

Digital Logic Design

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Prototype Implementation Techniques

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Why prototyping?

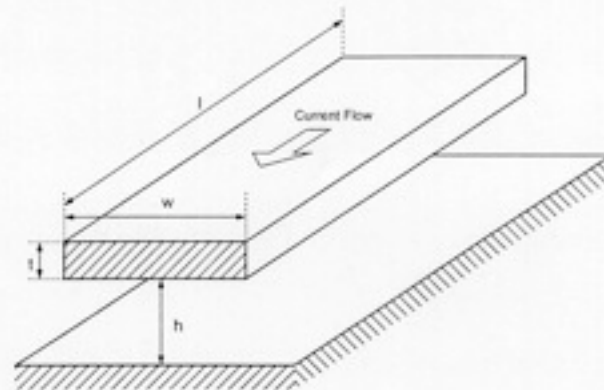
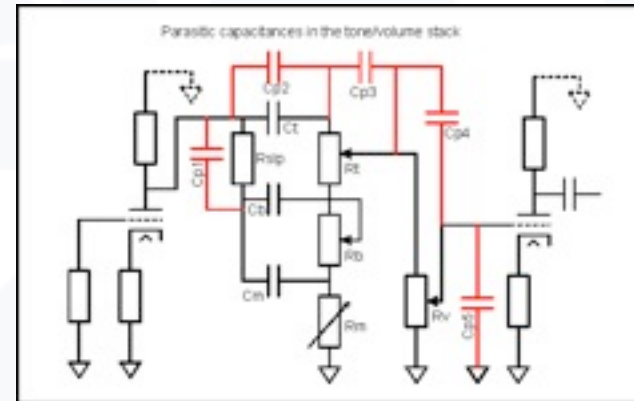
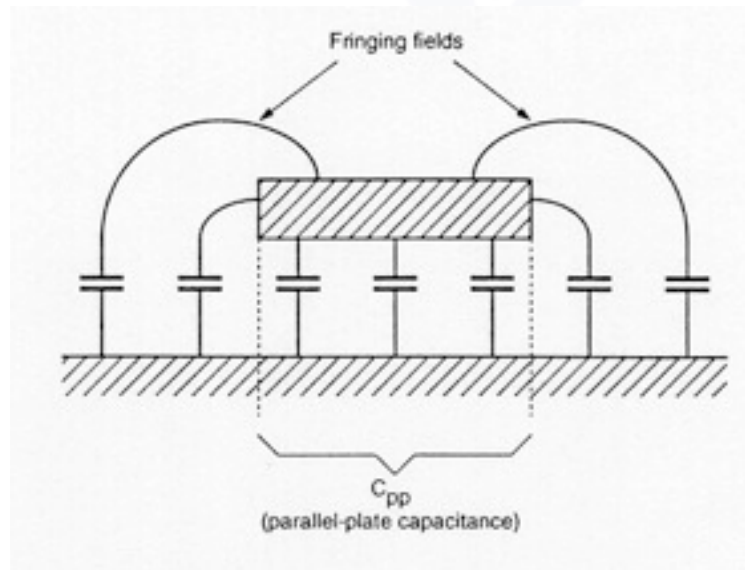
- Validate your design
- Simulation versus prototyping
 - Simulation is accurate only when
 - Based on accurate and realistic information
 - Use of range of information
 - Accurate simulation is generally expensive and time consuming
 - No free lunch
 - Experienced engineers better minimize prototyping overhead
 - Students must maximize possible chances for prototyping

Various prototyping methods

- What prototyping technique is good?
 - Good signal integrity
 - Less parasitic capacitance, inductance and resistance
 - Less crosstalk and coupling
 - Less reflection
 - Good power integrity
 - Close to the final product
 - Less cost and time
 - Easy to debug and modify
 - Not very much dependent on the hand skill of the engineer

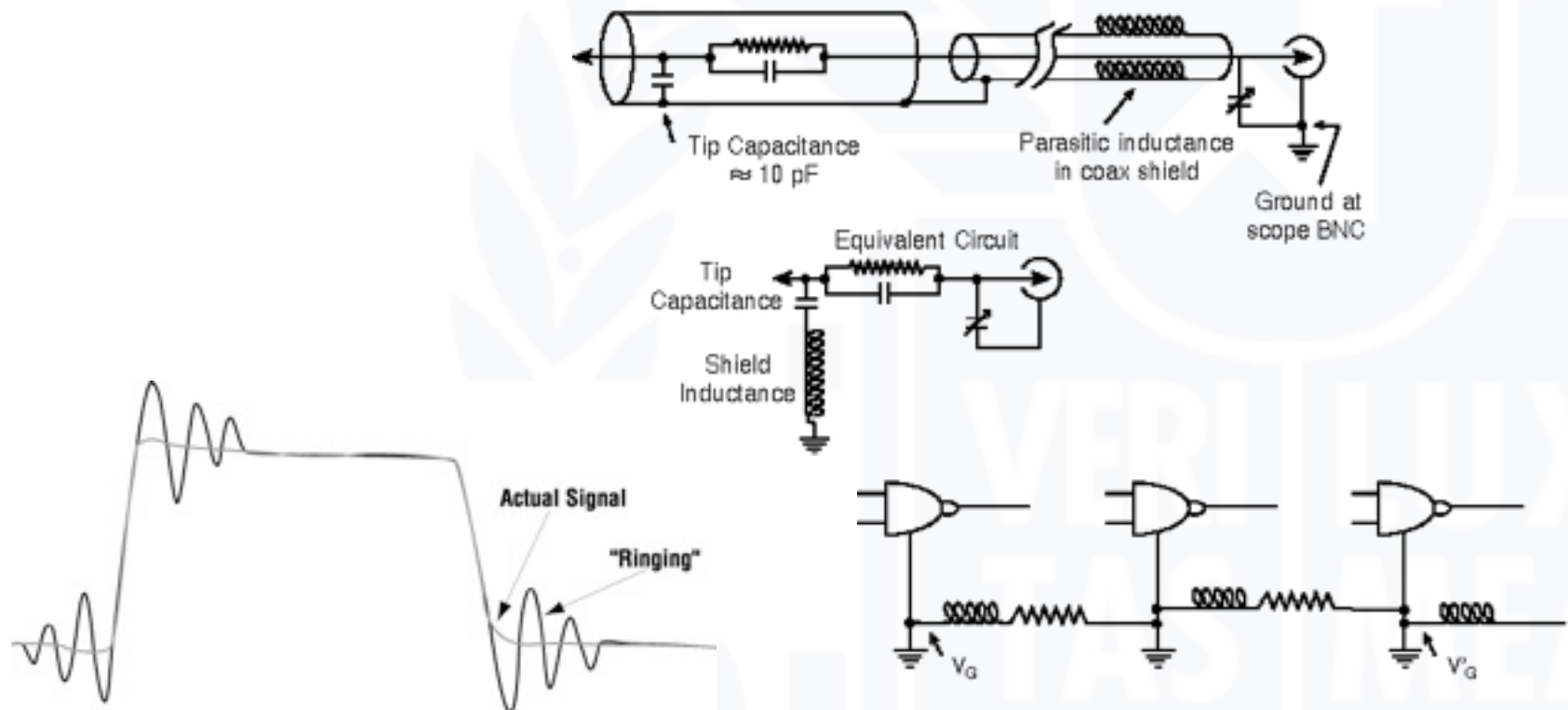
Parasitic capacitance

- Unwanted circuit modification by adding capacitors
- Parallel connections



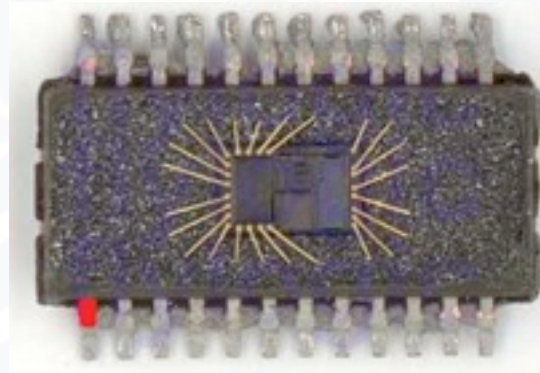
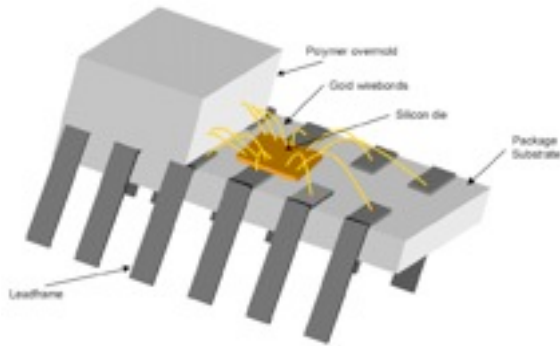
Parasitic inductance

- Unwanted circuit modification by adding series inductors

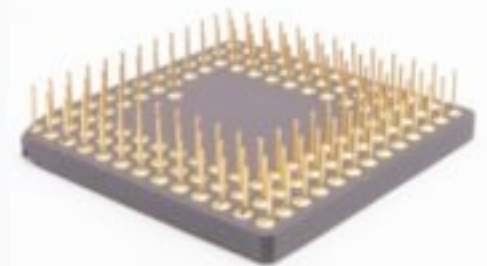


Minimization of parasitic inductance

● DIP (dual inline package)

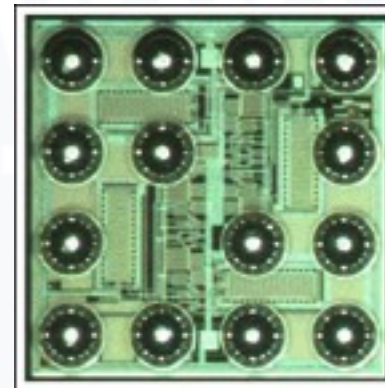
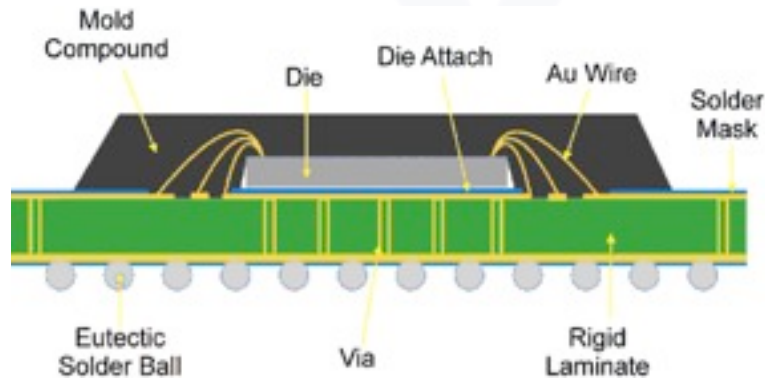
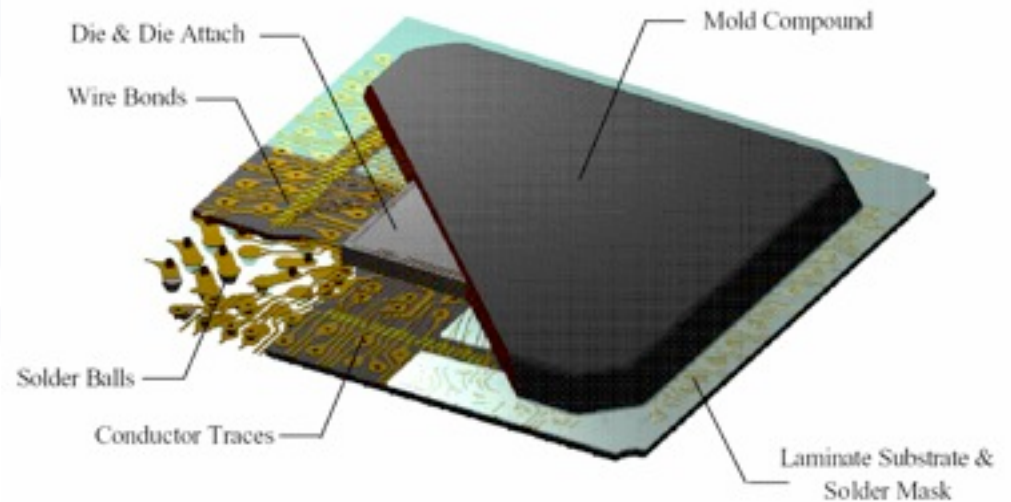


● PGA (pin grid array)



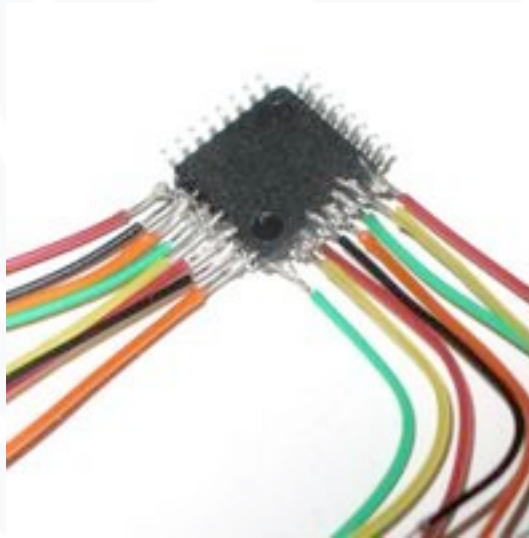
Minimization of parasitic inductance

- Ball grid array
- Very low inductance



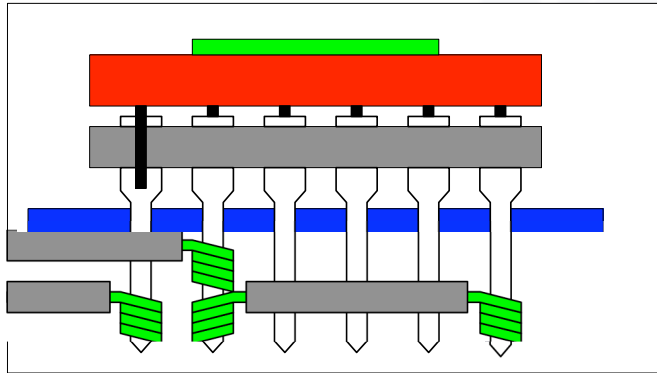
Minimization of parasitic inductance

- Parasitic inductance makes resistance (impedance) of the wire variable by the signal frequencies

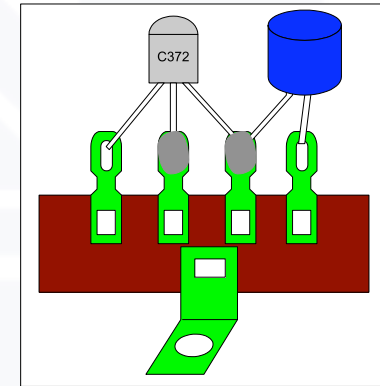


Large series inductance and coupling capacitance

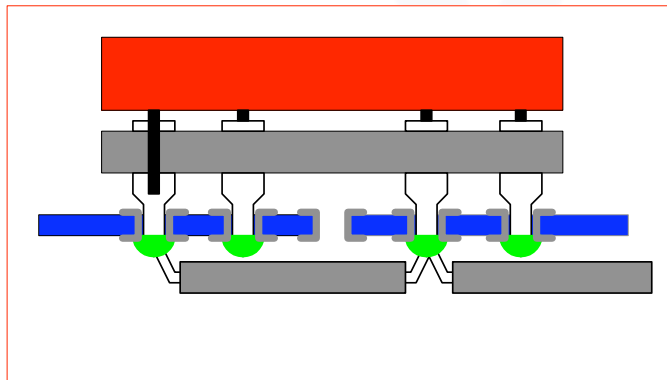
Various types of prototyping methods



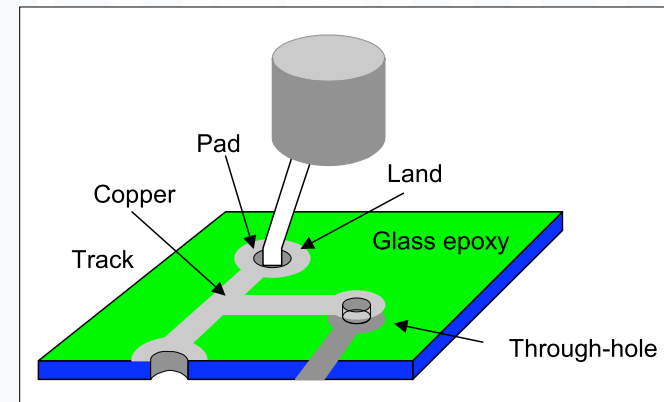
Wire wrapping



Lug terminals



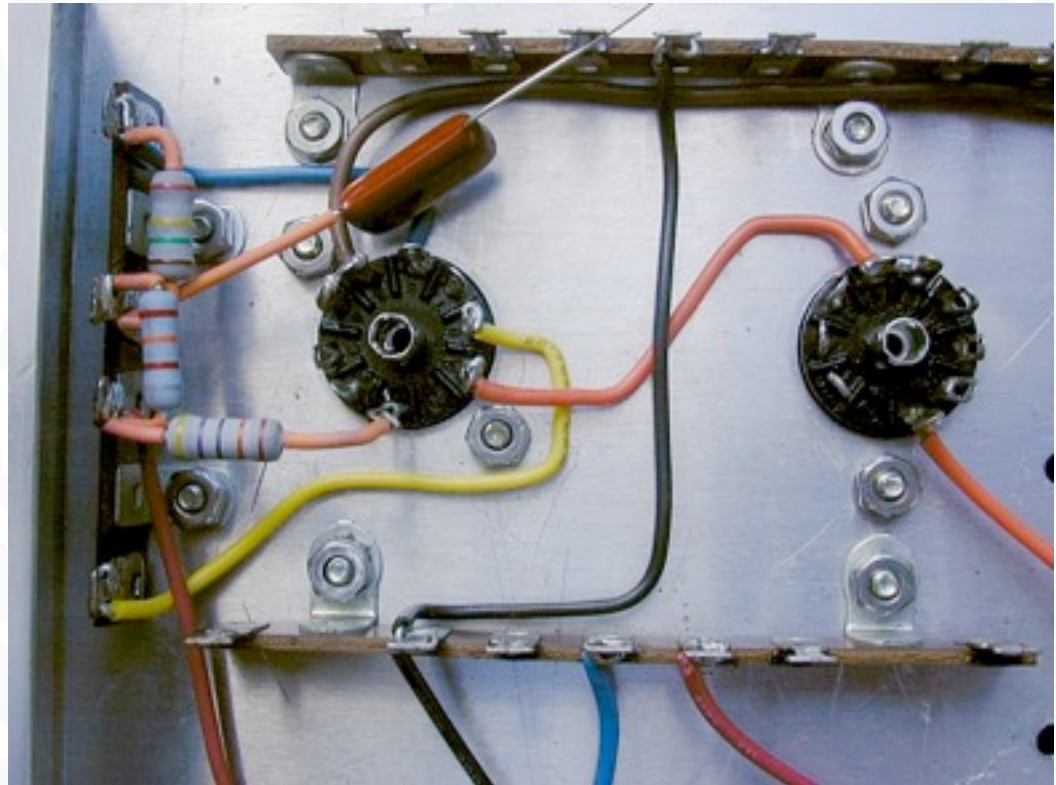
Soldering



Printed circuit board

Lug terminal circuits

- Typically used for vacuum tube circuits
- Good for analog circuits with a limited bandwidth
- Good isolation but higher inductance



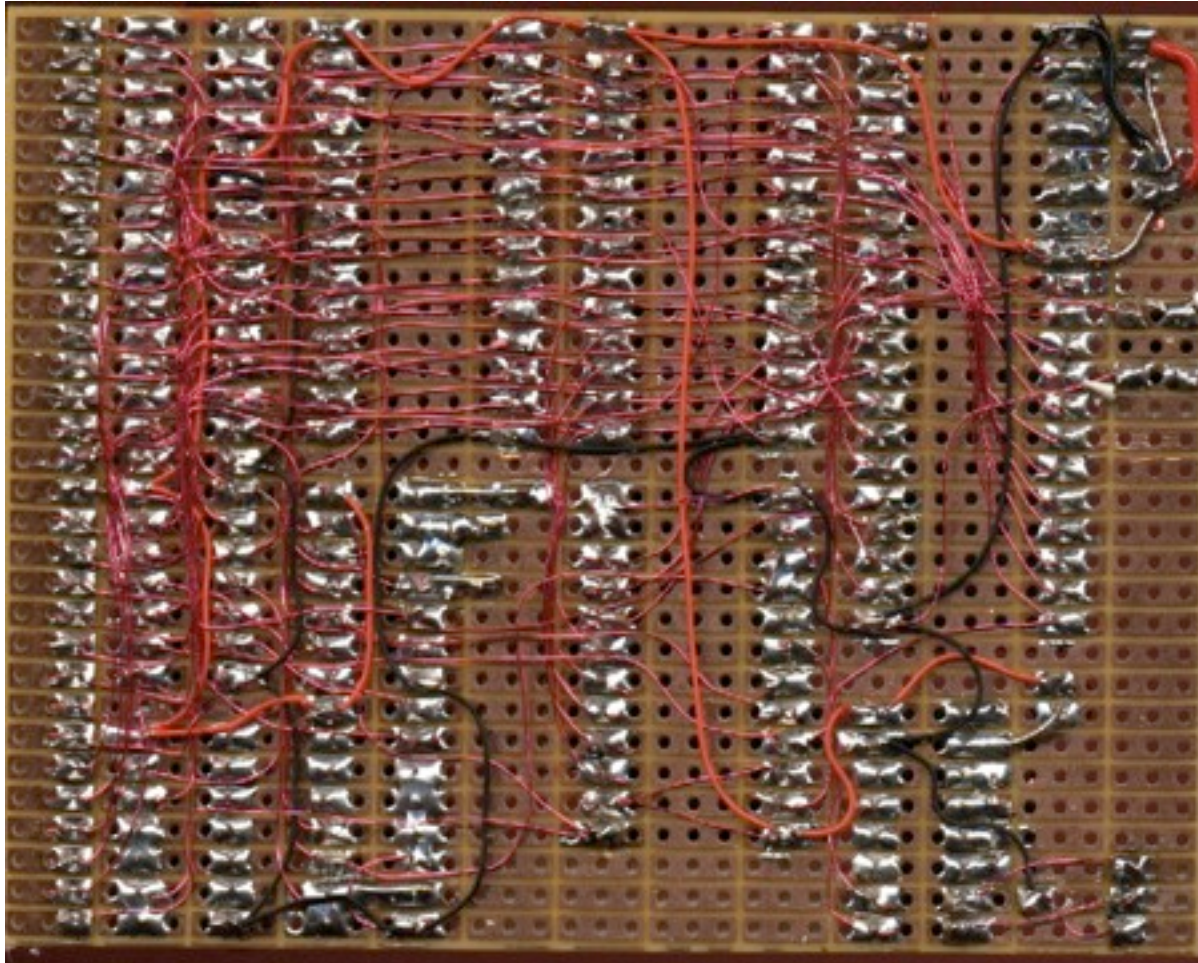
Wire wrapping

- No soldering and high reliability
- High impedance due to the distance from the ground plane



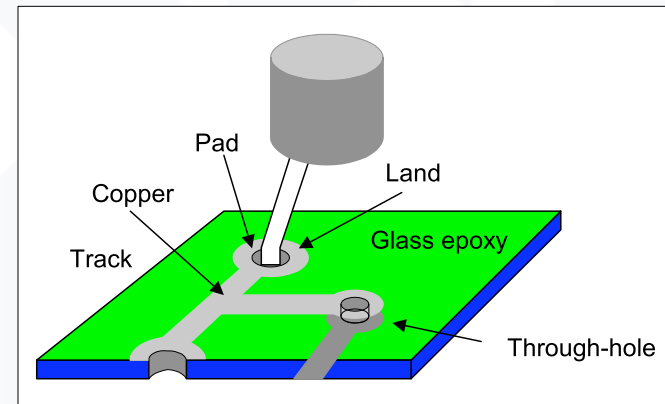
Soldering on universal PCBs

- Lower impedance due to low distance from the ground plane if used
 - This photo does not have the ground plane



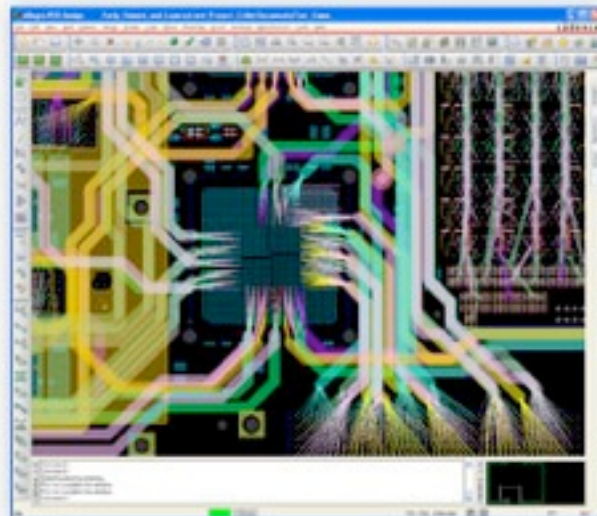
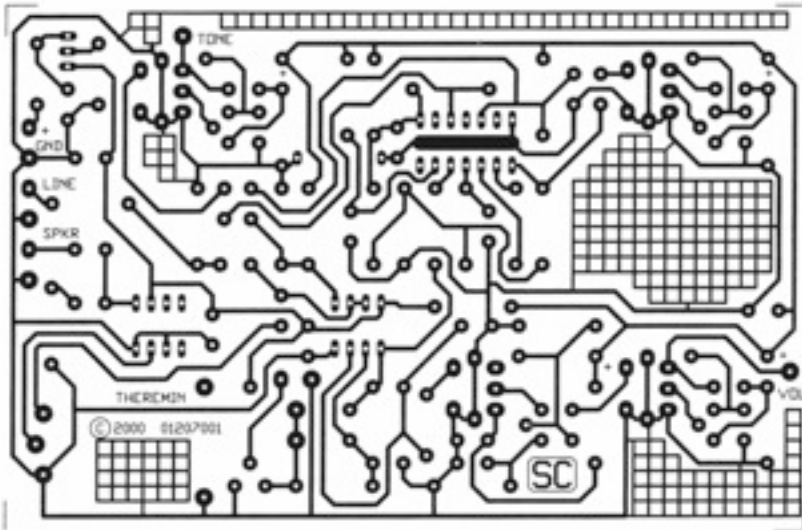
Printed circuit board

- Parts are mounted on a board
 - Base materials
 - FR2, Phenol Formaldehyde Resin (Bakelite)
 - FR4, Fiber Glass Resin
 - Layers
 - Single sided
 - Double sided
 - Multi-layers with solid ground planes
- Printed circuit board
 - Wiring is already printed on the board
- Universal circuit board
 - Wire wrapping
 - Soldering



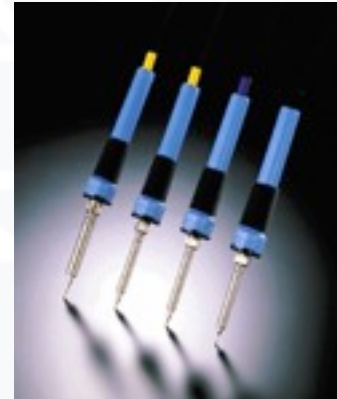
Printed circuit board

- Ideal implementation
 - Layout and route
 - Film printing with a photo laser printer
 - Developing and etching
 - Drilling



Soldering tools

- Soldering iron
- Temperature controlled Soldering iron
- Solder tube and dispenser
- Solder pot



Desoldering tools

- Desoldering braid



- Desoldering pump



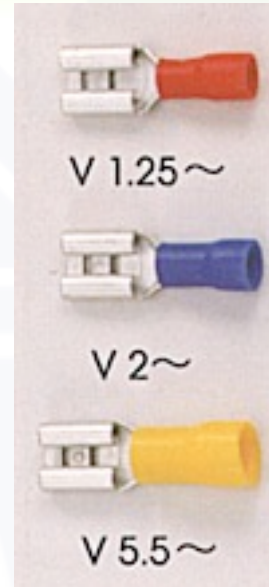
Wire and lead management tools

- Bead nippers
- Side cutting pliers
- Long nose pliers
- Diagonal cutting nippers
- Pincers
- Wire strippers



Terminals

- Ring terminals
- Spade terminals
- Square terminals
- Female disconnectors
- Male disconnectors
- Terminal crimping tools



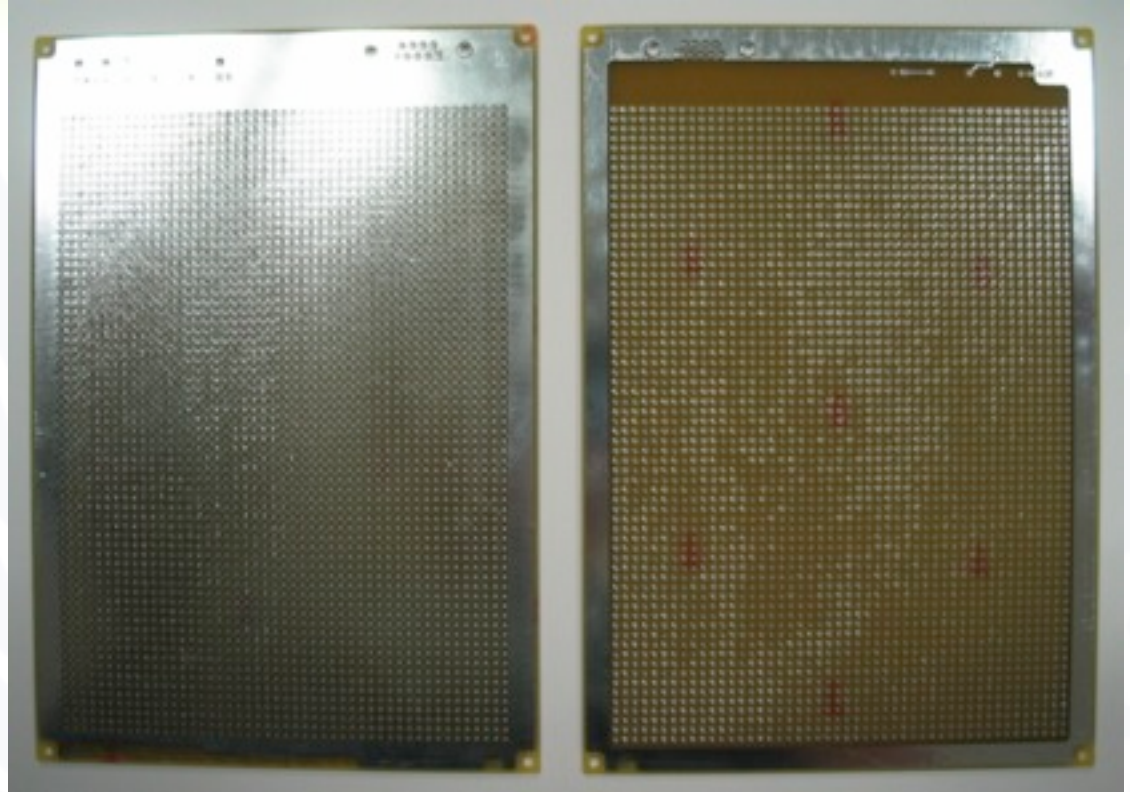
Cabling

- Cable tie
- Tie mount
- Heat shrink tube
- Hot air gun



Universal PCB

- Array of dangling pads
 - Various pitches
- Single or double sided
- FR2 or FR4
- Power supply routes
 - Wiring
 - Pre-printed
 - Solid ground plane



You will be learned

- How to solder
- How to desolder
- How to strip and bend wires
- How to mount components
- How to supply power
 - Power bus and solid power plane
 - Bypass capacitors
- Schematic drawing with a CAD tool

Rule of thumb

- If a prototype looks good, it works well.
If a prototype looks bad, it works badly.

