

# Schematic Diagrams: Art and Rules

- ▶ Benefits
  - ▶ A good schematic will save way more time than it takes to produce.
  - ▶ Even the eventual CAD drawing will go much faster.
  - ▶ Errors, forgotten pins, omissions jump out at you
  - ▶ Avoid the rush to implementation before things are thought out.
  - ▶ A schematic is code and comments for the HW designer when coupled with a written description.
  - ▶ Drawing the schematic **IS** part of the act of design, not an afterthought.
- ▶ Schematic Diagram Must Include:
  - ▶ All electrical connectivity including decoupling caps
  - ▶ On parts: pins, pin numbers, pin function, part number
  - ▶ On nets: annotate (name) where helpful
  - ▶ On nets: Use off-page connection symbols

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- ▶ Fine points
  - ▶ No "horseshoe" jumpers
  - ▶ Keep all lines straight, use a straight edge
  - ▶ Don't "drag" Vdd and Vss all over
  - ▶ Grouping decoupling caps on one page is nice
  - ▶ Let designer intent be clear
  - ▶ Schematic should aid in visualizing functionality
  - ▶ Signal/control flow usually left to right, rarely top to bottom
  - ▶ Limit excessive hierarchical blocks, use only when necessary for clarity
  - ▶ Hierarchy clearly shown with multiple pages
  - ▶ Write on the schematic: comments, measurements, questions, etc.

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- ▶ Fine points cont.
  - ▶ If you scan/copy your schematic and turn in the copy, make sure its readable.
  - ▶ Don't just print the schematics provided on the course webpage and turn them in. This shows no effort and undermines the benefits for drawing a schematic.
  - ▶ You are drawing schematics, not a block diagram. You should not (for example) replace an entire board with an empty block and label
  - ▶ When appropriate to combine multiple wires into a *bus*, you may do that

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- ▶ Tools for making schematics
  - ▶ Make the medium easily extensible, small is not necessarily good
  - ▶ Green engineering paper, scotch tape, pencil, no colors, KISS
  - ▶ Beyond two/three taped pages, split design into separate pages
  - ▶ Prototypes change a lot, make schematic changes easy as well
  - ▶ Expect many changes, sometimes large; use a big eraser
  - ▶ Bottom line: Can an engineer familiar with your design, replicate it without any further explanation? If not, your schematic and documentation is incomplete.
  - ▶ CAD drawing is a necessary last step. During development however, messing with another tool hinders thinking and progress.
  - ▶ Some best schematics are started on napkins!

