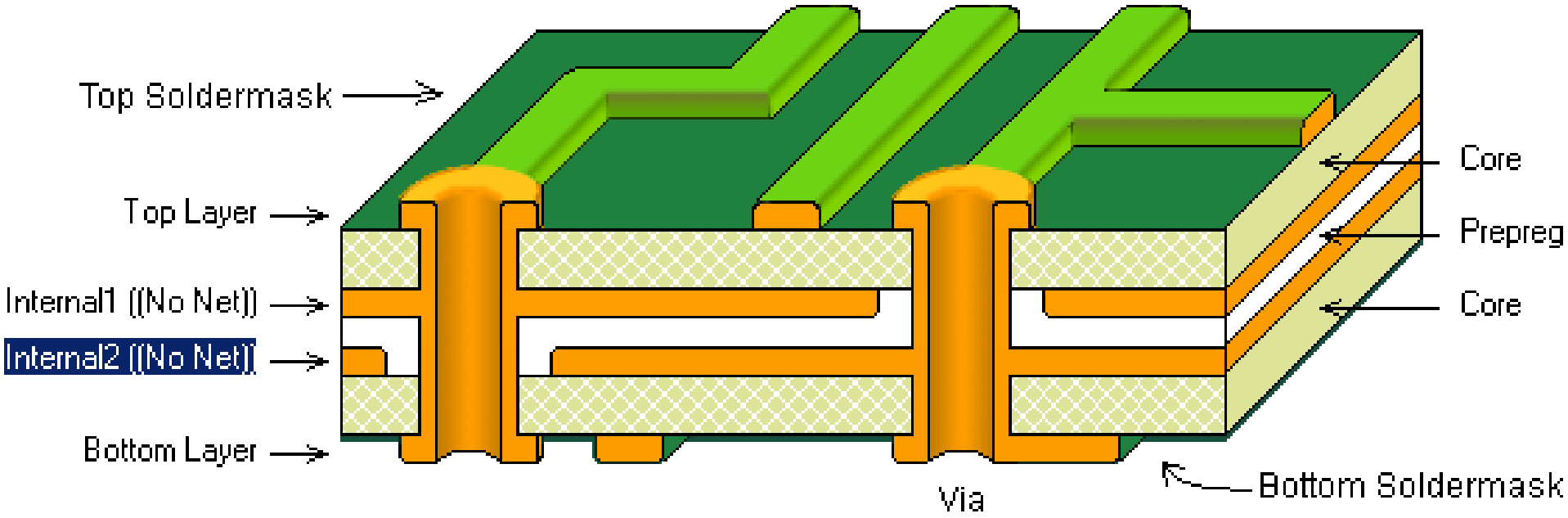
Breadboards

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



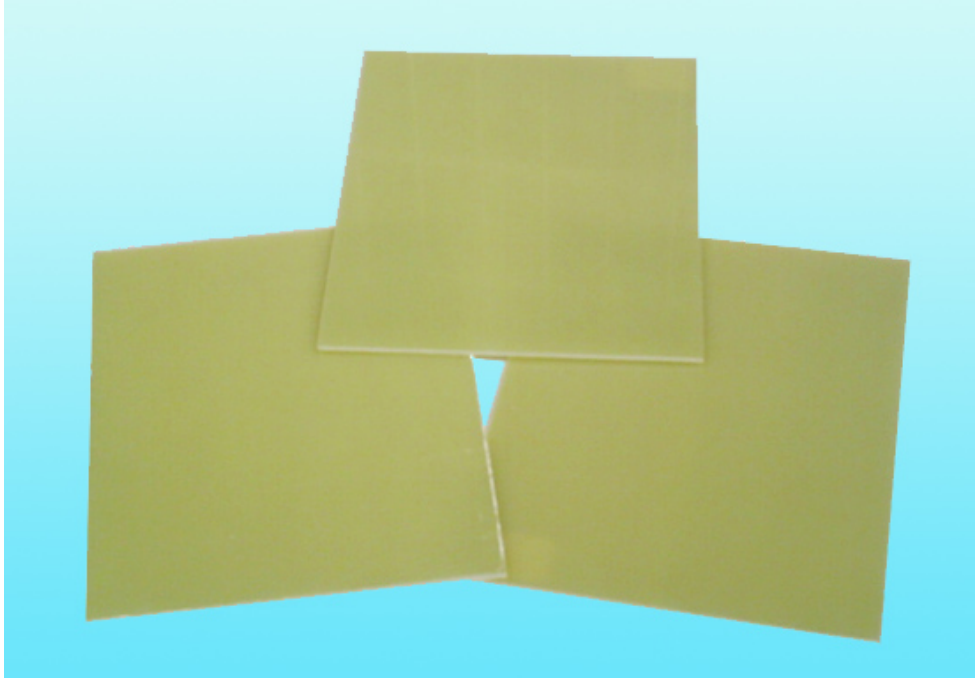
What is PCB?

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



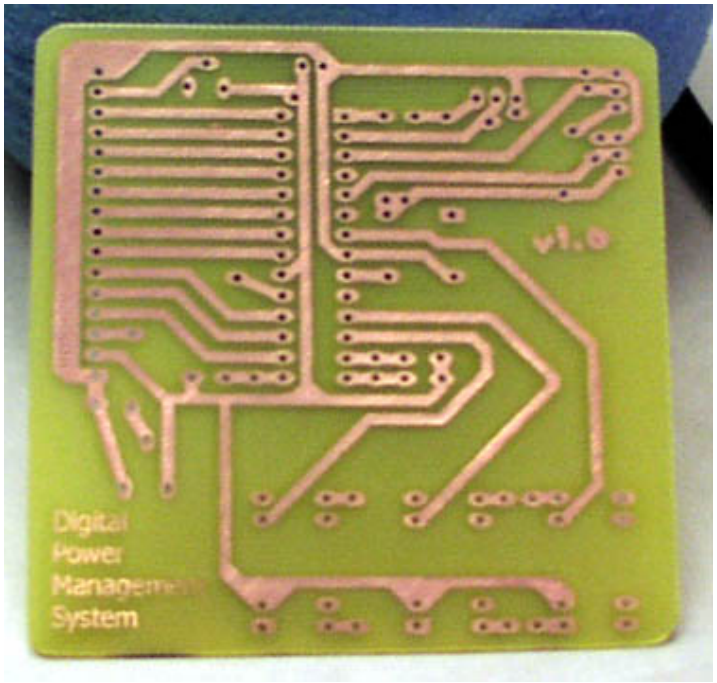
Substrate

- 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

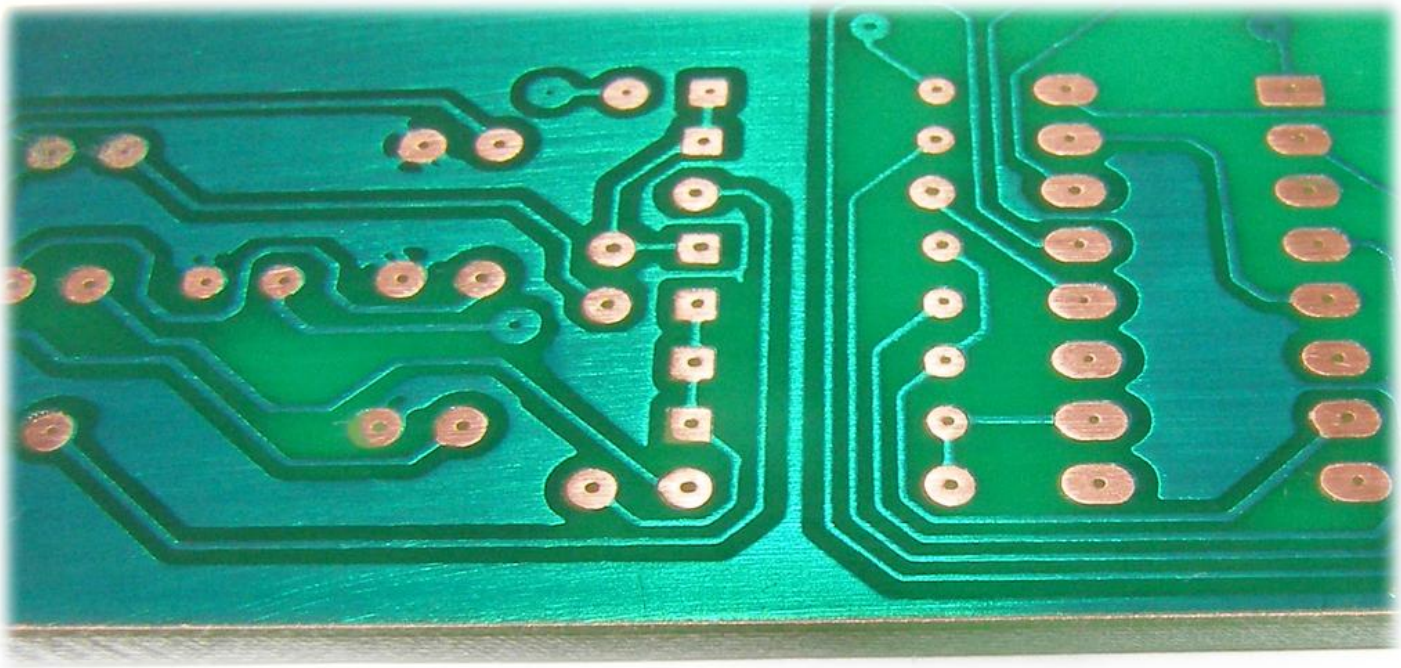
- makes electrical connections
- typically thin layer of copper foil bonded on substrate
- etched to the designed pattern



Sean Klaiber

Copper Layer Features

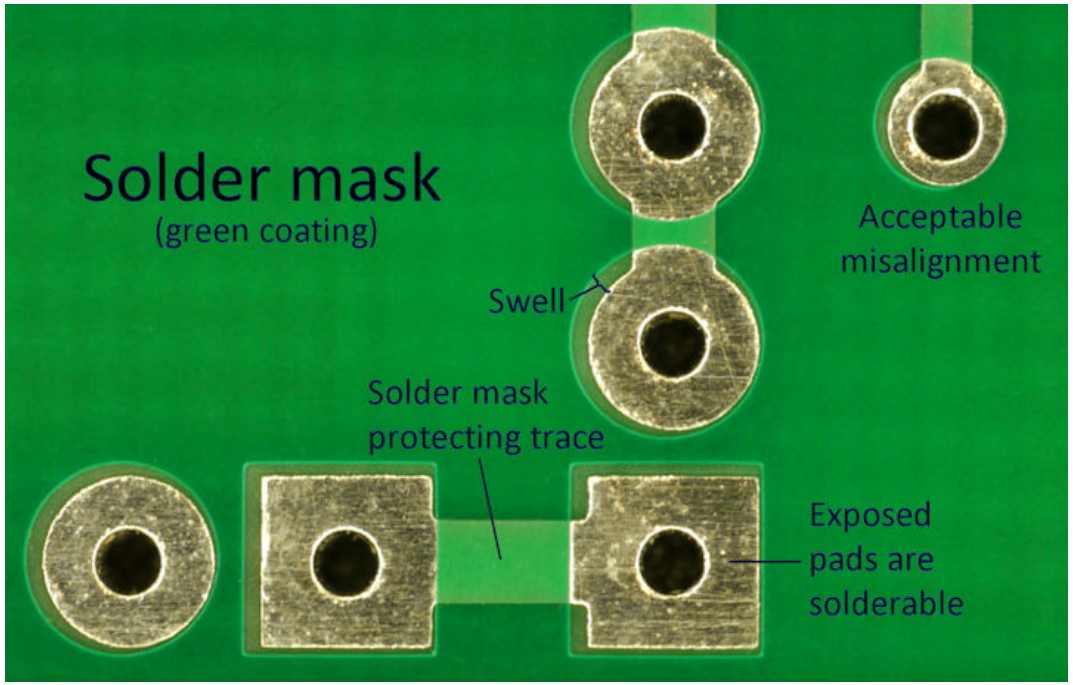
- pad is copper shape to which componet pins are soldered
- trace is copper wiring connecting pads
- copper pour also used to connect pads – copper filled area
- usually copper pour is used as a ground



Robin Mitchell

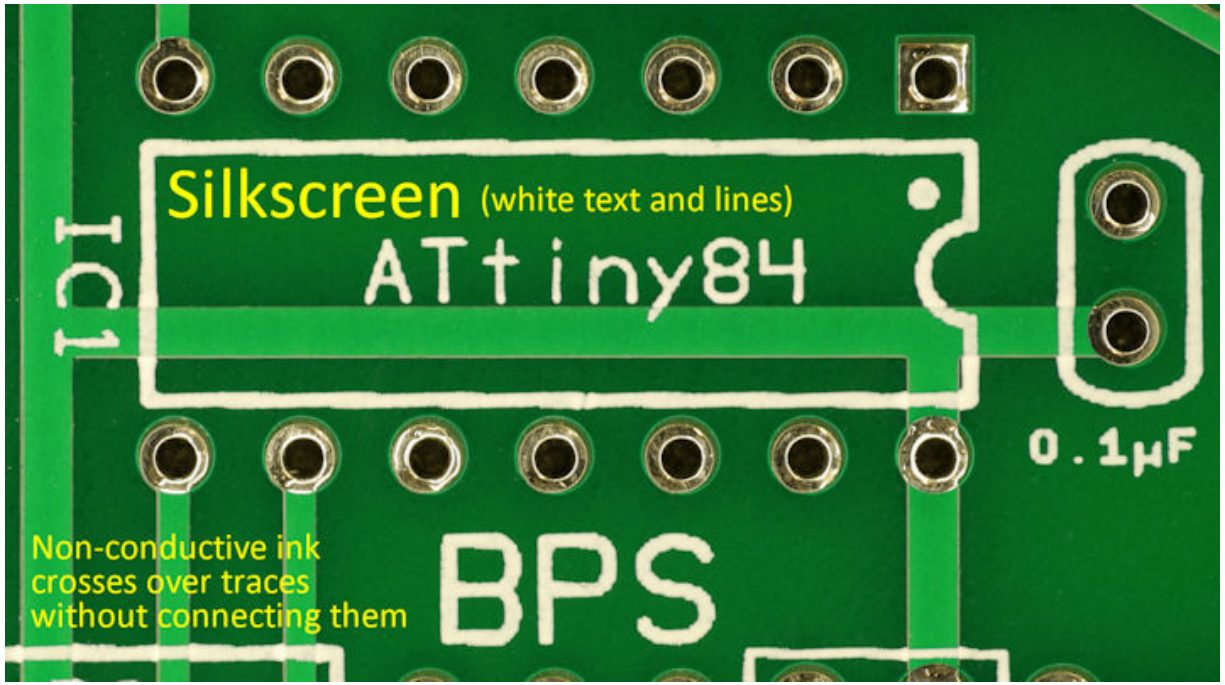
Solder Mask

- 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



Silkscreen

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



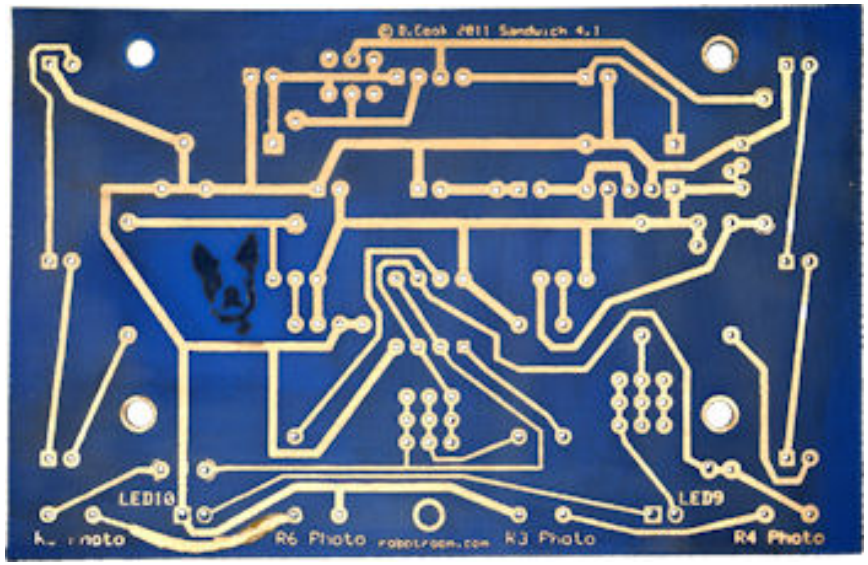
Robotroom

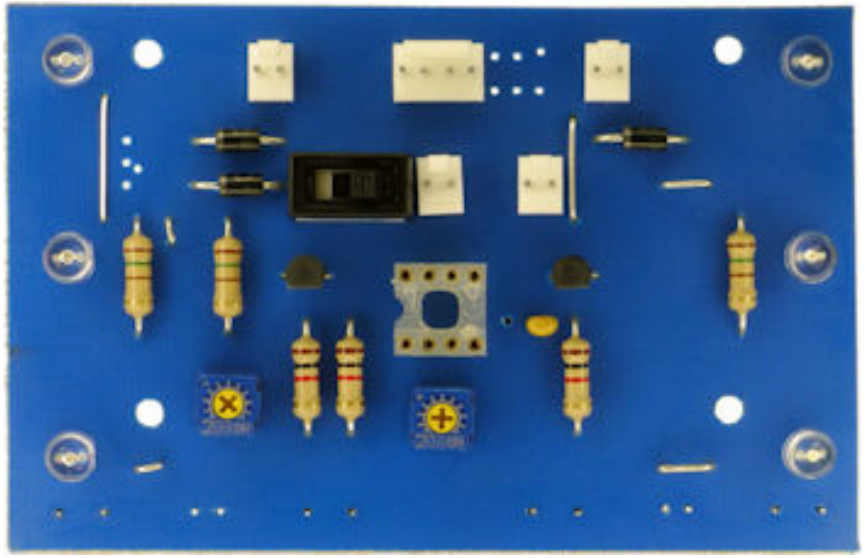
Conformal Coating

- has extra protective layer to protect from elements
- usually silicone rubber, polyurethane, acrylic, or epoxy.

Single Sided Board

- inexpensive
- has copper on only one side
- limited wiring possible
- quality inversely proportional to number of jumper wires





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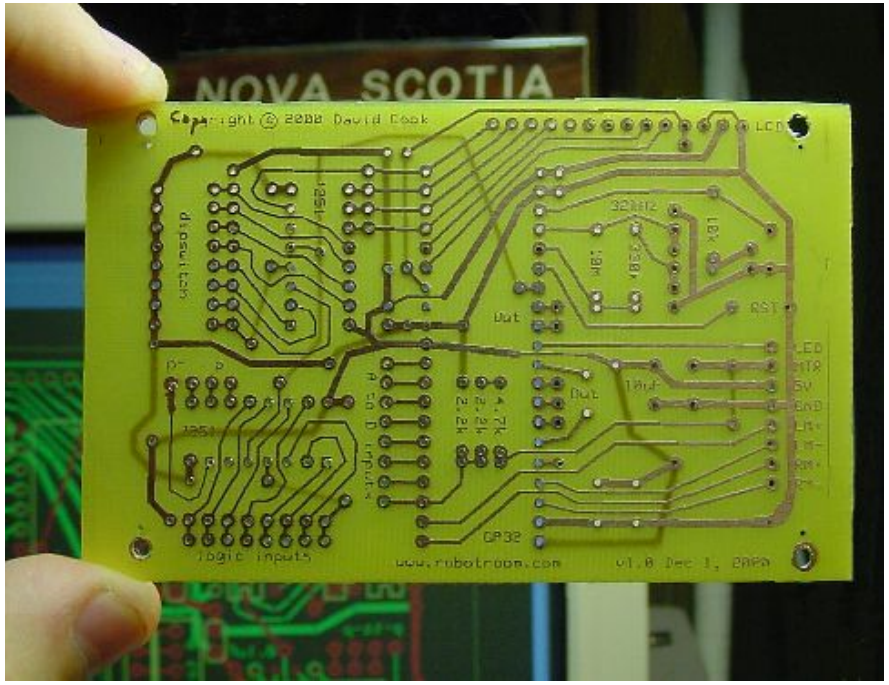
Double Sided Board

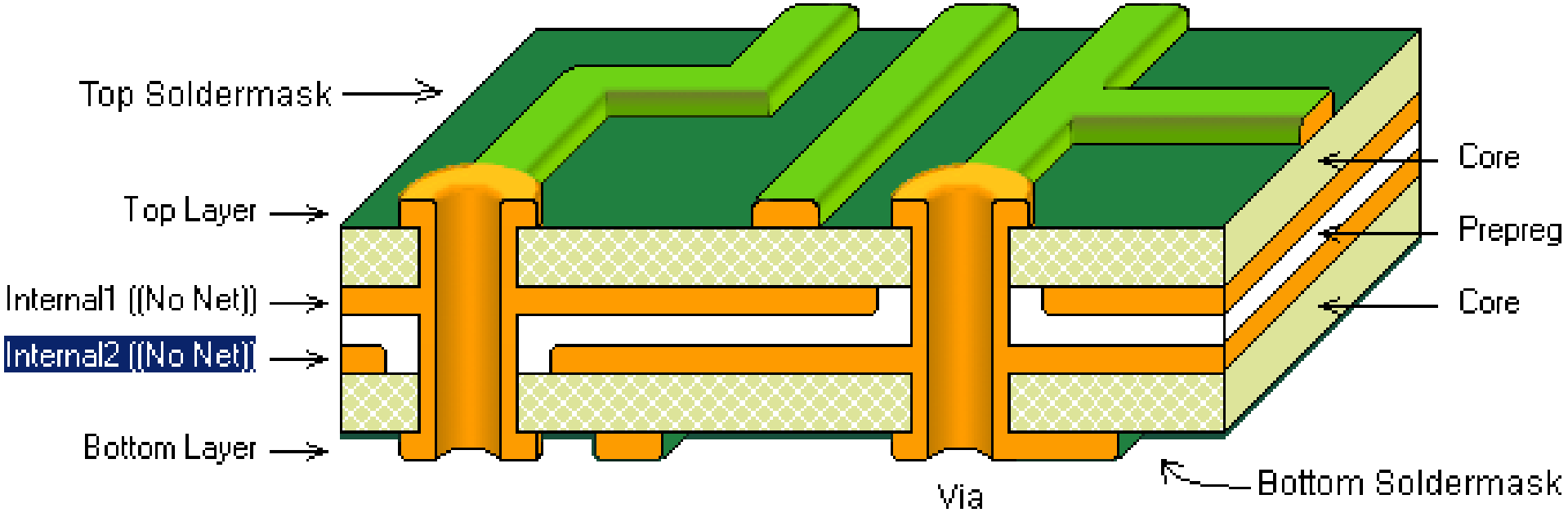
- have copper on two sides: top and bottom
- vias or through holes are holes passing through one layer to the next
- often vias are plated so that they can connect copper between top and bottom layers



RobotRoom

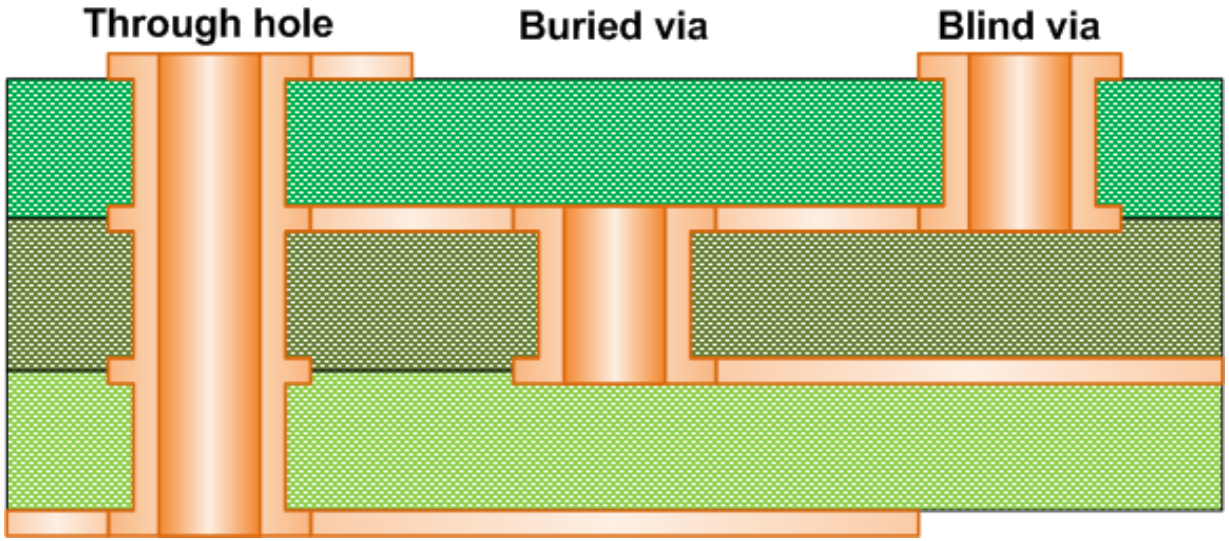
Multiple Layer Board

- 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

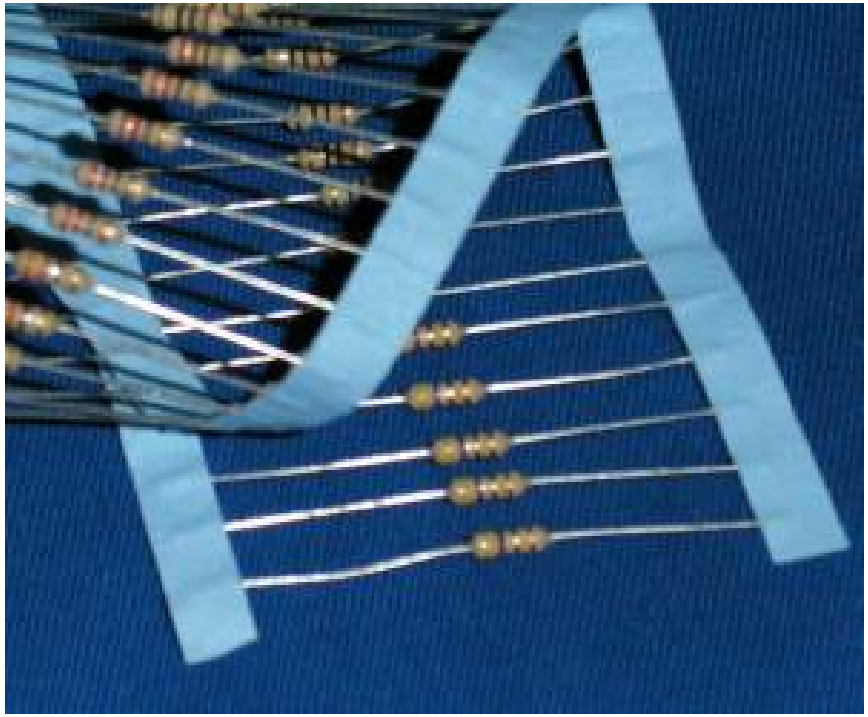


Components

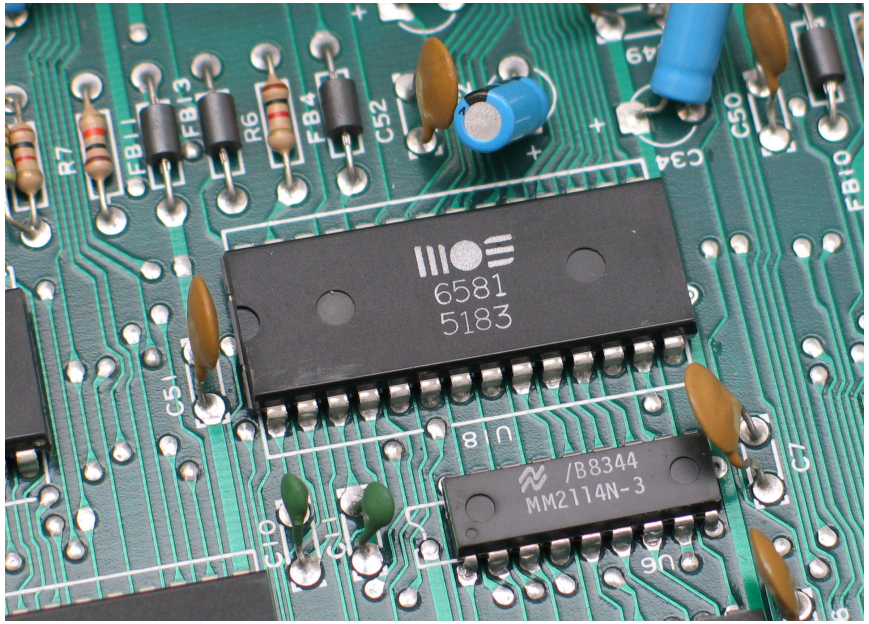
- through hole – older – wires into holes
- surface mount – newer – tabs to pads

Through Hole Components

- bigger
- mounted using wires and plated holes



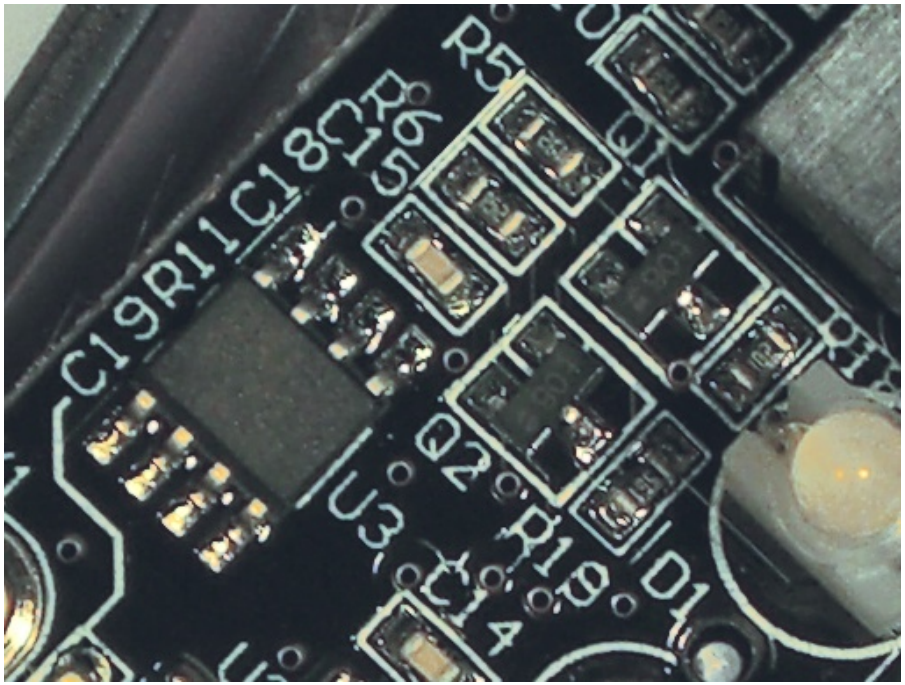
by Cyp



by Christian Taube

Surface Mount Components

- smaller
- mounted on one side
- tabs to pads



by Zephyris

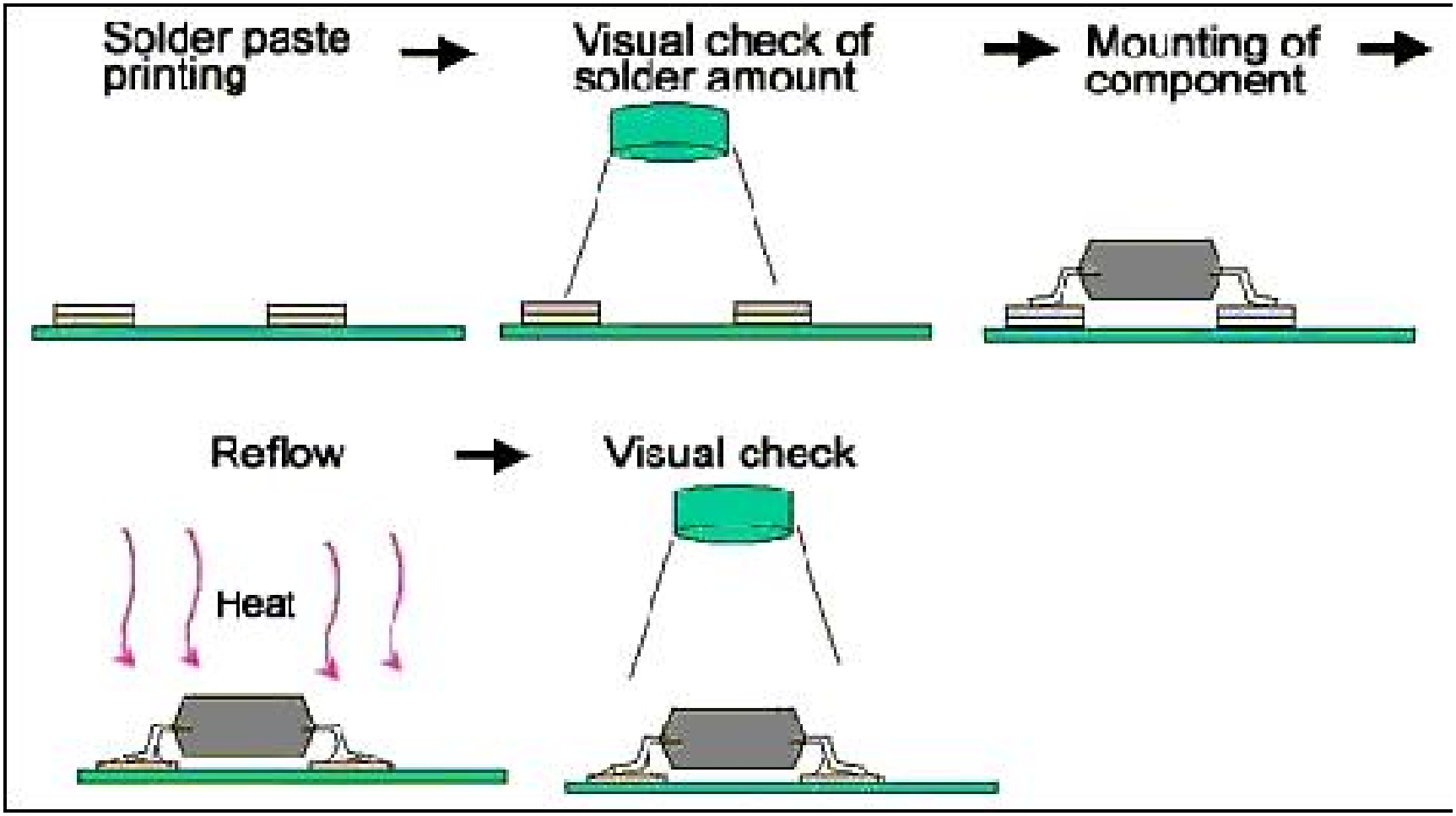
Soldering Techniques

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

instructables

Reflow Soldering

- squeegee solder paste using solder mask
- dispense solder paste through syringe



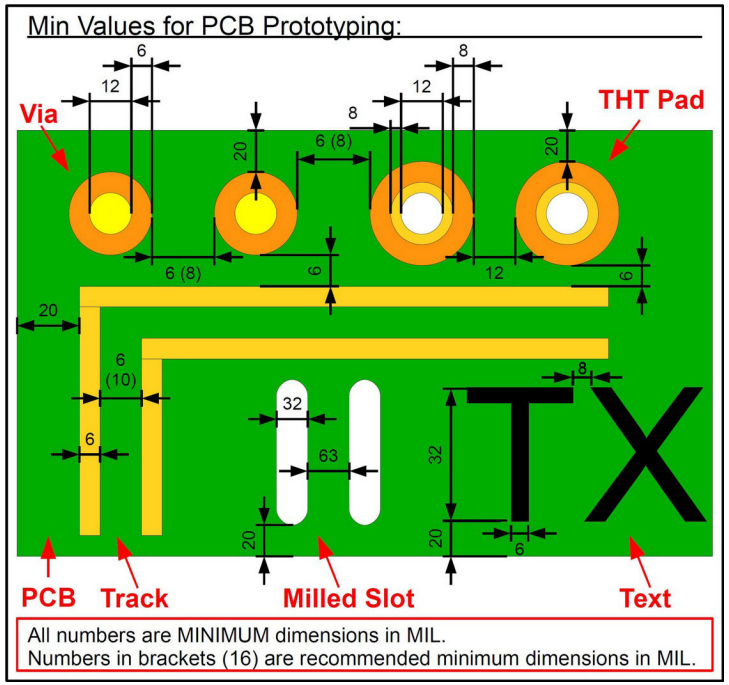
Units

- 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



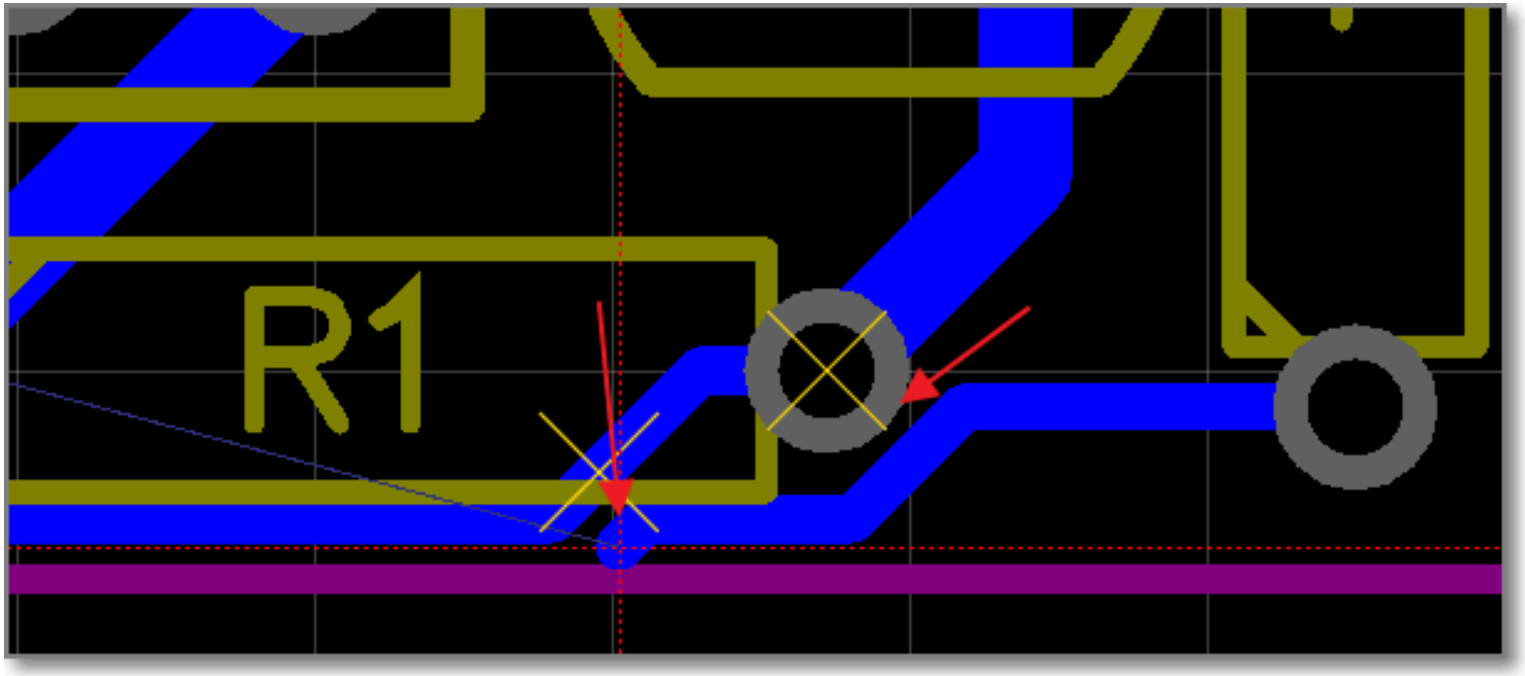
Smart prototyping

Practical Concerns

- 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

Gerbers

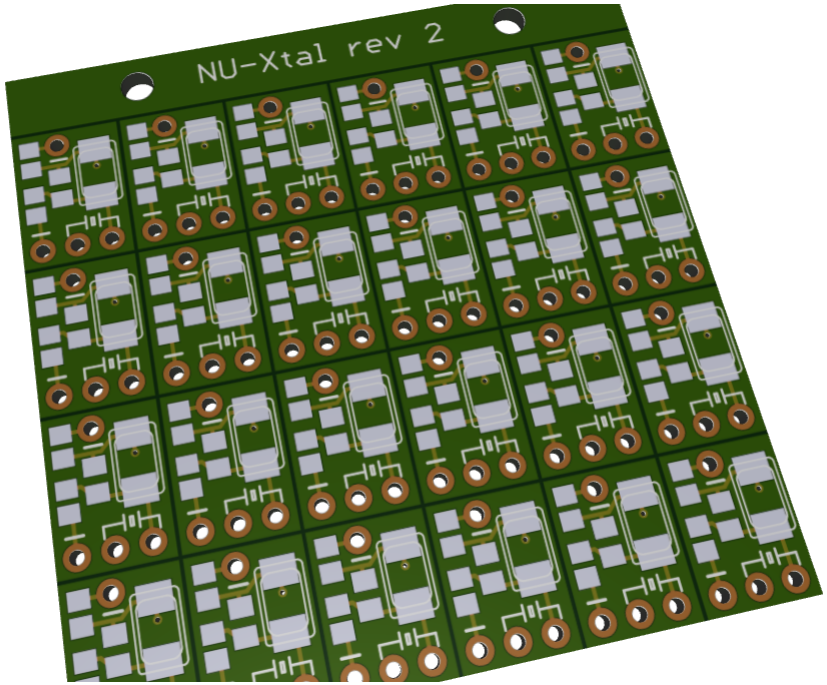
- file format for PCB manufacturing data
- board design software should be able to export in this format
- one file per board layer
- each file with 2D vector image
- also need NC Drill file for holes (in excellon file format)

Manufacturing

- 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 reduces manufacturing time and cost
- broken into separate boards called depaneling
- some manufacturers will score between panels



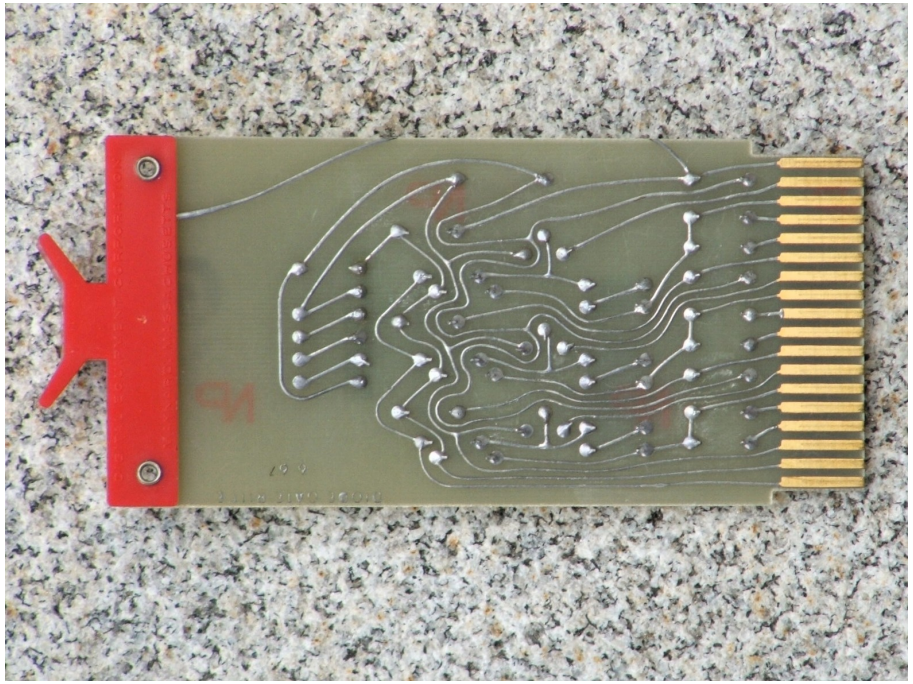
by Brian Benchoff

PCB Manufacturers

- Advanced Circuits `4pcb.com`: have special student offer $33 each
- Seeed Studios in China: $9.90 + shippingfor 10 copies of 5cm x 5cm board

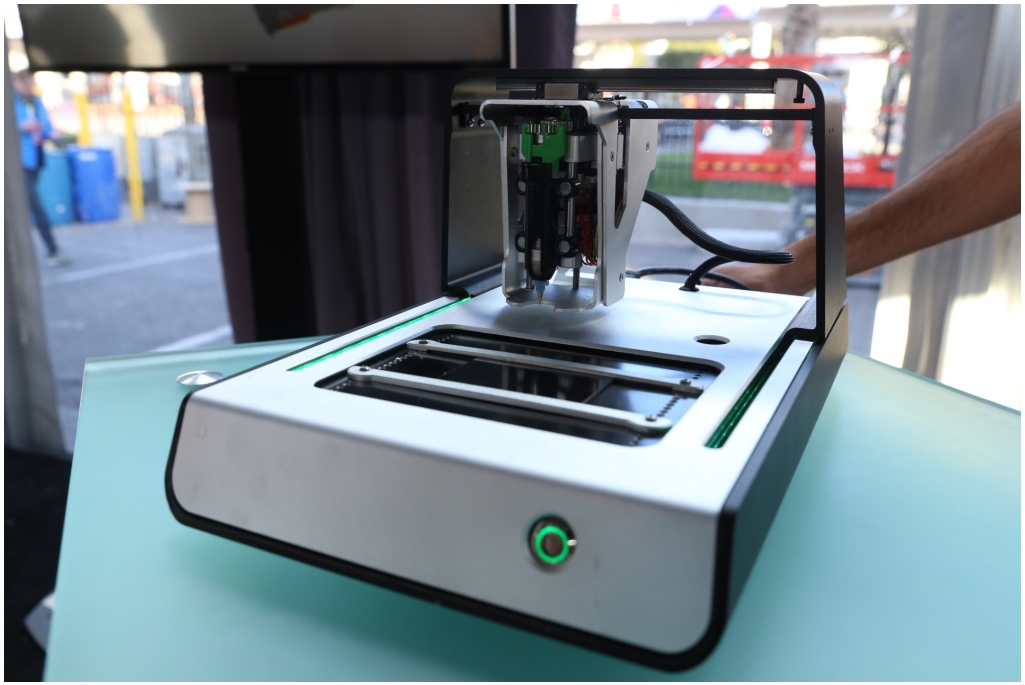
History of PCBs

- 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



Douglas Jones

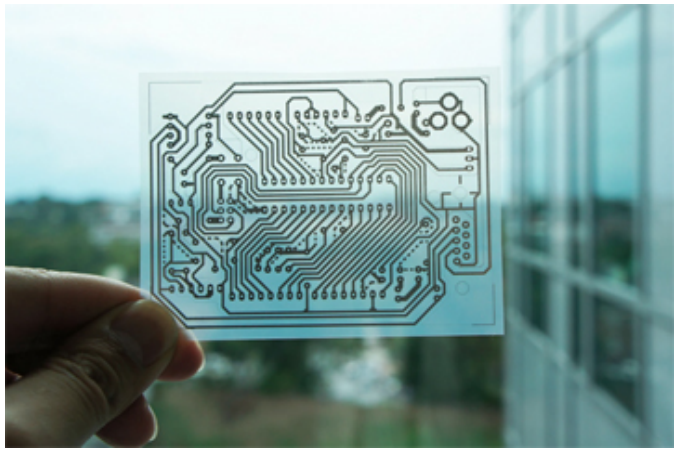
- limited conductivity



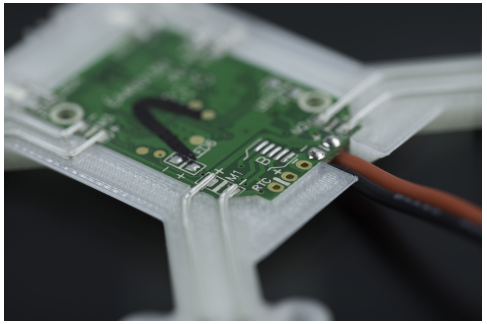
Voltera

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

References

- 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
- RobotRoom Articles: www.robotroom.com/PCB1.html, www.robotroom.com/PCB2.html, www.robotroom.com/PCB3.html
- AlternateZone PCB Tutorial: http://alternatezone.com/electronics/files/PCBDesignTutorialRevA.pdf
- EE4: Circuit Board Design by Ducky Lin for CalSol team