

RedBoard



CURRENT SENSE

HEATER

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PHY335 Spring 2022 Lecture 4

Jan C. Bernauer

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The spice must flow. – Baron Harkonnen

Widespread standard: SPICE - Simulation Program with Integrated Circuit Emphasis

- Many commercial and free implementations
- e.g. LTspice from Analog devices (Linear Technology)
- open source: ngspice

Schematics capture

- To simulate, the simulation program needs to know the devices and their connections.
- This list is called the "netlist"
- Can be created by hand
- But mostly via some form of graphical interface

This process is called "schematic capture"

- AC analysis: linear small-signal frequency-domain analysis

Modes of simulation

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- DC analysis: nonlinear quiescent/working point calculation
- DC transfer curve analysis

Modes of simulation

- AC analysis: linear small-signal frequency-domain analysis
- DC analysis: nonlinear quiescent/working point calculation
- DC transfer curve analysis
- Noise analysis

Modes of simulation

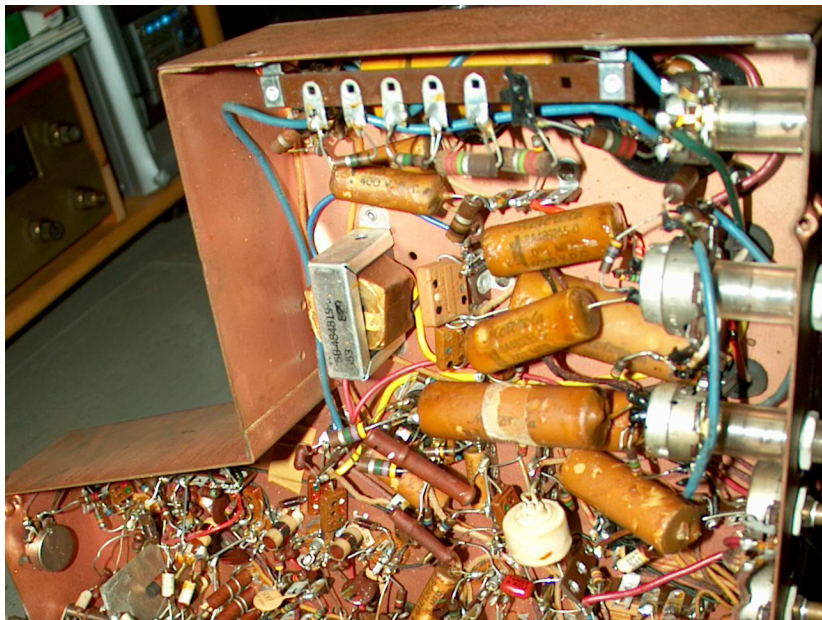
- AC analysis: linear small-signal frequency-domain analysis
- DC analysis: nonlinear quiescent/working point calculation
- DC transfer curve analysis
- Noise analysis
- Transfer function analysis: small-signal input/output gain and impedance

Modes of simulation

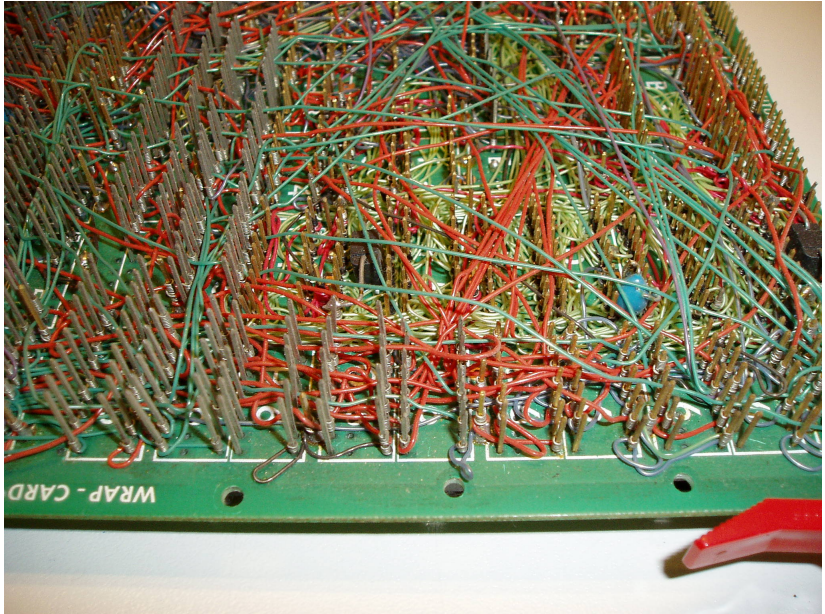
- AC analysis: linear small-signal frequency-domain analysis
- DC analysis: nonlinear quiescent/working point calculation
- DC transfer curve analysis
- Noise analysis
- Transfer function analysis: small-signal input/output gain and impedance
- Transient analysis: non-linear time-domain large-signal analysis

- The simulation needs to know how electrical devices work.
- This is documented in "models"
 - Many build-in, especially for ideal components
 - Parametric models
 - replace element with equivalent circuit of more basic elements
 - Sometimes: behavior described with code
- Most manufacturers supply SPICE models

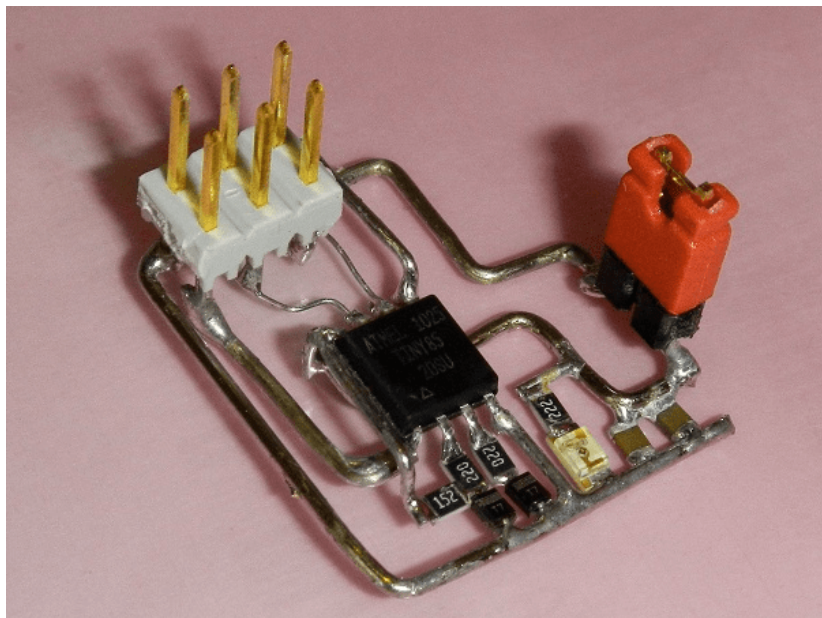
Electronics manufacturing: Point-to-point



Electronics manufacturing: Wire-wrap

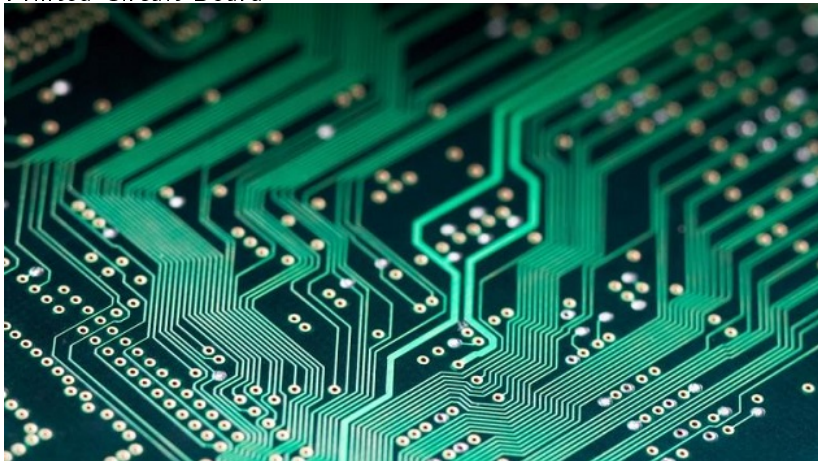


Electronics prototyping: Dead-bug



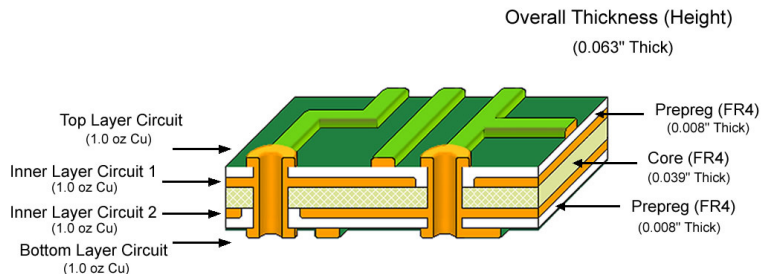
Modern electronics manufacturing: PCB

Printed Circuit Board



Anatomy of a PCB: stackup

A PCB board can have several copper layers.
Typically 1,2,4,6,8,10 ...



A wide variation of base materials:

- FR-2 (cheap), phenolic paper / phenolic cotton paper, paper impregnated with a phenol formaldehyde resin.
Common in consumer electronics with single-sided boards (rarely 2 sided, never more).
- FR-4 (most common) a woven fiberglass cloth impregnated with an epoxy resin.
- Flexible: Kapton, UPILEX, or Pyralux

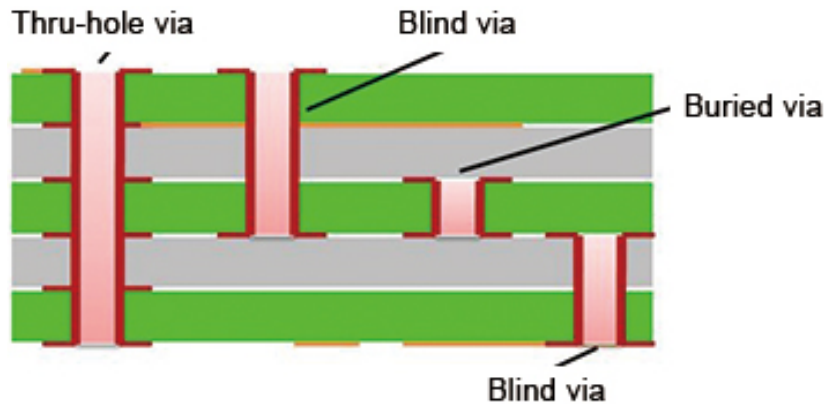
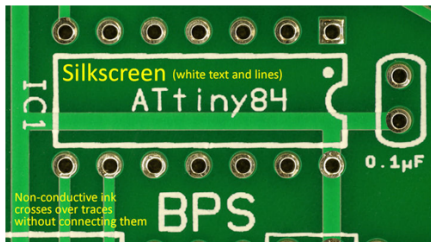
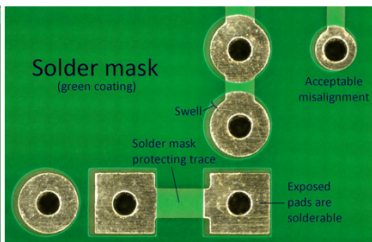


Figure 1 Types of Vias

Solder mask and Silk screen

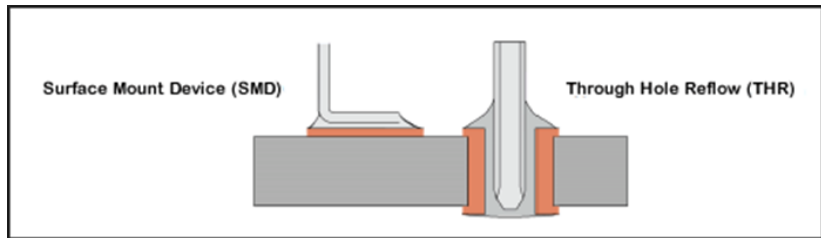


Silkscreen on a PCB

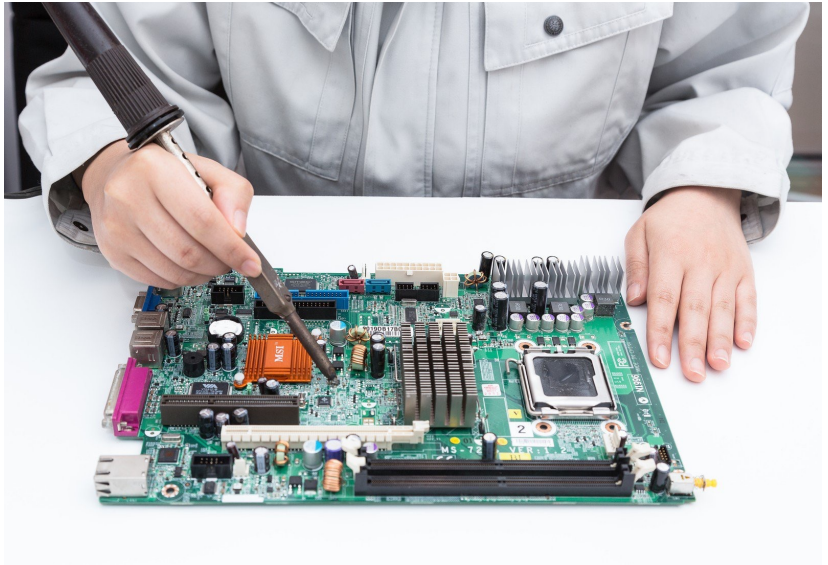


Solder mask on a PCB

Through-hole and SMD



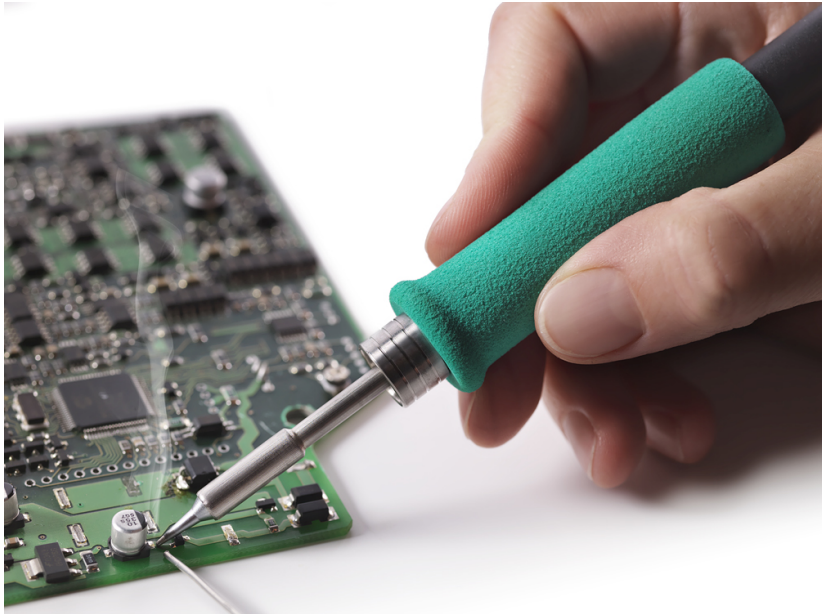
Soldering techniques: Hand soldering



Soldering techniques: Hand soldering



Soldering techniques: Hand soldering



Soldering techniques: Wave

Bath of molten solder. Mainly for THT



EDA: Electronic design automation

Workflow:

- Schematic capture
- Layout of board
 - part placement
 - routing of connections
- Production of "Gerber files": geometry for production

- Cost depends on
 - Layer count and PCB size
 - Feature size (trace size, vias etc)
 - Options
 - Turn-around time
- Fastest: 1 day
- Cheapest: 2\$ for 10x10cm 2 layers!

A board we built

